January 2022

Modesto Subbasin

Groundwater Sustainability Plan

Stanislaus and Tuolumne Rivers Groundwater Basin Association (STRGBA) Groundwater Sustainability Agency

&

County of Tuolumne Groundwater Sustainability Agency

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Stanislaus & Tuolumne Rivers Groundwater Basin Association
Groundwater Sustainability Agency
1231 11th Street | Modesto, CA 95354
Email: www.strgba.org

January 31, 2022

Department of Water Resources (DWR)
Attention: Mr. Paul Gosselin
Deputy Director, Sustainable Groundwater Management
715 P Street
Sacramento, CA 95814

Re: Submittal of the Modesto Subbasin Groundwater Sustainability Plan

Dear Mr. Gosselin:

On behalf of the Stanislaus and Tuolumne Rivers Groundwater Basin Association Groundwater Sustainability Agency (STRGBA GSA) and the County of Tuolumne GSA, I am pleased to submit the Modesto Subbasin Groundwater Sustainability Plan (GSP). The GSP was adopted by the STRGBA GSA on January 31, 2022. In compliance with §353.4(b), this transmittal letter accompanies the GSP, which is being uploaded to the DWR SGMA portal.

We look forward to working with DWR during GSP implementation. If you or your staff have any questions regarding the GSP or submittal process, please feel free to contact me at (209) 840-5525 or at ethorburn@oakdaleirrigation.com.

Sincerely,

Eric Thorburn

Eric Thorburn, P.E.,
GSP Plan Manager
STRGBA GSA

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MODESTO SUBBASIN GROUNDWATER SUSTAINABILITY PLAN (GSP)

STANISLAUS AND TUOLUMNE RIVERS GROUNDWATER BASIN ASSOCIATION (STRGBA) GROUNDWATER SUSTAINABILITY AGENCY

COUNTY OF TUOLUMNE GROUNDWATER SUSTAINABILITY AGENCY

JANUARY 2022

Prepared by:
Todd Groundwater and
Woodard & Curran

In association with
Stantec

SIGNATURE PAGE

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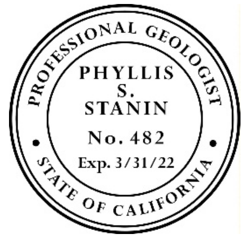
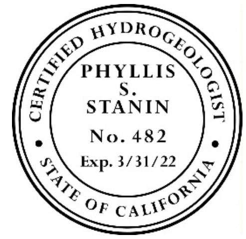
Todd Groundwater, Alameda, CA





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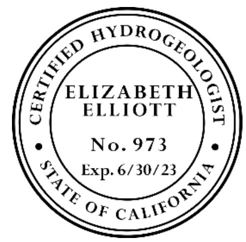

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ACKNOWLEDGMENTS

This Groundwater Sustainability Plan was prepared for the Stanislaus and Tuolumne Rivers Groundwater Basin Association Groundwater Sustainability Agency (STRGBA GSA) and the County of Tuolumne Groundwater Sustainability Agency (Tuolumne GSA) by a team of technical and outreach consultants under the guidance of a Technical Advisory Committee (TAC) that served as advisors to the GSAs. Technical consulting firms along with their general roles and responsibilities are summarized below:

Todd Groundwater led the technical team providing overall project management, hydrogeologic characterization, development of sustainable management criteria and the monitoring network, and primary responsibility for GSP development.

Woodard & Curran developed the local C2VSimTM integrated surface water-groundwater model, analyzed water budgets, and developed projects and management actions.

Stantec provided GSP outreach support including preparation of a Communications and Engagement Plan and the Notice and Communication GSP chapter, stakeholder engagement, and outreach support for public comments and GSP adoption.

In addition to GSP development activities summarized above, **Todd Groundwater** and **Ground Zero Analysis, Inc.** provided technical assistance and onsite field supervision for the installation of monitoring wells to support the GSP.

Funding for GSP development has been provided, in part, by a $1,000,000 Sustainable Groundwater Management (SGM) grant through an agreement with the State Department of Water Resources (DWR). Funding for this grant was provided by the Water Quality, Supply, and Infrastructure Improvement Act of 2014 (Proposition 1).

Additional funding to support GSP planning was provided by a second $1,000,000 SGM grant managed by DWR and funded by the California Drought, Water, Parks, Climate, Coastal Protection, and Outdoor Access for All Act of 2018 (Proposition 68). The provision of these State funds is through an amended agreement with the State of California Department of Water Resources. These funds were used for the installation of monitoring wells to support the GSP.

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Acronyms

AF	Acre-feet
AFY	Acre-feet per year
AWMP	Agricultural Water Management Plan
bgs	Below ground surface
BMP	Best Management Practices
Brown Act	Ralph M. Brown Act
BPA	Basin Plan Amendment
C2VSim	California Central Valley Groundwater-Surface Water Simulation Model
C2VSim-TM	C2VSim-Turlock/Modesto; revised regional C2VSim model for Turlock and Modesto subbasins
CALSIMETAW	California Simulation of Evapotranspiration of Applied Water
CARB	California Air Resources Board
CASGEM	California Statewide Groundwater Elevation Monitoring
CEQA	California Environmental Quality Act
CCR	California Code of Regulations
CDFW	California Department of Fish and Wildlife
cfs	Cubic feet per second
CGPF	CalSim II Generated Perturbation Factors
CPD	Comprehensive Planning District

CDPH	California Department of Public Health
CGPF	CalSim II Generated Perturbation Factors
CGPS	Continuously Operating Global Positioning System
COC	Constituent of Concern
Committee	STRGBA GSA representatives and/or alternates tasked with overseeing activities to achieve the objectives of SGMA as applicable within the Modesto Subbasin
CPD	Comprehensive Planning District
CUF	Consumptive Use Factor
CVRWQCB	Regional Water Quality Control Board, Central Valley Region
CV-SALTS	Central Valley Salinity Alternatives for Long-Term Sustainability
DAC	Disadvantaged Community
DBCP	Dibromochloropropane
DEM	Digital Elevation Map
DMMs	Demand Management Measures
DMS	Data Management System
DNAPL	Dense Non-Aqueous Phase Liquid
DO	Dissolved Oxygen
DOGGR	California Department of Oil, Gas and Geothermal Resources
DTSC	Department of Toxic Substances Control
DWR	Department of Water Resources, State of California
EDA	Economically Distressed Area
ESJ	Eastern San Joaquin
ESJWQC	East San Joaquin Water Quality Coalition
ETAW	Evapotranspiration of Applied Water
ET	Evapotranspiration
EWMP	Efficient Water Management Practices
FloodMAR	Flood Managed Aquifer Recharge
FMMP	Farmland Mapping and Monitoring Program
ft/day	Feet per day
GAMA	Groundwater Ambient Monitoring and Assessment
GDE	Groundwater dependent ecosystem

GPCD	Gallons per capita per day
gpd/ft	Gallons per day per foot
gpm	Gallons per minute
GPS	Global Positioning System
GSA	Groundwater Sustainability Agency
GSP	Groundwater Sustainability Plan
GWMP	Groundwater Management Plan
ILRP	Irrigated Lands Regulatory Program
IM	Interim Milestone
InSAR	Interferometric Synthetic Aperture Radar
IWFM	Integrated Water Flow Model
LAFCo	Local Agency Formation Commissions
LID	Low Impact Development
LUST	Leaking Underground Storage
MA	Management Area
MAF	Million Acre Feet
MCL	Maximum Contaminant Level
MG	Million Gallon
mg/L	milligrams per liter
mgd	Million Gallons per Day
MHI	Median Household Income
MID	Modesto Irrigation District
MO	Measurable Objective
MOU	Memorandum of Understanding
MRWTP	Modesto Regional Water Treatment Plant
msl	Mean Sea Level
MT	Minimum Threshold
NCCAG	Natural Communities Commonly Associated with Groundwater
NCP	Nitrate Control Program
NDE	Non-District East – areas in the eastern Subbasin outside of a water or irrigation district boundary
NED	National Elevation Dataset

NL	Notification Level
NMFS	National Marine Fisheries Service
NMP	Nitrogen Management Plan
NPDES	National Pollution Discharge Elimination System
NWIS	National Water Information System
OID	Oakdale Irrigation District
PCE	Tetrachloroethylene
pCi/L	Picocuries per Liter
PEIR	Programmatic Environmental Impact Report
PMAs	Projects and Management Actions
ppm	parts per million
PRISM	Parameter-elevation Relationships on Independent Slopes Model
QA/QC	Quality Assurance/Quality Control
RWQCB	Regional Water Quality Control Board
RWS	Rural Water System
SCADA	Supervisory Control and Data Acquisition
SCHM	Stanislaus County Hydrologic Model
SGMA	Sustainable Groundwater Management Act
SMC	Sustainable Management Criteria
SMCL	California Secondary Maximum Contaminant Level
SDAC	Severely Disadvantaged Community
SSJID	South San Joaquin Irrigation District
SSURGO	Soil Survey Geographic Database
STRGBA GSA	Stanislaus and Tuolumne Rivers Groundwater Basin Authority Groundwater Sustainability Agency
STRGBA	Stanislaus and Tuolumne Rivers Groundwater Basin Association
SWRCB	State Water Resources Control Board
T	Transmissivity
TAC	Technical Advisory Committee
TCP	1,2,3-Trichloropropane
TDS	Total Dissolved Solids
TNC	The Nature Conservancy

TRE	TRE ALTAMIRA Inc.
TRRP	Tuolumne River Regional Park
TRS	Tuolumne River System
umhos/cm	micromohs per centimeter
µg/L	Micrograms per liter
UR	Undesirable Result
USACE	United States Army Corps of Engineers
USBR	United States Bureau of Reclamation
USDA	United States Department of Agriculture
USGS	United States Geological Survey
UWMP	Urban Water Management Plan
VIC	Variable Infiltration Capacity
VOC	Volatile Organic Compound
WDR	Waste Discharge Requirements
WQO	Water Quality Objective
WRIMS	Water Resource Integrated Modeling System
WTSGSA	West Turlock Subbasin GSA
WY	Water Year

EXECUTIVE SUMMARY

This **Groundwater Sustainability Plan (GSP)** covers the entire Modesto Subbasin (5-22.02), designated a high-priority basin by the Department of Water Resources (DWR). The Modesto Subbasin covers about 245,253 acres in the northern San Joaquin Valley Groundwater Basin and is bounded by the Stanislaus River on the north, the Tuolumne River on the south, the San Joaquin River on the west and the crystalline basement rocks of the Sierra Nevada Foothills on the east. The Modesto Subbasin relies on two primary sources of water supply – surface water from the Stanislaus and Tuolumne rivers and groundwater pumped from the Subbasin.

This GSP is being prepared jointly by the **Stanislaus and Tuolumne Rivers Groundwater Basin Association (STRGBA) Groundwater Sustainability Agency (STRGBA GSA) and the County of Tuolumne Groundwater Sustainability Agency (Tuolumne GSA)**. The Subbasin GSAs are shown on Figure ES-1. The STRGBA GSA covers approximately 99.5 percent of the Modesto Subbasin, with the Tuolumne GSA covering approximately 1,000 acres that extends eastward into Tuolumne County. The Tuolumne GSA coordinated with the STRGBA GSA on the development of the Modesto Subbasin GSP through an agreement with Stanislaus County.

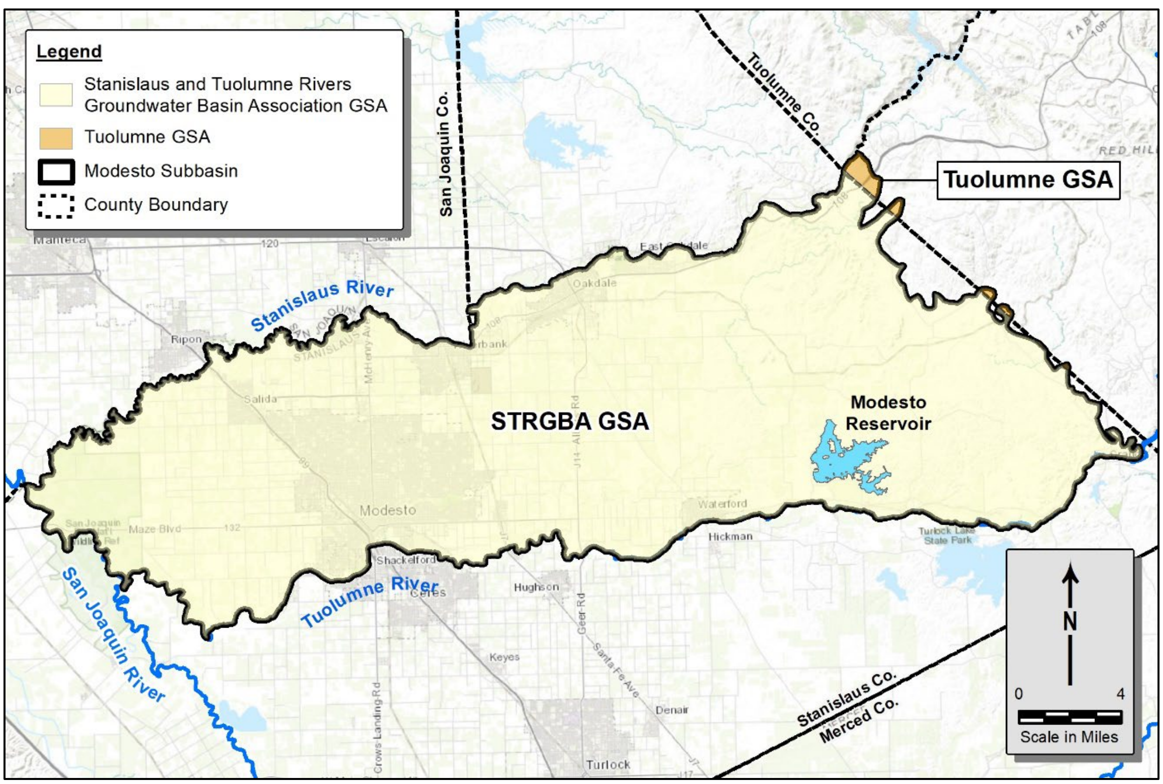

Figure ES-1 GSA Jurisdictional Boundaries

The STRGBA GSA is composed of seven member agencies that entered into a Memorandum of Understanding (MOU) to form a GSA and prepare a GSP. Member agencies of the STRGBA GSA include the City of Modesto, City of Oakdale, City of Riverbank, City of Waterford, Modesto Irrigation District

(MID), Oakdale Irrigation District (OID), and Stanislaus County. Service areas of these agencies in the Modesto Subbasin are shown on Figure ES-2. Many GSA member agencies have service areas in adjacent subbasins providing coordination for GSPs across the northern San Joaquin Valley.

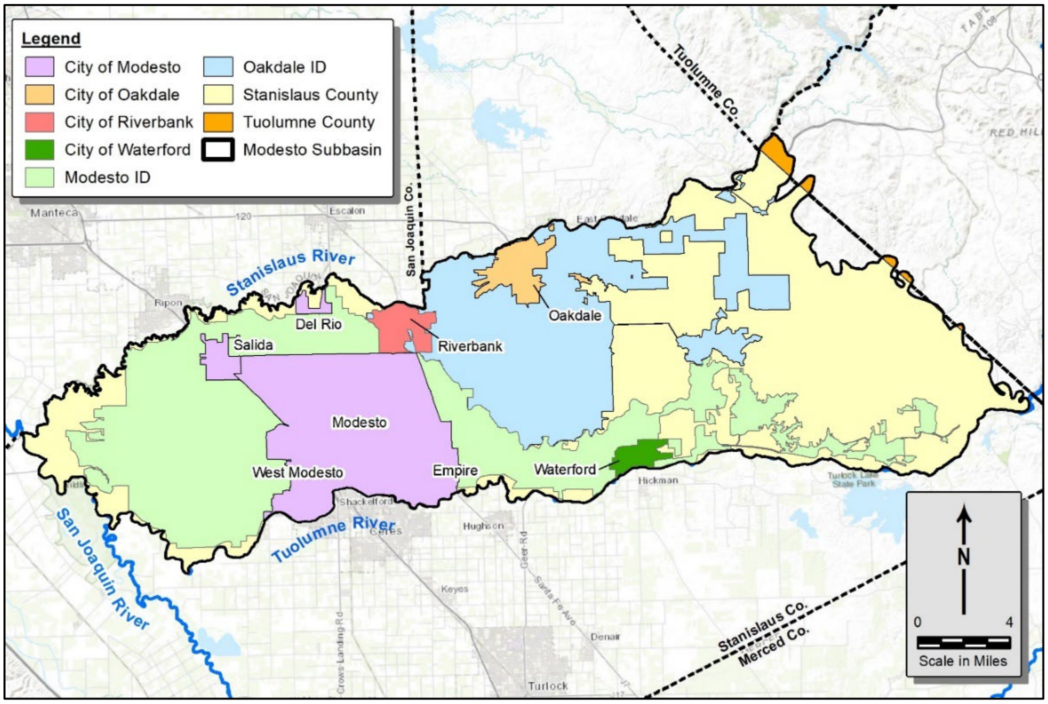

Figure ES-2 GSA Member Agency Jurisdictional Boundaries

GSA member agencies also represent stakeholders in disadvantaged areas in the Subbasin including the City of Modesto, City of Oakdale, City of Waterford, Stanislaus, and Tuolumne counties (Figure ES-3).

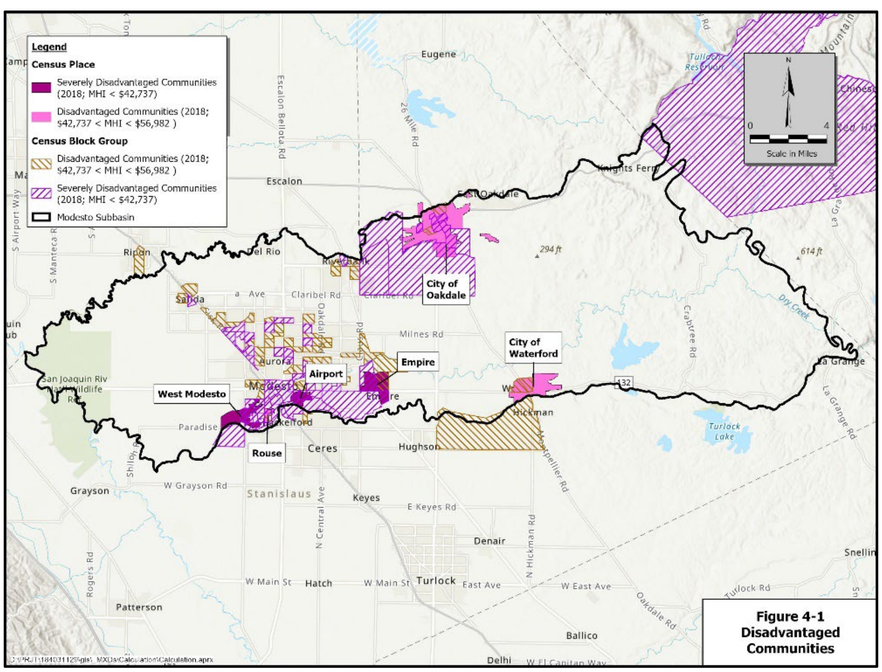

Figure ES-3 Disadvantaged Communities in the Modesto Subbasin

About 64 percent of the Modesto Subbasin is agricultural, with major crop types including almonds and other deciduous trees, corn, grains, pasture, vines, citrus and truck crops. Urban areas cover about 13 percent of the Subbasin. Remaining lands consist of non-agriculture, non-irrigated agriculture, undeveloped areas, and surface water (23 percent). Most of the undeveloped land is in the eastern portion of the Modesto Subbasin as shown by the 2017 land use map on Figure ES-4.

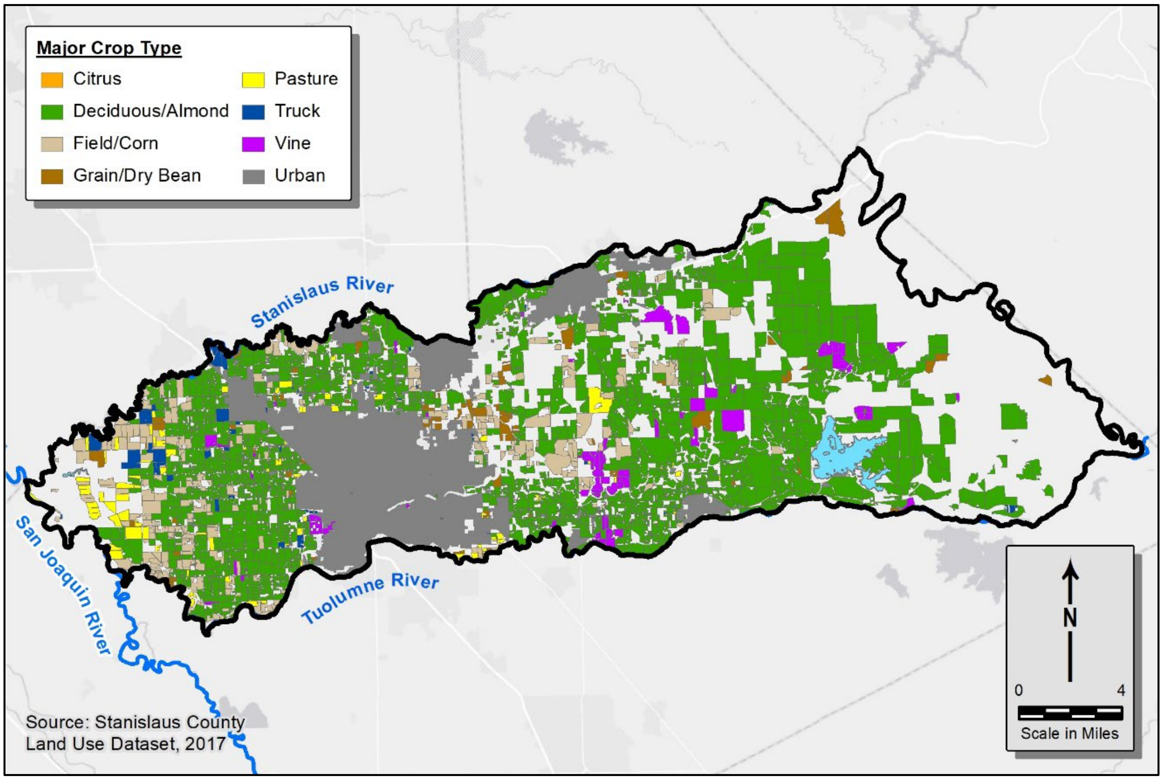

Figure ES-4 Existing Land Use

A significant expansion of irrigated agriculture occurred in the Subbasin during the GSP study period. In 1996, irrigated agriculture covered approximately 46 percent of the Subbasin (approximately 111,946 acres). Over the next 20 years, irrigated agriculture expanded by about 40 percent and by 2017 had added another 45,965 acres (total 157,911 acres, approximately 64 percent of the Subbasin). The increase in irrigated agriculture primarily resulted from a conversion of pasture to deciduous/almond orchards. Much of this expansion occurred in the eastern Subbasin – outside of Modesto ID and Oakdale ID service areas – where groundwater is the primary source of water supply.

Beneficial uses of groundwater in the Subbasin include municipal, small water system, and domestic drinking water, industrial and agricultural supply, and environmental uses. Environmental uses include interconnected surface water uses, aquatic habitat, and groundwater dependent ecosystems (GDEs).

Four separate Management Areas are delineated in the GSP to reflect areas of similar water supplies, streamlining coordination of water management and prioritizing areas for GSP project implementation. These management areas include Modesto ID Management Area, Oakdale ID Management Area, Non-District East Management Area, and Non-District West Management Area as shown on Figure ES-5.

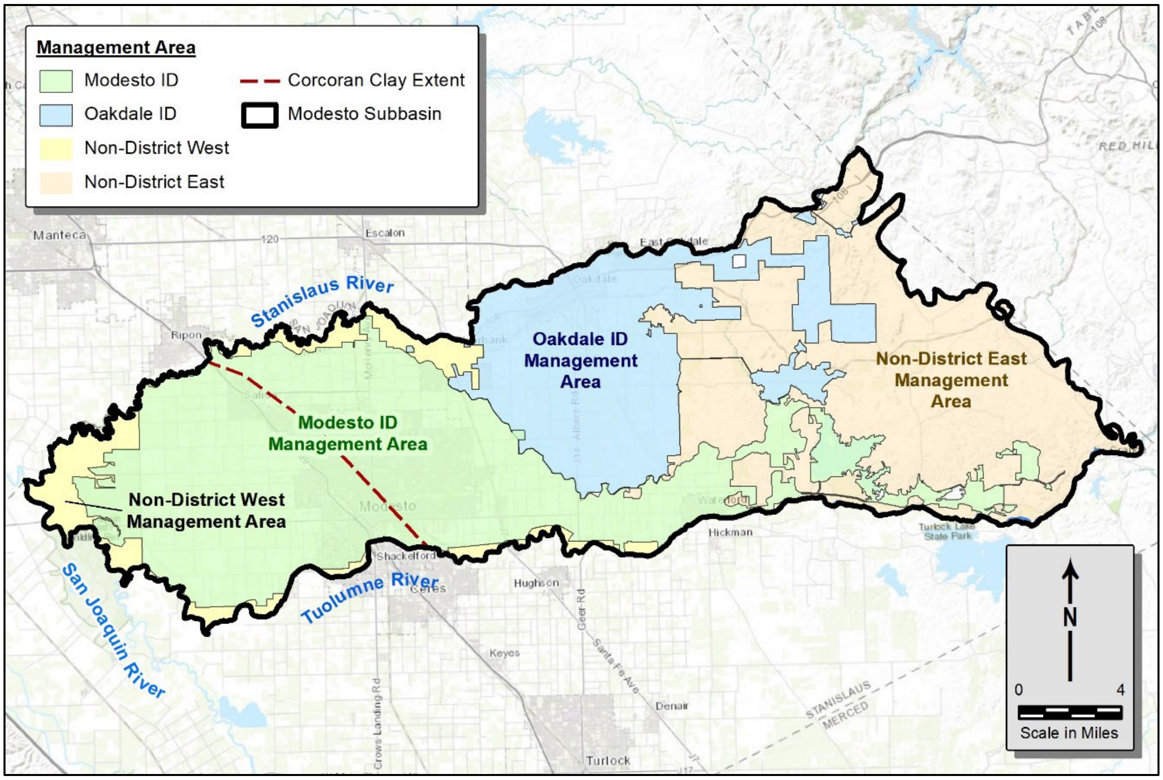

Figure ES-5 Modesto Subbasin Management Areas

The Non-District West Management Area contains lands along the western rim of the Subbasin, where both groundwater and surface water (riparian rights) are available for beneficial uses. The Non-District East Management Area includes lands outside of Modesto ID and Oakdale ID service areas in the eastern Subbasin, where groundwater is the primary water supply.

The Modesto ID and Oakdale ID Management Areas coincide with their service area boundaries, which facilitates ongoing water management responsibilities. Modesto ID manages Tuolumne River water and groundwater conjunctively, and Oakdale ID manages Stanislaus River water and groundwater conjunctively. The Non-District East and Non-District West Management Areas cover remaining lands outside of MID and OID jurisdiction, where Stanislaus County is the lead member agency.

The physical and water management setting of the Plan Area is contained in Chapter 2 and the hydrogeologic setting and groundwater conditions are provided in Chapter 3.

As summarized in the basin setting, the Modesto Subbasin extends from the Sierra Nevada foothills to the San Joaquin Valley floor, with ground surface elevations ranging from approximately 650 feet mean sea level (msl) in the eastern Subbasin to 20 feet msl along the San Joaquin River. The western Subbasin is relatively flat and the eastern Subbasin is hummocky, as the San Joaquin Valley floor transitions to the Sierra Nevada foothills. The eastern Subbasin boundary generally follows the contact of Subbasin sedimentary deposits with the crystalline basement rocks of the Sierra Nevada. This contact slopes steeply and the Modesto Subbasin is filled with sedimentary deposits that may extend thousands of feet below the surface. The base of fresh water, as mapped by USGS and incorporated into the C2VSimTM model used for this GSP, is used to define the bottom of the basin.

Three principal aquifers were defined in the Modesto Subbasin for future groundwater management under SGMA. The Corcoran Clay, underlying the western Subbasin, is the primary aquitard in the Subbasin and used to demarcate the three principal aquifers: the Western Upper Principal Aquifer is the unconfined aquifer above the Corcoran Clay, the Western Lower Principal Aquifer is the confined aquifer below the Corcoran Clay and the Eastern Principal Aquifer is the unconfined to semi-confined aquifer system east of the Corcoran Clay.

Cross sections were developed for the GSP based on geologic textures that illustrate the distribution of coarse- and fine-grained deposits within the Subbasin and the westerly dipping and thickening Corcoran Clay. Simplified cross sections were also developed to represent the geologic formations within the Subbasin. A conceptual cross section on Figure ES-6 is provided to illustrate subsurface conditions across the Subbasin including the principal aquifers, the Corcoran Clay, the westerly dipping formations, offsets caused by two interpreted geologic faults in the central and eastern Subbasin, and the base of fresh water which represents the bottom of the basin. The bottom of the basin is about -550 feet msl along the eastern Subbasin boundary, dips to about -1,000 feet msl in the center of the Subbasin and then rises to about -700 feet msl along the western Subbasin boundary.

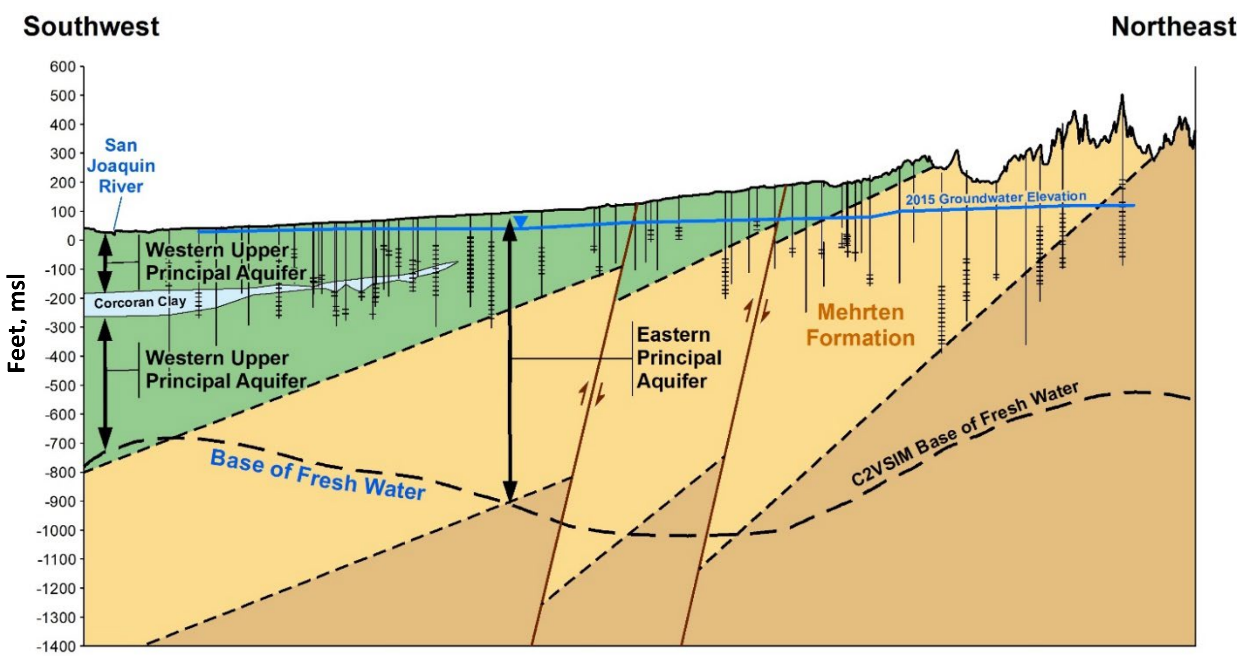

Figure ES-6 Cross Section of Hydrogeologic Framework

The cross section also depicts the shallow groundwater elevation across the Subbasin in Fall 2015 (blue line near top of section). As indicated on Figure ES-6, the water table is shallow in the western Subbasin and deepens to the east with the rising ground surface elevation. A small area of lowered water levels is indicated in the eastern Subbasin, reflecting an area with ongoing water level declines, although data in that area are sparse.

An analysis of **groundwater conditions** was conducted based on water levels measurements from approximately 450 wells during the study period. Most of the available water level measurements were from wells screened in the Western Upper Principal Aquifer and the Eastern Principal Aquifer; there are only a few wells screened solely in the Western Lower Principal Aquifer. Water level data were used to calibrate the C2VSimTM model, which was used to assist with groundwater flow analyses.

As indicated by the simulated contours in Figure ES-7, groundwater in the Subbasin flows generally to the southwest, with local water levels controlled by groundwater pumping. Water levels in the Western Upper Principal Aquifer were relatively low in the early 1990s and rose after 1995 when the City of Modesto began receiving water from the Modesto Regional Water Treatment Plant and began pumping less groundwater. Since then, water levels appear to be relatively stable, with small declines during drought (about 10 to 20 feet) followed by recovery in post-drought years. Water levels in the Eastern Principal Aquifer have declined since about 2000, with significant declines during the recent drought. In the eastern Subbasin, long-term rates of decline are up to about 2.7 feet per year, and rates of decline during drought are up to 6 feet per year. A generalized area is delineated in the eastern Subbasin on Figure ES-7 where water level declines have occurred (dashed blue line).

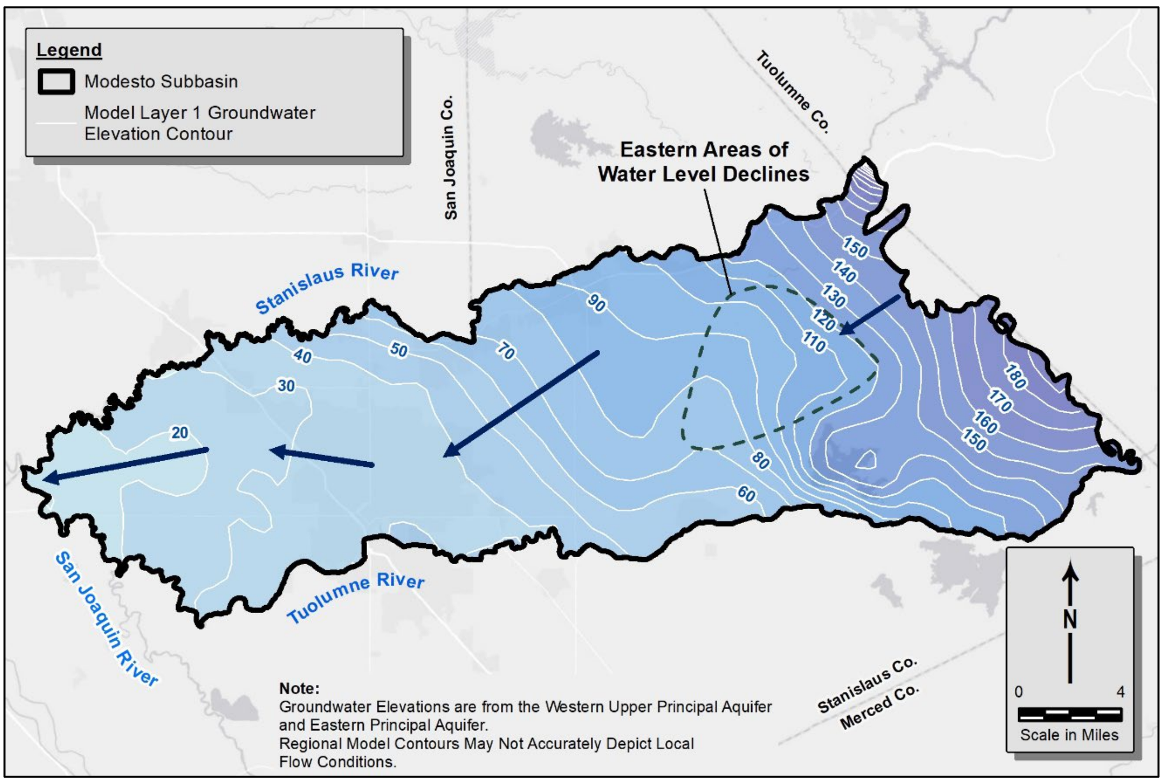

Figure ES-7 Simulated Groundwater Elevation Contours, September 2015, Unconfined Aquifer

The Tuolumne, Stanislaus and San Joaquin rivers flow for approximately 122 miles along three of the four Subbasin boundaries and are each **interconnected surface water as defined by SGMA**. The interconnectedness of the rivers was analyzed using the integrated surface water-groundwater model C2VSimTM, developed for the GSP. Model results show that the San Joaquin River along the Modesto Subbasin has been, and is projected to be, a net gaining reach. The Stanislaus and Tuolumne river systems are more dynamic, with recharge and baseflow varying along segments of the rivers both seasonally and over time. Total stream inflows into the Subbasin during the historical study period are approximately 2.5 million acre feet (MAF), more than one-half of which is from the San Joaquin River (1.3 MAF). The remaining inflows are from the Stanislaus River (0.5 MAF) and Tuolumne River (0.7 MAF). The Stanislaus and Tuolumne rivers drain into the San Joaquin River, which has an outflow from the Subbasin of approximately 2.8 MAF during the historical study period.

C2VSimTM was used to develop **water budgets** for the historical (1991 to 2015), current (2010) and projected conditions, which represents average hydrology and current land use over a 50-year future period. Inflows and outflows from the water budget analysis for these three conditions are summarized in Table ES-1.

Table ES-1 Average Annual Water Budget – Groundwater System, Modesto Subbasin (AFY)

Component	Historical Condition Water Budget	Current Condition Water Budget	Projected Condition Water Budget
Hydrologic Period	WY 1991- 2015	WY 2010	Hydrology from WY 1969 - 2018
Gain from Stream	40,000	51,000	76,000
Gain from Stanislaus River	19,000	20,000	36,000
Gain from Tuolumne River	20,000	30,000	38,000
Gain from San Joaquin River	1,000	-	2,000
Canal & Reservoir Recharge	49,000	47,000	47,000
Deep Percolation	272,000	257,000	228,000
Subsurface Inflow	80,000	79,000	77,000
Flow from the Sierra Nevada Foothills	9,000	5,000	9,000
Eastern San Joaquin Subbasin Inflows	8,000	9,000	28,000
Turlock Subbasin Inflows	30,000	34,000	33,000
Delta Mendota Subbasin Inflows	33,000	31,000	7,000
Total Inflow	**440,000**	**434,000**	**428,000**
Discharge to Stream	100,000	80,000	50,000
Discharge to Stanislaus River	35,000	27,000	12,000
Discharge to Tuolumne River	51,000	39,000	27,000
Discharge to San Joaquin River	15,000	13,000	11,000
Subsurface Outflow	73,000	63,000	75,000
Eastern San Joaquin Subbasin Outflows	6,000	5,000	35,000
Turlock Subbasin Outflows	32,000	24,000	34,000
Delta Mendota Subbasin Outflows	36,000	35,000	6,000
Groundwater Production	311,000	416,000	314,000
Agency Ag. Groundwater Production	26,000	15,000	25,000
Private Ag. Groundwater Production	222,000	345,000	229,000
Urban Groundwater Production	63,000	56,000	60,000
Total Outflow	**483,000**	**559,000**	**438,000**
Change in Groundwater Storage	(43,000)	(125,000)	(11,000)

Note: sub-categories may not sum together due to rounding error

As shown on Table ES-1, the Modesto Subbasin experienced a **decline of groundwater in storage** of 43,000 AFY during historical conditions, based on an inflow of 440,000 AFY and an outflow of 483,000 AFY. The historical water budget estimates groundwater production of 311,000 AFY; by subtracting the groundwater deficit from the groundwater production, a simplified sustainable yield of 268,000 AFY can be estimated for the historical study period. The average annual depletion in groundwater for the current and projected conditions are 125,000 AFY and 11,000 AFY, respectively.

The average decline of groundwater in storage of 11,000 AFY during projected conditions is significantly less than historical storage depletion of 43,000 AFY. However, this decline occurs at the expense of increased seepage of 86,000 AFY from primarily the Stanislaus and Tuolumne rivers in response to water level declines. This future increase in streamflow depletion as predicted by the model is considered significant and unreasonable.

Based on the basin setting and water budget analysis, **the GSP developed sustainable management criteria** to avoid undesirable results for the five sustainability indicators applicable to the Subbasin: chronic lowering of water levels, reduction of groundwater in storage, degraded water quality, inelastic land subsidence, and depletion of interconnected surface water. The seawater intrusion sustainability indicator is not applicable to the inland Modesto Subbasin. Subbasin conditions that were the primary considerations for sustainability were incorporated into the analysis. Those sustainability considerations are illustrated on Figure ES-8. DWR icons for each sustainability indicator are placed on the map to highlight the area and reference the discussion below.

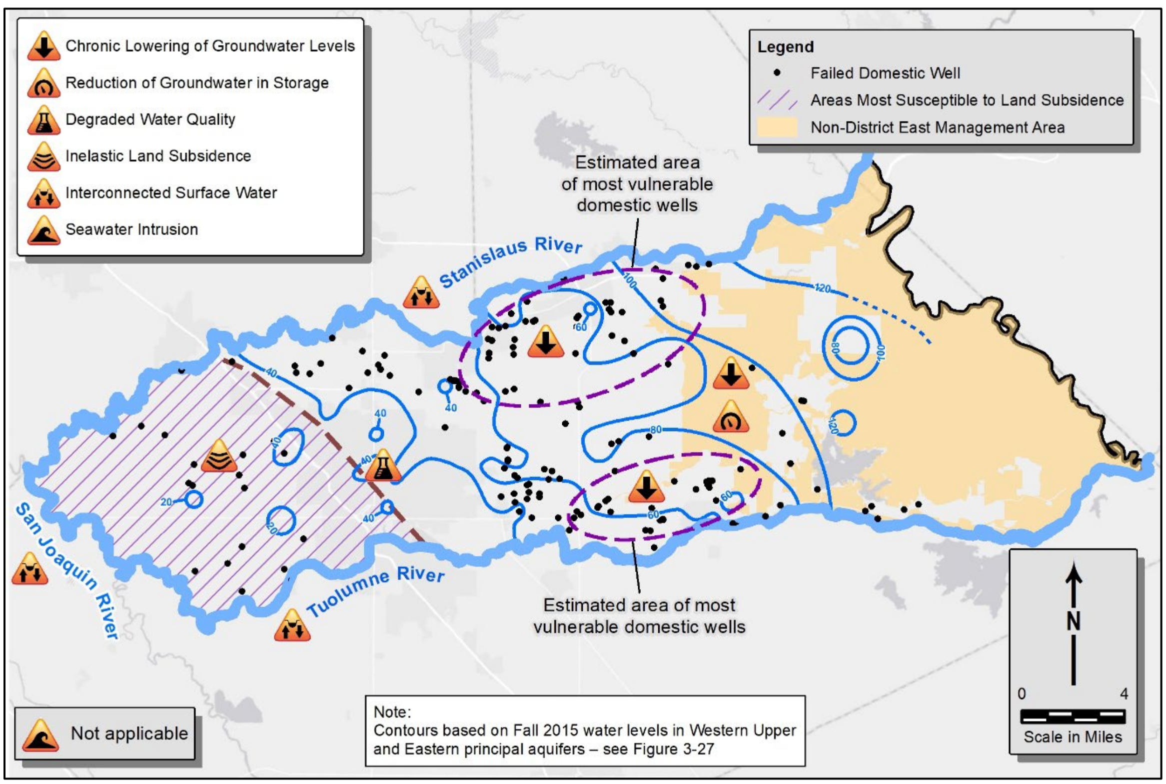

Figure ES-8 Sustainability Considerations for the Modesto Subbasin

As indicated on Figure ES-8, the Modesto Subbasin has experienced chronic lowering of water levels and reduction of groundwater in storage primarily within and around the Non-District East Management Area in the eastern Subbasin. The declining water levels in this area have propagated westward during drought conditions (2013-2017), lowering water levels in eastern Oakdale ID and in the vicinity of Waterford and causing impacts to domestic and public drinking water wells. A number of water quality constituents have been detected in excess of their maximum contaminant levels (MCLs) for drinking water, especially in the western Subbasin where most of the public drinking water wells occur. Although the City of Modesto and other public water suppliers manage their wellfield operations to control impacts to drinking water, the potential for degraded water quality in the future is also a consideration. No impacts from land subsidence have been observed in the Subbasin, but areas within the Corcoran Clay extent may be most susceptible to the potential for future land subsidence if water levels decline. Finally, the interconnected surface water sustainability indicator is a concern along the river boundaries, especially along the Tuolumne and Stanislaus rivers, where future increases in streamflow depletion are predicted unless water level declines and overdraft conditions are arrested.

To address these concerns, definitions of undesirable results, minimum thresholds, and other sustainable management criteria have been developed. A summary of the sustainable management criteria is provided in Table ES-3 below.

Table ES-3 Sustainable Management Criteria

Sustainability Indicator	Undesirable Results (narrative)	Minimum Thresholds
Chronic Lowering of Groundwater Levels	Adverse impacts to water supply wells from over-pumping	Historical low water level WY 1991–2020 (typically 2015, 1991, or current)
Reduction of GW in Storage	Long-term overdraft conditions based on projected water use and average hydrology	As above; linked to sustainable yield volume
Degraded Water Quality	Degradation caused by GSA projects/actions or management of water levels/extractions	MCLs of 7 constituents of concern
Seawater Intrusion	Not applicable	Not applicable
Inelastic Land Subsidence	Inelastic land subsidence that adversely impacts land use/infrastructure	Historical low water level WY 1991–2020 (typically 2015, 1991, or current)
Interconnected Surface Water	Adverse impacts on beneficial uses of surface water caused by groundwater extraction	Fall 2015 water levels (in coordination with adjacent subbasins)

These sustainable management criteria were tested with the C2VSimTM model to assist with evaluations of sustainability. This analysis, referred to as a **sustainable conditions analysis**, was conducted to determine how best to achieve the sustainability criteria and avoid undesirable results. The analysis modified the future projected conditions by reducing agricultural demand for groundwater users in the Non-District East Management Area (where groundwater is the primary water supply). This allowed the GSAs to optimize projects and management actions with respect to locations and quantities for future sustainable management.

Results from the sustainable conditions analysis are summarized in Table ES-2 and show that a 58 percent reduction in demand from the projected baseline levels would achieve a sustainable yield of approximately 266,000 for the Subbasin to avoid undesirable results. Since future projected groundwater production in the Subbasin is estimated at 314,000 AFY, an increase in supply or reduction in demand that adds approximately 47,000 AFY is required to bring the Subbasin into sustainability. Modeling suggests that the sustainable management criteria can be met under these conditions. It was recognized that these conditions could be met by increases in water supply as well as reductions in demand.

Table ES-2 Sustainable Yield Average Annual Water Budget, Modesto Subbasin (AFY)

Component	Projected Conditions	Sustainable Conditions
Hydrologic Period	Hydrology from WY 1969 - 2018	Hydrology from WY 1969 - 2018
Gain from Stream	76,000	58,000
Gain from Stanislaus River	36,000	27,000
Gain from Tuolumne River	38,000	29,000
Gain from San Joaquin River	2,000	1,000
Canal & Reservoir Recharge	47,000	47,000
Deep Percolation	228,000	213,000
Subsurface Inflow	77,000	83,000
Flow from the Sierra Nevada Foothills	9,000	9,000
Eastern San Joaquin Subbasin Inflows	28,000	9,000
Turlock Subbasin Inflows	33,000	29,000
Delta Mendota Subbasin Inflows	7,000	37,000
Total Inflow	**428,000**	**401,000**
Discharge to Stream	50,000	71,000
Discharge to Stanislaus River	12,000	18,000
Discharge to Tuolumne River	27,000	40,000
Discharge to San Joaquin River	11,000	14,000
Subsurface Outflow	75,000	63,000
Eastern San Joaquin Subbasin Outflows	35,000	4,000
Turlock Subbasin Outflows	34,000	30,000
Delta Mendota Subbasin Outflows	6,000	30,000
Groundwater Production	314,000	267,000
Agency Ag. Groundwater Production	25,000	25,000
Private Ag. Groundwater Production	229,000	181,000
Urban Groundwater Production	60,000	60,000
Total Outflow	**438,000**	**401,000**
Change in Groundwater Storage	(11,000)	-

Note: sub-categories may not sum together due to rounding error

Groundwater level monitoring networks were developed to track and document the achievement of sustainable management criteria for the chronic lowering of groundwater levels, reduction of groundwater in storage, land subsidence, and depletions of interconnected surface water. The monitoring networks are composed of representative monitoring wells that will be used to monitor sustainable management criteria for these sustainability indicators during the GSP implementation and planning horizon. Groundwater elevations were selected for a minimum threshold and measurable objective for each well in the monitoring network. The monitoring networks consist of CASGEM wells, City of Modesto monitoring wells, USGS monitoring wells and monitoring wells constructed in 2021 with Proposition 68 grant funding from DWR. The monitoring network for degradation of water quality will be based on wells monitored by others and available at the State Water Resources Control Board (SWRCB) GeoTracker website.

The water level monitoring network is shown on Figure ES-9. (The water quality monitoring network being implemented by others is shown on Figure 7-4).

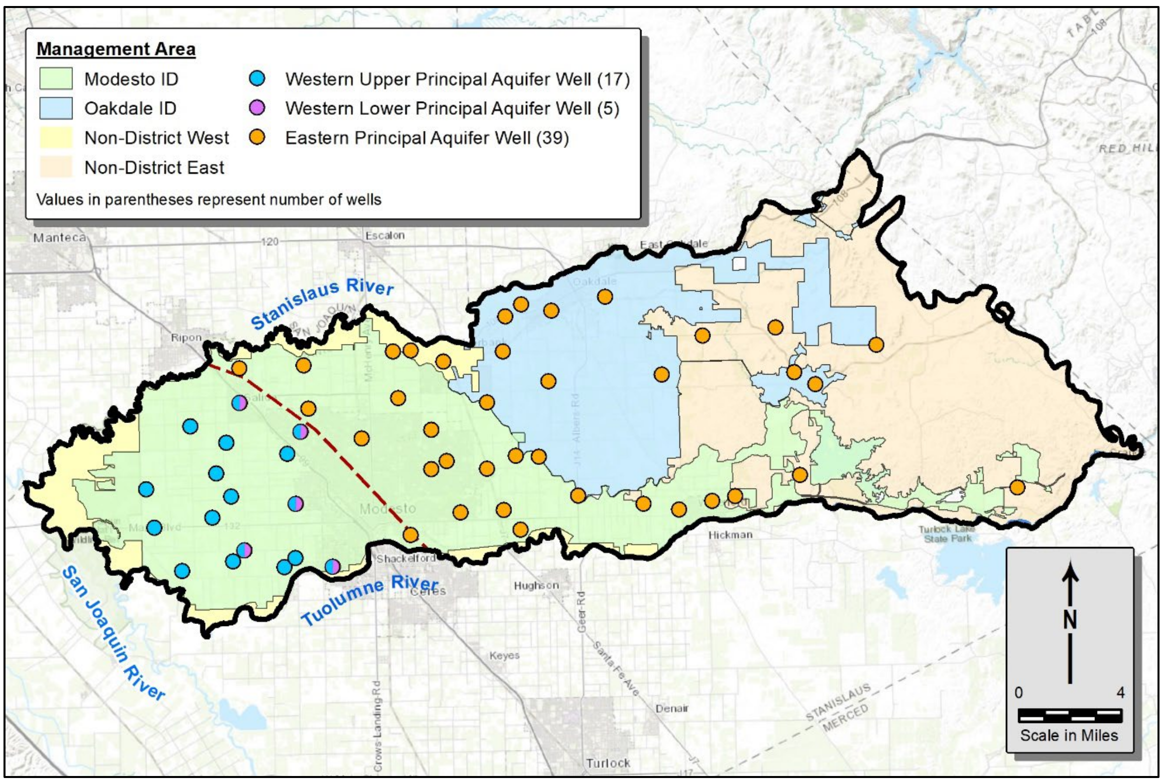

Figure ES-9 Summary of Monitoring Network

To achieve the sustainability goals for the Modesto Subbasin by 2042, and to avoid undesirable results over the remainder of a 50-year planning horizon, multiple **Projects and Management Actions** were identified by the GSAs. Three groups of projects were identified: Group 1 projects are in place and will continue to be implemented, Group 2 projects are still in the planning stages but are generally implementable, and Group 3 projects are being considered and are subject to feasibility. A summary of projects and management actions is provided in Table ES-4.

Table ES-4 GSP Projects for the Modesto Subbasin

Number	Proponent(s)	Project Name	Primary Mechanism(s)	Partner(s)	Group
1	City of Modesto	Growth Realization of Surface Water Treatment Plant Phase II	In-lieu Groundwater Recharge	N/A	1
2	City of Modesto	Advanced Metering Infrastructure Project (AMI)	Conservation	N/A	1
3	City of Modesto	Storm Drain Cross Connection Removal Project	Stormwater Capture	N/A	2
4	City of Waterford	Waterford/Hickman Surface Water Pump Station and Storage Tank	In-lieu Groundwater Recharge	City of Modesto, MID	2
5	Non-District East Areas	Modesto Irrigation District In-lieu and Direct Recharge Project	Direct or In-lieu Groundwater Recharge	Modesto ID	2
6	NDE Areas	Oakdale Irrigation District In-lieu and Direct Recharge Project	Direct or In-lieu Groundwater Recharge	OID	2
7	NDE Areas	Tuolumne River Flood Mitigation and Direct Recharge Project	Direct Groundwater Recharge	Modesto ID	2
8	NDE Areas	Dry Creek Flood Mitigation and Direct Recharge Project	Direct Groundwater Recharge	Stanislaus County	2
9	NDE Areas	Stanislaus River Flood Mitigation and Direct Recharge Project	Direct Groundwater Recharge	Stanislaus County	3
10	City of Modesto	Detention Basin Standards Specifications Update	Groundwater Recharge	N/A	3
11	NDE Areas	Recharge Ponds	Groundwater Recharge	N/A	3
12	City of Oakdale	OID Irrigation and Recharge to Benefit City of Oakdale	Direct or In-lieu Groundwater Recharge	N/A	3
13	MID	MID FloodMAR Projects	Direct Groundwater Recharge	N/A	3

Projects were coupled with additional management actions that are being developed for implementation with an adaptive management approach. Management actions generally refer to non-structural programs or policies designed to incentivize actions and strategies to support the sustainability of the groundwater Subbasin and include strategies for water conservation and demand reduction.

Table ES-65 List of Management Actions

Category	Number	Proponent[2]	Management Action	Primary Mechanism(s)[1]
Demand Reduction Strategies	1	Modesto Subbasin GSAs	Voluntary Conservation and/or Land Fallowing	Conservation/ Land Fallowing
	2	Modesto Subbasin GSAs	Conservation Practices	Conservation
Water Accounting framework	3	Modesto Subbasin GSAs	Groundwater Extraction and Surface Water Reporting Program	Pumping Reduction
	4	Modesto Subbasin GSAs	Groundwater Allocation and Pumping Management Program	Pumping Reduction
	5	Modesto Subbasin GSAs	Groundwater Extraction Fee	Pumping Reduction
	6	Modesto Subbasin GSAs	Groundwater Pumping Credit Market and Trading Program	Pumping Reduction

Group 1 and 2 projects were analyzed using the C2VSimTM model under the 50-year projected conditions. Two scenarios were simulated, Scenario 1 includes three urban and municipal projects and Scenario 2 adds agriculturally based in-lieu and direct recharge projects to Scenario 1. Scenario 1 projects are expected to reduce net groundwater pumping in the Subbasin by 13,700 AFY and will reduce the annual groundwater storage deficit by 1,500 AFY, from 11,000 AFY under Baseline conditions to 9,500 AFY under Scenario 1. Scenario 2 projects are expected to reduce groundwater pumping by 44,000 AFY and will reduce the annual groundwater storage deficit by 12,400 AFY, resulting in a net positive change in storage of 1,400 AFY.

Modeling analyses demonstrated the ability of Groups 1 and 2 GSP projects to meet the sustainable management criteria developed in Chapter 6 of the GSP. Modeling of representative monitoring sites indicate that undesirable results can be avoided over the 50-year implementation and planning horizon. **Results indicate that through regional cooperation and the commitment of project beneficiaries, groundwater sustainability can be achieved in the Modesto Subbasin without demand management**. Nonetheless, demand management is provided in the GSP as a backstop to avoid undesirable results in the future.

GSP implementation will begin immediately after the GSP is submitted in January 2022. Annual reports will be submitted by April 1 of each year following GSP adoption. Every five years, GSPs will be evaluated with respect to their progress in meeting sustainability goals. **Additional implementation activities are described in Chapter 9**.

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1. ADMINISTRATIVE INFORMATION

1.1. AGENCY INFORMATION

This Groundwater Sustainability Plan (GSP) covers the Modesto Subbasin (5-22.02) located in the northern San Joaquin Valley Groundwater Basin. The GSP is being prepared jointly by the Stanislaus and Tuolumne Rivers Groundwater Basin Association Groundwater Sustainability Agency (STRGBA GSA) and the County of Tuolumne Groundwater Sustainability Agency (Tuolumne GSA). Collectively, these two GSAs have been deemed exclusive GSAs and cover the entire Subbasin. The Modesto Subbasin boundaries and service areas of the STRGBA GSA and Tuolumne GSA are shown on **Figure 1-1**.

Service area boundaries for the two GSAs are aligned with Subbasin boundaries and are defined on the north and south by the Stanislaus River and the Tuolumne River, respectively. The STRGBA GSA is bounded on the west by the San Joaquin River. The eastern STRGBA GSA boundary is defined by the boundary between Stanislaus County and Tuolumne County, and also represents the western boundary of the Tuolumne GSA. The STRGBA GSA covers approximately 99.5 percent of the Modesto Subbasin. The Tuolumne GSA is composed of five areas covering approximately 1,000 acres (approximately 0.5 percent) of the Modesto Subbasin that extend into Tuolumne County (**Figure 1-1**).

The Modesto Subbasin has been designated as a High-Priority basin by the Department of Water Resources (DWR) with implications under the Sustainable Groundwater Management Act (SGMA). In compliance with SGMA deadlines, the Modesto Subbasin GSP is being completed, adopted, and submitted to DWR by January 31, 2022.

1.1.1. Stanislaus and Tuolumne Rivers Groundwater Basin Association Groundwater Sustainability Agency (STRGBA GSA)

In April 1994, six agencies in the Modesto Groundwater Subbasin executed a Memorandum of Understanding (MOU) to establish the Stanislaus and Tuolumne Rivers Groundwater Basin Association (STRGBA). In 2015, the MOU was revised to include the City of Waterford. STRGBA has historically been the primary entity responsible for coordinating, planning, and management of the shared groundwater resources in the Modesto Subbasin.

The STRGBA agencies entered into an MOU to form the STRGBA groundwater sustainability agency (GSA) and filed a Notice of Intent with DWR on February 16, 2017. Currently, STRGBA GSA is located at 1231 11th Street, Modesto, CA 95354, in the offices of Modesto Irrigation District; the GSA maintains an informational website at www.strgba.org.

The STRGBA GSA includes seven local agencies with service areas in the Subbasin:

- City of Modesto
- City of Oakdale
- City of Riverbank
- City of Waterford
- Modesto Irrigation District (MID)
- Oakdale Irrigation District (OID)
- Stanislaus County

Some STRGBA GSA members also serve areas outside of the Subbasin. Oakdale Irrigation District overlies portions of the Eastern San Joaquin Subbasin and participates in that subbasin GSP as the Oakdale Irrigation District Eastern San Joaquin Subbasin GSA. The City of Modesto provides water to communities within the Turlock Subbasin and participates as a member agency of the West Turlock Subbasin GSA (WTSGSA). The City of Waterford also has service areas in both the Modesto and Turlock subbasins and is an Associate Member of the WTSGSA. Stanislaus County spans portions of three subbasins in addition to the Modesto Subbasin including the Eastern San Joaquin Subbasin, the Turlock Subbasin, and the Delta-Mendota Subbasin; as such, the County is a member of multiple GSAs and participates in multiple GSPs. These cross-basin relationships provide a cooperative and coordinated approach to GSP development in the northern San Joaquin Valley.

Representatives of the STRGBA GSA member agencies have formed a Technical Advisory Committee (TAC) to assist the GSAs in preparation of the GSP. All TAC meetings are public meetings held in accordance with the Ralph M. Brown Act (California Government Code sections 54950 et seq.).

1.1.2. County of Tuolumne Groundwater Sustainability Agency

The Tuolumne GSA was formed on May 16, 2017, by adoption of County of Tuolumne Resolution No. 63-17 for the approximately 1,000-acre portion of the Modesto Subbasin that is within Tuolumne County. The Tuolumne GSA is cooperating with the STRGBA GSA on the development of one GSP for the entire Modesto Subbasin through a cooperation agreement with Stanislaus County (**Appendix A**). The Tuolumne GSA address is at the County of Tuolumne County Administrator's Office on 2 South Green Street, Sonora, CA 95370 (**Appendix A**).

1.2. ORGANIZATION AND MANAGEMENT STRUCTURE FOR PLAN DEVELOPMENT

On March 14, 2018, the STRGBA GSA notified DWR of their intent to prepare a GSP for the Modesto Subbasin (**Appendix A**). As noted above, the GSP is being developed by the STRGBA GSA and the Tuolumne GSA (through a Stanislaus County agreement). A TAC planning group was formed to provide oversight and direction to the technical consulting team assisting with plan preparation. Periodic public TAC meetings, typically held the second Tuesday of each month, allowed ongoing coordination with the TAC, local stakeholders, and the public.

TAC meetings also provided an opportunity to coordinate with SGMA activities in adjacent subbasins. Two of the adjacent subbasins, Delta-Mendota Subbasin and Eastern San Joaquin Subbasin, are designated as Critically-Overdrafted Basins and, as such, were required to submit GSPs to DWR in 2020. Accordingly, those two subbasins are progressing with GSP implementation. The Turlock Subbasin to the south is designated a High-Priority Basin, the same designation as the Modesto Subbasin and is on a similar schedule for plan development. The two subbasins coordinated the GSP technical approach and shared in the development of one integrated water resources model that covers both subbasins.

The City of Modesto, a STRGBA GSA member agency, has taken the lead on securing grant funding to cover a portion of the GSP preparation costs and is the administrator for a DWR grant under the Sustainable Groundwater Management (SGM) Planning Grant Program funded by Proposition 1. The Grant Agreement was executed on August 14, 2018. That grant was supplemented with a second SGM Planning Grant for the installation of monitoring wells in the Subbasin. That grant was funded by Proposition 68; the SGM grant agreement was amended to include the Proposition 68 grant on May 12, 2020.

Although GSP development occurred through a joint GSA effort, a Plan Manager has been authorized as the point of contact between the GSAs and DWR as required by SGMA. The Plan Manager is the authorized representative appointed through a coordination agreement or other agreement, who has been delegated authority for submitting the Plan to DWR. Contact information for the Plan Manager is provided in the transmittal letter and repeated below:

Eric C. Thorburn, P.E.
Water Operations Manager/District Engineer
Oakdale Irrigation District
1205 East F Street, Oakdale, CA 95361
(209) 840-5525
ethorburn@oakdaleirrigation.com

Following a public hearing, the STRGBA GSA adopted the GSP on January 31, 2022; the Resolution of Adoption is included in **Appendix B**. Prior to that date, member agencies also adopted the GSP separately in support of the process; see documentation in **Appendix B**.

1.3. IMPLEMENTATION OF THE GSP

The implementation of the GSP will be shared by the STRGBA GSA and the Tuolumne GSA, continuing their ongoing coordination developed during GSP preparation. The STRGBA GSA TAC will continue to serve as the advisory group for the GSA. Stakeholder outreach and communication of these activities will continue throughout the GSP implementation period.

The GSAs will oversee the development and implementation of GSP projects and management actions described in **Chapter 8**. The implementation plan for these projects and management actions, including schedule and funding sources, is described in **Chapter 9**.

1.3.1. GSP Implementation Costs

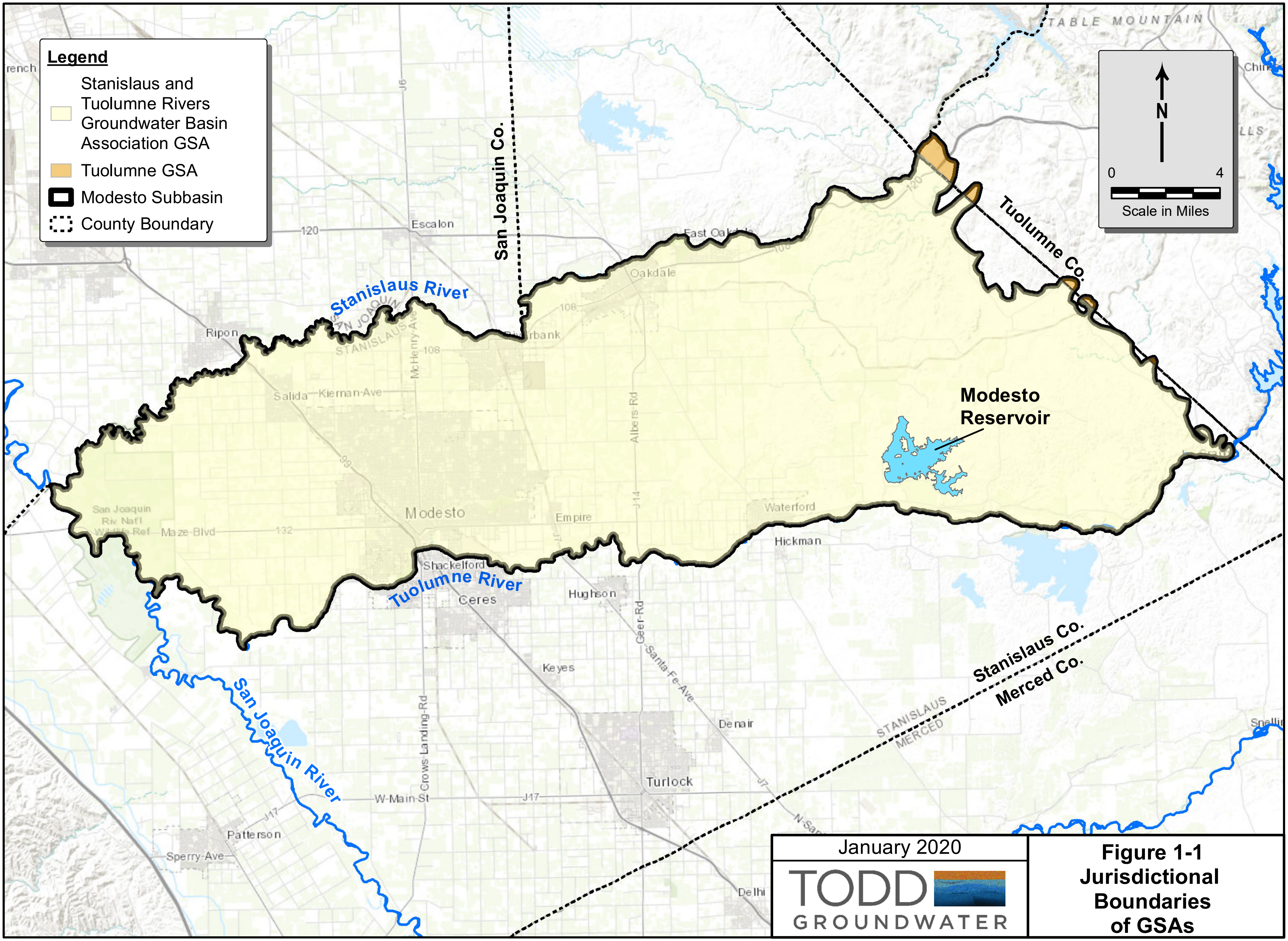
The operation of the Modesto Subbasin GSAs and GSP implementation will incur costs, which will require funding. There are five primary activities that will incur costs: implementing the GSP, implementing GSP-related projects and management actions, operation and administration of the GSAs, developing annual reports, and developing five-year evaluation reports. The total estimated annual budget for GSA operation and GSP implementation is anticipated to be between $250,000 and $350,000. Given the projects being proposed are anticipated to be funded by grants and/or the project proponent(s), this total estimated annual GSA budget figure excludes project related costs. However, it does provide flexibility for funding grant application preparation expenses for, or direct GSA funding of, more immediate development of management actions such that implementation of those actions could more readily occur if and when the need arose (i.e., fewer than anticipated projects were implemented, actual groundwater level decline exceeds projections, etc.). The total estimated cost of the proposed projects is approximately between $237,610,600 and $268,440,000. Costs for several additional projects and the management actions will be developed in the future contingent upon the need for implementation. The details of these estimated GSP implementation costs are provided **in Table 9-1**.

1.3.2. Financial Plan for Implementing the GSP

Costs associated with GSP implementation and operation of the GSAs could include GSA administration and legal support, stakeholder/Board engagement, outreach, GSP implementation program management, and monitoring. Operation of the GSAs is fully funded through contributions from GSA member agencies. Although ongoing operation of the GSAs is anticipated to include contributions from its member agencies, which are ultimately funded through customer fees or other public funds, additional funding may be required to implement the GSP. Funding through grants or loans has varying levels of certainty and as such, the GSAs may develop a financing plan that could include one or more of the following financing approaches: pumping fees, assessments based on irrigated acreage, or a combination of fees and assessments.

The STRGBA GSA member agencies intend to pursue grants and loans to help pay for project costs to the extent possible. If grants or loans are secured for project implementation, potential pumping fees and assessments may be adjusted to align with operating costs of the GSAs and ongoing GSP implementation activities. A potential hurdle to the utilization of state grant funding is that delays in payment by the State can cause hardships for disadvantaged communities. Therefore, it would be appropriate to expedite payments associated with grant funding by DWR.

Financing options for the projects and management actions are summarized on **Table 9-2** and may include grants, loans, funding from one or multiple GSA member agencies, GSA operating funds and/or funding from NDE landowners.



January 2020

TODD GROUNDWATER

Figure 1-1
Jurisdictional Boundaries of GSAs

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2. PLAN AREA

The Modesto Subbasin covers 245,253 acres (about 383 square miles) of the larger San Joaquin Valley Groundwater Basin, as defined by DWR (5-22.02) in the 2019 basin prioritization. The San Joaquin Valley Groundwater Basin is defined on the west by the Coast Ranges, on the south by the San Emigdio and Tehachapi mountains, on the east by the Sierra Nevada, and on the north by the Sacramento-San Joaquin Delta and Sacramento Valley. The Modesto Subbasin is in the northern portion of the San Joaquin Valley and is bounded on the north by the Stanislaus River, on the south by the Tuolumne River, and on the west by the San Joaquin River (**Figure 2-1**). The eastern basin boundary is defined by crystalline basement rocks of the Sierra Nevada Foothills (DWR, 2006).

The Modesto Subbasin is hydraulically connected with surrounding subbasins along shared river boundaries (**Figure 2-1**). Adjacent subbasins include the Turlock Subbasin south of the Tuolumne River, the Delta-Mendota Subbasin west of the San Joaquin River, and the Eastern San Joaquin Subbasin north of the Stanislaus River. Of these subbasins, Delta-Mendota and Eastern San Joaquin are listed by DWR as being in critical overdraft. As such, these subbasins are required to prepare GSPs on an expedited schedule and to submit complete GSPs to DWR by January 31, 2020. Although the Modesto Subbasin GSP has a submittal date of January 31, 2022 – two years after the critically-overdrafted basins deadline – the Modesto Subbasin is coordinating with its neighbors through meetings and shared analyses.

2.1. AGENCIES AND JURISDICTIONAL BOUNDARIES

The Modesto Subbasin contains irrigation districts, municipalities, and portions of two counties. The jurisdictional boundaries of these agencies are shown on **Figure 2-2**. Note that these agencies are member agencies of one (or more) GSAs.

Two irrigation districts, Modesto Irrigation District (MID) and Oakdale Irrigation District (OID), provide surface water supply to the Modesto Subbasin, primarily for agricultural irrigation. MID also delivers surface water from the Tuolumne River to the Modesto Regional Water Treatment Plant for treatment and delivery to the City of Modesto. MID covers most of the western half of the Subbasin with its service areas bounded by the Stanislaus River to the north, the San Joaquin River to the west and the Tuolumne River to the south. The OID service area covers a portion of the central and eastern Subbasin (**Figure 2-2**). Approximately 60 percent of the OID service area is in the Modesto Subbasin with 40 percent in the Eastern San Joaquin Subbasin to the north (Bookman-Edmonston, 2005).

The Modesto Subbasin contains four municipalities and additional urban communities. Three municipalities are entirely within the boundaries of the Subbasin and include Oakdale, Riverbank, and Waterford. Most of the City of Modesto lies within the Modesto Subbasin, but the southern portion extends into the Turlock Subbasin. Waterford and Modesto are within the irrigation service area boundary of MID; Oakdale is within the service area boundary of OID. Riverbank straddles both irrigation districts. Additional urban communities include Del Rio, Salida, Empire and West Modesto (**Figure 2-2**). As described in

Chapter 4, and shown on **Figure 4-1**, there are six disadvantaged and severely disadvantaged communities in the Modesto Subbasin: Airport, Empire, Oakdale, Rouse, Waterford and West Modesto.

Portions of the Subbasin not located within an irrigation district are within the jurisdiction of Stanislaus County. As shown on **Figure 2-2**, these Stanislaus County areas occur mostly in the eastern Subbasin and along the Stanislaus, Tuolumne and San Joaquin rivers. These Stanislaus County areas represent approximately 22 percent of the Subbasin.

Approximately 1,000 acres of the Subbasin extends into Tuolumne County and is covered by the Tuolumne Groundwater Sustainability Agency (Tuolumne GSA). The Tuolumne GSA is cooperating in the Modesto Groundwater Subbasin GSP through a cooperation agreement with Stanislaus County; the County also represents the Tuolumne GSA during STRGBA GSA and TAC meetings.

Additional jurisdictional boundaries, including Federal or State land and/or other agencies with water management responsibilities were identified using the DWR Water Management Planning Tool (2018). As shown on **Figure 2-3**, the Subbasin contains California Department of Fish & Wildlife (CDFW) lands and easements, Federal Lands, and California Conservation Easements, as listed below:

- CDFW owned and operated lands and conservation easement: the Tuolumne River Restoration Center, adjacent to the Tuolumne River in the eastern Subbasin.
- Federal Land (data from the Bureau of Land Management) along the Tuolumne River, the San Joaquin River National Wildlife Refuge, and the Riverbank Army Ammunition Plant.
- California Conservation Easements, including San Joaquin River National Wildlife Refuge, Wetlands Reserve Program, Menghetti Farm, Ulm Farms Inc, and the Emergency Watershed Protection Program Floodplain Easement.

No other state or federal agencies with jurisdictional lands in the Subbasin are documented in the DWR Water Management Planning Tool. In addition, no tribal lands are documented in the DWR Water Management Planning Tool or are known to exist in the Modesto Subbasin.

2.2. EXISTING LAND USE

Figure 2-4 illustrates land use in the Modesto Subbasin based on a 2017 Stanislaus County land use map. As shown by the map, the Modesto Subbasin is largely agricultural, with the major crop types including almonds and other deciduous trees, corn, grains, pasture, vines, citrus, and truck crops. In 2017, approximately 64 percent of the Subbasin is defined as irrigated agriculture, covering about 157,911 acres. About 13 percent of the basin is classified as urban (approximately 30,564 acres), which includes the cities of Modesto, Oakdale, Riverbank and Waterford. The remaining 23 percent of the Subbasin (about 56,777 acres) consists of non-agriculture, non-irrigated agriculture (e.g., rangeland), undeveloped land, and surface water. Most of the undeveloped land is in the eastern portion of Modesto Subbasin (**Figure 2-4**).

Figure 2-5 illustrates the Prime Farmland in the Subbasin in 2016 as designated by the California Department of Conservation Farmland Mapping and Monitoring Program (FMMP). The FMMP map shows that most of the Subbasin is composed of Prime Irrigated Farmland and Unique Farmland. Unique Farmland consists of lesser quality soils used for the production of the State's leading agricultural crops. As described in **Section 2.6**, many of the land use planning agencies in the Subbasin have goals and policies for the preservation of these land uses. Other land uses identified by the FMMP in the Subbasin include urban, confined animal agriculture, non-irrigated grazing land, rural residential, vacant/disturbed land, nonagricultural/natural vegetation and semi-agricultural and rural commercial land.

Figure 2-6 illustrates previous land use from 1996, as mapped by DWR. In 1996, approximately 46 percent of the Subbasin is defined as irrigated agriculture, covering about 111,946 acres. A comparison of 1996 and 2017 land uses (**Figure 2-4**) shows that a significant amount of pasture has been converted to deciduous/almond and other crops over the last 20 years. In addition, irrigated acreage increased from 1996 to 2017 by approximately 45,965 acres, or 18.7 percent of the Subbasin. Most of this increase occurred in the eastern Subbasin outside of MID and OID jurisdiction, where groundwater is the primary source of water supply.

Figure 2-7 is a chart illustrating the number of wells drilled by year in the Modesto Subbasin based on information from the DWR Well Completion Report database. The database indicates approximately 6,360wells drilled in the Modesto Subbasin, about 4,540 of which have completion dates and were drilled from 1948 to August 2021. As shown on the figure, only a few wells were drilled each year before the mid-1950s and less than 40 wells per year were drilled before the 1970s. Well drilling increased significantly in the 1970s, with the number of wells fluctuating between about 50 to over 100 wells per year. A significant increase in well drilling occurred during the most recent drought, with 148 wells drilled in 2013 and 257 wells drilled in 2014. The number of wells drilled dropped significantly in 2015 through 2018. The timing of the Stanislaus County Groundwater Ordinance (discussed in **Section 2.6.1.3**) may also have influenced well drilling activity over the last several years.

Figure 2-8 shows the locations of the drilled wells. The upper panel of this figure shows the wells that were drilled before 2000 (i.e., from 1948 to 1999) and the lower panel shows the wells that were drilled from 2000 to August 2018. These figures illustrate an increase in the number of wells drilled in the eastern Subbasin since 2000, outside of MID or OID irrigation service areas.

2.3. WATER SOURCES AND USE

The two primary sources of water used in the Modesto Subbasin are surface water, from the Stanislaus and Tuolumne rivers, and Subbasin groundwater. No sources of imported water are available in the Subbasin.

Urban Water Management Plans (UWMPs) and Agricultural Water Management Plans (AWMPs), document surface water and groundwater use in the Subbasin. These plans include descriptions of local surface water and groundwater models, including the Stanislaus County Hydrologic Model (SCHM), and data provided by local agencies for the GSP. UWMPs are available for Modesto (2015), Modesto and Modesto Irrigation District (2010), Oakdale (2015), Riverbank (2015) and Waterford (2005). AWMPs are available for MID (2015) and OID (2015). A summary of the information on surface water and groundwater use from these planning documents is provided below.

2.3.1. Surface Water

Surface water facilities and conveyance infrastructure across the Subbasin are illustrated on **Figure 2-9**. As shown on the figure, the Subbasin contains a web of lined and unlined canals and pipelines to facilitate surface water conveyance. The Hetch Hetchy Aqueduct crosses the northern half of the Subbasin as part of a 167-mile project that conveys water from Hetch Hetchy Reservoir to the City and County of San Francisco and other municipalities.

OID diverts water from the Stanislaus River under pre-1914 water rights shared equally with the South San Joaquin Irrigation District (SSJID), located north of the Stanislaus River in the Eastern San Joaquin Subbasin. The adjudicated diversion rate from the Stanislaus River is 1,816.6 cubic feet per second (cfs). In 1988, after the construction of New Melones Dam upstream of Goodwin Dam, OID and SSJID entered into an operational agreement with United States Bureau of Reclamation (USBR) that provides the districts a combined supply of 600,000 acre-feet (AF) of water annually (Davids Engineering Inc., 2016).

OID diverts water at the Goodwin Dam into the South Main Canal, which serves agricultural irrigation water throughout OID south of the river in the Modesto Subbasin. OID also diverts water into the Joint Main Canal, for use north of the river in the Eastern San Joaquin Subbasin. Water flows from these canals through a system of unlined earthen ditches, concrete-lined canals, low-head pipelines and gates. Irrigation tailwater is reclaimed by OID using reclamation pumps or discharged to other landowners or irrigation districts via drainage canals.

MID diverts water from the Tuolumne River for agricultural irrigation and municipal supply. The mean annual MID diversion from the Tuolumne River is approximately 294,000 AF, based on the average hydrologic period from 2003 to 2012. Approximately twenty percent of this amount (67,000 AF) is currently delivered to the Modesto Regional Water Treatment Plant (MRWTP) for treatment and delivery to the City of Modesto (Provost and Pritchard, 2015).

New Don Pedro Reservoir, built in 1971 and located northeast of La Grange in the Sierra Nevada foothills, is jointly owned by MID and TID and has a maximum storage capacity of 2,030,000 AF. MID's share of water stored in New Don Pedro Reservoir is approximately 543,000 AF. La Grange Diversion Dam, constructed in 1893, is used to divert water from the Tuolumne River into the MID Upper Main Canal. Diversions flow through the Upper Main Canal to the Modesto Reservoir for temporary storage and irrigation deliveries and for delivery to the water treatment plant and then on to the City of Modesto. The Modesto Reservoir, owned and operated by MID, was built in 1911 and has a storage capacity of 28,000 AF.

MID distributes Tuolumne River water and groundwater via a network of facilities, including 15 miles of unlined canals, 147 miles of lined canals, 42 miles of pipelines and 39 miles of drains (Provost and Pritchard, 2015). In 2012, approximately 66,500 acres of land were irrigated within MID, 57,000 acres of which received surface water from MID (Provost and Pritchard, 2015).

2.3.2. Groundwater

Groundwater in the Modesto Subbasin is extracted primarily for agricultural irrigation, municipal, and domestic potable water supply. Based on the Stanislaus County Hydrologic Model (SCHM), groundwater pumping in the Subbasin for Water Year 2015 was estimated at 222,730 acre-feet per year (AFY). Approximately 77 percent was pumped for agricultural irrigation (170,892 AFY), 20.1 percent for municipal uses (45,968 AFY) and 2.6 percent for rural domestic use (5,870 AFY) (JJ&A, 2017).

Modesto ID pumps groundwater from approximately 100 production and drainage wells to supplement surface water supply and to help control the high water table in the western Subbasin. Groundwater pumping supplements reduced supply from the Tuolumne River during consecutive dry years and to serve areas where it is more difficult to deliver adequate amounts of surface water (Provost and Pritchard, 2015).

Oakdale ID pumps groundwater from 13 deep wells in the Modesto Subbasin to supplement surface water deliveries from the Stanislaus River. OID also provides domestic water from District owned wells for its rural water system (RWS) and serves as the trustee of six improvement districts that get water from deep wells that are individually owned by each improvement district.

Agricultural pumping by the districts is supplemented by numerous private agricultural wells throughout the Subbasin. In the western Subbasin, where groundwater levels are relatively shallow, drainage wells are used to maintain groundwater levels below the root zone to facilitate farming operations and manage salinity. Irrigation wells are used in areas of surface water availability to supplement supply, especially during droughts when surface water is insufficient to meet demands. In the eastern Subbasin, where surface water supplies are generally unavailable, irrigation wells provide the primary water supply for agricultural lands.

The cities of Modesto, Oakdale, Riverbank and Waterford pump groundwater for water supply. There are approximately 150 active supply wells in these four cities.

There are a number of small community water supply systems located throughout the Subbasin that are operated by the respective community and regulated by Stanislaus County. **Figure 2-10** illustrates the public water systems within Modesto Subbasin that are mapped by the California Environmental Health Tracking Program. The mapped systems include irrigation districts (MID and OID), municipal systems (Modesto, Oakdale, Riverbank and Waterford), and smaller, non-municipal and non-district systems. The municipal systems are outlined in black on **Figure 2-10**. There are approximately 77 systems within Modesto Subbasin that are not municipal or irrigation districts, illustrated by the burgundy shaded areas on **Figure 2-10** (some systems are so small that they appear as only a dot). A summary of these non-municipal and non-irrigation systems is provided on **Table 2-1**. Approximately 56 of these systems are very small, with 10 or less service connections, and almost all (71) have less than 50 service connections.

Groundwater extraction occurs throughout the Subbasin as indicated by the density of wells shown on **Figure 2-11**. This map, illustrating the number of production wells drilled per square mile, was developed from DWR's Well Completion Report Map Application. Production wells include water supply wells[1] designated as irrigation, public, municipal, and industrial on well completion reports. The highest density of production wells occurs in the western Subbasin, particularly north and west of Modesto. DWR's 2018 basin prioritization indicates that there+ are about 4,000 production wells in the Subbasin (DWR, 2018a).

Figure 2-12 illustrates the density of public supply wells in the Subbasin. Similar to **Figure 2-11**, this map was developed from DWR's Well Completion Report Application and includes water supply wells designated as public on well completion reports and is therefore a subset of the wells on **Figure 2-11**. The highest densities generally coincide within municipalities and urban centers. Public supply well densities associated with small community water systems are also indicated. Based on data received for the GSP, there are approximately 150 municipal public supply wells in the Subbasin; these are shown on **Figure 2-13**.

Information on domestic wells is provided in **Section 2.3.3**, following **Table 2-1** below.

[1] DWR's definitions of water supply wells are provided in DWR's *How to Fill Out a Well Completion Report* pamphlet, updated in March 2007.

Table 2-1: Public Water Systems in the Modesto Subbasin

Water System Name	Number of Service Connections
WATERFORD-RIVER POINTE	317
RIVERVIEW MOBILE HOME ESTATES	175
MODESTO MOBILE HOME PARK	150
PARK HEIGHTS MUTUAL WATER CO	95
DEL RIO EAST HOA WATER SYSTEM	55
OLIVE LANE MOBILEHOME PARK	51
LAZY B MOBILEHOME PARK	49
MORNINGSIDE MOBILEHOME PARK	49
MAZE BLVD MOBILEHOME PARK	40
WATERFORD SPORTSMEN'S CLUB	40
LONE PINE MHP	32
OASIS INVESTMENTS	31
STERLING INDUSTRIAL	30
A & M INDUSTRIES INC	25
RIVERBANK LRA	22
KIERNAN BUSINESS CENTER	20
TURLOCK STATE RECREATION AREA	19
LIBITZKY	15
MCHENRY BUSINESS PARK	15
TULLY MOBILE ESTATES	15
FEE WATER SYSTEM	12
CARDOZA WATER SYSTEM	10
CHARITY WAY WATER SYSTEM	10
GREGORI HIGH SCHOOL	9
HART- RANSOM UNION SCHOOL & DISTRICT	9
BLOOMINGCAMP WATER SYSTEM	7
FRAZIER NUT FARMS, INC.	7
SHILOH SCHOOL DISTRICT	7
COVENANT GROVE CHURCH	6
BURCHELL NURSERY, INC	5
MESA ELEMENTARY SCHOOL	5
STORER TRANSPORTATION	5
STRATOS WAY WATER COMPANY, INC	5
THE COUNTRY MARKET	5
LOS INDIOS WATER SYSTEM	4
MID VALLEY AG	4
THE FRUIT YARD RESTAURANT	4
JEHOVAH'S WITNESS SIERRA VISTA CONG	3
KIERNAN/MCHENRY WATER COMPANY, INC	3
LA GRANGE PARK-OHV	3

Table 2-1 (*continued*)

Water System Name	Number of Service Connections
ROBERTS FERRY NUT CO, INC (WS)	3
SALIDA HULLING ASSOCIATION WATER SYSTEI	3
5033 PENTECOST	2
AT&T WATER SYSTEM	2
BRETHREN HERITAGE SCHOOL, INC	2
EL RINCON & YOSEMITE HACIENDA MARKET	2
FISHER NUT	2
FOSTER FARMS-ELLENWOOD HATCHERY	2
GROVER LANDSCAPE WATER SYSTEM	2
LIBERTY BAPTIST CHURCH	2
OAKDALE GOLF & COUNTRY CLUB (EH)	2
ONE STOP WS	2
PARADISE SCHOOL	2
RATTO BROS, INC	2
ROBERTS FERRY SCHOOL CAFETERIA	2
STANISLAUS REGIONAL WATER AUTHORITY	2
WOOD COLONY CHRISTIAN SCHOOL	2
BECKLEY LYONS WATER SYSTEM	1
BEL PASSI BASEBALL	1
DEEVON WATER CO	1
ELKS LODGE 1282	1
FLOYD OVERHOLTZER WATER SYSTEM	1
FOX GROVE FISHING ACCESS	1
KNIGHTS FERRY RECREATION AREA	1
MABLE AVE BAPTIST CHURCH	1
MCHENRY GOLF CENTER	1
MODESTO CHRISTIAN CENTER (WATERSYSTEM	1
NINO'S PLACE WATER SYSTEM	1
OLIVEIRA WATER SYSTEM	1
PENTECOST PROPERTIES WATER SYSTEM	1
RAINBOW SPORTS COMPLEX	1
RAM NAAM MANDALI CHURCH OF MODESTO	1
SCONZA CANDY COMPANY	1
SHILOH-PARADISE BASEBALL FOR YOUTH	1
SMART STOP FOOD MART (EH)	1
STANISLAUS UNION SCHOOL DIST	1
SUNRISE ROCK & REDI-MIX	1

Notes:

1. Does not include municipal and irrigation district systems.

2. Source: California Environmental Health Tracking Program, Water System Map Viewer

2.3.3. Domestic Wells

Residents in the Modesto Subbasin that live outside of public water systems rely on domestic wells for their water supply. Based on DWR Well Completion Report records as of November 2020, approximately 3,190 domestic wells were constructed in the Modesto Subbasin. Of this number, about 210 new domestic wells were drilled since 2015; that was when many domestic wells began to fail during the drought as discussed below. An estimated 2,980 domestic wells were in place at the end of 2014. The density of domestic wells (number per square mile) is illustrated on **Figure 2-14**. Domestic wells are present throughout the Subbasin, but the highest density occurs in the central region of the Subbasin, along the Stanislaus and Tuolumne rivers, and west of Modesto. DWR records include many older wells dating back to the 1940s and do not indicate how many of these domestic wells are currently active.

During the recent drought, 159 domestic wells in the Subbasin were reported to be dry or suffered structural failure because of declining water levels, representing about five percent of the then-current number of domestic wells (2,980 total wells as stated above). **Figure 2-15** shows the domestic wells that were reported as dry or failed from 2014 through 2017 in Stanislaus County. According to Stanislaus County, most of these wells were less than 100 feet deep and more than 50 years old. As such, many of these wells likely had to be replaced. As part of their Dry Well Program, the County assisted well owners with storage tanks and new well installations.

An analysis was conducted to investigate the areas of the Subbasin with domestic wells that were most vulnerable to becoming dry during the recent drought. Based on the DWR Well Completion Report database, some construction data and completion dates were available for 2,356 domestic wells installed in the Subbasin between 1948 and November 2014. As stated previously, DWR records do not indicate how many of these domestic wells are currently active. The depths of these wells were compared to the groundwater depth in October 2015, based on groundwater elevation contours developed for the GSP (see **Figure 3-27a**). The difference between the bottom of the screen interval, or total depth if screen interval was not available, of each domestic well was subtracted from the depth to water to determine the water column thickness above the screen or base of the well. The estimated water column thickness at each domestic well is indicated by color on **Figure 2-16**. Domestic wells where the water level may be below the bottom of the screen or below the bottom of the well (i.e., dry) in October 2015 are shown as pink dots. There are 30 potentially dry wells, located primarily in the east-central region of the Subbasin near the river boundaries (about one percent of the wells with construction data and completion depths).

About 20 percent of the domestic wells have less than 50 feet of water above the bottom of their screen or base of the well as shown by yellow dots. These wells are considered to be vulnerable to becoming dry if water levels drop up to 50 feet below October 2015 levels. For context, analysis of water levels indicated that very few wells were observed to have declined up to 50 feet during the 2012-2016 time frame when rates of decline were generally the largest (see **Section 3.2.2** and **Figures 3-21** – **3-25**). In addition, those declines were observed in the eastern Subbasin where groundwater has been the primarily water supply. As shown on **Figure 2-16**, the more vulnerable wells are located primarily in the central region of the Subbasin along the river boundaries. These areas are consistent with the areas of reported dry wells between 2014 and 2017 (see **Figure 2-15**).

A similar analysis was conducted for domestic wells constructed since 2015 to investigate where and how many newer wells might be most vulnerable to dewatering if water levels declined significantly below 2015 levels. Between January 2015 and November 2020, approximately 210 domestic wells were constructed in the Subbasin. Many of these wells likely replaced the previously failed wells. In general, the wells were drilled to deeper depths – 75 percent were drilled to depths of over 200 feet.

The depths of the wells constructed since 2015 were compared to depth to water in October 2015 and color-coded in a similar manner as on **Figure 2-16**. The results, illustrated on **Figure 2-17**, indicate that most wells have 50 or more feet of water column thickness, and are not vulnerable to becoming dry. However, there are a small number (less than 10) of new domestic wells in areas that remain vulnerable if water levels decline significantly. These wells are in the east-central region of the Subbasin near the river boundaries; the same region identified as most vulnerable for domestic wells constructed before 2015 (**Figure 2-16**) and where most reports of dry wells occurred (**Figure 2-15**). These vulnerable areas are circled in red on **Figure 2-17**.

Based on reports of dry wells on DWR's Household Water Supply Shortage Reporting System (https://mydrywell.water.ca.gov/report/), as of November 2021, five wells were reported dry in the Modesto Subbasin between May and August 2021. These five wells are located in the east-central region of the Subbasin and generally correlate with the areas determined to be most the most vulnerable.

Note that the numbers in this domestic well analysis vary because not all wells contain complete information for construction or completion dates. And, as mentioned previously, it is unknown how many domestic wells are no longer in use or destroyed. However, the information above is based on the best available data at this time. The GSP implementation plan in Section 9 includes an activity to address these data gaps over time (see **Section 9.5.3**)

This analysis found that the percentage of vulnerable domestic wells is small. Approximately four percent (8 out of 210) of the new domestic wells constructed since 2015 are vulnerable to dewatering if water levels decline significantly below 2015 levels. As described in **Section 6.8** and shown in **Chapter 7**, minimum thresholds set for both interconnected surface water (Fall 2015 levels) and water levels (historic low levels) have been exceeded in recent years because of declining water levels, particularly in the eastern Subbasin. Yet, Stanislaus County reports that only a few wells have reported problems since 2017. In 2021, only five domestic wells were reported to be dry, representing less than one percent of the total domestic wells in the Subbasin. Given the consideration of data discussed above and MTs selected in Chapter 5, widespread failures of more than the five percent of total domestic wells drilled in the Subbasin (as occurred in 2014-2017) can likely be avoided under the selected sustainable management criteria. Data gaps for numbers of active domestic wells and construction information limit the ability to accurately predict the number of specific failures (addressed in **Section 9.5.3**).

2.4. WATER RESOURCES MONITORING PROGRAMS

Numerous monitoring programs that could support GSP development have been implemented in the Modesto Subbasin. These and other existing monitoring networks and protocols will be considered for improvements and/or adoption as part of the GSP monitoring network. GSP monitoring networks will be designed to:

- Evaluate sustainability indicators in each management area
- Address identified data gaps
- Monitor for minimum thresholds in each management area to avoid undesirable results
- Track interim milestones and measurable objectives to demonstrate progress on reaching sustainability goals for the Subbasin.

2.4.1. CASGEM Monitoring Program

The California Ambient Statewide Groundwater Elevation Monitoring (CASGEM) Program, administered by DWR, has compiled groundwater elevation data from designated monitoring entities since 2009. Data are used to track seasonal and long-term groundwater elevation trends in groundwater basins statewide. In addition to designated CASGEM wells, groundwater elevation data from other wells are also compiled into the system on a voluntary basis. Data are available for review online at the DWR CASGEM website (https://water.ca.gov/Programs/Groundwater-Management/Groundwater-Elevation-Monitoring--CASGEM).

The Stanislaus and Tuolumne Rivers Groundwater Basin Association (STRGBA) serves as the CASGEM Monitoring Entity for the Modesto Subbasin. Since 1994, STRGBA has coordinated groundwater planning and management in the Subbasin. As part of the CASGEM program, STRGBA measures water levels in 56 Subbasin wells. The monitoring network consists of wells owned by MID, OID, and the U. S. Geological Survey (USGS).

The current CASGEM online database contains approximately 2,400 unique water level measurements from the 56 Modesto Subbasin wells, spanning from November 1991 to October 2019. These wells are measured semi-annually to capture seasonal variation, typically once in February/March (seasonal high elevations) and once in October/November (seasonal low elevations) of each year. Information supplied by the CASGEM database includes local and state well numbers, latitude and longitude of the well, a unique CASGEM ID and station number, well use, ground surface elevation, depth to water, and calculated groundwater elevation.

Figure 2-18 illustrates the locations of the CASGEM monitoring wells and DWR Water Data Library wells that have been recently monitored (2015 to present). This figure includes 71 wells monitored by DWR and included in the DWR Water Data Library. The CASGEM wells are a subset of the DWR Water Data Library wells. As shown, the monitored wells are almost all located west of Modesto Reservoir.

2.4.2. Public Water Suppliers Groundwater Monitoring Programs

Public water suppliers in the Modesto Subbasin have implemented water level and water quality monitoring programs for their service areas. Water levels are monitored in production wells either monthly or quarterly. The City of Modesto is in the process of designing and constructing five sets of multi-completion monitoring wells for water quality and water level monitoring.

Each municipality also monitors groundwater quality for its supply wells in compliance with State requirements. Water quality monitoring requirements for public water systems are set by Title 22, Chapter 15, of the California Code of Regulations (CCR). Groundwater quality monitoring data are also compiled by local regulatory agencies for sites associated with groundwater contamination. Various municipalities have identified constituents of concern over time including nitrate, arsenic, uranium, trichloropropane (TCP), tetrachloroethylene (PCE), and dibromochloropropane (DBCP). Some of these data sets are maintained on the State Water Resources Control Board web-based database, referred to as GeoTracker.

A summary of the groundwater monitoring programs conducted by the public water suppliers is provided on the following table.

Table 2-2 : Groundwater Monitoring Programs by Public Water Suppliers

Agency	Monitoring Programs	
	Groundwater Levels	Groundwater Quality
City of Oakdale	Monthly water level monitoring conducted in most production wells.	State-required sampling in production wells.
City of Riverbank	Quarterly water level monitoring conducted in all production wells.	State-required sampling in production wells. Additional water quality sampling in production wells for local constituents of concern.
City of Waterford	Monthly water level monitoring conducted in production wells	State-required sampling in production wells.
City of Modesto	Ongoing water level monitoring program in monitoring wells (numbers and frequency vary with time).	State-required sampling in production wells. Additional water quality sampling in monitoring wells for local constituents of concern.

2.4.3. Agricultural Water Suppliers Monitoring Programs

Agricultural water suppliers conduct surface water and groundwater monitoring programs in the Subbasin. Such programs implemented by MID and OID are summarized below.

2.4.3.1. Modesto Irrigation District (MID)

MID measures water levels in approximately 50 deep irrigation wells and approximately 50 shallow drainage wells on a semi-annual basis, in February and November. On behalf of STRGBA, MID also measures water levels within their district as part of the CASGEM program.

MID monitors water quality as part of several programs:

- Modesto Reservoir: Daily monitoring of water quality in Modesto Reservoir for domestic water quality standards.
- Surface and Subsurface Drainage: Monitor surface water and groundwater in compliance with the aquatic herbicide general permit.
- NPDES permit: Monitoring program in compliance with a statewide general NPDES permit for discharge of aquatic herbicides.
- Irrigated Lands Regulatory Program: Water quality monitoring in compliance with the Irrigated Lands Regulatory Program as a member of the East San Joaquin Water Quality Coalition. Program is administered by the Central Valley Regional Water Quality Control Board (CVRWQCB). (see also **Section 2.4.4**).
- UC Davis Water Quality Study: The MID Domestic Water Treatment Plant, in conjunction with UC Davis, conducted water quality monitoring to identify constituents of greatest concern for water treatment.

2.4.3.2. Oakdale Irrigation District (OID)

OID measures water levels in a total of 12 OID and private wells within the district in the Modesto Subbasin on a semi-annual basis, in spring and fall. OID provides water levels to STRGBA, which serves as the CASGEM reporting agency.

- Irrigated Lands Regulatory Program: Water quality monitoring in compliance with the CVRWQCB Irrigated Lands Regulatory Program as a member of the East San Joaquin Water Quality Coalition (discussed in more detail below in **Section 2.4.4**).
- District water quality: OID measures electrical conductivity in 12 deep wells and 8 private wells as part of the groundwater monitoring program (GWMP) developed in the Integrated Regional Groundwater Management Plan (Bookman-Edmonston, 2005).
- NPDES permit: Monitoring program in compliance with a statewide general NPDES permit for discharge of aquatic herbicides.

2.4.4. Irrigated Lands Regulatory Programs

The Irrigated Lands Regulatory Program (ILRP) requires monitoring and reporting in compliance with the Conditional Waiver of Waste Discharge Requirements for Discharges from Irrigated Lands, a program administered by the CVRWQCB. It was initiated in 2003 to prevent impacts to surface water and groundwater from agricultural runoff, with a focus on nitrate.

The East San Joaquin Water Quality Coalition (ESJWQC) is a group of agricultural interests and growers that formed to represent dischargers who own or operate irrigated lands east of the San Joaquin River in Madera, Merced, Stanislaus, Tuolumne, and Mariposa counties. The ESJWQC files reports in compliance with Central Valley Water Board requirements (ESJWQC, 2019). The ESJWQC monitoring program samples for a wide array of constituents in drains and canals. The sampling program and monitoring stations are dynamic, with sampling stations and constituents changing frequently, as the program rotates throughout the watershed. In the Modesto Subbasin, both MID and OID are members of the coalition for the lands that they own.

The ESJWQC joined the Central Valley Salinity Coalition, a non-profit organization which manages funding for the Central Valley Salinity Alternatives for Long-Term Sustainability (CV-SALTS). CV-SALTS was formed in 2006 to address the salt problem in the Central Valley and prepared a Salt and Nutrient Management Plan for the entire Central Valley. Based on that plan, the SWRCB adopted a Basin Plan Amendment (BPA) in 2019 to guide nitrate and salt regulations. ESJWQC representatives participated in the framework development for regulatory requirements under the BPA (ESJWQC, 2020).

In December 2012, a new Waste Discharge Requirements (WDR) order for the ESJWQC was approved by the CVRWQCB that expanded the monitoring to include groundwater under the ILRP. The program ensured that surface water monitoring would continue but focused on a management approach rather than strict enforcement of water quality standards. A Nitrogen Management Plan (NMP) was implemented, which requires growers to document how much nitrogen is added and removed from irrigated lands. These numbers are reported to the CVRWQCB annually.

In January 2020, the Nitrate Control Program (NCP) was initiated, which requires growers to ensure safe drinking water supplies for well owners impacted by nitrate. Growers can elect to comply with these regulations cooperatively with other growers in designated Management Zones. Six priority groundwater subbasins were identified for Management Zones including Chowchilla, Kaweah, Kings, Turlock, Tule, and Modesto (ESJWQC, 2020).

The Valley Water Collaborative, which was funded by ESJWQC to implement the NCP, was formed to cover the Management Zones in the Turlock and Modesto subbasins. The Executive Director of the Valley Water Collaborative is in communication with the Subbasin GSAs about NCP program implementation in the Modesto Subbasin. The Executive Director provided an overview of the program at the December 2020 regular public meeting of the STRGBA GSA.

2.5. WATER RESOURCES MANAGEMENT PROGRAMS

As demonstrated from the monitoring programs described above, Modesto Subbasin agencies are actively managing surface water and groundwater conjunctively. Water management programs in the Modesto Subbasin have been documented in various planning documents prepared both separately by local water agencies and collaboratively through cooperative groups of agencies. Key water resources management programs in the Subbasin are summarized below.

2.5.1. Groundwater Management Plan

In April 1994, six agencies within the Modesto Subbasin formed the Stanislaus and Tuolumne Rivers Groundwater Basin Association (STRGBA) to manage groundwater. In 2003, STRGBA began preparing an Integrated Regional Groundwater Management Plan (GWMP) in compliance with the Groundwater Management Planning Act of 2002 (SB 1938) and the Integrated Regional Water Management Planning Act of 2002 (SB 1672) (Bookman-Edmonston, 2005). The GWMP describes several actions to protect groundwater resources that are implemented by STRGBA member agencies (Bookman-Edmonston, 2005). The following is a summary of these actions.

- Identification and Management of Wellhead Protection Areas: The purpose is to protect groundwater used for public supply, by protecting the area around a public supply well, or a recharge area that contributes water to a public supply well, to prevent water quality impacts.
- Regulation of the Migration of Contaminated Groundwater: STRGBA coordinates with responsible parties and regulatory agencies to keep STRGBA members informed of the status of known groundwater contamination.
- Identification of Well Construction Policies: Stanislaus County Department of Environmental Resources administers the well permitting program in the unincorporated areas of the Subbasin. STRGBA member agencies are required by State law to adopt the State Model Well Ordinance as a minimum standard for well construction.
- Administration of Well Abandonment and Destruction Programs: Unused wells must be properly abandoned to prevent the migration of contaminants.
- Mitigation of Overdraft Conditions: Reduce dependency on groundwater, by providing surface water to areas previously dependent on groundwater, and by encouraging growers to use surface water for irrigation, when available, instead of groundwater.
- Replenishment of Groundwater Extracted by Water Producers: Protect and manage the major recharge areas within the Subbasin.

- Construction and Operation of Recharge, Storage, Conservation, Water Recycling and Extraction Projects: Local agencies will encourage cooperation and sharing of information between the agencies to promote water management projects.
- Control of Saline Water Intrusion: STRGBA coordinates with member agencies to monitor groundwater quality to ensure that saline water from the San Joaquin River or the saline water associated with groundwater from the western San Joaquin Valley does not migrate into the Subbasin.

2.5.2. Urban Water Management Plans

The Urban Water Management Planning Act requires water suppliers that provide over 3,000 AFY or have over 3,000 connections to submit an Urban Water Management Plan (UWMP) to the State every five years. 2015 UWMPs are available for two cities in the Modesto Subbasin: Modesto (2015) and Riverbank (2015). The City of Modesto owned and operated Waterford's water system until July 1, 2015, and therefore Waterford's system is covered under the Modesto 2015 UWMP. Oakdale completed a 2010 UWMP Update (MCR Engineering, 2015) and has a Draft 2015 UWMP awaiting adoption. Modesto and MID completed a joint UWMP in 2010 (West Yost Associates, 2011)[2].

The 2015 UWMPs for the cities of Modesto (West Yost Associates, 2016a) and Riverbank (KSN Inc., 2016) are consistent with the Urban Water Management Planning Act as amended by SB X7-7 in 2009 and provide evaluations of water demand and water supply into the future. Each describes the service area, water system, historical and projected water use, and water supply sources, and provides a comparison of projected water supplies to water demands during normal, single-dry, and multiple-dry years in five-year increments from 2020 to 2035. Both cities indicate the availability of water supply to meet water demand into the future. Riverbank, which relies exclusively on groundwater, plans to meet future demands with groundwater. The City of Modesto, which relies on groundwater and treated surface water from MID, plans to continue to use these two sources of water to meet future demands. Each UWMP describes constraints (e.g., legal, environmental, water quality) on water supplies.

As required by SB X7-7, the UWMPs present each city's 2015 and 2020 water use targets, verify compliance with the interim 2015 water use target, and describe implementation plans for meeting the 2020 water use target. Recognizing the importance of water conservation, the UWMPs describe the six Demand Management Measures (DMMs) in compliance with SB X7-7. These DMMs include water waste prevention ordinances, metering, conservation pricing, public education and outreach, programs to assess and manage distribution system real loss, and water conservation program coordination and

[2] In June 2021, the City of Modesto and Modesto Irrigation District completed an updated joint UWMP for 2020. Data from these and other updated planning documents will be incorporated into future GSP analyses, such as in GSP Annual Reports.

staffing support. The cities each implement additional water conservation programs, as follows.

- Modesto has three additional DMMs, including residential conservation programs; commercial, industrial, institutional conservation programs; and large landscape irrigation conservation programs.
- Riverbank has several additional DMMs:
    - Water survey programs for single-family residential and multi-family residential customers
    - Large landscape conservation programs and incentives
    - High efficiency washing machine rebate program
    - High efficiency toilet replacement
    - Residential plumbing retrofit
    - Conservation programs for commercial, industrial and institutional accounts

Oakdale's 2010 UWMP (MCR Engineering, 2015) identifies fourteen similar demand management measures. As stated in the 2010 UWMP, Oakdale was implementing or partially implementing five of the demand management measures (MCR Engineering, 2015).

2.5.3. Agricultural Water Management Plans

Agricultural Water Management Plans (AWMPs) were prepared in 2015 in accordance with the Water Conservation Act of 2009 (SB X7-7) by two irrigation districts within the Modesto Subbasin: MID (Provost and Pritchard, 2015) and OID (Davids Engineering, 2016). The following is a summary of the water resources management programs described in these AWMPs.

The MID and OID 2015 AWMPs each describe the same Efficient Water Management Practices (EWMPs) in conformance with the California Code. These include two critical EWMPs that are mandatory for all agricultural water suppliers, and additional or conditional EWMPs, which are required if technically feasible and locally cost effective. The two mandatory EWMPs are to accurately measure the volume of water delivered to customers and to adopt a pricing structure based, at least partially, on the quantity of water delivered. MID and OID each describe the same thirteen additional EWMPs that are being implemented, as follows:

- Facilitate use of available recycled water that otherwise would not be used beneficially, meets all health and safety criteria, and does not harm crops or soils.
- Facilitate financing of capital improvements for on-farm irrigation systems.
- Implement an incentive pricing structure that promotes one or more of the following goals: (A) More efficient water use at farm level, (B) Conjunctive use of groundwater, (C) Appropriate increase of groundwater recharge, (D) Reduction in problem drainage, (E) Improved management of environmental resources, (F)

Effective management of all water sources throughout the year by adjusting seasonal pricing structures based on current conditions.

- Expand line or pipe distribution systems and construct regulatory reservoirs to increase distribution system flexibility and capacity, decrease maintenance and reduce seepage.
- Increase flexibility in water ordering by, and delivery to, water customers within operational limits.
- Construct and operate supplier spill and tailwater recovery systems
- Increase planned conjunctive use of surface water and groundwater within the supplier service area.
- Automate canal control structures.
- Facilitate or promote customer pump testing and evaluation.
- Designate a water conservation coordinator who will develop and implement the water management plan and prepare progress report.
- Provide for the availability of water management services to water users.
- Evaluate the policies of agencies that provide the supplier with water to identify the potential for institutional changes to allow more flexible water deliveries and storage.
- Evaluate and improve the efficiencies of the supplier's pumps.

In addition to these, MID is implementing an EWMP to facilitate alternative land use for lands with exceptionally high water duties or whose irrigation contributes to significant problems, such as drainage problems.

2.5.4. Additional Plan Elements

The California Water Code contains a checklist for preparation of GSPs, which provide groundwater management elements that may be applicable for incorporation into the Modesto Subbasin GSP. Most management programs relevant to this checklist are described in the previous sections; programs are summarized below for each topic to ensure that the additional plan elements listed in the GSP regulations (Section 354.8 (g)) have been considered.

(a) *Control of saline water intrusion*: saline water intrusion is not applicable because this is not a coastal Subbasin. However, as summarized in **Section 2.5.1**, the Integrated Groundwater Management Plan (Bookman-Edmonston, 2005) describes STGRBA's efforts to prevent saline groundwater from migrating into the Subbasin from the San Joaquin River and from the west side of the San Joaquin Valley.

(b) *Wellhead protection areas and recharge areas*: as described in **Section 2.5.1**.

(c) *Migration of contaminated groundwater*. As described in **Section 2.5.1**, STRGBA GSA will coordinate with responsible parties and regulatory agencies to keep STRGBA GSA member agencies informed of the status of known groundwater contamination. The oversight regulatory agencies may include the State Water Resources Control Board, the State Department of Toxic Substances Control (DTSC), or the County Department of Environmental Health.

(d) *A well abandonment and well destruction program*: As described in **Section 2.5.1**, the Integrated Regional Groundwater Management Plan (Bookman-Edmonston, 2005), states that the unused wells must be properly abandoned to prevent the migration of contaminants.

(e) *Replenishment of groundwater extractions*: As described in **Section 2.5.1**, the Integrated Regional Groundwater Management Plan (Bookman-Edmonston, 2005), the major recharge areas in the Subbasin will be protected and managed. In 2007, a recharge characterization for STRGBA was completed to define recharge areas by evaluating physical characteristics and anthropogenic conditions (WRIME, 2007).

(f) *Activities implementing, opportunities for, and removing impediments to, conjunctive use or underground storage*. Conjunctive use is an active groundwater management strategy being implemented by the City of Modesto, MID and OID. In addition, maximizing groundwater recharge is a goal or policy identified by many agencies with land use planning responsibility in the Subbasin (see **Section 2.6** below).

(g) *Well construction policies*. Stanislaus County has a well permitting program in accordance with the State Water Code that ensures proper well construction (see **Section 2.6.2** below).

(h) *Measures addressing groundwater contamination cleanup, groundwater recharge, in-lieu use, diversions to storage, conservation, water recycling, conveyance, and extraction projects*. As discussed above, most of these are addressed in the Integrated Regional GWMP (Bookman-Edmonston, 2005). Water conservation measures are provided in the UWMPs and AWMPs, as described in **Sections 2.5.2 and 2.5.3**.

(i) *Efficient water management practices, as defined in Section 10902, for the delivery of water and water conservation methods to improve the efficiency of water use*. Efficient water practices are provided in the UWMPs and AWMPs, as described in **Sections 2.5.2 and 2.5.3**.

(j) *Efforts to develop relationships with state and federal regulatory agencies*. These relationships are developed and coordinated in a variety of ways including coordination with CDFW on river issues, working with regulatory agencies regarding environmental sites within the City, oversight of the County for small community water system provision of water, among other activities (see also **Section 2.5.1**).

(k) *Processes to review land use plans and efforts to coordinate with land use planning agencies to assess activities that potentially create risks to groundwater quality or quantity.* As described in **Section 2.6** below, agencies within the Subbasin are conducting land use planning to ensure water supply availability and groundwater protection.

(l) *Impacts on groundwater dependent ecosystems (GDEs).* Groundwater elevation data collected as part of the groundwater level monitoring programs described in **Section 2.4** will be used to analyze the interconnectedness of surface water and groundwater and potential impacts on groundwater dependent ecosystems (GDEs). Additional analysis will incorporate results from the Modesto Subbasin integrated surface water- groundwater model, currently being revised.

The GSP will incorporate existing water resource management programs summarized above. In addition, goals, policies, and implementation measures in several General Plans in the Subbasin address aspects of water resource management programs, as discussed in the following section.

2.6. Land Use Planning and Elements

General Plans, Groundwater Ordinances, and information from other land use planning activities were compiled for review and consideration during GSP preparation and for coordination during GSP implementation. This section includes a summary of those plans and well permitting programs being implemented in the Modesto Subbasin.

2.6.1. Summary of General Plans and Groundwater Ordinances

Four cities and one county (including urban communities in the unincorporated areas) share land use planning responsibilities and authorities for the Modesto Subbasin. Most of the General Plans prepared by these entities contain goals and policies relating to water supplies, water use, and water resources. Land use designations, assumptions on growth, preservation of agricultural lands, or protection of environmental resources are examples of land use planning that could result in changes in water use over the planning horizon.

As part of GSP preparation, General Plans for Stanislaus County and the cities of Modesto, Oakdale, Riverbank and Waterford were reviewed. City and urban community boundaries and the Stanislaus County line are shown on **Figure 2-2**. Selected goals, policies, implementation measures, and issues from the General Plans are highlighted in the following sections with a focus on water resources and management.

2.6.1.1. Stanislaus County General Plan

In August 2016, Stanislaus County adopted its 2015 Comprehensive General Plan Update (County of Stanislaus, 2016). The General Plan area covers the entire County, which overlies portions of four groundwater subbasins, including the Modesto Subbasin as shown on **Figure 2-2**. Although the protection of natural resources in the County is a thread throughout the General Plan, a key goal with respect to water resources is contained in the Conservation/Open Space Element. That goal, along with associated policies and implementation measures are summarized in **Table 2-3**.

Although most of the County's population growth (96.8 percent) from 2000 to 2010 occurred in the incorporated areas, population increases in the 1990s created pressure to convert agricultural lands to non-agricultural use. In response to these conditions, county voters passed the *30-Year Land Use Restriction Initiative* (Measure E) in 2008. This measure requires that voters approve any future re-designation or re-zoning of agricultural or open space land use to residential use.

In addition, Stanislaus County has implemented a *Right-to-Farm Ordinance*. The County's ordinance establishes mechanisms designed to protect normal agricultural operations from pressures that can be created by urban neighbors. The County has also developed a *Farmland Mitigation Program* that requires any loss of farmland to residential development to be mitigated by the permanent protection of an equal amount of farmland. Agricultural Conservation easements granted in perpetuity are used as a means of minimizing farmland loss. Based on communications with the California Farmland Trust in October 2018, Agricultural Conservation easements continue to be granted and there are four parcels in Modesto, ranging from approximately 55 to 96 acres in size, with easements.

Notwithstanding the ongoing preservation of agricultural lands, the Stanislaus Council of Governments is projecting a population increase of 21.3 percent in the unincorporated areas by 2035 (from 110,236 to 133,753).

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Table 2-3: Selected Stanislaus County General Plan Goals and Policies

Table 2-3: Selected Stanislaus County General Plan Goals and Policies – Chapter Three: Conservation/Open Space Element		
Goal	**Policy**	**Implementation Measures**
Goal One. Encourage the protection and preservation of natural and scenic areas throughout the County	**Policy Three:** Areas of sensitive wildlife habitat and plant life (e.g., vernal pools, riparian habitats, flyways and other waterfowl habitats, etc.) including those habitats and plant species listed by state or federal agencies shall be protected from development and/or disturbance.	**1.** Review all development requests to ensure that sensitive areas (e.g., riparian habitats, vernal pools, rare plants, flyways, etc.) are left undisturbed or that mitigation measures acceptable to appropriate state and federal agencies are included in the project. **2.** In known sensitive areas, the State Department of Fish and Wildlife shall be notified as required by the California Native Plant Protection Act; the U.S. Fish and Wildlife Service also shall be notified. **3.** All discretionary projects that will potentially impact riparian habitat and/or vernal pools or other sensitive areas shall include mitigation measures for protecting that habitat. **4**. All discretionary projects within an adopted Airport Influence Area (AIA) that have the potential to create habitat, habitat conservation, or species protection shall be reviewed by the Airport Land Use Commission. **5.** Implementation of this policy shall not be extended to the level of an unconstitutional "taking" of property. **6**. Any ground disturbing activities on lands previously undisturbed that will potentially impact riparian habitat and/or vernal pools or other sensitive areas shall include mitigation measures for protecting that habitat, as required by the State Department of Fish and Wildlife.
Goal Two. Conserve water resources and protect water quality in the County	**Policy Five:** Protect groundwater aquifers and recharge areas, particularly those critical for the replenishment of reservoirs and aquifers.	**1**. Review proposals for urbanization in groundwater recharge areas to maximize recharge, prevent water quality degradation, and to not exacerbate groundwater overdraft. Areas susceptible to overdraft shall include a hydrogeological analysis and mitigation measures. Wastewater treatment may be required in areas susceptible to deterioration of groundwater quality. **2**. Department of Environmental Resources shall identify and require control of pollutants stored, handled, or disposed at the site. Groundwater monitoring programs will be adopted where hydrogeological assessment indicate the likely potential for groundwater deterioration. **3**. Stanislaus County shall discourage the use of dry wells for street drainage in urban areas to avoid contaminants reaching aquifers with beneficial uses. Storm water disposal systems shall be designed not to pollute receiving surface groundwater but integrated into an area-wide groundwater recharge program when feasible. **4**. Encourage new development to incorporate water conservation measures to minimize adverse impacts on water supplies. **5**. Continue to implement landscape provisions of the Zoning Ordinance, which encourage drought-tolerant landscaping and water-conserving irrigation methods. **6**. Encourage new urban development to be served by community wastewater treatment facilities and water systems rather than by package treatment plants or private septic tanks and wells.
	Policy Six: Preserve natural vegetation to protect waterways from bank erosion and siltation.	**1**. Development proposals and mining activities including, or in the vicinity of, waterways and/or wetlands shall be closely reviewed to minimize destruction of riparian habitat and vegetation. This includes referral to the US Army Corps of Engineers, US Fish and Wildlife Service, CA Depart. of Fish and Wildlife, and the CA Depart. of Conservation. **2**. Continue to encourage best management practices for agriculture and coordinate with soil and water conservation efforts of Stanislaus County Farm Bureau, Resource Conservation Districts, the US Soil Conservation Service, and local irrigation districts.
	Policy Seven: New development that does not derive domestic water from pre-existing domestic and public water supply systems shall be required to have a documented water supply that does not adversely impact Stanislaus County water resources.	**1**. Proposals for development to be served by new water supply systems shall be referred to appropriate water districts, irrigation district, community services district, the State Water Resources Board and any other appropriate agencies for review and comments. **2**. Review all development request to ensure a sufficient water supply to meet short and long-term water needs of the project without adversely impacting the quality and quantity of existing local water resources.
	Policy Eight: The county shall support efforts to develop and implement water management strategies.	**1**. The County will pursue state and federal funding options to improve water management resources in the County. **2.** The Department of Environmental Resources should continue to monitor groundwater quality for public water systems under the department's supervision and oversee investigations of soil and groundwater contamination. **3**. The County will coordinate with water purveyors, private landowners, and other water resource agencies in the region on data collection for groundwater conditions and in the development of a groundwater usage tracking system, including well location/construction mapping and groundwater level monitoring to guide future policy development. **4**. The County shall promote efforts to increase reliability of groundwater supplies through water resource management tools (surface water protection, conservation, public education, and expanded opportunities for conjunctive use of groundwater, surface water, and appropriately treated wastewater and stormwater reuse opportunities). **5.** The County will support and facilitate the formation of integrated, comprehensive county-wide regional water resources management plans, which incorporates existing water management plans and identifies and plans for management within the gaps between existing water management plans. **6**. The County will cooperate with other pertinent agencies, including cities and water district, in the preparation and adoption of a groundwater sustainability plan pursuant to SGMA and any subsequent legislation. The County will use its regulatory authority to implement the requirements of the groundwater sustainability plan. **7**. The County will obtain technical information and develop the planning/policies to improve groundwater recharge opportunities and groundwater conditions in the County. **8**. As information becomes available, the County will adopt General Plan changes to protect recharge areas and manage land use changes that have an impact on groundwater use and quality.

Table 2-3: Selected Stanislaus County General Plan Goals and Policies – Chapter Three: Conservation/Open Space Element (continued)		
Goal	**Policy**	**Implementation Measures**
	Policy Nine: The County will investigate additional sources of water for domestic use.	1. The County will work with irrigation and water districts, community services districts, municipal and private water providers in developing surface water and other potential water sources for domestic use.
Chapter Seven: Agricultural Element		
Goal One. Strengthen the agricultural sector of our economy.	**Policy 1.22:** The County shall encourage regional coordination of planning and development activities for the entire Central Valley.	**1.** The County shall participate in regional efforts to address long-range planning, infrastructure, conservation, and economic development issues facing the Central Valley.
Goal Two. Conserve our agricultural lands for agricultural uses.	**Policy 2.15:** In order to mitigate the conversion of agricultural land resulting from a discretionary project requiring a General Plan or Community Plan amendment from "Agriculture" to a residential land use designation, the County shall require the replacement of agricultural land at a 1:1 ratio with agricultural land of equal quality located in Stanislaus County.	**1.**Mitigation shall be applied consistent with the Farmland Mitigation Program Guidelines
Goal Three. Protect the natural resources that sustain our agricultural industry.	**Policy 3.4:** The County shall encourage the conservation of water for both agricultural, rural domestic, and urban uses.	**1.** The County shall encourage water conservation by farmers by providing information on irrigation methods and best management practices and coordinating with conservation efforts of the Farm Bureau, Resource Conservation Districts, Natural Resource Conservation Service, and irrigation districts. **2.** The County shall encourage urban water conservation and coordinate with conservation efforts of cities, local water districts and irrigation districts that deliver domestic water. **3.** The County shall continue to implement adopted landscape and irrigation standards designed to reduce water consumption in the landscape environment. **4.** The County shall work with local irrigation districts to preserve water rights and ensure that water saved through conservation may be stored and used locally, rather than "appropriated" and moved to metropolitan areas outside of Stanislaus County. **5.** The County shall encourage the development and use of appropriately treated water (reclaimed wastewater and stormwater) for both agricultural and urban irrigation.
	Policy 3.5: The County will continue to protect the quality of water necessary for crop production and marketing.	**1.** The County shall continue to require analysis of groundwater impacts in Environmental Impact Reports for proposed developments. **2.** The County shall investigate and adopt appropriate regulations to protect water quality.
	Policy 3.6: The County will continue to protect local groundwater for agricultural, rural domestic, and urban use in Stanislaus County.	**1**. The County shall implement the existing groundwater ordinance to ensure the sustainable supply and quality of local groundwater.

Table 2-3: Selected Stanislaus County General Plan Goals and Policies – Chapter One: Land Use Element (continued)		
Goal	**Policy**	**Implementation Measures**
Goal One. Provide for diverse land use needs by designating patterns which are responsive to the physical characteristics of the land as well as to environmental, economic, and social concerns of the residents of Stanislaus County**.**	**Policy 7:** Riparian habitat along the rivers and natural waterways of Stanislaus County shall, to the extent possible, be protected.	**1.** All requests for development which require discretionary approval and include lands adjacent to or within riparian habitat shall include measures for protecting that habitat to the extent that such protection does not pose threats to proposed site uses, such as airports.
Goal Four. Ensure that an effective level of public service is provided in unincorporated areas.	**Policy 24:** Future growth shall not exceed the capabilities/capacity of the provider of services such as sewer, water, public safety, solid waste management, road systems, schools, health care facilities, etc.	**2**. Development within a public water district and/or wastewater district shall connect to the public water system and/or the wastewater treatment facility; except where capacity is limited or connection to existing infrastructure is limiting, and an alternative is approved by the County's Department of Environmental Resources. For development outside a water and/or wastewater district, it shall meet the standards of the Stanislaus County Primary and Secondary Sewage Treatment Initiative (Measure X) and domestic water. **9**. The County will coordinate development with existing irrigation, water, utility, and transportation systems by referring projects to appropriate agencies and organizations for review and comment.
Goal Six. Promote and protect healthy living environments	**Policy 29**: Support the development of a built environment that is responsive to decreasing air and water pollution, reducing the consumption of natural resources and energy, increasing the reliability of local water supplies, and reduces vehicle miles traveled by facilitating alternative modes of transportation, and promoting active living (integration of physical activities, such as biking and walking, into everyday routines) opportunities.	**1**. County development standards shall be evaluated and revised, as necessary, to facilitate development incorporating the following (or similar) design features: • Alternative modes of transportation such as bicycle lanes, pedestrian paths, and facilities for public transit; • Alternative modes of storm water management (that mimic the functions of nature); and • Pedestrian friendly environments through appropriate setback, landscape, and wall/fencing standards.

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2.6.1.2. Stanislaus County Community Plans

The 2015 Update of the Stanislaus County General Plan includes Community Plans for two urban communities in the Modesto Subbasin including Del Rio and Salida (location on **Figure 2-2**).

Del Rio is a small community of approximately 2.1 square miles located north of the City of Modesto along the Stanislaus River. Del Rio is a mixed residential, recreational and agricultural community. Water is provided to portions of the community by the City of Modesto, while other areas are reliant on groundwater from private wells. Future development, which will require environmental review, would include low-density residential, natural open recreational space, and potential expansion of the Del Rio County Club golf course. Agricultural use would be confined to the southern portion of the community.

Salida is a small community of approximately 4,600 acres northwest of the City of Modesto along Highway 99. The community plan includes the existing community of Salida and an amendment area. The amendment area includes the Salida Area Planning, Road Improvement, Economic Development, and Farmland Protection Initiative approved by the Board of Supervisors in August 2007. Approximately one-third of the planned amended area is for industrial, one-third is for residential (low-density, medium density, and medium high-density), and one-third is for a business park, commercial and agriculture. Water is provided by the City of Modesto. Future development will require environmental review and an evaluation of water/sewer services.

2.6.1.3. Stanislaus County Groundwater Ordinance

In November 2014, Stanislaus County adopted a Groundwater Ordinance[3] to promote sustainable groundwater extraction in the unincorporated portions of Stanislaus County. The ordinance prohibits groundwater extractions that are unsustainable and prohibits exports of groundwater from the County. The ordinance references undesirable results as defined by SGMA and requires periodic reporting of groundwater information to the County Department of Environmental Resources that is “reasonably necessary to monitor the existing condition of groundwater resources within the County…”. The ordinance allows for well permits to be issued on a discretionary basis; applications for non-exempt wells must include substantial evidence that they will not withdraw groundwater unsustainably as defined in the ordinance. To comply with the ordinance, the County has developed its Discretionary Well Permitting and Management Program, described below in **Section 2.6.2**.

2.6.1.4. City of Modesto General Plan

The City of Modesto adopted its Urban Area General Plan in October 2008 to provide a planning horizon through 2025 (City of Modesto, 2008). Most of the City is located in the Modesto Subbasin, but a small portion is located south of the Tuolumne River in the Turlock Subbasin. The City of Modesto has established 23 comprehensive planning districts (CPD). Two of these, Whitmore/Carpenter CPD and Fairview CPD, are in the Turlock Subbasin,

[3] Chapter 9.37, County Code.

while the remaining 21 CPDs are in the Modesto Subbasin. The CPDs in the Modesto Subbasin include residential, commercial, business park, mixed use, and open space land uses, with a total of approximately 42,000 acres, 174,000 dwelling units and 277,000 jobs.

The General Plan for the City of Modesto identifies water as the most critical natural resource in California. Water supply in Modesto is from City owned and operated wells and treated surface water purchased from MID. There are some private wells within City limits in parks and golf courses, and for industrial and agricultural uses. The General Plan has a water goal, wastewater goal and storm drainage goal. The policies to achieve these goals are summarized in **Table 2-4**. This table is based on the October 2008 General Plan and some items may be out-of-date and will be updated, if needed, in future GSP analyses.

Table 2-4: Selected City of Modesto General Plan Goals and Policies

Table 2-4: Selected City of Modesto General Plan Goals and Policies - Community Services and Facilities	
Goal	**Policy**
General Water Goal Ensure a consistent, reliable, high-quality water supply for the City of Modesto and its customers.	**Water Policies—Baseline Developed Area** a. During review of all proposed development, the City shall require, as a condition of approval, that all developments reduce their potable water demand. The City should refer to Table 5-1 in the Joint Urban Water Management Plan for potential techniques to reduce potable water demand, as well as those identified in the City's current UWMP. b. The City's Public Works Director may require water infrastructure master plans for the public infrastructure or when otherwise pertinent to provision of service at adopted service levels for the specific plan areas or other projects depending on site issues and location. c. Individual development projects, including lot splits, are subject to review by the City's Public Works Director for adequate water supply. d. According to state law (Senate Bill 1087 of 2005), no provider of water services may deny or condition the approval of an application for services, or reduce the amount of the services applied for, if the proposed development includes housing affordable to lower income households, except upon making specific findings in accordance with SB 1087. e. All new connections to the public water system shall have meters installed. In addition, on or before January 1, 2025, all existing municipal and industrial service connections shall have water meters installed. On or before January 1, 2010, the City shall charge all customers with water meters based on the volume of water delivered. f. The City of Modesto shall prepare and adopt an Urban Water Management Plan every five years in accordance with Water Code Section 10621. g. The City shall implement the Demand Measurement and Conservation Measures identified in the City's adopted Urban Water Management Plan. h. The City of Modesto shall prepare and maintain a Water Master Plan. The Water Master Plan shall be updated, as needed, to incorporate changes in growth projections, water supplies, and demands. i. The City of Modesto should continue to pursue additional potential water supply alternatives available to the City to accommodate growth and meet future demand in both normal and dry years. j. The City of Modesto will encourage the optimum beneficial use of water resources within the City. The City shall strive to maintain an adequate supply of high-quality water for urban uses. At a minimum, potable water supplies (including well water) delivered to water customers shall conform to the primary maximum contaminant levels as defined in the California Code of Regulations, Title 22, Section 64431-64444. k. The City of Modesto will strive to stabilize groundwater levels and eliminate groundwater overdraft, as part of a conjunctive groundwater–surface water management program. The City shall view regional water resources, such as groundwater, surface water, and recycled wastewater, as an integrated hydrologic system when developing water management programs. l. The City of Modesto will be the sole provider of municipal and industrial water services to the area within the City's Sphere of Influence, with the exception of private wells. The City will cooperate with the overlying agricultural water providers, MID and TID, and with adjacent municipal and industrial providers for the mutually beneficial management of the limited water resources. The City will also take into consideration its public trust duty with regard to environmental uses of water resources. m. The City will provide water service within the original Del Este service area. n. Water facilities will be constructed, operated, maintained, and replaced in a manner that will provide the best possible service to the public. The City shall ensure that infrastructure is installed before or concurrently with development. The City will take a comprehensive approach to financing, using a blend of special taxes, benefit assessments, and other methods to ensure that infrastructure installation occurs in a timely manner. o. The City will continue to establish guidelines, policies, and programs to implement water conservation to the maximum extent feasible. Funding for large conservation rebate or exchange programs should be in place. The City shall strive to maximize the utilization of water resources when developing and implementing its Economic Development Strategy. p. The City of Modesto shall participate in the development of a TID Surface Water Supply Project (SWSP). q. The City of Modesto shall implement Local Basin Management Objectives (BMOs) discussed in the Integrated Regional Groundwater Management Plan that relate to the specific approaches to water management goals including groundwater supply, groundwater quality, and protection against inelastic land surface subsidence. r. The City of Modesto shall support the Regional BMOs discussed in the Integrated Regional Groundwater Management Plan. s. The City of Modesto should develop and implement a water recycling program to reduce the demands for new water supplies in the City and basin. *This section addresses the requirements of Government Code Section 66455.3 for proposed residential subdivisions of over 500 dwellings.* t. For projects within the City's water service area, a copy of any project application shall be sent to the City Public Works Department within 5 days of the application being accepted as complete for processing by the City of Modesto. u. When approving a proposed residential subdivision of over 500 dwelling units, the City of Modesto must include a condition requiring a sufficient water supply to be available. Proof of availability of water supply depends upon several factors.

Table 2-4: Selected City of Modesto General Plan Goals and Policies - Community Services and Facilities (continued)	
Goal	**Policy**
	This section addresses the requirements of Senate Bills 221 and 610 of 2001 that establish the requirement for public water systems to prepare water supply assessments for projects as follows: v. A project means any of the following (consistent with Water Code Section 10912): a proposed residential development of more than 500 dwelling units; a proposed shopping center or business establishment employing more than 1,000 persons or having more than 250,000 square feet of floor space; a proposed hotel or motel, or both, having more than 500 rooms; a proposed industrial, manufacturing, or processing plant, or industrial park planned to house more than 1,000 persons, occupying more than 40 acres of land, or having more than 650,000 square feet of floor area; a mixed-use project that includes one or more of the projects identified above; or a project that would demand an amount of water equivalent to, or greater than, the amount of water required by a 500 dwelling unit project. w. The City shall consider adopting more specific or restrictive standards for the definition of a project within its water service area. x. For projects requiring an environmental impact report, negative declaration, or mitigated negative declaration under CEQA, the City, as the retail water supplier, shall prepare a Water Supply Assessment (WSA) that complies with the requirements of SB 610 and SB 221 in evaluating the sufficiency of water supply to serve the project, and include the findings of the WSA in the CEQA document. *This section addresses the requirements of Senate Bill 2095 of 2000 (Government Code Section 65601 et seq.) that relate to the mandated use of recycled water for landscaping purposes as follows:* y. Any local public or private entity that produces recycled water and determines that within 10 years it will provide recycled water within the boundaries of the City of Modesto must notify the City of that fact. Within 180 days of receipt of the notice, the City of Modesto shall adopt and enforce a specified recycled water ordinance. The recycled water ordinance must comply with the recycled water policies detailed in the City of Modesto's UWMP.
	Water Policies—Planned Urbanizing Area a. All of the Water Policies for the Baseline Developed Area apply within the Planned Urbanizing Area. b. The City of Modesto shall coordinate land development projects with the expansion of water treatment and supply facilities.
General Wastewater Goal The objective of the City's wastewater system is to meet increasingly strict wastewater regulations in a cost-effective manner. As demand for water increases in California, reclaiming wastewater could create opportunities to optimize the region's water resources. Similar opportunities exist for the beneficial reuse of biosolids and digester gas, and other residuals of wastewater treatment.	**Wastewater Policies—Baseline Developed Area** a. To protect public health and the environment, the City's wastewater treatment facilities will conform to standards for wastewater and biosolids treatment and disposal, as established by the Central Valley Regional Water Quality Control Board, in compliance with the Federal Clean Water Act, the State Porter-Cologne Act, and their implementing regulations, current and future. b. The City shall support the near-term expansion of the wastewater treatment and disposal capacity of the Jennings Road Secondary Treatment Plant. c. The City shall support both wastewater collection and treatment system improvements and associated costs needed to serve the City's existing and future customers. d. Wastewater facilities will be constructed, operated, maintained, and replaced in a manner that will provide the best possible service to the public as required by federal and state laws and regulations. In developing implementation plans, consideration shall be given to rehabilitation of essential existing facilities, expansion to meet current excess demand, and the timely expansion for future demand. e. If available, the City shall provide wastewater services within the sewer service agreement area. f. The City of Modesto shall continue to support, develop, and research future water reclamation opportunities as a water resource. g. The City's wastewater system capacity will be allocated to existing and future residential, commercial, and industrial customers. Discharges from environmental cleanup sites may be issued conditional discharge permits subject to the availability of excess treatment capacity. In accordance with federal and state regulations, all discharges to the wastewater system may not, or may not threaten to, upset, interfere, or pass through the wastewater system. h. The City Engineer may require wastewater infrastructure master plans for the specific public infrastructure or when otherwise pertinent to provision of service at adopted service levels for the specific plan areas or other projects depending on site issues and location. i. Individual development projects, including lot splits, are subject to review by the City's Public Works Director for adequate wastewater collection service. j. Within the entire General Plan boundary and sewer service areas, the City shall avoid increasing the burden on existing septic systems that results from the addition of new plumbing fixtures. k. Subject to the approval of the Stanislaus Local Agency Formation Commission, the City of Modesto will be the sole provider of wastewater services to the area within the City's Sphere of Influence and sewer service area. l. Prior to annexation, the City must find that adequate wastewater treatment and disposal capacity can be provided for the proposed annexation. m. The City will encourage the regional beneficial reuse of reclaimed water. The City is committed to development of a full reclamation program in the long term. The City will comply with Title 22 standards for use of reclaimed water and criteria contained in the California Department of Public Health (CDPH) "Purple Book." n. The City shall strive to use land application of biosolids as the most environmentally beneficial reuse of this resource, rather than the disposal options of landfilling or incineration. o. The City shall develop methods to discontinue the current practice of using the sanitary system to temporarily drain stormwater runoff. p. The City shall establish odor buffer zones around primary and secondary wastewater plants, thereby minimizing the likelihood of odors impacting new residential or commercial development. q. The City shall utilize source control and demand management among its tools for accomplishing the most cost-effective wastewater management, protective of public health and the environment. r. The City shall establish 10th percentile river flows as the baseline condition for design to minimize risks of exceeding Waste Discharge Requirements (WDR) and National Pollution Discharge Elimination System (NPDES) permit requirements. s. According to state law (Senate Bill 1087 of 2004), no provider of wastewater services may deny or condition the approval of an application for services, or reduce the amount of the services applied for, if the proposed development includes housing affordable to lower income households, except upon making specific findings in accordance with SB 1087.

Table 2-4: Selected City of Modesto General Plan Goals and Policies - Community Services and Facilities (continued)	
Goal	**Policy**
	Wastewater Policies—Planned Urbanizing Area a. All of the Wastewater policies for the Baseline Developed Area apply within the Planned Urbanizing Area. b. The City of Modesto will require each new development project to be served with public sanitary sewers. Utilities located in private streets shall be part of the public sewerage system and shall be connected to a sewer lateral. c. The City of Modesto will coordinate land development proposals with the expansion of wastewater facilities.
General Storm Drainage Goal The City should have an operating storm drainage system that protects people and property from flood damage and that protects the environment.	**Stormwater Drainage Policies—Baseline Developed Area** a. One-third of the Baseline Developed Area is served by "rock wells." New rock wells shall be allowed only under very limited circumstances. New storm drainage in the Baseline Developed Area shall be by means of positive storm drainage systems unless otherwise approved by the City Engineer. The new storm drainage facilities shall consider the drainage facility requirements presented in Table 9-1 of the Final Master Environmental Impact Report and the SDMP. This policy applies to both positive storm drainage systems and to new rock wells (which are generally discouraged) in the Baseline Developed Area. b. MID shall be consulted during the preparation of drainage studies required by this General Plan. c. The City shall prevent water pollution from urban storm runoff as established by the Central Valley Regional Water Quality Control Board Basin Plan for surface discharges and the Environmental Protection Agency for underground injection. d. Stormwater drainage facilities shall be constructed, operated, maintained, and replaced in a manner that will provide the best possible service to the public, as required by federal and state laws and regulations. In developing implementation plans, consideration shall be given to rehabilitation of existing facilities, remediation of developed areas with inadequate levels of drainage service, and the timely expansion of the system for future development. e. The City shall update and maintain its Storm Drainage Master Plan to cover the entire area within the City's Sphere of Influence. The City of Modesto shall adopt the Storm Drainage Master Plan, in consultation with Stanislaus County, MID, and TID, to address the projected cumulative flows that would be discharged to MID and TID facilities from the urbanized drainage areas. The master drainage program should include the procedures for planning, evaluation, and design of necessary stormwater drainage facilities to ensure that facilities are capable of accommodating the additional flows. The master drainage program should include capital improvement, operations, and maintenance-financing plans necessary to ensure that facilities are constructed in a timely fashion to reduce the impacts from potential flooding problems. f. New development shall comply with City requirements for conveyance, retention, and detention. New development shall include onsite storage of stormwater as necessary. Rock wells shall not be allowed for new development except at infill areas smaller than three acres where no other feasible alternative is available. g. The City Engineer may require stormwater drainage infrastructure master plans for the public infrastructure or when otherwise pertinent to provision of service at adopted service levels for the specific plan areas or other projects depending on site issues and location. h. Construction activities shall comply with the requirements of the City's Stormwater Management Plan under its municipal NPDES stormwater permit, and the State Water Resources Control Board's General Permit for Discharges of Storm Water Associated with Construction Activity. i. For developments within a mapped 100-year floodplain, studies shall be prepared that demonstrate how the development will comply with both the construction and postconstruction programs under the City's municipal NPDES permit. Developments in these areas shall not lead to increased erosion or releases of other contaminants that would cause violations of the City's municipal NPDES permit. j. The City shall ensure that new development complies with the City of Modesto's *Stormwater Management Program: Guidance Manual for New Development Stormwater Quality Control Measures*.
	Stormwater Drainage Policies—Planned Urbanizing Area a. All of the Stormwater Drainage policies for the Baseline Developed Area apply within the Planned Urbanizing Area. b. The City of Modesto shall require each new development area to be served with positive storm drainage systems. A positive storm drainage system may be comprised of catch basins, pipelines, channels, recharge/detention basins, and pumping facilities that discharge stormwater to surface waters. New detention basins must typically include new technologies in their design that allow for full, healthy, and sustainable landscaping. The City of Modesto *Design Standards for Dual Use Flood Control / Recreation Facilities* manual is the guiding document for the development of these facilities. The positive storm drainage facilities shall consider the requirements presented in Table 9-1 of the Final Master Environmental Impact Report and the SDMP. c. The City of Modesto shall require positive storm drainage facilities in the Planned Urbanizing Area. Recharge shall be typically accomplished at recharge/detention basins, designed to be in compliance with applicable federal and state water quality regulations for both groundwater and surface water. d. Where feasible, dual-use flood control/recreation facilities shall be developed (dual-use facilities) as part of the storm drainage system. Dual-use facilities maximize efficient use of land and funds by satisfying needs for water quality, flood control, recreation, and aesthetics within a single consolidated facility. e. Dual-use facilities shall be designed and constructed in accordance with the standards in the City of Modesto *Design Standards for Dual Use Flood Control/Recreation Facilities* manual and the Open Space and Parks/Planned Urbanizing Area Policy e. f. New developments shall be required to implement an appropriate selection of permanent pollution control measures in accordance with the City's implementation policies for the municipal NPDES stormwater permit. Permanent erosion control measures such as seeding and planting vegetation for new cut-and-fill slopes, directing runoff through vegetation, or otherwise reducing the off-site discharge of particulates and sediment are the most effective method of controlling off-site discharges of urban pollutants.

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2.6.1.5. City of Oakdale General Plan

The City of Oakdale is a small community spanning six square miles along the Stanislaus River in the northern region of the Modesto Subbasin (**Figure 2-2**). Oakdale adopted its 2030 General Plan (ESA, 2013) and anticipates an increase in population from approximately 21,000 in 2011 to 35,000 in 2030. This population growth is expected to require an increase in demand for residential, industrial, public/semi-public, retail and office development. Oakdale is completely reliant on groundwater for its water supply. The City is surrounded by agricultural lands consisting mostly of orchards. Water resource goals and policies from the Oakdale General Plan are summarized in **Table 2-5**.

Table 2-5: Selected City of Oakdale General Plan Goals and Policies

Goal	Policy
Goal PF-1 A sustainable supply of water delivered through an efficient infrastructure system to meet existing and future needs.	
Water Service Policies	
	PF-1.1 Reliable Supply and Distribution. Maintain a reliable supply of high quality water and a cost-effective distribution system to meet normal and emergency demands in both wet and dry years.
	PF-1.2 Urban Water Management Plan. Regularly review and update the City's Urban Water Management Plan and other water master planning and capital improvement tools to ensure adequate water supply, infrastructure, maintenance, rehabilitation, funding and conservation measures.
	PF 1.3 New Development. Require new development to demonstrate the availability of adequate water supply (either existing water supply or provision of new water sources) and infrastructure in accordance with city plans and standards. Ensure that new development constructs, dedicates and/or pays its fair share contribution to the water supply, treatment, storage, and distribution system necessary to serve the demands created by the development.
	PF 1.4 Existing OID Facilities. Coordinate with OID on the potential abandonment, relocation and/or reuse of existing facilities and easements within the City where appropriate.
	PF-1.5 Water Well Use. Discourage the use of private wells for domestic water use when connection to the City's water system is feasible.
	PF-1.6 Groundwater. Monitor and protect the quality and quantity of groundwater.
	PF-1.7 Groundwater Recharge. Preserve areas that provide important groundwater recharge capabilities such as undeveloped open space and natural drainage areas.
	PF-1.8 Regional Coordination. Continue to coordinate with other jurisdictions and agencies in preparing, and regularly reviewing and updating regional groundwater management plans to ensure acceptable groundwater quality and to minimize the potential for aquifer overdraft.
	PF-1.9 Surface Water. Work with the Oakdale Irrigation District to explore the potential use of surface water as future demands for groundwater increase.

Goal	Policy
	PF-1.10 Drinking Water Standards. Continue to provide domestic water that meets or exceeds state and federal drinking water standards by providing well water treatment, when necessary.
	PF-1.11 Energy Efficiency. Employ best practices to maintain the highest possible energy efficiency in the water infrastructure system to reduce costs and greenhouse gas emissions.
Water Conservation Policies	
	PF-1.12 Water Conservation Programs. Implement the City's water conservation program and amend the program as appropriate to reflect evolving technologies and best practices, consistent with the Oakdale Climate Action Plan.
	PF-1.13 Building and Site Design. Require new development to incorporate water saving techniques such as water efficient fixtures, drought-tolerant landscaping, on-site stormwater capture and re-use, and on-site commercial/industrial water reuse in accordance with state and other relevant standards.
	PF-1.14 Recycled Water. Explore opportunities to use recycled water in the city.
	PF-1.15 Water Education. Educate residents and businesses about the importance of water conservation and associated techniques and programs.
Goal NR-4: Water Resources and Quality	
Water Resource Protection Policies	
	NR-4.1 Stanislaus River. Protect surface water resources in Oakdale, including the Stanislaus River.
	NR-4.2 Groundwater Management Plan. Continue to work with applicable agencies to prepare, regularly review, update, and implement regional groundwater management plans to ensure the sustainability of groundwater quality and quantity.
	NR-4.3 Natural Open Space Areas. Preserve areas that provide important groundwater recharge, stormwater management, and water quality benefits such as undeveloped open spaces, natural habitat, riparian corridors, wetlands, and other drainage areas.
WATER QUALITY PROTECTION POLICIES	
	NR-4.4 National Pollution Discharge Elimination System. Regulate construction and operational activities to incorporate stormwater protection measures and best management practices in accordance with the City's National Pollution Discharge Elimination System (NPDES) permit.
	NR-4.5 Industrial, Agricultural, and Septic System Discharge. Regulate discharge from industrial users, use of agricultural chemicals (pesticides) and use of septic systems in accordance with local and State regulations to protect the City's natural water bodies.
	NR-4.6 Regulation of Runoff. Protect Oakdale's water resources from contamination by regulating stormwater collection and conveyance to ensure pollutants in runoff have been reduced to the maximum extent practicable.
	NR-4.7 New Development. Require new development to protect the quality of

Goal	Policy
	surface and groundwater bodies and natural drainage systems through site design, stormwater treatment, low impact development measures, and best management practices.
	NR-4.8 Regional Coordination. Coordinate and collaborate with agencies in the region and watershed to address water quality issues.
	NR-4.9 Education. Educate the public about practices and programs to minimize surface water and groundwater pollution.

2.6.1.6. City of Riverbank General Plan

The City of Riverbank updated its General Plan with a vision from 2005 to 2025 (City of Riverbank, 2009). Riverbank is small community located north of the City of Modesto along the Stanislaus River with a population of approximately 22,000 in 2008. The 2025 vision preserves the small-town character while anticipating population growth to approximately 52,500. Land use changes under the 2005-2025 Riverbank General Plan include residential, open space, commercial, industrial, multi-use recreation, mixed use, parks and civic. Water resources goals and policies from the Riverbank General Plan are summarized in **Table 2-6**.

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Table 2-6: Selected City of Riverbank General Plan Goals, Policies, and Implementation Strategies

Table 2-6: Selected City of Riverbank General Plan Goals, Policies, and Implementation Strategies		
Goal	**Policy**	**Implementation Strategies**
Goal DESIGN-19 Water Quality is Protected Throughout the Development Process and Occupation of the Site	**19.1** The City will establish site design criteria for allowing natural hydrological systems to function with minimum or no modification. **19.2** The City will promote the use of rain gardens, open ditches or swales, and pervious driveways and parking areas in site design to maximize infiltration of storm water and minimize runoff into environmentally critical areas. **19.3** The City will promote inclusion of passive rainwater collection systems in site and architectural design for non-potable water (gray-water) storage and use, thereby saving potable (drinking) water for ingestion.	
Goal CONS-4 Preserve Habitat Associated with the Stanislaus River While Increasing Public Access	**4.1** Approved projects, plans, and subdivisions shall avoid conversion of habitat within the existing Stanislaus River riparian corridor, including Great Valley Mixed Riparian Forest, Great Valley Willow Scrub, and Riparian Scrub areas, and shall preserve an open space buffer along the Stanislaus River and associated riparian areas. The open space buffer shall be designed to avoid impacts to habitat and special status species in the riparian corridor, as specified in Policy CONS 5.1, Policy CONS 5.2, Policy CONS 5.3, and Policy CONS 5.6, based on project specific biological resource assessment. The precise size of buffer from the river and associated riparian corridor is to be determined by site specific analysis. The riparian corridor preservation and open space buffer shall be provided through a permanent covenant, such as a conservation easement and shall also include an ongoing maintenance agreement with a land trust or other qualified nonprofit organization. The preservation of the riparian corridor and ongoing maintenance agreement is required prior to City approval of any subdivision of property or development project located in areas outside City limits as of January 1, 2007 (see Figure CONS-1). Low impact recreation could be allowed in this buffer area to the extent that impacts to these sensitive habitats are avoided or fully mitigated by demonstrating no net loss of habitat functions or value. Urban development shall not be allowed in this buffer area. **4.2** Approved projects, plans, and subdivisions shall provide for collection, conveyance, treatment, detention, and other stormwater management measures in a way that does not decrease water quality or alter hydrology in the Stanislaus River or associated groundwater recharge areas.	**1.** Development projects and subdivisions will be consistent with, and implement land use planning and greenhouse gas emission reduction measures developed pursuant to the regional Sustainable Community Strategy (per SB 375 of 2008), and consistent with Countywide and regional agricultural preservation planning, to the maximum extent feasible. In determining feasibility, there is a recognized need to balance the importance of agricultural resource conservation with other needs of Riverbank, such as State defined affordable housing, air quality, noise, water usage, and other public resources and services.
Goal CONS-6 Maintain or Increase Surface and Groundwater Quality Supply	**6.1** The City will require that waterways, floodplains, watersheds, and groundwater recharge areas are maintained in their natural condition, wherever feasible. **6.2** The City will coordinate with appropriate regional, state, and federal agencies to address local sources of groundwater and soil contamination, including underground storage tanks, septic tanks, agriculture, and industrial uses. **6.3** Approved projects, plans, and subdivisions in new growth areas shall incorporate natural drainage system design that emphasizes infiltration and decentralized treatment (rather than traditional piped approaches that quickly convey stormwater to large, centralized treatment facilities). **6.4** The City will encourage the use of permeable surfaces for hardscape. Impervious surfaces such as driveways, streets, and parking lots will be minimized so that land is available for a natural drainage system to absorb stormwater, reduce polluted urban runoff, recharge groundwater, and reduce flooding. **6.5** City street standards and parking requirements will balance the needs of transportation with the full range of community planning issues, including water quality, storm drainage, air quality, and other considerations. **6.6** The City will encourage the use of recycled water for appropriate use, including but not limited to outdoor irrigation, toilet flushing, fire hydrants, and commercial and industrial processes. **6.7** The City will require mitigation measures, in coordination with the Regional Water Quality Control Board, as a part of approved projects, plans, and subdivisions to address the quality and quantity of urban runoff, including that attributable to soil erosion.	**3.** The City will update the water, wastewater, and stormwater drainage master plans at least every five years to ensure the appropriate level of service is maintained as the City grows, and to ensure that appropriate projects are include in capital improvements planning and can be funded. The City will cooperate with local irrigation districts and public agencies to explore feasible surface water supplies or conjunctive use opportunities.

Table 2-6: Selected City of Riverbank General Plan Goals, Policies, and Implementation Strategies (continued)		
Goal	**Policy**	**Implementation Strategies**
Goal PUBLIC-2 Adequate Supply of Quality Water to Serve Existing and Future Project Development Needs	**2.1** The City will require that water supply, treatment, and delivery meet or exceed local, State, and federal standards. **2.2** The City will manage and enhance the City's water supply and facilities to accommodate existing and planned development, as identified in the City's Water Master Plan, Urban Water Management Plan, and Groundwater Source Efficiency Report. **2.3** New developments shall incorporate water conservation techniques to reduce water demand in new growth areas, including the use of reclaimed water for landscaping and irrigation. **2.4** The City will condition approval of new developments on demonstrating the availability of adequate water supply and infrastructure, including multiple dry years, as addressed in the City's Water Master Plan, Urban Water Management Plan, and Groundwater Source Efficiency Report. **2.5** The City will not induce urban development by providing provide water services in areas outside the Planning Area or areas not planned for urban development, such as areas designated for agriculture or open space.	**3.** The City will update the water, wastewater, and stormwater drainage master plans at least every five years to ensure the appropriate level of service is maintained as the City grows, and to ensure that appropriate projects are include in capital improvements planning and can be funded. The City will cooperate with local irrigation districts and public agencies to explore feasible surface water supplies or conjunctive use opportunities.
Goal PUBLIC-4 Storm Drainage Systems that Protect Public Safety, reserve Natural Resources, and Prevent Erosion and Flood Potential	**4.1** The City will maintain and improve, as necessary, existing public storm basins and flood control facilities, as identified in the Stormwater Master Plan. **4.2** The City will coordinate with County and Regional agencies, as well as the railroad, in the maintenance and improvement of storm drainage facilities to protect the City's residents, property, and structures from flood hazards. **4.3** The City will consider a variety of means for floodplain management, depending on the context, which may include development, improvement, and maintenance of structural flood control facilities; land use policy and zoning to prohibit incompatible urban development within the floodplain; erosion control techniques; setbacks from flood-prone areas; and other measures, as circumstances dictate. **4.4** The City will identify areas, such as wetlands, low-lying natural runoff areas, and pervious surfaces and percolation ponds, for natural storm water collection and filtration, in concert with the City's existing and future drainage infrastructure, to help reduce the amount of runoff and encourage groundwater recharge. **4.5** New development shall be designed to control surface runoff discharges to comply with the National Pollutant Discharge Elimination System Permit and the receiving water limitations assigned by the Regional Water Quality Control Board. **4.6** The City will establish that new development shall implement nonpoint source pollution control measures and programs designed to reduce and control the discharge of pollutants into the City's storm drains and river. **4.7** The City will require minimization of the amount of new impervious surfaces and directly connected impervious surfaces in areas of new development and redevelopment and, where feasible, maximize onsite infiltration of stormwater runoff. **4.8** The City will encourage pollution prevention methods, supplemented by pollutant source controls and treatment. Use small collection strategies located at, or as close to possible to the source (i.e., the point where water initially meets the ground) to minimize the transport or urban runoff and pollutants off-site. **4.9** The City will require the preservation and, where possible, will encourage that creation or restoration of areas that provide important water quality benefits, such as riparian corridors, wetlands, and buffer zones. **4.10** The City will limit disturbances of natural water bodies and natural drainage systems cause by development, including roads, highways, and bridges. **4.11** The City will require that new development avoid development in areas that are particularly susceptible to erosion and sediment loss; or will require that these areas are identified and protected from erosion and sediment loss. **4.12** The City will encourage and/or require the use of open, vegetated swales, stormwater cascades, and small wetland ponds instead of pipes and vaults, as a part of urban development proposed outside current City limits to mitigate stormwater impacts. **4.13** The City will enforce a no-net-runoff policy for areas proposed for development outside the current City limits.	**1.** The City will coordinate with area reclamation districts, Stanislaus County, the City of Modesto, and other agencies and jurisdictions for planning and coordinating drainage programs and policies on an areawide and regional basis.

2.6.1.7. City of Waterford General Plan

Waterford is a small community covering approximately 2.4 square miles along the Tuolumne River with a population of approximately 8,000 (**Figure 2-2**). In 2017, the City of Waterford updated its General Plan with a vision towards 2025, to plan for future growth that could double, triple or even quadruple its population over the next 20 to 30 years (Waterford Planning Department, 2007). The General Plan anticipates the need for future residential development and recognizes the need to accommodate business and industry.

Waterford is completely reliant on groundwater for water supply. Waterford currently owns and operates its water system, but before July 1, 2015, the City of Modesto provided water service to Waterford. Several policies in the General Plan address water, including Preserve and Enhance Water Quality, Promote Water Conservation Throughout the Planning Area and Use of Sustainable or "Green" Building Principals to Promote Water Conservation. Selected goals, policies and implementing actions in Waterford's General Plan are summarized on **Table 2-7**.

2.6.1.8. Tuolumne River Regional Park Master Plan

The Tuolumne River Regional Park (TRRP) Master Plan was developed in December 2001 for the Joint Powers Authority including the City of Modesto, City of Ceres and Stanislaus County (EDAW, Inc., 2001). The overall goals of the TRRP are to:

- Create a park where the recreational experience is oriented towards and compatible with the Tuolumne River, its water, natural resources, and processes.
- Provide a park that is a source of pride for the citizens of Stanislaus County and reflects and accommodates the County's diverse peoples and cultures.

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Table 2-7: Selected City of Waterford General Plan Goals, Policies, and Implementing Actions

Table 2-7: Selected City of Waterford General Plan Goals, Policies, and Implementing Actions		
Goal	**Policy**	**Implementing Actions**
Public Services and Facilities • Adequate Public Services and Facilities to Meet the Needs of the City's Residents • Cost-Effective Public Service Delivery Systems and Facilities • Public Services and Facilities Standards that are Applied Uniformly Throughout the City	**PF-1.3** Establish and Maintain a Program for Cost Effective Expansion of Municipal Services and Facilities to Meet Future Community Growth Needs. **PF-1.5** Assure that Expansion of the City Results in the Enhancement of Municipal Services and Facilities within Waterford Without Increasing Costs to The Existing City.	**PF-1.3.a** The City shall prepare and maintain master plans for the provision of sewer, water, storm drainage, streets and roadways and other public facilities and infrastructure for the service of the existing City and for the planned expansion of the City boundaries. **PF-1.5.j** Extension of infrastructure to newly annexed areas shall utilize the City's master plans for sewer, streets, storm drain, water and other infrastructure.
Urban Design • A Rural Community with a Unique Identity. • A Well Defined Urban Center. • An Integrated Community-Well Connected.	**UD-10** Maintain and Enhance the Unique Community Appearance of Waterford.	**UD-10d.** Encourage the development of methods to require acceptable levels of landscaping for new development and for landscaping maintenance in highly visible areas of the community. Landscape designs shall incorporate water conservation and low maintenance features.
Open Space for the Preservation of Natural Resources • OS-Maintain Waterford's Biological Resources. • OS-Maintain a High-Quality, Expanding Urban Forest • OS-Preserve Scenic Corridors and Resources • OS-Improve and Enhance Water Quality	**OS-A-1a** Identify, and recognize as significant, wetland habitats which meet the appropriate legal definition of federal and state law. **OS-A-2** Preserve and Enhance Tuolumne River and Dry Creek in Their Natural State Throughout the Planning Area. **OS-A-2c** Encourage alternatives to concrete channeling of existing natural drainage courses as part of any flood control project and support more natural flood control methods. **OS-A-5** Preserve and Enhance Water Quality.	**OS-A-5a.** Utilize storm water retention basins and other "Best Management Practices" to improve the quality of storm water discharged into the region's natural surface water system. **OS-A-5b** Monitor known sources of groundwater contamination within the City and its future expansion area. **OS-A-5c.** Periodically monitor the quality of surface water in the surface water system within the City and implement programs to minimize or eliminate sources of pollution. **OS-A-5d** Monitor ground water in areas in and around the City using septic system wastewater disposal systems.
Conservation of Resources • OS-Conserve Water Resources • OS-Preserve and Protect Soil Resources	**OS-E-1** Promote Water Conservation Throughout the Planning Area.	**OS-E-1a Develop and enforce water conservation policies and standards.** The City should consider adoption of a water conservation ordinance. **OS-E-1b Develop a Water Efficient Landscaping and Irrigation Ordinance.** Promote the conservation of water and the preservation of water quality by requiring drought tolerant plant material in landscaping and the retention of existing natural vegetation on new development projects. **OS-E-1c Provide leadership in conserving urban water resources.** City buildings and facilities should be equipped with water saving devices whenever practical. Municipal parks and playgrounds should employ water conservation techniques such as mulching, drip irrigation and other appropriate technologies. **OS-E-1d Encourage public water conservation efforts.** Through established public information systems in the community, the City should promote water conservation by providing information on water savings from low-flow fixtures and the value of insulating hot water lines in water re-circulating systems. Other conservation techniques can be addressed, such as the use of non-potable water for landscape irrigation purposes (water re-use, MID water, etc.).
Sustainable Design • SD-Sustainable "Green" Buildings City of Waterford. • SD- Application of "Green" or High Performance Building Technology	**SD-5.2** Use of Sustainable or "Green" Building Principals to promote Water Conservation.	**SD-5.2a. Manage Site Water** Create on-site small scale water features as part of landscape design that can serve as onsite storm water detention and minimize storm-water runoff during peak winter storm periods. **SD-5.2b. Use Gray Water Systems** Design landscape areas to make maximum use of treated wastewater or "purple pipe" systems. **SD-5.2c. Conserve Building Water Consumption** Use low flow water fixtures throughout the building.

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2.6.2. Stanislaus County Discretionary Well Permitting and Management Program

Well permitting processes have been established by Stanislaus County to implement county-wide groundwater ordinances that prevent export and overdraft and to ensure proper well construction and abandonment for the protection of groundwater resources. These processes are summarized below. Cities maintain control of well permitting within their city limits.

To implement the 2014 Stanislaus County Groundwater Ordinance (described above in **Section 2.6.1.3**), the County has developed its Discretionary Well Permitting and Management Program to prevent the unsustainable extraction from new wells subject to the Stanislaus County Groundwater Ordinance. The objectives of the Program, as stated in the County Programmatic Environmental Impact Report for the Program (PEIR), are as follows:

- Avoid or minimize potential adverse environmental impacts from the unsustainable extraction of groundwater resources, including, but not limited to, increased groundwater overdraft, land subsidence, uncontrolled movement of inferior quality groundwater, the lowering of groundwater levels, and increased groundwater degradation (Stanislaus County Code § 9.37.020 (4)); and

- Avoid or minimize potential adverse economic impacts from the unsustainable extraction of groundwater resources, including, but not limited to, loss of arable land, a decline in property values, increased pumping costs due to the lowering of groundwater levels, increased groundwater quality treatment costs, and replacement of wells due to declining groundwater levels, replacement of damaged wells, conveyance infrastructure, roads, bridges and other appurtenances, structures, or facilities due to land subsidence (Stanislaus County Code § 9.37.020 (5)). (Stanislaus County, March 2018).

The County program is designed to work cooperatively with SGMA and incorporates authorities and requirements provided under this GSP. In brief, the Program involves a discretionary well permitting process in non-exempt areas[4] of the County for all non-de minimis extraction in compliance with the Ordinance. After GSP adoption, the discretionary well permit program will apply to the installation of any new well or regulation of groundwater extraction from any existing well if the County reasonably concludes that a new or existing well is not in compliance with the GSP. The program includes a permit renewal process in five-year increments that coincides with the five-year GSP updates required by the GSP regulations.

[4] Exempt areas include incorporated areas and areas within the service area of a public water agency in compliance with a Groundwater Management Plan or GSP.

The Well Application review process, along with an application package and required mitigation measures, can be downloaded from the Stanislaus County website at: http://www.stancounty.com/er/pdf/application-packet.pdf.

2.6.3. How the General Plans and the GSP Affect the Other

In general, the General Plans reviewed in this section are accommodating population growth in the Subbasin, while preserving other beneficial uses of water by agriculture and the environment, which will result in increased water demands in the Subbasin. However, most of the plans recognize the need for water conservation, alternative supplies, and resource management. Many, especially the more recent plans, acknowledge the need for sustainable groundwater management. Ordinances for Stanislaus County incorporate the GSP planning process and SGMA requirements into specific programs, as described above.

All of the agencies with land use planning responsibilities and authorities are also STRGBA GSA member agencies. In addition, three member agencies (i.e., City of Modesto, OID, and Stanislaus County) are members of GSAs in neighboring subbasins which will help to ensure a high level of coordination in the GSP process. No conflicts between these land use plans and the Modesto Subbasin GSP have been identified.

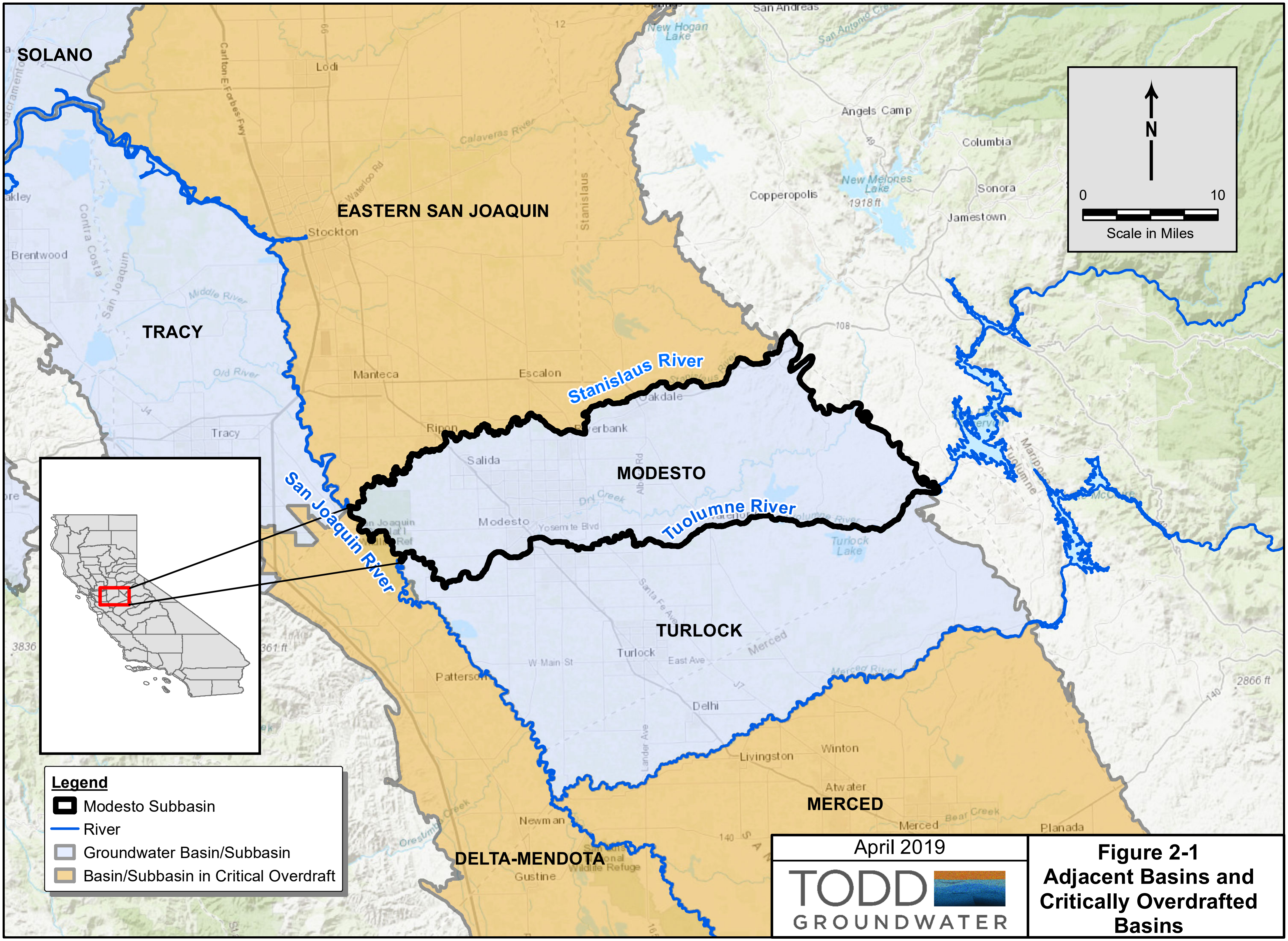
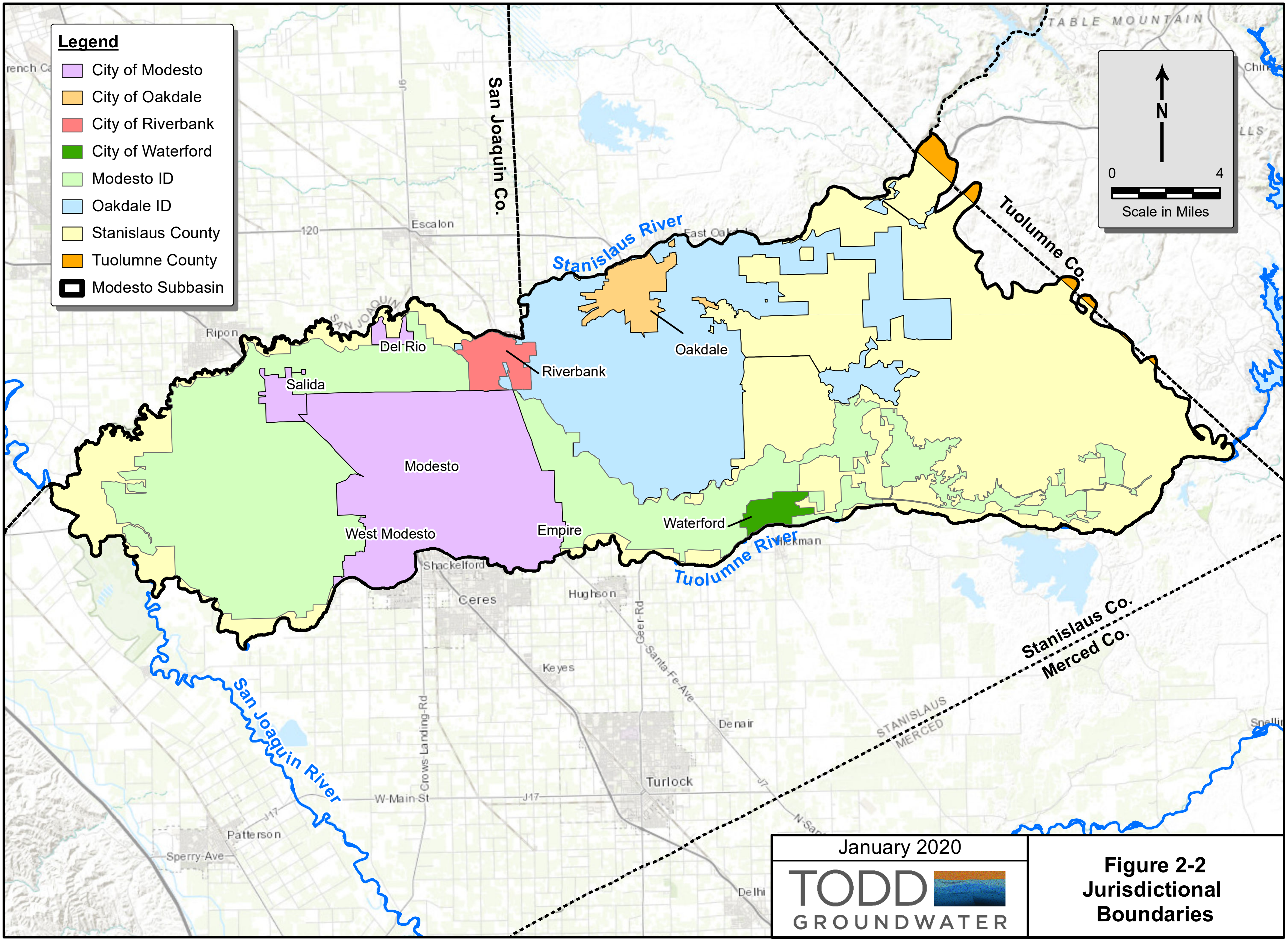


Figure 2-1
Adjacent Basins and Critically Overdrafted Basins



January 2020

TODD GROUNDWATER

Figure 2-2
Jurisdictional Boundaries

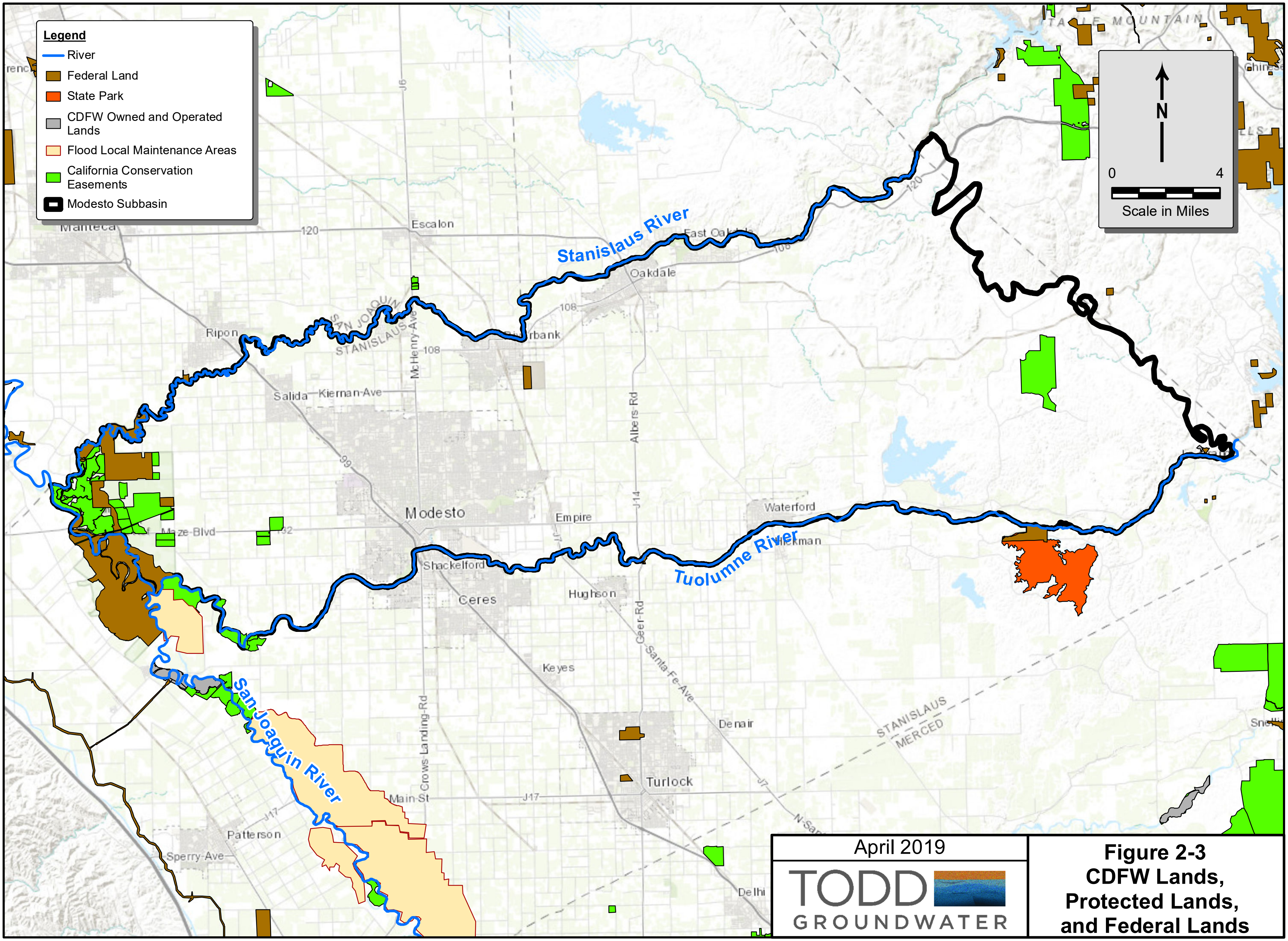
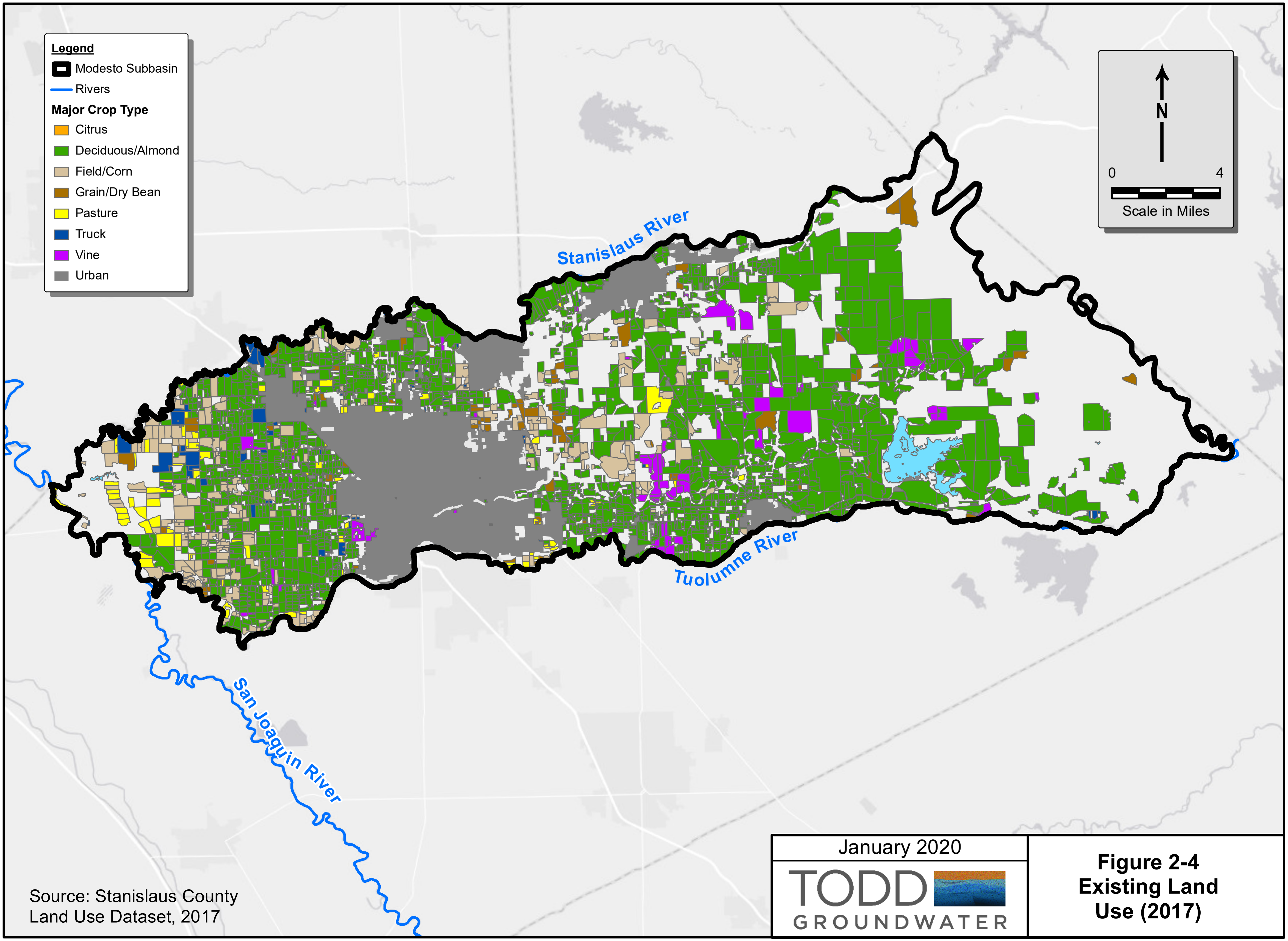


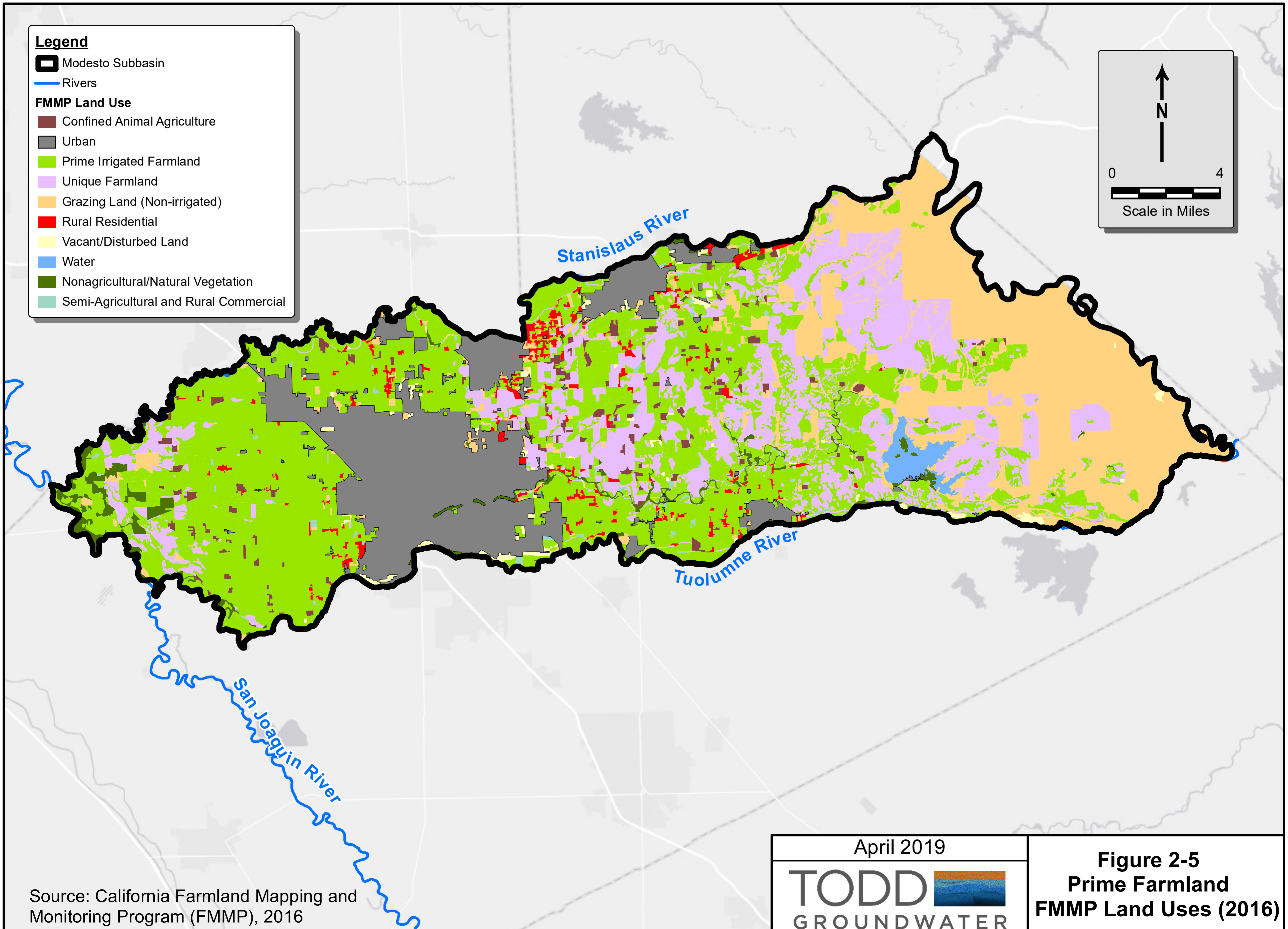
Figure 2-3
CDFW Lands, Protected Lands, and Federal Lands



January 2020

TODD GROUNDWATER

Figure 2-4
Existing Land Use (2017)



Source: California Farmland Mapping and Monitoring Program (FMMP), 2016

April 2019

TODD GROUNDWATER

Figure 2-5
Prime Farmland
FMMP Land Uses (2016)

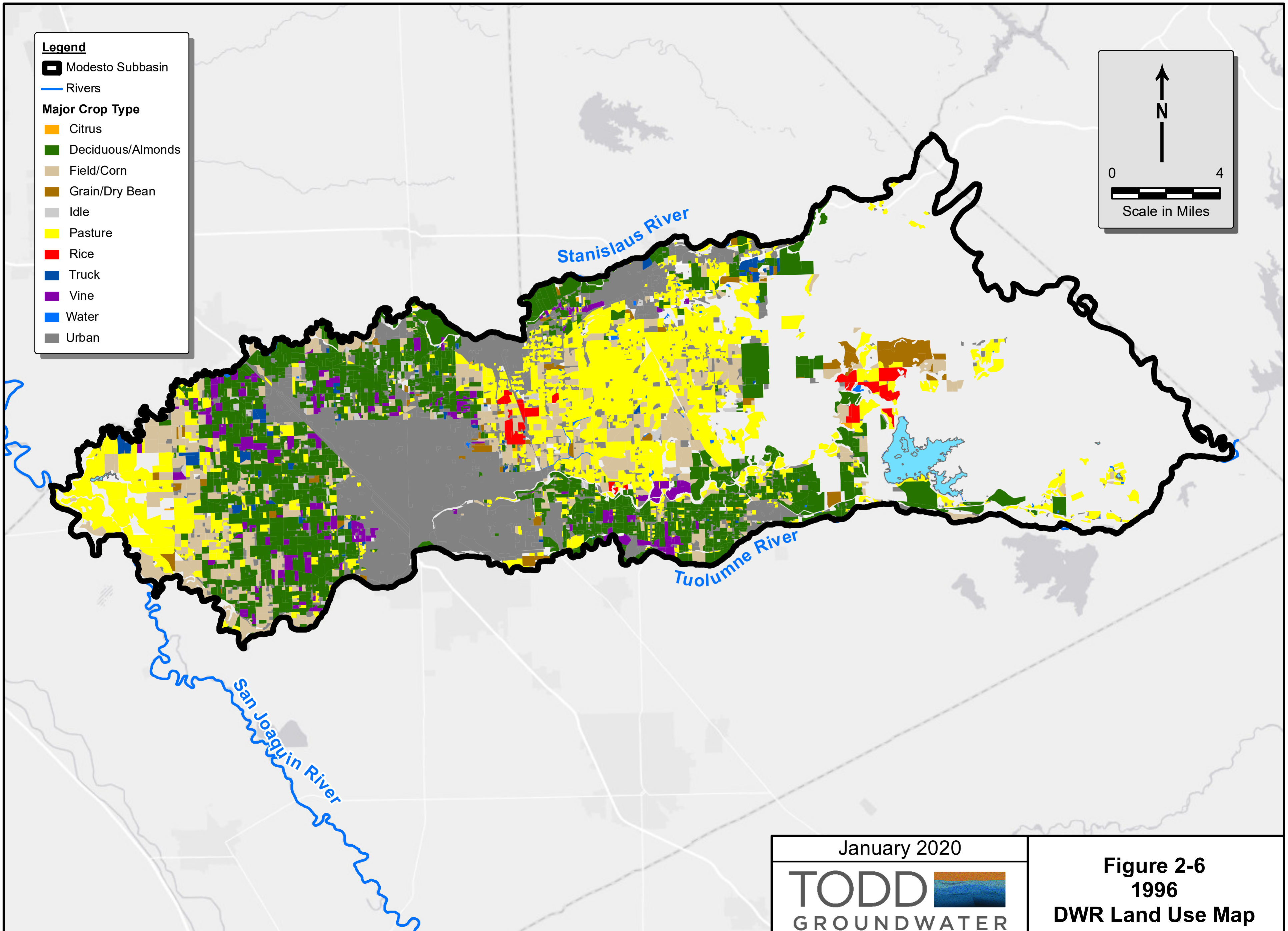
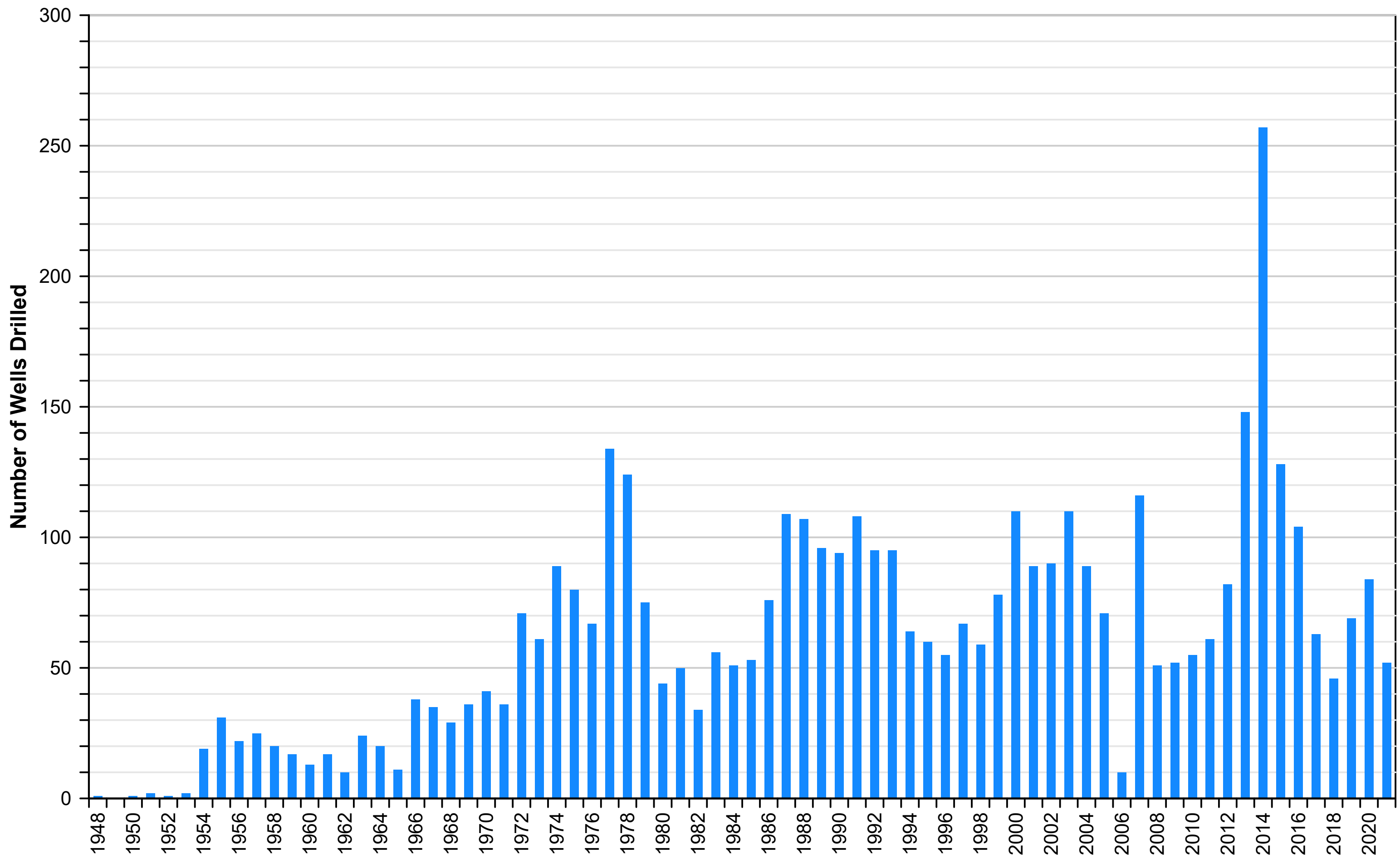


Figure 2-6
1996
DWR Land Use Map

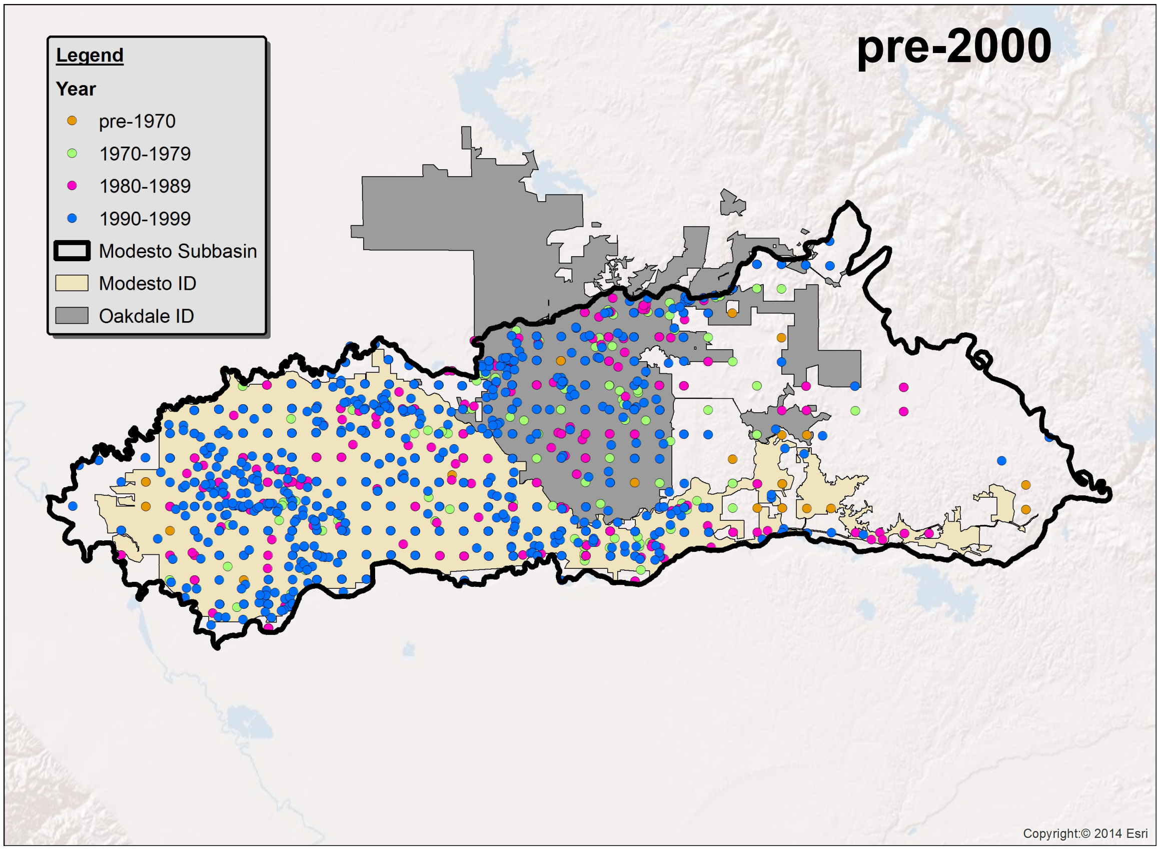


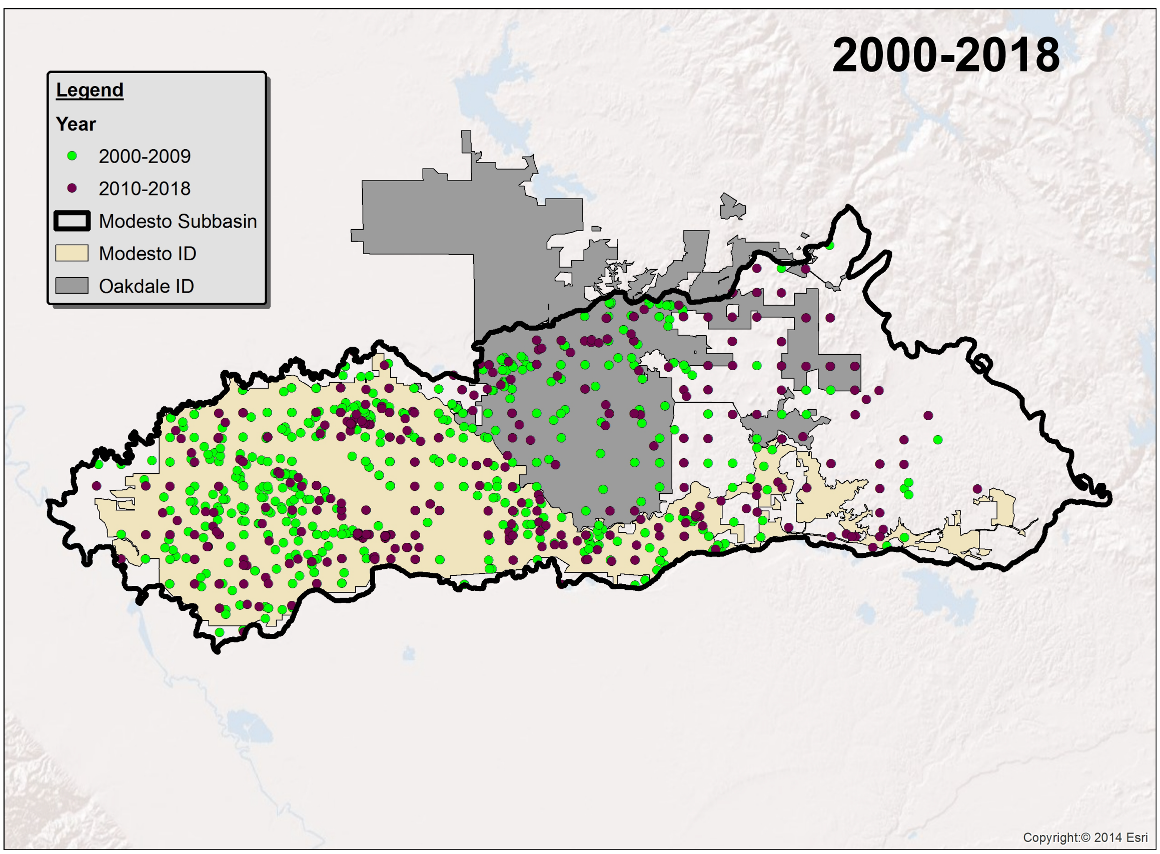
Source: DWR Well Completion Report Database.

November 2021

TODD GROUNDWATER

Figure 2-7
Number of Wells Drilled in Modesto Subbasin



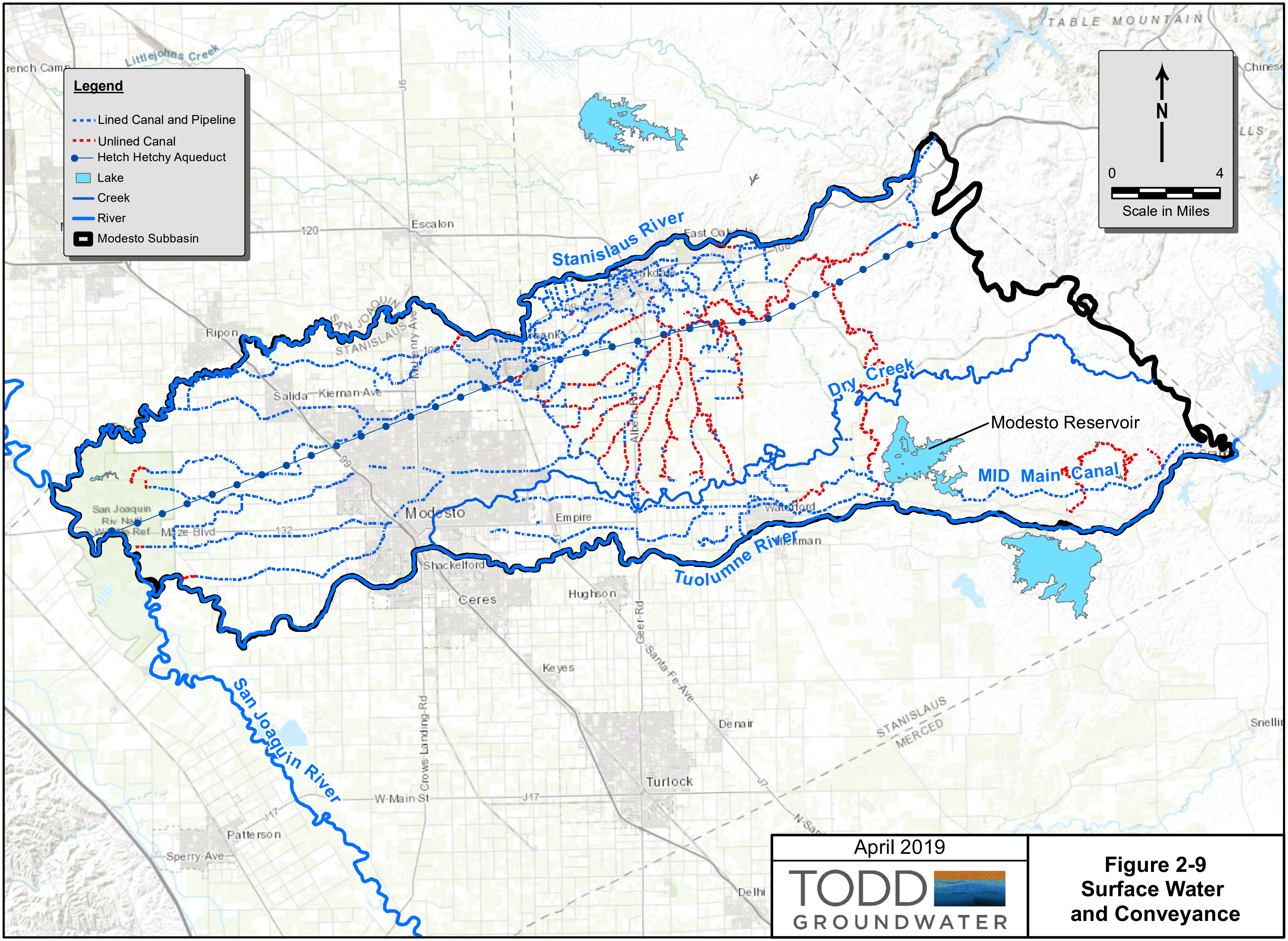


Source: DWR Well Completion Report Database

April 2019

TODD GROUNDWATER

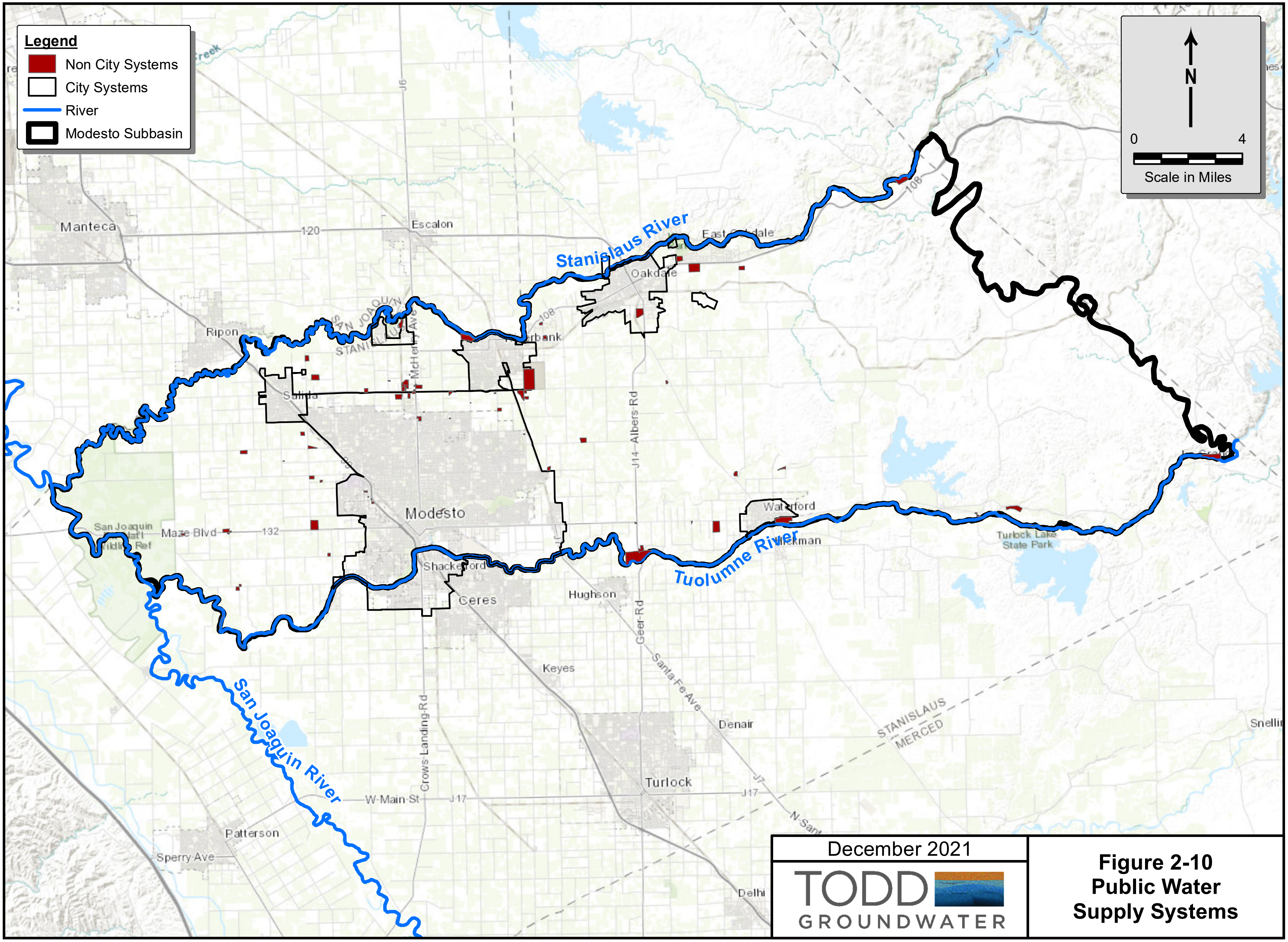
Figure 2-8
Modesto Subbasin Wells



April 2019

TODD GROUNDWATER

Figure 2-9
Surface Water and Conveyance



December 2021

TODD GROUNDWATER

Figure 2-10
Public Water Supply Systems

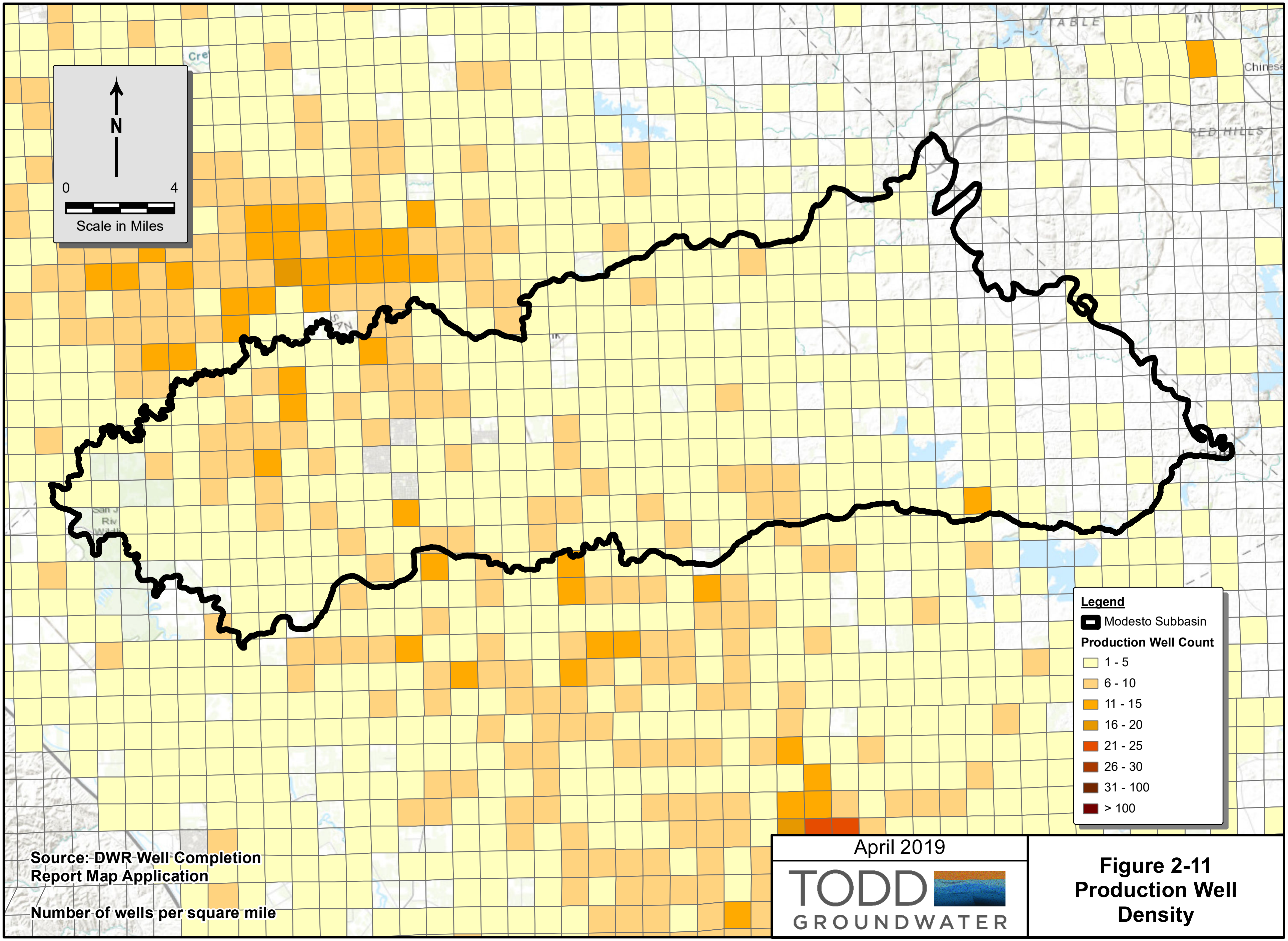
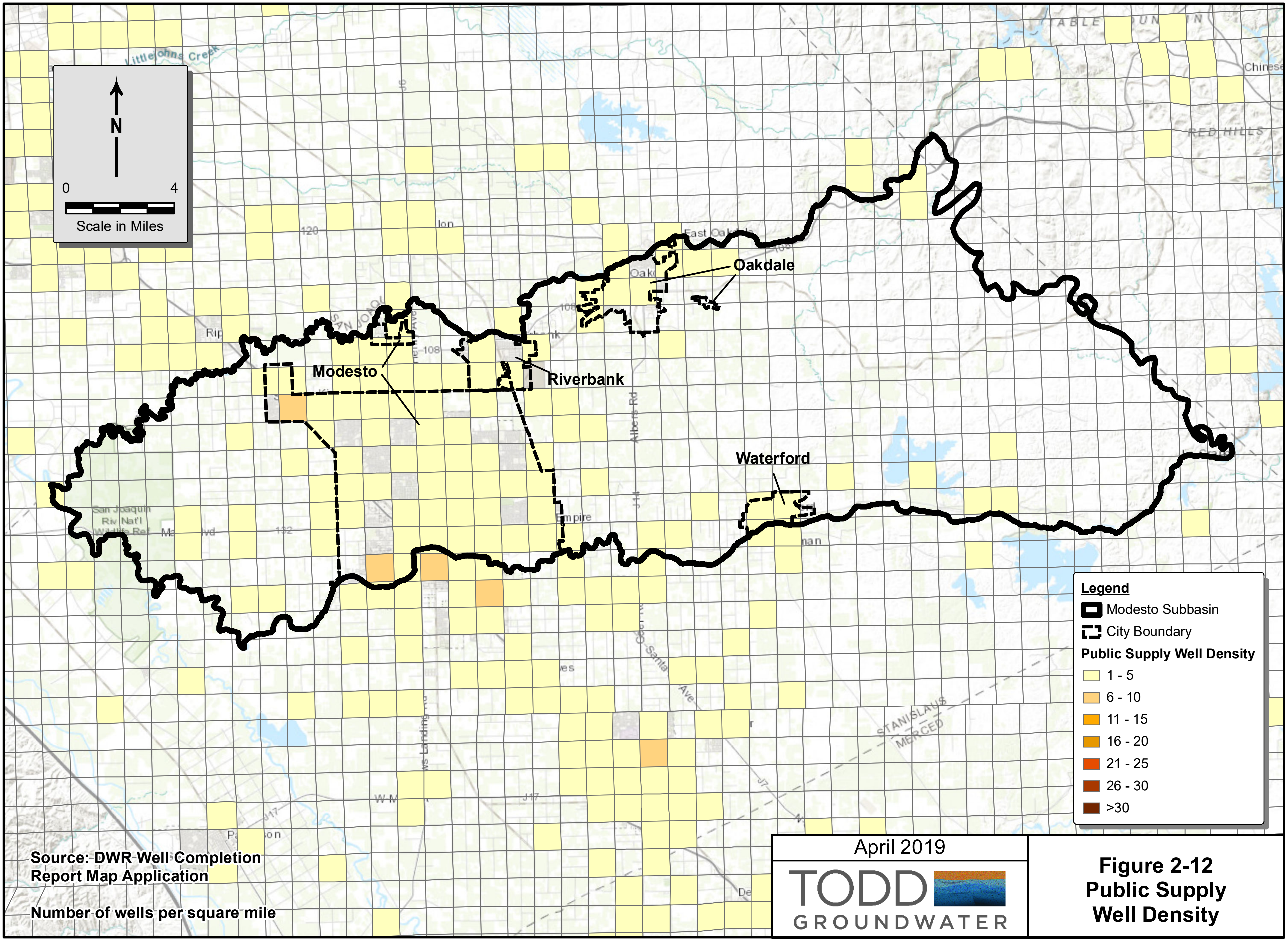


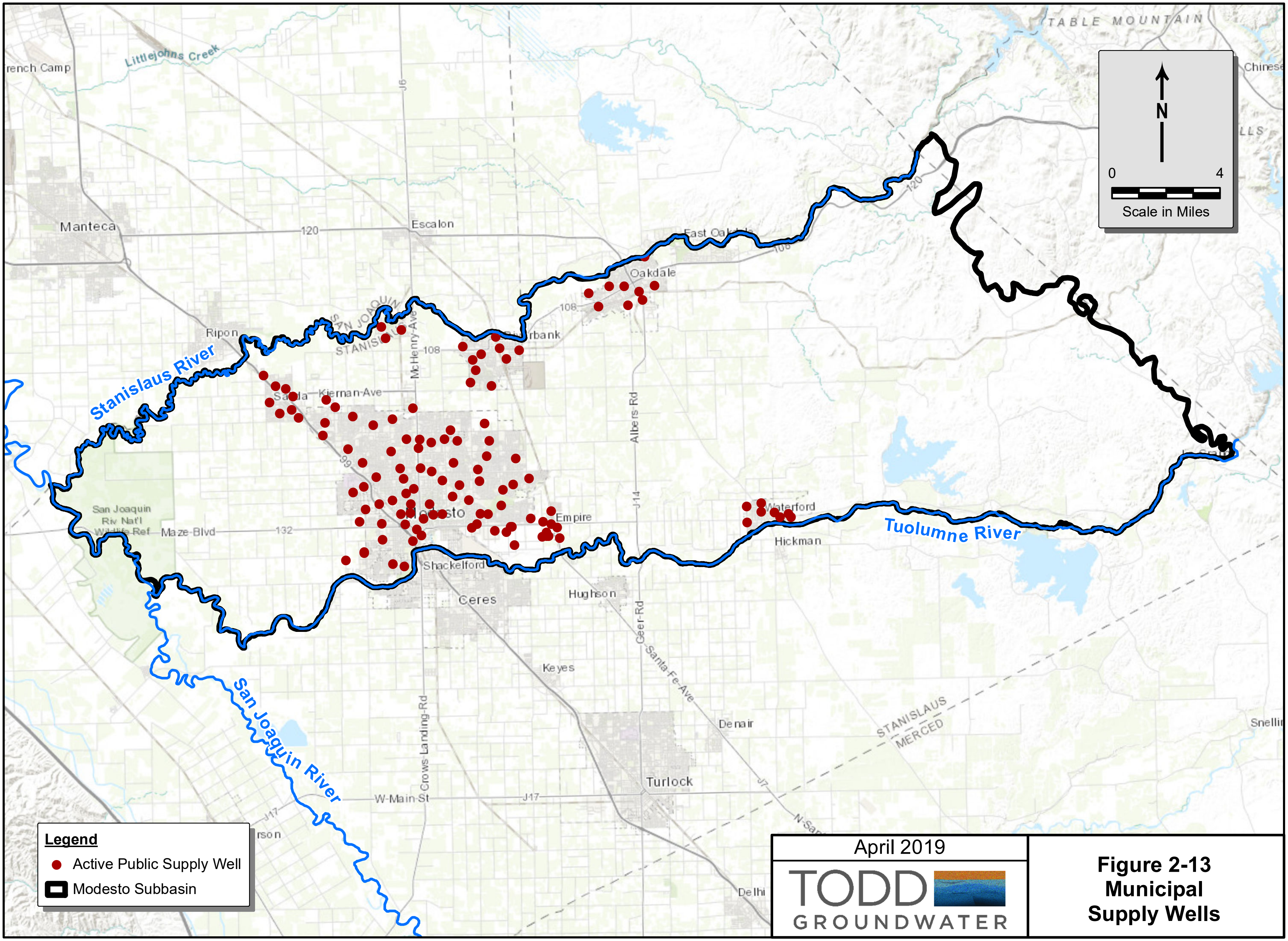
Figure 2-11
Production Well Density



April 2019

TODD GROUNDWATER

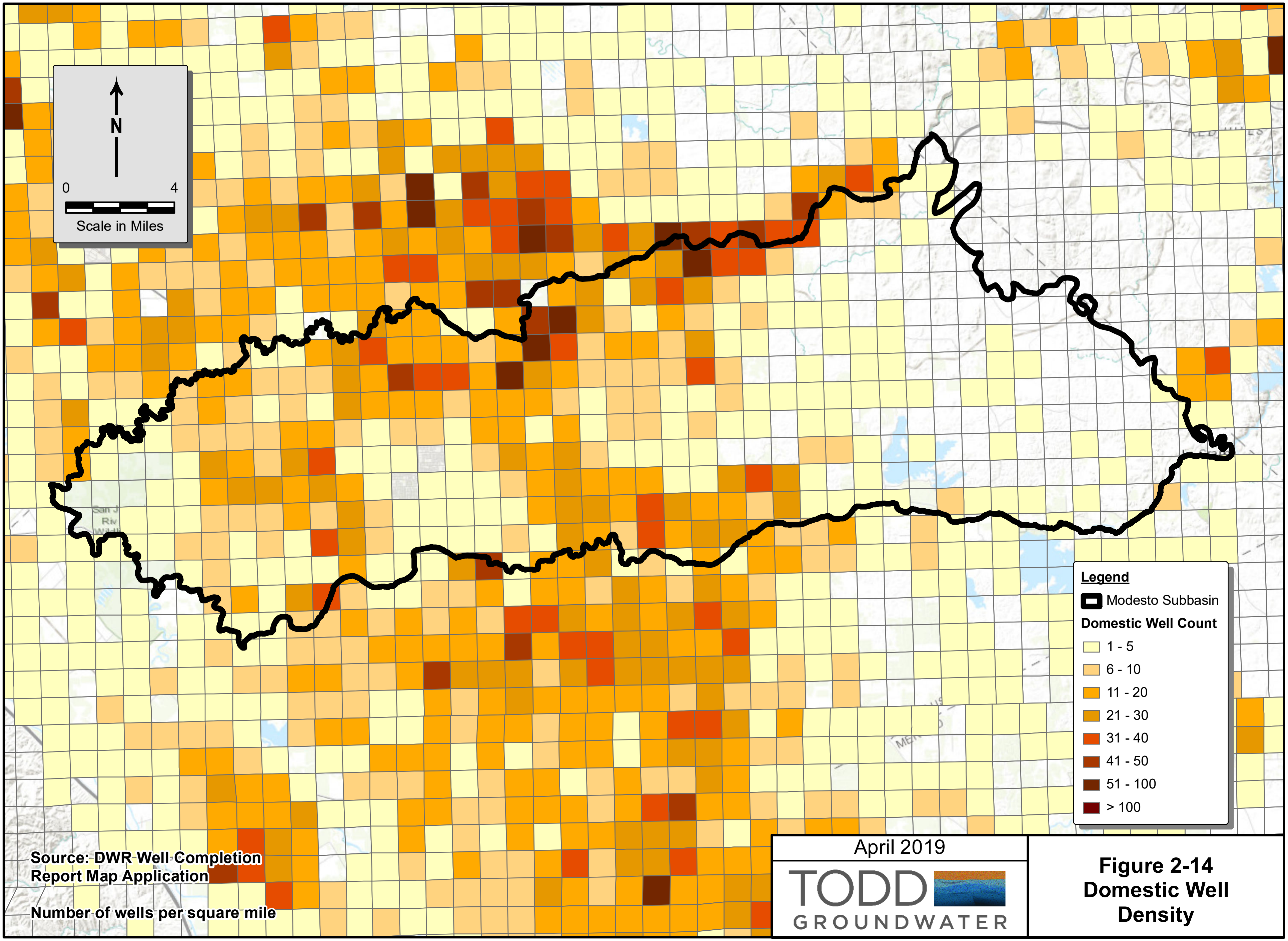
Figure 2-12
Public Supply Well Density



April 2019

TODD GROUNDWATER

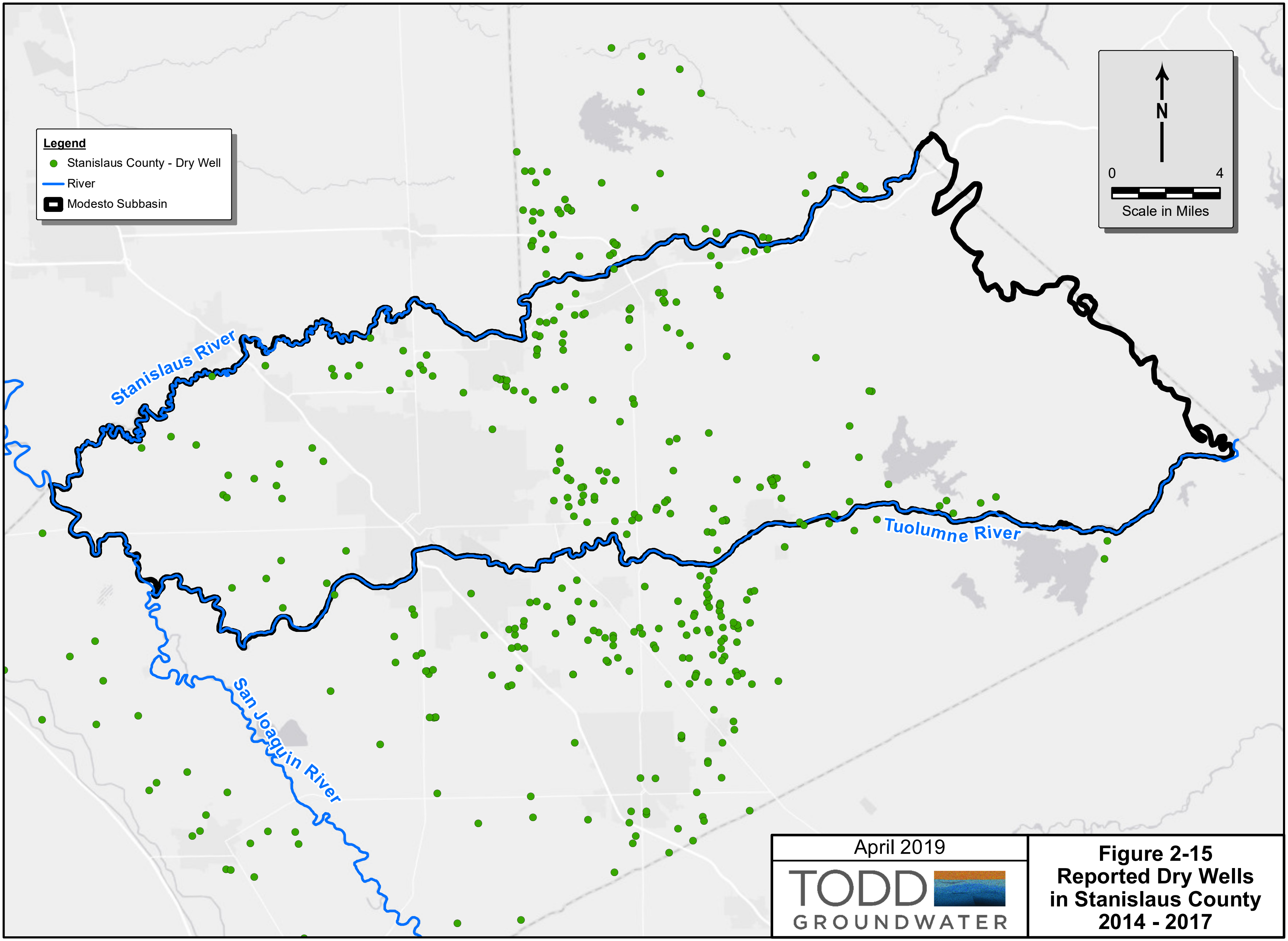
Figure 2-13 Municipal Supply Wells



April 2019

TODD GROUNDWATER

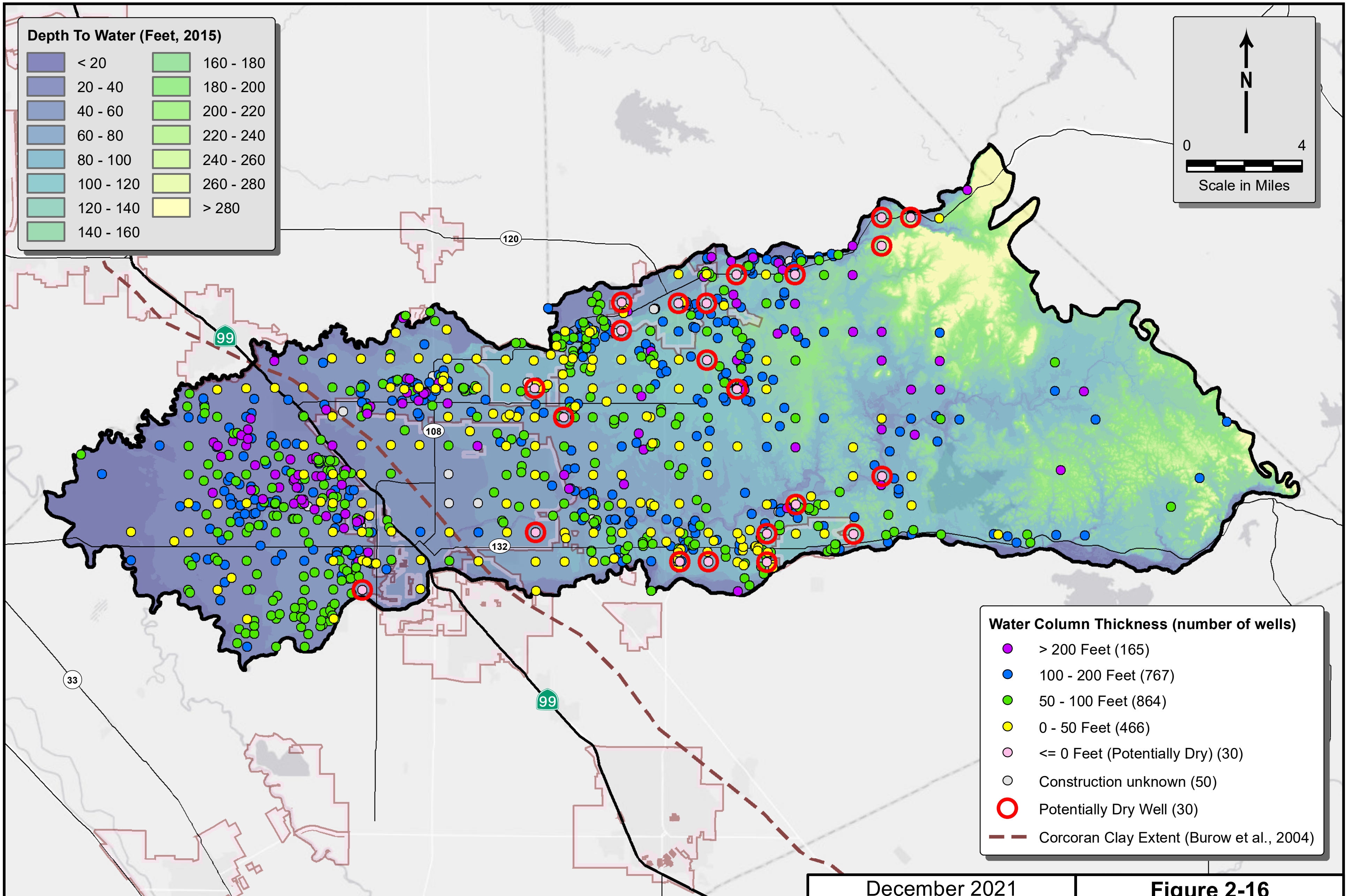
Figure 2-14
Domestic Well Density



April 2019

TODD GROUNDWATER

Figure 2-15
Reported Dry Wells in Stanislaus County 2014 - 2017



Notes:
30 potentially dry wells are circled in red. These well depths appear to be below 2015 water levels.
Some red circles include more than one potentially dry well.

December 2021

TODD GROUNDWATER

Figure 2-16
Domestic Wells Constructed Before 2015

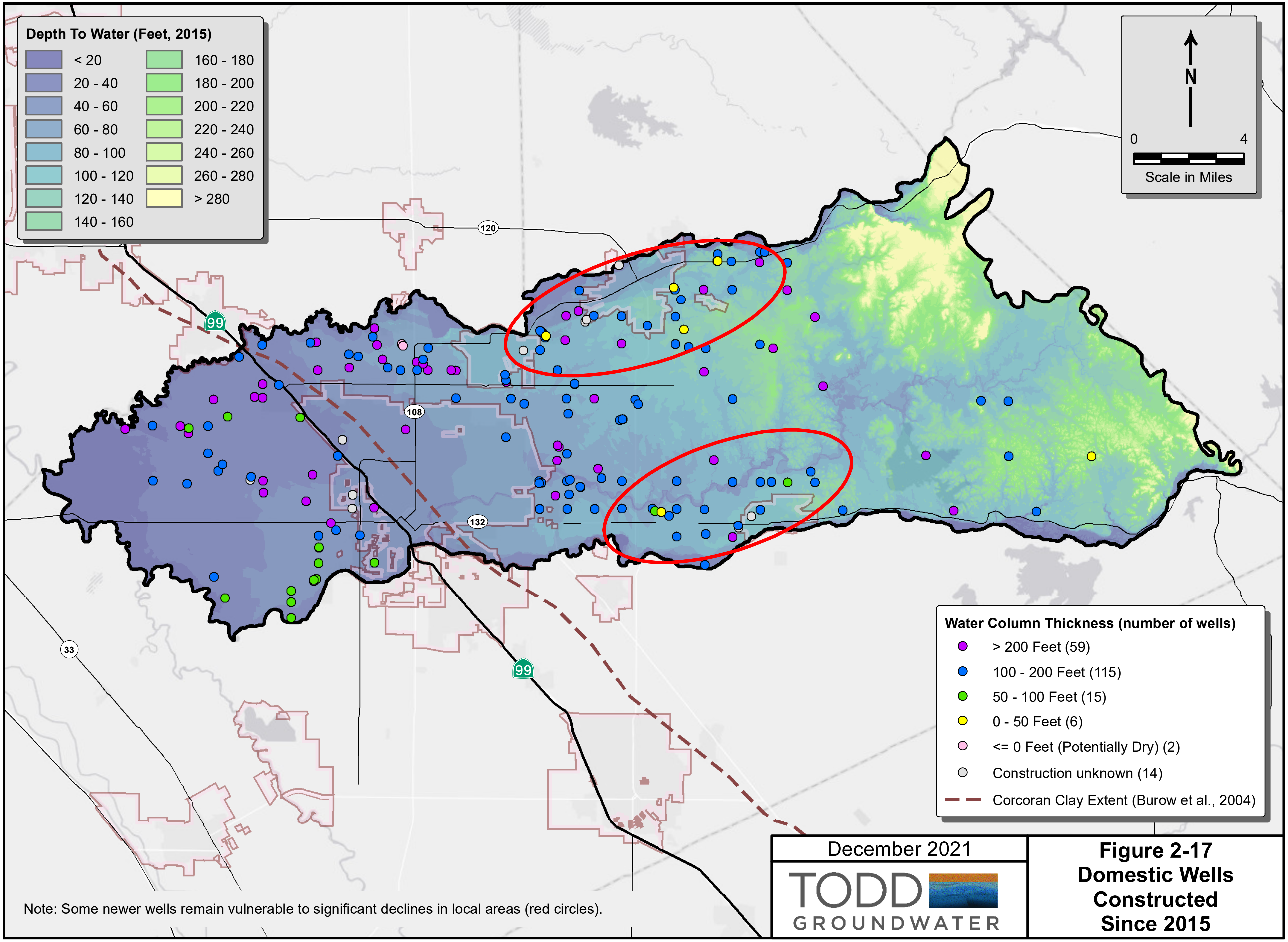


Figure 2-17
Domestic Wells Constructed Since 2015

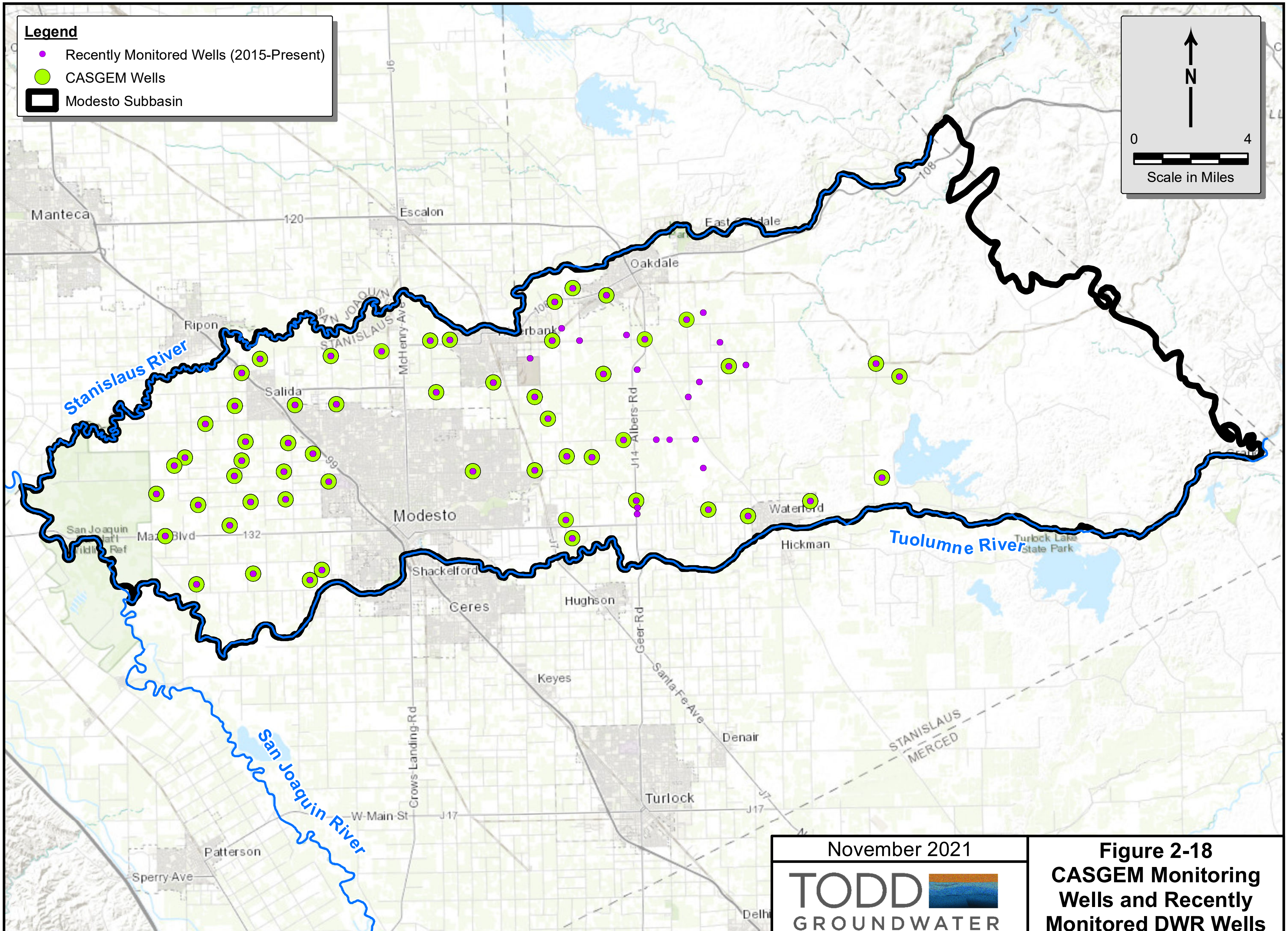


Figure 2-18
CASGEM Monitoring Wells and Recently Monitored DWR Wells

3. BASIN SETTING

The Modesto Subbasin of the San Joaquin Valley Groundwater Basin (DWR Basin 5-22.02) is approximately 247,000 acres (385 square miles) and located in the northern San Joaquin Valley in Stanislaus County. It is bordered by the Stanislaus River on the north, Tuolumne River on the south, San Joaquin River on the west and the foothills of the Sierra Nevada on the east. The Subbasin is categorized as high priority in DWR's 2019 Basin Prioritization (DWR, 2019a) based on its:

- number of public supply wells: 194 or 0.5 per square mile (DWR prioritization score of 4 out of 5);
- number of production wells: 4,009 or 10.5 per square mile (score of 4 out of 5);
- irrigated acreage: 119,066 acres or 311 acres per square mile, covering approximately 48 percent of the Subbasin (score of 4 out of 5);
- groundwater use: 216,522 AF or 0.88 AF per acre (score of 5 out of 5); and
- declining groundwater levels: long term hydrographs show groundwater level decline.

Although categorized as high priority, the Subbasin is not one of the 21 groundwater basins determined by DWR to be critically overdrafted[5]. To mitigate potential future overdraft and provide a foundation for sustainable groundwater management in this high priority Subbasin, the physical conditions associated with the groundwater system, referred to as the Basin Setting, are documented and described herein. The Basin Setting consists of three interrelated analyses:

1. Hydrogeologic Conceptual Model, which provides a physical description of the groundwater Subbasin including the geologic and hydrogeologic setting, basin geometry and principal aquifers.
2. Groundwater Conditions, which describes groundwater occurrence and flow, groundwater levels and quality, and interconnected surface water.
3. Water Budgets, which provide an accounting of inflows and outflows of the surface water and groundwater systems for historical, current, and future conditions.

Because the water budget analysis is relatively complex, water budgets are presented in a separate **Section 4** of this GSP. The hydrogeologic conceptual model and groundwater conditions are described in the following sections.

[5] Two adjacent subbasins, Delta-Mendota and Eastern San Joaquin, have been designated as critically overdrafted.

3.1. HYDROGEOLOGIC CONCEPTUAL MODEL

The development of the hydrogeologic conceptual model is based on an analysis of the regional geologic and structural setting, physical setting, basin boundaries, and principal aquifers and aquitards. Key building blocks of the hydrogeologic conceptual model include the development of new hydrogeologic cross sections and analyses conducted by others, including published technical studies, data, and maps, along with data provided by member agencies of the STRGBA GSA.

3.1.1. Regional Geologic and Structural Setting

The Modesto Subbasin is in the northeastern San Joaquin Valley where valley-fill sediments overlie consolidated, westward-dipping sedimentary units and basement rock of the Sierra Nevada. Older units crop out in the eastern subbasin and dip west-southwest into the San Joaquin Valley below younger units. The surface geology of the Modesto Subbasin, showing relatively older units in the east and younger units in the west, is shown on **Figure 3-1**.

The San Joaquin Valley is a large northwest-trending structural trough in the southern Central Valley, up to 200 miles long and 70 miles wide and filled with marine and continental sediments up to 6 miles thick (Burow et al., 2004). It evolved during the Cenozoic era from tectonic activity and changes in sea level and climate (Bartow, 1991). Tectonic processes included basin subsidence, uplift of the Sierra Nevada and Coast Ranges, and associated deformation (Burow et al., 2004).

Bartow (1991) divides the San Joaquin Valley into five regions based on structural style. The Modesto Subbasin is within the northern Sierran block, which extends from the Stockton arch on the north to Fresno on the south This region is the least deformed area of the San Joaquin Valley (Bartow, 1991). Deformation in this region consists mostly of a southwest tilt and minor late Cenozoic normal faulting (Bartow, 1991). The normal faulting is mostly within the foothills, a result of the valley side of the Sierra block subsiding faster than the Sierra Nevada was rising (Bartow, 1991). Faults in the foothills, east of the Subbasin, are shown on **Figure 3-1**.

Geologic units along the eastern subbasin boundary represent the oldest units in the Subbasin and include the Valley Springs Formation of Late Miocene age and the underlying Ione Formation of Middle Eocene age. These two formations are labeled Tvs and Ei on **Figure 3-1**, respectively. These consolidated units were formed from mostly non-marine sediments and represent both the eastern lateral extent and the local bottom of the groundwater basin. Jurassic-age metamorphic and volcanic rocks of the Sierra Nevada are in contact with these formations to the east and underlie them locally. In general, the eastern groundwater basin boundary is coincident with the base of the Ione Formation, which crops out along the eastern boundary (**Figure 3-1**).

The Mehrten Formation (late Miocene) crops out along a small portion of the northeastern Subbasin boundary, but primarily crops out as remnant hills in the eastern Subbasin (Tm on

Figure 3-1). This consolidated unit includes fluvial deposits (sandstone and conglomerates) consisting of eroded andesite and other rocks associated with volcanic eruptions in the adjacent Sierra Nevada. The re-working of andesite has produced distinctive black sands, which are locally well-sorted with relatively high permeability. These zones represent the primary aquifer system in the eastern Subbasin, especially in areas where the younger overlying sediments (discussed below) are unsaturated.

The younger geologic units in the Subbasin include alluvial sediments of Neogene (Pliocene) and Quaternary (Pleistocene and Holocene) age, including Quaternary alluvium deposited along the Stanislaus and Tuolumne rivers (shown in light yellow and labeled Q on **Figure 3-1**) and other alluvial/riverbank/terrace deposits. These additional deposits are also identified on **Figure 3-1** where they occur at the surface, and are listed below from oldest to youngest:

- Laguna Formation (Pl) of Pliocene age,
- Turlock Lake Formation (Qtl) of Early Pleistocene age,
- Riverbank Formation (Qr) of Middle Pleistocene age and
- Modesto Formation (Qm) of Late Pleistocene age.

The Corcoran Clay represents a regional aquitard in the upper part of the Turlock Lake Formation. The Corcoran Clay is a laterally-extensive clay unit deposited by an ancient lake that covers over 4,000 square miles in the San Joaquin Valley. It occurs beneath the western Subbasin and pinches out in the subsurface near Highway 99. The Corcoran Clay does not crop out and, as such, does not appear on **Figure 3-1**.

The Modesto Formation (Qm) is the primary surficial geologic unit in the western Subbasin. Younger alluvium (Q) is present along the Stanislaus and Tuolumne rivers and the Dos Palos Alluvium (Qdp) is present along the San Joaquin River.

The younger geologic units, including the Modesto Formation (Qm), Turlock Lake Formation (Qtl), Riverbank Formation (Qr), and Mehrten Formation (Tm) have been associated with high quality groundwater as characterized by total dissolved solids (TDS). The underlying older units of the Valley Springs Formation (Tvs) and the Ione Formation (Ei) have been associated with higher mineral and salt content. The hydrogeology and groundwater conditions in the Modesto Subbasin aquifer units are described in more detail in subsequent sections of the Basin Setting.

3.1.2. Physical Setting

3.1.2.1. Precipitation and Average Hydrologic Conditions

The Modesto Subbasin is characterized as a Mediterranean-type climate with hot, dry summers and cool, wet winters, with most of the precipitation occurring between November and March.

Figure 3-2 illustrates annual precipitation in the Modesto Subbasin on a water year (WY) basis from WY 1990 through 2017 as measured at the Modesto Irrigation District weather station in Modesto. The chart on **Figure 3-2** illustrates the variability in precipitation, from approximately 7.0 inches in WY 2014 to more than 24 inches in WY 1998. The long-term average rainfall in the Modesto Subbasin is about 12.6 inches per year based on data from 1961 – 2015. A Study Period from WY 1991 through WY 2015 has been selected for GSP analyses that is representative of average hydrologic conditions. The Study Period also overlaps the time period of a regional groundwater model being develop for the GSP and is associated with a relatively large amount of available data. As indicated on **Figure 3-2**, the average annual precipitation during the Study Period is 12.8 inches per year, which is within two percent of the long-term average.

Annual precipitation data on **Figure 3-2** is color-coded based on water year type using the San Joaquin Valley WY hydrologic classification indices (CDEC, 2018): wet (blue), above normal (green), below normal (brown), dry (yellow), and critically dry (red). The San Joaquin Valley WY indices do not always correlate directly with precipitation measured in the Modesto Subbasin because the indices are based on runoff from several rivers, including the Stanislaus, Tuolumne, Merced, and San Joaquin Rivers. However, the indices are a useful benchmark for establishing consistent water year types across numerous subbasins in the San Joaquin Valley.

Figure 3-2 shows that the wettest water years, with precipitation above 15 inches per year, occurred in water years 1993, 1995, 1996, 1998, 2000, 2005, 2010, 2011, 2016 and 2017 (all of which are designated as wet or above normal water year types, except water year 2016). The driest years, with precipitation less than 9 inches per year, occurred in water years 1990, 1991, 2004, 2007, 2009 and 2014 (all of which are designated as critically dry or dry water year types, except 2009).

Data from the PRISM Climate Group were compiled to evaluate spatial variability of precipitation across the Subbasin. These data are based on application of an interpolation model, *Parameter-elevation Relationships on Independent Slopes Model* (PRISM), to detailed datasets from 1895 to present as developed by Oregon State University and the U.S. Department of Agriculture. A PRISM isohyetal map showing 30-year average annual precipitation from 1981 – 2010 across the Subbasin is presented on **Figure 3-3**. This period is slightly wetter than the long-term average but provides the most complete data set for evaluation across the Subbasin.

As shown on **Figure 3-3**, the average annual precipitation varies across the Subbasin, increasing with topography from west to east. Average precipitation ranges from approximately 11 inches per year along the western Subbasin boundary to approximately 21 inches per year along the eastern boundary.

3.1.2.2. Topography

The Modesto Subbasin extends from the Sierra Nevada foothills to the San Joaquin Valley floor. Ground surface elevations dip to the west, from approximately 650 feet mean sea level (msl) in the foothills to less than 20 feet msl along the San Joaquin River. A Digital Elevation Map (DEM) of Subbasin topography based on the United States Geological Society

(USGS) National Elevation Dataset (NED) is provided on **Figure 3-4** and illustrates these ground surface elevations.

The western Subbasin is relatively flat. Ground surface elevations rise from about 20 feet msl along the San Joaquin River to about 200 feet msl near the center of the Subbasin. The topography in the eastern Subbasin is hilly and dissected by small drainages and by Dry Creek, a larger drainage and tributary of the Tuolumne River (**Figure 3-4**). The topography in the eastern Subbasin represents the transition from San Joaquin Valley floor to the Sierra Nevada foothills.

To better illustrate the ground surface elevations, four topographic profiles were generated from the NED. These profiles are illustrated on **Figure 3-5**. Profile 1-1' is along the center of the Subbasin from southwest to northeast and profiles 2-2', 3-3' and 4-4' extend from northwest to southeast across the Subbasin in the western, central and eastern Subbasin.

Profile 1-1' illustrates the rise in ground surface elevations from the San Joaquin River to the eastern Subbasin. Ground surface elevations range from about 20 to 500 feet msl along this profile. This profile illustrates the relatively gradual and uniform elevation gain in the western Subbasin and the hilly, dissected terrain in the east.

Profile 2-2' illustrates the Stanislaus and Tuolumne river channels and the flat topography between these channels in the western Subbasin. The ground surface elevations along this profile are relatively flat, sloping from approximately 100 feet msl near the Stanislaus River to approximately 90 feet msl along the Tuolumne River. On this profile, the Stanislaus River channel is wider and shallower than the Tuolumne River channel.

Profile 3-3' illustrates the ground surface elevations in the central Subbasin On this profile, the ground surface slopes from about 170 feet msl along the Stanislaus River to approximately 135 feet msl along Dry Creek. The ground surface between Dry Creek and the Tuolumne River is relatively flat. The topography along this profile is more variable, marking the transition from the flat western Subbasin to the hilly eastern Subbasin. On this profile, the Stanislaus River channel is wider and deeper than the Tuolumne River channel.

Profile 4-4' illustrates the higher elevations and more topographic relief in the eastern Subbasin. The dissected nature of the eastern hills is evident on the northern portion of the profile. Ground surface elevations along this profile vary from approximately 200 feet msl near the Stanislaus River to almost 500 feet msl between the Stanislaus River and Dry Creek. Ground surface elevations decline to about 200 feet msl at Dry Creek and remain relatively flat between Dry Creek and the Tuolumne River. On this profile, the Tuolumne River channel is wider and deeper than the Stanislaus River channel.

3.1.2.3. Soils

Soil textures from the Soil Survey Geographic (SSURGO) database for Stanislaus County, as developed by the U.S. Department of Agriculture Natural Resources Conservation Service (USDA), are illustrated on **Figure 3-6**. Soil textures are color-coded and listed in the legend by increasing grain size (texture). Most of the Subbasin is covered by silty sands (brown shading), clayey sands (dark blue shading), and clayey, silty sands (grayish blue shading). There are coarser-grained soils along the Stanislaus and Tuolumne rivers in the form of gravel and sand (red shading) along the upstream reaches and poorly graded sand and silt (yellow shading) along the middle reaches. The eastern Subbasin is dominated by clay (black shading), clay and silt (brown shading) and coarser-grained silty gravels (pink shading). Fine grained soils are present along the San Joaquin River in the form of clayey and silty sands (blue shading) and clay and silt (dark brown shading). The clay-rich soils in the west along the San Joaquin River limit infiltration and create localized perched conditions.

The USDA soil data shows that the eastern Subbasin is widely covered by low permeability surficial zones, generally referred to as "hardpan." These are considered restrictive layers in that they restrict or prevent surface water infiltration and serve to reduce groundwater recharge from precipitation or streamflow. The surficial occurrence of these materials is illustrated on **Figure 3-6** by cross hatching. Except for small areas near the Stanislaus and Tuolumne rivers and Dry Creek, most of the eastern Subbasin is covered by restrictive layers.

3.1.2.4. Surface Water Bodies and Water Conveyance

The Modesto Subbasin is bounded by rivers on three sides: the Stanislaus River on the north, the Tuolumne River on the south and the San Joaquin River on the west. The Modesto Subbasin is also internally drained by numerous small drainageways, the largest of which is Dry Creek. The Stanislaus and Tuolumne rivers originate in the Sierra Nevada and are tributaries of the San Joaquin River.

The Stanislaus River drains a watershed of about 1,051 square miles to the confluence of the San Joaquin River near Vernalis (Burow et al., 2004). Streamflow on the Stanislaus River ranges between 100 cubic feet per second (cfs) and 10,000 cfs (Phillips et al., 2015). The Tuolumne River drains a watershed of approximately 1,635 square miles and flows to the confluence of the San Joaquin River near Grayson (Burow et al., 2004). Typical average monthly streamflow in the Tuolumne River ranges from 100 to 400 cfs during low streamflow to more than 1,000 cfs, and sometimes more than 10,000 cfs, during high streamflow (Phillips et al., 2015).

The San Joaquin River is the primary drainage for the northern San Joaquin Valley and flows north into the Sacramento-San Joaquin River Delta and San Francisco Bay. Streamflow on the San Joaquin River from 1960 to 2004 ranged from less than 100 cfs upstream of the Merced River to more than 40,000 cfs downstream of the Stanislaus River (Phillips et al., 2015).

Water is diverted from both the Stanislaus and Tuolumne rivers for irrigation and municipal supply within the Subbasin. OID diverts water from the Stanislaus River at the Goodwin Dam into the South Main Canal, which serves agricultural irrigation water throughout OID within the Modesto Subbasin (Davids Engineering, Inc, 2016). Water flows from these canals through a system of unlined earthen ditches, concrete-lined canals, low-head pipelines and gates. Irrigation tailwater is reclaimed by OID using reclamation pumps or discharged to other landowners or irrigation districts via drainage canals. MID diverts water from the Tuolumne River at the La Grange Diversion Dam into the MID Upper Main Canal and onto the Modesto Reservoir (Provost & Pritchard, 2015). Most of the diverted water is used for irrigation, but approximately 20 percent is treated at the Modesto Regional Water Treatment Plan and delivered to the City of Modesto. MID delivers water through a network of lined and unlined canals, pipelines and drains.

3.1.3. Basin Boundaries

In order to define the subsurface lateral and bottom boundaries of the Modesto Subbasin, numerous features of the Subbasin are considered including the surficial river boundaries, the physical contact between the alluvial aquifers and basement rocks of the Sierra Nevada, and groundwater quality changes with depth. These considerations are discussed in the following sections.

3.1.3.1. Lateral Boundaries

Although the surficial river boundaries along the Stanislaus, Tuolumne, and San Joaquin rivers do not represent the extent of the Subbasin aquifers in the subsurface, they do represent important institutional boundaries and authorities for groundwater management. Accordingly, these boundaries are projected vertically in the subsurface to define the Subbasin lateral boundaries for groundwater management purposes.

The eastern Subbasin boundary generally follows the contact of Subbasin sedimentary deposits with the crystalline basement rocks of the Sierra Nevada, specifically the Jurassic-age Gopher Ridge Volcanics (Jgo) **Figure 3-1**. The eastern Subbasin boundary is primarily coincident with the base of the Ione Formation (Ei), which crops out along the boundary and overlies the crystalline basement rocks. The extent of this lateral boundary contact into the subsurface is not known with certainty but is assumed to be relatively steep. The northeastern Subbasin boundary is coincident with outcrops of both the Mehrten Formation (Tm) and the Table Mountain Latite (Mtm) volcanic rocks. Increasing salinity with depth may control the extent of this lateral boundary as discussed in more detail below.

3.1.3.2. Basin Bottom

The sedimentary units of the Modesto Subbasin likely extend several thousand feet into the subsurface. Therefore, using the contact between these units and crystalline basement rocks may not be appropriate for defining a basin bottom for management purposes. It has been well-documented by USGS (Page, 1973) and others that groundwater salinity in the San Joaquin Valley increases significantly with depth, often creating an operational bottom of the basin. The base of fresh water has been mapped by USGS and used in Central Valley subbasins to define the basin bottom. This map has been incorporated and extended by DWR in support of its regional central valley model C2VSim, the same model being revised and applied for the Modesto Subbasin GSP. Because the analysis for C2VSim provides a base of fresh water over the entire Subbasin, this model surface has been selected as a tentative basin bottom for GSP management purposes. Elevations defining that surface are reproduced on **Figure 3-7** and explained in more detail below.

A map on the base of fresh water was first developed on a San Joaquin Valley-wide basis by the USGS in 1973 (Page, 1973). The map was based on a specific conductance value of 3,000 micromohs per centimeter (umhos/cm), which is equivalent to a TDS range of about 2,000 to 2,880 milligrams per liter (mg/L), or parts per million (ppm), varying with temperature and differences in water chemistry. The map was highly detailed in some areas of the valley but only sparsely controlled in others, including the Modesto Subbasin. The few contours from the Page (1973) map that are near or within the Modesto Subbasin are reproduced in red on **Figure 3-7**. These contours are along the western Subbasin boundary and indicate that the elevation of the base of fresh water is between -400 and -600 feet mean sea level[6] (ft msl). The elevation of the base of fresh water continues to decline west of the western Subbasin boundary to an elevation of -800 feet msl.

Figure 3-8 illustrates the layers of the C2VSim model. As shown, the model is composed of five layers representing four aquifer layers and one aquitard: the unconfined aquifer (L1), Corcoran Clay (A2), primary shallow pumping layer (L2), deeper pumping layer (L3), and saline aquifer (L4). The base of the deeper pumping layer (L3) represents the base of fresh water. **Figure 3-7** shows elevation contours of the base of fresh water (base of L3) from C2VSim. The Page (1973) contours along the western Subbasin boundary are about 100 to 300 feet higher than in C2VSim. However, the elevation of the base of fresh water used in the C2VSim model represents the best available information for the base of fresh water and the operational bottom of the Subbasin.

As indicated on **Figure 3-7**, this Subbasin operational bottom is an undulating surface with the deepest portion occurring in the central Subbasin. Along the eastern Subbasin boundary, the bottom of the Subbasin is at approximately -600 feet msl. It rises slightly and then dips westward to an elevation of approximately -1,000 ft msl in the central Subbasin. The Subbasin bottom then gradually rises to an elevation of approximately -700 ft msl along the western Subbasin boundary.

3.1.3.3. Areas of Recharge and Discharge

Prior to groundwater use in the Modesto Subbasin, groundwater was recharged primarily in the eastern Subbasin where the Stanislaus and Tuolumne rivers entered the Subbasin. Groundwater flowed from these areas to the west (Burow et al., 2004). Artesian conditions occurred in the western Subbasin from upward movement of groundwater from the confined aquifer (Burow et al., 2004).

Since groundwater use began, deep percolation from irrigation is the primary source of recharge to the Subbasin and pumping (municipal, domestic, agricultural and drainage) is the primary source of discharge (Burow et al., 2004). Currently, there is apparent

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[6] Elevations represented as negative numbers in this GSP represent elevations below mean sea level and are denoted as -400 ft msl, for example.

downward flow of groundwater in the western Subbasin where artesian conditions were historically documented. Downward gradients are apparently created from pumping beneath the Corcoran Clay, including areas on the west side of the San Joaquin River (Burow et al., 2004).

Other sources of recharge include deep percolation of precipitation, underflow from the foothills, Modesto Reservoir leakage, leakage from unlined canals, and seepage from rivers and streams. Modesto Reservoir leakage was estimated by Modesto Irrigation District to be approximately 24,000 acre-feet per year (Phillips et al., 2015). Other sources of discharge include flow into the downstream (western) reaches of the Stanislaus and Tuolumne rivers, flow into the San Joaquin River, underflow beneath the western Subbasin boundary, flow out of subsurface drains and consumption by riparian vegetation.

3.1.4. Principal Aquifers and Aquitards

As mentioned previously, the Corcoran Clay represents the primary aquitard in the Subbasin and separates the alluvial aquifers above and below the clay, creating confined conditions at depth in the western Subbasin where the Corcoran Clay occurs. The Corcoran Clay does not extend into the eastern Subbasin, and no additional regional aquitard has been defined in this area. Accordingly, the Corcoran Clay defines two aquifer systems in the western Subbasin, but aquifers are more hydraulically connected in the eastern Subbasin where the regional clay is absent.

Recognizing these conditions, , three principal aquifers are defined in the Subbasin for the purposes of this GSP and future management of groundwater under SGMA. These three aquifers are defined as follows:

- Western Upper Principal Aquifer – unconfined aquifer above the Corcoran Clay.
- Western Lower Principal Aquifer – confined aquifer below the Corcoran Clay.
- Eastern Principal Aquifer – unconfined to semi-confined aquifer system east of the extent of the Corcoran Clay.

The definition of these three Principal Aquifers is consistent with the Principal Aquifer definitions for the Turlock Subbasin GSP, allowing for consistent interpretations along the shared Tuolumne River boundary. The Principal Aquifers in the Eastern San Joaquin Subbasin are different because the Corcoran Clay is only found in the southwest corner of the Subbasin. The Eastern San Joaquin GSP defines one principal aquifer the provides water from three production zones: a Shallow Zone, Intermediate Zone and Deep Zone.

The Western Upper Principal Aquifer and the Eastern Principal Aquifer are composed of Plio-Pleistocene- to Holocene- age alluvial sediments of the Modesto, Riverbank, Turlock Lake formations, and younger alluvium (where saturated). Not all of these alluvial sediments are present everywhere within the Eastern Principal Aquifer due to erosion or non-deposition. The base of the Western Principal Aquifer is the Corcoran Clay. The Eastern

Principal Aquifer (east of the Corcoran Clay) also includes the Laguna, Mehrten and older formations that extend to the operational bottom of the Subbasin (i.e., base of fresh water).

The Modesto, Riverbank and Turlock Lake formations form sequences of overlapping terrace and alluvial fan deposits in response to cycles of alluviation, soil formation and channel incision influenced by changes in climate and glacial stages in the Sierra Nevada (Jurgens et al., 2008). The Modesto Formation forms a thin veneer at the surface, approximately 20 feet thick (Jurgens et al., 2008) throughout most of the western Subbasin (Burow et al., 2004). The Modesto Formation is composed of fluvially-deposited arkosic sand, gravel and silt and its lithology is similar to the underlying Riverbank, Turlock Lake, and Laguna formations (Burow et al., 2004). Where saturated, the Modesto Formation yields moderate amounts of water (Burow et al., 2004).

The Riverbank Formation is also composed of fluvial arkosic sand, gravel and silt and varies in thickness from approximately 150 to 250 feet (Burow et al., 2004). Its depositional dip is slightly steeper than the Modesto Formation, resulting in westward thickening of the deposits. The formation yields moderate quantities of water.

The Turlock Lake Formation is the most developed aquifer in the western Subbasin, both within the Western Upper Principal Aquifer and the Eastern Principal Aquifer, yielding up to 2,000 gallons per minute (gpm) from gravel and sand units (Burow et al., 2004). Similar to the Modesto and Riverbank formations, the Turlock Lake Formation is composed of a coarsening-upward sequence of silt, arkosic sand, and gravel layers (Burow et al., 2004).

The Western Lower Principal Aquifer consists of the Turlock Lake Formation below the Corcoran Clay, the Laguna Formation and the underlying Mehrten Formation. Both the Western Lower Principal Aquifer and the Eastern Principal Aquifer extend to the base of fresh water, which is located within or below the Mehrten Formation, respectively.

The Laguna Formation is composed of alluvial deposits of gravel, sand, and silt in at least two coarsening-upwards sequences (Burow et al., 2004). Laguna Formation sediments are more consolidated than the younger overlying formations (Jurgens et al., 2008) and yield variable amounts of water (Burow et al., 2004). The Laguna Formation is commonly mapped as part of the Turlock Lake Formation in the Modesto area (Burow et al., 2004). The Laguna Formation is not clearly identifiable from adjacent units in areas to the east where it crops out at the surface (Burow et al., 2004).

USGS indicates that the Eastern Principal Aquifer is unconfined and becomes semi-confined with depth due to numerous discontinuous clay lenses and extensive paleosols (Burow et al., 2004). In addition, the Mehrten Formation is more consolidated than the overlying formations and the sand beds are generally thin, so the degree of hydraulic connection between the Mehrten and overlying deposits is not well understood (Burow et al., 2004). However, many wells in the Eastern Principal Aquifer are screened in both the Mehrten Formation and overlying younger formations, where present, providing for some hydraulic connection in wells. Further, these wells provide average water levels across these zones and would represent a combined aquifer system for managing water levels. In the absence of a defined aquitard, it is likely that there is hydraulic connection among the formations, especially where the shallow formations thin to the east.

The Corcoran Clay is defined in this GSP as the only principal aquitard, which delineates the base of the Western Upper Principal Aquifer and the top of the Western Lower Principal Aquifer. The eastern edge of the Corcoran Clay is oriented from northwest to southeast, approximately parallel to the axis of the Valley (Burow et al., 2004). Where present, the blue lacustrine Corcoran Clay is up to 100 feet thick and occurs at depths ranging from 80 to 210 feet (Burow et al., 2004). The Corcoran Clay is generally well sorted clay to silty clay but becomes siltier and grades into coarser textures along the edges (Burow et al., 2004).

The Corcoran Clay surface from the C2VSim Model within the Modesto Subbasin was replaced with the Corcoran Clay surface from the USGS MERSTAN model (Phillips et al., 2015). During analysis for this GSP, it was discovered that the top of the Corcoran Clay surface from C2VSim suggested a mounded area in the western Subbasin where the top of the clay was higher than anticipated and not supported by well logs or USGS texture data. This anomaly was discussed with DWR staff, who supported revision of the surface in the model. The Corcoran Clay surface used in the USGS MERSTAN model (Phillips et al., 2015) is based on USGS hydrogeologic characterization of the Modesto Area (Burow et al., 2004) and represents the most detailed mapping of the Corcoran Clay in the Modesto Subbasin.

The elevation contours of the top and base of the revised Corcoran Clay surface within the Modesto Subbasin is shown on **Figures 3-9 and 3-10**, respectively. The Corcoran Clay generally dips to the west, with some irregularities. The eastern edge of the top of the Corcoran Clay slopes from an elevation of approximately -70 ft msl along the southern Subbasin boundary to -110 ft msl along the northern Subbasin boundary. The top of the Corcoran Clay is deepest in the northwestern Subbasin, at an elevation of approximately -210 ft msl. The elevation contours of the base of the Corcoran Clay generally mimic the top surface, ranging in elevation from approximately -120 to -140 ft msl along its eastern boundary to -260 ft msl in the northwestern Subbasin.

3.1.4.1. Cross Section Development

Five hydrogeologic cross sections (A through E) were developed to illustrate the hydrostratigraphy of the principal aquifers in the Modesto Subbasin, with a focus on aquifer textures and geometry. Cross section locations are shown on **Figures 3-11**. Cross section A-A’ extends from southwest to northeast along the length of the Subbasin, cross sections B-B’, C-C’, and D-D’ are perpendicular to A-A’, oriented northwest to southeast. Cross section E-E’ is a local cross section parallel to A-A’ in the vicinity of Oakdale and along the Stanislaus River.

Cross sections were developed based on USGS texture data, DWR well completion reports, California Department of Oil, Gas and Geothermal Resources (DOGGR) geophysical logs, and localized cross sections in the City of Modesto as part of a previous study (Todd, 2016). Cross sections are presented on **Figures 3-12** through **3-18**.

The cross sections present generalized interpretations of coarse-grained (sands and gravels) and fine-grained (silts and clays) textures based on data from the USGS and DWR Well Completion Reports, along with interpretations of specific formations including the Corcoran Clay and Mehrten Formation. **Figure 3-11** shows the cross section locations, wells that were used to construct the cross sections (red dots), and the wells in the USGS texture database (black dots). Most of the cross section texture data are from wells in the USGS texture database (red dots with black dots). DWR Well Completion Reports were used in areas where USGS texture data were not available (red dots without black dots). In addition, geophysical logs from deep oil and gas wells used for cross section development are shown as green dots. **Figure 3-11** also shows the Corcoran Clay extent defined by the USGS (Burow et al., 2004). Ground surface elevations shown on the cross sections were generated from the National Elevation Dataset (NED, 10m) developed by the USGS, as illustrated on **Figure 3-4**.

The texture data were developed by the USGS for a hydrogeologic investigation (Burow et al., 2004) and incorporated into the USGS MERSTAN groundwater flow model (Phillips, et al., 2015). As part of the hydrogeologic investigation (Burow et al., 2004), the USGS reviewed over 10,000 well logs in the region and compiled a texture database using approximately 3,500 of these logs. There are approximately 900 wells in the Modesto Subbasin that are in the texture database. As illustrated on **Figure 3-11**, the USGS texture data does not extend into the eastern Subbasin because the MERSTAN model does not extend east of the Modesto Reservoir.

The USGS used a binary texture classification of either “coarse grained” (100 percent coarse) or “fine grained” (0 percent coarse) to categorize each interval on the well logs. Coarse-grained texture was defined as consisting primarily of sand or gravel while fine grained texture was defined as consisting primarily of silt or clay (Burow et al., 2004). Once this binary texture classification was complete, the coarse-grained percentage was averaged at 1-meter intervals along the depth of the well. This simplification of the lithology on a well basis allows identification of regions and/or depths of the groundwater basin that contain higher percentages of sand-rich zones, likely representing more permeable aquifers and large quantities of groundwater in storage.

The cross sections were created using the ESRI ArcHydro module for ArcGIS. The ArcHydro module allows import and three-dimensional plotting of geologic data from boreholes and topological surfaces. ArcHydro analysis tools include projection of borehole and surface data along cross-sections at selected orientations for analysis and geologic correlation.

DWR Well Completion Reports were available for most USGS texture database wells on the cross sections. The lithologic descriptions on the Well Completion Reports were used to define marker beds, such as black sands (Mehrten Formation) or blue clays (Corcoran Clay). The Well Completion Reports were also used to identify the screened intervals in the wells.

Where USGS texture data were not available, Well Completion Reports were used to interpret the lithology. Without the binary method used by USGS, the texture categories from the Well Completion Reports were defined on the cross sections at the same depth and thickness for which they were described on the Well Completion Reports. In this manner, the texture detail on each Well Completion Report is preserved. In areas with several closely-spaced wells, only higher-quality Well Completion Reports (i.e., most detailed data) were used.

The cross sections honor the texture information from the USGS and Well Completion Reports at well locations. Between well locations, the coarse-grained units were generally correlated based on elevation and thickness. Thick sand lenses were assumed to be more continuous and more likely to be interconnected than thinner sand lenses. The surficial geologic map (Wagner et al., 1991) presented as **Figure 3-1** was used to estimate surface contacts of the geologic formations on the cross sections when appropriate.

3.1.4.2. Cross Sections

Interpretations and observations for each of the five cross sections are described below.

Cross Section A-A'

Cross section A-A', shown on **Figure 3-12**, illustrates the lithology through the center of the Subbasin from southwest to northeast. The lithology is based on data from 61 wells and incorporates a local cross section (H-H') developed for the City of Modesto associated with a previous hydrogeologic study (Todd, 2016). The local cross section is incorporated into A-A' immediately east of cross section B-B' and extends for about 3 to 4 miles (see H-H' on **Figure 3-12**).

The Corcoran Clay extends from the western edge of A-A' and extends almost to the intersection of B-B'. Its extent agrees with that mapped by USGS (Burow et al., 2004). The top of the Corcoran Clay is approximately 150 feet below ground surface (bgs) at its eastern extent and dips to the west to a depth of approximately 220 feet bgs (equivalent to elevations of approximately -80 feet msl to -185 feet msl. The Corcoran Clay generally thickens to the west, ranging in thickness from about 10 feet in the east to about 70 feet in the west. The depth and thickness of the Corcoran Clay generally agrees with the Corcoran Clay in the USGS MERSTAN model (Phillips et al., 2015) and with the data incorporated into the Modesto Subbasin C2VSim model (**Figures 3-9** and **3-10**).

The top of the Mehrten Formation is estimated on the cross section based on the presence of black sands, which are colored orange on **Figure 3-12**. The Mehrten Formation crops out in the eastern Subbasin and is generally consistent with the geologic map illustrated on **Figure 3-1**. Black sands were not identified in the central and western Subbasin because not many wells extend deep enough to intersect the Mehrten Formation in that area. Based on the interpolated dip of the black sands, the top of the Mehrten Formation is approximately 400 feet below the City of Modesto (H-H' on **Figure 3-12**), east of where cross section B-B' crosses A-A' (**Figure 3-12**).

An offset in the top of the black sands was observed during construction of cross section E-E', located north of and parallel to cross section A-A'. As described in more detail for cross section E-E', this offset suggests vertical movement caused by a geologic fault. An offset in the black sands is also suggested by the data in a similar location on cross section A-A', east of the intersection with cross section C-C' (**Figure 3-12**). The vertical movement – down-dropped eastern block relative to the western block – is also consistent with offset observed on cross section E-E'. The estimated location of the fault plane is shown on cross section A-A'.

Cross section A'A' also illustrates the presence of thick coarse-grained units both above and below the Corcoran Clay, at the western edge of the Corcoran Clay. Thick sand units are also noted in the eastern Subbasin within the Mehrten Formation. Note that the lithology shown below the Corcoran Clay is only based on a few wells and is less certain than other areas with more wells. Wells in the western Subbasin are primarily screened either immediately above or immediately below the Corcoran Clay with some wells screened in both aquifers. Most of the wells in the eastern Subbasin are screened within the black sands of the Mehrten Formation.

Cross Section B-B'

Cross section B-B', shown on **Figure 3-13**, illustrates the lithology from the northern to the southern Subbasin boundary in the western Subbasin, through the City of Modesto. The lithology is based on texture information from 38 wells and incorporates a local cross section (D-D') developed in the City of Modesto from a previous study (Todd, 2016). The local cross section extends from north of the intersections with A-A' to the southern edge of the cross section (at B', **Figure 3-13**).

The Corcoran Clay extends from the southern edge of the cross section to slightly north of the Tuolumne River. At the Subbasin boundary, the top of the Corcoran Clay is at a depth of about 130 feet bgs (about -65 feet msl) and is about 65 feet thick. As shown on the cross section location map (**Figure 3-11**), the edge of the Corcoran Clay is oriented northwest to southeast and only intersects the southern portion of section B-B'. However, the Corcoran Clay does not extend as far east in this area as mapped by USGS (compare the edge of the Corcoran Clay on cross section B-B' to the Corcoran Clay extent mapped by USGS and shown on **Figure 3-11**). This could indicate that the extent is more irregular than previously mapped or extends farther than indicated by well data on this section. Because the cross section interpretation is based only on a few logs, the unit may have been too thin to be identified (or not recorded) on the Well Completion Reports.

Wells present in the southern region of the cross section are screened both above and below the Corcoran Clay. To the north of the Corcoran Clay, wells tend to have long screened intervals that intersect multiple coarse-grained units. The thickest coarse-grained units on cross section B-B' are present along the edge of the Corcoran Clay.

The wells on cross section B-B' are not deep enough to penetrate the Mehrten Formation. Based on where B-B' intersects A-A', the Mehrten Formation is at an elevation of approximately -370 feet msl in this area of the Subbasin (near the bottom of B-B' on **Figure 3-13**). The deepest wells on cross section B-B' extend to about -300 feet msl.

Cross Section C-C'

Cross section C-C', illustrated on **Figure 3-14**, depicts the lithology in the central Subbasin, east of the Corcoran Clay between Riverbank and Oakdale. The cross section is based on geologic information from 43 wells.

Most of the wells on cross section C-C' section are too shallow to encounter the Mehrten Formation. However, a few wells are several hundred feet deep and have sufficiently long screens that intercept the Mehrten Formation black sands. These wells allow the top of the Mehrten Formation to be approximated on the cross section (**Figure 3-14**).

As shown on C'C', the top of the Mehrten Formation is present at an elevation between -100 and -200 feet msl, shallower than in cross section B-B' due to its westward dip. The elevation of the top of the Mehrten Formation dips gently to the south along this cross section, with elevations ranging from approximately -125 feet msl along the northern Subbasin boundary to approximately -220 feet msl at the southern Subbasin boundary. The depth to the Mehrten Formation from the edge of the river channels at the Subbasin boundaries range from about 285 feet bgs in the north to 325 feet in the south. The Mehrten is likely shallower in the northern section because it crops out over a larger area in the northern part of the Subbasin (see **Figure 3-14**).

The thickest and most continuous coarse-grained units on the section are in the center of the Subbasin. Coarse-grained units appear to be thicker and more continuous in the southern Subbasin near Dry Creek and the Tuolumne River than along the northern Subbasin boundary.

Cross Section D-D'

Cross section D-D' (**Figure 3-15**) illustrates the lithology in the eastern Subbasin. The cross section extends from the Stanislaus River to the Tuolumne River and crosses Dry Creek and the Modesto Reservoir. The cross section is based on lithology from 27 wells. Due to the lack of USGS texture data in the eastern Subbasin, most of the lithologic information on this cross section is from DWR Well Completion Reports.

The cross section shows that the Mehrten Formation is shallow or crops out as remnant hills in the eastern Subbasin. The delineation of Mehrten Formation outcrop is based on the presence of black sands and the geologic map (**Figure 3-1**). The cross section is dominated by coarse-grained material and black sands. It should be noted that some Well Completion Reports do not indicate the color of the textures and much of the yellow color on the section may, in fact, also represent black sands.

The cross section shows that most of the wells are hundreds of feet deep and screened within or across the black sands. The black sands and coarse-grained material appear to be thicker and more extensive in the northern half of the Subbasin.

Cross Section E-E'

Cross section E-E', illustrated on **Figure 3-16**, is a local cross section in the northeast Subbasin oriented from southwest to northeast, parallel to cross section A-A'. The cross section is along the northern Subbasin boundary and extends from cross section C-C', through Oakdale, to east of cross section D-D'. The cross section approximately follows the Stanislaus River channel, crossing it in two places, and is based on lithology from 62 wells. Due to the high density of wells on the cross section, well numbers are shown on a separate expanded-scale version of this section, provided as **Figure 3-17**.

The Mehrten Formation is shallow throughout most of the cross section and crops out in the eastern region of the section. Similar to cross section D-D', the delineation of the Mehrten Formation outcrop is based on the presence of black sands and the geologic map (**Figure 3-1**). The Mehrten Formation crops out as remnant hills with the erosional surface roughly corresponding to the ground surface elevation on the cross section. The dip of the Mehrten Formation is visible because the transect is roughly parallel to the dip direction. The coarse-grained material and black sands appear to be the thickest and most continuous at depth, but this interpretation is based on only a few deep wells.

There was some irregularity in the elevation of the top of the black sands in wells in the western region of the section. It appears that the black sands on the western side of this fault are at a significantly higher elevation than on the east side of the fault, suggesting vertical movement possibly associated with a geologic fault as interpreted on E-E'. The eastern block is down-dropped relative to the western block.

The USGS (Marchand, 1980) mapped multiple surface lineaments (trending northwest to southeast) south of the Modesto Subbasin, within the Turlock Subbasin. This mapping included folds and faults with approximately northwest to southeast trends. The faulting, which occurred post-deposition, resulted in a down-dropped eastern block relative to the western block, showing reverse offset because of compressive stresses. The evidence of a fault in the Modesto Subbasin has a similar pattern of offset and trend as the faults mapped in the Turlock Subbasin.

Cross Section A-A' with Hydrogeologic Framework

Cross section A-A' is repeated on **Figure 3-18** with a focus on formations and the geometry of the Principal Aquifers rather than textures. The cross section depicts the formation boundaries and the base of fresh water from C2VSim through the center of the Subbasin from southwest to northeast (**Figure 3-11**). The boundary between the base of the undifferentiated Modesto, Riverbank, and Turlock Lake Formations and the top of the Mehrten Formation is the same as shown on cross section A-A' and is based on the geologic texture data. The base of the Mehrten Formation was approximated from geophysical logs at 13 deep oil and gas wells available from the California Department of Oil, Gas and Geothermal Resources (DOGGR). (The location of the DOGGR geophysical logs is shown on **Figure 3-11**).

The cross section shows the westward dip of the formations and offsets caused by two faults in the central and eastern Subbasin. The fault east of intersection with C-C' was identified based on offset of Mehrten Formation black sands. The fault identified west of intersection with C-C' is based on offset of the base of the Mehrten Formation identified from DOGGR geophysical logs. The fault west of C-C' is not shown on **Figure 3-12** because the wells in this area are not deep enough to intersect the black sands of the Mehrten Formation, and therefore offset could not be identified.

The base of fresh water surface from C2VSim, which represents the bottom of the Subbasin, is overlaid onto the conceptual cross section. The base of fresh water undulates throughout the Subbasin. It is highest in the eastern Subbasin, at an elevation of approximately -550 feet msl, and deepest in the central Subbasin, at an elevation of approximately -1,000 feet msl. In the eastern Subbasin, the base of fresh water is below the Mehrten Formation, within the undifferentiated continental and marine sediments. In the central Subbasin it rises into the base of the Mehrten Formation. The undulations approximately correspond with the locations of the faults.

The conceptual cross section also illustrates the three principal aquifers: the Western Upper Principal Aquifer above the Corcoran Clay, the Western Lower Principal Aquifer below the Corcoran Clay and above the base of fresh water, and the Eastern Principal Aquifer east of the Corcoran Clay and above the base of fresh water.

3.1.4.3. Aquifer Properties

The USGS compiled aquifer property data for the Modesto and Turlock subbasins (Burow et al., 2004). The USGS reported hydraulic conductivity above the Corcoran Clay, in the Western Upper Principal Aquifer, to range from 27 to 54 feet per day (ft/day) (Page, 1977 in Burow et al., 2004). The C2VSim Modesto Model has an average hydraulic conductivity above the Corcoran Clay of 42 ft/day, which is within this published range.

The hydraulic conductivities in the Mehrten Formation, at the base of both the Eastern Principal Aquifer and Western Lower Principal Aquifer, ranged from 0.01 to 67 ft/day (Page and Balding, 1973 in Burow et al., 2004). Average hydraulic conductivity in the lower aquifer of the C2VSIM Modesto Model, which includes the Mehrten Formation, is 25 ft/day, which is within this published range.

In the Eastern Principal Aquifer, the transmissivity (T) in the shallow unconsolidated sediments is estimated to be 9,100 ft^2/day (68,068 gpd/ft). The T in the deeper, partly consolidated sediments of both the Eastern Principal Aquifer and Western Lower Principal Aquifer was lower, approximately 8,000 ft^2/day (59,840 gpd/ft) (Page and Balding, 1973 in Burow et al., 2004).

3.1.5. Hydrogeologic Conceptual Model Representation in Modesto C2VSim Model

The hydrogeologic conceptual model was compared with the Modesto C2VSim Model to ensure that the hydrogeologic system is well represented in the model.

As discussed previously in Section 3.1.4, the original Corcoran Clay surface that was in the model was replaced with the Corcoran Clay surface from the USGS MERSTAN Model (Phillips et al., 2015). This was because an anomaly in the original surface was discovered while comparing the cross sections and well logs to the model. The Corcoran Clay surface in the USGS MERSTAN Model is the most detailed mapping of the Corcoran Clay in the Modesto Subbasin. The depth, thickness and extent of the Corcoran Clay shown on the cross sections generally agrees with the USGS MERSTAN Model, and consequently, with the revised surface in the Modesto C2VSim Model.

The model layers are a good representation of the Principal Aquifers. The primary shallow pumping layer of the model contains most of the pumping wells. As mentioned in the previous section, the average hydraulic conductivity in the model in the Western Upper Principal Aquifer and within the Mehrten Formation were within the range published in the literature.

The hydrogeologic conceptual model is well represented in the Modesto C2VSim Model. Because of this, the model is an effective tool for estimating water levels in areas lacking water level data, such as within the Western Lower Principal Aquifer and in the eastern Subbasin. The model is also an effective tool for developing water budgets, which will be presented in Section 4.

3.1.6. Data Gaps and Uncertainties in the Hydrogeologic Conceptual Model

This section will summarize hydrogeologic data gaps that affect implementation of the Plan and are related to the GSAs ability to sustainably manage groundwater. The Plan Implementation section, when developed, will describe how these data gaps will be addressed in future GSP actions. A summary of the data gaps for the Hydrogeologic Conceptual Model is summarized in the table below.

Table 3-1: Data Gaps for the Hydrogeologic Conceptual Model

Issue	Area	Impacts on Groundwater Management	Actions to Address
Eastern Subbasin Aquifers	East and Northeast of Modesto Reservoir	Sparse number of wells in this area of the Subbasin means more uncertainty regarding the Eastern Principal Aquifer.	• Collect relevant data from landowners, as available. • Install additional monitoring wells. • Examine lithologic logs and other well data when new wells are drilled in this area.
Mehrten Formation	Central and Western Subbasin	Depth to top of Mehrten Formation not well understood in central and western Subbasin due to shallow wells. Impacts understanding of aquifer properties and geometry.	• Examine lithologic logs and other well information as additional deep wells are drilled in central and western Subbasin. • Add testing program, such as geophysical logs, to proposed deep wells where needed.
Exact Base of Fresh Water	Entire Subbasin	Uncertainty in Subbasin geometry, fresh groundwater in storage, and water quality with depth.	Compile TDS data for wells with known screen intervals. Test water quality in all new Subbasin wells.

3.2. GROUNDWATER CONDITIONS

An evaluation of groundwater conditions in the Modesto Subbasin was conducted using water level data obtained from numerous sources, including the DWR Water Data Library (which includes CASGEM data), USGS, MID, OID, and the municipalities and urban communities. There are more than 600 wells in the Subbasin with measured water levels between 1918 and 2018, with most measurements occurring after 1970. The locations of these wells are shown on **Figure 3-19**. As shown on the figure, most water level data are from wells in the western and central Subbasin, with limited data in the eastern Subbasin.

The groundwater analysis focused on data from 1990 to 2018; this water level study period overlaps the water budget study period (WY 1991 – WY 2015, see **Section 3.1.2.1**) while including more recent data to examine current groundwater conditions. During this period, water levels were measured at approximately 450 of these wells.

3.2.1. Groundwater Occurrence

As summarized in **Section 3.1.4**, groundwater is present in unconfined to semi-confined aquifers above and east of the Corcoran Clay and in confined aquifers below the Corcoran Clay. Groundwater is also present in the shallow alluvial unconsolidated to semi-consolidated deposits as well as the underlying consolidated sediments; however, groundwater conditions are not well defined in the deeper aquifers due to a lack of data.

3.2.2. Water Levels and Trends

To examine water level trends over the study period, working hydrographs were constructed for each of the approximately 450 wells with water level measurements since 1990. Representative hydrographs were chosen for discussion from wells in each principal aquifer based on data availability and on levels, fluctuations, and trends consistent with other hydrographs in a certain area. The locations of selected wells with representative hydrographs are shown on **Figure 3-20** and are color-coded based on the principal aquifer in which they are screened.

Representative hydrographs are presented on **Figures 3-21** through **3-25**. These hydrographs have consistent horizontal scales (1990 to 2018) and vertical scales (0 to 160 feet msl) to facilitate comparisons across the Subbasin. The ground surface elevation is shown as a black line on the hydrographs unless it is greater than 160 ft msl, in which case it is noted at the top of the hydrograph. If known, the depth of the screened intervals for each well are noted on the hydrograph. Representative hydrographs include data measured at MID wells, City of Modesto wells, City of Oakdale wells, CASGEM wells and DWR Water Data Library wells.

Eight representative hydrographs from the Western Upper Principal Aquifer are illustrated on **Figures 3-21** and **3-22**. As shown on **Figure 3-21**, groundwater elevations in the western and central regions of the Western Upper principal aquifer are shallow. Depth to water in the northwest Subbasin (hydrograph 1) is within ten feet of ground surface and deepens to the south (hydrograph 2) and east (hydrographs 3, 4 and 5). Water levels are relatively stable, especially along the western Subbasin boundary near the San Joaquin River (hydrographs 1 and 2). Water levels fluctuate more to the east. Hydrographs 3, 4 and 5 show slightly more pronounced water level declines during the recent drought. The declines are greater in the center of the Subbasin (hydrograph 4, approximately 13 feet) than near the rivers (hydrographs 3 and 5, approximately 5 or less feet).

Three hydrographs from the eastern edge of the Western Upper Principal Aquifer are shown on **Figure 3-22** and illustrate a similar historical water level trend. Water levels between 1990 and 1995 are relatively low and rise after 1995 when the City of Modesto began receiving water from the Modesto Regional Water Treatment Plant (MRWTP) and pumping less groundwater. Water levels were relatively steady from 2000 to the recent drought, when declines up to 10 feet (hydrograph 7) and 15 feet (hydrograph 6) occurred. Water levels have recovered slightly since the end of the drought.

Hydrograph 8 illustrates water levels from a City of Modesto pumping well (Well 17). In 1994, shortly before the City of Modesto began receiving water from the MRWTP, water levels were the lowest of the study period. Between 1995 and 2000, after the City began receiving water from the MRWTP, water levels rose almost 50 feet. Since 2000, water levels indicate significant seasonal pumping variation, but overall have remained relatively steady.

Three hydrographs from the Western Lower Principal Aquifer are shown on **Figure 3-23**. Each of these hydrographs are from City of Modesto pumping wells (Well 290, Well 313 and Well 56). Each of these hydrographs illustrate significant seasonal pumping variations. When compared to Well 17, in the Wester Upper Principal Aquifer (hydrograph 8 on **Figure 3-22**), it appears that the water level variation below the Corcoran Clay is more significant than above the Corcoran Clay, consistent with pumping in a confined aquifer. Water levels in City of Modesto Well 56 (hydrograph 11) depict the historical trend of water level recovery between 1995 and 2000 followed by relatively stable water levels with seasonal pumping fluctuations. In general, water levels appear to be relatively stable, with small declines during drought (about 10 to 20 feet) followed by recovery in post-drought years.

Representative hydrographs from ten wells east of the edge of the Corcoran Clay in the Eastern Principal Aquifer are illustrated on **Figures 3-24** and **3-25**. Hydrographs from wells in the western side of the Eastern Principal Aquifer are shown on **Figure 3-24** and include three MID wells, one City of Modesto well and one well from the DWR WDL. These hydrographs indicate a deeper water table as ground surface elevations rise to the east. Hydrographs illustrate depths to water ranging from approximately 40 feet bgs in MID-208 to more than 80 feet bgs in MID-197 (**Figure 3-24**). The water levels in the MID wells are relatively steady until declines during the most recent drought. Those declines increase to the east, ranging from about 12 feet in MID-208 to 27 feet in MID-214. Some recovery occurred after the drought, but water levels remain approximately 20 feet below pre-drought levels in the two easternmost wells, MID-214 and MID-197.

The City of Modesto well 37 (hydrograph 13), located in the center of the Subbasin close to the edge of the Corcoran Clay, has a similar water level pattern to other City of Modesto wells in the western principal aquifers. The water level in City of Modesto Well 37 rose approximately 50 feet between 1995 and 2000 and remained relatively steady, with pumping cycles, since then. There is a slight downward water level trend since about 2005 that was less pronounced in the City of Modesto wells in the western principal aquifers.

Five hydrographs from the eastern region of the Eastern Principal Aquifer are illustrated on **Figure 3-25**. These hydrographs are from a City of Oakdale well (Well 5), two MID wells and two wells from the DWR WDL. Although the City of Oakdale Well 5 (hydrograph 17) has missing data between 1995 and 2009, the measured record illustrates up to 40 feet of seasonal pumping variations and an overall slightly declining trend. The other four hydrographs show historical declining trends since about the mid-2000s. For example, water levels in MID-228 (hydrograph 19, near the Tuolumne River), declined approximately 30 feet from the late 1990s to present. Most of the declines occur during the recent drought (2013 – 2016) and appear most significant in the eastern Subbasin. Water levels during the drought declined approximately 25 feet in MID-228 (hydrograph 19) and MID-223 (hydrograph 21) and about 40 feet in the DWR WDL well 02S12E32P01M (hydrograph 18), north of Modesto Reservoir. In that well, recent water levels have not recovered or stabilized substantially, even during the wet year of 2017.

In general, hydrographs in the Eastern Principal Aquifer indicate that water levels in the eastern Subbasin have declined since about 2000 and have significant declines during the most recent drought. The historical declining trends and the magnitude of decline during the recent drought are most pronounced in the eastern region of the Eastern Principal Aquifer. In the eastern Subbasin, long-term rates of decline are up to about 2.7 feet/year and rates of decline during drought are up to 6 feet/year. Due to a lack of data, water level trends east of the Modesto Reservoir and in the northeastern region of the Subbasin are not known.

3.2.3. Groundwater Flow

3.2.3.1. Groundwater Elevation Contour Maps

Groundwater elevation contour maps were developed at three different times within the study period: the wettest year (1998), a dry year during the recent drought (2015), and the most recent year with a sufficient set of measured data (2017). These contour maps are shown on **Figures 3-26, 3-27a, and 3-28**. Each groundwater elevation contour map includes water levels measured in the unconfined Western Upper Principal Aquifer and unconfined to semi-confined Eastern Principal Aquifer. Water levels from these two principal aquifers are shown and contoured on the same map as representative of water table conditions. In addition, simulated groundwater elevation contours from September 2015 in the Unconfined Aquifer are shown on **Figure 3-27b**.

Maps illustrating the available water level data in the Western Lower Principal Aquifer were developed for each time period and are shown on **Figures 3-29, 3-30a and 3-31**. Water levels in the Western Lower Principal Aquifer cannot be contoured due to limited data. Although many wells in the western Subbasin were drilled below the Corcoran Clay, most have screened intervals both above and below the clay. Wells shown on these figures are screened only below the Corcoran Clay. Simulated groundwater elevation contours from the groundwater model provide a more complete representation of water levels in the Western Lower Principal Aquifer than could be developed with current data. A simulated groundwater elevation contour map for the Confined Aquifer in September 2015 is shown on **Figure 3-30b**.

<u>Groundwater Flow in Spring 1998 (March and April)</u>

Groundwater elevations measured in spring 1998 are illustrated on **Figure 3-26**. As shown on **Figure 3-2**, water year 1998 is the wettest year between 1990 and 2017. With almost 25 inches of rain, precipitation during water year 1998 was almost double the long term average (12.6 inches) and study period average (12.8 inches). As shown on the hydrographs, water levels throughout most of the Subbasin rebounded between 1995 and

2000 in response to the reduction of groundwater pumping within the City of Modesto as a result of the delivery of water from the MRWTP. For this and other reasons, 1998 water levels do not always represent the highest water levels in all parts of the Subbasin.

Groundwater elevations in spring 1998 ranged from about 150 feet msl near the Modesto Reservoir to approximately 35 feet msl in the western Subbasin. The lowest groundwater elevations occurred along the western edge of the Subbasin and within the City of Modesto along the Tuolumne River. Groundwater flow is generally to the southwest with flatter hydraulic gradients in the west. There is a southerly component of flow towards the Tuolumne River in the western Subbasin caused by a pumping depression in the City of Modesto. Groundwater elevations in this region are between about 30 and 40 feet msl, which is similar to the groundwater elevations along the western edge of the Subbasin next to the San Joaquin River. There is a general area of higher groundwater elevations in the central Subbasin, with elevations slightly over 100 feet msl. Additional localized areas of higher or lower groundwater elevations also occur in the Subbasin. As illustrated on **Figure 3-26**, there is a lack of measured water level data in the eastern Subbasin.

Groundwater elevations in the Western Lower Principal Aquifer are available in only two wells during spring 1998 (**Figure 3-29**). The wells are along the eastern edge of the aquifer and have similar water levels (41 and 44 ft msl); levels are also similar to water levels in the Western Upper Principal Aquifer.

<u>Groundwater Flow in October 2015</u>

Figure 3-27a illustrates groundwater elevations measured in October 2015. Water year 2015 was the third consecutive critically dry year during the recent drought and water levels reached historical lows in many areas of the Subbasin. January 2015 is defined in the Water Code as the SGMA baseline, so this map generally represents baseline conditions for the Subbasin.

As shown on **Figure 3-27a**, groundwater elevations ranged from approximately 130 feet msl in the eastern Subbasin to 14 feet msl in the western Subbasin along the Tuolumne River in Modesto. In October 2015, more water level data are available in the eastern Subbasin than in spring 1998 and the highest water level (132 feet msl) was measured in the northeastern Subbasin.

Groundwater flow patterns in October 2015 are similar to spring 1998, with groundwater flow to the southwest, with a southerly component towards the Tuolumne River, especially within the City of Modesto. Hydraulic gradients are steeper in the eastern Subbasin and become flatter to the west. Even though flow directions are the same as 1998, groundwater levels in October 2015 are generally lower throughout the Subbasin.

Increased municipal pumping during the drought has created a pumping depression within the City of Modesto, with water levels approximately 20 feet lower than in spring 1998. Similarly, increased irrigation pumping has created a pumping depression east of the City of

Modesto in the central Subbasin, with water levels approximately 20 to 30 feet lower than in spring 1998. Water levels in the Western Upper Principal Aquifer appear to have the least amount of decline, on the order of 10 to 20 feet lower than in spring 1998. The magnitude of water level declines between these two time periods is larger in the east. For example, water levels in October 2015 near the Modesto Reservoir are approximately 30 to 40 feet lower than they were in spring 1998.

Simulated groundwater elevation contours in the unconfined aquifer from September 2015 are shown on **Figure 3-27b**. This figure shows that there is general agreement between simulated groundwater elevations from the model and measured groundwater elevations (see **Figure 3-27a**). Simulated groundwater elevations in the Western Upper Principal Aquifer range from approximately 20 to 40 feet msl, similar to measured data. Simulated groundwater elevations gradually increase to the east, with the 120 foot simulated contour in a similar location in the eastern Subbasin as depicted on the measured contour map. The simulated groundwater elevation contours in the central Subbasin are smoother than the contours based on measured data. This is because there is more well-by-well variability in the measured data based on localized pumping.

Groundwater elevations are available in four wells in the Western Lower Principal Aquifer for October 2015 (**Figure 3-30a**). The wells, located along the eastern edge of the aquifer, have elevations ranging from 26 to 41 feet msl; although there are more wells with 2015 data, elevations for the same wells are between 3 feet and 10 feet lower than in spring 1998. Simulated groundwater elevations in September 2015 provide a more complete representation of groundwater conditions in the Western Lower Principal Aquifer (**Figure 3-30b**). Simulated contours show flow to the northeast, with groundwater elevations ranging from over 30 to under 20. The simulated contours are in general agreement with the limited measured data shown on **Figure 3-30a**.

Groundwater Flow in Spring 2017 (February through May)

Groundwater elevations measured in spring 2017 are illustrated on **Figures 3-28 and 3-31**. Water year 2017 was a wet year with above average precipitation; as such, water levels are higher throughout the Subbasin than in October 2015.

As shown on **Figure 3-28**, groundwater elevations range from 110 feet msl north of the Modesto Reservoir to about 20 feet msl within the City of Modesto near the Tuolumne River. Groundwater flow patterns are similar to spring 1998 and October 2015. Flow is to the southwest with a southerly component towards the Tuolumne River, most notably in the vicinity of the City of Modesto, but also in other areas.

Groundwater elevations have recovered more in the western Subbasin than they have in the eastern Subbasin. For example, water levels within the City of Modesto are about 10 to 20 feet higher than in October 2015. Groundwater elevations in the central Eastern Principal Aquifer are less than 10 feet higher than in October 2015. Although data are limited, it appears that water levels have continued to decline further to the east. Two wells north of the Modesto Reservoir show water level declines of 13 feet (from 118 to 105 feet msl) and 3 feet (from 113 to 110 feet msl) since October 2015.

Water levels at four wells in the Western Lower Principal aquifer are shown on **Figure 3-31**. As in 1998 and 2015, the wells are along the eastern edge of the aquifer. Groundwater elevations are higher than they were in October 2015, ranging from 44 to 53 feet msl.

3.2.3.2. Vertical Groundwater Flow

The USGS has found that vertical groundwater movement within the extent of the Corcoran Clay is downward, from the Western Upper Principal Aquifer to the Western Lower Principal Aquifer (Burow et al., 2004). An analysis of groundwater elevation data in the Modesto Subbasin supports this.

The analysis of vertical gradients is based on water levels from a USGS well cluster and a group of nearby wells that are screened above and below the Corcoran Clay. The location of these wells is shown on **Figure 3-32** and hydrographs are shown on **Figures 3-33 and 3-34**. The extent of the Corcoran Clay, as defined by the USGS (Burow et al., 2004), is shown on **Figure 3-32**.

In 2004, USGS installed a cluster (MRWA) of three wells in the southwestern Subbasin. Two of the wells are screened above the Corcoran Clay (MRWA-1 and MRWA-2) and one is screened below the Corcoran Clay (MRWA-3). MRWA-1 is screened at a depth of 25 to 30 feet bgs (37 to 32 feet msl), in the shallow portion of the Western Upper Principal Aquifer. MRWA-2 is screened in the deeper portion of the Western Principal Aquifer just above the Corcoran Clay, at a depth of 174 to 179 feet bgs (-112 to -117 feet msl). MRWA-3 is screened in the Western Lower Principal Aquifer, at a depth of 269 to 274 feet bgs (-207 to -212 feet msl). According to data provided by the USGS, the Corcoran Clay was encountered from 195 to 240 feet bgs (-133 to -178 feet msl) at this location. The USGS collected water levels from these wells between 2004 and 2006 and again in 2009. These water levels are shown on **Figure 3-33**.

Water levels measured in the MRWA cluster show that groundwater elevations are higher in the Western Upper Principal Aquifer than the Western Lower Principal Aquifer. Groundwater elevations above the Corcoran Clay in MRWA-1 and MRWA-2 are similar to one another and are between about 1.5 and 6 feet higher than in MRWA-3, below the Corcoran Clay. Therefore, groundwater flow is downward from the Western Upper Principal Aquifer to the Western Lower Principal Aquifer (**Figure 3-33**).

Groundwater elevations in the shallow and deep regions of the Western Upper Principal Aquifer (MRWA-1 and MRWA-2) are similar except when steep declines occur below the Corcoran Clay. These declines are likely associated with pumping increases below the Corcoran Clay. The shallow unconfined aquifer does not appear to be affected (MRWA-1). The water levels show consistent downward groundwater flow from the Western Upper Principal Aquifer to the Western Lower Principal Aquifer, which is increased with pumping in the Western Lower Principal Aquifer (**Figure 3-33**).

The second set of wells used for the vertical groundwater flow analysis includes one MID well (MID-103), screened above the Corcoran Clay from 53 to 81 feet bgs, and two City of Modesto wells (MOD-63 and MOD-313), screened below the Corcoran Clay at multiple intervals ranging from 171 to 456 feet bgs. Well depths in relation to the Corcoran Clay were verified with the cross sections and the base elevation of the Corcoran Clay in the model. These wells, shown on **Figure 3-32**, are in close proximity to one another near the eastern edge of the Corcoran Clay.

Hydrographs for these three wells are shown on **Figure 3-34**. The City of Modesto wells show cyclic seasonal pumping fluctuations of up to 30 feet, while the MID well is relatively steady, with fluctuations of 10 or less feet. Groundwater elevations below the Corcoran Clay in the two City of Modesto wells are very similar to one another and consistently lower than the elevations in the MID well above the Corcoran Clay. Groundwater elevations above the Corcoran Clay are about 10 to 40 feet higher than below the Corcoran Clay. The biggest differences occurred during the recent drought (2014 to 2016) due to increased pumping. Water levels in this group of wells indicate consistent downward groundwater flow from the Western Upper Principal Aquifer to the Western Lower Principal Aquifer in this area of the Subbasin.

3.2.4. Changes of Groundwater in Storage

In Bulletin 118 (DWR, 2003), DWR estimates that there is 6.5 million acre feet (MAF) of fresh groundwater in storage to a depth of 300 feet in the Modesto Subbasin. However, as shown on the cross section on **Figure 3-18**, the depth to the base of fresh water is deeper than 300 feet, and therefore, the DWR estimate is likely too low. In 1961, it was estimated that 14 MAF of stored groundwater is present in the Subbasin to depths of up to 1,000 feet, a more reasonable estimate given the current understanding of subbasin geometry (DWR, 2003). Since 1961, based on declining water levels trends and fluctuations observed throughout the Subbasin, depletions in groundwater in storage has occurred in the Modesto Subbasin. Water level trends are described in **Section 3.2.2**.

One accepted method of estimating current groundwater in storage changes is to construct groundwater elevation contour maps during seasonal highs for various water years and develop change in water level maps between them. By applying storage parameters to these water level changes, a change in groundwater in storage can be estimated. However, these maps cannot be developed over the entire Modesto Subbasin with the desired level of certainty due to significant data gaps for water levels both within certain areas of the Subbasin as well as for one of the three Principal Aquifers. Consequently, the C2VSimTM model was used to develop GSP water budget analyses.

Results from the C2VSimTM model, which is well-calibrated and has reliable water budget data, provide an alternative method for estimating changes in groundwater in storage. The model also has the advantage of providing this information over the entire Subbasin, even where water level data are lacking. Selection, refinements, and calibration of the C2VSimTM model are provided in **Appendix C**. Water budgets, including change in groundwater in storage over a 25-year Study Period have been developed and are summarized in **Chapter 5** of this GSP. Those model results represent the best technical data available for determining changes in groundwater in storage over time.

The historical water budget is described in **Section 5.1.4.2**. As shown on **Table 5-8**, about 43,000 AFY has been depleted from groundwater in storage during the historical study period, from WY 1991 to 2015. This is equivalent to a cumulative depletion of approximately 1.07 MAF. The annual and cumulative change in storage is illustrated on **Figure 5-20**. Given that much of the groundwater level declines have occurred during the historical study period (primarily due to increased agricultural water demand), remaining groundwater in storage can be approximated at about 13 MAF.

As summarized on **Table 5-8**, the historical water budget estimates groundwater production of approximately 311,000 AFY. Given the average depletion of groundwater in storage is 43,000 AFY, a sustainable yield of approximately 268,000 AFY can be estimated for the historical study period. This is a simplistic estimate and does not take into account other important components of the water budget, such as interconnected surface water. Accordingly, this estimate cannot be projected for future conditions in the Subbasin. A more technically defensible sustainable yield estimate was developed for projected future conditions using the C2VSimTM as described in **Section 5.3**.

3.2.5. Groundwater Quality

Historical and current groundwater quality conditions of the Modesto Subbasin have been reviewed to characterize groundwater quality of the principal aquifers including an analysis of any constituents of concern. In particular, the analysis allows identification of groundwater quality issues that may affect the supply and beneficial uses of groundwater, including possible plumes of groundwater contamination. The compilation and analysis of historical and current data is described in the following sections, including the sources of data, screening procedures and quality assurance of the data, selection of constituents to analyze, and characteristics of the resulting data sets. Statistical summaries are also presented for select constituents.

3.2.5.1. Regional Groundwater Quality

Groundwater quality in the San Joaquin Valley is highly variable and reliant on the quality of the water recharging the aquifer, the chemical changes that occur as surface water percolates to groundwater, and chemical changes that occur within the aquifer (Dale et al., 1966). USGS has categorized regional groundwater quality in the San Joaquin Valley into three groups based on geography: east side, west side, and axial trough (Dale et al., 1966).

East side groundwater quality is of the bicarbonate type with low total dissolved solids (TDS). This groundwater is characteristic of the surface waters that drain the granitic Sierra Nevada Range to the east of the San Joaquin Valley groundwater basin (Dale et al., 1966). Groundwater quality in the east side reflects the quality of the quality of the local surface water including the Stanislaus and Tuolumne rivers, the primary sources of recharge to the Modesto Subbasin aquifers.

3.2.5.2. Local Groundwater Quality

Publicly available groundwater quality data for the Modesto Subbasin were used in this analysis. These data sources include STRGBA GSA member agencies (City of Modesto, City of Riverbank, City of Waterford, and Modesto Irrigation District), Eastern San Joaquin Water Quality Coalition, Central Valley Salinity Alternatives for Long-term Sustainability (CV-SALTS), and the California State Water Resources Control Board GeoTracker-GAMA and GAMA database. Water quality data from other STRGBA GSA member agencies, such as City of Oakdale, Oakdale Irrigation District, Stanislaus County, and Tuolumne County, were either not available or associated with constituents that were not included in this water quality analysis, such as total coliform and E. Coli coliform. The City of Modesto dataset includes >76,000 water quality records consisting of >30 different constituents collected between 1938 and 2018. The Eastern San Joaquin Water Quality Coalition dataset includes 50,696 records of nitrate analyses between 1902 and 2013, and 19,923 records of total dissolved solids (TDS) analyses between 1925 and 2013. The CV-SALTS database includes nitrate and TDS that were collected between 1934 to 2014 from the following five original collection agencies or sources: Regional Water Quality Control Board (RWQCB) Waste Discharge Requirements (WDR) data per the Dairy CARES program (Dairy); California Department of Public Health (CDPH); Department of Water Resources (DWR); the (USGS) National Water Information System (NWIS) program; and GeoTracker Groundwater Ambient Monitoring and Assessment (GAMA) program.

The data compiled here includes all well types, including domestic, public supply, industrial, monitoring, irrigation, and stock wells, and from all local groundwater quality monitoring programs in the Modesto Subbasin. Using these data, a Microsoft Access database was built that includes over 118,203 groundwater quality records that were collected from 1,339 wells between the start of water year 1995 (October 1, 1994) to 2019. The database includes 260 unique water quality constituents. However, only the most relevant water quality constituents for the Modesto Subbasin are analyzed here. Prior to analysis, quality assurance/quality control (QA/QC) steps were performed on the data, including the identification and removal of duplicate samples and cross-checking the correct well location.

3.2.5.3. Constituents of Concern

A list of potential constituents of concern was developed by the technical team based on a preliminary data review, and review of previous water quality analyses developed in the Subbasin. The constituent list was reviewed at two public STRGBA GSA TAC meetings – April and July 2019. Based on input from TAC members, nine potential constituents of concern were identified for the analysis as listed in the following table.

Table 3-2: Potential Constituents of Concern

Nitrate (as N)	**Boron**	**Dibromo-3-chloropropane (DBCP)**
Total Dissolved Solids (TDS)	**Uranium**	**Tetrachloroethene (PCE)**
Arsenic	**Gross Alpha, 1,2-**	**1,2,3-Trichloropropane (TCP)**

The following is a summary of groundwater quality conditions in the Modesto Subbasin during historical (water year 1995 to 2014) and present (2015 to 2019) periods, emphasizing these potential constituents of concern (COCs). Based on a review of water quality and input from the TAC, these COCs are the most likely to affect groundwater quality from irrigated agriculture (i.e., nitrate, TDS, and DBCP), which is the dominant land use across the Modesto Subbasin, from other human point sources (i.e., PCE) and from natural geogenic sources (i.e., arsenic, boron, uranium, and Gross Alpha) in the Subbasin. Nitrate is reported here as nitrate (as N); nitrate values reported in the original data sources as nitrate (as NO_3^-) were converted to nitrate (as N) prior to analysis.

Nitrate

Nitrate is the most common soluble form of nitrogen in natural groundwater and originates from natural and anthropogenic sources. In general, naturally occurring nitrate is found in low concentrations in groundwater and is derived from precipitation, atmospheric deposition, and natural biogeochemical cycling processes in soils, including the decomposition of organic matter. The most common anthropogenic source of nitrate is the application of nitrogen fertilizers, particularly on irrigated agricultural lands (Gurdak and Qi, 2012). As a result, nitrate is the most ubiquitous nonpoint-source COC of groundwater resources worldwide, including the Central Valley in California (Gurdak and Qi, 2012).

Point sources of nitrate in groundwater include feedlot and dairy drainage, leaching from septic systems, wastewater percolation, industrial wastewater, aerospace activities, and food processing waters (Viers et al., 2012). Denitrification is the only natural process that attenuates nitrate concentrations in groundwater. Previous studies have shown that denitrification is promoted in groundwater with anoxic conditions (dissolved oxygen (DO) < 0.5 mg/L) and large amounts of organic carbon (Gurdak and Qi, 2012). However, there are too few measurements of DO (N = 29) in the database to evaluate if oxic or anoxic conditions exist and the potential for denitrification. All of the DO samples except for two have concentrations in the oxic range (>0.5 milligrams per liter (mg/L)), which indicates a limited potential for denitrification. Future groundwater quality monitoring that includes measurements of DO could help characterize the potential for denitrification and explain the vulnerability of groundwater in the Modesto Subbasin to nitrate contamination.

Nitrate in groundwater from municipal wells in the Modesto Subbasin has been detected in concentrations that approach and, in some cases, exceed the MCL for drinking water (JJ&A and Formation Environmental, 2019). Currently, six municipal wells in the City of Modesto have been taken off-line due to elevated nitrate concentrations (JJ&A and Formation

Environmental, 2019). Blending of water is being used to reduce nitrate concentrations at other municipal wells. Nitrate is present in the City of Modesto's drinking water aquifers because of historical agricultural and wastewater management activities. Nitrate is often detected in the shallow aquifer system, but in some cases, can be drawn down into the deeper aquifer by pumping or through wells with long screened or perforated intervals (Jurgens et al., 2008). Nitrate migration is influenced by downward hydraulic gradients created by municipal pumping, and elevated nitrate concentrations are being drawn deeper in the aquifer near local cones of depression (JJ&A and Formation Environmental, 2019).

A total of 41,898 groundwater samples in the Modesto Subbasin have nitrate analyses and an average concentration of 5.3 mg/L (as N) and generally meet drinking water quality standards (**Table 3-3)**. The median value (5.0 mg/L) is approximately double of the range of nitrate concentrations (2 to 3 mg/L) that have been established by previous studies as representing relative background concentrations from natural processes (Gurdak and Qi, 2012). Although isotopic analysis on the nitrate is needed to identify the source, the median value of 5.0 mg/L indicates that more than half of the samples are above the relative background concentration and thus have a nitrogen input from mostly human sources, such as fertilizers. The majority (93%) of the nitrate analyses have concentrations that are below the MCL of 10 mg/L (as N) (**Table 3-3**). However, 7% of the nitrate samples have concentrations that exceed the MCL (**Table 3-3**).

The average and maximum concentrations of nitrate in groundwater from wells in the Modesto Subbasin during the period of water year 1995 to 2019 are shown in **Figures 3-35 and 3-36**. Nitrate concentrations are illustrated as green circles (less than 5 mg/L), yellow circles (between 5 mg/L and the MCL of 10 mg/L), orange circles (between 10 and 15 mg/L), and red circles (greater than 15 mg/L). Wells with average nitrate concentrations below the MCL of 10 mg/L (as N) tend to be located within the central part of the Subbasin, especially within the urban areas surrounding Modesto, Oakdale, Riverbank, and Waterford (**Figure 3-35**). The wells that have average nitrate concentrations that exceed the MCL of 10 mg/L (as N) are mostly located within the agricultural lands to the west and east of Modesto, but there are also clusters of exceedances within the City of Modesto (**Figure 3-35**). The spatial pattern of maximum nitrate concentrations is similar to the spatial pattern of average nitrate concentrations; most wells with maximum nitrate concentrations below the MCL tend to be in urban areas and the maximum nitrate concentrations above the MCL tend to be in the agricultural lands (**Figure 3-36).** However, there are several wells in Modesto and other urban areas of the Subbasin that have maximum nitrate concentrations above the MCL. The spatial patterns in the average and maximum nitrate concentrations are apparently influenced by the general land-use pattern of the Subbasin.

Table 3-3: Summary Statistics of Select Groundwater Quality Constituents

Water Quality Constituent	California MCL[1] or SMCL[2]	Number of Samples	Percentage of Samples			Concentrations			
			<0.5MCL	>0.5MCL to MCL	>MCL	Min.	Median	Avg.	Max.
Nutrients									
Nitrate (as N), mg/L	10 mg/L[1]	41,898	50%	42%	7%	0.0	5.0	5.3	490
Pesticides									
DBCP, µg/L	0.2 µg/L[1]	9,636	74%	12%	14%	0.0	0.0	0.1	18
TCP, µg/L	0.005 µg/L[1]	5,004	96%	0%	4%	0.000	0.000	0.008	12
Radionuclides									
Gross Alpha, pCi/L	15 pCi/L[1]	1,369	65%	20%	15%	-0.6	4.1	6.9	47
Uranium, pCi/L	20 pCi/L[1]	3,326	71%	20%	8%	0.0	4.9	7.4	65
Secondary Maxiumum Contaminant Level Constituents									
Total dissolved solids, mg/L	1,000 mg/L[2]	16,288	55%	30%	14%	0.0	450.0	703.2	20,000
Trace Elements									
Arsenic, µg/L	10 µg/L[1]	5,993	72%	20%	7%	0.0	2.9	4.8	300
Boron, mg/L	1 mg/L*	841	98%	1%	1%	0.0	0.0	1.9	200
Volatile Organic Compounds (VOC)									
PCE, µg/L	5 µg/L[1]	8,262	87%	4%	8%	0.0	0.0	10.4	8,860

Notes:

[1]**MCL**: California drinking water Maximum Contaminant Level

[2]**SMCL**: California drinking water Secondary Maximum Contaminant Level

<0.5MCL: percentage of samples with concentrations less than one-half the MCL.

>0.05MCL to MCL: percentage of samples with concentrations between one-half of the MCL to the MCL.

>MCL: percentage of samples with concentrations greater than the MCL.

***California State Notification Level (CA-NL). Boron does not have an MCL.

min.: minimum concentration

avg.: average concentration

max.: maximum concentration

Summary statistics of nitrate concentrations in groundwater from the Eastern Principal Aquifer, Western Upper Principal Aquifer, and Western Lower Principal Aquifer are shown in **Tables 3-4**, **3-5**, and **3-6**, respectively. The average nitrate concentrations are similar (5.6, 5.9, and 5.8 mg/L) in the Eastern, Western Upper, and Western Lower Principal Aquifers. The percentage of samples that exceed the 10 mg/L MCL in the Western Upper (13%) and Western Lower (22%) is greater than in the Eastern Principal Aquifer (3%). The data indicate that groundwater quality is relatively similar above and below the Corcoran Clay.

Table 3-4: Summary Statistics of Select Groundwater Quality Constituents for the Eastern Principal Aquifer

Water Quality Constituent	California MCL[1] or SMCL[2]	Number of Samples	Percentage of Samples			Concentrations			
			<0.5MCL	>0.5MCL to MCL	>MCL	Min.	Median	Avg.	Max.
Nutrients									
Nitrate (as N), mg/L	10 mg/L[1]	25,425	39%	58%	3%	0.0	5.7	5.6	490
Pesticides									
DBCP, µg/L	0.2 µg/L[1]	8,518	71%	14%	15%	0.0	0.0	0.1	18
TCP, µg/L	0.005 µg/L[1]	4,568	96%	0%	4%	0.000	0.000	0.008	12
Radionuclides									
Gross Alpha, pCi/L	15 pCi/L[1]	920	72%	17%	12%	-0.6	3.6	5.7	31
Uranium, pCi/L	20 pCi/L[1]	2,285	81%	14%	5%	0.0	4.0	5.9	52
Secondary Maxiumum Contaminant Level Constituents									
Total dissolved solids, mg/L	1,000 mg/L[2]	6,963	74%	25%	1%	0.0	380	389	3,000
Trace Elements									
Arsenic, µg/L	10 µg/L[1]	4,245	86%	11%	3%	0.0	2.2	3.1	130
Boron, mg/L	1 mg/L*	606	97%	1%	2%	0.0	0.0	2.6	200
Volatile Organic Compounds (VOC)									
PCE, µg/L	5 µg/L[1]	5,983	86%	5%	9%	0.0	0.0	6.3	8,860

Notes:

[1]**MCL**: California drinking water Maximum Contaminant Level

[2]**SMCL**: California drinking water Secondary Maximum Contaminant Level

<0.5MCL: percentage of samples with concentrations less than one-half the MCL.

>0.05MCL to MCL: percentage of samples with concentrations between one-half of the MCL to the MCL.

>MCL: percentage of samples with concentrations greater than the MCL.

*California State Notification Level (CA-NL). Boron does not have an MCL.

min.: minimum concentration

avg.: average concentration

max.: maximum concentration

Table 3-5: Summary Statistics of Select Groundwater Quality Constituents for the Western Upper Principal Aquifer

Water Quality Constituent	California MCL[1] or SMCL[2]	Number of Samples	Percentage of Samples			Concentrations			
			<0.5MCL	>0.5MCL to MCL	>MCL	Min.	Median	Avg.	Max.
Nutrients									
Nitrate (as NO3), mg/L	10 mg/L[1]	2,326	47%	40%	13%	0.0	5.3	5.9	52
Pesticides									
DBCP, µg/L	0.2 µg/L[1]	434	75%	2%	23%	0.0	0.0	0.1	1.5
TCP, µg/L	0.005 µg/L[1]	118	100%	0%	0%	0.0	0.000	0.000	0.000
Radionuclides									
Gross Alpha, pCi/L	15 pCi/L[1]	153	33%	33%	33%	0.0	11.4	12.4	47.2
Uranium, pCi/L	20 pCi/L[1]	433	29%	52%	20%	0.0	13.0	13.6	32
Secondary Maxiumum Contaminant Level Constituents									
Total dissolved solids, mg/L	1,000 mg/L[2]	1,215	46%	41%	13%	0.0	530	733	20,000
Trace Elements									
Arsenic, µg/L	10 µg/L[1]	1,108	42%	41%	17%	0.0	5.4	9.5	300
Boron, mg/L	1 mg/L*	139	100%	0%	0%	0.0	0.2	0.1	0.3
Volatile Organic Compounds (VOC)									
PCE, µg/L	5 µg/L[1]	1,014	93%	1%	7%	0.0	0.0	0.9	250

Notes:

[1]**MCL**: California drinking water Maximum Contaminant Level

[2]**SMCL**: California drinking water Secondary Maximum Contaminant Level

<0.5MCL: percentage of samples with concentrations less than one-half the MCL.

>0.05MCL to MCL: percentage of samples with concentrations between one-half of the MCL to the MCL.

>MCL: percentage of samples with concentrations greater than the MCL.

***California State Notification Level (CA-NL). Boron does not have an MCL.

min.: minimum concentration

avg.: average concentration

max.: maximum concentration

Table 3-6: Summary Statistics of Select Groundwater Quality Constituents for the Western Lower Principal Aquifer

Water Quality Constituent	California MCL[1] or SMCL[2]	Number of Samples	Percentage of Samples			Concentrations			
			<0.5MCL	>0.5MCL to MCL	>MCL	Min.	Median	Avg.	Max.
Nutrients									
Nitrate (as N), mg/L	10 mg/L[1]	445	50%	28%	22%	0.0	4.8	5.8	17
Pesticides									
DBCP, µg/L	0.2 µg/L[1]	110	100%	0%	0%	0.0	0.0	0.0	0
TCP, µg/L	0.005 µg/L[1]	133	95%	0%	5%	0.000	0.000	0.000	0
Radionuclides									
Gross Alpha, pCi/L	15 pCi/L[1]	30	93%	7%	0%	0.0	0.0	1.7	14
Uranium, pCi/L	20 pCi/L[1]	92	97%	3%	0%	0.0	1.0	1.4	13
Secondary Maxiumum Contaminant Level Constituents									
Total dissolved solids, mg/L	1,000 mg/L[2]	66	100%	0%	0%	45.0	188	192	468
Trace Elements									
Arsenic, µg/L	10 µg/L[1]	222	9%	74%	17%	0.0	9.0	8.3	14
Boron, mg/L	1 mg/L*	13	100%	0%	0%	0.0	0.1	0.1	0
Volatile Organic Compounds (VOC)									
PCE, µg/L	5 µg/L[1]	438	100%	0%	0%	0.0	0.0	0.0	1

Notes:

[1]**MCL**: California drinking water Maximum Contaminant Level

[2]**SMCL**: California drinking water Secondary Maximum Contaminant Level

<0.5MCL: percentage of samples with concentrations less than one-half the MCL.

>0.05MCL to MCL: percentage of samples with concentrations between one-half of the MCL to the MCL.

>MCL: percentage of samples with concentrations greater than the MCL.

*California State Notification Level (CA-NL). Boron does not have an MCL.

min.: minimum concentration

avg.: average concentration

max.: maximum concentration

Total Dissolved Solids

Total dissolved solids (TDS) represent the total concentration of anions and cations in water and is a useful indicator of mineralization, salt content, and overall groundwater quality. The TDS concentrations in groundwater of the Modesto Subbasin generally meet drinking water quality standards (**Table 3-3**) and some irrigation requirements. A total of 16,288 groundwater samples in the Modesto Subbasin have TDS analyses and only 14% of those samples exceed the California Secondary Maximum Contaminant Level (SMCL) of 1,000 mg/L (**Table 3-3**).

TDS can also be used to characterize the salinity of irrigation water, which can affect crop health and yield (Grattan, 2002). It is recommended that TDS concentrations should be below about 450 mg/L for irrigation of salt sensitive crops, and TDS concentrations between about 450 and 1,000 mg/L can represent a salinity hazard for plants if used as irrigation water (Bauder et al., 2014). About half (49%) of the samples have TDS concentrations less than 450 mg/L and would not cause plant stress. However, 36% of samples are between 450 and 1,000 mg/L and 14% of samples are greater than 1,000 mg/L. Therefore, about 51% of groundwater samples have TDS concentrations that could result in plant stress and salinity hazard as irrigation water.

To identify any areas of concern, the average and maximum TDS concentrations in groundwater from wells within the Modesto Subbasin during the period of water year 1995 to 2019 are shown in **Figures 3-37 and 3-38.** TDS concentrations are illustrated as green circles (below 500 mg/L), yellow circles (between 500 and 1,000 mg/L), orange circles (between 1,000 and 1,500 mg/L), and red circles (above 1,500 mg/L). The median and maximum TDS concentrations in groundwater throughout most of the Modesto are below 1,000 mg/L (**Figures 3-37 and 3-38**). Concentrations of TDS are generally lowest (less than 500 mg/L) in the central part of the Subbasin, especially within the urban areas surrounding Modesto, Oakdale, Riverbank, and Waterford (**Figure 3-37 and 3-38**). Concentrations of TDS above the MCL are generally found in wells located in the San Joaquin River National Wildlife Refuge on the western extent of the Subbasin, in southwest Modesto, and to the southeast of Modesto (**Figure 3-37 and 3-38**).

Summary statistics of TDS concentrations in groundwater from the Eastern Principal Aquifer, Western Upper Principal Aquifer, and Western Lower Principal Aquifer are shown in **Tables 3-4**, **3-5**, and **3-6**, respectively. The average TDS concentrations are similar (389 and 192 mg/L) in the Eastern and Western Lower Principal Aquifers. However, the average TDS in the Western Upper Principal Aquifer (733 mg/L) is much higher than in the other two Principal Aquifers. Similarly, 13% of TDS samples from the Western Upper Principal Aquifer exceed the MCL, while only 1 and 0% of the samples from the Eastern and Western Lower exceed the MCL. These results, along with the 20,000 mg/L maximum concentration may indicate a point source affecting TDS concentrations in the Western Upper Principal Aquifer (**Table 3-5**).

Arsenic

Arsenic is a naturally occurring trace element in rocks, soils, and groundwater in some areas of the Central Valley aquifer (Burton et al., 2012). In the Modesto Subbasin, arsenic in groundwater is generally naturally occurring and is largely derived from the Sierran sediments that were transported to the eastern San Joaquin Valley by glacial and fluvial processes (Jurgens et al., 2008). Previous studies of arsenic in the San Joaquin Valley (Belitz et al., 2003; Welch et al., 2006; Izbicki et al., 2008; and Burton et al., 2012) and a literature review of arsenic (Welch et al., 2000) have identified two dominant mechanisms for elevated arsenic in groundwater. The first mechanism is the reductive dissolution of arsenopyrite or other iron or manganese oxyhydroxides under iron- or manganese-reducing conditions. The second mechanism is the pH-dependent desorption of arsenic from aquifer sediments under oxic conditions, which tends to occur in groundwater with pH above 7.5 (Stollenwerk, 2003). Given the general oxic nature of groundwater in the Subbasin, sorption and desorption on iron oxyhydroxides at pH above 7.5 is expected to be the most significant control on arsenic groundwater mobility. Another mechanism that has been identified is the decreased resorption due to increasing pH, competing species, or lack of sorption sites (Jurgens et al., 2008; Jurgens et al., 2009). Arsenic can also be mobilized from aquitards by dewatering (Smith et al., 2018). The USGS (2008) indicate that migration of arsenic in groundwater in the study area can be facilitated by lateral and vertical gradients created by municipal pumping and by vertical movement through wells with long screened or perforated intervals. Additionally, it has been proposed that geochemical changes in modern recharge water, such as relatively high dissolved organic carbon concentrations could contribute to mobilization of arsenic in the aquifer (JJ&A and Formation Environmental, 2019). Anthropogenic sources of arsenic in groundwater can include the use of wood preservatives, paints and dyes, and from some mining and oilfield operations (Welch et al., 2000).

Groundwater arsenic concentrations in the Subbasin are generally higher in older and deeper groundwater samples (Jurgens et al., 2009). Arsenic in groundwater from municipal wells has been detected in concentrations that approach and, in some cases, exceed the MCL for drinking water (JJ&A and Formation Environmental, 2019). Several municipal wells from the City of Modesto have been taken off-line due to elevated arsenic concentrations (JJ&A and Formation Environmental, 2019).

The concentrations of arsenic are generally low in groundwater of the Modesto Subbasin as compared to the MCL (**Table 3-3**). A total of 5,993 groundwater samples have arsenic analyses and only 7% of those analyses exceed the California MCL of 10 µg/L (**Table 3-3**). The wells with average concentrations of arsenic that exceed the MCL are generally located in the urban area of Modesto and in wells on the western extent of the Subbasin (**Figures 3-39**). Wells with maximum concentrations of arsenic that exceed the MCL are also generally located in the urban areas of Modesto and Riverbank, and wells on the western extent of the Subbasin (**Figure 3-40**).

Summary statistics of arsenic concentrations in groundwater from the Eastern Principal Aquifer, Western Upper Principal Aquifer, and Western Lower Principal Aquifer are shown in **Tables 3-4**, **3-5**, and **3-6**, respectively. The average arsenic concentrations in the Western Upper (9.5 µg/L) and Western Lower (8.3 µg/L) Principal Aquifers are more than double the 3.1 µg/L average concentration in the Eastern Principal Aquifer. Similarly, 17% of the arsenic samples in both the Western Upper and Western Lower exceed the MCL, as compared to only 3% of samples in the Eastern Principal Aquifer. These data indicate important differences may exist in the source(s) and geochemical conditions that control arsenic in groundwater of the Western Upper and Lower Principal Aquifers as compared to the Eastern Principal Aquifer.

Uranium

Uranium in groundwater in the Modesto Subbasin is generally naturally occurring and is largely derived from granitic rocks in the Sierra Nevada rather than sources at land surface (Jurgens et al., 2008). The uranium was weathered from these rocks and oxidized and adsorbed to sediments that were transported to the eastern San Joaquin Valley by glacial and fluvial processes and deposited in the alluvial fans that now make up the Modesto Subbasin (Jurgens et al., 2008). Uranium is a relatively prevalent contaminant in shallow and intermediate depth aquifers in the study area, including beneath the City of Modesto (JJ&A and Formation Environmental, 2019). The mobilization of uranium in the shallow and intermediate aquifer is likely influenced by elevated bicarbonate concentrations in modern and oxic recharge water resulting from agricultural activities (Jurgens et al., 2009). Irrigation return flow that recharges the aquifer can be relatively elevated in bicarbonate concentrations because of the rich and active biomes of the agricultural soils that create elevated carbon dioxide and relatively high partial pressures of carbon dioxide that often result in bicarbonate water type of modern recharge. The uranium is mobilized from the natural sediments when the bicarbonate-rich water flow downward through the aquifer and replaces older groundwater that has relatively lower bicarbonate concentrations (Jurgens et al., 2009). Uranium concentrations have also been observed to be negatively correlated with pH (Burton et al., 2012). Therefore, uranium concentrations are generally higher near the water table and in shallow groundwater and decrease with depth (Jurgens et al., 2008).

Uranium has been detected in municipal wells at concentrations that approach and, in some cases, exceed the MCL for drinking water (JJ&A and Formation Environmental, 2019). Currently, nine municipal wells in the City of Modesto have been taken off-line due to elevated uranium concentrations (JJ&A and Formation Environmental, 2019).

The concentrations of uranium are generally low in groundwater across much of the Modesto Subbasin as compared to the MCL (**Table 3-3**). A total of 3,326 groundwater samples have uranium analyses and 8% of those analyses exceed the California MCL of 20 pCi/L (**Table 3-3**). Most of the uranium samples were collected from supply wells within the urban areas of Modesto, Oakdale, Riverbank, and Waterford. The wells with average (**Figure 3-41**) and maximum (**Figure 3-42**) uranium concentrations that exceed the MCL tend to be located in the City of Modesto.

Summary statistics of uranium concentrations in groundwater from the Eastern Principal Aquifer, Western Upper Principal Aquifer, and Western Lower Principal Aquifer are shown in **Tables 3-4**, **3-5**, and **3-6**, respectively. The uranium concentrations in groundwater are much greater in the Western Upper Principal Aquifer, as compared to the Eastern or Western Lower Principal Aquifers. A total of 20% of uranium samples in the Western Upper exceed the MCL, while only 5 and 0% in the Eastern and Western Lower, respectively, exceed the MCL. These differences in uranium concentration among groundwater of the Principal Aquifers are consistent with the processes of the oxic and bicarbonate rich irrigation return flow that mobilizes uranium in the shallow and intermediate aquifer.

Gross Alpha

Alpha particles (α-particles) are a type of radiation emitted by some radionuclides. The alpha particles consist of two protons and two neutrons. Their travel range is only a few centimeters. Once alpha particles lose energy, they pick up electrons and become helium.

Alpha emitting radionuclides are naturally occurring elements, and include radium-226, uranium-238, radium-226, and radon-222. Radium-226 and radon-222 are generally the alpha emitters of greatest interest to drinking water because they are groundwater contaminants widely distributed in the U.S. and associated with granitic rock, including the Sierra Nevada. The California MCL for gross alpha in drinking water is 15 pCi/L.

The concentrations of gross alpha are relatively low in groundwater across much of the Modesto Subbasin as compared to the MCL (**Table 3-3**). A total of 1,369 groundwater samples have gross alpha analyses and 85% of those analyses have concentrations that are less than the California MCL of 15 pCi/L. A total of 15% of the groundwater samples exceed the gross alpha MCL, which is a higher percentage than uranium samples exceeding the MCL (**Table 3-3**). Similar to the uranium samples, most of the gross alpha samples were collected from supply wells within the urban areas of Modesto, Oakdale, Riverbank, and Waterford. The wells with average (**Figure 3-43)** and maximum (**Figure 3-44**) uranium concentrations that exceed the MCL tend to be located in the City of Modesto, especially in the southwest part of Modesto.

Summary statistics of gross alpha in groundwater from the Eastern Principal Aquifer, Western Upper Principal Aquifer, and Western Lower Principal Aquifer are shown in **Tables 3-4**, **3-5**, and **3-6**, respectively. Similar to the pattern of uranium, the gross alpha in groundwater is much greater in the Western Upper Principal Aquifer, as compared to the Eastern or Western Lower Principal Aquifers. A total of 20% of uranium samples in the Western Upper exceed the MCL, while only 5 and 0% in the Eastern and Western Lower, respectively, exceed the MCL. Similar to uranium, these differences in gross alpha among groundwater of the Principal Aquifers are consistent with the processes of the oxic and bicarbonate rich irrigation return flow that mobilizes uranium in the shallow and intermediate aquifer.

Boron

Boron is a naturally occurring trace element in many minerals and rocks, including igneous rocks such as granite and pegmatite, and some evaporite minerals. Borax is a boron-containing evaporite mineral that is mined in California and is used as a cleaning agent and therefore may be present in sewage and industrial wastes (Burton et al., 2012). There is no MCL for boron. However, California has a Notification Level (NL) of 1 mg/L. Boron is an essential element for plant growth in relatively small concentrations. However, for many crops, boron concentrations greater than 1 to 2 mg/L may be toxic (Ayers and Westcot, 1994).

The concentrations of boron are generally very low in groundwater in the Modesto Subbasin as compared to the NL (**Table 3-3**). A total of 841 groundwater samples have boron analyses and 99% of those analyses have concentrations that are less than the California NL of 1.0 mg/L and 1% have concentrations that exceed the NL (**Table 3-3**). The average (**Figures 3-45**) and maximum (**Figures 3-46**) boron concentrations of groundwater in wells that exceed the NL are generally located in Waterford, which may indicate a potential point-source contamination issue. 98% of the boron analyses have concentrations below 0.5 mg/L (**Table 3-3**), and thus the boron concentrations in groundwater of the Modesto Subbasin are well below toxic levels for plants.

Summary statistics of boron concentrations in groundwater from the Eastern Principal Aquifer, Western Upper Principal Aquifer, and Western Lower Principal Aquifer are shown in **Tables 3-4**, **3-5**, and **3-6**, respectively. There are no major differences in boron concentration or percentage of samples that exceed the NL among the three Principal Aquifers.

Pesticides

Pesticides in groundwater can result from the over-application on agricultural lands or from point-source contamination and preferential flow down improperly constructed wells. While pesticides are typically soluble in water, many can be highly sorptive to soils, which can slow their transport to the water table. The analysis is focused on the two widely detected pesticides Dibromochloropropane (DBCP) and 1,2,3-Trichloropropane (TCP).

Dibromochloropropane (DBCP)

Dibromochloropropane (DBCP) was a widely used agricultural nematocide and soil fumigant in parts of the Central Valley that was first detected in California drinking water in 1979 and later banned in the late 1970s. In 1983, a statewide drinking water source monitoring program was initiated and found DBCP to be the most commonly detected pesticide in groundwater (CA Department of Health Services, 1999). DBCP is relatively mobile when dissolved in water and free DBCP may occur as a dense non-aqueous phase liquid (DNAPL). DBCP is toxic to humans at low concentrations, and thus has presented a local concern (JJ&A and Formation Environmental, 2019). The Federal and California MCL for DBCP is 0.2 µg/L. DBCP was detected in at least seven municipal wells in the City of Modesto at concentrations above the MCL that warranted the use of wellhead treatment using granular activated carbon (Jurgens et al., 2008). DBCP has also been detected at lower concentrations below the MCL in water from at least seven municipal wells from the City of Modesto (JJ&A and Formation Environmental, 2019).

The concentrations of DBCP are generally low in groundwater of the Modesto Subbasin as compared to the MCL (**Table 3-3**). A total of 9,636 groundwater samples have DBCP analyses and 86% of those analyses and below the California MCL of 0.2 µg/L (**Table 3-3**). The remaining 14% of samples with DBCP concentrations above the MCL are from wells that are generally located to the north, west, and southeast of the City of Modesto (**Figures 3-47 and 3-48**).

Summary statistics of DBCP concentrations in groundwater from the Eastern Principal Aquifer, Western Upper Principal Aquifer, and Western Lower Principal Aquifer are shown in **Tables 3-4**, **3-5**, and **3-6**, respectively. The percentage of DBCP samples that exceed the MCL are somewhat similar (15 and 23%) in the Eastern and Western Upper and greater than in the Western Lower (0%) Principal Aquifer. Unlike nitrate concentrations that were somewhat similar above and below the Corcoran Clay, relatively higher concentrations of DBCP appears to be more frequently detected in only the Western Upper Principal Aquifer. The relatively longer flow paths and travel times for groundwater below the Corcoran Clay may help to limit DBCP concentrations in the Western Lower Principal Aquifer.

1,2,3-Trichloropropane (TCP)

1,2,3-Trichloropropane (TCP) is a chlorinated hydrocarbon with high chemical stability that often occurs as an intermediate in chemical manufacturing. It is a manmade chemical that is often found at industrial or hazardous waste sites, used as a cleaning and degreasing solvent, and associated with pesticide products (SWRCB, 2019). TCP may be produced as a byproduct of processes used to produce soil fumigant chemicals. TCP is also a major and minor component of several soil fumigants that were used historically in California through most of the 1980s (Burton et al., 2012). Although TCP was banned from pesticides in the 1990s, it has been detected in groundwater beneath agricultural areas of the Central Valley as part of the GAMA sampling program (Shelton et al., 2008). TCP is an emerging contaminant of concern because it is widely detected and is a probable carcinogen to humans (SWRCB, 2019). In 2017, California adopted an MCL of 0.005 µg/L for drinking water, and now many water supply systems are being monitored for TCP. TCP has been detected in several wells throughout the Subbasin at concentrations above the MCL (JJ&A and Formation Environmental, 2019).

The concentrations of TCP in groundwater in the Modesto Subbasin as compared to the MCL are shown in **Table 3-3**. A total of 5,004 groundwater samples have TCP analyses and 4% of those analyses are above the California MCL of 0.005 µg/L (**Table 3-3**). The wells with average (**Figures 3-49**) and maximum (**Figures 3-50**) TCP concentrations that exceed the MCL are located primarily in the urban areas of Modesto, Riverbank and Waterford. As discussed below in the section on historical and present trends, the wells with elevated TCP tend to have concentrations that are sometimes two to three orders of magnitude greater than the MCL. Such high concentrations of TCP may indicate locations of point-source contamination.

Summary statistics of TCP concentrations in groundwater from the Eastern Principal Aquifer, Western Upper Principal Aquifer, and Western Lower Principal Aquifer are shown in **Tables 3-4**, **3-5**, and **3-6**, respectively. TCP exceedances of the MCL occur in 15% of Eastern Principal Aquifer samples, 23% of Western Upper Principal Aquifer samples, and 0% of Western Lower Principal Aquifer samples. These data suggest that relatively lower concentrations of TCP are below the Corcoran Clay.

Tetrachloroethylene (PCE)

Volatile organic compounds (VOCs) have been detected in several wells in and around the City of Modesto and in Oakdale (JJ&A and Formation Environmental, 2019). The source of the VOCs is largely attributed to historical dry-cleaning operations. At least seven City of

Modesto wells are currently receiving treatment to remove PCE, trichloroethylene, and (or) Freon-113 (JJ&A and Formation Environmental, 2019). There have been a number of response actions in the Modesto area to the PCE contamination, including site investigations, groundwater extraction to address shallow groundwater contamination, and soil vapor extraction to address source removal and potential vapor intrusion into buildings (JJ&A and Formation Environmental, 2019). Therefore, the VOC analysis here is focused on PCE.

Tetrachloroethylene (PCE) is a manufactured chemical and does not occur naturally in the environment. It is a regulated contaminant with a Federal and California MCL of 5 µg/L (SWRCB, 2017). Common sources of PCE include dry cleaning operations, textile operations, and metal degreasing processes. It was also widely used in the production of CFC-113 and other fluorocarbons. PCE is also used in rubber coatings, solvent soaps, printing inks, adhesives and glues, sealants, polishes, lubricants, and pesticides. PCE is a DNAPL and has moderate to high mobility.

The concentrations of PCE are generally low in groundwater in the Modesto Subbasin as compared to the MCL (**Table 3-3**). A total of 8,262 groundwater samples have PCE analyses and 92% of those analyses are below the California MCL of 5 µg/L (**Table 3-3**). Most PCE concentrations above the MCL are from wells located in Modesto and Oakdale, which are likely impacted by historical dry-cleaning operations (**Figures 3-51 and 3-52**).

Summary statistics of PCE concentrations in groundwater from the Eastern Principal Aquifer, Western Upper Principal Aquifer, and Western Lower Principal Aquifer are shown in **Tables 3-4**, **3-5**, and **3-6**, respectively. The percentage of PCE samples that exceed the MCL are somewhat similar (9% and 7%) in the Eastern and Western Upper and greater than in the Western Lower (0%) Principal Aquifer. Similar to patterns in DBCP and TCP concentrations, relatively lower concentrations of PCE appear to be detected below the Corcoran Clay in the Western Lower Principal Aquifer. The low permeability of the clay associated with relatively longer flow paths and travel times for groundwater below the Corcoran Clay may help to limit PCE concentrations in the Western Lower Principal Aquifer.

3.2.5.4. Trends in Historical and Present Groundwater Quality

Statistical tests were used to evaluate if the concentrations of groundwater quality constituents are statistically similar or different between historical (water year 1995 to 2014) and present (2015 to 2019) periods. This analysis will help identify processes that may affect the temporal trends in the groundwater quality of the Modesto Subbasin.

First, the Shapiro-Wilk test for normality was used to test the null hypothesis that the groundwater quality constituents come from a normal distribution. Results of the Shapiro-Wilk test support a rejection of the null hypothesis (α-level = 0.05) and indicate that nitrate, DBCP, TCP, Gross Alpha, Uranium, TDS, arsenic, boron, and PCE all have a non-normal distribution.

Based on the results of the Shapiro-Wilk tests, the nonparametric Wilcoxon rank-sum test was used to test the null hypothesis that the groundwater quality constituents sampled between the historical and present period come from populations that have the same distribution and thus are statistically similar. Results of the Wilcoxon rank-sum test support the decision to fail to reject the null hypothesis (α-level = 0.05) for TCP (p-value = 0.767), gross alpha (p-value = 0.212), and PCE (p-value = 0.981) (**Figure 3-53**), which indicates that these groundwater quality constituents have statistically similar median concentrations during the historical and present periods. However, the results of the Wilcoxon rank-sum test for nitrate (p-value = <0.001), DBCP (p-value = <0.001), uranium (p-value = <0.001), TDS (p-value = 0.001), arsenic (p-value = <0.001), and boron (p-value = <0.001) support the decision to reject the null hypothesis (**Figure 3-54**), which indicates that these groundwater quality constituents have statistically different median concentrations during the historical and present periods. The median concentrations of nitrate, DBCP, arsenic, and boron are statistically lower in the present period than the historical period (**Figure 3-54**). Conversely, the median concentrations for uranium and TDS are statistically higher in the present period than the historical period (**Figure 3-54**).

The temporal linear trends in groundwater quality constituents are evaluated in **Figures 3-55 and 3-56**. Results of the trend analysis indicate statistically significant (α-level = 0.05) increasing trends for TCP (p-value = <0.001) and gross alpha (p-value = <0.001) concentrations, but no statistically significant temporal trend for PCE (p-value = 0.141) (**Figure 3-55**). Results of the trend analysis indicate statistically significant (α-level = 0.05) increasing trends for TDS (p-value = <0.001), nitrate (p-value = <0.001), and uranium (p-value = <0.001) concentrations (**Figure 3-56**). Conversely, there are decreasing trends for DBCP (p-value = <0.001) and arsenic (p-value = 0.002), but no statistically significant trend for boron (p-value = 0.232) (**Figure 3-56**).

These findings indicate that TCP, gross alpha, TDS, nitrate, and uranium concentrations are increasing over time in the Modesto Subbasin, while DBCP and arsenic concentrations are decreasing over time in the Modesto Subbasin.

3.2.5.5. Contamination Sites from GeoTracker

The State Water Resources Control Board (SWRCB) GeoTracker online database was accessed to identify active and former contamination cleanup sites within the Subbasin. As of November 2021, 320 cleanup sites are documented on GeoTracker in the Modesto Subbasin. Less than 10 percent of these (28 sites) are open, and the remaining (292 sites) are closed. Active remediation or monitoring is still occurring at the open sites. The open cases include 2 Leaking Underground Storage (LUST) sites, 24 Cleanup Program sites, and 2 Military sites.

The contamination sites from GeoTracker are presented on **Figure 3-57**, and the number of each site (open and closed) is shown in the legend of this figure. Most of the sites are in the cities of Modesto, Riverbank, Oakdale and Waterford. Available data uploaded to GeoTracker from these sites will be considered in the annual analysis of groundwater quality to be conducted by the GSAs as part of GSP implementation (see **Section 6.6**).

3.2.6. Land Subsidence

The overdraft conditions exacerbated by the recent drought resulted in lowered groundwater levels – a condition that can contribute to subsidence of the ground surface. As water levels decline in the subsurface, dewatering and compaction of predominantly fine-grained deposits, such as clay and silt, can cause the overlying ground surface to subside.

This process is illustrated by two conceptual diagrams shown on **Figure 3-58**. The upper diagram depicts an alluvial groundwater basin with a regional clay layer and numerous smaller discontinuous clay layers. Water level declines associated with pumping cause a decrease in water pressure in the pore space (pore pressure) of the aquifer system (Galloway, et al., 1999). Because the water pressure in the pores helps support the weight of the overlying aquifer, the pore pressure decrease causes more weight of the overlying aquifer to be transferred to the grains within the structure of the sediment layer. The difference between the water pressure in the pores and the weight of the overlying aquifer is the effective stress. If the effective stress borne by the sediment grains exceeds the structural strength of the sediment layer, then the aquifer system begins to deform. This deformation consists of rearrangement and compaction of fine-grained units[7], as illustrated on the lower diagram of **Figure 3-58**. The tabular nature of the fine-grained sediments allows for preferred alignment and compaction. As the sediments compact, the ground surface can sink, as illustrated by the 2nd column on the lower diagram of **Figure 3-58**.

Land subsidence due to groundwater withdrawals can be temporary (elastic) or permanent (inelastic).

Elastic deformation occurs when sediments compress as pore pressures decrease but expand by an equal amount as pore pressures increase. A decrease in water levels from groundwater pumping causes a small elastic compaction in both coarse- and fine-grained sediments; however, this compaction recovers as the effective stress returns to its initial value. Because elastic deformation is relatively minor and fully recoverable, it is not considered an impact.

Inelastic deformation occurs when the magnitude of the greatest pressure that has acted on the clay layer since its deposition (preconsolidation stress) is exceeded. This occurs when groundwater levels in the aquifer reach a historically low level. During inelastic deformation, or compaction, the sediment grains rearrange into a tighter configuration as pore pressures are reduced. This causes the volume of the sediment layer to reduce, which causes the land surface to subside. Inelastic deformation is permanent because it does not recover as pore pressures increase. Clay particles are often planar in form and more subject to permanent realignment (and inelastic subsidence). In general, coarse-grained deposits (e.g., sand and gravels) have sufficient intergranular strength and do not undergo inelastic

[7] Although extraction of groundwater by pumping wells causes a more complex deformation of the aquifer system than discussed herein, the simplistic concept of vertical compaction is often used to illustrate the land subsidence process (Galloway, et al., 1999; LSCE et al., 2014).

deformation within the range of pore pressure changes encountered from groundwater pumping.

The volume of compaction is equal to the volume of groundwater that is expelled from the pore space, resulting in a loss of storage capacity. This loss of storage capacity is permanent but may not be substantial because clay layers do not typically store significant amounts of usable groundwater (LSCE, et al., 2014). Inelastic compaction, however, may decrease the vertical permeability of the clay resulting in minor changes in vertical flow.

The following potential impacts can be associated with land subsidence due to groundwater withdrawals (modified from LSCE, et al., 2014):

- Damage to infrastructure including foundations, roads, bridges, or pipelines;
- Loss of conveyance in canals, streams, or channels;
- Diminished effectiveness of levees;
- Collapsed or damaged well casings; and
- Land fissures.

Land subsidence in the San Joaquin Valley has been documented for more than 90 years and recent investigations using satellite imagery indicate continuing problems in some areas. However, subsidence is not a significant issue in Modesto Subbasin. **Figure 3-59** illustrates the results of a subsidence study conducted by the USGS (Faunt et al., 2015) in the San Joaquin Valley from 2008 to 2010. This study shows that subsidence did not occur within Modesto Subbasin during this time period.

Beginning in June 2015, vertical displacement was estimated throughout many California groundwater basins using Interferometric Synthetic Aperture Radar (InSAR) data. The InSAR data are collected by the European Space Agency (ESA) Sentinel-1A satellite and processed by TRE ALTAMIRA Inc. (TRE), under contract with DWR as part of DWR's SGMA technical assistance. **Figure 3-60** illustrates vertical displacement (in feet) for the Modesto Subbasin from June 2015 to October 2020, a period of approximately five years. Most of the Subbasin is shaded grey on this figure, indicating an absence of land subsidence. Negative vertical displacement (subsidence), shown by yellow to light brown colors, is indicated in the central and eastern Subbasin, within the Eastern Principal Aquifer (east of the Corcoran Clay), and also in the northwest corner of the Subbasin and in a thin strip along the lower reach of the Stanislaus River. Most of the eastern Subbasin indicates vertical displacement between 0 and 0.05 feet (0.6 inches), as shown by the yellow shading. This equates to a rate of approximately 0.12 inches per year over the five year period. There are two small areas in the eastern Subbasin where a larger rate of subsidence is indicated. The maximum measured subsidence, shown by the small brown shaded area, is 0.15 feet (1.8 inches). This is a minimal amount of measured subsidence and could possibly be due, in part, to the abundance of clay surficial soils (see black shading on **Figure 3-6**) that have the potential to shrink. Also, there are restrictive layers in the soil in the eastern part of the Subbasin that, if disturbed by agricultural operations, could alter the ground surface elevation. This type of vertical displacement is not likely related to groundwater extraction. This subsidence is not likely to impact critical infrastructure in this area. The measured subsidence in the northwest Subbasin is mostly between 0 and 0.5 feet (0.6 inches) over the five year period (yellow shading), with maximum measured subsidence on the order of 0.1 feet (1.2 inches, orange shading) over the five year period. There is a higher potential for subsidence in the western Modesto Subbasin if groundwater levels are lowered below the Corcoran Clay.

A recent study conducted by Towill, Inc. and TRE Altamira, Inc., under contract with DWR, showed that InSAR vertical displacement data is highly accurate in most areas. The study compared vertical displacement ground surface elevation data from InSAR to continuously operating global positioning system (CGPS) base stations (Towill, 2021). The study found that the two data sets had a high degree of correlation, with only a very small state-wide absolute difference of 8.86 mm. The study concludes that InSAR data accurately measured vertical displacement in California's ground surface to within 18 mm (0.7 inches) between January 1, 2015, and October 1, 2020. The InSAR data cover the full extent of the Subbasin and provide a reasonable dataset to use as a screening tool to evaluate subsidence in the Modesto Subbasin. The InSAR data will be updated annually and discussed in the GSP annual reports.

In addition to the InSAR data, there are four GPS stations in the Subbasin. As shown on **Figure 3-60**, three of these stations are along the Highway 99 corridor in Salida and Modesto, and one is in the northeastern corner of the Subbasin. These GPS stations indicate zero to low rates of vertical displacement. Stations P260, CMOD and P306 showed no subsidence, while P781 indicated land subsidence of about 0.048 inches per year. The data from these stations shows a cyclic pattern to ground surface elevation, demonstrating the effects of inelastic land subsidence.

3.2.7. Interconnected Surface Water

The Tuolumne, Stanislaus, and San Joaquin rivers are all interconnected surface water as defined by SGMA. These three rivers flow for approximately 122 miles along three of the four Subbasin boundaries. The Stanislaus River is approximately 59 miles long along the northern Subbasin boundary, the Tuolumne River approximately 47 miles along the southern boundary and the San Joaquin River approximately 16 miles along the western boundary.

The segment of the San Joaquin River along the Modesto Subbasin can be characterized as a net gaining reach, historically and also based on future projected conditions. The Tuolumne and Stanislaus river systems are more dynamic, with recharge and baseflow varying along segments of the rivers both seasonally and over time. This dynamic system is a result of both natural conditions and managed operations. Both rivers are actively managed to provide critical water supplies for the Modesto, Turlock, and Eastern San Joaquin subbasins.

As described in more detail in **Chapter 5** (see **Section 5.1.4**), total stream inflows into the Subbasin during the historical study period are approximately 2.5 MAF. Approximately half of this inflow (1.3 MAF) is from the San Joaquin River, with the other half split between the

Stanislaus River (0.5 MAF) and the Tuolumne River (0.7 MAF). The Stanislaus River and Tuolumne River drain into the San Joaquin River, and the outflow from the San Joaquin River out of the Subbasin is approximately 2.8 MAF during the historical study period.

The location, quantity, and timing of deletions of these interconnected rivers were analyzed using the integrated surface water-groundwater model C2VSimTM. Development of the model and model calibration is described in **Appendix C** (see **Appendix C Sections 2.1.2, 3.4,** and **4.3.2**). Analysis of interconnected surface water and surface water budgets under historical, current, and future projected conditions is provided in **Chapter 5**.

Data tables in **Chapter 5** provide details for estimating average gaining or losing conditions along each river. As shown on **Table 5-2**, during the historical period (WY 1991 – WY 2015), the Tuolumne, Stanislaus, and San Joaquin rivers were all net gaining rivers in the Modesto Subbasin. During that period, net gains from the groundwater system (baseflow) to the Tuolumne, Stanislaus, and San Joaquin rivers were 31,000 AFY, 16,000 AFY, and 14,000 AFY, respectively.

The model predicts that under the 50-year projected conditions the San Joaquin River will remain a net gaining river into the future with a net gain of 9,000 AFY. The Tuolumne and Stanislaus rivers are predicted to transition to overall net losing rivers, with average net losses of 11,000 and 24,000 AFY, respectively (**Table 5-2**). An increase in stream seepage to groundwater (streamflow depletion) was predicted for all rivers if current land and water use remain the same without additional water supplies.

To illustrate the variability of losing/gaining reaches along each river, the C2VSimTM was used to analyze each river node in the model as predominantly gaining, losing, or mixed conditions for both historical and projected future conditions. This nodal analysis is presented on **Figure 3-61**. Model nodes are represented as small circles along each of the rivers.

For illustration purposes, the model nodes are color coded with respect to net gaining or losing conditions for the two different simulation periods. Although conditions are highly dynamic at each node, the predominant condition (occurring in 85 percent of the model months represented) is highlighted. If conditions at the node are predominantly gaining, the node is blue; predominantly losing nodes are orange, and nodes that are not predominantly losing or gaining are labeled “mixed” and colored green. The node color does not represent quantity and does not account for seasonal or annualized volumes of water (**Figure 3-61**).

A comparison between the historical simulation and the projected future simulation shows locations where predominantly gaining reaches (blue) transition to predominantly losing reaches (orange) or mixed conditions (green) over time (**Figure 3-61**). On the Stanislaus River, this transition occurs over most of the river but is most pronounced downstream of Oakdale. On the Tuolumne River, most of the change occurs in the eastern two-thirds of the river, upstream of the City of Modesto. Along the short segment of the San Joaquin River that defines the Modesto Subbasin, conditions are either gaining or mixed with less change predicted from historical to future conditions (**Figure 3-61**).

Although the model indicates that all reaches of the rivers remain connected through historical and future projected conditions, increases in streamflow depletion over time are indicated by the model water budgets and illustrated by the nodal analysis. The nodal analysis correlated strongly with predicted changes in groundwater elevations. This correlation indicates that streamflow depletions are primarily associated with groundwater extractions. The correlation further suggests that if water level declines associated with local overdraft conditions are arrested, predicted increases in streamflow depletions can be reduced. Additional modeling supports this conclusion (**Sections 5.3 and 8.5.1**).This indication highlights the need for water level monitoring (**Chapter 7**). These conditions also guided the selection of sustainable management criteria (**Chapter 6**) for interconnected surface water and the development of GSP projects and management actions to arrest local water level declines (**Chapter 8**). Additional details on the water budget analysis of surface water are provided in **Chapter 5**.

3.2.8. Groundwater Dependent Ecosystems

A groundwater dependent ecosystem (GDE) is defined under SGMA as "ecological communities of species that depend on groundwater emerging from aquifers or on groundwater occurring near the ground surface" (23 CCR § 351(m)).

To support identification of groundwater dependent ecosystems (GDEs), DWR created the Natural Communities Commonly Associated with Groundwater (NCCAG) dataset. This Natural Communities dataset is a compilation of 48 publicly available State and federal agency datasets that map vegetation, wetlands, springs, and seeps in California. The resultant mapping of natural vegetation communities and wetlands commonly associated with groundwater has been reviewed by DWR, California Department of Fish and Wildlife (CDFW), and The Nature Conservancy (TNC) and provided online for California groundwater basins. The data included in the Natural Communities dataset do not necessarily represent GDEs but can be used as a starting point in identifying GDEs within a groundwater basin.

The NCCAG dataset includes two sets of polygons that represent different habitat classes. The first class is wetland features commonly associated with the surface expression of groundwater under natural, unmodified conditions. The second class is vegetation types that are commonly associated with the sub-surface presence of groundwater (phreatophytes) (DWR, 2018d). The presence of wetland or vegetation polygons in the NCCAG dataset, however, does not necessarily indicate the presence of a GDE. Rather, the NCCAG dataset provides a starting point for identifying potential GDEs.

The vegetation and wetlands polygons from the NCCAG dataset within the Modesto Subbasin are illustrated on **Figure 3-62.** There are approximately 1,800 NCCAG polygons (768 wetlands and 1,027 vegetative) in the Modesto Subbasin. Most of the wetlands and vegetation polygons are present along the three major rivers (Stanislaus, Tuolumne and San Joaquin rivers), along Dry Creek, between Dry Creek and the Tuolumne River, scattered in the eastern Subbasin, and along the western Subbasin boundary, within the San Joaquin River Natural Wildlife Refuge.

Given the large number of NCCAG polygons, it was not feasible to investigate the details of each polygon in the Subbasin. However, a depth to water analysis was conducted as a first approximation to identify wetlands and vegetation polygons in areas where depth to water exceeds rooting depths, in accordance with The Nature Conservancy's guidance (The Nature Conservancy, 2018).

Groundwater elevations were used to estimate depth to water during the wettest year of the GSP Study Period (Spring 1998) and at the end of the GSP Study Period, during a critically dry year (Fall 2015). These two years generally represent periods of high (1998) and low (2015) water levels over average hydrologic conditions. Using ArcGIS, a groundwater elevation surface was developed from simulated groundwater elevations from the C2VSim-TM model for each of the two years. This surface was subtracted from a digital elevation map (DEM) of ground surface elevations to develop depth to water maps.

The areas within the Modesto Subbasin with a depth to water within 30 feet in Spring 1998 are shown on **Figure 3-63**. In general, depth to water is within 30 feet along the river boundaries, along Dry Creek, and in the western Subbasin. The NCCAG polygons were then overlaid onto the depth to water map and polygons were removed from the map in areas where depth to water exceeded 30 feet. It is assumed that the vegetation and wetlands do not have access to groundwater when depth to water is deeper than 30 feet.

The map showing wetland and vegetation polygons in areas with depth to water within 30 feet in Spring 1998 is illustrated on **Figure 3-64**. This map has 1,525 polygons (567 wetland and 958 vegetative), an approximate 15 percent decrease from the original NCCAG dataset. Potential GDEs are present along the river boundaries, along Dry Creek and in the western Subbasin. Potential GDEs were eliminated in the eastern Subbasin, and away from the rivers and Dry Creek. **Figure 3-64** represents the potential GDEs that were present in Spring 1998. Since this was the wettest period within the GSP study period, with the highest water levels in many parts of the Subbasin, this map represents the potential GDEs that could have been present in the Modesto Subbasin during the GSP Study Period (WY 1990 – WY 2015).

A similar analysis was conducted for water levels in Fall 2015. The areas of the Modesto Subbasin with a depth to water within 30 feet are illustrated on **Figure 3-65**. Depth to water is within 30 feet within a thin band along the river boundaries, the western stretch of Dry Creek and along the western edge of the Subbasin. The wetland and vegetative polygons in areas where depth to water is within 30 feet are shown on **Figure 3-66**. As compared to the 1998 map (**Figure 3-64**), potential GDEs were eliminated along most of Dry Creek. This map has 1,285 polygons (462 wetland and 823 vegetative), an approximate 28 percent decrease from the original NCCAG dataset.

SGMA legislation requires the Subbasin GSAs to be responsible for GDEs that are present at the end of the GSP Study Period (WY 2015). Therefore, the polygons shown on **Figure 3-66** are potential GDEs that will be further evaluated following GSP adoption.

In 2021, Moore Biological Consultants reviewed the potential GDEs identified in Fall 2015 (**Figure 3-66**) within Mapes Ranch, a private property near the San Joaquin River. Moore Biological Consultants conducted a desktop study and a field survey and concluded that 56 potential GDE polygons (46 wetland and 10 vegetative) identified within the Mapes Ranch property are not GDEs. This study is provided in **Appendix D**. These polygons were removed from the Fall 2015 map of potential GDEs, as shown on **Figure 3-67**.

Based on the Fall 2015 depth to water analysis and the study conducted by Moore Biological Consultants, there are 1,229 potential GDE polygons (416 wetland and 813 vegetative) in the Modesto Subbasin (**Figure 3-67**). This is an approximate 31 percent decrease from the original NCCAG dataset. These potential GDEs occur along the river boundaries, the downstream reach of Dry Creek and along the western Subbasin boundary.

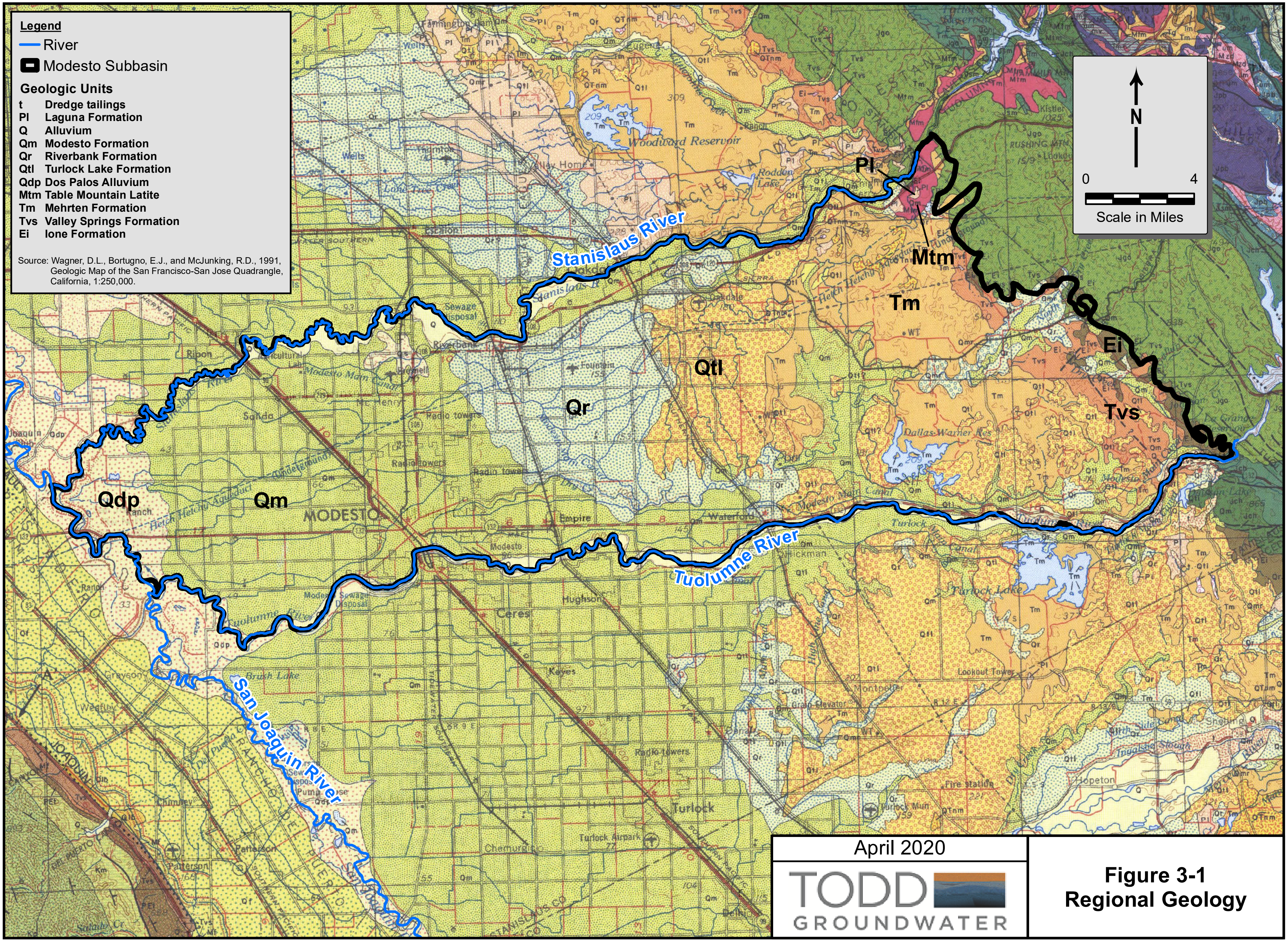
The GSAs plan to further investigate the potential GDEs during GSP implementation.

3.2.9. Data Gaps and Uncertainties for Groundwater Conditions

This section will summarize groundwater condition data gaps that affect implementation of the Plan and are related to the GSAs ability to sustainably manage groundwater. The Plan Implementation section, when developed, will describe how these data gaps will be addressed in future GSP actions. A summary of data gaps identified for the Groundwater Conditions analysis in the Modesto Subbasin is summarized in the following table.

Table 3-7: Data Gaps for the Groundwater Conditions

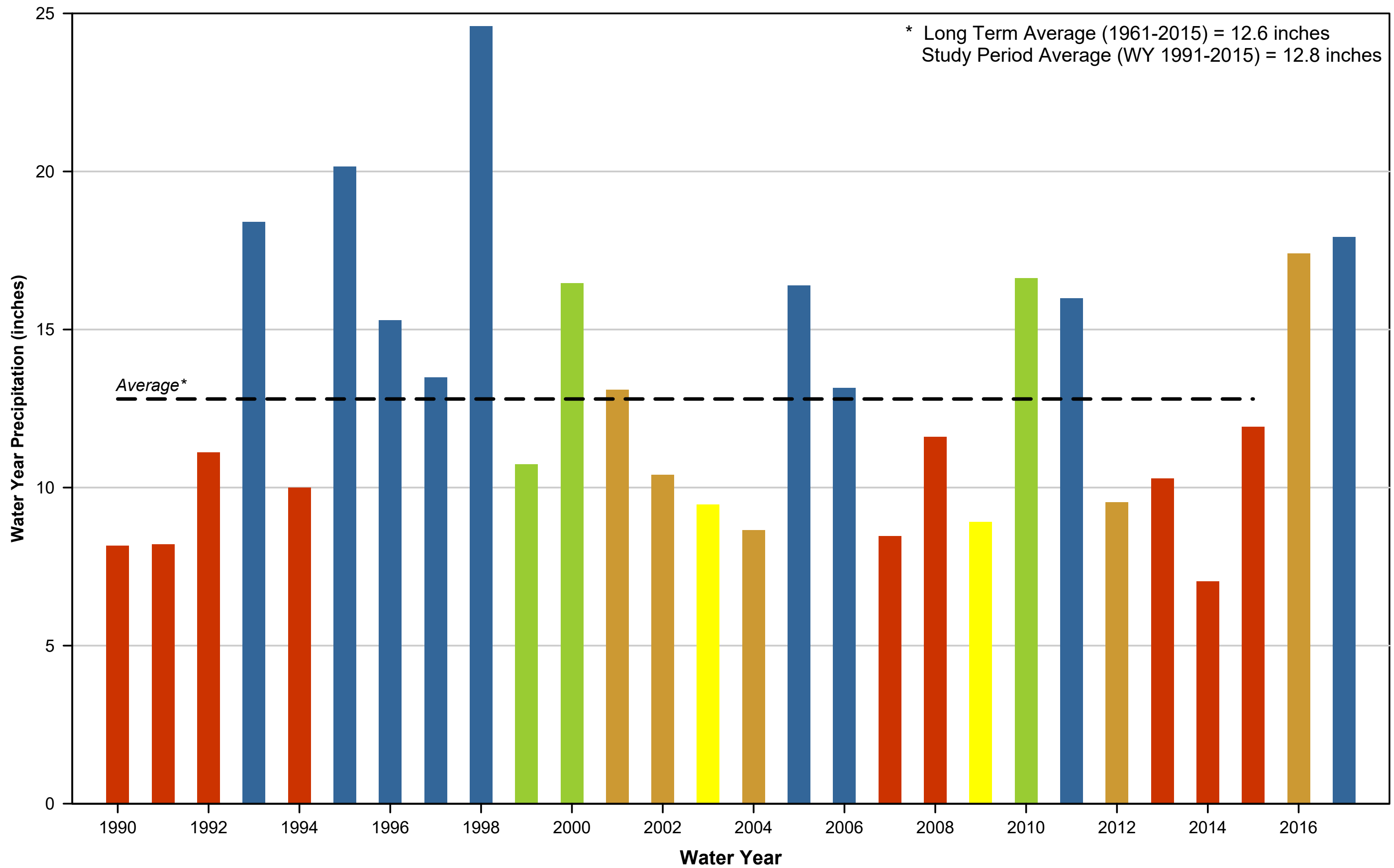
Issue	Area	Impacts on Groundwater Management	Actions to Address
Water Levels in Western Lower Principal Aquifer	Western Lower Principal Aquifer	Groundwater levels and flow; vertical gradients; evaluation for potential future land subsidence; insufficient wells for groundwater elevation mapping.	• Install monitoring wells screened solely in the Western Lower Principal Aquifer. • Locate existing wells to incorporate into monitoring program, if available.
Groundwater Conditions in Eastern Subbasin	East of the Oakdale-Waterford Highway	Groundwater flow and quality of Eastern Principal Aquifer	• Install monitoring wells in eastern Subbasin. • Obtain water level data from landowners.
Interconnected Surface Water	River boundaries	Groundwater levels and flow, surface water availability, water budgets	• Continued analysis with C2VSimTM Model. • Improve monitoring.
GDEs	River boundaries	Groundwater levels and flow	Verify presence of GDEs based on NCCAG dataset.



April 2020

TODD GROUNDWATER

Figure 3-1
Regional Geology



Wet
Above Normal
Below Normal
Dry
Critically Dry

Notes:
Source - MID weather station (Modesto CA).
Water Year - October 1 through September.

April 2020

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Figure 3-2
Annual Precipitation
Water Year

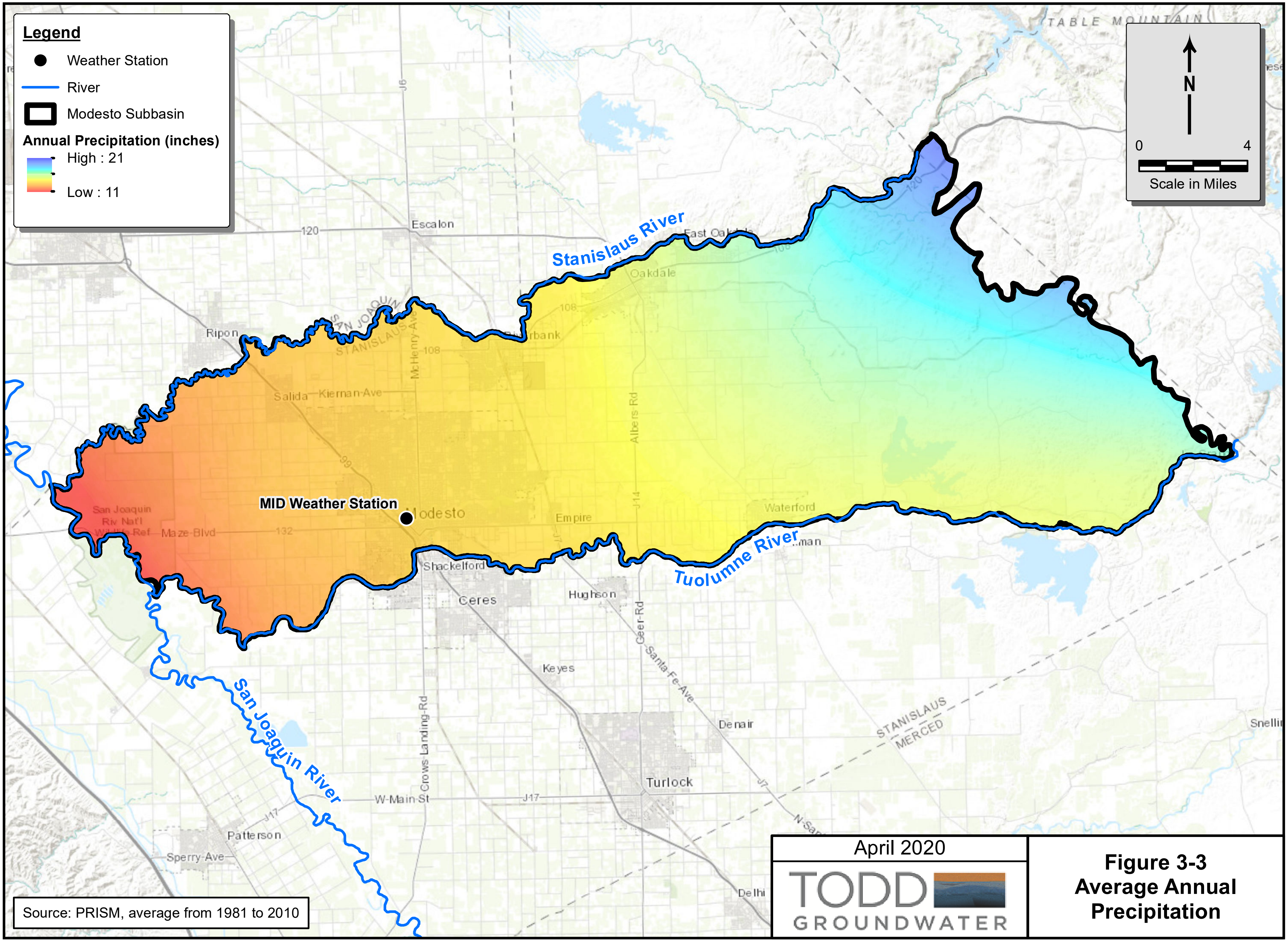


Figure 3-3
Average Annual Precipitation

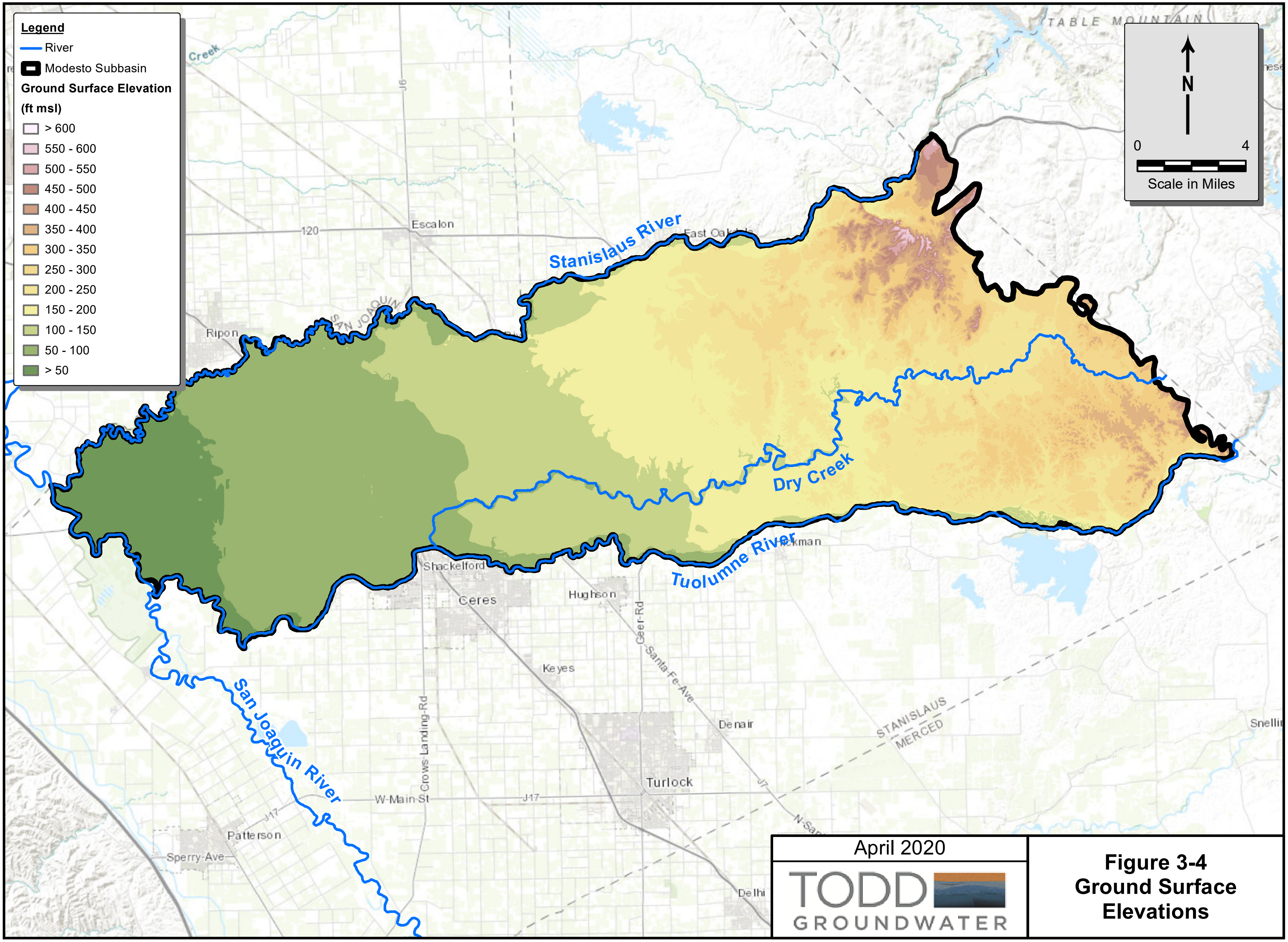


Figure 3-4
Ground Surface Elevations

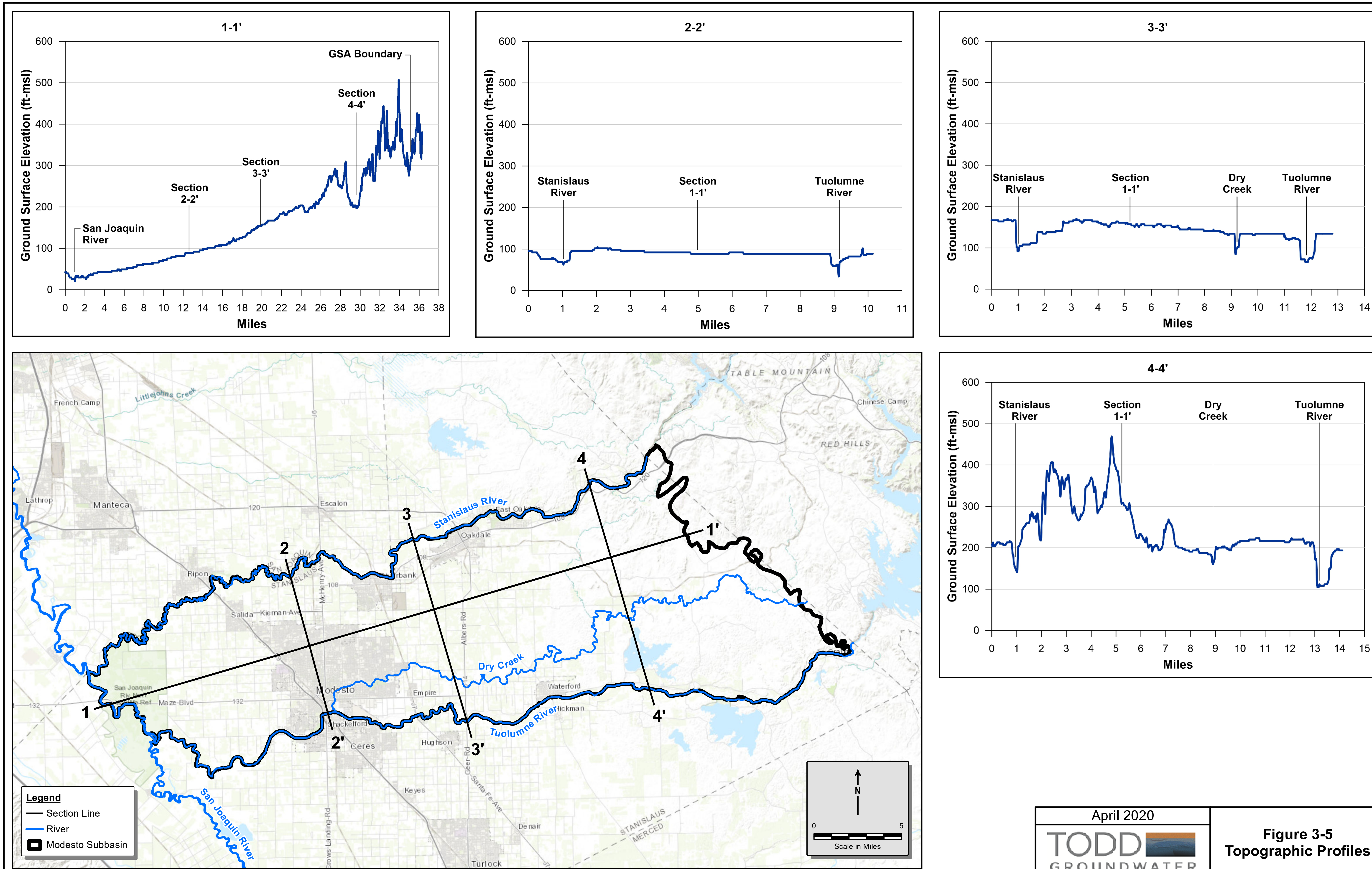
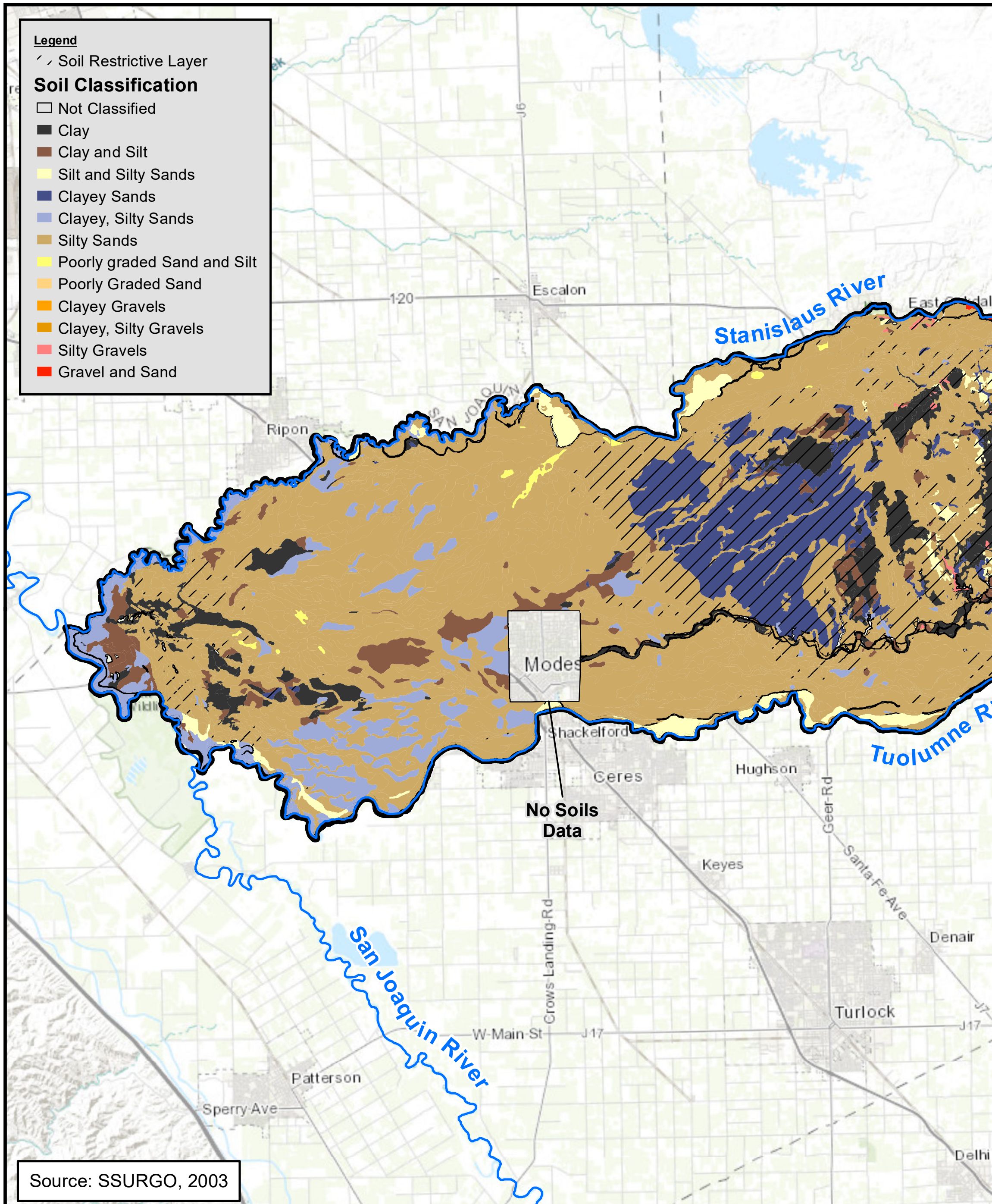


Figure 3-5
Topographic Profiles



November 2021

TODD GROUNDWATER

Figure 3-6
Soils and Surficial Restrictive Layers

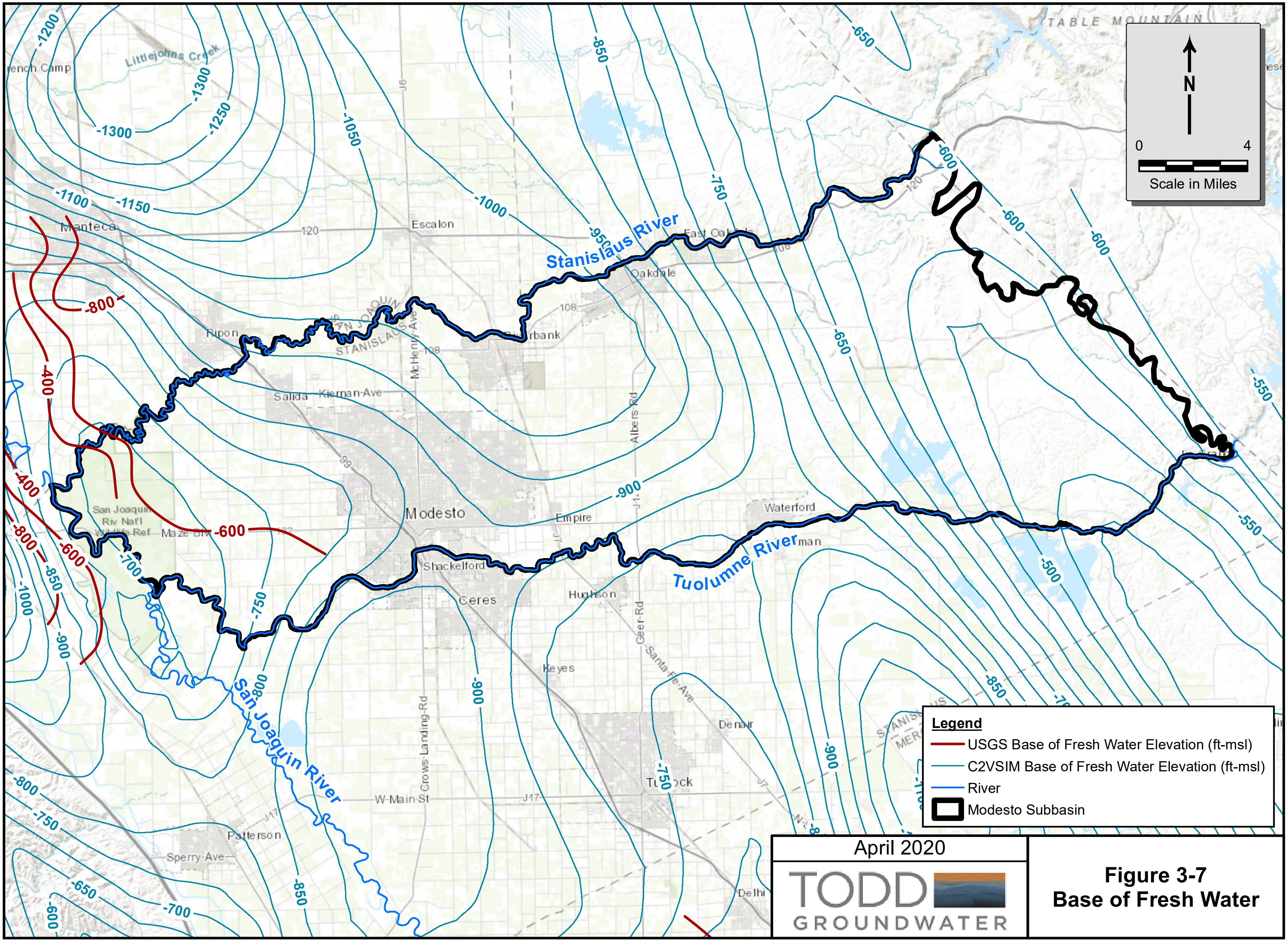
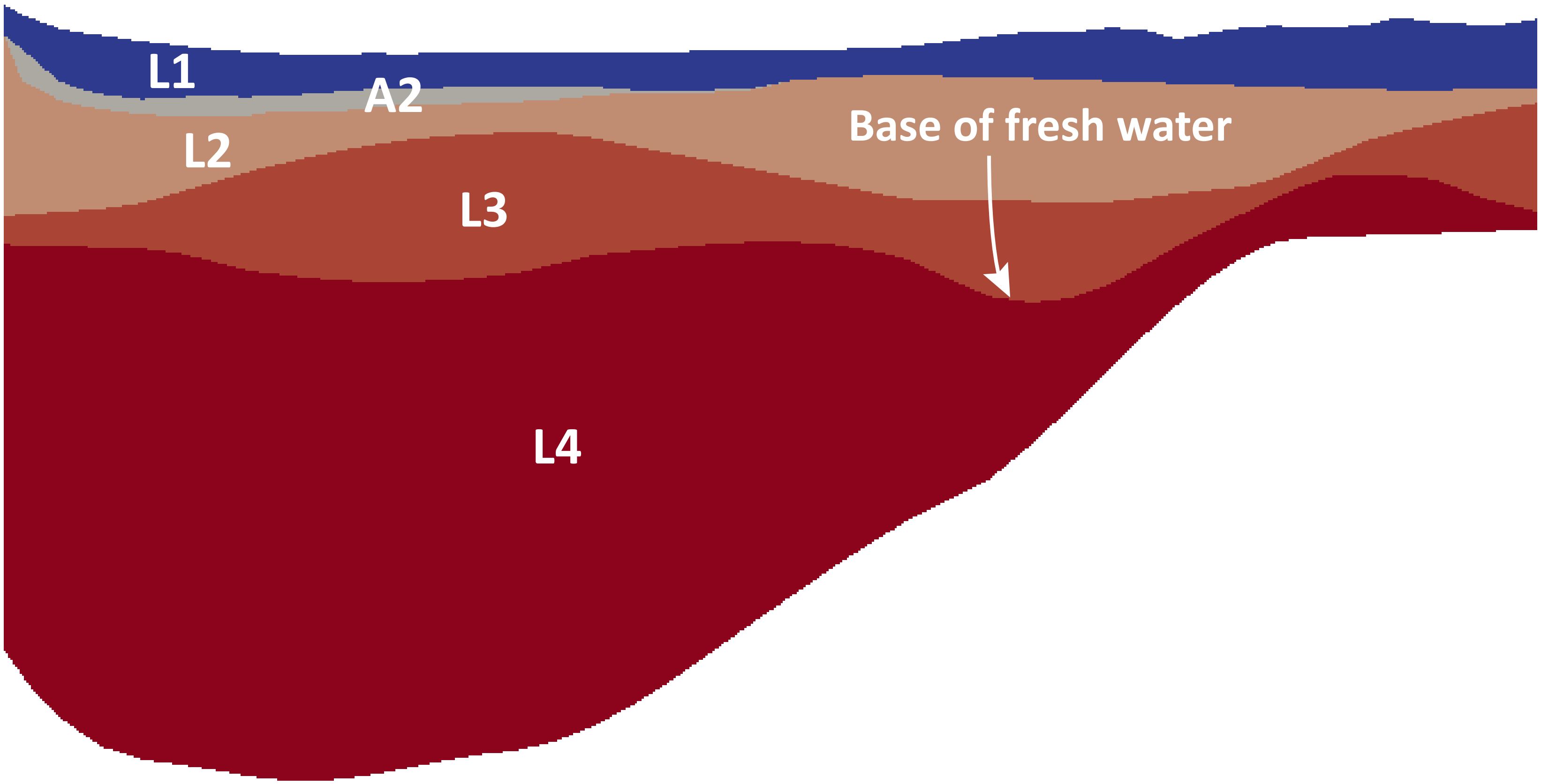


Figure 3-7
Base of Fresh Water



L1: Aquifer ranging from the ground surface to the top of the pumping layer

A2: Corcoran Clay

L2: Primary shallow pumping layer

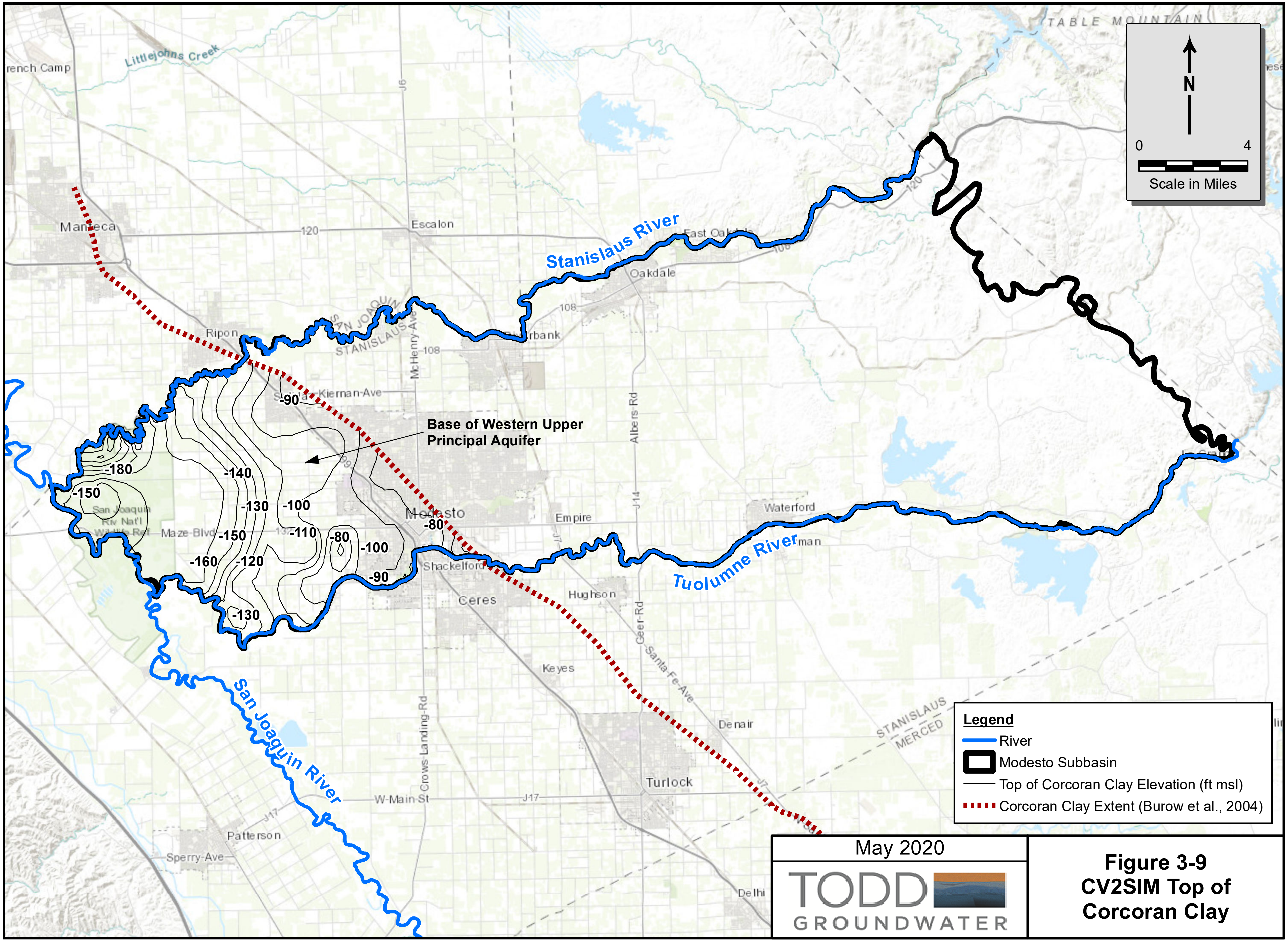
L3: Deeper pumping layer (bottom of layer is the base of fresh water)

L4: Saline aquifer (bottom of layer is the base of continental deposits)

April 2020

TODD GROUNDWATER

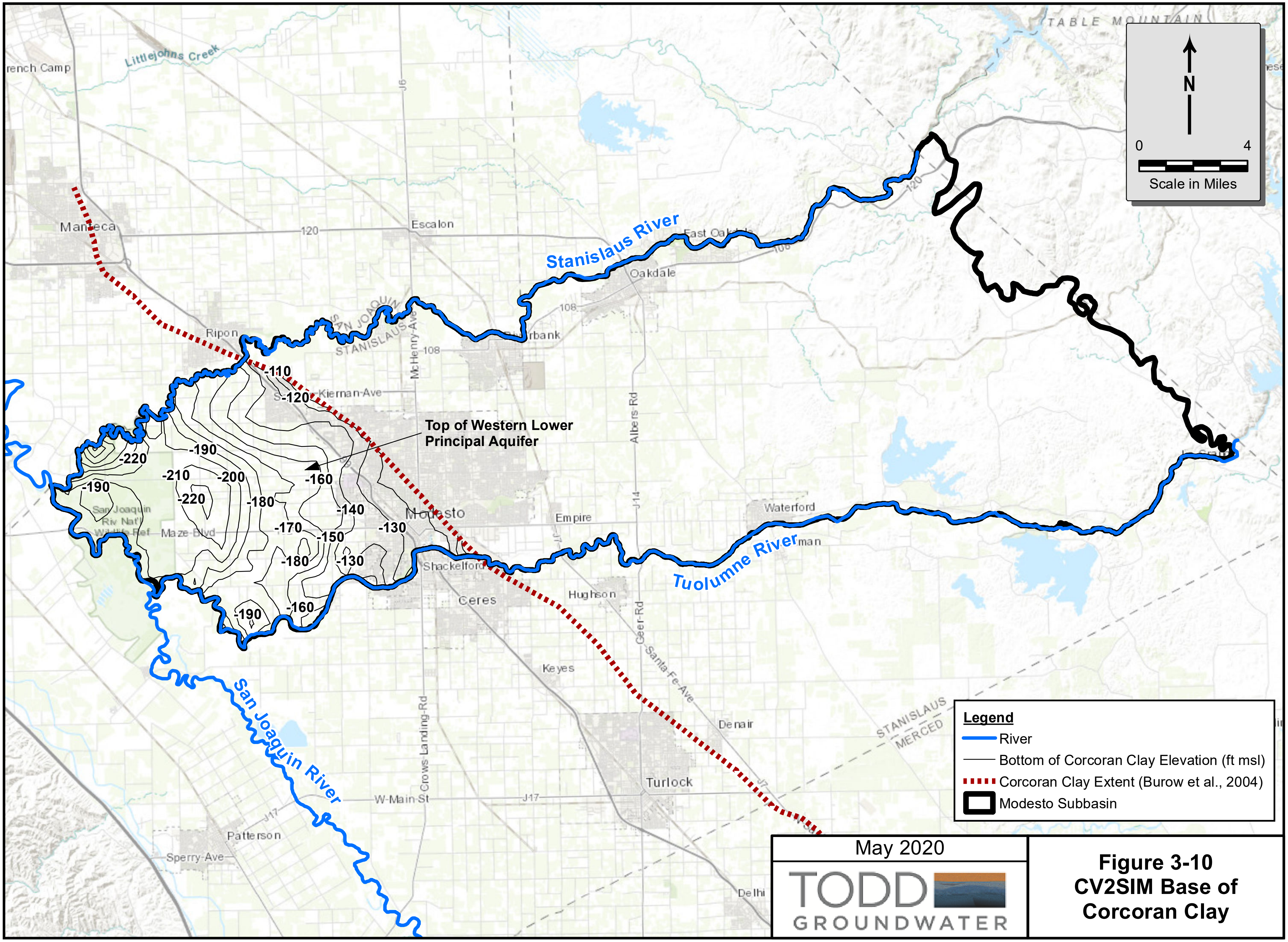
Figure 3-8
C2VSIM
Model Layers



May 2020

TODD GROUNDWATER

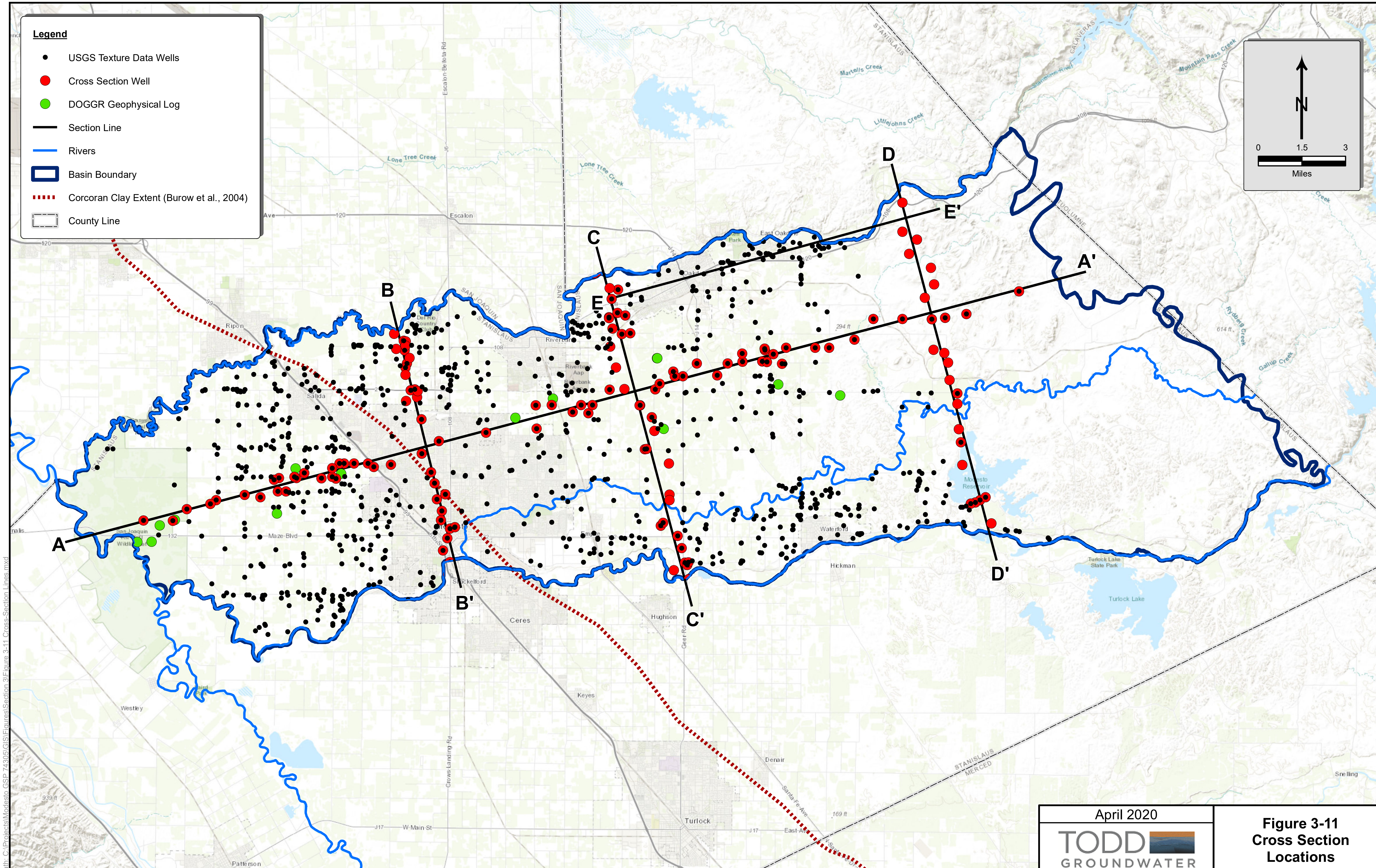
Figure 3-9
CV2SIM Top of Corcoran Clay



May 2020

TODD GROUNDWATER

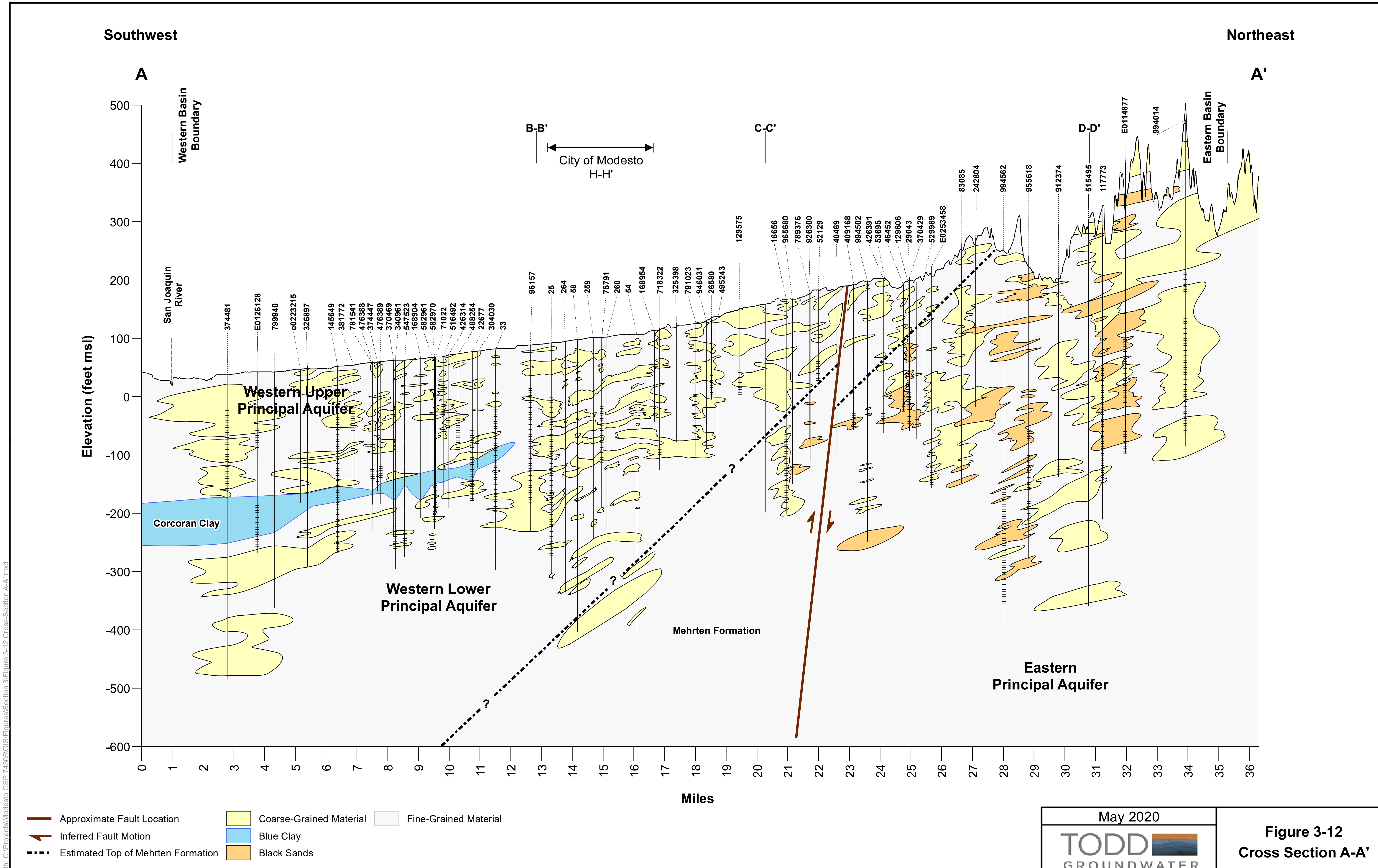
Figure 3-10
CV2SIM Base of Corcoran Clay



April 2020

TODD GROUNDWATER

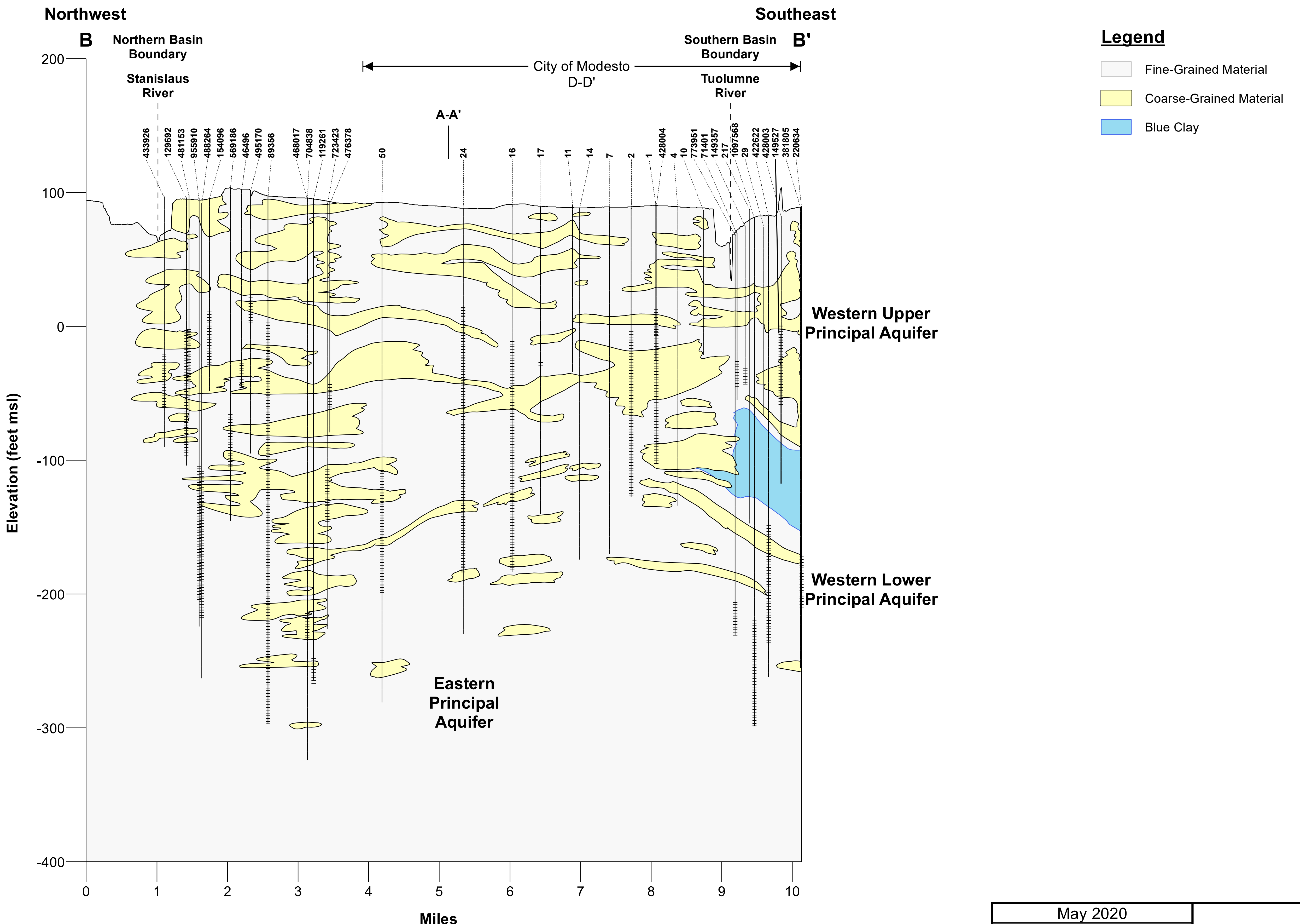
Figure 3-11
Cross Section Locations



May 2020

TODD GROUNDWATER

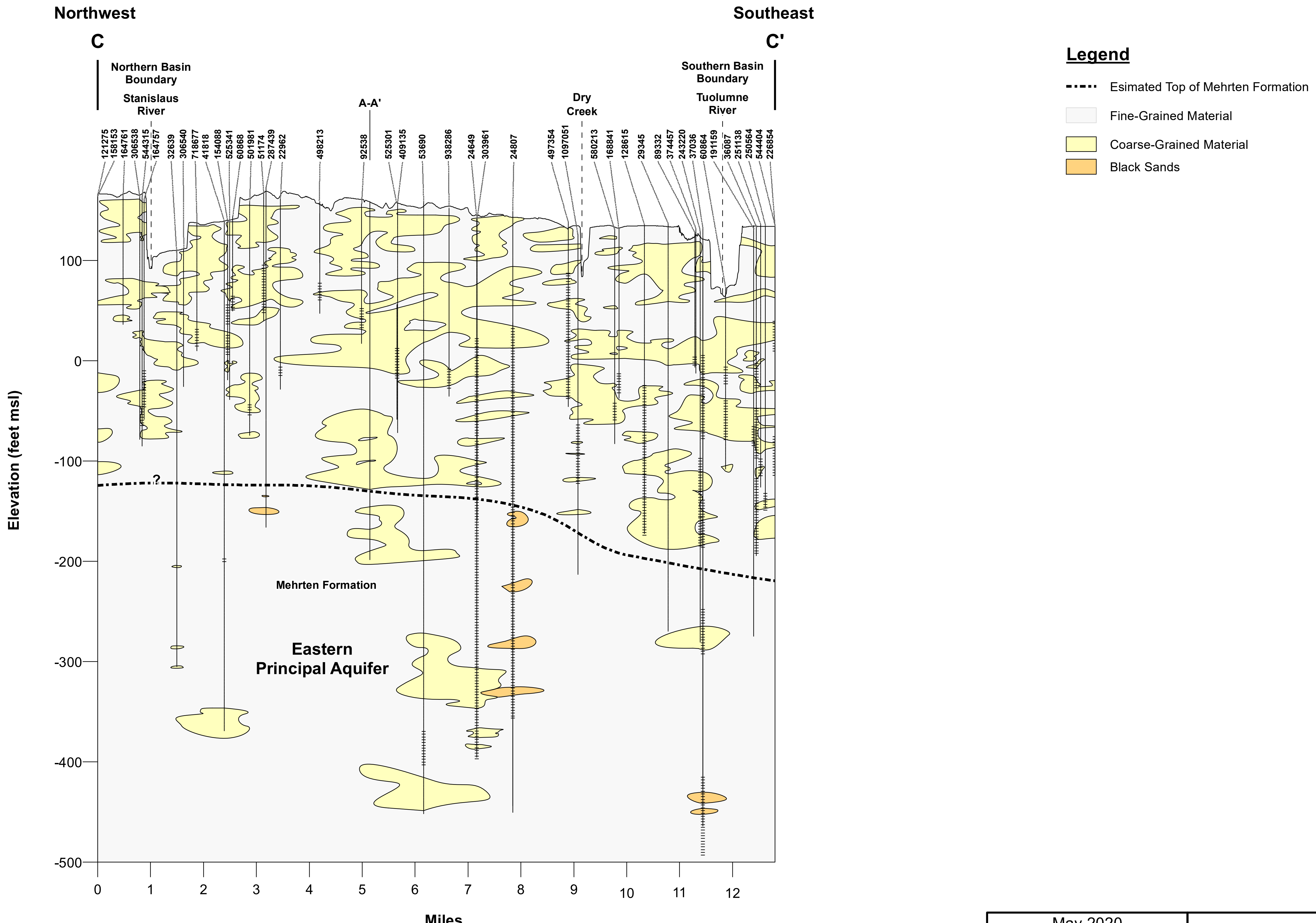
Figure 3-12
Cross Section A-A'



May 2020

TODD GROUNDWATER

Figure 3-13
Cross Section B-B'

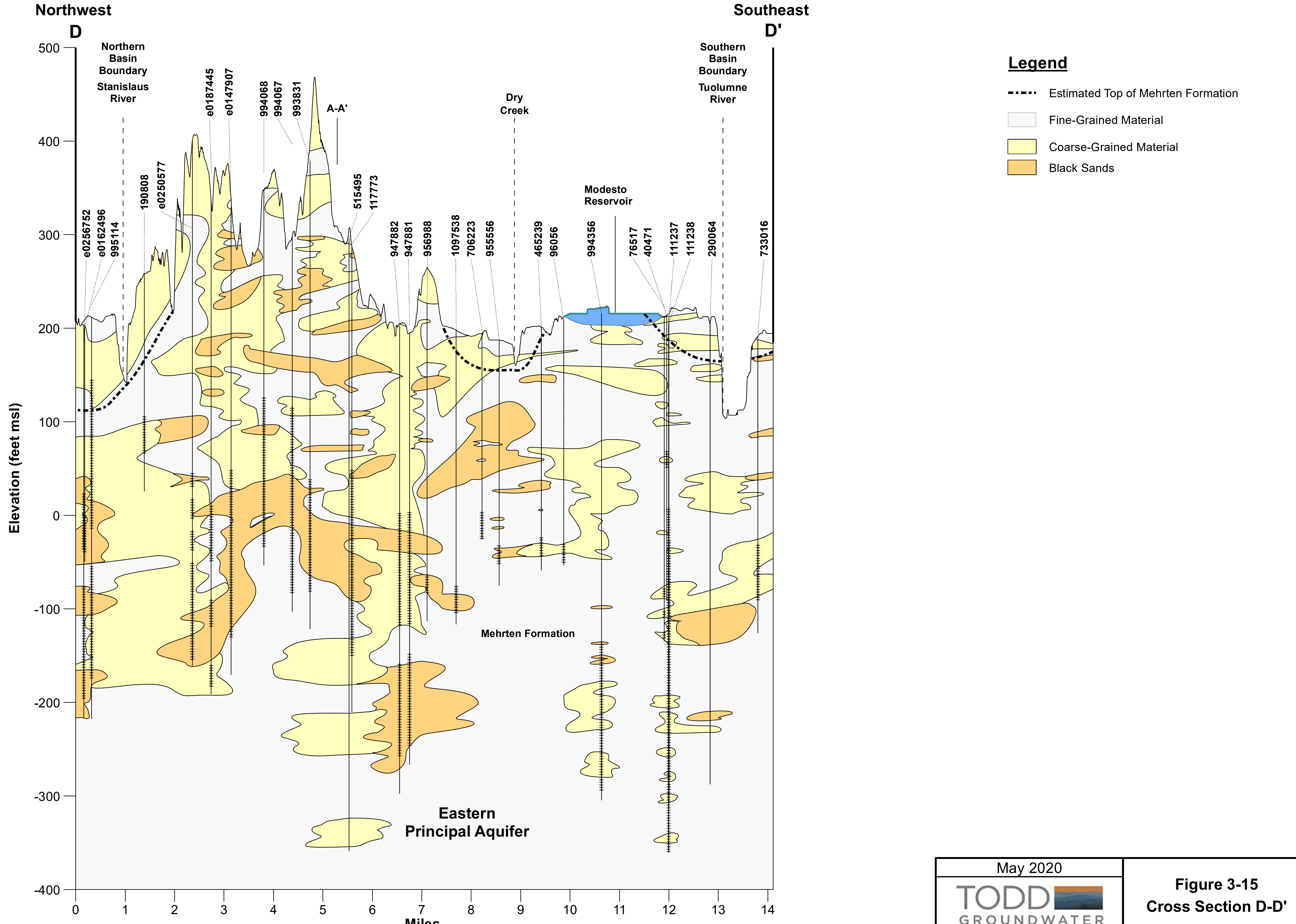


May 2020

TODD GROUNDWATER

Figure 3-14
Cross Section C-C'

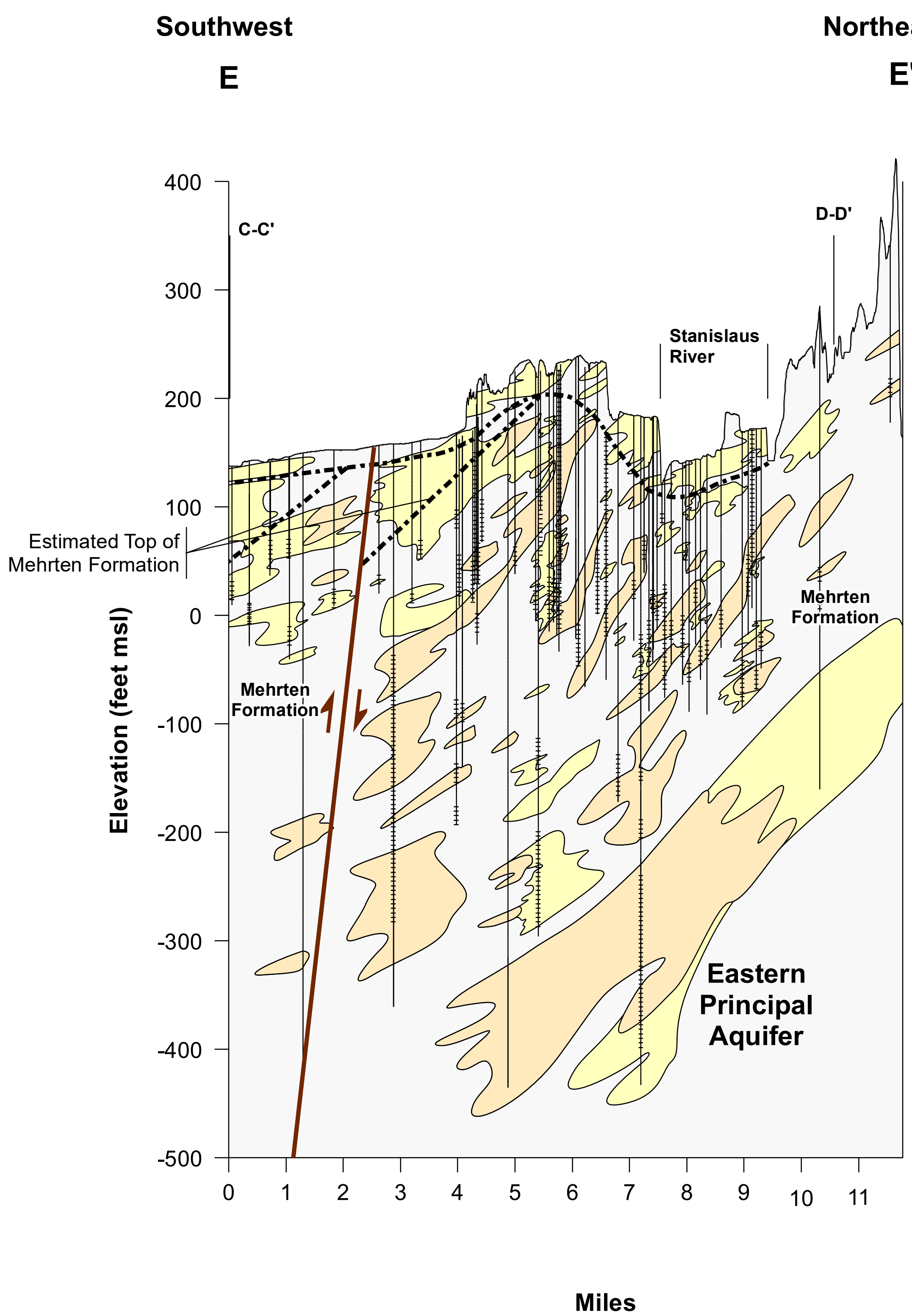
Path: C:\Projects\Modesto GSP 74305\GIS\Figures\Section 3\Figure 3-14 Cross-Section C-C'.mxd



May 2020

TODD GROUNDWATER

Figure 3-15
Cross Section D-D'



Legend

Fine-Grained Material

Coarse-Grained Material

Black Sands

Approximate Fault Location

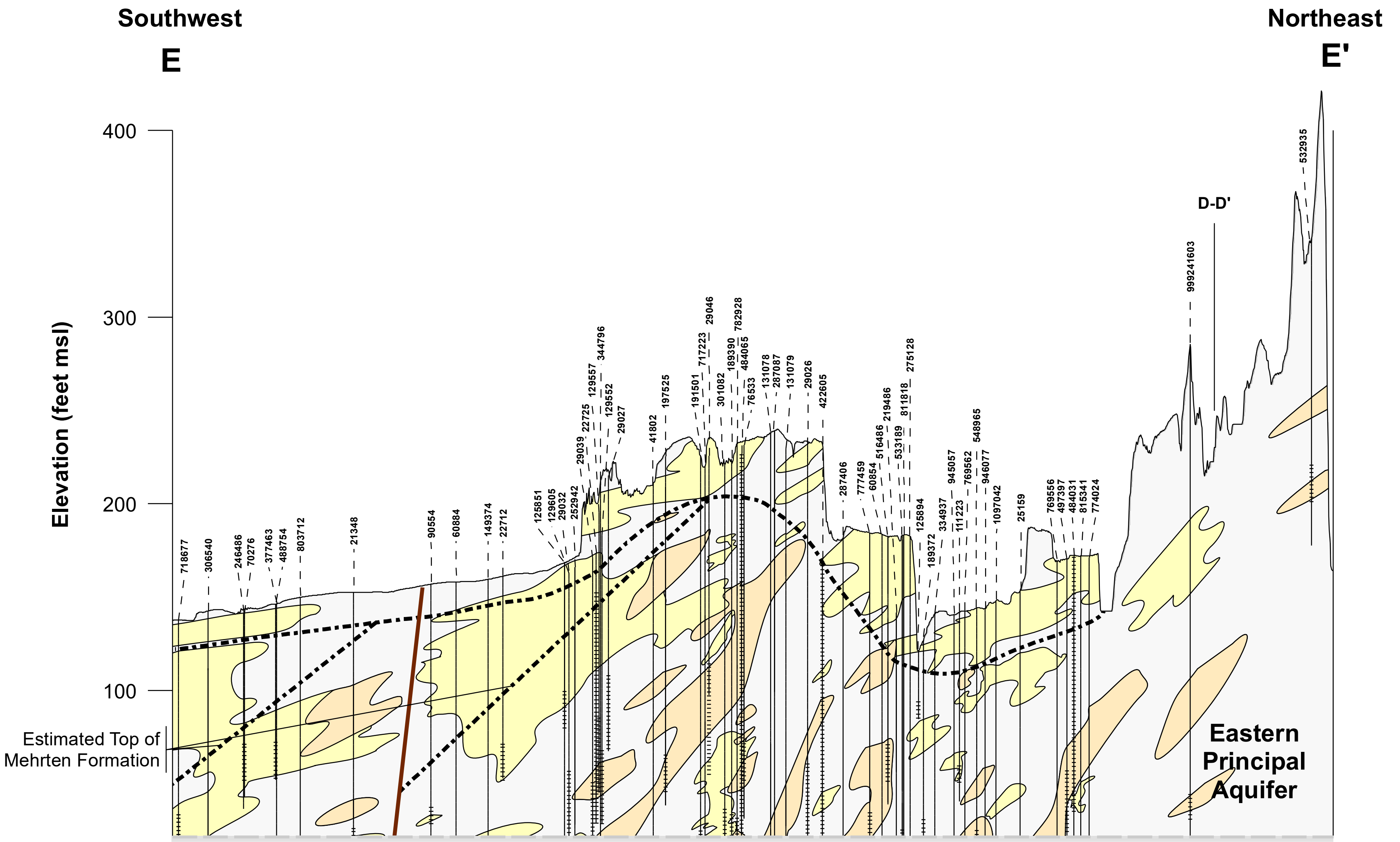
Inferred Fault Motion

May 2020

TODD GROUNDWATER

Figure 3-16
Cross Section E-E'

Path: C:\Projects\Modesto GSP 74305\GIS\Figures\Section 3\Figure 3-16 Cross-Section E-E'.mxd



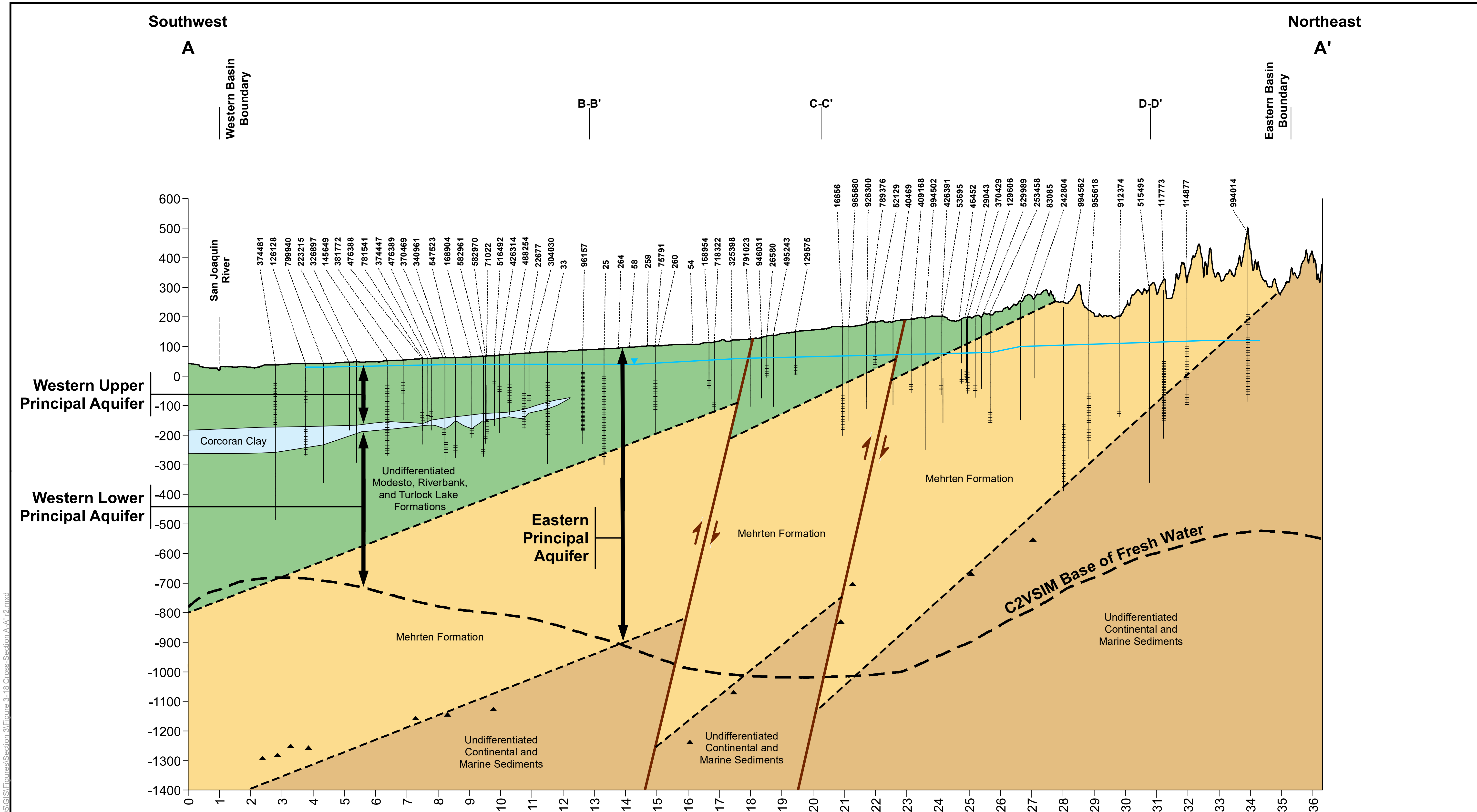
Legend

- Fine-Grained Material
- Coarse-Grained Material
- Black Sands
- Approximate Fault Location
- Inferred Fault Motion

May 2020

TODD GROUNDWATER

Figure 3-17
Cross Section E-E'
Alternative Scale



Approximate Fault Location

Inferred Fault Motion

Approximate Formation Boundary

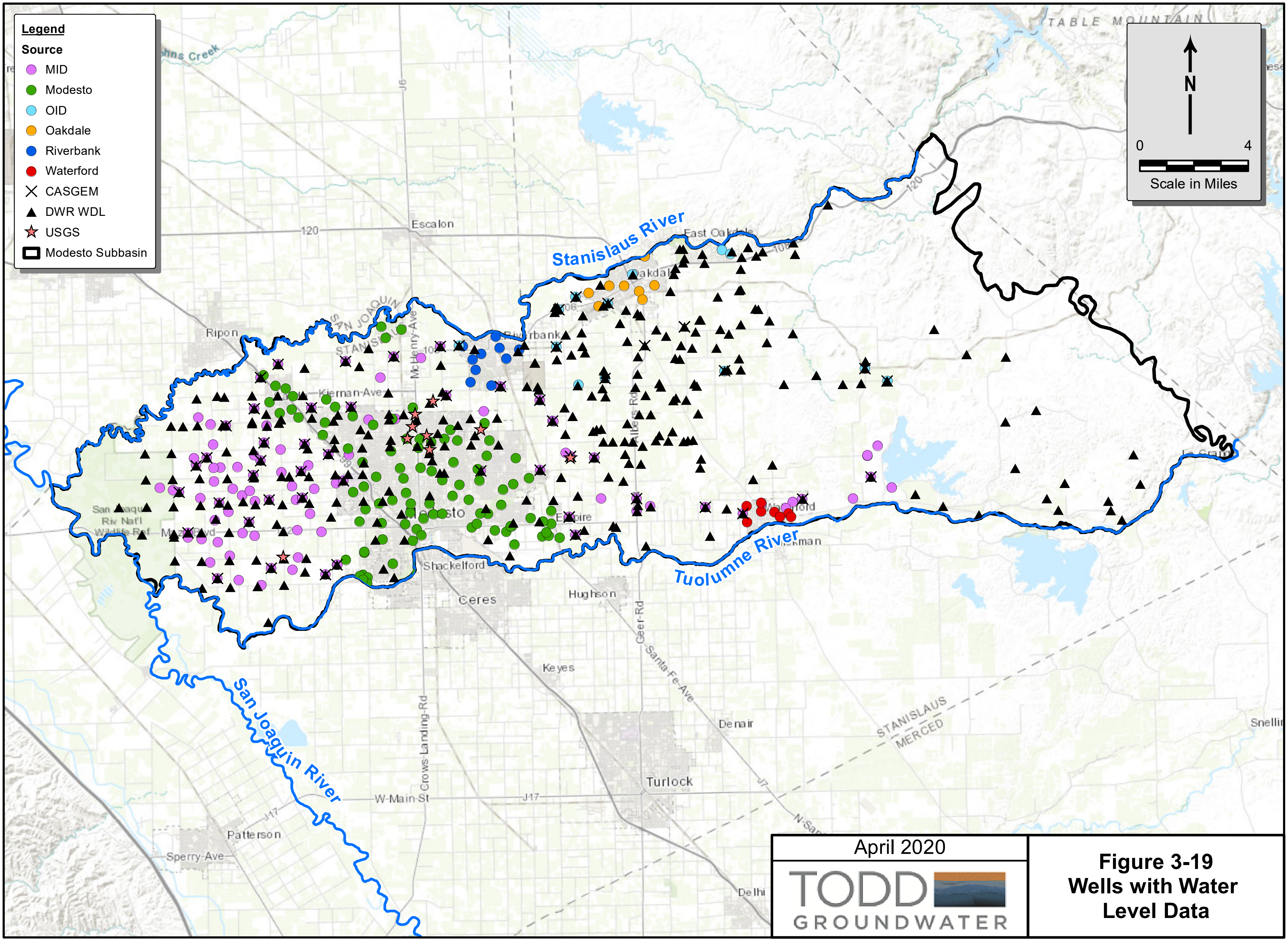
Approximate Base of Mehrten Formation Inferred from DOGGR Geophysical Log

Groundwater Elevation October 2015

May 2020

TODD GROUNDWATER

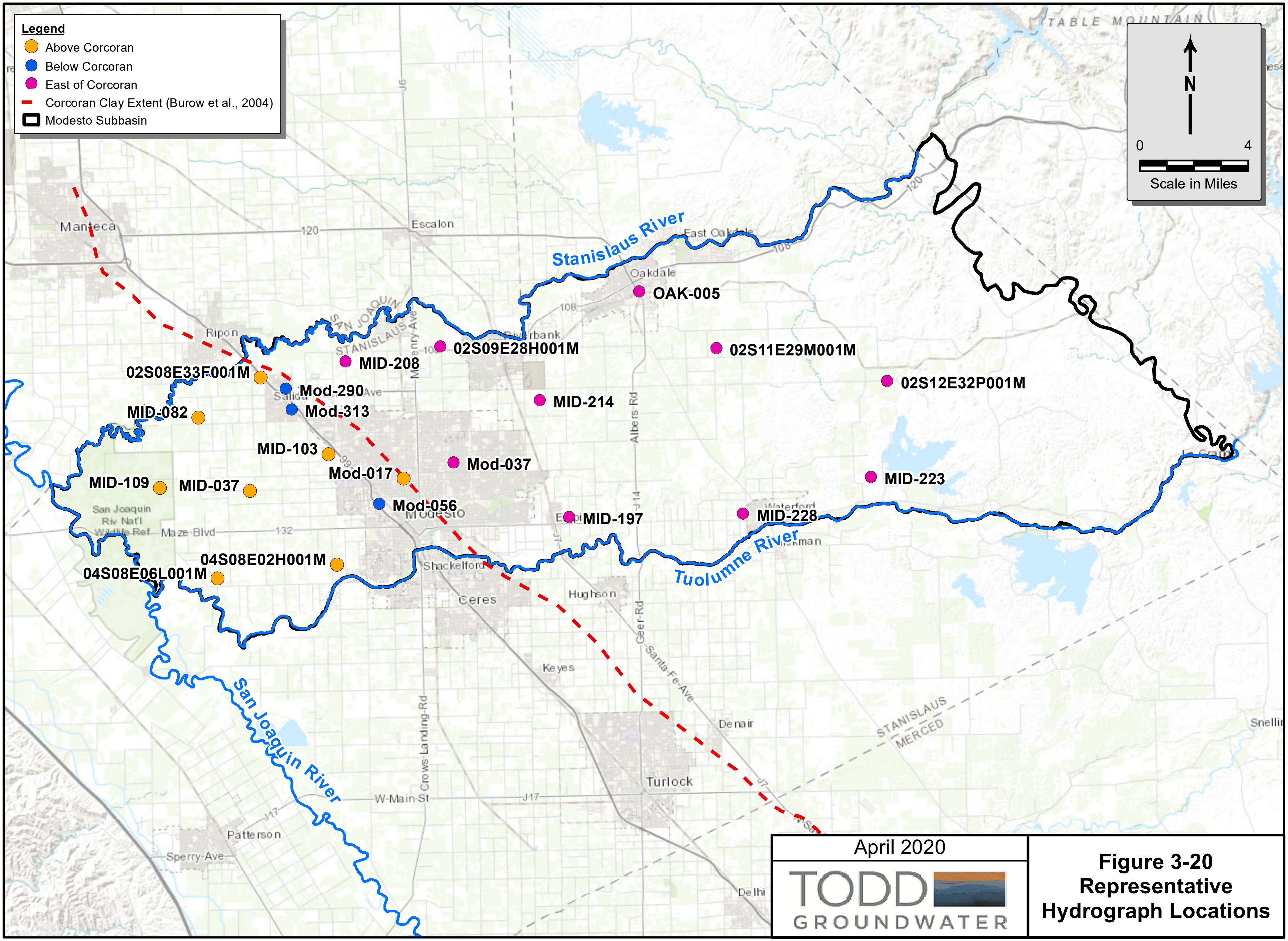
Figure 3-18
Hydrogeologic Framework
Cross Section A-A'



April 2020

TODD GROUNDWATER

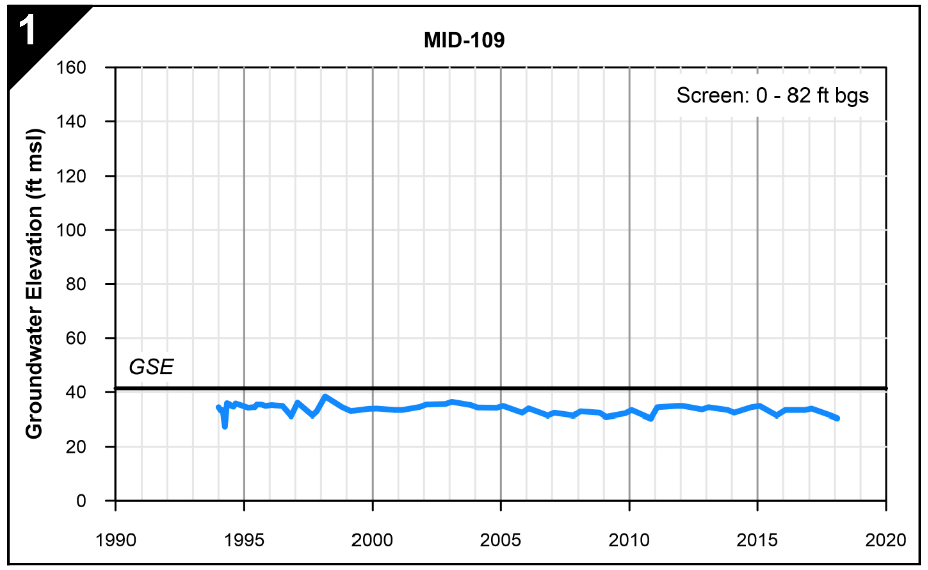
Figure 3-19
Wells with Water Level Data

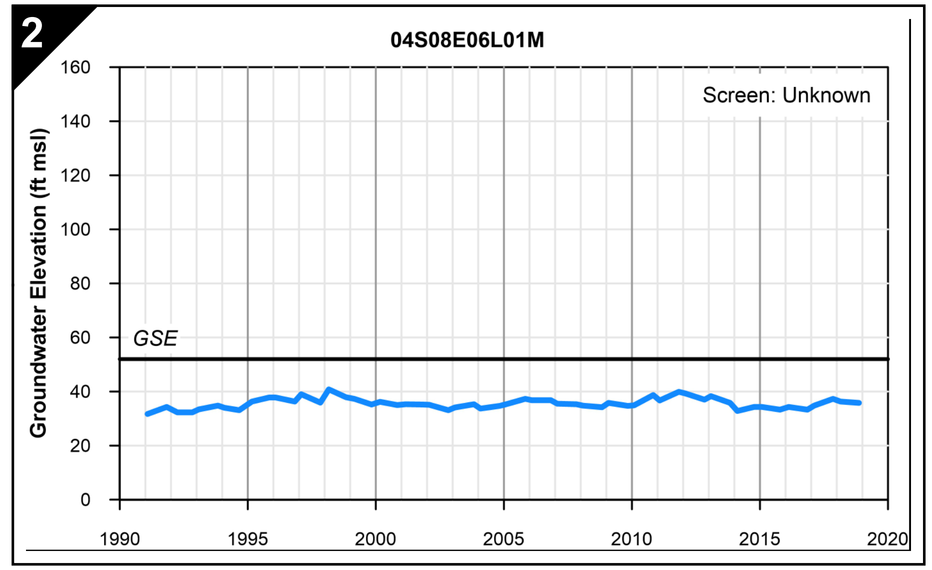


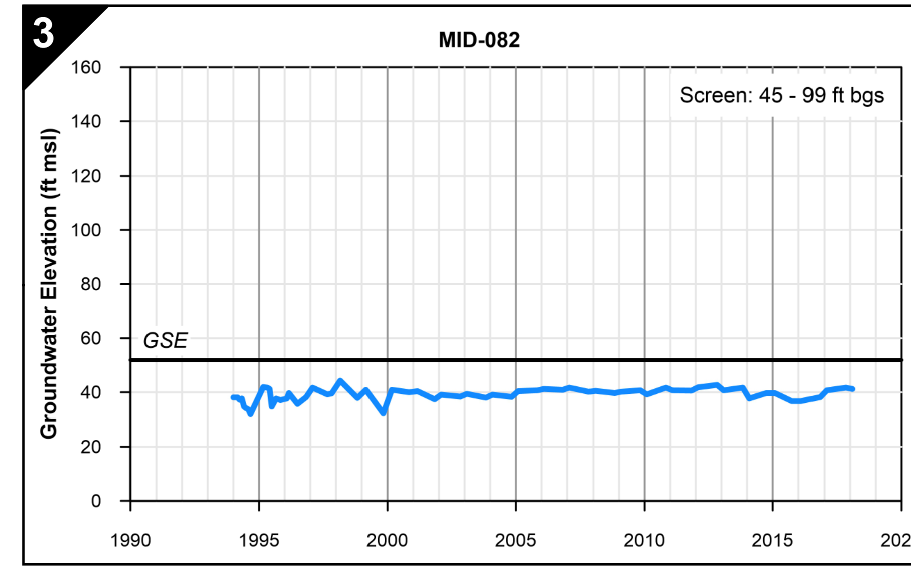
April 2020

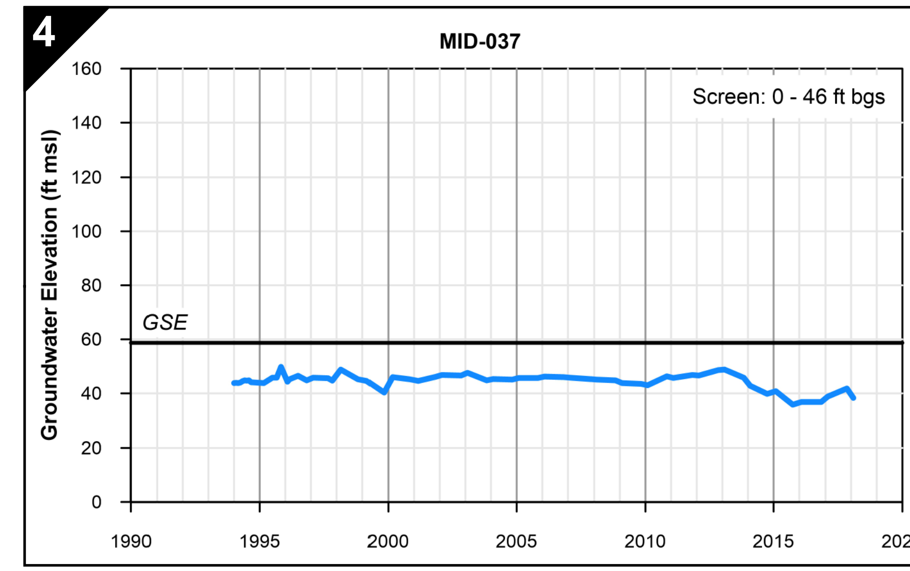
TODD GROUNDWATER

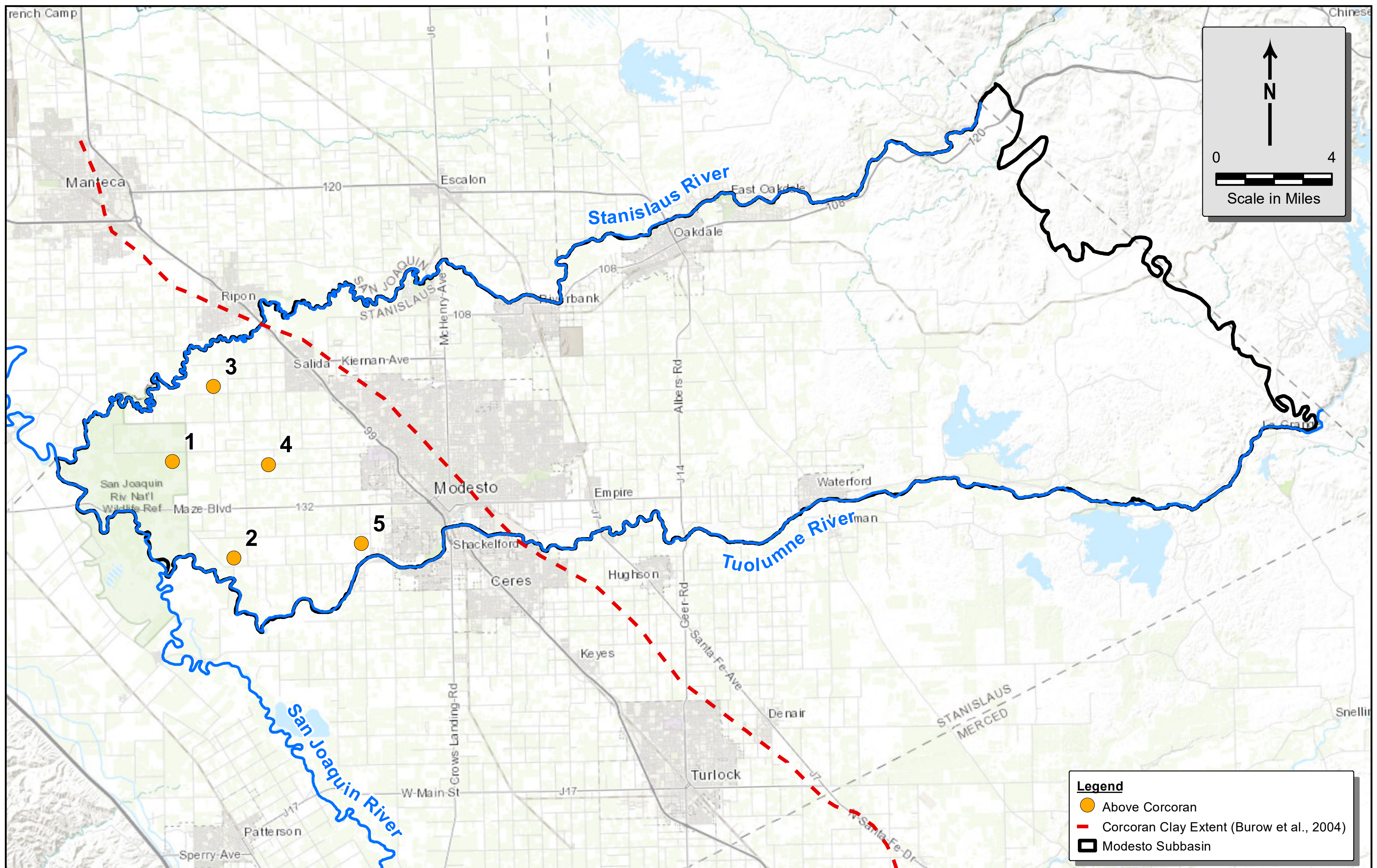
Figure 3-20
Representative Hydrograph Locations

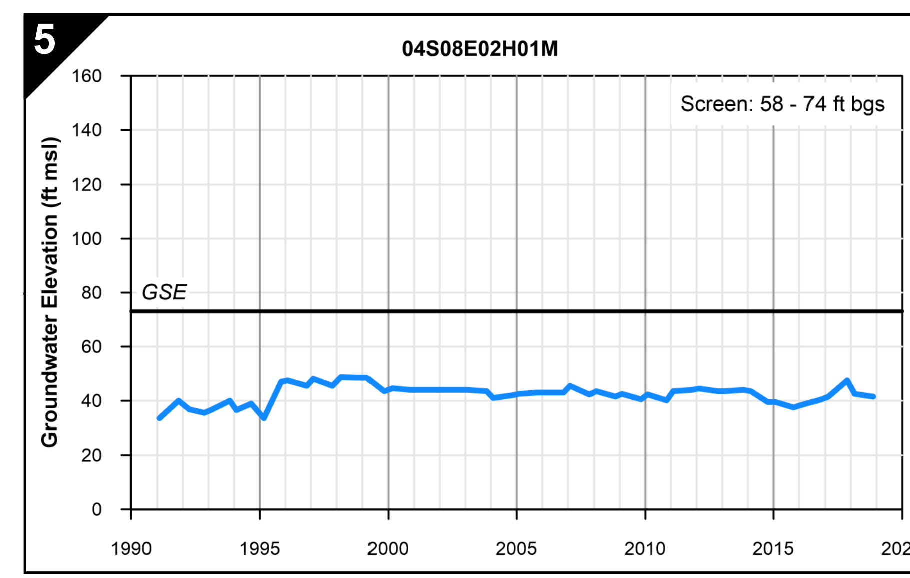








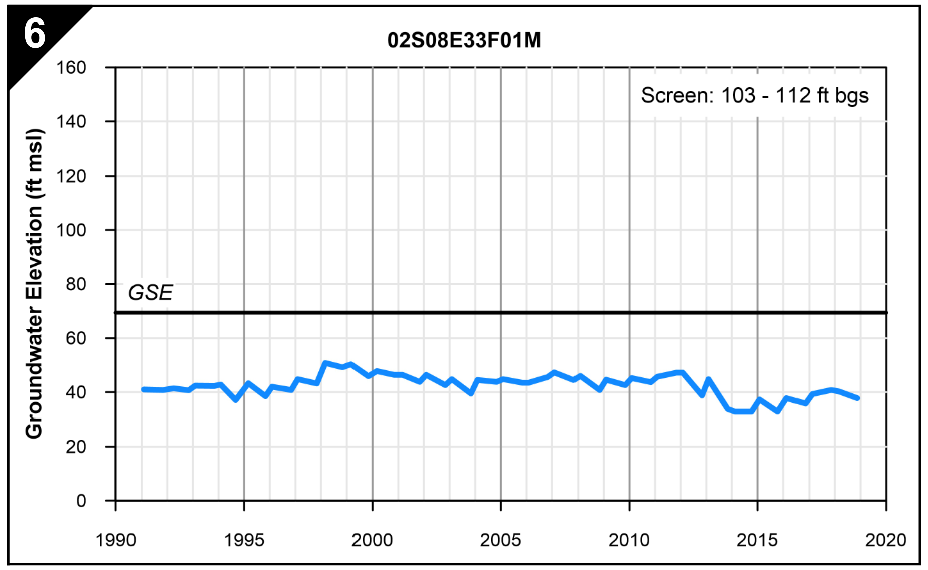


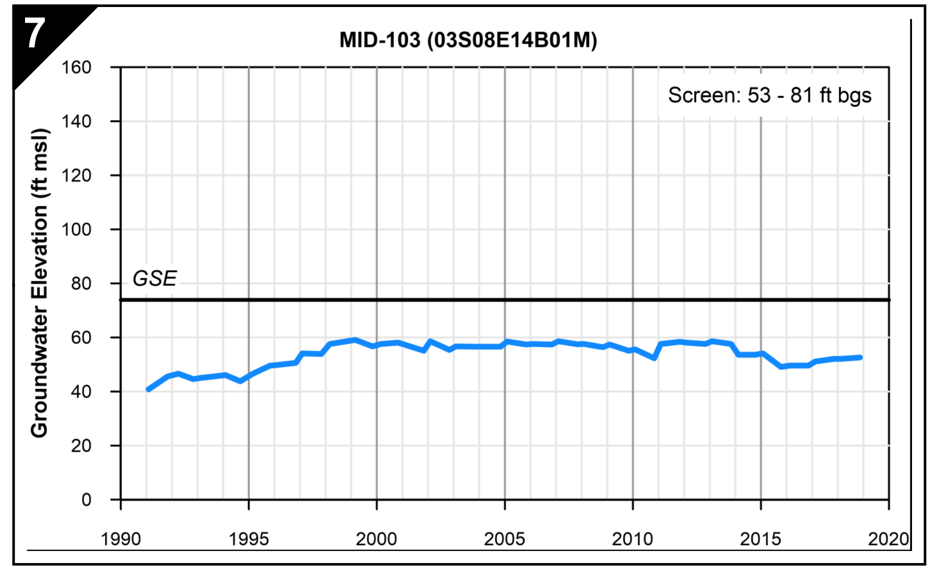


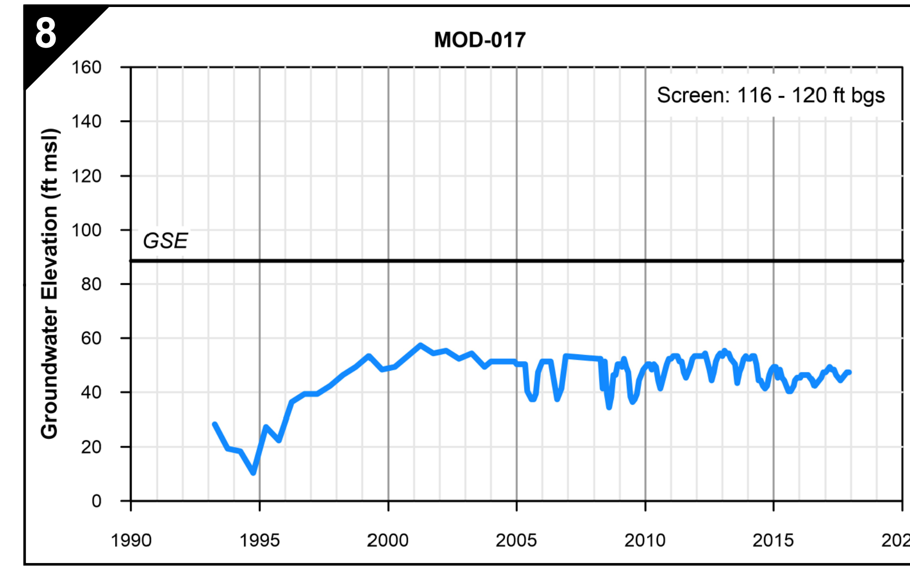
May 2020

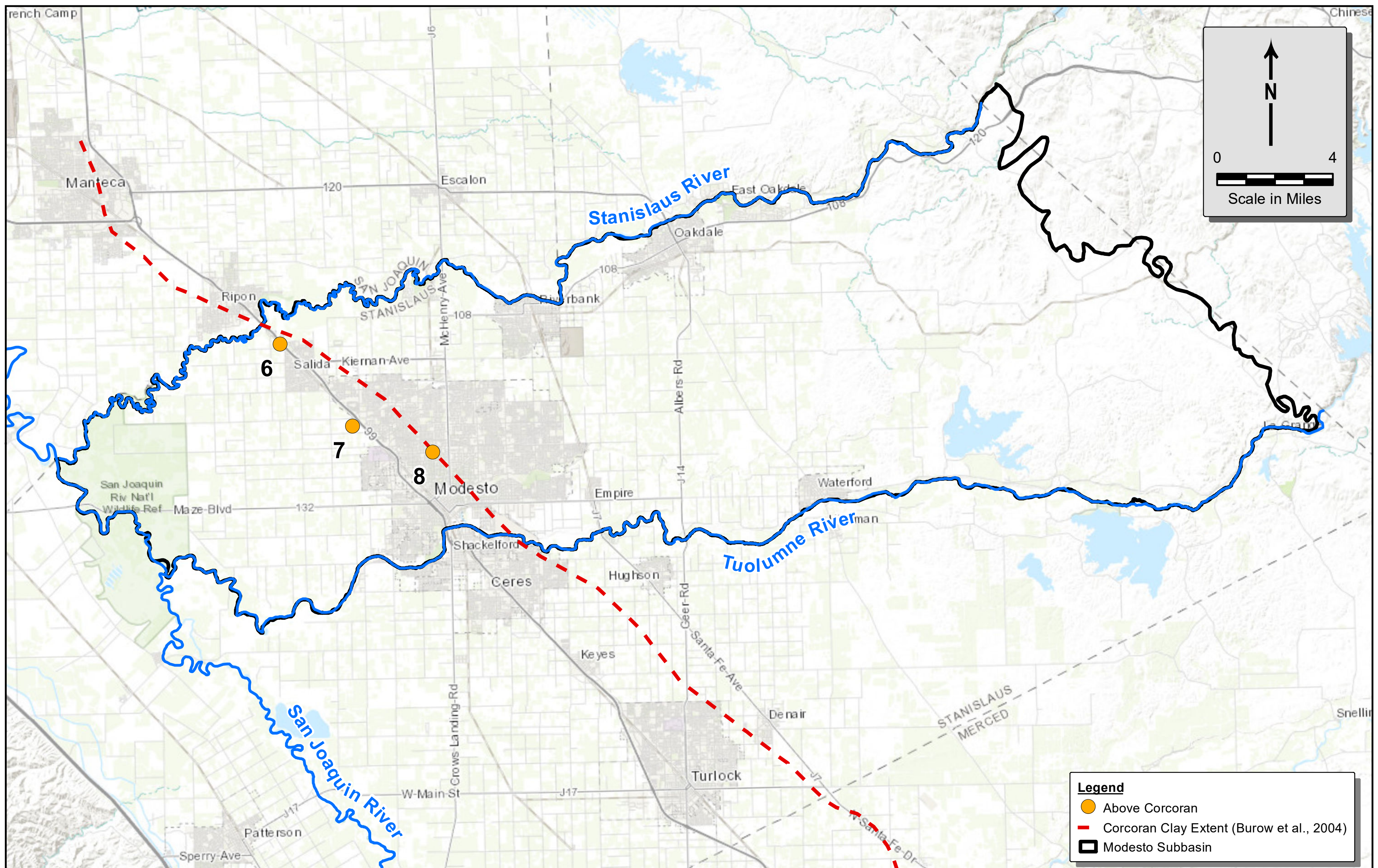
TODD GROUNDWATER

Figure 3-21
Representative Hydrographs
Western Upper
Principal Aquifer (1 of 2)





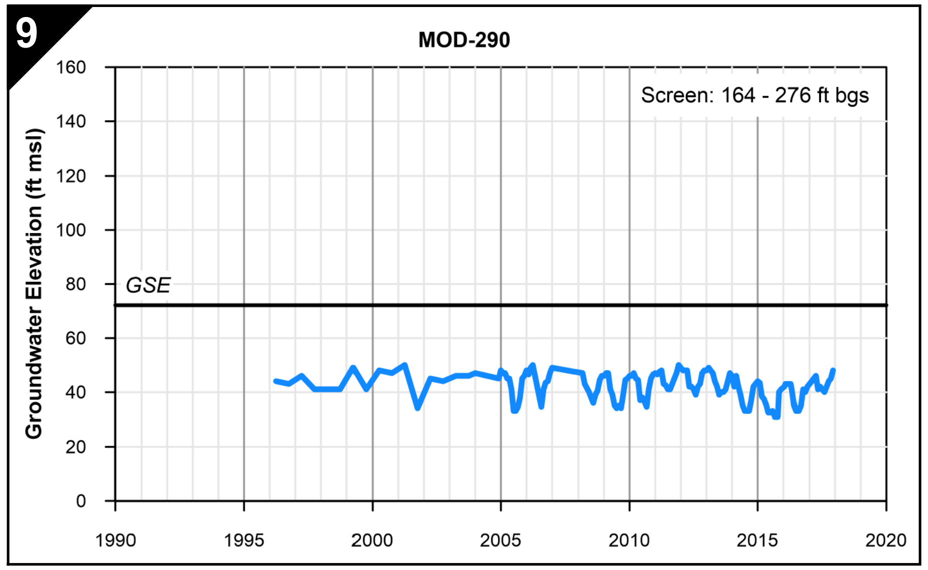


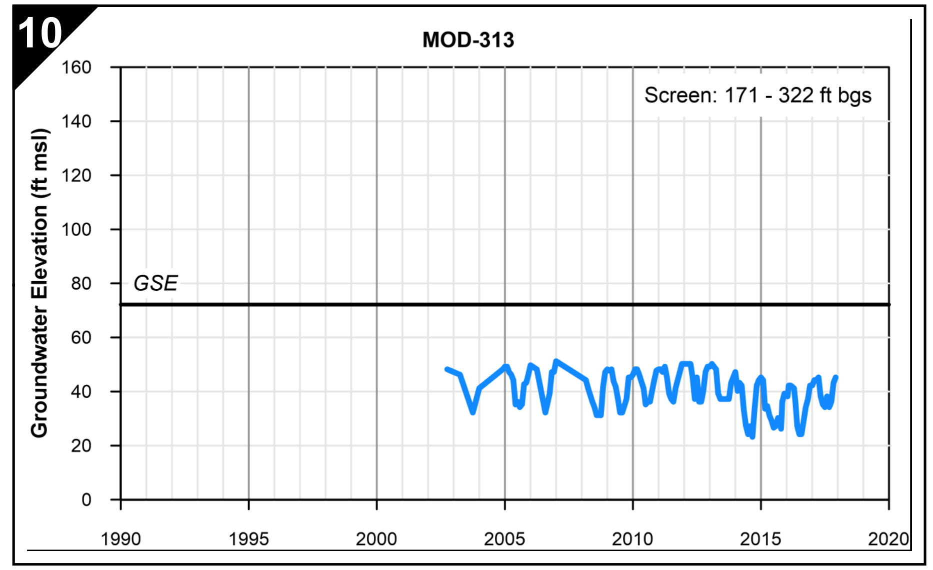


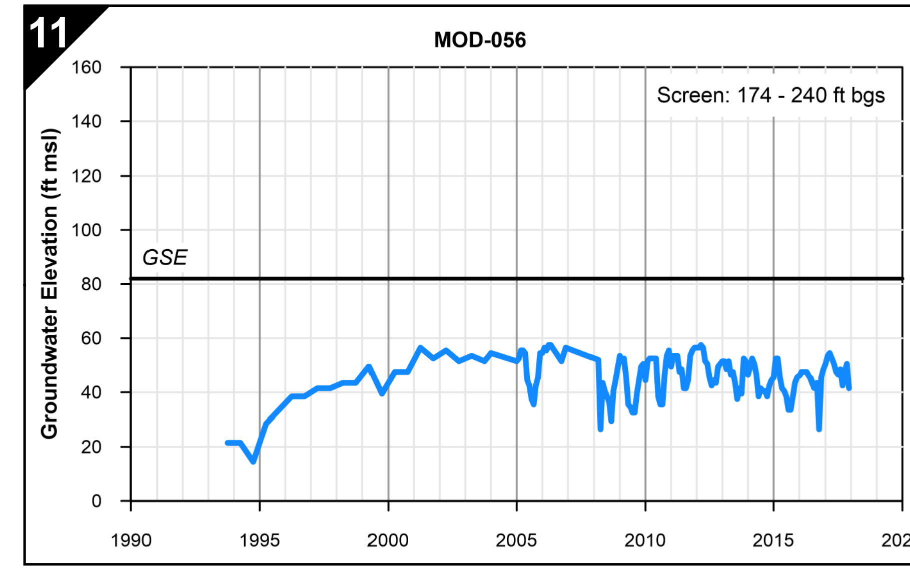
May 2020

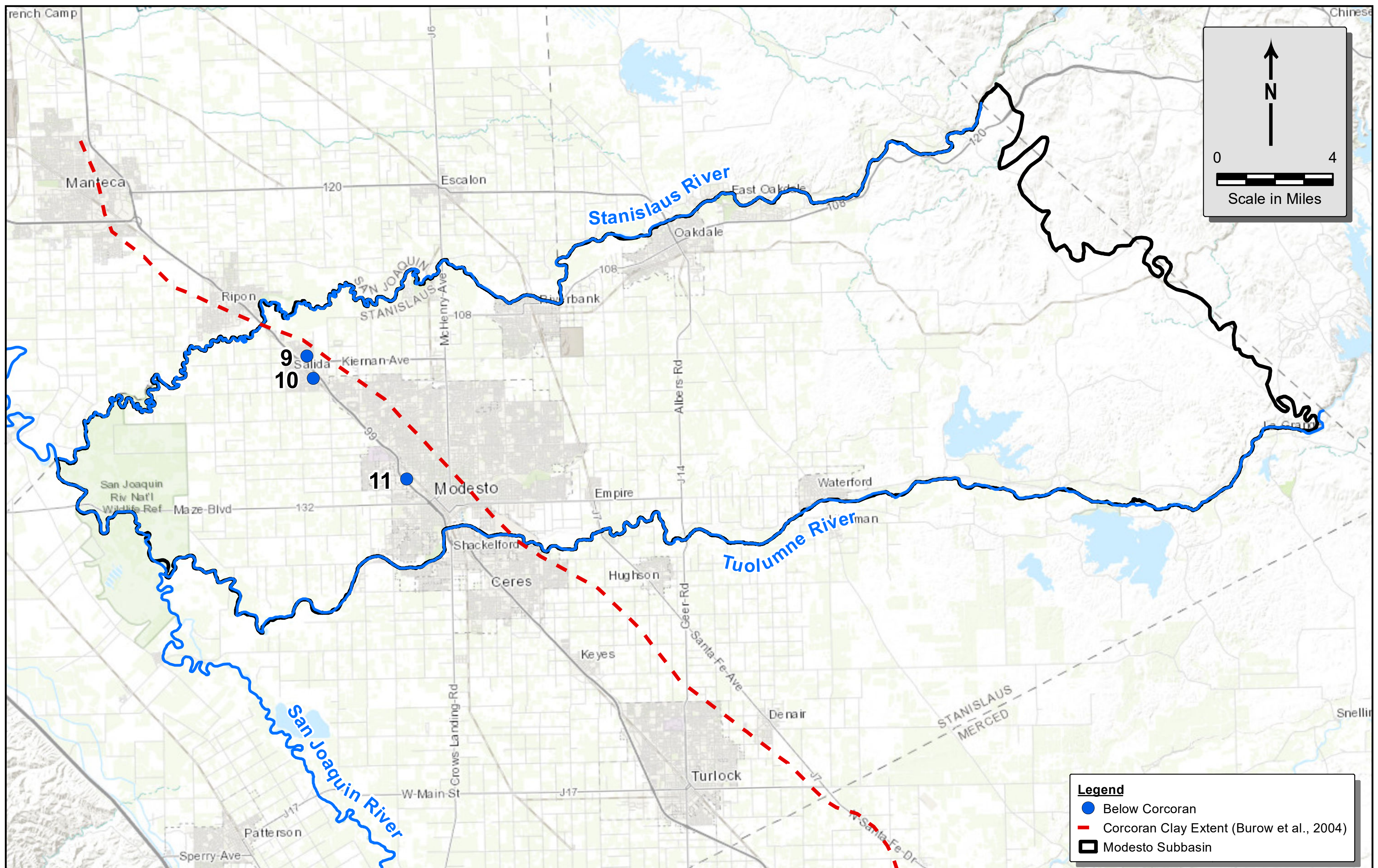
TODD GROUNDWATER

Figure 3-22
Representative Hydrographs
Western Upper
Principal Aquifer (2 of 2)









May 2020

TODD GROUNDWATER

Figure 3-23
Representative Hydrographs
Western Lower
Principal Aquifer

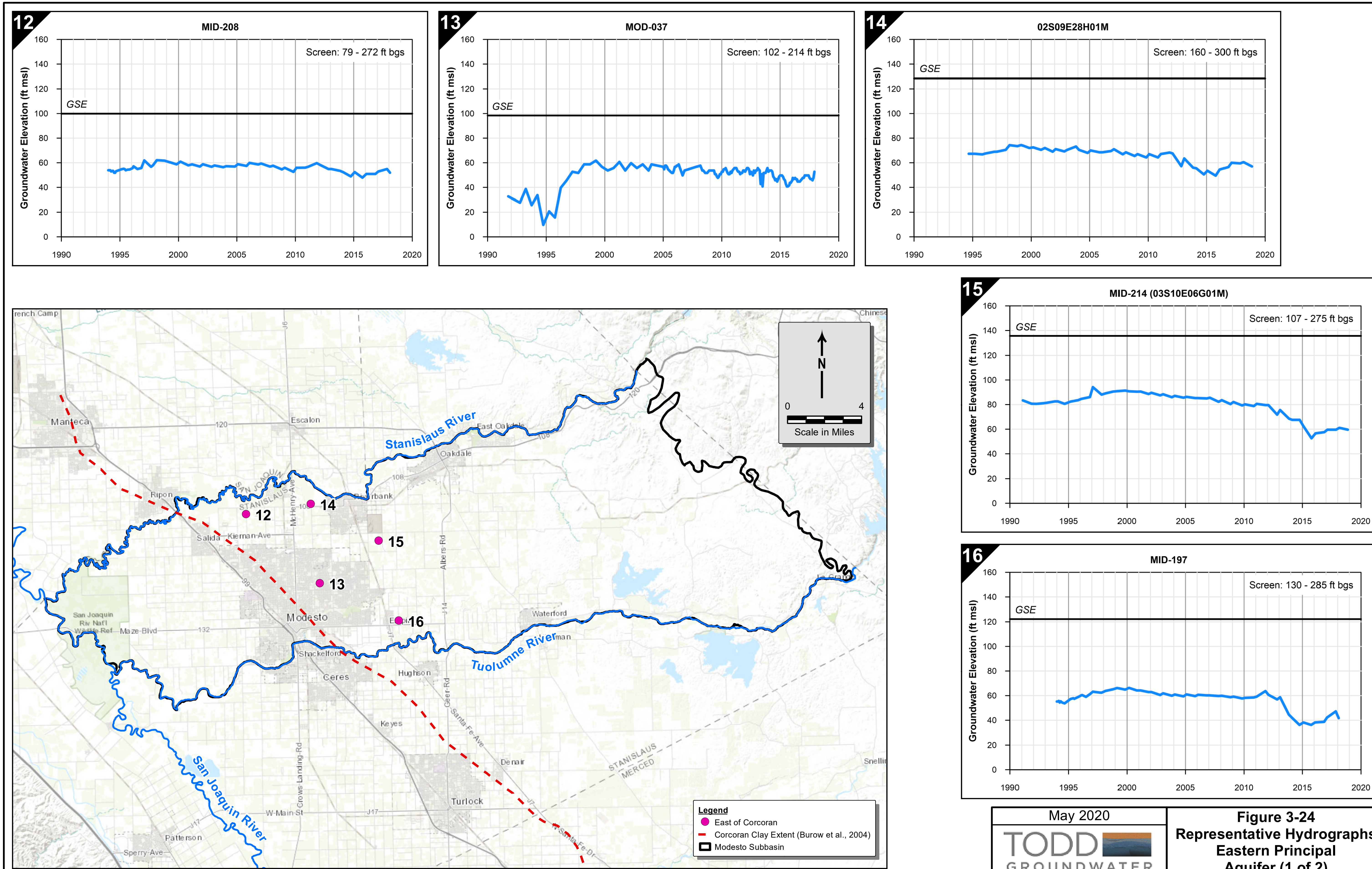
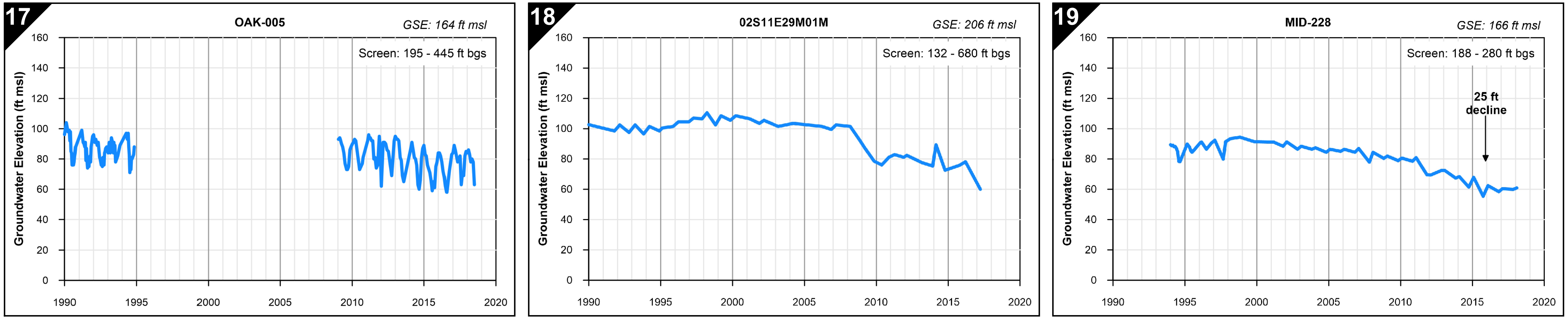
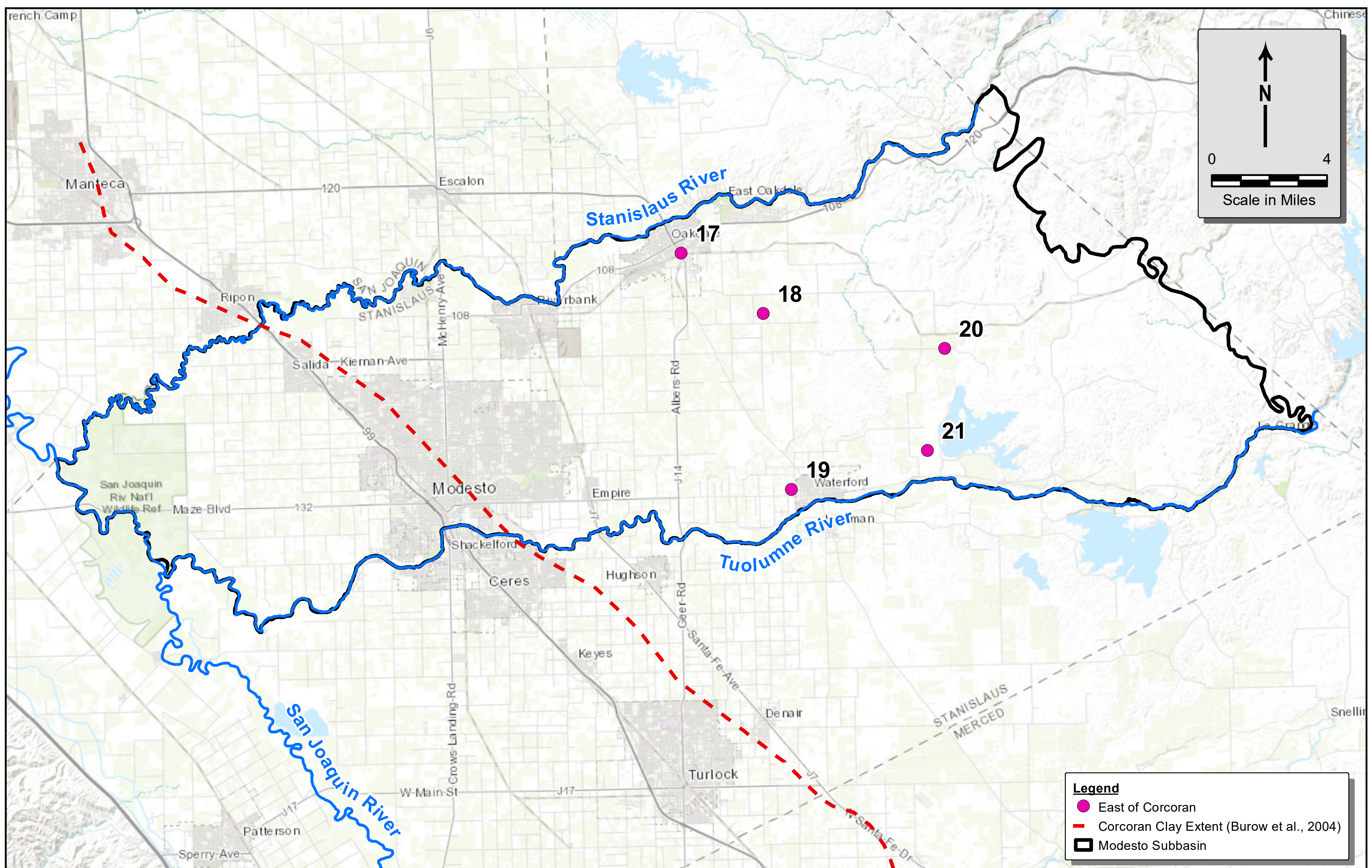
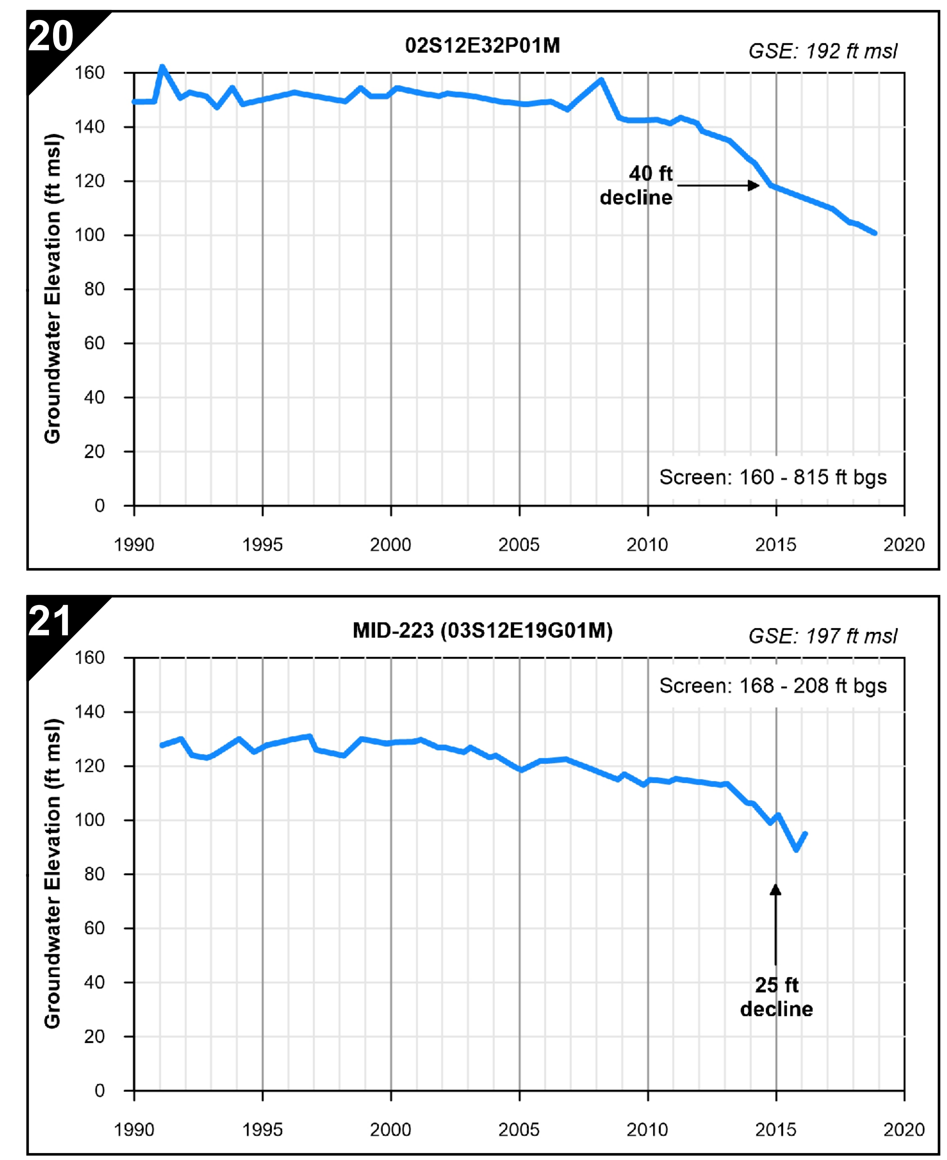


Figure 3-24
Representative Hydrographs
Eastern Principal
Aquifer (1 of 2)



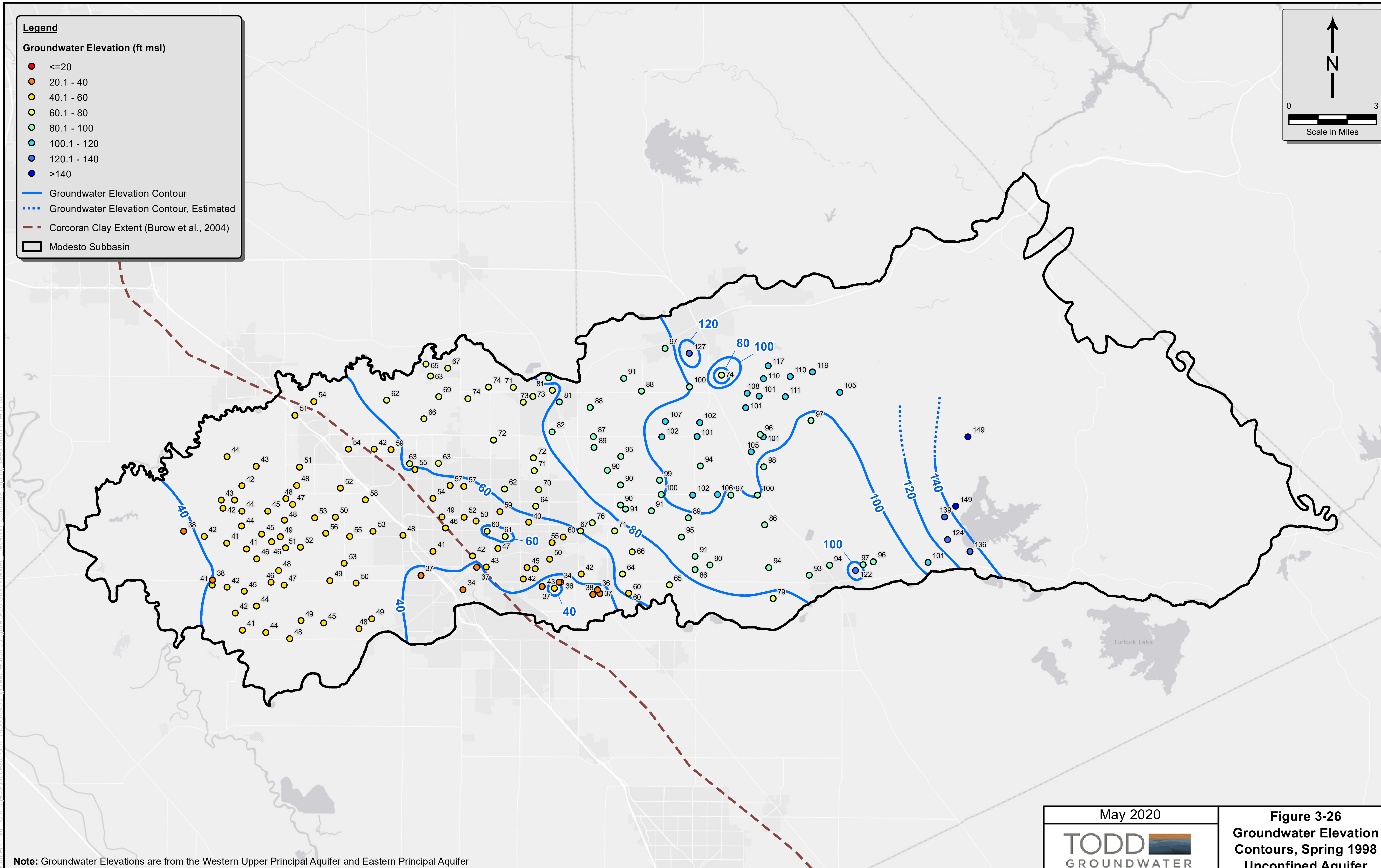




May 2020

TODD GROUNDWATER

Figure 3-25
Representative Hydrographs
Eastern Principal
Aquifer (2 of 2)

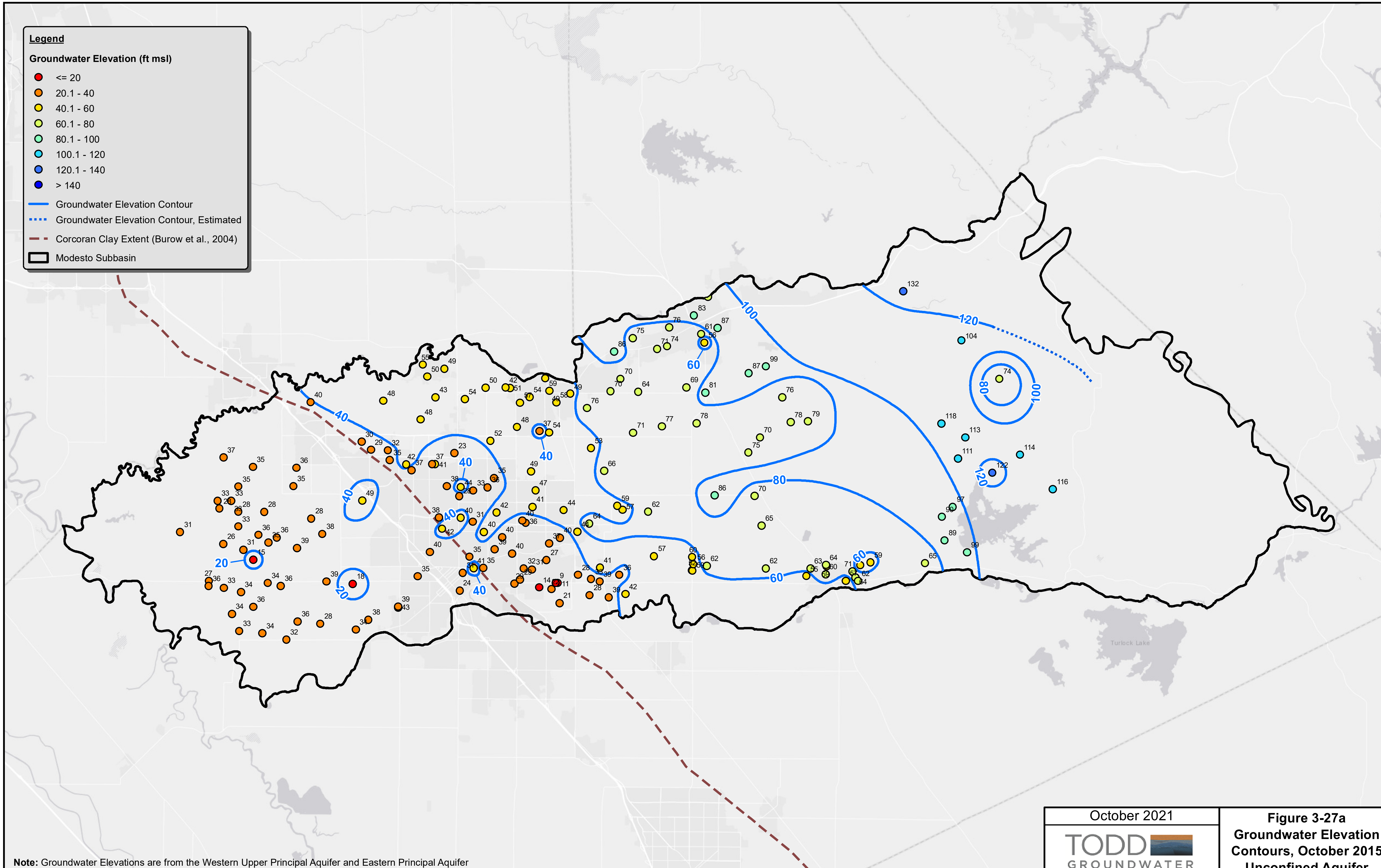


Note: Groundwater Elevations are from the Western Upper Principal Aquifer and Eastern Principal Aquifer

May 2020

TODD GROUNDWATER

Figure 3-26
Groundwater Elevation Contours, Spring 1998
Unconfined Aquifer

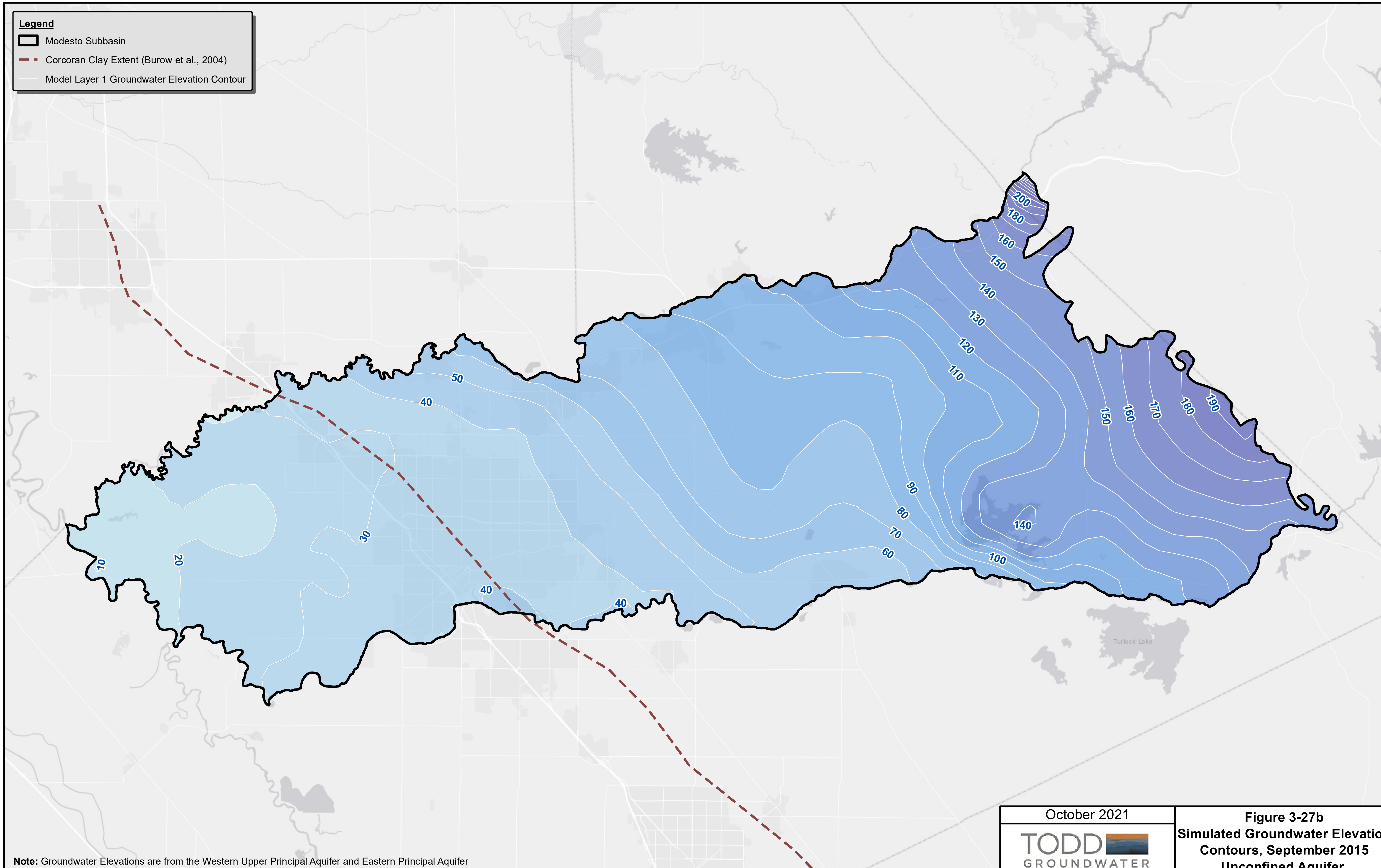


Note: Groundwater Elevations are from the Western Upper Principal Aquifer and Eastern Principal Aquifer

October 2021

TODD GROUNDWATER

Figure 3-27a
Groundwater Elevation Contours, October 2015
Unconfined Aquifer



October 2021

TODD GROUNDWATER

Figure 3-27b
Simulated Groundwater Elevation Contours, September 2015
Unconfined Aquifer

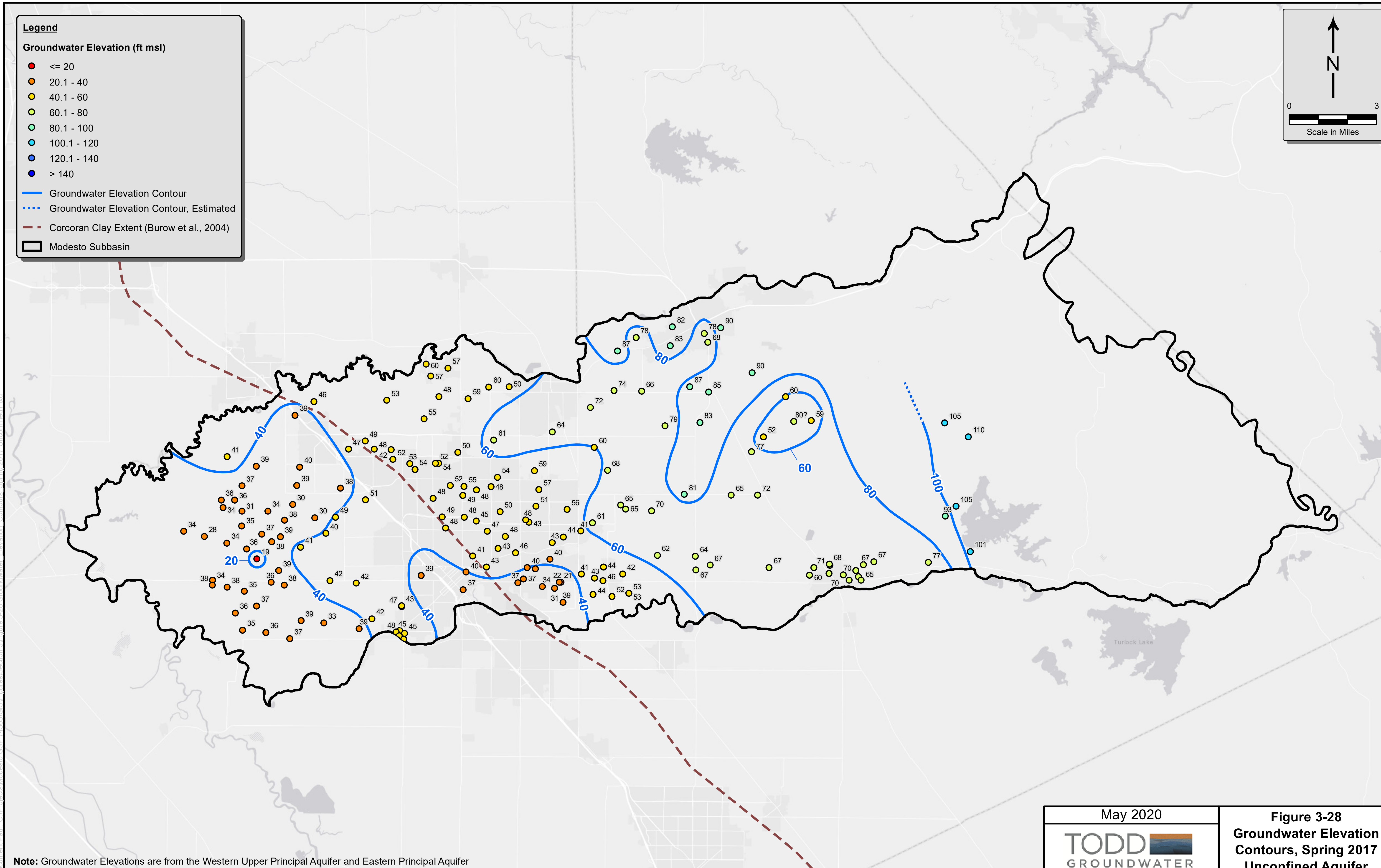


Figure 3-28
Groundwater Elevation Contours, Spring 2017 Unconfined Aquifer

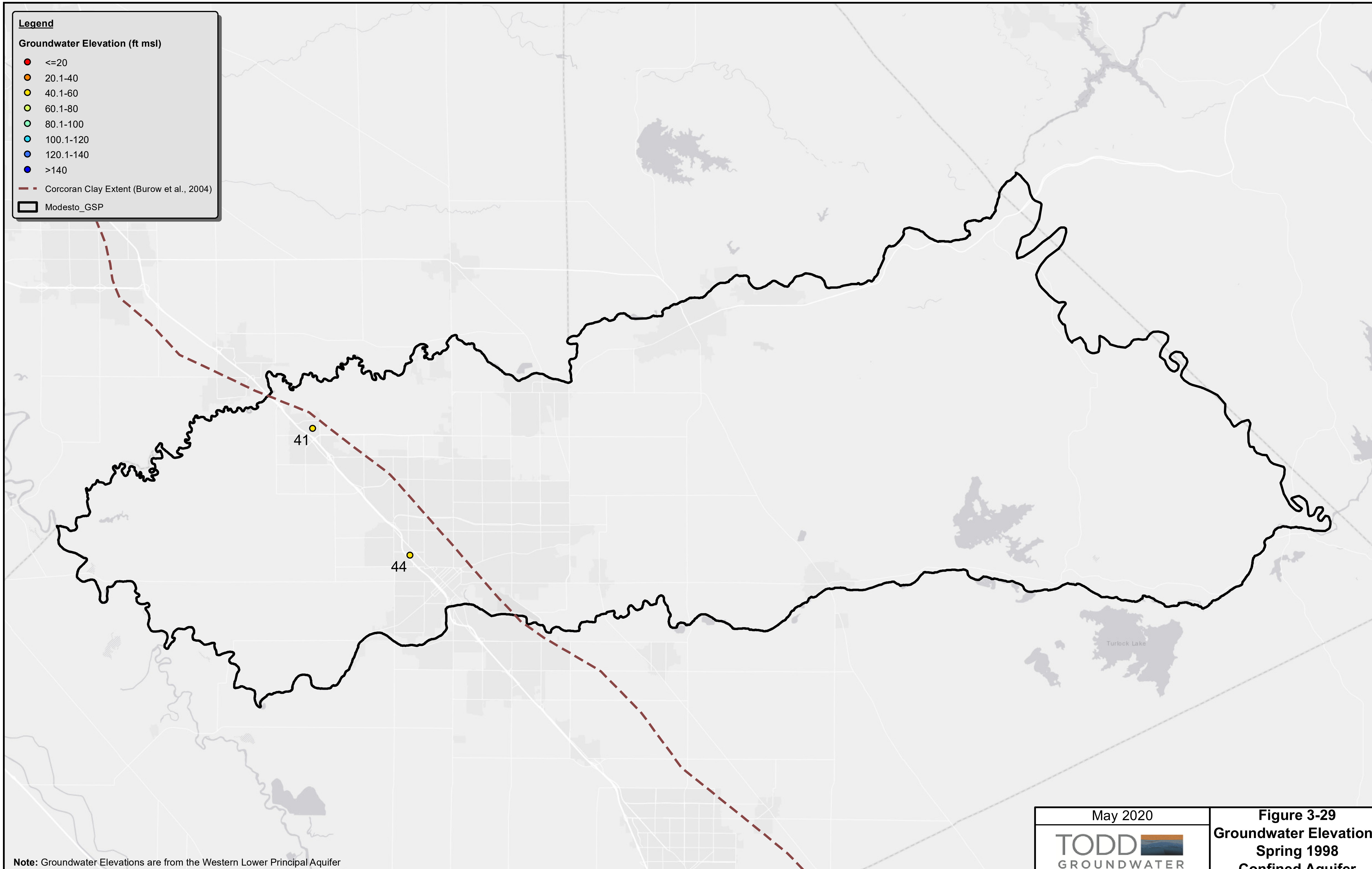


Figure 3-29
Groundwater Elevations
Spring 1998
Confined Aquifer

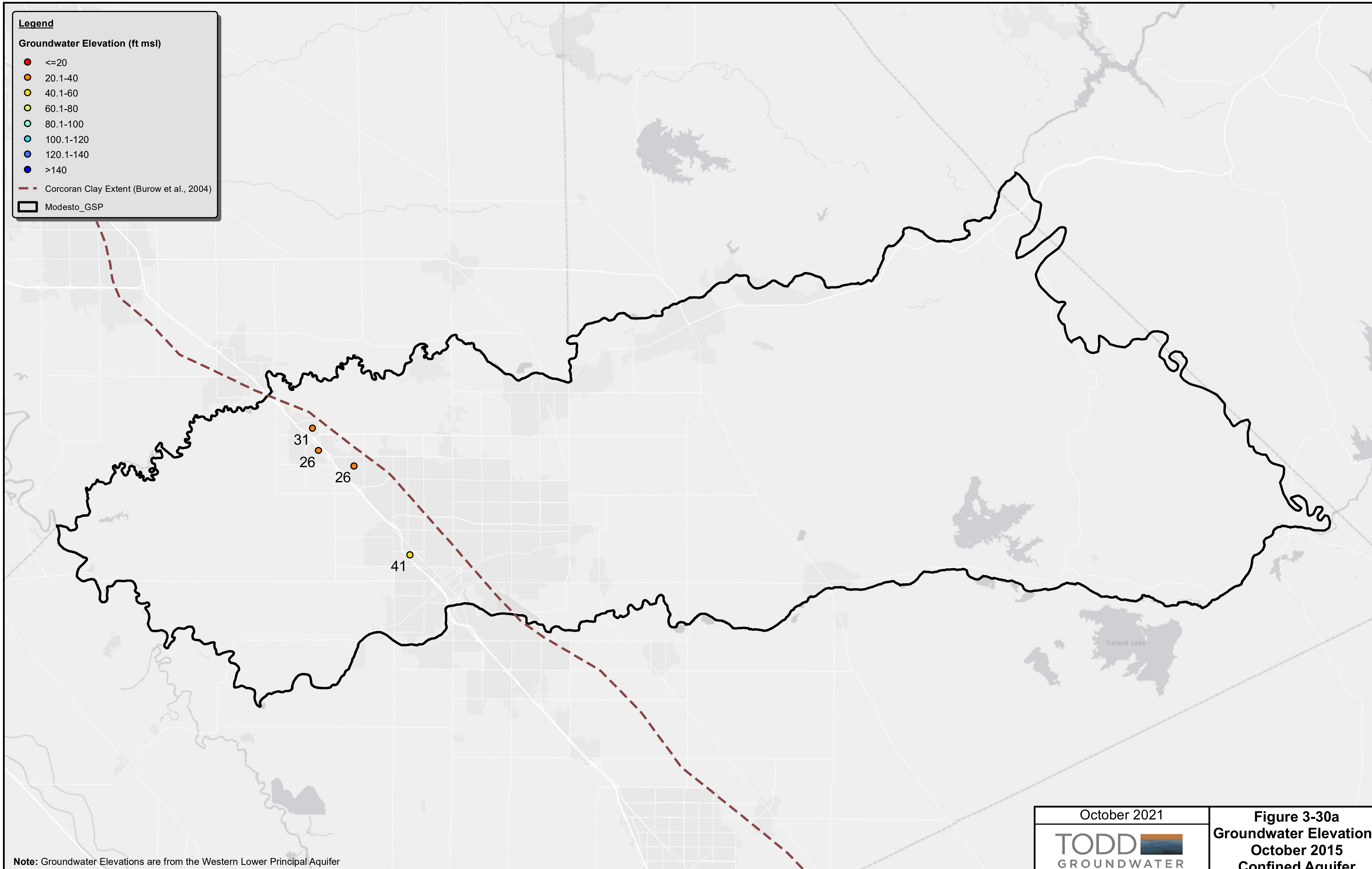
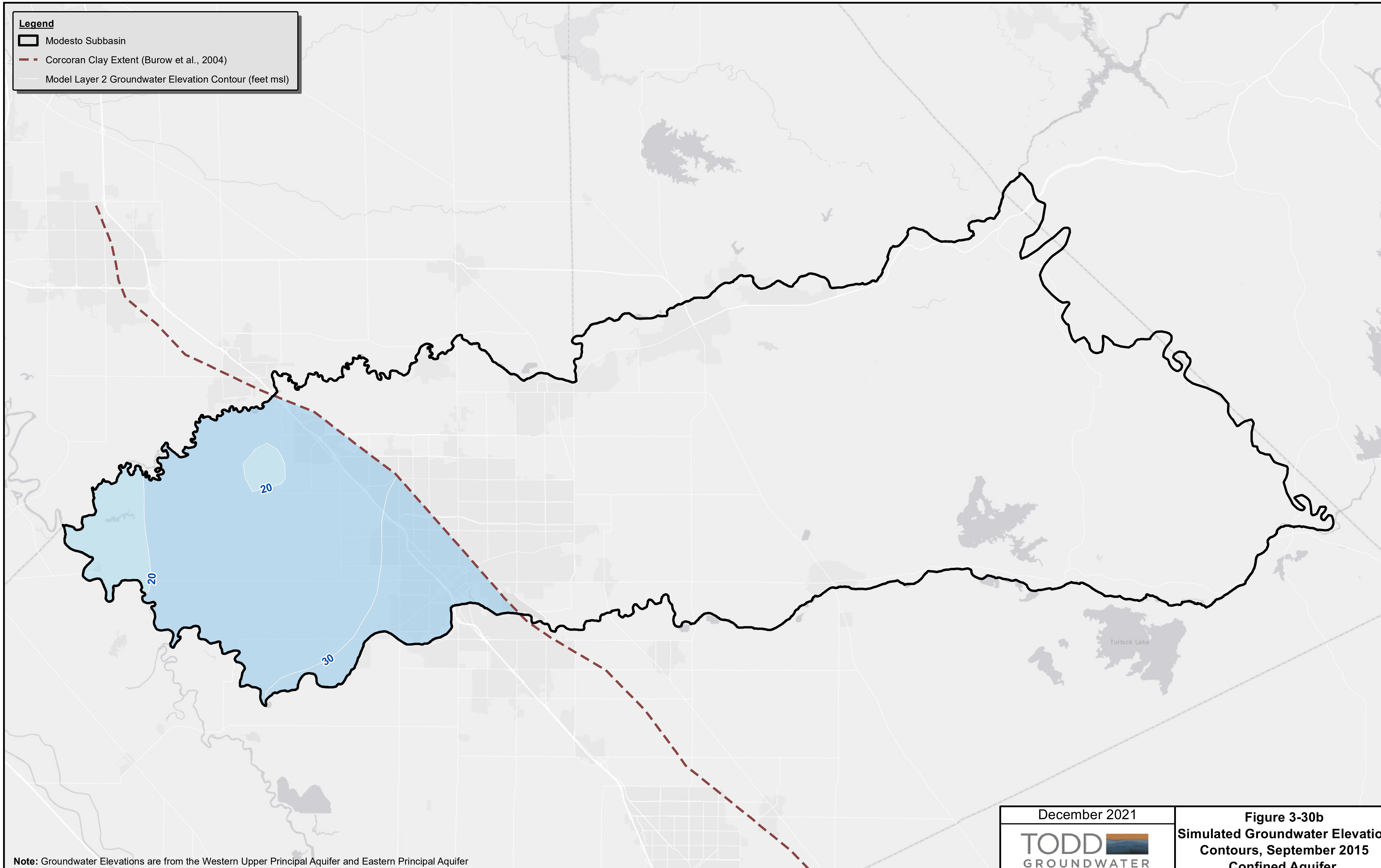


Figure 3-30a
Groundwater Elevations
October 2015
Confined Aquifer



Note: Groundwater Elevations are from the Western Upper Principal Aquifer and Eastern Principal Aquifer

December 2021

TODD GROUNDWATER

Figure 3-30b
Simulated Groundwater Elevation Contours, September 2015
Confined Aquifer

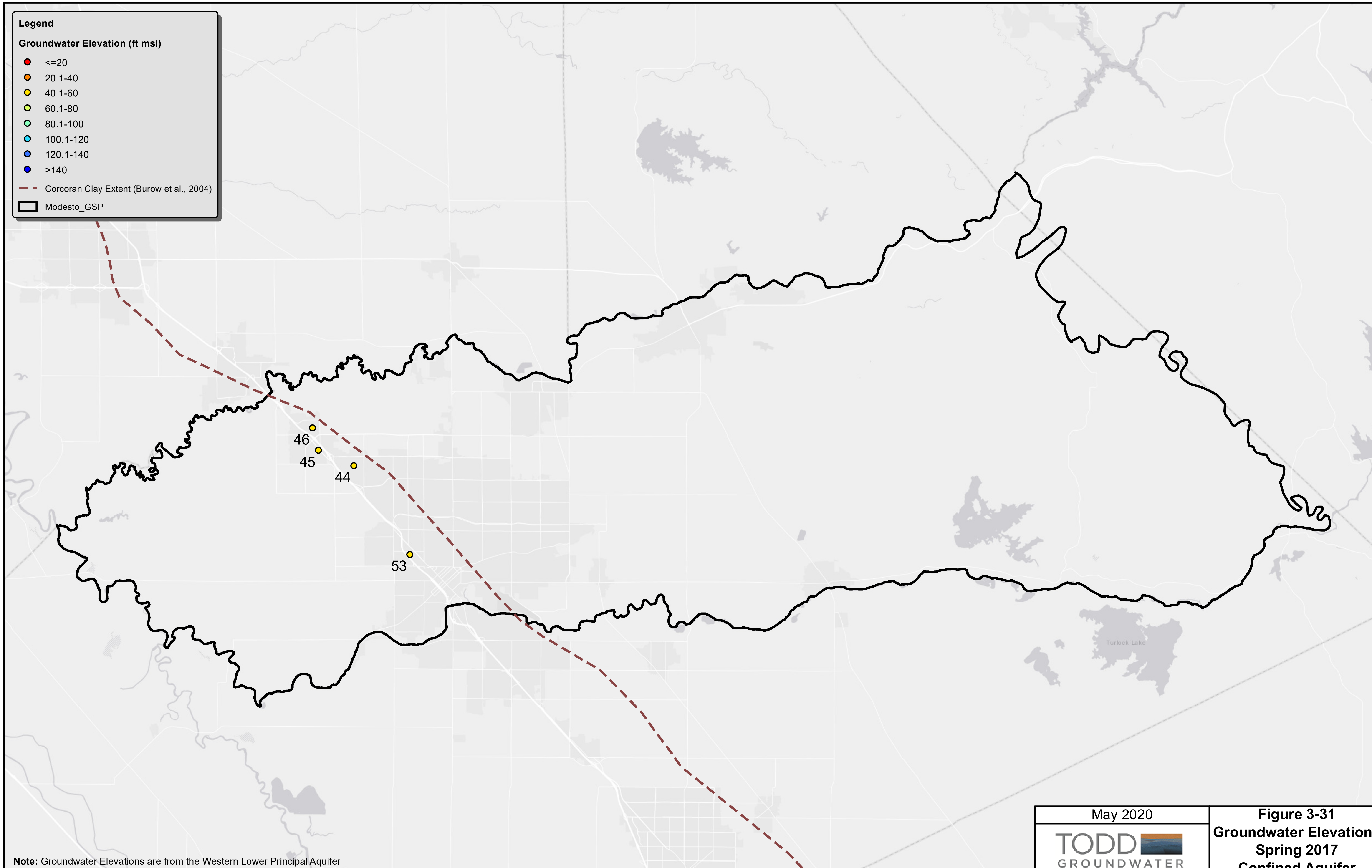


Figure 3-31
Groundwater Elevations Spring 2017 Confined Aquifer

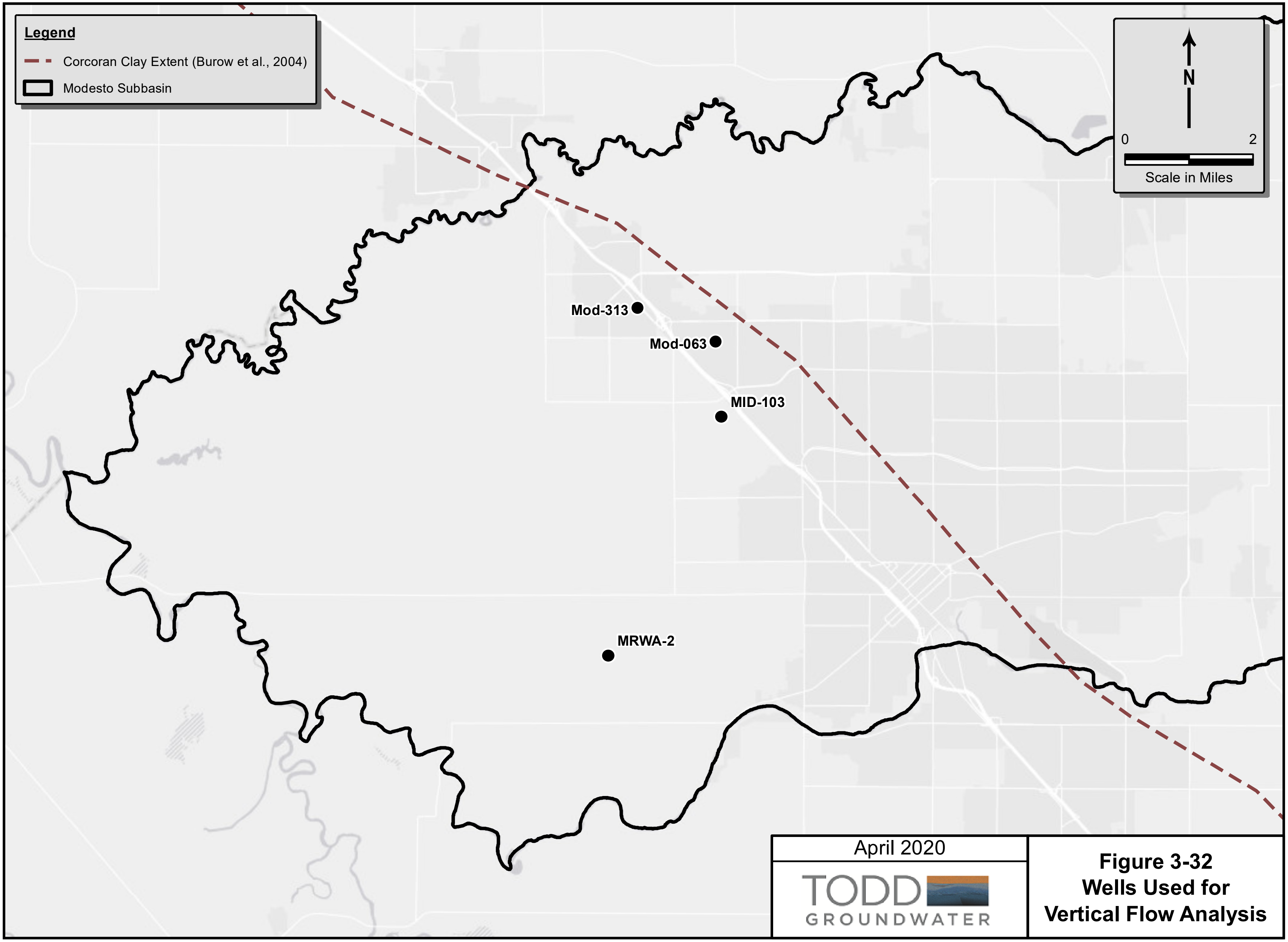
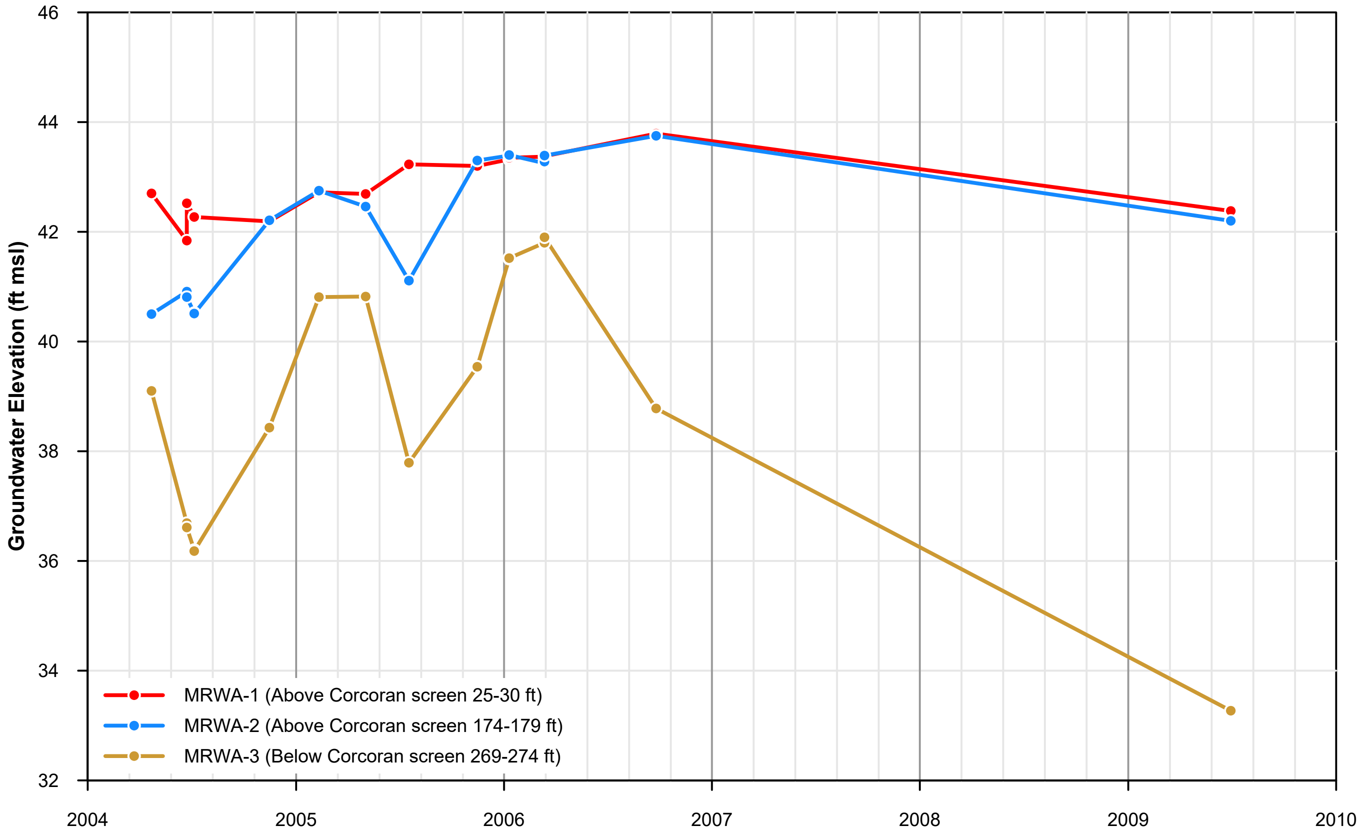


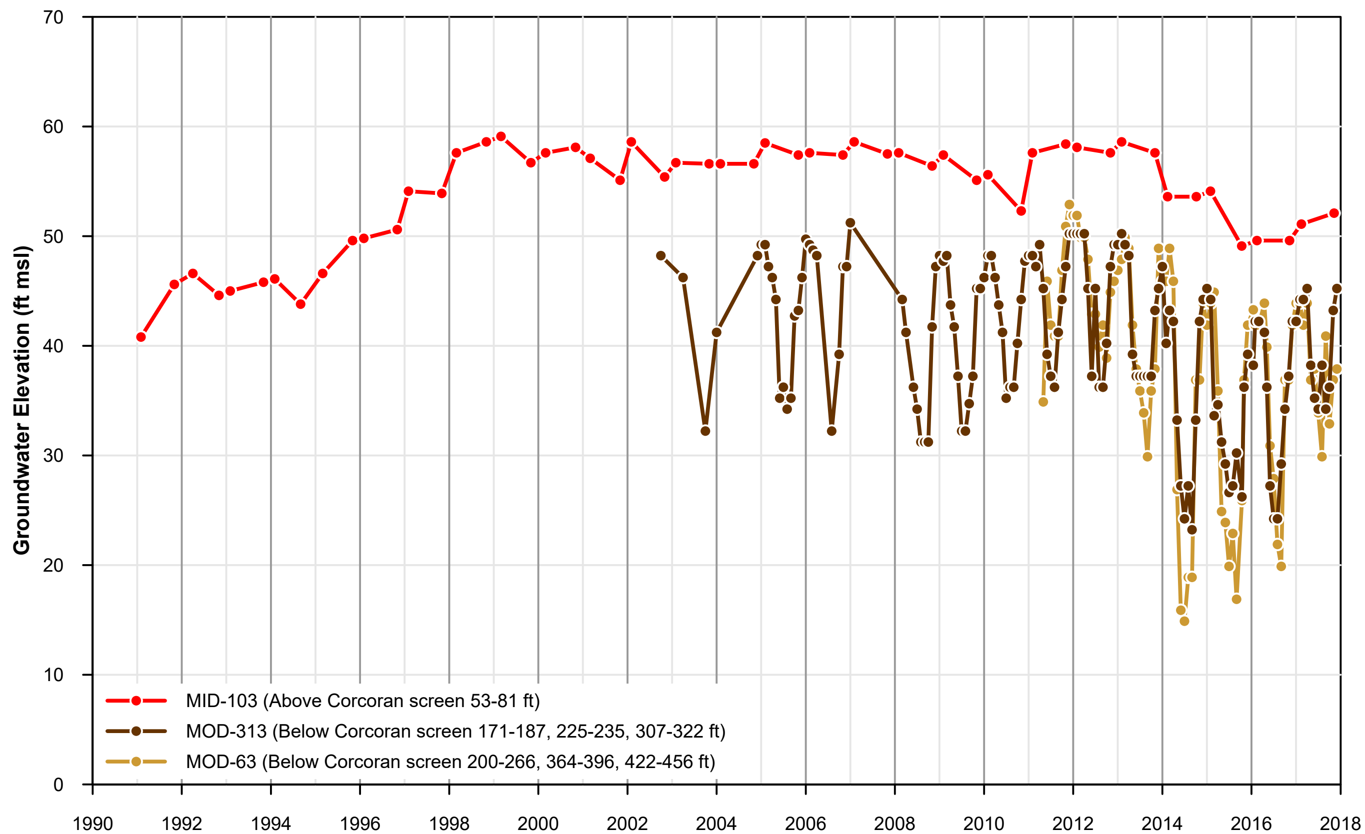
Figure 3-32
Wells Used for Vertical Flow Analysis



April 2020

TODD GROUNDWATER

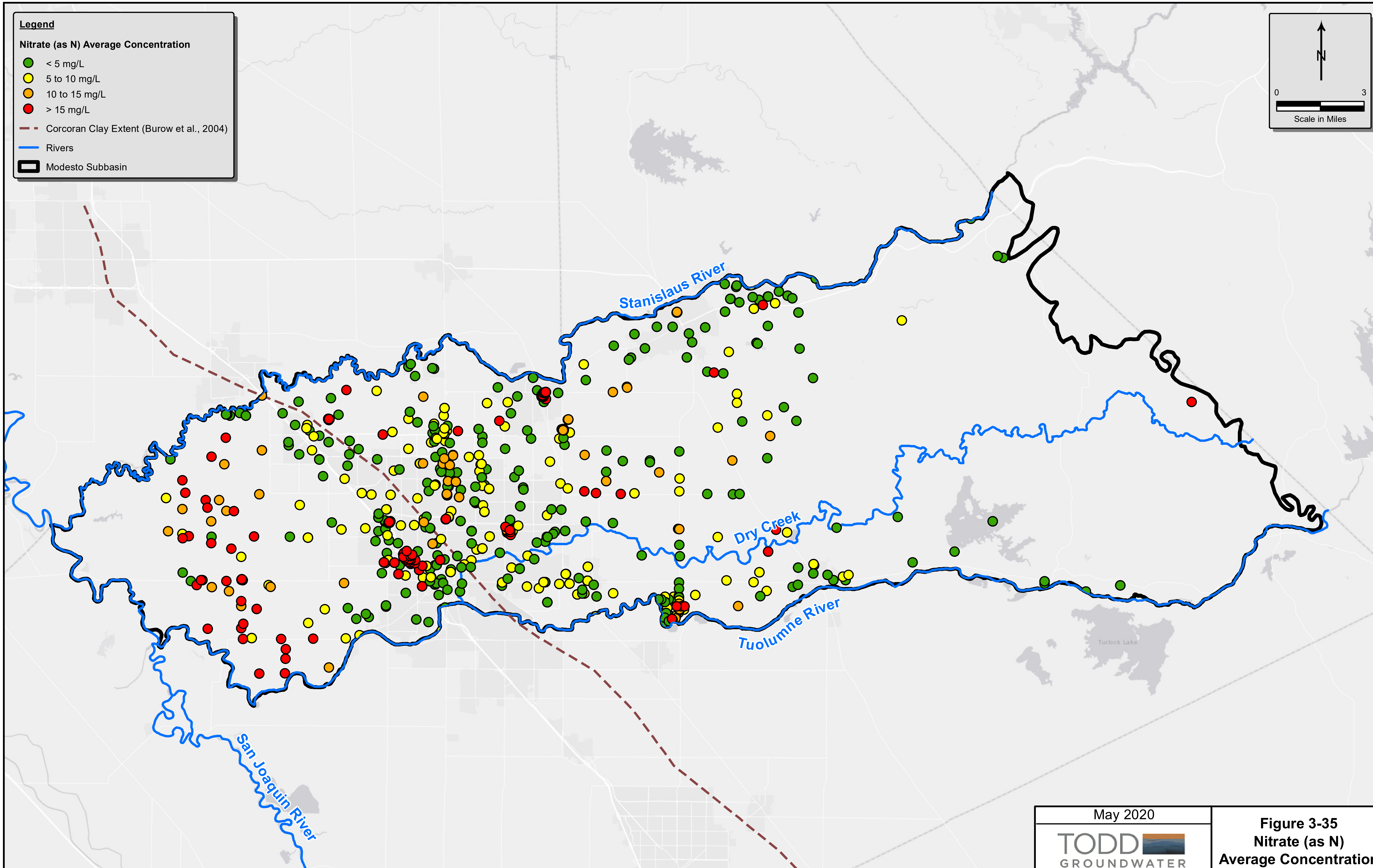
Figure 3-33
Vertical Flow Hydrographs, USGS Well Cluster



April 2020

TODD GROUNDWATER

Figure 3-34
Vertical Flow Hydrographs, MID and City of Modesto Wells



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TODD GROUNDWATER

Figure 3-35
Nitrate (as N)
Average Concentration

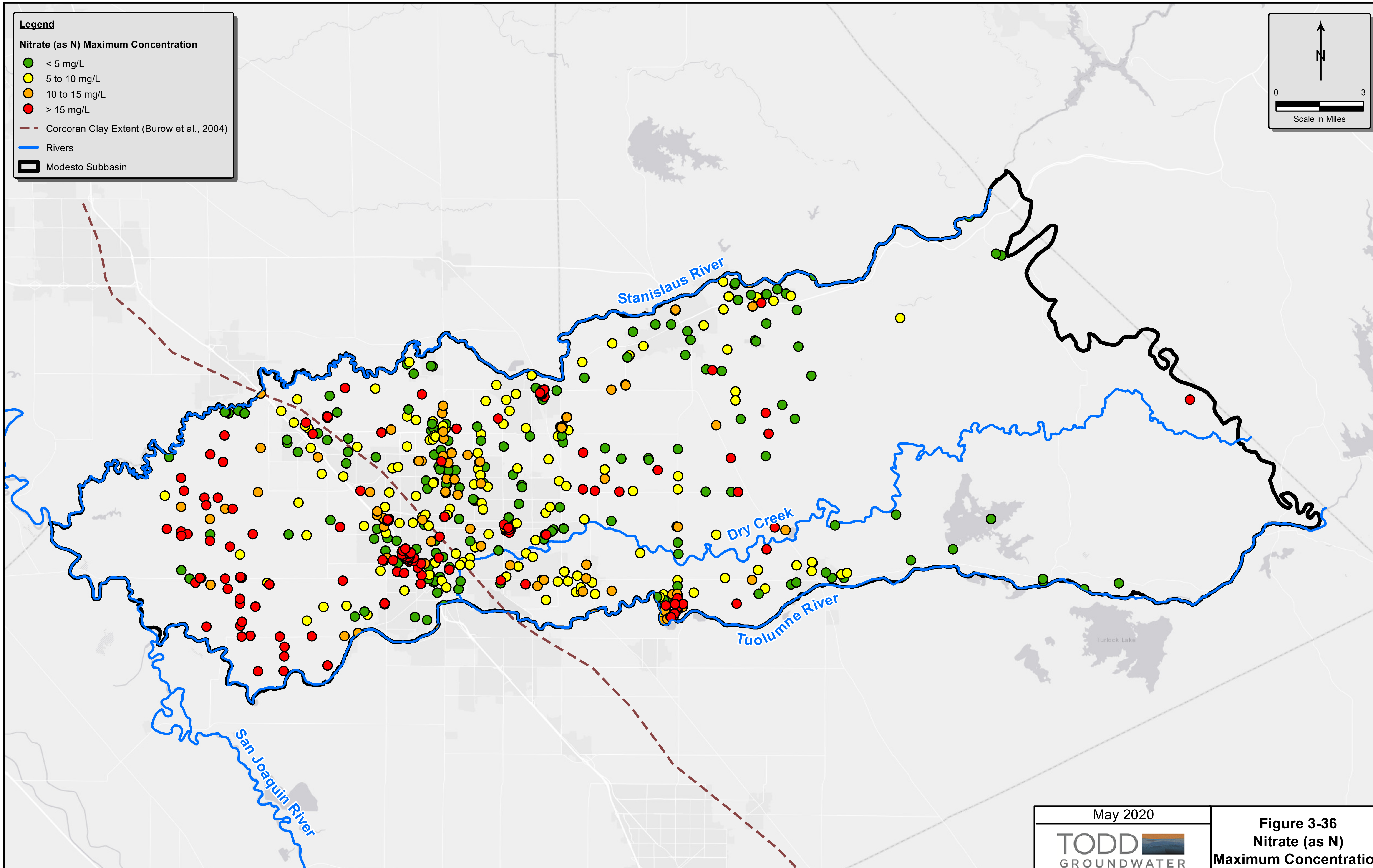
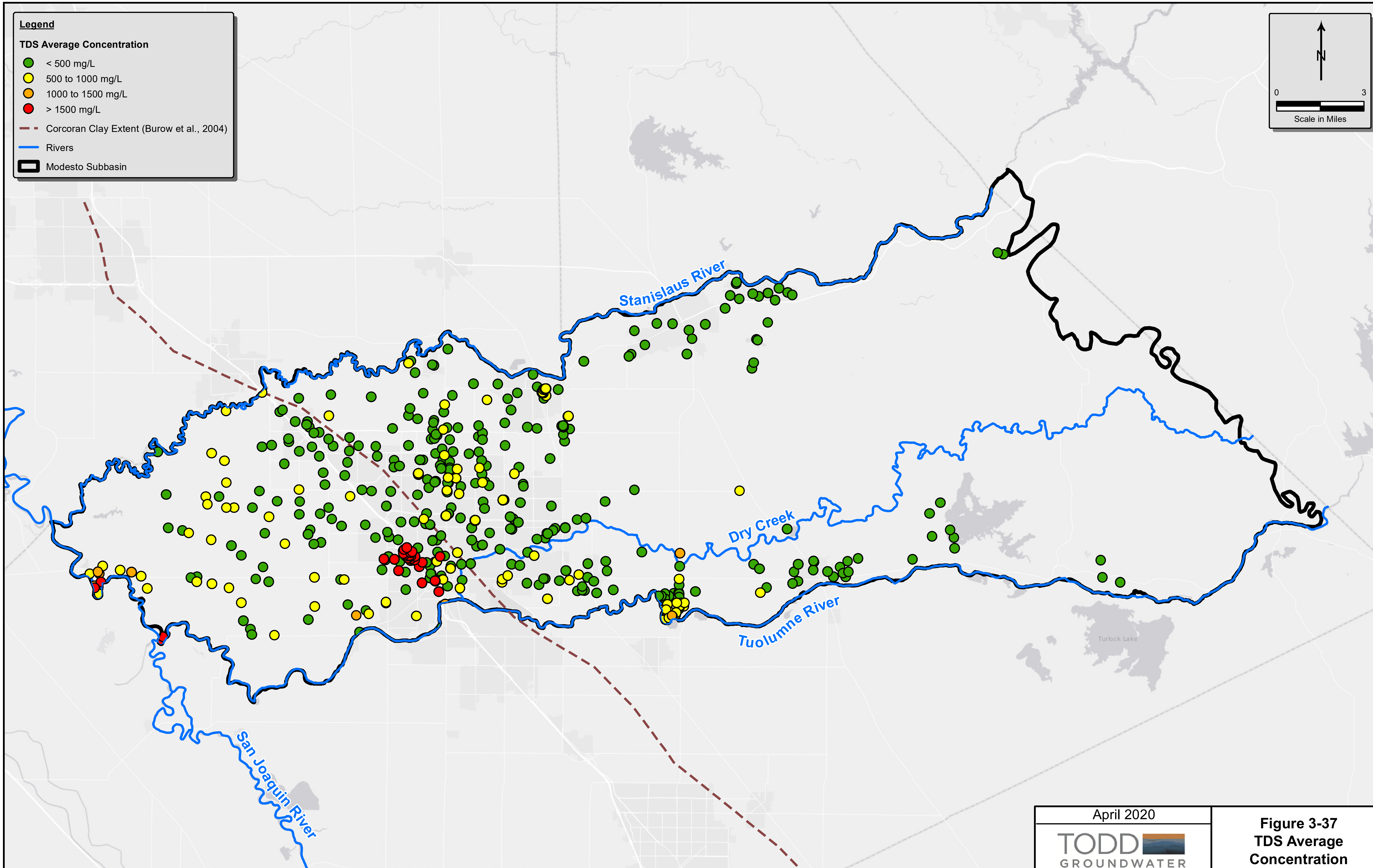


Figure 3-36
Nitrate (as N)
Maximum Concentration



April 2020

TODD GROUNDWATER

Figure 3-37
TDS Average Concentration

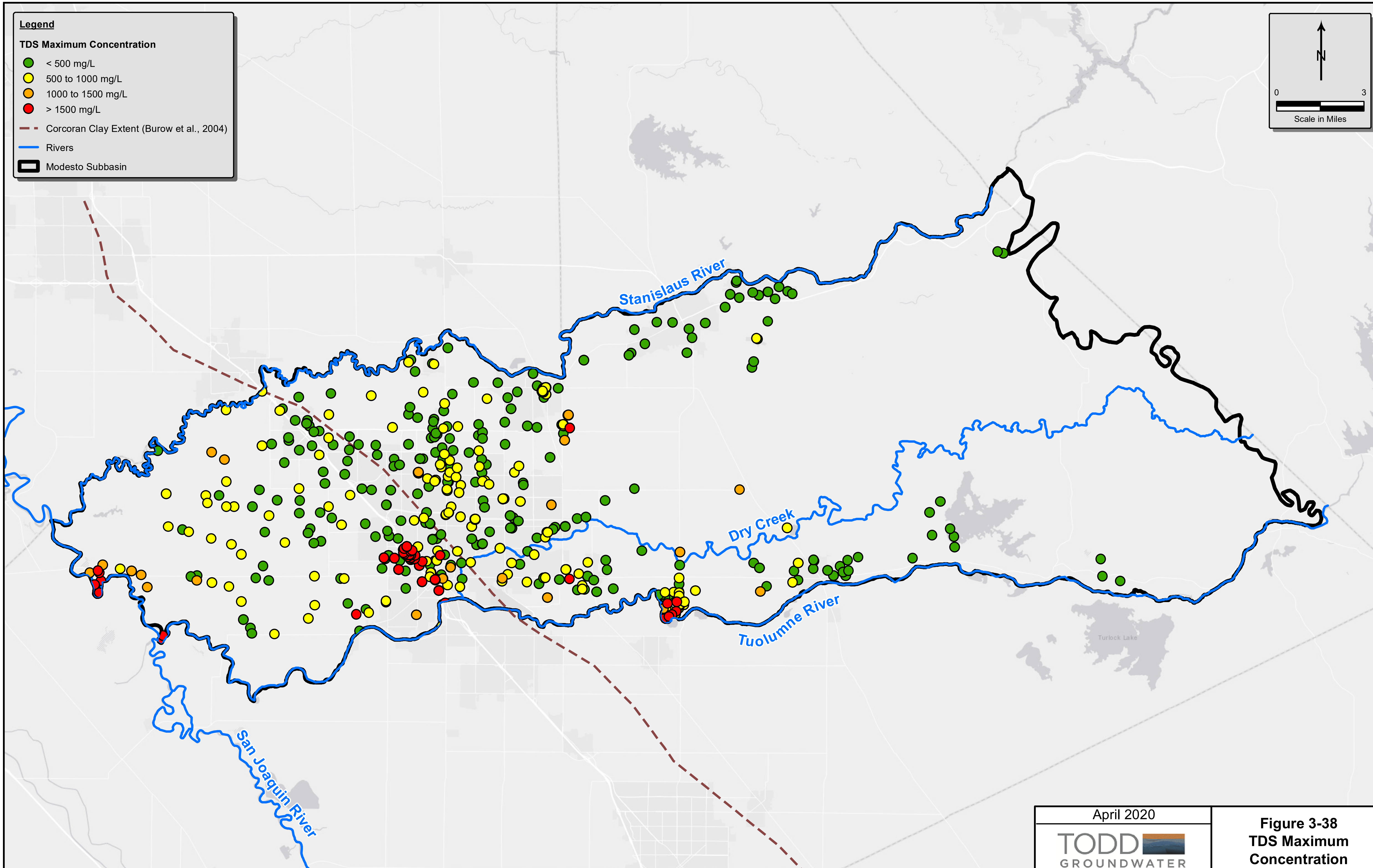


Figure 3-38
TDS Maximum Concentration

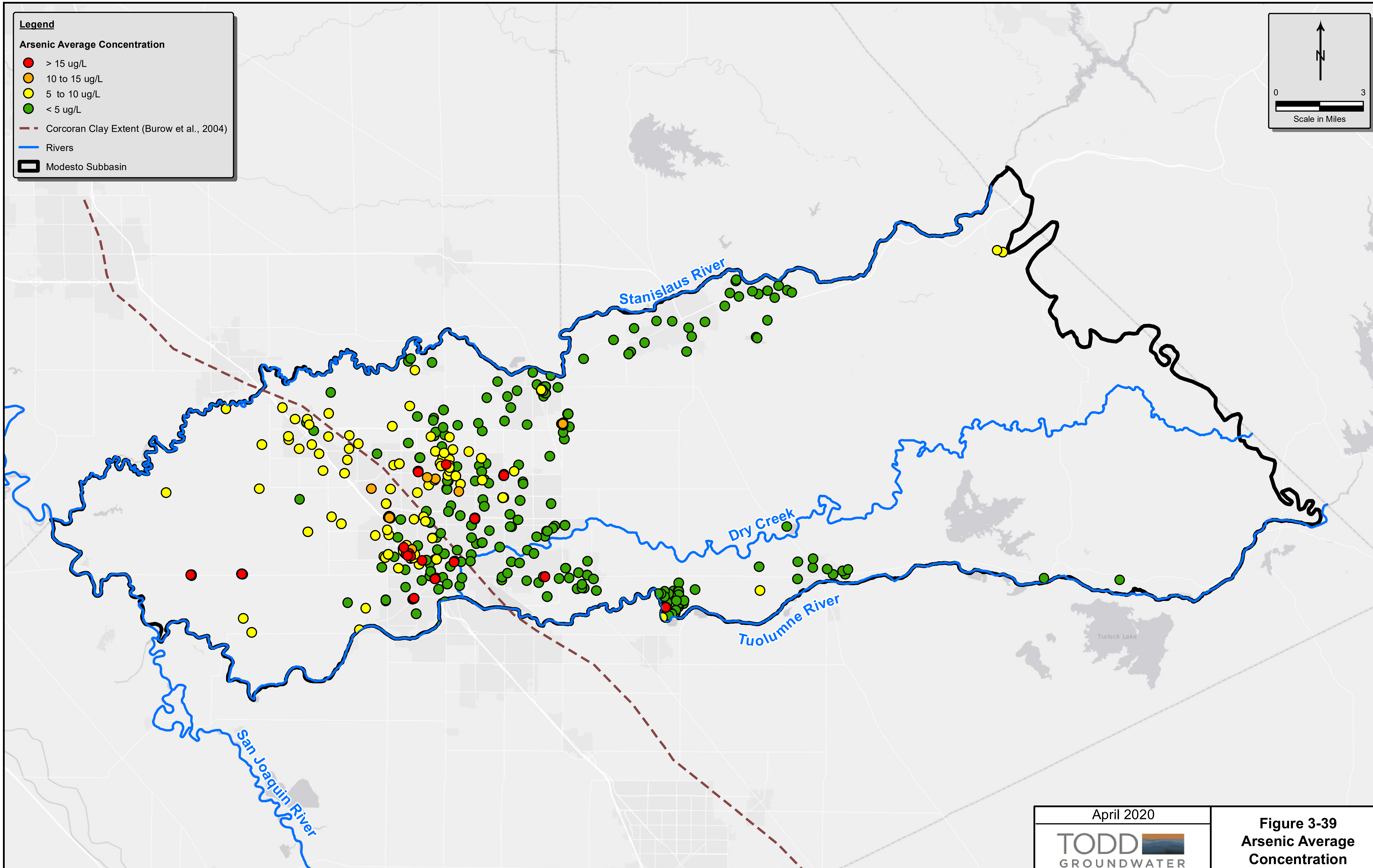


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Figure 3-39 Arsenic Average Concentration

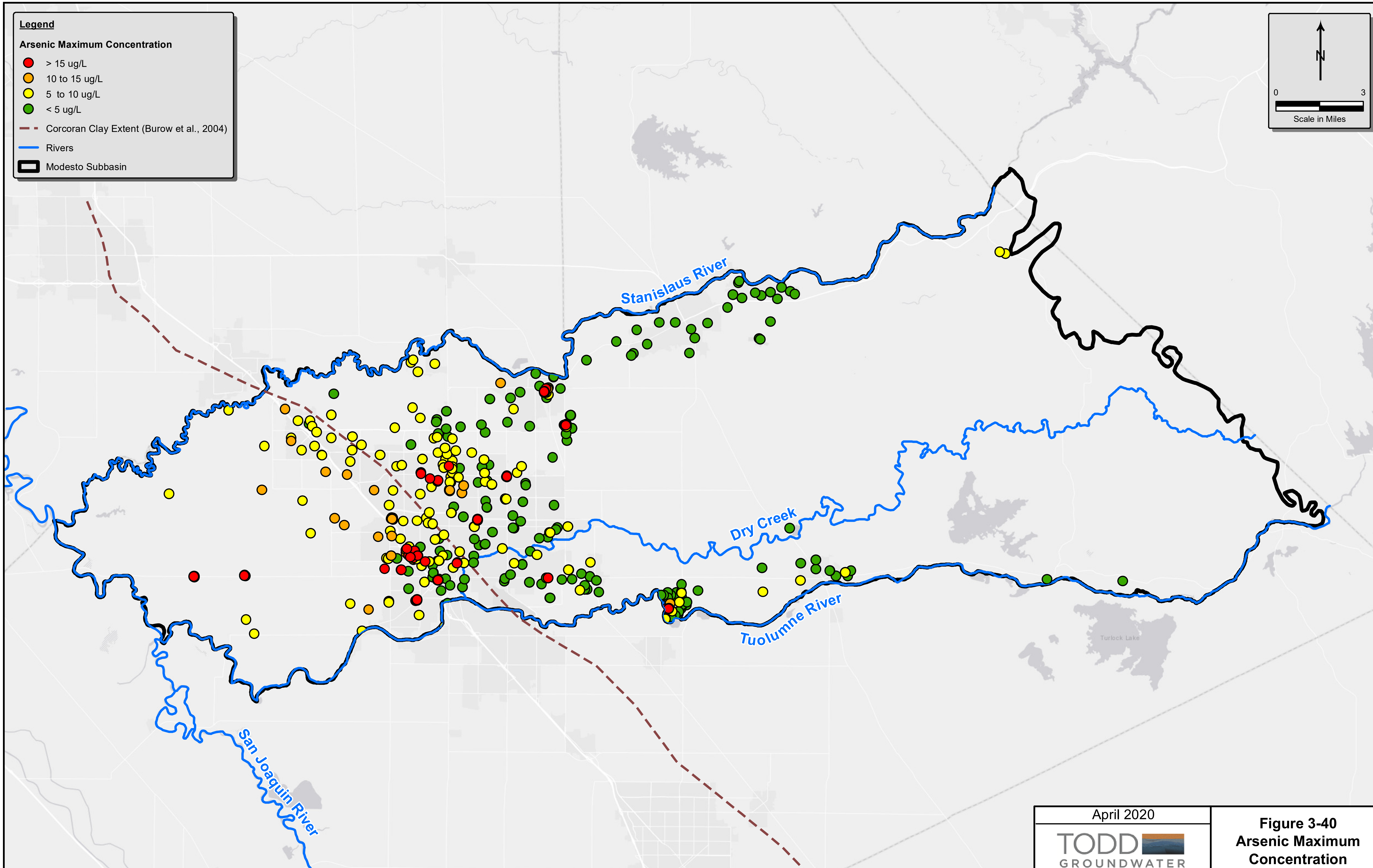


Figure 3-40
Arsenic Maximum Concentration

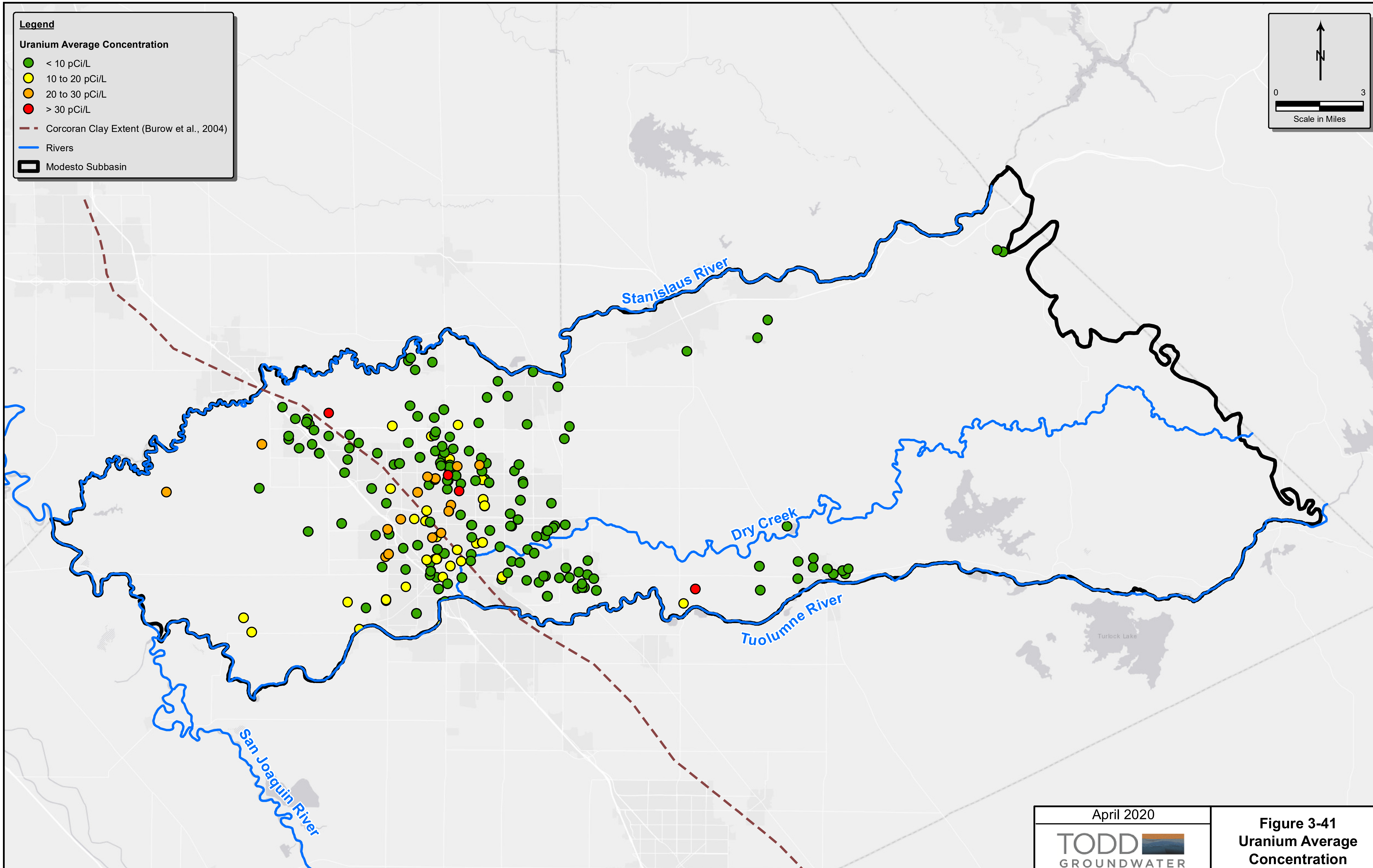


Figure 3-41
Uranium Average Concentration

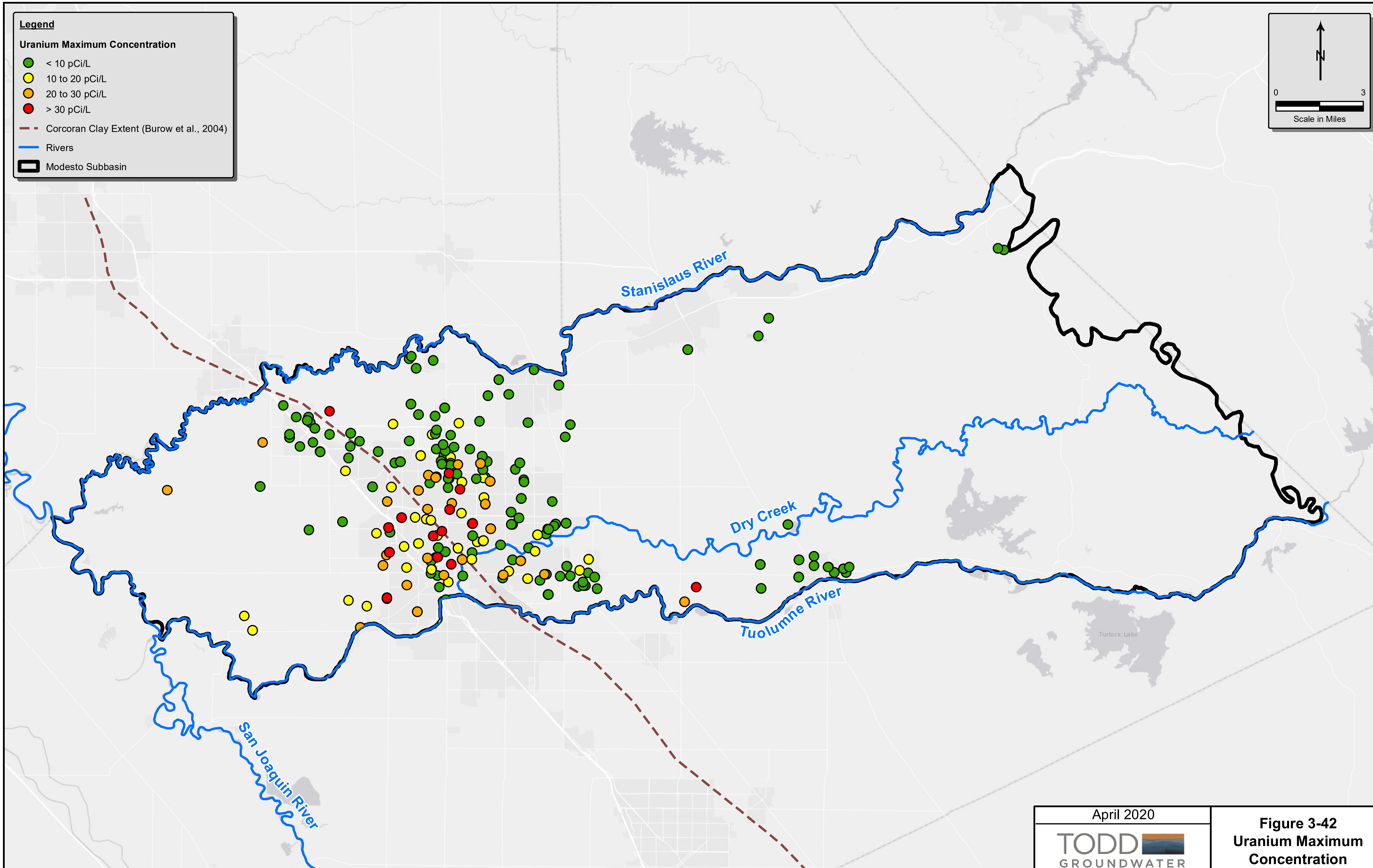


Figure 3-42
Uranium Maximum Concentration

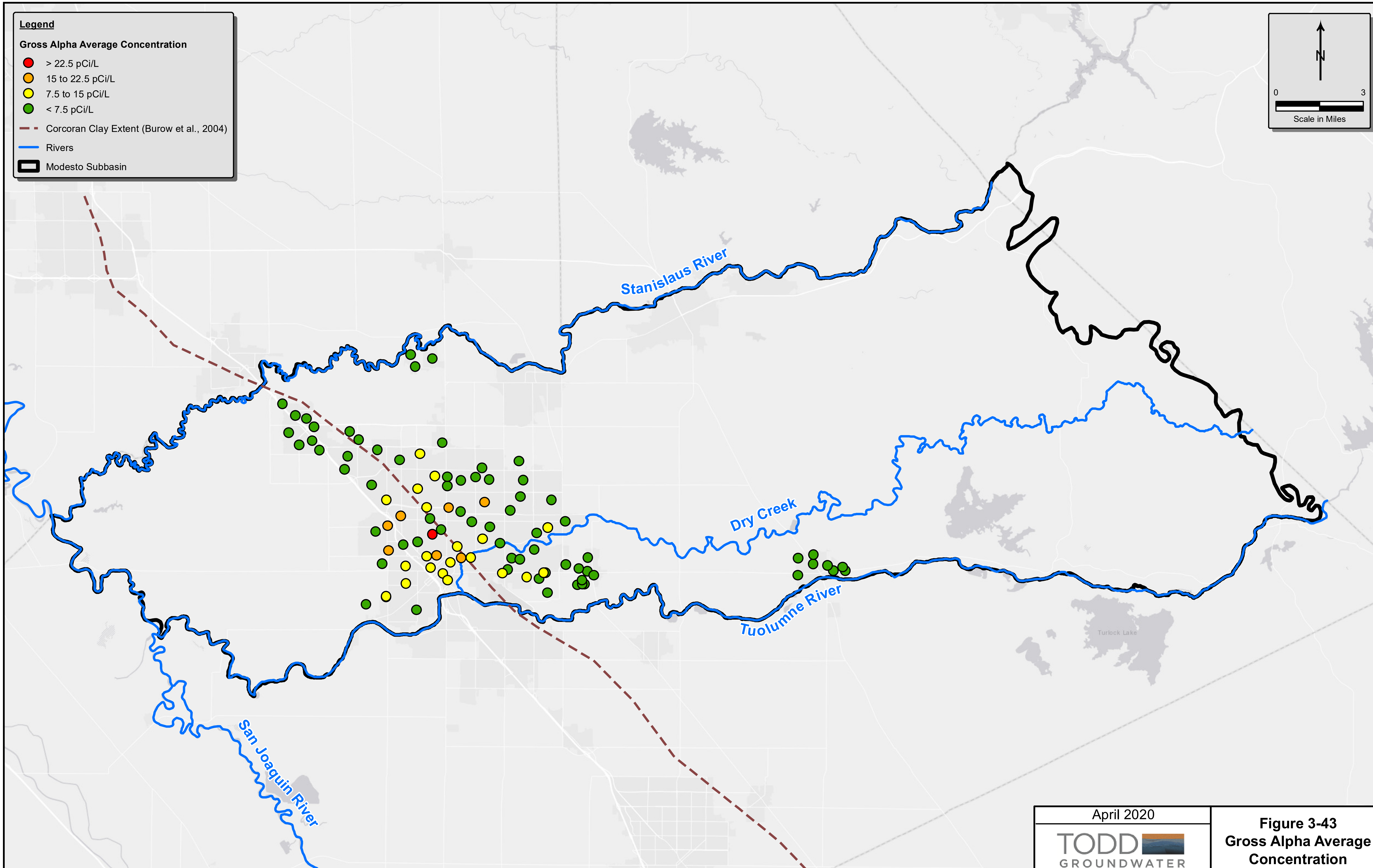
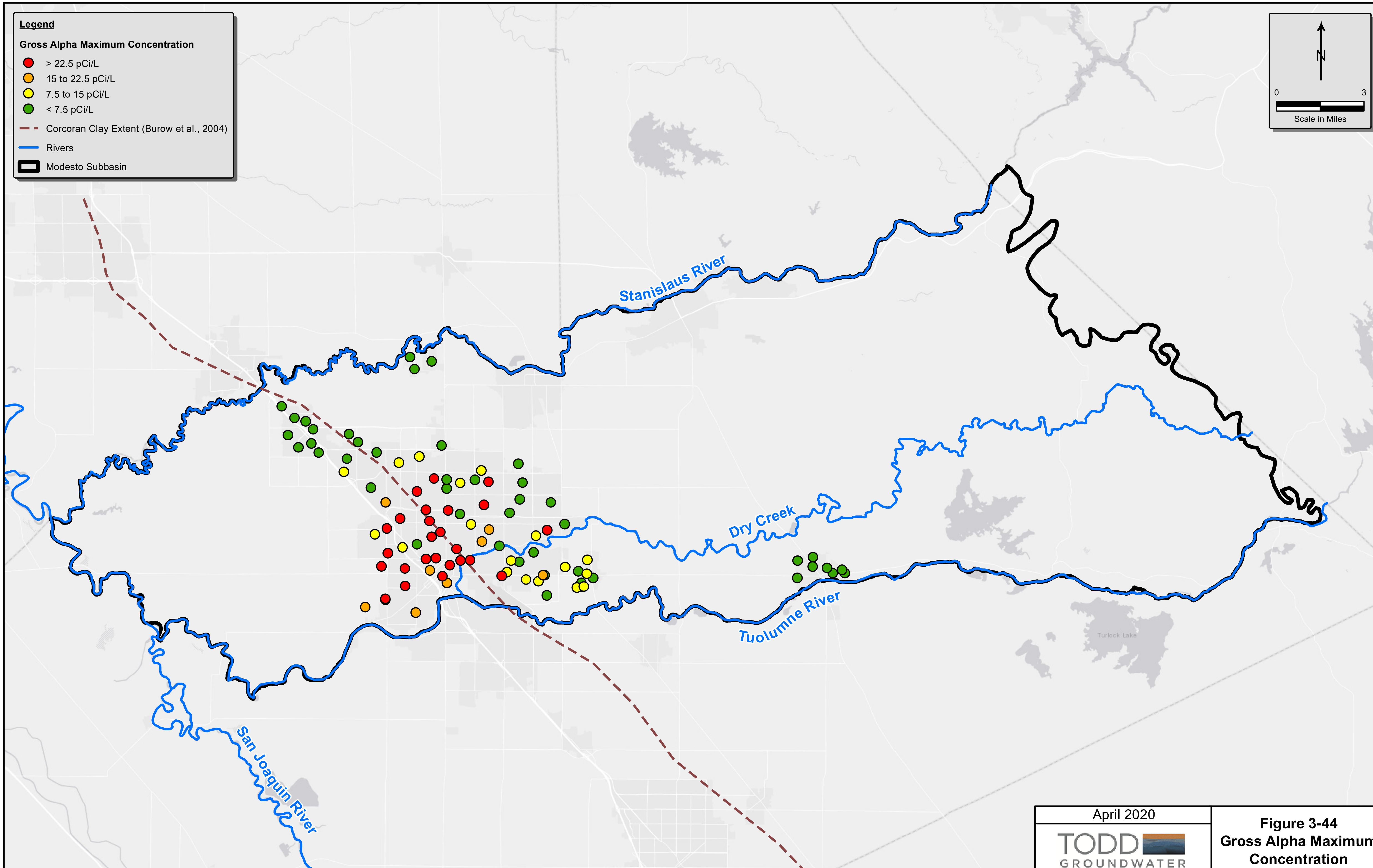


Figure 3-43
Gross Alpha Average Concentration



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TODD GROUNDWATER

Figure 3-44
Gross Alpha Maximum Concentration

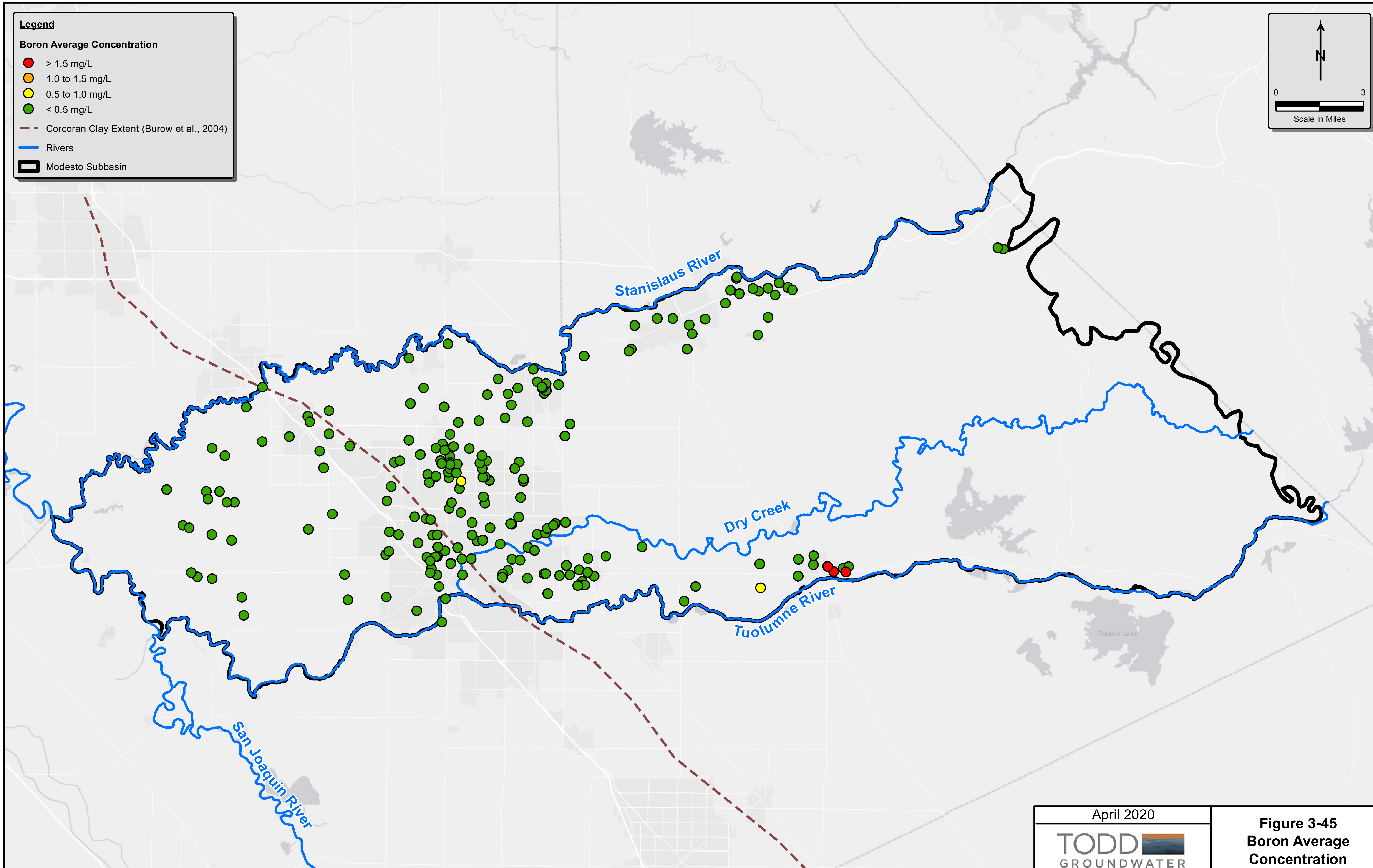


Figure 3-45 Boron Average Concentration

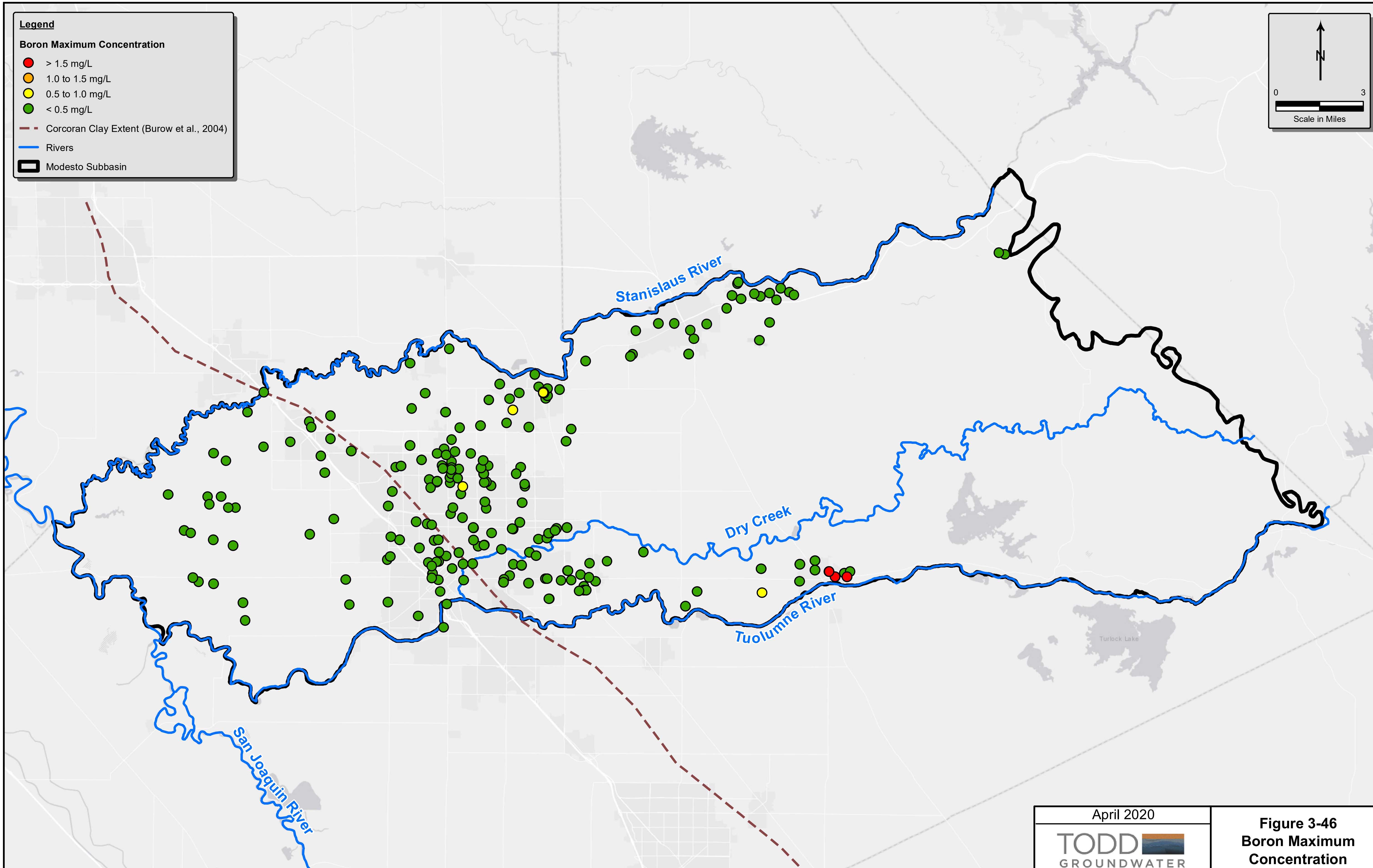
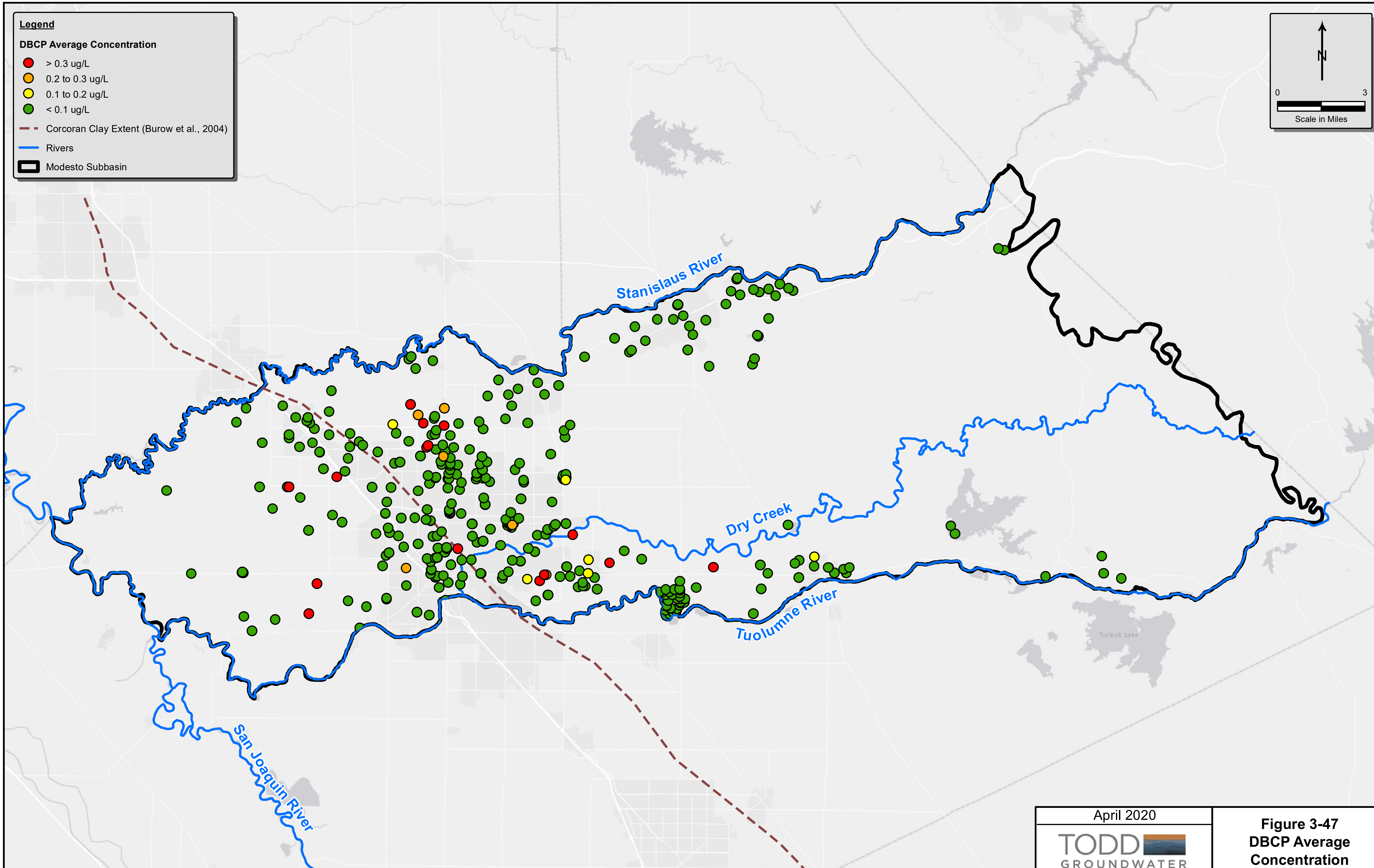


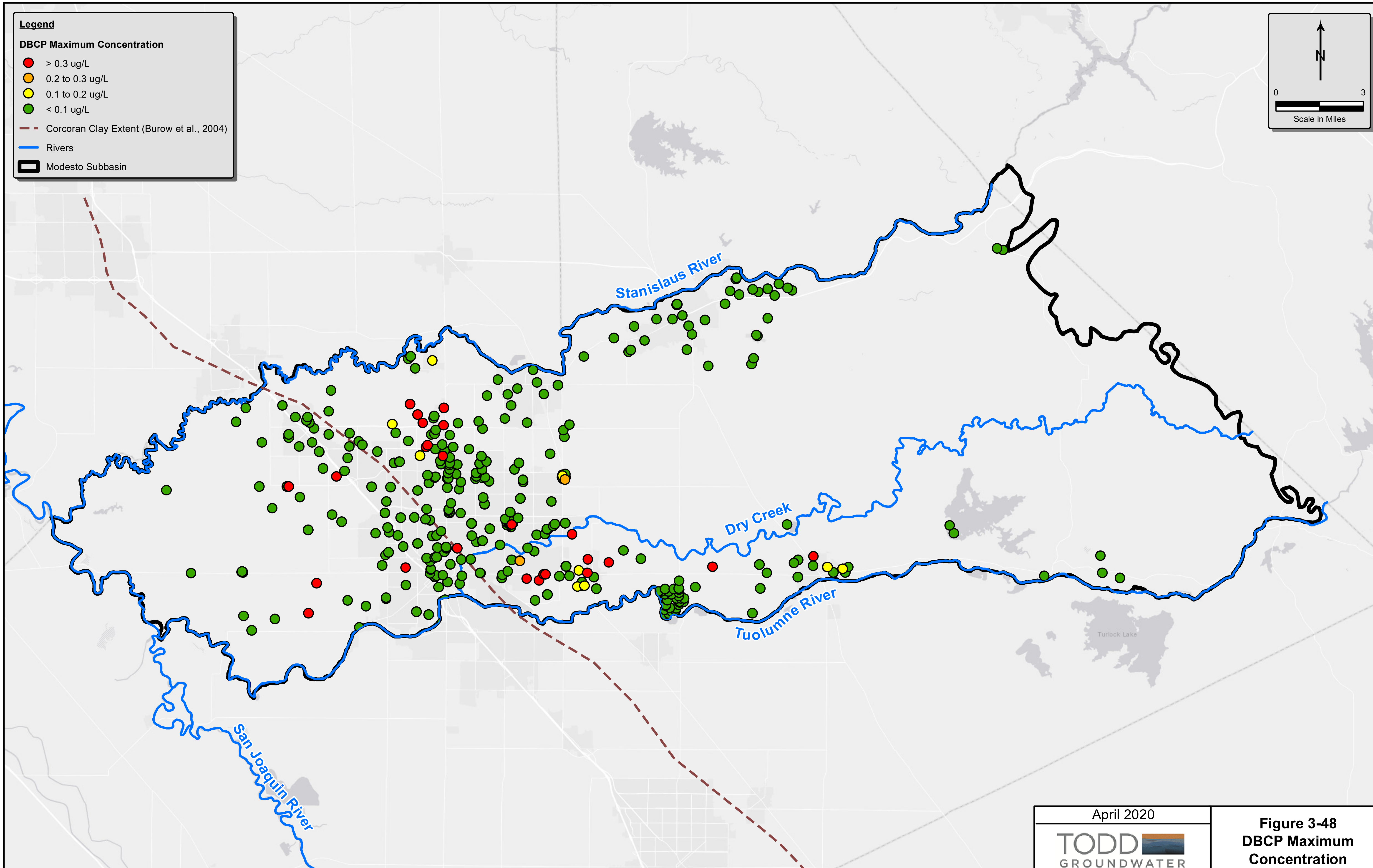
Figure 3-46
Boron Maximum Concentration



April 2020

TODD GROUNDWATER

Figure 3-47
DBCP Average Concentration



April 2020

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Figure 3-48
DBCP Maximum Concentration

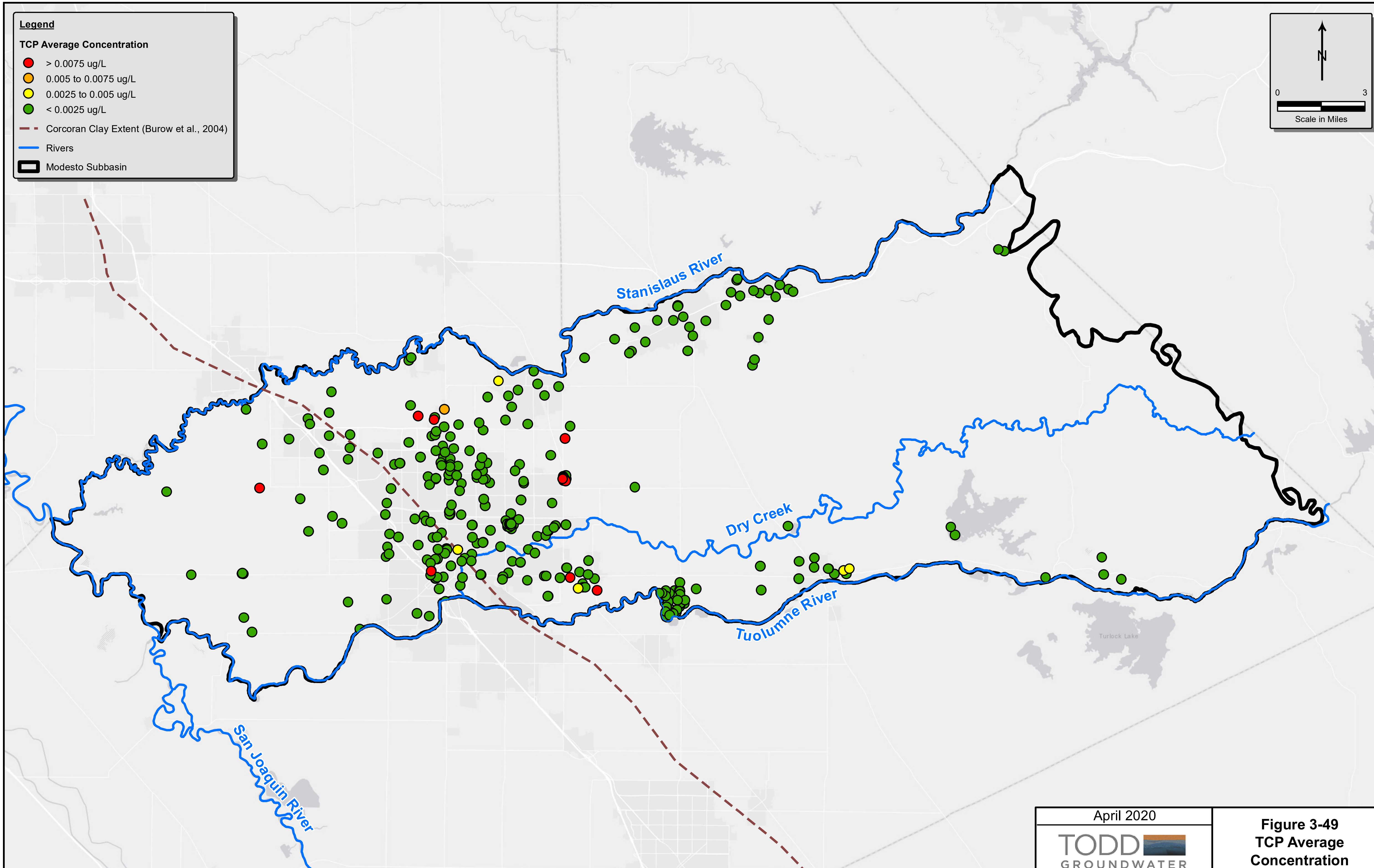

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Figure 3-49
TCP Average Concentration

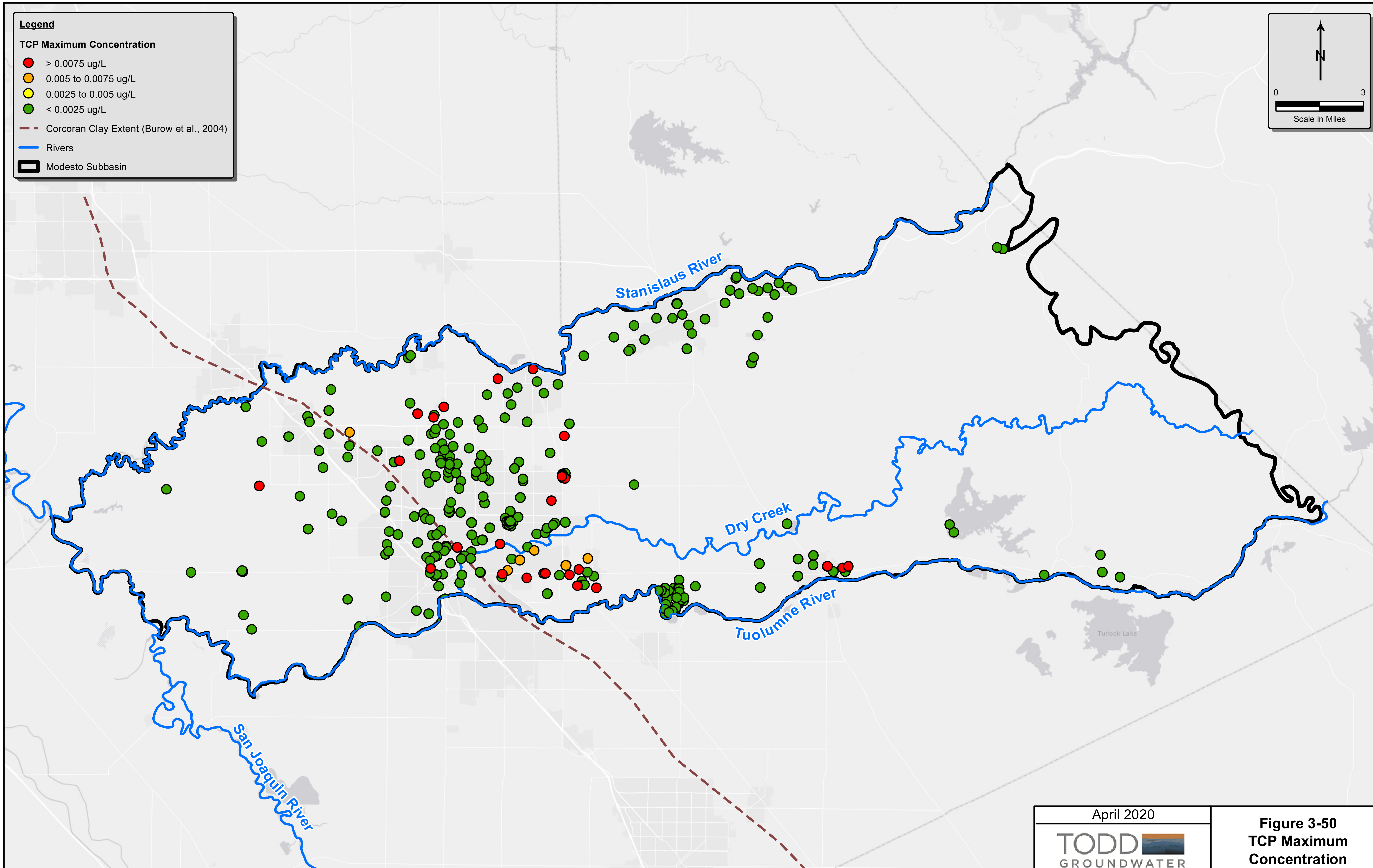

Figure 3-50
TCP Maximum Concentration

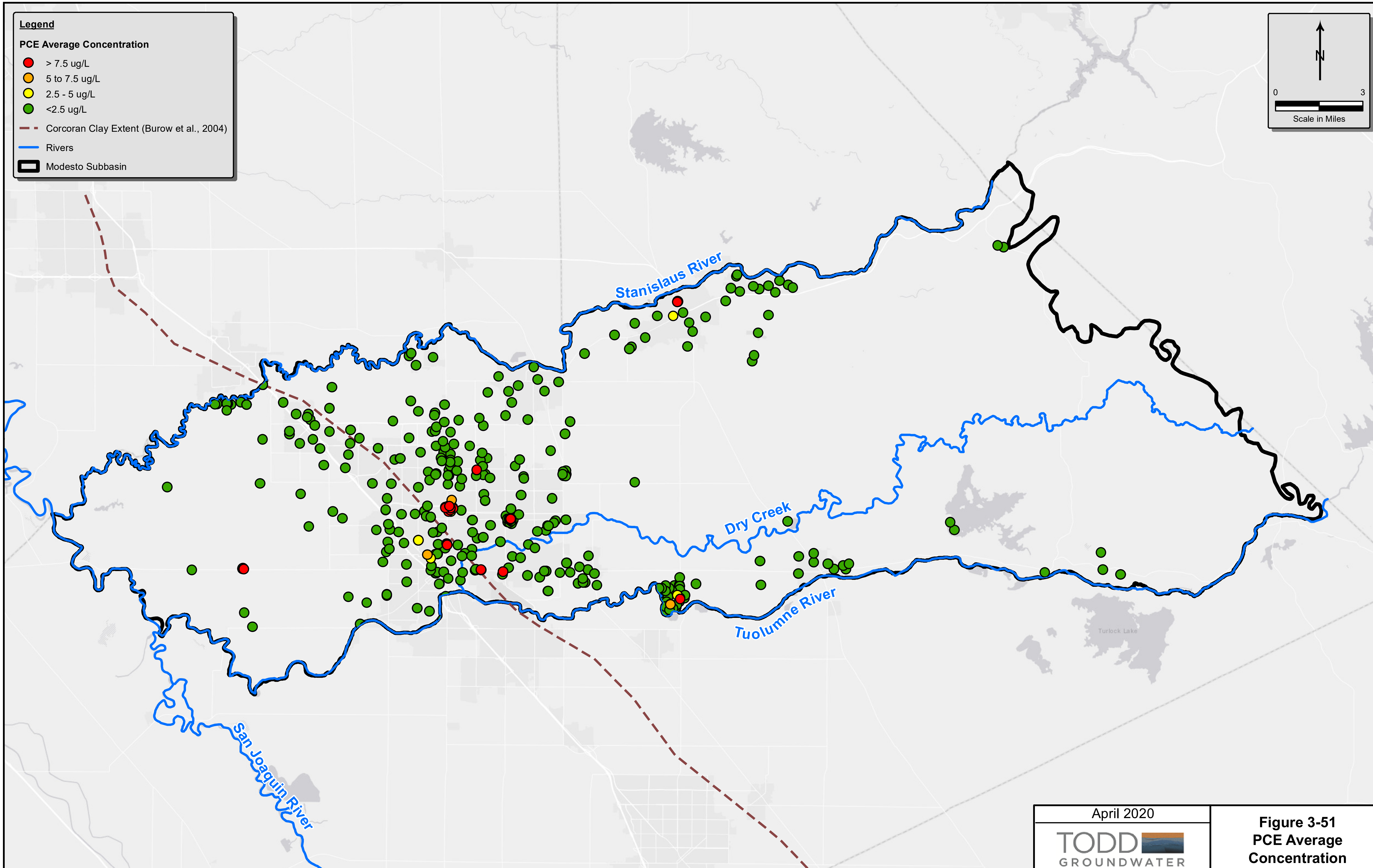

Figure 3-51
PCE Average Concentration

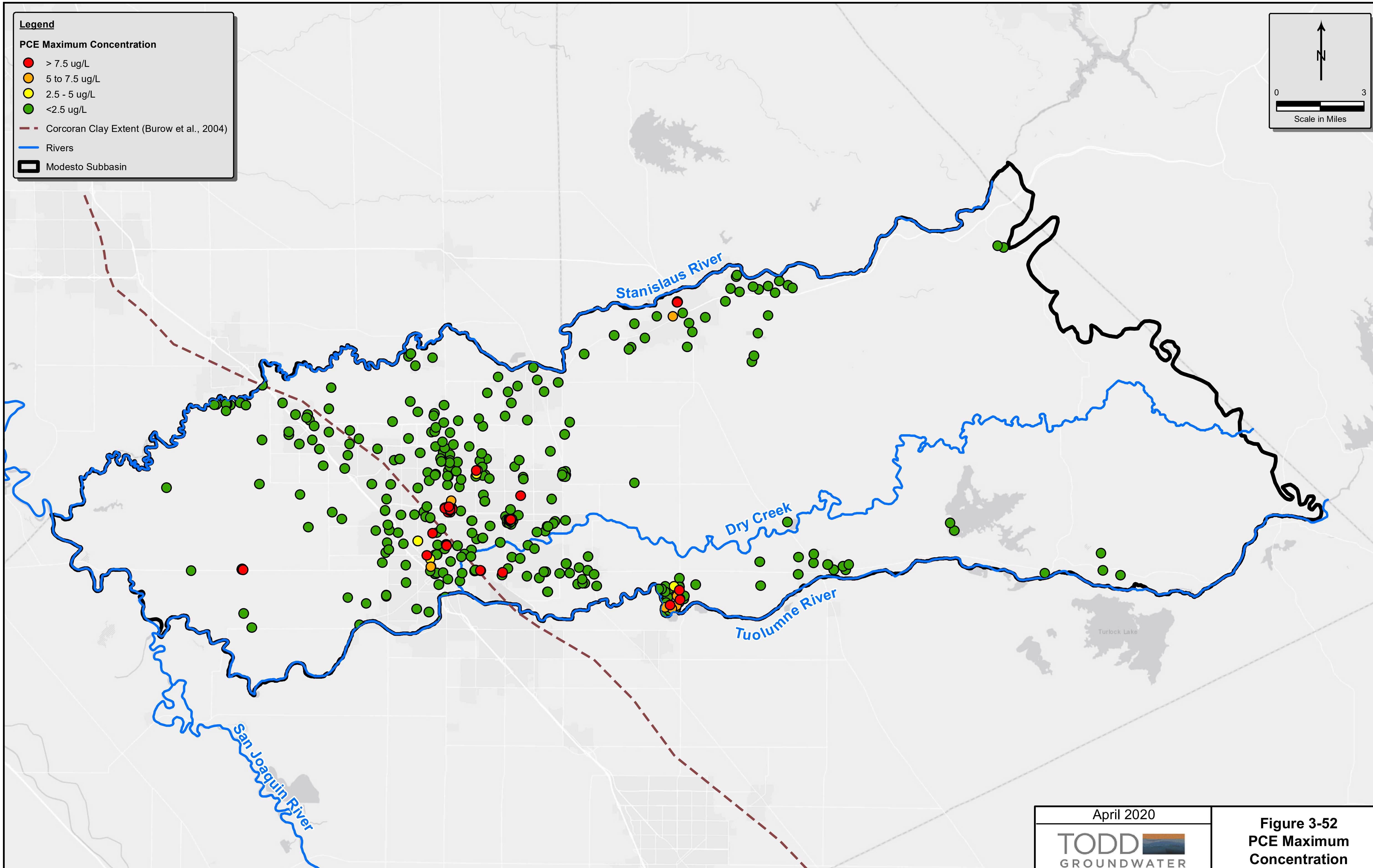

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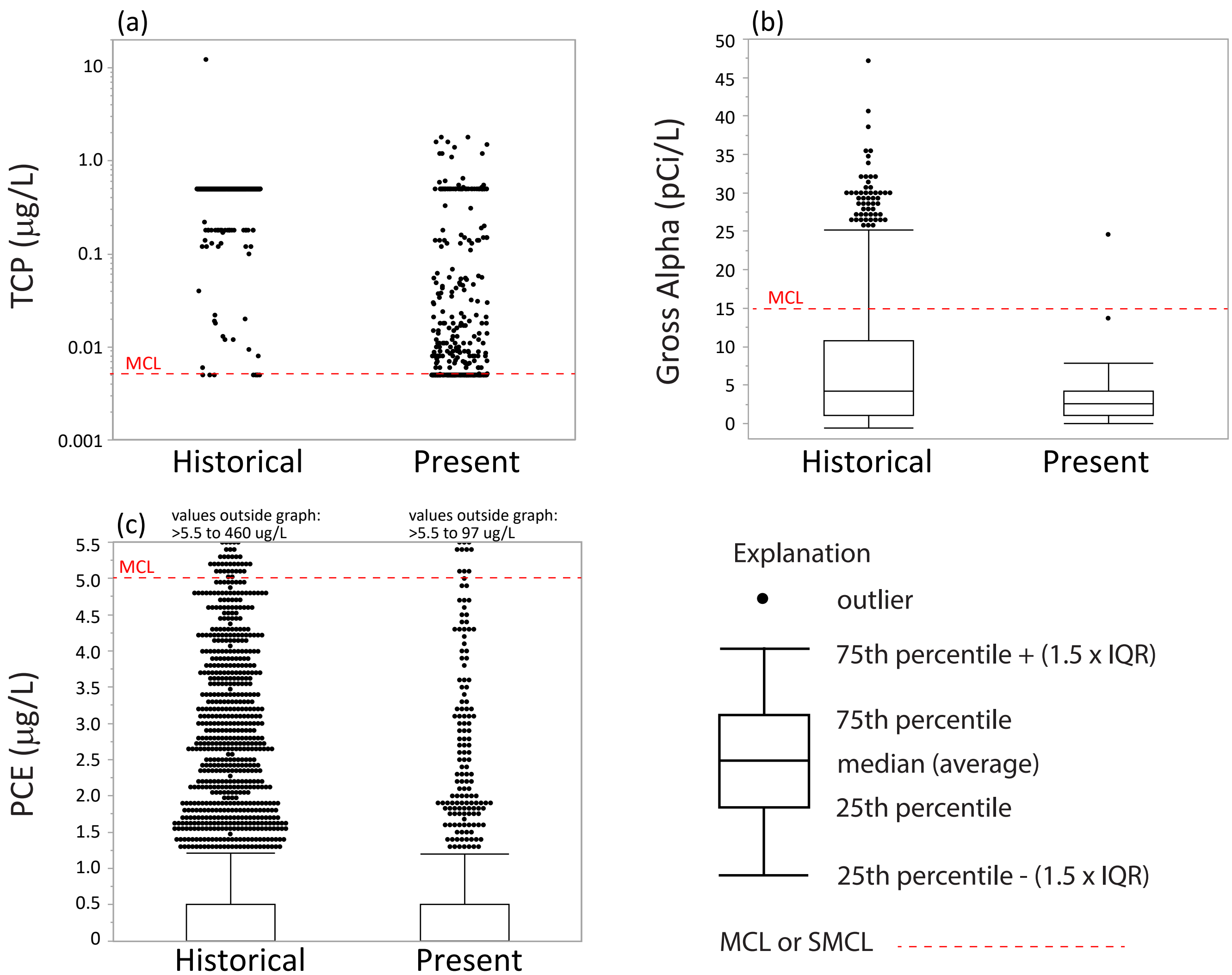
Figure 3-52
PCE Maximum Concentration



Note:
Concentrations of (a) TCP, (b) Gross Alpha, and (c) PCE under historical (water year 1995 to 2014) and present (2015 to 2019) periods, as compared to their respective Maximum Contaminant Level (MCL) or Secondary Maximum Contaminant Level (SMCL).

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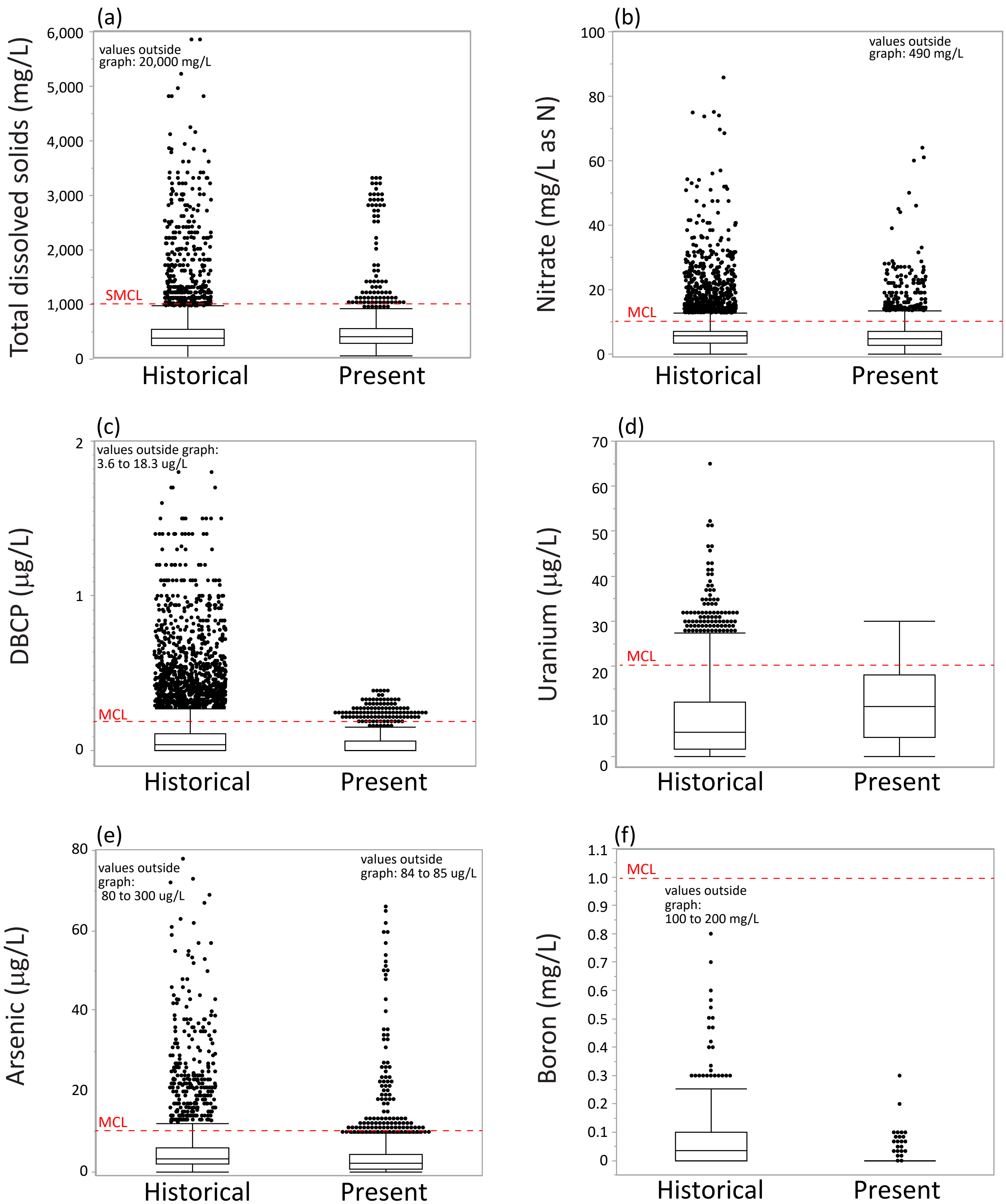
Figure 3-53
Box Plots (1 of 2)



Note:
Concentrations of (a) total dissolved solids, (b) nitrate (as N), (c) DBCP, (d) uranium, (e) arsenic, and (f) boron under historical (water year 1995 to 2014) and present (2015 to 2019) periods, as compared to their respective Maximum Contaminant Level (MCL) or Secondary Maximum Contaminant Level (SMCL).

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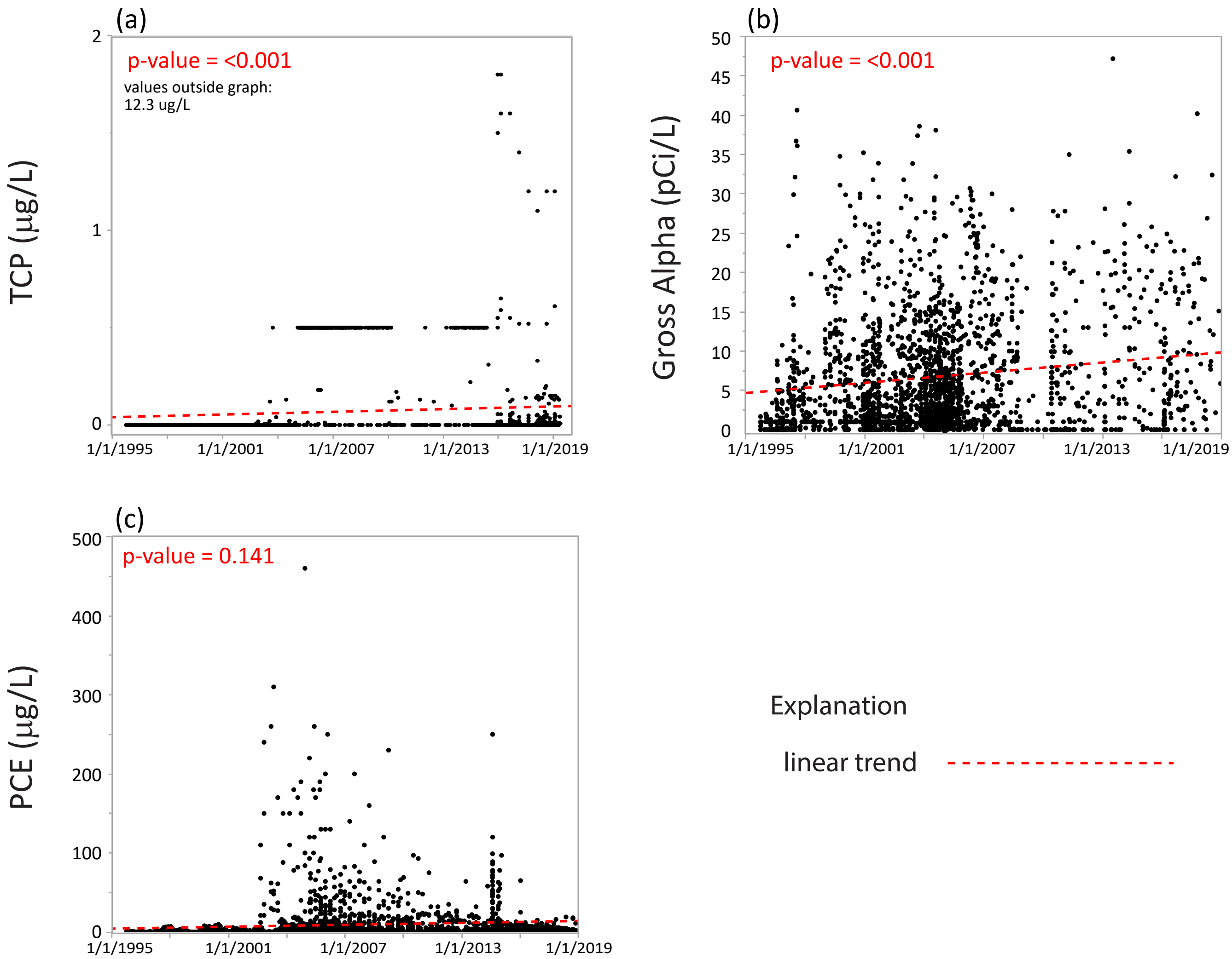
TODD GROUNDWATER

Figure 3-54
Box Plots (2 of 2)

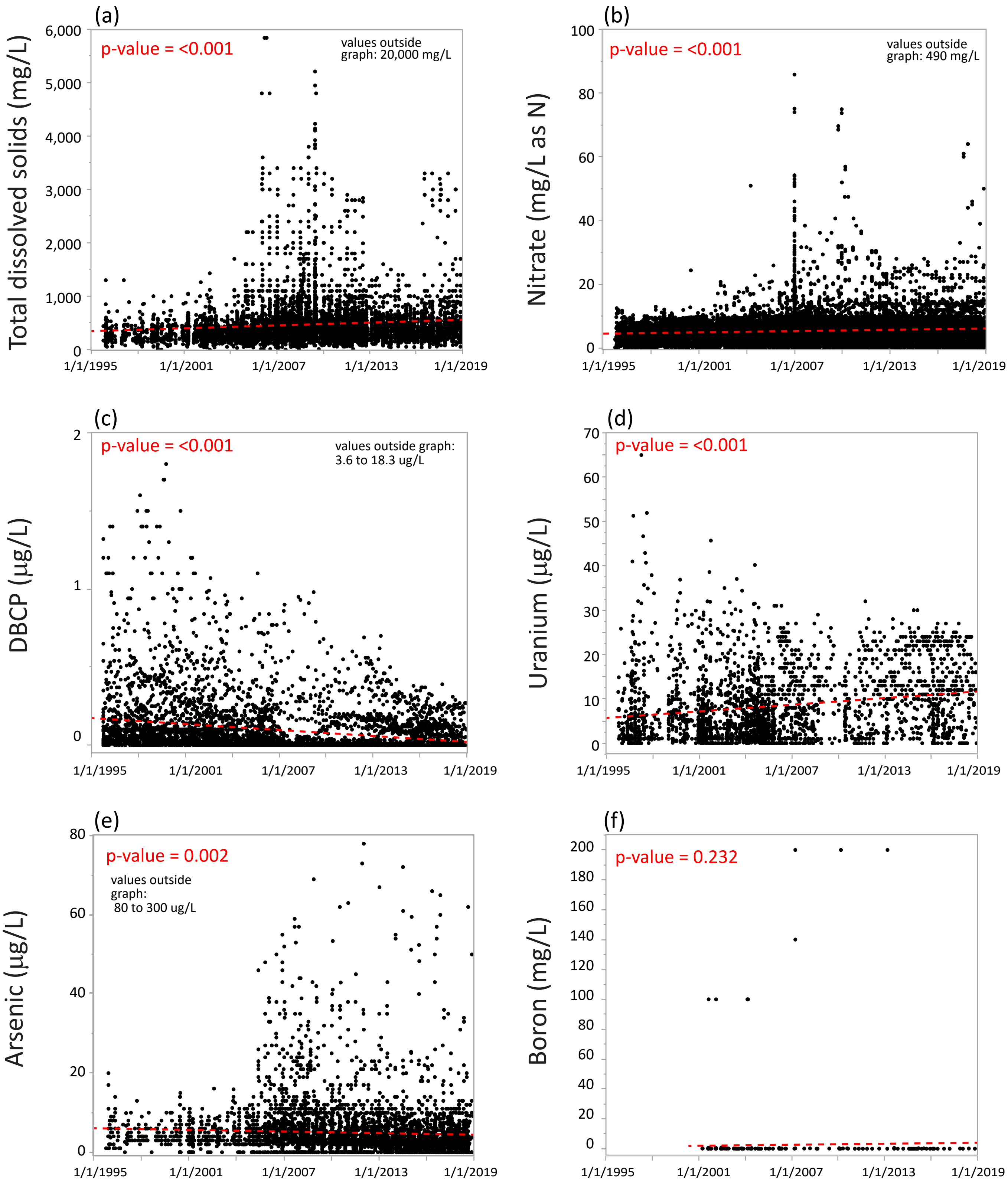


Note:
Linear temporal trends of (a) TCP, (b) Gross Alpha, and (c) PCE. The p-values less than the alpha-level of 0.05 are statistically significant trends.

April 2020

TODD GROUNDWATER

Figure 3-55
Linear Temporal Trends (1 of 2)



Note:
Linear temporal trends of (a) total dissolved solids, (b) nitrate (as N), (c) DBCP, (d) uranium, (e) arsenic, and (f) boron . The p-values less than the alpha-level of 0.05 are statistically significant trends.

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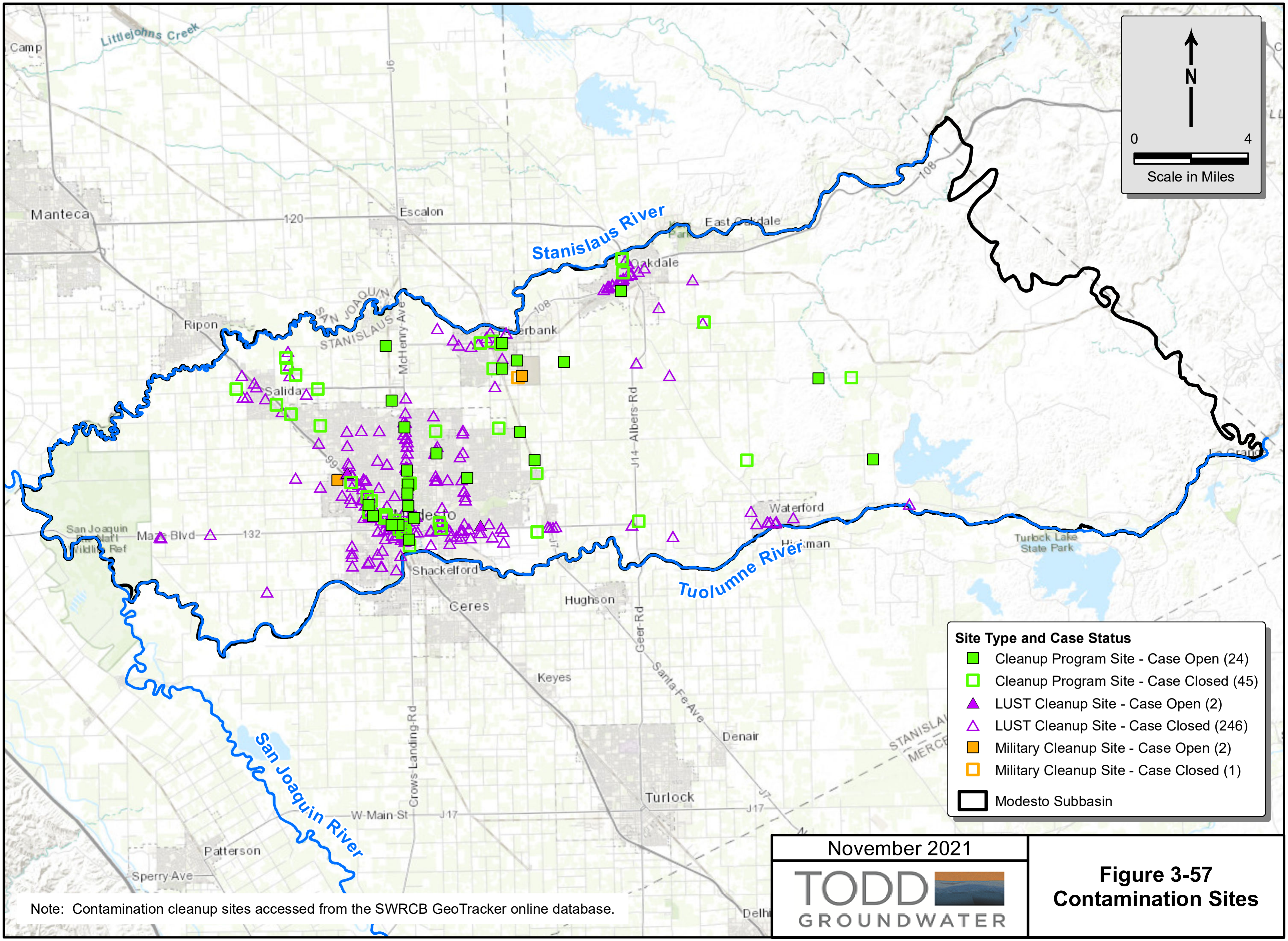
TODD GROUNDWATER

Figure 3-56
Linear Temporal Trends (2 of 2)



Note: Contamination cleanup sites accessed from the SWRCB GeoTracker online database.

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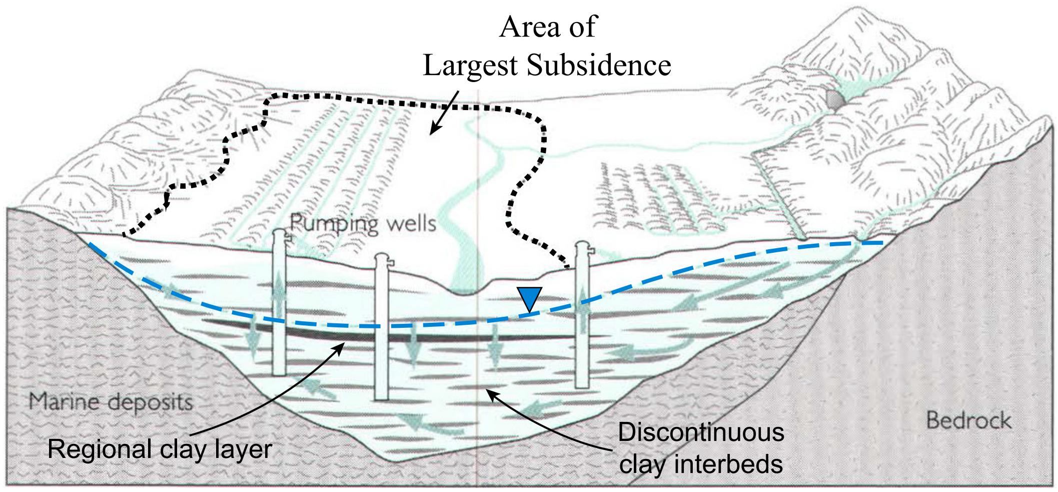
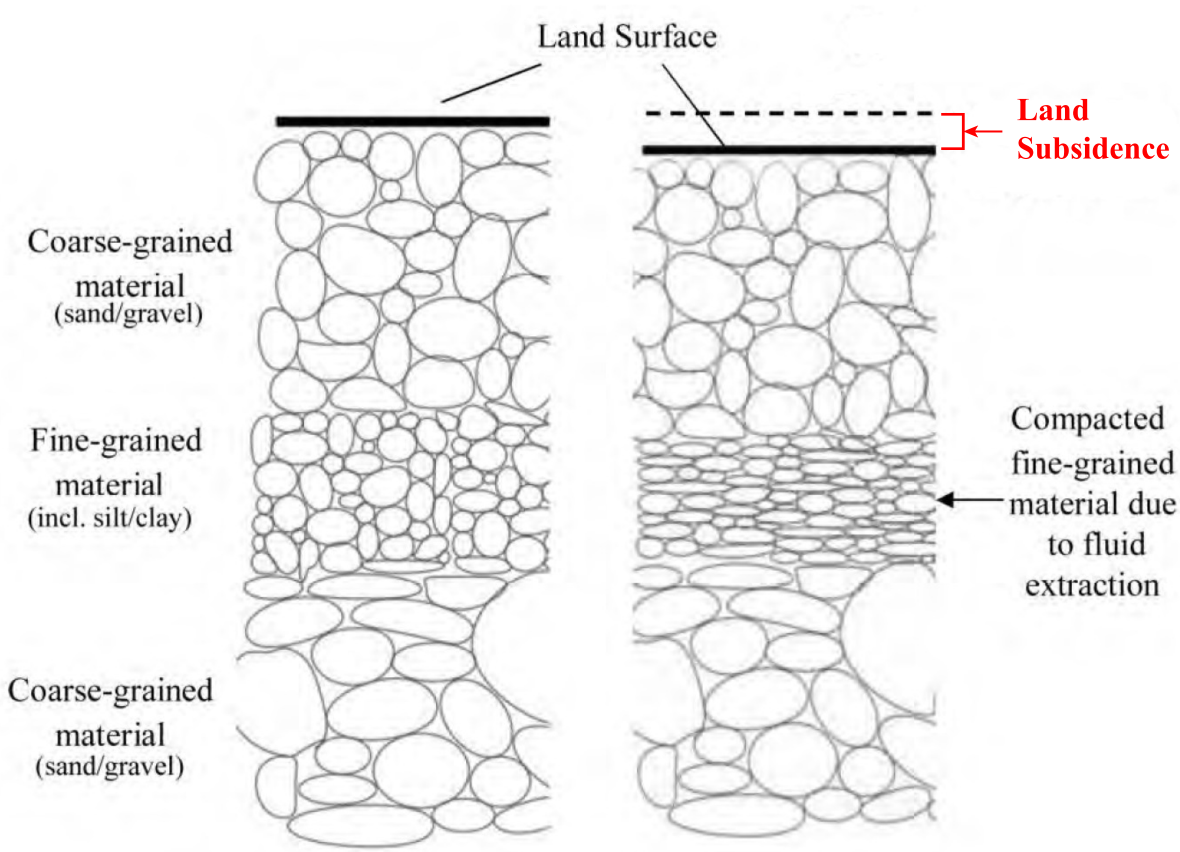
TODD GROUNDWATER

Figure 3-57
Contamination Sites



Source: Galloway et al., 1999.



After LSCE et al., 2014.

November 2021	**Figure 3-58 Concepts of Land Subsidence**
TODD GROUNDWATER	

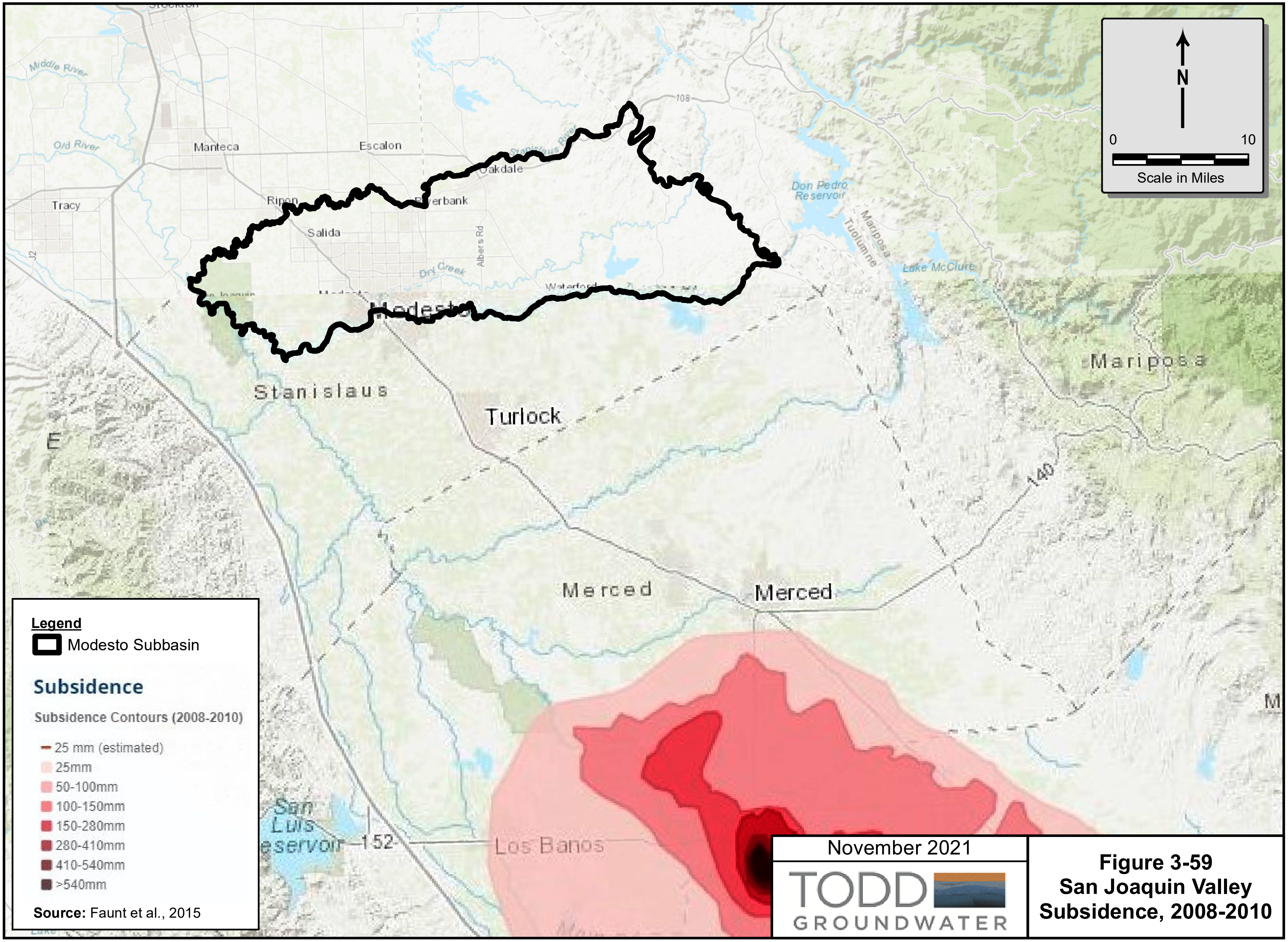


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Figure 3-59
San Joaquin Valley Subsidence, 2008-2010

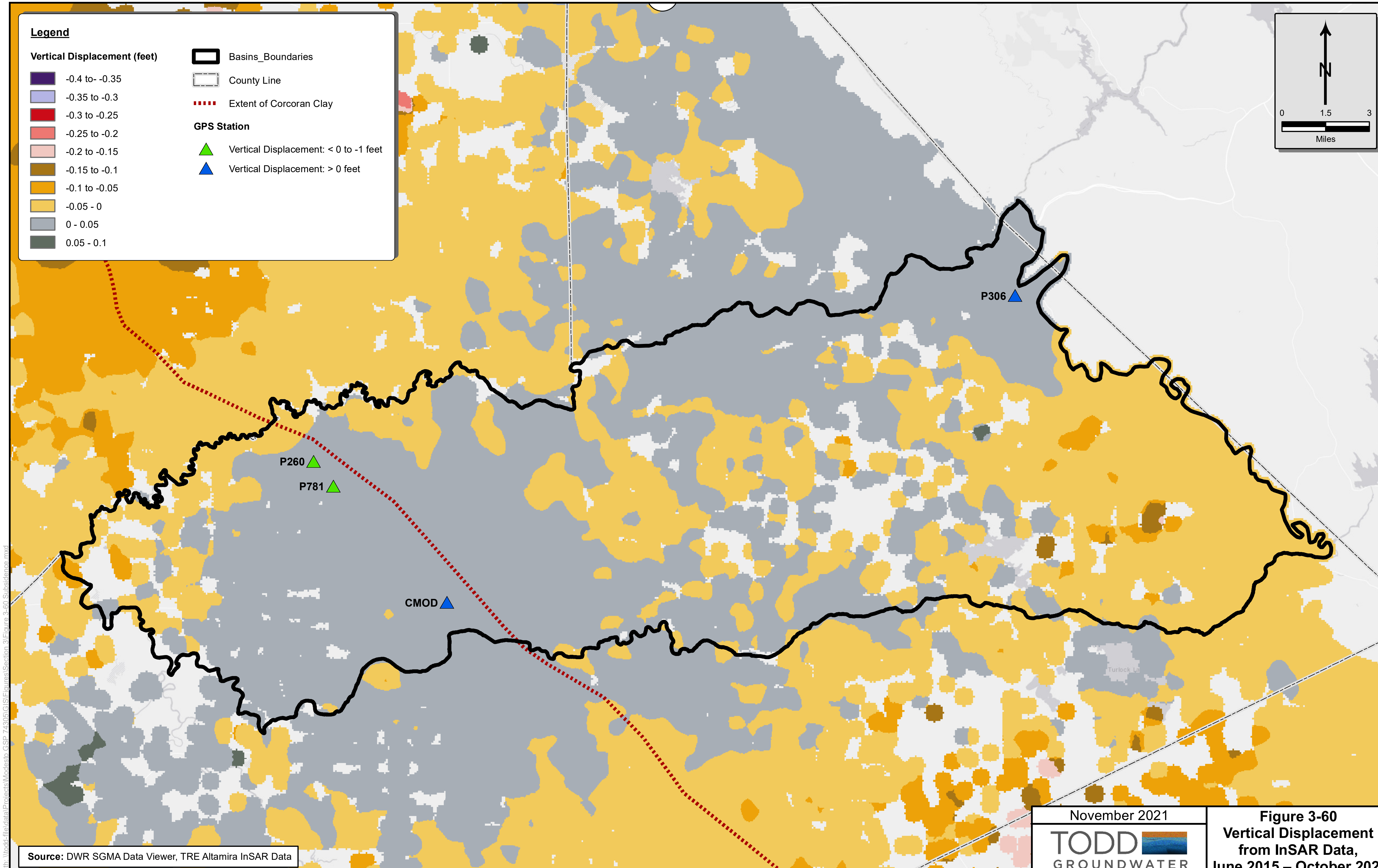
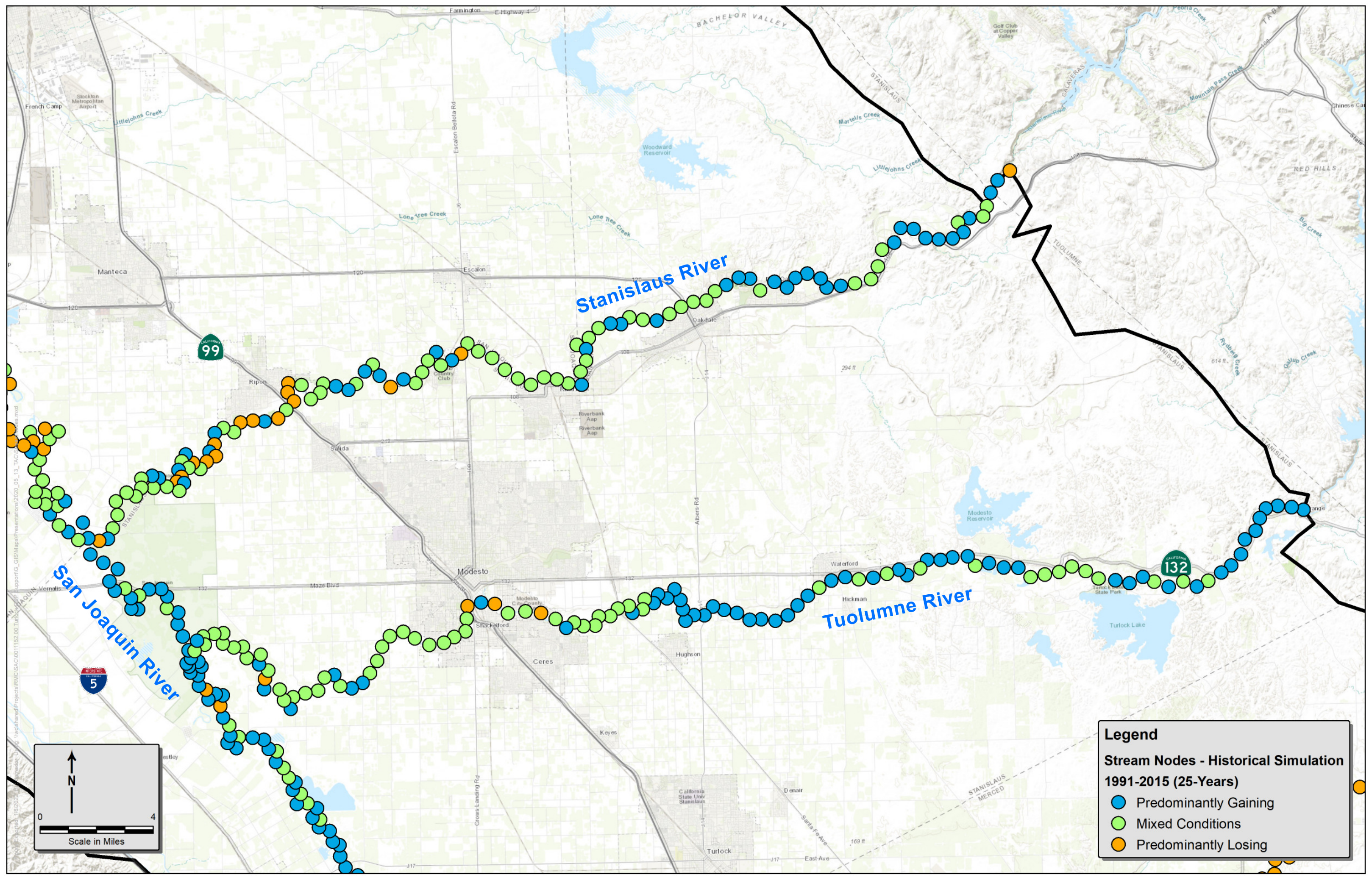
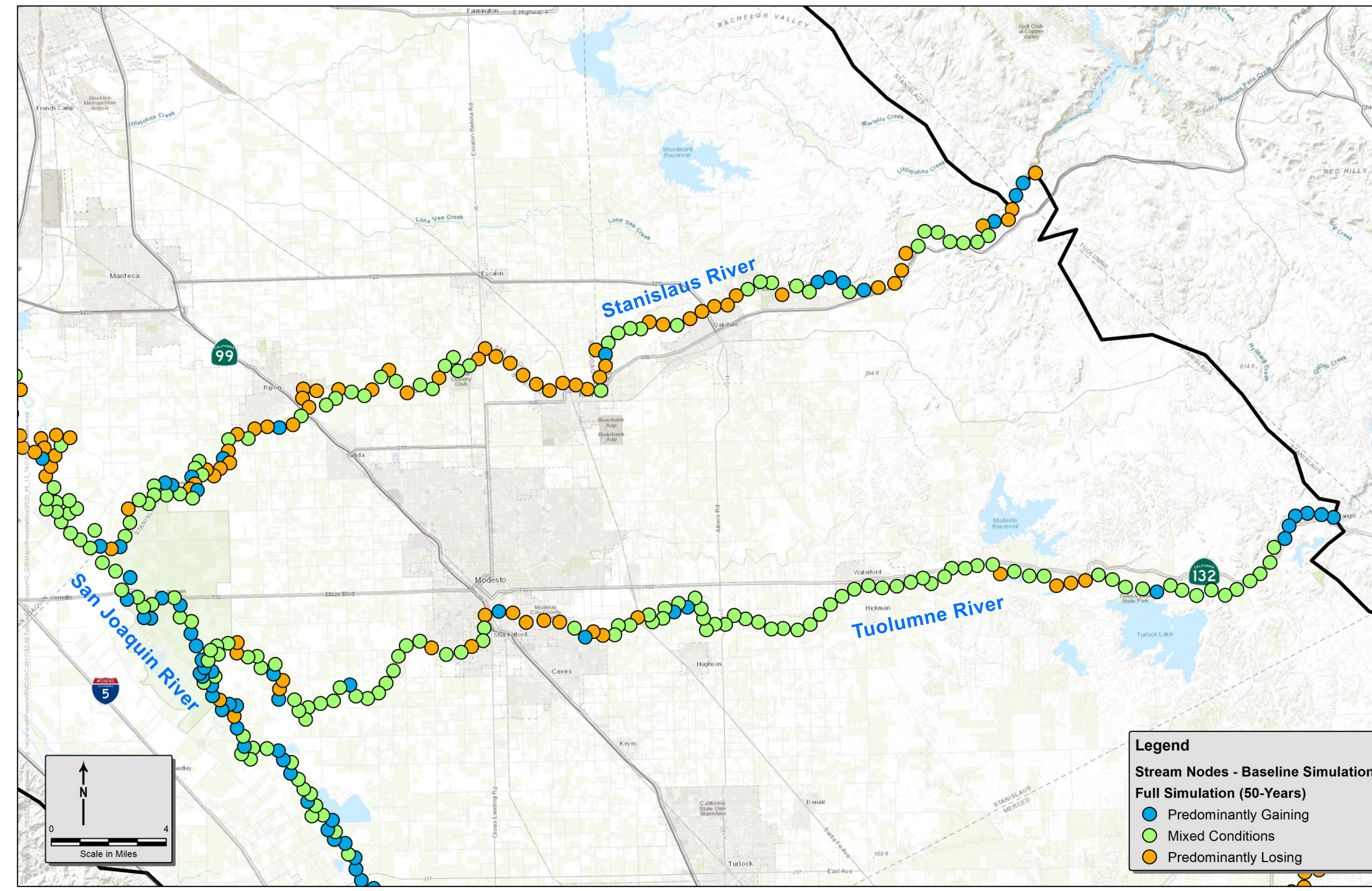


Figure 3-60
Vertical Displacement from InSAR Data, June 2015 – October 2020

Historical Conditions Simulation WY 1991-WY 2015



Projected Future Conditions Simulation Years 1-50



WOODARD &CURRAN

January 2022

Figure 3-61
Interconnected
Surface Water Conditions

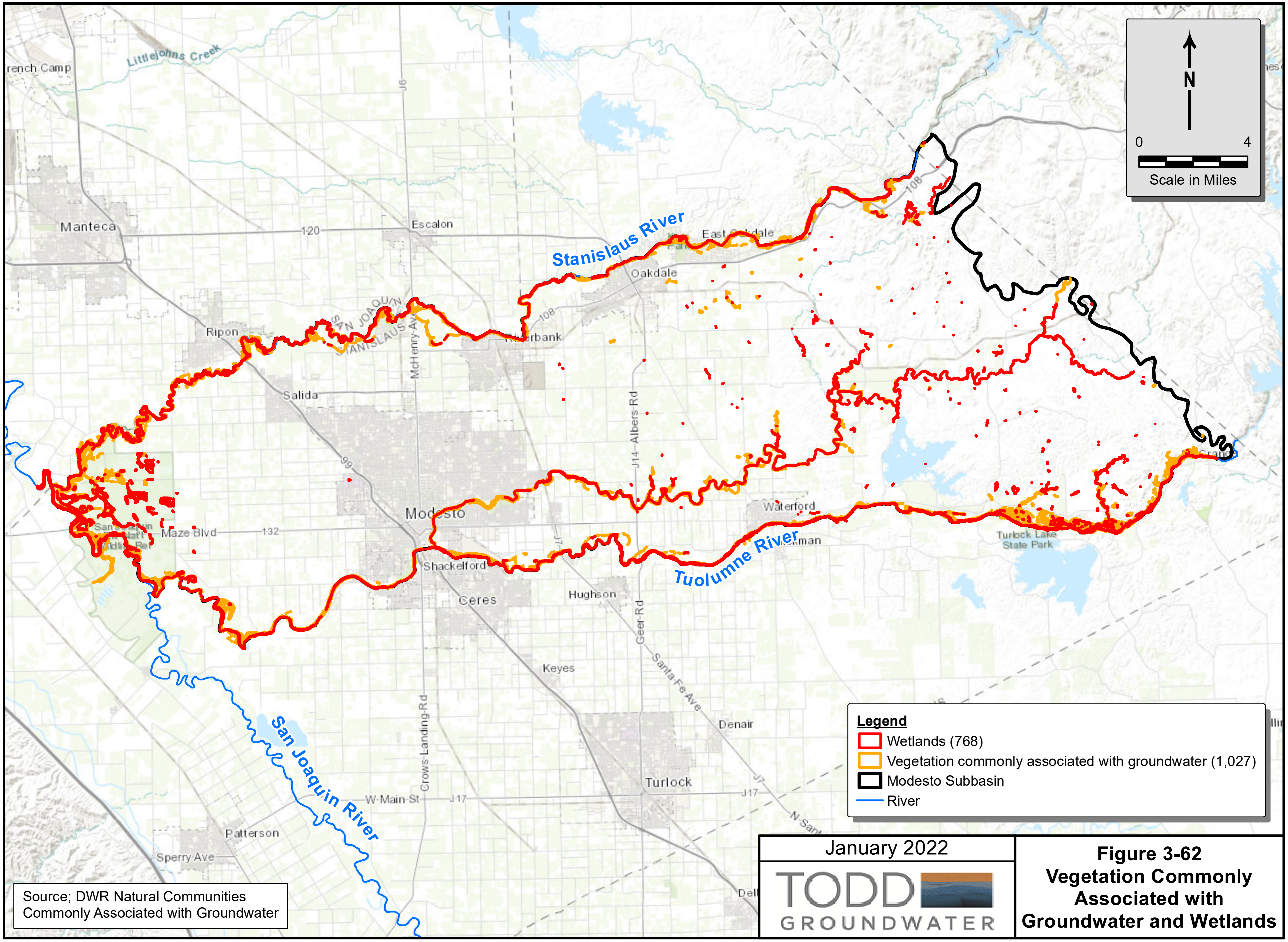
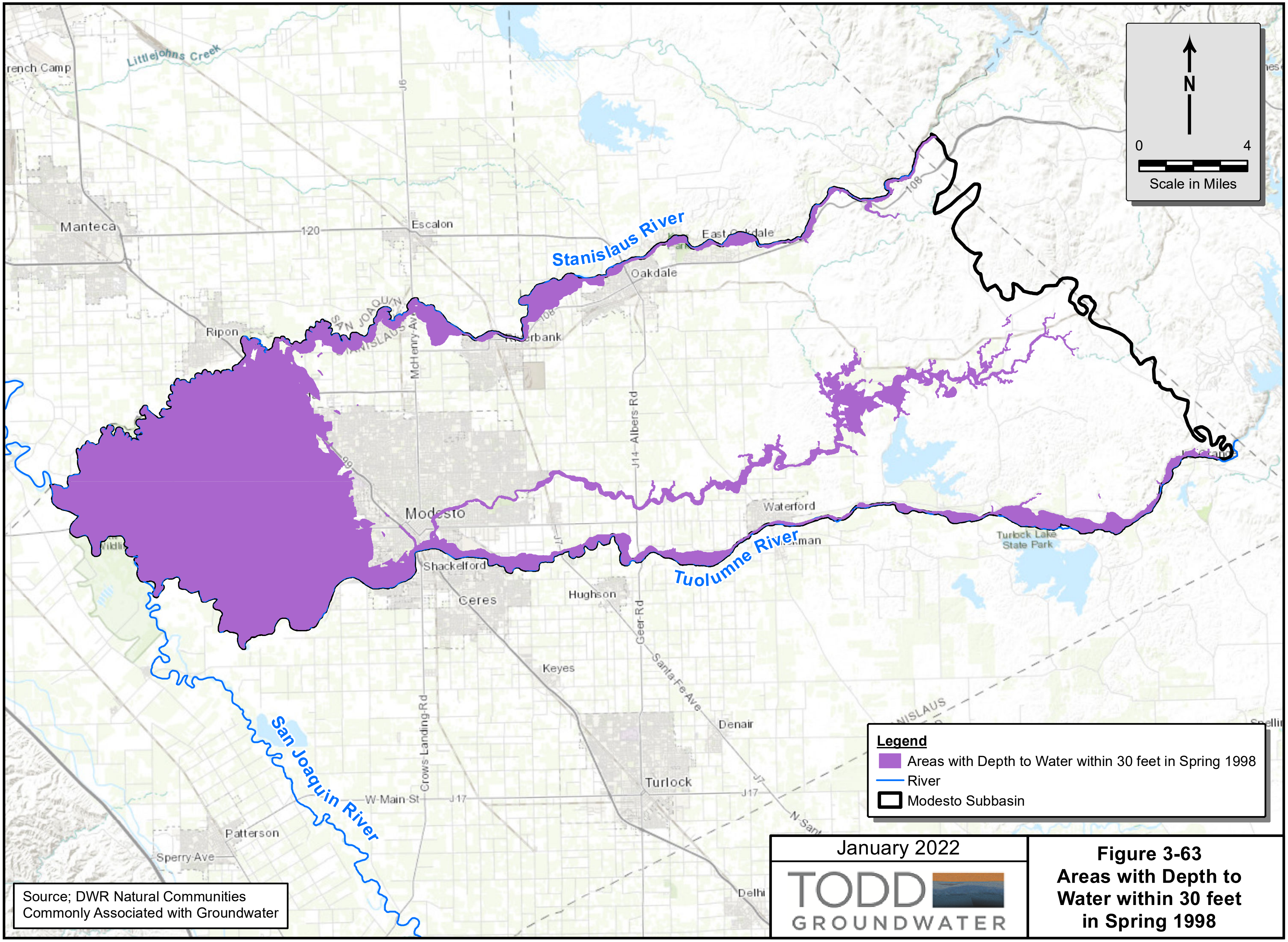


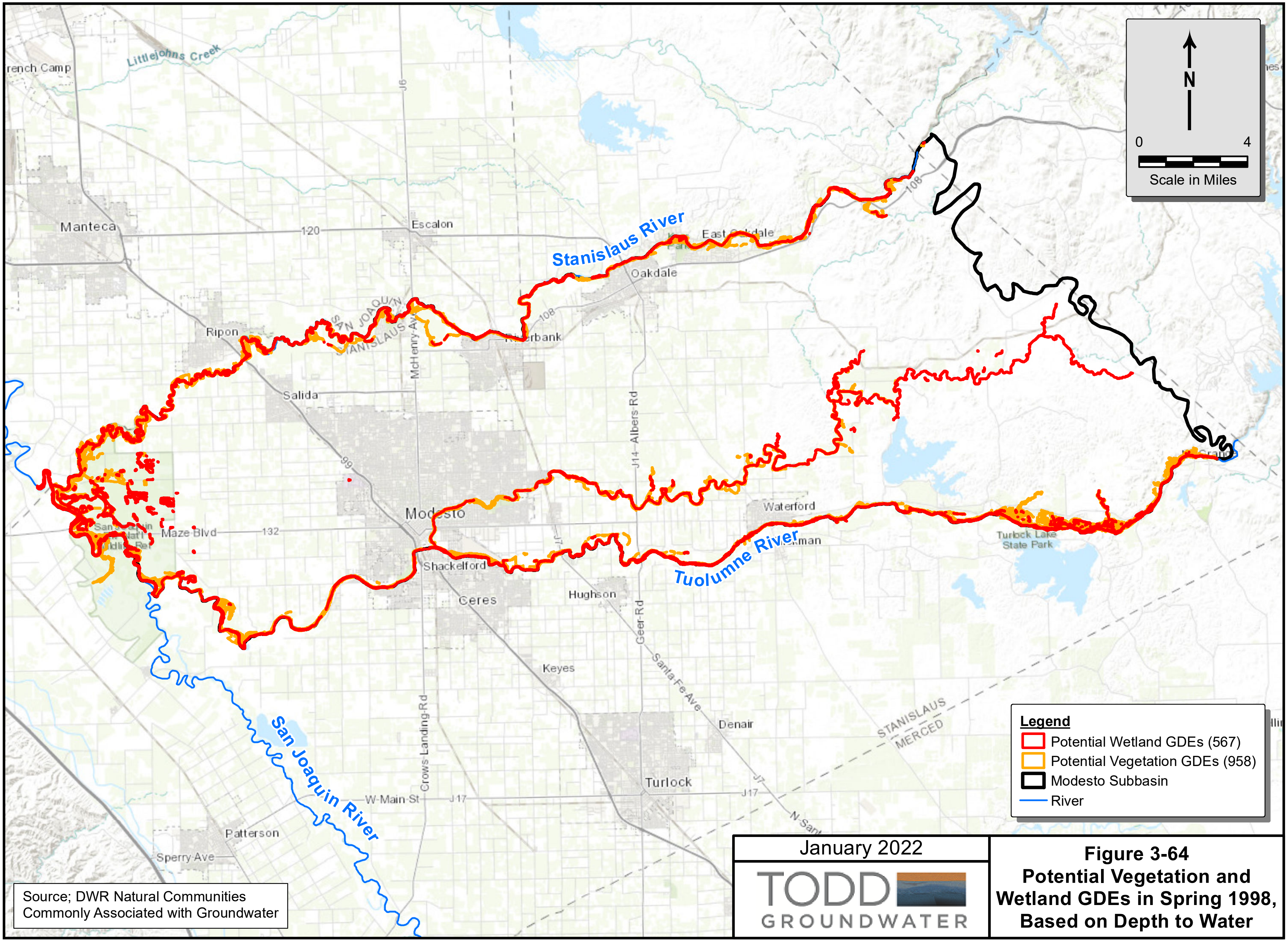
Figure 3-62
Vegetation Commonly Associated with Groundwater and Wetlands



January 2022

TODD GROUNDWATER

Figure 3-63
Areas with Depth to Water within 30 feet in Spring 1998

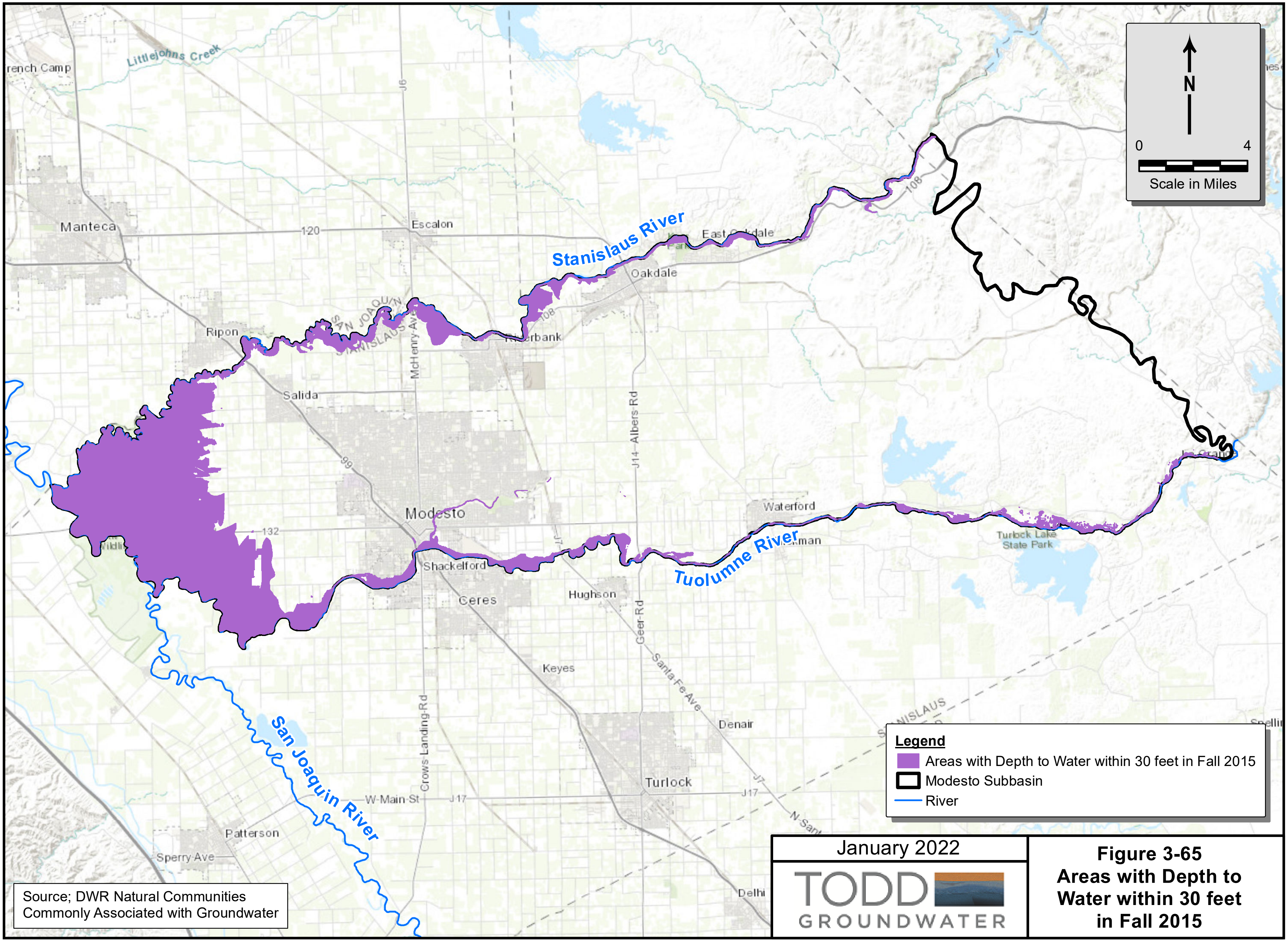


Source; DWR Natural Communities Commonly Associated with Groundwater

January 2022

TODD GROUNDWATER

Figure 3-64
Potential Vegetation and Wetland GDEs in Spring 1998, Based on Depth to Water



January 2022

TODD GROUNDWATER

Figure 3-65
Areas with Depth to Water within 30 feet in Fall 2015

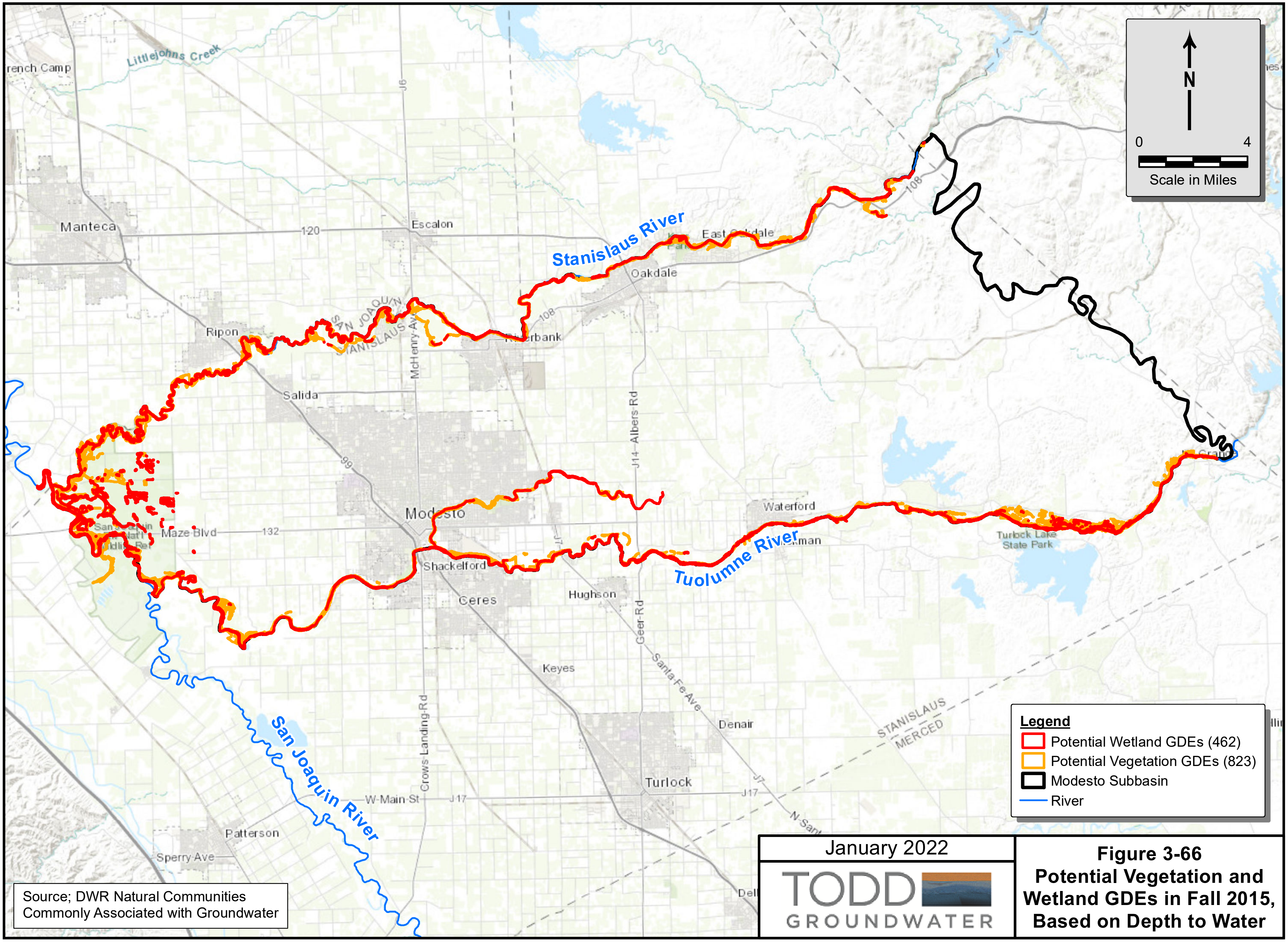
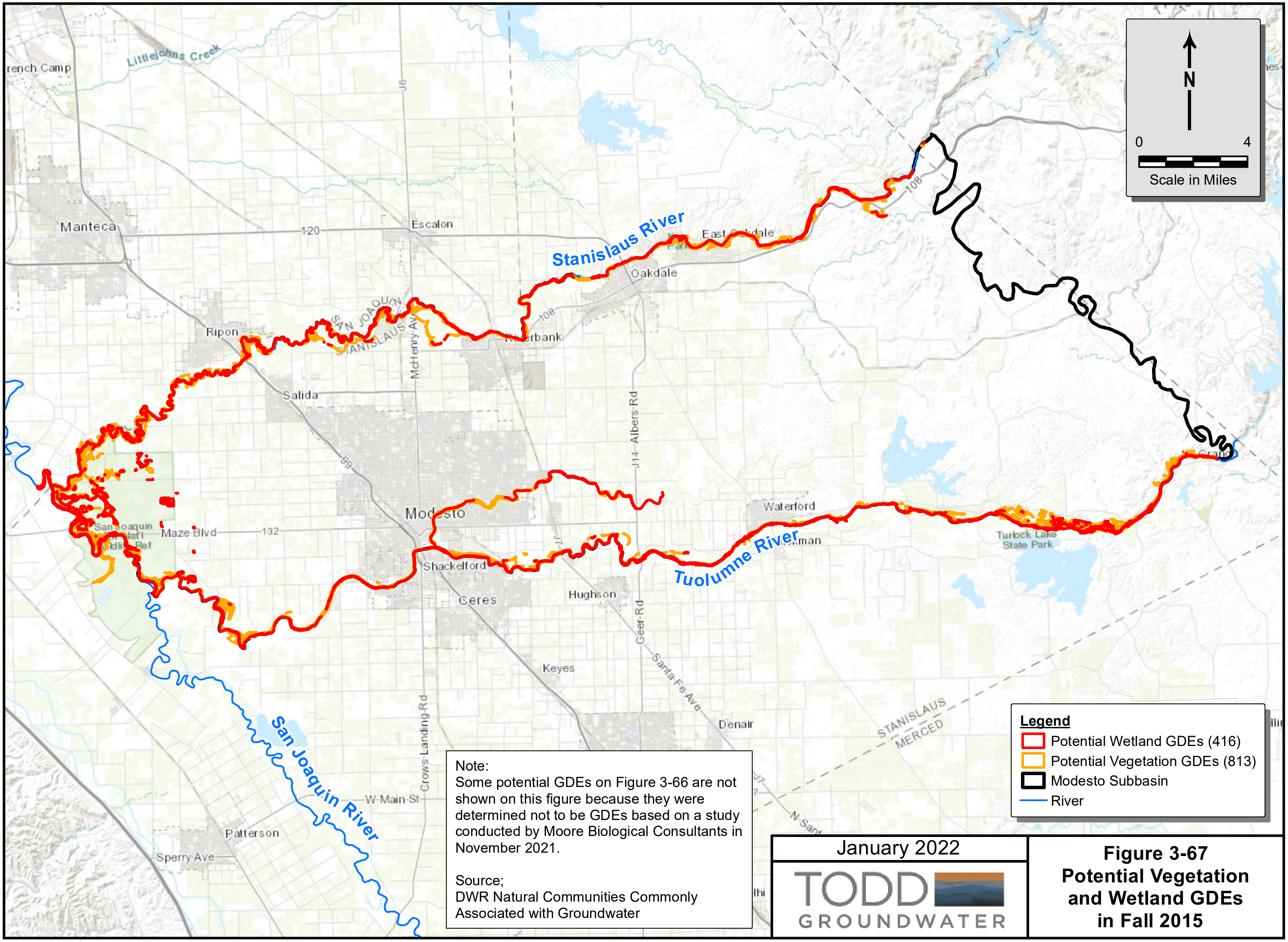


Figure 3-66
Potential Vegetation and Wetland GDEs in Fall 2015, Based on Depth to Water



Note:
Some potential GDEs on Figure 3-66 are not shown on this figure because they were determined not to be GDEs based on a study conducted by Moore Biological Consultants in November 2021.

Source;
DWR Natural Communities Commonly Associated with Groundwater

January 2022

TODD GROUNDWATER

Figure 3-67
Potential Vegetation and Wetland GDEs in Fall 2015

4. NOTICE AND COMMUNICATION

The GSAs in the Modesto Subbasin conducted a number of activities to engage beneficial users of groundwater, interested parties, and the general public in the development of the GSP. The STRGBA GSA and Tuolumne GSA were responsible for conducting outreach and engagement related to the SGMA for the portions of the Subbasin located within their respective service areas. The STRGBA GSA, which covers almost all of the Subbasin, took the lead in outreach with Tuolumne GSA coordinating through an agreement with Stanislaus County (**Appendix A**).

4.1. DECISION MAKING PROCESS

As described in **Chapter 1** of this GSP, the Stanislaus and Tuolumne Rivers Groundwater Basin Association (STRGBA) agencies entered into a Memorandum of Understanding (MOU) to form the STRGBA GSA in February 2017. The STRGBA GSA is governed by a committee tasked with overseeing activities to achieve the objectives of SGMA applicable within the Modesto Subbasin (Committee). Each member agency designates one staff person and one or more alternates to serve on the Committee. Stanislaus County participates in the Committee on behalf of the Tuolumne GSA.

Each calendar year, the Committee elects a chair and vice chair from its members. The chair is responsible for presiding over and notifying members of Committee meetings. Except for actions for which a different approval standard is set forth in the MOU, all actions of the Committee are approved by a majority vote carried by of the members present.

To provide a venue for discussion of technical topics related to the development of the GSP, the STRGBA GSA also formed a Technical Advisory Committee (TAC). TAC membership is not defined in the MOU, but it generally includes one participating representative from each of the STRGBA GSA member agencies. Stanislaus County, a STRGBA GSA member agency, represented both itself as well as the Tuolumne GSA in these TAC meetings.

Both Committee and TAC meetings are open to the public and held in accordance with the Ralph M. Brown Act (California Government Code section 5490 et sq.). These meetings are further described in **Section 3.4.1**.

4.2. GROUNDWATER BENEFICIAL USES AND USERS

Beneficial users and uses of groundwater were identified and engaged by the GSAs based on the place- and interest-based categories described in SGMA and codified in Water Code Section 10723.2:

(a) Holders of overlying groundwater rights, including:

(1) Agricultural users, including farmers, ranchers, and dairy professionals

(2) Domestic well owners

(b) Municipal well owners

(c) Public water systems

(d) Local land use planning agencies

(e) Environmental users of groundwater

(f) Surface water users, if there is a hydrologic connection between surface and groundwater bodies

(g) The federal government, including, but not limited to, the military and managers of federal lands

(h) California Native American tribes

(i) Disadvantaged communities, including, but not limited to, those served by private domestic wells or small community water systems

(j) Entities listed in Section 10927 that are monitoring and reporting groundwater elevations in all or a part of a groundwater basin managed by the groundwater sustainability agency

Beneficial users and uses representing these categories and nature of consultation with these users are further described below and identified in **Table 4-1**.

Table 4-1: Nature of Consultation with Beneficial Users

Beneficial User Category	Beneficial Users	Nature of Consultation: Participation in Stakeholder Assessment	Membership on STRGBA GSA and/or Technical Advisory Committee or Tuolumne County GSA	Interested Parties Database	Public Meetings, Workshops, and Subbasin Office Hours	Targeted Outreach to Representatives of Beneficial Users
Agricultural Users	Agricultural water providers - MID, OID	X	X	X	X	X
	Individual agricultural water users, including dairies, farmers, and ranchers	X		X	X	X
Domestic Well Owners	Domestic well owners	X		X	X	X
Municipal and Industrial Well Owners	City of Modesto	X	X	X	X	X
	City of Oakdale	X	X	X	X	X
	City of Riverbank	X	X	X	X	X
	City of Waterford	X	X	X	X	X
	Municipal supply wells owners	X	X	X	X	X
	MID	X	X	X	X	X
	OID	X	X	X	X	X
Public Water Systems	[See Section 2, Table 2-1 for the list of public water systems in the Subbasin]			X	X	
Local Land Use Planning Agencies	City of Modesto Planning Commission		X		X	
	City of Oakdale Planning Commission		X		X	
	City of Riverbank Planning Commission		X		X	
	City of Waterford Planning Commission		X		X	
	Stanislaus County Local Agency Formation Commission			X	X	
	Stanislaus County Planning Commission		X	X	X	
	Tuolumne County Local Agency Formation Commission				X	
	Tuolumne County Local Planning Commission		X	X	X	
Environmental Users of Groundwater	California Department of Fish and Wildlife			X	X	
	Tuolumne River Trust	X		X	X	
	U.S. Fish and Wildlife Service			X	X	
Surface Water Users	Individual landowners			X	X	
	MID	X	X	X	X	
	OID	X	X	X	X	
	Tuolumne River Trust	X		X	X	
Federal Government	U.S. Fish and Wildlife Service			X		
California Native American Tribes	[There are no tribal lands are documented in the DWR Water Management Planning Tool or are known to exist in the Modesto Subbasin.]					
Disadvantaged Communities (Census Designated Tracts)	Airport				X	X
	City of Oakdale	X	X	X	X	X
	City of Waterford	X	X	X	X	X
	Empire			X	X	X
	Rouse				X	X
	West Modesto				X	X
Groundwater Monitoring and Reporting Entities	STRGBA	X	X	X	X	X

KEY: GSA = Groundwater Sustainability Agency, MID = Modesto Irrigation District, OID = Oakdale Irrigation District, STRGBA = Stanislaus and Tuolumne Rivers Groundwater Basin Association

4.2.1. Agricultural Users (§10723.2(a)(1))

The Modesto Subbasin is largely agricultural. In 2017, approximately 64 percent of the Subbasin was defined as irrigated agriculture (Stanislaus Land Use dataset, 2017). Irrigated agriculture covers about 157,911 acres. Approximately 23 percent of the Subbasin (about 56,777 acres) consists of non-agriculture, non-irrigated agriculture (e.g., rangeland), undeveloped land, and surface water.

Agricultural groundwater users include growers, ranchers, and dairies. Water for agricultural purposes is primarily provided through groundwater extracted from the Subbasin, as well as surface water supplies provided by the Modesto Irrigation District (MID) and Oakdale Irrigation District (OID). MID and OID each operate groundwater wells to supplement surface water deliveries and manage the water table.

Agricultural interests are represented on the Committee by MID and OID; in addition, the elected boards and councils of the STRGBA GSA member agencies provide broad agricultural representation. Individuals representing agricultural water users were also part of the initial stakeholder assessment conducted to develop the Communication and Engagement Plan; and actively participated in monthly Committee and TAC meetings, public workshops, and GSP chapter public comment processes.

During development of the GSP, MID and OID conducted outreach on groundwater management practice and SGMA to their agricultural customers. Information was provided at MID and OID grower meetings, in newsletters, and during presentations to the MID and OID Boards of Directors. Agricultural groundwater users also participated in the Subbasin stakeholder assessment, which is described in the Communication and Engagement Plan.

4.2.2. Domestic Well Owners (§10723.2(a)(2))

Domestic wells are present throughout the Subbasin, but the highest density occurs in the central region of the Subbasin, along the Stanislaus and Tuolumne Rivers, and west of the City of Modesto. OID also provides domestic water from District-owned wells for its rural water system and serves as the trustee of six improvement districts. A density of domestic wells is illustrated on **Figure 2-14** in **Chapter 2**.

Domestic well owners are represented on the Committee by OID and Stanislaus County and had the opportunity to consult in development of the GSP through monthly public meetings, workshops, and GSP public comment processes. An informational postcard was distributed to over 350 landowners in the eastern part of the Subbasin with a high density of domestic wells to inform them about development of the GSP. The STRGBA GSA also engaged the Municipal Advisory Councils for the communities of Airport, West Modesto, and Empire, located in unincorporated Stanislaus County, to inform them about development of the GSP and solicit input on locations for new groundwater monitoring wells.

4.2.3. Municipal & Industrial Well Owners (§10723.2(b))

There are approximately 150 municipal supply wells in the Subbasin, as shown in Chapter **2, Figure 2-13**. The highest concentration of municipal supply wells is located within the City of Modesto. There are also public supply wells located in the Cities of Oakdale, Riverbank, and Waterford; and unincorporated areas of Stanislaus County. The Cities of Modesto, Oakdale, Riverbank, and Waterford pump groundwater for municipal and industrial water supply. MID and OID also operate groundwater wells to supplement surface water supplies and manage the water table.

All four cities, Stanislaus County, MID, and OID are member agencies of the STRGBA GSA and represent municipal and industrial well owners. Member agency staff provided periodic updates to their respective governing bodies informing them about progress developing the GSP and consulting on key groundwater management decisions. STRGBA GSA staff also provided presentations on SGMA and the GSP at meetings of the Manufacturer's Council of Central Valley. In addition, municipal and industrial well owners participated in the stakeholder assessment.

4.2.4. Public Water Systems (§10723.2(c))

Public water systems in the Subbasin include the Cities of Modesto, Oakdale, Riverbank, and Waterford, as well as small community water supply systems operated by the respective community and regulated by Stanislaus County. There are approximately 77 water systems in the Subbasin that are not municipal or irrigation districts. A majority of these systems are very small. A summary of these non-municipal and non-irrigation systems is provided in **Chapter 2, Table 2-1** of the GSP.

The Cities of Modesto, Oakdale, Riverbank, and Waterford are all represented on the STRGBA Committee. Small community water systems were represented in development of the GSP by Stanislaus County.

4.2.5. Local Land Use Planning Agencies

Local land use planning agencies in the Modesto Subbasin include the planning commissions of the City of Modesto, City of Oakdale, City of Riverbank, City of Waterford, Stanislaus County, and Tuolumne County, as well the Stanislaus County and Tuolumne County Local Agency Formation Commissions. These agencies are represented on the Committee by their respective STRGBA GSA representative.

4.2.6. Environmental Users of Groundwater

The GSAs used the California Department of Water Resources' (DWR) Natural Communities Commonly Associated with Groundwater as a starting point to identify groundwater dependent ecosystems within the Modesto Subbasin. The mapping shows wetlands and vegetation along the three major rivers (Stanislaus, Tuolumne, and San Joaquin Rivers), along Dry Creek and areas between Dry Creek and the Tuolumne River, and within the San Joaquin River Natural Wildlife Refuge.

Environmental users of groundwater were invited to participate in monthly Committee and TAC meetings as well as public workshops. A representative from the Tuolumne River Trust also participated in the stakeholder assessment.

4.2.7. Surface Water Users (§10723.2(f))

The Tuolumne and Stanislaus Rivers provide the primary sources of water in the Modesto Subbasin. Surface water is used for agricultural, municipal, industrial, and environmental purposes. MID delivers surface water from the Tuolumne River for agricultural irrigation. MID also treats and delivers surface water from the Tuolumne River to the City of Modesto for municipal and industrial use. OID diverts water from the Stanislaus River to municipal and agricultural customers. Other surface water users include individual landowners with riparian water rights.

Surface water users are represented on the Committee and TAC by MID and OID. The STRGBA GSA also coordinated with GSAs in the Turlock Subbasin regarding management of flows in the Tuolumne River. In addition, Stanislaus County represents surface water users in non-district areas.

4.2.8. Federal Government (§10723.2(g))

Federal government agencies in the Modesto Subbasin include the U.S. Fish and Wildlife Service, which runs the San Joaquin River National Wildlife Refuge. The Local Redevelopment Authority oversees the transfers, reuse, and redevelopment of the former Riverbank Army Ammunition Plant, which was previously owned by the U.S. Army. Federal agencies were invited to participate in monthly Committee and TAC meetings and public workshops.

4.2.9. California Native American Tribes (§10723.2(h))

No tribal lands are documented in the DWR Water Management Planning Tool or are known to exist in the Modesto Subbasin.

4.2.10. Disadvantaged Communities (§10723.2(i))

Data published by the U.S. Census Bureau in 2018 show six Census Designated Places within the Modesto Subbasin that meet the annual Median Household Income (MHI) criteria to be considered a disadvantaged community or severely disadvantaged community by the State: Airport, Empire, Oakdale, Rouse, Waterford, and West Modesto. These communities are identified in **Figure 4-1**. The MHI for each is identified in **Table 4-2**.

Figure 4-1: Disadvantaged and Severely Disadvantaged Communities

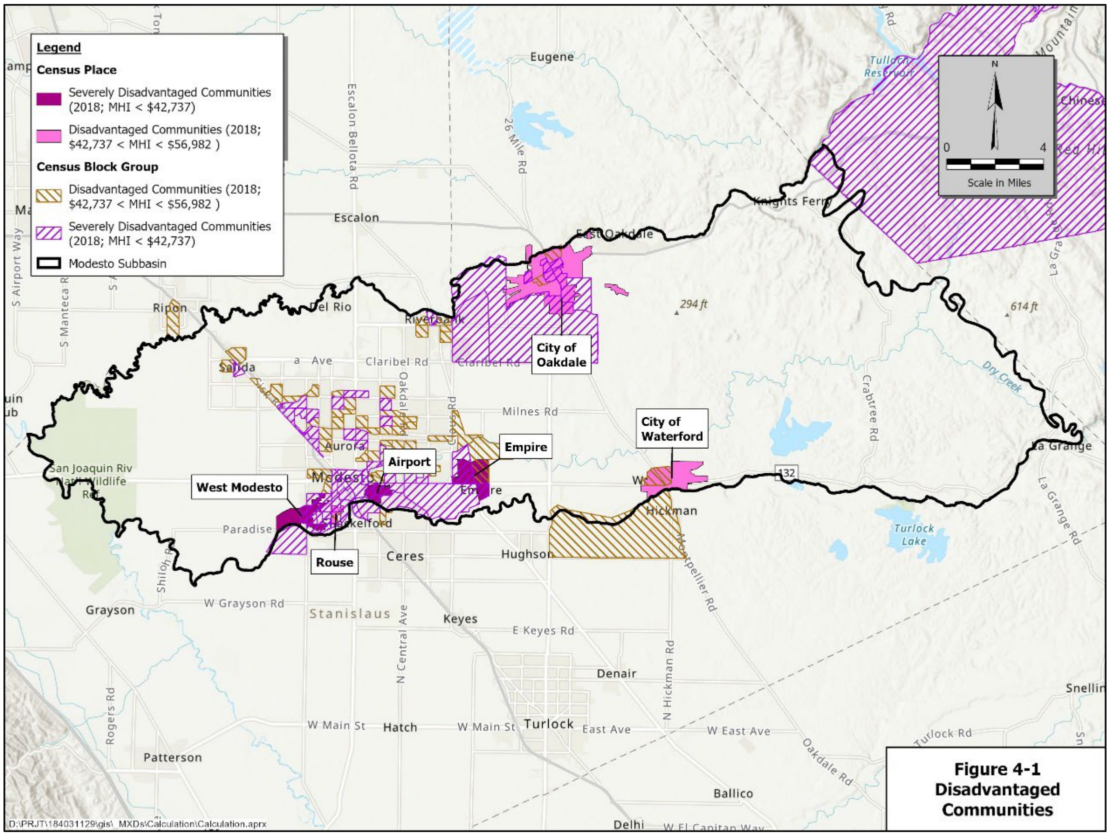


Table 4-2: Census-Designated Places Designated as Disadvantaged

Census-Designated Place	Median Household Income[1]	Population[2]
Airport	$28,352	1,389
City of Oakdale	$54,443	23,181
City of Waterford	$54,886	9,120
Empire	$36,774	4,202
Rouse	$46,300	1,913
West Modesto	$33,920	5,965

Notes;
[1] Median Household Income is based on 2014–2018 American Community Survey 5-Year Estimates
[2] Population is based on U.S. Census Bureau 2020 Decennial Census data

These communities are represented on the Committee and TAC by the City of Modesto, City of Oakdale, City of Waterford, and Stanislaus County. Water users in these communities were notified about development of the GSP through bilingual (English-Spanish) water bill inserts; notices and information distributed through the STRGBA GSA member agencies' existing communication platforms (e.g., websites, social media accounts, newsletters); and presentations provided at community advisory councils and other organizations.

The STRGBA GSA distributed a bilingual electronic survey in Spring and Summer 2019 to assess stakeholders' understanding and perspectives on key SGMA topics and gather input on preferred outreach strategies. The survey was promoted via utility bill inserts, postings on the STRGBA GSA and GSA member agencies' websites and social media pages, and a notice in the Stanislaus County Farm Bureau's Farm News. The survey went out to all water service customers, which included the communities of West Modesto, Rouse, Airport, Empire, and the City of Modesto. The survey results were posted on the STRGBA GSA website and used to develop the Modesto Subbasin Communication and Engagement Plan.

City of Modesto staff, on behalf of the STRGBA GSA, also attended various community meetings to discuss proposed locations for new groundwater monitoring wells and inform community members about development of the GSP. This included presentations at the Airport Neighborhood Collaborative, West Modesto Community Collaborative, and Empire Municipal Advisory Council in August and September 2019. In addition, informational materials were distributed through Stanislaus County Municipal Advisory Councils. Groundwater users in communities designated as disadvantaged also had the opportunity to participate in development of the GSP through monthly Committee and TAC meetings and public workshops.

4.2.11. Groundwater Elevation Monitoring and Reporting Entities (§10723.2(j))

STRGBA serves as the CASGEM Monitoring Entity for the Modesto Subbasin. Each municipality also monitors groundwater quality for its supply wells in compliance with state requirements.

4.3. PUBLIC ENGAGEMENT

The GSAs utilized a variety of tools and activities to encourage the active involvement of diverse social, cultural, and economic elements of the population within the Modesto Subbasin. These activities were guided by the Modesto Subbasin Communication and Engagement Plan, which is provided in **Appendix E**. The activities identified in the Communication and Engagement Plan were adapted in accordance with state and local social distancing requirements resulting from the COVID-19 pandemic.

To support execution of the activities identified in the plan and ensure a collaborative and inclusive GSP development process, the GSAs utilized DWR's Facilitation Support Services. Facilitation and outreach support was provided by Stantec Consulting Services Inc (Stantec).

4.3.1. Outreach Tools

The GSAs used several tools to support communication and engagement activities with stakeholders in the Modesto Subbasin. These tools include the following:

- **Project Website**: The STRGBA GSA member agencies have updated the STRGBA website (www.strgba.org) to provide information about SGMA and house GSA meeting and outreach materials. The Tuolumne GSA has added a SGMA-related page (https://www.tuolumnecounty.ca.gov/1292/Sustainable-Groundwater-Management-Act-S) to the Tuolumne County website.
- **Interested Parties Database**: Pursuant to the requirements of SGMA, the GSAs developed and maintain an Interested Party Database. The Database is used to notify stakeholders of pending meetings and workshops, opportunities for public comment, and notices of other GSA outreach actions.
- **Newsletter**: The STRGBA GSA distributes a semi-annual electronic newsletter to keep interested parties informed about progress in developing the GSP, opportunities for public engagement, and groundwater management issues or news of regional importance. Newsletters were distributed to the Interested Parties Database in Spring 2020, Fall 2020, and Spring 2021. Copies of the newsletter were also posted on the Subbasin website.
- **Informational Materials:** The Modesto Subbasin GSAs developed a suite of materials to inform beneficial users and interested parties about SGMA and topics pertaining to the GSP. This included fact sheets, frequently asked questions, presentation slides, and utility bill inserts. Many of these materials were translated into Spanish. To ensure consistent messaging across the basin, the GSAs also developed template presentation slides at different stages of GSP development to support presentations to member agency briefings and presentations to local industry and community groups.
- **Postcard:** The STRGBA GSA distributed an informational postcard to over 350 landowners in the non-districted area of the eastern portion of the Subbasin in September 2020 informing them about development of the GSP and inviting them to participate in the plan development process.

4.3.2. Outreach Activities

The GSAs conducted a variety of outreach activities to provide opportunities for beneficial users and other interested parties to stay informed and engaged in the development of the GSP. These activities were informed by the results of an electronic survey distributed by the

STRGBA GSA and stakeholder assessment conducted by Stantec staff in Spring 2019. Outreach activities included public STRGBA GSA and TAC meetings, GSP development workshops and office hours, member agency briefings, and presentations to organizations representing beneficial users of groundwater. Each of these activities is described in the Modesto Subbasin Communication and Engagement Plan, provided in **Appendix E**.

The GSAs utilized partnerships with trusted messengers in the Modesto Subbasin to broaden the dissemination of SGMA information and connect with hard-to-reach stakeholder groups. This included disseminating information through the Stanislaus County Farm Bureau, Manufacturers Council of the Central Valley, Empire Municipal Advisory Council, and local neighborhood collaboratives and community organizations. In addition, the STRGBA GSA conducted extensive public outreach to the communities of West Modesto, Rouse, Empire, Airport, and the City of Modesto regarding the locations and installation of new groundwater monitoring wells.

4.4. LIST OF PUBLIC MEETINGS

To consult beneficial users in development of the GSP and make decisions in a transparent and inclusive setting, the GSAs coordinated monthly public meetings, annual public workshops, and regular GSP office hours. In addition, the GSAs representatives provided presentations on the GSP at public meetings of their governing bodies and parties representing beneficial users. **Table 4-3** provides a list of the public meetings where the GSP was discussed or considered by the GSAs. A description of the committee meetings and public workshops is provided below.

Table 4-3: List of Public Meetings at Which the Groundwater Sustainability Plan Was Discussed

Type of Meeting	Format	Date(s)	
Community Presentations	Manufacturer's Council of Central Valley Meeting	04/18/2018	
	Airport Neighborhood Collaborative Meeting	09/09/2019	
	West Modesto Community Collaborative Meeting	09/11/2019	
	Empire Municipal Advisory Council Meeting	08/28/2019	
	Manufacturer's Council of Central Valley Meeting	07/15/2020	
	Modesto Chamber of Commerce, Government Relations Committee Meeting	11/20/2020	
	Mid San Joaquin RFMP Stakeholder Meeting	07/29/2021	
	Modesto Rotary	08/04/2021	
	Soroptimist International of Modesto	09/23/2021	
	Modesto Chamber of Commerce, Government Relations Committee Meeting	10/15/2021	
Public Workshop/ Groundwater Sustainability Plan Office Hours	Virtual	06/01/2020	
		03/25/2021	
		05/28/2021	
		08/25/2021	
Stanislaus and Tuolumne Rivers Groundwater Basin Association Groundwater Sustainability Agency Committee Meeting	In-Person and Virtual	01/18/2018	01/08/2020
		02/14/2018	02/12/2020
		05/09/2018	03/11/2020
		06/13/2018	04/08/2020
		07/11/2018	05/13/2020

Table 4-3: List of Public Meetings at Which the Groundwater Sustainability Plan Was Discussed (contd.)

Type of Meeting	Format	Date(s)	
Stanislaus and Tuolumne Rivers Groundwater Basin Association Groundwater Sustainability Agency Committee Meeting (contd.)	In-Person and Virtual (contd.)	08/08/2018	06/10/2020
		09/12/2018	07/08/2020
		10/10/2018	08/12/2020
		01/09/2019	09/09/2020
		02/13/2019	10/14/2020
		03/13/2019	12/09/2020
		04/10/2019	03/10/2021
		05/08/2019	04/14/2021
		06/12/2019	05/12/2021
		07/10/2019	06/09/2021
		08/14/2019	07/14/2021
		09/11/2019	08/11/2021
		10/09/2019	09/08/2021
		11/13/2019	10/13/2021
		12/11/2019	11/10/2021
			12/08/2021
Stanislaus and Tuolumne Rivers Groundwater Basin Association Groundwater Sustainability Agency Technical Advisory Committee Meeting	In-Person and Virtual	04/10/2019	01/13/2021
		07/10/2019	02/10/2021
		08/14/2019	06/23/2021
		11/13/2019	07/28/2021
		12/11/2019	08/11/2021
		05/13/2020	09/08/2021
		08/12/2020	09/22/2021
		10/27/2020	10/13/2021
		12/9/2020	11/20/2021

4.4.1. STRGBA Committee and Technical Advisory Committee Meetings

Monthly STRGBA GSA Committee and TAC meetings served as key opportunities for beneficial users and interested parties to track the process and consult in development of the GSP. Both meetings are held and noticed in accordance with the Brown Act and are open for members of the public to listen and provide comments. Comments on items on the agenda may be provided after STRGBA GSA discussion on the item. There is also time set aside for members of the public to provide comment on items not on the agenda. Public comments are recorded in the meeting minutes, which are posted on the STRGBA GSA website. Comments were recorded and considered by the planning team when developing and revising the GSP chapters.

The meetings were initially held in-person at MID's office at 1231 11th Street, Modesto, CA 95354 and by teleconferencing. In April 2020, the meetings were shifted to a virtual platform due to social distancing requirements and temporary changes in Brown Act requirements resulting from the COVID-19 pandemic. Members of the public were able to provide comment at the meetings via calling into the meeting or submitting comments in the virtual meeting platforms.

The GSAs noticed the meetings via a posting on the STRGBA GSA website and email distributed to the Interested Parties Database. A notice was also posted at the MID office for in-person meetings. Meeting agendas and materials were distributed to the Interested Parties Database and posted on the STRGBA GSA website prior to each meeting.

4.4.2. Public Workshops and GSP Office Hours

The GSAs held a public workshop and several Office Hours to inform beneficial users and interested parties about the GSP development process and collect input on topics central to the development of the GSP and groundwater management practices. The GSAs hosted a public workshop in June 2020 focused on SGMA and GSP development process.

The GSAs also hosted three Office Hours in March 2021, May 2021, and August 2021. The workshop topics included the draft sustainable management criteria, groundwater monitoring network, and management areas. The Office Hours are less formal than regular workshops and provide members of the public an opportunity to have a dialogue with STRGBA GSA representatives outside of the monthly meetings.

All workshops and Office Hours scheduled after April 2020 were held virtually due to local and state social distancing requirements resulting from the COVID-19 pandemic. Questions and comments submitted by members of the public was recorded by the planning and outreach staff. A summary of feedback provided by workshop participants was provided at GSP Coordination Committee and Technical Committee meetings and recorded in the workshop summaries, provided in **Appendix E**. Recordings of the May and August 2021 Office Hours were also made available on the STRGBA GSA website.

The GSAs noticed the workshops and GSP Office Hours via a bilingual (English-Spanish) flyer which was posted on the STRGBA GSA and member agencies' websites and member agencies' social media sites and was distributed to the Interested Parties Database.

4.4.3. Other Public Meetings

In addition to monthly public meetings and annual workshops, the STRGBA GSA member agency representatives also discussed the GSP at public meetings of the respective governing bodies and local community and civic organizations. **Table 4-3** provides a list of other public meetings during which the GSP was discussed or considered.

4.5. GSP Comments and Responses

This section describes the process the GSAs used to solicit and respond to comments on the draft GSP. The draft GSP chapters were released for public review and comment as they were developed. Public comments were collected via email. In addition, interested parties could provide verbal comments during monthly Committee and TAC meetings and public workshops. Comments that raised substantive technical or policy issues resulted in revisions to the Draft GSP and are reflected in the draft plan.

4.5.1. Public Comment Process

The GSAs used a serial public comment process to provide beneficial users and members of the public multiple opportunities to review and provide comment on the draft GSP. Draft GSP chapters were released for public review and comment as they were completed. Members of the public were notified of the public comment period through an email distributed to the Interested Parties Database.

Comments were collected via an email to the STRGBA GSA and verbally during monthly Committee and TAC meetings. Comments provided at public meetings and workshops were recorded in the meeting minutes or workshop summary and reviewed by STRGBA GSA member agency staff. Copies of comments received on the draft GSP chapters were posted on the STRGBA GSA website.

At the close of each GSP chapter public comment period, comments received were reviewed by the STRGBA GSA member agency staff and summarized and discussed at monthly Committee and TAC meetings. Comments that raised credible technical or policy issues resulted in revisions to the draft GSP.

Pursuant to the requirements of California Water Code Section 10728.4, the GSAs also distributed a notice of intent to adopt the GSP to cities and counties within the GSP area. The notice was jointly distributed on August 10, 2021. A copy of the notice is provided in **Appendix E**.

4.6. PUBLIC INVOLVEMENT DURING GSP IMPLEMENTATION

The GSAs will keep members of the public and interested parties informed about progress implementing the GSP through emails to the Interested Parties Database, regularly scheduled public meetings, and annual workshops. The GSAs will continue to maintain the website and Interested Parties Database. Emails will be distributed to the Interested Parties Database on a regular basis to inform interested parties about upcoming meetings and public workshops, GSP implementation milestones, and the status of projects and management actions. The website will be updated on an as-needed basis to include information on and announcements pertaining to GSP implementation. The website will also serve as a repository for copies of the Modesto Subbasin Annual Reports and other materials developed during GSP implementation.

It is anticipated at that the STRGBA GSA will continue to meet on a monthly basis. Committee meetings will be noticed on the STRGBA GSA website and via an email to the Interested Parties Database. The GSAs will also hold public workshops as needed to keep members of the public and interested parties informed about progress implementing the GSP. The GSAs will notice the workshops via posting on the website, e-blast, and targeted outreach to organizations and agencies representing beneficial users in the Subbasin. The GSAs and GSA member agencies will also continue to conduct presentations to key stakeholder organizations on an as-needed basis to inform the about implementation of the GSP and groundwater conditions.

Additional public outreach activities may be conducted to support planning, design, and construction activities related to the groundwater management projects. Such activities will be noticed on the website and via an e-blast to the Interested Parties Database.

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5. WATER BUDGETS

Water budgets are a critical component of understanding and evaluating a groundwater basin's sustainability. This chapter discusses the:

- General background on water budgets, the basis of the selected water budgets (historical, current conditions, projected conditions), and their components
- Average annual Subbasin- and area[8]-wide stream, land and water use, and groundwater budgets summarized in tabular format
- Results and insights from the water budget for the historical, current conditions, and projected conditions budgets with supporting figures
- Projected water budget under climate change conditions, including climate change methodology and resulting impacts on the Subbasin
- Sustainable yield assumptions and resulting water budgets

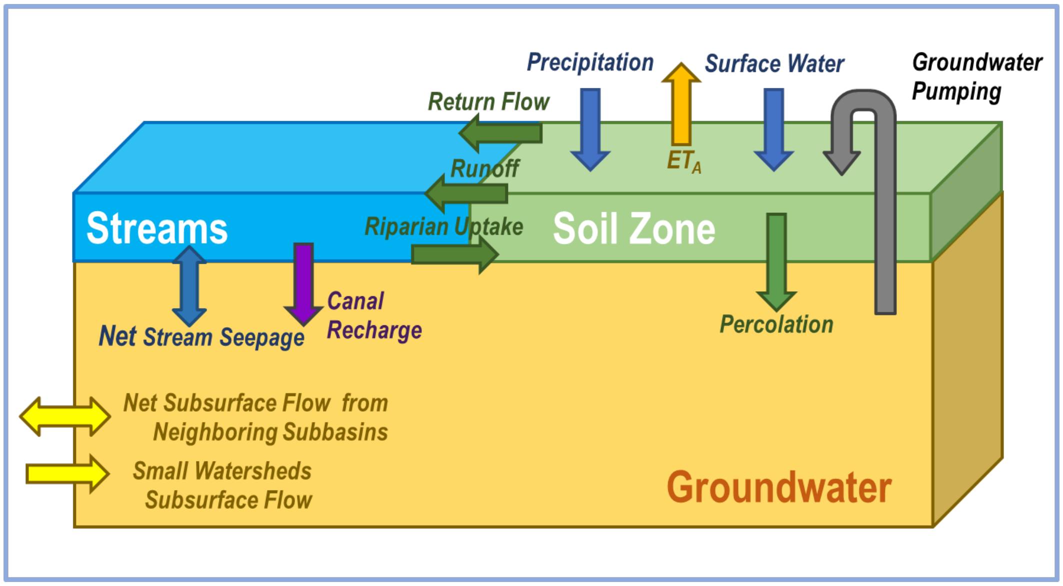
5.1. WATER BUDGET INFORMATION

Comprehensive hydrologic water budgets were developed to provide a quantitative understanding of water entering (inflows) and leaving (outflows) the Modesto Subbasin and are a requirement of the GSP regulations. Water budgets are provided for the three interconnected systems that define the overall hydrologic balance in the Modesto Subbasin - the land surface system, the stream and river system, and the groundwater system. Water entering and leaving each one of the physical systems, and water movement among the systems are a combination of natural processes and anthropogenic conditions. **Figure 5-1** highlights the main water budget components and interconnectivity of stream, surface, and groundwater components used in this analysis.

The values presented in the water budget provide hydrologic information on the historical, current, and projected conditions of the Modesto Subbasin relating to water demand, water supply, land use, population, climate change, groundwater and surface water interaction, and subsurface groundwater flow. An understanding of these impacts can assist in management of the Subbasin by identifying the scale of different water uses, highlighting potential risks presented by each condition, and identifying potential opportunities to improve water supply conditions and use of resources.

[8] The term "area" herein represents the four main subdivisions of the Modesto Subbasin discussed in this report – Modesto Irrigation District, Oakdale Irrigation District, Non-District East, and Non-District West. The establishment of these zones as Management Areas is discussed in **Section 6.2**.

Figure 5-1: Generalized Water Budget Diagram



The water budgets presented below reflect the interconnected movement of water through the land surface system (the soil zone), the stream system, and the groundwater system. Together, these systems and their interactions comprise the integrated water resources system which represents the comprehensive water cycle for the Subbasin. This comprehensive water budget is consistent with SGMA, GSP regulations, best management practices (BMPs), and recommendations in the Handbook for Water Budget Development published by the DWR (2020).

Water budgets can also be developed at different temporal scales. Daily water budgets can be used to demonstrate diurnal variation in the temperature and water use for agriculture and/or stream flows to assess implications on the fisheries and wildlife. Monthly water budgets are typically used to demonstrate variability in agricultural water demand during the irrigation season, or monthly and seasonal variability in surface water supply and/or groundwater pumping. The water budget for the Modesto Subbasin were developed on monthly intervals, though are presented on an annual basis in this report for presentation purposes and to facilitate their incorporation into policy decisions.

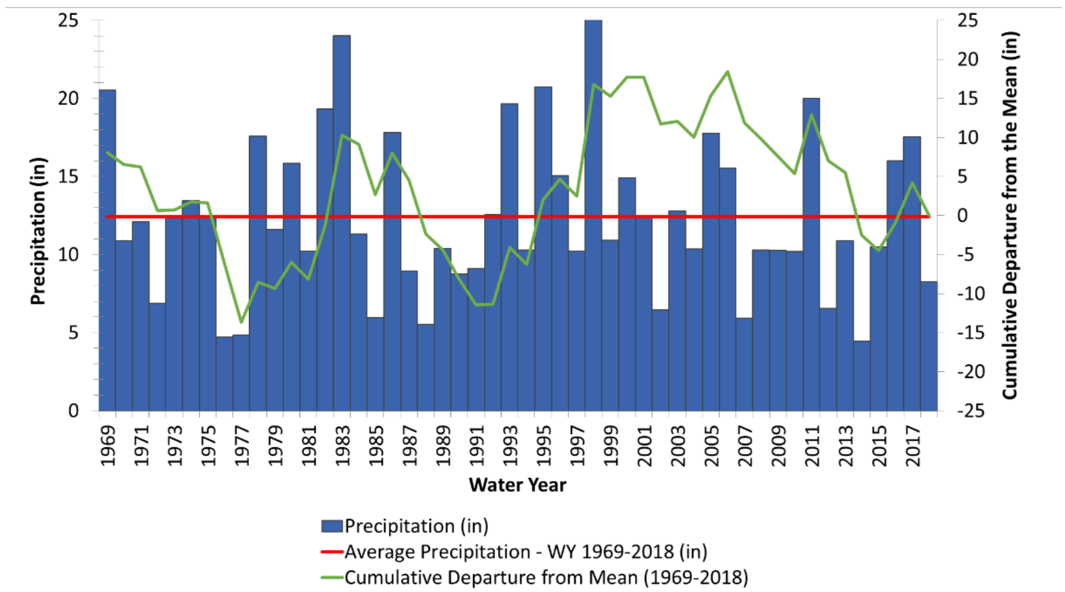
GSP regulations require that three sets of annual water budgets be developed, each reflecting the hydrology under historical, current, and projected levels of urban and agricultural development. Water budgets are developed to capture long-term conditions, which are assessed by averaging hydrologic conditions over several different timeframes. The historical water budgets reflect the average hydrology over a 25-year period (1991-2015), while current conditions are represented by a recent average year from the historical period (2010), and projected conditions are represented by the average of a 50-year hydrologic period. This provides opportunities to incorporate dry years and drought conditions, wet periods, and normal periods. By incorporating these varied conditions into the water budgets, the system can be analyzed in the short- and long-terms, allowing for assessment of the system response to certain hydrologic conditions (e.g., drought) and for assessment of broader system averages. The following subsection provides additional detail on identification of hydrologic periods.

5.1.1. Identification of Hydrologic Periods

Hydrologic periods were selected to meet the needs of developing historical, current, and projected water budgets. The GSP regulations require that the projected conditions are assessed over a 50-year hydrologic period to represent long-term hydrologic conditions. Precipitation data for the Modesto Subbasin were used to identify hydrologic periods that are representative of wet and dry periods and long-term average conditions needed for water budget analyses.

Rainfall data for the Subbasin is derived from the detailed database provided by the Precipitation-Elevation Regressions on Independent Slopes Model (PRISM) dataset. This data set is commonly used by DWR and other organizations for mapping the spatial and temporal distribution of precipitation throughout the state. DWR uses PRISM for the California Simulation of Evapotranspiration of Applied Water (CALSIMETAW) model, which is a major source of estimates of ET of applied water (ETAW) throughout the state. Periods with a balance of wet and dry intervals were identified by evaluating the cumulative departure from mean precipitation. **Figure 5-2** shows the annual precipitation and cumulative departure from the mean for the Modesto Subbasin. While the annual rainfall and precipitation data provides information on annual variability of rainfall over the course of the planning period, the cumulative departure from mean is indicative of long-term trends in Subbasin precipitation. In this context, the rising limbs of the cumulative departure line indicate short-term and long-term wet periods (e.g., 1978-83 and 1992-98), while falling limbs indicate short and long dry periods (e.g., 1976-77 and 2011-15). For the Modesto Subbasin water budget analysis, rainfall and water supply and demand conditions are available for the period October 1968 to September 2018 (WY 1969-2018), with an average annual rainfall of 12.4 inches. For the historical water budget analysis, the period WY 1991-2015 (average annual precipitation of 12.6 inches) is used, which coincides with the period for which the C2VSimTM model is calibrated, and for which the historical water demand and supplies have been confirmed. These periods of record meet the GSP regulatory requirement of at least 10 years for the historical water budget analysis. For the projected water budget purposes, the full period of WY 1969-2018 is used, which provides a 50-year record as required by GSP regulations.

Figure 5-2: 50-Year Historical Precipitation and Cumulative Departure from Mean Precipitation, Modesto Subbasin, California



5.1.2. Usage of C2VSimTM and Associated Data in Water Budget Development

Water budgets were developed utilizing C2VSimTM, a fully integrated surface and groundwater flow model covering the entire Central Valley. This version of C2VSim is based on the C2VSimFG-BETA2 model released by DWR. To support the GSP, C2VSimTM was developed and refined with a focus on land and water use operational data for both the Modesto and Turlock Subbasins. C2VSimTM, a quasi-three-dimensional finite element model, was developed using the Integrated Water Flow Model (IWFM) 2015 software package to simulate the relevant hydrologic processes prevailing in the model domain. The C2VSimTM integrates the groundwater aquifer with the surface hydrologic system and land surface processes and operations. Using data from federal, state, and local resources, the C2VSimTM was calibrated for the hydrologic period of October 1991 to September 2015 by comparing simulated evapotranspiration, groundwater levels, and streamflow records with historical observed records. Development of the model involved the study and analyses of hydrogeologic conditions, agricultural and urban water demands, agricultural and urban water supplies, and an evaluation of regional water quality conditions. Additional information on the data used to develop C2VSimTM is included in **Appendix C**.

All integrated hydrologic models contain assumptions and some level of uncertainty. They are decision support tools used to better understand complex interactive systems. Sources of model uncertainty include heterogeneity in hydrogeologic properties and stratigraphy, quality of historical data, projections of future land use, hydrology, operational data, and climatic conditions.

C2VSimTM has been calibrated and validated. The data and assumptions for Modesto and Turlock Subbasins were developed in a collaborative manner with the respective districts and are based on best available data and science. Projections of future land use and water demands were based on the most recent planning documents prepared by agencies in the Subbasin. In its current form, the model represents the best available data for the Subbasin. As additional information is collected during GSP implementation, the model will be updated to reflect the newly available resources. Efforts to address Subbasin data gaps will improve information available for the model.

With the C2VSimTM as the underlying framework, model simulations were developed to allow for the estimation of water budgets. Four model simulations were used to develop the water budgets for historical, current, projected, and climate change conditions, which are discussed in detail below:

The **historical water budget** is based on a simulation of historical conditions in the Modesto Subbasin (1991-2015).

The **current water budget** is based on an average year (2010) of the historical simulation that incorporates current irrigation and operational practices.

The **projected water budget** is based on a simulation of future land and water use over the historical hydrologic conditions.

The **climate change water budget** is based on the projected water budget under 2070 climate conditions and is discussed in **Section 5.2**.

The **sustainable yield water budget** is based on the projected water budget refined to meet SGMA sustainability criteria and is discussed in **Section 5.3**

5.1.3. Water Budget Definitions and Assumptions

Definitions and assumptions for the historical, current, and projected water budgets are provided below. These assumptions are summarized in **Table 5-1**.

5.1.3.1. Historical Water Budget

The historical water budget is intended to evaluate availability and reliability of past surface water supply deliveries, aquifer response to water supply, and demand trends relative to WY type. The historical calibration of the C2VSimTM reflects the historical conditions in the Modesto Subbasin through the 2015 water year. The hydrologic period of WY 1991 through 2015 is selected for the GSP historical water budget because it provides a period of representative hydrology while capturing recent operations within the Subbasin. The period WY 1991 through 2015 has an average annual precipitation of approximately 12.6 inches, slightly higher than the long-term average of 12.4 inches observed for the 50-year projected hydrologic period of WY 1969-2018. Both periods include the recent WY 2012-2015 drought, the wetter years of WY 1998 and 2010-2011, and periods of normal precipitation.

5.1.3.2. Current Water Budget

The current conditions water budget uses recent historical conditions. The 2010 water year was selected to represent current conditions because it was the last normal water year before the 2012-2015 drought. It represents the current level of development within the Subbasin and reflects current agricultural irrigation practices, land use patterns, surface water operations, and urban water usage under non-drought conditions.

5.1.3.3. Projected Water Budget

The projected water budget is intended to assess the hydrologic systems of the Subbasin under the projected agricultural and urban demand, water supply, and operational conditions over the next 50-years. The Projected Conditions Baseline scenario applies projected future land and water use conditions to the 50-year hydrologic period of WY 1969-2018. The Projected Condition Baseline assumes urban population and land use expansion based on each municipality's 2015 Urban Water Management Plan. Under projected conditions, agricultural land is held constant at 2015 cropping patters except where urban expansion pulls acreage out of production. Furthermore, under projected conditions, the consumptive use factor (CUF), or the ratio of evapotranspiration per unit of applied water, was increased relative to the historical to simulate modernization of irrigation management and technologies within the Subbasin.

The Projected Conditions Baseline includes the following conditions:

- Hydrologic period:
    - WY 1969-2018 (50-year hydrology)
- River flow is based on:
    - Tuolumne River: Tuolumne River System (TRS) operations model
    - Stanislaus River: Average monthly values by water year type
    - San Joaquin River: CalSim II baseline operations
- Land use is based on:
    - 2015 agricultural land use and cropping patterns held constant
    - Urban land use expansion based on 2015 UWMP
- Agricultural water demand is based on:
    - IWFM estimates based on current land use and refined CUF
- Surface water deliveries are based on data from:
    - Modesto ID – Tuolumne River System (TRS) operations model
    - Oakdale ID – Historical monthly average by water year type
    - Subbasin Riparian Users – Historical monthly average by water year type
- Urban water demand is based on:

- 2015 Urban Water Management Plans (UWMPs)
- Continuation of historical population trends, while meeting 2020 State of California GPCD goals.

- Urban water supply is based on:
  - Expanded surface water deliveries from MID to the City of Modesto
  - Projected urban groundwater production based on 2015 UWMPs distributed to existing wells

Table 5-1: Summary of Groundwater Budget Assumptions

Water Budget Type	Historical	Current	Projected
Tool	C2VSimTM	C2VSimTM	C2VSimTM
Scenario	Historical Simulation	Current Conditions Baseline	Projected Conditions Baseline
Hydrologic Years	WY 1991-2015	WY 2010	WY 1969-2018
Level of Development	Historical Records	WY 2010	General Plan buildout
Agricultural Demand	Historical Records	WY 2010	Projected based on refined 2015 land use and modern irrigation practices
Urban Demand	Historical Records	WY 2010	Projected based on local UWMP data and historical population growth
Water Supplies	Historical Records	WY 2010	Projected based on local operations modeling and historical trends

5.1.4. Water Budget Estimates

The primary components of the stream system, presented at the Subbasin scale, are:

- Inflows:
  - Stream inflows into the Tuolumne River and Stanislaus River at the boundary of the model and San Joaquin River inflows at upstream of the confluence of the Tuolumne and San Joaquin River (bounding the Modesto Subbasin)
  - Tributary inflows from surface water contributions from small watersheds

- Total stream gain from the groundwater system
    - Surface runoff from precipitation to the stream system
    - Return flow of applied water to the stream system
- Outflows:
    - San Joaquin River flow downstream of the Stanislaus River confluence
    - Surface water supplies diverted from the stream system to meet agricultural or urban demand downstream of La Grange Dam.
    - Stream seepage to the groundwater system
    - Uptake of river water from native or riparian vegetation along the stream bed

The primary components of the land surface system, presented for each water budget zone, include:

- Supplies:
    - Precipitation
    - Surface water supplies
    - Groundwater supplies
    - Uptake of river water from native or riparian vegetation along the stream bed
- Demands:
    - Evapotranspiration
    - Surface runoff of precipitation to the stream system
    - Return flow of applied water to the stream system
    - Percolation of water to the groundwater system
- Land surface system balance

The primary components of the groundwater system, presented at the Subbasin scale, are:

- Inflows:
    - Percolation of water from the land surface system
    - Groundwater gains from stream system
    - Subsurface inflow from neighboring subbasins and the foothills
- Outflows:
    - Groundwater discharge to the stream system
    - Groundwater production (pumping)
    - Subsurface outflow to neighboring subbasins

- Change in groundwater in storage - negative values represent a depletion of storage

The estimated water budgets are provided below in **Table 5-2** through **Table 5-8** for the historical, current, and projected water budgets. The land surface water budgets are presented for the entire Subbasin and for each water budget zone (Modesto Irrigation District managed zone (Modesto), Oakdale South, NDE, and Non-District West). Each of these zones represent the geographic area shown in **Figure 5-3** and include all sectors, including agricultural, industrial, municipal, and domestic water users. These zones have been used to develop *Management Areas* (as defined in the GSP regulations) based primarily on the availability of surface water sources. These Management Areas, along with the justification and rationale for each, are presented in **Section 6.2** on Sustainable Management Criteria.

Developing operational water budgets for the land surface system has allowed the GSAs to better quantify how varying anthropogenic processes have affected and will continue to affect the aquifer system. In contrast, the stream and groundwater system budgets are presented at the subbasin scale, to best target the GSA's sustainability goals and metrics.

Figure 5-3: Water Budget Zones

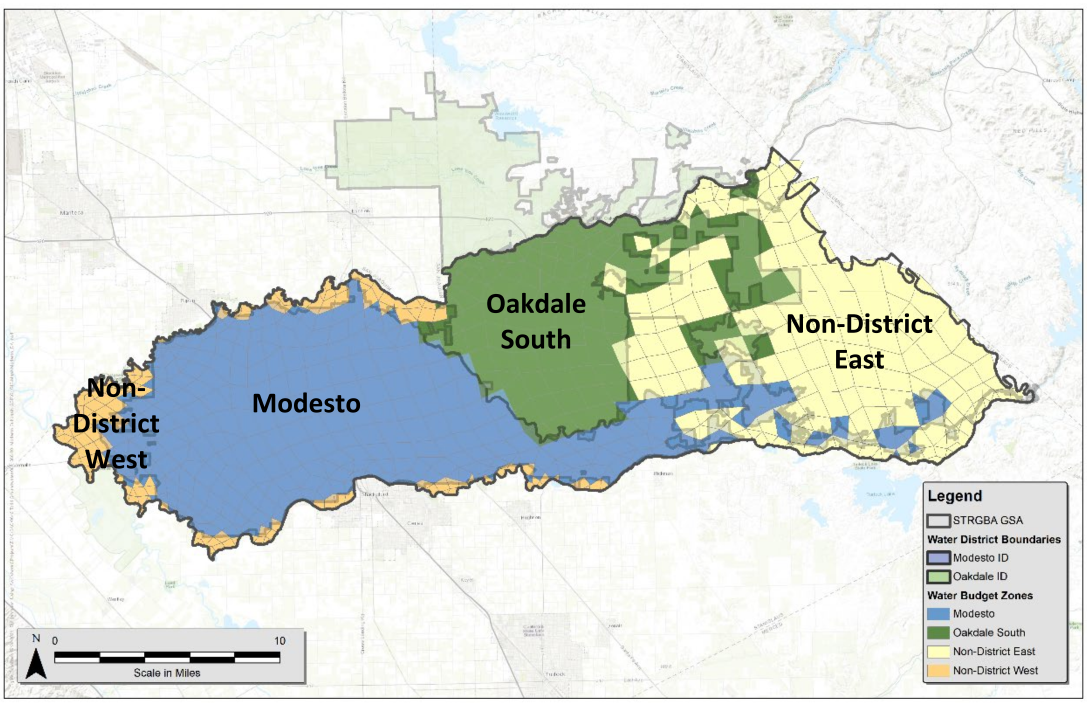


Table 5-2: Average Annual Water Budget – Stream Systems, Modesto Subbasin (AFY)

Component	Historical Condition Water Budget	Current Condition Water Budget	Projected Condition Water Budget
Hydrologic Period	WY 1991- 2015	WY 2010	Hydrology from WY 1969 - 2018
Stream Inflows	2,547,000	1,625,000	2,650,000
Stanislaus River	520,000	320,000	536,000
Tuolumne River	742,000	593,000	812,000
San Joaquin River	1,285,000	711,000	1,302,000
Tributary Inflow[1]	6,000	-	6,000
Stream Gain from Groundwater	207,000	167,000	104,000
Modesto Subbasin	100,000	80,000	50,000
Stanislaus River - South[2]	35,000	27,000	12,000
Tuolumne River - North	51,000	39,000	27,000
San Joaquin River - East	15,000	13,000	11,000
Other Subbasins	108,000	88,000	54,000
Stanislaus River – North	37,000	30,000	12,000
Tuolumne River - South	56,000	44,000	31,000
San Joaquin River - West	15,000	14,000	11,000
Surface Runoff to the Stream System[3]	57,000	35,000	60,000
Return Flow to Stream System[3]	104,000	97,000	113,000
Total Inflow	**2,922,000**	**1,923,000**	**2,934,000**
San Joaquin River Outflows	2,770,000	1,745,000	2,717,000
Diverted Surface Water[4]	43,000	47,000	33,000
Stream Seepage to Groundwater	74,000	95,000	146,000
Modesto Subbasin	40,000	51,000	76,000
Stanislaus River - South	19,000	20,000	36,000
Tuolumne River - North	20,000	30,000	38,000
San Joaquin River - East	1,000	-	2,000
Other Subbasins	34,000	44,000	71,000
Stanislaus River - North	13,000	14,000	31,000
Tuolumne River - South	20,000	30,000	38,000
San Joaquin River - West	1,000	-	2,000
Native & Riparian Uptake from Streams	35,000	37,000	37,000
Total Outflow	**2,922,000**	**1,923,000**	**2,934,000**

Note: sub-categories may not sum together due to rounding error

1 Tributary inflow includes surface water contributions from small watersheds

2 Represents the location of the Modesto Subbasin relative to the stream, i.e., "South" represents the gains/losses of that stream to the Modesto Subbasin where as "North" represents the gains/losses of that stream to the Eastern San Joaquin Subbasin.

3 Includes runoff/return flow from all subbasins adjacent to the stream system, not just the Modesto Subbasin.

4 Some surface water diversions are upstream of the Tuolumne River or Stanislaus River inflows and thus not included in this stream system (streams and canals) water budget.

Table 5-3: Average Annual Water Budget – Land Surface System, Modesto Subbasin (AFY)

Component	Historical Condition Water Budget	Current Condition Water Budget	Projected Condition Water Budget
Hydrologic Period	**WY 1991- 2015**	**WY 2010**	**Hydrology from WY 1969 - 2018**
Agricultural Areas Precipitation	147,000	122,000	139,000
Agricultural Water Supply	513,000	611,000	497,000
Agency Surface Water	264,000	250,000	241,000
Agency Groundwater	26,000	15,000	25,000
Private Groundwater	222,000	345,000	229,000
Urban Areas Precipitation	32,000	26,000	38,000
Urban Water Supply	89,000	88,000	111,000
Groundwater	63,000	56,000	60,000
Surface Water	26,000	32,000	51,000
Native Areas Precipitation	92,000	78,000	92,000
Native Uptake from Stream	20,000	20,000	22,000
Total Supplies	**892,000**	**945,000**	**900,000**
Agricultural ET	368,000	416,000	402,000
Agricultural ET of Precipitation	80,000	73,000	82,000
Agricultural ET of Surface Water	149,000	143,000	159,000
Agricultural ET of Agency Groundwater	14,000	8,000	16,000
Agricultural ET of Private Groundwater	125,000	192,000	146,000
Agricultural Percolation	246,000	236,000	201,000
Agricultural Percolation of Precipitation	57,000	39,000	45,000
Agricultural Percolation of Surface Water	99,000	83,000	75,000
Agricultural Percolation of Agency Groundwater	10,000	5,000	8,000
Agricultural Percolation of Private Groundwater	81,000	110,000	73,000
Agricultural Runoff & Return Flow	35,000	31,000	31,000
Urban Runoff & Return Flow	74,000	68,000	91,000
Urban ET	28,000	27,000	38,000
Urban Percolation	18,000	17,000	20,000
Native Runoff	12,000	5,000	12,000
Native ET	91,000	88,000	95,000
Native Percolation	8,000	3,000	7,000
Total Demands	**879,000**	**892,000**	**898,000**
Land Surface System Balance	13,000	53,000	2,000
Land Surface System Balance (% of supplies)	1.5%	5.6%	0.2%

Note: sub-categories may not sum together due to rounding error

Table 5-4: Average Annual Water Budget – Land Surface System, Modesto Area (AFY)

Component	Historical Condition Water Budget	Current Condition Water Budget	Projected Condition Water Budget
Hydrologic Period	WY 1991- 2015	WY 2010	Hydrology from WY 1969 - 2018
Agricultural Areas Precipitation	73,000	58,000	65,000
Agricultural Water Supply	281,000	315,000	244,000
Agency Surface Water	125,000	121,000	106,000
Agency Groundwater	22,000	11,000	21,000
Private Groundwater	135,000	183,000	117,000
Urban Areas Precipitation	26,000	21,000	32,000
Urban Water Supply	73,000	72,000	96,000
Groundwater	47,000	40,000	45,000
Surface Water	26,000	32,000	51,000
Native Areas Precipitation	11,000	9,000	11,000
Native Uptake from Stream	5,000	5,000	5,000
Total Supplies	**468,000**	**481,000**	**453,000**
Agricultural ET	193,000	210,000	195,000
Agricultural ET of Precipitation	38,000	34,000	38,000
Agricultural ET of Surface Water	69,000	68,000	68,000
Agricultural ET of Agency Groundwater	12,000	6,000	14,000
Agricultural ET of Private Groundwater	74,000	103,000	75,000
Agricultural Percolation	136,000	137,000	97,000
Agricultural Percolation of Precipitation	29,000	21,000	21,000
Agricultural Percolation of Surface Water	48,000	44,000	33,000
Agricultural Percolation of Agency Groundwater	8,000	4,000	6,000
Agricultural Percolation of Private Groundwater	51,000	67,000	36,000
Agricultural Runoff & Return Flow	20,000	18,000	16,000
Urban Runoff & Return Flow	61,000	56,000	78,000
Urban ET	22,000	21,000	31,000
Urban Percolation	16,000	16,000	19,000
Native Runoff	1,000	-	1,000
Native ET	14,000	13,000	14,000
Native Percolation	1,000	1,000	1,000
Total Demands	**463,000**	**471,000**	**453,000**
Land Surface System Balance	6,000	10,000	1,000
Land Surface System Balance (% of supplies)	1.2%	2.1%	0.1%

Note: sub-categories may not sum together due to rounding error

Table 5-5: Average Annual Water Budget – Land Surface System, Oakdale South Area (AFY)

Component	Historical Condition Water Budget	Current Condition Water Budget	Projected Condition Water Budget
Hydrologic Period	WY 1991- 2015	WY 2010	Hydrology from WY 1969 - 2018
Agricultural Areas Precipitation	46,000	40,000	45,000
Agricultural Water Supply	150,000	174,000	143,000
Agency Surface Water	120,000	109,000	121,000
Agency Groundwater	4,000	4,000	4,000
Private Groundwater	26,000	61,000	18,000
Urban Areas Precipitation	4,000	3,000	4,000
Urban Water Supply	11,000	12,000	9,000
Groundwater	11,000	12,000	9,000
Surface Water	-	-	-
Native Areas Precipitation	13,000	10,000	13,000
Native Uptake from Stream	2,000	2,000	2,000
Total Supplies	**225,000**	**241,000**	**217,000**
Agricultural ET	112,000	125,000	124,000
Agricultural ET of Precipitation	25,000	24,000	27,000
Agricultural ET of Surface Water	69,000	63,000	81,000
Agricultural ET of Agency Groundwater	2,000	2,000	3,000
Agricultural ET of Private Groundwater	15,000	36,000	12,000
Agricultural Percolation	72,000	59,000	57,000
Agricultural Percolation of Precipitation	17,000	11,000	14,000
Agricultural Percolation of Surface Water	45,000	30,000	37,000
Agricultural Percolation of Agency Groundwater	1,000	1,000	1,000
Agricultural Percolation of Private Groundwater	9,000	17,000	5,000
Agricultural Runoff & Return Flow	8,000	6,000	7,000
Urban Runoff & Return Flow	9,000	9,000	8,000
Urban ET	4,000	4,000	5,000
Urban Percolation	2,000	1,000	1,000
Native Runoff	2,000	1,000	2,000
Native ET	12,000	11,000	12,000
Native Percolation	1,000	1,000	1,000
Total Demands	**221,000**	**217,000**	**217,000**
Land Surface System Balance	4,000	24,000	-
Land Surface System Balance (% of supplies)	1.7%	9.8%	0.0%

Note: sub-categories may not sum together due to rounding error

Table 5-6: Average Annual Water Budget – Land Surface System, Non-District East (AFY)

Component	Historical Condition Water Budget	Current Condition Water Budget	Projected Condition Water Budget
Hydrologic Period	WY 1991- 2015	WY 2010	Hydrology from WY 1969 - 2018
Agricultural Areas Precipitation	19,000	16,000	19,000
Agricultural Water Supply	48,000	84,000	81,000
Agency Surface Water	-	-	-
Agency Groundwater	-	-	-
Private Groundwater	48,000	84,000	81,000
Urban Areas Precipitation	-	-	-
Urban Water Supply	-	-	-
Groundwater	-	-	-
Surface Water	-	-	-
Native Areas Precipitation	65,000	57,000	65,000
Native Uptake from Stream	6,000	6,000	7,000
Total Supplies	**137,000**	**163,000**	**173,000**
Agricultural ET	37,000	54,000	60,000
Agricultural ET of Precipitation	11,000	11,000	10,000
Agricultural ET of Surface Water	-	-	-
Agricultural ET of Agency Groundwater	-	-	-
Agricultural ET of Private Groundwater	26,000	43,000	50,000
Agricultural Percolation	22,000	23,000	34,000
Agricultural Percolation of Precipitation	7,000	4,000	7,000
Agricultural Percolation of Surface Water	-	-	-
Agricultural Percolation of Agency Groundwater	-	-	-
Agricultural Percolation of Private Groundwater	16,000	19,000	27,000
Agricultural Runoff & Return Flow	5,000	5,000	6,000
Urban Runoff & Return Flow	-	-	-
Urban ET	-	-	-
Urban Percolation	-	-	-
Native Runoff	9,000	4,000	9,000
Native ET	56,000	54,000	58,000
Native Percolation	5,000	2,000	5,000
Total Demands	**134,000**	**142,000**	**171,000**
Land Surface System Balance	4,000	21,000	1,000
Land Surface System Balance (% of supplies)	2.6%	13.1%	0.8%

Note: sub-categories may not sum together due to rounding error

Table 5-7: Average Annual Water Budget – Land Surface System, Non-District West (AFY)

Component	Historical Condition Water Budget	Current Condition Water Budget	Projected Condition Water Budget
Hydrologic Period	WY 1991- 2015	WY 2010	Hydrology from WY 1969 - 2018
Agricultural Areas Precipitation	10,000	8,000	10,000
Agricultural Water Supply	35,000	38,000	29,000
Agency Surface Water	19,000	20,000	15,000
Agency Groundwater	-	-	-
Private Groundwater	15,000	17,000	14,000
Urban Areas Precipitation	2,000	2,000	2,000
Urban Water Supply	5,000	4,000	6,000
Groundwater	5,000	4,000	6,000
Surface Water	-	-	-
Native Areas Precipitation	3,000	2,000	3,000
Native Uptake from Stream	7,000	7,000	8,000
Total Supplies	**61,000**	**61,000**	**57,000**
Agricultural ET	26,000	27,000	24,000
Agricultural ET of Precipitation	6,000	5,000	6,000
Agricultural ET of Surface Water	11,000	12,000	9,000
Agricultural ET of Agency Groundwater	-	-	-
Agricultural ET of Private Groundwater	9,000	10,000	9,000
Agricultural Percolation	16,000	18,000	13,000
Agricultural Percolation of Precipitation	4,000	3,000	3,000
Agricultural Percolation of Surface Water	7,000	8,000	5,000
Agricultural Percolation of Agency Groundwater	-	-	-
Agricultural Percolation of Private Groundwater	5,000	7,000	4,000
Agricultural Runoff & Return Flow	3,000	2,000	2,000
Urban Runoff & Return Flow	4,000	3,000	5,000
Urban ET	2,000	2,000	3,000
Urban Percolation	-	-	-
Native Runoff	-	-	-
Native ET	10,000	10,000	11,000
Native Percolation	-	-	-
Total Demands	**61,000**	**62,000**	**57,000**
Land Surface System Balance	-	(2,000)	-
Land Surface System Balance (% of supplies)	0.7%	-2.5%	-0.2%

Note: sub-categories may not sum together due to rounding error

Table 5-8: Average Annual Water Budget – Groundwater System, Modesto Subbasin (AFY)

Component	Historical Condition Water Budget	Current Condition Water Budget	Projected Condition Water Budget
Hydrologic Period	WY 1991- 2015	WY 2010	Hydrology from WY 1969 - 2018
Gain from Stream	40,000	51,000	76,000
Gain from Stanislaus River	19,000	20,000	36,000
Gain from Tuolumne River	20,000	30,000	38,000
Gain from San Joaquin River	1,000	-	2,000
Canal & Reservoir Recharge	49,000	47,000	47,000
Deep Percolation	272,000	257,000	228,000
Subsurface Inflow	80,000	79,000	77,000
Flow from the Sierra Nevada Foothills	9,000	5,000	9,000
Eastern San Joaquin Subbasin Inflows	8,000	9,000	28,000
Turlock Subbasin Inflows	30,000	34,000	33,000
Delta Mendota Subbasin Inflows	33,000	31,000	7,000
Total Inflow	**440,000**	**434,000**	**428,000**
Discharge to Stream	100,000	80,000	50,000
Discharge to Stanislaus River	35,000	27,000	12,000
Discharge to Tuolumne River	51,000	39,000	27,000
Discharge to San Joaquin River	15,000	13,000	11,000
Subsurface Outflow	73,000	63,000	75,000
Eastern San Joaquin Subbasin Outflows	6,000	5,000	35,000
Turlock Subbasin Outflows	32,000	24,000	34,000
Delta Mendota Subbasin Outflows	36,000	35,000	6,000
Groundwater Production	311,000	416,000	314,000
Agency Ag. Groundwater Production	26,000	15,000	25,000
Private Ag. Groundwater Production	222,000	345,000	229,000
Urban Groundwater Production	63,000	56,000	60,000
Total Outflow	**483,000**	**559,000**	**438,000**
Change in Groundwater in Storage	(43,000)	(125,000)	(11,000)

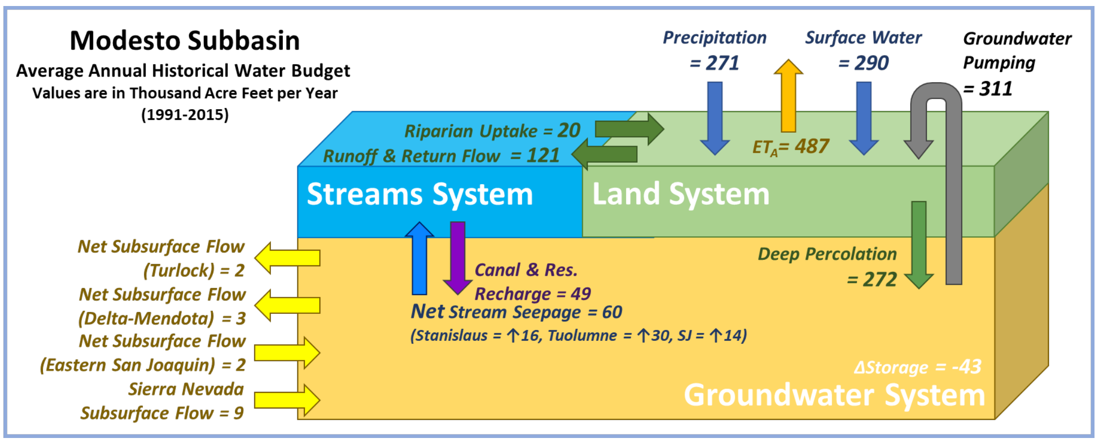
Note: sub-categories may not sum together due to rounding error

5.1.4.1. Historical Water Budget

The historical water budget is a quantitative evaluation of the historical surface and groundwater supply covering the 25-year period from WY 1991 to 2015. This period was selected as the representative hydrologic period as it reflects the most recent basin operations and has similar average precipitation compared to a longer historical period (WY 1969-2018). The goal of the water budget analysis is to characterize the water supply and demand, while summarizing the accounting of water demand and supply components and their changes within each area, and the Subbasin as a whole.

Figure 5-4 below shows the average annual water budget components for the entirety of the Modesto Subbasin and the interaction between the land surface, stream, and groundwater systems for the historical simulation.

Figure 5-4: Average Annual Historical Water Budget – Modesto Subbasin

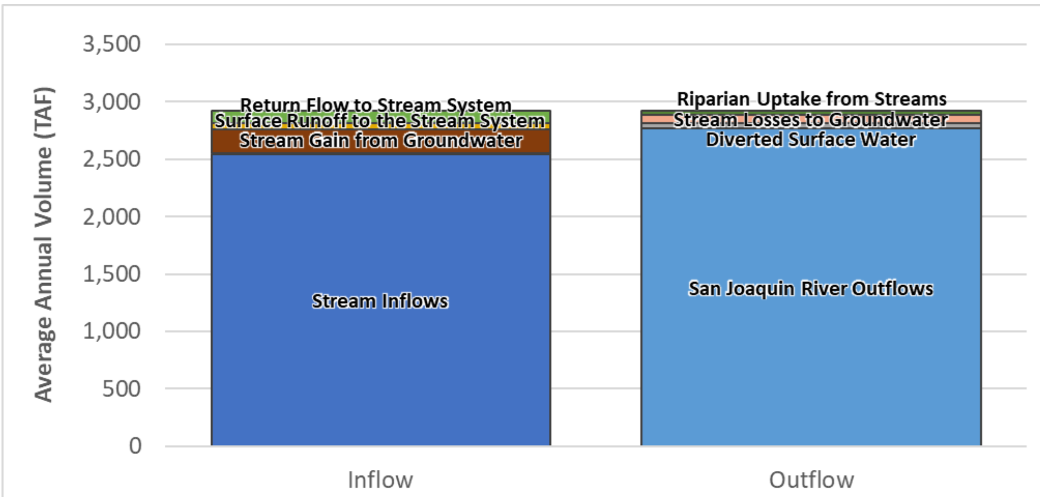


Note: sub-categories may not sum together due to rounding error

The existing stream system supplies multiple water users and agencies in the Modesto Subbasin, including Modesto ID, Oakdale ID, and riparian diverter along each of the major rivers. Analysis of the stream system accounts for potentially significant effects related to both natural interactions and managed operations of adjacent subbasins. Therefore, the water budget in **Table 5-2** above and **Figure 5-5**, shown below, provides average annual quantities of surface and canal system flows within the Modesto Subbasin, plus estimates of interactions with adjoining subbasins. Average annual surface water inflow to the streams adjacent to the Subbasin is estimated to be 2,921,000 AFY. Most of these flows enter the stream system through inflows from regulated reservoirs and river courses, with an average of 742,000 AFY from the Tuolumne, 520,000 AFY from the Stanislaus, and 1,285,000 AFY from the San Joaquin Rivers, respectively. Other stream system inflows include inflow from tributary watersheds (6,000 AFY), surface runoff from precipitation (57,000 AFY), return flow from applied water (104,000 AFY), and gain from groundwater (207,000 AFY).

Outflows from the Modesto Subbasin stream system total 2,922,000 AFY and include stream losses to the groundwater system (74,000 AFY), surface water diversions (43,000 AFY), and riparian uptake (35,000 AFY). Most outflows from the stream system are San Joaquin River flows, which discharge from the Modesto Subbasin downstream of its confluence with the Stanislaus River at an average of 2,770,000 AFY. Note that surface water diversions for Oakdale and Modesto Irrigation Districts occur from reservoirs upstream of the Subbasin boundaries and are not included in the stream-system budget.

Figure 5-5: Historical Average Annual Water Budget – Stream Systems, Modesto Subbasin



The land surface system of the Modesto Subbasin, shown in **Table 5-3** and in **Figure 5-6**, represents the demand and supplies in the Modesto Subbasin and in each zone. During the historical period, total average annual water supplies to the Modesto Subbasin is estimated at 892,000 AFY, consisting of precipitation (271,000 AFY), surface water deliveries (290,000 AFY), and groundwater supplies (312,000 AFY), as well as water uptake by riparian vegetation along the river courses (20,000 AFY). Surface water supplies are provided primarily through Modesto ID's and Oakdale ID's canal networks to growers in the districts, with some riparian surface water diversions in the Non-District West. Each of these areas supplement their surface water with some groundwater production to meet their agricultural and urban demand, whereas the NDE areas rely primarily on groundwater production for its agricultural supplies.

Average annual water demand in the Modesto Subbasin totals 879,000 AFY, and is comprised of agricultural crops, urban landscaping, and native evapotranspiration (487,000 AFY), surface runoff and return flow to the stream system (121,000 AFY), and deep percolation (272,000 AFY). **Figure 5-7** shows the annual volumes of major agricultural water demand and supply components throughout the historical water budget period. The surface water supply in this water budget is reflective of the applied water thus does not include operational return flow or canal seepage. **Figure 5-8** shows the annual supply and demand for municipal and private domestic water use in the Modesto Subbasin.

Figure 5-6: Historical Average Annual Water Budget – Land Surface System, Modesto Subbasin

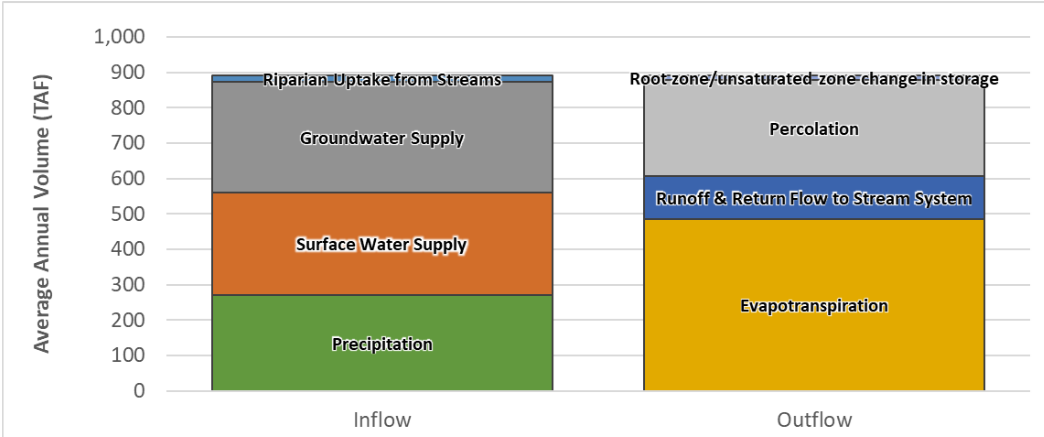


Figure 5-7: Historical Annual Water Budget – Agricultural Land Surface System, Modesto Subbasin

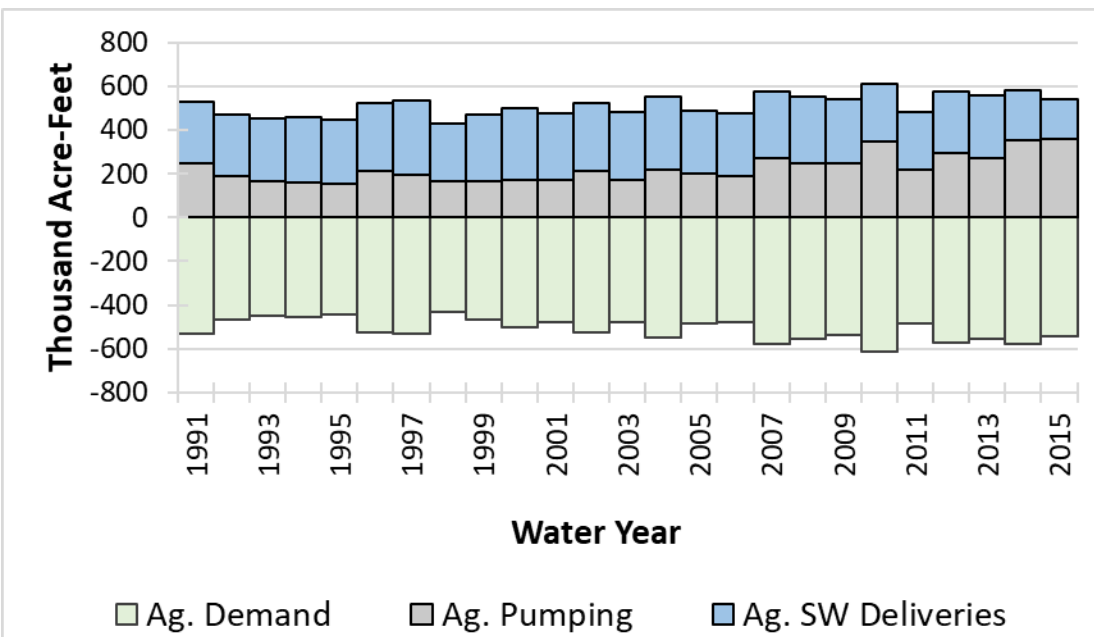


Figure 5-8: Historical Annual Water Budget – Urban Land Surface System, Modesto Subbasin

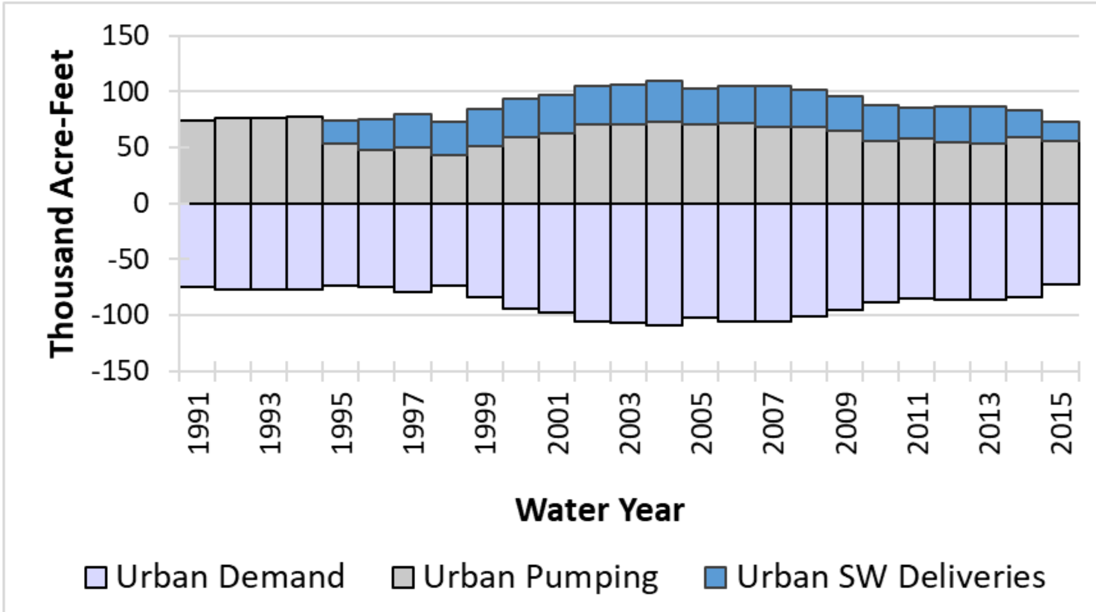


Table 5-8 highlights the major flow components of the Modesto Subbasin's groundwater system. As shown in this table, the aquifer receives approximately 440,000 AFY of inflows each year, which consist of recharge from streams (40,000 AFY), seepage from canals and reservoirs (49,000 AFY), deep percolation from precipitation and applied water (272,000 AFY), as well as subsurface inflows from the Sierra Nevada foothills and the neighboring subbasins of Eastern San Joaquin, Delta-Mendota, and Turlock (80,000 AFY combined).

Table 5-8 also shows the outflows from the Modesto Subbasin. On average, the outflows exceed the inflows in the Subbasin. The largest component of outflow from the groundwater system is groundwater pumping (311,000 AFY), followed by discharge to streams (100,000 AFY), and subsurface outflow to the neighboring subbasins (73,000 AFY).

In conjunction with the land surface budgets presented for each water budget area, a net-recharge analysis was preformed to better understand the relationship of water supply conditions and recharge to the groundwater system. This analysis is documented below, both at the Subbasin level and for each water budget area.

Figure 5-9 shows the total annual groundwater pumped from, and the subsequent recharge to the Modesto Subbasin. In this figure, groundwater pumping represents the combination of groundwater extracted for both agricultural and urban use for each year during the historical period. Recharge into the aquifer system includes both deep percolation from the land system and direct recharge from the canal and reservoir system. The deep percolation in this figure includes recharge from percolated precipitation, agricultural applied water, outdoor irrigation from municipal and rural domestic users.

Figure 5-10 shows the net-recharge in the Modesto Subbasin and is based on the annual balance from the previous figure. This figure indicates that during the historical period, the Subbasin has trended increasingly toward net extraction, but has on average experienced net recharge. This is both indicative of local hydrology and increasing demand on the aquifer system. Over the 25-year historical period, the Modesto Subbasin has seen a large increase in both urban demand and agricultural production. Over time, increases in groundwater production has further stressed the subbasin leading to more consistently negative values, or net extractions. Furthermore, through the 2012-2015 drought, the subbasin experienced a greater net-extraction from the aquifer system corresponding to reduced surface water supply, whereas in periods of wetter or normal operations, the Subbasin has historically been a net-contributor to the groundwater system.

Figure 5-11 through **Figure 5-18** show similar trends conditions for each water budget area. The Oakdale South water budget zone (**Figure 5-14**) has predominately experienced net recharge, while the NDE zone has predominately experienced net extraction (**Figure 5-16**). The Modesto water budget zone and the Non-District West zone experience more variable conditions trending in near-balance (**Figure 5-12** and **Figure 5-18**, respectively). Over the historical period, all zones have trended increasingly toward net extraction due to increased water demand from all sectors and drought conditions at the end of the period.

Overall, the Modesto Subbasin's groundwater system has experienced long term (25-year) decline in storage averaging 43,000 AFY as shown in **Figure 5-19**. This decline is more heavily weighted to the end of the study period due to increased stresses relating to both local hydrology, and water demand as shown in **Figure 20**. **Figure 20** also shows the temporal breakdown of the groundwater budget and highlights the intensifying decline of groundwater in storage in recent years, particularly under drought conditions where groundwater production has increased to a long-term high.

The historical inflows and outflows to the Modesto Subbasin change with hydrologic conditions. In wet years, precipitation and increased surface water availability reduces the need for groundwater use. However, in dry years, more groundwater is pumped to meet the demand not met by surface water or precipitation. This leads to an increase in groundwater in storage in wet years and a decrease in dry years. These trends are shown in **Table 5-9**, which provides average historical water supply and demand by water year type.

Figure 5-9: Groundwater Recharge and Extraction – Modesto Subbasin

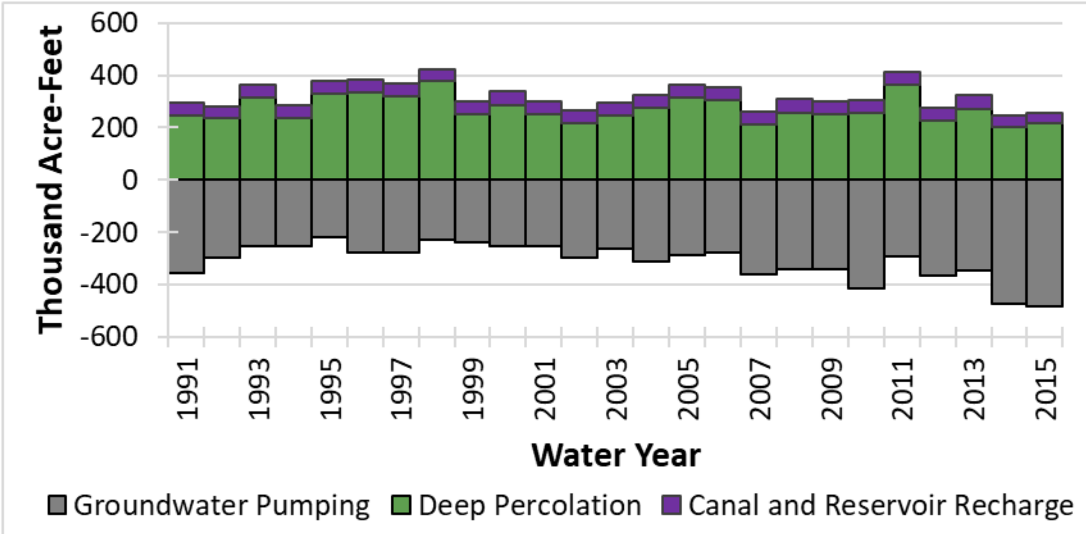


Figure 5-10: Net Recharge – Modesto Subbasin

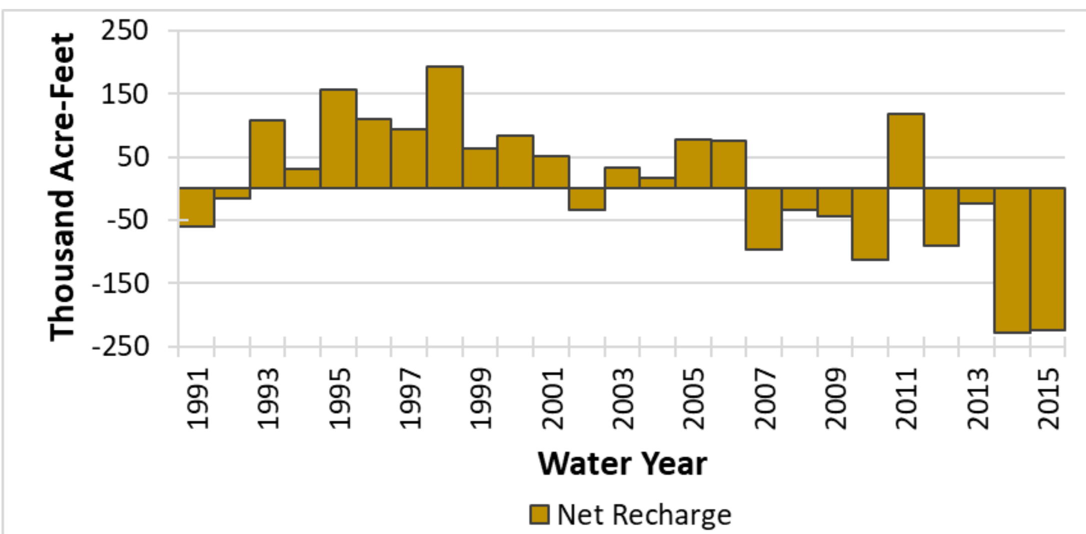


Figure 5-11: Groundwater Recharge and Extraction – Modesto Zone

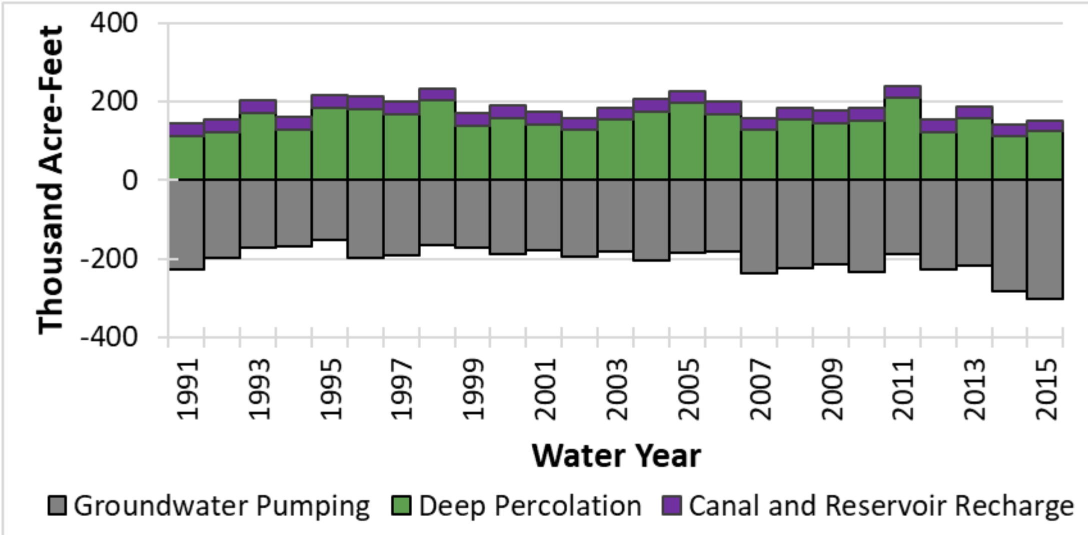


Figure 5-12: Net Recharge – Modesto Zone

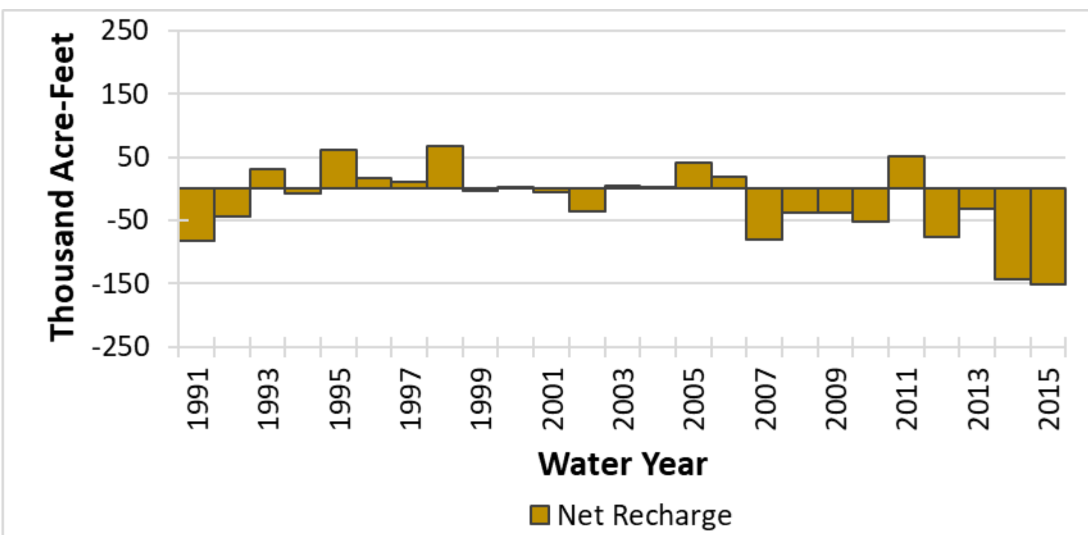


Figure 5-13: Groundwater Recharge and Extraction – Oakdale South Zone

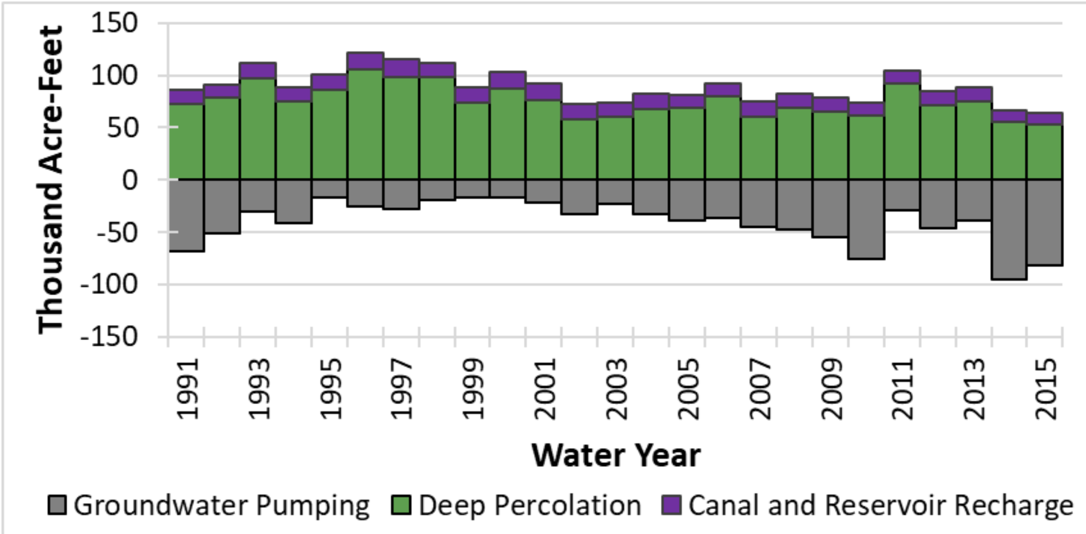


Figure 5-14: Net Recharge – Oakdale South Zone

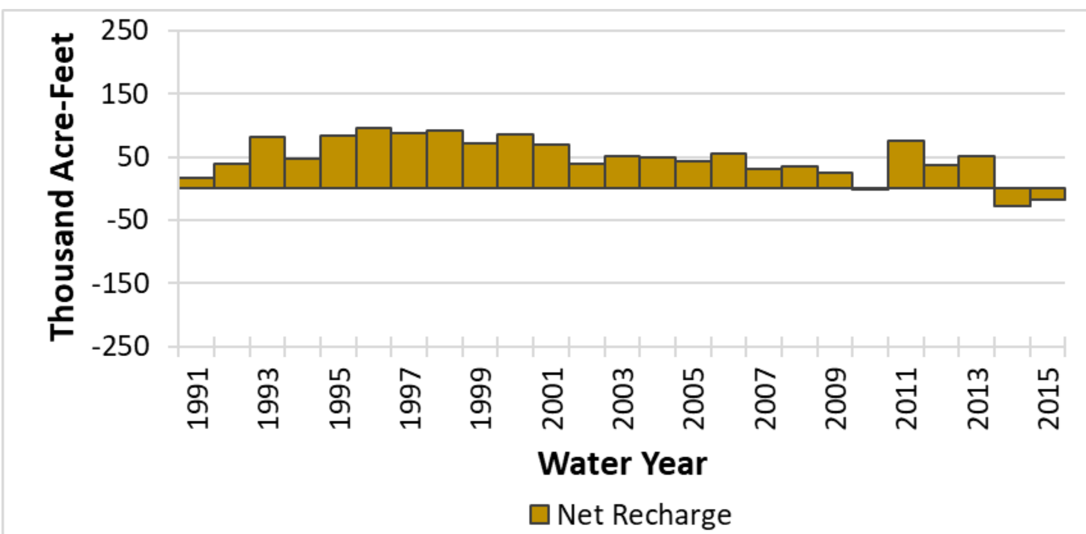


Figure 5-15: Groundwater Recharge and Extraction – Non-District East Zone

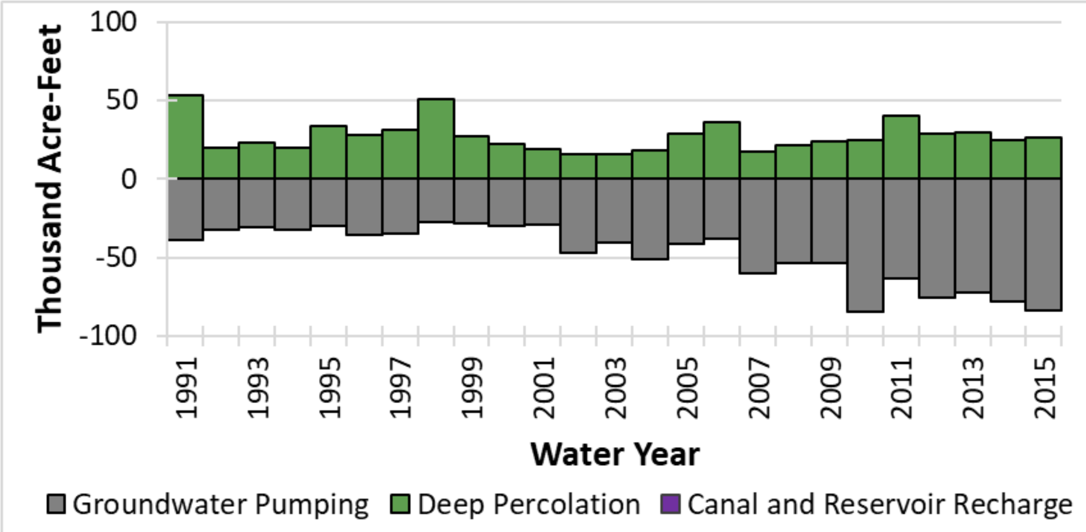


Figure 5-16: Net Recharge – Non-District East Zone

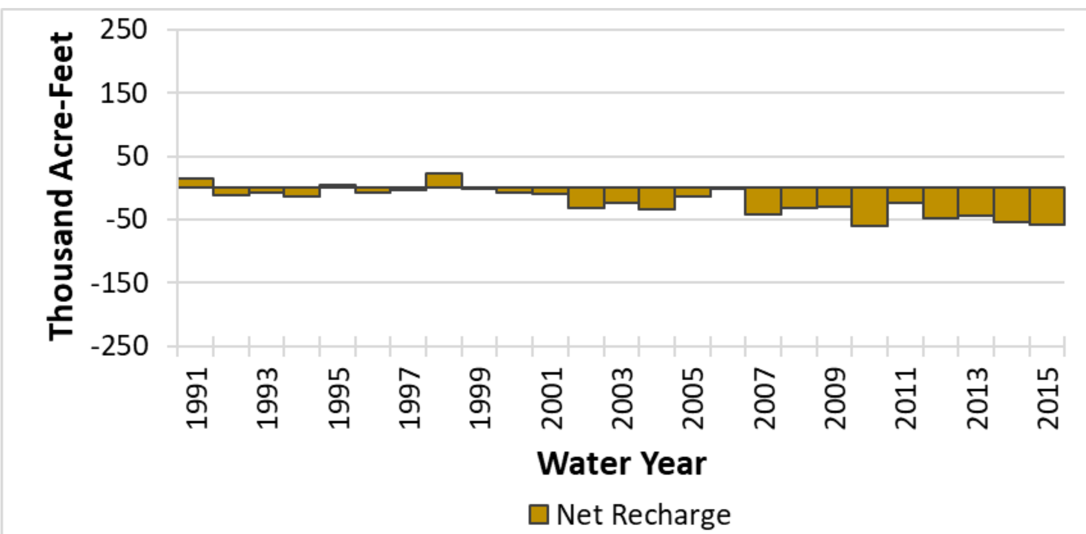


Figure 5-17: Groundwater Recharge and Extraction – Non-District West Area

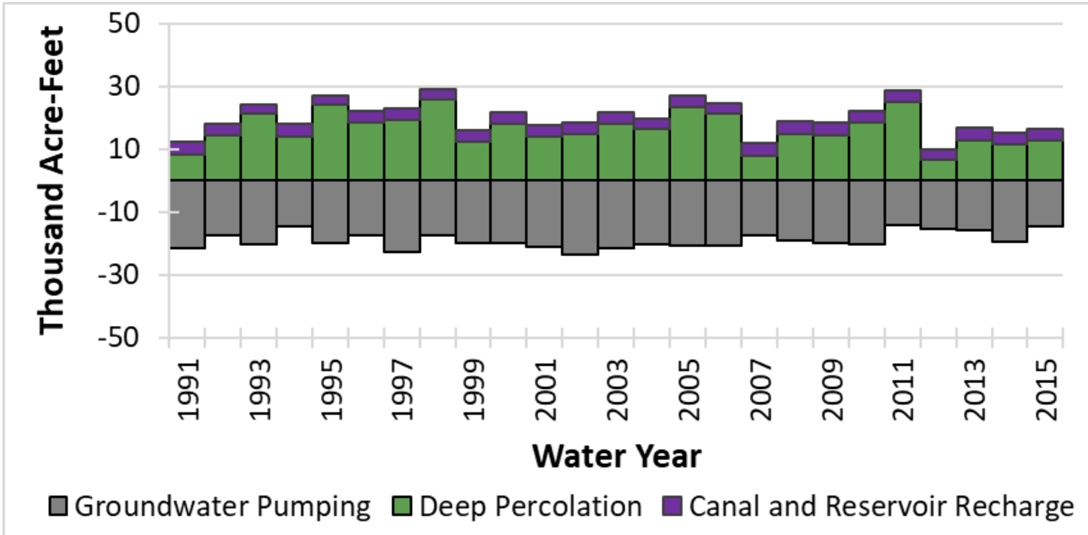


Figure 5-18: Net Recharge – Non-District West Area

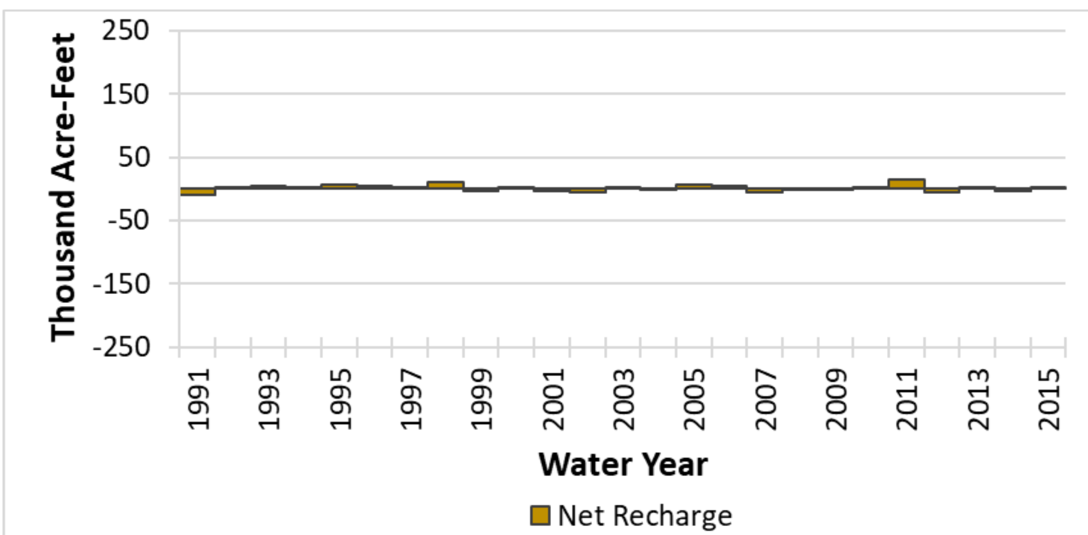


Figure 5-19: Historical Average Annual Water Budget – Groundwater System, Modesto Subbasin

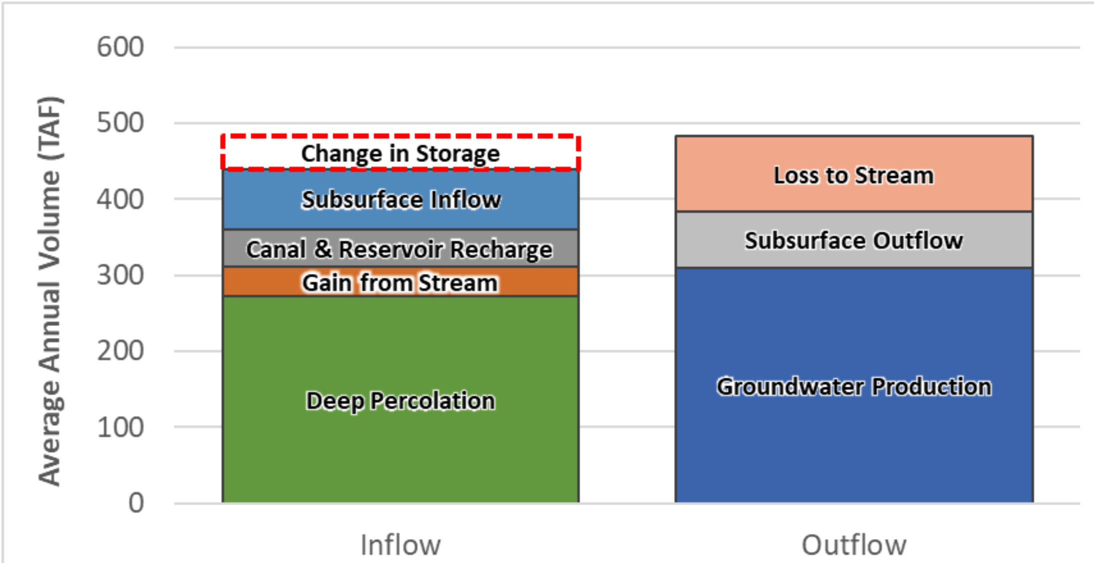
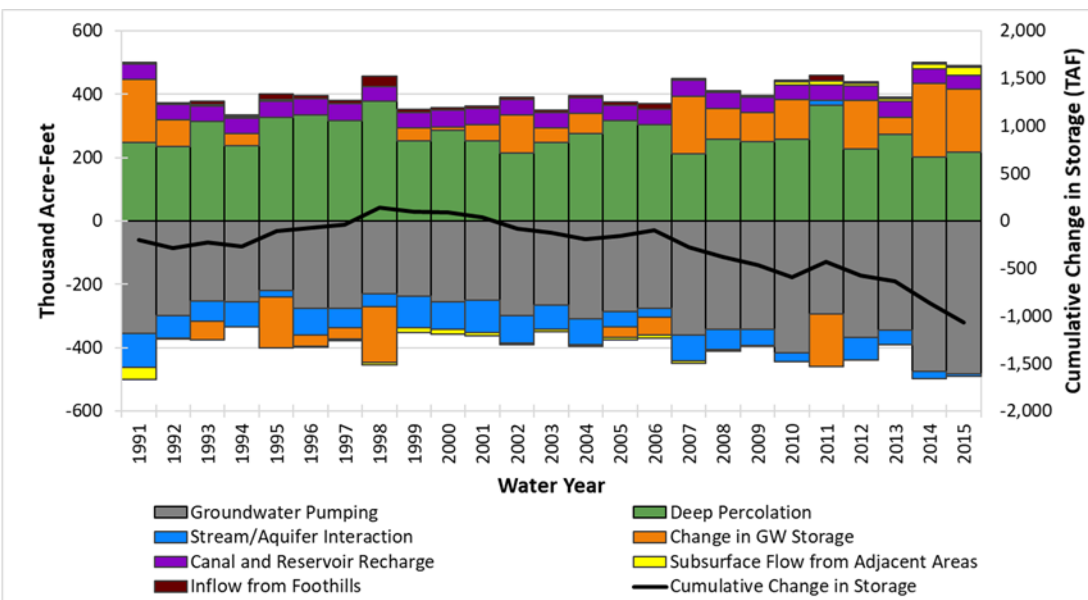


Figure 5-20: Historical Annual Water Budget – Groundwater System, Modesto Subbasin



*On **Figure 20**, positive numbers indicate inflows into the Subbasin aquifer, while negative numbers indicate outflows from the Subbasin aquifer.*

Table 5-9: Water Supply and Demand Budget by Year Type (AFY)

Component	Water Year Type (San Joaquin River Index)					
	Wet	Above Normal	Below Normal	Dry	Critical	Average
Agricultural Demand	479,000	526,000	511,000	532,000	533,000	516,000
Urban Demand	84,000	89,000	101,000	100,000	85,000	92,000
Total Water Demand	563,000	615,000	612,000	632,000	618,000	608,000
Total Surface Water Supply	317,000	332,000	335,000	342,000	289,000	323,000
Agricultural	292,000	299,000	302,000	308,000	271,000	294,000
Urban	25,000	33,000	33,000	34,000	18,000	29,000
Total Groundwater Supply	246,000	283,000	277,000	290,000	329,000	285,000
Agricultural	187,000	227,000	209,000	225,000	262,000	222,000
Urban	59,000	56,000	68,000	65,000	67,000	63,000
Total Water Supply	563,000	615,000	612,000	632,000	618,000	608,000
Change in GW Storage	90,000	-59,000	-69,000	-96,000	-136,000	-43,000

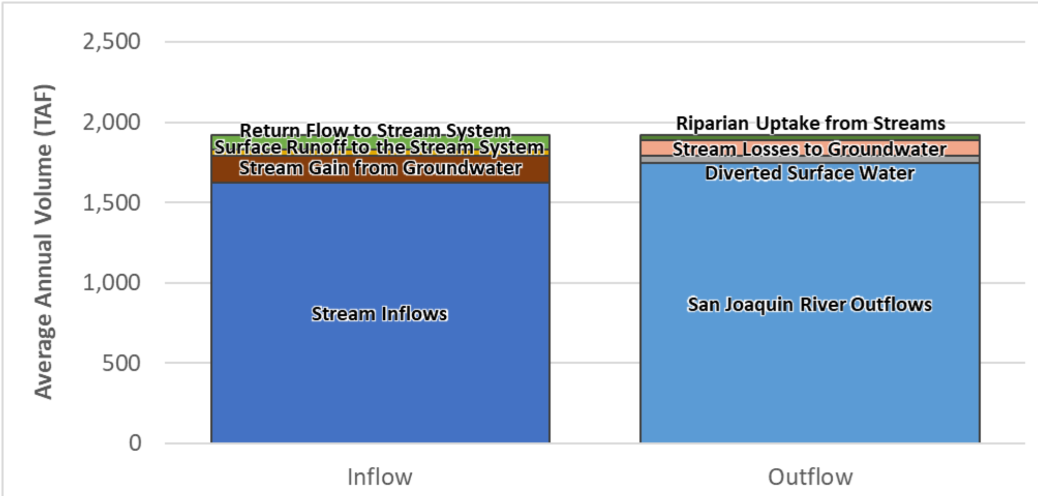
Notes: sub-categories may not sum together due to rounding error
All values in **Table 5-9** are from WYs 1991-2015

5.1.4.2. Current Water Budget

The current water budget quantifies inflows to and outflows from the basin under existing conditions. The 2010 water year was selected to represent current conditions because it reflects an average, non-drought water supply with existing land use and water demand.

Table 5-2 and **Figure 5-21** summarize the average annual inflows and outflows of the Current Conditions Baseline in the Modesto Subbasin stream system. Under current conditions, inflows to the stream system total 1,923,000 AFY with 1,625,000 AFY coming directly as inflow to the Stanislaus, Tuolumne, and San Joaquin Rivers, 35,000 AFY is the result of surface runoff from precipitation, 97,000 AFY of return flow from applied water, and 167,000 AFY of groundwater contributions. In contrast to stream inflow, stream system outflows under current conditions include an average of 47,000 AFY of surface water diversions for agricultural use, 95,000 AFY of discharge to the groundwater system, 37,000 AFY of direct uptake by riparian vegetation, and 1,745,000 AFY of downstream outflows in the San Joaquin River.

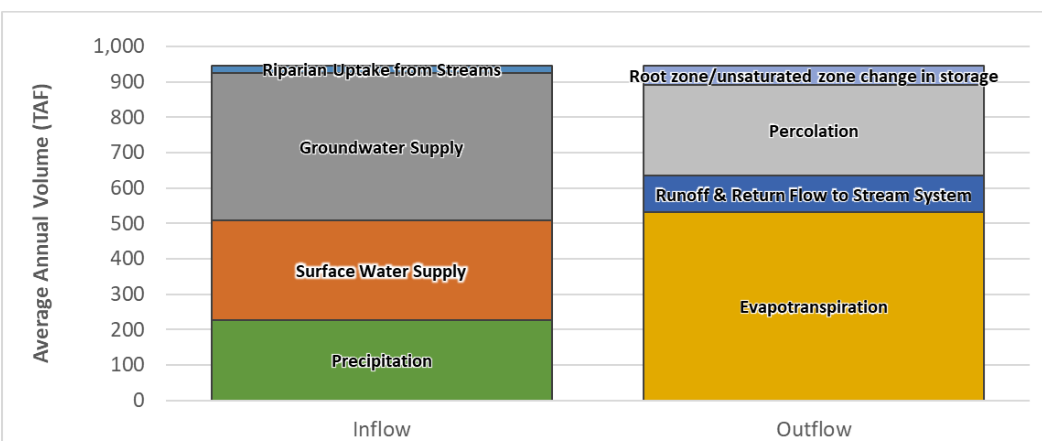
Figure 5-21: Current Conditions Annual Water Budget – Stream Systems, Modesto Subbasin



The land surface system water supply under Current Conditions, shown in **Table 5-3** and in **Figure 5-22**, is estimated using 2010 cropping patterns as the Subbasin experienced significant changes due to the 2012-2015 drought. Under the current Conditions Baseline the average annual water supply is estimated to be 945,000 AFY, including 226,000 AFY of precipitation, 699,000 AFY of surface and groundwater supply for irrigation and urban use (282,000 AFY of surface water and 417,000 AFY of groundwater), and 20,000 AFY of riparian uptake from the stream system.

The total water demand is estimated to be 892,000 AFY, which includes evapotranspiration (531,000 AFY), surface runoff and return flow to the stream system (105,000 AFY), and deep percolation (257,000 AFY). **Figure 5-22** summarizes the average annual current condition supplies and demands in the land surface budget for the Modesto Subbasin.

Figure 5-22: Current Conditions Average Annual Water Budget – Land Surface System, Modesto Subbasin

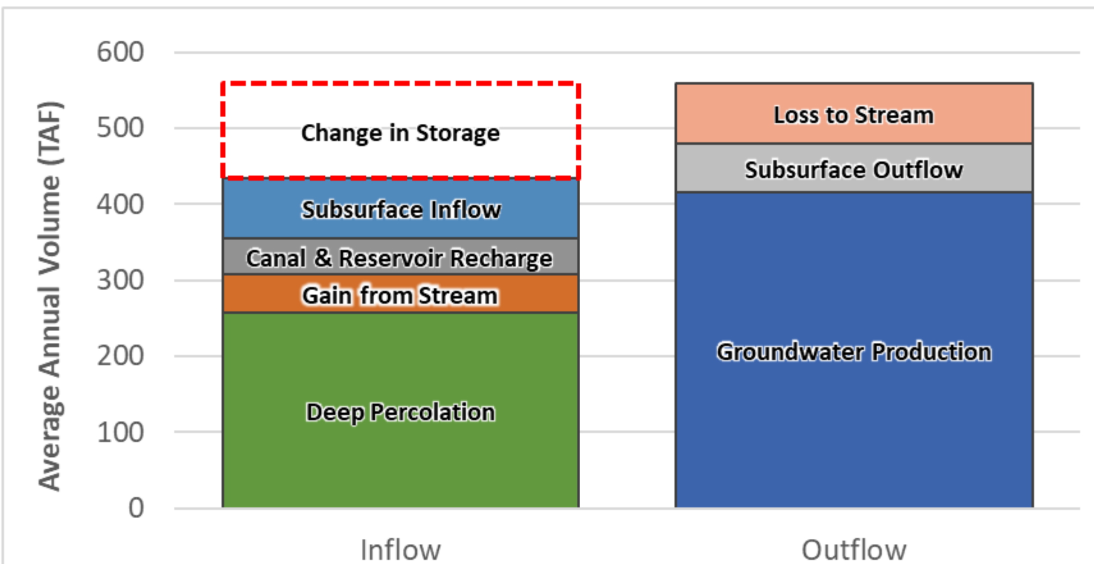


The groundwater system budget for current conditions baseline indicates an average annual inflow of 434,000 AFY, including 257,000 AFY of deep percolation, 47,000 AFY of canal and reservoir seepage, 51,000 AFY from stream seepage, and total subsurface inflows of 79,000 AFY.

Analysis of the groundwater system budget indicates that the system's average annual outflows exceed its inflows under current conditions, resulting in a net reduction in groundwater in storage. As under historical conditions, groundwater production (416,000 AFY) remains the largest component of groundwater discharge, with subsurface outflows (63,000 AFY) and discharge to the stream system (80,000 AFY) bringing the total system outflows to 559,000 AFY annually. Operational water budgets and net-groundwater interaction under current conditions remain like those of the historical period, based on the 2010 water year. On a Subbasin-wide scale, the groundwater in storage deficit under the current conditions baseline is approximately 125,000 AFY.

Figure 5-23 and **Table 5-8** summarize the average current conditions groundwater inflows and outflows in the Modesto Subbasin.

Figure 5-23: Current Conditions Average Annual Water Budget – Groundwater System, Modesto Subbasin



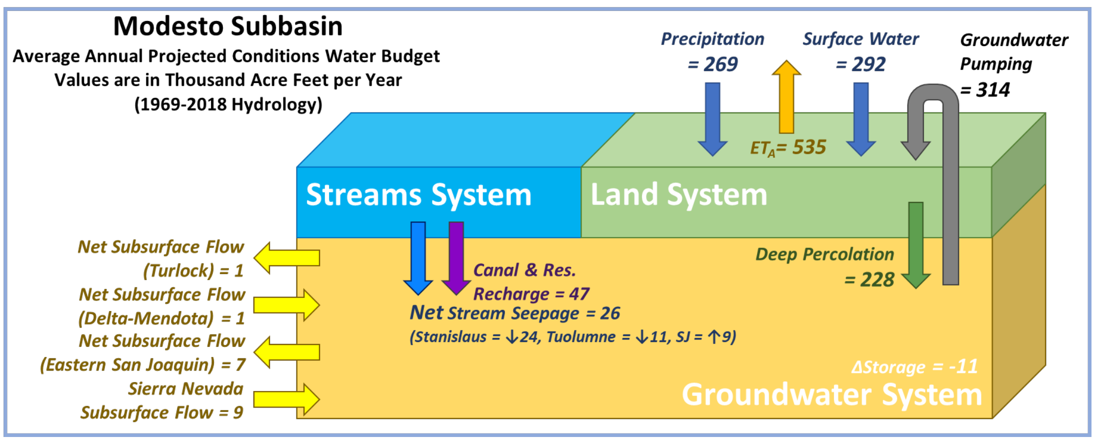
5.1.4.3. Projected Water Budget

The projected water budget provides an estimate of supplies and demands as defined under the projected conditions baseline listed above, including land use operations and their impact to the aquifer system. The projected conditions baseline is a version of C2VSimTM and was used to evaluate the water budget using projected operations in conjunction with the 50-year hydrologic period, 1969 to 2018.

Development of the projected water demand is based on the population growth trends reported in the 2015 UWMPs and the land use, evapotranspiration, and crop coefficient information from the Modesto ID and Oakdale ID 2015 AWMPs. Projected Tuolumne River inflows to the groundwater Subbasin and surface water supplies are determined through a combination of historical trends and the Tuolumne River System (TRS) operations model. Additional information about model development and inputs are detailed in the C2VSimTM Model Development Technical Memo in **Appendix C**.

Figure 5-24 shows the water budget schematic for the Modesto Subbasin with average annual projected values for each component.

Figure 5-24: Average Annual Projected Conditions Water Budget – Modesto Subbasin



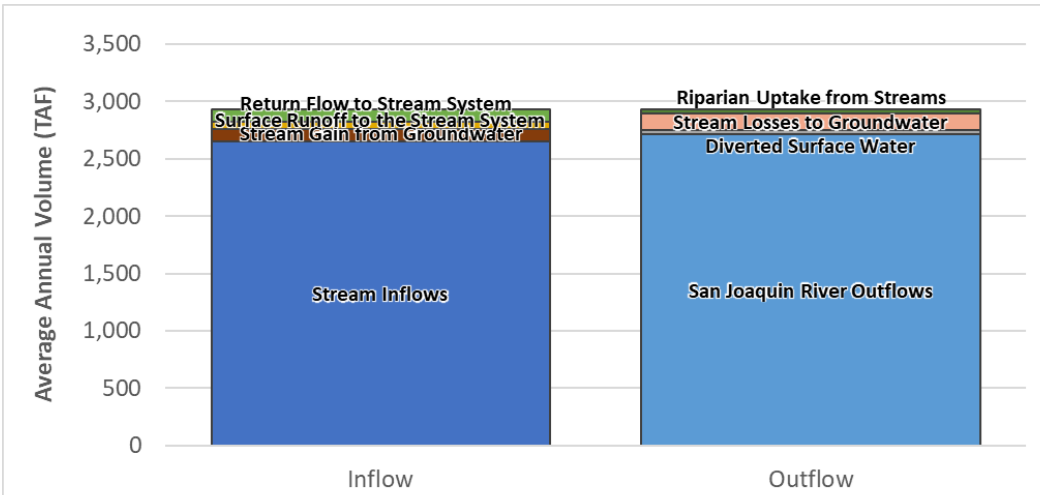
Note: sub-categories may not sum together due to rounding error

As shown in **Table 5-2**, average annual surface water inflows to the Modesto Subbasin's stream system total an average of 2,934,000 AFY. As with the historical and current conditions water budgets, stream inflows from the Stanislaus, Tuolumne, and San Joaquin Rivers comprise most of the inflows, averaging 2,650,000 AFY. Other inflows include contributions from tributaries (6,000 AY), gain from the aquifer (104,000 AFY), surface runoff from precipitation (60,000 AFY), and return flow from applied water to the stream system (113,000 AFY).

Under projected conditions, volumes of surface water diverted from Modesto Subbasin's stream system are lower than under historical conditions, down to 33,000 AFY from 43,000 AFY. Reduced diversion volumes under projected conditions are due to reduced demand by riparian users resulting from projected increases in irrigation efficiency. Other stream system outflows include seepage to the aquifer system (146,000 AFY), direct uptake by native vegetation (37,000 AFY), and San Joaquin River outflows downstream of the Tuolumne River confluence (2,717,000 AFY).

Groundwater levels are predicted to be further reduced under projected conditions than under historical conditions, and thus the 86,000 AFY reduction in net contribution from the aquifer[9] to the stream system matches the expected trend. Under such a decrease in aquifer contribution, streams in Modesto Subbasin transition from average net gaining streams to net losing streams. Therefore, under historical conditions, aquifers on average recharge streams, but under projected conditions, streams on average, recharge the aquifer. **Figure 5-25** summarizes the average projected inflows and outflows in the Modesto Subbasin surface water network.

Figure 5-25: Projected Conditions Average Annual Water Budget – Stream Systems, Modesto Subbasin



The land surface water budget for the Projected Conditions Baseline is shown on **Table 5-3** and has average annual supplies of 900,000 AFY. Supplies are comprised of precipitation (270,000 AFY), applied surface water (293,000 AFY), applied groundwater (315,000 AFY), and riparian uptake from streams (22,000 AFY). Demands total 898,000 AFY and are comprised of evapotranspiration (536,000 AFY), surface runoff and return flow (134,000 AFY) to the stream system, and deep percolation (228,000 AFY).

Urban supplies and demands increase relative to historical conditions due to forecasted population growth. Additionally, agricultural demand (evapotranspiration) is higher because agricultural land use is assumed to be at the historical high, reflecting more developed acres than average historical conditions. However, there is less percolation out of the root zone and agricultural return flow because of the projected improvements in irrigation efficiency (e.g., drip irrigation). The lower runoff in the projected conditions baseline compared to the historical scenario is driven by lower precipitation. There are no projected changes to soil

[9] Net contribution from the aquifer includes stream gains and losses within and outside of the Modesto Subbasin – any region adjacent to the Stanislaus River, Tuolumne River, and San Joaquin River.

characteristics (i.e., curve number or soil parameters) between the historical and projected conditions baseline scenarios.

A summary of these flows can be seen below in **Figure 5-26** though **Figure 5-28**. **Figure 5-27** and **Figure 5-28** show the annual change in the land surface water budget components through the simulation period.

Figure 5-26: Projected Conditions Average Annual Water Budget – Land Surface System, Modesto Subbasin

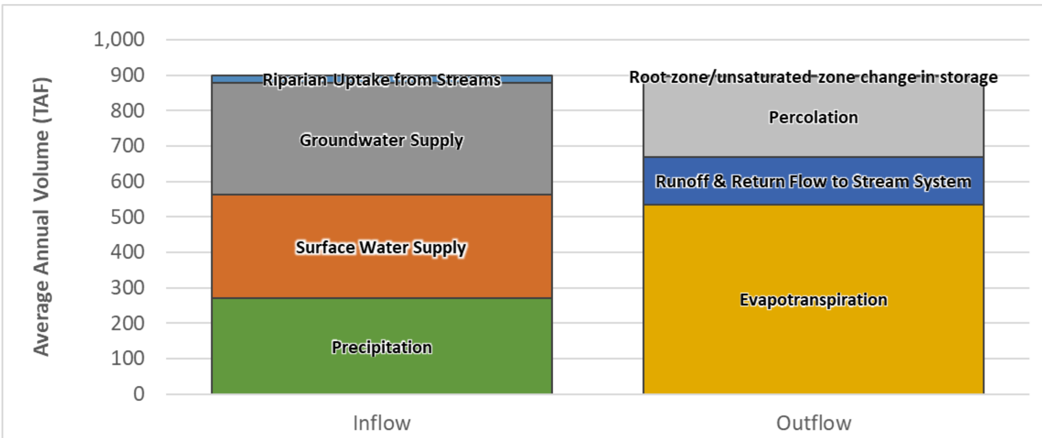


Figure 5-27: Projected Conditions Annual Water Budget – Agricultural Land Surface System, Modesto Subbasin

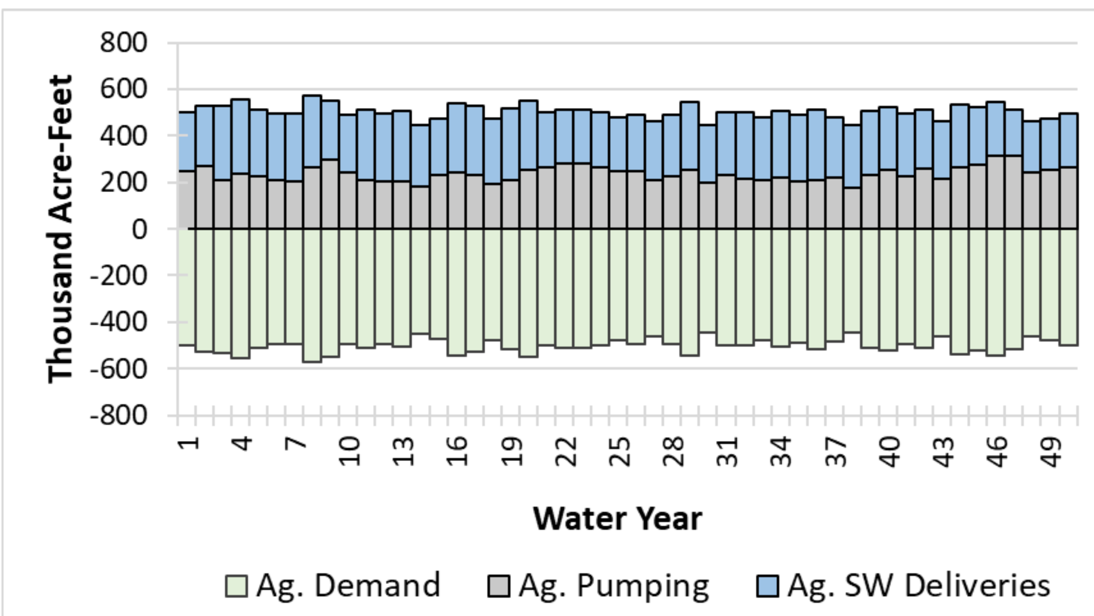
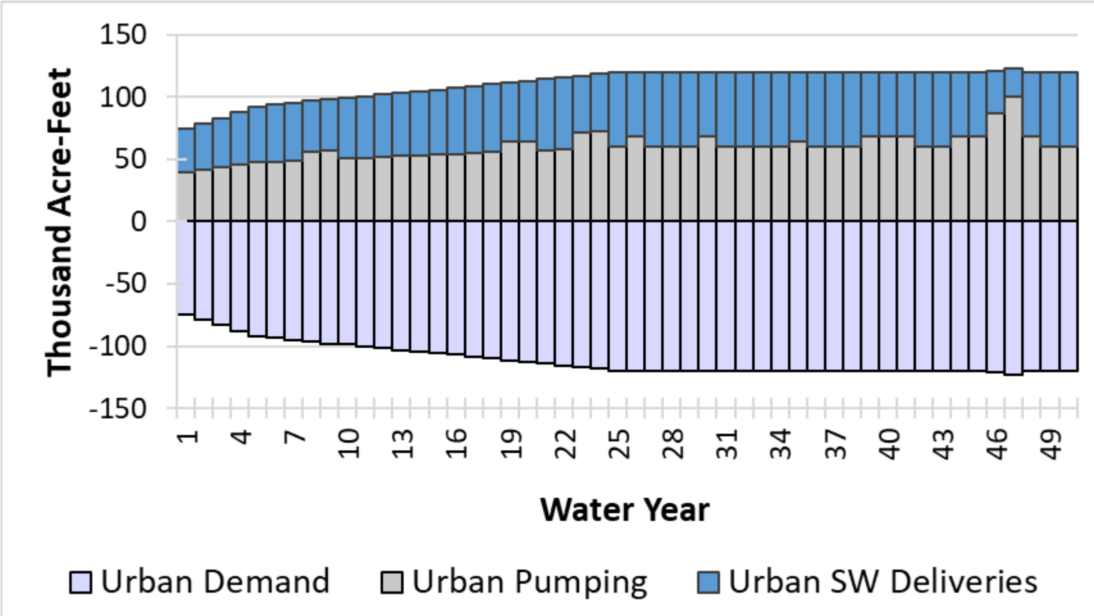


Figure 5-28: Projected Conditions Annual Water Budget – Urban Land Surface System, Modesto Subbasin



Anticipated growth in the Projected Conditions Baseline slightly increases groundwater production (314,000 AFY), compared to historical pumping. Subsurface outflows to neighboring subbasins (75,000 AF) and stream gain from groundwater (50,000 AFY) bring the total Subbasin discharges to 438,000 AFY.

Under projected conditions, the groundwater system of the Modesto Subbasin experiences an average of 428,000 AFY of inflows each year, of which 228,000 AFY is from deep percolation of rainfall and applied water. As previously mentioned, deep percolation from applied water is lower than under historical conditions because of projected increases in irrigation efficiency. Other inflows to the groundwater system consist of recharge from stream seepage (76,000 AFY), seepage from conveyance canals and reservoirs (47,000 AFY), and subsurface inflows from the Sierra Nevada foothills and neighboring subbasins of Eastern San Joaquin, Delta-Mendota, and Turlock (77,000 AFY combined). A summary of annual averages of the Modesto Subbasin groundwater system is provided on **Table 5-8**.

Under the projected conditions the groundwater system outflows are greater than the system inflows, resulting in an average annual groundwater in storage deficit of 11,000 AFY. While an average groundwater in storage decline of 11,000 AFY is significantly less than historical depletion (43,000 AFY), the decline is buffered by the net gain of 86,000 AFY of seepage from the stream system. This change in the projected groundwater conditions and stream-aquifer interactions are considered significant and unreasonable, which affects groundwater sustainability of the Subbasin.

An analysis of net recharge in the Projected Conditions model was performed for Modesto Subbasin and for each water budget area. **Figure 5-29** shows the total groundwater production and land-surface recharge each year under the projected conditions scenario. Additionally, the net-groundwater under projected conditions, shown in **Figure 5-30**, is predominantly negative, meaning that on average, the subbasin is a net-extractor. This continuation of historical trends reflects the relationship between the Subbasin's increased groundwater demand and declining storage.

Figure 5-31 through **Figure 5-38** show similar surface-to-groundwater operations and net-interaction to the historical water budgets. Under the projected conditions baseline, the Oakdale South water budget area maintains a constant net-contribution to the aquifer system while the Non-District West continues to be variable conditions and the NDE continues to be a net-extractor. The Modesto water budget area shows the greatest variance from the historical water budget, being predominantly a net-extractor under projected conditions. This is due to both changes in agricultural operations, combined with growing populations in the urban centers.

Figure 5-39 summarizes the average projected groundwater inflows and outflows in the Modesto Subbasin, while **Figure 5-40** shows the annual change in each component of the groundwater budget plus cumulative change in storage throughout the simulation period. Based on this figure, Modesto Subbasin is projected to experience approximately 11,000 AFY of storage decline under projected conditions, leading to cumulative reduction of approximately 530,000 AFY of groundwater in storage over the 50-year planning horizon.

Figure 5-29: Projected Conditions Groundwater Recharge and Extraction – Modesto Subbasin

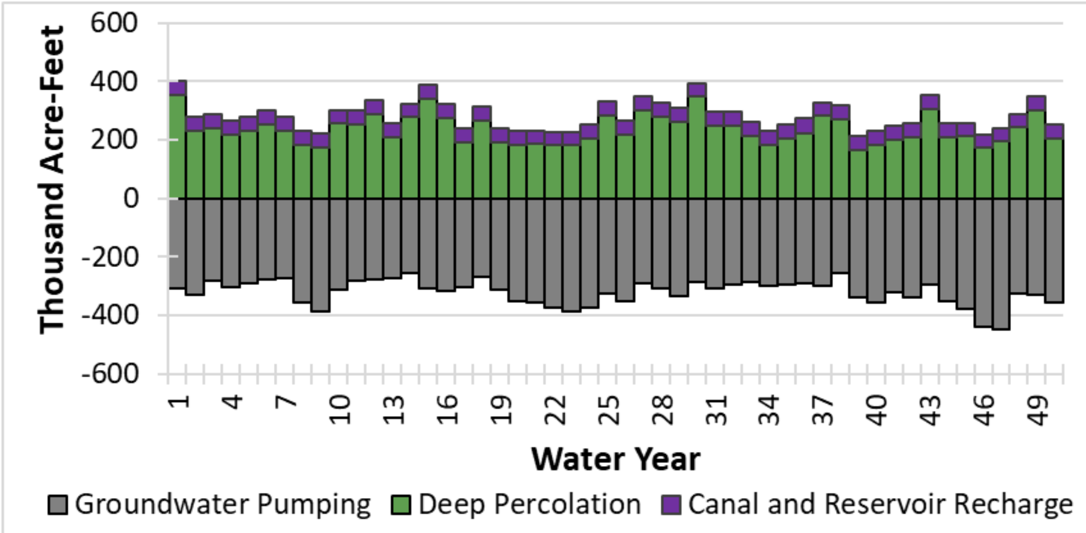


Figure 5-30: Projected Conditions Net Recharge – Modesto Subbasin

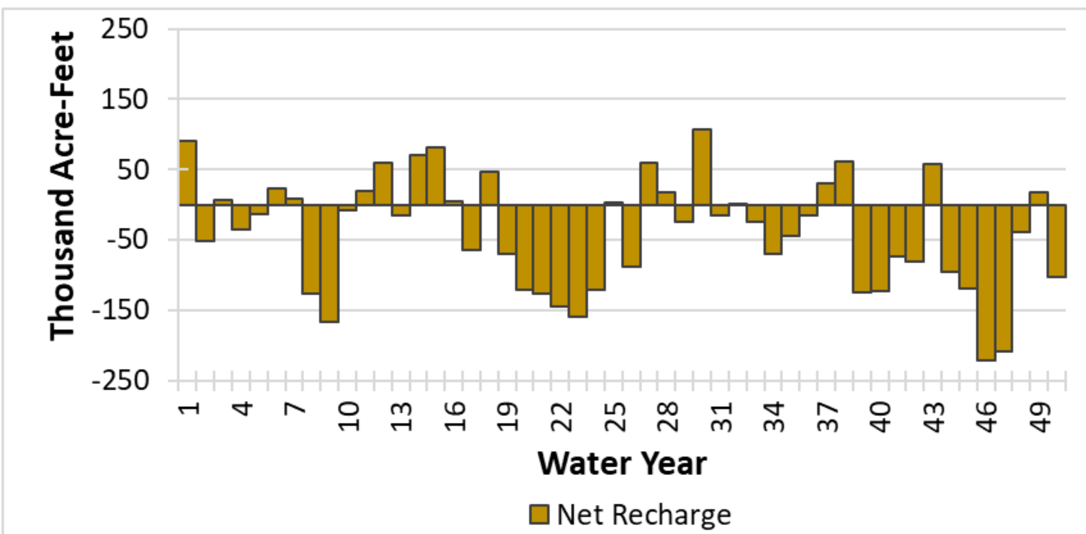


Figure 5-31: Projected Conditions Groundwater Recharge and Extraction – Modesto Zone

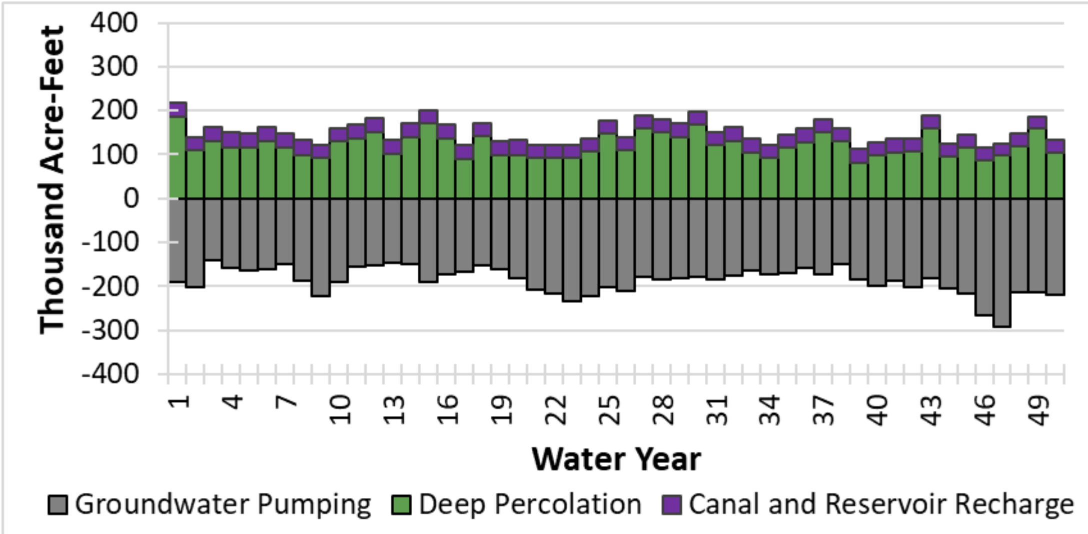


Figure 5-32: Projected Conditions Net Recharge – Modesto Zone

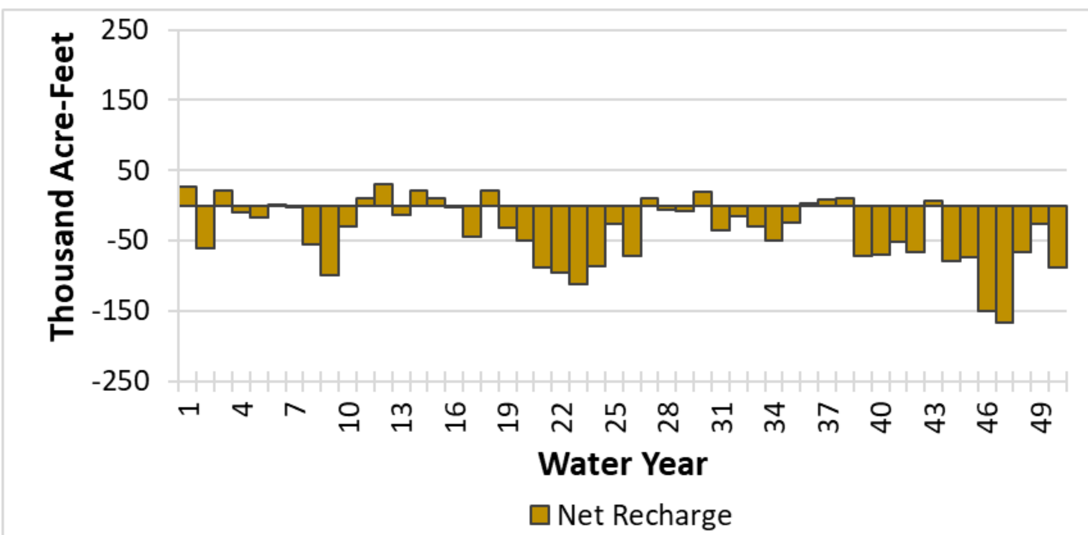


Figure 5-33: Projected Conditions Groundwater Recharge and Extraction – Oakdale South Zone

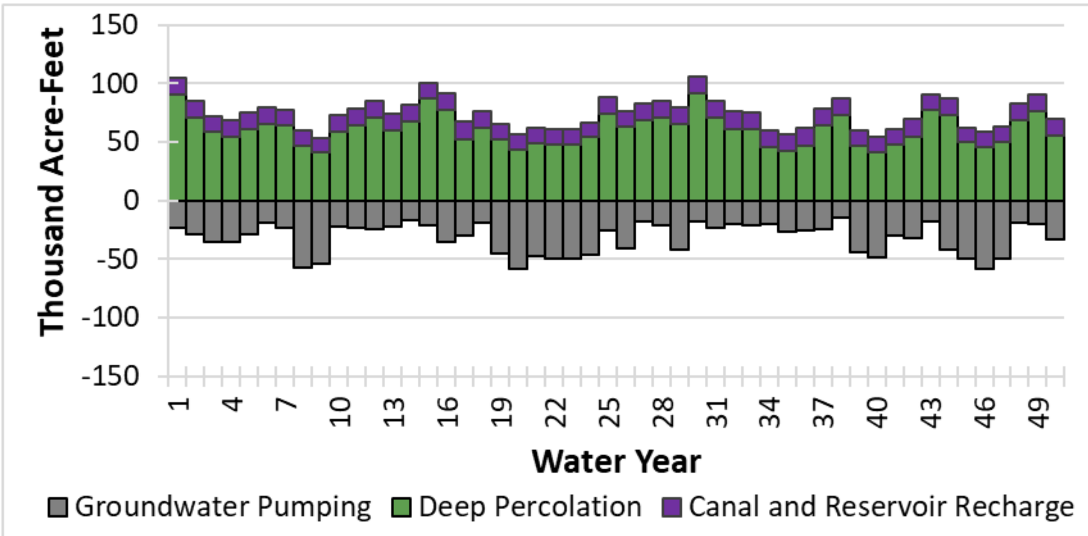


Figure 5-34: Projected Conditions Net Recharge – Oakdale South Zone

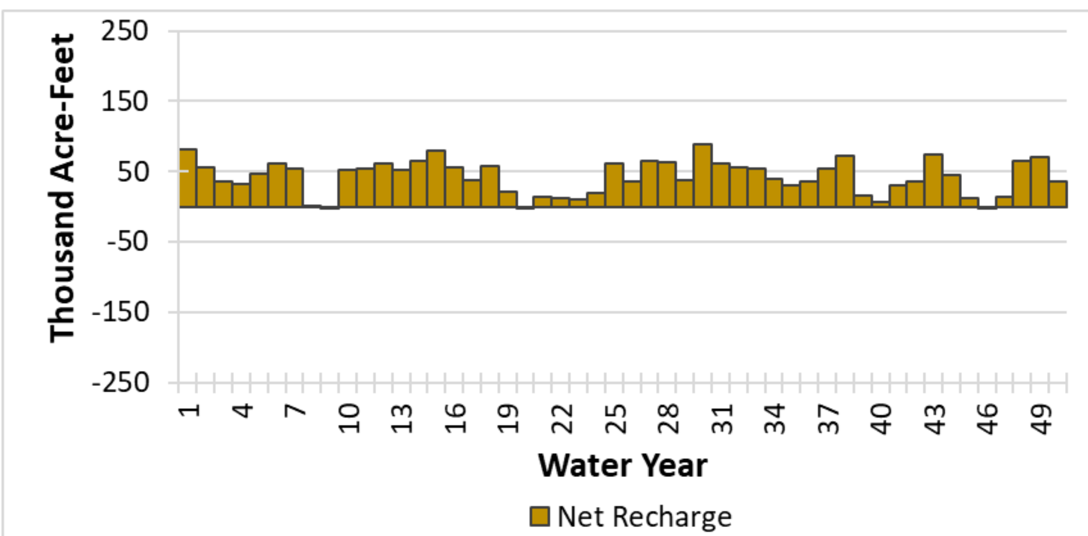


Figure 5-35: Groundwater Recharge and Extraction – Non-District East Area

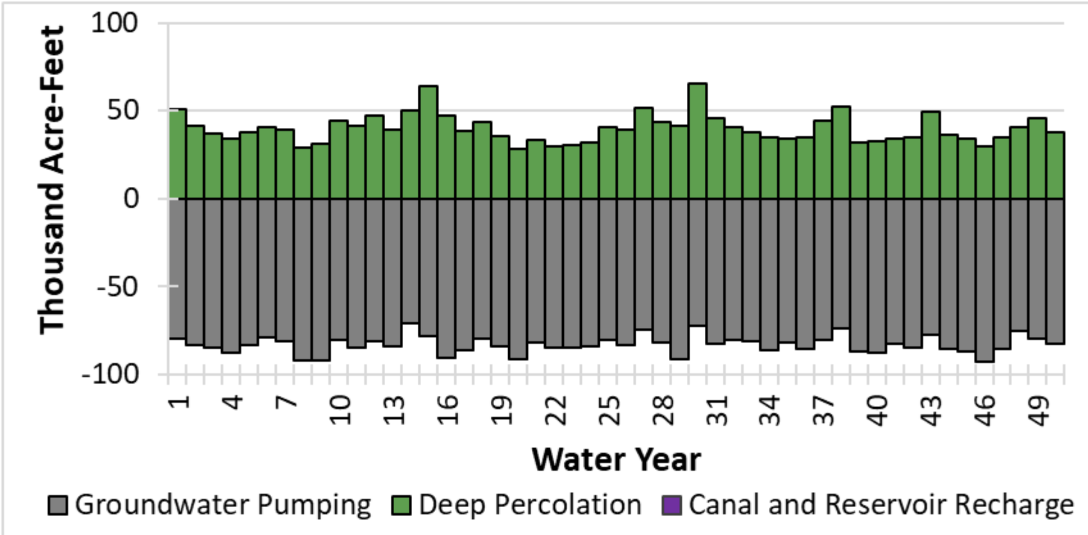


Figure 5-36: Net Recharge – Non-District East Area

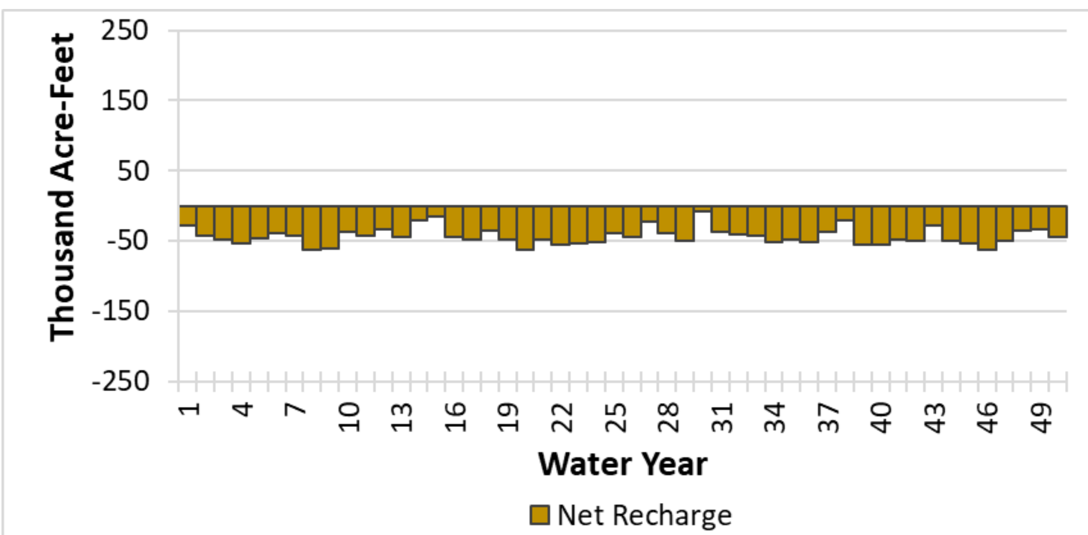


Figure 5-37: Groundwater Recharge and Extraction – Non-District West Zone

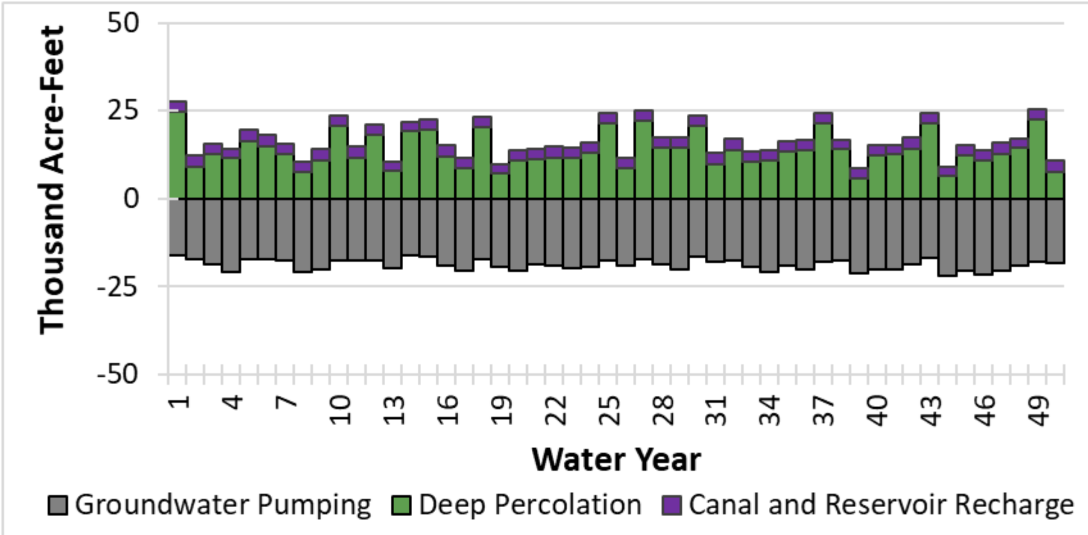


Figure 5-38: Net Recharge – Non-District West Zone

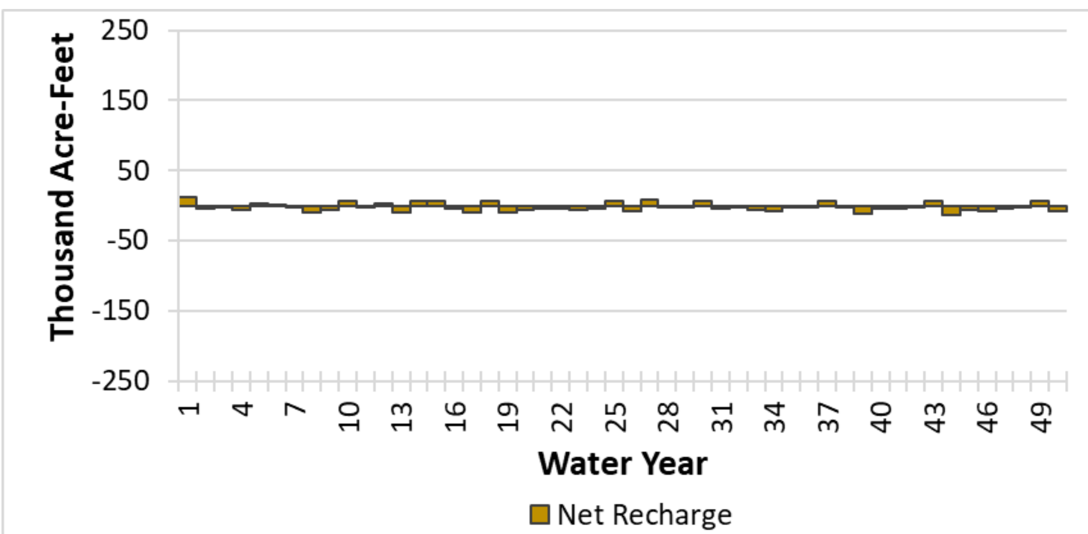


Figure 5-39: Projected Conditions Average Annual Water Budget – Groundwater System, Modesto Subbasin

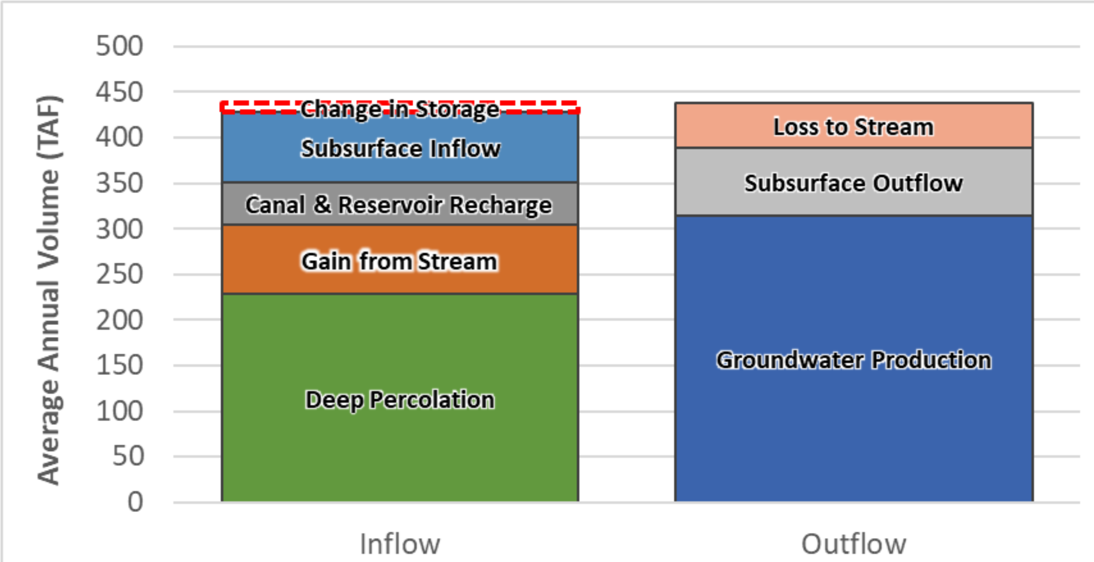
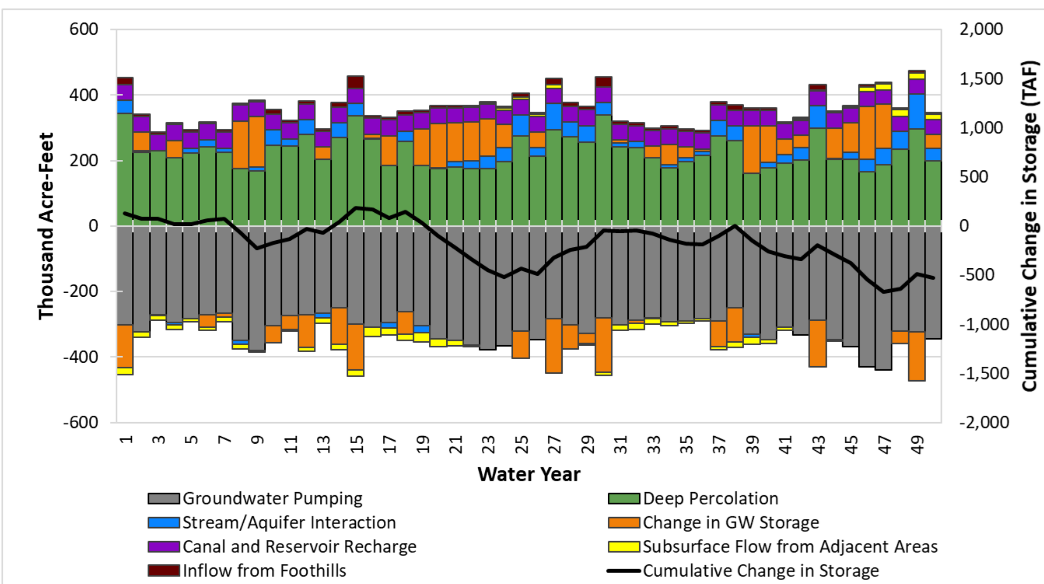


Figure 5-40: Projected Conditions Annual Water Budget – Groundwater System, Modesto Subbasin



5.2. CLIMATE CHANGE ANALYSIS

5.2.1. Regulatory Background

SGMA requires consideration of uncertainties associated with climate change in the development of GSPs. Consistent with §354.18(d)(3) and §354.18(e) of the SGMA Regulations, analyses for the Modesto GSP evaluated the projected water budget with and without climate change conditions.

5.2.2. DWR Guidance

Climate change analysis and the associated methods, tools, forecasted datasets, and the predictions of greenhouse gas concentrations in the atmosphere are continually evolving. The approach developed for this GSP is based on the methodology in DWR's guidance document (DWR, 2018b), which, in combination with Subbasin-specific modeling tools, was deemed to be the most appropriate information for evaluating climate change in the Modesto Subbasin GSP. The following resources from DWR were used in the climate change analysis:

- SGMA Data Viewer
- Guidance for Climate Change Data Use During Sustainability Plan Development and Appendices (Guidance Document)
- Water Budget BMP
- Desktop IWFM Tools

SGMA Data Viewer provides the location for which the climate change forecasts datasets[10] were downloaded for the Modesto Subbasin (DWR, 2019b). The guidance document details the approach, development, applications, and limitations of the datasets available from the SGMA Data Viewer (DWR, 2018b). The Water Budget BMP describes in greater detail how DWR recommends projected water budgets be computed (DWR, 2016a). The Desktop IWFM Tools (DWR, 2018c) are available to calculate the projected precipitation and evapotranspiration inputs under climate change conditions.

The methods suggested by DWR in the above resources were used, with modifications where appropriate, to ensure the resolution would be reasonable for the Modesto Subbasin and align with the assumptions of the C2VSimTM. **Figure 5-41** shows the overall process developed for the Modesto GSP consistent with the Climate Change Resource Guide (DWR, 2018b) and describes workflow beginning with baseline projected conditions to perturbed 2070 conditions for the projected model run. For this analysis, it is assumed that the projected climate change conditions for 2070 central tendency is used.

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[10] In the industry, climate change impacted variable forecasts are sometimes referred to as "data" and their collections are called "datasets." Calling forecasted variable values "data" can be misleading, so this document tries to be explicit when referring to data (historical data) vs. forecasts or model outputs.

Figure 5-41: Modesto GSP Climate Change Analysis Process

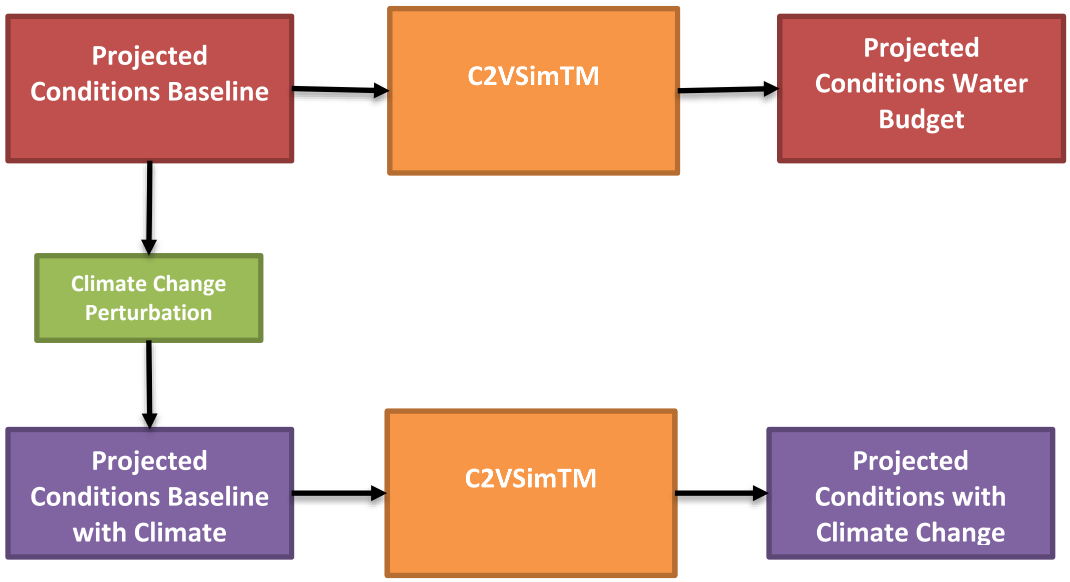


Table 5-10 summarizes the forecasted variable datasets provided by DWR that were used to carry out the climate change analysis. The "VIC" model (Variable Infiltration Capacity) referred to in **Table 5-10** is the hydrologic model used by DWR to estimate unimpaired flows in upper watersheds. "Unimpaired" streamflow refers to the natural streamflow produced by a watershed, without modifications to streamflow from reservoir regulations, diversions, and other operations. On the other hand, "impaired" streamflow referred to in **Table 5-10** is DWR's terminology for streams whose flow is impacted by ongoing water operations and upstream regulations, such as diversions, deliveries, and reservoir storage. Flows on these streams are simulated using the CalSim II model results from the DWR baseline model. For Modesto Subbasin GSP, stream inflow and surface water deliveries to MID and OID were utilized from the CalSim II baseline model results. The San Joaquin River flows were also based on the results of CalSim II baseline model from DWR. All timeseries shown in **Table 5-10** use a monthly timestep. **Section 5.2.3** includes further description of the methodology, datasets, and results.

Table 5-10: DWR-Provided Climate Change Datasets

Input Variable	DWR Provided Dataset
Unimpaired Streamflow	Combined VIC model runoff and baseflow to generate change factors, provided by HUC 8 watershed geometry
Impaired Streamflow (Ongoing Operations)	CalSim II time series outputs in .csv format
Precipitation	VIC model-generated GIS grid with associated change factor time series for each cell
Reference ET	VIC model-generated GIS grid with associated change factor time series for each cell

5.2.3. Climate Change Methodology

Climate change affects precipitation, streamflow, evapotranspiration and, for coastal aquifers, sea level rise, which in turn have impacts on the aquifer system. For the Modesto Subbasin, sea level rise is not relevant and not considered in this analysis. The method for perturbing the streamflow, precipitation, and evapotranspiration input files is described in the following sections. The late-century, 2070 central tendency climate scenario was evaluated in this analysis, consistent with DWR guidance (DWR, 2018b).

DWR combined 10 global climate models (GCMs) for two different representative climate pathways (RCPs) to generate the central tendency scenarios in the datasets used in this analysis. The “local analogs” method (LOCA) was used to downscale these 20 different climate projections to a scale usable for California (DWR, 2018b). DWR provides datasets for two future climate periods: 2030 and 2070. For 2030, there is one set of central tendency datasets available. For 2070, DWR has provided one central tendency scenario and two extreme scenarios: one that is drier with extreme warming and one that is wetter with moderate warming.

The 2070 central tendency projection serves to assess impacts of climate change over the long-term planning and implementation period and was therefore selected as the most appropriate scenario under which to assess in the Modesto GSP.

5.2.3.1. Streamflow under Climate Change

Hydrological forecasts for streamflow under various climate change scenarios are available from DWR as either a flow-based timeseries or a series of perturbation factors applicable to local data. DWR simulated volumetric flow in most regional surface water bodies by utilizing the Water Resource Integrated Modeling System (WRIMS, formally named CalSim II). While river flows and surface water diversions in the Tuolumne, Stanislaus, and San Joaquin Rivers are simulated in CalSim II, there are significant variations when compared to local historical data. Due to the uncertainty in CalSim II-simulated reservoir operations, flows from CalSim II provided by the state are not used directly in the Modesto GSP climate change analysis. Instead, relative perturbation factors were used to derive surface water inflows and diversions for analysis with the C2VSimTM.

The major streams entering the Modesto Subbasin are the Tuolumne River and Stanislaus River. All rivers are regulated and there are no unimpaired rivers or creeks that contribute significantly to the basin.

CalSim II estimated flows for point locations on the Tuolumne River and Stanislaus River were downloaded from DWR. The key flows obtained from CalSim II include:

- **Tuolumne River:** La Grange Outflow
- **Stanislaus River:** Goodwin Outflow

The San Joaquin River inflow was not adjusted in the climate change analysis because the Friant Dam is located far from the Modesto Subbasin and subbasins that are upstream of the Modesto Subbasin can have significant impacts on stream accretions/depletions, diversions, and operations. As these upstream impacts which are outside of the Modesto Subbasin cannot be captured without detailed analysis of projected flows under climate change conditions, the San Joaquin River flows are assumed to be same as the projected baseline conditions. This would not have a significant impact on the climate change analysis for the Modesto Subbasin, as majority of the surface water supplies, and interaction of surface and groundwater systems take place within Subbasins and along Tuolumne and Stanislaus Rivers.

The streamflow data extracted from CalSim II represent projected hydrology with climate change based on reservoir outflow, operational constraints, and diversions and deliveries of water for the State Water Project and the Central Valley Project. CalSim II data from WY 1965 to WY 2003 was available. For WY 2004 to WY 2018, streamflow data was synthesized based on similar year methodology, and used flows from WY 1965 to WY 2003 and the DWR San Joaquin Valley water year type (CDEC, 2018). (For example, the streamflow for October 2009 was calculated as the average of the October 1966 and October 1971 streamflow because these are all the Below Normal water years between WY 1965 and WY 2003.)

CalSim II outputs are considered more appropriate for regulated streams than streamflow derived using the unimpaired flow adjustment factors because CalSim II accounts for reservoir operations. As expected, streamflow simulated in CalSim II and those derived using the unimpaired flow adjustment factors did not present similar trends, particularly in dry years. DWR-provided unimpaired flow change factors do not account for variations in the operation of the reservoirs that would result from climate change conditions. The CalSim II flows, however, were also not considered completely appropriate for local conditions so a method was derived to compute change factors from CalSim II flows, as described below.

Using DWR's method of deriving the precipitation and evapotranspiration factors as a guide, a hybrid approach was derived to improve upon the discrepancy between the CalSim II and local models while accounting for some change in reservoir operations. In this approach, change factors are generated from the difference between each simulated future climate change CalSim II scenario (i.e., 2070) and the "without climate change" baseline CalSim II run. This "without climate change" baseline run is the CalSim II 1995 Historical Detrended simulation run provided through personal communication from DWR. The change perturbation factors are bounded by a maximum of 5 and minimum 0.2. For the purposes of simplicity, this method is referred to throughout the rest of the document as CalSim II Generated Perturbation Factors (CGPF). The generated change factors are then used to perturb the regulated baseline river inflows:

- Tuolumne River – CGPF multiplied by the projected conditions baseline for the Tuolumne River which is based on Tuolumne River System (TRS) operations model
- Stanislaus River – CGPF multiplied by the projected conditions baseline for the Stanislaus River which is based on historical trends and local hydrology

As previously discussed, the San Joaquin River flows were not perturbed due to the much larger tributary areas of the San Joaquin River that are outside the Modesto Subbasin. The CGPF method presents limitations given that the resulting flows are not directly obtained from an operations model. The actual mass balance on the reservoirs is not tracked in the estimates of the flows and, instead, the method relies on CalSim II tracking that storage and managing the reservoir based on the appropriate rule curves.

Figure 5-42 through **Figure 5-49** provide a comparison of projected conditions baseline and the CGPF method described above. Exceedance curves are included for each of the CGPF flows against the projected conditions baseline.

Figure 5-42: Tuolumne River Hydrograph

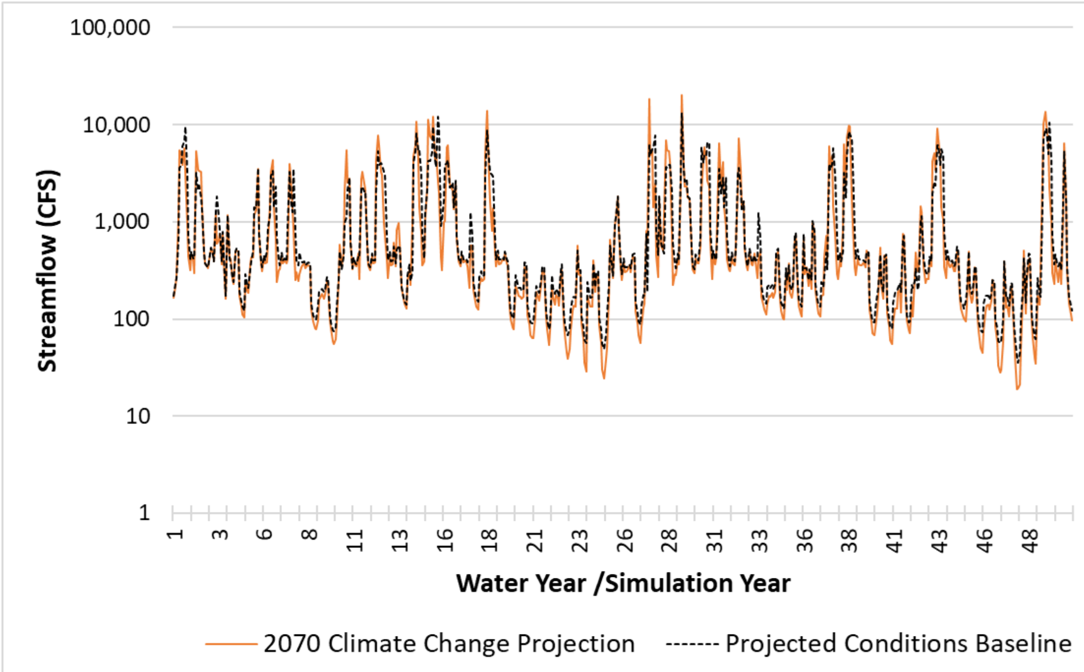


Figure 5-43: Tuolumne River Exceedance Curve

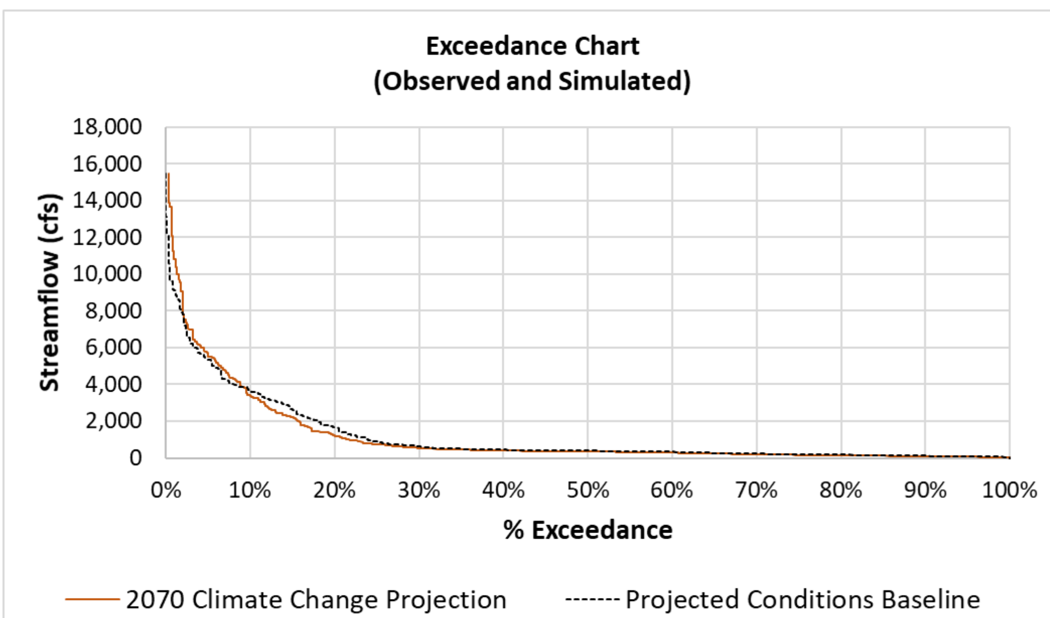


Figure 5-44: Stanislaus River Hydrograph

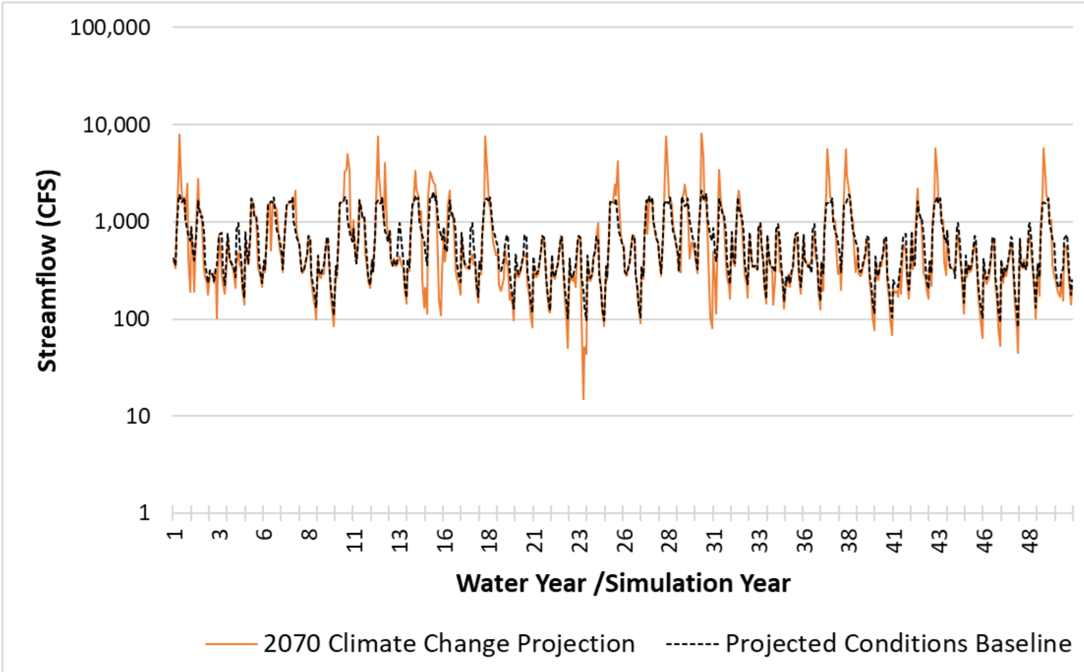
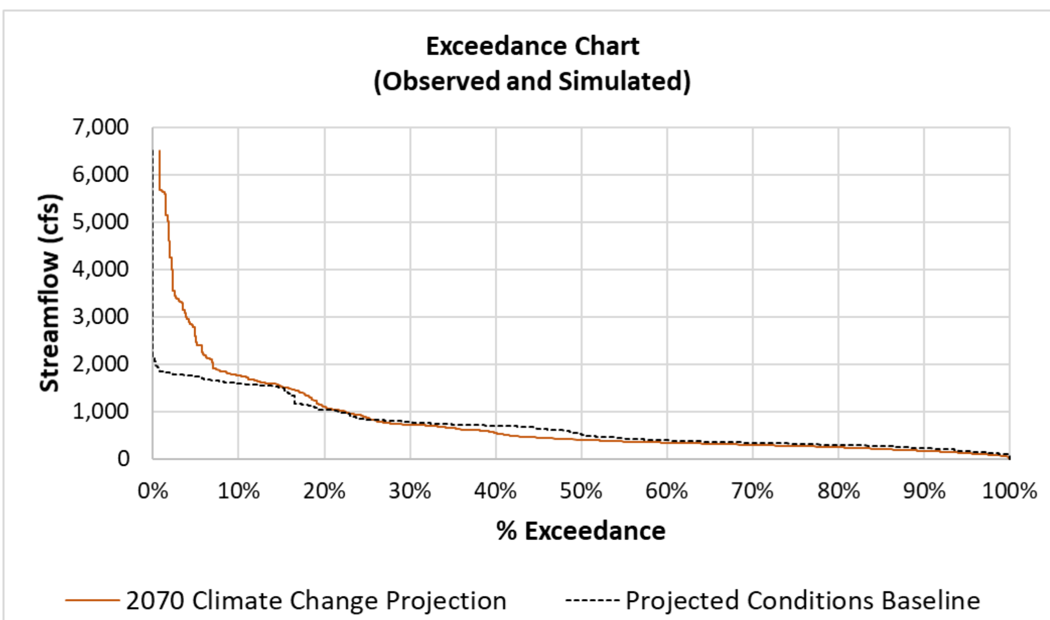


Figure 5-45: Stanislaus River Exceedance Curve



5.2.3.2. Precipitation and Evapotranspiration under Climate Change

Projected precipitation and evapotranspiration (ET) change factors provided by DWR were calculated using a climate period analysis based on historical precipitation and ET from January 1915 to December 2011 (DWR, 2018b). The Variable Infiltration Capacity (VIC) hydrologic model was used by DWR to simulate land-surface atmosphere exchanges of moisture and energy on a six-kilometer grid. Model output includes both precipitation and reference evapotranspiration change factors. The change factors provided by DWR were calculated as a ratio of a variable under a "future scenario" divided by a baseline. The baseline data is the 1995 Historical Template Detrended scenario by the VIC model through GCM downscaling. The "future scenario" corresponds to VIC outputs of the simulation of future conditions using GCM forecasted hydroclimatic variables as inputs. These change factors are thus a simple perturbation factor that corresponds to the ratio of a future with climate change divided by the past without it. Change factors are available on a monthly time step and spatially defined by the VIC model grid. Supplemental tables with the time series of perturbation factors are available by DWR for each grid cell. DWR has made accessible a Desktop GIS tool for both IWFM and MODFLOW to process these change factors (DWR, 2018c).

5.2.3.2.1. Applying Change Factors to Precipitation

DWR change factors were multiplied by projected conditions baseline precipitation to generate projected precipitation under the 2070 central tendency future scenario using the Desktop IWFM GIS tool (DWR, 2018c). The tool calculates an area weighted precipitation change factor for each model grid geometry. This model grid geometry was generated based on polygons built around the PRISM nodes that are within the model area.

However, the DWR tool only includes change factors through 2011. The remaining seven years of the time series were synthesized according to historically comparable water years (i.e., wet years were synthesized based on a wet year within the available time frame of the DWR tool). The perturbation factor from the corresponding month of the comparable year was applied to the baseline of the missing years (2012-2018) to generate projected values. Months with no precipitation in the baseline were assumed a monthly precipitation of 1 mm under climate change to account for increased precipitation that cannot be calculated from a baseline of 0 mm for these synthesized years. The comparable years that were used can be found in **Table 5-1101**.

Table 5-11: Comparable Water Years (Precipitation)

Missing Water Year	Comparable Water Year
2012	1968
2013	2007
2014	2002
2015	1971
2016	1981
2017	1993
2018	1987

The resulting perturbed precipitation values and the baseline precipitation values for the representative historical period can be found in **Figure 5-46** below. The exceedance plot for these two times series can be found in **Figure 5-47**.

Figure 5-46: Perturbed Precipitation Under Climate Change

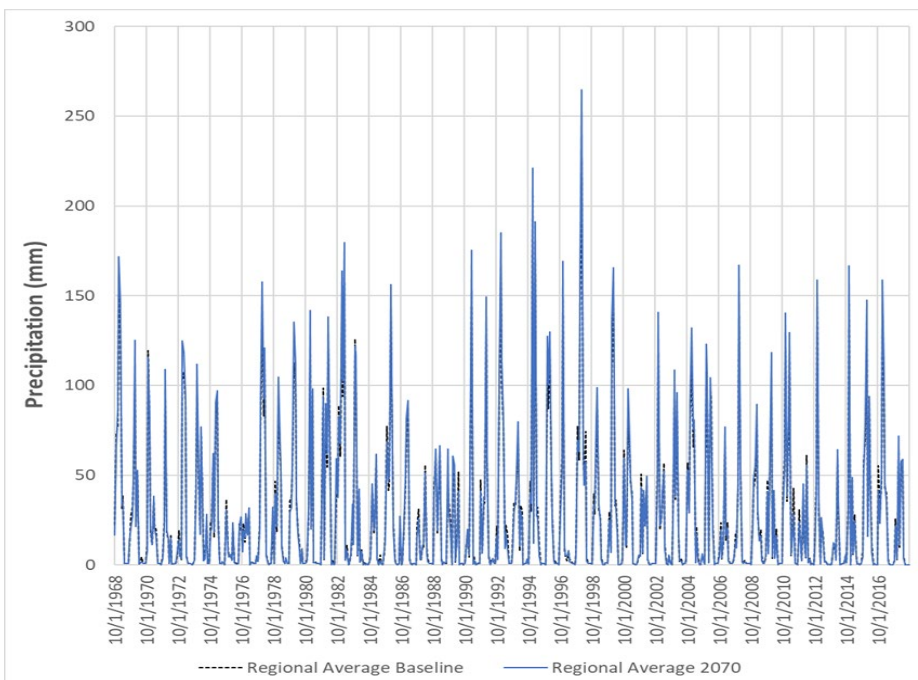


Figure 5-47: Perturbed Precipitation Exceedance Curve

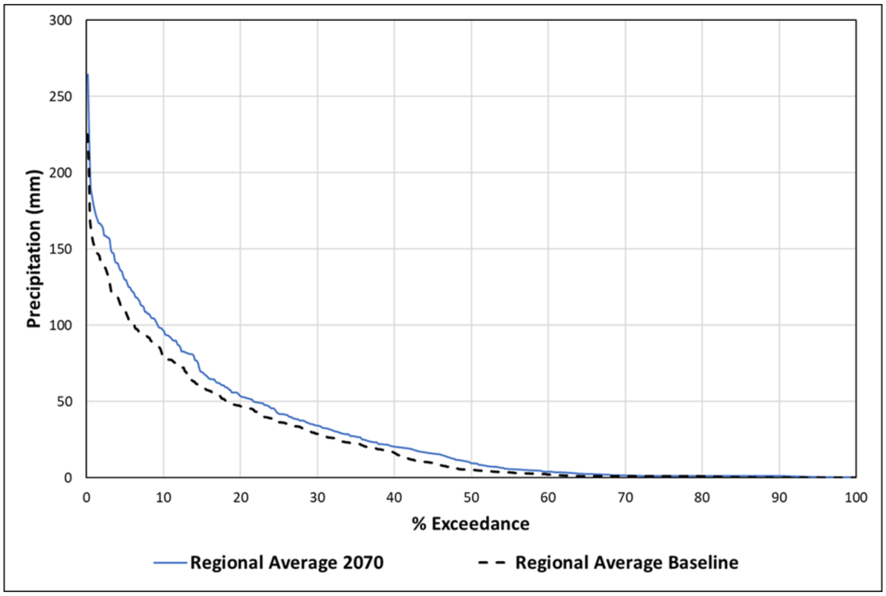


Figure 5-48 shows the difference between the regional average under 2070 climate change conditions and the regional average under projected conditions baseline plotted against different amounts of projected monthly precipitation. The average was taken across the area of the Modesto Subbasin.

Figure 5-48: Variation from Baseline of Perturbed Precipitation

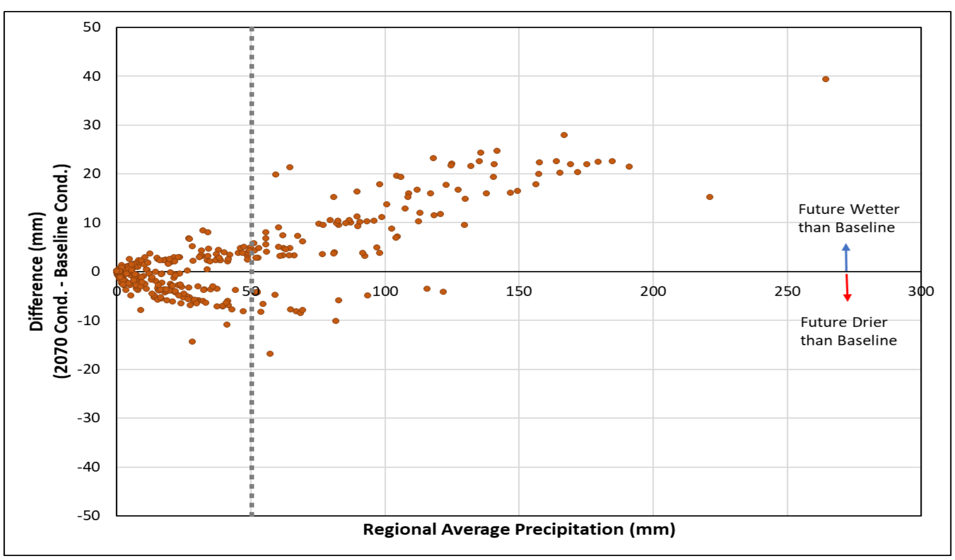
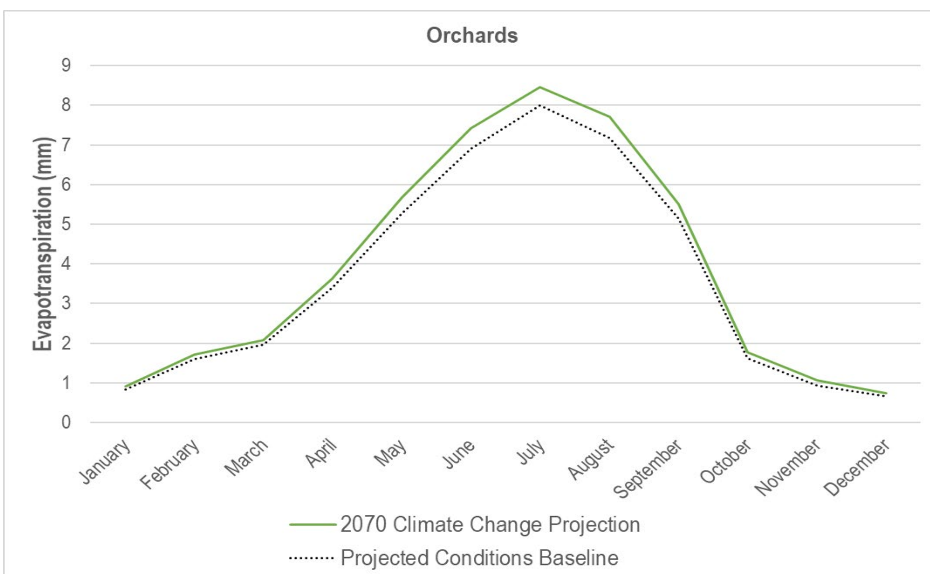


Figure 5-48 demonstrates that in 2070 with climate change added, in low precipitation months, there is approximately equal probability that the month will be wetter or drier than projected conditions baseline. However, under climate change, the 2070 conditions will be wetter in months with precipitation above approximately 50 mm, indicated by the vertical gray dashed line. Therefore, under climate change conditions (in the scenario selected for the GSP), we can see that the occurrence of low precipitation months will likely not change significantly, but the higher precipitation months are predicted to be wetter overall than the projected conditions baseline.

5.2.3.2.2. Applying Change Factors to Evapotranspiration

Potential ET in the Modesto Subbasin is aggregated to one of twenty-five land use categories but does not vary spatially. DWR provides change factors for ET in the same spatially distributed manner as precipitation, as described above. However, to match the level of discretization with the C2VSimTM, an average ET change factor was calculated across all VIC grid cells within the Modesto Subbasin boundary. Therefore, the tool to process ET provided by DWR was not needed or used. Change factors provided by DWR for November 1, 1964, through December 1, 2011, were averaged. This average ET change factor was then applied to the baseline ET time series for each crop type. Because the same ET change factor was applied over the entire baseline, no synthesis was required in this analysis. Refinement to the simulated evapotranspiration of orchards under 2070 climate conditions is shown in **Figure 5-49** below as an example. For 2070, the average change factor is 1.08.

Figure 5-49: Monthly ET for Sample Crops



5.2.3.3. Modesto Subbasin Water Budget Under Climate Change

A climate change scenario was developed for the C2VSimTM to evaluate the hydrological impacts under these conditions. The analysis was based on the projected conditions baseline with climate change perturbed inputs for streamflow, precipitation, and ET. Results are presented below in **Table 5-12** though **Table 5-14**.

Under the climate change scenario, the average annual volume of evapotranspiration is over six percent higher than the projected conditions baseline, increasing from 536,000 AFY to 568,000 AFY. Due to changes to local hydrology, the average annual surface water availability is projected to decrease by 1.6 percent from 293,000 AFY to 288,000 AFY.[11] As a result of less surface water and increased agricultural demands, private groundwater production is simulated to increase by approximately 14 percent, from 230,000 AFY to 262,000 AFY. Under climate change conditions, depletion in aquifer storage is expected to increase by more than half to an average annual rate of 17,000 AFY, from 11,000 AFY in the projected conditions baseline. This has an impact on the stream system and the net difference in stream-aquifer interactions, drawing 46,000 AFY on average from streamflow to the aquifer.

A graphical representation of simulated changes to evapotranspiration, surface deliveries, and groundwater pumping are presented in **Figure 5-50** though **Figure 5-52** below, and complete water budgets for the climate change scenario are shown in **Figure 5-53** though **Figure 5-55**.

[11] There are various approaches to estimating the effects of climate change on local hydrology. The 2070 Central Tendency used in this GSP according to DWR guidelines for GSP submittal may differ from local studies or certain Flood-MAR scenarios.

Figure 5-50: Simulated Changes in Evapotranspiration due to Climate Change (Scenario minus Baseline)

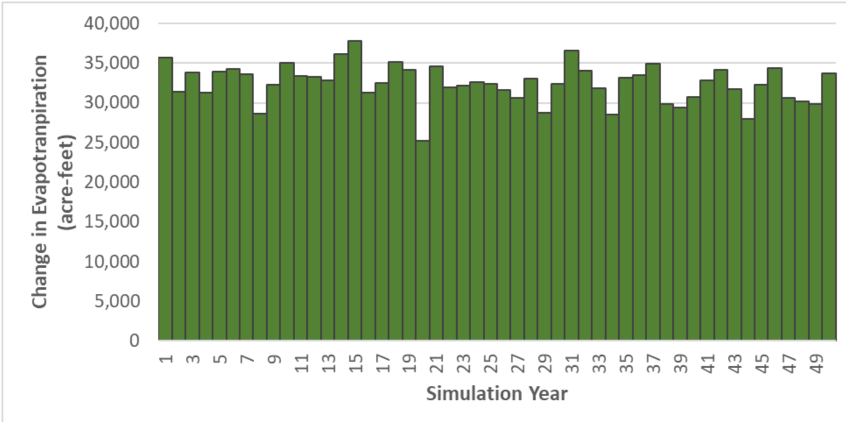


Figure 5-51: Simulated Changes in Surface Water Supplies due to Climate Change (Scenario minus Baseline)

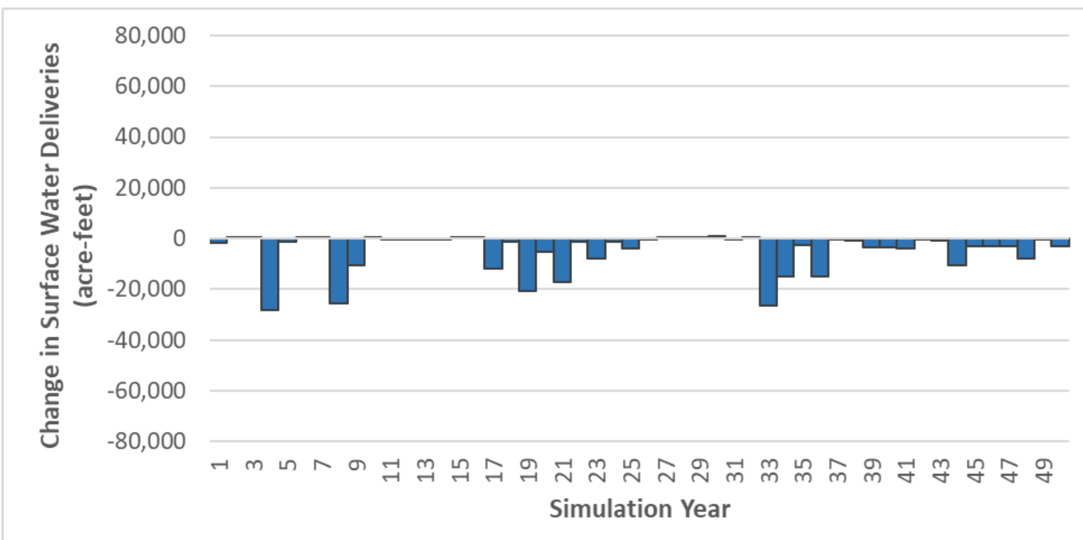


Figure 5-52: Simulated Changes in Groundwater Production due to Climate Change (Scenario minus Baseline)

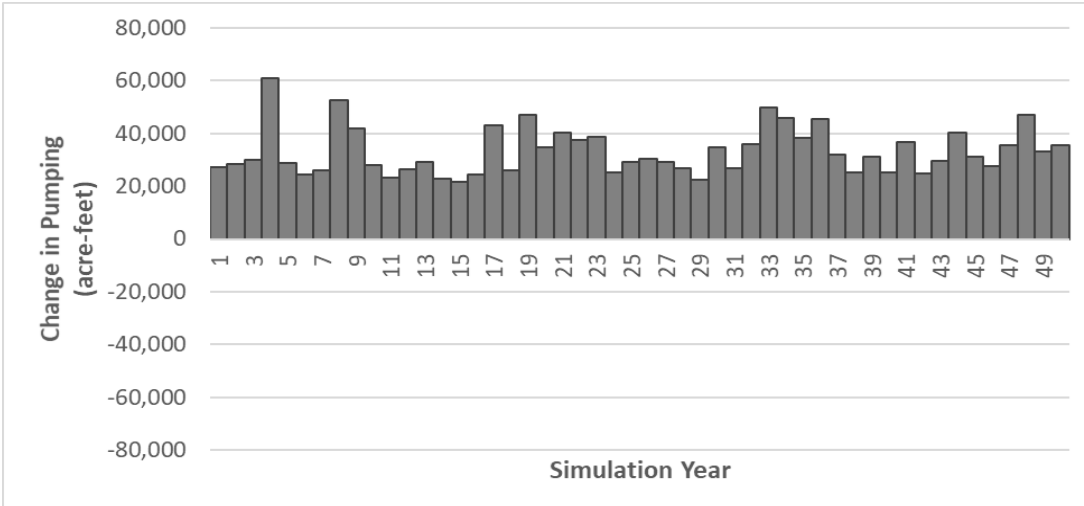


Figure 5-53: Agricultural Land and Water Use Budget – C2VSimTM Climate Change Scenario

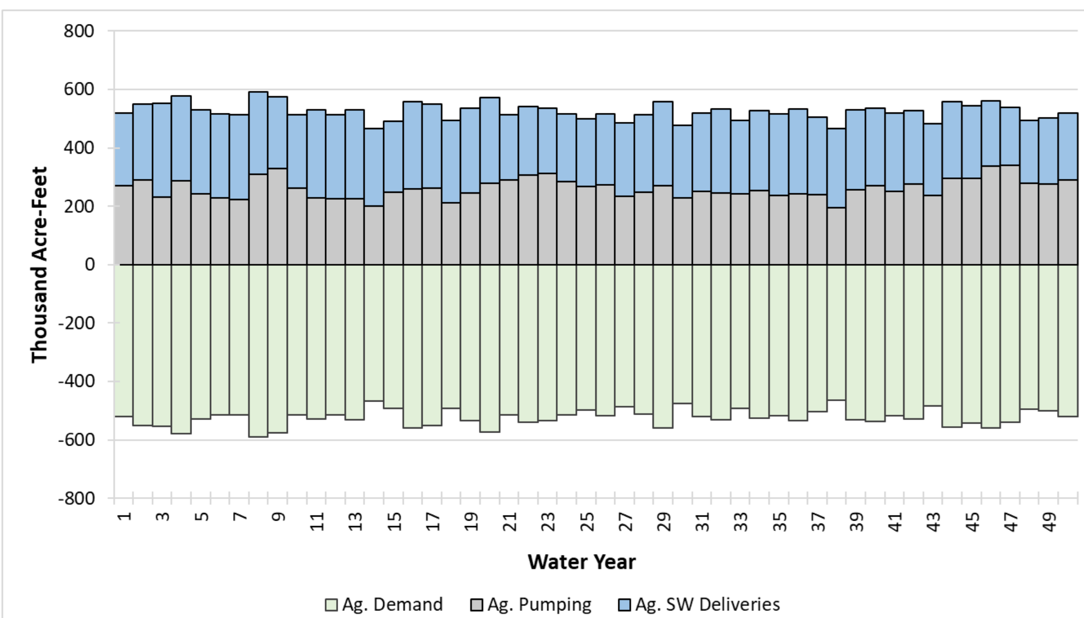


Figure 5-54: Urban Land and Water Use Budget – C2VSimTM Climate Change Scenario

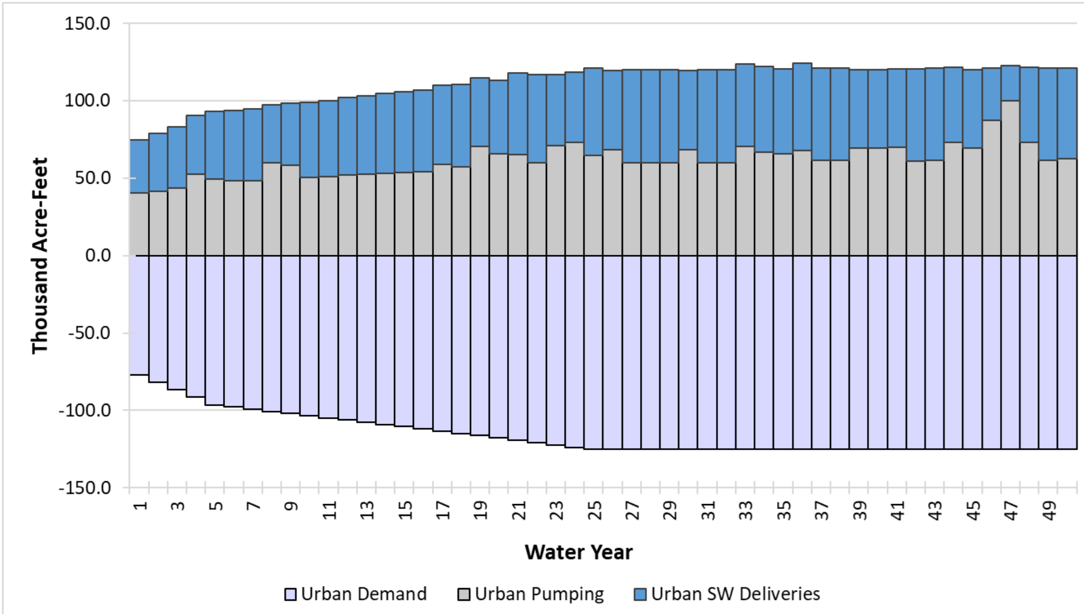


Figure 5-55: Groundwater Budget – C2VSimTM Climate Change Scenario

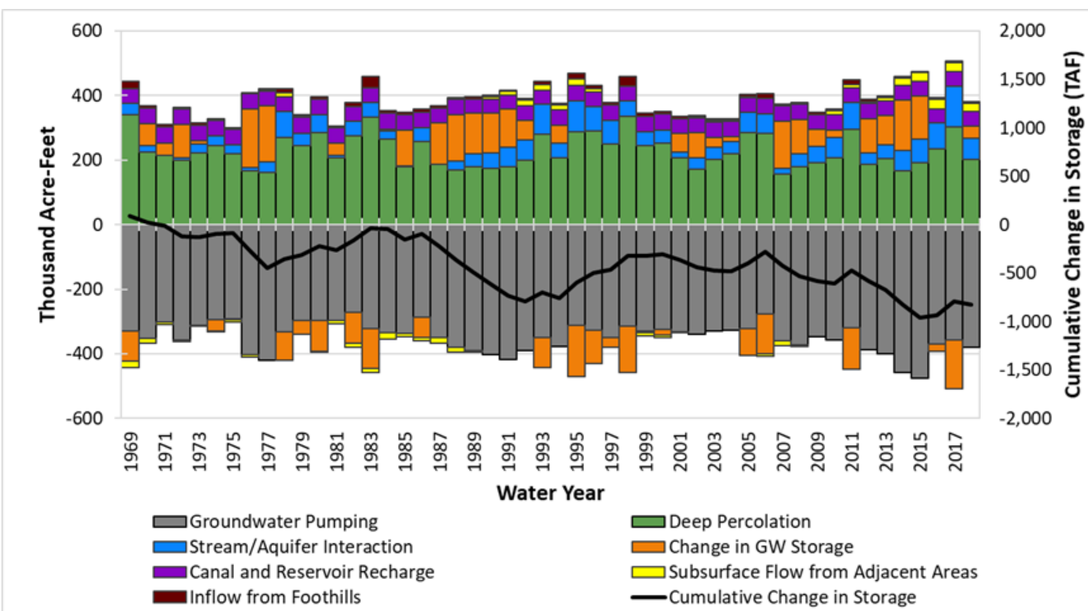


Table 5-12: Average Annual Water Budget Under Climate Change – Stream Systems, Modesto Subbasin (AFY)

Component	Projected Condition Water Budget	Climate Change Water Budget
Hydrologic Period	WY 1969 - 2018	WY 1969 - 2018
Stream Inflows	2,650,000	2,739,000
Stanislaus River	536,000	626,000
Tuolumne River	812,000	818,000
San Joaquin River	1,302,000	1,295,000
Tributary Inflow[1]	6,000	5,000
Stream Gain from Groundwater	104,000	96,000
Modesto Subbasin	50,000	45,000
Stanislaus River – South[2]	12,000	13,000
Tuolumne River - North	27,000	22,000
San Joaquin River - East	11,000	11,000
Other Subbasins	54,000	50,000
Stanislaus River - North	12,000	13,000
Tuolumne River - South	31,000	27,000
San Joaquin River - West	11,000	11,000
Surface Runoff to the Stream System[3]	60,000	72,000
Return Flow to Stream System[3]	113,000	114,000
Total Inflow	**2,934,000**	**3,025,000**
San Joaquin River Outflows	2,717,000	2,774,000
Diverted Surface Water[4]	33,000	33,000
Stream Seepage to Groundwater	146,000	177,000
Modesto Subbasin	76,000	91,000
Stanislaus River - South	36,000	44,000
Tuolumne River - North	38,000	45,000
San Joaquin River - East	2,000	2,000
Other Subbasins	71,000	86,000
Stanislaus River - North	31,000	39,000
Tuolumne River – South	38,000	45,000
San Joaquin River - West	2,000	2,000
Native & Riparian Uptake from Streams	37,000	41,000
Total Outflow	**2,934,000**	**3,025,000**

Note: sub-categories may not sum together due to rounding error

1 Tributary inflow include surface water contributions from small watersheds

2 Represents the location of the Modesto Subbasin relative to the stream, i.e., "North" represents the gains/losses of that stream to the Modesto Subbasin to the North.

3 Includes runoff/return flow from all subbasins adjacent to the stream system, not just the Modesto Subbasin.

4 Some surface water diversions are upstream of the Tuolumne River or Stanislaus River inflows and thus not included in this stream and canal water budget.

Table 5-13: Average Annual Water Budget Under Climate Change – Land Surface System, Modesto Subbasin (AFY)

Component	Projected Condition Water Budget	Climate Change Water Budget
Hydrologic Period	WY 1969 - 2018	WY 1969 - 2018
Agricultural Areas Precipitation	139,000	147,000
Agricultural Water Supply	497,000	525,000
Agency Surface Water	241,000	238,000
Agency Groundwater	25,000	25,000
Private Groundwater	230,000	262,000
Urban Areas Precipitation	38,000	40,000
Urban Water Supply	111,000	112,000
Groundwater	60,000	62,000
Surface Water	51,000	50,000
Native Areas Precipitation	92,000	97,000
Native & Riparian Uptake from Stream	22,000	24,000
Total Supplies	**900,000**	**945,000**
Agricultural ET	402,000	430,000
Agricultural ET of Precipitation	82,000	84,000
Agricultural ET of Surface Water	159,000	160,000
Agricultural ET of Agency Groundwater	16,000	17,000
Agricultural ET of Private Groundwater	146,000	170,000
Agricultural Percolation	201,000	202,000
Agricultural Percolation of Precipitation	45,000	46,000
Agricultural Percolation of Surface Water	75,000	70,000
Agricultural Percolation of Agency Groundwater	8,000	7,000
Agricultural Percolation of Private Groundwater	73,000	79,000
Agricultural Runoff & Return Flow	31,000	36,000
Urban Runoff & Return Flow	91,000	93,000
Urban ET	38,000	40,000
Urban Percolation	20,000	19,000
Native Runoff	12,000	15,000
Native ET	95,000	98,000
Native Percolation	7,000	8,000
Total Demands	**898,000**	**941,000**
Land Surface System Balance	2,000	4,000
Land Surface System Balance (% of supplies)	0.2%	0.4%

Note: sub-categories may not sum together due to rounding error

Table 5-14: Average Annual Water Budget Under Climate Change – Groundwater System, Modesto Subbasin (AFY)

Component	Projected Condition Water Budget	Climate Change Water Budget
Hydrologic Period	WY 1969 - 2018	WY 1969 - 2018
Gain from Stream	76,000	91,000
Gain from Stanislaus River	36,000	44,000
Gain from Tuolumne River	38,000	45,000
Gain from San Joaquin River	2,000	2,000
Canal & Reservoir Recharge	47,000	47,000
Deep Percolation	228,000	229,000
Subsurface Inflow	77,000	80,000
Flow from the Sierra Nevada Foothills	9,000	8,000
Eastern San Joaquin Subbasin Inflows	28,000	8,000
Turlock Subbasin Inflows	33,000	33,000
Delta Mendota Subbasin Inflows	7,000	32,000
Total Inflow	**428,000**	**446,000**
Discharge to Stream	50,000	45,000
Discharge to Stanislaus River	12,000	13,000
Discharge to Tuolumne River	27,000	22,000
Discharge to San Joaquin River	11,000	11,000
Subsurface Outflow	75,000	70,000
Eastern San Joaquin Subbasin Outflows	35,000	5,000
Turlock Subbasin Outflows	34,000	31,000
Delta Mendota Subbasin Outflows	6,000	35,000
Groundwater Production	314,000	347,000
Agency Ag. Groundwater Production	25,000	25,000
Private Ag. Groundwater Production	229,000	260,000
Urban Groundwater Production	60,000	62,000
Total Outflow	**438,000**	**463,000**
Change in Groundwater in Storage	(11,000)	(17,000)

Note: sub-categories may not sum together due to rounding error

5.2.3.4. Opportunities for Future Refinement

The climate change approach developed for this GSP is based on the methodology in DWR's guidance document (DWR, 2018b) and uses "best available information" related to climate change in the Modesto Subbasin. There are limitations and uncertainties associated with the analysis. One important limitation is that CalSim II does not fully simulate local surface water operations. Thus, the analysis conducted for this GSP may not fully reflect how surface and groundwater basin operations would respond to the changes in water demand and availability caused by climate change. For this first GSP iteration, use of a regional model and the perturbation factor approach were deemed appropriate given the uncertainties in the climate change analysis.

A recommendation for future refinements of this analysis is utilization of the local surface water operations model, the Tuolumne Reservoir Simulation (TRS) model. Use of this model would allow for greater resolution in the simulation of Tuolumne River flows and surface water supply based on local management. Additionally, utilization of TRS will allow for analysis of the localized climate conditions effecting snowpack and its implications on reservoir operations and streamflow. Further monitoring and adaptive management should be considered for the next update of the GSP along with improvements in DWR's climate change data.

5.3. SUSTAINABLE YIELD ESTIMATE

Sustainable yield is defined for SGMA purposes as "the maximum quantity of water, calculated over a base period representative of long-term conditions in the basin and including any temporary surplus, that can be withdrawn annually from a groundwater supply without causing an undesirable result." (CWC §10721(w)). Sustainable yield for the Modesto Subbasin was calculated through development of a C2VSimTM scenario in which the long-term (50-year) SGMA sustainability indicators are met either directly or by groundwater levels as a proxy as outlined in **Chapter 6: Sustainable Management Criteria**.

- **Reduction of Groundwater in Storage –** An Undesirable result is defined as significant and unreasonable reduction of groundwater in storage that would occur if the volume of groundwater supply is at risk of depletion and is not accessible for beneficial use, or if the Subbasin remains in a condition of long-term overdraft based on projected water use and average hydrologic conditions. in a manner that cannot be readily managed or mitigated.
- **Chronic Lowering of Groundwater Levels** – Undesirable results are defined as significant and unreasonable groundwater level declines – either due to multi-year droughts or due to chronic declines where groundwater is the sole supply – such that water supply wells are adversely impacted in a manner that cannot be readily managed or mitigated.
- **Depletion of Interconnected Surface Water –** An Undesirable Result is defined as significant and unreasonable adverse impacts to the beneficial uses of surface water caused by groundwater extraction.

The sustainable yield water budget is based on the Projected Conditions Baseline and is analyzed by reducing groundwater production through changes in the agricultural demand of the net groundwater extractors in Modesto Subbasin. Net-contributing and net-extracting users in the Subbasin are divided into the two groups shown in **Figure 5-56**. Group 1 users predominately rely on both surface and groundwater, while users in Group 2 predominantly rely on groundwater.

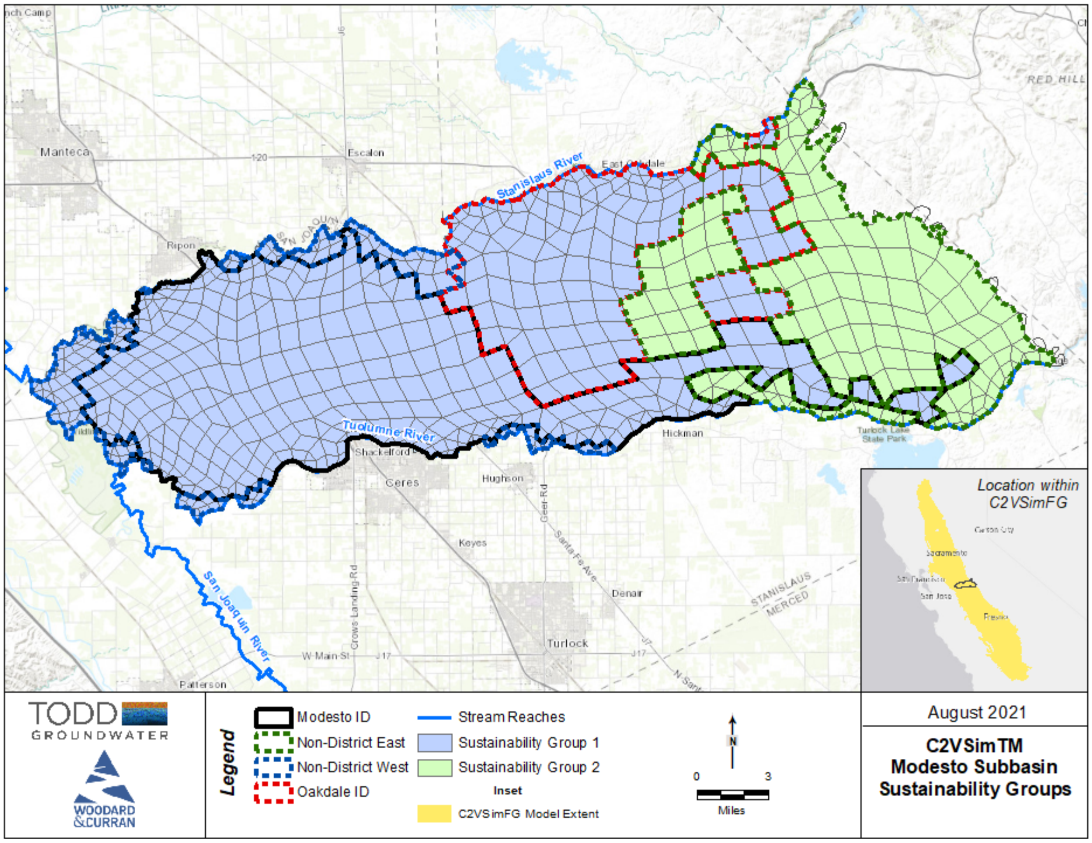
Group 1: Surface and Groundwater Users

- Modesto Irrigation District
- Oakdale Irrigation District
- Non-District West (riparian surface water users)

Group 2: Groundwater Only Users

- Non-District East

Figure 5-56: Modesto Subbasin Sustainability Groups



The Sustainable Yield Scenario varies from the Projected Conditions Baseline in its volume of agricultural water demand. These demands were reduced by decreasing agricultural land use via a global reduction in projected cropped acreage at the element level.

The sustainable yield water budget is intended to estimate future supply, demand, and aquifer response in the Modesto Subbasin under sustainable conditions achieved with a demand reduction scenario. To meet the goals set forth by the sustainability indicators listed above, Group 2 agricultural users would need to reduce demand by 58-percent from the projected baseline levels. This reduction in groundwater usage results in a sustainable yield of approximately 267,000 acre-feet per year for the Subbasin.

The methodology for reducing Subbasin-wide pumping to estimate sustainable yield is developed solely to estimate the subbasin’s sustainable yield and is not intended to prescribe or describe how pumping would be reduced in the basin during GSP implementation to achieve sustainability. The reduction of groundwater demand to sustainable levels would be implemented in close coordination among the various Subbasin zones. The groundwater demand reduction is only one and/or part of the overall management actions that would result in groundwater sustainability within the Subbasin; factors such as water rights, beneficial uses, needs, and human right to water should also be considered. The status of plans for implementing management actions related to pumping reductions is further discussed in **Chapter 8 - Projects and Management Actions**.

Table 5-15 provides a detailed listing of the water flow components of the Modesto Subbasin's groundwater system for the historical, projected conditions baseline and sustainable yield conditions. To achieve sustainability and maintain minimum groundwater level thresholds, the Subbasin needs to experience an average annual net gain of groundwater in storage of 11,000 AFY. These conditions are met through 213,000 AFY of deep percolation, 47,000 AFY of canal and reservoir recharge, and 20,000 AFY of net subsurface inflow from the Sierra Nevada foothills and the neighboring Turlock, Delta-Mendota, and Eastern San Joaquin Subbasins. Outflows from the subbasin include 266,000 AFY of pumping and 14,000 AFY of net groundwater discharge to the surface water bodies. The major flow components are represented graphically in **Figure 5-57** and **Figure 5-58**, on an annual and average annual basis.

Figure 5-59 and **Figure 5-60** show the groundwater recharge and extraction and net recharge for the Modesto Subbasin. Under sustainable conditions, the Modesto Subbasin is expected to maintain an average net extraction of 7,000 AFY, compared to a net extraction of 39,000 AFY under projected conditions. This reduction in net extraction is attributed to the reduction of groundwater pumping, which is reduced from 314,000 AFY under the Baseline to 267,000 AFY under sustainable yield, combined with an overall reduction in percolation of agricultural applied water of 14,000 AFY between the two scenarios.

Table 5-15: Sustainable Yield Average Annual Water Budget Groundwater System – Modesto Subbasin

Component	Projected Conditions	Sustainable Conditions
Hydrologic Period	Hydrology from WY 1969 - 2018	Hydrology from WY 1969 - 2018
Gain from Stream	76,000	58,000
Gain from Stanislaus River	36,000	27,000
Gain from Tuolumne River	38,000	29,000
Gain from San Joaquin River	2,000	1,000
Canal & Reservoir Recharge	47,000	47,000
Deep Percolation	228,000	213,000
Subsurface Inflow	77,000	83,000
Flow from the Sierra Nevada Foothills	9,000	9,000
Eastern San Joaquin Subbasin Inflows	28,000	9,000
Turlock Subbasin Inflows	33,000	29,000
Delta Mendota Subbasin Inflows	7,000	37,000
Total Inflow	**428,000**	**401,000**
Discharge to Stream	50,000	71,000
Discharge to Stanislaus River	12,000	18,000
Discharge to Tuolumne River	27,000	40,000
Discharge to San Joaquin River	11,000	14,000
Subsurface Outflow	75,000	63,000
Eastern San Joaquin Subbasin Outflows	35,000	4,000
Turlock Subbasin Outflows	34,000	30,000
Delta Mendota Subbasin Outflows	6,000	30,000
Groundwater Production	314,000	267,000
Agency Ag. Groundwater Production	25,000	25,000
Private Ag. Groundwater Production	229,000	181,000
Urban Groundwater Production	60,000	60,000
Total Outflow	**438,000**	**401,000**
Change in Groundwater in Storage	(11,000)	-

Note: sub-categories may not sum together due to rounding error

Figure 5-57: Sustainable Yield Average Annual Water Budget Groundwater System – Modesto Subbasin

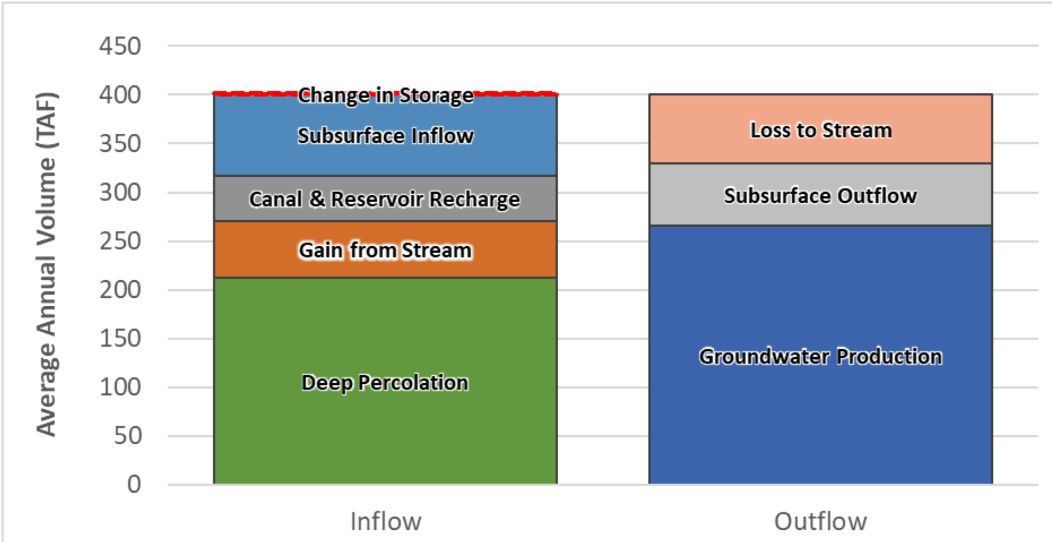


Figure 5-58: Sustainable Yield Water Budget Groundwater System – Modesto Subbasin

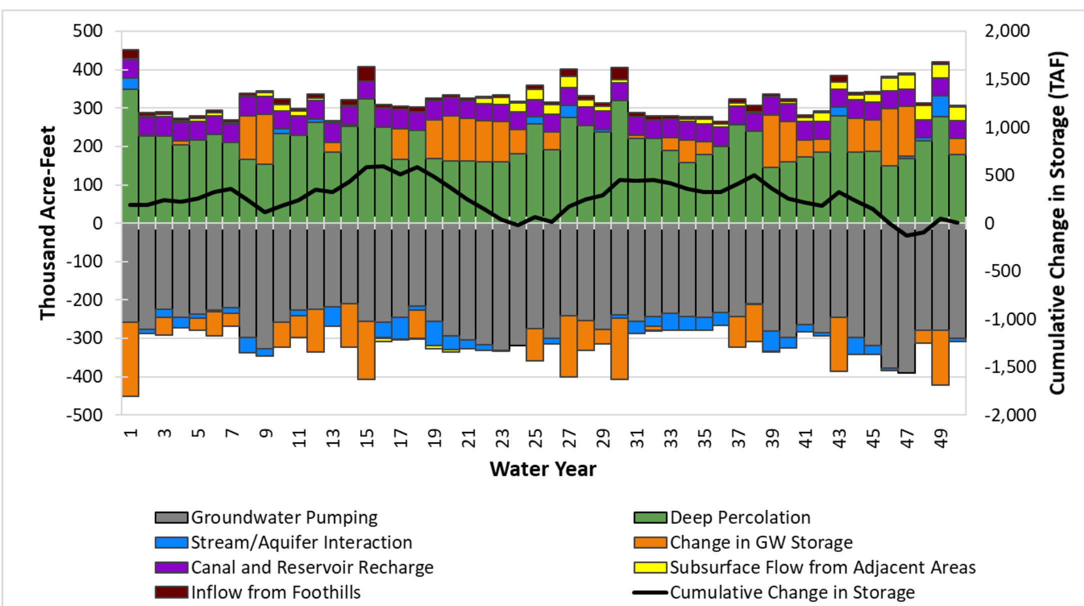


Figure 5-59: Sustainable Yield Water Budget Groundwater Recharge and Extraction – Modesto Subbasin

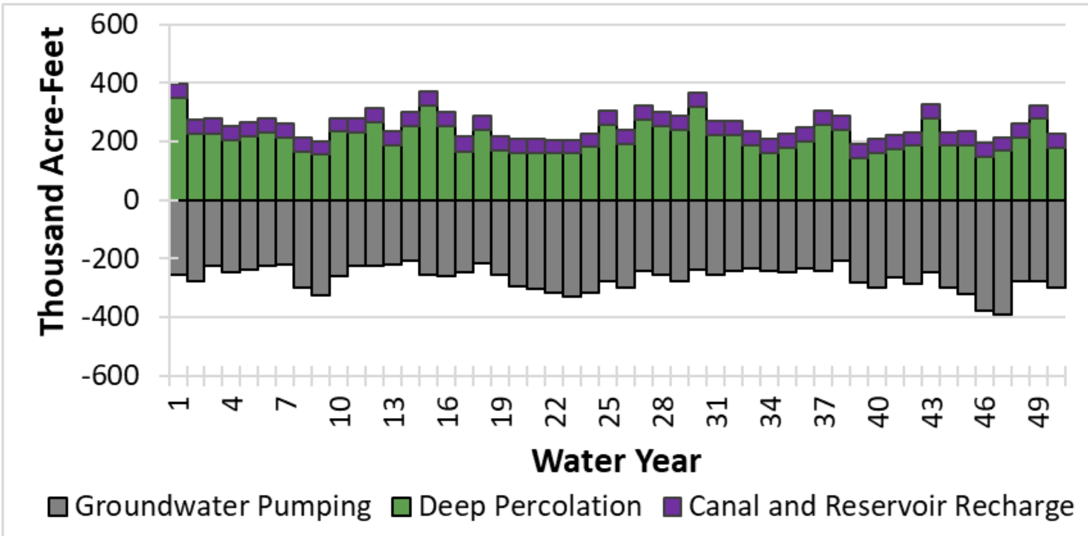
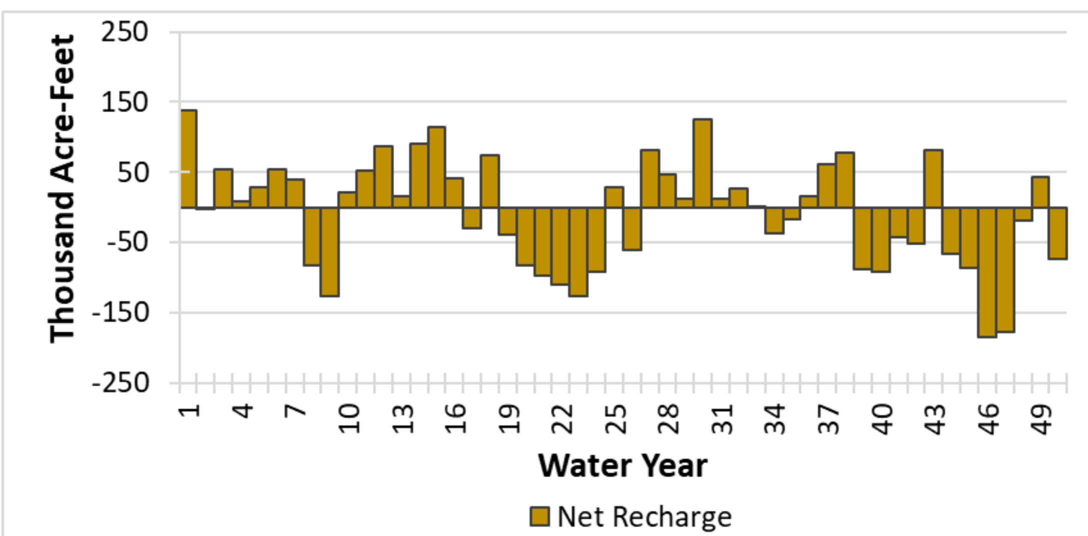


Figure 5-60: Sustainable Yield Water Budget Net Recharge – Modesto Subbasin



SUMMARY

The sustainable yield of the Modesto Subbasin is developed by methodically reducing groundwater demand for the net groundwater extractors (Sustainability Group 2) in the Subbasin. The goal of this groundwater demand reduction is to reduce groundwater pumping to a level that would result in no undesirable results if continued in the long-term. The presence of undesirable results is evaluated by analyzing sustainability indicators produced by the numerical model, including groundwater in storage, groundwater levels, and interconnected stream systems. It is assumed that by using groundwater levels as proxy for other applicable sustainability indicators (i.e., groundwater quality and land subsidence), the sustainable yield would address all applicable sustainability indicators in the Modesto Subbasin.

This analysis results in a sustainable yield of 267,000 AFY for the Modesto Subbasin.

The sustainable yield is based on the current and latest data and information for the subbasin. It is expected that the sustainable yield estimate would be updated for the next GSP update in 2027, as additional data and information become available on the operation of the Subbasin, implementation of projects and management actions, groundwater levels, storage, and quality, and as updates to the tools and technology, such as updates to the integrated numerical model are implemented.

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6. SUSTAINABLE MANAGEMENT CRITERIA

GSP regulations provide a framework for locally-defined and quantitative *sustainable management criteria*, which allows the GSAs to quantitatively measure and track ongoing sustainable management. These criteria include a sustainability goal, which has been developed as a mission statement for the GSP. Additional criteria include specific terminology from SGMA; a brief summary[12] of these terms – and the application of each – are provided below:

- Undesirable Results (URs[13]) – significant and unreasonable adverse conditions for any of the six sustainability indicators defined in the GSP regulations.
- Minimum Threshold (MT^2) – numeric value used to define undesirable results for each sustainability indicator at representative monitoring sites.
- Measurable Objective (MO^2) – numeric goal to track the performance of sustainable management at representative monitoring sites.
- Interim Milestone (IM^2) – target numeric value representing measurable groundwater conditions, in increments of five years, as set by the GSAs as part of the GSP.

Collectively, these criteria define sustainable groundwater management by:

- quantifying groundwater conditions to avoid, along with associated warning signs (URs and MTs);
- identifying favorable groundwater conditions and operational parameters (MOs); and
- providing targets for monitoring Subbasin progress toward achieving the sustainability goal (MTs, MOs, and IMs).

6.1. SUSTAINABILITY GOAL

A sustainability goal provides a mission statement for what the GSAs wish to achieve through sustainable management. GSP regulations provide requirements for a GSP Sustainability Goal, as follows:

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[12] Sustainable management criteria are more fully defined in SGMA (CWC 10721(a) – (ab) and GSP regulations (§351(a) – (an)).

[13] Because of the frequency of use, and to facilitate review of the text, the terms "undesirable results" "minimum threshold," "measurable objective," and "interim milestone" are abbreviated as "UR", "MT", "MO", and "IM" respectively, throughout remaining sections of the GSP. However, the terms are spelled out in un-abbreviated form where helpful for context and clarity or when contained in a direct quotation.

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

In the Best Management Practices (BMPs) document on sustainable management criteria, DWR recommends that one succinct, common sustainability goal be developed for the entire Subbasin.

The requirements and guidance for a GSP sustainability goal were reviewed in a public meeting of the STRGBA GSA Technical Advisory Committee (TAC) in February 2021. That meeting was followed with a technical memorandum prepared by the technical team, in part, to assist TAC members with development of a goal. The memorandum summarized GSP requirements and how the sustainability goal fits within the overall sustainable management criteria process.

Based on TAC feedback, DWR guidance, and GSP requirements, the TAC Planning Group[14] developed a draft sustainability goal reviewed by the TAC at a public meeting on May 12, 2021. At that meeting, additional comments on the sustainability goal were received from stakeholders and TAC members. Those comments were incorporated into the draft sustainability goal presented below.

The Sustainability Goal of the Modesto Subbasin GSP *is to provide a sustainable groundwater supply for the local community and for the economic vitality of the region. Groundwater levels, storage volume, and quality will be actively managed by the STRGBA GSA to:*

- ***Operate the Subbasin within its sustainable yield to support beneficial uses including municipal, domestic, agricultural, industrial, and environmental;***
- ***Maintain a reliable, accessible, and high-quality groundwater supply, especially during droughts;***
- ***Manage groundwater levels such that beneficial uses of interconnected surface water are not adversely impacted by groundwater extractions;***
- ***Optimize conjunctive management of local surface water and groundwater resources;***
- ***Avoid adverse impacts from future potential land subsidence associated with groundwater level declines;***

[14] The TAC Planning Group is a small working group composed of representatives from the TAC to guide the GSP process and provide recommendations to the full TAC.

- ***Cooperate and coordinate with GSAs in neighboring subbasins to avoid undesirable results along the shared Subbasin boundaries.***

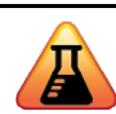
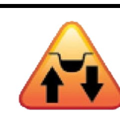
This goal will be achieved within the 20-year implementation period and maintained throughout the planning horizon through a robust monitoring program and a series of projects and management actions that involve groundwater recharge, in lieu surface water use, conservation, stormwater management, and other strategies to be developed and modified over time through adaptive management.

The sustainability goal is supported by information provided in GSP chapters on the plan area (**Chapter 2**) and basin setting (**Chapters 3** and **5**). Specific information used to inform the sustainability goal included the identification of land and water use in the Subbasin (**Chapter 2**), ongoing conjunctive management of surface water and groundwater (**Chapter 2.**), delineation of the base of fresh water and groundwater in storage (**Section 3.1.3**), the establishment of Principal Aquifers (**Section 3.1.4**), groundwater conditions (**Sections 3.2**), and historical and projected water budgets (**Chapter 5**). Additional considerations of basin conditions that support the sustainability goal are described in the following section.

6.2. SELECTION OF SUSTAINABLE MANAGEMENT CRITERIA

Six sustainability indicators are defined in the GSP regulations to represent groundwater conditions that, when determined to be significant and unreasonable, cause undesirable results. The avoidance of undesirable results is the foundation for sustainable groundwater management. Accordingly, these sustainability indicators are analyzed in the Modesto Subbasin to define undesirable results and other sustainability criteria, including MTs, MOs, and IMs. A representative monitoring network is established for each applicable indicator to track these conditions throughout the implementation and planning horizon.

Those six indicators and their associated icons developed by DWR are illustrated below.

					
Chronic Lowering of Water Levels	**Reduction of Groundwater in Storage**	**Seawater Intrusion**	**Degraded Water Quality**	**Inelastic Land Subsidence**	**Depletion of Inter-connected Surface Water**

6.2.1. Sustainability Considerations in the Modesto Subbasin

As explained in subsequent sections, this GSP analyzes conditions related to the six sustainability indicators that support definitions for undesirable results. SGMA legislation states that the GSAs are not required to address undesirable results that occurred before – and have not been corrected by – January 1, 2015 (§10727.2 (b)(4)). Accordingly, the focus for several indicators is to avoid future conditions that could lead to undesirable results.

Basin conditions as of 2015 and management considerations for each sustainability indicator are summarized in **Table 6-1**, along with the respective GSP section where each indicator is analyzed. General locations for the conditions described in the table are shown on **Figure 6-1** with certain areas highlighted by the sustainability indicator icons for reference.

Table 6-1: Sustainability Considerations for Modesto Subbasin

Basin Conditions		Undesirable Results in Modesto Subbasin as of 2015?	Management Considerations	GSP Sect.
	Declining water levels are occurring, primarily in the eastern Subbasin. Other local areas experienced water level declines during drought.	Yes	Adverse impacts to public and domestic water supply wells caused by declining water levels. Water levels will be managed to avoid future impacts.	**6.3**
	Overdraft conditions, primarily in areas where groundwater is the primary source of supply.	Yes	Over-pumping in certain areas has caused water level declines, which impact beneficial uses of both groundwater and surface water. GSP will arrest overdraft conditions.	**6.4**
	Not applicable to this inland Subbasin.	No	None	**6.5**
	Groundwater concentrations for certain constituents of concern are exceed drinking water standards over widespread areas of the Subbasin. Groundwater extractions, GSA projects, and GSA management actions may have the potential to degrade water quality in the future.	No	Historical water quality impacts have not been caused by GSA management activities, and therefore are not undesirable results as defined in this GSP. GSAs need to manage Subbasin groundwater so as not to further degrade groundwater quality.	**6.6**
	No documented impacts from land subsidence in Subbasin; potential for compressible clays to cause land subsidence in the future.	No	If groundwater levels are managed at or near historic low levels, the potential for future undesirable results can be avoided.	**6.7**
	Streamflow depletions have increased over time, especially on the Tuolumne and Stanislaus rivers. All 3 river boundaries remain interconnected, and no current impacts to surface water rights have been identified. Modeling predicts increased depletions in the future.	No	GSAs are not responsible for correcting conditions before 2015. However, modeling projects future streamflow depletions that may lead to undesirable results. GSAs will manage water levels to reduce future increases in streamflow depletions.	**6.8**

As indicated in **Table 6-1**, the Modesto Subbasin has experienced undesirable results associated with chronic lowering of water levels and reduction of groundwater in storage. These conditions have occurred primarily within and around the Non-District East Management Area (NDE MA) as shown on **Figure 6-1**. Over the historical study period, agricultural production has expanded in the eastern Subbasin where groundwater is the primary source of water supply. Over-pumping in this area has led to water level declines expanding into other areas, which exacerbated conditions during the 2014-2016 drought and caused impacts to both public and domestic water supply wells. During this time, more than 150 domestic wells failed (indicated on **Figure 6-1** by the small black dots). As explained in **Section 6.3**, most of the impacted wells appear to have been replaced with deeper wells. Nonetheless, some wells remain vulnerable to future multi-year droughts, including two areas highlighted on **Figure 6-1**.

As indicated in **Table 6-1**, the GSAs have determined that the seawater intrusion sustainability indicator, as described in GSP regulations, does not apply to the Modesto Subbasin; as such, no sustainable management criteria have been selected for this indicator (see **Section 6.5**).

As indicated in **Table 6-1**. undesirable results have not been experienced for the degraded water quality sustainability indicator even though numerous constituents of concern have been detected above drinking water standards over time. Undesirable results for this indicator refer to water quality impacts specifically *caused* by GSA management (see **Section 6.6.1**), which has not yet been initiated. The water quality icon on **Figure 6-1** is located in the City of Modesto where water quality is actively managed through groundwater extractions, wellhead treatment, and other operational strategies. Future GSA management will focus on protection against further degradation that could be caused by GSA activities.

As indicated in **Table 6-1**, no impacts from land subsidence have been observed in the Subbasin. However, basin conditions indicate that land subsidence could occur if water levels continue to decline. Compressible clay layers within and below the Corcoran Clay have been associated with land subsidence in other portions of the Central Valley. Areas within the extent of the Corcoran Clay are highlighted on **Figure 6-1** as most susceptible to land subsidence.

The Stanislaus, Tuolumne, and San Joaquin rivers are all interconnected surface water as defined by SGMA (see icons on **Figure 6-1**). Projected water budget analyses indicate increased streamflow depletion will occur in the future, which could lead to undesirable results unless water level declines are arrested (see **Section 6.8**).

The overall process for developing sustainable management criteria is discussed in the following section. Subsequent sections document the sustainable management criteria for each sustainability indicator (**Section 6.3** through **6.8**).

6.2.2. Public Process for Sustainable Management Criteria

An interactive and public process was established by the STRGBA GSA to develop sustainable management criteria for the Modesto Subbasin. The Tuolumne GSA participated through an agreement with Stanislaus County, a member agency of the STRGBA GSA. The STRGBA GSA formed a technical advisory committee (TAC) composed of GSA member agencies, who reviewed and commented on technical presentations throughout the GSP development process. The TAC formed a small planning group to guide development of technical analyses to support the process.

TAC meetings generally followed the monthly STRGBA GSA meetings (typically held on the 2nd Wednesday of each month at 1:30pm). The STRGBA GSA Chair led the TAC public meetings – with input from stakeholders – for development of recommended sustainable management criteria to be incorporated into the GSP. TAC meetings were held according to the Brown Act and technical presentations on sustainable management criteria were typically posted on the STRGBA GSA website prior to the meetings. In general, presentations provided information on the following topics relating to sustainable management criteria:

- requirements from the GSP regulations,
- relevant hydrogeological conditions in the Modesto Subbasin,
- recommendations from the DWR BMP on Sustainable Management Criteria, and
- examples from adjacent or other relevant subbasins.

Steps taken during this process were provided in a technical memorandum in February 2021 – information from which has been incorporated into this GSP chapter. The steps are summarized below:

1. Analyze the six Sustainability Indicators, applying conditions from the Basin Setting.
2. Define Undesirable Results (URs) as specific groundwater conditions to avoid.
3. Assign minimum threshold (MTs) for each indicator as a metric that can be used to define undesirable results.
4. Select measurable objectives (MOs) for each indicator as an operational target metric to avoid operating too close to the MT and to avoid undesirable results.
5. Develop interim milestones (IMs) that show progress toward each MO over the 20-year planning horizon.
6. Develop a Sustainability Goal that culminates in the absence of undesirable results (**Section 6.1**).

The sustainability indicators were introduced at the public GSP kickoff meeting on September 12, 2018 and were considered during development of the technical portions of the Plan Area (**Chapter 2**) and basin setting (**Chapters 3 and 5**). A TAC meeting focused solely on the sustainable management criteria was held on November 13, 2019, when the TAC considered examples of sustainable management criteria from neighboring subbasins.

Historical water budgets, zone budgets, and projected future water budgets were developed, presented, and discussed throughout 2020 (see details on the water budgets in **Chapter 5**).

More than 15 public TAC meetings were focused on sustainable management criteria, monitoring networks, and management areas. During these meetings, undesirable results were established, and MTs and MOs were selected. Sustainable management criteria, including undesirable results, MTs and MOs were quantified for each representative monitoring site for all three principal aquifers and the four management areas.

6.2.3. Management Areas

Regulations allow for the establishment of management areas within a Subbasin to facilitate implementation of the GSP. A management area can be operated differently from the others and can also define different sustainable management criteria. The GSP must explain the reason for creating each management area and provide rationale for the proposed operation of each; in particular, operation of one management area cannot cause undesirable results in other areas.

In the Modesto Subbasin management areas have been developed to facilitate GSP implementation of projects and are based on areas of similar water supplies and similar ongoing water management activities. Four management areas have been established in the Modesto Subbasin as shown on **Figure 6-2** and listed below (approximate acres as calculated in GIS):

- Modesto ID Management Area (101,914 acres)
- Oakdale ID Management Area (49,893 acres)
- Non-District East Management Area (77,218 acres)
- Non-District West Management Area (15,777 acres)

Boundaries of the first two management areas coincide with the current service area boundaries of Oakdale ID and Modesto ID (**Figure 6-2**). These areas also include most of the urban areas within the Subbasin including Modesto, Oakdale, most of Waterford, and parts of Riverbank. In these two management areas, surface water is available for conjunctive use and supplements groundwater supply for beneficial uses. Specifically, Oakdale ID conjunctively manages Stanislaus River water and groundwater within the Oakdale ID Management Area. Similarly, Modesto ID manages Tuolumne River water and groundwater conjunctively throughout the Modesto ID Management Area.

Surface water supply in these management areas was originally developed for agricultural uses but has been expanded over time to also provide drinking water supplies (e.g., City of Modesto) or non-potable urban uses. As a result, close coordination and partnerships already exist between STRGBA GSA member agencies within the Modesto ID and Oakdale ID management areas. Delineation of management areas coincident with current Modesto ID and Oakdale ID service area boundaries allow for seamless coordination of ongoing management activities with new management responsibilities under SGMA.

The Non-District East Management Area and Non-District West Management Area are located on lands outside of the two large irrigation district boundaries where management is currently coordinated through Stanislaus County[15] as a member agency of the STRGBA GSA. The Non-District West Management Area is the smaller of the two and contains lands between the rivers and Modesto ID and Oakdale ID management areas along the rim of the western Subbasin. Surface water is also available in this management area through riparian rights along the river boundaries. Delineation of these lands as a separate management area combines areas of similar water supply activities in the western Subbasin to facilitate GSA management.

The Non-District East Management Area is defined as lands in the eastern Subbasin outside of the Oakdale ID and Modesto ID management areas. Unlike the other management areas, surface water has not been widely available for water supply; groundwater has served as the primary water supply for the expanding agricultural production in the Non-District East Management Area.

As described above and explained in more detail in subsequent sections of **Chapter 6**, the Non-District East Management Area is the primary area with declining water levels in the Subbasin. Accordingly, projects and management actions are prioritized for this management area in order to achieve the Subbasin's Sustainability Goal.

Most of the infrastructure required for GSP projects will need to be developed in the Non-District East Management Area by local landowners. The Non-District East Management Area will need to develop agreements and partnerships with both the Modesto ID and the Oakdale ID management areas to bring additional water supply into the area.

As indicated by the information above, the delineation of management areas shown on **Figure 6-2** facilitates the future management activities anticipated by the GSP.

6.2.4. Organization of Sustainability Indicators

Each sustainability indicator is discussed separately in **Sections 6.3** through **6.8** below. Information within each of these sections is organized similarly and tracks the order of GSP requirements provided in *Subarticle 3. Sustainable Management Criteria*. Headings and subheadings in the subsequent sections are as follows:

- Introduction including regulatory definitions
- Definition of Undesirable Results along with quantitative criteria that are used to define when and where undesirable results would occur.
    - Causes of Undesirable Results

[15] As mentioned previously, Stanislaus County also represents the Tuolumne GSA by agreement.

    - Potential Effects on Beneficial Uses and Users of Groundwater
- Quantification of minimum thresholds (MTs) followed by the six requirements for MT analysis in the regulations
    - Justification and support for MTs
    - Relationship of MTs to other sustainability indicator MTs and how GSAs determined that undesirable results would be avoided
    - Impacts of MTs on adjacent subbasins
    - Effects of MTs on beneficial uses and users of groundwater
    - Consideration of State, Federal, or local standards in MT Selection
    - Quantitative measurement of MTs
- Quantification of measurable objectives (MOs)
- Quantification of interim milestones (IMs).

The description of the Plan Area (**Chapter 2**) was used to provide the context for groundwater wells and the overall water resources for the Subbasin. The hydrogeologic conceptual model and groundwater analyses (**Chapter 3**) were used to understand the basin conditions relevant to sustainability. The historical, current, and projected future water budgets (**Chapter 5**) were used to analyze overdraft conditions, streamflow depletions, and subsurface flows with adjacent subbasins. Water budgets were also used to establish a sustainable yield for the Subbasin that analyzed sustainable management criteria required to avoid undesirable results.

Collectively, these analyses informed and supported the selection of sustainable management criteria as discussed for each sustainability indicator below.

6.3. CHRONIC LOWERING OF GROUNDWATER LEVELS

SGMA defines an undesirable result for the chronic lowering of groundwater levels as a "significant and unreasonable depletion of supply if continued over the planning and implementation horizon" (§10721 (x)(1)). As described in **Section 3.2.4**, DWR estimated the amount of fresh groundwater supply beneath the Modesto Subbasin at about 14 million acre feet (MAF) in 1961. An analysis of the historical water budget (WY 1991 – WY 2015) estimates a depletion of about 1.1 MAF of this supply over the 25-year period (about 43,000 AFY, see **Figure 5-20** and **Table 5-8**), about 8 percent of the estimated total supply. Most of the deficit likely occurred in recent years with increases in agricultural water demand; this indicates that about 13 MAF of groundwater remains in storage.

Although significant amounts of fresh groundwater remain in the Subbasin, the chronic lowering of groundwater levels has created adverse impacts to numerous water supply wells. Because wells are the primary method for accessing groundwater for beneficial uses, adverse impacts to water supply wells can lead to undesirable results. As such, the emphasis of this sustainability indicator is depletion of *accessible* supply and focuses on adverse impacts to Subbasin supply wells. This emphasis is also consistent with GSP regulations, which note that depletion of supply should be considered "*at a given location*" (§354.28(c)(1)), such as at a well.

The SGMA definition of chronic lowering of groundwater levels also addresses water level declines within the context of overdraft and storage as shown below:

> 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. (§10721 (x)(1)).

This definition allows for water level declines during drought as long as such declines do not result in undesirable results and as long as water levels recover to acceptable levels over average hydrologic conditions. Accordingly, the analysis of the chronic lowering of groundwater levels focuses on long-term trends of water level declines that do not recover during wet periods.

Undesirable results, including causes and impacts to beneficial uses, are described below in **Section 6.3.1**. The undesirable result definition, along with criteria to quantify where and when undesirable results will occur, is provided in **Table 6-3** at the end of **Section 6.3.1**. **Section 6.3.2** describes the quantification of minimum thresholds (MTs). **Section 6.3.3** provides the approach and selection of measurable objectives (MOs). Interim milestones that cover all of the applicable sustainability indicators are described in **Section 6.9**.

6.3.1. Undesirable Results for Chronic Lowering of Groundwater Levels

As summarized previously, groundwater level declines in the Modesto Subbasin are the combined results of overdraft and multi-year drought conditions. Over-pumping, primarily in the Non-District East Management Area (NDE MA) (**Figure 6-1**), has contributed to a historical Subbasin overdraft of about 43,000 AFY (**Section 5.1.4** and **Table 5-6**). Groundwater level declines associated with this overdraft have propagated outside of the NDE MA and affected water levels in adjacent areas to the west where additional water supply wells have been impacted (see estimated areas of vulnerable domestic wells on **Figure 6-1**).

Impacts to water supply wells are exacerbated during droughts. Chronic declines in groundwater levels are accelerated due to less availability of surface water for water supply, decreased recharge from decreases in precipitation and runoff, and/or increased irrigation demand due to higher temperatures. If groundwater declines are not arrested following a drought, future droughts will begin with even lower water levels, resulting in increased impacts to water supply wells and beneficial uses that worsen with each drought.

In addition to impacts to wells as described below, the lowering of groundwater levels may also lead to undesirable results for the other sustainability indicators such as reduction of groundwater in storage, land subsidence, depletions of interconnected surface water and adverse impacts to groundwater dependent ecosystems (GDEs). These impacts are summarized in **Section 6.3.2.2** and described separately for each indicator in remaining sections of this chapter.

6.3.1.1. Causes of Undesirable Results – Adverse Impacts to Wells

The combination of over-pumping and drought caused widespread adverse impacts to Subbasin water supply wells during drought conditions WY 2014 – WY 2017, resulting in undesirable results. Even though well owners appear to have mitigated most of these impacts, GSAs intend to arrest water level declines so that future widespread impacts to water supply wells can be avoided. Adverse impacts to water supply wells caused by chronic lowering of groundwater levels are discussed below.

In general, lower water levels increase pumping costs. If water levels fall below the pump intake, costs may be incurred for pump lowering and/or other well modifications. Further declines can result in water levels falling below the top of well screens, potentially decreasing capacity or well integrity due to geochemical changes, biological clogging, and/or air entrainment. Water level declines can also damage wellbore equipment, such as pumps or casing, from cavitation or other mechanisms. If water levels fall below the bottom of the well and do not sufficiently recover, the well is dewatered and would require replacement. Older wells, shallow wells, and/or wells with casing integrity issues typically have a higher risk of failure.

In the Modesto Subbasin, the STRGBA GSA member agencies responsible for public drinking water supplies documented numerous adverse impacts to public supply wells caused by declining water levels during drought (WY 2014 to WY 2017). During that period, declining water levels provided an opportunity to observe impacts associated with the historic low levels throughout much of the Subbasin. Most agencies observed a decrease in capacity and well efficiency. Some drinking water wells failed due to collapsed casing or other problems. More than 150 domestic wells were also adversely impacted (locations on **Figure 6-1**).

Significant adverse impacts to water supply wells in the Modesto Subbasin during this drought period are summarized in **Table 6-2** as follows.

Table 6-2: Adverse Impacts to Wells Associated with Declining Groundwater Levels

Adverse Impacts to Water Supply Wells from 2014 – 2017	Agencies Reporting Impacts
159 dry[1] or failed domestic wells (most were more than 50 years old and less than 100 feet deep)	Stanislaus County
Loss of capacity in municipal wells (pump replaced and lowered)	City of Waterford
Replace or deepen pumps in 3 agency wells; OID landowners also complained of well issues	Oakdale Irrigation District

[1]For purposes of this table, a "dry" domestic well does not necessarily mean that water levels in the aquifer have declined below the bottom of the well; well failures are also associated with water levels falling below a shallow pump intake or below the top of well screens such that capacity is adversely affected.

As indicated in **Table 6-2**, not all beneficial users of groundwater wells in the Modesto Subbasin experienced adverse impacts during the 2014 to 2017 drought. During this period, the cities of Riverbank and Oakdale were able to operate their deep drinking water supply wells without interruption. Similarly, Modesto ID did not experience well problems. The City of Modesto did not experience well impacts directly related to the drought but had water quality problems that could be exacerbated if groundwater levels continue to decline in the Subbasin. In the western Subbasin, groundwater levels experienced relatively small declines (less than 10 feet) and recovered quickly after 2016.

Most well impacts in **Table 6-2** occurred in the central-eastern Subbasin due to the presence of numerous water supply wells in areas of more significant water level declines (**Figure 6-1**; see also hydrographs on **Figure 3-25**). Although the 159 reported domestic well failures occurred throughout the Subbasin, most failures were concentrated in the eastern half of the Subbasin (**Figure 6-1**). Although most of these domestic wells appear to have been replaced, areas with vulnerable domestic wells have been identified along the Tuolumne and Stanislaus rivers (dashed areas on **Figure 6-1**). More details and analyses of failed and replacement domestic wells are provided in **Section 2.3.3**.

The City of Waterford is located within the vulnerable area along the Tuolumne River, where one of its primary water supply wells required replacing and lowering of a well pump during the 2015 drought (**Table 6-2**). Near the vulnerable area along the Stanislaus River, Oakdale ID reported water level declines of 20 feet to 50 feet from 2005 to 2020 in its deep water supply wells. Since 2016, water levels have continued to decline about 1.3 feet per year in the main service area and 2 to 4 feet per year in eastern OID. These declines caused adverse impacts to Oakdale ID deep agency wells. In addition, many landowners complained to Oakdale ID regarding private well issues.

Finally, the outreach team noted impacts to a few private wells as reported on the Modesto Subbasin Stakeholder Survey (see Chapter 4). Out of 12 responses from well owners, two reported either capacity or water quality issues with their well; the remaining 10 responders did not report well issues during the 2014-2017 drought.

6.3.1.2. Potential Effects on Beneficial Uses

Adverse impacts described above affect all beneficial uses of groundwater accessed through wells including municipal, domestic, industrial, and agricultural water supply. Any of these impacts can also affect property interests.

For agricultural users, impacts can increase costs, delay irrigation operations, and result in damage to crops. For industrial users, well issues can affect operational costs, delay goods and services, or adversely affect industrial processes relying on a specific groundwater quality. For public water suppliers, well impacts can increase wellfield operational costs, reduce pressure in distribution systems, cause water quality concerns, or even jeopardize the ability to provide a reliable and safe drinking water supply.

Impacted domestic well owners during the 2014-2017 drought reported the need for trucked water, use of temporary or permanent storage tanks, purchase of bottled water, lowering of well pumps, drilling of replacement wells, and other measures . A valley-wide shortage of drillers caused significant delay in the ability to lower a pump or otherwise modify/replace a well. In addition, domestic well owners in the Modesto Subbasin are often without financial resources necessary to replace their household water supply. Many domestic wells are located in underrepresented and economically-disadvantaged communities where wells are the only available drinking water source.

Although this sustainability indicator is focused on adverse impacts to wells, chronic lowering of groundwater levels can also adversely impact environmental uses of groundwater, including GDEs (**Section 3.2.8**). Given that GDEs in the Modesto Subbasin are primarily located along the three river boundaries, GDE impacts are also affected by the interconnected surface water sustainability indicator, as discussed in **Section 6.8**.

Many of these adverse well impacts that occurred during the 2014-2017 drought appear to have been mitigated. Public water suppliers have secured groundwater supply from new or modified wells. Proposed GSP projects will increase surface water deliveries for municipal supply in both Waterford and Modesto (see **Chapter 8**).

Most of the failed domestic wells appear to have been replaced. DWR well completion records indicate that about 236 new domestic wells have been drilled since 2015 – about 1.5 times the number of previously-reported failed wells. Although data are insufficient to provide a one-to-one match, most new wells are near the estimated location of a failed well and appear to be replacement wells[16].

Since 2016, only three domestic wells have been reported as being impacted from lower water levels. These domestic wells were reported to be dry as of August and September 2021 as indicated on the DWR Household Water Supply Shortage Reporting System (Household Water Supply Shortage Reporting System (ca.gov)). Of those three wells, the two in the City of Modesto were shallow wells with total depths of 29 feet and 79 feet. The reported failed well in the City of Oakdale had a total depth of 149 feet. `

SGMA does not require the protection of all groundwater wells or the correction of historical undesirable results. For this GSP, the widespread impacts to water supply wells during the 2014-2017 drought (which were caused by then-historic groundwater level declines) are considered to be undesirable results. Although impacts appear to be mostly mitigated at current groundwater levels, the GSP strives to avoid similar undesirable results in the future by arresting chronic groundwater level declines in the Subbasin.

[16] The DWR database of domestic wells has been recognized to be incomplete, with uncertainty associated with numbers of wells, exact location, and well construction (including screen intervals, pump settings, or total depth. See analysis of domestic wells in **Section 2.3.2**.

6.3.1.3. Modesto Subbasin Definition of Undesirable Results

Based on the information summarized above and additional information presented in previous sections of this GSP (especially **Sections 2.3.2** and **3.2**), the definition of undesirable results focuses on maintaining access to groundwater supply through Subbasin wells.

Regulations also require that the undesirable result definition include quantitative criteria defining when and where groundwater conditions can cause an undesirable result (§354.26(b)(2)). These criteria include the number of monitoring sites/events where MT exceedances may create those conditions; criteria recognize that a single MT exceedance at one monitoring site during one monitoring event may not be sufficient to cause an undesirable result. This framework allows for clear identification as to when an undesirable result is triggered.

The undesirable result definition for the Modesto Subbasin, along with the criteria that may lead to an undesirable result, is summarized in the table below.

Table 6-3: Undesirable Results for Chronic Lowering of Groundwater Levels

	Undesirable Results Definition	Principal Aquifer(s)
Chronic Lowering of Groundwater Levels	Undesirable results are defined as significant and unreasonable groundwater level declines – either due to multi-year droughts or due to chronic declines where groundwater is the sole supply – such that water supply wells are adversely impacted in a manner that cannot be readily managed or mitigated. An undesirable result will occur when at least 33% of representative monitoring wells exceed the MT for a principal aquifer in 3 consecutive Fall monitoring events.	All

As indicated in the criteria above, an undesirable result is triggered when a third or more of the monitoring wells in each principal aquifer exceed the MT during three consecutive Fall monitoring events. To provide context for these criteria, additional Subbasin considerations are provided below.

At this time, the monitoring network for chronic lowering of water levels contains 61 wells distributed among the three principal aquifers. Maps of these representative monitoring well locations are provided in **Chapter 7** (**Figures 7-1**, **7-2**, and **7-3**). The number of wells in each principal aquifer are summarized below along with the number of wells that could trigger an undesirable result (i.e., 33 percent):

- Western Upper Principal Aquifer: 17 wells (33% - 6 wells)
- Western Lower Principal Aquifer: 5 wells (33% - 2 wells)
- Eastern Principal Aquifer: 39 wells (33% - 13 wells)

The number of representative monitoring wells that could trigger an undesirable result condition is relatively small (i.e., between 2 and 13 wells for each principal Aquifer), which provides protection for water supply wells in the Subbasin. The number of wells allowed to exceed the MTs are commensurate with the area of the aquifer being monitored. For example, the western aquifers cover about 56,000 acres while the Eastern Principal Aquifer is about three times as large (190,000 acres). Therefore, the number of wells associated with exceedances in the Eastern Principal Aquifer is much larger.

In addition, the areas that could cause undesirable results represent a relatively small percentage of the Subbasin – about 8 percent for exceedances in the western aquifers and about 25 percent of the Subbasin for exceedances in the Eastern Principal Aquifer. This indicates that undesirable results will be triggered when a relatively small area of the Subbasin exceeds the MT. In this manner, the undesirable results definition and criteria are protective against widespread exceedances of the MT.

Data gaps are recognized in the monitoring networks for both the Eastern Principal Aquifer and the Western Lower Principal Aquifer. Additional wells are planned for these networks in the initial years of GSP implementation (see Chapter 8). Accordingly, the number of wells with MT exceedances required to trigger undesirable results may need to be revised going forward.

The number of monitoring events with MT exceedances is also considered in the undesirable results definition in **Table 6-3**. This provides some flexibility for future drought conditions whereby wells are allowed to exceed the MT in drought as long as periods of decline are relatively short, and ongoing projects/management actions support subsequent water level recovery above the MTs. The use of three consecutive Fall semi-annual monitoring events is based on observation that three critically dry years (WY 2013 – WY 2015, see **Figure 3-2**) lead to previous undesirable results. Most of the adverse impacts to wells used to define undesirable results began at the end of this three-year period (i.e., Fall 2015) and extended throughout 2016. As described above, previous impacts to wells have been managed and mitigated for current (2021) groundwater elevations. The undesirable results criteria above are selected to avoid undesirable results during future multi-year droughts.

Even though monitoring will be conducted on a semi-annual basis (i.e., Spring and Fall), criteria limit the MT exceedances to Fall monitoring events. This focuses GSP management on long-term trends rather than seasonal fluctuations and is more protective against undesirable results. A partial Spring recovery above the MT may not indicate an improvement to an overall declining water level trend. When considered in the context of water year type, a comparison of Fall events allows for a better management tool for differentiating a short-term decline versus a longer term decline below the MT.

Collectively, these criteria provide a reasonable management approach for avoidance of undesirable results for chronic lowering of groundwater levels in the Modesto Subbasin.

6.3.2. Minimum Thresholds for Chronic Lowering of Groundwater Levels

Regulations require that the quantitative MT metric for this indicator be "the groundwater elevation indicating a depletion of supply at a given location that may lead to undesirable results" (§354.28 (c)(1). In the Modesto Subbasin, MTs are quantified as the low groundwater elevation from WY 1991 – WY 2020 at representative monitoring sites for all three Principal Aquifers.

While water levels have continued to decline in eastern portions of the Subbasin, the MT period contains the historic low water level for much of the Subbasin. Many of the selected MTs occurred in the 2015-2016 time period associated with drought conditions (**Figure 6-1**). However, some areas of the western Subbasin reached a historic low during the early to mid-1990s before surface water was available to the City of Modesto.

Table 6-5 states the selected approach for the MTs; the MT value at each representative monitoring well is presented in **Chapter 7**, which describes the GSP monitoring network (see **Section 7.1.1**). Hydrographs of all monitoring network wells with MTs and MOs are provided in **Appendix F**.

Table 6-4: Minimum Thresholds for Chronic Lowering of Groundwater Levels

	Minimum Thresholds	Principal Aquifer(s)
Chronic Lowering of Groundwater Levels	Minimum thresholds are set as the historic low groundwater elevation observed or estimated during WY 1991 – WY 2020 at each representative monitoring location, based on available data.	All

Information from the basin setting used to support these MTs are summarized in the following section.

6.3.2.1. Justification and Support for Minimum Thresholds

GSP regulations require that MTs for this indicator be supported by:

- The rate of groundwater elevation decline based on historical trends, water year type, and projected water use in the basin.
- Potential effects on other sustainability indicators. (§354.28 (c)(1)(A)(B)).

Historical declines in groundwater levels across the Subbasin are discussed throughout **Section 3.2** and specifically in **Section 3.2.2**; associated water year types are based on the detailed information in **Section 4.2.2.1** (also see **Figure 3-2**). **Figures 3-21** through **3-25** present hydrographs showing rates of decline in selected wells with relatively long water level records across the Subbasin. **Figure 6-1** provides locations of failed domestic wells from 2014 to 2017, representing undesirable results caused by groundwater level declines (also discussed in **Section 2.3.3** and shown on **Figure 2-15**). **Figure 2-17** shows the location of new and/or replacement domestic wells drilled since the 2015 drought.

As indicated by the hydrographs on **Figures 3-24 and 3-25**, water level declines become progressively larger from west to east in the Subbasin, especially since recent drought conditions began in WY 2013. Although wells with water level data are sparse in the NDE MA, groundwater levels in eastern-most wells have declined about 40 feet over the last seven years (decline rate of about 5.7 feet per year; see hydrograph 20 on **Figure 3-25**).

Rates of groundwater level declines are summarized briefly by principal aquifer below.

- <u>Western Upper Principal Aquifer (**Figures 3-21** and **3-22**)</u>: Water levels in this principal aquifer have been relatively shallow and stable throughout the study period with minimal – but observable – declines during drought. Water levels have recovered to near pre-drought levels in almost every well shown and no significant long-term water level declines have been observed. Depth to water ranges from less than 10 feet bgs to about 40 feet bgs. Most of historic low water levels occurred during 2015-2016 drought conditions. Some wells near the City of Modesto exhibit historic low water levels during the 1990s drought when groundwater was primarily the City's sole water supply (see hydrographs 7 and 8 on **Figure 3-22**). The availability of surface water to supplement the City's drinking water supply allowed water levels to recover. During more recent droughts, water levels in these wells have generally remained above the previous historic low levels.
- <u>Western Lower Principal Aquifer (**Figure 3-23**)</u>: Although water levels have been tracked in numerous wells in the western Subbasin, many wells are screened in both the Western Upper Principal Aquifer (unconfined) and the Western Lower Principal Aquifer (confined). Wells known to be screened only in the Western Lower Principal Aquifer are sparse; nonetheless, water levels appear to be relatively stable with small declines during drought (about 10 feet to 20 feet) followed by recovery in post-drought years. The decline and recovery for hydrograph 11 on **Figure 3-23** is due to the change in surface water availability for the City of Modesto as described above. Larger seasonal fluctuations are observed on the hydrographs due to the confined nature of the aquifer and its use by active pumping wells.

  <u>Eastern Principal Aquifer (**Figures 3-24** and **3-25**)</u>: Overall declines are observed in the Eastern Principal Aquifer, with increasing rates of decline and total declines from west to east. For wells in the western portion of the aquifer, long-term declines are relatively small (less than about 10 feet) over the study period (see hydrographs 12 and 13 on **Figure 3-24**). Wells slightly farther to the east exhibit

declines during the 2015 drought of about 20 feet with only partial recovery (hydrographs 14, 15, and 16 on **Figure 3-24**).

Wells in the eastern Subbasin have experienced the largest declines, both during drought and over the long term since at least the mid-2000s (**Figure 3-25**). As shown by hydrograph 20 on **Figure 3-25**, eastern wells have overall declines of about 40 feet during the recent drought and long-term declines since the mid-2000s. During that time, water demand in the eastern Subbasin increased due to the expansion of irrigated agriculture and changes in cropping patterns (see discussion in **Section 2.2** and **Figure 2-8**). In the eastern Subbasin, long-term rates of decline are up to about 2.7 feet/year; rates of decline during drought are up to about 6 feet/year (**Figure 3-25**).

Water level declines in the eastern Subbasin occur primarily in the NDE MA (**Figure 6-1**). However, local over-pumping in that area appears to have propagated westward, causing water level declines in other management areas – especially in eastern Oakdale ID MA. The area of water level declines also appears to be expanding to the north and south, intercepting groundwater that would typically be flowing toward the river boundaries.

The GSP intends to arrest these high rates of expanding water level declines by establishing MTs at the historic low water level observed (or estimated, if data are not available) during WY 1991 – WY 2020. Using this time period, MTs were selected for the 61 wells in the representative monitoring network for chronic lowering of groundwater levels; those MTs are discussed in **Section 7.1.1**, posted on **Figures 7-1**, **7-2**, and **7-3**, and listed in **Table 7-1**. Almost all of the selected MTs represent one of three time periods:

- Fall 2015 groundwater elevation (most western Subbasin wells)
- Fall 1991 groundwater elevation (a few wells near the City of Modesto)
- Fall 2020 groundwater elevations (most eastern Subbasin wells)

For most western wells, the MT was typically defined by 2015-2016 water levels. Even if water levels continue to decline in the eastern Subbasin while the GSP is being implemented, projects and management actions will have to be sufficient for water levels to recover back to the selected MT. The following conditions were considered when setting the MT at the historic low groundwater elevation:

- Replacement wells and other well improvements appear to have mitigated impacts from low water levels during the 2015-2016 drought conditions.
- The large number of new and deeper domestic wells drilled since 2015 can reasonably be assumed to accommodate current low water levels, with some tolerance for future droughts.
- The analysis in **Section 2.3.3** indicates that MTs will avoid the widespread failures of about five percent of the total domestic wells drilled in the Subbasin that occurred during the 2015 drought conditions. Uncertainties associated with data gaps

regarding domestic wells limit the ability to accurately identify the exact number of wells subject to impacts (see also **Section 9.5.3**).

- The Subbasin is not currently experiencing widespread adverse impacts to water supply wells that occurred in 2015-2016 and formed the basis for its undesirable result definition.
- Most of the MTs are commensurate with recent Fall 2020 water levels; no additional undesirable results were identified during that Fall period.
- As of Spring 2021, groundwater levels are within about 10 feet of the MT; several wells are below the MT.

Collectively, these considerations support the selection of the MTs for chronic lowering of groundwater levels.

6.3.2.2. Relationship between MTs of Each Sustainability Indicator

Regulations require a description of the relationship between the MTs for each sustainability indicator and how the GSAs have determined that basin conditions at each MT will avoid undesirable results (§354.28(b)(2)). To facilitate a comparison between MTs, a summary table of MTs for each sustainability indicator is provided below. Justification for the approach to the MTs for each indicator is provided in subsequent GSP sections, as indicated in the table.

Table 6-5: Summary of Minimum Thresholds by Sustainability Indicator

Sustainability Indicator	Minimum Threshold (MT)	GSP Section
Chronic Lowering of Groundwater Levels	Low groundwater elevation WY 1991 – WY 2020	**6.3.2**
Reduction of Groundwater in Storage	Low groundwater elevation WY 1991 – WY 2020	**6.4.2**
Seawater Intrusion	Not applicable	**6.5**
Degraded Water Quality	MCL of each Constituent of Concern	**6.6.2**
Land Subsidence	Low groundwater elevation WY 1991 – WY 2020	**6.7.2**
Interconnected Surface Water	Fall 2015 groundwater elevation	**6.8.2**

As indicated in the table above, the historic low groundwater elevation – as observed or estimated during the period WY 1991 – WY 2020 – has been selected as the MT for three of the six sustainability indicators (chronic lowering of groundwater levels, reduction of groundwater in storage, and land subsidence).

Groundwater elevations are also used as a proxy for interconnected surface water MTs but are set differently from other water level MTs. To be more protective of basin conditions along the three river boundaries, MTs for interconnected surface water are set as the Fall

2015 groundwater elevations. This approach is consistent with the need to guard against projected increases in streamflow depletion by the water budget modeling analyses (**Section 5.1.4.3**). In particular, projected increases in average streamflow depletions from the Stanislaus and Tuolumne rivers could lead to undesirable results. This approach is discussed in more detail in **Section 6.8**.

As discussed previously and indicated in the table above, the seawater intrusion indicator has been determined by the GSAs as not applicable to the inland Modesto Subbasin. Accordingly, no MTs have been set for seawater intrusion.

A different approach to MTs was used for the degraded water quality sustainability indicator. MTs for that indicator are set as the California drinking water standard for water quality constituents of concern most applicable to the Modesto Subbasin. This MT approach will not conflict with the other MTs for the Subbasin. Further, the MTs set for the other sustainability indicators are supportive of the MTs for degraded water quality, as described in more detail in **Section 6.6**.

The interrelatedness of the MTs among the four sustainability indicators with groundwater levels as a proxy are summarized below.

- MTs for chronic lowering of groundwater levels are used as a proxy for reduction of groundwater in storage and land subsidence for all three Principal Aquifers. Therefore, the MTs will not present conflicts between these three indicators.
- As explained in **Sections 6.4**, the use of groundwater elevations as a proxy for reduction of groundwater in storage is supported by the sustainable yield analysis (**Section 5.3**), whereby the historic low water levels are correlated directly to a sustainable yield <u>volume</u> for the Subbasin (267,000 AFY), which avoids undesirable results and also meets the requirement to use a volume as the metric for the reduction of groundwater in storage indicator (see **Section 6.4.2**).
- As explained in **Section 6.7**, the historic low water level is also an appropriate MT for land subsidence. By preventing significant groundwater level declines below the historic low level, the depressurization/dewatering of compressible subsurface clay layers can be avoided (see Section 6.7). Because this mechanism has been the primary cause of land subsidence in the Central Valley, the use of MTs for chronic lowering of groundwater levels as a proxy is supported (**Section 6.7.2**).
- The MTs for interconnected surface water are sufficiently close to the MTs for chronic lowering of water levels. Many of the MTs for chronic lowering of water levels are either the same or within only a few feet of the MTs for interconnected surface water. Accordingly, there are no conflicts between these two MT data sets. The use of water levels as a proxy for the interconnected surface water MTs is supported by the sustainable yield analysis in **Section 5.3** and demonstrates the ability of the aquifer to meet selected MTs for both sustainability indicators under the same basin conditions (see also **Section 6.8**).

Although presentation and review of technical information and selection of MTs by the TACs generally occurred one sustainability indicator at a time, basin conditions and sustainable yield analyses support the interrelatedness of the MTs. (Basin conditions that supported chronic lowering of water levels were discussed in **Section 6.3.2.1** above). Sustainable yield analyses were conducted interactively for future conditions and sustainable management criteria to determine how MTs could be achieved on a Subbasin-wide basis (**Section 5.3**). By first setting MTs to correct overdraft conditions and arrest future groundwater elevation declines, all of the other sustainability indicators in the Modesto Subbasin could be supported. The application of consistent methodologies in each principal aquifer and in each of the four management areas (**Figure 6-2**) allow the collective MTs to work well together to avoid undesirable results and support sustainable groundwater management.

Notwithstanding the protective MTs above, preventing all impacts to water supply wells may be difficult where large numbers of densely-spaced water supply wells are pumping at maximum capacities during drought conditions. Closely-spaced pumping wells can cause interference with other wells, even if basin-wide water levels are managed at reasonable levels. Well interference between two closely-spaced wells is not included in the undesirable results definition and will be managed locally, as needed. By setting MTs at historic low groundwater elevations across most of the Subbasin, regional long-term declines will be arrested and significant and unreasonable adverse impacts to water supply wells can be avoided.

6.3.2.3. Impacts of MTs on Adjacent Subbasins

Regulations require consideration of how Modesto Subbasin MTs impact the ability of an adjacent subbasin to achieve its sustainability goal. Significant technical similarities among the Modesto Subbasin and its three neighboring subbasins facilitate this process. For example, all of the subbasins have delineated principal aquifers in the same manner. In addition, all of the adjacent subbasins are linked to the Modesto Subbasin by a shared river boundary (i.e., Turlock Subbasin south of the Tuolumne River, Eastern San Joaquin Subbasin north of the Stanislaus River, and the Delta-Mendota Subbasin west of the San Joaquin River, see **Figure 6-1**). Due to the shared interconnected surface water along these rivers, MTs in each of the subbasins have been set in a similar manner.

There is also significant inter-basin coordination occurring among GSAs and member agencies across all of these subbasins. Multiple member agencies are actively involved in the GSP process in both the Modesto Subbasin and one of the adjacent subbasins.

For example, in the Eastern San Joaquin (ESJ) Subbasin to the north, both Oakdale ID and Stanislaus County are member agencies of ESJ GSAs and actively participated in GSP development for that subbasin. Oakdale ID has service areas and operations in both the Modesto and the ESJ subbasins, located along a large portion of the boundary between the two. Stanislaus County also provides consistent coordination in the Delta Mendota Subbasin to the west. In addition, members of the technical consulting team and outreach team in the Modesto Subbasin were also involved in GSP development in both the ESJ and Delta Mendota subbasins.

In the Turlock Subbasin to the south, several member agencies are represented in both the Turlock and Modesto subbasins, including Stanislaus County, City of Modesto (with pumping wells in the Turlock Subbasin), and the City of Waterford (which operates the water supply system for Hickman in the Turlock Subbasin). Also, Turlock ID and Modesto ID coordinate on diversions from the Tuolumne River to provide a large supply of Tuolumne River water to both subbasins. Finally, the GSP technical consulting team is the same in both Turlock and Modesto subbasins and has developed one integrated surface water-groundwater model for coordinated GSP analyses.

Through coordination activities by these member agencies, additional coordination meetings with adjacent subbasin representatives, and review of draft and completed GSPs, the MTs selected for chronic lowering of water levels in the three adjacent subbasins have been considered together. In brief, the Modesto Subbasin MTs are not expected to either cause undesirable results or adversely impact GSP implementation in adjacent subbasins, as summarized below.

6.3.2.3.1. Eastern San Joaquin Subbasin

The MTs for chronic lowering of water levels in the ESJ Subbasin are defined as the shallower groundwater elevation of the following (ESJGWA, 2019):

- the deeper of 1992 and 2015-2016 historical groundwater levels with a buffer of 100 percent of the historical range applied, or
- the 10th percentile domestic well total depth of wells within a 3-mile radius of the monitoring well.

MTs have been set for 20 representative monitoring wells in the ESJ Subbasin, four of which are within about three miles from the shared boundary with the Modesto Subbasin (02S07E31N001, 02S08E08A001, Burnett-OID4, and 01S10E26J001M; see Figure 3-2 in ESJGWA, 2019). All of the MTs set for the ESJ monitoring wells appear to be lower than the closest Modesto Subbasin MTs.

For example, the closest ESJ Subbasin well to the Modesto Subbasin is Burnett (OID4), located across the Stanislaus River from Modesto Subbasin monitoring wells Allen (OID1) and Birnbaum (OID3). The Burnett MT is 60.7 feet msl (Table 3-1 in ESJGWA, 2019) and the Birnbaum and Allen MTs are 74 and 75 feet msl, respectively (see **Figure 7-7**). MTs for all three wells are based on 2015 groundwater elevations, although the ESJ monitoring well has a buffer equal to the historical water level range (see first bullet above). As indicated by these values, MTs in the ESJ Subbasin are lower, but close to the MTs in the Modesto Subbasin. Accordingly, the MTs do not appear to conflict across the Subbasin boundary and MTs in the Modesto Subbasin are not expected to adversely impact GSP implementation in the ESJ Subbasin.

ESJ Subbasin MTs for chronic lowering of water levels are also used as a proxy for the reduction of groundwater in storage, land subsidence, and interconnected surface water. Therefore, these MTs represent the best MTs for evaluation of potential impacts across the shared Stanislaus River boundary. Finally, as noted above, Oakdale ID operates within its service areas on both sides of this boundary and has GSP monitoring and management responsibilities in both subbasins. This close coordination allows the tracking of potential impacts in each subbasin going forward.

6.3.2.3.2. Delta-Mendota Subbasin

Sustainable management criteria in the adjacent Delta-Mendota Subbasin are provided in the Northern & Central Delta-Mendota Regions GSP (W&C and P&P, 2019). In that GSP, the MTs for water levels are defined as the hydrologic low groundwater level for the Upper Principal Aquifer and 95 percent of the hydrologic low groundwater level for the Lower Principal Aquifer. Because these low groundwater levels generally occurred in WY 2015, and MTs along the San Joaquin River in the Modesto Subbasin are also set at WY 2015 levels (for interconnected surface water – see **Table 6-5**), there should be no conflict in MTs along this boundary.

Because the shared San Joaquin River boundary between the Delta-Mendota Subbasin and the Modesto Subbasin is relatively short, there are no representative monitoring wells in the Delta-Mendota Subbasin along that boundary. The two closest wells are 06-004 (Upper Aquifer) and 06-003 (Lower Aquifer), both located about three miles to the southwest from the southwestern corner of the Modesto Subbasin. MTs for those two wells are 14.8 feet msl and -8.6 feet msl, respectively.

In the Modesto Subbasin, the closest representative monitoring wells in equivalent principal aquifers are Canfield 90 (Western Upper Principal Aquifer) and MRWA-3 (Western Lower Principal Aquifer). MTs for chronic lowering of water levels in those wells are 32 feet msl and 28 feet msl, respectively. Given the higher elevations and distance from representative monitoring locations, the MTs in these two subbasins do not conflict and are not expected to adversely impact GSP implementation in either Subbasin.

6.3.2.3.3. Turlock Subbasin

By selecting MTs for the chronic lowering of groundwater levels at the historic low groundwater elevations, MTs in the inland portions of the Subbasin are slightly lower in some places than in the Turlock Subbasin. However, the methodology for selecting MTs along the shared Tuolumne River boundary is identical for both subbasins. Along that boundary MTs are set at the Fall 2015 groundwater elevations in the Modesto Subbasin for interconnected surface water (**Table 6-6**; see also **Section 6.8**). Sustainable yield analyses indicate very small subsurface flows between the two subbasins (within about 1,000 AFY) along the approximate 35-mile river boundary (see **Table 5-15** for the net subsurface flows between the two subbasins). These conditions suggest that there will be no adverse impacts on GSP implementation from MTs in the Modesto Subbasin on Turlock Subbasin MTs.

6.3.2.4. Effects of MTs on Beneficial Uses and Users of Groundwater

By arresting groundwater level declines in the Subbasin, long-term use of groundwater will become more sustainable and provide benefits to all beneficial uses of groundwater in the

Subbasin. However, there are consequences to maintaining these MTs for some current beneficial uses of groundwater.

In brief, the current level of groundwater use will not be able to be sustained without sufficient projects or management actions to replenish the Subbasin. This will require maintenance of water levels in deep wells that could otherwise accommodate additional declines. In the NDE MA, where growers are currently reliant on groundwater for agricultural beneficial uses, significant investment in projects and supplemental water will be required to support the current level of agricultural production. If projects cannot meet the sustainable yield, demand reduction will need to be considered, which could negatively affect property interests in the Subbasin.

Conversely, the beneficial uses of public water suppliers and domestic well owners will be supported by the MTs. Although water levels will be allowed to decline somewhat during drought conditions, the Subbasin will not be subject to the continual historic lows that would occur with deeper MTs. With improved long-term maintenance of water levels, municipal water suppliers will avoid the loss of expensive public drinking water supply wells as has been documented in public meetings (e.g., by the City of Waterford). The need for widespread domestic well replacements can also be avoided (see **Table 6-1**).

The prevention of further water level declines will also support the potential GDEs that have been identified in the Subbasin, most of which are located along the river boundaries (see **Section 3.2.8**). Even more protective MTs have been set along the rivers as described in more detail in **Section 6.8.2**.

6.3.2.5. Consideration of State, Federal, or Local Standards in MT Selection

GSP regulations require that GSAs consider how the selection of MTs might differ from other regulatory standards. For the chronic lowering of groundwater levels, the MT consists of quantified water levels in each representative monitoring well, which present no conflicts with regulatory standards.

6.3.2.6. Quantitative Measurement of Minimum Thresholds

As stated above, the MTs for the chronic lowering of groundwater levels will be monitored by quantitatively measuring water levels in representative monitoring well networks for each principal aquifer as described in **Chapter 7** (Monitoring Network) of this GSP (see **Section 7.1.1**, **Table 7-1**, and **Figures 7-1** through **7-3**. Monitoring will occur on a semi-annual basis, in Spring and Fall, to represent the seasonal high and low water level and to adhere to basin-wide water level sampling protocols (**Section 7.2.4**).

6.3.3. Measurable Objectives for Chronic Lowering of Groundwater Levels

GSP regulations define measurable objectives (MOs) as "specific, quantifiable goals for the maintenance or improvement of specified groundwater conditions that have been included in an adopted Plan to achieve the sustainability goal for the basin" (§351(s)). The MO is used to target desired groundwater conditions and provide a margin of operational flexibility above the MTs.

For chronic lowering of water levels, the MT represents a “floor” for maintenance of low water levels, with allowance for short-term exceedances by less than a third of representative monitoring wells during droughts (see **Table 6-5**). Accordingly, water levels will be managed generally between the MT and anticipated high water levels that occur during wet periods.

This operational range is represented by the midpoint between the MT and high water levels observed over average hydrologic conditions. Using the average hydrologic condition for the historical water budget study period of WY 1991 – WY 2015, the MO is defined as the midpoint between the selected MT and the high water level during that period (usually observed in 1998) for each representative monitoring location as summarized in the following table.

Table 6-6: Measurable Objectives for Chronic Lowering of Groundwater Levels

	Measurable Objectives	Principal Aquifer(s)
Chronic Lowering of Groundwater Levels	Measurable objectives are established as the midpoint between the historical high groundwater elevation and the MT at each representative monitoring location.	All

Each representative monitoring well is assigned a quantitative MO; these data are provided in **Chapter 7** (see **Table 7-1**).

Setting the MO at the midpoint between the MT and the high-water level results in a very small margin of operational flexibility for some western Subbasin wells screened in the Western Upper Principal Aquifer. In the far western areas of the Subbasin, water levels are shallow, and historical water levels have not fluctuated significantly. As a result, the MO is close to the MT; in some portions of the western Subbasin, there are only a few feet between the MO and the MT in representative monitoring wells. Setting the MO higher would not be consistent with the need to manage shallow groundwater such that existing agricultural land use can be preserved. MOs and MTs may require future adjustment to allow for more operational flexibility in the future.

It is also recognized that this methodology may be setting MOs higher than may be easily attained if ongoing drought conditions persist. At the time of preparation of this GSP, most years since the end of the historical study period (WY 2015) have been dry; these conditions may have reset the range of future expected high water levels in the Subbasin.

Nonetheless, this approach to MO selection provides a reasonable method to quantify desired groundwater conditions using best available data. Compliance with selected sustainable management criteria will be reported in GSP Annual Reports and revisited in the five-year GSP evaluation for possible adjustment as needed.

6.4. REDUCTION OF GROUNDWATER IN STORAGE

SGMA defines an undesirable result for the groundwater in storage sustainability indicator as "significant and unreasonable reduction of groundwater storage." (§10721 (x)(2)). GSP regulations require that the MT for the reduction of groundwater in storage be set as "a total volume of groundwater that can be withdrawn from the basin without causing conditions that may lead to undesirable results" (§354.28(c)(2)). This requirement contains almost identical language as the SGMA definition of sustainable yield.[17] In addition, regulations require the MT for this indicator to be supported specifically by the sustainable yield. The sustainable yield analysis for the Modesto Subbasin is presented in **Section 5.3** and discussed in the context of this indicator throughout the remaining subsections of **Section 6.4**, as well as throughout the remaining sections of **Chapter 6**.

Although the Modesto Subbasin is not at risk of depleting a large percentage of its total volume of groundwater supply, the ongoing depletion due to pumping larger volumes from the groundwater basin than can be reasonably replenished (overdraft conditions) requires mitigation to meet the Subbasin sustainability goal. As discussed in **Section 6.3**, the chronic lowering of groundwater levels in the Modesto Subbasin is caused primarily by overdraft conditions, illustrating the close relationship between these two indicators.

As explained in subsequent subsections, sustainable management criteria for chronic lowering of groundwater levels are used as a proxy for the reduction of groundwater in storage criteria. GSP regulations allow for use of groundwater elevations as a proxy metric when there is a significant correlation between groundwater levels and the metric for the other indicator (DWR, 2017). In this case, that metric is the volume of groundwater that can be extracted without causing undesirable results.

The definition of undesirable results for reduction of groundwater in storage, including causes and impacts to beneficial uses, is described in **Section 6.4.1** below, along with additional criteria to quantify where and when undesirable results occur. **Section 6.4.2** describes the selection and quantification of MTs, along with the justification and rationale. **Section 6.4.3** provides the approach and selection of MOs. Interim milestones that cover all of the applicable sustainability indicators are described in **Section 6.9**.

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[17] SGMA defines sustainable yield as "the maximum quantity of water, calculated over a base period representative of long-term conditions in the basin and including any temporary surplus, that can be withdrawn annually from a groundwater supply without causing an undesirable result." (§10721(w)).

6.4.1. Undesirable Results for Reduction of Groundwater in Storage

As described in **Chapter 5**, the historical reduction of groundwater in storage is estimated at about 43,000 AFY (see **Table 5-8**). This reduction is primarily related to overdraft[18], which is determined to be unsustainable and thereby an undesirable result in this GSP.

Modeling analyses of projected future conditions indicate that historical overdraft conditions could potentially improve to about 11,000 AFY but would do so at the expense of significant streamflow depletion of the rivers along the Subbasin boundaries (compare net gains/discharges to streams from historical to projected conditions in **Table 5-8**). These increases in projected streamflow depletions have also been determined to be an undesirable result.

The causes of groundwater conditions that lead to undesirable results for the reduction of groundwater in storage are described below. Impacts to beneficial uses are also discussed.

6.4.1.1. Cause of Undesirable Results

In the Modesto Subbasin, the reduction of groundwater in storage is caused by over-pumping primarily in the NDE MA in the eastern Subbasin (**Figure 6-1**). In this area, surface water is generally not available, and groundwater has provided the primary supply for the expansion of irrigated agriculture and conversion to crops with higher water demand. Over-pumping has caused lowering of water levels in this area.

Because overdraft conditions cause chronic lowering of groundwater levels, overdraft contributes to all of the undesirable results associated with that indicator (**Section 6.3.1.1** and **6.3.1.3**). Overdraft also contributes directly to undesirable results for each of the remaining applicable sustainability indicators.

Ongoing overdraft conditions are expected to expand the area of low groundwater levels to the north and south beneath the Stanislaus and Tuolumne rivers, resulting in significant and unreasonable streamflow depletions and impacts to surface water uses (see **Section 6.8.1.1** and **6.8.1.3**). Overdraft conditions can lower water levels in areas where poorer groundwater quality occurs at depth and contribute to undesirable results for the degradation of water quality (see **Section 6.6.1.1** and **6.6.1.3**). Finally, overdraft conditions can also contribute to undesirable results for land subsidence if the lowering of water levels depressurize or dewater subsurface compressible clays. Where this occurs, significant amounts of land subsidence could be triggered and ultimately cause significant and unreasonable impacts to land uses and/or critical infrastructure – defined in this GSP as undesirable results (see **Section 6.7.1.1** and **6.7.1.3**)

[18] Other causes of reduction of groundwater in storage include net subsurface outflows or contributions to baseflow in rivers or streams.

6.4.1.2. Potential Effects on Beneficial Uses

The reduction of groundwater in storage causes lowering of water levels, which in turn, affects beneficial uses of groundwater and wells. As such potential effects on beneficial uses for reduction of groundwater in storage also includes the potential effects for chronic lowering of water levels as documented in **Sections 6.3.1.2** and **6.3.1.3**.

Recognizing that the volume of usable groundwater in the Modesto Subbasin is relatively large, and the base of freshwater is deep, a large groundwater supply would be accessible with sufficiently deep wells. However, the increased costs associated with installation and pumping lifts could ultimately place limits on beneficial uses of groundwater. With the large number of wells in the Subbasin, increased costs could be substantial and could also negatively impact land use and property interests.

Operating the Subbasin at significantly deeper levels also has the potential to pump groundwater with increased constituents of concern at depth. Deeper groundwater is often confined and subject to a geochemical environment that can impact the quality of drinking water supplies, increase public agency operational costs, and increase the potential for water quality impacts on water aesthetics such as odor or taste. Certain constituents, such as iron and manganese, can also cause impacts to groundwater conveyance pipes and fixtures. In addition, depth-related constituents can be associated with health effects if drinking water standards are exceeded (see also **Section 6.6.1.2**).

If overdraft contributes to land subsidence, beneficial users could experience adverse impacts to the physical ground surface, affecting surface operations, land uses, and potentially affecting property interests. Costs to repair or maintain infrastructure could increase; damage to roads or bridges may be associated with public safety concerns (see **Section 6.7.1.2**).

If overdraft results in inducing additional surface water from rivers, streamflow depletions could increase, potentially affecting all surface water beneficial uses including habitat, surface water rights holders, riparian vegetation, among others (see **Section 6.8.1.2**).

6.4.1.3. Modesto Subbasin Definition of Undesirable Results

Based on the information summarized above and supported in other chapters of this GSP, a definition of undesirable results has been developed for *Reduction of Groundwater in Storage* in the Modesto Subbasin.

Regulations require that the undesirable result definition include quantitative criteria used to define when and where groundwater conditions can cause an undesirable result (§354.26(b)(2)). These criteria address the number of monitoring sites and events that an MT can be exceeded before causing an undesirable result. These criteria recognize that a single MT exceedance at one monitoring site may not indicate an undesirable result. This framework also allows clear identification for when an undesirable result is triggered under the GSP. The undesirable result and associated criteria are provided in the following table.

Table 6-7: Undesirable Results for Reduction of Groundwater in Storage

	Undesirable Results Definition	Principal Aquifer(s)
Reduction of Groundwater in Storage	An undesirable result is defined as a significant and unreasonable reduction of groundwater in storage that would occur if the volume of groundwater supply is at risk of depletion and is not accessible for beneficial use, or if the Subbasin remains in a condition of long-term overdraft based on projected water use and average hydrologic conditions. An undesirable result will occur when at least 33% of representative monitoring wells exceed the MT for a principal aquifer in 3 consecutive Fall monitoring events.	All

The use of 33 percent of the representative monitoring wells is based on the chronic lowering of groundwater levels criteria as discussed in **Section 6.3.1.3**. The use of three Fall events for triggering undesirable results recognizes that short-term declines during drought are anticipated as long as reductions of groundwater in storage are eliminated over average hydrologic conditions. SGMA allows for reduction of groundwater in storage during droughts if water levels subsequently recover (see introductory paragraphs in **Section 6.3** above; see also **Section 6.3.1.3**).

The change in groundwater in storage is a required element for the GSP annual reports and will be documented annually in those reports over time. Over average hydrologic conditions, this element can be used to substantiate the correlation of overdraft conditions to the combination of MT exceedances for each principal aquifer as provided in the definition above.

The MTs selected for this indicator use MTs from the chronic lowering of water levels as a proxy, as presented in the following section.

6.4.2. Minimum Thresholds for Reduction of Groundwater in Storage

As indicated in the previous sections, reductions of groundwater in storage resulting from overdraft can be partially offset by inducing recharge from rivers (baseflow) or increasing subsurface inflows from other subbasins. Each of these can cause undesirable results relating to either streamflow depletions or adverse impacts to adjacent beneficial uses of groundwater. However, overdraft conditions can be corrected through projects and management actions such that undesirable results are avoided as demonstrated by an analysis of sustainable yield using the integrated surface water-groundwater model developed for the GSP (C2VSimFG-TM).

Under such an analysis – presented in **Section 5.3** – groundwater demand is reduced iteratively in areas of over-pumping until sustainable management criteria is met. The resulting sustainable yield for the Subbasin is used to inform and confirm the sustainable management criteria selected for the sustainability indicators. The sustainable yield is also used to guide locations and volumes required for projects and management actions.

For the Modesto Subbasin, the analysis estimated a sustainable yield of about 267,000 AFY (see the total volume of groundwater production in **Table 5-15**). Given that future projected groundwater production in the Subbasin has been estimated at 314,000, an increase in supply or reduction in demand that adds approximately 47,000 AFY is required to bring the Subbasin into sustainability.

The sustainable yield modeling analysis incorporated the sustainable management criteria for chronic lowering of water levels and was also shown to eliminate overdraft in the Subbasin over the 50-year implementation and planning horizon (**Section 5.3**; see **Figure 5-58**). Accordingly, both the chronic lowering of water levels criteria and elimination of overdraft are correlated to the sustainable yield of 267,000 AFY. This volume can be applied as a metric for reduction of groundwater in storage and linked directly to management criteria for the chronic lowering of groundwater levels indicator.

In this manner, the selection of a volume as the required metric for the reduction of groundwater in storage indicator is met (i.e., 267,000), and justification is provided by the sustainable yield modeling that the chronic lowering of water levels criteria can be applied as a proxy for the reduction of groundwater in storage sustainability indicator.

Table 6-8: Minimum Thresholds for Reduction of Groundwater in Storage

	Minimum Thresholds	Principal Aquifer(s)
Reduction of Groundwater in Storage	Minimum thresholds are defined as the historic low groundwater elevation observed or estimated during WY 1991 – WY 2020 at each representative monitoring location, based on available data. (Chronic Lowering of Groundwater Levels MT as a proxy.)	All

It is recognized that sustainable yield is not a fixed number and will vary over time with changes in land use, hydrologic conditions, and GSP implementation of projects and management actions. Nonetheless, this sustainable yield represents the current best available estimate to use as a required metric for the MT of this indicator.

6.4.2.1. Justification and Support for Minimum Thresholds

In the BMP on sustainable management criteria, DWR lists several technical topics to consider when selecting an MT for reduction of groundwater in storage. Those considerations, along with a summary of relevant information from the basin setting (and other related portions of the GSP), are provided below:

- Historical trends, water year types, and projected water use: In the Modesto Subbasin the historical conditions of overdraft were analyzed annually over a 25-year period and summarized for conditions in each of the management areas. As indicated on **Figure 5-3**, 17 of the 25 years experienced a net reduction of groundwater in storage, primarily due to overdraft. As indicated in **Table 5-9**, this imbalance even occurred in water year types of above normal precipitation. As indicated on **Figure 5-16**, much of this imbalance occurs in the NDE MA where annual water budgets indicated a new extraction from groundwater in storage in this area. Specifically, only 3 of the 25 years indicate more recharge than extraction in the NDE MA. Net extractions occurred in the NDE MA during every year since 1991. Water level declines described in **Section 6.3.2.1** support the water budget analysis in the NDE MA (see also **Figure 3-25**).

  Projected water budgets are shown annually for the 25-year period on **Figure 5-40** and confirm the continuation of overdraft conditions into the future. As indicated in the discussion on sustainable yield above, the avoidance of undesirable results estimated over-pumping of about 47,000 AFY, primarily in the NDE MA, as compared to the projected future water use in the Subbasin (see **Table 5-15**).

- Groundwater reserves needed to withstand future droughts: During recent drought conditions from WY 2013 through WY 2020, groundwater declines in the Subbasin were observed to range from less than 10 feet in the western Modesto ID MA to more than 40 feet in some areas of the NDE MA (see **Figures 3-21** through **3-25**). With about 13 MAF of fresh groundwater in storage to depths of more than 1,000 feet in some areas, groundwater reserves will be available to meet future demands under sustainable yield conditions.

- Whether production wells have ever gone dry: As described in **Section 2.3.2**, more than 150 domestic wells failed during the 2014 – 2016 drought of record. Additional adverse impacts to public supply wells related to water level declines were also documented (see **Section 6.3.1.1** and **Table 6-2** above). Since that time, well impacts appear to have been mitigated with the installation of more than 200 new and typically deeper domestic wells. Accordingly, the MTs are set at historical low groundwater levels and projects and management actions have been developed to avoid widespread well failures in the future (see **Chapter 8**).

- Effective storage of the basin: As mentioned previously, the Subbasin contains more than about 13 MAF of fresh groundwater in storage and overall depletion of groundwater supply is unlikely (**Section 3.2.4**. **Figure 3-18** illustrates the thickness of fresh groundwater in storage (between current groundwater level and the base of freshwater) across the Subbasin.

- Understanding of well construction and potential impacts to pumping costs: Well construction was considered in adverse impacts to public water supply wells summarized in **Section 6.3.1.3** above. Most of those wells were sufficiently deep for water supply during the 2015 drought; however, adverse impacts associated with declining water levels were documented (**Section 6.3.1.** and **Table 6-2**). By setting MTs close to current levels, existing Subbasin wells are supported.
- Adjacent Subbasin MTs: MTs for chronic lowering of groundwater levels are compared to and analyzed for each adjacent subbasin in **Sections 6.3.2.3.1** through **6.3.2.3.3** above. The Modesto Subbasin and all adjacent subbasins are using these MTs as a proxy for the reduction of groundwater in storage indicator; accordingly, those analyses apply to both indicators.

6.4.2.2. Relationship between MTs of Each Sustainability Indicator

Regulations require a description of the relationship between the MTs for each sustainability indicator and how the GSAs have determined that basin conditions for each MT will avoid undesirable results (§354.28(b)(2)). As previously discussed, the MTs for each sustainability indicator are summarized in **Table 6-5** and discussed in **Section 6.3.2.2**.

Section 6.3.2.2 also describes the relationship between the MT for chronic lowering of water levels and the MTs for each of the remaining sustainability indicators. Because the MTs for reduction of groundwater in storage are the same as the MTs for chronic lowering of water levels, that discussion would be identical for the reduction of groundwater in storage. As such, please refer to **Section 6.3.2.2** for this required component of the GSP.

6.4.2.3. Impacts of MTs on Adjacent Subbasins

Regulations require consideration of how Modesto Subbasin MTs impact the ability of an adjacent subbasin to achieve its sustainability goal. For the reduction of groundwater in storage sustainability indicator, all three adjacent subbasins – the ESJ Subbasin, the Delta-Mendota Subbasin and the Turlock Subbasin – are also using the MTs for the chronic lowering of groundwater levels as a proxy. Therefore, the considerations of how Modesto Subbasin MTs impact adjacent subbasin MTs are already analyzed for this sustainability indicator through the proxy. As such, please refer to **Section 6.3.2.3** for this required component of the GSP (see **Sections 6.3.2.3.1** through **6.3.2.3.3** on each of the three adjacent subbasins).

6.4.2.4. Effects of MTs on Beneficial Uses and Users of Groundwater

Benefits of these MTs on the beneficial uses and users of groundwater provide a balanced groundwater basin and eliminate overdraft conditions. As such, groundwater level declines are generally arrested. Long term benefits include a more sustainable groundwater supply for all beneficial uses, including municipal, industrial, domestic, agricultural, and environmental uses.

The effects of these conditions on beneficial uses and users of groundwater are similar to those stated for the chronic lowering of groundwater levels; as such, please refer to **Section 6.3.2.4** for this required component of the GSP.

6.4.2.5. Consideration of State, Federal, or Local Standards in MT Selection

GSP regulations require that GSAs consider how the selection of MTs might differ from other regulatory standards. For the reduction of groundwater in storage indicator, the MT consists of quantified water levels in each representative monitoring well. Accordingly, there are no conflicts with regard to other regulatory standards.

6.4.2.6. Quantitative Measurement of Minimum Thresholds

As stated above, the MTs for the chronic lowering of groundwater levels are used as a proxy for monitoring reduction of groundwater in storage. Accordingly, the representative monitoring network, along with individual MTs and MOs, for chronic lowering of water levels are also applied to the reduction of groundwater in storage indicator.

MTs will be monitored by quantitatively measuring water levels in representative monitoring wells for each principal aquifer as described in **Chapter 7** (Monitoring Network – see **Section 7.1.2**). Monitoring will occur on a semi-annual basis, in Spring and Fall, to represent the seasonal high and low water level and adhere to water level sampling protocols (**Section 7.2.4**). **Table 7-1** provides the quantitative MTs for each representative monitoring well used to monitor both chronic lowering of groundwater levels and reduction of groundwater in storage. Representative monitoring wells for both indicators are shown on **Figures 7-1** through **7-3**.

6.4.3. Measurable Objectives for Reduction of Groundwater in Storage

In the same manner that the MTs for chronic lowering of groundwater levels are used as a proxy for the reduction in groundwater in storage, the same MOs are also applied to this indicator, as provided in the following table.

Table 6-9: Measurable Objectives for Reduction of Groundwater in Storage

	Measurable Objectives	Principal Aquifer(s)
Reduction of Groundwater in Storage	Measurable objectives are established at the midpoint between the historical high groundwater elevation and the MT at each representative monitoring location. (Using Chronic Lowering of Groundwater Levels as a proxy).	All

Even though GSP regulations note that reduction in groundwater in storage is controlled by a single value for the Subbasin (in this case, 267,000 AFY), the management of that single value is manifested by applying chronic lowering of water levels criteria as a proxy for reduction of groundwater in storage including both the MTs and MOs at the same representative monitoring wells. MOs are listed for representative monitoring wells on **Table 7-1** for chronic lowering of groundwater levels, which are used as a proxy for reduction of groundwater in storage.

6.5. SEAWATER INTRUSION

GSP regulations define *Seawater Intrusion* as "the advancement of seawater into a groundwater supply that results in degradation of water quality in the basin and includes seawater from any source." The minimum threshold for the indicator "sh*all be defined by a chloride concentration isocontour*…where seawater intrusion may lead to undesirable results." Further, the seawater intrusion minimum threshold must consider the effects of "*current and projected sea levels*" (§354.28 (c)(3) *emphasis added*).

Typically, these conditions would occur in a coastal groundwater basin where aquifers are in hydraulic communication with the open ocean, either directly or indirectly by interconnected waterways such as bays, deltas, or inlets. As an inland basin, the Modesto Subbasin is not directly or indirectly connected to the open ocean. The Subbasin aquifers are separated from the Pacific Ocean by the bedrock units of the Coast Ranges; further Subbasin aquifers are more than 10 miles upgradient from the edge of the Sacramento-San Joaquin Delta and not influenced by deltaic seawater intrusion. GSAs in the Eastern San Joaquin Subbasin to the north have determined that seawater is not occurring nor is likely to occur in that subbasin, even though elevated salinity has been encountered in groundwater and the subbasin is closer the Sacramento-San Joaquin Delta. Elevated salinity conditions do not exist in the Modesto Subbasin such that a chloride concentration isocontour could be developed and used for the MT as required by the regulations.

GSP regulations state that if GSAs are "able to demonstrate that undesirable results related to one or more sustainability indicators are not present and are not likely to occur…" then sustainable management criteria are not required to be established (§354.26 (d)). To assess the applicability of the seawater intrusion indicator to the Modesto Subbasin, the technical team provided both a public presentation to the TAC (January 2021) as well as a technical memorandum on the issues (March 23, 2021). At a public meeting of the STRGBA GSA on April 14, 2021, the GSAs made the determination "that seawater intrusion does not exist and is not likely to occur in the future, and therefore a seawater intrusion sustainability indicator is not applicable in the Modesto Subbasin (Resolution 2021-2).

6.6. DEGRADATION OF WATER QUALITY

Degraded water quality is unique among the sustainability indicators in that other regulatory agencies have the primary responsibility for groundwater quality. SGMA does not authorize or mandate GSAs to duplicate these efforts. The GSAs are not responsible for enforcing drinking water requirements or for remediating groundwater quality problems caused by others (Moran and Belin, 2019). Similar to the other sustainability indicators, GSAs are not required to correct degraded water quality that occurred before January 1, 2015. Further, the existing regulatory framework does not require the GSAs to take affirmative actions to manage existing groundwater quality.

However, SGMA does give the GSAs the authority to regulate groundwater extractions and groundwater levels. In addition, GSAs are responsible for development and implementation of projects and management actions to bring the Subbasin into sustainable groundwater conditions. Given these authorities, GSA activities have the potential to impact groundwater quality; this GSP focuses on avoidance of these potential impacts.

To protect against GSA impacts to water quality in the future, the GSAs intend to:

track water quality annually through existing monitoring programs,

assess the potential for GSA impacts to water quality, and

confer and coordinate with other regulatory water quality agencies and regulated water quality coalitions in the Subbasin to ensure ongoing protection groundwater quality in the Subbasin.

Because most of the public drinking water suppliers in the Modesto Subbasin are also member agencies of the GSAs, there is already close coordination between water quality regulators and GSA members including the cities of Modesto, Riverbank, Oakdale, and Waterford.

The undesirable results associated with degraded water quality, including causes and impacts to beneficial uses, are described in **Section 6.6.1** below. **Section 6.6.2** describes the quantification of minimum thresholds (MTS), along with justification on how MTs avoid undesirable results. **Section 6.6.3** provides the approach and selection of MOs. Interim milestones (IMs) are described in **Section 6.9** but are not set for this sustainability indicator.

6.6.1. Undesirable Results for Degraded Groundwater Quality

SGMA defines an undesirable result for the water quality sustainability indicator as "significant and unreasonable degraded water quality, including the migration of contaminant plumes that impair water supplies." (§10721 (x)(4)). GSP guidance clarifies that GSAs are only responsible for degraded water quality caused by GSA management activities including regulation of pumping and water levels, along with projects and management actions (Moran and Belin, 2019). Such GSA activities that could lead to undesirable results are described in more detail below.

6.6.1.1. Causes of Undesirable Results

GSA management could potentially affect groundwater quality in several ways. GSAs could allow groundwater level declines in areas where poorer quality groundwater occurs at depth. In those areas, groundwater quality in water supply wells could be adversely impacted. In addition, GSA-allowed groundwater extractions could alter hydraulic gradients and local groundwater flow directions such that degraded water quality could spread laterally into un-impacted areas. Groundwater pumping can also induce the vertical migration of constituents of concern into un-impacted deeper aquifers.

High salinity groundwater is inferred to exist in the Modesto Subbasin below the base of fresh water. Although the base of fresh water is designated as the bottom of the groundwater basin, deep pumping could induce groundwater with elevated total dissolved solids (TDS) to migrate vertically into a well and/or into the freshwater zone of the aquifer. These actions could locally impair water supply and potentially reduce the amount of freshwater in the Subbasin. Deep wells that pump elevated concentrations of constituents of concern may also need to be abandoned to prevent conduits for migration of low quality groundwater.

GSP-related projects and management actions also have the potential to impact groundwater quality. For example, recharge projects could introduce water with constituents of concern or affect the migration of existing constituents. GSP regulations specifically require consideration of whether projects or management actions could inadvertently exacerbate the migration of contaminant plumes.

In the Modesto Subbasin, public water suppliers have noted some deterioration in water quality during recent drought conditions, especially constituents of concern arsenic and TDS; these observations suggest that concentrations of these constituents may be elevated at depth. However, nitrate, which is sourced from the surface has also increased in many areas, perhaps in wells with deeper screens that now pull from shallower, nitrate-impacted groundwater. The City of Modesto has conducted numerous investigations of water quality issues in their wellfields and notes that correlations between constituent concentration and depth are complex.

Degraded water quality can impair groundwater supplies, causing restrictions and/or costs for operation of drinking water supply wells. Increasing costs to provide a reliable and safe drinking water supply could lead to undesirable results. Costs and impacts for domestic wells are also a concern because those wells often represent the sole water supply for the household. Impacts to other beneficial uses other than drinking water supply could also lead to undesirable results. Certain constituents can harm crops, limit water supply for certain industrial processes, harm pipes, cause accelerated corrosion or clogging of fixtures, cause staining on bathtubs and sinks, produce bad taste or odor, and cause acute or chronic health effects.

In the Modesto Subbasin, seven constituents of concern have been identified as having the most likely potential for causing undesirable results based on widespread exceedances of MCLs and adverse impacts on public water suppliers in the Subbasin. Those constituents have been of most concern to STRGBA GSA member agencies as documented in a July 2019 public workshop on Subbasin water quality.

The constituents of concern are associated with a variety of sources including both naturally-occurring (geogenic) conditions and human related (anthropogenic) activities. The naturally-occurring constituents of concern may be elevated at certain depths or in certain aquifer layers and may be of most use in tracking impacts from GSA management of groundwater levels.

The anthropogenic constituents of concern, including nitrate, TCP and PCE (and some sources of TDS), are likely sourced at or near the ground surface where human-related activities occur. This suggests that shallow aquifers are more often impacted from these constituents. However, pumping can cause downward migration of these constituents into deeper aquifers either through more permeable portions of an aquitard or in conduits such as wells.

GSA management activities that cause degraded water quality and lead to significant operations costs and impaired groundwater supply are incorporated into the GSP definition of undesirable results. Specific impacts on beneficial users of groundwater from these conditions are summarized below.

6.6.1.2. Potential Effects on Beneficial Uses

As summarized above, degraded water quality can impair water supply and create considerable operational costs or constraints on public water suppliers. Public water suppliers may need to inactivate or abandon impacted wells, re-distribute wellfield pumping, blend contaminants with clean wells or surface water, drill additional wells, install wellhead or regional treatment facilities, and/or make other operational changes. Immediate notifications to customers may also be required.

If constituents of concern impact domestic wells, residents may lose their water supply; if water quality is not well known in domestic wells, impacts to public health and safety could occur. Agricultural and industrial uses of groundwater could also be adversely impacted as summarized in the previous section. Finally, environmental beneficial uses of groundwater could be impacted; for example, if pumping caused the migration of high salinity groundwater into freshwater areas, GDEs could be affected.

For the Modesto Subbasin, six of the seven constituents of concern have primary maximum contaminant levels (MCLs) that are associated with health concerns such as toxicity (i.e., nitrate, uranium) or carcinogens (i.e., arsenic, TCP, DBCP, and PCE). Accordingly, elevated concentrations of these constituents in drinking water can cause deleterious health effects. Wellhead treatment has been installed on numerous drinking water supply wells to manage these constituents. In particular, the City of Modesto has removed numerous water supply wells from service over time to manage local water quality issues (as indicated by the water quality icon on **Figure 6-1**). Constituents with concentrations above the health-based MCLs significantly affect operations and costs for public water suppliers to ensure a safe drinking water supply.

The regulatory drinking water standard for TDS is not health based and is referred to as a secondary MCL, which is related to aesthetics of the water such as taste or odor. However, public water suppliers incur costs for managing TDS concentrations to provide low salinity groundwater for customer satisfaction. In addition, elevated TDS concentrations in groundwater can also impact agricultural beneficial users by limiting crop yields and causing other operational problems. TDS can also limit industrial beneficial uses for industrial processes requiring low salinity water.

6.6.1.3. Modesto Subbasin Definition of Undesirable Results

Based on the information summarized above and presented in the basin setting, a definition for undesirable results has been developed for degraded water quality in the Modesto Subbasin. Regulations also require that the undesirable result definition include quantitative criteria used to define when and where groundwater conditions can cause an undesirable result (§354.26(b)(2)). This framework allows clear identification for when an undesirable result is triggered under the GSP; definition and criteria are provided below.

Table 6-10: Undesirable Results for Degraded Water Quality

	Undesirable Results Definition	Principal Aquifer(s)
Degraded Water Quality	An Undesirable Result is defined as significant and unreasonable adverse impacts to groundwater quality as indicated by a new (first-time) exceedance of, or further exceedance from, an MCL for a constituent of concern that is caused by GSA projects, management actions, or management of groundwater levels or extractions such that beneficial uses are affected and well owners experience an increase in operational costs. An undesirable result will occur when a Subbasin potable water supply well in the defined monitoring network reports a new (first-time) exceedance of an MT or an increase in concentration above the MT for a Modesto Subbasin constituent of concern that results in increased operational costs and is caused by GSA management activities as listed above.	All

The undesirable result is highly protective in that it requires analysis of every first-time exceedance of an MT or an increase above the MCL of an MT for any of the seven constituents of concern in each potable supply well monitored for that constituent. These criteria ensure that all key data are analyzed with respect to GSA activities. The GSAs will conduct this analysis on an annual basis.

To accomplish this annual analysis, historical data for each potable water supply well in the network must be reviewed on an annual basis to determine if the constituent has been exceeded in that well in the past. Each new (i.e., first-time) exceedance or increase in concentration above the MT – occurring after GSP adoption – must be tracked and analyzed separately to determine if such a concentration could have been caused by GSA regulated groundwater levels, extractions, or projects/management actions, and if additional operational costs are incurred by the well owner. If so, the concentration represents an undesirable result by definition.

This analysis will consider the recent groundwater elevations and extractions near each impacted well. Data will be analyzed in the context of the historical record to establish correlations between groundwater levels, monitoring well locations and construction, and water quality analyses. Changes in water levels and water quality in nearby wells will be incorporated into the analysis. Each constituent of concern will be analyzed using information on sources, historical records of nearby and regional wells, and occurrence/concentrations with respect to the principal aquifer and well screens.

Increases in concentration will also be tracked to comply with the MO described in **Section 6.6.3** below. Hydrographs and chemographs will be used to support the analyses, as needed. Analyses will be coordinated with local public agencies providing drinking water supply including member agencies of the GSAs. Data and analyses will be summarized in annual reports and coordinated with the regulatory agencies responsible for water quality. Any undesirable results will be identified, and GSAs will coordinate with regulatory agencies on options and mitigation measures for water quality impacts.

The MTs are quantified in the following section. The MOs are quantified in subsequent **Section 6.6.3**.

6.6.2. Minimum Thresholds for Degraded Water Quality

GSP regulations require that the MT metric for degraded water quality be set at the water quality measurement that indicates degradation at the monitoring site (DWR, 2017). Regulations also require the consideration of state and federal standards and Basin Plan water quality objectives when setting the MT.

The seven constituents of concern have already exceeded MCLs over a relatively widespread area in Subbasin principal aquifers. Accordingly, MCLs (including primary and secondary MCLs) are set as the MTs and are expressed as follows.

Table 6-11: Minimum Thresholds for Degraded Water Quality

	Minimum Thresholds	Principal Aquifer(s)
Degraded Water Quality	Minimum thresholds are set as the primary or secondary California maximum contaminant level (MCL) for each of seven (7) constituents of concern: • Nitrate (as N) - 10 mg/L • Arsenic - 10 ug/L • Uranium - 20 pCi/L • Total dissolved solids (TDS) - 500 mg/L • Dibromochloropropane (DBCP) - 0.2 ug/L • 1,2,3-Trichloropropane (TCP) - 0.005 ug/L • Tetrachloroethene (PCE) - 5 ug/L.	All

6.6.2.1. Justification and Support for Minimum Thresholds

Analysis of existing groundwater quality conditions in the Modesto Subbasin is provided in **Section 3.2.5 as** part of the basin setting. As explained in the text, the analysis included potential constituents of concern based on a review of the water quality database, local knowledge of constituents of concern from previous studies, and identified by GSA member agencies and stakeholders at a public TAC meeting in July 2019. Public water suppliers, including the City of Modesto, shared information on constituents of concern that have been identified in their drinking water wells over the historical study period. Other GSA members identified other potential constituents of concern that had been the target of several ongoing water quality programs including the Irrigated Lands Regulatory Program (ILRP) and Central Valley Salinity Alternatives for Long-Term Sustainability (CV-SALTS).

As presented in **Section 3.2.5**, data for these potential constituents of concern were analyzed over a 25-year study period based on available data. Analyses included development and posting of average and recent water quality data on Subbasin maps, along with various statistical analyses for concentration distribution, temporal trends and occurrence by principal aquifers (when known) (see **Tables 3-4**, **3-5**, and **3-6**).

Based on these analyses seven constituents of concern were selected for assignment of an MT and further characterization on an annual basis based on elevated concentrations over a relatively widespread area of the Subbasin. These constituents have been the most difficult to manage according to public water suppliers. The constituents also include a variety of sources and occurrences across the Subbasin to provide a more comprehensive tracking of groundwater quality. Specifically, the constituents include:

- naturally-occurring constituents (arsenic, uranium, TDS)
- special constituents with widespread areas of multiple non-point sources (nitrate, TCP, DBCP)
- constituents associated with industrial point sources and environmental investigations (PCE).

Data were evaluated for all three principal aquifers in the Subbasin because all are used for drinking water supply. The City of Modesto is the largest drinking water supplier and has wells in all three principal aquifers. The cities of Riverbank, Oakdale, and Waterford have municipal supply wells in the Eastern Principal Aquifer (see **Figure 2-13**). In addition to these providers, more than 75 smaller water systems scattered throughout the Subbasin also have wells in each of the principal aquifers. Numerous domestic wells also occur in both western and eastern principal aquifers. However, very few wells or drinking water systems are located in the eastern third of the Subbasin, (i.e., generally east of Waterford and Oakdale. See **Figures 2-10, 2-13**, **2-14**, and **6-1**).

Summary information is provided below on the seven constituents of concern assigned an MT; more detailed information is provided in **Section 3.2.5.3** including statistical analyses and temporal trends over a 25-year study period (1995 through 2019) and numerous water quality distribution maps on **Figures 3-35** through **3-52**.

6.6.2.1.1. Nitrate

Nitrate is the most widespread constituent of concern in both the California Central Valley and the Modesto Subbasin (see **Section 3.2.5**). Because of its serious health effects, the MCL of 10 mg/L of nitrate as N is selected as the MT. Sources, median and maximum concentrations, and occurrence of nitrate in Modesto Subbasin groundwater are described in **Section 3.2.5.3** and shown on **Figures 3-35** and **3-36**. Elevated nitrate concentrations are detected in all principal aquifers, including the confined Western Lower Principal Aquifer below the Corcoran Clay. Nitrate concentrations have exhibited a slightly increasing trend over the 25-year study period.

The widespread occurrence of nitrogen in California's Central Valley is being regulated by the Central Valley RWQCB under several programs (in addition to individual site regulatory orders). Those programs include the General Dairy Order (Dairy Order), the ILRP, and CV-SALTS. Nitrate concentrations in domestic wells are being mitigated through the Nitrate Control Program, which involves management areas with mandates to provide safe drinking water to impacted well owners (**Section 2.4.4**).

6.6.2.1.2. Arsenic

Arsenic is a naturally-occurring trace element in the rocks, soils, and groundwater of the Modesto Subbasin. Given its toxicity, the MT has been set at the arsenic MCL of 10 micrograms per liter (µg/L). Other water quality investigations have indicated that arsenic concentrations are higher in older and deeper groundwater samples (see **Section 3.2.5.3**). Although elevated arsenic has been detected in all principal aquifers, average concentrations are much higher in the Western Upper Principal Aquifer and Wester Lower Principal Aquifer than in the Eastern Principal Aquifer. Arsenic concentrations appear to be decreasing in Subbasin wells over the 25-year study period. Additional information on the occurrence and concentrations of arsenic in Modesto Subbasin groundwater is included in **Section 3.2.5.3** and shown on **Figures 3-39** and **3-40**.

6.6.2.1.3. Uranium

Uranium is another naturally-occurring trace element largely derived from granitic rocks in the Sierra Nevada. It is toxic and associated with health effects; the MT is set at the MCL of 20 picocuries per liter (pCi/L). Uranium has been detected at or above the MCL in shallow and intermediate depth wells in the City of Modesto wellfield; about nine wells have been taken offline due to elevated uranium concentrations. In general, concentrations of uranium are higher in the Western Upper Principal Aquifer compared to the other two aquifers. This occurrence is consistent with the geochemical conditions that lead to mobilization of uranium in the aquifers (**Section 3.2.5.3**). Over the 25-year study period, uranium concentrations have exhibited an increasing trend in Modesto Subbasin groundwater. Additional information on the occurrence and concentrations of uranium is included in **Section 3.2.5.3** and shown on **Figures 3-41** and **3-42**.

6.6.2.1.4. Total Dissolved Solids
TDS represents the total concentration of anions and cations in groundwater and is a useful indicator of mineralization, salt content, and overall groundwater quality. TDS generally meets drinking water standards in the Subbasin with only 14 percent of the TDS samples exceeding the upper limit California Secondary MCL of 1,000 mg/L. Most samples also meet the MT recommended secondary MCL for drinking water of 500 mg/L. The lower secondary MCL is used as the MT to address recommended concentrations for both drinking water and irrigation of some Modesto Subbasin crops (see **Section 3.2.5.3**) and to provide for a more protective water quality analysis.

Average and recent concentrations of TDS in groundwater samples are provided on **Figures 3-37** and **3-38**, respectively. As indicated on the maps, TDS concentrations are generally lowest in the central Subbasin, especially in the urban areas around Modesto, Oakdale, Riverbank, and Waterford. Elevated concentrations occur in the western Subbasin (in the San Joaquin National Wildlife Refuge) and in southwest Modesto.

Even though elevated TDS is inferred to occur in deeper portions of the Subbasin (below the base of freshwater), the statistical analysis in **Section 3.2.5.3** indicates that the highest TDS concentrations have been observed in the Western Upper Principal Aquifer (i.e., in the western Subbasin as indicated above). However, these high concentrations were not necessarily widespread and may indicate local point sources of TDS, especially near the San Joaquin River.

Additional information on the occurrence and concentrations of TDS in Modesto Subbasin groundwater is included in **Section 3.2.5.3** and shown on **Figures 3-37** and **3-38**.

6.6.2.1.5. 1,2,3-Trichloropropane (TCP)
TCP is a manufactured chlorinated hydrocarbon used for degreasing and previously associated with soil fumigants, which were widely used in agriculture through most of the 1980s. The chemical was banned in the 1990s. The MT is set at the MCL of 0.005 µg/L, which was only recently established (effective 2018). As a result, historical data for TCP in groundwater are sparse.

Elevated TCP concentrations have been detected in mostly urban areas, including Modesto, Riverbank, and Waterford, likely due to the increased sampling in drinking water supply wells. Even though TCP has been associated with relatively widespread application throughout the Central Valley, elevated concentrations are relatively sparse and localized in the Modesto Subbasin. This may indicate a lack of historical use in the Subbasin with just a few local point sources indicated. Elevated concentrations have not been detected in the Western Lower Principal Aquifer, indicating a surficial source and local protection against vertical migration by the Corcoran Clay.

Additional information on the occurrence and concentrations of TCP in Modesto Subbasin groundwater is included in **Section 3.2.5.3** and shown on **Figures 3-49** and **3-50**.

6.6.2.1.6. Dibromochloropropane (DBCP)
DBCP was a widely used pesticide (nematocide and soil fumigant) in the Central Valley prior to being banned in the late 1970s.Due to its mobility and toxicity, the MT is set at the MCL of 0.2 ug/L.

Concentrations are relatively low in the Modesto Subbasin with about 14 percent of the samples from the historical database exceeding the MCL. Similar to TCP, DBCP has not been detected in the Western Lower Principal Aquifer. In addition, data indicate a declining trend of concentrations over time, likely due to its long-term ban. Additional information on the occurrence and concentrations of DBCP in Modesto Subbasin groundwater is included in **Section 3.2.5.3** and shown on **Figures 3-47** and **3-48**.

6.6.2.1.7. Tetrachloroethene (PCE)
PCE is a volatile organic compound (VOC) developed as an industrial solvent. PCE has been widely use in a variety of industrial applications including as a dry cleaning fluid. Discharges from a number of dry cleaners in the City of Modesto have resulted in local contaminant plumes of PCE, all of which are being managed by other local regulatory agencies responsible for water quality. PCE has also been detected at Modesto Subbasin landfills and other sites under regulatory investigations and remediation. At least seven City of Modesto wells have installed wellhead treatment systems for managing PCE impacts. The MT is set at the California and Federal MCL of 5 ug/L.

Elevated concentrations of PCE are generally associated with point sources of the contaminant including industrial and commercial sites. Similar to TCP and DBCP, PCE has not been detected in the Western Lower Principal Aquifer, indicating surficial sources and protection by the Corcoran Clay.

Additional information on the occurrence and concentrations of PCE in Modesto Subbasin groundwater is included in **Section 3.2.5.3** and shown on **Figures 3-51** and **3-52**.

6.6.2.2. Relationship between MTs of Each Sustainability Indicator
Regulations require a description of the relationship between the MTs for each sustainability indicator and how the GSAs have determined that basin conditions at each MT will avoid undesirable results (§354.28(b)(2)). To facilitate a comparison between MTs, a summary of MTs for each sustainability indicator was provided in **Table 6-5** and discussed previously in **Section 6.3.2.2**.

As provided in **Section 6.3.2.2**, the MCLs for each constituent of concern – selected as the MTs – would not interfere with the MTs for the other sustainability indicators. All other MTs consist of groundwater elevations that are at or above the historic low water in the Subbasin. As such, the groundwater level MTs are protective against increases in constituents of concern that occur primarily at depth. Further, because these groundwater level MTs are similar to recent water levels across the Subbasin, hydraulic gradients would not be altered substantially that might cause migration of constituents into previously un-impacted areas.

In this manner, the MTs for the other sustainability indicators are supportive of the MTs for degraded water quality and cause no conflicts for groundwater management. The constituents will be tracked on an annual basis and analyzed with respect to changes in groundwater levels and extractions to determine if GSA management activities might be impacting groundwater quality.

GSA member agencies have already been coordinating with regulatory agencies responsible for drinking water quality in the Subbasin. In addition, these agencies are actively engaged with regulated water quality coalitions that have ongoing monitoring programs for certain Modesto Subbasin constituents of concern including the Nitrate Control Program and CV-Salts. Representatives from the Valley Water Collaborative – a coalition responsible for implementing the Nitrate Control Program (NCP) – provided a presentation at a public TAC meeting in December 2020. Many Subbasin landowners are directly participating in the NCP, providing additional opportunities for coordination.

Finally, as previously stated, multiple GSA member agencies are responsible for drinking water quality and routinely coordinate with water quality regulatory agencies. Because the drinking water standard (MCLs) are the target for both the water quality coalitions mentioned above and the water quality regulatory agencies, the selection of the MCLs as the MTs is consistent with other water quality programs. In this manner, the GSAs have determined that the MTs will avoid undesirable results.

6.6.2.3. Impacts of MTs on Adjacent Subbasins

Regulations require consideration of how Modesto Subbasin MTs impact the ability of an adjacent subbasin to achieve its sustainability goal. As summarized in more detail in **Section 6.3.2.3**, similar principal aquifers, shared interconnected surface water boundaries, and multiple GSA member agencies that overlap both the Modesto Subbasin and adjacent subbasins have facilitated setting MTs in the Modesto Subbasin that will not adversely impact adjacent subbasins GSP implementation.

Additional water quality considerations for MTs in each adjacent subbasin are summarized below.

6.6.2.3.1. Eastern San Joaquin Subbasin

The MT for degraded water quality in the ESJ Subbasin is defined as a TDS concentration of 1,000 mg/L TDS in representative monitoring wells, none of which occur along the shared subbasin boundary with the Modesto Subbasin. Rather, water quality monitoring is focused along the western rim of the ESJ Subbasin where TDS concentrations are of most concern in the ESJ Subbasin. The closest water quality monitoring well more than six miles north of the Modesto Subbasin. In addition, MTs for interconnected surface water, set at 2015 groundwater elevations along the Stanislaus River, are set similarly in both subbasins. Finally, water budget analyses for sustainable yield conditions indicate that subsurface flow is relatively small and occurs from the ESJ Subbasin into the Modesto Subbasin. Therefore, MTs in the Modesto Subbasin are not expected to conflict or affect the MTs in the ESJ Subbasin.

6.6.2.3.2. Delta-Mendota Subbasin

The Delta-Mendota Northern & Central GSP focused on constituents that are linked to groundwater elevations or other groundwater-management activities. Undesirable results are to be triggered if TDS, nitrate, or boron exceed the MCL or water quality objectives (WQOs) in three consecutive sampling events in non-drought years or additional degradation where current groundwater quality already exceeds the MCLs or WQOs. An undesirable result would also occur if a recharge project exceeded 20 percent of the aquifer's assimilative capacity without justification of a greater public benefit.

MTs were set at each monitoring site based on these criteria. As indicated in the GSP, there are no representative monitoring sites adjacent to the shared river boundary with the Modesto Subbasin (see the Delta-Mendota representative monitoring wells for degraded water quality on Figures 6-4 and 6-5 in W&C and P&P, 2019). The closest monitoring wells are 06-004 in the Upper Aquifer and 0-003 in the Lower Aquifer, located about three miles to the southwest of the southwestern corner of the Modesto Subbasin.

At those wells, the MTs for TDS are 4,000 mg/L and 2,000 mg/L for the Upper Aquifer and Lower Aquifer, respectively. The MTs for nitrate (as N) are 80 mg/L and 50 mg/L for the Upper Aquifer and Lower Aquifer, respectively. These MTs are much higher than the MCLs established for the MTs in the Modesto Subbasin. In addition, the closest monitoring wells are upgradient and would not be impacted by any degraded groundwater quality in the Modesto Subbasin.

In addition, water budget analyses indicate a net subsurface inflow from the Delta Mendota Subbasin into the Modesto Subbasin for projected future and sustainable yield conditions (**Table 5-15**). Collectively, the 3-mile distance from the nearest monitoring well, the upgradient location of the Delta-Mendota wells, the higher MTs for TDS and nitrate in the Delta-Mendota Subbasin, and the indicated subsurface flow direction into the Modesto Subbasin indicate that MTs in the Modesto Subbasin will not impact MTs for degraded water quality or impact GSP implementation in the Delta-Mendota Subbasin.

6.6.2.3.3. Turlock Subbasin

The Turlock Subbasin has defined undesirable results for degraded water quality in a similar manner to the Modesto Subbasin, using MCLs for six of the seven Modesto Subbasin constituents of concern as the MTs. Both subbasins have similar water quality issues and will coordinate the tracking and analysis across the Tuolumne River boundary.

In addition to the coordination of sustainable management criteria, two member agencies in the Modesto Subbasin - the City of Modesto and the City of Waterford[19] – monitor for groundwater quality in both subbasins, allowing for close coordination of any water quality issues along the Tuolumne River boundary. Water quality data for both subbasins will be analyzed annually using similar data sources and methods, which will allow for close

[19] The City of Waterford operates drinking water supply wells for the community of Hickman in the Turlock Subbasin.

coordination of any degraded water quality across the two subbasins. Analyses in both subbasins will be conducted to determine if GSA management of groundwater extractions, levels, or GSP projects/management actions are impacting groundwater quality. These analyses will be presented in Annual Reports for each subbasin.

6.6.2.4. Effects of MTs on Beneficial Uses and Users of Groundwater

The setting of MCLs as the MTs is protective with respect to the avoidance of undesirable results. By protecting drinking water quality, the long-term quality and quantity of useable groundwater for all beneficial uses will be preserved.

The City of Modesto has been historically impacted by water quality problems in their wellfields. About 18 water supply wells had to be removed from service for impacts related to arsenic, nitrate, or uranium (see **Section 3.2.5.3**). Another 9 water supply wells have been taken offline due to TCP or PCE contamination. To address these issues, the City has conducted numerous water quality studies and is currently completing a wellfield investigation and feasibility study to identify remedial options for wellfield management. Those independent studies and Subbasin-wide annual tracking of groundwater quality will each inform the other, providing a better understanding of degraded water quality in the Subbasin.

The commitment to analyze a large groundwater quality dataset across the Subbasin on an annual basis will improve GSA understanding of water quality in each Principal Aquifer and lead to better management practices. Expanded and ongoing data collection and analysis will also support ongoing regulatory monitoring, allowing others to evaluate their local water quality monitoring data in the context of Subbasin-wide water quality. For example, an improved understanding of water quality with depth allows future wells to be sited and designed such that water quality is optimized. Overall, these improvements will support all beneficial uses of groundwater in the Subbasin.

6.6.2.5. Consideration of State, Federal, or Local Standards in MT Selection

In setting MTs for degraded water quality, GSP regulations require that GSAs consider local, state, and federal water quality standards applicable to the Subbasin (354.28(c)(4)). As provided above, the degraded water quality sustainability indicator relies on California MCLs for the MT; in this manner, the MT adheres to drinking water quality standards set by California, which are either as protective or more protective than federal standards. The MCLs are also consistent with the local standards and water quality objectives (WQO) in the Central Valley RWQCB Basin Plan for the San Joaquin River Basin (2018). Accordingly, there are no conflicts with regard to regulatory standards.

6.6.2.6. Quantitative Measurement of Minimum Thresholds

As stated above, the MTs for the degradation of water quality will be quantitatively monitored through existing monitoring programs that are being managed by the SWRCB and uploaded to the public GeoTracker website. These water quality data are monitored by public agencies, regulated coalitions, and others in representative monitoring wells for each Principal Aquifer using regulatory-approved sampling protocols. Data will be downloaded from the State GeoTracker water quality website and supplemented with data from the salt and nutrient regulatory programs in the Subbasin (see **Section 2.4.4**). Water quality data will be analyzed for constituents of concern in each Principal Aquifer as described in **Chapter 7** (Monitoring Network) of this GSP (see **Section 7.1.4**). Analyses will be included in the Subbasin GSP annual reports.

These data are considered comprehensive for characterization of water quality in the Subbasin. More than 300 wells with water quality data for Modesto Subbasin constituents of concern were available from GeoTracker from January 2020 to May 2021; these water quality monitoring sites are shown on **Figure 7-4** as part of the GSP monitoring network and tabulated in **Appendix G**. As shown on **Figure 7-4**, wells are distributed throughout the Subbasin but focused in areas of drinking water supply wells (see **Figure 2-10**). This is appropriate given the emphasis on drinking water supply impacts (i.e., MCL exceedances) in the definition of undesirable results.

Although monitored wells will change from year to year based on regulatory monitoring requirements, public water suppliers generally monitor and report water quality data for all active drinking water wells (see **Figure 2-13**). GeoTracker also includes water quality monitoring data from sites with contaminant plumes as a part of the RWQCB regulatory programs (see summary data on **Figure 4-57**). As indicated in **Appendix G**, monitoring sites consist of municipal supply wells, monitoring wells, and domestic wells. Although most domestic wells are currently sampled for nitrate only (**Appendix G**), the SWRCB is planning to expand water quality monitoring in those wells, adding additional constituents of concern including most of those in the Modesto Subbasin.

Additional wells from supplemental regulatory programs are also either included on GeoTracker or available for public download to allow for a broad analysis of water quality on an annual basis. Monitoring programs for TDS and nitrate are conducted by the Eastern San Joaquin Water Quality Coalition (ESJWQC) in coordination with the CV-SALTS program and the Nitrate Control Program, which requires growers in management zones to ensure safe drinking water supplies for well owners impacted by nitrate concentrations (see **Section 2.4.4**). As a result of this large dataset, the GSAs are not planning to develop a separate GSP water quality monitoring network, and no water quality sampling will be conducted by the GSAs.

However, GSAs will ensure that projects and management actions comply with regulatory water quality requirements. GSAs will consider appropriate constituents, MCLs, and water quality objectives (WQOs) as projects are initiated to avoid undesirable results. Potential water quality considerations for currently proposed projects will be evaluated through the CEQA process as projects are implemented.

6.6.3. Measurable Objectives for Degraded Water Quality

To avoid exacerbation of the nature and extent of current groundwater quality by management activities, the GSAs are using the MOs to establish a target water quality condition whereby GSA management does not cause an increase in historical concentrations of constituents of concern (i.e., further degradation of water quality). This target is managed by the definition of measurable objectives for degraded water quality as follows.

Table 6-12: Measurable Objectives for Degraded Water Quality

	Measurable Objectives	Principal Aquifer(s)
Degraded Water Quality	Measurable objectives are defined as the historical maximum concentration of each constituent of concern at each representative monitoring location.	All

The same monitoring data summarized in **Section 6.6.2.6** above will be used to analyze MOs for the constituents of concern (see also **Figure 7-4**).

6.7. LAND SUBSIDENCE

SGMA defines an undesirable result for land subsidence as "significant and unreasonable land subsidence that substantially interferes with surface land uses" (§10721 (x)(5)). In general, land subsidence can interfere with land use by causing damage to either the natural land surface (e.g., surface fissures) or to structures on the land surface (e.g., roads or pipelines). Potential impacts from land subsidence are documented in **Section 3.2.6** and summarized in **Section 6.7.1.1** below.

As described in **Section 3.2.6**, there have been no known impacts from inelastic land subsidence in the Modesto Subbasin. Land subsidence associated with groundwater extraction has been documented across large segments of the San Joaquin Valley since the 1950s, but these areas are located significant distances to the south of the Modesto Subbasin (see **Figure 3-58**).

However, as explained in the remainder of **Section 6.7**, the potential for future land subsidence in the Subbasin cannot be dismissed, given the presence of the Corcoran Clay, the decline of groundwater levels in certain management areas, and the results of recent GPS station monitoring and remote sensing data. As a protective measure, sustainable management criteria for the land subsidence sustainability indicator have been selected for all principal aquifers in the Modesto Subbasin.

Because there have been no known impacts from land subsidence, it is difficult to determine what rates of subsidence would lead to undesirable results. For the Modesto Subbasin, the sustainable management criteria for chronic lowering of water levels were developed to arrest groundwater level declines caused by groundwater extraction (**Section 6.3**). As such, those criteria would protect against future land subsidence (see **Section 6.7.1.1**). Accordingly, the sustainable management criteria, including MTs set as the historical low groundwater levels for WY 1991 through WY 2020, are used as a proxy for land subsidence sustainable management criteria.

Potential undesirable results, including causes and impacts to beneficial uses, are described in **Section 6.7.1** below, with a definition of undesirable results provided at the end of the section. **Section 6.7.2** describes the quantification of minimum thresholds (MTs) and provides additional information on rationale and coordination of MTs in adjacent subbasins. **Section 6.7.3** provides the approach and selection of measurable objectives (MOs). Interim milestones that cover all of the applicable sustainability indicators are described in **Section 6.9**.

6.7.1. Undesirable Results for Land Subsidence

Vertical displacement of the land surface can be caused by a variety of mechanisms, including extraction of oil and gas, the wetting of collapsible soils, piping of sediment from underground pipeline or tank leaks, collapse from underground mining facilities, tectonic activity along geological faults, and other conditions. This GSP only focuses on land subsidence related to groundwater extraction. The following sections summarize the physical processes that could potentially cause future land subsidence in the Modesto Subbasin as well as the related causes and effects of potential undesirable results.

6.7.1.1. Causes of Undesirable Results for Land Subsidence

Areas of the San Joaquin Valley have had impacts from land subsidence related to groundwater pumping, which has lowered water levels within and below the thick and compressible Corcoran Clay. For example, land subsidence in the Merced Subbasin to the south occurred in this manner (W&C, 2019) (see **Figure 3-58**).

As pumping removes groundwater from storage, the pore pressure and support of the aquifer framework are reduced, and sediments can be realigned and compacted at depth. This compaction is typically associated with thick and compressible clay layers. Subsurface compaction reduces the volume of subsurface sediments, causing the ground surface to depress. The processes and mechanisms that result in land subsidence are more complex than summarized herein, but the concept of subsurface compaction is typically used to provide a general understanding of the process. Additional information is summarized in **Section 3.2.6** and illustrated on **Figure 3-57**.

The western Modesto Subbasin within the extent of the Corcoran Clay is thought to be the area most susceptible to future land subsidence (see red striped area on **Figure 6-1**). Recent processing of satellite data to analyze vertical displacement – referred to as InSAR[20] – suggests that no land subsidence has recently occurred in the western Subbasin (see **Figure 3-59**). However, data show some small amounts of vertical displacement in the eastern

[20] InSAR refers to Interferometric Synthetic Aperture Radar data.

Modesto Subbasin (see **Figure 3-59**). It is not known whether this vertical displacement is related to groundwater extraction or other mechanisms described in **Section 6.7.1** above.

Nonetheless, the hydrogeological conditions in the western Subbasin and the InSAR data in the eastern Subbasin highlight the need for monitoring and management. Because groundwater drains slowly from compacted clay layers, there is a time lag between the triggering mechanisms that cause land subsidence and the actual depression on the land surface. A slow and small rate of decline in the land surface can go unnoticed until disruption of infrastructure or other physical manifestation of the problem occurs.

The processes above describe the causes of potential land subsidence, but the causes of undesirable results are related to the adverse impacts that land subsidence could have on land uses. For example, the documented land subsidence in the California Central Valley has caused numerous adverse impacts that could lead to undesirable results if they occurred in the Modesto Subbasin. Land subsidence could interfere with land use through a physical alteration of the ground surface, such as fissures, cracks, or depressions or by damaging physical structures on the ground surface such as buildings or infrastructure.

Adverse impacts are likely to occur in urban areas where numerous buildings, utilities, and pipelines are present. In addition, areas of groundwater wells could experience casing or other wellbore damage. Impacts have also been documented along surface water canals and transportation corridors, with damage to canals, roads, freeways or bridges. These impacts could cause an interruption to vital services or increase risks to public health and safety. In addition to physical damage, land subsidence can also affect gravity drainage in sewers, pipelines, or water conveyance canals and can also increase the risk of flooding (LSCE, 2014; W&C, 2019; W&C and P&P, 2019).

In consideration of these adverse impacts, the Modesto Subbasin GSAs incorporated impacts to infrastructure into its undesirable result definition. Definitions from GSPs in adjacent subbasins, including the Delta-Mendota and the Eastern San Joaquin subbasins, were also reviewed (W&C and P&P, 2019; ESJGWA, 2019). The definition of undesirable results for the Modesto Subbasin is provided in **Section 6.7.1.3** below.

6.7.1.2. Effects on Beneficial Uses of Groundwater

Two commonly-cited effects on almost all beneficial users of groundwater in the Central Valley include damage to casings in water supply wells and interference with water canal capacity and conveyance (LSCE, 2014). Widespread collapse of well casings resulting from land subsidence have been well-documented in numerous areas. Near El Nido, California, well casings have been observed protruding above the land surface, in some cases with the connected concrete well pad suspended in the air (LSCE, 2014). Casing damage typically requires well replacement, resulting in significant costs to beneficial users of groundwater.

Given the close linkage between groundwater and surface water use in the Central Valley, land subsidence impacts on water conveyance facilities can have a negative impact on the beneficial uses and users of groundwater. Land subsidence has reduced freeboard and flow capacity in large water conveyance canals such as the Delta-Mendota Canal, the California Aqueduct, and the Friant-Kern Canal. Repairs to restore conveyance capacity along critical segments of the Friant-Kern Canal alone is estimated to cost as much as $200 million or more (FWA, 2018). In the Merced Subbasin GSP, undesirable results for land subsidence were related primarily to the viability of the Eastside Bypass Canal, where subsidence has caused a reduction in freeboard and capacity over the last 50 years. These impacts to surface water canals can result in an increase in groundwater pumping, often from groundwater basins already experiencing overdraft conditions, which can lead to a depletion in water supply.

Subsurface compaction of clay layers also causes permanent removal of groundwater from storage. Although the usable storage capacity of an aquifer is not substantially impacted by the dewatering and compaction of clay layers, there is some amount of groundwater that is permanently lost. Pumping an identical amount of groundwater after this loss can result in a lower water level than before the clay layer was drained. Lower groundwater levels can result in higher pumping lift costs and other negative effects on beneficial uses of groundwater (see **Section 6.3.1.2**) (LSCE, 2014).

Land subsidence could also disrupt activities on the land surface including agricultural production. Changes to the land surface, such as with fissures or depressions, could affect how both surface water and groundwater is conveyed onto and within productive agricultural parcels. These effects could create inefficiencies in beneficial groundwater use or interferences with agricultural land uses.

Finally, any of the above activities that lead to increased groundwater pumping would also have the potential to affect environmental users of groundwater including potential GDEs (**see Section 3.2.8** and **Figure 3-60**).

6.7.1.3. Modesto Subbasin Definition of Undesirable Results

In consideration of the land use and infrastructure impacts summarized above, an undesirable result has been developed for the Modesto Subbasin. Regulations require that the undesirable result definition include quantitative criteria used to define when and where groundwater conditions can cause an undesirable result (§354.26(b)(2)). These criteria address the number of monitoring sites and events that an MT can be exceeded before causing an undesirable result while recognizing that a single MT exceedance at one monitoring site may not indicate an undesirable result. Criteria also allow for a clear identification when an undesirable result is triggered.

The definition of undesirable results is provided as follows.

Table 6-13: Undesirable Results for Land Subsidence

	Undesirable Results Definition	Principal Aquifer(s)
Land Subsidence	An Undesirable Result is defined as significant and unreasonable inelastic land subsidence, caused by groundwater extraction and associated water level declines, that adversely affects land use or reduces the viability of the use of critical infrastructure. An undesirable result will occur when 33 percent of representative monitoring wells exceed the MT in three consecutive Fall monitoring events.	All

The criteria for triggering an undesirable result were developed for the chronic lowering of water levels indicator as discussed in **Section 6.3.1.3** and are applied as a proxy for the land subsidence sustainability indicator.

Accordingly, the monitoring networks for both land subsidence and chronic lowering of water levels are identical. As stated in **Section 6.3.1.3**, 33 percent is equivalent to 6 of 17 wells in the Western Upper Principal Aquifer, 2 of 5 wells in the Western Lower Principal Aquifer, and 13 of 39 wells in the Eastern Principal Aquifer.

MT exceedances are limited to 3 consecutive Fall monitoring events to avoid the potential seasonal component of elastic land subsidence. Elastic subsidence may occur in the fall, during low water level conditions, only to rebound during the spring, during high water level conditions. Data from a GPS station in the Subbasin illustrates this seasonal rebound (see **Section 3.2.6**, information on existing GPS stations). If groundwater elevations are managed at or above the MTs on a regional and multi-year basis, potential undesirable results for land subsidence should be avoided.

Water level monitoring will be supplemented by annual screening of InSAR data. These data will be re-evaluated with the water level monitoring network in the five-year GSP evaluation. If InSAR data indicate increasing rates of subsidence, the monitoring network will be bolstered by additional monitoring, such as the installation of GPS stations, in targeted areas of the Subbasin. In addition, the criteria could also be adjusted to be more protective.

6.7.2. Minimum Thresholds for Land Subsidence

As provided in the GSP regulations, the MT for land subsidence "shall be the rate and extent of subsidence that substantially interferes with surface land uses and may lead to undesirable results" (§354.28(c)(5)). Given the lack of undesirable results associated with land subsidence in the Modesto Subbasin, it is not possible to correlate a rate of subsidence to undesirable results. As explained in more detail below, available data sets indicate no land subsidence over most of the Subbasin. InSAR data indicate very low rates of vertical displacement in the central and eastern Subbasin, but this may also be due to irrigation on clay-rich soils or other land surface modifications associated with agricultural operations (see **Figure 3-6**). Additional supporting technical information on land subsidence in the Modesto Subbasin is provided in **Section 3.2.6** and summarized below in **Section 6.7.2.1**.

Because the greatest risk for land subsidence in the Modesto Subbasin is the dewatering/depressurization of clays, setting MTs at historic low groundwater levels (WY 2015 – WY 2020) was viewed as a reasonable strategy for minimizing future subsidence. In this manner, groundwater levels would be protective against worsening conditions that could lead to future undesirable results for land subsidence. Because the chronic lowering of water level MTs were developed to arrest water level declines in the Subbasin, they serve as reasonable MTs for avoidance of undesirable results for land subsidence. As such, chronic lowering of water levels MTs are used as a proxy for directly monitoring for land subsidence as follows.

Table 6-14: Minimum Thresholds for Land Subsidence

	Minimum Thresholds	Principal Aquifer(s)
Land Subsidence	Minimum thresholds are defined as the historic low groundwater elevation observed or estimated during WY 1991 – WY 2020 at each representative monitoring location, based on available data. (Using Chronic Lowering of Groundwater Levels as a proxy.)	All

Additional support and justifications for the MTs, along with the quantitative criteria for the combination of MT exceedances provided in the undesirable results definition, are discussed in the following section.

6.7.2.1. Justification and Support for Minimum Thresholds

GSP regulations require that the MTs for land subsidence be supported by:

- Identification of land uses and property interests that have been affected or are likely to be affected by land subsidence, including an explanation of how these uses and interests were determined.
- Rationale for establishing MTs in consideration of the above effects
- Maps and graphs showing the extent and a rate of land subsidence in the basin that defines the MT and MO.

With regards to the identification of land uses and property interests that are likely to be affected by land subsidence, potential effects of land subsidence on property interests are mentioned above in **Sections 6.7.1.1** and **6.7.1.2**. These effects on beneficial uses are general and hypothetical because no effects on beneficial uses caused by land subsidence have been identified in the Subbasin.

As mentioned previously, InSAR data published by DWR provides the best available vertical displacement data for the Subbasin. **Figure 3-60** illustrates cumulative vertical displacement over more than five years, from June 2015 through October 2020. As indicated by the dark gray areas, there is no negative vertical displacement (land subsidence) over most of the Subbasin. Only one small area of land subsidence is indicated within the extent of the Corcoran Clay. This area, located in the northwest corner of the Subbasin in the San Joaquin Wildlife Refuge, indicates a rate of land subsidence of up to 0.24 inches per year.

InSAR data indicate larger rates of vertical displacement in the central-southeastern Subbasin (orange and brown on **Figure 3-60**). Data in this area indicate a vertical displacement rate of about 0.12 inches per year with rates up to about 0.36 inches per year in two small, isolated areas (**Figure 3-60**). This area is outside of the Corcoran Clay and is characterized by relatively shallow, consolidated aquifers (i.e., Mehrten Formation) that would be less likely to experience significant land subsidence than areas with compressible clays.

In addition, there are clay-rich soils and multiple restrictive layers (e.g., duripan) in the eastern Subbasin that could be the cause of these small rates of vertical displacement (rather than groundwater extractions) (see **Figure 3-6**). For example, clay soils can be subject to swelling when wetted. In addition, the disruption of restrictive layers on agricultural lands could also result in small local differences in surface elevation, as can other agricultural operations. However, this area is also associated with increasing groundwater extractions over the historical study period, and the potential for land subsidence associated with these extractions cannot be ruled out at this time.

The map on **Figure 3-59** also shows the locations of three existing global positioning system (GPS) stations[21] along Highway 99, within the extent of the Corcoran Clay. The two northern stations are in Salida, and the southern station is in Modesto. These existing stations, monitored by other programs, provide highly-accurate ground surface elevation data. Data available from the northern (August 2006 to December 2007) and southern (November 2006 to July 2001) GPS stations indicate that there has been no inelastic land subsidence at those locations. The central station indicates a rate of land subsidence of about 0.048 inches per year (less than 5 inches over 100 years), for the period of August 2008 to June 2014 (see **Section 3.2.6** for more information).

Increased rates of subsidence are often triggered during drought conditions (LSCE, 2014); the available recent land subsidence data in the Modesto Subbasin were collected during the long-term (and ongoing) drought conditions that resulted in historic low water levels

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[21] Installed and operated by the U.S. Bureau of Reclamation in connection with the San Joaquin River Restoration Program.

throughout the Subbasin. It is not possible to know whether the current rates will continue beyond the drought.

Collectively, these data suggest that significant rates of land subsidence are not occurring in the Modesto Subbasin. Accordingly, MTs are selected to be protective against triggering significant rates of subsidence in the future. All of the information and data reviewed to date indicate that undesirable results from land subsidence could be avoided by arresting the ongoing water level declines in the Subbasin. By setting MTs at the historical low, water level declines are controlled, and any current land subsidence is not exacerbated. As indicated above, the MTs for chronic lowering of groundwater levels are being used as a proxy for land subsidence MTs because these MTs manage groundwater levels near or above historic low groundwater levels (WY 1991 – WY 2020).

As an additional protective measure, the GSAs intend to download and review DWR's InSAR data on an annual basis, for screening purposes. As illustrated on **Figure 3-59**, the InSAR data cover the entire extent of the Subbasin. Data will be used for ongoing evaluation of the rate and extent of land subsidence. The data will be re-evaluated for the five-year evaluation in 2027. If significant rates of subsidence have occurred between 2022 and 2027, additional monitoring, such as additional wells or GPS stations, will be installed in areas of concern.

In this manner, the GSAs will ensure that the potential for impacts to land uses from land subsidence is not missed. This approach is reasonable, based on the best available data in the Modesto Subbasin.

6.7.2.2. Relationship between MTs of Each Sustainability Indicator

Regulations require a description of the relationship between the MTs for each sustainability indicator and how the GSAs have determined that basin conditions at each MT will avoid undesirable results (§354.28(b)(2)). To facilitate this comparison, MTs for each sustainability indicator were summarized in **Table 6-5,** as discussed above in **Section 6.3.2.2**.

Because the MTs for chronic lowering of groundwater levels are being used as a proxy for land subsidence, the interaction between the MTs for land subsidence and the other MTs is the same as for chronic lowering of water levels. As such, please refer to **Section 6.3.2.2** above for meeting this regulatory requirement for the land subsidence sustainability indicator. These sustainability indicators are also analyzed separately in other subsections of **Chapter 6**, as referenced in **Table 6-4**.

6.7.2.3. Impacts of MTs on Adjacent Subbasins

Regulations require consideration of how Modesto Subbasin MTs impact the ability of an adjacent subbasin to achieve its sustainability goal. As summarized in more detail in **Section 6.3.2.3**, similar principal aquifers, shared interconnected surface water boundaries, and multiple GSA member agencies that overlap both the Modesto Subbasin and adjacent subbasins have facilitated setting MTs in the Modesto Subbasin that will not adversely impact adjacent subbasins GSP implementation. Additional details relevant to each adjacent subbasin are summarized below.

6.7.2.3.1. Eastern San Joaquin Subbasin

ESJ Subbasin MTs for chronic lowering of water levels are also used as a proxy for the reduction of groundwater in storage, land subsidence, and interconnected surface water. Therefore, the analysis presented for the chronic lowering of water levels in **Section 6.3.2.3.1** provides the technical rationale for concluding that MTs in the Modesto Subbasin for land subsidence will not adversely affect GSP implementation in the ESJ Subbasin.

6.7.2.3.2. Delta Mendota Subbasin

Land subsidence is a prevalent issue in the Delta-Mendota Subbasin, with impacts to infrastructure of statewide importance (such as the California Aqueduct and the Delta-Mendota Canal). However, no significant land subsidence has been documented near the Modesto Subbasin. Most of the subsidence maps in the Northern & Central Delta-Mendota GSP either do not contain data or do not indicate significant amounts of land subsidence along its shared San Joaquin River boundary with the Modesto Subbasin (see Figures 5-113, 5-114, and 5-116 in W&C and P&P, 2019). The closest UNAVCO GPS station (P255) along the Delta-Mendota Canal is located approximately nine miles to the west of the Modesto Subbasin, and data from 2007 to 2018 at that station did not indicate inelastic land subsidence.

For the Northern & Central Delta-Mendota GSP, land subsidence MTs in the management area adjacent to the Modesto Subbasin are based on an acceptable loss in distribution capacity in subbasin canals, to be determined in a future study (W&C and P&P, 2019). The closest subsidence monitoring station to the Modesto Subbasin is more than two miles to the southwest of the Modesto Subbasin boundary (04-002), and the MT had not yet been quantified. However, given that MTs are set at the historical low groundwater levels, no impacts on land subsidence in the Delta-Mendota Subbasin would be anticipated. In addition, MTs for interconnected surface water are the Fall 2015 groundwater elevations along the San Joaquin River, providing even more protection for the adjacent subbasin (see **Section 6.8.2.3.2**). Given these conditions, no impacts are expected on GSP implementation in the Delta-Mendota Subbasin.

6.7.2.3.3. Turlock Subbasin

Both the Turlock Subbasin and Modesto Subbasin have approved MTs for interconnected surface water that are based on Fall 2015 water levels along both sides of the Tuolumne River (see **Section 6.8.2.3.3**). In that manner, the two GSPs are coordinating on MTs and avoiding undesirable results for streamflow depletion. Accordingly, MTs in the Modesto Subbasin for land subsidence will not have an adverse impact on GSP implementation in the Turlock Subbasin.

6.7.2.4. Effects of MTs on Beneficial Uses and Users of Groundwater

The setting of MTs is protective with respect to the avoidance of undesirable results. However, the MTs place operational constraints on agricultural wells and other water supply wells, especially during long-term multi-year droughts. Because the MTs for chronic lowering of water levels are used as a proxy for land subsidence, all of the same effects on beneficial uses and users of groundwater discussed previously also apply to this indicator (see **Section 6.3.2.4**).

Shallow groundwater levels in the Western Upper Principal Aquifer create operational issues for agriculture and groundwater pumping is required in some areas to drain fields and allow access for farming. Given the small fluctuations in these wells, maintaining water levels at MTs may impose restrictions on these extractions and limit beneficial uses of groundwater. However, the definition of undesirable results allows for short-term declines and criteria for undesirable results focus on the lowest seasonal levels (Fall). These criteria will assist with the necessary operational pumping of shallow groundwater in the western Subbasin.

Notwithstanding the constraints placed on various well owners, groundwater users would benefit from the control and mitigation of potential impacts from land subsidence in the future. Those impacts could negatively affect agricultural or urban land uses or other beneficial uses of groundwater as explained in **Section 6.7.1** above.

6.7.2.5. Consideration of State, Federal, or Local Standards in MT Selection

GSP regulations require that GSAs consider how the selection of MTs might differ from other regulatory standards. For land subsidence, the MT consists of managing water levels in each representative monitoring well, which would not conflict with other regulatory standards.

6.7.2.6. Quantitative Measurement of Minimum Thresholds

As stated above, the MTs for land subsidence will be monitored by quantitatively measuring water levels as a proxy in representative monitoring well networks for each applicable Principal Aquifer as described in **Section 7.1.5** of this GSP. Monitoring will occur on a semi-annual basis, in Spring and Fall, to represent the seasonal high and low water level and adhere to water level sampling protocols (**Section 7.2**).

For land subsidence, supplemental monitoring is also planned. To provide a backstop for the uncertainties associated with future rates and extents of land subsidence, the GSAs also intend to use the annual DWR-published InSAR data as a screening tool. Those data cover the entire extent of the Subbasin and will provide a valuable tool for evaluating future vertical displacement. When combined with the annual data on groundwater extractions and groundwater elevations, the InSAR data can be used to identify areas where vertical displacement rates are changing and provide areas of the Subbasin where additional monitoring may be warranted. Data from existing GPS stations will be incorporated in the annual analysis, as available. Collectively, InSAR and GPS stations will serve as future land subsidence screening tools and, if necessary, will help identify optimal locations for either additional wells or future GPS stations.

6.7.3. Measurable Objectives for Land Subsidence

The MO for land subsidence is the midpoint between the MT and the historical high water level (WY 1991 – WY 2020). This is the same approach as for chronic lowering of water levels and is developed at the same representative monitoring sites.

Table 6-15: Measurable Objectives for Land Subsidence

	Measurable Objectives	Principal Aquifer(s)
Land Subsidence	Midpoint between the historical high groundwater elevation and the MT at each representative monitoring location. (Using Chronic Lowering of Groundwater Levels as a proxy)	All

6.8. DEPLETION OF INTERCONNECTED SURFACE WATER

SGMA defines an undesirable result for the interconnected water sustainability indicator as "depletions of interconnected surface water that have significant and unreasonable adverse impacts on beneficial uses of the surface water." (§10721 (x)(6)). In the Modesto Subbasin, the Tuolumne, Stanislaus, and San Joaquin rivers are all interconnected surface water. Along these boundary rivers, groundwater occurs above the channel invert elevation on an average basis, allowing groundwater to interact with surface water. All three rivers are interconnected during historical, current, and projected future conditions (**Figure 6-1**).

STRGBA GSA member agencies Modesto ID and Oakdale ID manage surface water supplies from the Tuolumne River and Stanislaus River, respectively. The districts provide local management of diversions and conveyance of surface water for municipal drinking water (City of Modesto), non-potable municipal uses, and agricultural supply. Agency experience was used to guide the analysis of streamflow depletions and undesirable results. Both agencies provided information and data to incorporate into the integrated surface water-groundwater model (C2VSim-TM) for streamflow depletion analyses under historical, current, and projected future water budgets (see **Chapter 5**). Agencies also provided expertise on potential undesirable results for surface water rights. Modesto ID and the consultant team also coordinated with TID on information along the Tuolumne River; TID operates New Don Pedro Dam for releases to the Tuolumne River for water supply.

The undesirable results, including causes and impacts to beneficial uses, are described in **Section 6.8.1** below, with a definition of undesirable results at the end of the section that includes criteria to quantify where and when undesirable results would occur. **Section 6.8.2** describes the quantification of MTs. **Section 6.8.3** provides the approach and selection of MOs. IMs that cover all of the applicable sustainability indicators (except degraded water quality) are described in **Section 6.9**.

6.8.1. Undesirable Results for Interconnected Surface Water

Analyses of groundwater conditions and water budget modeling in the Modesto Subbasin highlight the linkages between groundwater extractions, reduction of groundwater in storage, and interconnected surface water. In its Water Budget BMP, DWR notes that increases in groundwater extraction will initially result in a decline in groundwater in storage. However, over time, this decline in storage will be ultimately balanced by decreases in groundwater flow to streams (DWR, 2016a). This condition will induce groundwater recharge, removing water from the rivers (streamflow depletion). Although beneficial to water levels and storage, this streamflow depletion may impact beneficial uses of surface water including municipal, agricultural, and environmental uses.

Modeling shows that increased streamflow depletion (i.e., net groundwater recharge) along the Modesto Subbasin boundaries is associated with groundwater level declines. This observation indicates that water levels along the rivers can be used as a proxy for streamflow depletions if the water level declines can be shown to be protective against undesirable results.

Groundwater level monitoring for this purpose is best accomplished with a series of shallow monitoring wells adjacent to and transitioning away from the river. Although not ideal, current GSP monitoring wells are relatively close to the rivers and are screened in the unconfined aquifers that are connected to the rivers. When coupled with stream gage data and ongoing modeling, current wells are likely to be sufficient for monitoring surface water-groundwater conditions in the short term (see **Section 7.1.6**, **Table 7-2**, and **Figure 7-5**). Over time, additional monitoring wells will be added to the interconnected surface water monitoring network. A management action to improve the monitoring network provides for additional shallow monitoring wells to be installed along the rivers over time (**Chapter 8**).

6.8.1.1. Causes of Undesirable Results

In the Modesto Subbasin, groundwater extractions – primarily in the NDE MA – have lowered groundwater levels locally and in adjacent areas to the west. These extractions intercept groundwater that would have naturally flowed toward the river boundaries, depleting some amount of baseflow to the rivers. This streamflow depletion increases over time during the historical study period (note the declining amounts of stream/aquifer interaction as groundwater outflow, as shown in blue on **Figure 5-20**).

Modeling of projected future conditions suggests that the area of groundwater level declines will expand to the north and south toward the Stanislaus and Tuolumne rivers and cause increases in streamflow depletion (compare the net river gains/losses between historical and projected conditions in **Table 5-8)**. Groundwater extractions in other parts of the Subbasin also contribute to this depletion, especially along the rivers. In the projected conditions scenario, both the Tuolumne and Stanislaus rivers transition from net gaining streams to net losing streams, a continuation of a trend that began in recent years.

If depletion increased significantly more than indicated from the modeling, the groundwater system could become disconnected from the surface water system. At that point, groundwater would no longer contribute baseflow to the river. Lower groundwater levels would induce more recharge from the river, significantly depleting flows; these conditions would produce an undesirable result.

In the Modesto Subbasin, integrated surface water-groundwater modeling indicates that the groundwater system and river system remain connected through the 50-year implementation and planning horizon under future projected conditions. This indicates that even if future water levels declined to the extent estimated, connection between the two systems could be maintained. The projected streamflow depletions average about 26,000 AFY, only about one percent of the total river outflows from the Subbasin.

Nonetheless, these future projected increases in streamflow depletion result in a net loss of streamflow from the river systems compared to a net gain in streamflow over historical conditions. In addition, beneficial uses could be adversely impacted at these predicted levels of streamflow depletion even if the groundwater and surface water systems remain connected (see **Section 6.8.1.2** below). Accordingly, the projections for future streamflow depletions are considered undesirable results in this GSP.

GSAs are not required to correct undesirable results that occurred prior to January 1, 2015. Rather, the GSAs intend to protect against future projected increases in depletions and set a "floor" at 2015 conditions. In this manner, future projected declines in groundwater elevations will be managed, and future projections for streamflow depletion will be reduced.

6.8.1.2. Potential Effects on Beneficial Uses

Beneficial uses of the three Modesto Subbasin rivers are provided in the Basin Plan for the Sacramento River Basin and the San Joaquin River Basin (CVRWQCB, 2018). All three rivers are associated with almost all categories of beneficial uses including municipal (including potential uses), agricultural, and/or industrial supply; recreation; freshwater habitat, migration, and spawning; and wildlife habitat. The three rivers also support large riparian corridors. A preliminary evaluation of vegetative and wetland areas mapped by TNC as natural communities commonly associated with groundwater (NCCAG) indicates potential GDEs along most of the river reaches in the Modesto Subbasin (DWR, 2018d) (see **Section 3.2.8**).

Although predicted future streamflow over the 50-year baseline conditions are not precise, the predicted depletions result in lower streamflow during low flow conditions. These changes could exacerbate drought conditions on the rivers and adversely affect all beneficial uses that rely on surface water.

Both Modesto ID and Oakdale ID noted that more water would have to be released over time to meet current downstream flow requirements. This would make operation of the river more difficult, especially during low-flow conditions, and provide less water supply for municipal and agricultural beneficial uses during times when water demands are high.

In addition to adverse impacts to surface water rights holders, these conditions could also adversely impact flows needed to support fish and other wildlife. The large riparian corridors along the river could be adversely impacted. Lower groundwater levels adjacent to the rivers could impact GDEs and other environmental uses of groundwater that occur along the Subbasin river boundaries.

6.8.1.3. Modesto Subbasin Definition of Undesirable Results

The definition of undesirable results for interconnected surface water in the Modesto Subbasin is based on the causes and effects discussed above, along with additional information from the basin setting and water budgets (**Chapters 3** and **5**). Regulations also require that the undesirable result definition include quantitative criteria used to define when and where groundwater conditions can cause an undesirable result (§354.26(b)(2)). These criteria set the number of monitoring sites and events to determine where and when an MT can be exceeded before causing undesirable results. This framework recognizes that a single MT exceedance at one monitoring site may not indicate an undesirable result. The criteria also allow clear identification for when an undesirable result is triggered under the GSP.

The definition of undesirable results along with the quantitative combination of MT exceedances that cause undesirable results are provided below.

Table 6-16: Undesirable Results for Interconnected Surface Water

	Undesirable Results Definition	Principal Aquifer(s)
Interconnected Surface Water	An Undesirable Result is defined as significant and unreasonable adverse impacts to the beneficial uses of surface water caused by groundwater extraction. An undesirable result will occur on either the Tuolumne or Stanislaus rivers when 33% of representative monitoring wells for that river exceed the MT in three consecutive Fall monitoring events. An undesirable result will occur on the San Joaquin River when 50% of representative monitoring wells for that river exceed the MT in three consecutive Fall monitoring events.	All

The 50% criterion for the San Joaquin River is because there are only two representative monitoring wells along the San Joaquin River, and MT exceedances in both wells (100%) is difficult to justify. This criterion may change when additional wells are added to the monitoring network along the San Joaquin River. An exceedance in only one well may not lead to undesirable results as being set in this GSP, so incorporating additional wells is a priority for improvements to the monitoring network. This and other improvements are included as an implementation action in **Chapter 9**.

The total number of current wells and the number of MT exceedances allowed by the undesirable result definition are summarized below. The monitoring network is described in **Chapter 7** and shown on **Figure 7-5**.

- Tuolumne River: 10 wells (33% - 3 wells)
- Stanislaus River: 8 wells (33% - 3 wells)
- San Joaquin River: 2 wells (50% - 1 well)

The MT exceedance is limited to three consecutive Fall events (semi-annual monitoring). Spring events will be monitored but not used in the criterion because the increase in Spring water levels would not be representative of potential negative impacts during low flows on the rivers.

These criteria were incorporated into the sustainable yield modeling (**Section 5.3**), which demonstrated that these criteria could be met using simulated hydrographs at wells along the river. Sustainable yield conditions indicate significant decreases in streamflow depletion at each of the three rivers as discussed below.

6.8.2. Minimum Thresholds for Interconnected Surface Water

GSP regulations require the metric for interconnected surface water MTs to be "the rate or volume of surface water depletions caused by groundwater use that has adverse impacts on beneficial uses of the surface water and may lead to undesirable results" (§354.28(c)(6)) (emphasis added). As explained in **Section 6.8.1.1**, the modeling projections of future volumes of streamflow depletion have been determined by the GSAs to be undesirable results and is caused by lower groundwater levels. Therefore, specific groundwater levels can be directly correlated to these volumes of streamflow depletion and used as a proxy for interconnected surface water MTs.

The link between streamflow depletion volume and groundwater levels is confirmed by a sustainable yield modeling analysis described in **Section 5.3**. For this analysis, groundwater extractions were reduced to test aquifer response to groundwater level MTs, resulting in a reduction in projected surface water depletions and elimination of net depletions over the Subbasin. That is, there was a net contribution to streamflow from the groundwater system at the Subbasin outflow (i.e., the downstream point past the confluence of the Stanislaus and San Joaquin rivers). By managing water levels at or near the Fall 2015 groundwater elevations, modeling showed that the projected net depletions could be eliminated. Accordingly, MTs for this sustainability indicator are defined at the 2015 groundwater elevations as follows.

Table 6-17: Minimum Thresholds for Interconnected Surface Water

	Minimum Thresholds	Principal Aquifer(s)
Interconnected Surface Water	Minimum Thresholds are defined as the low groundwater elevation observed in Fall 2015 at each representative monitoring location.	Western Upper and Eastern Principal Aquifers

6.8.2.1. Justification and Support for Minimum Thresholds

GSP regulations require that the MTs be supported by:

- Location, quantity, and timing of depletions of interconnected surface water
- A description of the groundwater and surface water model used to quantify surface water depletion (§354.28(c)(6)(A)(B)).

Background information for the interconnected surface water analysis is provided in **Section 3.2.7**, followed by a preliminary analysis of potential GDEs, which occur along the river boundaries (**Section 3.2.8** and **Figure 3.60**). The historical, projected, and sustainable yield water budgets provide a detailed assessment of groundwater-surface water interaction and are presented in **Chapter 5**. As described above in **Section 6.8.2**, the sustainable yield analysis in **Section 5.3** was used to support the selection of MTs for this indicator. These collective analyses are summarized below.

In brief, the Tuolumne, Stanislaus, and San Joaquin rivers are interconnected surface water as defined by SGMA. The surface water-groundwater interaction is dynamic, with recharge and baseflow varying along segments of the river both seasonally and over time. This dynamic system of mixed gaining and losing segments along the Tuolumne and Stanislaus rivers is the result of both natural interactions and managed operations. As mentioned previously, both rivers are actively managed to provide critical water supplies for the Modesto, Turlock, and Eastern San Joaquin subbasins. The San Joaquin River has less variability and has the largest flows of the three Subbasin rivers. The segment of the San Joaquin River along the western Modesto Subbasin can be characterized as a net gaining reach during both historical and projected future conditions.

The location, quantity, and timing of deletions of these interconnected rivers were analyzed using the integrated surface water-groundwater model C2VSimTM. This local model is based on the DWR regional C2VSimFG-BETA2 model, which has been revised to include local water budget data for both the Turlock and Modesto subbasins in order to simulate the river boundary more accurately. Local surface water and groundwater data from the Eastern San Joaquin Subbasin to the north was also incorporated into the modeling analyses. These revisions provided increased ability and accuracy for modeling interconnected surface water across the northern and southern river boundaries. Documentation of the revised C2VSim-TM model is provided in **Appendix C** of this GSP.

Interconnected surface water was analyzed with C2VSimTM for historical, current, and future projected water budget conditions including separate average annual water budgets for the Modesto Subbasin surface water systems (see **Table 5-2**). Total surface water inflows into the Subbasin historically have averaged about 2,547,000 AFY[22] for all three river systems, with about one-half consisting of the San Joaquin River flows. Surface water outflows are estimated at 2,770,000 AFY under historical conditions as measured at the confluence of the Stanislaus River and the San Joaquin River at the northwest corner of the Modesto Subbasin (**Table 5-2**).

During historical conditions, all three rivers were net gaining on an average annual basis with baseflow contributions of about 61,000 AFY (see the net of the Modesto Subbasin total gains from groundwater (baseflow) and losses to groundwater (seepage/recharge) under historical conditions in **Table 5-2**). Under future conditions, streamflow seepage is projected to increase in all three rivers, resulting in net depletions on both the Tuolumne and Stanislaus rivers over the 50-year period of analysis. Smaller streamflow depletions are projected to occur along the San Joaquin River, but the river remains a net gaining stream overall.

Historical conditions represent an average over a 25-year period. During that time, streamflow depletions increased along each of the Subbasin rivers as groundwater extractions increased, especially after about 2005. **Figure 5-20** illustrates this increase by showing overall smaller groundwater outflows to the surface water system from WY 2005 to WY 2015 (see annual estimates represented by the stream/aquifer interaction shaded blue on **Figure 5-20**). **Figure 5-25** shows the relatively small amount of total streamflow that is affected by the groundwater system.

To reduce the potential for projected future depletions to cause undesirable results, groundwater level declines associated with groundwater extractions need to be arrested. By managing groundwater at or above 2015 groundwater levels, sustainable yield modeling predicts significant improvements in the future projections. A summary of these improvements is shown in the following table.

[22] As footnoted in **Table 5-2**, some diversions occur upstream of the inflow measurement point into the Subbasin and are not included in these totals.

Table 6-18: Improvements to Interconnected Surface Water under Sustainable Yield Conditions

Modesto Subbasin Surface Water	Projected Future Baseline Conditions (AFY)	Sustainable Yield Conditions (AFY)	Increase in Baseflow* under Sustainable Yield Conditions (AFY)	(%)
Total GW-SW Interaction	26,000	-15,000	41,000	158%
San Joaquin River	-9,000	-13,000	4,000	44%
Tuolumne River	11,000	-11,000	22,000	200%
Stanislaus River	24,000	9,000	15,000	63%

Positive numbers represent net recharge from surface water to groundwater (i.e., streamflow depletion, also referred to as a net losing river) over average hydrologic conditions.
Negative numbers represent a net contribution to surface water (SW) from groundwater (GW) (i.e., net baseflow, also referred to as a net gaining river) over average hydrologic conditions.
**"Increase in baseflow" refers to the larger contributions to surface water from groundwater (i.e., lower amounts of streamflow depletion) under Sustainable Yield Conditions.*

As shown in the table above, net streamflow depletion in the Modesto Subbasin rivers is estimated at 26,000 AFY under the projected future baseline conditions. Under sustainable yield conditions, which incorporated the 2015 groundwater elevation MTs, the projected future streamflow depletion is eliminated, and the overall surface water system returns to a net gaining condition. Sustainable yield conditions indicate an increase of 41,000 AFY of baseflow over projected future conditions. Additional details of these data are provided in **Section 5.1.4.4** for projected conditions (see also **Table 5-2** and **Figure 5-24**); additional details on the sustainable yield analysis are provided in **Section 5.3** (see **Table 5-15** and **Figure 5-24**).

6.8.2.2. Relationship between MTs of Each Sustainability Indicator

Regulations require a description of the relationship between the MTs for each sustainability indicator and how the GSAs have determined that basin conditions at each MT will avoid undesirable results (§354.28(b)(2)). **Table 6-5** summarizes the MTs for the sustainability indicators.

The use of 2015 groundwater levels as a proxy for interconnected surface water coordinates well to the other sustainability indicators, most of which are also tied to similar or identical water levels. The relationship between the MTs for interconnected surface water and the other MTs are summarized below:

- MTs for interconnected surface water are either identical or a few feet higher than the MTs selected for chronic lowering of water levels to allow more protection against streamflow depletions along the rivers. For the 20 wells along the rivers that are included in the monitoring networks for both the chronic lowering of groundwater levels and interconnected surface water indicators, MTs vary by four feet or less (compare **Figures 7-1** and **7-3** with **Figure 7-5**). These differences are not sufficient to create a conflict for GSP implementation and management.
- MTs for reduction of groundwater in storage and land subsidence are the same as those for the chronic lowering of water levels. As such, interaction of those MTs with interconnected surface water MTs occurs in the same manner as discussed above (see also **Section 6.4.2** and **6.5.2**).
- MTs have not been selected for the Seawater Intrusion indicator because it is not applicable to the inland Turlock Subbasin (see **Section 6.5**).
- MTs for interconnected surface water will not affect water quality and, as such, will not conflict with degraded water quality MTs. In addition, by setting MTs at the Fall 2015 groundwater levels along the rivers, groundwater will continue to contribute fresh water to the rivers. (see also **Section 6.6**).

Although these MTs were considered and approved separately for each of the sustainability indicators separately, the TAC reviewed technical presentations on how the MTs for each indicator coordinates with the others. Technical information and modeling analyses were reviewed both by mangers and representatives in the TAC planning group as well as in public TAC meetings held in tandem with monthly STRGBA GSA meetings.

6.8.2.3. Impacts of MTs on Adjacent Subbasins

Regulations require consideration of how Modesto Subbasin MTs impact the ability of an adjacent subbasin to achieve its sustainability goal. As summarized in more detail in **Section 6.3.2.3**, similar principal aquifers, shared interconnected surface water boundaries, and multiple GSA member agencies that overlap both the Modesto Subbasin and adjacent subbasins have facilitated setting MTs in the Modesto Subbasin that will not adversely impact adjacent subbasins GSP implementation. Additional details relevant to each adjacent subbasin are summarized below.

6.8.2.3.1. Eastern San Joaquin Subbasin

ESJ Subbasin MTs for chronic lowering of water levels are also used as a proxy for the reduction of groundwater in storage, land subsidence, and interconnected surface water. Given that the MTs for interconnected surface water are either the same or only a few feet higher than the MTs for the chronic lowering of water levels, the previous analysis in **Section 6.3.2.3.1** is applicable to this indicator. Information in that section provides the technical rationale for concluding that MTs in the Modesto Subbasin for interconnected surface water will not adversely affect GSP implementation in the ESJ Subbasin.

6.8.2.3.2. Delta-Mendota Subbasin

The Delta-Mendota Northern & Central GSP defines undesirable results for interconnected surface water as a percentage increase in streamflow depletions that is to be determined within the first five years of GSP implementation. A quantitative MT is not set due to insufficient data. The data to be incorporated into the evaluation will be collected from two wells along the San Joaquin River south of the Modesto Subbasin (see wells 03-001 and 03-003 on GSP Figure 6-7 *in* W&C and P&P, 2019). In the interim, the GSP selects a narrative MO, which states "no increased depletions of surface water occur as a result of groundwater pumping." (W&C and P&P, 2019).

In the absence of a quantitative MT for interconnected surface water, the MT for the Modesto Subbasin seems sufficiently high to not interfere with the Delta-Mendota Subbasin achieving its sustainability goal. As mentioned previously, MTs for chronic lowering of water levels have been set similarly in both subbasins adjacent to the San Joaquin River. Sustainable yield modeling shows that MTs for the San Joaquin River in the Modesto Subbasin are correlated to conditions that contribute a net baseflow of 13,000 AFY (**Table 6-18**), an amount that differs from the average historical net baseflow of only 1,000 AFY (i.e., 14,000 AFY; subtract outflows from inflow for the San Joaquin River on **Table 5-8**). With this contribution to baseflow and MTs from 2015 conditions on both sides of the river, the MT for interconnected surface water in the Modesto Subbasin would not be expected to negatively impact implementation of the Delta-Mendota Northern & Central GSP.

6.8.2.3.3. Turlock Subbasin

MTs selected in both subbasins are Fall 2015 groundwater levels for the interconnected surface water sustainability indicator along the shared Tuolumne River boundary. Representatives from both subbasins have determined that future projected depletions of streamflow on the Tuolumne River may lead to undesirable results and have selected groundwater levels as a proxy for monitoring interconnected surface water and avoiding those future conditions (see **Table 6-18** above).

Further, GSAs in both subbasins have tested the MTs through similar sustainable yield modeling analyses (**Section 5.3**) to ensure that interconnected surface water conditions are protected. Results of the sustainable yield modeling indicate similar net contributions to baseflow on both sides of the river (16,200 AFY from Turlock Subbasin compared to 11,000 AFY from Modesto Subbasin).

6.8.2.4. Effects of MTs on Beneficial Uses and Users of Groundwater

The setting of MTs is protective with respect to the avoidance of undesirable results related to streamflow depletion. By arresting groundwater level declines along the river boundaries, the net future projected streamflow depletions can be substantially reduced or eliminated at each of the Modesto Subbasin rivers, and long-term use of groundwater can become more sustainable. Environmental uses of surface water and groundwater would also be supported.

However, there will be consequences on current uses of groundwater. The MTs will not be able to be achieved without sufficient projects or management actions to raise and maintain water levels along the Subbasin river boundaries. This will require significant investment in projects to replenish the Subbasin. Although projects identified in Chapter 8 of this GSP appear to provide sufficient supplemental water supply to achieve the MTs, a management action of demand reduction is included in the GSP as a backstop in the event that projects and associated aquifer response are not as expected. In that case, both agricultural beneficial uses and property interests could be negatively impacted if demand reduction is required to meet the Subbasin sustainability goal.

6.8.2.5. Consideration of State, Federal, or Local Standards in MT Selection

GSP regulations require that GSAs consider how the selection of MTs might differ from other regulatory standards. For interconnected surface water, the MT consists of water levels quantified at each representative monitoring well. Surface water rights holders on the Stanislaus and Tuolumne rivers estimate that the MTs will not adversely impact surface water rights and will allow for compliance with state and federal requirements. Accordingly, there are no conflicts with regard to other regulatory standards.

6.8.2.6. Quantitative Measurement of Minimum Thresholds

As stated above, the MTs for interconnected surface water will be monitored by quantitatively measuring water levels in representative monitoring wells along the river boundaries as described in **Chapter 7** (see **Section 7.1.6**, **Table 7-2,** and **Figure 7-5**). Monitoring will occur on a semi-annual basis, in Spring and Fall, to represent the seasonal high and low water level and will adhere to water level sampling protocols (**Section 7.2**).

6.8.3. Measurable Objectives for Interconnected Surface Water

Similar to the other sustainability indicators, the MO for interconnected surface water is set as the midpoint between the high groundwater elevation and the MT in each of the representative monitoring wells. As explained in **Section 6.3.3**, the MTs represents a “floor” for maintenance of low water levels, with allowance for short-term exceedances during droughts. Accordingly, water levels will be managed over an operational range generally occurring between the MT (with temporary exceedances) and anticipated high water levels that occur during wet periods.

Table 6-19: Measurable Objectives for Interconnected Surface Water

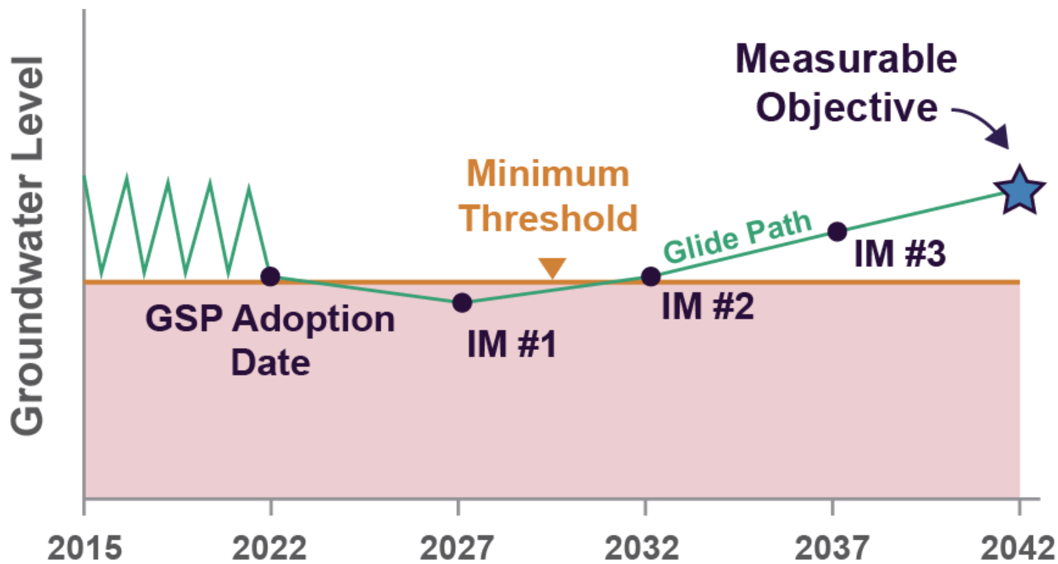
	Measurable Objectives	Principal Aquifer(s)
Interconnected Surface Water	Measurable objectives are established at the midpoint between the MT and the historical high groundwater elevation at each representative monitoring site.	Western Upper and Eastern Principal Aquifers

6.9. INTERIM MILESTONES

GSP regulations define an interim milestone (IM) as "a target value representing measurable groundwater conditions, in increments of five years, set by an Agency as part of a Plan." For the Modesto Subbasin, water levels are used as a metric for the IMs, consistent with the metric being used for MTs and MOs for all sustainability indicators except degraded water quality.

IMs provide a glide path for the Modesto Subbasin to reach its sustainability goal. The incremental approach recognizes that the path to sustainability is determined by the timing and effectiveness of GSP implementation, including projects and management actions designed to avoid undesirable results. For the Modesto Subbasin, a glide path provides needed flexibility for MAs of the Subbasin that will continue to decline – at rates dependent on future hydrologic conditions – until projects and management actions are implemented.

The following graphic prepared by DWR illustrates the concept of how IMs relate to the MT and MO. As shown, the IMs provide a glide path to sustainable management whereby MTs and MOs are maintained to avoid undesirable results.



In this conceptual graphic, the pink area represents water levels below the MT as designated in a representative monitoring well (i.e., an MT exceedance). In this example, water levels are expected to continue to decline after the GSP is adopted while projects are brought online. This concept acknowledges that the aquifer response to projects and management actions will take time. Interim milestones are illustrated in increments of five years following Plan adoption to define the glide path from undesirable results to the MO and achieving sustainable management by 2042.

In the Modesto Subbasin, long-term declines have occurred in NDE MA (**Figure 6-1**) and have expanded into the Oakdale ID MA (**Figure 6-2**). Accordingly, 2027 target values below the MT have been developed for representative monitoring wells in the management areas.

The amount of the anticipated declines between adoption and 2027 is dependent on future unknown hydrologic conditions. Since drought conditions began in WY 2013, dry hydrologic conditions have persisted in the Subbasin. Water year types as categorized by the DWR San Joaquin Valley indices since 2014 are summarized in the following table.

Table 6-20: Water Year Hydrologic Classification Indices Since 2014

Water Year	Water Year Type San Joaquin Valley Water Year Index
2014	Critically Dry
2015	Critically Dry
2016	Dry
2017	Wet
2018	Below Normal
2019	Wet
2020	Dry

Source : : https://cdec.water.ca.gov/reportapp/javareports?name=WSIHIST

As shown in the table, five out of seven water years between WY 2014 and WY 2020 have been categorized as below normal, dry, or critically dry. Water level declines associated with the last seven years may continue if hydrologic conditions do not improve, and/or if the aquifer response to GSP project implementation is delayed.

In order to plan for a worst-case scenario, a 2027 IM has been developed for declining wells based on the declines observed over the last seven years. By 2032, project implementation is expected to support water level recovery and the 2032 IM is set as the MT. If needed, the IM for 2037 is defined as the halfway point between the MT and MO. This trajectory is similar to the DWR conceptual diagram illustrated above. The 2027 IMs are provided in **Chapter 7** (see **Table 7-1** and **Table 7-3**) and shown on the hydrographs in **Appendix F**.

IMs have been designated conservatively for monitoring wells in the Oakdale ID MA and the NDE MA but will not be used to defer implementation of GSP projects or management actions. Other projects and/or management actions may also be needed during the first five years of GSP implementation to avoid undesirable results near wells if water levels reach the IMs.

To provide protection against IMs causing undesirable results, the following projects and management actions are being included in the GSP:

- A Group 2 project provides treated surface water to the City of Waterford to reduce pumping near interconnected surface water and in areas where domestic wells have previously failed (see **Figure 6-1**).
- Group 2 projects providing surface water as in lieu supply or for direct recharge are scheduled to begin immediately upon GSP adoption through coordination with, and actions by, landowners in the NDE MA to secure agreements and to plan for infrastructure with Oakdale ID and Modesto ID.

6.10. SUMMARY OF SUSTAINABLE MANAGEMENT CRITERIA AND ADAPTIVE MANAGEMENT

Collectively, the sustainable management criteria discussed in this GSP chapter provide a robust set of criteria to avoid undesirable results and achieve the Modesto Subbasin sustainability goal. Sustainable management criteria provided in multiple tables above are summarized in **Table 6-21**, including the definition of undesirable results, minimum thresholds (MTs), and measurable objectives (MOs) for all sustainability indicators applicable to the Modesto Subbasin GSP.

Modesto Subbasin GSAs note that this initial sustainable management criteria employs new SGMA terminology and represents reasonable estimates for sustainable management of groundwater through the planning horizon. Nonetheless, it is recognized that sustainable management criteria – including the definition of undesirable results – may require adjustment in the future.

Improvements to the GSP monitoring network including new installations of monitoring wells are incorporated into this GSP. As the GSAs implement the GSP and monitoring network, additional information will be routinely compiled and analyzed to evaluate aquifer response to the initial sustainable management criteria.

GSAs recognize that monitoring results may indicate that the initial undesirable results definition and MTs require adjustment in the future. Actual MTs that lead to undesirable results may be higher or lower than those selected in **Table 6-21** as projects and management actions are implemented. Consistent with the concept of adaptive management, the GSAs report compliance and GSP implementation in Annual Reports. The GSAs will also re-evaluate the criteria in the five-year GSP evaluation and make appropriate adjustments to ensure that the Subbasin meets its sustainability goal within the GSP implementation period as required.

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Table 6-21: Sustainable Management Criteria Summary

Sustainability Indicator	Undesirable Result Definition		Minimum Thresholds (MTs)	Measurable Objectives (MOs)	Principal Aquifers	GSP Section
	Narrative	Quantitative				
Chronic Lowering of Groundwater Levels	Undesirable results are defined as significant and unreasonable groundwater level declines – either due to multi-year droughts or due to chronic declines where groundwater is the sole supply – such that water supply wells are adversely impacted in a manner that cannot be readily managed or mitigated.	An undesirable result fwill occur when at least 33% of representative monitoring wells exceed the MT for a principal aquifer in 3 consecutive Fall monitoring events.	Historic low groundwater elevation observed or estimated during WY 1991 – WY 2020 at each representative monitoring location, based on available data.	Midpoint between the historical high groundwater elevation and the MT at each representative monitoring location.	All Principal Aquifers	6.3
Reduction of Groundwater in Storage	An Undesirable result is defined as significant and unreasonable reduction of groundwater in storage that would occur if the volume of groundwater supply is at risk of depletion and is not accessible for beneficial use, or if the Subbasin remains in a condition of long-term overdraft based on projected water use and average hydrologic conditions.	An undesirable result will occur for a principal aquifer when at least 33% of representative monitoring wells exceed the MT for for that principal aquifer in 3 consecutive Fall monitoring events.	Historic low groundwater elevation observed or estimated during WY 1991 – WY 2020 at each representative monitoring location, based on available data. (Chronic Lowering of Groundwater Levels as a proxy.)	Midpoint between the historical high groundwater elevation and the MT at each representative monitoring location. (Chronic Lowering of Groundwater Levels as a proxy.)	All Principal Aquifers	6.4
Seawater Intrusion	Not applicable in the Modesto Subbasin.	N/A	N/A	N/A	N/A	6.5
Degraded Water Quality	An Undesirable Result is defined as significant and unreasonable adverse impacts to groundwater quality as indicated by a new (first-time) exceedance of or further exceedance from an MCL of a constituent of concern (COC), that is caused by GSA projects, management actions, or management of groundwater levels or extractions such that beneficial uses are affected and well owners experience an increase in operational costs.	An undesirable result will occur when a Subbasin potable water supply well in the defined monitoring network reports a new (first-time) exceedance of an MT or an increase in concentration above the MT for a Modesto Subbasin constituent of concern (COC) that results in increased operational costs and is caused by GSA management activities as listed at left.	Minimum thresholds are set as the primary or secondary California maximum contaminant level (MCL) for each of seven (7) constituents of concern (COCs): Nitrate (as N) - 10 mg/L Arsenic - 10 ug/L Uranium - 20 pCi/L Total dissolved solids (TDS) - 500 mg/L Dibromochloropropane (DBCP) - 0.2 ug/L 1,2,3-Trichloropropane (TCP) - 0.005 ug/L Tetrachloroethene (PCE) - 5 ug/L.	Historical maximum concentration of each constituent of concern (COC) at each representative monitoring location.	All Principal Aquifers	6.6
Inelastic Land Subsidence	An Undesirable Result is defined as significant and unreasonable inelastic land subsidence, caused by groundwater extraction and associated water level declines, that adversely affects land use or reduces the viability of the use of critical infrastructure.	An undesirable result will occur when 33 percent of representative monitoring wells exceed the MT in three consecutive Spring monitoring events.	Historic low groundwater elevation observed or estimated during WY 1991 – WY 2020 at each representative monitoring location, based on available data. (Chronic Lowering of Groundwater Levels as a proxy.)	Midpoint between the historical high groundwater elevation and the MT at each representative monitoring location. (Chronic Lowering of Groundwater Levels as a proxy.)	All Principal Aquifers	6.7
Interconnected Surface Water	An Undesirable Result is defined as significant and unreasonable adverse impacts to the beneficial uses of surface water caused by groundwater extraction.	An undesirable result will occur on either the Tuolume or Stanislaus rivers when 33% of representative monitoring wells for that river exceed the MT in three consecutive Fall monitoring events. An undesirable result will occur on the San Joaquin River when 50% of representative monitoring wells for that river exceed the MT in three consecutive Fall monitoring events. The 50% criterion is based on the small number of representative montiroing wells currently avilable for the San Joaquin River and may change when additional wells are added to the monitoring network.	Low groundwater elevation observed in Fall 2015 at each representative monitoring location.	Midpoint between the historical high groundwater elevation and the MT at each representative monitoring site.	Western Upper Principal Aquifer and Eastern Principal Aquifer	6.8

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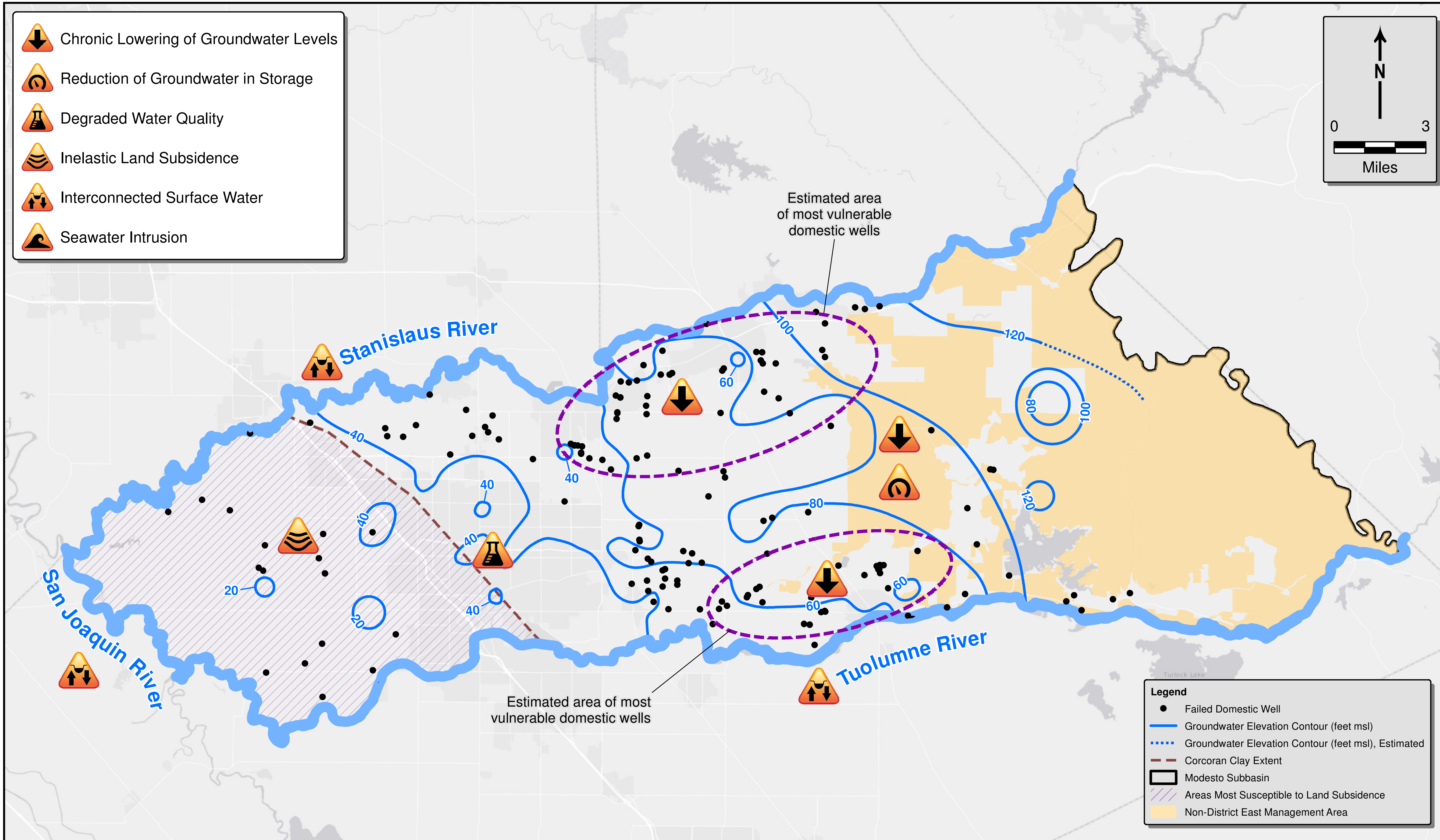

December 2021

TODD GROUNDWATER

Figure 6-1
Sustainability Considerations for the Modesto Subbasin

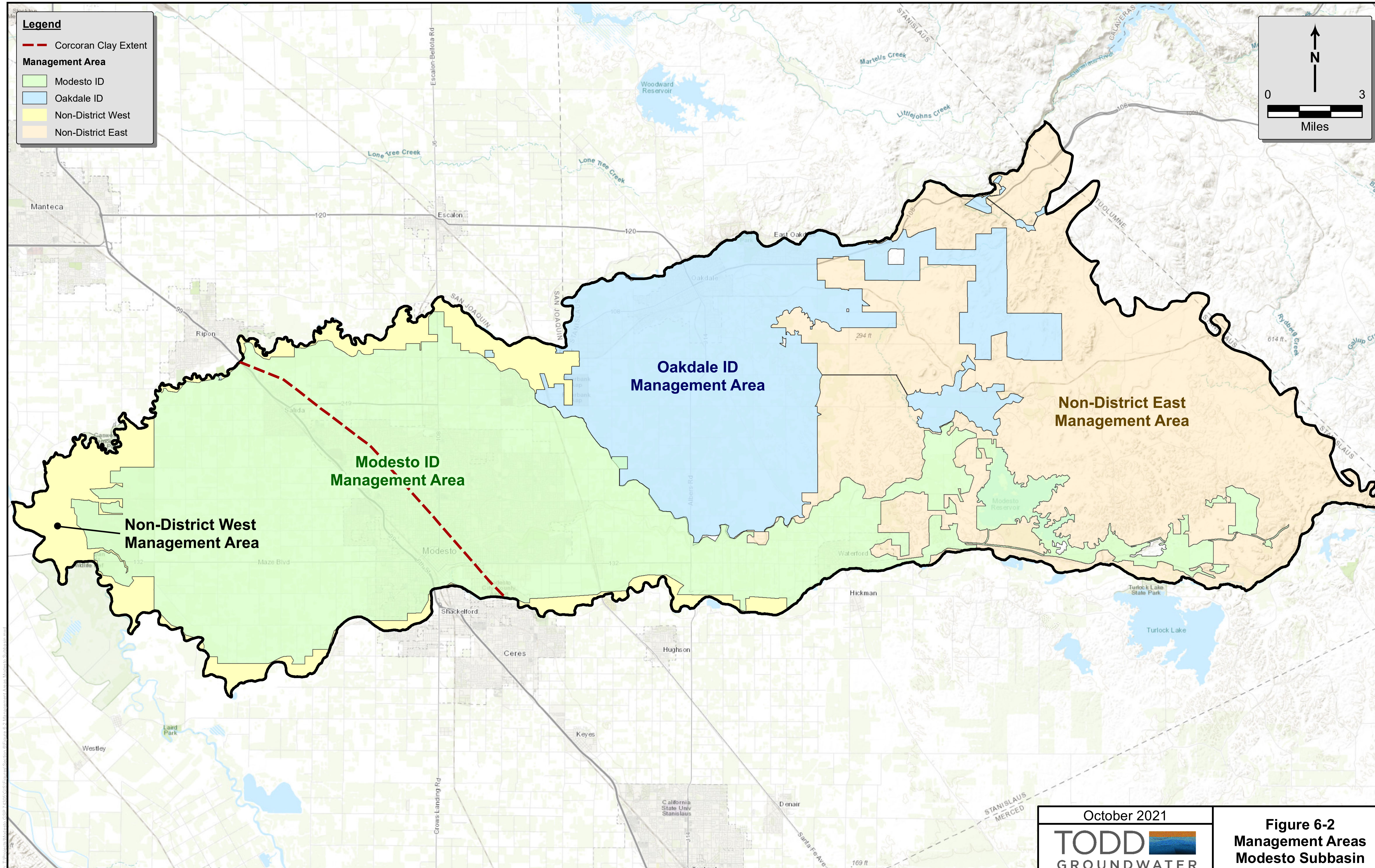

Figure 6-2
Management Areas
Modesto Subbasin

7. MONITORING NETWORK

The overall objective of the monitoring network for this Groundwater Sustainability Plan (GSP) is to yield representative information about groundwater conditions to guide and evaluate GSP implementation. Specifically, the GSP monitoring network is designed to:

- Evaluate groundwater conditions relative to sustainability indicators.
- Monitor for minimum thresholds to avoid undesirable results.
- Track interim milestones and measurable objectives to demonstrate progress on reaching sustainability goals for the Subbasin.
- Expand the existing monitoring network to better represent the entire Subbasin and address data gaps.
- Reduce uncertainty and provide better data to guide management actions, document the water budget, and improve understanding of the interconnection of surface water and groundwater.
- Identify and track potential impacts on beneficial uses and users of groundwater.

This GSP builds on existing monitoring programs with the intent to provide sufficient data for demonstrating short-term, seasonal, and long-term trends in groundwater levels. Existing monitoring programs include the CASGEM monitoring program, public water supplier groundwater monitoring programs in the municipalities, agricultural water supplier groundwater monitoring programs in Modesto Irrigation District (MID) and Oakdale Irrigation District (OID), and the Irrigated Lands Regulatory Program. These existing monitoring programs are described in **Section 2.4**.

The following summarizes the monitoring network. **Section 7.1** describes the monitoring network for each sustainability indicator. **Section 7.2** provides protocols for data collection and monitoring. **Section 7.3** describes how the monitoring network will be assessed and improved. **Section 7.4** summarizes the data management system (DMS) for data collected from the monitoring network. Figures for **Chapter 7** are provided at the end of the text to minimize interruption and facilitate multiple references to each figure.

7.1. DESCRIPTION OF MONITORING NETWORK

Groundwater level monitoring networks were developed to observe and document the chronic lowering of groundwater levels, reduction of groundwater in storage, land subsidence, and depletions of interconnected surface water. The applicability and rationale for using groundwater elevations to monitor each of these four sustainability indicators is discussed in **Chapter 6**, Sustainable Management Criteria. The monitoring networks are composed of representative monitoring wells that will be used to monitor sustainable management criteria for these sustainability indicators during the GSP implementation and planning horizon. Accordingly, groundwater elevations have been selected for a minimum threshold (MT) and measurable objective (MO) for each well in the monitoring network.

The monitoring networks consist of CASGEM wells, City of Modesto monitoring wells, USGS monitoring wells and monitoring wells constructed in 2021 with Proposition 68 grant funding from DWR. The monitoring networks are illustrated on **Figures 7-1** through **7-5.** The figures show locations of the wells in each monitoring network and the MT and MO for each well. Note that the current CASGEM program is being phased out and transitioned to the GSP monitoring network.

As described in **Chapter 6**, the monitoring network for degradation of water quality will be based on wells monitored by others and available at the State Water Resources Control Board (SWRCB) GeoTracker website. This network consists of drinking water supply wells, regulated facilities, and regional water quality programs such as the Groundwater Ambient Monitoring and Assessment (GAMA) Program. When combined with additional data from regulated water quality coalitions, this collective dataset represents a comprehensive network for tracking and evaluation of water quality with respect to the sustainable management criteria. Additional information on this monitoring network is provided in **Section 7.1.4** below.

A monitoring network was not developed for the seawater intrusion sustainability indicator. As discussed in **Chapter 6**, the GSAs found that seawater intrusion, as defined by GSP regulations, is not applicable to the inland Modesto Subbasin. Specifically, GSAs determined that seawater intrusion is not present in the Subbasin and is not likely to occur in the future (see **Section 6.5**). In accordance with GSP regulations, no sustainable management criteria have been assigned to this indicator, and no monitoring network has been established (§354.34(j)).

As described in **Chapter 6**, 2027 Interim Milestones (IMs) were developed for monitoring network wells in the OID and Non-District East Management Areas. The first IM occurs in 2027 with target values set below the MTs to provide a buffer to allow water levels to drop below the MT, recognizing that water levels in these wells may continue to decline after the GSP is adopted as projects are being brought online. This concept acknowledges that the aquifer response to projects and management actions will take time. 2027 IM values assume that recent water level declines will continue at similar rates between 2022 and 2027. Additional IMs are at five-year increments: the 2032 IM is the MT, the 2037 IM is half-way between the MT and the MO, and the 2042 IM is the MO. IMs provide a glide path for the Modesto Subbasin to reach its sustainability goal.

Summaries of the monitoring networks are provided in **Tables 7-1** and **7-2**. Well information includes the well ID, State Well Number, CASGEM identification number where applicable, well type, and Principal Aquifer and Management Area in which the well is located, location coordinates, well depth, screen interval depth, the MT and MO, a brief summary of how the MT and MO were developed, and the 2027 IM where applicable.

Table 7-1: Summary of Monitoring Network, Chronic Lowering of Groundwater Levels

Program	Well ID	State Well Number	CASGEM Identification Number	Well Use / Status	Principal Aquifer	Management Area				Latitude (NAD 83)	Longitude (NAD 83)	Ground Surface Elevation (feet msl)	Reference Point Elevation (feet msl)	Total Well Depth (feet bgs)	Screen Interval Depths (feet bgs)	Minimum Threshold (MT) (feet msl)	Measurable Objective (MO) (feet msl)	MT/MO Note	Interim Milestone (2027) (feet msl)
						MID	OID	Non-District East	Non-District West										
CASGEM	Albers 232	03S10E26D001M	3559	Active Irrigation	Eastern	x				37.651020	-120.847696	145.4	145.7	460	196-288	60	76	based on measured data at the well	--
CASGEM	Allen OID-01	02S10E16M001M	4430	Active Irrigation	Eastern		x			37.759897	-120.885401	145.6	145.7	415	0-120	72	81	based on measured data at the well	61
CASGEM	American 208	02S08E25P001M	3723	Active Irrigation	Eastern	x				37.728064	-121.041430	99.9	99.9	320	79-272	48	55	based on measured data at the well	--
CASGEM	Bangs Ave 243	03S08E01K001M	3152	Active Irrigation	Eastern	x				37.703436	-121.038476	90.0	90.0	346	141-251	32	46	based on measured data at the well	--
CASGEM	Bentley OID-02	02S10E33J001M	4590	Active Irrigation	Eastern		x			37.715973	-120.866949	171.9	172.1	500	120-175	71	85	based on measured data at the well	56
CASGEM	Birnbaum OID-03	02S10E15N001M	4429	Active Irrigation	Eastern		x			37.755921	-120.863872	149.4	149.8	293	55-293	72	86	based on measured data at the well	61
CASGEM	Blossom 230	03S11E30K001M	3903	Active Irrigation	Eastern	x				37.645614	-120.801537	154.8	155.0	412	179-283	61	78	based on measured data at the well	--
CASGEM	Canfield 90	04S08E06L001M	26633	Active Irrigation	Western Upper	x				37.613113	-121.130799	52.0	52.3	151	40-75	32	36	based on measured data at the well	--
CASGEM	Cavil 214	03S10E06G001M	27057	Active Irrigation	Eastern	x				37.705044	-120.911296	135.6	135.6	480	107-275	53	73	based on measured data at the well	--
CASGEM	Claribel 206	03S09E03D001M	2093	Active Irrigation	Eastern	x				37.708526	-120.974280	114.1	114.5	650	96-550	49	62	based on measured data at the well	--
CASGEM	Crane OID-06	02S10E29E001M	29444	Active Irrigation	Eastern		x			37.733378	-120.899126	160.1	160.4	505	155-198	66	77	based on measured data at the well	55
CASGEM	Curtis #2 100	03S08E09P001M	3303	Active Irrigation	Western Upper	x				37.685351	-121.097462	63.6	63.6	124	79-100	34	41	based on measured data at the well	--
CASGEM	Furtado OID-07	02S11E32L001M	2529	Active Irrigation	Eastern		x			37.718381	-120.786289	212.0	212.5	590	200-580	69	81	based on measured data at the well	51
CASGEM	Gates Road 101	03S07E24M001M	3146	Active Irrigation	Western Upper	x				37.659699	-121.155215	44.2	44.2	64	--	24	33	based on measured data at the well	--
CASGEM	Hart Road 88	03S08E08D001M	3301	Active Irrigation	Western Upper	x				37.694807	-121.122902	54.9	55.2	130	73-85	35	40	based on measured data at the well	--
CASGEM	Head Lateral 3 215	03S10E17K001M	3552	Active Irrigation	Eastern	x				37.674398	-120.891430	135.8	135.6	476	116-400	56	73	based on measured data at the well	--
CASGEM	Head Lateral 8 194	02S08E27N001M	38870	Active Irrigation	Eastern	x				37.727189	-121.087002	79.5	79.8	302	148-211	40	47	based on measured data at the well	--
CASGEM	Jones WID 228	03S11E29J001M	38872	Active Irrigation	Eastern	x				37.641798	-120.776177	166.4	166.4	324	188-280	55	75	based on measured data at the well	--
CASGEM	Katen 69	03S07E25P001M	3147	Active Irrigation	Western Upper	x				37.637929	-121.149890	45.1	45.1	160	13-148	27	33	based on measured data at the well	--
CASGEM	Langdon Merle 241	02S09E28H001M	3876	Active Irrigation	Eastern	x				37.734908	-120.977526	128.4	128.5	595	160-300	50	62	based on measured data at the well	--
CASGEM	Lateral one 195	03S10E32G001M	3877	Active Irrigation	Eastern	x				37.632523	-120.889283	126.0	126.0	260	141-210	42	52	based on measured data at the well	--
CASGEM	Machado 23	03S08E17R001M	3864	Active Irrigation	Western Upper	x				37.668045	-121.105038	59.1	59.3	80	--	31	40	based on measured data at the well	--
CASGEM	Marquis OID-10	02S10E20C001M	29436	Active Irrigation	Eastern		x			37.753232	-120.896930	138.4	138.8	125	27-125	85	91	based on measured data at the well	78
CASGEM	North Ave 103	03S08E14B001M	3854	Active Irrigation	Western Upper	x				37.678393	-121.054335	73.9	74.6	130	53-81	41	50	based on measured data at the well	--
CASGEM	Paradise 235	04S08E02L001M	2151	Active Irrigation	Western Upper	x				37.614186	-121.057863	73.7	73.9	258	96-132	34	41	based on measured data at the well	--
CASGEM	Paulsell 1 OID-11	02S12E31K001M	26187	Active Irrigation	Eastern			x		37.717864	-120.691876	195.9	197.5	815	195-410	88	117	based on measured data at the well	53
CASGEM	Paulsell 2 OID-12	02S12E32P001M	38865	Active Irrigation	Eastern			x		37.710953	-120.676939	193.9	195.6	815	132-815	94	123	based on measured data at the well	58
CASGEM	Perley 202	03S09E14P001M	2109	Active Irrigation	Eastern	x				37.667719	-120.951955	104.9	105.4	255	76-204	36	45	based on measured data at the well	--
CASGEM	Philbrick 201	04S08E02H001M	26591	Active Irrigation	Western Upper	x				37.619159	-121.050003	73.1	73.5	88	58-74	34	41	based on measured data at the well	--
CASGEM	Quesenberry 223	03S12E19G001M	27424	Active Irrigation	Eastern			x		37.659773	-120.689681	197.0	197.0	380	168-208	89	110	based on measured data at the well	72
CASGEM	Riverbank OID-13	02S09E27G001M	49463	Active Irrigation	Eastern	x				37.735134	-120.964821	132.3	134.2	560	200-550	42	54	based on measured data at the well	--
CASGEM	Schmidt 227	03S11E27G003M	3897	Active Irrigation	Eastern	x				37.648671	-120.736000	192.3	192.2	248	113-153	59	78	based on measured data at the well	--
CASGEM	Van Buren 43	03S08E21Q001M	3873	Active Irrigation	Western Upper	x				37.654644	-121.094887	63.3	63.5	196	76-116	38	45	based on measured data at the well	--
CASGEM	Warnock 46	03S08E29K001M	4015	Active Irrigation	Western Upper	x				37.642900	-121.108575	55.1	55.1	240	--	35	42	based on measured data at the well	--

Table 7-1: Summary of Monitoring Network, Chronic Lowering of Groundwater Levels

Program	Well ID	State Well Number	CASGEM Identification Number	Well Use / Status	Principal Aquifer	Management Area				Latitude (NAD 83)	Longitude (NAD 83)	Ground Surface Elevation (feet msl)	Reference Point Elevation (feet msl)	Total Well Depth (feet bgs)	Screen Interval Depths (feet bgs)	Minimum Threshold (MT) (feet msl)	Measurable Objective (MO) (feet msl)	MT/MO Note	Interim Milestone (2027) (feet msl)
						MID	OID	Non-District East	Non-District West										
CASGEM	Wellsford 233	03S10E16K001M	3551	Active Irrigation	Eastern	x				37.673607	-120.875297	141.9	142.0	468	158-358	62	77	based on measured data at the well	--
CASGEM	Wood 210	03S10E18P001M	3553	Active Irrigation	Eastern	x				37.667487	-120.912168	121.3	121.3	606	87-547	52	66	based on measured data at the well	--
CASGEM	Young 76	04S08E04G001M	38078	Active Irrigation	Western Upper	x				37.618051	-121.094288	61.5	62.1	175	12-152	36	42	based on measured data at the well	--
City of Modesto	MOD-MWA-2	--	not applicable	Monitoring Well	Eastern	x				37.642986	-120.931770	--	103.8	175	150-170	30	36	MT: based on Oct 2015 contour map; MO: based on historic high, spring 1998 contour map	--
City of Modesto	MOD-MWB-1	--	not applicable	Monitoring Well	Western Upper	x				37.690559	-121.044299	--	78.8	177	152-172	40	49	MT: estimated from fall 2015 contour map; MO: historic high estimated from spring 1998 contour map	--
City of Modesto	MOD-MWB-2	--	not applicable	Monitoring Well	Western Lower	x				37.690559	-121.044245	--	78.7	250	225-245	26	34	MT: estimated from fall 2015 contour map; MO: historic high estimated from spring 1998 contour map	--
City of Modesto	MOD-MWC-3	--	not applicable	Monitoring Well	Eastern	x				37.672249	-120.940908	--	105.6	285	260-280	40	50	MT: based on October 2015 contour map, MO: based on spring 1998 contour map	--
City of Modesto	MOD-MWD-1	--	not applicable	Monitoring Well	Western Upper	x				37.649959	-121.048685	--	73.3	129	104-124	30	40	MT: estimated from fall 2015 contour map and MT at nearby CASGEM well (McDonald); MO: based on historic high from spring 1998 contour map	--
City of Modesto	MOD-MWD-3	--	not applicable	Monitoring Well	Western Lower	x				37.649958	-121.048649	--	73.2	243	218-238	30	37	MT: estimated from fall 2015 measured contour map and model contours (Layer 2); MO: historic high estimated from spring 1998 contour map	--
USGS	FPA-2	003S009E08K004M	not applicable	Monitoring Well	Eastern	x				37.686194	-121.000917	--	91.0	122.2	115-120	38	48	MT: based on October 2015 contour map; MO: based on maximum of measured data (higher than estimate from spring 1998 contour map)	--
USGS	OFPB-2	003S009E11F002M	not applicable	Monitoring Well	Eastern	x				37.690194	-120.951417	--	104.0	174.5	166-171	35	53	MT: based on fall 2015 contour map; MO: historic high based on spring 1998 contour map	--
USGS	MRWA-2	003S008E33R002M	not applicable	Monitoring Well	Western Upper	x				37.624121	-121.086103	--	64.0	183	174-179	36	43	MT: estimated from fall 2015 contour map and based on nearby CASGEM well (Young); MO: historic high estimated from spring 1998 contour map and CASGEM well (Young)	--
USGS	MRWA-3	003S008E33R001M	not applicable	Monitoring Well	Western Lower	x				37.624121	-121.086103	--	64.0	280	269-274	28	36	MT: estimated from model contours September 2015 (Layer 2); MO: historic high based on measured data	--
Prop 68	MW-1S	--	not applicable	Monitoring Well	Western Upper	x				37.707630	-121.087167	68.4	68.0	125	100-120	33	43	MT: based on fall 2015 contour map; MO: historic high based on spring 1998 contour map	--
Prop 68	MW-1D	--	not applicable	Monitoring Well	Western Lower	x				37.707631	-121.087136	68.5	67.9	250	225-245	14	27	MT: based on measured data in April 2021 (lower than fall 2015 contour map); MO: historic high based on spring 1998 contour map	--

Table 7-1: Summary of Monitoring Network, Chronic Lowering of Groundwater Levels

						Management Area													
Program	Well ID	State Well Number	CASGEM Identification Number	Well Use / Status	Principal Aquifer	MID	OID	Non-District East	Non-District West	Latitude (NAD 83)	Longitude (NAD 83)	Ground Surface Elevation (feet msl)	Reference Point Elevation (feet msl)	Total Well Depth (feet bgs)	Screen Interval Depths (feet bgs)	Minimum Threshold (MT) (feet msl)	Measurable Objective (MO) (feet msl)	MT/MO Note	Interim Milestone (2027) (feet msl)
Prop 68	MW-2S	--	not applicable	Monitoring Well	Western Upper	x				37.613886	-121.023442	71.1	70.7	135	110-130	34	41	MT/MO: based on nearby CASGEM well (Philbrick)	--
Prop 68	MW-2D	--	not applicable	Monitoring Well	Western Lower	x				37.613886	-121.023475	71.2	71.0	281	256-276	35	40	MT: based on fall 2015 model contour map (Lay 2); MO: based on historic high of measured data	--
Prop 68	MW-3S	--	not applicable	Monitoring Well	Eastern	x				37.630743	-120.967621	95.8	95.6	161	136-156	25	31	MT: based on historic low at nearby MOD-225; MO: based on max of measured data (slightly higher than historic high based on spring 1998 contour map)	--
Prop 68	MW-3D	--	not applicable	Monitoring Well	Eastern	x				37.630711	-120.967621	95.7	95.3	283	258-278	25	31	MT/MO: same as MW-3S (so far, measured water level data are similar)	--
Prop 68	MW-4S	--	not applicable	Monitoring Well	Eastern				x	37.728565	-120.941555	136.6	136.3	165	140-160	56	67	MT: based on fall 2015 contour map; MO: historic high based on spring 1998 contour map	--
Prop 68	MW-5S	--	not applicable	Monitoring Well	Eastern		x			37.763120	-120.825360	191.9	191.6	175	150-170	69	89	MT: based on historic low at nearby Oak-008; MO: based on historic high at nearby Oak-008	68
Prop 68	MW-6S	--	not applicable	Monitoring Well	Eastern	x				37.646100	-120.752540	171.3	170.9	179	154-174	65	83	MT: based on fall 2015 contour map; MO: historic high based on spring 1998 contour map	--
Prop 68	MW-7	--	not applicable	Monitoring Well	Eastern			x		37.743410	-120.704350	242.6	242.3	300	275-295	75	110	MT: based on minimum of available measured data at this well. There is a lack of water level data in this area of the Subbasin. MO: based on historic high at CASGEM well Paulsell-1 (~2 miles south).	40
Prop 68	MW-8	--	not applicable	Monitoring Well	Eastern			x		37.732370	-120.632880	292.9	292.3	290	265-285	75	110	MT: based on minimum of available measured data at this well. Similar value to nearby well on fall 2015 contour map. MO: based on historic high at CASGEM well Paulsell-1	49
Prop 68	MW-9	--	not applicable	Monitoring Well	Eastern			x		37.649510	-120.535140	244.5	247.6	365	340-360	150	180	MT: based on minimum of available measured data at this well. There is a lack of water level data in this area of the Subbasin. MO: Based on similar operational range as other eastern Subbasin wells (~30 ft)	138
Prop 68	MW-10	--	not applicable	Monitoring Well	Eastern			x		37.739630	-120.756490	265.1	264.7	265	240-260	72	101	MT: based on historic low at a nearby DWR WDL well - Dec 2013 (data from 1990 to 2014); MO: based on historic high at nearby DWR WDL well - Nov 1997	63
Prop 68	MW-11	--	not applicable	Monitoring Well	Eastern	x				37.643970	-120.900997	116.3	116.1	175	150-170	35	48	MT: based on historic low at nearby MOD-247; based on historic high at nearby MOD-247	--

Notes: IMs were developed for wells in the Non-District East Management Area and the OID Management Area, where water levels may continue to decline while projects are being brought online.
IMs were not assigned to wells in the Non-District West Management Area and the MID Management Area, where water levels are relatively stable and consistent with established MTs and MOs.
IMs provided on this table represent 5-year IMs (2027), as described in Section 7.1. The 10-year IMs (2032) are the MTs and the 15-year IMs (2037) are the midpoint between the MT and the MO (see Section 7.1).

Table 7-2: Summary of Monitoring Network, Interconnected Surface Water

						Management Area													
Program	Well ID	State Well Number	CASGEM Identification Number	Well Use / Status	Principal Aquifer	MID	OID	Non-District East	Non-District West	Latitude (NAD 83)	Longitude (NAD 83)	Ground Surface Elevation (feet msl)	Reference Point Elevation (feet msl)	Total Well Depth (feet bgs)	Screen Interval Depths (feet bgs)	Minimum Threshold (MT) (feet msl)	Measurable Objective (MO) (feet msl)	MT/MO Note	Interim Milestone (2027) (feet msl)
San Joaquin River																			
CASGEM	Canfield 90	04S08E06L001M	26633	Active Irrigation	Western Upper	x				37.613113	-121.130799	52.0	52.3	151	40-75	33	37	based on measured data at the well	--
CASGEM	Katen 69	03S07E25P001M	3147	Active Irrigation	Western Upper	x				37.637929	-121.149890	45.1	45.1	160	13-148	27	33	based on measured data at the well	--
Stanislaus River																			
CASGEM	Allen OID-01	02S10E16M001M	4430	Active Irrigation	Eastern		x			37.759897	-120.885401	145.6	145.7	415	0-120	75	83	based on measured data at the well	61
CASGEM	American 208	02S08E25P001M	3723	Active Irrigation	Eastern	x				37.728064	-121.041430	99.9	99.9	320	79-272	48	55	based on measured data at the well	--
CASGEM	Birnbaum OID-03	02S10E15N001M	4429	Active Irrigation	Eastern		x			37.755921	-120.863872	149.4	149.8	293	55-293	74	87	based on measured data at the well	61
CASGEM	Head Lateral 8 194	02S08E27N001M	38870	Active Irrigation	Eastern	x				37.727189	-121.087002	79.5	79.8	302	148-211	40	47	based on measured data at the well	--
CASGEM	Langdon Merle 241	02S09E28H001M	3876	Active Irrigation	Eastern	x				37.734908	-120.977526	128.4	128.5	595	160-300	50	62	based on measured data at the well	--
CASGEM	Marquis OID-10	02S10E20C001M	29436	Active Irrigation	Eastern		x			37.753232	-120.896930	138.4	138.8	125	27-125	86	92	based on measured data at the well	78
CASGEM	Riverbank OID-13	02S09E27G001M	49463	Active Irrigation	Eastern	x				37.735134	-120.964821	132.3	134.2	560	200-550	42	54	based on measured data at the well	--
Prop 68	MW-4S	--	not applicable	Monitoring Well	Eastern				x	37.728639	-120.941518	136.6	136.3	165	140-160	56	67	MT: based on fall 2015 contour map; MO: historic high based on spring 1998 contour map	--
Tuolumne River																			
CASGEM	Jones WID 228	03S11E29J001M	38872	Active Irrigation	Eastern	x				37.641798	-120.776177	166.4	166.4	324	188-280	55	75	based on measured data at the well	--
CASGEM	Lateral one 195	03S10E32G001M	3877	Active Irrigation	Eastern	x				37.632523	-120.889283	126.0	126.0	260	141-210	42	52	based on measured data at the well	--
CASGEM	Paradise 235	04S08E02L001M	2151	Active Irrigation	Western Upper	x				37.614186	-121.057863	73.7	73.9	258	96-132	34	41	based on measured data at the well	--
CASGEM	Philbrick 201	04S08E02H001M	26591	Active Irrigation	Western Upper	x				37.619159	-121.050003	73.1	73.5	88	58-74	38	43	based on measured data at the well	--
CASGEM	Quesenberry 223	03S12E19G001M	27424	Active Irrigation	Eastern			x		37.659773	-120.689681	197.0	197.0	380	168-208	89	110	based on measured data at the well	72
CASGEM	Schmidt 227	03S11E27G003M	3897	Active Irrigation	Eastern	x				37.648671	-120.736000	192.3	192.2	248	113-153	59	78	based on measured data at the well	--
Prop 68	MW-2S	--	not applicable	Monitoring Well	Western Upper	x				37.613886	-121.023442	71.1	70.7	135	110-130	38	43	MT/MO: based on nearby CASGEM well (Philbrick)	--
Prop 68	MW-3S	--	not applicable	Monitoring Well	Eastern	x				37.630743	-120.967621	95.8	95.6	161	136-156	26	32	MT: based on fall 2015 level at nearby MOD-225; MO: historic high based on spring 1998 contour map	--
Prop 68	MW-6S	--	not applicable	Monitoring Well	Eastern	x				37.646100	-120.752540	171.3	170.9	179	154-174	65	83	MT: based on fall 2015 contour map; MO: historic high based on spring 1998 contour map	--
Prop 68	MW-9	--	not applicable	Monitoring Well	Eastern			x		37.649510	-120.535140	244.5	247.6	365	340-360	150	180	MT: based on minimum of available measured data at this well. There is a lack of water level data in this area of the Subbasin. MO: Based on similar operational range as other eastern Subbasin wells (~30 ft)	138

Notes: IMs were developed for wells in the Non-District East Management Area and the OID Management Area, where water levels may continue to decline while projects are being brought online.
IMs were not assigned to wells in the Non-District West Management Area and the MID Management Area, where water levels are relatively stable and consistent with established MTs and MOs.
IMs provided on this table represent 5-year IMs (2027), as described in Section 7.1. The 10-year IMs (2032) are the MTs and the 15-year IMs (2037) are the midpoint between the MT and the MO (see Section 7.1).

Hydrographs for each monitoring network well are provided in **Appendix F**. The hydrographs include well screen interval, ground surface elevation, the MT and MO for each well, and the 2027 IM, where applicable. Hydrograph presentation meets the data and reporting standards for hydrographs in Article 3 of the GSP regulations (§352.4(e)).

In addition to the representative wells in the monitoring networks, the GSAs will measure groundwater elevations in over 40 existing wells. These wells will be designated as SGMA monitoring wells and will not be used to monitor the sustainability indicators, and therefore do not have MTs and MOs. However, groundwater elevation data collected from the SGMA monitoring wells will be used for monitoring overall groundwater conditions and support analyses, such as the preparation of groundwater elevation contour maps. As part of the GSP five-year update, water level data from the SGMA monitoring wells will be compared to data from representative monitoring wells and these wells can be added to the monitoring network to reduce uncertainty or address data gaps, as needed. This task will be a part of the overall monitoring network assessment required by GSP regulations (§354.38(a)). The SGMA monitoring wells are summarized in **Table 7-3**.

A data gap analysis has been incorporated into the GSP Implementation Plan to address current data gaps and other improvements needed for the current GSP monitoring network (see **Section 9.5.1**).

The monitoring networks for each sustainability indicator are described in the following sections.

7.1.1. Chronic Lowering of Groundwater Levels

The monitoring network for chronic lowering of groundwater levels for each of the three principal aquifers is presented on **Figures 7-1, 7-2 and 7-3.** The wells in this monitoring network are summarized in **Table 7-1**.

Well density was an important consideration in identifying monitoring network wells for this sustainability indicator. DWR guidance (DWR, 2016b, see Table 1) generally recommends between one and ten monitoring wells per 100 square miles. This monitoring network is consistent with this guidance.

The following is a description of the monitoring network in each principal aquifer of the Subbasin.

7.1.1.1. Western Upper Principal Aquifer

The monitoring network for the Western Upper Principal Aquifer is illustrated on **Figure 7-1**. The monitoring network is composed of 17 wells, including 12 CASGEM wells, 2 City of Modesto monitoring wells, 2 Proposition 68 monitoring wells, and 1 USGS well. The STRGBA GSA is working with the USGS to obtain ownership and access to the USGS monitoring well. Well data are summarized in **Table 7-1**.

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Table 7-3: Summary of SGMA Monitoring Wells

						Management Area									
Program	Well ID	State Well Number	CASGEM Identification Number	Well Use / Status	Principal Aquifer	MID	OID	Non-District East	Non-District West	Latitude (NAD 83)	Longitude (NAD 83)	Ground Surface Elevation (feet msl)	Reference Point Elevation (feet msl)	Total Well Depth (feet bgs)	Screen Interval Depths (feet bgs)
CASGEM	Basso 2	03S08E18C001M	3865	Active Irrigation	Western Upper	x				37.677888	-121.136328	49.0	49.0	200	1-119
CASGEM	Gove 18	03S08E19Q001M	3868	Active Irrigation	Western Upper	x				37.653607	-121.128597	54.7	54.7	136	36-96
City of Modesto	MOD-MWA-1	--	not applicable	Monitoring Well	Eastern	x				37.643037	-120.931769	--	103.9	109	84-104
City of Modesto	MOD-MWA-3	--	not applicable	Monitoring Well	Eastern	x				37.642945	-120.931770	--	103.7	285	260-280
City of Modesto	MOD-MWA-4	--	not applicable	Monitoring Well	Eastern	x				37.642905	-120.931769	--	103.6	356	331-351
City of Modesto	MOD-MWB-3	--	not applicable	Monitoring Well	Western Lower	x				37.690560	-121.044196	--	78.7	299	274-294
City of Modesto	MOD-MWB-4	--	not applicable	Monitoring Well	Western Lower	x				37.690561	-121.044144	--	78.7	385	360-380
City of Modesto	MOD-MWC-1	--	not applicable	Monitoring Well	Eastern	x				37.672249	-120.940957	--	105.5	135	110-130
City of Modesto	MOD-MWC-2	--	not applicable	Monitoring Well	Eastern	x				37.672250	-120.941012	--	105.3	191	166-186
City of Modesto	MOD-MWC-4	--	not applicable	Monitoring Well	Eastern	x				37.672250	-120.941058	--	105.3	445	420-440
City of Modesto	MOD-MWD-2	--	not applicable	Monitoring Well	Western Upper	x				37.649920	-121.048682	--	73.3	179	154-174
City of Modesto	MOD-MWD-4	--	not applicable	Monitoring Well	Western Lower	x				37.649919	-121.048652	--	73.0	325	300-320
City of Modesto	MOD-MWE-2	--	not applicable	Monitoring Well	Eastern	x				37.635224	-121.010426	--	83.9	200	175-195
City of Modesto	MOD-MWE-3	--	not applicable	Monitoring Well	Eastern	x				37.635184	-121.010427	--	83.8	265	240-260
City of Modesto	MOD-MWE-4	--	not applicable	Monitoring Well	Eastern	x				37.635272	-121.010426	--	83.8	430	405-425
USGS	FPA-1	003S009E08K005M	not applicable	Monitoring Well	Eastern	x				37.686194	-121.000917	--	91.0	37	30-35
USGS	FPA-3	003S009E08K003M	not applicable	Monitoring Well	Eastern	x				37.686194	-121.000917	--	91.0	222	215-220
USGS	FPA-4	003S009E08K002M	not applicable	Monitoring Well	Eastern	x				37.686194	-121.000917	--	91.0	350	343-348
USGS	FPB-1	003S009E08H003M	not applicable	Monitoring Well	Eastern	x				37.692611	-120.997333	--	95.0	39	30-35
USGS	FPB-2	003S009E08H002M	not applicable	Monitoring Well	Eastern	x				37.692611	-120.997333	--	95.0	194	187-192
USGS	FPB-3	003S009E08H001M	not applicable	Monitoring Well	Eastern	x				37.692611	-120.997333	--	95.0	335	328-333
USGS	FPD-1	003S009E04G003M	not applicable	Monitoring Well	Eastern	x				37.705972	-120.983250	--	104.0	35	28-33
USGS	FPD-2	003S009E04G002M	not applicable	Monitoring Well	Eastern	x				37.705972	-120.983250	--	104.0	174	167-172
USGS	FPD-3	003S009E04G001M	not applicable	Monitoring Well	Eastern	x				37.705972	-120.983250	--	104.0	359	334-339
USGS	FPE-1	003S009E09L003M	not applicable	Monitoring Well	Eastern	x				37.687722	-120.988056	--	96.0	39	30-35
USGS	FPE-2	003S009E09L002M	not applicable	Monitoring Well	Eastern	x				37.687722	-120.988056	--	96.0	106	98-103
USGS	FPE-3	003S009E09L001M	not applicable	Monitoring Well	Eastern	x				37.687722	-120.988056	--	96.0	211	203-208
USGS	OFPA-1	003S009E16C003M	not applicable	Monitoring Well	Eastern	x				37.680000	-120.986000	--	94.0	38	30-35
USGS	OFPA-2	003S009E16C002M	not applicable	Monitoring Well	Eastern	x				37.680000	-120.986000	--	94.0	105	95-100
USGS	OFPA-3	003S009E16C001M	not applicable	Monitoring Well	Eastern	x				37.680000	-120.986000	--	94.0	200	188-193
USGS	OFPB-1	003S009E11F003M	not applicable	Monitoring Well	Eastern	x				37.690194	-120.951417	--	104.0	36	28-33
USGS	SA	003S009E09F001M	not applicable	Monitoring Well	Eastern	x				37.692361	-120.987333	--	99.0	39	30-35

Table 7-3: Summary of SGMA Monitoring Wells

						Management Area									
Program	**Well ID**	**State Well Number**	**CASGEM Identification Number**	**Well Use / Status**	**Principal Aquifer**	**MID**	**OID**	**Non-District East**	**Non-District West**	**Latitude (NAD 83)**	**Longitude (NAD 83)**	**Ground Surface Elevation (feet msl)**	**Reference Point Elevation (feet msl)**	**Total Well Depth (feet bgs)**	**Screen Interval Depths (feet bgs)**
USGS	SB	003S009E10D001M	not applicable	Monitoring Well	Eastern	x				37.692944	-120.973389	--	104.0	36	30-35
USGS	SC	003S009E10L001M	not applicable	Monitoring Well	Eastern	x				37.685722	-120.971500	--	99.0	41	30-35
USGS	MRWA-1	003S008E33R003M	not applicable	Monitoring Well	Western Upper	x				37.624121	-121.086103	--	64.0	35	25-30
USGS	MREA-1	003S010E17K004M	not applicable	Monitoring Well	Eastern	x				37.674092	-120.891361	--	132.0	46	40-45
USGS	MREA-2	003S010E17K003M	not applicable	Monitoring Well	Eastern	x				37.674092	-120.891361	--	132.0	56	51-56
USGS	MREA-3	003S010E17K002M	not applicable	Monitoring Well	Eastern	x				37.674092	-120.891361	--	132.0	266	100-260
Prop 68	MW-4D	--	not applicable	Monitoring Well	Eastern				x	37.728568	-120.941473	136.7	136.4	255	230-250
Prop 68	MW-5D	--	not applicable	Monitoring Well	Eastern		x			37.763080	-120.825350	191.8	191.5	285	260-280
Prop 68	MW-6D	--	not applicable	Monitoring Well	Eastern	x				37.646090	-120.752510	171.3	170.8	261	236-256

The wells in this monitoring network were chosen based on the following scientific rationale:

- Known locations and construction, with screen intervals or total depth above the Corcoran Clay (in the Western Upper Principal Aquifer).
- Spatial distribution and density of wells throughout the Western Upper Principal Aquifer.
- Length, completeness, and reliability of historical groundwater level record.
- Accessibility for future water level measurement.

Hydrographs for the wells in this monitoring network are presented in **Appendix F**. The CASGEM wells have historical water level records, many with water level data since the start of the GSP study period (water year (WY) 1991). As described in **Chapter 6**, the MT for the chronic lowering of groundwater level sustainability indicator is the historical low groundwater elevation observed from WY 1991 to WY 2020 and the MO is the midpoint between the historical high groundwater elevation during this time period and the MT. The MTs and MOs for the CASGEM wells were based on direct measurements in each well.

The City of Modesto monitoring wells, USGS wells and Proposition 68 monitoring wells have limited water level data. The MTs and MOs at these wells are based on the groundwater elevation contour maps in fall 2015 and spring 1998 (see **Figures 3-26 and 3-27**) or nearby wells with historical data.

The USGS well (MRWA-2) and one of the City of Modesto monitoring wells (MOD-MWD-1) are part of well clusters. At each of these locations, there are two wells screened in the Western Upper Principal Aquifer (and wells screened in the Western Lower Principal Aquifer). One representative well was chosen for the monitoring network from each location based on a review of the water level data, lithologic logs, and geophysical logs. The wells chosen for the monitoring network are screened in conductive sand or gravel units and have similar water levels to the other well in the cluster. The remaining well at each location are SGMA monitoring wells and are summarized in **Table 7-3**.

Static groundwater elevations will be measured twice a year in these monitoring wells to represent seasonal high and seasonal low groundwater conditions. The wells in this monitoring network will be monitored by one of the STRGBA GSA member agencies.

The SGMA monitoring wells in the Western Upper Principal Aquifer will also be monitored twice a year. These wells can be added to the monitoring network if problems arise with current monitoring network wells.

7.1.1.2. Western Lower Principal Aquifer

The monitoring network for the Western Lower Principal Aquifer contains five wells, as illustrated on **Figure 7-2** and summarized in **Table 7-1**. The monitoring network includes two City of Modesto monitoring wells, two Proposition 68 monitoring wells, and one USGS monitoring well.

The wells in this monitoring network were chosen because they have known locations and construction, with discrete screen intervals in the Western Lower Principal Aquifer (below the Corcoran Clay), and because they will be accessible for water level measurement in the future. As described in **Section 3.1.4**, The Corcoran Clay is the primary aquitard in the Subbasin and separates the alluvial aquifers above and below the clay, creating confined conditions in the Western Lower Principal Aquifer. The STRGBA GSA is working with the USGS to obtain ownership and access to the USGS monitoring well.

The two City of Modesto wells in this monitoring network (MOD-MWB-2 and MOD-MWD-3) are part of well clusters with two or three wells screened in the Western Lower Principal Aquifer at each location. One representative well was chosen for the monitoring network from each location based on a review of the water level data, lithologic logs, and geophysical logs. The wells chosen for the monitoring network are screened in conductive sand or gravel units and have similar water levels to the other well at the same location. The remaining well(s) at each location are SGMA monitoring wells and are summarized in **Table 7-3**.

As shown on **Figure 7-2**, most of the wells in the monitoring network are in the eastern region of the Western Lower Principal Aquifer, with one City of Modesto monitoring well in the southwestern Western Lower Principal Aquifer. There is a lack of well coverage in the central and western regions of the aquifer. This data gap of groundwater elevations in the Western Lower Principal Aquifer is identified in **Section 3.2.9**. Further improvements to the monitoring network are described in the data gap analysis included in the GSP Implementation Plan in **Chapter 9** (**Section 9.5.1**).

Hydrographs for wells in this monitoring network are presented in **Appendix F**. There are no measured data from Fall 2015 at any of these monitoring network wells. Historic data from other wells in the western aquifers suggest the historic low water level occurred during the recent drought in 2015 and have recovered to some degree since then. As noted in **Table 7-1**, the MTs selected for the Western Lower Principal Aquifer wells are based on estimates from the Fall 2015 groundwater elevation contour map (see **Figure 3-27**) or Fall 2015 model groundwater elevation contours. The MOs are based on the Spring 1998 contour map (see **Figure 3-26**) or available measured data at the well.

Static groundwater elevations will be measured in these monitoring wells twice a year, once in the spring and once in the fall, to represent seasonal high and seasonal low groundwater conditions. The wells will be monitored by one of the STRGBA GSA member agencies.

7.1.1.3. Eastern Principal Aquifer

The monitoring network for the Eastern Principal Aquifer consists of 39 wells, as shown on **Figure 7-3**. The monitoring network includes CASGEM wells, City of Modesto monitoring wells, Proposition 68 monitoring wells and USGS monitoring wells. Well data are summarized in **Table 7-1**.

The wells were chosen for this monitoring network because they have known locations and construction, are accessible for future water level measurement, and have good spatial distribution throughout the Eastern Principal Aquifer. The STRGBA GSA is working with the USGS to obtain ownership and access to the USGS monitoring wells.

The monitoring network wells are distributed throughout most of the Eastern Principal Aquifer but are sparse in the eastern Subbasin. This data gap of groundwater elevations in the Eastern Principal Aquifer is identified in **Section 3.2.9**. The four Proposition 68 monitoring wells constructed in the eastern Subbasin in 2021 (MW-7, MW-8, MW-9, and MW-10) help to fill this data gap. However, additional monitoring wells are necessary to fully characterize groundwater levels and flow in the eastern Subbasin. Further improvements to the monitoring network are described in the data gap analysis incorporated into the GSP implementation Plan in **Chapter 9** (**Section 9.5.1**).

Hydrographs for wells in this monitoring network are presented in **Appendix F**. Several methods were used to develop MTs and MOs, based on available data. Most of the wells in the monitoring network are CASGEM wells with sufficient historical water level records and therefore, MTs and MOs are based on measured data at the wells. The City of Modesto, Proposition 68 and USGS monitoring wells, however, do not have sufficient historical measured water levels so their MTs and MOs were developed with a variety of methods. For these wells, MTs were either based on the Fall 2015 groundwater elevation contour map (see **Figure 3-27**), groundwater elevations at nearby wells, or the limited measured water level data at the well. MOs were based on either measured historic high groundwater levels or estimates from the Spring 1998 contour map (see **Figure 3-26**). A summary of the MT/MO development method for each well in the monitoring network is provided in **Table 7-1**.

The City of Modesto wells (MOD-MWA-2 and MOD-MWC-3) and the USGS wells (FPA-2 and OFPB-2) are part of well clusters with two or four wells at each location. One representative well was chosen for the monitoring network from each location based on a review of the water level data, lithologic logs, and geophysical logs. The wells chosen for the monitoring network are screened in conductive sand or gravel units and have similar water levels to the other well at the same location. Similarly, the three Proposition 68 monitoring wells (MW-4S, MW-5S and MW-6S) have two wells at each location and the shallower of the two wells at each location were chosen for the monitoring network. The remaining well(s) at each location are SGMA monitoring wells and are summarized in **Table 7-3**.

Static depth to water will be measured twice a year in these monitoring network wells to represent seasonal high and seasonal low groundwater conditions. The wells will be monitored by one of the STRGBA GSA member agencies.

As summarized on **Table 7-3**, there are SGMA monitoring wells in the Eastern Principal Aquifer that will be monitored on a semi-annual basis. Future water level data from these wells will be evaluated, and some of these wells may be added to the monitoring network during the GSP five-year update.

7.1.2. Reduction of Groundwater in Storage

As described in **Section 6.4**, the sustainable management criteria for chronic lowering of groundwater levels will be used as a proxy for the reduction of groundwater in storage indicator. Accordingly, the monitoring network for the reduction of groundwater in storage is the same as the monitoring network for the chronic lowering of groundwater levels. This monitoring network is described above in **Section 7.1.1**, summarized in **Table 7-1**, and illustrated on **Figures 7-1, 7-2, and 7-3**.

Static groundwater elevations will be measured twice a year in these monitoring network wells to represent seasonal high and low groundwater conditions.

In addition to the required reporting of groundwater levels over time, regulations also require that the GSP annual reports provide an annual estimation of the change in groundwater in storage (§354.34(c)(2)). As described in **Chapters 5 and 6**, the historical reduction of groundwater in storage is estimated at about 43,000 AFY. As discussed in **Section 6.4**, both the change in groundwater in storage and corresponding water levels in the Subbasin will be documented annually in the GSP annual reports. Collectively, these data will allow the connection between the reduction of groundwater in storage to groundwater elevations to be documented on an annual basis, providing further justification for the use of a groundwater elevation proxy for this indicator.

7.1.3. Seawater Intrusion

As described in **Section 6.5**, the STRGBA GSA found that seawater intrusion is not an applicable sustainability indicator for the Modesto Subbasin. Specifically, the STRGBA GSA determined that seawater intrusion is not present in the Modesto Subbasin and is not likely to occur in the future. Therefore, neither sustainable management criteria nor a monitoring network has been established for this sustainability indicator (§354.34(j)).

7.1.4. Degraded Water Quality

As summarized in **Section 6.6.1.3**, undesirable results for degraded water quality are defined as significant and unreasonable adverse impacts to groundwater quality caused by GSA projects, management actions, or other management of groundwater such that beneficial uses are affected and well owners experience an increase in operational costs. The MTs are set as a new exceedance of the maximum contaminant level (MCL) at a potable supply well for any of the seven constituents of concern (COC): nitrate, uranium tetrachloroethene (PCE), 1,2,3-trichloropropane (TCP), Dibromochloropropane (DBCP), total dissolved solids (TDS), and arsenic.

The SWRCB and other agencies have the primary responsibility for water quality and the GSAs do not intend to duplicate this authority. Numerous regulated water quality monitoring programs exist in the Modesto Subbasin, providing data from hundreds of monitoring sites over time. Accordingly, the monitoring network for this sustainability indicator will incorporate existing monitoring data. The MTs will be quantitively monitored by public agencies (and others) in representative monitoring wells for each Principal Aquifer in accordance with other water quality regulatory monitoring program requirements. The GSAs will download water quality data from the State GeoTracker website each year and analyze any new exceedances of the seven COCs in potable supply wells. New exceedances or further degradation of the wells with prior exceedances will be evaluated in relation to GSA management of water level and groundwater extractions, as well as GSA projects and management actions, to determine whether these exceedances were caused, or exacerbated, by the GSAs. This analysis will be included in the GSP annual reports.

The monitoring network consists of drinking water supply wells, monitoring wells at regulated facilities, and monitoring sites associated with other regulatory water quality programs such as GAMA. Data from two specific regulatory water quality programs, CV-SALTS and the Nitrate Control Program (implemented by the Valley Water Collaborative – see **Section 2.4.4**), will be compiled separately if not already included in the GeoTracker data. These two programs are regulated through the CVRWQCB and provide water quality data for nitrate and total dissolved solids in groundwater throughout the Subbasin. Collectively, this dataset represents a comprehensive network for ongoing tracking and evaluation with respect to the sustainable management criteria.

The monitoring network will vary from year-to-year based on regulatory requirements for each water quality program. Water quality data collected in Subbasin wells during water year 2020 (October 2019 to September 2020) for the COCs were downloaded from GeoTracker as an example dataset. The wells with this water quality data are represented on **Figure 7-4** and tabulated in **Appendix G**. During this time, water quality data for the COCs were collected from over 300 wells in the Subbasin. Most of the data are from municipal drinking water systems and are therefore clustered in and around the municipalities. As indicated by the numbers of wells sampled for each of the COCs on **Figure 7-4** and tabulated in **Appendix G**, there is sufficient data to track and characterize water quality COCs to meet beneficial uses across the Subbasin.

7.1.5. Land Subsidence

Although impacts from land subsidence have not been documented in the Modesto Subbasin, future land subsidence is most likely to occur as a result of the dewatering/depressurization of clays within and below the Corcoran Clay. As described in **Section 6.7**, the sustainable management criteria for chronic lowering of groundwater levels will be used as a proxy for land subsidence. Accordingly, the monitoring network for land subsidence is the same as the monitoring network for the chronic lowering of groundwater levels. This monitoring network is described above in **Section 7.1.1**, summarized in **Table 7-1**, and illustrated on **Figures 7-1, 7-2, and 7-3**.

Static depth to water will be measured twice a year in the monitoring network wells to represent seasonal high and seasonal low groundwater conditions. The wells in this monitoring network will be monitored by one of the STRGBA GSA member agencies.

Remote sensing data will be used as a screening tool to evaluate land subsidence in the Modesto Subbasin as a supplemental monitoring program, but MTs and MOs will not be assigned to these data. As summarized in **Section 3.2.6**, vertical displacement data has been collected using Interferometric Synthetic Aperture Radar (InSAR) since 2015 by TRE Altamira Inc., under contract with DWR. This data set is available on the SGMA Data Viewer (https://sgma.water.ca.gov/webgis/?appid=SGMADataViewer#landsub). Data collected from June 2015 to June 2018 in the Modesto Subbasin is illustrated on **Figure 3-59**. As shown on this figure, vertical displacement data covers the full extent of the Modesto Subbasin. Land subsidence will be monitored in the Subbasin by updating and evaluating this InSAR data on an annual basis. This evaluation will be included in the GSP annual reports.

7.1.6. Depletions of Interconnected Surface Water

The monitoring network for depletions of interconnected surface water, summarized in **Table 7-2** and presented on **Figure 7-5**, includes 20 wells along the San Joaquin River, Stanislaus River and Tuolumne River. The wells are screened in the Western Upper Principal Aquifer and the Eastern Principal Aquifer and include CASGEM wells and Proposition 68 monitoring wells.

Groundwater data will be supplemented with surface water data monitored by others. Data include releases and diversions on the Tuolumne and Stanislaus rivers (**Tables 3** and **4** in **Appendix C**), coupled with stream gauge data monitored by USGS (**Table 7** in **Appendix C**). These data have been used in model calibration to analyze streamflow depletions in this GSP as documented in **Appendix C** (see **Sections 2.1.2 and 3.4** in **Appendix C**).

The wells in this monitoring network were chosen because they are relatively close to the rivers and will be accessible for water level measurement in the future. The wells have known locations with depth-discrete screen intervals and will enable monitoring of the unconfined water level surface adjacent to the river boundaries.

The following summarizes the monitoring network wells along each of the rivers.

7.1.6.1. San Joaquin River

Two CASGEM wells are part of the monitoring network along the San Joaquin River. These wells are approximately 0.75 and 2.0 miles from the San Joaquin River and are the closest wells to the river screened in the Western Upper Principal Aquifer that are accessible for future monitoring. These wells have known construction, with discrete screened intervals from 13 to 148 ft bgs (**Table 7-2**). Each of these wells has historical water level data (hydrographs in **Appendix F**).

As shown on **Figure 7-5**, these two wells are along the Subbasin's central reach of the San Joaquin River and there is a gap in well coverage along the upstream and downstream reaches. This is consistent with the data gap in groundwater conditions along the river boundaries that was identified and described in **Section 3.2.9**.

As described in **Section 6.8.2**, the MT for the San Joaquin River is defined as the low groundwater elevation observed in Fall 2015. The MO is the midpoint between the historical high groundwater elevation and the MT (**Table 7-2**). As noted on **Table 7-2**, the MT and MO are close together (about 6 feet or less), providing relatively small amounts of operational flexibility; however, historical groundwater elevations have been relatively stable in this part of the Subbasin. The MTs and MOs at each of these wells is based on measured data, as shown on the hydrographs in **Appendix F**.

Static groundwater elevations will be measured twice a year, in spring and fall, to represent seasonal high and low groundwater conditions. The wells along the San Joaquin River will be monitored by one of the STRGBA GSA member agencies.

7.1.6.2. Stanislaus River

Eight wells are part of the monitoring network along the Stanislaus River. As shown on **Figure 7-5**, these include CASGEM wells and one Proposition 68 monitoring well. These wells were chosen for the monitoring network because they are close to the Stanislaus River (one mile or less from the river) and will be accessible for future water level monitoring.

The wells in this monitoring network are in the Eastern Principal Aquifer. The screen intervals of these wells range from ground surface to 550 ft bgs. The wells are along the central reach of the Stanislaus River, with gaps in well coverage along the upstream and downstream reaches. Data gaps in the monitoring network are being addressed with a data gap analysis incorporated into the GSP Implementation Plan to improve future GSP monitoring (see **Section 9.5.1**).

As described in **Section 6.8.2**, the MT for the Stanislaus River is defined as the low groundwater elevation observed in Fall 2015. The MTs at the CASGEM wells are observed water levels in Fall 2015. The Proposition 68 monitoring well (MW-4S) was constructed in 2021 and its MT is estimated from the October 2015 groundwater elevation contour map (see **Figure 3-27**).

Static groundwater elevations will be measured twice a year, in spring and fall, to represent seasonal high and low groundwater conditions. The wells will be monitored by one of the STRGBA GSA member agencies.

7.1.6.3. Tuolumne River

As shown on **Figure 7-5**, the monitoring network along the Tuolumne River includes 10 wells: 6 CASGEM wells and 4 Proposition 68 monitoring wells. These wells were chosen for the monitoring network because they are close to the Tuolumne River and will be accessible for future monitoring. Well data are summarized in **Table 7-2**.

Most of the wells in this monitoring network are within 1.0 mile of the Tuolumne River, with some between 1.0 and 1.5 miles from the river. Three of the wells (Paradise 235, Philbrick 201 and MW-2S) are within the Corcoran Clay extent and screened within the Western Upper Principal Aquifer. Screens in these three wells range from a depth of 58 ft bgs to 132 ft bgs. The remaining wells are in the Eastern Principal Aquifer, with screens ranging from 113 ft bgs to 360 ft bgs. Although MW-3S appears on **Figure 7-5** to be on the edge of the Corcoran Clay as mapped by the USGS (Burow et al., 2004), Corcoran Clay was not encountered during well drilling.

As shown on **Figure 7-5**, these wells are spaced apart along the full extent of the Tuolumne River. There is less well coverage, however, along the upstream reach of the river. The recently constructed MW-9 helps to fill a previous gap in the upstream reach. As stated previously, groundwater conditions along the river boundaries were identified as a data gap in **Section 3.2.9**.

As described in **Section 6.8.2**, the MT for the Tuolumne River is defined as the low groundwater elevation observed in Fall 2015. The MTs at the CASGEM wells are based on measured data in Fall 2015. The MTs at the Proposition 68 monitoring wells are based on either the Fall 2015 contour map (see **Figure 3-27**) or nearby wells with historical water level data. Due to a lack of data in the eastern Subbasin, the MT at MW-9 is based on the limited measured water levels at the well since it was constructed in March 2021. Hydrographs with MTs and MOs are in **Appendix F**.

Static groundwater elevations will be measured twice a year, in spring and fall, to represent seasonal high and low groundwater conditions. The wells will be monitored by one of the STRGBA GSA member agencies.

7.2. PROTOCOLS FOR DATA COLLECTION AND MONITORING

As required by the GSP regulations, protocols are provided for groundwater elevation monitoring in the representative monitoring wells in the monitoring network. Applicable portions of DWR's best management practices (BMP) for monitoring protocols have been considered and incorporated. As required by the regulations, monitoring protocols will be reviewed at least every five years as part of the periodic evaluation of the GSP, and modified as necessary.

Protocols are focused on groundwater elevation monitoring standards because that is the only monitoring method applicable to the monitoring network for the Modesto Subbasin (see justification and rationale for the use of groundwater elevations for applicable sustainability indicators described in **Chapter 6**). As discussed in **Section 7.1.4.**, water quality monitoring will be conducted by others, and therefore water quality sampling protocols are not included in this section.

This section describes general procedures for documenting wells in the monitoring program and for collecting consistent high quality groundwater elevation data. In general, the methods for establishing location coordinates (and reference point elevations) follow the data and reporting standards described in the GSP Regulations (§352.4) and the guidelines presented by USGS Groundwater Technical Procedures. These procedures are summarized below.

7.2.1. Field Methods for Monitoring Well Surveying

As described previously, further improvements to the monitoring network will be made in the future. When new monitoring wells are constructed, the following survey procedures will be followed:

- Location coordinates will be surveyed with a survey grade Global Positioning System (GPS). The coordinates will be in Latitude/Longitude decimal degrees and reference the NAD83 datum.
- Reference point elevations will be surveyed with a survey grade GPS with elevation accuracy of approximately 0.5 feet. During surveying, the elevations of the reference point and ground surface near the well will be measured to the nearest 0.5 foot. All elevation measurements will reference NAVD88 vertical datum.

7.2.2. Additional Well Standards

Additional standards and information applicable to new and existing wells are also incorporated into the monitoring network as required by the GSP regulations. This information is summarized on **Tables 7-1** and **7-2** and includes the following:

- CASGEM Well ID (as applicable),
- Well location, ground surface elevation and reference point elevation,
- Description of the well use and status (i.e., active irrigation well or monitoring well),
- Well depth and screen interval depth, and
- Principal Aquifer that is being monitored.

Additional information will be provided on the DWR templates for wells and water levels. For example, well completion report number, well construction diagram and geophysical log will be provided, if available. Additional well details such as boring total depth and well casing diameter, if available, will also be provided on the DWR templates.

There are three representative wells in the monitoring network for which the screen interval information is unknown: CASGEM wells Gates Road 101, Machado 23 and Warnock 46 (see

Tables 7-1 and **7-2**). But, based on the total depths of these wells, they are completed in the Western Upper Principal Aquifer.

7.2.3. Field Methods for Groundwater Elevation Monitoring

Field methods for collecting depth to water measurements at representative monitoring wells in the Modesto Subbasin GSP monitoring network are described below:

- Active production wells will be turned off prior to collecting a depth to water measurement.
- The standard period of time that a well needs to be off before a static measurement is taken is 48 hours; field personnel will attempt to verify the time that the pump last ran and record that time in the field notes.
- To verify that the wells are ready for measurement, STRGBA GSA will coordinate with well operators and/or owners as necessary.
- Coordination with well operators/owners should occur approximately four days prior to the expected measurement date.
- Each well has a unique manner to access the well bore (e.g., inspection port, sounding tube, hole drilled into the side of the casing).
- Depth to groundwater will be measured relative to the established reference point elevation, which will be marked with a marker or notch in the top of the well casing. In the absence of a mark or notch, the groundwater elevation will be measured from the north side of the well casing and then marked for future measurements.
- If a pressure release is observed when the well cap or sounding port plug is removed, the water level will be allowed to stabilize for a short period of time before the depth to groundwater measurement is taken.
- Depth to groundwater measurements are collected by either electric sounding tape (Solinst or Powers type sounders) or by steel tape methods. The depth to water measurement methods described in DWR's Groundwater Elevation Monitoring Guidelines, will apply to the Modesto Subbasin monitoring network for wells monitored with electric sounding tape or a steel tape (DWR, 2010).
- Depth to groundwater will be measured and reported in feet to the nearest 0.01 foot relative to the reference point.
- The measurement will be recorded on a field sheet with the date and time the measurement was made. Any factor that may influence the depth to water measurement will be noted, such as well condition or local flooding.
- The well cap or sounding port cap will be placed back on the well, and the well will be secured and locked.

7.2.4. Frequency and Timing of Groundwater Elevation Monitoring

- Semi-annual monitoring is determined to be appropriate to capture the seasonal high and low groundwater elevations associated with the irrigation pumping cycle.

- Groundwater elevations will be measured in monitoring network wells within as short a time as possible, preferably within a 1 to 2 week period (DWR, 2016c), in order to:
    - provide a snapshot of elevations in time to support mapping and management;
    - capture the seasonal high and low elevations in the Subbasin; and
    - meet reporting requirements for semi-annual monitoring data as required by DWR.
- Based on historical data and current land uses in the Modesto Subbasin, the following measurement time intervals are established:
    - Seasonal high: February 1 through April 15 for reporting to DWR by July 1.
    - Seasonal low: September 1 through November 30 for reporting to DWR by January 1. Although October and November are technically part of the subsequent water year, they are included in the fall monitoring event to ensure that the seasonal low water level can be measured. Depending on the hydrology, agricultural fields may be irrigated through October in the Modesto Subbasin.
- Water level measurements may be adjusted within the time intervals based on hydrologic and land use conditions at that time. The timing for the monitoring events will be coordinated among the GSAs.

7.3. ASSESSMENT AND IMPROVEMENT OF MONITORING NETWORK

The Modesto Subbasin took a big step towards improving the monitoring network by constructing 17 monitoring wells at 11 locations throughout the Subbasin in 2021 with Proposition 68 grant funding. However, as described in **Section 3.2.9**, data gaps still exist in the Western Lower Principal Aquifer, Eastern Principal Aquifer and along the river boundaries. These data gaps are consistent with the gaps in well coverage in the monitoring networks, described in **Section 7.1**. The following specific data gaps have been identified for the GSP monitoring network, organized by each sustainability indicator:

- Chronic Lowering of Groundwater Levels: Insufficient number and location of accessible and representative wells screened in the Western Lower Principal Aquifer and in the eastern region of the Eastern Principal Aquifer.
- Reduction of Groundwater in Storage: Insufficient number and location of accessible and representative wells screened in the Western Lower Principal Aquifer and in the eastern region of the Eastern Principal Aquifer.
- Seawater Intrusion: Not applicable.
- Degraded Water Quality: No data gaps. GSAs will rely on a robust water quality monitoring network that combines numerous ongoing monitoring programs conducted by others (see **Section 7.1.4** and **Figure 7-4**).
- Land Subsidence: Insufficient number and location of accessible and representative wells screened in the Western Lower Principal Aquifer.

- Depletions of Interconnected Surface Water: Insufficient number and location of appropriately constructed, accessible, and representative wells along various segments of all three river boundaries to measure the water table in the Western Upper Principal Aquifer and Eastern Principal Aquifer.

The GSAs have committed to a data gap analysis to make ongoing improvements to the current GSP monitoring network (see **Section 9.5.1**). Additional improvements to the monitoring network are envisioned in the first five years of GSP implementation as described in **Section 9.5.1**. In addition, the monitoring network will be reviewed and evaluated in each five-year assessment in compliance with GSP regulations (§354.38, see **Section 9.4.4**).

7.4. DATA MANAGEMENT SYSTEM

Groundwater elevation data measured in the representative monitoring wells and the additional SGMA wells will be recorded in the data management system (DMS) developed for the GSP. The data collected for the GSP from the GSA member agencies, and other sources, currently resides in relational databases, which consist of an Access database, GIS geodatabase, and Excel workbooks. Future upgrades to this DMS are being considered by the GSAs. The DMS will be updated with the monitoring data annually and provided in the GSP annual reports. Monitoring data will also be submitted to DWR on the Monitoring Network Module of the online SGMA portal.

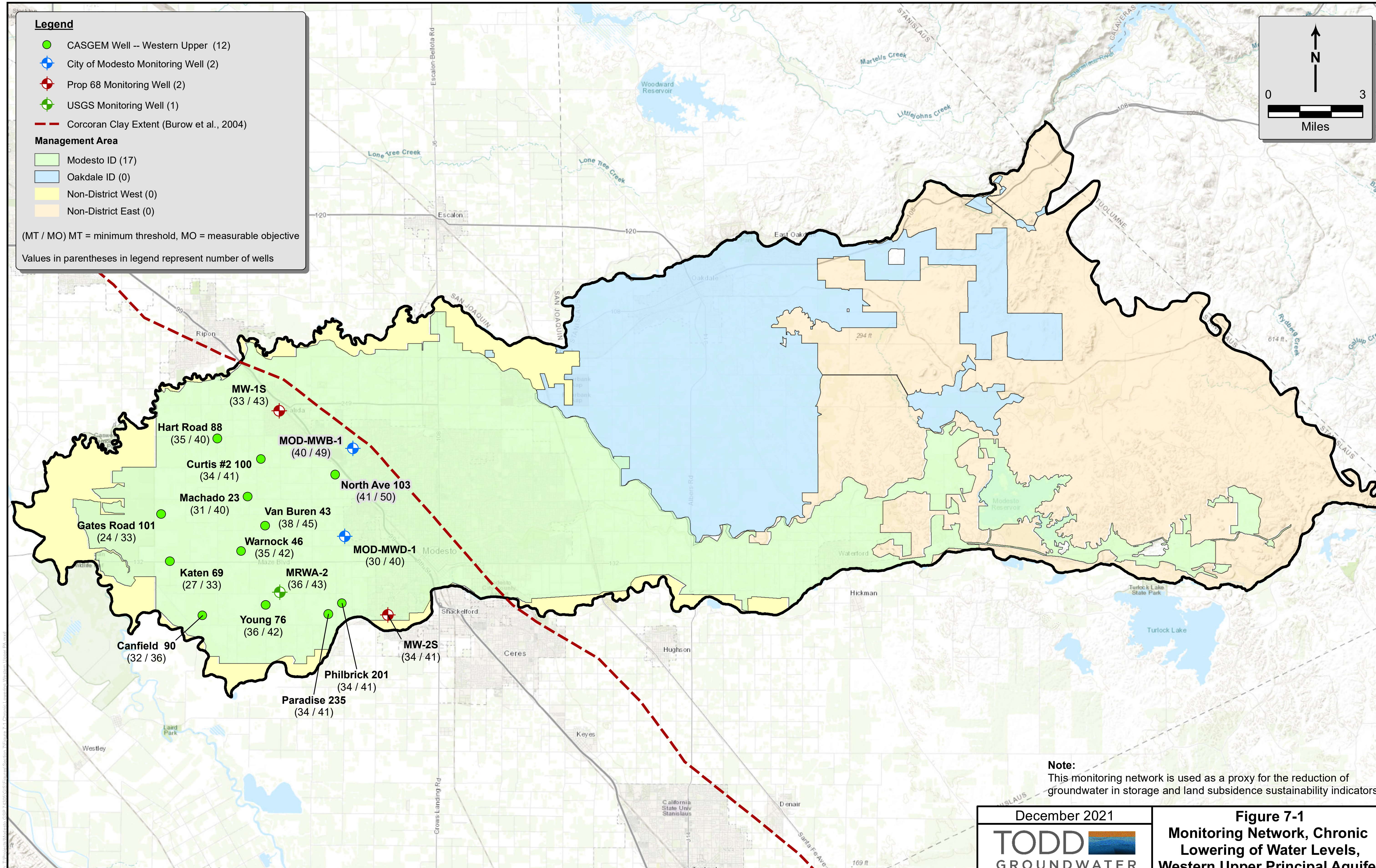
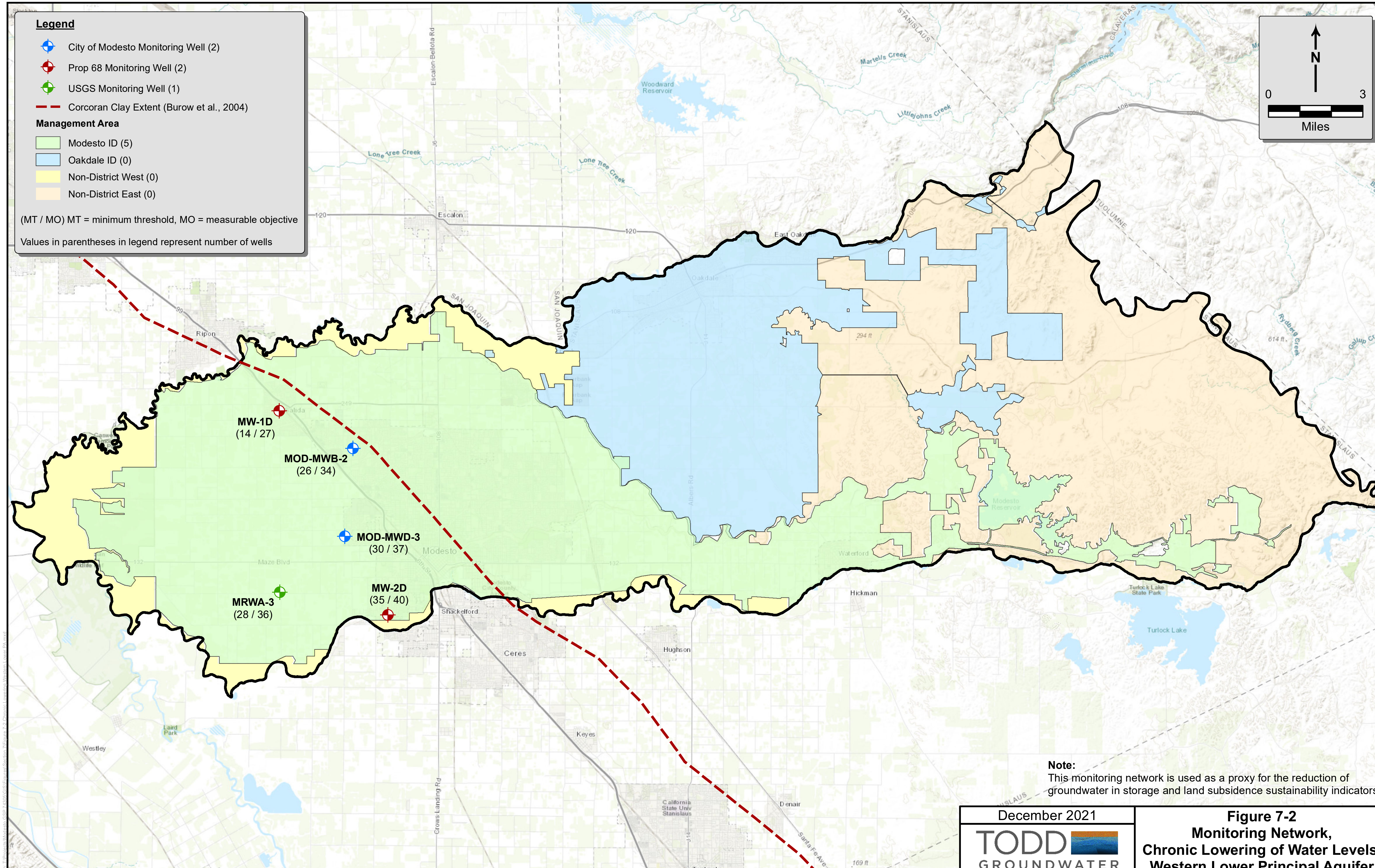


Figure 7-1
Monitoring Network, Chronic Lowering of Water Levels, Western Upper Principal Aquifer



Note:
This monitoring network is used as a proxy for the reduction of groundwater in storage and land subsidence sustainability indicators.

December 2021

TODD GROUNDWATER

Figure 7-2
Monitoring Network,
Chronic Lowering of Water Levels,
Western Lower Principal Aquifer

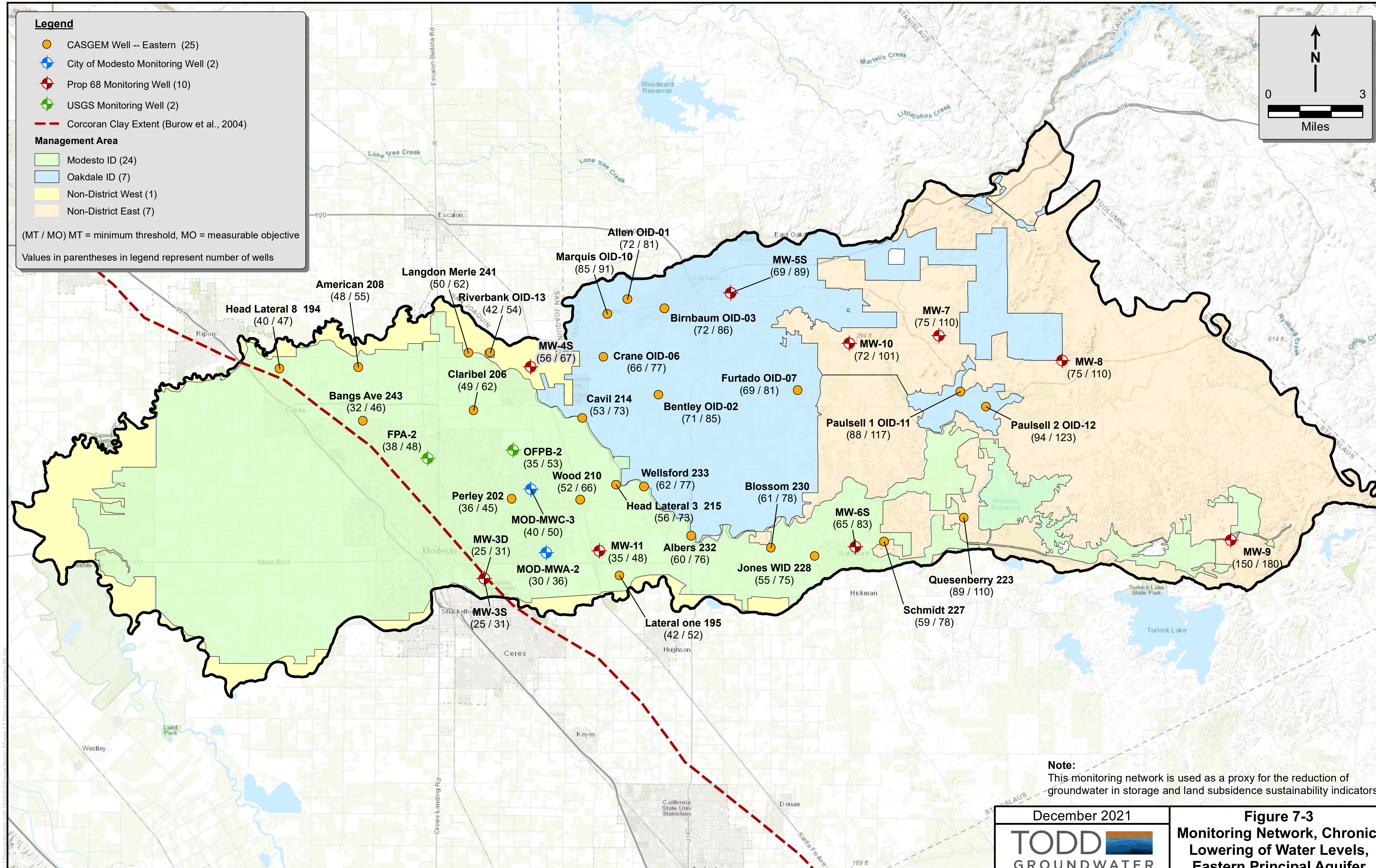
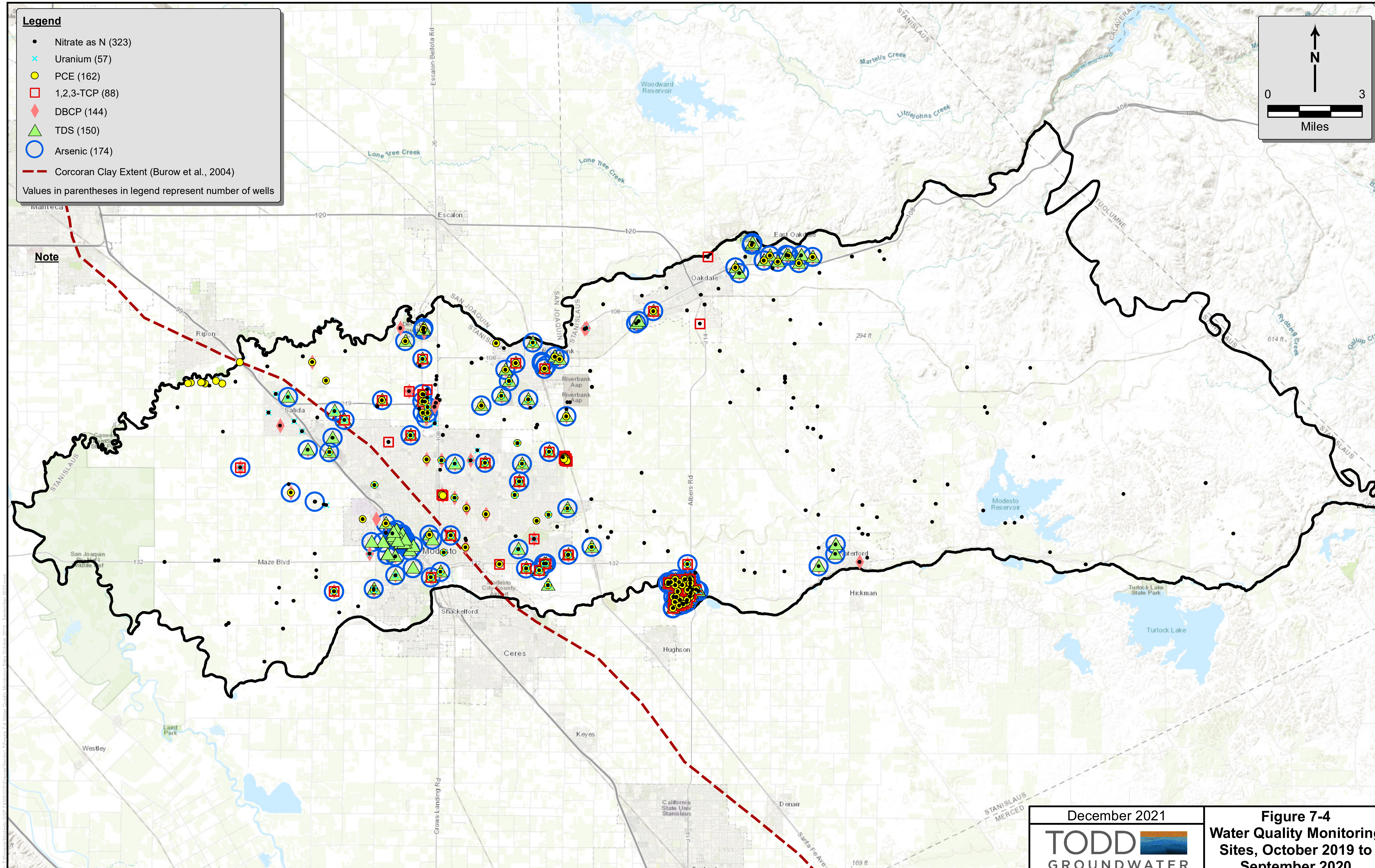


Figure 7-3
Monitoring Network, Chronic Lowering of Water Levels, Eastern Principal Aquifer



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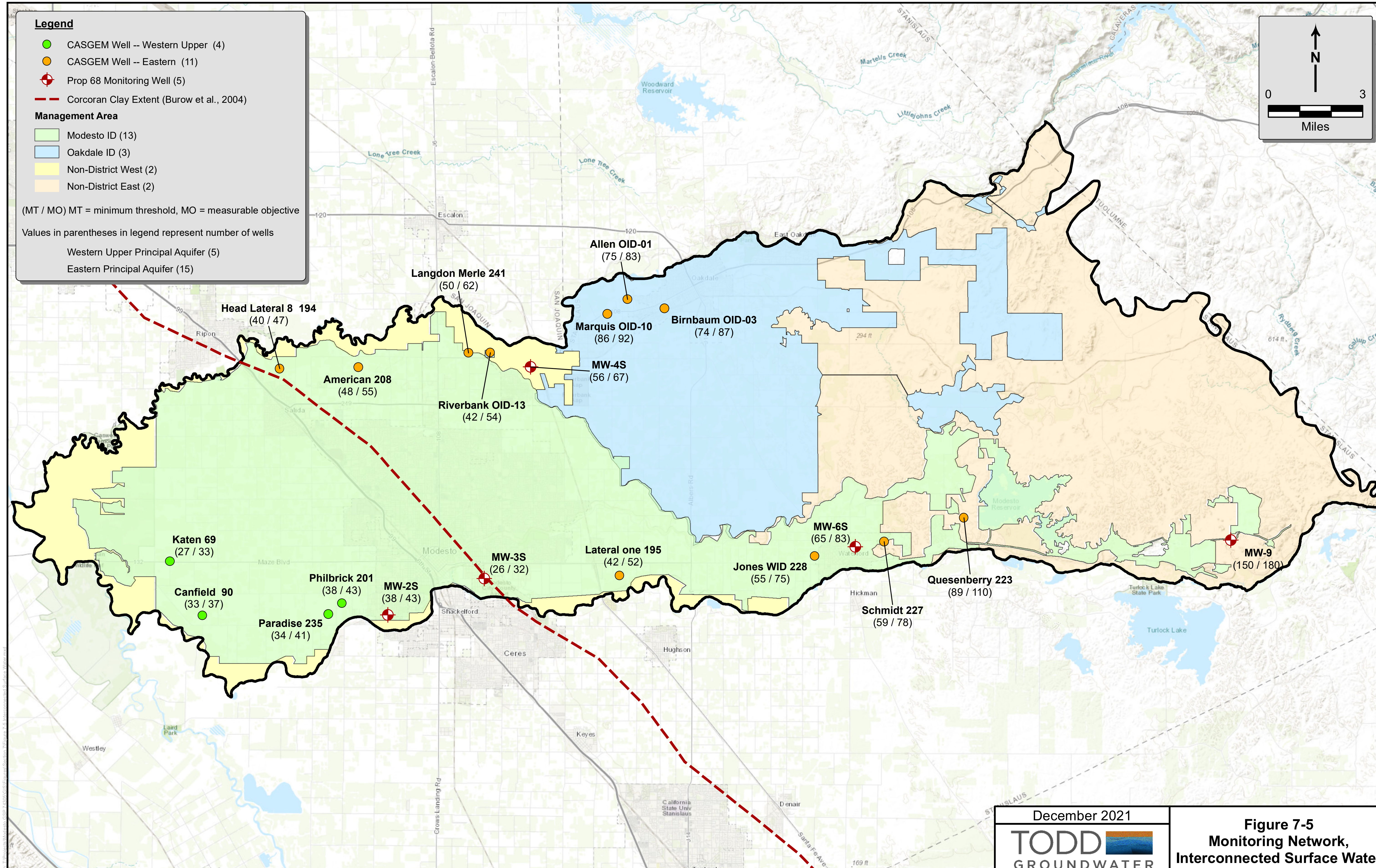
TODD GROUNDWATER

Figure 7-4
Water Quality Monitoring Sites, October 2019 to September 2020



December 2021

TODD GROUNDWATER

Figure 7-5
Monitoring Network, Interconnected Surface Water

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8. PROJECTS AND MANAGEMENT ACTIONS

To achieve the sustainability goals for the Modesto Subbasin by 2042, and to avoid undesirable results over the remainder of a 50-year planning horizon, as required by SGMA regulations, multiple Projects and Management Actions (PMAs) have been identified and considered by the Modesto Subbasin Groundwater Sustainability Agencies (GSAs) in this Groundwater Sustainability Plan (GSP).

A description of PMAs that will contribute to the achievement of sustainability goals in the Modesto Subbasin is provided herein. PMAs are described in accordance with §354.42 and §354.44 of the SGMA regulations. An evaluation of the benefits and/or impacts of various planned projects on groundwater levels and storage volumes is also provided.

"Projects" generally refer to physically constructed (structural) features whereas "Management Actions" generally refer to non-structural programs or policies designed to incentivize reductions in groundwater pumping or optimize management of the Subbasin. The PMAs discussed in this chapter are intended to help the GSAs progress toward meeting the sustainability goals and Measurable Objectives (MOs), as well as avoid Minimum Thresholds (MTs) and undesirable results identified for the Subbasin in **Chapter 6: Sustainable Management Criteria** (SMCs). The subsequent **Chapter 9: Plan Implementation** describes the plan for implementing the PMAs detailed in this chapter.

Recognizing the data gaps identified in the GSP and uncertainties in the basin setting (per §354.44(d)), PMA development and implementation in the Modesto Subbasin applies an adaptive management approach informed by continued monitoring of groundwater conditions. The adaptive approach includes two categories:

1 **<u>PMAs developed for implementation at this time</u>** that would help to achieve and maintain groundwater sustainability while supporting other local goals. These PMAs include:
   - PMAs that are in place and will continue to be implemented by specific participating agencies, that will support groundwater management and GSP implementation.
   - PMAs that are currently planned and will be implemented by specific participating agencies, that will contribute to attainment of the Subbasin sustainability goal and will support GSP implementation

2 **<u>Other PMAs to be implemented as needed</u>** to gather and evaluate monitoring and investigation data as well as achieve and maintain long-term sustainable groundwater management across the Modesto Subbasin. These potential PMAs will be managed adaptively via further evaluation and initiation during GSP implementation if the GSAs finds that established Interim Milestones (IMs) or MOs cannot be achieved and/or if MTs are being approached.

A range of PMAs is presented to allow the GSAs flexibility in their response to changing groundwater conditions. However, it is anticipated that not all PMAs will need to be implemented, or that some PMAs will be implemented by one GSA but not the other. Adaptive implementation of PMAs will be informed by ongoing monitoring of groundwater conditions using the monitoring network and methods described in the GSP. Any adverse groundwater conditions or challenges in maintaining groundwater sustainability will be addressed by scaling and implementing PMAs in a targeted and proportional manner, consistent with conditions observed in the Subbasin.

PMAs will be periodically assessed during the GSP implementation period. As planning is at very early stages of development, complete information on construction requirements, operations, costs, permitting requirements, and other details are not uniformly available for all the PMAs. Potential timing and funding of PMAs are described under each PMA where known. Other implementation and funding efforts will be determined and reported if/when the PMA is evaluated and selected for implementation. This information will be reported in annual reports and five-year updates to the GSP when known. For more detailed information, refer to **Chapter 9: Plan Implementation**.

8.1. PROJECTS OVERVIEW

This section describes the Projects that are in place, planned, or may be considered for implementation in the Modesto Subbasin. In accordance with 23 CCR §354.44, Projects were developed to help achieve and maintain the Subbasin sustainability goal by 2042 and avoid undesirable results over the GSP planning and implementation horizon. Broadly, Projects provide tools that can be used to achieve and maintain groundwater sustainability.

Projects were developed, where possible, to be aligned with State grant program preferences and the Governor's Water Action Plan, by providing multiple benefits, embracing innovation and new technologies, and benefitting disadvantaged communities (DACs) and environmental water users. This Plan prioritizes Projects that contain multi-benefit approaches that address multiple needs and stress the utilization of natural infrastructure, including the Subbasin itself for storage and the natural waterways and floodplains as recharge areas. An emphasis is also placed on Projects that are located in targeted areas to achieve maximum recharge results and address water level decline. Additionally, the Plan stresses coordination among users, STRBGA GSA member agencies, and neighboring basins to improve the region's groundwater condition and achieve sustainability.

Projects were identified in the Modesto Subbasin through a several-month process involving the STRGBA GSA Technical Advisory Committee. Project information was provided by the STRGBA GSA and compiled into a draft list. The initial set of projects was reviewed further, and a final list of 13 possible projects was identified for inclusion in the GSP, representing a variety of project types including direct and in-lieu recharge, water recycling, and advancements to metering infrastructure. Projects are classified into three groups based on project status: Group 1, Group 2, and Group 3, as defined below.

- Group 1 – Projects that are in place and will continue to be implemented by specific participating agencies within the Modesto Subbasin to support groundwater management and GSP implementation.
- Group 2 – Projects that are, generally, readily implementable but may still be in the planning stages of development and may be pursued by specific participating agencies within the Modesto Subbasin which will contribute to attainment of Sustainable Management Criteria (SMC) and will support GSP implementation.
- Group 3 – Projects which have been identified for consideration in the Modesto Subbasin in the future subject to feasibility. These projects would provide benefits in contributing to the attainment of the sustainability goal and Sustainable Management Criteria (SMCs) and would otherwise support GSP implementation.

Group 1 and Group 2 Projects are summarized in **Section 8.2: Projects Developed for Implementation**. These Projects were analyzed as part of scenarios using the C2VSimTM model to estimate their benefit to the groundwater system over the projected planning period. The results of the model scenarios are discussed in **Section 8.5**: Plan for Achieving Sustainability.

Group 3 Projects are summarized in **Section 8.3**: **Conceptual Projects to be Implemented as Needed**. Group 3 Projects are currently not evaluated in detail, and are described at a more general level, reflecting their conceptual nature and planning status at this time. Additional feasibility studies and details for these Projects will be developed in the future, as needed.

The proposed Projects identified in this chapter will be either directly funded and implemented by the Project Proponent or will be subject to grant funding requests through state and federal funding opportunities. Project proponents are listed in Table 8-1.

Each individual Project proponent will manage the permitting and other specific implementation oversight for its own Projects. Inclusion of Projects in this GSP does not forego any obligations regarding individual Project implementation under local, state, or federal regulatory programs. While the GSAs do not have an obligation to oversee progress towards groundwater sustainability, they are not the primary regulator of land use, water quality, or environmental Project compliance. It is the responsibility of the implementing agencies of planned Projects to ensure that they are collaborating with outside trustee and responsible regulatory agencies to ensure their Projects are in compliance with all applicable laws and permitting requirements.

The GSAs will collaborate with Project proponents and partners to track progress and support Project implementation. The implementation of PMAs will be enhanced by the development of clear policy and guidance by the GSAs that lays out applicable sustainable management criteria (as described in **Chapter 6: Sustainable Management Criteria**) as well as PMA-specific monitoring and reporting frameworks to facilitate adaptive management toward Subbasin protection and sustainability. The GSP implementation will include guidelines and protocols to coordinate implementation of Projects in such a way that the Subbasin sustainability is achieved in a coordinated environment in the GSAs, with the Project proponents and sponsors, and other stakeholders.

Table 8-1 shows the Projects with their respective groups. This represents an initial list of Projects that will be further refined as additional Projects are identified during GSP implementation, with updates included in Annual Reports and the GSP updates, as appropriate. A description of each Project in more detail is provided in **Sections 8.2** [Projects Developed for Near-Term Implementation (Groups 1 and 2)] and **Section 8.3** [Other Projects to be Implemented as Needed].

Table 8-1: List of Projects

Number	Proponent(s)	Project Name	Primary Mechanism(s)[1]	Partner(s)	Group	Included in Modeling Scenario
Urban Projects						
1	City of Modesto	Growth Realization of Surface Water Treatment Plant Phase II	In-lieu Groundwater Recharge	N/A	1	Baseline
2	City of Modesto	Advanced Metering Infrastructure Project (AMI)	Conservation	N/A	1	×
3	City of Modesto	Storm Drain Cross Connection Removal Project	Stormwater Capture	N/A	2	×
4	City of Waterford	Project 3: Waterford/Hickman Surface Water Pump Station and Storage Tank	In-lieu Groundwater Recharge	City of Modesto, MID	2	×
In-Lieu & Direct Recharge Projects						
5	Non-District East Areas	Modesto Irrigation District In-lieu and Direct Recharge Project	Direct or In-lieu Groundwater Recharge	Modesto ID	2	×
6	NDE Areas	Oakdale Irrigation District In-lieu and Direct Recharge Project	Direct or In-lieu Groundwater Recharge	OID	2	×
Flood Mitigation Projects						
7	NDE Areas	Tuolumne River Flood Mitigation and Direct Recharge Project	Direct Groundwater Recharge	Modesto ID	2	×
8	NDE Areas	Dry Creek Flood Mitigation and Direct Recharge Project	Direct Groundwater Recharge	Stanislaus County	2	×
Potential Future Projects						
9	NDE Areas	Stanislaus River Flood Mitigation and Direct Recharge Project	Direct Groundwater Recharge	Stanislaus County	3	
10	City of Modesto	Detention Basin Standards Specifications Update	Groundwater Recharge	N/A	3	

Number	Proponent(s)	Project Name	Primary Mechanism(s)[1]	Partner(s)	Group	Included in Modeling Scenario
11	NDE Areas	Recharge Ponds	Groundwater Recharge	N/A	3	
12	City of Oakdale	OID Irrigation and Recharge to Benefit City of Oakdale	Direct or In-lieu Groundwater Recharge	N/A	3	
13	MID	MID FloodMAR Projects	Direct Groundwater Recharge	N/A	3	

These Projects are considered as potential projects to support the GSP implementation. They are currently considered as alternative options and are not directly analyzed in this Chapter.

8.2. Projects Developed for Near-Term Implementation (Groups 1 and 2)

This section describes the Projects that were developed for near-term implementation in the Modesto Subbasin, organized by proponent. This includes all Group 1 and 2 Projects identified in **Table 8-1**. These Projects are either:

- Currently in place and will continue to be implemented by specific participating agencies, or are
- Currently planned and will be implemented or started by specific participating agencies in the next five years.

The Projects developed for near-term implementation were modeled in the C2VSimTM to estimate their potential benefit to the groundwater system over the projected future water budget period. Applicable assumptions used to model each Project are described in each Project description. The results of these model scenarios are discussed in **Section 8.5**: **Plan for Achieving Sustainability**.

As described above, the Group 1 and Group 2 PMAs described in this section are either currently in place or are planned to be initiated within 5 years. Those PMAs that are currently in place will continue to be implemented over the 2042 Plan horizon.

Table 8-2 lists all Group 1 and Group 2 PMAs described in the subsections that follow. Each Project description is organized to address the applicable regulatory requirements:

- **Project Description**: 23 CCR §354.44(b)
- **Public Noticing:** 23 CCR §354.44(b)(1)(B)
- **Permitting and Regulatory Process:** 23 CCR §354.44(b)(3)
- **Expected Benefits:** 23 CCR §354.44(b)(4), §354.44(b)(5)
- **Implementation Criteria, Status, and Plan:** 23 CCR §354.44(b)(1)(A); §354.44(b)(4); §354.44(b)(6)
- **Water Source and Reliability:** 23 CCR §354.44(b)(6)
- **Legal Authority:** 23 CCR §354.44(b)(7)
- **Estimated Costs and Funding Plan:** 23 CCR §354.44(b)(8)
- **Management of Groundwater Extractions and Recharge:** 23 CCR §354.44(b)(9)

Summary of Criteria for Project Implementation (23 CCR §354.44(b)(1)(A))

As described above, the Group 1 and Group 2 PMAs described in this section are either currently in place or are planned to be initiated within 5 years. Those PMAs that are currently in place will continue to be implemented over the 2042 Plan horizon.

Table 8-2: List of Projects Developed for Implementation in the Modesto Subbasin

Location (Proponent)	Project Name	Primary Mechanism(s)[1]
City of Modesto	Project 2: Advanced Metering Infrastructure Project (AMI)	Water Conservation
	Project 3: Storm Drain Cross Connection Removal Project	Stormwater Capture
City of Waterford	Project 4: Waterford/Hickman Surface Water Pump Station and Storage Tank	Water Conservation
NDE Areas	Project 5: Modesto Irrigation District In-lieu and Direct Recharge Project	In-lieu and Direct Recharge Project
	Project 6: Oakdale Irrigation District In-lieu and Direct Recharge Project	In-lieu and Direct Recharge Project
	Project 7: Tuolumne River Flood Mitigation and Direct Recharge Project	Flood control and Direct Recharge Project
	Project 8: Dry Creek Flood Mitigation and Direct Recharge Project	Flood control and Direct Recharge Project

[1]The primary mechanism of the Project as conceptualized, although during implementation Projects may be used for multiple functions to support groundwater sustainability and multiple other benefits.

8.2.1. Urban and Municipal Projects

PMAs developed for implementation by urban and municipal proponents in the Modesto Subbasin are summarized in the sections below.

8.2.1.1. Growth Realization of Surface Water Treatment Plant Phase II (Project 1)

8.2.1.1.1. Project Description

This project continues the water purchase agreement between Modesto Irrigation District (MID) and the City of Modesto to meet urban demands. It utilizes the expansion from Phase II of the Modesto Regional Water Treatment Plant (MRWTP).

The Modesto Irrigation District operates the MRWTP to treat surface water for use within the City and has been expanding its capacity to meet growing and future water demands from its customers. The Initial Phase (first phase) of the MRWTP Project included the construction of a 30 million-gallon per day (mgd) surface water treatment plant, two 5-million-gallon (MG) terminal storage tanks and associated pumping facility. The pump station delivered water into the MID transmission system for distribution into either the Del Este or City water distribution systems through several MID turnouts. The City now owns the Del Este water system. Figure 1-1 shows the existing transmission mains and turnouts constructed as part of the Phase One MRWTP Project

The Expansion Phase of the MRWTP Project (second phase) included the construction of a new parallel treatment process consisting of low-pressure membranes, ozone disinfection system, a dissolved air flotation thickener and a new Supervisory Control and Data Acquisition (SCADA) system. The total capacity available at the MRWTP with the completion of the MRWTP Phase Two Expansion Project is 60 MGD with a maximum annual supply of up to 67,200 AFY.

The City of Modesto currently operates its treatment and conveyance systems at capacity and has not been able to utilize any additional surface water supply. However, recently the City has taken several proactive steps to increase its infrastructural optimization, particularly its water utilization and storage. Some of these steps include: (1) the submittal of a conceptual grant application to modify up to four recharge basins to dilute aquifer contaminants, increase aquifer storage, and improve water quality, and (2) hiring an outside consultant to study system optimization and (3) investigate the feasibility of integrating additional surface water supply for recharge in wet years.

8.2.1.1.2. Public Noticing

The public and other agencies will be notified of the planned or ongoing implementation of PMA activities through the outreach and communication channels identified in the GSP and during updates presented at regularly scheduled STRGBA GSA meetings. Noticing will occur as potential activities are being considered for implementation, and as ongoing and planned activities are implemented. Noticing will inform the public and other agencies that the proponent is considering or will be implementing the PMA and will provide a description of the actions that will be taken.

Public and/or inter-agency noticing may be facilitated through the STRGBA GSA's board meetings and/or City and Agency meetings, associated website(s), inter-basin coordination meetings, other public meetings hosted by the GSAs, GSP annual reports and five-year updates, public scoping meetings, and/or environmental/regulatory permitting notification processes.

8.2.1.1.3. Permitting and Regulatory Process

This Project includes the continued transfer of water purchased between MID and the City of Modesto, and therefore, permitting, and regulatory requirements have already been completed. Future permitting and regulatory processes, if needed to continue Project activities, will be managed through MID and the City of Modesto.

8.2.1.1.4. Expected Benefits

Benefits to Sustainability Indicators

Utilization of purchased water for urban water demands is expected to offset groundwater pumping demands, with in-lieu groundwater recharge benefits to the Subbasin. The sustainability indicators expected to benefit from this Project are groundwater levels, groundwater in storage, interconnected surface water, and possibly land subsidence. All benefits to sustainability indicators in the Modesto

Subbasin will be evaluated through groundwater monitoring at nearby monitoring sites, identified in the GSP.

Benefits to Disadvantaged Communities

Water supplied through this Project directly benefits areas within the City of Modesto's contiguous water service areas within the Modesto Subbasin, most of which is classified as a DAC. By supplementing and diversifying their drinking water supply, this Project will provide an alternate drinking water source and operational flexibility to remove or blend production wells with treated surface water to comply with safe drinking water regulations and meeting Maximum Contaminant Levels (MCLs). The additional surface water supply will also reduce groundwater pumping and increase groundwater levels near the communities which can reduce pumping costs and potentially mitigate some groundwater quality concerns. Additionally, benefits to groundwater conditions in the Modesto Subbasin are also expected to broadly benefit all DACs, SDACs (Severely Disadvantaged Communities), and EDAs (Economically Distressed Areas) in the Modesto Subbasin.

Volumetric Benefits to the Subbasin Groundwater System

The expected yield of the benefits from the Growth Realization of Surface Water Treatment Plan Phase II Project was estimated by simulating this Project in the C2VSimTM model. General information and assumptions used to simulate this Project are summarized in the Implementation section below. Additional information is provided in **Section 8.5**: **Plan for Achieving Sustainability**.

This Project has provided an estimated additional 10 mgd (11,200 AFY) starting in 2016 and continuing at 10 mgd through 2020, and then is anticipated to gradually increase to an additional 30 mgd (33,600 AFY) by 2050.

Evaluation of benefits will be based on analysis of without-Project and with-Project measurements supported by modeling. Measured parameters will include surface water deliveries, groundwater levels, and other parameters to be determined. Modeling will be done with the C2VSimTM model used for GSP development.

8.2.1.1.5. Implementation Criteria, Status, and Strategy

Implementation Strategy and Timeline

This Project is being implemented by the City of Modesto and MID and is expected to provide 10 mgd initially and eventually increase to 30 mgd. This Project includes the expansion of current water transfers between MID and the City of Modesto. Updates to the status and continuation of this agreement and Project will be provided in GSP Annual Reports and Five-Year GSP updates.

Implementation Assumptions for Modeling

Impacts to the Subbasin from the Growth Realization of Surface Water Treatment Plan Phase II Project were already captured in the Projected Conditions Baseline and thus no additional changes were needed to simulate this Project in the PMA scenarios. Baseline conditions include both the expansion of the City of Modesto's footprint and the resulting increase of surface water available for urban use.

8.2.1.1.6. Water Source and Reliability

This Project would use water from MID to supplement water for the City of Modesto for urban demands. This Project has provided an estimated additional 10 mgd (11,200 AFY) starting in 2016 and continuing at 10 mgd through 2020, and then is anticipated to gradually increase to an additional 30 mgd (33,600 AFY) by 2050. These assumptions are included in the model development. The exact volume will be reported in Annual Reports and GSP Five-Year Update Reports when known.

8.2.1.1.7. Legal Authority

The GSAs, Districts, and individual Project proponents have the authority to plan and implement Projects through consultation with applicable governing agencies. MID has the authority to construct and continue to operate its water treatment plant and to continue to transfer water to the City of Modesto.

8.2.1.1.8. Estimated Costs and Funding Plan

The Growth Realization of Surface Water Treatment Plant Phase II Project is a continuation of water transfers from MID to the City of Modesto. Because an agreement and water transfers have already commenced, the estimated costs of this Project are low and include agreement/coordination costs and yearly costs. Infrastructure for this Project has already been constructed and therefore is not needed. Continued capital cost for this Project is $4.1M annually which will increase to $8.3M in FY 2024 when payment towards principal begins. The City of Modesto has been utilizing the Water Fund as a funding sources to cover Project costs as part of Project development and continuation. Other funding sources may be identified in the future including grants (e.g., Prop 1, Prop 68m, NRCS), fees, local cost share, loans, and other assessments.

8.2.1.1.9. Management of Groundwater Extractions and Recharge

Per 23 CCR § 354.44(b)(9), all PMAs developed for implementation are targeted to maintain the balance of groundwater extractions and recharge to help ensure that lowering of groundwater levels or depletion of supply during periods of drought is offset by increases in groundwater levels and storage in other years.

In-lieu recharge benefits of this Project are expected to increase the use and recharge of available surface water supplies during wetter years, helping to offset potential increases in groundwater pumping during drought when surface water supplies are limited.

8.2.1.2. Advanced Metering Infrastructure Project (AMI) (Project 2)

The City of Modesto is in the initial stages of on installing AMI smart meters to support water reduction goals. Smart meters will assist the City of Modesto in notifying residents of leaking pipes and helping to reduce overall domestic water consumption through improved and direct consumer data.

8.2.1.2.1. Project Description

The City of Modesto is planning on upgrading 75,000 meters to AMI smart meters to support water reduction goals. Smart meters will assist the City in providing analytical tools to manage water usage better such as identifying potential leaks sooner and providing customers more usable and user friendly data to manage their water usage.

8.2.1.2.2. Public Noticing

Public and/or inter-agency noticing will be facilitated through GSAs, City Council or District Board meetings, GSAs and/or district website(s), GSAs and/or district newsletters, inter-basin coordination meetings, GSP Annual Reports and Five-Year Assessment Reports, public scoping meetings, and environmental/regulatory permitting notification processes.

8.2.1.2.3. Permitting and Regulatory Process

Required permitting and regulatory review will be Project-specific and initiated through consultation with applicable governing agencies. Governing agencies for which consultation will be initiated may include, but is not limited to: DWR, SWRCB, CDFW, Flood Board, Regional Water Boards, USFWS, NMFS, LAFCO, County of Stanislaus, and CARB.

8.2.1.2.4. Expected Benefits

Benefits to Sustainability Indicators

The sustainability indicators expected to benefit are groundwater levels, groundwater in storage, and depletion of interconnected surface water.

Benefits to Disadvantaged Communities

This Project would apply to and benefit all water customers served by the City of Modesto, most of which are considered a DAC or SDAC.

Volumetric Benefits to the Subbasin Groundwater System

This Project is currently in the early conceptual stage. Thus, the expected yield of this Project has yet to be determined and will be reported in GSP Annual Reports and Five-Year Assessment Reports when known. However, the Project is expected to reduce water use in the City of Modesto to meet future water use mandates and conservation goals.

Evaluation of benefits will be based on analysis of without-Project and with-Project effects on the SGMA sustainability indicators. Each Project is evaluated as part of a scenario and the C2VSimTM is used to assess the benefits and impacts on the subbasin sustainability.

8.2.1.2.5. Implementation Criteria, Status, and Strategy

Implementation Strategy and Timeline

This Project would install AMI smart meters to support water reduction goals, helping the City to obtain the analytical tools to manage water usage better. The planning phase is scheduled for 2022 through 2023 with implementation occurring from 2024 through 2026.

Implementation Assumptions for Modeling

The Advanced Metering Infrastructure Project has been modeled in the C2VSimTM model. Additional information about Project-related modeling is described in **Section 8.5**: **Plan for Achieving Sustainability**.

The following general information and assumptions were used to simulate implementation of the Project:

- Modeled as part of scenario of ongoing conservation efforts within the City of Modesto. Simulated change includes the reduction of urban water demand from 228 gallons per person per day (GPCD) (2015 City of Modesto UWMP) to 175 GPCD (2020 City of Modesto UWMP) (West Yost Associates, 2016 & 2021).

8.2.1.2.6. Water Source and Reliability

This Project would not directly use a water source but would help to manage and enhance use of existing water City of Modesto supplies.

8.2.1.2.7. Legal Authority

The GSAs, Districts, and individual Project proponents have the authority to plan and implement Projects.

8.2.1.2.8. Estimated Costs and Funding Plan

The anticipated costs of this Project are estimated to be $20 million. Any updates or changes to the estimated costs will be reported in GSP Annual Reports and Five-Year Assessment Reports when known. The Project proponent will identify funding sources to cover Project costs as part of Project development. These may include grants, fees, loans, and other assessments.

8.2.1.2.9. Management of Groundwater Extractions and Recharge

This Project would not directly use a water source (e.g., no groundwater extraction or recharge is involved) but would help to manage and enhance use of existing water City of Modesto water supplies.

8.2.1.3. Storm Drain Cross Connection Removal Project (Project 3)

8.2.1.3.1. Project Description

This multi-benefit and multi-component Project captures, treats, and infiltrates stormwater within the City of Modesto. Projects use low impact development (LID) techniques including bio-retention planters, infiltration trenches, and underground retention basins under city parks to recharge the groundwater aquifer. Other benefits include reduced stormwater flows to the City of Modesto's wastewater treatment plant, reduced number of sanitary sewer overflows, reduction of localized flooding in heavily traveled and localized streets, and improved water quality for Dry Creek and Lower Tuolumne River (both of which are 303d water bodies). Each Project component is located within the City of Modesto jurisdiction in areas with no positive storm drainage systems. The Project components are a cost effective and LID alternative to constructing detention basins in undeveloped portions of the city and constructing miles of storm drains. This Project also includes the removal of failed dry wells and storm to sanitary sewer cross connections. The Project components, status, and expected recharge benefits are included in Table 8-3.

Table 8-3: Storm Drain Cross Connection Removal Project Components, Status, and Expected Recharge Benefit

Component	Status	Expected Recharge Benefit
Garrison Park	Completed	12 AFY
Roosevelt Park	Completed	29 AFY
JM Pike Park	Design in Progress	53 AFY
Catherine Everett Park	Planning/Construction (2026 completion)	29 AFY
Other	Planning	125 AFY
Removal of failed dry wells and storm to sanitary sewer cross connection	In Progress	N/A

8.2.1.3.2. Public Noticing

The public and other agencies will be notified of the planned or ongoing implementation of PMA activities through the outreach and communication channels identified in the GSP, during the preparation process of the PEIR (if applicable), and during updates presented at regularly scheduled STRGBA GSA meetings. Noticing will occur as potential activities are being considered for implementation, and as ongoing and planned activities are implemented. Noticing will inform the public and other agencies that the proponent is considering or will be implementing the PMA and will provide a description of the actions that will be taken.

Public and/or inter-agency noticing may be facilitated through the GSA's board meetings and/or City and Agency meetings, associated website(s), inter-basin coordination meetings, other public meetings hosted by the GSAs, GSP annual reports and five-year updates, public scoping meetings, and/or environmental/regulatory permitting notification processes.

8.2.1.3.3. Permitting and Regulatory Process

Required permitting and regulatory review is being initiated as necessary through consultation with applicable governing agencies. Governing agencies that may be consulted for this Project include, but are not limited to: DWR, SWRCB, the California Department of Fish and Wildlife (CDFW), the Central Valley Flood Protection Board (Flood Board), Regional Water Boards, the United States Bureau of Reclamation (Reclamation or USBR), the United States Army Corps of Engineers (USACE), the United States Fish and Wildlife Service (USFWS), the National Marine Fisheries Service (NMFS), Local Agency Formation Commissions (LAFCo), the County of Stanislaus and/or Tuolumne, and the California Air Resources Board (CARB).

8.2.1.3.4. Expected Benefits

Benefits to Sustainability Indicators

Stormwater flows going to sewer will be disconnected and rerouted to provide direct groundwater recharge to the Subbasin. Sustainability indicators expected to benefit from this Project are groundwater levels, groundwater in storage, and interconnected surface water. All benefits to sustainability indicators in the Modesto Subbasin will be evaluated through groundwater monitoring at nearby monitoring sites, identified in the GSP.

Benefits to Disadvantaged Communities

The City of Modesto storm drain cross connection removal Project is expected to provide direct recharge in and around the City of Modesto. Most communities in the Modesto Subbasin are classified as DACs, SDACs, or EDAs (according to 2018 census data, evaluated by place, tract, and block group). Depending on which specific parcels receive surface water deliveries, this Project may directly benefit specific DACs in this area. In addition, maintenance or improvement of groundwater levels will help to protect beneficial groundwater use by rural domestic wells from potential adverse impacts related to chronic groundwater level decline. Benefits to groundwater conditions in the Modesto Subbasin are also expected to broadly benefit all DACs, SDACs, and EDAs.

Volumetric Benefits to the Subbasin Groundwater System

The expected yield of the City of Modesto storm drain cross connection removal Project was estimated by simulating this Project in the C2VSimTM model. General information and assumptions used to simulate this Project are summarized in the Implementation section below. Additional information is provided in **Section 8.5: Plan for Achieving Sustainability**.

On average across all years, the City of Modesto storm drain cross connection removal Project is expected to provide approximately 248 AFY of recharge benefit to the Modesto Subbasin, once completed.

Evaluation of benefits will be based on analysis of without-Project and with-Project measurements supported by modeling. Measured parameters will include surface water deliveries, groundwater levels, and other parameters to be determined. Modeling may be done with the C2VSimTM model used for GSP development.

8.2.1.3.5. Implementation Criteria, Status, and Strategy

Implementation Strategy and Timeline

This Project consists of several different components of a larger program which has relied on the success of previous grant funds. For the components included in this Project, work is already in progress. The JM Pike Park component is expected to be completed in 2023. Overall, the final storm to sewer cross connection removals for the program are estimated to be completed in 2061.

Implementation Assumptions for Modeling

The Storm Drian Cross Connection Removal Project has been modeled in the C2VSimTM model. Additional information about Project-related modeling is described in **Section 8.5**: **Plan for Achieving Sustainability**.

The following general information and assumptions were used to simulate implementation of the Project:

- Volume of water: 41 AFY were provided during the first 10 years of simulation, 70 AFY during the following 5 years of simulation, and 248 AFY for the rest of the simulation, distributed evenly between the months of October and April. The annual average during the 50-year simulation period would be of 189 AFY.
- The total volume would be provided as direct recharge over the aquifer.

8.2.1.3.6. Water Source and Reliability

This Project would use flows that became available from disconnecting storm drain flows going to sewer and redirecting them to recharge groundwater. Stormwater flows are more dependent on precipitation events. It is anticipated that annual contributions from this Project will collect approximately 12 AF from Garrison Park, 29 AF from Roosevelt Park, 53 AF from JM Pike Park, 29 AF from Catherine Everett, and an additional 125 AF from other areas. The precise reliability of available water will be identified as the Project is evaluated during implementation. This information will be reported in GSP annual reports and five-year updates when known.

8.2.1.3.7. Legal Authority

The GSAs, Districts, and individual Project proponents have the authority to plan and implement Projects. Required permitting and regulatory review will be Project-specific and initiated through consultation with applicable governing agencies. Governing agencies for which consultation will be initiated may include, but is not limited to: DWR, SWRCB, CDFW, Flood Board, Regional Water Boards, USFWS, NMFS, LAFCO, Stanislaus County, and CARB.

8.2.1.3.8. Estimated Costs and Funding Plan

Potential costs of this Project include construction or improvements to new or existing recharge basin and alteration of current stormwater and sewer system connections. The current cost estimate for this Project is $40 million for all Project components. It is anticipated that the City of Modesto would identify funding sources to cover Project costs as part of Project development. These may include grants (e.g., Prop 1, Prop 68, NRCS), fees, local cost share, loans and other assessments.

8.2.1.3.9. Management of Groundwater Extractions and Recharge

Per 23 CCR § 354.44(b)(9), all PMAs developed for implementation are expected to maintain the balance of groundwater extractions and recharge to ensure that lowering of groundwater levels or depletion of supply during periods of drought is offset by increases in groundwater levels and storage in other years.

8.2.1.4. Surface Water Pump Station and Storage Tank (Project 4)

8.2.1.4.1. Project Description

The Surface Water Pump Station and Storage Tank (Project) entails connecting the City of Waterford (Waterford) to Modesto Irrigation District's (MID) water treatment plant and potable surface water supply system. The Project includes several components, described in order of the flow of the surface water. Surface water will be diverted from MID's distribution network at a pipeline turn-out located at the corner of Tim Bell and Vineyard Road, northeast of the Waterford. The surface water will be piped into a one-million-gallon storage tank that will be constructed at this intersection. A pump station at this location and transmission line will also be constructed that transports the water to Yosemite Boulevard in Waterford. This project involves water supply agreements between Modesto Irrigation District, the City of Modesto, and the City of Waterford, the details of which are currently being negotiated.

As part of a separate Project, by the end of 2023 Waterford is planning to combine its distribution network and provide water to the disadvantaged community of Hickman, located in the Turlock Subbasin. While Hickman is in the Turlock Subbasin, supplying surface water to the community would support the Modesto Subbasin's sustainability goals of mitigating stream depletions along the Tuolumne River and protecting domestic wells by reinforcing groundwater levels along the Subbasin boundary.

8.2.1.4.2. Public Noticing

The public and other agencies will be notified of the planned or ongoing implementation of PMA activities through the outreach and communication channels identified in the GSP, during the preparation process of the PEIR (if applicable), and during updates presented at regularly scheduled STRGBA GSA meetings. Noticing will occur as potential activities are being considered for implementation, and as ongoing and planned activities are implemented. Noticing will inform the public and other agencies that the proponent is considering or will be implementing the PMA and will provide a description of the actions that will be taken.

Public and/or inter-agency noticing may be facilitated through the STRGBA GSA board meetings and/or MID board meetings, the Modesto Subbasin and/or MID website(s), the MID newsletter, inter-basin coordination meetings, other public meetings hosted by the STRGBA and/or MID, GSP annual reports and five-year updates, public scoping meetings, and/or environmental/regulatory permitting notification processes.

8.2.1.4.3. Permitting and Regulatory Process

Required permitting and regulatory review would be initiated through consultation with applicable governing agencies. Governing agencies for which consultation will be initiated may include, but are not limited to: DWR, SWRCB, CDFW, Flood Board, Regional Water Boards, USFWS, NMFS, LAFCO, Counties of Stanislaus and/or Tuolumne, and CARB. Specific permitting and regulatory processes that may potentially affect the construction of Project-related infrastructure include, but are not limited to:

- USACE Section 404 Permits (potential exemption under Section 404(f)(1)(C) of Clean Water Act)

- Regional Water Quality Control Board Section 401 Water Quality Certification (not required if exempt from USACE Section 404)
- SWRCB Construction General Permit and Storm Water Pollution Prevention Plan (SWPPP)
- State Historic Preservation Office (SHPO) and National Historic Preservation Act (NHPA) Section 106 Coordination
- CEQA Environmental Review Process
- California Endangered Species Act (CESA) Consultation
- Endangered Species Act (ESA) Compliance
- National Environmental Policy Act (NEPA) Compliance (expected to require either an Environmental Impact Report and Negative Declaration or Mitigated Negative Declaration)

8.2.1.4.4. Expected Benefits

Benefits to Sustainability Indicators

Utilization of surface water for urban water demands in Waterford and Hickman is expected to offset groundwater pumping demands, with in-lieu groundwater recharge benefits to the Modesto Subbasin. Because a single water Waterford and Hickman use a combined system, Hickman (which lies in the Turlock Subbasin) will also benefit. Benefits in this area are seen in Tuolumne River stream depletions and will further protect domestic wells in both the Modesto and Turlock Subbasins. The sustainability indicators expected to benefit from this Project are groundwater levels, groundwater in storage, interconnected surface water, and possibly land subsidence. All benefits to sustainability indicators in the Modesto Subbasin will be evaluated through groundwater monitoring at nearby monitoring sites, identified in the GSP.

Benefits to Disadvantaged Communities

The Waterford/Hickman Surface Water Pump Station and Storage Tank Project directly benefits Waterford and Hickman, both classified as a DACs, by supplementing and diversifying their drinking water supply. This Project will provide an alternate drinking water source in case of infrastructure or contamination concerns with the communities' groundwater production wells. The additional surface water supply will also reduce groundwater pumping and increase groundwater levels near the communities which can reduce pumping costs, decrease the likelihood of dewatering domestic wells, and potentially mitigate some groundwater quality concerns. Additionally, benefits to groundwater conditions in the Modesto Subbasin are also expected to broadly benefit all DACs, SDACs, and EDAs in the Modesto Subbasin.

Volumetric Benefits to the Subbasin Groundwater System

The expected yield of the Waterford/Hickman Surface Water Pump Station and Storage Tank was estimated by simulating this Project in the C2VSimTM model. General information and assumptions used to simulate this Project are summarized in the Implementation section below. Additional information is provided in **Section 8.5: Plan for Achieving Sustainability**.

It is assumed that MID will provide 900 AF/year to Waterford and Hickman, except for critical years which will provide a partial allotment (approximately 750 AF/year in critical years).

Evaluation of benefits will be based on analysis of without-Project and with-Project measurements supported by modeling. Measured parameters will include surface water deliveries, groundwater levels, and other parameters to be determined. Modeling will be done with the C2VSimTM model used for GSP development.

8.2.1.4.5. Implementation Criteria, Status, and Strategy

Implementation Strategy and Timeline

The Waterford/Hickman Surface Water Pump Station and Storage Tank will be implemented by the City of Waterford. Waterford will oversee the Project financing and funding, permitting, and construction. The Project will require an agreement(s) between MID and the City of Modesto to purchase treated surface water. Negotiations are underway but have not been concluded. Once negotiations are finalized and financing is secured, then design and subsequent construction will begin. This PMA is currently in the early conceptual stage. Thus, the start and completion dates for this PMA have yet to be determined and will be provided in GSP annual reports and five-year updates when known. Once the Project construction is complete, it is expected that MID would provide 900 AF/year to Waterford and Hickman in all water years except critical years which will provide a partial allocation.

Implementation Assumptions for Modeling

The Waterford/Hickman Surface Water Pump Station and Storage Tank has been modeled in the C2VSimTM model. Additional information about Project-related modeling is described in **Section 8.5: Plan for Achieving Sustainability**.

The following general information and assumptions were used to simulate implementation of the Project:

- Estimated volume of surface water deliveries: Proportional to the MID irrigation water allotment based on water year type, not to exceed 900 AFY. The surface water deliveries are distributed throughout the months proportional to monthly urban demands.
- Area receiving surface water deliveries: Surface water is delivered to the jurisdictional extent of the Hickman and Waterford communities, consistent with the extent in the historical C2VSimTM model. Surface water is distributed between Waterford and Hickman proportional to simulated demands of each community.
- Water source: It is assumed that all surface water is diverted from MID's distribution system, with no adjustment to modeled MID diversions, spillage, and seepage.
- Groundwater pumping: It is assumed that groundwater production is reduced by the volume of surface water deliveries which is distributed evenly among all wells in Waterford and Hickman.

8.2.1.4.6. Water Source and Reliability

The Waterford/Hickman Surface Water Pump Station and Storage Tank will use water diverted from MID's surface water distribution network. MID has existing water rights on the Tuolumne River and existing storage and conveyance facilities that afford secure surface water supplies. Surface water is expected to be available for this Project in all hydrologic years, proportional to MID irrigation allotment, while still meeting the demand of existing MID customers.

8.2.1.4.7. Legal Authority

The GSAs, Districts, and individual Project proponents have the authority to plan and implement Projects through consultation with applicable governing agencies. MID and the City of Modesto have the authority to sell surface water to the City of Waterford.

8.2.1.4.8. Estimated Costs and Funding Plan

Costs of this Project include right of way purchase, environmental permitting, design, construction, and Project management costs. The estimate cost is approximately $8.5 million. However, this Project is currently in the early conceptual stage and a more refined cost can be reported in GSP annual reports and five-year updates when known. It is anticipated that Waterford would identify grant funding sources to cover Project costs as part of Project development.

8.2.1.4.9. Management of Groundwater Extractions and Recharge

Per 23 CCR § 354.44(b)(9), all PMAs developed for implementation are expected to maintain the balance of groundwater extractions and recharge to ensure that lowering of groundwater levels or depletion of supply during periods of drought is offset by increases in groundwater levels and storage in other years.

In particular, in-lieu recharge benefits of this Project are expected to increase the use and recharge of available surface water supplies, helping to offset any potential increases in groundwater pumping during drought when surface water supplies are limited.

8.2.2. In-Lieu & Direct Recharge Projects

8.2.2.1. Modesto Irrigation District In-Lieu and Direct Recharge Project (Project 5)

8.2.2.1.1. Project Description

The Modesto Irrigation District In-lieu and Direct Recharge Project (Project) is intended to be a cooperative long-term Project between Modesto Irrigation District (MID) and the non-district east (NDE) landowners. The purpose of this Project is to allow MID to facilitate recharge for NDE landowners during times and conditions that will not impact MID's existing agricultural and urban customers. This Project would be operated separately but coordinated with the Oakdale Irrigation District In-lieu and Direct Recharge Project, which shares a similar goal of facilitating groundwater sustainability in the NDE areas.

Currently developed agriculture in the NDE areas of the Modesto subbasin is estimated to be approximately 36,000 acres, of which approximately 30,000 acres is deciduous fruits and nuts (permanent crops). With limited exception, the entire NDE area is solely reliant on groundwater from the Modesto subbasin. The Project involves the delivery of approximately 60,000 AF of surface water from the Tuolumne River in Wet and Above Normal water years (WYs) through a limited number of new points of diversions off MID's existing irrigation conveyance infrastructure and subsequent conveyance through newly constructed private irrigation conveyance infrastructure for in-lieu and direct recharge during the growing season. Historically (1972-2020), Wet and Above Normal WYs have occurred approximately 47% of the time on the Tuolumne River. Under the current Final Environmental Impact Statement for the relicensing of Don Pedro Reservoir, there is estimated to be approximately 1,500,000 AF of surface water in Wet WYs and 620,000 AF of surface water in Above Normal WYs in the Tuolumne River above and beyond that necessary to meeting existing customer demands (all Tuolumne River Partners) and the recommended instream flow obligations. As a result, 60,000 AF of Tuolumne River surface water to applicable NDE areas amounts to approximately 4% and 10% of available surface water supply respectively, for Wet and Above Normal WYs. Project operation is intended to make surface water delivery available to applicable NDE areas in most WYs.

8.2.2.1.2. Public Noticing

The public and other agencies will be notified of the planned or ongoing implementation of PMA activities through the outreach and communication channels identified in the GSP, during the preparation process of the PEIR (if applicable), and during updates presented at regularly scheduled STRGBA GSA meetings. Noticing will occur as potential activities are being considered for implementation, and as ongoing and planned activities are implemented. Noticing will inform the public and other agencies that the proponent is considering or will be implementing the PMA and will provide a description of the actions that will be taken.

Public and/or inter-agency noticing may be facilitated through the GSA's board meetings and/or District meetings, associated website(s), inter-basin coordination meetings, other public meetings hosted by the GSAs, GSP annual reports and five-year updates, public scoping meetings, and/or environmental/regulatory permitting notification processes.

8.2.2.1.3. Permitting and Regulatory Process

Required permitting and regulatory review would be initiated as necessary through consultation with applicable governing agencies. Surface water would be diverted for this Project by MID through existing pre- and post-1914 water rights. Governing agencies that may be consulted for this Project include but are not limited to the State Water Resources Control Board (SWRCB), the County(ies) of Stanislaus and/or Tuolumne, and DWR.

If necessary for field flooding, the Project proponent will obtain land grading permits from the County(ies). Recharge Projects may also require an environmental review process under CEQA.

8.2.2.1.4. Expected Benefits

Benefits to Sustainability Indicators

Surface water deliveries during the non-irrigation season are expected to provide direct groundwater recharge to the Subbasin. For fields that are irrigated using groundwater, surface water deliveries during the irrigation season are expected to offset groundwater demand and provide in-lieu groundwater recharge benefits. In both cases, the sustainability indicators expected to benefit from this Project are groundwater levels, groundwater in storage, interconnected surface water, and land subsidence (depending on where recharge occurs). All benefits to sustainability indicators in the Modesto Subbasin will be evaluated through groundwater monitoring at nearby monitoring sites, identified in the GSP.

Benefits to Disadvantaged Communities

The MID in-lieu and direct recharge Project is expected to provide direct or in-lieu recharge for use in the NDE area. Most communities in the Modesto Subbasin, particularly in the NDE area, are classified as DACs, SDACs, or EDAs (according to 2018 census data, evaluated by place, tract, and block group). Depending on which specific parcels receive surface water deliveries, this Project may directly benefit specific DACs in this area. In addition, maintenance or improvement of groundwater levels will help to protect beneficial groundwater use by rural domestic wells from potential adverse impacts related to chronic groundwater level decline. Benefits to groundwater conditions in the Modesto Subbasin are also expected to broadly benefit all DACs, SDACs, and EDAs.

Volumetric Benefits to the Subbasin Groundwater System

The expected yield of the MID in-lieu and direct recharge Project was estimated by simulating this Project in the C2VSimTM model. General information and assumptions used to simulate this Project are summarized in the Implementation section below. Additional information is provided in **Section 8.5: Plan for Achieving Sustainability**.

On average across all years, the MID in-lieu and direct recharge Project is expected to provide an average annual benefit 28,800 AFY of recharge benefit to the Modesto Subbasin. These benefits would accrue in years with Wet or Above Normal hydrologic conditions when sufficient water is expected to be available for on-farm recharge (approximately 50 percent of years historically). In those years, approximately 60,000 AFY of groundwater recharge is expected to occur.

Evaluation of benefits will be based on analysis of without-Project and with-Project measurements supported by modeling. Measured parameters will include surface water deliveries, groundwater levels, and other parameters to be determined. Modeling may be done with the C2VSimTM model used for GSP development.

8.2.2.1.5. Implementation Criteria, Status, and Strategy

Implementation Strategy and Timeline

Project involves the delivery of surface water from the Tuolumne River in Wet and Above Normal water years (WYs) through a limited number of new points of diversions off MID's existing irrigation conveyance infrastructure and subsequent conveyance through existing and newly constructed private irrigation conveyance infrastructure for in-lieu and direct recharge during the growing season.

It is anticipated that most of the surface water made available will be used to meet agricultural demand during the irrigation season throughout the NDE area. This in-lieu use is intended to reduce the pumping needed in this area of the subbasin in wet and above normal years.

This Project is currently in the early conceptual stage. Thus, the start and completion dates for this Project have yet to be determined and will be provided in GSP Annual Reports and Five-Year Assessment Reports when known.

Implementation Assumptions for Modeling

The MID In-lieu and Direct Recharge Project has been modeled in the C2VSimTM model. Additional information about Project-related modeling is described in **Section 8.5: Plan for Achieving Sustainability.**

The following general information and assumptions were used to simulate implementation of the Project:

- Volume of water: 60,000 AFY were provided during Wet and Above Normal years, distributed in the months following the demand distribution. During the 50-year simulation period, the average annual water supply from this Project would be 28,800 AFY.
- One third of the total volume would be provided as direct recharge over the aquifer. The other two thirds would be delivered as in-lieu recharge.
- The location of the in-lieu and direct recharge would be within the NDE area, located near existing MID conveyance facilities and those parcels with low/medium infrastructure requirements.

8.2.2.1.6. Water Source and Reliability

The Project involves the delivery of approximately 60,000 AF of surface water from the Tuolumne River in Wet and Above Normal water years (WYs) through a limited number of new points of diversions off MID's existing irrigation conveyance infrastructure and subsequent conveyance through newly constructed private irrigation conveyance infrastructure for in-lieu and direct recharge during the growing season. Historically (1969-2018), Wet and Above Normal WYs have occurred approximately 48% of the time on the Tuolumne River. Under the current Final Environmental Impact Statement for the relicensing of Don Pedro Reservoir, there is estimated to be approximately 1,500,000 AF of surface water in Wet WYs and 620,000 AF of surface water in Above Normal WYs in the Tuolumne River above and beyond that necessary to meeting existing customer demands (all Tuolumne River Partners) and the recommended instream flow obligations. As a result, 60,000 AF of Tuolumne River surface water to applicable NDE areas amounts to approximately 4% and 10% of available surface water supply respectively, for Wet and Above Normal WYs.

8.2.2.1.7. Legal Authority

The GSAs, Districts, and individual Project proponents have the authority to plan and implement Projects through consultation with applicable governing agencies. MID has the authority to contract with and provide deliveries to non-districted east landowners area, and individual irrigators have the authority to apply surface water to their fields for on-farm recharge.

8.2.2.1.8. Estimated Costs and Funding Plan

Potential costs of this Project may include Project coordination and administration, financial, or other incentives to encourage on-farm recharge, field preparation to enhance flooding, and other potential on-field monitoring equipment. Costs per site may vary depending on changes in Project implementation and incentives. Slightly higher costs per site would likely be incurred in the first year an irrigator participates, as more coordination and site preparation may be required. The total costs of the Project will vary over time, depending on the number of sites receiving water, the extent to which irrigators require coordination and support, and any applicable Project incentives.

This Project is currently in the early conceptual stage. Thus, the anticipated costs contained herein are planning level costs and subject to change. However, high-level initial estimates are on the order of \$53,340,000 – \$75,000,000 of new conveyance infrastructure. Most costs are anticipated to be borne by the NDE participants; however, member agencies of the STRGBA GSA may identify funding sources to cover Project costs as part of Project development. These may include grants (e.g., Prop 1, Prop 68, NRCS, others), fees, and loans. Participating NDE landowners would ultimately be responsible for payment and installation of their private conveyance systems and the volumetric rate of MID surface water deliveries.

8.2.2.1.9. Management of Groundwater Extractions and Recharge

Per 23 CCR § 354.44(b)(9), all PMAs developed for implementation are targeted to maintain the balance of groundwater extractions and recharge to help ensure that lowering of groundwater levels or depletion of supply during periods of drought is offset by increases in groundwater levels and storage in other years.

In-lieu recharge benefits of this Project are expected to increase the use and recharge of available surface water supplies during wetter years, helping to offset potential increases in groundwater pumping during drought when surface water supplies are limited.

8.2.2.2. Oakdale Irrigation District In-lieu and Direct Recharge Project (Project 6)

8.2.2.2.1. Project Description

The Oakdale Irrigation District In-lieu and Direct Recharge Project (Project) is intended to be a cooperative long-term Project between OID and the NDE east landowners. The purpose of this Project is to allow OID to facilitate recharge for NDE landowners during times and conditions that will not impact OID's existing agricultural customers. The Project is separate from but coordinated with the Modesto Irrigation District In-lieu and Direct Recharge Project, which shares a similar goal of facilitating groundwater sustainability in the NDE areas. Coordination between the two Districts is ongoing and these projects may be operated in tandem, utilizing the MID-OID interconnected distribution systems to potentially work together and convey water to the NDE or others from OID.

Currently developed agriculture in the NDE areas of the Modesto subbasin is estimated to be approximately 36,000 acres, of which approximately 30,000 acres is deciduous fruits and nuts (permanent crops). With limited exception, the NDE area is solely reliant on groundwater from the Modesto subbasin. The Project envisions the development of up to approximately 20,000 AF of surface water from the Stanislaus River in all water years (WYs) except Critically Dry WYs through a limited number of existing and new points of diversions off OID's existing irrigation conveyance infrastructure and subsequent newly constructed private irrigation conveyance infrastructure for in-lieu use between March 1st- October 31st. Some direct recharge is expected to occur as canal or reservoir seepage in the expanded conveyance network. OID surface water will not be delivered to the NDE between November 1st- March 1st. The OID Board of Directors would consider and define the volume of water (if any) available to this Project on an annual basis in non-Critically Dry WYs. The Project is in the initial planning phase and as such, the Project terms have yet to be considered or approved by the OID Board of Directors. Historically (2010-2019), OID diverts between approximately 165,000 AF to 246,000 AF, with an overall average of approximately 208,000 AF. Given OID's existing surface water rights from the Stanislaus (300,000 AF) and its overall average system inflows, the surface water contemplated for this Project amounts to approximately 22% of the total available surface water supply above and beyond that necessary to meet their existing customer demands (on an average basis). As a result, if this Project were approved, it would provide the opportunity for OID to meet a portion of the NDE area needs while retaining some volume of water for "high-value" out-of-basin water transfers.

Voluntary transfers of water have provided a basis for funding improvements to the OID distribution system under the District's Water Resources Plan. As water is conserved and transferred, OID receives revenue and implements additional improvements, resulting in additional water conservation. More information on OID's WRP implementation to date can be found in Section 8 of OID's AWMP. Both the OID WRP and AWMP are available for reference on OID's website (www.oakdaleirrigation.com). OID has participated in numerous water transfers in the past and continues to seek opportunities for mutually beneficial temporary transfer agreements with water users (agricultural, urban, and others) outside of the District.

8.2.2.2.2. Public Noticing

The public and other agencies will be notified of the planned or ongoing implementation of PMA activities through the outreach and communication channels identified in the GSP, during the preparation process of the PEIR (if applicable), and during updates presented at regularly scheduled STRGBA GSA meetings. Noticing will occur as potential activities are being considered for implementation, and as ongoing and planned activities are implemented. Noticing will inform the public and other agencies that the proponent is considering or will be implementing the PMA and will provide a description of the actions that will be taken.

Public and/or inter-agency noticing may be facilitated through the GSA's board meetings and/or District meetings, associated website(s), inter-basin coordination meetings, other public meetings hosted by the GSAs, GSP annual reports and five-year updates, public scoping meetings, and/or environmental/regulatory permitting notification processes.

8.2.2.2.3. Permitting and Regulatory Process

Required permitting and regulatory review would be initiated as necessary through consultation with applicable governing agencies. Surface water would be diverted for this Project by OID through existing water rights. Governing agencies that may be consulted for this Project include but are not limited to the State Water Resources Control Board (SWRCB), the County(ies) of Stanislaus and/or Tuolumne, USBR, and DWR.

If necessary, Project proponent will obtain any applicable permits from the County(ies). Recharge projects and construction or expansion of conveyance facilities may also require an environmental review process under CEQA.

8.2.2.2.4. Expected Benefits

Benefits to Sustainability Indicators

For fields that are irrigated using groundwater, surface water deliveries during the irrigation season are expected to offset groundwater demand and provide in-lieu groundwater recharge benefits. Some additional recharge is anticipated to occur from canal and reservoir seepage in the expanded conveyance network. The sustainability indicators expected to benefit from this Project are groundwater levels, groundwater in storage, interconnected surface water, and land subsidence (depending on where recharge occurs). All benefits to sustainability indicators in the Modesto Subbasin will be evaluated through groundwater monitoring at nearby monitoring sites, identified in the GSP.

Benefits to Disadvantaged Communities

The Oakdale Irrigation District in-lieu and direct recharge Project is expected to provide direct or in-lieu recharge for NDE landowners area. The majority of communities in the Modesto Subbasin, including the NDE area, are classified as DACs, SDACs, or EDAs (according to 2018 census data, evaluated by place, tract, and block group). Depending on which specific parcels receive surface water deliveries, this Project may directly benefit specific DACs in this area. In addition, maintenance or improvement of groundwater levels will help to protect beneficial groundwater use by rural domestic wells from potential adverse impacts related to chronic groundwater level decline. Benefits to groundwater conditions in the Modesto Subbasin are also expected to broadly benefit all DACs, SDACs, and EDAs.

Volumetric Benefits to the Subbasin Groundwater System

The expected yield of the Oakdale Irrigation District in-lieu and direct recharge Project was estimated by simulating this Project in the C2VSimTM model. General information and assumptions used to simulate this Project are summarized in the Implementation section below. Additional information is provided in **Section 8.5: Plan for Achieving Sustainability**.

On average across all years, the Oakdale Irrigation District in-lieu and direct recharge Project is expected to provide approximately 14,400 AFY of recharge benefit to the Modesto Subbasin. These benefits would accrue in all hydrologic conditions except for critically dry years (approximately 72 percent of years historically). In those years, approximately 20,000 AFY of groundwater recharge is expected to occur.

Evaluation of benefits will be based on analysis of without-Project and with-Project measurements supported by modeling. Measured parameters will include surface water deliveries, groundwater levels, and other parameters to be determined. Modeling has been done with the C2VSimTM model used for GSP development and will continue to be analyzed during plan implementation.

8.2.2.2.5. Implementation Criteria, Status, and Strategy

Implementation Strategy and Timeline

Project involves the delivery of surface water from the Stanislaus River in Wet, Above Normal, Below Normal and Dry water years (WYs) through a limited number of existing and new points of diversions off OID's existing irrigation conveyance infrastructure and subsequent newly constructed private irrigation conveyance infrastructure for in-lieu and direct recharge during the growing season. It is expected that most of the Project water will be used for in-lieu recharge on parcels that have previously purchased surface water from OID, but it is anticipated that other NDE growers will participate as additional conveyance infrastructure is constructed.

This Project is currently in the early conceptual stage. Thus, the start and completion dates for this Project have yet to be determined and will be provided in GSP Annual Reports and Five-Year Assessment Reports when known.

Implementation Assumptions for Modeling

The OID In-lieu and Direct Recharge Project has been modeled in the C2VSimTM model. Additional information about Project-related modeling is described in **Section 8.5: Plan for Achieving Sustainability.**

The following general information and assumptions were used to simulate implementation of the Project:

- Volume of water: Up to 20,000 AFY of water was made available in all years except critically dry hydrologic year types. Surface water deliveries were made within the irrigation season, distributed based on agricultural demand. The annual average water supply during the 50-year simulation period would be of 14,400 AFY.
- The location of the in-lieu and direct recharge would be within the NDE area, located near existing OID conveyance facilities and those parcels with low/med infrastructure requirements.

8.2.2.2.6. Water Source and Reliability

The Project contemplates the delivery of approximately 20,000 AF of surface water from the Stanislaus River in all water years (WYs) except Critically Dry WYs, through a limited number of existing and new points of diversions off OID's existing irrigation conveyance infrastructure and subsequent newly constructed private irrigation conveyance infrastructure for in-lieu and direct recharge during the growing season. Historically (2010-2019), OID diverts between approximately 165,000 AF to 246,000 AF, with an overall average of approximately 208,000 AF. Given OID's existing surface water rights from the Stanislaus (300,000 AF) and its overall average system inflows, the surface water contemplated for this Project amounts to approximately 22% of the total available surface water supply above and beyond that necessary to meet their existing customer demands (on an average basis). As a result, if this Project were approved, it would provide the opportunity for OID to meet a portion of the NDE area demands while retaining some volume of water for "high-value" out-of-basin water transfers.

8.2.2.2.7. Legal Authority

The GSAs, Districts, and individual Project proponents have the authority to plan and implement Projects through consultation with applicable governing agencies. OID has the authority to contract with and provide deliveries to non-districted east landowners area, and individual irrigators have the authority to apply surface water to their fields for in-lieu recharge.

8.2.2.2.8. Estimated Costs and Funding Plan

Potential costs of this Project may include Project coordination and administration, permitting, CEQA analysis, construction or expansion of conveyance facilities, and financial or other incentives to encourage in-lieu use. Costs per site may vary depending on proximity to OID conveyance facilities and changes in Project implementation or incentives. The total costs of the Project will vary over time depending on how many NDE landowners participate, the amount of construction necessary, the volumetric rate of OID surface water deliveries, and the extent to which irrigators require coordination and support.

This Project is currently in the early conceptual stage. Thus, the anticipated costs have yet to be determined and will be reported in GSP Annual Reports and Five-Year Assessment Reports when known. However, high-level initial estimates are on the order of $17,780,000 - $25,000,000 of new conveyance infrastructure. The majority of costs are anticipated to be borne by the NDE participants, however, STRGBA GSA member agencies may identify funding sources to cover Project costs as part of Project development. These may include grants (e.g., Prop 1, Prop 68, NRCS, others), fees, and loans. The participating NDE landowners will ultimately be responsible for the cost of new private conveyance infrastructure and the volumetric rate of OID surface water deliveries.

8.2.2.2.9. Management of Groundwater Extractions and Recharge

Per 23 CCR § 354.44(b)(9), all PMAs developed for implementation are targeted to maintain the balance of groundwater extractions and recharge to help ensure that lowering of groundwater levels or depletion of supply during periods of drought is offset by increases in groundwater levels and storage in other years.

In-lieu recharge benefits of this Project are expected to increase the use and recharge of available surface water supplies during wetter years, helping to offset potential increases in groundwater pumping during drought when surface water supplies are limited.

8.2.3. Flood Mitigation Projects

8.2.3.1. Tuolumne River Flood Mitigation and Direct Recharge Project (Project 7)

8.2.3.1.1. Project Description

The Tuolumne River Flood Mitigation and Direct Recharge Project (Project) is intended to be a cooperative long-term Project between Modesto Irrigation District (MID) and the NDE landowners and is designed to be implemented with no impacts to MID's existing agricultural and urban customers. Currently developed agriculture in the NDE areas of the Modesto subbasin is estimated to be approximately 36,000 acres, of which approximately 30,000 acres is deciduous fruits and nuts (permanent crops). With limited exception, the entire NDE area is solely reliant on groundwater from the Modesto subbasin. The Project is different than the Modesto Irrigation District In-lieu and Direct Recharge Project, namely from a timing perspective, and involves the delivery of approximately 20,000 AF of surface water from the Tuolumne River in Wet and Above Normal water years (WYs) through a limited number of new points of diversions off MID's existing irrigation conveyance infrastructure and subsequent conveyance through newly constructed private irrigation conveyance infrastructure for storage and direct recharge during the non-growing season. Historically (1972-2020), Wet and Above Normal WYs have occurred approximately 47% of the time on the Tuolumne River. In addition to measurable benefits to groundwater resources within the Modesto subbasin, this Project is intended to mitigate flood releases from Don Pedro Reservoir during the winter months whereby reducing impacts on the lower Tuolumne River (City of Modesto and growers near the confluence of the lower Tuolumne River and the San Joaquin River), the San Joaquin River and the Delta. Under the current Final Environmental Impact Statement for the relicensing of Don Pedro Reservoir, there is estimated to be approximately 1,500,000 AF of surface water in Wet WYs and 620,000 AF of surface water in Above Normal WYs in the Tuolumne River above and beyond that necessary to meeting existing customer demands (all Tuolumne River Partners) and the recommended instream flow obligations. As a result, 20,000 AF of Tuolumne River surface water to applicable NDE areas during the non-growing season amounts to approximately 1% and 3% of available surface water supply respectively, for Wet and Above Normal WYs. New licenses for diversions/water rights may be required for this Project.

8.2.3.1.2. Public Noticing

The public and other agencies will be notified of the planned or ongoing implementation of PMA activities through the outreach and communication channels identified in the GSP, during the preparation process of the PEIR (if applicable), and during updates presented at regularly scheduled STRGBA GSA meetings. Noticing will occur as potential activities are being considered for implementation, and as ongoing and planned activities are implemented. Noticing will inform the public and other agencies that the proponent is considering or will be implementing the PMA and will provide a description of the actions that will be taken.

Public and/or inter-agency noticing may be facilitated through the GSA's board meetings and/or District meetings, associated website(s), inter-basin coordination meetings, other public meetings hosted by the GSAs, GSP annual reports and five-year updates, public scoping meetings, and/or environmental/regulatory permitting notification processes.

8.2.3.1.3. Permitting and Regulatory Process

Required permitting and regulatory review would be initiated through consultation with applicable governing agencies. Surface water would be diverted for this Project by MID through existing pre- and post-1914 water rights. Governing agencies that may be consulted for this Project include but are not limited to the State Water Resources Control Board (SWRCB), the County(ies) of Stanislaus and/or Tuolumne, and DWR.

If necessary for field flooding, the Project proponent will obtain land grading permits from the County(ies). Recharge Projects may also require an environmental review process under CEQA.

8.2.3.1.4. Expected Benefits

Benefits to Sustainability Indicators

Surface water deliveries during the non-irrigation season are expected to provide direct groundwater recharge to the Subbasin. For fields that are irrigated using groundwater, surface water deliveries during the irrigation season are expected to offset groundwater demand and provide groundwater recharge benefits. In both cases, the sustainability indicators expected to benefit from this Project are groundwater levels, groundwater in storage, interconnected surface water, and land subsidence (depending on where recharge occurs). All benefits to sustainability indicators in the Modesto Subbasin will be evaluated through groundwater monitoring at nearby monitoring sites, identified in the GSP.

Benefits to Disadvantaged Communities

The Tuolumne River flood mitigation and direct recharge Project is expected to provide direct recharge for NDE landowners area. Most communities in the Modesto Subbasin, particularly the NDE area, are classified as DACs, SDACs, or EDAs (according to 2018 census data, evaluated by place, tract, and block group). Depending on which specific parcels receive surface water deliveries, this Project may directly benefit specific DACs in this area. In addition, maintenance or improvement of groundwater levels will help to protect beneficial groundwater use by rural domestic wells from potential adverse impacts related to chronic groundwater level decline. Benefits to groundwater conditions in the Modesto Subbasin are also expected to broadly benefit all DACs, SDACs, and EDAs.

Volumetric Benefits to the Subbasin Groundwater System

The expected yield of the Tuolumne River flood mitigation and direct recharge Project was estimated by simulating this Project in the C2VSimTM model. General information and assumptions used to simulate this Project are summarized in the Implementation section below. Additional information is provided in **Section 8.5**: **Plan for Achieving Sustainability.**

On average across all years, the Tuolumne River flood mitigation and direct recharge Project is expected to provide approximately 9,600 AFY of recharge benefit to the Modesto Subbasin. These benefits would accrue in years with wet or above normal hydrologic conditions when sufficient water is expected to be available for on-farm recharge (approximately 50 percent of years historically). In those years, approximately 20,000 AFY of groundwater recharge is expected to occur.

Evaluation of benefits will be based on analysis of without-Project and with-Project measurements supported by modeling. Measured parameters will include surface water deliveries, groundwater levels, and other parameters to be determined. Modeling may be done with the C2VsimTM model used for GSP development.

8.2.3.1.5. Implementation Criteria, Status, and Strategy

Implementation Strategy and Timeline

Project involves the delivery of surface water from the Tuolumne River in Wet and Above Normal water years through a limited number of new points of diversions off MID’s existing irrigation conveyance infrastructure and subsequent conveyance through newly constructed private irrigation conveyance infrastructure for direct recharge. It is expected that fields with non-permanent crops, permeable soils, and existing flood irrigation infrastructure will be most suitable for Project participation.

This Project is currently in the early conceptual stage. Thus, the start and completion dates for this Project have yet to be determined and will be provided in GSP Annual Reports and Five-Year Assessment Reports when known.

However, once Project implementation begins, it is expected that MID would deliver surface water during wet and above normal hydrologic years (approximately 50 percent of years historically) when sufficient water is available for field flooding and on-farm recharge. MID would deliver surface water to participating fields, and irrigators would use that water to flood their fields for recharge. Subsequent analysis of projected water availability, actual annual application rates, and extent of participating lands will be necessary as Project development continues and implementation begins.

Implementation Assumptions for Modeling

The Tuolumne River Flood Mitigation Direct Recharge Project has been modeled in the C2VsimTM model. Additional information about project-related modeling is described in **Section 8.5: Plan for Achieving Sustainability**.

The following general information and assumptions were used to simulate implementation of the project:

- Volume of water: 20,000 AFY were provided during Wet and Above Normal years, distributed between the months of January and February for direct recharge. The annual average during the 50-year simulation period would be of 9,600 AFY.

8.2.3.1.6. Water Source and Reliability

The Project involves the delivery of approximately 20,000 AF of surface water from the Tuolumne River in Wet and Above Normal water years through a limited number of new points of diversions off MID's existing irrigation conveyance infrastructure and subsequent conveyance through newly constructed private irrigation conveyance infrastructure for and direct recharge during the non-growing season. Historically (1972-2020), Wet and Above Normal WYs have occurred approximately 47% of the time on the Tuolumne River. In addition to measurable benefits to groundwater resources within the Modesto subbasin, this Project is intended to mitigate flood releases from Don Pedro Reservoir during the winter months whereby reducing impacts on the lower Tuolumne River (City of Modesto and growers near the confluence of the lower Tuolumne River and the San Joaquin River), the San Joaquin River and the Delta. Under the current Final Environmental Impact Statement for the relicensing of Don Pedro Reservoir, there is estimated to be approximately 1,500,000 AF of surface water in Wet WYs and 620,000 AF of surface water in Above Normal WYs in the Tuolumne River above and beyond that necessary to meeting existing customer demands (all Tuolumne River Partners) and the recommended instream flow obligations. As a result, 20,000 AF of Tuolumne River surface water to applicable NDE areas during the non-growing season amounts to approximately 1% and 3% of available surface water supply respectively, for Wet and Above Normal WYs. New licenses for diversions/water rights may be required for this project.

8.2.3.1.7. Legal Authority

The GSAs, Districts, and individual Project proponents have the authority to plan and implement projects through consultation with applicable governing agencies. MID has the authority to contract with and provide deliveries to non-districted east landowners area, and individual irrigators have the authority to apply surface water to their fields for on-farm recharge.

8.2.3.1.8. Estimated Costs and Funding Plan

Potential costs of this Project may include Project coordination and administration, financial, or other incentives to encourage on-farm recharge, field preparation to enhance flooding, and other potential on-field monitoring equipment. Costs per site may vary depending on changes in Project implementation and incentives. Slightly higher costs per site would likely be incurred in the first year an irrigator participates, as more coordination and site preparation may be required. The total costs of the Project will vary over time, depending on the number of sites receiving water, the extent to which irrigators require coordination and support, and any applicable Project incentives.

This Project is currently in the early conceptual stage. Thus, the anticipated costs have yet to be determined and will be reported in GSP Annual Reports and Five-Year Assessment Reports when known. This project shares the same infrastructural development as the Modesto Irrigation District In-Lieu and Direct Recharge Project (Project 5). However, if implemented without Project 5, high-level initial estimates are on the order of $53,340,000 – $75,000,000 of new conveyance infrastructure. It is anticipated that STRGBA GSA member agencies and/or NDE landowners would identify funding sources to cover Project costs as part of Project development. These may include grants (e.g., Prop 1, Prop 68, NRCS, others), fees, and loans.

8.2.3.1.9. Management of Groundwater Extractions and Recharge

Per 23 CCR § 354.44(b)(9), all PMAs developed for implementation are targeted to maintain the balance of groundwater extractions and recharge to help ensure that lowering of groundwater levels or depletion of supply during periods of drought is offset by increases in groundwater levels and storage in other years.

Recharge benefits of this Project are expected to increase the use and recharge of available surface water supplies during wetter years, helping to offset potential increases in groundwater pumping during drought when surface water supplies are limited.

8.2.3.2. Dry Creek Flood Mitigation and Direct Recharge Project (Project 8)

8.2.3.2.1. Project Description

The Dry Creek Flood Mitigation and Direct Recharge Project (Project) is intended to be a cooperative long-term Project implemented by the NDE landowners and is designed to be constructed and managed in a way to prevent negative impacts to downstream users. Currently developed agriculture in the NDE areas of the Modesto subbasin is estimated to be approximately 36,000 acres, of which approximately 30,000 acres is deciduous fruits and nuts (permanent crops). With limited exception, the entire NDE area is solely reliant on groundwater from the Modesto Subbasin. The Project involves the delivery of approximately 5,400 AF of surface water from Dry Creek through a limited number of new and/or existing points of diversions off Dry Creek and subsequent conveyance through new and/or existing private irrigation conveyance infrastructure for direct recharge during the non-growing season. The volume of water associated with this Project was derived from previous work done on behalf of Stanislaus County and is representative of only a fraction of modeled results for a 2-year storm event in the lower reaches of Dry Creek. As a result, both the frequency and volume of water available are conservative estimates. In addition to measurable benefits to groundwater resources within the Modesto subbasin, this Project is intended to mitigate flood flows in Dry Creek whereby reducing impacts on the lower Tuolumne River (City of Modesto and growers near the confluence of the lower Tuolumne River and the San Joaquin River), the San Joaquin River and the Delta. New licenses for diversions/water rights may be required for this project.

8.2.3.2.2. Public Noticing

The public and other agencies will be notified of the planned or ongoing implementation of PMA activities through the outreach and communication channels identified in the GSP, during the preparation process of the PEIR (if applicable), and during updates presented at regularly scheduled STRGBA GSA meetings. Noticing will occur as potential activities are being considered for implementation, and as ongoing and planned activities are implemented. Noticing will inform the public and other agencies that the proponent is considering or will be implementing the PMA and will provide a description of the actions that will be taken.

Public and/or inter-agency noticing may be facilitated through the GSA's board meetings and/or City and Agency meetings, associated website(s), inter-basin coordination meetings, other public meetings hosted by the GSAs, GSP annual reports and five-year updates, public scoping meetings, and/or environmental/regulatory permitting notification processes.

8.2.3.2.3. Permitting and Regulatory Process

Required permitting and regulatory review would be initiated through consultation with applicable governing agencies. Governing agencies that may be consulted for this Project include but are not limited to the State Water Resources Control Board (SWRCB), the County(ies) of Stanislaus and/or Tuolumne, and DWR.

If necessary for field flooding, the Project proponent will obtain land grading permits from the County(ies). Recharge projects may also require an environmental review process under CEQA.

8.2.3.2.4. Expected Benefits

Benefits to Sustainability Indicators

Surface water deliveries from storm events during the non-irrigation season are expected to provide direct groundwater recharge to the Subbasin. The sustainability indicators expected to benefit from this Project are groundwater levels, groundwater in storage, interconnected surface water, and land subsidence (depending on where recharge occurs). All benefits to sustainability indicators in the Modesto Subbasin will be evaluated through groundwater monitoring at nearby monitoring sites, identified in the GSP.

Benefits to Disadvantaged Communities

The Dry Creek flood mitigation and direct recharge Project is expected to provide direct recharge for NDE landowners area. Most communities in the Modesto Subbasin, including the NDE area, are classified as DACs, SDACs, or EDAs (according to 2018 census data, evaluated by place, tract, and block group). Depending on which specific parcels receive surface water deliveries, this Project may directly benefit specific DACs in this area. In addition, maintenance or improvement of groundwater levels will help to protect beneficial groundwater use by rural domestic wells from potential adverse impacts related to chronic groundwater level decline. Benefits to groundwater conditions in the Modesto Subbasin are also expected to broadly benefit all DACs, SDACs, and EDAs.

Volumetric Benefits to the Subbasin Groundwater System

The expected yield of the Dry Creek flood mitigation and direct recharge Project was estimated by simulating this Project in the C2VSimTM model. General information and assumptions used to simulate this Project are summarized in the Implementation section below. Additional information is provided in **Section 8.5**: **Plan for Achieving Sustainability**.

On average across all years, Dry Creek flood mitigation and direct recharge Project is expected to provide approximately 5,400 AFY of recharge benefit to the Modesto Subbasin.

Evaluation of benefits will be based on analysis of without-Project and with-Project measurements supported by modeling. Measured parameters will include surface water deliveries, groundwater levels, and other parameters to be determined. Modeling may be done with the C2VSimTM model used for GSP development.

8.2.3.2.5. Implementation Criteria, Status, and Strategy

Implementation Strategy and Timeline

The Project involves the delivery of approximately 5,400 AF of surface water from Dry Creek through a limited number of new and/or existing points of diversions off Dry Creek and subsequent conveyance through new and/or existing private irrigation conveyance infrastructure for direct recharge during the non-growing season. At the initiation of this Project and on an ongoing basis, the GSAs and/or NDE landowners plan to identify fields that are most suitable for groundwater recharge. It is expected that fields with non-permanent crops, permeable soils, and existing flood irrigation infrastructure will be most suitable for Project participation.

This Project is currently in the early conceptual stage. Thus, the start and completion dates for this Project have yet to be determined and will be provided in GSP Annual Reports and Five-Year Assessment Reports when known.

However, once Project implementation begins, it is expected that storm water would be available for diversion during wet and above normal hydrologic years (approximately 50 percent of years historically) when sufficient water is available for field flooding and on-farm recharge. Subsequent analysis of projected water availability, actual annual application rates, and extent of participating lands will be necessary as Project development continues and implementation begins.

Implementation Assumptions for Modeling

The Dry Creek Flood Mitigation Direct Recharge Project has been modeled in the C2VSimTM model. Additional information about project-related modeling is described in **Section 8.5: Plan for Achieving Sustainability**.

The following general information and assumptions were used to simulate implementation of the project:

- Volume of water: 5,400 AFY were diverted during all years, distributed evenly in the months of January and February. The annual average during the 50-year simulation period would be of 5,400 AFY.
- The total volume would be applied as direct recharge over the aquifer.

8.2.3.2.6. Water Source and Reliability

The Project involves the diversion and application of approximately 5,400 AF of surface water from Dry Creek through a limited number of new and/or existing points of diversions off Dry Creek and subsequent conveyance through new and/or existing private irrigation conveyance infrastructure for direct recharge during the non-growing season. The volume of water associated with this Project was derived from previous work done on behalf of Stanislaus County and is representative of only a fraction of modelled results for a 2-year storm event in the lower reaches of Dry Creek. As a result, both the frequency and volume of water available are conservative estimates. In addition to measurable benefits to groundwater resources within the Modesto subbasin, this Project is intended to mitigate flood flows in Dry Creek whereby reducing impacts on the lower Tuolumne River (City of Modesto and growers near the confluence of the lower Tuolumne River and the San Joaquin River), the San Joaquin River and the Delta. New licenses for diversions/water rights may be required for this project.

8.2.3.2.7. Legal Authority

The GSAs and individual Project proponents have the authority to plan and implement projects through consultation with applicable governing agencies. Individual irrigators have the authority to apply surface water to their fields for on-farm recharge. However, new licenses for diversions/water rights may be required for this Project.

8.2.3.2.8. Estimated Costs and Funding Plan

Potential costs of this Project may include Project coordination and administration, financial, or other incentives to encourage on-farm recharge, field preparation to enhance flooding, and other potential on-field monitoring equipment. Costs per site may vary depending on changes in Project implementation and incentives. Slightly higher costs per site would likely be incurred in the first year an irrigator participates, as more coordination and site preparation may be required. The total costs of the Project will vary over time, depending on the number of sites receiving water, the extent to which irrigators require coordination and support, and any applicable Project incentives.

This Project is currently in the early conceptual stage. Thus, the anticipated costs have yet to be determined and will be reported in GSP Annual Reports and Five-Year Assessment Reports when known.

However, high-level initial estimates are on the order of $4,800,600 - $6,750,000 of new conveyance infrastructure. It is anticipated that STRGBA GSA member agencies would identify funding sources to cover Project costs as part of Project development. These may include grants (e.g., Prop 1, Prop 68, NRCS, others), fees, and loans.

8.2.3.2.9. Management of Groundwater Extractions and Recharge

Per 23 CCR § 354.44(b)(9), all PMAs developed for implementation are targeted to maintain the balance of groundwater extractions and recharge to help ensure that lowering of groundwater levels or depletion of supply during periods of drought is offset by increases in groundwater levels and storage in other years.

In particular, recharge benefits of this Project are expected to increase the use and recharge of available surface water supplies during wetter years, helping to offset potential increases in groundwater pumping during drought when surface water supplies are limited.

8.3. OTHER PROJECTS TO BE IMPLEMENTED AS NEEDED (GROUP 3)

This section describes potential Project(s) that would be implemented if determined to be necessary, pending future conditions in the Modesto Subbasin (Group 3 Projects, Table 8-1). While these Projects could contribute to attainment of the sustainability goal and support GSP implementation, they are in the early conceptual or planning stages at this time, with no specific implementation timeline established.

To the extent that future monitoring indicates the occurrence of undesirable results in the Subbasin, additional Projects will be implemented to address these changing conditions. As additional development occurs for the Projects described below or for other projects identified in the future, updates will be documented and reported in subsequent GSP Annual Reports and Five-Year Assessment Reports.

Summary of Criteria for Project Implementation (23 CCR §354.44(b)(1)(A))

As described above, the Projects described in this section are still in the early conceptual or planning stages. These potential Projects could be implemented as needed to achieve and maintain long-term sustainable groundwater management across the Modesto Subbasin. The Projects would be evaluated for implementation if, based on data gathered during GSP implementation, the GSAs find that established IMs and MOs cannot be maintained and/or if MTs are being approached. This adaptive approach will be informed by continued monitoring of groundwater conditions, using the monitoring network and methods described in the GSP. This initial list will likely be supplemented with additional projects as they are identified and reported through Annual Reports and Five-Year Assessment Reports of the GSP.

In addition, there are projects that have been considered in the past as part of the Integrated Regional Water Management Planning (IRWMP) and are included in the East Stanislaus IRWMP project database[1]. These projects are considered as potential projects to support the GSP implementation but are currently considered as alternative options and are not directly analyzed in this Chapter.

[1] http://www.eaststanirwm.org/projects/

8.3.1. Stanislaus River Flood Mitigation and Direct Recharge Project (Project 9)

The Stanislaus River Flood Mitigation and Direct Recharge Project (Project) is conceptually proposed by the NDE landowners to be a cooperative long-term Project with Oakdale Irrigation District (OID) and is designed to be implemented with no impacts to OID's existing agricultural customers. Currently developed agriculture in the NDE areas of the Modesto subbasin is estimated to be approximately 36,000 acres, of which approximately 30,000 acres is deciduous fruits and nuts (permanent crops). With limited exception, the NDE area is solely reliant on groundwater from the Modesto subbasin. The Project is different than the Oakdale Irrigation District In-lieu and Direct Recharge Project, namely from a timing perspective, and involves the delivery of approximately 5,000 AF of surface water from the Stanislaus River in Wet water years (WYs) through a limited number of new points of diversion off OID's existing irrigation conveyance infrastructure and subsequent newly constructed private irrigation conveyance infrastructure for direct recharge during the non-growing season. Storage in New Melones is approximately 2.5 times what the watershed yields on an average annual basis and as a result, the magnitude and frequency (5,000 AF and wet WYs) of this Project has been limited. Nonetheless, this Project is intended to mitigate flood releases from New Melones Reservoir during the winter months whereby reducing impacts on the lower Stanislaus River (growers along the lower Stanislaus River), the San Joaquin River and the Delta. This Project may require the acquisition of a right to divert flood flows and supplemental groundwater in storage application, as well as agreements with multiple agencies potentially including but not limited to, UBSR, OID, and the SWRCB for the revised operation of existing storage facilities, water diversion and rights on the Stanislaus River.

If this project is pursued, further analysis, consultation and review would be needed prior to any additional refinement of water availability and utilization given it may be contingent upon the terms and negotiations of a new water rights permit/license if required. Of note, historical operations of New Melones Reservoir and future water supply availability also has the potential to change significantly if the Lower San Joaquin River flow objectives proposed in the Bay-Delta Plan amendments and Final SED are implemented.

A summary of the Project is provided in **Table 8-4.**

Table 8-4: Stanislaus River Flood Mitigation and Direct Recharge Project: Summary (23 CCR §354.44(b))

Item in GSP Regulations	Description
Implementation Strategy and Criteria (§354.44(b)(1)(A); §354.44(b)(6))	Although similar to the OID In-lieu and Direct Recharge Project, this Project is different because of the timing perspective and the delivery of approximately 5,000 AF of surface water from the Stanislaus River in Wet water years (WYs). This Project is intended to mitigate flood releases from New Melones Reservoir during the winter months whereby reducing impacts on the lower Stanislaus River, the San Joaquin River and the Delta. This is currently in the conceptual stage and is a Project the NDE landowners may wish to pursue in the future if additional Projects are needed to reach sustainability in lieu of Management Actions.
Timeline and Implementation Status (§354.44(b)(4))	This Project is currently in the early conceptual stage and thus, the start and completion dates for this Project have yet to be determined. If it should ultimately be implemented, an updated timeline will be provided in GSP Annual Reports and Five-Year Assessment Reports. Benefits are expected to accrue in wet hydrologic year types when flood water is available for use, potentially beginning the first year of Project implementation.
Notice to public and other agencies (§354.44(b)(1)(B))	Public and/or inter-agency noticing will be facilitated through GSAs and/or district board meetings, GSAs and/or district website(s), GSAs and/or district newsletters, inter-basin coordination meetings, GSP Annual Reports and Five-Year Assessment Reports, public scoping meetings, and environmental/regulatory permitting notification processes.
Water source & reliability (§354.44(b)(6))	This Project would use available flood water from the Stanislaus River. This Project is currently in the early conceptual stage. The precise reliability of available water would be identified if/when the Project is evaluated and selected for implementation. This information will be reported in GSP Annual Reports and Five-Year Assessment Reports when known.
Legal authority, permitting processes, and regulatory control (§354.44(b)(3); §354.44(b)(7))	Required permitting and regulatory review will be project-specific and initiated through consultation with applicable governing agencies. Governing agencies for which consultation will be initiated may include, but is not limited to: OID, USBR, DWR, SWRCB, CDFW, Flood Board, RWQCBs, USFWS, NMFS, LAFCo, County(ies) of Stanislaus and/or Tuolumne, and CARB.

Item in GSP Regulations	Description
Benefits and benefit evaluation methodology (§354.44(b)(5))	The sustainability indicators expected to benefit are groundwater levels, groundwater in storage, and depletion of interconnected surface water. This Project is currently in the early conceptual stage. Thus, the expected yield of this Project has yet to be determined and will be reported in GSP Annual Reports and Five-Year Assessment Reports when known. Evaluation of benefits will be based on analysis of without-Project and with-Project effects on the SGMA sustainability indicators. Each Project may be evaluated as part of a scenario and the C2VSimTM would be used to assess the benefits and impacts on the subbasin sustainability.
Costs (§354.44(b)(8))	This Project is currently in the early conceptual stage. Thus, the anticipated costs of this Project have yet to be determined and will be reported in GSP Annual Reports and Five-Year Assessment Reports when known. The NDE landowners, as the Project proponent, would identify funding sources to cover Project costs as part of Project development. These may include grants, fees, loans, and other assessments.

8.3.2. Retention Basin Standards Specifications Update (Project 10)

This Project would aim to change standards for future storm drains so that the drains would not discharge straight to rivers, creeks, or canals but rather to retention basins. This would increase the sustainability footprint of the City of Modesto through future growth. Currently, approximately 16.37 Square miles out of 45 Square miles (36 percent) of the City of Modesto area drain to surface water, with approximately 64 percent draining and contributing to local recharge. If the City of Modesto adopts new storm drain standards, 100 percent of runoff from newly developed areas would reach a retention system with an approximate runoff coefficient of 0.7, and an average rainfall of 12.14 inches per year.

A summary of the Project is provided in **Table 8-5**.

Table 8-5: Retention Basin Standards Specifications Update: Summary (23 CCR §354.44(b))

Item in GSP Regulations	Description
Implementation Strategy and Criteria (§354.44(b)(1)(A); §354.44(b)(6))	This Project would aim to change standards for future storm drains so that the drains would not discharge straight to rivers, creeks, or canals but rather to retention basins. This is currently in the conceptual stage and is a Project the GSAs may decide to pursue in the future if additional strategies are needed to reach sustainability.
Timeline and Implementation Status (§354.44(b)(4))	This Project is currently in the early conceptual stage and will be implemented at the discretion of the GSAs. Thus, the start and completion dates for this Project have yet to be determined and if the GSAs determine it should be implemented, an update will be provided in GSP Annual Reports and Five-Year Assessment Reports. Benefits are expected to accrue in all years and potentially beginning the first year of Project implementation.
Notice to public and other agencies (§354.44(b)(1)(B))	Public and/or inter-agency noticing will be facilitated by the City of Modesto as well as through GSAs and/or City council meetings, GSAs and/or city website(s), GSAs and/or district newsletters, inter-basin coordination meetings, GSP Annual Reports and Five-Year Assessment Reports, public scoping meetings, and environmental/regulatory permitting notification processes.
Water source & reliability (§354.44(b)(6))	This Project would use urban storm runoff flows from the City of Modesto. This Project is currently in the early conceptual stage. The precise reliability of available water would be identified if/when the Project is evaluated and selected for implementation. This information would be reported in GSP Annual Reports and Five-Year Assessment Reports when known.
Legal authority, permitting processes, and regulatory control (§354.44(b)(3); §354.44(b)(7))	The GSAs and individual Project proponents have the authority to plan and implement projects. Required permitting and regulatory review will be project-specific and initiated through consultation with applicable governing agencies. Governing agencies for which consultation will be initiated may include, but is not limited to: DWR, SWRCB, CDFW, Flood Board, RWQCBs, USFWS, NMFS, LAFCo, County of Stanislaus, and CARB.
Benefits and benefit evaluation methodology (§354.44(b)(5))	The sustainability indicators expected to benefit are groundwater levels, groundwater in storage, and depletion of interconnected surface water. This Project is currently in the early conceptual stage. Thus, the expected yield of this Project has yet to be determined and would be reported in GSP Annual Reports and Five-Year Assessment Reports when known. Evaluation of benefits would be based on analysis of without-Project and with-Project effects on the SGMA sustainability indicators. Each Project may be evaluated as part of a scenario and the C2VSimTM would be used to assess the benefits and impacts on the subbasin sustainability.
Costs (§354.44(b)(8))	This Project is currently in the early conceptual stage. Thus, the anticipated costs of this Project have yet to be determined and would be reported in GSP Annual Reports and Five-Year Assessment Reports when known. The Project proponent would identify funding sources to cover Project costs as part of

Item in GSP Regulations	Description
	Project development. These may include grants, fees, loans, and other assessments.

8.3.3. Recharge Ponds Constructed by Non-District East Landowners (Project 11)

This Project would aim to capture some wintertime runoff from the Dry Creek Watershed by constructing detention basins. These basins would be constructed by NDE Landowners.

A summary of the Project is provided in **Table 8-6**.

Table 8-6: Recharge Ponds Constructed by Non-District East Landowners: Summary (23 CCR §354.44(b))

Item in GSP Regulations	Description
Implementation Strategy and Criteria (§354.44(b)(1)(A); §354.44(b)(6))	This Project would aim to capture some wintertime runoff from the Dry Creek Watershed by constructing detention basins. These basins would be constructed by NDE Landowners.
Timeline and Implementation Status (§354.44(b)(4))	This Project is currently in the early conceptual stage and will be implemented at the discretion of the NDE Landowners. Thus, the start and completion dates for this Project have yet to be determined and if the NDE Landowners determines it should be implemented, an updated timeline will be provided in GSP Annual Reports and Five-Year Assessment Reports. Benefits are expected to accrue during winter periods when water is available for use, potentially beginning the first year of Project implementation.
Notice to public and other agencies (§354.44(b)(1)(B))	Public and/or inter-agency noticing may be facilitated through GSAs or other agency meetings, GSAs website(s), GSAs newsletters, inter-basin coordination meetings, GSP Annual Reports and Five-Year Assessment Reports, public scoping meetings, and environmental/regulatory permitting notification processes.
Water source & reliability (§354.44(b)(6))	This Project would use water from the Dry Creek Watershed. This Project is currently in the early conceptual stage. The precise reliability of available water would be identified if/when the Project is evaluated and selected for implementation. This information would be reported in GSP Annual Reports and Five-Year Assessment Reports when known.
Legal authority, permitting processes, and regulatory control (§354.44(b)(3); §354.44(b)(7))	Required permitting and regulatory review will be project-specific and initiated through consultation with applicable governing agencies. Governing agencies for which consultation will be initiated may include, but is not limited to: DWR, SWRCB, CDFW, Flood Board, RWQCBs, USFWS, NMFS, LAFCo, County(ies) of Stanislaus and/or Tuolumne, and CARB.

Item in GSP Regulations	Description
Benefits and benefit evaluation methodology (§354.44(b)(5))	The sustainability indicators expected to benefit are groundwater levels, groundwater in storage, and depletion of interconnected surface water. This Project is currently in the early conceptual stage. Thus, the expected yield of this Project has yet to be determined and would be reported in GSP Annual Reports and Five-Year Assessment Reports when known. Evaluation of benefits would be based on analysis of without-Project and with-Project effects on the SGMA sustainability indicators. Each Project may be evaluated as part of a scenario and the C2VSimTM would be used to assess the benefits and impacts on the subbasin sustainability.
Costs (§354.44(b)(8))	This Project is currently in the early conceptual stage. Thus, the anticipated costs of this Project have yet to be determined and would be reported in GSP Annual Reports and Five-Year Assessment Reports when known. The NDE landowners, as the Project proponent would identify funding sources to cover Project costs as part of Project development. These may include grants, fees, loans, and other assessments.

8.3.4. OID Irrigation and Recharge to Benefit City of Oakdale (Project 12)

This Project proposes to utilize surface water from OID to irrigate the City of Oakdale's parks. The first phase of this Project is being constructed at two City of Oakdale parks to assess the costs and benefits. The two parks involved in this initial phase are located within close proximity to an existing OID conveyance system. Surface water for irrigation would be provided for City of Oakdale use during the irrigation, starting as early as March 1st and ending no later than October 31st each year. Anticipated yield of this Project is approximately 50 AF per year. Pending results from the initial phase of the Project, expanded implementation of this Project in cooperation with OID may be subsequently considered by the City of Oakdale.

A summary of the Project is provided in **Table 8-7**.

Table 8-7: OID Irrigation and Recharge to Benefit City of Oakdale Summary (23 CCR §354.44(b))

Item in GSP Regulations	Description
Implementation Strategy and Criteria (§354.44(b)(1)(A); §354.44(b)(6))	This Project would aim to reduce City of Oakdale groundwater pumping by providing OID surface water for irrigation of City parks. Construction of the first phase of implementation is currently in progress. The City of Oakdale may decide to pursue expansion in the future if the first phase is successful and additional strategies are needed to reach sustainability.
Timeline and Implementation Status	Construction of the first phase of the Project will likely be completed by the summer of 2022.An updated timeline and Project results will be provided in GSP Annual Reports and Five-Year Assessment Reports. Benefits are expected

Item in GSP Regulations	Description
(§354.44(b)(4))	to accrue in all hydrologic year types provided OID's surface water allocation is sufficient, potentially beginning the first year of Project implementation.
Notice to public and other agencies (§354.44(b)(1)(B))	Public and/or inter-agency noticing will be facilitated through GSAs and/or City/District board meetings, GSAs and/or district website(s), GSAs and/or district newsletters, inter-basin coordination meetings, GSP Annual Reports and Five-Year Assessment Reports, public scoping meetings, and environmental/regulatory permitting notification processes.
Water source & reliability (§354.44(b)(6))	The City of Oakdale remains within the OID boundary and thus is entitled to receive OID surface water when it is available.
Legal authority, permitting processes, and regulatory control (§354.44(b)(3); §354.44(b)(7))	The Districts/Cities and individual Project proponents have the authority to plan and implement projects. Required permitting and regulatory review will be project-specific and initiated through consultation with applicable governing agencies.
Benefits and benefit evaluation methodology (§354.44(b)(5))	The sustainability indicators expected to benefit are groundwater levels, groundwater in storage, and depletion of interconnected surface water. This first phase of the Project is currently being constructed. The anticipated yield of this Project is approximately 50 AF per year and actual results will be reported in GSP Annual Reports and Five-Year Assessment Reports when known. Evaluation of benefits will be based on analysis of without-Project and with-Project effects on the SGMA sustainability indicators. Each Project may be evaluated as part of a scenario and the C2VSimTM would be used to assess the benefits and impacts on the subbasin sustainability.
Costs (§354.44(b)(8))	This first phase of the Project is estimated to cost approximately $300,000. Costs of any future expansion have yet to be determined and would be reported in GSP Annual Reports and Five-Year Assessment Reports if pursued and when known. The City of Oakdale, as the Project proponent, would identify funding sources to cover Project costs as part of Project development. These may include grants, fees, loans, and other assessments.

8.3.5. MID FloodMAR Projects (Project 13)

This Project would support the development of flood managed aquifer recharge (FloodMAR) activities in locations in the Modesto Irrigation District boundaries where storm flows are available, or where existing surface water facilities can be utilized to direct and control surface water for various beneficial uses. Components of this Project would be developed privately or as coordinated efforts. Necessary infrastructure would be installed to connect existing delivery systems to FloodMAR activities. This is a conceptual Project and has not benefited from a feasibility analysis or any subsequent design.

A summary of the Project is provided in **Table 8-8**.

Table 8-8: MID FloodMAR Projects Summary (23 CCR §354.44(b))

Item in GSP Regulations	Description
Implementation Strategy and Criteria (§354.44(b)(1)(A); §354.44(b)(6))	This Project would support the development of flood managed aquifer recharge (FloodMAR) activities in locations in the Modesto Irrigation District where storm flows are available, or where existing surface water facilities can be utilized to direct and control stormwater for various beneficial uses. The Project may be implemented and would be monitored and quantified with respect to groundwater conditions, as needed, if sustainable levels are not reached following implementation of other PMAs. This is currently in the conceptual stage and is a Project that may be considered in the future if additional strategies are needed to reach sustainability.
Timeline and Implementation Status (§354.44(b)(4))	This Project is currently in the early conceptual stage thus, the start and completion dates for this Project have yet to be determined. If the Project proponents determine it should be implemented, an updated timeline will be provided in GSP Annual Reports and Five-Year Assessment Reports. Benefits would be expected to accrue in wet and above normal hydrologic years when flood water is available for use, potentially beginning the first year of Project implementation.
Notice to public and other agencies (§354.44(b)(1)(B))	Public and/or inter-agency noticing would be facilitated through GSAs and/or district board meetings, GSAs and/or district website(s), GSAs and/or district newsletters, inter-basin coordination meetings, GSP Annual Reports and Five-Year Assessment Reports, public scoping meetings, and environmental/regulatory permitting notification processes.
Water source & reliability (§354.44(b)(6))	This Project is currently in the early conceptual stage. The precise reliability of storm flows or other excess flows would be identified if/when the Project is evaluated and selected for implementation. This information would be reported in GSP Annual Reports and Five-Year Assessment Reports when known.
Legal authority, permitting processes, and regulatory control (§354.44(b)(3); §354.44(b)(7))	Required permitting and regulatory review will be project-specific and initiated through consultation with applicable governing agencies. Governing agencies for which consultation will be initiated may include, but is not limited to: MID, DWR, SWRCB, CDFW, Flood Board, RWQCBs, USFWS, NMFS, LAFCo, County(ies) of Stanislaus and/or Tuolumne, and CARB.
Benefits and benefit evaluation methodology (§354.44(b)(5))	The sustainability indicators expected to benefit are groundwater levels, groundwater in storage, and depletion of interconnected surface water. This Project is currently in the early conceptual stage. Thus, the expected yield of this Project has yet to be determined and would be reported in GSP Annual Reports and Five-Year Assessment Reports when known. Evaluation of benefits would be based on analysis of without-Project and with-Project effects on the SGMA sustainability indicators. Each Project may

Item in GSP Regulations	Description
	be evaluated as part of a scenario and the C2VSimTM would be used to assess the benefits and impacts on the subbasin sustainability.
Costs (§354.44(b)(8))	This Project is currently in the early conceptual stage. Thus, the anticipated costs of this Project have yet to be determined and would be reported in GSP Annual Reports and Five-Year Assessment Reports when known. The Project proponent would identify funding sources to cover Project costs as part of Project development. These may include grants, fees, loans, and other assessments.

8.4. MANAGEMENT ACTIONS

This Section identifies and describes proposed Management Actions (MA) that may be undertaken by the Modesto Subbasin GSAs as an element of GSP implementation. Management Actions generally refer to non-structural programs or policies designed to incentivize reductions in groundwater pumping, optimize management of the Subbasin, or implement GSA management authorities. **Table 8-9** shows a list of the six MAs organized into two categories: demand reduction strategies (**Section 8.4.1**) and pumping management framework (**Section 8.4.2**). Demand reduction strategies are a broad and strategic set of actions intended to reduce water demand, some of which may be incentivized by State programs or policies, or by a pumping management framework. The pumping management framework provides a suite of administrative procedures, programs, and policies that describe how the GSAs will manage and monitor groundwater extractions. Implementation activities such as monitoring, annual reporting, and GSP updates are discussed in further detail in **Chapter 9**.

As described in **Chapter 5**, the Subbasin has experienced overdraft conditions. Per § 354.44(b)(2), the GSP must describe Projects or MAs, including a quantification of demand reduction or other methods, for the mitigation of overdraft. Several Projects identified in earlier sections of this chapter would increase the available water in the Subbasin through increased recharge or use of alternate supplies and are expected to reduce the groundwater deficit sufficiently to achieve the Subbasin's sustainability goal. Additional Group 3 projects could be implemented to further decrease this deficit if necessary. Projects will need to be implemented as soon as feasible to prevent the need for MAs to be imposed. MAs are strategies the GSAs could additionally implement or implement in parallel to assist in achieving the sustainability goal if needed. A modeling analysis to assess the effectiveness of the current Group 1 and Group 2 projects is provided in **Section 8.5**. Although the C2VSim-TM model used in this analysis is currently the best available tool for this analysis, its ability to accurately predict future groundwater levels is limited and the estimate is therefore approximate and subject to future refinement. In addition, the extent and effectiveness of the Group 3 projects that will be implemented in the future, and of the water conservation MAs described in **Sections 8.4.1** and **8.4.2** is not yet known.

This section describes potential MAs that could be implemented in the Subbasin. While the tools described in this section will be available for implementation basin wide, implementation will be determined based upon need within each Management Area separately. PMAs implemented in one Management Area represent that Management Area's contributions to subbasin sustainability. As such, it is anticipated that responsibility for implementing MAs will correspond with the relative Management Area contribution to overdraft and impacts associated with other sustainability criteria within that Management Area.

A range of MAs is presented to allow the GSAs flexibility in their response to changing groundwater conditions and as data gaps and uncertainties are addressed during GSP implementation. However, it is anticipated that not all MAs will need to be implemented, or that individual MAs may be implemented by the GSAs in one Management Area but not by the other. In addition, implementation of MAs will be based on adaptive management strategies informed by ongoing monitoring of groundwater conditions using the monitoring network and methods described in the GSP. Monitoring data will be used to assess the need for PMAs in the Subbasin as a whole, in the Management Area, and at specific locations. This will occur incrementally as monitoring data become available, the effectiveness of prior PMAs is established, and knowledge of the Subbasin improves over time. The advent or threat of undesirable results and the performance or failure of the Subbasin to meet Interim Milestones or Measurable Objectives will serve as triggers for scaling and implementing both Projects and MAs in a targeted and proportional manner, consistent with conditions observed in the Subbasin.

Table 8-9 lists the MAs described in the subsections that follow. Each MA description is organized to address the applicable regulatory requirements:

- **Management Action Description**: 23 CCR §354.44(b)
- **Public Notice:** 23 CCR §354.44(b)(1)(B)
- **Permitting and Regulatory Process:** 23 CCR §354.44(b)(3)
- **Expected Benefits:** 23 CCR §354.44(b)(4), §354.44(b)(5)
- **Implementation Criteria, Status, and Plan:** 23 CCR §354.44(b)(1)(A); §354.44(b)(4); §354.44(b)(6)
- **Water Source and Reliability:** 23 CCR §354.44(b)(6)
- **Legal Authority:** 23 CCR §354.44(b)(7)
- **Estimated Costs and Funding Plan:** 23 CCR §354.44(b)(8)
- **Management of Groundwater Extractions and Recharge:** 23 CCR §354.44(b)(9)

Summary of Criteria for Project Implementation (23 CCR §354.44(b)(1)(A))

Most of the MAs described in this section are presented as frameworks and will be fully developed into implementation plans during the first years of GSP implementation as indicated in the subsequent sections. These potential MAs will be implemented by the GSAs as needed to achieve and maintain long-term sustainable groundwater management across the Modesto Subbasin. They would be evaluated and selected for implementation if, based on data gathered during GSP implementation, the GSAs find that established IMs and MOs cannot be maintained and/or if MTs are being approached. This adaptive approach will be informed by continued monitoring of groundwater conditions, using the monitoring network and methods described in the GSP.

Table 8-9: List of Management Actions

Category	Number	Proponent[2]	Management Action	Primary Mechanism(s)[1]	Partner(s)
Demand Reduction Strategies	1	Modesto Subbasin GSAs	Voluntary Conservation and/or Land Fallowing	Conservation/ Land Fallowing	N/A
	2	Modesto Subbasin GSAs	Conservation Practices	Conservation	N/A
Water Accounting framework	3	Modesto Subbasin GSAs	Groundwater Extraction and Surface Water Reporting Program	Pumping Reduction	N/A
	4	Modesto Subbasin GSAs	Groundwater Allocation and Pumping Management Program	Pumping Reduction	N/A
	5	Modesto Subbasin GSAs	Groundwater Extraction Fee	Pumping Reduction	N/A
	6	Modesto Subbasin GSAs	Groundwater Pumping Credit Market and Trading Program	Pumping Reduction	N/A

[1]The primary mechanism of the MA as conceptualized. MAs may support groundwater sustainability through multiple mechanisms during implementation.

[2] It is anticipated that MAs will be implemented by the GSAs or by each GSA member agency as needed to mitigate overdraft within their jurisdictional areas and assure that the SMC adopted in **Chapter 6** are met.

8.4.1. Demand Management Strategies

In case Projects are insufficient to manage the Subbasin in a sustainable condition, strategies may need to be developed to manage the agricultural and urban water demands in the Subbasin. These strategies could be implemented in the form of voluntary conservation and/or land fallowing (see **Section 8.4.1.1**) or other urban and agricultural conservation practices (see **Section 8.4.1.2**). While conservation practices are expected to be implemented throughout GSP implementation, specific strategies are in preliminary stages of discussion and possible consideration. Should the Modesto Subbasin GSAs decide to pursue a program in the future, the program would be implemented as necessary in a targeted and proportional manner consistent with conditions observed in the Subbasin. Similarly, the Conservation Practices MA is expected to be implemented adaptively.

8.4.1.1. Voluntary Conservation and/or Land Fallowing (Management Action 1)

8.4.1.1.1. Management Action Description

Voluntary Conservation and/or Land Fallowing covers several strategies that can be designed to achieve both temporary and permanent water demand reduction. Should the Modesto Subbasin GSAs decide to pursue such strategies, this MA would assess options and develop a program to incentivize voluntary conservation and/or fallowing strategies in close coordination and collaboration with the landowners. Examples of this strategy could include repurposing of lands growing lower value crops. These lands could be dry farmed, fallowed in rotation, or used for recreation, habitat restoration, groundwater recharge, or solar power generation. This MA would also try to prioritize those lands that are more favorable for groundwater recharge projects.

Temporary or permanent land fallowing could also be combined with recharge projects through the application of surplus surface water supplies to the fallowed lands.

8.4.1.1.2. Public Noticing

A successful Voluntary Conservation and/or Land Fallowing program will require a comprehensive and strategic outreach effort, including multiple public workshops and meetings, potential website and/or email announcements, along with other public notices for the workshops. The outreach will be targeted to both potential participants of the program (landowners) as well as other stakeholders who may be impacted by changes to land and water use.

8.4.1.1.3. Permitting and Regulatory Process

Preparation of a CEQA evaluation for a fallowing program will identify potential environmental impacts and identify feasible alternatives or feasible mitigation measures. Establishment of a voluntary land fallowing program is expressly authorized under SGMA (CWC, §10726.2(c)). The fallowing program, including program standards, will be developed and undergo CEQA review as necessary.

8.4.1.1.4. Expected Benefits

Benefits to Sustainability Indicators

Sustainability indicators that could benefit from Voluntary Conservation and/or Land Fallowing include:

- Chronic lowering of groundwater levels – By reducing groundwater demand, this MA would reduce pumping and pumping-related contributions to chronic lowering of groundwater levels.
- Reduction of groundwater in storage – Reduced pumping throughout the Subbasin contributes to a smaller rate of reduction of groundwater in storage.
- Land subsidence – Depending on the location of land fallowing or conservation, reduced pumping stress on local aquifer(s) may reduce the potential for subsidence.
- Depletion of interconnected surface water – Reduced pumping would reduce the potential for negative impacts to surface water flows associated with lowering groundwater levels.

Benefits to Disadvantaged Communities

Benefits to disadvantaged communities overlap with the benefits described above for sustainability indicators. Land repurposing can also provide other ancillary benefits to local communities, such as recreation.

Volumetric Benefits to Subbasin Groundwater System

The volumetric benefit to the groundwater system would depend on the extent to which a Voluntary Conservation and/or Land Fallowing program is adopted and would be further studied when the program is implemented by the GSAs.

8.4.1.1.5. Implementation Criteria, Status, and Plan

Temporary fallowing is a quick way to reduce demand with no capital costs or infrastructure needed. Because it is inexpensive, it can be implemented earlier and quicker while other long-term solutions like land repurposing are investigated. The Modesto Subbasin GSAs may explore options for encouraging voluntary and temporary fallowing during GSP implementation while developing a more structured program and exploring funding opportunities.

The Voluntary Conservation and/or Land Fallowing program is in preliminary stages of discussion and consideration. Should the Modesto Subbasin GSAs decide to pursue a program in the future, the program would be implemented as necessary in a targeted and proportional manner consistent with conditions observed in the Subbasin. To maximize recharge potential, the preservation lands that are more favorable for recharge projects could be prioritized while developing this MA. The implementation timeline has yet to be determined but would be provided in GSP annual reports and five-year updates when known. Any future changes in implementation would be communicated with the public and other agencies and would be documented in GSP annual reports and five-year updates.

8.4.1.1.6. Water Source and Reliability

This program does not rely on the supplies from outside the Subbasin because it is a planning effort that will result in conservation. It will support overall supply reliability by reducing overdraft in the Subbasin and moving the Subbasin towards sustainability.

8.4.1.1.7. Legal Authority

The GSAs have authority to “provide for a program of voluntary fallowing of agricultural lands or validate an existing program” (CWC, §10726.2(c)).

This MA carries forward the policy of the state and satisfies SGMA requirements by establishing a voluntary program that encourages water within the Subbasin to be dedicated to beneficial uses of water in a manner designed to achieve the sustainability goals and to protect against undesirable results.

8.4.1.1.8. Estimated Costs and Funding Plan

The Voluntary Conservation and/or Land Fallowing program is in preliminary stages of discussion and possible consideration. Therefore, no costs have been estimated for its development and implementation. Such costs would be developed should the Modesto Subbasin GSAs decide to pursue a program in the future. Separately, multiple funding programs exist as a potential source of revenue for individual landowners looking at options for land repurposing, including (EDF, 2021):

- Mitigation or Conservation Banks
- Conservation Easements
- Solar Rentals
- Grazing Leases
- Converting to Low Water Intensity Crops
- Federal and State Grant Funding Programs

8.4.1.1.9. Management of Groundwater Extractions and Recharge

This MA encourages the conservation of water; this will be applicable during both drought and non-drought conditions.

8.4.1.2. Conservation Practices (Management Action 2)

8.4.1.2.1. Management Action Description

This MA would create a program to support the use of conservation practices in both urban and agricultural sectors.

Urban water suppliers are already obligated to consider demand reduction and conservation efforts during dry periods. These demand MAs are described in their respective Urban Water Management Plans (UWMPs). These include:

- City of Modesto Urban Water Management Plan (West Yost Associates, 2016b)
  - o https://www.modestogov.com/860/Urban-Water-Management-Plan

- Modesto Irrigation District Urban Water Management Plan (West Yost Associates, 2021)
  - o https://wuedata.water.ca.gov/public/uwmp_attachments/2173444449/R%20-%20418%20-%20City%20of%20Modesto_MID%20-%20Final%202020%20UWMP%20%20-%2006-23-21.pdf
- City of Riverbank Urban Water Management Plan (KSN Inc, 2016)
  - o https://www.riverbank.org/610/Urban-Water-Management-Plan-WSCP
- City of Oakdale Urban Water Management Plan (MCR Engineering, 2015)
  - o https://cadwr.app.box.com/s/hg3k8bc9vuka689jkh1x4f9i1n58ey9a/file/521558561581
- City of Waterford (covered under City of Modesto 2015 UWMP)

In addition, SB 606 and AB 1668, both signed into law in May 2018, are laws that introduce conservation mandates that will cap indoor residential use and set a target for efficient outdoor landscape irrigation based on local climate and size of landscaped areas. Urban water suppliers will be required to report on progress to meeting urban water use objectives beginning in 2023 and comply with them beginning in 2028.

In addition to meeting urban water use objectives, this MA could include changing standards for storm drainage so that storm flows do not discharge straight to a river, creek, or canal, as contemplated by the City of Modesto as a potential Group 3 Project. This would help increase the sustainability footprint of the City of Modesto as it grows. Currently approximately 36% of the City of Modesto area drains to a river or canal, while approximately 64% is captured for local recharge. If the City of Modesto adopts new Storm Drain Standards, 100% of runoff from newly developed areas would reach a retention system and contribute to recharge.

In addition to urban conservation, agricultural water suppliers serving more than 25,000 irrigated acres must adopt an Agricultural Water Management Plan (AWMP) that include reports on the implementation status of specific Efficient Water Management Practices required by the Water Conservation Act of 2009 (SB X7-7). Agencies that have developed AWMPs include:

- Modesto Irrigation District Agricultural Water Management Plan
    - https://www.mid.org/water/awmp/default.html
- Oakdale Irrigation District Agricultural Water Management Plan
    - https://wuedata.water.ca.gov/public/awmp_attachments/3350354850/OID%202020%20AWMP%20FINAL%20210323.pdf

The Modesto Subbasin GSAs may choose to evaluate the existing UWMPs and AWMPs in the Subbasin and either expand upon minimum requirements to increase the impact of such programs or implement similar conservation practice programs in other areas of the Subbasin that may not be covered under an UWMP or AWMP.

Notably, conservation practices must be considered in the greater context of the Subbasin water budget, especially at the nexus between on-farm water use and groundwater sustainability. In areas where groundwater is the primary or sole water supply, conservation practices that reduce water demand may also reduce groundwater consumption, but conservation practices may also have unintended consequences that impede water conservation and sustainable groundwater management. Some of these consequences directly result from irrigation efficiency improvements: applying less water to an area and reducing the gap between irrigation and consumptive use also reduces deep percolation and seepage to the groundwater system. Other consequences may stem from behavioral responses and changes in irrigation resulting from these technologies and policies. If less water can be used to produce the same amount of a crop product, growers may be inclined to use the same amount of water and produce more (Lankford, et al., 2020). Additional considerations on the promises, pitfalls, and paradoxes of irrigation efficiency in water management planning are described by Lankford et al. (2020).

Further details on any expansion of the Conservation Practices program are preliminary as of the time of publishing and would need to be developed and refined further during GSP implementation.

8.4.1.2.2. Public Noticing

The Modesto Subbasin GSAs anticipates that public outreach and education on the potential structure of the Conservation Practices program, as well as feasible monitoring and enforcement mechanisms, would be necessary to enable a successful program. Outreach may include public notices, meetings, potential website presence and email announcements. Initial program implementation would likely focus on voluntary compliance while the GSAs or GSAs member agencies consider the necessary elements to begin enforcing the program potentially by 2027 (five years after adopting and submitting the GSP). This date is contingent upon monitoring results and achievement of Interim Milestones.

8.4.1.2.3. Permitting and Regulatory Process

Development of a Conservation Practices program is not a Project as defined by the California Environmental Quality Act (CEQA) and National Environmental Policy Act (NEPA) and would therefore not trigger either.

8.4.1.2.4. Expected Benefits

Benefits to Sustainability Indicators

Sustainability indicators benefitting from Conservation Practices include:

- Chronic lowering of groundwater levels – By reducing groundwater demand, this MA would reduce pumping and pumping-related contributions to chronic lowering of groundwater levels.
- Reduction of groundwater in storage – Reduced pumping throughout the Subbasin contributes to a smaller rate of reduction of groundwater in storage.
- Degraded water quality – This MA does not address this sustainability indicator.
- Land subsidence – Depending on the location of Conservation Practices, reduced pumping stress on local aquifer(s) may reduce the potential for subsidence.
- Depletion of interconnected surface water – Reduced pumping would reduce the potential for negative impacts to surface water flows associated with lowering groundwater levels.

Benefits to Disadvantaged Communities

Benefits to disadvantaged communities overlap with the benefits described above for sustainability indicators. Depending on how they're structured, urban conservation programs may also provide a financial benefit to individual users who reduce their water consumption, either via a lower water bill or reduced demand on a domestic well.

Volumetric Benefits to Subbasin Groundwater System

The volumetric benefit to the groundwater system will depend on the extent to which a Conservation Practices program is implemented and will be further studied if a program is developed by the GSAs.

8.4.1.2.5. Implementation Criteria, Status, and Plan

The implementation timeline has yet to be determined but would be provided in GSP annual reports and five-year updates when known. Any future changes in implementation would be communicated with the public and other agencies and would be documented in GSP annual reports and five-year updates.

8.4.1.2.6. Water Source and Reliability

This MA does not rely on the supplies from outside the Subbasin because it is a planning effort that will result in conservation benefits. It will support overall supply reliability by reducing groundwater demand in the Subbasin and moving the Subbasin towards sustainability.

8.4.1.2.7. Legal Authority

The Modesto Subbasin GSAs have the authority to develop a Conservation Practices program and may perform implementation and enforcement of practices via implementation of fees for noncompliance or through metering or other methods to quantify groundwater use. Mechanisms for enforcement would be outlined in the Conservation Practices program once developed and are expected to be enforced by the Modesto Subbasin GSAs and/or member agencies.

8.4.1.2.8. Estimated Costs and Funding Plan

Costs for UWMP and AWMP report preparation and submittals are ongoing for urban and agricultural water suppliers, respectively. Any future costs related to additional programming or program enforcement have yet to be developed.

8.4.1.2.9. Management of Groundwater Extractions and Recharge

This MA encourages the conservation of water; this will be applicable during both wet and dry conditions.

8.4.2. Water Accounting Framework

The Water Accounting Framework consists of four-tiered MAs that would be implemented in a prioritized order as determined by the Modesto Subbasin GSAs to meet the Subbasin's sustainability goal. Not all MAs may be needed – Subbasin conditions will be evaluated against the sustainability management criteria when considering whether an additional tiered MA is needed. The tiered order of potential Water Accounting Framework MAs implementation is:

1. Groundwater Extraction and Surface Water Accounting Reporting or Monitoring Program (Management Action 3) – see **Section 8.4.2.1**
2. Groundwater Allocation Program (Management Action 4) – see **Section 8.4.2.2**
3. Groundwater Extraction Fee (Management Action 5) – see **Section 8.4.2.3**
4. Groundwater Pumping Credit Market and Trading Program (Management Action 6) – see **Section 8.4.2.4**

The process of providing annual reports to DWR and of GSA self-reporting will allow them to update the Plan and adjust the implementation course as needed based on changing conditions.

8.4.2.1. Groundwater Extraction and Surface Water Accounting Reporting or Monitoring Program (Management Action 3)

8.4.2.1.1. Management Action Description

As required in SGMA regulations, groundwater extraction has been calculated by the GSAs for this GSP using the groundwater model (**Appendix C**). Presently, the GSAs intend to continue with its current data collection and groundwater extraction monitoring techniques. This MA is provided as an alternative to allow the GSAs flexibility and additional options in the event more or alternative forms of data are needed in the future.

There are several ways that this MA could be implemented by the GSAs. For this plan, two potential components have been developed and include a voluntary program and a comprehensive program. However, these two potential components are provided only as options, and likely would be implemented in Management Areas that are determined to be net extractors. If this MA is initiated, the GSAs will further develop options before implementing.

- Voluntary program – This program is intended to provide an annual reporting of groundwater use by agricultural and private well owners and surface water transfers for in-lieu use. The Data Management System will be set up with appropriate input data forms for voluntary reporting of groundwater use as well as other relevant information, such as irrigated acreage, crop type, and sources of water.
- Comprehensive program – This program is a more robust and elaborate strategy for reporting groundwater extraction that is intended to cover all groundwater users and surface water transfers for in-lieu use. Implementation of this program can be using satellite imagery to estimate the evapotranspiration of crops by parcel. Additionally, this strategy can take the form of requiring the installation of meters at all agricultural wells.

The Groundwater Extraction Reporting Program would exclude *de minimis* extractors (domestic use of 2 AF or less per year) but may also include surface water accounting in the Subbasin due to the amount of surface water transferred from MID and OID to the NDE area used for in-lieu and direct recharge.

8.4.2.1.2. Public Noticing

Successful implementation of either component of this program would require the support and coordination of member agencies, well owners throughout the Subbasin, and other stakeholders.

The voluntary program would be noticed via public outreach and education about the logistics of participating in the program as well as the purpose and importance of doing so. Outreach may include public notices, meetings, potential website presence and email announcements.

The comprehensive program would involve more of a robust planning process. The Modesto Subbasin GSAs anticipates that public outreach and education on the potential structure of this program would be necessary, including public notices, meetings, potential website presence and email announcements.

8.4.2.1.3. Permitting and Regulatory Process

The Groundwater Extraction Reporting Program is not expected to require any permitting or regulatory involvement.

8.4.2.1.4. Expected Benefits

Benefits to Sustainability Indicators

Direct measurement of groundwater extractions may not have direct impacts on sustainability indicators but would improve future water budget and sustainable yield refinement. The accurate and widespread collection of extraction data would provide the Modesto Subbasin GSAs with critical information to assist in management of the Subbasin, development of additional MAs, and monitoring the success of the GSP against the sustainable management criteria.

Benefits to Disadvantaged Communities

The Groundwater Extraction Reporting Program would exclude *de minimis* extractors.

Volumetric Benefits to Subbasin Groundwater System

Measurement of groundwater extractions provides a vast improvement to the refinement of water budgets and basin storage calculations.

8.4.2.1.5. Implementation Criteria, Status, and Plan

The Modesto Subbasin GSAs will develop annual reports to evaluate progress toward meeting the sustainability goal. If monitoring efforts demonstrate that the Projects and MAs being implemented are not effective in achieving stated targets, the GSAs will convene a working group to evaluate the implementation of additional supply-side and demand-side actions, such as the implementation of tiered approaches in the Pumping Management Framework.

8.4.2.1.6. Water Source and Reliability

This management action is an accounting and monitoring program and as such does not rely on water availability. The Groundwater Extraction and Surface Water Accounting Reporting or Monitoring Program is a planning effort that will support overall supply reliability by providing additional information for better management of the Subbasin and moving the Subbasin towards sustainability.

8.4.2.1.7. Legal Authority

SGMA provides GSAs with the authority to regulate the pumping of groundwater in order to stabilize the region's water supply and recharge aquifers. As such, the GSAs have the authority to: "control groundwater extractions by regulating, limiting, or suspending extractions from individual groundwater wells or extractions from groundwater wells in the aggregate, . . . or otherwise establishing groundwater extraction allocations" (CWC, §10726.4(a)).

8.4.2.1.8. Estimated Costs and Funding Plan

The estimated costs for the Groundwater Extraction Reporting Program would vary depending on the components that are implemented:

- The costs for the voluntary component are minimal and include:
  - One-time costs for initial public outreach and setup of tools and procedures to receive and compile voluntary submitted data
  - Ongoing annual administrative costs to review and compile the voluntarily submitted data as well as continued outreach
- The costs for implementing the more comprehensive program would be larger as they may include:
  - One-time costs to develop a remote sensing system or a more comprehensive program to track and monitor well meters, in addition to public outreach
  - Ongoing annual costs to administer the program, whether via purchase and analysis of the latest remote sensing data or to track and collect data from well meters

The Groundwater Extraction Reporting Program is in preliminary stages of discussion and possible consideration. Therefore, no costs have been estimated for its development and implementation. Such costs would be developed should the Modesto Subbasin GSAs decide to pursue a program in the future.

8.4.2.1.9. Management of Groundwater Extractions and Recharge

This program would directly develop and expand the reporting of groundwater extractions, including during both dry and wet periods, to support better management of the Subbasin.

8.4.2.2. Groundwater Allocation Program (Management Action 4)

8.4.2.2.1. Management Action Description

This strategy considers the development of a Groundwater Allocation Program for the Subbasin that would result in groundwater sustainability for the Subbasin as a whole.

Outlined here is a framework for how the Modesto Subbasin GSAs might develop and implement pumping allocations in the Subbasin based on the magnitude of projected overdraft estimated by Subbasin modeling.

There are four key steps to developing pumping allocations:

1. Identify the sources of water contributing to the native yield and estimate the quantity of native yield for the subbasin annually (see **Chapter 6** of this GSP)

2. Estimate the amount of native yield that can be used annually consistent with the Sustainable Yield

3. Allocate native yield to groundwater right holders based on:
   a. Priority of right
   b. Prescription

    c. Other legal principles, such as reasonable use
4. Determine how to account for new/additional supplies
5. Develop a timeline for reducing pumping to achieve allocations over time

The Groundwater Allocation Program is only conceptual at this time. There are numerous ways to structure and implement an allocation program which will need to be further evaluated, developed, and refined by the Modesto Subbasin GSAs prior to implementation.

8.4.2.2.2. Public Noticing

Development of a Groundwater Allocation Program would require substantial public input to understand the potential impacts of groundwater allocations and baseline needs that should be accounted for. The Modesto Subbasin GSAs anticipates that public outreach would include multiple public workshops and meetings, potential website and/or email announcements, along with other public notices for the workshops. The Groundwater Allocation Program would be circulated for public comment before finalized, though final approval of the plan would be made by the Modesto Subbasin GSAs in partnership with their respective member agencies. Implementation of the program may be confined to specific Management Areas.

8.4.2.2.3. Permitting and Regulatory Process

Development of a Groundwater Allocation Program would not require any permitting but would require consideration of existing water rights and applicable permits and regulations associated with groundwater pumping in the Subbasin.

8.4.2.2.4. Expected Benefits

Benefits to Sustainability Indicators

Sustainability indicators benefitting from the Groundwater Allocation Program include:

- Chronic lowering of groundwater levels – By reducing groundwater demand, this MA would reduce pumping and pumping-related contributions to chronic lowering of groundwater levels.
- Reduction of groundwater in storage – Reduced pumping throughout the Subbasin contributes to a smaller rate of reduction of groundwater in storage.
- Degraded water quality – This MA does not address this sustainability indicator.
- Land subsidence – Reduced groundwater pumping may reduce the risk of subsidence associated with lowering of groundwater levels.
- Depletion of interconnected surface water – Reduced pumping would reduce the potential for negative impacts to surface water flows associated with lowering groundwater levels.

Benefits to Disadvantaged Communities

Benefits to disadvantaged communities overlap with the benefits described above for sustainability indicators.

Volumetric Benefits to Subbasin Groundwater System

The volumetric benefit to the groundwater system will depend on the structure of the allocation framework and will be further studied if and when the program is developed by the GSAs.

8.4.2.2.5. Implementation Criteria, Status, and Plan

The Modesto Subbasin GSAs will develop annual reports to evaluate progress toward meeting the sustainability goal. If monitoring efforts demonstrate that the Projects and MAs being implemented are not effective in achieving stated targets, the GSAs will convene a working group to evaluate the implementation of additional supply-side and demand-side actions, such as the implementation of tiered approaches in the Water Accounting Framework.

8.4.2.2.6. Water Source and Reliability

This program does not rely on the supplies from outside the Subbasin because it is a planning effort that will result in conservation. It will support overall supply reliability by reducing overdraft in the Subbasin and moving the Subbasin towards sustainability.

8.4.2.2.7. Legal Authority

Under SGMA, GSAs have authority to establish groundwater extraction allocations. Specifically, SGMA authorizes GSAs to control groundwater by regulating, limiting, or suspending extractions from individual wells or extractions in the aggregate.[1] SGMA and GSPs adopted under SGMA cannot alter water rights.

8.4.2.2.8. Estimated Costs and Funding Plan

Development and initiation of an allocation program is expected to include upfront costs to conduct the analysis, set up the tracking system, and conduct outreach. Costs to implement the plan would depend on the level of enforcement required to achieve allocation targets and the level of outreach required annually to remind users of their allocation for a given year. The Groundwater Allocation Program would also include an annual cost that covers ongoing enforcement and implementation. Because the Groundwater Allocation Program is in preliminary stages of discussion and possible consideration, no costs have been estimated. Such costs could be developed if the Modesto Subbasin GSAs decide to pursue a program in the future.

8.4.2.2.9. Management of Groundwater Extractions and Recharge

The Groundwater Allocation Program would include provisions for the recovery of groundwater levels and groundwater in storage during non-drought periods.

[1] California Water Code § 10726.4(a)(2)

8.4.2.3. Groundwater Extraction Fee (Management Action 5)

8.4.2.3.1. Management Action Description

This strategy entails setting up a Groundwater Extraction Fee structure for each groundwater user. The fee structure could work in conjunction with the groundwater allocation and reporting programs, such that groundwater use above a certain allocation can be subject to a fee. This strategy could be implemented within the GSAs as needed to achieve the sustainability goals.

Revenue from these fees could then be used to pay for a variety of activities, such as the construction of water infrastructure, protection of groundwater, proper construction and destruction of wells to prevent contamination, groundwater recharge and recovery projects, purchase of imported water or other supplies to replenish the groundwater basin, and/or purchasing and permanent fallowing of marginally-productive agricultural lands dependent on groundwater. Fees could also be used to pay for administration, enforcement, and implementation of the MA.

8.4.2.3.2. Public Noticing

Development of a Groundwater Extraction Fee would require substantial public input to understand the potential impacts and needs that should be accounted for. The Modesto Subbasin GSAs anticipates that public outreach would include multiple public workshops and meetings, potential website and/or email announcements, along with other public notices for the workshops. The Groundwater Extraction Fee framework would be circulated for public comment before being finalized, though final approval of the plan would be made by the Modesto Subbasin GSAs in partnership with its member agencies.

Additional noticing for the public would be conducted consistent with permitting requirements in the case of the enactment of fees. GSA outreach may include public notices, meetings, website or social media presence, and email announcements. Prior to implementing any fee or assessment program, the GSAs would complete a rate assessment study or other analysis if required by the regulatory requirements.

Per Water Code §10730, prior to imposing or increasing a fee, a groundwater sustainability agency shall hold at least one public meeting, at which oral or written presentations may be made as part of the meeting. Notice of the time and place of the meeting shall include a general explanation of the matter to be considered and a statement that the data required by this section is available. The notice shall be provided by publication pursuant to §6066 of the Government Code, by posting notice on the Internet Web site of the groundwater sustainability agency, and by mail to any interested party who files a written request with the agency for mailed notice of the meeting on new or increased fees. A written request for mailed notices shall be valid for one year from the date that the request is made and may be renewed by making a written request on or before April 1 of each year. At least 20 days prior to the meeting, the groundwater sustainability agency shall make available to the public data upon which the proposed fee is based. Any action by a groundwater sustainability agency to impose or increase a fee shall be taken only by ordinance or resolution.

8.4.2.3.3. Permitting and Regulatory Process

Fees imposed pursuant to Water Code §10730 shall be adopted in accordance with all applicable laws.

A fee or charge shall not be extended, imposed, or increased by any agency unless it meets all of the following requirements:

- Revenues derived from the fee or charge shall not exceed the funds required to provide the property related service.
- Revenues derived from the fee or charge shall not be used for any purpose other than that for which the fee or charge was imposed.
- The amount of a fee or charge imposed upon any parcel or person as an incident of property ownership shall not exceed the proportional cost of the service attributable to the parcel.
- No fee or charge may be imposed for a service unless that service is actually used by, or immediately available to, the owner of the property in question. Fees or charges based on potential or future use of a service are not permitted. Standby charges, whether characterized as charges or assessments, shall be classified as assessments and shall not be imposed without compliance with Section 4 (Water Code §10730).
- No fee or charge may be imposed for general governmental services including, but not limited to, police, fire, ambulance or library services, where the service is available to the public at large in substantially the same manner as it is to property owners.

8.4.2.3.4. Expected Benefits

Benefits to Sustainability Indicators

Collection of groundwater extraction fees incentivizes the use of supplemental or alternative water supplies where fees can also fund activities/projects that increase groundwater supplies, such as groundwater recharge, thus reducing declines in groundwater elevations and groundwater in storage. Other sustainability indicators benefitting from the Groundwater Extraction Fee program include:

- Degraded water quality – Funded activities and projects can also reduce degradation of groundwater quality (such as proper construction/destruction of wells to prevent contamination).
- Land subsidence – Reduced groundwater pumping would reduce the risk of subsidence associated with lowering of groundwater levels.
- Depletion of interconnected surface water – Reduced pumping would reduce the potential for negative impacts to surface water flows associated with lowering groundwater levels.

Benefits to Disadvantaged Communities

Any fees would comply with CWC, §10730(a) and shall exclude *de minimis* extractors from fees, where appropriate.

Volumetric Benefits to Subbasin Groundwater System

The volumetric benefit to the groundwater system would depend on the framework of the fee implemented and would be further studied as the Groundwater Extraction Fee framework was developed by the GSAs.

8.4.2.3.5. Implementation Criteria, Status, and Plan

The Modesto Subbasin GSAs will develop annual reports to evaluate progress toward meeting the sustainability goal. If monitoring efforts demonstrate that the Projects and MAs being implemented are not effective in achieving stated targets, the GSAs will convene a working group to evaluate the implementation of additional supply-side and demand-side actions, such as the implementation of tiered approaches in the Water Accounting Framework.

8.4.2.3.6. Water Source and Reliability

The Groundwater Extraction Fee program will apply in both drought and non-drought periods.

8.4.2.3.7. Legal Authority

The GSAs possess the legal authority to implement special taxes, assessments, and user fees within the Project proponent service area or area of Project benefit. Fees imposed include fixed fees and fees charged on a volumetric basis, including, but not limited to, fees that increase based on the quantity of groundwater produced annually, the year in which the production of groundwater commenced from a groundwater extraction facility, and impacts to the basin.

8.4.2.3.8. Estimated Costs and Funding Plan

While there are certain administrative costs anticipated with the development and implementation of a Groundwater Extraction Fee, the Groundwater Extraction Fee itself is a potential mechanism to fund the costs of groundwater management. This includes, but is not limited to, the following:

- Administration, operation, and maintenance, including a prudent reserve
- Acquisition of lands or other property, facilities, and services
- Supply, production, treatment, or distribution of water
- Other activities necessary or convenient to implement the plan

8.4.2.3.9. Management of Groundwater Extractions and Recharge

This program, in conjunction with the Groundwater Extraction Reporting Program (MA 3), would directly develop and expand the reporting of groundwater extractions, including during both drought and non-drought periods, to support better management of the Subbasin.

8.4.2.4. Groundwater Pumping Credit Market and Trading Program (Management Action 6)

8.4.2.4.1. Management Action Description

Groundwater credit markets and trading programs can be used to exchange and trade the allocation of groundwater use by each landowner within the GSAs. This strategy is contingent upon implementation of the groundwater reporting and allocation programs (MAs 1 and 2), so that the credit and trading market can monitor the exchange of groundwater allocations among the landowners and/or the GSAs. Should the Modesto Subbasin GSAs decide to pursue a program in the future, the Modesto Subbasin GSAs would seek guidance from agencies with experience in water markets to identify options for communications and outreach with stakeholders, program design, and mechanisms to ensure that non-participating stakeholders are not adversely impacted by the program.

8.4.2.4.2. Public Noticing

Development and implementation of a Groundwater Pumping Credit Market and Trading Program would require substantial public input to understand the potential impacts and nuances of implementing such a program. The Modesto Subbasin GSAs anticipate that public outreach would include multiple public workshops and meetings, potential website and/or email announcements, along with other public notices for the workshops. The program plan would be circulated for public comment before being finalized, though final approval of the plan would be made by the Modesto Subbasin GSAs in partnership with their member agencies.

8.4.2.4.3. Permitting and Regulatory Process

Permitting and other regulatory compliance issues will be identified and addressed when the program is being further explored and developed, consistent with SGMA §10726.4 (a) (3 & 4).

8.4.2.4.4. Expected Benefits

Benefits to Sustainability Indicators

Sustainability indicators benefitting from the Groundwater Pumping Credit Market and Trading Program include:

- Chronic lowering of groundwater levels – By reducing groundwater demand, this MA would reduce pumping and pumping-related contributions to chronic lowering of groundwater levels.
- Reduction of groundwater in storage – Reduced pumping throughout the Subbasin contributes to a smaller rate of reduction of groundwater in storage.
- Degraded water quality – This MA does not address this sustainability indicator.
- Land subsidence – Reduced groundwater pumping would reduce the risk of subsidence associated with lowering of groundwater levels.
- Depletion of interconnected surface water – Reduced pumping would reduce the potential for negative impacts to surface water flows associated with lowering groundwater levels.

Benefits to Disadvantaged Communities

Benefits to disadvantaged communities overlap with the benefits described above for sustainability indicators.

Volumetric Benefits to Subbasin Groundwater System

The volumetric benefit to the groundwater system will depend on the framework of the credit market and trading program implemented and would be further studied when the program was developed by the GSAs.

8.4.2.4.5. Implementation Criteria, Status, and Plan

The Modesto Subbasin GSAs will develop annual reports to evaluate progress toward meeting the sustainability goal. If monitoring efforts demonstrate that the Projects and MAs being implemented are not effective in achieving stated targets, the GSAs will convene a working group to evaluate the implementation of additional supply-side and demand-side actions, such as the implementation of tiered approaches in the Pumping Management Framework.

8.4.2.4.6. Water Source and Reliability

The Subbasin area will be the source of groundwater and will be limited by the hydrology of the region.

8.4.2.4.7. Legal Authority

SGMA §10726.4 (a) (3 & 4) provide legal authority for groundwater transfer and accounting programs.

8.4.2.4.8. Estimated Costs and Funding Plan

The Groundwater Pumping Credit Market and Trading Program is in preliminary stages of discussion and possible consideration. Therefore, no costs have been estimated for its development and implementation. Such costs would be developed should the Modesto Subbasin GSAs decide to pursue a program in the future. Costs would likely include additional staffing required to administer the program and would be borne by the participants.

8.4.2.4.9. Management of Groundwater Extractions and Recharge

The implementation of a Groundwater Pumping Credit Market and Trading Program will include provisions for the recovery of groundwater levels and groundwater in storage during non-drought periods.

8.5. PLAN FOR ACHIEVING SUSTAINABILITY

8.5.1. Integrated Modeling Scenarios

To evaluate the effects of PMAs in meeting the sustainability goals of the Modesto Subbasin, Group 1 and 2 Projects have been analyzed using the C2VSimTM model. C2VSimTM is a fully integrated surface and groundwater flow model capable of analyzing the effects of the PMAs on the land surface, stream, and groundwater systems of the Modesto Subbasin. The C2VSimTM model is used to develop the GSP's water budget estimates for historical, current, and projected conditions, as well as Subbasin groundwater levels, streamflow, and interconnected surface water bodies under historical, baseline, and various Project conditions. It is understood that the projections of future groundwater conditions using the C2VSimTM model are based on the current understanding of the Subbasin, which can be further refined as more information becomes available. The 50-year projection of groundwater conditions using C2VSimTM is based on assumptions that has uncertainties in hydrologic and climatic conditions, agricultural crop mix and patterns, irrigation practices, population growth patterns and urban development trends, and land use plans, and environmental regulations. However, the C2VSimTM is currently the best available analysis tool to assist in evaluation of Project benefits and impacts, not in an absolute sense, but in a relative scale.

The analysis below evaluates the proposed projects relative to the C2VSimTM Projected Conditions Baseline. The results of this analysis are then compared to MTs to estimate the approximate amount of additional net demand reduction that will be needed to meet the sustainability goal of the Subbasin. The Projected Conditions Baseline applies the projected water supply and demand conditions under the 50-year hydrologic period of WYs 1969-2018. A total of seven (7) Group 1 and 2 Projects were grouped into two (2) scenarios based on their use-sector and Project type. **Table 8-10** shows a matrix of the simulated projects and their respective scenarios. Each of these projects are described in detail in **Section 8.2**, with modeling assumptions outlined in sub-section 5 for each project.

Table 8-10: Projects Analyzed Using C2VSimTM Model

	Urban and Municipal Projects	Scenario 1	Scenario 2
1	Growth Realization of Surface Water Treatment Plant Phase II	**Baseline**	**Baseline**
2	Municipal Conservations Projects	**X**	**X**
3	Storm Drain Cross Connection Removal Project	**X**	**X**
4	Surface Water Supply Project	**X**	**X**
	In-lieu Supply or Recharge Projects		
5	MID to Out-of-District Lands In-lieu and Direct Recharge Project		**X**
6	OID to Out-of-District Lands In-lieu and Direct Recharge Project		**X**
	Flood Mitigation Projects		
7	Tuolumne River Flood Mitigation Direct Recharge Project		**X**
8	Dry Creek Flood Mitigation Direct Recharge Project		**X**

Scenario 1: Urban and Municipal Surface Water Supply

Scenario 1 includes the three urban and municipal projects as proposed by their respective agencies. These projects, shown in **Table 8-11** total an average net-recharge of 13,700 AFY over the 50-year simulation period. Impacts to the subbasin were simulated by reducing the urban demand in the City of Modesto, providing surface water supplies to the City of Waterford, and incorporating additional recharge facilities throughout the City of Modesto. **Table 8-11** below summarizes the individual and cumulative impacts of each Project within this scenario.

Table 8-11: Scenario 1 Project Summary

	Project	Direct Recharge	In-Lieu Recharge	Demand Reduction
Urban and Municipal Projects	Municipal Conservation Projects[1]			12,800
	Storm Drain Cross Connection Removal Project	200		
	City of Waterford Surface Water Supply Project[1]		700	
	All Urban and Municipal Projects	200	700	12,800
All Scenario 1 Projects		**200**	**700**	**12,800**

Notes: All Units are in acre-feet

[1] The City of Modesto Conservation Projects and the City of Waterford Surface Water Supply Project include beneficiaries in both the Turlock and Modesto Subbasin. The volumes in this table represent an estimated fraction of the effective contribution to the Modesto Subbasin

Scenario 1 projects are expected to reduce net groundwater pumping in the subbasin by 13,700 AFY. The net benefit to groundwater in storage is to reduce the projected average annual groundwater in storage deficit from 11,000 AFY under the Baseline conditions to 9,500 AFY with these projects, resulting in a net savings of 1,500 AFY of groundwater in storage. Details are shown in **Table 8-13** and **Error! Reference source not found.**.

Principally, Scenario 1 projects were implemented to mitigate lowering groundwater levels, depletions of interconnected surface water systems, and potential subsidence near the urban centers within the Modesto Subbasin. **Section 8.5.2** presents the simulated groundwater conditions under both the projected conditions baseline and each of the PMA scenarios.

Scenario 1 is anticipated to be implemented in conjunction with multiple other agriculturally based projects to further improve and project aquifer conditions. See the descriptions of the following scenario for information on the cumulative impacts to the system.

Scenario 2: In-Lieu Supply Recharge and Flood Mitigation Projects

Scenario 2 builds on the benefits of Scenario 1 to incorporate the agriculturally based in-lieu and direct recharge projects. The addition of the projects to this scenario increases the net simulated contribution to the groundwater system from an average of 13,700 AF to 71,900 AFY. The four proposed projects include

1. The MID to Out-of-District Lands In-lieu and Direct Recharge Project, providing up to 60,000 AF of in-lieu recharge in Wet and Above Normal years, or an average annual contribution of 28,800 over the 50-year simulation period.

2. The OID to Out-of-District Lands In-lieu and Direct Recharge Project, providing up to 20,000 AFY of in-lieu recharge in all non-critically dry years, providing an average of 14,400 across the planning horizon.

3. The Tuolumne River Flood Mitigation Direct Recharge Project, providing 20,000 AFY of direct recharge in Wet and Above Normal years (9,600 AFY in the 50-year simulation average),

4. The Dry Creek Flood Mitigation Direct Recharge Project, providing 5,400 AFY of direct recharge in all year types.

The table below summarizes the individual and cumulative impacts of each Project within this scenario.

Table 8-12: Scenario 2 Project Summary

	Project	Direct Recharge	In-Lieu Recharge	Demand Reduction
Urban and Municipal Projects	Municipal Conservation Projects[1]			12,800
	Storm Drain Cross Connection Removal Project	200		
	City of Waterford Surface Water Supply Project[1]		700	
	All Urban and Municipal Projects	200	700	12,800
In-lieu Supply and Direct Recharge Projects	MID to Out-of-District Lands In-lieu and Direct Recharge Project	9,600	19,200	
	OID to Out-of-District Lands In-lieu and Direct Recharge Project	1,400	13,000	
	All In-lieu Supply or Recharge Projects	11,000	32,200	0
Flood Mitigation Projects	Tuolumne River Flood Mitigation Direct Recharge Project	9,600		
	Dry Creek Flood Mitigation Direct Recharge Project	5,400		
	All In-lieu Supply or Recharge Projects	15,000	0	0
All Scenario 2 Projects		**26,200**	**32,900**	**12,800**

Notes: All Units are in acre-feet
[1] The City of Modesto Conservation Projects and the City of Waterford Surface Water Supply Project include beneficiaries in both the Turlock and Modesto Subbasin. The volumes in this table represent an estimated fraction of the effective contribution to the Modesto Subbasin

Scenario 2 projects are expected to reduce groundwater pumping in the subbasin by 44,400 AFY. The net benefit to groundwater in storage projected is to reduce the average annual groundwater in storage deficit from 11,000 AFY under the Baseline conditions to an average annual positive change in storage of 1,400 AFY with these projects, resulting in a net savings of 12,400 AFY of groundwater in storage. Details are shown in **Table 8-13** and **Error! Reference source not found..**

Analysis of conditions under Scenario 2 show that under Project buildout, sustainability goals as defined by the Minimum Thresholds (MTs) outlined in **Chapter 6, Sustainable Management Criteria,** can be met without demand management. **Section 8.5.2** below shows how Scenarios 1 and 2 effect groundwater levels at representative monitoring locations throughout the subbasin relative to the simulated minimum thresholds.

While simulated conditions meet sustainability metrics in the long-term, the Modesto Subbasin acknowledges that these scenarios assume immediate implementation of the projects and MAs listed above. In the near-term, sustainability of the Modesto Subbasin relies on the NDE area to actively pursue the development of these projects and understands that interim MAs, including the potential for demand reduction, may be necessary to meet SMCs.

Figure 8-1: Scenario 1-2 Cumulative Change in Storage

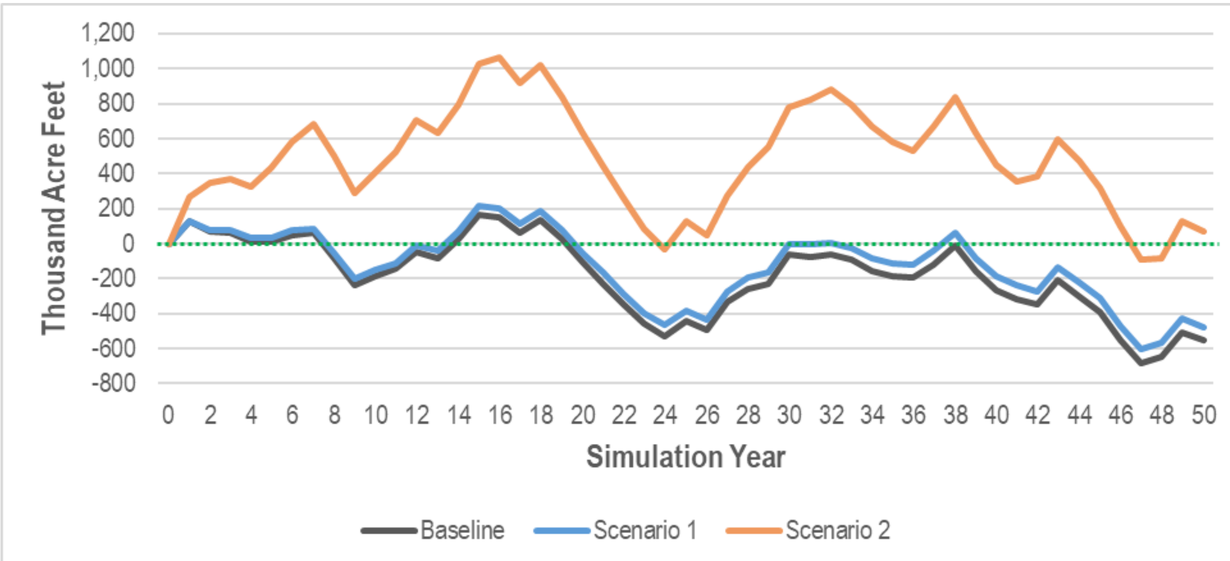


Figure 8-2: Scenario 2 Groundwater Budget

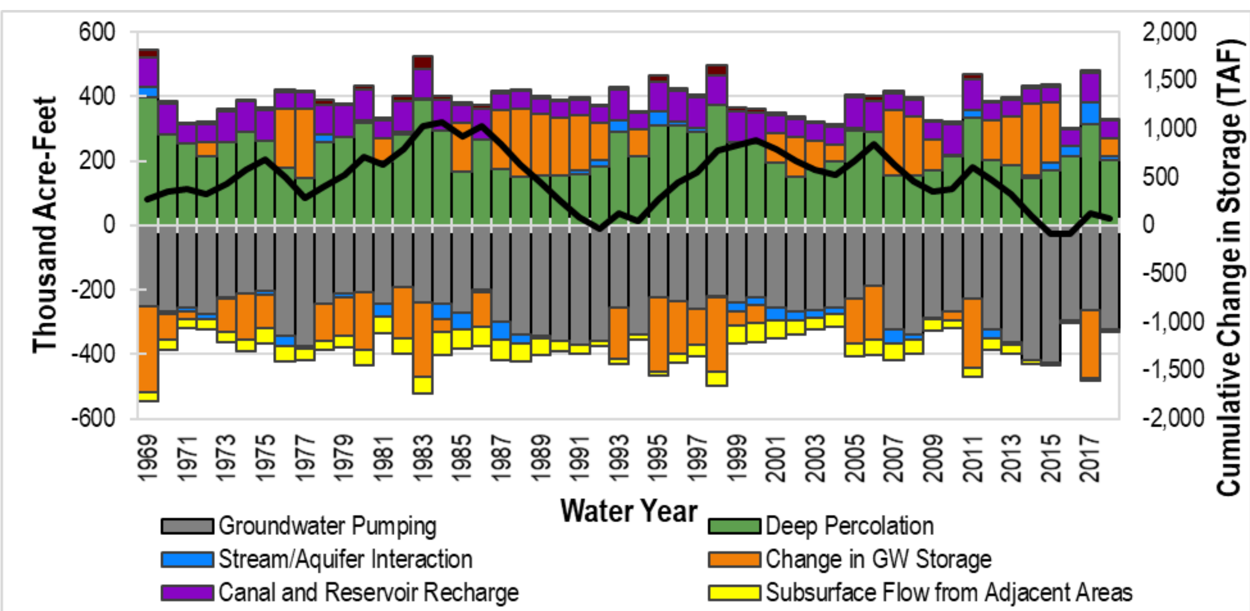


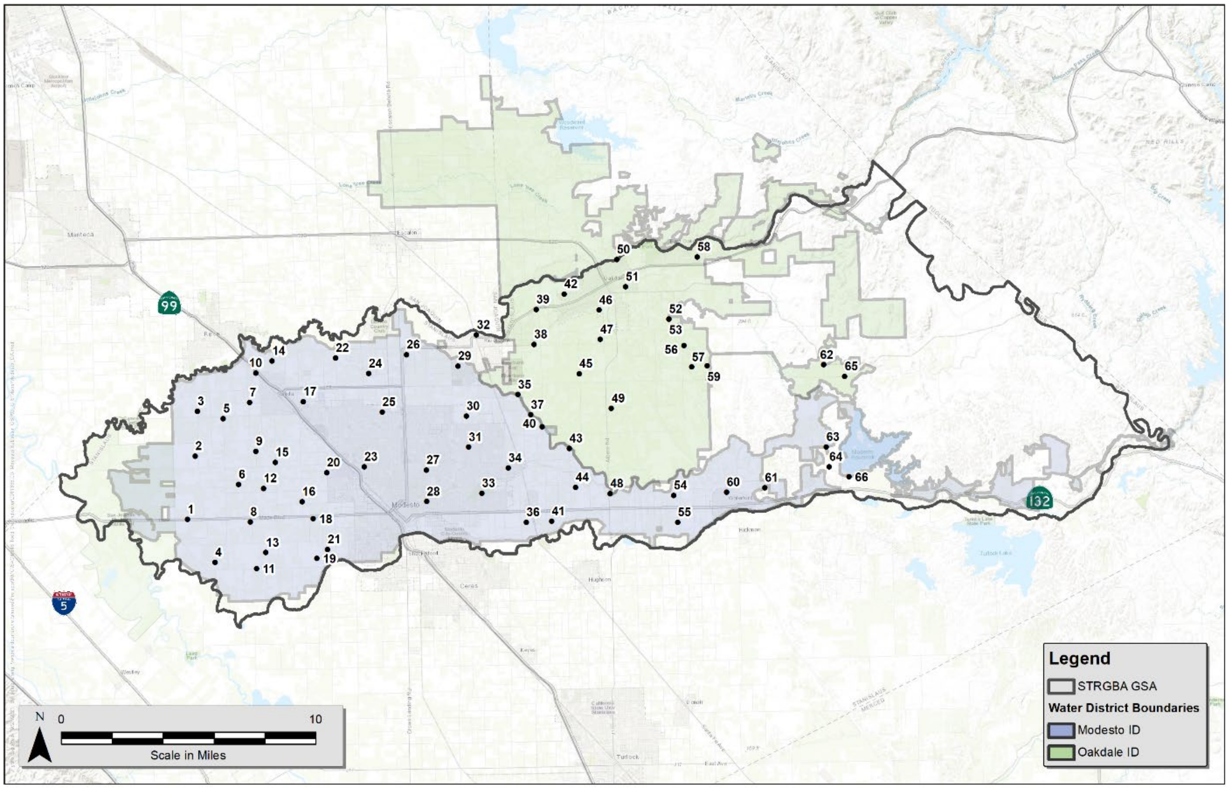
Table 8-13: Scenarios 1-2 Groundwater Budgets

	Baseline	Scenario 1 Urban & Municipal	Scenario 2 In-lieu and Direct Recharge Projects
Deep Percolation	234,900	230,100	235,800
Canal, Res., & Direct Recharge	47,300	47,500	73,500
Net Stream Seepage	24,300	18,800	-4,100
Inflow from Foothills	9,300	9,300	9,300
Net Subsurface Flow	-5,900	-7,600	-36,500
Groundwater Pumping	321,000	307,600	276,600
Groundwater in Storage Deficit	11,000	9,500	-1,400

8.5.2. Representative Hydrographs Scenarios 1-2

Figure 8-3 shows the location of the representative monitoring wells that were used in the development and calibration of the Modesto Subbasin in C2VSimTM. As representative wells of simulated conditions, these wells were used to evaluate the performance of the PMAs in each of the different scenarios.

Figure 8-3: Modesto Subbasin Representative Wells



Chapter 6: Sustainable Management Criteria describes thresholds for representative monitoring network wells that protect the Subbasin from experiencing Undesirable Results from the chronic lowering of groundwater levels (SMC1), and depletions of interconnected surface water systems (SMC6). **Chapter 6** defines Undesirable Results such that at no more than 33% of the representative monitoring wells shall exceed the 2015-low for a period longer than 3 consecutive years. Under Scenario 2, SGMA compliance was predicted to be met throughout the simulation period. As shown in the figures below, simulated groundwater levels occasionally drop below the MT, but do not exceed the combination of drought-time spatial and temporal limitations.

Note, the twelve wells listed below (**Figure 8-5** though **Figure 8-14**) are not inclusive of all monitoring locations, rather this subset was included as they are considered representative of RMS throughout the Subbasin. Locations of these example representative hydrographs are shown in the following figure.

Figure 8-4: SMC1 Example Hydrographs

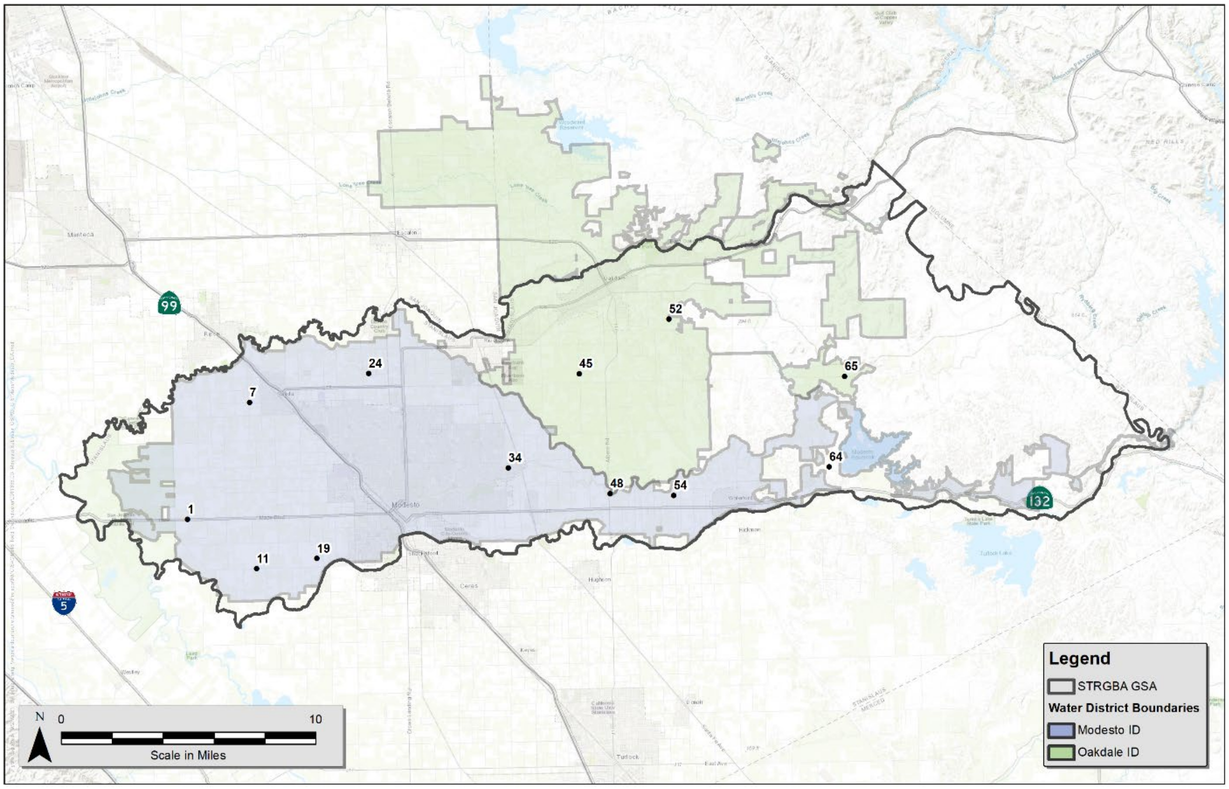


Figure 8-5: SMC1 Hydrograph C2VSimTM 01

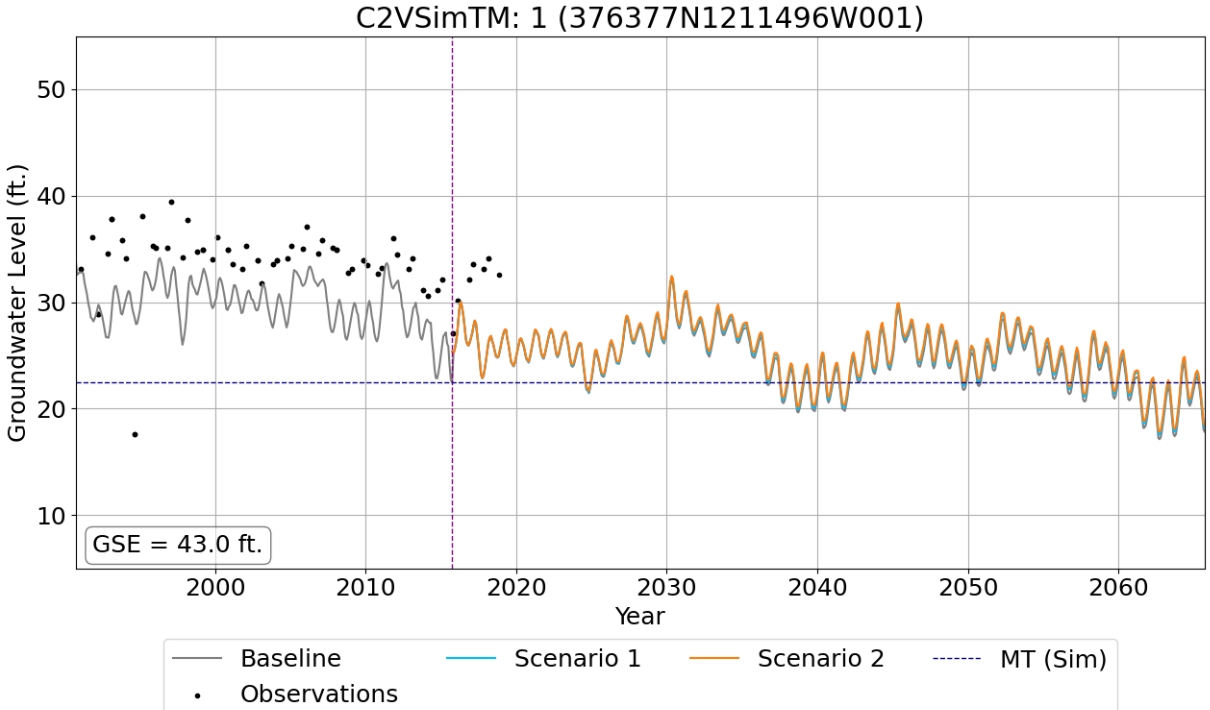


Figure 8-6: SMC1 Hydrograph C2VSimTM 07

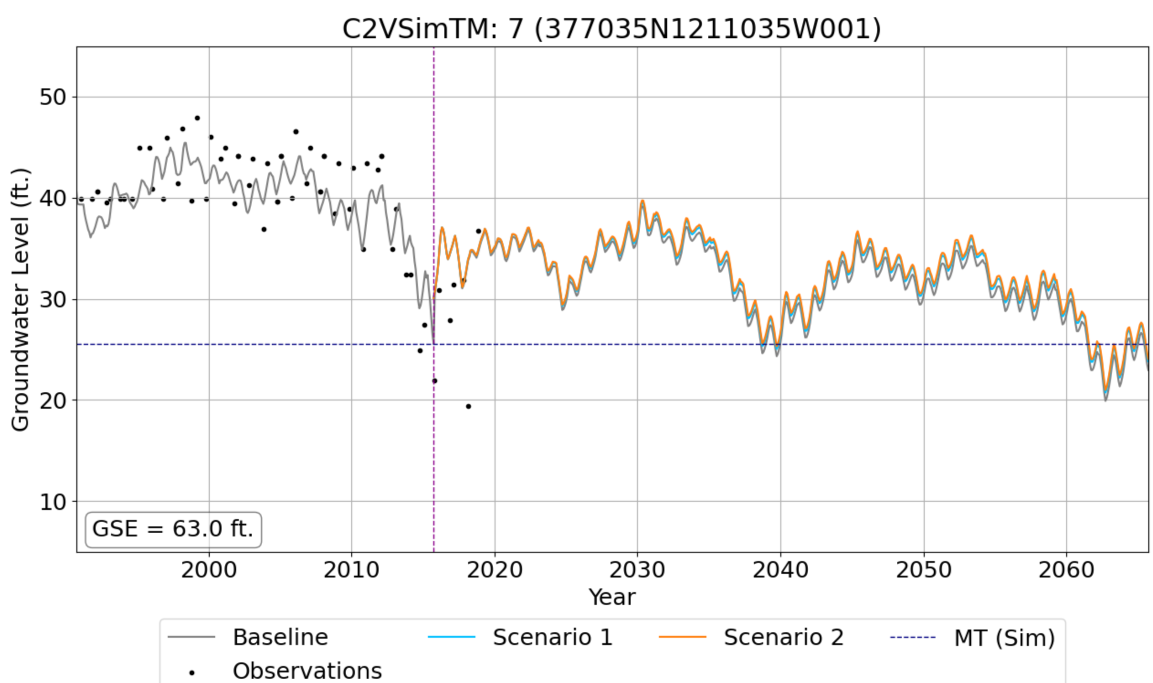


Figure 8-7: SMC1 Hydrograph C2VSimTM 11

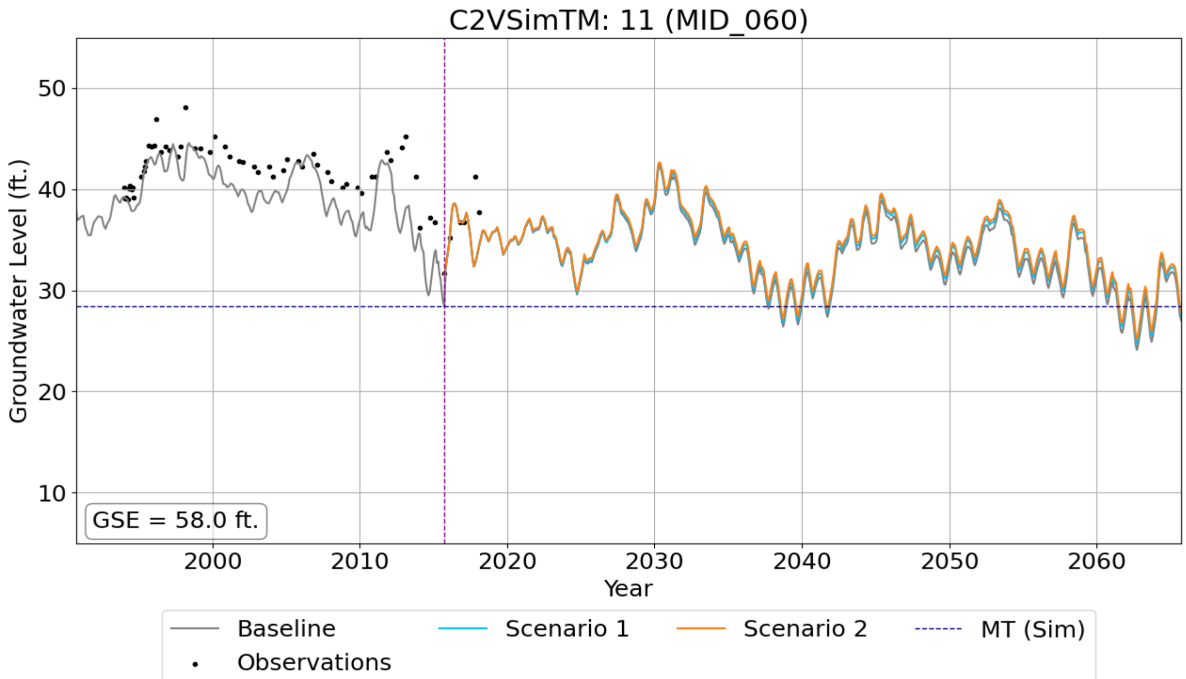


Figure 8-8: SMC1 Hydrograph C2VSimTM 19

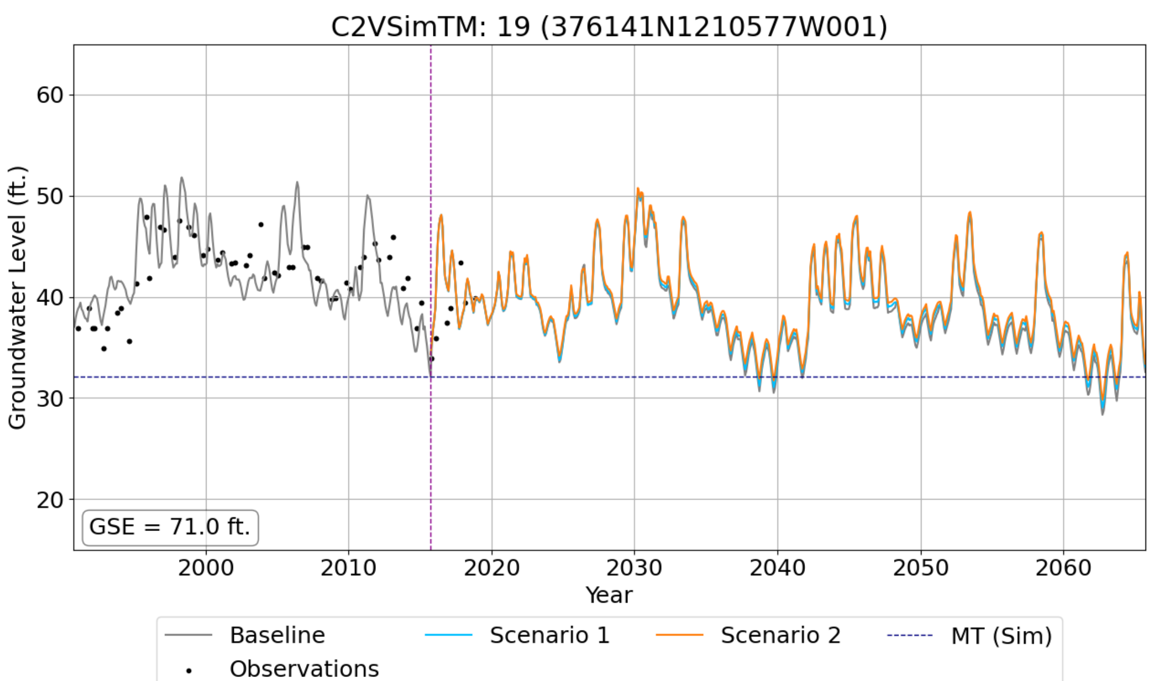


Figure 8-9: SMC1 Hydrograph C2VSimTM 24

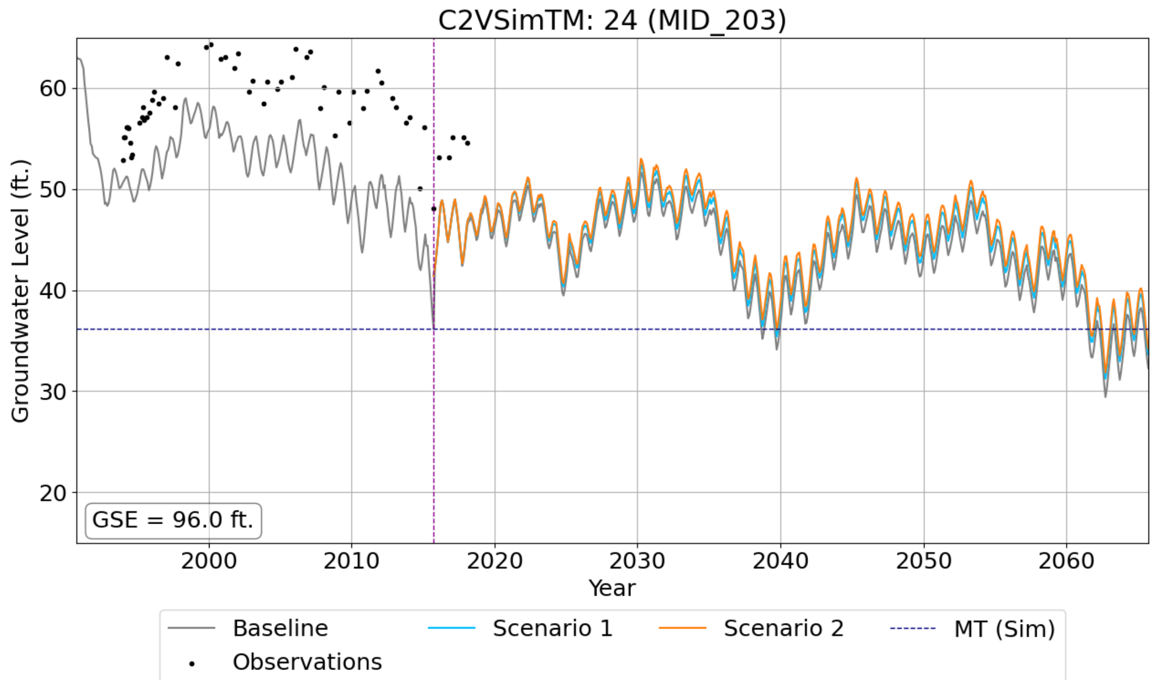


Figure 8-10: SMC1 Hydrograph C2VSimTM 34

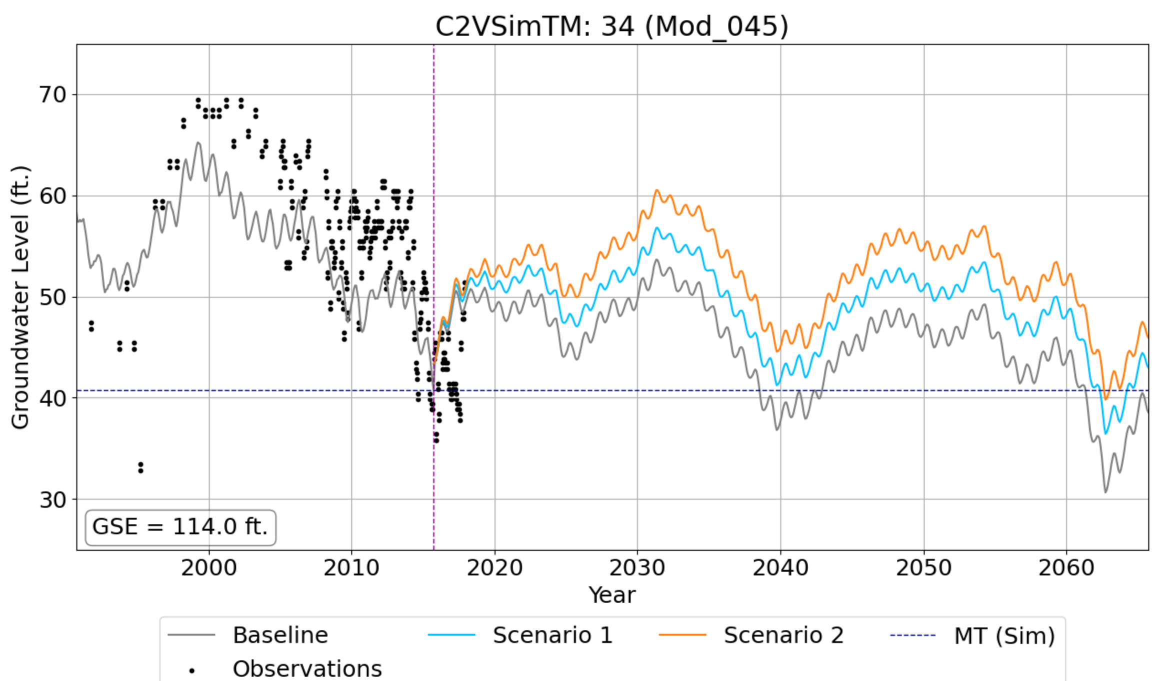


Figure 8-11: SMC1 Hydrograph C2VSimTM 45

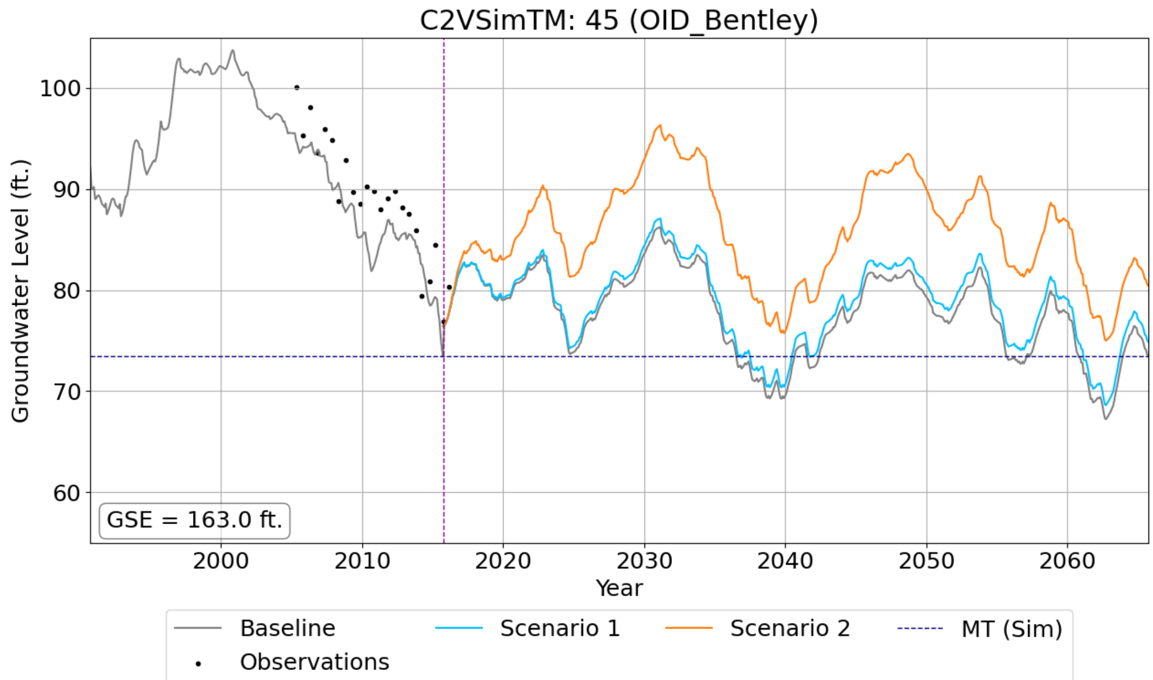


Figure 8-12: SMC1 Hydrograph C2VSimTM 48

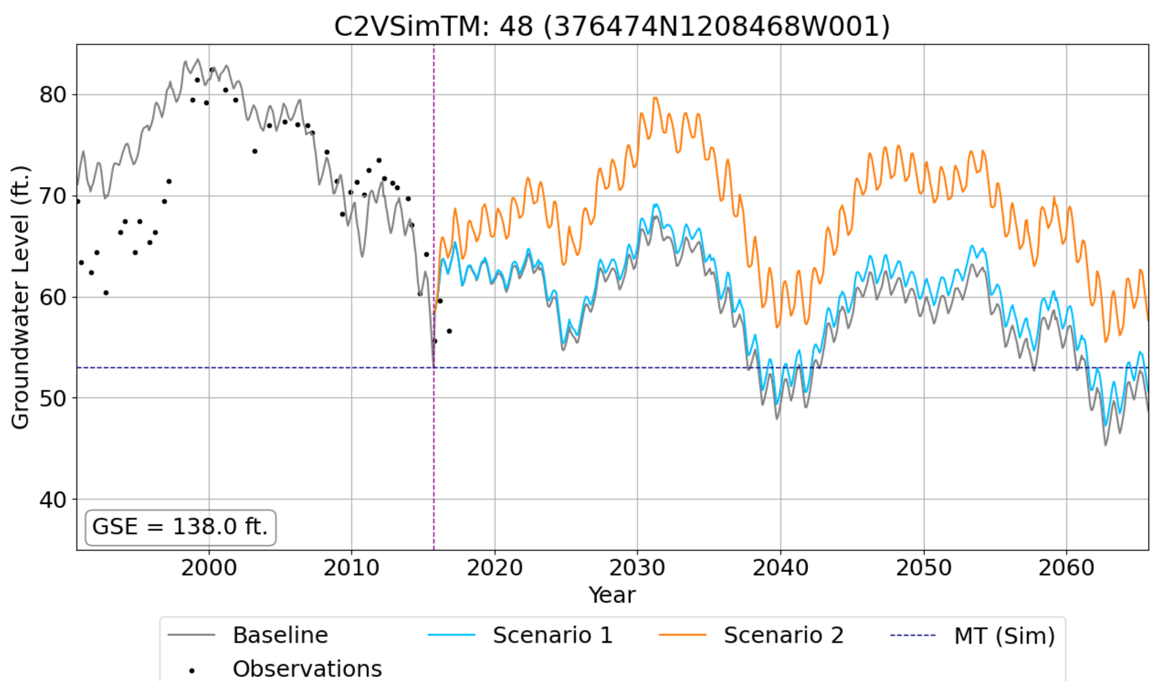


Figure 8-13: SMC1 Hydrograph C2VSimTM 52

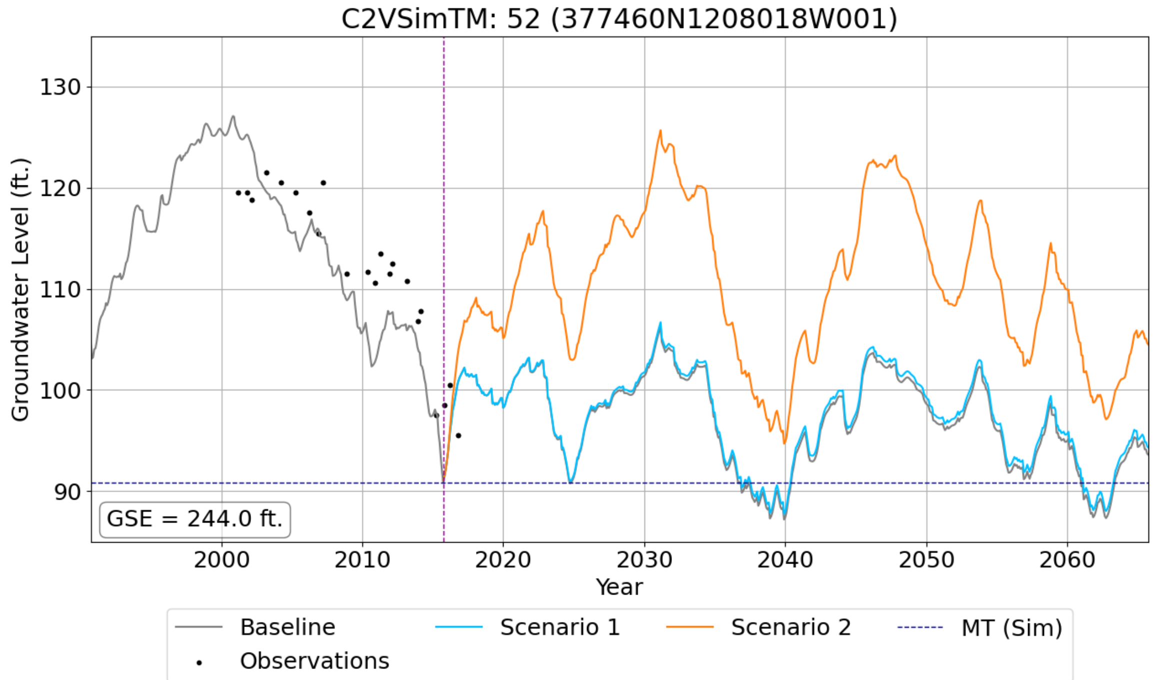


Figure 8-14: SMC1 Hydrograph C2VSimTM 54

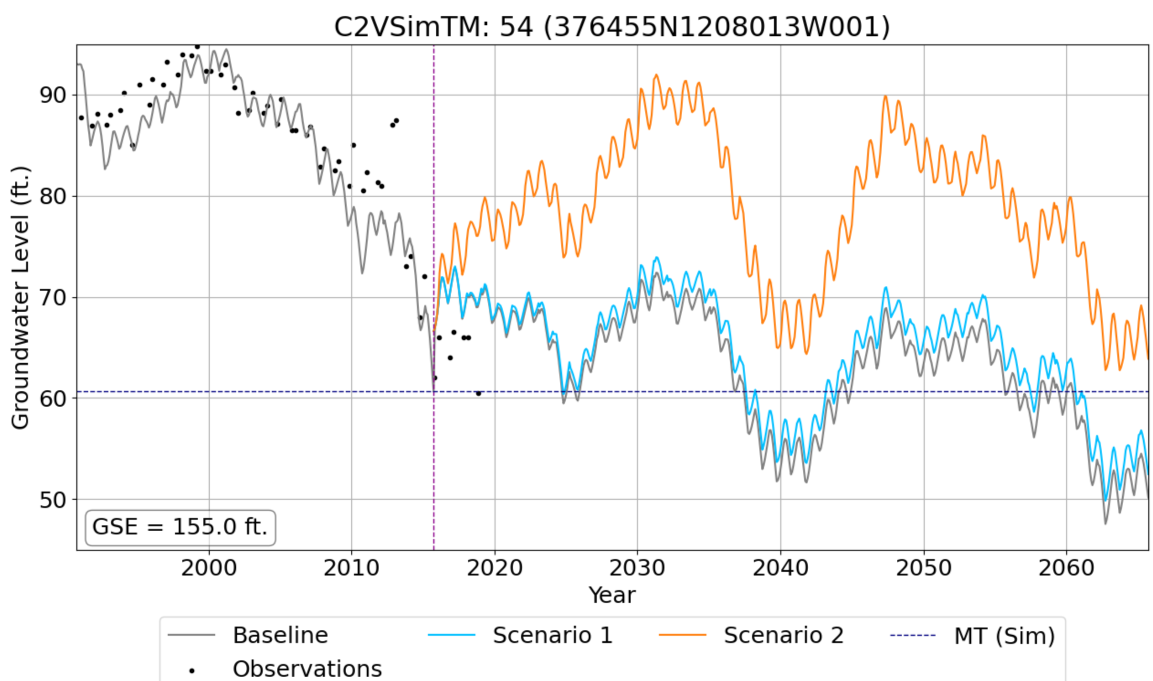


Figure 8-15: SMC1 Hydrograph C2VSimTM 64

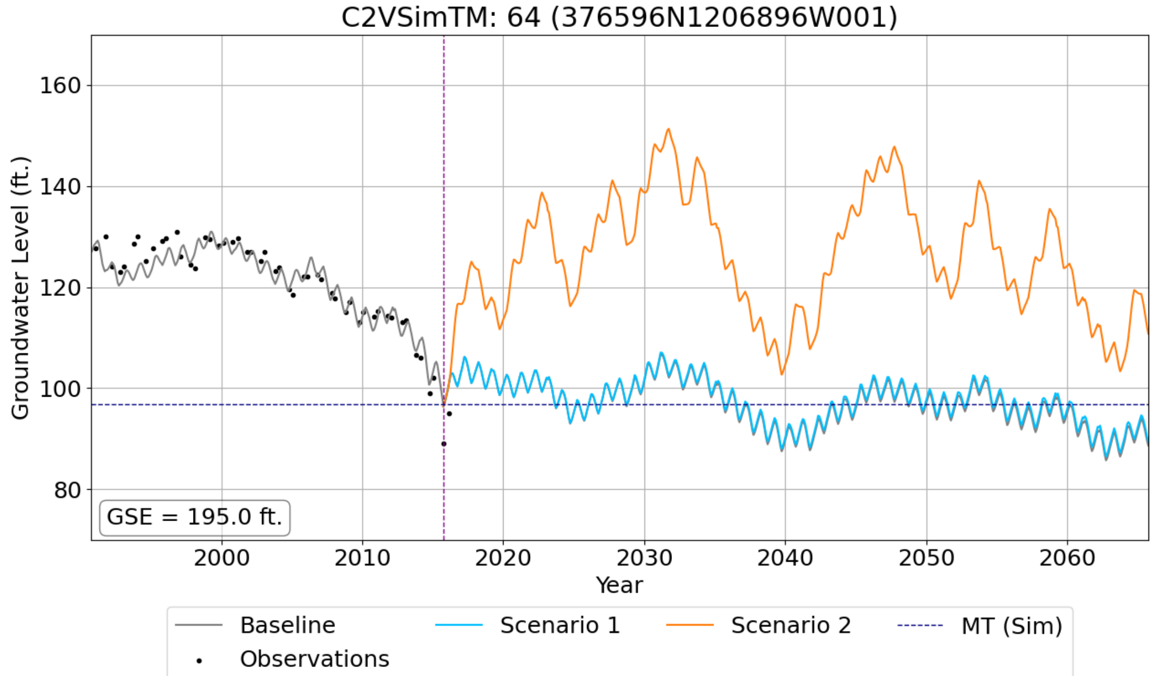
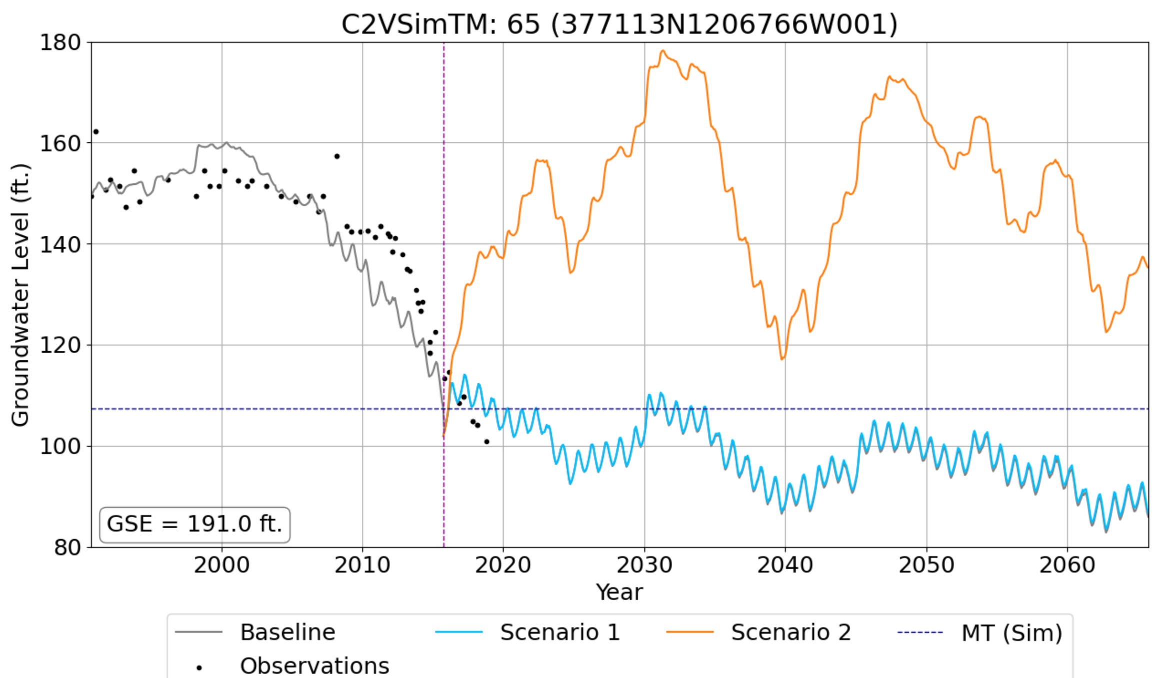


Figure 8-16: SMC1 Hydrograph C2VSimTM 65



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9. IMPLEMENTATION PLAN

9.1. PLAN IMPLEMENTATION

Implementation of this GSP includes implementation of the projects and MAs included in **Chapter 8**, as well as the following:

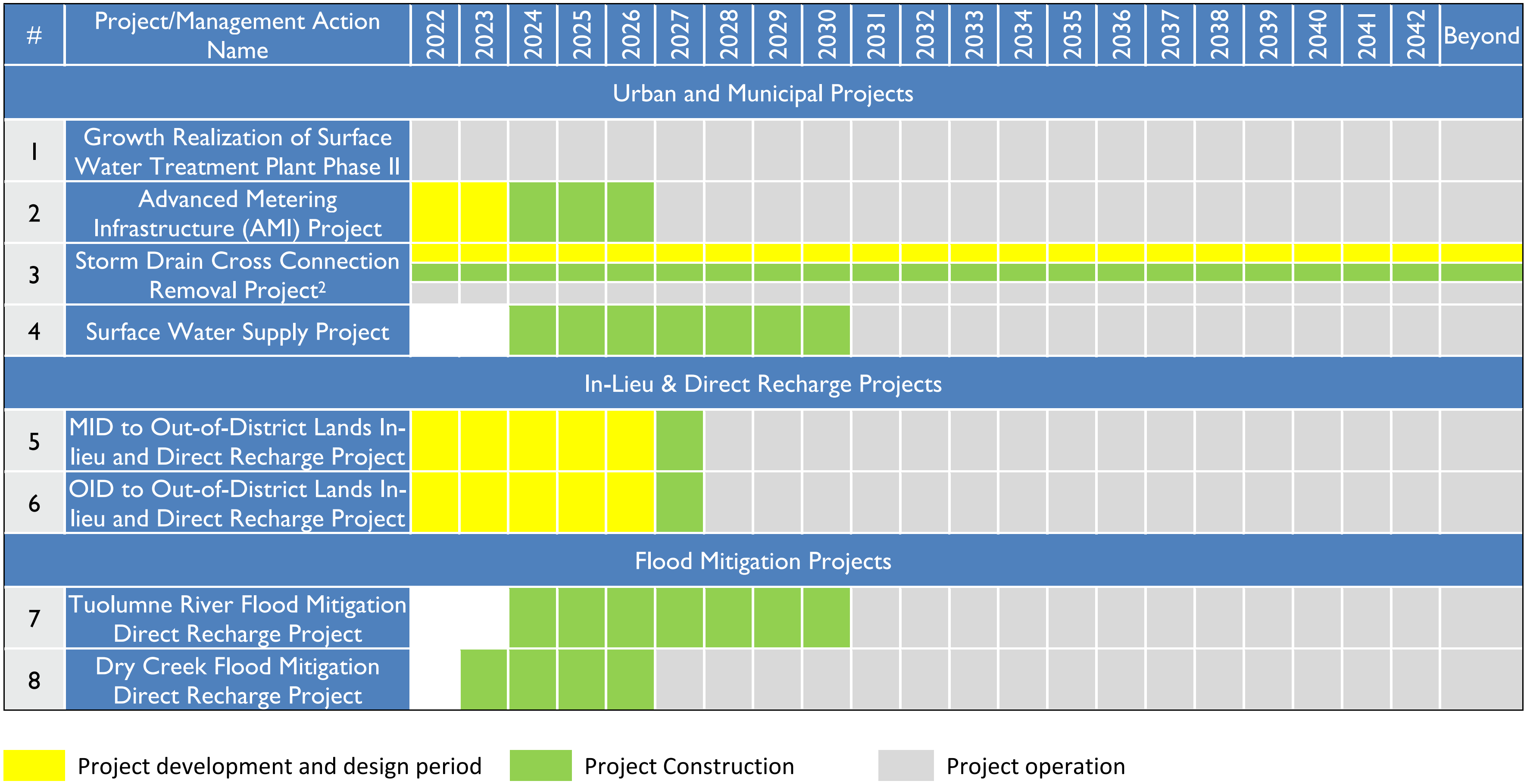
- Modesto Subbasin GSAs administration and management
- Implementing the monitoring program
- Implementation of Projects and MAs
- Developing annual reports
- Developing required five-year GSP updates

This chapter also describes the contents of both the annual and five-year reports that must be provided to the California Department of Water Resources (DWR) as required by Sustainable Groundwater Management Act (SGMA) regulations.

9.1.1. Implementation Schedule

Figure 9-1 illustrates the GSP's implementation schedule. Included in the chart are activities necessary for ongoing GSP monitoring and updates, as well as tentative schedules for projects and MAs. Additional details about the activities included in the schedule are provided in these activities' respective sections of this GSP. Adaptive management would only be implemented if triggering events are reached, as described in **Chapter 8**, and are shown as ongoing in the schedule.

Figure 9-1: Implementation Estimated Schedule[1]



[1] Potential future projects (Projects 9 through 13) are not included because they will be implemented by the GSAs as needed and do not have a planned schedule at this time.

[2] This Project has multiple phases and components that will be developed over time and therefore portions are in development/design, construction, or are completed simultaneously.

9.2. IMPLEMENTATION COSTS BUDGETS AND FUNDING SOURCES

The operation of the Modesto Subbasin GSAs and GSP implementation will incur costs, which will require funding. The five primary activities that will incur costs are listed here. **Table 9-1** summarizes these activities and their estimated costs. These estimates will be refined during GSP implementation as more information becomes available.

- Implementing the GSP
- Implementing GSP-related projects and MAs
- Operations of the GSAs
- Developing annual reports
- Developing five-year evaluation reports

Table 9-1: Modesto Subbasin GSAs and GSP Implementation Budgets

Activity	Estimated Annualized Budget [a]
GSP Implementation and GSA Management	
Administration and Legal Support for the GSAs	$35,000
Stakeholder and Board Engagement	$3,000
Outreach	$5,000
GSP Implementation Program Management	$25,000
Monitoring Program, including Data Management	$15,000
Annual Reporting	$100,000
Five-Year GSP Updates (total cost estimated to be $500,000, $100,000 annually)	$100,000
Data Gap Analysis	TBD
Projects and Management Actions	
Project 1: Growth Realization of Surface Water Treatment Plant Phase II	$93,190,000
Project 2: Advanced Metering Infrastructure Project (AMI)	$20,000,000
Project 3: Storm Drain Cross Connection Removal Project	$40,000,000
Project 4: Waterford/Hickman Surface Water Pump Station and Storage Tank	$8,500,000
Project 5: Modesto Irrigation District In-lieu and Direct Recharge Project	$53,340,000 - $75,000,000
Project 6: Oakdale Irrigation District In-lieu and Direct Recharge Project	$17,780,000 - $25,000,000
Project 7: Tuolumne River Flood Mitigation and Direct Recharge Project	See Project 5 above [b]
Project 8: Dry Creek Flood Mitigation and Direct Recharge Project	$4,800,600 - $6,750,000
Project 9: Stanislaus River Flood Mitigation and Direct Recharge Project	To be developed if implementation is needed
Project 10: Detention Basin Standards Specifications Update	To be developed if implementation is needed
Project 11: Recharge Ponds	To be developed if implementation is needed

Activity	Estimated Annualized Budget [a]
Project 12: OID Irrigation and Recharge to Benefit City of Oakdale	To be developed if implementation is needed
Project 13: Modesto Irrigation District FloodMAR Projects	To be developed if implementation is needed
MA 1: Voluntary Conservation and/or Land Fallowing	To be developed if implementation is needed
MA 2: Conservation Practices	To be developed if implementation is needed
MA 3: Groundwater Extraction and Surface Water Accounting Reporting Program	To be developed if implementation is needed
MA 4: Groundwater Allocation Program	To be developed if implementation is needed
MA 5: Groundwater Extraction Fee	To be developed if implementation is needed
MA 6: Groundwater Pumping Credit Market and Trading Program	To be developed if implementation is needed
[a] Estimates are rounded and based on full implementation years (FY 2023 through FY 2042). Different costs may be incurred in FY 2022 as GSP implementation begins and during each 5-year update cycle. [b] Projects 5 and 7 use the same infrastructure for surface water conveyance.	

9.2.1. GSP Implementation and Funding

Costs associated with GSP implementation and operation of the GSAs could include the following:

- **Modesto Subbasin GSAs administration and legal support:** Overall program management and coordination activities, and legal services
- **Stakeholder Engagement:** GSAs board meetings, Technical Advisory (TAC) meetings, general GSA meetings, and public workshops as needed.
- **Outreach:** Email communications, newsletters, and website management
- **GSP implementation program management:** Program management and oversight of project and management action implementation, including coordination among GSAs Boards, staff and stakeholders, coordination of GSAs implementation technical activities, oversight and management of the GSAs consultants and subconsultants, budget tracking, schedule management, and quality assurance/quality control of project implementation activities, and integrating and maintaining a live projects and management actions list

- **Monitoring:** Data collection, filling data gaps, improvements and/or enhancements to DMS

Implementation of this GSP is projected to run between $250,000 and $350,000 per year, and projects and MAs totaling between $237,610,600 - $268,440,000. Development of this GSP was funded through a Proposition 1 Sustainable Groundwater Planning Grant. Operation of the GSAs is fully funded through contributions from GSAs member agencies. Although ongoing operation of the GSAs is anticipated to include contributions from its member agencies, which are ultimately funded through customer fees or other public funds, additional funding may be required to implement the GSP. Of the implementation activities in the GSP, only project implementation is likely to be eligible for grant or loan funding; funding through grants or loans have varying levels of certainty. As such, the GSAs will develop a financing plan that may include one or more of the following financing approaches:

- **Pumping Fees:** Pumping fees would implement a charge for pumping that would be used to fund GSP implementation activities. In the absence of other sources of funding (i.e., grants, loans, or combined with assessments) fees could range between $10 and $100 per AF per year. To meet the funding needs of the GSP, fees would be lower when pumping is higher, such as current pumping levels, and higher when pumping is lower, such as when sustainable pumping levels are achieved. Although this funding approach would meet the financial needs of the GSP and GSAs, it may discourage pumping reductions due to cost. The financing plan developed by the GSAs would evaluate how to balance the need for funding with encouraging pumpers to commit to compliance with desired groundwater pumping reduction goals.

- **Assessments:** Assessments would charge a fee based on land areas. There are two methods for implementing an assessment based on acreage. The first option would assess a fee for all acres in the Subbasin outside of those in federal lands, which would cost approximately $5 to $10 per acre per year. This option would not distinguish between land use types. The second option would be to assess a fee only on irrigated acres. Based on current irrigated acreage, the assessment would be $10 to $50 per acre per year. Similar to the pumping fee approach, assessment based on irrigated acreage could affect agricultural operations and contribute to land use conversions, which could affect the assessment amount or ability to fully fund GSP implementation.

- **Combination of fees and assessments:** This approach would combine pumping fees and assessments to moderate the effects of either approach on the economy in the Basin. This approach would likely include an assessment that would apply to all acres in the Basin, rather than just to irrigated acreage. It would be coupled with a pumping fee to account for those properties that use more water than others.

During development of a financing plan, the GSAs would also determine whether to apply fees across the Subbasin as a whole or just within certain Management Areas. Prior to implementing any fee or assessment program, the GSAs would complete a rate assessment study and other analysis consistent with the requirements of Proposition 218.

The GSAs member agencies will pursue grants and loans to help pay for project costs to the extent possible. If grants or loans are secured for project implementation, potential pumping fees and assessments may be adjusted to align with operating costs of the GSAs and ongoing GSP implementation activities. A potential hurdle to the utilization of state grant funding is that delays in payment by the state can cause hardships for disadvantaged communities. Therefore, it would be appropriate to expedite payments associated with grant funding by DWR.

9.2.2. Projects and Management Actions

Costs for the Projects and MAs are described in **Chapter 8: Projects and Management Actions** of this GSP. Financing of the projects and MAs would vary depending on the activity. Potential financing options for projects and MAs are provided in **Table 9-2**, though other financing may be pursued as opportunities arise or as appropriate.

Table 9-2: Financing Options for Proposed Projects, Management Actions, and Adaptive Management Strategies

Project/Activity	Responsible Entity	Potential Financing Options
Projects		
Project 1: Growth Realization of Surface Water Treatment Plant Phase II	City of Modesto/MID	City of Modesto Operating Costs Grants Loans
Project 2: Advanced Metering Infrastructure Project (AMI)	City of Modesto	City of Modesto Operating Costs Grants Loans
Project 3: Storm Drain Cross Connection Removal Project	City of Modesto	City of Modesto Operating Costs Grants Loans

Project/Activity	Responsible Entity	Potential Financing Options
Project 4: Waterford/Hickman Surface Water Pump Station and Storage Tank	City of Waterford	City of Waterford Operating Costs
Project 5: Modesto Irrigation District In-lieu and Direct Recharge Project	NDE Areas	Grants Loans Participating NDE landowners
Project 6: Oakdale Irrigation District In-lieu and Direct Recharge Project	NDE Areas	Grants Loans Participating NDE landowners
Project 7: Tuolumne River Flood Mitigation and Direct Recharge Project	NDE Areas	Grants Loans Participating NDE landowners
Project 8: Dry Creek Flood Mitigation and Direct Recharge Project	Stanislaus County/NDE Areas	Grants Loans Participating NDE landowners
Project 9: Stanislaus River Flood Mitigation and Direct Recharge Project	NDE Areas	Grants Loans Participating NDE landowners
Project 10: Retention Basin Standards Specifications Update	City of Modesto	Grants Loans City of Modesto Operating Costs
Project 11: Recharge Ponds	NDE Areas	Grants Loans Participating NDE landowners
Project 12: OID Irrigation and Recharge to Benefit City of Oakdale	OID/City of Oakdale	Grants Loans City of Oakdale Operating Costs

Project/Activity	Responsible Entity	Potential Financing Options
Project 13: Modesto Irrigation District FloodMAR Projects	MID	Grants Loans MID Operating Costs
Management Actions		
MA 1: Voluntary Conservation and/or Land Fallowing	GSAs	Grants Loans GSA's Operating Funds GSA's Member Agencies
MA 2: Conservation Practices	GSAs	Grants Loans GSA's Operating Funds GSA's Member Agencies
MA 3: Groundwater Extraction and Surface Water Accounting Reporting Program	GSAs	Grants Loans GSA's Operating Funds GSA's Member Agencies
MA 4: Groundwater Allocation Program	GSAs	Grants Loans GSA's Operating Funds GSA's Member Agencies
MA 5: Groundwater Extraction Fee	GSAs	Grants Loans GSA's Operating Funds GSA's Member Agencies
MA 6: Groundwater Pumping Credit Market and Trading Program	GSAs	Grants Loans GSA's Operating Funds GSA's Member Agencies

9.3. ANNUAL REPORTS

Annual reports must be submitted by April 1 of each year following GSP adoption per California Code of Regulations. Annual reports must include three key sections as follows

- General Information
- Basin Conditions
- Plan Implementation Progress

An outline of what information will be provided in each of these sections in the annual report is included below. Annual reporting will be completed in a manner and format consistent with Section 356.2 of the SGMA regulations. As annual reporting continues, it is possible that this outline will change to reflect Subbasin conditions, priorities of the GSAs, and applicable requirements.

9.3.1. General Information

General information will include an executive summary that highlights the key content of the annual report. As part of the executive summary, this section will include a description of the sustainability goals, provide a description of GSP projects and their progress as well as an annually updated implementation schedule and map of the Subbasin. Key components as required by SGMA regulations include:

- Executive Summary
- Map of the Basin

9.3.2. Basin Conditions

Basin conditions will describe the current groundwater conditions and monitoring results. This section will include an evaluation of how conditions have changed in the Subbasin over the previous year and compare groundwater data for the year to historical groundwater data. Pumping data, effects of project implementation (e.g., recharge data, conservation, if applicable), surface water flows, total water use, and groundwater in storage will be included. Key components as required by SGMA regulations include:

- Groundwater elevation data from the monitoring network
- Hydrographs of elevation data
- Groundwater extraction data
- Surface water supply data
- Total water use data
- Change in groundwater in storage, including maps

9.3.3. Plan Implementation Progress

Progress toward successful plan implementation would be included in the annual report. This section of the annual report would describe the progress made toward achieving interim milestones as well as implementation of projects and MAs. Key components as required by SGMA regulations include:

- Plan implementation progress
- Sustainability progress

This section may include updates to the projects and management actions list, as new project ideas are presented or existing projects are phased out, completed, or found not to be feasible.

9.4. FIVE-YEAR EVALUATION REPORT

SGMA requires evaluation GSPs regarding their progress toward meeting approved sustainability goals at least every five years. SGMA also requires developing a written assessment and submitting this assessment to DWR. An evaluation must also be made whenever the GSP is amended. A description of the information that will be included in the five-year report is provided below and would be prepared in a manner consistent with Section 356.4 of the SGMA regulations.

9.4.1. Sustainability Evaluation

This section will contain a description of current groundwater conditions for each applicable sustainability indicator and will include a discussion of overall Subbasin sustainability. Progress toward achieving interim milestones and measurable objectives will be included, along with an evaluation of groundwater elevations (i.e., those being used as direct or proxy measures for the sustainability indicators) in relation to minimum thresholds. If any of the adaptative management triggers are found to be met during this evaluation, a plan for implementing adaptive management described in the GSP would be included.

9.4.2. Plan Implementation Progress

This section will describe the status of project and MA implementation, and report on whether any adaptive MA triggers had been activated since the previous five-year report. An updated project implementation schedule will be included, along with any new projects that were developed to support the goals of the GSP and a description of any projects that are no longer included in the GSP. The benefits of projects that have been implemented will be included, and updates on projects and MAs that are underway at the time of the five-year report will be reported.

9.4.3. Reconsideration of GSP Elements

Part of the five-year report will include a reconsideration of GSP elements. As additional monitoring data are collected during GSP implementation, land uses and community characteristics change over time, and GSP projects and MAs are implemented, it may become necessary to revise the GSP. This section of the five-year report will reconsider the Basin setting, management areas, undesirable results, minimum thresholds, and measurable objectives. If appropriate, the five-year report will recommend revisions to the GSP.

Revisions would be informed by the outcomes of the monitoring network, and changes in the Basin, including changes to groundwater uses or supplies and outcomes of project implementation.

9.4.4. Monitoring Network Description

A description of the monitoring network will be provided in the five-year report. Data gaps, or areas of the Subbasin that are not monitored in a manner commensurate with the requirements of Sections 352.4 and 354.34(c) of the SGMA regulations will be identified. An assessment of the monitoring network's function will also be provided, along with an analysis of data collected to date. If data gaps are identified, the GSP will be revised to include a program for addressing these data gaps, along with an implementation schedule for addressing gaps and how the GSAs will incorporate updated data into the GSP.

9.4.5. New Information

New information that becomes available after the last five-year evaluation or GSP amendment would be described and evaluated. If the new information warrants a change to the GSP, this would also be included.

9.4.6. Regulations or Ordinances

The five-year report will include a summary of the regulations or ordinances related to the GSP that have been implemented by DWR since the previous report, and address how these may require updates to the GSP.

9.4.7. Legal or Enforcement Actions

Enforcement or legal actions taken by the GSAs or its member agencies in relation to the GSP will be summarized in this section along with how such actions support sustainability in the Subbasin.

9.4.8. Plan Amendments

A description of amendments to the GSP will be provided in the five-year report, including adopted amendments, recommended amendments for future updates, and amendments that are underway during development of the five-year report.

9.4.9. Coordination

The Modesto Subbasin GSAs will continue to work collaboratively to ensure implementation of the GSP to reach sustainability in the Subbasin by 2042. The GSAs will also coordinate with neighboring Subbasins including Eastern San Joaquin, Turlock, Delta-Mendota, and Tracy as needed, or any other land use agencies or entities for project implementation. This section of the five-year report will describe coordination activities between these entities, such as meetings, joint projects, or data collection efforts.

9.5. DATA GAP ANALYSIS

As documented in **Table 3-7**, data gaps have been identified that would support sustainable groundwater management. Those data gaps include improved monitoring and analysis for the Western Lower Principal Aquifer, Eastern Principal Aquifer, interconnected surface water, and GDEs. In addition, the analysis in **Section 2.3.3** identified data gaps for domestic wells. Each of these data gaps are described in the sections below.

9.5.1. Improvements to Monitoring Network

The current GSP monitoring network described in **Chapter 7** meets monitoring objectives for initial tracking and evaluation of sustainable groundwater management criteria in each principal aquifer across the Subbasin. Nonetheless, there are data and knowledge gaps that could improve local monitoring and management. Monitoring improvements targeted for early GSP implementation are summarized below. These improvements will be made over time based on priorities and funding. As mentioned above, a comprehensive assessment of the monitoring network will be conducted as part of the five-year GSP evaluation.

9.5.1.1. Western Lower Principal Aquifer

As noted in **Table 3-7**, an insufficient number of monitoring wells are screened solely in the Western Lower Principal Aquifer to monitor groundwater levels and flow. **Figure 7-2** shows the five existing monitoring sites for this aquifer and illustrates the need for additional wells in the west. As noted on the figure, these wells support monitoring for chronic lowering of groundwater levels, reduction of groundwater in storage, and land subsidence. Additional wells would provide better coverage for development and tracking of sustainable management criteria and development of groundwater elevation contour maps. In turn, these improvements would allow better protection against future land subsidence, assist with water budgets and model calibration, and provide a better understanding of groundwater quality data in the Subbasin.

As part of this process, the GSAs will prioritize unmonitored areas of the aquifer and identify district-owned or other available lands where new monitoring wells might be sited in the future. To expedite collection of key data in the short-term, GSAs will explore the use of existing, properly-screened wells from cooperative private well owners. If available, the GSAs would use grant funding for additional monitoring well installations in the future. Two of the existing five monitoring sites were recently installed with a Sustainable Groundwater Management grant funded by Proposition 68.

9.5.1.2. Eastern Principal Aquifer

As noted in **Table 3-7** and described in **Section 7.1.1**, the Eastern Principal Aquifer in the Non-District East Management Area represents a critical data gap for both historical and current data on groundwater levels and flow. As documented throughout the technical analyses in **Chapters 3**, **5**, and **6**, groundwater in this area has had the largest rates of decline and continuing overdraft – conditions that have the greatest potential to lead to undesirable results.

Proposition 68 provided an opportunity to install additional monitoring wells in this area to provide more information on local groundwater conditions. However, existing wells are insufficient for development and tracking of sustainable management criteria in key areas of the Non-District East Management Area. It is anticipated that new wells will be installed as part of project implementation by the Non-District East Management Area. Grant funding will be used for these new wells, as available.

In addition to new monitoring wells, there are data gaps with respect to the existing agricultural wells that need to be better understood. Construction and extraction data from active irrigation wells in this area are unknown. Using available well records and working directly with Non-District East Management Area landowners, the GSAs will work to fill these data gaps, providing more accurate assessments of groundwater conditions in the future. These new data will be incorporated into the water budget analyses as available, which will be provided in annual reports (see **Section 9.3**).

9.5.1.3. Interconnected Surface Water

As indicated in **Table 3-7** and illustrated on **Figure 7-5**, data gaps exist for monitoring and management of interconnected surface water along the Subbasin river boundaries. The Proposition 68 grant provided the opportunity to install five new wells along the Tuolumne and Stanislaus rivers to support GSP monitoring of interconnected surface water. However, given the long river boundaries and other priorities for monitoring, the current network is incomplete. Additional wells would also assist with monitoring GDEs.

GSAs in the neighboring subbasins, including the Eastern San Joaquin, Turlock and Delta-Mendota subbasins, are currently planning additional wells along the shared river boundaries of the Stanislaus, Tuolumne, and San Joaquin rivers. Consistent with the Modesto Subbasin Sustainability Goal, the GSAs will coordinate with neighboring GSAs to site and install wells that are capable of generating useful data for the shared surface water resources.

9.5.2. Analyses of Groundwater Dependent Ecosystems

The dataset of Natural Communities Commonly Associated with Groundwater (NCCAG) provided by DWR were published after the GSP work plan and grant application had been completed. As such, it was difficult to include anything more than a high-level screening of potential GDEs in the initial GSP using periods of high and low groundwater elevations (**Section 3.2.8**). Following this screening, more than 70 percent of the original NCCAG polygons were retained as potential GDEs for future analyses.

As explained in **Section 3.2.8**, Moore Biological Consultants reviewed the potential GDEs within Mapes Ranch, a private property near the San Joaquin River. Using both a desktop study and field survey, Moore Biological Consultants concluded that 56 potential GDE polygons within Mapes Ranch are not GDEs. Given this, there may be more potential GDEs in the Subbasin that are not actually GDEs.

Because of the large number of potential GDE polygons, it was unreasonable to incorporate field surveys for all of these areas in the initial GSP assessment. As noted in **Section 6.8**, MTs were set at 2015 levels along the interconnected surface water to be protective of the GDEs along the rivers (where most of the potential GDE polygons occur). Monitoring data will be used to consider potential impacts on GDEs and shared publicly in annual reports.

In addition, the GSAs will continue to investigate potential GDEs and conduct additional analyses going forward. As an initial step, the GSAs will seek technical consultants with expertise to assist in developing a plan for additional GDE analyses.

9.5.3. Domestic Well Data

During the analysis of impacts to domestic wells, it was determined that significant data gaps exist. As noted in **Table 6-2** (**Section 6.3.1.1**), 159 domestic wells failed during 2015-2017 drought conditions (see also **Figures 2-15** and **6-1**). However, recent records of well permits also indicate that many of the failed wells appear to have since been replaced. Although more than 3,000 domestic wells are included in the DWR Well Completion Report database, hundreds of those lack either completion date, construction data or complete location information and there is no indication of which wells have since been destroyed or taken offline. In addition, the well use is not documented for many additional wells in the DWR database, which could represent unknown domestic wells.

The technical team worked with the GSA representative from the City of Modesto to test the DWR database in a rural neighborhood outside of the city where domestic wells are known to be located. Even in that small area, many wells could not be correlated to DWR data and/or did not have construction or other key data in the DWR dataset.

Although production from these wells is likely to be de minimis (less than 2 AFY/well) as defined by SGMA, it would be helpful to better understand the number of active domestic wells. As part of GSP implementation, GSAs will consider how best to improve domestic well datasets. Areas where domestic wells are concentrated or vulnerable to declining water levels will be prioritized (see **Figures 2-14**, **2-17**, and **6-1**). An additional resource for domestic well data includes the Nitrate Control Program (NCP), where ongoing monitoring for nitrate and other constituents is focused on domestic wells (see **Sections 2.4.4**, **6.6.2.1.1**, **6.6.2.2**, and **7.1.4**); access to well data will be coordinated through the Valley Water Collaborative, which is implementing the NCP in the Modesto Subbasin. Outreach and well registration activities being applied in other subbasins will also be considered for the Modesto Subbasin.

9.6. CLOSING

The GSP implementation activities are designed to identify and document steps for successful implementation. Collectively, the sustainable management criteria, monitoring networks, and projects and management actions are anticipated to achieve the Modesto Subbasin sustainability goal. Although it is recognized that more information and actions will be needed over time, the GSAs will incorporate an adaptive management approach to prioritize activities based on best available information and document those activities and data through continued outreach and annual reporting.

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January 2022

Modesto Subbasin

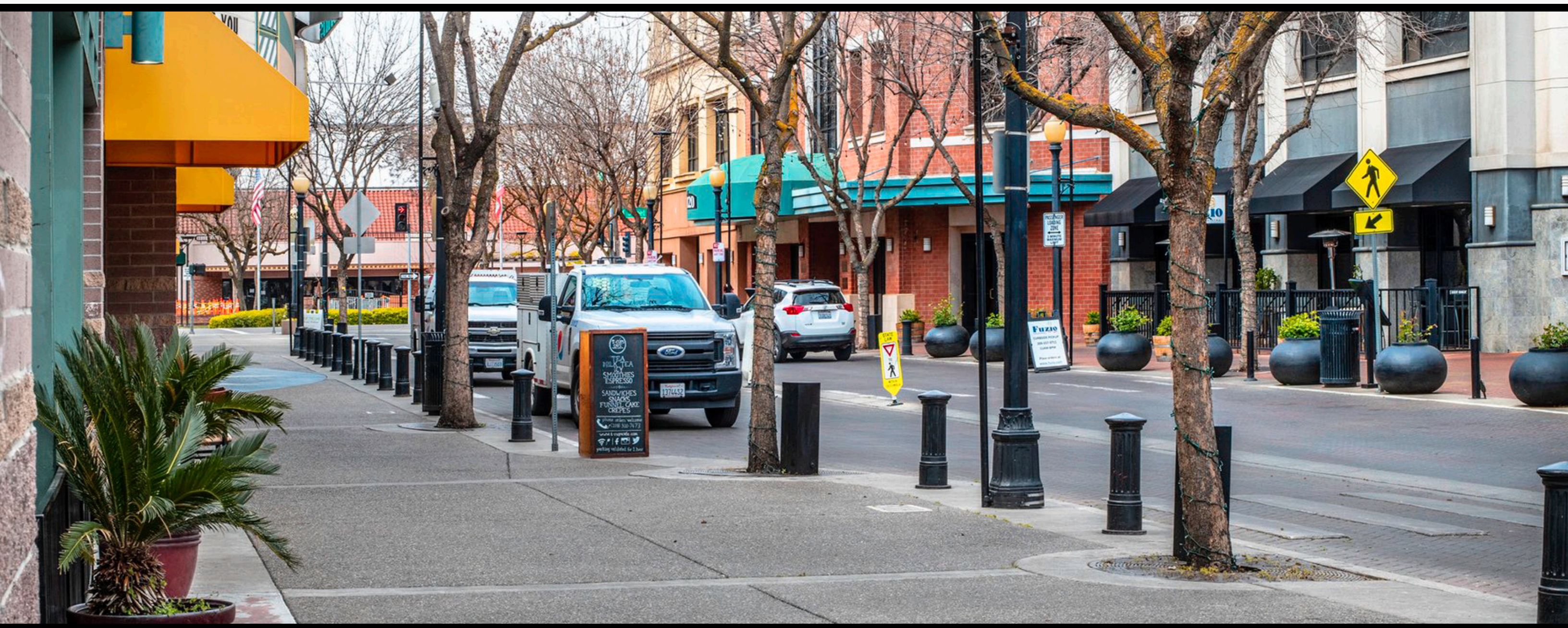
Groundwater Sustainability Plan

Appendices

Stanislaus and Tuolumne Rivers Groundwater Basin Association (STRGBA) Groundwater Sustainability Agency

&

County of Tuolumne Groundwater Sustainability Agency



Appendix A

Notice of Intent to Prepare a GSP

Stanislaus and Tuolumne Rivers Groundwater Basin Association
Groundwater Sustainability Agency
1231 11th Street ● Modesto, CA 95354
Phone: (209) 526-7564 ● Fax: (209) 526-7352
E-mail: John.Davids@mid.org

March 14, 2018

Mr. Trevor Joseph
California Department of Water Resources
901 P Street, Room 201
P.O. Box 942836
Sacramento, CA 94236-0001

Re: Stanislaus and Tuolumne Rivers Groundwater Basin Association Groundwater Sustainability Agency - Notification of Intent to Develop a Groundwater Sustainability Plan

Dear Mr. Joseph,

Pursuant to California Water Code Section 10727.8 and California Code of Regulations, Title 23, Section 353.6, the Stanislaus and Tuolumne Rivers Groundwater Basin Association Groundwater Sustainability Agency (STRGBA GSA) hereby notifies the Department of Water Resources (DWR) of its intent to develop a Groundwater Sustainability Plan (GSP) for the Modesto Sub-basin (Sub-basin) in cooperation with other Groundwater Sustainability Agencies within the Sub-basin. The action of the STRGBA GSA authorizing the submission of this initial notification is attached.

The public may participate in the development of the GSP for the Sub-basin by attending the STRGBA GSA's monthly meetings held at the Modesto Irrigation District's offices – 1231 11th Street, Modesto, California 95354. A schedule of upcoming meetings, meeting agendas, meeting minutes and information on the GSP development process are available on the STRGBA GSA website at: www.strgba.org.

The STRGBA GSA looks forward to working collaboratively with the public and DWR staff to develop and implement the GSP for the Sub-basin. Should you have any questions or concerns regarding the information noted herein, please feel free to contact me at (209) 526-7564.

Sincerely,

John B. Davids, P.E.
STRGBA GSA Coordinator

Enclosure: STRGBA GSA February 14, 2018 Meeting Minutes

Stanislaus and Tuolumne Rivers Groundwater Basin Association
Groundwater Sustainability Agency
1231 11th Street ● Modesto, CA 95354
Phone: (209) 526-7564 ● Fax: (209) 526-7352
E-mail: John.Davids@mid.org

cc: Administration Files
Stanislaus County Board of Supervisors
City of Modesto City Council
City of Oakdale City Council
City of Riverbank City Council
City of Waterford City Council
Modesto Irrigation District Board of Directors
Oakdale Irrigation District Board of Directors

Attachment B

STRGBA Member Resolutions and Proofs of Publication of Notice

MODESTO CITY COUNCIL
RESOLUTION NO. 2017-30

RESOLUTION AUTHORIZING THE GROUNDWATER SUSTAINABILITY AGENCY MEMORANDUM OF UNDERSTANDING, AND AUTHORIZING THE CITY MANAGER, OR HIS DESIGNEE, TO EXECUTE THE MEMORANDUM OF UNDERSTANDING, AND PREPARE AND SUBMIT NOTICE OF THE STANISLAUS AND TUOLUMNE RIVERS GROUNDWATER BASIN ASSOCIATION GROUNDWATER SUSTAINABILITY AGENCY'S ELECTION TO BE THE GROUNDWATER SUSTAINABILITY AGENCY FOR THE MODESTO SUB-BASIN TO DEPARTMENT OF WATER RESOURCES

WHEREAS, in September of 2014, Governor Edmund G. Brown signed into law, the Sustainable Groundwater Management Act of 2014 (SGMA), which changed the method for groundwater management, and

WHEREAS, SGMA is a comprehensive three bill package that sets the framework for statewide sustainable groundwater management by local agencies, and

WHEREAS, SGMA requires the formation of Groundwater Sustainable Agencies (GSA) and the preparation of Groundwater Sustainability Plans (GSP) with a focus on long-term sustainability, and

WHEREAS, formation of a GSA must occur no later than June 30, 2017, and development and adoption of a GSP must be adopted no later than January 31, 2022, for high and medium priority basins not currently in critical overdraft, and

WHEREAS, the Modesto Sub-basin (designated basin number 5-22.02 in DWR's CASGEM groundwater basin system) is designated as a high-priority basin, and

WHEREAS, SGMA authorizes a local agency, or a combination of local agencies, overlying a groundwater basin to form a GSA, and

WHEREAS, multi-agency GSAs may be formed through either a Memorandum of Understanding (MOU) or other legal agreement, and

WHEREAS, the Stanislaus and Tuolumne Rivers Groundwater Basin Association (STRGBA) member agencies are all local agencies, pursuant to SGMA's definition, and

WHEREAS, the STRGBA member agencies include the cities of Oakdale, Riverbank, Modesto, and Waterford; Stanislaus County; Oakdale Irrigation District; and Modesto Irrigation District, and

WHEREAS, since its inception in 1994, STRGBA has provided a forum for local agencies to work cooperatively to provide for coordinated planning in the pursuit of effective and sustainable management of the Modesto Sub-basin, and

WHEREAS, the STRGBA member agencies believe that the sustainable management of the Modesto Sub-basin pursuant to SGMA may best be achieved through the cooperation of the Member Agencies operating through the GSA MOU, and

WHEREAS, SGMA requires formal procedures be followed to become a GSA, and

WHEREAS, each of the local agencies electing to be a GSA must hold a noticed public hearing to receive public comment on the local agency's decision to become the GSA for the Basin, and

WHEREAS, at the conclusion of this public hearing, it is anticipated that the governing board for each local agency will authorize the execution of the **attached** GSA MOU and adopt the **attached** resolution forming the GSA for the Basin,

NOW, THEREFORE, BE IT RESOLVED by the Council of the City of Modesto that it hereby authorizing the Groundwater Sustainability Agency Memorandum of Understanding, and authorizing the City Manager, or his designee, to execute the Memorandum of Understanding, and prepare and submit notice of the Stanislaus and

Tuolumne Rivers Groundwater Basin Association Groundwater Sustainability Agency's election to be the Groundwater Sustainability Agency for the Modesto Sub-basin to Department of Water Resources.

BE IT FURTHER RESOLVED that the City Manager, or his designee, is hereby authorized to execute said Memorandum of Understanding on behalf of the City, and prepare and submit notice of the Stanislaus and Tuolumne Rivers Groundwater Basin Association Groundwater Sustainability Agency's election to be the Groundwater Sustainability Agency for the Modesto Sub-basin to Department of Water Resources.

The foregoing resolution was introduced at a regular meeting of the Council of the City of Modesto held on the 24th day of January, 2017, by Councilmember Ridenour, who moved its adoption, which motion being duly seconded by Councilmember Grewal, was upon roll call carried and the resolution adopted by the following vote:

AYES:	Councilmembers:	Ah You, Grewal, Kenoyer, Madrigal, Ridenour, Zoslocki, Mayor Brandvold
NOES:	Councilmembers:	None
ABSENT:	Councilmembers:	None

ATTEST: Stephanie Lopez

STEPHANIE LOPEZ, City Clerk

(SEAL)

APPROVED AS TO FORM:

By: Adam Lindgren

ADAM U. LINDGREN, City Attorney

DECLARATION OF PUBLICATION
(C.C.P. S2015.5)

COUNTY OF STANISLAUS
STATE OF CALIFORNIA

I am a citizen of the United States and a resident Of the County aforesaid; I am over the age of Eighteen years, and not a party to or interested In the above entitle matter. I am a printer and Principal clerk of the publisher of THE MODESTO BEE, printed in the City of MODESTO, County of STANISLAUS, State of California, daily, for which said newspaper has been adjudged a newspaper of general circulation by the Superior Court of the County of STANISLAUS, State of California, Under the date of February 25, 1951, Action No. 46453; that the notice of which the annexed is a printed copy, has been published in each issue there of on the following dates, to wit:

Jan 09, 2017, Jan 16, 2017

I certify (or declare) under penalty of perjury That the foregoing is true and correct and that This declaration was executed at

MODESTO, California on

January 16th, 2017

(By Electronic Facsimile Signature)

Cynthia A. Williams

PUBLIC NOTICE

Notice is hereby given that, pursuant to Water Code section 10723, City of Modesto will hold a public hearing during a regular meeting on Tuesday, January 24, 2017 at 5:30 P.M., in the City of Modesto Council Chambers, Basement Level, located at 1010 10th Street, Modesto, to determine whether the City of Modesto will authorize the execution of the MEMORANDUM OF UNDERSTANDING FORMING THE STANISLAUS AND TUOLUMNE RIVERS GROUNDWATER BASIN ASSOCIATION GROUNDWATER SUSTAINABILITY AGENCY and participate in the Stanislaus and Tuolumne Rivers Groundwater Basin Association (STRGBA) election to become a groundwater sustainability agency for the Modesto Groundwater Sub-Basin. Written comments may be submitted to City of Modesto at Attn: Miguel Alvarez, 1010 10th Street, Suite 4500, Modesto, CA 95353. During the hearing, City of Modesto will allow oral comments and will receive additional written comments until the STRGBA elects to be a groundwater sustainability agency.

Pub Dates 1/9/17 & 1/16/17

IN THE CITY COUNCIL
OF THE CITY OF OAKDALE
STATE OF CALIFORNIA
CITY COUNCIL RESOLUTION 2017-001

A RESOLUTION OF THE CITY OF OAKDALE CITY COUNCIL AUTHORIZING THE CITY MANAGER TO EXECUTE A MEMORANDUM OF UNDERSTANDING TO FORM THE STANISLAUS AND TUOLUMNE RIVERS GROUNDWATER BASIN ASSOCIATION GROUNDWATER SUSTAINABILITY AGENCY AND TO PREPARE AND SUBMIT NOTICE OF THE STANISLAUS AND TUOLUMNE RIVERS GROUNDWATER BASIN ASSOCIATION GROUNDWATER SUSTAINABILITY AGENCY'S ELECTION TO BE THE GROUNDWATER SUSTAINABILITY AGENCY FOR THE MODESTO SUB-BASIN (DESIGNATED BASIN NUMBER 5-22.02 IN THE CALIFORNIA DEPARTMENT OF WATER RESOURCES' CASGEM GROUNDWATER BASIN SYSTEM) TO THE CALIFORNIA DEPARTMENT OF WATER RESOURCES

THE CITY OF OAKDALE CITY COUNCIL DOES HEREBY RESOLVE THAT:

WHEREAS, the California Legislature has adopted, and the Governor has signed into law, the Sustainable Groundwater Management Act of 2014 ("SGMA"), which authorizes local agencies to manage groundwater in a sustainable fashion; and,

WHEREAS, the legislative intent of SGMA is to provide for sustainable management of groundwater basins, to enhance local management of groundwater, to establish minimum standards for sustainable groundwater management, and to provide local groundwater agencies with the authority and the technical and financial assistance necessary to sustainably manage groundwater; and,

WHEREAS, SGMA requires that a GSA be formed for all basins designated by the Department of Water Resources as a high-priority basin, such as the Modesto Sub-basin (designated basin number 5-22.02 in the California Department of Water Resources' CASGEM groundwater basin system) ("Basin"), by June 30, 2017; and,

WHEREAS, SGMA permits a combination of local agencies to form a groundwater sustainability agency ("GSA") through a Memorandum of Understanding ("MOU"); and

WHEREAS, the County of Stanislaus, the Oakdale Irrigation District, the City of Oakdale, the City of Riverbank, the City of Modesto, the City of Waterford, and the Modesto Irrigation District ("MOU Agencies") are all local agencies, as SGMA defines that term; and,

WHEREAS, the MOU Agencies are committed to sustainable management of the Basin's groundwater resources as shown by, among other actions, the MOU Agencies' creation of the Stanislaus and Tuolumne Rivers Groundwater Basin Association ("STRGBA") in 1994, which was created to ensure coordinated and effective management of the Basin; and,

WHEREAS, the MOU Agencies each exercise jurisdiction upon lands overlying the Basin and are all committed to the sustainable management of the Basin's groundwater resources; and,

WHEREAS, the MOU Agencies have determined that the sustainable management of the Basin pursuant to SGMA may best be achieved through the cooperation of the MOU Agencies operating through an MOU; and,

WHEREAS, notice of a hearing on the MOU Agencies' decision to form a GSA for the Basin ("Notice") has been published in the Oakdale Leader as provided by law; and,

WHEREAS, on this day, the City Council of the City of Oakdale held a public hearing to consider whether it should enter into the Memorandum of Understanding Forming the Stanislaus and Tuolumne Rivers Groundwater Basin Association Groundwater Sustainability Agency ("GSA MOU") (attached hereto as Exhibit A) to form the Stanislaus and Tuolumne Rivers Groundwater Basin Association GSA ("STRGBA GSA") for the Basin; and,

WHEREAS, it would be in the best interests of the MOU Agencies to form the GSA for the Basin, and to begin the process of preparing a groundwater sustainability plan ("Sustainability Plan"); and,

WHEREAS, adoption of this resolution does not constitute a "project" under California Environmental Quality Act Guidelines Section 15378(b)(5), including organization and administrative activities of government, because there would be no direct or indirect physical change in the environment.

NOW, THEREFORE, BE IT RESOLVED by the **CITY COUNCIL** of the **CITY OF OAKDALE**:

1. All the recitals in this resolution are true and correct and the City of Oakdale so finds, determines and represents.

2. The City Clerk of the City of Oakdale is hereby authorized and directed to attest the signature of the authorized signatory, and to affix and attest the seal of the City of Oakdale, as may be required or appropriate in connection with the execution and delivery of the GSA MOU.

3. The City of Oakdale hereby elects to enter into the GSA MOU with the MOU Agencies to form the GSA for the Basin.

4. Within thirty (30) days of the date of this resolution, the City of Oakdale City Manager is directed to provide notice of the City of Oakdale to enter into the GSA MOU with the MOU Agencies to form the GSA for the Basin ("Notice of GSA Election") to the California Department of Water Resources in the manner required by law.

5. One of the elements of the Notice of GSA Election is the boundaries of the area of the Basin or the portion of the Basin that the MOU Agencies intend to manage. Until further action of the MOU Agencies, the boundaries of the GSA shall be the boundaries of the portion of the Basin within the MOU Agencies' combined jurisdiction. A copy of a map of the management area is attached as Exhibit B.

6. This resolution shall take effect immediately upon passage and adoption.

CITY OF OAKDALE
City Council Resolution 2017-001

THE FOREGOING RESOLUTION IS HEREBY ADOPTED THIS 17th DAY OF JANUARY, 2017, by the following vote:

AYES:	COUNCIL MEMBERS:	Bairos, Dunlop, McCarty, Murdoch and Paul	(5)
NOES:	COUNCIL MEMBERS:	None	(0)
ABSENT:	COUNCIL MEMBERS:	None	(0)
ABSTAINED:	COUNCIL MEMBERS:	None	(0)

SIGNED:

Pat Paul

Pat Paul, Mayor

ATTEST:

Kathy Teixeira

Kathy Teixeira, CMC
City Clerk

I, KATHY TEIXEIRA, City Clerk of the City of Oakdale, DO HEREBY CERTIFY that foregoing Resolution 2017-001 was duly passed and adopted by the City Council of the City of Oakdale at a regular meeting held on the 17th day of January 2017.

IN WITNESS WHEREOF, I have hereby set my hand and affixed the seal of the City of Oakdale this 25th day of January 2017.

Kathy Teixeira

KATHY TEIXEIRA, CMC
CITY CLERK

PROOF OF PUBLICATION
(2015.5 C. C. P.)

STATE OF CALIFORNIA,

County of Stanislaus

I am a citizen of the United States and a resident of the county aforesaid; I am over the age of twenty-one years, and not a party to or interested in the above entitled matter. I am the principal clerk of THE OAKDALE LEADER, 122 South Third Avenue, Oakdale, California, a newspaper of general circulation, published in Oakdale, California in the City of Oakdale, County of Stanislaus, and which newspaper has been adjudged a newspaper of general circulation, by the Superior Court of the County of Stanislaus, State of California. That the notice, of which the annexed is a printed copy (set in type not smaller than nonpareil), has been published in each regular and entire issue of said newspaper and not in any supplement thereof on the following dates, to-wit:

January 4, 11, in the year 2017

I certify or declare under penalty of perjury that the foregoing is true and correct.

Dated at Oakdale,

This 11th day of January 2017.

Signature

This space is for the County Clerk's Filing Stamp

Proof of Publication of

PUBLIC HEARING (STRGBA)

PUBLIC NOTICE
NOTICE OF PUBLIC HEARING

NOTICE IS HEREBY GIVEN that pursuant to California Water Code section 10723 the City of Oakdale City Council will hold a public hearing during a regular meeting on Tuesday, January 17, 2017, in the Council Chambers, 277 North Second Avenue, at 7:00 p.m. or as soon thereafter to determine whether City Council will authorize the execution of the MEMORANDUM OF UNDERSTANDING FORMING THE STANISLAUS AND TUOLUMNE RIVERS GROUNDWATER BASIN ASSOCIATION GROUNDWATER SUSTAINABILITY AGENCY and participate in the Stanislaus and Tuolumne Rivers Groundwater Basin Association (STRGBA) election to become a groundwater sustainability agency for the Modesto Groundwater Sub-Basin. Written comments may be submitted to City of Oakdale, Public Services Department, Attn: Michael Renfrow, 455 South Fifth Avenue Oakdale, CA 95361 prior to the hearing. During the hearing, Oakdale City Council will accept public testimony and will receive additional written comments until the STRGBA elects to be a groundwater sustainability agency.

If a challenge to the above application is made in court, persons may be limited to raising only those issues they or someone else raised at the Public Hearing described in the notice, or in written correspondence delivered to the City Council.

If you have any questions, please call the Public Services Department at 845-3600, or stop by the office at 455 South Fifth Avenue.

BY ORDER OF THE OAKDALE CITY COUNCIL
KATHY TEIXEIRA, CMC
City Clerk
DATED: December 22, 2016
January 4, 11, 2017
OL #17-001

CITY OF RIVERBANK

RESOLUTION NO. 2017-005

A RESOLUTION OF THE CITY COUNCIL OF THE CITY OF RIVERBANK, CALIFORNIA, AUTHORIZING AND DIRECTING THE EXCUTION OF A MEMORANDUM OF UNDERSTANDING FORMING THE STANISLAUS AND TOLOUMNE RIVERS GROUNDWATER BASIN ASSOCIATION GROUNDWATER SUSTAINABILITY AGENCY

WHEREAS, the California Legislature has adopted, and the Governor has signed into law, the Sustainable Groundwater Management Act of 2014 ("SGMA"), which authorizes local agencies to manage groundwater in a sustainable fashion; and,

WHEREAS, the legislative intent of SGMA is to provide for sustainable management of groundwater basins, to enhance local management of groundwater, to establish minimum standards for sustainable groundwater management, and to provide local groundwater agencies with the authority and the technical and financial assistance necessary to sustainably manage groundwater; and,

WHEREAS, SGMA requires that a GSA be formed for all basins designated by the Department of Water Resources as a high-priority basin, such as the Modesto Sub-basin (designated basin number 5-22.02 in the California Department of Water Resources CASGEM groundwater basin system(("Basin"), by June 30, 2017; and,

WHEREAS, SGMA permits a combination of local agencies to form a groundwater sustainability agency ("GSA") through a Memorandum of Understanding ("MOU"); and

WHEREAS, the County of Stanislaus, the Oakdale Irrigation District, City of Riverbank, the City of Oakdale, the City of Modesto, the City of Waterford, and the Modesto Irrigation District ("MOU Agencies") are all local agencies, as SGMA defines that term; and

WHEREAS, the MOU Agencies are committed to sustainable management of the Basin's groundwater resources as shown by, among other actions, the MOU Agencies creation of the Stanislaus and Tuolumne Rivers Groundwater Basin Association ("STRGBA") in 1994, which was created to ensure coordinated and effective management of the Basin; and

WHEREAS, the MOU Agencies each exercise jurisdiction upon lands overlying the Basin and are all committed to the sustainable management of the Basin's groundwater resources; and

WHEREAS, the MOU Agencies have determined that the sustainable management of the Basin pursuant to SGMA may best be achieved through the cooperation of the MOU Agencies operating through an MOU; and

WHEREAS, notice of a hearing on the MOU Agencies decision to form a GSA for the Basin ("Notice") has been published in the Riverbank News as provided by law; and

WHEREAS, on this day, the City of Riverbank City Council held a public hearing to consider whether it should enter into the Memorandum of Understanding Forming the Stanislaus and Tuolumne Rivers Groundwater Basin Association Groundwater Sustainability Agency ("GSA MOU") (attached here to as Exhibit A) to form the Stanislaus and Tuolumne Rivers Groundwater Basin Association GSA ("STRGBA GSA") for the Basin; and

WHEREAS, it would be in the best interests of the MOU Agencies to form the GSA for the Basin, and to begin the process of preparing a groundwater sustainability plan; and

WHEREAS, adoption of this resolution does not constitute a "project" under California Environmental Quality Act Guidelines Section 15378(b) (5), including organization and administrative activities of government, because there would be no direct or indirect physical change in the environment.

NOW, THEREFORE, BE IT RESOLVED that the City Council of the City of Riverbank hereby declares that:

1. All the recitals in this resolution are true and correct and the City of Riverbank City Council so finds, determines and represents.

2. The City Clerk of the City of Riverbank is hereby authorized and directed to attest the signature of the authorized signatory, and to affix and attest the seal of the City of Riverbank, as may be required or appropriate in connection with the execution and delivery of the GSA MOU.

3. The City of Riverbank hereby elects to enter into the GSA MOU with the MOU Agencies to form the GSA for the Basin.

4. Within thirty (30) days of the date of this resolution, the City of Riverbank City Manager is directed to provide notice of City of Riverbank's to enter into the GSA MOU Agencies to form the GSA for the Basin ("Notice of GSA Election") to the California Department of Water Resources in the manner required by law.

5. One of the elements of the Notice of GSA Election is the boundaries of the area of the Basin or the portion of the Basin that the MOU Agencies intend to manage. Until further action of the MOU Agencies, the boundaries of the GSA shall be the boundaries of the portion of the Basin within the MOU Agencies combined jurisdiction. A copy of a map of the management area is attached as **Exhibit B.**

6. This resolution shall take effect immediately upon passage and adoption.

PASSED AND ADOPTED by the City Council of the City of Riverbank at a regular meeting held on the 24th day of January 24, 2017; motioned by Councilmember District 4 Darlene Barber-Martinez, seconded by Vice Mayor Leanne Jones Cruz, and upon roll call was carried by the following City Council vote of *4-0:

AYES:	**Barber-Martinez, Campbell, Jones Cruz, and Mayor O'Brien**
NAYS:	**None**
ABSENT:	**None**
ABSTAINED:	**None**

ATTEST:

Annabelle H. Aguilar

Annabelle H. Aguilar, CMC
City Clerk

APPROVED:

Richard D. O'Brien

Richard D. O'Brien
Mayor

Attachments: MOU and Exhibit B - Management Area Map

*Councilmember District 2 Cindy Fosi, recused herself.

CERTIFICATION
I hereby certify the foregoing is a true and correct copy of the original document on file in the office of the City Clerk of the City of Riverbank.

Annabelle Aguilar
CITY CLERK

DATED 02/01/2017

PROOF OF PUBLICATION

(2015.5 C. C. P.)

STATE OF CALIFORNIA,

County of Stanislaus

I am a citizen of the United States and a resident of the county aforesaid; I am over the age of twenty-one years, and not a party to or interested in the above entitled matter. I am the principal clerk of THE RIVERBANK NEWS, 122 South Third Ave, Oakdale, California, a newspaper of general circulation, published in Riverbank, California in the City of Riverbank, County of Stanislaus, and which newspaper has been adjudged a Newspaper of general circulation, by the Superior Court of the County of Stanislaus, State of California. That the Notice, of which the annexed is a printed copy (set in type not smaller than nonpareil), has been published in each regular and entire issue of said newspaper and not in any supplement thereof on the following dates, to-wit:

January 11, in the year 2017

I certify or declare under penalty of perjury that the Foregoing is true and correct.

Dated at Riverbank, California

This 11th day of January 2017.

Signature

This space is for the County Clerk's Filing Stamp

Proof of Publication of

PUBLIC NOTICE GSA/SGMA

PUBLIC NOTICE
NOTICE OF PUBLIC HEARING
City of Riverbank City Council

NOTICE IS HEREBY GIVEN that the City Council of the City of Riverbank will hold a public hearing on Tuesday, January 24, 2017, in the City Hall Council Chambers, 6707 Third Street, Suite B, Riverbank, California, at 6:00 p.m. or soon thereafter to consider and review the following matter: Whether the City Council of the City of Riverbank should elect to become a Groundwater Sustainability Agency (GSA) under the Sustainable Groundwater Management Act (SGMA) (California Water Code, Section 10720 et seq.) for the portion of the Modesto Sub-basin designated basin number 5-22.02 in the California Dept. of Water Resources groundwater basin system within the City of Riverbank's service area ALL INTERESTED PARTIES are invited to attend the public hearing on January 24, 2017, at the time and place specified above to express opinions or submit evidence for or against the subject matter being considered. Written comments submitted to the City Clerk at 6707 Third Street, Suite A, Riverbank, California, 95367 or cityclerk@riverbank.org will be accepted by the City Clerk up to 5:00 p.m. on said date. Oral comments will be received by the City Council prior to the close of the Public Hearing. Any public materials of the subject matter will be made available for review at the City Clerk's office and (when technologically possible) at www.riverbank.org upon distribution to a majority of the City Council, (typically 72 hours prior to the meeting). In compliance with ADA, any person requiring special assistance to participate in the meeting should notify the Administration Dept. at (209) 863-7122 or cityclerk@riverbank.org at least 72 hours prior to the meeting. For questions regarding the proposed subject matter contact Michael Riddell, Public Works Superintendent at (209) 869-7128 or mriddle@riverbank.org, or contact the City Clerk at (209) 863-7198. Published this 11th day of January, 2017
/s/ Annabelle H. Aguilar, CMC, City Clerk, City of Riverbank

January 11, 2017
RN #17-003

WATERFORD CITY COUNCIL
RESOLUTION 2017-02

A RESOLUTION OF THE CITY COUNCIIL OF THE CITY OF WATERFORD AUTHORIZING AND DIRECTING THE EXECUTION OF A MEMORANDUM OF UNDERSTANDING FORMING THE GROUNDWATER SUSTAINABILITY AGENCY FOR THE MODESTO SUB-BASIN

WHEREAS, the California Legislature has adopted, and the Governor has signed into law, the Sustainable Groundwater Management Act of 2014 ("SGMA"), which authorizes local agencies to manage groundwater in a sustainable fashion; and

WHEREAS, the legislative intent of SGMA is to provide for sustainable management of groundwater basins, to enhance local management of groundwater, to establish minimum standards for sustainable groundwater management, and to provide local groundwater agencies with the authority and the technical and financial assistance necessary to sustainably manage groundwater; and

WHEREAS, SGMA requires that a GSA be formed for all basins designated by the Department of Water Resources as a high-priority basin, such as the Modesto Sub-basin (designated basin number 5-22.02 in the California Department of Water Resources' CASGEM groundwater basin system) ("Basin"), by June 30, 2017; and

WHEREAS, SGMA permits a combination of local agencies to form a groundwater sustainability agency ("GSA") through a Memorandum of Understanding ("MOU"); and

WHEREAS, the County of Stanislaus, the Oakdale Irrigation District, the City of Oakdale, the City of Riverbank, the City of Modesto, the City of Waterford, and the Modesto Irrigation District ("MOU Agencies") are all local agencies, as SGMA defines that term; and

WHEREAS, the MOU Agencies are committed to sustainable management of the Basin's groundwater resources as shown by, among other actions, the MOU Agencies' creation of the Stanislaus and Tuolumne Rivers Groundwater Basin Association ("STRGBA") in 1994, which was created to ensure coordinated and effective management of the Basin; and

WHEREAS, the MOU Agencies each exercise jurisdiction upon lands overlying the Basin and are all committed to the sustainable management of the Basin's groundwater resources; and

WHEREAS, the MOU Agencies have determined that the sustainable management of the Basin pursuant to SGMA may best be achieved through the cooperation of the MOU Agencies operating through an MOU; and

WHEREAS, notice of a hearing on the MOU Agencies' decision to form a GSA for the Basin ("Notice") has been published in the Waterford News as provided by law; and

WHEREAS, a courtesy copy of the Notice was also mailed to the Tuolumne County Board of Supervisors; and

WHEREAS, on this day, the City Council of the City of Waterford held a public hearing to consider whether it should enter into the Memorandum of Understanding Forming the Stanislaus and Tuolumne Rivers Groundwater Basin Association Groundwater Sustainability Agency ("GSA MOU") (attached hereto as Exhibit A) to form the Stanislaus and Tuolumne Rivers Groundwater Basin Association GSA ("STRGBA GSA") for the Basin; and

WHEREAS, it would be in the best interests of the MOU Agencies to form the GSA for the Basin, and to begin the process of preparing a groundwater sustainability plan ("Sustainability Plan"); and

WHEREAS, adoption of this resolution does not constitute a "project" under California Environmental Quality Act Guidelines Section 15378(b)(5), including organization and administrative activities of government, because there would be no direct or indirect physical change in the environment.

THEREFORE, BE IT RESOLVED by the City Council of the Waterford, as follows:

1. All the recitals in this resolution are true and correct and the Waterford City Council so finds, determines and represents.

2. The City Clerk of the City of Waterford is hereby authorized and directed to attest the signature of the authorized signatory, and to affix and attest the seal of the City of Waterford, as may be required or appropriate in connection with the execution and delivery of the GSA MOU.

3. The Waterford City Council hereby elects to enter into the GSA MOU with the MOU Agencies to form the GSA for the Basin.

4. Within thirty (30) days of the date of this resolution, the Waterford City Manager is directed to provide notice of the City of Waterford's intent to enter into the GSA MOU with the MOU Agencies to form the GSA for the Basin ("Notice of GSA Election") to the California Department of Water Resources in the manner required by law.

5. One of the elements of the Notice of GSA Election is the boundaries of the area of the Basin or the portion of the Basin that the MOU Agencies intend to manage. Until further action of the MOU Agencies, the boundaries of the GSA shall be the boundaries of the portion of the Basin within the MOU Agencies' combined jurisdiction. A copy of a map of the management area is attached as Exhibit B.

6. **This resolution shall take effect immediately upon passage and adoption.**

WE, THE UNDERSIGNED, do hereby certify that the above and foregoing Resolution No. 2017-02 was duly adopted and passed by the City Council of the City of Waterford at a regularly scheduled meeting held on the 19th day of January, 2017, by the following vote:

AYES: 4 Van Winkle, Aldaco, Krause, Whitfield

NOES: 0

ABSENT: 1 Powell

City of Waterford

DocuSigned by:

C29072A7DE70453...

Michael Van Winkle, Mayor

ATTEST:

DocuSigned by:

Lori Martin

Lori Martin, City Clerk

0E40B251B23D4F2...

Approved as to Form:

DocuSigned by:

Corbett Browning

Corbett J. Browning, City Attorney

F261FA69CB4B4A7...

Affidavit of Publication

STATE OF CALIFORNIA }ss.
County of Stanislaus

Lisa Freitas

Here-un-to being first duly sworn, deposes and says that all time hereinafter mentioned he/she was a citizen of the United States over the age of twenty-one (21) years, and doing business in said county, not interested in the matter of the attached publication, and is competent to testify in said matter, that he/she was at and during all said time the principal clerk to the printer and publisher of the

WATERFORD NEWS

a legal newspaper of general circulation published weekly in Waterford in said County of Stanislaus, State of California: that said

WATERFORD NEWS

is and was at all times herein mentioned, a newspaper of general circulation as that term is defined by Section 6000 of the Government Code, and as provided by said section and so adjudicated by Decree No. 41155 by the Superior Court of Stanislaus County, State of California, is published for the dissemination of local and telegraphic news and intelligence of a general character, have a bonafide subscription list of paying subscribers, and is not devoted to the interest, or published for the entertainment or instruction of a particular class, profession, trade, calling, race of denomination: or for the entertainment and instruction of any number of such classes, professions, trades, callings, races or denominations: that at all times said newspaper has been established, in Waterford; in said County and State, at regular intervals for more than one year preceding the first publication of the notice herein mentioned, that said notice was set in type not smaller than nonpareil and was preceded with words printed in blackface type not smaller than nonpareil, describing and expressing in general terms, the purport and character of the notice intended to be given

Legal # 2381

PUBLIC HEARING NOTICE

Publish Dates: 01-03-2017 & 01-10-2017

of which named annexed is a printed copy, was published and printed in said

WATERFORD NEWS

at least 2 TIMES, commencing on the 3RD Day of JANUARY 2017 and ending on the 10TH of JANUARY 2017 the days inclusive, and as often during said time as said newspaper was regularly issued, to wit:

I declare under penalty of perjury under the laws of the State of California that the foregoing is true and correct.
Dated this 10TH day of JANUARY 2017

Lisa Freitas

PRINCIPAL CLERK OF THE PRINTER

Legal # 2381

PUBLIC HEARING NOTICE

Notice is hereby given that, pursuant to Water Code section 10723, the City Council of the City of Waterfod will hold a public hearing during a regular meeting on January 19, 2017, in the City Council Chambers located at 101 E Street, Waterford, CA to determine whether the City Council will authorize the execution of the MEMORANDUM OF UNDERSTANDING FORMING THE STANISLAUS AND TUOLUMNE RIVERS GROUNDWATER BASIN ASSOCIATION GROUNDWATER SUSTAINABILITY AGENCY and participate in the Stanislaus and Tuolumne Rivers Groundwater Basin Association (STRGBA) election to become a groundwater sustainability agency for the Modesto Groundwater Sub-Basin. Written comments may be submitted to City of Waterford ,Attn: Lori Martin, City Clerk, PO Box 199 / 101 E Street, Waterford, CA 95386. During the hearing, the City Council will allow oral comments and will receive additional written comments until the STRGBA elects to be a groundwater sustainability agency.

Publish dates: 01-03 & 01-10-2017

THE BOARD OF SUPERVISORS OF THE COUNTY OF STANISLAUS
STATE OF CALIFORNIA

2017-69

Date: February 14, 2017

On motion of Supervisor Withrow Seconded by Supervisor Olsen
and approved by the following vote,
Ayes: Supervisors: Olsen, Withrow, Monteith, DeMartini and Chairman Chiesa
Noes: Supervisors: None
Excused or Absent: Supervisors: None
Abstaining: Supervisor: None

THE FOLLOWING RESOLUTION WAS ADOPTED: Item # 9:05 a.m.

A RESOLUTION OF THE BOARD OF SUPERVISORS OF STANISLAUS COUNTY AUTHORIZING AND DIRECTING THE EXECUTION OF A MEMORANDUM OF UNDERSTANDING FORMING THE GROUNDWATER SUSTAINABILITY AGENCY FOR THE MODESTO GROUNDWATER SUBBASIN

WHEREAS, the California Legislature has adopted, and the Governor has signed into law, the Sustainable Groundwater Management Act of 2014 ("SGMA"), which authorizes local agencies to manage groundwater in a sustainable fashion; and

WHEREAS, the legislative intent of SGMA is to provide for sustainable management of groundwater basins, to enhance local management of groundwater, to establish minimum standards for sustainable groundwater management, and to provide local groundwater agencies with the authority and the technical and financial assistance necessary to sustainably manage groundwater; and

WHEREAS, SGMA requires that a GSA be formed for all basins designated by the Department of Water Resources as a high-priority basin, such as the Modesto Sub-basin (designated basin number 5-22.02 in the California Department of Water Resources' CASGEM groundwater basin system) ("Basin"), by June 30, 2017; and

WHEREAS, SGMA permits a combination of local agencies to form a groundwater sustainability agency ("GSA") through a Memorandum of Understanding ("MOU"); and

WHEREAS, the County of Stanislaus, the Oakdale Irrigation District, the City of Oakdale, the City of Riverbank, the City of Modesto, the City of Waterford, and the Modesto Irrigation District ("MOU Agencies") are all local agencies, as SGMA defines that term; and

WHEREAS, the MOU Agencies are committed to sustainable management of the Basin's groundwater resources as shown by, among other actions, the MOU Agencies' creation of the Stanislaus and Tuolumne Rivers Groundwater Basin Association ("STRGBA") in 1994, which was created to ensure coordinated and effective management of the Basin; and

WHEREAS, the MOU Agencies each exercise jurisdiction upon lands overlying the Basin and are all committed to the sustainable management of the Basin's groundwater resources; and

WHEREAS, the MOU Agencies have determined that the sustainable management of the Basin pursuant to SGMA may best be achieved through the cooperation of the MOU Agencies operating through an MOU; and

WHEREAS, notice of a hearing on the MOU Agencies' decision to form a GSA for the Basin ("Notice") has been published in the Modesto Bee as provided by law; and

WHEREAS, a courtesy copy of the Notice was also mailed to the Tuolumne County Board of Supervisors; and

WHEREAS, on this day, the Board of Supervisors of Stanislaus County ("Board of Supervisors") held a public hearing to consider whether it should enter into the Memorandum of Understanding Forming the Stanislaus and Tuolumne Rivers Groundwater Basin Association Groundwater Sustainability Agency ("GSA MOU") to form the Stanislaus and Tuolumne Rivers Groundwater Basin Association GSA ("STRGBA GSA") for the Basin; and

WHEREAS, it would be in the best interests of the MOU Agencies to form the GSA for the Basin, and to begin the process of preparing a groundwater sustainability plan ("Sustainability Plan"); and

WHEREAS, adoption of this resolution does not constitute a "project" under California Environmental Quality Act Guidelines Section 15378(b)(5), including organization and administrative activities of government, because there would be no direct or indirect physical change in the environment.

THEREFORE, BE IT RESOLVED by the Board of Supervisors of Stanislaus County, as follows:

1. All the recitals in this resolution are true and correct and the Board of Supervisors so finds, determines and represents.

2. The Clerk of the Board of Supervisors is hereby authorized and directed to attest the signature of the authorized signatory, and to affix and attest the seal of the Board of Supervisors, as may be required or appropriate in connection with the execution and delivery of the GSA MOU.

3. The Board of Supervisors hereby elects to enter into the GSA MOU with the MOU Agencies to form the GSA for the Modesto Groundwater Subbasin.

4. Within thirty (30) days of the date of this resolution, the Board of Supervisors Chairman is directed to provide notice of the Stanislaus County Board of Supervisors intention to enter into the GSA MOU with the MOU Agencies to form the GSA for the Modesto Groundwater Subbasin ("Notice of GSA Election") to the California Department of Water Resources in the manner required by law.

5. One of the elements of the Notice of GSA Election is the boundaries of the area of the Basin or the portion of the Basin that the MOU Agencies intend to manage. Until further action of the MOU Agencies, the boundaries of the GSA shall be the boundaries of the portion of the Basin within the MOU Agencies' combined jurisdiction.

6. This resolution shall take effect immediately upon passage and adoption.

FEB 14 2017

I hereby certify that the foregoing is a full, true and correct copy of the Original entered in the Minutes of the Board of Supervisors.
ELIZABETH A. KING
Clerk of the Board of Supervisors of the County of Stanislaus, State of California

By Patricia Gonzalez

BOARD OF SUPERVISORS STANISLAUS COUNTY CAL.

ATTEST: ELIZABETH A. KING, Clerk
Stanislaus County Board of Supervisors,
State of California

Elizabeth A King

File No. **GSA-1-1**

DECLARATION OF PUBLICATION
(C.C.P. S2015.5)

COUNTY OF STANISLAUS
STATE OF CALIFORNIA

I am a citizen of the United States and a resident Of the County aforesaid; I am over the age of Eighteen years, and not a party to or interested In the above entitle matter. I am a printer and Principal clerk of the publisher of THE MODESTO BEE, printed in the City of MODESTO, County of STANISLAUS, State of California, daily, for which said newspaper has been adjudged a newspaper of general circulation by the Superior Court of the County of STANISLAUS, State of California, Under the date of February 25, 1951, Action No. 46453; that the notice of which the annexed is a printed copy, has been published in each issue there of on the following dates, to wit:

Jan 30, 2017, Feb 06, 2017

I certify (or declare) under penalty of perjury That the foregoing is true and correct and that This declaration was executed at

MODESTO, California on

February 6th, 2017

(By Electronic Facsimile Signature)

Cynthia A. Williams

STANISLAUS COUNTY
NOTICE OF PUBLIC HEARING

NOTICE IS HEREBY GIVEN that on Tuesday, February 14, 2017, at 9:05 a.m., or as soon thereafter as the matter may be heard, the Stanislaus County Board of Supervisors will meet in the Basement Chambers, 1010 10th Street, Modesto, CA, pursuant to California Water Code Section 10723, to consider approval of the of the "Memorandum of Understanding Forming the Stanislaus and Tuolumne Rivers Groundwater Basin Association (STRGBA) Groundwater Sustainability Agency" for the Modesto Groundwater Subbasin.

NOTICE IS FURTHER GIVEN that at the said time and place, interested persons will be given the opportunity to be heard. Written comments may be submitted to Stanislaus County at Attn: Walter Ward, Water Resources Manager, 3800 Cornucopia Way, Suite C, Modesto, CA, or at wward@envres.org.

BY ORDER OF THE BOARD OF SUPERVISORS. DATED: January 24, 2017. ATTEST: ELIZABETH A. KING, Clerk of the Board of Supervisors of the County of Stanislaus, State of California. BY: Pam Villarreal, Assistant Clerk.

Pub Dates Jan 30, Feb 6, 2017

CASE NO. 10117916 key 86102

RESOLUTION NO. 2017-04

AUTHORIZING AND DIRECTING THE EXECUTION OF A MEMORANDUM OF UNDERSTANDING FORMING THE GROUNDWATER SUSTAINABILITY AGENCY FOR THE MODESTO SUB-BASIN

WHEREAS, the California Legislature has adopted, and the Governor has signed into law, the Sustainable Groundwater Management Act of 2014 (SGMA), which authorizes local agencies to manage groundwater in a sustainable fashion; and

WHEREAS, the legislative intent of SGMA is to provide for sustainable management of groundwater basins, to enhance local management of groundwater, to establish minimum standards for sustainable groundwater management, and to provide local groundwater agencies with the authority and the technical and financial assistance necessary to sustainably manage groundwater; and

WHEREAS, SGMA requires that a Groundwater Sustainability Agency (GSA) be formed for all basins designated by the Department of Water Resources as a high-priority basin, such as the Modesto Sub-basin (designated basin number 5-22.02 in the California Department of Water Resources' CASGEM groundwater basin system) (Basin), by June 30, 2017; and

WHEREAS, SGMA permits a combination of local agencies to form a GSA through a Memorandum of Understanding (MOU); and

WHEREAS, the County of Stanislaus, the Oakdale Irrigation District, the City of Oakdale, the City of Riverbank, the City of Modesto, the City of Waterford, and the Modesto Irrigation District (MOU Agencies) are all local agencies, as SGMA defines that term; and

WHEREAS, the MOU Agencies are committed to sustainable management of the Basin's groundwater resources as shown by, among other actions, the MOU Agencies' creation of the Stanislaus and Tuolumne Rivers Groundwater Basin Association (STRGBA) in 1994, which was created to ensure coordinated and effective management of the Basin; and

WHEREAS, the MOU Agencies each exercise jurisdiction upon lands overlying the Basin and are all committed to the sustainable management of the Basin's groundwater resources; and

WHEREAS, the MOU Agencies have determined that the sustainable management of the Basin pursuant to SGMA may best be achieved through the cooperation of the MOU Agencies operating through an MOU; and

WHEREAS, notice of a hearing on the MOU Agencies' decision to form a GSA for the Basin (Notice) has been published in the Modesto Bee as provided by law; and

WHEREAS, on this day, the Modesto Irrigation District (MID) held a public hearing to consider whether it should enter into the Memorandum of Understanding Forming the Stanislaus and Tuolumne Rivers Groundwater Basin Association Groundwater Sustainability Agency (GSA MOU) (attached hereto as Exhibit A) to form the Stanislaus and Tuolumne Rivers Groundwater Basin Association GSA (STRGBA GSA) for the Basin; and

WHEREAS, it would be in the best interests of the MOU Agencies to form the GSA for the Basin, and to begin the process of preparing a groundwater sustainability plan (Sustainability Plan); and

WHEREAS, adoption of this resolution does not constitute a "project" under California Environmental Quality Act Guidelines Section 15378(b)(5), including organization and administrative activities of government, because there would be no direct or indirect physical change in the environment.

THEREFORE, BE IT RESOLVED, by the Board of Directors of the Modesto Irrigation District, as follows:

1. All the recitals in this resolution are true and correct and the MID so finds, determines and represents.

2. The Board Secretary of the MID is hereby authorized and directed to attest the signature of the authorized signatory, and to affix and attest the seal of the MID, as may be required or appropriate in connection with the execution and delivery of the GSA MOU.

3. The MID hereby elects to enter into the GSA MOU with the MOU Agencies to form the GSA for the Basin.

4. Within thirty (30) days of the date of this resolution, the MID General Manager is directed to provide notice of MID's intent to enter into the GSA MOU with the MOU Agencies to form the GSA for the Basin (Notice of GSA Election) to the California Department of Water Resources in the manner required by law.

5. One of the elements of the Notice of GSA Election is the boundaries of the area of the Basin or the portion of the Basin that the MOU Agencies intend to manage. Until further action of the MOU Agencies, the boundaries of the GSA shall be the boundaries of the portion of the Basin within the MOU Agencies' combined jurisdiction. A copy of a map of the management area is attached as Exhibit B.

6. This resolution shall take effect immediately upon passage and adoption.

Moved by Director Wenger, seconded by Director Campbell, that the foregoing resolution be adopted.

The following vote was had:

Ayes:	Directors Blom, Byrd, Campbell, Mensinger, Wenger
Noes:	Director None
Absent:	Director None

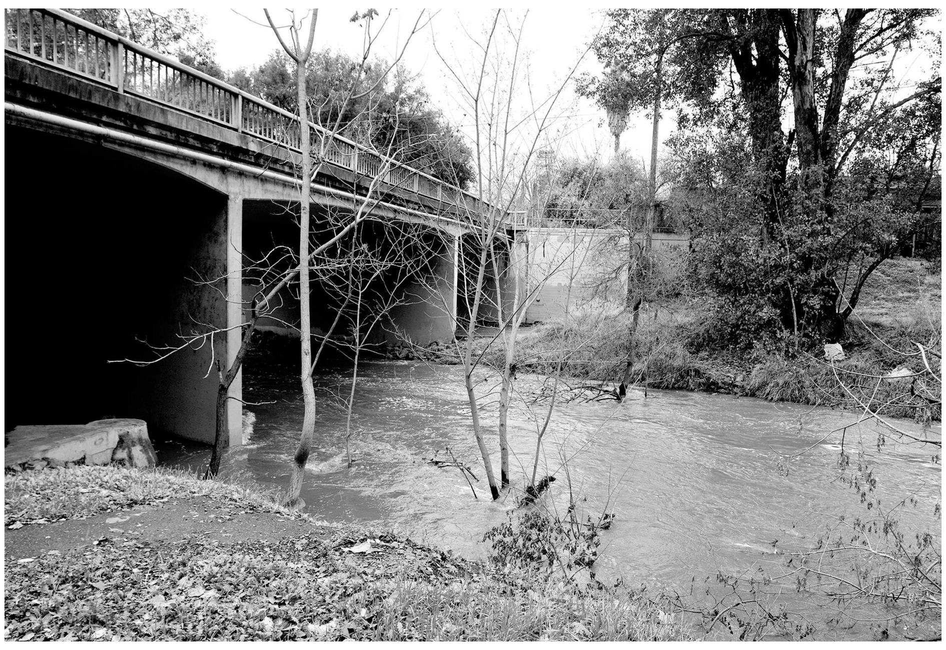
The President declared the resolution adopted.

o0o

I, Heliane Burns, Assistant Secretary to the Board of Directors of the Modesto Irrigation District, do hereby CERTIFY that the foregoing is a full, true and correct copy of a resolution duly adopted at a special meeting of said Board of Directors held the twenty fourth day of January 2017.

Heliane Burns

Assistant Secretary to the Board of
Directors of the Modesto Irrigation District



CHRISTOPHER WINTERFELDT cwinterfeldt@modbee.com

Water rushed through Dry Creek while staying within its banks in Kewin Park at the La Loma Avenue overpass on Monday in Modesto.

FROM PAGE 1A

STORM

cast shows it peaking at just under 52 feet Wednesday, then receding through Saturday. Turlock Irrigation District records showed it flowing at 5,693 cubic feet per second midmorning Monday.

Dry Creek, notorious for flooding, has stayed to its banks this season. But American Legion Post 74, located at 1001 S. Santa Cruz Ave., just north of Legion Park on the Tuolumne, is taking no chances. The threat of flooding led the veterans service organization to move most of its equipment out of the building and into storage. Consequently, its monthly dinner, scheduled for Tuesday, and monthly breakfast, scheduled for Sunday, have been canceled.

In the January 1997 flooding, "the small hall was completely submerged and the large hall was flooded all the way to the roof," said Becky Crow, Post 74 adjutant. "In light of that, we thought it was prudent to get as much out as we could, given the weather forecast by Saturday morning."

In advance of the storm that moved through the region Saturday through Monday, the weather service issued a forecast saying Modesto could get 3 to 4 inches of rain. But according to Modesto Irrigation District measurements, 0.79 inches fell downtown Saturday, 0.77 Sunday and 0.18 in the early hours Monday.

The bull's eye of the storm tracked farther north than expected, Clapp said.

This next storm will be maybe two-thirds the strength of the last, he said. The weather service forecast says Sonora can expect 2 to 3 inches of precipitation, and Yosemite 3 to 4 inches.

The service's snow forecast through Wednesday is broken down by routes. Along Highway 4, Arnold could get 6 to 8 inches, and Bear Valley 48 to 60. Along Highway 108, Twain Harte could get 3 to 4 inches, Mi-Wuk Village 8 to 12, and Strawberry, 36 to 48. And on Highway 120, the area of Big Oak Flat Road is looking at 8 to 12 inches.

Wind could be a big issue in this storm. The weather service says strong winds from the south could bring gusts of 50 mph or more in lower elevations, 65 mph or more at higher elevations. It warns the gusts could lead to falling trees and branches, downed power lines and moderate-size power failures. Again, though, Clapp said the strongest winds are likely to be felt north of Modesto, in Stockton and Sacramento.

To report a power failure to MID, call 209-526-8222, day or night. To report one to Turlock Irrigation District, call the 24-hour service line at 209-883-8301.

Tuesday will bring a 90 percent chance of rain, the weather services says, with thunderstorms also possible after 4 p.m. The high should be near 56 degrees. The chance of precipitation Tuesday night rises to 100 percent, again with up to half an inch possible.

On Wednesday, there's a 40 percent chance of showers, mainly before 4 p.m. Otherwise, the day should be partly sunny, with a high near 56. The chance of rain Wednesday night is 60 percent – mainly after 10 p.m.

There's a 50 percent chance of showers Thursday, which otherwise will be partly sunny, with a high near 53.

Deke Farrow: 209-578-2327

Flood watch vs. warning

Flood warning: Take action! A flood warning is issued when the hazardous weather event is imminent or already happening. A flood warning is issued when flooding is imminent or occurring.

Flood watch: Be prepared. A flood watch is issued when conditions are favorable for a specific hazardous weather event to occur. A flood watch is issued when conditions are favorable for flooding. It does not mean flooding will occur, but it is possible.

Source: National Weather Service

FROM PAGE 1A

SUPERVISOR

homes for foster youth," Olsen said. "Group homes are going away. We want to make sure every foster child has a nurturing, loving home."

By pushing through a 2015 bill, the former legislator played a key role in ending a tax inequity that caused the county to lose an estimated $72 million over 35 years. The county now keeps an extra $6 million a year, and Olsen wants to use some of that as seed money for projects developed by Focus on Prevention.

The county's 10-year prevention initiative aims to tackle problems with homelessness, family dysfunction, troubled youths and crime recidivism.

While serving on the Modesto council, Olsen often grilled staff members about the costs of projects and government administration. She vowed to emphasize fiscal accountability as a county leader.

Olsen raised some eyebrows when she waited until late in the filing period last year to announce she would run for District 1 supervisor. Within a half-hour of announcing her candidacy, O'Brien announced he would not run and endorsed Olsen, creating the impression of an easy transition from one Republican to another. A filing period extension left only four days for others to decide whether to challenge Olsen, a well-funded political veteran, and no one did.

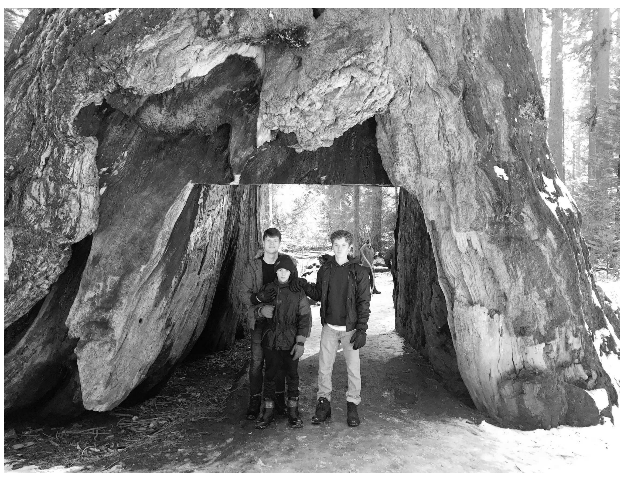
Olsen defended her timing, saying she didn't have much advance notice that O'Brien was going to step down. "When I announced I was not going to run for state Senate, I thought I was going to take a break from public service" and devote time to family life, she said.

Olsen will stay involved with state politics as the recently appointed vice chairwoman of the California Republican Party. She said her party responsibilities will require her attendance at three weekend conventions in the next two years, and "beyond that the schedule is up to me," she said.

Olsen planned to fly Monday night to San Diego to speak with Republicans there and then return to Modesto for the county's swearing-in ceremony Tuesday morning. "The goal is to elect more Republicans to improve the quality of life in California," Olsen said. "One-party dominance is not good for any state in our nation."

Ken Carlson: 209-578-2321

> "WE NEED TO OPERATE WITH GOOD DATA AND SOUND SCIENCE WHEN WE ARE MAKING DECISIONS ON WATER MANAGEMENT.
>
> ***Kristin Olsen***



DEKE FARROW jfarrow@modbee.com

Visitors to Calaveras Big Trees State Park in Arnold stand in the tunnel of the Pioneer Cabin Tree on Dec. 29.

FROM PAGE 1A

TREE

Tree in Yosemite National Park was carved, the owners of the North Grove responded by doing the same. The Pioneer Cabin Tree was chosen because of its wide base – about 22 feet in diameter. It had the widest trunk in the park's North Grove, said California State Parks Supervising Ranger Tony Tealdi. It also was chosen because its trunk already had a hole from fire damage, Tealdi said. The sequoias don't heal themselves after damage like that, they send all their nutrients to the treetop, he said.

The tree reportedly fell about 2 p.m. Sunday. Though the park was open, there were no witnesses to it, Tealdi said. People working in the visitors center didn't hear or feel a thing when the giant toppled, he said. Park docent Jim Allday of Arnold was taking a walk on the trail and made the discovery.

The tree fell onto the trail, and because the wood of sequoias easily splits, the top shattered as it hit the ground, Tealdi said. There's no estimate on how tall the roughly 2,000-year-old tree was.

The tree did not snap where the tunnel was carved, but rather uprooted. The North Grove trail is closed as environmental scientists assess the tree, Tealdi said. The trail will be rerouted because the Pioneer Cabin Tree will be left where it lies.

"You have to look at the life cycle of these trees," he said. "... At this point in time, the next part of its life cycle is on the ground, as a habitat for animals and insects. It's still a producing factor in nature – it also helps with greenhouse gases."

The park remains open with about 25 campsites available. It got nearly 8 inches of rain over the weekend, Tealdi said, and about 6 inches of snow already on the ground is melting with the rainfall. There is standing water throughout the trail.

The Pioneer Cabin Tree's shallow root system, combined with the inundation from the rain, likely contributed to its fall.

The loss of the tree has made news internationally. Tealdi said he's received calls from Russian media and the BBC. "It's a sad day, and we've seen goosebumps thinking about that tree that went down," Tealdi said, "but it is part of the life cycle."

For updates on the North Grove Trail, Tealdi suggested people check in at parks.ca.gov.

For more, visit the Facebook pages of Calaveras Big Trees State Park and the Calaveras Big Trees Association.

The Sacramento Bee and news services contributed to this report.

Deke Farrow: 209-578-2327

AROUND THE REGION

MODESTO

What: Modesto Kiwanis meeting
When: Tuesday, 11:30 a.m.
Where: Famiglia Bistro, 2501 McHenry Ave.
Info: The Modesto Kiwanis invites the public to its weekly lunch meeting. This week's special guest is Nancy Salmeron, who will discuss personnel development and entrepreneurship. Lunch is $15; reservation is needed. Seating is limited. For more information or to make a reservation, contact Anthony at 209-985-3473 or anthony.btr@gmail.com.

What: Modesto Parkinson's Support Group
When: Wednesday, 1:30 to 3:30 p.m.
Where: Trinity Presbyterian Church, 1600 Carver Road
Info: The Modesto Parkinson's Support Group will be holding its monthly meeting for caregivers and those with the Parkinson's disease.

What: Latino Emergency Council meeting
When: Friday, 8:15 to 9:15 a.m.
Where: El Concilio Community Center, 1314 H St.
Info: The El Concilio Community Center invites the public to its monthly morning meeting. The guest is Modesto Irrigation District spokeswoman Melissa Williams. She will discuss the impact the weather has had on the Modesto area. The meeting is free to attend; come early, because seating is limited. For more information, contact Dale Butler 209-613-1058.

TURLOCK

What: Turlock Chamber of Commerce mixer
When: Tuesday, 5 to 7 p.m.
Where: VaraniSmile Dentistry, 527 E. Olive Ave.
Info: Join the Turlock Chamber of Commerce and VaraniSmile Dentistry in an evening of networking with the community. The event is free to attend. For more information, call 209-632-2221 or visit www.turlockchamber.com.

Send Region items to Region, The Modesto Bee, P.O. Box 5256, Modesto 95352; call 209-578-2330; fax 209-578-2207; or email region@modbee.com.

25 YEARS AGO: Increased evening and weekend bus service was on top of the list for Stanislaus County. At a meeting where bus riders voiced their concerns, the Stanislaus Area Association of Governments also considered increased service for the disabled. The hearing was a small step in securing an estimated $8.2 million in transportation funds for the following year. The suggestions from the public included the use of international symbols to make transit signs more understandable to the illiterate and those who don't speak English.

Hackathon returns to test programmers

Bee Staff Reports

The third annual Valley Hackathon – a 24-hour competition for programmers – will be held Friday in downtown Modesto.

More than 100 programmers are expected to turn out, competing in teams of one to four participants to build a software project in just a day. Each will be judged by a panel on how complete, viable, aesthetically pleasing and technical it is.

Competitors can register right up until check-in begins at 5 p.m. Friday. As of Monday, there were 81 participants.

The top 10 teams will present their hacks in the event's finals. Prejudging will take place during the final hour of the programming time.

The event was begun to harness interest and talent in technology within the Central Valley, but has grown to draw entrants from as far away as the Bay Area, Sacramento and Fresno, organizers say. Participation in the Valley Hackathon has increased from 22 participants in 2015 to 63 last year.

"The Central Valley's economy is seeing a big shift right now," said David White, chief executive officer of Opportunity Stanislaus, one of the event's sponsoring organizations, in a news release. "We see hackathons as a sort of pipeline for talent in the technology sector and believe that events like the Valley Hackathon will be instrumental in creating connections for this community, as well as nurturing the innovative ideas such an event creates. This is a fun event in and of itself but it's also a piece in the larger puzzle that is a local revolution of sorts."

Other sponsors include Inventaweb, the Alliance Small Business Development Center, Oportun and California Community Colleges.

The free event draws some amazing talent, organizers say, but the hackathon also is for beginning programmers and designers. The minimum age to compete is 18.

"Though 24 hours is not a ton of time, we have been very impressed by the complexity of the projects," said Phillip Lan, Valley Hackathon organizer and head of business development for Hearst Digital. "We've seen everything from a program designed to sample soil moisture to software that scanned movie reviews to create viewing suggestions to users based on their current mood, so competitors will want to be sure their project is both inventive and interesting."

The winning teams will walk away with more than $5,000 in prize money

Other draws include chair massages, free meals, snacks and energy drinks and a Lego competition with its own separate kitty.

This year's hackathon has a "Star Wars" theme and a prize for the best team "Star Wars" cosplay.

The event will be at Redeemer Church, at 820 H St. Check-in is at 5 p.m., orientation at 6, and the competition begins at 6:30. To learn more, visit www.valleyhackathon.com.

More rain and snow in the forecast for Valley, foothills

Bee Staff Reports

Rain is expected to return to the Modesto area Wednesday afternoon and could stick around beyond the weekend, according to the National Weather Service.

After patchy fog in the morning, Tuesday should be mostly sunny, with a high near 54. Clouds will gather in the night.

Wednesday brings an 80 percent chance of rain, mainly after 4 p.m., and the high is expected to be near 58. The chance of rain increases to 90 percent Wednesday night.

There's a 60 percent chance of showers Thursday, which otherwise will be mostly cloudy, with a high near 57. Rain is likely Thursday night, the weather service predicts.

Weather service meteorologists say Friday also will bring rain, and a high near 54.

There's a chance of showers Saturday, and rain is likely Sunday. The high both days is expected to be near 54.

The first storm system passing through will be Wednesday and Thursday. Modesto is expected to receive 1 to 2 inches of rain, while Sonora and Yosemite National Park could get 2 to 3 inches.

Snow levels Wednesday should be at 5,000 to 6,000 feet, lowering to 3,000 to 4,000 feet Thursday. The weather service says Tioga Pass could get 18 to 24 inches of snow, while the Sonora, Ebbetts and Carson passes all could see 24 to 30 inches.

The second system should bring its heaviest precipitation Friday, with lingering showers Saturday. No estimate of amounts for Modesto and Sonora has been provided by the weather service.

Snow level will be down to 3,000 feet Friday, lowering to perhaps 2,000 feet by Saturday morning and during a third storm system expected to be here Sunday through Monday.

"None of these storms appear to be as strong or wet as last week's storms," the weather service said in a report issued Monday morning. "However, with soils still saturated and rivers and streams still running high, any additional rainfall will bring localized flooding concerns."

For updates on conditions and problems locally, follow the Stanislaus County Office of Emergency Services at StanEmergency on Facebook and Twitter.

LAW & ORDER

OLD ICE-MAKING PLANT IN RIVERBANK BURNS AGAIN

Stanislaus Consolidated Fire Protection District crews spent about an hour battling a small blaze at a one-time ice-making plant in Riverbank early Monday. "It wasn't much of a fire, just hard to access," Battalion Chief Eric DeHart said of the blaze in the 5800 block of Terminal Avenue. Because the report of the fire at the vacant site went out as a commercial structure fire, it drew a large response: five engines and two trucks. But two to three crews were released from the scene almost immediately, DeHart said. The fire was reported about 12:40 a.m. The mostly concrete building burned in the mid-'90s and a couple of times since, DeHart said. The building is attractive to transients seeking shelter. Earlier fires caused the roof to collapse, which created lean-tos, of sorts, which offer protection from the outside elements, he said. Without knowing for sure, DeHart said, this blaze likely was a warming fire that got out of control. No one was found at the scene and there are no known injuries. Crews did what they could from the ground, then put up ladders and used hoses from above. They battled the fire from outside because entering the collapsed interior would have put firefighters at risk. The building once served as an ice-making facility for the Burlington Northern Santa Fe Railway. The railroad has a switchyard adjacent to the plant.

TURLOCK MAN ARRESTED IN ROAD-RAGE INCIDENT

A Turlock man was arrested on suspicion of making criminal threats Sunday afternoon after Tuolumne County sheriff's deputies responded to a reported road-rage incident near the Dodge Ridge ski area. The road in the area was backed up and many cars were passing illegally, the Sheriff's Office said in a post on Facebook. Tony Alahverdi was trying to pass, but another motorist was in the way, the post said. Alahverdi, 36, pointed a firearm and threatened to kill the motorist, the Sheriff's Office said. The driver spotted the 2016 gray Toyota Tundra pickup near Dodge Ridge lodge and gave the Sheriff's Office its description and license plate number. The California Highway Patrol located and stopped the truck after Alahverdi left the area. Deputies arrived, searched the truck and found a handgun. Alahverdi was taken to the Tuolumne County jail.

SETTING IT STRAIGHT

We want to make sure the information in this paper is accurate. Please call mistakes to our attention, so we may correct them.

Local News 578-2330
City Desk 578-2327
Work & Money ...578-2343
Features 578-2312
Sports 578-2300

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NOTICE OF PUBLIC HEARING

Notice is hereby given that, pursuant to Water Code section 10723, Modesto Irrigation District (MID) will hold a public hearing during a special meeting on January 24, 2017, at Modesto Irrigation District Board Room, 1231 11th Street, Modesto, to determine whether MID will authorize the execution of the MEMORANDUM OF UNDERSTANDING FORMING THE STANISLAUS AND TUOLUMNE RIVERS GROUNDWATER BASIN ASSOCIATION GROUNDWATER SUSTAINABILITY AGENCY and participate in the Stanislaus and Tuolumne Rivers Groundwater Basin Association (STRGBA) election to become a groundwater sustainability agency for the Modesto Groundwater Sub-Basin.

Written comments may be submitted to MID at Attn: John Davids, P.O. Box 4060, Modesto, CA 95352.

During the hearing, MID will allow oral comments and will receive additional written comments until the STRGBA elects to be a groundwater sustainability agency.

Public Hearing:	*Groundwater Sustainability Agency*
Location:	*MID Board Room*
	1231 11th Street, Modesto
Date:	*January 24, 2017*
Time:	*9 a.m.*
Phone:	*209.526.7360*

MID Modesto Irrigation District Water and Power
1231 11th Street | P.O. Box 4060 | Modesto, CA
www.mid.org

OAKDALE IRRIGATION DISTRICT
RESOLUTION NO. 2017-08

A RESOLUTION AUTHORIZING AND DIRECTING THE EXECUTION OF A MEMORANDUM OF UNDERSTANDING FORMING THE GROUNDWATER SUSTAINABILITY AGENCY FOR THE MODESTO SUB-BASIN

WHEREAS, the California Legislature has adopted, and the Governor has signed into law, the Sustainable Groundwater Management Act of 2014 ("SGMA"), which authorizes local agencies to manage groundwater in a sustainable fashion; and

WHEREAS, the legislative intent of SGMA is to provide for sustainable management of groundwater basins, to enhance local management of groundwater, to establish minimum standards for sustainable groundwater management, and to provide local groundwater agencies with the authority and the technical and financial assistance necessary to sustainably manage groundwater; and

WHEREAS, SGMA requires that a GSA be formed for all basins designated by the Department of Water Resources as a high-priority basin, such as the Modesto Sub-basin (designated basin number 5-22.02 in the California Department of Water Resources' CASGEM groundwater basin system) ("Basin"), by June 30, 2017; and

WHEREAS, SGMA permits a combination of local agencies to form a groundwater sustainability agency ("GSA") through a Memorandum of Understanding ("MOU"); and

WHEREAS, the County of Stanislaus, the Oakdale Irrigation District, the City of Oakdale, the City of Riverbank, the City of Modesto, the City of Waterford, and the Modesto Irrigation District ("MOU Agencies") are all local agencies, as SGMA defines that term; and

WHEREAS, the MOU Agencies are committed to sustainable management of the Basin's groundwater resources as shown by, among other actions, the MOU Agencies' creation of the Stanislaus and Tuolumne Rivers Groundwater Basin Association ("STRGBA") in 1994, which was created to ensure coordinated and effective management of the Basin; and

WHEREAS, the MOU Agencies each exercise jurisdiction upon lands overlying the Basin and are all committed to the sustainable management of the Basin's groundwater resources; and

WHEREAS, the MOU Agencies have determined that the sustainable management of the Basin pursuant to SGMA may best be achieved through the cooperation of the MOU Agencies operating through an MOU; and

WHEREAS, notice of a hearing on the MOU Agencies' decision to form a GSA for the Basin ("Notice") has been published in the Oakdale Leader as provided by law; and

WHEREAS, on this day, the OAKDALE IRRIGATION DISTRICT ("OID") held a public hearing to consider whether it should enter into the Memorandum of Understanding Forming the Stanislaus and Tuolumne Rivers Groundwater Basin Association Groundwater Sustainability Agency ("GSA MOU") (attached hereto as Exhibit A) to form the Stanislaus and Tuolumne Rivers Groundwater Basin Association GSA ("STRGBA GSA") for the Basin; and

WHEREAS, it would be in the best interests of the MOU Agencies to form the GSA for the Basin, and to begin the process of preparing a groundwater sustainability plan ("Sustainability Plan"); and

WHEREAS, adoption of this resolution does not constitute a "project" under California Environmental Quality Act Guidelines Section 15378(b)(5), including organization and administrative activities of government, because there would be no direct or indirect physical change in the environment.

NOW, THEREFORE, BE IT RESOLVED by the Board of Directors of the Oakdale Irrigation District as follows:

1. All the recitals in this resolution are true and correct and the OID so finds, determines and represents.

2. The Secretary of the OID is hereby authorized and directed to attest the signature of the authorized signatory, and to affix and attest the seal of the OID, as may be required or appropriate in connection with the execution and delivery of the GSA MOU.

3. The OID hereby elects to enter into the GSA MOU with the MOU Agencies to form the GSA for the Basin.

4. Within thirty (30) days of the date of this resolution, the OID General Manager is directed to provide notice of OID's intent to enter into the GSA MOU with the MOU Agencies to form the GSA for the Basin ("Notice of GSA Election") to the California Department of Water Resources in the manner required by law.

5. One of the elements of the Notice of GSA Election is the boundaries of the area of the Basin or the portion of the Basin that the MOU Agencies intend to manage. Until further action of the MOU Agencies, the boundaries of the GSA shall be the boundaries of the portion of the Basin within the MOU Agencies' combined jurisdiction. A copy of a map of the management area is attached as Exhibit B.

6. This resolution shall take effect immediately upon passage and adoption.

Upon Motion of Director Santos, seconded by Director Altieri, and duly submitted to the Board for its consideration, the above-titled Resolution was adopted this 18th day of January, 2017.

OAKDALE IRRIGATION DISTRICT

Steve Webb
President

Steve Knell, P.E.
Secretary

I HEREBY CERTIFY that the foregoing is a true and correct copy of the original on file with the Oakdale Irrigation District.

OAKDALE IRRIGATION DISTRICT

Steve Knell, P.E.
General Manager/Secretary

PROOF OF PUBLICATION

(2015.5 C. C. P.)

STATE OF CALIFORNIA,

County of Stanislaus

I am a citizen of the United States and a resident of the county aforesaid; I am over the age of twenty-one years, and not a party to or interested in the above entitled matter. I am the principal clerk of THE OAKDALE LEADER, 122 South Third Avenue, Oakdale, California, a newspaper of general circulation, published in Oakdale, California in the City of Oakdale, County of Stanislaus, and which newspaper has been adjudged a newspaper of general circulation, by the Superior Court of the County of Stanislaus, State of California. That the notice, of which the annexed is a printed copy (set in type not smaller than nonpareil), has been published in each regular and entire issue of said newspaper and not in any supplement thereof on the following dates, to-wit:

December 28, 2016 and January 4, in the year 2017

I certify or declare under penalty of perjury that the foregoing is true and correct.

Dated at Oakdale,

This 4th day of January 2017.

Signature

RECEIVED

JAN 27 2017

OAKDALE ID

This space is for the County Clerk's Filing Stamp

Proof of Publication of

PUBLIC NOTICE
(STRGBA) MEETING

OID
OAKDALE IRRIGATION DISTRICT

PUBLIC NOTICE

Notice is hereby given that, pursuant to Water Code section 10723, Oakdale Irrigation District (OID) will hold a public hearing during a regular meeting on Wednesday, January 18, 2016, at 1205 East F Street, Oakdale, CA 95361, to determine whether OID will authorize the execution of the MEMORANDUM OF UNDERSTANDING FORMING THE STANISLAUS AND TUOLUMNE RIVERS GROUNDWATER BASIN ASSOCIATION GROUNDWATER SUSTAINABILITY AGENCY and participate in the Stanislaus and Tuolumne Rivers Groundwater Basin Association (STRGBA) election to become a Groundwater Sustainability Agency under the Sustainable Groundwater Management Act (California Water Code, Section 10720 et seq.) for the Modesto Groundwater Subbasin (Groundwater Subbasin Number: 5-22.02). Written comments may be submitted to OID at Attn: Eric Thorburn, 1205 East F Street, Oakdale, CA 95361. During the hearing, OID will invite oral comments to be heard and will receive additional written comments until the STRGBA elects to be a Groundwater Sustainability Agency.

Attachment C

Filed: __

No. 63-17

May 16 2017

By: [signature]

Clerk of the Board of Supervisors

RESOLUTION

OF THE BOARD OF SUPERVISORS OF THE COUNTY OF TUOLUMNE ESTABLISHING THE COUNTY OF TUOLUMNE AS A GROUNDWATER SUSTAINABILTY AGENCY PURSUANT TO THE SUSTAINABLE GROUNDWATER MANAGEMENT ACT

WHEREAS, the California Legislature has adopted, and the Governor has signed into law, the Sustainable Groundwater Management Act of 2014 (SGMA), which authorizes and requires local agencies to manage groundwater in a sustainable fashion; and

WHEREAS, the legislative intent of SGMA is to provide for sustainable management of groundwater basins, to enhance local management of groundwater, to establish minimum standards for sustainable groundwater management, and to provide local groundwater agencies with the authority and the technical and financial assistance necessary to sustainably manage groundwater; and

WHEREAS, SGMA requires that a Groundwater Sustainability Agency (GSA) be formed by June 30, 2017, for all basins designated by the California Department of Water Resources (DWR) CASGEM basin priority system as a high-priority or medium-priority basin; and

WHEREAS, the Modesto Sub-basin (Basin No. 5-22.02 in DWR Bulletin 118) (Basin) has been designated a high-priority basin by DWR; and

WHEREAS, Water Code Section 10724 establishes a presumption that a County shall be a GSA for areas of a high- or medium-priority basin that are not within the management area of a GSA; and

WHEREAS, Tuolumne County exercises jurisdiction upon lands overlying the portions of the Basin that are currently unmanaged, and is committed to the sustainable management of the Basin's groundwater resources and to working cooperatively with other GSAs, entities, and stakeholders within the Basin to implement SGMA; and

WHEREAS, notice of a hearing on Tuolumne County's decision to form a GSA for the Basin has been published in the Union Democrat as required by Water Code Section 10723; and

WHEREAS, each property owner in Tuolumne County within a half mile of the Basin boundary was also notified by mail of Tuolumne County's decision to form a GSA and the subsequent public hearing; and

WHEREAS, on this day, the Board of Supervisors of Tuolumne County held a public hearing to consider whether it should form the Tuolumne GSA; and

WHEREAS, SGMA requires a local agency to inform DWR within 30 days of deciding to become a GSA of its decision and intent to undertake sustainable groundwater management and to submit required documentation pursuant to Water Code Section 10723.8, and also to maintain a list of interested persons pursuant to Water Code Section 10723.4; and

WHEREAS, adoption of this resolution does not constitute a "project" under California Environmental Quality Act Guidelines Section 15378(b)(5) because it involves organizational and administrative activities of government that will not result in direct or indirect physical change in the environment.

NOW, THEREFORE BE IT RESOLVED by the Board of Supervisors of Tuolumne County, as follows:

1. The Board of Supervisors herby elects to form the Tuolumne Groundwater Sustainability Agency for the portions of the Modesto Groundwater Sub-basin (Bulletin 118 No. 5-22.02) underlying Tuolumne County's jurisdiction.

2. Within thirty (30) days of the date of this resolution, the Board of Supervisors Chair or her designee is directed to provide to DWR a copy of this resolution, information about the boundaries of the GSA and Basin areas to be managed, and all other notification documentation required to become a GSA and to otherwise comply with the requirements of Water Code Section 10723.8.

3. The County Administrator or his designee shall maintain a list of interested parties pursuant to Water Code Section 10723.4.

4. This resolution shall take effect immediately upon passage and adoption.

ADOPTED BY THE BOARD OF SUPERVISORS OF THE COUNTY OF TUOLUMNE ON MAY 16, 2017

AYES: 1st Dist. Brennan		NOES: ____ Dist.	
2nd Dist. Hanvelt		____ Dist.	
3rd Dist. Royce		ABSENT: 4th Dist. Gray	
4th Dist. absent		____ Dist.	
5th Dist. Rodefer		ABSTAIN: ____ Dist.	

Sherri Brennan

CHAIR OF THE BOARD OF SUPERVISORS

ATTEST: [signature]
Clerk of the Board of Supervisors

No. 63-17

I hereby certify that according to the provisions of Government Code Section 25103, delivery of this document has been made.

ALICIA L. JAMAR
Clerk of the Board

By: [signature]

COOPERATION AGREEMENT

BETWEEN COUNTY OF STANISLAUS AND COUNTY OF TUOLUMNE

This Cooperation Agreement ("Agreement") is entered into as of May 8, 2018, by and between the County of Stanislaus ("Stanislaus") and the County of Tuolumne ("Tuolumne") (each a "Party" and collectively, the "Parties"), both of which are political subdivisions of California, for the purpose of ensuring compliance with the Sustainable Groundwater Management Act within the Modesto Sub-basin (Basin No. 5-022.02) ("Basin").

RECITALS

A. In 2014, California enacted the Sustainable Groundwater Management Act ("Act"). The Act requires the formation of groundwater sustainability agencies ("GSA") and the adoption of groundwater sustainability plans ("GSP"), or an alternative that complies with the Act, for all groundwater basins designated as medium-priority or high-priority by the Department of Water Resources ("DWR").

B. The Act further provides that groundwater basins designated as medium-priority or high-priority, but which are not in critical overdraft, must be managed under a GSP by January 31, 2022.

C. DWR has designated the Basin as a high-priority groundwater basin that is not in critical overdraft.

D. Stanislaus overlies the portion of the Basin in Stanislaus County. Stanislaus has executed a memorandum of understanding with Oakdale Irrigation District, the City of Oakdale, the City of Riverbank, the City of Modesto, the City of Waterford and Modesto Irrigation District to form the Stanislaus and Tuolumne Rivers Groundwater Basin Association Groundwater Sustainability Agency ("STRGBA GSA"). The STRGBA GSA's purpose is ensuring compliance with the Act for the portion of the Basin within the member agencies' collective jurisdiction – more generally, the portion of the Basin in Stanislaus County.

E. Tuolumne overlies the portion of the Basin in Tuolumne County. Tuolumne formed the Tuolumne Groundwater Sustainability Agency ("Tuolumne GSA") to ensure compliance with the Act for the portion of the Basin in Tuolumne County.

F. Collectively, the STRGBA GSA and the Tuolumne GSA cover the entirety of the Basin.

G. The Act provides that where multiple GSAs cover a basin, the GSAs may choose to adopt a single GSP for the entirety of the basin, which is implemented by each of the basin's GSAs. (Wat. Code § 10727(b)(2).)

H. GSAs must comply with all applicable provisions contained in the GSP Emergency Regulations adopted by the California Water Commission on May 18, 2016 ("GSP Regulations") (23 Cal. Code Regs., § 350 et seq.).

I. Tuolumne has expressed its desire to work collaboratively with the STRGBA in GSP development, avoiding standalone GSPs for the same Basin. Tuolumne and Stanislaus intend that any GSP adopted by the STRGBA GSA encompass the entirety of the Basin, including the portion governed by the Tuolumne GSA. As such, Tuolumne will take the necessary actions and provide the required information to Stanislaus to ensure a GSP developed, adopted and implemented by the STRGBA GSA encompasses the Tuolumne GSA portion of the Basin and thereby covers the entirety of the Basin.

J. In exchange, Stanislaus has agreed to provide Tuolumne with the support and services needed to adopt the GSP prepared by the STRGBA GSA and satisfy its ongoing obligations under the Act.

K. The Parties seek to memorialize this Agreement and manage their cooperation pursuant to the terms below.

ARTICLE 1

RIGHTS AND RESPONSIBILITIES

1.1 Tuolumne's Responsibilities. Tuolumne, acting as the Tuolumne GSA, shall exercise its good faith and best efforts to take all necessary actions to help to effect the timely adoption of a GSP for the entire Basin and satisfy its ongoing obligations under the Act, including the implementation and enforcement of the GSP. Tuolumne shall cooperate to the fullest extent practical with Stanislaus' efforts, through the STRGBA GSA, to develop and implement the GSP for the entire Basin. Such cooperation shall include, but not be limited to, the prompt delivery of all necessary data and information to prepare the GSP and the taking of all necessary actions to review, adopt and implement the GSP. Tuolumne shall further ensure the timely filing of annual reports and documents as required by the Act.

1.2 Stanislaus' Responsibilities. Stanislaus shall provide the necessary support to Tuolumne in order for the Tuolumne GSA to adopt the GSP for the entire Basin, and satisfy Stanislaus' ongoing obligations under the Act, including the implementation and enforcement of the GSP. Stanislaus shall support Tuolumne by:

a. ensuring, to the maximum extent possible, that the interests of the Tuolumne County portion of the Basin are included in any GSP developed by the STRGBA GSA;

b. ensuring that DWR receives the necessary initial notification indicating the intent to develop a GSP for the Basin, pursuant to Water Code, section 10727.8 and Title 23 of the California Code of Regulations, section 353.6;

c. assisting the STRGBA GSA in drafting the GSP in compliance with the Act and with the GSP Regulations and drafting all necessary documents for the adoption of the GSP, which shall include the Tuolumne GSA area;

d. complying with all public notification and stakeholder participation requirements in the Act, including, but not limited to, Water Code sections 10723.2, 10723.4, 10727.8 and 10728.4 and all relevant provisions in the GSP Regulations and assisting the Tuolumne GSA in all such public notification and stakeholder participation requirements, including noticing and holding a public hearing regarding the adoption of the GSP; and

e. assisting the Tuolumne GSA in satisfying any other ongoing obligations under the Act and the GSP Regulations, including implementation of the GSP and annual reporting requirements.

1.3 Cooperation. The Parties shall, whenever and as often as reasonably requested to do so by the other Party, execute, acknowledge, and deliver or cause to be executed, acknowledged, and delivered any and all documents and instruments as may be necessary, expedient, or proper in the reasonable opinion of the requesting Party to carry out the intent and purposes of this Agreement.

1.4 Relationship of Parties. Except as otherwise provided in this Agreement, neither Party shall have any authority to bind or obligate the other Party to any agreements or undertakings. In their performance of their respective responsibilities arising out of this Agreement, the Parties are in no way forming an agency or employee relationship. Each Party retains the right to exercise full supervision and control of the manner and method in which it performs its responsibilities arising out of this Agreement, including full supervision and control over the employment, direction, compensation, and discharge of all persons assisting in the performance of responsibilities under this Agreement. With respect to each Party's employees, if any, and consultants, each Party shall be solely responsible for payment of wages, benefits, and other compensation, compliance with all occupational safety, welfare, and civil rights laws, tax withholding, and payment of employee taxes, whether federal, state, or local, and compliance with any and all other laws regulating employment. The Parties acknowledge that nothing in SGMA shall be construed as authorizing a local agency to make a binding determination of the water rights of any person or entity, and that nothing in SGMA or a GSP shall be interpreted as superseding the land use authority of cities and counties. The Parties intend that this Agreement shall not limit or interfere with either Party's rights or authority over its own jurisdiction and internal matters, including, but not limited to, a Party's police powers, land use powers, other powers, or legal rights to surface water supplies, groundwater supplies, and any other water management facilities and operations.

1.5 GSP Review. The Parties agree that it is desirable for all entities responsible for approving and implementing the GSP within the Basin to fully support the adopted GSP. Accordingly, the Parties agree that Stanislaus shall strive to ensure that Tuolumne be given ample opportunity to provide input on provisions relevant to Tuolumne within the draft GSP developed by the STRGBA GSA prior the STRGBA GSA's adoption of the GSP. To the extent reasonably feasible, Stanislaus shall assist in incorporating into the draft GSP any recommended changes or additions made by Tuolumne prior to its adoption by the STRGBA GSA. To the extent any Tuolumne recommendations for changes or additions are not included in the draft GSP, Stanislaus shall provide to Tuolumne a written explanation documenting the reason or reasons why the recommendations were not included.

1.6 Cost-Sharing and Contracting. If the Parties determine that cost-sharing is required for any contract or expenditure made pursuant to this Agreement, any cost-sharing allocations shall be agreed to in writing by the Parties in advance of executing any contracts with consultants, vendors or other contractors. Such written approval for cost-sharing shall be subject to any necessary approvals required by a Party's governing Board or designee pursuant to that Party's contract approval procedures. Any such contracts shall be drafted in a manner that reflects that consultants, vendors or contractors hired to perform work under this Agreement are working on behalf of both Parties and will be expected to work with the Parties on a collective basis and with each Party on an individual basis as needed. Such contracts shall be made to be enforceable by both Parties. Additionally, the contracts shall include appropriate indemnity and insurance provisions as required in Section 3.2.

In the event a Party to this Agreement acts as the official contracting agency and executes a contract on behalf of both Parties (the "Contracting Party"), the Contracting Party:

a. shall comply with all applicable local, state and federal laws including, without limitation, the California Public Contract Code and the California Labor Code;

b. shall provide to the other Party a reasonable opportunity to review any bids received and to review and provide input on any draft contract prior to its execution;

c. shall not approve any change orders that increase the cost of the original contract by more than 10 percent without prior consultation and written consent of the other Party;

d. shall, in advance of executing a contract involving cost-sharing by the Parties, establish a mutually agreeable understanding with the other Party about invoicing and payment procedures related to such a contract;

e. shall provide diligent oversight of the work conducted by any contractor, vendor or consultant under a contract executed pursuant to this Agreement; and

f. shall maintain complete, accurate, and clearly identifiable records with respect to all contracts executed and provide to the other Party access to all records, documents, reports, conclusions and other information related in any way to any contract executed on behalf of both Parties pursuant to this Agreement.

1.7 . **Dispute Resolution**. The Parties desire to informally resolve all disputes and controversies related to this Agreement, whenever possible, at the least possible level of formality and cost. If informal resolution of a dispute or controversy cannot be achieved, the Parties agree to neutral facilitation or mediation of the dispute as a next step prior to commencement of legal action. The cost of mediation shall be shared equally between the Parties. The choice of the mediator shall be voluntarily agreed upon by the Parties, or if such agreement cannot be reached, appointed by the Superior Court of Stanislaus or Tuolumne Counties upon motion for appointment of a neutral mediator. If the mediation process fails to provide a final resolution to the raised controversy, either Party may pursue any judicial or administrative remedies otherwise available. However, notwithstanding this Section 1.5, a Party may seek injunctive or other interlocutory judicial relief prior to completion of the mediation if necessary to avoid irreparable damage or to preserve the status quo.

ARTICLE 2

TERM

2.1 **Term**. This Agreement shall commence on May 8, 2018 ("Effective Date") and remain in full force and effect until it is terminated by either Party.

2.2 **Termination of Agreement**. In its sole discretion and upon ninety (90) days' written notice, either Party may terminate this Agreement at any time the Party deems necessary. Termination shall not relieve the terminating Party from its obligations that accrued prior to termination.

ARTICLE 3

INDEMNITY AND INSURANCE

3.1 Mutual Indemnification and Protection. Except as otherwise described herein, each Party (the "Indemnifying Party") covenants and agrees to indemnify and to hold harmless the other Party and its successors and assigns (the "Indemnified Party") for, from and against any and all third party claims, liabilities and expenses (including, but not limited to, reasonable attorneys' fees, court costs, expert witness fees and other litigation-related expenses) which may be claimed or asserted against the Indemnified Party on account of the exercise by the Indemnifying Party of the rights granted to it under this Agreement; provided, however, in no event shall the Indemnifying Party be responsible to the Indemnified Party for any claims, liabilities or expenses that may be claimed or asserted against the Indemnified Party relating to the gross negligent or willful misconduct of the Indemnified Party or any of its employees, directors, officers, trustors, trustees, agents, affiliates, personal representatives, successors or assigns. This indemnification provision shall apply to "active" as well as "passive" negligence but does not apply to either Party's "sole negligence" or "willful misconduct" within the meaning of Civil Code Section 2782. The provisions of this Section 3.1 will survive termination of this Agreement and shall not be restricted to insurance proceeds, if any, received by the Parties or their directors, officials, officers, employees, agents or volunteers.

3.2 Third-Party Agreements. Each Party shall include within any third party contract entered into in furtherance of this Agreement, provisions requiring the contractor, consultant or vendor to (a)_indemnify, defend and hold harmless the other non-contracting Party and its officials, officers, employees and agents to the same extent as the contracting Party is indemnified, and (b) provide insurance coverage to the other non-contracting Party and its officials, officers, employees and agents equivalent to the coverage provided to the contracting Party. Without limiting the foregoing and to the extent the following policies are required by the contract, the non-contracting Party and its officials, officers, employees and agents shall: (1) be named as additional insureds and provided coverage on a primary and non-contributory basis on the contractor, consultant or vendor's policies of commercial general liability and business automobile liability insurance and (2) be included in any waiver of subrogation endorsements issued on the commercial general liability, business liability and workers' compensation/employer's liability policies.

ARTICLE 4

GENERAL PROVISIONS.

4.1 Notices. Any notice under this Agreement shall be deemed sufficient if given by one Party to the other in writing and: delivered in person; transmitted by electronic mail or facsimile (with acknowledgement of receipt provided by the receiving Party); or, by mailing the same by United States mail (postage prepaid, registered or certified, return receipt requested) or by Federal Express or other similar overnight delivery service, to the Party to whom the notice is directed at the address of such Party as follows:

If to Stanislaus:

County of Stanislaus
Attn: Department of Environmental Resources
3800 Cornucopia Way, Suite C

Modesto, CA 95358

If to Tuolumne:

County of Tuolumne
Attn: County Administrator's Office
2 S. Green St.
Sonora, CA 95370

Any communication given by mail shall be deemed delivered two (2) business days after such mailing date, and any written communication given by overnight delivery service shall be deemed delivered one (1) business day after the dispatch date. Either Party may change its address by giving the other Party notice of its new address pursuant to this Section 4.1.

4.2 Assignability. The Parties may not assign all or any part of this Agreement without advance written consent of each Party's governing board.

4.3 Waiver. No waiver by any Party of any of the provisions shall be effective unless explicitly stated in writing and executed by the Party so waiving. Except as provided in the preceding sentence, no action taken pursuant to this Agreement, including, without limitation, any investigation by or on behalf of any Party, shall be deemed to constitute a waiver by the Party taking such action of compliance with any representations, warranties, covenants, or agreements contained in this Agreement, and in any documents delivered or to be delivered pursuant to this Agreement. The waiver by any Party of a breach of any provision of this Agreement shall not operate or be construed as a waiver of any subsequent breach. No waiver of any of the provisions of this Agreement shall be deemed, or shall constitute, a waiver of any other provision, whether or not similar, nor shall any waiver constitute a continuing waiver.

4.4 Headings. The section headings contained in this Agreement are for convenience and reference only and shall not affect the meaning or interpretation of this Agreement.

4.5 Severability. If any term, provision, covenant or condition of this Agreement shall be or become illegal, null, void or unenforceable, the remaining provisions of this Agreement shall remain in full force and effect, and shall not be affected, impaired or invalidated. The term, provision, covenant or condition that is so invalidated, voided or held to be unenforceable, shall be modified or changed by the Parties to the extent possible to carry out the intentions and directives set forth in this Agreement.

4.6 Governing Law. This Agreement shall be governed by, and interpreted in accordance with, the laws of the State of California.

4.7 Parties in Interest. Nothing in this Agreement, whether expressed or implied, is intended to confer any rights or remedies under or by reason of this Agreement on any persons other than the Parties to it and their respective successors and assigns, nor is anything in this Agreement intended to relieve or discharge the obligation or liability of any third persons to any party to this Agreement, nor shall any provision give any third persons any right of subrogation or action against any party to this Agreement.

4.8 Attorney Fees. Each Party shall bear its own legal costs, fees and expenses in any dispute between the Parties arising out of this Agreement.

4.9 Good Faith. The Parties agree to exercise their best efforts and utmost good faith to effectuate all the terms and conditions of this Agreement and to execute such further instruments or documents as are necessary or appropriate to effectuate all of the terms and conditions of this Agreement.

4.10 Construction. The provisions of this Agreement should be liberally construed to effectuate its purposes. The language of all parts of this Agreement shall be construed simply according to its plain meaning and shall not be construed for or against either Party, as each Party has participated in the drafting of this document and had the opportunity to have their counsel review it. Whenever the context and construction so requires, all words used in the singular shall be deemed to be used in the plural, all masculine shall include the feminine and neuter, and vice versa.

4.11 Entire Agreement. This Agreement contains the entire understanding and agreement of the Parties, and supersedes all prior agreements and understandings, oral and written, between the Parties concerning the subject matter of this Agreement. There have been no binding promises, representations, agreements, warranties or undertakings by any of the Parties, either oral or written, of any character or nature, except as stated in this Agreement. This Agreement may only be altered, amended or modified, in whole or in part, by a written agreement executed by the Parties to this Agreement and by no other means. Each Party waives its future right to claim, contest or assert that this Agreement was modified, canceled, superseded or changed by any oral agreement, course of conduct, waiver or estoppels.

4.12 Counterparts. This Agreement may be executed in any number of counterparts, each of which shall be deemed to be an original, but all of which shall constitute one and the same instrument.

IN WITNESS WHEREOF, the Parties have executed this Agreement on the day and year and at the place first written above.

COUNTY OF TUOLUMNE 4/17/18 Evan Royce for By: John Gray, Chair Board of Supervisors	COUNTY OF STANISLAUS By: Jim DeMartini, Chair, Board of Supervisors
APPROVED AS TO LEGAL FORM: Sarah Carr By: Sarah Carrillo, County Counsel	APPROVED AS TO LEGAL FORM: By: Thomas E. Boze, Assistant County Counsel
ATTEST: By: Alicia Jamar, Chief Deputy Clerk of the Board	ATTEST: Elizabeth A King By: Elizabeth A. King, Clerk of the Board

Appendix B

Adoption of GSP

D R A F T

RESOLUTION NO. 2022-03

RESOLUTION ADOPTING THE MODESTO SUBBASIN GROUNDWATER SUSTAINABILITY PLAN (GSP) AND AUTHORIZING THE STRGBA GSA PLAN MANAGER TO SUBMIT THE GSP TO DWR BY JANUARY 31, 2022.

WHEREAS, in April 1994, the City of Modesto, Modesto Irrigation District, City of Oakdale, Oakdale Irrigation District, City of Riverbank, and County of Stanislaus executed a Memorandum of Understanding to form the Stanislaus and Tuolumne Rivers Groundwater Basin Association (STRBGA) for the purpose of coordinating planning and groundwater management activities in the Modesto Subbasin;; and

WHEREAS, in July 2015, the Memorandum of Understanding was amended to include the City of Waterford as a member agency of STRGBA; and

WHEREAS, in August 2014, the California Legislature passed, and in September 2014 the Governor signed, legislation creating the Sustainable Groundwater Management Act (SGMA) “to provide local groundwater sustainability agencies with the authority and technical and financial assistance necessary to sustainably manage groundwater” (Wat. Code, § 10720, (d)); and

WHEREAS, SGMA requires sustainable management through the development of groundwater sustainability plans (“GSP”), which can be a single plan developed by one or more groundwater sustainability agency (“GSA”) or multiple coordinated plans within a basin or subbasin (Wat. Code, § 10727); and

WHEREAS, SGMA requires a GSA to manage groundwater in all basins designated by the Department of Water Resources (“DWR") as a medium or high priority, including the Modesto Subbasin (designated basin number 5-022.02); and

WHEREAS, the STRGBA GSA was formed on February 16, 2017, for the purpose of sustainably managing groundwater in the Modesto Subbasin, within its jurisdictional boundaries, pursuant to the requirements of SGMA; and

WHEREAS, the STRGBA GSA has the authority to draft, adopt, and implement a GSP (Wat. Code, § 10725 et seq.); and

WHEREAS, the STRGBA GSA submitted an Initial Notification to DWR to jointly develop a GSP for the Modesto Subbasin on February 28, 2017; and

WHEREAS, the STRGBA GSA has coordinated with the Tuolumne County GSA to develop a single, coordinated GSP for the Modesto Subbasin; and

WHEREAS, on August 10, 2021 the STRGBA GSA released the Notice of Intent to Adopt the GSP to cities and counties in the plan area pursuant to Water Code section 10728.4

WHEREAS, the STRGBA GSA and Tuolumne County GSA developed the draft Modesto Subbasin GSP and released the draft Modesto Subbasin GSP chapters for public review and comment; and

WHEREAS, the STRGBA GSA and Tuolumne County GSA reviewed and responded to comments on the Modesto Subbasin GSP; and

WHEREAS, all seven STRGBA GSA member agencies have held public hearings, adopted the draft GSP and authorized the Plan Manager to submit the final GSP to DWR; and

WHEREAS, the final Modesto Subbasin GSP is incorporated in its entirety by reference hereto this resolution.

NOW, THEREFORE, THE GOVERNING BODY OF THE STANISLAUS AND TUOLUMNE RIVERS GROUNDWATER BASIN ASSOCIATION GROUNDWATER SUSTAINABILITY AGENCY DOES HEREBY ADOPT THE MODESTO SUBBASIN GROUNDWATER SUSTAINABILITY PLAN AND AUTHORIZES THE STRGBA GSA PLAN MANAGER TO SUBMIT THE MODESTO SUBBASIN GSP TO DWR BY JANUARY 31, 2022.

AGENDA REPORT

GSA Meeting Date: January 31, 2022

Subject:	Modesto Subbasin Groundwater Sustainability Plan
Recommended Action:	Resolution adopting the Modesto Subbasin Groundwater Sustainability Plan (GSP) and authorizing the STRGBA GSA Plan Manager to submit the GSP to DWR by January 31, 2022.
Background and Discussion:	In April 1994, the Modesto Irrigation District along with Oakdale Irrigation District, Stanislaus County and the Cities of Modesto, Oakdale, and Riverbank executed a Memorandum of Understanding to form the Stanislaus and Tuolumne Rivers Groundwater Basin Association (STRBGA) for the purpose of coordinating planning and groundwater management activities in the Modesto Subbasin. In July 2015, the Memorandum of Understanding was amended to include the City of Waterford as a member agency of STRGBA. In August 2014, the California Legislature passed, and in September 2014 the Governor signed, legislation creating the Sustainable Groundwater Management Act (SGMA) "to provide local groundwater sustainability agencies with the authority and technical and financial assistance necessary to sustainably manage groundwater" (Wat. Code, § 10720, (d)). SGMA requires sustainable management through the development of groundwater sustainability plans (GSP), which can be a single plan developed by one or more groundwater sustainability agency (GSA) or multiple coordinated plans within a basin or subbasin (Wat. Code, § 10727). SGMA also requires a GSA to manage groundwater in all basins designated by the Department of Water Resources (DWR) as a medium or high priority, including the Modesto Subbasin (designated basin number 5-022.02). The STRGBA GSA was formed on February 16, 2017, for the purpose of sustainably managing groundwater in the Modesto Subbasin, within its jurisdictional boundaries, pursuant to the requirements of SGMA. The STRGBA GSA also has the authority to draft, adopt, and implement a GSP (Wat. Code, § 10725 et seq.). On February 28, 2017, the STRGBA GSA submitted an Initial Notification to DWR to jointly develop a GSP for the Modesto Subbasin along with Tuolumne County GSA. The STRGBA GSA has since then worked with the Tuolumne County GSA to develop a single, coordinated GSP for the Modesto Subbasin. On August 10, 2021 the STRGBA GSA released the Notice of Intent to Adopt the GSP to cities and counties in the plan area pursuant to Water Code section 10728.4. On November 15, 2021, the STRGBA GSA and Tuolumne County GSA released the completed draft of the Modesto Subbasin GSP for public review and comment. The STRGBA GSA and Tuolumne County GSA have subsequently

	received, reviewed, and incorporated public comments into the final document where appropriate. All seven STRGBA GSA member agencies (MID, OID, Stanislaus County, Cities of Modesto, Oakdale, Riverbank, and Waterford) have held public hearings, adopted the draft GSP and authorized the Plan Manager to submit the final GSP to DWR by January 31, 2022. The final Modesto Subbasin GSP will be incorporated in its entirety by reference hereto this resolution.
Alternatives, Pros and Cons of Each Alternative:	1. Do Nothing – Cons: Does not comply with State law, not eligible for DWR grant funding, liable for costs associated with DWR engagement of 3rd party to prepare plan; Pros: No staff time or consultant costs. 2. Approve GSP – Cons: Staff time and consultant costs; Pros: Complies with State law, eligible for DWR grant funding, demonstrates unified long-term water resource planning with other STRGBA GSA member agencies..
Concurrence:	The GSP has been prepared in accordance with the requirements of the Sustainable Groundwater Management Act of 2014, and Water Code, § 10727. All seven STRGBA GSA member agencies have adopted the final draft of the GSP.
Fiscal Impact:	In July 2018, the STRGBA GSA member agencies entered into a cost share agreement for the preparation of the GSP for the Modesto Subbasin. In August 2017, City awarded a contract to Todd Groundwater to prepare the GSP for a total cost of $1,616,226 inclusive of a 10% contingency. Subsequently, the City of Modesto applied for and was awarded a $1,000,000 grant from DWR to help defray the plan preparation costs. The seven STRGBA GSA member agencies along with the Tuolumne County GSA agreed to each pay approximately 12.5% (1/8) of the unfunded balance, or $77,028, to cover their share of the GSP development.
Recommendation:	Resolution adopting the Modesto Subbasin Groundwater Sustainability Plan (GSP) and authorizing the STRGBA GSA Plan Manager to submit the GSP to DWR by January 31, 2022.

AGENDA REPORT

Attachments: Supporting documents attached:

☒ Resolution ☐ Presentation ☐ Other supporting docs ☐ None attached

Note: Original contracts and agreements are housed in the GSA Secretary's Office, phone (209) 526-7360.

Presenter	GSA Chairman
Gordon J. Enas	Eric Thorburn
Gordon Enas, P.E.	Eric Thorburn, P.E.
1/25/22	1/25/22
Date Signed	Date Signed

MODESTO CITY COUNCIL
RESOLUTION NO. 2021-512

RESOLUTION APPROVING THE ADOPTION OF THE MODESTO SUBBASIN GROUNDWATER SUSTAINABILITY PLAN AND AUTHORIZING THE STANISLAUS AND TUOLUMNE RIVERS GROUNDWATER SUSTAINABILITY ASSOCIATION GROUNDWATER SUSTAINABILITY AGENCY TO SUBMIT THE MODESTO SUBBASIN GROUNDWATER SUSTAINABILITY PLAN TO THE DEPARTMENT OF WATER RESOURCES

WHEREAS, in September of 2014, Governor Edmund G. Brown signed into law the Sustainable Groundwater Management Act of 2014 (SGMA), which changed groundwater management in California. SGMA is a comprehensive package of legislation that sets the framework for statewide sustainable groundwater management and declares that such authority be given to local public agencies that have either water supply, land use authority, or both, and

WHEREAS, SGMA requires the formation of Groundwater Sustainability Agencies (GSAs) made up of local public agencies, and

WHEREAS, GSAs are the local agencies responsible for the development and implementation of the Groundwater Sustainability Plans (GSPs), ultimately aimed at ensuring groundwater sustainability over a 20-year implementation period, and

WHEREAS, the City of Modesto overlies the Modesto Subbasin and the Turlock Subbasin, which are designated as high priority, non-critically overdrafted groundwater basins by the State. The regulatory deadline for the completion of the GSPs for the Modesto Subbasin and Turlock Subbasin is January 31, 2022, and

WHEREAS, on January 24, 2017, by Resolution No. 2017-30, Council authorized a Groundwater Sustainability Agency Memorandum of Understanding with the Stanislaus and Tuolumne Rivers Groundwater Basin Association (STRGBA) member agencies and approved the formation of the Stanislaus and Tuolumne Rivers

Groundwater Basin Association Groundwater Sustainability Agency (STRGBA GSA). The STRGBA GSA was officially formed on February 16, 2017. The STRGBA GSA is a partnership consisting of the cities of Modesto, Oakdale, Riverbank and Waterford; the Oakdale Irrigation District, Modesto Irrigation District and Stanislaus County, and

WHEREAS, due to the structure of the Memorandum of Understanding governing the administration of the STRGBA GSA, all member agencies must approve and adopt the Modesto Subbasin GSP by their respective governing bodies. All member agencies of the STRGBA GSA and the Tuolumne County GSA, will be taking action to approve and adopt the Modesto Subbasin GSP, and

WHEREAS, this proposed action is in compliance with State legislation known as the "Sustainable Groundwater Management Act" which mandates the adoption of a Groundwater Sustainability Plan for groundwater basins categorized as high priority, but not in a condition of critical overdraft, by January 31, 2022, and

WHEREAS, failure to adopt such GSP would result in the groundwater resources of the basin being subject to regulation by the State of California Water Resources Control Board.

NOW, THEREFORE, BE IT RESOLVED by the Council of the City of Modesto that it hereby approves the adoption of the Modesto Subbasin Groundwater Sustainability Plan and authorizes the Stanislaus and Tuolumne Rivers Groundwater Sustainability Association Groundwater Sustainability Agency to submit the Modesto Subbasin Groundwater Sustainability Plan to the Department of Water Resources.

The foregoing resolution was introduced at a regular meeting of the Council of the City of Modesto held on the 14th day of December, 2021, by Councilmember Madrigal, who moved its adoption, which motion being duly seconded by Councilmember Wright, was upon roll call carried and the resolution adopted by the following vote:

AYES:	Councilmembers:	Escutia-Braaton, Kenoyer, Madrigal, Ricci, Wright, Zoslocki, Mayor Zwahlen
NOES:	Councilmembers:	None
ABSENT:	Councilmembers:	None

ATTEST: Dana Sanchez
DANA SANCHEZ, Interim City Clerk

(SEAL)

APPROVED AS TO FORM:

BY: ______________________
JOSE M. SANCHEZ, City Attorney

CITY OF RIVERBANK

RESOLUTION NO. 2021-114

A RESOLUTION OF THE CITY COUNCIL OF THE CITY OF RIVERBANK, CALIFORNIA, ADOPTING THE MODESTO SUBBASIN GROUNDWATER SUSTAINABILITY PLAN

WHEREAS, in April 1994, the City of Modesto, Modesto Irrigation District, City of Oakdale, Oakdale Irrigation District, City of Riverbank, and County of Stanislaus executed a Memorandum of Understanding to form the Stanislaus and Tuolumne Rivers Groundwater Basin Association ("STRBGA") for the purpose of coordinating planning and management activities in the Modesto Subbasin; and

WHEREAS, in July 2015, the Memorandum of Understanding was amended to include the City of Waterford as a member agency of STRGBA; and

WHEREAS, in August 2014, the California Legislature passed, and in September 2014 the Governor signed, legislation creating the Sustainable Groundwater Management Act ("SGMA") "to provide local groundwater sustainability agencies with the authority and technical and financial assistance necessary to sustainably manage groundwater" (Wat. Code, § 10720, (d)); and

WHEREAS, SGMA requires sustainable management through the development of groundwater sustainability plans ("GSP"), which can be a single plan developed by one or more groundwater sustainability agency ("GSA") or multiple coordinate plans within a basin or subbasin (Wat. Code, § 10727); and

WHEREAS, SGMA requires a GSA to manage groundwater in all basins designated by the Department of Water Resources ("DWR") as a medium or high priority, including the Modesto Subbasin (designated basin number 5-022.02); and

WHEREAS, the STRGBA GSA was formed on February 16, 2017 for the purposes of sustainably managing groundwater in the Modesto Subbasin, within its jurisdictional boundaries, pursuant to the requirements of SGMA; and

WHEREAS, the STRGBA GSA has the authority to draft, adopt, and implement a GSP (Wat. Code, § 10725 *et seq.*); and

WHEREAS, the STRGBA GSA submitted an Initial Notification to DWR to jointly develop a GSP for the Modesto Subbasin on February 28, 2017; and

WHEREAS, the STRGBA GSA has coordinated with the Tuolumne County GSA to develop a single, coordinated GSP for the Modesto Subbasin; and

WHEREAS, on August 10, 2021 the STRGBA GSA released the Notice of Intent to Adopt the GSP to cities and counties in the plan area pursuant to Water Code Section 10728.4; and

WHEREAS, the STRGBA GSA and Tuolumne County GSA developed the draft Modesto Subbasin GSP and released the draft Modesto Subbasin GSP chapters for public review and comment;

WHEREAS, the STRGBA GSA and Tuolumne County GSA reviewed and responded to comments on the Modesto Subbasin GSP; and

WHEREAS, the STRGBA GSA and Tuolumne County GSA released the final Modesto Subbasin GSP which is incorporated in its entirety by reference hereto this resolution as **Exhibit A**; and

NOW, THEREFORE, BE IT RESOLVED that the City Council of the City of Riverbank declares as follows:

1. The City of Riverbank hereby approves and adopts the final Modesto Subbasin GSP as drafted.
2. The City of Riverbank authorizes the Modesto Sub basin Plan Manager and consultants to take such other actions as may be reasonably necessary to submit the Modesto Subbasin GSP to DWR by January 31, 2022, and implement the purpose of this Resolution.

PASSED AND ADOPTED by the City Council of the City of Riverbank at a regular meeting held on the 14th day of December, 2021; motioned by Councilmember District 3 Cal Campbell, seconded by Vice Mayor (CM-D1) Luis Uribe, and upon roll call was carried by the following City Council vote of 5-0:

AYES:	**Barber-Martinez, Campbell, Hernandez, Uribe, and Mayor O'Brien**
NAYS:	**None**
ABSENT:	**None**
ABSTAINED:	**None**

ATTEST:

Annabelle H. Aguilar, CMC
City Clerk

APPROVED:

Richard D. O'Brien
Mayor

Attachment: https://www.strgba.org/Home/GSP

IN THE CITY COUNCIL
OF THE CITY OF OAKDALE
STATE OF CALIFORNIA
CITY COUNCIL RESOLUTION 2022-004

RESOLUTION OF THE CITY OF OAKDALE CITY COUNCIL ADOPTING THE FINAL STAFF VERSION OF THE MODESTO SUBBASIN GROUNDWATER SUSTAINABILITY PLAN (GSP) AND AUTHORIZING THE STANISLAUS & TUOLUMNE RIVERS GROUNDWATER BASIN ASSOCIATION GROUNDWATER SUSTAINABILITY AGENCY (STRGBA GSP) TO SUBMIT THE FINAL MODESTO SUBBASIN GSP TO DEPARTMENT OF WATER RESOURCES (DWR) BY JANUARY 31, 2022

THE CITY OF OAKDALE CITY COUNCIL DOES HEREBY RESOLVE THAT:

WHEREAS, in April 1994, the City of Modesto, Modesto Irrigation District, City of Oakdale, Oakdale Irrigation District, City of Riverbank, and County of Stanislaus executed a Memorandum of Understanding to form the Stanislaus and Tuolumne Rivers Groundwater Basin Association ("STRBGA") for the purpose of coordinating planning and management activities in the Modesto Subbasin; and

WHEREAS, in July 2015, the Memorandum of Understanding was amended to include the City of Waterford as a member agency of STRGBA; and

WHEREAS, in August 2014, the California Legislature passed, and in September 2014 the Governor signed, legislation creating the Sustainable Groundwater Management Act ("SGMA") "to provide local groundwater sustainability agencies with the authority and technical and financial assistance necessary to sustainably manage groundwater" (Wat. Code, § 10720, (d)); and

WHEREAS, SGMA requires sustainable management through the development of groundwater sustainability plans ("GSP"), which can be a single plan developed by one or more groundwater sustainability agency ("GSA") or multiple coordinate plans within a basin or subbasin (Wat. Code, § 10727); and

WHEREAS, SGMA requires a GSA to manage groundwater in all basins designated by the Department of Water Resources ("DWR") as a medium or high priority, including the Modesto Subbasin (designated basin number 5-022.02); and

WHEREAS, the STRGBA GSA was formed on February 16, 2017 for the purposes of sustainably managing groundwater in the Modesto Subbasin, within its jurisdictional boundaries, pursuant to the requirements of SGMA; and

WHEREAS, the STRGBA GSA has the authority to draft, adopt, and implement a GSP (Wat. Code, § 10725 et seq.); and

WHEREAS, the STRGBA GSA submitted an Initial Notification to DWR to jointly develop a GSP for the Modesto Subbasin on February 28, 2017; and

WHEREAS, the STRGBA GSA has coordinated with the Tuolumne County GSA to develop a single, coordinated GSP for the Modesto Subbasin; and

WHEREAS, on August 10, 2021 the STRGBA GSA released the Notice of Intent to Adopt the GSP to cities and counties in the plan area pursuant to Water Code Section 10728.4; and

WHEREAS, the STRGBA GSA and Tuolumne County GSA developed the draft Modesto Subbasin GSP and released the draft Modesto Subbasin GSP chapters for public review and comment; and

WHEREAS, the STRGBA GSA and Tuolumne County GSA reviewed and responded to comments on the Modesto Subbasin GSP; and

WHEREAS, the STRGBA GSA and Tuolumne County GSA released the final Modesto Subbasin GSP on November 15, 2021, which is attached to this resolution as Exhibit A; and

WHEREAS, there is no fiscal impact associated with the adoption of the Modesto Subbasin Groundwater Sustainability Plan. However, there will be costs associated with implementing the GSP over the coming decades. These costs, once determined, will be subject to future City budget considerations and City Council approval; and

WHEREAS, in the course of Department of Water Resources (DWR) review, it may be required to edit the final version presented to the Oakdale City Council at the January 18, 2022 meeting. City of Oakdale Staff, the STRGBA GSA and consultant team will finalize the GSP by making non-substantive revisions to the final Modesto Subbasin GSP presented on January 18, 2022; and

WHEREAS, the final Modesto Subbasin GSP will be incorporated in its entirety by reference hereto this resolution as Attachment B: https://www.strgba.org/Home/GSP; and

WHEREAS, Staff recommends that the City Council adopt the Resolution adopting the final staff version of the Modesto Subbasin Groundwater Sustainability Plan (GSP) and authorizing the Stanislaus & Tuolumne Rivers Groundwater Basin Association Groundwater Sustainability Agency (STRGBA GSA) to submit the final Modesto Subbasin GSP to Department of Water Resources (DWR) by January 31, 2022.

NOW, THEREFORE, BE IT RESOLVED that the **CITY COUNCIL** hereby adopts the final staff version of the Modesto Subbasin Groundwater Sustainability Plan (GSP) and authorizes the Stanislaus & Tuolumne Rivers Groundwater Basin Association Groundwater Sustainability Agency (STRGBA GSA) to submit the final Modesto Subbasin GSP to Department of Water Resources (DWR) by January 31, 2022.

CITY OF OAKDALE
City Council Resolution 2022-004 (Continued)

THE FOREGOING RESOLUTION IS HEREBY ADOPTED THIS 18th DAY OF JANUARY, 2022, by the following vote:

AYES:	COUNCIL MEMBERS:	C. Smith, Haney, Bairos	(3)
NOES:	COUNCIL MEMBERS:	None	(0)
ABSENT:	COUNCIL MEMBERS:	F. Smith	(1)
ABSTAINED:	COUNCIL MEMBERS:	None	(0)

SIGNED:

Cherilyn Bairos, Mayor

ATTEST:

Rouzé Roberts, City Clerk

WATERFORD CITY COUNCIL
RESOLUTION #2021-64

RESOLUTION ADOPTING THE MODESTO SUBBASIN GROUNDWATER SUSTAINABILITY PLAN AND AUTHORIZING THE SUBMISSION TO THE DEPARTMENT OF WATER RESOURCES

WHEREAS, in April 1994, the City of Modesto, Modesto Irrigation District, City of Oakdale, Oakdale Irrigation District, City of Riverbank, and County of Stanislaus executed a Memorandum of Understanding to form the Stanislaus and Tuolumne Rivers Groundwater Basin Association ("STRBGA") for the purpose of coordinating planning and groundwater management activities in the Modesto Subbasin; and

WHEREAS, in July 2015, the Memorandum of Understanding was amended to include the City of Waterford as a member agency of STRGBA; and

WHEREAS, in August 2014, the California Legislature passed, and in September 2014 the Governor signed, legislation creating the Sustainable Groundwater Management Act ("SGMA") "to provide local groundwater sustainability agencies with the authority and technical and financial assistance necessary to sustainably manage groundwater" (Wat. Code, § 10720, (d)); and

WHEREAS, SGMA requires sustainable management through the development of groundwater sustainability plans ("GSP"), which can be a single plan developed by one or more groundwater sustainability agency ("GSA") or multiple coordinated plans within a basin or subbasin (Wat. Code, § 10727); and

WHEREAS, SGMA requires a GSA to manage groundwater in all basins designated by the Department of Water Resources ("DWR") as a medium or high priority, including the Modesto Subbasin (designated basin number 5-022.02); and

WHEREAS, the STRGBA GSA was formed on February 16, 2017, for the purpose of sustainably managing groundwater in the Modesto Subbasin, within its jurisdictional boundaries, pursuant to the requirements of SGMA; and

WHEREAS, the STRGBA GSA has the authority to draft, adopt, and implement a GSP (Wat. Code, § 10725 *et seq*.); and

WHEREAS, the STRGBA GSA submitted an Initial Notification to DWR to jointly develop a GSP for the Modesto Subbasin on February 28, 2017; and

WHEREAS, the STRGBA GSA has coordinated with the Tuolumne County GSA to develop a single, coordinated GSP for the Modesto Subbasin; and

WHEREAS, on August 10, 2021 the STRGBA GSA released the Notice of Intent to Adopt the GSP to cities and counties in the plan area pursuant to Water Code section 10728.4; and

WHEREAS, the STRGBA GSA and Tuolumne County GSA developed the draft Modesto Subbasin GSP and released the draft Modesto Subbasin GSP chapters for public review and comment; and

WHEREAS, the STRGBA GSA and Tuolumne County GSA reviewed and will respond to comments on the Modesto Subbasin GSP; and

WHEREAS, the final staff version of the Modesto Subbasin GSP was presented to the Waterford City Council on December 16, 2021; and

WHEREAS, the City of Waterford understands its staff and consultant team will finalize the GSP by making non-substantive revisions to the final Modesto Subbasin GSP presented on December 16, 2021; and

WHEREAS, the final Modesto Subbasin GSP will be incorporated in its entirety by reference hereto this resolution.

NOW, THEREFORE, BE IT RESOLVED that the City Council of the City of Waterford hereby finds as follows:

1. The City of Waterford hereby approves and adopts the final staff version of the Modesto Subbasin GSP.

2. The City of Waterford authorizes the Modesto Subbasin Plan Manager and consultants to take such actions as may be reasonably necessary to:

    a. finalize the staff version of the Modesto Subbasin GSP, barring any substantive changes to the document;

    b. submit the final Modesto Subbasin GSP to DWR by January 31, 2022; or

    c. implement the purpose of this Resolution.

The foregoing Resolution was passed and adopted by the City Council of the City of Waterford, County of Stanislaus, State of California, at a regular meeting thereof held on December 16, 2021, by the following vote:

AYES: Aldaco, Kitchens, Talbott
NOES: None
ABSTAIN: None
ABSENT: Ewing, Hilton

City of Waterford,

DocuSigned by:
Jose M Aldaco
6504969EAF3E4B2...

Jose Aldaco, Mayor

ATTEST:

DocuSigned by:
Patricia Krause
0E40B251B23D4F2...

Patricia Krause, CMC, City Clerk

APPROVED AS TO FORM:

DocuSigned by:
Corbett Browning
F2D1FA69CB4B4A7...

Corbett J. Browning, City Attorney

RESOLUTION 2021-68

ADOPTING THE MODESTO SUBBASIN GROUNDWATER SUSTAINABILITY PLAN AND AUTHORIZING THE SUBMISSION TO THE DEPARTMENT OF WATER RESOURCES

WHEREAS, in April 1994, the City of Modesto, Modesto Irrigation District, City of Oakdale, Oakdale Irrigation District, City of Riverbank, and County of Stanislaus executed a Memorandum of Understanding to form the Stanislaus and Tuolumne Rivers Groundwater Basin Association (STRBGA) for the purpose of coordinating planning and groundwater management activities in the Modesto Subbasin; and

WHEREAS, in July 2015, the Memorandum of Understanding was amended to include the City of Waterford as a member agency of STRGBA; and

WHEREAS, in August 2014, the California Legislature passed, and in September 2014 the Governor signed, legislation creating the Sustainable Groundwater Management Act (SGMA) "to provide local groundwater sustainability agencies with the authority and technical and financial assistance necessary to sustainably manage groundwater" (Wat. Code, § 10720, (d)); and

WHEREAS, SGMA requires sustainable management through the development of groundwater sustainability plans ("GSP"), which can be a single plan developed by one or more groundwater sustainability agency ("GSA") or multiple coordinated plans within a basin or subbasin (Wat. Code, § 10727); and

WHEREAS, SGMA requires a GSA to manage groundwater in all basins designated by the Department of Water Resources ("DWR") as a medium or high priority, including the Modesto Subbasin (designated basin number 5-022.02); and

WHEREAS, the STRGBA GSA was formed on February 16, 2017, for the purpose of sustainably managing groundwater in the Modesto Subbasin, within its jurisdictional boundaries, pursuant to the requirements of SGMA; and

WHEREAS, the STRGBA GSA has the authority to draft, adopt, and implement a GSP (Wat. Code, § 10725 et seq.); and

WHEREAS, the STRGBA GSA submitted an Initial Notification to DWR to jointly develop a GSP for the Modesto Subbasin on February 28, 2017; and

WHEREAS, the STRGBA GSA has coordinated with the Tuolumne County GSA to develop a single, coordinated GSP for the Modesto Subbasin; and

WHEREAS, on August 10, 2021 the STRGBA GSA released the Notice of Intent to Adopt the GSP to cities and counties in the plan area pursuant to Water Code section 10728.4; and

WHEREAS, the STRGBA GSA and Tuolumne County GSA developed the draft Modesto Subbasin GSP and released the draft Modesto Subbasin GSP chapters for public review and comment; and

WHEREAS, the STRGBA GSA and Tuolumne County GSA reviewed and will respond to comments on the Modesto Subbasin GSP; and

WHEREAS, the Modesto Irrigation District understands its staff and consultant team will finalize the GSP by making non-substantive revisions to the final Modesto Subbasin GSP presented on December 14, 2021; and

WHEREAS, the final Modesto Subbasin GSP will be incorporated in its entirety by reference hereto this resolution.

BE IT RESOLVED, That the Board of Directors of the Modesto Irrigation District hereby approves and adopts the final staff version of the Modesto Subbasin GSP and authorizes the Modesto Subbasin Plan Manager and consultants to take such actions as may be reasonably necessary to finalize the staff version of the Modesto Subbasin GSP, barring any substantive changes to the document, and submit the final Modesto Subbasin GSP to DWR by January 31, 2022.

Moved by Director Blom, seconded by Director Byrd, that the foregoing resolution be adopted.

The following roll call vote was had:

Ayes:	Directors Blom, Byrd, Campbell, Gilman and Mensinger
Noes:	Director None
Absent:	Director None

The President declared the resolution adopted.

o0o

I, Angela Cartisano, Board Secretary of the Modesto Irrigation District, do hereby CERTIFY that the foregoing is a full, true and correct copy of a resolution duly adopted at a regular meeting of said Board of Directors held the fourteenth day of December 2021.

Board Secretary of the
Modesto Irrigation District

OAKDALE IRRIGATION DISTRICT
RESOLUTION NO. 2021-29

RESOLUTION ADOPTING THE MODESTO SUBBASIN GROUNDWATER SUSTAINABILITY PLAN AND AUTHORIZING THE SUBMISSION TO THE DEPARTMENT OF WATER RESOURCES

A. **WHEREAS**, in April 1994 the City of Modesto, Modesto Irrigation District, City of Oakdale, Oakdale Irrigation District, City of Riverbank, and County of Stanislaus executed a Memorandum of Understanding to form the Stanislaus and Tuolumne Rivers Groundwater Basin Association ("STRBGA") for the purpose of coordinating planning and groundwater management activities in the Modesto Subbasin;

B. **WHEREAS**, in July 2015, the Memorandum of Understanding was amended to include the City of Waterford as a member agency of STRGBA;

C. **WHEREAS,** in August 2014, the California Legislature passed, and in September 2014 the Governor signed, legislation creating the Sustainable Groundwater Management Act ("SGMA") "to provide local groundwater sustainability agencies with the authority and technical and financial assistance necessary to sustainably manage groundwater" (Wat. Code, § 10720, (d));

D. **WHEREAS**, SGMA requires sustainable management through the development of groundwater sustainability plans ("GSP"), which can be a single plan developed by one or more groundwater sustainability agency ("GSA") or multiple coordinated plans within a basin or subbasin (Wat. Code, § 10727);

E. **WHEREAS**, SGMA requires a GSA to manage groundwater in all basins designated by the Department of Water Resources ("DWR") as a medium or high priority, including the Modesto Subbasin (designated basin number 5-022.02);

F. **WHEREAS**, the STRGBA GSA was formed on February 16, 2017, for the purpose of sustainably managing groundwater in the Modesto Subbasin, within its jurisdictional boundaries, pursuant to the requirements of SGMA;

G. **WHEREAS**, the STRGBA GSA has the authority to draft, adopt, and implement a GSP (Wat. Code, § 10725 *et seq.*);

H. **WHEREAS**, the STRGBA GSA submitted an Initial Notification to DWR to jointly develop a GSP for the Modesto Subbasin on February 28, 2017;

I. **WHEREAS**, the STRGBA GSA has coordinated with the Tuolumne County GSA to develop a single, coordinated GSP for the Modesto Subbasin;

J. **WHEREAS**, on August 10, 2021 the STRGBA GSA released the Notice of Intent to Adopt the GSP to cities and counties in the plan area pursuant to Water Code section 10728.4;

K. **WHEREAS,** the STRGBA GSA and Tuolumne County GSA developed the draft Modesto Subbasin GSP and released the draft Modesto Subbasin GSP chapters for public review and comment;

L. **WHEREAS**, the STRGBA GSA and Tuolumne County GSA reviewed and will respond to comments on the Modesto Subbasin GSP;

M. **WHEREAS**, the final staff version of the Modesto Subbasin GSP was presented to the Board of Directors on December 14, 2021;

N. **WHEREAS**, the Oakdale Irrigation District understands its staff and consultant team will finalize the GSP by making non-substantive revisions to the final Modesto Subbasin GSP presented on December 14, 2021;

O. **WHEREAS**, the final Modesto Subbasin GSP will be incorporated in its entirety by reference hereto this resolution.

NOW, THEREFORE, BE IT RESOLVED that the Board of Directors of the Oakdale Irrigation District finds as follows:

1. Oakdale Irrigation District hereby approves and adopts the final staff version of the Modesto Subbasin GSP.

2. Oakdale Irrigation District authorizes the Modesto Subbasin Plan Manager and consultants to take such actions as may be reasonably necessary to:

   a. finalize the staff version of the Modesto Subbasin GSP, barring any substantive changes to the document;

   b. submit the final Modesto Subbasin GSP to DWR by January 31, 2022; or

   c. implement the purpose of this Resolution.

Upon motion of Director Doornenbal, seconded by Director Tobias, and duly submitted to the Board for its consideration, the above-titled Resolution was adopted this 14th day of December, 2021.

OAKDALE IRRIGATION DISTRICT

Thomas D. Orvis, President
Board of Directors

Steve Knell, P.E.
General Manager/Secretary

THE BOARD OF SUPERVISORS OF THE COUNTY OF STANISLAUS
BOARD ACTION SUMMARY

DEPT: Environmental Resources

BOARD AGENDA:6.B.2
AGENDA DATE: August 31, 2021

SUBJECT:
Approval to Set a Public Hearing on December 7, 2021, at the 9:00 a.m. Meeting to Consider Adoption of the Modesto Groundwater Subbasin Groundwater Sustainability Plan

BOARD ACTION AS FOLLOWS: **RESOLUTION NO. 2021-0400**

On motion of Supervisor Grewal **Seconded by Supervisor** B. Condit
and approved by the following vote,
Ayes: Supervisors: B. Condit, Withrow, Grewal, C. Condit, and Chairman Chiesa
Noes: Supervisors: None
Excused or Absent: Supervisors: None
Abstaining: Supervisor: None

1) X **Approved as recommended**
2) ______ **Denied**
3) ______ **Approved as amended**
4) ______ **Other:**

MOTION:

Kelly Rodriguez

ATTEST: **KELLY RODRIGUEZ, Assistant Clerk of the Board of Supervisors** **File No.**

THE BOARD OF SUPERVISORS OF THE COUNTY OF STANISLAUS
AGENDA ITEM

DEPT: Environmental Resources

BOARD AGENDA:6.B.2
AGENDA DATE: August 31, 2021

CONSENT: ☑

CEO CONCURRENCE: YES

4/5 Vote Required: No

SUBJECT:

Approval to Set a Public Hearing on December 7, 2021, at the 9:00 a.m. Meeting to Consider Adoption of the Modesto Groundwater Subbasin Groundwater Sustainability Plan

STAFF RECOMMENDATION:

1. Set a public hearing on December 7, 2021, at the 9:00 a.m. meeting for consideration of adoption of the Modesto Groundwater Subbasin Groundwater Sustainability Plan.

DISCUSSION:

In September of 2014, Governor Edmund G. Brown signed into law the Sustainable Groundwater Management Act of 2014 (SGMA), which changed the landscape of groundwater management in California. SGMA is a comprehensive package of legislation that sets the framework for statewide sustainable groundwater management and declares that such authority be given to local public agencies that have either water supply or land use authority, or both.

SGMA requires, among many other items, the formation of Groundwater Sustainability Agency's (GSAs) made up of local public agencies. SGMA empowers these GSAs to use a number of management tools to achieve "sustainability" in the affected groundwater basins, including authorities required in order to manage groundwater in a sustainable manner. GSAs are the local agencies responsible for the development and implementation of the Groundwater Sustainability Plans (GSPs), ultimately aimed at ensuring groundwater sustainability over a 20 year implementation period. GSPs are focused on the development and implementation of long-term groundwater sustainability programs, plans and practices over a 50 year planning horizon.

There are four groundwater subbasins underlying Stanislaus County, in whole or in part. These basins include the following:

1. Eastern San Joaquin Groundwater Subbasin
2. Modesto Groundwater Subbasin
3. Turlock Groundwater Subbasin
4. Delta-Mendota Groundwater Subbasin

The Delta-Mendota Groundwater Subbasin and the Eastern San Joaquin Groundwater Subbasin have been designated by the California Department of Water Resources to be in a condition of “critical overdraft.” Pursuant to SGMA, groundwater subbasins in this category were required to develop and adopt GSPs by January 31, 2020. The Stanislaus County Board of Supervisors adopted both of these GSPs on December 10, 2019. The regulatory deadline for the completion of the GSPs for the Modesto Groundwater Subbasin and the Turlock Groundwater Subbasin, categorized as high priority, is January 31, 2022.

The formation deadline for creating the GSAs was June 30, 2017. On February 14, 2017, the Board of Supervisors approved the adoption of a Memorandum of Understanding creating the Stanislaus & Tuolumne Rivers Groundwater Basin Association Groundwater Sustainability Agency (STRGBA GSA); a partnership consisting of the cities of Modesto, Oakdale, Riverbank and Waterford; Oakdale Irrigation District, Modesto Irrigation District and Stanislaus County.

Additionally, in May 2017, the Tuolumne County Board of Supervisors elected to become a Groundwater Sustainability Agency (GSA) for that area of the Modesto Groundwater Subbasin that falls within Tuolumne County’s political jurisdiction. The remainder of the Modesto Groundwater Subbasin lies wholly within Stanislaus County. Furthermore, Tuolumne County and Stanislaus County entered into a Cooperation Agreement on May 8, 2018 regarding preparation of the GSP. This agreement recognized the status of Tuolumne County as an independent GSA with jurisdiction over specific lands lying within the Modesto Groundwater Subbasin and yet allowed for these lands to be integrated into a single, basin-wide GSP in full compliance with SGMA regulations.

The GSP that has been developed for the Modesto Groundwater Subbasin includes the following main chapters:

1. Administrative Information
2. Plan Area
3. Notice and Communication
4. Basin Setting
5. Water Budgets
6. Sustainable Management Criteria
7. Monitoring Networks
8. Projects and Management Actions
9. References

In addition to the regularly scheduled and publically noticed meetings of the committee groups preparing the draft Modesto Groundwater Subbasin GSP, “Office Hours” or public working sessions have been conducted on: March 25, 2021, May 28, 2021 and August 9, 2021.

As the formal adoption date of the GSP approaches into the fall months, additional public outreach meetings pertaining to the elements of the plan will be held.

Todd Groundwater, the name of the consultant firm preparing the Modesto Groundwater Subbasin GSP, will also be making a presentation regarding the GSP to the Stanislaus County Water Advisory Committee on September 29, 2021. This is a meeting that is open to the public.

Pursuant to California Water Code Section 10728.4, Adoption or Amendment of a Plan following Public Hearing, a GSA must take the following action:

"A groundwater sustainability agency may adopt or amend a groundwater sustainability plan after a public hearing, held at least 90 days after providing notice to a city or county within the area of the proposed plan or amendment. The groundwater sustainability agency shall review and consider comments from any city or county that receives notice pursuant to this section and shall consult with a city or county that requests consultation within 30 days of receipt of the notice. Nothing in this section is intended to preclude an agency and a city or county from otherwise consulting or commenting regarding the adoption or amendment of a plan."

This notice has been prepared and delivered to all of the principal parties involved in this matter. In the case of the STRGBA GSA, this requirement is routine in that all of the cities within the footprint of the GSP are member agencies of the STRGBA GSA, including Stanislaus County.

Furthermore, pursuant to California Water Code Section 10728.6, Division 13 (commencing with Section 21000) of the Public Resources Code, the provisions of the California Environmental Quality Act do not apply to the preparation and adoption of plans pursuant to SGMA.

Due to the structure of the MOU governing the administration of the STRGBA GSA, all member agencies must approve and adopt the Modesto Groundwater Subbasin GSP by their respective governing bodies. All member agencies, including Tuolumne County, will be taking action to approve and adopt the Modesto Groundwater Subbasin GSP.

A hard copy of the Public Draft of the Modesto Groundwater Sustainability Plan may be reviewed at the Stanislaus County Department of Environmental Resources, 3800 Cornucopia Way, Suite C, in Modesto. All documents pertaining to the Modesto Groundwater Subbasin GSP may also be found at the following electronic address: https://www.strgba.org/.

POLICY ISSUE:

This proposed action is in compliance with State legislation known as the "Sustainable Groundwater Management Act" which mandates the adoption of a Groundwater Sustainability Plan (GSP) for groundwater basins categorized as high priority, but not in a condition of critical overdraft, by January 31, 2022. Failure to adopt such GSP would result in the groundwater resources of the basin being subject to regulation by the State of California Water Resources Control Board.

FISCAL IMPACT:

There is no fiscal impact associated with the adoption of the Modesto Subbasin Groundwater Sustainability Plan. However, there will be costs associated with implementing the GSP over the coming decades. These costs, once determined, will be subject to future County budget considerations and Board approval.

BOARD OF SUPERVISORS' PRIORITY:

Approval of these actions are consistent with the Board's *priority of Supporting Strong and Safe Neighborhoods, Supporting Community Health, Developing a Healthy Economy and Delivering Community Infrastructure* by ensuring a coordinated approach towards regional groundwater resources management.

STAFFING IMPACT:

Existing Department of Environmental Resources staff will continue to oversee the work associated with this item.

CONTACT PERSON:

Patrick Cavanah, Interim Director, DER	209-525-6818
Walter Ward, Water Resources Manager	209-525-6710

ATTACHMENT(S):

1. Notice of Public Hearing Modesto Groundwater Subbasin

STANISLAUS COUNTY
NOTICE OF PUBLIC HEARING

NOTICE IS HEREBY GIVEN that on Tuesday, December 7, 2021, at 9:00 a.m., or as soon thereafter as the matter may be heard, the Stanislaus County Board of Supervisors will meet in the Basement Chambers, 1010 10th Street, Modesto, CA, pursuant to California Water Code Section 10728.4, to consider approval and adoption of the Modesto Groundwater Subbasin Groundwater Sustainability Plan.

NOTICE IS FURTHER GIVEN that at the said time and place, interested persons will be given the opportunity to be heard. Written comments may be submitted to Stanislaus County at Attn: Walter Ward, Water Resources Manager, 3800 Cornucopia Way, Suite C, Modesto, CA, or at wward@envres.org.

BY ORDER OF THE BOARD OF SUPERVISORS

DATED: August 31, 2021

ATTEST: ELIZABETH A. KING, Clerk
of the Board of Supervisors
of the County of Stanislaus,
State of California

BY: Kelly Rodriguez
Kelly Rodriguez, Assistant Clerk

THE BOARD OF SUPERVISORS OF THE COUNTY OF STANISLAUS
BOARD ACTION SUMMARY

DEPT: Environmental Resources | BOARD AGENDA:7.1
AGENDA DATE: December 7, 2021

SUBJECT:
Public Hearing to Consider Adoption of the Modesto Groundwater Sustainability Plan

BOARD ACTION AS FOLLOWS: **RESOLUTION NO. 2021-0592**

On motion of Supervisor Withrow **Seconded by Supervisor** C. Condit
and approved by the following vote,
Ayes: Supervisors: B. Condit, Withrow, Grewal, C. Condit, and Chairman Chiesa
Noes: Supervisors: None
Excused or Absent: Supervisors: None
Abstaining: Supervisor: None

1) X **Approved as recommended**
2) ______ **Denied**
3) ______ **Approved as amended**
4) ______ **Other:**

MOTION:

Elizabeth A. King

ATTEST: ELIZABETH A. KING, Clerk of the Board of Supervisors | File No.

THE BOARD OF SUPERVISORS OF THE COUNTY OF STANISLAUS
AGENDA ITEM

DEPT: Environmental Resources

BOARD AGENDA:7.1
AGENDA DATE: December 7, 2021

CONSENT ☐

CEO CONCURRENCE: YES

4/5 Vote Required: No

SUBJECT:

Public Hearing to Consider Adoption of the Modesto Groundwater Sustainability Plan

STAFF RECOMMENDATION:

1. Conduct a public hearing to consider approval and adoption of the Modesto Groundwater Sustainability Plan.
2. Approve and adopt the resolution regading the Modesto Groundwater Sustainability Plan.
3. Authorize the Modesto Groundwater Sustainability Agency's, it's consultants, and the Plan Manager to take such other actions as may be reasonably necessary to submit the Modesto Groundwater Sustainability Plan to the California Department of Water Resources by January 31, 2022, and implement the purpose of this resolution.

DISCUSSION:

In September of 2014, Governor Edmund G. Brown signed into law the Sustainable Groundwater Management Act of 2014 (SGMA), which changed the landscape of groundwater management in California. SGMA is a comprehensive package of legislation that sets the framework for statewide sustainable groundwater management and declares that such authority be given to local public agencies that have either water supply or land use authority, or both.

SGMA requires, among many other items, the formation of Groundwater Sustainability Agency's (GSAs) made up of local public agencies. SGMA empowers these GSAs to use a number of management tools to achieve "sustainability" in the affected groundwater basins, including authorities required in order to manage groundwater in a sustainable manner. GSAs are the local agencies responsible for the development and implementation of the Groundwater Sustainability Plans (GSPs), ultimately aimed at ensuring groundwater sustainability over a 20 year implementation period. GSPs are focused on the development and implementation of long-term groundwater sustainability programs, plans and practices over a 50 year planning horizon.

There are four groundwater subbasins underlying Stanislaus County, in whole or in part. These basins include the following:

1. Eastern San Joaquin Groundwater Subbasin
2. Modesto Groundwater Subbasin

3. Turlock Groundwater Subbasin
4. Delta-Mendota Groundwater Subbasin

The Delta-Mendota Groundwater Subbasin and the Eastern San Joaquin Groundwater Subbasin are designated by the California Department of Water Resources as being in a condition of "critical overdraft." Pursuant to SGMA, groundwater subbasins in this category are required to develop and adopt GSPs by January 31, 2020. The Stanislaus County Board of Supervisors adopted both of these GSPs in December, 2019. The regulatory deadline for the completion of the GSPs for the Modesto Groundwater Subbasin and the Turlock Groundwater Subbasin is January 31, 2022.

The formation deadline for creating the GSAs was June 30, 2017. On February 28, 2017, the Board of Supervisors approved the adoption of a Memorandum of Understanding creating the Stanislaus & Tuolumne Rivers Groundwater Basin Association Groundwater Sustainability Agency (STRGBA GSA); a partnership consisting of the cities of Modesto, Oakdale, Riverbank and Waterford; Oakdale Irrigation District, Modesto Irrigation District and Stanislaus County.

Additionally, in May 2017, the Tuolumne County Board of Supervisors elected to become a Groundwater Sustainability Agency (GSA) for that area of the Modesto Groundwater Subbasin that falls within Tuolumne County's political jurisdiction. The remainder of the Modesto Groundwater Subbasin lies wholly within Stanislaus County. Furthermore, Tuolumne County and Stanislaus County entered into a Cooperation Agreement on May 8, 2018 regarding preparation of the GSP. This agreement recognized the status of Tuolumne County as an independent GSA with jurisdiction over specific lands lying within the Modesto Groundwater Subbasin and yet allowed for these lands to be integrated into a single, basin-wide GSP (avoiding the need for a formal Coordination Agreement) in full compliance with SGMA regulations.

The GSP developed for the Modesto Groundwater Subbasin includes the following main chapters.

1. Administrative Information
2. Plan Area
3. Basin Setting
4. Notice and Communication
5. Water Budgets
6. Sustainable Management Criteria
7. Monitoring Networks
8. Projects and Management Actions
9. References

In addition to the regularly scheduled and publically noticed meetings of the committee groups preparing the draft Modesto Subbasin GSP, the following "Office Hours" or public working sessions have been conducted:

- March 25, 2021
- May 28, 2021
- August 9, 2021

Todd Groundwater, the principal consultant firm preparing the Modesto Groundwater Subbasin GSP, also made a presentation regarding the GSP to the Stanislaus County Water Advisory Committee on September 29, 2021. This presentation is located here:

http://www.stancounty.com/er/groundwater/pdf/wac/StanislausCountyWaterAdvisory092921.pdf

Pursuant to California Water Code Section 10728.4, Adoption or Amendment of Plan following Public Hearing, a GSA must take the following action:

"A groundwater sustainability agency may adopt or amend a groundwater sustainability plan after a public hearing, held at least 90 days after providing notice to a city or county within the area of the proposed plan or amendment. The groundwater sustainability agency shall review and consider comments from any city or county that receives notice pursuant to this section and shall consult with a city or county that requests consultation within 30 days of receipt of the notice. Nothing in this section is intended to preclude an agency and a city or county from otherwise consulting or commenting regarding the adoption or amendment of a plan."

This notice has been prepared and delivered to all of the principal parties involved in this matter. In the case of the STRGBA this requirement is routine in that all of the cities within the footprint of the GSP are member agencies of the STRGBA GSA, including Stanislaus County.

Furthermore, pursuant to California Water Code Section 10728.6, Division 13 (commencing with Section 21000) of the Public Resources Code, the provisions of the California Environmental Quality Act do not apply to the preparation and adoption of plans pursuant to SGMA.

Due to the structure of the MOU governing the administration of the STRGBA GSA, all member agencies must approve and adopt the Modesto Groundwater Subbasin GSP by their respective governing bodies. All member agencies, including Tuolumne County, will be taking action to approve and adopt the Modesto Groundwater Subbasin GSP.

A hard copy of the Public Draft of the Modesto Subbasin Groundwater Sustainability Plan may be reviewed at the Stanislaus County Department of Environmental Resources, 3800 Cornucopia Way, Suite C, in Modesto. All documents pertaining to the Modesto Groundwater Subbasin GSP may also be found at the following electronic address:

https://www.strgba.org/

POLICY ISSUE:

This proposed action is in compliance with State legislation known as the "Sustainable Groundwater Management Act" which mandates the adoption of a Groundwater Sustainability Plan (GSP) for groundwater basins categorized as high priority, but not in a condition of critical overdraft, by January 31, 2022. Failure to adopt such GSP would result in the groundwater resources of the basin being subject to regulation by the State of California Water Resources Control Board.

FISCAL IMPACT:

There is no fiscal impact associated with the adoption of the Modesto Subbasin Groundwater Sustainability Plan. However, there will be costs associated with implementing the GSP over the coming decades. These costs, once determined, will be subject to future County budget considerations and Board approval.

BOARD OF SUPERVISORS' PRIORITY:

Approval of these actions are consistent with the Board's priorities of *Supporting Strong and Safe Neighborhoods, Supporting Community Health, Developing a Healthy Economy, and Delivering Community Infrastructure* by ensuring a coordinated approach towards regional groundwater resources management.

STAFFING IMPACT:

Existing staff from the Department of Environmental Resources and other relevant County departments will continue to oversee the work associated with this item.

CONTACT PERSON:

Robert Kostlivy, Director, DER	209-525-6818
Walter Ward, Water Resources Manager	209-525-6710

ATTACHMENT(S):

1. Resolution

ORACLE ACCOUNT CODING STRIP
Single Supplier - Multiple Invoices

Shaded areas for A/P only

BATCH NAME	PREPARED Fay Tamez	DEPT: ENVIRONMENTAL RESOURCES
KEYED BY	DATE: 12/13/2021	PHONE: 525-6795
DATE		

SUPPLIER: MCCLATCHY **INVOICE DATE: VARIOUS** **TOTAL:** $101.64 **PAY ALONE**

SITE: 74253 - MI **TERMS: IMMED** **Y / N**

LINE	PO #		INVOICE #	DATE	AMOUNT	FUND	ORG	ACCT	GL PROJ	LOCATION	MISC	OTHER	DESCRIPTION
1		P/F	82582	11/30/2021	$101.64	100	34301	62630	0	0	0	0	30440 - GW
2		P/F											
3		P/F											
4		P/F											
5		P/F											
6		P/F											
7		P/F											
8		P/F											

12/13/21 Christine [signature]

DATE AUTHORIZED DEPARTMENTAL SIGNATURE

OK TO PAY OVERAGE

BUYER SIGNATURE

DATE AUDITOR APPROVING SIGNATURE (Exceeding $75,000)

REPORTABLE: Y or N **BOX #** **SITE NAME:** 74253

McCLATCHY

Beaufort Gazette
Belleville News-Democrat
Bellingham Herald
Bradenton Herald
Centre Daily Times
Charlotte Observer
Columbus Ledger-Enquirer
Fresno Bee
The Herald - Rock Hill
Herald Sun - Durham
Idaho Statesman
Island Packet
Kansas City Star
Lexington Herald-Leader
Merced Sun-Star
Miami Herald
el Nuevo Herald - Miami
Modesto Bee
Raleigh News & Observer
The Olympian
Sacramento Bee
Fort Worth Star-Telegram
The State - Columbia
Sun Herald - Biloxi
Sun News - Myrtle Beach
The News Tribune Tacoma
The Telegraph - Macon
San Luis Obispo Tribune
Tri-City Herald
Wichita Eagle

CO STAN ENVIRONMENTAL RESOURCE
Attn: Accounts Payable
3800 CORNUCOPIA WAY STE C
MODESTO, CA 95358

RECEIVED
STANISLAUS CO.
DEC 10 2021
ENVIRONMENTAL RESOURCES

INVOICE	
Invoice No.:	82582
Invoice Date:	11/30/2021
Due Date:	12/30/2021
Bill-To Account:	30440
Sales Rep:	Jane Durand

Dates	Order No.	Description	Product	Size	Billed Units	Times Run	Net Amount
11/21/2021 - 11/28/2021	153686	Print Legal Ad IPL0045135	MOD-The Modesto Bee Legal | Legals & Public Notices CLS	1 x 32 L	32 L	2	$101.64

Summary	
Amount Due:	$101.64

OK to Pay
UPW
12/10/21

Please Return This Portion With Your Payment (Thank You)

McClatchy Company LLC
PO Box 510150
Livonia MI 48151

INVOICE	
Invoice No.:	82582
Account No.:	30440
Account Name:	CO STAN ENVIRONMENTAL RESOURCE
Amount Due:	$101.64

Email questions to ssccreditandcollections@mcclatchy.com

3006000066 PRESORT PBPS001 <B>

CO STAN ENVIRONMENTAL RESOURCE
ATTN: ACCOUNTS PAYABLE
3800 CORNUCOPIA WAY STE C
MODESTO CA 95358-9494

McClatchy Company LLC
PO Box 510150
Livonia MI 48151

0000030440 0000082582 000010164 1

McCLATCHY

Beaufort Gazette
Belleville News-Democrat
Bellingham Herald
Bradenton Herald
Centre Daily Times
Charlotte Observer
Columbus Ledger-Enquirer
Fresno Bee
The Herald - Rock Hill
Herald Sun - Durham
Idaho Statesman
Island Packet
Kansas City Star
Lexington Herald-Leader
Merced Sun-Star
Miami Herald
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Attention: Julie Mendoza

CO STAN ENVIRONMENTAL RESOURCE
3800 CORNUCOPIA WAY STE C
MODESTO, CA 95358

STANISLAUS COUNTY NOTICE OF PUBLIC HEARING

NOTICE IS HEREBY GIVEN that on Tuesday, December 7, 2021, at 9:00 a.m., or as soon thereafter as the matter may be heard, the Stanislaus County Board of Supervisors will meet in the Basement Chambers, 1010 10th Street, Modesto, CA, pursuant to California Water Code Section 10728.4, to consider approval and adoption of the Modesto Groundwater Subbasin Groundwater Sustainability Plan.

NOTICE IS FURTHER GIVEN that at the said time and place, interested persons will be given the opportunity to be heard. Written comments may be submitted to Stanislaus County at Attn: Walter Ward, Water Resources Manager, 3800 Cornucopia Way, Suite C, Modesto, CA, or at wward@envres.org.

BY ORDER OF THE BOARD OF SUPERVISORS
DATED: August 31, 2021
ATTEST:
ELIZABETH A. KING, Clerk of the Board of Supervisors of the County of Stanislaus, State of California
BY: /s/Kelly Rodriguez, Assistant Clerk
IPL0045135
Nov 21,28 2021

Declaration of Publication
C.C.P. S2015.5

STATE OF CALIFORNIA)
) ss.
County of Stanislaus)

I am a citizen of the United States; I am over the age of eighteen years, and not a party to or interested in the above entitled matter. I am the principal clerk of the printer of the Modesto Bee, a newspaper of general circulation, printed and published in the city of Modesto, County of Stanislaus, and which newspaper has been adjudged a newspaper of general circulation by the Superior Court of the County of Stanislaus, State of California, under the date of February 25, 1951 Action No. 46453 that the notice, of which the annexed is a printed copy, has been published in each regular and entire issue of said newspaper and not in any supplement thereof on the following dates, to wit:

No. of Insertions: 2

Beginning Issue of: 11/21/2021

Ending Issue of: 11/28/2021

I certify (or declare) under penalty of perjury that the foregoing is true and correct and that this declaration was executed at Dallas, Texas on:

Date: 29th, day of November, 2021

Notary Public in and for the state of Texas, residing in Dallas County

AMANDA DAWN GRISHAM
My Notary ID # 132031326
Expires May 30, 2023

Extra charge for lost or duplicate affidavits.
Legal document please do not destroy!

THE BOARD OF SUPERVISORS OF THE COUNTY OF STANISLAUS
STATE OF CALIFORNIA

2021-0592

Date: December 7, 2021

On motion of Supervisor Withrow Seconded by Supervisor C. Condit
and approved by the following vote,
Ayes: Supervisors: B. Condit, Withrow, Grewal, C. Condit, and Chairman Chiesa
Noes: Supervisors: None
Excused or Absent: Supervisors: None
Abstaining: Supervisor: None

THE FOLLOWING RESOLUTION WAS ADOPTED: Item # 7.1

THE MODESTO SUBBASIN GROUNDWATER SUSTAINABILITY PLAN AND AUTHORIZING THE SUBMISSION TO THE DEPARTMENT OF WATER RESOURCES

A. WHEREAS, in April 1994, the City of Modesto, Modesto Irrigation District, City of Oakdale, Oakdale Irrigation District, City of Riverbank, and County of Stanislaus executed a Memorandum of Understanding to form the Stanislaus and Tuolumne Rivers Groundwater Basin Association ("STRBGA") for the purpose of coordinating planning and groundwater management activities in the Modesto Subbasin;

B. WHEREAS, in July 2015, the Memorandum of Understanding was amended to include the City of Waterford as a member agency of STRGBA;

C. WHEREAS, in August 2014, the California Legislature passed, and in September 2014 the Governor signed, legislation creating the Sustainable Groundwater Management Act ("SGMA") "to provide local groundwater sustainability agencies with the authority and technical and financial assistance necessary to sustainably manage groundwater" (Wat. Code, § 10720, (d));

D. WHEREAS, SGMA requires sustainable management through the development of groundwater sustainability plans ("GSP"), which can be a single plan developed by one or more groundwater sustainability agency ("GSA") or multiple coordinated plans within a basin or subbasin (Wat. Code, § 10727);

E. WHEREAS, SGMA requires a GSA to manage groundwater in all basins designated by the Department of Water Resources ("DWR") as a medium or high priority, including the Modesto Subbasin (designated basin number 5-022.02);

F. WHEREAS, the STRGBA GSA was formed on February 16, 2017, for the purpose of sustainably managing groundwater in the Modesto Subbasin, within its jurisdictional boundaries, pursuant to the requirements of SGMA;

G. WHEREAS, the STRGBA GSA has the authority to draft, adopt, and implement a GSP (Wat. Code, § 10725 et seq.);

H. WHEREAS, the STRGBA GSA submitted an Initial Notification to DWR to jointly develop a GSP for the Modesto Subbasin on February 28, 2017;

I. WHEREAS, the STRGBA GSA has coordinated with the Tuolumne County GSA to develop a single, coordinated GSP for the Modesto Subbasin;

J. WHEREAS, on August 10, 2021 the STRGBA GSA released the Notice of Intent to Adopt the GSP to cities and counties in the plan area pursuant to Water Code section 10728.4;

K. WHEREAS, the STRGBA GSA and Tuolumne County GSA developed the draft Modesto Subbasin GSP and released the draft Modesto Subbasin GSP chapters for public review and comment;

L. WHEREAS, the STRGBA GSA and Tuolumne County GSA reviewed and will respond to comments on the Modesto Subbasin GSP;

M. WHEREAS, the final staff version of the Modesto Subbasin GSP was presented to Stanislaus County on December 7, 2021;

N. WHEREAS, the Stanislaus County understands its staff and consultant team will finalize the GSP by making non-substantive revisions to the final Modesto Subbasin GSP presented on December 7, 2021;

O. WHEREAS, the final Modesto Subbasin GSP will be incorporated in its entirety by reference hereto this resolution.

NOW, THEREFORE, BE IT RESOLVED that the Board of Supervisors of the Stanislaus County finds as follows:

1. Stanislaus County hereby approves and adopts the final staff version of the Modesto Subbasin GSP.

2. Stanislaus County authorizes the Modesto Subbasin Plan Manager and consultants to take such actions as many be reasonably necessary to:

   a. finalize the staff version of the Modesto Subbasin GSP, barring any substantive changes to the document;

   b. submit the final Modesto Subbasin GSP to DWR by January 31, 2022; or

   c. implement the purpose of this Resolution.

ATTEST: **ELIZABETH A. KING, Clerk**
Stanislaus County Board of Supervisors,
State of California

Elizabeth A King

File No.

Appendix C

C2VSimTM

The Turlock-Modesto Integrated Water Resources Model

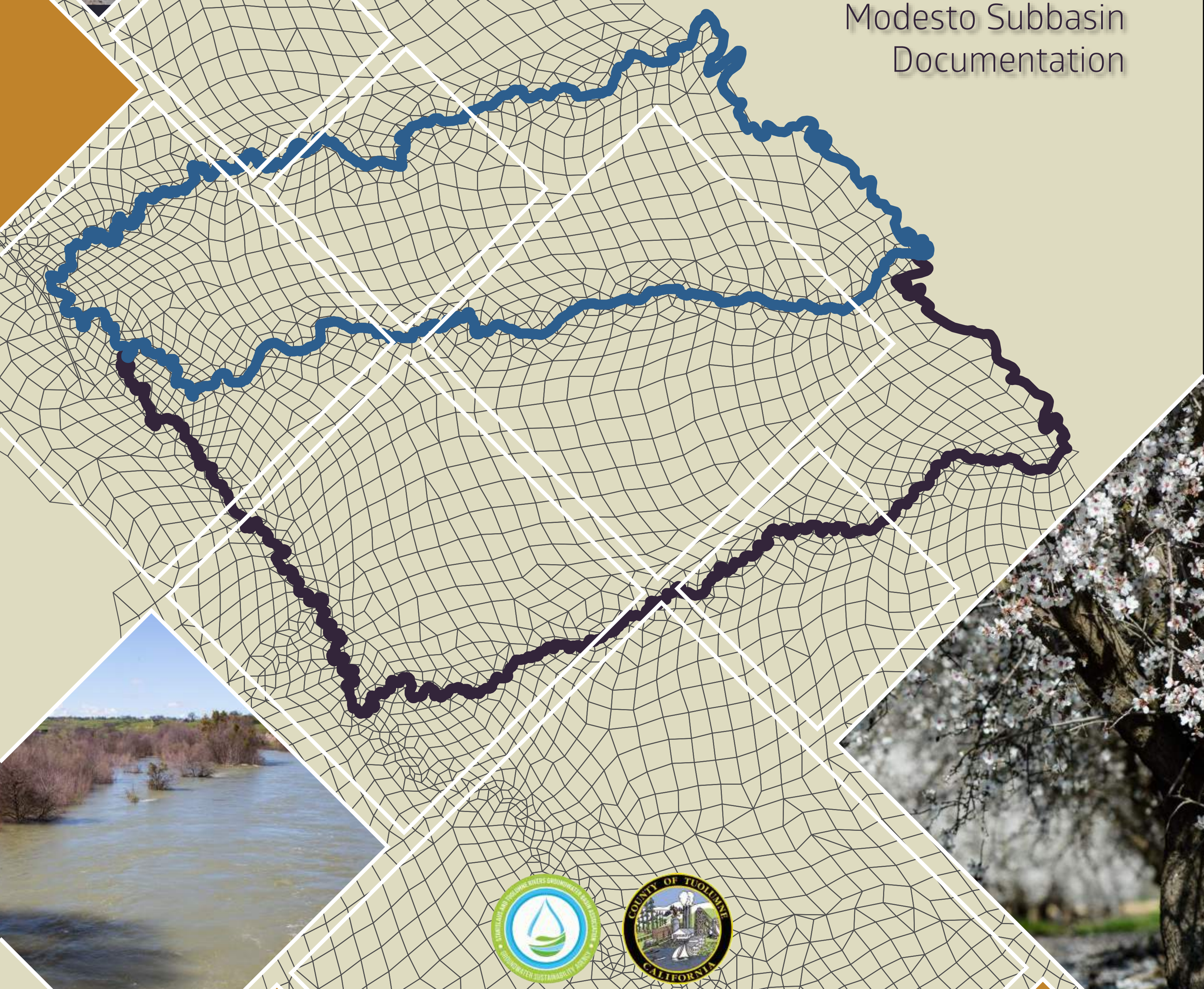
Modesto Subbasin Documentation

C2VSimTM

The Turlock-Modesto Integrated Water Resources Model

A Refined Version of C2VSimFG for the Turlock & Modesto Subbasins

Modesto Subbasin Documentation



JANUARY 2022

C2VSimTM

The Turlock-Modesto Integrated Water Resources Model

A Refined Version of C2VSimFG for the Turlock & Modesto Subbasins

Modesto Subbasin Documentation

January 2022

Stanislaus & Tuolumne Rivers Groundwater Basin Association
GROUNDWATER SUSTAINABILITY AGENCY

County of Tuolumne
Groundwater Sustainability Agency

Prepared by: Woodard & Curran, Inc.
In Association with: Todd Groundwater

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List of Abbreviations

ASCE	American Society of Civil Engineers
EWRI	Environmental & Water Resources Institute
AWMP	Agriculture Water Management Plan
C2VSimFG	California Central Valley Simulation Model – Fine Grid
C2VSimTM	California Central Valley Simulation Model – Turlock & Modesto
Cal-SIMETAW	California Simulation of Evapotranspiration of Applied Water
CASGEM	California Statewide Groundwater Elevation Monitoring
CDEC	California Data Exchange Center
CIMIS	California Irrigation Management Information System
DWR	Department of Water Resources
eWRIMS	Electronic Water Rights Information Management System
ITRC	Irrigation Training and Research Center at Cal Poly, San Luis Obispo
METRIC	Mapping Evapotranspiration at High Resolution and Internalized Calibration
MID	Modesto Irrigation District
NDE	Non-District East
NDW	Non-District West
NASS	National Agricultural Statistics Service
NRCS	Natural Resource Conservation Service
OID	Oakdale Irrigation District
OSWCR	Online System for Well Completion Reports
SCS-CN	Soil Conservation Service Curve Number Method
SSURGO	Soil Survey Geographic Database
TID	Turlock Irrigation District
USDA	United States Department of Agriculture
USGS	United States Geological Survey
UWMP	Urban Water Management Plan

1. INTRODUCTION

Water is a precious resource in the San Joaquin Valley, providing the underlying needs for cities and residents, agriculture, and ecosystems. However, water supply can fluctuate dramatically between drought and floods in the San Joaquin Valley due to variable hydrology. In years of little precipitation and snowmelt that results in reduced surface water supply, agricultural water users often turn to groundwater to meet their crop demands.

Due to an overreliance on groundwater in California, the Sustainable Groundwater Management Act (SGMA) was passed in 2014. SGMA requires that local agencies develop and implement plans to achieve sustainable groundwater management over the course of twenty years. As part of SGMA, Groundwater Sustainability Agencies (GSAs) need to quantify conditions in the subbasin under historical, current, and projected conditions.

The Turlock-Modesto Water Resources Model (C2VSimTM) is a fully integrated surface and groundwater flow model, based on the California Central Valley Groundwater-Surface Water Simulation Model – Fine Grid (C2VSimFG). The Turlock-Modesto Model is a refined version of the state's regional model that reflects the local data including hydrology, hydrogeology, land use and cropping patterns, and water resources operations for the Turlock and Modesto Subbasins (Figure M1). These refinements are made to enable the model to support the development of groundwater sustainability plans for the respective subbasins. While the C2VSimTM model retains its Central Valley-wide simulation capabilities, the refinements are made specific to each subbasin, and, as such, the refinements to the model for each Subbasin are documented in a separate report.

This report describes the details of the refinements for the Modesto Subbasin, and describes the objectives, data refinements, calibration refinements, and results of the C2VSimTM model for the Modesto Subbasin. As this model was developed as a local refinement of C2VSimFG, the purpose of this report is to present the additional details that have gone into the refinement of the Modesto Subbasin. All details relating to the construction of the base C2VSimFG model are documented in the California Department of Water Resources (DWR) Report (DWR, 2020) and the reader is encouraged to consider this report as an addendum to the C2VSimFG documentation.

The report is outlined as follows:

- Section 1 Introduction
- Section 2 C2VSimFG in the Modesto Subbasin
- Section 3 Model Development
- Section 4 Model Calibration
- Section 5 Discussion
- Section 6 Summary & Recommendations

1.1 GOALS OF MODEL DEVELOPMENT

The objective of the Modesto Model's development and calibration is to have a robust, technically sound, publicly accepted analytical computer tool that simulates the details of the integrated land surface system; stream and river system; and groundwater hydrologic and hydrogeologic system in the model area for use in regional water management.

Specifically, SGMA requires that GSAs discuss historical, current, and projected water demands and supplies (Water Code §10727.2(a)(3)). These can be evaluated in the context of water budgets, which are a useful tool for understanding water availability. Water budgets allow water resource managers to quantify inflows, outflows, and changes in storage at both the local and regional scale. The preparation of a water budget allows water resource managers to check their understanding of regional water supplies, demands based on available data, and use that understanding to make management decisions such as investing in new water supplies, water conveyance infrastructure or reducing water demands. Water budget development can reveal data gaps and uncertainties in how much water is available. The Modesto Model goes beyond C2VSimFG to capture and represent local considerations and conditions.

It is challenging to represent the hydraulic system without an integrated model; surface water and groundwater are an integrated physical system that is used to meet water demands in the San Joaquin Valley. Particularly as monitoring of groundwater pumping, recharge, and subsurface flows is not widely possible. As a result, there is a need to represent the physical properties of the hydrologic system in an integrated way to enable estimation of the unknown water budget components. An integrated hydrologic model is designed for this purpose. This type of model simulates both surface water and groundwater flow, as well as the interactions between surface water and groundwater, while representing the known physical constraints of the area of interest. This coupling dynamically accounts for available water based on the limited information accessible and enforces both conservation of mass and momentum. Inclusion of both conservation of mass and momentum allows simulation of local effects related to the rate of movement of groundwater, which is important to sustainable groundwater management. Water budgets are considered for the historical period, existing conditions baseline, projected conditions baseline, and baseline under climate change and sustainable yield scenarios.

1.2 MODESTO SUBBASIN

The Modesto Subbasin located near the center of the California Central Valley within the San Joaquin River Valley. The Subbasin is predominantly located within Stanislaus County and extends slightly into Tuolumne County. It is bounded by the Tuolumne River and Turlock Subbasin to the south, the Stanislaus River and Eastern San Joaquin Subbasin to the north, the San Joaquin River and Delta Mendota Subbasin to the west, and the Sierra Nevada Mountains to the east. The Modesto Subbasin is Bulletin 118 number 5-022.02 as shown in Figure M2.

The Stanislaus and Tuolumne Rivers Groundwater Basin Association Groundwater Sustainability Agency (STRGBA GSA) is the governing sustainability agency of the Modesto Subbasin, whose member agencies include a variety of agricultural and urban water purveyors. Modesto Irrigation District (MID) and Oakdale Irrigation District (OID) are the major agricultural water purveyors within the subbasin. Urban municipalities within the Modesto Subbasin include the Cities of Modesto, Oakdale, Riverbank and Waterford. Unincorporated areas within the subbasin, commonly referred to in this document as Non-district East and Non-district West, are represented by and within the jurisdictional area of Stanislaus and Tuolumne Counties. Locations of member agencies are presented in Figure M3.

1.3 ACKNOWLEDGEMENTS

The C2VSimTM is developed in a collaborative environment with open and transparent process in compilation of data and information for the Subbasin, detailed assumptions including those on the land use, cropping patterns, water use, water supply, reservoir operations and surface water deliveries, irrigation practices, drainage conditions, hydrogeologic conditions, groundwater use, and other detailed features.

The following individuals had significant contributions in development of the model for the Modesto Subbasin:

- Gordon Enas — Modesto Irrigation District
- Eric Thorburn — Oakdale Irrigation District
- Emily Sheldon — Oakdale Irrigation District
- Miguel Alvarez — City of Modesto
- Walt Ward — Stanislaus County
- John Davids — Previously with Modesto Irrigation District
- Chad Tienken — Previously with Modesto Irrigation District

The model development task was funded by the Department of Water Resources as part of the grant for groundwater sustainability plan development. Following DWR individuals played key role in the model development activities:

- Tyler Hatch — DWR: Sustainable Groundwater Management Office
- Can Dogrul — DWR: Bay Delta Office

The following consultants were engaged in development and calibration of the model, and/or development of the baseline conditions and application of the model for sustainable groundwater management in the Turlock Subbasin:

Woodard & Curran, Inc.

- Ali Taghavi — Principal in Charge and Senior Oversight
- Dominick Amador — Lead Modeler

Todd Groundwater (Prime Consultant)

- Phyllis Stanin — GSP Project Manager
- Liz Elliott — Hydrogeologic Conceptual Model

2. C2VSIMFG IN THE MODESTO SUBBASIN

The C2VSimTM model is a locally enhanced version of DWR's California Central Valley Groundwater-Surface Water Simulation Model – Fine Grid (C2VSimFG). This version of the model was updated by DWR to support SGMA activities throughout the Central Valley at a regional scale (DWR, 2020). The decision to use a locally refined version of C2VSimFG for the Modesto Subbasin's GSP effort was made based on the high degree of regional calibration the model had already achieved, as well as consistency in methodology with groundwater planning efforts in surrounding subbasins.

Unless otherwise noted, the standard inputs to C2VSimFG were used directly in the Modesto Model.

2.1 MODEL FRAMEWORK

The Modesto Integrated Water Resources Model simulates the entire C2VSimFG model domain, including all C2VSimFG model features, with appropriate refinements in the Modesto Subbasin. The Modesto Model was originally based on the C2VSimFG BETA2 release but was later updated to reflect DWR updates made to the Modesto Subbasin. The base version of C2VSimFG version uses the IWFM-2015 code, includes hydrologic data from period of water years 1922-2015, and was calibrated from October 1973 through September 2015.

Although the C2VSimTM was originally based on the BETA2 release, and the C2VSimFG has since been released as version 1.1, the foundational model datasets, such as the grid, hydrologic and hydrogeologic data sets, and soil conditions have maintained consistency through the various model versions. Version 1.1 has refinements to the land and water use, as well as hydrologic and hydrogeologic parameters that were refined during C2VSimFG model calibration (DWR, 2020). As part of the model's refinements, these datasets and parameters were refined and over-written for the Modesto Subbasin. The details of data refinements and sources of data are presented in remaining sections of this report. The Modesto Model, thus, maintains consistency with C2VSimFG datasets and uses the most recent relevant information. Therefore, the Modesto Model is the latest and most defensible model available to address the integrated groundwater and surface water resources in the Modesto Subbasin.

In total, there are 32,537 elements in the entire model, covering an area of more than 20,000 square miles. Starting from the C2VSimFG model features and standard inputs, subsequent modifications and refinements were made to land surface parameters corresponding to model features within the Modesto and Turlock Subbasins. Although the model encompasses data refinements and calibration enhancements for the Turlock and Modesto Subbasins, this report documents the data and calibration refinements in the Modesto Subbasin portion of the model only, which is used to support the development of the Modesto Subbasin GSP. As such, this report refers to the model as the "Modesto Model". The refinements for the Turlock Subbasin are documented in a separate report.

2.1.1 Land Surface System

The IWFM modeling platform is configured to simulate water demand and exchanges between the land surface and groundwater system at each element level based on various land use types and crop categories (Dogrul et al., 2016). Land use information, soil characteristics, and various other root zone parameters were developed and specified as inputs to the Modesto Model as the basis for characterizing and simulating all land surface processes in the Modesto Subbasin. The data sources and approach used to specify these inputs are described in **Section 3.3: Land Surface System**.

2.1.2 Stream System

As described above, the Modesto Model encompasses the entire C2VSimFG model domain and, as such, includes all C2VSimFG surface water network features. A total of 110 stream reaches are simulated across the entire model domain, represented by 4,634 total stream nodes. More than 400 diversions are specified to distribute water from these streams or from outside the model domain on elements across the entire model domain.

Surrounding the Modesto Subbasin, the Modesto Model dynamically simulates flow in the Stanislaus, Tuolumne, and San Joaquin Rivers. In addition to the three major rivers, the Modesto Model also accounts for recharge and runoff from local creeks and tributaries. Contributions to the Subbasin's groundwater system from the upper watersheds outside of the Subbasin boundary are captured as surface and subsurface flows from the small watershed package within IWFM (**Section 2.1.4**). On the other hand, recharge and runoff from watersheds that originate within the model area are estimated at the element level using the Natural Resource Conservation Service (NRCS) Curve Number Method (**Section 0**).

Streams along the boundary of the Modesto Subbasin and diversions to land within the Modesto Subbasin were reviewed and revised, as needed, in the Modesto Model. Diversions to the subbasin were adapted to accommodate the distribution and delivery of surface water by Modesto and Oakdale Irrigation Districts, along with riparian diverters. The data sources and methodologies used to specify these changes to the surface water network are described in **Section 0**.

2.1.3 Groundwater System

The Following section highlights the hydrogeologic analysis and structures within Modesto Subbasin. Additional detailed information relating to stratigraphy and the development of model layers are available in the C2VSimFG Documentation: *California Central Valley Groundwater-Surface Water Simulation Model – Fine Grid (C2VSimFG) Development and Calibration Version 1.0* (DWR 2020).

2.1.3.1 Hydrogeologic Structure

The Modesto Subbasin lies predominately within the San Joaquin Valley, which forms the southern half of California's Central Valley, a large, northwest-southeast-trending sediment-filled basin underlain by the igneous and metamorphic bedrock of the Sierra Nevada batholiths and the east-dipping of marine sedimentary rocks of the Coast Ranges (Norris & Webb, 1990). Major water bearing formations in the San Joaquin Valley include the Valley Springs, Mehrten, Laguna, Turlock Lake, Etchegoin, San Joaquin, Tulare, Riverbank, Modesto, and Kern River Formations, seven of which are present in the Modesto Subbasin:

Valley Springs Formation
The Valley Springs Formation crops out discontinuously along the eastern flank of the Central Valley from just south of the Bear River to just north of the Chowchilla River. The Valley Springs is a mostly fluvial sequence consisting chiefly of sandy clay, quartz sand, rhyolitic ash, and siliceous gravel (Davis & Hall, 1959). The Valley Springs Formation ranges in thickness from 0 to about 450 feet in the San Joaquin Valley (DWR, 1978). The Valley Springs Formation is considered largely non-water-bearing due to its fine ash and clay matrix (ESJGA, 2019).

Mehrten Formation
The Mehrten Formation is considered the oldest significant fresh water-bearing formation within the Eastern San Joaquin Valley. The Mehrten Formation in the east-central portion of the Central Valley is comprised of sandstone composed of amphiboles, pyroxenes, and pebbles with lenticular bedding (Bartow & Doukas, 1979). The Mehrten Formation outcrops discontinuously along the eastern flank of the Valley and was laid down by streams carrying andesitic debris from the Sierra Nevada (Ferriz, 2001). It is typically between 700 and 1,200 feet thick. The black sands of the Mehrten Formation have moderate to high permeability and yield large quantities of fresh water to wells (Davis & Hall, 1959) (DWR, 1967).

Laguna Formation

The Laguna Formation is exposed in the eastern foothills in the northern portion of the San Joaquin Valley. The Laguna Formation is a sequence of predominantly non-volcanic, fine-grained, poorly bedded, somewhat-compacted continental sedimentary deposits that are typically tan to brown in color (Olmsted & Davis, 1961).

The Laguna Formation outcrops in the northeastern part of San Joaquin County and reaches a maximum thickness of 1,000 feet. The Laguna Formation is moderately permeable with some reportedly highly permeable coarse-grained fresh water-bearing zones.

Turlock Lake Formation
The Turlock Lake Formation consists of mostly fine sand, silt, and, in places, clay. The Turlock Lake Formation coarsens upward, with silt and clay at the bottom of the formation and more sand and gravel near the top of the formation (Marchand & Allwardt, 1981). The thickness of the Turlock Lake is variable and appears to increase toward the east, ranging from 160 to 1,000 feet thick. Near the valley axis, it is intercalated with the Tulare Formation, described below.

Tulare Formation
The Tulare Formation is made up of lenticular and generally poorly sorted clay, silt, sand, and gravel. It consists of interfingered sediments ranging in texture from clay to gravel (Hotchkiss & Balding, 1971). The Tulare Formation conformably overlies the San Joaquin Formation. In the southwestern part of the San Joaquin Valley, the exposed Tulare ranges in thickness from a few tens of feet to more than 4,000 feet (Wood & Dale, 1964).

The Tulare Formation includes alluvial fan deposits, deltaic deposits, flood plain deposits, and lake deposits. The lake deposits compose the Corcoran Clay (E-Clay) member of the Tulare Formation, a prominent aquitard present in the western portion of Turlock Subbasin. The Corcoran Clay separates the semi-confined Upper Tulare from the confined Lower Tulare Formation (Hotchkiss & Balding, 1971). The Corcoran Clay extends eastward into the Turlock Lake Formation and separates the semi-confined Upper Turlock Lake from the confined Lower Turlock Lake Formation.

Riverbank Formation
The Riverbank Formation consists primarily of arkosic sand with gravel lenses derived mainly from the interior Sierra Nevada, which forms at least three sets of terraces and coalescing alluvial fans along the eastern San Joaquin Valley (Marchand & Allwardt, 1981). The Riverbank Formation unconformably overlies the Laguna Formation and is typically between 65 and 260 feet thick (ESJGA, 2019).

Modesto Formation
The Modesto Formation is composed of arkosic gravels and sands with silt, which were deposited over top of late Riverbank alluvium as a series of coalescing alluvial fans extending continuously from the Kern River drainage on the south to the Sacramento River tributaries in the north. The total thickness of the Modesto deposits is reported to be 50 to 100 feet in eastern Stanislaus County, 130 feet along the Merced River, and about 65 feet along the Chowchilla River fan.

2.1.3.2 Model Layering and Initial Parameters

The Modesto Model layering is the same as the C2VSimFG stratigraphy, a detailed description of which is available within the C2VSimFG Model Report (DWR 2020). A developmental summary of model layering is described below. The C2VSimFG stratigraphy and initial parameters are based upon a Central Valley-wide texture model produced by DWR. It included a total of 10,444 well and boring logs and provided information about the three-dimensional distribution of coarse-grained and fine-grained materials within the groundwater system. These texture distributions were then adopted as the initial aquifer parameters and stratigraphy by node and layer in the Modesto Model and were refined during calibration.

Based on the geologic information in the lithologic dataset, C2VSimFG is divided into four aquifer layers that were adopted in the Modesto Model. The top three layers represent freshwater aquifers while the bottom layer (Layer 4) corresponds to the saline layer where little to no pumping occurs. Information, as well as supporting source data, on each layer is provided as follows.

Ground Surface Elevation

Ground surface elevation is established for each Modesto Model groundwater node relative to mean sea level. The ground surface elevation for the Modesto Model was derived from the USGS National Elevation Dataset, using the 1/3 arc-second DEM.

Layer 1

Layer 1 represents the portion of the unconfined aquifer in which groundwater pumping occurs. Layer 1 thickness ranges from 24 feet to 587 feet in the Modesto Subbasin. Layer 1 represents the western-upper principal aquifer where the Corcoran Clay exists and is the unconfined section of the eastern-principal aquifer. Because of the relatively large thickness of this layer, locally perched aquifers are not simulated.

Layer 2 Aquitard

The Layer 2 aquitard, which falls between aquifer Layer 1 and Layer 2, represents the Corcoran, or E-Clay that separates the upper western principal aquifer from the lower western principal aquifer. Refinement of the C2VSimFG model grid in the Modesto Subbasin included the adoption of the Corcoran Clay depth and thickness as defined by the MERSTAN model. This characterization was made after evaluating well logs and lithological data in the region. It was determined that the MERSTAN model presents a more refined definition of the Corcoran Clay compared to the base-layering in C2VSimFG. This is primarily due localized nature of the model and its detailed analysis of the Modesto Subbasin.

The Corcoran Clay is the only confining layer explicitly modeled as an aquitard in the Modesto Model and pinches out in the eastern portion of the model. The Modesto Model simulates vertical movement of groundwater through an aquitard layer as an aquitard between the two aquifer layers, as opposed to a separate, intervening low conductivity aquifer layer. Both formulations have shown to be valid and relatively comparable.

Layer 2

Layer 2 generally represents the portion of the confined aquifer in which groundwater pumping occurs. In western areas of the Modesto Subbasin where the Corcoran Clay exists, Layer 2 represents the upper fraction of the western-lower principal aquifer where most of the groundwater production occurs. In the eastern-principal aquifer, Layer 2 is considered the lower-pumping zone where most of the production occurs. Layer 2 thickness ranges from roughly 50 feet to 544 feet in the Modesto Subbasin.

Layer 3

Layer 3 generally corresponds to the deeper, confined aquifer where little pumping occurs. The bottom of Layer 3 is defined in C2VSimFG as the base of fresh groundwater. Layer 3 thickness ranges from 50 to 586 feet in the Modesto Subbasin. The base of freshwater, or the bottom of Layer 3, was prepared by the DWR South Central Regional Office by reviewing the DOGGR electric logs and induction-electric logs to estimate the quality of water at a specific depth. (DWR, 2015; Olivera, 2016).

Layer 4

Layer 4 is bounded by the base of fresh groundwater at the top and by the basement complex (relatively impermeable igneous and metamorphic rocks and the Cretaceous Great Valley sequence) at the bottom. The bottom of Layer 4 represents the interface between the post-Eocene continental deposits and underlying, lower-permeability Cretaceous or Eocene deposits of marine origin. This layer contains primarily saline groundwater with concentrations defined as Total Dissolved Solids (TDS) of more than 3,000 parts per million. This layer is up to 2,250 feet thick in the Modesto Subbasin. Although there is little to no active pumping in layer 4 at this depth, inclusion of this layer in the model is important for several reasons: (i) a hydraulically defensible no-flow boundary condition is established at the bedrock; (ii) including the complete saturated thickness of the aquifer can facilitate simulation of interconnection between fresh water (Layers 1-3) and salt water (Layer 4) layers, and (iii) potential impacts of upward movement of groundwater due to pumping from deep wells in layer 3 can be simulated. The thickness of the aquifer was developed by Williamson et al. 1989 and included in USGS's Central Valley Regional Aquifer System Analysis (CV-RASA).

2.1.4 Small-Stream Watersheds

A significant portion of the water that flows through Modesto Subbasin originates in the rim watersheds up-gradient from the alluvial portion of the valley. Within the Modesto Model, these rim watersheds can be divided into two broad classes: gauged watersheds with specified inflows into the C2VSimFG stream network, which are described in **Section 3.4.2**, and ungauged watersheds whose outflow is dynamically calculated using the IWFM Small Watershed component, which are discussed below.

The land cover in these small watersheds is generally native vegetation. The watersheds receive precipitation and discharge surface water into small and intermittent streams that flow across the valley floor into larger streams and rivers, with a portion of this flow entering the aquifer as recharge. They also discharge a small amount of groundwater laterally into Modesto Subbasin aquifers. These monthly surface water discharge, recharge, and subsurface groundwater flow values from small watersheds are dynamically calculated in the Modesto Model.

The Modesto Model includes the same number of small watersheds as C2VSimFG and includes 14 small watersheds bounding the Subbasin to the east (**Figure M4**). The small watersheds were delineated using the USGS Watershed Boundary Dataset. The outer boundary of the small watersheds conforms to the HUC-12 boundaries, which were clipped to the C2VSimFG boundary. Surface flows from small watersheds are routed along specified groundwater nodes, with a user-defined maximum percolation rate to groundwater at each node, selected using the USGS NHD Flow Lines. Precipitation, which is further explained in **Section 3.3.1**, is defined for each small watershed and was developed using the same method as precipitation for the model elements. All subsurface inflows from the small watersheds are routed to the model's Layer 1. These assumptions were not changed between C2VSimFG and the Modesto Model.

The range of selected small watershed parameters are shown in Table 1. Root zone hydraulic conductivity, wilting point, field capacity, total porosity, and pore size distribution index for each watershed are like average root zone soil parameters of elements bordering the small watersheds. An average curve number of 60 was selected for all watersheds to represent the native vegetation coverage of the foothills based on NRCS runoff curve number descriptions in Technical Release 55 (TR-55).

Table 1: Average Small Watershed Root Zone Parameters near the Modesto Subbasin

ET Rate	Wilting Point	Field Capacity	Total Porosity	Pore Size Dist Index	Rooting Depth	Hyd. Cond.	Curve Number
1.64 in/mo	0.10	0.21	0.33	0.39 ft	6.20	0.39 ft/mo	60

3. MODEL DEVELOPMENT

3.1 SUMMARY OF INPUT DATA

IWFM model files and corresponding major data sources used in the development of the Modesto Model are presented in Table 2 along with the report sections where the model data and data sources are described.

Table 2: Modesto Model Input Data

Major Data Category	Minor Data Category	Data Source	Section
Hydrogeological Data	Geologic Stratification	C2VSimFG Local data	2.1.3
	Model Layering	C2VSimFG Local data	2.1.3
	Initial Parameters	C2VSimFG	2.1.3
	Small Watersheds	C2VSimFG	2.1.4
Land Surface Data	Precipitation	PRISM	3.3.1
	Land Use	DWR county surveys DWR statewide mapping USDA NASS CropScape Stanislaus County Parcel Maps	3.3.2
	Soil Properties	USDA NRCS SSURGO	3.3.3
	Evapotranspiration	C2VSimFG Cal-SIMETAW CIMIS ITRC METRIC	3.3.4
	Population	U.S. Census Bureau tract data Local UWMPs	3.3.5
	Per Capita Water Use	California Water Plan Local UWMPs	3.3.5
Stream Data	Stream Configuration	C2VSimFG	3.4.1
	Stream Inflow	USGS DWR CDEC Local data	3.4.2
	Surface Water Deliveries	C2VSimFG State Water Board eWRIMS Local data	0
	Calibration Gages	USGS DWR CDEC	3.4.4
Groundwater Data	Groundwater Pumping	IWFM estimates Local data	3.5.1
	Calibration Wells	DWR CASGEM & WDL Local data	3.5.2
	Initial Conditions	DWR CASGEM & WDL Local data	1.1.1
	Boundary Conditions	DWR SGMA Data Viewer DWR CASGEM & WDL Local data	3.5.4

3.2 SIMULATION PERIOD

The Modesto Model simulates historical conditions in the basin for the period of water years 1991 through 2015 (October 1, 1990 through September 30, 2015). Monthly data was used as model input, and the model simulation uses a monthly time step. Model output can be reported on a monthly or annual time increment, as needed. The Model's simulation period was selected to be representative of moderate to long term hydrologic conditions, while capturing a period of operations with relatively high degree of quality and resolution of data that is digitally available. Precipitation data for the Modesto Subbasin, discussed in Section 3.3.1, was used to identify hydrologic periods that are representative of wet and dry periods and long-term average conditions needed for analyses.

3.3 LAND SURFACE SYSTEM

The Modesto Water Resources Model is a fully integrated surface and groundwater flow model. Modeling surface processes include the quantification of agricultural and urban water demand, as well as dynamically simulating flows through the root and unsaturated zones of both developed and undeveloped lands. The process of simulating root-zone flow dynamics and operational water demand includes the integration of precipitation, land use, evapotranspiration, soil characteristics, and other parameters described in the following sections.

Data and model inputs used to characterize all land surface processes were carefully evaluated and refined for all areas within the Modesto Subbasin using federal, state, and local information. Where local information is unavailable, model inputs have been evaluated and refined using the best available information and professional standards of practice. Generally, more local information is available for member agencies of the STRGBA GSA, as they have developed and maintained a detailed water budget information throughout the historical period. Although less local information is available for the non-district agriculture and private domestic areas of the subbasin, the land surface processes for these areas have been simulated using all pertinent, available information, sound professional judgment, and standards of practice.

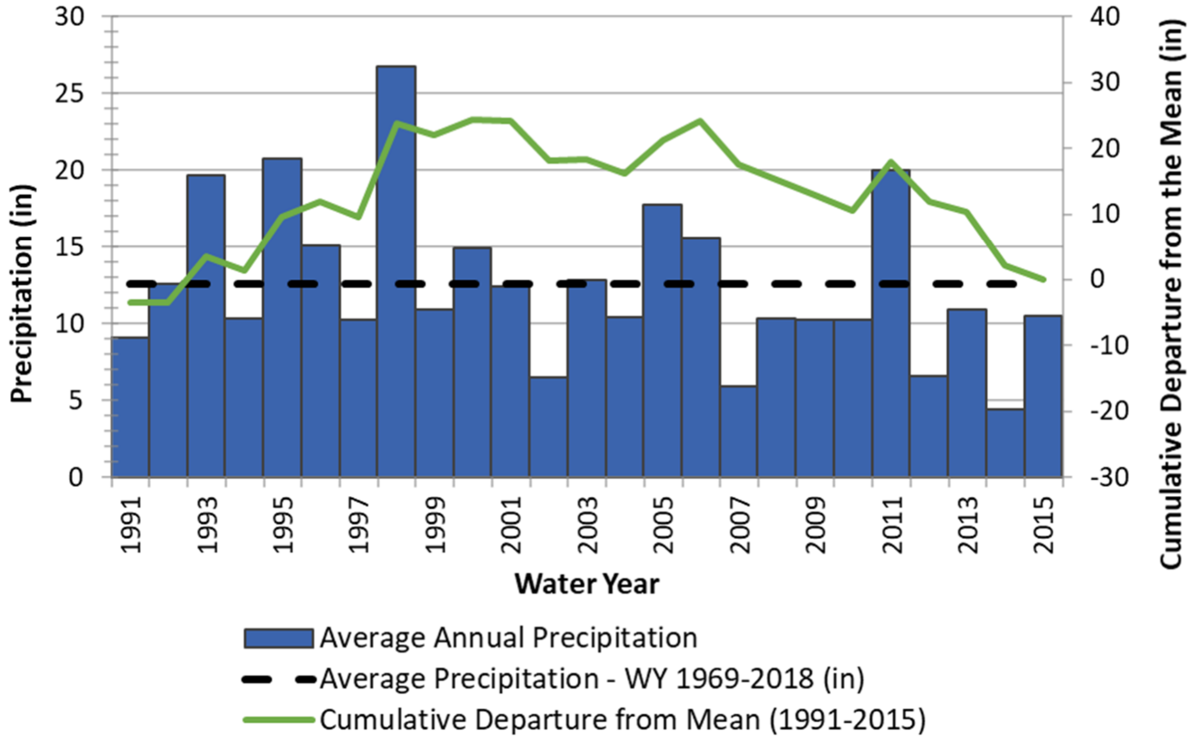
This section describes the data sources and methodologies used to specify model parameters and monthly time series data provided as inputs to the Modesto Model to simulate these land surface processes. Unless otherwise noted, other inputs to the C2VSimFG model were generally used directly in the Modesto Model.

3.3.1 Precipitation

Rainfall data for the model area was derived from the PRISM (Precipitation-Elevation Regressions on Independent Slopes Model) database used in the DWR's C2VSimFG and Cal-SIMETAW (California Simulation of Evapotranspiration of Applied Water) model. The database contains daily precipitation data from October 1, 1921, to September 30, 2018, on an 800-meter grid throughout the model area. The Modesto Model has monthly rainfall data defined for every model element to preserve the spatial distribution of precipitation. Each of the model elements was mapped to the nearest PRISM reference node and the resulting average annual precipitation is shown in Figure M5.

Figure 1 shows the annual rainfall in the Subbasin and the cumulative departure from mean, which is an indication of long-term rainfall trends in the area. For the 1991-2015 calibration period, the minimum precipitation was in 2014 with 4.4 inches, while the maximum occurred in 1998 with 26.7 inches, and the average annual precipitation over this period was 12.6 inches. Based on the San Joaquin Valley River Index, there were 3 critical, 5 dry, 5 below normal, 3 above normal, and 8 wet years.

Figure 1: Modesto Subbasin Average Annual Precipitation (1991-2015)



3.3.2 Land Use

The Modesto Model is an integrated water resources model and, as such, dynamically simulates water demand for each element within its domain. In conjunction with hydrology and soil properties, land use is a major dataset that drives water use and demands. The model divides all land use types into three primary water use sectors: native, urban, and agriculture. For each element and year simulated by the model, acreage is defined for each of 28 Land use classifications, 18 of which are represented in the Modesto Subbasin.

Spatial land use data, an example of which is shown below in Figure M6, were used to specify land use types and crop acreages for each model element for each year. The three major reference sources include DWR county land use surveys, DWR Statewide Crop Mapping, and CropScape. A summary of data sources and periods available are presented in Table 3 and a summary of the land use data represented in the Modesto Model is shown in Table 4 and Figure 2.

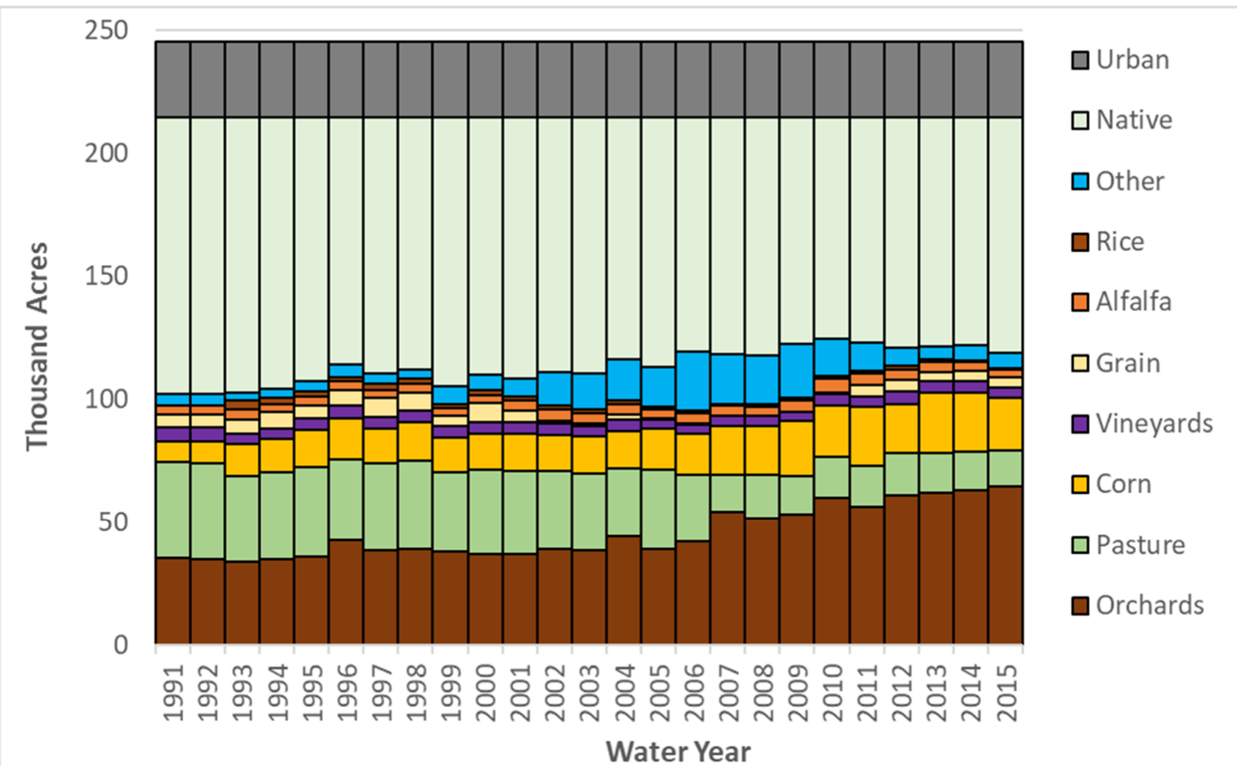
Table 3: Land Use Data Sources Available during the Historical Period (1991-2015).

Data Type	Data Source	Years Available (1991-2015)
Spatially distributed land use data	DWR County Land Use surveys (Stanislaus County)	1996, 2004, 2010
	Land IQ remote sensing-based land use identification	2014
	Stanislaus County Land Use Survey	2014
	CropScape: NASS Cropland Data Layer	2007-2015

Table 4: Summary of Land Use in the Modesto Subbasin.

Water Use Sector	Land Use Class	Land Use Code	Acreage 1991	Average Acreage 1991-2015	Acreage 2015
Agricultural	Alfalfa	AL	3,800	3,900	3,200
	Almonds & Pistachios	AP	18,400	29,400	47,300
	Citrus & Subtropical	CS	0	100	200
	Corn	CN	8,700	16,900	21,100
	Cucurbits	CU	900	300	200
	Dry Beans	DB	1,300	500	200
	Grain	GR	5,000	3,800	4,300
	Idle	ID	35,600	23,400	19,200
	Other Deciduous	OR	16,700	16,100	17,400
	Other Field	FL	1,300	6,500	1,700
	Other Truck	TR	1,100	3,100	3,500
	Pasture	PA	39,100	27,400	14,600
	Rice	RI	100	1,400	600
	Tomato	TP	0	200	600
	Vineyards	VI	5,700	4,500	4,200
Native	Native Vegetation	NV	69,600	69,900	69,100
	Riparian Vegetation	RV	7,200	7,100	7,100
Urban	Urban	UR	30,800	30,800	30,800
Total			245,300	245,300	245,300
Note: Average land use areas rounded to nearest 100 acres.					

Figure 2: Modesto Subbasin Land Use, 1991-2015



3.3.3 Soil Parameters

IWFM simulates water demands at the land surface and their interactions with the aquifer below using a soil-moisture balance. Flow through the root zone is primarily governed by soil properties, including wilting point, field capacity, porosity, pore size distribution index (λ), and saturated hydraulic conductivity.

Each element within the model domain is identified as one of the four hydrological soil groups showing in Figure M7 and is categorized according to their runoff potential and infiltration characteristics. The Natural Resource Conservation Service (NRCS) defines these hydrological soil groups as follows:

> **Group A** – Soils in this group have low runoff potential when thoroughly wet. Water is transmitted freely through the soil. Group A soils typically have less than 10 percent clay and more than 90 percent sand or gravel and have gravelly or sandy textures. Some soils having loamy sand, sandy loam, loam or silt loam textures may be placed in this group if they are well aggregated, of low bulk density, or contain greater than 35 percent rock fragments.
>
> **Group B** – Soils in this group have moderately low runoff potential when thoroughly wet. Water transmission through the soil is unimpeded. Group B soils typically have between 10 percent and 20 percent clay and 50 percent to 90 percent sand and have loamy sand or sandy loam textures. Some soils having loam, silt loam, silt, or sandy clay loam textures may be placed in this group if they are well aggregated, of low bulk density, or contain greater than 35 percent rock fragments.
>
> **Group C** – Soils in this group have moderately high runoff potential when thoroughly wet. Water transmission through the soil is somewhat restricted. Group C soils typically have between 20 percent and 40 percent clay and less than 50 percent sand, and have loam, silt loam, sandy clay loam, clay loam, and silty clay loam textures. Some soils having clay, silty clay, or sandy clay textures may be placed in this group if they are well aggregated, of low bulk density, or contain greater than 35 percent rock fragments.
>
> **Group D** – Soils in this group have high runoff potential when thoroughly wet. Water movement through the soil is restricted or very restricted. Group D soils typically have greater than 40 percent clay, less than 50 percent sand, and have clayey textures. In some areas, they also have high shrink-swell potential.

Textural information and hydraulic parameters were developed for C2VSimFG using data available from the Soil Survey Geographic (SSURGO) database, a product of the United States Department of Agriculture's Natural Resources Conservation Service (USDA-NRCS). The Modesto Model uses representative values from SSURGO as the initial parameters, and refinements were made during the water budget calibration as described in **Section 4.2.1**.

3.3.4 Evapotranspiration

Evapotranspiration (ET) is the process by which water is transferred from the land to the atmosphere by evaporation from the soil and transpiration from plants. Evapotranspiration is primary consumptive use of water in the agricultural, urban, and native sectors within the Modesto subbasin. Within the Modesto Model, every land use type and small-stream watersheds are assigned values for each timestep throughout the simulation period.

The ET values through September 2015 were adopted from C2VSimFG after validation and refinement based on published research, local data, and remote sensing. Base reference evapotranspiration and crop coefficient values were based on data from the DWR Water Use Efficiency Branch and included values from the Cal-SIMETAW model and local California Irrigation Management Information System (CIMIS) stations. During the calibration process, these values were refined based on the following sources:

Remote Sensing:

- Mapping Evapotranspiration at High Resolution and Internalized Calibration (METRIC), developed by the Irrigation Training and Research Center (ITRC) at California Polytechnic State University, San Luis Obispo
- Element level evapotranspiration summaries developed by Formation Environmental, LLC

State of California modeling efforts and resources:

- California Central Valley Groundwater-Surface Water Simulation Model (C2VSimFG)
- California Simulation of Evapotranspiration of Applied Water (Cal-SIMETAW)
- California Irrigation Management Information System (CIMIS)

Local Planning Documents:

- Modesto Irrigation District (MID) Agriculture Water Management Plan (AWMP)
- Oakdale Irrigation District (OID) Agriculture Water Management Plan (AWMP)

A comparative summary of the AWMPs to modeled ET is presented and described in **Section 4.2.1**, Land Surface System Calibration.

3.3.5 Urban Water Demand

Urban water demand in C2VSimFG is divided into the 105 zones that make up the combination of the California Water Plans' Detailed Analysis Units (DAU). During development of the Modesto Model, the C2VSimFG model was updated to utilize local data and improve the resolution operations throughout the subbasin. The new urban demand areas include the cities of Modesto, Oakdale, Riverbank, and Waterford, as well as two rural categories for private domestic demand on the east and west sides of the subbasin (**Figure M8**).

Population, per capita water use, and urban indoor water use fractions were the key urban inputs that were identified and refined for the development of the Modesto Model. Values for each of these parameters were taken from published Urban Water Management Plans (UWMPs) for each municipality and validated through analysis of their water supply data. Data for rural areas were based on estimated values from the California Water Plan. Average values for each population, per-capita water use and total urban demand is listed below in **Table 5**.

Table 5: Average Urban Demand Factors (1991-2015)

Urban Area	Average Population 1991-2015	Average Per-Capita Water Use 1991-2015	Average Urban Water Demand 1991-2015
Units	**-**	**Gallons x Day^{-1}**	**Acre-Feet**
City of Modesto	229,000	270	62,500
City of Oakdale	19,000	240	4,800
City of Riverbank	18,000	230	4,500
City of Waterford	7,000	220	1,700
Detailed Analysis Unit 206[1]	40,000	320	18,700
Detailed Analysis Unit 207[2]	12,000	310	5,200

Notes: Values are presented by service area and includes all sub-communities supplied by the agency.
[1] Detailed Analysis Unit 206/207 as described in this table includes the rural fraction of this DAU in the Modesto Subbasin and represents the western/eastern rural areas presented in **Figure M8**.

3.3.6 Other Land Surface Parameters

Below are operational parameters governing the procedures and management of agricultural, urban, and native flow dynamics throughout the land surface system.

Runoff Curve Number

The Modesto Model uses a modified version of the Soil Conservation Service (SCS) Curve Number (CN) method (USDA, 2004) to compute runoff of precipitation. Curve number is specified for a combination of land use type, soil type and management practice for each element and governs the infiltration and runoff of precipitation events. Initial curve number values were based on the USDA TR-55 publication Urban Hydrology for Small Watersheds (USDA, 1986) and were adjusted during calibration to account for the effects of a monthly time-step.

Effective Rooting Depth

The effective rooting depth is the depth from which vegetation can access moisture in the soil. Rooting depths were mapped from the C2VSimFG and compared to data from Cal-SIMETAW, ASCE-EWRI, and other local models. Rooting depths were found to be consistent with typical characteristics reported in the above resources and were unchanged. For all land use classes, rooting depths were assumed to remain constant, on average, over the duration of the monthly simulation.

Reuse and Return Flow Fractions

Surface water operations within the Modesto Subbasin include both operational spills and return flows as a necessary product on water conveyance. Fractions to represent return flow (i.e., irrigation flow returning to the stream system) and reuse (i.e., the fraction of applied irrigation water to be reused for irrigation) are based on data from C2VSimFG. All agricultural lands are assigned a 5% return flow and 1% reuse.

Unchanged Surface System Parameters

IWFM utilizes several other parameters, important to modeling surface layer processes and control flow through the root zone. These parameters, listed below, were not changed from the base version of the model and additional information on these features are available in the C2VSimFG Documentation: *California Central Valley Groundwater-Surface Water Simulation Model – Fine Grid (C2VSimFG) Development and Calibration Version 1.0* (DWR 2020).

- Irrigation Period
- Initial Soil Moisture
- Target Soil Moisture
- Irrigation Timing
- Indoor Water Use Fraction
- Urban Pervious Area Fraction

3.4 SURFACE WATER SYSTEM

Surface water operations and supplies are a critical resource in the groundwater management and sustainability of the Modesto Subbasin. The Subbasin is located on the eastern side of the California Central Valley, between the Stanislaus and Tuolumne Rivers. Both rivers are regulated, and reservoir operations are managed by local irrigation districts.

3.4.1 Stream Configuration

Model hydrology throughout the Central Valley is simulated through a combination of 4,634 stream notes and 110 stream reaches. Each stream-node in C2VSimFG is dynamically simulated and governed by unique parametric values, including invert elevation, wetted perimeter, streambed conductance, and stage-discharge rating tables. Within the Modesto Subbasin, the stream system is comprised of 112 stream nodes simulating the Stanislaus River, 113 stream nodes simulating the Tuolumne River, and 19 stream nodes simulating the San Joaquin River (Figure M9). Development of the Modesto Model included the adoption these parameters and additional details relating to their values and data sources can be referenced in the C2VSimFG Documentation: *California Central Valley Groundwater-Surface Water Simulation Model – Fine Grid (C2VSimFG) Development and Calibration Version 1.0* (DWR 2020).

3.4.2 Stream Inflows

Stream inflow along the subbasin boundary to the east is provided by the operating agency and represents the flow downstream of the Goodwin Dam on the Stanislaus River and La Grange Dam on the Tuolumne River. In addition to reservoir releases, the river system dynamically simulates San Joaquin River inflows at the Modesto subbasin, as wells as operational spills, runoff, and return flow to the river system. Location of direct inflows to the river system are presented below in **Table 6**.

Table 6: Summary of Stream Inflows in the Modesto Subbasin (1991-2015)

Stream Reach	Inflow Location	Inflow Location (Stream Node)	Average Annual Inflow (TAF/year)
Tuolumne River	La Grange Dam Releases	1930	520,000
Stanislaus River	Goodwin Dam Releases	2056	742,000

3.4.3 Surface Water Supply

Historical surface water diversions for the simulation period were compiled from a combination of sources including gauged data, water rights reports, Urban Water Management Plans (UWMPs), and Agricultural Water Management Plans (AWMPs). Most of the surface water supply in the Modesto Subbasin is diverted from the Stanislaus River by Oakdale Irrigation District, and the Tuolumne River by Modesto Irrigation District, with smaller diversions available to riparian water rights holders. Spatial coverage of surface water delivery areas is shown in Figure M10.

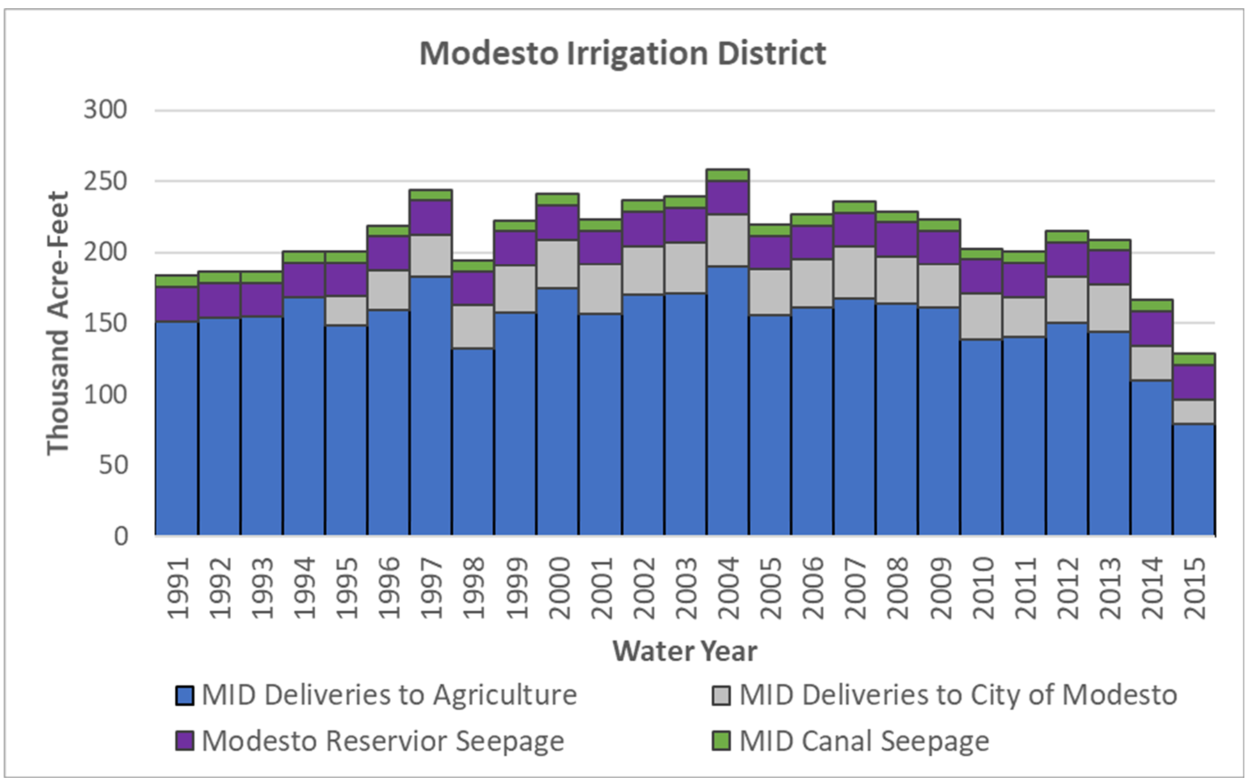
Total surface water supply to the Modesto Subbasin averages 337,000 AFY of deliveries to agricultural and municipal users throughout the 1991-2015 historical period. Of this, 311,000 is delivered to growers to meet agricultural demand and 26,000 is treated and delivered to the City of Modesto (30,000 acre-feet per year since its inception in 1994).

Modesto Irrigation District

Modesto Irrigation District provides surface water to nearly 104,000 acres of farmland in the Modesto Subbasin. Founded in 1887, Modesto Irrigation district hold pre-1914 water rights from the Tuolumne River Watershed. MID jointly operates the Don Pedro and La Grange Dam reservoir system with Turlock Irrigation District (TID) and diverts an average of nearly 300,000 AFY from the Tuolumne River Watershed for agricultural and urban use each year.

Throughout the 1991-2015 historical period, MID delivered an average of 154,000 acre-feet to agricultural users and 26,000 acre-feet of potable water to the City of Modesto. In addition to their direct deliveries, MID has provided beneficial recharge to the Subbasin through 24,000 acre-feet of seepage from Modesto Reservoir, and 8,000 acre-feet of seepage from their canal system. An annualized breakdown of MID surface water deliveries and recharge is presented in Figure 3.

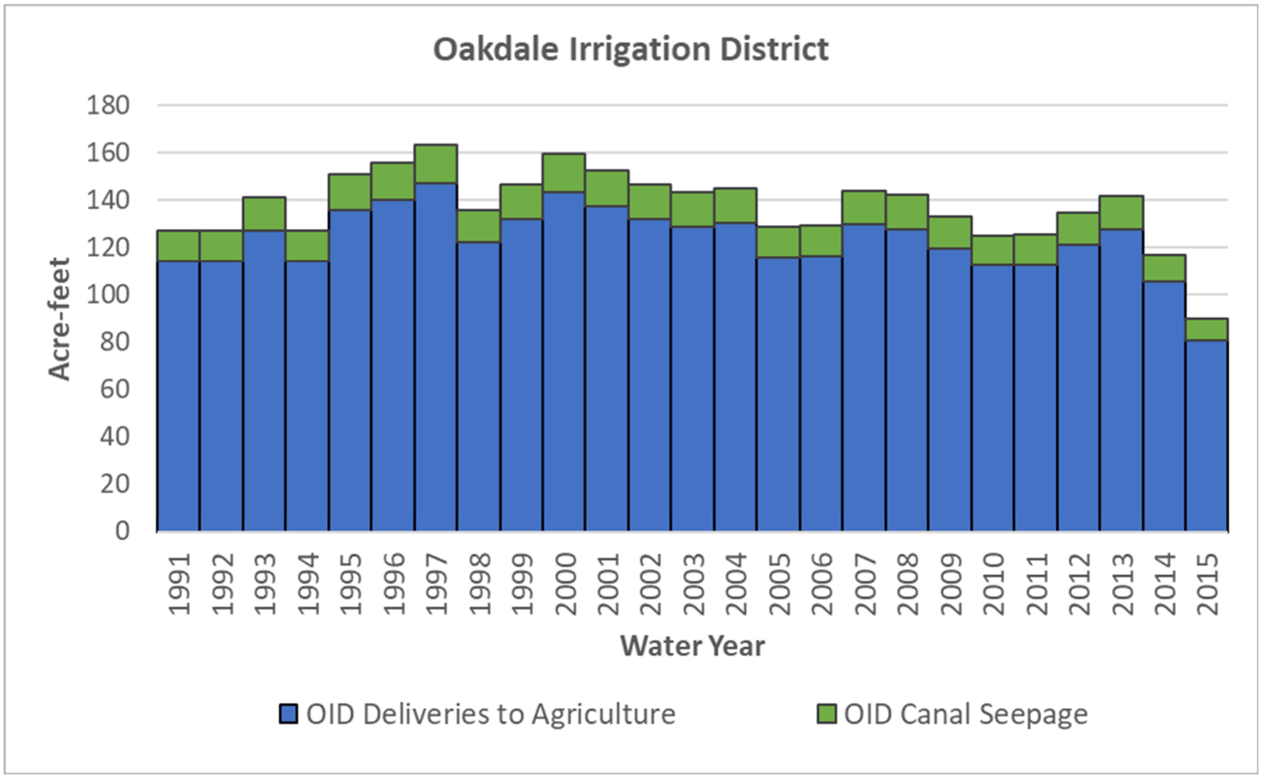
Figure 3: Modesto Irrigation District Surface Water Deliveries and Recharge



Oakdale Irrigation District

Oakdale Irrigation District (OID) was formed in 1909 and holds pre-1914 water rights, supplying over 67,000 acres of farmland with irrigation water. The district includes over 27,000 acres to the north of the Stanislaus River in the Eastern San Joaquin Subbasin, along with over 40,000 acres in the Modesto Subbasin. The district shares operational control of New Melones Reservoir with South San Joaquin Irrigation District (SSJID) and diverts up to 300,000 AFY Stanislaus River at Goodwin Dam. As shown in Figure 4, Oakdale Irrigation District delivered an average of 124,000 acre-feet and recharged and additional and 13,000 acre-feet of canal recharge the Modesto Subbasin during the historical simulation.

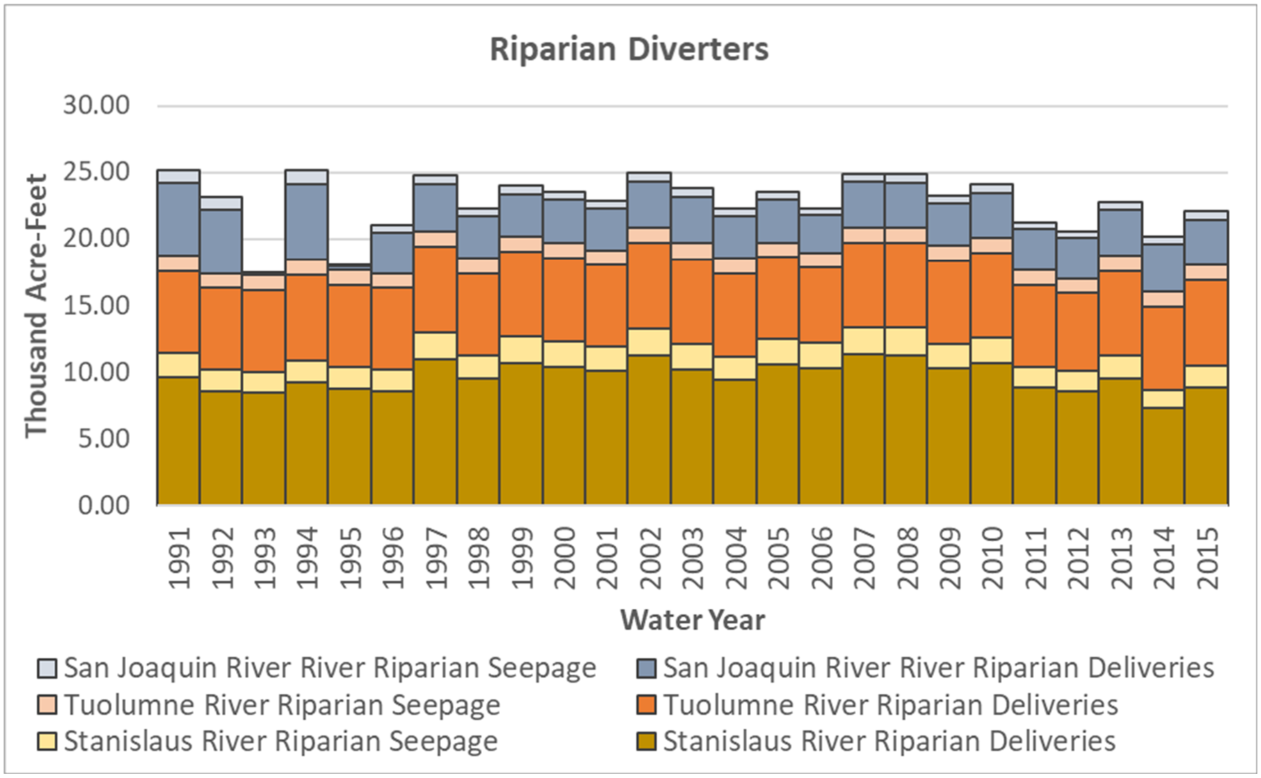
Figure 4: Oakdale Irrigation District Surface Water Deliveries and Recharge



Riparian Diverters

In addition to the Subbasin's main irrigation districts, there are multiple riparian diverters along each of the major rivers. A small amount of surface water supply is diverted by water right holders from these boundary waterways. Volumetric diversions of riparian water users were estimated based an agricultural demand and verified against water rights listed in the California State Water Resources Control Board Electronic Water Rights Information Management System (eWRIMS) database. Riparian surface water deliveries to the Modesto Subbasin were estimated to be approximately 19,200 AF each year, with 9,700 AF being diverted from the Stanislaus, 6,200 AF diverted from the Tuolumne, and 3,300 AF diverted from the San Joaquin Rivers. Conveyance Seepage from riparian diverters were estimated to be 1,800 AF, 1,100 AF and 600 AF for the Stanislaus, Tuolumne, and San Joaquin Rivers respectively. Riparian deliveries and conveyance recharge are shown below in Figure 5.

Figure 5: Modesto Subbasin Riparian Surface Water Deliveries and Recharge



3.4.4 Streamflow Monitoring Locations

The three dynamically simulated streams in the Modesto Subbasin are calibrated to achieve reasonable agreement between the simulated and observed streamflow at specific gaging stations. Calibrational stream gauges are selected to be representative of the conditions throughout the reach and are usually located at a downstream point along the river. Streamflow calibration of the Modesto Model is primarily performed by the adjustment of stream and aquifer parameters as outlined in **Section 4.3.2.** A list of the stream gauges used in the calibration of the Modesto Model is listed in **Table 7** and their spatial location is shown in **Figure M11**.

Table 7: Summary of Modesto Model Stream Calibration Gauges

Stream	Stream Node	Description	Station ID
Stanislaus River	2141	Stanislaus River at Ripon	USGS: 11303000
Tuolumne River	2005	Tuolumne River at Modesto	USGS: 11290000 CDEC: MOD
San Joaquin River	2182	San Joaquin River at Vernalis	USGS: 11303500 CDEC: VNS

3.5 GROUNDWATER SYSTEM

This section presents the source and analysis of input data used in the development of aquifer conditions for the Modesto Model. This includes spatial and temporal information for hydrologic, hydrogeologic, water use, water supply, and operations data sets included in the model, as well as physical settings, parameters, and assumptions.

3.5.1 Groundwater Pumping

The Modesto Model divides groundwater pumping into (1) pumping by wells, which includes agency-operated wells, and (2) pumping by elements, representing private agricultural and domestic groundwater production. The division between the different types of pumping in IWFM predominantly relies on the availability of data. As an active member of model development, local water purveyors within the Modesto Subbasin provided well construction information and volumetric pumping data for integration into the model. In contrast, volumetric data from private well owners are largely unknown, and therefore are estimated by the Modesto Model based on publicly available information and water demand.

3.5.1.1 Agency Pumping

Pumping by wells is done when pumping data is specified for the characteristics of the well (geographical location, total depth, screen perforation depth, use), and a time-series for the historical pumping records. **Table 8** summarizes the data received and incorporated into the Modesto Model, the spatial breakdown of agency wells can be seen in Figure M12.

Agricultural Agencies – Both Modesto and Oakdale Irrigation Districts use pumping to supplement their surface water supplies and support deliveries to customers. Volumetric and construction data was provided by both agencies and verified against reported values in their AWMPs.

Urban Agencies - Municipal groundwater production in the Modesto Subbasin was based on records received directly from the four cities within the Modesto Subbasin and verified against their Urban Water Management Plans (UWMPs). Each water agency provided the location, depth, and monthly pumping time-series of their well facilities.

Table 8: Summary of Agency Wells in the Modesto Subbasin

Purveyor	Well Const.	Time Period of Data	Number of Wells[1]	Average Annual Pumping[2]
Modesto ID	yes	1990-2019	106	21,700
Oakdale ID	yes	1995-2017	33	4,900
City of Modesto	yes	1995-2018	155	37,300
City of Oakdale	yes	2001-2018	9	4,800
City of Riverbank	yes	2006-2018	10	4,500
City of Waterford	yes	2005-2018	8	1,700
Total Average Annual Pumping				74,500

Notes: [1] Due to the historical nature of the simulation, not all wells in the model are currently active
[2] All values represent the annual pumping, in acre-feet, over the 1991-2015 historical period.

3.5.1.2 Private Groundwater Pumping

Private groundwater pumping quantities on an individual well basis are largely unknown, and therefore they are estimated by the Modesto Model on an element basis. Water demands at each element are used to calculate pumping necessary to meet the demand.

The perforation interval, which dictates the layers a simulated well extracts water from, were assigned separately to the domestic (i.e., rural residential) and agricultural wells. Perforation intervals were compiled by DWR using data from the California Statewide Groundwater Elevation Monitoring (CASGEM) and the Online System for Well Completion Reports (OSWCR, pronounced "Oscar") databases. Simulated perforation intervals were assigned as the 5th and 95th percentiles of the well perforation interval data for each township/range block. Additional information on how this data was developed is available in the C2VSimFG Documentation: *California Central Valley Groundwater-Surface Water Simulation Model – Fine Grid (C2VSimFG) Development and Calibration Version 1.0* (DWR 2020).

Private Agricultural Pumping

The volume of the private agricultural pumping was estimated in the Modesto Model on an element basis as part of the root zone simulation. The volume of water needed to meet the agricultural demand of each specific element, is estimated after distributing any other specified agency water supply (surface water deliveries or agency-based groundwater supply).

Within Modesto and Oakdale Irrigation District boundaries, model-calculated private pumping volumes were validated through comparison with agency estimates of the total private pumping volume. In the Non-District East and West areas, root zone characteristics were calibrated to ensure that groundwater pumping, and crop consumptive use characteristics resulted in water demands appropriate to the irrigation systems and crop types known to occur throughout the Modesto Subbasin (see Section 4.2.1).

Private Urban and Domestic Pumping

Like the calculation of private groundwater pumping for agricultural use, private groundwater pumping for domestic use was calculated in the Modesto Model on an element basis as part of the root zone simulation. The volume of pumping in each element was calculated within the model as the additional volume of water necessary to meet urban demand within that element, after distributing any other specified, available water supplies.

3.5.2 Groundwater Monitoring Wells

Groundwater levels are calibrated to achieve acceptable agreement between the simulated and observed values (in this case, groundwater levels at the calibration wells). Within the Modesto Subbasin, over 500 wells were evaluated to be used as potential representative hydrograph locations (**Figure M13**). Data for these wells were obtained from DWR's CASGEM program, DWR's Water Data Library, and local monitoring data. After a review of the available observation data, a working set of 66 wells (**Figure M14**) was selected to be used as the primary, or representative wells for evaluation in the calibration process. The calibration wells were selected based on the following criteria

- The period of record
- Number of observations
- Temporal distribution of available data
- Spatial distribution
- Representative nature of the data
- Trends of nearby wells.

3.5.3 Initial Conditions

Groundwater heads for each model node and each layer at the beginning of the calibration simulation (October 1, 1990) were developed using local observation data, combined with DWR's CASGEM and WDL databases. The available 531 wells with data were analyzed for use in building the initial groundwater heads. Due to the availability of data in different wells, a hierarchy of data was used to compile sufficient coverage over the model domain for development of initial conditions:

- October 1990 where available
- Fall 1990 (September-November) where available
- Surrounding years data, averaged (Fall 1989 or Fall 1991)
- Surrounding years data, averaged (Fall 1988 or Fall 1992)
- Where all the above sources were unavailable, depth to water was extrapolated

Observation data was interpolated to develop a raster representing initial groundwater levels over the model domain. Due to the lack of construction information for many of the monitoring locations, the groundwater heads described above are used for all layers. The initial conditions for the Modesto Model representing October 1, 1990, are shown in **Figure M15** though **Figure M18**.

3.5.4 Boundary Conditions

Specified head boundary conditions define the subsurface inflow for the western and southern boundaries of the Modesto Subbasin. The Modesto Model utilizes boundary conditions for all active layers at groundwater nodes between one to two miles away from the subbasin boundaries Conditions in the Eastern San Joaquin and Delta-Mendota subbasins and were defined based on a combination of historical data available from observed groundwater elevations from DWR's CASGEM program, DWR's Water Data Library, groundwater contours from DWR's SGMA Data Viewer web application, and local monitoring data. The location of defined boundary nodes is shown in **Figure M19**.

3.5.5 Parametric Grid

Aquifer properties and flow dynamics in the Modesto Subbasin are governed by a set of characteristic parameters defined at representative locations known as parametric nodes. Parameters for the Modesto Model are defined at these locations and are integrated into the model's primary grid. The representative parametric nodes for the Modesto Model are shown in **Figure M20**. During the calibration process, refinements to aquifer parameters are performed by adjusting parameters at these locations.

4. MODEL CALIBRATION

The Modesto Model is an integrated water resources model developed to simulate the interconnected nature of the various components of the hydrologic system. The Modesto Model was calibrated to align simulated and observed records, including water budget components, surface water flow, and groundwater levels. The sources used during the calibration process include local knowledge, Agriculture Water Management Plans (AWMPs), Urban Water Management Plans UWMPs, other local planning efforts, observed groundwater levels and associated contours, and observed streamflow data.

Model calibration is an important part of model development, performed to meet the following principal objectives:

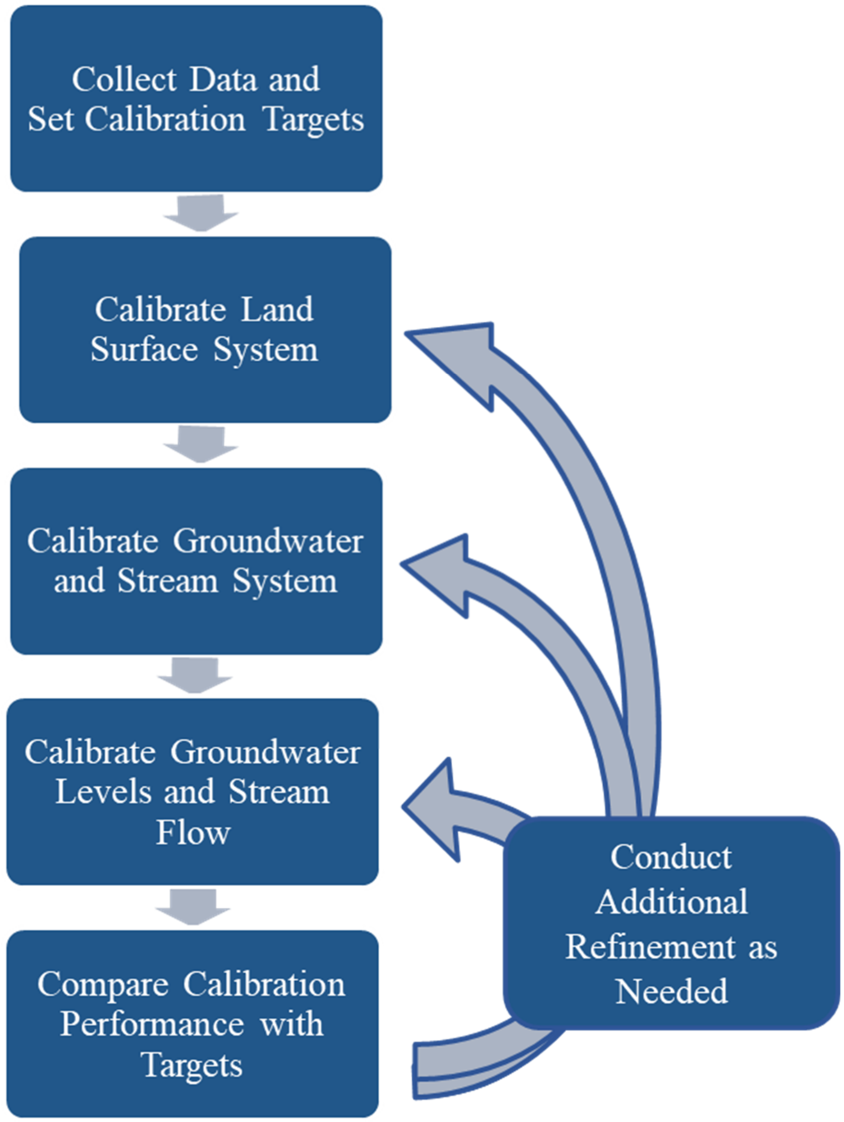
- Develop water budgets that properly represent each of the hydrologic systems modeled (i.e., land surface, stream, and groundwater system), across various geographic scales (i.e., Subbasin, GSA, and districts), and temporal timesteps (i.e., monthly, and annually).
- Represent the regional distribution of groundwater conditions, while optimizing the agreement between simulated results and observed values for short-term seasonal and long-term trends in groundwater levels at selected calibration wells.
- Represent appropriate level of stream-aquifer interaction by simulating the modeled streams in such a way as to optimize the agreement between simulated results and observed streamflow hydrographs at selected gaging stations.
- Properly represent the interbasin flows across between the Modesto Subbasin and its adjacent areas, the Turlock, Eastern San Joaquin, and Delta-Mendota Subbasins.

These objectives are achieved through careful review of the model input and adjusted model parameters. The model results also provide insight to key components of the groundwater basin including historical recharge, subsurface flows, and changes in groundwater storage.

4.1 CALIBRATION PROCESS AND METHODOLOGY

Model calibration begins after the data analysis and input data file development is complete. The calibration effort can be broken down into subsets that align with multiple packages within the IWFM platform. As an integrated hydrologic model, the results of each part of the simulation are interdependent on one another. The model calibration is a systematic process that is illustrated in **Figure 6** and includes the following steps.

Figure 6: Model Calibration Process



1) **Set Calibration Targets:** The first step in model calibration was the collection and refinement of data related to model calibration targets for the calibration period. Data related to model calibration was collected and refined for the calibration period. This process includes the systematic review of both published and observed information, as well the preparation of the statistical data for the evaluation of both local and regional calibration.

2) **Calibrate the Land Surface System:** In the second step, preliminary rootzone and land and water use budgets were established and verified. The calibration effort focused on soil hydraulic parameters, curve numbers, cropping and irrigation coefficients, urban water use specifications, deep percolation, runoff and return flow. Urban and agricultural demand, groundwater pumping, and surface water supply from water budgets were verified against available data from a combination of state and local resources.

3) **Calibrate the Groundwater and Stream Systems:** The third step was calibration of the groundwater and stream system budgets. The water budgets for the stream and aquifer systems are calibrated in tandem through the evaluation of both flow components and simulated hydrographs. Due to the interconnected nature of these systems, this process is often preformed iteratively, with step five as refinements to the system parameters or operational budgets affect both groundwater levels and stream flow.

4) **Calibrate Groundwater Levels and Stream Flow:** The fourth step calibrates groundwater levels by changing aquifer parameters with the use of a parameter grid and stream flow through a combination of land surface and stream-bed parameters. This step aims to obtain a reasonable match between the simulated groundwater levels and stream flows with recorded measurements. The iterative calibration process continues until the calibration goals are met.

5) **Compare Calibration Targets with Targets:** The final step in model calibration is to evaluate model sensitivity and uncertainty in context with the available data and knowledge of the Subbasin. This step includes review of the simulated water budgets and hydrographs in conjunction with the local technical advisory committee and stakeholders to evaluate model performance.

4.2 WATER BUDGET CALIBRATION

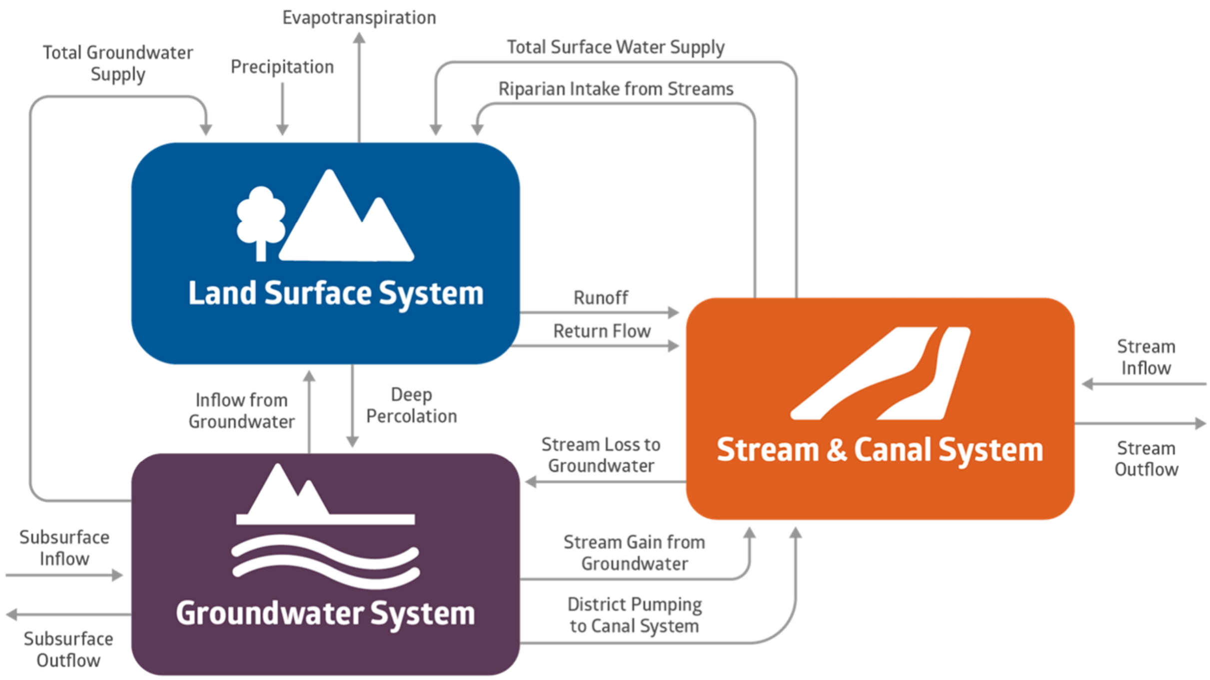
Water budget calibration ensures that the operational and hydrologic characteristics of the subbasin are accurately represented. The goal of the water budget analysis is to validate flow dynamics and develop a balanced system between supply and demand while describing the movement water such as rainfall, irrigation, streamflow, and subsurface flows. During the calibration process, model datasets and parameters are refined to better match local data at both a monthly and annual timescale. The Modesto Model water budget results are summarized in the following sections.

IWFM-2015 simulates all hydrologic processes and conditions at the node and element level. In total, the Modesto Subbasin contains 768 elements that cover approximately 245,900 acres. Elements range in size from approximately 17 acres to 1,391 acres, with an average size of 320 acres. IWFM can output data from an element or group of elements, representing processes involving water use, the rootzone, unsaturated zone, and groundwater systems. To support basin understanding, water budget development, and local management, elements are grouped into the four subareas listed below and shown in **Figure M21**: Modesto Subbasin Water Budget Areas.

The Modesto Area:	The Modesto Irrigation District service area, including the Cities of Modesto and Waterford.
The Oakdale Area:	The Oakdale Irrigation District service area including the City of Oakdale.
The Non-District West Area:	The non-district areas in the western half of the subbasin, including the City of Riverbank.
The Non-District East Area:	The non-district areas in the eastern half of the subbasin.

Water budgets in the Modesto Model were broken into three primary categories: land surface system (including the land and water use, root-zone, and unsaturated zone budgets), stream system and groundwater system. The interconnectivity of each of these systems are presented below in Figure 7, and a detailed description of the calibration process and results are described in Section 4.2.1 through 4.2.3.

Figure 7: Modesto Model Water Budget Flow Diagram



4.2.1 Land Surface System Calibration

Calibration of the land surface system includes the alignment of the IWFM land and water use and root-zone budgets with published reports, studies, and data. Calibration of these parameters include the validation and refinement to all model inputs, including hydrological and operational parameters along with soil flow properties.

The primary calibration target agricultural use in the Modesto Model was the Modesto and Oakdale Irrigation District Agriculture Water Management Plans (AWMPs). The Water Conservation Act of 2009 (SB x7-7) requires agricultural water suppliers serving more than 25,000 irrigated acres to develop a detailed analysis and water budgets of their systems These water budgets represent substantial efforts by each district to evaluate and quantify their operations related to surface water conveyance, on-farm irrigation, and drainage systems.

Data available from the local AEMPs also served as the foundation for the calibration of lands outside of both MID and OID. Since there is very little operational information for the non-district areas, calibration of agricultural demand for these lands was performed by developing statistical relationship between hydrologic soil type, crop type, and irrigation methodology. Combined with known land use and cropping patterns, extrapolation of these soil and operational parameters allowed for the development of reasonable estimates of agricultural demand throughout the subbasin.

As part of the calibration of the land and water use budget, root zone parameters are adjusted as needed to achieve reasonable estimates of agricultural demand and to develop the components of a balanced root zone budget. Land surface calibration serves as the foundation of the groundwater system as the demand estimated often translates directly to groundwater pumping, which is the primary stress on the groundwater system. To adjust agricultural demand, element-level root zone parameters, particularly the soil hydraulic conductivity and the pore size distribution index, were adjusted in accordance with the hydrologic soil group and subregion. The spatial distribution of these calibrated parameters is shown in **Figure M22** though

Figure M25, and highlights the calibrated soil parameter values specified for elements within the Modesto Subbasin. **Figure 8** and **Figure 9** shows a comparison of each of the major flow components in the Modesto Model and their respective AWMP budget item.

Table 9: Soil Textures and Corresponding Soil Parameters in the Modesto Subbasin

Hydrologic Soil Type	Average Parametric Value				
	Wilting Point (-)	Field Capacity (-)	Porosity (-)	PSDI (-)	K_{sat} (ft/d)
Type A	0.022	0.081	0.400	1.020	29.70
Type B	0.126	0.261	0.397	0.160	7.80
Type C	0.120	0.241	0.392	0.180	9.90
Type D	0.211	0.350	0.439	0.150	0.30
Weighted Average	0.115	0.226	0.406	0.398	12.68

Figure 8: Modesto Model Calibration of MID Land Surface Operations (1991-2015)

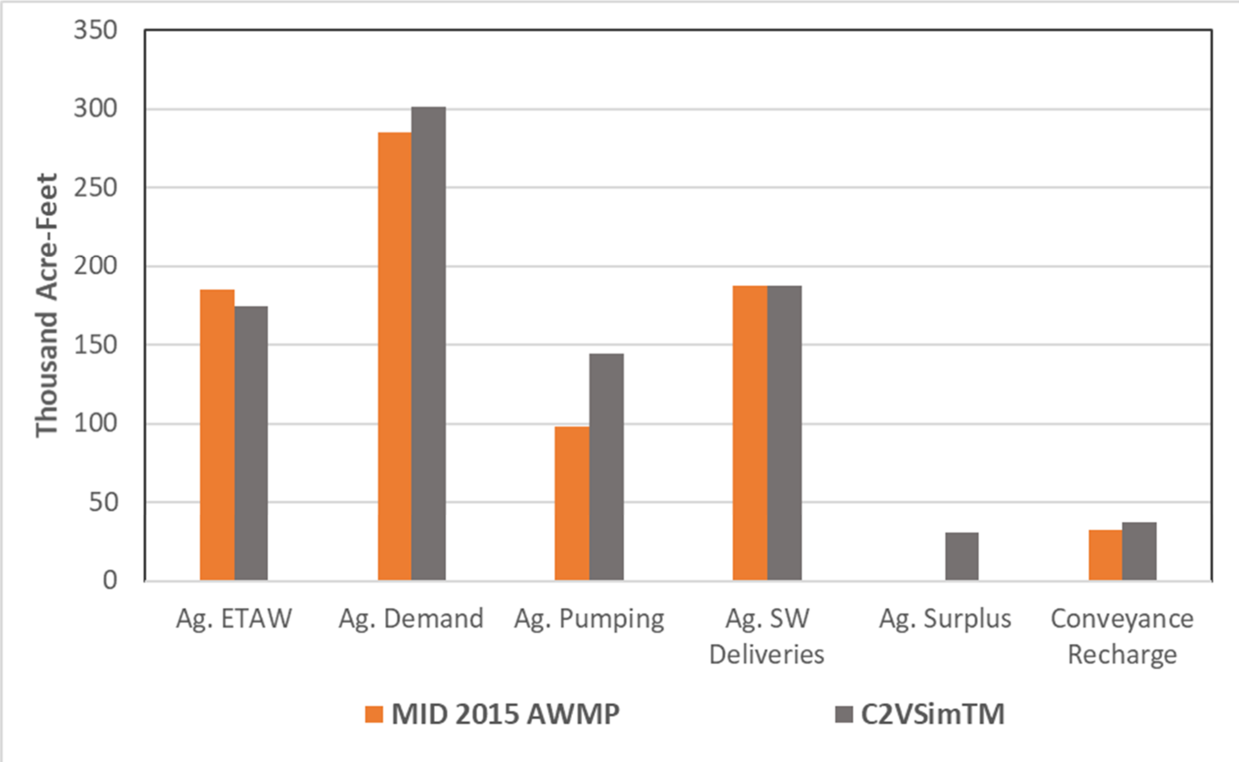
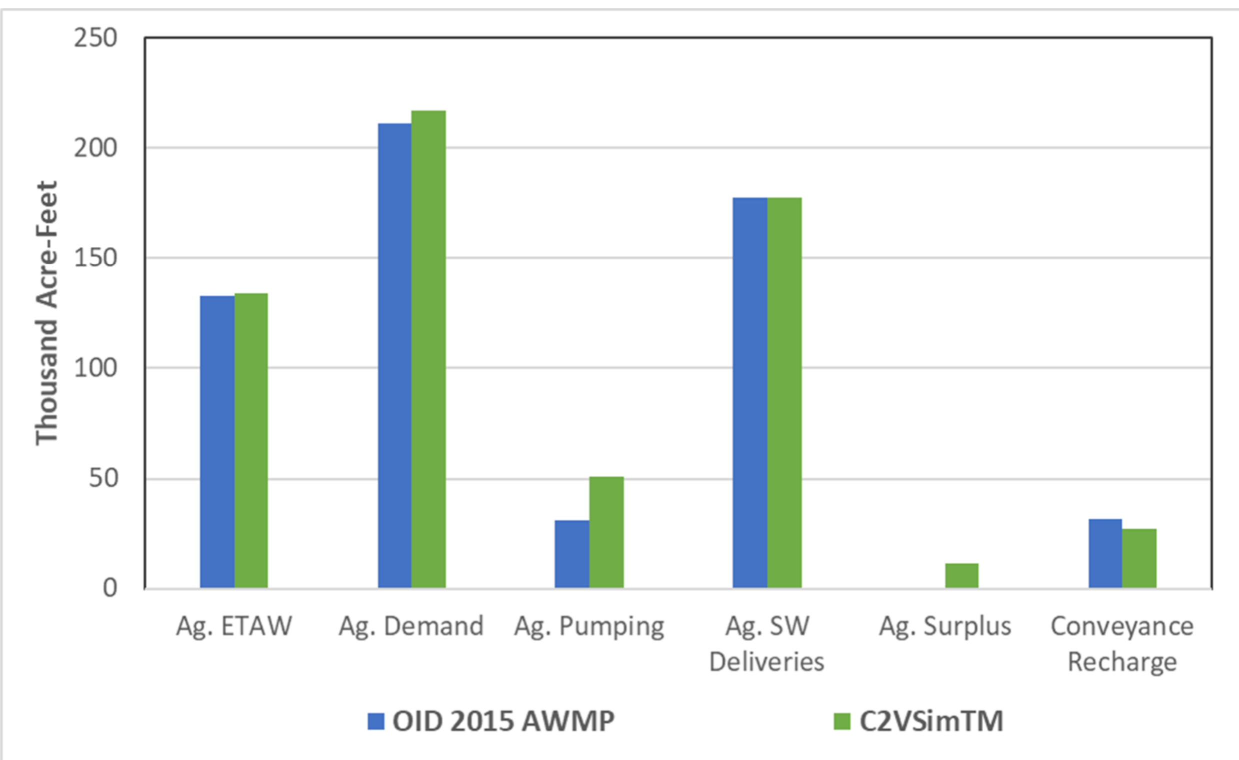


Figure 9: Modesto Model Calibration of OID Land Surface Operations (1991-2015)



Note: Comparison to the OID AWMP includes both the Modesto and Eastern San Joaquin Subbaisns

The land and water use budget represents the balance of the IWFM-calculated water demands with the water supplied for the urban and agricultural sectors. Both the agricultural and urban versions include the same components that make up the water balance:

- Water demand (either agricultural or urban)
- Surface water supply (including recycled water deliveries and pumping delivered as surface water)
- Groundwater supply (does not include pumping delivered as surface water)

In its entirety, the Modesto Subbasin has an agricultural supply requirement of approximately 513,000 AFY. During the historical calibration period, on average, the Modesto Subbasin's agricultural demand is met through an of 289,400 AFY of surface water and 223,600 AFY of groundwater production. Additionally, the urban water demand in the Modesto Subbasin has averaged 88,600 AFY, with 26,000 AFY coming from surface water, and 62,600 AFY coming from groundwater. The land and water use budgets are presented below in **Table 10, Figure 10,** and **Figure 11**.

Table 10: Summary of Modesto Model Land and Water Use Budget
(Average Annual for the Period WY 1991-2015; Units are in Acre-Feet per Year)

	Modesto Subbasin	Modesto Area	Oakdale Area	Non-District West	Non-District East
Agricultural Demand	513,000	281,200	149,700	34,600	47,500
Agricultural Surface Water Supply	289,300	146,200	123,900	19,200	0
Agricultural Groundwater Supply	223,700	135,000	25,800	15,400	47,500
Urban Demand	88,600	73,000	11,000	4,600	0
Urban Surface Water Supply	26,000	26,000	0	0	0
Urban Groundwater Supply	62,600	47,000	11,000	4,600	0
Note: Values represent volumes available to meet the water demand, as such surface water supplies represent the surface water delivered to the growers.					

Figure 10: Modesto Subbasin Annual Agricultural Land and Water Use Budget

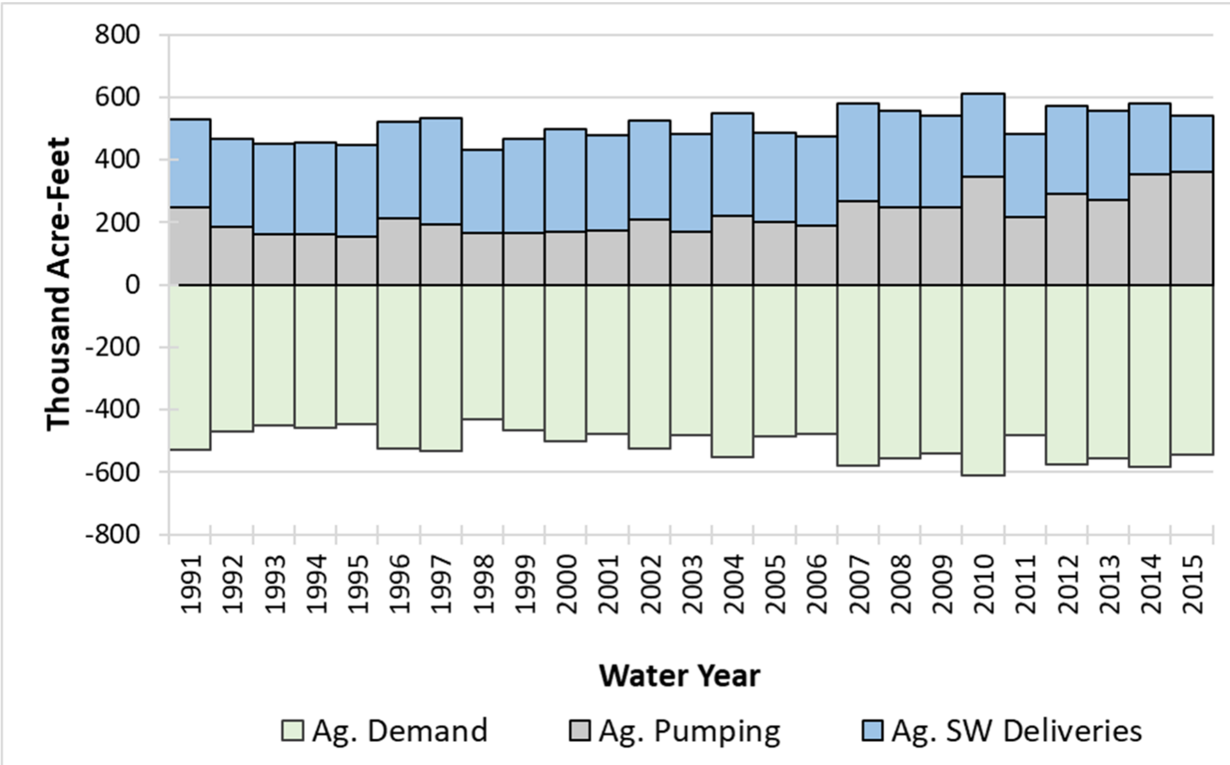
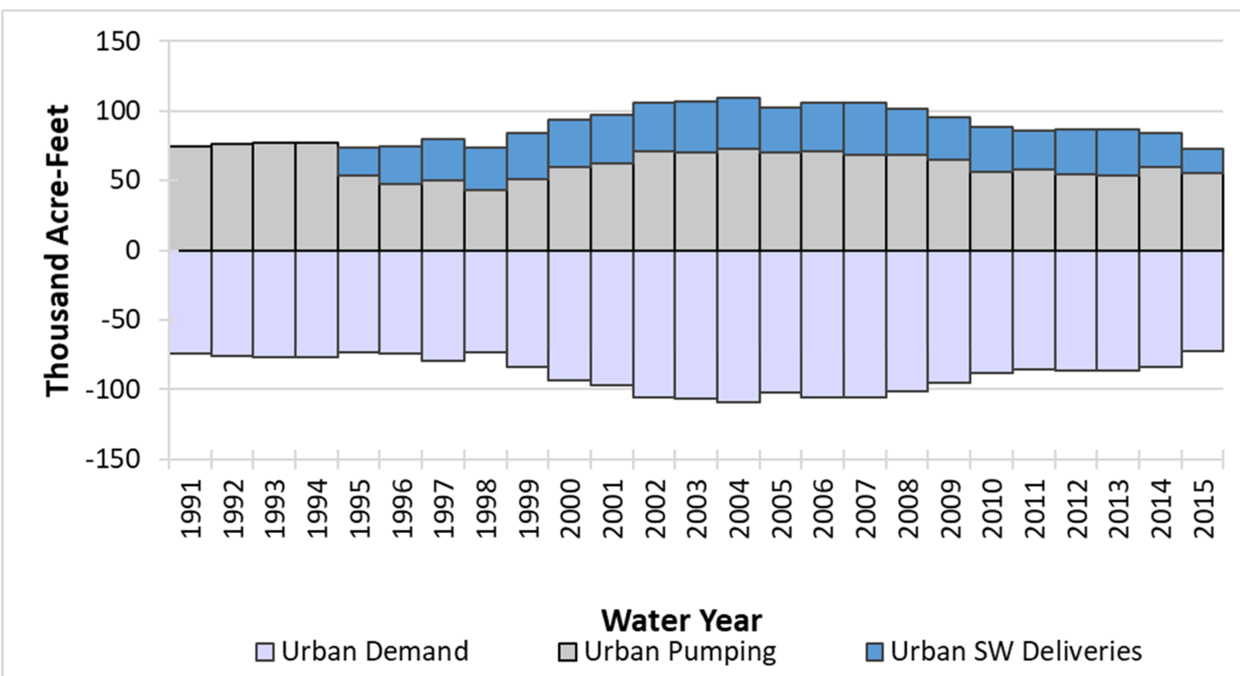


Figure 11: Modesto Subbasin Annual Urban Land and Water Use Budget



4.2.2 Groundwater System Calibration

Groundwater budgets provide a valuable evaluation tool and a means of validating the calibration process. The groundwater budget quantifies inflows and outflows from the groundwater system. The primary components of the groundwater budget, corresponding to the major hydrologic processes affecting groundwater flow in the model area, are:

- Inflows:
  - Deep percolation (from rainfall and applied water)
  - Gain from stream (recharge due to stream and river seepage)
  - Recharge (Modesto Reservoir seepage, conveyance losses, and other recharge facilities)
  - Boundary inflow (from outside the model area)
  - Subsurface inflow (from adjacent subbasins)
- Outflows:
  - Groundwater pumping (for both urban and agricultural use)
  - Loss to stream (outflow to streams and rivers)
  - Subsurface outflow (to adjacent subbasins)
- Change in aquifer storage

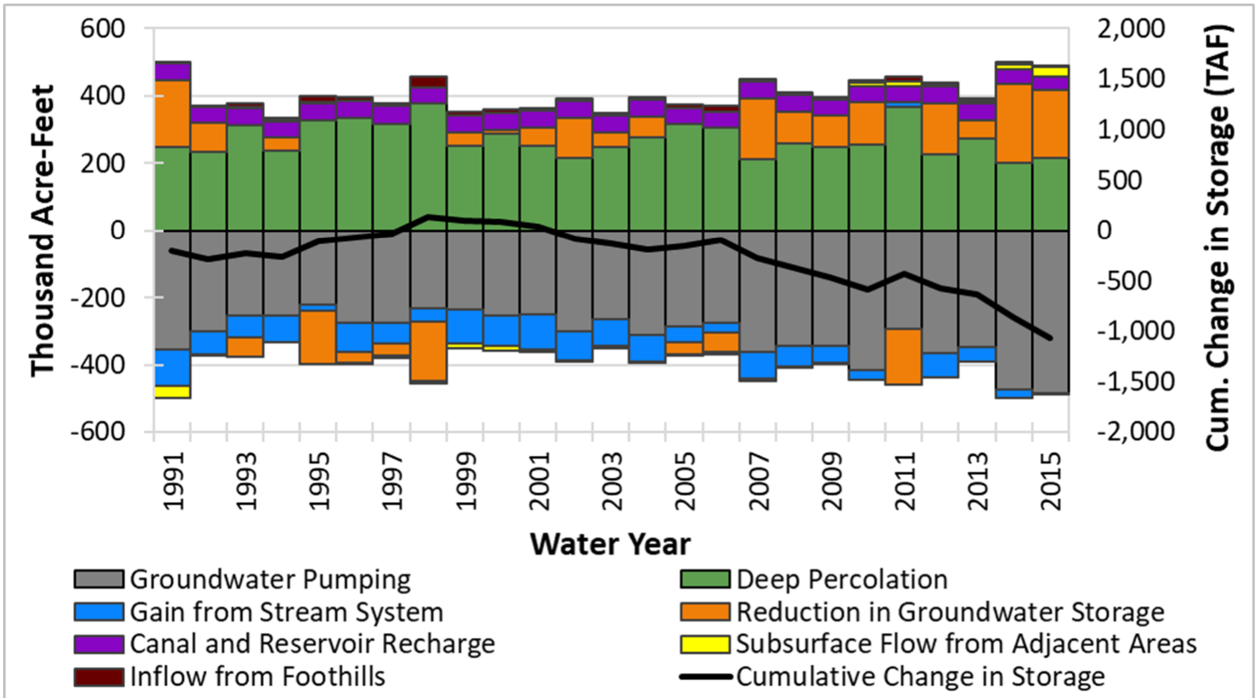
For the historical simulation of water years 1991-2015, the majority of Modesto Subbasin is irrigated agricultural land, and thus the main source of groundwater recharge is deep percolation of water from rain and applied irrigation water, which averages approximately 272,000 AFY. Seepage from canals and reservoirs are the second largest source of groundwater recharge in the Subbasin, totaling approximately 49,000 AFY. Modesto Subbasin also receives net groundwater inflows from neighboring subbasins in most years, gaining approximately 1,900 and 2,400 AFY from the Eastern San Joaquin and Turlock Subbasins, respectively, and losing approximately 2,300 AFY to the Delta-Mendota Subbasin.

Groundwater pumping to meet agricultural and urban demands is the largest source of outflow from Modesto Subbasin at an average of 311,100 AFY during the model period, as both agricultural and urban areas in the subbasin rely to a large part on groundwater supplies. Groundwater discharges to local rivers at an average rate of approximately 59,600 AFY, with 15,800 AF discharging to the Stanislaus River, 30,200 AF discharging to the Tuolumne River, and 13,600 AF discharging to the San Joaquin River. During the historical period modeled, total outflows from the groundwater in the Modesto Subbasin were greater than inflows to the Subbasin, leading to a long-term reduction in groundwater storage of over 1.5 million acre-feet or approximately 42,700 AFY of groundwater storage deficit. The groundwater budgets, including cumulative change in storage, are summarized in **Table 11** and annual values are shown in **Figure 12**.

Table 11: Modesto Subbasin Historical Groundwater Budget (1991-20015)

Groundwater Flow Component	Modesto Subbasin (1991-2015)
Deep Percolation	271,900
Canal and Reservoir Recharge	48,900
Subsurface Flow from Adjacent Areas	-2,000
Inflow from Foothills	9,200
Gain from Stream System	-59,600
Groundwater Pumping	-311,100
Reduction in Groundwater Storage	42,700

Figure 12: Modesto Subbasin Historical Groundwater Budget (1991-20015)



4.2.3 Stream Budget Calibration

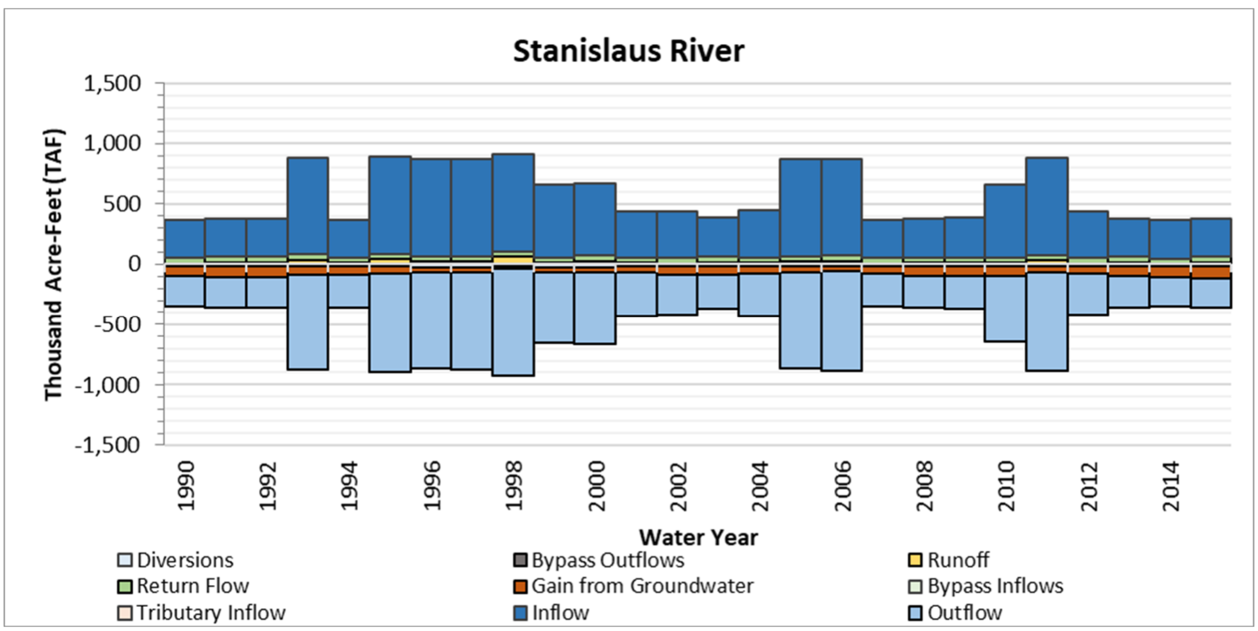
Calibration of the stream system is divided into streamflow and stream budget calibration. Stream budget calibration is principally a validation step during model calibration to ensure that the user-defined inflows and outflows are represented in model output. Within the Modesto model, these inflows and outflows principally include stream reach inflow, surface water diversions, agricultural and urban return flow, and runoff. Parameters controlling stream-aquifer interaction are then adjusted to ensure a reasonable representation while aligning simulated and observed stream flow and groundwater level hydrographs, which are discussed in more detail in **Section 4.3.2**.

A summary of inflows and outflows for each of the three major river is presented below:

Stanislaus River

The Modesto Model simulates the Stanislaus River along the northern boundary of the Modesto Subbasin, extending from just east of the Stanislaus-Tuolumne County line to the San Joaquin River confluence. The Stanislaus River exhibits gaining stream behavior in approximately 48% of years, with average net gains of 2,200 AFY from 1991 to 2015. Surface water diversions represent the Stanislaus River's largest non-discharge outflow, at an average rate of 29,100 AFY. Other major non-discharge outflows from the Stanislaus River include uptake by riparian vegetation, at an average of 17,400 AFY. Return flow and runoff provide the greatest secondary inflows to the Stanislaus River, at an average of approximately 34,500 and 17,600 AFY, respectively. An annualized presentation of the Stanislaus River water budget is presented below in **Figure 13**.

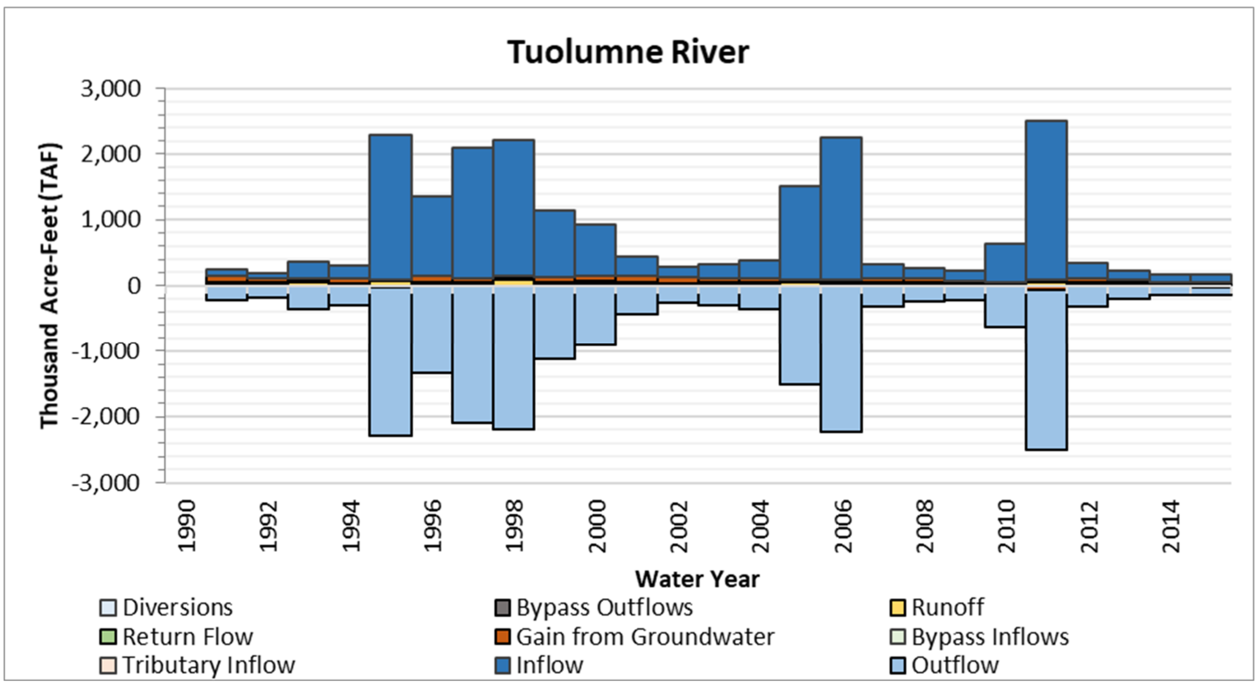
Figure 13: Stanislaus River Annual Stream Budget



Tuolumne River

The Modesto Model simulates flow from La Grange Dam at the head of the Tuolumne River to the River's confluence with the San Joaquin River. Inflow to the Tuolumne River are releases from La Grange, as reported by Turlock and Modesto Irrigation Districts. These releases result in average annual inflows of 741,600 AFY, with an overall range from 82,200 AF in the critically dry year 1992 to 2,431,700 AF in the wet year 2011. As the Modesto Model simulates the Tuolumne River downstream of La Grange Dam, MID and TID diversion are not included in the river's water budget. As such, the only diversions off this reach of the Tuolumne River average 10,300 AFY for riparian water users. The Tuolumne River flows, on average, receive 44,700 AFY of net-inflows from the groundwater system. The Tuolumne River also receives tributary, runoff, and return flows estimated at 57,200 AFY combined. On average, the Tuolumne River outflows to the San Joaquin River at an average of 819,200 AFY from WY 1991 to 2015. A graphical representation for the Tuolumne River water budget is show below in **Figure 14**.

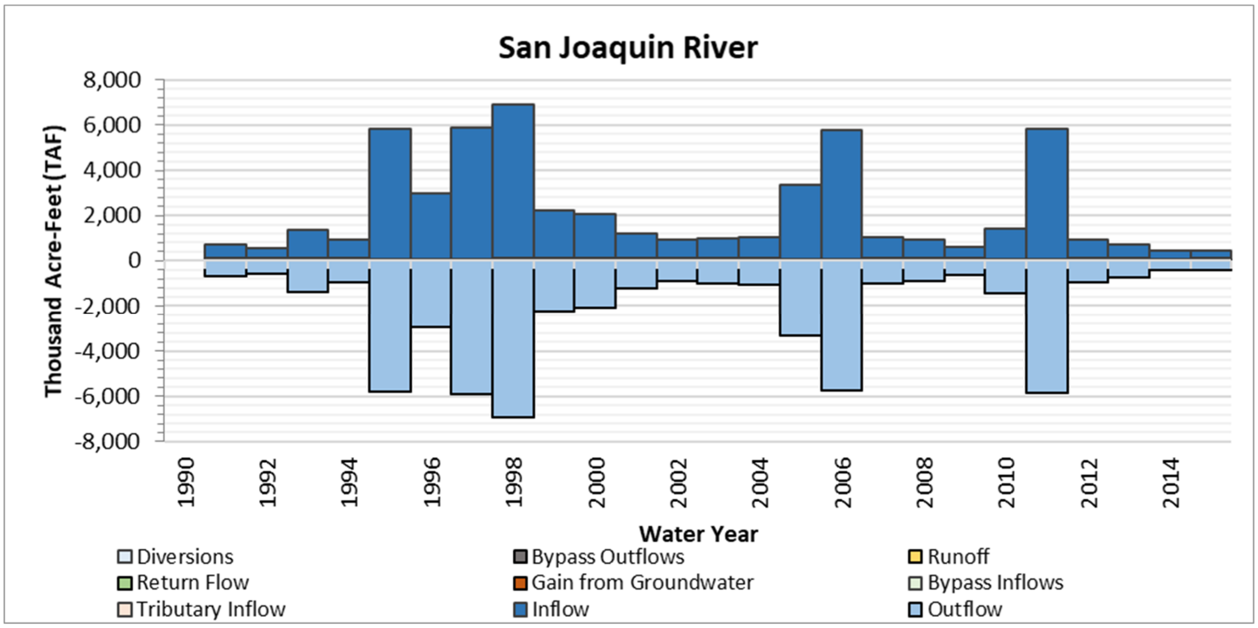
Figure 14: Tuolumne River Annual Stream Budget



San Joaquin River

The San Joaquin River is the second largest stream system in the Central Valley. The Modesto Subbasin is affected by the San Joaquin River from its confluence with the Tuolumne River to its confluence with the Stanislaus River. Within the Modesto Model domain, annual inflows to the San Joaquin River average 2,104,000 AFY, with a high of 6,816,300 AF reported in 1998 and a low of 339,200 AF reported in 2014. Average annual diversions from this reach of the San Joaquin River totaled 3,900 AFY, while riparian evapotranspiration averages 3,200 AFY. Along the Modesto Subbasin, the San Joaquin River receives average net inflows of 65,800 AFY from the groundwater system. Average annual tributary and runoff inflows to the San Joaquin River total approximately 35,700 AFY. Approximately an average of 2,198,800 AFY of water reaches the confluence of the Stanislaus River each year. Inflows and outflows for the San Joaquin River are shown in **Figure 15**.

Figure 15: San Joaquin River Annual Stream Budget



4.3 GROUNDWATER LEVELS AND STREAMFLOW CALIBRATION

After the water budgets are reasonably calibrated, the next step in the iterative process is attuning groundwater levels and streamflow. This step in the calibration process includes refining water budget components along with aquifer and streambed parameters to capture both the values and general trends throughout the subbasin over the simulation period.

4.3.1 Groundwater Level Calibration

The goal of this stage of calibration is to achieve a reasonable agreement between the simulated and observed groundwater levels at the calibration wells. The groundwater level calibration process included an iterative process of refining the water use budgets and adjusting system parameters to achieve a reasonable agreement between the simulated and observed groundwater levels at the calibration wells. As described in **Section 3.5.2**, 66 calibration wells selected as the primary indicator wells to represent the long-term conditions at both a local and regional scale. The selected calibration wells provide reliable historical data that has served as a fair representation of the conditions across the Subbasin.

The groundwater level calibration is performed in two stages:

- The initial calibration effort is focused on the regional scale to verify hydrogeological assumptions made during development and confirm the accuracy of water budgets and general groundwater flow vectors.
- The second stage of calibration of groundwater levels is to compare the simulated and observed groundwater level at each calibration well. This comparison provides information on the overall model performance during the simulation period. The simulated groundwater elevations at the 66 calibration wells were compared with corresponding observed values for long-term trends as well as seasonal fluctuations.

Calibration targets for the aquifer system focused on groundwater levels and were primarily driven by hydrologic conditions and land surface operations. To calibrate the model to observed groundwater levels, data from 66 wells throughout the Modesto Subbasin were compiled and analyzed for model input and use.

To minimize residuals between the simulated and observed groundwater levels, various aquifer parameters were adjusted with appropriate spatial distribution and interpolated to each of the model nodes. Aquifer parameter adjustments were limited to plausible value ranges established from available lithologic data. Calibration was performed in three steps. First, vertical conductivity of the upper aquitard unit (locally corresponding to the Corcoran Clay) was adjusted to reduce residuals. Then, the horizontal and vertical conductivities of the aquifer layers were modified. Lastly, the specific yield and specific storage values of the aquifers were adjusted until residuals between simulated and observed groundwater levels had been minimized. This is an iterative process and is implemented in a methodical way to obtain best fit with minimum deviation between the simulated and observed groundwater levels calibration observation wells.

The results of the groundwater level calibration indicate that the Modesto Model reasonably simulates the long-term responses under various hydrologic conditions. **Figure M14**, presented in **Section 3.5.2** shows the spatial location of the calibration wells used in the model, while **Figure 16** through **Figure 23** offer a cursory overview of the groundwater level calibration across the model domain, and Appendix A contains groundwater hydrographs at all calibration wells.

In addition to the detailed analysis at each of the calibration wells, groundwater level contours were developed to evaluate conditions and the model's behavior in areas that are not covered by the calibration wells. Examples of these contours are shown in **Figure M26** and **Figure M27** and represent conditions in Layers 1 and 2 at the end of the simulation period.

Figure 16: Modesto Calibration Well 1, Simulated and Observed

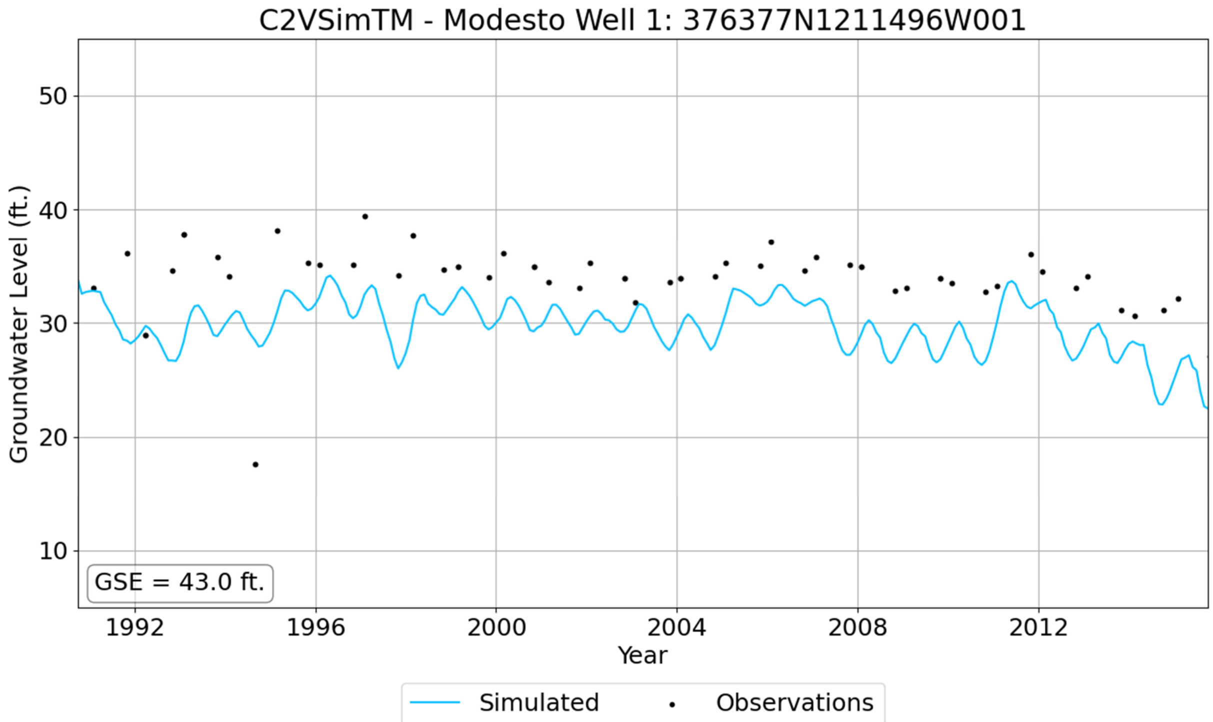


Figure 17: Modesto Calibration Well 21, Simulated and Observed

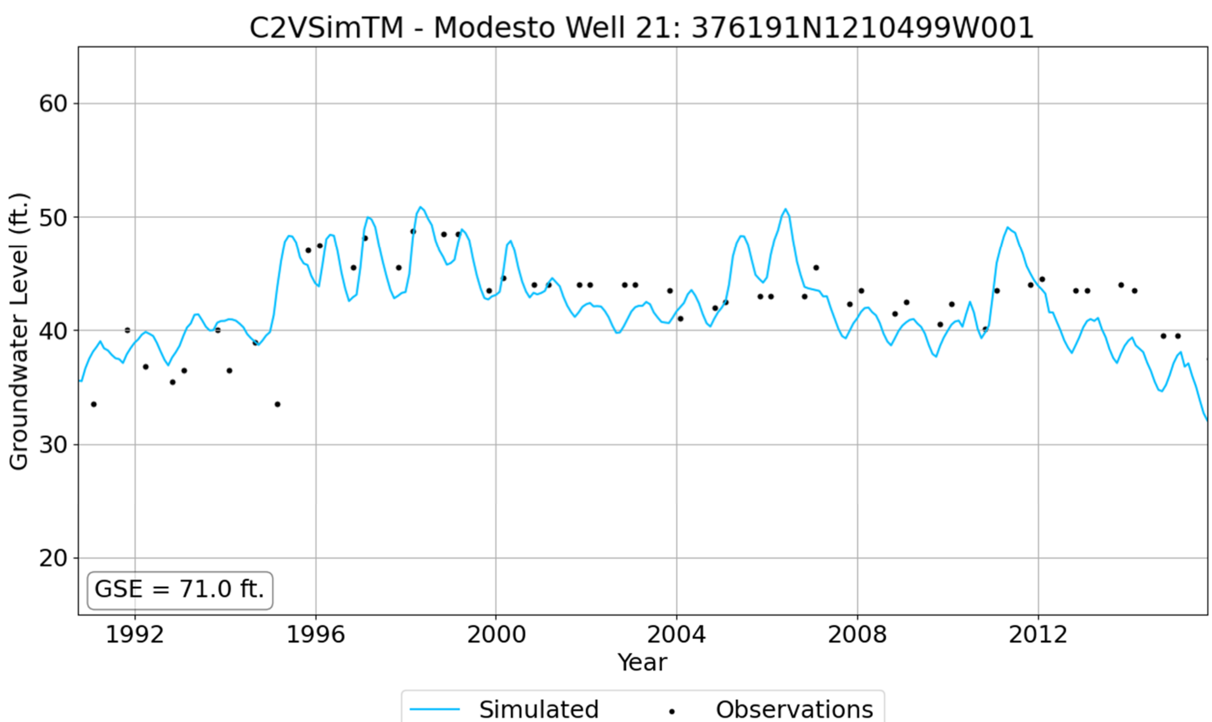


Figure 18: Modesto Calibration Well 27, Simulated and Observed

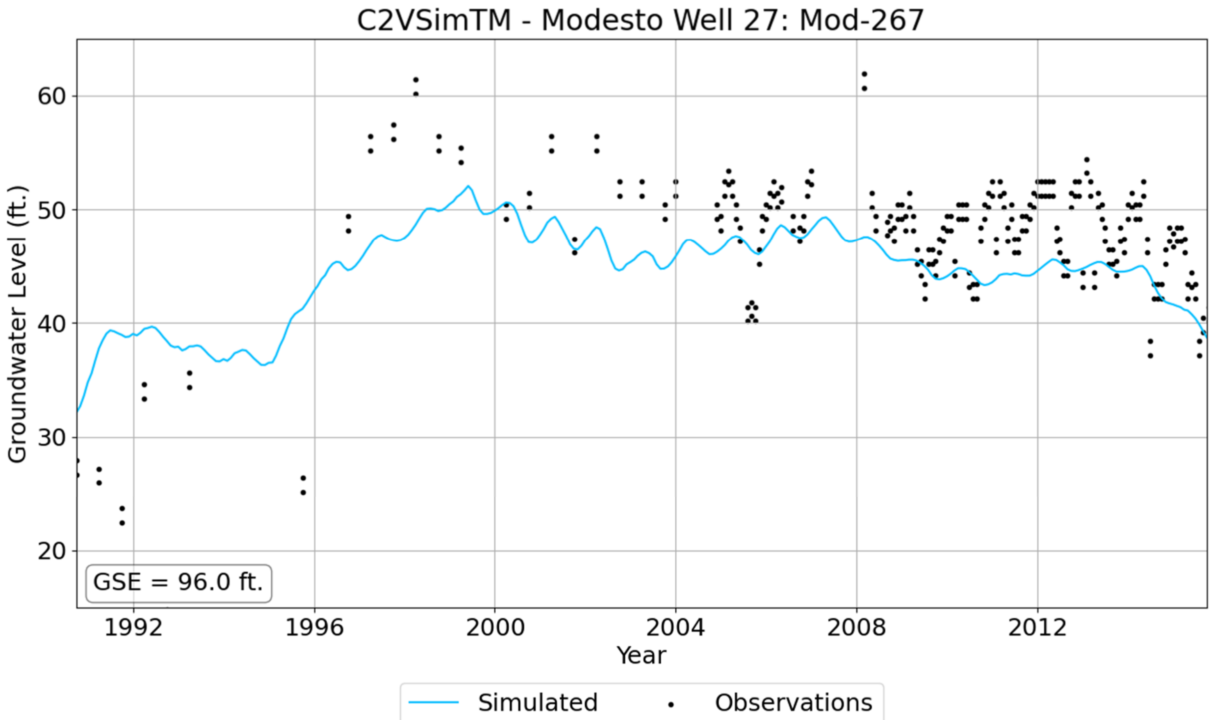


Figure 19: Modesto Calibration Well 43, Simulated and Observed

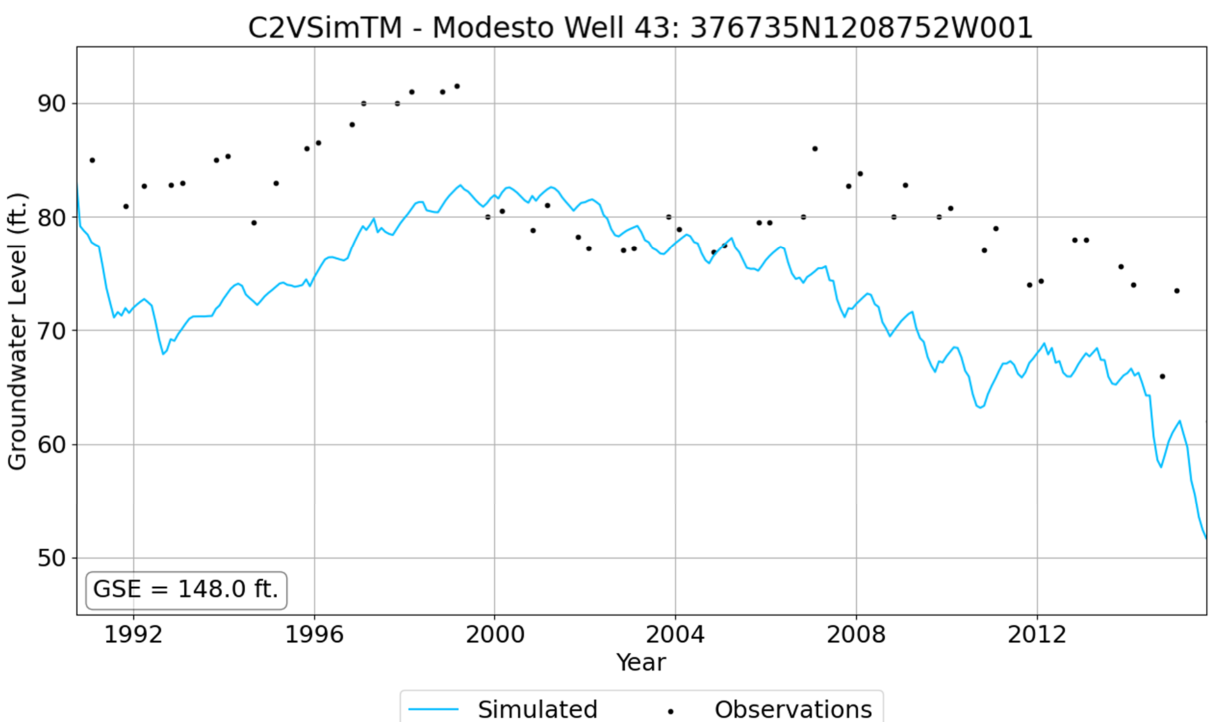


Figure 20: Modesto Calibration Well 45, Simulated and Observed

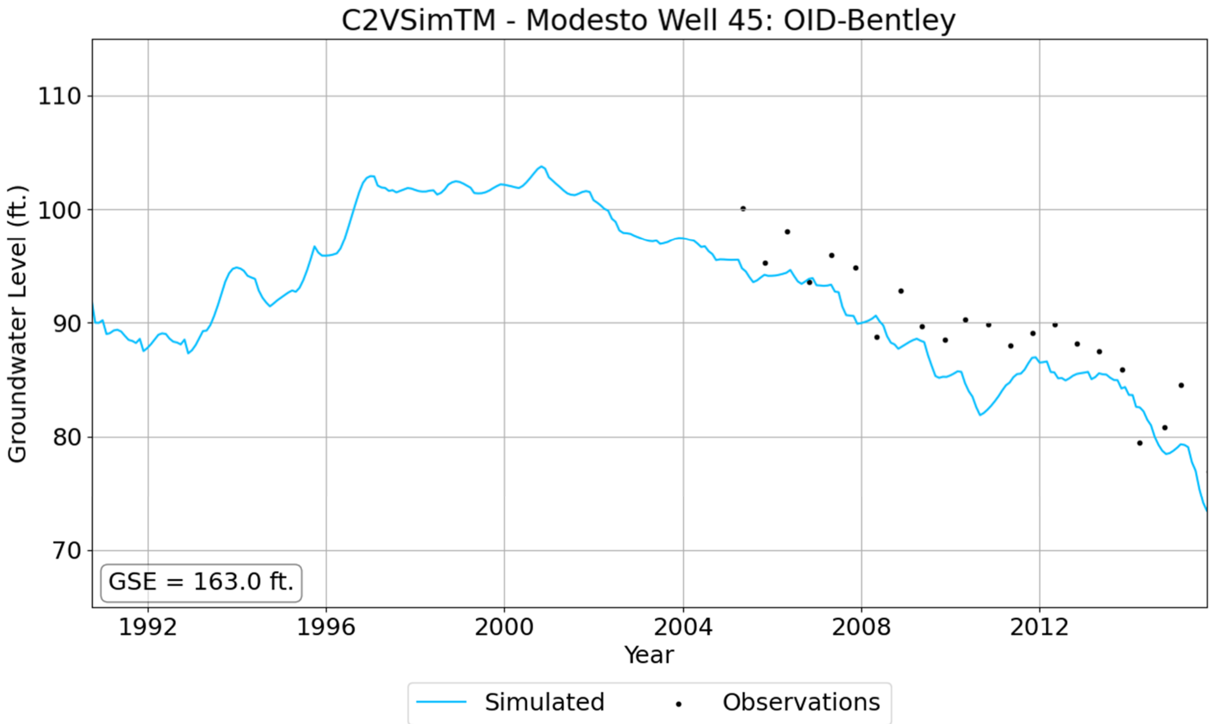


Figure 21: Modesto Calibration Well 55, Simulated and Observed

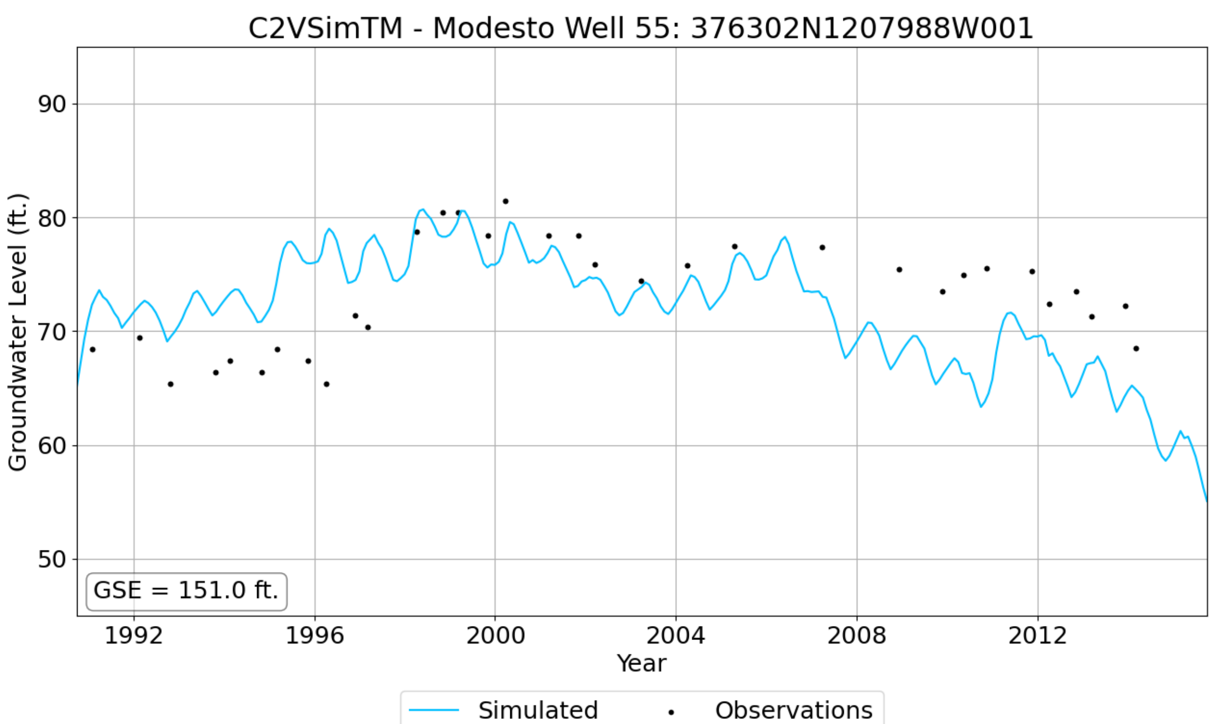


Figure 22: Modesto Calibration Well 64, Simulated and Observed

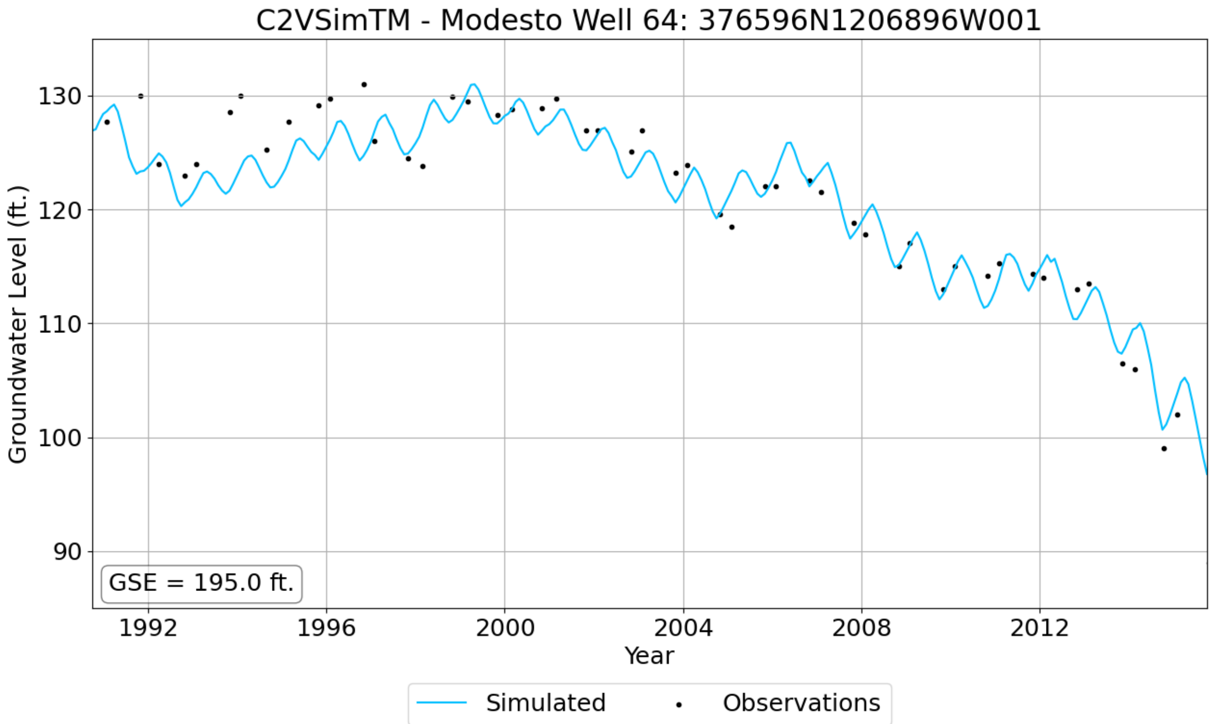
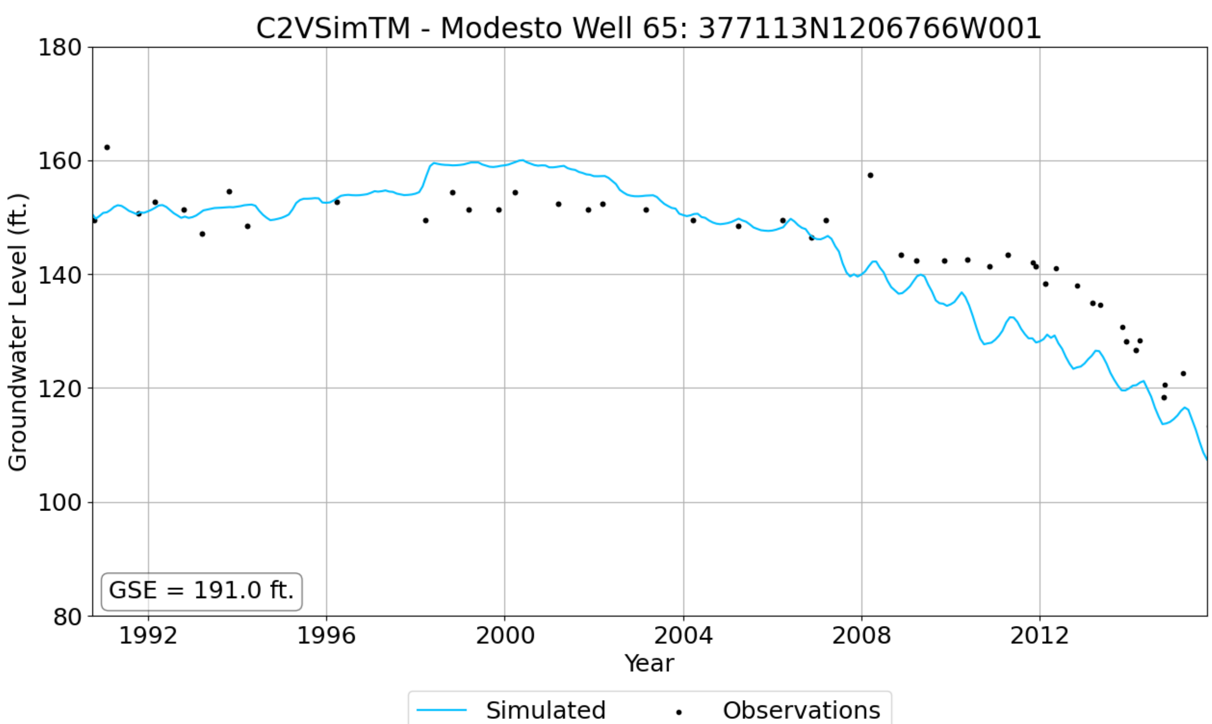


Figure 23: Modesto Calibration Well 65, Simulated and Observed



4.3.2 Stream Flow Calibration

Streamflow calibration included refinement of the streambed conductance originally from C2VSimFG. Simulated streamflow was compared with observed records, and exceedance charts were also used to evaluate the model performance when simulating variable conditions, particularly to check the quality of calibration under high and low flows at each gage location. Calibration results from each river's primary calibration wells are presented below in **Figure 24** though **Figure 29**.

Figure 24: Observed vs. Simulated Streamflow for the Stanislaus River

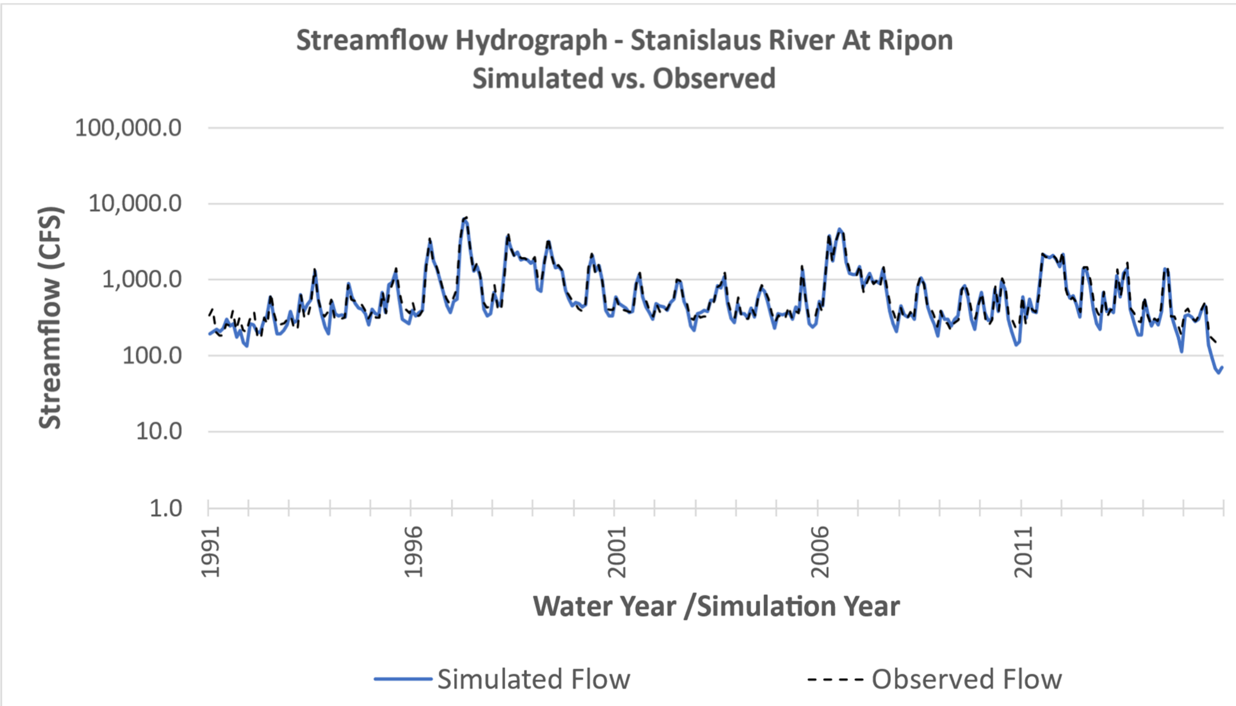


Figure 25: Streamflow Exceedance Probability for the Stanislaus River

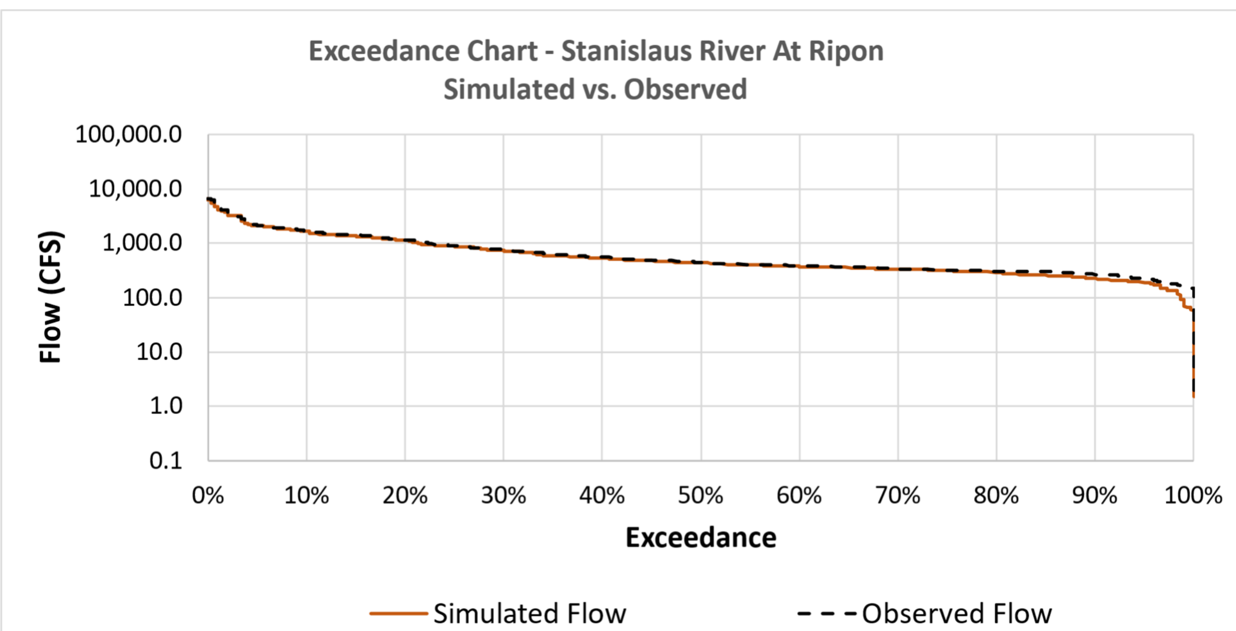


Figure 26: Observed vs. Simulated Streamflow for the Tuolumne River

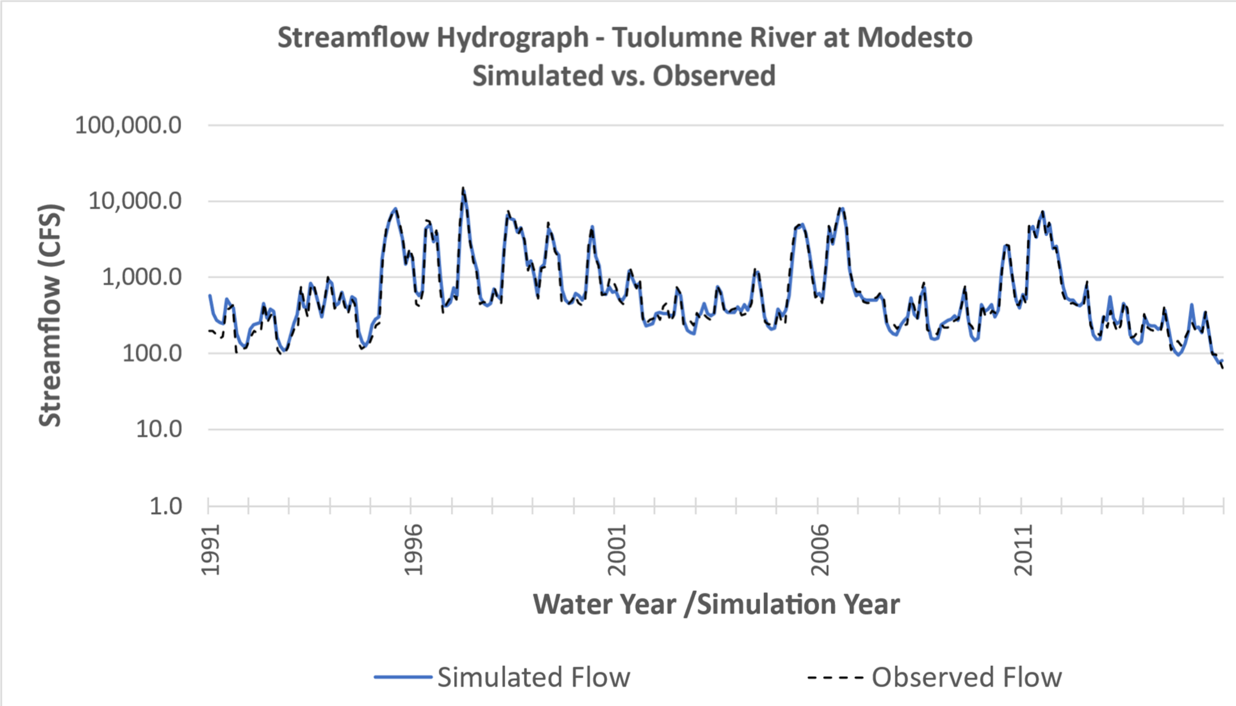


Figure 27: Streamflow Exceedance Probability for the Tuolumne River

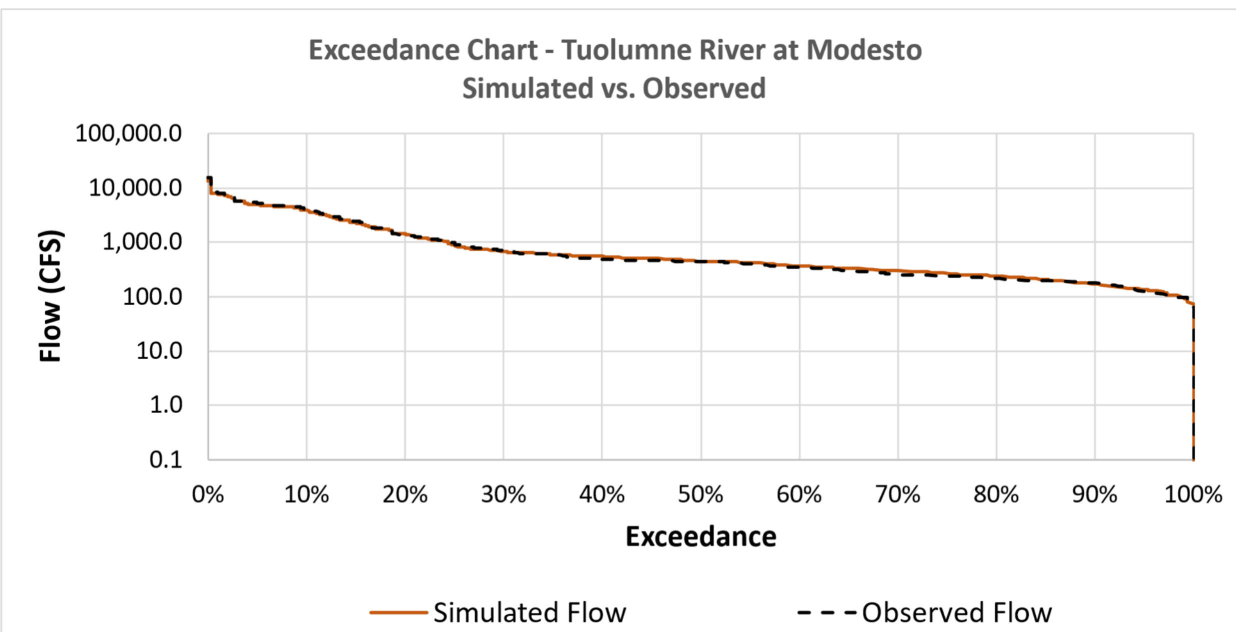


Figure 28: Observed vs. Simulated Streamflow for the San Joaquin River at Vernalis

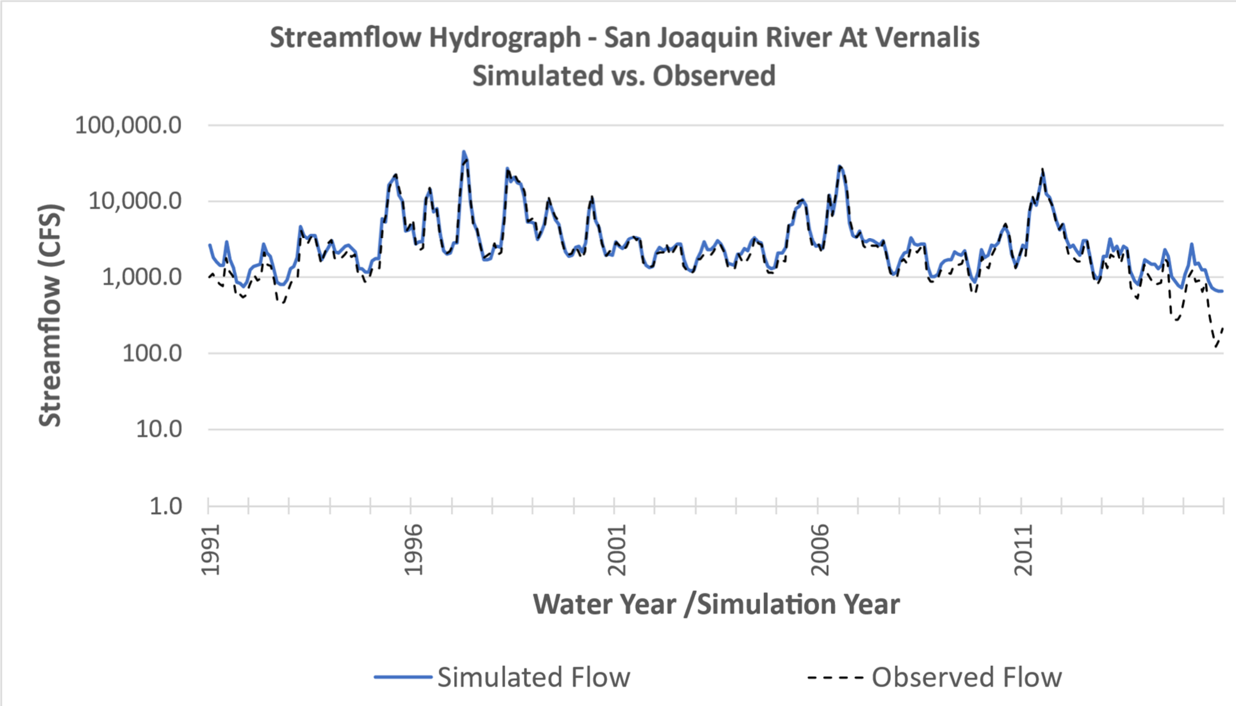
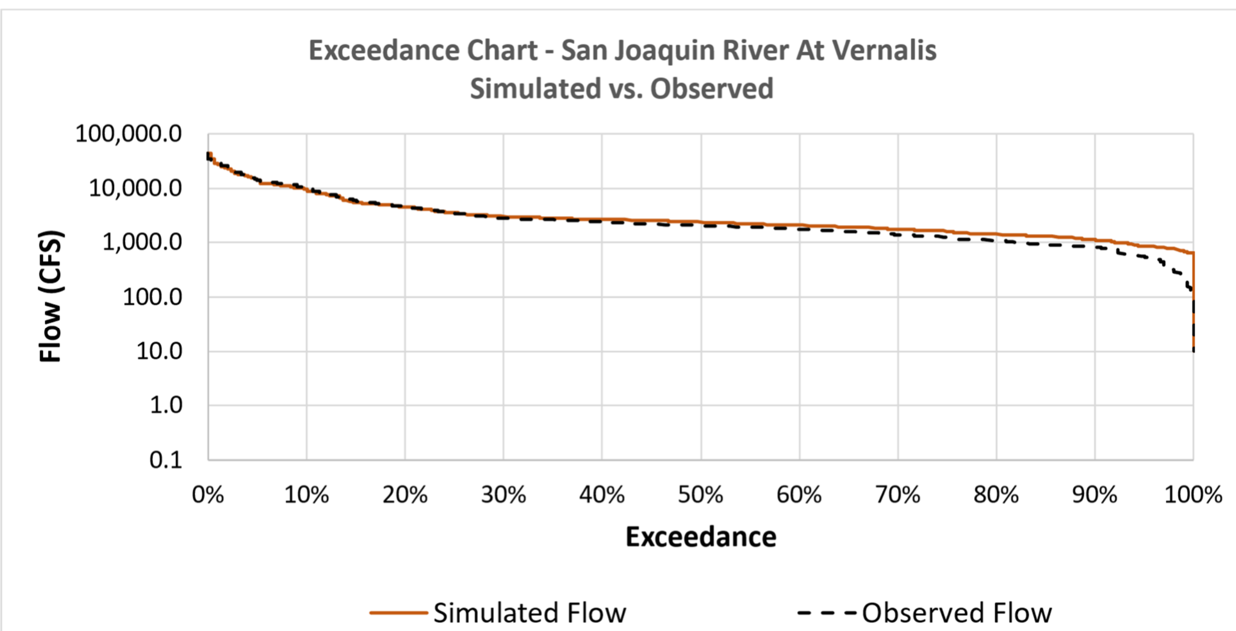


Figure 29: Streamflow Exceedance Probability for the San Joaquin River at Vernalis



4.4 MODEL PERFORMANCE

4.4.1 Final Calibration Parameters

The California Central Valley Groundwater-Surface Water Simulation Model (C2VSimFG) served as the basis of aquifer parameters within the Modesto Model. These parameters were adjusted throughout the calibration process such that water budgets, groundwater head, and streamflow of the simulated model were best aligned with the observed data. The parameters resulting from the calibration process are listed in the subsection below and summary of final stream and aquifer parameters in **Table 12** and **Table 13**.

Horizontal Hydraulic Conductivity (K_H) in the Modesto Model varies across the horizontal direction and across model layers. The fully calibrated values remain descriptive of the initial hydrogeologic analysis and range from 3.68 ft/day in Layer 4 to 100 ft/day in Layer 1. Values for the Unconfined Aquifer (Layer 1) average 63.01 ft/day while those in the confined, freshwater aquifers (Layers 2 and 3) average to 30.62 ft/day. The spatial distribution is represented in **Figure M28** through **Figure M31**.

Vertical Hydraulic Conductivity (K_V) facilitates the separation between each of the vertical layers simulated in the Modesto Model. Average values typically range from 1.43 ft/day in the unconfined aquifer to 0.51 ft/day in the lower layers. The maximum values range from 6.97 ft/day in Layer 1 to 2.31 ft/day in Layer 2, while the minimum values are in the 0.03-0.09 ft/day range.

Aquitard Vertical Hydraulic Conductivity (K_{AV}) is primarily a constraining factor across the Corcoran Clay. The vertical conductivity of the Corcoran aquitard is generally found to be between one-thousandth and one-ten-thousandth of the horizontal conductivity of the surrounding aquifer systems.

Specific Storage – Specific Storage (S_S) is used to represent the available storage at nodes in a confined aquifer, where the hydraulic head is above the top of the aquifer. Specific Storage is the unit volume of water released or taken into storage per unit change in head. All Layers presented a maximum value of 1.00E-04 ft^{-1}, with an average value ranging from 7.14E-05 ft^{-1} in Layer 1 to 7.96E-05 ft^{-1} in Layer 4.

Specific Yield – Specific Yield (S_Y) is representative of the available storage in an unconfined aquifer and defined as the unit volume of volume released from the aquifer per unit change in head due to gravity. All layers presented a maximum value of 0.2, and a minimum of 0.05, with an average ranging from 0.151 in Layer 1 to 0.144 in Layer 3.

Streambed Conductance (C_S) is represented in the Modesto Model as the product of streambed thickness and the streambed hydraulic conductivity. Due to the uncertainty related to the streambed thickness, C2VSimFG defines all streambed thicknesses as one foot so that the hydraulic conductivity input parameter (CSTRM) represents streambed conductance for each node. The maximum conductance values range from 1.9 day^{-1} in the San Joaquin River, to 2.8 day^{-1} in the Tuolumne River. The minimum values range from 1.3 day^{-1} in the Stanislaus River, to 1.7 day^{-1} in the San Joaquin River, while the average values are close to 1.8 day^{-1} for all rivers.

Table 12: Range of Aquifer Parameter Values

Data		Layer 1	Layer 2	Layer 3	Layer 4
Horizontal Hydraulic Conductivity (ft/day)	Maximum	100.00	66.64	94.16	84.98
	Average	63.01	31.52	29.73	33.11
	Minimum	12.45	7.77	4.96	3.68
Vertical Hydraulic Conductivity (ft/day)	Maximum	6.96	2.31	3.30	2.97
	Average	1.43	0.51	0.51	0.57
	Minimum	0.09	0.03	0.04	0.04
Aquitard Hydraulic Conductivity (ft/day)	Maximum		4.95E-02		
	Average		1.14E-02		
	Minimum		9.27E-04		
Specific Yield (unitless)	Maximum	0.200	0.200	0.200	0.200
	Average	0.151	0.145	0.144	0.145
	Minimum	0.050	0.050	0.050	0.050
Specific Storage (1/ft)	Maximum	1.00E-04	1.00E-04	1.00E-04	1.00E-04
	Average	7.14E-05	7.78E-05	7.91E-05	7.96E-05
	Minimum	1.74E-06	2.25E-06	2.49E-06	2.40E-06

Table 13: Range and Average of Streambed Conductance (C_S) by River

River	Average Conductance (day^{-1})	Minimum Conductance (day^{-1})	Maximum Conductance (day^{-1})
Stanislaus River	1.7	1.3	2.7
Tuolumne River	1.9	1.4	2.8
San Joaquin River	1.8	1.7	1.9

4.4.2 Measurement of Calibration Status

The Modesto Model's calibration was primarily assessed using two metrics: groundwater level trends and the correlation between simulated and observed groundwater levels. Qualitative methods included review of stream hydrographs, groundwater level hydrographs, residual maps, and the spatial and temporal distribution of trends therein. Quantitative measures included the calculation of statistical measures of error, residual scatter plots and histograms. Relative to the qualitative review of the hydrographs, the statistical analysis of model calibration described below, uses all 531 monitoring wells for a more complete analysis.

Statistics related to the differences between simulated and observed groundwater levels were evaluated relative to the American Standard Testing Method (ASTM) standard. The "Standard Guide for Calibrating a Groundwater Flow Model Application" (ASTM D5981) states that "the acceptable residual should be a small fraction of the head difference between the highest and lowest heads across the site." The residual is defined as the simulated head minus the observed head. An analysis of all calibration water levels within the model indicated the presence of a range in groundwater levels of 150 feet. Using 10 percent as the small fraction, the acceptable residual level would be 15 feet. The calibration exceeds that standard, as shown by the following statistics.

- 82.8% of observed groundwater levels are within +/- 10 feet of its respective simulated values
- 96.2% of observed groundwater levels are within +/- 15 feet of its respective simulated values
- 98.5% of observed groundwater levels are within +/- 20 feet of its respective simulated values

An additional comparison is provided by Rumbaugh and Rumbaugh, 2017, in which the quotient between the Root Mean Square Error (RMSE) and the Range is compared against a 10% threshold. For the hydrograph set used in the calibration, the RMSE was calculated at 7.72, while the range is of 154 feet, for which the quotient would be 5.01%, making the results acceptable, using unweighted head residuals.

The simulated vs observed scatter plot and residual histogram and for the Modesto Model is shown in **Figure 30** and **Figure 31**. In the Modesto Subbasin, simulated groundwater levels were on average lower than observed values by 2.29 feet, with a maximum absolute residual of 34.3 feet.

Simulated and observed groundwater elevation data and their residuals were plotted on scatterplots and assessed visually, as shown on **Figure 30**. The simulated-observed scatterplot shows that correlation between simulated and observed data is generally strong, and it maintains consistent variance throughout the data band.

The residual histogram is fairly balanced with over 80% of the readings being within 10 feet, although it does show the model has a leftward bias. The histogram also shows "thin-tailed" distribution, suggesting an overall low probability that the model would produce extreme outlier values. As shown on **Figure 31**, residuals greater than 20 feet have approximately a 1.4 percent probability of occurring, while residuals between 10 and 20 feet have approximately a 15.6 percent probability of occurring. 83 percent of the simulated groundwater levels are within 10 feet of observed levels.

Qualitative assessment was also performed on 66 select calibration wells spread throughout the subbasin. The hydrographs, presented in **Appendix A**, allow for review of temporal patterns that may not appear in the residuals.

Figure 30: Modesto Subbasin Simulated vs. Observed Scatter Plot

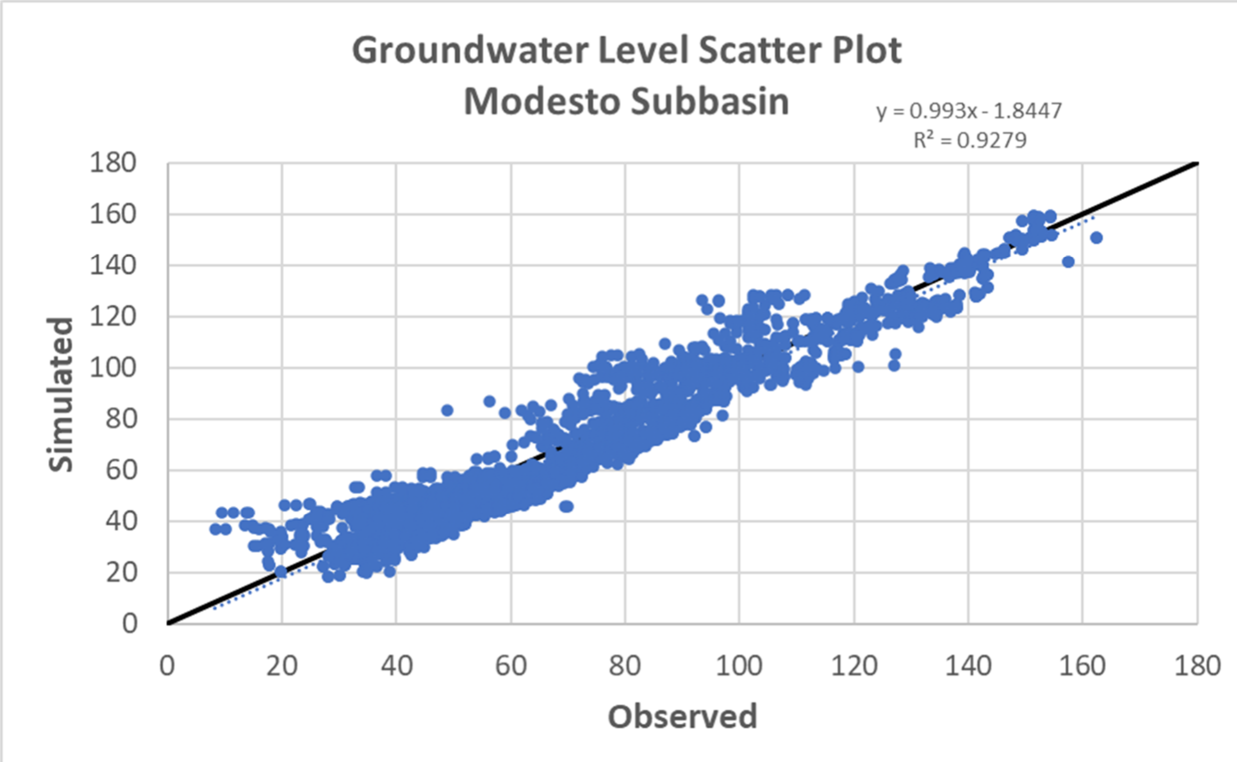
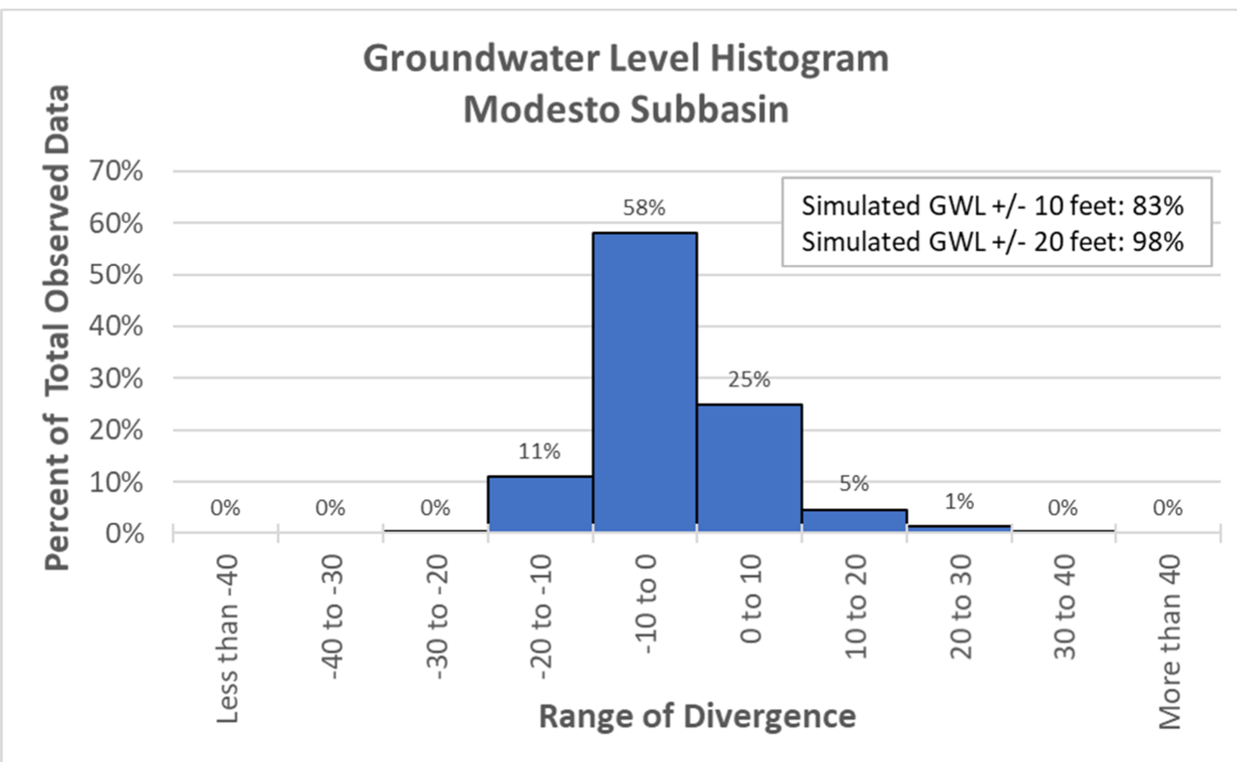


Figure 31: Modesto Subbasin Simulated vs. Observed Residual Histogram



5. DISCUSSION

5.1 MODEL FEATURES, STRENGTHS, AND LIMITATIONS

Modeling limitations are related to the simplifying assumptions made to produce a mathematical representation of a complex hydraulic system. It is not possible to develop a complete mathematical description of the physical world without introducing certain simplifying assumptions. These simplifying assumptions provide us with the Darcy's equation and the governing set of differential equations that are universally used in all groundwater models. As such, the model data sets, conceptual representation of the groundwater system, interaction with the surface water and land surface processes, and model calibration contain inherent limitations that are outlined as follows:

5.1.1 Spatial Extent and Resolution

The accuracy of the model simulation is a function of spatial resolution of the data, as well as spatial discretization of the finite elements. As the spatial data such as land use or soil conditions are mapped to the elements, the size of elements reflect the accuracy of the underlying data sets as mapped. Much of the spatial data has been reviewed and verified against available statewide and local data available. The model is calibrated to target levels based on the spatial resolution in the model. However, when using the model for local scale analysis and modeling, the experienced user is encouraged to perform further validation of the underlying spatial data prior to use of the model for analysis of projects or management actions.

Within the Modesto Subbasin, one modeling limitation is that the C2VSimFG framework includes four stratigraphic layers. While this is more than enough to estimate macro-scale aquifer dynamics, it can be difficult to evaluate perched or shallow groundwater levels, often associated with groundwater dependent ecosystems. Additionally, the average element grid size is approximately 0.5 miles, so the model can only represent water budgets at this scale.

5.1.2 Temporal Scale

The Modesto Model includes monthly hydrologic data for the period WY 1969-2018. The model is calibrated for the period WY 1991-2015. The monthly time step is a reasonable one for a regional model and reflects the resolution of much of the recorded and reported data. However, the monthly time step at times may pose limitations for simulation of some of the model features, such as streamflow during peak conditions. This is not of major concern as the regional model context and utilization of model for most long-term water supply planning needs is not affected by this limitation.

5.1.3 Land Use Data

Land use is one of the key data sets that affect water demand estimation as well as rainfall runoff, infiltration, and recharge conditions. This dataset was developed based on numerous DWR land use surveys, and local sources. This information was assembled, analyzed, and discrepancies were reconciled, which resulted in annual crop data by each model element. Mapping of land use data from various maps to element level within the model, and temporal interpolation of land use changes between years of available data, may introduce inaccuracies at a higher level of resolution. These inconsistencies may need to be considered in evaluation of land use conditions at smaller spatial scales, such as parcel level, and for years in between dates of source data.

5.1.4 Water Demand Estimates

Water demands in the model are estimated for both urban and agricultural entities. The urban demands are based on the reported water supply and demand data from the urban purveyors. The agricultural demand estimates are based on respective model data sets and calibration of the model for each agricultural area. While care has been given to estimation of agricultural water use estimates, and the results have been shared and reviewed by the agricultural entities within the model area, inaccuracies in the source data or those mapped to the model may introduce inaccurate estimates in certain conditions.

5.1.5 Water Supply Data

The surface water delivery data set in the model is one of the most reliable data sets as it is provided by the purveyors. However, the exact location of these deliveries by the agricultural entities are subject to more uncertainty, which affects the model simulation results. Local entities are encouraged to review the surface water delivery data and provide feedback to the model developers as issues arise or inaccuracies are identified.

5.1.6 Groundwater Pumping Estimates

The Modesto Model includes both the location and a monthly timeseries of all groundwater wells operated by the various agricultural and urban agencies across the subbasin. The model also includes estimated monthly groundwater pumping of private agricultural and rural residential users by each model element. Private groundwater pumping is estimated as the balance of agricultural or urban demand estimates and surface water that is available to meet the demand for each element and at each model time step.

5.1.7 Water Budgets

The Modesto Model provides detailed water budgets at each model element, which, when aggregated, can provide water budgets for a selected geographic area representing the subbasin, water/irrigation district, a GSA, or other geographies. The model water budgets have been verified for major model regions against data and information available from local sources. Additionally, the subbasin-scale model water budgets have been reviewed and verified by the respective technical staff and/or representatives of the GSAs to check the accuracy and reliability of the water budgets for GSP use. When using the Modesto Model for more detailed analysis, the user is encouraged to verify the water budgets for reasonableness and consistency with local data and information.

5.1.8 Groundwater Flow and Levels

The Modesto Model has been calibrated against long-term groundwater trends and seasonal groundwater level changes at 66 wells throughout the model area. The calibration process included adjustments to model input data and/or parameters to ensure that reasonable water budgets are achieved for each zone, and long-term simulated groundwater levels match the observed levels within acceptable tolerances. Data gaps and inaccuracies in observation and reported groundwater levels may influence the quality of calibration. Further, lack of detailed well construction information in many of the calibration wells limited the ability to use data at those sites to properly calibrate the model with depth.

5.2 MODELING UNCERTAINTIES

A model is a numerical representation of physical process and inherently possesses uncertainties that affect the calibration, performance, and results of the model. Integrated hydrologic models are complex models that involve simulation of complex physical systems and interrelationships and require many different types of data, each of which may be available at different temporal and spatial scales. Uncertainties in the performance of an integrated hydrologic model can arise from uncertainties in how the physical processes are conceptualized and formulated, inaccuracies in the underlying data, calibration process and eventually the assumptions used in applications of the model to evaluate projects, including projections of future conditions. The following are additional details on each of these uncertainty categories.

5.2.1 Structural Uncertainties

First set of model uncertainties can arise due to the structural framework of the model, which can include:

Representation of Physical Features - To properly represent natural conditions, the physical and natural features need to be well understood so that they can be conceptualized in a simplified manner for development of theoretical formulations.

Theoretical Concepts and Representation of the Natural and Physical Systems - This type of uncertainty can be attributed to the conceptualization of the physical and natural systems in the form of mathematical functions and formulas that govern the movement of groundwater and surface water systems and the interrelation of these systems. These formulas are typically referred to as governing equations for each of the hydrologic or hydrogeologic features modeled.

Formulation, Code Development, Solution Techniques, and Assumptions - The governing equations are typically so complex that analytical solutions to these equations are either not available or are so simplified that they would add to the inaccuracies in the representation of complex hydrologic systems. Therefore, numerical solutions are employed, including finite element or finite difference techniques, which require their own set of assumptions. Computer software is used to implement the theoretical formulations.

Model Spatial and Temporal Resolution - The governing equations representing the natural and/or physical systems are either solved at two levels:

- **Lumped solution -** At this level, the formulation represents a lumped parameter system, and the solution will be for an aggregated system at the large scale. This aggregated and lumped scale can be both for the spatial and temporal scale of the problem. Lumped level solutions are typically employed in conditions where there is a lack of accurate information or where the system is small enough that further spatial or temporal breakdown of the system is not possible due to lack of data and information.

- **Distributed Solution -** At this level, the system is subdivided in further spatial resolution to take advantage of spatial variability in the data and information that is available at smaller scales. Additionally, the solution to the formulation of the system is also subdivided in smaller temporal scales, such as a monthly or daily time step, so that short-term and long-term variability in the data over time is properly represented in the solution.

5.2.2 Data Uncertainties

This category of uncertainty is related to the data and information that is used and employed in development of a model.

Data and Information Accuracy, Data Gaps, and Estimates - Collection and compilation of data for natural and physical systems, including precipitation, streamflow, land use, cropping patterns, population, water use, crop evapotranspiration, soil conditions, groundwater levels, streamflow, surface water use, groundwater pumping, infrastructure, facilities, and operations all include a certain level of inaccuracy and uncertainty. This uncertainty is exacerbated when data gaps and inconsistencies exist. The methodology used to identify and fill data gaps can introduce levels of uncertainty.

Data Spatial and Temporal Resolution - In addition to the above, the spatial and temporal resolution of data may contain inaccuracies and uncertainties that would affect the data that are used in the model.

5.2.3 Calibration Uncertainties

Estimates of Hydrologic and Hydrogeologic Parameters - Often, data and/or information for specific parameters that are used to represent the governing equations in the model may not be available. In these circumstances, the modeler uses professional judgement, or adopts conditions from similar areas, which may introduce uncertainties and inaccuracies in model simulations.

Calibration Approach, Target Characteristics, and Accuracy - Model calibration requires certain quality, consistency, and care, so that the model properly represents the natural and physical conditions observed in the field. In addition to the quality and uncertainties in data and methodologies, the approach employed, tools and techniques used, and experience and expertise of the model developer affects the quality of model calibration and accuracy of the results. Often, the calibration targets are prone to uncertainty or lack of information. For example, information on the depth of the screened interval, as well as pumping rate and depth at the well, whether the recorded groundwater level reflects static or pumping conditions, and whether a well is under the influence from other nearby wells or a nearby stream can have significant bearing on the approach and quality of the calibration.

5.2.4 Application Uncertainties

Assumptions and Project Applications, Including Data Projections and Forecasting Methods - It is imperative that model application be defined and considered in such a way that is supported by model calibration. Assumptions on a model application to analyze a particular project can often be generalized with little knowledge of the conditions. For example, significant uncertainties exist with respect to the following data, which can affect the quality and results of the model output for planning and policy making:

- Hydrologic conditions and rainfall patterns
- Land use and cropping patterns
- Population and water use
- Water supply conditions
- Climate change conditions

While modeling uncertainties need to be considered in use and application of models for evaluation of project conditions for potential impacts, benefits, and design of plans and facilities, the model should be considered a reasonably robust tool to support the major decisions, including GSPs, projects and management actions, and sustainability analysis.

6. SUMMARY & RECOMMENDATIONS

The Modesto Model is an integrated hydrologic model, which simulates land surface processes, groundwater flow, streamflow, and the interaction between these systems. The model includes a historical, hydrologic period of WY 1991-2015. The model, adapted from the DWR's C2VSimFG, has been refined to reflect local data, information, and conditions, and has been calibrated extensively to the local reported groundwater and streamflow conditions, making it an effective numerical analysis tool to evaluate the integrated groundwater and surface water system, including the water budgets and other groundwater sustainability criteria in the Modesto Subbasin.

Model results provide detailed water budgets that provide information on monthly and annual changes in agricultural and urban land use, surface water use and distribution, and groundwater pumping. Additionally, the model provides a robust analysis tool to evaluate the impacts of actions on the Modesto Subbasin's hydrologic system, including changes to the groundwater levels and trends and estimates of changes in groundwater storage. The results from the Modesto Model are used to better understand the Subbasin's hydrologic and hydrogeologic system and evaluate action that would result in groundwater sustainability under SGMA.

6.1 RECOMMENDATIONS

The Modesto Model, in its current state, is a defensible and well-established model for use in assessment of the water resources within the Modesto Subbasin under historical and projected conditions. However, development of the model and its application to the Modesto GSP have highlighted areas for additional study. Based on these findings, the following recommendations are to be considered for further refinement and enhancement of the Model:

Boundary Flow: The current boundary flows between the Modesto Subbasin and neighboring groundwater basins are dependent on a combination of the C2VSimFG calibration and limited groundwater data in the adjoining subbasins. It is recommended that the Subbasin continues to work with DWR along with the Eastern San Joaquin and Delta-Mendota Subbasins to further refine and verify the groundwater flows across these boundaries.

Stream-Aquifer Interaction: Sustainability conditions in the Modesto Subbasin rely heavily on the surface water systems of the Stanislaus, Tuolumne, and San Joaquin Rivers. These are critical features outlined in the GSP and it is recommended that future updates to the model include additional study and refinement along these water bodies. Such refinement could potentially include the evaluation of near-stream groundwater conditions, more detailed rating tables (particularly under low-flow conditions), and stream-bed parameters.

Inclusion of Local Creeks: Recharge and runoff of local tributaries are currently simulated through a combination of the small watershed and root-zone packages and their implementation of the TR-55 Curve Number Method. To support the projects outlined in the Modesto Subbasin GSP (e.g. Dry Creek Flood Mitigation, In-lieu and Direct Recharge Project) and to better quantify their natural contributions to the aquifer system, it may be beneficial to dynamically simulate these surface water features using the stream-package in IWFM. Inclusion of the local creeks would more accurately simulate recharge from these watersheds and courses. However, this requires a much higher resolution of the model grid, both spatially and vertically. This can be considered at a time that the GSAs would like to consider overhauling the model for future applications.

Update of Monitoring Network: As part of GSP development, the Modesto Subbasin developed a representative monitoring to evaluate conditions throughout the region and have adopted a Management Action to evaluate and improve the current wells available. It is recommended that the Modesto Model be regularly updated with any additional data. The collection and integration of supplementary observations will support future refinement of the model and understanding of simulated conditions.

Data Gaps (Non-District Areas): To improve the representation of conditions throughout the subbasin, it is recommended that additional data be collected relating to geologic, hydrogeologic, and land surface operations. Model calibration should be improved upon collection of additional water use and groundwater level data from the representative monitoring wells throughout the eastern sections of the Subbasin.

Model update schedule: To keep the Modesto Model up-to-date and current for analysis of water resources and especially for supporting SGMA implementation, it is recommended that the model hydrology, land, and water use data be updated and used for preparation of the GSP Annual Reports on an annual basis. It is further recommended that the model be updated for other major data sets, as well as enhanced for additional features every 5 years. This 5-year update would include an update of the model calibration and would be developed for use in the 5-year GSP update.

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MAPS

Figure M1: Locations of Modesto and Turlock Subbasins within C2VSimFG

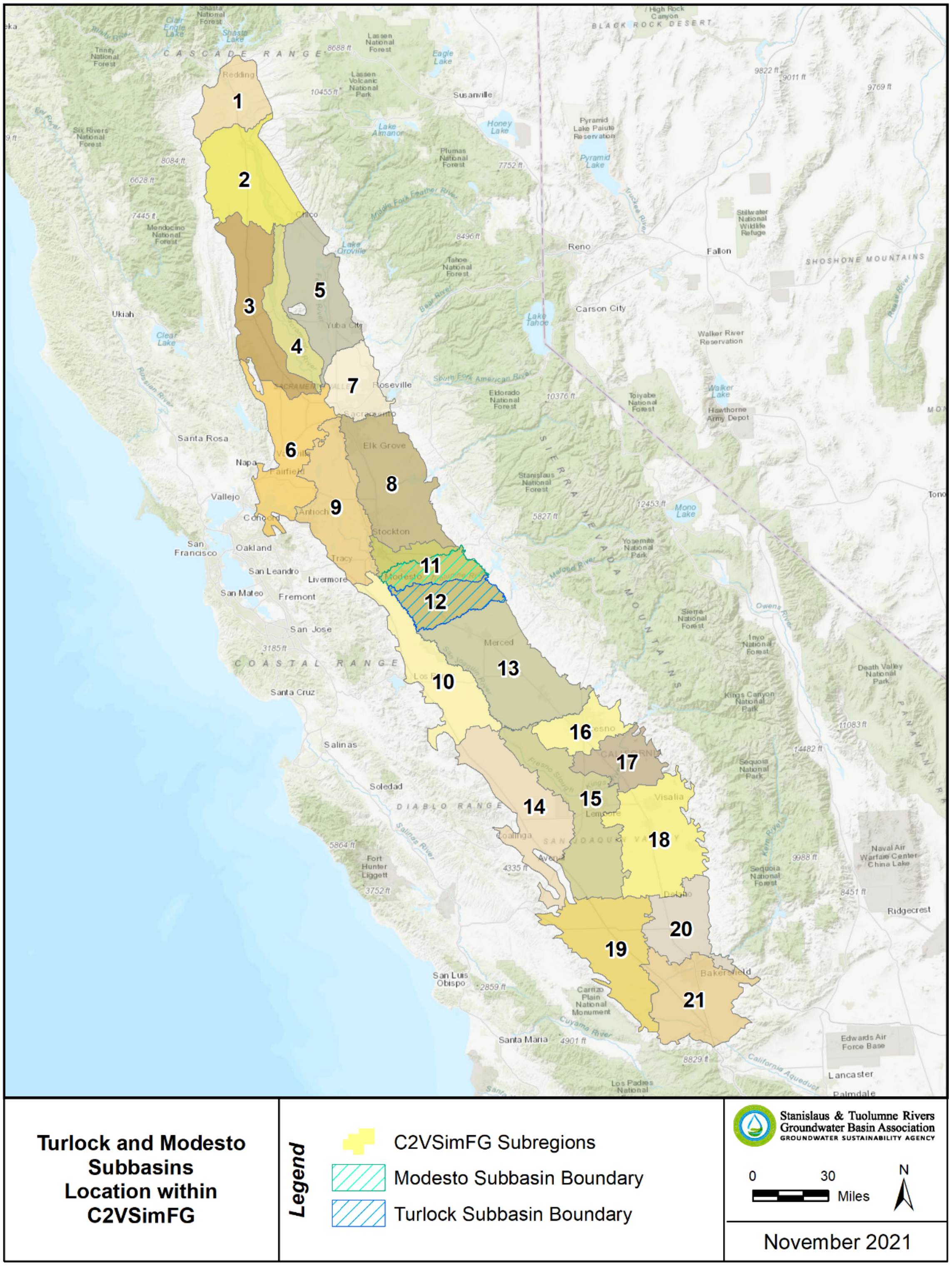


Figure M2: Modesto Subbasin

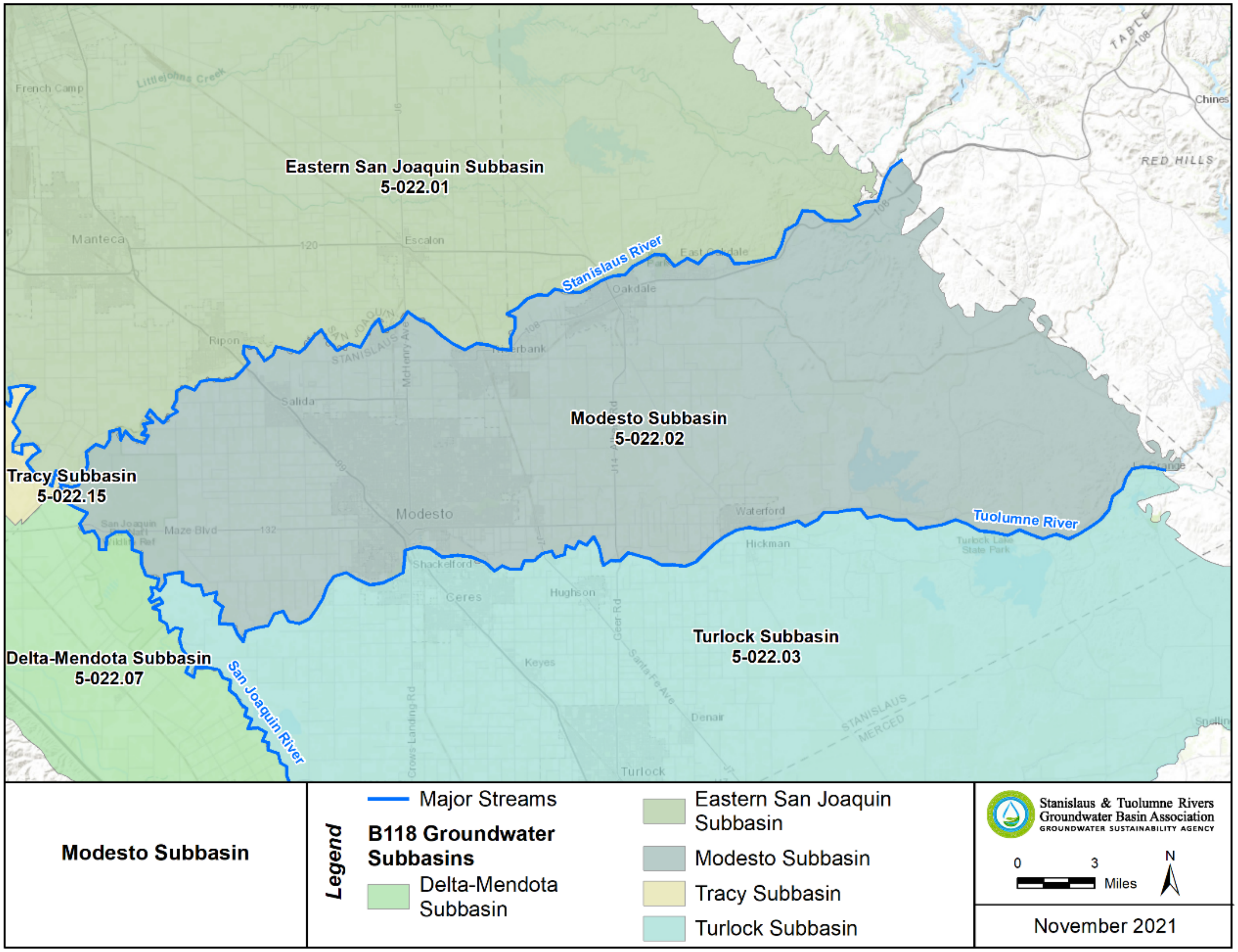


Figure M3: Modesto Subbasin Water Agencies

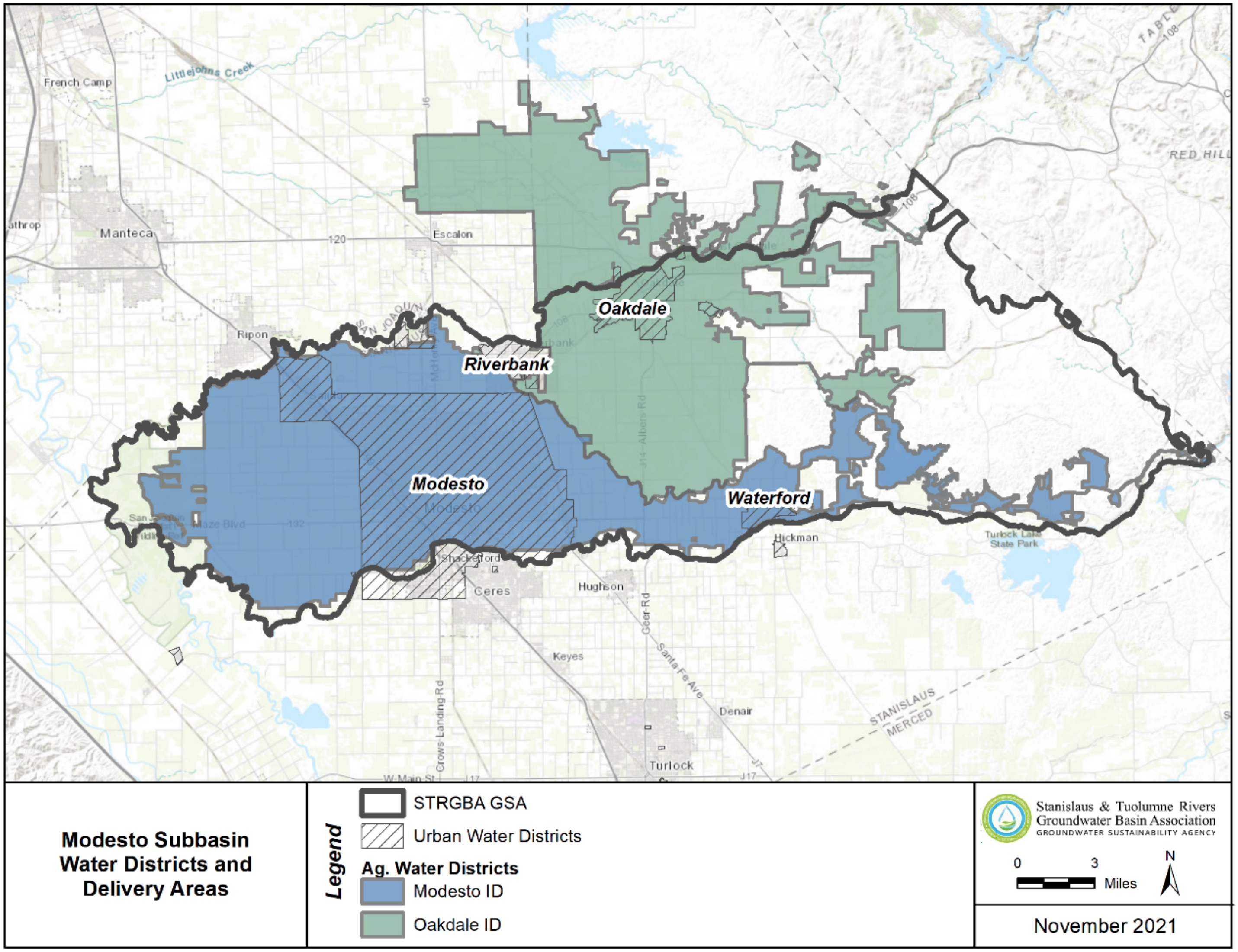


Figure M4: Modesto Subbasin Simulated Small Watersheds

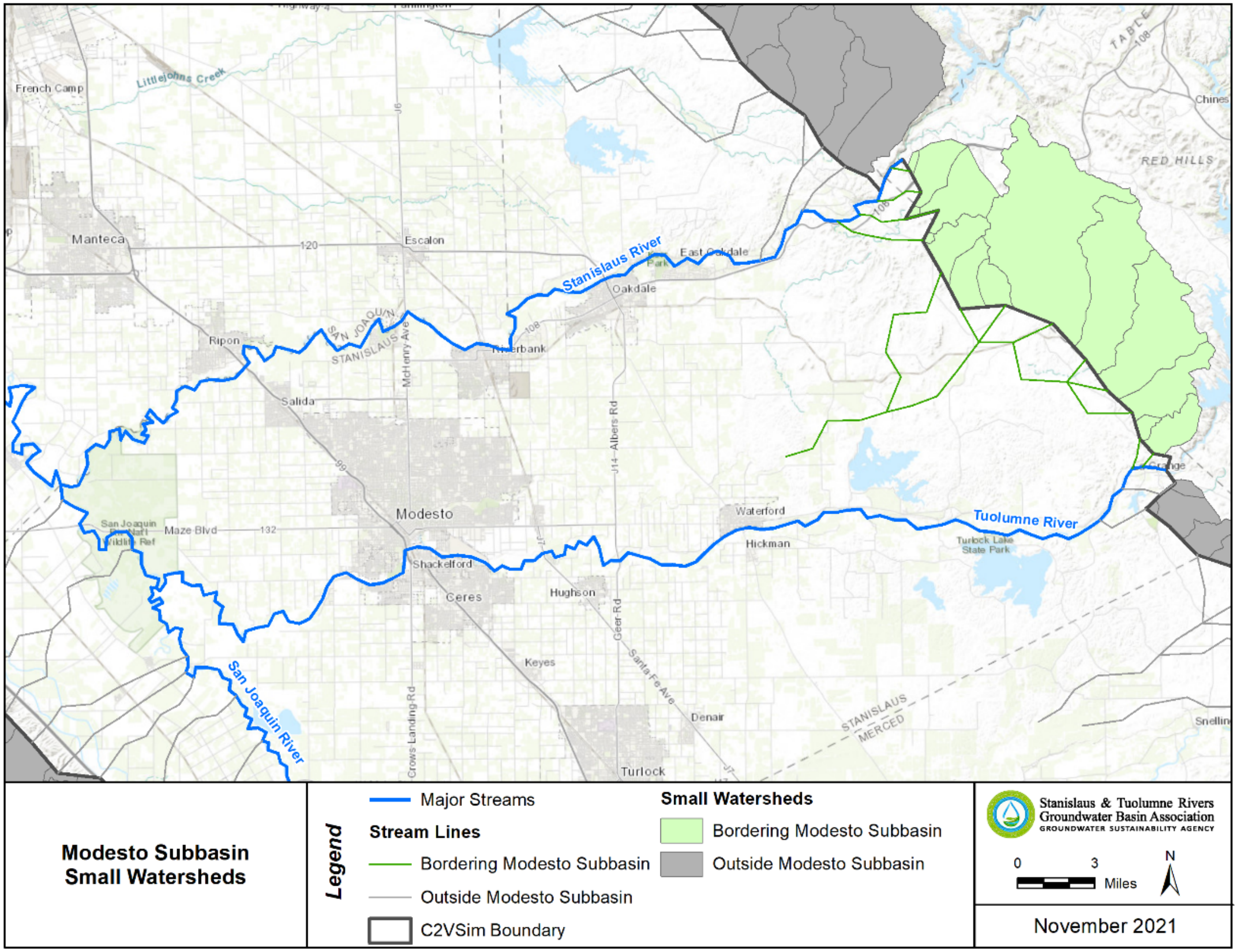


Figure M5: Modesto Subbasin Average Annual Precipitation

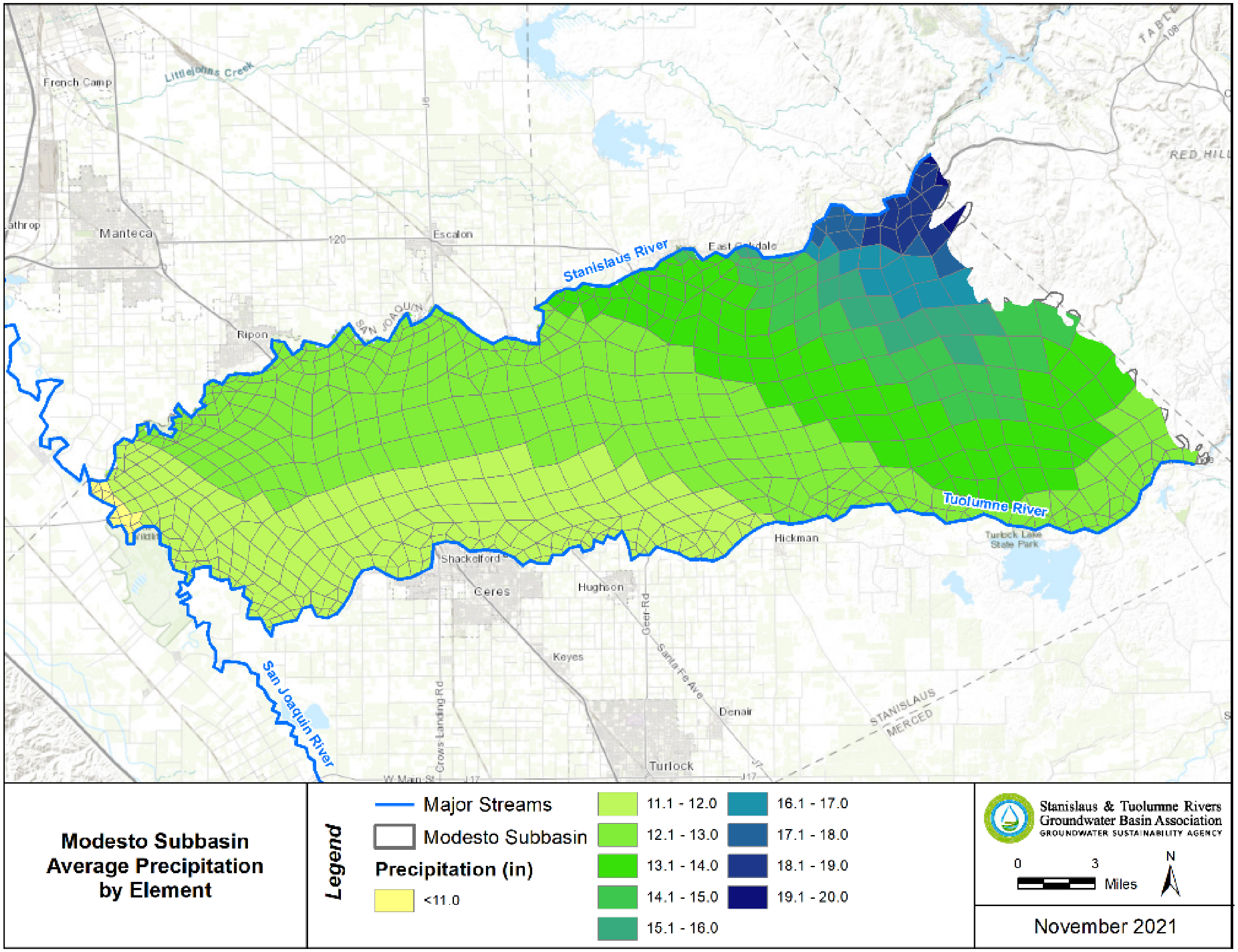


Figure M6: Modesto Subbasin Land Use, LandIQ 2014

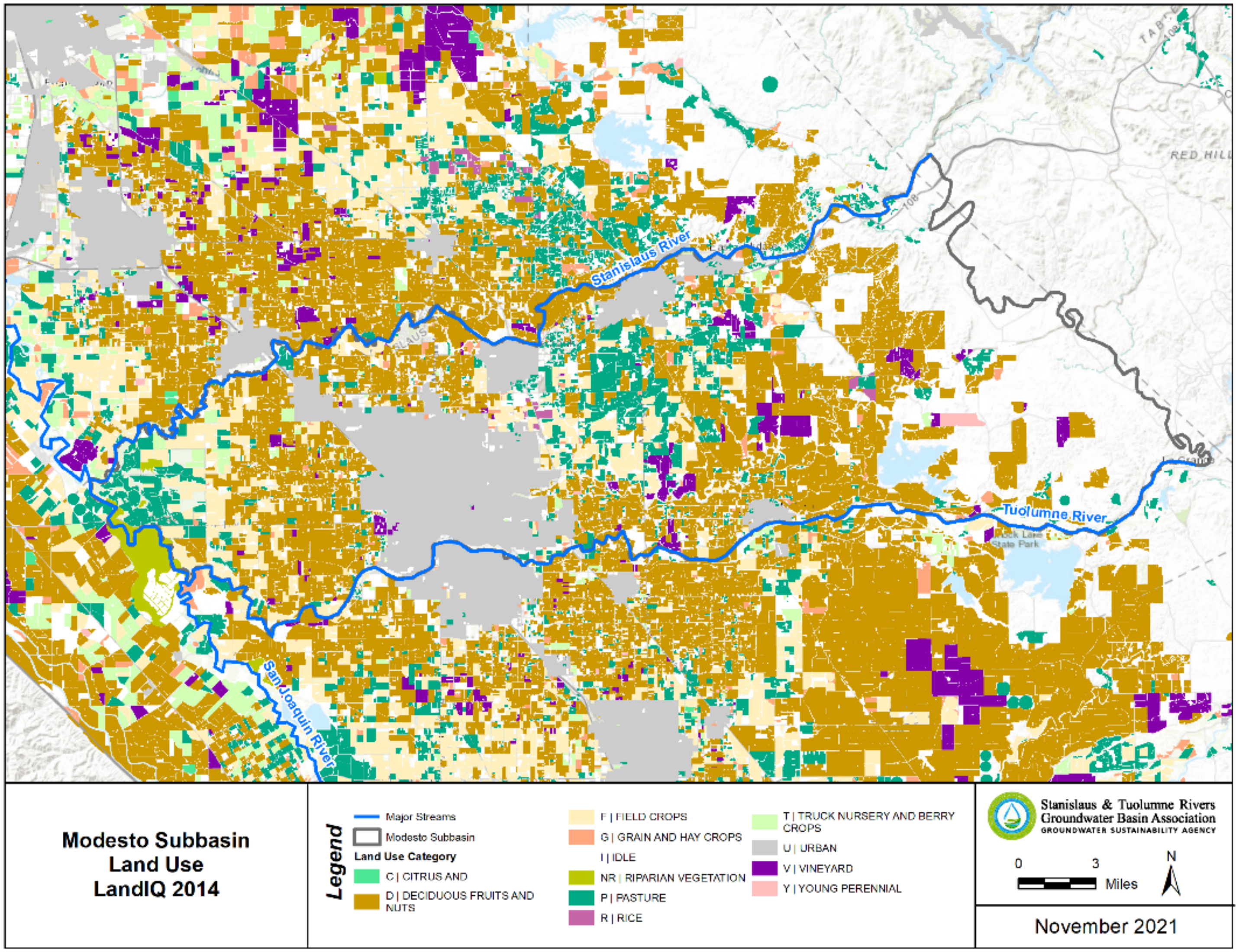


Figure M7: USDA Soil Hydrologic Groups

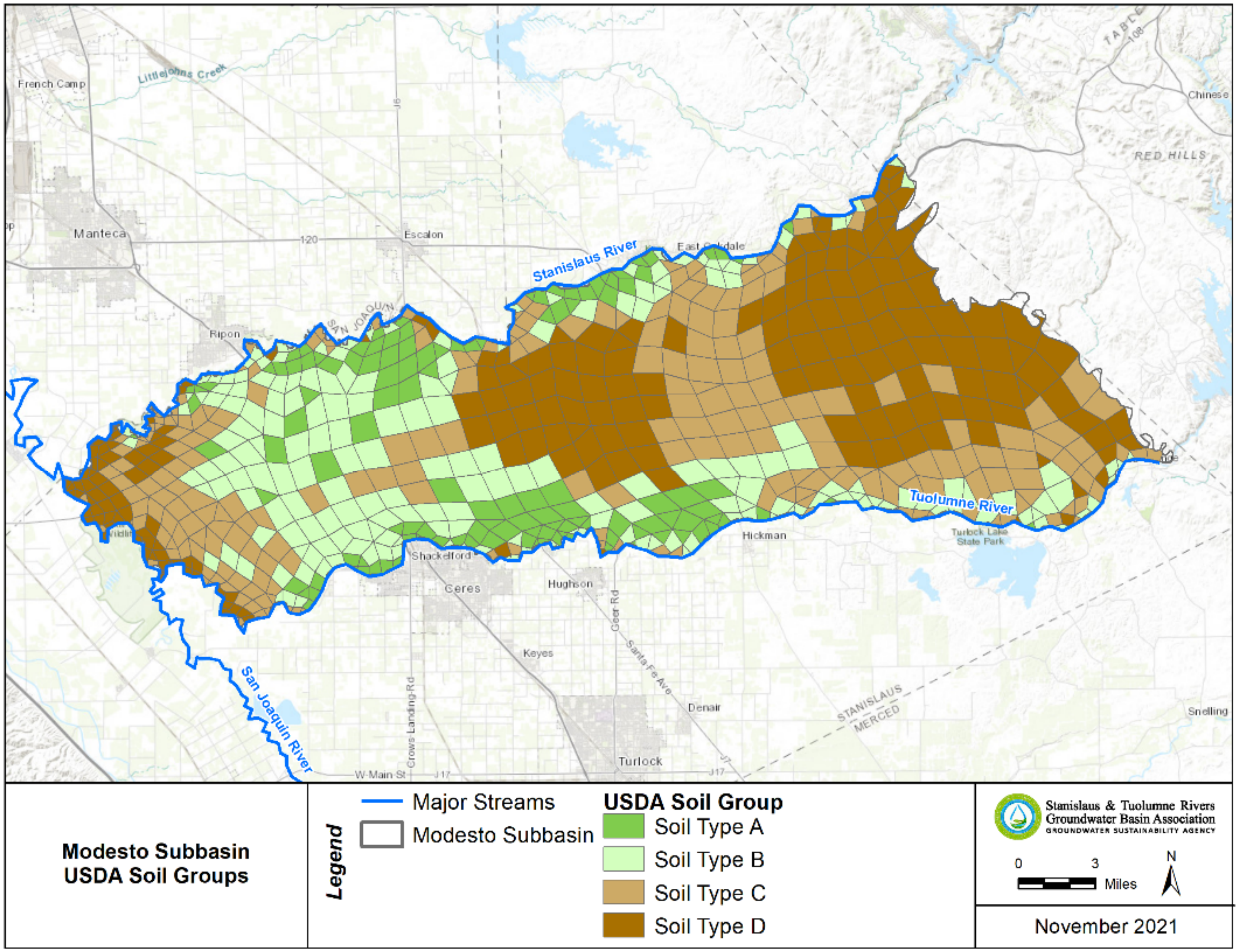


Figure M8: Modesto Model Urban Demand Areas

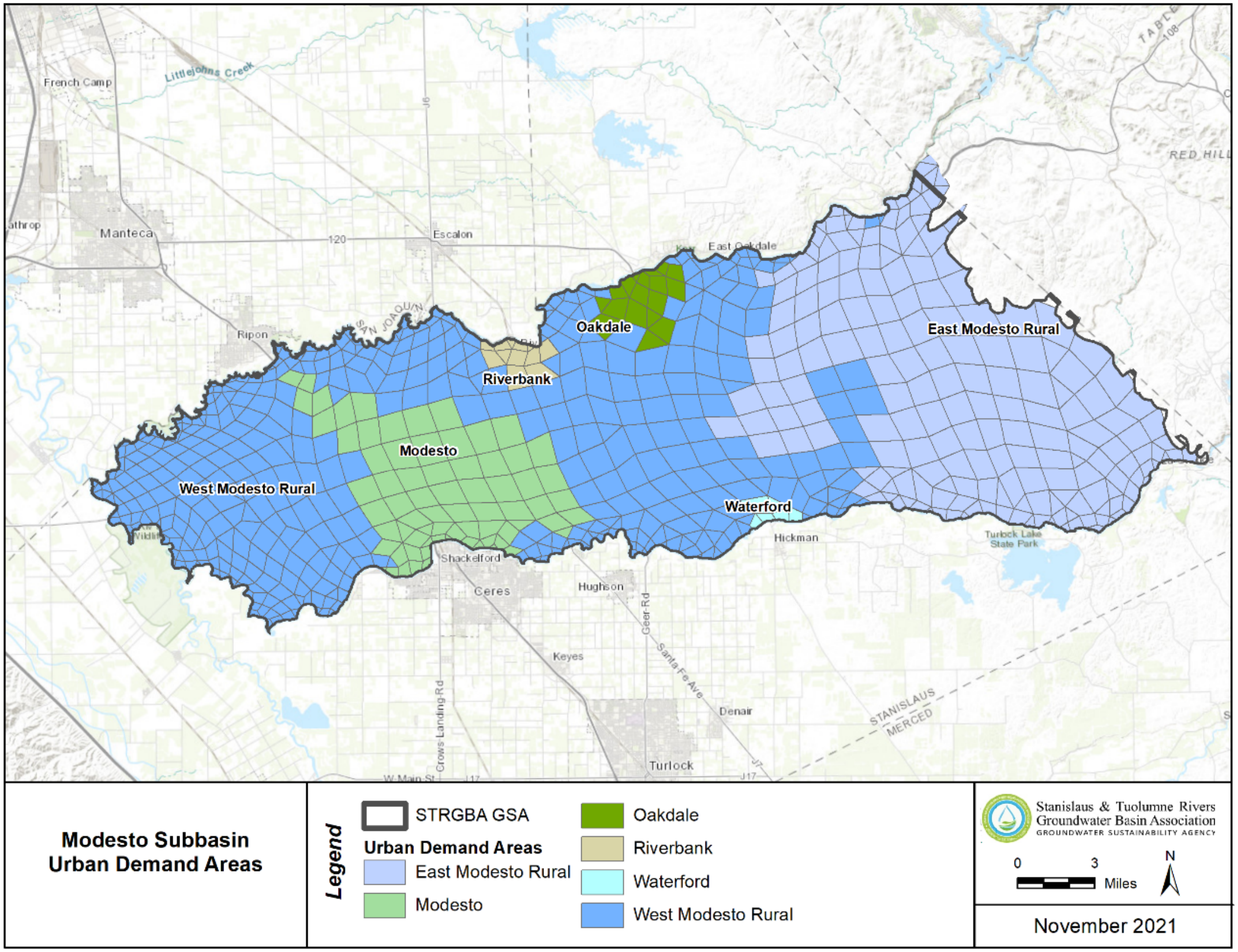


Figure M9: Modesto Model Stream Nodes and Reaches

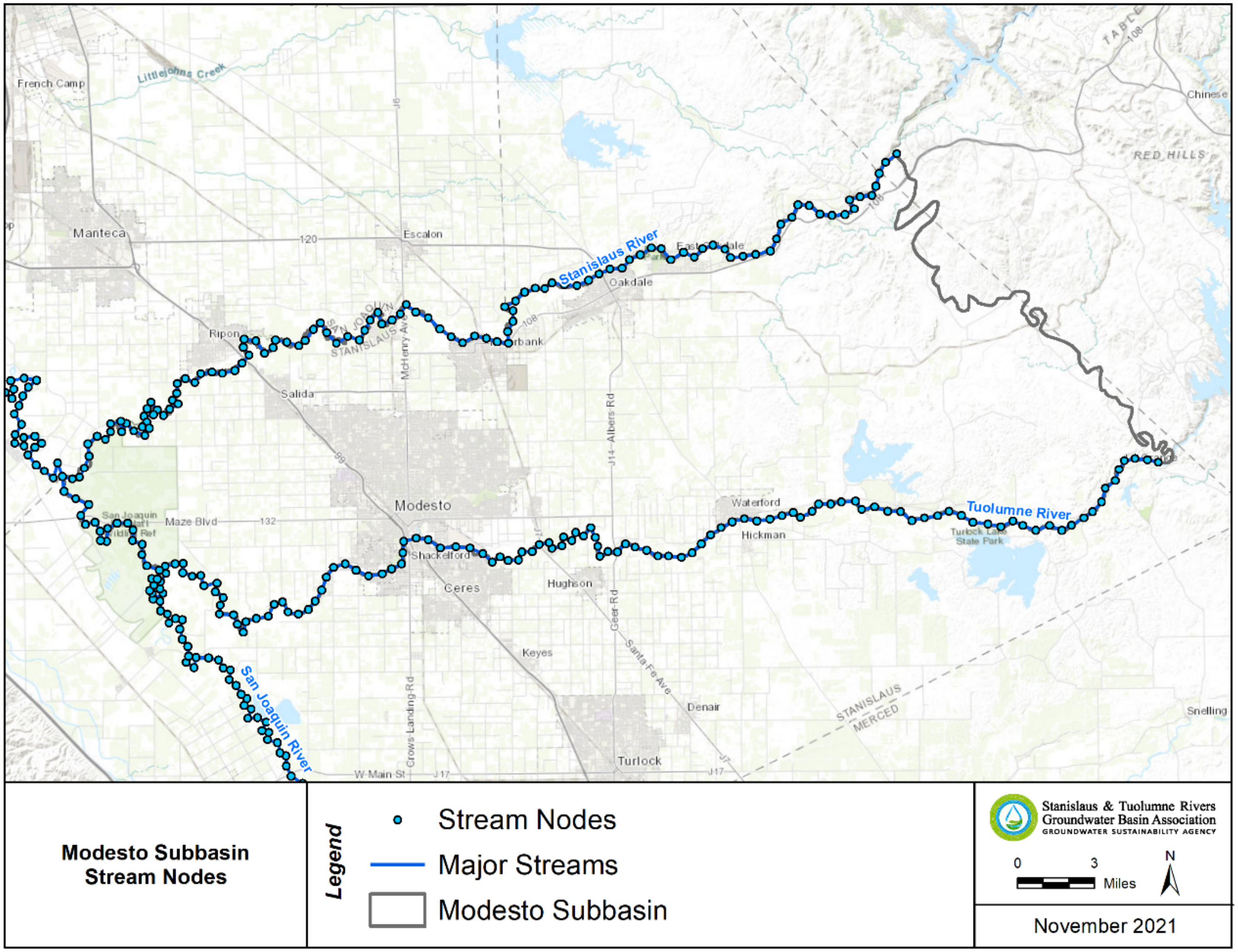


Figure M10: Modesto Model Surface Water Delivery Areas

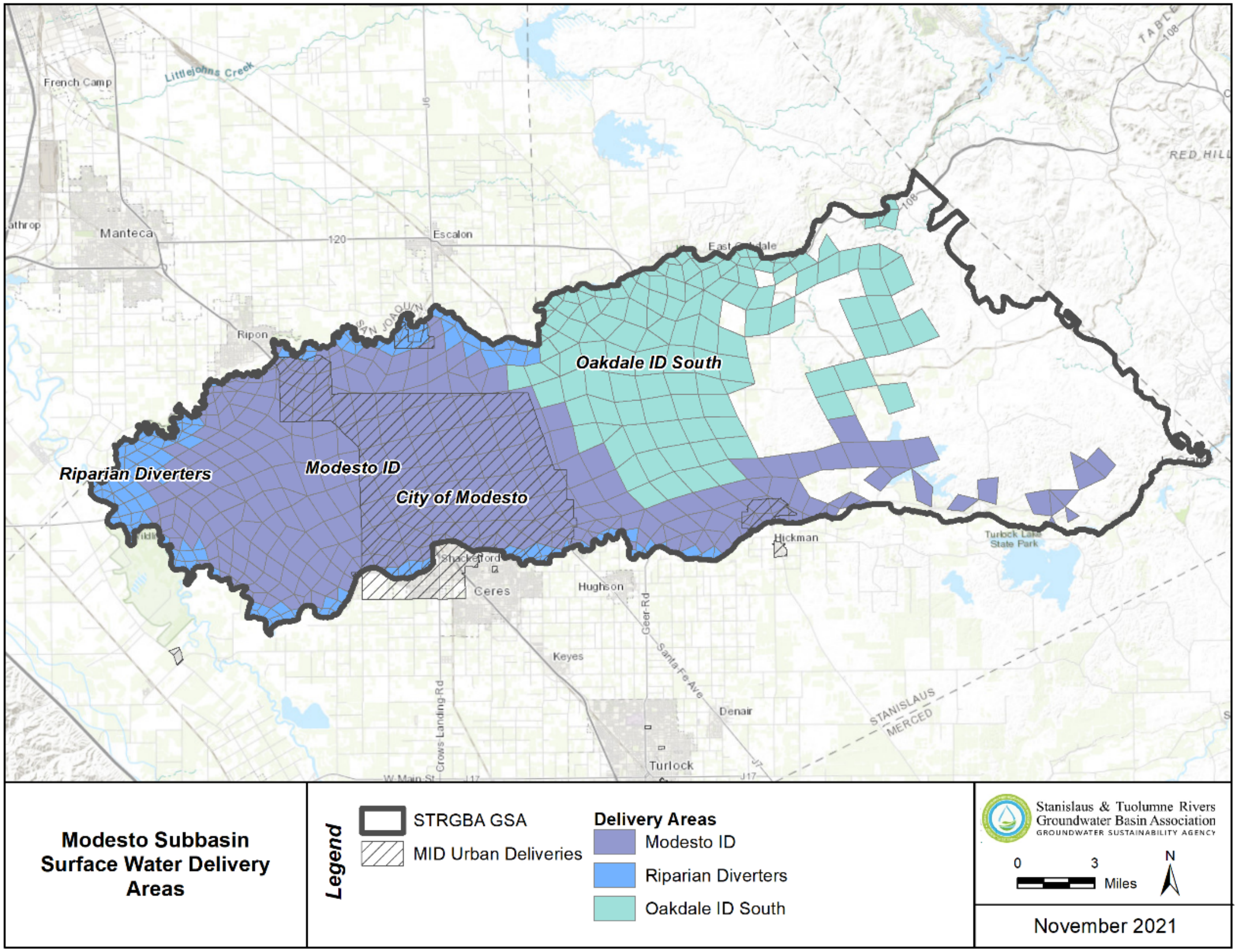


Figure M11. Stream Gauges location in the Modesto Model.

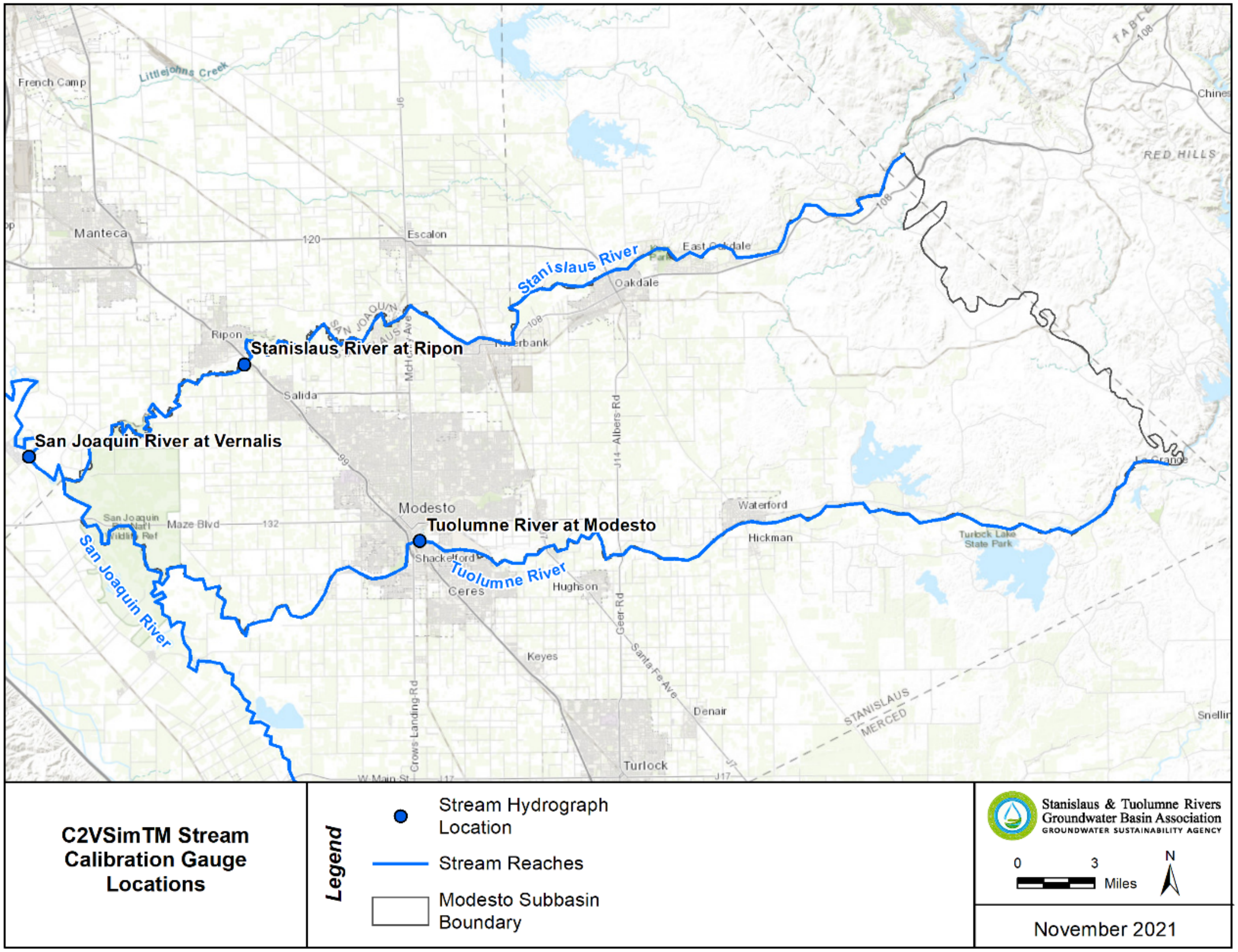


Figure M12: Modesto Model Agency Production Wells

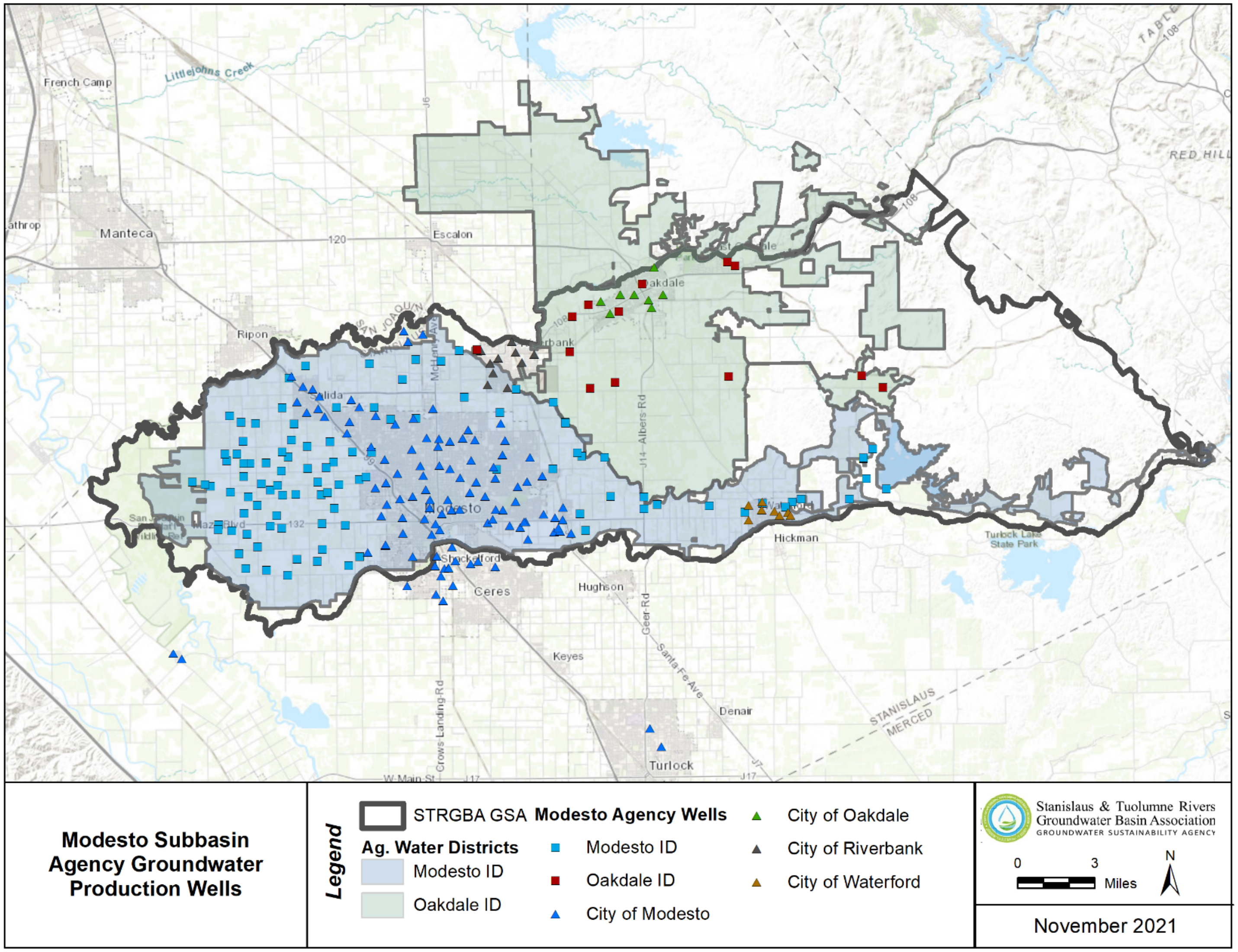


Figure M13: Modesto Model Monitoring Wells

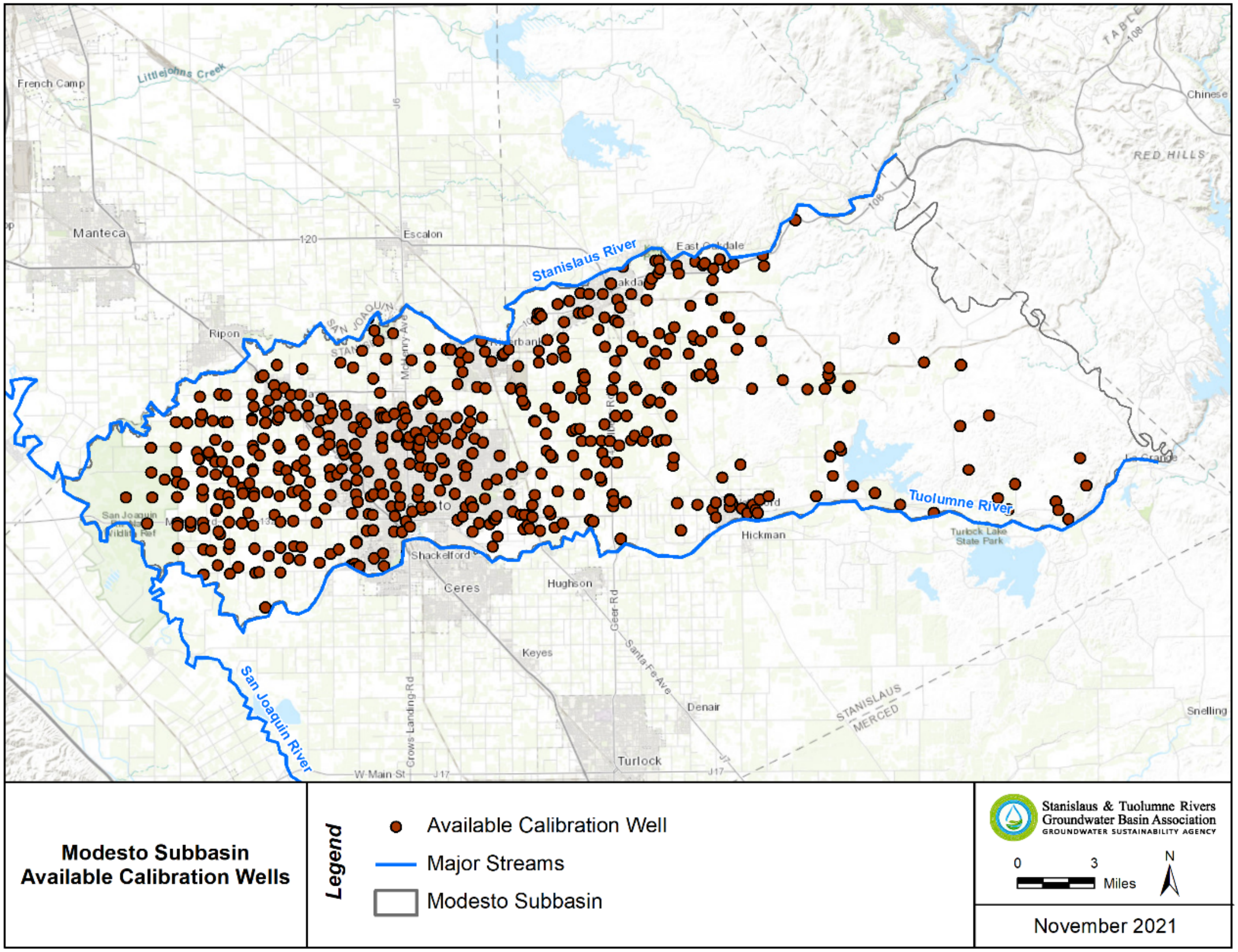


Figure M14: Modesto Model Calibration Wells

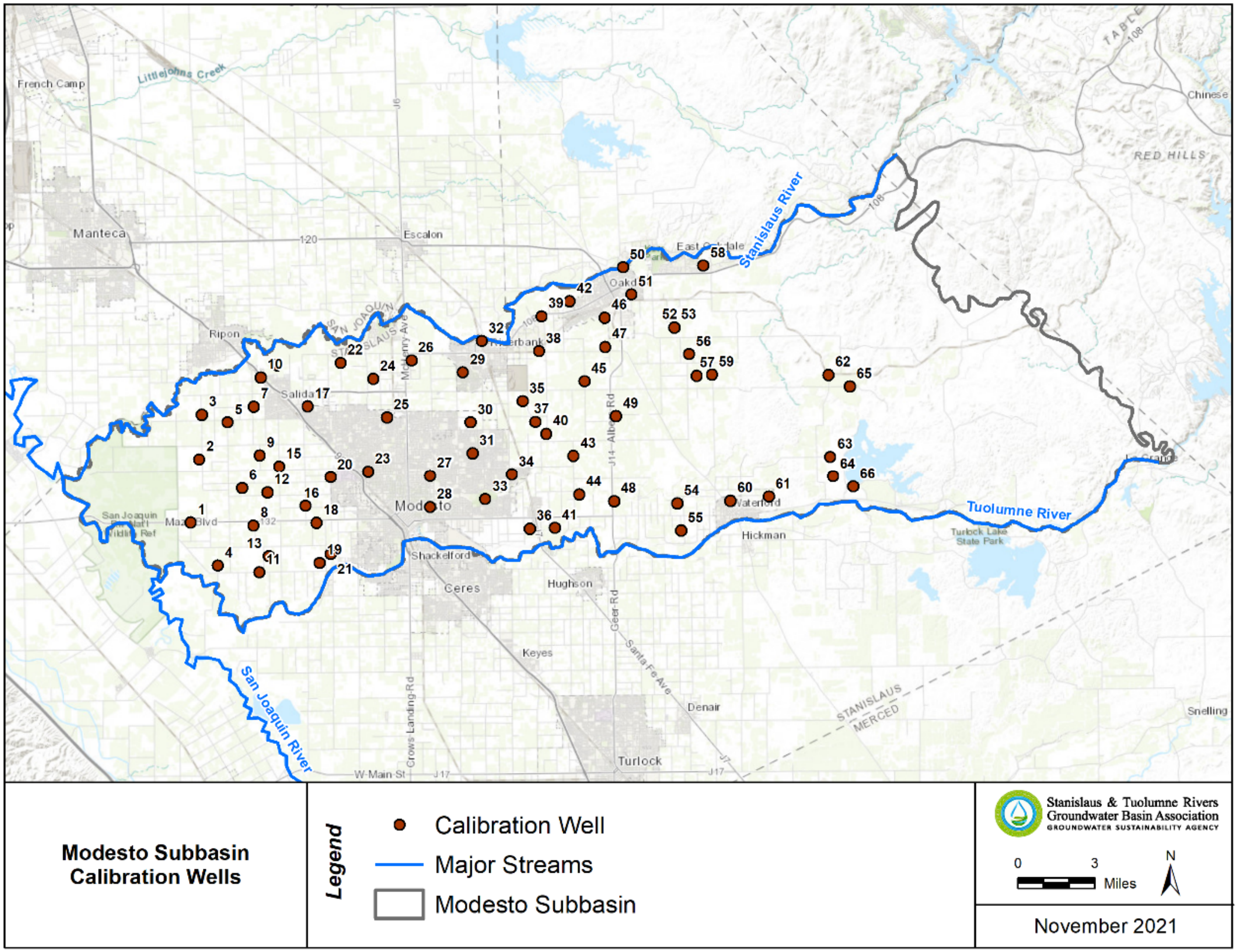


Figure M15: Initial Groundwater Heads for Layer 1

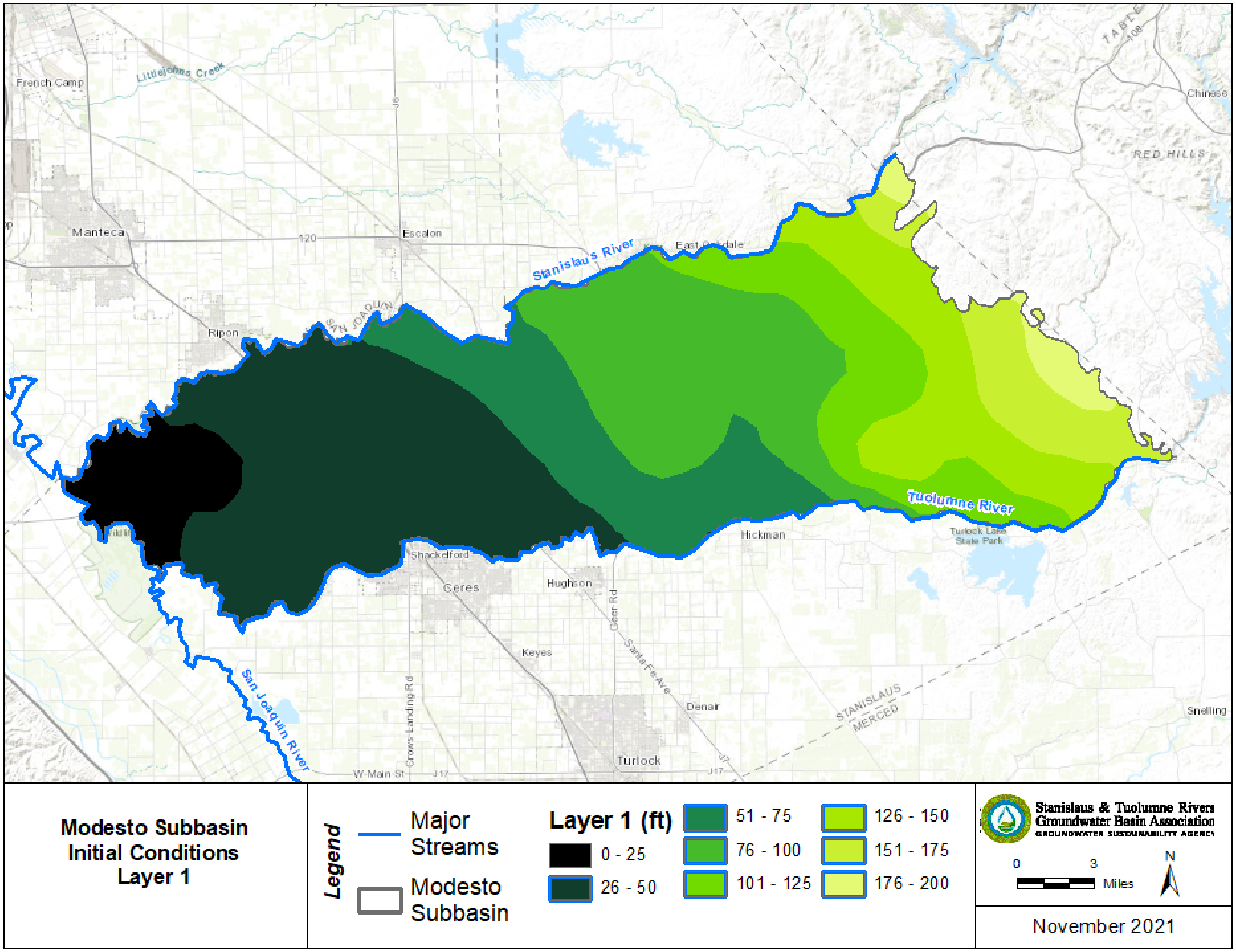


Figure M16: Initial Groundwater Heads for Layer 2

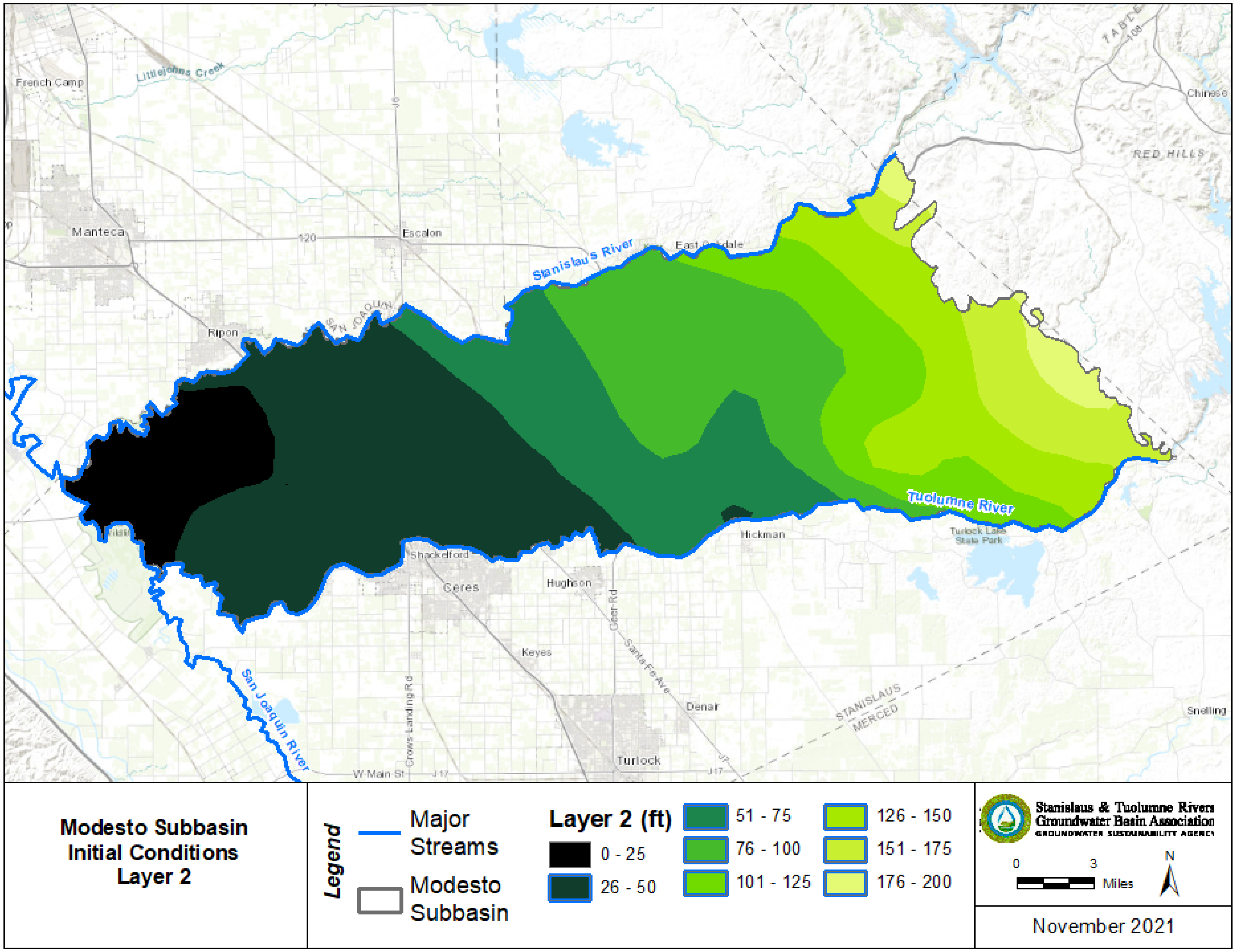


Figure M17: Initial Groundwater Heads for Layer 3

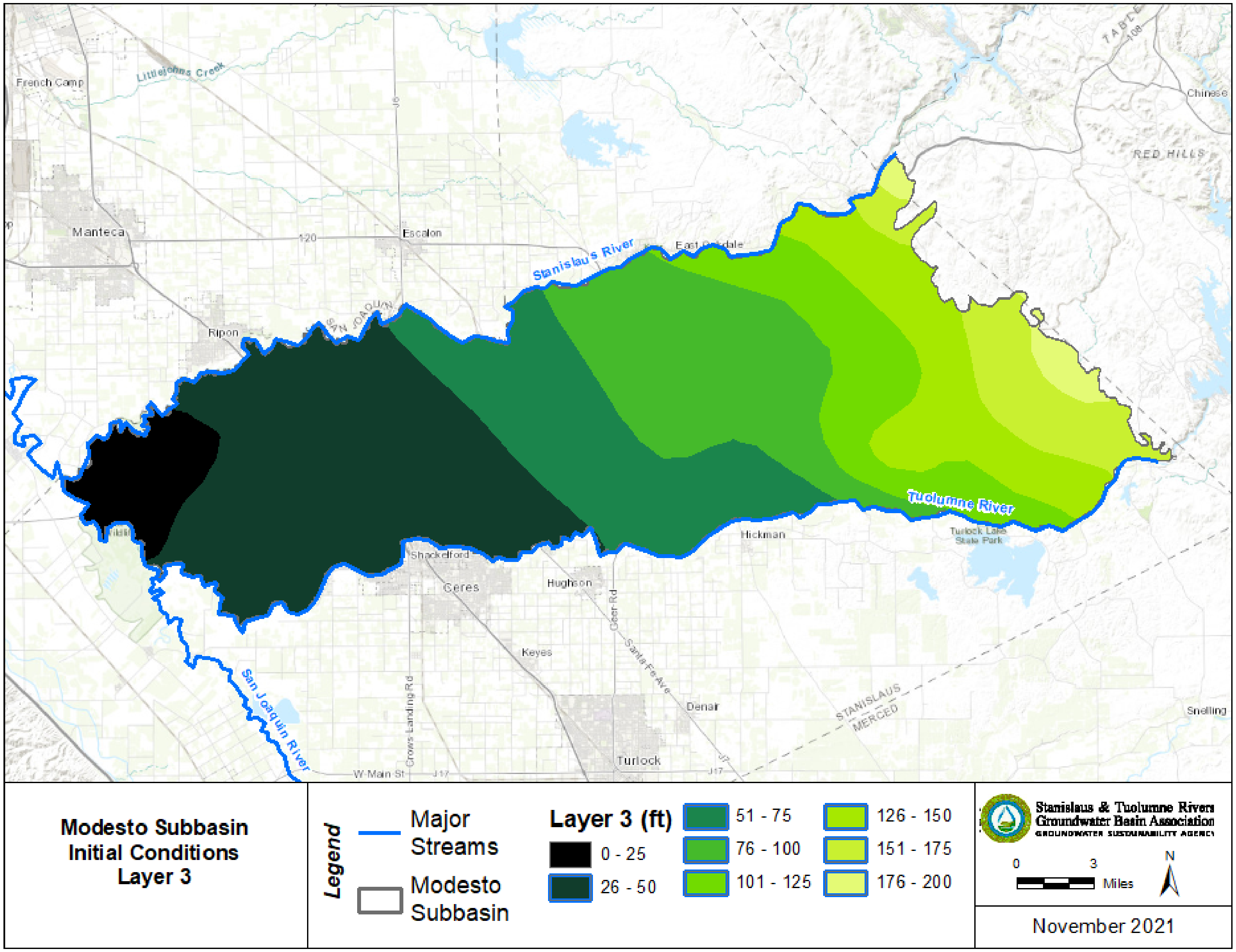


Figure M18: Initial Groundwater Heads for Layer 4

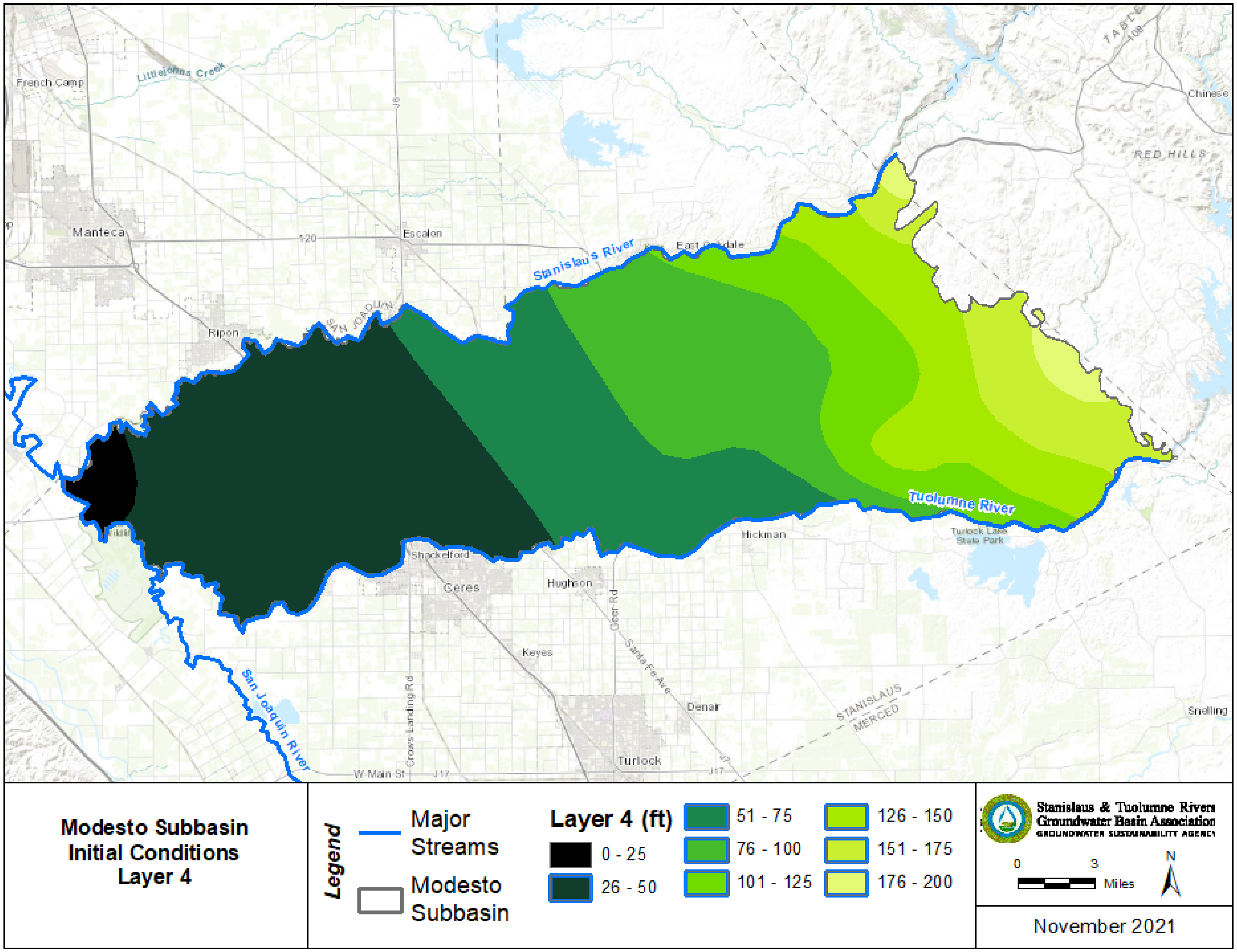


Figure M19: Modesto Model Boundary Conditions

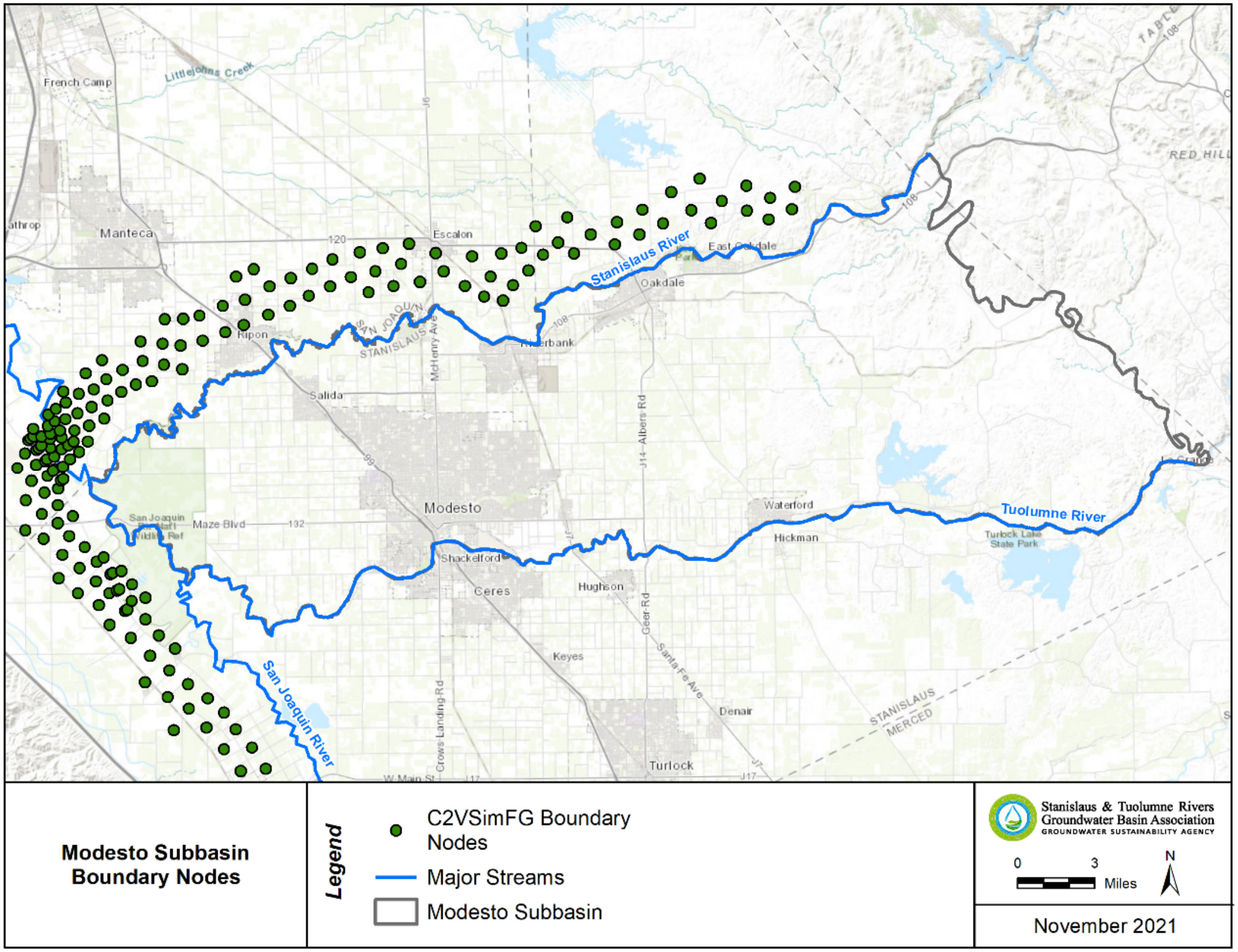


Figure M20: Modesto Model Parametric Grid

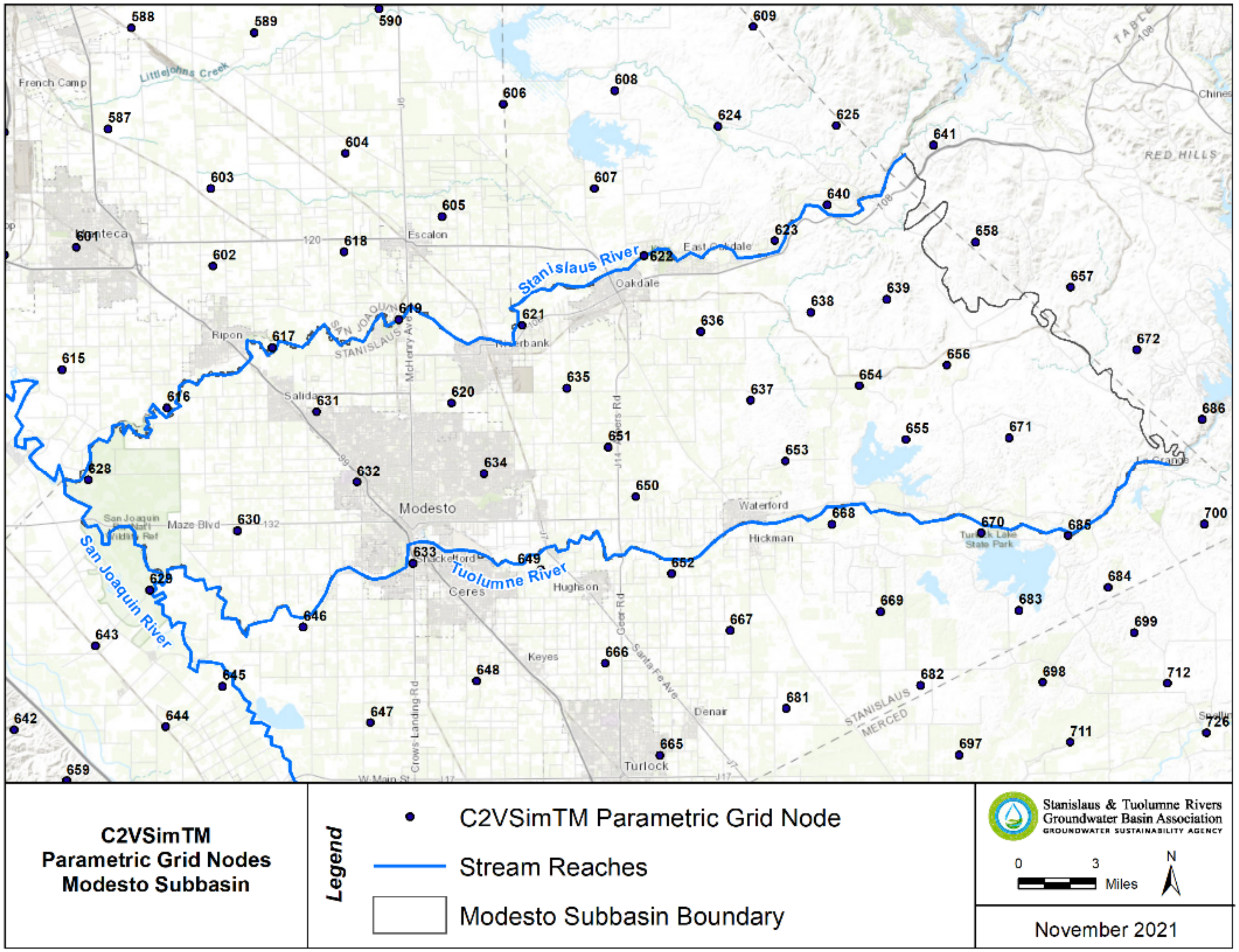


Figure M21: Modesto Subbasin Water Budget Areas

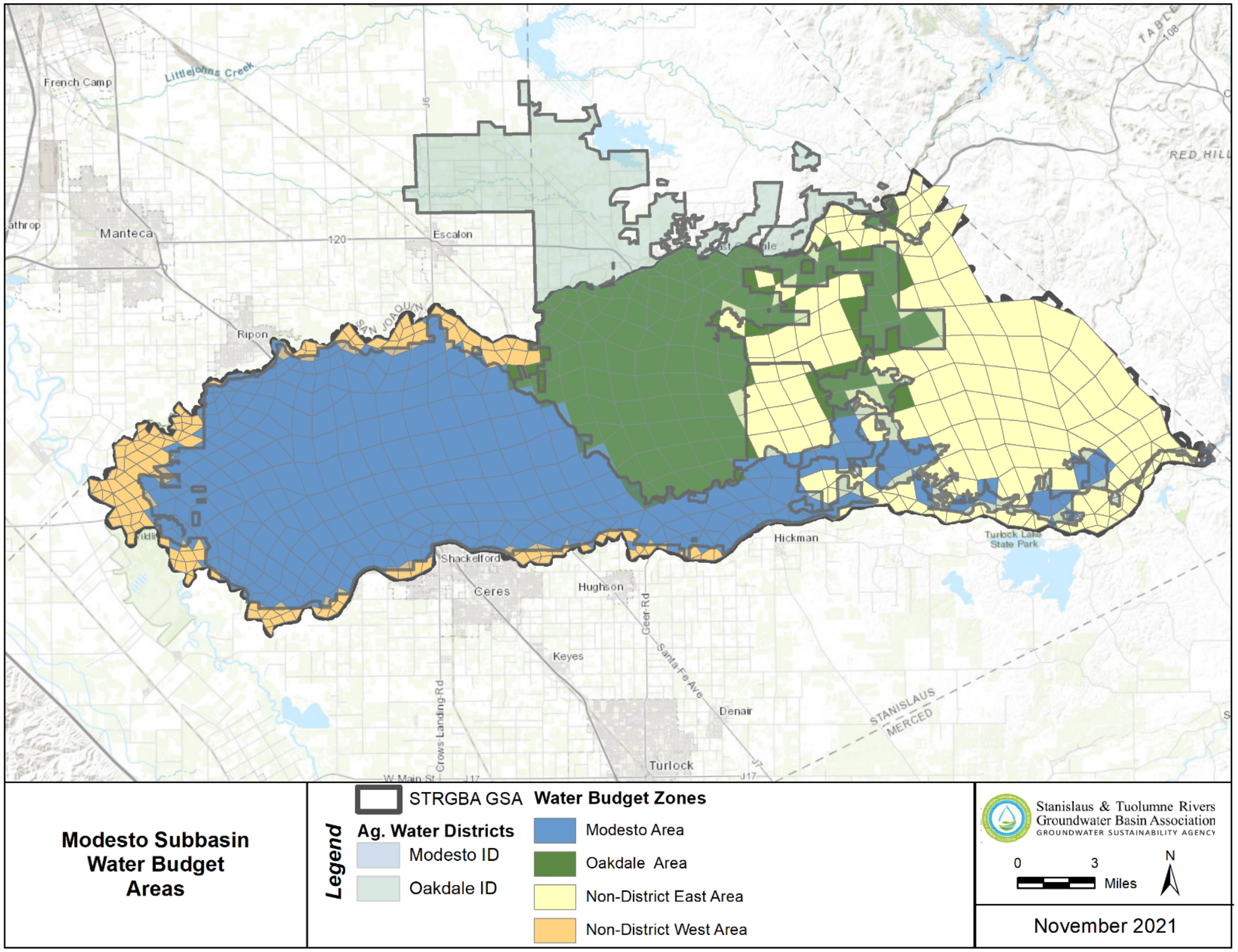


Figure M22:Modesto Model Parameters: Soil Field Capacity

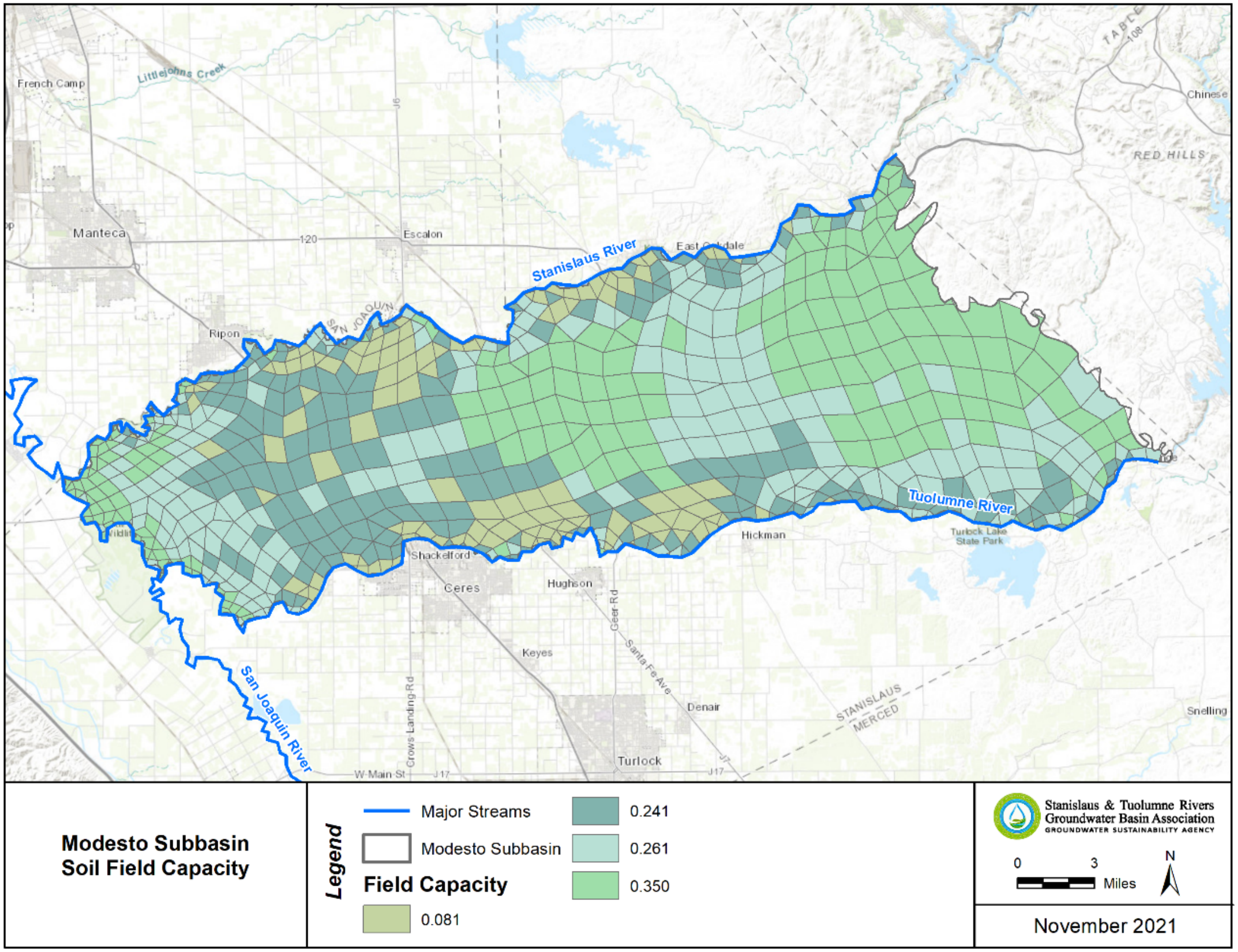


Figure M23:Modesto Model Parameters: Soil Wilting Point

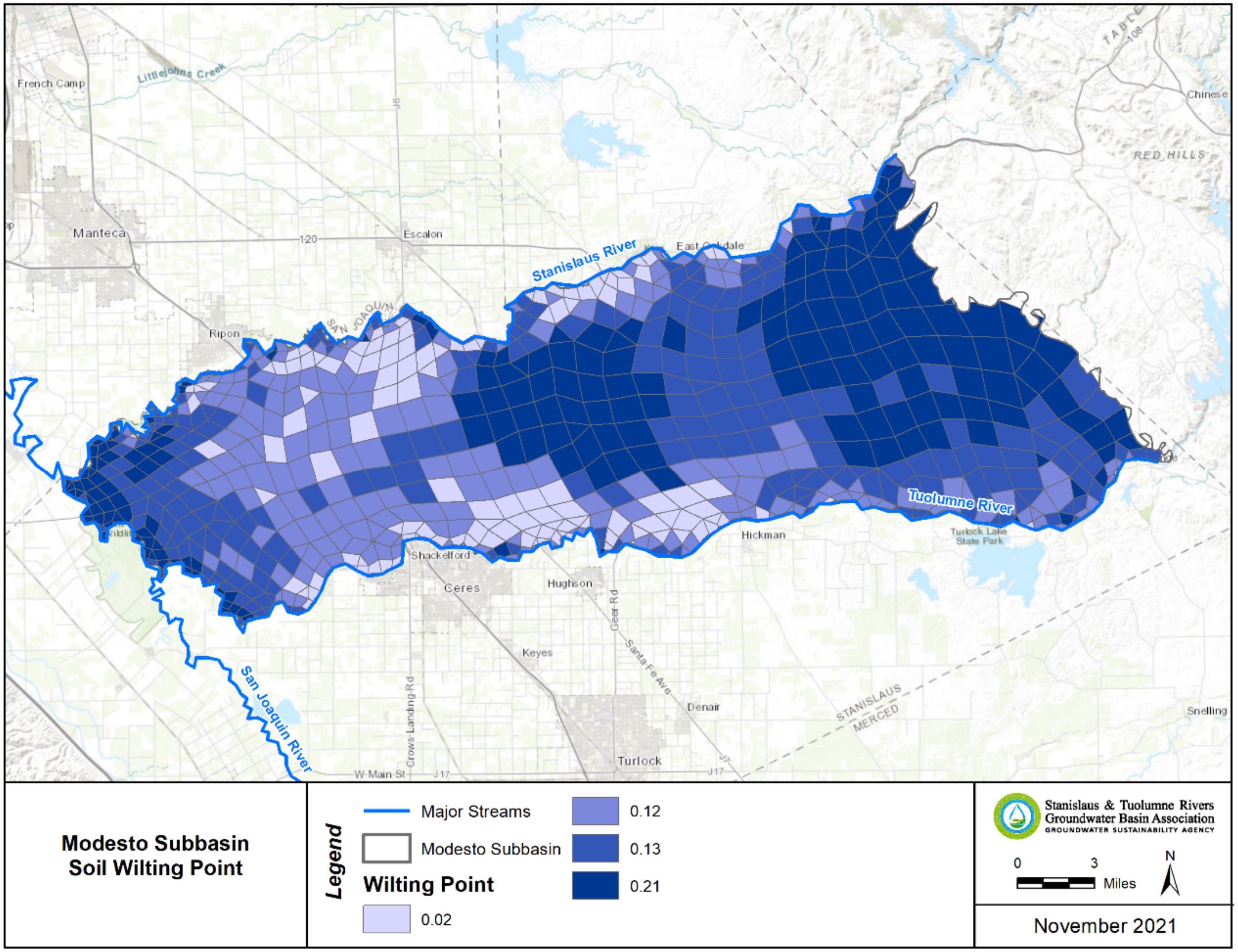


Figure M24:Modesto Model Parameters: Soil Hydraulic Conductivity

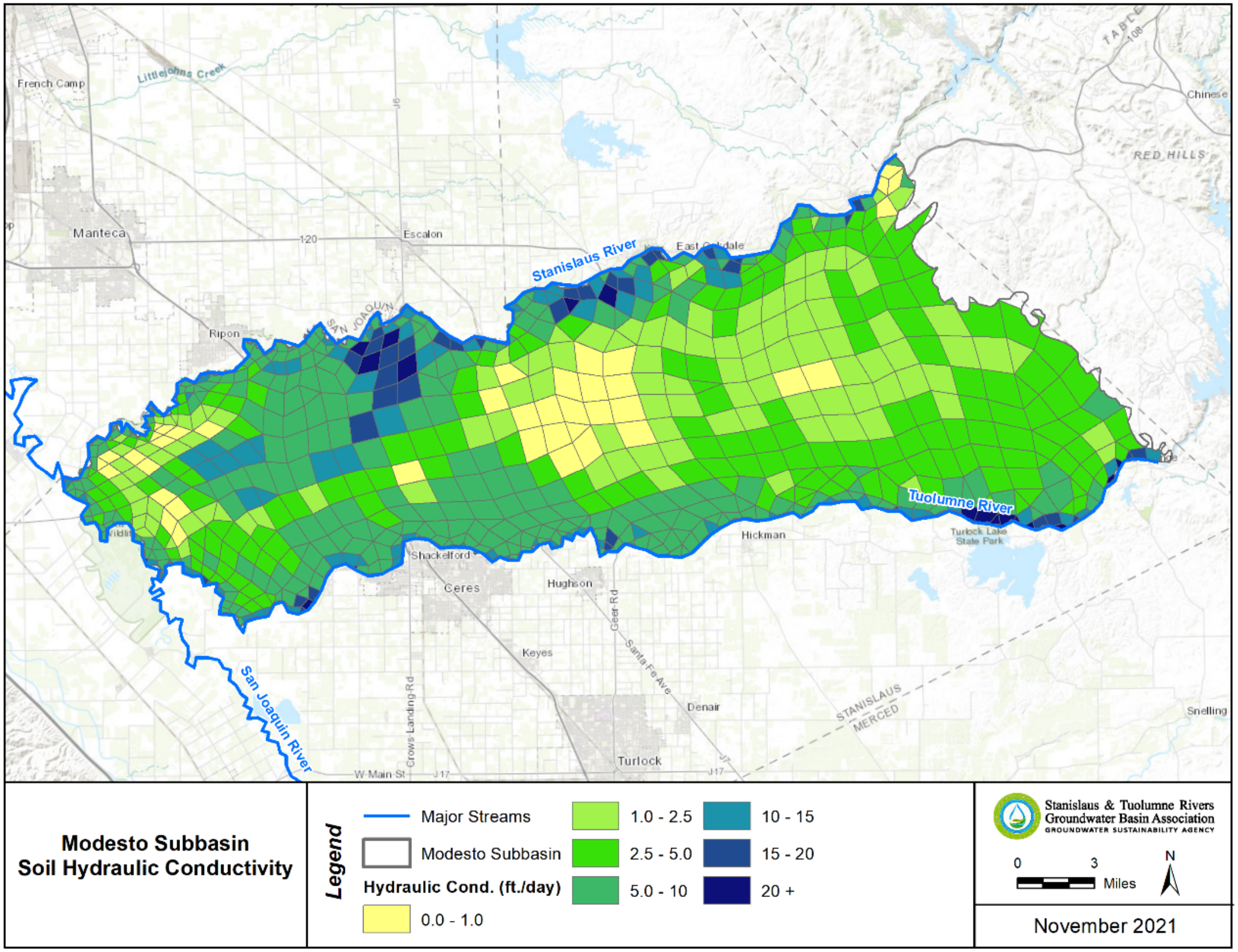


Figure M25:Modesto Model Parameters: Soil Porosity

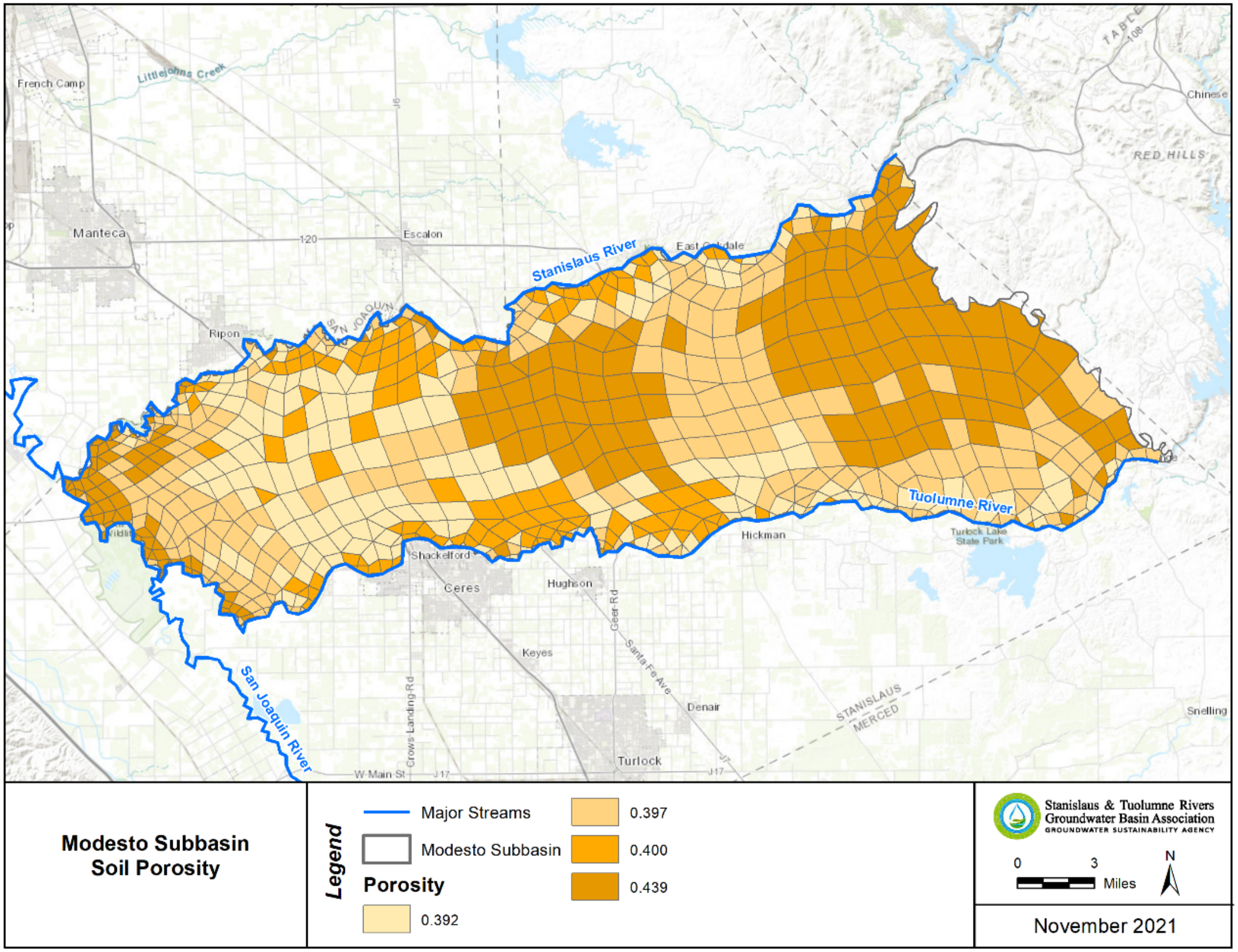


Figure M26. Groundwater Level Contours Layer 1 September 2015

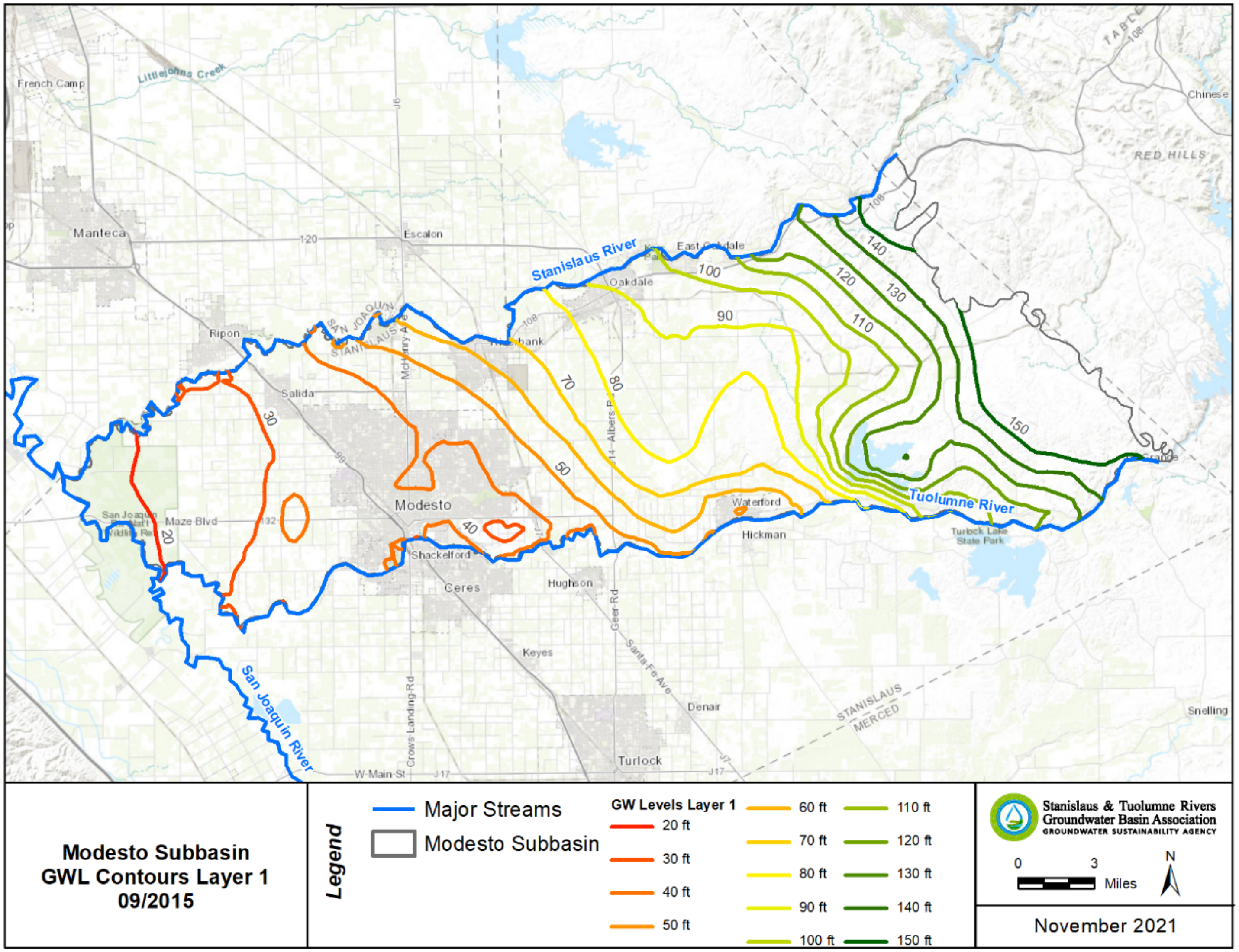


Figure M27. Groundwater Level Contours Layer 2 September 2015

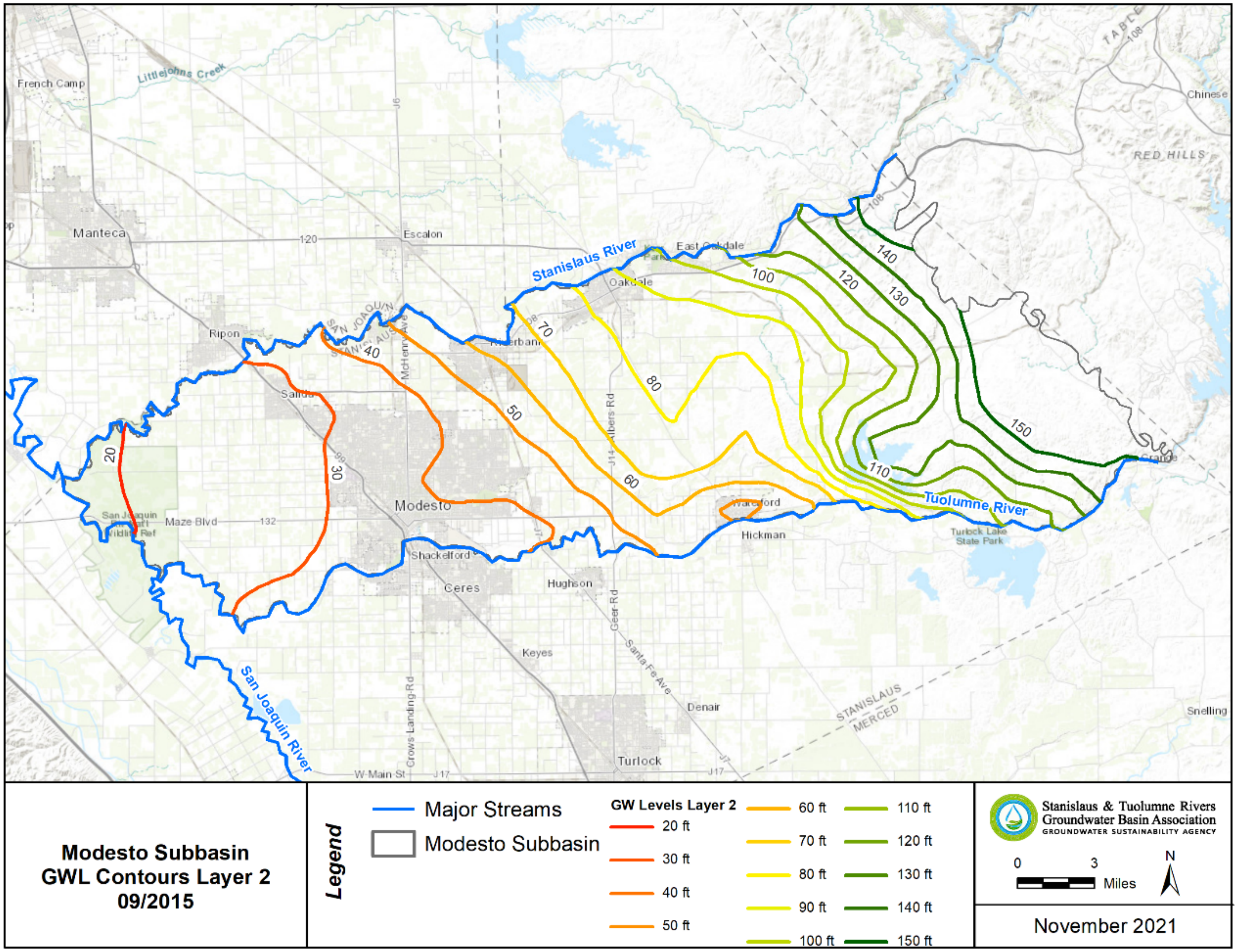


Figure M28: Calibrated Horizontal Hydraulic Conductivity of Layer 1

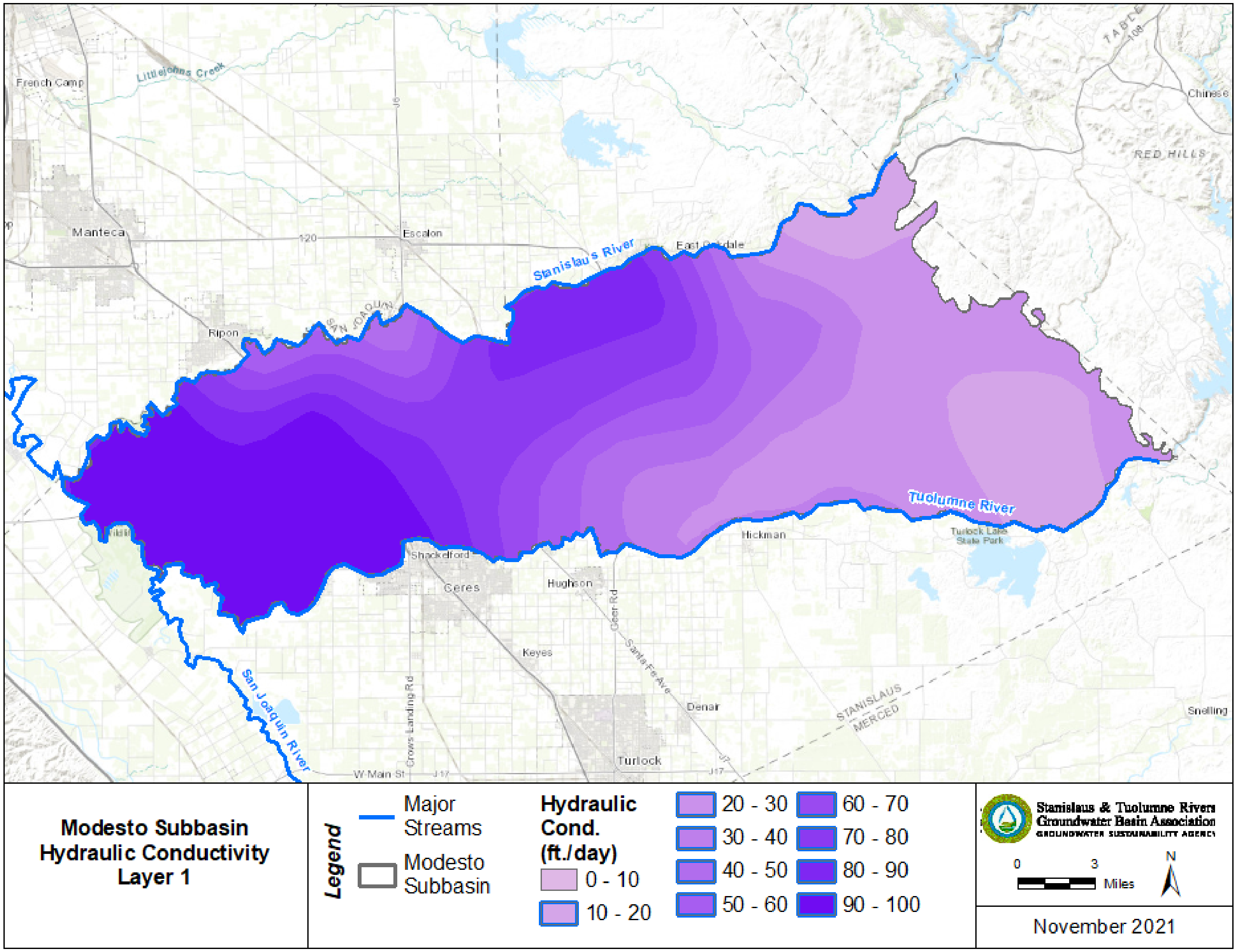


Figure M29: Calibrated Horizontal Hydraulic Conductivity of Layers 2

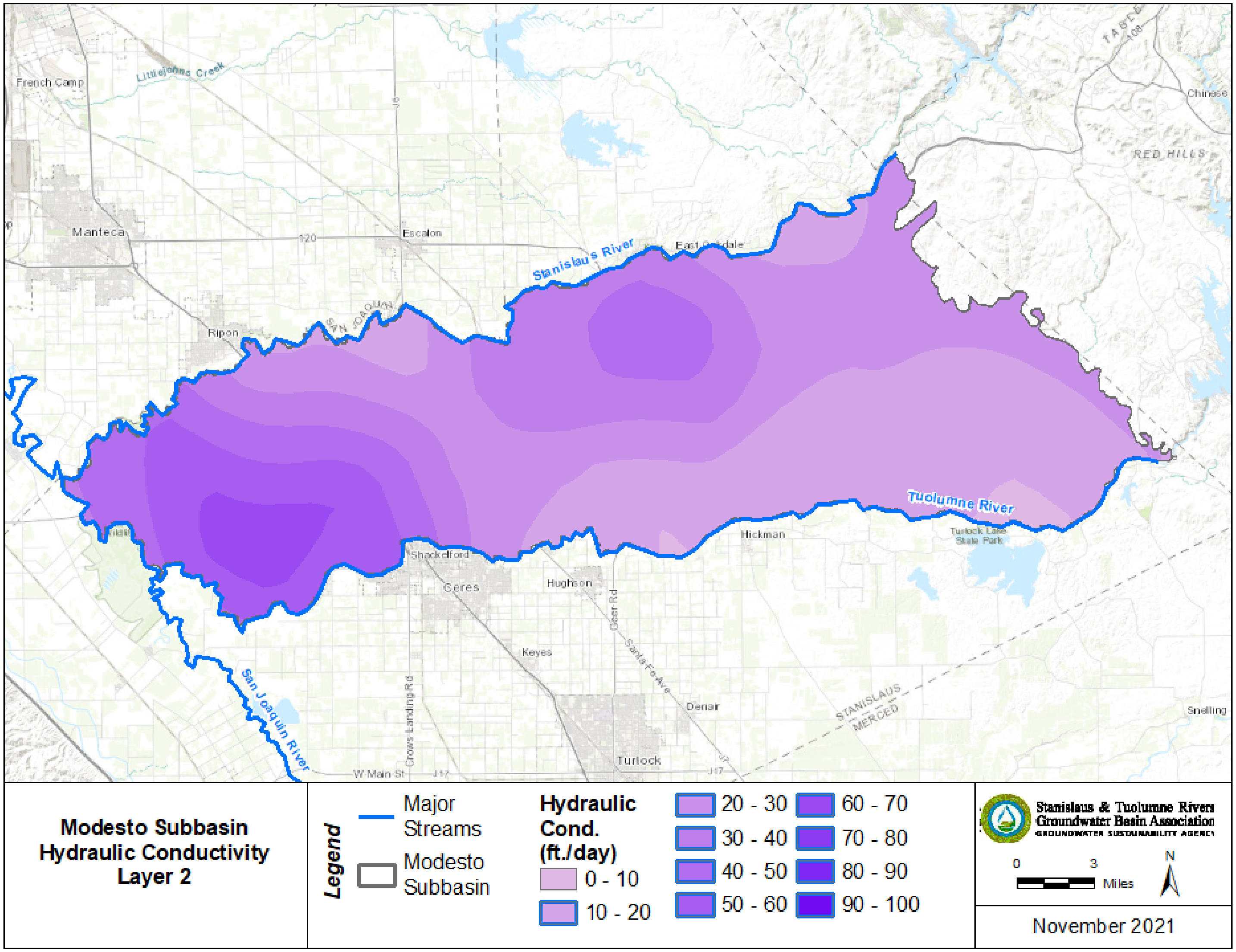


Figure M30: Calibrated Horizontal Hydraulic Conductivity of Layers 3

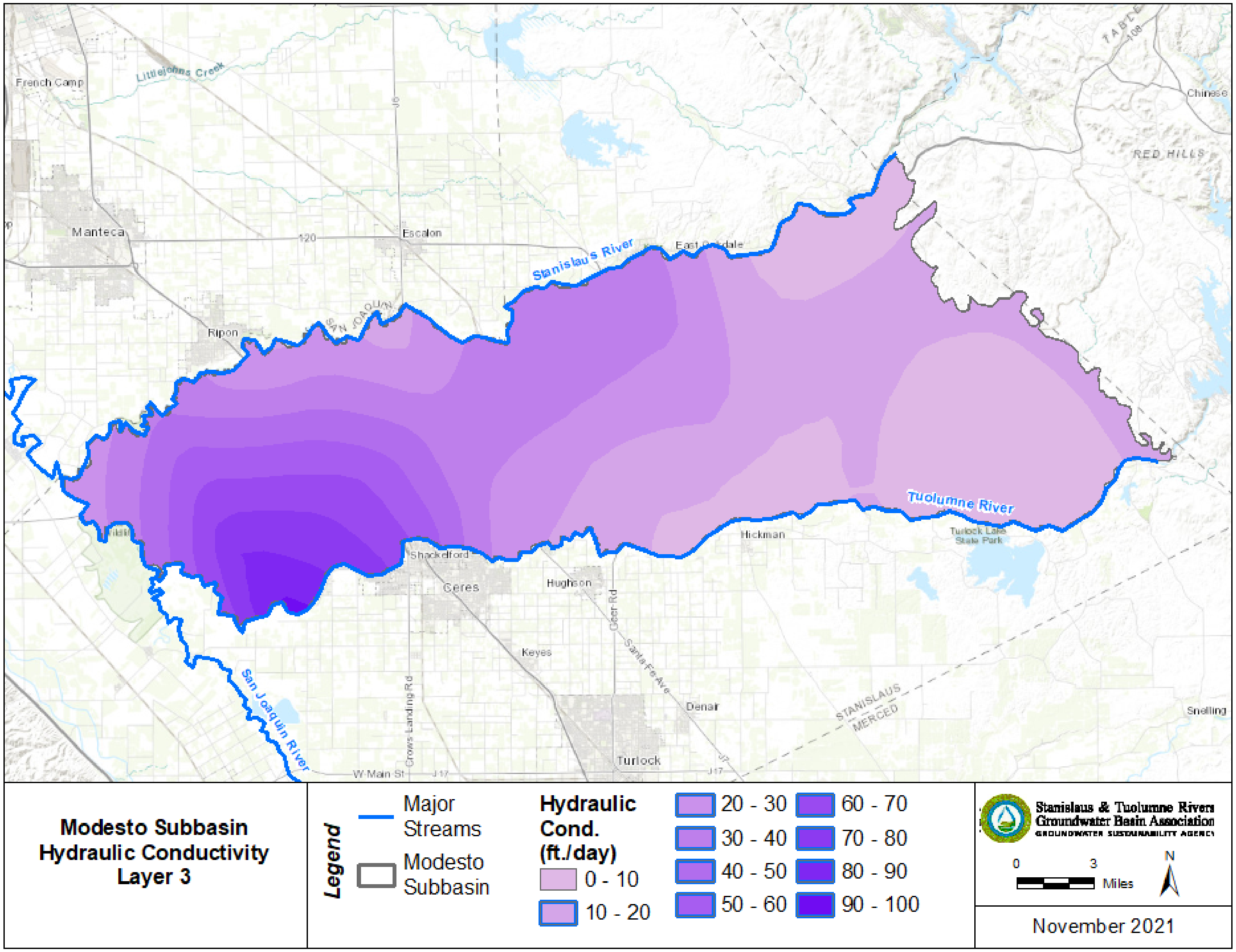
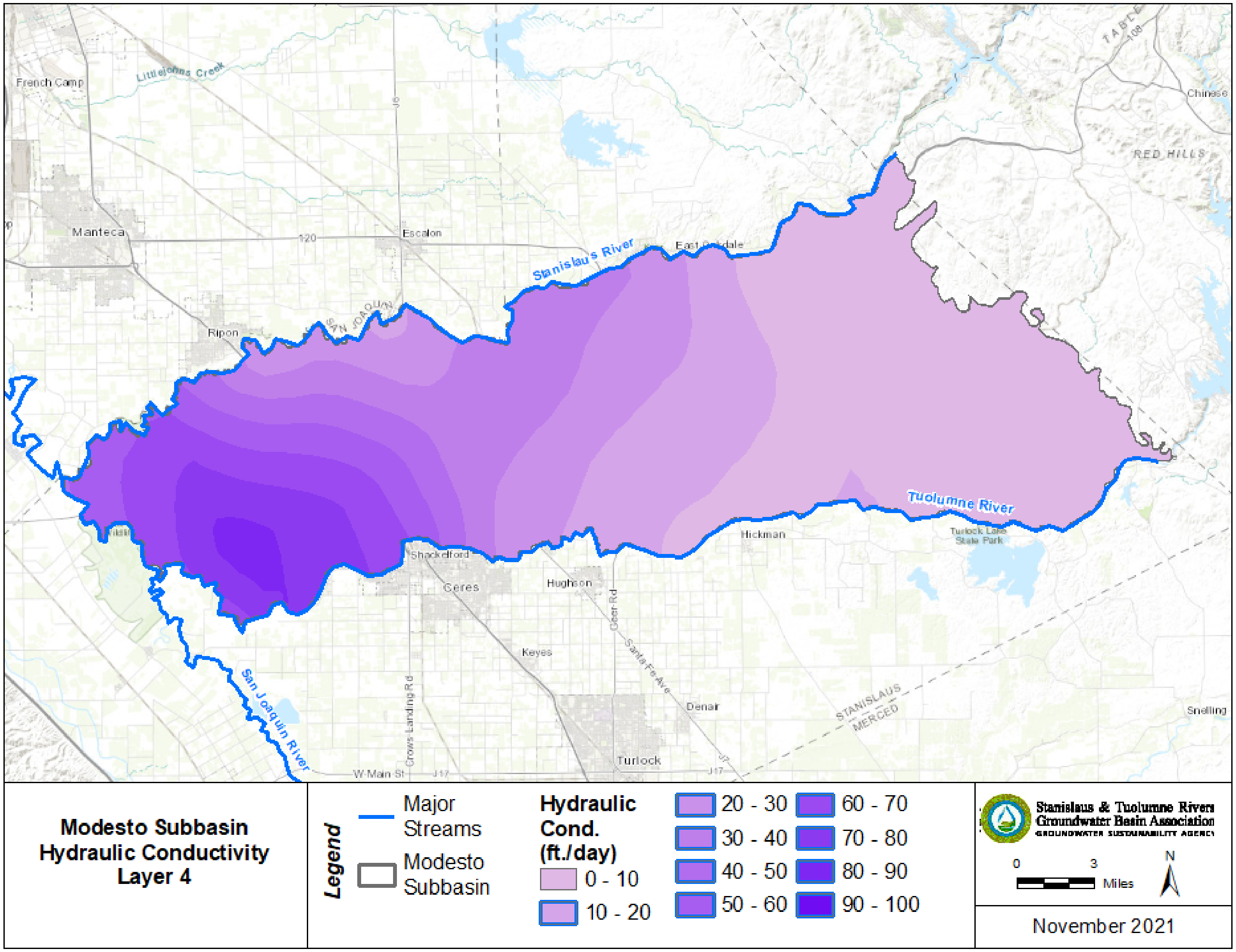
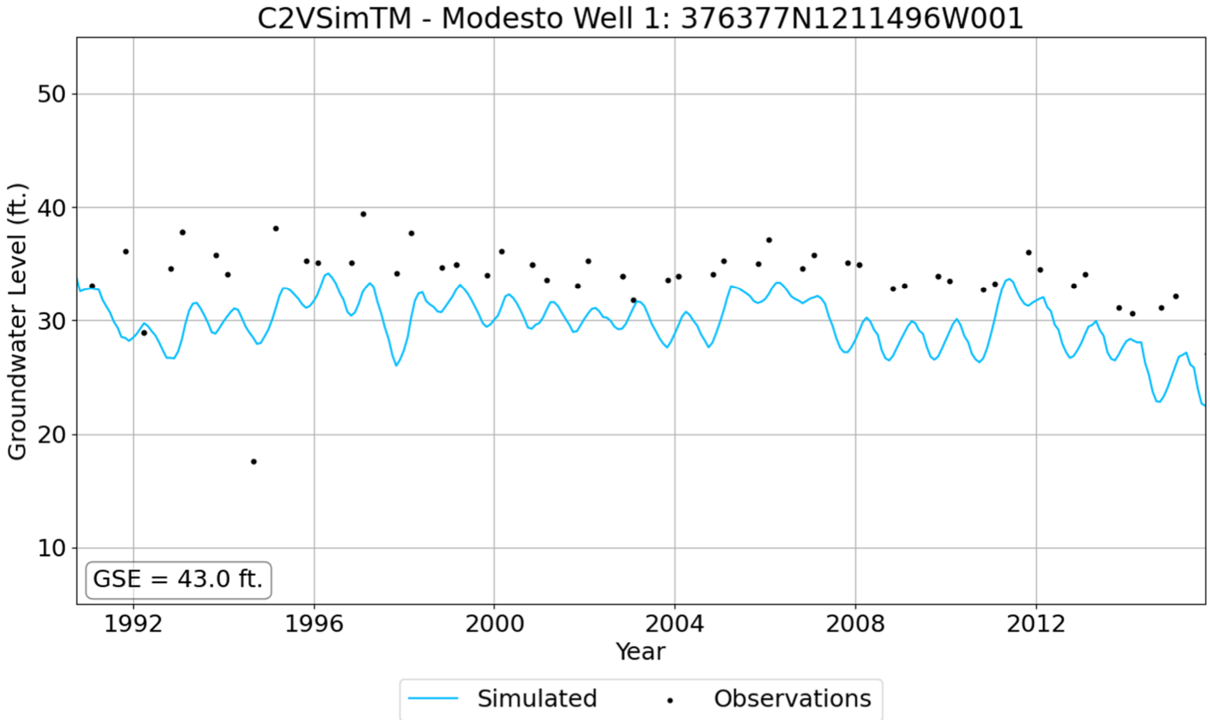
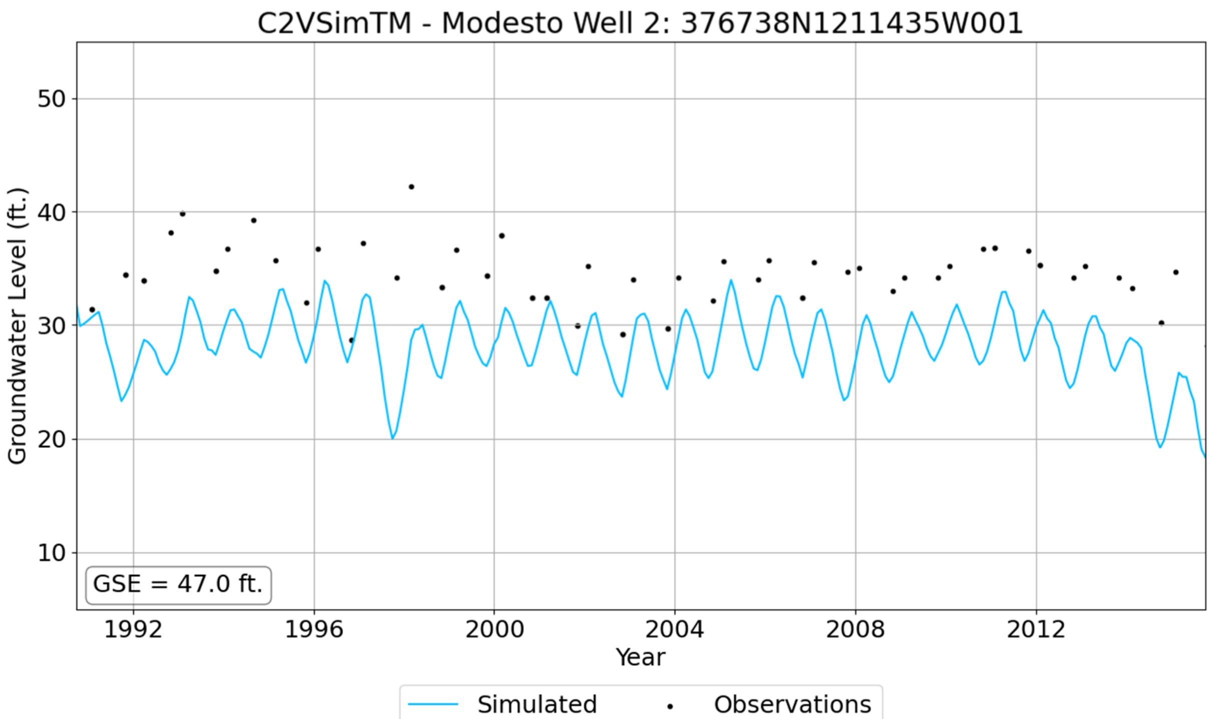


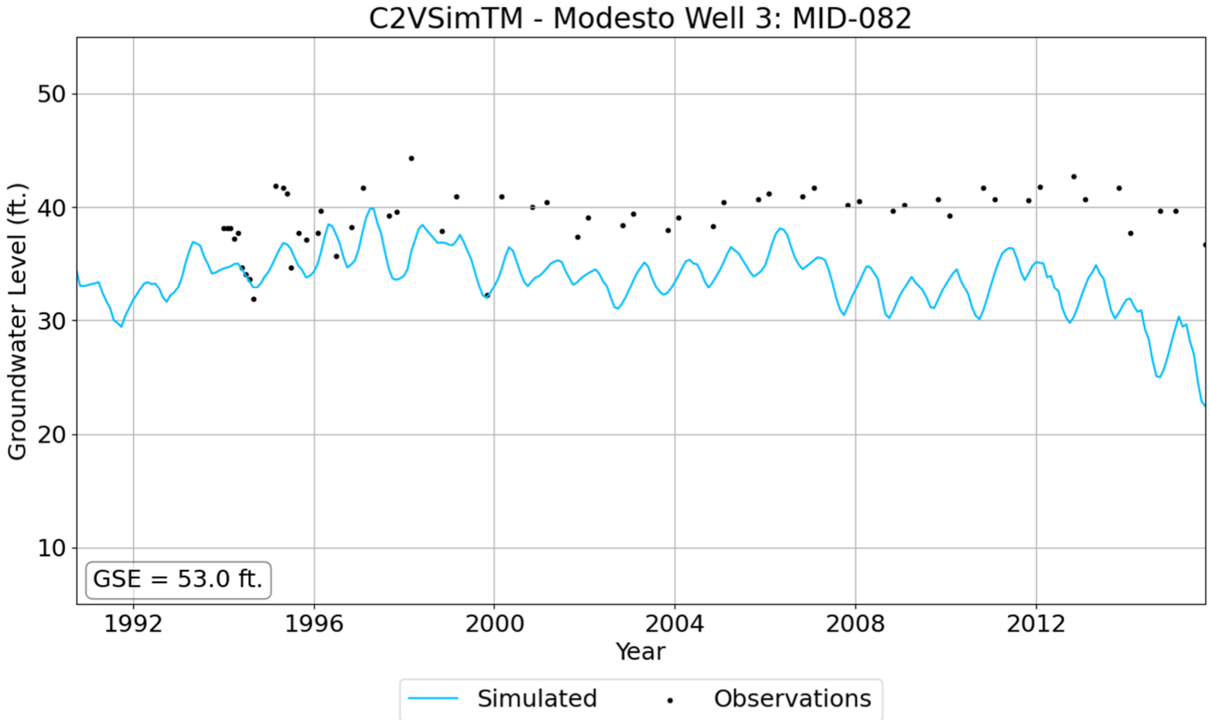
Figure M31: Calibrated Horizontal Hydraulic Conductivity of Layers 4



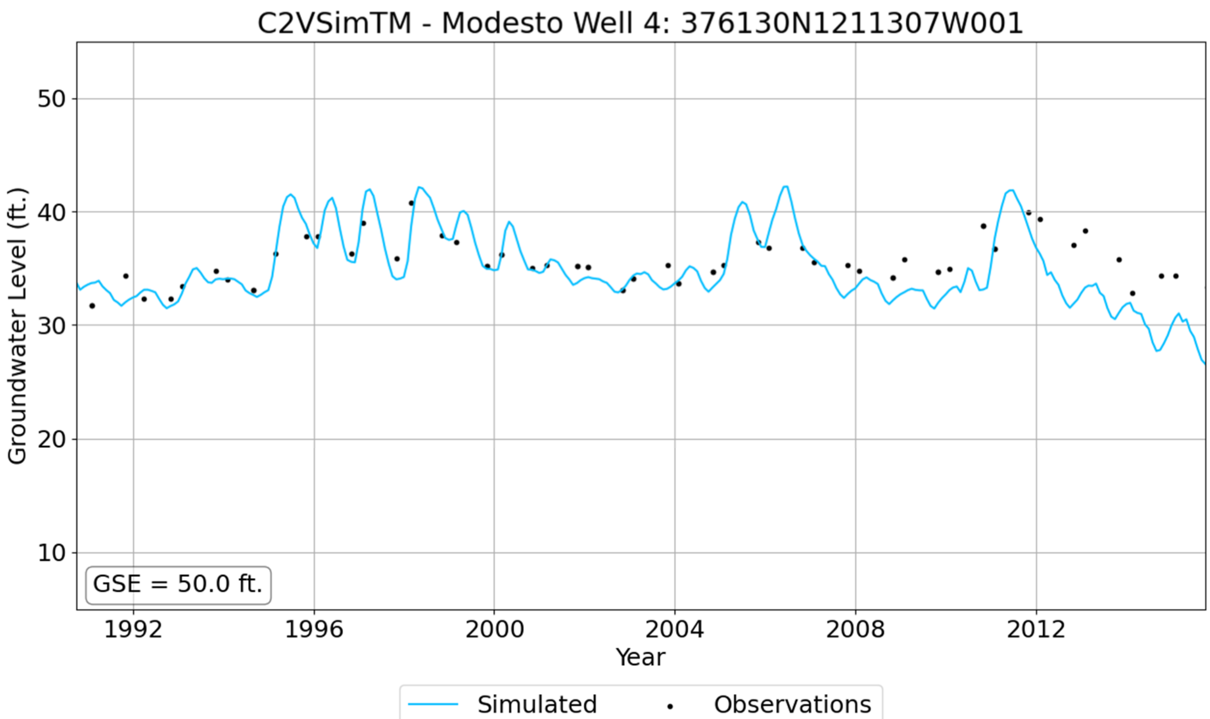
APPENDIX A: GROUNDWATER LEVEL HYDROGRAPHS


C2VSimTM - Modesto Well 1: 376377N1211496W001
Groundwater Level (ft.)
Year
GSE = 43.0 ft.
Simulated
Observations

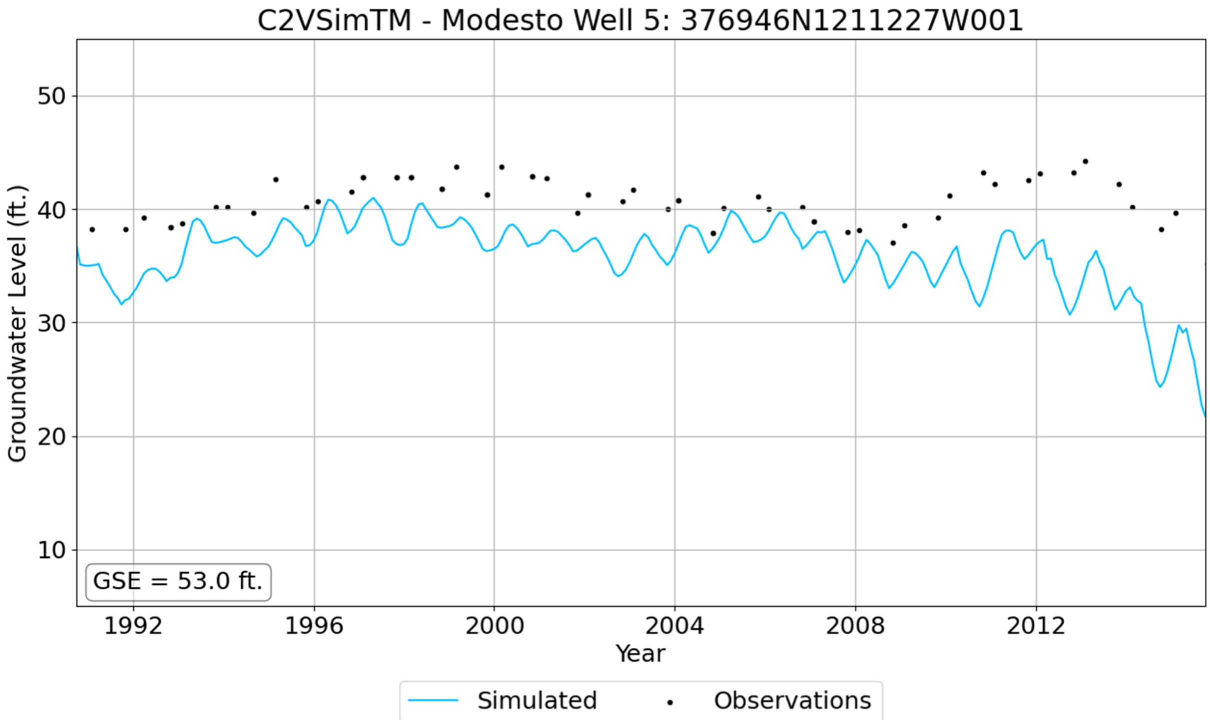

C2VSimTM - Modesto Well 2: 376738N1211435W001
Groundwater Level (ft.)
Year
GSE = 47.0 ft.
Simulated
Observations

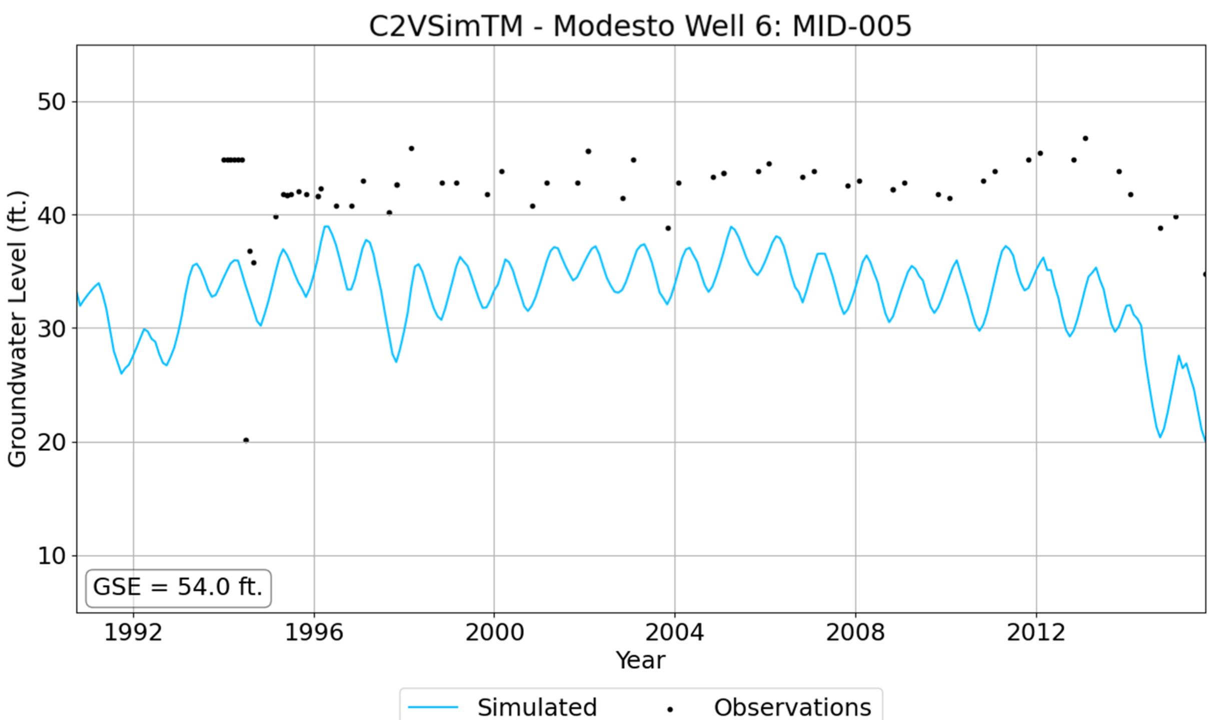


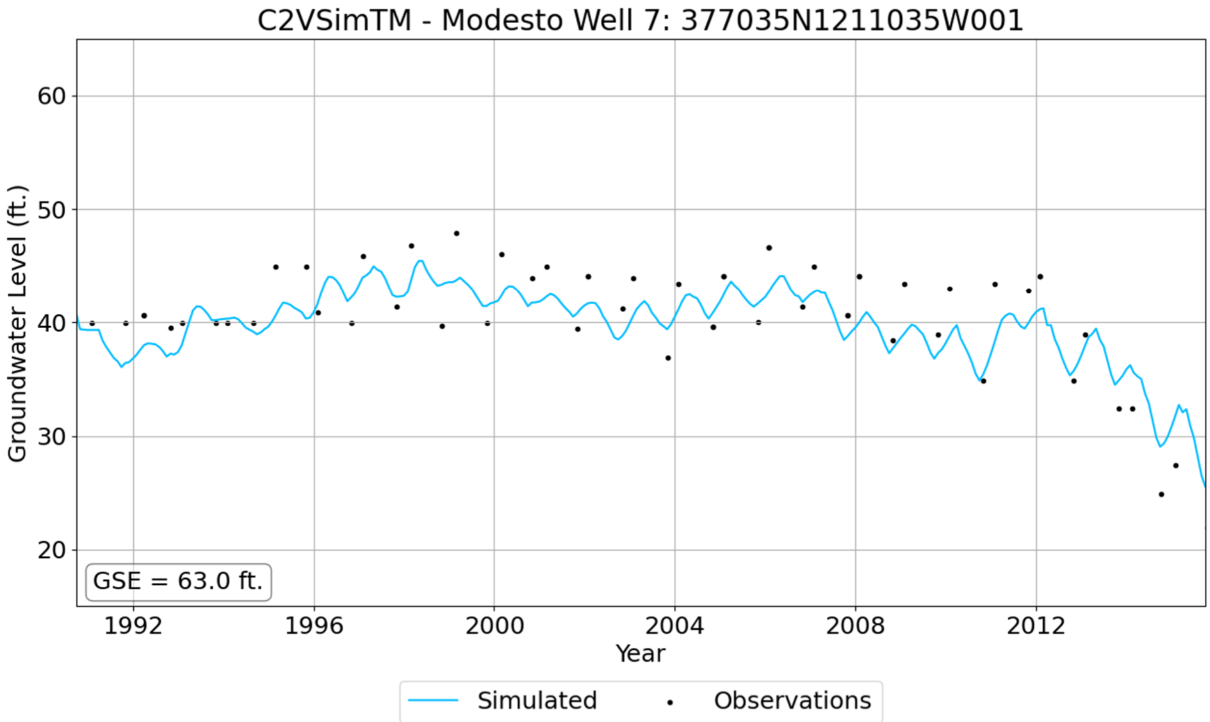
C2VSimTM - Modesto Well 3: MID-082
Groundwater Level (ft.)
Year
GSE = 53.0 ft.
50
40
30
20
10
1992
1996
2000
2004
2008
2012
Simulated
Observations

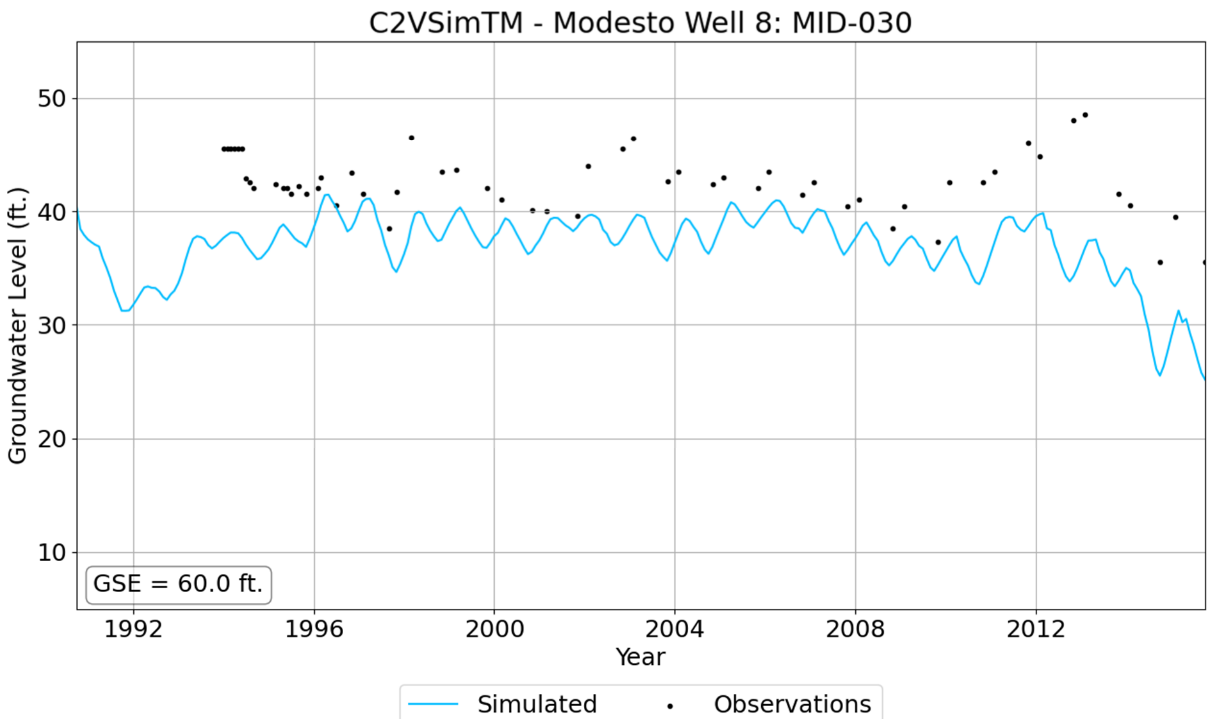


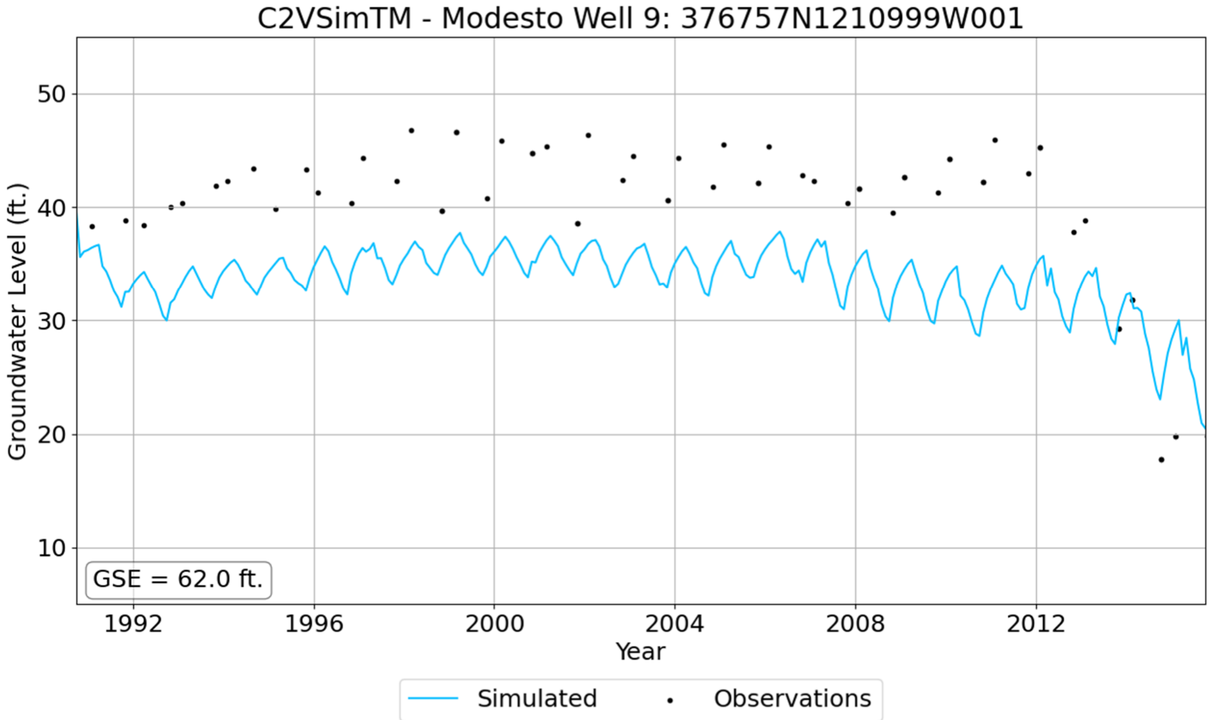
C2VSimTM - Modesto Well 4: 376130N1211307W001
Groundwater Level (ft.)
Year
GSE = 50.0 ft.
50
40
30
20
10
1992
1996
2000
2004
2008
2012
Simulated
Observations

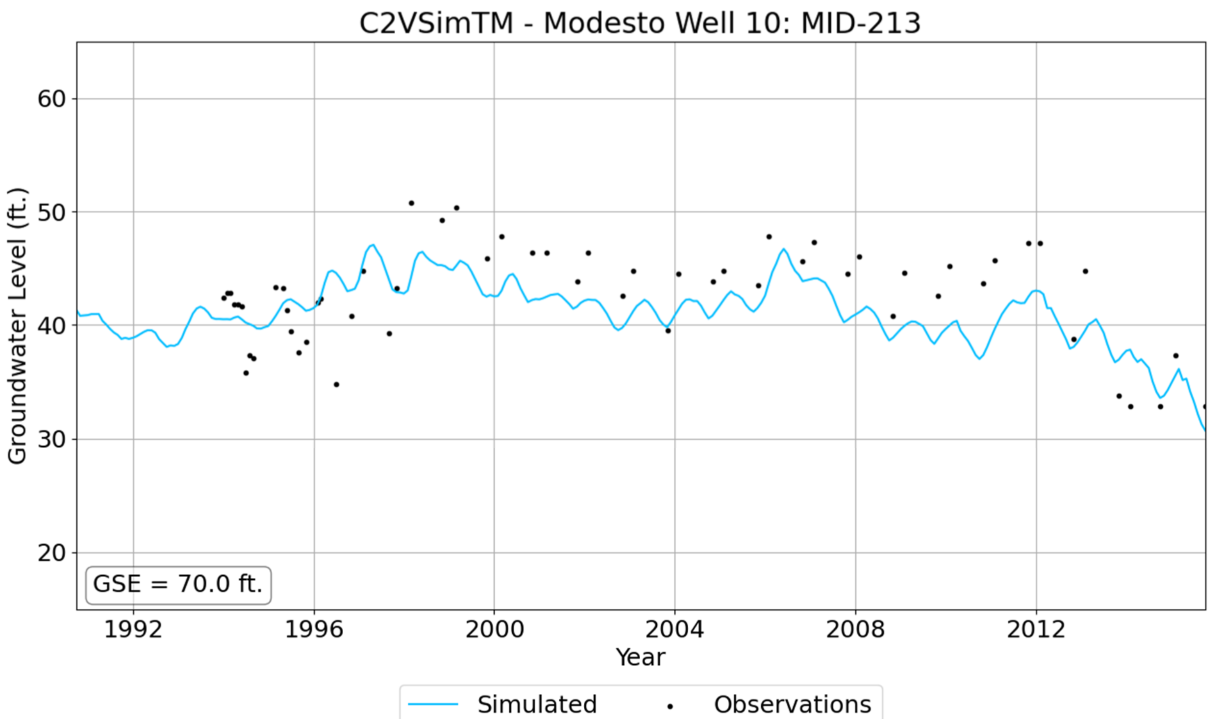

C2VSimTM - Modesto Well 5: 376946N1211227W001
Groundwater Level (ft.)
50
40
30
20
10
GSE = 53.0 ft.
1992
1996
2000
2004
2008
2012
Year
Simulated
Observations

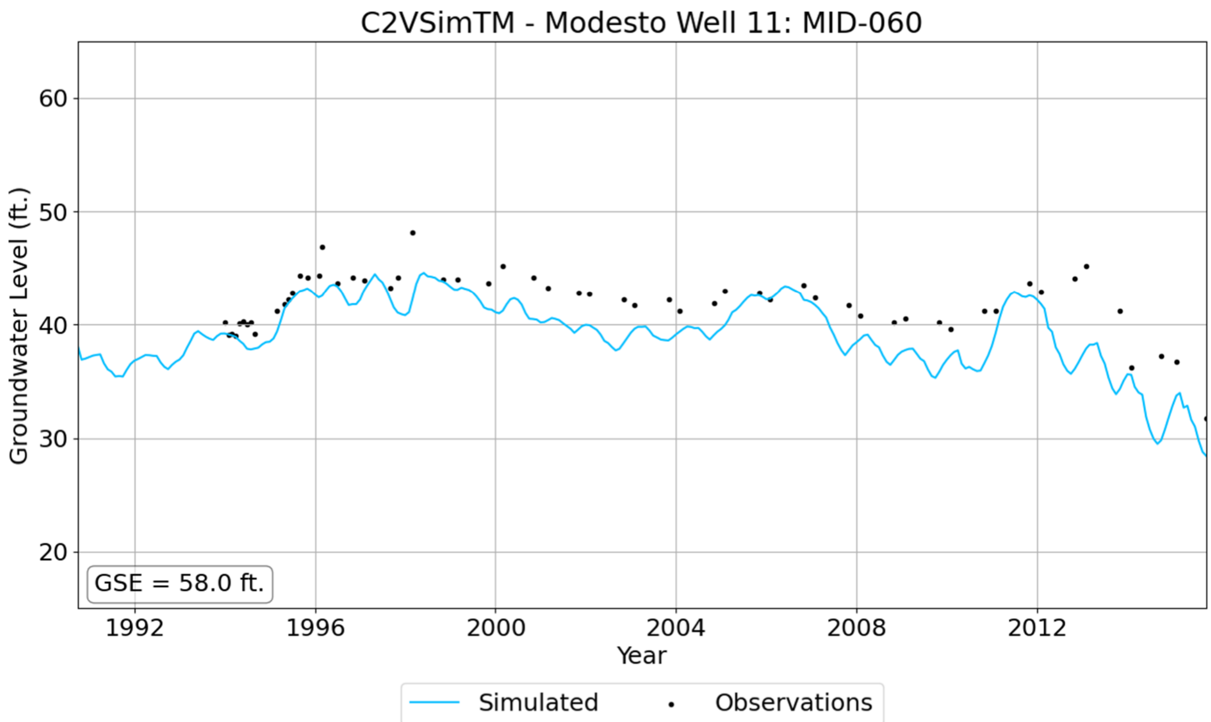

C2VSimTM - Modesto Well 6: MID-005
Groundwater Level (ft.)
50
40
30
20
10
GSE = 54.0 ft.
1992
1996
2000
2004
2008
2012
Year
Simulated
Observations

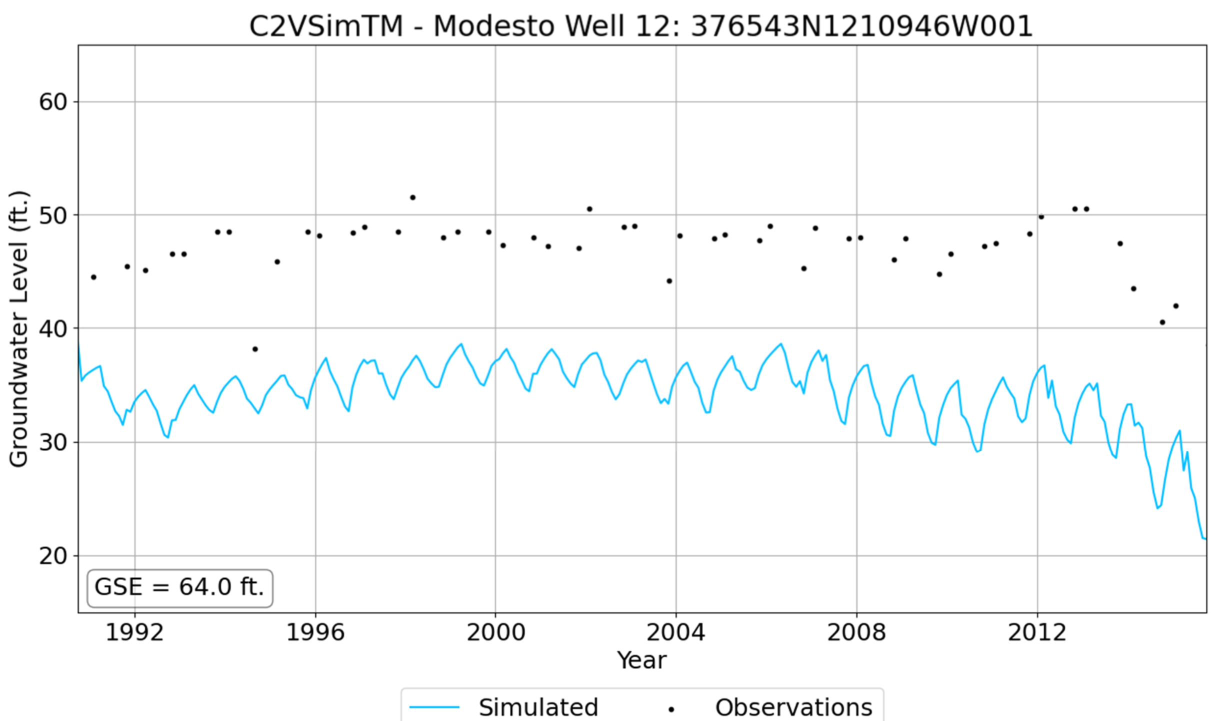

C2VSimTM - Modesto Well 7: 377035N1211035W001
Groundwater Level (ft.)
60
50
40
30
20
GSE = 63.0 ft.
1992
1996
2000
2004
2008
2012
Year
Simulated
Observations

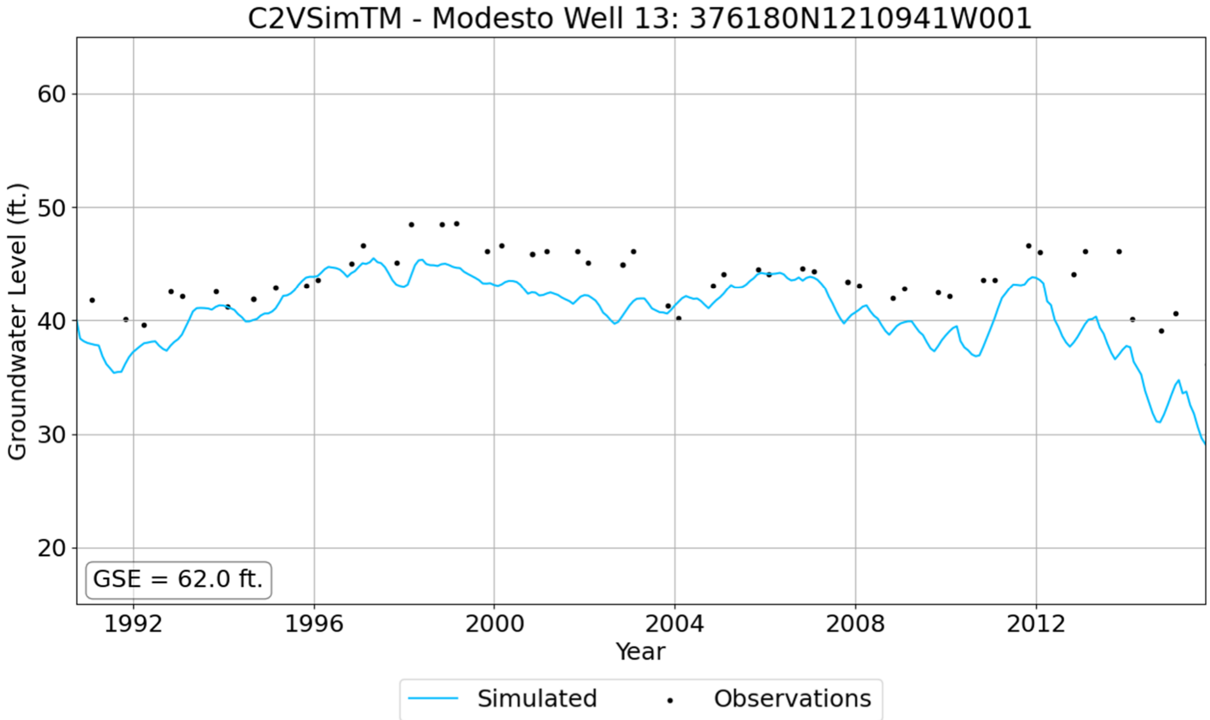

C2VSimTM - Modesto Well 8: MID-030
Groundwater Level (ft.)
50
40
30
20
10
GSE = 60.0 ft.
1992
1996
2000
2004
2008
2012
Year
Simulated
Observations

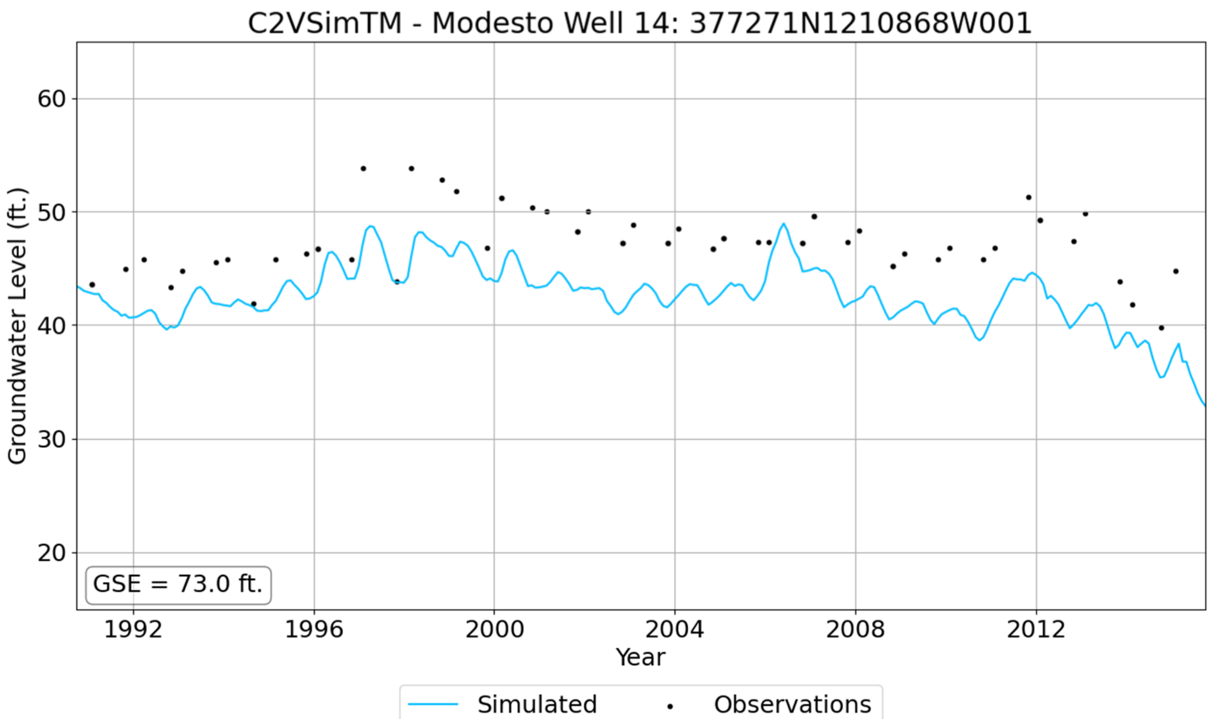

C2VSimTM - Modesto Well 9: 376757N1210999W001
Groundwater Level (ft.)
Year
GSE = 62.0 ft.
Simulated
Observations

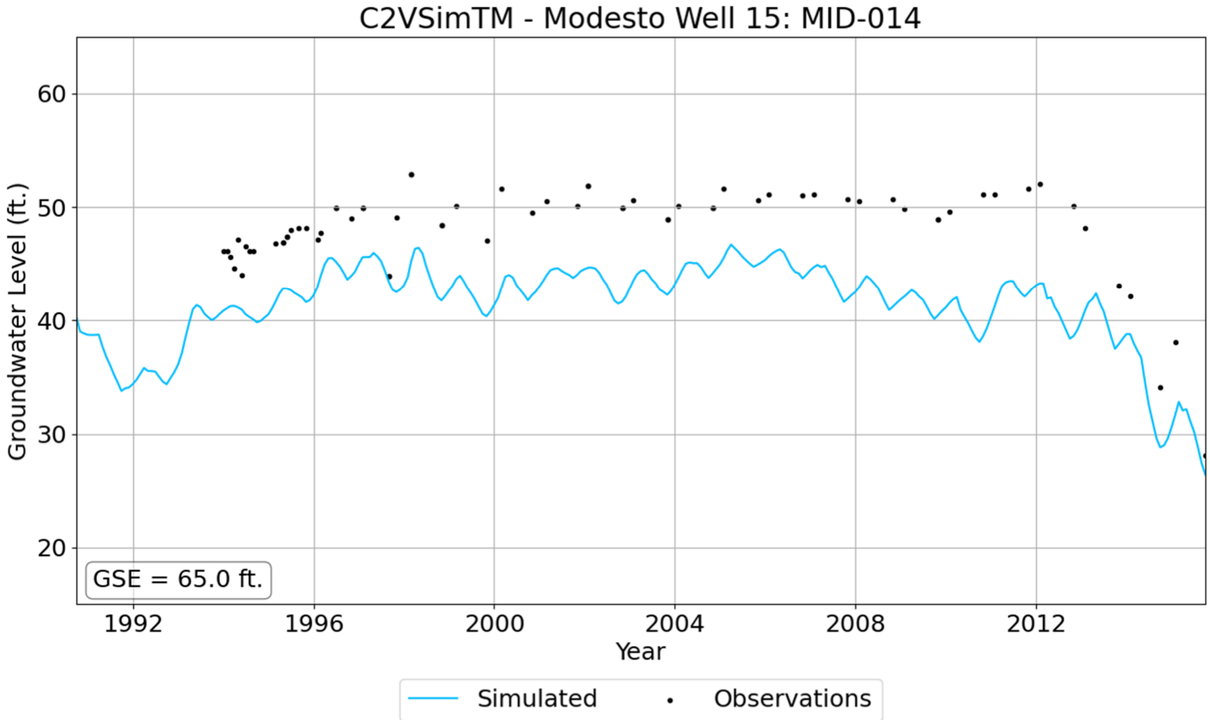

C2VSimTM - Modesto Well 10: MID-213
Groundwater Level (ft.)
Year
GSE = 70.0 ft.
Simulated
Observations


C2VSimTM - Modesto Well 11: MID-060
Groundwater Level (ft.)
Year
GSE = 58.0 ft.
Simulated
Observations

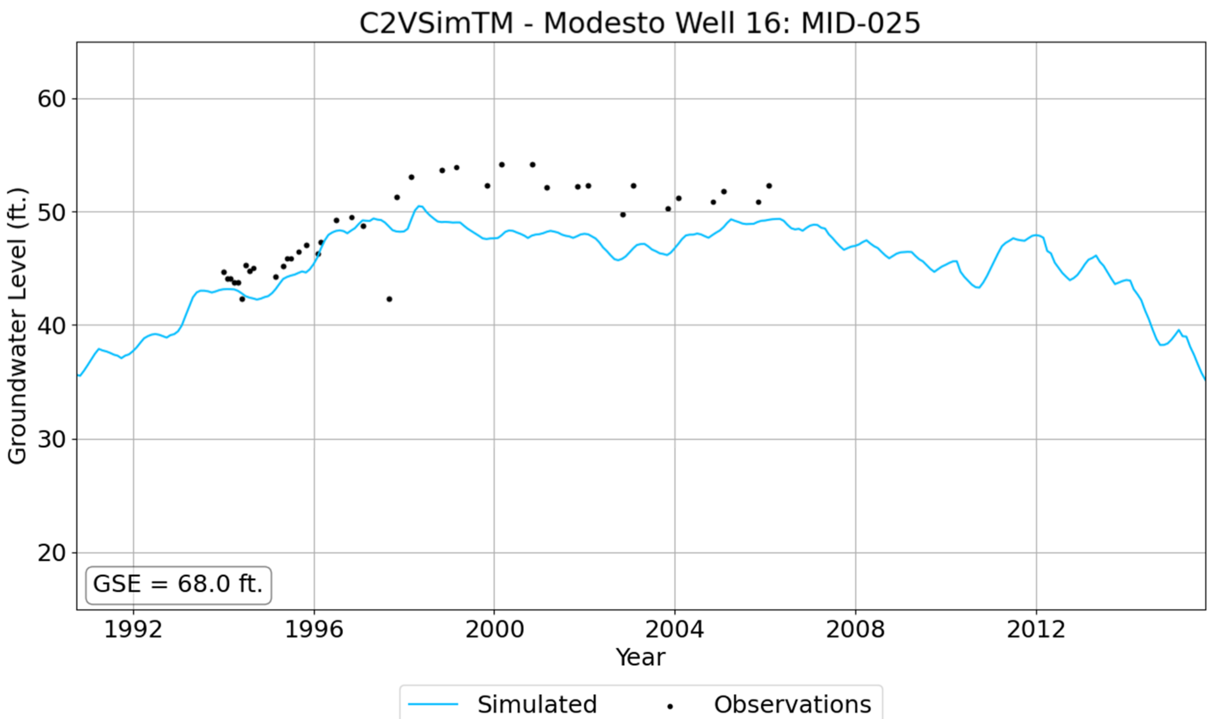

C2VSimTM - Modesto Well 12: 376543N1210946W001
Groundwater Level (ft.)
Year
GSE = 64.0 ft.
Simulated
Observations


C2VSimTM - Modesto Well 13: 376180N1210941W001
Groundwater Level (ft.)
60
50
40
30
20
GSE = 62.0 ft.
1992
1996
2000
2004
2008
2012
Year
Simulated
Observations

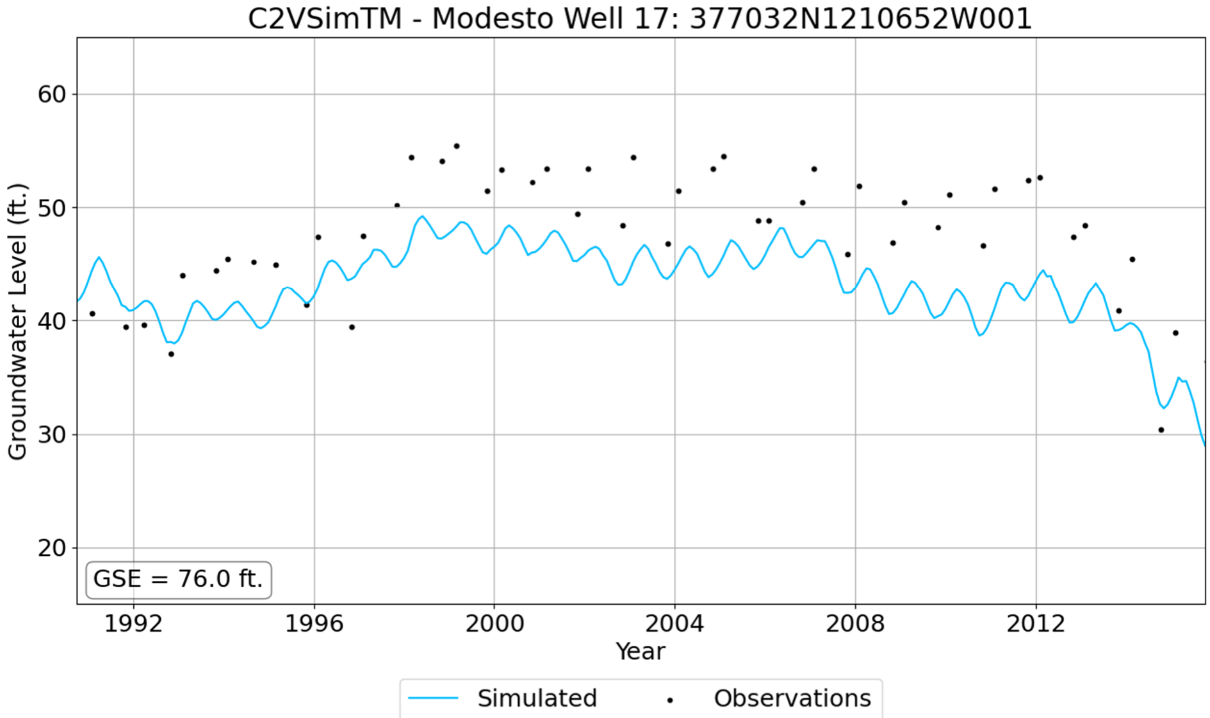

C2VSimTM - Modesto Well 14: 377271N1210868W001
Groundwater Level (ft.)
60
50
40
30
20
GSE = 73.0 ft.
1992
1996
2000
2004
2008
2012
Year
Simulated
Observations

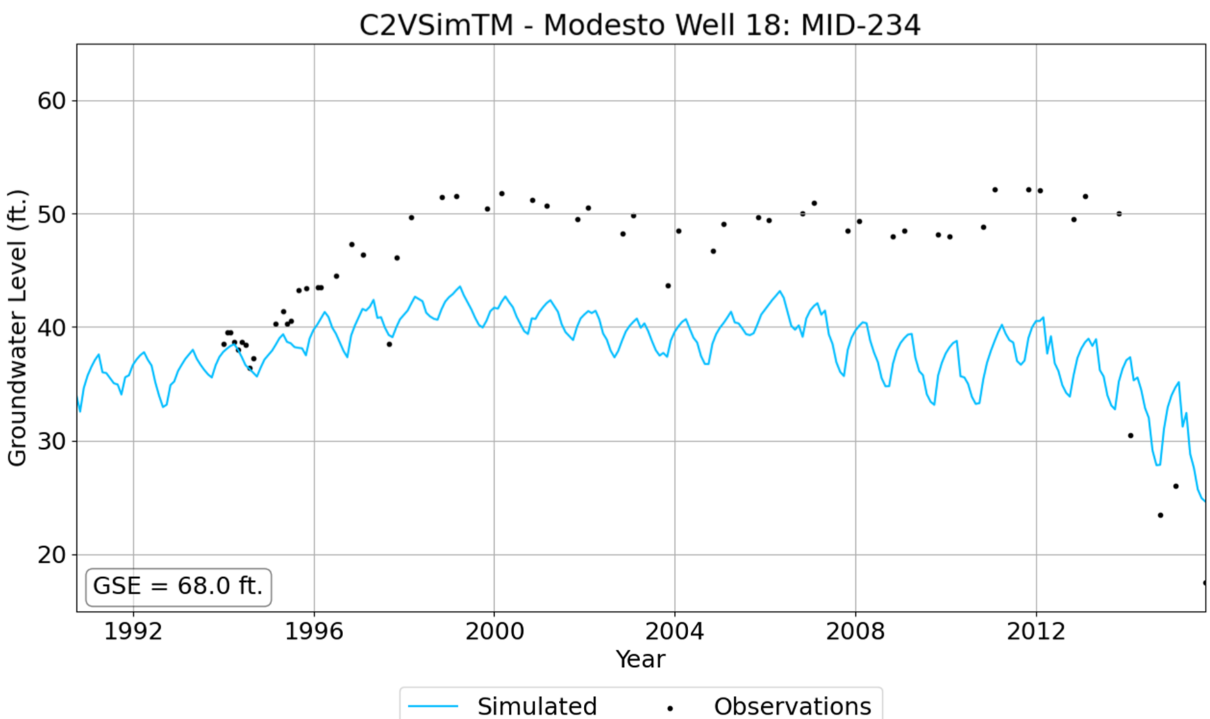


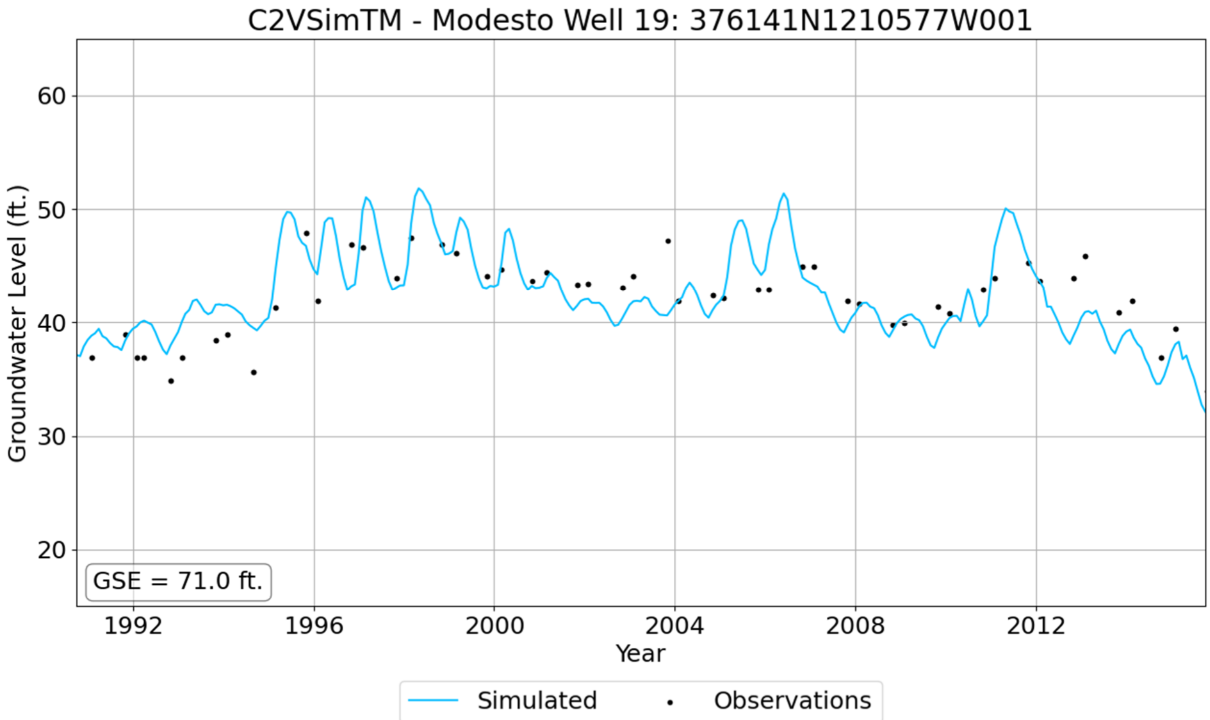
C2VSimTM - Modesto Well 15: MID-014
Groundwater Level (ft.)
Year
GSE = 65.0 ft.
Simulated
Observations

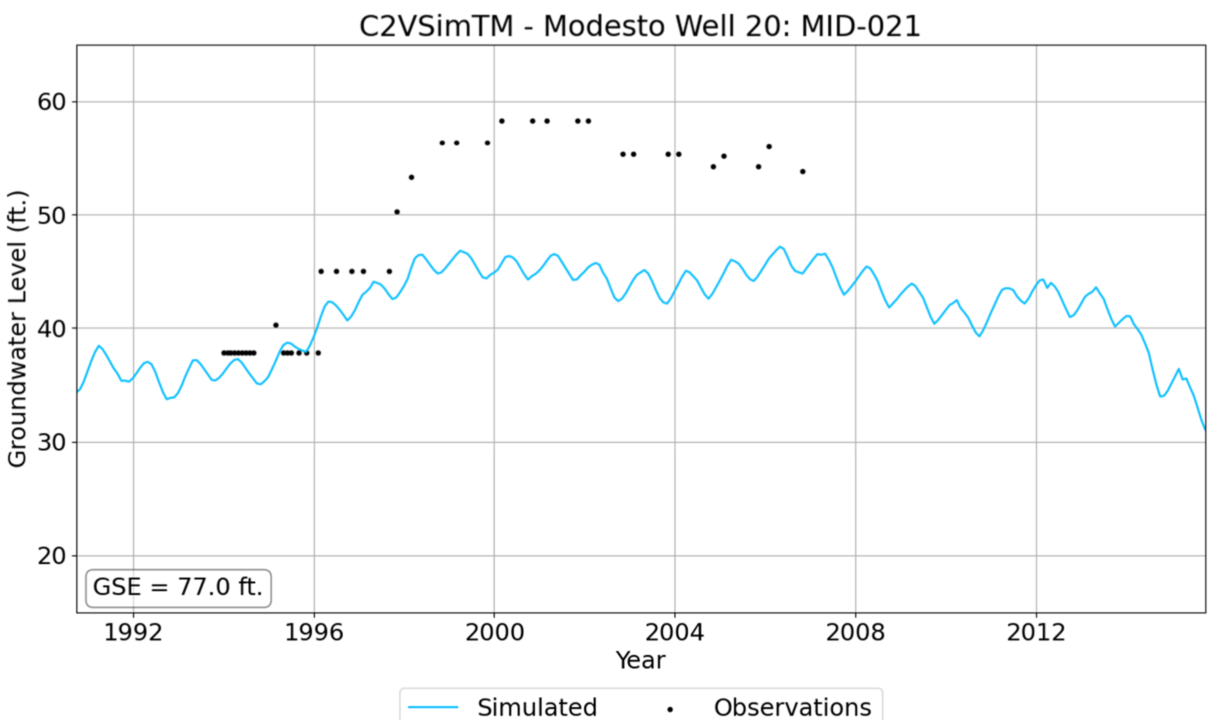


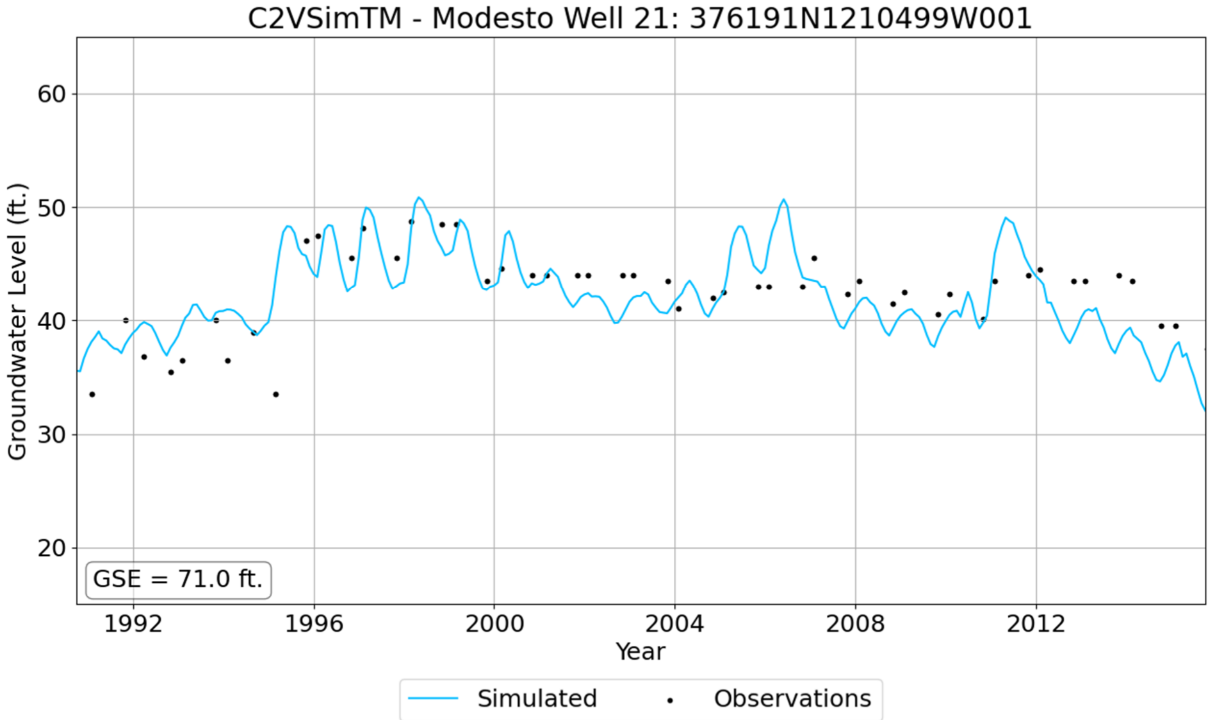
C2VSimTM - Modesto Well 16: MID-025
Groundwater Level (ft.)
Year
GSE = 68.0 ft.
Simulated
Observations

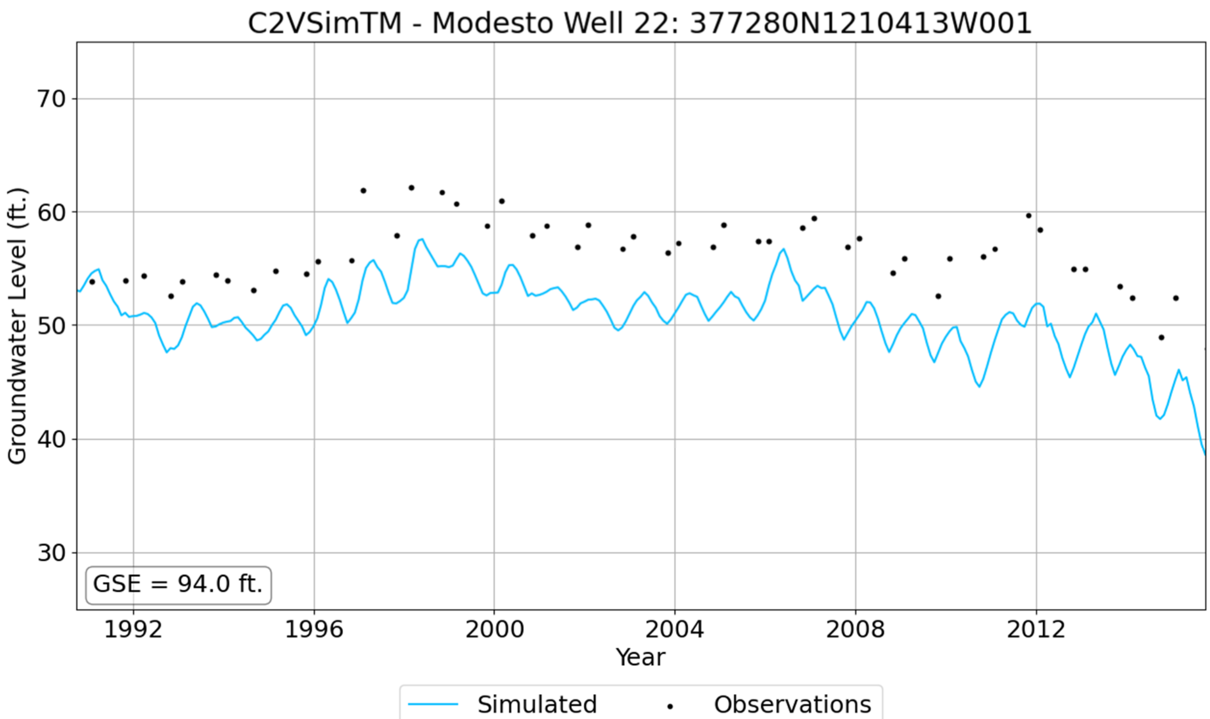

C2VSimTM - Modesto Well 17: 377032N1210652W001
Groundwater Level (ft.)
60
50
40
30
20
GSE = 76.0 ft.
1992
1996
2000
2004
2008
2012
Year
Simulated
Observations

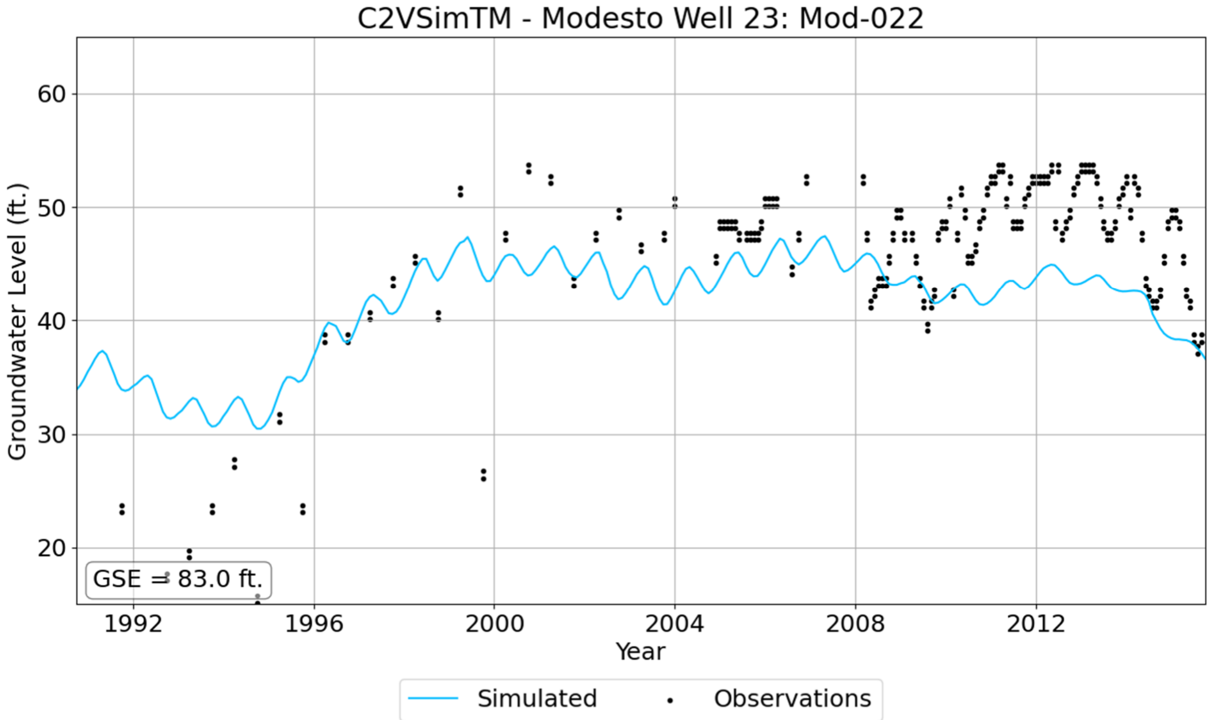

C2VSimTM - Modesto Well 18: MID-234
Groundwater Level (ft.)
60
50
40
30
20
GSE = 68.0 ft.
1992
1996
2000
2004
2008
2012
Year
Simulated
Observations

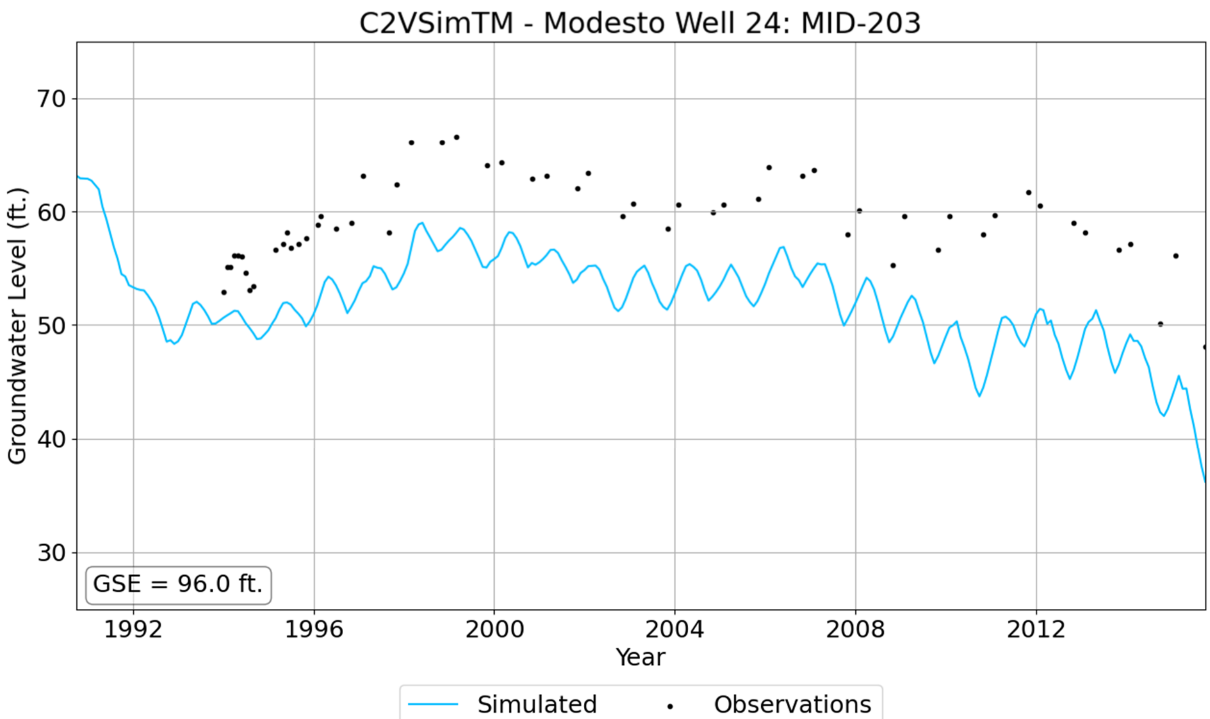

C2VSimTM - Modesto Well 19: 376141N1210577W001
Groundwater Level (ft.)
60
50
40
30
20
GSE = 71.0 ft.
1992
1996
2000
2004
2008
2012
Year
Simulated
Observations

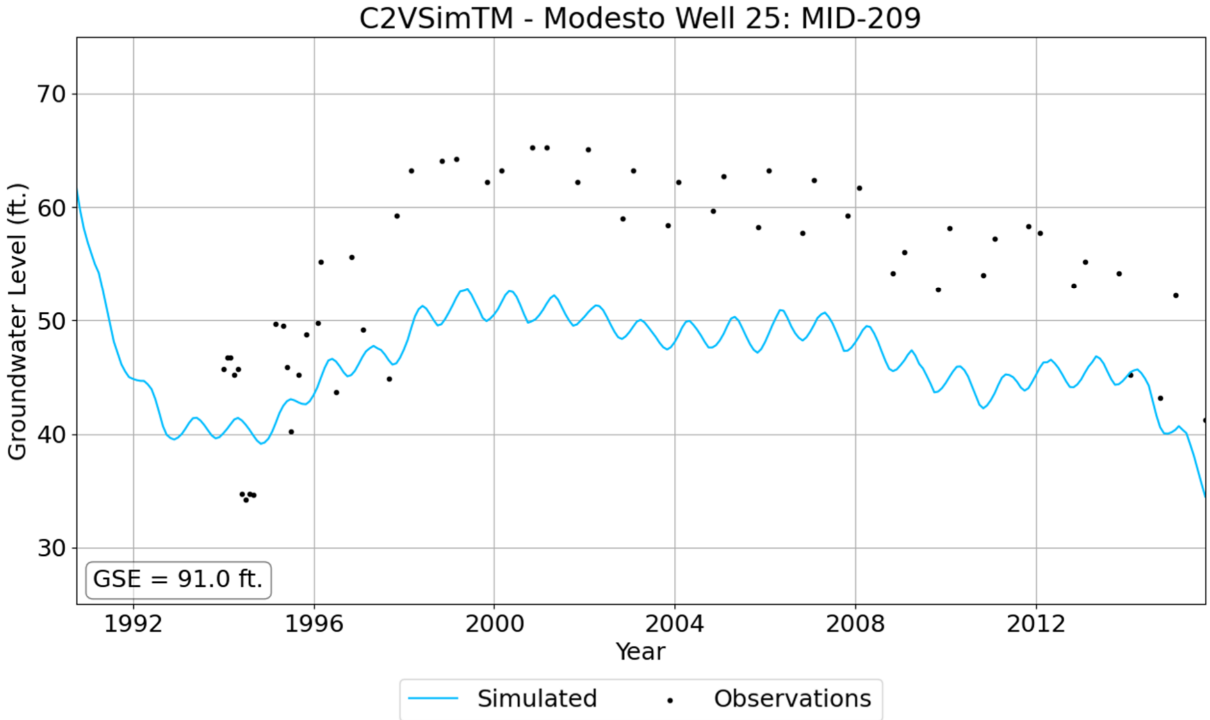

C2VSimTM - Modesto Well 20: MID-021
Groundwater Level (ft.)
60
50
40
30
20
GSE = 77.0 ft.
1992
1996
2000
2004
2008
2012
Year
Simulated
Observations

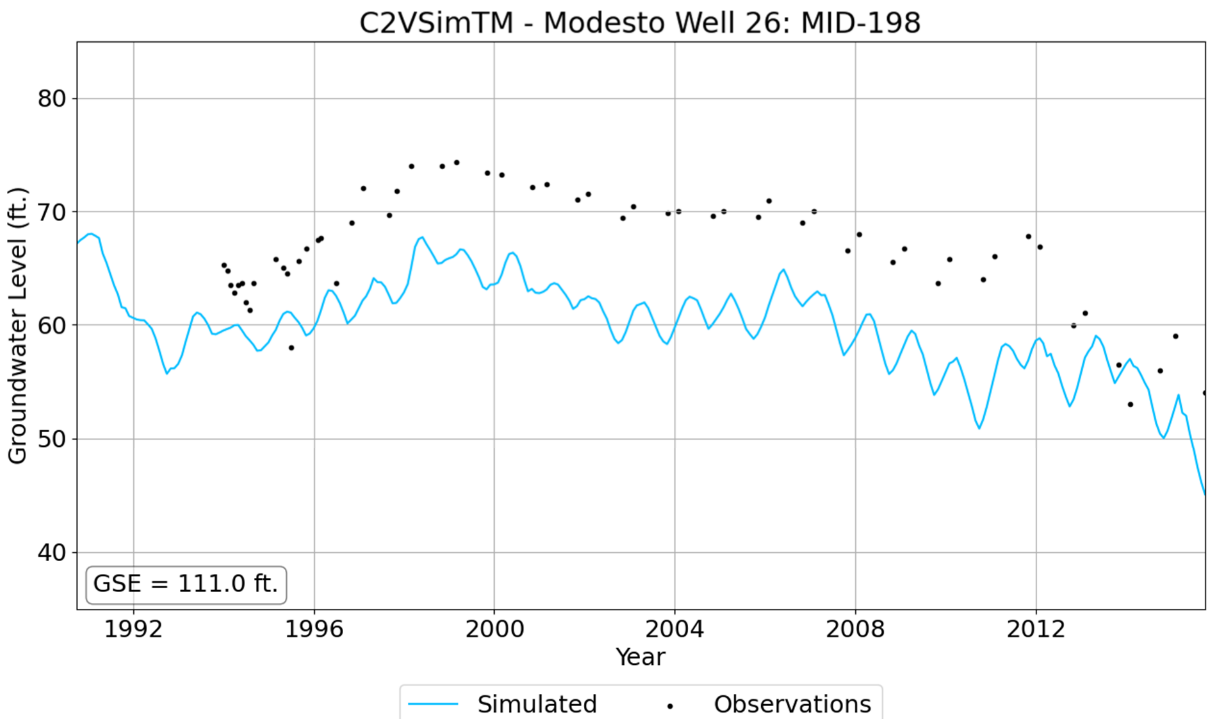

C2VSimTM - Modesto Well 21: 376191N1210499W001
Groundwater Level (ft.)
60
50
40
30
20
GSE = 71.0 ft.
1992
1996
2000
2004
2008
2012
Year
Simulated
Observations

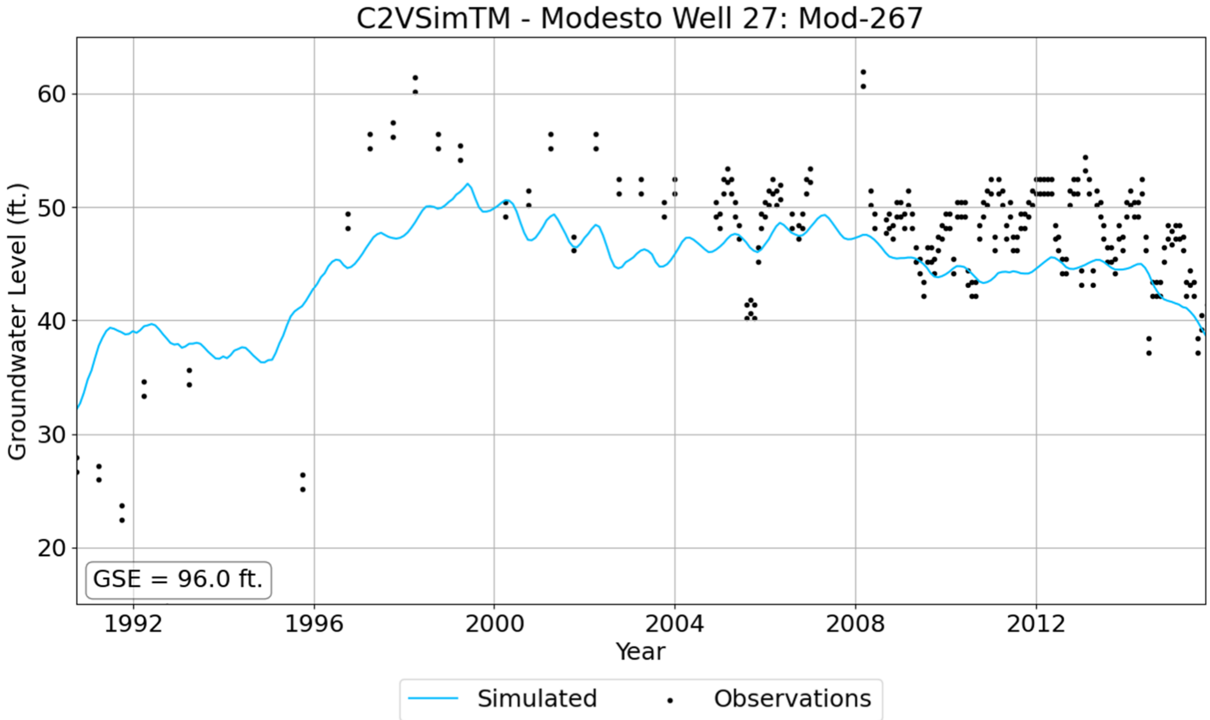

C2VSimTM - Modesto Well 22: 377280N1210413W001
Groundwater Level (ft.)
70
60
50
40
30
GSE = 94.0 ft.
1992
1996
2000
2004
2008
2012
Year
Simulated
Observations


C2VSimTM - Modesto Well 23: Mod-022
Groundwater Level (ft.)
60
50
40
30
20
GSE = 83.0 ft.
1992
1996
2000
2004
2008
2012
Year
Simulated
Observations

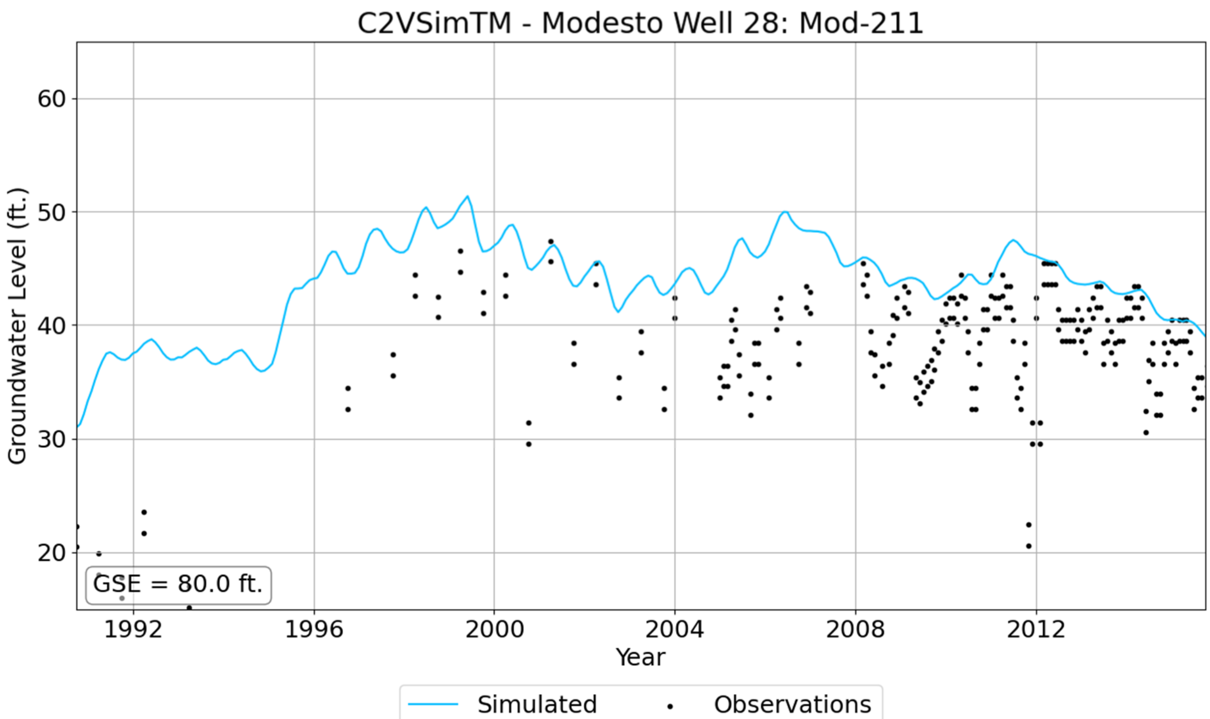

C2VSimTM - Modesto Well 24: MID-203
Groundwater Level (ft.)
70
60
50
40
30
GSE = 96.0 ft.
1992
1996
2000
2004
2008
2012
Year
Simulated
Observations


C2VSimTM - Modesto Well 25: MID-209
Groundwater Level (ft.)
70
60
50
40
30
GSE = 91.0 ft.
1992
1996
2000
2004
2008
2012
Year
Simulated
Observations

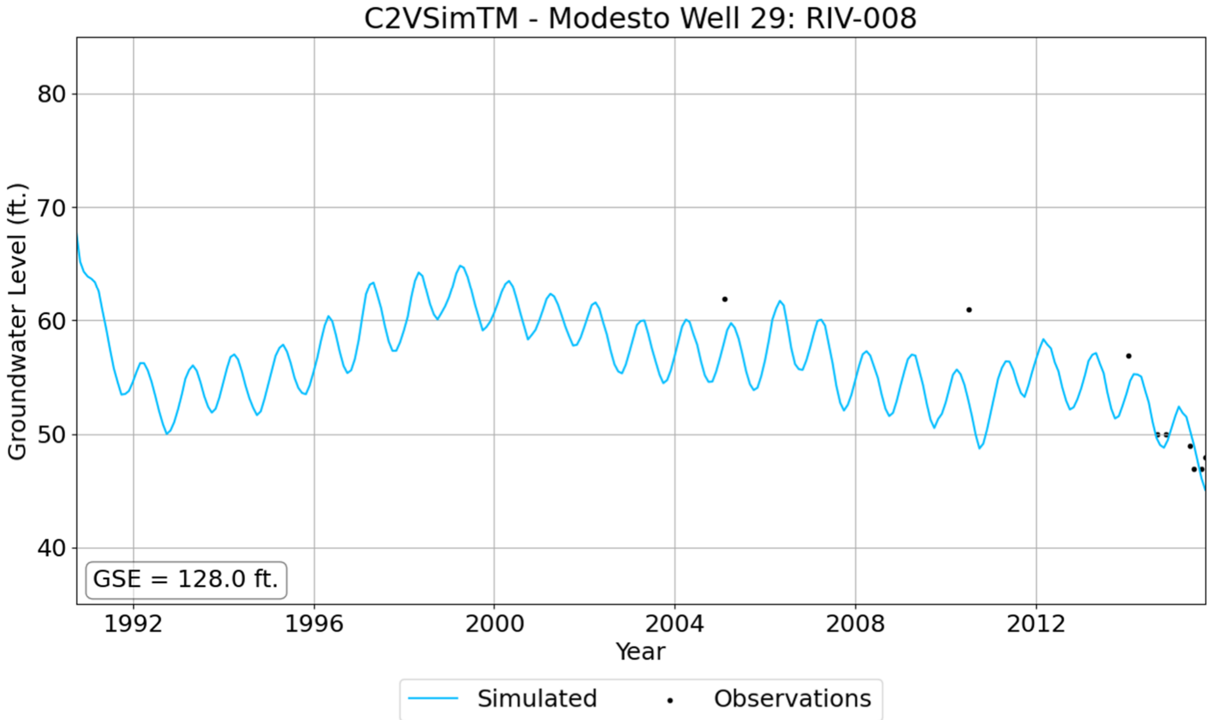

C2VSimTM - Modesto Well 26: MID-198
Groundwater Level (ft.)
80
70
60
50
40
GSE = 111.0 ft.
1992
1996
2000
2004
2008
2012
Year
Simulated
Observations

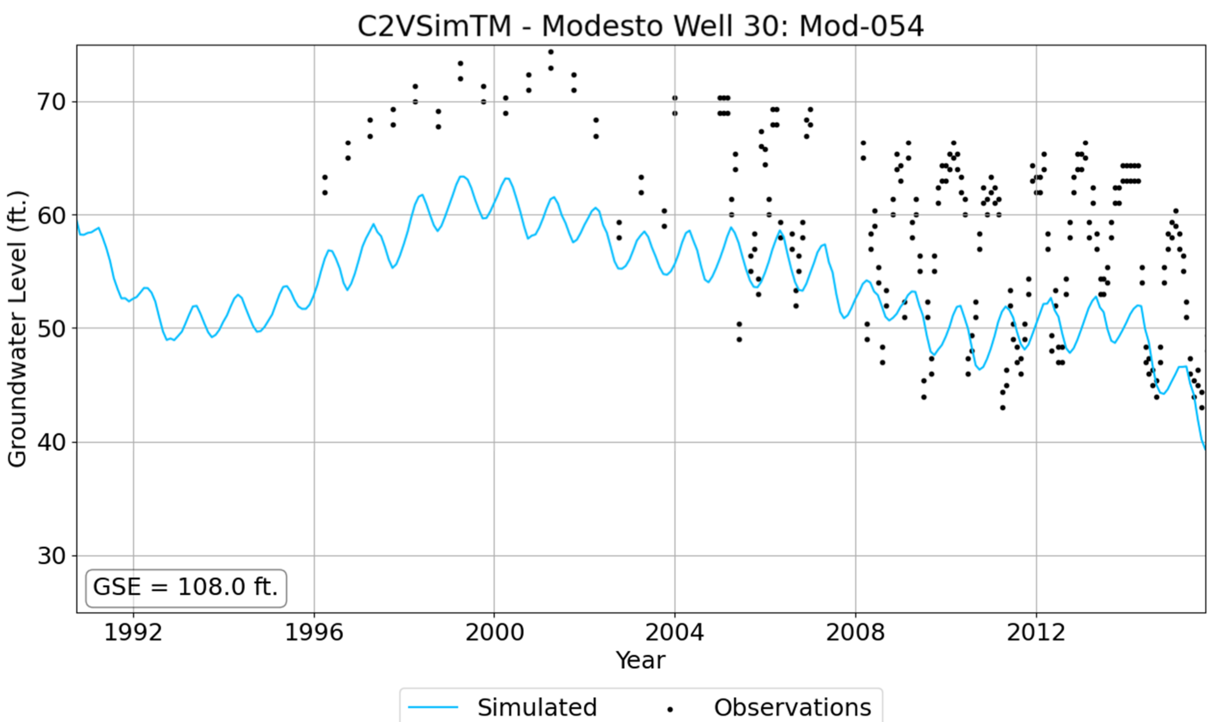


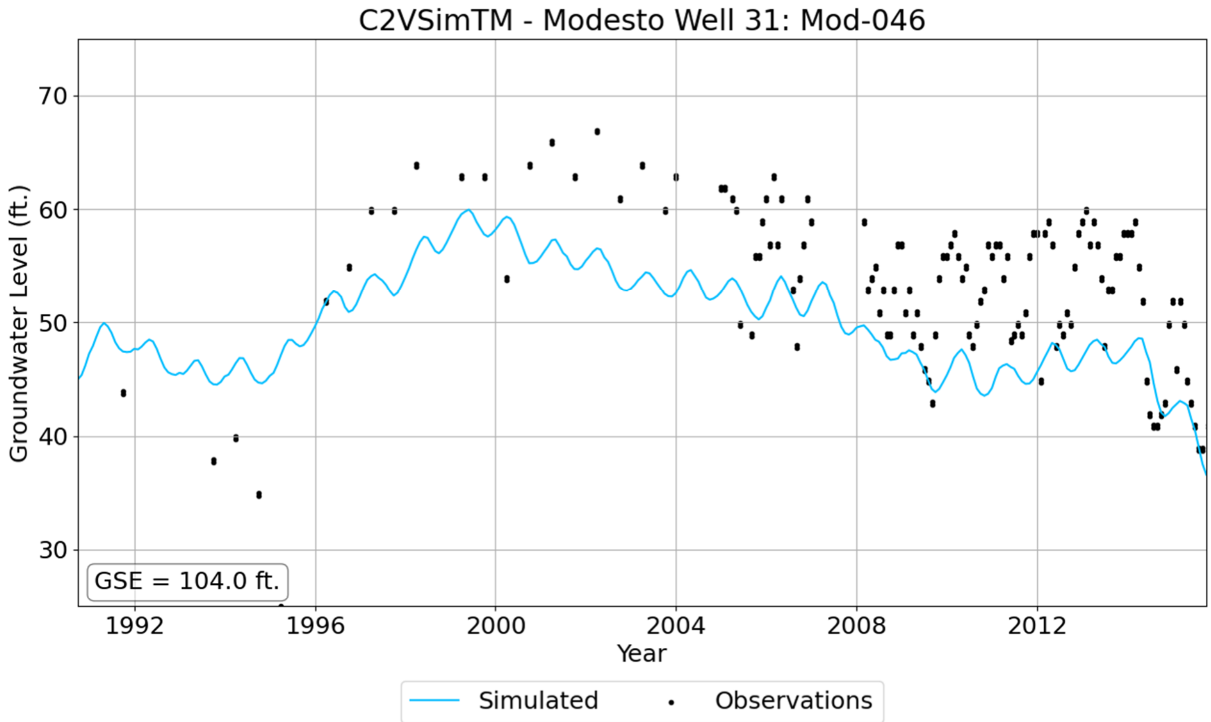
C2VSimTM - Modesto Well 27: Mod-267
Groundwater Level (ft.)
60
50
40
30
20
GSE = 96.0 ft.
1992
1996
2000
2004
2008
2012
Year
Simulated
Observations



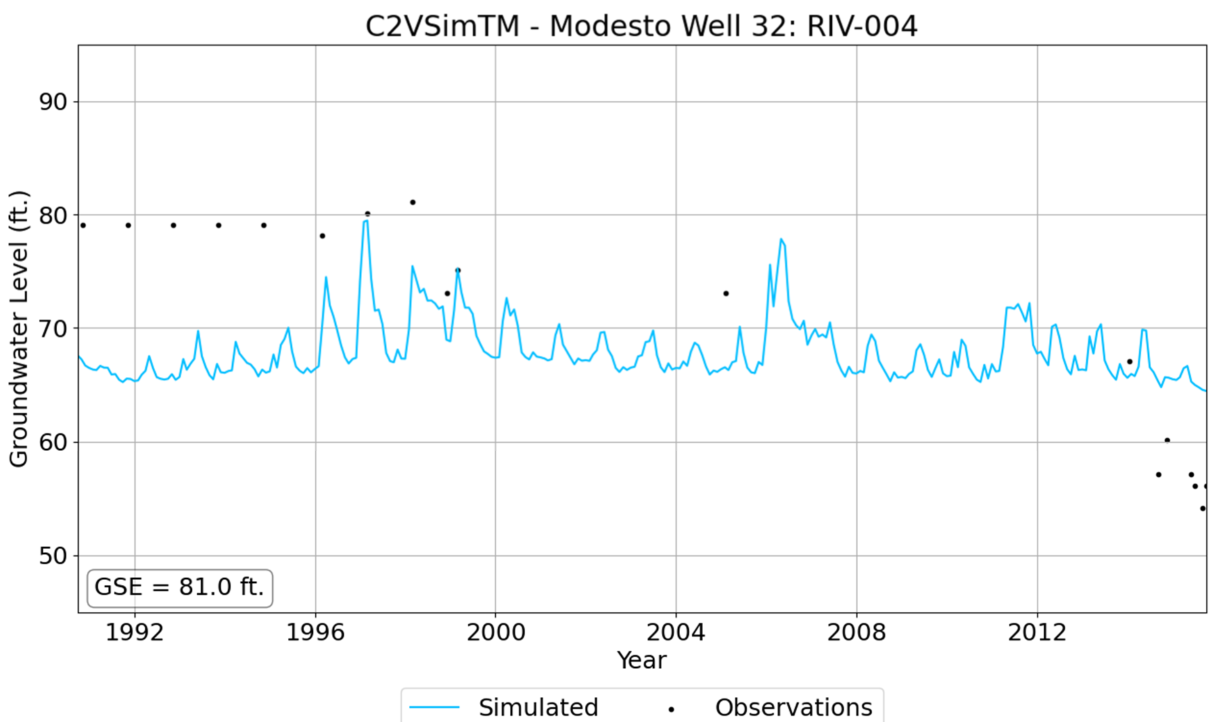
C2VSimTM - Modesto Well 28: Mod-211
Groundwater Level (ft.)
60
50
40
30
20
GSE = 80.0 ft.
1992
1996
2000
2004
2008
2012
Year
Simulated
Observations


C2VSimTM - Modesto Well 29: RIV-008
Groundwater Level (ft.)
80
70
60
50
40
GSE = 128.0 ft.
1992
1996
2000
2004
2008
2012
Year
Simulated
Observations

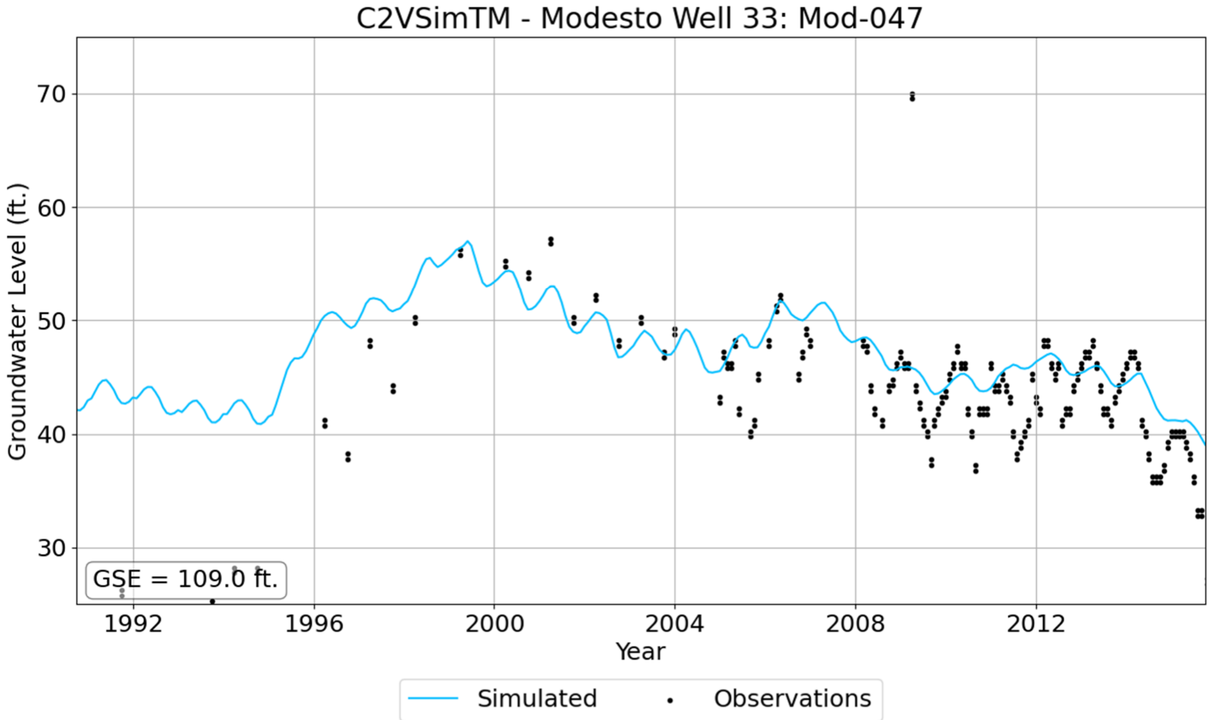

C2VSimTM - Modesto Well 30: Mod-054
Groundwater Level (ft.)
70
60
50
40
30
GSE = 108.0 ft.
1992
1996
2000
2004
2008
2012
Year
Simulated
Observations

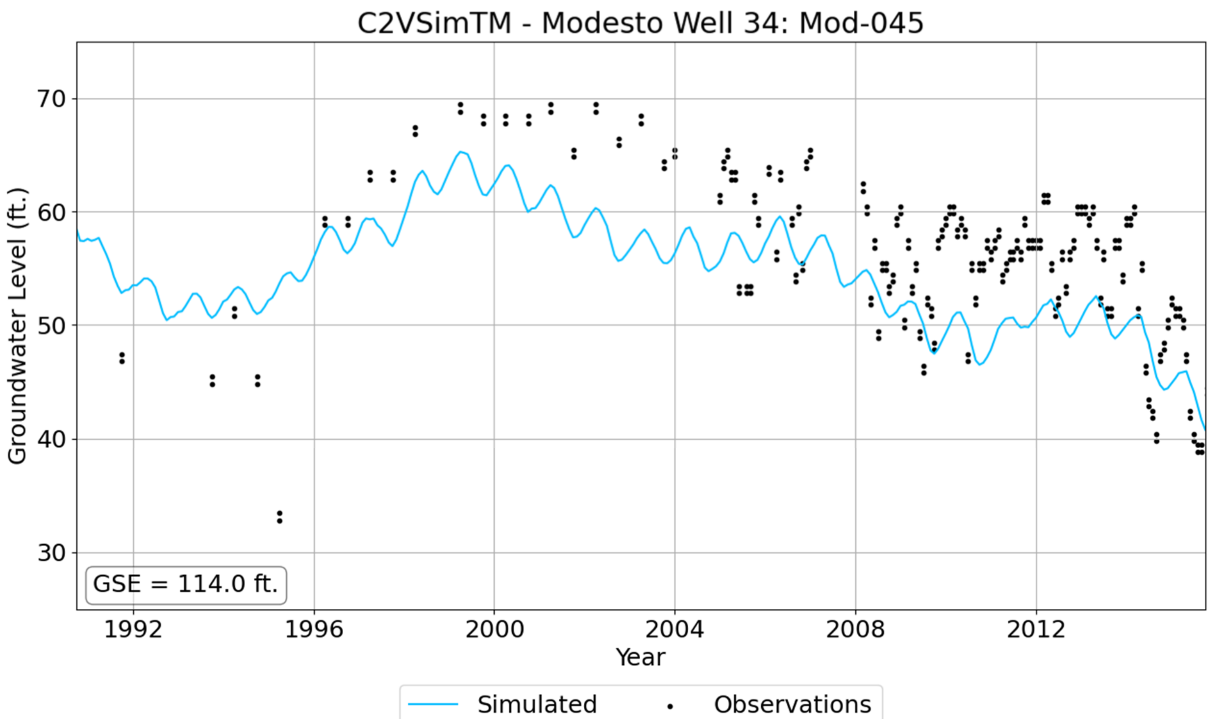


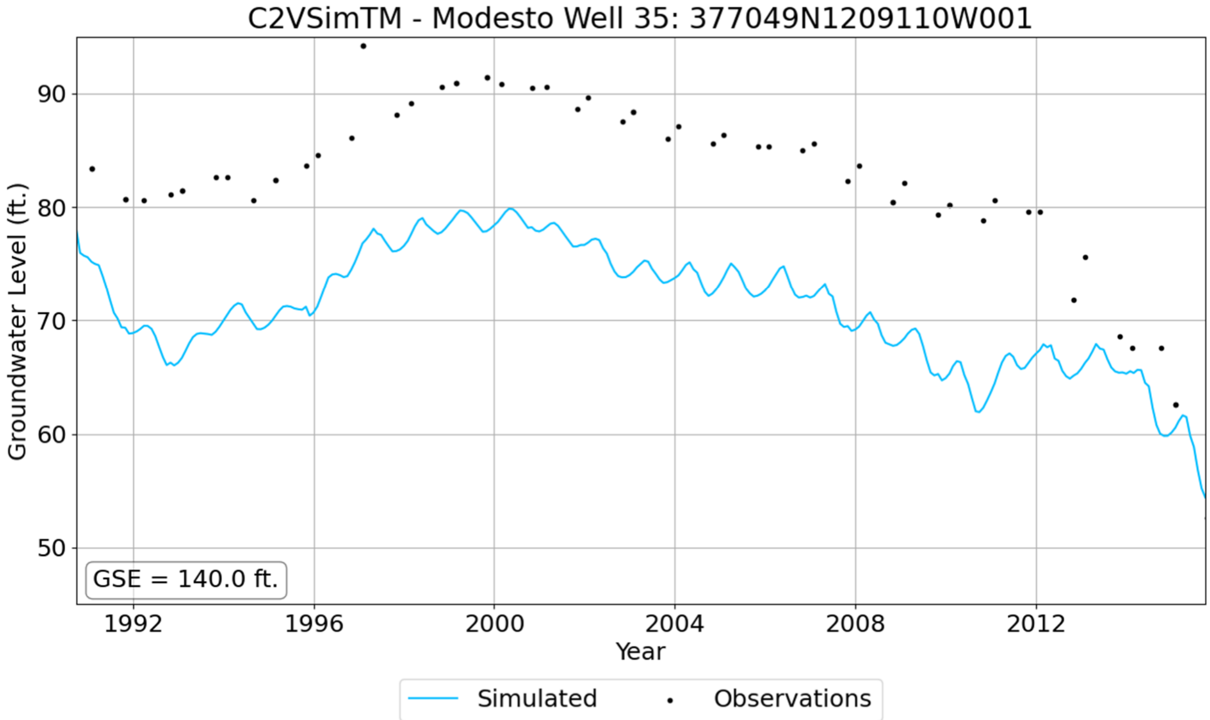
C2VSimTM - Modesto Well 31: Mod-046
Groundwater Level (ft.)
70
60
50
40
30
GSE = 104.0 ft.
1992
1996
2000
2004
2008
2012
Year
Simulated
Observations

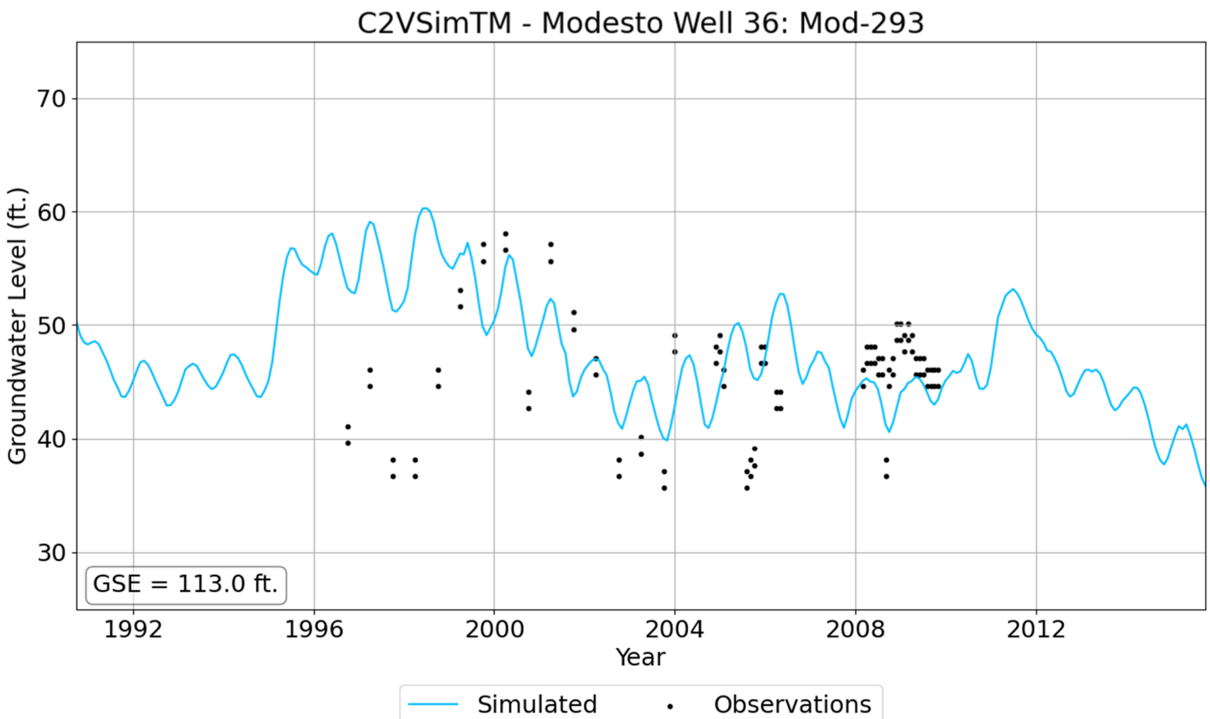


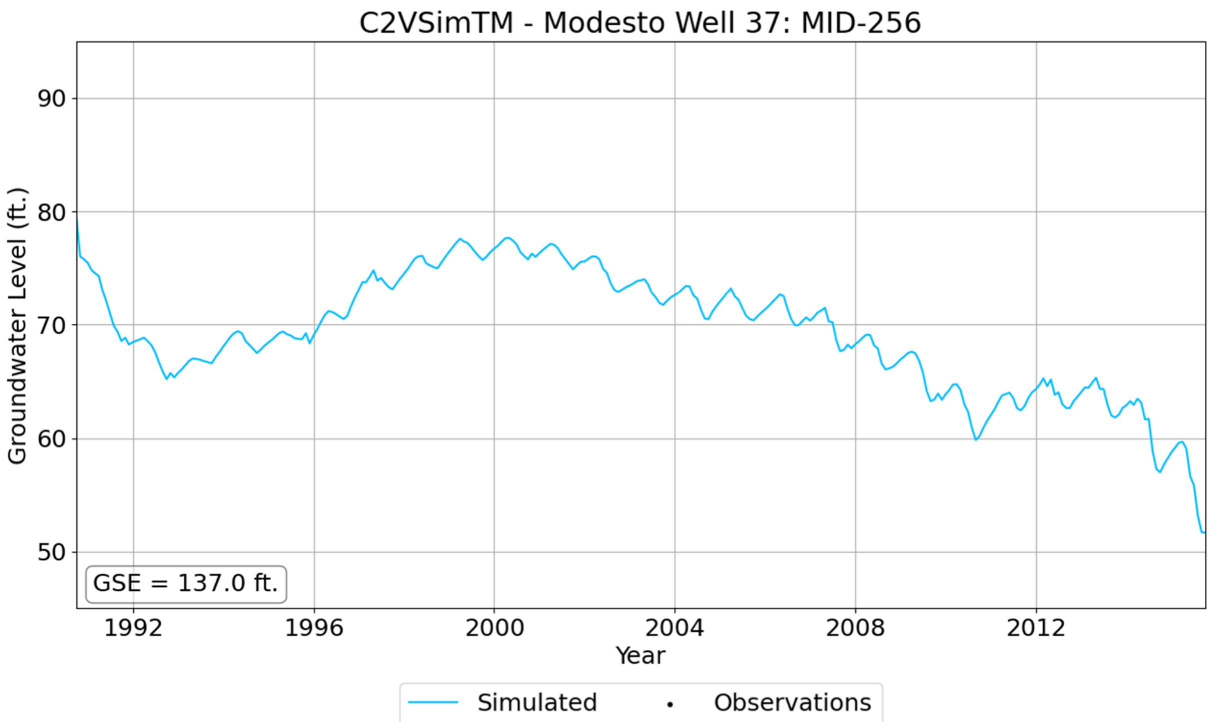
C2VSimTM - Modesto Well 32: RIV-004
Groundwater Level (ft.)
90
80
70
60
50
GSE = 81.0 ft.
1992
1996
2000
2004
2008
2012
Year
Simulated
Observations

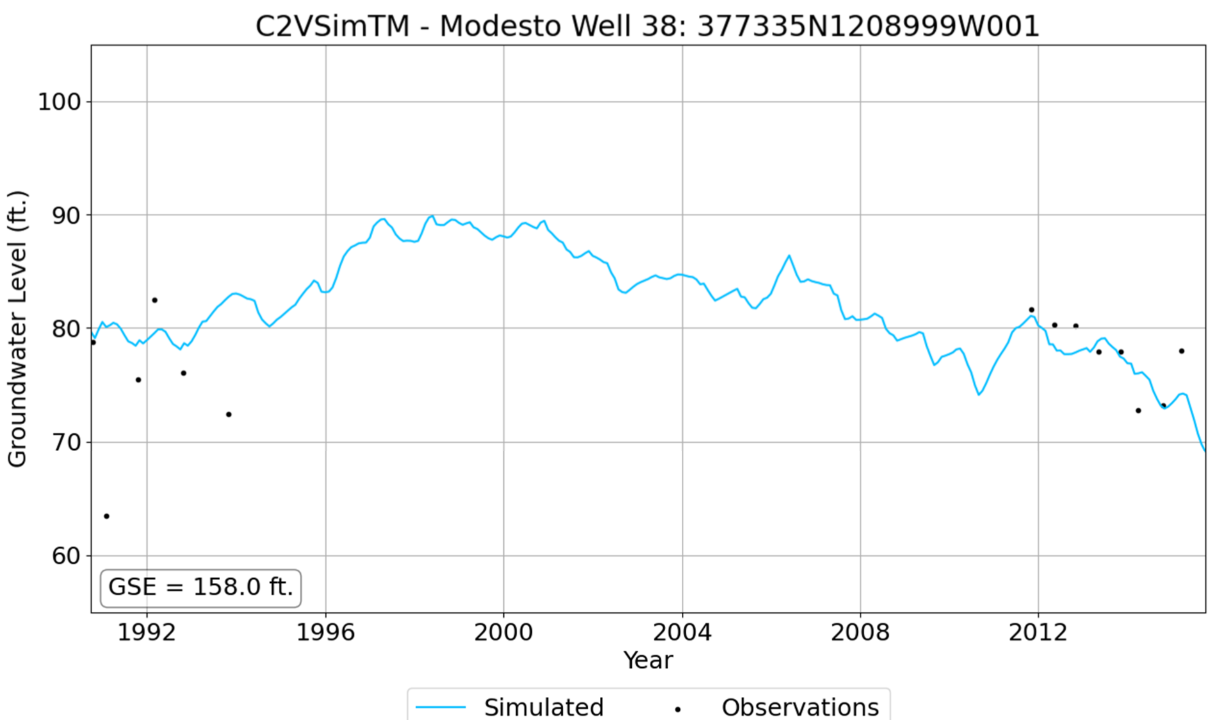

C2VSimTM - Modesto Well 33: Mod-047
Groundwater Level (ft.)
70
60
50
40
30
GSE = 109.0 ft.
1992
1996
2000
2004
2008
2012
Year
Simulated
Observations

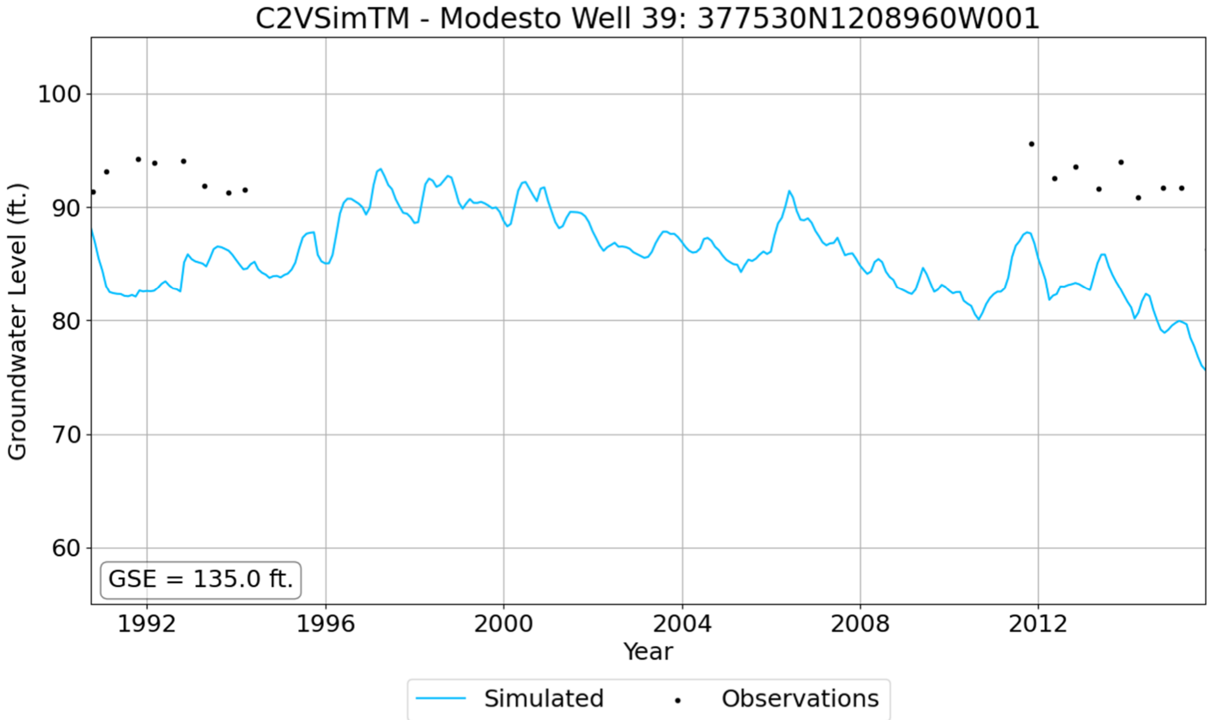

C2VSimTM - Modesto Well 34: Mod-045
Groundwater Level (ft.)
70
60
50
40
30
GSE = 114.0 ft.
1992
1996
2000
2004
2008
2012
Year
Simulated
Observations

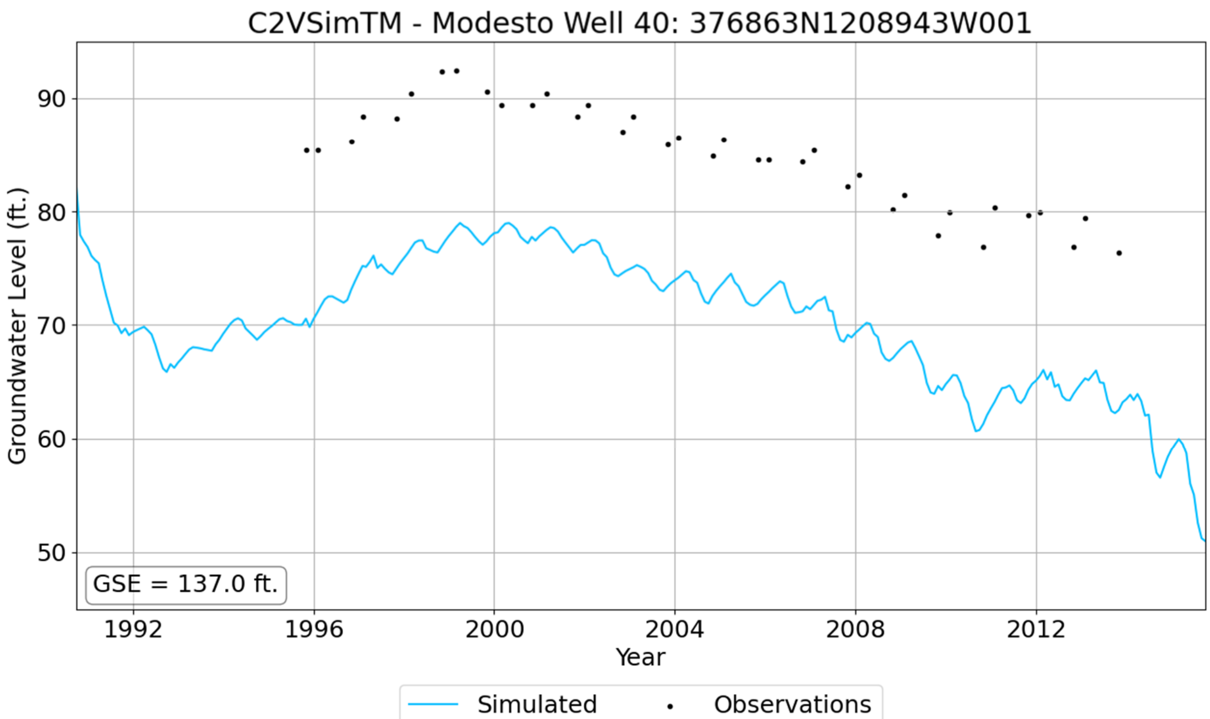

C2VSimTM - Modesto Well 35: 377049N1209110W001
Groundwater Level (ft.)
90
80
70
60
50
GSE = 140.0 ft.
1992
1996
2000
2004
2008
2012
Year
Simulated
Observations

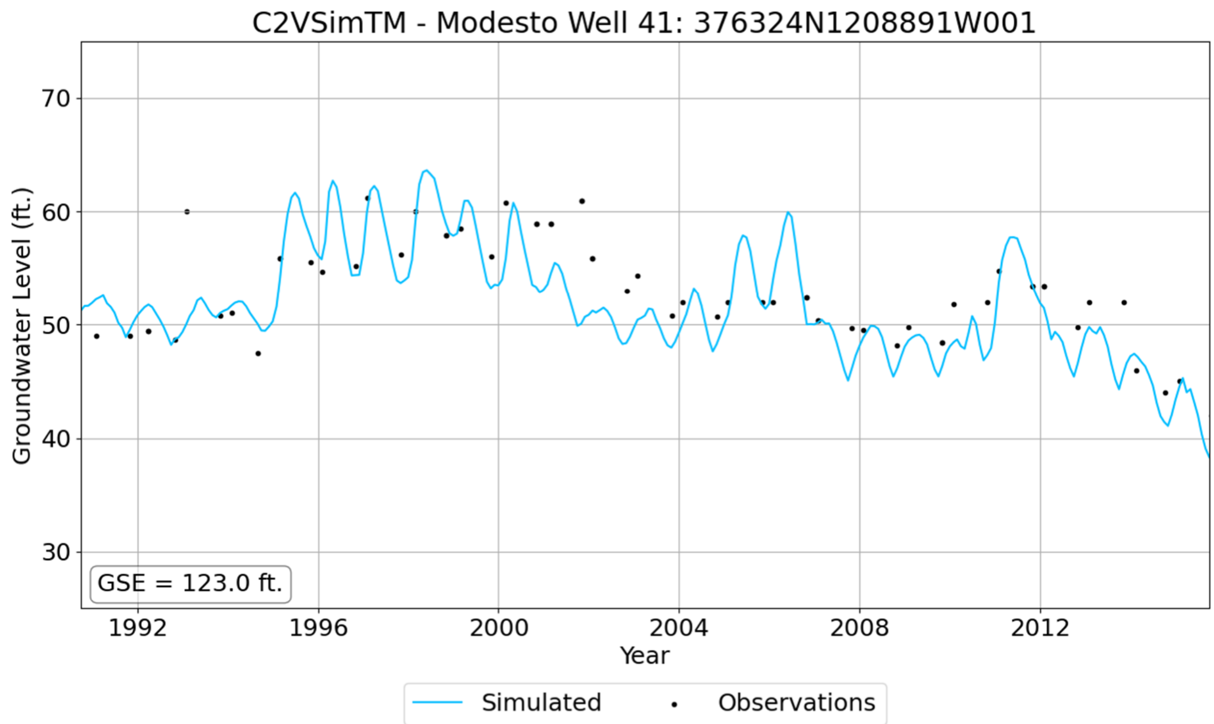

C2VSimTM - Modesto Well 36: Mod-293
Groundwater Level (ft.)
70
60
50
40
30
GSE = 113.0 ft.
1992
1996
2000
2004
2008
2012
Year
Simulated
Observations

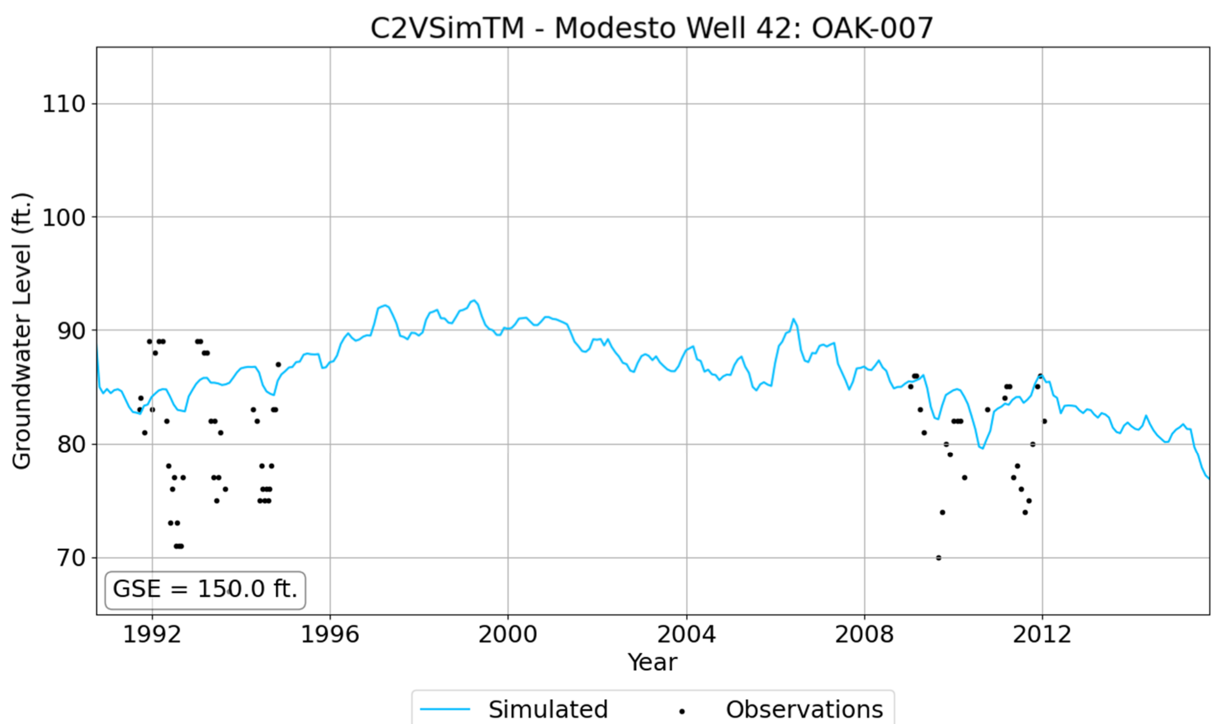

C2VSimTM - Modesto Well 37: MID-256
Groundwater Level (ft.)
90
80
70
60
50
GSE = 137.0 ft.
1992
1996
2000
2004
2008
2012
Year
Simulated
Observations

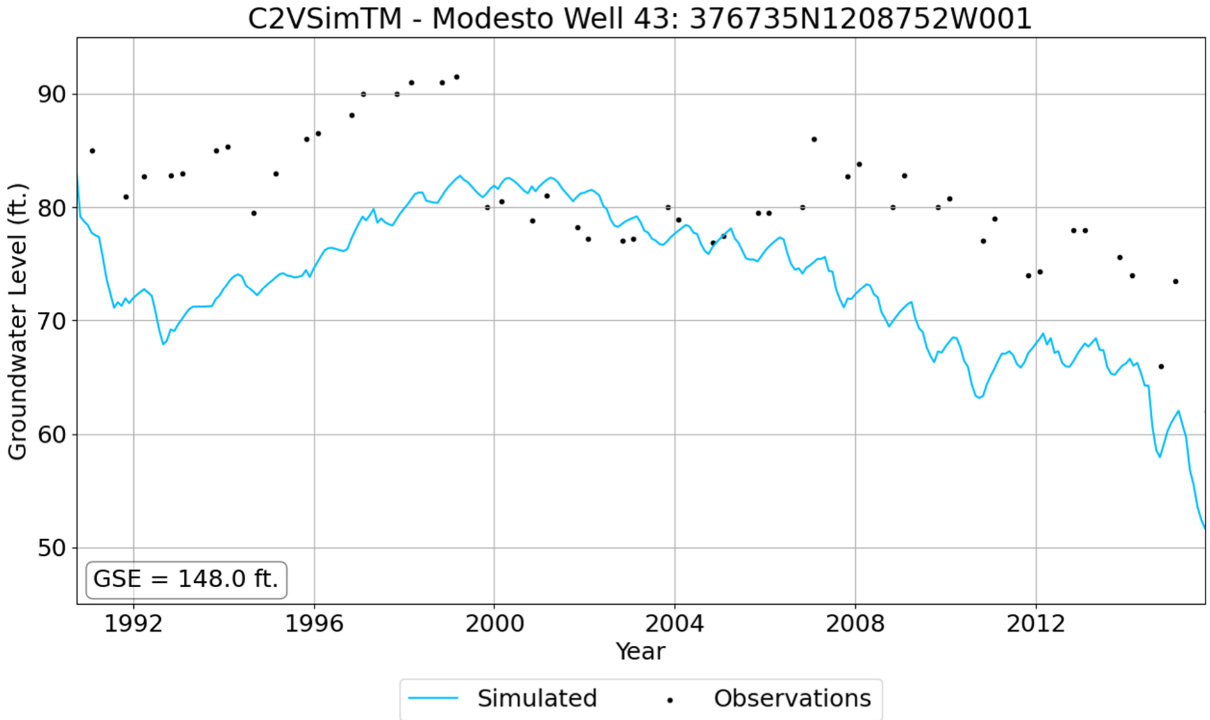

C2VSimTM - Modesto Well 38: 377335N1208999W001
Groundwater Level (ft.)
100
90
80
70
60
GSE = 158.0 ft.
1992
1996
2000
2004
2008
2012
Year
Simulated
Observations

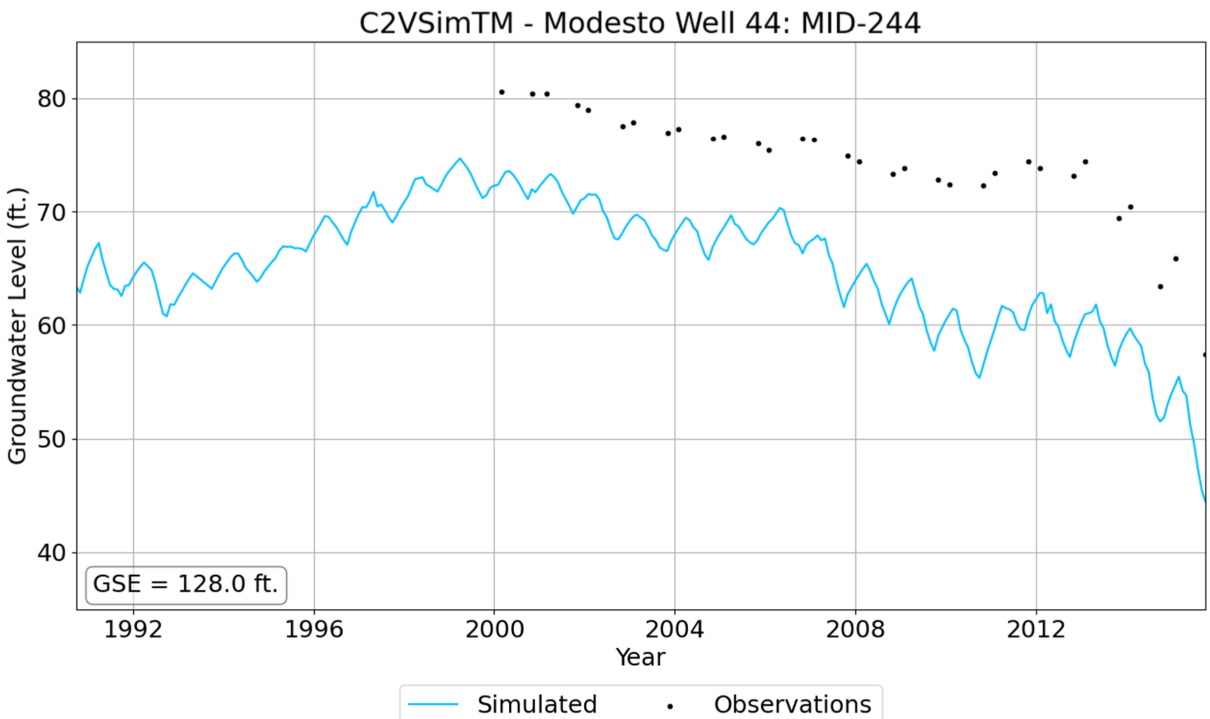

C2VSimTM - Modesto Well 39: 377530N1208960W001
Groundwater Level (ft.)
100
90
80
70
60
GSE = 135.0 ft.
1992
1996
2000
2004
2008
2012
Year
Simulated
Observations

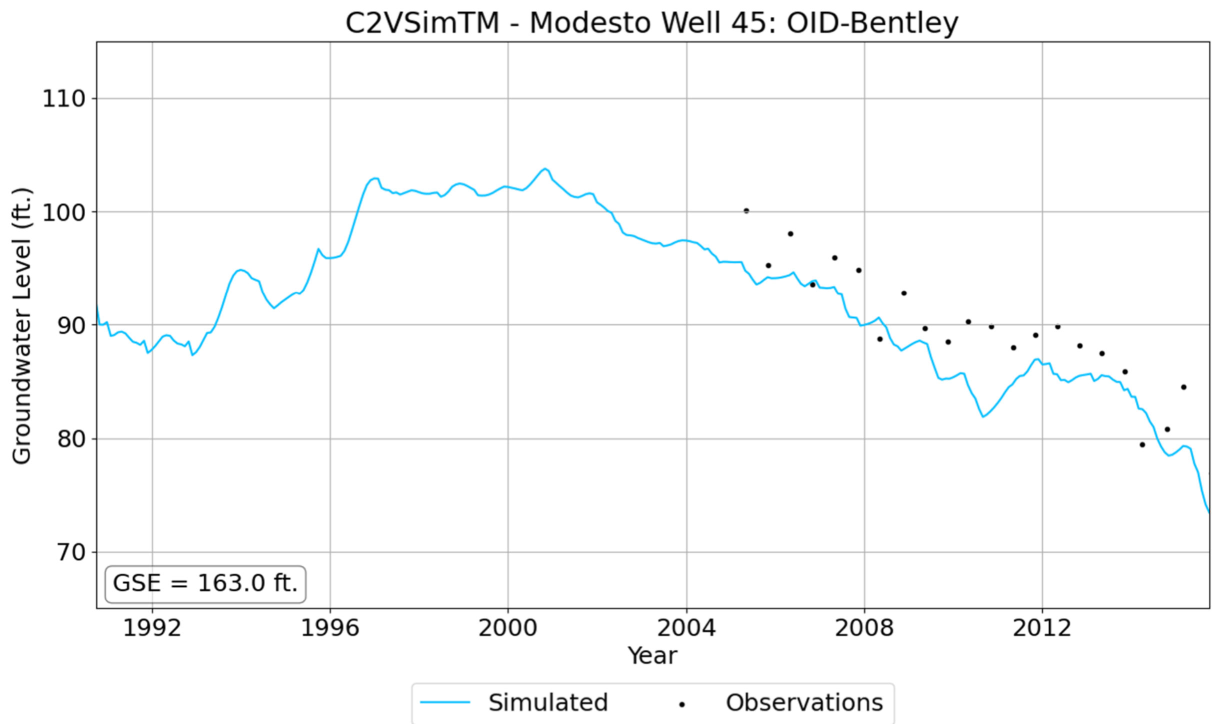

C2VSimTM - Modesto Well 40: 376863N1208943W001
Groundwater Level (ft.)
90
80
70
60
50
GSE = 137.0 ft.
1992
1996
2000
2004
2008
2012
Year
Simulated
Observations

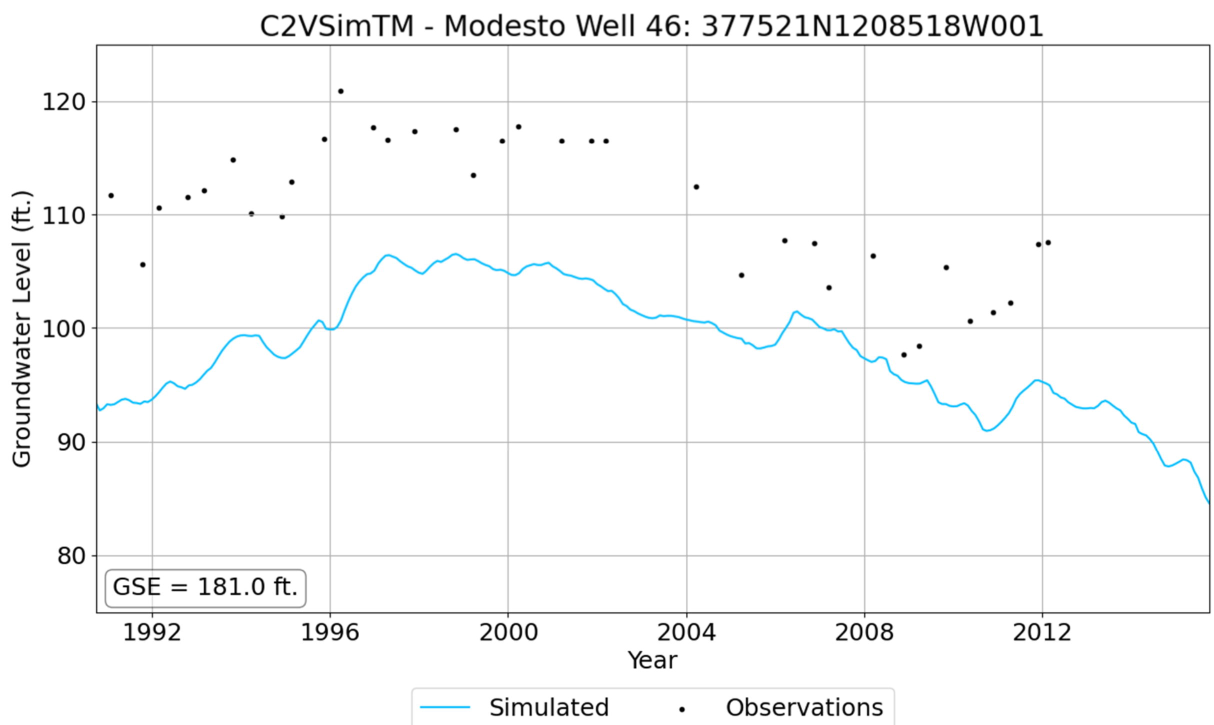

C2VSimTM - Modesto Well 41: 376324N1208891W001
Groundwater Level (ft.)
70
60
50
40
30
GSE = 123.0 ft.
1992
1996
2000
2004
2008
2012
Year
Simulated
Observations

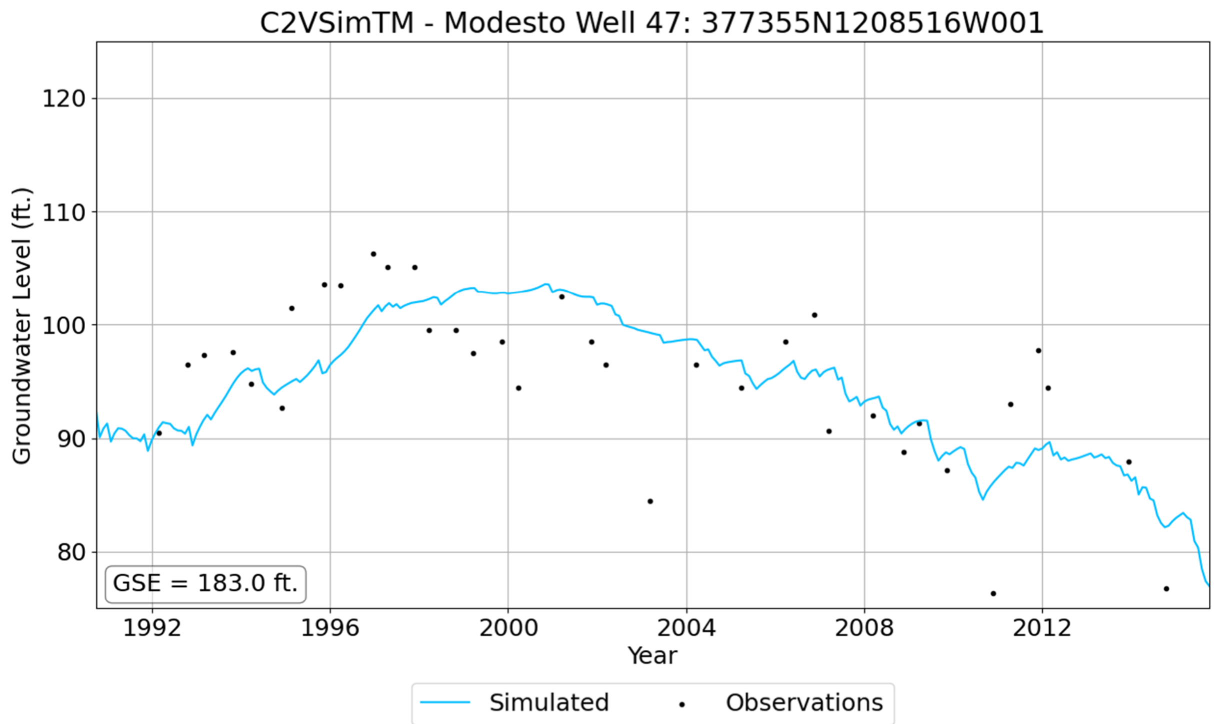

C2VSimTM - Modesto Well 42: OAK-007
Groundwater Level (ft.)
110
100
90
80
70
GSE = 150.0 ft.
1992
1996
2000
2004
2008
2012
Year
Simulated
Observations


C2VSimTM - Modesto Well 43: 376735N1208752W001
Groundwater Level (ft.)
90
80
70
60
50
GSE = 148.0 ft.
1992
1996
2000
2004
2008
2012
Year
Simulated
Observations

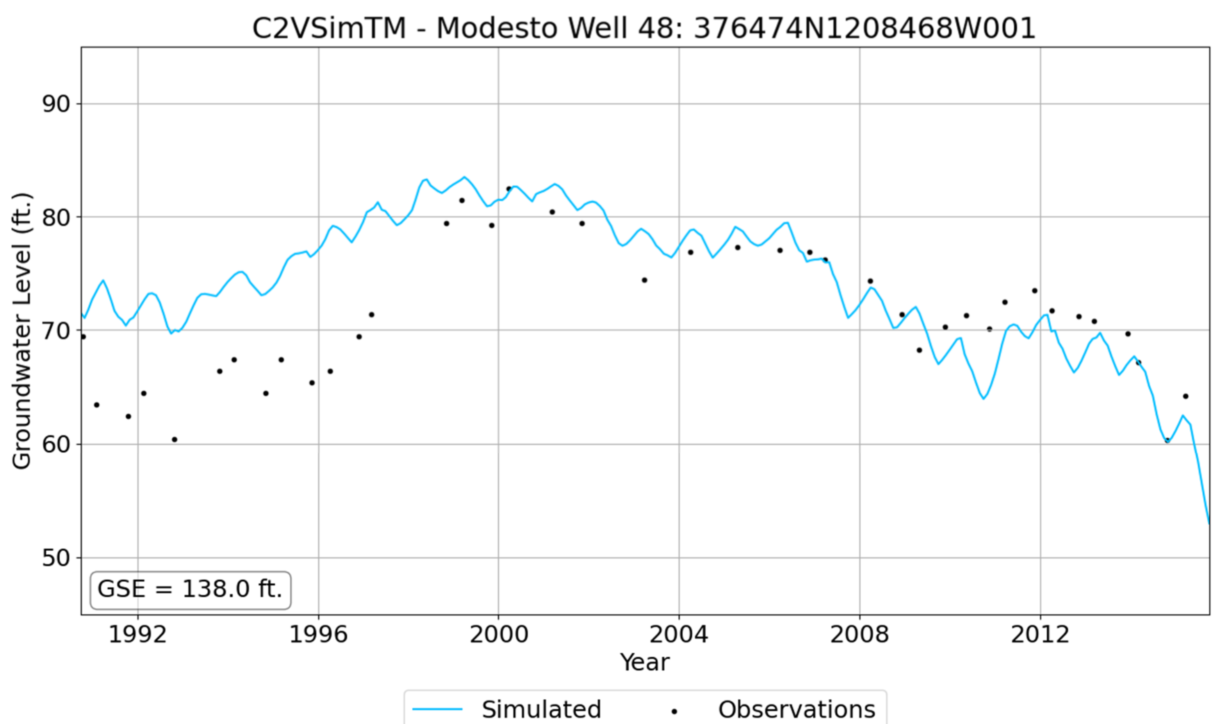

C2VSimTM - Modesto Well 44: MID-244
Groundwater Level (ft.)
80
70
60
50
40
GSE = 128.0 ft.
1992
1996
2000
2004
2008
2012
Year
Simulated
Observations


C2VSimTM - Modesto Well 45: OID-Bentley
Groundwater Level (ft.)
Year
GSE = 163.0 ft.
Simulated
Observations

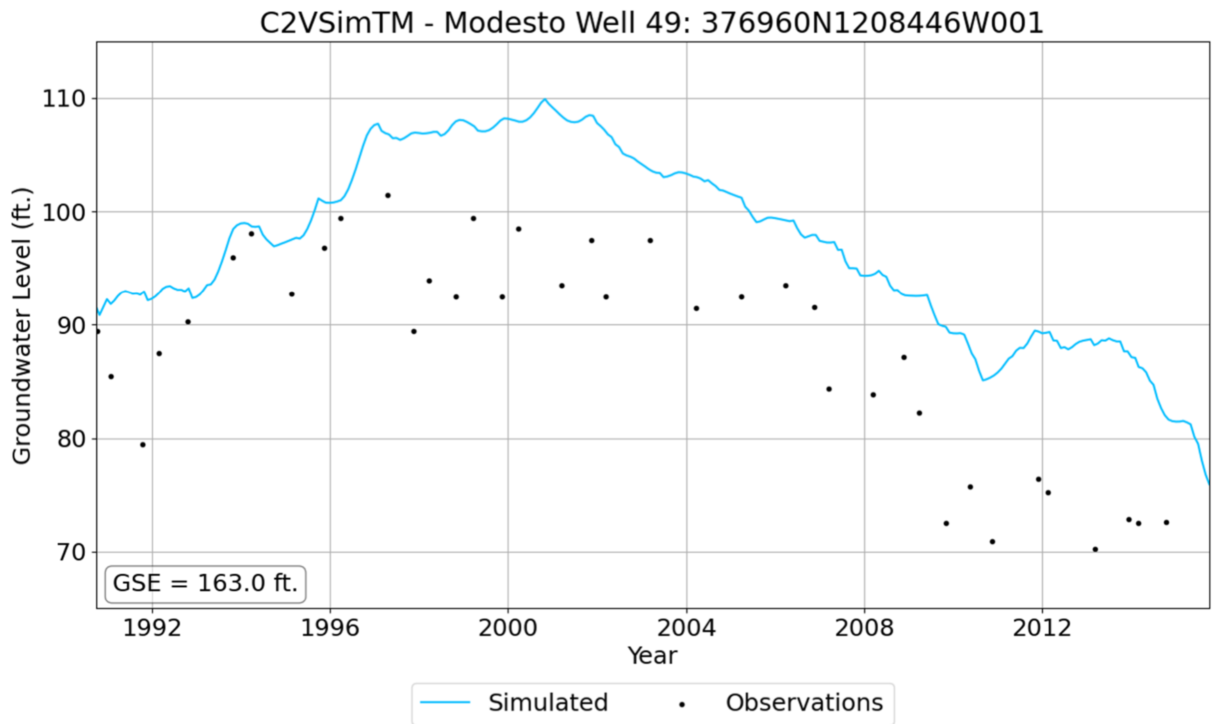

C2VSimTM - Modesto Well 46: 377521N1208518W001
Groundwater Level (ft.)
Year
GSE = 181.0 ft.
Simulated
Observations

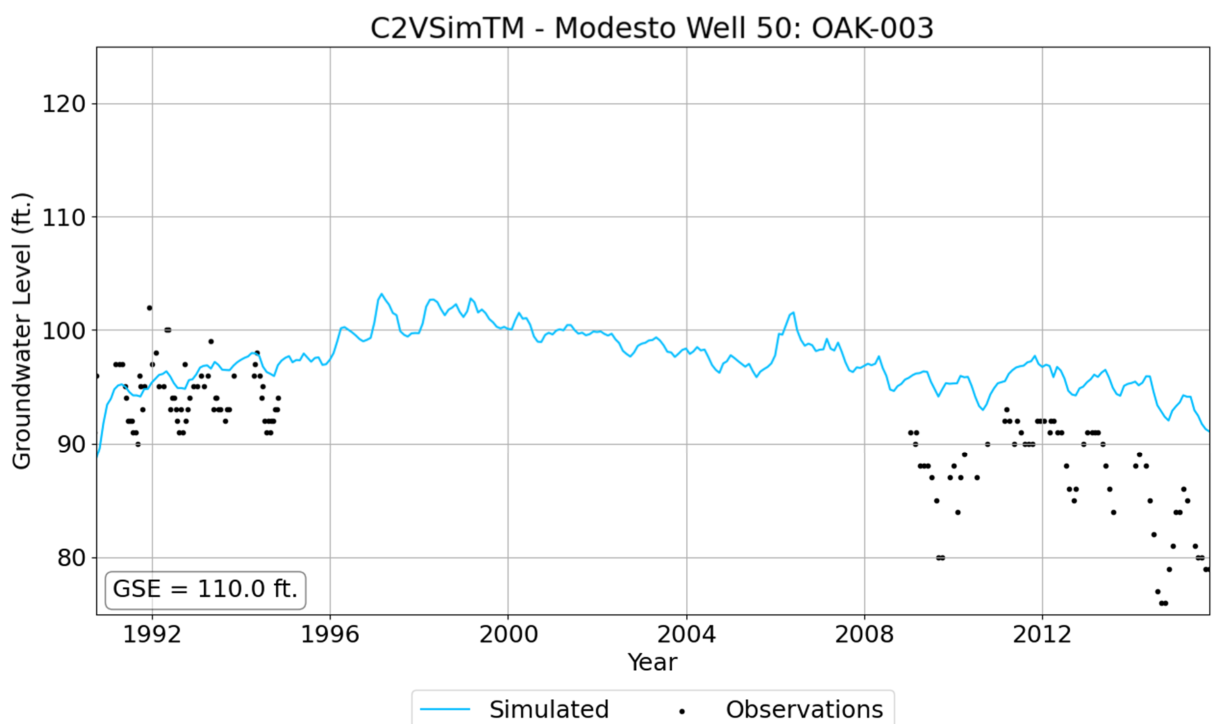


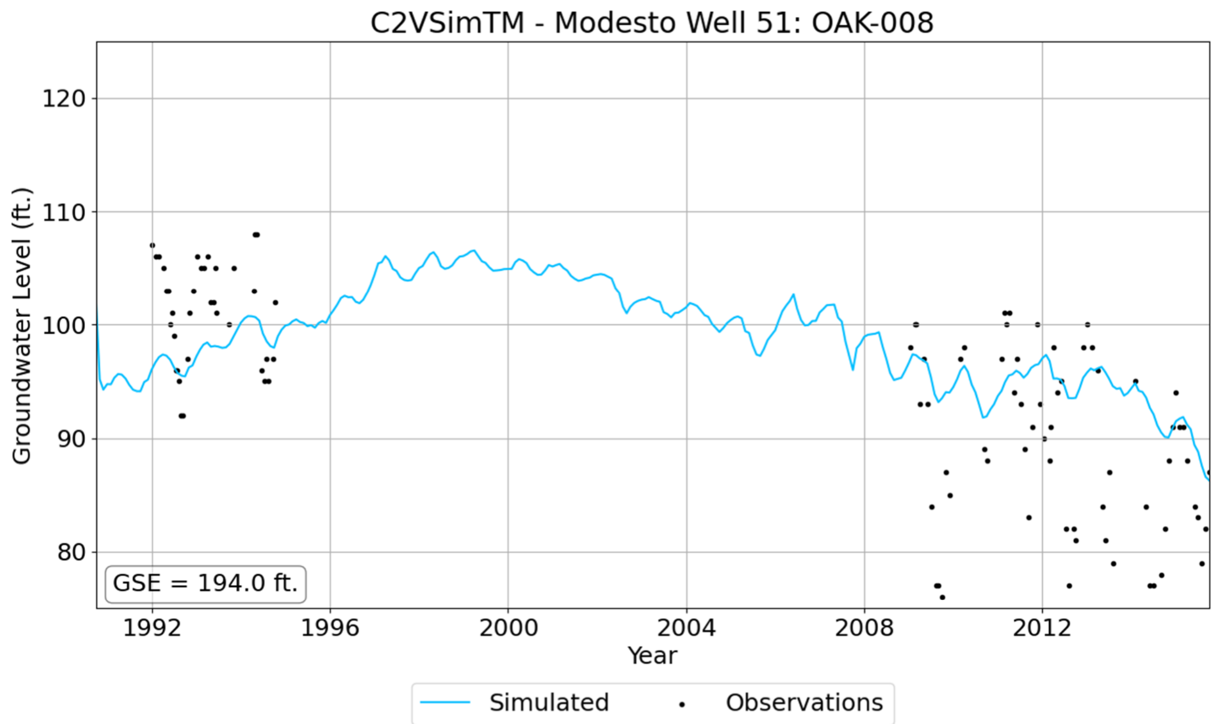
C2VSimTM - Modesto Well 47: 377355N1208516W001
Groundwater Level (ft.)
120
110
100
90
80
GSE = 183.0 ft.
1992
1996
2000
2004
2008
2012
Year
Simulated
Observations

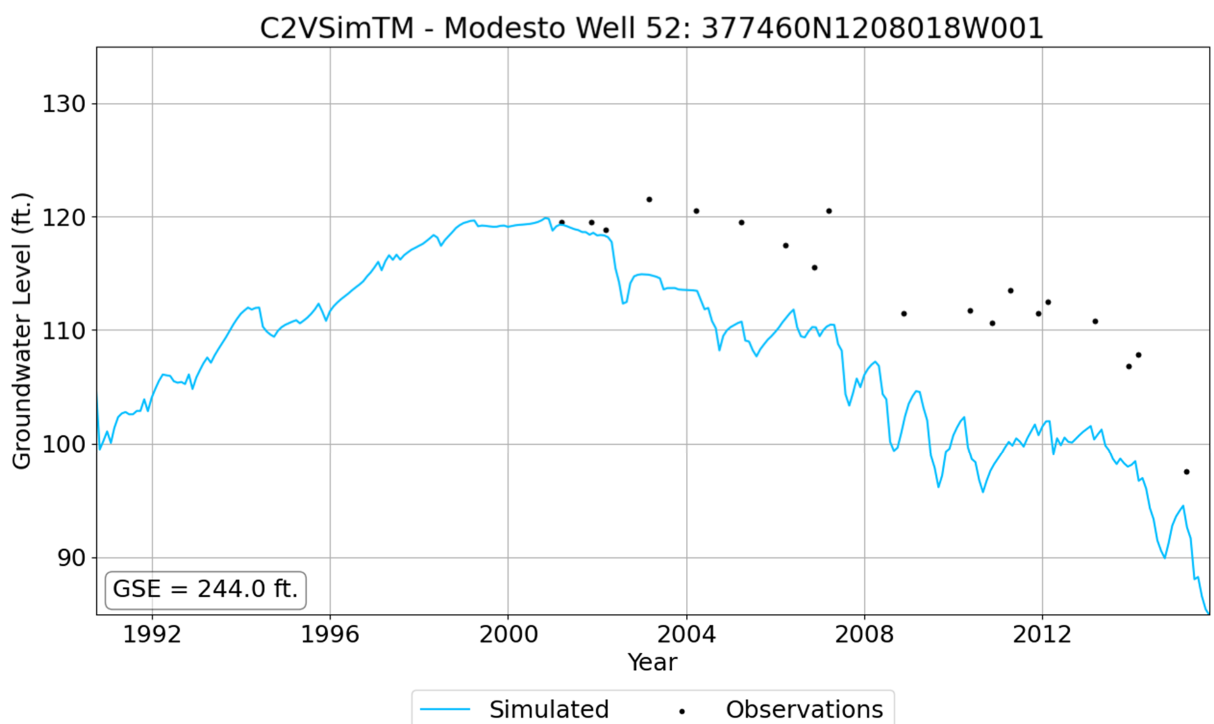


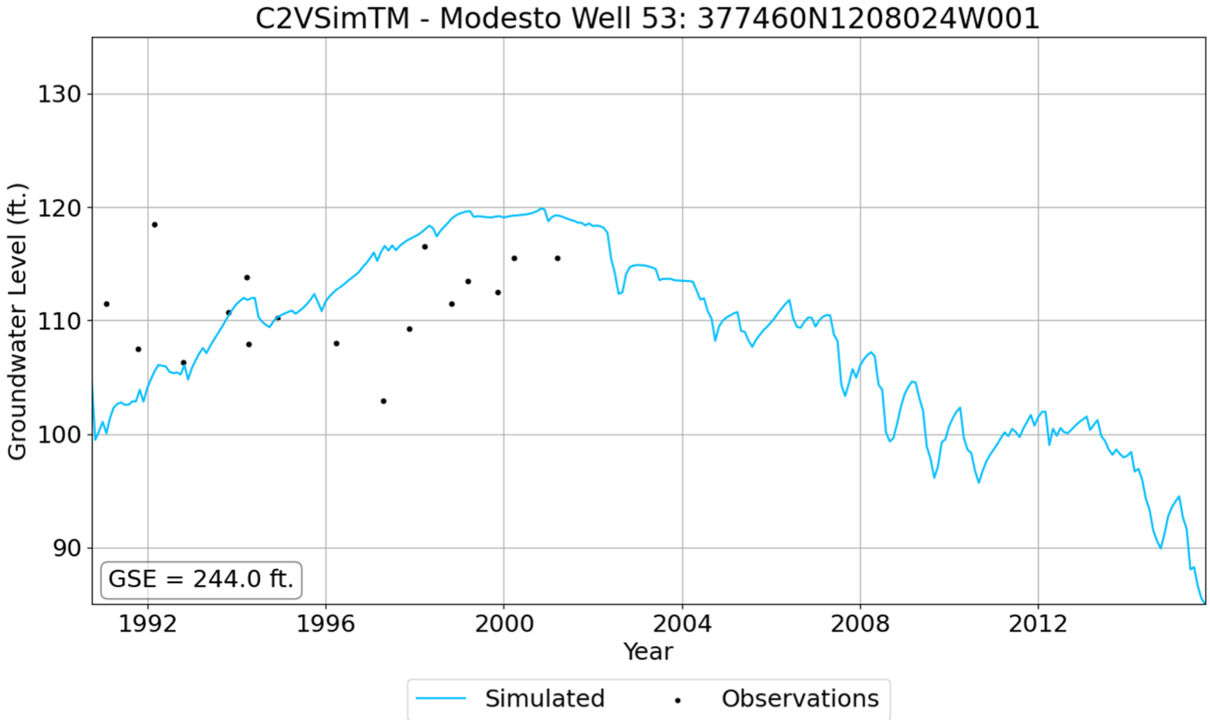
C2VSimTM - Modesto Well 48: 376474N1208468W001
Groundwater Level (ft.)
90
80
70
60
50
GSE = 138.0 ft.
1992
1996
2000
2004
2008
2012
Year
Simulated
Observations

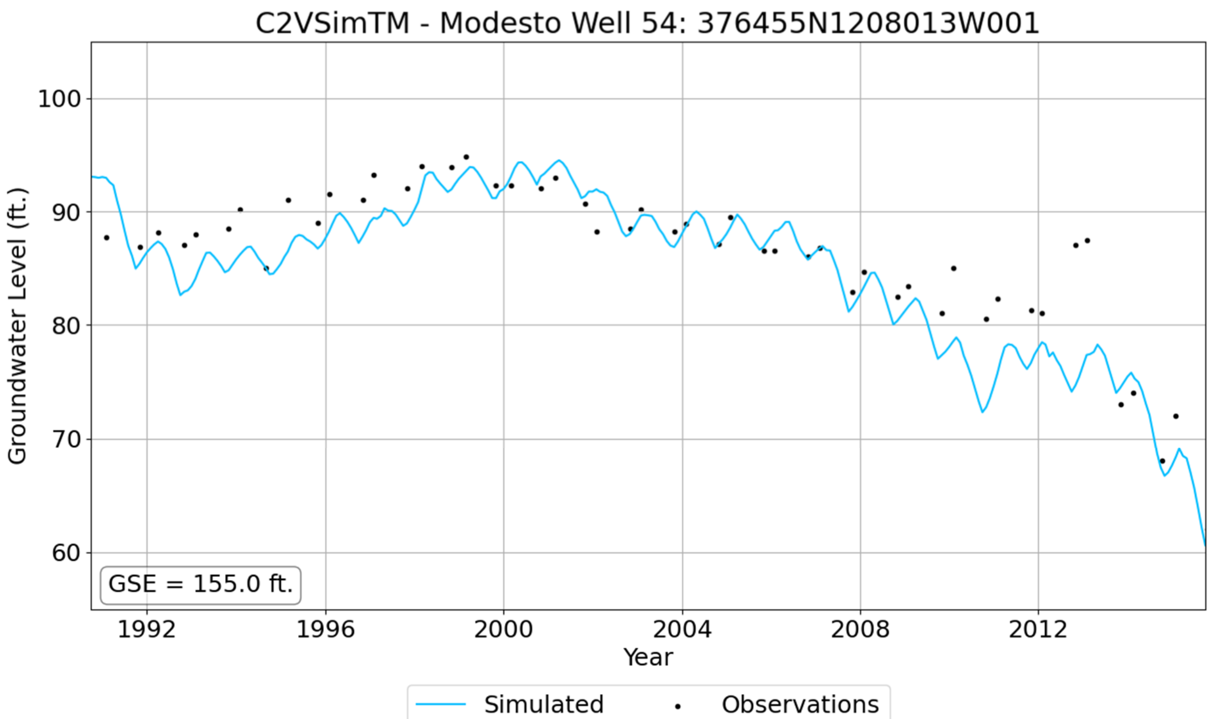

C2VSimTM - Modesto Well 49: 376960N1208446W001
Groundwater Level (ft.)
110
100
90
80
70
GSE = 163.0 ft.
1992
1996
2000
2004
2008
2012
Year
Simulated
Observations

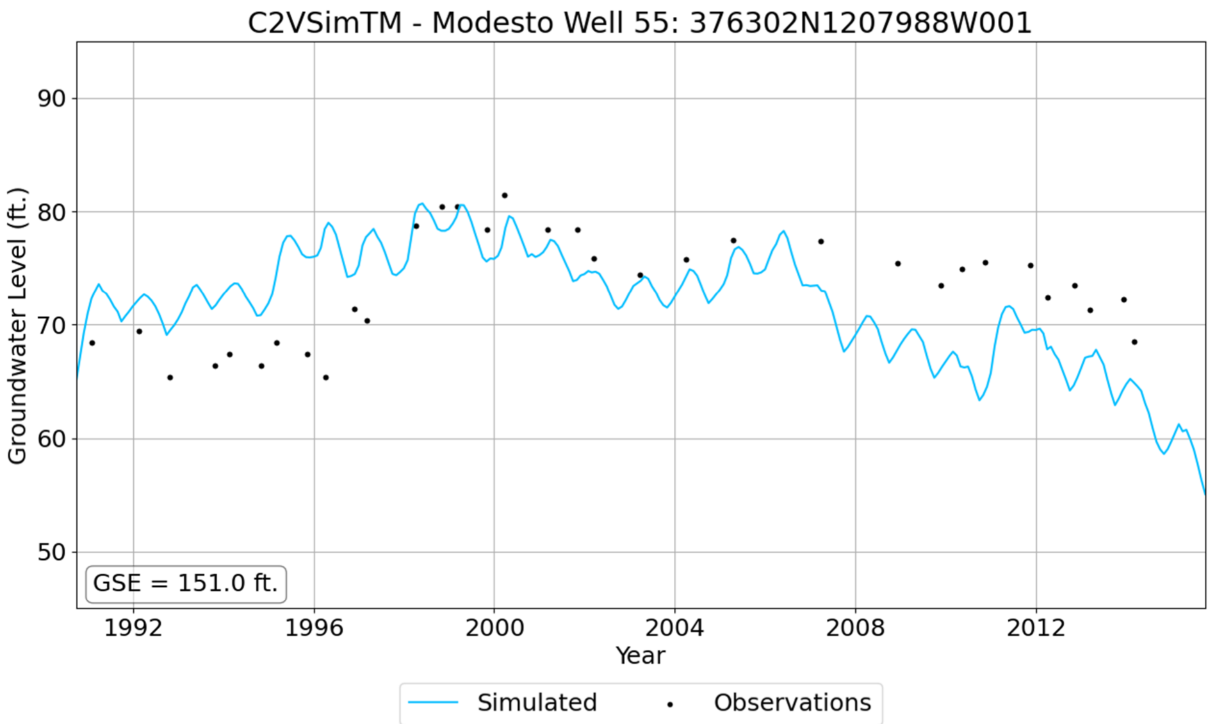

C2VSimTM - Modesto Well 50: OAK-003
Groundwater Level (ft.)
120
110
100
90
80
GSE = 110.0 ft.
1992
1996
2000
2004
2008
2012
Year
Simulated
Observations


C2VSimTM - Modesto Well 51: OAK-008
Groundwater Level (ft.)
120
110
100
90
80
GSE = 194.0 ft.
1992
1996
2000
2004
2008
2012
Year
Simulated
Observations

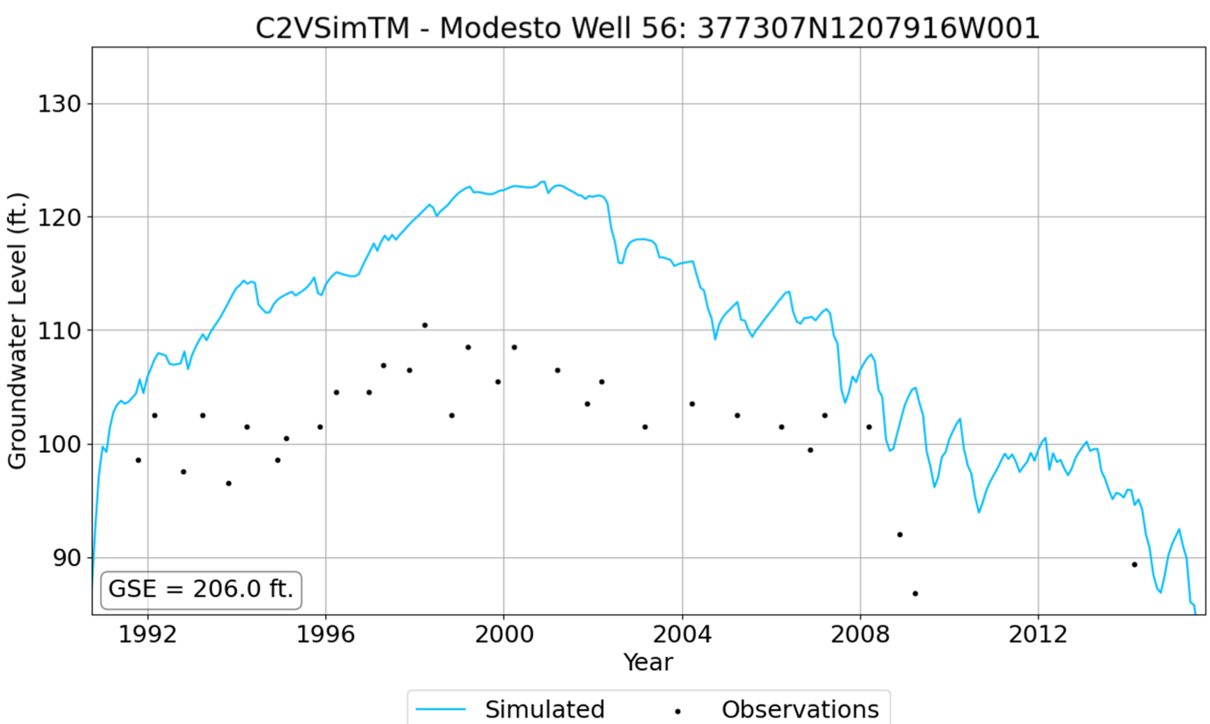

C2VSimTM - Modesto Well 52: 377460N1208018W001
Groundwater Level (ft.)
130
120
110
100
90
GSE = 244.0 ft.
1992
1996
2000
2004
2008
2012
Year
Simulated
Observations


C2VSimTM - Modesto Well 53: 377460N1208024W001
Groundwater Level (ft.)
130
120
110
100
90
GSE = 244.0 ft.
1992
1996
2000
2004
2008
2012
Year
Simulated
Observations

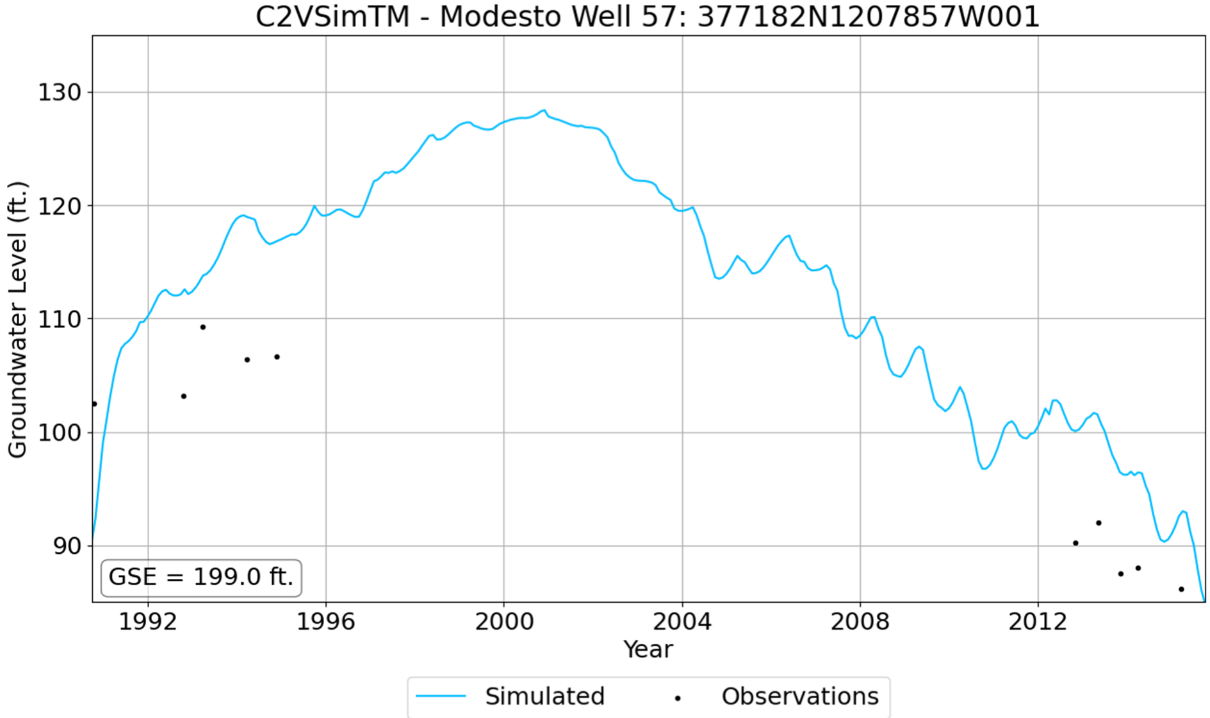

C2VSimTM - Modesto Well 54: 376455N1208013W001
Groundwater Level (ft.)
100
90
80
70
60
GSE = 155.0 ft.
1992
1996
2000
2004
2008
2012
Year
Simulated
Observations

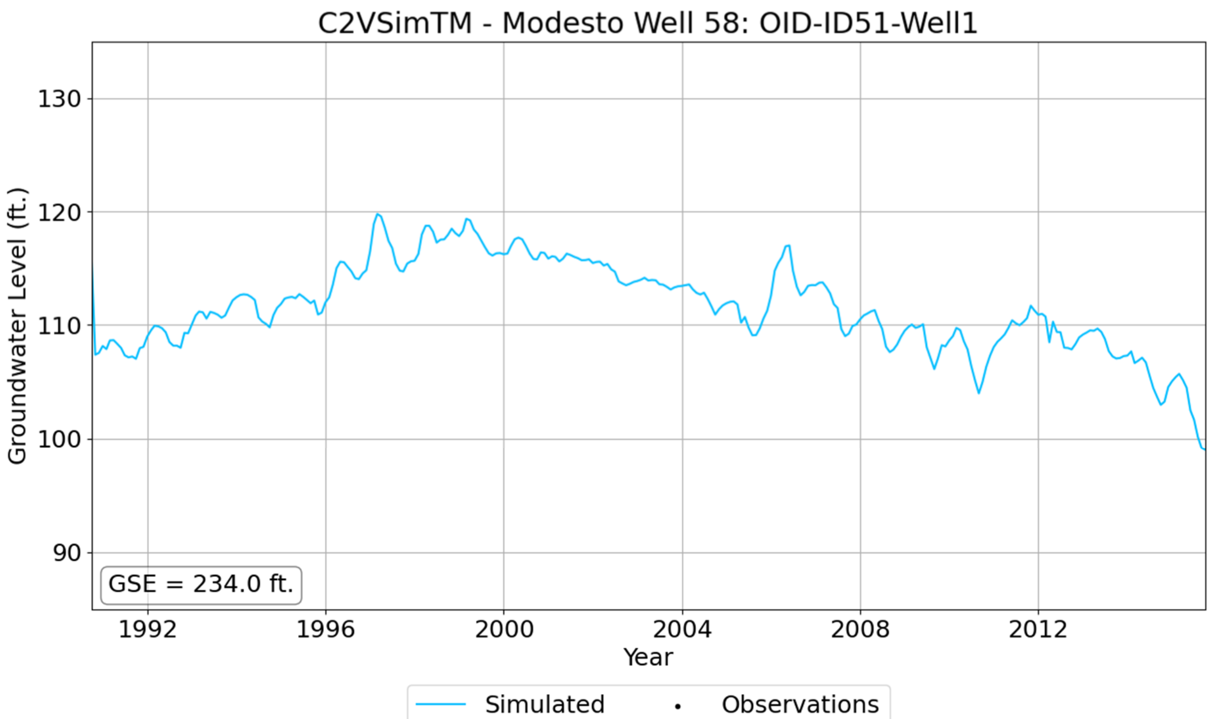


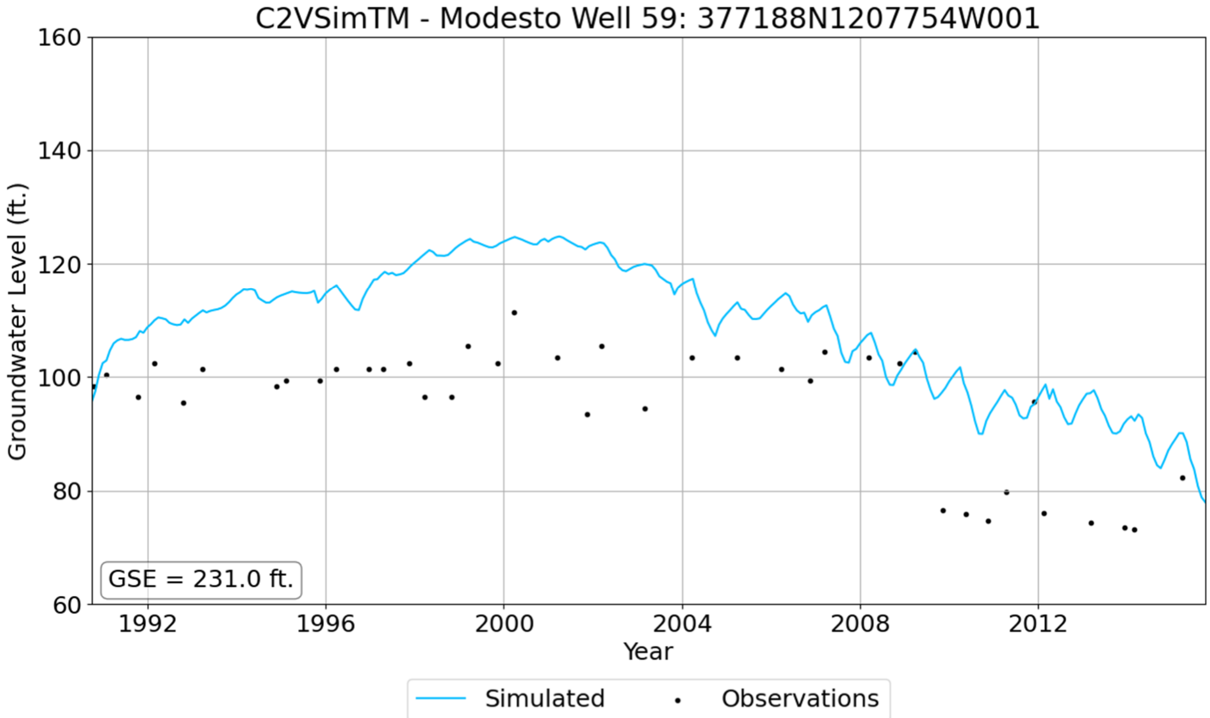
C2VSimTM - Modesto Well 55: 376302N1207988W001
Groundwater Level (ft.)
90
80
70
60
50
GSE = 151.0 ft.
1992
1996
2000
2004
2008
2012
Year
Simulated
Observations

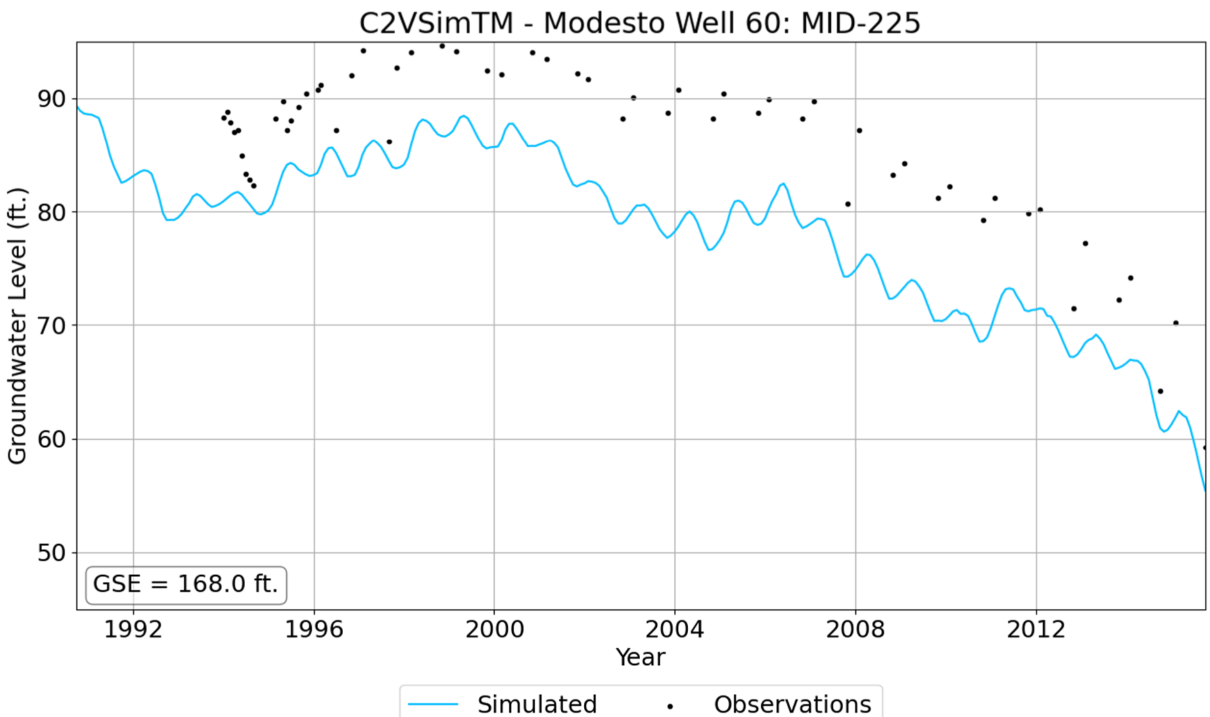


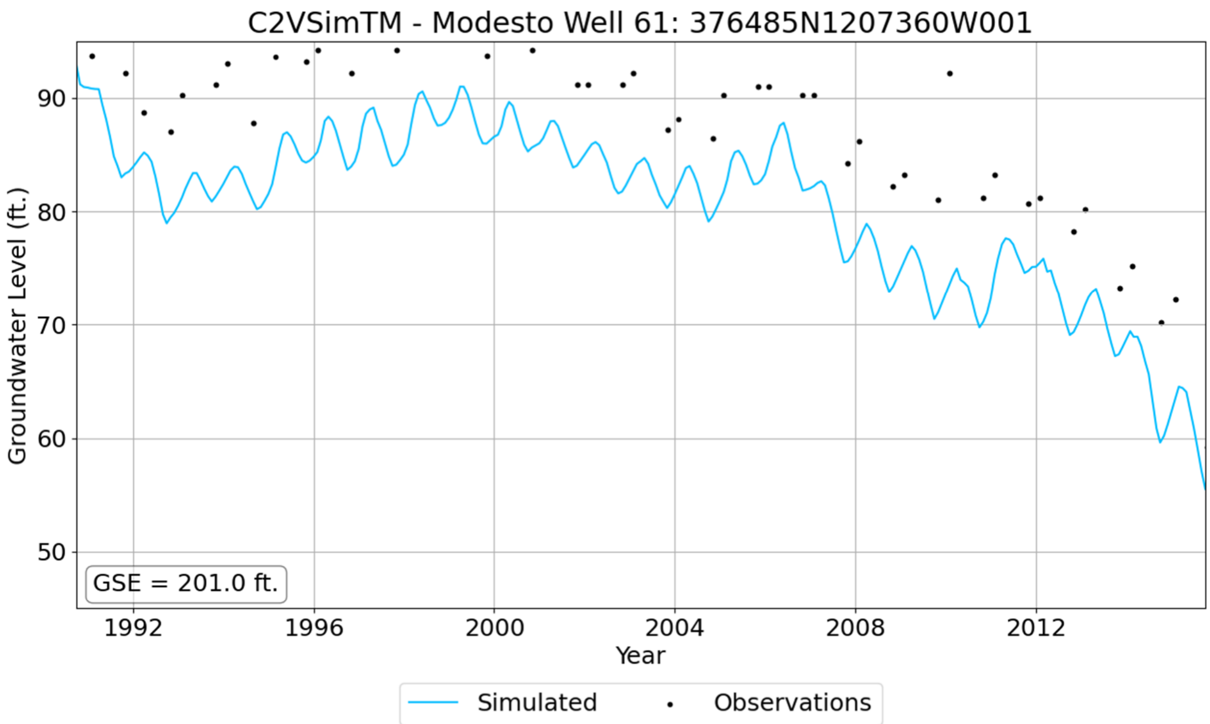
C2VSimTM - Modesto Well 56: 377307N1207916W001
Groundwater Level (ft.)
130
120
110
100
90
GSE = 206.0 ft.
1992
1996
2000
2004
2008
2012
Year
Simulated
Observations

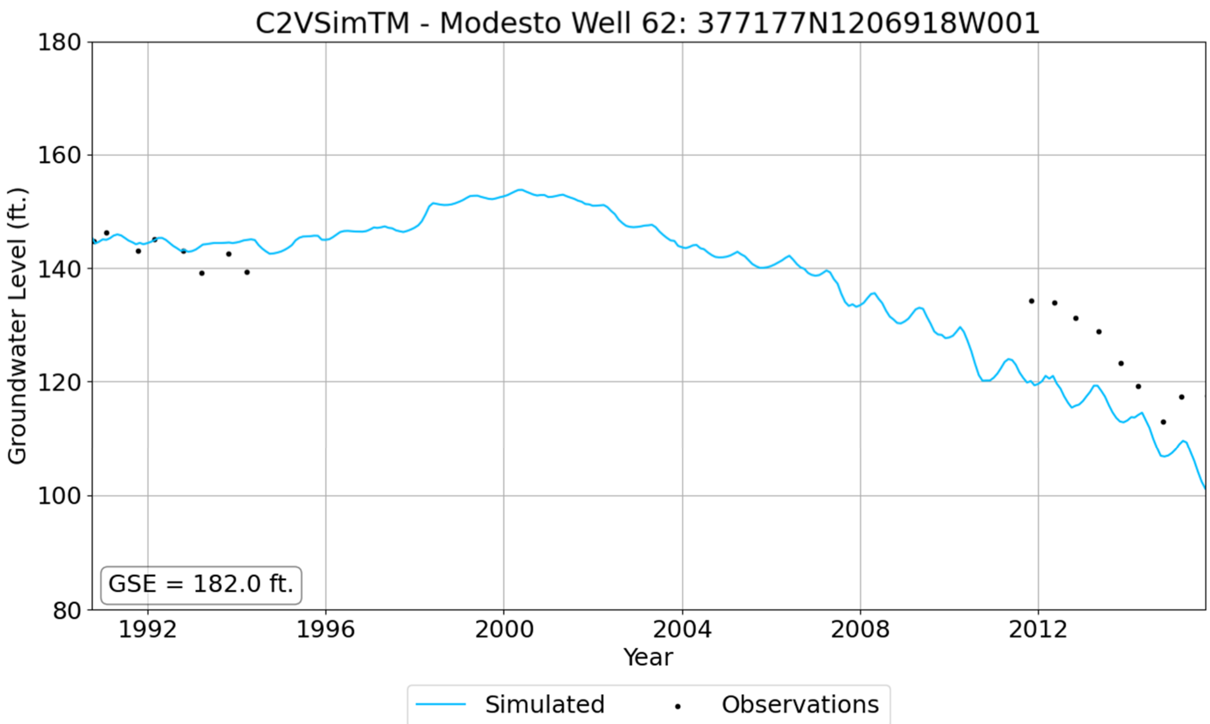

C2VSimTM - Modesto Well 57: 377182N1207857W001
Groundwater Level (ft.)
130
120
110
100
90
GSE = 199.0 ft.
1992
1996
2000
2004
2008
2012
Year
Simulated
Observations

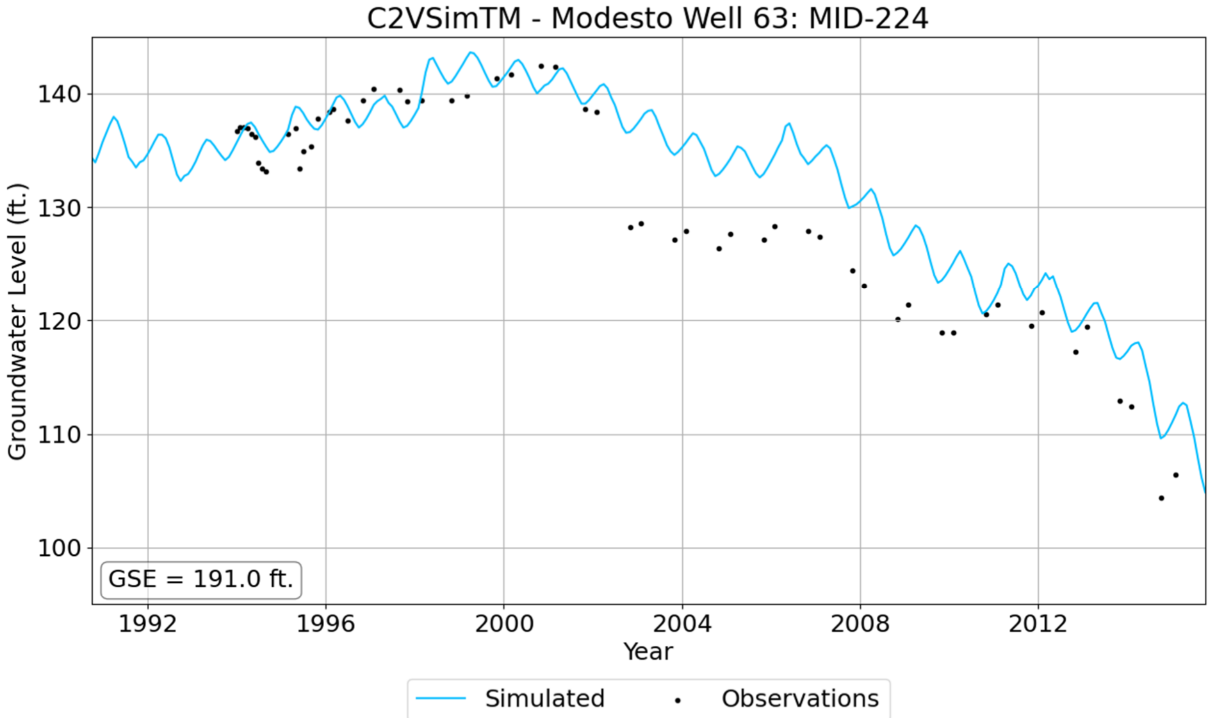

C2VSimTM - Modesto Well 58: OID-ID51-Well1
Groundwater Level (ft.)
130
120
110
100
90
GSE = 234.0 ft.
1992
1996
2000
2004
2008
2012
Year
Simulated
Observations

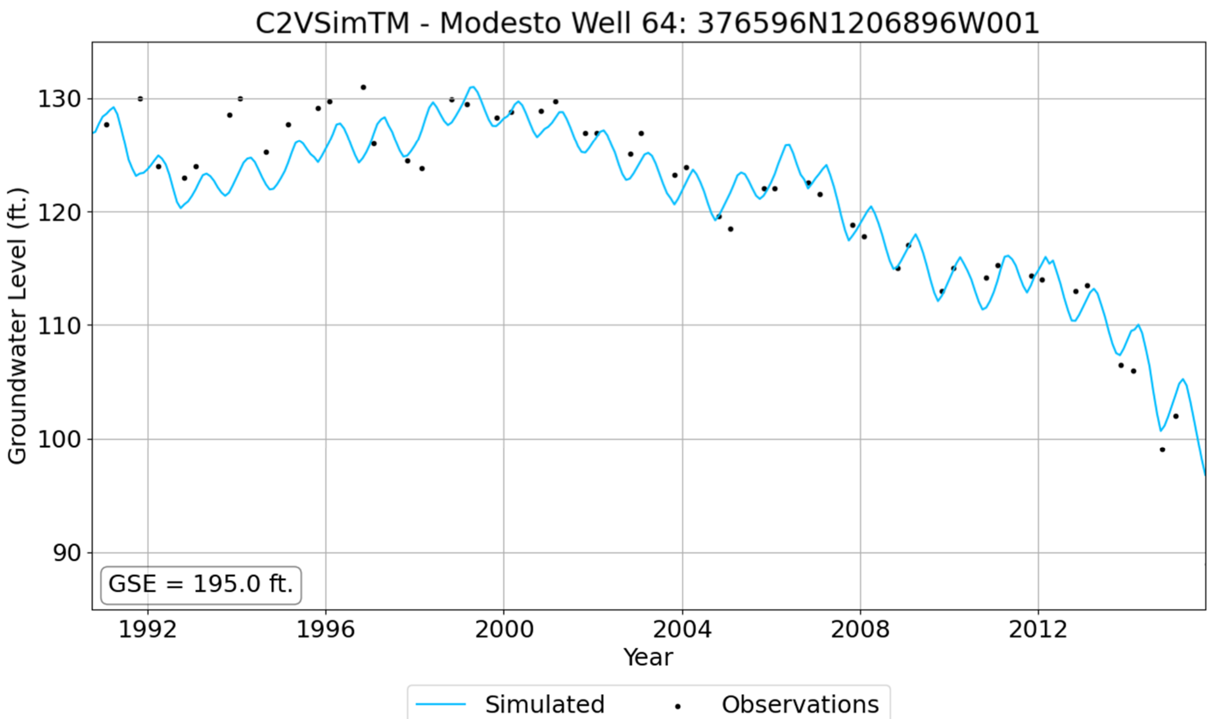

C2VSimTM - Modesto Well 59: 377188N1207754W001
Groundwater Level (ft.)
GSE = 231.0 ft.
Year
Simulated
Observations

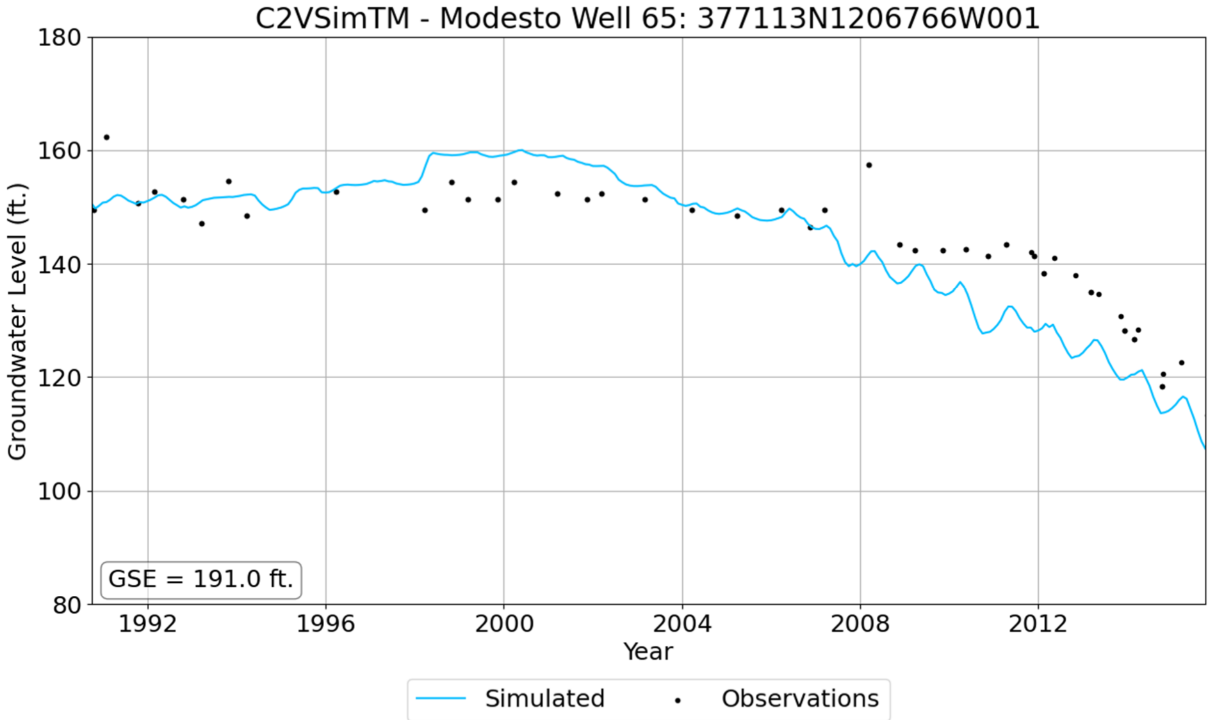

C2VSimTM - Modesto Well 60: MID-225
Groundwater Level (ft.)
GSE = 168.0 ft.
Year
Simulated
Observations

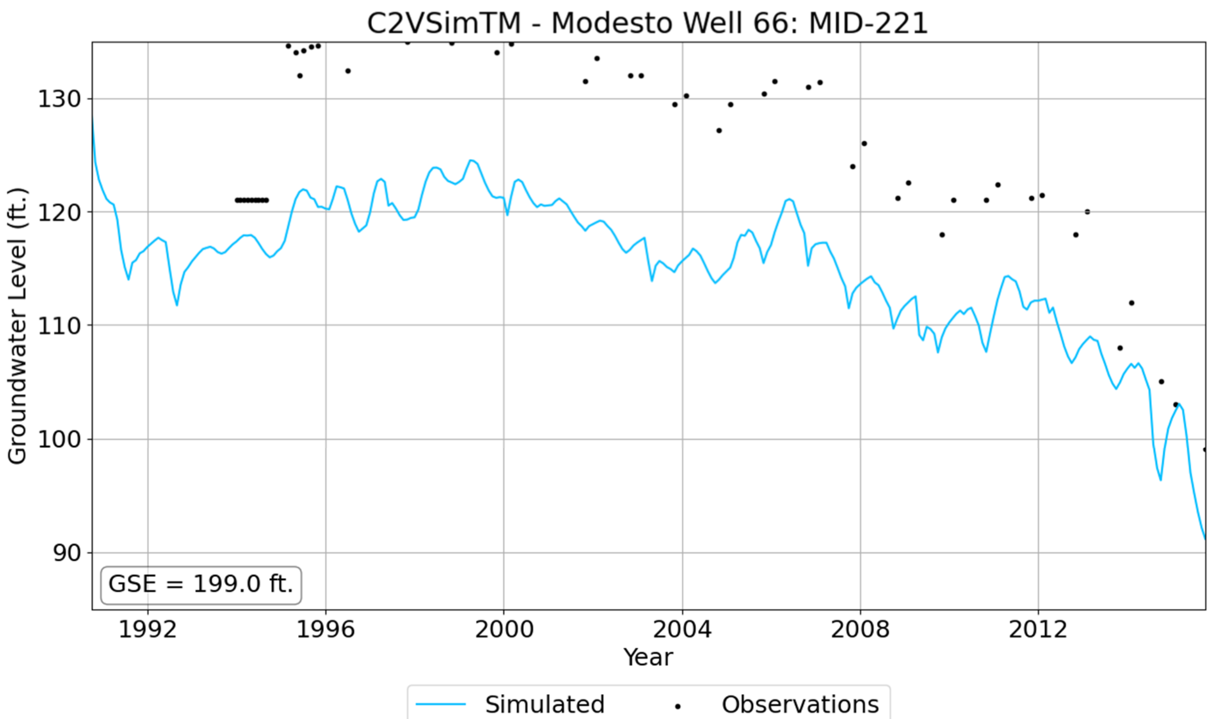

C2VSimTM - Modesto Well 61: 376485N1207360W001
Groundwater Level (ft.)
GSE = 201.0 ft.
Year
Simulated
Observations


C2VSimTM - Modesto Well 62: 377177N1206918W001
Groundwater Level (ft.)
GSE = 182.0 ft.
Year
Simulated
Observations


C2VSimTM - Modesto Well 63: MID-224
Groundwater Level (ft.)
140
130
120
110
100
GSE = 191.0 ft.
1992
1996
2000
2004
2008
2012
Year
Simulated
Observations


C2VSimTM - Modesto Well 64: 376596N1206896W001
Groundwater Level (ft.)
130
120
110
100
90
GSE = 195.0 ft.
1992
1996
2000
2004
2008
2012
Year
Simulated
Observations


C2VSimTM - Modesto Well 65: 377113N1206766W001
Groundwater Level (ft.)
Year
GSE = 191.0 ft.
Simulated
Observations


C2VSimTM - Modesto Well 66: MID-221
Groundwater Level (ft.)
Year
GSE = 199.0 ft.
Simulated
Observations

Appendix D

Mapes Ranch, Stanislaus County, California:

Review of Potential Groundwater Dependent Ecosystems

MOORE BIOLOGICAL CONSULTANTS

November 10, 2021

Todd Groundwater
Attn: Ms. Phyllis Stanin and Ms. Liz Elliott
2490 Mariner Square Loop, Ste. 215
Alameda, CA 94501

Subject: "MAPES RANCH", STANISLAUS COUNTY, CALIFORNIA: REVIEW OF POTENTIAL GROUNDWATER DEPENDENT ECOSYSTEMS

Dear Ms. Stanin and Ms. Elliott:

During the past 2 months, I reviewed the areas on the privately-owned parcels on the Mapes Ranch that have been identified as potential Groundwater Dependent Ecosystems ("GDEs") by Todd Groundwater, consultants to the Stanislaus & Tuolumne Rivers Groundwater Basis Association ("STRGBA") Groundwater Sustainability Agency ("GSA"). I also conducted a cursory review of a few areas initially described as potential GDEs on adjacent properties managed by the Mapes Ranch ownership, but owned by the U.S. Fish and Wildlife Service ("USFWS"). Figure 1 depicts the Mapes Ranch ownership and the adjacent USFWS parcels, cumulatively described as the "Mapes Ranch". Figure 2 depicts the areas initially described as potential GDEs identified in the review area. This expanded analysis is a follow-up to my September 29, 2021 letter that discussed a few of the areas which were initially described potential GDEs, but that are very obviously not GDEs.

Methods

My analysis of the areas initially described as potential GDEs involved review of publicly available information, as well as several field surveys. I downloaded the Natural Communities Commonly Associated with Groundwater Dataset On-line

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e-mail: moorebio@softcom.net

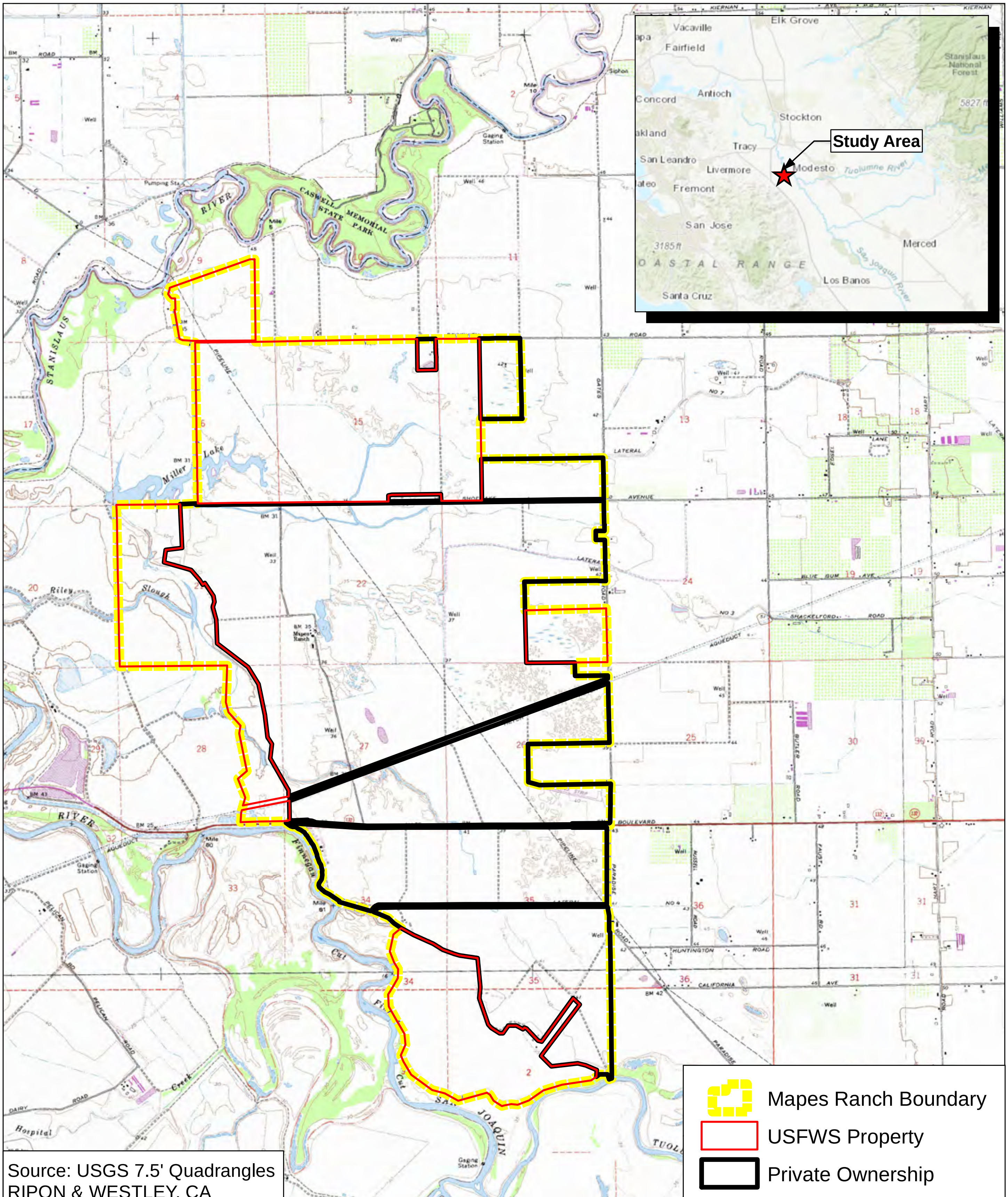

Figure 1

Moore Biological Consultants

0 2,000 4,000

N W E S

Map Date: 10/18/2021

USGS

Mapes Ranch

Stanislaus County, CA

C:\FEC_INC\Projects\Moore Biological\Mapes_Ranch\MXD\mapes_ranch_usgs_figure_1.mxd

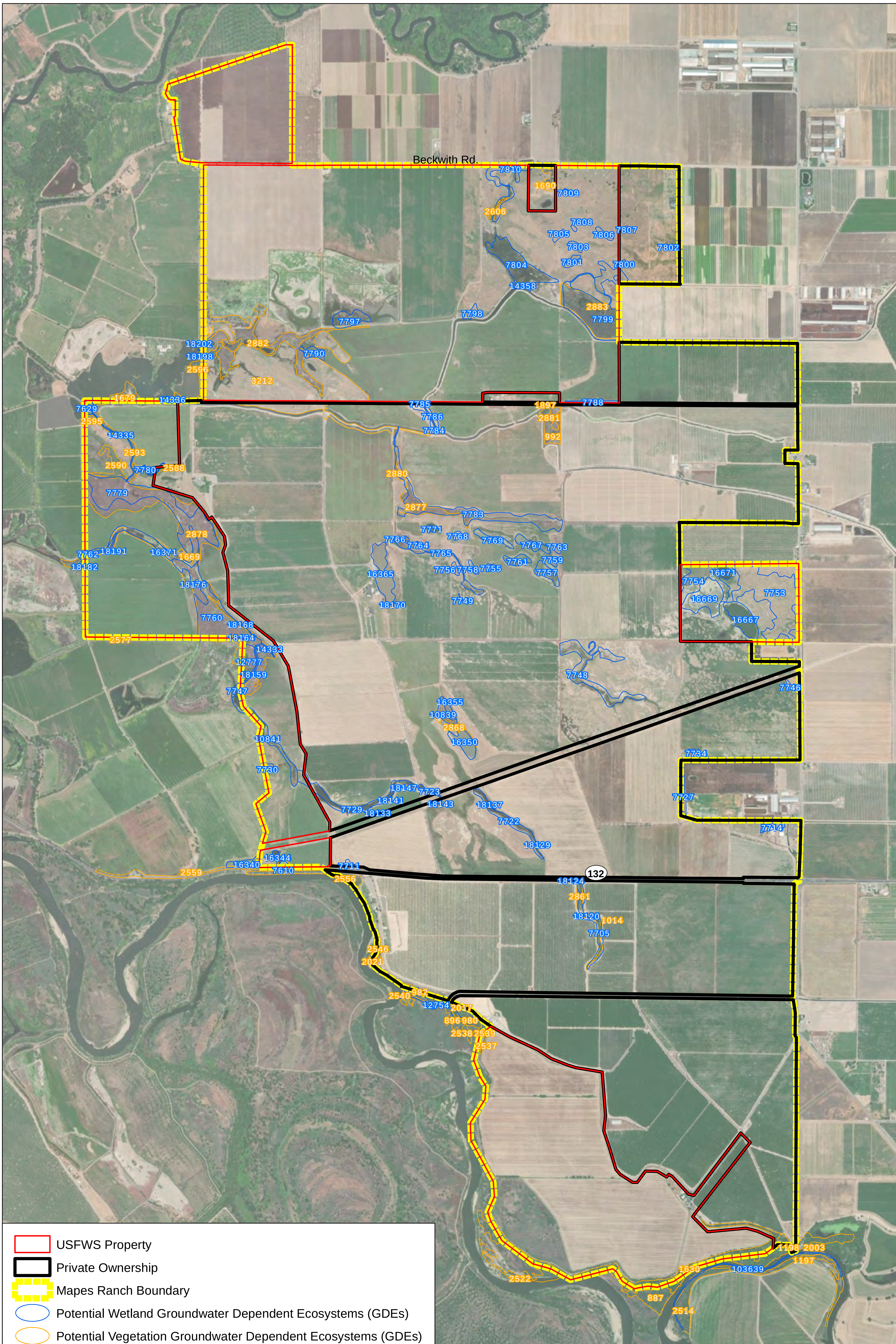

Figure 2

Moore Biological Consultants

Map Date: 10/19/2021
Aerial Source: Maxar (05/2020)

Potential GDEs

Mapes Ranch

Stanislaus County, CA

Viewer (NC DataSet, 2021).   I conducted a review of historical USGS topographic maps, relatively recent (1985 – 2020) aerial imagery on Google Earth, soils information (USDA NRCS, 2021), and the National Wetlands Inventory ("NWI") (USFWS, 2021). I also obtained historical aerial imagery (1932 – 1998) from the United States Department of Agriculture Natural Resources Conservation Service ("USDA NRCS"), and groundwater monitoring well data from Modesto Irrigation District ("MID"). Additionally, I reviewed the Plant Rooting Depth Database (Groundwater Resources Hub, 2021). Finally, I toured Mapes Ranch and spoke at length with the Ranch's ownership regarding the history of the Ranch, past and current land uses, irrigation and drainage practices, bottom depths of some of the areas initially described as potential GDEs, and management of conservation areas for waterfowl (i.e., duck ponds, flooded fields and crop management). All of this information was useful in understanding existing habitats, watershed areas, drainage patterns, soil permeability, land uses, groundwater levels, as well as irrigation and drainage improvements and operations on the Ranch.

The fieldwork involved an inspection of each area initially described as a potential GDE on the Ranch's privately owned parcels and inspection of a few representative potential GDE sites on the USFWS properties. At each site, I took notes on land use, topography, vegetation, and water management. Ground-level photographs were also taken of representative potential GDE sites. Special attention was made to identify the source(s) of hydrology of the areas initially described as potential GDEs. For example, many of the polygons depicted as potential GDEs are upland areas where a gate from a lateral can be opened to flood the area for waterfowl habitat and many others are agricultural drains conveying irrigation water runoff from adjacent pastures and croplands. Finally, observations were made regarding the mapping accuracy, as many of the areas initially described as potential GDEs included not just a wetland area, but also portions of adjacent roads, as well as other uplands.

Each of the areas described as potential GDE sites was evaluated to determine if they met the three criteria for delineating wetlands as defined by the U.S. Army Corps of Engineers (“ACOE”) Wetlands Delineation Manual (1987) and 2008 Regional Supplement: hydrophytic vegetation, hydric soils, and wetland hydrology. This step was undertaken because most GDEs are either waters or wetlands (i.e., wetlands, rivers, streams, estuaries, seeps, springs); GDEs also include plants that are supported groundwater via their roots, such as riparian forests adjacent to rivers and some valley oak woodlands.

At each potential GDE site, the vegetation was identified as shallow or deep-rooting (Groundwater Resources Hub, 2021) to determine if the vegetation could be supported by groundwater. For example, the maximum rooting depth of tules (*Schoenoplectus acutus*) and cattails (*Typha latifolia*) is 1 to 2 feet, while the rooting depths of black willow (*Salix gooddingii*), Freemont cottonwood (*Populus fremontii*), and valley oak (*Quercus lobata*) are approximately 7, 7, and 80 feet, respectively.

We first evaluated the riparian forest areas with deep-rooting vegetation associated with the Tuolumne River and San Joaquin Rivers, and concluded that such riparian forest vegetation and floodplain wetland vegetation are *potential* GDEs and, therefore, we did not conduct further analysis for purposes of this report. A few photographs of the Tuolumne River, San Joaquin Rivers, and adjacent riparian forest and scrub vegetation are included in Attachment A.

On relatively higher elevation portions of the Ranch, including all of the privately owned parcels, the combined depth of the area initially described as potential GDEs below adjacent lands and rooting depth of vegetation was then compared to groundwater levels below the ground surface documented by the MID monitoring wells or observations of groundwater in the field. For example, an agricultural drain incised 3 feet below the adjacent uplands supporting tules with a rooting depth of 1 to 2 feet (i.e., 4 to 5 feet total) was compared to groundwater levels of 15+/- feet below the ground surface.

In the few areas on the Ranch where the roots of willows and cottonwoods could potentially be long enough to extend underground within a few feet of groundwater during some years, further analysis was undertaken regarding the trees' level of dependence on artificial irrigation. Conclusions were then made about whether the trees would be present absent water management on the Ranch, and whether the trees would die if the irrigation ceased. Historical aerial imagery was particularly helpful to evaluate whether these areas naturally supported trees, as this would indicate a potential dependence on groundwater.

The areas initially described as potential GDEs which consist of uplands (i.e., not meeting the 3 wetland criteria), such as paved and graveled areas, leveled fields, equipment and hay storage pads, and developed areas were classified as uplands and eliminated as GDEs. Areas initially described as potential GDE sites supporting vegetation with rooting depths clearly too shallow to reach groundwater were classified as either vernal pool grasslands, agricultural drains, or constructed habitat and thus eliminated as potential GDEs. Finally, potential GDE sites supporting vegetation that my study, research, and analysis leads to the conclusion that the vegetation would not persist absent artificial irrigation were also classified as either vernal pool grasslands, agricultural drains, or constructed habitat and eliminated as potential GDEs.

Results

SETTING: Mapes Ranch is situated north of the confluence of the Tuolumne River and the San Joaquin River, and east of the confluence of the Stanislaus River and the San Joaquin River, in Stanislaus County, California (Figure 1). The Ranch is located within Sections 9, 14-16, 21-23, 26, 27, 34 and 35 in Township 3 South, Range 7 East, and Sections 2 and 3 in Township 4 South, Range 7 East of the USGS 7.5-minute Ripon and Westley topographic quadrangles (Figure 1).

The Ranch is generally flat and is at elevations of approximately 20 to 45 feet above mean sea level (Figure 1). The north part of the Ranch slopes down gently to the southwest and the central part of the Ranch slopes down gently to the northwest, with all of this land draining towards the San Joaquin River. The southeast part of the Ranch slopes down gently to the south, draining towards the Tuolumne River. The privately owned parcels are situated on relatively higher lands in the east part of the ranch, mostly at elevations of 35 to 45 feet above mean sea level. The USFWS holdings include much lower areas along the San Joaquin River, as well as some higher ground in the north and east parts of the Ranch.

SOILS: There are numerous soils types throughout the Ranch (Figure 3). The soils on the privately owned parcels, such as Fresno sandy loam, slightly alkaline, 0 to 1 percent slopes, and Waukena Fresno sandy loam, strongly saline- alkaline, 0 to 1 percent slopes, have hardpans or other impermeable substrates precluding vegetation being associated with the underlying groundwater.

NATIONAL WETLAND INVENTORY: The NWI was compiled primarily from interpretation of aerial photographs from the 1980s and is very patchy in coverage. Further, the NWI is a compilation of wetlands that may potentially be identified as GDEs, as well as seasonal wetlands, such as vernal pools, that are not GDEs. The NWI also contains many irrigation canals, dairy lagoons, and other man-made features. The NWI is a data source that wetland consultants rely on little, if at all, in conducting wetland delineations.

Most of the areas initially described as potential GDEs on the Mapes Ranch were pulled directly from the NWI (Figure 4). The Tuolumne River and the San Joaquin River are mapped as Riverine features, as were the MID canals and drains that cross through the ranch. Despite being extensive, very little of the well-developed riparian forests along the Tuolumne River and San Joaquin River are mapped in the NWI as Freshwater Forested/Shrub Wetland features.

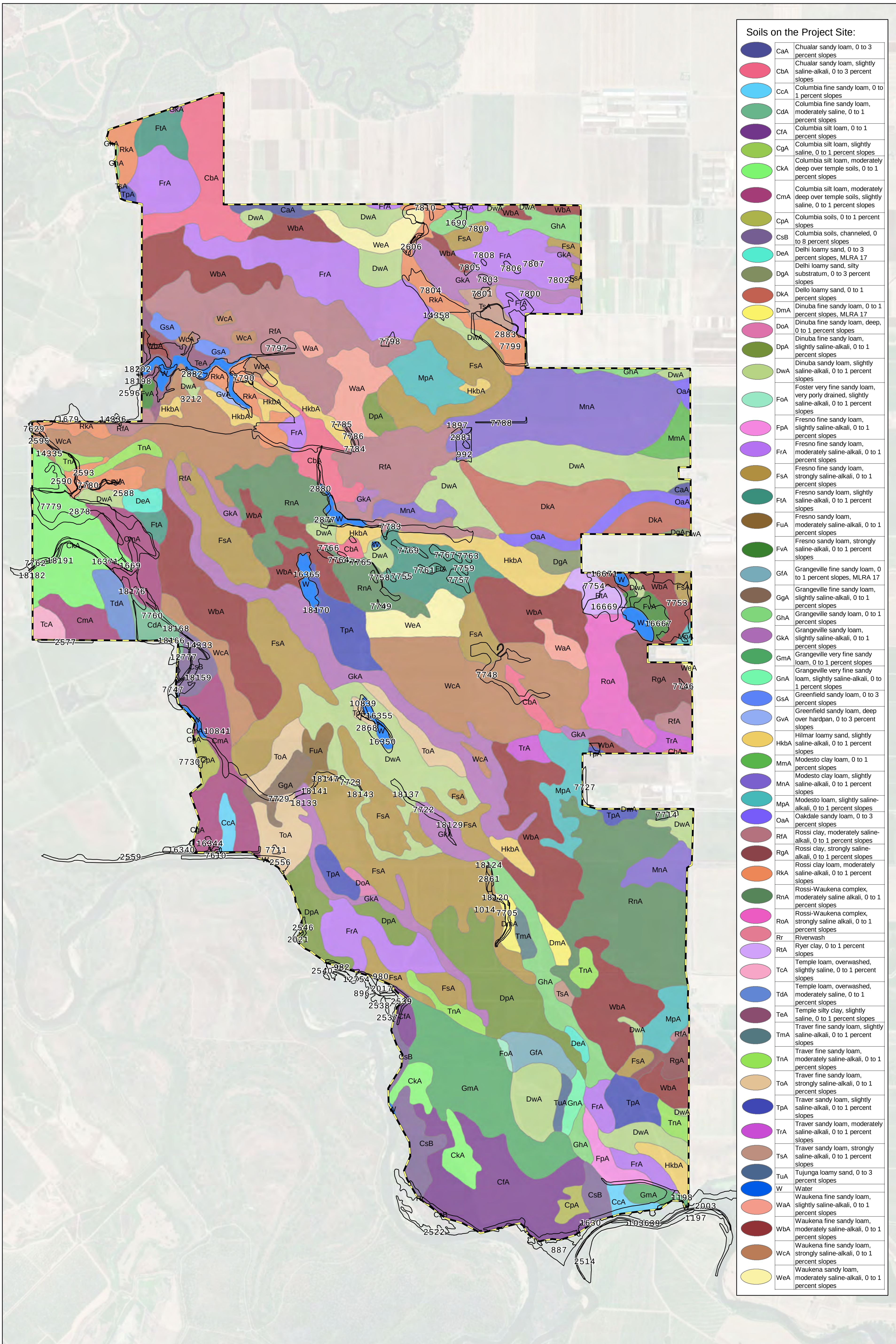

Figure 3

Moore Biological Consultants

N E S W

0 1,500 3,000

Study Area

Potential Wetland & Vegetation Groundwater Dependent Ecosystems (GDEs)

SOILS

Mapes Ranch

Stanislaus County, CA

Data Source: Natural Resources Conservation Service (2021) Aerial Photo: ESRI; Maxar (2020)
Map Date: 10/19/2021

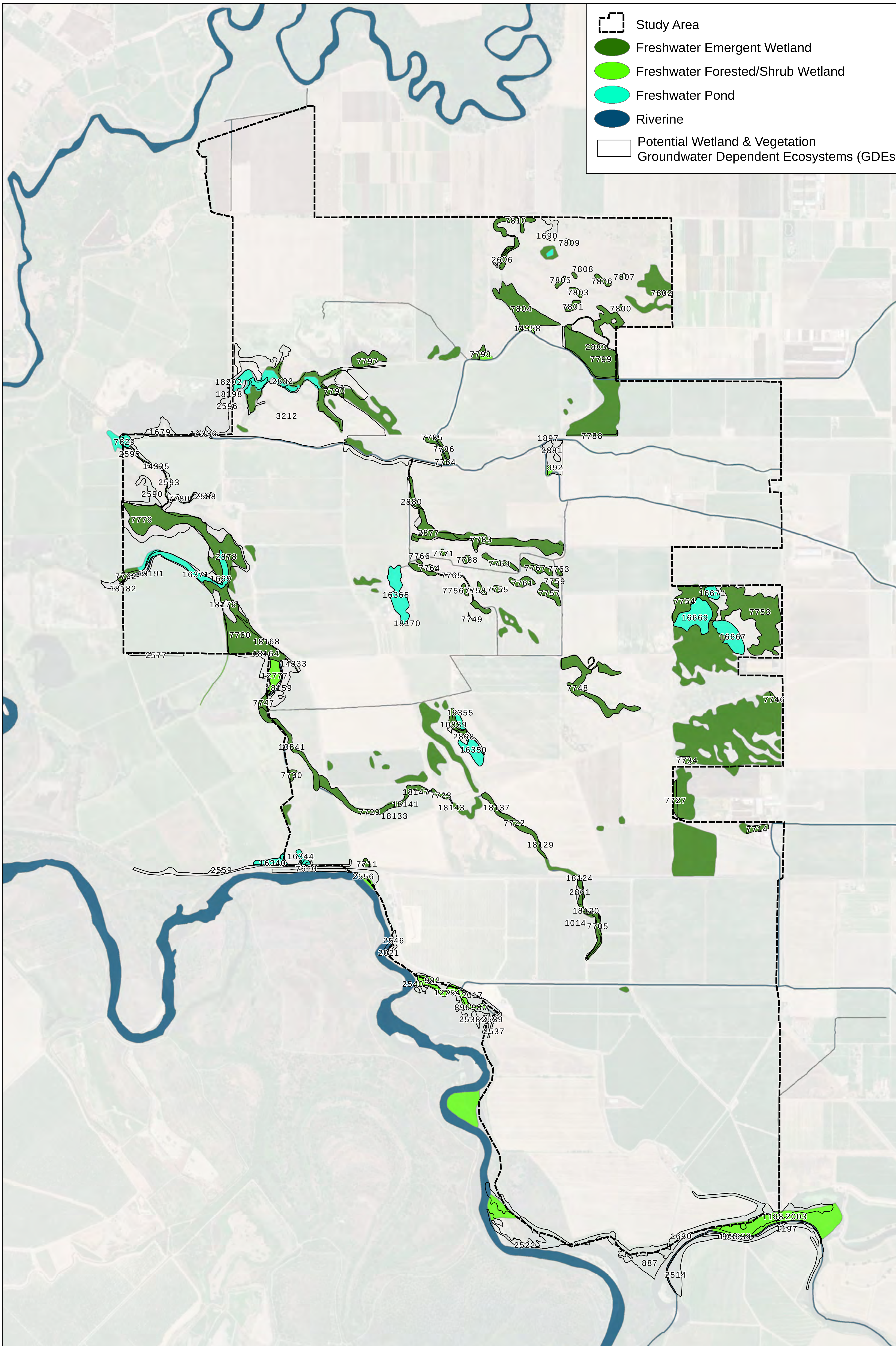

Figure 4

Moore Biological Consultants

N W E S

0 1,500 3,000

National Wetlands Inventory (NWI)

Mapes Ranch

Stanislaus County, CA

Data Source: NWI (USFWS; 2021) *Aerial Photo: ESRI; Maxar (2020)*
Map Date: 10/19/2021

A few constructed ponds on the Ranch are mapped as Freshwater Pond features, including two constructed duck ponds on the privately owned parcels (i.e., areas identified as potential GDEs # 16350/16355/10839 and 16365/18170). The NWI also depicts three constructed duck ponds on the USFWS holdings (i.e., areas identified as potential GDEs # 16667, 16669, and 16671) as Freshwater Pond features. Virtually all of the vernal pool grasslands on the Ranch are depicted as Freshwater Emergent Wetlands, as were the agricultural drains throughout much of the Ranch. The NWI also depicts some Freshwater Emergent Wetland areas on the Ranch which are not mapped as potential GDE sites.

MID MONITORING WELL DATA: MID has been documenting groundwater levels in the spring and fall in two locations on Mapes Ranch and one location just east of the Ranch (Figure 5 and Table 1). Groundwater levels in the area experience minor fluctuations over time for a number of factors such as periods of drought and periods of heavy rainfall, among others. Groundwater depths at Well 101 from 2000 through 2020 range from 6 to 20 feet below the ground surface, with a mean of 11.4 and 13.4 feet in the spring and fall, respectively. At Well 109, groundwater depths are notably consistent from 2000 through 2020 range from 5 to 11 feet below the ground surface, with means of 7.7 and 8.3 feet in the spring and fall, respectively. Groundwater depths at Well 108 from 2000 through 2013 are also quite consistent, ranging from 7 to 13 feet below the ground surface, with means of 8.2 and 10 feet in the spring and fall, respectively.

GDES AND OTHER HABITATS: The areas shown as potential GDEs on the maps provided to the GSA by Todd Groundwater were derived from the Natural Communities Commonly Associated with Groundwater Dataset (NC DataSet, 2021), which is largely comprised of features mapped in the NWI. **Based upon my extensive research, I have concluded that the majority of the areas mapped as potential GDEs on the privately owned parcels of Mapes Ranch, as well as many of the areas mapped as potential GDEs mapped on the USFWS holdings on the Ranch are <u>not</u> GDEs. In reality, the majority of the**

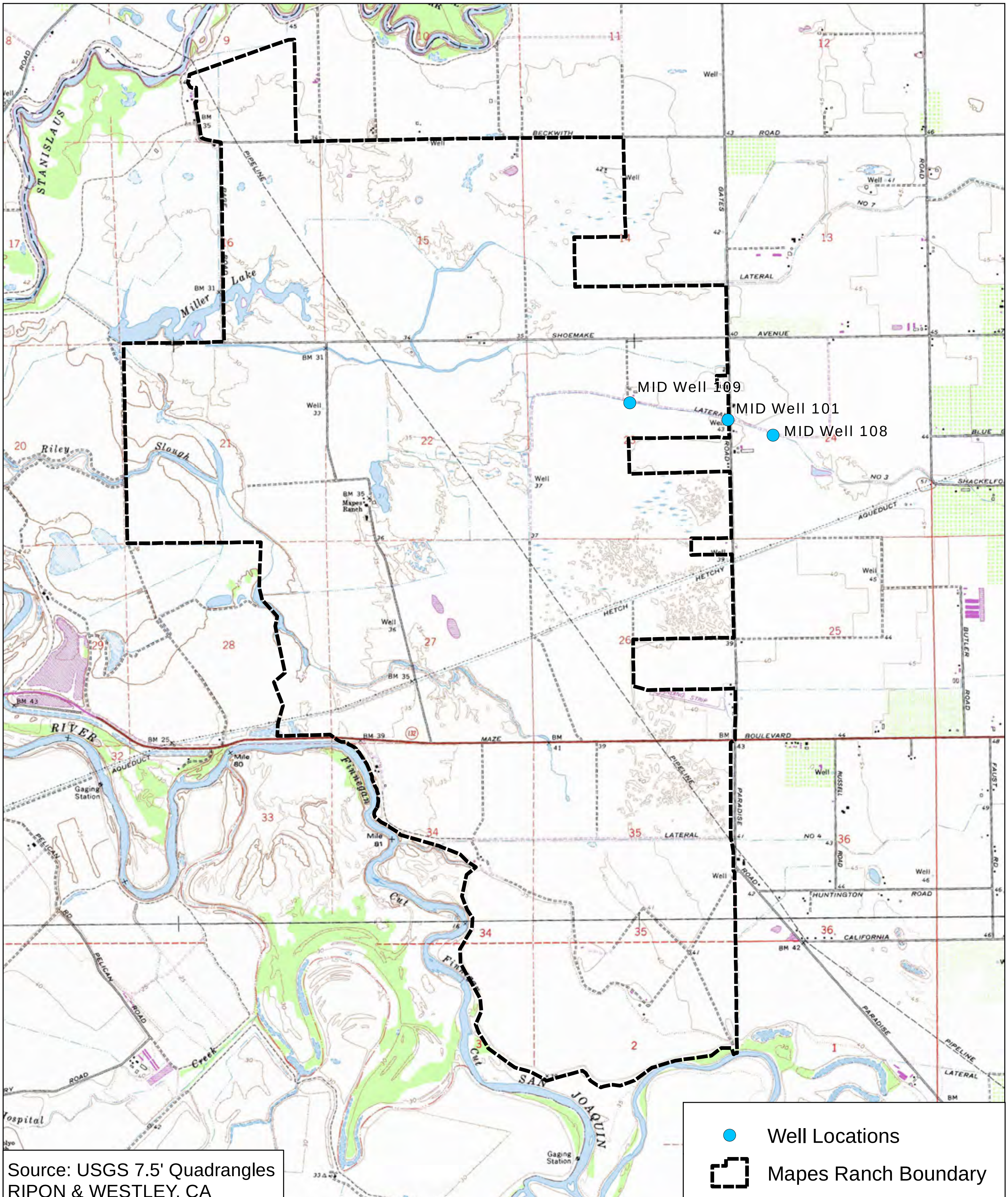

Figure 5

Moore Biological Consultants

0 2,000 4,000

Map Date: 10/20/2021

Monitoring Wells

Mapes Ranch

Stanislaus County, CA

TABLE 1
MID GROUNDWATER MONITORING WELL DATA

Year	MID Well 101 Depth to Water (ft)**		MID Well 108* Depth to Water (ft)**		MID Well 109 Depth to Water (ft)**	
	Spring	Fall	Spring	Fall	Spring	Fall
2000	7	10.1	7.8	9	7.5	8
2001	9.3	9.8	8.3	8	8	6.9
2002	8	12.7	7	9	6	5.8
2003	9	12.1	8.3	9.8	5	6.2
2004	10	10.2	9	9.3	7.1	7.2
2005	7.2	11.2	6.3	9.2	6.5	9
2006	8.4	11.5	7.5	10.3	7.4	10
2007	9	12.1	9.2	11.2	9	10
2008	10	12.5	10.3	10.6	8.5	9
2009	10.7	12.7	9.8	11.2	10.5	9.2
2010	10.5	13.1	9.2	10.8	8	11.1
2011	9.8	10.8	8.5	13.2	7	6.5
2012	8.4	5.4	7	9	6.5	7.8
2013	6	16	7		7	8
2014	18	17			9	7
2015	15	19.5			6.5	10
2016	18	20			8	8
2017	16.5	16.5			7.5	10
2018	16	15.5			11	8.5
2019	13.5	16.5			7	9.5
2020	16	16			8	7
2021	15				8	
Mean	11.4	13.4	8.2	10.0	7.7	8.3

* Note: Measurements during 2013 to 2017 indicated a potential issue with the well and are not considered reliable. Measurements were discontinued after 2017.
** Note: Depth to water below the ground surface.

areas mapped as potential GDEs are in fact areas where an irrigation gate from a MID lateral is only opened when the private landowner decides to open the irrigation valve to flood the area for waterfowl habitat, groundwater recharge, irrigation water recapture, or production of pasture for cattle. It is pretty clear that numerous of the areas initially described as potential GDEs would be bone dry if the landowners did not intentionally provide water in these areas. These areas are more appropriately referred to as "Controlled Artificial Surface Water Dependent Ecosystems" (CASWDEs).

Areas initially described as potential GDEs and “other habitats” that had been described as potential GDEs are depicted on Figure 6 and listed on Table B1 in Attachment B. The “other habitats” actually include upland areas such as buildings, pavement, graveled areas, and leveled fields, constructed habitats (e.g., duck ponds), vernal pool grasslands, and agricultural drains, including “Riley Slough,” which is a notable drain in the south part the Ranch. Each of these habitat types are described below and photographs of representative habitats are included in Attachment A.

Uplands: Upland areas on the Ranch are clearly not GDEs, as they are not wetlands and are not vegetated (Figure 6 and series of photographs in Attachment A). For example, the area described as potential GDE #7785 is actually a leveled concrete pad, adjacent gravel areas, and a sliver of MID’s lateral. A second example is the area described as potential GDE #7714, which is a hay barn and equipment storage yard in the east part of Mapes Ranch. A third example, identified as potential GDE # 18124, is a portion of Highway 132, which primarily consists of the paved road and road shoulders, and also includes a portion of an agricultural drain and a portion of a leveled hay field. Similarly, the area identified as potential GDE # 7711 primarily consists of a portion of a leveled hay field, and also includes a farm road and a road shoulder.

Constructed Habitats: All of the areas depicted as Constructed Habitats on Figure 6 are ponds that were either entirely constructed in uplands or shallow basins (i.e., seasonal wetlands and vernal pools) **that were enlarged**. All of the ponds are relatively shallow (i.e., 1 to 3 feet) and are supported by surface water and/or water pumped from private wells. While trees have been planted around some of the ponds, none of the constructed ponds support vegetation with deep enough roots to be supported by groundwater.

There is a cluster of constructed habitats in the central part of the Ranch comprised of the areas described as potential GDEs # 7755, 7757, 7758, 7759, 7761, 7767, 7768, 7769, and 7771 that are connected together with a series of

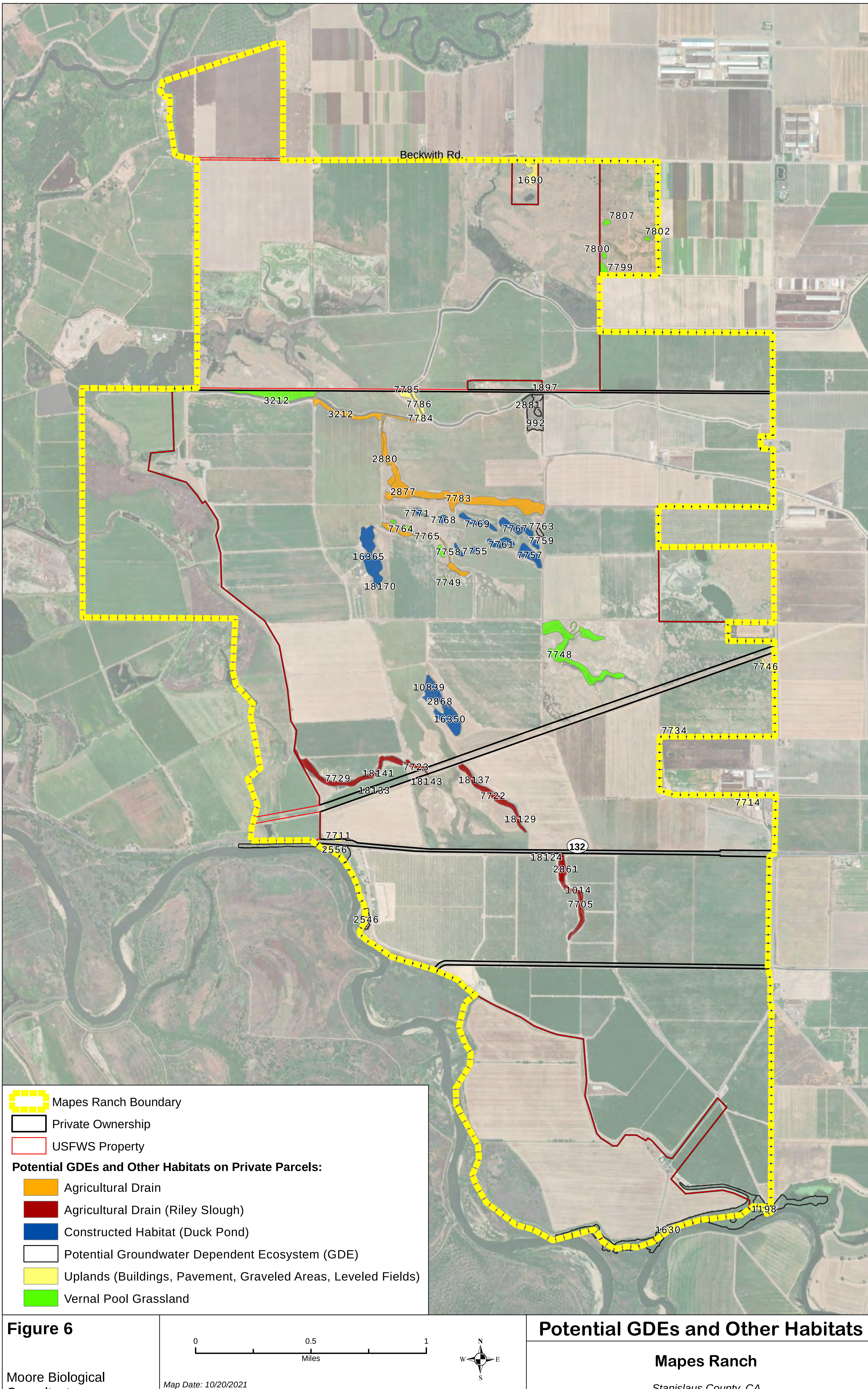

Figure 6

Moore Biological Consultants

Map Date: 10/20/2021
Aerial Source: Maxar (05/2020)

Potential GDEs and Other Habitats

Mapes Ranch

Stanislaus County, CA

pipes and control gates to manage the water. Many of these shallow basins were first constructed in the early-1900's for waterfowl hunting, and some have been improved several times, including planting of trees approximately 20 years ago. This managed conservation area receives water when a gate along the MID lateral to the east is opened and/or through water pumped from private wells. The area described as potential GDE # 7769 is an example of one of these constructed habitats, consisting of a very shallow basin excavated in uplands for waterfowl (see photographs in Attachment A).

There is a similar set of constructed habitats in the east part of the Ranch, on USFWS property comprised of the areas described as potential GDEs # 16667, 16669, and 16671, all of which are supported by water from MID and/or water pumped from private wells. Mapes Ranch ownership manages the water levels in these ponds, pursuant to the direction of USFWS, and USFWS pays for the electricity when water is provided from the private wells.

The area described as potential GDE # 16365/18170 is another good example of a constructed habitat. This large shallow basin adjacent to the Mapes Ranch's office is less than 3 feet deep and was also constructed in the early-1900's for waterfowl hunting. This constructed habitat receives water from the MID lateral to the east via a pipeline and/or through water pumped from private wells. This constructed habitat is kept full year-round and portions of the adjacent lands are landscaped.

Agricultural Drains, including Riley Slough: All of the areas depicted as Agricultural Drains, including Riley Slough on Figure 6 are topographically low areas, most of which were historical ephemeral streams and/or seasonal wetland swales. Over many decades, the drains have been incorporated into the Ranch irrigation and drainage infrastructure; there control gates in some areas to manage the water for agricultural and/or conservation purposes. **All of the agricultural drains are relatively shallow (i.e., 1 to 5 feet) and are supported by surface water and/or water pumped from private wells.** The very limited number of willows and cottonwoods along the edges of Riley Slough are supported by irrigation water as evidence by the fact that there are no trees apparent in historical aerial imagery. There are also no trees along the other agricultural drains.

Riley Slough (i.e., the areas described as potential GDEs # 1014/7705/2861, 18129/7732/18137, and 18143/7723/18141/18133/7729) is an excellent example of an agricultural drain (Figure 6 and series of photographs in Attachment A). Water is delivered to the upstream tip of Riley Slough from the MID lateral to the south via a pipeline, and/or from groundwater wells. Riley Slough also receives runoff from flood irrigated pastures along its length.

Riley Slough does not support vegetation with deep enough roots to be supported by groundwater. For example, the deepest part of Riley Slough is incised 3 to 5 feet below the adjacent uplands along most of its length. The relatively deeper parts of the slough primarily support tules and cattails, and there are a few willows and cottonwoods in higher areas along the edges of the slough. By comparing the maximum rooting depth of this vegetation to groundwater levels ranging from approximately 5 to 15 feet below the ground surface over time, it is clear the vegetation in Riley Slough is not dependent on groundwater.

Another example of an agricultural drain is the east part of the area described as potential GDE # 3212, just south of Shoemake Road, which also demonstrates mapping accuracy issues of many of the areas initially described as potential GDEs (see photograph in Attachment A). In this location, the area described as potential GDE # 3212 encompasses the low end of an irrigated pasture, the adjacent agricultural irrigation drain, an elevated MID access/maintenance road, and the south edge of an MID drain. Further east of where the photograph was taken, the area described as potential GDE # 3212 narrows down to only encompass the elevated MID access/maintenance road. The agricultural irrigation drain and the MID drain are a maximum of 5 feet below the adjacent uplands in this area, several feet above groundwater, and are not dependent on groundwater. The low end of the irrigated pasture and the elevated MID access/maintenance road are clearly not dependent on groundwater.

Artificially Flooded Vernal Pool Grasslands: All of the areas depicted as Vernal Pool Grasslands on Figure 6 are ponds are grasslands containing artificial vernal pools, artificial seasonal wetlands, and artificial seasonal wetland swales that are managed for agricultural and/or conservation purposes. Some of the naturally low areas in the vernal pool grasslands have been slightly enlarged by excavation, yet all are relatively shallow (i.e., 1 to 3 feet). The vernal pool grasslands are flooded with surface water and/or water pumped from private wells, or from irrigation water runoff from adjacent pastures and croplands.

The area described as potential GDE # 7748 is an excellent example of vernal pool grasslands that are flooded for agricultural and/or conservation purposes (Figure 6 and series of photographs in Attachment A). This potential GDE site actually receives water from the MID canal to the south via a pipeline, from groundwater wells and/or runoff from irrigated lands to the south. There is a similarly flooded vernal pool grassland area on a Mapes Ranch ownership parcel in the northeast part of the Ranch (i.e., the area identified as potential GDEs # 7799, 7800, 7802, and 7807). Another example of a vernal pool grassland area that may be flooded on occasion is the west part of potential GDE # 3212, just south of Shoemake Road (see photograph in Attachment A). There are also flooded vernal pool grassland areas on USFWS property in the east part of the Ranch (i.e., the area identified as potential GDE # 7753), a cluster of flooded vernal pool grassland areas described as potential GDEs in the northeast part of the Ranch, and on USFWS property (i.e., the areas described as potential GDEs # 7800, 7801, 7803, 7805, 7806, and 7809).

Through my review of aerial imagery and soils data, and based upon my understanding of vernal pool grasslands gained through 25+ years of

conducting wetland delineations in the Central Valley, I am confident these artificial vernal pool grasslands are not dependent on groundwater and would be bone dry nearly year-round absent the intentional application of surface water or pumped groundwater.

Conclusion

I highly encourage Todd Groundwater to eliminate all of the areas initially described in the maps provided to the GSA as potential GDEs on the Mapes Ranch property that have been ground-truthed and determined to be other habitats, as depicted on Figure 6 and as listed in Table B1 in Attachment B from the GSP altogether. Further, additional analysis needs to be conducted for the areas on the Mapes Ranch property that have not yet been definitely ruled out as potential GDEs. Finally, a more thorough analysis should be completed prior to concluding the many similar "other habitats" on the USFWS owned parcels are GDEs.

I look forward to continuing my analysis of the areas initially described as potential GDEs. Although my background is generally described in my September 29, 2021 letter, a more thorough summary is provided in Attachment C.

Please call me at (209) 745-1159 with any questions.

Sincerely,

Diane S. Moore, M.S.
Principal Biologist

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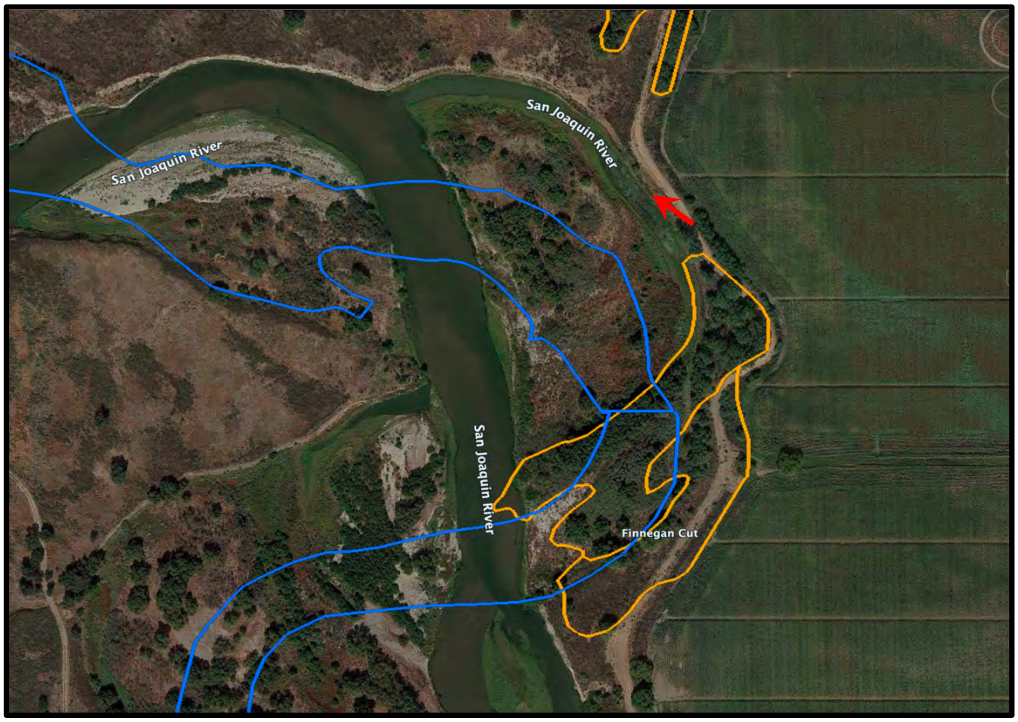
Attachment A

Photographs

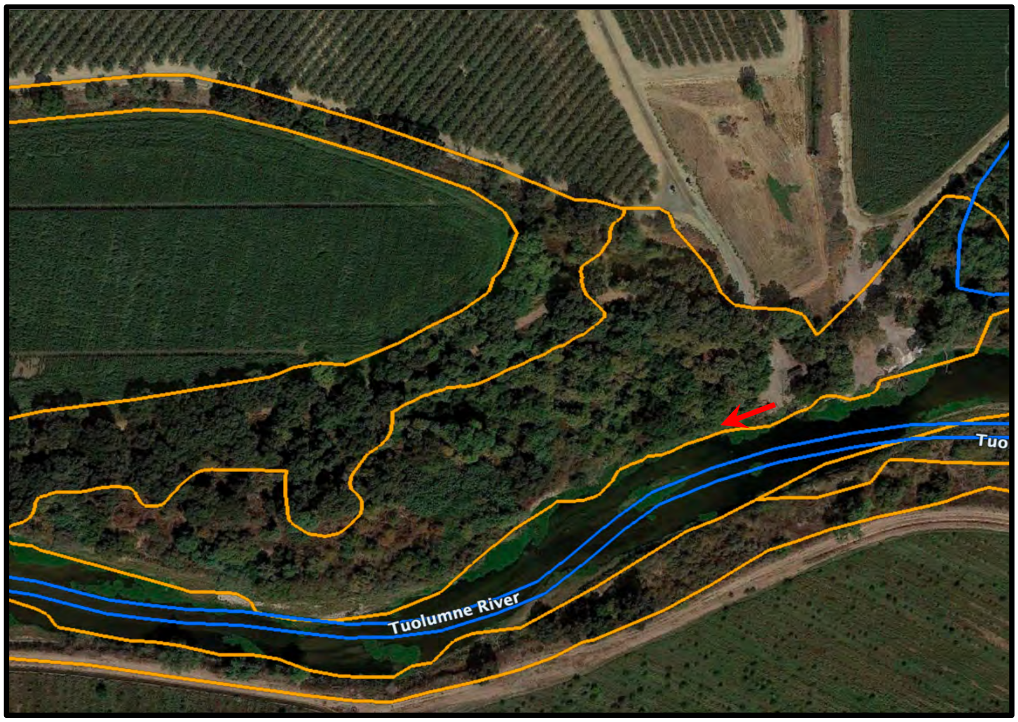
San Joaquin River, Tuolumne River, and Adjacent

Riparian Forest and Scrub Wetlands



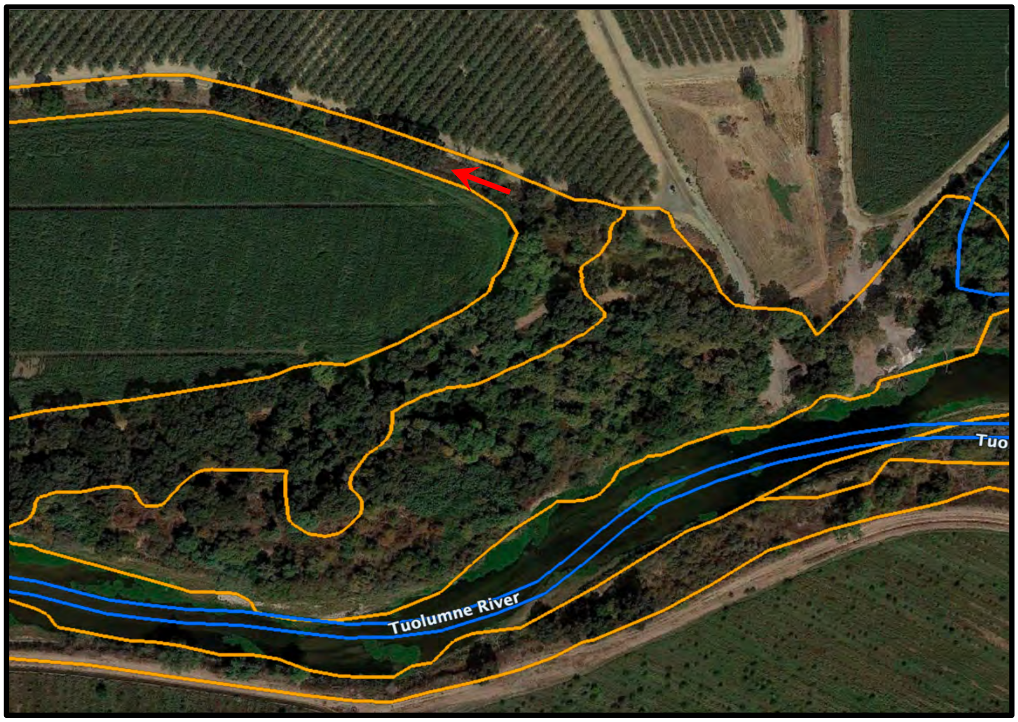
San Joaquin River just west of Mapes Ranch. The arrow notes the location and direction of the photograph below. The blue swath that is supposed to be the active channel demonstrates issues with mapping accuracy of potential GDEs in the NC DataSet.


San Joaquin River and riparian forest/scrub wetland along the river, looking northwest; 10/19/21.



Potential GDE #1198 is along the Tuolumne River in the southeast corner of the site. The arrow notes the location and direction of the ground-level photograph below.

Tuolumne River and well developed riparian forest along the north bank of the river, looking southwest; 10/19/21. The riparian forest is potential GDE #1198.



Potential GDE #1630 is along the north side of the Tuolumne River in the southeast corner of the site. The arrow notes the location and direction of the ground-level photograph below.


Well developed riparian forest associated with the Tuolumne River, looking northwest; 10/19/21. This topographically low channel in the north part of potential GDE # 1630 may fill with water backing up from the river under very high river flow conditions.

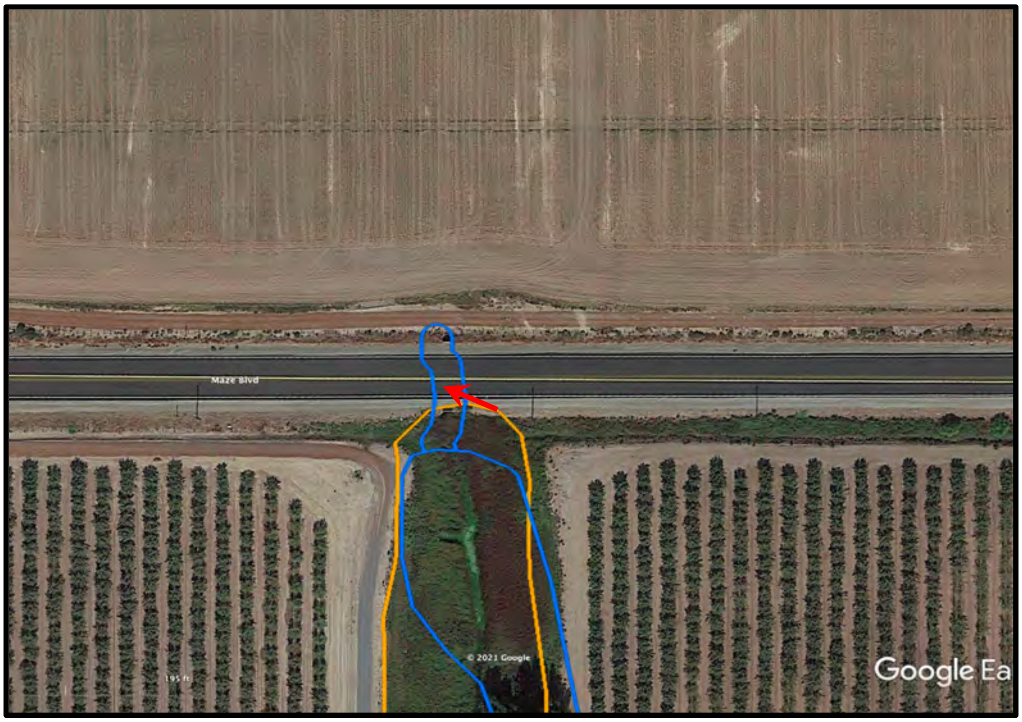
Example Uplands that are not GDEs

Potential GDE #7785 is a polygon just south of Shoemake Avenue and west of the MID lateral. The arrow notes the location and direction of the ground-level photograph below.

Potential GDE #7785, looking west from the east end of the concrete pad; 09/03/21. This potential GDE comprises the concrete pad, adjacent gravel areas, and a sliver of the MID lateral.

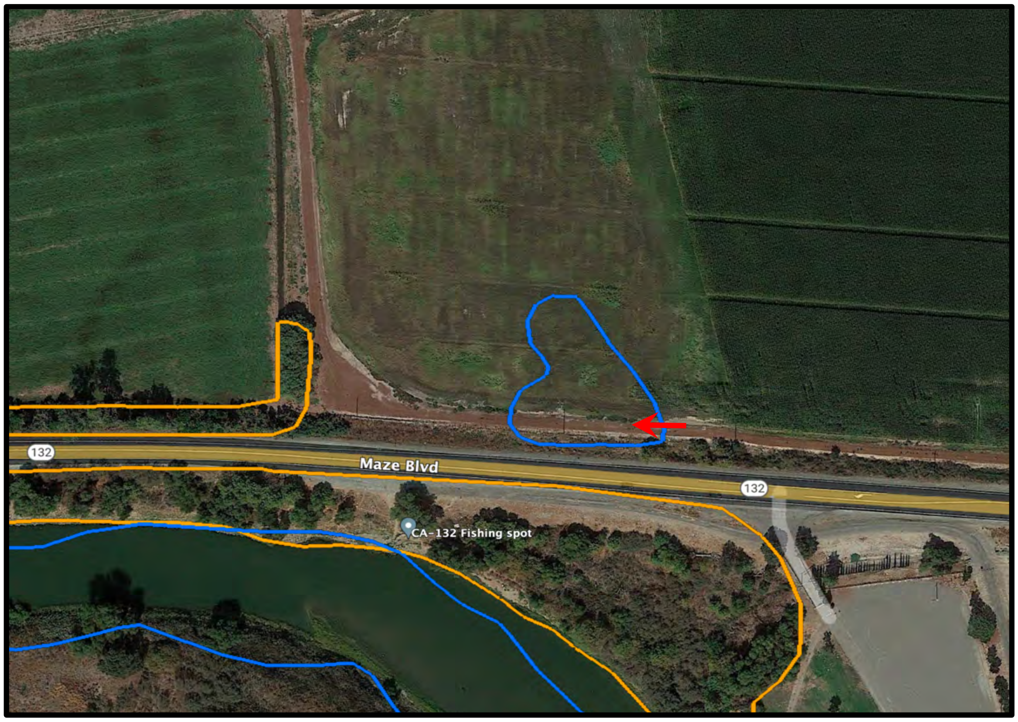
Potential GDE #7714 is a polygon just west of N. Gates Road and north of Maze Boulevard. The arrow notes the location and direction of the ground-level photograph below.

Potential GDE #7714, looking southwest from the northeast corner of a farm equipment storage yard; 09/15/21. This potential GDE is comprised of a portion of a hay barn and various farm-related equipment.



Potential GDE #18124 is a polygon that cuts across Highway 132 (Maze Boulevard). The arrow notes the location and direction of the ground-level photograph below.

Potential GDE #18124, looking northwest at Maze Boulevard; 09/15/21. This potential GDE is primarily comprised of the road and road shoulder, and also includes a portion of an agricultural drain and part of a leveled field.



Potential GDE #7711 in the west part of the ranch. The arrow notes the location and direction of the ground-level photograph below.


Potential GDE #7711, looking west; 10/14/21. Potential GDE#7711 primarily consists of a portion of a leveled hay field and also includes a farm road and road shoulder.

Example Constructed Habitats (i.e., duck ponds) that are not GDEs

Gate valve along the MID lateral in the northeast part of the ranch. The arrow notes the location and direction of the ground-level photograph below.

Gate valve along the MID lateral that can be opened to provide water to a cluster of constructed habitats to the west (i.e., potential GDEs # 7755, 7757, 7758, 7759, 7761, 7767, 7768, 7769, and 7771), looking northwest; 09/03/21.

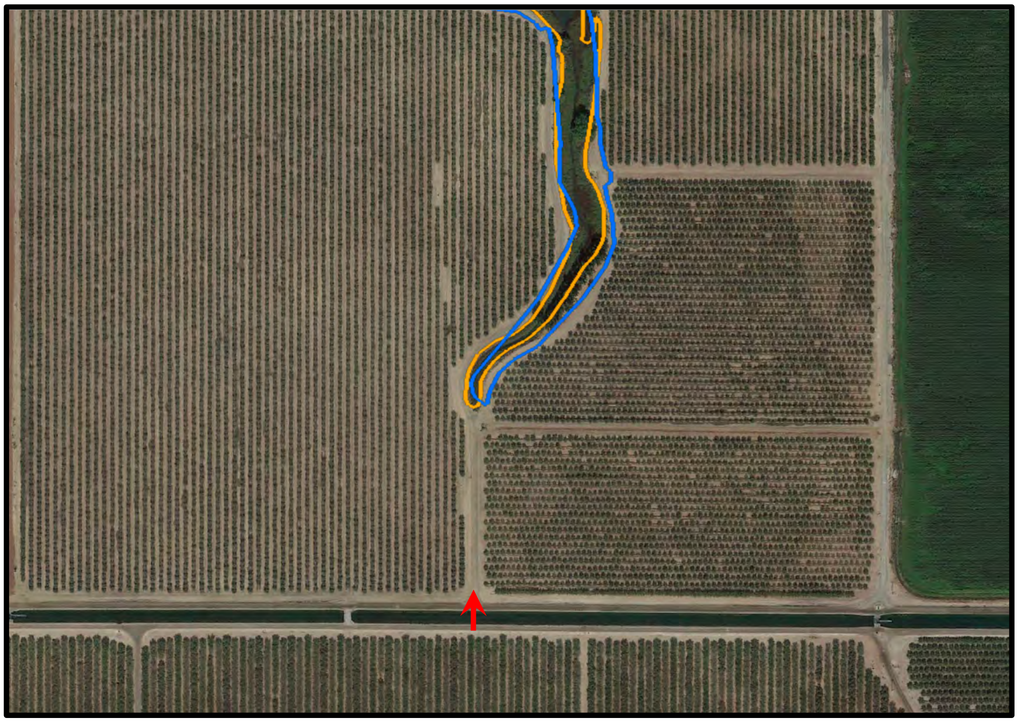
Potential GDE #7769 is a long polygon in the approximate center portion of Mape's Ranch. The arrow notes the location and direction of the ground-level photograph below.

Potential GDE #7769, looking west from a duck blind in a field managed for waterfowl; 09/03/21. This potential GDE receives water via an outlet from MID's lateral just east of the potential GDE.

Potential GDE #16365 is a large polygon just east of the Mapes Ranch main office. The arrow notes the location and direction of the ground-level photograph below.

Potential GDE #16365, looking south; 09/03/21. This pond was constructed in the early 1900's for duck hunting, is only a few feet deep, and can be filled with water from MID and/or groundwater wells.

Example Agricultural Drains that are not GDEs



South tip of Riley Slough and the MID lateral in the south part of the ranch. The arrow notes the location and direction of the ground-level photograph below.

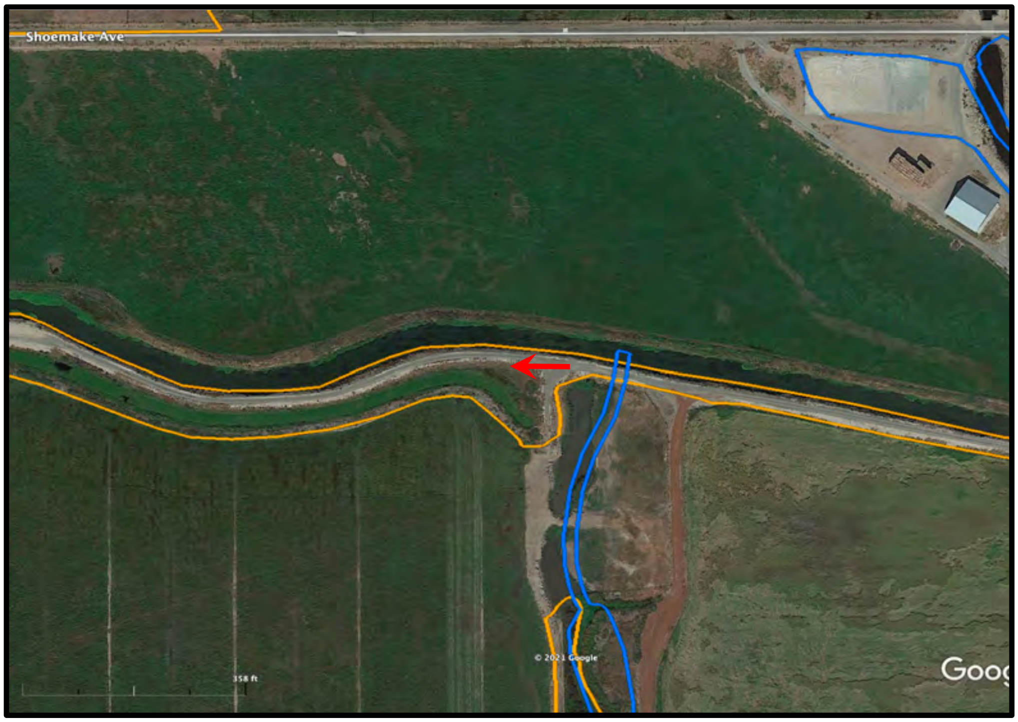
Outlet from the MID lateral and adjacent groundwater well that provide water to Riley Slough via a pipeline, looking north; 09/15/21.

South tip of Riley Slough just north of the MID lateral in the south part of the ranch. The arrow notes the location and direction of the ground-level photograph below.

South tip of Riley Slough, looking north; 09/15/21.

Riley Slough just south of Highway 132, in the south part of the ranch. The arrow notes the location and direction of the ground-level photograph below.

Potential GDE # 7705 (Riley Slough), looking northeast; 09/15/21. There are control gates and valves along the length of this agricultural drain, allowing water levels to be adjusted for irrigation, drainage, and/or conservation purposes.



The east part of potential GDE #3212 is a long polygon south of Shoemake Road. The arrow notes the location and direction of the ground-level photograph below.

East part of potential GDE #3212, looking west from on top of an access road; 09/03/21. This portion of potential GDE is comprised of the edge of a field, a private agricultural drain, MID's maintenance road, and the south edge of MID's drainage canal.

Example Vernal Pool Grasslands that are not GDEs

Constructed ditch conveying water in to potential GDE #7748 in the central-east part of the ranch. The arrow notes the location and direction of the ground-level photograph below.

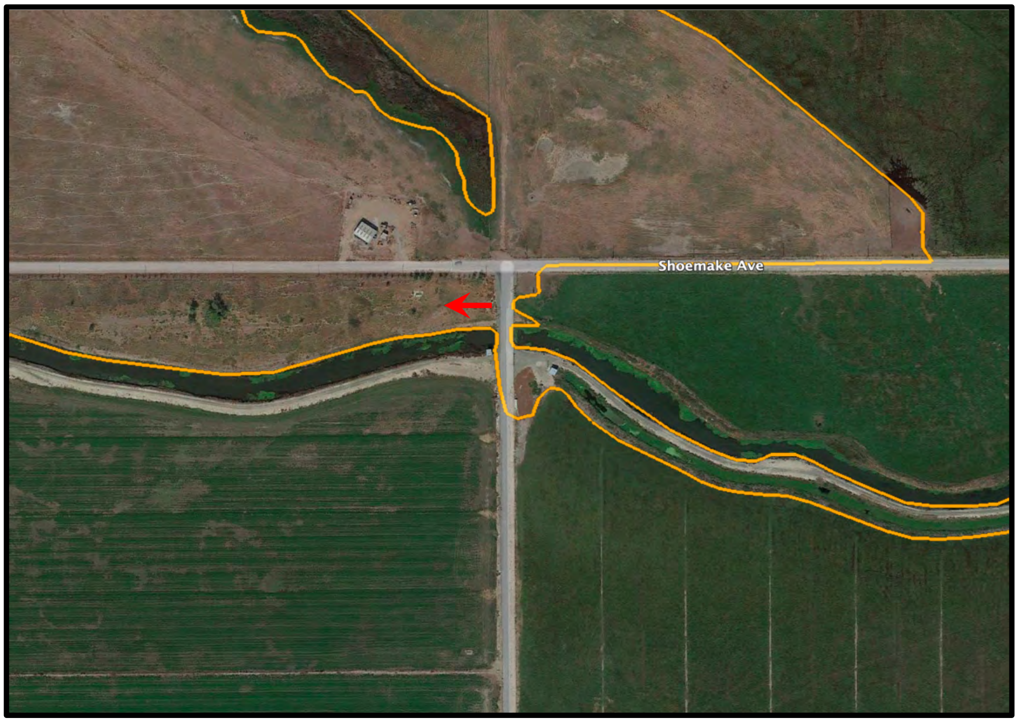
Water being conveyed from the MID lateral and/or groundwater wells via a pipeline in to potential GDE #7748, looking northwest; 09/03/21.

East tip of potential GDE #7748 located in the central-east part of the ranch. The arrow notes the location and direction of the ground-level photograph below.

Potential GDE #7748, looking west; 09/15/21. This historical ephemeral creek or seasonal wetland swale is in an area of vernal pool grasslands that are artificially flooded.

Vernal pool grasslands adjacent to potential GDE #7748 in the central-east part of the ranch. The arrow notes the location and direction of the ground-level photograph below.

Vernal pool grasslands adjacent to potential GDE #7748, looking northwest; 08/12/21. Absent flooding to support cattle grazing, these grasslands would be dry nearly year-round.



The west part of potential GDE #3212 is a long polygon south of Shoemake Road in the northwest part of the ranch. The arrow notes the location and direction of the ground-level photograph below.

West part of potential GDE #3212, looking west; 09/03/21. This portion of the potential GDE consists of vernal pool grassland this is dry almost year-round.

Attachment B

Ground-Truthed Habitats

TABLE B1
GROUND-TRUTHED HABITATS

Ground-Truthed Habitat Type	GDE?	Potential GDE in NC DataSet	Polygon # in NC DataSet	Habitat Description in NC DataSet	Field Notes
Agricultural Drain	No	Wetland	7765	Palustrine, Emergent, Persistent, Seasonally Flooded	Agricultural irrigation drain; vegetation includes cattails and water primrose.
Agricultural Drain	No	Wetland	7783	Palustrine, Emergent, Persistent, Seasonally Flooded	Part of an agricultural irrigation drain; partially overlaps polygons 2880 & 2877; vegetation includes tules, rushes, and sedges.
Agricultural Drain	No	Vegetation	2877	Schoenoplectus (acutus, californicus)	Part of an agricultural irrigation drain; partially overlaps polygon 7783; vegetation includes tules, rushes, and sedges.
Agricultural Drain	No	Vegetation	2880	Schoenoplectus (acutus, californicus)	Part of an agricultural irrigation drain; partially overlaps polygon 7783; vegetation includes tules, rushes, cattails, and water primrose.
Agricultural Drain	No	Vegetation	3212	Sporobolus airoides	The east part of the this polygon consists of an agricultural drain, the edge of MID's drain, and an elevated MID maintenance road along the south edge of the drain.
Agricultural Drain (Riley Slough)	No	Wetland	7705	Palustrine, Emergent, Persistent, Seasonally Flooded	Part of an agricultural irrigation drain; partially overlaps polygons 1014 & 2861; vegetation includes tules, rushes, and sedges. This polygon also includes part of a farm road adjacent to Riley Slough.
Agricultural Drain (Riley Slough)	No	Wetland	7722	Palustrine, Emergent, Persistent, Seasonally Flooded	Riley Slough north of Highway 132; part of an agricultural irrigation drain; vegetation includes tules, rushes, sedges, and water primrose; includes some upland areas adjacent to Riley Slough. Polygons 18129, 18131, and 18137 are tiny polygons along the edges of this primary polygon.
Agricultural Drain (Riley Slough)	No	Wetland	7723	Palustrine, Emergent, Persistent, Seasonally Flooded	Riley Slough north of the Hetch Hetchy Aqueduct; part of an agricultural irrigation drain; vegetation includes tules and water primrose. This polygon also includes part of a farm road adjacent to Riley Slough.
Agricultural Drain (Riley Slough)	No	Wetland	7729	Palustrine, Emergent, Persistent, Seasonally Flooded	Riley Slough west of the Ranch entrance road; part of an agricultural irrigation drain; vegetation includes tules, rushes, sedges, water primrose, and a few willows and cottonwoods. This polygon also includes parts of farm roads and some uplands adjacent to Riley Slough.
Agricultural Drain (Riley Slough)	No	Wetland	18120	Riverine, Unknown Perennial, Unconsolidated Bottom, Semipermanently Flooded	Riley Slough south of Highway 132; part of an agricultural irrigation drain along the edge of polygon 7705; vegetation includes tules, rushes, and sedges.
Agricultural Drain (Riley Slough)	No	Wetland	18129	Riverine, Unknown Perennial, Unconsolidated Bottom, Semipermanently Flooded	Riley Slough north of Highway 132; part of an agricultural irrigation drain along the edge of polygon 7722; a few live and dead cottonwoods.
Agricultural Drain (Riley Slough)	No	Wetland	18131	Riverine, Unknown Perennial, Unconsolidated Bottom, Semipermanently Flooded	Riley Slough north of Highway 132; part of an agricultural irrigation drain along the edge of polygon 7722; vegetation is tules.
Agricultural Drain (Riley Slough)	No	Wetland	18133	Riverine, Unknown Perennial, Unconsolidated Bottom, Semipermanently Flooded	Riley Slough west of the Ranch entrance road; part of an agricultural irrigation drain along the edge of polygon 7729; vegetation is primarily tules.
Agricultural Drain (Riley Slough)	No	Wetland	18137	Riverine, Unknown Perennial, Unconsolidated Bottom, Semipermanently Flooded	Riley Slough north of Highway 132; part of an agricultural irrigation drain along the edge of polygon 7722; vegetation is tules.
Agricultural Drain (Riley Slough)	No	Wetland	18141	Riverine, Unknown Perennial, Unconsolidated Bottom, Semipermanently Flooded	Riley Slough west of the Ranch entrance road; part of an agricultural irrigation drain along the edge of polygon 7729; vegetation is primarily tules.
Agricultural Drain (Riley Slough)	No	Wetland	18143	Riverine, Unknown Perennial, Unconsolidated Bottom, Semipermanently Flooded	Riley Slough north of the Hetch Hetchy Aqueduct; part of an agricultural irrigation drain; vegetation includes tules, rushes, sedges, and water primrose; upstream tip of polygon 7723.
Agricultural Drain (Riley Slough)	No	Wetland	18147	Riverine, Unknown Perennial, Unconsolidated Bottom, Semipermanently Flooded	Riley Slough north of the Hetch Hetchy Aqueduct; part of an agricultural irrigation drain; vegetation includes tules. This polygon also includes part of a paved road and some upland grassland.
Agricultural Drain (Riley Slough)	No	Vegetation	1014	Freshwater Emergent Marsh	South tip of Riley Slough; part of an agricultural irrigation drain; partially overlaps polygon 7705; vegetation includes tules, rushes, and sedges; further north there are a few scattered willows and cottonwoods.
Agricultural Drain (Riley Slough)	No	Vegetation	2861	Schoenoplectus (acutus, californicus)	Riley Slough south of Highway 132; part of an agricultural irrigation drain; partially overlaps polygon 7705; vegetation includes tules, rushes, and sedges. and a few willows and cottonwoods.

Constructed Habitat (Duck Pond)	No	Wetland	7755	Palustrine, Emergent, Persistent, Seasonally Flooded	Constructed shallow basin in a cluster of basins that are interconnected with pipelines and managed for waterfowl conservation and hunting; less than or equal to 12 inches deep; vegetation is a combination of upland and wetland grasses and weeds. Surrounded by planted trees.
Constructed Habitat (Duck Pond)	No	Wetland	7757	Palustrine, Emergent, Persistent, Seasonally Flooded	Constructed shallow basin in a cluster of basins that are interconnected with pipelines and managed for waterfowl conservation and hunting; less than or equal to 12 inches deep; vegetation is a combination of upland and wetland grasses and weeds. Partially surrounded by planted trees.
Constructed Habitat (Duck Pond)	No	Wetland	7758	Palustrine, Emergent, Persistent, Seasonally Flooded	Constructed shallow basin in a cluster of basins that are interconnected with pipelines and managed for waterfowl conservation and hunting; less than or equal to 12 inches deep; vegetation is a combination of upland and wetland grasses and weeds. Surrounded by planted trees. There is a pit blind is situated just west of the polygon.
Constructed Habitat (Duck Pond)	No	Wetland	7759	Palustrine, Emergent, Persistent, Seasonally Flooded	Shallow basin in a cluster of basins that are interconnected with pipelines and managed for waterfowl conservation and hunting; less than or equal to 6 inches deep; gate valve from MID at north tip of the polygon; vegetation is a combination of upland and wetland grasses and weeds. Partially surrounded by planted trees.
Constructed Habitat (Duck Pond)	No	Wetland	7761	Palustrine, Emergent, Persistent, Seasonally Flooded	Constructed shallow basin in a cluster of basins that are interconnected with pipelines and managed for waterfowl conservation and hunting; less than or equal to 12 inches deep; vegetation is a combination of upland and wetland grasses and weeds. Surrounded by planted trees.
Constructed Habitat (Duck Pond)	No	Wetland	7767	Palustrine, Emergent, Persistent, Seasonally Flooded	Constructed shallow basin in a cluster of basins that are interconnected with pipelines and managed for waterfowl conservation and hunting; less than or equal to 12 inches deep; vegetation is a combination of upland and wetland grasses and weeds. Planted in sorghum and surrounded by planted trees.
Constructed Habitat (Duck Pond)	No	Wetland	7768	Palustrine, Emergent, Persistent, Seasonally Flooded	Constructed shallow basin in a cluster of basins that are interconnected with pipelines and managed for waterfowl conservation and hunting; 2 to 3 feet deep; vegetation is a combination of upland and wetland grasses and weeds. Vegetation includes Bermuda grass, salt grass, and cocklebur.
Constructed Habitat (Duck Pond)	No	Wetland	7769	Palustrine, Emergent, Persistent, Seasonally Flooded	Constructed shallow basin in a cluster of basins that are interconnected with pipelines and managed for waterfowl conservation and hunting; less than or equal to 12 inches deep; vegetation is a combination of upland and wetland grasses and weeds. Surrounded by planted trees.
Constructed Habitat (Duck Pond)	No	Wetland	7771	Palustrine, Emergent, Persistent, Seasonally Flooded	Construction basin in a cluster of basins that are interconnected with pipelines and managed for waterfowl conservation and hunting; the basin had been filled with water for livestock watering. Vegetation includes rushes and water primrose.
Constructed Habitat (Duck Pond)	No	Wetland	10839	Palustrine, Emergent, Persistent, Semipermanently Flooded	Part of a constructed basin with tule and cattail fringe; grazed.
Constructed Habitat (Duck Pond)	No	Wetland	16350	Palustrine, Unconsolidated Bottom, Permanently Flooded	Part of a constructed basin with tule and cattail fringe; grazed.
Constructed Habitat (Duck Pond)	No	Wetland	16355	Palustrine, Unconsolidated Bottom, Permanently Flooded	Part of a constructed basin with tule and cattail fringe; grazed.
Constructed Habitat (Duck Pond)	No	Wetland	16365	Palustrine, Unconsolidated Bottom, Permanently Flooded	Large pond adjacent to the Ranch office that is partially landscaped; fringe of tules.
Constructed Habitat (Duck Pond)	No	Wetland	18170	Riverine, Unknown Perennial, Unconsolidated Bottom, Semipermanently Flooded	South tip of the large pond adjacent to the Ranch office.
Constructed Habitat (Duck Pond)	No	Vegetation	2868	Schoenoplectus (acutus, californicus)	Tule fringe that partially overlaps polygons 16350 and 10839 and also includes some uplands adjacent to the duck pond.
Potential GDE	Maybe	Wetland	7763	Palustrine, Emergent, Persistent, Seasonally Flooded	South part of a potentially naturally low area that can be filled via a valve from the MID lateral. The lateral was constructed around the low area. Vegetation includes tules and some willows.
Potential GDE	Maybe	Vegetation	992	California Warm Temperate Marsh/Seep	Part of a potentially naturally low area just south of the MID drain; also invludes some higher elevation areas.

Potential GDE	Maybe	Vegetation	1198	Populus fremontii	Well developed riparian forest in a topographically low area adjacent to the Tuolumne River. Vegetation includes willows, cottonwoods, box elder, and valley oaks.
Potential GDE	Maybe	Vegetation	1630	Quercus lobata	Topographically low channel that may fill by water backing up from the Tuolumne River. Vegetation includes willows, cottonwoods, box elder, valley oaks, and blue elderberry.
Potential GDE	Maybe	Vegetation	1897	Rubus armeniacus	Part of a potentially naturally low area just south of the MID drain. Vegetation includes tules, cattails, willows and water primrose.
Potential GDE	Maybe	Vegetation	2546	Salix gooddingii	Well developed riparian forest in a topographically low area adjacent to the San Joaquin River. Vegetation includes willows, cottonwoods, box elder, and valley oaks.
Potential GDE	Maybe	Vegetation	2556	Salix gooddingii	Well developed riparian forest in a topographically low area adjacent to the Stanislaus River. Vegetation includes willows, cottonwoods, box elder, and valley oaks.
Potential GDE	Maybe	Vegetation	2881	Schoenoplectus (acutus, californicus)	Part of a potentially naturally low area just south of the MID drain. Vegetation includes tules and stinging nettle.
Upland	No	Wetland	7711	Palustrine, Emergent, Persistent, Seasonally Flooded	Leveled field; no trees.
Upland	No	Wetland	7714	Palustrine, Emergent, Persistent, Seasonally Flooded	Equipment storage yard and hay barn; no trees.
Upland	No	Wetland	7734	Palustrine, Emergent, Persistent, Seasonally Flooded	Leveled hay storage yard; no trees.
Upland	No	Wetland	7746	Palustrine, Emergent, Persistent, Seasonally Flooded	Leveled agriculture area/cattle feeding area; no trees.
Upland	No	Wetland	7784	Palustrine, Emergent, Persistent, Seasonally Flooded	Agricultural staging area; bare dirt; no trees.
Upland	No	Wetland	7785	Palustrine, Emergent, Persistent, Seasonally Flooded	Agricultural storage area (paved); no trees.
Upland	No	Wetland	7786	Palustrine, Emergent, Persistent, Seasonally Flooded	Low end of irrigated pasture bermed by canal road; no trees.
Upland	No	Wetland	18124	Riverine, Unknown Perennial, Unconsolidated Bottom, Semipermanently Flooded	Paved road and road shoulders, and also includes a portion of an agricultural drain and a portion of a leveled hay field; no trees.
Upland	No	Vegetation	1690	Quercus lobata	Home site surrounded by trees, including a few valley oaks. The cluster of oaks were planted, as evidence as being absent in historical aerials.
Vernal Pool Grassland	No	Wetland	7748	Palustrine, Emergent, Persistent, Seasonally Flooded	Vernal pool grassland (flooded) that is heavily grazed. Vegetation include tules, sedges, and other emergent wetland vegetation.
Vernal Pool Grassland	No	Wetland	7749	Palustrine, Emergent, Persistent, Seasonally Flooded	Vernal pool grassland (flooded) at the low end of an irrigated pasture that is heavily grazed.
Vernal Pool Grassland	No	Wetland	7756	Palustrine, Emergent, Persistent, Seasonally Flooded	Vernal pool grassland at the low end of an irrigated pasture.
Vernal Pool Grassland	No	Wetland	7764	Palustrine, Emergent, Persistent, Seasonally Flooded	Vernal pool grassland (flooded) that is heavily grazed.
Vernal Pool Grassland	No	Wetland	7766	Palustrine, Emergent, Persistent, Seasonally Flooded	Vernal pool grassland (flooded) that is heavily grazed.
Vernal Pool Grassland	No	Wetland	7799	Palustrine, Emergent, Persistent, Seasonally Flooded	Vernal pool grassland (flooded) that is heavily grazed.
Vernal Pool Grassland	No	Wetland	7800	Palustrine, Emergent, Persistent, Seasonally Flooded	Vernal pool grassland (flooded) that is heavily grazed.
Vernal Pool Grassland	No	Wetland	7802	Palustrine, Emergent, Persistent, Seasonally Flooded	Vernal pool grassland (flooded) that is heavily grazed.
Vernal Pool Grassland	No	Wetland	7807	Palustrine, Emergent, Persistent, Seasonally Flooded	Vernal pool grassland (flooded) that is heavily grazed.
Vernal Pool Grassland	No	Vegetation	3212	Sporobolus airoides	The west part of the this relatively large area initially described as potential GDE (which continues to the north on USFWS property) is a mosaic of vernal pool grasslands and agricultural drains.

Attachment C

Summary of Qualifications - Diane S. Moore, M.S.

Diane S. Moore, M.S.
SUMMARY OF QUALIFICATIONS

Moore Biological Consultants (MBC) was founded in mid-1997 and has provided consulting services addressing wetlands, endangered species, fisheries, wildlife biology, impact analysis, and wetland permitting since 1986. Principal Diane S. Moore, M.S. is the Principal Biologist of MBC. She received a B.S. from U.C. Berkeley in 1982 and an M.S. in Ecology from U.C. Davis in 1987. Ms. Moore has over 30 years or experience with wetlands, wildlife, fisheries, and wetland resources including inventory, impact assessment, permitting, and preparation of various environmental documents.

Ms. Moore is recognized by the Army Corps of Engineers (ACOE) as a Wetland Consultant, and has prepared numerous wetland delineations that have been verified by ACOE. She is known for her success in securing permits for work in waters of the U.S. and wetlands from agencies with frequently conflicting requirements. Ms. Moore has conducted after-the-fact wetland delineations for agricultural wetland conversions and other un-permitted wetland fills, and has helped negotiate after-the-fact permits and mitigation settlements with ACOE and U.S. Environmental Protection Agency for Clean Water Act violations.

Ms. Moore was among the first set of scientists in the country to receive a permit to conduct surveys for federally listed fairy and tadpole shrimp, and is recognized by California Department of Fish and Wildlife as a raptor biologist, with extensive experience with burrowing owl and Swainson’s hawk.

Ms. Moore frequently conducts due-diligence reviews for development and agricultural clients prior to acquisition of new properties. She reviews sites for the potential to contain waters of the U.S. or wetlands, special-status species, or suitable habitat for special-status species, as these resources can significantly constrain agricultural development. For many due-diligence reviews on agricultural properties, Ms. Moore utilizes historical aerial imagery and topographic maps to understand the history of the potential acquisition. She has also provided consulting support to numerous irrigation districts, water conservation districts, and reclamation districts.

Ms. Moore is recognized as an expert in biological resource inventory and impact analysis and IS asked to provide peer review on work done by other biologists. She has also provided expert witness testimony in local and federal courts and tribunals regarding vernal pools and other wetlands. Unlike many consultants, she has extensive experience in agricultural projects, primarily focused on compliance with endangered species and wetlands regulations.

MOORE BIOLOGICAL CONSULTANTS

December 2, 2021

Todd Groundwater
Attn: Ms. Phyllis Stanin and Ms. Liz Elliott
2490 Mariner Square Loop, Ste. 215
Alameda, CA 94501

Subject: "MAPES RANCH", STANISLAUS COUNTY, CALIFORNIA: REVIEW OF POTENTIAL GROUNDWATER DEPENDENT ECOSYSTEMS (ADDENDUM TO NOVEMBER 10, 2021 REPORT)

Dear Ms. Stanin and Ms. Elliott:

During Fall 2021, I reviewed the areas on the privately-owned parcels on the Mapes Ranch that have been identified as potential Groundwater Dependent Ecosystems ("GDEs") by Todd Groundwater, consultants to the Stanislaus & Tuolumne Rivers Groundwater Basis Association ("STRGBA") Groundwater Sustainability Agency ("GSA"). I also conducted a cursory review of a few areas initially described as potential GDEs on adjacent properties managed by the Mapes Ranch ownership, but owned by the U.S. Fish and Wildlife Service ("USFWS"). Figure 1 depicts the Mapes Ranch ownership and the adjacent USFWS parcels, cumulatively described as the "Mapes Ranch". Figure 2 depicts the areas initially described as potential GDEs identified in the review area. My initial concerns were described in a September 29, 2021 report and my overall findings were described in my November 10, 2021 report.

On November 17, 2021, I had the opportunity to further review four areas which were initially described as potential GDEs (i.e., #992, #1897, #2881, and #7763) that I had not been able to fully analyze during prior visits. This letter describes my conclusions on these areas and is an addendum to my November 10, 2021 report.

10330 Twin Cities Road, Suite 30 • Galt, CA 95632
(209) 745–1159 • Fax (209) 745-7513
e-mail: moorebio@softcom.net

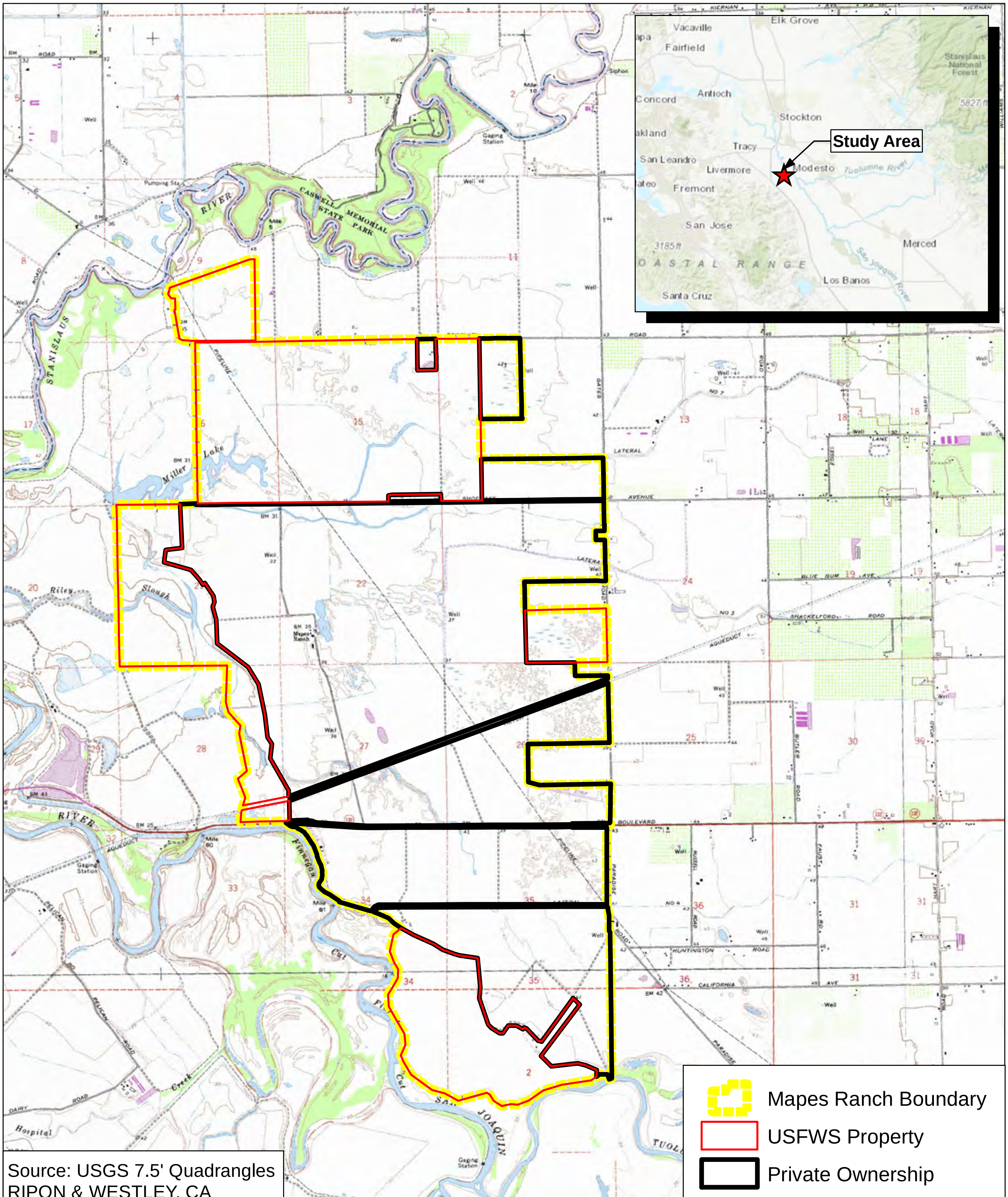


Figure 1

Moore Biological Consultants

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N W E S

Map Date: 10/18/2021

USGS

Mapes Ranch

Stanislaus County, CA

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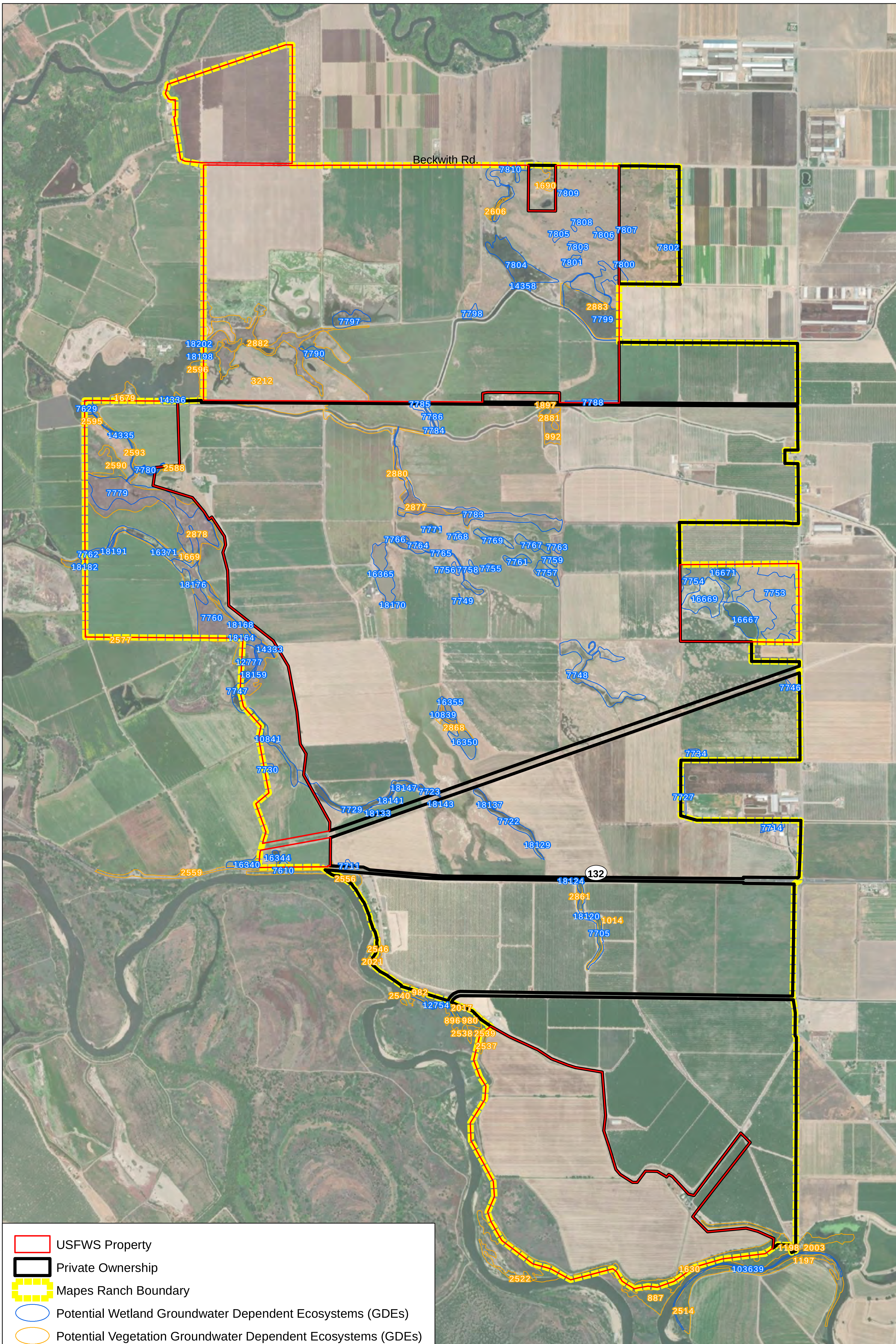

Figure 2

Moore Biological Consultants

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Map Date: 10/19/2021
Aerial Source: Maxar (05/2020)

Potential GDEs

Mapes Ranch

Stanislaus County, CA

Methods

This supplemental analysis of the areas initially described as potential GDEs #992, #1897, #2881, and #7763 utilized the same methods described in November 10, 2021 report. During the November 17, 2021 follow-up field survey, managed water levels in Modesto Irrigation District's ("MID") Lateral No. 3, MID's drain, and a private spur lateral off of Lateral No. 3 were much lower, allowing me to walk throughout these areas initially described as potential GDEs. During my prior visits, managed water levels prevented access needed to determine elevations of these areas and associated potential maximum rooting depths of existing vegetation.

Results

Photographs of the areas initially described as potential GDEs #992, #1897, #2881, and #7763 are provided in Attachment A. All of the areas on the privately owned parcels of the Ranch that were initially described as potential GDEs and "other habitats" that had been described as potential GDEs are depicted on Figure 3 and listed on Table B1 in Attachment B.

Agricultural Drains: The areas initially described as potential GDEs #992, #1897, and #2881 are located in a cluster immediately south of MID's drain and bounded on the south and west by MID's Lateral No. 3 and are functionally one low area. This low area is approximately 2 feet lower in elevation than adjacent farmland. This low area is saturated or flooded when managed water levels in MID's Lateral No. 3 and/or MID's drain are high. A culvert connecting MID's drain and the low area allows water to flow in to the low area when the drain is full; the absence of a levee or berm along the edge of MID's Lateral No. 3 allows water to flow in to the low area when the lateral is full. When water levels in both the lateral and drain are low, such as during my November 17, 2021 follow-up field survey, this low area is dry.

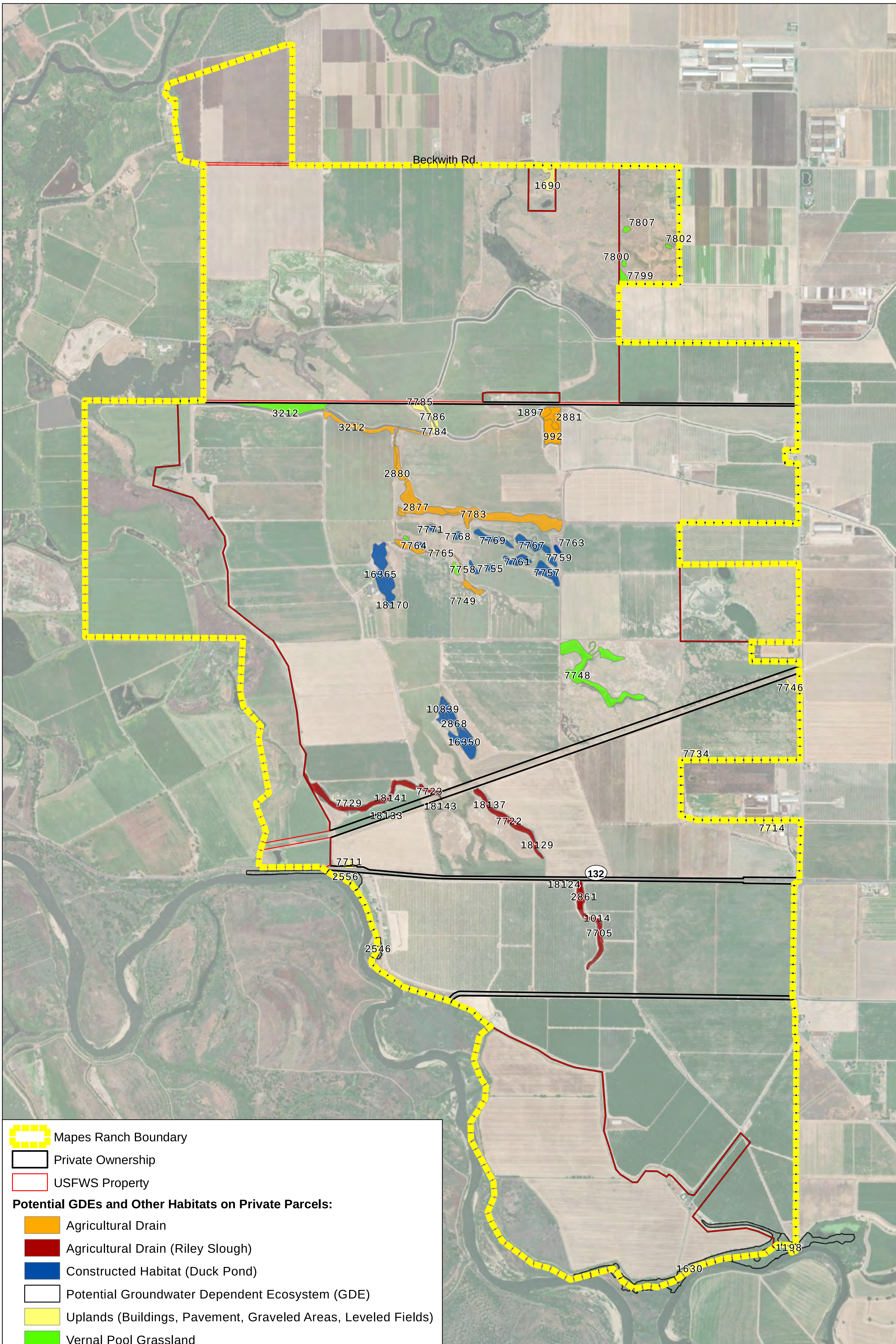

Figure 3

Moore Biological Consultants

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Map Date: 12/01/2021
Aerial Source: Maxar (05/2020)

Potential GDEs and Other Habitats

Mapes Ranch

Stanislaus County, CA

The majority of this low area supports a mixture of upland and wetland species; there are tules, cattails, and a few willows in the few relatively small and deeper parts of this low area. This vegetation is supported by surface water and/or water pumped from private wells and none of these areas initially described as potential GDEs support vegetation with deep enough roots to be supported by groundwater. The small patch of willows along the north edge of potential GDE #1897 is supported by managed water as evidenced by the fact that there are no trees apparent in historical aerial imagery. **The areas initially described as potential GDEs #992, #1897, and #2881 are not GDEs and are best classified as "Agricultural Drains".**

Constructed Habitat: The area initially described as potential GDE #7763 is located along the east edge of a cluster of constructed habitats in the central part of the Ranch that are connected together with a series of pipes and control gates to manage the water. This area initially described as potential GDE #7763 is the south part of a larger low area that is approximately 2 feet lower in elevation than adjacent farmland. The entire low area has been subject to grading to provide a combination of upland and upland habitats for waterfowl and much of the low area is saturated or flooded when managed water levels a private spur lateral off MID's Lateral No. 3 are high. When water levels in the spur lateral are low, such as during my November 17, 2021 follow-up field survey, the area initially described as potential GDE #7763 is dry.

The area initially described as potential GDE #7763 supports a mixture of upland and wetland species; there is a small patch of tules in the relatively deeper part of this overall low area and a few scattered willow shrubs. This vegetation is supported by surface water and/or water pumped from private wells that is delivered to the area from an adjacent lateral. The vegetation does not have deep enough roots to be supported by groundwater. **The area initially described as potential GDE #7763 is not a GDE and is best classified as a "Constructed Habitat".**

Conclusion

I highly encourage Todd Groundwater to eliminate the areas initially described as potential GDEs #992, #1897, #2881, and #7763 on the maps provided to the GSA as potential GDEs on the Mapes Ranch property that have been ground-truthed and determined to be other habitats, as depicted on Figure 3 and as listed in Table B1 in Attachment B from the GSP altogether.

Please call me at (209) 745-1159 with any questions.

Sincerely,

Diane S. Moore, M.S.
Principal Biologist

Cc: Stanislaus & Tuolumne Rivers Groundwater Basin Association, GSA
E-mail: strgba@mid.org

Modesto Irrigation District c/o Chad Tienken
E-mail: chad.tienken@mid.org

Oakdale Irrigation District c/o Eric Thorburn
E-mail: ethorburn@oakdaleirrigation.com

City of Waterford c/o Mike Pitcock
E-mail: mpitcock@cityofwaterford.org

Stanislaus County c/o Walt Ward
E-mail: wward@envres.org

City of Modesto c/o Miguel Alvarez
E-mail: malvarez@modestogov.com

City of Oakdale c/o Michael Renfrow
E-mail: mrenfrow@ci.oakdale.ca.us

Attachment A

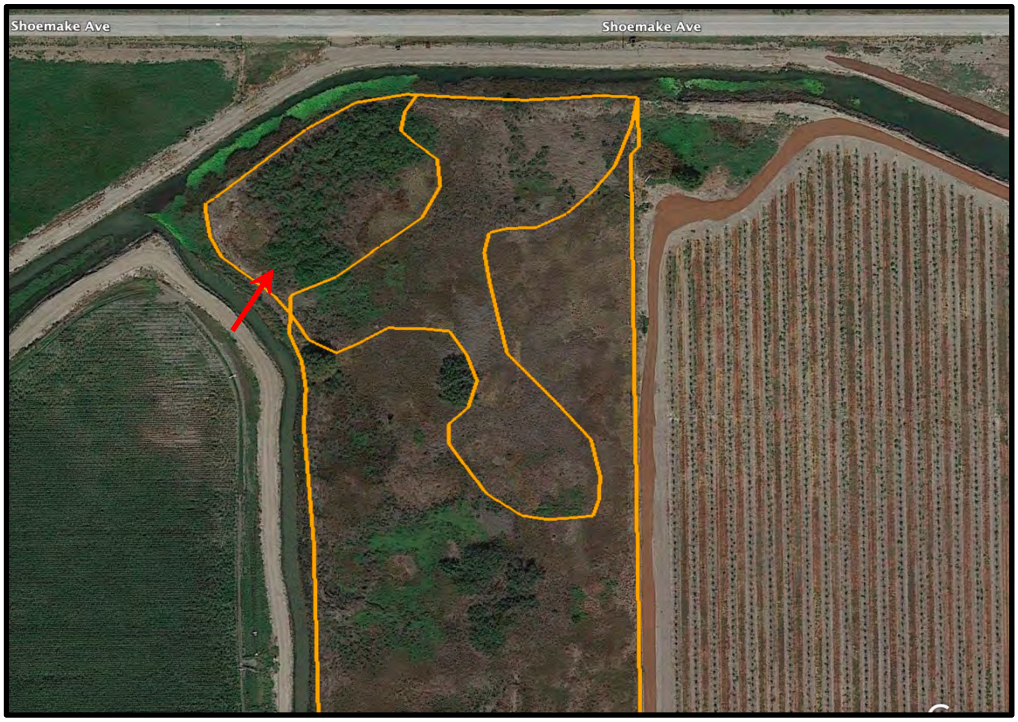
Photographs

Example Constructed Habitat that is not a GDE

Potential GDE #7763 is located along the east edge of the cluster of constructed habitats in the central part of the ranch. The arrow notes the location and direction of the ground-level photograph below.

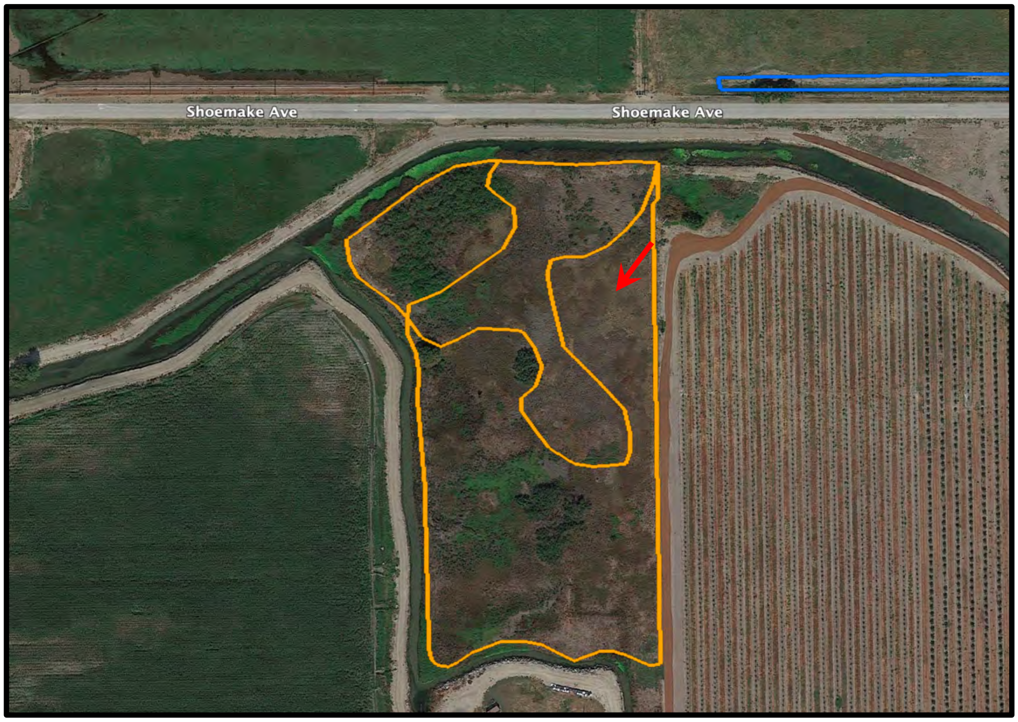
Potential GDE #7763, looking northeast; 09/03/21. This shallow basin is only a few feet deep and can be filled by opening a valve from a private lateral. This area has been graded to provide upland and wetland habitats and is managed for conservation.

Example Agricultural Drains that are not GDEs



Potential GDE #1897 is located in a shallow basin along the east side of MID's Lateral #3 and south of MID's drain.


Potential GDE #1897, looking northeast; 09/03/21. The cattails in the foreground are in MID's Lateral No. 3. The small patch of willows are on the north edge of Potential GDE #1897, adjacent to MID's drain.



Potential GDEs #1897, 2881 and 992 are located in a shallow basin bounded on the south and west by MID's Lateral #3, and bounded on the north by MID's drain.

East part of potential GDEs #992 and 2881, looking southwest; 09/03/21. This area supports a mixture of upland and wetland species and is saturated or flooded when water levels are high in MID's adjacent lateral and drain.

Attachment B

Ground-Truthed Habitats

TABLE B1

GROUND-TRUTHED HABITATS

(Revisions to Table B-1 in 11/10/21 Report are Noted in RED)

Ground-Truthed Habitat Type	GDE?	Potential GDE in NC DataSet	Polygon # in NC DataSet	Habitat Description in NC DataSet	Field Notes
Agricultural Drain	No	Wetland	7765	Palustrine, Emergent, Persistent, Seasonally Flooded	Agricultural irrigation drain; vegetation includes cattails and water primrose.
Agricultural Drain	No	Wetland	7783	Palustrine, Emergent, Persistent, Seasonally Flooded	Part of an agricultural irrigation drain; partially overlaps polygons 2880 & 2877; vegetation includes tules, rushes, and sedges.
Agricultural Drain	No	Vegetation	992	California Warm Temperate Marsh/Seep	Part of a potentially naturally low area just south of the MID drain and includes some higher elevation areas supporting upland species. This low area is approximately 2 feet in elevation below the adjacent farmland
Agricultural Drain	No	Vegetation	1897	Rubus armeniacus	Part of a potentially naturally low area just south of the MID drain. Vegetation includes tules, cattails, a small patch of willows,water primrose, and some upland species.
Agricultural Drain	No	Vegetation	2877	Schoenoplectus (acutus, californicus)	Part of an agricultural irrigation drain; partially overlaps polygon 7783; vegetation includes tules, rushes, and sedges.
Agricultural Drain	No	Vegetation	2880	Schoenoplectus (acutus, californicus)	Part of an agricultural irrigation drain; partially overlaps polygon 7783; vegetation includes tules, rushes, cattails, and water primrose.
Agricultural Drain	No	Vegetation	2881	Schoenoplectus (acutus, californicus)	Part of a potentially naturally low area just south of the MID drain. Vegetation includes tules and stinging nettle.
Agricultural Drain	No	Vegetation	3212	Sporobolus airoides	The east part of the this polygon consists of an agricultural drain, the edge of MID's drain, and an elevated MID maintenance road along the south edge of the drain.
Agricultural Drain (Riley Slough)	No	Wetland	7705	Palustrine, Emergent, Persistent, Seasonally Flooded	Part of an agricultural irrigation drain; partially overlaps polygons 1014 & 2861; vegetation includes tules, rushes, and sedges. This polygon also includes part of a farm road adjacent to Riley Slough.
Agricultural Drain (Riley Slough)	No	Wetland	7722	Palustrine, Emergent, Persistent, Seasonally Flooded	Riley Slough north of Highway 132; part of an agricultural irrigation drain; vegetation includes tules, rushes, sedges, and water primrose; includes some upland areas adjacent to Riley Slough. Polygons 18129, 18131, and 18137 are tiny polygons along the edges of this primary polygon.
Agricultural Drain (Riley Slough)	No	Wetland	7723	Palustrine, Emergent, Persistent, Seasonally Flooded	Riley Slough north of the Hetch Hetchy Aqueduct; part of an agricultural irrigation drain; vegetation includes tules and water primrose. This polygon also includes part of a farm road adjacent to Riley Slough.
Agricultural Drain (Riley Slough)	No	Wetland	7729	Palustrine, Emergent, Persistent, Seasonally Flooded	Riley Slough west of the Ranch entrance road; part of an agricultural irrigation drain; vegetation includes tules, rushes, sedges, water primrose, and a few willows and cottonwoods. This polygon also includes parts of farm roads and some uplands adjacent to Riley Slough.
Agricultural Drain (Riley Slough)	No	Wetland	18120	Riverine, Unknown Perennial, Unconsolidated Bottom, Semipermanently Flooded	Riley Slough south of Highway 132; part of an agricultural irrigation drain along the edge of polygon 7705; vegetation includes tules, rushes, and sedges.
Agricultural Drain (Riley Slough)	No	Wetland	18129	Riverine, Unknown Perennial, Unconsolidated Bottom, Semipermanently Flooded	Riley Slough north of Highway 132; part of an agricultural irrigation drain along the edge of polygon 7722; a few live and dead cottonwoods.
Agricultural Drain (Riley Slough)	No	Wetland	18131	Riverine, Unknown Perennial, Unconsolidated Bottom, Semipermanently Flooded	Riley Slough north of Highway 132; part of an agricultural irrigation drain along the edge of polygon 7722; vegetation is tules.
Agricultural Drain (Riley Slough)	No	Wetland	18133	Riverine, Unknown Perennial, Unconsolidated Bottom, Semipermanently Flooded	Riley Slough west of the Ranch entrance road; part of an agricultural irrigation drain along the edge of polygon 7729; vegetation is primarily tules.
Agricultural Drain (Riley Slough)	No	Wetland	18137	Riverine, Unknown Perennial, Unconsolidated Bottom, Semipermanently Flooded	Riley Slough north of Highway 132; part of an agricultural irrigation drain along the edge of polygon 7722; vegetation is tules.
Agricultural Drain (Riley Slough)	No	Wetland	18141	Riverine, Unknown Perennial, Unconsolidated Bottom, Semipermanently Flooded	Riley Slough west of the Ranch entrance road; part of an agricultural irrigation drain along the edge of polygon 7729; vegetation is primarily tules.
Agricultural Drain (Riley Slough)	No	Wetland	18143	Riverine, Unknown Perennial, Unconsolidated Bottom, Semipermanently Flooded	Riley Slough north of the Hetch Hetchy Aqueduct; part of an agricultural irrigation drain; vegetation includes tules, rushes, sedges, and water primrose; upstream tip of polygon 7723.

Agricultural Drain (Riley Slough)	No	Wetland	18147	Riverine, Unknown Perennial, Unconsolidated Bottom, Semipermanently Flooded	Riley Slough north of the Hetch Hetchy Aqueduct; part of an agricultural irrigation drain; vegetation includes tules. This polygon also includes part of a paved road and some upland grassland.
Agricultural Drain (Riley Slough)	No	Vegetation	1014	Freshwater Emergent Marsh	South tip of Riley Slough; part of an agricultural irrigation drain; partially overlaps polygon 7705; vegetation includes tules, rushes, and sedges; further north there are a few scattered willows and cottonwoods.
Agricultural Drain (Riley Slough)	No	Vegetation	2861	Schoenoplectus (acutus, californicus)	Riley Slough south of Highway 132; part of an agricultural irrigation drain; partially overlaps polygon 7705; vegetation includes tules, rushes, and sedges. and a few willows and cottonwoods.
Constructed Habitat (Duck Pond)	No	Wetland	7755	Palustrine, Emergent, Persistent, Seasonally Flooded	Constructed shallow basin in a cluster of basins that are interconnected with pipelines and managed for waterfowl conservation and hunting; less than or equal to 12 inches deep; vegetation is a combination of upland and wetland grasses and weeds. Surrounded by planted trees.
Constructed Habitat (Duck Pond)	No	Wetland	7757	Palustrine, Emergent, Persistent, Seasonally Flooded	Constructed shallow basin in a cluster of basins that are interconnected with pipelines and managed for waterfowl conservation and hunting; less than or equal to 12 inches deep; vegetation is a combination of upland and wetland grasses and weeds. Partially surrounded by planted trees.
Constructed Habitat (Duck Pond)	No	Wetland	7758	Palustrine, Emergent, Persistent, Seasonally Flooded	Constructed shallow basin in a cluster of basins that are interconnected with pipelines and managed for waterfowl conservation and hunting; less than or equal to 12 inches deep; vegetation is a combination of upland and wetland grasses and weeds. Surrounded by planted trees. There is a pit blind is situated just west of the polygon.
Constructed Habitat (Duck Pond)	No	Wetland	7759	Palustrine, Emergent, Persistent, Seasonally Flooded	Shallow basin in a cluster of basins that are interconnected with pipelines and managed for waterfowl conservation and hunting; less than or equal to 6 inches deep; gate valve from MID at north tip of the polygon; vegetation is a combination of upland and wetland grasses and weeds. Partially surrounded by planted trees.
Constructed Habitat (Duck Pond)	No	Wetland	7761	Palustrine, Emergent, Persistent, Seasonally Flooded	Constructed shallow basin in a cluster of basins that are interconnected with pipelines and managed for waterfowl conservation and hunting; less than or equal to 12 inches deep; vegetation is a combination of upland and wetland grasses and weeds. Surrounded by planted trees.
Constructed Habitat (Duck Pond)	No	Wetland	7763	Palustrine, Emergent, Persistent, Seasonally Flooded	South part of a naturally low area that can be filled via a gate valve from a private lateral that surrounds three sides of the low area. Vegetation includes tules and a small patch of shrubby willows, as well as some upland species on a constructed mound.
Constructed Habitat (Duck Pond)	No	Wetland	7767	Palustrine, Emergent, Persistent, Seasonally Flooded	Constructed shallow basin in a cluster of basins that are interconnected with pipelines and managed for waterfowl conservation and hunting; less than or equal to 12 inches deep; vegetation is a combination of upland and wetland grasses and weeds. Planted in sorghum and surrounded by planted trees.
Constructed Habitat (Duck Pond)	No	Wetland	7768	Palustrine, Emergent, Persistent, Seasonally Flooded	Constructed shallow basin in a cluster of basins that are interconnected with pipelines and managed for waterfowl conservation and hunting; 2 to 3 feet deep; vegetation is a combination of upland and wetland grasses and weeds. Vegetation includes Bermuda grass, salt grass, and cocklebur.
Constructed Habitat (Duck Pond)	No	Wetland	7769	Palustrine, Emergent, Persistent, Seasonally Flooded	Constructed shallow basin in a cluster of basins that are interconnected with pipelines and managed for waterfowl conservation and hunting; less than or equal to 12 inches deep; vegetation is a combination of upland and wetland grasses and weeds. Surrounded by planted trees.
Constructed Habitat (Duck Pond)	No	Wetland	7771	Palustrine, Emergent, Persistent, Seasonally Flooded	Construction basin in a cluster of basins that are interconnected with pipelines and managed for waterfowl conservation and hunting; the basin had been filled with water for livestock watering. Vegetation includes rushes and water primrose.
Constructed Habitat (Duck Pond)	No	Wetland	10839	Palustrine, Emergent, Persistent, Semipermanently Flooded	Part of a constructed basin with tule and cattail fringe; grazed.
Constructed Habitat (Duck Pond)	No	Wetland	16350	Palustrine, Unconsolidated Bottom, Permanently Flooded	Part of a constructed basin with tule and cattail fringe; grazed.

Constructed Habitat (Duck Pond)	No	Wetland	16355	Palustrine, Unconsolidated Bottom, Permanently Flooded	Part of a constructed basin with tule and cattail fringe; grazed.
Constructed Habitat (Duck Pond)	No	Wetland	16365	Palustrine, Unconsolidated Bottom, Permanently Flooded	Large pond adjacent to the Ranch office that is partially landscaped; fringe of tules.
Constructed Habitat (Duck Pond)	No	Wetland	18170	Riverine, Unknown Perennial, Unconsolidated Bottom, Semipermanently Flooded	South tip of the large pond adjacent to the Ranch office.
Constructed Habitat (Duck Pond)	No	Vegetation	2868	Schoenoplectus (acutus, californicus)	Tule fringe that partially overlaps polygons 16350 and 10839 and also includes some uplands adjacent to the duck pond.
Potential GDE	Maybe	Vegetation	1198	Populus fremontii	Well developed riparian forest in a topographically low area adjacent to the Tuolumne River. Vegetation includes willows, cottonwoods, box elder, and valley oaks.
Potential GDE	Maybe	Vegetation	1630	Quercus lobata	Topographically low channel that may fill by water backing up from the Tuolumne River. Vegetation includes willows, cottonwoods, box elder, valley oaks, and blue elderberry.
Potential GDE	Maybe	Vegetation	2546	Salix gooddingii	Well developed riparian forest in a topographically low area adjacent to the San Joaquin River. Vegetation includes willows, cottonwoods, box elder, and valley oaks.
Potential GDE	Maybe	Vegetation	2556	Salix gooddingii	Well developed riparian forest in a topographically low area adjacent to the Stanislaus River. Vegetation includes willows, cottonwoods, box elder, and valley oaks.
Upland	No	Wetland	7711	Palustrine, Emergent, Persistent, Seasonally Flooded	Leveled field; no trees.
Upland	No	Wetland	7714	Palustrine, Emergent, Persistent, Seasonally Flooded	Equipment storage yard and hay barn; no trees.
Upland	No	Wetland	7734	Palustrine, Emergent, Persistent, Seasonally Flooded	Leveled hay storage yard; no trees.
Upland	No	Wetland	7746	Palustrine, Emergent, Persistent, Seasonally Flooded	Leveled agriculture area/cattle feeding area; no trees.
Upland	No	Wetland	7784	Palustrine, Emergent, Persistent, Seasonally Flooded	Agricultural staging area; bare dirt; no trees.
Upland	No	Wetland	7785	Palustrine, Emergent, Persistent, Seasonally Flooded	Agricultural storage area (paved); no trees.
Upland	No	Wetland	7786	Palustrine, Emergent, Persistent, Seasonally Flooded	Low end of irrigated pasture bermed by canal road; no trees.
Upland	No	Wetland	18124	Riverine, Unknown Perennial, Unconsolidated Bottom, Semipermanently Flooded	Paved road and road shoulders, and also includes a portion of an agricultural drain and a portion of a leveled hay field; no trees.
Upland	No	Vegetation	1690	Quercus lobata	Home site surrounded by trees, including a few valley oaks. The cluster of oaks were planted, as evidence as being absent in historical aerials.
Vernal Pool Grassland	No	Wetland	7748	Palustrine, Emergent, Persistent, Seasonally Flooded	Vernal pool grassland (flooded) that is heavily grazed. Vegetation include tules, sedges, and other emergent wetland vegetation.
Vernal Pool Grassland	No	Wetland	7749	Palustrine, Emergent, Persistent, Seasonally Flooded	Vernal pool grassland (flooded) at the low end of an irrigated pasture that is heavily grazed.
Vernal Pool Grassland	No	Wetland	7756	Palustrine, Emergent, Persistent, Seasonally Flooded	Vernal pool grassland at the low end of an irrigated pasture.
Vernal Pool Grassland	No	Wetland	7764	Palustrine, Emergent, Persistent, Seasonally Flooded	Vernal pool grassland (flooded) that is heavily grazed.
Vernal Pool Grassland	No	Wetland	7766	Palustrine, Emergent, Persistent, Seasonally Flooded	Vernal pool grassland (flooded) that is heavily grazed.
Vernal Pool Grassland	No	Wetland	7799	Palustrine, Emergent, Persistent, Seasonally Flooded	Vernal pool grassland (flooded) that is heavily grazed.
Vernal Pool Grassland	No	Wetland	7800	Palustrine, Emergent, Persistent, Seasonally Flooded	Vernal pool grassland (flooded) that is heavily grazed.
Vernal Pool Grassland	No	Wetland	7802	Palustrine, Emergent, Persistent, Seasonally Flooded	Vernal pool grassland (flooded) that is heavily grazed.
Vernal Pool Grassland	No	Wetland	7807	Palustrine, Emergent, Persistent, Seasonally Flooded	Vernal pool grassland (flooded) that is heavily grazed.
Vernal Pool Grassland	No	Vegetation	3212	Sporobolus airoides	The west part of the this relatively large area initially described as potential GDE (which continues to the north on USFWS property) is a mosaic of vernal pool grasslands and agricultural drains.

Appendix E

Modesto Subbasin Communication and Engagement Plan

MODESTO SUBBASIN COMMUNICATION AND ENGAGEMENT PLAN

PREPARED FOR:
Stanislaus and Tuolumne Rivers Groundwater Basin Association Groundwater Sustainability Agency and the Tuolumne County Groundwater Sustainability Agency

PREPARED BY:
Stantec Consulting Services Inc.

SEPTEMBER 2020

Executive Summary

The Modesto Subbasin Communication and Engagement Plan (Plan) provides a high-level overview of potential near- and long-term outreach strategies, tactics, and tools that support public and stakeholder communication actions, as required by the Sustainable Groundwater Management Act (SGMA) of 2014 and for consideration by the Stanislaus and Tuolumne Rivers Groundwater Basin Association Groundwater Sustainability Agency (STRGBA GSA). This Plan recognizes that one-size doesn't fit all and describes potential actions that may be implemented by the STRGBA GSA and Tuolumne County Groundwater Sustainability Agency (Tuolumne County GSA) to inform and engage stakeholders about development of the Groundwater Sustainability Plan (GSP), deliver clear and consistent messaging about SGMA, and comply with the SGMA outreach requirements. The potential outreach tools and activities identified in this document were informed by a Stakeholder Assessment conducted by the Modesto Subbasin GSAs in Spring 2020. Both the Stakeholder Assessment and this Plan were funded through a Facilitation Support Services grant (Implementation Service Plan no. 08, see **Attachment A**) from the California Department of Water Resources (DWR). Stantec developed these documents as part of the Implementation Service Plan tasks for the Modesto Subbasin.

Outreach Tools

This Plan identifies several potential tools to support communication and engagement activities with stakeholders in the Modesto Subbasin. For the purposes of this Plan, stakeholders are defined as beneficial users of groundwater in the Subbasin or individuals or organizations with interest or stake in the management of water resources in the region. These tools include the following:

- Project Website: The STRGBA GSA member agencies have updated the STRGBA website (www.strgba.org) to provide information about SGMA and to house GSA meeting and outreach materials. The Tuolumne County GSA has added a SGMA-related page (https://www.tuolumnecounty.ca.gov/1292/Sustainable-Groundwater-Management-Act-S) to the Tuolumne County website. The page also links to the STRGBA website.
- Interested Parties Database: Pursuant to the requirements of SGMA, the Modesto Subbasin GSAs have developed and will maintain an Interested Party Database. The Database will be used to notify stakeholders of pending meetings and workshops, opportunities for public comment, and notices of other GSA outreach actions.
- Newsletter: The STRGBA GSA has developed and distributes a quarterly electronic newsletter to keep interested parties informed about progress in developing the GSP, opportunities for public engagement, and groundwater management issues or news of regional importance.
- Informational Materials: The Modesto Subbasin GSA will develop template outreach materials for each phase of the GSP development and implementation process. These materials may be translated as needed into Spanish or other languages, and may include informational fact sheets, template presentation slides, notices, and new releases.

Outreach Activities

This Plan identifies a variety of potential outreach activities to provide opportunities for interested parties and stakeholders to stay informed and engaged in the development of the GSP. These potential outreach activities seek to build and expand public awareness of the Modesto Subbasin GSAs and SGMA and to actively engage key stakeholder groups to coordinate and collaborate on technical issues important for GSP development. Below is a summary of existing and potential additional outreach opportunities.

- Public Meetings: The primary way for members of the public to provide input on development of the GSP is by attending and providing public comment at regular STRGBA GSA GSP Coordination and Technical Advisory Committee meetings.
- Member Agency Briefings: GSA representatives or consultant staff may conduct periodic presentations to boards, councils, and commissions of the Modesto Subbasin GSAs' member agencies on an as-needed basis. These presentations are intended to provide updates on GSP progress and next steps and to respond to questions.
- GSP Development Workshops: In support of plan development, the Modesto Subbasin GSAs will periodically host public workshops aimed at educating members of the public about key GSP topics and to solicit input on technical content and draft GSP chapters. It is anticipated that up to five workshops will be held between Summer 2020 and Fall 2021.
- Community Presentations: The Modesto Subbasin GSAs may provide brief, high-level overviews of the GSP process and status at meetings hosted by various civic, nonprofit, and community groups in the Subbasin.
- GSP Office Hours: GSP office hours entail establishing a designated block of time when interested parties can talk to a GSA representative, ask questions, or provide input on draft GSP chapters in an informal setting. The GSA representative(s) hosting the office hours will record questions and feedback from participants. Questions and answers will be posted on the STRGBA GSA website..
- Partnerships with Trusted Messengers: The Modesto Subbasin GSAs may utilize partnerships with trusted messengers in the Subbasin to broaden the dissemination of SGMA information and connect with hard-to-reach stakeholder groups. This may include sending these organizations notices and informational materials for distribution to their stakeholders, cohosting events or workshops, and/or holding briefings with organization leadership.
- Targeted Outreach: The Modesto Subbasin GSAs may also conduct targeted outreach to specific stakeholder groups that may be underrepresented in other outreach activities or require targeted messaging or activities. This may include targeted outreach to tribes, agricultural water users, urban water users, disadvantaged communities, and watershed stewardship organizations.

Groundwater Sustainability Plan Comment Process Adoption Outreach

The Modesto Subbasin GSAs will release draft GSP chapters for public review and comment as chapters are developed. Interested parties will be able to view draft chapters on the STRGBA GSA website and to submit comments remotely via email or in-person during public workshops. The draft chapters may be revised according to comments received during the respective comment periods.

It is currently envisioned that a complete Public Draft GSP will be released for public review in Fall 2021, for a 45-day public comment period. A summary of the comments received during this period will be attached to the Final GSP and posted on the STRGBA GSA website. The Final GSP will be adopted at a public hearing and then submitted to DWR no later than January 31, 2022.

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Acronyms and Abbreviations

CASGEM	California Statewide Groundwater Elevation Monitoring
Plan	Communication and Engagement Plan
DWR	California Department of Water Resources
FSS	Facilitation Support Services
GSA	Groundwater Sustainability Agency
GSP	Groundwater Sustainability Plan
MHI	Median Household Income
MID	Modesto Irrigation District
Modesto Subbasin GSAs	Stanislaus and Tuolumne Rivers Groundwater Basin Association Groundwater Sustainability Agency and Tuolumne County Groundwater Sustainability Agency
MOU	Memorandum of Understanding
SGMA	Sustainable Groundwater Management Act of 2014
Stakeholder Assessment	Modesto Subbasin Stakeholder Assessment
STRGBA GSA	Stanislaus and Tuolumne Rivers Groundwater Basin Association Groundwater Sustainability Agency
Subbasin	Modesto Subbasin
Tuolumne County GSA	Tuolumne County Groundwater Sustainability Agency

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1.0 INTRODUCTION

1.1 About SGMA

The Sustainable Groundwater Management Act (SGMA) was signed into law by Governor Jerry Brown on September 16, 2014—three years after the start of California's historic drought. The legislation requires local public agencies and newly formed Groundwater Sustainability Agencies (GSA) in high- and medium-priority subbasins to meet certain requirements for the long-term sustainable management of California's groundwater resources. These requirements include the following:

- June 30, 2017: Establish GSAs (or equivalent) for all high- and medium-priority basins. (Water Code § 10724(b))
- July 1, 2017: County must affirm or disaffirm responsibility as GSA if no GSA has been established. (Water Code § 10724(b))
- Jan. 31, 2022: All non-critically overdrafted high- and medium-priority basins must be managed under a Groundwater Sustainability Plan (GSP). (Water Code § 10720.7(a)(1))
- On April 1, following GSP adoption and annually thereafter, GSAs will provide reports on progress towards sustainability to the California Department of Water Resources (DWR). (Water Code § 10728)

Oversight of these requirements is provided by DWR with potential intervention by the State Water Resources Control Board, if management activities are determined to be inadequate.

1.1.1 GSP Emergency Regulations

Following the passage of SGMA, DWR embarked on a series of public and agency meetings to develop the GSP Emergency Regulations. These regulations were released in July of 2016 and are chaptered under the California Code of Regulations Title 23. Waters (§350-§358.4). In conjunction with the release of these regulations, DWR published the Groundwater Sustainability Plan Emergency Regulations Guide. This guide summarizes and defines the processes and requirements for GSA formation found in Title 23, the development and implementation of GSPs, the responsibilities of DWR (and by extension the State Water Resources Control Board), and inter-basin coordination (§357.2).

The Modesto Subbasin Communication and Engagement Plan (Plan) describes options available to the Modesto Subbasin GSAs' as they seek to achieve the communication and engagement activities identified in the GSP Emergency Regulations and chaptered in California Code of Regulations Section 354.10:

> *Each plan shall include a summary of information relating to notification and communication by the agency with other agencies and interested parties including the following:*
>
> *(a) A description of the beneficial uses and users of groundwater in the basin, including the land uses and property interests potentially affected by the use of*

groundwater in the basin, the types of parties representing those interests, and the nature of consultation with those parties.

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

(c) Comments regarding the plan received by the agency and a summary of any responses by the agency.

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

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

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

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

1.2 About the Modesto Subbasin

There are a total of 515 groundwater subbasins in the State of California. The Modesto Subbasin (Subbasin) (DWR Bulletin 118 Basin Number 5-022.02) is primarily located within Stanislaus County with a portion in Tuolumne County. It is one of the 19 subbasins making up the greater San Joaquin Valley Basin. It is also one of the 94 subbasins that have been designated as high or medium priority by DWR's California Statewide Groundwater Elevation Monitoring (known as CASGEM) program. With CASGEM data and analysis, DWR has classified the Modesto Subbasin as a high-priority, non-critically overdrafted subbasin. This classification requires the GSAs in the Subbasin to submit a GSP to DWR no later than January 31, 2022.

1.3 About the Stanislaus and Tuolumne Rivers Groundwater Basin Association and Tuolumne County Groundwater Sustainability Agencies

The Stanislaus and Tuolumne Rivers Groundwater Basin Association Groundwater Sustainability Agency (STRGBA GSA) and the Tuolumne County Groundwater Sustainability Agency (Tuolumne County GSA) (collectively known herein as the Modesto Subbasin GSAs) have formed in response to the regulations set forth by SGMA. They are working cooperatively to develop a single GSP for the Modesto Subbasin, conduct general and targeted outreach communication and engagement activities, and to maintain groundwater sustainability in the Subbasin through the use of proven sustainable groundwater management actions.

STRGBA was formed under a Memorandum of Understanding (MOU) in April of 1994 to provide a forum for coordinated planning and management activities for the Modesto Subbasin. Initially, the MOU was between six entities in the Subbasin: City of Modesto, Modesto Irrigation District (MID), City of Oakdale, Oakdale Irrigation District (OID), City of Riverbank, and Stanislaus County. In 2015, the MOU was revised to add the City of Waterford. Each of these entities are eligible to serve as an independent GSA, pursuant to Water Code §10721(n). The STRGBA member agencies passed resolutions to amend the existing MOU to officially form the singular STRGBA GSA in compliance with SGMA on May 29, 2017.

Tuolumne County formed a GSA on May 16, 2017, to cover the portion of the Modesto Subbasin within the County's jurisdiction and not covered by an existing GSA. The Tuolumne County GSA represents an area of approximately 1,000 acres, primarily located in the northern part of the Subbasin. This area is a fraction of one percent of the 247,000-acre Subbasin. Therefore, the Tuolumne County GSA is cooperating in the Modesto Subbasin GSP process through a coordination agreement with Stanislaus County, included as **Attachment B** to this Plan. As a STRGBA GSA member agency, Stanislaus County is participating in the GSP process on behalf of the Tuolumne County GSA.

Figure 1 shows the boundaries of the Modesto Subbasin and illustrates how the Modesto Subbasin GSAs collectively cover the entirety of the Subbasin.

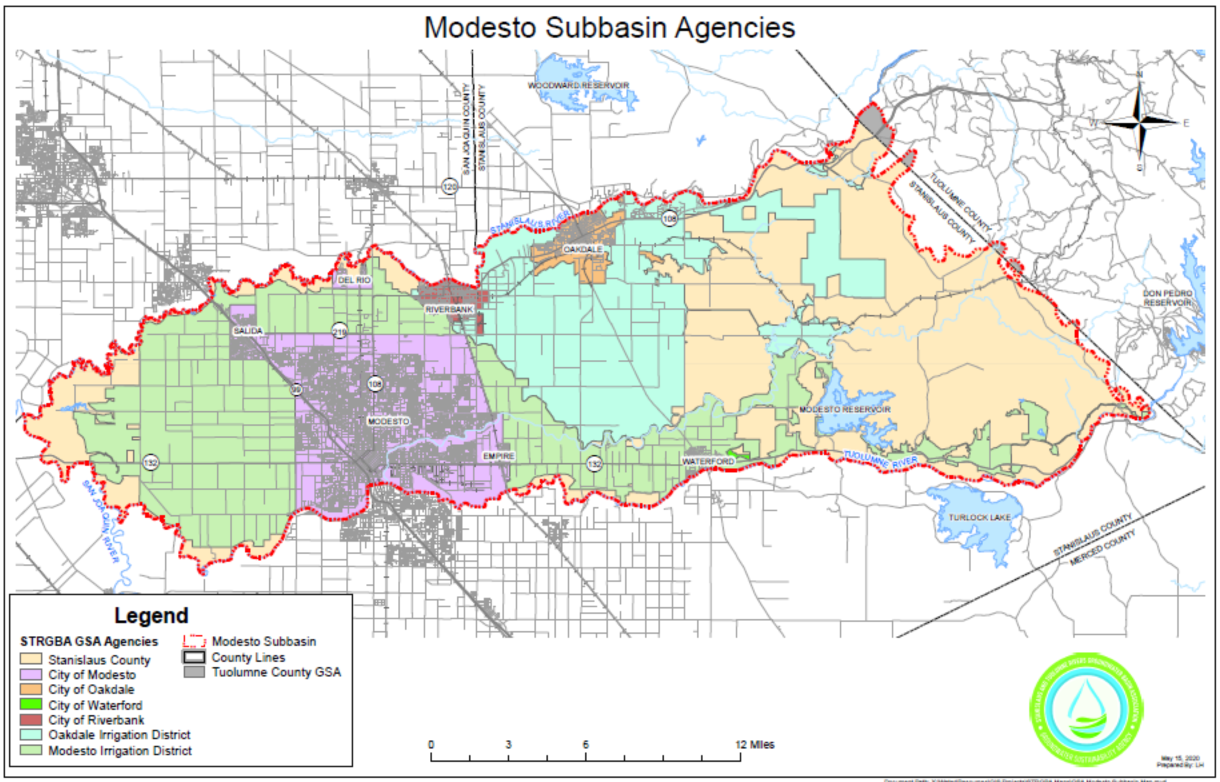

Figure 1. Map of the Modesto Subbasin Groundwater Sustainability Agencies

1.4 About the Plan

This Plan was developed by Stantec in coordination with the Modesto Subbasin GSAs, with funding provided by DWR's SGMA Facilitation Support Services (FSS) program. It provides a roadmap of potential communication and engagement activities that will support members of the Modesto Subbasin GSAs, as well as technical and other consultant staff, with GSP development, adoption, and implementation efforts. The purpose of the Plan is to provide options that may aid them as they work to: (1) meet the regulatory requirements of SGMA, (2) support the GSP development processes (technical, policy, and others, as applicable), and (3) accomplish the communication and engagement objectives specific to the members of the Modesto Subbasin GSAs.

INTRODUCTION

Every chapter of this Plan begins with the California Water Code or California Code of Regulations section(s) identifying the applicable requirements for public outreach and engagement under SGMA. Introduction of these requirements serve as a reminder of the regulatory and statutory requirements of SGMA, and they initiate content development for incorporation in the Modesto Subbasin GSP.

2.0 DECISION-MAKING PROCESS

Legal Requirements:

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

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

The STRGBA GSA has taken the responsibility for overseeing development of a GSP for the Modesto Subbasin, and it serves as the administrative body for public outreach and GSP implementation on behalf of the member agencies, consistent with the MOU and the coordination agreement with the Tuolumne County GSA. Working collectively, the Modesto Subbasin GSAs will agree on an outreach approach. They are coordinating on all Subbasin-wide outreach implementation efforts and activities. The Modesto Subbasin GSAs are also consulting and coordinating, both individually and collectively as a group, with community organizations and nonprofits to support or implement outreach efforts and activities.

Pursuant to the SGMA regulation §354.10 (d), the Modesto Subbasin GSP will include a description of the GSAs’ decision-making process, which will include their governance structure. Consistent with the adopted MOU, administrative and plan-development activities of STRGBA GSA have been delegated to representatives of the member agencies by their locally elected officers. These representatives will be used to solicit input, plan public outreach activities, make key decisions, and to achieve adoption of the GSP.

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3.0 BENEFICIAL USES AND USERS

Legal Requirements:

> **§354.10** Each plan shall include a summary of information relating to notification and communication by the Agency with other agencies and interested parties including the following:
>
> (1) A description of the beneficial uses and users of groundwater in the basin, including the land uses and property interests potentially affected by the use of groundwater in the basin, the types of parties representing those interests, and the nature of consultation with those parties.

SGMA requires that each GSP include a description of beneficial uses and users of groundwater in the Subbasin, and to describe the nature of consultation with those parties. California Water Code §10723.2 identifies beneficial user types, including:

- Agricultural well owners
- Domestic well owners
- Municipal well operators
- Public water systems
- Local land-use planning agencies
- Environmental users of groundwater
- Surface water users
- Federal government
- California Native American tribes
- Disadvantaged communities (DAC)
- Groundwater elevation monitoring entities

As part of its initial GSA formation notification, the Modesto Subbasin GSAs provided a preliminary list of beneficial users within their jurisdiction and described potential actions to engage those users. These actions centered around leveraging existing relationships with stakeholders in the Subbasin. Stakeholders identified in the initial notification included:

- Agricultural water users, particularly small individual landowners that rely on groundwater for agriculture
- Domestic well owners
- Improvement districts and other special districts that own or maintain water infrastructure

- Land-use planning agencies, including the Stanislaus Local Agency Formation Commission
- Riparian water users
- Environmental groups, including state and federal regulatory agencies
- Federal agencies, including the US Geologic Survey, US Fish and Wildlife Service, and US Army Corps and Engineers
- DACs

This Plan identifies recommended tools and activities to engage and consult each of these beneficial users in development of the GSP for the Subbasin. In some cases, these beneficial users will be consulted through the general public and stakeholder outreach activities identified in **Section 4.3**. In other cases, targeted outreach activities may be needed, and targeted stakeholder outreach activities are described in **Section 4.4**.

4.0 COMMUNICATION AND ENGAGEMENT

Legal Requirements:

§354.10 (d)
(2) Identification of opportunities for public engagement and a discussion of how public input and response will be used.
(3) A description of how the Agency encourages the active involvement of diverse social, cultural, and economic elements of population within the basin.
(4) The method the Agency shall follow to inform the public about progress implementing the Plan, including the status of projects and actions.

Consistent with SGMA, the Modesto Subbasin GSAs intend to develop and implement their GSP in close coordination with the public and stakeholders through various outreach tools and activities. These notifications serve as the foundation for consistent and progressive engagement with diverse social, cultural, and economic stakeholder communities within the jurisdictional boundaries of the Subbasin.

Communication and engagement activities described in this section include tools, activities, and strategies tailored to the unique needs of the stakeholders within the Subbasin. These tools and activities have either already been initiated/completed, are currently in progress, or may be scheduled to be initiated/completed on an as-needed basis. They draw from results of the Modesto Subbasin Stakeholder Assessment, further described below, and are framed to establish and maintain stakeholders' awareness and understanding of SGMA, the Modesto Subbasin GSAs, and the GSP development process.

4.1 Stakeholder Assessment

The Modesto Subbasin Stakeholder Assessment (Stakeholder Assessment) was conducted by Stantec (outreach consultant) on behalf of the Modesto Subbasin GSAs. The purpose of the Stakeholder Assessment was to evaluate stakeholders' knowledge of SGMA and groundwater management practices in the Modesto Subbasin, and to establish goals and strategies for public outreach, communication, and engagement to achieve SGMA compliance. Stantec conducted the Stakeholder Assessment in two parts: an online stakeholder survey and a series of focus group interviews. This section describes each of these parts and summarizes the key Stakeholder Assessment findings.

4.1.1 Stakeholder Survey

The first part of the Stakeholder Assessment was an online stakeholder survey conducted by the STRGBA GSA to assess stakeholders' understanding and perspectives on key SGMA topics and groundwater conditions in the Subbasin. The STRGBA GSA sent out the survey in Spring 2019 and promoted it through its website and member agencies' email lists and websites. The survey was made available for more than one year. In total, 161 individuals took the survey. Of those 161 survey participants, 35 were agricultural water users and 73 were municipal water users. The remaining participants identified as private well users, government agency workers, non-government organizations, academia, or “other.”

4.1.2 Focus Groups

The second part of the Stakeholder Assessment was a series of focus group interviews with stakeholders that were identified by the STRGBA GSA member agencies. The purpose of the focus groups was to gain deeper insights into preliminary findings from the survey and gather additional information on preferred methods for public outreach in the Subbasin. STRGBA GSA representatives identified 27 stakeholders as candidates to participate in the focus groups. Due to participants’ scheduling constraints, Stantec ultimately conducted interviews with 15 stakeholders representing the following STRGBA GSA member agencies: City of Modesto, City of Riverbank, MID, OID, and Stanislaus County.

Stantec conducted five focus groups in April and March 2020. Each focus group was comprised of one to four stakeholders. Stakeholders were grouped by the STRGBA GSA member agency jurisdiction in which they work or reside. The STRGBA GSA representatives were invited, but not required, to attend the focus group for their agency to act as a listener. The interviews were originally intended to be conducted in-person; however, due to shelter-in-place orders and other directives in response to COVID-19, all interviews were conducted via conference call.

Prior to each interview, the focus group participants were required to fill out a pre-meeting questionnaire and take the online stakeholder survey. Stantec compared the survey results from each interview participant to that of the other interviewees in their group, as well as to those of other survey participants. The results of this analysis were a key discussion topic during the focus groups. The other discussion topics included expectations for and barriers to the GSP development process, priorities for water use in the Subbasin, projects and actions to manage groundwater, funding for SGMA implementation, and activities and communication channels for stakeholder outreach. The Stantec facilitator recorded the responses from focus group participants, and these notes were distributed to the participants for review following each focus group.

4.1.3 Stakeholder Assessment Findings

Stantec staff collated and analyzed the results of the stakeholder survey and focus groups interviews to identify common trends and deviations between the survey and focus group results. The results of this analysis were summarized in a series of presentation slides. Stantec staff presented the Stakeholder Assessment findings summary at a STRGBA GSA GSP Coordination meeting on June 10, 2020. Key findings from the Stakeholder Assessment include the following:

- Agricultural and municipal waters users in the Subbasin have differing opinions on how groundwater should be managed and who should pay for management actions and projects.
- Members of the general public have low interest in SGMA.
- SGMA is not perceived to be a broad threat to water users in the Subbasin.

- Stakeholders are most concerned about the costs and potential financial burden of implementing SGMA.

The Stakeholder Assessment findings serve as the basis for many of the selected outreach tools and activities recommended in this Plan. It is important to note that the Stakeholder Assessment was based on a statistically small sample size and some of the results may not represent the opinion of the majority of stakeholders in the Subbasin. For some issues, assessment findings were contrary to the common understanding of the Modesto GSAs representatives. For example, the focus group participants, who were primarily agricultural water users, stated that they felt fees for groundwater projects and management actions should be paid by all water users. However, some of the Modesto Subbasin GSAs representatives felt that a majority of their stakeholders preferred fees assessed on groundwater users only. Therefore, this Plan reflects both the findings from the Stakeholder Assessment as well as discussions with the GSAs representatives and best practices for stakeholder engagement in groundwater sustainability planning.

4.2 Outreach Tools

This section describes the suite of tools the Modesto Subbasin GSAs have developed, plan to develop, or may develop to disseminate information to the public and engage stakeholders in development of the GSP. The Modesto Subbasin GSAs intend to, on an as-needed basis, translate materials in Spanish or other languages to reach alternative-language communities. For unity, a common visual identity will be used for all printed and electronic information materials intended for public and stakeholder audiences.

4.2.1 Website

The Modesto Subbasin GSAs have developed websites to keep stakeholders and other interested parties informed of GSP development and implementation activities. The STRGBA GSA website (http://www.strgba.org) includes copies of informational, technical, and planning documents; STRGBA GSA meeting agendas and materials; information on the Modesto Subbasin; and member-agency contact information. In addition, the STRGBA GSA has and intends to continue to post draft GSP chapters on its website for public review and comment.

The Tuolumne County GSA has added a web page specific to SGMA on the Tuolumne County website (https://www.tuolumnecounty.ca.gov/1292/Sustainable-Groundwater-Management-Act-S). The page offers information for Tuolumne County residents residing in the Subbasin, and provides a link to the STRGBA GSA website.

4.2.2 Interested Parties Databases

California Water Code §10723.8 requires GSAs to "establish and maintain a list of persons interested in receiving notices regarding plan preparation, meeting announcements, and availability of draft plans, maps, and other relevant documents." Pursuant to this requirement, the Modesto Subbasin GSAs have each developed an Interested Parties Database. An Interested Parties Database is a list of individuals, organizations, or agencies that have expressed interest in being informed about the GSAs' activities and development of the GSP. The Modesto Subbasin GSAs use their Interested Parties Databases as the primary contact lists for public meetings, workshops, and announcements related to SGMA implementation in the Modesto Subbasin. Interested parties can self-select to be added to the Interested Parties

Databases by filling out a form on the STRGBA GSA or Tuolumne County GSA websites or contacting their local GSA representative.

4.2.3 Newsletter

The STRGBA GSA has developed an electronic newsletter to keep interested parties informed about GSP development activities, upcoming opportunities for public engagement, and news alerts on statewide issues of importance to SGMA. Each newsletter is typically one to two pages in length and distributed electronically through an email to the Interested Parties Databases on a quarterly basis. Copies of the newsletter are also made available on the STRGBA GSA website.

4.2.4 Informational Materials

The Modesto Subbasin GSAs intend to develop a suite of informational materials aimed at educating members of the public and stakeholders about key SGMA topics, and for keeping interested parties informed about GSP development and implementation. These materials can be used to bridge information gaps between agricultural and municipal water users, regarding SGMA and groundwater conditions in the Modesto Subbasin. The Modesto Subbasin GSAs intend to adapt the materials over time as the GSP is completed, adopted, and implemented; and may have the materials translated into Spanish and other languages on an as-needed basis to reach alternative-language communities. As such, these documents are fit-for-purpose outreach tools that include the following:

Fact Sheets

The Modesto Subbasin GSAs may develop a suite of informational fact sheets aimed at educating members of the public about SGMA and key topics identified in the GSP. The purpose of the fact sheets is to prepare interested parties to provide meaningful input on the GSP and to encourage engagement at public meetings and workshops. Fact sheet topics may include the following:

- SGMA 101: Aimed at a general audience, this fact sheet provides an introductory-level overview of SGMA, the Modesto Subbasin, the Modesto Subbasin GSAs, and the GSP development process.
- Groundwater Conditions: This fact sheet educates stakeholders about historical and current groundwater conditions in the Modesto Subbasin, including groundwater supply, storage, and quality.
- Water Budget: This fact sheet explains a water budget, water budget inputs/outputs, and how the water budget will be used as part of the GSP.
- Sustainable Management Criteria: This fact sheet defines key terms related to sustainable management criteria, including minimum thresholds and measurable objectives, and describe how the sustainable management criteria will be used to manage groundwater conditions in the Subbasin.
- Overview of the Modesto Subbasin GSP: This fact sheet provides an overview of each chapter of the GSP, and then describes the GSP public comment and adoption process.

The fact sheets can be distributed through postings on websites and/or distributing them electronically or via hard copy through existing communication channels.

Presentation Slides

The Modesto Subbasin GSAs have developed a set of template presentation slides aimed at educating members of the general public about SGMA, the Modesto Subbasin, and the GSAs' governance structure. These slides help ensure consistent messaging and reinforce a cohesive visual identity that unifies materials across the Subbasin.

These slides may be adapted for use at public meetings, workshops, and presentations to community groups or agency decision-making bodies (e.g., boards or city councils).

Notices

The Modesto Subbasin GSAs may develop fliers, email text, social media posts, and other types of notices to promote public meetings, workshops, and other opportunities for public involvement. The Modesto Subbasin GSAs will distribute these notices to the Interested Parties Databases, customers and constituents of the member agencies, and other stakeholders. The materials may be distributed via email, by posting on websites and social media accounts, and/or delivered by hard-copy mailings.

The GSAs may also periodically develop template email, social media posts, and/or website text to promote public comment periods and educate members of the public on key SGMA topics. To the extent possible, these posts will be scheduled to align with other public outreach events (e.g., National Groundwater Awareness Week, Public Works Week).

News Releases

The Modesto Subbasin GSAs may develop news releases aimed at informing the media about upcoming public events and GSP development milestones, including the release of public documents.

4.3 Outreach Activities

The Modesto Subbasin GSAs may conduct and monitor a variety of public outreach activities to inform, engage, and respond to stakeholders and other interested parties during GSP development, adoption, and later, implementation. These activities serve to engage and interact with the public and stakeholders during GSP development, and to assist GSA staff and leadership in collecting information important to groundwater sustainability planning. This engagement and interaction will occur through six primary activities: regular GSP development meetings, member agency briefings, public workshops, community presentations, GSP office hours, and partnerships with local organizations in the Subbasin. Each of these activities are further described below.

Most of these activities will be promoted through similar outreach tactics, including sending an email to the Interested Parties Databases, posting on the Modesto Subbasin GSAs' websites, and adding updates about them to the STRGBA GSA newsletter. In addition, some activities may require other tactics to target specific stakeholder groups. The activities identified in this section are assumed to be promoted by these standard tactics, unless otherwise noted in the activity description.

In response to social-distancing and local health ordinances resulting from the COVID-19 pandemic, the Modesto Subbasin GSAs are prepared to adapt these activities to virtual or other distance-engagement formats. The GSAs will utilize online collaboration platforms and implement best practices for virtual engagement. In addition, the GSAs may relay information and materials through trusted organizations and existing communication channels in the Subbasin, to keep stakeholders—who may not have access to the technical equipment required to engage—virtually informed.

4.3.1 GSP Development Meetings

The primary way for members of the public to provide input on development of the GSP is by attending and providing public comment at standing public meetings of the Modesto Subbasin GSAs. The STRGBA GSA holds monthly meetings and bi-monthly Technical Advisory Committee meetings. Both of these meetings include GSP development updates and discussions and are open for the public to attend and provide comment. These meetings are also open to stakeholders from the Tuolumne County GSA and include participation from a Tuolumne County GSA representative. The meetings' calendar and associated materials are available on the STRGBA GSA website. The meetings are additionally noticed by emails to the Interested Parties Databases.

4.3.2 Member Agency Briefings

Representatives for the Modesto Subbasin GSAs, or consultant staff, regularly brief member agency councils and boards on the status of GSP development and upcoming outreach activities. These briefings are conducted during member agencies' publicly noticed meetings, which include opportunities for public comment. The primary purpose of these briefings is to update the member agencies' governing bodies on GSP progress and next steps, and to respond to questions. These presentations also provide opportunities to share and describe how elements of the GSP apply to the service area of the respective member agency. The frequency of member agency briefings varies by the agency and GSP development process phase.

In addition to regular briefings throughout development of the GSP, the Modesto Subbasin GSAs may also brief each of the member agencies during the public review and comment process for the Public Draft GSP. This public comment process is further described in **Section 6.0**, below.

4.3.3 Public Workshops

Public workshops are another venue to educate the public about SGMA, collect feedback on results of technical analyses, and solicit input on the content of the draft GSP chapters. **Table 2**, below, identifies the anticipated schedule, topics, and desired outcomes for the GSP development workshops for the Subbasin.

Table 1. GSP Development Workshops

Tentative Date	Topics	Desired Outcome(s)
Summer 2020	• Introduction to SGMA • Modesto Subbasin • Modesto Subbasin GSAs • GSP Development Process	• Educate the public about SGMA and identify how interested parties can engage in the GSP development process.
Fall 2020	• Groundwater Conditions • Introduction to Water Budgets	• Educate stakeholders on current and projected groundwater conditions in the Modesto Subbasin. • Provide an overview of purpose and components of water budgets to prepare stakeholders to participate in the next workshop.
Winter 2020	• Water Budgets • Introduction to Sustainable Management Criteria	• Receive feedback on the drafted past, current, and future water budgets for the Modesto Subbasin. • Provide an overview of the key components of sustainable management criteria to prepare stakeholders to participate in the next workshop.
Spring 2021	• Sustainable Management Criteria • Groundwater Monitoring	• Receive feedback on the draft minimum thresholds and measurables objectives for the Modesto Subbasin. • Describe the groundwater monitoring network.
Fall 2021	• Public Draft GSP	• Provide a forum for stakeholders and interested parties to discuss comments on the Public Draft GSP.

Key:
GSA = Groundwater Sustainability Agency
GSP = Groundwater Sustainability Plan
SGMA = Sustainable Groundwater Management Act

The format of each workshop will be adapted according to the workshop content, feedback from stakeholders, and changing conditions in the Subbasin. During periods when state and local ordinances limit or prohibit in-person gatherings, workshops may be held using virtual collaboration platforms (e.g., Zoom, GoToMeeting/GoToWebinar, Microsoft Teams). The Modesto Subbasin GSAs intend to record both the virtual and in-person workshops and post the recordings on STRGBA GSA's website and YouTube page for public viewing. This tactic allows those unable to attend—either due to scheduling conflicts or health and safety concerns—to have the ability to stay informed about GSP development.

4.3.4 Community Presentations

The Modesto Subbasin GSAs may conduct presentations to existing civic, nonprofit and other community organizations to build and maintain awareness about SGMA, encourage participation at public meetings and workshops, and to encourage self-selection into the Interested Parties Databases. Representatives from the Modesto Subbasin GSAs will conduct the presentations. Presenters will be encouraged to use the template presentation slides and other informational materials to ensure consistent messaging and branding.

Should these presentations take place and in the early stages, the Modesto Subbasin GSAs intend to focus on building awareness and partnerships with local organizations and agencies identified during the Stakeholder Assessment as potential “partner agencies.” Subsequent presentations may be provided upon request by organizations or stakeholder groups. The presentations will be tracked in the Communications Plan Database, described in **Section 5.0**, below.

4.3.5 GSP Office Hours

The Modesto Subbasin GSAs may hold periodic GSP office hours to answer questions on the draft GSP chapters and to promote dialogue between stakeholders and GSA representatives. Office hours’ activities are typically informal and do not have a specific agenda or discussion topic. Instead, the discussion topics are driven by questions from the participants. Participants will be notified of GSP office hours through the standard outreach tactics, as well as via messaging to local community groups as necessary.

Office hours may be held in-person or virtually utilizing an online collaboration platform. The Modesto Subbasin GSAs will select a designated time frame for the office hours; interested parties can join at any time during this period. One or more representatives from the GSAs will be available during the entirety of the office hours period to answer questions. Once an interested party joins, he or she may ask any questions related to SGMA or the GSP. The GSA representative(s) will record the question, and respond. GSA representatives intend to summarize the questions received and comments during the office hours for the other members of the GSA and technical consultant staff during regular GSP development or Technical Advisory Committee meetings.

4.3.6 Partnerships with Local Organizations

The Modesto Subbasin GSAs may partner with local community and industry organizations to broaden the dissemination of SGMA information and connect with stakeholder groups. Participants in the Stakeholder Assessment identified the following active organizations in the Subbasin:

- Almond Alliance of California
- Manufacturers Council of the Central Valley
- Stanislaus County Farm Bureau
- Tuolumne County Farm Bureau
- Western United Dairies

The Modesto Subbasin GSAs may identify additional potential partner organizations during GSP development. The Modesto Subbasin GSAs already maintain relationships with many of these organizations and intend to keep them informed throughout GSP development and implementation through personal communications or one-on-one meetings. The Modesto Subbasin GSAs may also ask partner agencies to distribute notices and materials to their stakeholders and offer to cohost events, workshops, and GSP office hours.

4.4 Targeted Stakeholder Outreach Tools and Activities

In addition to general public outreach, the Modesto Subbasin GSAs may also conduct outreach to targeted stakeholder groups that may be underrepresented in public-involvement activities or that benefit from targeted messaging or engagement.

4.4.1 Tribes

No tribes were identified in the list of beneficial users included in the STRGBA GSA initial notification. However, the STRGBA GSA may consider filling a Sacred Lands File & Native American Contacts List Request with the Native American Heritage Commission to determine whether a tribe has indicated sacred land or traditional/cultural resources interest within the Modesto Subbasin. If tribes are identified, STRGBA member agencies would convene to discuss engagement options consistent with applicable regulatory requirements and existing tribal consultation processes or agreement(s).

The Tuolumne County GSA's initial notification listed two tribes with potential interests in their region: the Tuolumne-Band of the Me-Wuk Indians and the Chicken Ranch Rancheria Band of the Me-Wuk Indians of California. The Tuolumne County GSA will consult with these tribes to identify and consider their interests.

4.4.2 Agricultural Water Users

Agriculture plays a vital role in both the economy and the social fabric of the Subbasin, and groundwater resources are essential to maintaining this industry. Engaging agricultural water users will be key to the success of the GSP. The elected boards and councils of Modesto Subbasin GSAs provide broad agricultural representation. MID and OID already conduct outreach on groundwater management practices and SGMA to their agricultural customers. MID holds annual grower meetings before the start of irrigation season; publishes a bi-annual newsletter (The Irrigator) for their irrigation customers; and provides a water report, which includes highlights of GSA activities, at MID Board of Directors' meetings. In addition, MID maintains a website, which includes a page specifically on water supply management, and active social media accounts (Facebook, Twitter, and YouTube). OID staff provide regular updates and periodic presentations at public OID Board of Directors meetings, publish a regular newsletter, and included SGMA updates on OID's website. MID and OID intend to incorporate SGMA messaging into these ongoing communication activities to keep agricultural water users informed about the GSP development process.

In addition, the Modesto Subbasin GSAs may conduct targeted outreach to agricultural water users in the *non-districted* areas of the Subbasin. A non-districted area is an area where private well owners/operators are represented under SGMA by the county of record, often in absence of a municipality, irrigation district, water district, or other special district eligible to serve as a local public agency under California Water Code §10723(n). Most of the non-districted areas are in the eastern, unincorporated portion of the Subbasin where groundwater is commonly used for both agricultural and domestic water supplies. There are approximately 75,000 acres of non-districted land in the eastern subbasin. A portion of this area is being represented by Water & Land Solutions, a consulting firm hired to represent local landowners' interests in GSP development for the Subbasin. The Modesto Subbasin GSAs are working with Water & Land Solutions to gather data and engage with stakeholders in the region he represents. In addition, Stanislaus and Tuolumne Counties intend to develop a database of landowners in all non-districted areas and to engage those landowners through direct mailings, targeted webinars/meetings, and in partnership with local community and industry organizations.

4.4.3 Urban Water Users

A key finding from the Stakeholder Assessment focus groups was that water users in urban areas of the Subbasin were perceived to have less interest in participating in the GSP development process than agricultural water users or water users in rural areas. This finding was supported by the results from the stakeholder survey that indicated that municipal water users (who often live in urban areas) generally have less of an understanding of SGMA than agricultural water users.

To bridge this knowledge gap, and to encourage engagement with urban water users, the Modesto Subbasin GSAs may conduct targeted outreach in urban areas. These activities may include developing fact sheets on groundwater use and conditions in the Modesto Subbasin and distributing these materials through existing communication channels and community gathering locations (e.g., libraries, community centers, civic centers); providing presentations on SGMA to local civic and community organizations; and inviting community leaders to GSP office hours. Each of these activities is furthered described in **Section 4.3**, above. In addition, the GSAs may develop key messages on the importance of groundwater to the local economy and environment, and to incorporate these messages in all informational materials and talking points.

4.4.4 Disadvantaged Communities

California Code of Regulations §79505.5(a) defines a *disadvantaged community* as a “community with an annual median household income (MHI) that is less than 80 percent of the statewide annual median household income.” The American Community Survey of the US Census Bureau provides a dataset than can be used as a source to estimate a community’s MHI. According to 2012–2016 American Community Survey 5-Year Estimates, California’s statewide MHI is $63,783. Thus, a community with an MHI less than or equal to $51,026 is considered disadvantaged.

The Modesto Subbasin GSAs’ boundaries include three census-designated places considered disadvantaged by the state: Empire, Airport, and West Modesto. These communities are also identified in DWR’s DAC Mapping Tool. The MHI for each is identified in **Table 3** below. All three of these communities are located within and receive water from the City of Modesto. Therefore, they will be represented by the City of Modesto during the groundwater sustainability planning process.

Table 2. Communities Designated as Disadvantaged in the Modesto Subbasin

Census-Designated Place	Median Household Income[1]
Airport	$ 29,868
City of Modesto	$ 50,996
City of Waterford	$ 49,500
Empire	$ 35,519
Rouse	$ 33,292
West Modesto	$ 30,682

Notes:
[1] Median Household Income is based on 2014–2018 American Community Survey 5-Year Estimates

Individuals living in communities state-designated disadvantaged face unique challenges when it comes to participating in public planning processes. This may include physical and/or linguistic barriers which may impede their ability to provide input on plans or regulations that impact them. The Modesto Subbasin GSAs intend to use best practices to help address barriers these communities may face in participating in the GSP development and implementation processes. These may include translating materials and fliers into multiple languages, offering interpreting services at public workshops and meetings, holding workshops and meetings at familiar and trusted locations (e.g., schools, community centers, churches), and ensuring workshops/meetings are held at times accessible by a wide range of people. (Note that due to social-distancing and local health ordinances resulting from the COVID-19 pandemic, many of the subbasin's outreach activities are being adapted to virtual engagement formats.)

The Modesto Subbasin GSAs may also partner with local community advocates or organizations to educate community members about SGMA and to encourage involvement in public events. Often leveraging the communication channels of these trusted messengers is a more effective means of reaching DACs than traditional communication methods.

4.4.5 Watershed Stewardship Organizations

GSAs are obligated to consider the potential impact of sustainable groundwater management activities on groundwater-dependent ecosystems. These considerations may range from monitoring activities to steps to preserve and expand these natural resources. Stewardship of these resources has primarily been led through a combination of regulatory and nonprofit organizations. In the Subbasin, the Tuolumne River Trust—an advocacy group representing the Tuolumne River—is actively involved in water-management planning activities. Other organizations may include The Nature Conservancy, Stanislaus Audubon Society Chapter, and others. These organizations represent sources of valuable input on the subject matter of groundwater-dependent ecosystems that are being considered during GSP development.

The Modesto Subbasin GSAs may engage leadership from these groups throughout the groundwater sustainability planning process for discussion of environmental water needs and groundwater-dependent ecosystems. These meetings may include participation from other watershed stewardship organizations in the Subbasin. In addition, interested stewardship organizations may also request briefings with the Modesto Subbasin GSAs and participate in the outreach activities described in **Section 4.3**, above.

4.4.6 Government and Land-Use Agencies

The Modesto Subbasin GSAs may engage local and regional governmental and land-use agencies early and throughout the GSP development process. This may include presentations or meetings with local planning commissions, local agency formation commissions, and housing authorities (e.g., Housing Authority of City of Riverbank, Stanislaus Regional Housing Authority). In addition, local cities and counties will receive notice at least 90-days prior to adoption of the Final GSP, as described in **Section 6.2**.

5.0 SUMMARY OF ENGAGEMENT

Legal Requirements:

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

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

SGMA requires that GSAs include a list of public meetings at which the GSP was discussed or considered by an agency. To fulfill this requirement, and to follow best practices for outreach and communication, each GSA should develop a tool or database to track all SGMA-related outreach conducted by the agency.

Modesto Subbasin GSAs have developed the Communications Plan Database to track all SGMA public and stakeholder engagement activities and to identify potential organizations, individuals, and media contacts where outreach was sent. Within the database, stakeholders are placed into three tiers, based on the stakeholders' level of interest and current and potential uses of groundwater: (1) Tier A, (2) Tier B, or (3) Tier C.

The database is currently in an electronic (Microsoft Excel) format. The database may be posted on a platform accessible by member agencies (e.g., SharePoint, DropBox) to allow agency staff to update it as outreach is conducted. However, a single individual should be identified to ensure the database is kept current and properly maintained. A copy of the Communications Plan Database will be attached to the Final GSP to demonstrate the Modesto Subbasin GSAs' efforts to involve members of the public in GSP development and to comply with California Code of Regulations §354.10.

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6.0 PUBLIC ENGAGMENT IN GSP ADOPTION

Legal Requirements:

> **§354.10** Each plan shall include a summary of information relating to notification and communication by the Agency with other agencies and interested parties including the following:
>
> (c) Comments regarding the Plan received by the Agency and a summary of any responses by the Agency.
>
> **§10728.4**
>
> (2) A groundwater sustainability agency may adopt or amend a groundwater sustainability plan after a public hearing, held at least 90 days after providing notice to a city or county within the area of the proposed plan or amendment. The groundwater sustainability agency shall review and consider comments from any city or county that receives notice pursuant to this section and shall consult with a city or county that requests consultation within 30 days of receipt of the notice.

This chapter describes requirements and approaches for collecting and summarizing comments on the Draft GSP and required steps necessary, prior to GSP adoption.

6.1 Public Comment Process

California Code of Regulations §354.10 states that each GSP must include a summary of comments received regarding the GSP and a summary of any responses that resulted from the GSA. However, the SGMA regulations do not provide a prescriptive public review process or comment period for the Public Draft GSP. After the Final GSP is submitted to DWR, the agency will post the GSP to its website and hold a public comment period. Pursuant to California Code of Regulations §353.8(b), the minimum period for public comment is 60 days. However, DWR intends to open the comment period for 75 days or more.

The Modesto Subbasin GSAs intend to release the Draft GSP chapters for public review and comment as the chapters are developed. Chapters will be released individually or in groups in a phased or serial review process. The Modesto Subbasin GSAs intend to post the drafts on the STRGBA GSA website for review and to collect comments through a designated project email address, direct mail, or at public workshops and meetings. Interested parties will have a designated time (e.g., 30 days) to review the draft chapters and submit comments. Comments received during the comment period will be reviewed by the Modesto Subbasin GSAs and consultant staff. In addition, the Modesto Subbasin GSAs intend to provide a summary of comments received and intends to post on the STRGBA GSA website.

Once all the draft chapters have been released and revised, the Modesto Subbasin GSAs intend to issue a complete Public Draft GSP for further public review and comment. The Public Draft GSP will be released for a 45-day public comment period in Fall 2021. Public comments will be collected via direct mail and email. In addition, the Modesto Subbasin GSAs intend to hold a special STRGBA GSA GSP development meeting and possibly GSP office hours to answer stakeholder questions.

The Modesto Subbasin GSAs intend to summarize comments received during this 45-day period and to present them in a GSP Public Comment Summary attached to the Final GSP. The GSP Public Comment Summary will describe the public comment process, summarize the major themes or topics that individuals submitted comments on, and will include copies of written comments. In addition, any comments that raise substantive technical or policy issues may be addressed in the Final GSP text.

6.2 Notice to Cities and Counties

California Water Code §10728.4 states that a GSA must provide notice to any cities or counties within the GSP area at least 90-days prior to adopting or amending a GSP at a public meeting. The cities and counties have 30 days upon receipt of the notice to request consultation on the plan. Pursuant to these requirements, the Modesto Subbasin GSAs will develop and distribute a notice to cities and counties within the Subbasin during the Public Draft GSP public comment period, no later than 90 days before the first scheduled GSP adoption hearing.

The notice will provide an overview of SGMA and the GSAs; identify where the Public Draft GSP can be viewed, or copies can be obtained; identify the time, date, and location for the adoption public hearing(s); and describe the method for agencies to submit consultation requests. A single point of contact should be identified in the notice; however, requests for consultation should be collectively reviewed by Modesto Subbasin GSAs and a collective response should be developed and distributed to the consulting agencies. Cities and counties will have 30-days to respond to the notice.

6.3 Final GSP Adoption Process

Following the 30-day consultation request period, if no cities or counties have requested consultation, the Final GSP will be adopted at a series of public hearings. Each of the STRGBA GSA member agencies will adopt the Final GSP at a public hearing held by each agency's governing body. The Tuolumne County GSA will adopt the Final GSP at a public hearing held by the Tuolumne County Board of Supervisors. These hearings may be held as part of the agencies' standard public meetings, or at a special meeting of the governing body. Notices for the public hearings will follow all applicable local, state, and federal regulations regarding meeting noticing practices that apply.

At this time, it is not anticipated that fees would be adopted with the Final GSP. However, if fees are associated with adoption of the Final GSP, then additional public meeting notices will be required pursuant to Government Code §6066.

7.0 PUBLIC ENGAGEMENT IN GSP IMPLEMENTATION

Legal Requirements:

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

Note: This section will be revised and expanded upon next year, depending upon the implementation identified in the Draft GSP.

As part of its GSP, the Modesto Subbasin GSAs must describe how they plan to inform the public about progress in implementing the GSP. GSP implementation outreach activities should build upon activities conducted during GSP development. Successful activities should be continued throughout GSP implementation and then updated to include new stakeholder groups and prevailing issues.

The primary methods to inform the public about progress of the GSP include posting on the websites for STRGBA GSA, Tuolumne County GSA, and member agencies; sending out progress information to the Interested Parties Databases; and holding regular public meetings focused on GSP implementation. In addition, the Modesto Subbasin GSAs may choose to continue other general public outreach activities, such as GSP office hours, community presentations, and the newsletter. Informational materials and website content will be updated at key implementation milestones (e.g., annual reporting periods, Five-Year Updates) to reflect the status of the GSP and Subbasin conditions. In addition, new materials will be developed to help the public understand next steps and how they can stay engaged in GSP implementation.

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8.0 INTER- AND INTRA-BASIN COORDINATION

Legal Requirements:

> **§ 357.2.** Inter-basin Agreements
>
> Two or more Agencies may enter into an agreement to establish compatible sustainability goals and understanding regarding fundamental elements of the Plans of each Agency as they relate to sustainable groundwater management.

The Modesto Subbasin is surrounded by the Turlock Subbasin to the south, Eastern San Joaquin Subbasin to the north, and Delta-Mendota Subbasin to the west. It is bounded to the east by the Sierra Nevada Foothills. Many Modesto Subbasin GSAs' member agencies are also members of one or more GSAs in these and other subbasins. SGMA does not require a formal inter-basin coordination agreement; however, per California Code of Regulations §357.2, Modesto Subbasin GSAs' member agencies may choose to establish a voluntary agreement with GSAs or the Plan Manager in adjacent subbasins to address basin-boundary flow and other issues. These agreements often reflect the technical and governance issues most central to management of the regions' groundwater resources. GSAs and Plan Managers in some regions have established an inter-basin coordination committee or working group to discuss these types of issues. These groups often meet semi-annually or quarterly and include representation from each of the subbasins in the region.

As critically-overdrafted basins, two adjacent subbasins, Eastern San Joaquin Subbasin and Delta-Mendota Subbasin, submitted their GSPs to DWR in January 2020. The Modesto Subbasin GSAs may coordinate efforts with GSAs in these subbasins through semi-annual inter-basin coordination meetings focused on discussing inter-basin boundary flows and other regional issues of concern. These meetings also serve to share lessons learned from the GSP development and implementation process between the critically overdrafted and non-critically overdrafted subbasins. At least one of these meetings will be planned and hosted by the GSAs in the Delta-Mendota Subbasin, as part of their FSS grant to support inter-basin coordination.

The Turlock Subbasin is on the same GSP-submission schedule as the Modesto Subbasin, and it also shares the same groundwater model. In addition, some member agencies of the STRGBA GSA also serve communities in the Turlock Subbasin. Accordingly, the Modesto Subbasin GSAs are coordinating more frequently with the GSAs in the Turlock Subbasin. The Modesto Subbasin and Turlock Subbasin GSAs have already held inter-basin coordination meetings focused on ensuring consistent analyses along the shared Tuolumne River boundary, and plan to continue holding theses meeting moving forward. In addition, the GSAs in the subbasins intend to coordinate outreach efforts to stakeholders near the Modesto-Turlock Subbasins boundary. This may include developing and distributing joint notices and newsletters to landowners in this region, cohosting workshops or events, or cohosting GSP office hours focused on inter-basin coordination and Tuolumne River flows.

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MODESTO SUBBASIN
JUNE 2020 GSP DEVELOPMENT WORKSHOP SUMMARY

Monday, June 1, 2020 (2:30 p.m. – 4:00 p.m.)
Webinar

ATTENDESS

Name	Agency
Miguel Alvarez	City of Modesto*
Jim Alves	City of Modesto*
John Brichetto	Brichetto Farms
Christine Campbell	G3 Enterprises
Luke Castle	Condor Earth
Aluriel Ceballos	Opportunity Stanislaus
Khandriale Clark	Stantec
Kathleen Danicourt	TCOS
John Davids**	Modesto Irrigation District*
Peter Drekmeier	Tuolumne River Trust
Gordon Enas	Modesto Irrigation District*
Dana Ferreira	Modesto Irrigation District*
Bill Fogarty	N/A
Stu Gilman	Modesto Irrigation District*
Stacy Henderson	Terpstra Henderson
Mary Ann Henriques	N/A
Lindsay Hofsteen	N/A
Gordon Hollingsworth	N/A
Chase Hurley	Water & Land Solutions
Bill Jackson	V A Rodden
Eric Kappmeier	Modesto Irrigation District*
Matthew Kinzie	Modesto Irrigation District*
Kim MacFarlane	Tuolumne County*
Jim Mortensen	N/A
Craig Moyle	Stantec
Tony Ott	Carl Ott & Sons Dairy
Marisa Pascoal	GEI
Kirsten Pringle**	Stantec
Michael Renfrow	City of Oakdale
Michael Riddell	City of Riverbank
Herb Smart	Turlock Irrigation District
Phyllis Stanin**	Todd Groundwater
Alexis Stevens	Somach Simmons & Dunn
Matthew Toste	Woolf Enterprises
Eric Thorburn**	Oakdale Irrigation District*
Luis Uribe	City of Riverbank*
Nick Waelty	N/A

Name	Agency
Walter Ward**	Stanislaus County*
Kevin Weber	Fisher Nut Co
Melissa Williams	Modesto Irrigation District*
Ruben Willmarth	N/A
Terry Withrow	Stanislaus County
Jennifer Wright	Modesto Irrigation District*

* indicates that agency is a member agency of the Stanislaus and Tuolumne Rivers Groundwater Basin Association Groundwater Sustainability Agency or Tuolumne County Groundwater Sustainability Agency
** indicates that individual was one of the workshop speakers

WORKSHOP SUMMARY

The Stanislaus and Tuolumne Rivers Groundwater Basin Association Groundwater Sustainability Agency (STRBGA GSA) and Tuolumne County Groundwater Sustainability Agency (Tuolumne County GSA) held a coordinated, virtual public workshop on June 1, 2020 from 2:30 p.m. – 4:00 pm. This was the first in a series of public workshops aimed at educating and soliciting input from members of the public about key topics related to development of a Groundwater Sustainability Plan (GSP) for the Modesto Subbasin. The purpose of the June workshop was to educate stakeholders and interested parties about the Sustainable Groundwater Management Act and GSP development process and identify opportunities for public input in this process.

The workshop was held virtually using an online webinar platform. In total, 51 individuals registered for the workshop and 39 individuals attended. The workshop was promoted through postings on the GSAs and member agencies' websites and social media accounts and an email to the Modesto Subbasin interested parties database. In addition, the Modesto Subbasin GSAs partnered with local organizations and industry associations to distribute the workshop information.

The workshop included a series of short presentations from GSA representatives and consultant staff. Speakers included John Davids, Modesto Irrigation District; Walter Ward, Stanislaus County; Eric Thorburn, Oakdale Irrigation District; Phyllis Stanin, Todd Groundwater; and Kirsten Pringle, Stantec. Ms. Pringle also serve as the workshop facilitator. Workshop topics included: introduction to SGMA, the STRGBA and Tuolumne County GSAs, the GSP development process, status of the Modesto Subbasin GSP, next steps, and how to get involved in the GSP development process.

The GSAs held question and answer session following each presentation. Participants could submit questions using the webinar platform or by texting the facilitator. Participants were given the option to have their question read out loud by the facilitator or read the question to the panelists themselves. A summary of the questions asked by workshop participants is provided below.

Following the workshop, a link to the recording of the webinar and copies of the workshops slides and handout were posted on the Modesto Subbasin GSAs' websites. In addition, Spanish-English bilingual copies of the slides and handout were also posted.

WORKSHOP FEEDBACK

Workshop participants asked the following questions:

- John Brichetto, Brichetto Farms, asked: Who is creating this groundwater overdraft problem? The irrigation districts actually help the underground water and are net contributors to the groundwater, correct? Will the districts get credit for actually adding water to the underground?
- Peter Drekmeier, Tuolumne River Trust, asked: What do we know about the interconnectivity of groundwater and the Tuolumne River?
- Stacy Henderson, Terpstra Henderson, asked: Have all of the monitoring wells been installed using the grant funding received to date? If not, will the model and water budget be updated after they are installed?
- Tony Ott, Carl Ott & Sons Dairy, asked: Will additional storage be allowed by the state to meet goals?
- Alexis Stevens, Somach Simmons & Dunn, asked: If storage project are identified as necessary, who will pay for them? How will that be decided/determined?
- Luis Uribe, City of Riverbank, asked: What info do you use to prepare for the Water Budget?

MODESTO SUBBASIN
OFFICE HOURS #1

Thursday, March 25, 2021 (12:00 p.m. – 1:00 p.m.)
Virtual Meeting (Zoom)

ATTENDEES

Name	Agency
Lisa	Barton Ranch
Miguel Alvarez	City of Modesto*
Michael Renfrow	City of Oakdale*
Claudia Hidahl	Member of the public
Hilary	Member of the public
Louie B.	Member of the public
John Beckman	Member of the public
Mike Day	Member of the public
Tom Orvis	Member of the public
Gordon Enas	Modesto Irrigation District*
Jennifer Wright	Modesto Irrigation District*
John Davids	Modesto Irrigation District*
Melissa Williams	Modesto Irrigation District*
Samantha Wookey	Modesto Irrigation District*
Stu Gilman	Modesto Irrigation District (Board of Directors)*
Eric Thorburn	Oakdale Irrigation District*
Alexis Stevens	Somach, Simmons & Dunn
Khandriale Clark	Stantec*
Kirsten Pringle	Stantec*
Stacy Henderson	Terpstra Henderson

* This indicates that the agency is a member agency of the Stanislaus and Tuolumne Rivers Groundwater Basin Association Groundwater Sustainability Agency, Tuolumne County Groundwater Sustainability Agency, or consultant staff.
Key: N/A = No Answer/Not Applicable

PURPOSE AND FORMAT

In March 2021, the Stanislaus and Tuolumne Rivers Groundwater Basin Association (STRGBA) Groundwater Sustainability Agency (GSA) held the first in a series of basin Office Hours. Office Hours are a public engagement activity focused on soliciting questions from and engaging in informal dialogue with members of the public about key topics related to implementation of the Sustainable Groundwater Management Act and the Groundwater Sustainability Plan (GSP) being developed for the Modesto Subbasin.

The first Office Hours was held on March 25, 2021 from 12:00 p.m. – 1:00 p.m. via Zoom. In total, 9 individuals attended, apart from GSA and consultant staff (see the attendee list above for more details). The activity was promoted using a bilingual (English-Spanish) flyer that was distributed via the STRGBA GSA's website and social media accounts and an email to the Modesto Subbasin interested parties database.

The Office Hours topics were dictated through questions posed by members of the public. A summary of the questions and responses is provided below. Participants could submit questions verbally or using the chat function within webinar platform. The discussion was not recorded to promote an open dialogue with the attendees. At the request of the attendees, future Office Hours will be recorded and recordings made publicly available to allow those unable to attend to listen to the discussion.

SUMMARY OF FEEDBACK

The following is a summary of attendee questions and GSA representative responses from the first Office Hours. The questions are organized by the topics or themes that they address.

Projects and Management Actions

Mike Day, member of the public, noted the importance of flood irrigation to recharge groundwater. He asked if there would be an incentive for growers to use surface irrigation and whether individuals would be able to continue to flood for recharge purposes. John Davids, Modesto Irrigation District, acknowledged the conversion from flood irrigation to drip irrigation in the region and responded that the GSA may consider how to use old flood infrastructure for recharge purposes. Gordon Enas, Modesto Irrigation District, added that the STRGBA GSA will be discussing potential projects and management actions at the next several GSA and Technical Advisory Committee meetings.

Hilary, member of the public, asked when the GSA anticipated that the projects and management actions would be identified. Mr. Enas responded that he anticipated that a complete list of groundwater management projects and actions would be available in June.

GSP Implementation Funding and Financing

Stu Gilman, Modesto Irrigation District Board of Directors, expressed concerns over the possibility of the GSA charging irrigators for additional expenses related to fees or maintenance not within the Modesto Irrigation District’s jurisdiction. Mr. Davids responded that the GSAs are working on developing a fee schedule and anticipates there may be a base fee across the basin with some variations in different locations. He added that the matter had not yet been decided upon and would continue to be discussed.

Mr. Day asked what process the GSAs would be using to ensure that costs for projects and management actions are allocated fairly across the basin. He stated that certain costs should be allocated to the areas that are causing the overdraft or undesirable results. Mr. Davids responded that the first step is defining the extent of the issue that projects and actions need to address and then look at the projected costs to implement those projects and actions. He noted that discussions around the cost allocation model will occur in a public setting.

Other Topics

Stacy Henderson, Terpstra Henderson, asked whether the new monitoring wells would be owned by the STRGBA GSA and what would be the cost to monitor and maintain the wells. Mr. Enas responded that ownership of the monitoring wells would likely reside with the STRGBA GSA and that costs for well operation and maintenance would be identified in the STRGBA GSA budget for Fiscal Year 2022. Ms. Henderson asked when the budget would be developed and whether it would be developed in a public meeting. Mr. Enas responded that the budget would be developed in June. Mr. Davids, the member agencies will be discussing the fee structure to pay for implementation costs at public meetings.

Mr. Day stated that landowners were concerned about groundwater dependent ecosystems (GDE) and asked whether the GSAs would be 'ground truthing' the GDE information provided in the California Department of Water Resources' GDE dataset. Mr. Enas responded that the STRGBA GSA has not yet collected additional data on GDEs, but understood that one of the neighboring subbasins had and that the STRGBA GSA would look into it.

Lisa, Barton Ranch, asked what percentage of the basin's water supply was out of balance, particularly in the northeastern region, when the basin is projected it to be in balance, and how GSAs plan to achieve balance. Mr. Enas responded that the final current and projected water budgets have not be been developed, but the technical consultants from Todd Groundwater would respond during the next Technical Advisory Committee meeting and follow up with that attendee directly. Mr. Enas and Miguel Alvarez, City of Modesto, added that the historic water budgets have been completed and those results are available on the meetings page (specifically for the October 22, 2020 meeting) of the STRGBA GSA's website.

Ms. Henderson asked whether the GSAs were able to get data from landowners in the white are of the eastern portion of the basin and what the GSAs' plans were to fill data gaps in that region. Mr. Enas responded that the basin's technical consultants were unsuccessful in getting information from landowners in the eastern portion of the basin and were forced to push forward with data collection and modeling efforts. Mr. Davids added that the GSAs will continue to work to get additional data from across the basin, but particularly data on wells in the eastern portion of the basin pumping under the Corcoran Clay. He encouraged the participants to stay engaged to be part of the ongoing data collection efforts.

MODESTO SUBBASIN
OFFICE HOURS #2

Friday, May 28, 2021 (12:00 p.m. – 1:00 p.m.)
Virtual Meeting (Zoom)

ATTENDEES

Name	Agency
Miguel Alvarez	City of Modesto*
Michael Renfrow	City of Oakdale*
Allison and Dave Boucher	Members of the public
Louie Brichetto	Member of the public
Brad Johnson	Member of the public
Dennis Wakefield	Member of the public
Gordon Enas	Modesto Irrigation District*
John Davids	Modesto Irrigation District*
Melissa Williams	Modesto Irrigation District*
Samantha Wookey	Modesto Irrigation District*
Eric Thorburn	Oakdale Irrigation District*
Walt Ward	Stanislaus County*
Khandriale Clark	Stantec*
Kirsten Pringle	Stantec*
Phyllis Stanin	Todd Groundwater*

* This indicates that the agency is a member agency of the Stanislaus and Tuolumne Rivers Groundwater Basin Association Groundwater Sustainability Agency, Tuolumne County Groundwater Sustainability Agency, or consultant staff.

PURPOSE AND FORMAT

In May 2021, the Stanislaus and Tuolumne Rivers Groundwater Basin Association (STRGBA) Groundwater Sustainability Agency (GSA) held the second in a series of basin Office Hours. Office Hours are a public engagement activity focused on soliciting questions from and engaging in informal dialogue with members of the public about key topics related to implementation of the Sustainable Groundwater Management Act and the Groundwater Sustainability Plan (GSP) being developed for the Modesto Subbasin.

The second Office Hours was held on May 28, 2021 from 12:00 p.m. – 1:00 p.m. via Zoom. In total, four individuals attended, apart from GSA and consultant staff (see the attendee list above for more details). The activity was promoted using a bilingual (English and Spanish) flyer that was distributed via the STRGBA GSA's website and social media accounts and an email to the Modesto Subbasin interested parties database.

STRGBA GSA and consultant staff provided a presentation on Sustainable Management Criteria (SMC) and the GSP, which was followed by a live question and answer session with STRGBA GSA member agency representatives. Participants could submit questions verbally or using the chat function within the Zoom platform. A summary of the questions and responses is provided below. A recording of the Office Hours was also made publicly available and posted on the STRGBA website.

SUMMARY OF FEEDBACK

The following is a summary of attendee questions and GSA representative responses from the second Office Hours. The questions and responses are organized by the topic that they address.

Projects and Management Actions and Associated Costs

Brad Johnson, member of the public, asked if the offline, high nitrate city wells could be helpful for areas with lower groundwater levels. Phyllis Stanin, Todd Groundwater, responded that water from high nitrate wells cannot be consumed as drinking water but could be used for a potential project to manage the basin's groundwater levels. She noted that several wells have gone offline in the City of Modesto. Eric Thorburn, Oakdale Irrigation District (OID), added that the City of Oakdale, which is within OID's jurisdiction, has had a few, isolated incidents involving nitrates and noted that the East San Joaquin Water Quality Coalition is making efforts to tackle the nitrate issue.

Allison and Dave Boucher, members of the public, asked if any fees for GSP implementation have been set for landowners. Mr. Thorburn responded that the GSAs have not yet discussed or set fees for GSP implementation. He anticipated that the GSAs would discuss the funding plan for GSP implementation after the SMC are developed and the projects and management actions are selected. He stated that GSP development efforts are being covered by a grant so there isn't additional funding needed until the GSAs start implementing the GSP. Michael Renfrow, City of Oakdale, added that the City is looking at potential grants to mitigate the costs of implementing projects and management actions in its area.

Dennis Wakefield, member of the public, asked what was the likelihood that the GSAs will implement limits on pumping before the 2042 deadline for basin sustainability and interim five-year milestone. Mr. Thorburn responded that the GSAs have not established pumping limits at this time. He explained that that the Subbasin is in a state of non-critical overdraft and most the overdraft is occurring in the eastern part of the basin. The GSAs have their first interim milestone five years after the initial submittal of the GSP; at that point, the GSAs will reevaluate the data available to them as well as conditions in the basin to determine whether pumping limitations will be needed.

Sustainable Management Criteria

Kirsten Pringle, the Office Hours moderator, asked the GSA representatives to elaborate on the draft sustainability goal for the Subbasin. Mr. Thorburn explained that the basin's sustainability goal was developed to ensure that the GSP is flexible. He explained that the STRGBA GSA has already identified a host of priority issues that the GSP will address. After finding and implementing solutions to those issues, the GSAs will continue to monitor the Subbasin conditions and adapt to any changing conditions, as needed.

Ms. Pringle asked how the SMC would be used to manage the Modesto Subbasin. Mr. Thorburn responded that the GSAs will continue to closely monitor the basin conditions in order to avoid the exceedance of minimum thresholds identified in the GSP. If a minimum threshold is exceeded, the GSAs will adapt the projects and management actions to bring the basin into sustainability.

Ms. Pringle asked what would happen if a groundwater conditions exceeded the minimum threshold. Ms. Stanin responded that the GSAs will adapt the projects and management actions and monitoring network to the groundwater conditions. She stated that there are numerous wells located throughout the Modesto Subbasin that the STRGBA GSA has access to, including wells from the California Department of Water

Resources (DWR) California Statewide Groundwater Elevation Monitoring (CASGEM) program, the City of Modesto, and the United States Geological Survey. All of these together comprise a relatively robust monitoring program that the GSAs will use to help inform the GSP and its future iterations.

Ms. Pringle asked the GSA representatives to identify the next steps in the GSP and SMC development process. Mr. Thorburn stated that the GSAs have developed the groundwater model and created the water budgets; the next step is to set up a monitoring network and create an approach for the SMCs using all of the information that has been gathered.

Other

Ms. And Mr. Boucher asked how severe the overdraft is in the eastern portion of the Subbasin. Mr. Thorburn responded that there is 43,000 acre-feet of overdraft on average. Ms. Stanin added that most of that 43,000 acre-feet is in the eastern non-districted areas of the Subbasin and the GSAs are working on developing a sustainable yield analysis for that area. The GSAs are also working on projecting changes in the groundwater system and evaluating what the GSAs can try to do to bring some areas back into sustainability. Mr. Renfrow noted that the GSAs are evaluating projects that could help tackle the overdraft .

Ms. Pringle asked how the public could get involved in the SMC and GSP development process. Mr. Thorburn stated that the best ways for interested members of the public to get involved are to attend the monthly GSA meetings, visit the GSAs' and GSA member agencies websites, and speak with their member agency representative. He added that the GSAs are releasing chapters of the GSP for public review and comment as they are developed. Mr. Renfrow noted that the City of Oakdale also has regular meetings that the public attend.

MODESTO SUBBASIN
OFFICE HOURS #3
Wednesday, August 25, 2021 (5:30 p.m. – 6:30 p.m.)
Virtual Meeting (Zoom)

ATTENDEES

Name	Agency
Miguel Alvarez	City of Modesto*
Michael Riddell	City of Riverbank*
Dennis Wittchow	Members of the public
Jeff Gravel	Members of the public
John Brichetto	Members of the public
John Davids	Members of the public
Luis Uribe	Members of the public
Terpstra Hatfield	Members of the public
Thomas Helme	Members of the public
Gordon Enas	Modesto Irrigation District*
Chad Tienken	Modesto Irrigation District*
Melissa Williams	Modesto Irrigation District*
Samantha Wookey	Modesto Irrigation District*
Eric Thorburn	Oakdale Irrigation District*
Walt Ward	Stanislaus County*
Khandriale Clark	Stantec*
Kirsten Pringle	Stantec*
Phyllis Stanin	Todd Groundwater*
N/A	Unknown Callers

* This indicates that the agency is a member agency of the Stanislaus and Tuolumne Rivers Groundwater Basin Association Groundwater Sustainability Agency, Tuolumne County Groundwater Sustainability Agency, or consultant staff.

PURPOSE AND FORMAT

In August 2021, the Stanislaus and Tuolumne Rivers Groundwater Basin Association (STRGBA) Groundwater Sustainability Agency (GSA) held the third in a series of basin Office Hours. Office Hours are a public engagement activity focused on soliciting questions from and engaging in informal dialogue with members of the public about key topics related to implementation of the Sustainable Groundwater Management Act and the Groundwater Sustainability Plan (GSP) being developed for the Modesto Subbasin.

The third Office Hours was held on August 25, 2021, from 5:30 p.m. – 6:30 p.m. via Zoom. At least seven individuals attended, apart from GSA and consultant staff (see the attendee list above for more details). The activity was promoted using a bilingual (English and Spanish) flyer that was distributed via the STRGBA GSA's website and social media accounts and an email to the Modesto Subbasin interested parties database.

STRGBA GSA and consultant staff provided a presentation on groundwater monitoring well networks and an update on development of the GSP. This was followed by a live question and answer session facilitated by Stantec staff. Participants could submit questions verbally or using the chat function within the Zoom platform. Michael Riddell, City of Riverbank; Walt Ward, Stanislaus County; and Phyllis Stanin, Todd Groundwater (technical consultant preparing the GSP) were the main speakers and responded to questions from the participants. A summary of the questions and responses is provided below. A recording of the Office Hours was also made publicly available and posted on the STRGBA website.

SUMMARY OF FEEDBACK

The following is a summary of attendee questions and GSA representative responses from the third Office Hours. The questions and responses are organized by the topic that they address.

Groundwater Monitoring Well Networks

Mr. Ward commented on the significance of the monitoring well network. He stated that the network will help the STRGBA GSA evaluate its progress towards meeting the goals identified in the GSP. He added that having a good geographic distribution of wells allows the GSA to collect a range of information and invited members of the public to reach out to the STRGBA GSA if they know of a well that may be of use in the monitoring well networks or have data to share.

Kirsten Pringle, Stantec, asked if private wells could be included in the monitoring well network. Mr. Ward replied that a private well could be included in the network, but the well must meet certain screening criteria and provide the type of data that would be useful for the GSA's purposes. Ms. Stanin added that if a private well were to be included in the monitoring network it would (1) have to be an inactive, non-pumping well, (2) the owner would need to provide certain information about the well, and (3) the GSA would need access to monitor the well. To include a well in the monitoring network, the GSA would need to know the well's construction and screen information, well diameter, and any other available details regarding the well's internal structure. The GSA would also like to know if there is any static water level data available from the historical record and what the vertical and horizonal distribution is.

Ms. Pringle asked how installation, operation, and maintenance of the new monitoring wells was paid for. Ms. Stanin replied that the STRGBA GSA was able to secure a one-million-dollar Proposition 68 grant administered by the California Department of Water Resources (DWR). She stated that Miguel Alvarez, City of Modesto, led the application development and worked with underrepresented communities in the Subbasin to identify potential well locations. Mr. Ward added that all of the new monitoring wells have been fully permitted through Stanislaus County. Construction on the new wells has been fully completed and data is ready to be collected. Well maintenance and staff time dedicated to the wells will be the responsibility of the agency with jurisdiction over the well's location. The GSAs have yet to contract with a water quality lab to analyze any data collected from the wells, but it is a factor that will be discussed at a later date.

Ms. Pringle asked if and how the public would be given access to the data collected from the monitoring well network. Ms. Stanin replied that the information would be made available through the annual reports and five-year GSP updates submitted to DWR. The monitoring data may also be made available in the future through DWR's SGMA Portal.

John Davids, member of the public, asked what the process would be like if new wells were to be added to the monitoring well network through private landowners or additional funding. Ms. Stanin replied that the GSA is able to add new wells to the monitoring network any time after the GSP has been adopted. If a well was added, the GSA would notify DWR of this change via the annual reports and five-year GSP updates. She noted that one of the potential management actions for the Modesto Subbasin is to improve the monitoring network to fill data gap. Ms. Stanin reiterated Mr. Ward's previous call for information on wells that could be included in the monitoring well network and stated that while the GSA will continue to strategize on the matter, they encourage the public to reach out if anyone knows of wells that may fit the GSA's needs.

Projects and Management Actions

Dennis Wittchow, member of the public, asked how the public could view projects and management actions that are being considered by the GSA. Ms. Stanin responded that a preliminary list of projects had been presented at a previous meeting. This list included projects related to stormwater recharge and water supply located in urban areas. The project details are still being developed and the potential benefits are being analyzed using the groundwater model. The preliminary list of management actions hasn't been released. The STRGBA GSA will be discussing the draft list of projects and management actions at the STRGBA GSA Committee and Technical Advisory Committee meetings being held in September.

Annual Reports

Mr. Ward commented that the annual reports should be utilized as an opportunity for the STRGBA GSA to measure its performance and adapt to changing conditions in the Subbasin. Michael Riddell, City of Riverbank, added that the annual report and groundwater monitoring network are tools for the STRGBA GSA to manage the Subbasin's groundwater resources.

Stanislaus & Tuolumne Rivers Groundwater Basin Association
Groundwater Sustainability Agency
1231 11th Street | Modesto, CA 95354
Phone: (209) 847-0341
Email: strgba@mid.org

August 10, 2021

Modesto Irrigation District
Board of Directors
1231 11th Street
Modesto, CA 95354

Re: Notice of Intent to Adopt a Groundwater Sustainability Plan

Dear Board of Directors:

On behalf of the local agencies comprising the Stanislaus and Tuolumne Rivers Groundwater Basin Association Groundwater Sustainability Agency (STRGBA GSA), pursuant to California Water Code Section 10728.4, the STRGBA GSA hereby gives notice to the legislative body of any City, County, or Public Utilities Commission-regulated company within the geographic area covered by the pending Modesto Subbasin Groundwater Sustainability Plan (GSP) of its intent to adopt the GSP for the Modesto Subbasin (DWR Basin 5-22.02). A map of the area covered by the GSP is included herein.

Interested parties may provide comments on the Public Draft GSP during the scheduled public comment period, September 1 through October 31, 2021. Information regarding the Draft GSP has been posted on the STRGBA GSA website at www.strgba.org. According to Water Code Section 10728.4, "a groundwater sustainability agency may adopt or amend a groundwater sustainability plan after a public hearing, held at least 90 days after providing notice to a city or county within the area of the proposed plan or amendment. The groundwater sustainability agency shall review and consider comments from any city or county that receives notice pursuant to this section and shall consult with a city or county that requests consultation within 30 days of receipt of the notice."

No sooner than 90 days from the date of this Notice, the STRGBA GSA will hold a public hearing and consider adopting the GSP. For meeting information and public hearing dates, please refer to the STRGBA GSA website.

Should you have any questions about this, please contact me by email at strgba@mid.org or by phone at (209) 847-0341.

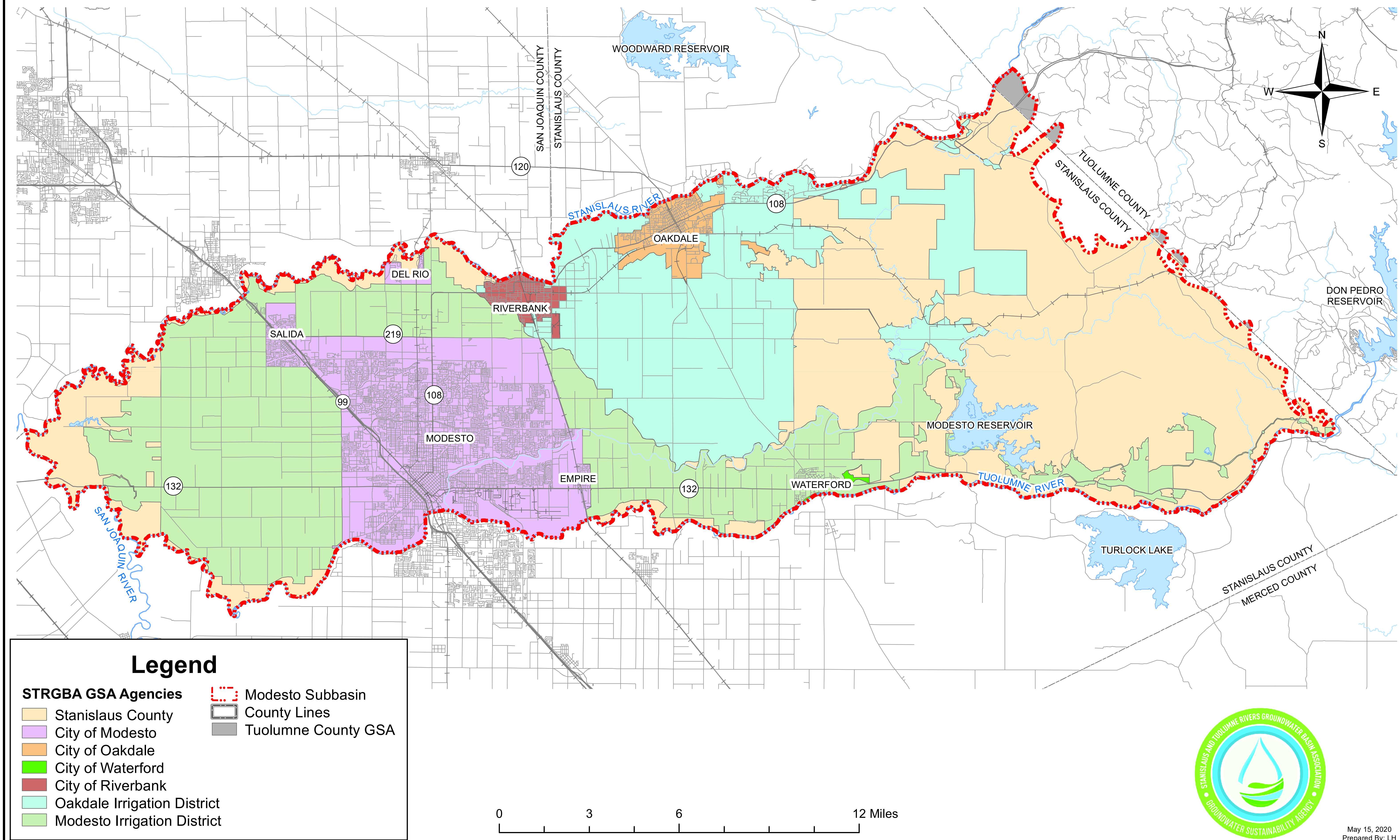
Stanislaus & Tuolumne Rivers Groundwater Basin Association
Groundwater Sustainability Agency
1231 11th Street | Modesto, CA 95354
Phone: (209) 847-0341
Email: strgba@mid.org

Sincerely,

Eric Thorburn, P.E.
STRGBA GSA Chairman

Enclosure: GSA Modesto Subbasin Map

Modesto Subbasin Agencies



May 15, 2020
Prepared By: LH

Document Path: X:\Water\Resources\GIS Projects\STRGBA Maps\GSA Modesto Subbasin Map.mxd

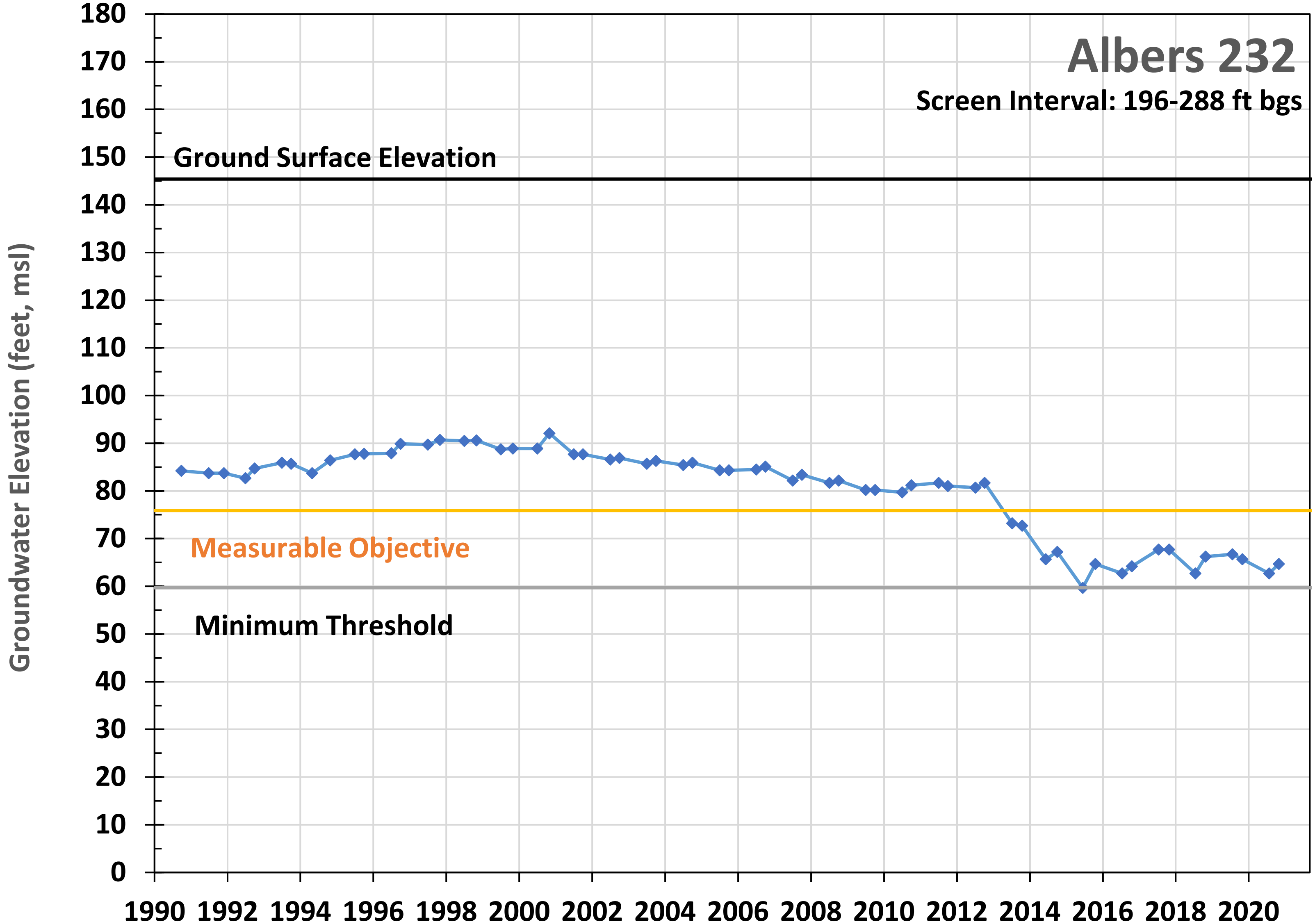
Appendix F

Hydrographs for Representative Monitoring Wells

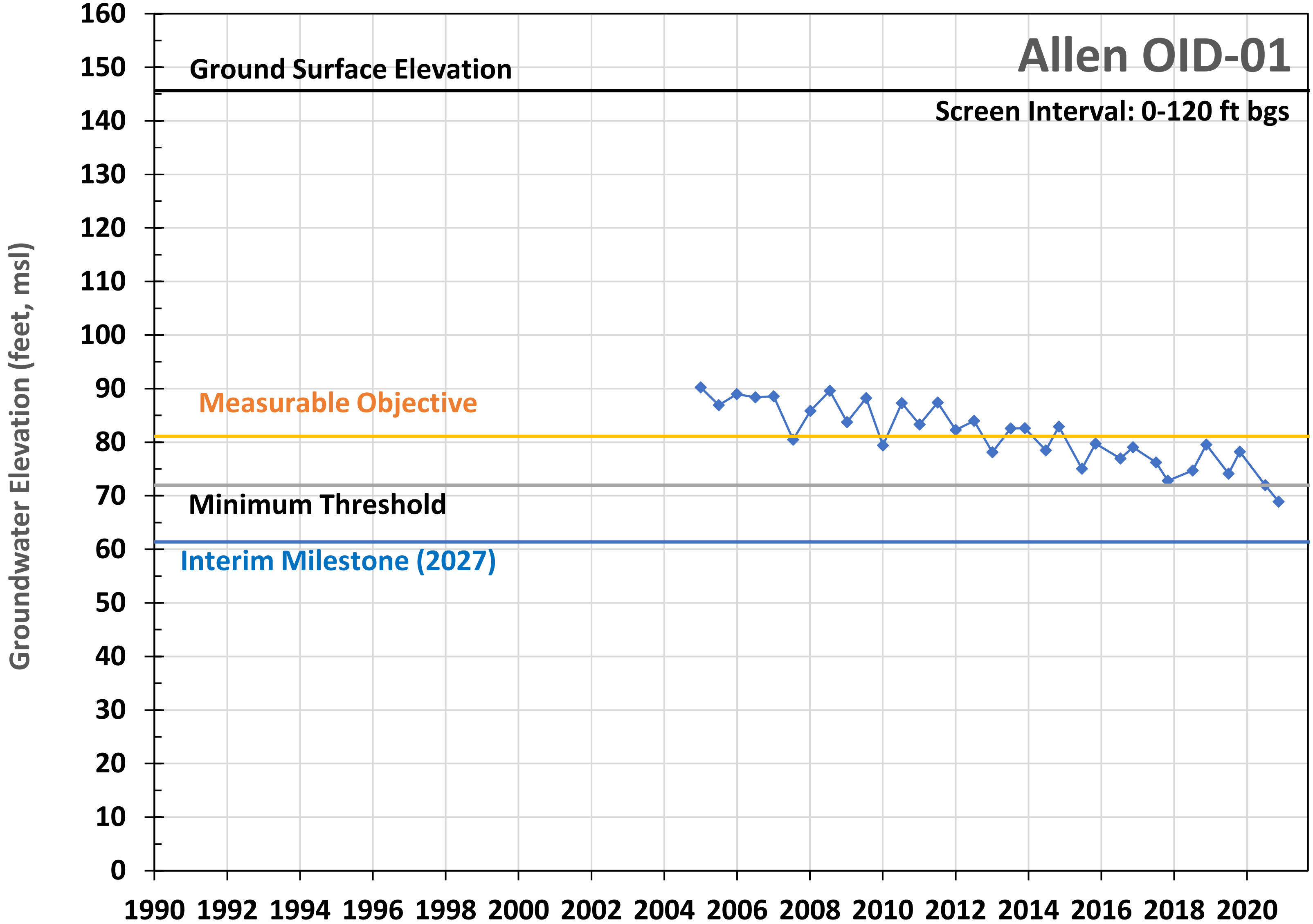
Modesto Subbasin Monitoring Network

Hydrographs for Wells in the Monitoring Network for:
Chronic Lowering of Groundwater Levels
Reduction of Groundwater in Storage
Land Subsidence

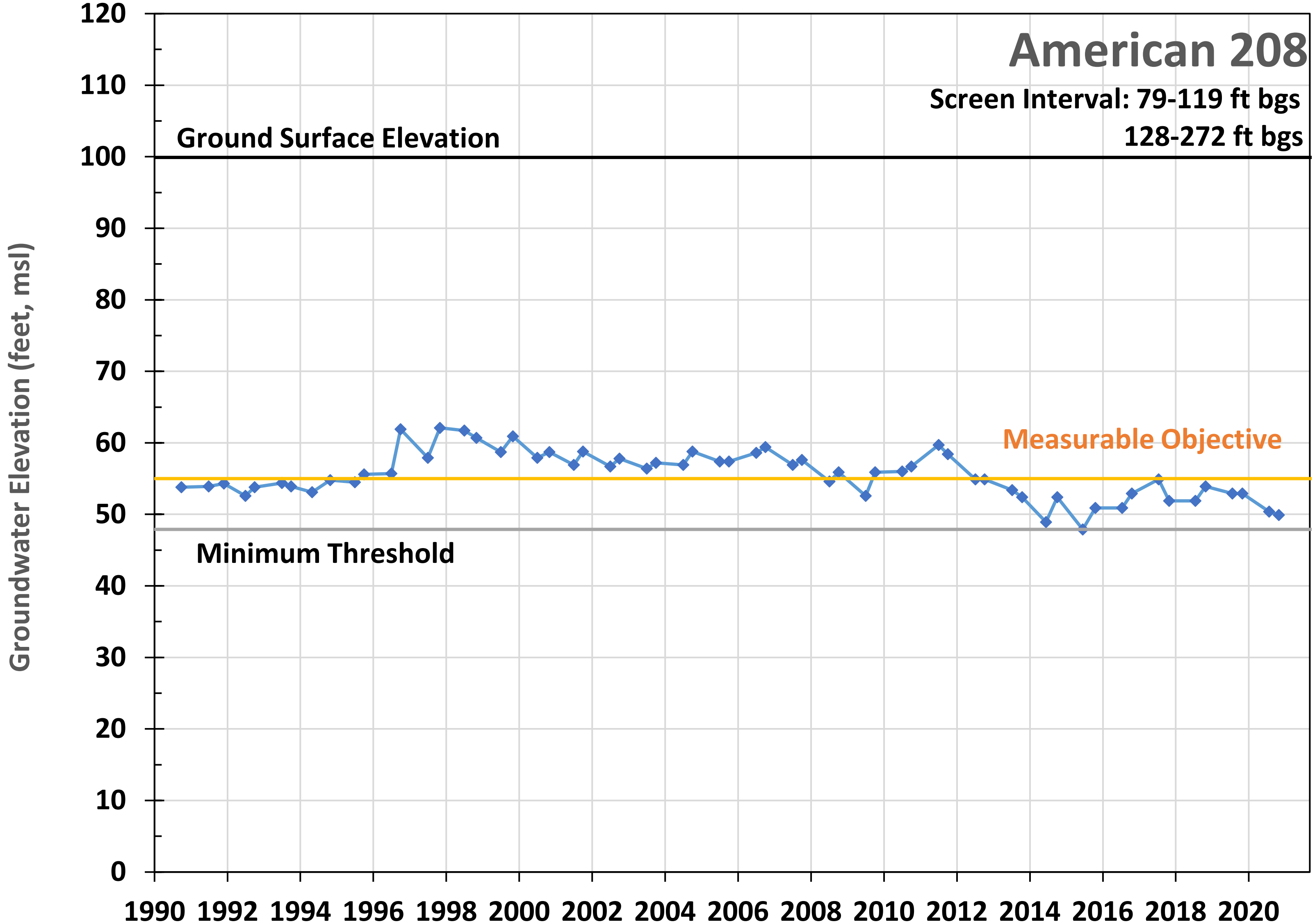
(in the order as they appear on Tables 7-1 and 7-2)

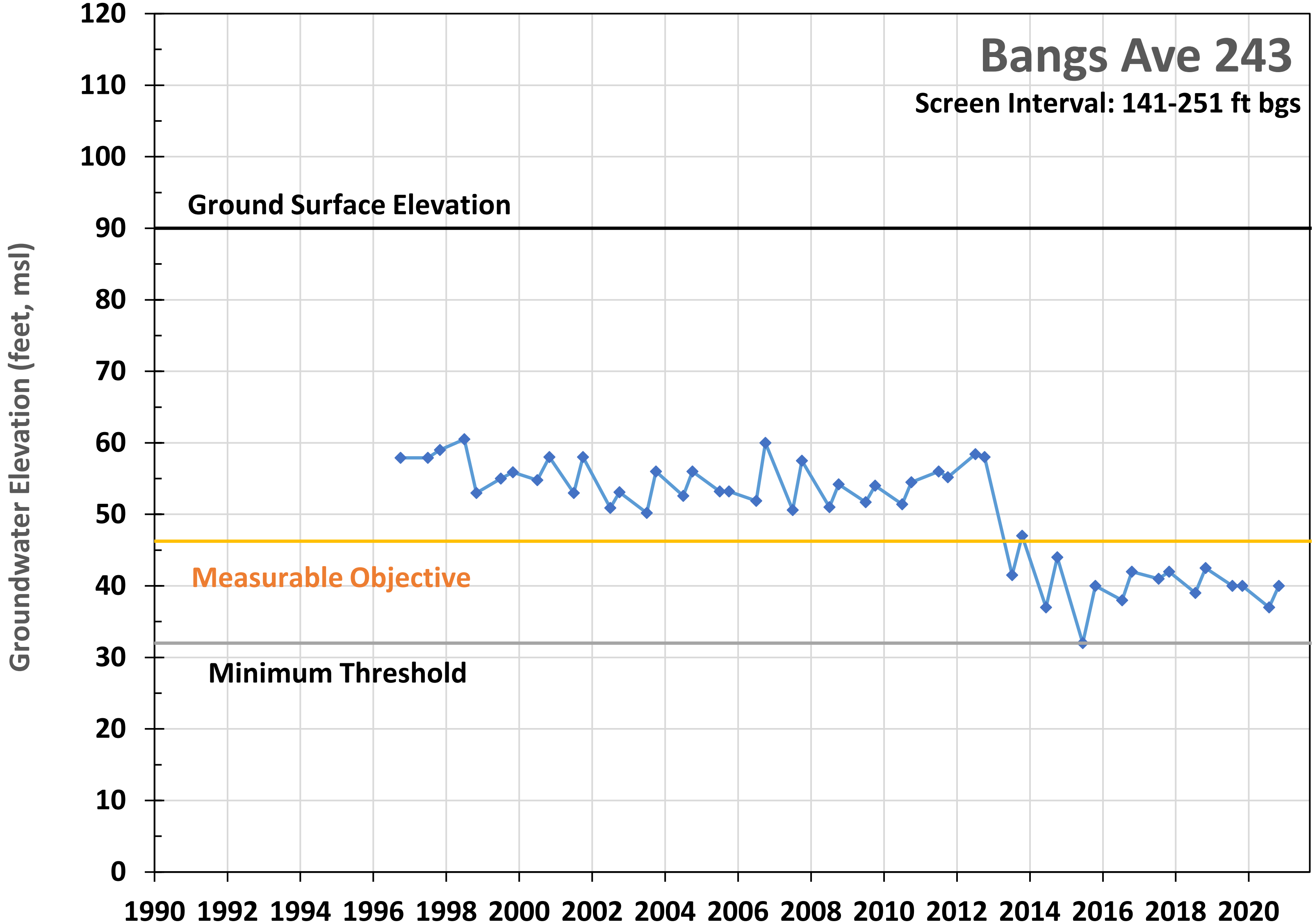


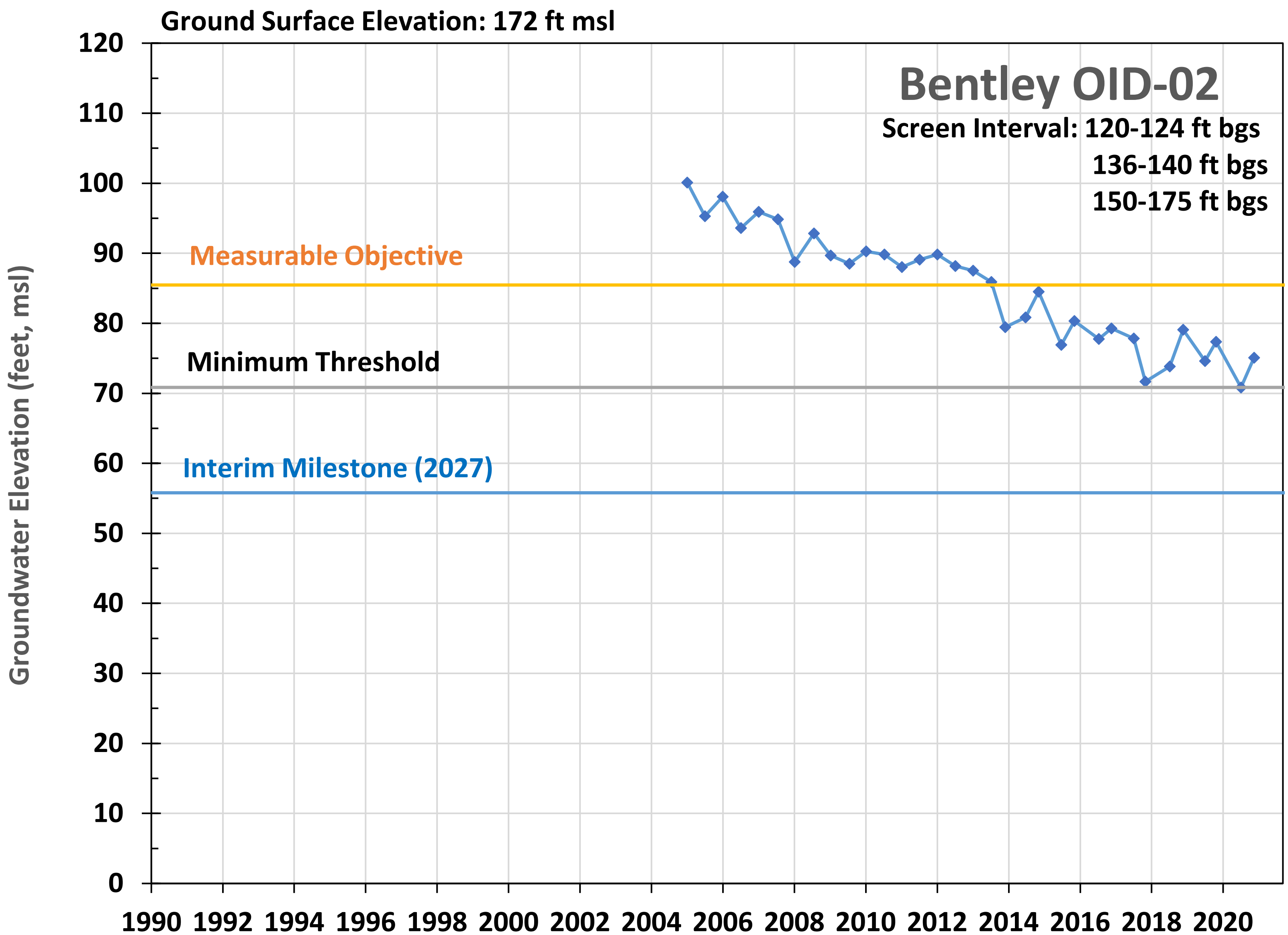
Albers 232
Screen Interval: 196-288 ft bgs
Ground Surface Elevation
Measurable Objective
Minimum Threshold
Groundwater Elevation (feet, msl)
0
10
20
30
40
50
60
70
80
90
100
110
120
130
140
150
160
170
180
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016
2018
2020



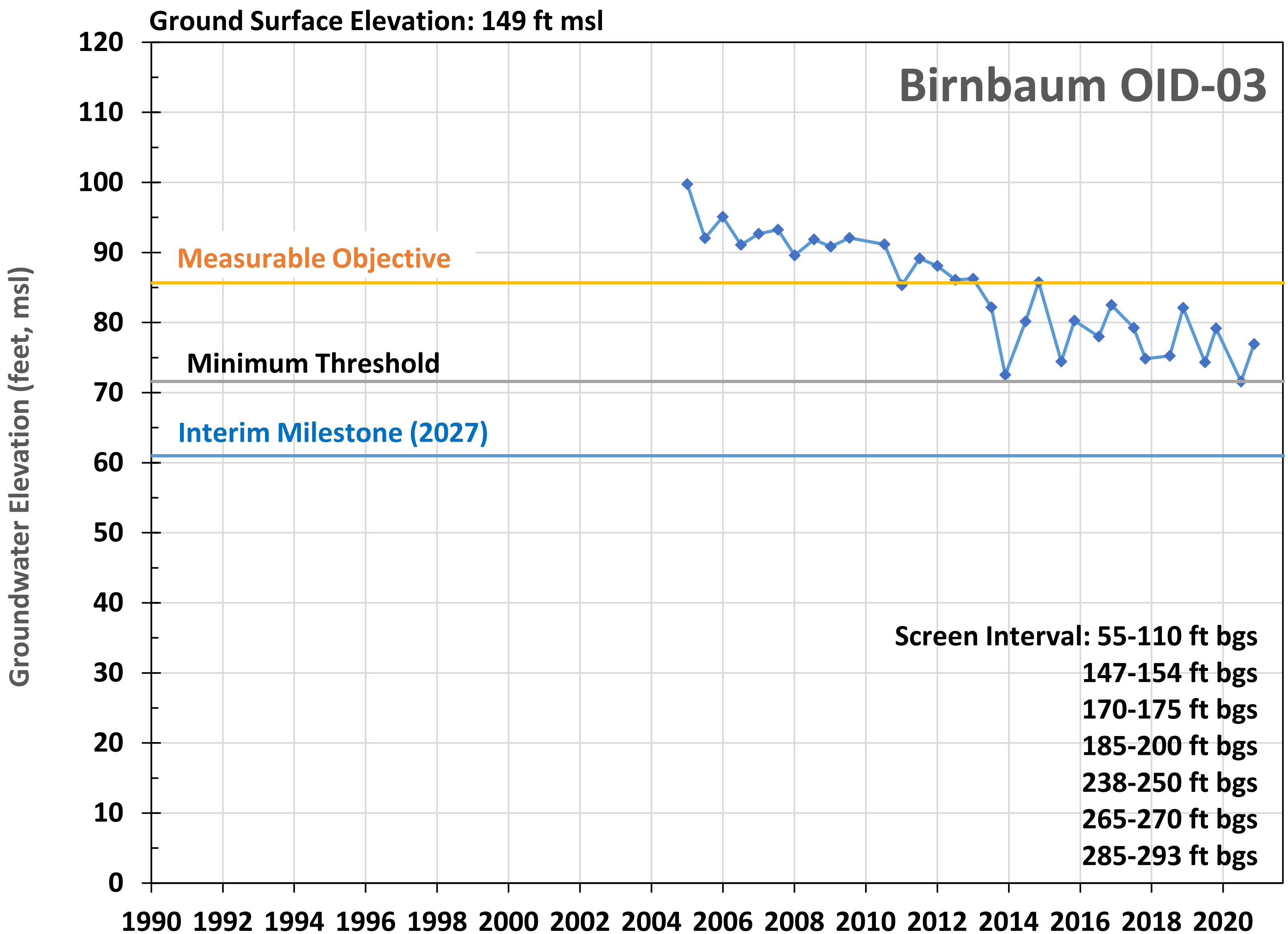
Allen OID-01
Ground Surface Elevation
Screen Interval: 0-120 ft bgs
Measurable Objective
Minimum Threshold
Interim Milestone (2027)
Groundwater Elevation (feet, msl)
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016
2018
2020

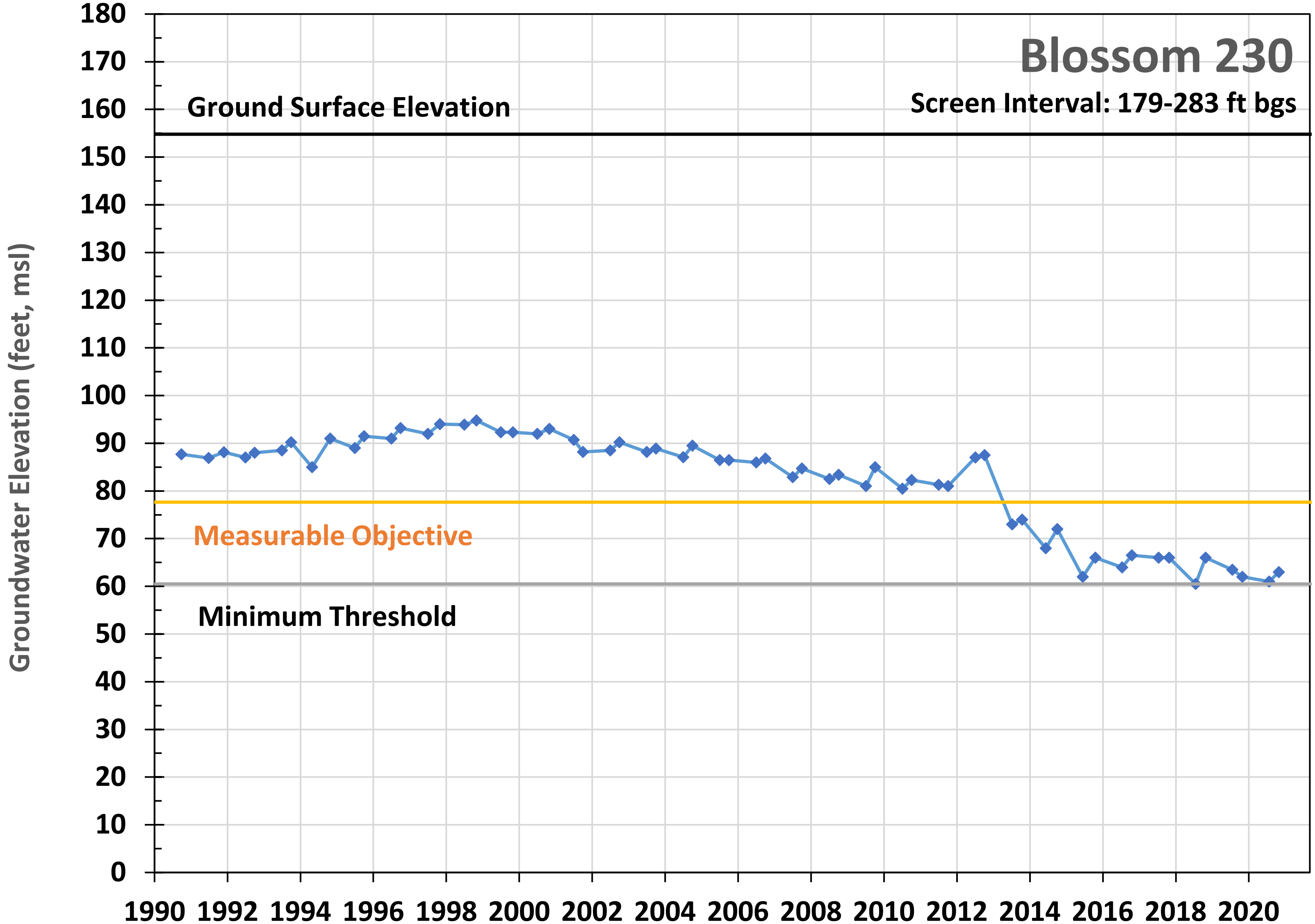

American 208
Screen Interval: 79-119 ft bgs
128-272 ft bgs
Ground Surface Elevation
Measurable Objective
Minimum Threshold
Groundwater Elevation (feet, msl)
0
10
20
30
40
50
60
70
80
90
100
110
120
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016
2018
2020


Bangs Ave 243
Screen Interval: 141-251 ft bgs
Ground Surface Elevation
Measurable Objective
Minimum Threshold
Groundwater Elevation (feet, msl)
0
10
20
30
40
50
60
70
80
90
100
110
120
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016
2018
2020

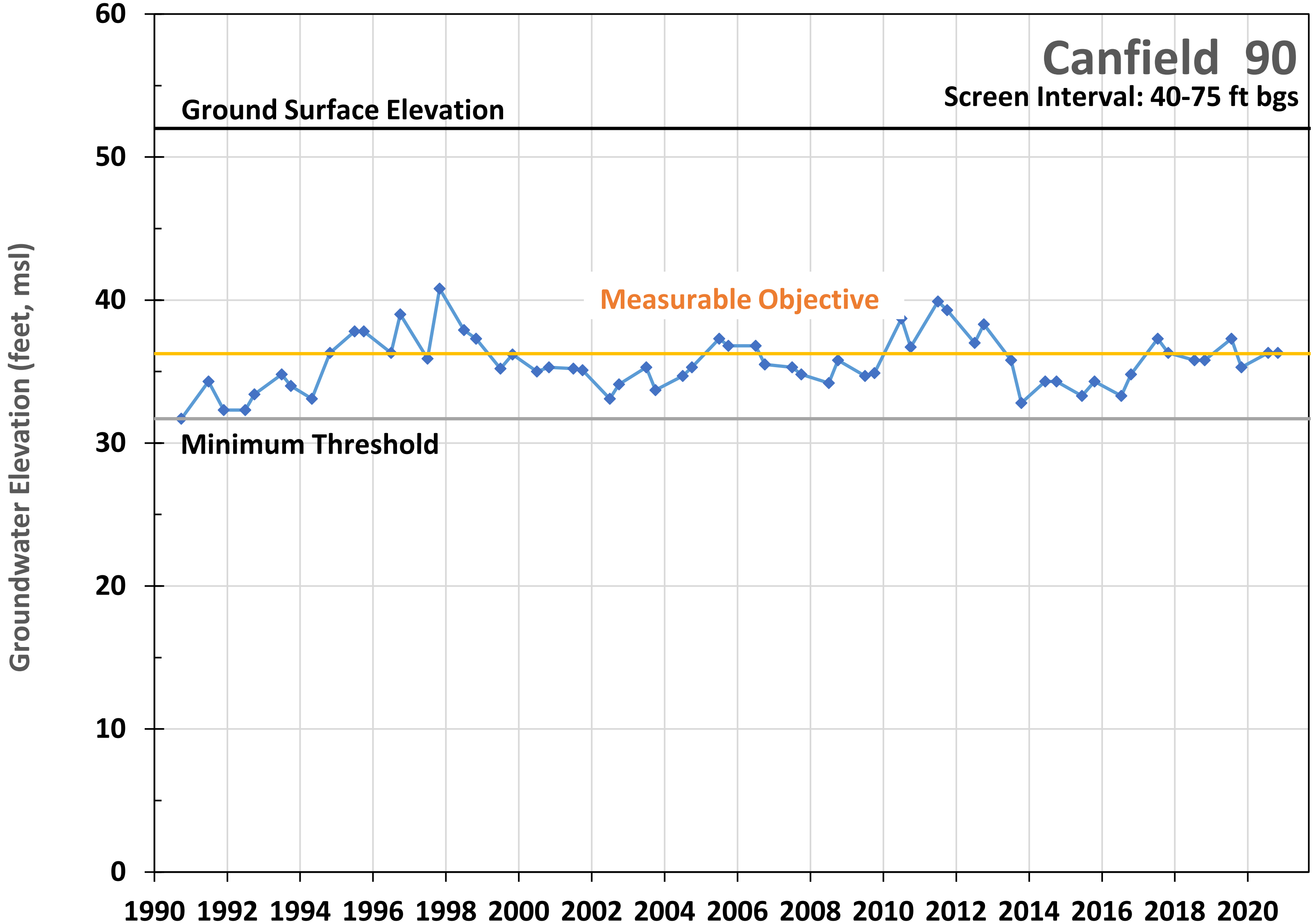


Ground Surface Elevation: 172 ft msl
Bentley OID-02
Screen Interval: 120-124 ft bgs
136-140 ft bgs
150-175 ft bgs
Measurable Objective
Minimum Threshold
Interim Milestone (2027)
Groundwater Elevation (feet, msl)
120
110
100
90
80
70
60
50
40
30
20
10
0
1990 1992 1994 1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020

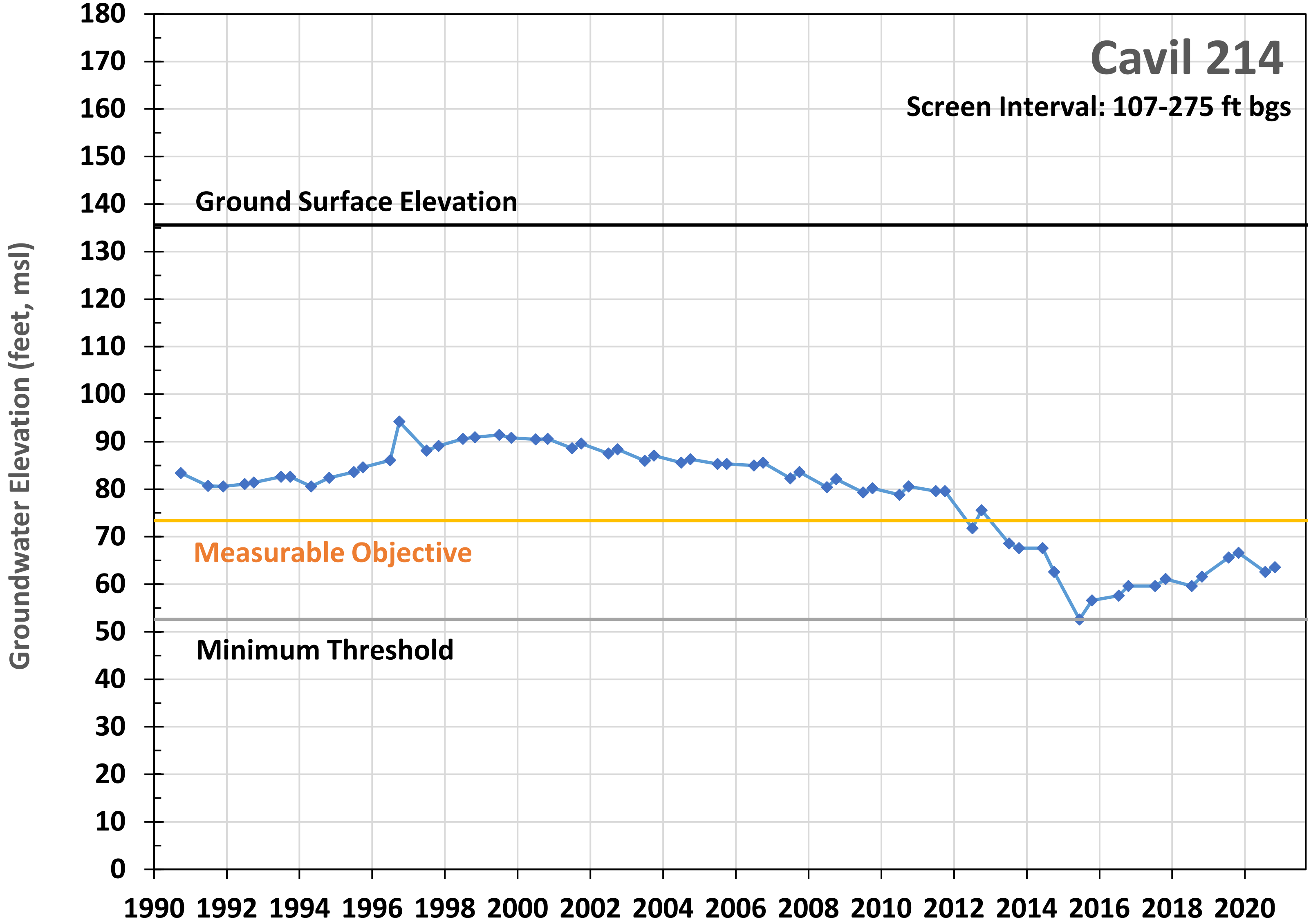

Ground Surface Elevation: 149 ft msl
Birnbaum OID-03
Measurable Objective
Minimum Threshold
Interim Milestone (2027)
Screen Interval: 55-110 ft bgs
147-154 ft bgs
170-175 ft bgs
185-200 ft bgs
238-250 ft bgs
265-270 ft bgs
285-293 ft bgs
Groundwater Elevation (feet, msl)
0
10
20
30
40
50
60
70
80
90
100
110
120
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016
2018
2020



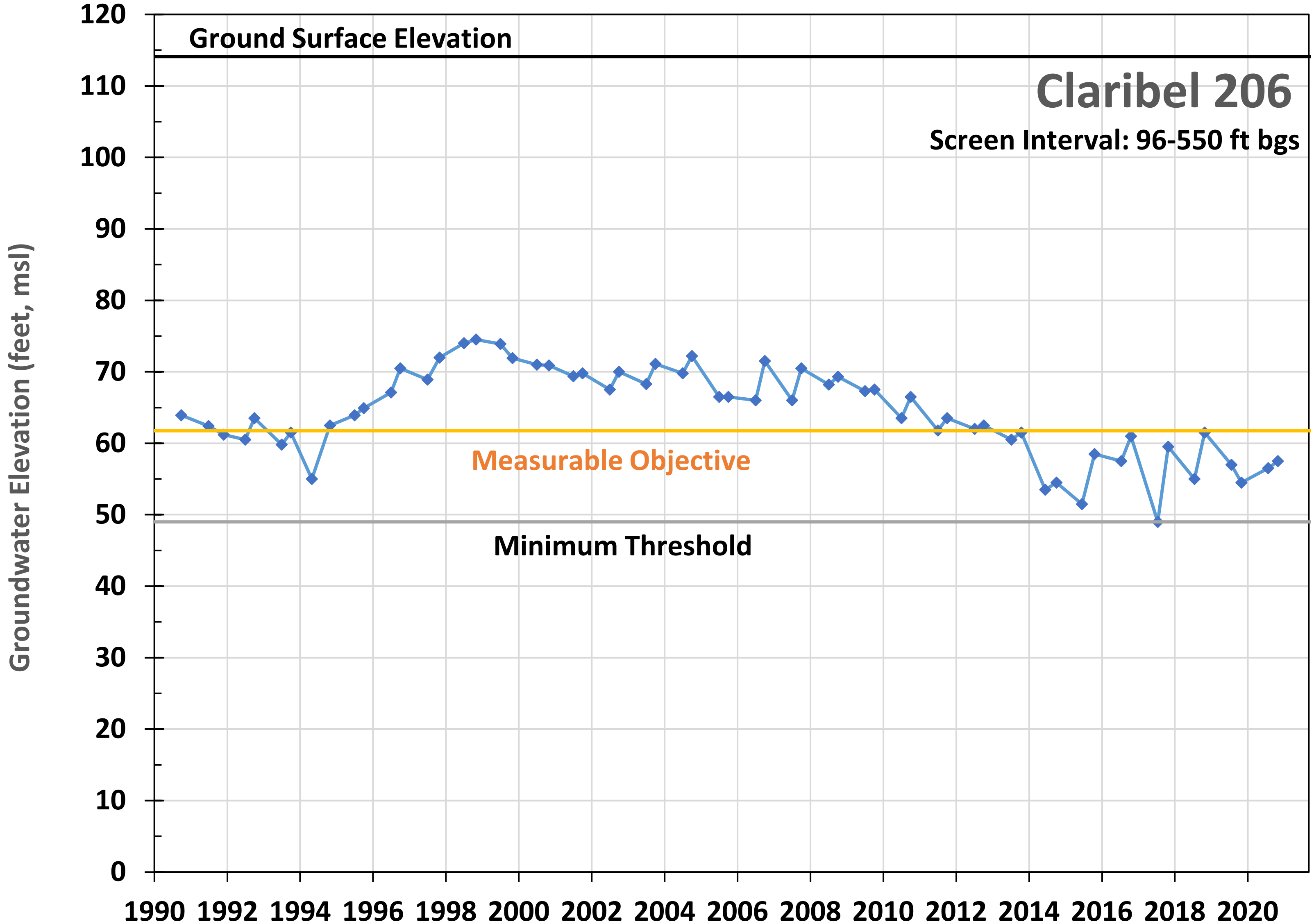
Blossom 230
Screen Interval: 179-283 ft bgs
Ground Surface Elevation
Measurable Objective
Minimum Threshold
Groundwater Elevation (feet, msl)
0
10
20
30
40
50
60
70
80
90
100
110
120
130
140
150
160
170
180
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016
2018
2020



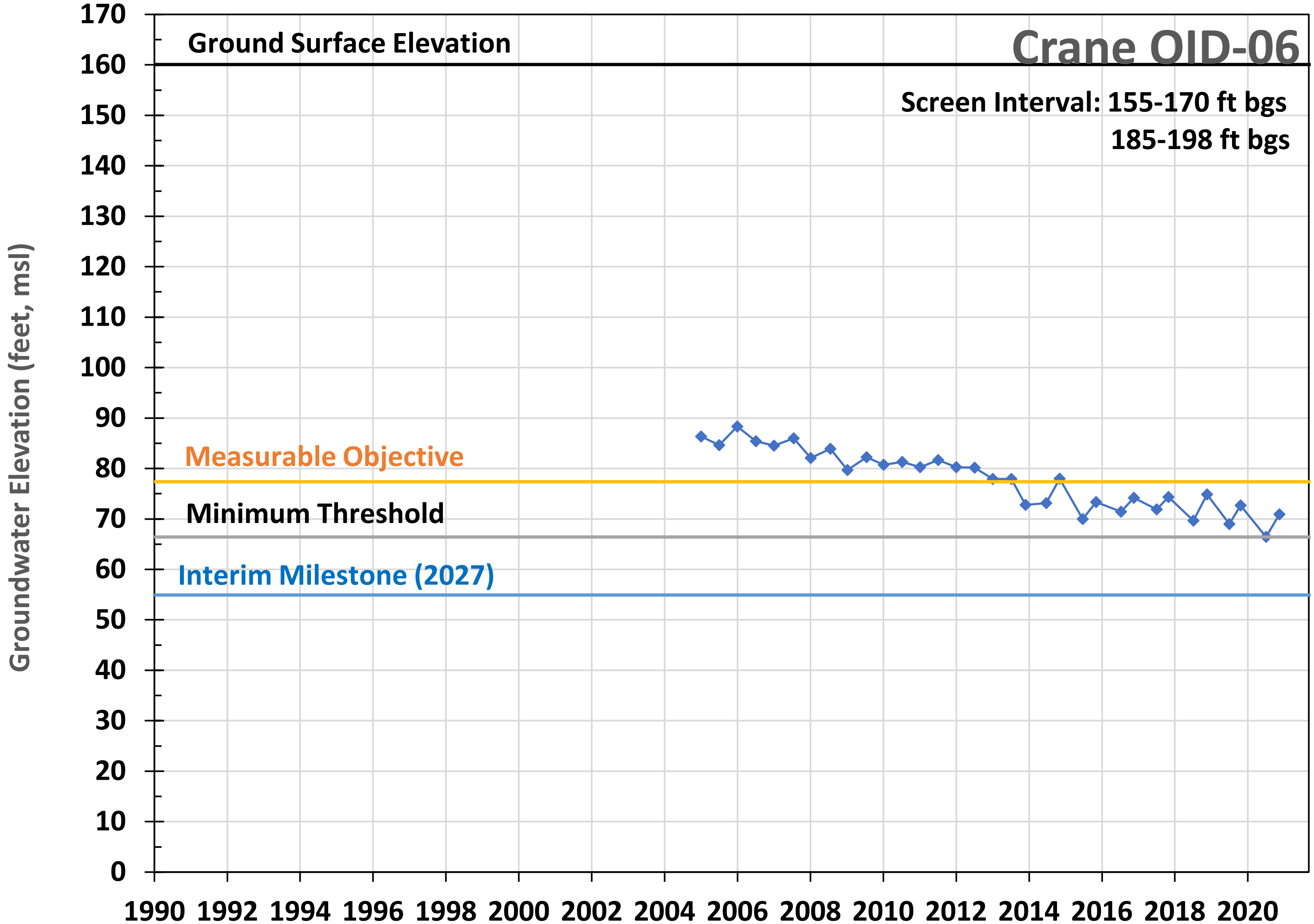
Canfield 90
Screen Interval: 40-75 ft bgs
Ground Surface Elevation
Measurable Objective
Minimum Threshold
Groundwater Elevation (feet, msl)
60
50
40
30
20
10
0
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016
2018
2020



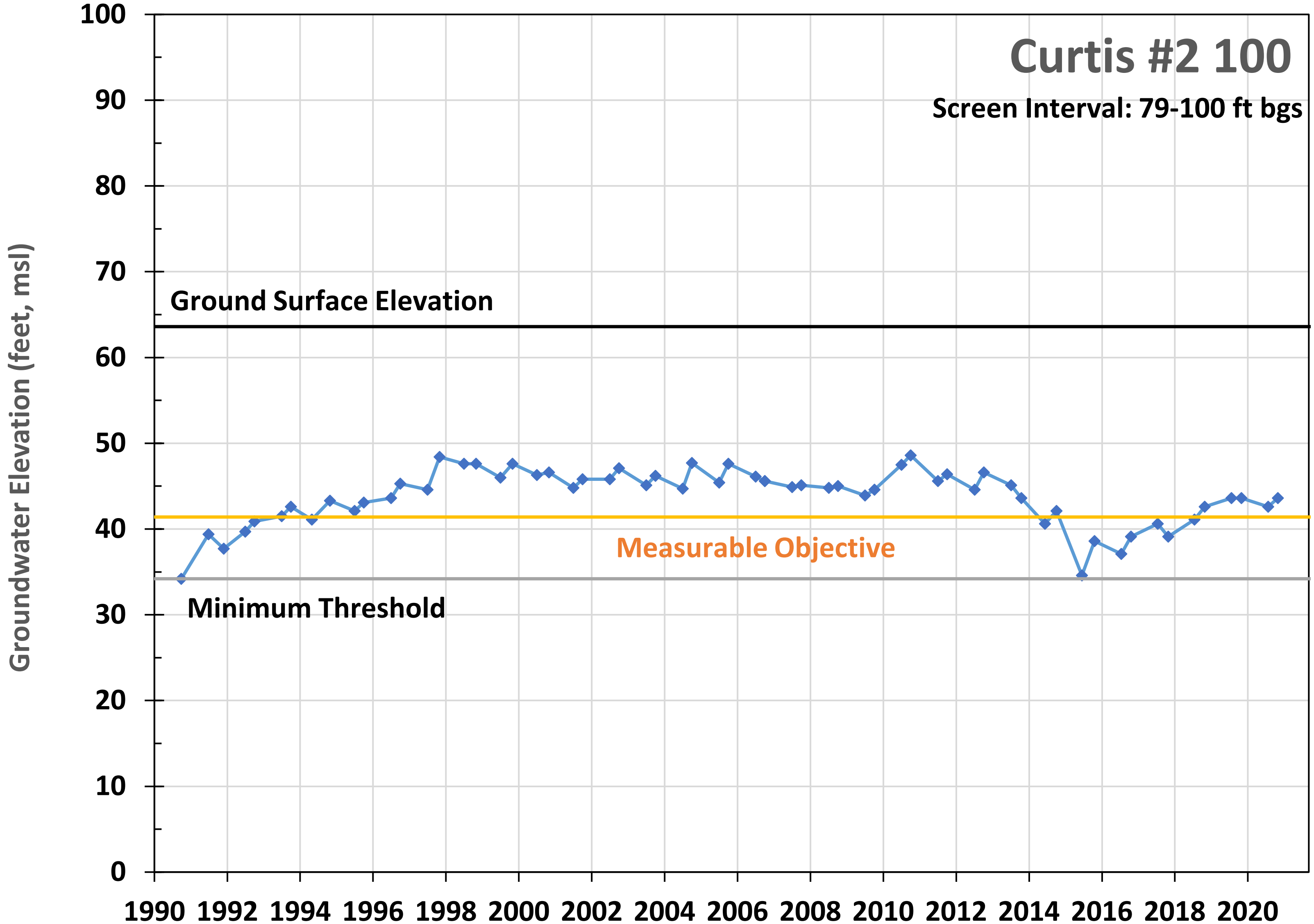
Cavil 214
Screen Interval: 107-275 ft bgs
Ground Surface Elevation
Measurable Objective
Minimum Threshold
Groundwater Elevation (feet, msl)
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016
2018
2020



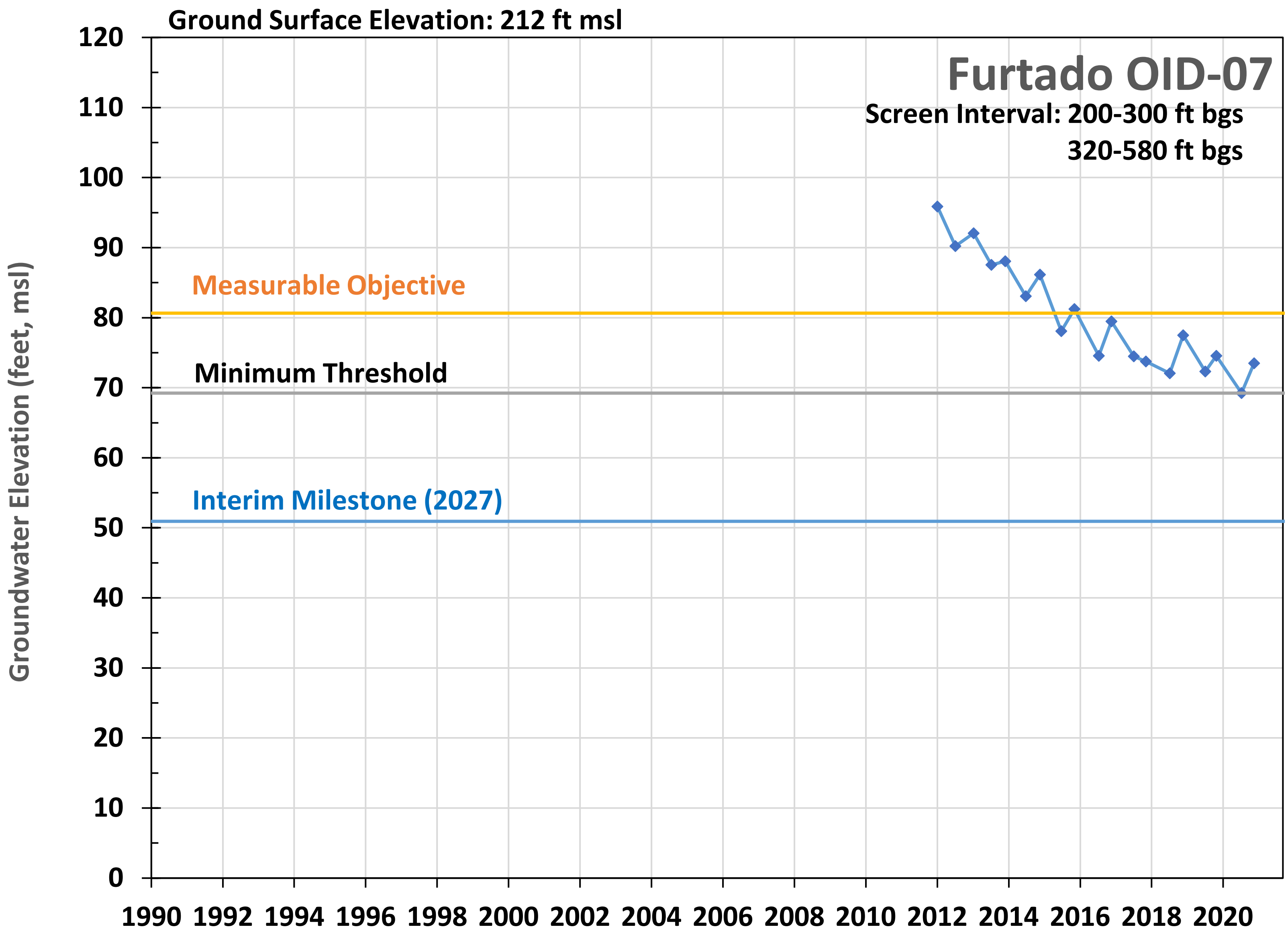
Claribel 206
Screen Interval: 96-550 ft bgs
Ground Surface Elevation
Measurable Objective
Minimum Threshold
Groundwater Elevation (feet, msl)
0
10
20
30
40
50
60
70
80
90
100
110
120
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016
2018
2020

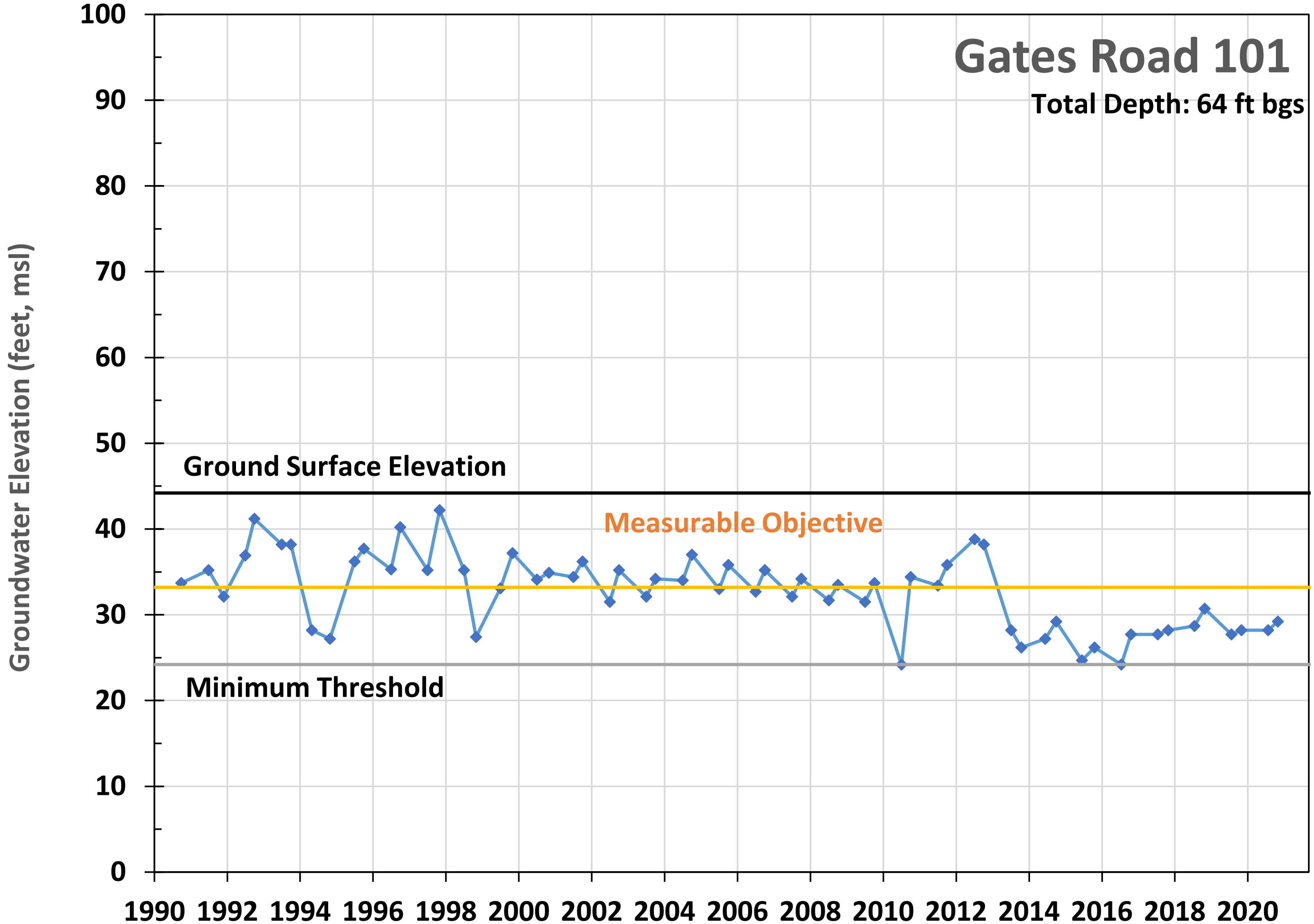


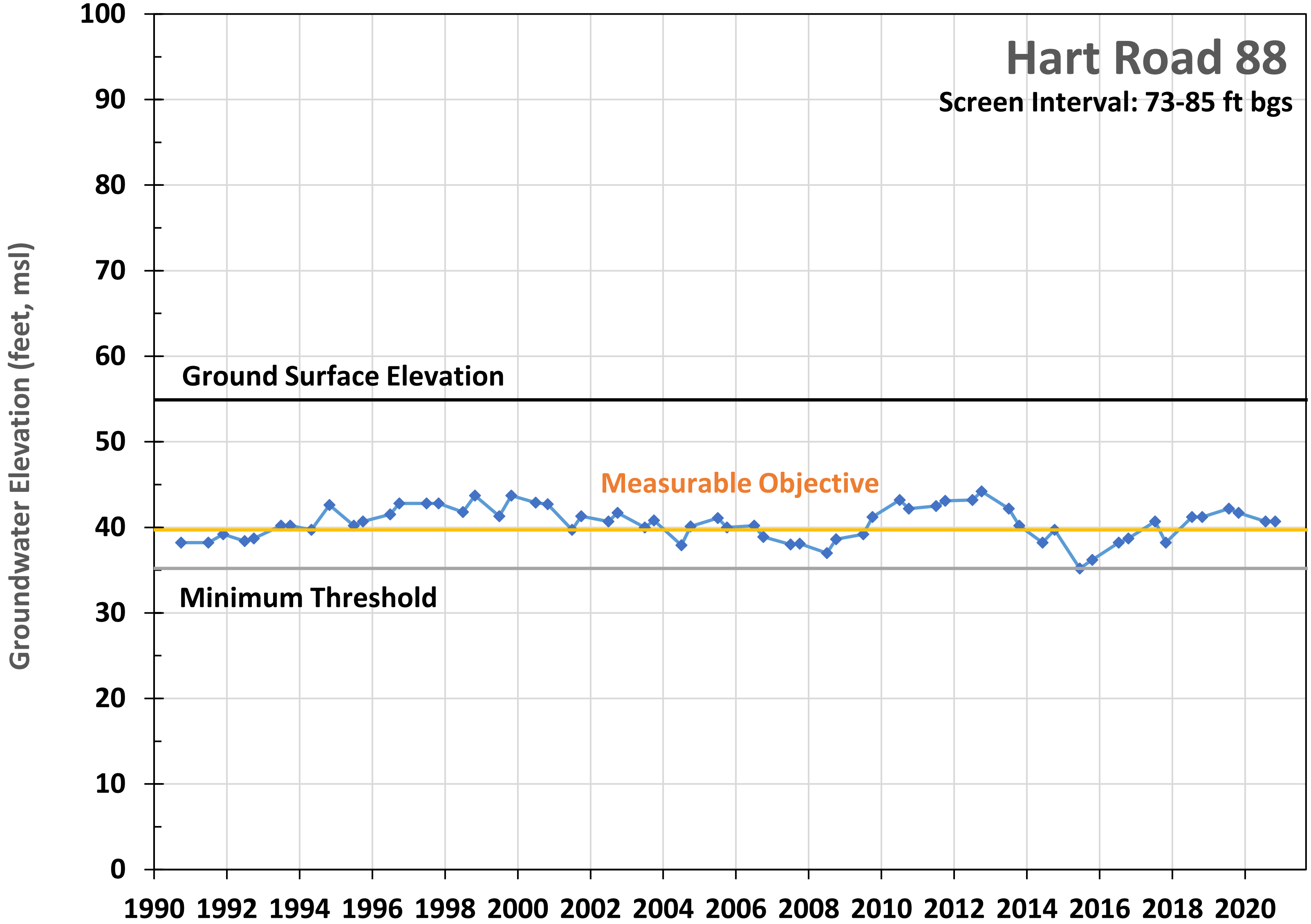
Crane OID-06
Ground Surface Elevation
Screen Interval: 155-170 ft bgs
185-198 ft bgs
Measurable Objective
Minimum Threshold
Interim Milestone (2027)
Groundwater Elevation (feet, msl)
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016
2018
2020

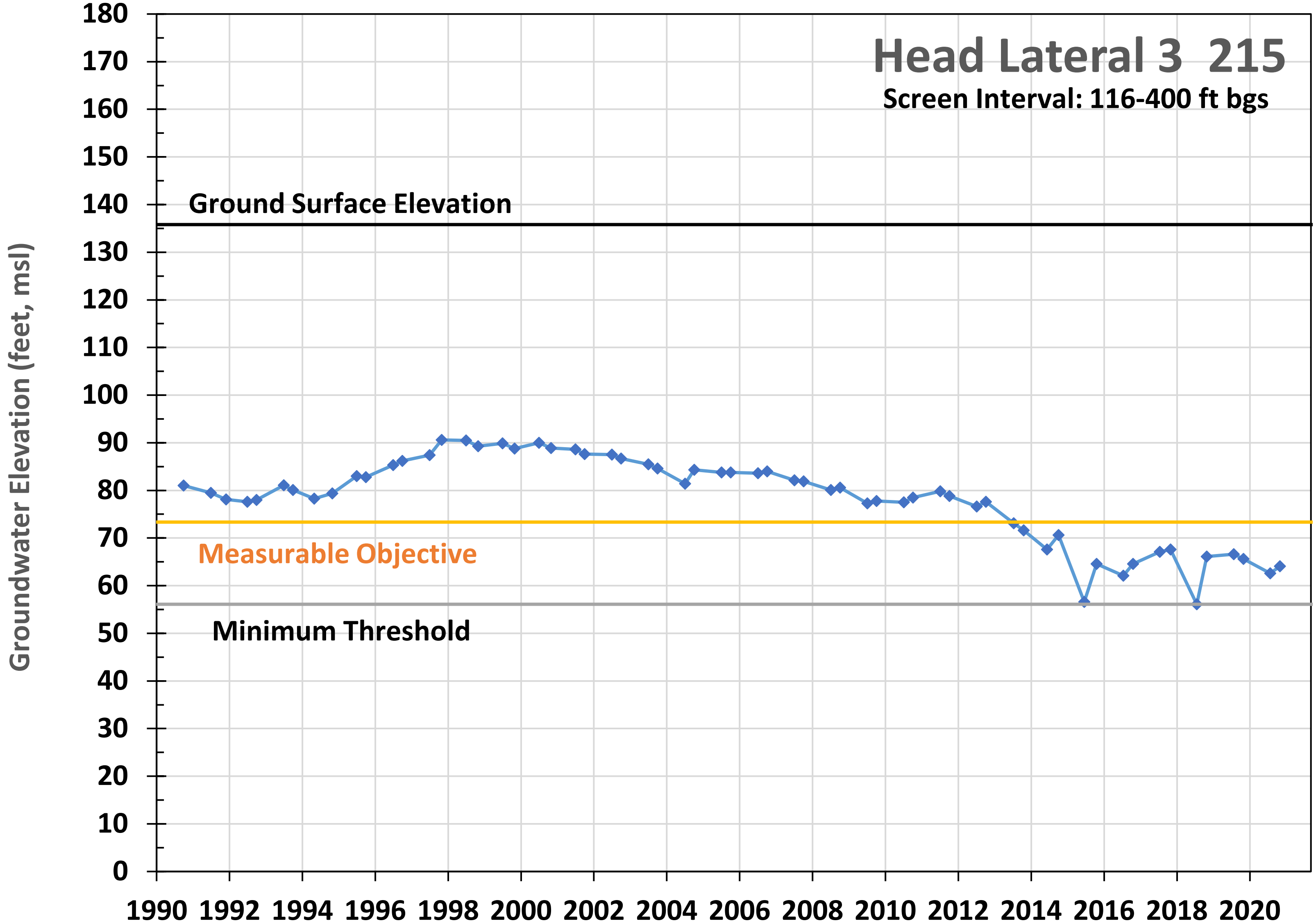


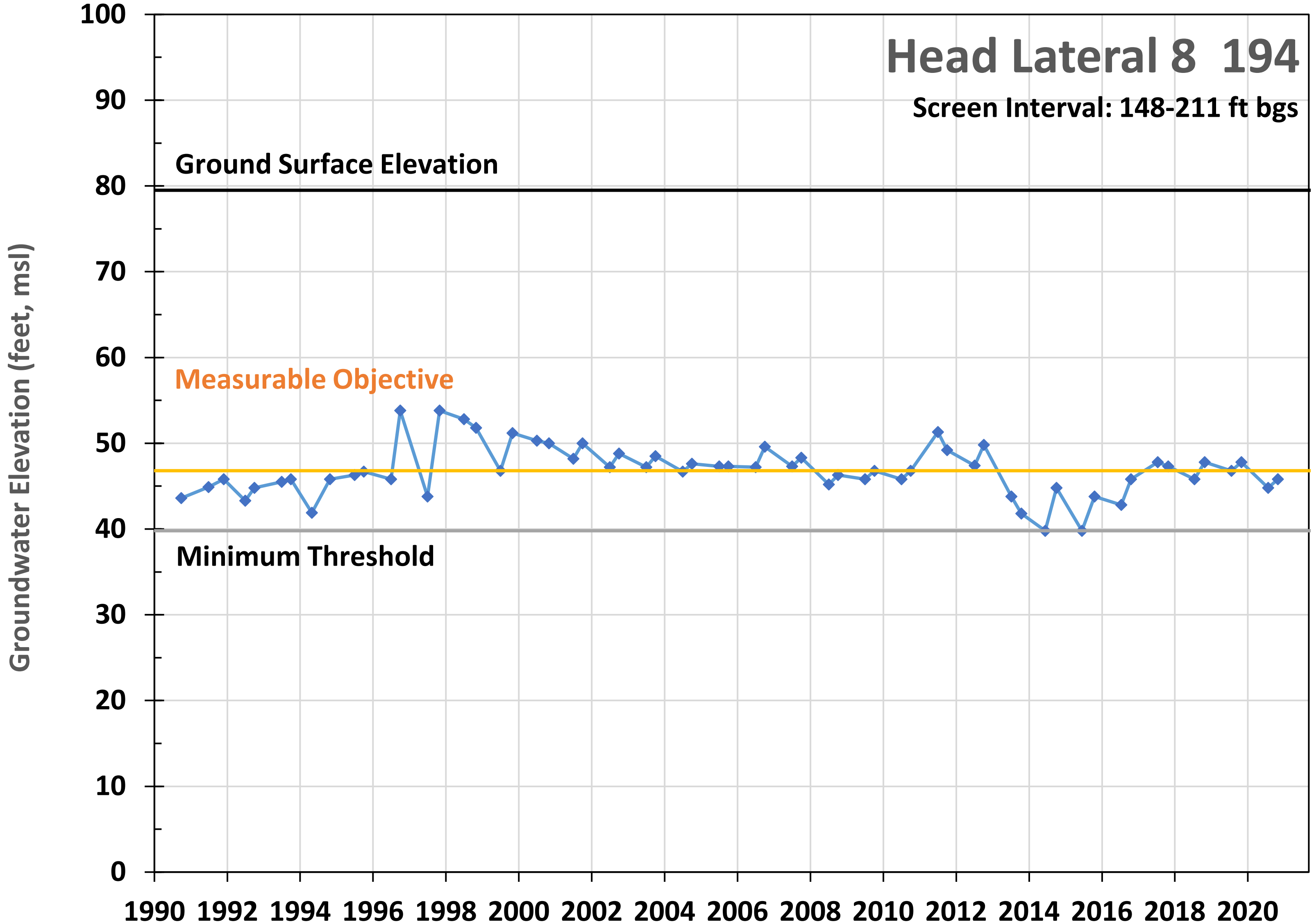
Curtis #2 100
Screen Interval: 79-100 ft bgs
Ground Surface Elevation
Measurable Objective
Minimum Threshold
Groundwater Elevation (feet, msl)
100
90
80
70
60
50
40
30
20
10
0
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016
2018
2020


Ground Surface Elevation: 212 ft msl
Furtado OID-07
Screen Interval: 200-300 ft bgs
320-580 ft bgs
Measurable Objective
Minimum Threshold
Interim Milestone (2027)
Groundwater Elevation (feet, msl)
120
110
100
90
80
70
60
50
40
30
20
10
0
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016
2018
2020

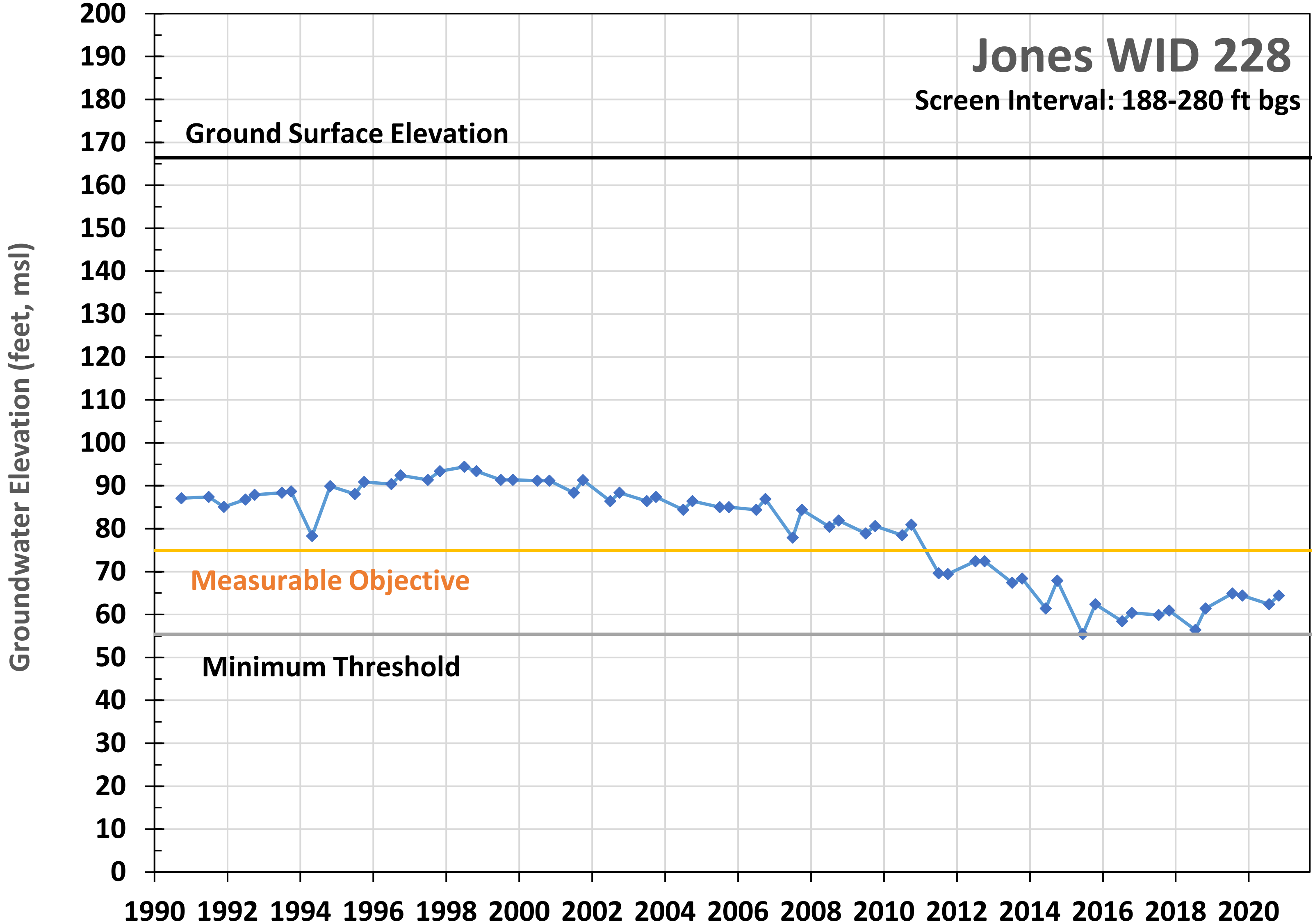

Gates Road 101
Total Depth: 64 ft bgs
Ground Surface Elevation
Measurable Objective
Minimum Threshold
Groundwater Elevation (feet, msl)
0
10
20
30
40
50
60
70
80
90
100
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016
2018
2020


Hart Road 88
Screen Interval: 73-85 ft bgs
Ground Surface Elevation
Measurable Objective
Minimum Threshold
Groundwater Elevation (feet, msl)
100
90
80
70
60
50
40
30
20
10
0
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016
2018
2020

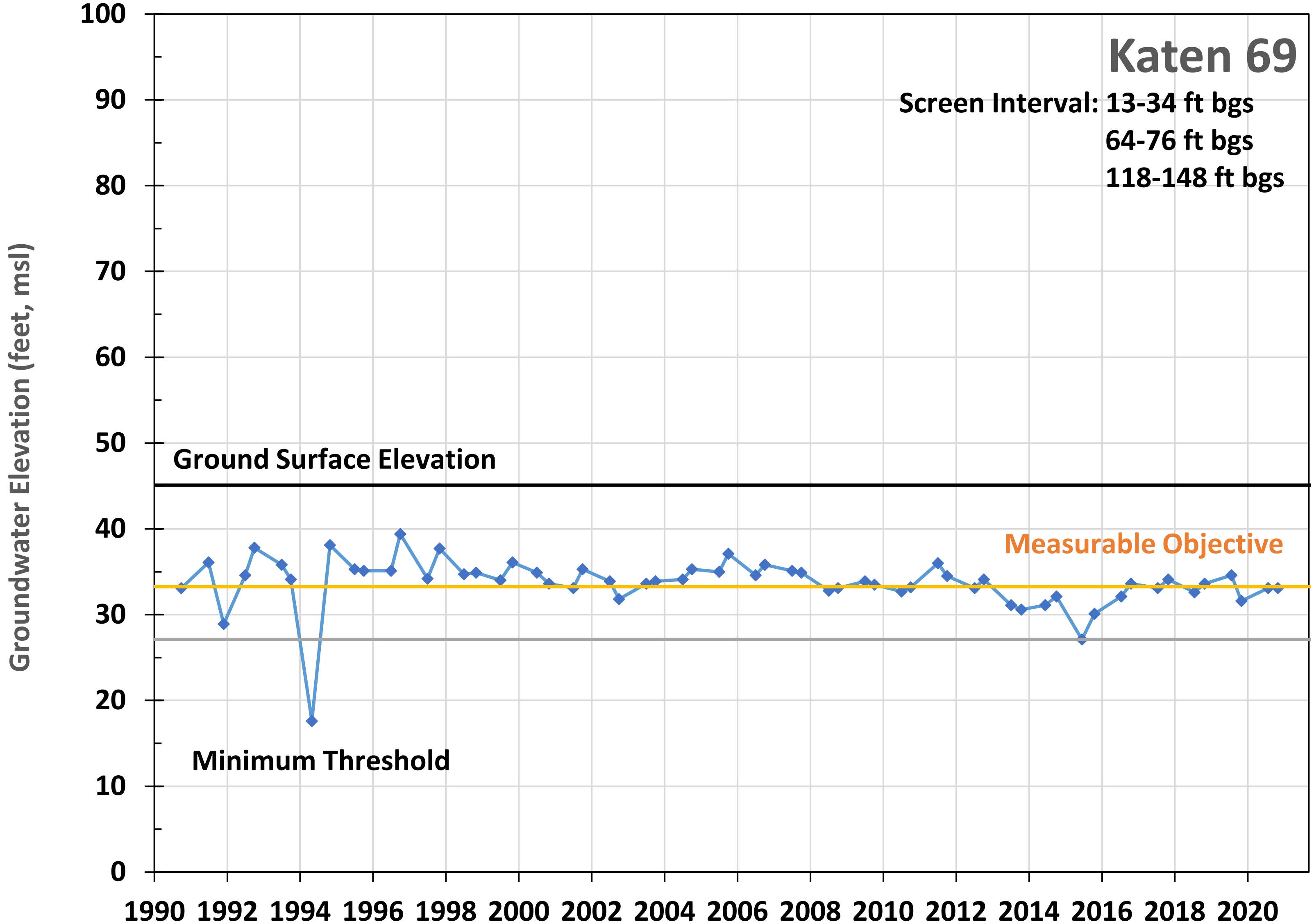

Head Lateral 3 215
Screen Interval: 116-400 ft bgs
Ground Surface Elevation
Measurable Objective
Minimum Threshold
Groundwater Elevation (feet, msl)
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016
2018
2020



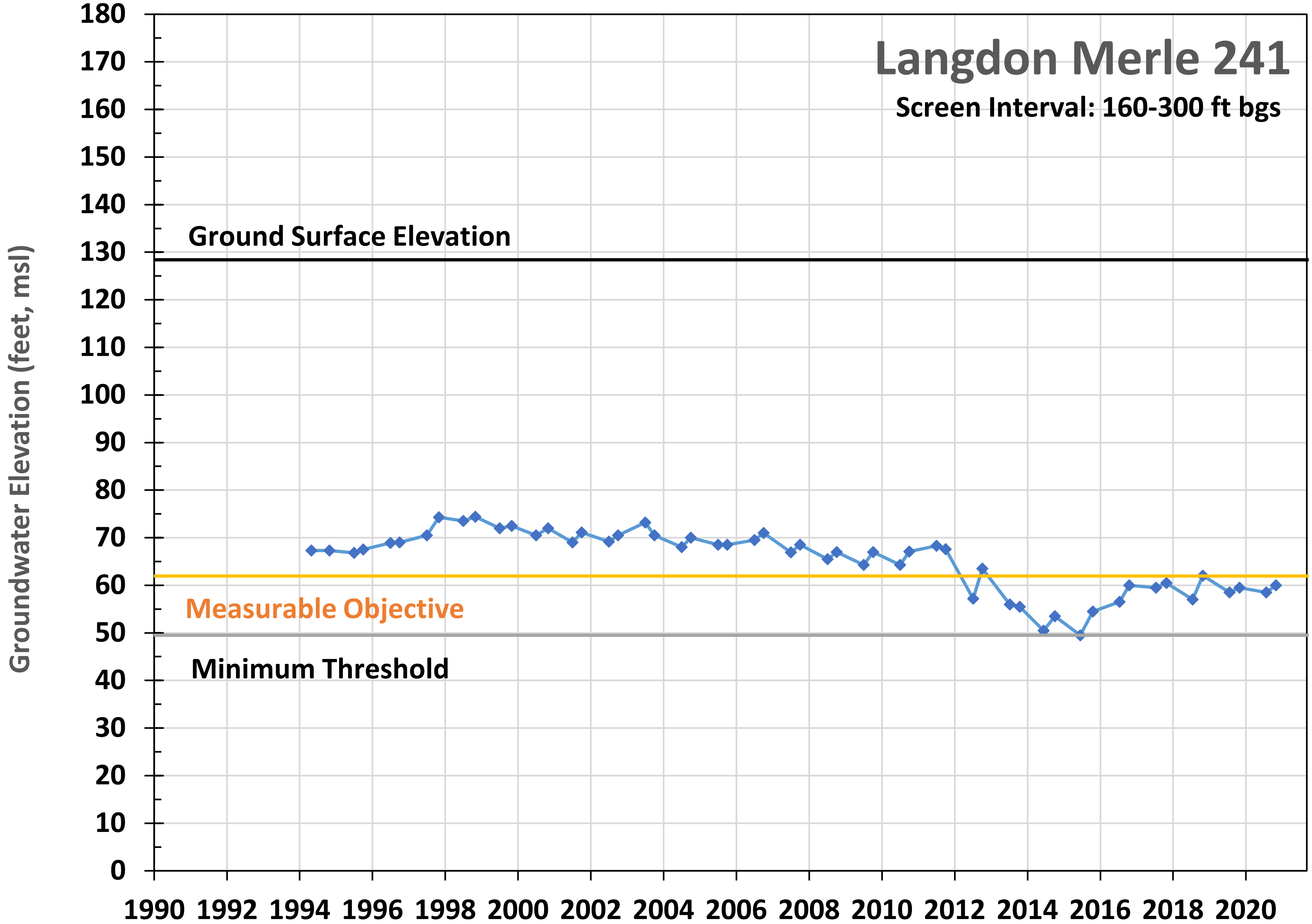
Head Lateral 8 194
Screen Interval: 148-211 ft bgs
Ground Surface Elevation
Measurable Objective
Minimum Threshold
Groundwater Elevation (feet, msl)
100
90
80
70
60
50
40
30
20
10
0
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016
2018
2020



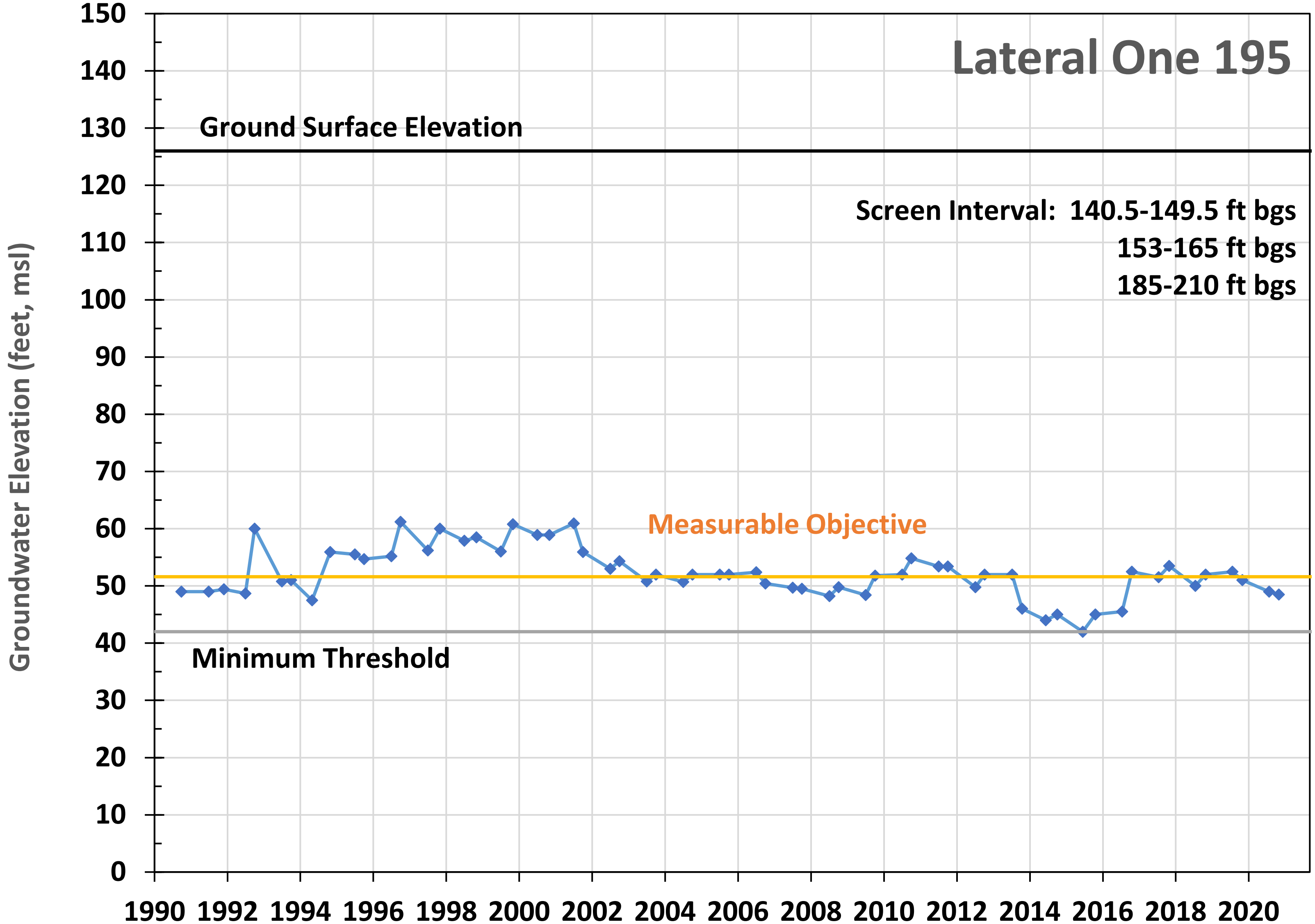
Jones WID 228
Screen Interval: 188-280 ft bgs
Ground Surface Elevation
Measurable Objective
Minimum Threshold
Groundwater Elevation (feet, msl)
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016
2018
2020



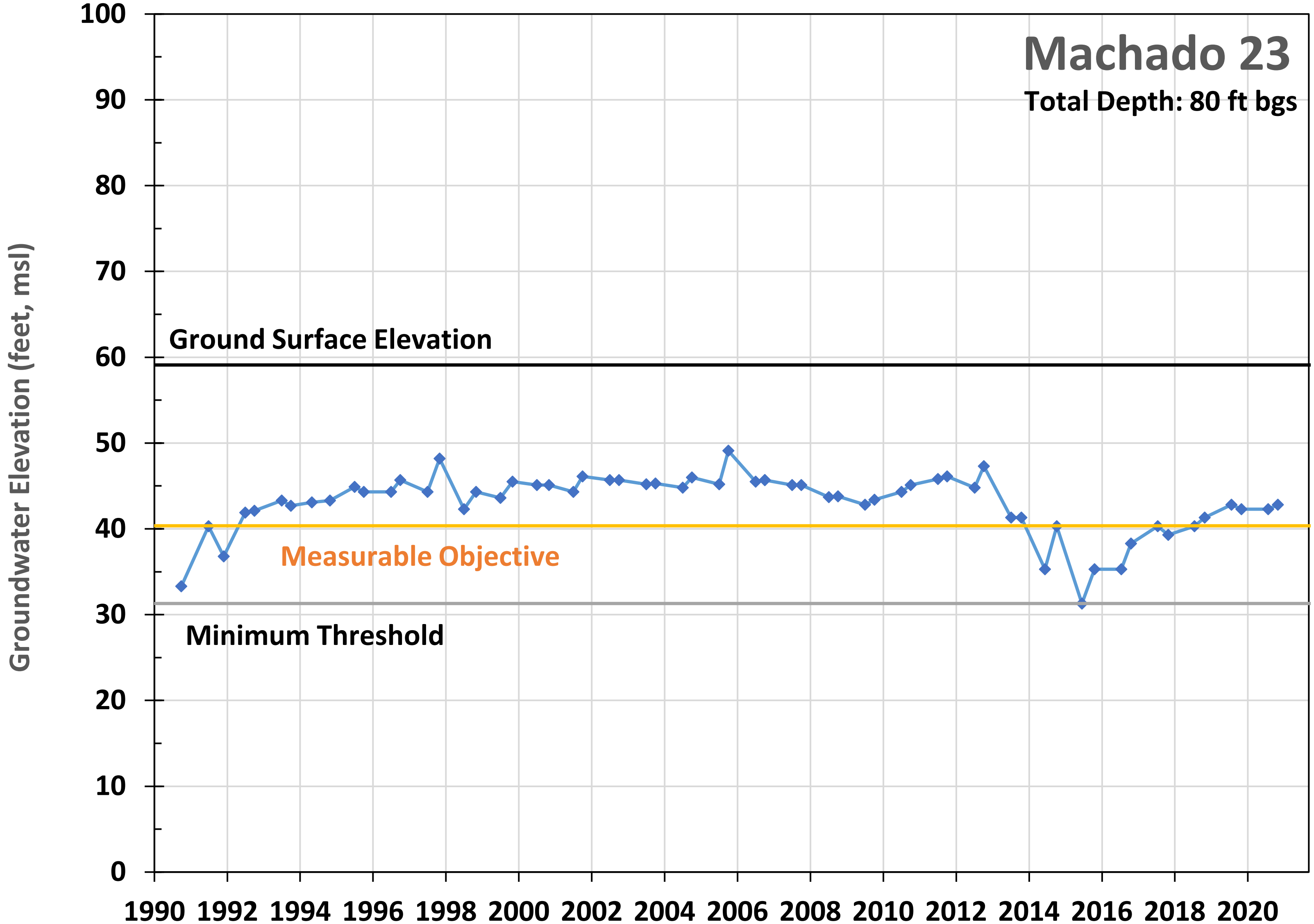
Katen 69
Screen Interval: 13-34 ft bgs
64-76 ft bgs
118-148 ft bgs
Ground Surface Elevation
Measurable Objective
Minimum Threshold
Groundwater Elevation (feet, msl)
100
90
80
70
60
50
40
30
20
10
0
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016
2018
2020

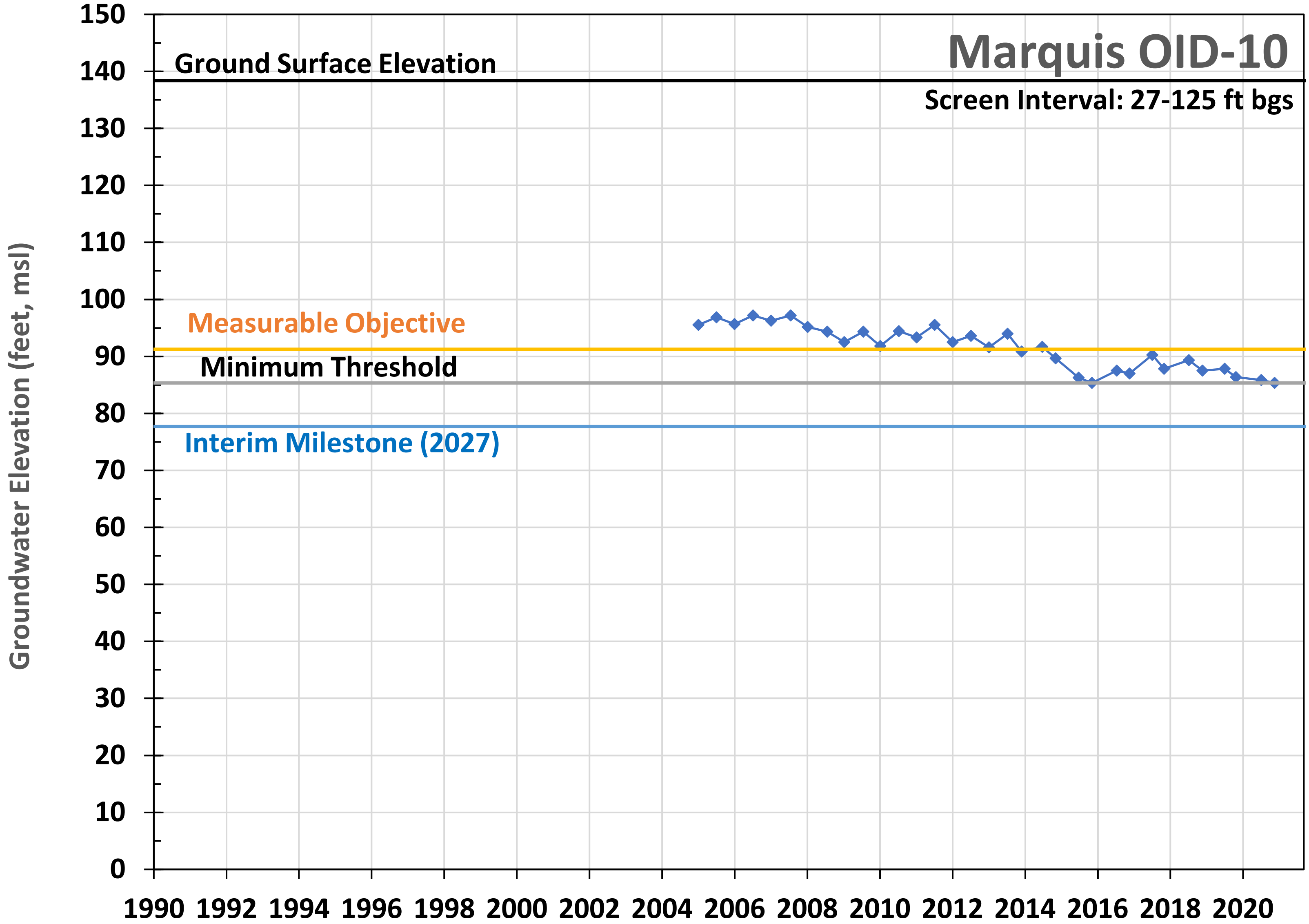


Langdon Merle 241
Screen Interval: 160-300 ft bgs
Ground Surface Elevation
Measurable Objective
Minimum Threshold
Groundwater Elevation (feet, msl)
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016
2018
2020

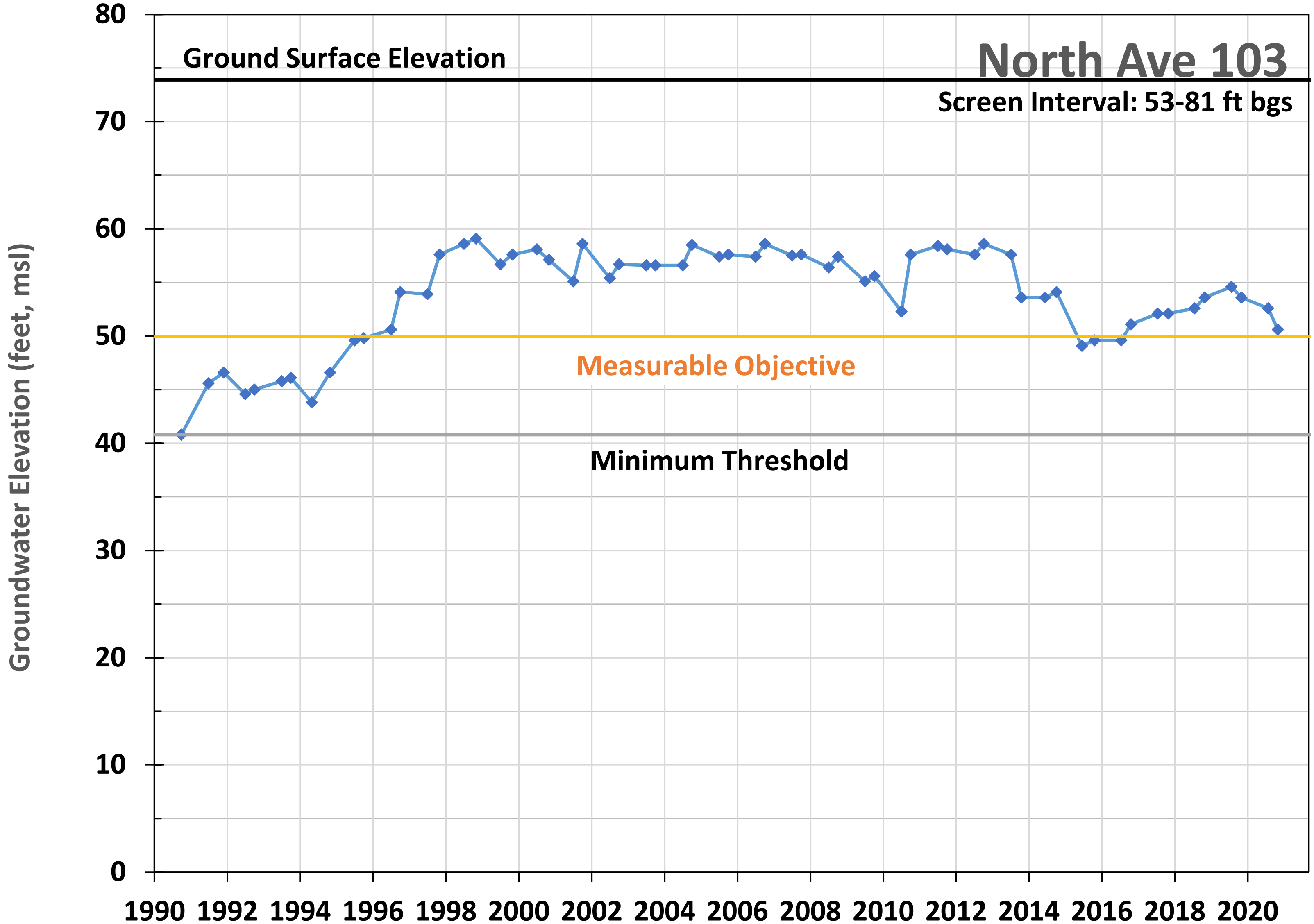


Lateral One 195
Ground Surface Elevation
Screen Interval: 140.5-149.5 ft bgs
153-165 ft bgs
185-210 ft bgs
Measurable Objective
Minimum Threshold
Groundwater Elevation (feet, msl)
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
1990 1992 1994 1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020

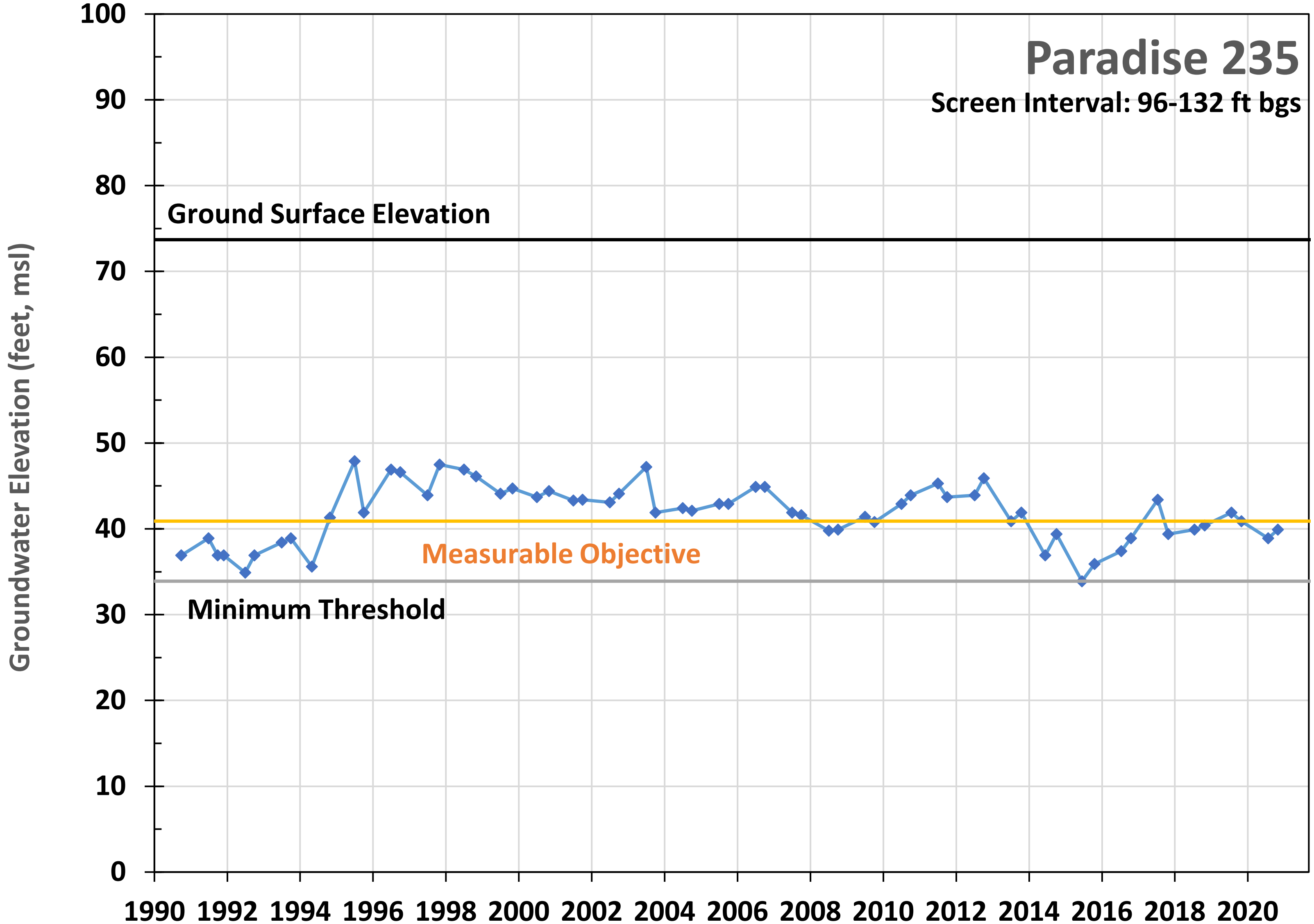

Machado 23
Total Depth: 80 ft bgs
Groundwater Elevation (feet, msl)
Ground Surface Elevation
Measurable Objective
Minimum Threshold
100
90
80
70
60
50
40
30
20
10
0
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016
2018
2020

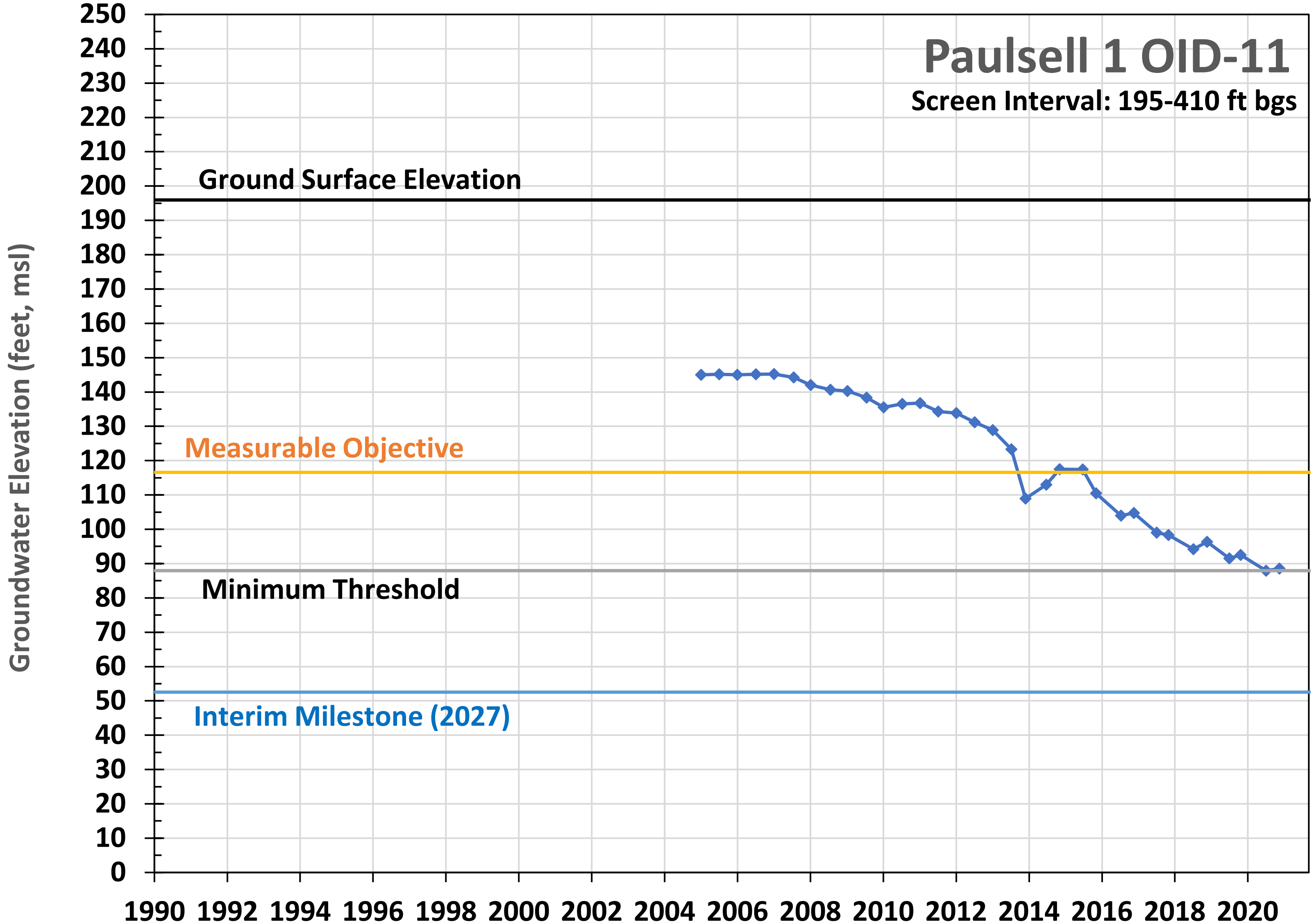


Marquis OID-10
Screen Interval: 27-125 ft bgs
Ground Surface Elevation
Measurable Objective
Minimum Threshold
Interim Milestone (2027)
Groundwater Elevation (feet, msl)
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016
2018
2020

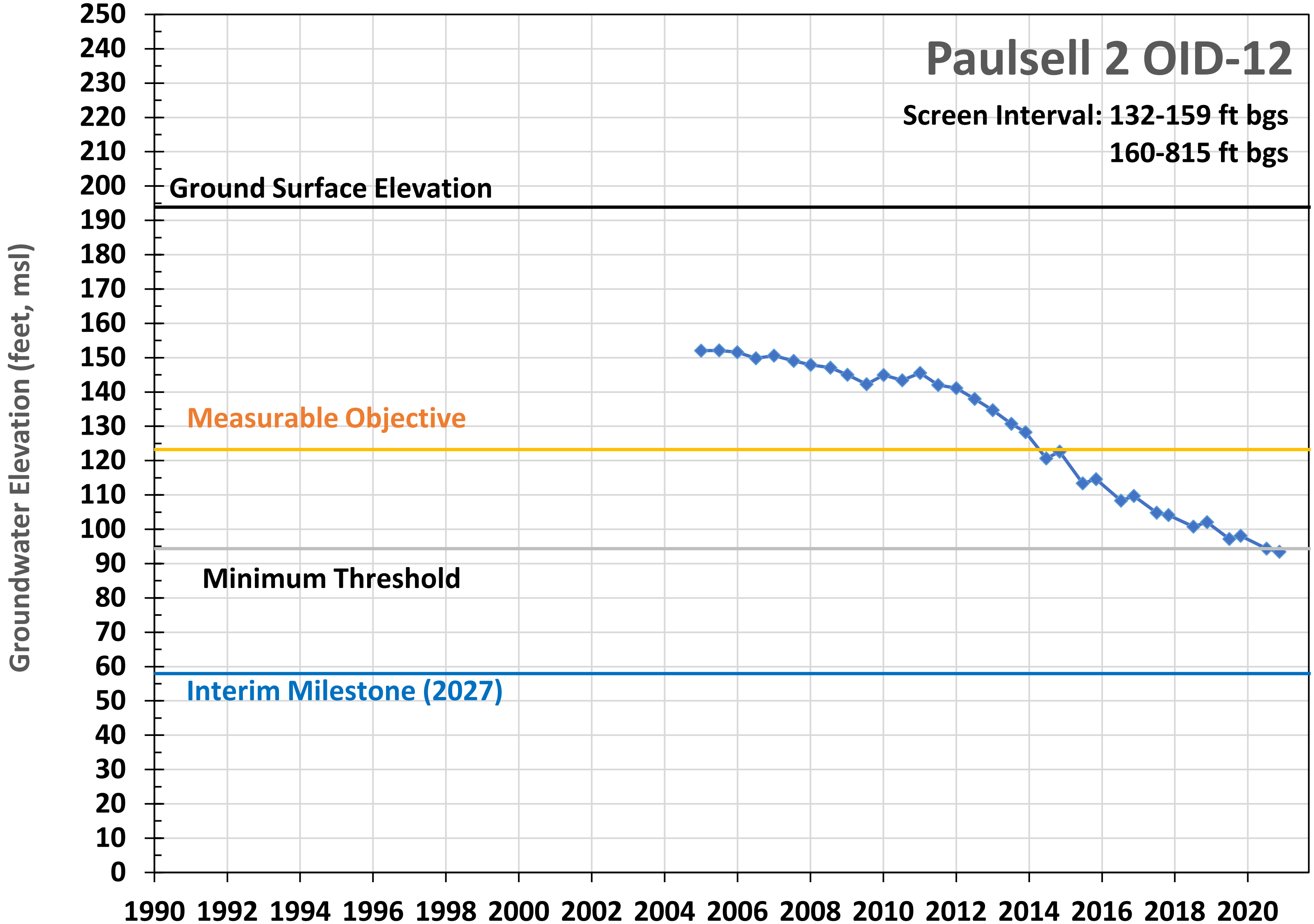


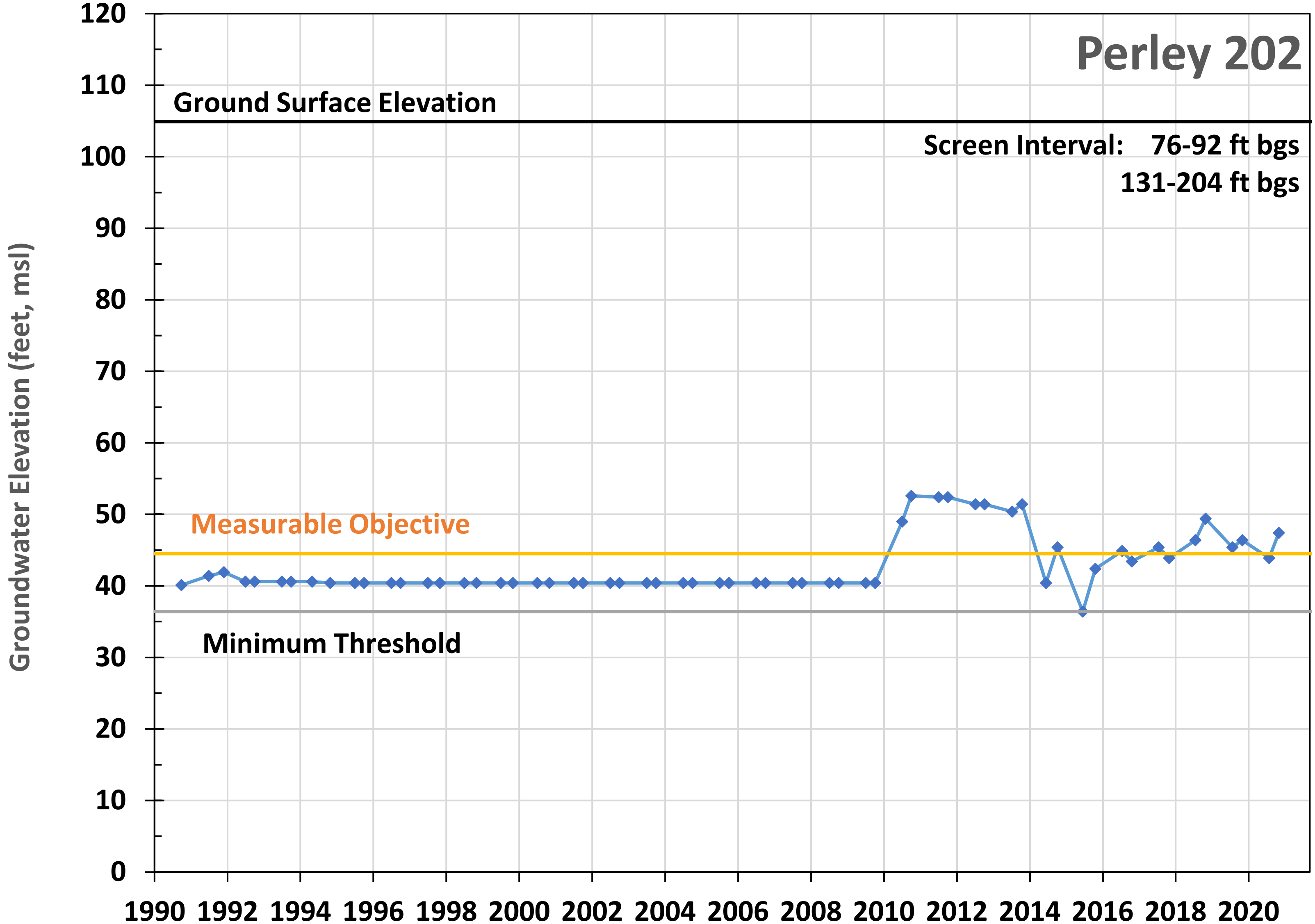
North Ave 103
Screen Interval: 53-81 ft bgs
Ground Surface Elevation
Measurable Objective
Minimum Threshold
Groundwater Elevation (feet, msl)
80
70
60
50
40
30
20
10
0
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016
2018
2020


Paradise 235
Screen Interval: 96-132 ft bgs
Ground Surface Elevation
Measurable Objective
Minimum Threshold
Groundwater Elevation (feet, msl)
100
90
80
70
60
50
40
30
20
10
0
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016
2018
2020

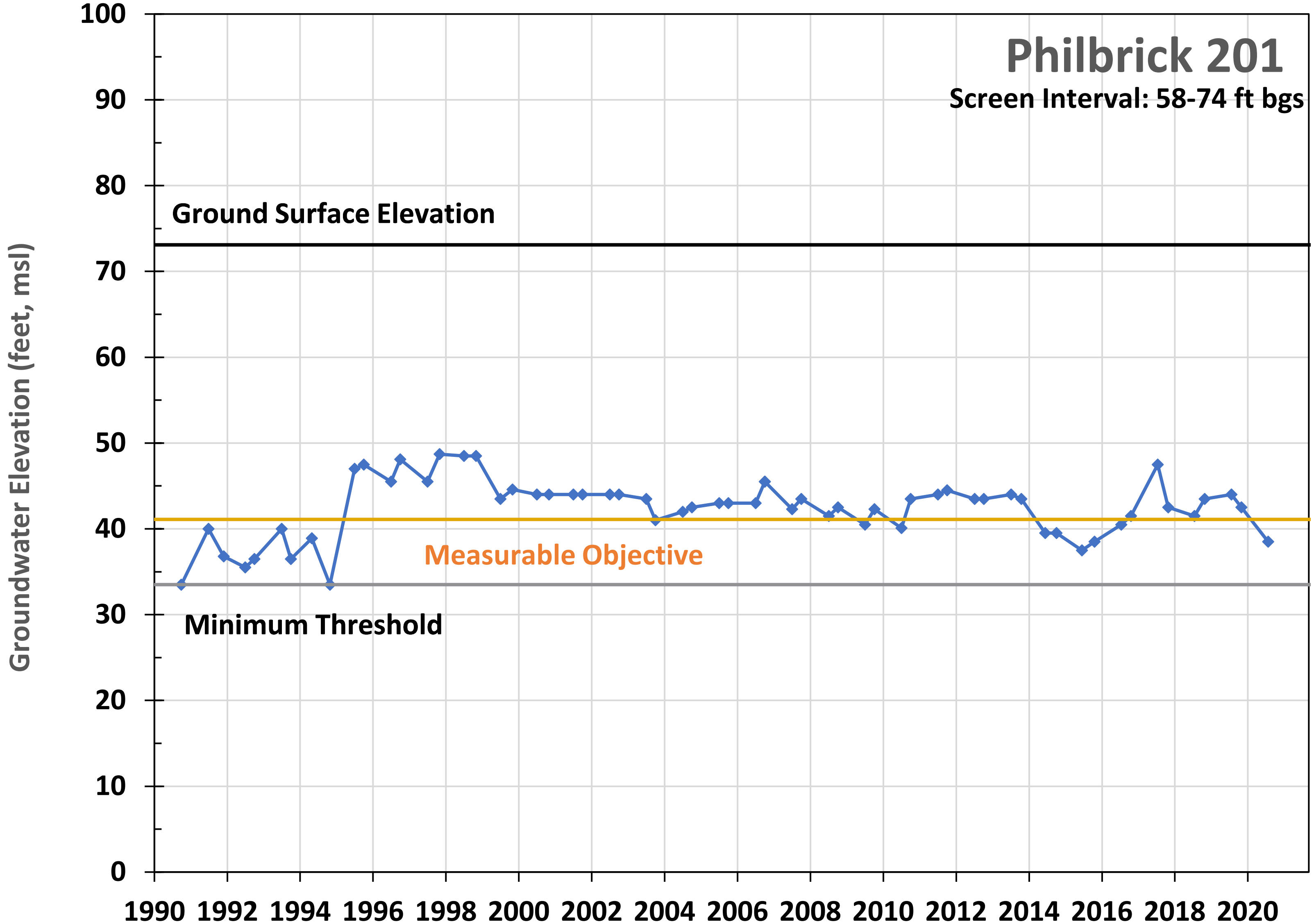


Paulsell 1 OID-11
Screen Interval: 195-410 ft bgs
Ground Surface Elevation
Measurable Objective
Minimum Threshold
Interim Milestone (2027)
Groundwater Elevation (feet, msl)
250
240
230
220
210
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016
2018
2020

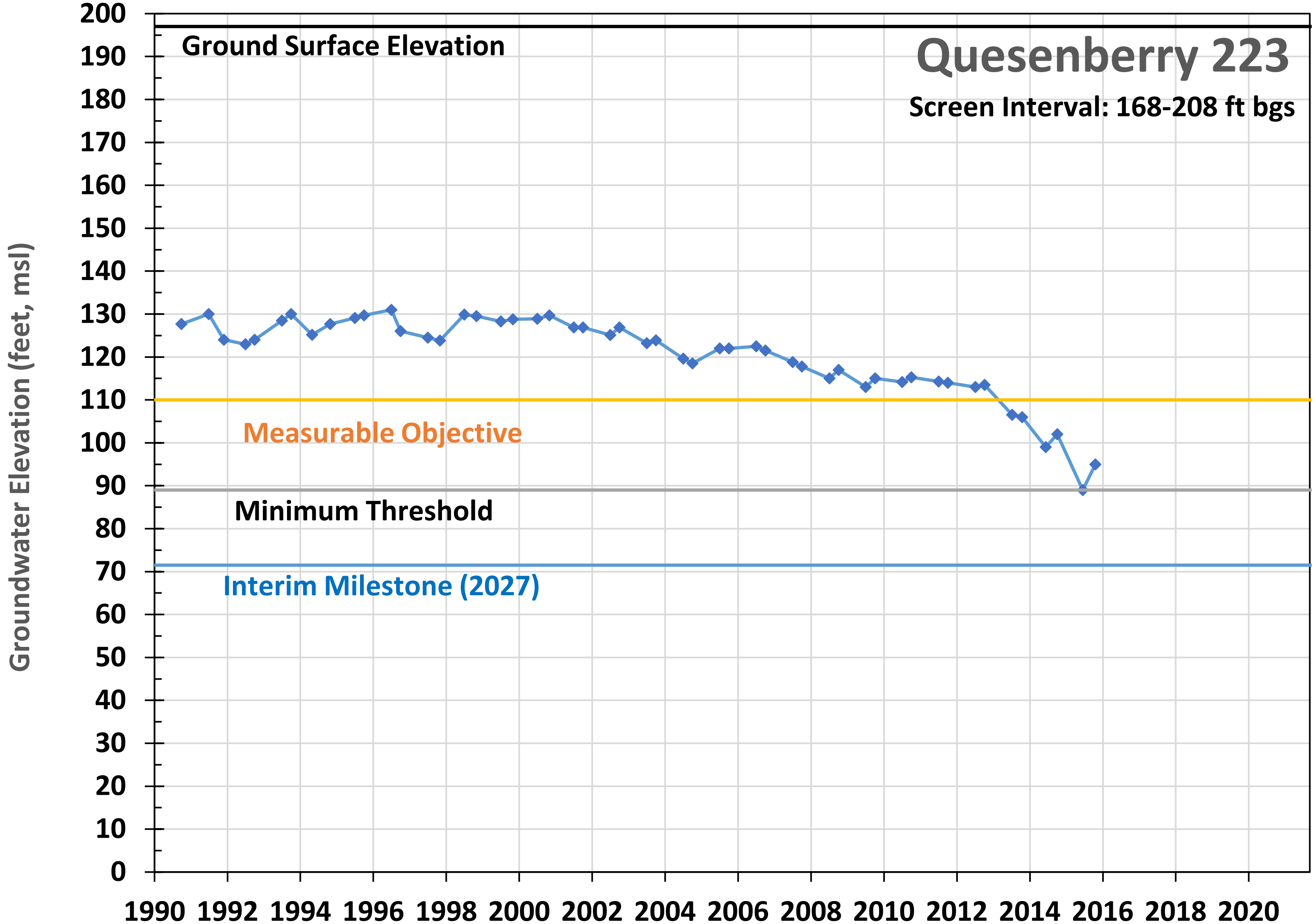

Paulsell 2 OID-12
Screen Interval: 132-159 ft bgs
160-815 ft bgs
Ground Surface Elevation
Measurable Objective
Minimum Threshold
Interim Milestone (2027)
Groundwater Elevation (feet, msl)
0
10
20
30
40
50
60
70
80
90
100
110
120
130
140
150
160
170
180
190
200
210
220
230
240
250
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016
2018
2020

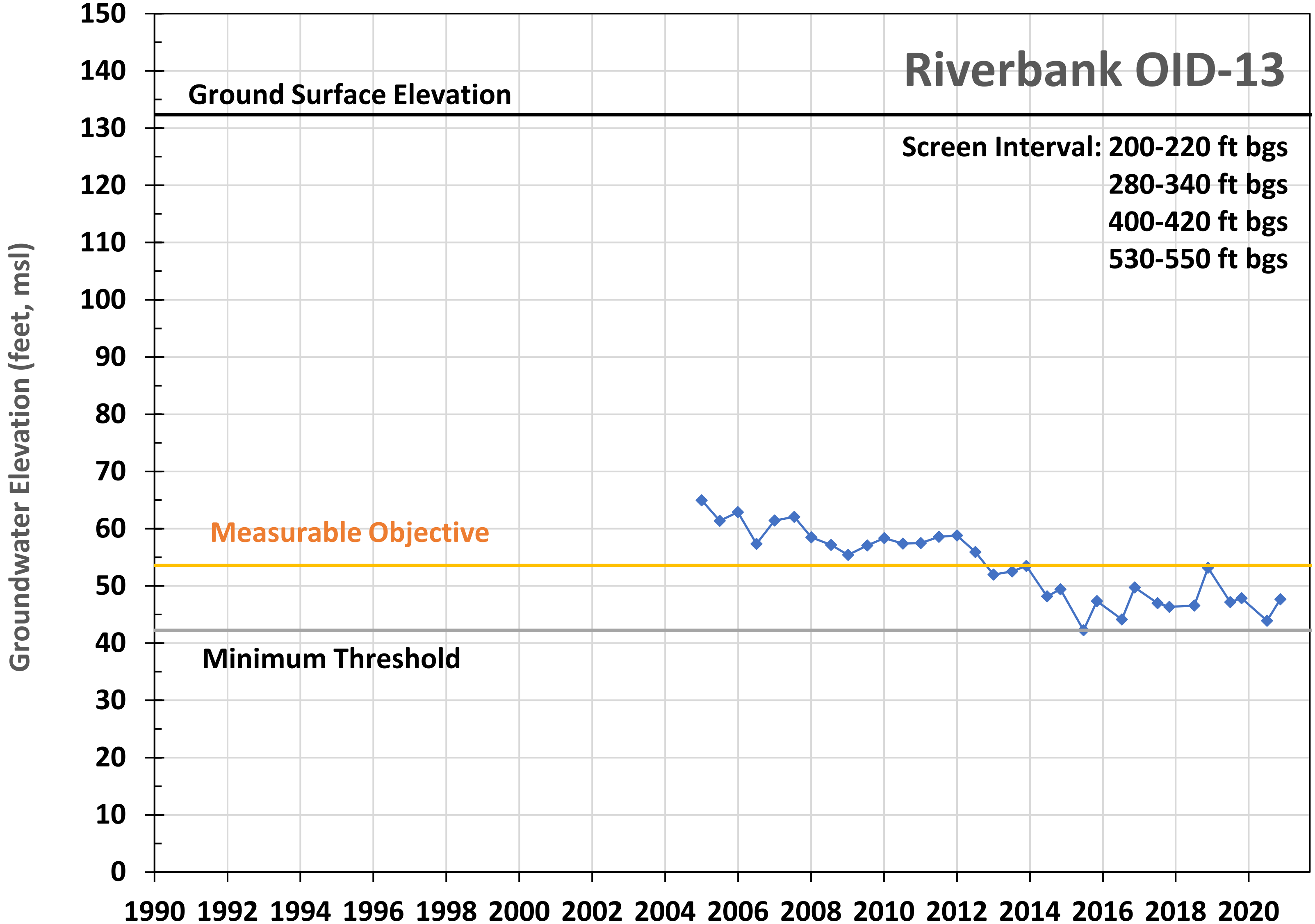


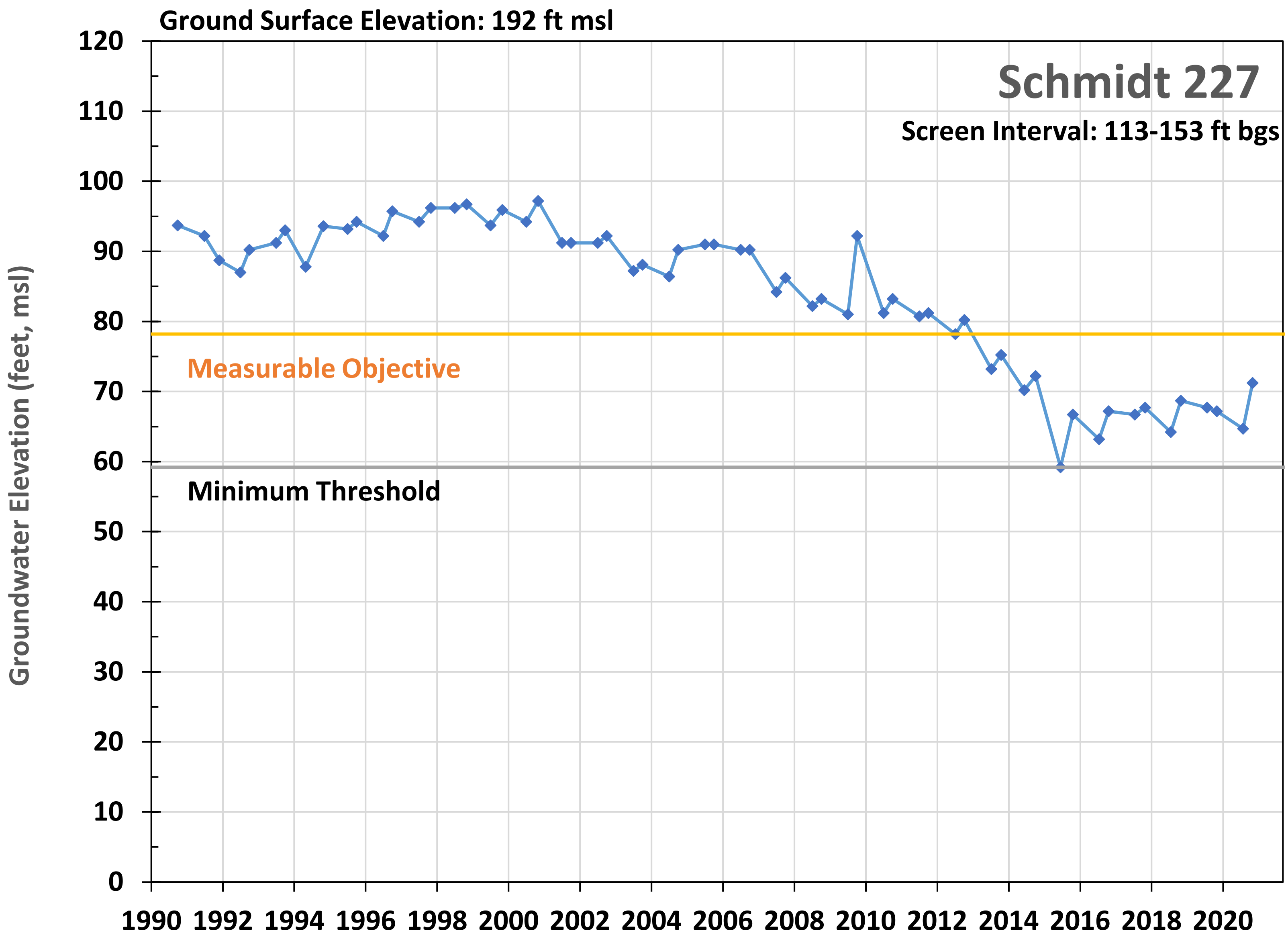
Perley 202
Ground Surface Elevation
Screen Interval: 76-92 ft bgs
131-204 ft bgs
Measurable Objective
Minimum Threshold
Groundwater Elevation (feet, msl)
0
10
20
30
40
50
60
70
80
90
100
110
120
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016
2018
2020

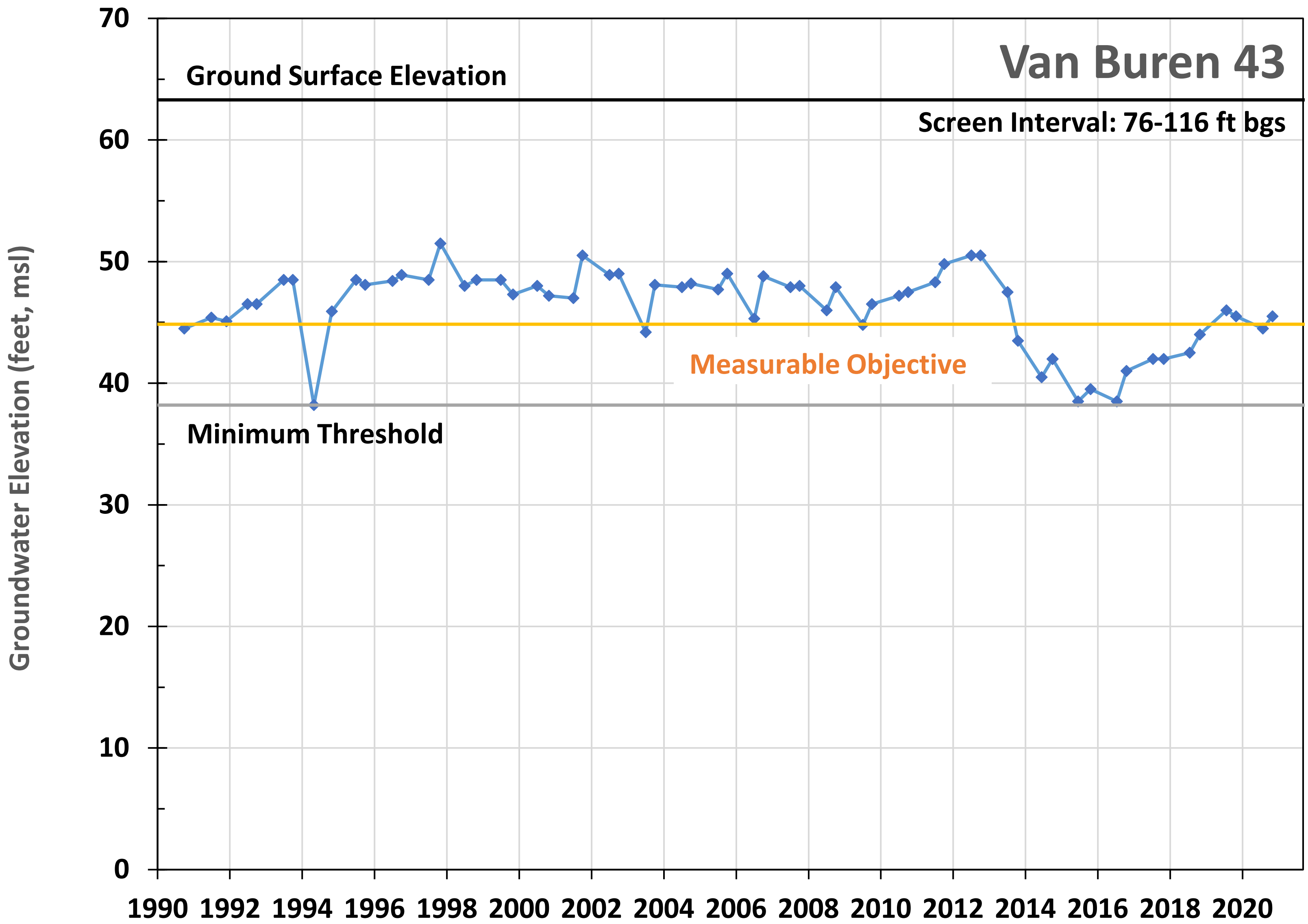


Philbrick 201
Screen Interval: 58-74 ft bgs
Groundwater Elevation (feet, msl)
Ground Surface Elevation
Measurable Objective
Minimum Threshold
100
90
80
70
60
50
40
30
20
10
0
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016
2018
2020

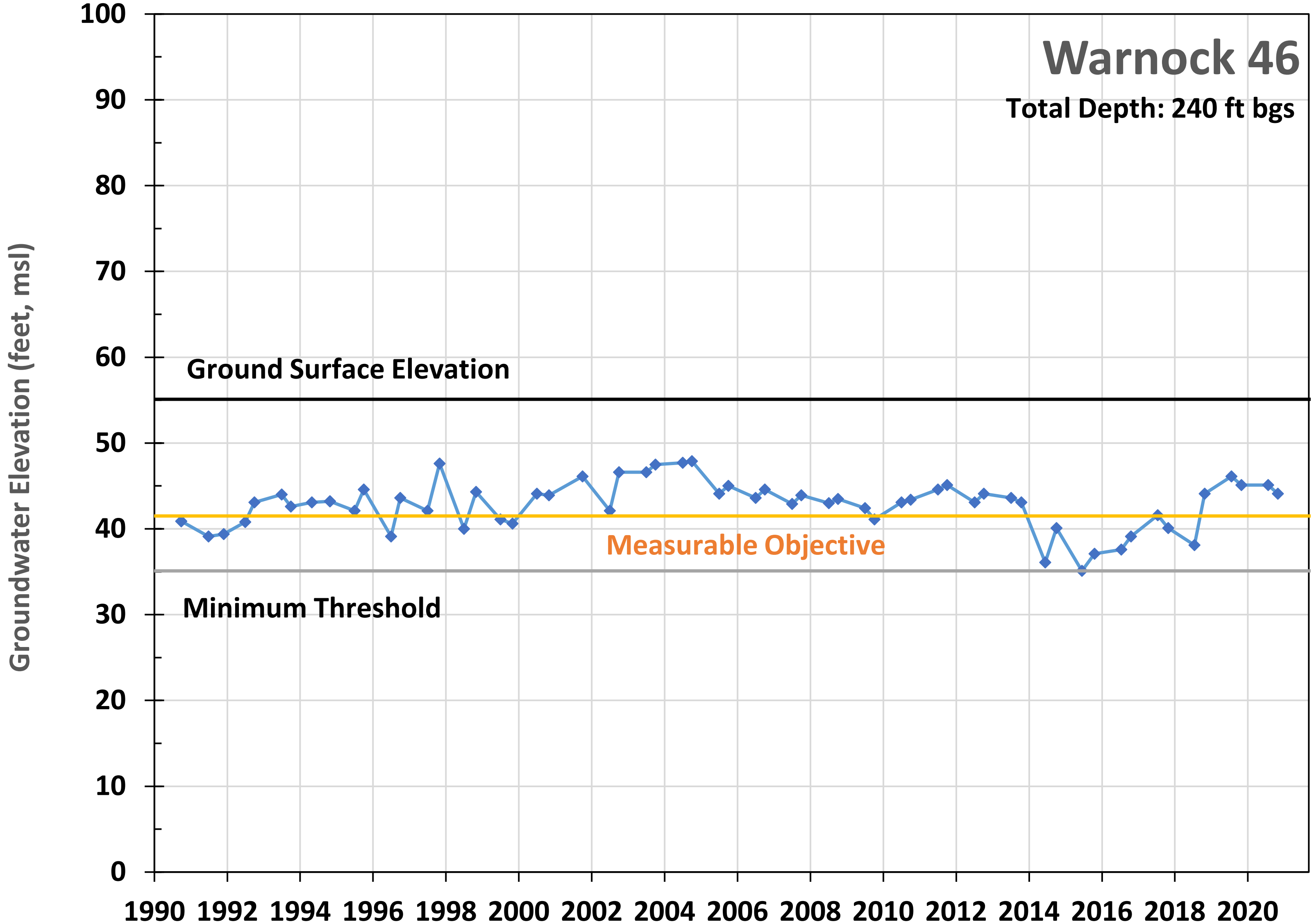

Quesenberry 223
Screen Interval: 168-208 ft bgs
Ground Surface Elevation
Measurable Objective
Minimum Threshold
Interim Milestone (2027)
Groundwater Elevation (feet, msl)
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
1990 1992 1994 1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020

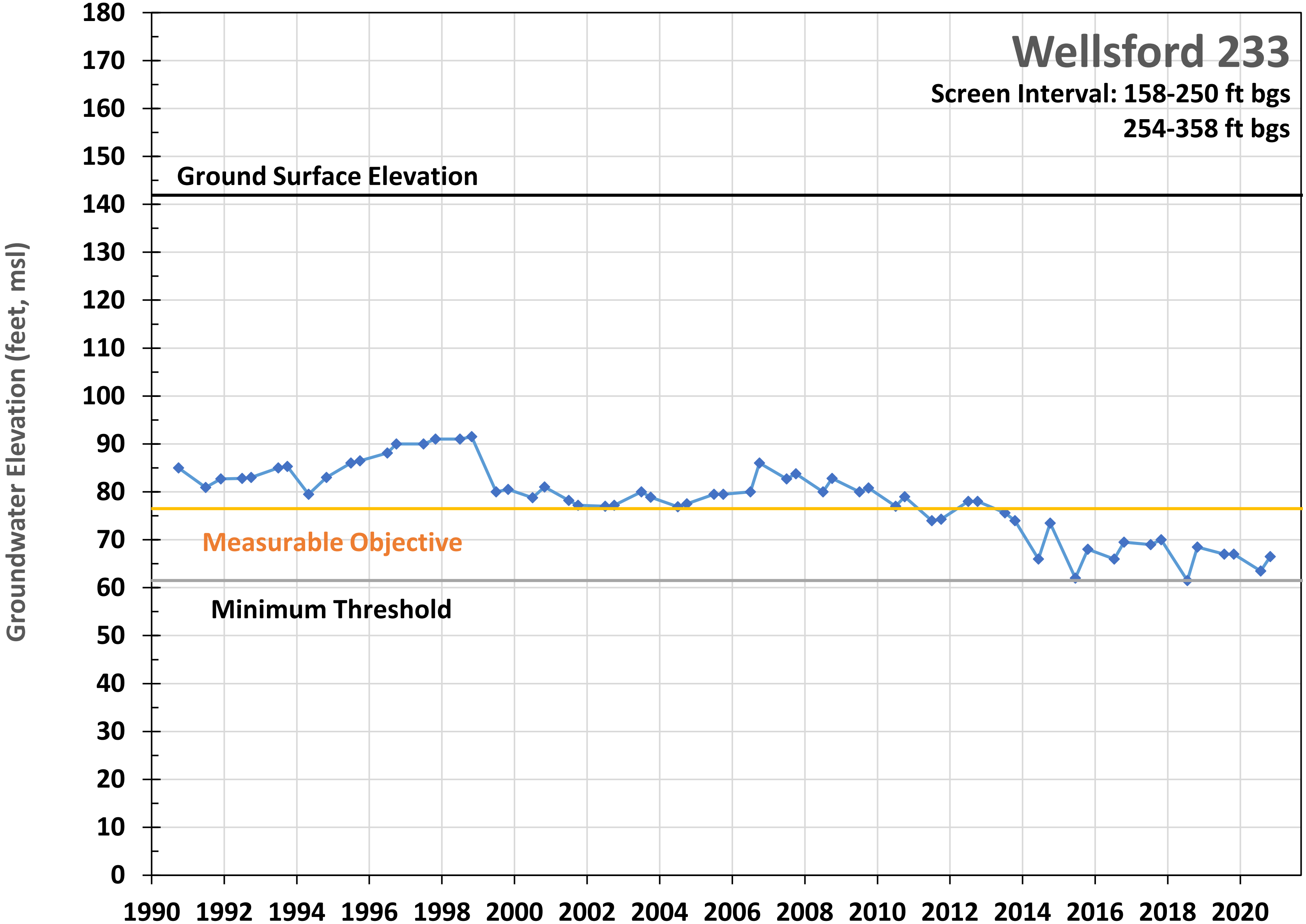

Riverbank OID-13
Ground Surface Elevation
Screen Interval: 200-220 ft bgs
280-340 ft bgs
400-420 ft bgs
530-550 ft bgs
Measurable Objective
Minimum Threshold
Groundwater Elevation (feet, msl)
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016
2018
2020


Ground Surface Elevation: 192 ft msl
Schmidt 227
Screen Interval: 113-153 ft bgs
Measurable Objective
Minimum Threshold
Groundwater Elevation (feet, msl)
120
110
100
90
80
70
60
50
40
30
20
10
0
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016
2018
2020

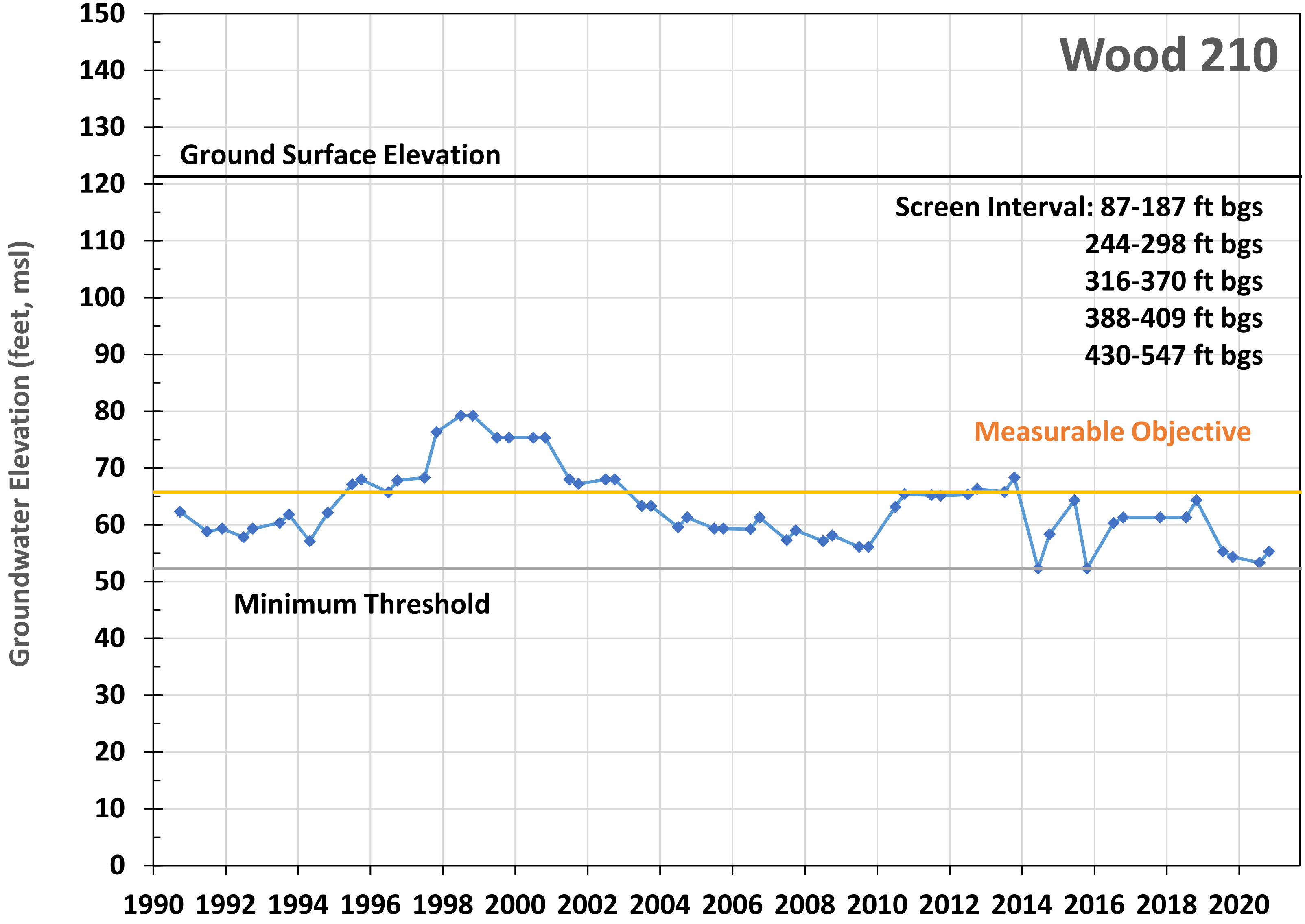


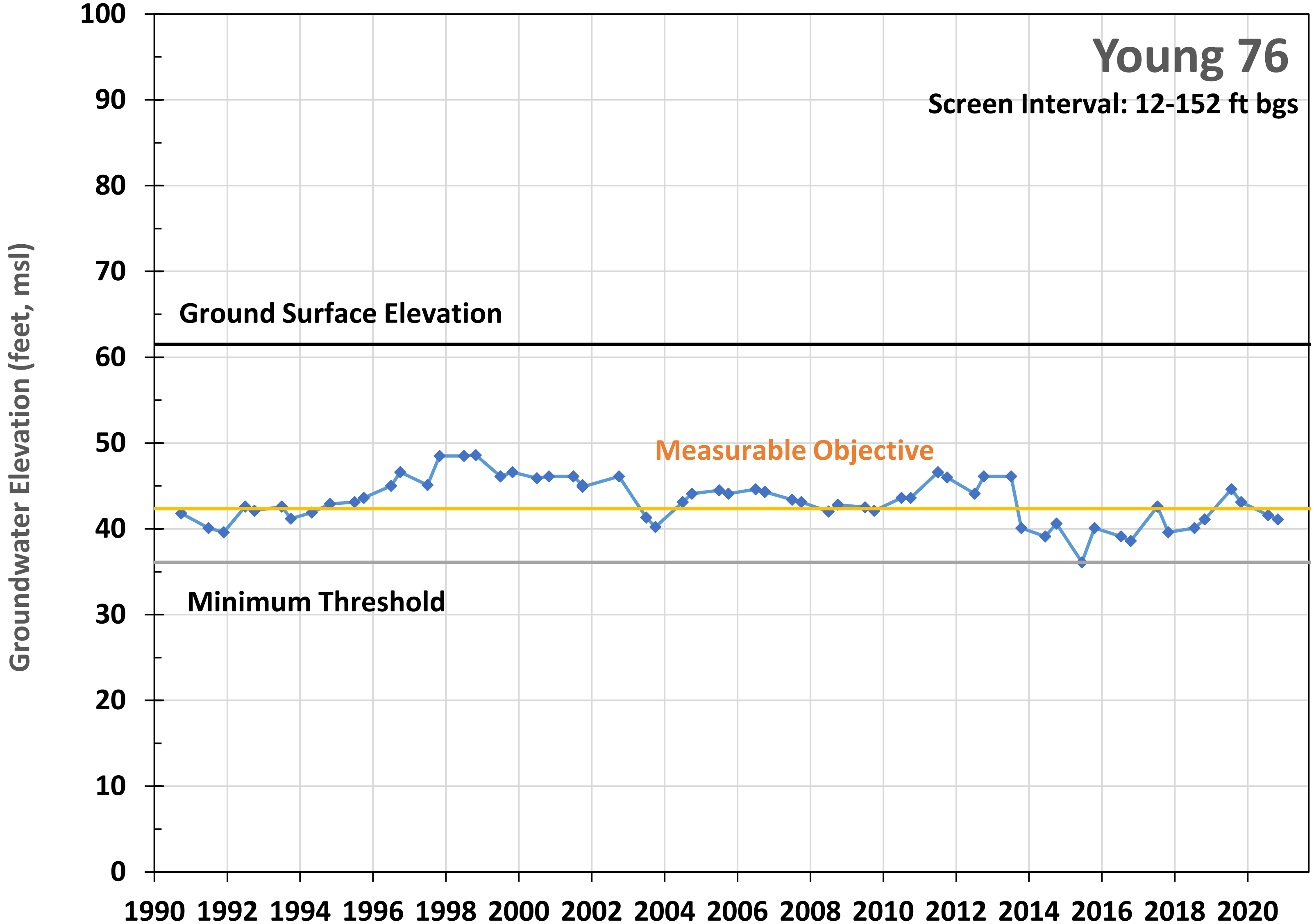
Van Buren 43
Ground Surface Elevation
Screen Interval: 76-116 ft bgs
Measurable Objective
Minimum Threshold
Groundwater Elevation (feet, msl)
70
60
50
40
30
20
10
0
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016
2018
2020


Warnock 46
Total Depth: 240 ft bgs
Groundwater Elevation (feet, msl)
Ground Surface Elevation
Measurable Objective
Minimum Threshold
0
10
20
30
40
50
60
70
80
90
100
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016
2018
2020

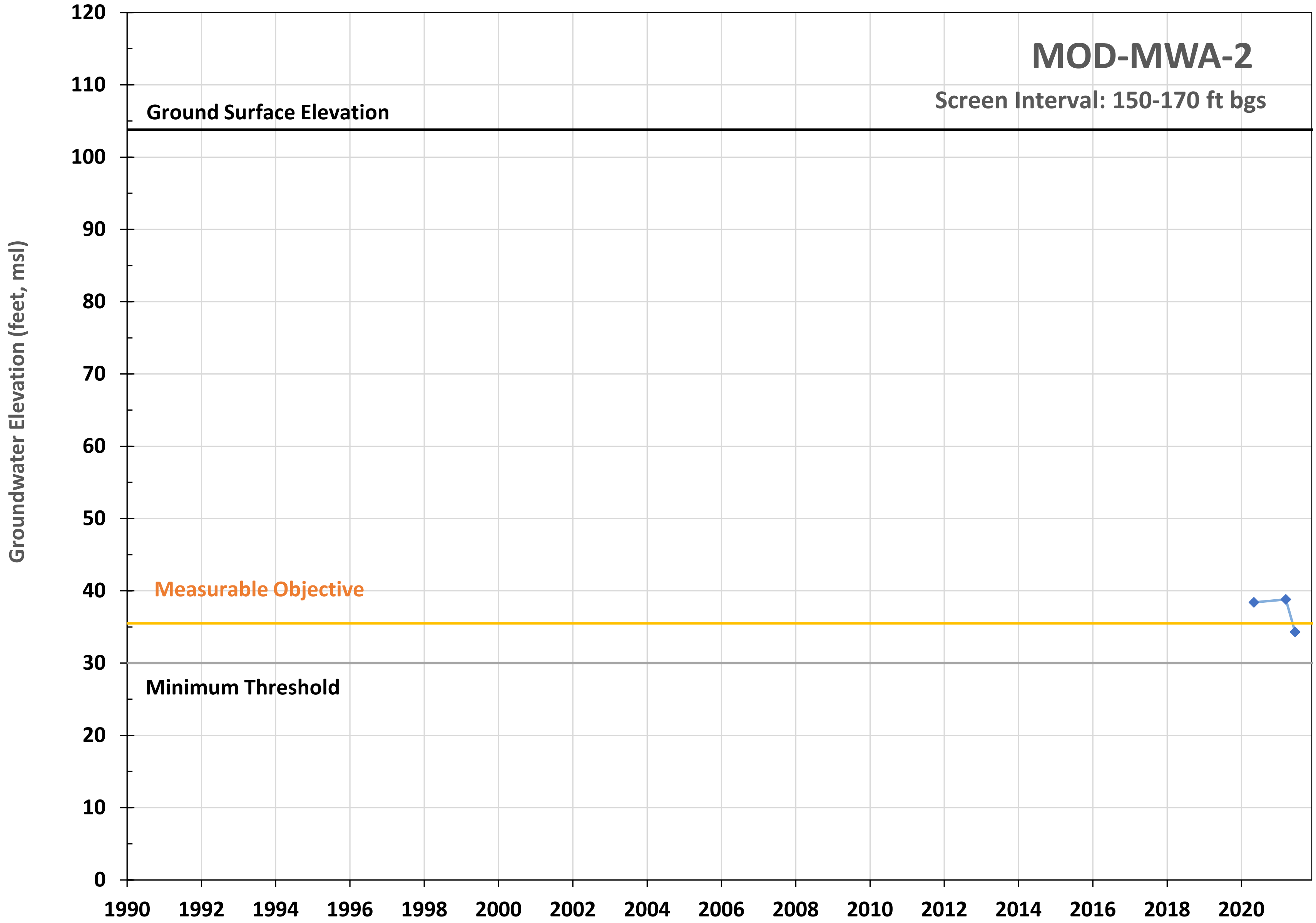


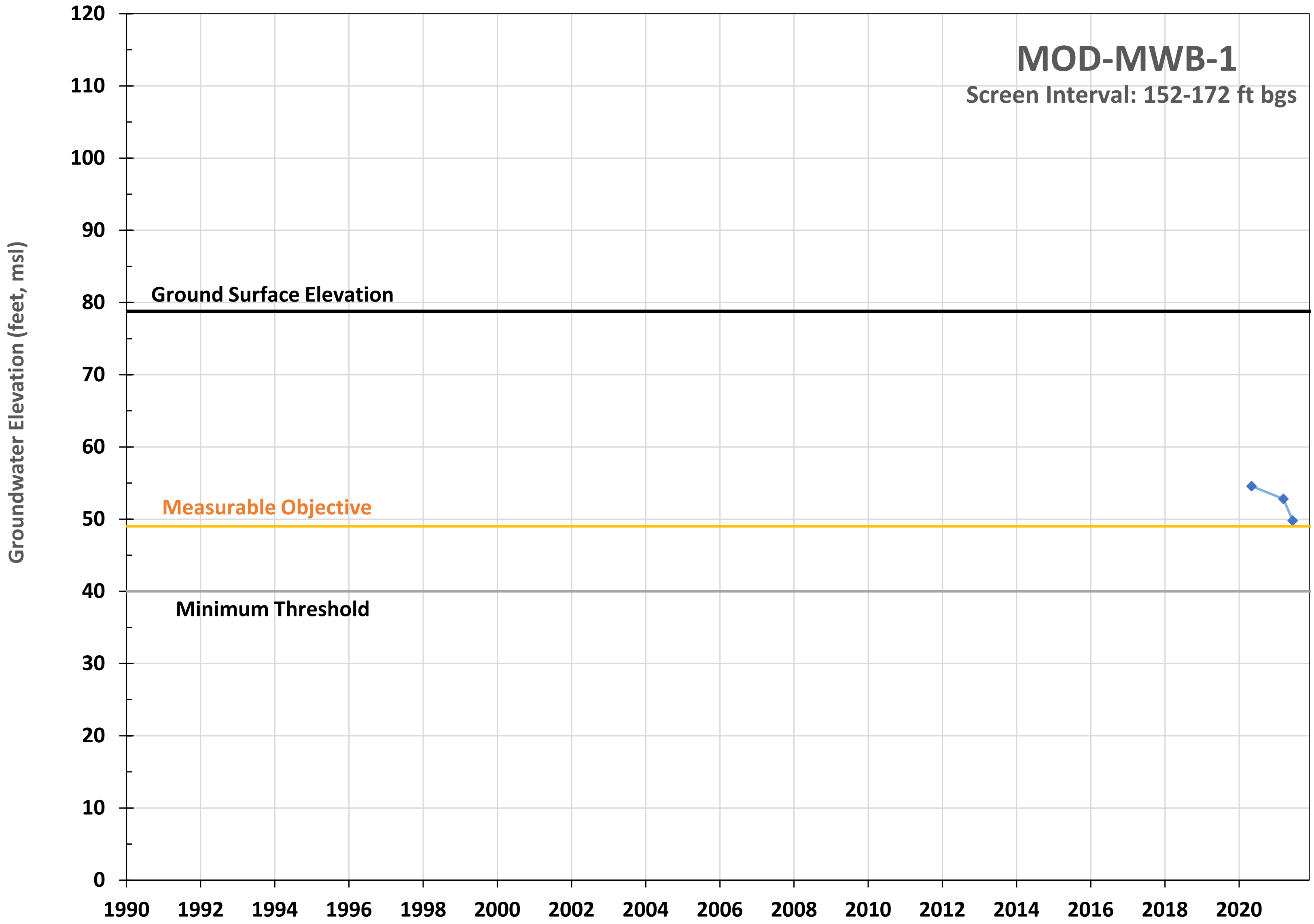
Wellsford 233
Screen Interval: 158-250 ft bgs
254-358 ft bgs
Ground Surface Elevation
Measurable Objective
Minimum Threshold
Groundwater Elevation (feet, msl)
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016
2018
2020

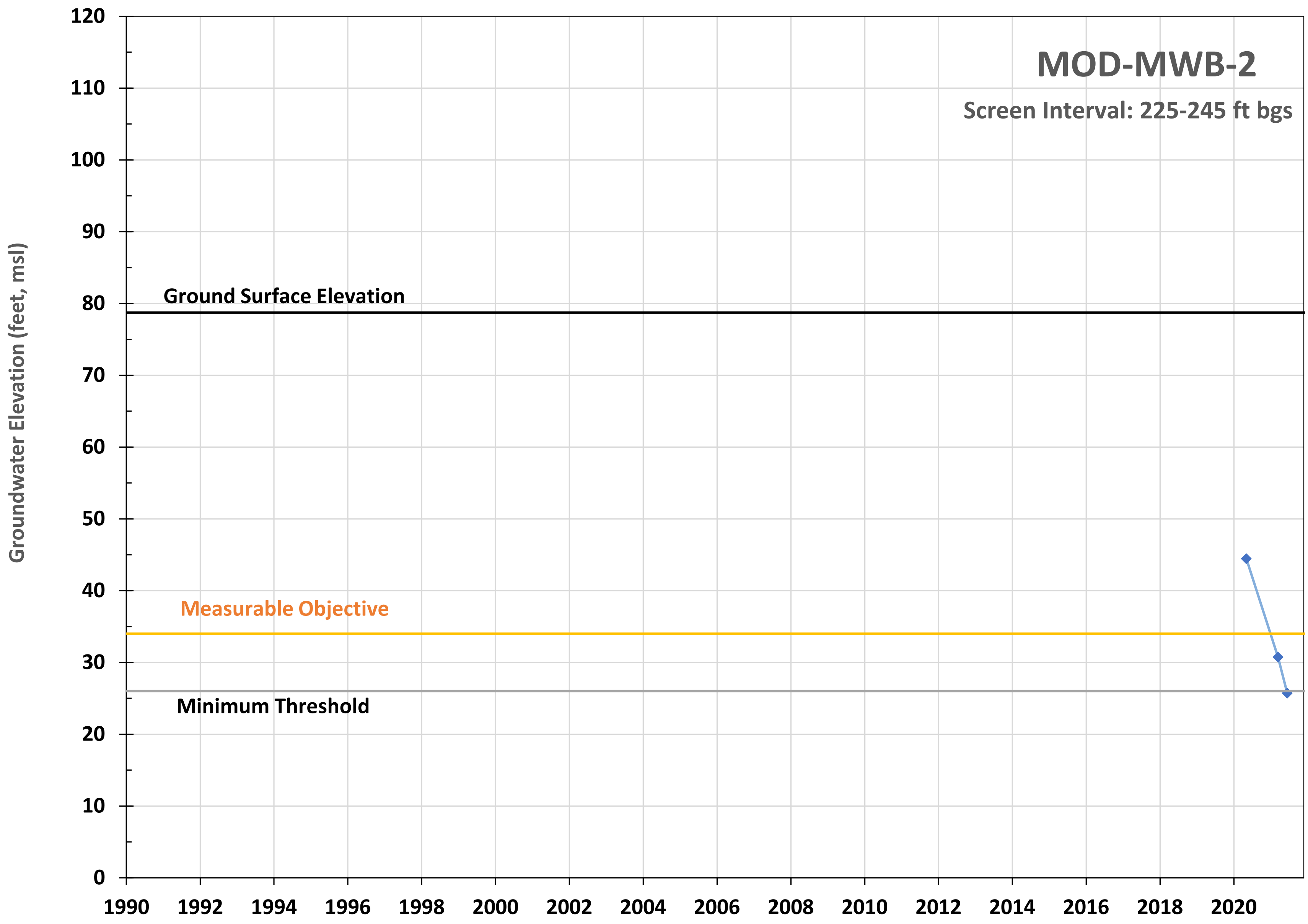

Wood 210
Ground Surface Elevation
Screen Interval: 87-187 ft bgs
244-298 ft bgs
316-370 ft bgs
388-409 ft bgs
430-547 ft bgs
Measurable Objective
Minimum Threshold
Groundwater Elevation (feet, msl)
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016
2018
2020

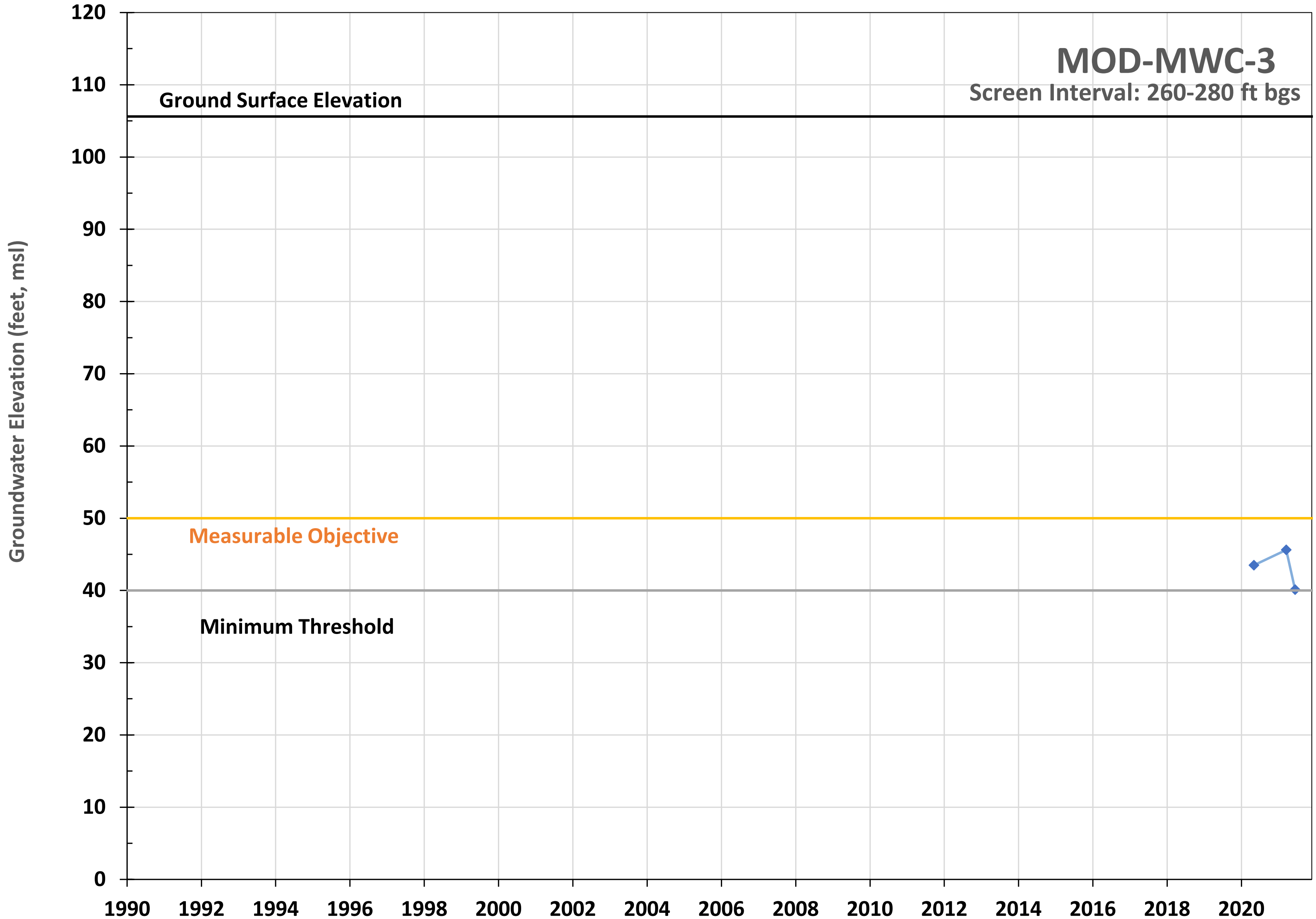


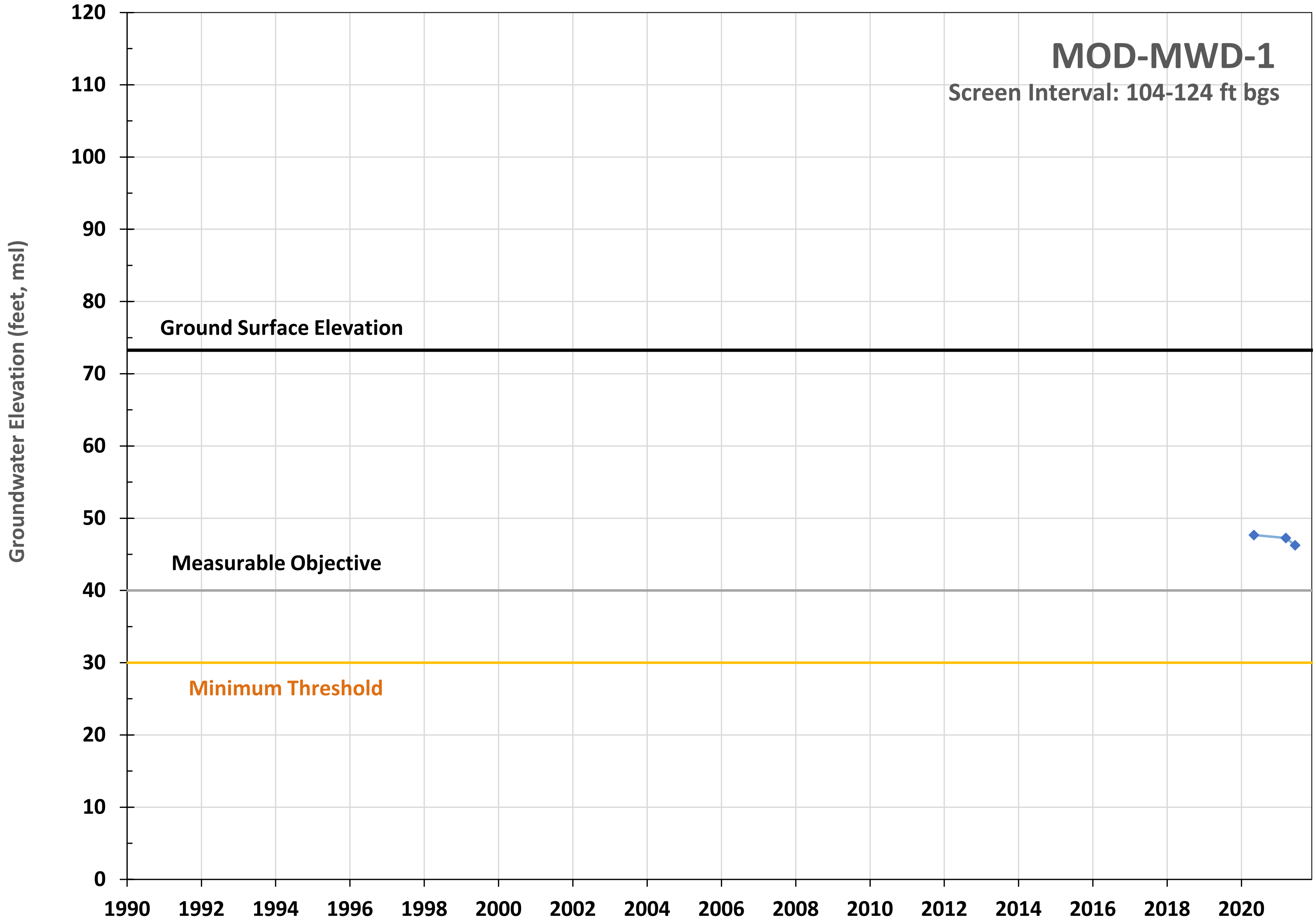
Young 76
Screen Interval: 12-152 ft bgs
Ground Surface Elevation
Measurable Objective
Minimum Threshold
Groundwater Elevation (feet, msl)
100
90
80
70
60
50
40
30
20
10
0
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016
2018
2020

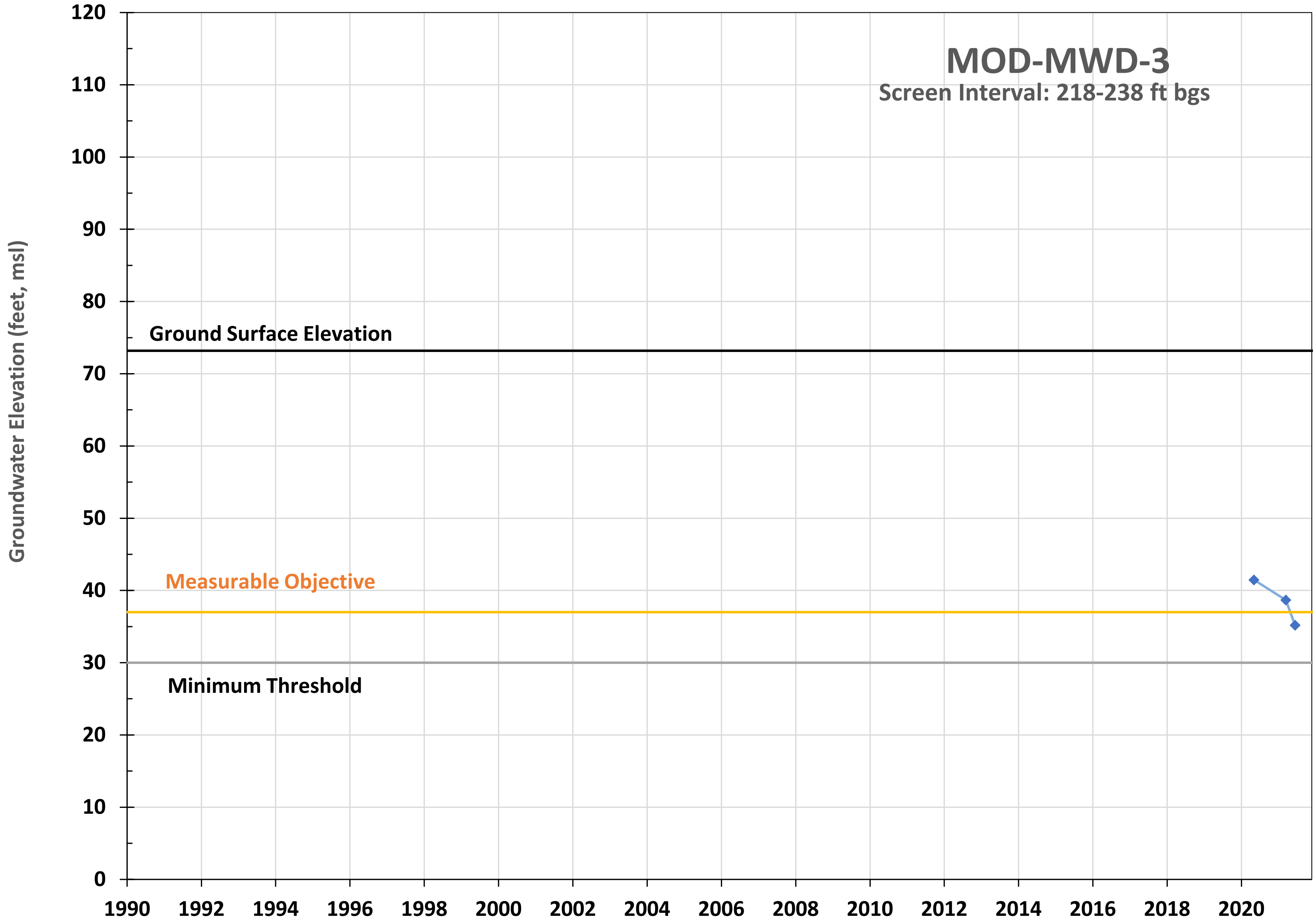

MOD-MWA-2
Screen Interval: 150-170 ft bgs
Ground Surface Elevation
Measurable Objective
Minimum Threshold
Groundwater Elevation (feet, msl)
120
110
100
90
80
70
60
50
40
30
20
10
0
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016
2018
2020


MOD-MWB-1
Screen Interval: 152-172 ft bgs
Groundwater Elevation (feet, msl)
Ground Surface Elevation
Measurable Objective
Minimum Threshold
0
10
20
30
40
50
60
70
80
90
100
110
120
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016
2018
2020

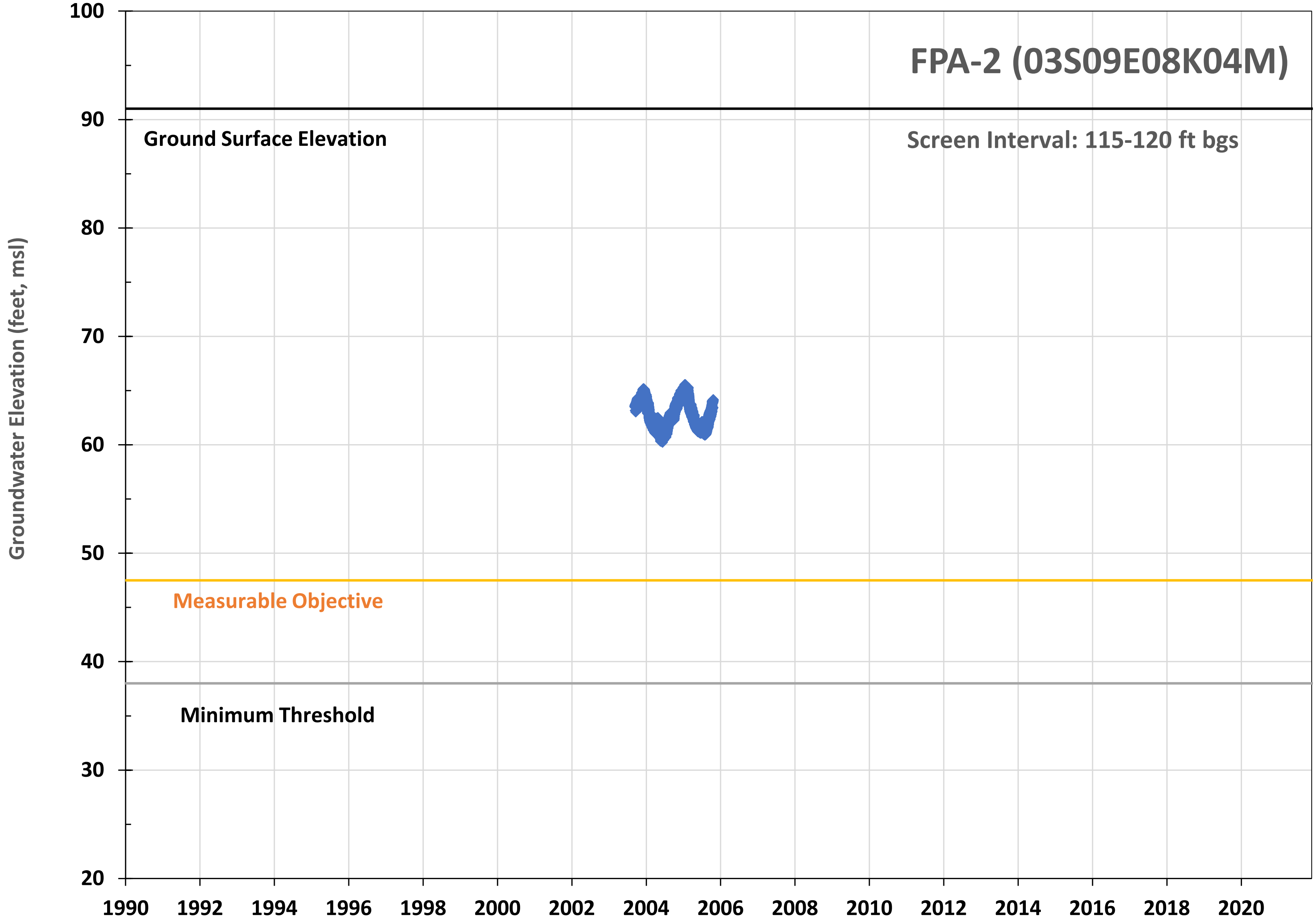

MOD-MWB-2
Screen Interval: 225-245 ft bgs
Groundwater Elevation (feet, msl)
Ground Surface Elevation
Measurable Objective
Minimum Threshold
120
110
100
90
80
70
60
50
40
30
20
10
0
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016
2018
2020

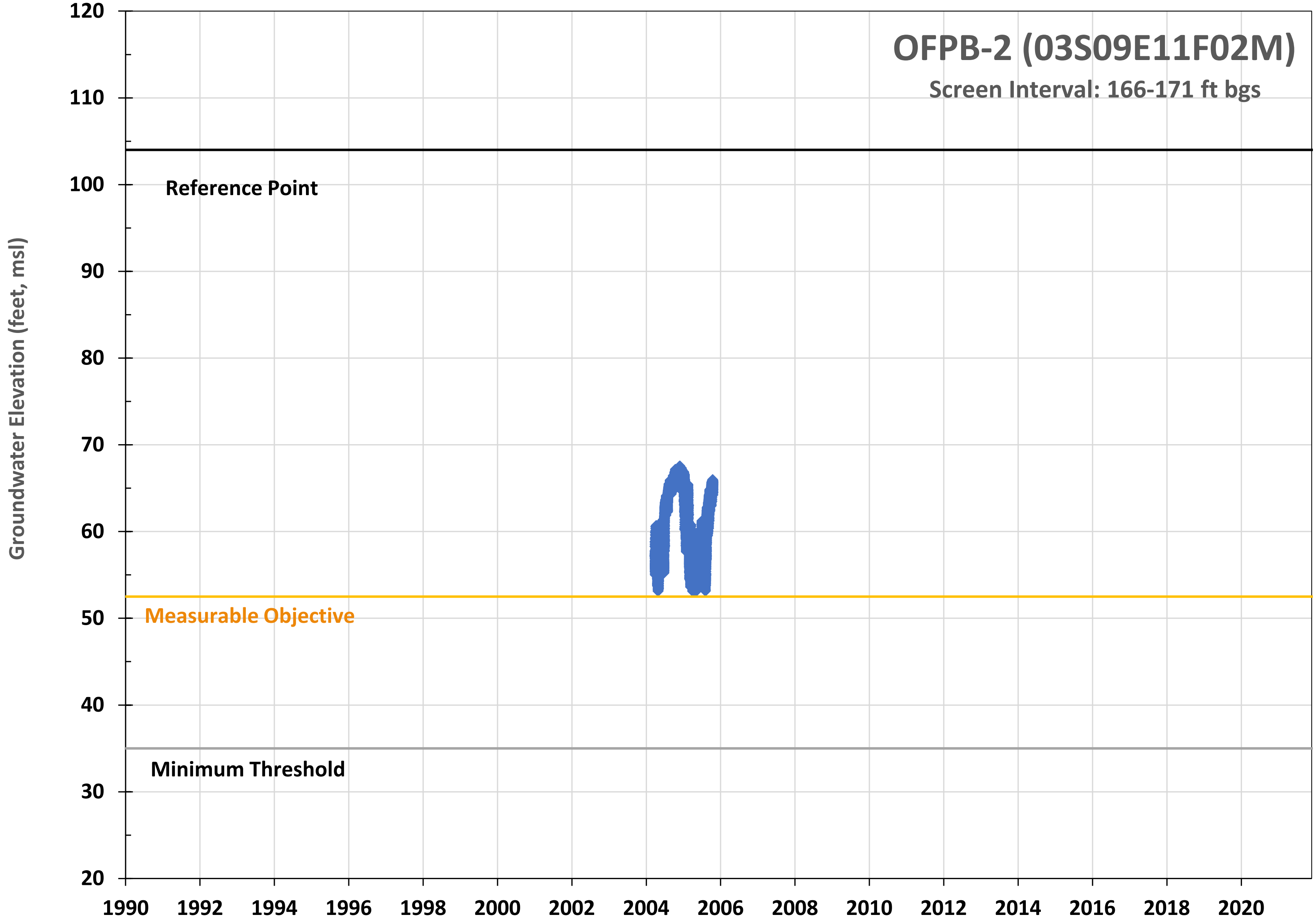

MOD-MWC-3
Screen Interval: 260-280 ft bgs
Ground Surface Elevation
Measurable Objective
Minimum Threshold
Groundwater Elevation (feet, msl)
120
110
100
90
80
70
60
50
40
30
20
10
0
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016
2018
2020


MOD-MWD-1
Screen Interval: 104-124 ft bgs
Groundwater Elevation (feet, msl)
Ground Surface Elevation
Measurable Objective
Minimum Threshold
0
10
20
30
40
50
60
70
80
90
100
110
120
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016
2018
2020

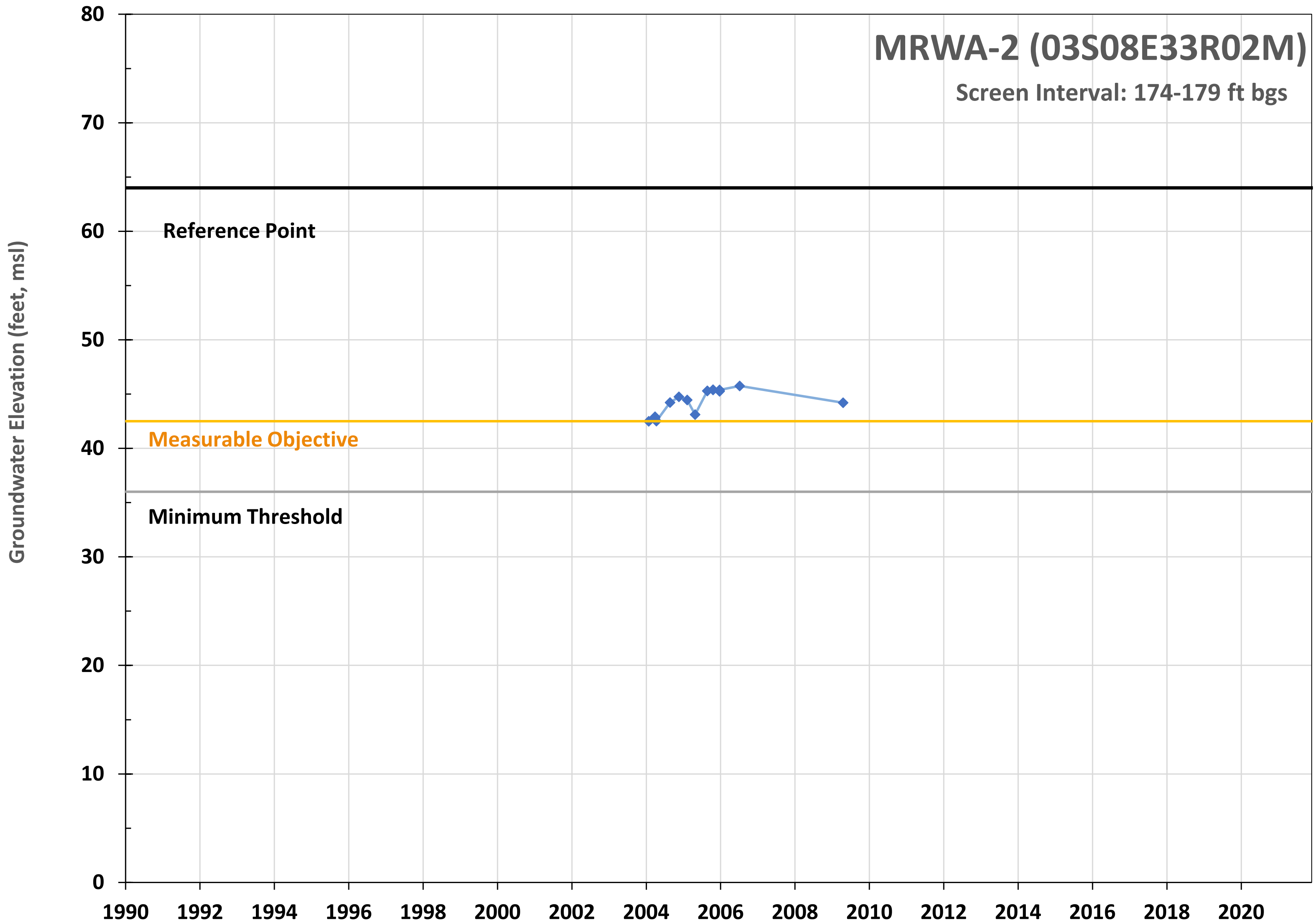


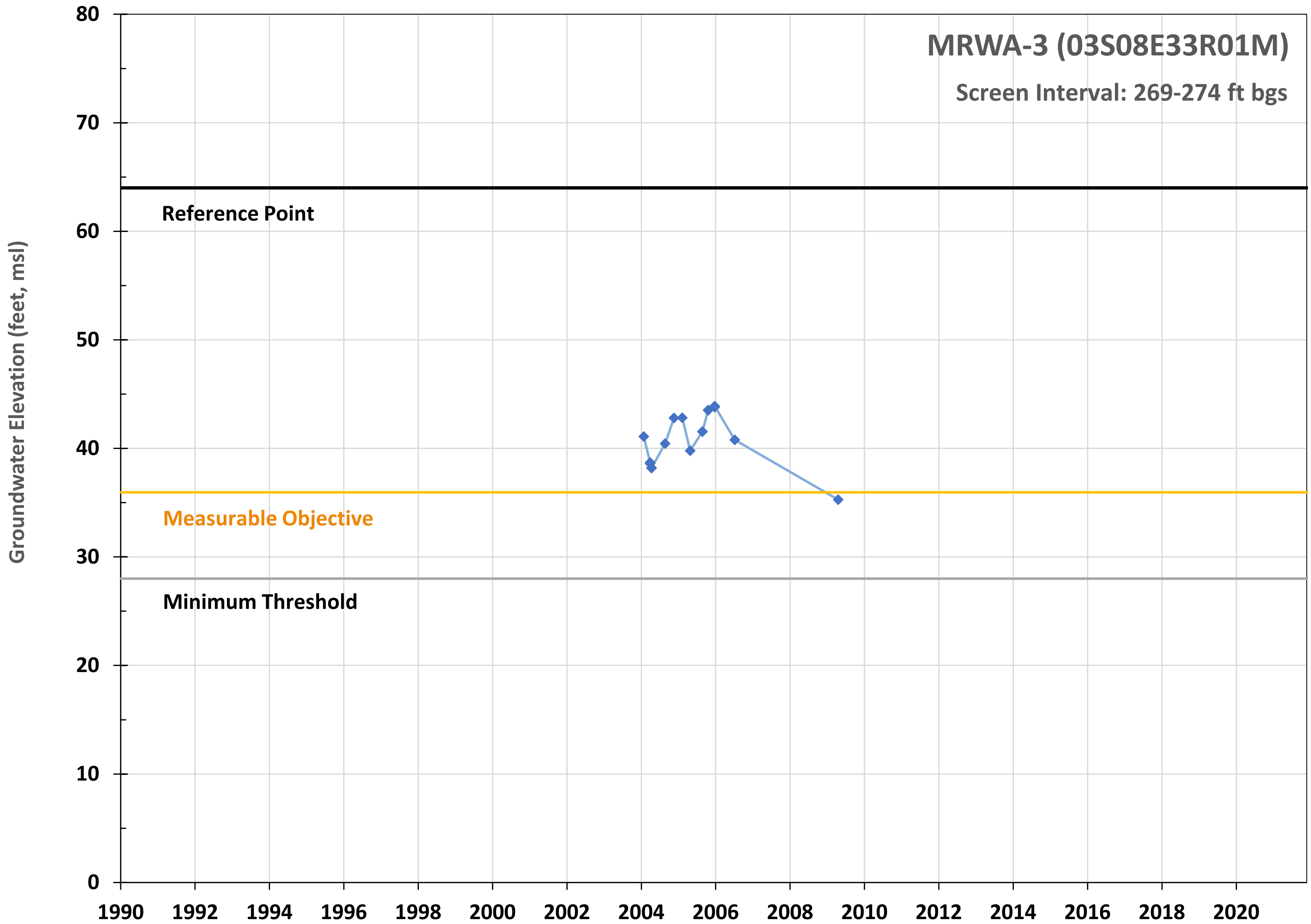
MOD-MWD-3
Screen Interval: 218-238 ft bgs
Groundwater Elevation (feet, msl)
Ground Surface Elevation
Measurable Objective
Minimum Threshold
120
110
100
90
80
70
60
50
40
30
20
10
0
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016
2018
2020

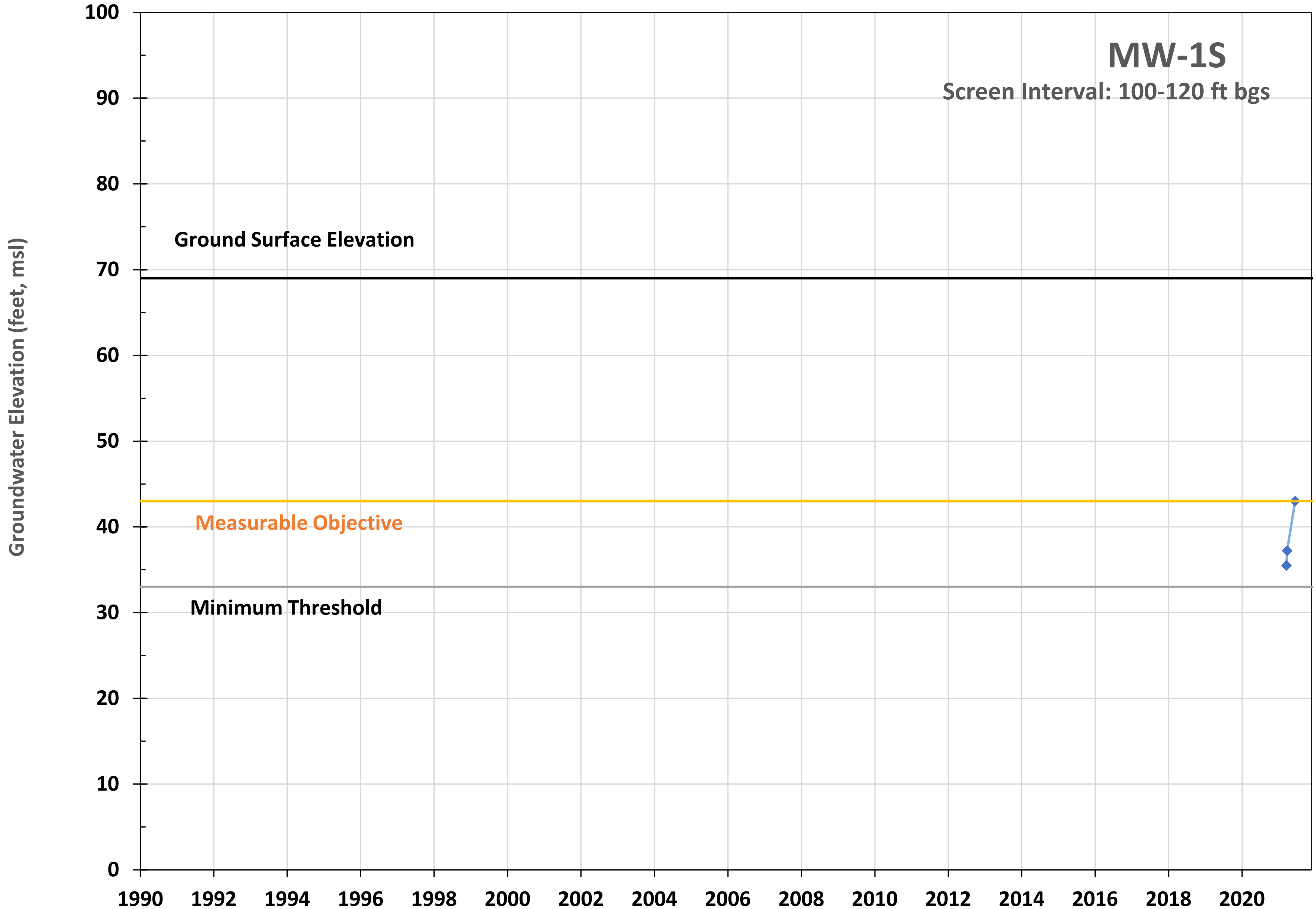

FPA-2 (03S09E08K04M)
Screen Interval: 115-120 ft bgs
Ground Surface Elevation
Measurable Objective
Minimum Threshold
Groundwater Elevation (feet, msl)
100
90
80
70
60
50
40
30
20
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016
2018
2020

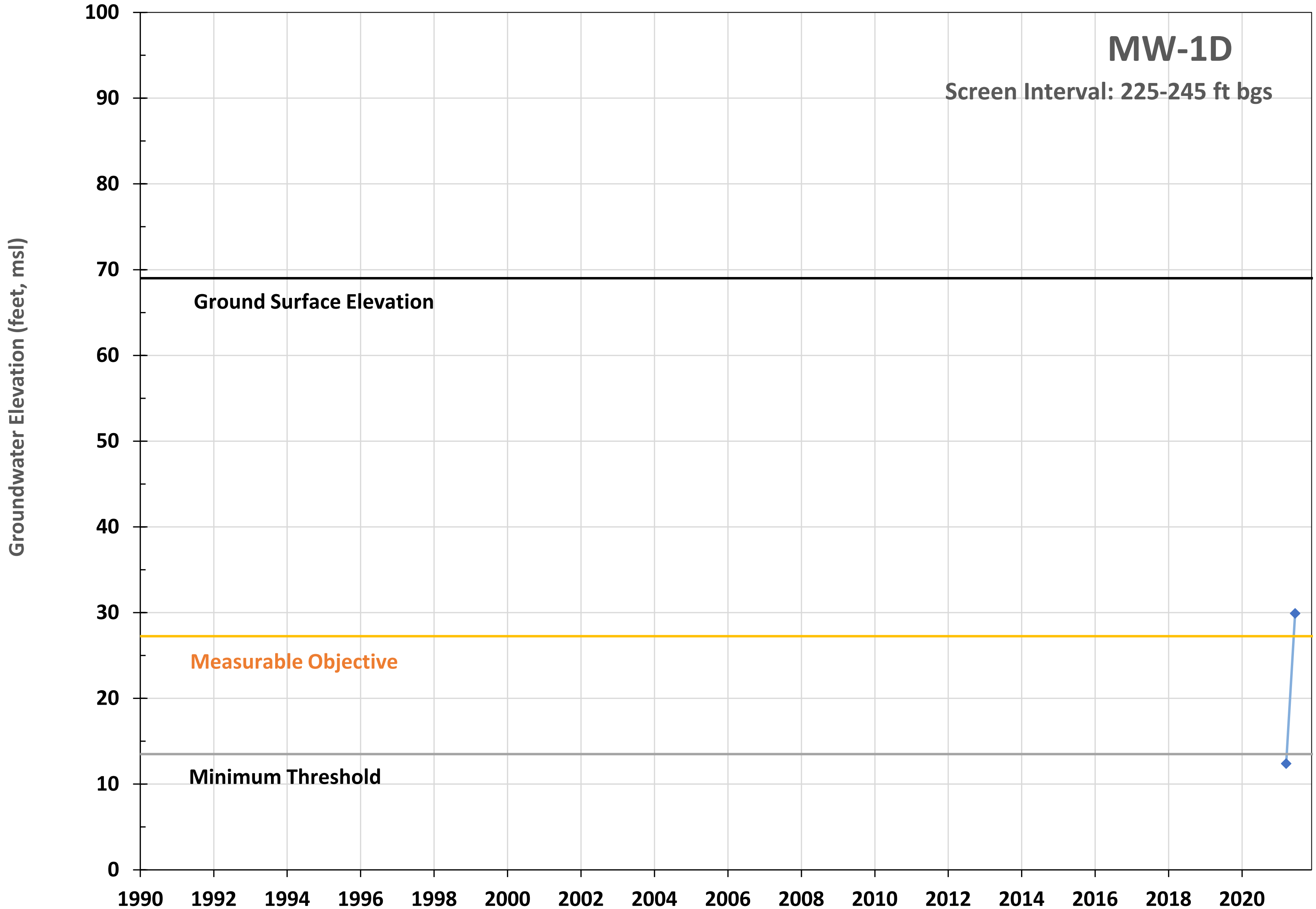


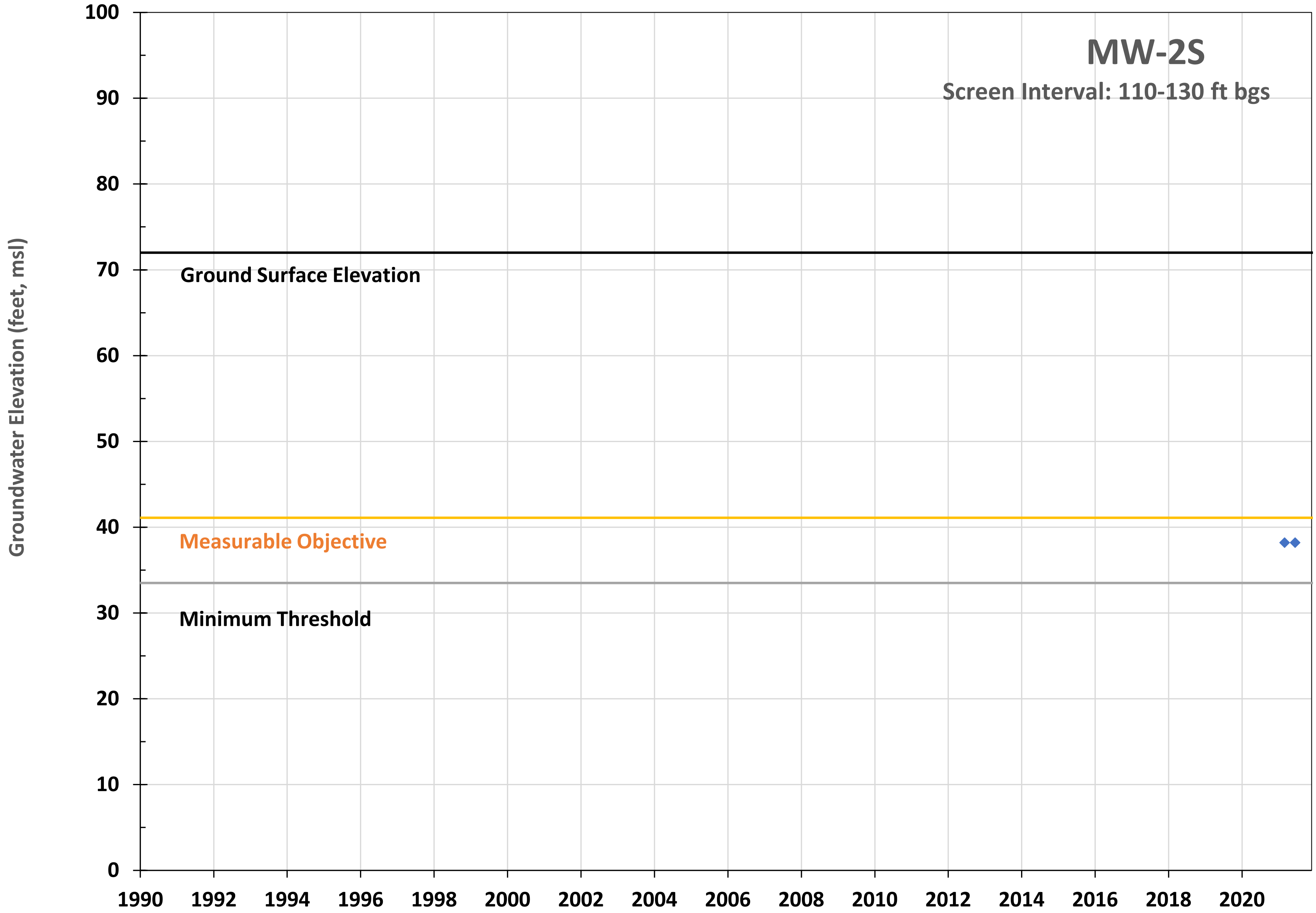
OFPB-2 (03S09E11F02M)
Screen Interval: 166-171 ft bgs
Groundwater Elevation (feet, msl)
Reference Point
Measurable Objective
Minimum Threshold
120
110
100
90
80
70
60
50
40
30
20
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016
2018
2020

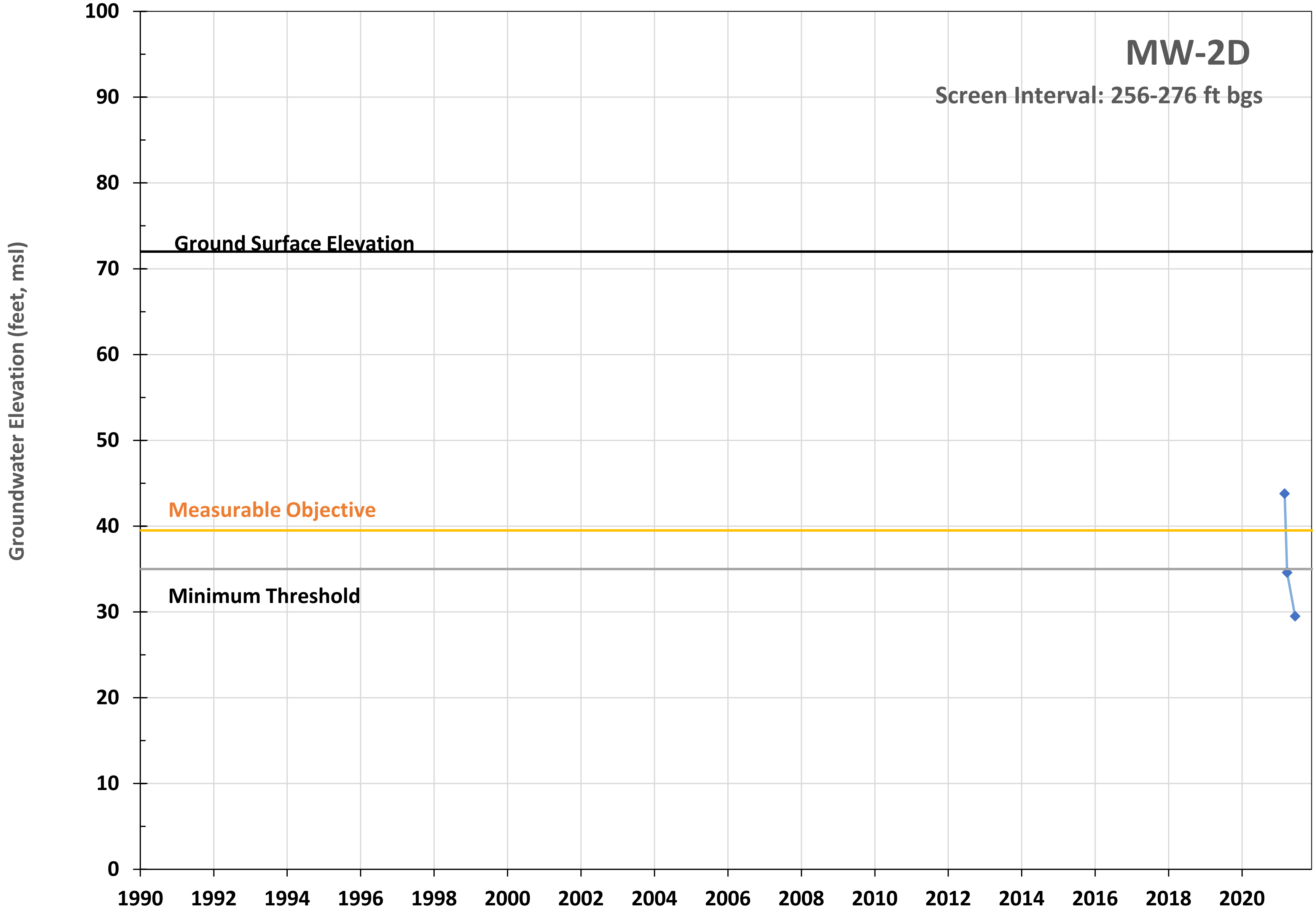

MRWA-2 (03S08E33R02M)
Screen Interval: 174-179 ft bgs
Reference Point
Measurable Objective
Minimum Threshold
Groundwater Elevation (feet, msl)
0
10
20
30
40
50
60
70
80
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016
2018
2020

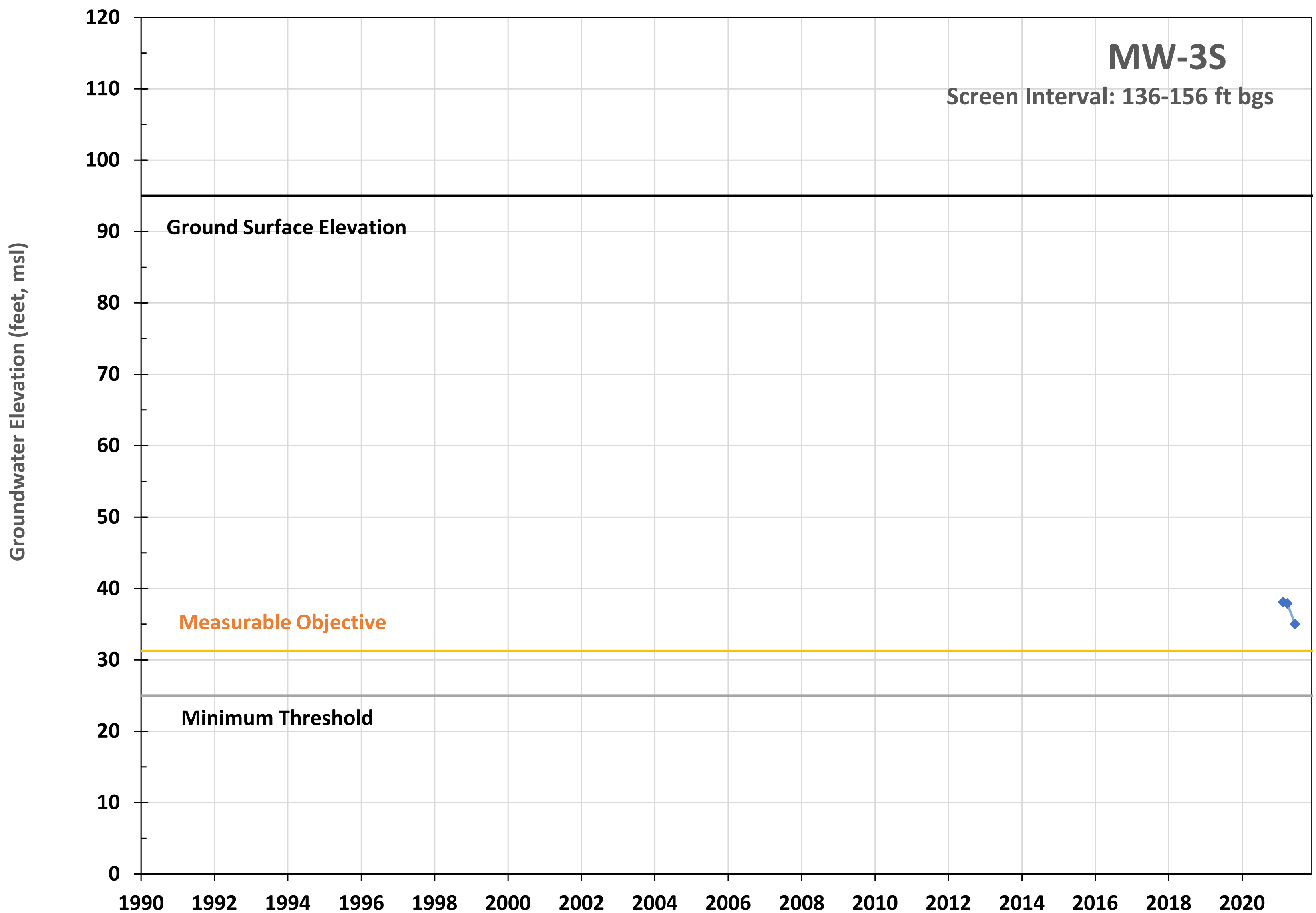

MRWA-3 (03S08E33R01M)
Screen Interval: 269-274 ft bgs
Reference Point
Measurable Objective
Minimum Threshold
Groundwater Elevation (feet, msl)
80
70
60
50
40
30
20
10
0
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016
2018
2020

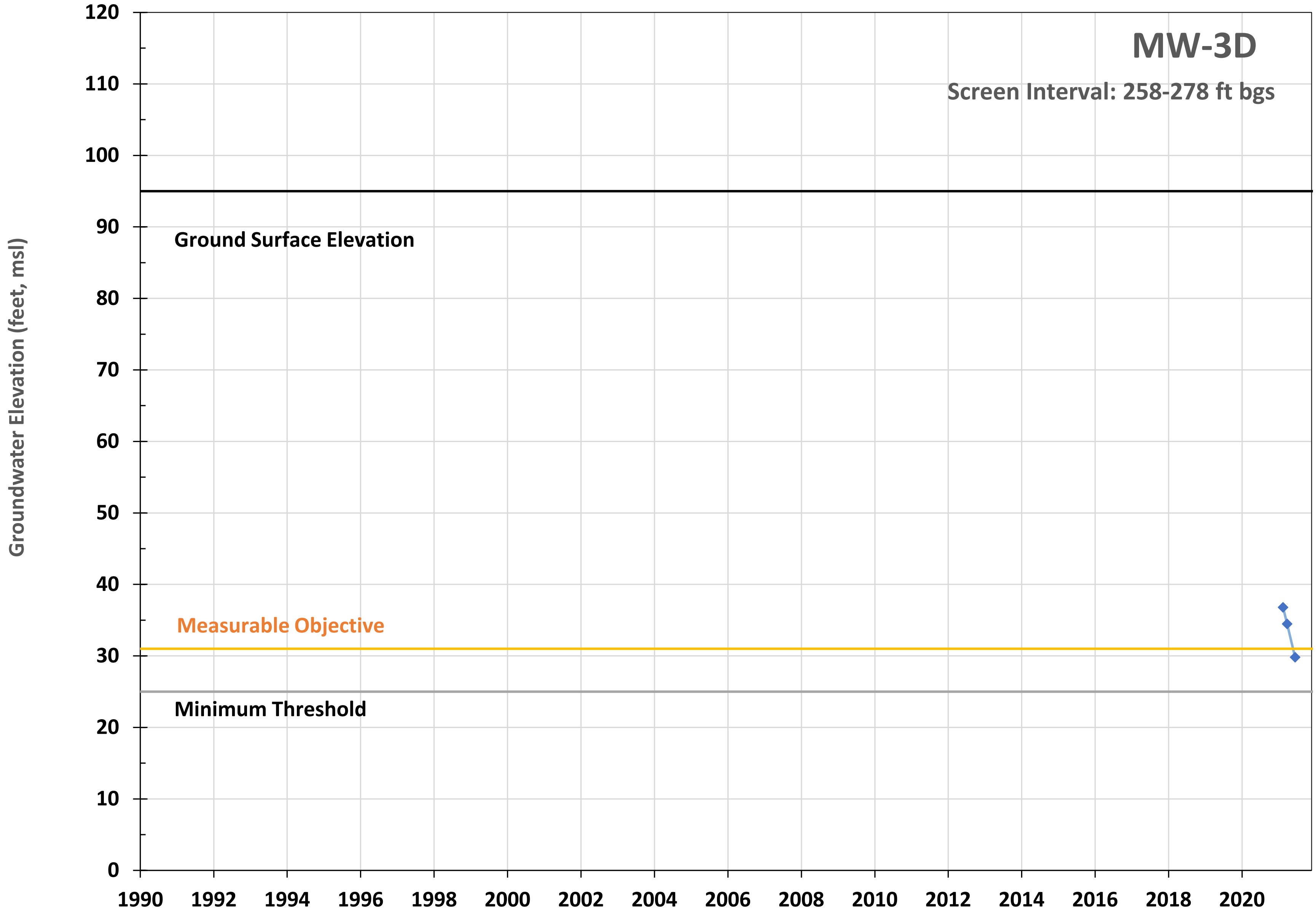

MW-1S
Screen Interval: 100-120 ft bgs
Ground Surface Elevation
Measurable Objective
Minimum Threshold
Groundwater Elevation (feet, msl)
100
90
80
70
60
50
40
30
20
10
0
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016
2018
2020

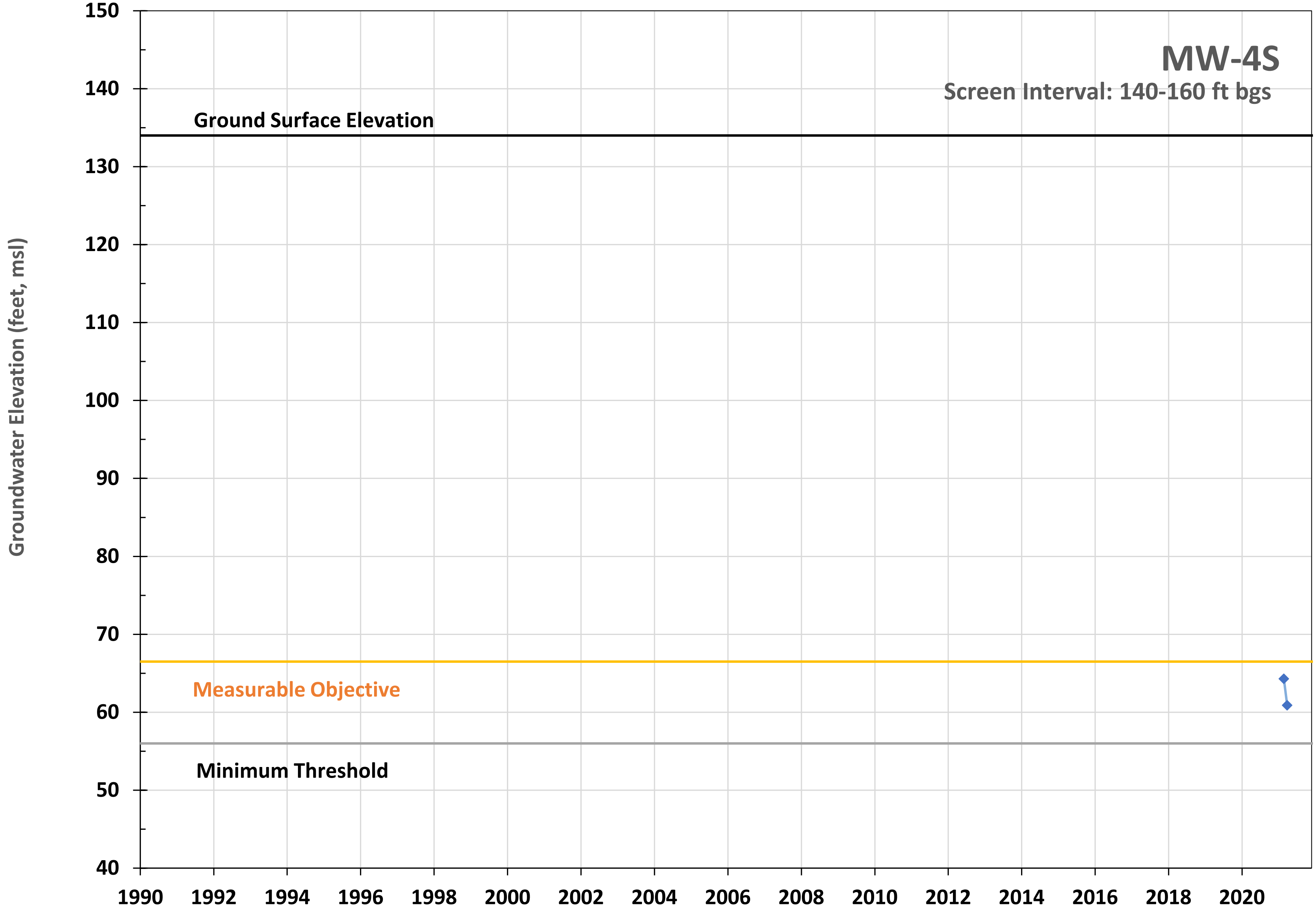

MW-1D
Screen Interval: 225-245 ft bgs
Groundwater Elevation (feet, msl)
Ground Surface Elevation
Measurable Objective
Minimum Threshold
100
90
80
70
60
50
40
30
20
10
0
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016
2018
2020

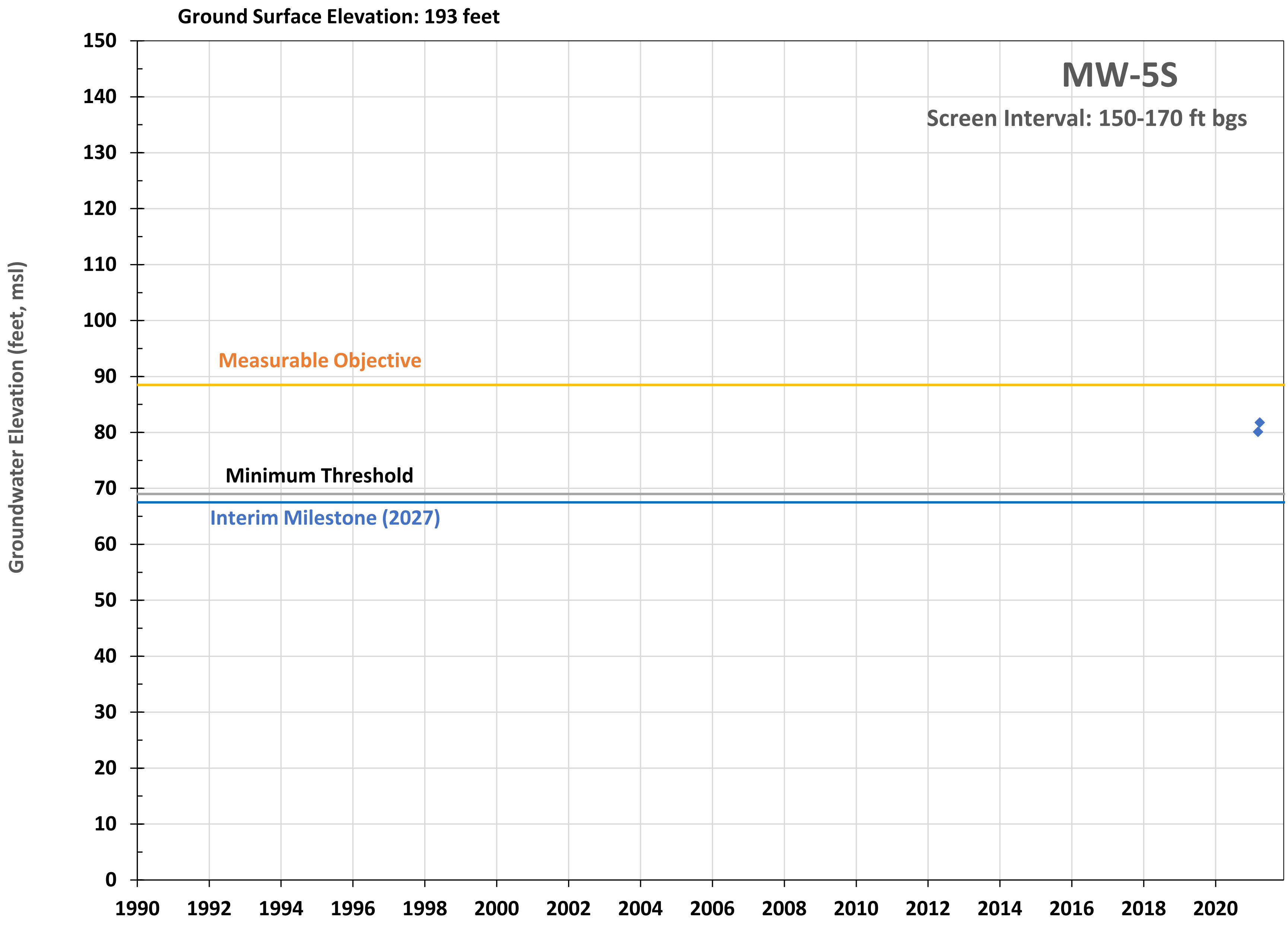

MW-2S
Screen Interval: 110-130 ft bgs
Ground Surface Elevation
Measurable Objective
Minimum Threshold
Groundwater Elevation (feet, msl)
100
90
80
70
60
50
40
30
20
10
0
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016
2018
2020

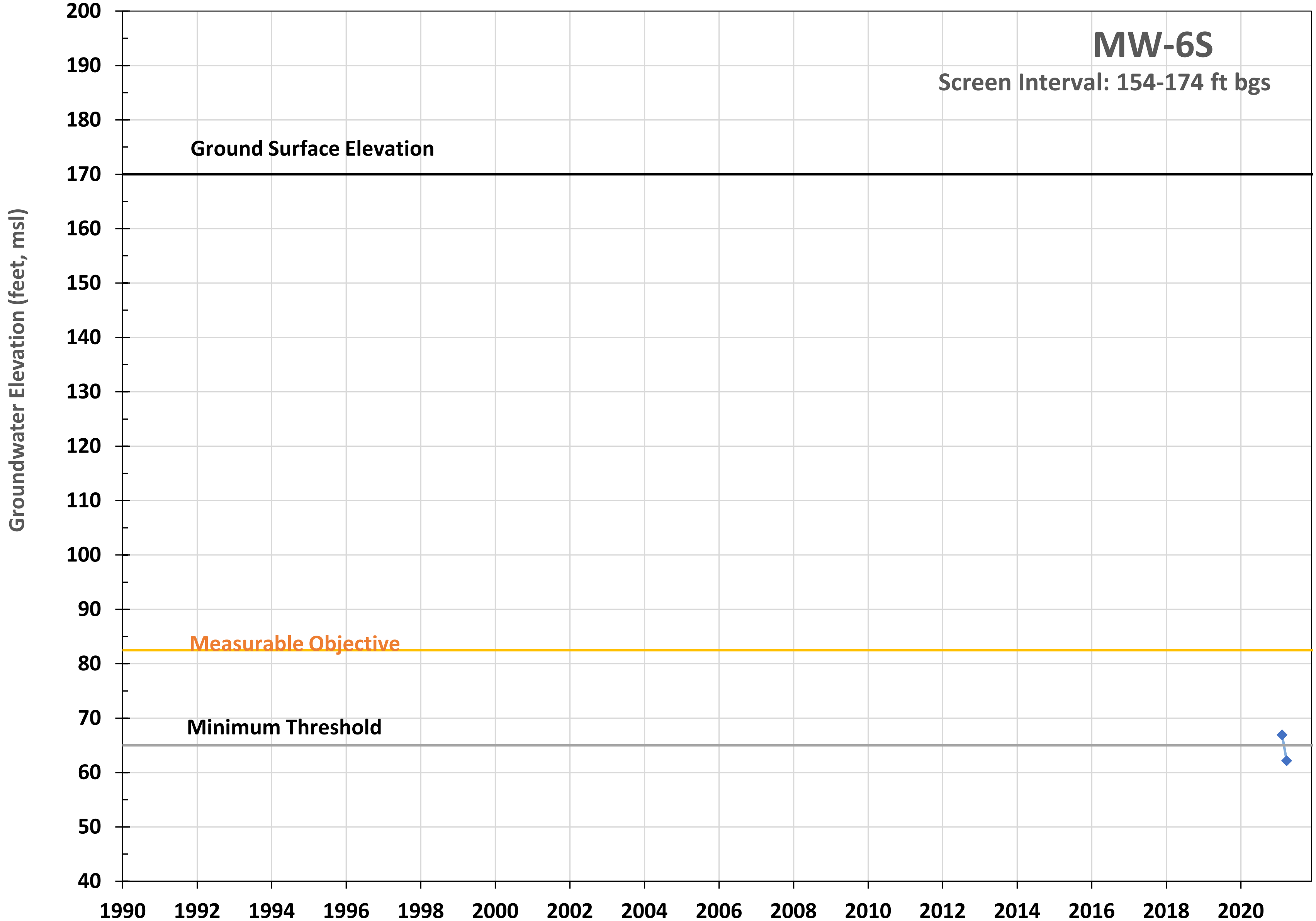

MW-2D
Screen Interval: 256-276 ft bgs
Ground Surface Elevation
Measurable Objective
Minimum Threshold
Groundwater Elevation (feet, msl)
100
90
80
70
60
50
40
30
20
10
0
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016
2018
2020

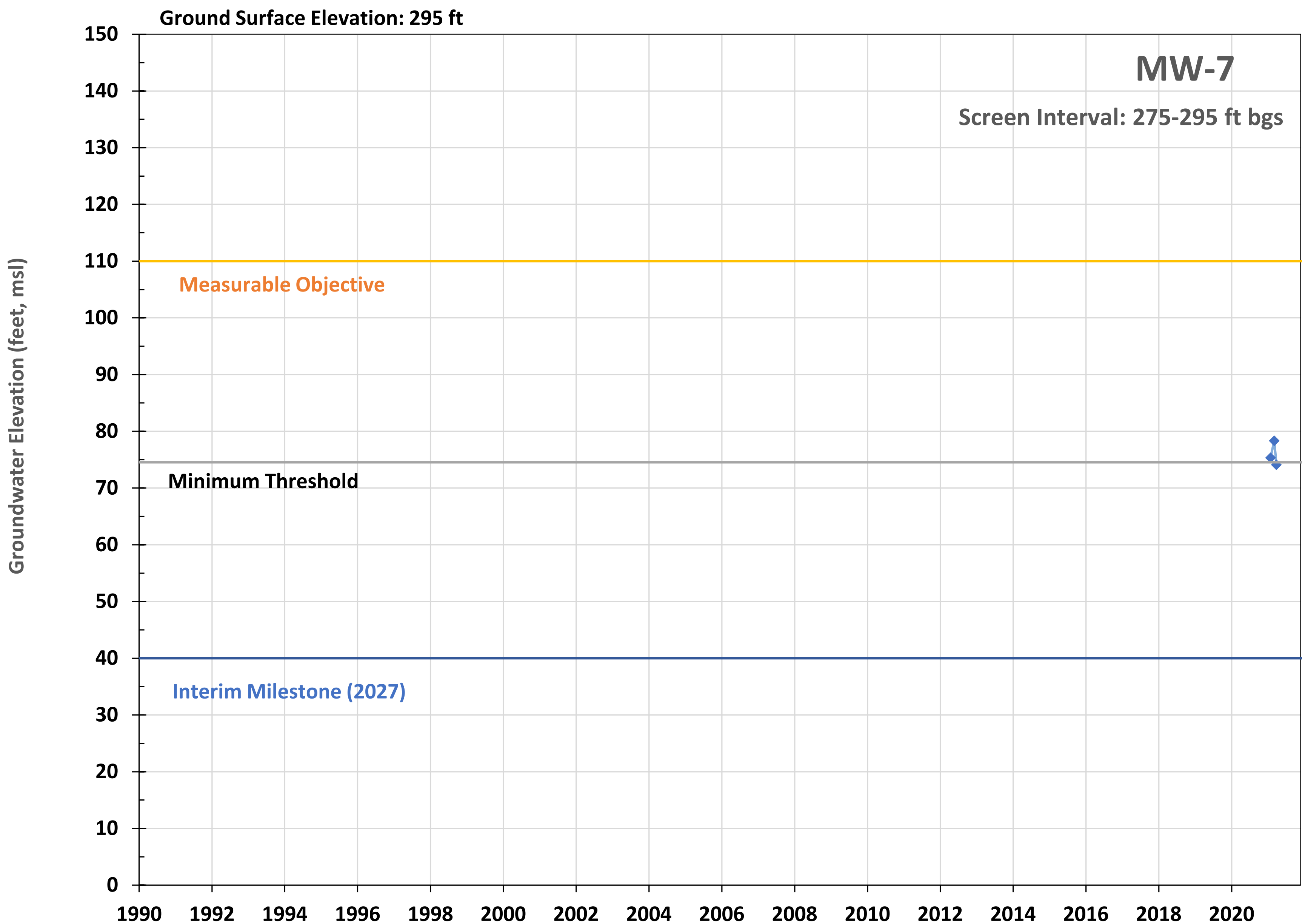

MW-3S
Screen Interval: 136-156 ft bgs
Ground Surface Elevation
Measurable Objective
Minimum Threshold
Groundwater Elevation (feet, msl)
120
110
100
90
80
70
60
50
40
30
20
10
0
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016
2018
2020


MW-3D
Screen Interval: 258-278 ft bgs
Ground Surface Elevation
Measurable Objective
Minimum Threshold
Groundwater Elevation (feet, msl)
120
110
100
90
80
70
60
50
40
30
20
10
0
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016
2018
2020

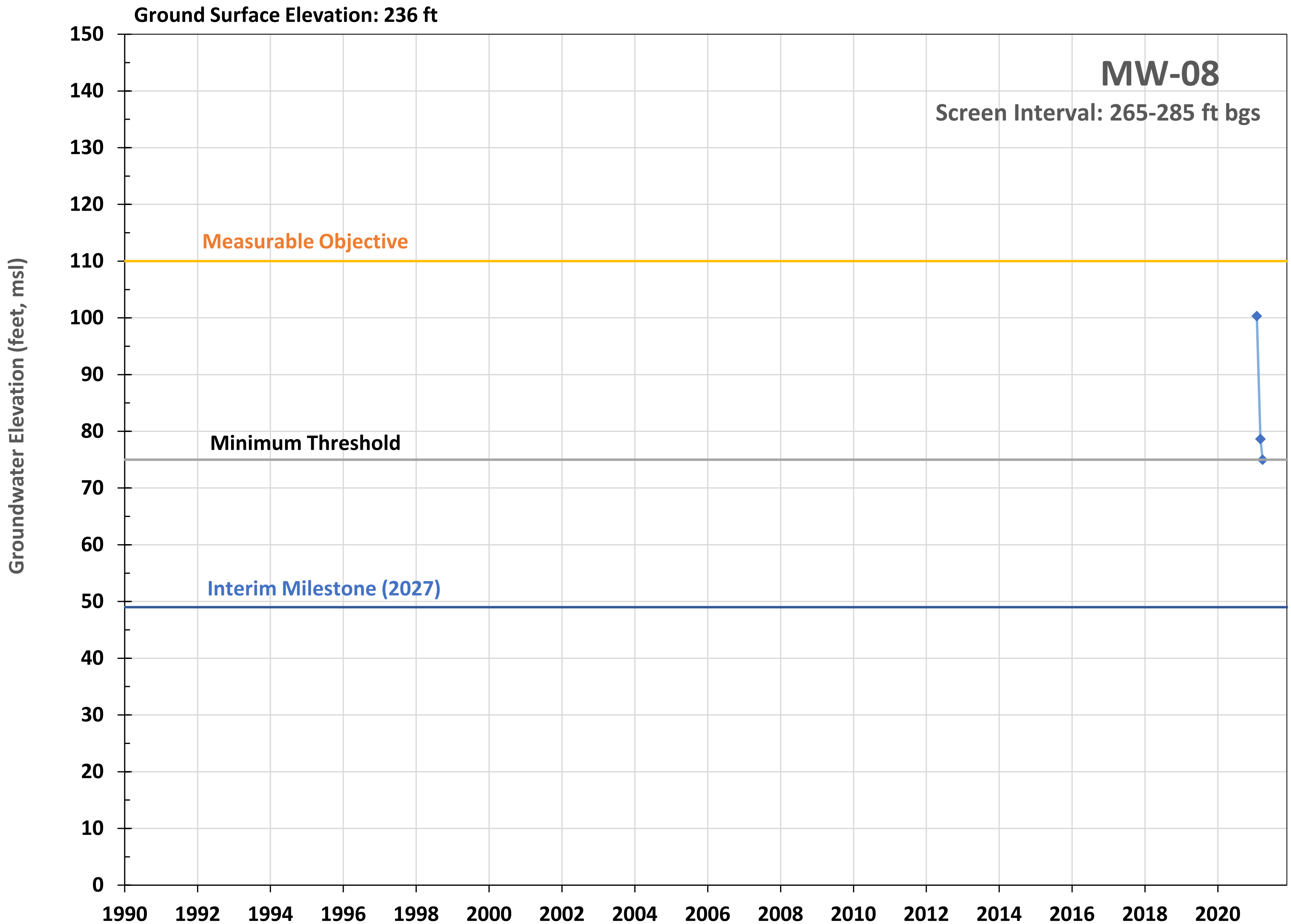

MW-4S
Screen Interval: 140-160 ft bgs
Ground Surface Elevation
Measurable Objective
Minimum Threshold
Groundwater Elevation (feet, msl)
150
140
130
120
110
100
90
80
70
60
50
40
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016
2018
2020

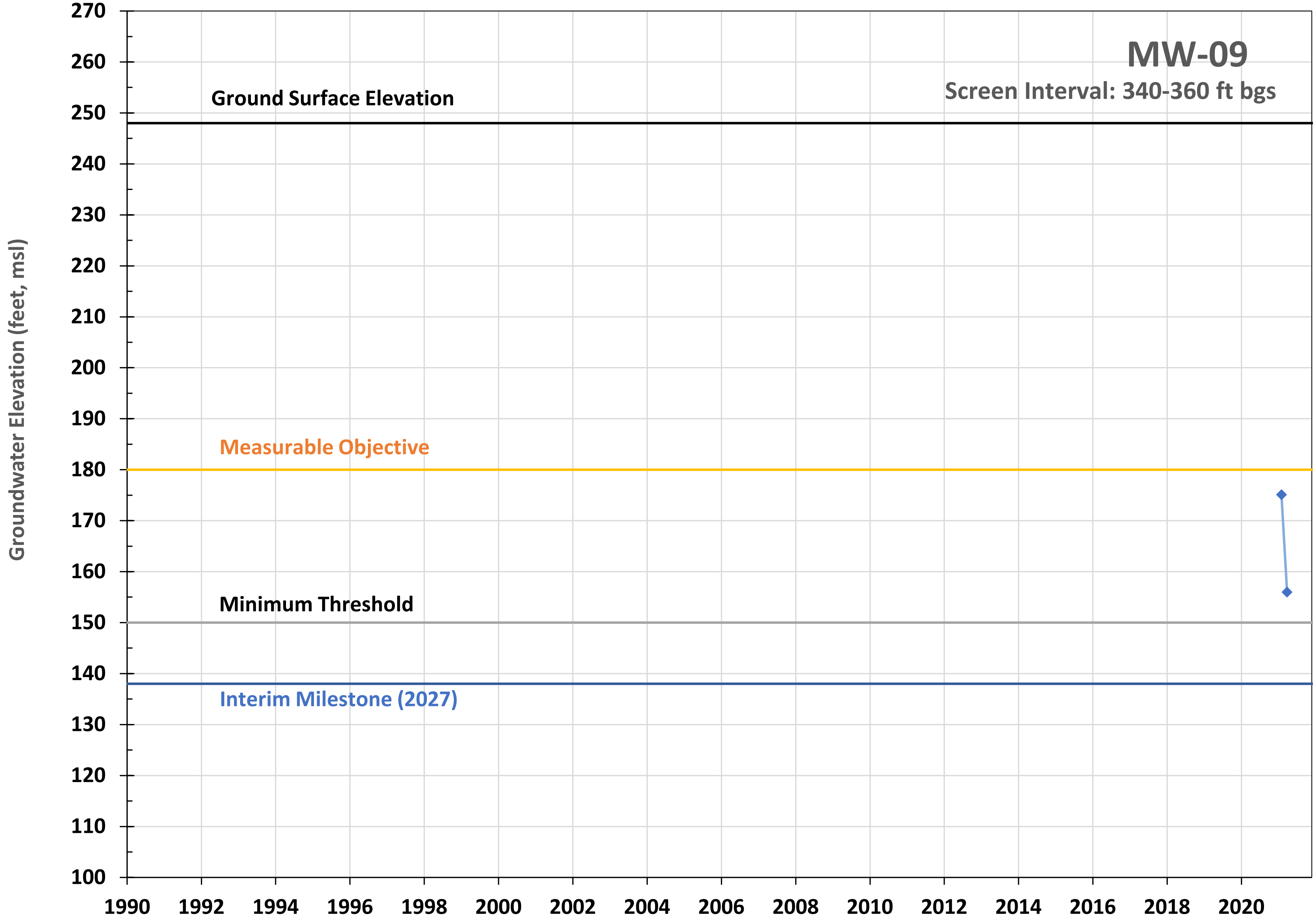

Ground Surface Elevation: 193 feet
MW-5S
Screen Interval: 150-170 ft bgs
Measurable Objective
Minimum Threshold
Interim Milestone (2027)
Groundwater Elevation (feet, msl)
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016
2018
2020

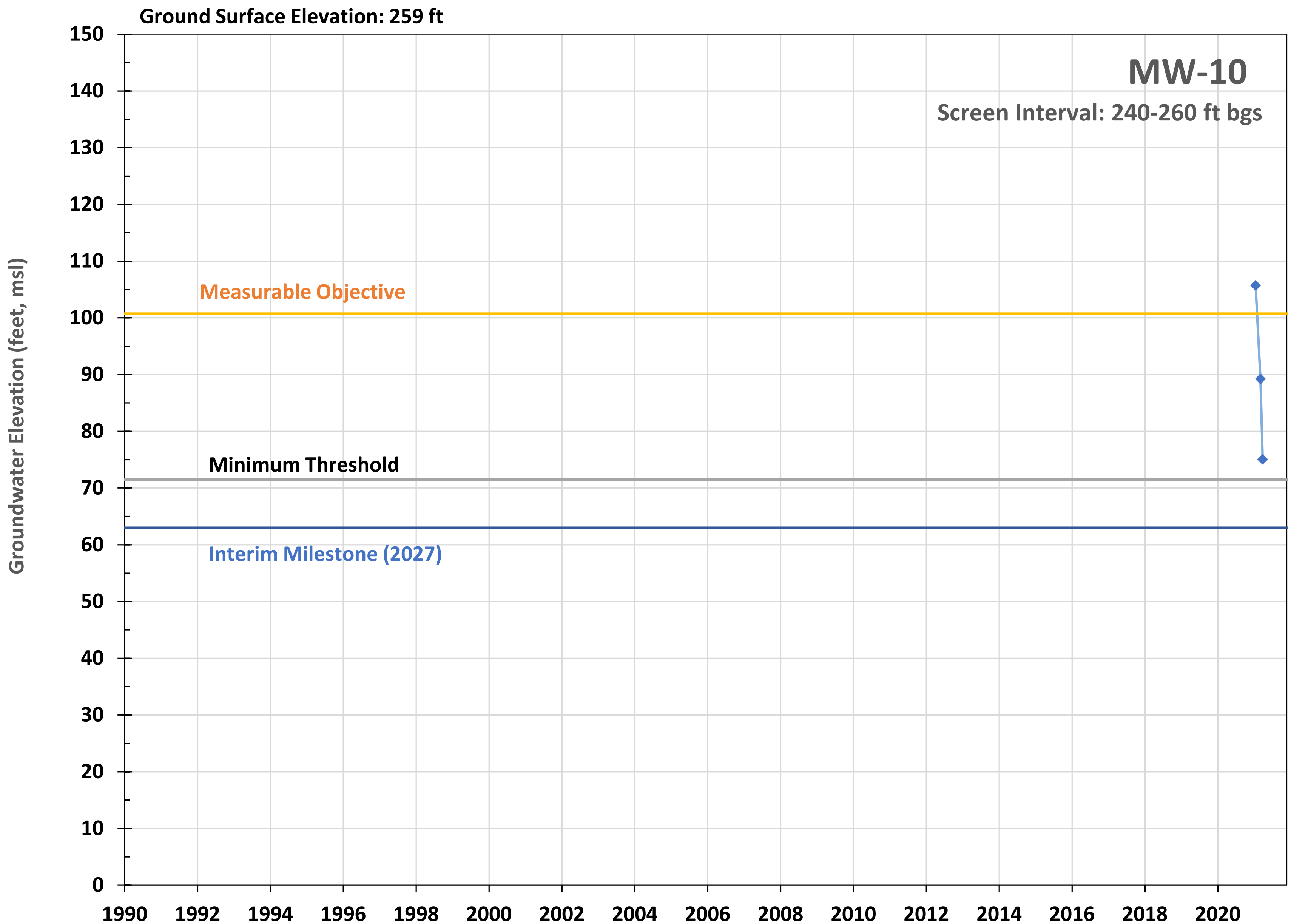

MW-6S
Screen Interval: 154-174 ft bgs
Ground Surface Elevation
Measurable Objective
Minimum Threshold
Groundwater Elevation (feet, msl)
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016
2018
2020

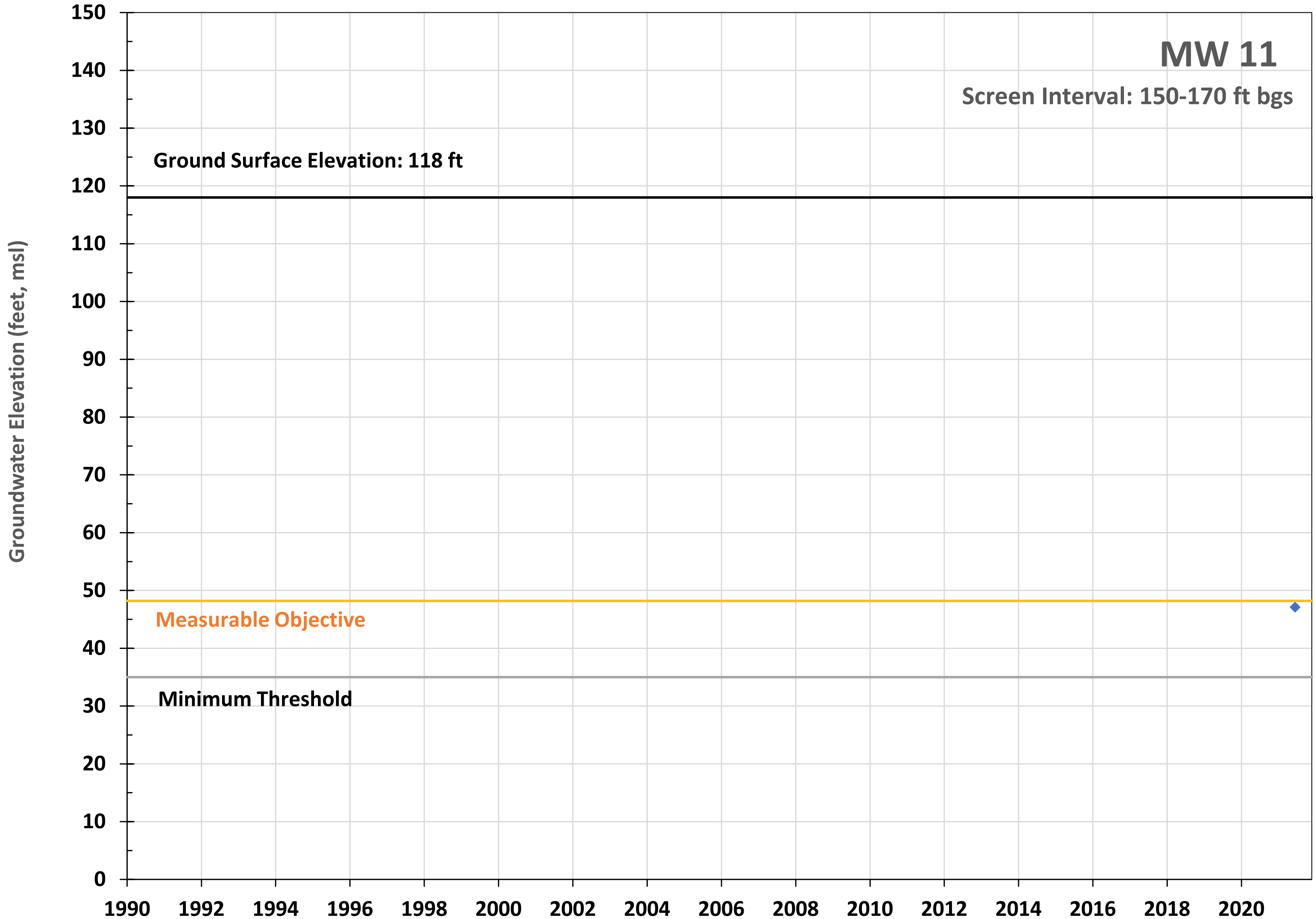


Ground Surface Elevation: 295 ft
MW-7
Screen Interval: 275-295 ft bgs
Measurable Objective
Minimum Threshold
Interim Milestone (2027)
Groundwater Elevation (feet, msl)
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016
2018
2020


Ground Surface Elevation: 236 ft
MW-08
Screen Interval: 265-285 ft bgs
Measurable Objective
Minimum Threshold
Interim Milestone (2027)
Groundwater Elevation (feet, msl)
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016
2018
2020

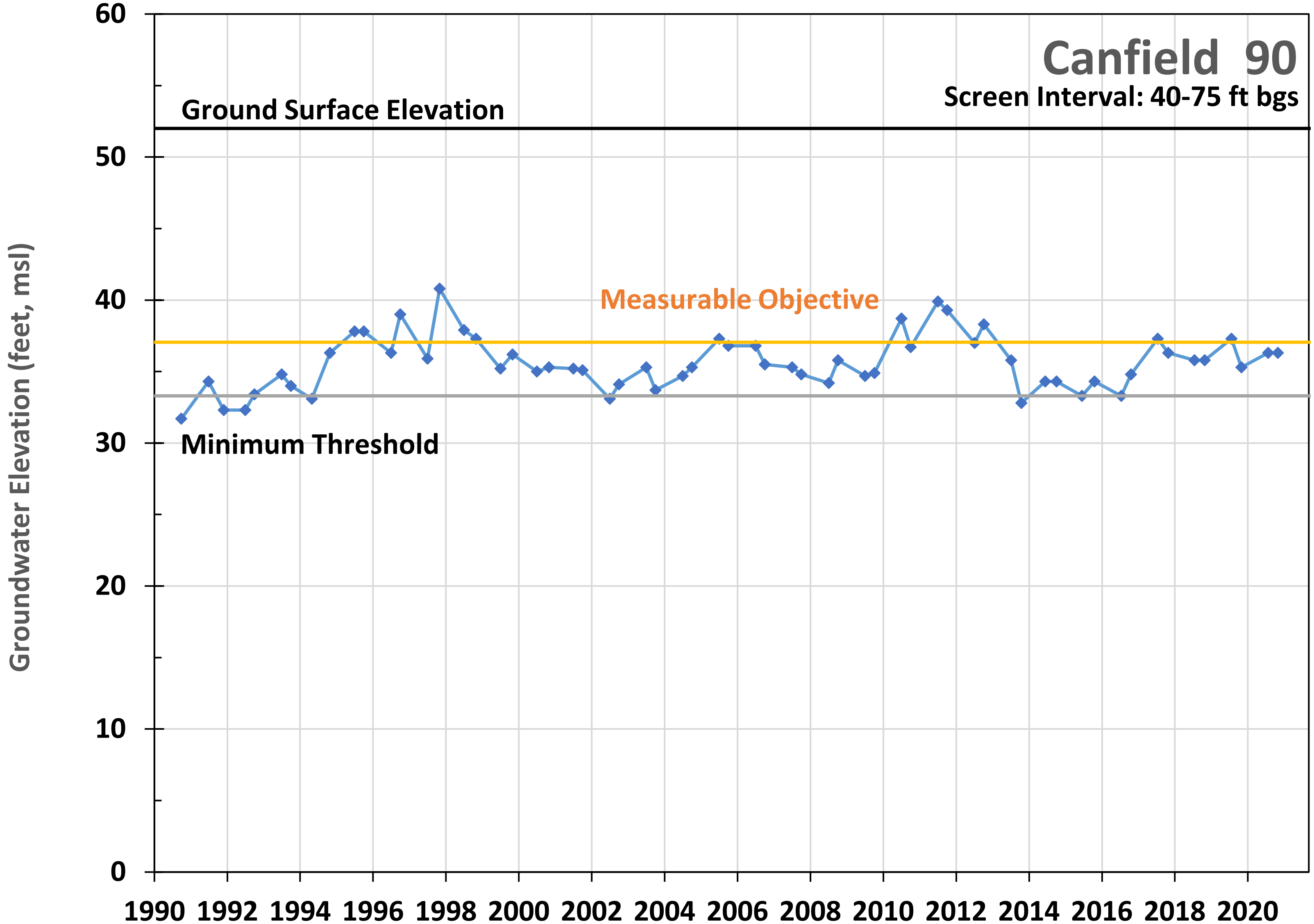

MW-09
Screen Interval: 340-360 ft bgs
Ground Surface Elevation
Measurable Objective
Minimum Threshold
Interim Milestone (2027)
Groundwater Elevation (feet, msl)
270
260
250
240
230
220
210
200
190
180
170
160
150
140
130
120
110
100
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016
2018
2020

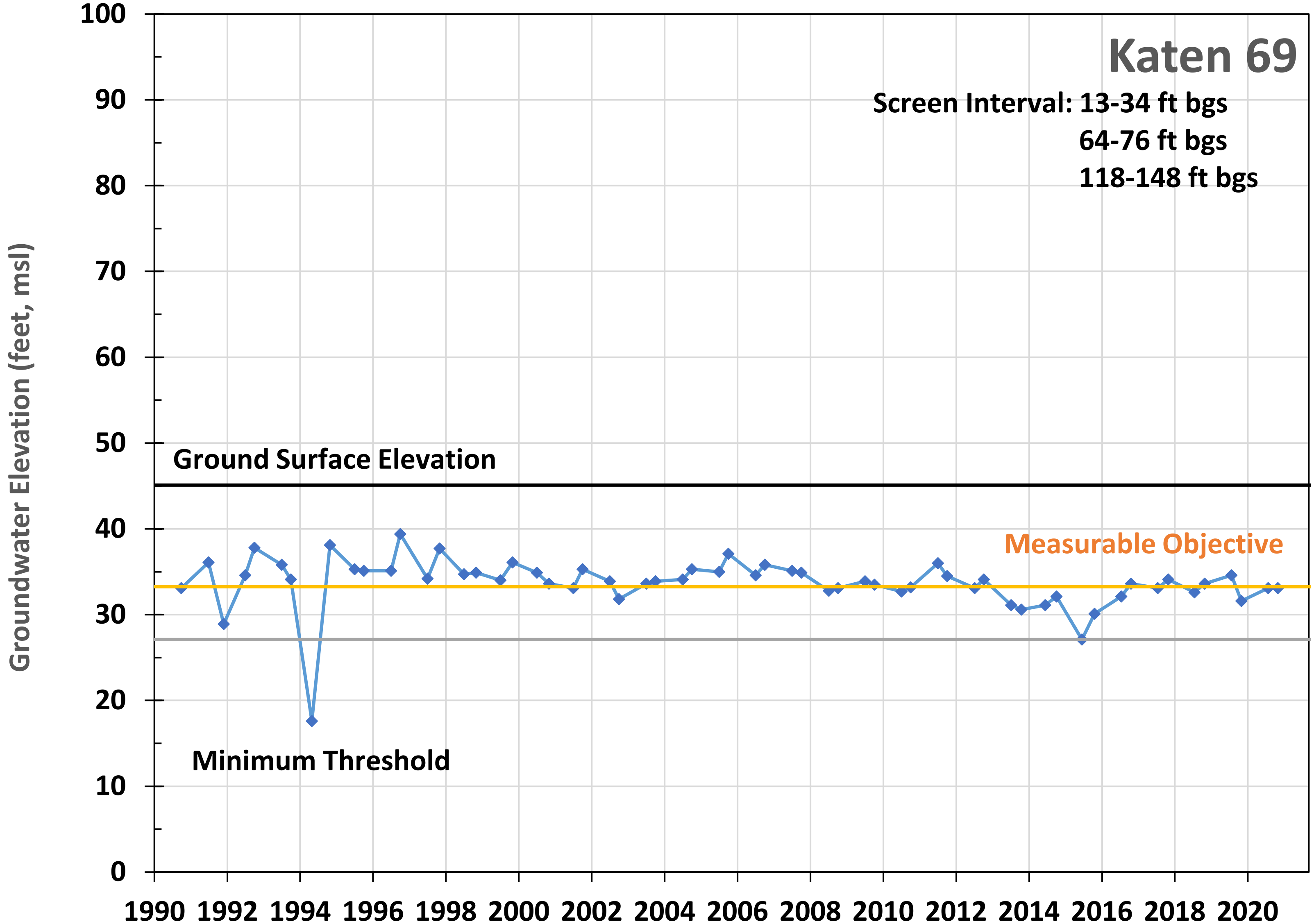

Ground Surface Elevation: 259 ft
MW-10
Screen Interval: 240-260 ft bgs
Measurable Objective
Minimum Threshold
Interim Milestone (2027)
Groundwater Elevation (feet, msl)
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016
2018
2020

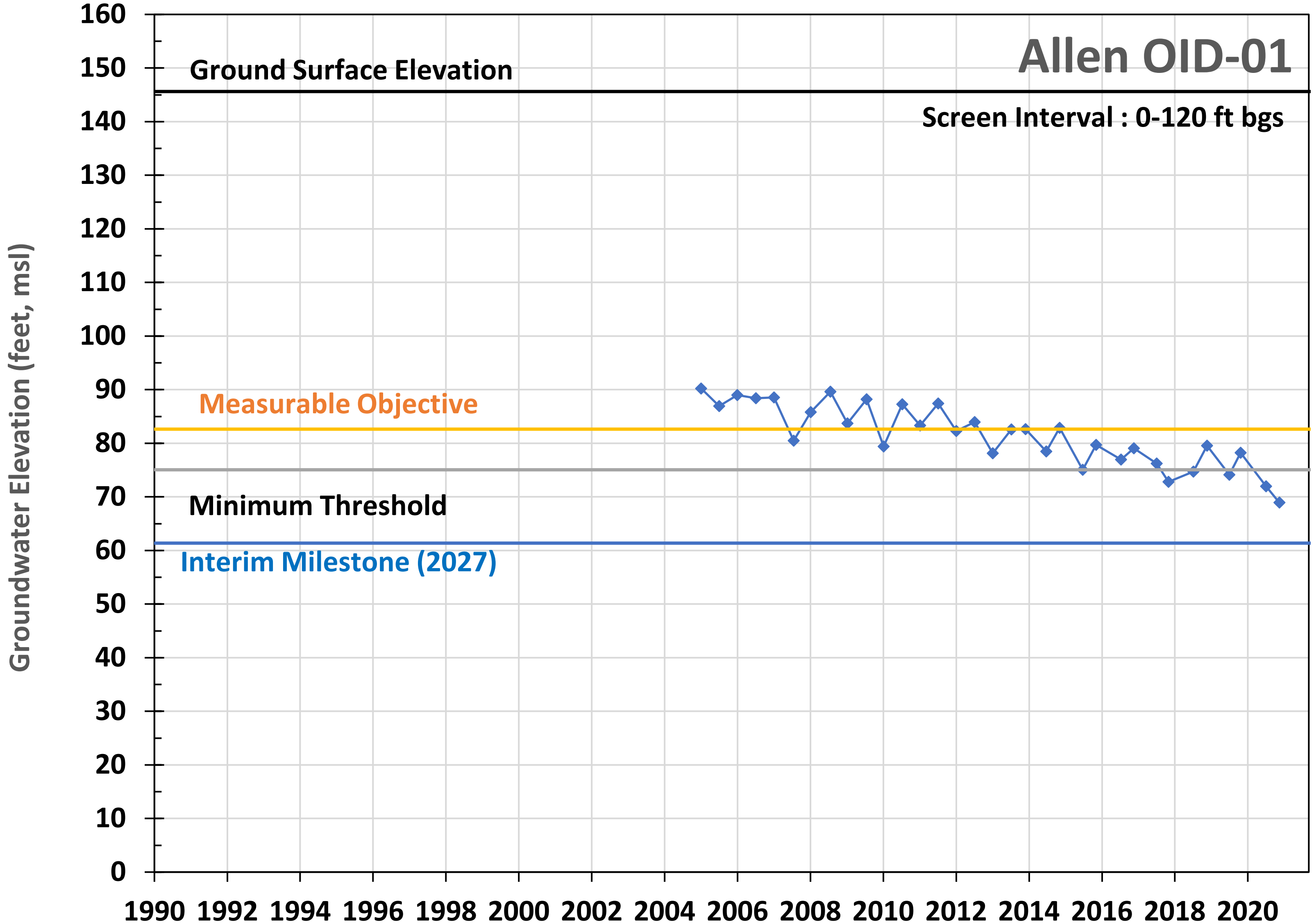

MW 11
Screen Interval: 150-170 ft bgs
Ground Surface Elevation: 118 ft
Measurable Objective
Minimum Threshold
Groundwater Elevation (feet, msl)
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016
2018
2020

Hydrographs for Wells in the Monitoring Network for Depletions of Interconnected Surface Water

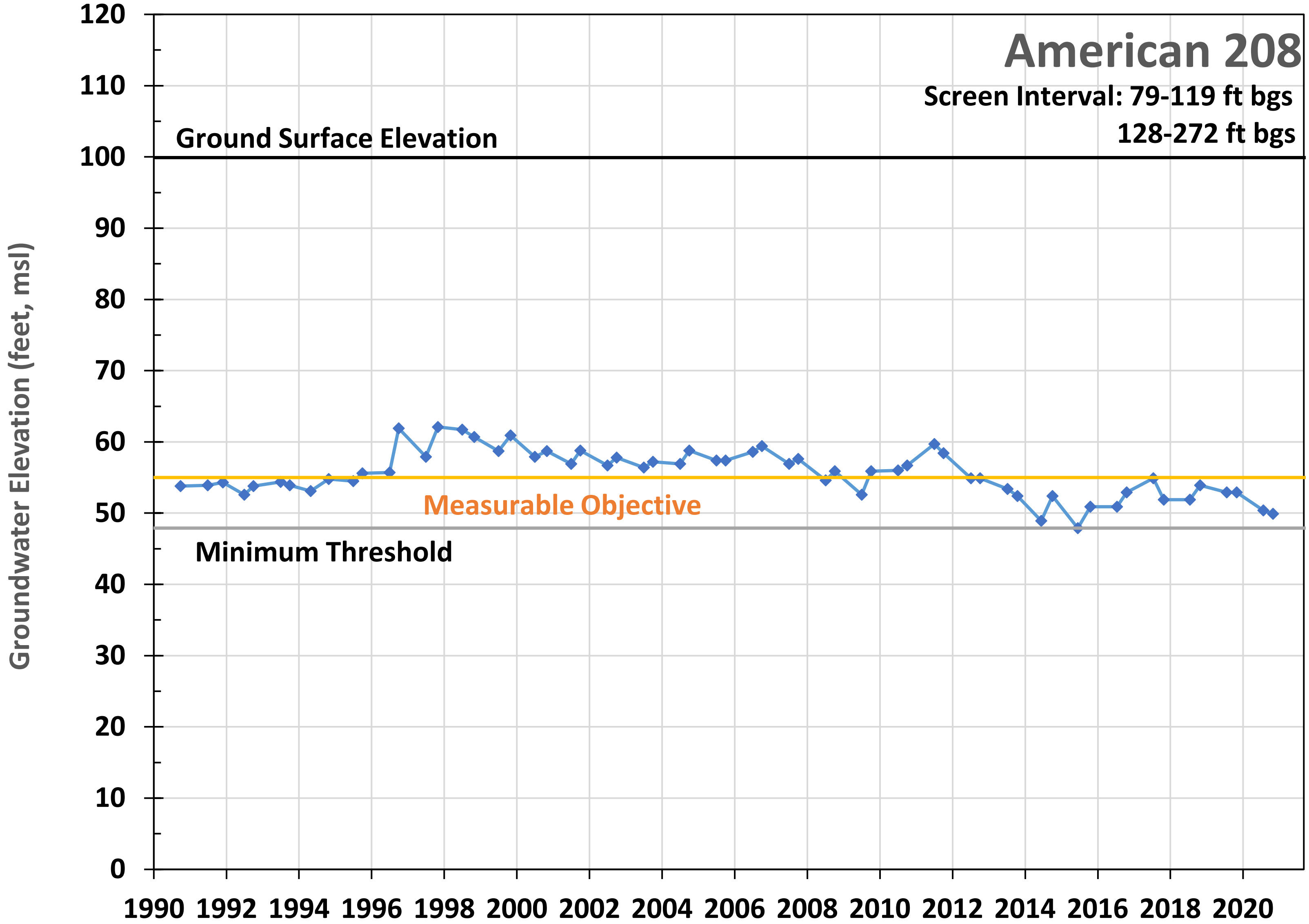
(in the order as they appear on Table 7-3)

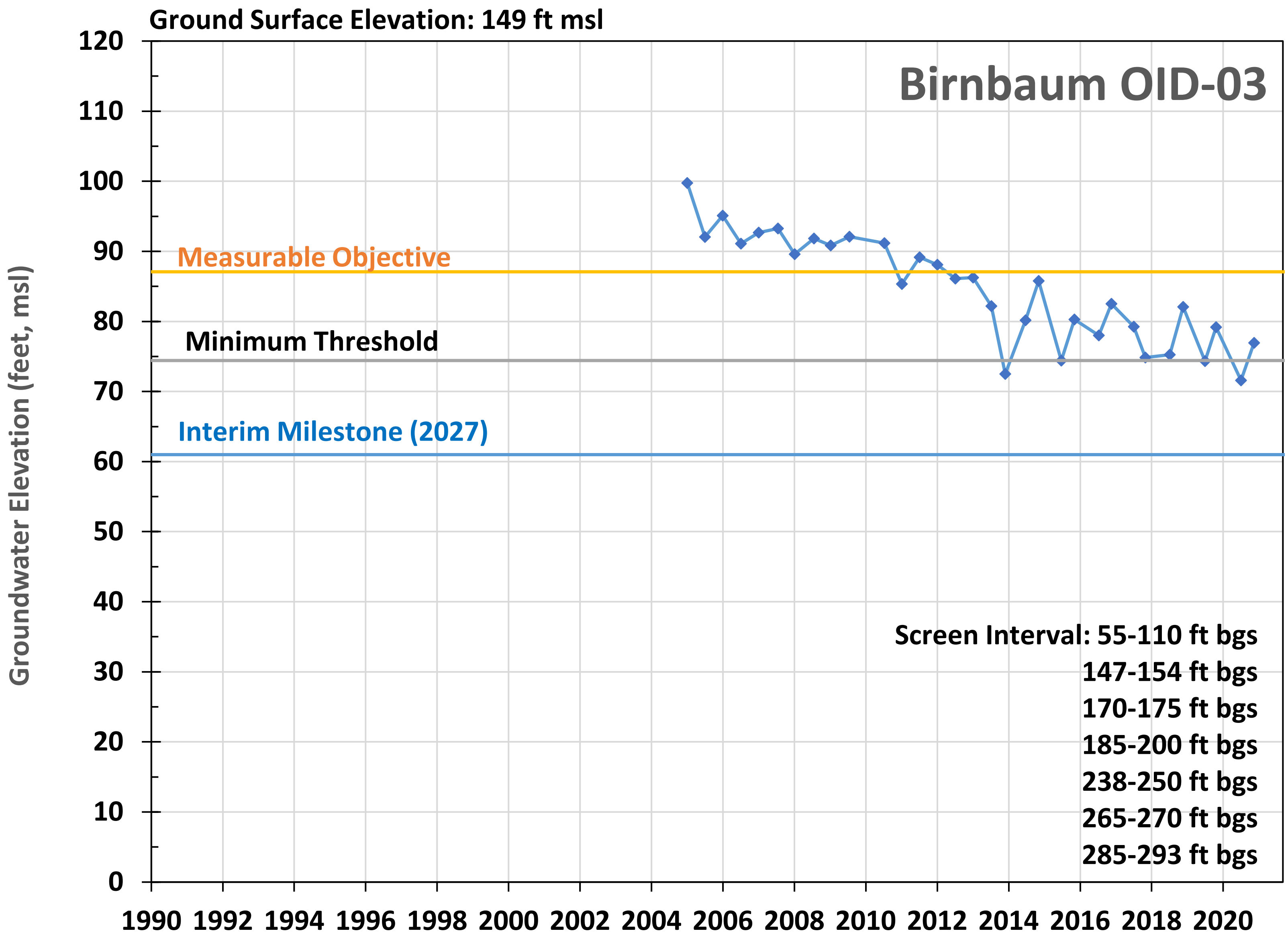

Canfield 90
Screen Interval: 40-75 ft bgs
Ground Surface Elevation
Measurable Objective
Minimum Threshold
Groundwater Elevation (feet, msl)
60
50
40
30
20
10
0
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016
2018
2020


Katen 69
Screen Interval: 13-34 ft bgs
64-76 ft bgs
118-148 ft bgs
Ground Surface Elevation
Measurable Objective
Minimum Threshold
Groundwater Elevation (feet, msl)
100
90
80
70
60
50
40
30
20
10
0
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016
2018
2020

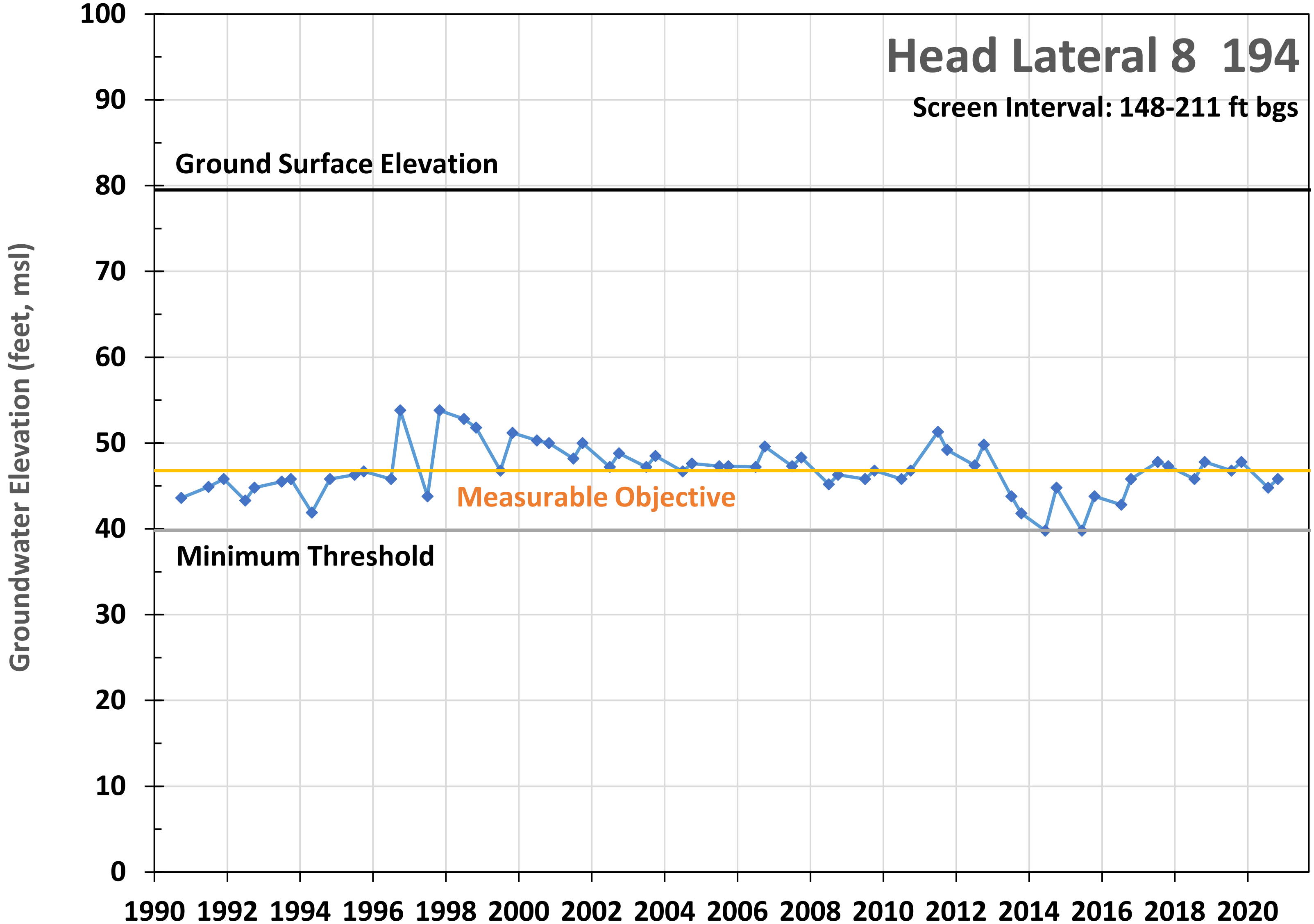


Allen OID-01
Ground Surface Elevation
Screen Interval : 0-120 ft bgs
Measurable Objective
Minimum Threshold
Interim Milestone (2027)
Groundwater Elevation (feet, msl)
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016
2018
2020

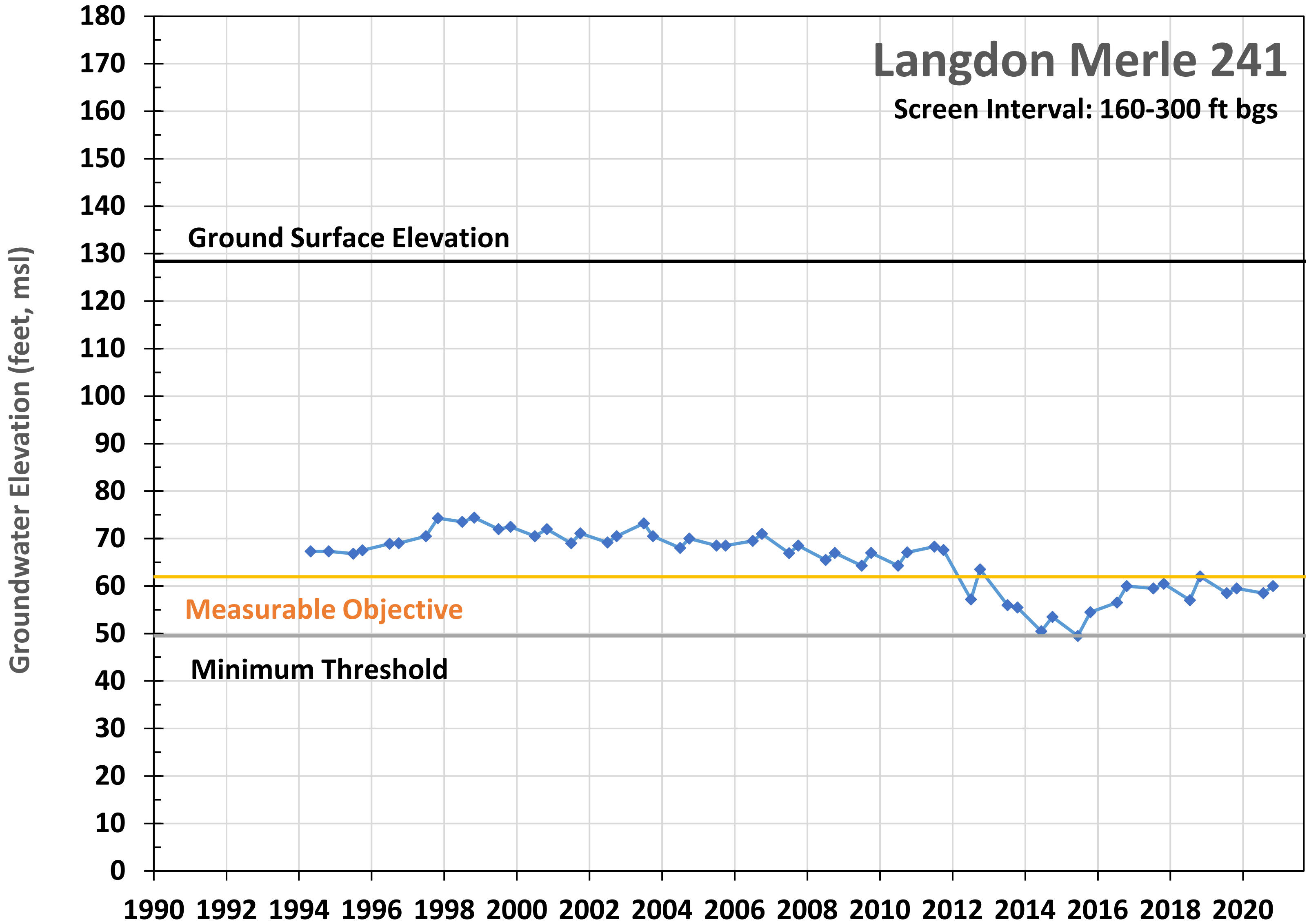

American 208
Screen Interval: 79-119 ft bgs
128-272 ft bgs
Ground Surface Elevation
Measurable Objective
Minimum Threshold
Groundwater Elevation (feet, msl)
0
10
20
30
40
50
60
70
80
90
100
110
120
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016
2018
2020

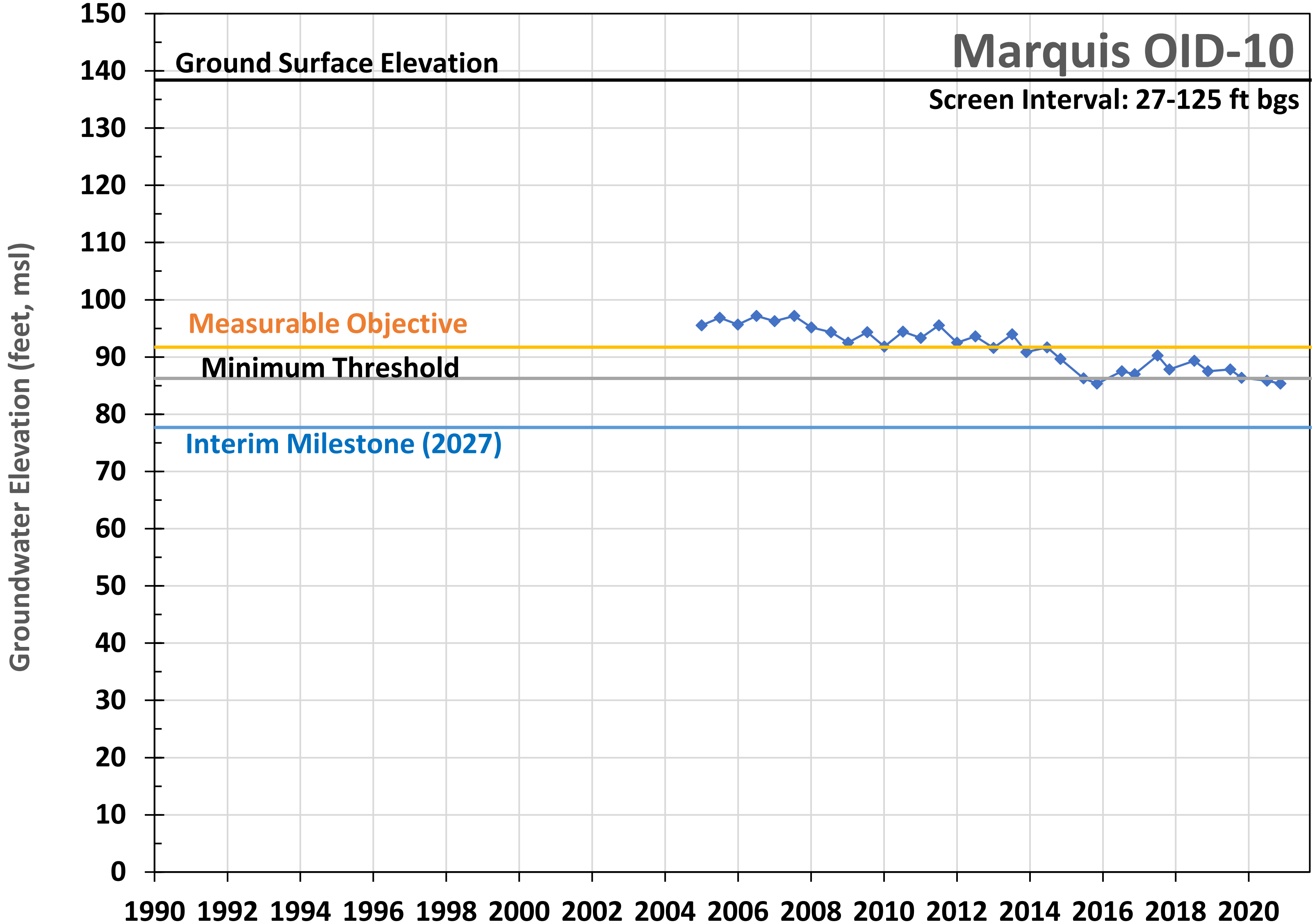


Ground Surface Elevation: 149 ft msl
Birnbaum OID-03
Groundwater Elevation (feet, msl)
Measurable Objective
Minimum Threshold
Interim Milestone (2027)
Screen Interval: 55-110 ft bgs
147-154 ft bgs
170-175 ft bgs
185-200 ft bgs
238-250 ft bgs
265-270 ft bgs
285-293 ft bgs
0
10
20
30
40
50
60
70
80
90
100
110
120
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016
2018
2020

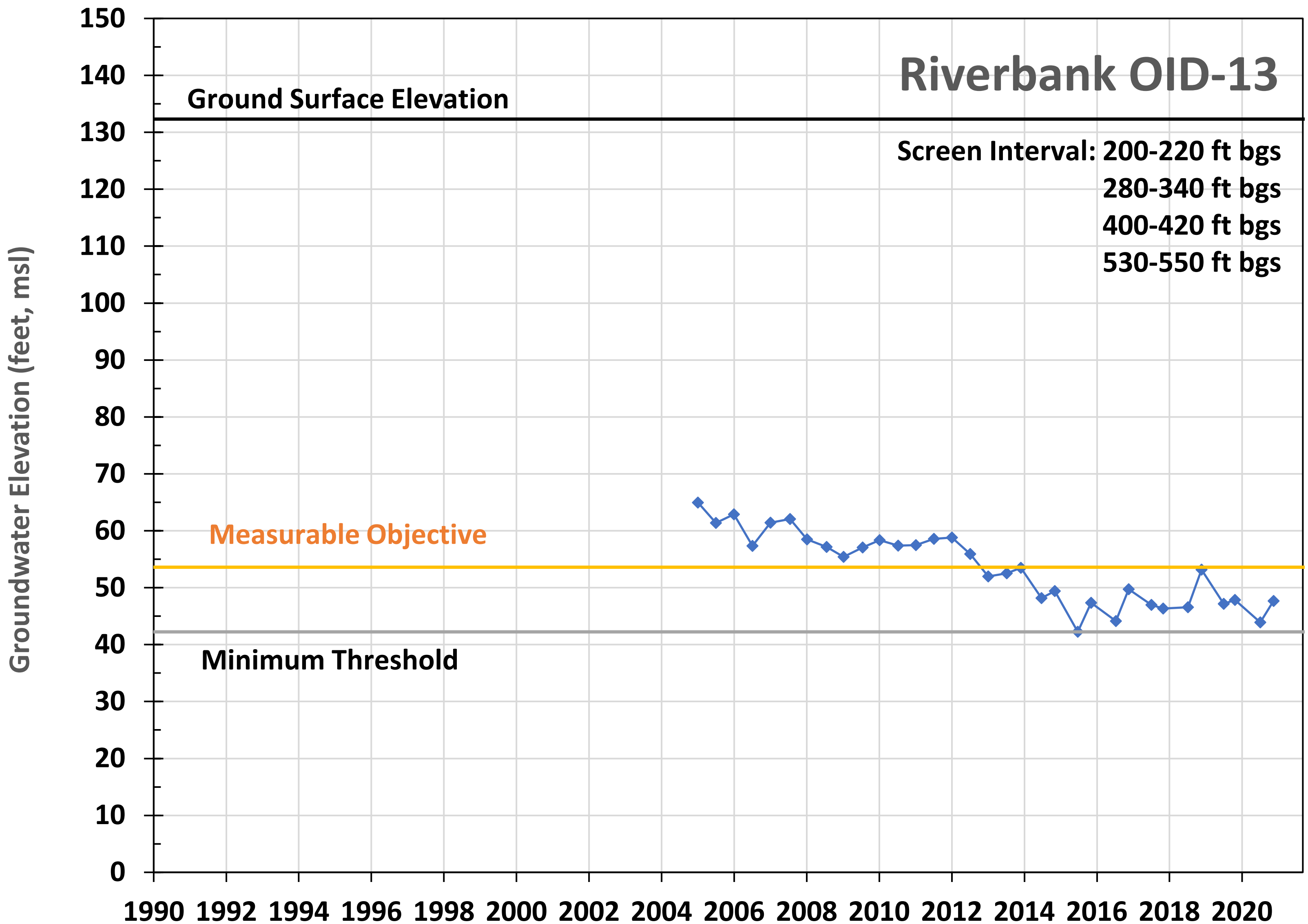


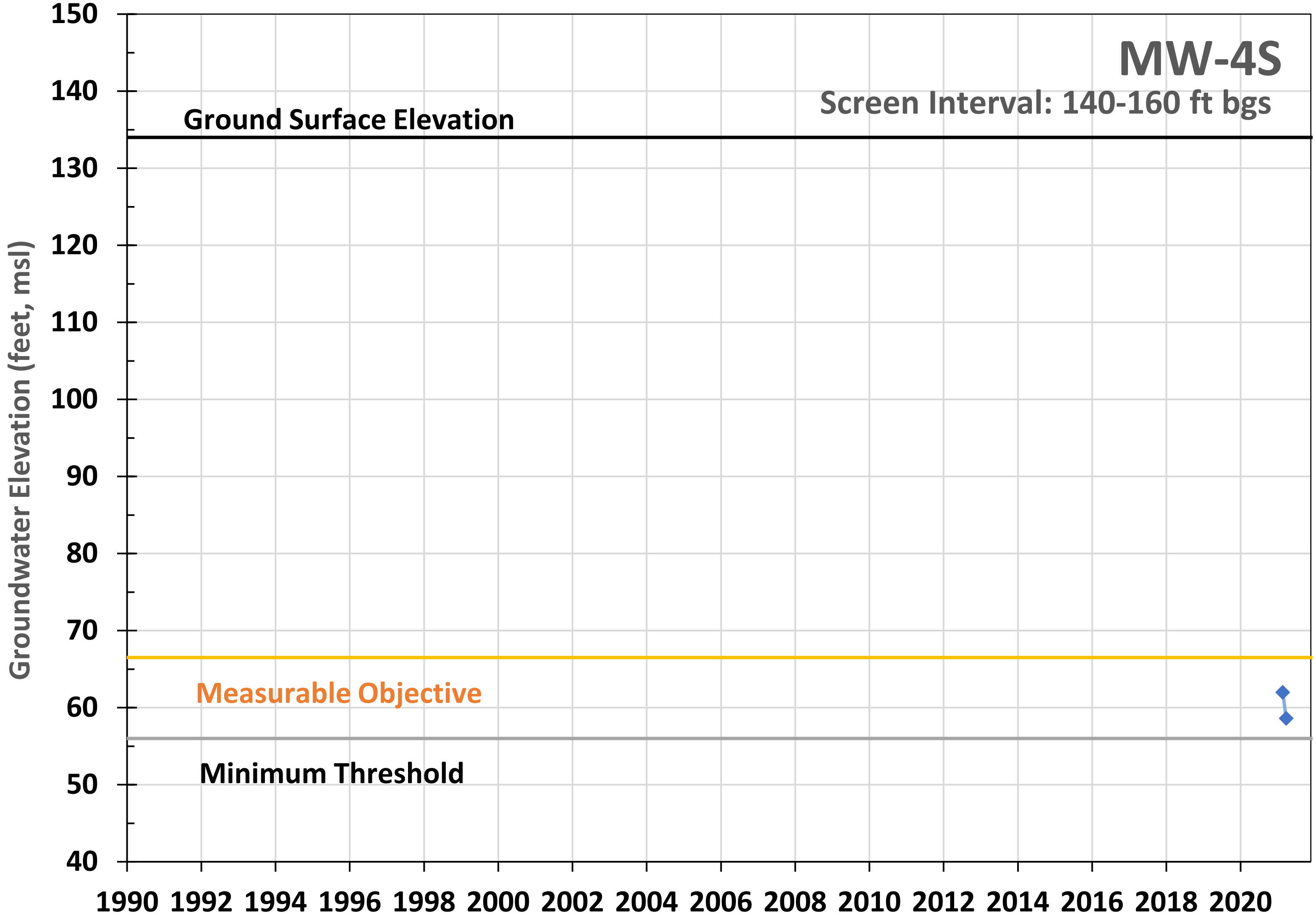
Head Lateral 8 194
Screen Interval: 148-211 ft bgs
Ground Surface Elevation
Measurable Objective
Minimum Threshold
Groundwater Elevation (feet, msl)
100
90
80
70
60
50
40
30
20
10
0
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016
2018
2020

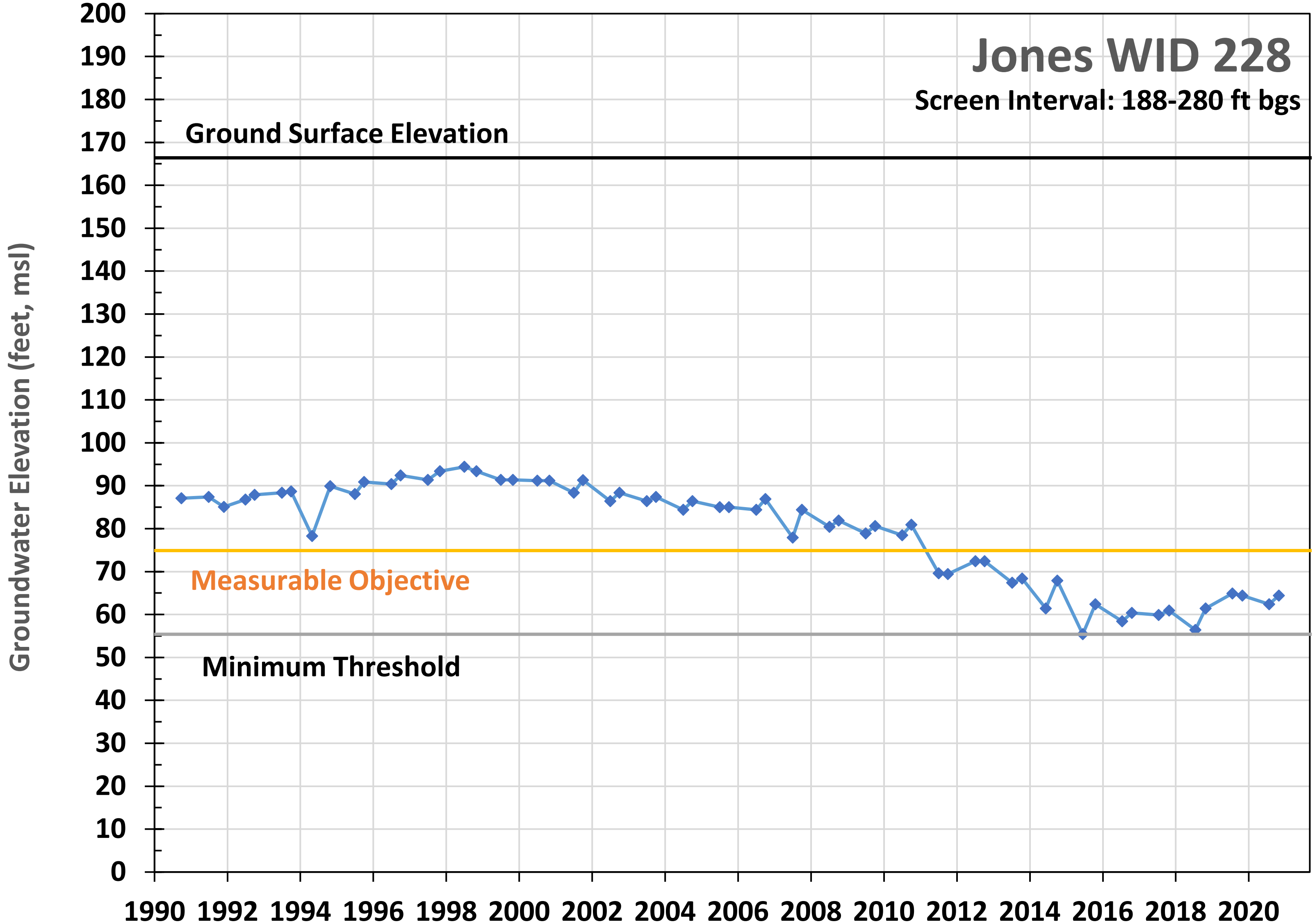

Langdon Merle 241
Screen Interval: 160-300 ft bgs
Ground Surface Elevation
Measurable Objective
Minimum Threshold
Groundwater Elevation (feet, msl)
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016
2018
2020



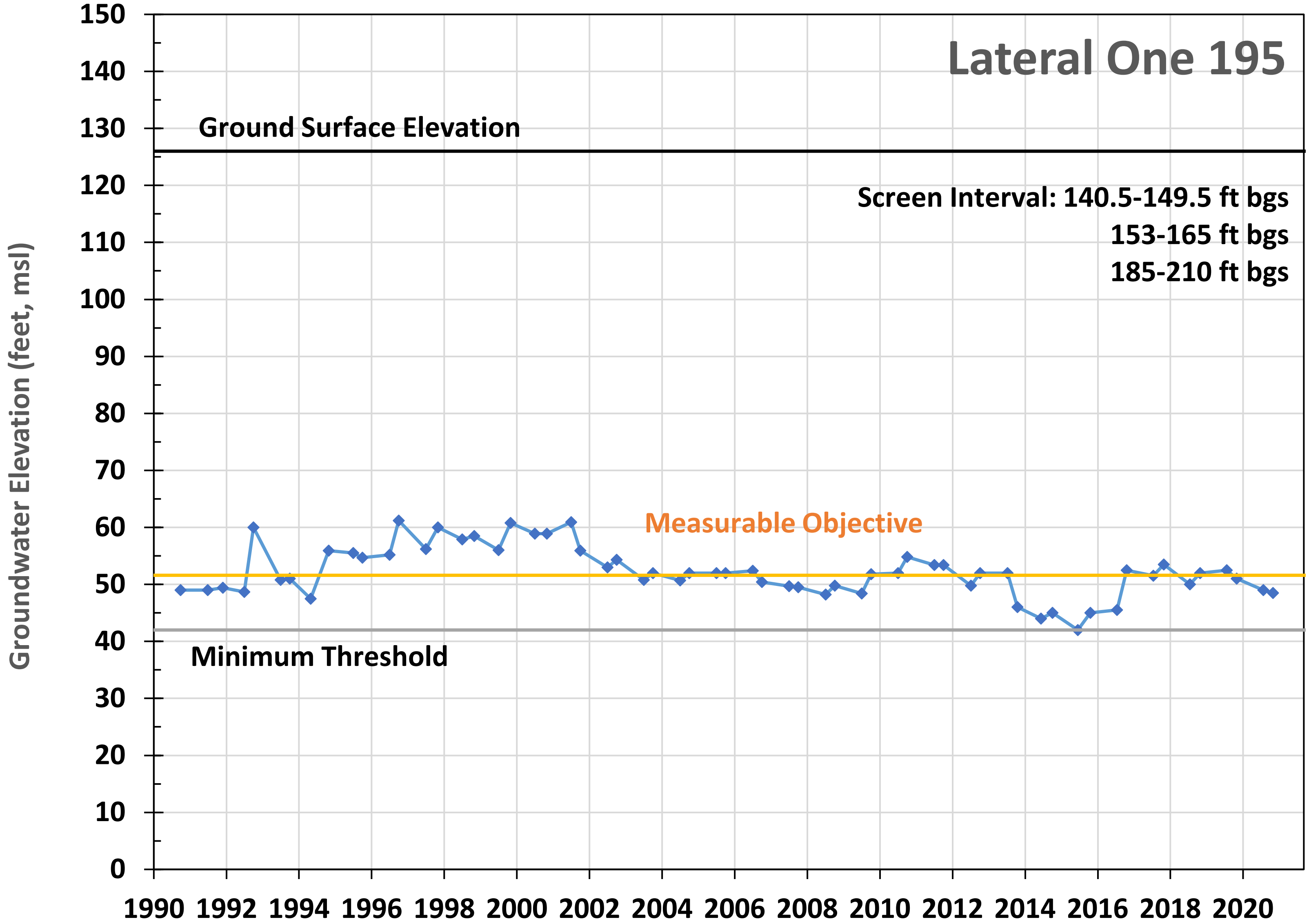
Marquis OID-10
Screen Interval: 27-125 ft bgs
Ground Surface Elevation
Measurable Objective
Minimum Threshold
Interim Milestone (2027)
Groundwater Elevation (feet, msl)
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
1990 1992 1994 1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020

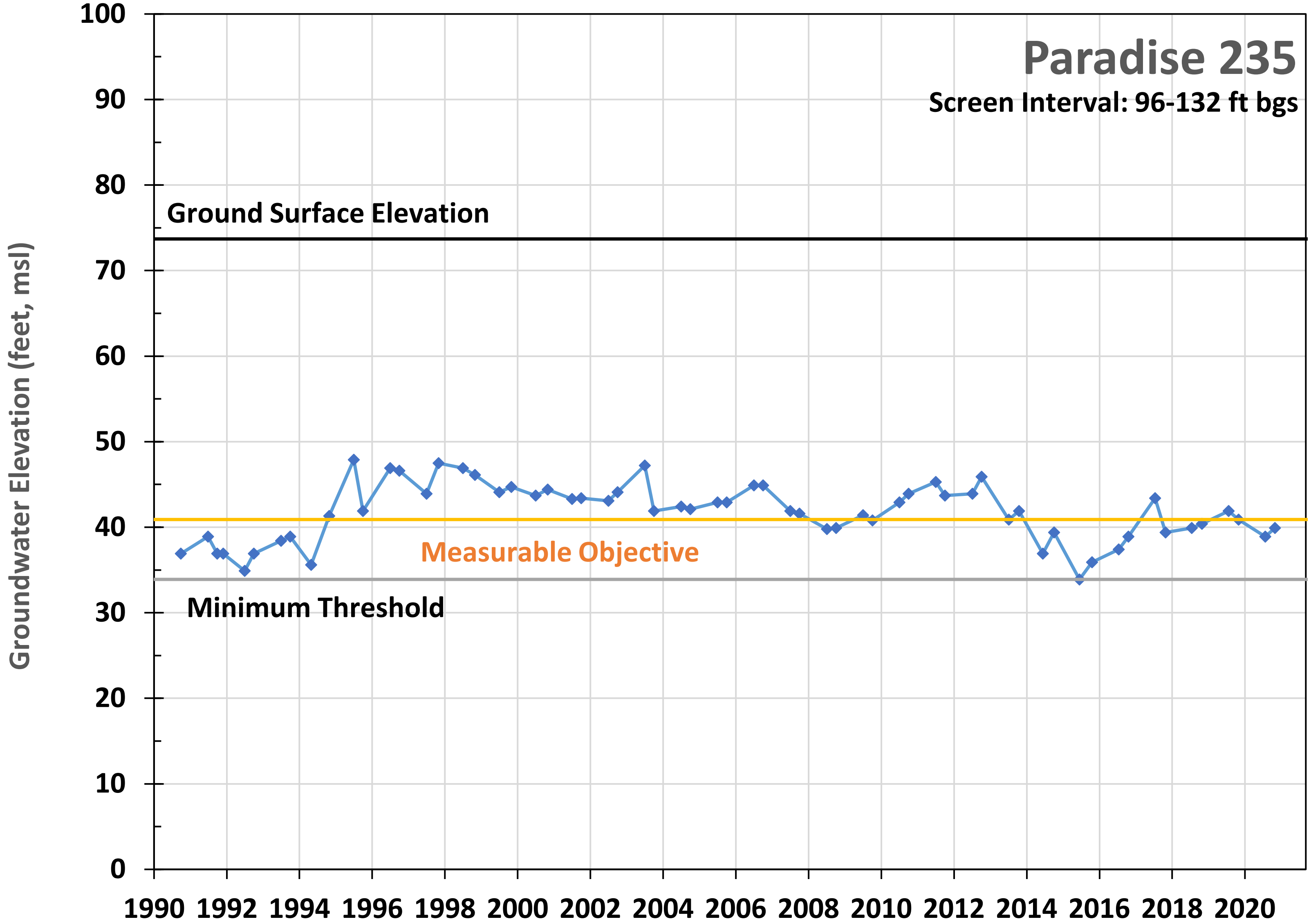

Riverbank OID-13
Ground Surface Elevation
Screen Interval: 200-220 ft bgs
280-340 ft bgs
400-420 ft bgs
530-550 ft bgs
Measurable Objective
Minimum Threshold
Groundwater Elevation (feet, msl)
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
1990 1992 1994 1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020


MW-4S
Screen Interval: 140-160 ft bgs
Ground Surface Elevation
Measurable Objective
Minimum Threshold
Groundwater Elevation (feet, msl)
150
140
130
120
110
100
90
80
70
60
50
40
1990 1992 1994 1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020

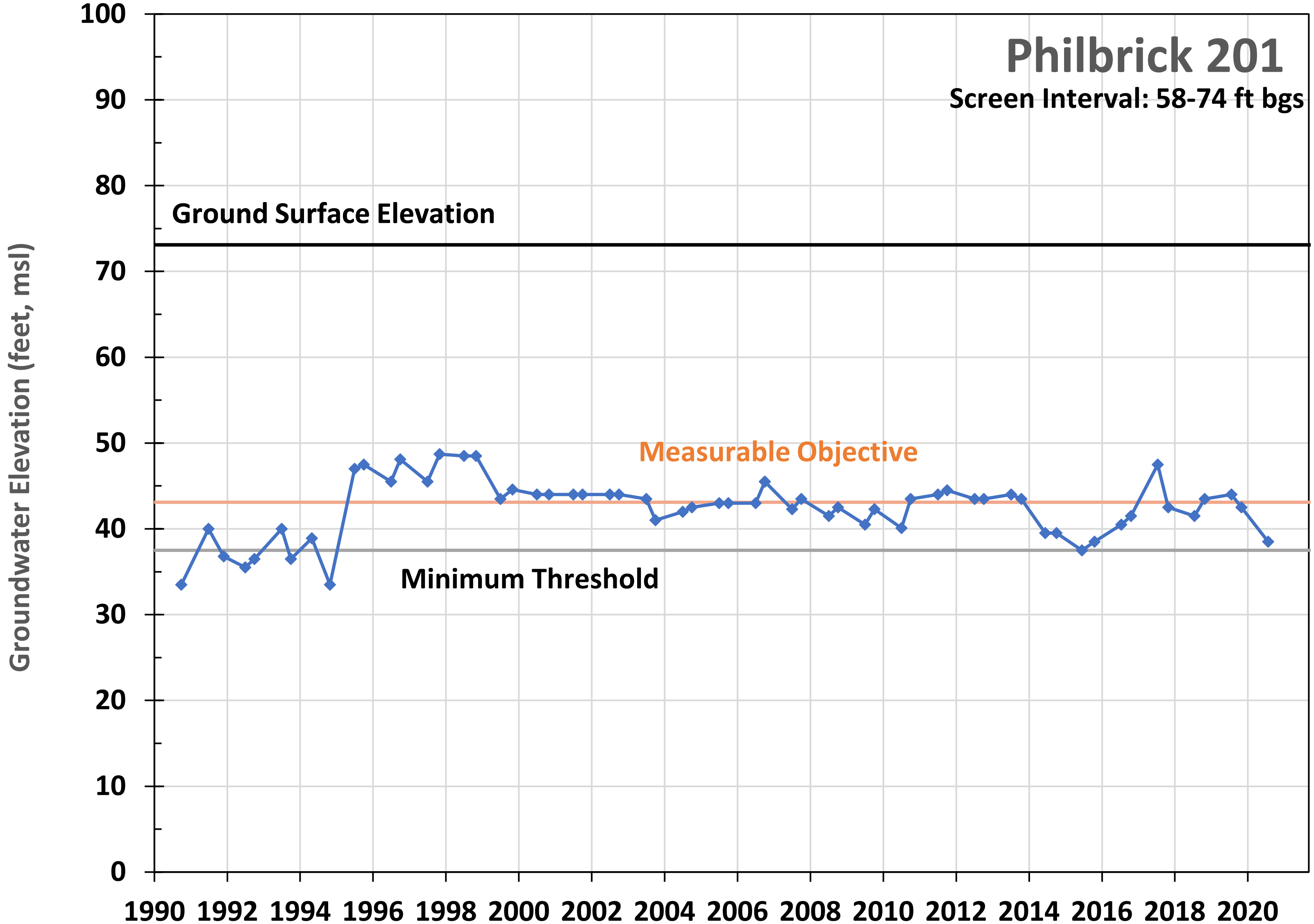


Jones WID 228
Screen Interval: 188-280 ft bgs
Ground Surface Elevation
Measurable Objective
Minimum Threshold
Groundwater Elevation (feet, msl)
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
1990 1992 1994 1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020

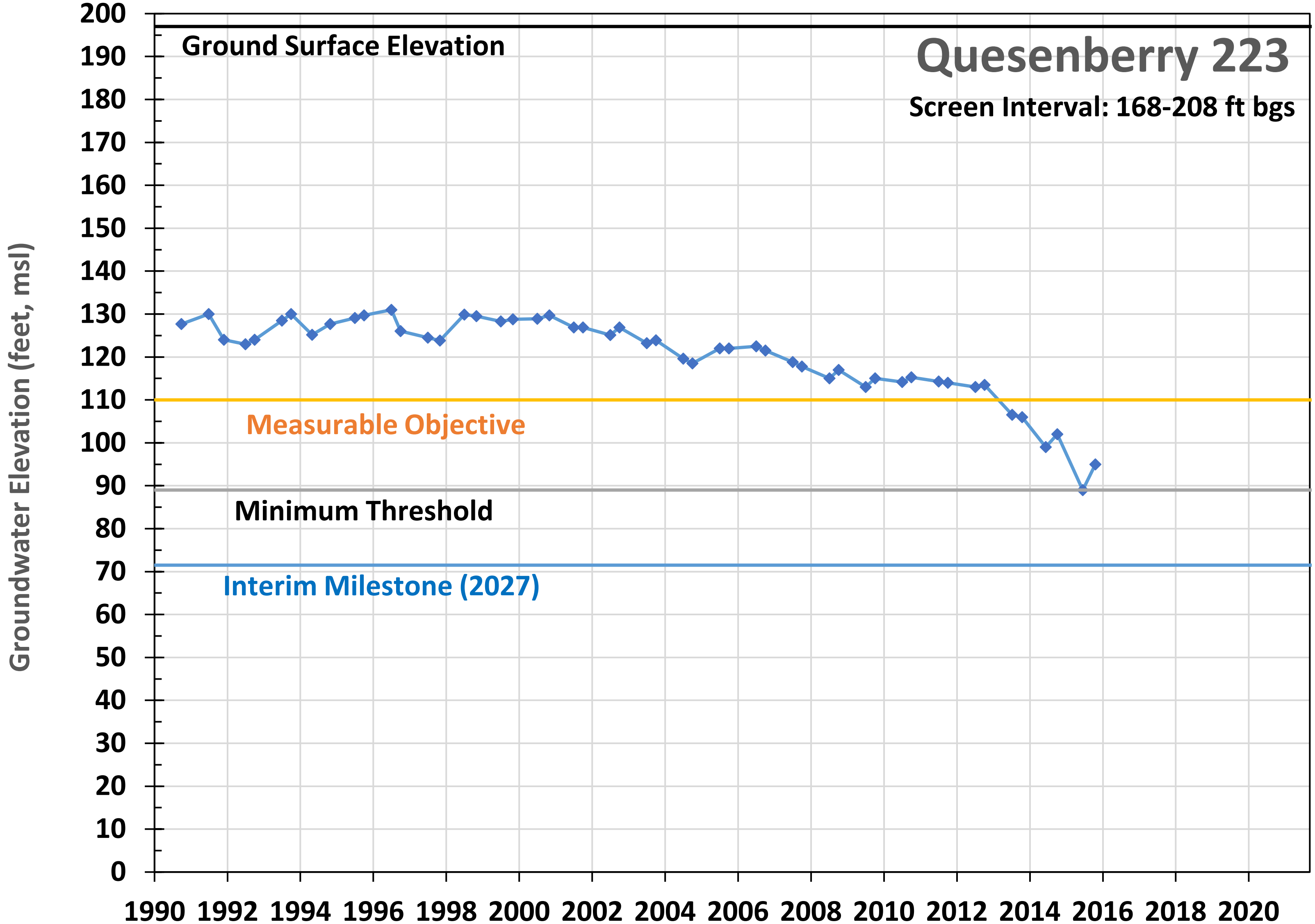

Lateral One 195
Ground Surface Elevation
Screen Interval: 140.5-149.5 ft bgs
153-165 ft bgs
185-210 ft bgs
Measurable Objective
Minimum Threshold
Groundwater Elevation (feet, msl)
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016
2018
2020

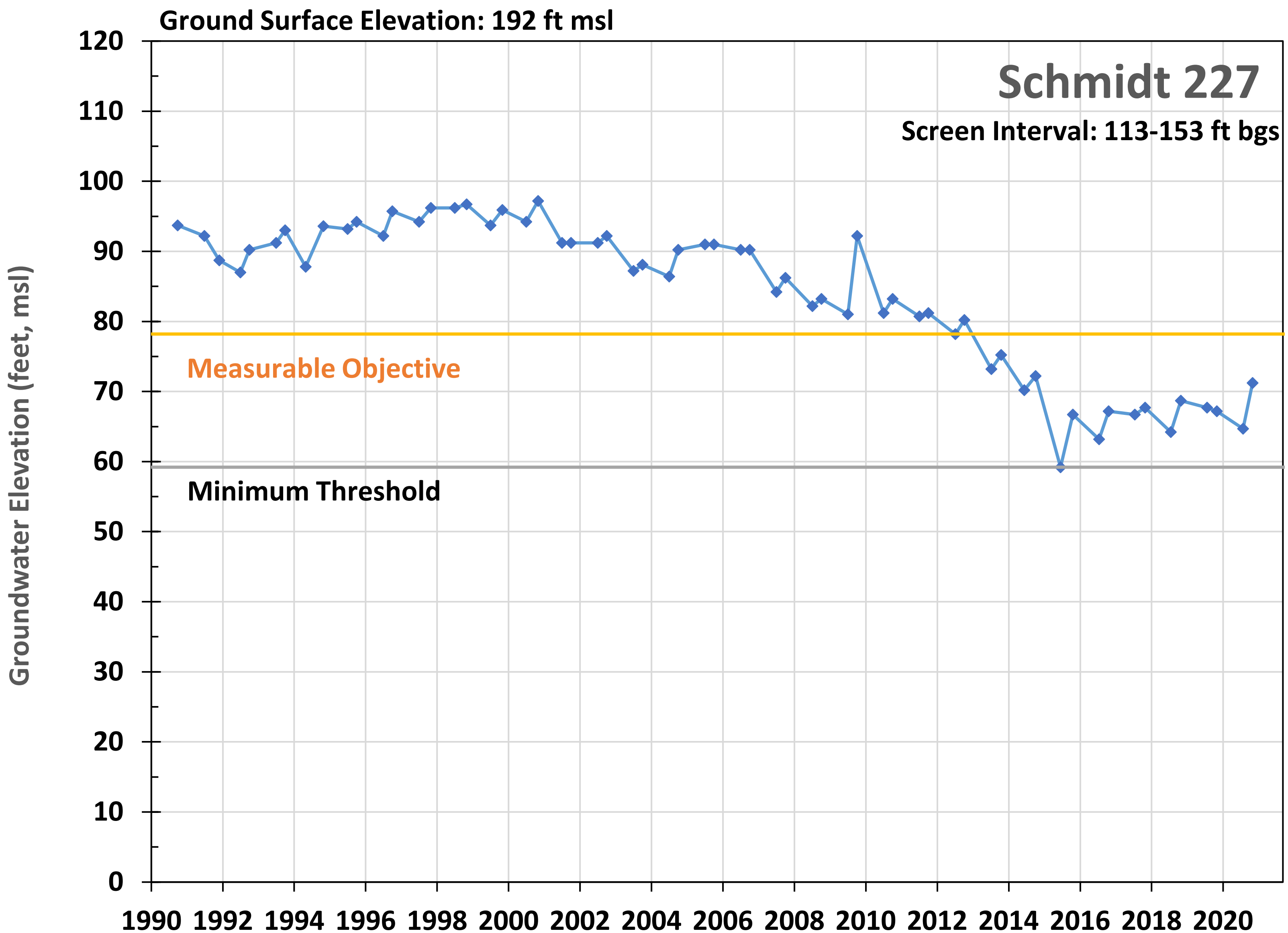


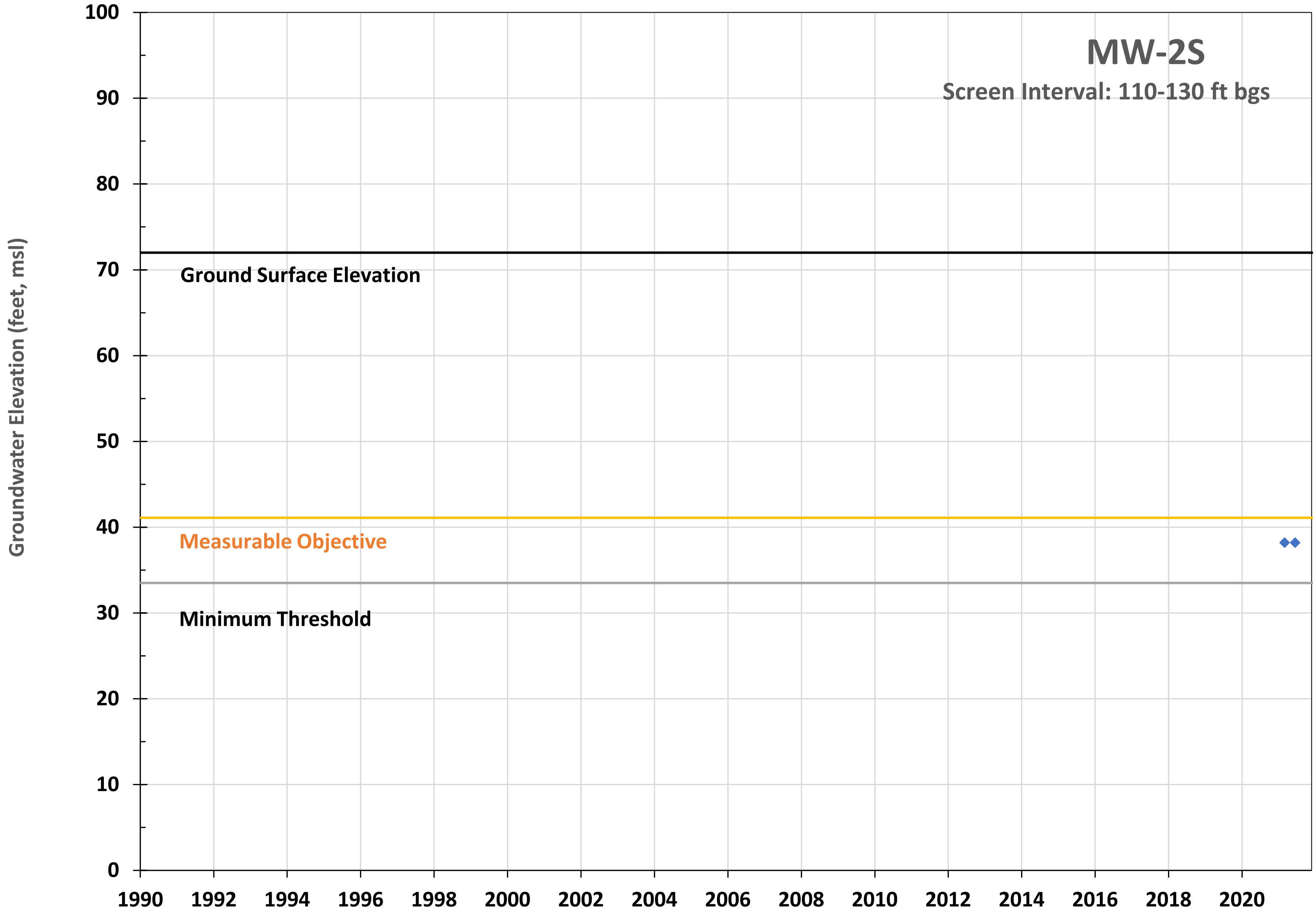
Paradise 235
Screen Interval: 96-132 ft bgs
Ground Surface Elevation
Measurable Objective
Minimum Threshold
Groundwater Elevation (feet, msl)
100
90
80
70
60
50
40
30
20
10
0
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016
2018
2020

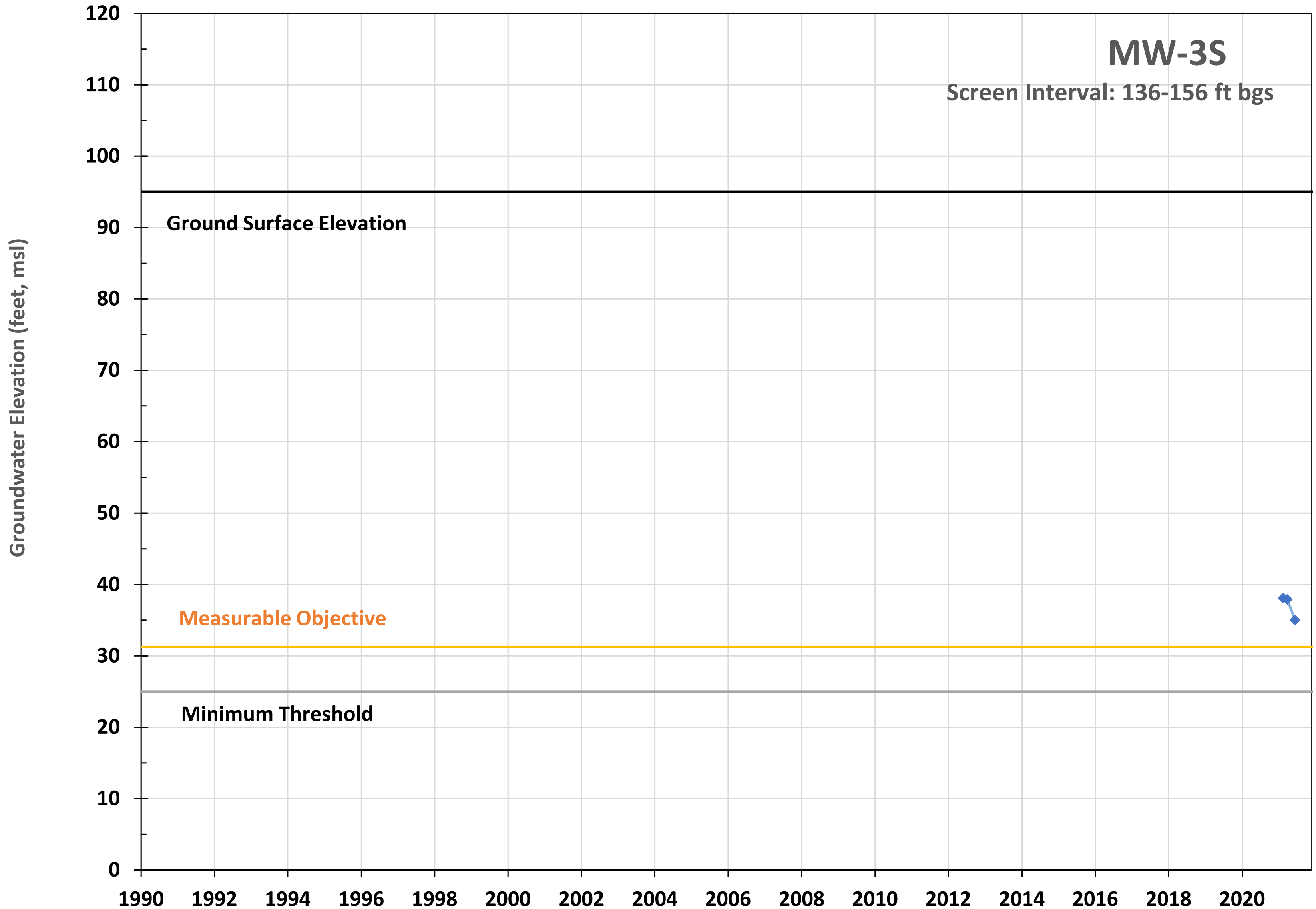


Philbrick 201
Screen Interval: 58-74 ft bgs
Ground Surface Elevation
Measurable Objective
Minimum Threshold
Groundwater Elevation (feet, msl)
100
90
80
70
60
50
40
30
20
10
0
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016
2018
2020

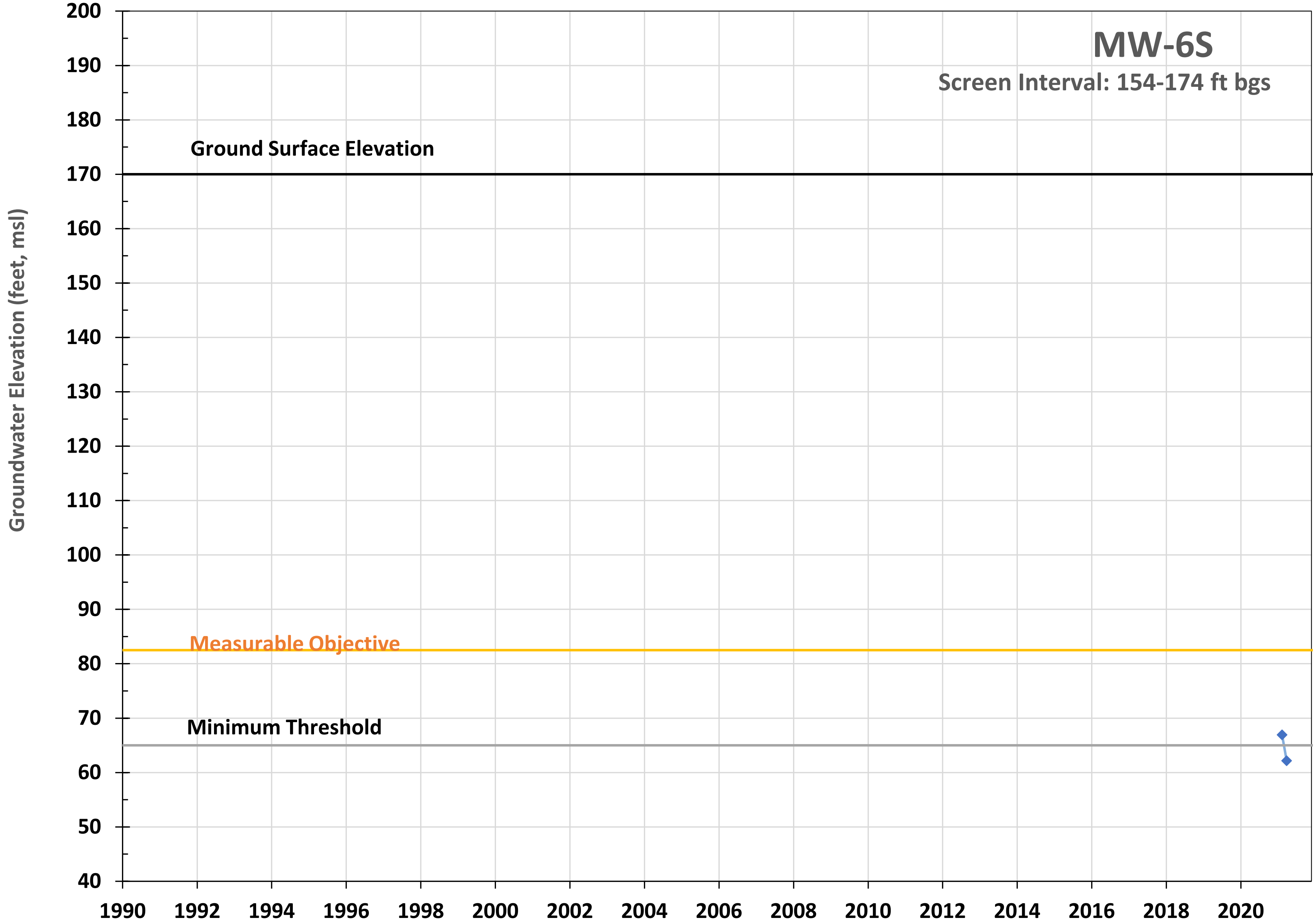

Quesenberry 223
Screen Interval: 168-208 ft bgs
Ground Surface Elevation
Measurable Objective
Minimum Threshold
Interim Milestone (2027)
Groundwater Elevation (feet, msl)
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
1990 1992 1994 1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020

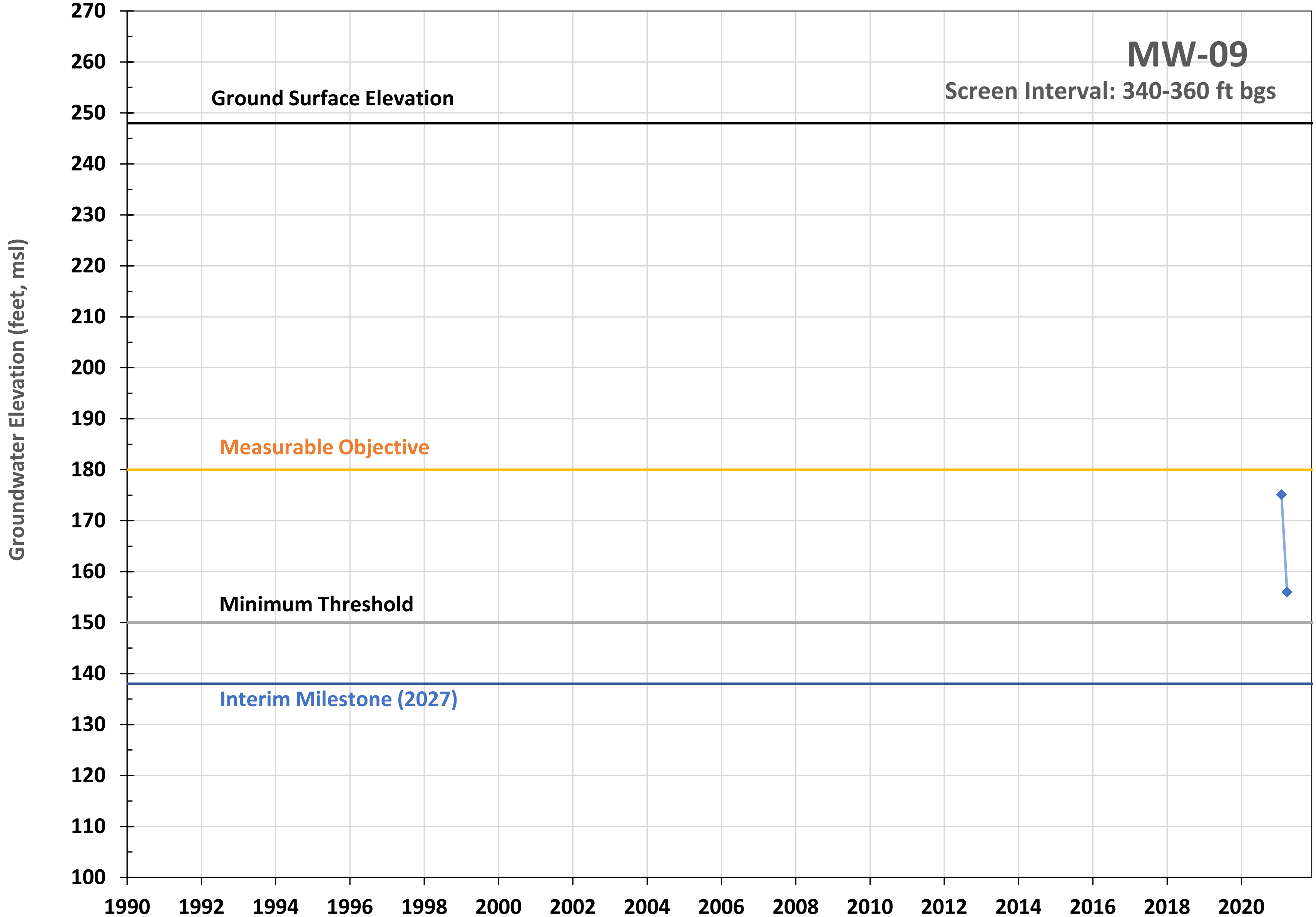

Ground Surface Elevation: 192 ft msl
Schmidt 227
Screen Interval: 113-153 ft bgs
Measurable Objective
Minimum Threshold
Groundwater Elevation (feet, msl)
0
10
20
30
40
50
60
70
80
90
100
110
120
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016
2018
2020


MW-2S
Screen Interval: 110-130 ft bgs
Groundwater Elevation (feet, msl)
Ground Surface Elevation
Measurable Objective
Minimum Threshold
100
90
80
70
60
50
40
30
20
10
0
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016
2018
2020



MW-3S
Screen Interval: 136-156 ft bgs
Ground Surface Elevation
Measurable Objective
Minimum Threshold
Groundwater Elevation (feet, msl)
0
10
20
30
40
50
60
70
80
90
100
110
120
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016
2018
2020


MW-6S
Screen Interval: 154-174 ft bgs
Ground Surface Elevation
Measurable Objective
Minimum Threshold
Groundwater Elevation (feet, msl)
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016
2018
2020



MW-09
Screen Interval: 340-360 ft bgs
Ground Surface Elevation
Measurable Objective
Minimum Threshold
Interim Milestone (2027)
Groundwater Elevation (feet, msl)
270
260
250
240
230
220
210
200
190
180
170
160
150
140
130
120
110
100
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016
2018
2020

Appendix G

Water Quality Monitoring Network

Appendix G - Water Quality Monitoring Network

Well ID	Latitude	Longitude	Well Type	Well Depth (ft bgs)	Top of Screen (ft bgs)	Screen Length (ft)	Dataset Name	Alternative Well ID	Alternative Well ID 2	Water Quality Parameters						
										Nitrate	Uranium	PCE	TCP	DBCP	TDS	Arsenic
AGW080011487-6813	37.66217	-120.86911	Domestic	0	0	0	AGLAND	6813	6813	x						
AGW080012448-MCEWEN	37.63413	-120.81047	Domestic	0	0	0	AGLAND	MCEWEN	MCEWEN	x						
AGW080011757-WVD1	37.72876	-120.65104	Domestic	0	0	0	AGLAND	WVD1	WVD1	x						
AGW080011759-LRD1	37.75982	-120.80018	Domestic	0	0	0	AGLAND	LRD1	LRD1	x						
AGW080012802-566	37.64760	-120.87470	Domestic	0	0	0	AGLAND	566	566	x						
AGW080012137-NDW	37.78267	-120.73881	Domestic	0	0	0	AGLAND	NDW	NDW	x						
AGW080011831-SAL	37.72807	-121.09417	Domestic	0	0	0	AGLAND	SAL	SAL	x						
AGW080011066-HOME	37.65984	-120.73983	Domestic	0	0	0	AGLAND	HOME	HOME	x						
AGW080013073-6442	37.67991	-120.87642	Domestic	0	0	0	AGLAND	6442	6442	x						
AGW080011022-541	37.65261	-120.89410	Domestic	0	0	0	AGLAND	541	541	x						
AGW080010972-HOUSE F	37.69667	-120.77267	Domestic	0	0	0	AGLAND	HOUSE F	HOUSE F	x						
AGW080012608-RUBBERT	37.65216	-120.74834	Domestic	0	0	0	AGLAND	RUBBERT	RUBBERT	x						
AGW080012240-W#1	37.65495	-120.92531	Domestic	0	0	0	AGLAND	W#1	W#1	x						
AGW080012064-5618	37.71954	-120.90549	Domestic	0	0	0	AGLAND	5618	5618	x						
AGW080012136-SDW	37.77879	-120.73608	Domestic	0	0	0	AGLAND	SDW	SDW	x						
AGW080010977-JKSN CLABL	37.71079	-120.67741	Domestic	0	0	0	AGLAND	JKSN CLABL	JKSN CLABL	x						
AGW080012464-HOME	37.59192	-121.09463	Domestic	0	0	0	AGLAND	HOME	HOME	x						
AGW080010967-HOUSE	37.69013	-120.79227	Domestic	0	0	0	AGLAND	HOUSE	HOUSE	x						
AGW080011786-HOME	37.70469	-121.06488	Domestic	0	0	0	AGLAND	HOME	HOME	x						
AGW080012405-5261	37.75763	-120.89916	Domestic	0	0	0	AGLAND	5261	5261	x						
AGW080011855-1772	37.61476	-121.05149	Domestic	0	0	0	AGLAND	1772	1772	x						
AGW080012636-KLINE	37.73240	-120.96980	Domestic	0	0	0	AGLAND	KLINE	KLINE	x						
AGW080013064-PATT	37.73042	-120.97544	Domestic	0	0	0	AGLAND	PATT	PATT	x						
AGW080012671-HAZL	37.64383	-120.86108	Domestic	0	0	0	AGLAND	HAZL	HAZL	x						
AGW080012016-3136	37.70185	-120.93718	Domestic	0	0	0	AGLAND	3136	3136	x						
AGW080012605-WEBB	37.67504	-120.69885	Domestic	0	0	0	AGLAND	WEBB	WEBB	x						
AGW080011034-6245	37.72105	-121.11248	Domestic	0	0	0	AGLAND	6245	6245	x						
AGW080012192-848	37.72874	-121.00560	Domestic	0	0	0	AGLAND	848	848	x						
AGW080012666-1649	37.61769	-121.04054	Domestic	0	0	0	AGLAND	1649	1649	x						
AGW080011020-661	37.65012	-120.89588	Domestic	0	0	0	AGLAND	661	661	x						
AGW080011823-1081	37.65770	-120.70782	Domestic	0	0	0	AGLAND	1081	1081	x						
AGW080010974-HULLER	37.68141	-120.76551	Domestic	0	0	0	AGLAND	HULLER	HULLER	x						
AGW080012665-4600	37.62013	-121.07802	Domestic	0	0	0	AGLAND	4600	4600	x						
AGW080012670-A1	37.73970	-120.78800	Domestic	0	0	0	AGLAND	A1	A1	x						
AGW080012806-BARN	37.66602	-120.70584	Domestic	0	0	0	AGLAND	BARN	BARN	x						
AGW080011346-WALI	37.71874	-120.80881	Domestic	0	0	0	AGLAND	WALI	WALI	x						
AGW080010979-ALMONDS	37.68781	-120.64916	Domestic	0	0	0	AGLAND	ALMONDS	ALMONDS	x						
AGW080011876-530	37.63100	-121.06498	Domestic	0	0	0	AGLAND	530	530	x						
AGW080010973-HUDSON	37.71083	-120.77460	Domestic	0	0	0	AGLAND	HUDSON	HUDSON	x						
AGW080012447-CRABTREE	37.63413	-120.81047	Domestic	0	0	0	AGLAND	CRABTREE	CRABTREE	x						
AGW080013324-8142	37.70896	-121.14608	Domestic	0	0	0	AGLAND	8142	8142	x						
AGW080011877-431	37.63428	-121.06490	Domestic	0	0	0	AGLAND	431	431	x						
AGW080010535-HOME	37.67591	-120.54922	Domestic	0	0	0	AGLAND	HOME	HOME	x						
AGW080012678-WELL	37.63396	-120.84524	Domestic	0	0	0	AGLAND	WELL	WELL	x						
AGW080012607-BC WARD	37.65175	-120.74515	Domestic	0	0	0	AGLAND	BC WARD	BC WARD	x						
AGW080011375-HOUSE WEL	37.65039	-120.94948	Domestic	0	0	0	AGLAND	HOUSE WELL	HOUSE WELL	x						
AGW080011852-6106	37.72682	-120.90655	Domestic	0	0	0	AGLAND	6106	6106	x						
AGW080011758-ARD1	37.72693	-120.81828	Domestic	0	0	0	AGLAND	ARD1	ARD1	x						
AGW080011032-SHR	37.67078	-120.59682	Domestic	0	0	0	AGLAND	SHR	SHR	x						
AGW080012935-5907	37.72360	-120.79360	Domestic	0	0	0	AGLAND	5907	5907	x						
AGW080012938-1934	37.64380	-120.63930	Domestic	0	0	0	AGLAND	1934	1934	x						
AGW080017190-6407	37.72903	-120.68775	Domestic	0	0	0	AGLAND	6407	6407	x						
AGW080017133-6325	37.72903	-120.68775	Domestic	0	0	0	AGLAND	6325	6325	x						

Appendix G - Water Quality Monitoring Network

										Water Quality Parameters						
Well ID	Latitude	Longitude	Well Type	Well Depth (ft bgs)	Top of Screen (ft bgs)	Screen Length (ft)	Dataset Name	Alternative Well ID	Alternative Well ID 2	Nitrate	Uranium	PCE	TCP	DBCP	TDS	Arsenic
AGW080012860-HOME	37.67647	-120.71800	Domestic	0	0	0	AGLAND	HOME	HOME	x						
AGW080012178-AGR	37.74813	-120.91754	Domestic	0	0	0	AGLAND	AGR	AGR	x						
AGW080012936-5937	37.72460	-120.79350	Domestic	0	0	0	AGLAND	5937	5937	x						
AGW080013323-4718	37.67395	-121.08119	Domestic	0	0	0	AGLAND	4718	4718	x						
AGW080010976-JKSN SOUTH	37.70816	-120.67605	Domestic	0	0	0	AGLAND	JKSN SOUTH	JKSN SOUTH	x						
AGW080012609-PRICE	37.65470	-120.75050	Domestic	0	0	0	AGLAND	PRICE	PRICE	x						
AGW080012664-4912	37.60724	-121.08406	Domestic	0	0	0	AGLAND	4912	4912	x						
AGW080011033-GIL2	37.75067	-120.79034	Domestic	0	0	0	AGLAND	GIL2	GIL2	x						
AGW080011480-DW1	37.71468	-120.78850	Domestic	0	0	0	AGLAND	DW1	DW1	x						
AGW080011023-DW2	37.70045	-120.77700	Domestic	0	0	0	AGLAND	DW2	DW2	x						
AGW080012327-HOME	37.71006	-120.78962	Domestic	0	0	0	AGLAND	HOME	HOME	x						
AGW080010965-HOUSE	37.70330	-120.64263	Domestic	0	0	0	AGLAND	HOUSE	HOUSE	x						
AGW080012603-BT WARD	37.67504	-120.69885	Domestic	0	0	0	AGLAND	BT WARD	BT WARD	x						
AGW080011224-1131	37.62612	-121.08638	Domestic	0	0	0	AGLAND	1131	1131	x						
AGW080012103-HOUSE	37.78000	-120.75480	Domestic	0	0	0	AGLAND	HOUSE	HOUSE	x						
AGW080013770-6725	37.69784	-121.11962	Domestic	0	0	0	AGLAND	6725	6725	x						
AGW080012942-DW1	37.65250	-120.53320	Domestic	0	0	0	AGLAND	DW1	DW1	x						
AGW080012673-1	37.65303	-120.90810	Domestic	0	0	0	AGLAND	1	1	x						
AGW080011035-HALL	37.71903	-121.12773	Domestic	0	0	0	AGLAND	HALL	HALL	x						
AGW080012014-6401	37.73283	-121.07351	Domestic	0	0	0	AGLAND	6401	6401	x						
AGW080012937-5737	37.72200	-120.79350	Domestic	0	0	0	AGLAND	5737	5737	x						
AGW080011021-918	37.65504	-120.90046	Domestic	0	0	0	AGLAND	918	918	x						
AGW080013782-454	37.64352	-120.81778	Domestic	0	0	0	AGLAND	454	454	x						
AGW080012604-HARRIS	37.67504	-120.69885	Domestic	0	0	0	AGLAND	HARRIS	HARRIS	x						
AGW080012011-6373	37.73759	-121.07469	Domestic	0	0	0	AGLAND	6373	6373	x						
AGW080011029-GIL1	37.74882	-120.77300	Domestic	0	0	0	AGLAND	GIL1	GIL1	x						
AGW080011760-OWD1	37.73642	-120.83138	Domestic	0	0	0	AGLAND	OWD1	OWD1	x						
AGW080010971-HQ	37.69691	-120.77239	Domestic	0	0	0	AGLAND	HQ	HQ	x						
AGW080012606-TA WARD	37.65216	-120.74834	Domestic	0	0	0	AGLAND	TA WARD	TA WARD	x						
AGW080013065-COFF	37.73042	-120.97544	Domestic	0	0	0	AGLAND	COFF	COFF	x						
AGW080012667-1313	37.61906	-121.08775	Domestic	0	0	0	AGLAND	1313	1313	x						
AGW080011024-DW1	37.70099	-120.78019	Domestic	0	0	0	AGLAND	DW1	DW1	x						
AGW080013900-237	37.63519	-120.81686	Domestic	0	0	0	AGLAND	237	237	x						
AGW080014842-HOME	37.66093	-120.77381	Domestic	0	0	0	AGLAND	HOME	HOME	x						
AGW080013120-2901	37.73540	-121.04881	Domestic	0	0	0	AGLAND	2901	2901	x						
5000433-004	37.78037	-120.80252	Municipal	0	0	100	DHS	5000433-004	HILLSBOROUGH ESTATES WELL NO. 01	x		x		x	x	x
5000141-004	37.70900	-121.00577	Municipal	0	50	180	DHS	5000141-004	WELL #3 (COLD STORAGE)	x						
5000433-006	37.77968	-120.77772	Municipal	0	0	0	DHS	5000433-006	COUNTRY OAK MANOR WELL NO. 01	x		x		x	x	x
5000015-002	37.77225	-120.82033	Municipal	0	350	125	DHS	5000015-002	WELL #1 - SOUTH	x				x	x	x
5000099-003	37.74545	-121.00378	Municipal	0	50	40	DHS	5000099-003	NEW NORTH GATE	x		x		x	x	x
5000048-002	37.74658	-120.90888	Municipal	0	164	20	DHS	5000048-002	NORTH EAST WELL #1	x				x		
5000014-002	37.74884	-120.88009	Municipal	0	60	35	DHS	5000014-002	WELL#2	x				x	x	x
5000067-001	37.71702	-121.01164	Municipal	0	330	20	DHS	5000067-001	WELL 03	x			x	x		
5000411-003	37.71786	-121.00124	Municipal	0	310	38	DHS	5000411-003	WELL #3 WEST PARK	x			x			
5010018-008	37.72194	-120.95380	Municipal	0	210	40	DHS	5010018-008	WELL 08	x	x	x		x	x	x
5010006-003	37.64117	-120.74547	Municipal	0	124	50	DHS	5010006-003	WELL NO. 245	x						
5010042-002	37.63917	-120.75000	Municipal	0	0	0	DHS	5010042-002	WELL NO. 02 - RAW - GRNSD - FE&MN	x				x		
5010010-049	37.64931	-120.93879	Municipal	0	0	110	DHS	5010010-049	WELL 047	x	x		x	x		
5010010-047	37.66340	-120.91952	Municipal	0	0	153	DHS	5010010-047	WELL 045	x	x	x			x	x
5000066-001	37.69706	-120.99203	Municipal	0	200	97	DHS	5000066-001	NORTH EAST NEW WELL (MAIN WELL)	x						
5000189-004	37.70716	-121.00371	Municipal	0	280	90	DHS	5000189-004	W.WELL#3 (BEHIND 4719 N. STAR WAY)	x		x		x		x
5000133-003	37.66597	-121.06601	Municipal	0	0	0	DHS	5000133-003	2011 WELL	x						x
5010010-241	37.70767	-121.05488	Municipal	0	0	0	DHS	5010010-241	WELL 61	x	x				x	x

Appendix G - Water Quality Monitoring Network

Well ID	Latitude	Longitude	Well Type	Well Depth (ft bgs)	Top of Screen (ft bgs)	Screen Length (ft)	Dataset Name	Alternative Well ID	Alternative Well ID 2	Water Quality Parameters						
										Nitrate	Uranium	PCE	TCP	DBCP	TDS	Arsenic
5010014-011	37.76502	-120.83228	Municipal	0	240	140	DHS	5010014-011	WELL 08	x						
5000155-001	37.63823	-120.61884	Municipal	0	50	10	DHS	5000155-001	WELL 01	x						
5010010-243	37.69540	-121.05603	Municipal	0	0	0	DHS	5010010-243	WELL 63	x					x	x
5010005-008	37.71553	-121.08905	Municipal	0	240	120	DHS	5010005-008	WELL 298	x	x					
5000372-003	37.66461	-121.06086	Municipal	0	0	0	DHS	5000372-003	SW NEW WELL	x						
5000317-001	37.68982	-121.07024	Municipal	0	312	73	DHS	5000317-001	WELL#1	x				x	x	x
5000592-001	37.71245	-120.82519	Municipal	0	0	0	DHS	5000592-001	2014 WELL	x						
5000189-005	37.70721	-121.00081	Municipal	0	320	20	DHS	5000189-005	E.WELL, #4 622 GALAXY WAY	x		x		x		x
5010018-012	37.73216	-120.92441	Municipal	0	0	0	DHS	5010018-012	WELL NO. 12	x		x		x	x	x
5000433-003	37.77747	-120.79795	Municipal	0	264	100	DHS	5000433-003	HUNTER RANCH ESTATES WELL NO. 01	x		x		x	x	x
5000013-001	37.78530	-120.81297	Municipal	0	0	35	DHS	5000013-001	WELL 01	x		x		x	x	x
5000014-001	37.78058	-120.79294	Municipal	0	50	45	DHS	5000014-001	WELL#1	x				x	x	x
5010014-008	37.76212	-120.84250	Municipal	0	195	250	DHS	5010014-008	WELL 05-A - SIERRA & J	x						
5000404-002	37.67000	-121.08000	Municipal	0	245	20	DHS	5000404-002	02 NEW SCHOOL	x		x		x		x
5010010-245	37.68948	-120.93022	Municipal	0	0	0	DHS	5010010-245	WELL NO. 67	x	x	x	x	x	x	x
5000433-002	37.77809	-120.80597	Municipal	0	325	42	DHS	5000433-002	COUNTRY CLUB ESTATES WELL NO. 02	x		x		x	x	x
5010014-010	37.76164	-120.87669	Municipal	0	274	204	DHS	5010014-010	WELL 07	x						
5010018-002	37.73336	-120.92734	Municipal	0	0	68	DHS	5010018-002	WELL 02	x		x		x	x	x
5000048-003	37.74622	-120.91000	Municipal	0	50	10	DHS	5000048-003	WEST #02	x				x		
5010006-004	37.64558	-120.77354	Municipal	0	200	92	DHS	5010006-004	WELL NO. 286	x						
5010010-130	37.68534	-120.99272	Municipal	0	0	55	DHS	5010010-130	WELL 264 - SHERWOOD FOREST	x	x	x		x		
5010006-005	37.63711	-120.77367	Municipal	0	152	85	DHS	5010006-005	WELL NO. 302	x				x	x	x
5000249-004	37.71283	-121.02746	Municipal	0	285	70	DHS	5000249-004	WELL 02 RAW	x		x	x	x	x	x
5000563-001	37.71561	-121.00339	Municipal	0	270	20	DHS	5000563-001	WELL	x			x			
5000565-001	37.71575	-121.00392	Municipal	0	0	0	DHS	5000565-001	NEW WELL	x		x	x	x		x
5000110-002	37.64922	-120.97849	Municipal	0	50	10	DHS	5000110-002	NORTH/BACK UP WELL	x						
5010014-012	37.75455	-120.87014	Municipal	0	0	0	DHS	5010014-012	WELL 09	x		x	x	x	x	x
5000481-002	37.66285	-120.78124	Municipal	0	50	20	DHS	5000481-002	OLD WELL (WESTERN BY PLANT)	x						
5010010-131	37.68089	-120.99341	Municipal	0	0	45	DHS	5010010-131	WELL 262 - HART WELL 02	x						
5010010-068	37.69341	-120.94873	Municipal	0	162	58	DHS	5010010-068	WELL 054	x	x	x				
5010010-053	37.70363	-121.04910	Municipal	0	0	225	DHS	5010010-053	WELL 051	x	x		x	x	x	x
5000584-001	37.73803	-120.99481	Municipal	0	0	0	DHS	5000584-001	NEW WELL 2009	x						
5000179-004	37.66001	-120.65574	Municipal	0	350	130	DHS	5000179-004	#4 WELL NORTH WEST	x						
5010029-001	37.74016	-121.01405	Municipal	0	380	40	DHS	5010029-001	WELL 271 - HILLCREST ESTATES	x		x			x	x
5010010-097	37.66944	-120.95000	Municipal	0	0	0	DHS	5010010-097	WELL 65 - RAW	x	x	x				
5010005-005	37.70691	-121.09319	Municipal	0	224	62	DHS	5010005-005	WELL 288 - SUNNYBROOK	x	x					
5010006-001	37.64277	-120.76405	Municipal	0	290	55	DHS	5010006-001	WELL NO. 242	x					x	x
5010010-062	37.68394	-120.94584	Municipal	0	0	190	DHS	5010010-062	WELL 052	x	x	x		x	x	x
5000433-005	37.78032	-120.79170	Municipal	0	0	0	DHS	5000433-005	SIERRA SUNSET ESTATES WELL NO. 01	x		x		x	x	x
5010018-004	37.73973	-120.93995	Municipal	0	132	154	DHS	5010018-004	WELL 04	x	x	x		x	x	x
5010005-001	37.70083	-121.08642	Municipal	0	225	85	DHS	5010005-001	WELL 250 - SALIDA GAS	x				x		
5010010-129	37.68533	-120.97581	Municipal	0	0	45	DHS	5010010-129	WELL 259 - COFFEE VILLAGE 01	x	x			x		
5000573-002	37.71230	-121.00251	Municipal	0	0	0	DHS	5000573-002	SCS 2007 WELL	x		x				
5000384-003	37.65604	-121.02473	Municipal	0	390	40	DHS	5000384-003	NEW LONE PALM	x		x		x	x	x
5000055-003	37.70586	-120.92032	Municipal	0	104	10	DHS	5000055-003	EAST FIELD	x		x		x	x	x
5000016-001	37.74986	-120.87875	Municipal	0	160	24	DHS	5000016-001	WELL#2	x				x	x	x
5000517-001	37.71001	-120.99702	Municipal	0	330	40	DHS	5000517-001	WELL	x				x		
5000317-002	37.78055	-120.78424	Municipal	0	418	54	DHS	5000317-002	WELL#2	x				x	x	x
5010018-006	37.72784	-120.93318	Municipal	0	195	360	DHS	5010018-006	WELL 06	x		x	x	x	x	x
5000499-004	37.68138	-121.10948	Municipal	0	0	0	DHS	5000499-004	2018 WELL	x	x		x	x		x
5010014-005	37.77968	-120.83856	Municipal	0	137	160	DHS	5010014-005	WELL 03 - ON THE HILL	x			x			
5000568-001	37.72180	-121.05999	Municipal	0	0	0	DHS	5000568-001	WELL #1 2007	x		x				
5010005-017	37.70294	-121.07842	Municipal	0	0	0	DHS	5010005-017	WELL 313 - RAW	x	x					

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Well ID	Latitude	Longitude	Well Type	Well Depth (ft bgs)	Top of Screen (ft bgs)	Screen Length (ft)	Dataset Name	Alternative Well ID	Alternative Well ID 2	Water Quality Parameters						
										Nitrate	Uranium	PCE	TCP	DBCP	TDS	Arsenic
5010010-043	37.66040	-120.93046	Municipal	0	124	92	DHS	5010010-043	WELL 041	x	x	x				
5000552-001	37.71237	-121.00386	Municipal	0	0	0	DHS	5000552-001	WELL	x		x	x	x	x	x
5000017-002	37.73936	-120.96136	Municipal	0	0	10	DHS	5000017-002	PARK RIDGE WEST	x		x				
5000049-001	37.77481	-120.82256	Municipal	0	117	40	DHS	5000049-001	NORTH WELL	x		x		x	x	x
5000263-002	37.71179	-120.99603	Municipal	0	320	40	DHS	5000263-002	NEW 2006	x				x		
5000179-003	37.74886	-120.84306	Municipal	0	280	300	DHS	5000179-003	#3 WELL SOUTH	x			x			
5010029-004	37.74423	-121.00330	Municipal	0	360	109	DHS	5010029-004	WELL 289 - KRISTINA	x				x		
5000335-001	37.68982	-121.07024	Municipal	0	240	20	DHS	5000335-001	WELL, PUBLIC/SOUTH	x						x
5010014-013	37.75502	-120.85043	Municipal	0	0	0	DHS	5010014-013	WELL 10	x						
5000580-001	37.73025	-121.06814	Municipal	0	0	0	DHS	5000580-001	WELL	x		x		x		
5000211-003	37.71228	-120.91821	Municipal	0	50	150	DHS	5000211-003	WELL NO. 06	x						
5010029-002	37.74611	-121.01690	Municipal	0	139	132	DHS	5010029-002	WELL 282 - DEL RIO	x				x		
5010029-010	37.73200	-121.00397	Municipal	0	0	0	DHS	5010029-010	WELL NO. 68	x	x	x	x	x	x	x
5000433-007	37.77693	-120.78556	Municipal	0	0	0	DHS	5000433-007	OLIVE RANCH ESTATES WELL NO. 01	x		x		x	x	x
5000433-001	37.77810	-120.80610	Municipal	0	323	42	DHS	5000433-001	COUNTRY CLUB ESTATES WELL NO. 01	x		x		x	x	x
5010006-006	37.64727	-120.76391	Municipal	0	224	80	DHS	5010006-006	WELL NO. 303 - RAW TO GAC	x				x	x	x
5000099-001	37.74617	-121.00344	Municipal	0	115	120	DHS	5000099-001	NORTH WELL LAKE WELL	x		x		x	x	x
5000189-006	37.70981	-121.00082	Municipal	0	195	40	DHS	5000189-006	N.WELL, #5, 4825 STRATOS	x	x	x		x		x
5010014-009	37.75773	-120.84036	Municipal	0	240	160	DHS	5010014-009	WELL 06	x						
5010010-048	37.67571	-120.94764	Municipal	0	149	145	DHS	5010010-048	WELL 046	x	x	x			x	x
5010010-221	37.68369	-120.98493	Municipal	0	0	185	DHS	5010010-221	WELL 058	x	x			x	x	x
5010010-050	37.70231	-120.99673	Municipal	0	0	165	DHS	5010010-050	WELL 048	x	x					
5010005-007	37.69834	-121.07377	Municipal	0	292	120	DHS	5010005-007	WELL 297	x	x					
5000530-004	37.63466	-120.79356	Municipal	0	0	0	DHS	5000530-004	2011 WELL	x						
5010010-170	37.62793	-120.93048	Municipal	0	0	75	DHS	5010010-170	WELL 308	x	x	x			x	
5010014-007	37.76531	-120.86258	Municipal	0	90	156	DHS	5010014-007	WELL 04 OAK STREET	x						
5010010-226	37.64198	-120.91903	Municipal	0	0	120	DHS	5010010-226	WELL 059	x			x	x		
5010010-044	37.68880	-121.05788	Municipal	0	144	55	DHS	5010010-044	WELL 042	x	x	x			x	x
5010010-180	37.63785	-120.93172	Municipal	0	0	55	DHS	5010010-180	WELL 291 - MARIPOSA EAST	x	x	x	x	x	x	x
5000529-001	37.70417	-120.95640	Municipal	0	0	0	DHS	5000529-001	WELL	x						
5010010-124	37.65796	-121.03818	Municipal	0	0	36	DHS	5010010-124	WELL 241 - HAMMET	x		x				
5000117-001	37.77475	-120.82256	Municipal	0	210	20	DHS	5000117-001	DOMESTIC WELL	x		x		x		x
5010005-006	37.71402	-121.08200	Municipal	0	164	112	DHS	5010005-006	WELL 290 - CLARENDON	x	x				x	x
5010010-127	37.65759	-120.93726	Municipal	0	0	53	DHS	5010010-127	WELL 265 - LINCOLN ESTATES	x		x				
5000154-002	37.63783	-120.84967	Municipal	0	0	0	DHS	5000154-002	WELL 02 OLD EASTERN	x	x	x	x	x		x
5010018-009	37.71361	-120.94250	Municipal	0	0	0	DHS	5010018-009	WELL 09	x	x	x		x	x	x
5010010-061	37.65147	-121.02083	Municipal	0	0	70	DHS	5010010-061	WELL 056	x				x	x	x
5010010-041	37.69001	-120.97187	Municipal	0	116	100	DHS	5010010-041	WELL 039	x	x					
5010010-191	37.64560	-120.90525	Municipal	0	0	50	DHS	5010010-191	WELL 247 - NORTH EMPIRE	x	x	x		x	x	x
5010010-052	37.69679	-121.01066	Municipal	0	200	90	DHS	5010010-052	WELL 050	x		x		x	x	x
5000372-001	37.66433	-121.05939	Municipal	0	245	20	DHS	5000372-001	WELL 01	x	x					
5010010-184	37.63483	-120.93568	Municipal	0	0	100	DHS	5010010-184	WELL 279 - FARRAR (OLD 06)	x	x	x	x	x	x	x
5010018-007	37.72726	-120.95580	Municipal	0	209	132	DHS	5010018-007	WELL 07	x		x		x	x	x
5000058-002	37.74658	-120.90888	Municipal	0	80	20	DHS	5000058-002	WEST- MHP WELL	x	x					
5010018-010	37.71508	-120.95810	Municipal	0	0	0	DHS	5010018-010	WELL 10	x	x	x		x	x	x
5000017-001	37.73708	-120.95675	Municipal	0	150	100	DHS	5000017-001	ARROWOOD (EAST) WELL	x						
5000211-004	37.71232	-120.91980	Municipal	0	104	110	DHS	5000211-004	WELL NO. 05	x						
5010010-045	37.69369	-121.02357	Municipal	0	151	152	DHS	5010010-045	WELL 043 -STANDBY	x			x			
5010010-027	37.68571	-121.00140	Municipal	0	91	275	DHS	5010010-027	WELL 025	x		x		x		
5000110-001	37.64850	-120.97817	Municipal	0	20	10	DHS	5000110-001	SOUTH/ MAIN WELL	x						
5000013-002	37.78609	-120.81264	Municipal	0	0	0	DHS	5000013-002	WELL 02- 2709 OAKHURST	x				x	x	x
5010018-003	37.73033	-120.94992	Municipal	0	0	80	DHS	5010018-003	WELL 03	x		x	x	x	x	x
5000213-001	37.66593	-121.06596	Municipal	0	0	0	DHS	5000213-001	LPA REPORTED PRIMARY SOURCE	x						

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Well ID	Latitude	Longitude	Well Type	Well Depth (ft bgs)	Top of Screen (ft bgs)	Screen Length (ft)	Dataset Name	Alternative Well ID	Alternative Well ID 2	Water Quality Parameters						
										Nitrate	Uranium	PCE	TCP	DBCP	TDS	Arsenic
5000041-001	37.63766	-121.15292	Municipal	0	210	20	DHS	5000041-001	EAST WELL NEW #02	x						
5010010-148	37.63222	-121.01908	Municipal	0	0	75	DHS	5010010-148	WELL 283 - ANWAR MANOR	x	x			x	x	x
5000316-001	37.62464	-121.05458	Municipal	0	50	10	DHS	5000316-001	WELL 01	x	x		x			x
5010010-070	37.63391	-120.99295	Municipal	0	0	148	DHS	5010010-070	WELL 057	x	x	x		x	x	x
5010010-009	37.65093	-120.99944	Municipal	0	160	50	DHS	5010010-009	WELL 007	x		x			x	x
5010010-146	37.62581	-121.03147	Municipal	0	0	38	DHS	5010010-146	WELL 304	x	x	x		x	x	x
5010010-187	37.66055	-120.96670	Municipal	0	0	75	DHS	5010010-187	WELL 269 - ROSE AVENUE	x		x		x		
5010010-149	37.64199	-121.03415	Municipal	0	0	10	DHS	5010010-149	WELL 237 - ELM	x	x			x		
5000189-003	37.70452	-121.00170	Municipal	0	295	20	DHS	5000189-003	S. WELL #1 (BY 4500 N. STAR)	x	x	x		x		x
5000295-001	37.60964	-121.11564	Municipal	0	110	20	DHS	5000295-001	WELL 01	x						
5000411-001	37.72012	-120.99655	Municipal	0	185	20	DHS	5000411-001	WELL 4 EAST MAIN WELL	x						
5010010-008	37.65071	-120.98702	Municipal	0	0	100	DHS	5010010-008	WELL 006	x	x	x	x		x	x
5010010-042	37.64458	-120.94783	Municipal	0	97	132	DHS	5010010-042	WELL 040	x	x			x	x	x
5010010-196	37.64526	-120.97845	Municipal	0	0	95	DHS	5010010-196	WELL 211 - THOUSAND OAKS	x		x		x		
5010010-194	37.63565	-120.94334	Municipal	0	0	95	DHS	5010010-194	WELL 212 - BEARD AVENUE	x	x	x	x	x	x	x
5010010-172	37.66808	-120.98508	Municipal	0	0	68	DHS	5010010-172	WELL 300	x	x	x		x		
5010010-178	37.63784	-120.93285	Municipal	0	0	60	DHS	5010010-178	WELL 292 - MARIPOSA WEST	x	x	x	x	x	x	x
5010010-003	37.64277	-120.99117	Municipal	0	0	100	DHS	5010010-003	WELL 001	x	x	x				
5010010-147	37.62531	-121.03148	Municipal	0	0	38	DHS	5010010-147	WELL 301	x	x	x		x		
5000274-001	37.62464	-121.05458	Municipal	0	72	73	DHS	5000274-001	NEW WELL	x		x		x		x
5010010-035	37.67377	-121.03156	Municipal	0	96	188	DHS	5010010-035	WELL 033	x	x	x				
5000346-001	37.71408	-120.99550	Municipal	0	310	20	DHS	5000346-001	WELL 01	x						
5000435-002	37.77464	-120.80089	Municipal	0	264	25	DHS	5000435-002	NEW WELL 01	x						
5000049-002	37.77475	-120.82256	Municipal	0	50	10	DHS	5000049-002	SOUTH WELL	x		x		x	x	x
5000090-002	37.62556	-120.84303	Municipal	0	50	20	DHS	5000090-002	SOUTH WELL	x	x				x	x
5000090-013	37.62557	-120.84319	Municipal	0	110	30	DHS	5000090-013	SOUTH WEST NEW WELL	x	x				x	x
5000320-001	37.71000	-121.03000	Municipal	0	0	0	DHS	5000320-001	WELL 01 - INACTIVE	x						
5000164-001	37.65733	-120.66006	Municipal	0	0	10	DHS	5000164-001	WELL #1	x						
5000164-004	37.66001	-120.65574	Municipal	0	235	40	DHS	5000164-004	WELL #4	x						
5000164-003	37.65726	-120.66549	Municipal	0	300	25	DHS	5000164-003	WELL #3	x						
5000054-002	37.71066	-120.96966	Municipal	0	20	18	DHS	5000054-002	SOUTH WELL	x		x			x	x
5000284-001	37.60964	-121.11564	Municipal	0	50	24	DHS	5000284-001	WELL 01	x						
5010010-189	37.66316	-120.97808	Municipal	0	0	75	DHS	5010010-189	WELL 267 - ORANGEBURG	x		x		x		
5010010-151	37.64091	-121.01933	Municipal	0	0	55	DHS	5010010-151	WELL 236 - EMERALD	x				x	x	x
5000261-003	37.72249	-120.99584	Municipal	0	0	0	DHS	5000261-003	2007 WELL	x						
5000535-001	37.71417	-121.00101	Municipal	0	0	0	DHS	5000535-001	2003 WELL 01	x	x					
5000562-002	37.71516	-120.99481	Municipal	0	0	0	DHS	5000562-002	NEW 2006 WELL	x						
5000571-001	37.66536	-120.74831	Municipal	0	0	0	DHS	5000571-001	WELL	x						
5000493-002	37.70913	-120.92022	Municipal	0	0	0	DHS	5000493-002	2016 WELL	x						
5000509-001	37.77256	-120.77358	Municipal	0	330	40	DHS	5000509-001	MAIN 2/96 WELL OLD OFFICE	x						
5000457-002	37.72415	-120.99566	Municipal	0	0	0	DHS	5000457-002	WELL 01	x						
5000516-001	37.70967	-120.94115	Municipal	0	205	20	DHS	5000516-001	WELL	x						
5010010-192	37.63757	-120.95876	Municipal	0	0	158	DHS	5010010-192	WELL 225 - BUDGET PACK	x		x	x			
5000538-001	37.66759	-120.90568	Municipal	0	0	0	DHS	5000538-001	2003 WELL	x						
5000462-001	37.68692	-120.92228	Municipal	0	333	30	DHS	5000462-001	MOTEL WELL	x						
5000467-001	37.68692	-120.92228	Municipal	0	130	20	DHS	5000467-001	LPA REPORTED PRIMARY SOURCE	x						
5000426-001	37.70085	-120.98959	Municipal	0	50	10	DHS	5000426-001	WELL 01	x						
5000585-001	37.63855	-121.12369	Municipal	0	0	0	DHS	5000585-001	1999 DOMESTIC WELL	x						
5000409-001	37.60867	-121.11690	Municipal	0	50	10	DHS	5000409-001	LPA REPORTED PRIMARY SOURCE	x						
5000164-002	37.66297	-120.67831	Municipal	0	0	14	DHS	5000164-002	WELL #2	x						
5000561-001	37.71313	-120.99368	Municipal	0	0	0	DHS	5000561-001	2005 DOMESTIC WATER WELL	x						
5000368-001	37.69661	-120.97175	Municipal	0	92	110	DHS	5000368-001	WELL 01	x						
5000388-001	37.65169	-121.02475	Municipal	0	50	10	DHS	5000388-001	WELL 01	x						

Appendix G - Water Quality Monitoring Network

										Water Quality Parameters						
Well ID	Latitude	Longitude	Well Type	Well Depth (ft bgs)	Top of Screen (ft bgs)	Screen Length (ft)	Dataset Name	Alternative Well ID	Alternative Well ID 2	Nitrate	Uranium	PCE	TCP	DBCP	TDS	Arsenic
5000401-001	37.60867	-121.11690	Municipal	0	100	200	DHS	5000401-001	LPA REPORTED PRIMARY SOURCE	x						
5000091-001	37.77980	-120.81679	Municipal	0	80	10	DHS	5000091-001	SOUTH WELL	x						
5000506-001	37.69836	-120.88367	Municipal	0	0	0	DHS	5000506-001	WELL 01	x						
5000551-001	37.70059	-120.93784	Municipal	0	0	0	DHS	5000551-001	WELL	x						
5000290-001	37.63844	-121.12181	Municipal	0	50	10	DHS	5000290-001	LPA REPORTED PRIMARY SOURCE	x						
5000583-001	37.64193	-121.06593	Municipal	0	0	0	DHS	5000583-001	WELL 1	x						
5000486-001	37.70914	-120.92019	Municipal	0	0	10	DHS	5000486-001	LPA REPORTED PRIMARY SOURCE	x						
L10005824413-MW-12S	37.62429	-120.84759	Monitoring	60.35	43	20	EDF	MW-12S	MW-12S	x		x	x	x	x	x
L10005824413-MW-18D	37.63122	-120.84827	Monitoring	128.82	108	20	EDF	MW-18D	MW-18D	x		x	x	x	x	x
L10005824413-MW-15S	37.61763	-120.85804	Monitoring	42.63	0	0	EDF	MW-15S	MW-15S	x		x	x	x	x	x
L10005824413-MW-1S	37.62139	-120.84983	Monitoring	62.94	48	63	EDF	MW-1S	MW-1S	x		x	x	x	x	x
L10005824413-MW-22D	37.62909	-120.84804	Monitoring	116.89	100	20	EDF	MW-22D	MW-22D	x		x	x	x	x	x
L10005824413-MW-2D	37.61980	-120.85249	Monitoring	97.18	75	20	EDF	MW-2D	MW-2D	x		x	x	x	x	x
L10005824413-MW-23S	37.62277	-120.85776	Monitoring	37.09	0	0	EDF	MW-23S	MW-23S	x		x	x	x	x	x
L10005824413-MW-25D3	37.62267	-120.85618	Monitoring	132.34	132.25	15	EDF	MW-25D3	MW-25D3	x		x	x	x	x	x
L10005824413-MW-26S	37.62829	-120.85277	Monitoring	87.34	87.2	20	EDF	MW-26S	MW-26S	x		x	x	x	x	x
L10005824413-MW-13S	37.62747	-120.84811	Monitoring	81.18	60	20	EDF	MW-13S	MW-13S	x		x	x	x	x	x
L10005824413-MW-16S	37.62618	-120.84678	Monitoring	87.15	64	20	EDF	MW-16S	MW-16S	x		x	x	x	x	x
L10005824413-MW-17D	37.63090	-120.85130	Monitoring	118.74	98	20	EDF	MW-17D	MW-17D	x		x	x	x	x	x
L10005824413-MW-19D	37.62471	-120.84766	Monitoring	98.15	84	20	EDF	MW-19D	MW-19D	x		x	x	x	x	x
L10005824413-MW-8S	37.62040	-120.85687	Monitoring	29.95	0	0	EDF	MW-8S	MW-8S	x		x	x	x	x	x
L10005824413-MW-21D	37.63065	-120.84806	Monitoring	116.09	109	10	EDF	MW-21D	MW-21D	x		x	x	x	x	x
L10005824413-MW-23D	37.62281	-120.85772	Monitoring	80.24	0	0	EDF	MW-23D	MW-23D	x		x	x	x	x	x
L10005824413-MW-24S	37.62620	-120.84461	Monitoring	93.04	93	20	EDF	MW-24S	MW-24S	x		x	x	x	x	x
L10005824413-MW-3D	37.62532	-120.85532	Monitoring	85.53	0	0	EDF	MW-3D	MW-3D	x		x	x	x	x	x
L10005824413-MW-1D	37.62137	-120.84984	Monitoring	90.29	80	10	EDF	MW-1D	MW-1D	x		x	x	x	x	x
L10005824413-MW-21S	37.63065	-120.84806	Monitoring	80.74	65	20	EDF	MW-21S	MW-21S	x		x	x	x	x	x
L10005824413-MW-14SR	37.62154	-120.85382	Monitoring	65.96	66	20	EDF	MW-14SR	MW-14SR	x		x	x	x	x	x
L10005824413-MW-24D	37.62620	-120.84469	Monitoring	132.81	133	20	EDF	MW-24D	MW-24D	x		x	x	x	x	x
L10005824413-MW-27D	37.62883	-120.86088	Monitoring	72.25	72.3	20	EDF	MW-27D	MW-27D	x		x	x	x	x	x
L10005824413-MW-5S	37.61952	-120.85203	Monitoring	63.91	0	0	EDF	MW-5S	MW-5S	x		x	x	x	x	x
L10005824413-PZ-3	37.62822	-120.85672	Monitoring	25.88	0	0	EDF	PZ-3	PZ-3	x		x	x	x	x	x
L10005824413-PZ-6	37.62959	-120.86088	Monitoring	25.29	0	0	EDF	PZ-6	PZ-6	x		x	x	x	x	x
L10005824413-MW-9S	37.61878	-120.85437	Monitoring	29.66	12	20	EDF	MW-9S	MW-9S	x		x	x	x	x	x
L10005824413-MW-17S	37.63090	-120.85130	Monitoring	88.58	68	20	EDF	MW-17S	MW-17S	x		x	x	x	x	x
L10005824413-MW-18S	37.63122	-120.84827	Monitoring	88.17	68	20	EDF	MW-18S	MW-18S	x		x	x	x	x	x
L10005824413-MW-22S	37.62909	-120.84804	Monitoring	77.89	62	20	EDF	MW-22S	MW-22S	x		x	x	x	x	x
L10005824413-MW-26D	37.62830	-120.85280	Monitoring	127.11	127	20	EDF	MW-26D	MW-26D	x		x	x	x	x	x
L10005824413-MW-7D	37.62611	-120.84943	Monitoring	126.34	104	20	EDF	MW-7D	MW-7D	x		x	x	x	x	x
L10005824413-PZ-2	37.63084	-120.85678	Monitoring	24.96	0	0	EDF	PZ-2	PZ-2	x		x	x	x	x	x
L10005824413-PZ-4	37.62958	-120.85914	Monitoring	26.93	0	0	EDF	PZ-4	PZ-4	x		x	x	x	x	x
L10005824413-MW-11S	37.62294	-120.84817	Monitoring	80.24	55	20	EDF	MW-11S	MW-11S	x		x	x	x	x	x
L10005824413-MW-7S	37.62610	-120.84943	Monitoring	84.35	63	20	EDF	MW-7S	MW-7S	x		x	x	x	x	x
L10005824413-MW-25D2	37.62269	-120.85618	Monitoring	82.25	82.2	10	EDF	MW-25D2	MW-25D2	x		x	x	x	x	x
L10005824413-PZ-1	37.62960	-120.85449	Monitoring	25.36	0	0	EDF	PZ-1	PZ-1	x		x	x	x	x	x
L10005824413-MW-4S	37.62283	-120.85614	Monitoring	34.93	0	0	EDF	MW-4S	MW-4S	x		x	x	x	x	x
L10005824413-MW-15D	37.61766	-120.85800	Monitoring	76.72	63	10	EDF	MW-15D	MW-15D	x		x	x	x	x	x
L10005824413-MW-3S	37.62534	-120.85531	Monitoring	25.05	0	0	EDF	MW-3S	MW-3S	x		x	x	x	x	x
L10005824413-MW-4D	37.62277	-120.85618	Monitoring	60.29	0	0	EDF	MW-4D	MW-4D	x		x	x	x	x	x
L10005824413-MW-19S	37.62471	-120.84767	Monitoring	66.72	49	20	EDF	MW-19S	MW-19S	x		x	x	x	x	x
L10005824413-MW-2S	37.61982	-120.85246	Monitoring	57.45	0	0	EDF	MW-2S	MW-2S	x		x	x	x	x	x
L10005824413-MW-10S	37.62024	-120.85017	Monitoring	68.06	50	20	EDF	MW-10S	MW-10S	x		x	x	x	x	x
L10005824413-MW-27S	37.62885	-120.86090	Monitoring	39.28	39.4	20	EDF	MW-27S	MW-27S	x		x	x	x	x	x

Appendix G - Water Quality Monitoring Network

										Water Quality Parameters						
Well ID	Latitude	Longitude	Well Type	Well Depth (ft bgs)	Top of Screen (ft bgs)	Screen Length (ft)	Dataset Name	Alternative Well ID	Alternative Well ID 2	Nitrate	Uranium	PCE	TCP	DBCP	TDS	Arsenic
100834	37.63130	-120.99850	Municipal	0	0	0	LLNL	100834	03S/09E-32G01 M	x	x	x	x	x	x	x
100830	37.68420	-120.96730	Municipal	0	0	0	LLNL	100830	03S/09E-10P01 M	x	x	x	x	x	x	x
100833	37.67570	-120.94760	Municipal	0	0	0	LLNL	100833	03S/09E-14G01 M	x	x	x	x	x	x	x
100832	37.64210	-120.91890	Monitoring	0	35	75	LLNL	100832	03S/10E-30M01 M	x	x	x	x	x	x	x
100829	37.69680	-121.01070	Monitoring	0	70	62	LLNL	100829	03S/09E-05N02 M	x	x	x	x	x	x	x
5000055-002	37.70583	-120.92042	Municipal	0	100	40	DHS	5000055-002	WEST FIELD			x		x		
SL205012989-M-19C1	37.73000	-121.11000	Monitoring	0	137	20	EDF	M-19C1	M-19C1			x				
SL205012989-M-31C2D	37.72000	-121.12000	Monitoring	0	196	15	EDF	M-31C2D	M-31C2D			x				
SL205833043-MMW-01A	37.68713	-120.92128	Monitoring	0	70	90	EDF	MMW-01A	MMW-01A			x	x	x		
SL205833043-MMW-24A	37.68665	-120.92103	Monitoring	0	70	90	EDF	MMW-24A	MMW-24A			x	x	x		
SL205012989-M-20C1	37.72000	-121.12000	Monitoring	0	140	10	EDF	M-20C1	M-20C1			x				
SL205012989-M-21C1	37.72000	-121.13000	Monitoring	0	125	20	EDF	M-21C1	M-21C1			x				
SL205012989-M-21D	37.72000	-121.13000	Monitoring	0	215	20	EDF	M-21D	M-21D			x				
SL205012989-M-23C1	37.72000	-121.12000	Monitoring	0	110.8	20	EDF	M-23C1	M-23C1			x				
SL205012989-M-31C1	37.72000	-121.12000	Monitoring	0	120	5	EDF	M-31C1	M-31C1			x				
SL205012989-M-5C1	37.73000	-121.11000	Monitoring	0	149	15	EDF	M-5C1	M-5C1			x				
SL205012989-M-35A	37.72030	-121.13850	Monitoring	0	115	5	EDF	M-35A	M-35A			x				
SL205012989-MW-11	37.72000	-121.14000	Monitoring	0	125	30	EDF	MW-11	MW-11			x				
SL205012989-M-7A	37.73000	-121.11000	Monitoring	0	94	20	EDF	M-7A	M-7A			x				
SL205012989-M-32D	37.72050	-121.13170	Monitoring	0	217	15	EDF	M-32D	M-32D			x				
SL205012989-M-30C2	37.72000	-121.12000	Monitoring	0	150	5	EDF	M-30C2	M-30C2			x				
SL205012989-TH-9	37.72000	-121.12000	Monitoring	0	80	20	EDF	TH-9	TH-9			x				
SLT5S1883227-DD-4	37.66904	-120.99180	Monitoring	119.22	109.22	10	EDF	DD-4	DD-4			x	x	x		
SL205012989-M-30C1	37.72000	-121.12000	Monitoring	0	120	15	EDF	M-30C1	M-30C1			x				
SL205012989-M-34D	37.72050	-121.13240	Monitoring	0	224	10	EDF	M-34D	M-34D			x				
SL205012989-M-35D	37.72030	-121.13850	Monitoring	0	244	7	EDF	M-35D	M-35D			x				
SL205833043-MMW-27A	37.68517	-120.91972	Monitoring	0	70	90	EDF	MMW-27A	MMW-27A			x	x	x		
SL205012989-TH-10	37.72000	-121.12000	Monitoring	0	120	10	EDF	TH-10	TH-10			x				
SL205833043-MMW-28A	37.68629	-120.92163	Monitoring	0	70	90	EDF	MMW-28A	MMW-28A			x	x	x		
SL205012989-M-23D	37.72000	-121.12000	Monitoring	0	221.2	10	EDF	M-23D	M-23D			x				
SL205012989-M-36C	37.72130	-121.12380	Monitoring	0	134	5	EDF	M-36C	M-36C			x				
SL205833043-MMW-18A	37.68647	-120.92049	Monitoring	0	70	90	EDF	MMW-18A	MMW-18A			x	x	x		
SL205012989-TH-1	37.73000	-121.11000	Monitoring	0	250	60	EDF	TH-1	TH-1			x				
SL205012989-MW-7	37.73000	-121.11000	Monitoring	0	80	40	EDF	MW-7	MW-7			x				
SL205012989-M-20D	37.72000	-121.12000	Monitoring	0	205	20	EDF	M-20D	M-20D			x				
SL205012989-M-23A	37.72000	-121.12000	Monitoring	0	74.8	20	EDF	M-23A	M-23A			x				
SL205012989-M-34A	37.72050	-121.13240	Monitoring	0	79	10	EDF	M-34A	M-34A			x				
SL205012989-M-35B	37.72030	-121.13850	Monitoring	0	60	10	EDF	M-35B	M-35B			x				
SL205012989-M-5C2	37.73000	-121.11000	Monitoring	0	180	10	EDF	M-5C2	M-5C2			x				
SL205012989-M-5A	37.73000	-121.11000	Monitoring	0	95	20	EDF	M-5A	M-5A			x				
SL205012989-M-34C	37.72050	-121.13240	Monitoring	0	135	10	EDF	M-34C	M-34C			x				
SLT5S1883227-DD-1	37.66953	-120.99252	Monitoring	118.67	108.67	10	EDF	DD-1	DD-1			x	x	x		
SL205012989-M-26C2	37.73000	-121.11000	Monitoring	0	180	15	EDF	M-26C2	M-26C2			x				
SL205833043-MMW-14A	37.68550	-120.92110	Monitoring	0	70	90	EDF	MMW-14A	MMW-14A				x			
SL205833043-MMW-21A	37.68613	-120.92034	Monitoring	0	70	90	EDF	MMW-21A	MMW-21A				x			
SL205833043-MMW-02A	37.68549	-120.92007	Monitoring	0	70	90	EDF	MMW-02A	MMW-02A				x	x		
SL205833043-MMW-25A	37.68758	-120.92127	Monitoring	0	70	90	EDF	MMW-25A	MMW-25A				x			
5000588-001	37.65809	-121.03037	Municipal	0	0	0	DHS	5000588-001	WELL 01					x		
SL185742938-M-151	37.64856	-121.01341	Monitoring	88	68	20	EDF	M-151	M-151						x	x
SL185742938-M-101	37.64664	-121.01610	Monitoring	75	55	20	EDF	M-101	M-101						x	x
SL185742938-M-103	37.65059	-121.01623	Monitoring	75	55	20	EDF	M-103	M-103						x	x
SL185742938-M-107	37.65057	-121.01623	Monitoring	145	134	11	EDF	M-107	M-107						x	x
SL185742938-M-113	37.64365	-121.01084	Monitoring	80	55	20	EDF	M-113	M-113						x	x

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										Water Quality Parameters						
Well ID	Latitude	Longitude	Well Type	Well Depth (ft bgs)	Top of Screen (ft bgs)	Screen Length (ft)	Dataset Name	Alternative Well ID	Alternative Well ID 2	Nitrate	Uranium	PCE	TCP	DBCP	TDS	Arsenic
SL185742938-M-121	37.64566	-121.00876	Monitoring	71	60	25	EDF	M-121	M-121						x	x
SL185742938-M-150	37.64871	-121.01612	Monitoring	175	155	20	EDF	M-150	M-150						x	x
SL185742938-M-154	37.64725	-121.02637	Monitoring	65	45	20	EDF	M-154	M-154						x	x
SL185742938-M-157	37.64161	-121.02370	Monitoring	65	45	20	EDF	M-157	M-157						x	x
SL185742938-M-159	37.63559	-121.00900	Monitoring	65	45	20	EDF	M-159	M-159						x	x
SL185742938-M-9R	37.65204	-121.02030	Monitoring	75	55	20	EDF	M-9R	M-9R						x	x
SL185742938-M-105	37.65301	-121.01874	Monitoring	75	55	20	EDF	M-105	M-105						x	x
SL185742938-M-111	37.64751	-121.01610	Monitoring	125.5	96	24	EDF	M-111	M-111						x	x
SL185742938-M-152	37.64703	-121.01359	Monitoring	95	75	20	EDF	M-152	M-152						x	x
SL185742938-M-156	37.64161	-121.02377	Monitoring	168	148	20	EDF	M-156	M-156						x	x
SL185742938-M-161	37.64677	-121.01631	Monitoring	172	152	20	EDF	M-161	M-161						x	x
SL185742938-M-2R	37.65010	-121.02073	Monitoring	75	55	20	EDF	M-2R	M-2R						x	x
SL185742938-M-102	37.64854	-121.01611	Monitoring	75	55	20	EDF	M-102	M-102						x	x
SL185742938-M-118	37.65303	-121.01877	Monitoring	170	146	19	EDF	M-118	M-118						x	x
SL185742938-M-153	37.64867	-120.99769	Monitoring	65	45	20	EDF	M-153	M-153						x	x
SL185742938-M-158	37.63557	-121.00898	Monitoring	150	130	20	EDF	M-158	M-158						x	x
SL185742938-M-162	37.64693	-121.01441	Monitoring	175	155	20	EDF	M-162	M-162						x	x
SL185742938-M-112	37.64369	-121.01082	Monitoring	180	145	30	EDF	M-112	M-112						x	x
SL185742938-M-104	37.64899	-121.01712	Monitoring	75	55	20	EDF	M-104	M-104						x	x
SL185742938-M-120	37.65110	-121.01524	Monitoring	190	155	30	EDF	M-120	M-120						x	x
SL185742938-M-155	37.64736	-121.03298	Monitoring	147	125	20	EDF	M-155	M-155						x	x
SL185742938-M-108	37.65060	-121.01623	Monitoring	105	95	10	EDF	M-108	M-108						x	x
SL185742938-M-160	37.64939	-121.01989	Monitoring	170	150	20	EDF	M-160	M-160						x	x
SL185742938-M-109	37.64763	-121.01610	Monitoring	93.5	60	28	EDF	M-109	M-109						x	x
SL185742938-M-163	37.64860	-121.01338	Monitoring	165	145	20	EDF	M-163	M-163						x	x
SL185742938-M-119	37.65112	-121.01527	Monitoring	80	56	19	EDF	M-119	M-119						x	x
SL185742938-M-6R	37.64782	-121.01803	Monitoring	75	55	20	EDF	M-6R	M-6R						x	x
SL185742938-M-106	37.64871	-121.01911	Monitoring	75	55	20	EDF	M-106	M-106						x	x
T10000009029-MW-12C	37.72915	-120.93208	Monitoring	0	139	10	EDF	MW-12C	MW-12C							x
T10000009029-MW-3R	37.73055	-120.93464	Monitoring	0	75	20	EDF	MW-3R	MW-3R							x
T10000009029-MW-12A	37.72915	-120.93213	Monitoring	0	93.5	10	EDF	MW-12A	MW-12A							x
T10000009029-MW-20	37.73093	-120.93474	Monitoring	0	95	15	EDF	MW-20	MW-20							x
T10000009029-MW-22	37.73061	-120.93465	Monitoring	0	0	0	EDF	MW-22	MW-22							x
T10000009029-MW-4R	37.73033	-120.93411	Monitoring	0	81.5	20	EDF	MW-4R	MW-4R							x
T10000009029-MW-1R	37.73084	-120.93463	Monitoring	0	75	20	EDF	MW-1R	MW-1R							x
T10000009029-MW-12B	37.72915	-120.93217	Monitoring	0	115	5	EDF	MW-12B	MW-12B							x
T10000009029-MW-21	37.73023	-120.93472	Monitoring	0	0	0	EDF	MW-21	MW-21							x
T10000009029-MW-4B	37.73037	-120.93411	Monitoring	0	103	5	EDF	MW-4B	MW-4B							x
T10000009029-MW-4C	37.73044	-120.93412	Monitoring	0	135	5	EDF	MW-4C	MW-4C							x
T10000009029-MW-7R	37.73093	-120.93470	Monitoring	0	81.5	25	EDF	MW-7R	MW-7R							x
									Total Count	**323**	**57**	**162**	**88**	**144**	**150**	**174**

Abbreviations
ft: feet
bgs: below ground surface
PCE: Tetrachloroethene
TCP: 1,2,3-Trichloropropane
DBCP: Dibromochloropropane
TDS: total dissolved solids