TULARE LAKE SUBBASIN PROBATIONARY HEARING DRAFT STAFF REPORT

October 2023

CALIFORNIA
Water Boards
STATE WATER RESOURCES CONTROL BOARD
REGIONAL WATER QUALITY CONTROL BOARDS

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Definitions and Abbreviations

2020 GSP – The version of the Tulare Lake Subbasin Groundwater Sustainability Plan adopted January 29, 2020, and submitted to the Department of Water Resources on January 29, 2020.

2020 GSP Incomplete Determination – The Department of Water Resources' January 28, 2022, determination that the 2020 GSP was "incomplete" pursuant to California Code of Regulations, title 23, section 355.2, subdivision (e)(2).

2022 GSP – The version of the Tulare Lake Subbasin Groundwater Sustainability Plan adopted in two separate versions (one version for the Southwest Kings GSA and one for the remaining four GSAs) and submitted to the Department of Water Resources on July 27, 2022. A single GSP was adopted by all five GSAs on December 9, 2022, and resubmitted to DWR. This GSP includes the Tulare Lake Addendum.

2022 GSP Inadequate Determination – The Department of Water Resources' October 12, 2022, determination that the 2020 GSP was "inadequate" pursuant to California Code of Regulations, title 23, section 355.2, subdivision (e)(3).

ACS – American Community Survey, an annual survey conducted by the U.S. Census

AF – Acre-feet

AFY – Acre-feet per year

AMSL – Above Mean Sea Level

Annual Report – The report Groundwater Sustainability Agencies must submit annually to the Department of Water Resources (Wat. Code, § 10728).

B118 or Bulletin 118 – The Department's report entitled "California's Groundwater: Bulletin 118."

Basin – Groundwater basin or subbasin

bgs – Below Ground Surface

Board or State Water Board – State Water Resources Control Board

Caltrans – California Department of Transportation

CASGEM – The California Statewide Groundwater Elevation Monitoring Program

Central Valley Water Board – Central Valley Regional Water Quality Control Board

CEQA – California Environmental Quality Act

CDFA – California Department of Food and Agriculture

CDP – Census Designated Place

CGPS – Continuous Global Positioning System

CNRA – California Natural Resources Agency

Constituents – Chemical elements and compounds

Coordination Agreement – A legal agreement adopted between two or more groundwater sustainability agencies that provides the basis for coordinating multiple agencies or groundwater sustainability plans within a basin pursuant Part 2.74 of the California Water Code (Wat. Code, §10721, subd. (d)).

CV-SALTS – Central Valley Salinity Alternatives for Long-Term Sustainability

CWS – Community Water System

DAC – Disadvantaged Community, meaning a community with an annual median household income less than 80 percent of the statewide annual median household income (Wat. Code, § 79505.5).

Data Gap – Refers to a lack of information that significantly affects the understanding of the basin setting or evaluation of the efficacy of Plan implementation and could limit the ability to assess whether a basin is being sustainably managed (Cal. Code Regs., tit. 23, § 351, subd. (*l*)).

De-designated area – The portion of the Tulare Lake Subbasin containing groundwater which the Central Valley Regional Water Quality Control Board de-designated for municipal and agricultural supply beneficial uses, as described in the Regional Board's 2017 Tulare Lake Basin Plan Amendment.

De minimis extractor – A person who extracts, for domestic purposes, two acre-feet or less per year (Wat. Code, § 10721, subd. (e)).

DBCP – 1,2-Dibromo-3-chloropropane

Domestic Purposes – The use of water in homes, resorts, motels, organization camps, camp grounds, etc., including the incidental watering of domestic stock for family sustenance or enjoyment and the irrigation of not to exceed one-half acre in lawn, ornamental shrubbery, or gardens at any single establishments. The use of water at a camp ground or resort for human consumption, cooking or sanitary purposes is a domestic use (Cal. Code Regs., tit. 23, § 660).

DWR or Department – Department of Water Resources

ET – Evapotranspiration

Ft – US feet

GAMA Program – Groundwater Ambient Monitoring and Assessment Program

GEARS – Groundwater Extraction Annual Reporting System

Groundwater – Water beneath the surface of the earth within the zone below the water table in which the soil is completely saturated with water, but does not include water that flows in known and definite channels unless included pursuant to Section 10722.5 (Wat. Code, §10721, subd. (g)).

Groundwater-Dependent Ecosystems – (Cal. Code Regs., tit. 23, § 351, subd. (m))

Groundwater Flow –The volume and direction of groundwater movement into, out of, or throughout a basin.

Groundwater Recharge – The augmentation of groundwater, by natural or artificial means (Wat. Code, §10721, subd. (i)).

Groundwater Sustainability Program – Coordinated and ongoing activity undertaken to benefit a basin, pursuant to a groundwater sustainability plan.

GSA or Groundwater Sustainability Agency – One or more local agencies that implement the provisions of SGMA (i.e., Part 2.74 of Division 6 of the California Water Code) (Wat. Code, § 10721, subd. (j)).

GSP, Groundwater Sustainability Plan, or Plan – A plan of a groundwater sustainability agency proposed or adopted pursuant to SGMA (i.e., Part 2.74 of Division 6 of the California Water Code) (Wat. Code, § 10721, subd. (k)).

GSP Regulations – California Code of Regulations, title 23, section 350 et seq.

HR2W – Human Right to Water

ILRP – Irrigated Lands Regulatory Program

IM – Interim Milestone

InSAR – Interferometric Synthetic Aperture Radar

KRWQC – Kings River Water Quality Coalition

Long-term Overdraft –The condition of a groundwater basin where the average annual amount of water extracted for a long-term period, generally 10 years or more, exceeds the long-term average annual supply of water to the basin, plus any temporary surplus. Overdraft during a period of drought is not sufficient to establish a condition of long-term overdraft if extractions and 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.

Management Area – An area within a basin for which the Plan may identify different minimum thresholds, measurable objectives, monitoring, or projects and management actions based on differences in water use sector, water source type, geology, aquifer characteristics, or other factors (Cal. Code Regs., tit. 23, § 351, subd. (r)).

MCL – Maximum Contaminant Level

Meter – A device that measures groundwater extractions and that meets the requirements of California Code of Regulations, title 23, section 1042.

Mg/L – Milligrams per liter

MO – Measurable Objective – refer to 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.

MT – Minimum Threshold – refers to a numeric value for each sustainability indicator used to define undesirable results.

OpenET – Online tool to estimate evapotranspiration via satellite-driven models.

OSWCR – Online System of Well Completion Reports

Overdraft – occurs where the average annual amount of groundwater extraction exceeds the average annual supply of water to the basin.

pCi/L – Picocuries per liter

Plan – See “Groundwater Sustainability Plan.”

Person – Any person, firm, association, organization, partnership, business, trust, corporation, limited liability company, or public agency, including any city, county, city and county, district, joint powers authority, state, or any agency or department of those entities. “Person” includes, to the extent authorized by federal or tribal law and subject to the limitations described in Water Code section 10720.3, the United States, a department, agency or instrumentality of the federal government, an Indian tribe, an authorized Indian tribal organization, or interstate body.

PMA – Project and Management Action

Principal Aquifers – Aquifers or aquifer systems that store, transmit, and yield significant or economic quantities of groundwater to wells, springs, or surface water systems (Cal. Code Regs., tit. 23, §351, subd. (aa)).

Probationary Basin – Basin for which the State Water Board has issued a determination under California Water Code Section 10735.2.

Recharge – See “Groundwater Recharge” above.

Recharge Area – The area that supplies water to an aquifer in a groundwater basin (Wat. Code, § 10721, subd. (t)).

Report – A report of groundwater extraction as required by Section 5202 of the Water Code that includes the information required by Section 5203 of the Water Code.

RMS or Representative Monitoring Site – A monitoring site within a broader network of sites that typifies one or more conditions within the basin or an area of the basin.

RWQCB – Regional Water Quality Control Board

SAFER – Safe and Affordable Funding for Equity and Resilience

SDFR – Socially Disadvantaged Farmer or Rancher

Secondary MCL – Also known as a secondary drinking water standard. Defined in the California Code of Health and Safety, section 116275, subdivision (d), as a standard that specify maximum contaminant level that, in the judgment of the State Water Board, is necessary to protect the public welfare. Secondary drinking water standards may apply to any contaminant in drinking water that may adversely affect the odor or appearance of the water and may cause a substantial number of persons served by the public water system to discontinue its use, or that may otherwise adversely affect the public welfare.

SGMA – Sustainable Groundwater Management Act

SMC – Sustainable Management Criteria - includes the sustainability goals, undesirable results, minimum thresholds, and measurable objectives outlined within a given GSP.

Statutory Deadline – The date by which an Agency must be managing a basin pursuant to an adopted Plan, as described in Water Code sections 10720.7 or 10722.4.

Sustainability Goal – 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 (Wat. Code, §10721, subd. (u)).

Sustainable Groundwater Management – The management and use of groundwater in a manner that can be maintained during the planning and implementation horizon without causing undesirable results.

Sustainability Indicator – Any of the effects caused by groundwater conditions occurring throughout the basin that, when significant and unreasonable, cause undesirable results, as described in Water Code section 10721, subd. (x) (Cal. Code Regs., tit. 23, § 351, subd. (ah)).

Sustainable Yield – The maximum quantity of water, calculated over a base period representative of long-term conditions in the basin and including any temporary surplus, that can be withdrawn annually from a groundwater supply without causing an undesirable result (Wat. Code, § 10721, subd. (w)).

1,2,3 - TCP – 1,2,3-Trichloropropane

TCWA – Tri-County Water Authority

TDS – Total Dissolved Solids

µg/L – Micrograms per liter

UR or Undesirable Result – one or more of the following effects caused by groundwater conditions occurring throughout a basin as described in Wat. Code, § 10721, subd. (x):

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.

Water Budget – An accounting of the total groundwater and surface water entering and leaving a basin including the changes in the amount of water stored.

Water Year or WY – October 1 to September 30 of the succeeding year

Executive Summary

The mission of the State Water Resources Control Board (State Water Board) is to preserve, enhance, and restore the quality of California's water resources and drinking water for the protection of the environment, public health, and all beneficial uses, and to ensure proper water resource allocation and efficient use, for the benefit of present and future generations. The State Water Board is committed to racial equity and working towards a California where race no longer predicts a person's access to, or quality of, water resources.

In 2014, the state Legislature passed the historic Sustainable Groundwater Management Act (SGMA) that established a new framework for how groundwater would be managed locally at the basin scale to achieve long-term sustainability. Local agencies are responsible for the sustainable management of their groundwater basins; however, state agencies are responsible for ensuring local groundwater management achieves SGMA's goals. SGMA provides the State Water Board and the California Department of Water Resources (DWR) with oversight of groundwater resources to protect them for use by the communities, farms, and environmental resources that depend upon them. The Tulare Lake Subbasin (subbasin) is critically overdrafted; on average, water is being pumped out of the basin faster than it is recharged by rain and other sources. Overdraft can cause the land surface to sink, potentially damaging infrastructure.

In addition, overdraft threatens groundwater levels and drinking water quality and could have disparate impacts on communities, many economically disadvantaged, that rely on shallow wells. Due to historic urban segregation, redlining, and the racialized exclusion from public benefits, people of color are often disparately impacted.

The State Water Board recognizes that significant efforts were made by local public agencies in the Tulare Lake Subbasin since the passage of SGMA to form groundwater sustainability agencies (GSAs) and then develop detailed technical and other information supporting the adoption and implementation of a groundwater sustainability plan (GSP) for the subbasin. Despite those efforts, in January of 2022, DWR reviewed the GSP to determine if it met SGMA's requirements and found it to be incomplete. Following revisions made by the GSAs in the subbasin, DWR reevaluated the GSP in March of 2023, determined it to be inadequate, and referred the subbasin to the State Water Board, as required by SGMA. Consistent with SGMA, the State Water Board may now consider whether to designate the Tulare Lake Subbasin as a "probationary basin," a term that is used in SGMA to describe the first stage of state intervention.

The goals of this executive summary are to:

- Describe SGMA and the State Water Board's state intervention process to provide context for the State Water Board's upcoming Tulare Lake Subbasin Probationary Hearing (Probationary Hearing).
- Briefly describe the demographics, geology, and hydrology of the Tulare Lake Subbasin; and
- Summarize the recommendations by State Water Board staff, which are actions the State Water Board could take at the subbasin Probationary Hearing. These recommendations are to:
    - Designate the subbasin probationary. In the short-term, this would mean most groundwater pumpers in the basin would need to start measuring their groundwater extractions, report them to the State Water Board, and pay fees. State Water Board staff recommends that most domestic household users (people who use less than two acre-feet per year for domestic purposes only) be exempt from reporting extractions and paying fees.
    - Identify certain deficiencies (issues with the subbasin's current groundwater sustainability plan) and potential actions to address them.
    - Not exclude any portions of the subbasin from the probationary status.
    - Require people who extract more than 500 acre-feet per year of groundwater from the subbasin to install and use meters to measure their groundwater extractions.
    - Shift the reporting deadline for groundwater extractors from February 1 of each year to December 1.

SGMA and State Intervention (Section 2)

SGMA established a new framework for groundwater management in California. SGMA requires local agencies to form GSAs in high- and medium-priority basins and to develop and implement GSPs. GSAs are responsible for achieving long-term sustainable management of their groundwater basins that avoids certain undesirable results within 20 years of implementing their GSPs.

When DWR, in consultation with the State Water Board, deems the GSP or GSPs in a high- or medium-priority basin inadequate[1], DWR refers the basin to the State Water Board for a determination as to whether to begin the state intervention process[2]. State intervention is additional to local management and intended to be temporary, and is a two-step process:

- The first step under SGMA is for the State Water Board to determine, through a public process, whether to place the basin on probation.
- In the second step, through a public process, the State Water Board may implement an Interim Plan for the basin. This can only happen if deficiencies are not fixed after at least one year of the basin being on probation.

In determining whether to put a basin on probation, the State Water Board analyzes whether deficiencies identified by DWR were sufficiently addressed prior to the probationary hearing. As part of its analysis, and as reflected in State Water Board Resolution 2021-0050, *Condemning Racism, Xenophobia, Bigotry, and Racial Injustice and Strengthening Commitment to Racial Equity, Diversity, Inclusion, Access and Anti-Racism,* the State Water Board considers the impacts of basin non-compliance on vulnerable communities, including communities of color.

During a probationary period, GSAs would have time to resolve deficiencies identified in their GSPs and the State Water Board would collect data on groundwater extractions, collect fees from certain groundwater users, and may conduct additional investigations. Importantly, the GSA retains its authorities and responsibilities and must continue to implement its GSP regardless of if the basin is in probation.

Basin Description (Section 3)

Located in California's Central Valley in the southern portion of the San Joaquin Valley, the Tulare Lake Subbasin (Figure 3-1) is bounded to the north by the Kings Subbasin, the northeast by the Kaweah Subbasin, the southeast by the Tule Subbasin, the south by the Kern Subbasin, the southwest by the Kettleman Plain Subbasin, and to the northwest by the Westside Subbasin. The Subbasin covers approximately 535,869 acres or about 837 square miles.[3]

The subbasin contains six localized urban areas, including the cities of Corcoran, Lemoore, Hanford, and the communities of Armona, Home Garden, Stratford, and Kettleman City. According to the Census Block Group Data 2022, the Tulare Lake Subbasin has an estimated population of 145,933 people as of 2022. Most of the land within the subbasin and surrounding areas is used for growing crops and raising livestock. The primary land use designations for urban land are residential, commercial, and industrial. The Tulare Lake Subbasin is currently managed by five GSAs, and the full list of member agencies can be found in Section 3.

Beneficial uses of groundwater in the subbasin include drinking water, agriculture, environment, and oil and gas production. The subbasin contains several aquifers, which are bodies of rock and/or sand and soil that hold groundwater. These aquifers are separated by layers of clay, which slows the movement of water between aquifers and can act as a barrier. The GSP divided the subbasin into three different aquifer zones relevant to groundwater management:

- A-zone: is the shallowest aquifer and is generally about 100 feet deep from the surface.
- B-zone: is below the A-zone and is separated from the other zones by clay layers. This zone is approximately 100 to 700 feet deep.
- C-zone: is below the B-zone and is separated from the B-zone by a thick clay layer that extends underground across much of the San Joaquin Valley. The aquifer below this thick clay layer behaves differently than the shallow aquifers because of physical properties. The C-zone is approximately more than 700 feet deep in the subbasin.

Groundwater is the main source of water for agricultural and urban land uses, but surface water is also available as a resource. The Kings River is the largest and most consistent source of surface water to the subbasin. Currently, both local and imported surface water is delivered through at least 34 conveyance systems (rivers, streams, canals, and diversions) throughout the subbasin (2022 GSP).

For more information on the history, demographics, economy, governance context, groundwater levels, groundwater quality, and subsidence in the subbasin, please refer to Section 3.

Recommendations for State Water Board Action (Section 4)

SGMA states, “in those circumstances where a local groundwater management agency is not managing its groundwater sustainably, the State needs to protect the resource until it is determined that a local groundwater management agency can sustainably manage the groundwater basin or subbasin.” In March 2023, DWR determined the Tulare Lake Subbasin 2022 GSP to be inadequate. State Water Board staff agree with this determination. Now, the State Water Board may determine whether a probationary designation is warranted. State Water Board staff have reviewed the GSP and the DWR staff reports documenting DWR’s review of the GSP.

Staff recommends the State Water Board designate the subbasin as probationary, and note the following:

The GSP will allow substantial impacts to people who rely on domestic wells for drinking, bathing, food preparation, and cleaning, as well as impacts to critical

infrastructure such as canals, levees, and the aquifer itself within the subbasin. These undesirable results are likely to occur to an extent in the subbasin that will prevent the subbasin from reaching sustainability by 2040, as required by SGMA. Designating the subbasin probationary is critical for getting the subbasin back on track to achieve sustainability by 2040.

Section 4 of the Draft Staff Report explains State Water Board staff recommendations for a potential probationary designation of the subbasin. These recommendations are described below.

GSP Deficiencies and Potential Actions to Address Deficiencies (Section 4.1)

State Water Board staff have identified specific deficiencies in the Tulare Lake Subbasin 2022 GSP and have outlined potential corrective actions to address those specific deficiencies. The Draft Staff Report also incorporates deficiencies identified by DWR's determination. Deficiencies that have been identified within the GSP relate to:

Chronic lowering of groundwater levels with insufficient management criteria.

Continued land subsidence (sinking).

Further degradation of groundwater quality.

A summary of the GSP deficiencies and corrective actions are described in further detail below.

To end State Water Board intervention in a groundwater basin, GSAs in that basin must demonstrate their ability and willingness to manage groundwater sustainably and address the issues that caused state intervention to occur. Ultimately, the State Water Board will evaluate any updated and adopted GSP as a whole and will determine whether the GSAs have addressed the deficiencies, whether the GSP is consistent with SGMA, and whether the GSAs are implementing the GSP in a manner that the State Water Board finds will likely achieve sustainability in the subbasin.

Defining and Avoiding Undesirable Results Related to Chronic Lowering of Groundwater Levels (Deficiency GL – Section 4.1.1)

Under SGMA, one piece of achieving the sustainability objective for a basin is avoiding "chronic lowering of groundwater levels indicating a significant and unreasonable depletion of supply if continued over the planning and implementation horizon."[4] Lowering groundwater levels can cause shallow wells to go dry or reduce their productivity, increase the energy costs of pumping, bring polluted water closer to well screens (the area where groundwater enters a well), or reduce water available for deep-rooted plants. Lowering groundwater levels also makes it more difficult to avoid other,

related undesirable results caused by groundwater conditions, including land subsidence and depletions of interconnected surface water.

In the Tulare Lake Subbasin, the A-zone and B-zone aquifers are most susceptible to impacts from lowering of groundwater levels, as there are many domestic wells and community water system wells screened in the A- and B-zones.

DWR concluded that the Tulare Lake Subbasin 2022 GSP does not adequately justify its approach for developing sustainable management criteria for lowering groundwater levels. These are the criteria the GSAs will use to evaluate success in the subbasin. In addition, DWR notes that the sustainable management criteria would likely result in significant and unreasonable impacts to people who rely on shallow wells.

State Water Board staff have built on DWR's analysis, noting the GSP does not clearly address the likelihood that all the wells in the shallow part of the basin (the A-zone) could go dry based on the GSP's approach, nor does it identify the wells that could be impacted by the GSP's current approach. Staff also describe gaps in the GSAs' proposed well impact mitigation proposal and the feasibility of avoiding chronic lowering of groundwater levels with the projects and management actions proposed in the GSP.

Staff propose potential actions to address the deficiency, including the following:

- Define the undesirable result for the chronic lowering of groundwater levels. Meaningfully engage with users in the subbasin to seek and incorporate feedback on a definition of an undesirable result for chronic lowering of groundwater levels specific to the subbasin and protective of drinking water users.
- Fill data gaps in the subbasin water budget and use the data to develop quantitative criteria that avoid undesirable results.
- Fill data gaps in the groundwater level monitoring network, especially in the A-zone.
- Commit to accessible, comprehensive, and appropriately funded well impact mitigation programs that mitigate for impacts to wells affected by lowering of groundwater levels and degradation of water quality.
- Plan ahead for drought conditions and commit to managing demand.
- Describe the relationship between minimum thresholds (the lowest acceptable level) for each sustainability indicator. Revise groundwater level minimum thresholds as necessary to avoid undesirable results for other sustainability indicators.

Defining and Avoiding Undesirable Results Related to Land Subsidence (Deficiency LS – Section 4.1.2)

Another consideration under SGMA is avoiding "significant and unreasonable land subsidence that substantially interferes with surface land uses."[5] Subsidence is the sinking of land caused by groundwater removal. Land subsidence from excessive groundwater extraction can cause irreversible damages to infrastructure (bridges, roads, pipelines, canals, levees, and buildings) and aqueduct operations. Land subsidence can also diminish the storage capacity of an aquifer, which reduces the available groundwater storage for the future. Importantly, subsidence and its reductions on groundwater storage are often irreversible.

In the Tulare Lake Subbasin, subsidence is primarily caused by the removal of water from the clay layers by groundwater extraction, which causes irreversible compaction and sinking of the land surface. In the subbasin, pumping from the C-zone is likely the primary cause of subsidence.

DWR concluded that the Tulare Lake Subbasin 2022 GSP does not adequately justify its approach for developing sustainable management criteria for subsidence, the criteria that the GSAs will use to evaluate success in the subbasin. DWR also noted that the GSP does not clearly define how it avoids "significant and unreasonable effects on critical infrastructure."[6]

State Water Board staff have built on DWR's analysis, noting that subsidence may substantially increase flooding risks, and have concluded that the 2022 GSP lacks a detailed analysis of the effects of subsidence on all beneficial uses and users within the subbasin. State Water Board staff therefore conclude that significant and unreasonable subsidence may occur under the 2022 GSP.

Potential actions to address the subsidence deficiency include the following:

- Clearly describe the subsidence conditions that would result in an undesirable result for the basin and provide enough detail that associated minimum thresholds can be determined.[7]
- Develop quantitative criteria that avoid undesirable results and conform with agreements with other agencies.
- Consult with flood management agencies and expand the GSP's analysis of land subsidence impacts on flood infrastructure.
- Plan ahead to avoid significant and unreasonable land subsidence.

Degraded Groundwater Quality (Deficiency GWQ – Section 4.1.3)

Another consideration under SGMA is avoiding "significant and unreasonable degraded water quality, including the migration of contaminant plumes that impair water

supplies."[8] Degradation of water quality can limit local water supplies and beneficial uses, and SGMA requires GSAs to consider the interests of all beneficial uses and users of groundwater, including municipal well operators and public water systems.[9] Water quality degradation that significantly and unreasonably affects the supply or suitability of groundwater for use in drinking water systems is an undesirable result.

In the Tulare Lake Subbasin, water quality degradation could occur in any of the three zones.

DWR concluded the Tulare Lake Subbasin 2022 GSP does not adequately justify its approach for developing sustainable management criteria for Degraded Water Quality, the criteria that the GSAs will use to evaluate success in the subbasin. DWR also recommended that the GSA describe the historic and current groundwater quality conditions within the principal aquifers including the primary groundwater quality constituents (pollutants) identified.

State Water Board staff have built on DWR's analysis, noting concerns with the monitoring network and monitoring frequency and an absence of projects and management actions identified to avoid undesirable results.

Potential actions to address the water quality sustainable management criteria deficiency include the following:

- Update the definition of an undesirable result to be consistent with GSP Regulations.[10]
- Update minimum thresholds to be consistent with GSP Regulations.
- Update measurable objectives to be consistent with GSP Regulations.
- Update the water quality monitoring plan in the 2022 GSP to be consistent with GSP regulations.
- Plan additional sampling when water quality is degraded.

Additional Staff Recommendations for State Water Board Action (Sections 4.2-4.4)

Exclusions from Probationary Status

The State Water Board must exclude from probation any portions of the basin for which a GSA demonstrates compliance with the sustainability goal.[11] Staff believe no GSAs in the Tulare Lake Subbasin have demonstrated compliance with the sustainability goal. All five GSAs have adopted and are implementing the same GSP, which DWR has determined to be inadequate. State Water Board staff recommend the State Water Board not exclude any portions of the subbasin from the probationary designation.

Modification to Water Year and Reporting Dates

State Water Board staff do not recommend the State Water Board modify the water year, but staff do recommend modifying the extraction reporting deadline for groundwater extraction reports required pursuant to Water Code section 5202 by changing it from February 1 to December 1.

Requirements for Installation and Use of Measuring Devices

As part of a probationary designation, the State Water Board may require groundwater extraction reporters to install and use measuring devices, such as flow meters, for measuring their groundwater extractions.

State Water Board staff recommend the State Water Board:

- Require people extracting more than two acre-feet per year for any reason to report their groundwater extractions.
- Require people extracting more than 500 acre-feet per year to install and use meters that meet the requirements of Cal. Code Regs., tit. 23, § 1042 on all their production wells within the subbasin.
- Exclude people who extract two acre-feet or less per year for domestic uses only from reporting requirements and paying fees. This exception includes most household users.

Conclusion

Despite significant efforts by GSAs in the Tulare Lake Subbasin, State Water Board staff's analysis supports DWR's determination that the Tulare Lake Subbasin 2022 GSP is inadequate. The current plan allows substantial impacts to communities who rely on domestic wells and to critical infrastructure. The Tulare Lake Subbasin is therefore unlikely to achieve sustainability by 2040, as required by SGMA.

Addressing deficiencies related to lowering groundwater levels and groundwater quality degradation is also consistent with the State Water Board's mission to ensure every Californian has safe and affordable drinking water as reflected in its commitment to the Human Right to Water and administration of the Safe and Affordable Drinking Water Fund.

State Water Board staff recommend probationary status as a critical next step for getting the subbasin back on track to achieve sustainability and protect groundwater resources for the communities, farms, and environmental resources that depend on them.

1.0 Purpose and Organization of Staff Report

The purpose of the Staff Report is to inform the State Water Resources Control Board (State Water Board) as it considers whether to designate the Tulare Lake Subbasin as a probationary basin consistent with the requirements of the Sustainable Groundwater Management Act (SGMA). The Department of Water Resources (DWR) deemed the groundwater sustainability plans (GSPs) for the Tulare Lake Subbasin to be inadequate. The Staff Report provides the State Water Board staff's characterization of the specific deficiencies in the GSPs, outlines an approach to state intervention for the Tulare Lake Subbasin, and more generally explains the State intervention process.

The Staff Report consists of five sections of subbasin-specific content regarding state intervention and a final section of references.

- **Section 1.0. Purpose and Organization.** Discusses the purpose of the report and provides an outline of the content.
- **Section 2.0**. **SGMA Background, State Intervention Process, and Equity Considerations.** Details what it means for a subbasin to be deemed inadequate by DWR, provides a history of SGMA and discusses what it means for a groundwater subbasin to go into the state intervention process. This section also includes a discussion of probation, a potential first step in state intervention; the reporting and fee requirements; and an interim plan, the potential second step in state intervention, as well as describing Board consideration of groundwater challenges for DAC communities.
- **Section 3.0. Historical, Physical, and Demographical Description of the Basin.** Describes the Tulare Lake Subbasin and contains the geographic, demographic, economic, and governance context within the subbasin, including a history of human use and development. This section also details the Groundwater Sustainable Agencies (GSAs) and their members, beneficial uses of groundwater, geologic history of the basin, and basin hydrology.
- **Section 4.0. State Water Board Staff Recommendations.** Details DWR's inadequate determination and its purpose, and the deficiencies and potential actions to address those deficiencies that have been identified by DWR and State Water Board staff. Also included in this section is a discussion of exclusions from probationary status (Wat. Code, § 10735.2, subd. (e)), modification to water year (WY) reporting dates, and requirements for installation and use of measuring devices (Wat. Code, § 10735.2, subd. (c)(3)).
- **Section 5.0. Additional Considerations.** Presents other considerations that State Water Board staff have addressed related to the California Environmental Quality Act (CEQA), the human right to water, and the public trust doctrine.

The State Water Board will consider public comments, this Staff Report, and other relevant information that is presented during its public process as it evaluates whether to designate the Tulare Lake Subbasin as a probationary basin.

2.0 The Sustainable Groundwater Management Act and State Intervention

Section 2.1 provides general background on SGMA, including its goals and the role it defines for local and state agencies. Section 2.2 then describes the State Water Board's role as a backstop, to protect groundwater and those who depend on it when local efforts alone are inadequate.

2.1 The Sustainable Groundwater Management Act Background

2.1.1 Legislative Enactment of the Sustainable Groundwater Management Act

Groundwater, one of California's greatest natural resources, makes up a significant portion of the state's water supply. Approximately 80 percent of Californians use groundwater for drinking or other household uses. Rain replenishes groundwater each year, but the amount of replenishment (or recharge) varies and depends on local conditions. Overdraft occurs when groundwater pumping removes water faster than precipitation can recharge the groundwater in a basin. Some groundwater basins in California are in a state of critical overdraft causing significant adverse environmental, economic, and social impacts. In some cases, groundwater levels have dropped so low that many existing wells are no longer able to pump water, including domestic supply wells in rural, largely economically disadvantaged communities (DACs). Wildlife and ecosystems that rely on shallow groundwater or rivers and streams connected to groundwater can also be adversely affected by low groundwater levels (CDFW, 2019). Excessive pumping has led to land subsidence in some areas, in turn causing damage to critical infrastructure such as levees and canals.

To protect California's groundwater resources, former California Governor Jerry Brown signed a three-bill legislative package in 2014, composed of Assembly Bill 1739 (Dickinson), Senate Bill (SB) 1168 (Pavley), and SB 1319 (Pavley). These bills created SGMA, the first legislative act in California to establish a statewide framework for sustainable groundwater management.

SGMA applies to California's alluvial groundwater basins that are designated as high and medium priority by DWR. SGMA requires local public agencies in those basins to form GSAs and develop and implement GSPs. GSAs are responsible for achieving a long-term management of their groundwater basins that avoids "undesirable results" (as defined under SGMA) within 20 years of implementing their GSPs.

SGMA's framework to sustainably manage groundwater at the local level is implemented through a division of governance between GSAs, DWR, and the State Water Board. Under SGMA, governance of groundwater sustainability in a subbasin begins with GSAs. SGMA provides the GSAs with authorities to implement rules and regulations for GSPs, monitor and enforce compliance with plans, and oversee or control groundwater extractions. DWR is the primary state technical assistance and oversight agency in SGMA and is tasked with assessing and evaluating GSPs for compliance with SGMA's requirements. The State Water Board acts when necessary to ensure SGMA is implemented successfully and may temporarily intervene in groundwater management when the proposed management of a groundwater basin is deemed inadequate due to deficiencies in the GSP. The State Water Board's role is discussed further in Section 2.2.

The federal government and federally recognized California Native American Tribes are subject to SGMA only to the extent authorized under federal or tribal law; however, they may voluntarily participate in development or administration of GSPs and in Board SGMA processes (Wat. Code, § 10720.3)

2.1.2 Path to Sustainability

As noted above, SGMA required the formation of GSAs in high- or medium-priority groundwater basins and subbasins (basins) by June 30, 2017. Any local public agency with water supply, water management, or land use responsibilities within a groundwater basin was eligible to be a GSA. The current set of GSAs and the set of local public agencies that compose those GSAs reflect local decision-making. GSAs have authority to create new rules and ordinances to manage groundwater users located within the GSA boundary.

GSAs operating within a given basin are collectively required to ensure groundwater is managed sustainably. To this end, SGMA provides GSAs with authorities to develop and implement GSPs, conduct investigations, register groundwater wells or require installation of meters, require pumpers to report extractions or recharge activities, build and operate projects, gather data, regulate or restrict extractions, and charge fees (Wat. Code, § 10725 et seq.). In developing and updating a GSP, GSAs must create opportunities for public engagement, encourage active involvement of diverse social, cultural, and economic elements of the population within the basin, and inform the public about their progress implementing the GSP (Cal. Code Regs., tit. 23, § 354.10, subd. (d)). A GSA may also "appoint and consult with an advisory committee consisting of interested parties" as it develops and implements a GSP (Wat. Code, § 10727.8).

GSPs outline how groundwater is to be used and managed without causing the following six undesirable results in the basins: significant and unreasonable declines in groundwater levels, reductions in groundwater storage, intrusion of seawater, degradation of water quality, subsidence of land, and depletions of interconnected

surface waters. These are often referred to as the sustainability indicators. GSPs are not required to address undesirable results that occurred before and were not corrected by January 1, 2015 (Wat. Code, § 10727.2, subd. (b)(4)).

SGMA requires that GSAs develop a sustainability goal description for each basin. According to SGMA, the sustainability goal shall be the use of groundwater that can be maintained during the fifty-year GSP planning and implementation horizon without causing undesirable results (Wat. Code, § 107271, subd. (v)).

2.1.2.1 Define Undesirable Results

GSAs are required to develop a definition of when effects caused by groundwater conditions occurring throughout a basin are considered to be significant and unreasonable for their basin (Cal. Code Regs., tit. 23, § 354.26). The definition of undesirable results includes both a narrative definition and a quantitative definition for each sustainability indicator. The definitions are based on sustainable management criteria (SMC) developed by the GSAs.

2.1.2.2 Define Quantitative Thresholds to Avoid Undesirable Results

To avoid undesirable results and to achieve the basin's long-term sustainability goals, GSPs must set quantitative minimum thresholds (MTs) and measurable objectives (MOs) for each of the sustainability indicators, as well as interim milestones. MTs quantify groundwater conditions for each applicable sustainability indicator at representative monitoring sites (RMSs) within the basin (Cal. Code Regs., tit. 23, § 354.28). MOs define quantifiable goals for sustainability indicators that maintain or improve sustainable groundwater conditions within the subbasin. Interim milestones define measurable target values for groundwater conditions over increments of five years (Wat. Code, § 10727.2, subd. (b)(1); Cal Code Regs., tit. 23, § 354.30).

2.1.2.3 Achieve Sustainability through Project and Management Actions

GSPs are required to describe project and management actions that the GSA has determined will achieve the sustainability goal for the subbasin (Cal. Code Regs., tit. 23, § 354.44). The project descriptions must include the criteria that would trigger implementation, a timetable for implementation, an explanation of the source and reliability of the water on which the projects rely, and a funding plan (Cal. Code Regs., tit. 23, § 355.44). GSPs must provide descriptions of current or future projects to achieve balanced levels of groundwater to reach long-term sustainable conditions. For those groundwater basins experiencing the most severe (critical) overdraft, GSPs were due by 2020 and must achieve groundwater sustainability within 20 years (by 2040). For the remaining high- and medium-priority basins, GSPs were due by 2022, thus requiring them to achieve groundwater sustainability by 2042 unless submitted earlier (Wat. Code, § 10720.7, subd. (a)) (Wat. Code, § 10727.2, subd. (b)).

2.2 State Intervention

When DWR, in consultation with the State Water Board, deems the GSP or GSPs in a basin inadequate (Wat. Code, § 10735.2, subd. (3)), it refers the basin to the State Water Board for potential state intervention (Wat. Code, § 10735 et seq.). State intervention is a two-step process. If the basin successfully resolves its plan deficiencies before or during the first step, the basin will not proceed to the second step. The first step under the SGMA statute is for the Board to consider and potentially designate a basin as probationary (described in Section 2.2.1). The second step is for the Board to consider the imposition of an interim plan for the basin (described in Section 2.2.2), which may occur only if deficiencies have not been remedied within one year of the probationary designation. Even during probation, GSAs have time to resolve deficiencies and the State Water Board collects data on groundwater extractions, collects fees from certain groundwater users, and may conduct additional investigations. Importantly, the GSA retains its authorities and responsibilities and must continue to implement its plan regardless of the probationary status.

If the basin is in probation for at least one year, and the GSP deficiencies remain unresolved, the State Water Board may develop and adopt an interim plan that allows the Board to implement the actions necessary to sustainably manage the basin's groundwater. An interim plan is intended to be a temporary measure to protect groundwater until the State Water Board determines that locally led management complies with SGMA and will be effective. Under an interim plan, the State Water Board can manage groundwater use in a basin, including enacting restrictions on groundwater extractions (Wat. Code, § 10735.8).

Under an interim plan, GSAs coordinate their ongoing management of the basin with the State Water Board, which will work with groundwater users and directly with the GSAs to achieve compliance with SGMA. Once the Board determines deficiencies have been resolved and the basin is likely to achieve sustainability, the Board will end state intervention, and GSAs will continue managing their basins at the local level.

2.2.1 Probation – First Potential Step

As of 2020, if DWR determines a GSP for a medium- or high-priority basin in critical overdraft to be inadequate, the State Water Board, after notice and a public hearing, may designate the basin as a probationary basin (Wat. Code, § 10735.2, subd. (a)(3)). Other situations can also trigger the State Water Board's state intervention authorities (Wat. Code, § 10735.2, subds. (a)(1)-(5)).

The State Water Board can only designate a basin probationary at a public hearing after ample public notice (see Section 2.2.1.1). Following a probationary designation, groundwater pumpers in the basin must report information about their groundwater use to the State Water Board (Section 2.2.1.2) and pay associated fees (Section 2.2.1.3). As

part of the probationary designation, the State Water Board has discretion to require groundwater pumpers to use meters or other specific methods to measure groundwater extractions (Section 2.2.1.4) or to exempt certain categories of pumpers from reporting and fees (Section 2.2.1.4). SGMA provides that the State Water Board shall exclude any portion of a basin from probationary status if a GSA demonstrates compliance with the sustainability goal (see Section 4.2; Wat. Code, § 10735.2, subd. (e)).

2.2.1.1 Probationary Hearing Process

The State Water Board must provide notice of the hearing at least 90 days before it occurs by publishing the hearing dates on its website and notifying DWR and each city and county overlapping with the basin (Wat. Code, § 10736, subds. (a), (b)(1)-(2)).

In addition, at least 60 days before the hearing, the Board must mail or send by electronic mail notice to all persons known to the Board who extract or who propose to extract water from the basin, or who have made written or electronic mail requests to the Board for special notice of hearing pursuant to SGMA (Wat. Code, § 10736, subd. (b)(3)(B)).

Although not required by the statute, the State Water Board staff are providing these draft recommendations for action in the basin, in the form of a draft staff report, to the public for a minimum 60-day public comment period prior to the probationary hearing. Staff also expect to host one or more in-person or virtual public engagement meetings during the public comment period to explain state intervention and receive public comments on staff's recommendations.

2.2.1.2 Reporting

Any person who extracts or pumps groundwater from a probationary basin must file a groundwater extraction report (report) with the State Water Board each year (Wat. Code, § 5202; see possible exceptions below). Reports must be submitted electronically (Cal. Code Regs., tit. 23, § 1032). On May 16, 2017, the State Water Board adopted a resolution for an emergency regulation to help implement SGMA that included electronic filing requirements. The emergency regulation was authorized under Water Code § 348, which allows DWR or the Board to adopt emergency regulations for the electronic filing of reports required under Water Code § 5200 et seq. The Office of Administrative Law approved the final regulation on June 29, 2017.

These reports must include:

- the name and address of the person who extracted groundwater
- the name of the basin from which the water was extracted
- the place of groundwater extraction

- the capacity of the groundwater extraction facilities
- monthly records of the groundwater extractions
- the purpose of use
- a general description of the area in which the water was used, and
- the year groundwater extraction commenced (Wat. Code, § 5203).

Persons extracting groundwater within a basin will be required to begin reporting their extractions to the Board 90 days after any probationary designation (Wat. Code, § 5205). Groundwater extraction reports, by default, are due by February 1 of each year for groundwater extractions made during the previous water year (Wat. Code, § 5202, subd. (b)). However, the Board may modify the water year or reporting date for a report of groundwater extractions (also see Section 4.3) (Wat. Code, § 10735.2, subd. (c)(4)).

Data collected by the State Water Board can be used by GSAs and stakeholders in remedying deficiencies and achieving sustainable groundwater management. If the State Water Board eventually develops an interim plan for a basin, the State Water Board may rely on the data to ensure the interim plan is consistent with water rights priorities, as required by SGMA (Wat. Code, §10735.8, subd. (d)).

2.2.1.3 Fees

The State Water Board will notify well-owners and landowners of their extraction reporting requirements and associated filing fees. Any person that is required to file a groundwater extraction report to the State Water Board is also required to pay a report filing fee. Fees are required because Water Code section 1529.5 directs the State Water Board to recover the costs of state intervention activities via a schedule of fees. These fees were adopted under the 2017 emergency regulation described above.

The current annual fee for groundwater extractions (excluding de minimis extractions) in a probationary groundwater basin is a base filing fee of $300 per well and $40 per acre-foot (AF) of water extracted in the probationary basin. The State Water Board may amend fees as needed by subsequent emergency regulation (Wat. Code, § 348).

2.2.1.4 Measurement Requirements

All groundwater extractors subject to reporting requirements must report monthly records of groundwater extractions. The measurements of the extractions must be made by a methodology, water-measuring device, or combination thereof satisfactory to the Board (Wat. Code, § 5203, subd. (e)). The State Water Board's Options for Measuring Extraction Volumes guidance document identifies acceptable ways to measure extractions (State Water Board, 2022). Options include a totalizing flowmeter,

the run time method, or other methods as evaluated and approved by staff on a case-by-case basis.

The State Water Board can require extractors to install meters to measure and report their groundwater extractions accurately, or the State Water Board can specify other means for measuring and reporting groundwater extractions (Wat. Code, § 10735.2, subd. (c)(3)).

Default Exemption for De Minimis Users

A well owner who extracts two AF or less of groundwater per year from a parcel of land for domestic purposes only is defined as a "de minimis user" under the SGMA statute. De minimis users in probationary basins are exempt from reporting and fees unless the State Water Board determines reporting information from those users is necessary to sustainably manage the basin (Wat. Code, § 10735.2, subd. (c)(2)).

Optional Exemption from Reporting for Certain Classes or Categories of Users

The State Water Board may choose to exclude certain classes or categories of groundwater extractions from extraction reporting and associated fees (Wat. Code, § 10735.2, subd. (c)). Specifically, the State Water Board could exempt classes or categories of extractors subject to a local plan or program that adequately manages groundwater within a portion of the basin if extractors are likely to have a minimal impact on basin withdrawals.

2.2.2 Interim Plan – Second Potential Step

The potential second step of state intervention involves the development and implementation of an interim plan for the basin by the State Water Board. The Board may develop an interim plan for the probationary basin one year after the probationary designation of the basin if the Board, in consultation with DWR, determines that a GSA(s) has not remedied the deficiencies that resulted in designating the basin as probationary (Wat. Code, § 10735.4, subd. (c)).

If the State Water Board adopts an interim plan, it would temporarily manage groundwater in the basin pursuant to the interim plan until the local agencies could demonstrate their ability to resume sustainable management of the basin. An interim plan is intended to be a temporary measure to protect groundwater until the State Water Board determines that locally led management complies with SGMA's requirements. An interim plan will include corrective actions, a schedule for those actions, monitoring, and enforcement (Wat. Code, § 10735.8, subd. (b)). An interim plan will likely focus on reducing groundwater use in the basin to sustainable levels as soon as practical. An interim plan may include elements of an existing plan or adjudication that the Board finds would help meet the basin's sustainability goal.

2.2.3 Equity Considerations in State Water Board Decisions

The State Water Board mission—to preserve, enhance, and restore the quality of California's water resources and drinking water—is strengthened by the Board's commitment to racial equity and environmental justice[1] (State Water Board, 2021a). The State Water Board acknowledges and condemns inequities, past and present, in water access, affordability, and quality. The Board seeks to proactively use existing processes and authorities to help address structures and practices that may perpetuate these inequities. These considerations have informed the analyses employed in this report, as well as the determination of deficiencies, and proposed corrective actions identified herein. Some of these proposed actions, if implemented, would both help address past and present inequities and resolve GSP deficiencies by addressing groundwater supply and quality impacts related to management actions. Proposed actions would ensure, where appropriate, that sufficient mitigation measures are in place to protect communities from chronic lowering of groundwater levels and other undesirable results that are significant and unreasonable. The State Water Board will continue to engage with and consider the needs of potentially affected DACs and Black, Indigenous, and people of color (BIPOC) communities in the Tulare Lake Subbasin as it implements its responsibilities under SGMA.

It is estimated that in California 9.4 million people, 25% of the state's population, live in DACs. In the San Joaquin Valley approximately 2.2 million people, 55% of the state's population, live in DACs (Fernandez-Bou et al., 2021a). The geography of DACs is a product of urban segregation, redlining, and the racialized exclusion from public benefits that occurred as people of color were pushed outside of city limits, into industrial and service worker areas, or relegated to far flung farmworker camps where they often experienced degraded and exploitative conditions (London et al., 2021).

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[1] For the State Water Board, racial equity is achieved when race can no longer be used to predict life outcomes (that is, when racial information does not help explain patterns of outcomes) and when outcomes for all groups are improved. For the State Water Board, environmental justice means the fair treatment of people of all races, cultures, and incomes with respect to the development, adoption, implementation, and enforcement of environmental laws, regulations, and policies. One way that inequities can relate to outcomes for water users is through the likelihood of success of policies and efforts. Theory and numerous case studies of local organizations with roles in the management of groundwater or other natural resources with common-pool properties, for example, suggest those organizations may be more likely to succeed where more resource users perceive the organizations and outcomes as fair and where more resource users choose to work with the local organizations (Ostrom, 2012).

DACs often are served by small public water systems and rely on groundwater either in whole or in part for their water supply. Their groundwater wells often are shallow and thus are more susceptible to water quality issues or the risk of going dry if the groundwater level is lowered. While the public water systems serving DACs still are required to maintain essential resources and meet public health requirements, these systems are less likely to have the resources (e.g., infrastructure and financing) of more affluent communities to respond adequately to water supply or water quality emergencies. Systems serving DACs may be unable to treat their water source, find alternative supplies for a contaminated drinking water source, deepen their wells, or build new wells. As a result, DACs may be more vulnerable than other municipalities and cities to impacts on surface water and groundwater supplies. Section 3.0 includes information regarding the history of human occupation and development of the San Joaquin Valley and Tulare Lake subbasin and existing inequalities in water access, affordability, and quality.

3.0 Basin Description

The basin is the default physical scale at which SGMA responsibilities and authorities, at the state and local levels, apply.

3.1 Geographic Context

Located in California's Central Valley in the southern portion of the San Joaquin Valley, the Tulare Lake Subbasin (subbasin) (**Figure 3-1**) is bounded:

- to the north by the Kings Subbasin,
- the northeast by the Kaweah Subbasin,
- the southeast by the Tule Subbasin and Tulare County,
- the south by the Kern Subbasin and Kern County,
- the southwest by the Kettleman Hills,
- to the northwest by the Westside Subbasin.

The subbasin covers approximately 535,869 acres or about 837 square miles (DWR, 2016).

The land of the subbasin slopes from slightly higher elevations at its boundaries toward the center of Tulare Lake (USGS Topo **Figure 3-2**). The highest elevations within the subbasin are approximately 405 ft Above Mean Sea Level (AMSL) and occur along the northeast flank of Kettleman Hills. From the northeast edge to the center of Tulare Lake, ground surface elevations range from about 292 to 188 ft AMSL. Drainage within the

subbasin flows toward the Tulare lakebed, which is located on the southern half of the Tulare Lake Subbasin in Kings County.

The climate of the subbasin is classified as a semi-arid climate under the Köppen climate classification, which is characterized as hot, dry summers and cool moist winters (GSP, 2022 p. 3-3).

3.2 Geologic Context

The Tulare Lake Subbasin sits in the south-central segment of the San Joaquin Valley. The San Joaquin Valley is a linear sediment filled depression, typically known as a structural trough. The sediments overlay crystalline basement rocks (USGS, 1991). The structural trough is 200 miles long and 70 miles wide and is filled with 32,000 ft of marine and continental sediments at its greatest depth (DWR, 2006). Sediments were deposited during inundation of the Pacific Ocean and by erosion of the surrounding Sierra Nevada and Coastal Range mountains, respectively. These sediments of loose clay, silt, sand, or gravel deposited by flowing water are known as alluvial deposits. When deposited away from direct connection to the ocean, they are known as continental deposits. Continental deposits form an alluvial wedge that thickens from the eastern edge of the valley toward the structural trough. The axis, or center line, of sediment deposition is beneath and slightly west of the rivers, lakes, sloughs, and marshes, and marks the current and historic artery of surface water drainage in the San Joaquin Valley.

See **Figure 3-3** for a map of the geology of the subbasin.

3.2.1 Geologic History

The subbasin within the San Joaquin Valley is geologically complex, has evolved on a geologic time scale, and was dominated by a pattern of movement of the earth's crust – a tectonic regime, with a presence of one crustal plate descending below the edge of another, known as a subduction zone, along the western continental margin (USGS, 1991). During the Late Mesozoic and early Cenozoic (145 to 65.5 million years ago) a structural process of lateral crustal compression and deformation, a mountain building phase known as the Cordilleran Orogeny, took place, and the Farallon Plate subducted under the North American Plate (**Figure 3-4**). This tectonic geological process began to develop the following:

- an accretionary prism (marine sediments scraped off from the Farallon Plate), now known as the Costal Range Mountains
- a continental volcanic arc, creating the batholith that would become the Sierra Nevada Mountains

- a forearc basin (region between a subduction zone and the mountain belt), which was beginning to develop the Central Valley where the subbasin is located

The Tulare Lake Subbasin was originally connected to the Pacific Ocean. Its connection to marine water periodically flooded the forearc basin, allowing deep marine sediment deposition (Bartow, 1991). As the rising mountains from the Coastal Ranges blocked the flow between the forearc basin and the Pacific Ocean and the Sierra Nevada Mountains continued to uplift, erosion and deposition of the surrounding mountains filled the valley for millions of years.

The sediment depositional history of the San Joaquin Valley, from deepest to relatively shallow sediments, can be divided into several periods:

- Late Mesozoic and early Cenozoic: The San Joaquin Valley was part of a forearc basin that was open to the Pacific Ocean as deep marine sediment was deposited in the basin.
- Late Miocene: The San Andreas Fault to the west of the forearc basin shifted movement and began to close off the area that now forms the San Joaquin Valley from the ocean, creating an extensive inland sea where marine sediments of the Etchegion Formation and San Joaquin Formation were deposited.
- Pliocene: The San Joaquin Basin west of the San Andreas Fault continued to close off, causing the extensive inland sea to shallow. Marine sediments were deposited in the shallowing sea bottom.
- Late-Pliocene and early-Pleistocene: The San Joaquin Valley began to evolve into its current form. Tulare Formation sediments were eroded from the uplifting mountains and deposited into the subsiding valley.
- Pleistocene: Quaternary sediments filled the basin and were deposited on alluvial fans and along the San Joaquin Basin axis by the rivers and streams emanating from the adjoining mountains.
- Pleistocene: Aggrading alluvial fans cut off the flow of the San Joaquin Rivers to the sea due to glacial and wet climate events (Atwater et al., 1986). Large-scale lacustrine deposits (formed at lake bottoms) accumulated in the shallow lakes that developed as a result of the internal drainage. This is also when the Corcoran Clay (E-Clay of Croft 1972) accumulated in the Tulare Lakebed.

3.2.2 Stratigraphy

Sediments comprising the Tulare Lake Subbasin include younger and older alluvium, flood-basin deposits, lacustrine and marsh deposits, and continental deposits (**Figure 3-5**). Older alluvium consists of poorly sorted lenticular (lentil or lens shaped) deposits of clay, silt, sand, and gravel, which may range from loosely consolidated to cemented.

Younger alluvium consists of a heterogeneous complex of interstratified discontinuous beds of unsorted to fairly-well sorted clay, silt, sand, and gravel. A summary of the subbasin stratigraphy can be found in **Table 2-3**.

3.3 Human Use and Development

Humans have occupied the southern Central Valley for tens of thousands of years (Smith and Secrest, 2004). Prior to and for decades after European contact with California, much of the Tulare Lake Subbasin was covered by the Tulare Lake, the largest freshwater body west of the Mississippi and a shallow, highly biologically productive water system fed by the Kings, Kaweah, and Tule Rivers, among other streams (**Figure 3-6**).

Prior to European contact, the southern Central Valley held one of the densest populations of peoples north of Mexico (Cook, 1955). Native California Indians hunted and managed a wide variety of game on the lakeshore and on the lake itself, fished and managed fisheries in the lake and streams, and cultivated a variety of pines, oaks, and grasses. Tules, many of which were located on islands that dotted the Lake, also provided material for building boats, baskets, and dwellings.

What Europeans were seeing when they encountered the rich diversity of people, plants, animals, and landscapes (more than 2,000 native plant species are endemics and grow nowhere else on earth) and when they “admired the grand vistas of Yosemite and the gold and purple flowers carpeting the Central Valley were the fertile gardens of the Sierra Miwok and Valley Yokuts Indians, modified and made productive by centuries of harvesting, tilling, sowing, pruning, and burning” (Anderson, M. Kat 2006, p.3, 13-14).

Indigenous Californian land and water management

During the 1970's and 1980’s a new appreciation developed for the complex and diverse economies of Native Californians prior to European contact, including a deeper understanding of the sophisticated systems of traditional knowledge employed by Native Californians (Blackburn, Thomas C., 1993, p.16).”

As part of land, plant, and animal management, Native Californians managed water resources, and practiced flood control and erosion control (Blackburn, 1993, p.21). Over several thousand years and to adapt to variable climate conditions, people managed water to keep ground waters close to valley surfaces, to keep springs and streams usable, and to benefit plant and animal species. Kumeyaay elders describe a process

in which rocks were aligned in parallel rows on alluvial fans along the desert mountain edge and in the mountain valleys east of Laguna Crest. These rock ridges were also aligned across small drainage channels to slow the downward flow of rain water and to allow more to enter the ground…for the purpose of spreading the summer storm water and catching the fine silt carried by it;…on all steep slopes (Shipek 1991, p.384).

People placed plants along streams, rivers, and new cuts in banks created by storms to maintain good drainage and prevent erosion; and they placed boulders and brush along narrows to keep water in upstream portions for longer periods and maintain groundwater close to the surface (*Ibid*., p.385-386).

Irrigation "was an indigenous technique, practiced long before the Spanish and other Europeans introduced their agricultural knowledge." Written accounts of at least two communities – the Owens Valley Paiute and the Eureka Valley Indians – describe the irrigation techniques they used (Anderson 2006, pp.42,137; Blackburn 1993, pp.19,33,45,239-330). Native Californians used groundwater to supplement surface water. For example, the Cahuilla people developed natural springs and groundwater wells, including digging walk-in wells as a water source during times of scarcity for personal consumption, food processing and preparation, personal hygiene, medicinal uses, spiritual and ceremonial uses, production of household items, the construction of dwellings, and spiritual practices.[2]

When Europeans arrived, they were witnessing the culmination of centuries, or perhaps millennia, of the use of sophisticated practices and traditional knowledge that allowed plants, animals, and ecosystems to thrive (Blackburn, p.151 citing Heizer and Elsasser, 1980). Although Native Californians faced many challenges to practicing traditional land and water management after European contact,[3] expertise persists, traditional techniques endure and have been revived in many places, and in some cases are integrated with state and local agencies land management practices.[4]

European Contact

The Spanish did not build any missions in the interior of California, but they did visit the Central Valley. Francisco Tomás Hermenegildo Garcés may have been one of the first Spaniards to visit and write about the Southern San Joaquin Valley. He saw expanses of grassland, forested banks along the rivers and waterways, and observed the ephemeral nature of some of the tributaries to the larger rivers. He engaged socially with people

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[2] Trial Motion, Memorandum and Affidavit (October 21, 2014), *Agua Caliente Band of Cahuilla Indians v. Coachella Valley Water District*, et al. (C.D. Cal., Case No. 5:13-cv-00883-JGB-SP) (2014 WL 11152398).

[3] Governor's Exec. Order No. N-15-19 (June 18, 2019).

[4] For examples of Tribal, public and private funding efforts, e.g. "Partnering and Learning from Tribes to Integrate Traditional Ecological Knowledge" article, Yurok Condor Restoration Program website, California Department of Fish and Wildlife Tribal Affairs website). California's Fourth Climate Assessment, Summary Report of Tribal and Indigenous Communities within California)

along his journey including sharing meals that included the highly valued Chia, participating in a sweat, and consoling a dying boy and his family. (Garcés 1775-1776, p.270-286).

Later immigrants saw the grasslands of the Central Valley, the interior of the coastal range, and the Sierra foothills as prime ranching land, moving into the valley from 1836 to 1848, with at least one Mexican land grant made in the area north of Tulare Lake: Laguna de Tache ranch, located on approximately 48,800 acres between present-day Kingsburg and present-day Laton (Smith and Seacrest, 2004). During the Mexican era (1822-1848), Mexico sent governors and some soldiers, but otherwise did not institute significant changes. The Plan of Iguala guaranteed citizenship to Indians, protected property, and some rights, but in practice Indians continued to be forced to labor for the missions and major epidemics spread through the Indian population (Cook, 1978, p.91-98). From the 1820s to the 1840s, hunters and trappers came overland, followed by the gold rush of 1849, which brought a rapid influx of tens of thousands of people to California and major physical change to water and the environment.

Ranchers, herders, and speculators jockeyed for land and rights up and down the San Joaquin Valley (Smith and Secrest, 2004). In 1853, hydraulic mining eclipsed other mining activities when it was discovered that forceful jets of water at hillsides would reveal gold-bearing alluvium. As extensive networks of reservoirs, flumes, ditches, and iron pipes were built to carry billions of gallons of Sierran water to hydraulic mining operations, waste mud and gravel washed downstream forcing rivers out of their banks, causing major flooding, sweeping away farm structures, drowning cattle, and wiping out orchards (Anderson, 2006 p.99). Prior to contact with Europeans, the valley landscape consisted of large swaths of brackish and freshwater marshes, which are “among the most productive ecosystems on earth” (Barbour, 1993). In 1850, Congress passed the Swamp Land Act, which encouraged the reclamation of swampy “overflow” lands. Landowners and speculators began forming canal and ditch companies that corralled previously freely flowing streams, sloughs, and marshes into new channels, drying the land and making it more suitable for ranching and farming. The remaining marsh land in the Central Valley is now a fraction of what once existed (Mason, 1957, p.55).

Groundwater Development

Reclamation efforts resulted in more acreage being available for crop farming, which drove agricultural innovation, which in turn drove further interest in developing land for agriculture. Diversion and channelization of regional surface waters resulted in significantly less water flowing to Tulare Lake. By 1899, Tulare Lake had lost nearly 60,000 acres and was largely dry (USBR, 1970; Smith and Secrest, 2004). Modification of the surface water systems would continue through the 20th century with the completion of several large dams in the region, including Pine Flat Dam on the Kings River in 1954, Success Dam on the Tule River in 1961, and Terminus Dam on the Kaweah River in 1962. Nevertheless, as surface supplies dwindled, people in the region

turned to groundwater supplies. The end of the 19th century saw the first development of pump-driven irrigation wells, driven by steam and gasoline engines, in the San Joaquin Valley. The land area irrigated by pumped wells increased from approximately 39,000 acres in 1909 to almost 160,000 acres in 1921 in Tulare County alone (Austin, 2015).

Even in the early days of the rapid development of groundwater use there was recognition that groundwater pumping lowered the water table, resulting in the need to sink deeper and deeper wells to keep up production (Smith and Secrest, 2004; Anderson, 2006 p.97). People who came from East, Southeast, and South Asia, south of the border with Mexico, from states affected by the Dust Bowl, and from the Great Migration (of Black farmers from the South) were employed as farm laborers (Pannu 2012 p.231-232). Historically exclusionary policies meant that they were not able to incorporate into towns and cities, often increasing dependance on shallow groundwater wells for domestic and farm use. Depletion of the aquifers has posed increasing threats to the ability of these communities to access needed water for health, sanitation, and farming, which is often exacerbated by a lack of representation, investment, and exclusion from infrastructure services (*Ibid*). In 1980, DWR Bulletin 118-80 identified the Tulare Lake Basin as being subject to conditions of critical overdraft. By the turn of the 21st century, agriculture accounted for more than 90 percent of groundwater use in the Lake Tulare hydrologic region (Sumner et al. 2003, p. 81). Continued declines were noted in the early 2000s: DWR well monitoring data indicate that groundwater levels in the valley portion of the basin dropped about 17.5 feet over the five-year period from 2005-2010 and in 2014—just prior to the passage of SGMA—DWR released a report noting that groundwater levels were experiencing record historical lows throughout the state, including in the Tulare Lake Basin (Austin, 2015).

3.4 Demographics, Economy, and Governance Context

The subbasin contains six localized urban areas, including the cities of Corcoran, Lemoore, Hanford, and the communities of Armona, Home Garden, Stratford, and Kettleman City. The cities of Corcoran, Lemoore, Hanford, and the Kettleman City Community Service District are members of GSAs that manage the basin. The basin also includes the Santa Rosa Rancheria and part of the ancestral homelands of the Tachi-Yokut Tribe south of Lemoore. The Corcoran State Prison is also located in the basin, just south of Corcoran (**Figure 3-7**).

According to the Census Block Group Data 2022, the Tulare Lake Subbasin has an estimated population of 145,933 people as of 2022. Approximately 54% of the population is Hispanic or Latino, 33% white, 5% black, 4% Asian, 3.75% identified as other, and approximately 0.25% Native American.

According to the California Native American Heritage Commission, in addition to the Santa Rosa Rancheria Tachi-Yokut Tribe, other California Native American tribes may

have knowledge of cultural resources in the subbasin. These tribes include the Big Sandy Rancheria of Western Mono Indians, the Kings River Choinumni Farm Tribe, the Kitanemuk & Yowlumne Tejon Indians, Tule River Indian Tribe, and the Wuksache Indian Tribe/Eshom Valley Band (NAHC 2023, personal communication, 11 May).

According to the United States Census Bureau, the average annual household income, within the Tulare Lake Subbasin in 2021 is $64,837, significantly less than the California median household income of $84,097 (ACS 5-year survey in 2021). The area is extremely rural with approximately 48,850 housing units and an average population density of 174 people per square mile.[5] Most of the land within the subbasin and surrounding areas is used for growing crops and raising livestock (2022 GSP, Appendix B, p. B-5).

Agriculture (growing crops and raising livestock), food processing, and oil production are the top three industries within the Tulare Lake Subbasin. Agriculture is the largest private employer in the county and accounted for over $2 billion in sales according to the 2017 Kings County Agricultural Crop Report, which aggregates information directly reported by industry. Food processing is a major employer in the county and provides over 4,000 local jobs. Leprino Foods employs over 1,000 people and uses 40 percent of the water used within the South Fork Kings GSA. Oil production occurs primarily within the Kettleman City area. Oil and agricultural production share land surface and have joint usage of well drilling rigs and agricultural production such as grazing (2022 GSP, Appendix B, p. B-6).

As Public Policy Institute of California has noted:

> Like many agriculturally dependent regions, the [San Joaquin] valley faces significant socioeconomic challenges, including a high rate of unemployment and pockets of extreme rural poverty that worsen when the farm economy suffers. The region also faces difficult public health challenges in which farming plays a role, including unsafe drinking water in many small rural communities and some of the nation's worst air quality (PPIC, 2017; see also Hang et al., 2021).

3.4.1 Groundwater Sustainability Agencies

The Tulare Lake Subbasin is currently managed by five GSAs, with each GSA comprising multiple member agencies (**Figure 3-8**). A list of the GSA and their member agencies is in **Table 3-1**. The five GSAs have developed the GSP under an agreement

[5] Census 2022 data was not available for the 2022 GSP; staff is providing updated information, including from the 2022 Census Block Group Data and the ACS 5-year survey in 2021.

which ensure collaboration and coordination throughout the subbasin (2022 GSP p. ES-11).

Table 3-1 – Tulare Lake Subbasin Groundwater Sustainability Agencies

GSA	Member Agency	Date of GSA Formation
Mid-Kings River GSA	• City of Hanford • County of Kings • Kings County Water District	Not Applicable
South Fork Kings GSA	• City of Lemoore • Empire Westside Irrigation District • County of Kings • Stratford Irrigation District • Stratford Public Utility District	03/08/2017
Southwest Kings GSA	• Dudley Ridge Water District • Kettleman City Community Service District • Tulare Lake Basin Water Storage District • Tulare Lake Reclamation District #761 • County of Kings	03/08/2017
El Rico GSA	• Alpaugh Irrigation District • City of Corcoran • Corcoran Irrigation District • County of Kings • Lovelace Reclamation District #739739 • Melga Water District • Salyer Water District • Tulare Lake Basin Water Storage District • Tulare Lake Drainage District	02/08/2017
Tri-County Water Authority GSA*	• Angiola Water District • Deer Creek Storm Water District • County of Kings • W.H. Wilbur Reclamation District #825	09/01/2016

* The 2022 GSP also lists Atwell Island Water District and Tulare County as member agencies of Tri-County, but GSA formation materials posted to DWR's SGMA Portal do not reference the two agencies.

3.5 Basin Hydrology - Groundwater

The Tulare Lake Subbasin hydraulic boundaries are the Kings River on the northeastern edge of the subbasin and the Kettleman Hills on the southern edge of the subbasin. The remaining subbasin boundaries are defined by DWR and water management areas, but the actual physical water-bearing formations extend into adjacent areas of the Tulare Basin hydrologic area.

Groundwater from the Kings Subbasin, Kaweah Subbasin, Tule Subbasin, and surface water from the Kern River flows into the Tulare Lake drainage subbasin (**Figure 3-9**; DWR, 2006). Groundwater flow is generally southwestward, toward the Tulare lakebed (DWR, 2000). Based on current and historical groundwater elevation maps, horizontal groundwater barriers do not appear to exist in the subbasin (**Figures 3-10a to 3-10c**; DWR, 2006). The average annual precipitation is seven inches throughout most of the Tulare Lake Subbasin and nine inches at the northern margin (DWR, 2006).

3.5.1 Beneficial Uses of Groundwater

DWR surveyed land uses within the subbasin area in 2022 (**Figure 3-11**). The subbasin area contains approximately 88.5% agricultural and 3.8% urban land use designations. Agricultural land, including vineyards and orange groves, are interspersed with oil fields (Parsons, 1987). The primary land use designations for urban land are residential, commercial, and industrial. Groundwater is the main source of water for agricultural and urban land uses (DWR, 2017a). According to data reported by the WY 2022 Annual Report, during the period of 2015 – 2022, the average annual total groundwater extraction volume was approximately 488,624 AF and the average annual total water use in the subbasin was 934,272 AF (Annual Report, WY 2022).

3.5.1.1 Drinking Water

The subbasin contains three incorporated cities: Lemoore, Corcoran, and Hanford. These cities also use the groundwater from the subbasin. Lemoore and Corcoran meet the criteria of DACs. The water systems for Hanford and Lemoore are failing per the State Water Board's 2023 Drinking Water Needs Assessment (State Water Board, 2023a). Both are classed as failing in part for water exceeding Maximum Contaminant Levels (MCLs) of disinfection byproducts such as total trihalomethanes (both systems) and total haloacetic acids (Lemoore). However, Lemoore is also noted as failing due to treatment system violations for arsenic, which is naturally occurring in groundwater

sourced by the city. The relationship between arsenic and groundwater management is explained in Sections 3.5.6 and 4.1.3.

Within the subbasin, the communities of Armona, Home Garden, Stratford, and Kettleman City are Census Designated Places (CDPs)—concentrations of population that are not incorporated as cities, towns, or villages. The estimated population of the CDPs is 19,325 (ACS Survey, 2021). These four CDPs are designated as DACs. Of these CDPs, Kettleman City and Home Garden are also noted as failing systems (State Water Board, 2023a). Kettleman City is failing, in part, because its water has exceeded MCLs for both total trihalomethanes and arsenic. Kettleman is now reliant on surface water for its supplies (2022 GSP, p. 2-8). Kettleman City and Home Garden systems are rated as failing, in part, due to drought or water shortage risk.

In addition to the communities noted above, the federally recognized Tachi Yokut Tribe relies on groundwater for most of the water supply for the Santa Rosa Rancheria, which has an estimated population of 887 (2022 GSP p. 2-5; ACS Survey 2021). These communities rely on groundwater supplied by water systems. In addition, an estimated 2,080 domestic wells are used in the subbasin.

Domestic wells and community water systems in DACs and communities of color are typically disproportionately impacted by poor drinking water quality (Pace et al., 2022). These are significant issues: there are now around 450 “disadvantaged unincorporated communities” in the 8 counties of the San Joaquin Valley[6] and “over 30% of the population [of the San Joaquin Valley] lives in unincorporated areas with little infrastructure to support clean drinking water, sewage treatment and other services” (Hang et al. 2021, footnotes omitted).

Regarding water quality, “the region is a hot spot for unsafe drinking water, a problem that is most acute for small, poor, rural communities…” (PPIC, 2019). A “pervasive problem is the accumulation of nitrate in groundwater, due to decades of intensive use of nitrogen fertilizer and dairy manure on fields. The nitrate problem is most acute for small community and domestic wells that are relatively shallow, where nitrate concentration is often higher” (PPIC, 2017). Additionally, other studies have noted that values of shallow groundwater in drainage problem areas are as high as 40,000 mg/L (Beard et al., 1994; Fujii and Swain, 1995).

One indicator of water quality issues for drinking water users is dependency on a community water system (CWS) that is out of compliance with standards or requirements. As mentioned above, four of the ten CWS in the Tulare Lake Subbasin

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I.e., San Joaquin, Stanislaus, Merced, Madera, Fresno, Kings, Tulare, and Kern counties.

are listed as failing for reasons related to water quality, treatment, and supply shortage or drought risk (State Water Board, 2023a). In both disadvantaged unincorporated communities and economically disadvantaged cities in the San Joaquin Valley, “people of color are 84% and 83%, respectively, of those served by out-of-compliance CWSs.[…] These levels are roughly 10 percentage points higher than the overall representation of this group in the population” (London et al., 2021). Domestic wells in the subbasin could also be experiencing water quality impacts, but specific monitoring data is not available.

3.5.1.2 Agriculture

The subbasin used water to farm an average of 342,400 acres of crops per year between 1990 and 2016 (2022 GSP, p. 3-4). Between 1996 and 2015, cotton acreage experienced the greatest change with a decrease of more than 100,000 acres (approximately 46%). Around the same period, permanent crops (such as almonds, stone fruit, and pistachios) substantially increased in the subbasin (increases about 52,260 acres or 250%). As of 2016, a mix of crops and permanent nuts continue to be grown in the subbasin with cotton crops covering the largest agricultural acreage, followed by almonds and pistachios (Wood, 2020).

The 2022 GSP estimates that agricultural pumping demand from 1990 through 2016, has ranged from 77,680 AFY (2011) to 618,840 AFY (1990) and averaged 318,410 acre-feet per year (AFY) in the subbasin (2022 GSP, p. 3-44).

3.5.1.3 Environment

Potential environmental beneficial uses of groundwater include providing water for natural habitat found along portions of public navigable waterways located in the subbasin. The southern fork of the Kings River near Highway 198 west of Lemoore, for example, is a public navigable waterway with natural habitat. Natural habitat is also present within a portion of the federal Atwell Island Recreation Area that is located within the southeast portion of the subbasin (**Figure 3-12**).

3.5.1.4 Oil and Gas Production

The 2022 GSP states, “Oil production is a main industry in certain areas of Kings County and the Tulare Lake Subbasin, primarily within in the Kettleman City area.” (2022 GSP, Appendix B, p. B-6). State Water Board staff reviewed the California Geologic Energy Management Division’s Well Finder web mapping application and found no active oil production wells in the Tulare Lake Subbasin. There are, however, about 10 idle oil and gas wells and one idle water disposal well in the Tulare Lake Subbasin, and almost 400 now-inactive oil- and gas-related wells were historically drilled in the basin (CalGEM Well Finder, 2023).

3.5.2 Aquifer Framework

The complex subbasin aquifer setting includes unconfined and semi-confined aquifers above the Corcoran Clay and a confined aquifer below the Corcoran Clay (**Figure 3-13**). The unconfined and semi-confined units are distributed throughout the upper portions above the Corcoran Clay and are comprised of course- to medium-grained sediments with abundant lenses of fine-grained deposits (clay, sandy clay, sandy silt, and silt) (USGS, 1998). A study conducted in the 1960s subdivided the coarser grained deposits into three units: older alluvium, younger alluvium, and undifferentiated continental deposits (Croft and Gordon, 1968).

The principal groundwater aquifers within the subbasin occur primarily in the coarser-grained Sierran sediment deposits that form alluvial fans along the Kaweah River, Kings River, Tule River, and streams that drain from the Sierra Nevada Mountains into the southeastern portion of the subbasin. Alluvial fans also form along streams that drain from the Coast Ranges into the west portion of the subbasin. The Tulare Formation, which is comprised of these fan deposits, is one of the most important water-bearing formations in the subbasin (2022 GSP, p. ES-12).

Physiography (geography that deals with physical features of the earth), weathering characteristics, and soils have typically been used to map formations in the subbasins within the Central Valley. However, classifying stratigraphic units (layers of sedimentary rock) in the subsurface has been challenging since lithology (type of rock formation) variations are not distinct (Bertoldi and others, 1991). As a result, most groundwater studies of the Central Valley define hydrogeologic units—aquifers and confining units—rather than stratigraphic units (USGS, 2009). In the Tulare Lake Subbasin 2022 GSP, the hydrogeologic setting was simplified for the Hydrogeologic Conceptual Model. The subbasin is divided into three different aquifer zones for groundwater level monitoring:

- A-zone is the shallow unconfined portion of the aquifer which is approximately less than 100 ft below ground surface (bgs) above the A-Clay and in areas where shallow groundwater is present outside of the A-Clay.
- B-zone: is the unconfined portion of the aquifer above the E-Clay (Corcoran Clay) and below the A-Clay and is approximately 100 to 700 ft bgs.
- C-zone: is the confined portion of the aquifer below the E-Clay and is approximately more than 700 ft bgs, however the E-Clay varies in depth and is much shallower in the northern portion of the subbasin.

The Tulare Lake Subbasin 2022 GSP states that the A-zone has been routinely de-watered due to lack of recharge and does not recommend use of the A-zone as a groundwater supply for public/domestic use because water levels in the aquifer are unstable (2022 GSP, p. ES-2 12).

The 2022 GSP also describes a shallow “R”-zone along the Kings River, described in Section 4.1.1.3, which may functionally be part of the A-zone.

3.5.3 Groundwater Levels

PPIC indicates that “Long-term depletion of the [San Joaquin Valley] region’s aquifers” can be traced to 1930s (PPIC, 2017), State Water Board staff confirmed this pattern in the Tulare Lake Subbasin by evaluating groundwater level data from the past 75 years.

Board staff analyzed groundwater level data from the California Statewide Groundwater Elevation Monitoring (CASGEM) Program to determine long term groundwater level trends. CASGEM data are often spatially and temporally inconsistent, as CASGEM wells are not all systemically monitored at the same time. To reduce the impact of disproportionate spatial and temporal monitoring, staff analyzed data from wells with:

- groundwater level data from at least 40 percent of the years in the study period of 1948 to 2023
- at least one groundwater measurement after 2000

Of the 679 wells available in CASGEM, 102 met these criteria to analyze trends in spring groundwater levels and 86 met these criteria to analyze trends in fall groundwater levels. These wells were then analyzed for trends at the 90% confidence level using a Mann Kendall test, which is a common statistical test for detecting trends.

- For spring, 84% (86) of the wells had a negative trend, 3% (3) had a positive trend, and the remaining 13% (13) had no trend at the 90% confidence level.
- For fall, 82% (70) of the wells had a negative trend, 1% (1) had a positive trend, and the remaining 17% (15) had no trend at the 90% confidence level.

Further, these analyses indicate that: (1) groundwater decline has been a long-standing, multi-decade problem, (2) groundwater elevations have generally declined by 100 or more feet, and (3) groundwater decline has generally accelerated since around the year 2000.

3.5.4 Groundwater Recharge

Groundwater recharge in the subbasin occurs primarily by two methods: (1) infiltration of surface water from the Kings River and unlined water conveyances (canals), and (2) deep percolation of applied irrigation water (Croft and Gordon, 1968; DWR, 1995).

The Mid-Kings River GSA and El Rico GSA are implementing several groundwater recharge projects in the subbasin (Annual Report, WY 2022). Currently, Mid-Kings River GSA is developing several new recharge basin projects in various locations while

expanding existing recharge basins. Concurrently, El Rico GSA is implementing several recharge and storage projects at their conveyance systems and storage facilities.

3.5.5 Groundwater Storage

In 1995, DWR estimated the total storage capacity of the Tulare Lake Subbasin based on an estimated specific yield of 8.5% and water level data collected by DWR and well owners who volunteered data. According to the calculations, the total groundwater storage capacity of the basin is approximately 17.1 million AF to a depth of 300 ft, and approximately 82.5 million AF to the base of fresh groundwater, often treated as the "bottom" of a basin (DWR, 2016). These same calculations estimate 12.1 million AF of groundwater to a depth of 300 ft stored in the subbasin as of 1995 (DWR, 1995). In 1989, the United States Geological Survey created a three-dimensional groundwater flow model and estimated the amount of stored groundwater in the subbasin as of 1961 was 37 million AF to a depth of < 1000 ft (Williamson, et al., 1989).

In the 2020 Tulare Lake Subbasin Hydraulic Model for the 2022 GSP, two numerical models were calibrated to look at the overall change in storage for the Tulare Lake Subbasin from 1990-2016 and 1998 to 2010. The model included outflow of groundwater from the subbasin to the Kings, Kaweah, and Tule subbasins and inflow of groundwater from the Westside and Kern subbasins. In the models, the subbasin was separated into two aquifers: an Upper Aquifer representing an unconfined/semi-confined aquifer above the Corcoran Clay, and a Lower Aquifer representing a confined aquifer which is below the Corcoran Clay.

The GSAs ran a total of four forecast models: two forecast models from the 1990-2016 calibration model that extend into the years 2017-2070 and two forecast models from the 1998-2010 calibration model that extend into the years 2040-2048. Each forecast model time period has 1) a baseline forecast model, which forecasted future gains and losses assuming business-as-usual groundwater use and recharge; and 2) a projects forecast model, which assumed implementation of the projects and management actions described in the GSP.[7]

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[7] From the 2022 GSP: A comparison of the 1990-2016 historical model, 2017-2070 Baseline Forecast, and 2017-2070 Projects Forecast was made using the annual average groundwater balance data for each simulation (2022 GSP, Appendix D, Table D7-3). The Baseline and Projects forecast models both assume that land fallowed during the 2011-2016 drought would be put back into production, and that overall crop

These models indicate a substantial decline of 142,214 AFY in upper-aquifer groundwater storage and a modest increase of 56.519 AFY in lower-aquifer groundwater storage between 1990 and 2016. Both aquifers, however, are projected to decline over coming decades, even with implementation of projects and management actions identified in the 2022 GSP. While models indicate that projects and management actions do not halt overdraft, they do decrease overdraft, as noted in **Table 3-2** (2022 GSP Appendix D, p. 30, Table D7-3, Figure D5-4).

Table 3-2 - Comparison of Modeled Recent Historic and Future Groundwater Storage Changes

Model Run	Upper Aquifer storage change (AFY)	Lower Aquifer storage change (AFY)
1990 - 2016 calibration	Annual loss of 142,214	Annual gain of 56,519
2017-2070 baseline forecast	Annual loss of 91,547	Annual loss of 51,440
2017-2070 projects forecast	Annual loss of 29,931	Annual loss of 6,269
1998 – 2010 calibration	Annual loss of 103,177	Annual gain of 29,412
2040-2048 baseline forecast	Annual loss of 104,055	Annual loss of 45,379
2040-2048 projects forecast	Annual loss of 25,079	Annual gain of 5,687

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demand would increase due to the maturation of permanent crop as described in Section 7.1.1. The increase in ET demand was also exacerbated by climate change. Furthermore, the forecasts also assume that groundwater levels would continue to decline at historical rates for 10 or more years prior to project implementation. As a result, even though the Baseline Forecast 2017-2070 average annual pumping, recharge, and river leakage are similar to the Calibration 1990-2016 average values, the net change in storage increased from -85,690 AF/Y to -142,990 AF/Y because there was more interbasin outflow from the Subbasin into the surrounding subbasins. The annual average values for 1998-2010 and 2040-2048 “normal hydrology” periods have similar results, where the net change in storage increased from -73,760 AF/Y to -149,430 AF/Y. (p. 581)

3.5.6 Groundwater Quality

Groundwater quality in the subbasin varies across the basin and with depth and is impacted by both natural and anthropogenic (human caused) constituents. Generally, groundwater quality increases with depth, with the poorest quality groundwater in the unconfined and semi-confined aquifers, the A-Zone and B-Zone, respectively (see Section 3.5.2, above, for more information on the aquifers). These shallow zones of the aquifer are degraded by anthropogenic constituents such as total dissolved solids (TDS) and nitrate, measured as N (nitrogen), from agricultural land use. The highest quality groundwater is typically in the deeper, confined aquifer, the C-zone. The C-zone is found beneath the E-clay (the Corcoran Clay) and is generally unimpacted by anthropogenic constituents. However, the C-zone may have increases in naturally occurring constituents, such as arsenic, due to over-pumping. Over-pumping can release arsenic and other constituents from clays through dewatering and compaction of clays related to subsidence.

Several existing water quality programs have either conducted sampling programs or required regulated entities (such as public water systems) to sample groundwater in the subbasin. Agencies that regulate and/or monitor groundwater quality in the subbasin include:

- State Water Board
    - Division of Drinking Water (regulatory)
    - Groundwater Ambient Monitoring and Assessment Program (monitoring)
- Central Valley Regional Water Quality Control Board (Central Valley Water Board)
    - Irrigated Lands Regulatory Program (regulatory)
- U.S. Geological Survey (monitoring)
- Department of Water Resources (monitoring)
- Department of Pesticide Regulation (regulatory)

Groundwater quality data from these programs can be accessed through the Groundwater Ambient Monitoring and Assessment (GAMA) Program's groundwater information system tool (State Water Board, 2023c). These agencies have collected groundwater quality samples from wells within the unconfined, semi-confined, and confined aquifers within the subbasin (A-Zone, B-Zone, and C-Zone, respectively).

3.5.6.1 Key Constituents

State Water Board staff developed the SGMA Groundwater Quality Visualization Tool (State Water Board, 2023b) to help GSAs and other interested parties identify the groundwater quality constituents that each GSP should address. The tool uses data from the GAMA dataset to summarize per-basin constituents that: 1) may be influenced by basin-wide groundwater management and 2) exceed regulatory thresholds. The tool identifies constituents that have exceeded regulatory standards in three or more wells since 2015.

As of March 28, 2023, the tool identifies five such constituents for Tulare Lake, as listed in **Table 3-3**, below. Seventy-eight (21%) of wells sampled for these five constituents had concentrations exceeding regulatory standards (see **Figure 3-14**). The actual extent and impact of these constituents is likely much greater since most wells are not part of a monitoring network or regularly monitored for water quality impacts. Moreover, this tool does not address whether all constituents are consistently monitored in the subbasin, so there may be other water quality issues in the subbasin that are not identified by the tool.

Table 3-3 - Summary of Water Supply Wells in the Tulare Lake Subbasin Exceeding Regulatory Water Quality Thresholds for Selected Constituents

Constituent**	Regulatory Threshold (MCL)	Wells above MCL or SMCL (%)	Risk
Arsenic	10 µg/L	56%	Digestive health, motor health, may cause cancer, and more (ATSDR, 1998)
Nitrate as Nitrogen	10 mg/L	4%	Decreases the ability for blood to carry oxygen to tissues (EPA, 2006)
Gross Alpha	15 pCi/L	19%	Risk of cancer (EPA, 2001)
Uranium	20 pCi/L	14%	Kidney damage and risk of cancer (EPA, 2001)
TDS	500-1000 mg/L*	4%	No health risk at SMCL (EPA, 2017)

* Secondary MCL
** 1,2,3-TCP has also exceeded regulatory standards, but it was not identified in the tool or listed in Table 3-3, as there have only been two exceedances, and only one was post-2015.

3.5.6.2 Driving Mechanisms

Constituent concentrations in groundwater are dependent on physical and chemical influences. Examples of physical influences include changes in groundwater levels, gradients, source water recharge volumes, and quality of recharge water. Examples of chemical influences include reduction/oxidation (redox) conditions of groundwater (which can cause mobilization, mineralization, or adsorption of constituents) and radioactive decay of elements (Jurgens et al., 2009).

Many studies suggest that groundwater level decline and subsidence may increase constituent concentrations by changing the physical and chemical influences on constituent concentrations (Levy et al., 2021; Haugen et al., 2021; Smith et al., 2018). For example:

- Shallow constituents, which typically exist in the top of the unconfined aquifer, may migrate downward with the water table resulting in those constituents being pulled downward into well screens at deeper depths.
- Groundwater decline may cause constituents to migrate by altering groundwater elevation gradients.
- Well users may encounter new constituents as wells are drilled deeper into the aquifer where there are often higher concentrations of arsenic, uranium, and TDS.
- Artificial recharge or changes in groundwater levels that alter redox conditions may cause the mobilization of constituents (e.g., Haugen et. al., 2021).
- Groundwater overdraft and resulting subsidence may expel pore water from compacted clay layers, increasing arsenic concentrations (Smith et. al., 2018; Underhill, 2023; Erban et. al., 2013). Arsenic can pose a significant threat to human health for people who depend on groundwater for drinking purposes (USEPA, 2023).

3.5.6.3 Impacts to Drinking Water Users

Four of the five constituents listed in Table 3-3 pose health risks to drinking water users. As shown in Table 3-3, these constituents pose health risks by causing digestive issues (arsenic), mobility and visual issues (arsenic), kidney disease (uranium), respiratory issues (nitrate), and cancer (arsenic, gross alpha, and uranium) (EPA, 2001; ATSDR, 1998). The remaining constituent in Table 3-3, TDS, does not pose a significant health risk but is assigned a Secondary Maximum Contaminant Level (SMCL) of 500 mg/L for taste, staining, hardness, and other non-health risk factors.

3.5.6.4 De-designated Area

A portion of the A-Zone and B-Zone aquifers does not legally provide beneficial use for municipal or agricultural supply purposes (**Figure 3-15**). In 2017, the Central Valley Water Board adopted Resolution R5-2017-0032, which changed the Tulare Lake Basin Water Quality Control Plan (WQCP, 2018) to de-designate (remove beneficial uses from specified areas where those uses are not suitable) beneficial use in this area for municipal or agricultural supply purposes (RWQCB, 2017). The Central Valley Water Board noted that groundwater salinity concentrations in this area already exceeded the maximum salinity concentration of 3,000 mg/L TDS for municipal beneficial use which is also the maximum salinity concentration identified to support agricultural beneficial uses (Resolution No. 88-63).

3.5.7 Subsidence

Land subsidence impacts in the subbasin have been attributed to groundwater management processes, predominantly over pumping in areas where fine-grained sediments overlie coarser grained sediments (USGS, 2018). As water is pumped and removed from sediment pore space, the sediment structure collapses, land surface elevations decline, and groundwater storage capacity is lost. Land subsidence in the basin can impact infrastructure, increase flooding due to sinking of levees, and permanently reduce aquifer storage. Many areas within the Tulare Lake Subbasin have experienced subsidence as a result of groundwater extractions. Interferometric Synthetic Aperture Radar (InSAR) uses radar images to remotely sense surface elevation changes over time. Recent InSAR data spanning June 2015 to April 2023 indicate the max subsidence in that time period in the Tulare Lake Subbasin is approximately 6 ft on the northwestern and western side of the subbasin near Hanford and Corcoran (**Figure 3-16**).

3.6 Basin Hydrology - Surface Water

Human activities over the last few centuries have substantially altered surface water hydrology in the area (see Section 3.3).

The Central Valley Water Board's Tulare Lake Basin Plan summarizes surface water systems in the Tulare Lake hydrological region, which includes the Tulare Lake groundwater subbasin:

> The Kings, Kaweah, Tule, and Kern Rivers, which drain the west face of the Sierra Nevada Mountains, are of excellent quality and provide the bulk of the surface water supply native to the basin. Imported surface supplies, which are also of good quality, enter the basin through the San Luis Canal/California Aqueduct System, Friant-Kern Canal, and the Delta-Mendota Canal. Adequate control to protect the quality of these resources is essential, as imported surface

water supplies contribute nearly half the increase of salts occurring within the basin.

Buena Vista Lake and Tulare Lake, natural depressions on the valley floor, receive flood water from the major rivers during times of heavy runoff. During extremely heavy runoff, flood flows in the Kings River reach the San Joaquin River as surface outflow through the Fresno Slough. These flood flows represent the only significant outflows from the basin.

In addition to the Kings, Kaweah, Tule, and Kern rivers, the basin contains numerous mountain streams. These streams have been administratively divided into eastside streams and westside streams using Highway 58 from Bakersfield to Tehachapi. Streams from the Tehachapi and San Emigdio Mountains are grouped with westside streams. In contrast to eastside streams, which are fed by Sierra snowmelt and springs from granitic bedrock, westside streams derive from marine sediments and are highly mineralized, and intermittent, with sustained flows only after extended wet periods (Central Valley Water Board, 2018).

According to the 2022 GSP, currently, surface water is delivered through at least 34 conveyance systems (rivers, streams, canals, and diversions) throughout the subbasin (2022 GSP, p. 3-7; **Figure 3-17**). The California Aqueduct, a major component of the State Water Project, runs along the western border of the subbasin, but smaller canals, such as the Homeland and Tulare Lake canals, move water within the subbasin.

The Kings River is the largest and most consistent source of surface water to the subbasin. Surface water delivery volumes from the Kaweah River, St. Johns River, Tule River, Deer Creek, and the State Water Project are minor compared to the Kings River delivery volumes (2022 GSP p. 3-51). The Kings River has the largest runoff volume and the second-largest drainage of the four rivers in the area (US EPA, 2007).

The reaches of the Kings and Tule Rivers that overlie the subbasin support the following beneficial uses:

- Agricultural Supply (AGR)
- Water Contact Recreation (REC-1)
- Non-Contact Water Recreation (REC-2)
- Warm Freshwater Habitat (WARM)
- Wildlife Habitat (WILD)
- Ground Water Recharge (GWR)

The Tule River below Lake Success also supports Municipal and Domestic Supply (MUN), Industrial Service Supply (IND), and Industrial Process Supply (PRO) (Central Valley Water, 2018).

The Kings, Kaweah, St. Johns, and Tule Rivers are all fully appropriated year-round, meaning those sources have insufficient supply for new surface water right applications for diversions at any time of the year. Poso Creek is fully appropriated from June 15 through October 31 of each year, meaning no water is available for new water rights applications for diversions during those months (State Water Board, 1998).

4.0 Recommendations for Board Action

SGMA states, “in those circumstances where a local groundwater management agency is not managing its groundwater sustainably, the State needs to protect the resource until it is determined that a local groundwater management agency can sustainably manage the groundwater basin or subbasin.” To ensure SGMA is implemented successfully, the State Water Board may temporarily intervene in groundwater management after DWR determines that proposed management of a groundwater basin is inadequate due to deficiencies in the GSP(s) for the basin (Wat. Code § 10735 et. Seq).

GSPs for critically over-drafted high- and medium-priority basins had to be adopted and submitted to DWR for their assessment by January 31, 2020 (Wat. Code § 10735.2, subd. (a)(2)). The Tulare Lake Subbasin 2020 GSP was submitted to DWR on January 29, 2020, and DWR posted the GSP to their website and established a 60-day comment period on January 31, 2020. DWR had two years within the GSP’s submittal date to issue a written assessment and a determination of the status of the GSP. On January 28, 2022, DWR gave the Tulare Lake Subbasin 2020 GSP an incomplete determination and the Tulare Lake GSAs had 180 days to address the GSP deficiencies identified in DWR’s Incomplete Determination of the 2020 Tulare Lake Subbasin GSP. The Tulare Lake GSAs then adopted a revised GSP (Tulare Lake Subbasin 2022 GSP), which was submitted to DWR on July 27, 2022, and posted to DWR’s website on August 1, 2022. DWR evaluated the 2022 GSP and determined that the GSP did not sufficiently correct the deficiencies identified in DWR’s incomplete determination. DWR officially determined the Tulare Lake Subbasin 2022 GSP “inadequate” on March 2, 2023.

The State Water Board now must determine whether a probationary designation is warranted (See Section 2.2.1.1). Board staff have reviewed the GSP and the DWR staff reports documenting DWR’s review of the GSP. Staff concur with DWR’s determination that the Tulare Lake GSP is inadequate, and staff analyses indicate the Tulare Lake GSAs are not managing their groundwater sustainably. Staff note:

- The GSP’s SMC will allow substantial impacts to people who rely on domestic wells for human consumption, cooking, and sanitary purposes and on infrastructure such as canals, levees, as well as impacts to the aquifer itself within the subbasin.
- Based on the above, the Tulare Lake GSAs are not on track to achieve sustainability by 2040. Designating the subbasin probationary is critical for getting the basin back on track to achieve sustainability by 2040.

Staff therefore recommends the State Water Board designate the subbasin as a probationary basin.

The State Water Board may designate a basin probationary if state intervention authorities are triggered and after providing notice and holding a public hearing (Wat. Code, § 10735.2, subd. (a)). The overall goal of probation is to gather information to help local GSAs address deficiencies in their plans, so they can sustainably manage their groundwater resources as soon as possible. During a probationary designation, the State Water Board will require many groundwater extractors to report their extractions, which will help resolve data gaps related to groundwater use, and State Water Board staff will provide guidance to GSAs working to develop an adequate sustainability plan (or plans). Concurrently, GSA efforts to fix deficiencies should continue.

After GSAs have adopted a revised plan (or plans) that resolve the deficiencies, they can seek to exit probationary status by submitting the plan (or plans) to the State Water Board. If the State Water Board determines that deficiencies were addressed, the Board may resolve to have the GSA (or GSAs) exit probation. If deficiencies are not addressed after a year, the State Water Board can take steps to manage groundwater more directly by developing and adopting, after noticing and a hearing, an interim plan for the basin. An interim plan is intended to temporarily manage the basin until GSAs can develop and implement an adequate plan or plans. A probationary determination is a first step to addressing continuing overdraft while also resolving plan deficiencies and is required before the State Water Board can move to the step of developing an interim plan.

The following sections explain staff recommendations for a probationary determination:

- Section 4.1 recommends identification of specific GSP deficiencies and potential actions to address deficiencies
- Section 4.2 recommends that no areas in the subbasin be excluded from probationary status
- Section 4.3 recommends that the groundwater extraction annual reporting deadline be altered such that:
    - Users who are required to report their extractions do so by December 1 of each year for the previous water year
- Section 4.4 recommends that:
    - Users extracting 2 AFY or less for domestic purposes only be excluded from reporting groundwater extractions and paying fees
    - Users extracting more than 2 AFY for any reason be required to report groundwater extractions and pay fees
    - Users extracting more than 500 AFY for any reason be required to install flow meters

4.1 Groundwater Sustainability Plan Deficiencies and Potential Actions to Address Deficiencies

If the State Water Board designates a basin probationary, the Board must identify the specific deficiencies and potential actions to address the deficiencies (Wat. Code § 10735.6, subd. (a)). This Staff Report incorporates deficiencies identified in DWR's determination. For the Tulare Lake Subbasin 2022 GSP, Board staff reviewed the GSPs and identified additional key issues generally within the scope of DWR deficiencies. Board staff are also considering that it would take time for basins to address deficiencies and exit probation. While other basins began implementing plans in 2020 that are now approved, the Tulare Lake subbasin does not yet have a plan that will achieve sustainable groundwater management by 2040. In order to meet the 20-year timeline, additional issues with the plan should be addressed that could have been reasonably deferred by other basins to 2025.

Below, State Water Board staff have identified specific deficiencies within the Tulare Lake Subbasin 2022 GSP and have outlined potential actions to address those specific deficiencies. Deficiencies that have been identified within the GSP(s) generally include but are not limited to: (1) chronic lowering of groundwater levels with insufficient SMC; (2) continued land subsidence; and (3) further degradation of groundwater quality.

DWR's 2022 Inadequate Determination evaluates the subbasin's 2022 GSP against the deficiencies DWR identified for the 2020 GSP in DWR's 2020 GSP Incomplete Determination. Consequently, for each of the three overarching deficiencies, State Water Board staff describe relevant portions of the 2020 GSP, DWR's 2020 GSP Incomplete Determination, and the 2022 GSP. Staff then break down the deficiency into components. Finally, staff identify potential actions to address the deficiency components: some actions contribute to addressing more than one deficiency.

The potential actions to address the deficiencies provide the GSAs with a possible path out of state intervention and State Water Board oversight. Ultimately, the State Water Board will evaluate any updated and adopted GSP as a whole and will determine whether the GSAs have addressed the deficiencies, whether the GSP is consistent with SGMA, and whether the GSAs are implementing the GSP in a manner that the Board finds will likely achieve the sustainability goal.

In some cases, a GSP revision may resolve a deficiency identified by the Board, but the Board may find the revision adversely affects other management criteria or may be inconsistent with other board priorities, such as:

- The Human Right to Water Resolution (State Water Board, 2016)
- Racial Equity Resolution (State Water Board, 2021a)

- Policy implementing the Safe and Affordable Funding for Equity and Resilience (SAFER) Program Fund Expenditure Plan (State Water Board, 2021b)
- Tribal beneficial uses of water (State Water Board, 2017)
- Executive Order B-10-11, which established Administration Policy to encourage State agencies to communicate and consult with California Native American tribes (Governor's Exec. Order No. B-10-11 (Sept. 19, 2011))
- Antidegradation Policy (State Water Board, 1968)
- Groundwater Management Principles & Strategies to Monitor, Analyze & Minimize Impacts to Drinking Water Wells (DWR, 2021)
- California Water Resilience Portfolio (CNRA, 2020)
- California's Water Supply Strategy (CNRA, 2022)
- The Board's public trust obligations (see section 5.3)

The Board may only amend or rescind a probationary designation decision after providing appropriate public notice of the proceeding (Wat. Code, § 10736, subds. (b), (c)).

Roadmap to Proposed Deficiencies

Table 4-1, below, summarizes the deficiencies described in sections 4.1.1 through 4.1.3. See the following sections for additional detail on each deficiency including potential actions to address the deficiencies. **Appendix A** summarizes the text in sections 4.1.1 through 4.1.3, including the sub deficiencies, what SGMA requires, a summary of deficiencies, and potential actions to correct the deficiencies.

Table 4-1 – Summary of Proposed State Water Board Deficiencies

Deficiency Groundwater Levels (GL)-1 – The 2022 GSP does not clearly describe the groundwater level conditions that would result in an undesirable result for the basin.
Deficiency GL-2 – The GSAs did not consider all beneficial uses and users in setting SMC for groundwater levels in the 2022 GSP or adequately describe the impacts of criteria on beneficial uses and users. MTs in the A-zone would allow for significant and unreasonable water level declines.

Deficiency GL-3 – The monitoring network does not provide sufficient coverage to monitor for impacts to beneficial uses and users in the three aquifers in the subbasin (due to data gaps in A-zone coverage and inconsistent sampling).
Deficiency GL-4 – The 2022 GSP's discussion of well impact mitigation lacks important details and the GSP does not explain how well impact mitigation fits into the GSAs' approach for avoiding undesirable results.
Deficiency GL-5 – The 2022 GSP does not describe a feasible path for halting chronic lowering of groundwater levels.
Deficiency GL-6 – The GSAs do not consider the effects on other sustainability indicators, such as groundwater storage, subsidence, degradation of groundwater quality, and depletions of interconnected surface water.
Deficiency Land Subsidence (LS)-1 - The 2022 GSP does not clearly describe the subsidence conditions that would result in an undesirable result for the basin.
Deficiency LS-2 - The GSAs did not consider all beneficial uses and users in setting quantitative criteria for subsidence in the 2022 GSP or adequately describe the impacts of criteria on beneficial uses and users
Deficiency LS-3 – The GSAs did not adequately consider the impacts of subsidence on flood protection infrastructure.
Deficiency LS-4 – The GSP does not provide adequate implementation details.
Deficiency Groundwater Quality (GWQ)-1 – The 2022 GSP's definition of an undesirable result is not consistent with GSP Regulations.
Deficiency GWQ-2 – Minimum thresholds set by the 2022 GSP are not consistent with GSP Regulations.
Deficiency GWQ-3 – Measurable Objectives set by the 2022 GSP are not consistent with GSP Regulations.

Deficiency GWQ-4 – The water quality monitoring plan in the 2022 GSP is not consistent with GSP regulations.
Deficiency GWQ-5 – Management actions should be responsive to water quality degradation.

4.1.1 Deficiency GL – Defining and Avoiding Undesirable Results Related to Chronic Lowering of Groundwater Levels

Under SGMA, one piece of achieving the sustainability objective for a basin is avoiding "chronic lowering of groundwater levels indicating a significant and unreasonable depletion of supply if continued over the planning and implementation horizon." (Wat. Code § 10721, subd. (x). Lowering groundwater levels can cause shallow wells to go dry or reduce their productivity, increase the energy costs of pumping, bring polluted water closer to well screens (the area where groundwater enters a well), or reduce water available for deep-rooted plants (see definition of groundwater-dependent ecosystems in Section 1.2). Lowering groundwater levels also makes it more difficult to avoid other, related undesirable results caused by groundwater conditions, including subsidence and depletions of interconnected surface water.

DWR concluded that the Tulare Lake Subbasin 2022 GSP does not adequately justify its approach for developing SMC for chronic lowering of groundwater levels, the criteria that the GSAs will use to evaluate success in the subbasin. DWR notes, moreover, that the SMC would likely result in significant and unreasonable impacts to people who rely on shallow wells (see sections below). Board staff have built on DWR's analysis, noting the 2022 GSP does not clearly address the likelihood that all how all wells in the shallow part of the basin (the "A-zone") could go dry based on the GSP's approach, nor does it identify the wells that could be impacted by the GSP's current approach. Staff also describe gaps in the GSAs' proposed well impact mitigation proposal and the feasibility of avoiding chronic lowering of groundwater levels with the projects and management actions proposed in the 2022 GSP.

Table 4-2 – Summary of the Department of Water Resources' Chronic Lowering of Groundwater Levels Deficiency and Relevant Components of the 2020 and 2022 Tulare Lake Subbasin Groundwater Sustainability Plans

2020 GSP	DWR's 2020 GSP Incomplete Determination	2022 GSP	DWR's 2022 GSP Inadequate Determination
The 2020 GSP set criteria for sustainability by projecting where groundwater levels would be with business-as-usual pumping and no new projects or management actions.	The GSP does not define undesirable results, minimum thresholds, and measurable objectives for groundwater levels in a manner consistent with the GSP Regulations.	The 2022 GSP approach is based on a regional analysis of aquifer geometry and well completion depths rather than a trend analysis of groundwater levels from modeling results.	GSAs have not taken sufficient action in resolving the deficiency because the GSP does not provide additional detail nor quantitative analysis describing significant and unreasonable conditions.

4.1.1.1 Tulare Lake Subbasin 2020 Groundwater Sustainability Plan

This subsection and following subsections describe the portions of each GSP or DWR determination relevant to the proposed Board deficiencies.

Plain-language Definition of an Undesirable Result

The 2020 GSP's definition of an undesirable result related to chronic lowering of groundwater levels did not specify the type and quantity of problems with wells, water quality, and subsidence and reads: "Lowering groundwater levels can result in the following main impacts, the degree to which will determine if the conditions of lower groundwater levels are significant and unreasonable:

- water well problems
- subsidence
- deterioration of groundwater quality" (2020 GSP, p. 4-6).

Quantitative Definition of an Undesirable Result, Minimum Thresholds and Measurable Objectives and Associated Impacts

MTs are the numeric values used to define undesirable results. MOs are specific, quantifiable goals for the maintenance or improvement groundwater conditions to achieve the sustainability goal for the basin.

The 2020 GSP described an undesirable result as occurring when groundwater levels decline below the MTs at 45 percent of the RMSs for three consecutive years. MTs, in turn, were developed based on MOs. The 2020 GSP calculated MOs for year 2040 groundwater levels by assuming 15 years of “business as usual” groundwater declines.[8] The MTs were then set as one standard deviation from the average forecasted water level in July 2035 or 50 feet below the MOs, whichever was greater.

An analysis by DWR staff determined that the MTs were, on average, 73 ft below the basin’s measured 2017 groundwater levels at the RMSs (2020 GSP Incomplete Determination, p. 9). The 2020 GSP did not describe how groundwater conditions at the MTs would impact beneficial uses of groundwater, e.g., estimating how many wells in the subbasin would be dry if groundwater levels were to drop to the MTs.

Representative Monitoring Sites and Monitoring Network

The monitoring network as described in the 2020 GSP comprised a total of 61 water level RMS sites, 44 water quality RMS sites, and 28 land subsidence RMS sites (2020 GSP., Table 5-1). The 2020 GSP also noted that 34 additional water level sites and 2 additional subsidence sites were proposed. The Mid-Kings River and South Fork Kings GSAs had the most RMS sites of each type, and the Southwest Kings and TCWA GSAs had the fewest. There were six water level RMS wells screened in the A-zone: five in the northern portion of the subbasin and one in the southeast (**Figure 4-1**). The parts of the basin that do not have active groundwater extractions (Secondary Management Areas A and B) were not proposed to be monitored. Additionally, the 2020 GSP states, "Other sites are monitored for groundwater levels in the subbasin and provide additional data to prepare groundwater level maps. These locations are not RMSs and the GSAs desire to keep these data private" (ibid., p. 5-3).

[8]The GSAs developed MOs by projecting groundwater levels expected in 2035, assuming historical water use and surface water deliveries, “normal” hydrology, and no projects or management actions.

Well Impact Mitigation

The 2020 GSP did not mention plans for any well impact mitigation that would lessen the significance of impacts to wells from groundwater level declines allowed in the GSP. In describing the general impacts of MTs on well users, the 2020 GSP noted that, "although all of these potential impacts can be mitigated technically, they are considered significant undesirable results due to the expense involved" (ibid., p. 4-10).

Projects and Management Actions

The projects and management actions identified in the 2020 GSP generally included demand reduction (voluntary fallowing, dry farming, fallowing or retirement of fields converted to recharge basins) and supply augmentation (groundwater recharge basins, surface storage in ponds, canal/ditch improvements). The GSP stated that, if the projects and management actions were implemented by 2040, demand reduction would save approximately 44,000 AFY and supply augmentation would add approximately 137,000 AF/Y. The 2020 GSP does not identify specific water sources for its supply augmentation projects.

The discussion of projects and management actions did not specify the criteria that would trigger implementation, a time-table for implementation, a description of how the GSAs would meet costs, or an explanation of the source and reliability of the water necessary for the supply augmentation projects. Instead, the 2020 GSP stated that project "locations will be identified by each GSA and their respective partners within their area as soon as the need arises and funding is available." (ibid., p. 6-5).

Potential Effects of Minimum Thresholds on Other Sustainability Indicators

The 2020 GSP did not explain how minimum thresholds had been selected to avoid causing undesirable results in adjacent basins.

The 2020 GSP also did not explicitly discuss how groundwater level MTs relate to the MTs for other sustainability indicators; nor did the 2020 GSP explain how the GSAs had determined that basin conditions at groundwater level MTs will avoid undesirable results for each of the sustainability indicators.

4.1.1.2 Department of Water Resources' 2020 Groundwater Sustainability Plan Incomplete Determination

In the January 28, 2022, DWR determination letter, DWR identified a deficiency in the 2020 GSP related to groundwater level SMC:

> Deficiency 1 – The [2020] GSP does not define undesirable results or set minimum thresholds and measurable objectives for groundwater levels in a manner consistent with the GSP regulations.

(2020 GSP Incomplete Determination, p. 7).

DWR only identified the most fundamental issues with MTs, noting that "Department staff therefore are unable to assess whether the GSAs have established sustainable management criteria based on a commensurate level of understanding of the basin setting or whether the interests of beneficial uses and users have been considered." (ibid., p. 9).

Plain-Language Definition of an Undesirable Result

Regarding how the GSP defined an undesirable result related to chronic lowering of groundwater levels, DWR noted that the GSP stated "general types of impacts that can occur due to lowering groundwater levels: water well problems, subsidence, and deterioration of water quality...", but that:

> ...the GSP does not explain at what level those impacts would be considered significant and unreasonable, nor does it appear that those impacts were accounted for in the development of site-specific measurable objectives and minimum thresholds... (ibid., p. 8).

Quantitative Definition of an Undesirable Result, Minimum Thresholds and Measurable Objectives and Associated Impacts

DWR staff concluded that:

> ...the [2020] GSP did not define metrics for undesirable results and minimum thresholds based on the significant and unreasonable depletion of groundwater supply they intend to avoid through the implementation of the Plan, informed by, and in consideration of, the relevant and applicable beneficial uses and users in the subbasin. Instead, the [2020] GSP developed those criteria based on a numerical modeling exercise that projected current rates of groundwater level decline into the future... (ibid., p. 7-8).

Further, DWR staff concluded that the 2020 GSP:

> ...failed to explain how minimum thresholds at the representative monitoring sites are consistent with the requirement to be based on a groundwater elevation indicating a depletion of supply at a given location that may lead to undesirable results. Department staff also do not find evidence in the [2020] GSP that indicates the GSAs considered the interests of beneficial users and uses of groundwater in defining undesirable results or establishing minimum thresholds (ibid., p. 9).

Department of Water Resources' 2020 Groundwater Sustainability Plan Corrective Actions

DWR staff proposed a two-part corrective action to address the water level deficiency in the 2020 GSP. Firstly, DWR staff recommended that:

> The GSAs should revise the [2020] GSP to describe, with information specific to the subbasin, the groundwater level conditions that are considered significant and unreasonable and would result in undesirable results […] The GSAs should then explain or justify how the quantitative definition of undesirable results (i.e., 45 percent minimum threshold exceedances for three consecutive years), is consistent with avoiding the effects the GSAs have determined are undesirable results (ibid., p. 9).

Secondly, DWR staff recommended that:

> Rather than relying on a projection of continued groundwater level and storage decline to define the undesirable results and minimum thresholds, the GSAs must determine and document criteria based on a significant and unreasonable depletion of groundwater supply, informed by their understanding of the subbasin's beneficial uses and users. The GSAs must document the effects of their selected minimum thresholds on beneficial uses and users in the subbasin. In particular, if the GSP retains minimum thresholds that allow for continued groundwater level decline then the GSP should explain the anticipated effects of that decline on beneficial uses and users and should clearly explain whether projects and management actions have been identified to address impacts to those uses and users (ibid., p. 9-10).

4.1.1.3 Tulare Lake Subbasin 2022 Groundwater Sustainability Plan Submission and Water Year 2022 Annual Report

The GSAs submitted a revised GSP to DWR on July 27, 2022, in compliance with the 180-day resubmittal deadline. While not considered in DWR's assessment of the 2022 GSP, the GSAs also filed the WY 2022 Annual Report for the subbasin on March 31, 2023.

Plain-Language Definition of an Undesirable Result

The GSAs did not revise the plain-language definition of an undesirable result related to chronic lowering of groundwater levels; however, the Addendum describing the changes made to the 2020 GSP states:

> The revised SMC for groundwater level defines an undesirable result with respect to exceedance of a numerical threshold (a minimum threshold or MT)

which would cause a significant and unreasonable loss of beneficial uses for water supply, particularly for domestic/public supply (2022 GSP Addendum, p. 9).

Quantitative Definition of an Undesirable Result, Minimum Thresholds and Measurable Objectives and Associated Impacts

The GSAs did not revise the MOs from the 2020 GSP; however, the GSAs made significant adjustments to their approach to the water level MTs. The 2022 GSP approach is based on a regional analysis of aquifer geometry and well completion depths rather than a trend analysis of groundwater levels from modeling results (ibid., p. 12). The method for setting MTs varies by aquifer zone (see Section 3.5.2). The 2022 GSP assign wells to an aquifer zone based on the depth of the aquifer and well completion information. The aquifer zone depth criteria are:

- A-zone: wells completed at depths shallower than 100 ft. (presumably below ground surface [bgs]), not including those near the Kings River
- B-zone: wells completed between 100 and 700 ft depths (presumably bgs)
- C-zone: wells completed deeper than 700 ft (presumably bgs)
- R-zone: wells in the shallow, unconfined aquifer along the Kings River

The 2022 GSP distinguishes part of the shallow, unconfined aquifer along the Kings River from the A-zone, describing it as a “recharge zone” called the R-zone, a two-mile-wide zone along the Kings River. The 2022 GSP treats the R-zone separately from the A-zone because, according to the GSP, the area has better groundwater quality from Kings River recharge and so, unlike the A-zone, is a viable groundwater supply for public water system and domestic uses.

The 2022 GSP acknowledges that the E-Clay, which is the top of the C-zone aquifer, is not uniformly 700 ft deep throughout the subbasin, stating, “This depth variation will be more carefully considered in the future when the data gaps of well location and construction are more fully addressed” (ibid., p. 7). The 2022 GSP well analysis used DWR’s Online System of Well Completion Reports (OSWCR) dataset, which has over 6,000 well records for the subbasin.

The 2022 GSP describes nine 100-foot elevation ranges for representing the elevation of the top of the E-Clay (Corcoran Clay), which were used to develop SMC for the B-zone and C-zone aquifers but were not used to assign wells to aquifer zones.

A-zone: The GSAs set the MTs for the A-zone at the top of the A-clay, which is the *bottom* of the A-zone. The 2022 GSP states groundwater pumping is not the cause of fluctuations in groundwater levels in the A-zone. The 2022 GSP adds that the A-zone has been routinely de-watered due to lack of recharge and that, “the GSAs would not encourage use of the A-zone as a groundwater supply for public/domestic use primarily

because of the reliability issues" (ibid., p. 12). The 2022 GSP acknowledges that there are up to 377 domestic or public supply wells drawing from the A-zone (See also "Well Impact Mitigation" section below).

B-zone: The 2022 GSP incorporates the findings from a statistical analysis of public water system or domestic wells in the B-zone. Based on this analysis, the 2022 GSP sets the B-zone MTs at a level that is, according to the 2022 GSP, protective of 90 percent of wells within an E-Clay zone.

However, the analysis did not include wells that were drilled before the year 2000 and completed at (i.e., drilled to) depths shallower than 200 feet. The GSAs argue that well owners in the subbasin have adapted to having to replace or deepen shallower wells as groundwater levels decline, and so any remaining older, shallower wells "have a high likelihood of either being abandoned, deepened, or not used currently for beneficial uses." This decision resulted in the exclusion of 627 of the 2,048 wells in the B-zone (i.e., 31%) from the analysis.

In describing MTs in the B-zone, the 2022 GSP noted:

> The GSAs believe that the [B-zone] MT will be protective of beneficial uses in the B-zone and, in conjunction with a mitigation program (described in Appendix D), will avoid a significant and unreasonable loss of beneficial uses. The GSAs recognize that mitigation and adaptation to the proposed SMC for groundwater level requires better information on actual well conditions and will require case-by-case assessments of whether beneficial uses have been impacted at a given point in time (ibid., p. 12; see also "Well Impact Mitigation" section below).

The 2022 GSP MTs in the B-zone were generally lower than the 2020 GSP MTs at the same wells: DWR noted in the 2022 GSP Inadequate Determination that, "for the 30 representative monitoring sites, the [MT] has been lowered by an average of 30.4 ft. Six of the sites have minimum thresholds raised, with the greatest increase being 42 ft; and 17 minimum thresholds were lowered by as much as 254 ft below 2020 GSP levels" (2022 GSP Inadequate Determination, p. 12).

C-zone: The GSAs set the MTs for the C-zone at 50 feet higher than the top of the E-Clay (the E-Clay defines the top of the C-zone). According to the GSP, maintaining groundwater levels at this elevation would protect wells in the C-zone by adding a buffer to account for local pumping-induced drawdown. Because the C-zone is a confined aquifer, the GSAs calculated the expected drawdown from a typical C-zone well (pumping rate of 1,000 gallons per minute) to be 50 ft. The analysis used the 90th-percentile value for specific capacity from "17 aquifer tests by the USGS" (2022 GSP Addendum., pg. 10), and states that the MTs are protective of 90 percent of C-zone public water system and domestic wells. The 2022 GSP acknowledges that, "This methodology has a number of uncertainties associated with the actual depth to the E-

clay and how representative the specific capacity data are for wells in the subbasin" (ibid., p. 10).

As with the new MTs in B-zone RMS wells, DWR noted that the revised C-zone MTs are considerably lower in elevation than the 2020 MTs, stating, "the average minimum threshold adjustment for the 22 representative monitoring sites has an average lowering of 196 ft from the minimum thresholds set in the 2020 GSP…21 representative monitoring sites [*sic*] minimum thresholds were lowered as much as 451 ft below the 2020 minimum thresholds" (2022 GSP Inadequate Determination, p.13).

R-zone: The GSAs set MTs in the R-zone using a similar methodology to that used for the B-zone, defining MTs based on percentile statistics for well completion depths of the 60 public water system or domestic wells in the zone (2022 GSP Addendum, p. 12).

Representative Monitoring Sites and Monitoring Network

RMS sites in the 2022 GSP are listed in GSP Table 2-10 (ibid., Table 2-10). GSP Table 2-10 notes 56 wells with assigned MTs and MOs, fewer than the RMS wells in the 2020 GSP. None of the RMS wells are in the R-zone. The GSP states, "It is anticipated that the 2025 update to the GSP will include changes to both the distribution of RMS locations and the numeric values for the MT" (ibid., p. 14).

The WY 2022 Annual Report indicates that the number of monitoring well locations has decreased and is reported inconsistently. The GSP originally listed 70 monitoring wells; the number was reduced to 50 monitoring wells by 2020 and 2021, and the Annual Report implies that in WY 2022 only 40 monitoring wells were used. The WY 2022 Annual Report states:

> The [2020] GSP originally listed seventy (70) RMSs… However, some of the wells were found to no longer be accessible or had been destroyed... Forty-nine RMSs were included in the [subbasin] monitoring network during WY19 and 50 RMSs were included in WY20. The WY 2021 Annual Report used 53 RMS *[sic*] wells within the subbasin to report groundwater elevations (WY 2022 Annual Report, p. 8).

Later, the Annual Report states that 40 RMSs were monitored for water elevations, saying, "of the 40 wells, 26 had spring groundwater elevations that had an average of 31.2 ft above the MO. When compared to the MT, water levels were an average of 66.8 ft above it for 38 of the wells. Only 14 wells had spring measurements below the MO and two had spring measurements below the MT" (ibid., p. 20).

Well Impact Mitigation

The 2022 GSP included a Mitigation Plan Framework as an appendix, Appendix D. According to Appendix D, "the GSAs have agreed to [the Mitigation Plan Framework]

and will prepare individual mitigation programs specific to their stakeholder needs by January 2025" (2022 GSP Addendum, Appendix D, p. 1). The Mitigation Plan Framework lists the types of information that will be in each plan, such as eligibility criteria, the application process, an evaluation process, and funding sources.

The 2022 GSP's discussion of MTs also includes references to well impact mitigation:

A-zone: Noting that the A-zone MTs could affect up to 377 domestic and public water supply wells, the 2022 GSP states, "mitigation approaches will include consideration of deepening of A-zone wells into the B-zone, restricting agricultural pumping in areas where there are clusters of domestic wells, or filtration requirements that would improve water quality" (ibid., p. 13).

B-zone: The 2022 GSP states that the GSAs are "potentially willing to mitigate as many [as] 152 B-zone wells and 25 R-zone wells used for domestic or public supply" (ibid., p. 12).

C-zone: The 2022 GSP and Addendum do not mention whether any mitigation is planned for C-zone wells.

Relatedly, the WY 2022 Annual Report described wells that had experienced water shortage issues over the Water Year:

> According to DWR's Household Water Supply Shortage Reporting System, sixteen wells have within the [subbasin] have reported domestic well issues from 2019 to present. Of the sixteen reports, two wells have collapsed, and fourteen wells have gone dry. Wells that reported dry within this time frame had a total well depth ranging from 25 ft to 230 ft with most dry wells located in the Hanford area. Most wells that were reported dry were completed within the A zone (WY 2022 Annual Report, pg. 20).

Projects and Management Actions

The GSAs did not update projects and management actions in the 2022 GSP.

The WY 2022 Annual Report noted some updates in project and management action development and implementation.

According to the WY 2022 Annual Report, TCWA GSA designed a groundwater allocation policy to substantially reduce demand over time. TCWA GSA expects the policy to have a positive impact on groundwater levels and subsidence (ibid., p. 28).

Potential Effects of Minimum Thresholds on Other Sustainability Indicators

The 2022 GSP, in its Addendum, acknowledged that groundwater level declines contribute to land subsidence, but put off evaluating the specific interactions until 2025:

> In this regard, the SMC is focused on levels of subsidence that would result in impacts to specific types of infrastructure, which are assumed to represent the surface land uses that are being protected by the Subsidence MT. However, groundwater levels in the B-zone and C-zone aquifers generate the relative magnitudes of the effective stresses acting on the clays in the aquifer system and are the underlying physics driving subsidence. This is described in greater detail in Section 3. The MTs for groundwater levels represent one component of what levels of subsidence might occur, but the variables and relationships that cause subsidence are very complex and require modeling to produce quantitative values. The connection between groundwater level and subsidence will be revisited for the 2025 GSP update through a revision of the groundwater flow model, which will be then used to calculate groundwater pumping levels that would minimize subsidence and avoid associated undesirable results. This will more explicitly link groundwater pumping to observed and projected subsidence at different levels of pumping (2022 GSP Addendum, p. 13).

Similarly, the GSAs did not revise groundwater storage SMC or specifically evaluate their relationship to the new chronic lowering of groundwater SMC, stating:

> the groundwater storage SMC will be revisited for the 2025 GSP update through further analysis using a groundwater flow model. The groundwater level MTs specified in this addendum will be factored into the revision of the groundwater flow model, which will then be used to calculate the minimum groundwater storage volume associated with the groundwater level MT. This will then factor into the definition of the groundwater storage MT and thereby tie it to beneficial uses in each aquifer zone (ibid., p. 13).

The 2022 GSP and the Addendum did not discuss the relationship between groundwater level MTs and degradation of water quality or depletions of interconnected surface water.

4.1.1.4 Proposed State Water Board Deficiencies

In DWR's 2022 GSP Inadequate Determination dated March 2, 2023, DWR staff determined that the GSAs had not corrected the chronic lowering of groundwater levels deficiency in the 2022 GSP. DWR's 2022 GSP Inadequate Determination states:

> Overall, Department staff conclude the GSAs have not taken sufficient action in resolving the deficiency because the GSP does not provide additional detail nor quantitative analysis describing significant and unreasonable conditions. The [2022] GSP also does not describe the impacts to beneficial uses and users given the undesirable results definition (2022 GSP Inadequate Determination, p. 10).

Board staff concurs with DWR's findings in their 2022 GSP Inadequate Determination and hereby incorporate it by reference. In addition, Board staff has identified additional issues with continuity in monitoring well data, the role of well impact mitigation in avoiding undesirable results, and the GSAs' reliance on uncertain new water supplies to achieve sustainability.

Below, State Water Board staff breaks down deficiencies for the subbasin related to lowering of groundwater levels. Deficiencies from DWR's inadequate determination are incorporated into the deficiencies identified below.

Deficiency Groundwater Levels (GL)-1 - The 2022 GSP does not clearly describe the groundwater level conditions that would result in an undesirable result for the basin.

What SGMA Requires: The GSP Regulations require a GSA to "describe...the processes and criteria relied upon to define undesirable results applicable to the basin." This description must include the cause of past or potential undesirable results, "the criteria used to define when and where the effects of the groundwater conditions cause undesirable results," and the potential effects of undesirable results on groundwater uses and users and land uses and property interests (Cal. Code Regs., tit. 23, § 354.26).

Deficiency: DWR noted in its 2020 GSP Incomplete Determination that the 2020 GSP did not explain at what level the impacts of chronic lowering of groundwater levels would be considered significant and unreasonable. The GSAs did not update the description of an undesirable result in the 2022 GSP.

Without a clear description of degree of impacts that are "significant and unreasonable," GSAs and the State cannot evaluate whether MTs or broader quantitative definitions of an undesirable result that will guide day-to-day basin management are appropriate for avoiding undesirable results.

A clear understanding of what impacts the GSAs are trying to avoid is particularly important because the 2022 GSP's MTs for the A-zone would allow for significant and unreasonable effects on beneficial uses of groundwater in the A-zone (see Deficiency GL-2).

State Water Board staff proposes Potential Action GL-1 to address the deficiency.

Deficiency GL-2 – The GSAs did not consider all beneficial uses and users in setting SMC for groundwater levels in the 2022 GSP or adequately describe the

impacts of criteria on beneficial uses and users. MTs in the A-zone would allow for significant and unreasonable water level declines.

What SGMA Requires: The GSP Regulations require GSAs to set their MTs for chronic lowering of groundwater levels at "the groundwater elevation indicating a depletion of supply at a given location that may lead to undesirable results" (Cal. Code Regs., tit. 23, § 354.28, subd. (c)(1)). In describing MTs, GSPs must describe how MTs "may affect the interests of beneficial uses and users of groundwater or land uses and property interests" (Cal. Code Regs., tit. 23, § 354.28, subd. (b)(4)).

MOs for chronic lowering of groundwater levels must be based on the same metrics and monitoring sites used for MTs. MOs must "provide a reasonable margin of operational flexibility under adverse conditions" (Cal. Code Regs., tit. 23, § 354.30, subd. (c)(d)).

Deficiency: DWR staff noted issues with the water level MTs and MOs for all three aquifer zones and the R-zone.

For the A-zone, "Department staff believe the approach...will allow for significant and unreasonable conditions to occur, such as diminished groundwater supplies for agricultural, municipal, industrial, and domestic needs" (2022 GSP Inadequate Determination, p. 9).

State Water Board staff agrees. Board staff analyzed the impact of the 2022 GSP's water level MTs on domestic and public supply wells by comparing an inverse distance weighting-interpolated MT surface against wells in the OSWCR database with known well depths and locations. As noted above, OSWCR is known to be incomplete, so the results described below likely understate the potential impacts (number of wells that could go dry) of water levels declining to the MTs.

The Board staff analysis demonstrated that nearly a third (31%, or 650 wells) of the 2,080 domestic wells with adequate information for analysis would be dry at the MTs, and nearly a quarter (23%, or 12 wells) of the 53 public supply wells with adequate information for analysis would be dry at the MTs. Virtually all wells in the unconfined aquifer (A-zone) would go dry at proposed minimum thresholds. **Figure 4-2** shows the location and concentration of wells expected to go dry at the MTs for groundwater levels. Darker red areas indicate a higher concentration of dry wells, while lighter red areas indicate a lower concentration of dry wells.

For the B-zone, DWR noted that, "while the revised [2022] GSP states this would be protective of water uses and users, it is unclear how 20 feet below the lowest recorded levels would not cause significant and undesirable results" (ibid., p. 10). Furthermore, "...minimum thresholds are on average approximately 65 feet below the most historical lows and range from 82 feet above historical lows to 319 feet below historical lows. For most of the representative monitoring sites, the historical lows occurred after 2015" (ibid., p.12).

Moreover, State Water Board staff notes that a significant number of older, shallower wells or wells not reflected in the OSWCR dataset, all of which are excluded from the analysis, may still be in use and could be at risk of dewatering if groundwater levels declined to the MTs.

For both the B- and C-zones, it is unclear whether impacts to agricultural and industrial wells would be considered undesirable results, as those types of wells were not included in the statistical analysis. Further, “it is unclear why the year 2000 (representing approximately 22 years) was selected as the cutoff for well removal when the revised [2022] GSP indicates the life of a well in the Subbasin could be up to 30 years” (ibid., p. 12).

DWR staff notes the new MTs are far below historical lows, writing that, “ ...the minimum threshold are approximately 169 feet on average below historical lows and a range of 20 feet to 279 feet below historical lows. For most of the representative monitoring sites, the historical low has occurred after 2015” (ibid., p. 13).

Regarding the unrevised MOs, DWR staff highlights,

> The 2020 GSP had the measurable objectives at a consistent 50 feet above the 2020 GSP minimum thresholds. Without updating the measurable objectives in the revised [2022] GSP, difference is now 80 feet on average for the B-zone with a range of 8 to 304 feet, The C-zone average difference is 233 feet with a range of 14 to 501 feet. […] Given that the [2022 GSP] completely revised the approach to minimum thresholds, the GSAs should have aligned the measurable objectives in the same manner, regardless of the corrective action specification (ibid., p. 15).

Additionally, the GSAs’ approach to assigning wells to the B- and C-zones in the SMC statistical analysis could result in greater impacts to wells than the 2022 GSP describes. The DWR 2022 GSP Inadequate Determination states:

There does [sic] not appear to be any adjustments, explained or otherwise, to the totals [well counts] based on the variable E-Clay elevations. Not doing so would place many wells in the northern portion of the Subbasin allocated in the B-zone when they might be better placed in the C-zone, thus potentially misrepresenting the impacts of the sustainable management criteria selected (ibid., p. 15-16).

For the C-zone, “…it is unclear how the GSAs determined 10% of wells would be impacted and what beneficial uses and users would be impacted.” (ibid.,p.10). Additionally, “The GSAs use of interpolating, averaging, and finally grouping of the E-Clay elevation can lead to significant margins of error, up to 100 feet or more above or below the actual elevation of the E-Clay at any given point. If the E-Clay elevation is shallower than expected, groundwater levels could drop below the E-Clay before reaching the minimum threshold causing undesirable results sooner than expected” (ibid., p. 12-13).

For the R-zone, DWR staff questions why it is appropriate to manage the R-zone separately from the A-zone. Further, “Department staff believe the minimum thresholds for the R-zone have not been established in a manner consistent with SGMA and the GSP Regulations and informed by the hydrogeology” (ibid., p. 14).

State Water Board staff proposes Potential Actions GL-2a and GL-2b to address the deficiency.

Deficiency GL-3 - The monitoring network does not provide sufficient coverage to monitor for impacts to beneficial uses and users in the three aquifers in the subbasin (due to data gaps in A-zone coverage and inconsistent sampling).

What SGMA Requires: The GSP Regulations require GSPs to include a description of the monitoring network objectives for the basin including how the GSA will “monitor impacts to the beneficial uses or users of groundwater” (Cal. Code Regs., tit. 23, § 354.34, subd. (b)(2)).

GSAs “may designate a subset of monitoring sites as representative of conditions in the basin or an area of the basin...”, (Cal. Code Regs., tit. 23, § 354.36). GSAs identify MTs, MOs, and Interim Milestones at these sites. "The designation of [an RMS] shall be supported by adequate evidence demonstrating that the site reflects general conditions in the area” (Cal. Code Regs., tit. 23, § 354.36, subds. (a) & (c)).

Deficiency: DWR noted an absence of RMS wells in the R-zone, stating “It is...noted that there are no A-zone representative monitoring sites within the R-zone. Department staff questions the GSAs ability to adequately monitor for undesirable results in the R-zone” (ibid., p. 14).

State Water Board staff notes that the GSAs’ inconsistent use of RMS locations may mask whether undesirable results in particular areas are occurring: the GSAs identified 70 RMS wells in the 2020 GSP and 56 in the 2022 GSP, and then reported groundwater levels for 49, 50, and 53 RMS wells in the WY-20, WY-21, and WY-22 Annual Reports, respectively.

State Water Board staff also notes that inconsistent groundwater level monitoring locations and frequencies make it difficult to monitor the impacts of groundwater condition changes on beneficial uses and users. The GSAs continue to update and expand the monitoring network for groundwater level SMC, as noted in the 2022 GSP and the WY 2021-2022 Annual Report. There are limited sites with continuous water level data; only seven sites have two or more water level measurements per water year over the past five years (WY 2018 through 2022). Recent water level monitoring is more consistent, and the monitoring network appears to be expanding, with 49 wells monitored in WY 2019-2020, 50 wells monitored in WY 2020-2021, and 53 wells monitored in WY 2021-2022. Staff recognizes these efforts to expand the monitoring

network but note that some sites are monitored only once a year and very few sites are monitored more than twice a year.

State Water Board staff proposes Potential Actions GL-3a and GL-3b to address the deficiency.

Deficiency GL-4 – The 2022 GSP's discussion of well impact mitigation lacks important details and the GSP does not explain how well impact mitigation fits into the GSAs' approach for avoiding undesirable results.

What SGMA Requires: Although SGMA and the GSP Regulations do not require development of a well impact mitigation plan, many GSAs have proposed to couple such plans with MTs to allow for greater groundwater level declines while avoiding undesirable results. The 2022 GSP states, "The GSAs will also consider appropriate mitigation or management efforts for A-zone wells (in accordance with the mitigation plan framework described in Appendix D)" (2022 GSP Addendum, p. 13).

Deficiency: DWR staff notes that the Mitigation Plan Framework proposed in the revised GSP does not provide details on how claims for well mitigation will be evaluated. The DWR 2022 GSP Inadequate Determination states, "Department staff do not believe sufficient details related to the framework have been provided; therefore, are unable to assess whether the GSAs have established sustainable management criteria based on a commensurate level of understanding of the basin setting or whether the interests of beneficial uses and users have been considered" (2022 GSP Inadequate Determination, p. 15).

State Water Board staff additionally notes that the Mitigation Plan Framework (Appendix D) states, "The impacts covered by the program would be limited to domestic wells, critical infrastructure, and land uses that are adversely affected by declining groundwater levels, land subsidence, or changes to groundwater quality" (2022 GSP Addendum, Appendix D, p. 1). This suggests that GSAs will not mitigate impacted public supply wells, irrigation wells, or industrial wells. It is not clear whether the GSAs plan to mitigate impacts to wells screened in the C-zone aquifer. Staff acknowledges that the Mitigation Plan Framework is intended to serve as the basis for GSA-specific well mitigation programs and is not a complete program in and of itself. Without details on the GSAs' commitment to implement well mitigation programs; information on any eligibility limitations; and information on steps the GSAs will take to ensure the programs are easily accessible, appropriately funded, and proactive at avoiding undesirable results; State Water Board staff cannot assess how the future mitigation plans may work in tandem with SMC to avoid undesirable results related to chronic lowering of groundwater levels.

The mitigation plan framework does not include mitigating impacted agricultural wells. Board staff could not find in the 2022 GSP any analysis of impacts to small farms in the subbasin under the proposed groundwater level SMC. The U.S. Department of

Agriculture (USDA) defines small farms as those that have an annual gross cash farm income under $350,000. The USDA's 2017 Census of Agriculture found that in Kings County, 49% of farms are 49 acres or fewer in size, and 53% of farms have sales values of $99,999 or less. The average net cash farm income is $310,725 per year in Kings County. Of 1,742 total producers in Kings County, 1,211 are male (70%) and 1,666 are white (96%) (USDA, 2017). Information about the number, location, and average well screen depths (indicating from which aquifer the wells are pumping) of small farm wells is essential for the GSAs to understand the beneficial uses and users of the subbasin and the potential impacts to them from the groundwater management plans described in the GSP.

State Water Board staff proposes Potential Actions GL-4a and GL-4b to address the deficiency.

Deficiency GL-5 – The 2022 GSP does not describe a feasible path for halting chronic lowering of groundwater levels.

What SGMA Requires: Each GSP is required to include a description of the projects and management actions the GSA has determined will achieve groundwater sustainability in the basin. The description must include project management actions, summary of data used to support proposed actions, and a review of the uncertainty associated with the basin setting when developing projects or management actions. The GSP must also describe the criteria that would trigger implementing or stopping a project or management action and the process for determining whether that trigger has occurred (Cal. Code Regs., tit. 23, § 354.44). More fundamentally, for basins in a condition of overdraft, the GSP "shall describe projects or management actions, including a quantification of demand reduction or other methods, for the mitigation of overdraft" (Cal. Code Regs., tit. 23, § 354.44, subd. (b)(2)) GSPs need to include 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 (Cal. Code Regs., tit. 23, § 354.44, subd. (b)(9)).

In reviewing GSPs, DWR must consider, among other questions, "whether sustainable management criteria and projects and management actions are commensurate with the level of understanding of the basin setting, based on the level of uncertainty, as reflected in the plan" and "whether the projects and management actions are feasible and likely to prevent undesirable results and ensure that the basin is operated within its sustainable yield" (Cal. Code Regs., tit. 23, § 355.4, subds. (b)(3), (5)).

Deficiency: State Water Board staff has determined that the 2022 GSP does not demonstrate that projects and management actions are feasible or sufficient to prevent undesirable results.

The 2022 GSP does not demonstrate feasibility projects. The 2022 GSP relies substantially on new surface water supplies to mitigate overdraft, but the GSP does not assess the feasibility of new supply projects based on water availability and climate change impacts to surface supplies. As noted above, the GSP expects to save approximately 44,000 AFY through voluntary demand management actions such as voluntary fallowing, dry farming, or converting fields to recharge basins; and to save approximately 137,000 AFY through supply augmentation. The 2022 GSP estimates annual overdraft in the basin to be approximately 73,760 AFY, based on a hydrology from 1998 to 2010, which excludes the state's two most recent droughts (2022 GSP, p. 3-47).

Demonstrating feasibility of supply augmentation projects is crucial because water sources are limited. Local surface water sources are generally fully appropriated (see Section 3.6). Imported water available from the State Water Project or Central Valley Project or other sources will vary from year to year based on statewide hydrogeology. Both local and imported sources of surface water will be in high demand as GSAs and interests in other critically over drafted basins in the region and elsewhere in the state implement SGMA. Climate change will continue to affect both the water demand of crops and regional hydrology.

The 2022 GSP does not contain a groundwater allocations plan, though it indicates that groundwater assessment and allocation plans will be developed in 2023 and implemented in 2025 (2022 GSP Addendum, Table 6-5). Otherwise, demand management actions in the 2022 GSP appear voluntary and therefore unlikely to provide sufficient contingency in case GSAs fail to secure new supplies or overdraft is greater than estimated.

State Water Board staff proposes Potential Actions GL-5a, GL-5b, and GL-5c to address the deficiency.

Deficiency GL-6 – The GSAs do not consider the effects on other sustainability indicators, such as groundwater storage, subsidence, degradation of groundwater quality, and depletions of interconnected surface water.

What SGMA Requires: In describing MTs, a GSA must explain "how the [GSA] has determined that basin conditions at each minimum threshold will avoid undesirable results for each of the sustainability indicators" (Cal. Code Regs., tit. 23, § 354.28, subd. (b)(2)).

Deficiency: Groundwater level declines can exacerbate loss of groundwater storage, degradation of groundwater quality, land subsidence, and depletions of interconnected surface water.

- **Reduction in Groundwater Storage**: Groundwater level declines generally indicate a reduction in groundwater storage. Land subsidence (see below) may also permanently reduce the storage capacity of an aquifer.
- **Degradation of Groundwater Quality**: Declines in groundwater levels can bring water with higher concentrations of constituents closer to well screens, effectively lowering the quality of water pumped at those wells. USGS scientists found that increased pumping from wells during drought can pull shallow, contaminated groundwater down to depths commonly tapped for public drinking-water supply (Levy et al., 2021).
- **Subsidence**. As summarized in Faunt et al., (2015), "long-term groundwater-level declines can result in a one-time release of 'water of compaction' from compacting fine-grained deposits, which causes land subsidence."
- **Depletions of Interconnected Surface Water**: Groundwater level declines near interconnected streams can reduce how much groundwater is discharged into interconnected streams or increase how much surface water is "lost" to the interconnected aquifer. The USGS notes "Surface-water depletion is directly associated with chronic lowering of groundwater levels" (USGS, undated).

DWR noted that the B-zone MTs at most of the RMS wells are substantially below historical lows, which are in turn often below 2015 levels. Consequently, "given these changes, Department staff believe the revised GSP should have included an updated discussion on impacts to other sustainability indicators, such as subsidence" (2022 GSP Inadequate Determination, p. 12).

DWR also noted that, for C-zone MTs, "the GSAs did not consider...effects on groundwater storage and subsidence" (ibid., p. 13).

In addition, State Water Board staff notes that the 2022 GSP did not describe the effects of MTs on degradation of groundwater quality if groundwater levels decline to the MTs in the A-, B-, and C-zones. Board staff is especially interested in the potential migration of de-designated water if groundwater elevations decline to MTs (2022 GSP complete strike version, p. 3-32; same language as 2020 GSP). Board staff also notes that declining groundwater levels may result in the migration of shallow constituents into wells (See Section 3.5.6.3). Additionally, declining groundwater levels may require existing wells to be deepened. If wells are deepened into a portion of an aquifer already impacted by degraded groundwater, newly deepened wells may be impacted by an existing constituent of concern, prohibiting the intended beneficial use for those wells.

The 2022 GSP also does not discuss the impact of MTs in the R-zone and the A-zone on depletions of interconnected surface water.

State Water Board staff proposes Potential Actions GL-3b and GL-6 to address the deficiency.

4.1.1.5 Potential Actions to Address the Groundwater Level Sustainable Management Criteria Deficiency

Potential Action GL-1 – Define the undesirable result for the chronic lowering of groundwater levels consistent with SGMA. Meaningfully engage with users in the subbasin to seek and incorporate feedback on the definition of an undesirable result for chronic lowering of groundwater levels specific to the subbasin and protective of drinking water users.

GSAs should prioritize engaging with representatives from the range of users in the subbasin, including domestic well owners, small farmers, infrastructure managers, state and federal fish and wildlife agencies, advocates, and others. The groundwater level conditions that are considered significant and unreasonable groundwater level SMC should reflect consensus decision-making that incorporates most of the use in the subbasin, particularly uses vulnerable to chronic lowering of groundwater levels. The definition of an undesirable result should be specific enough that GSAs and others can evaluate, over time, whether any quantitative definition of an undesirable result accurately represents those groundwater conditions the GSAs are trying to avoid.

Potential Action GL-2 – Fill data gaps in the subbasin water budget and use the data to update the SMC to avoid undesirable results.

Potential Action GL-2a – Further investigate and quantify components of the basin water budget inflows and outflows to support resolution of basin overdraft.

The subbasin water budget is the foundation for management of the subbasin. The following groundwater fluxes should be further investigated and quantified to refine the subbasin water budget as necessary:

- Inflows to the R-zone and A-zone, in order to define whether the R-zone is separate from the A-zone or part of the A-zone.
- Vertical gradients in the B- and C-zones.
- Inter-basin subsurface flows at the subbasin boundaries.

The subbasin sustainable yield should be updated as information on subbasin inflows and outflows is gathered and analyzed. Under SGMA, the sustainable yield is defined as, “the maximum quantity of water, calculated over a base period representative of long-term conditions in the basin and including any temporary surplus, that can be withdrawn annually from a groundwater supply without causing an undesirable result” (Wat Code, § 10721, subd. (w)).

The sustainable yield is not the same as an annual extraction volume for the subbasin; however, it can provide a guideline for balancing subbasin inflows and outflows.

Potential Action GL-2b – Set groundwater level sustainable management criteria to protect drinking water wells from dewatering at the minimum threshold elevations. Describe how minimum thresholds may affect the interests of beneficial uses and users of groundwater or land uses and property interests relative to 2015 conditions.

The revised groundwater level MT for the A-zone is the top of the A-clay, meaning that the A-zone could be completely dewatered before undesirable results occur. The 2022 GSP indicates that there are 377 domestic or public supply wells completed in the A-zone (2022 GSP Addendum, Table 2-2). This well count is based on the OSWCR database, which is not a comprehensive database of all wells, so it may be an undercount. Regular dewatering of drinking water wells demonstrates a chronic lowering of groundwater levels that is significant and unreasonable. The GSAs should clarify the undesirable results and SMC for the A-zone and should prioritize projects and management actions that protect the A-zone for drinking water use.

In setting MTs and MOs, GSAs should characterize the groundwater level conditions in the subbasin that are expected in 2040 under the management plans laid out in the subbasin GSP. GSAs should discuss the effects of MTs on beneficial uses and users relative to groundwater level conditions on January 1, 2015. GSAs should compare the proposed sustainable groundwater level conditions to the groundwater level conditions at the time SGMA first took effect on January 1, 2015. If groundwater levels under the subbasin GSP would be worse (significantly lower) in 2040 as compared to prior to January 1, 2015, explain how the decline is not significant and unreasonable.

Potential Action GL-3 – Fill data gaps in the groundwater level monitoring network.

Potential Action GL-3a – Use a consistent set of monitoring network wells from year to year.

Staff acknowledges that the GSAs continue to update and expand the monitoring network for groundwater level SMC, as noted in the Tulare Lake Subbasin 2022 GSP and the WY 2021-2022 Annual Report. Staff also recognizes that some wells may not always be accessible or may become abandoned or destroyed. However, GSAs should prioritize using a consistent set of monitoring wells from year to year in order to observe seasonal, annual, and longer-term trends in groundwater levels and groundwater quality. In the annual reports, GSAs should explain why any RMS wells were not used during that water year.

Potential Action GL-3b – Establish additional monitoring wells in the A-zone and establish monitoring wells in the R-zone to monitor impacts to drinking water users and begin gathering data on surface water-groundwater interactions.

As outlined in the Tulare Lake Subbasin 2022 GSP and DWR's 2022 GSP Inadequate Determination, there are significant data gaps in the RMS network. To address these gaps, the GSAs should establish additional monitoring wells in the A-zone to monitor groundwater level trends that could impact drinking water wells. Additionally, the GSAs should establish monitoring well(s) in the R-zone to understand water level trends in this zone adjacent to the river. Monitoring wells in the R-zone will be essential for identifying surface water-groundwater interactions, including any streamflow depletions.

The 2022 GSP acknowledges this data gap (ibid, p. 3-35).

The 2020 GSP suggests that the A-zone and R-zone are connected, stating "Limited studies have shown that groundwater pumping from the principal unconfined aquifer system in the immediate vicinity of the Kings River may induce limited drawdown (i.e., leakage) of shallow groundwater above the A-Clay into the regional aquifer system (P&P, 2009). The studies indicate that increased pumping does not significantly increase leakage, suggesting that the leakage rate primarily dependent based on the vertical conductivity of the A-Clay" (ibid., p. 3-37).

Potential Action GL-4 – Establish accessible, comprehensive, and appropriately funded well impact mitigation programs that mitigate impacts to wells affected by lowering of groundwater levels and degradation of water quality.

Potential Action GL-4a – Develop well mitigation programs with clear triggers, eligibility requirements, metrics, and funding sources.

Potential Action GL-4a would help address both Deficiency GL-4, and Deficiency Water Quality (GWQ)-4 (see Section 4.1.3.4). Staff recognizes that the Mitigation Plan Framework (Appendix D) included in the 2022 GSP is only a blueprint for each GSA to develop their own well mitigation policies.

As appropriate depending on the GSAs revised SMC and other projects and management actions, the GSAs should develop mitigation plans that include mitigation for both declining groundwater levels and water quality impacts. The mitigation plans should:

- Identify clear triggers for well mitigation that avoid undesirable results (e.g., employ mitigation prior to a well losing supply).
- Identify adequate and highly reliable funding sources for mitigation efforts commensurate with the magnitude of impacts allowed under the GSAs' MTs; demonstrating adequate funding may involve projecting out fee revenues to

demonstrate financial capacity that matches expected need. State Water Board staff notes that fee revenues levied by the GSAs on groundwater extractions are a more reliable funding source than grants and subsidies.

- Prioritize program accessibility by defining broad eligibility requirements, avoiding reimbursement-based mitigation that may not be accessible to low-income well users, offering translated program materials, and partnering with trusted community leaders and organizations in program development and roll-out.
- Identify approaches for preventing even the temporary loss of safe and reliable drinking water supplies, due to basin management, for people reliant on wells. For example, GSAs may proactively contact the owners of wells that are at risk of impacts from groundwater level declines or water quality degradation. Coordinating proactively with well owners may also reduce the overall financial costs of mitigation by reducing or eliminating the need for interim water supplies.

Mitigation options may include:

- Replacing or deepening wells.
- Support for expansion of public water system boundaries to private well communities or consolidation of smaller drinking water systems dependent on at-risk wells with larger public water systems. This would involve identifying vulnerable areas where consolidation or extension of service is feasible. Consolidation efforts may include: (1) providing financial assistance, particularly for low-cost intertie projects that are adjacent to larger systems, (2) working with County Planning agencies to ensure that communities served by at-risk wells are annexed into the service areas of larger water systems to limit barriers to future interties, and (3) facilitating outreach and introductions between small water systems and owners of domestic wells and larger water systems to assist in developing future partnerships.
- (For water quality degradation) Well water treatment (point-of-entry (POE)) for wells impacted by arsenic, nitrate, 1,2,3-Trichloropropane (1,2,3-TCP), and 1,2-Dibromo-3-chloropropane (DBCP; State Water Board et. al., 2022), drilling new wells completed in aquifers with better water quality, consolidation of existing water systems, or expanding service areas for existing public water systems not facing water quality impacts.

GSAs should not plan to fund well mitigation via the Safe and Affordable Drinking Water Fund administered through the State Water Board. This funding program was designed for addressing legacy impacts that are not within the scope of SGMA and not for addressing impacts caused by groundwater management actions or inactions by GSAs.

Where GSAs' mitigation plans rely on cooperation with the Central Valley Salinity Alternatives for Long-Term Sustainability (CV-SALTS) program, the GSAs should

explain the relationship between the mitigation programs, including timelines, mitigation strategies, and funding sources.

Potential Action GL-4b – Evaluate how small farm wells will be impacted.

GSAs should explain why agricultural wells are excluded from well mitigation program plans. GSAs should evaluate the number, locations, and average screen depths (i.e., primary aquifer) of irrigation wells serving small farms. The GSAs should evaluate how many small farm wells are likely to be dewatered at the MT groundwater elevations and should describe the options for small farmers to mitigate their wells, if impacted by declining groundwater levels, subsidence, and/or impaired groundwater quality.

The U.S. Department of Agriculture (USDA) defines small farms as those that have an annual gross cash farm income under $350,000. The USDA's 2017 Census of Agriculture found that in Kings County, 49% of farms are 49 acres or fewer in size, and 53% of farms have sales values of $99,999 or less. The average net cash farm income is $310,725 per year in Kings County. Of 1,742 total producers in Kings County, 1,211 are male (70%) and 1,666 are White (96%) (USDA, 2017).

The California Farmer Equity Act (AB 1348), signed into law in October 2017, states that a socially disadvantaged farmer or rancher (SDFR) is a farmer or rancher who is a member of a socially disadvantaged group. A socially disadvantaged group means a group whose members have been subjected to racial, ethnic, or gender discrimination. The legislation recognizes that California's farmers and ranchers are made up of a diverse group of people. Some have faced historical discrimination which in part exists today, and thus not all have historically had access to resources and information to successfully run their businesses. GSAs' implementation of SGMA should reflect the Governor's commitment to "California for All" and should endeavor to strengthen the agricultural industry's resiliency and success within the subbasin (CDFA, 2020).

Potential Action GL-5 – Plan ahead for drought conditions and commit to managing demand.

Potential Action GL-5a – Evaluate the feasibility of proposed supply augmentation projects.

Implementing some of the projects identified in the 2022 GSP may require new or amended water rights. If a project would rely on existing water rights, the GSAs should identify the water right identification numbers and other relevant details. It may be unreasonable for the GSP to assume that projects that currently lack adequate water rights for implementation can obtain either new water rights or modifications to existing water rights within a timeframe that will allow the project to contribute to the GSP achieving sustainability. For the GSP to demonstrate a likelihood of attaining the sustainability goal, the GSP should discuss the timing for obtaining approvals and

describe any uncertainties, such as water availability in source streams (e.g., Will less surface water be available with projected Bay-Delta Plan implementation? Is the source on the inventory of fully appropriated streams? Can potential protests be anticipated from downstream water users?).

Potential Action GL-5b – Develop basin-wide allocations or utilize another demand management structure to help bring the subbasin into balance and meet basin sustainability goals.

Bringing the subbasin into balance requires action to align demand with available supplies. The extent of groundwater overdraft in the subbasin and the uncertainty, limited availability, and expense of new water supplies make demand management likely necessary to achieve groundwater sustainability in the subbasin. The California Water Supply Strategy directs Californians to reduce demand (Action 3), and more specifically, recognizes the need to "Help stabilize groundwater supplies for all groundwater users, including a more drought-resilient agricultural economy" (CNRA, 2022).

The GSAs should develop programs that would enable demand management now and identify clear triggers for initiating or ramping up groundwater pumping restrictions, given the complexity and potential pushback in developing allocations or other demand management approaches. Information on the feasibility and timing of proposed supply projects developed for Potential Action GL5a should inform the scope and timeline for demand management actions.

Demand management actions could include allocations, pumping cutbacks/ramp-down rates, pumping caps, water trading, and/or fee structures. Demand management fee structures could include tiered fee structure, or a conditional structure in which fees are higher in dry years or when groundwater levels are in decline. Demand management should be equitable and should include consideration of the human right to water, the constitutional requirement of reasonable and beneficial use, and potential economic impacts on all extractors.

Sustainable management under SGMA requires planning for the range of likely hydrologic conditions. GSAs should account for a future scenario in which extended droughts occur within the SGMA timeframe (Cal. Code Regs., tit. 23, § 354.44, subd. (b)(9)). The 2013-2015 period of the 2012-2016 drought in California was the hottest and driest period on record at the time of the passage of SGMA. GSAs should make groundwater management plans for a recurrence of such conditions, as well as conditions that occur in extreme wet years.

GSAs should plan for the impacts from pumping cutbacks that will be necessary during wet years, dry years, and multi-year severe drought periods. GSAs can hold stakeholder meetings to educate irrigators on crop conversions, water efficiency practices, fallowing schemes, land transition options (particularly multi-benefit land

repurposing), and other adaptation methods. Multi-benefit land repurposing options include dryland crops, grazing, recharge basins, parks/recreational spaces for communities, solar (renewable energy), and wildlife habitat. GSAs could encourage farmers to work together to strategically locate repurposed lands to maximize benefits (e.g., use lands adjacent to existing habitat, recreation areas, or communities). Planning well for fallowing and land conversion can reduce possible land conversion impacts related to dust, pests, and/or invasive plants.

Potential Action GL-5c – 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.

GSAs should use groundwater elevations as the ultimate subbasin management metric. Groundwater levels in key representative monitoring wells are the clearest and simplest empirical data that reflect groundwater conditions in the subbasin. Groundwater elevation is simple to measure and can be monitored continuously and remotely using pressure transducers.

GSAs should identify key indicator wells in each of the three subbasin aquifers (managing the R-zone as part of the A-zone) that will serve as index wells that trigger pumping cutbacks when groundwater levels decline to critical groundwater elevations. Indicator wells should have sufficient spatial coverage to be representative of beneficial uses and users; drinking water users in particular should be represented by indicator well(s) that reflect shallow groundwater conditions in the A-zone.

GSAs should determine pumping cutbacks that will be triggered at specific groundwater elevations in a tiered trigger scheme based on the groundwater conditions on September 1 of each year (or as close to annual low measurements as is possible). Determining cutbacks on or shortly after September 1 for the subsequent year should provide irrigators with time to make crop planting and other business decisions. GSAs could re-evaluate the cutbacks and adjust as needed if a wet winter occurs. If GSAs establish management zones around each indicator well, extraction wells within an indicator well's management zone could follow pumping cutbacks according to the triggers for that indicator well and the aquifer in which they are completed. For example, when groundwater levels drop to the Trigger 1 level at an index well, all non-exempt pumpers within the index well's management zone must reduce their extractions by 15%; if water elevations drop to the Trigger 2 level, then all non-exempt pumpers must reduce pumping by 30%. Trigger elevations and the pumping cutback amounts could be set based on the groundwater level SMC. Pumping reduction amounts may be best determined through an iterative process and observations of the aquifers' responses.

This management approach is responsive to real-time conditions in the subbasin, making it more nimble than an approach based strictly on groundwater models, but cutback metrics should be informed by a revised water budget and groundwater model.

The impacts of recharge projects should be accounted for under this approach as groundwater levels respond to recharge, incorporating the time delay of infiltration to the aquifer(s).

Potential Action GL-6 – Describe the relationship between MTs for each sustainability indicator. Revise groundwater level MTs as necessary to avoid undesirable results for other sustainability indicators.

The GSAs should explain how groundwater level SMC affect the GSAs' ability to avoid other undesirable results and subsequently adjust groundwater level MTs, if necessary. The analyses necessary to describe these effects will differ depending on the sustainability indicator and the SMC the GSAs set for those indicators. DWR expects to release additional guidance on assessing subsidence and depletions of interconnected surface water under SGMA.

In general, setting groundwater level MTs at or above 2015 groundwater elevations would avoid undesirable results for other sustainability indicators beyond undesirable results that occurred before, and had not been corrected by, January 1, 2015.

4.1.2 Deficiency LS – Defining and Avoiding Undesirable Results Related to Land Subsidence

Another consideration under SGMA is avoiding "significant and unreasonable land subsidence that substantially interferes with surface land uses" (Wat. Code, § 10721, subd. (x)(5)). Land subsidence from excessive groundwater extraction can cause damage to infrastructure and aqueduct operations. Land subsidence can also diminish the storage capacity of an aquifer, which reduces the available water storage for the future. Importantly, subsidence and its reductions on groundwater storage are often irreversible.

DWR concluded that the Tulare Lake Subbasin 2022 GSP does not adequately justify its approach for developing SMC for subsidence (See Table 4-3 below). DWR also noted that the GSP does not clearly define how it avoids "significant and unreasonable effects on critical infrastructure" (2022 GSP Inadequate Determination, p. 17). Board staff have built on DWR's analysis, noting that subsidence may substantially increase flooding risks, and have concluded that the 2022 GSP lacks a detailed analysis of the effects of subsidence on all beneficial uses and users within the subbasin. Board staff therefore conclude that significant and unreasonable subsidence may occur under the Tulare Lake Subbasin 2022 GSP.

Table 4-3 – Summary of DWR Land Subsidence Deficiency and Relevant Components of the 2020 and 2022 Tulare Lake Subbasin GSPs

2020 GSP	DWR's 2020 GSP Incomplete Determination	2022 GSP	DWR's 2022 GSP Inadequate Determination
Defined undesirable result for subsidence as "the significant loss of functionality of critical infrastructure or facility, so the feature(s) cannot be operated as designed, requiring either retrofitting or replacement to a point that is economically unfeasible."	The GSP does not define undesirable results, minimum thresholds, and measurable objectives for subsidence in the manner required by SGMA and the GSP Regulations.	Did not change the definition of "undesirable result."	Definition of "undesirable result" fails to specify the tolerable amount of subsidence for critical infrastructure.
Identified only the California Aqueduct as critical infrastructure that could be impacted by land subsidence.	GSP is general regarding infrastructure and does not specifically address impacts of subsidence on facilities and infrastructure other than the California Aqueduct, such as flood control levees.	Listed all canals and aqueducts, high-speed rail line, levees, pipelines, other railroads, airports, bridges, and emergency facility buildings as critical infrastructure or facilities.	GSP did not assess the impacts of subsidence on the critical infrastructure and facilities identified in the GSP.

4.1.2.1 Tulare Lake Subbasin 2020 GSP

Plain-language Definition of an Undesirable Result

The 2020 GSP defined an undesirable result for land subsidence as "the significant loss of functionality of a critical infrastructure or facility, so the feature(s) cannot be operated as designed, requiring either retrofitting or replacement to a point that is economically unfeasible" (2020 GSP, p. 4-8). The California Aqueduct was the only critical infrastructure or facility identified by the GSP (ibid., p. 4-8).

Quantitative Definition of an Undesirable Result, Minimum Thresholds and Measurable Objectives and Associated Impacts

The 2020 GSP described an undesirable result as occurring when "land subsidence exceed[s] the MTs at either or both of the RMSs" MOs and MTs were based on a modeled, status-quo projection which assumed current land and water use conditions and a normal hydrologic cycle. MOs were based on the average projected subsidence in 2035. MTs were based on the maximum projected subsidence in 2070. No projects or management actions were considered in the projected status quo hydrologic model (ibid., p. 4-13).

Representative Monitoring Sites and Monitoring Network

The 2020 GSP included two RMSs for subsidence. Both were existing Continuous Global Positioning System (CGPS) Stations that are part of the Central Valley Spatial Reference Network operated by Caltrans; one RMS is in Lemoore and one is in Corcoran.

Infrastructure Mitigation

The 2020 GSP did not include specific plans to mitigate the impacts of subsidence even though its SMC allowed continued subsidence. In describing the general impacts of MTs on infrastructure, the 2020 GSP noted that "GSAs will need to act to mitigate the significant and unreasonable impact" but did not provide further details (ibid., p. 4-19).

Projects and Management Actions

The 2020 GSP states that "the path to sustainability on subsidence is through the development of projects and implementation of management actions that lead to stabilized groundwater levels which thereby diminishes the need to develop deeper wells" (ibid., p. 4-23). The projects and management actions identified in the 2020 GSP generally included supply augmentation (groundwater recharge basins, surface storage in ponds, canal/ditch improvements) and voluntary demand reduction (voluntary fallowing, dry farming, fallowing or retirement of fields converted to recharge basins).

The discussion of projects and management actions was very general and did not specify the criteria that would trigger implementation, a time-table for implementation, a description of how the GSAs would meet costs, or an explanation of the source and reliability of the water necessary for the supply augmentation projects. Instead, the 2020 GSP stated that project "locations will be identified by each GSA and their respective partners within their area as soon as the need arises and funding is available" (ibid., p. 6-5).

4.1.2.2 DWR's 2020 GSP Incomplete Determination

In the January 28, 2022, DWR Incomplete Determination Letter, DWR identified a deficiency in the 2020 GSP related to land subsidence SMC:

> Deficiency 2 – The [2020] GSP does not define undesirable results or set minimum thresholds and measurable objectives for subsidence in a manner consistent with the GSP regulations.

(2020 GSP Incomplete Determination, p. 10).

Plain-language Definition of an Undesirable Result

The DWR 2020 GSP Incomplete Determination indicated that GSAs should "revise their undesirable results to be consistent with SGMA and the GSP Regulations."

Quantitative Definition of an Undesirable Result, Minimum Thresholds and Measurable Objectives and Associated Impacts

DWR staff noted issues with the GSP's identification of critical infrastructure vulnerable to land subsidence, the GSP's qualitative definition of an undesirable result related to land subsidence, and the GSP's approach to establishing MOs, MTs, and RMSs. DWR staff concluded that:

> …the [2020] GSP did not define metrics for undesirable results and minimum thresholds based on the level of subsidence that substantially interferes with surface land uses, informed by, and in consideration of, the relevant and applicable beneficial uses and users in the Subbasin. Instead, the [2020] GSP developed those criteria based on a numerical modeling exercise that projected current subsidence rates into the future (ibid., p. 10-11).

Further, DWR staff concluded that:

> It is unclear to Department staff how the quantitative definition based on minimum thresholds is related to the qualitative definition, especially because the only critical infrastructure or facility identified by the GSP (i.e., the California Aqueduct) is not in the vicinity of the two representative monitoring sites (ibid., p. 11).

The California Aqueduct, which runs for 17 miles on the western edge of the subbasin, was the only critical infrastructure or facility identified by the 2020 GSP, yet the two RMS are not in the vicinity of the California Aqueduct. Thus, it is not clear how those RMSs could be used to monitor subsidence under the California Aqueduct. The 2020 GSP used general terms to describe the potential impact of subsidence on other critical facilities and infrastructure (e.g., the need to raise flood control levees) (ibid., p. 12). DWR staff did not believe setting the MOs and MTs purely on a projection of status quo

subsidence rates was consistent with the GSP Regulations. The 2020 GSP Incomplete Determination notes:

> The GSP does not explain, and Department staff do not find it reasonable to conclude, the rationale for why this seemingly worst-case scenario for subsidence over the twenty-year implementation period is an appropriate level for avoiding substantial interference to land surface uses and users (ibid., p. 12).

DWR staff noted concerns about the accuracy of MOs. DWR staff found inconsistencies between the subsidence at the RMSs in 2017 and the projected baseline in the status-quo modeling.

DWR staff also noted that the GSP inexplicably allowed subsidence to continue after the plan was implemented, until "benefits [of Plan implementation] accrue."

Public GSP comments contradicted claims the GSP made about subsidence. Comments provided historical accounts indicating that GSA member agencies had not effectively managed subsidence, even though the GSP claimed otherwise. Moreover, the historical accounts in these comments indicated disagreement with the amount of subsidence that is considered significant and unreasonable (ibid., p. 13).

DWR's 2020 GSP Corrective Actions

DWR staff proposed a four-part corrective action to address the subsidence deficiency in the 2020 GSP. DWR staff recommended that:

> a) The GSA should revise their undesirable results to be consistent with SGMA and the GSP Regulations, and to contain sufficient detail to demonstrate that they are reasonable, supported by best available information and science, are commensurate with the level of understanding of the basin, and consider the interests of users in the subbasin. If the GSAs are concerned with the functionality of critical infrastructure then they should clearly describe the critical infrastructure in the subbasin, and the level of subsidence that would substantially interfere with that infrastructure.
>
> b) The GSA should revise their discussions of measurable objectives and minimum thresholds to be consistent with the requirements of SGMA. Rather than basing those criteria on projections of status-quo subsidence, they should be informed by the site-specific consideration of the level of subsidence that would substantially interfere with land surface uses.
>
> c) In resolving this discrepancy, the GSAs should demonstrate that their representative monitoring sites, where minimum thresholds and measurable objectives are defined, are commensurate with monitoring for the undesirable results, such as impacts to critical infrastructure, that they are trying to avoid through implementation of the GSP.

d) In resolving this discrepancy, Department staff recommend including flood protection infrastructure in the assessment of users susceptible to potential interference from subsidence. Department staff recommend engaging with flood management agencies in the basin and region, as appropriate (ibid., p. 14).

4.1.2.3 Tulare Lake Subbasin 2022 GSP Submission

The GSAs submitted a revised GSP to DWR on July 27, 2022, in compliance with the 180-day resubmittal deadline.

***Plain-language Definition of an Undesirable* Result**

Although the 2022 GSP acknowledged the subjectivity of its definition of "undesirable results," the GSAs did not change that definition for the 2022 GSP (ibid., p. 17).

Quantitative Definition of an Undesirable Result, Minimum Thresholds and Measurable Objectives and Associated Impacts

The 2022 GSP updated the definition of an undesirable result to a subsidence rate of 36 inches in three years (2022 GSP Addendum, p. 25). The 2022 GSP did not update its approach to setting measurable objectives, continuing to base MOs on average modeled subsidence through 2035, but did update its approach to setting MTs.

The 2022 GSP developed MTs based on recent subsidence rates rather than the highest modeled subsidence through 2070. For each RMS, the 2022 GSP used InSAR data to calculate the subsidence rate from 2016 and 2022. The 2022 GSP then projected future "baseline" subsidence at each RMS under the assumption that the recent subsidence rate remained constant. The GSP then provided estimates of total subsidence based on modeled projections of projects and management actions. The 2022 GSP indicated, but did not clearly state, that the minimum thresholds are based on the modeled impacts of projects and management actions (i.e., neither column in the table containing these values is specified as minimum thresholds).

The 2022 GSP also included some discussion on the potential impact of subsidence on flood protection levees in the subbasin, and described two different ways that subsidence can influence levees: (1) by lowering the elevation of the crown of the levee with respect to the elevation of the flood area, and (2) by inducing differential subsidence along the longitudinal axis of the levee that could lead to longitudinal cracking or other distress. The GSP claimed that lowering crown elevation would not increase flooding risks, as land elevations would generally decrease at the same rate.

Regarding differential subsidence, the GSP acknowledged that there was limited literature available on the impacts on differential subsidence on levees, but dismissed the lack of understanding regarding this risk, claiming that levees are flexible earthen structures that can tolerate typical differential longitudinal settlement (ibid., p. 7).

The 2022 GSP Addendum noted that the GSAs communicated with DWR State Water Project, DWR, Division of Flood Management, the Central Valley Flood Protection Board, Kings County, and Cross Creek Flood Control District; however, the Addendum did not specifically describe how the GSAs considered input from those entities in the 2022 GSP (ibid., p. 2).

Representative Monitoring Sites and Monitoring Network

The 2022 GSP identifies additional critical infrastructure and facilities, including all canals and aqueducts, the high-speed rail line, levees, pipelines, other railroads, airports, bridges, and emergency facility buildings. GSAs increased the number of monitoring sites from two to twenty-seven to have better subsidence monitoring coverage and MTs were established for all but one monitoring site (2022 GSP Inadequate Determination, p. 19).

Infrastructure Mitigation

The 2022 GSP states that "a mitigation plan needs to be developed with significant local input and a broader understanding of the potential costs for various levels of mitigation," but further details are not provided (2022 GSP Addendum, p. 30).

Projects and Management Actions

The GSAs did not update projects and management actions in the 2022 GSP.

4.1.2.4 Proposed State Water Board Deficiencies

DWR's 2022 GSP Inadequate Determination dated March 2, 2023, found that the subsidence deficiency was not corrected in the 2022 GSP submitted on July 27, 2022. DWR's 2022 GSP Inadequate Determination states:

> …in total the revised [2022] GSP did not take sufficient action in addressing the corrective action as it relates to establishing sustainable management criteria in a manner consistent with SGMA and the GSP Regulations and protection of flood infrastructure (2022 GSP Inadequate Determination, p. 21).

Board staff concurs with DWR's findings in the 2022 GSP Inadequate Determination and hereby incorporate it by reference. In addition, Board staff has identified additional issues related to the deficiencies DWR identified. Below, State Water Board staff breaks down deficiencies for the subbasin related to subsidence. Deficiencies from DWR's inadequate determination are incorporated into the deficiencies below.

Deficiency Land Subsidence (LS)-1 – The 2022 GSP does not clearly describe the subsidence conditions that would result in an undesirable result for the basin.

What SGMA Requires: The GSP Regulations require a GSA to "describe...the processes and criteria relied upon to define undesirable results applicable to the basin." This description must include the cause of past or potential undesirable results, "the criteria used to define when and where the effects of the groundwater conditions cause undesirable results," and the potential effects of undesirable results on groundwater uses and users, land uses, and property interests (Cal. Code Regs., tit. 23, § 354.26).

Deficiency: DWR noted in its 2022 GSP Inadequate Determination that "the GSP has not defined the limits of what is considered economically feasible nor the tolerable amount of subsidence for the critical infrastructure." The Inadequate Determination further notes that "It is unclear to Department staff how [the undesirable result] definition will avoid significant and undesirable results" (ibid., p. 17).

Without a clear description of degree of impacts that are "significant and unreasonable." GSAs and the State cannot evaluate whether MTs or broader quantitative definitions of an undesirable result that would guide day-to-day basin management are appropriate for avoiding undesirable results.

State Water Board staff proposes Potential Action LS-1 to address the deficiency.

Deficiency LS-2 – The GSAs did not consider all beneficial uses and users in setting quantitative criteria for subsidence in the 2022 GSP or adequately describe the impacts of criteria on beneficial uses and users.

What SGMA Requires: Minimum thresholds are the numeric values used to define undesirable results. Measurable objectives are specific, quantifiable goals for the maintenance or improvement of groundwater conditions to achieve the sustainability goal for the basin.

The GSP Regulations state that MTs for land subsidence should identify the rate and extent of subsidence that substantially interferes with surface land uses and may lead to undesirable results. These quantitative values should be supported by:

- The identification of land use or property interests potentially affected by land subsidence
- An explanation of how impacts to those land use or property interests were considered when establishing minimum thresholds
- Maps or graphs showing the rates and extents of land subsidence defined by the minimum thresholds (Cal. Code Regs., tit. 23, § 354.28, subd. (c)(5)).

MOs for land subsidence must be based on the same metrics and monitoring sites used for MTs. MOs must “provide a reasonable margin of operational flexibility under adverse conditions” (Cal. Code Regs., tit. 23, § 354.30, subds. (c) & (d)).

GSAs must also establish interim milestones (IMs) for each sustainability indicator, “using the same metric as the measurable objective, in increments of five years.” These IMs support the GSP’s description of “a reasonable path to achieve the sustainability goal for the basin within 20 years of implementation” (Cal Code Regs., tit. 23, § 354.30, subd. (e)).

Deficiency: The DWR 2022 GSP Inadequate Determination noted that “GSAs should revise their discussions of measurable objectives and minimum thresholds to be consistent with the requirements of SGMA” (ibid., p. 17). This deficiency includes three sub-deficiencies: LS-2a through LS-2c.

Deficiency LS-2a – MTs were not established based on avoiding undesirable results.

The DWR 2022 GSP Inadequate Determination found that “the GSAs have not established minimum thresholds based on the level of subsidence that would substantially interfere with land surface use and avoid undesirable results.” Instead, the 2022 GSP established MTs based on cumulative baseline subsidence by 2040, which was estimated using the annual rate of subsidence calculated from InSAR data from 2016 through 2022. The GSP then provided estimates of subsidence “With GSP Implementation” (implementation subsidence) that appear to be based on modeled projections of projects and management actions. DWR staff notes that the 2022 GSP “does not describe how the minimum thresholds were determined and only identifies them as ‘being similar to the values determined by the groundwater model in the 2020 GSP.’” DWR staff also “still interpret baseline subsidence estimates and the estimates of subsidence with projects and management actions implemented as maintaining status-quo..." (ibid., p. 18).

Board staff concurs with DWR’s findings and further note that the 2022 GSP does not clearly list minimum thresholds. The 2022 GSP indicates that subsidence MTs are listed in GSP Table 3-2; however, GSP Table 3-2 does not list MTs. Instead, it lists baseline and implementation subsidence values. While Board staff interprets the GSP addendum language as indicating that the implementation subsidence values are the minimum thresholds, Board staff notes that MTs are fundamental to GSPs and should therefore not be left to interpretation.

State Water Board staff proposes Potential Action LS-2a to address the deficiency.

Deficiency LS-2b – Some MTs appear to exceed subsidence limits set in other pre-existing agreements.

The DWR 2022 GSP Inadequate Determination notes that MTs for eight RMS appear to exceed the allowable subsidence along the California Aqueduct. DWR staff notes that GSAs have an agreement with the DWR State Water Project managers to "keep subsidence along the aqueduct to 0.01 feet annually or a maximum of 0.2 feet during the 20-year implementation." DWR staff notes, however, that MTs at eight RMS exceed 0.2 feet, with MTs ranging from 0.7 to 1.9 feet (ibid., p.19).

State Water Board staff proposes Potential Action LS-2b to address the deficiency.

Deficiency LS-2c – MOs and IMs were not established.

The DWR 2022 GSP Inadequate Determination found that "measurable objectives have not been established for subsidence." The 2022 GSP indicates that the "measurable objective for subsidence will ultimately be achieved through the MTs and MOs set for groundwater levels and storage, which is expected to result in decreasing subsidence over time" (2022 GSP Addendum, p. 29). DWR staff notes that this results in "circular referencing," as the 2022 GSP MOs are "tied to groundwater storage SMC, subsidence SMC and associated projects and management actions..." DWR staff notes that this circular referencing is also inconsistent with GSP Regulations because the GSP does not use groundwater levels as a proxy for subsidence MTs.

Board staff concurs and further note that updating MTs and MOs will require updating IMs.

State Water Board staff proposes Potential Action LS-2c to address the deficiency.

Deficiency LS-3 – The GSAs did not adequately consider the impacts of subsidence on flood protection infrastructure.

What SGMA Requires: MTs for land subsidence must be supported by, in part, "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 [GSA] has determined and considered those uses and interests, and the [GSA's] rationale for establishing minimum thresholds in light of those effects" (Cal. Code Regs., tit. 23, § 354.28, subd. (c)(5)(A)).

The GSP must also include a description of beneficial uses and users in the basin, "the types of parties representing those interests, and the nature of consultation with those parties" (Cal. Code Regs., tit. 23, § 354.10, subd. (a)).

Deficiency: The DWR 2022 GSP Inadequate Determination finds that 2022 GSP did not adequately assess the impact of subsidence on flood protection infrastructure. The

2022 GSP assesses two ways that subsidence may impact levees: 1) lower crown elevations and 2) impact differential subsidence.

When assessing the impact of lower crown elevations, the 2022 GSP states that “the elevation of the flood protection levees and the elevation of the flood-prone areas (i.e., floodplain) generally decrease uniformly. With little or no differential movement between the crown of the levee and the floodplain, the performance of the levee is unaffected.” (ibid., Appendix B, p. 7). The DWR 2022 GSP Inadequate Determination notes that this assessment “fails to mention that if subsidence occurs, there is a risk of reducing the conveyance capacity of the channels and reduction of freeboard.” State Water Board staff agrees and additionally note that reduced channel capacity doesn’t only increase overtopping risks due to reduced freeboard; it also increases risk of landside slope failure and piping (creation of water paths both through and under the levee) due to increased hydraulic head above the landside levee toe.

When assessing the impact of differential subsidence, the 2022 GSP states that “levees are flexible earthen structures that can tolerate typical differential longitudinal settlement that occurs due to variability of soils in their foundation. As such, there is very little literature on performance limits of levees affected by differential settlement along their longitudinal axis” (ibid., Appendix B, p. 7). State Water Board staff notes that the extent and magnitude of differential settlement from foundational soils is substantially different than the extent and magnitude of differential subsidence. Moreover, the uncertainty of impacts of longitudinal differential subsidence should be a reason for GSAs to minimize subsidence, especially in areas where levees may be constructed with dispersive soils (soils which may easily dissolve into solution and erode), which substantially increase risks of piping in cracks through levees.

State Water Board staff also notes that areas with increased subsidence rates landside of levees can experience higher inundation if flooded.

Coordination with flood management agencies will be critical to understanding the impacts of subsidence on infrastructure managed by those agencies. The 2022 GSP Addendum did not explain how conversations with flood management agencies were considered and integrated in developing SMC. Board staff concurs with DWR that coordination with local management agencies is critical, given that subsidence has likely exacerbated the already substantial risk of flooding in the Tulare Lake subbasin. Indeed, shortly after DWR released its 2022 GSP Inadequate Determination for Tulare Lake, two major storms produced unusually high run-off, resulting in local flooding of several rivers and the failure of some local levees (**Figure 4-3**). State Water Board staff proposes Potential Actions 3a and 3b to address the deficiency.

Deficiency LS-4 – The GSP does not provide adequate implementation details.

What SGMA Requires: Each GSP is required to include a description of the projects and management actions the GSA has determined will achieve groundwater sustainability in the basin. The description must include project management actions, summary of data used to support proposed actions, and a review of the uncertainty associated with the basin setting when developing projects or management actions (Cal. Code Regs., tit. 23, § 354.44).

In reviewing GSPs, DWR must consider, among other questions, "whether sustainable management criteria and projects and management actions are commensurate with the level of understanding of the basin setting, based on the level of uncertainty, as reflected in the plan" and "whether the projects and management actions are feasible and likely to prevent undesirable results and ensure that the basin is operated within its sustainable yield" (Cal. Code Regs., tit. 23, § 355.4, subd. (b)(3), (5)).

Deficiency: The 2022 GSP provides very little detail about projects and management actions. The DWR 2022 GSP Inadequate Determination found that two monitoring sites have already exceeded MTs and that the GSP does not provide adequate details about projects and management actions. DWR staff notes that the 2022 GSP does not provide details on projects and management actions necessary to quantify benefits. DWR staff was therefore unable to "determine if projects and management actions will assist in minimizing and avoiding subsidence in the subbasin beyond 2040" (2022 GSP Inadequate Determination, p. 18).

These exceedances are especially concerning given that the 2020 GSP MTs may not even avoid undesirable results and sometimes even violate existing agreements to protect critical infrastructure. It is therefore crucial that the GSP provide adequate detail about projects and management actions so that feasibility can be evaluated. It is unclear if current subsidence rates provide operational flexibility against undesirable results, or if undesirable results may already be occurring.

State Water Board staff proposes Potential Actions LS-4a, LS-4b, and LS-4c to address the deficiency.

4.1.2.5 Potential Actions to Address the Land Subsidence Sustainable Management Criteria Deficiency

Potential Action LS-1 – Clearly define the subsidence conditions that would result in an undesirable result for the basin* and provide *enough detail that associated MTs can be determined (Cal. Code Regs., tit. 23 § 354.28).

The 2022 GSP defined an undesirable result for land subsidence as "the significant loss of functionality of critical infrastructure or facility, so the feature(s) cannot be operated as designed, requiring either retrofitting or replacement to a point that is economically

unfeasible." As the DWR 2022 GSP Inadequate Determination notes, the 2022 GSP does not define the costs that would be considered "economically unfeasible." MOs and MTs can therefore not be evaluated to ensure that they would prevent an undesirable result. These costs need to be defined so that associated MTs can be developed and evaluated, or the GSP needs to develop a new approach to defining an undesirable result.

Potential Action LS-2 – Establish quantitative criteria that avoid undesirable results and conform with agreements with other agencies.

Potential Action LS-2a – Define and clearly list MTs based on the level of subsidence at each RMS that would cause the undesirable results conditions that the GSAs are trying to avoid.

The 2022 GSP established MTs based on projected subsidence given recent rates and planned project and management implementation. This approach does not provide MTs that would necessarily avoid a UR. It instead provides MTs based on subsidence the GSAs expect to experience given implementation of current projects and management actions. This is problematic, as MTs should be used to assess the adequacy of projects and management actions in avoiding UR. The 2022 GSP effectively reverses this relationship.

Potential Action LS-2b – Ensure MTs conform with current agreements with other agencies.

The DWR 2022 GSP Inadequate Determination notes that eight 2022 GSP subsidence MTs exceed allowed subsidence along the California Aqueduct. MTs should not permit violation of the agreement with the Department State Water Project manager to "keep subsidence along the aqueduct to 0.01 feet annually or a maximum of 0.2 feet during the 20-year implementation."

Potential Action LS-2c – Establish MOs that avoid undesirable results and provide operational flexibility so that potential future droughts do not cause MT exceedances. Establish IMs that provide a reasonable path to achieving sustainable management.

The 2022 GSP did not update the 2020 GSP MOs. The 2020 GSP established MOs based on projected status-quo subsidence through 2035. This approach does not necessarily avoid undesirable results, nor does it necessarily provide operational flexibility to protect against undesirable results during future drought.

Moreover, the 2022 GSP did not establish MOs for the additional RMS. Additional RMS were required because DWR determined the previous monitoring network was deficient.

While the additional RMS adequately addressed the monitoring network deficiency, the 2022 GSP should have established MOs for the additional RMS.

Finally, IMs need to be updated for the previous RMS in the 2020 GSP and established for the additional RMS in the 2022 GSP. IMs should provide a reasonable path to achieving sustainability, so they very likely should be updated when MTs or MOs are updated – this is especially true when both MTs and MOs are updated.

Potential Action LS-3 – Consult with flood management agencies and expand the GSP's analysis of land subsidence impacts on flood infrastructure.

Potential Action LS-3a – Further engage with flood management agencies to establish SMC and describe how SMC consider flood management agencies.

GSAs and flood management agencies should coordinate to ensure that basin management fully considers the impact of groundwater management on flood management infrastructure and that infrastructure maintenance and improvement fully considers the impact of subsidence. Importantly, coordination should focus efforts on ensuring that flood control infrastructure protects communities where flooding would displace or otherwise impact people.

This coordination is even more important due to climate change, which generally increases the frequency and intensity of extreme precipitation events and alters the timing of precipitation, snowpack, and run off. Increasingly extreme events can cause substantial increases in localized flow, while altered timing reduces the ability to project future risks from historical data. GSA coordination with flood management agencies should therefore seriously consider how climate change will exacerbate the risks already elevated from subsidence.

The GSP should clearly explain how flood management agency concerns are addressed by SMC.

Potential Action LS-3b – Establish undesirable results and MTs that consider the impacts of reduced channel capacity, uncertainty around longitudinal differential subsidence, and increased inundation depths.

The 2022 GSP does not consider reduced channel capacity when establishing subsidence undesirable results and MTs. It instead claims that "the elevation of the flood protection levees and the elevation of the flood-prone areas (i.e., floodplain) generally decrease uniformly. With little or no differential movement between the crown of the levee and the floodplain, the performance of the levee is unaffected." This claim ignores the reduction in channel capacity caused by altered channel gradients. Reduced channel capacity doesn't only increase overtopping risks due to reduced freeboard; it

also increases risk of landside slope failure and piping due to increased hydraulic head above the landside levee toe.

The 2022 GSP also notes that there is limited literature on the impacts of differential subsidence along the longitudinal axis of levees, but then claims that levees "can tolerate typical differential longitudinal settlement that occurs due to variability of soils in their foundation." This comparison ignores that the extent and magnitude of differential settlement from foundational soils is substantially different than the extent and magnitude of differential subsidence. The GSP should instead evaluate the impacts of existing subsidence on foundation gradients to assess whether they are comparable to gradients typical of differential settlement from foundation soils. In the absence of such an evaluation, the uncertainty of impacts of longitudinal differential subsidence should be reason for GSAs to minimize subsidence. This is especially true in areas where levees may be constructed with dispersive soils (soils which may easily dissolve into solution and erode), which substantially increase risks of piping in cracks through levees.

Finally, the 2022 GSP ignores the fact that floodwater can travel down-gradient, away from breach sites. This means that differential subsidence, which the GSP acknowledges exists, could create localized areas that act as bowls where floodwater ponds and reaches substantially greater depths than it otherwise would.

Potential Action LS-4 – Plan ahead to avoid significant and unreasonable land subsidence.

Potential Action LS-4a – Develop a plan to trigger sufficient management actions when subsidence exceeds defined thresholds, especially near critical infrastructure/facilities.

The GSP should include detailed demand management plans to provide contingency in case future conditions are more difficult than anticipated. The GSAs should develop reasonable actions (e.g., pumping reductions for nearby wells) to halt subsidence along critical infrastructure when it exceeds defined thresholds. Because over pumping is the primary cause of subsidence in the subbasin, GSAs should identify the wells that have the greatest impact on subsidence near critical infrastructure and the specific aquifers from which they pump.

These management plans should ensure that subsidence is monitored frequently enough that triggered actions avoid undesirable results. If actions aren't triggered, for example, until right before MTs are exceeded, the quarterly monitoring provided by InSAR data may not be frequent enough to avoid MT exceedance. In these cases, continuous, ground-based GPS monitoring may be necessary.

Potential Action LS-4b – Update the Well Registration Program to meet subsidence goals in the subbasin; Do not allow new wells in areas where subsidence threatens critical infrastructure.

GSAs should build on their Well Registration Program (2022 GSP Addendum, p. 15) to prevent new wells from being installed near, and move existing wells away, from critical infrastructure (e.g., California Aqueduct, high-speed rail line, and levees). While Board staff acknowledges that the GSAs will require "all new wells within three miles of the California Aqueduct to provide a subsidence evaluation and appropriate coordination with DWR as part of the requirement to obtain a permit" (ibid., p. 26), staff recommends developing similar criteria for all critical infrastructure (e.g., high-speed rail line, levees). The GSAs should instead proactively analyze the ongoing impacts of subsidence on critical infrastructure to determine not just where new wells shouldn't be installed, but also where existing wells should be relocated to protect essential infrastructure.

Potential Action LS-4c – Develop infrastructure mitigation programs with clear triggers, eligibility requirements, metrics, and funding sources.

GSAs should minimize or avoid subsidence, as it causes irreversible harm; however, GSAs should also develop mitigation plans to repair infrastructure damaged by subsidence. The mitigation plans should:

- Identify infrastructure that may be damaged by subsidence and estimate associated repair costs.
- Identify adequate and highly reliable funding sources for mitigation efforts commensurate with the magnitude of impacts allowed under the GSAs' MTs; demonstrating adequate funding may involve projecting out fee revenues to demonstrate financial capacity that matches expected need. State Water Board staff notes that fee revenues levied by the GSAs on groundwater extractions are a more reliable funding source than grants and subsidies.
- Coordinate with local agencies responsible for maintaining and repairing infrastructure so that they understand how to apply for mitigation funds.

GSAs should not plan to fund infrastructure repair with state funding. For example, GSAs should develop funding necessary to restore capacity to canals rather than relying on funding from DWR.

4.1.3 Deficiency GWQ – Degraded Groundwater Quality

Another consideration under SGMA is avoiding "significant and unreasonable degraded water quality, including the migration of contaminant plumes that impair water supplies" (Wat. Code, § 10721, subd. (x)). Degradation of water quality can limit local water supplies and beneficial uses, and SGMA requires GSAs to consider the interests of all beneficial uses and users of groundwater, including municipal well operators and public water systems (Wat. Code, § 10723.2). Water quality degradation that significantly and unreasonably affects the supply or suitability of groundwater for use in drinking water systems is an undesirable result.

DWR concluded that the Tulare Lake Subbasin 2022 GSP does not adequately justify its approach for developing SMC for Degraded Water Quality, the criteria that the GSAs will use to evaluate success in the subbasin (See Table 4-4 below). DWR also recommended that the GSA characterize the historic and current groundwater quality conditions within the principal aquifers including the primary constituents identified. Board staff have built on DWR's analysis, noting concerns with the monitoring network and monitoring frequency and an absence of projects and management actions identified to avoid undesirable results.

Table 4-4 – Summary of DWR's Degraded Groundwater Quality Deficiency and Relevant Components of the 2020 and 2022 Tulare Lake Subbasin GSPs

2020 GSP	DWR's 2020 GSP Incomplete Determination	2022 GSP	DWR's 2022 GSP Inadequate Determination
The GSP relied on existing water quality regulations and policies to assess water quality issues.	The GSP does not identify sustainable management criteria for degraded water quality.	The GSP Identified the constituents of concern and established two criteria for indicating undesirable result.	GSP has sufficiently described how constituents will be monitored but has not taken sufficient action to describe how the monitoring and management that those programs implement align with the requirements of a GSP under SGMA.

4.1.3.1 Tulare Lake Subbasin 2020 GSP

This subsection and following subsections describe the portions of each GSP or DWR determination relevant to the proposed Board deficiencies.

Plain-language Definition of an Undesirable Result

The 2020 GSP briefly noted how pumping can impact water quality (2020 GSP, p.4-9) but did not define a water quality undesirable result for the subbasin.

Quantitative Definition of an Undesirable Result, Minimum Thresholds and Measurable Objectives and Associated Impacts

The 2020 GSP did not define a water quality undesirable result or set sustainable management criteria for water quality degradation. Instead, the 2020 GSP relied on existing water quality regulations and monitoring programs, such as the Irrigated Lands Regulatory Program (ILRP) and Groundwater Ambient Monitoring and Assessment Program (GAMA), to address water quality issues without providing information on those program's criteria or monitoring: "MTs will be determined as described by the agencies and coalitions which include ILRP, GAMA, Regional Water Quality Control Board (RWQCB), CV-SALTS, and cities and communities within the subbasin for the various constituents they monitor" (ibid., p. 4-15). The 2020 GSP then contradicted itself, stating that the subbasin would rely on federal and state water quality standards to function as the water quality MOs and MTs (ibid., p. 4-16), but the GSP did not provide any further information such as when or how water quality SMC would be determined and how they would relate to an as-yet-undefined undesirable result.

Monitoring

The 2020 GSP stated, "The groundwater quality RMS monitoring network is composed of wells currently sampled by the local cities/municipalities/small community systems, and the Kings River Water Quality Coalition (KRWQC)-Irrigated Lands Regulatory Program (ILRP)" (ibid., p. 5-2). Water quality RMS sites were all located in the northern portion of the subbasin, along with two wells in the extreme western point of the subbasin (**Figure 4-4**).

4.1.3.2 DWR's 2020 GSP Incomplete Determination

In its January 28, 2022, incomplete determination letter, DWR identified a deficiency in the subbasin's 2020 GSP related to water quality SMC:

> Deficiency 3 – The [2020] GSP does not identify sustainable management criteria for degraded water quality
>
> [This] deficiency relates to the GSP's absence of identified undesirable results and other sustainable management criteria for degraded water quality, as well shortcomings [sic] of the proposed monitoring network.

(2020 GSP Incomplete Determination, p. 15).

Plain-Language Definition of an Undesirable Result

DWR staff noted “The GSAs indication that existing water quality agencies and programs define undesirable results that represent degraded water quality conditions occurring throughout the subbasin for the purposes of SGMA does not satisfy the requirements of the GSP Regulations” (ibid., p.15).

Quantitative Definition of an Undesirable Result, Minimum Thresholds and Measurable Objectives and Associated Impacts

DWR staff found that the GSP’s reference to other regulatory programs regarding SMC was insufficient:

> As discussed above with defining undesirable results, it is also not the responsibility of the existing agencies and programs to establish minimum thresholds for the purposes of achieving the sustainability goal of the subbasin and avoiding undesirable results during GSP implementation.[…] As currently presented, Department staff do not believe the GSP adequately describes how the federal or state water quality standards (i.e., maximum contaminant levels, etc.) will be “utilized by the subbasin for MOs and MTs” as stated in the GSP.

(ibid., p. 16).

DWR staff also found that the GSP did not address potential water quality impacts to beneficial uses: “Department staff find the GSP does not discuss the groundwater quality issues in terms of how the chemicals of concern may affect the supply and beneficial uses of the groundwater” (ibid., p. 16).

DWR’s 2020 GSP Corrective Actions

To address the water quality deficiency in the 2020 GSP, DWR staff recommended that the GSAs do the following:

> Characterize historic and current groundwater quality conditions within the principal aquifers including the primary COCs [constituents of concern]. Describe how the constituents will be monitored and how the baseline concentrations or federal and state standards will be assessed to evaluate potential degradation. […] Define sustainable management criteria based on the GSAs [sic] level of understanding of the historic and current groundwater conditions as required by the GSP Regulations. […] Include a discussion of the methodology used to determine which constituents are included in the sustainable management criteria and describe the potential affects the undesirable results and minimum thresholds may have on groundwater supply and users.

(ibid., p. 17).

4.1.3.3 Tulare Lake Subbasin 2022 GSP Submission and WY 2022 Annual Report

The GSAs submitted a revised GSP to DWR on July 27, 2022, in compliance with the 180-day resubmittal deadline. While not considered in DWR's assessment of the 2022 GSP, the GSAs also filed the WY 2022 Annual Report for the subbasin on March 31, 2023.

Plain-Language Definition of an Undesirable Result

The GSAs revised the plain-language definition of an undesirable result related to degradation of water quality:

> An undesirable result for degraded water quality in the subbasin would be the result stemming from a causal nexus between groundwater-related GSP activities, such as groundwater extraction or recharge, and a degradation in groundwater quality that causes a significant and unreasonable reduction in long-term viability of domestic, agricultural, municipal, or environmental uses over the planning and implementation horizon of this GSP.

(2022 GSP Addendum, p. 37).

Quantitative Definition of an Undesirable Result, Minimum Thresholds and Measurable Objectives and Associated Impacts

The 2022 GSP identifies the primary constituents in the subbasin as TDS, nitrate as N, arsenic, uranium, 1,2,3-TCP, 1,2-Dibromo-3-chloropropane (DBCP), sulfate, and chloride and sets SMC for all constituents except for DBCP. The revised GSP notes that all the constituents except DBCP have concentrations exceeding the MCL or secondary MCL in the subbasin. The GSP states that the GSAs will conduct sampling in accordance with existing federal and state water quality monitoring programs and acknowledges data gaps in the RMS network for the A- and B-Zones.

The 2022 GSP establishes two criteria for indicating that an undesirable result in water quality has occurred:

1. When "A representative monitoring well within an individual aquifer zone exceeds the [MT] for two consecutive measurements when exceedances can be tied to a causal nexus between GSP-related activities and water quality and the individual well has been exhibiting an upward trend."
2. "When [MTs] are exceeded with no observable upward trend, when 25% of representative monitoring wells within an individual aquifer zone exceeds the [MTs] for two consecutive measurements at each location where these [MT] exceedances can be tied to a causal nexus between GSP-related activities and water quality" (ibid., p. 38).

The GSP explains that “Twenty-five percent of the representative monitoring wells were selected because no observable upward trend would indicate a non-GSP- related activity at an individual well. Although exceedances of minimum thresholds at 25% of the representative monitoring wells with no observable upward trend still indicate non-GSP-related activity, assessing the causal nexus with water quality at this value will provide a factor of safety” (ibid., p.38).

The 2022 GSP describes the approach to the water quality MTs:

> For the subbasin, the MTs for degraded water quality is established as the higher of: (1) the Upper Secondary Maximum Contaminant Level (SMCL) for TDS (1,000 mg/L), chloride (500 mg/L) and sulfate (500 mg/L) and Primary MCL for nitrate as N (10 mg/L), arsenic (0.010 mg/L), uranium (20 pCi/L), and 1,2,3-TCP (0.005 µg/L) or (2) current water quality conditions for all constituents defined as data available from 2000 to January 2020 at the representative monitoring well or nearby well within the same aquifer zones described in Section 3.1.8 of the Basin Setting chapter of the 2020 GSP, using the maximum concentration detected for each constituent.

(ibid., p. 40).

The 2022 GSP established MOs for TDS, sulfate, and chloride (analytes where only an SMCL are established) based on SMCL or based on a statistical analysis. If current conditions were below the recommended SMCL, then the GSP used the SMCL as the MO. If current conditions were above the recommended SMCL, then the GSP established the MO as the 95th percentile of background concentrations (upper 95 percent tolerance limit), which the GSP described as “one of the approved statistical methods described in Title 27, Division 2, Subdivision 1, Chapter 3, Subchapter 3, Article 1, Section 20415(e)(8)(c) for establishment of concentration limits” (ibid., p. 42). Where well-specific or nearby well data in the same aquifer are not available, the GSP would initially use the SMCL as the MO, but if future monitoring indicated concentrations exceeding the SMCL, the GSP would use the upper tolerance limit as the MO.

The 2022 GSP established MOs for nitrate (as N), arsenic, uranium, and 1,2,3-TCP (analytes with established MCLs) using the upper tolerance limit calculated from data between 2000 and January 2020 (presumably the upper 95 percent tolerance limit). For RMS wells where historical data are not available, the GSP sets the MO at 70% of the MCL, but the GSP would use the upper tolerance limit as the MO once data are available.

Monitoring

In the 2022 GSP, GSAs propose to continue monitoring groundwater quality using 34 exiting monitoring agency program wells. The water quality monitoring network consists of public water system wells regulated by the Board’s Division of Drinking Water which

have existing water quality monitoring requirements. The monitoring frequency is adopted from existing monitoring programs (ibid., p. 41). The frequency in which samples are collected vary based on the well and the constituent, ranging from 0.25 to 9-year frequencies (ibid, Table 4-2) and is subject to change as determined by each regulatory program. This GSP adds an additional monitoring well recently constructed by the Mid-Kings GSA which will be sampled biennially (2022 GSP Addendum, p. 42). Samples from each well in the monitoring network will only be analyzed for constituents subject to monitoring by each regulatory program the GSAs are relying on – not the full suite of constituents with SMC. Staff note that based on known depths, wells in the monitoring network are located within the B-zone and C-zone.

The 2022 GSP establishes that the monitoring network does not include wells completed in the A-zone, and that this is a data gap. Existing regulatory programs do not monitor any wells in the A-zone for any of the constituents with SMC. The GSP states that the GSAs will continue to look for additional monitoring locations in all three aquifers. If GSAs install new monitoring wells or add wells screened in the B-zone, the GSAs will conduct additional sampling for these wells (2022 GSP Addendum, p. 42).

While not evaluated in the 2023 DWR determination, the WY 2022 annual report stated that six additional monitoring wells were added to the monitoring well network by the Mid-Kings GSA to resolve data gaps. During WY 2022, 25 of the 36 RMS wells were sampled for at least one of the constituents with SMC. Of the 25 wells sampled, four exceeded the MT for arsenic. Additionally, samples from one well now indicate an increasing trend which the GSP specifies as an undesirable result trigger.

4.1.3.4 Proposed State Water Board Deficiencies

In DWR's 2022 GSP Inadequate Determination dated March 2, 2023, DWR staff determined that the GSAs had not corrected the degradation of water quality deficiency in the 2022 GSP. DWR's March 2, 2023, Inadequate Determination states:

> In all, Department staff conclude the GSP did not take sufficient action to address the entire deficiency. The revised GSP has not established sustainable management criteria and a monitoring network for managing degradation of water quality in a manner consistent with the GSP Regulations and SGMA (2022 GSP Inadequate Determination, p. 28).

Board staff concur with DWR's findings in their 2022 GSP Inadequate Determination and hereby incorporate it by reference. In addition, Board staff have identified additional issues with the GSA's monitoring network for the subbasin, monitoring frequency, and lack of consideration for how projects and management actions could impact water quality. Below, State Water Board staff breaks down deficiencies for the subbasin related to water quality degradation. Deficiencies from DWR's DWR 2022 GSP Inadequate Determination are incorporated into the deficiencies below.

Deficiency Groundwater Quality (GWQ)-1 – The 2022 GSP's definition of an undesirable result is not consistent with GSP Regulations.

What SGMA Requires: The GSP Regulations require a GSA to "describe...the processes and criteria relied upon to define undesirable results applicable to the basin." This description must include the cause of past or potential undesirable results, "the criteria used to define when and where the effects of the groundwater conditions cause undesirable results," and the potential effects of undesirable results on groundwater uses and users and land uses and property interests (Cal. Code Regs., tit. 23, § 354.26).

Deficiency: The DWR 2022 GSP Inadequate Determination finds that the "impacts to beneficial uses and users [the undesirable result] have not been described." Board staff concur and further note that the undesirable result definition requires triggering several components and is therefore unlikely to occur *on paper*, no matter the material impacts to beneficial uses and users. Accordingly, DWR and Board staff note multiple deficiencies concerning the degradation of water quality undesirable results. These deficiencies are summarized below as GWQ-1a, GWQ-1b, and GWQ-1c. Each of these deficiencies was identified by DWR; however, Board staff note additional detail for GWQ-1c.

Deficiency GWQ-1a – The 2022 GSP does not clearly describe the water quality conditions and impacts that would result in an undesirable result for the basin.

DWR's 2022 GSP Inadequate Determination finds that neither the water quality undesirable result nor its impacts to beneficial uses and users is adequately described. The 2022 GSP describes the undesirable results as **"...significant and unreasonable reduction in long-term viability of domestic, agricultural, municipal, or environmental uses over the planning and implementation horizon of this GSP."** DWR staff note that "it is unclear... what constitutes a significant and unreasonable reduction in **viability of groundwater use for the identified beneficial uses**," and specifically note that it is unclear what "long-term viability means to the GSAs."

Without a clear description of impacts that are "significant and unreasonable", GSAs and the State cannot evaluate whether MTs or broader quantitative definitions of an undesirable result that would guide day-to-day basin management are appropriate for avoiding undesirable results.

State Water Board staff propose Potential Action GWQ-1a to address the deficiency.

Deficiency GWQ-1b – The triggers for determining an undesirable result set by the 2022 GSP would result in delayed identification of an undesirable result and therefore delayed management of the basin.

The DWR 2022 GSP Inadequate Determination finds that the GSAs would "not be actively monitoring the subbasin to avoid an undesirable result..." DWR staff note that GSAs will not evaluate constituent data to determine if undesirable results may be occurring unless analysis indicates a positive trend. This trend analysis, however, will not even be conducted until "at least six samples have been collected for each analyte at each representative monitoring site." Some analytes at some monitoring sites are sampled only once every four years, indicating that trend analysis would sometimes not be conducted until the year 2046.

DWR staff note additional details that require clarity. It is not clear, for example, if historical sampling data may count toward the six samples required before trend analysis. Board staff concur, further noting that it is not clear whether the trend analysis for a given constituent will be conducted at a given well as soon as six samples are available or if no trend analysis will be conducted until six samples have been collected from each well in the monitoring network.

Board staff is also concerned that trend analysis may result in avoiding recognition of undesirable results no matter the actual impacts to beneficial uses and users. Board staff note that depending on the analysis time period, monitoring frequency, the selected confidence interval, and other technical details, trend analysis may delay or effectively prevent identification of undesirable results. Unless trends are detected, the 2022 GSP identifies an undesirable result only when a full quarter of all wells exceed MTs for two consecutive measurements. Board staff will therefore be very interested in carefully reviewing detailed methodologies for trend analysis and considering its impact on the GSAs' ability to manage the basin and avoid an undesirable result.

State Water Board staff propose Potential Action GWQ-1b to address the deficiency.

Deficiency GWQ-1c – The GSP does not describe how it would determine whether significant and unreasonable degradation of water quality was associated with basin management.

The DWR 2022 GSP Inadequate Determination notes that the GSP does not describe how it will determine whether degradation of water quality is associated with basin management. The GSP describes an undesirable result occurring only if it is "stemming from a causal nexus between groundwater-related GSP activities... and a degradation in groundwater quality..." **Board staff concur and further note that an undesirable result does not require a "causal nexus" with groundwater management; it instead must simply be caused by groundwater conditions occurring throughout the basin** (Water Code § 10721 subd. (x)). Moreover, Board staff is concerned that "causal nexus" criterion might be infeasible and impractical to determine absent a

substantially more robust monitoring network and sophisticated, well-performing basin model. Board staff is also concerned that the “causal nexus” criterion could be used to avoid responsibility for degraded water quality.

Moreover, Board staff note that the 2022 GSP lacks crucial, related information:

1) The impact of projects and management actions on water quality. Again, Board staff are especially interested in the potential migration of de-designated water. But Board staff also note that recharge projects could also result in the mobilization of shallow constituents into wells. Recharge projects may influence the migration of legacy constituents within the vadose zone (unsaturated zone between the ground surface and the top of the water table) or may change groundwater conditions that may favor the mobilization of constituents not previously in solution.

2) The impact of subsidence on water quality. Subsidence can mobilize constituents as the aquifer matrix or clay layers compact, as oxic groundwater levels decline, or as flooding frequency or severity increase (Galloway et al, 1999; Haugen et al, 2021; Smith et al. 2018). Much of the Tulare Lake subbasin has subsided due to continued and extensive groundwater extractions, so the GSP should consider associated impacts when assessing the “causal nexus” between basin management and degraded groundwater quality.

State Water Board staff propose Potential Action 1c to address the deficiency.

Deficiency GWQ-2 – Minimum thresholds set by the 2022 GSP are not consistent with GSP Regulations.

What SGMA Requires: The GSP Regulations require GSAs to base their MTs for degradation of water quality 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.” Also, GSAs must consider “local, state, and federal water quality standards applicable to the basin” in setting MTs (Cal. Code Regs., tit. 23, § 354.28, subd. (c)(4)). In describing MTs, GSPs must describe how MTs “may affect the interests of beneficial uses and users of groundwater or land uses and property interests.” (Cal. Code Regs., tit. 23, § 354.28, subd. (b)(4)).

The plan may, but is not required to, address undesirable results that occurred before, and have not been corrected by, January 1, 2015.

Deficiency: The 2022 GSP uses historical data to establish MTs when current conditions exceed MCLs or SMCLs. Board staff understand that GSAs do not have to address undesirable results that occurred before 2015, and Board staff understand that this is why GSAs are establishing MTs from historical data when current conditions exceed MCLs or SMCLs. But the DWR 2022 GSP Inadequate Determination and Board staff note multiple deficiencies concerning how these historical data are used and the

resulting MTs. These deficiencies are summarized below as GWQ-2a, GWQ-2b, GWQ-2c, GWQ-2d, and GWQ-2e. Deficiencies GWQ-2a and GWQ-2e were identified by DWR. Deficiencies GWQ-2b, GWQ-2c and GWQ-2d were identified by Board staff.

Deficiency GWQ-2a – The 2022 GSP establishes minimum thresholds that exceed regulatory water quality thresholds without explaining how that would not cause significant and unreasonable results or impacts to beneficial uses and users.

The 2022 GSP Inadequate Determination notes that the 2022 GSP establishes many MTs that exceed primary MCLs or upper SMCLs yet does not explain how exceeding health- or quality-protective standards is not an undesirable result. While GSAs are not required to address undesirable results for groundwater quality that occurred prior to January 1, 2015, pre-2015 undesirable results should still be identified and MTs established accordingly.

State Water Board staff propose Potential Action GWQ-2a to address the deficiency.

Deficiency GWQ-2b – Some MTs are based on data that may represent undesirable results that occurred after 2014, without justification.

As noted in deficiency GWQ-2, the 2022 GSP appears to establish MTs from historical data when current conditions exceed MCLs or SMCLs; however, the DWR 2022 GSP Inadequate Determination notes that this historical data ranges from 2000 to 2020, which "may include data that would be considered undesirable results." While GSAs are not required to address undesirable results for groundwater quality that occurred before 2015, GSAs are responsible for addressing degradation of water quality after 2015. GSAs should therefore not use exceedances between 2015 and 2020 to establish MTs that exceed MCLs or SMCLs or may otherwise indicate undesirable results.

State Water Board staff propose Potential Action GWQ-2b to address the deficiency.

Deficiency GWQ-2c – The GSP does not explain how it quantifies current conditions yet uses current conditions to justify establishing MTs that exceed MCLs or SMCLs.

As noted in deficiency GWQ-2, the 2022 GSP appears to establish MTs from historical data when current conditions exceed MCLs or SMCLs; however, Board staff note that the GSP does not appear to explain how it determines current conditions. For example, it does not explain how many exceedances the GSP requires before it concludes that current conditions exceed MCLs or SMCLs or whether it relies on a percentage of exceedances. Board staff note that this information is crucial for reviewing divergence from established, health-protective standards like MCLs.

Moreover, the GSP appears to assess current conditions from data between 2000 and 2020. While GSAs are not required to address undesirable results for groundwater

quality that occurred before 2015, GSAs are responsible for addressing degradation of water quality after 2015. GSAs should therefore not use exceedances between 2015 and 2020 to justify abandoning MCLs.

State Water Board staff propose Potential Action GWQ-2c to address the deficiency.

Deficiency GWQ-2d – MTs are sometimes set to the highest detected concentrations.

As noted in deficiency GWQ-2, the 2022 GSP appears to establish MTs from historical data when current conditions exceed MCLs or SMCLs; however, Board staff note that the 2022 GSP appears to set MTs at the highest observed concentration in these cases. While GSAs are not required to address undesirable results for groundwater quality that occurred before 2015, Board staff strongly object to using the highest detected concentration as a baseline for pre-2015 conditions. A single, anomalously high concentration, for example, would not represent pre-2015 conditions, and managing a basin to just under such a concentration would degrade water quality overall.

State Water Board staff propose Potential Action GWQ-2d to address the deficiency.

Deficiency GWQ-2e – MTs at some wells are based on data from wells nearby the RMS wells, rather than from the RMS wells themselves, without justification.

As noted in deficiency GWQ-2, the 2022 GSP appears to establish MTs from historical data when current conditions exceed MCLs or SMCLs; however, the DWR 2022 GSP Inadequate Determination notes that some MTs are calculated with data from nearby wells. DWR staff note that 1) it is not clear why MTs for a specific RMS would be based on data from other wells, and 2) the GSP does not provide supporting information, making review of nearby data impossible. Board staff concur, further noting that it appears the GSP does not even clearly indicate which MTs rely on nearby data. Without supporting information, these MTs cannot be reviewed to assess whether use of nearby well data is appropriate.

State Water Board staff propose Potential Action GWQ-2e to address the deficiency.

Deficiency GWQ-3 – Measurable Objectives set by the 2022 GSP are not consistent with GSP Regulations.

What SGMA Requires: MOs for water quality degradation must be based on the same metrics and monitoring sites used for MTs. MOs must “provide a reasonable margin of operational flexibility under adverse conditions” (Cal. Code Regs., tit. 23, § 354.30, subds. (c)(d)).

Deficiency: The 2022 GSP uses historical data to establish MOs when current conditions exceed MCLs or SMCLs. Board staff understand that GSAs do not have to

address undesirable results that occurred before 2015, and Board staff understand that this is why GSAs are establishing MOs from historical data when current conditions exceed MCLs or SMCLs. But the DWR 2022 GSP Inadequate Determination and Board staff note multiple deficiencies concerning how these historical data are used and the resulting MOs. These deficiencies are summarized below as GWQ-3a, GWQ-3b, GWQ-3c, GWQ-3d, GWQ-3e, GWQ-3f. Deficiencies GWQ-3a, GWQ-3b, and GWQ-3f were identified by DWR. Deficiencies GWQ-3c, GWQ-3d, and GWQ-3e were identified by Board staff.

Deficiency GWQ-3a – The 2022 GSP allows MOs that exceed regulatory water quality thresholds (e.g., MCLs) without explaining how that would not cause significant and unreasonable results or impacts to beneficial uses and users.

The 2022 GSP establishes many MOs that exceed primary MCLs or upper SMCLs yet does not explain how exceeding health- or quality-protective standards is not an undesirable result. While GSAs are not required to address undesirable results for groundwater quality that occurred prior to January 1, 2015, pre-2015 undesirable results should still be identified and MOs established accordingly.

State Water Board staff propose Potential Action GWQ-3a to address the deficiency.

Deficiency GWQ-3b – Some MOs are inexplicably based on data that may represent undesirable results.

As noted in deficiency GWQ-3, the 2022 GSP appears to establish MOs from historical data when current conditions exceed MCLs or SMCLs; however, the DWR 2022 GSP Inadequate Determination notes that this historical data ranges from 2000 to 2020. While GSAs are not required to address undesirable results for groundwater quality that occurred prior to 2015, GSAs are responsible for addressing degradation of water quality after 2015. GSAs should therefore not use exceedances between 2015 and 2020 to establish MOs that exceed MCLs or SMCLs or may otherwise indicate undesirable results.

State Water Board staff propose Potential Action GWQ-3b to address the deficiency.

Deficiency GWQ-3c – The GSP does not explain how it quantifies current conditions, yet the GSP uses current conditions to justify establishing MOs that exceed MCLs or SMCLs.

As noted in deficiency GWQ-3, the 2022 GSP appears to establish MOs from historical data when current conditions exceed MCLs or SMCLs; however, the GSP does not appear to explain how it determines current conditions. For example, it does not explain how many exceedances the GSP requires before it concludes that current conditions exceed MCLs or SMCLs, or whether it relies on a percentage of exceedances. Board

staff note that this information is crucial for reviewing divergence from established, health-protective standards like MCLs.

Moreover, the GSP appears to assess current conditions from data between 2000 and 2020. While GSAs are not required to address undesirable results for groundwater quality that occurred prior to January 1, 2015, GSAs are responsible for addressing degradation of water quality after 2015. GSAs should therefore not use exceedances between 2015 and 2020 to justify abandoning MCLs.

This deficiency would be addressed by Potential Action GWQ-2c, which Board staff proposed to also address Deficiency GWQ-2c.

Deficiency GWQ-3d – MOs are sometimes effectively set to 95th percentile concentrations.

As noted in deficiency GWQ-3, the 2022 GSP appears to establish MOs from historical data when current conditions exceed MCLs or SMCLs; however, Board staff note that the 2022 GSP appears to set some MOs at concentrations representing the 95th percentile. The GSP notes that it is following a "tolerance interval approach," which is "one of the approved statistical methods described in Title 27, Division 2, Chapter 3, Subchapter 3, Article 1, Section 20415(e)(8)(C) for establishment of concentration limits." This statutory reference is for the water quality monitoring requirements related to solid waste and is not related to SGMA. The GSP further clarifies that it uses a "95 percent tolerance coefficient," which would provide "95 percent coverage." Board staff interpret that MOs are effectively set at concentrations that are higher than 95% of all other observed concentrations. Board staff note that these concentrations do not actually represent current conditions and that managing to these MOs would result in degradation of groundwater quality.

State Water Board staff propose Potential Action GWQ-3d to address the deficiency.

Deficiency GWQ-3e – MOs at some wells are based on data from wells nearby the RMS wells, rather than from the RMS wells themselves, without justification.

As noted in deficiency GWQ-3, the 2022 GSP appears to establish MOs from historical data when current conditions exceed MCLs or SMCLs; however, the 2022 GSP indicates that some MOs may be calculated with data from nearby wells. The 2022 GSP describes methods for calculating MOs when there are no "well-specific data or nearby well data." Board staff note that 1) it is not clear why MOs for a specific RMS would be based on data from other wells, and 2) the GSP does not provide supporting information, making review of nearby data impossible. Moreover, it appears the GSP does not clearly indicate which MOs rely on nearby data. Without supporting information, these MOs cannot be reviewed to assess whether use of nearby well data is appropriate.

State Water Board staff propose Potential Action GWQ-3e to address the deficiency.

Deficiency GWQ-3f – The 2022 GSP establishes measurable objectives that may vary over time without explanation of how that would provide operational flexibility while avoiding significant and unreasonable results or impacts to beneficial uses and users.

As noted in deficiency GWQ-3, the 2022 GSP appears to establish MOs from historical data when current conditions exceed MCLs or SMCLs; however, the DWR 2022 GSP Inadequate Determination finds that this approach results in "dynamic measurable objectives that may change from year to year." Specifically, if MOs are always set to the 95th percentile, then they will become less protective of water quality as water quality degrades, because the 95th percentile will increase along average concentrations increase. Moreover, if average concentrations increase steadily without significant variation, it is possible for indefinite degradation of water quality to never exceed MOs.

State Water Board staff propose Potential Action GWQ-3f to address the deficiency.

Deficiency GWQ-4 – The water quality monitoring plan in the 2022 GSP is not consistent with GSP regulations.

What SGMA Requires: The GSP Regulations require GSPs to include a description of the monitoring network objectives for the basin including how the GSA will "monitor impacts to the beneficial uses or users of groundwater" (Cal. Code Regs., tit. 23, § 354.34, subd. (b)(2)). The monitoring network must be "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 [GSP] implementation." (Cal. Code Regs., tit. 23, § 354.34, subd. (a)). Data collected must be of "sufficient quality, frequency, and distribution" to characterize and evaluate groundwater conditions (Cal. Code Regs., tit. 23, § 354.32).

GSAs "may designate a subset of monitoring sites as representative of conditions in the basin or an area of the basin...", known as RMSs (Cal. Code Regs., tit. 23, § 354.36). GSAs identify MTs, MOs, and Interim Milestones at these sites. "The designation of [an RMS] shall be supported by adequate evidence demonstrating that the site reflects general conditions in the area" (Cal. Code Regs., tit. 23, § 354.36, subds. (a) & (c)).

Deficiency: The DWR 2022 GSP Inadequate Determination finds that GSAs have "not taken sufficient action to describe how the monitoring and management that those programs implement align with the requirements of a GSA under SGMA." DWR and Board staff note several deficiencies. These deficiencies are described below as GWQ-4a, GWQ-4b, GWQ-4c, and GWQ-4d. Each of these deficiencies was identified by

DWR; however, Board staff note further detail for deficiencies GWQ-4b, GWQ-4c, and GWQ-4d.

Deficiency GWQ-4a – The GSP does not monitor or manage the aquifer below the de-designated zone.

The DWR 2022 GSP Inadequate Determination finds that "the GSAs are not monitoring zones which fall outside the de-designated areas" and that "the GSAs are overextending the de-designated area" (2022 GSP Inadequate Determination, p. 23). Specifically, DWR staff note that the de-designation resolution (R5-2017-0032) includes a depth boundary. This means that the aquifer below the de-designated area has not been de-designated and should therefore be monitored. The 2022 GSP, however, does not monitor the aquifer below the de-designated area.

State Water Board staff propose Potential Action GWQ-4a to address the deficiency.

Deficiency GWQ-4b – The proposed monitoring frequency is insufficient to detect short-term and seasonal trends.

The DWR 2022 GSP Inadequate Determination finds that the GSP "has not explained... how this monitoring frequency is sufficient to demonstrate short-term and seasonal trends as indicated by the GSP Regulations." Board staff concur, noting that, for example, only eight wells appear to be sampled for Nitrate (as N) more than once a year, while no wells in the El Rico GSA are sampled for Nitrate (as N) more than once a year (2022 GSP Addendum, Table 4-2). Board staff also note that nearly a third of wells appear to be sampled for arsenic only once every four years. Finally, Board staff note that it's not clear which seasons wells will be sampled during given irregular sampling frequencies (e.g., three or nine times a year).

State Water Board staff propose Potential Action GWQ-4b to address the deficiency.

Deficiency GWQ-4c – The proposed monitoring network does not adequately monitor key aquifers.

The DWR 2022 GSP Inadequate Determination notes that there are data gaps in the 2022 GSP monitoring network. Board staff concur and specifically note that the current monitoring plan does not include sampling wells known to be screened in the A aquifer zone at all, while only three wells known to be screened in the B aquifer zone are included in the planned sampling. This is problematic, as domestic wells tend to be more shallow and therefore more likely to draw from the A and B aquifers. The 2022 GSP notes that 97% of the 2,489 known domestic and public supply wells are screened in either the A or B aquifer (2022 GSP Addendum, Table 2-2).

Board staff concur and further note that the GSAs do not know which aquifer six of its wells are screened within, and therefore, they do not know which aquifer the samples

represent. While these six wells represent less than 20% of the water quality monitoring network, the missing data are important, given inadequate shallow aquifer monitoring. GSAs should therefore fill this data gap so that they can better understand exactly how deficient their current monitoring network is.

State Water Board staff propose Potential Action GWQ-4c to address the deficiency.

Deficiency GWQ-4d – The proposed sampling plan relies entirely on other agencies.

The DWR 2022 GSP Inadequate Determination notes that, while GSAs can leverage other programs that monitor water quality, the GSP fails to "explain how activities in those programs are consistent with SGMA and the GSP Regulations..." Board staff concur and further note that it appears the GSA must reach beyond other existing programs in order to address the deficiencies in its proposed monitoring network and sampling plan. The 2022 GSP indicates that "constituents and sample frequencies are determined by existing programs set to drinking water standards..." (2022 GSP, PDF p. 41), so it appears that existing programs will not include the spatial and temporal sampling necessary to address deficiencies GWQ-4a, GWQ-4b, and GWQ-4c. Board staff note that GSAs have a statutory obligation to avoid undesirable results associated with degradation of water quality, no matter the availability of other sampling programs that they can leverage.

State Water Board staff propose Potential Action GWQ-4d to address the deficiency.

Deficiency GWQ-5 – Management actions should be responsive to water quality degradation.

What SGMA Requires: Each GSP is required to include a description of the projects and management actions the GSA has determined will achieve groundwater sustainability in the basin. The GSAs must 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" (Cal. Code Regs., tit. 23, § 354.44, subd. (b)(1)).

The description must include project management actions, summary of data used to support proposed actions, and a review of the uncertainty associated with the basin setting when developing projects or management actions (Cal. Code Regs., tit. 23, § 354.44).

In reviewing GSPs, DWR must consider, among other questions, "whether sustainable management criteria and projects and management actions are commensurate with the level of understanding of the basin setting, based on the level of uncertainty, as reflected in the plan" (Cal. Code Regs., tit. 23, § 355.4, subd. (b)(3)).

Deficiency: Deficiencies GWQ-5a and GWQ-5b concern deficiencies associated with management actions that should be responsive to MT exceedances. These are deficiencies that Board staff identified. They were not identified by DWR staff in the DWR 2022 GSP Inadequate Determination.

Deficiency GWQ-5a – Additional sampling should be triggered when MTs are exceeded.

The 2022 GSP does not include management actions that are responsive to MT exceedances. Board staff note, however, that elevated concentrations of arsenic, nitrate, uranium, and gross alpha can severely impact human health. It is difficult to understand how GSAs can avoid significant and unreasonable impacts from degradation of groundwater quality if MT exceedances don't trigger additional monitoring to better characterize risks to drinking water users.

State Water Board staff propose Potential Action GWQ-5a to address the deficiency.

Deficiency GWQ-5b – Well mitigation plans need to address water quality degradation.

The 2022 GSP does not include a well mitigation plan. Instead, it includes a 2.5-page framework for a well mitigation plan. As Board staff note in above Deficiency GWQ-5a, elevated concentrations of arsenic, nitrate, uranium, and gross alpha can severely impact human health. It is therefore difficult for Board staff to understand how GSAs can avoid significant and unreasonable impacts from degradation of groundwater quality if the GSAs have not even developed—let alone implemented—a well mitigation plan to address water quality degradation.

State Water Board staff propose Potential Action GL-4a to address the deficiency.

4.1.3.5 Potential Actions to Address Groundwater Quality Degradation Sustainable Management Criteria Deficiency

Potential Action GWQ-1 – Update the definition of an undesirable result to be consistent with GSP Regulations.

Potential Actions GWQ-1a, GWQ-1b, and GWQ-1c address undesirable result deficiencies. Importantly, it is very likely that the changes these potential actions will have on an undesirable result will require updating MTs and MOs.

Potential Action GWQ-1a – Clearly describe the water quality conditions and impacts that would result in an undesirable result or the basin.

The undesirable result should clearly describe the conditions that are significant and unreasonable with sufficient detail to establish MTs. As DWR staff note, “it is unclear... what constitutes a significant and unreasonable reduction in viability of groundwater use for the identified beneficial uses,” and that it is unclear what “long-term viability means to the GSAs.” Without quantifiable descriptions, neither GSAs nor the State can evaluate whether exceeding MTs causes an undesirable result.

GSAs have several options. They may consider definitions that describe the number of wells with degraded water quality. They may consider the number of wells that require mitigation or treatment due to degraded water quality. They may consider the total cost of mitigating or treating degrading water quality. No matter the option they choose, it should be quantifiable enough that MTs that can be used to identify when an undesirable result may be occurring.

Potential Action GWQ-1b – Do not rely on trend detection or other methods that may delay identification of undesirable results.

GSAs should remove the trend detection requirement from their identification of an undesirable result. Board staff note that the 2022 GSP strongly indicates that trend detection is used to help establish basin management attribution, claiming that “...no observable trend [indicates] non-GSP-related activity...” As below in Potential Action GWQ-1c, Board staff note that statute does not require that an undesirable result be caused by basin management. Nor does the statute indicate that an undesirable result requires a statistically significant trend.

Potential Action GWQ-1c – Remove the “causal nexus” requirement and add information about the impacts of basin management on water quality.

GSAs should remove the “causal nexus” requirement from their identification of an undesirable result. Board staff note that statute does not require that an undesirable result be caused by basin management; it requires only that it be caused by groundwater conditions occurring throughout the basin. Moreover, Board staff note that, because GSAs manage the basin, they are inherently responsible for conditions occurring throughout it.

GSAs should also provide information on how declining groundwater levels, projects and management actions, and subsidence impact groundwater quality. Board staff is especially interested in how basin management might impact 1) water in the de-designated area and 2) already-elevated concentrations of arsenic.

Potential Action GWQ-2 – Update minimum thresholds to be consistent with GSP Regulations.

Potential Actions GWQ-2a, GWQ-2b, GWQ-2c, GWQ-2d, and GWQ-2e address MT deficiencies. Importantly, it is very likely that the changes these Proposed Actions will have on MTs will require GSAs to update MOs.

Potential Action GWQ-2a – Establish minimum thresholds that do not inexplicably exceed regulatory water quality thresholds.

While GSAs are not required to address undesirable results for groundwater quality that occurred prior to January 1, 2015, pre-2015 undesirable results should still be identified and MTs should be established accordingly. MTs should therefore not exceed health- or quality-protective regulatory thresholds without substantial reason and explanation. It is especially difficult to imagine how exceeding thresholds that protect human health would not be significant or unreasonable. Where GSAs claim that these high MT are warranted due to pre-2015 undesirable results, Board staff would expect transparent, detailed analyses so that results can be verified.

Potential Action GWQ-2b – Don't base pre-2015 conditions and MTs on current conditions; quantify and use pre-2015 conditions instead.

GSAs are not required to address undesirable results for groundwater quality that occurred prior to January 1, 2015. It is therefore reasonable for GSAs to evaluate pre-2015 groundwater conditions to 1) determine if there were already undesirable results that SGMA does not require GSAs to address and 2) quantify the pre-2015 conditions that the GSA inherited so that the basin can establish reasonable SMC. These analyses, however, should consider only pre-2015 data. The 2022 GSP appears to consider data from 2000 through 2020 when both evaluating whether pre-2015 undesirable results occurred and in establishing MTs. Board staff note that many of the highest measured concentrations that the GSP uses to establish MTs were detected after January 1, 2015 (2022 GSP Addendum, Appendix C; Table 4-1).

If a pre-2015 undesirable result is identified, then GSAs should consider post-2015 data to determine if it persisted. For example, if constituent concentrations anomalously exceeded MCLs for a short period sometime prior to 2015 but thereafter returned to levels below MCLs, then the GSA did not inherit an undesired result and it should therefore manage to avoid further undesirable results.

Potential Action GWQ-2c – Fully explain how pre-2015 conditions are characterized.

GSAs should clearly explain methodologies if they identify pre-2015 undesirable results. The 2022 GSP indicates that many wells already exceed established MCLs or SMCLs.

But no details are provided. Board staff do not know if these claimed exceedances are based on a single exceedance, a percentage or exceedances, or an analysis of average conditions. If GSAs claim to identify pre-2015 undesirable results that the GSAs are therefore not required to address, Board staff will be very interested in verifying the results. Likewise, Board staff will be very interested in verifying that pre-2015 undesirable results were not anomalous events.

Potential Action GWQ-2d – Do not establish MTs that would allow for substantial degradation of water quality.

GSAs should carefully review MTs to ensure they would not allow for substantial degradation of water quality. Specifically, if GSAs identify a pre-2015 undesirable result and therefore believe that higher MTs may be warranted, they should not use the highest concentration ever detected. GSAs should center the concept of avoiding significant and unreasonable impacts when establishing MTs. When pre-2015 undesirable results exist, GSAs should be mindful that conditions are already significant and unreasonable for beneficial uses and users, and GSAs should therefore establish MTs that help them prevent conditions worsening even further.

Potential Action GWQ-2e – Do not use data from nearby wells when developing MTs without justification.

Supporting information and detailed explanation should be provided if GSAs lack enough well-specific data to establish MTs and therefore must analyze data from nearby wells instead. The GSP should include enough information that the use of data from nearby wells to set MTs can be independently evaluated.

Potential Action GWQ-3 – Update MOs to be consistent with GSP Regulations.

Potential Actions GWQ-3a, GWQ-3b, GWQ-3c, GWQ-3d, GWQ-3e, and GWQ-3f address MO deficiencies. Because the 2022 GSP used similar methods to establish MOs and MTs, many of these potential actions will be similar to the GWQ-2 potential actions provided to address MT deficiencies.

Potential Action GWQ-3a – Establish measurable objectives that do not inexplicably exceed regulatory water quality thresholds.

While GSAs are not required to address undesirable results for groundwater quality that occurred prior to January 1, 2015, pre-2015 undesirable results should still be identified and MOs that provide operational flexibility should be established accordingly. MOs should therefore not exceed health- or quality-protective regulatory thresholds without substantial reason and explanation. Where GSAs claim that these high MO are

warranted due to pre-2015 undesirable results, Board staff will expect transparent, detailed analyses so that results can be verified.

Potential Action GWQ-3b – Don't base pre-2015 conditions and MOs on current conditions; use pre-2015 conditions instead.

GSAs are not required to address undesirable results for groundwater quality that occurred prior to January 1, 2015. It is therefore reasonable for GSAs to evaluate pre-2015 groundwater conditions to 1) determine if there were already undesirable results that SGMA does not require GSAs to address and 2) quantify the pre-2015 conditions that the GSA inherited so that the basin can establish reasonable SMC. These analyses, however, should consider only pre-2015 data. The 2022 GSP appears to consider data from 2000 through 2020 when both evaluating whether pre-2015 undesirable results occurred and in establishing MOs.

If a pre-2015 undesirable result is identified, then GSAs should consider post-2015 data to determine if it persisted. For example, if constituent concentrations anomalously exceeded MCLs for a short period sometime prior to 2015 but thereafter returned to levels below MCLs, then the GSA did not inherit an undesired result and it should therefore manage to avoid further undesirable results.

Potential Action GWQ-3c – Do not establish MOs that would allow for substantial degradation of water quality.

GSAs should select MOs to ensure they would not allow for substantial degradation of water quality. Specifically, if GSAs identify a pre-2015 undesirable result and therefore believe that higher MOs may be warranted, they should not use concentrations that are higher than 95% of all observed concentrations. Moreover, Board staff note that for wells with smaller sample sizes, the 95% upper tolerance level exceeds the maximum detected concentration (2022 GSP Addendum, Appendix C).

GSAs should center the concept of avoiding significant and unreasonable impacts when establishing MOs. When pre-2015 undesirable results exist, GSAs should be mindful that conditions are already significant and unreasonable for beneficial uses and users, and GSAs should therefore establish MOs that help them prevent conditions worsening even further. To that end, MOs in these situations should represent typical conditions that GSAs aim to preserve, not some of the worst conditions ever noted. For example, where water quality was good on January 1, 2025, MOs should be set to maintain that good water quality. Where water quality was poor by January 1, 2025, MOs should reflect that water quality will be maintained and not allowed to degrade further. In general, all SMC should be set to avoid water quality degradation.

Potential Action GWQ-3d – Do not inexplicably use data from nearby wells when developing MOs.

Supporting information and detailed explanation should be provided if GSAs lack enough well-specific data to establish MOs and therefore should analyze data from nearby wells. The GSP should include enough information that the use of data from nearby wells to set MOs can be independently evaluated.

Potential Action GWQ-3e – Do not use measurable objectives that may vary over time.

The MOs established in GSPs should not vary over time. They represent a reasonable path toward sustainability that provides enough operational flexibility to avoid an undesirable result. Methodologies cannot allow MOs to change over time based on basin conditions, as this could result in MOs that no longer provide operational flexibility or a reasonable path to sustainability. If GSAs want to change MOs, they should submit updated, adopted GSPs to DWR for review.

Potential Action GWQ-4 – Update the water quality monitoring plan in the 2022 GSP to be consistent with GSP regulations.

Potential Actions GWQ-4a, GWQ-4b, GWQ-4c, and GWQ-4d address monitoring deficiencies. Importantly, some of these potential actions require substantial expansions of the monitoring network into new aquifers. Where this is necessary, GSAs should re-analyze aquifer water quality conditions and update the GSP accordingly.

Potential Action GWQ-4a – Monitor and manage the aquifer below the de-designated zone.

The GSP should include a plan to monitor and manage the aquifer below the de-designated zone.

Potential Action GWQ-4b – Increase monitoring frequency and better describe monitoring schedules.

The GSAs should increase monitoring frequency so that short-term and seasonal trends can be detected, such as twice a year or quarterly. Board staff note that only eight wells appear to be sampled for nitrate more than once a year, while no wells in the El Rico GSA are sampled for nitrate more than once a year (2022 GSP Addendum, Table 4-2). Board staff also note that nearly a third of wells appear to be sampled for arsenic only once every four years. Sampling frequency is especially important where GSAs propose to rely on two consecutive exceedances when identifying an undesirable result.

The GSP should also better describe the monitoring schedule. Board staff note that it is not clear which seasons wells will be sampled during given irregular sampling frequencies (e.g., three or nine times a year). Moreover, the 2022 GSP proposes an inconsistent monitoring schedule that might make it difficult to understand changes in basin conditions. GSAs should use increased monitoring frequency to improve monitoring consistency.

Potential Action GWQ-4c – Adequately monitor key aquifers.

GSAs should fill existing monitoring well data gaps. This should include determining the well construction information for the six wells with unknown screen intervals, as well as identifying new wells to provide comprehensive coverage of A and B aquifer conditions.

Importantly, as GSAs identify additional monitoring wells to inform their understanding of these aquifers, they should re-analyze basin conditions and update their GSP accordingly. The current lack of information precludes management of these aquifers. Until additional data are available, GSAs should consider implementing a domestic well sampling program.

Finally, GSAs are not responsible for mitigating portions of the A-zone aquifer that have been de-designated; however, Board staff is especially interested in how the GSAs will ensure that their monitoring program confirms that the de-designated water does not migrate out of the de-designated zone. Board staff note that recent groundwater gradients in the B-zone (WY2022 AR, p. 51) indicate potential for de-designated groundwater to migrate north.

Potential Action GWQ-4d – Add GSA monitoring capacity to fill data gaps.

GSAs should consider developing their own monitoring capacity by identifying monitoring wells or installing new wells as necessary and including these wells in a sampling program developed to meet GSP requirements. The 2022 GSP monitoring plan appears constrained due to its exclusive reliance on other programs that already monitor groundwater quality, as “constituents and sample frequencies are determined by existing programs set to drinking water standards...” (2022 GSP Addendum, p. 41). The monitoring network should be substantially improved (Potential Actions GWQ-4a, GWQ-4b, and GWQ-4c). It therefore appears unlikely that GSAs can continue to rely exclusively on other programs to monitor groundwater quality.

Potential Action GWQ-5 – Plan additional sampling when water quality is degraded.

GSAs should plan additional monitoring when MTs are exceeded, such as quarterly or more frequently. This is especially true for exceedances of arsenic, nitrate, uranium, and gross alpha MCLs, as elevated concentrations of these constituents can severely

impact human health. MT exceedances should therefore trigger further sampling to better understand risks to drinking water beneficial users, especially domestic well owners in the A-zone and B-zone. Further sampling could consist of higher frequency sampling for and sampling additional nearby wells (completed in the same aquifer) to better understand the extent of the increased concentrations and potential impacts to beneficial uses and users.

4.2 Exclusions from Probationary Status

The State Water Board must exclude from probation any portions of the basin for which a GSA demonstrates compliance with the sustainability goal (Wat. Code, § 10735.2, subd. (e)). Staff believe no GSAs in the subbasin have demonstrated compliance with the sustainability goal. All five GSAs have adopted and are implementing the same GSP, which DWR has determined to be inadequate. Staff recommends the State Water Board not exclude any portions of the subbasin from the probationary designation.

4.3 Modification to Water Year and Reporting Dates

Staff do not recommend the State Water Board modify the water year, but staff do recommend modifying the extraction reporting deadline for groundwater extraction reports required pursuant to Water Code section 5202.

4.3.1 Proposed Change

SGMA statute requires groundwater extraction data for the preceding water year be submitted to the State Water Board by February 1 of each year (Wat. Code § 5202, subd. (b)). State Water Board staff recommend modifying the extraction reporting deadline for reporters in the Tulare Lake subbasin to December 1 of each year. Staff do not recommend any modifications to the water year.

4.3.2 Justification

As stated in section 4.0 above, the overall goal of probation is to gather information to help local GSAs address deficiencies in their plans so they can sustainably manage their groundwater resources as soon as possible without outside help.

Requiring extraction reports be submitted to the State Water Board by December 1 of each year rather than February 1 will make extraction data available to staff, and GSAs if requested, two months sooner compared to relying on the default reporting date. Obtaining these data sooner means that staff and GSAs will fill data gaps sooner, potentially enabling GSAs to better address plan deficiencies and forestalling the need for the Board to develop and implement an interim plan. If GSAs do not address plan

deficiencies, the earlier reporting deadline will give staff additional time to evaluate extraction reporting information when evaluating the need to develop an interim plan.

Groundwater pumpers subject to reporting in a probationary basin must begin measuring and recording extractions 90 days after the probationary designation (Wat. Code, § 5202). If the State Water Board designates the subbasin probationary on April 16, 2023, pumpers would start recording extractions on July 15, 2024.

4.4 Requirements for Installation and Use of Measuring Devices

As part of a probationary designation, the State Water Board may require groundwater extraction reporters to install and use measuring devices, such as flow meters, for measuring their groundwater extractions (Wat. Code § 10735.2, subd. (c)(3)).

4.4.1 Proposed Requirement

State Water Board staff recommends the Board:

- Require people extracting more than two AFY for any reason to report their groundwater extractions.
- Require people extracting more than 500 AFY to install and use meters that meet the requirements of Cal. Code Regs., tit. 23, § 1042 on all their production wells within the basin.
- Exclude people who extract two AF or less per year for domestic uses only from reporting requirements.

These recommendations are specific to the water use and landownership patterns of the Tulare Lake subbasin, as described below in Section 4.4.1.3.

4.4.1.1 Importance of Measuring Groundwater Extractions with Meters

Despite the importance of monitoring water for management purposes, most agricultural water use worldwide—both from groundwater and surface water—remains unmetered (OECD, 2015). In the United States, only 36% of groundwater irrigation wells are equipped with flow meters (USDA, 2019), with large monitoring gaps in states such as California that have experienced severe aquifer depletion over recent decades (Scanlon et al., 2012; Liu et al., 2022). Many western states affected by long-term overdraft and severe drought conditions have begun requiring meters on groundwater extractions to fill these data gaps (e.g., Idaho Code § 42-701; Idaho Eastern Snake Plain Aquifer measurement order; Oregon ORS 540.435; Oregon ORS 537.780; Washington RCW 90.44.450; Arizona § 45-604 Water measuring devices, Montana Rule 36.12.1211, New

Mexico statewide groundwater measurement specifications, Colorado well metering, Wyoming meter selection specification, Nevada NRS 534.180 and NRS 534.193).

The sustainable management of groundwater conditions under SGMA will be difficult without measuring groundwater extractions by the subbasin's groundwater users. Estimating the volume of groundwater extractions using indirect methods can provide valuable information such as total water use. However, these methods have some drawbacks. For example, satellite measurements of evapotranspiration (ET) cannot be used to estimate groundwater extractions for sectors that do not apply groundwater for irrigation purposes (e.g., dairy operations, groundwater exports, commercial uses, and oil and gas injection). Estimates of groundwater extractions using crop water demand can vary due to climatic conditions, such as rainfall or temperature, and involves determining and monitoring agricultural practices, which can be a challenge (Meza-Gastelum et al., 2022).

The most appropriate and robust method for collecting groundwater use data is the measurement of groundwater extractions by metering devices. Requiring well owners to install meters and report groundwater extractions will help improve analysis of groundwater conditions and lead to more effective management of groundwater in the subbasin. Board staff recommend 1) groundwater extractors who extract over 500 AFY of groundwater be required to install meters and 2) the Board encourage other extractors using less than 500 AFY of groundwater to install meters voluntarily to improve the accuracy of pumping measurements in the subbasin.

4.4.1.2 Existing GSA Requirements for Metering in the Subbasin

Presently, at least three of the five GSAs in the subbasin have a measuring device requirement:

- Mid-Kings River requires that proposed wells are outfitted with a totalizing flow meter and that the GSA be allowed to check the flow rate and amount pumped from the well periodically (Resolution No. 2022-2, MKR GSA, 2022).
- Southwest Kings GSA requires the installation of meters on all active production wells (Annual Report, WY 2022).
- Tri-County Water Authority GSA requires all owners of non-domestic wells to install and maintain water meters (Tri-City Water Authority Water Meter and Policy and Procedures, 2020).

Staff is not aware of any metering requirements for the El Rico GSA or South Fork Kings GSA.

4.4.1.3 Rationale for Proposed Meter Requirement

Accurate measurement of groundwater extraction with meters will fill key data gaps that limit our understanding of overdraft conditions and effects on all beneficial uses in the subbasin.

In order to evaluate potential thresholds for requiring meters, board staff used OpenET[9] to estimate how much water is used by groups of landowners (grouped by water use) in the subbasin. While using ET data alone has limitations mentioned above, this was the best proxy for groundwater use in the subbasin that staff could use to evaluate potential thresholds. Staff evaluated OpenET data for Water Year 2022 (October 2021-September 2022) for the subbasin to evaluate water use. At this time, surface water accounted for 27% of total water use and included State Water Project allocation (3%), managed local supplies allocation (Kings River and Tule River; 15%), and local imported supplies allocation (9%) (Annual Report, WY 2022). The remaining 73% of consumed water was supplied by groundwater (ibid.).

Board staff summarized OpenET data for each non-residential parcel and consolidated the water use for all parcels owned by each parcel owner. Water users of more than 500 AFY of water as measured by OpenET:

- Are 299 parcel owners (or 12.7% of 2,357 owners of non-residential parcels in the subbasin).
- Own 87.6% of lands in the subbasin.
- Use 86% of water in the subbasin.

Staff find that the proposed requirement that all groundwater extractors of more than 500 AFY install meters will provide accurate extraction information for a large percentage of groundwater use in the basin while only impacting a small percentage of all groundwater extractors. If, after collecting reports, staff find that meters are needed for well owners extracting less than 500 AFY in order to evaluate basin conditions and potentially implement an interim plan, staff may adjust meter requirements for groundwater extractors in the subbasin via subsequent State Water Board action.

[9] OpenET provides satellite-based estimates of the total amount of water that is transferred from the land surface to the atmosphere through the process of evapotranspiration [OpenET website].

5.0 Additional Considerations

This section describes how the state intervention process is CEQA exempt and details the State Water Board's obligations to consider the Human Right to Water (HR2W) and the Public Trust Doctrine.

5.1 The California Environmental Quality Act

Pursuant to Water Code section 10736.2, the California Environmental Quality Act (Division 13 [commencing with Section 21000] of the Public Resources Code) does not apply to the State Water Board's designation of a basin as probationary under SGMA.

5.2 Human Right to Water

Assembly Bill 685 (2012) made California the first state in the nation to legislate the HR2W. Section 106.3 of the Water Code states that "every human being has the right to safe, clean, affordable, and accessible water for human consumption, cooking, and sanitary purposes." The State Water Board holds the HR2W as a top priority and core value and Senate Bill 200 tasks them with administration of the Safe and Affordable Drinking Water Fund.

5.2.1 Human Right to Water in the Subbasin

Access in the subbasin to safe, clean, and affordable water to human consumption would be enhanced by addressing the recommended deficiencies related to lowering groundwater levels (Section 4.1.1) and groundwater quality degradation (Section 4.1.3). According to the DWR's My Dry Wells tool (as of June 2023), 109 domestic supply wells have been reported as dry since 2014, 58 of those reported dry since 2015. Twenty-seven wells were reported dry in 2022 and thus far in 2023, there have been four domestic wells reported dry in the subbasin. There are four reported State Small Water Systems within the subbasin. According to the State Water Board analysis, two of these systems are considered At-Risk (Villa Terrace Apartments and Cesar Arevalo Rentals), one Potentially-At-Risk (Westlake Farms-Camp Nevada), and the fourth is Not-At-Risk (Kings Ranch Ministries). If management leads to a drop in groundwater elevations to MTs, there is a risk of dewatering more domestic and public supply wells; those risks are summarized earlier in this document.

5.3 Public Trust

5.3.1 General Principles and Application to SGMA

In California, the public trust doctrine is cited for protection of coastlines, navigable surface waters, their non-navigable tributaries, aquatic resources and the ecosystems that rely on them.

The public trust doctrine must be considered when groundwater has hydrologic connection to surface water bodies. For example, shallow groundwater can be hydrologically connected to surface water in wetlands, rivers, and coastlines; and those connections can vary by season and water year type. Therefore, agencies must consider public trust duties when operating and permitting wells in those places where a hydrologic connection between groundwater and surface water is established.

To the extent surface water (subject to public trust doctrine considerations) is used to recharge groundwater, or surface water contracts are used to supplement supply, those management actions that rely on surface water use may indirectly invoke public trust doctrine considerations.

5.3.2 A Brief History of the Public Trust Doctrine

The public trust doctrine flows to the present from ancient Roman codes and English Common Law judicial opinions about public rights to use water, air, wildlife, and common spaces that are held in trust by the sovereign for the benefit of the public. The sovereign here is the State of California and local jurisdictions implementing SGMA. “Thus, the following things are by natural law common to all—the air, running water, the sea, and consequently the seashore” (Institutes of Justinian 2.1.1).

Courts applied public trust concepts to the settling and conquest of the lands of the United States and to the Revolution that led to States becoming sovereigns of the land within their borders (with exceptions for federally held lands, including lands held in trust for Indigenous American Nations). Although problematic with respect to discrimination against people of varying national origin, ethnicity, and race, particularly Indigenous Americans who had already discovered the place; the public trust notion has endured. The water, the air, the seashore, and certain public spaces belong to the sovereign for benefit of the public (see *Johnson v. M'Intosh*, 21 U.S. 543 (1823), p.594, 595 concluding that title from the purchase and conveyance of land from the Piankeshaw Indians to a citizen of Illinois would not be recognized; see also *Martin v. Waddell's Lessee*, 41 U.S. 367 (1842) 367, 368 regarding the state of New Jersey’s rights in tide-waters and the fishery, specifically oyster beds). Another well-known case from Illinois set the tone in the late 1800’s. The court struck down the conveyance of lands under the navigable waters of the Great Lakes to a private railroad company, stating that “the same doctrine as to the dominion and sovereignty over and ownership of lands under

the navigable waters of the Great Lakes applies which obtains at the common law as to the dominion and sovereignty over and ownership of lands under tide waters in the borders of the sea, and that the lands are held by the same right in the one case as in the other, and subject to the same trusts and limitations" (*Illinois Cent. R. Co. v. State of Illinois*, p. 146 U.S. 387 (1892), p. 437).

The Supreme Court of California affirmed the scope of the public trust doctrine in 1971 *(Marks v. Whitney* (6 Cal.3d 251 (1971)). The court determined that Marks, the owner of property that included tidelands in Tomales Bay, did not have unfettered rights to fill and develop tidelands within his patent of 1874. Rather, he had title to the soil subject to the public right of navigation and the right of the state to take possession if necessary for public interest The doctrine had clearly covered traditional easements related to navigable waters such as "the right to fish, hunt, bathe, swim, to use for boating and general recreation purposes" and "to use the bottom of the navigable waters for anchoring, standing, or other purposes," and the court clarified that the doctrine included tidelands, stating that "In administering the trust the state is not burdened with an outmoded classification favoring one mode of utilization over another" (*Ibid.,* p. 259, citing *Colberg, Inc. V. State of California ex rel. Dept. Pub. Wks.*, 67 Cal.2d, p.408, 421-22). The court noted that "There is a growing public recognition that one of the most important public uses of the tidelands—a use encompassed within the tidelands trust—is the preservation of those lands in their natural state, so that they may serve as ecological units for scientific study, as open space, and as environments which provide food and habitat for birds and marine life, and which favorably affect the scenery and climate of the area (*Ibid.*, p. 260).

In National Audubon Society v. Superior Court (33 Cal.3d 419 (1983)) (National Audubon), the Supreme Court maintained that the public trust doctrine protected "navigable waters from harm caused by diversion of nonnavigable tributaries" (Ibid., p. 437). Plaintiffs National Audubon Society et al. filed suit to stop the City of Los Angeles from diverting waters from Mono Lake on the theory that the public trust protected the shores, bed, and waters of the lake, as the lake had significant ecological value. The Court agreed that before state courts and agencies approve water diversions, public trust interests should be considered, and harm to those interests should be avoided or minimized (Ibid., p. 426). The court noted in their review of the state's authority as administrator of the public trust that "the dominant theme is the state's sovereign power and duty to exercise continued supervision over the trust" (Ibid., p. 437). "The public trust is more than an affirmation of state power to use public property for public purposes; it is an affirmation of the duty of the state to protect people's common heritage of streams, lakes, marshlands and tidelands, surrendering that right of protection only in rare cases when abandonment of that right is consistent with the purposes of the trust" (Ibid., p. 441).

Building on the logic of National Audubon, the trial court (later affirmed by an appellate court), in Environmental Law Foundation v. State Water Resources Control Board (26

Cal.App.5th 844 (2018)) declared “the public trust doctrine applies if extraction of groundwater adversely impacts a navigable waterway to which the public trust doctrine does apply” (Ibid., p. 854, 859). By 2009 increased pumping of groundwater near the Scott River greatly affected the Scott River system; in some years pumping left the system nearly dry. Plaintiffs originally petitioned the board to act and later to determine the board’s authority to act under the public trust doctrine. The court found no conflict with SGMA and the public trust doctrine, and no reason for “the relationship between the appropriative water rights system and the public trust doctrine” discussed in National Audubon “not apply equally to the relationship between SGMA and the public trust doctrine—they coexist and neither occupies the field to the exclusion of the other” (Ibid., p. 854, 855). Concerning the Board’s authority to regulate groundwater extractions that affect public trust uses in the Scott River, the trial court stated that "The Water Code as a whole, as construed by the courts, ‘vest[s] in the Board broad adjudicatory and regulatory power and suggest[s] the Board's regulatory authority is coincident with that of the Legislature.’ Given the Board's broad authority to administer the State's water resources, it is but a short step to the conclusion that the Board has the authority to administer the public trust on behalf of the State" (Ibid.).

Legal experts such as Josepha L. Sax have concluded that the State Water Board had the authority to regulate all groundwater that was hydrologically connected to surface water streams or that violated constitutional or common-law prohibitions, such as those against waste or unreasonable use. Sax writes, “Assuming that a substantive violation exists, there is no doubt that the Board, through the Attorney General, can institute litigation to control groundwater use that (1) constitutes waste or unreasonable use or method of use within the meaning of article X, § 2 of the California Constitution, and Water Code § 100; or (2) that violates the public trust” *Desperate Times*, supra at 23, citing Joseph L. Sax, *Review of the Laws Establishing the [State Water Board’s] Permitting Authority Over Appropriations of Groundwater Classified as Subterranean Streams and the [State Water Board’s] Implementation of those Laws*, State Water Board No. 0-076-300-0 Jan. 19, 2002, p. 82).

In *El Dorado Irrigation District v. State Water Resources Control Board* 142 Cal.App.5th 937 (2020), an irrigation district and water agency challenged the condition imposed by the board on a permit, the condition that diversion of water was prohibited during release of water by federal and state water agencies to meet water quality objectives.

Although the appellate court ruled that the prohibition contravened the rule of priority without adequate justification (*Ibid*., p. 965), the court also stated that “when the rule of priority clashes with the rule against unreasonable use of water, the latter must prevail” (*Ibid*., p. 866). Furthermore, the court specified that “another important principle that may compete with the rule of priority is the public trust doctrine,” and referenced the trustee role of the sovereign over its “navigable waterways and the lands lying beneath them” and “ecological values are among those values protected by the public trust” (*Ibid*., p. 966, citing *National Audubon Society* p. 419, 434, 435). The appellate court

further affirmed the Board's authority to issue regulations to prevent unreasonable use in a case challenging minimum flow requirements on three tributaries of the Sacramento River (*Stanford Vina Ranch Irrigation Company v. State*, 50 Cal.App.5th 976 (2020)).

5.3.2.1 Water Code

Division 2 of the SGMA statute applies to the Public Trust Doctrine as it relates to upholding the right to divert water.

5.3.3 Public Trust Doctrine in the Subbasin

The record snowfall and precipitation in the Sierra Nevada and Tulare Basin this past winter (2022-23), amplified in part by extreme precipitation events and climate change, points to a future hydrology where flooding is expected to occur more frequently. Portions of the Tulare Lake basin have been flooded now for months and that is expected to continue for months as snowpack runoff continues. Sustainable groundwater management efforts in the subbasin should consider how altered hydrologic, surface water and flooding patterns may impact public trust resources. This should include consideration of public trust when operating or permitting for wells in places where groundwater and surface water may be connected.

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Appendix A – Summary Table of Proposed Deficiencies and Potential Actions to Address Deficiencies

Deficiency	What SGMA Requires	Deficiency Summary	Potential Actions to Correct the Deficiency
Deficiency Groundwater Levels (GL)-1 – The 2022 GSP does not clearly describe the groundwater level conditions that would result in an undesirable result for the basin.	The GSP Regulations require a GSA to "describe...the processes and criteria relied upon to define undesirable results applicable to the basin." This description must include the cause of past or potential undesirable results, "the criteria used to define when and where the effects of the groundwater conditions cause undesirable results," and the potential effects of undesirable results on groundwater uses and users and land uses and property interests (Cal. Code Regs., tit. 23, § 354.26).	**DWR Inadequate Determination summary**: The 2022 GSP has not addressed the deficiency related to the definition of the undesirable result for lowering groundwater levels; it does not provide additional detail nor quantitative analysis describing the prevalence and effects of the three types of impacts to beneficial uses and users that would constitute an undesirable result.	**Potential Action GL-1** – Define the undesirable result for the chronic lowering of groundwater levels consistent with SGMA. Meaningfully engage with users in the subbasin to seek and incorporate feedback on the definition of an undesirable result for chronic lowering of groundwater levels specific to the subbasin and protective of drinking water users.
Deficiency GL-2 – The GSAs did not consider all beneficial uses and users in setting SMC for groundwater levels in the 2022 GSP or adequately describe the impacts of criteria on beneficial uses and users. MTs in the A-zone would allow for significant and unreasonable water level declines.	The GSP Regulations require GSAs to set their MTs for chronic lowering of groundwater levels at "the groundwater elevation indicating a depletion of supply at a given location that may lead to undesirable results" (Cal. Code Regs., tit. 23, § 354.28, subd. (c)(1)). In describing MTs, GSPs must describe how MTs "may affect the interests of beneficial uses and users of groundwater or land uses and property interests" (Cal. Code Regs., tit. 23, § 354.28, subd. (b)(4)). MOs for chronic lowering of groundwater levels must be based on the same metrics and monitoring sites used for MTs. MOs must "provide a reasonable margin of operational flexibility under adverse conditions" (Cal Code Regs., tit. 23, § 342.30, subds. (c) & (d)).	**DWR Inadequate Determination summary**: The GSP does not describe the impacts to beneficial uses and users under the given definition of undesirable results. There are issues for all three aquifer zones and the R-zone. For the A-zone, the approach will allow for significant and unreasonable conditions to occur. For the B-zone, the MTs are on average about 65 feet lower than the most historical groundwater elevations. For the B- and C-zones, it is unclear whether impacts to agricultural and industrial wells are considered undesirable results. Additionally, the well impact analysis did not consider agricultural or industrial users, and therefore it is unclear how the approach will avoid significant and unreasonable impacts for these users. For the C-zone, the approximations used for the elevation of the E-clay may lead to greater impacts that occur sooner than expected, and some wells may have been incorrectly assigned to the B-zone (and therefore subject to the B-zone SMC), rather than the C-zone. For the R-zone, it is unclear why the R-zone would be managed separately from the A-zone, and the SMC were not adequately established for this area. The 2022 GSP did not update any groundwater level MOs for any aquifer zone. **Board additional issues**: A Board staff analysis determined that nearly a third (31%, or 650 wells) of the 2,080 domestic wells with adequate information for analysis would dry at MTs, and nearly a quarter (23%, or 12 wells) of the 53 public supply wells with adequate information for analysis would be dry at MTs. Virtually all wells in the A-zone would go dry at the proposed MTs. In the B-zone, a significant number of older, shallower wells or wells not reflected in the OSWCR dataset, all of which are excluded from the analysis, may still be in use and could be at risk of dewatering if groundwater levels declined to the MTs	**Potential Action GL-2** – Fill data gaps in the subbasin water budget and use the data to update the SMC to avoid undesirable results. • **Potential Action GL-2a** – Further investigate and quantify components of the basin water budget inflows and outflows to support resolution of basin overdraft. • **Potential Action GL-2b** – Set groundwater level sustainable management criteria to protect drinking water wells from dewatering at the minimum threshold elevations. Describe how minimum thresholds may affect the interests of beneficial uses and users of groundwater or land uses and property interests relative to 2015 conditions

Deficiency	What SGMA Requires	Deficiency Summary	Potential Actions to Correct the Deficiency
Deficiency GL-3 – The monitoring network does not provide sufficient coverage to monitor for impacts to beneficial uses and users in the three aquifers in the subbasin (due to data gaps in A-zone coverage and inconsistent sampling).	The GSP Regulations require GSPs to include a description of the monitoring network objectives for the basin including how the GSA will "monitor impacts to the beneficial uses or users of groundwater" (Cal. Code Regs., tit. 23, § 354.34, subd. (b)(2)). GSAs "may designate a subset of monitoring sites as representative of conditions in the basin or an area of the basin...", known as Representative Monitoring Sites (RMSs; Cal Code Regs., tit. 23, § 344.36). GSAs identify MTs, MOs, and Interim Milestones at these sites. "The designation of [an RMS] shall be supported by adequate evidence demonstrating that the site reflects general conditions in the area" (Cal Code Regs., tit. 23, § 354.36, subds. (a) & (c)).	**DWR Inadequate Determination summary**: The GSP does not identify any RMS wells in the R-zone, the shallow aquifer zone near the Kings River. Without data regarding this area, the GSAs will not be able to monitor or manage groundwater conditions in that area. **Board additional issues**: The RMS wells for which the GSAs report data have changed from year-to-year, and the GSAs' inconsistent use of RMS locations may mask whether undesirable results in particular areas are occurring. The GSAs identified 70 RMS wells in the 2020 GSP and 56 in the 2022 GSP, and then reported groundwater levels for 49, 50, and 53 RMS wells in the WY-20, WY-21, and WY-22 Annual Reports, respectively. Some sites are monitored only once a year and very few sites are monitored more than twice a year.	**Potential Action GL-3** – Fill data gaps in the groundwater level monitoring network. • **Potential Action GL-3a** – Use a consistent set of monitoring network wells from year to year. • **Potential Action GL-3b** – Establish additional monitoring wells in the A-zone and establish monitoring wells in the R-zone to monitor impacts to drinking water users and begin gathering data on surface water-groundwater interactions.
Deficiency GL-4 – The 2022 GSP's discussion of well impact mitigation lacks important details and the GSP does not explain how well impact mitigation fits into the GSAs' approach for avoiding undesirable results.	Although SGMA and the GSP Regulations do not require development of a well impact mitigation plan, many GSAs have proposed to couple such plans with MTs to allow for greater groundwater level declines while avoiding undesirable results.	**DWR Inadequate Determination summary**: The Mitigation Plan Framework proposed in the 2022 GSP does not provide details on how claims for well mitigation will be evaluated. The mitigation plan framework does not say whether impacted agricultural or industrial wells will be mitigated, nor whether wells in the C-zone will be mitigated at all. The DWR 2022 GSP Inadequate Determination states, "Department staff do not believe sufficient details related to the framework have been provided; therefore, are unable to assess whether the GSAs have established sustainable management criteria based on a commensurate level of understanding of the basin setting or whether the interests of beneficial uses and users have been considered." **Board additional issues**: The Mitigation Plan Framework (Appendix D) suggests that GSAs will not mitigate impacted public supply wells, irrigation wells, or industrial wells. Due to the lack of details, Board staff cannot assess how the future mitigation plans may work in tandem with SMC to avoid undesirable results related to chronic lowering of groundwater levels.	**Potential Action GL-4** – Establish accessible, comprehensive, and appropriately funded well impact mitigation programs that mitigate impacts to wells affected by lowering of groundwater levels and degradation of water quality. • **Potential Action GL-4a** – Develop well mitigation programs with clear triggers, eligibility requirements, metrics, and funding sources. (This action supports addressing both Deficiency GL-4 and Deficiency GWQ-5b.) • **Potential Action GL-4b** – Evaluate how small farms wells will be impacted.

Deficiency	What SGMA Requires	Deficiency Summary	Potential Actions to Correct the Deficiency
Deficiency GL-5 – The 2022 GSP does not describe a feasible path for halting chronic lowering of groundwater levels.	Each GSP is required to include a description of the projects and management actions the GSA has determined will achieve groundwater sustainability in the basin. The description must include project management actions, summary of data used to support proposed actions, and a review of the uncertainty associated with the basin setting when developing projects or management actions (Cal. Code Regs., tit. 23, § 354.44). More fundamentally, for basins in a condition of overdraft, the GSP "shall describe projects or management actions, including a quantification of demand reduction or other methods, for the mitigation of overdraft" (Cal. Code Regs., tit. 23, § 354.44, subd. (b)(2)). GSPs need to include 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 (Cal. Code Regs., tit. 23, § 354.44, subd. (b)(9)). In reviewing GSPs, DWR must consider, among other questions, "whether sustainable management criteria and projects and management actions are commensurate with the level of understanding of the basin setting, based on the level of uncertainty, as reflected in the plan" (Cal. Code Regs., tit. 23, § 355.4, subd. (b)(3)).	**DWR Inadequate Determination summary**: If the GSP retains MTs that allow for continued groundwater level decline then the GSP should explain the anticipated effects of that decline on beneficial uses and users and should clearly explain whether PMAs have been identified to address impacts to those uses and users. The 2022 GSP does not have any discussion on how PMAs were factored into the establishment of the MTs for groundwater levels. If the GSP does not include PMAs to address impacts to uses and users, then it should clearly explain the rationale and analysis that led to that decision. **Board additional issues**: Board staff has determined that the 2022 GSP does not demonstrate that projects and management actions are feasible or sufficient to prevent undesirable results. The 2022 GSP relies substantially on new surface water supplies to mitigate overdraft, but the GSP does not assess the feasibility of new supply projects based on water availability and climate change impacts to surface supplies. The 2022 GSP does not contain a groundwater allocations plan, though it indicates that groundwater assessment and allocation plans will be developed in 2023 and implemented in 2025 (2022 GSP Addendum, Table 6-5). Otherwise, demand management actions in the 2022 GSP appear voluntary and therefore unlikely to provide sufficient contingency in case GSAs fail to secure new supplies or overdraft is greater than estimated	**Potential Action GL-5** – Plan ahead for drought conditions and commit to managing demand. • **Potential Action GL-5a** – Evaluate the feasibility of proposed supply augmentation projects. • **Potential Action GL-5b** – Develop basin-wide allocations or utilize another demand management structure to help bring the subbasin into balance and meet basin sustainability goals. • **Potential Action GL-5c** – 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.

Deficiency	What SGMA Requires	Deficiency Summary	Potential Actions to Correct the Deficiency
Deficiency GL-6 – The GSAs do not consider the effects on other sustainability indicators, such as groundwater storage, subsidence, degradation of groundwater quality, and depletions of interconnected surface water.	In describing MTs, a GSA must explain "how the [GSA] has determined that basin conditions at each minimum threshold will avoid undesirable results for each of the sustainability indicators" (Cal. Code Regs., tit. 23, § 354.28, subd. (b)(3)).	**DWR Inadequate Determination summary:** The DWR Inadequate Determination noted that the B-zone MTs at most of the RMS wells are substantially below historical lows, which are in turn often below 2015 levels. Consequently, "given these changes, Department staff believe the revised GSP should have included an updated discussion on impacts to other sustainability indicators, such as subsidence." DWR also noted that, for C-zone MTs, "the GSAs did not consider...effects on groundwater storage and subsidence." **Board additional issues**: Board staff notes that the 2022 GSP did not describe the effects of MTs on degradation of groundwater quality if groundwater levels decline to the MTs in the A-, B-, and C-zones. The potential migration of de-designated water if groundwater elevations decline to MTs was not addressed in the 2022 GSP. Board staff also notes that declining groundwater levels may result in the migration of shallow constituents into wells. Additionally, declining groundwater levels may require existing wells to be deepened; newly deepened wells may be impacted by an existing constituent of concern, prohibiting the intended beneficial use for those wells. The 2022 GSP also does not discuss the impact of MTs in the R-zone and the A-zone on depletions of interconnected surface water.	**Potential Action GL-6** – Describe the relationship between MTs for each sustainability indicator. Revise groundwater level MTs as necessary to avoid undesirable results for other sustainability indicators.
Deficiency Land Subsidence (LS)-1 - The 2022 GSP does not clearly describe the subsidence conditions that would result in an undesirable result for the basin.	The GSP Regulations require a GSA to "describe...the processes and criteria relied upon to define undesirable results applicable to the basin." This description must include the cause of past or potential undesirable results, "the criteria used to define when and where the effects of the groundwater conditions cause undesirable results," and the potential effects of undesirable results on groundwater uses and users, land uses, and property interests (Cal. Code Regs., tit. 23, § 354.26).	**DWR Inadequate Determination summary:** "The GSP has not defined the limits of what is considered economically feasible nor the tolerable amount of subsidence for the critical infrastructure." This is problematic, because the 2022 GSP defines an undesirable result as "the significant loss of functionality of critical infrastructure or facility, so the feature(s) cannot be operated as designed, requiring either retrofitting or replacement to a point that is economically unfeasible." **Board additional issues**: None.	**Potential Action LS-1** – Clearly define the subsidence conditions that would result in an undesirable result for the basin and provide enough detail that associated MTs can be determined (Cal. Code Regs., tit. 23 § 354.28).

Deficiency	What SGMA Requires	Deficiency Summary	Potential Actions to Correct the Deficiency
Deficiency LS-2 - The GSAs did not consider all beneficial uses and users in setting quantitative criteria for subsidence in the 2022 GSP or adequately describe the impacts of criteria on beneficial uses and users. • **Deficiency LS-2a** – MTs were not established based on avoiding undesirable results. • **Deficiency LS-2b** – Some MTs appear to exceed subsidence limits set in other pre-existing agreements. • **Deficiency LS-2c** – MOs and IMs were not established.	Minimum thresholds are the numeric values used to define undesirable results. Measurable objectives are specific, quantifiable goals for the maintenance or improvement of groundwater conditions to achieve the sustainability goal for the basin. The GSP Regulations state that MTs for land subsidence should identify the rate and extent of subsidence that substantially interferes with surface land uses and may lead to undesirable results. These quantitative values should be supported by: the identification of land use or property interests potentially affected by land subsidence; an explanation of how impacts to those land use or property interests were considered when establishing minimum thresholds; and maps or graphs showing the rates and extents of land subsidence defined by the minimum thresholds (Cal. Code Regs., tit. 23, § 354.28, subd. (c)(5)). MOs for land subsidence must be based on the same metrics and monitoring sites used for MTs. MOs must "provide a reasonable margin of operational flexibility under adverse condition." (Cal Code Regs., tit. 23, § 342.30, subds. (c) & (d)). GSAs must also establish interim milestones (IMs) for each sustainability indicator, "using the same metric as the measurable objective, in increments of five years." These IMs support the GSP's description of "a reasonable path to achieve the sustainability goal for the basin within 20 years of implementation" (Cal Code Regs., tit. 23, § 342.30, subd. (e)).	**DWR Inadequate Determination summary:** • **LS-2a** - The DWR Inadequate Determination found that "the GSAs have not established minimum thresholds based on the level of subsidence that would substantially interfere with land surface use and avoid undesirable results." Instead, the 2022 GSP established MTs by estimating the cumulative subsidence that would occur by 2040 if GSAs took no action, and then adjusted the estimated subsidence based on the anticipated benefits of projects and management actions. • **LS-2b** - The DWR Inadequate Determination notes that MTs for eight RMS appear to exceed the maximum subsidence allowed along the California Aqueduct per an agreement with the DWR State Water Project managers. • **LS-2c** - The DWR Inadequate Determination found that "measurable objectives have not been established for subsidence." Instead, the 2022 GSP claimed that the "measurable objective for subsidence will ultimately be achieved through the MTs and MOs set for groundwater levels and storage, which is expected to result in decreasing subsidence over time." **Board additional issues:** • **LS-2a** - The 2022 GSP indicates that subsidence MTs are listed in GSP Table 3-2; however, GSP Table 3-2 does not list MTs. Instead, it lists baseline and implementation subsidence values. Board staff therefore must interpret that the implementation subsidence values are the minimum thresholds based on MT methodology language. MTs are fundamental to GSPs and should not be left to interpretation. • **LS-2b –** None. • **LS-2c –** Board staff note that, because MTs and MOs will need to be updated, IMs will need to be updated as well.	**Potential Action LS-2** – Develop quantitative criteria that avoid undesirable results and conform with other legal agreements. • **Potential Action LS-2a** – Define and clearly list MTs based on the level of subsidence at each RMS that would cause the undesirable results conditions that the GSAs are trying to avoid. • **Potential Action LS-2b** – Ensure MTs conform with current agreements with other agencies. • **Potential Action LS-2c** – Establish MOs that avoid undesirable results and provide operational flexibility so that potential future droughts do not cause MT exceedances. Establish IMs that provide a reasonable path to achieving sustainable management.

Deficiency	What SGMA Requires	Deficiency Summary	Potential Actions to Correct the Deficiency
Deficiency LS-3 – The GSAs did not adequately consider the impacts of subsidence on flood protection infrastructure.	MTs for land subsidence must be supported by, in part, "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 [GSA] has determined and considered those uses and interests, and the [GSA's] rationale for establishing minimum thresholds in light of those effects" (Cal. Code Regs., tit. 23, § 354.28, subd. (c)(5)(A)). The GSP must also include a description of beneficial uses and users in the basin, "the types of parties representing those interests, and the nature of consultation with those parties" (Cal. Code Regs., tit. 23, § 354.10, subd. (a)).	**DWR Inadequate Determination summary:** • **Infrastructure Impacts** - The 2022 GSP did not adequately consider the impacts of subsidence on flood protection infrastructure. Specifically, the DWR Inadequate Determination noted problems with how the GSP considered impacts from reduced crown elevations and differential subsidence. • **Lowered Crown Elevations** - The 2022 GSP states that "the elevation of the flood protection levees and the elevation of the flood-prone areas (i.e., floodplain) generally decrease uniformly. With little or no differential movement between the crown of the levee and the floodplain, the performance of the levee is unaffected." The DWR Inadequate Determination found that the GSP "fails to mention that if subsidence occurs, there is a risk of reducing the conveyance capacity of the channels and reduction of freeboard." • **Differential Subsidence** - The 2022 GSP states that "levees are flexible earthen structures that can tolerate typical differential longitudinal settlement that occurs due to variability of soils in their foundation. As such, there is very little literature on performance limits of levees affected by differential settlement along their longitudinal axis." DWR notes that "Regulations do not differentiate between residual and differential subsidence; therefore, total subsidence must be considered." • **Failure to coordinate with flood management agencies** - The DWR Inadequate Determination found that the 2022 GSP did not adequately coordinate with flood management agencies, despite being asked to do so. **Board additional issues**: • **Infrastructure Impacts** - Areas with increased subsidence rates landside of levees can experience higher inundation if flooded. • **Lowered Crown Elevations** - Reduced channel capacity also increases risk of slope failure and piping through and under the levee due to increased hydraulic head above the landside levee toe. • **Differential Subsidence** - The extent and magnitude of differential settlement from foundational soils is substantially different than the extent and magnitude of differential subsidence. Moreover, the uncertainty of impacts of longitudinal differential subsidence should be a reason for GSAs to minimize subsidence, especially in areas where levees may be constructed with dispersive soils (soils which may easily dissolve into solution and erode), which substantially increase risks of piping in cracks through levees. • **Failure to coordinate with flood management agencies** - None; however, Board staff note that the 2022 GSP noted conversations with flood management agencies but failed to explain how those conversations were considered in developing SMC.	**Potential Action LS-3** – Consult with flood management agencies and expand the GSP's analysis of land subsidence impacts on flood infrastructure. • **Potential Action LS-3a** – Engage with flood management agencies. • **Potential Action LS-3b** – When establishing undesirable results and MTs, evaluate the impacts of reduced channel capacity, uncertainty around longitudinal differential subsidence, and increased inundation depths.

Deficiency	What SGMA Requires	Deficiency Summary	Potential Actions to Correct the Deficiency
Deficiency LS-4 – The GSP does not provide adequate implementation details.	Each GSP is required to include a description of the projects and management actions the GSA has determined will achieve groundwater sustainability in the basin. The description must include project management actions, summary of data used to support proposed actions, and a review of the uncertainty associated with the basin setting when developing projects or management actions (Cal. Code Regs., tit. 23, § 354.44). In reviewing GSPs, DWR must consider, among other questions, "whether sustainable management criteria and projects and management actions are commensurate with the level of understanding of the basin setting, based on the level of uncertainty, as reflected in the plan" and "whether the projects and management actions are feasible and likely to prevent undesirable results and ensure that the basin is operated within its sustainable yield" (Cal. Code Regs., tit. 23, § 355.4, subd. (b)(3), (b)(5)).	**DWR Inadequate Determination summary:** The DWR Inadequate Determination found that the 2022 GSP did not provide adequate project and management action detail to "determine if projects and management actions will assist in minimizing and avoiding subsidence in the Subbasin beyond 2040." DWR further noted that "two monitoring sites (LEMA and CRCN) have exceeded their identified cumulative allowable subsidence." **Board additional issues**: None.	**Potential Action LS-4** – Plan ahead to avoid significant and unreasonable land subsidence. • **Potential Action LS-4a** – Develop a plan to trigger management actions when subsidence exceeds defined thresholds, especially near critical infrastructure/facilities. • **Potential Action LS-4b** – Update the Well Registration Program to meet subsidence goals in the subbasin; Do not allow new wells in areas where subsidence threatens critical infrastructure. • **Potential Action LS-4c** – Develop infrastructure mitigation programs with clear triggers, eligibility requirements, metrics, and funding sources.

Deficiency	What SGMA Requires	Deficiency Summary	Potential Actions to Correct the Deficiency
Deficiency Groundwater Quality (GWQ)-1 – The 2022 GSP's definition of an undesirable result is not consistent with GSP Regulations. • **Deficiency GWQ-1a** – The 2022 GSP does not clearly describe the water quality conditions and impacts that would result in an undesirable result or the basin. • **Deficiency GWQ-1b** – The triggers for determining an undesirable result set by the 2022 GSP would result in delayed identification of an undesirable result and therefore delayed management of the basin. • **Deficiency GWQ-1c** – The GSP does not describe how it would determine whether significant and unreasonable degradation of water quality was associated with basin management.	The GSP Regulations require a GSA to "describe...the processes and criteria relied upon to define undesirable results applicable to the basin." This description must include the cause of past or potential undesirable results, "the criteria used to define when and where the effects of the groundwater conditions cause undesirable results," and the potential effects of undesirable results on groundwater uses and users and land uses and property interests (Cal. Code Regs., tit. 23, § 354.26).	**DWR Inadequate Determination summary**: • **Deficiency GWQ-1a** Neither the water quality undesirable result nor its impacts to beneficial uses and users is adequately described. The 2022 GSP describes the undesirable results as "...significant and unreasonable reduction in long-term viability of domestic, agricultural, municipal, or environmental uses over the planning and implementation horizon of this GSP." DWR staff note that "it is unclear... what constitutes a significant and unreasonable reduction in viability of groundwater use for the identified beneficial uses," and specifically note that it is unclear what "long-term viability means to the GSAs." • **Deficiency GWQ-1b** - The GSAs would "not be actively monitoring the Subbasin to avoid an undesirable result..." GSAs will not evaluate constituent data to determine if undesirable results may be occurring unless analysis indicates a positive trend. This trend analysis, however, will not even be conducted until "at least six samples have been collected for each analyte at each representative monitoring site." Some analytes at some monitoring sites are sampled only once every four years, indicating that trend analysis would sometimes not be conducted until the year 2046. • **Deficiency GWQ-1c** - The GSP does not describe how it will determine whether degradation of water quality is associated with basin management. The GSP describes an undesirable result occurring only if it is "stemming from a causal nexus between groundwater-related GSP activities... and a degradation in groundwater quality..." **Board additional issues**: • **Deficiency GWQ-1a** - Without a clear description of impacts that are significant and unreasonable, GSAs and Board staff cannot evaluate whether MTs or broader quantitative definitions of an undesirable result that would guide day-to-day basin management are appropriate for avoiding undesirable results. • **Deficiency GWQ-1b** - Board staff is also concerned that trend analysis may result in avoiding undesirable results on paper only, no matter the impacts to beneficial uses and users. Depending on the analysis time period, monitoring frequency, the selected confidence interval, and other technical details, trend analysis may delay or effectively prevent identification of undesirable results. Unless trends are detected, the 2022 GSP identifies an undesirable result only when a full quarter of all wells exceed MTs for two consecutive measurements. • **Deficiency GWQ-1c** – Board staff note that an undesirable result does not require a "causal nexus" with groundwater management; it instead must simply be caused by groundwater conditions occurring throughout the basin (Water Code § 10721 subd. (x)). Moreover, Board staff is concerned that "causal nexus" criterion might be infeasible and impractical to determine absent a substantially more robust monitoring network and sophisticated, well-performing basin model. Additionally, the 2022 GSP lacks crucial, related information on (1) the impact of projects and management actions on water quality, and (2) the impact of subsidence on water quality.	**Potential Action GWQ-1** – Update the definition of an undesirable result to be consistent with GSP Regulations. • **Potential Action GWQ-1a** – Clearly describe the water quality conditions and impacts that would result in an undesirable result or the basin. • **Potential Action GWQ-1b** – Do not rely on trend detection or other methods that may delay identification of undesirable results. • **Potential Action GWQ-1c** – Remove the "causal nexus" requirement and add information about the impacts of basin management on water quality.

Deficiency	What SGMA Requires	Deficiency Summary	Potential Actions to Correct the Deficiency
Deficiency GWQ-2 – Minimum thresholds set by the 2022 GSP are not consistent with GSP Regulations. • **Deficiency GWQ-2a** – The 2022 GSP establishes minimum thresholds that exceed regulatory water quality thresholds without explaining how that would not cause significant and unreasonable results or impacts to beneficial uses and users. • **Deficiency GWQ-2b** – Some MTs are inexplicably based on data that may represent undesirable results. • **Deficiency GWQ-2c** – The GSP does not explain how it quantifies "current conditions," yet uses current conditions to justify establishing MTs that exceed MCLs or SMCLs. • **Deficiency GWQ-2d** – MTs are sometimes set to the highest detected concentrations. • **Deficiency GWQ-2e** – MTs at some wells are based on data from wells nearby the RMS wells, rather than from the RMS wells themselves, without justification.	The GSP Regulations require GSAs to base their MTs for degradation of water quality 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." Also, GSAs must consider "local, state, and federal water quality standards applicable to the basin" in setting MTs (Cal. Code Regs., tit. 23, § 354.28, subd. (c)(4)). In describing MTs, GSPs must describe how MTs "may affect the interests of beneficial uses and users of groundwater or land uses and property interests" (Cal. Code Regs., tit. 23, § 354.28, subd. (b)(4)). The plan may, but is not required to, address undesirable results that occurred before, and have not been corrected by, January 1, 2015.	**DWR Inadequate Determination summary:** • **Deficiency GWQ-2a** – The 2022 GSP establishes many MTs that exceed primary MCLs or upper SMCLs yet does not explain how exceeding health- or quality-protective standards is not an undesirable result. While GSAs are not required to address undesirable results for groundwater quality that occurred prior to January 1, 2015, pre-2015 undesirable results should still be identified and MTs established accordingly. • **Deficiency GWQ-2b** – The 2022 GSP appears to establish MTs from historical data when current conditions exceed MCLs or SMCLs; however, the DWR Inadequate Determination notes that this historical data ranges from 2000 to 2020, which "may include data that would be considered undesirable results." • **Deficiency GWQ-2c** – None. • **Deficiency GWQ-2d** – None. • **Deficiency GWQ-2e** – The DWR Inadequate Determination notes that some MTs are calculated with data from nearby wells. DWR staff note that 1) it is not clear why MTs for a specific RMS would be based on data from other wells, and 2) the GSP does not provide supporting information, making review of nearby data impossible. **Board additional issues**: • **Deficiency GWQ-2a** – None. • **Deficiency GWQ-2b** – GSAs should not use exceedances between 2015 and 2020 to establish MTs that exceed MCLs or SMCLs or may otherwise indicate undesirable results. • **Deficiency GWQ-2c** – The 2022 GSP appears to establish MTs from historical data when current conditions exceed MCLs or SMCLs; however, Board staff note that the GSP does not appear to explain how it determines current conditions. For example, it does not explain how many exceedances the GSP requires before it concludes that current conditions exceed MCLs or SMCLs or whether it relies on a percentage of exceedances. This information is crucial for reviewing divergence from established, health-protective standards like MCLs. • **Deficiency GWQ-2d** – Board staff note that the 2022 GSP appears to set MTs at the highest observed concentration in these cases. While GSAs are not required to address undesirable results for groundwater quality that occurred before 2015, Board staff strongly object to using the highest detected concentration as a baseline for pre-2015 conditions. • **Deficiency GWQ-2e** – The GSP does not clearly indicate which MTs rely on nearby data. Without supporting information, these MTs cannot be reviewed to assess whether use of nearby well data is appropriate.	**Potential Action GWQ-2** – Update minimum thresholds to be consistent with GSP Regulations. • **Potential Action GWQ-2a** – Establish minimum thresholds that do not inexplicably exceed regulatory water quality thresholds. • **Potential Action GWQ-2b** – Don't base pre-2015 conditions and MTs on current conditions; use pre-2015 conditions instead. • **Potential Action GWQ-2c** – Fully explain how pre-2015 conditions are characterized. • **Potential Action GWQ-2d** – Do not establish MTs that would allow for substantial degradation of water quality. • **Potential Action GWQ-2e** – Do not use data from nearby wells when developing MTs without justification.

Deficiency	What SGMA Requires	Deficiency Summary	Potential Actions to Correct the Deficiency
Deficiency GWQ-3 – Measurable Objectives set by the 2022 GSP for groundwater quality are not consistent with GSP Regulations. • **Deficiency GWQ-3a** – The 2022 GSP allows MOs that exceed regulatory water quality thresholds (e.g., MCLs) without explaining how that would not cause significant and unreasonable results or impacts to beneficial uses and users. • **Deficiency GWQ-3b** – Some MOs are inexplicably based on data that may represent undesirable results. • **Deficiency GWQ-3c** – The GSP does not explain how it quantifies current conditions, yet the GSP uses current conditions to justify establishing MOs that exceed MCLs or SMCLs. • **Deficiency GWQ-3d** – MOs are sometimes effectively set to 95th percentile concentrations. • **Deficiency GWQ-3e** – MOs at some wells are based on data from wells nearby the RMS wells, rather than from the RMS wells themselves, without justification. • **Deficiency GWQ-3f** – The 2022 GSP establishes measurable objectives that may vary over time without explanation of how that would provide operational flexibility while avoiding significant and unreasonable results or impacts to beneficial uses and users.	MOs for water quality degradation must be based on the same metrics and monitoring sites used for MTs. MOs must "provide a reasonable margin of operational flexibility under adverse conditions" (Cal Code Regs., tit. 23, § 342.30, subds. (c) & (d)).	**DWR Inadequate Determination summary**: • **Deficiency GWQ-3a** – The 2022 GSP establishes many MOs that exceed primary MCLs or upper SMCLs yet does not explain how exceeding health- or quality-protective standards is not an undesirable result. While GSAs are not required to address undesirable results for groundwater quality that occurred prior to January 1, 2015, pre-2015 undesirable results should still be identified and MOs established accordingly. • **Deficiency GWQ-3b** – 2022 GSP appears to establish MOs from historical data when current conditions exceed MCLs or SMCLs; however, this historical data ranges from 2000 to 2020. While GSAs are not required to address undesirable results for groundwater quality that occurred prior to 2015, GSAs are responsible for addressing degradation of water quality after 2015. GSAs should therefore not use exceedances between 2015 and 2020 to establish MOs that exceed MCLs or SMCLs or may otherwise indicate undesirable results. • **Deficiency GWQ-3c & 3d** – None. • **Deficiency GWQ-3e** – Some MOs are calculated with data from nearby wells. • **Deficiency GWQ-3f** – The MO approach results in "dynamic measurable objectives that may change from year to year." Specifically, if MOs are always set to the 95th percentile, then they will become less protective of water quality as water quality degrades, because the 95th percentile will increase along average concentrations increase. Moreover, if average concentrations increase steadily without significant variation, it is possible for indefinite degradation of water quality to never exceed MOs. **Board additional issues**: • **Deficiency GWQ-3a & 3b** – None. • **Deficiency GWQ-3c** – The 2022 GSP appears to establish MOs from historical data when current conditions exceed MCLs or SMCLs; however, the GSP does not explain how it determines current conditions. It does not explain how many exceedances the GSP requires before it concludes that current conditions exceed MCLs or SMCLs, or whether it relies on a percentage of exceedances. The 2022 GSP appears to assess current conditions from data between 2000 and 2020. GSAs should therefore not use exceedances between 2015 and 2020 to justify abandoning MCLs. • **Deficiency GWQ-3d** – The 2022 GSP appears to set some MOs at concentrations representing the 95th percentile. Board staff interpret that MOs are effectively set at concentrations that are higher than 95% of all other observed concentrations. These concentrations do not actually represent current conditions and that managing to these MOs would result in degradation of groundwater quality. • **Deficiency GWQ-3e** –It is not clear why MOs for a specific RMS would be based on data from other wells. The GSP does not provide supporting information, making review of nearby data impossible. It appears the GSP does not clearly indicate which MOs rely on nearby data. • **Deficiency GWQ-3f** – None.	**Potential Action GWQ-3** – Update MOs to be consistent with GSP Regulations. • **Potential Action GWQ-3a** – Establish measurable objectives that do not inexplicably exceed regulatory water quality thresholds. • **Potential Action GWQ-3b** – Don't base pre-2015 conditions and MOs on current conditions; use pre-2015 conditions instead. • **Potential Action GWQ-3c** – Do not establish MOs that would allow for substantial degradation of water quality. • **Potential Action GWQ-3d** – Do not inexplicably use data from nearby wells when developing MOs. • **Potential Action GWQ-3e** – Do not use measurable objectives that may vary over time.

Deficiency	What SGMA Requires	Deficiency Summary	Potential Actions to Correct the Deficiency
Deficiency GWQ-4 – The water quality monitoring plan in the 2022 GSP is not consistent with GSP regulations. • **Deficiency GWQ-4a** – The GSP does not monitor or manage the aquifer below the de-designated zone. • **Deficiency GWQ-4b** – The proposed monitoring frequency is insufficient to detect short-term and seasonal trends. • **Deficiency GWQ-4c** – The proposed monitoring network does not adequately monitor key aquifers. • **Deficiency GWQ-4d** – The proposed sampling plan relies entirely on other agencies.	The GSP Regulations require GSPs to include a description of the monitoring network objectives for the basin including how the GSA will "monitor impacts to the beneficial uses or users of groundwater" (Cal. Code Regs., tit. 23, § 354.34, subd. (b)(2)). The monitoring network must be "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 [GSP] implementation" (Cal. Code Regs., tit. 23, § 354.34, subd. (a)). Data collected must be of "sufficient quality, frequency, and distribution" to characterize and evaluate groundwater conditions (Cal. Code Regs., tit. 23, § 354.32).	**DWR Inadequate Determination summary**: • **Deficiency GWQ-4a** – The DWR Inadequate Determination finds that "the GSAs are not monitoring zones which fall outside the de-designated areas" and that "the GSAs are overextending the de-designated area". The 2022 GSP does not monitor the aquifer below the de-designated area. The de-designation resolution includes a depth boundary; the aquifer below the de-designated area has not been de-designated and should therefore be monitored. • **Deficiency GWQ-4b** – The 2022 GSP has not explained how the proposed monitoring frequency is sufficient to demonstrate short-term and seasonal trends. • **Deficiency GWQ-4c** – There are data gaps in the 2022 GSP monitoring network. • **Deficiency GWQ-4d** – The DWR 2022 GSP Inadequate Determination notes that, while GSAs can leverage other programs that monitor water quality, the GSP fails to "explain how activities in those programs are consistent with SGMA and the GSP Regulations...". **Board additional issues**: • **Deficiency GWQ-4a** – None. • **Deficiency GWQ-4b** – Board staff note that nearly a third of wells appear to be sampled for arsenic only once every four years. Additionally, it is not clear in which seasons wells will be sampled, given irregular sampling frequencies (e.g., three or nine times a year). • **Deficiency GWQ-4c** – The monitoring plan does not include sampling wells known to be screened in the A aquifer zone at all, while only three wells known to be screened in the B aquifer zone are included in the planned sampling. Additionally, the GSAs do not know which aquifer six of its wells are screened within, and therefore, they do not know which aquifer the samples represent. • **Deficiency GWQ-4d** – GSAs have a statutory obligation to avoid undesirable results associated with degradation of water quality, no matter the availability of other sampling programs that they can leverage.	**Potential Action GWQ-4** – Update the water quality monitoring plan in the 2022 GSP to be consistent with GSP regulations. • **Potential Action GWQ-4a** – Monitor and manage the aquifer below the de-designated zone. • **Potential Action GWQ-4b** – Increase monitoring frequency and better describe monitoring schedules. • **Potential Action GWQ-4c** – Adequately monitor key aquifers. • **Potential Action GWQ-4d** – Add GSA monitoring capacity.
Deficiency GWQ-5 – Management actions should be responsive to water quality degradation. • **Deficiency GWQ-5a** – Additional sampling should be triggered when MTs are exceeded. • **Deficiency GWQ-5b** – Well mitigation plans need to address MT exceedances.	Each GSP is required to include a description of the projects and management actions the GSA has determined will achieve groundwater sustainability in the basin. The GSAs must 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" (Cal. Code Regs., tit. 23, § 354.44, subd. (b)(1)).	**DWR Inadequate Determination summary**: • **Deficiency GWQ-5a** – None. • **Deficiency GWQ-5b** – None. **Board additional issues**: • **Deficiency GWQ-5a** – The 2022 GSP does not include management actions that are responsive to MT exceedances. is difficult to understand how the GSAs can avoid significant and unreasonable impacts from degradation of groundwater quality if MT exceedances don't trigger additional monitoring to better characterize risks to drinking water users. • **Deficiency GWQ-5b** – It is difficult to understand how GSAs can avoid significant and unreasonable impacts from degradation of groundwater quality if the GSAs have not even developed—let alone implemented—a well mitigation plan to address MT exceedances.	**Potential Action GWQ-5** – Plan additional sampling when water quality is degraded. **Potential Action GL-4a** – Develop well mitigation programs with clear triggers, eligibility requirements, metrics, and funding sources. (This action supports addressing both Deficiency GL-4 and Deficiency GWQ-5b.)

Appendix B - Figures

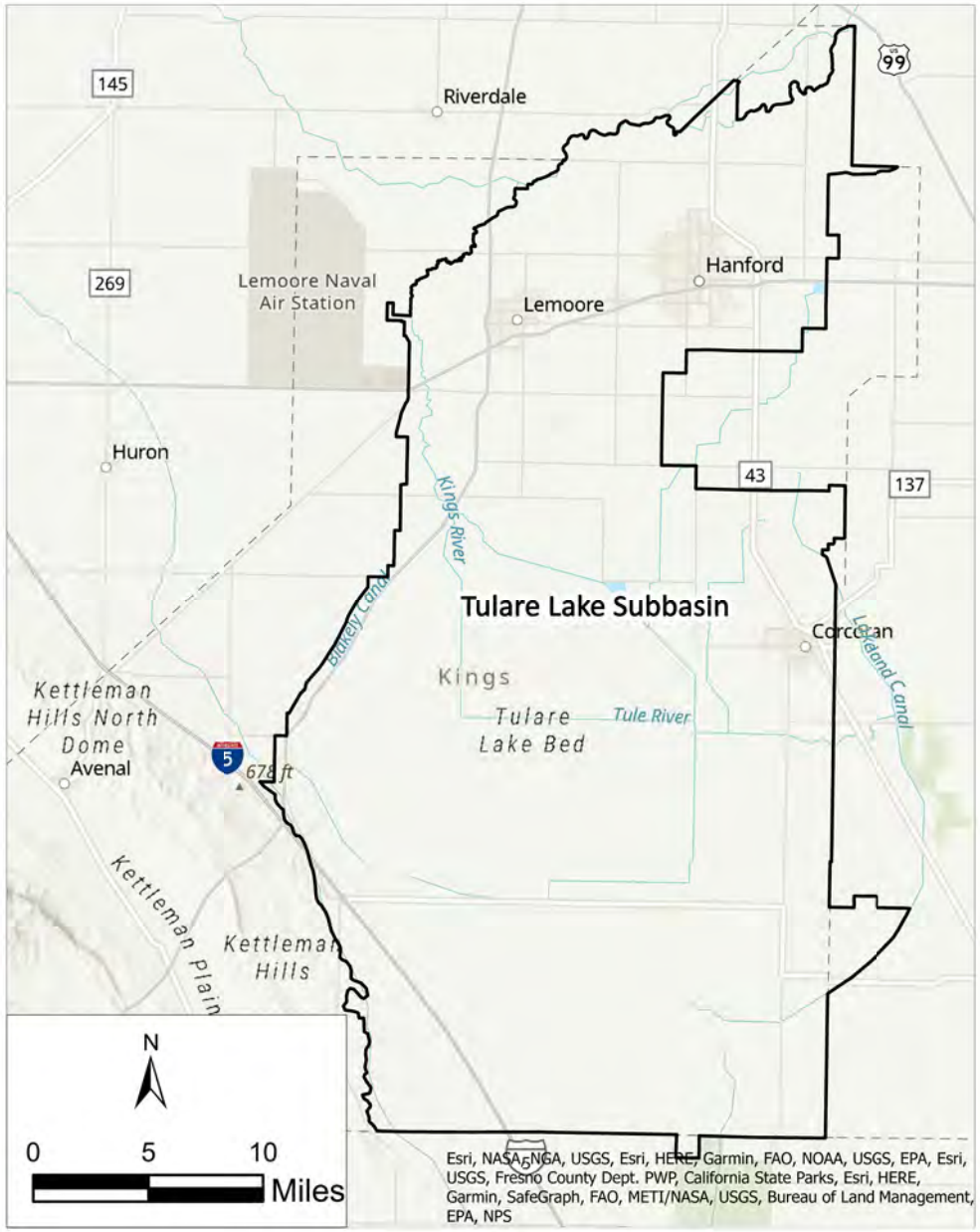

Figure 3-1

Overview of the Tulare Lake Subbasin

Tulare Lake Subbasin

Hydrologic Regions

Draft Staff Report
Tulare Lake Subbasin
October 2023

CALIFORNIA Water Boards
STATE WATER RESOURCES CONTROL BOARD
REGIONAL WATER QUALITY CONTROL BOARDS

Figure 3-2: Topographic Map of the Tulare Lake Subbasin

Excerpt from the Tulare Lake Subbasin 2022 GSP

Date: 1/9/2020 Printed by: elizabeth.chapman
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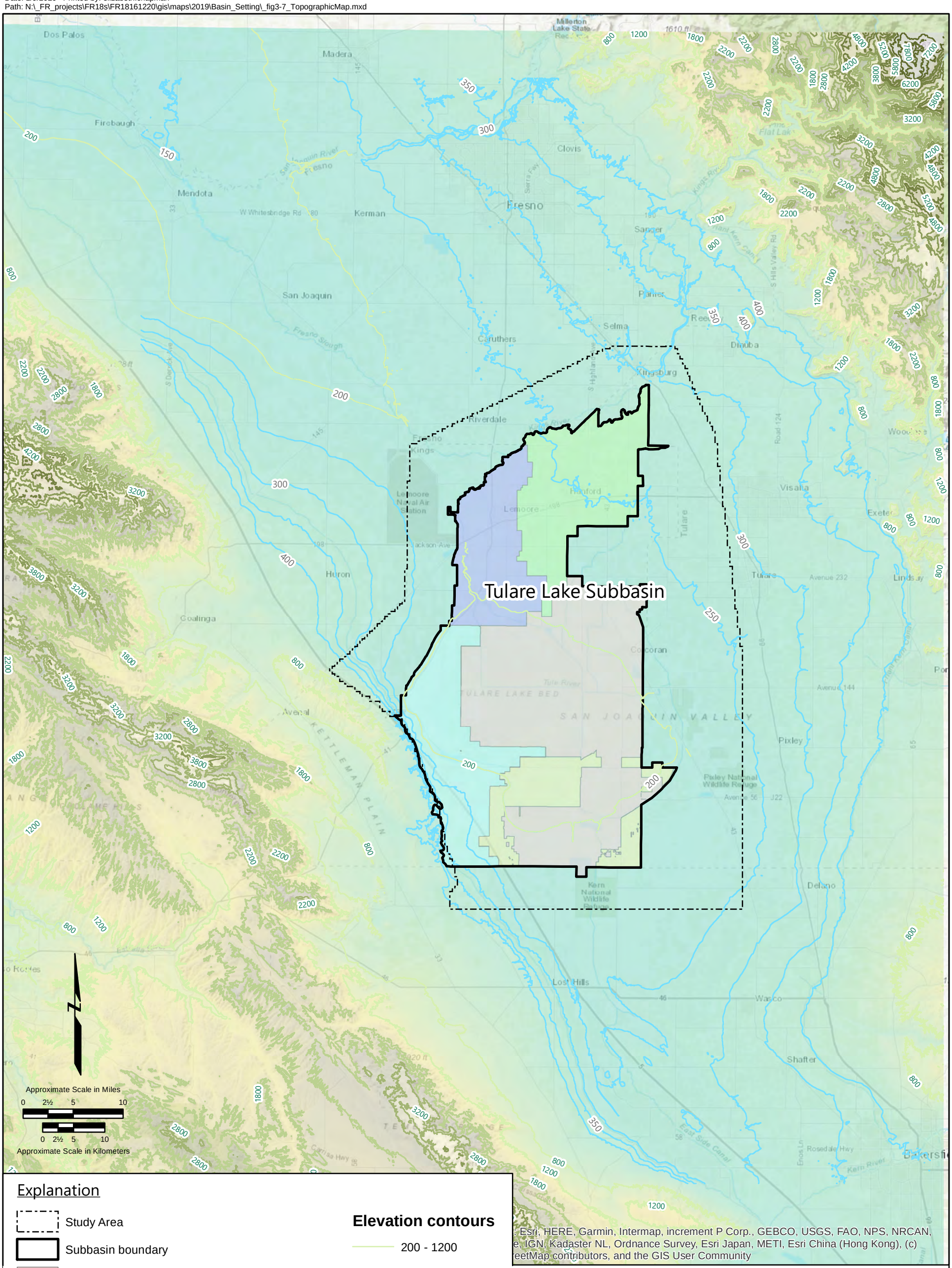


Topographic Map of the Tulare Lake Subbasin
Tulare Lake Subbasin Hydrologic Model
Kings County, California

By: SCM	Date: 1/9/2020	Project No.: FR18161220
		Figure 3-7

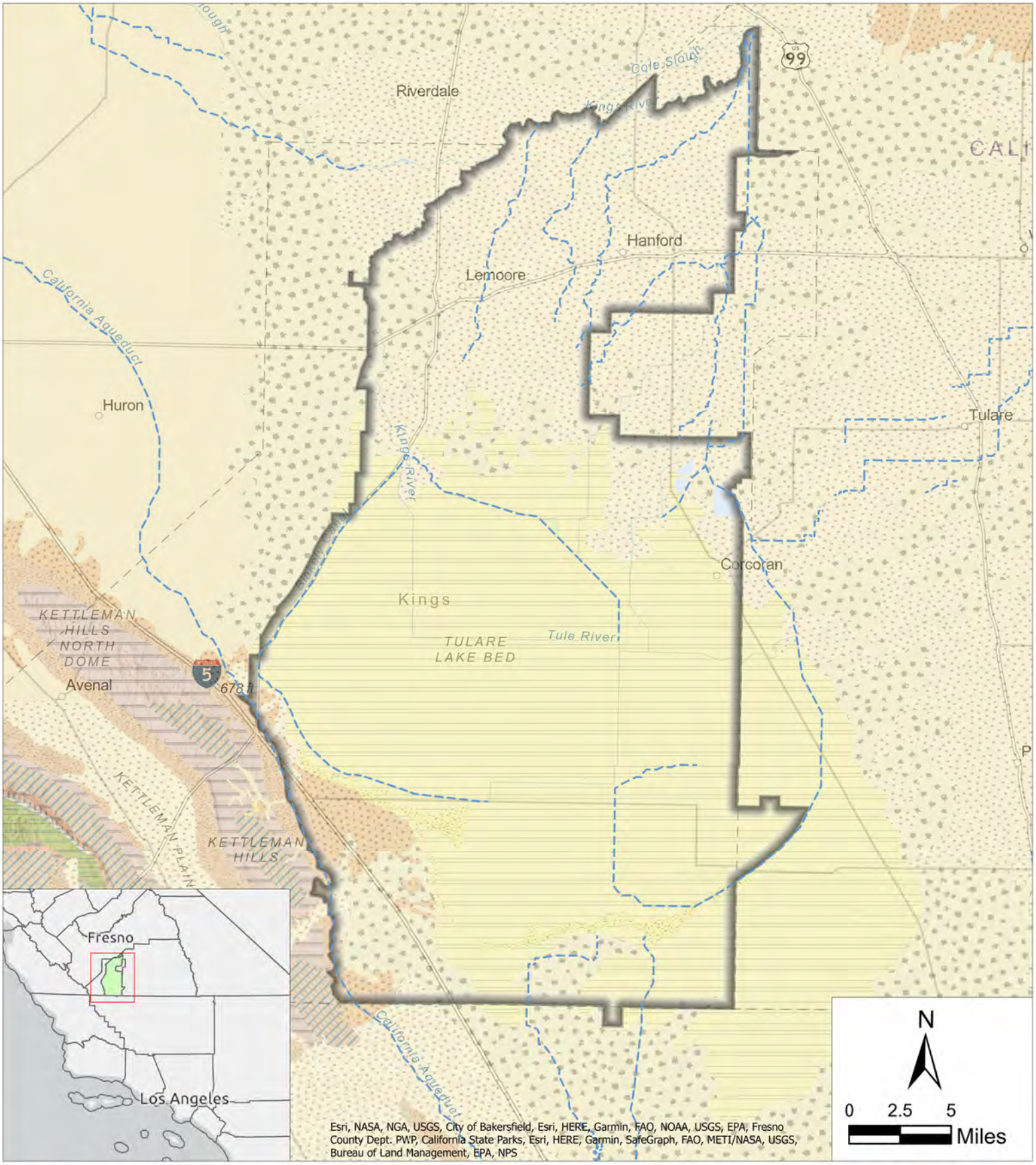


Figure 3-3

Geology of the Tulare Lake Subbasin

Draft Staff Report
Tulare Lake Subbasin
October 2023

Tulare Lake Subbasin

Geologic Unit

- E
- Kl
- Ku
- Ml
- Mm
- Mu
- Og
- Pml
- Pu
- QP
- Qal
- Qb
- Qc
- Qf
- Ql
- Qs
- ub
- water

CALIFORNIA Water Boards
STATE WATER RESOURCES CONTROL BOARD
REGIONAL WATER QUALITY CONTROL BOARDS

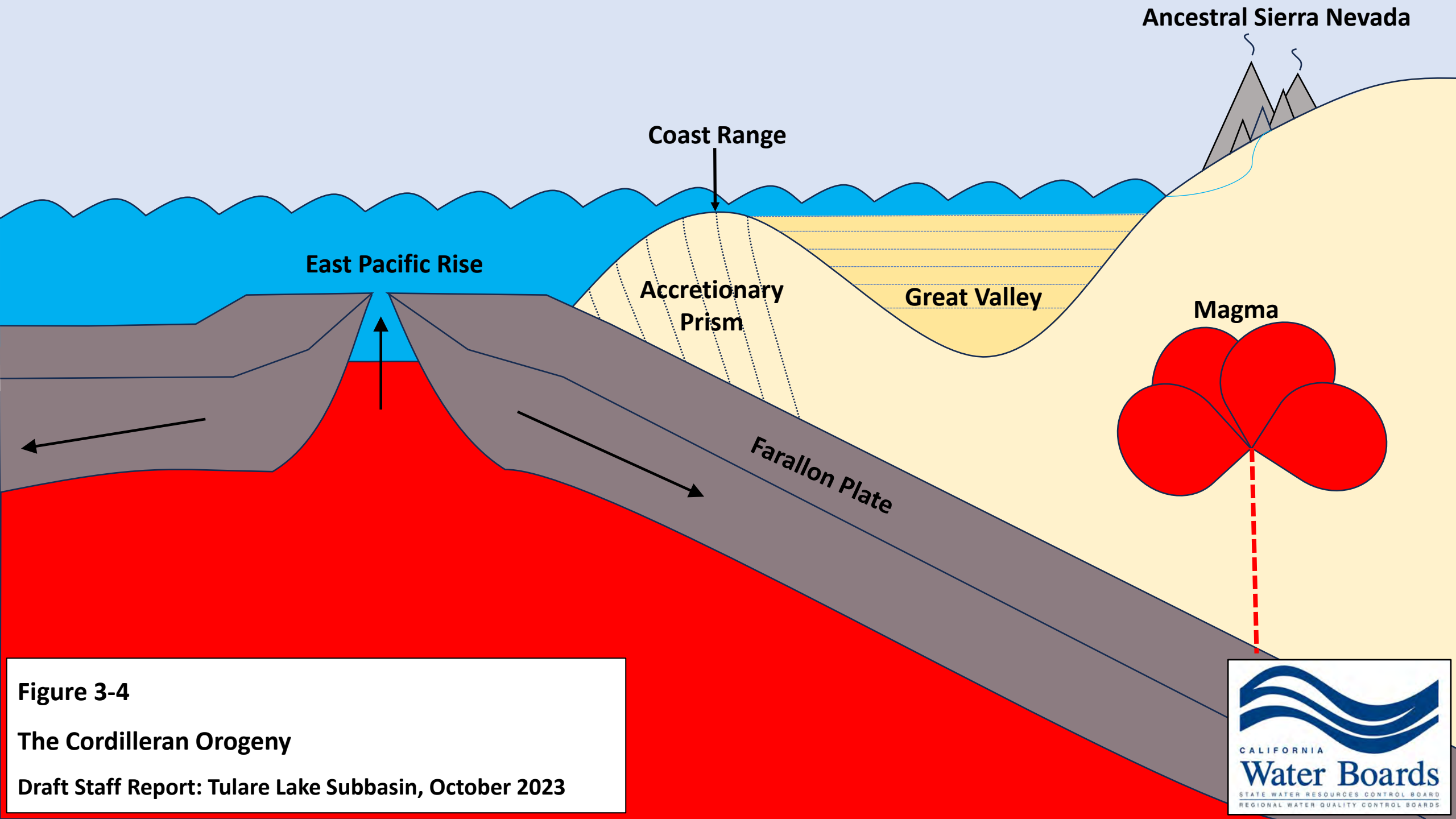


Figure 3-4

The Cordilleran Orogeny

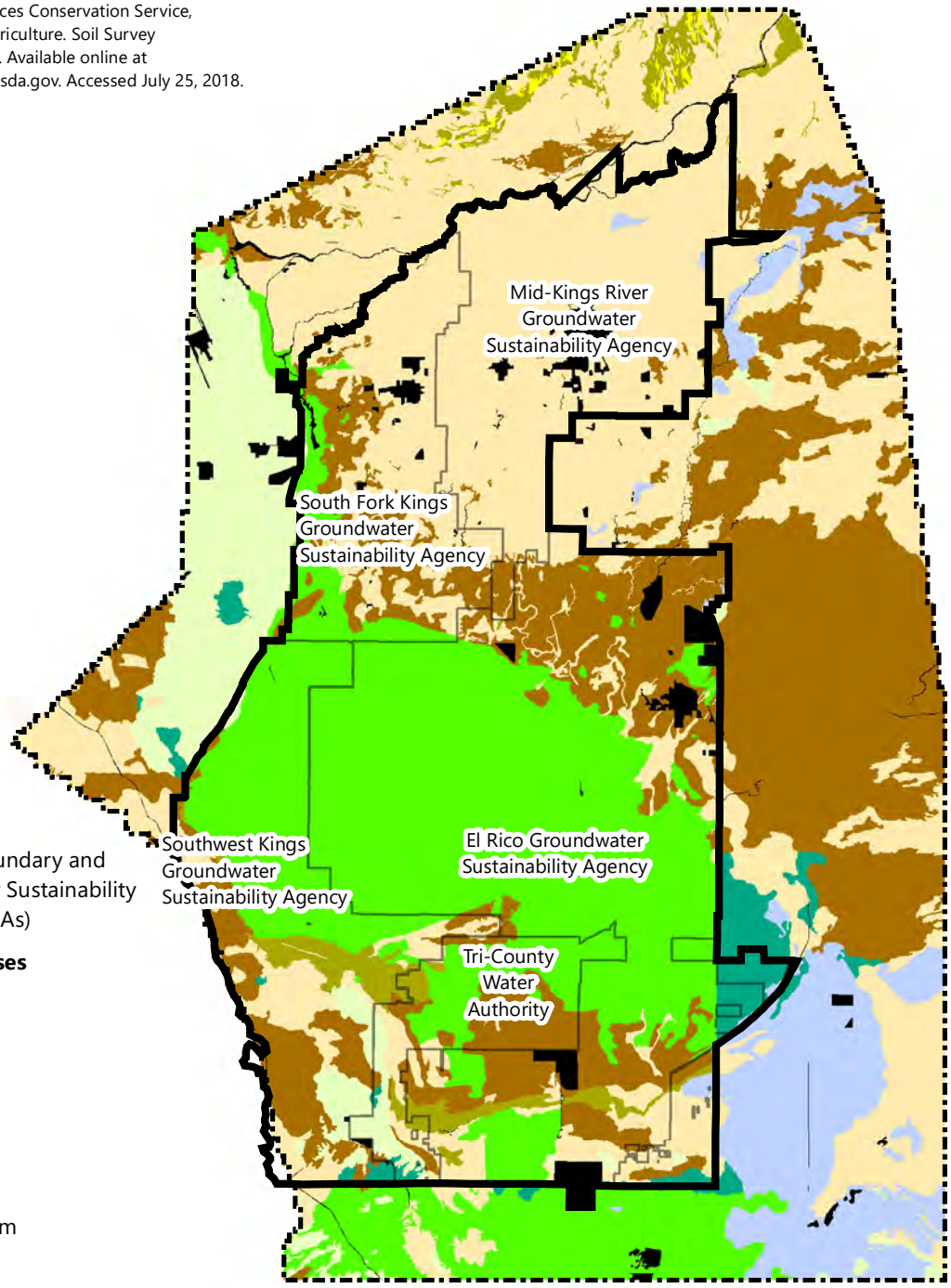
Draft Staff Report: Tulare Lake Subbasin, October 2023

CALIFORNIA Water Boards
STATE WATER RESOURCES CONTROL BOARD
REGIONAL WATER QUALITY CONTROL BOARDS

Figure 3-5: Soil Texture Map

Excerpt from the Tulare Lake Subbasin 2022 GSP

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



Explanation

- Study area
- Subbasin boundary and Groundwater Sustainability Agencies (GSAs)

USDA soil textural classes

- Clay
- Silty clay
- Clay loam
- Silty clay loam
- Silt loam
- Loam
- Sandy loam
- Loamy sand
- Sand
- Unweathered bedrock
- Soil data unavailable

Miles
0 2 4 8
0 2.5 5 10
Kilometers

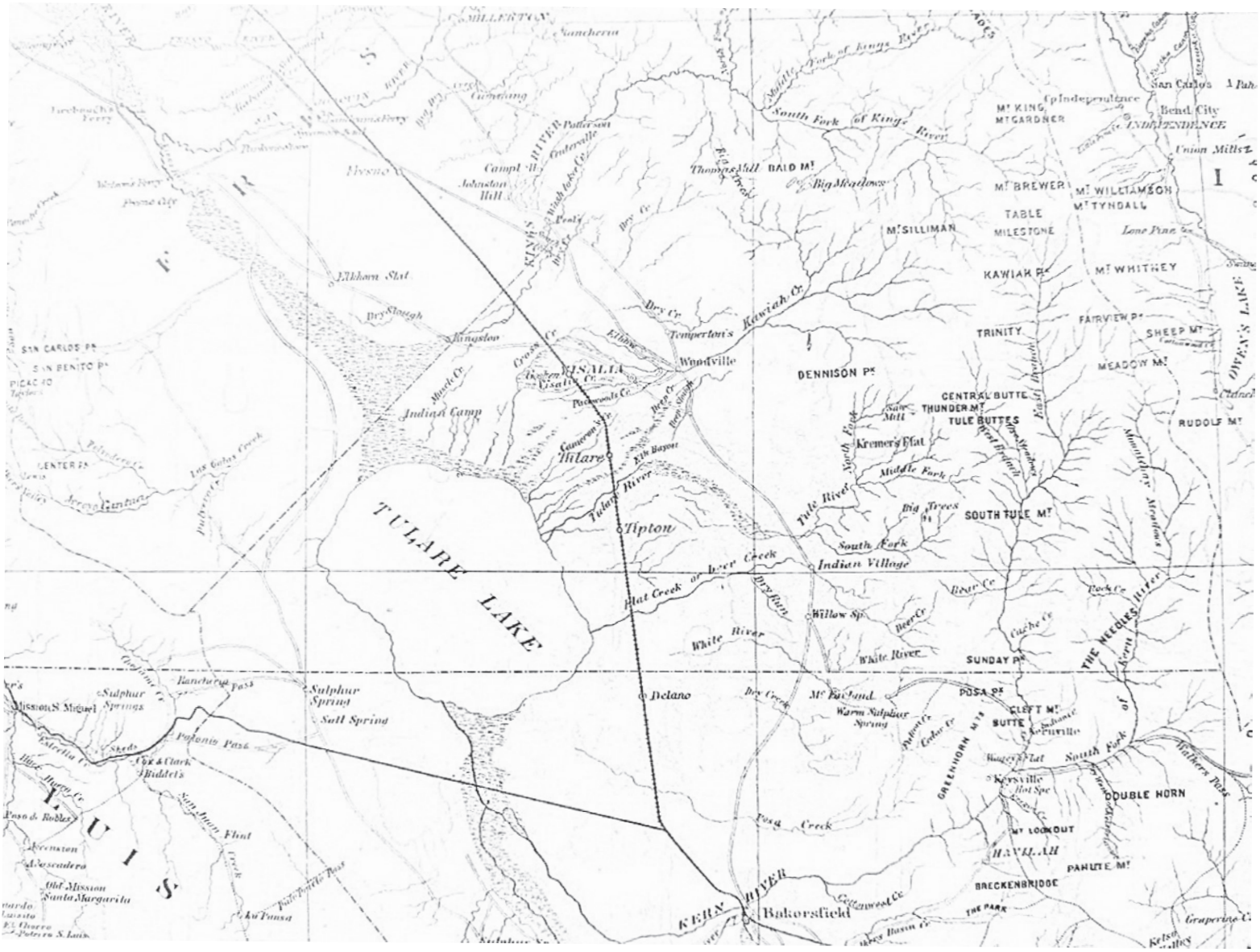
N

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

By: EMC	Date: 11/15/2019	Project No.: FR18161220
		Figure 3-9

Date: 11/15/2019 Printed by: elizabeth.chapman
Path: N:_FR_projects\FR18s\FR18161220\gis\maps\2019\Basin_Setting\8.5x11_fig3-9_SoilTexture.mxd

Figure 3-6: Historical Map of Tulare Lake (1873)



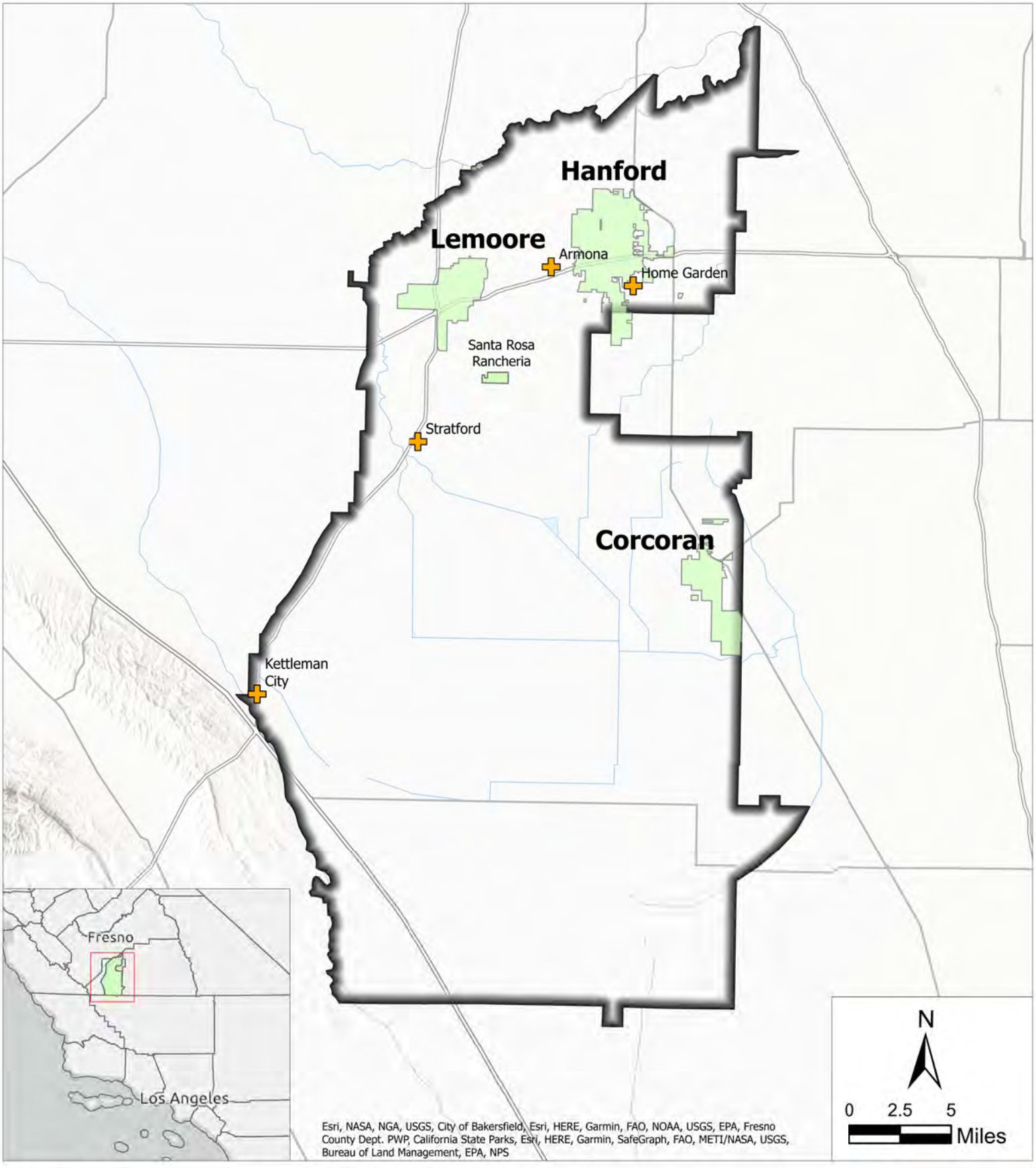


Figure 3-7

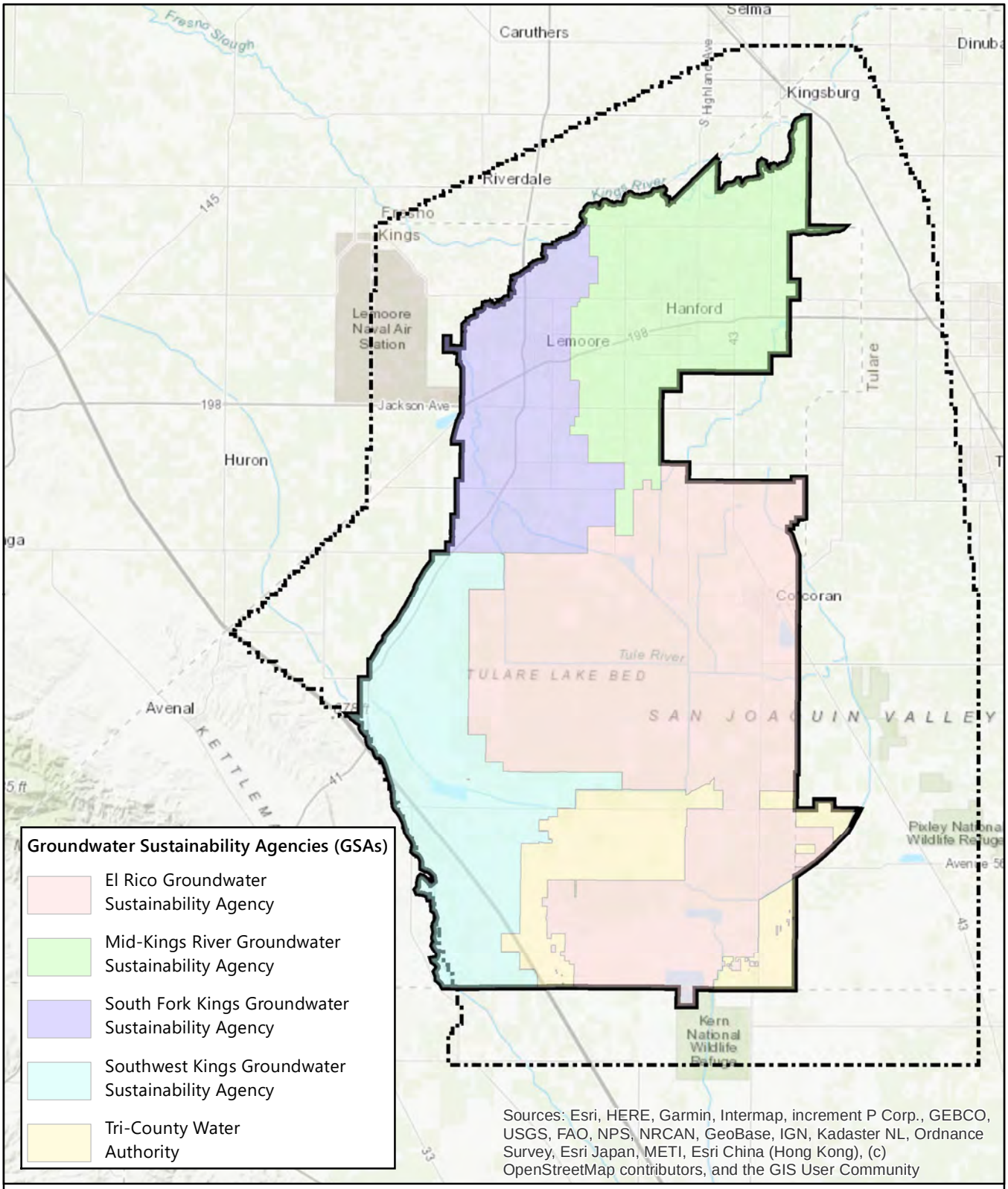
Urban Areas in the Tulare Lake Subbasin

Draft Staff Report
Tulare Lake Subbasin
October 2023

California Water Boards
State Water Resources Control Board
Regional Water Quality Control Boards

Figure 3-8: Groundwater Sustainability Agencies in the Tulare Lake Subbasin

Excerpt from the Tulare Lake Subbasin 2022 GSP



Explanation

Study area

Subbasin boundary

Miles
0 2 4 8
0 2.5 5 10
Kilometers

N

Groundwater Sustainability Agencies in Tulare Lake Subbasin

Tulare Lake Subbasin Groundwater Sustainability Plan
Kings County, California

By: EMC	Date: 11/27/2019	Project No.: FR18161220
		Figure **3-2**

Date: 11/27/2019 Printed by: elizabeth.chapman
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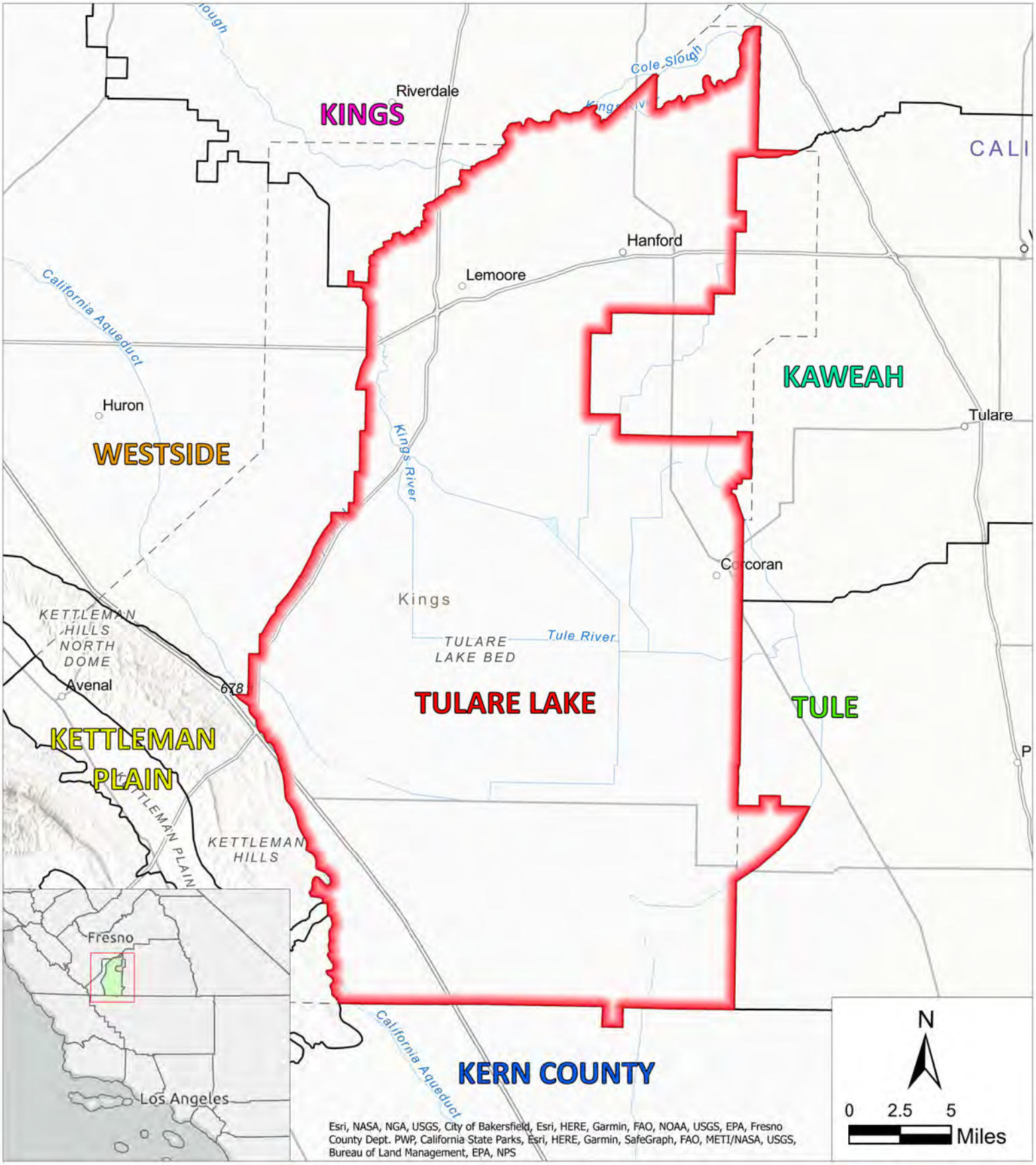


Figure 3-9 a, b, c

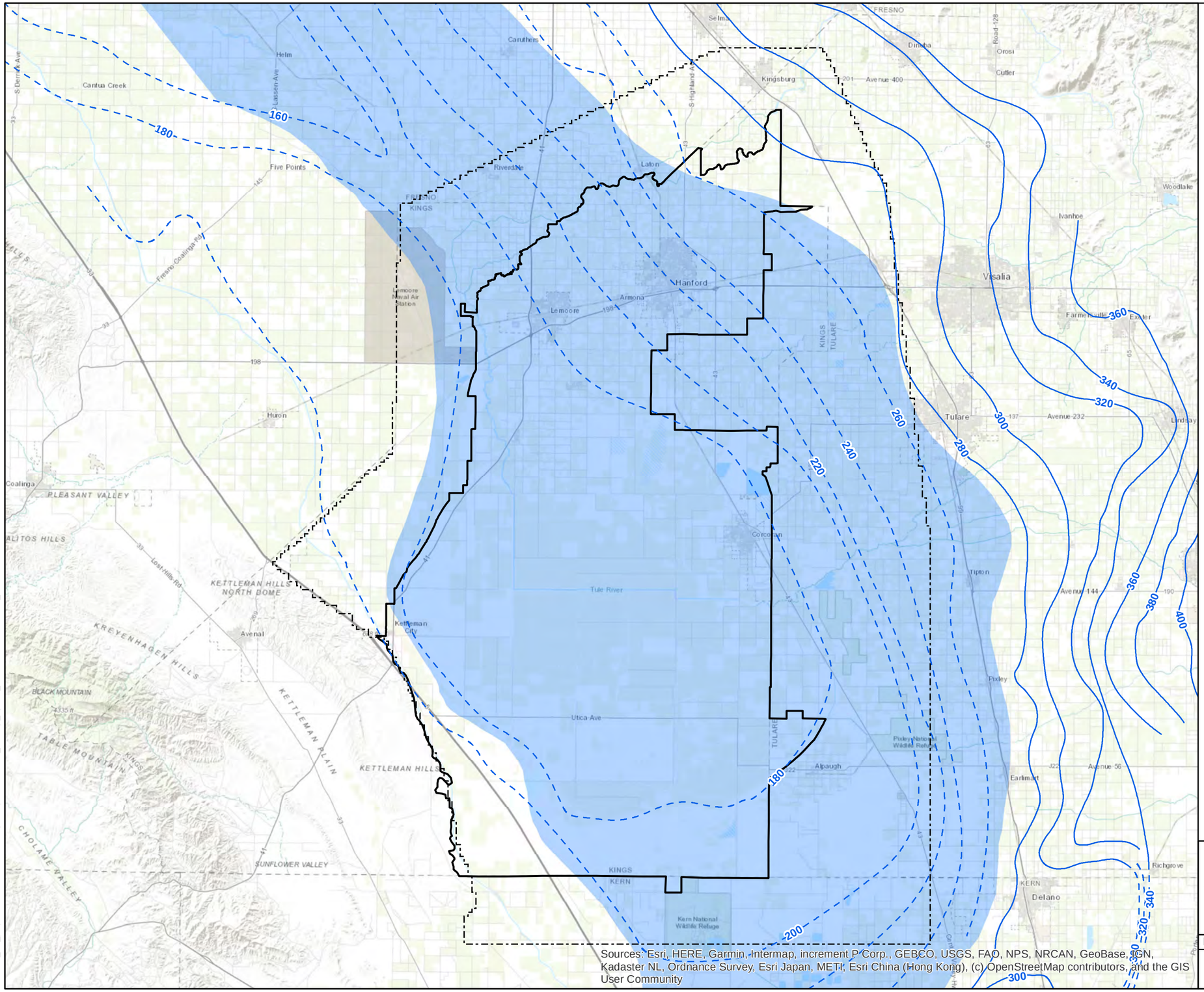
Tulare Lake Subbasin

Subbasins Adjacent to Tulare Lake Subbasin

Draft Staff Report
Tulare Lake Subbasin
October 2023

California Water Boards
State Water Resources Control Board
Regional Water Quality Control Boards

Figure 3-10a - Area of Flowing Wells 1905 - 1907



Explanation

- Areas of flowing wells
- Study area
- Subbasin boundary

20-ft groundwater elevation contours (fmsl)

- Certain
- Uncertain

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

N

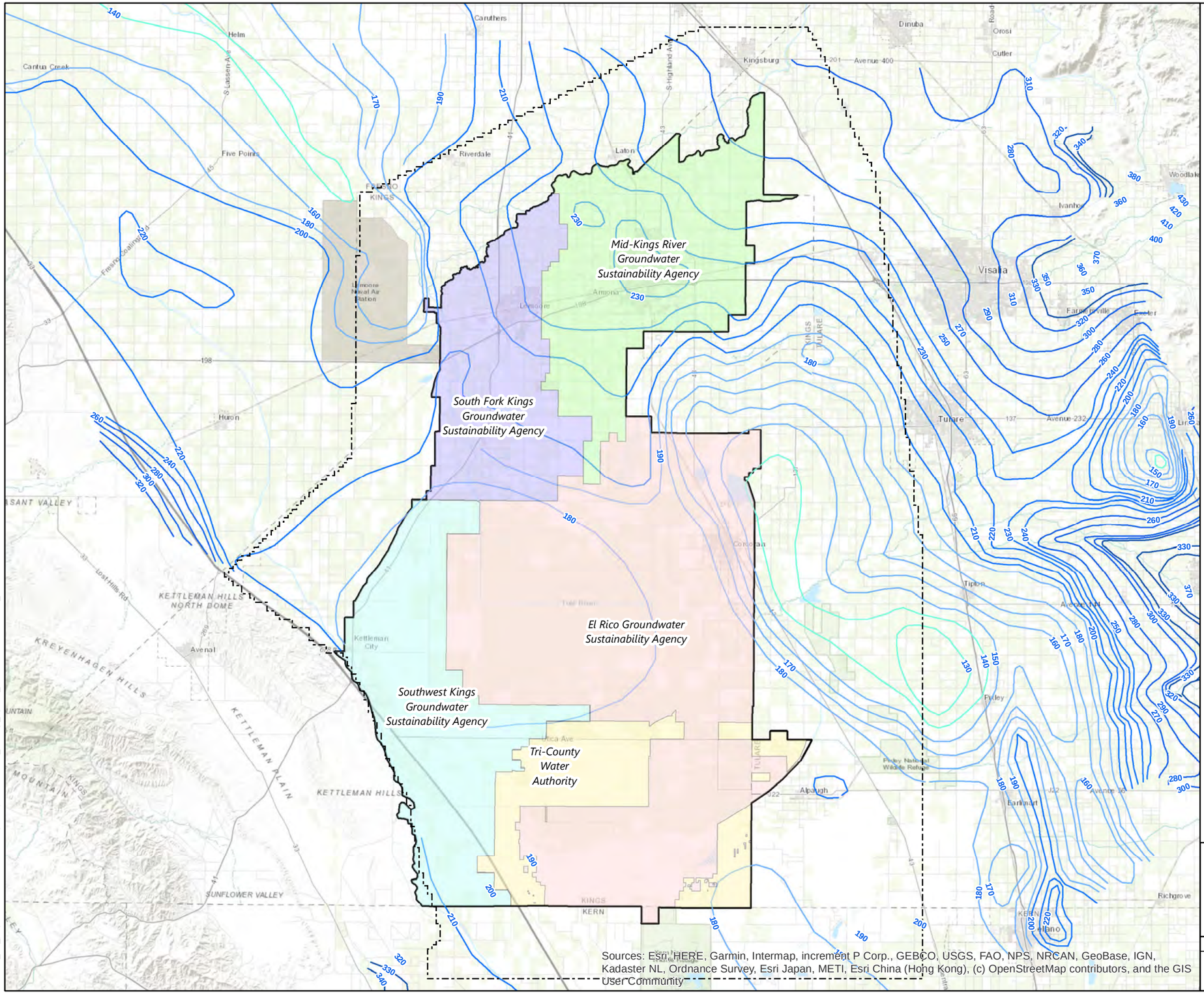
Miles
0 2.5 5 10
Kilometers
0 3 6 12

Area of Flowing Wells 1905-1907
Tulare Lake Subbasin Groundwater Sustainability Plan
Kings County, California

By: EMC	Date: 1/9/2020	Project No.: FR18161220
		Figure **3-23**

Date: 1/9/2020 Printed by: elizabeth.chapman
Path: N:_FR_projects\FR18s\FR18161220\gis\maps\2019\Basin_Setting_fig3-23_GroundwaterConditions_1907.mxd

Figure 3-10b - Map of Unconfined Groundwater Conditions 1952



Explanation

- Study Area
- Subbasin boundary

10-ft groundwater elevation contours

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

Groundwater Sustainability Agencies (GSAs)

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

N

Approximate Scale in Miles
0 2½ 5 10
0 2½ 5 10
Approximate Scale in Kilometers

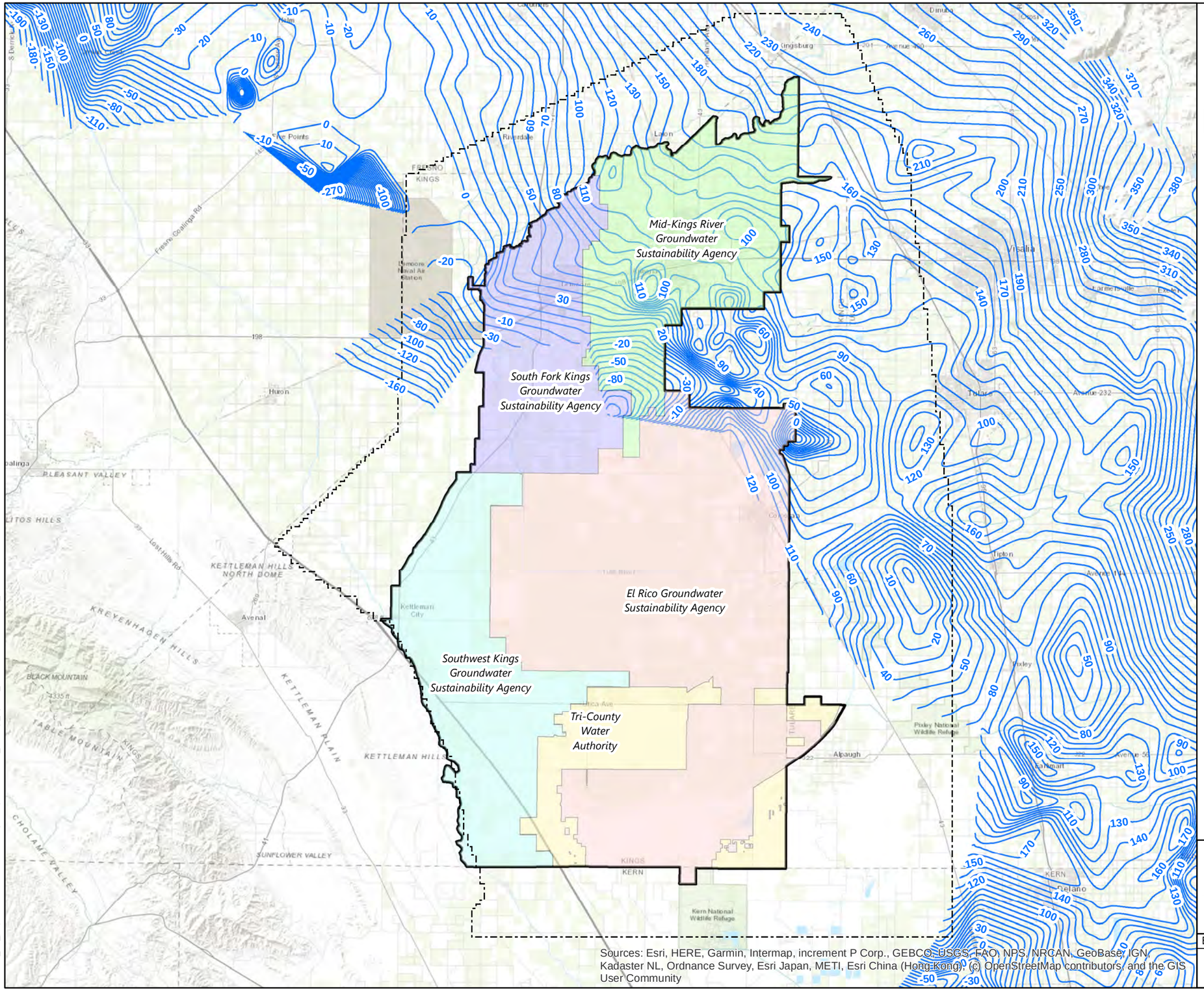
Notes:
1) Map adapted from Davis (1959), Plate 15.
2) Elevations in feet above mean sea level.

Map of Unconfined Groundwater Conditions1952
Tulare Lake Subbasin Groundwater Sustainability Plan
Kings County, California

By: EMC	Date: 1/9/2020	Project No.: FR18161220
		Figure **3-24**

Date: 1/9/2020 Printed by: elizabeth.chapman
Path: N:_FR_projects\FR18s\FR18161220\gis\maps\2019\Basin_Setting_fig3-24_GroundwaterConditions_1952.mxd

Figure 3-10c - Map of Unconfined Groundwater Elevations 2016



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

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

Map of Unconfined Groundwater Elevations 2016

Tulare Lake Subbasin Groundwater Sustainability Plan
Kings County, California

By: EMC	Date: 11/15/2019	Project No.: FR18161220
		Figure **3-25**

Date: 11/15/2019 Printed by: shaina.price
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Figure 11a - Mid-Kings River GSA Land Use Classification

Excerpt from the Tulare Lake Subbasin 2022 GSP

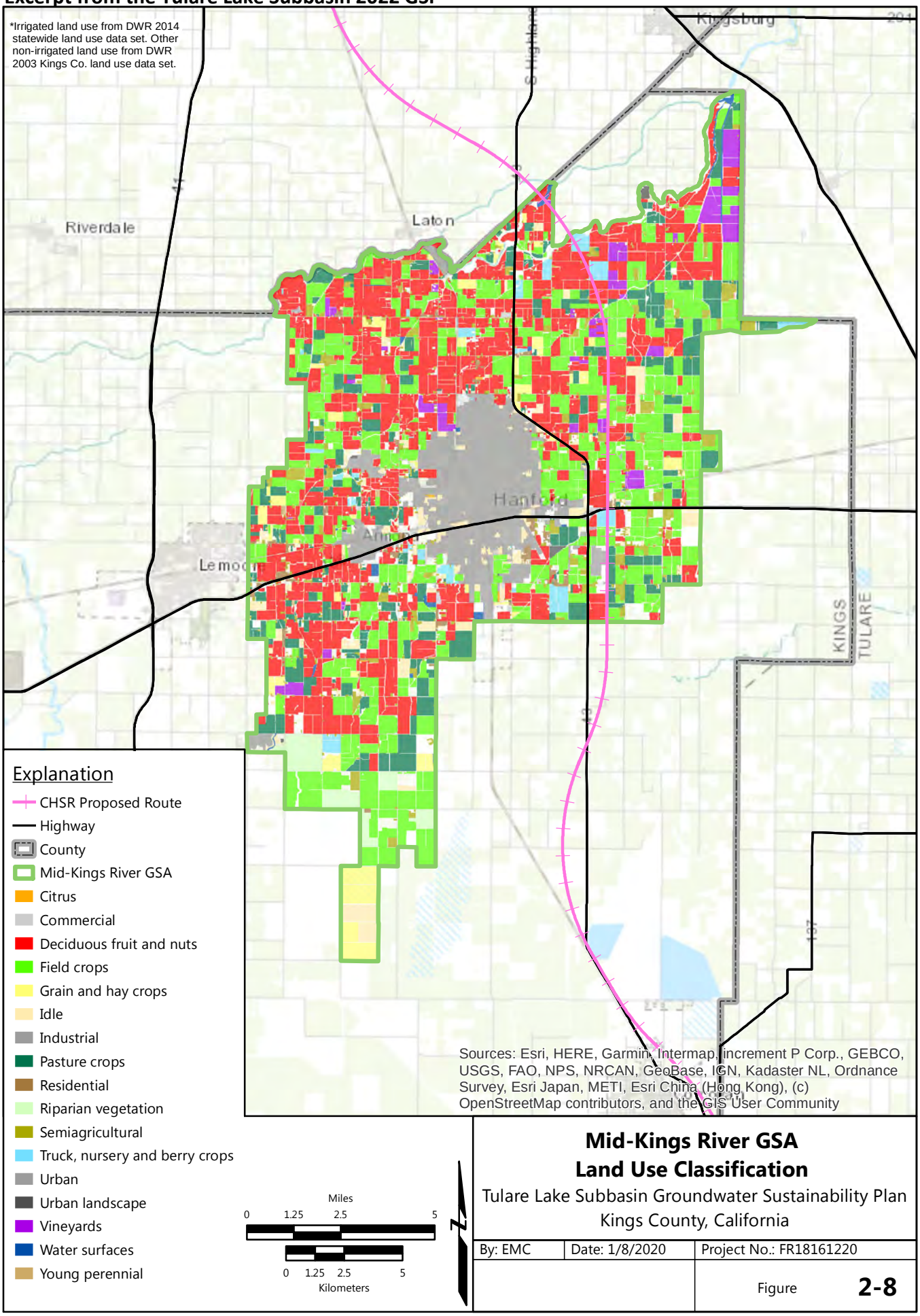
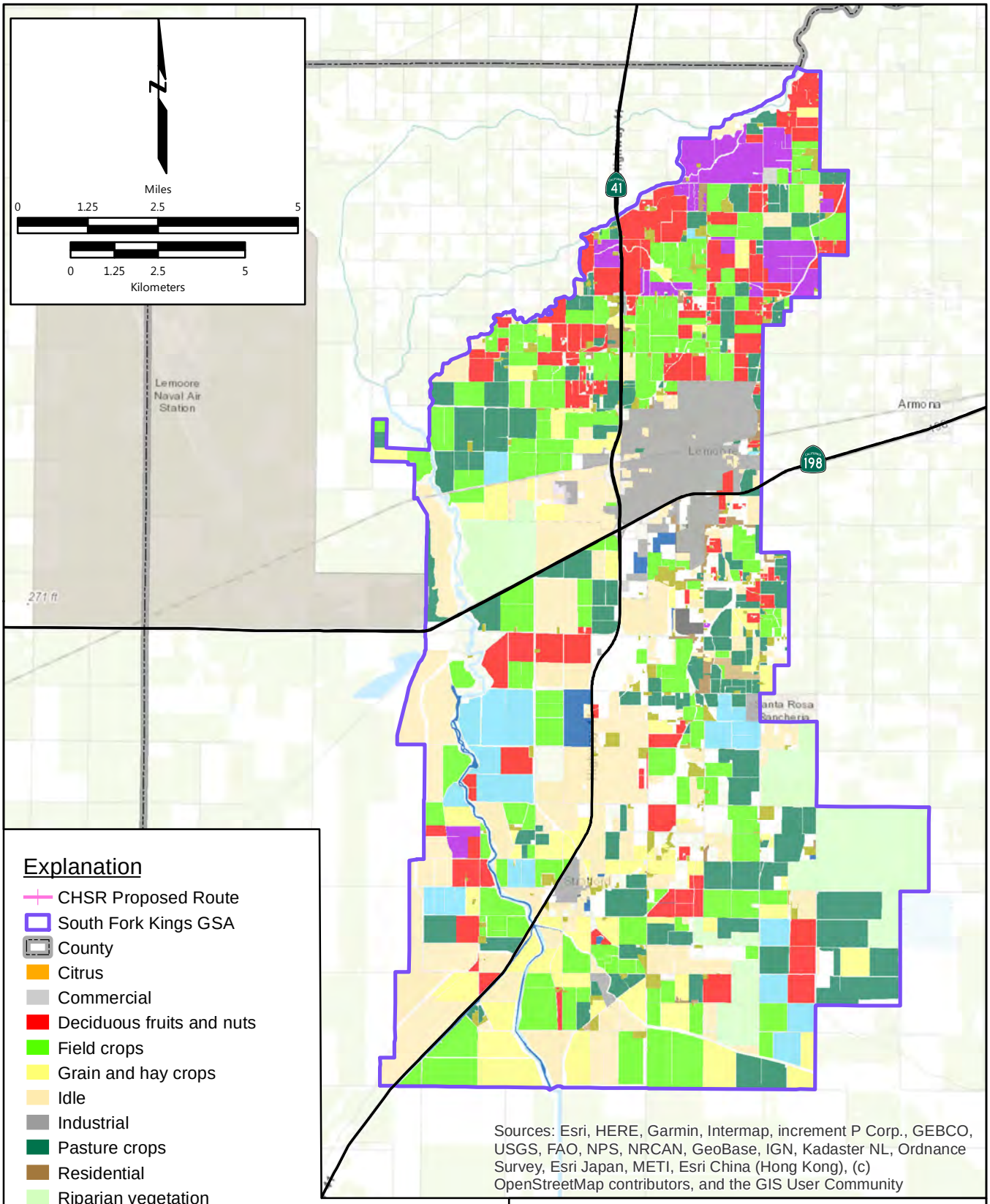


Figure 11b - South Fork Kings GSA Land Use Classifications

Excerpt from the Tulare Lake Subbasin 2022 GSP



*Irrigated land use from DWR 2014 statewide land use data set. Other non-irrigated land use from DWR 2003 Kings Co. land use data set.

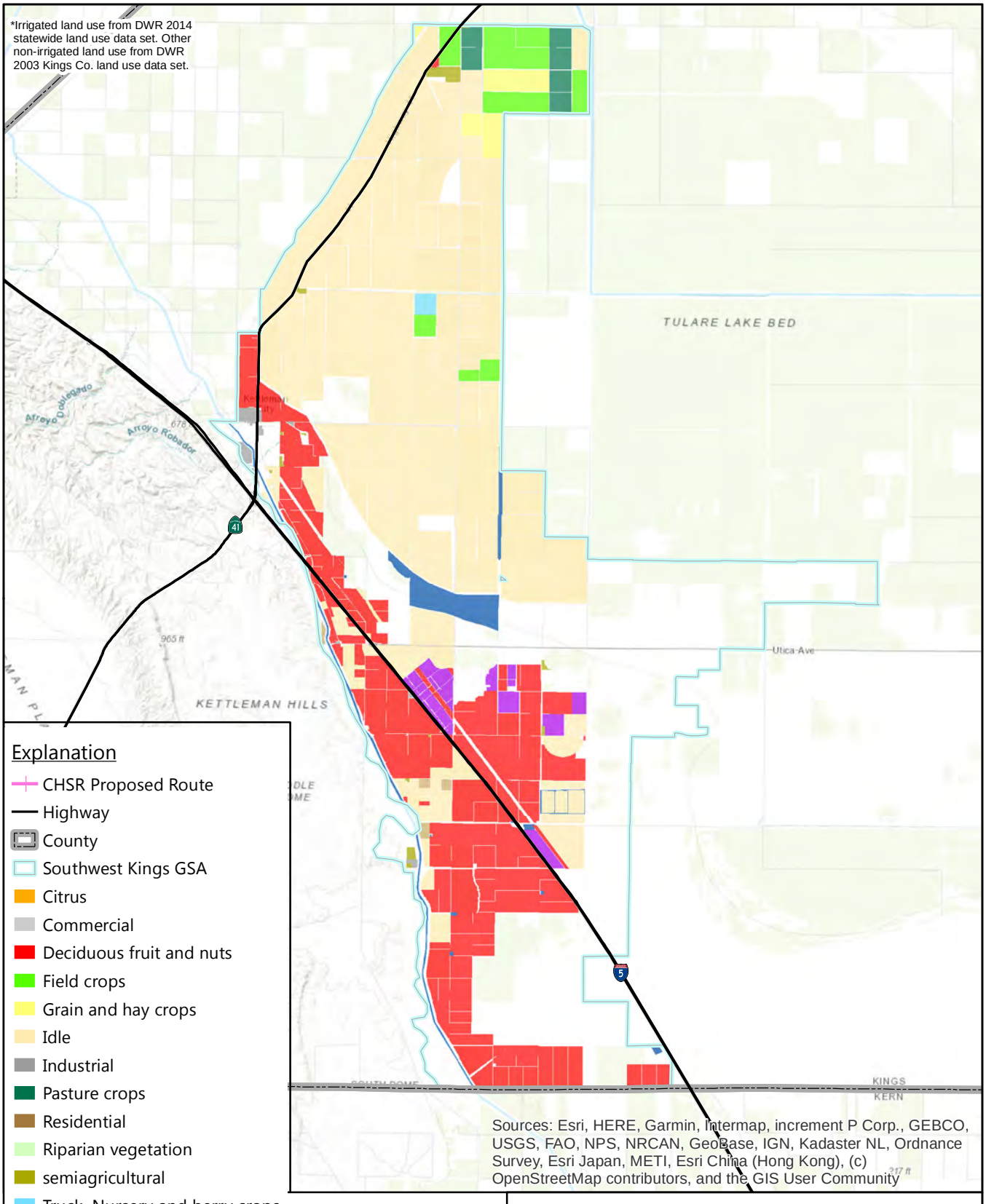
South Fork Kings GSA
Land Use Classifications
Tulare Lake Subbasin Groundwater Sustainability Plan
Kings County, California

By: EMC	Date: 1/8/2020	Project No.: FR18161220
		Figure **2-9**

Date: 1/8/2020 Printed by: scott.mitchell2
Path: N:_FR_projects\FR18s\FR18161220\gis\maps\2019\Plan_AreaNov2019_fig2-9_SouthFork_Landuse_8x11.mxd

Figure 11c - Southwest Kings GSA Land Use Classifications

Excerpt from the Tulare Lake Subbasin 2022 GSP



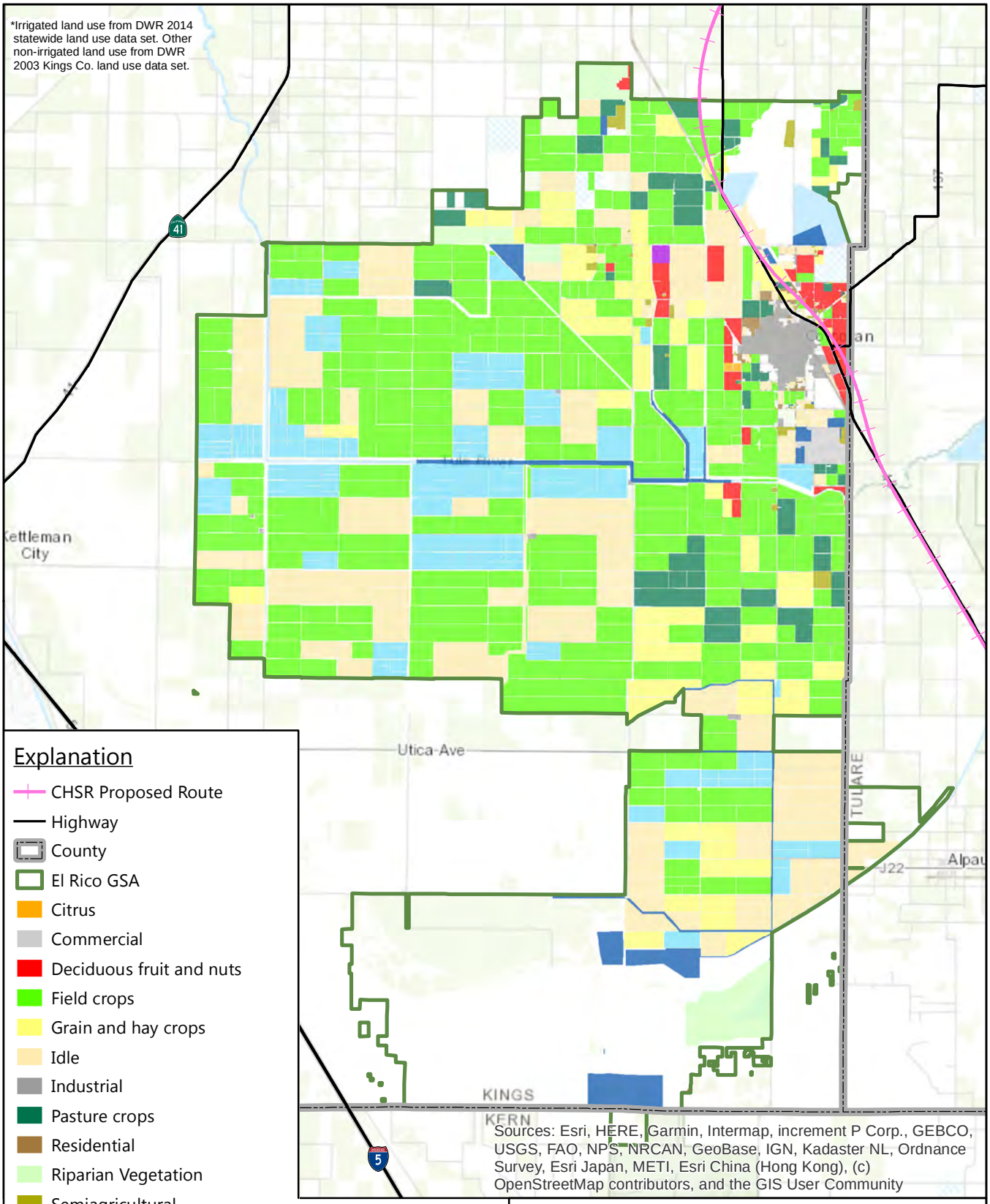
Date: 1/8/2020 Printed by: scott.mitchell2
Path: N:_FR_projects\FR18s\FR18161220\gis\maps\2019\Plan_AreaNov2019_fig2-10_SWKings_LandUse_8x11.mxd

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

By: EMC	Date: 1/8/2020	Project No.: FR18161220
		Figure **2-10**

Figure 11d - El Rico GSA Land Use Classification

Excerpt from the Tulare Lake Subbasin 2022 GSP



El Rico GSA Land Use Classification

Tulare Lake Subbasin Groundwater Sustainability Plan
Kings County, California

By: EMC	Date: 1/8/2020	Project No.: FR18161220
		Figure **2-11**

Date: 1/8/2020 Printed by: scott.mitchell2
Path: N:_FR_projects\FR18s\FR18161220\gis\maps\2019\Plan_AreaNov2019_fig2-11_ElRico_Landuse_8x11.mxd

Figure 3-12 - Distribution of Wetlands and Phreatophyte Vegetation

Distribution of Wetlands

Distribution of Phreatophyte Vegetation

Selma
Caruthers
Dinuba
Kingsburg
S Highland Ave
Riverdale
Kings River
Fresno
Kings
Road 124
Lemoore Naval Air Station
Hanford
Visalia
Lemoore
198
43
Tulare
Exeter
Jackson Ave
Huron
Tulare
Avenue 232
Coalinga
Tule River
TULARE LAKE BED
SAN JOAQUIN VALLEY
Avenue 144
KETTLEMAN PLAIN
41
Pixley
Pixley National Wildlife Refuge
Avenue 56
J22
Delano
Kern National Wildlife Refuge

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

Explanation

- Extent of A-Clay
- Subbasin boundary
- Study area
- California Natural Resources Agency wetlands
- California Natural Resources Agency phreatophyte vegetation

Groundwater Sustainability Agencies (GSAs)

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

Miles
0 4 8 16
0 5 10 20
Kilometers

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

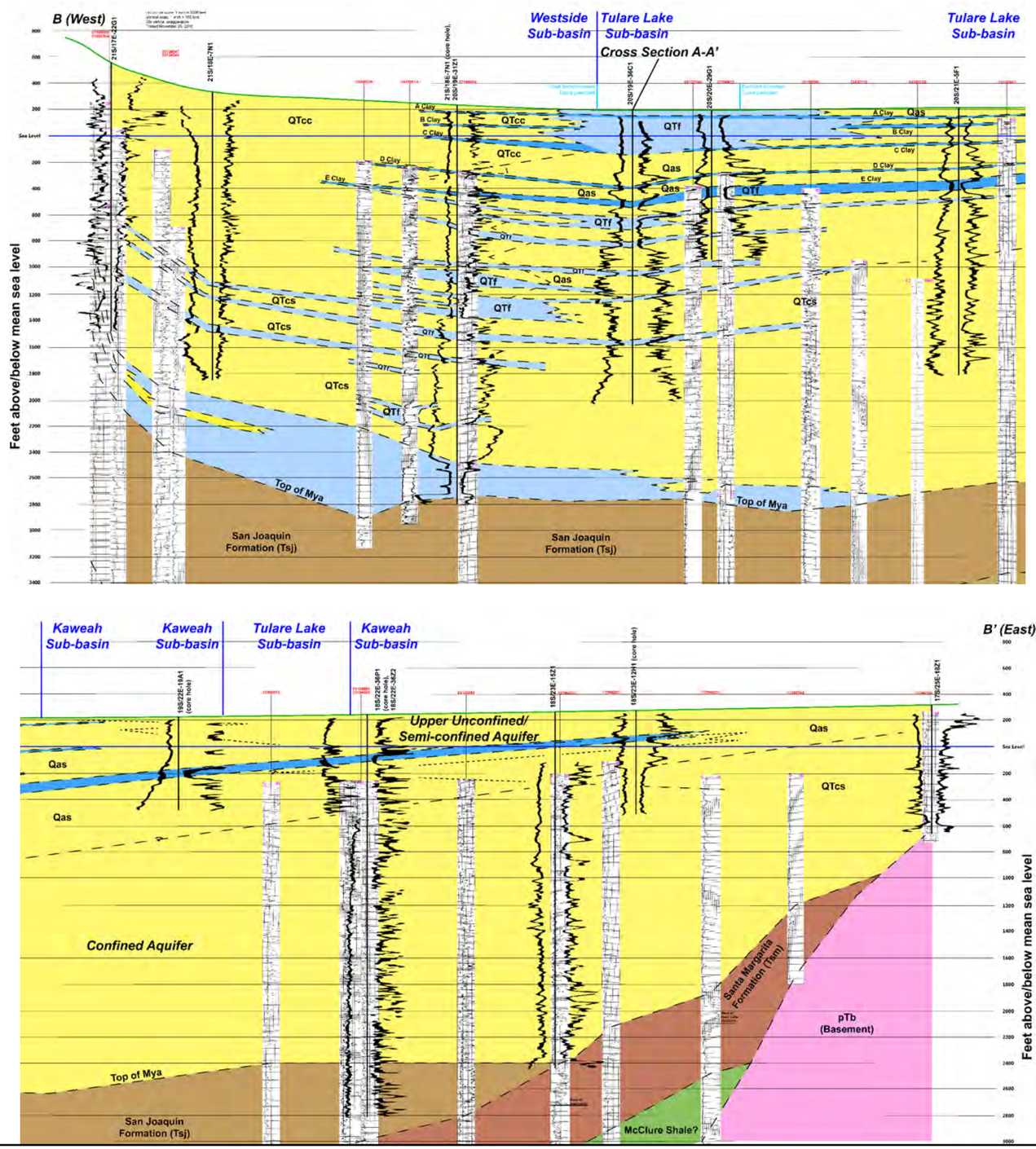
N

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

By: EMC	Date: 1/9/2020	Project No.: FR18161220
		Figure **3-38**

Date: 1/9/2020 Printed by: elizabeth.chapman
Path: N:_FR_projects\FR18s\FR18161220\gis\maps\2019\Basin_Setting_fig3-38_DistributionofWetlandsPhreatophyteVeg.mxd

Figure 3-13: Cross Section B-B'



Explanation

- Coarse-grained alluvium / Tulare Formation
- San Joaquin Formation
- Etchegoin Formation
- Santa Margarita Formation
- Alluvium / Tulare Formation lacustrine sediments
- Regional clay marker beds as defined by Croft (1972)
- Crystalline basement

25S/21E-1N — CA DWR well name

03120281 — CA DOGGR well APN

0 30 — Electric log resistivity scale (ohmmeters)

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

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

By: EMC	Date: 1/9/2020	Project No.: FR18161220
		Figure **3-14b**

Date: 1/9/2020 Printed by: elizabeth.chapman
Path: N:_FR_projects\FR18s\FR18161220\gis\maps\2019\Basin_Setting_fig3-14b_xsecB-B'.mxd

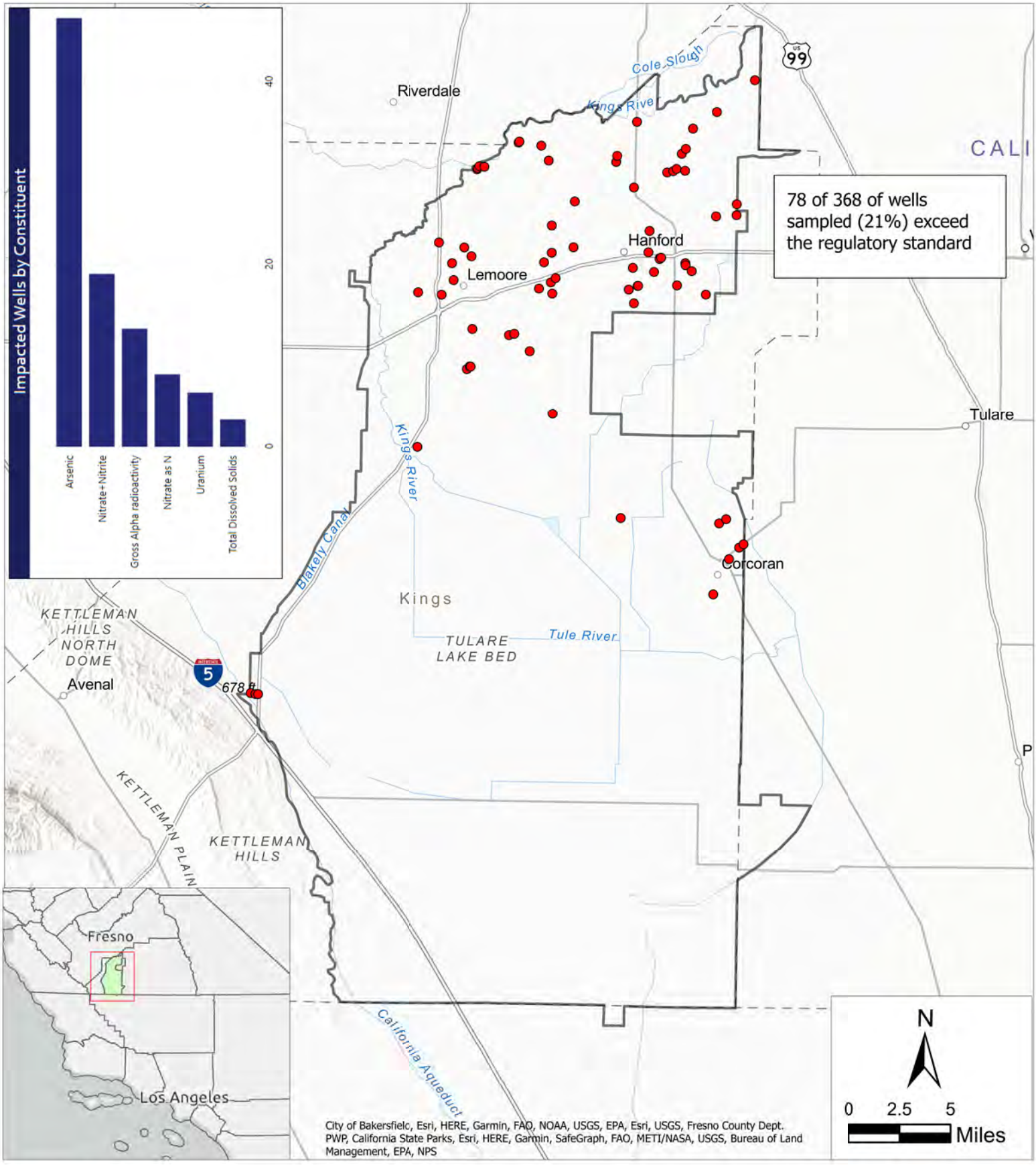


Figure 3-14

Wells with Constituent Detections Greater than the Comparable Concentration Value

Tulare Lake Subbasin

Wells with Detections Greater than the Comparable Concentration Value

Draft Staff Report
Tulare Lake Subbasin: October 2023

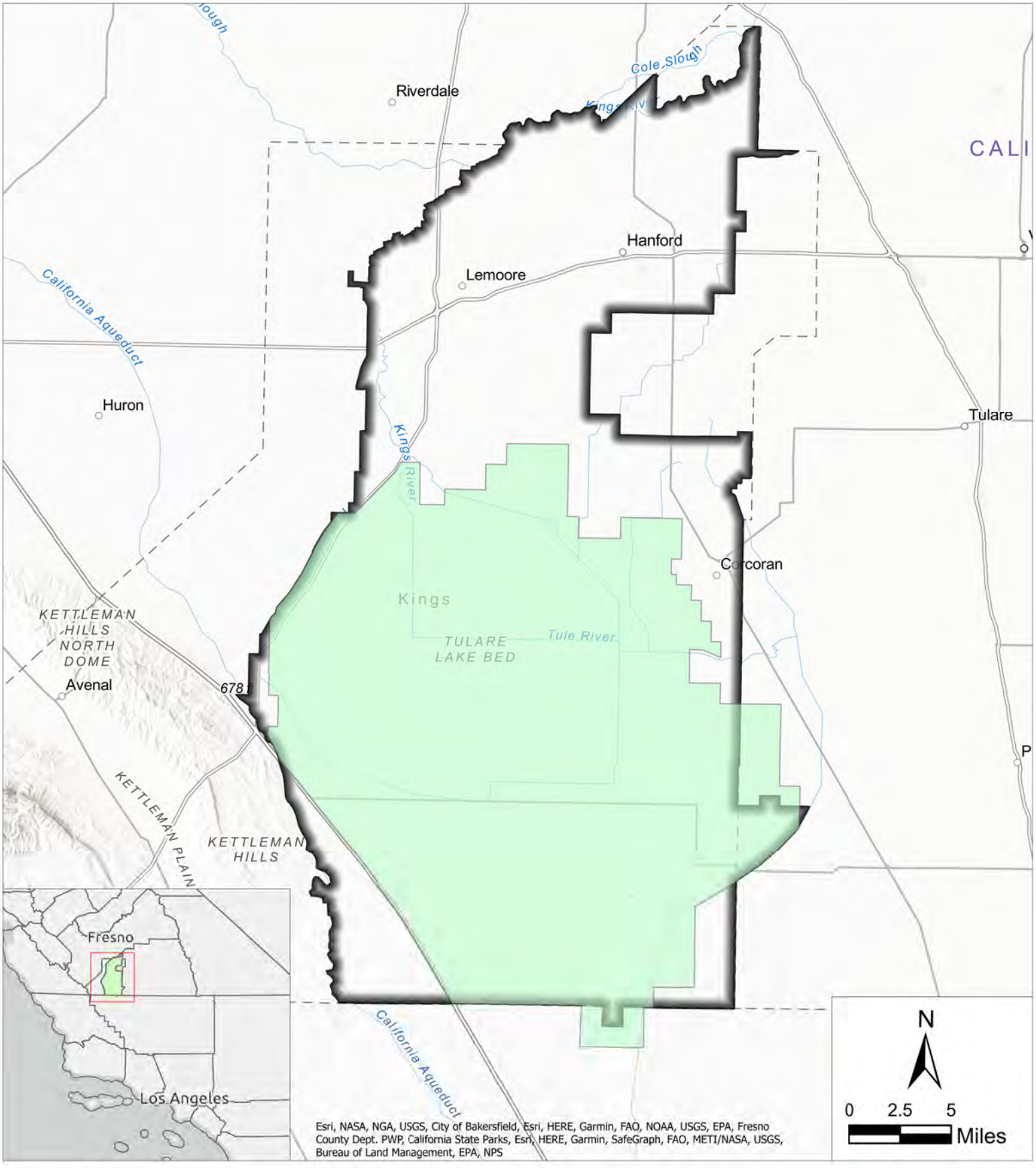


Figure 3-15

De-Designated Area in the Tulare Lake Subbasin

Tulare Lake Subbasin

De-Designated Area (Res. R5-2017-0032)
*A Vertical boundary exists above the E-Clay (Within the A and B Aquifer)

Draft Staff Report
Tulare Lake Subbasin
October 2023

California Water Boards
State Water Resources Control Board
Regional Water Quality Control Boards

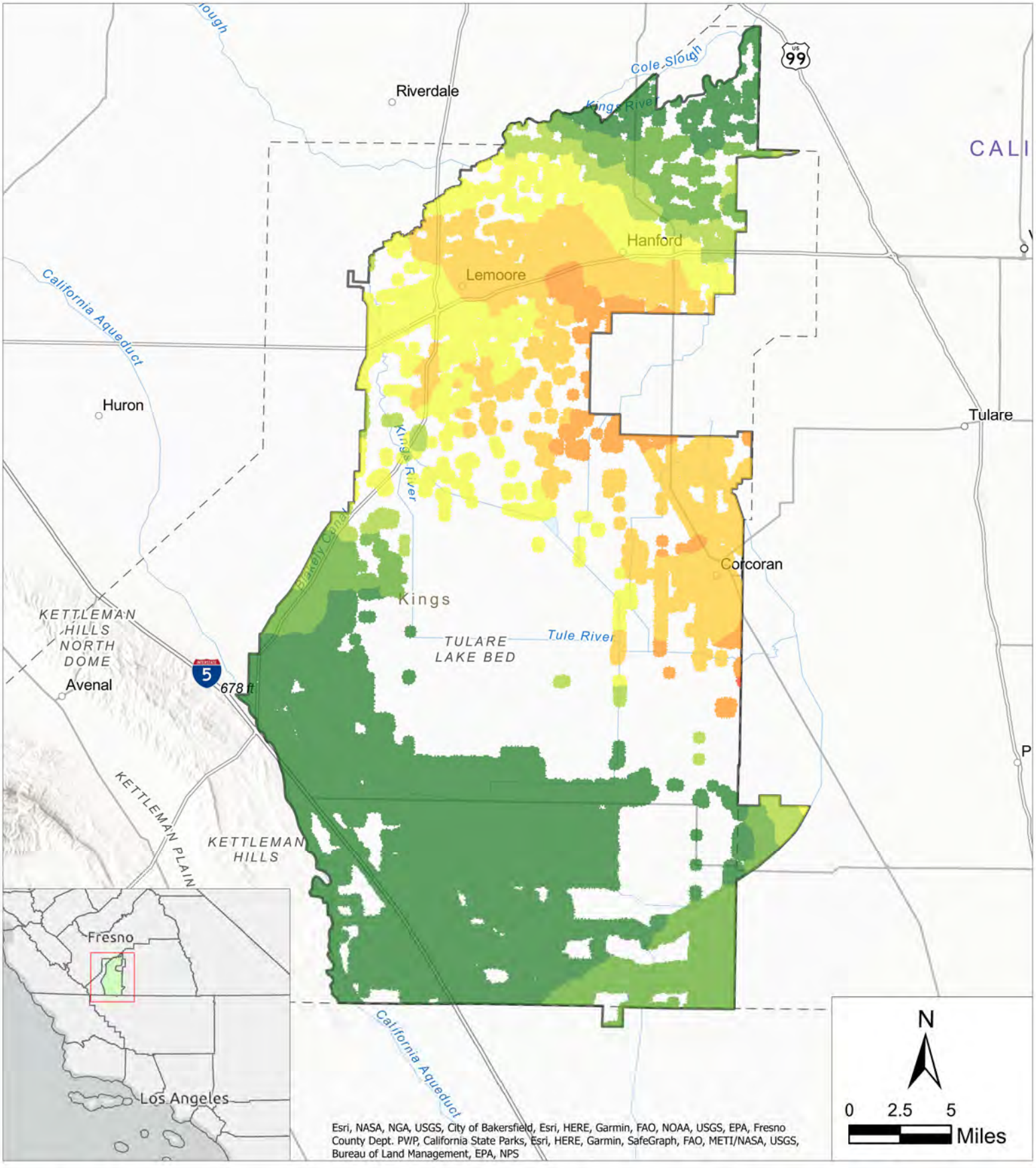


Figure 3-16

Subsidence in the Tulare Lake Subbasin (Jun '15 - Apr '23)

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October 2023

Subsidence from InSAR (ft.)

-7 to -6
-6 to -5
-5 to -4
-4 to -3
-3 to -2
-2 to -1
-1 to .25
Tulare Lake Subbasin

CALIFORNIA Water Boards
STATE WATER RESOURCES CONTROL BOARD
REGIONAL WATER QUALITY CONTROL BOARDS

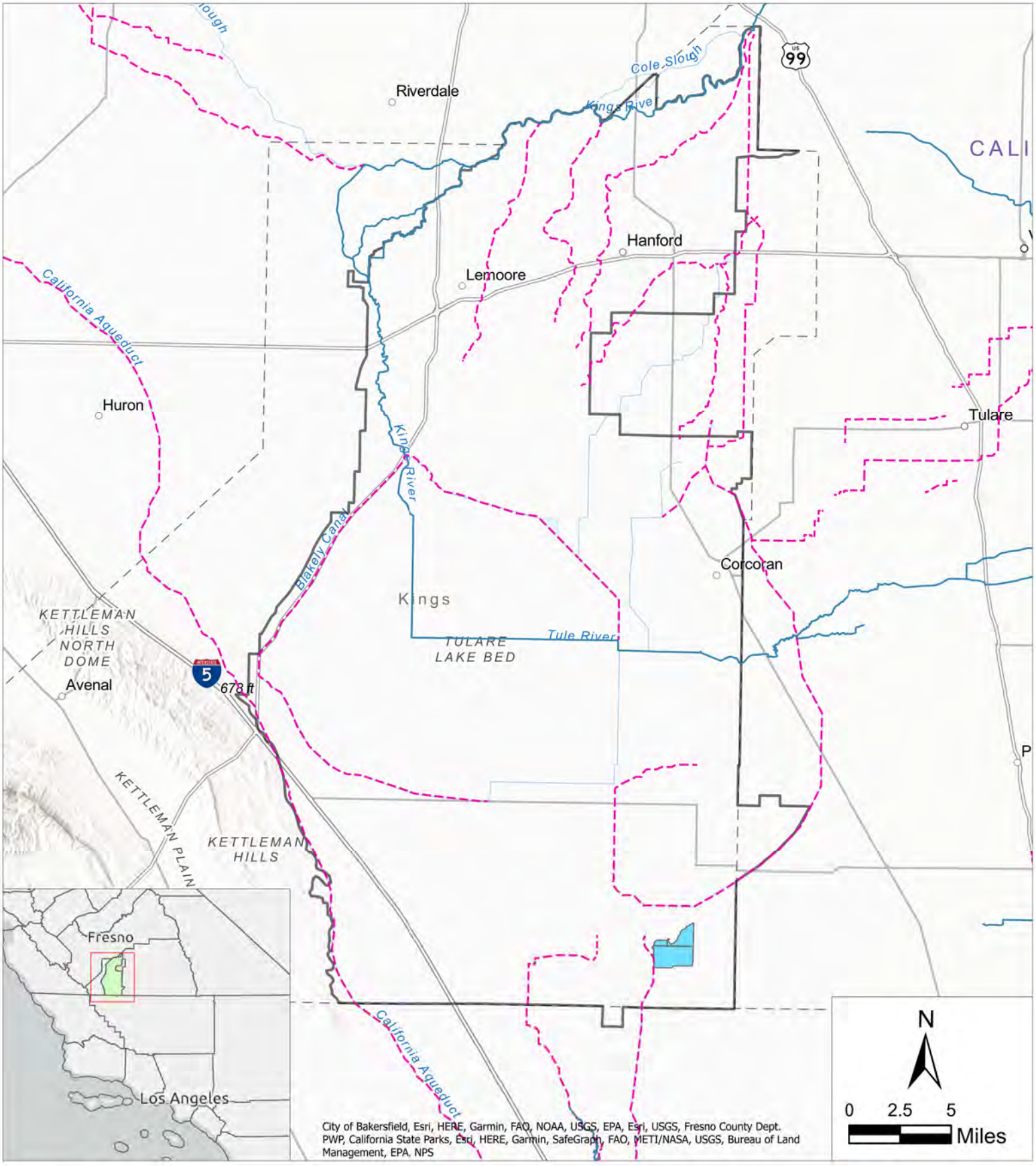

Figure 3-17

Surface Water Bodies and Canals

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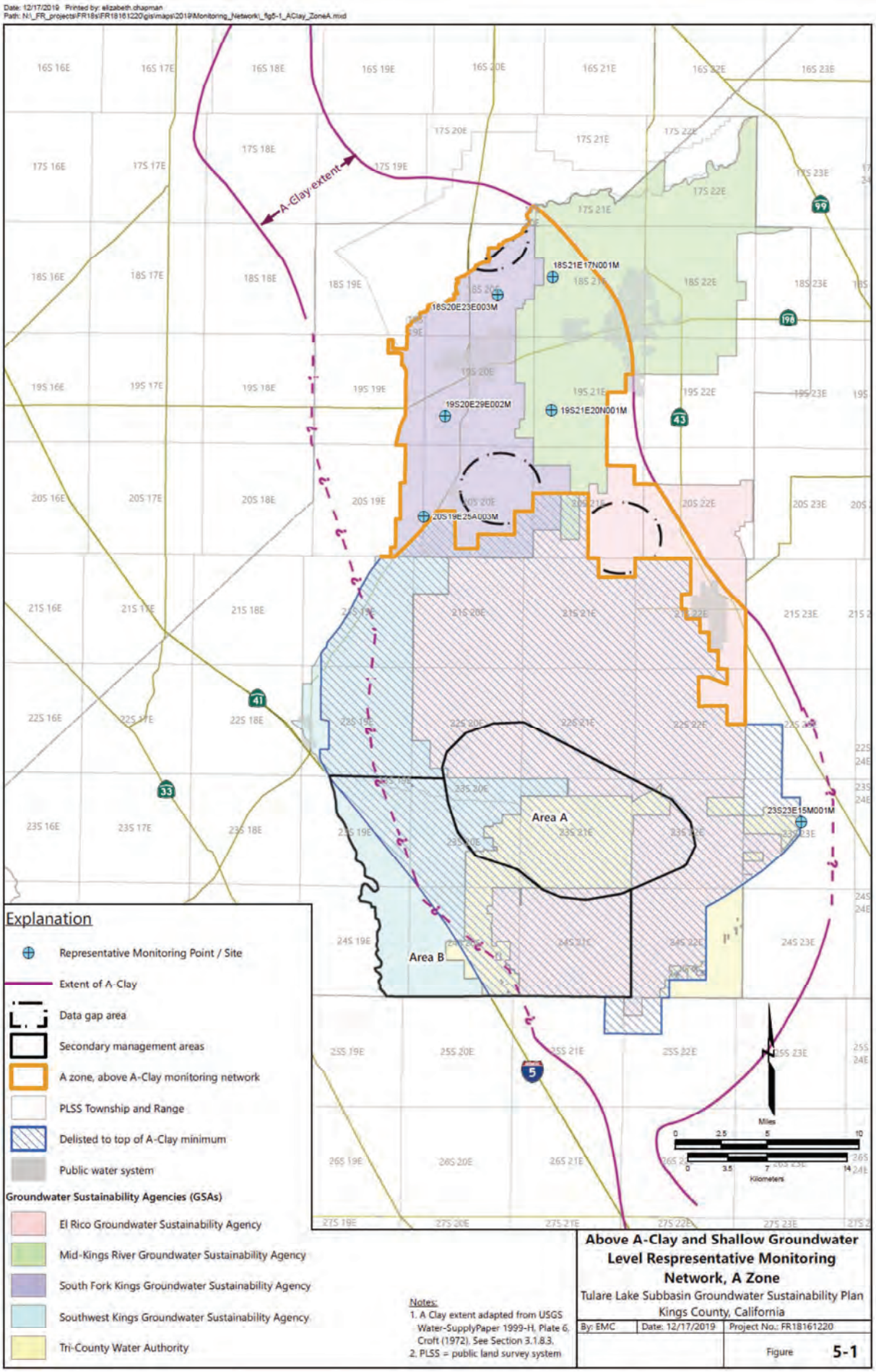
Tulare Lake Subbasin
October 2023

- Tulare Lake Subbasin
- Major Rivers
- Canals and Aqueducts
- Major Lakes and Reservoirs

California Water Boards
State Water Resources Control Board
Regional Water Quality Control Boards

Figure 4-1: Above A Clay and Shallow Groundwater Level Representative Monitoring Network, A Zone (Excerpt from the Tulare Lake Subbasin 2022 GSP)



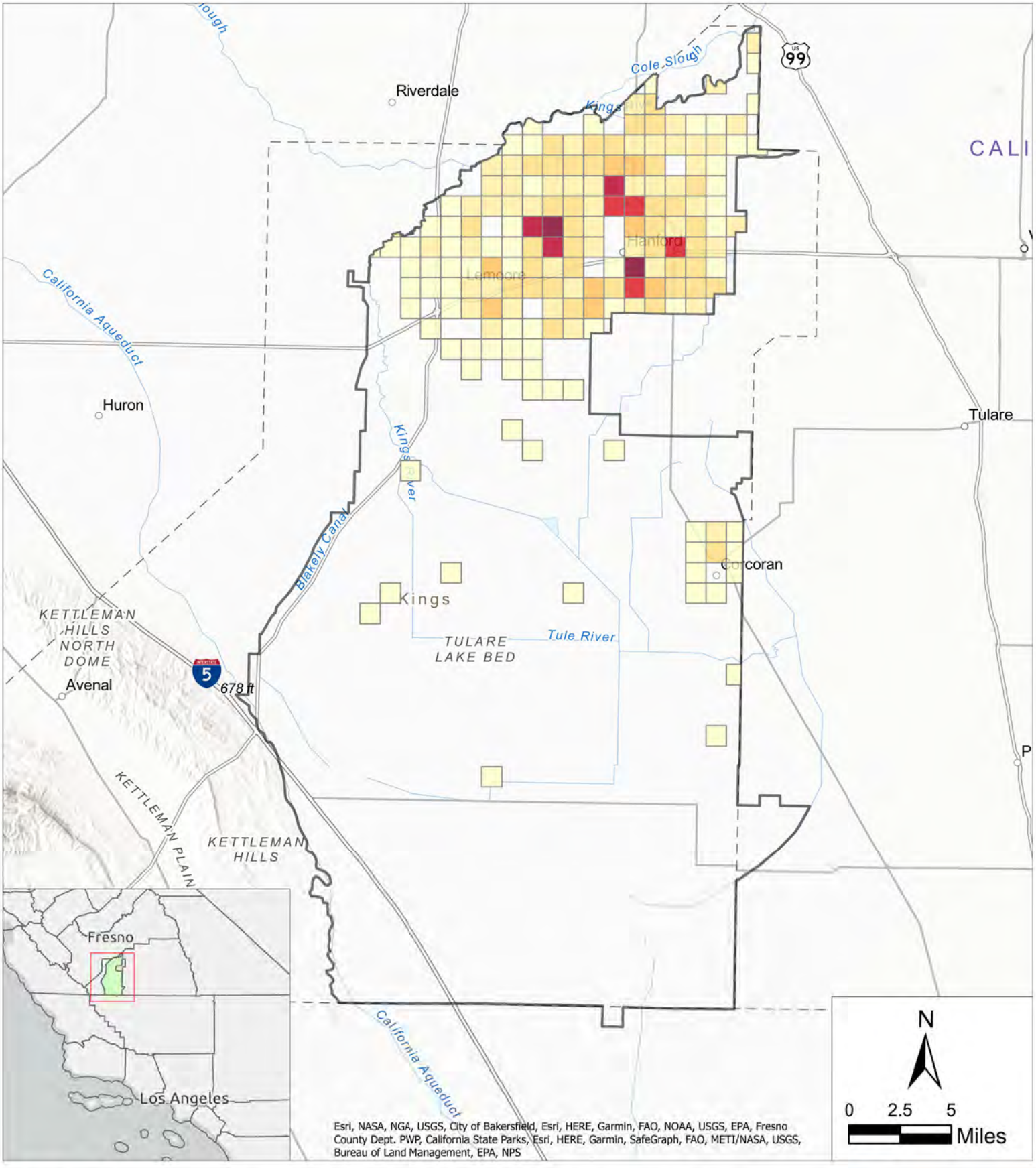


Figure 4-2

Minimum Threshold:
Dry Well Susceptibility

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Tulare Lake Subbasin
October 2023

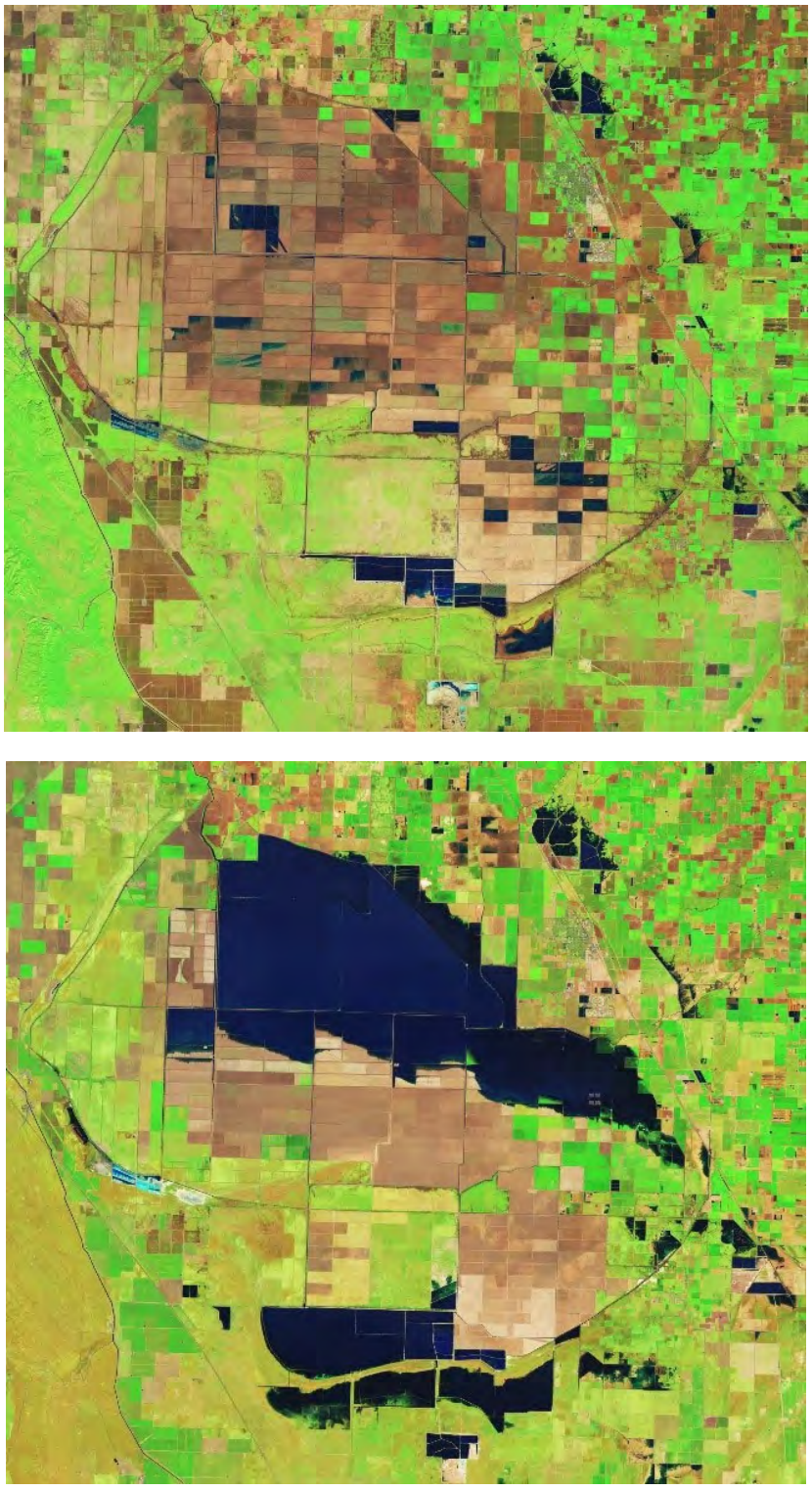
Tulare Lake Subbasin

Dry Wells per Sq. Mile at MTs

1 - 2	13 - 16
3 - 4	17 - 20
5 - 8	21 - 24
9 - 12	25 - 48

California Water Boards
State Water Resources Control Board
Regional Water Quality Control Boards

Figure 4-3: Flooding in the Tulare Lake Subbasin



Flooding in Tulare Lakebed in spring 2023. The image on the left shows the Lakebed on February 01, 2023, and the image on the right shows the Lakebed on April 30, 2023. Figures are obtained from NASA Earth Observatory.

Figure 4-4: Groundwater Quality Monitoring Network

Excerpt from the Tulare Lake Subbasin 2022 GSP