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

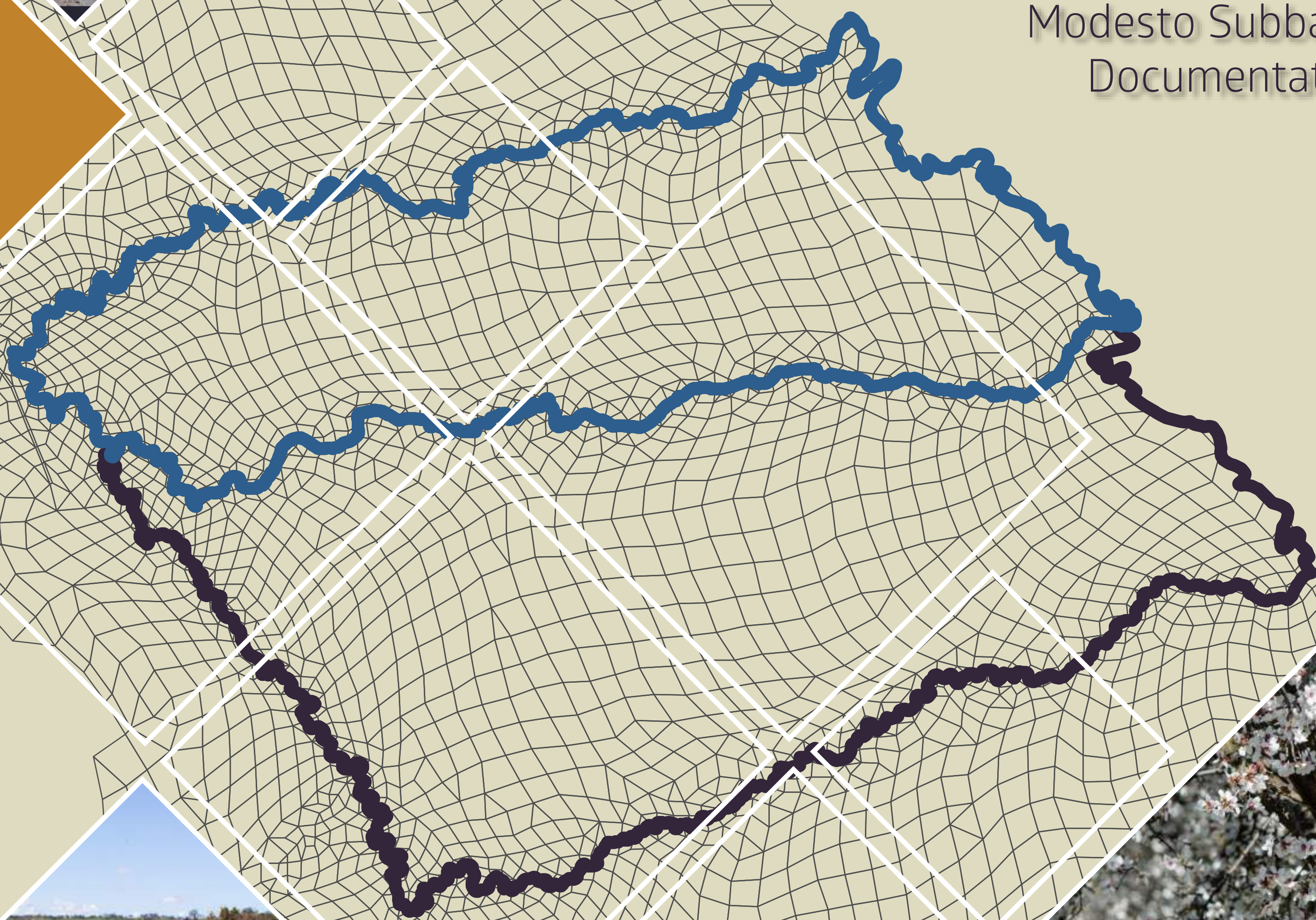
Modesto Subbasin Documentation

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.

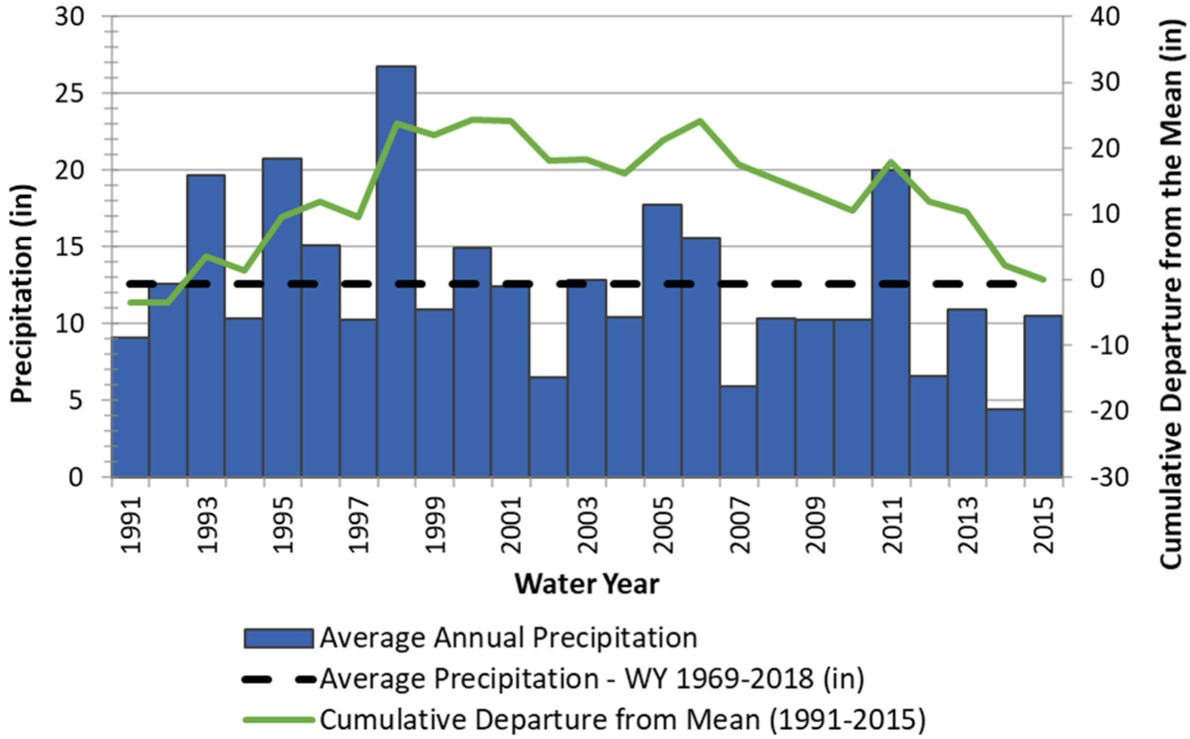
This section describes the data sources and methodologies used to specify model parameters and monthly time series data provided as inputs to the Modesto Model to simulate these land surface processes. Unless otherwise noted, other inputs to the C2VSimFG model were generally used directly in the Modesto 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.

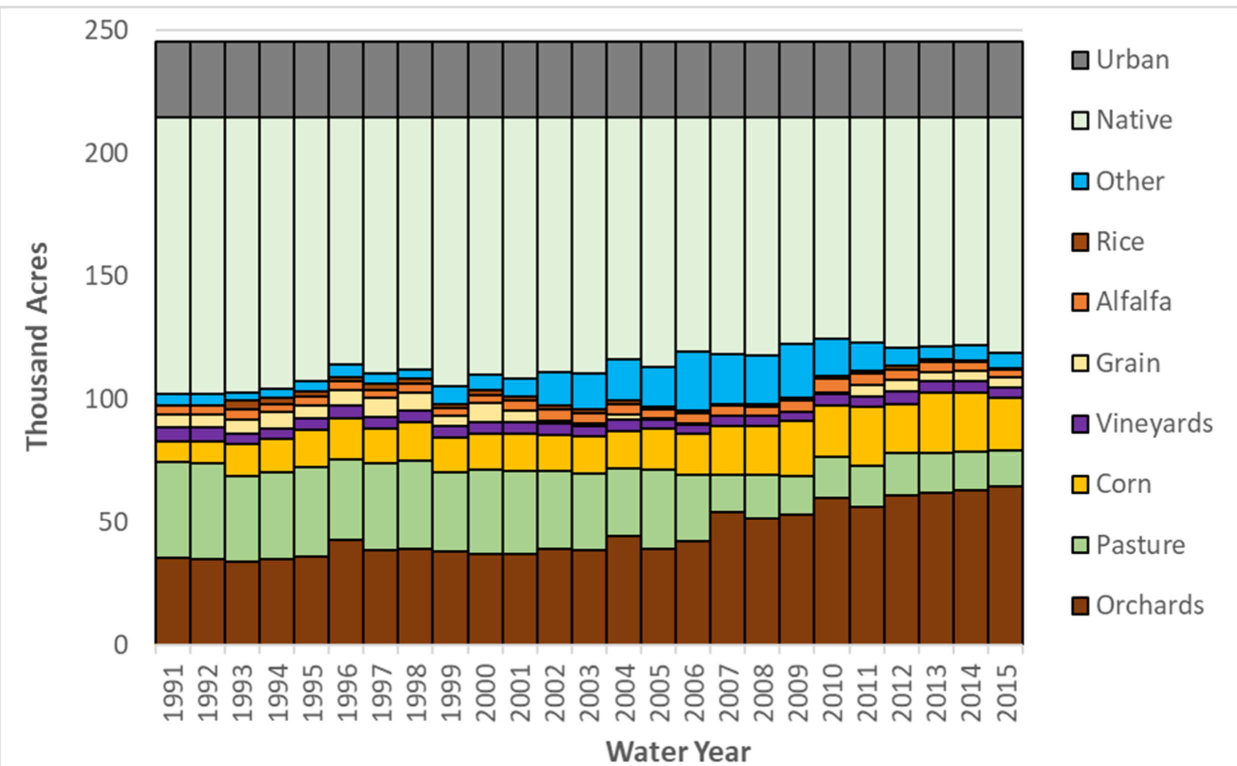
Table 3: Land Use Data Sources Available during the Historical Period (1991-2015).

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.

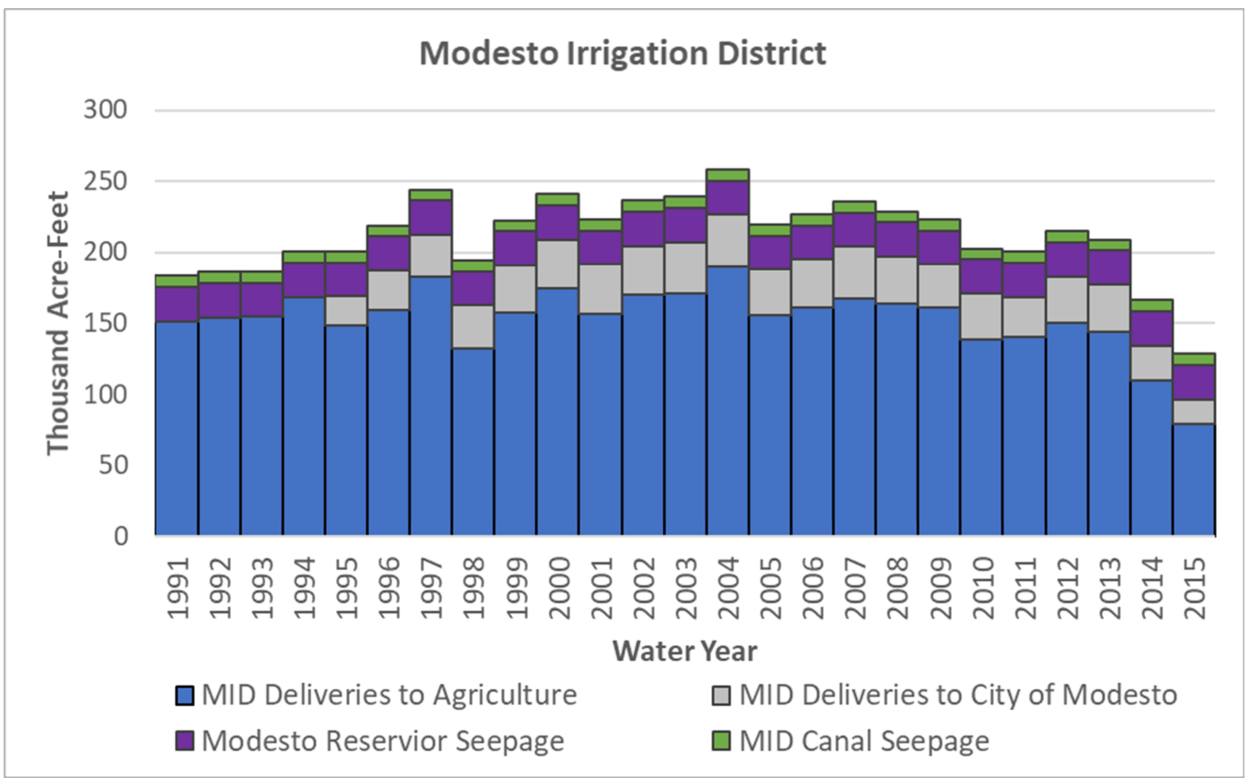
Total surface water supply to the Modesto Subbasin averages 337,000 AFY of deliveries to agricultural and municipal users throughout the 1991-2015 historical period. Of this, 311,000 is delivered to growers to meet agricultural demand and 26,000 is treated and delivered to the City of Modesto (30,000 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.

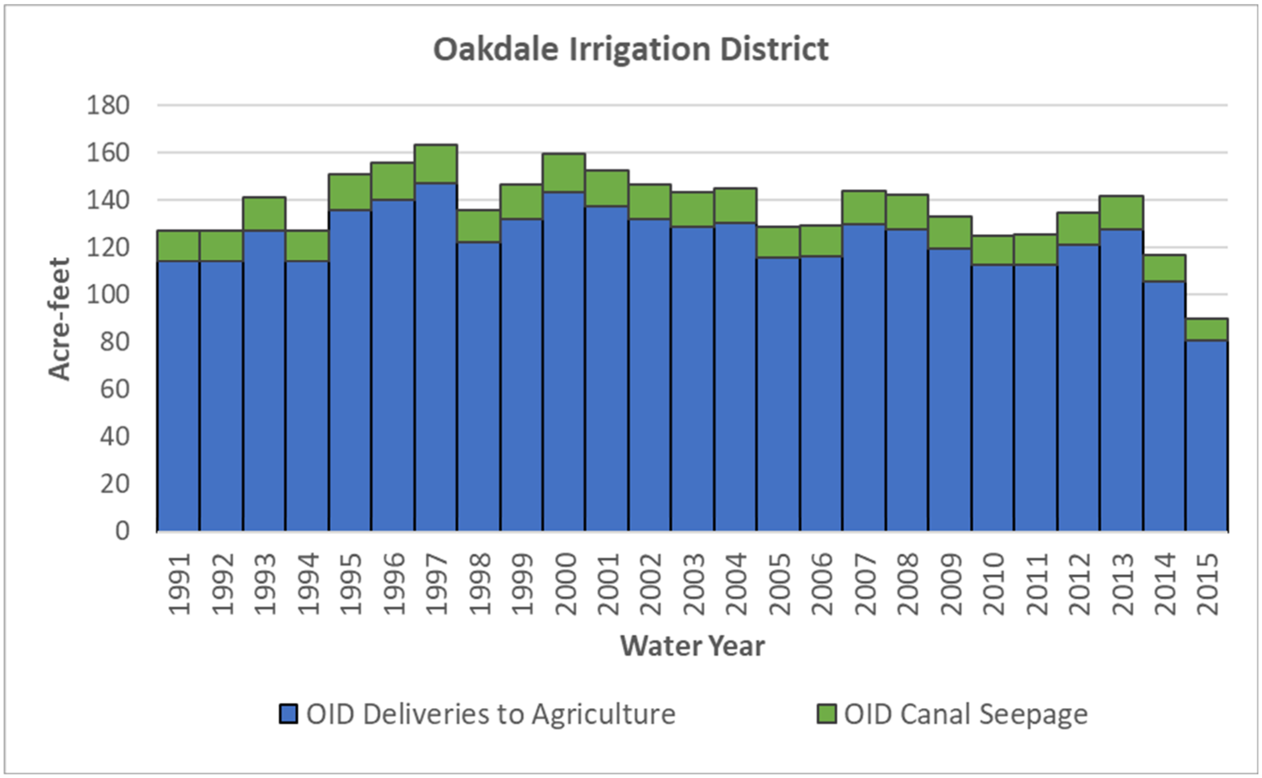
Figure 3: Modesto Irrigation District Surface Water Deliveries and Recharge



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.

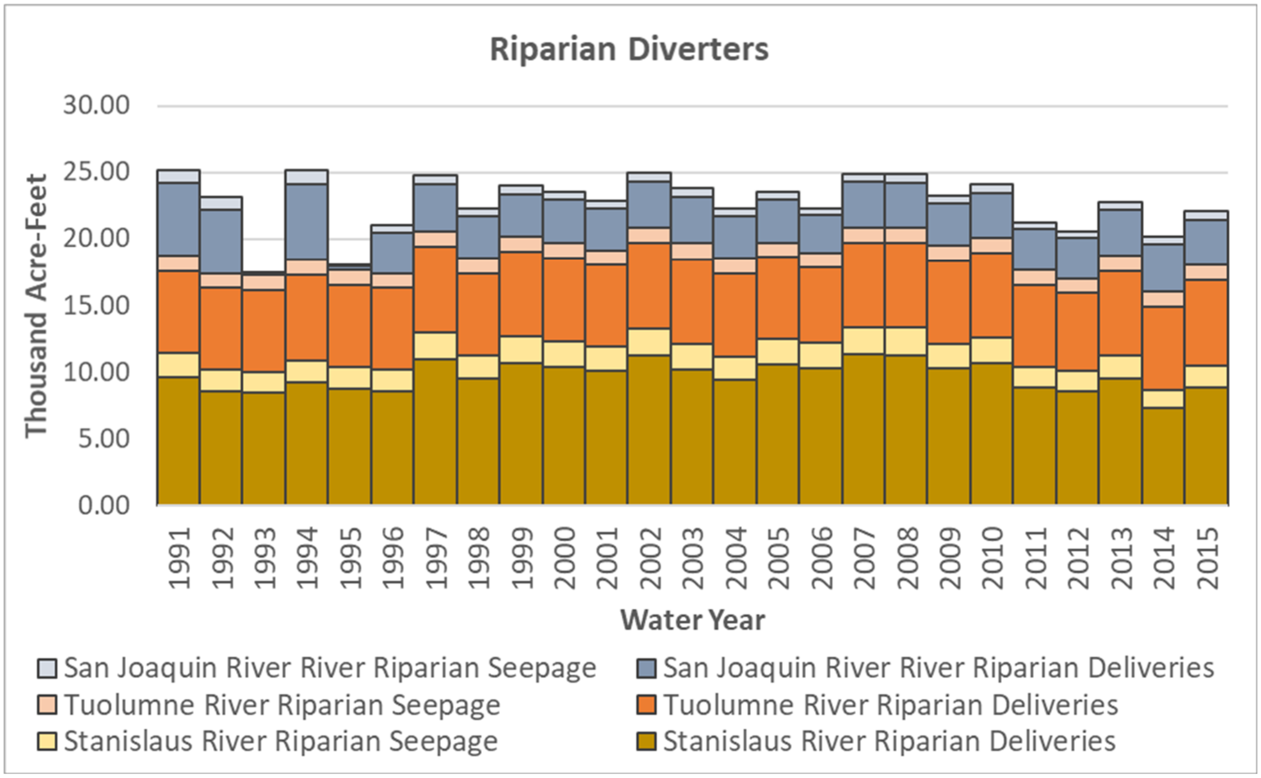
Figure 4: Oakdale Irrigation District Surface Water Deliveries and Recharge



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:

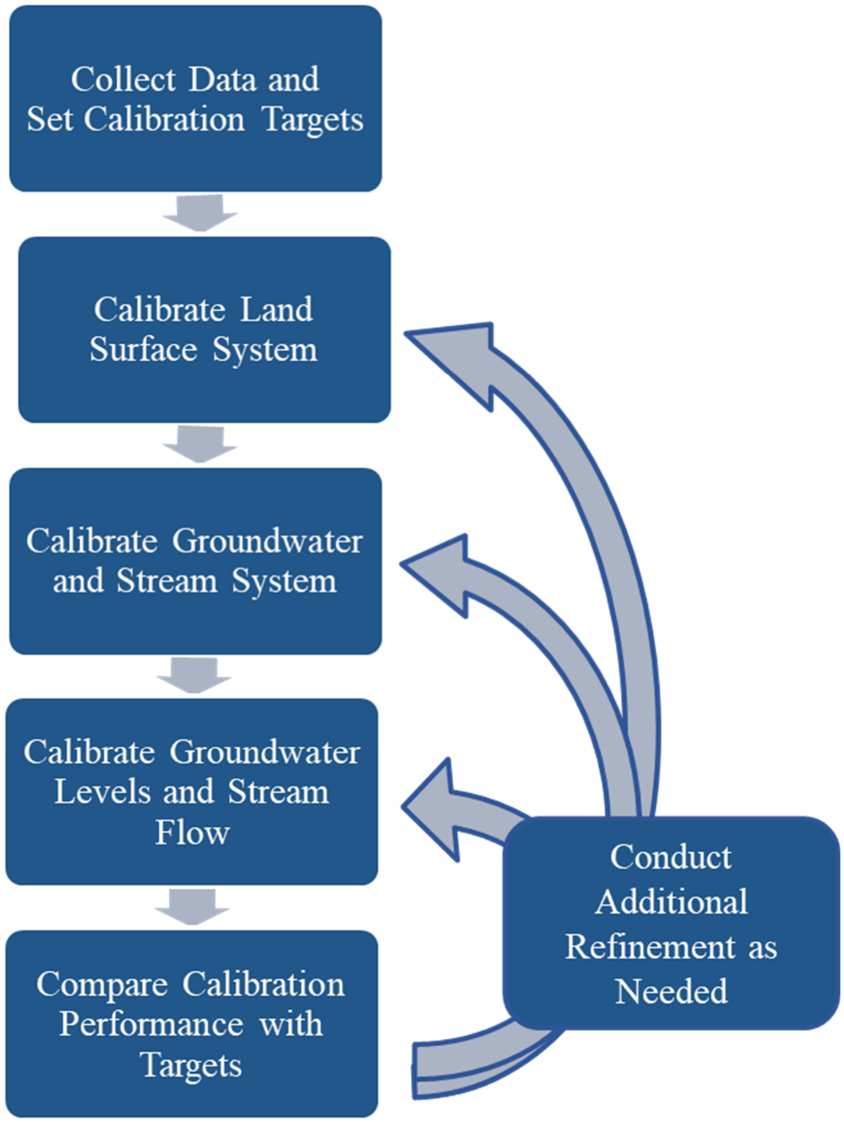
- Develop water budgets that properly represent each of the hydrologic systems modeled (i.e., land surface, stream, and groundwater system), across various geographic scales (i.e., Subbasin, GSA, and districts), and temporal timesteps (i.e., monthly, and annually).
- Represent the regional distribution 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

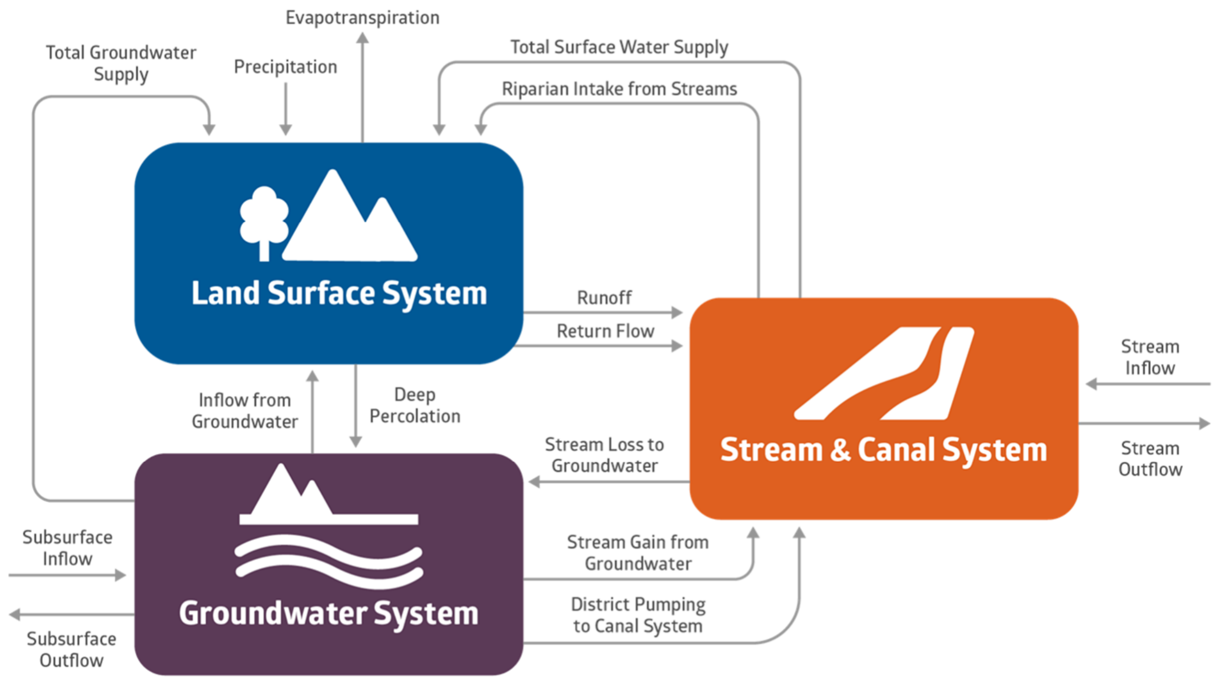
Water budget calibration ensures that the operational and hydrologic characteristics of the subbasin are accurately represented. The goal of the water budget analysis is to validate flow dynamics and develop a balanced system between supply and demand while describing the movement water such as rainfall, 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)

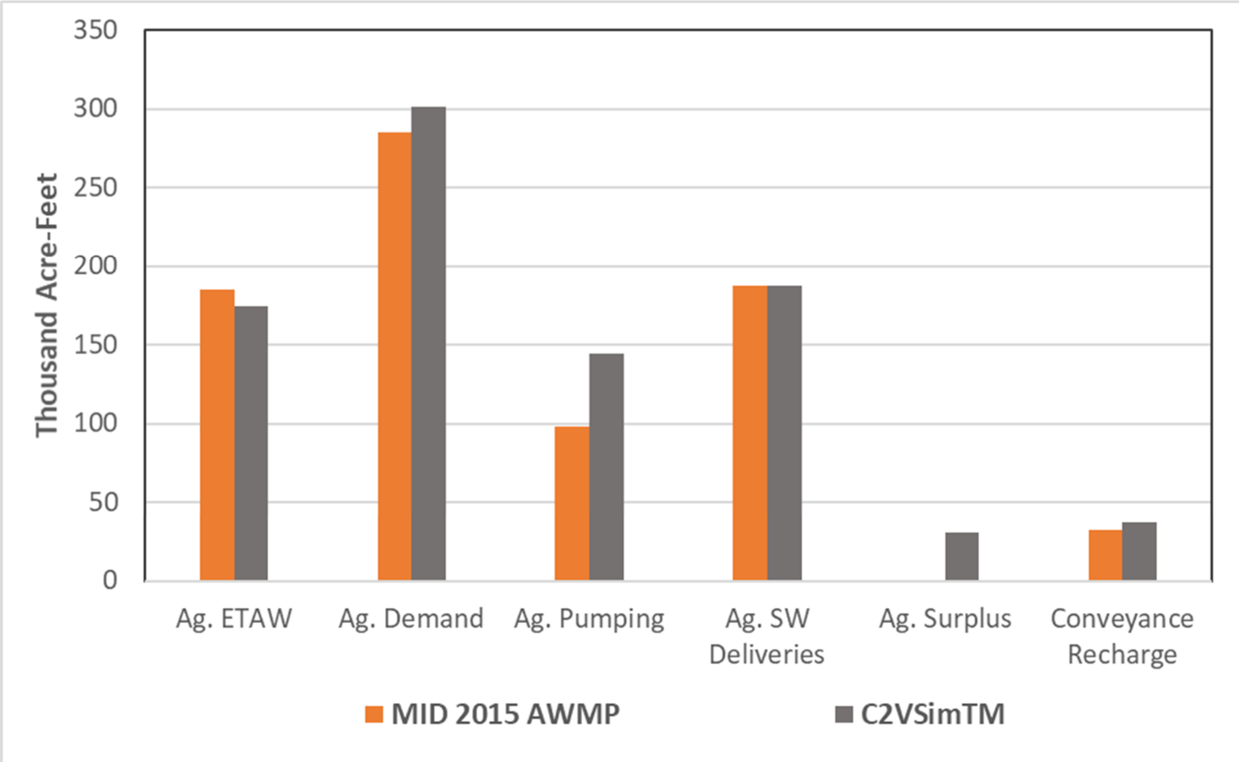
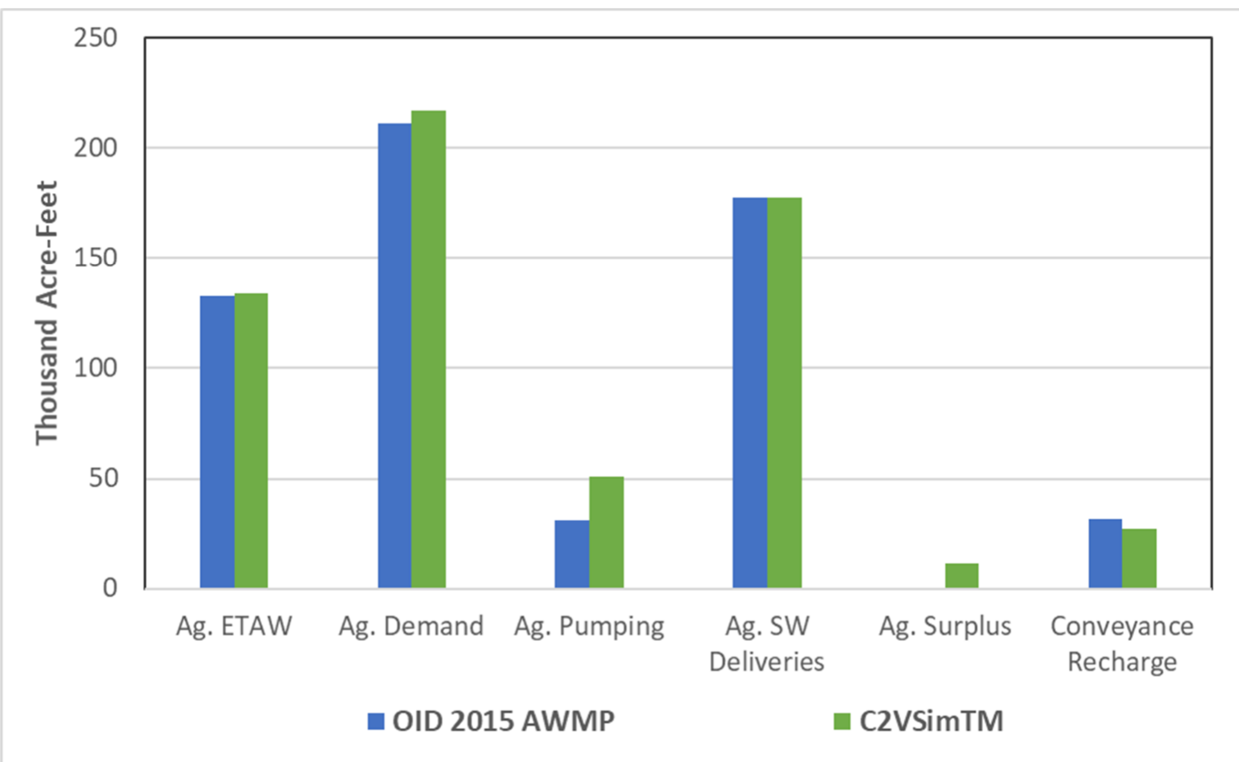


Figure 9: Modesto Model Calibration of OID Land Surface Operations (1991-2015)



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

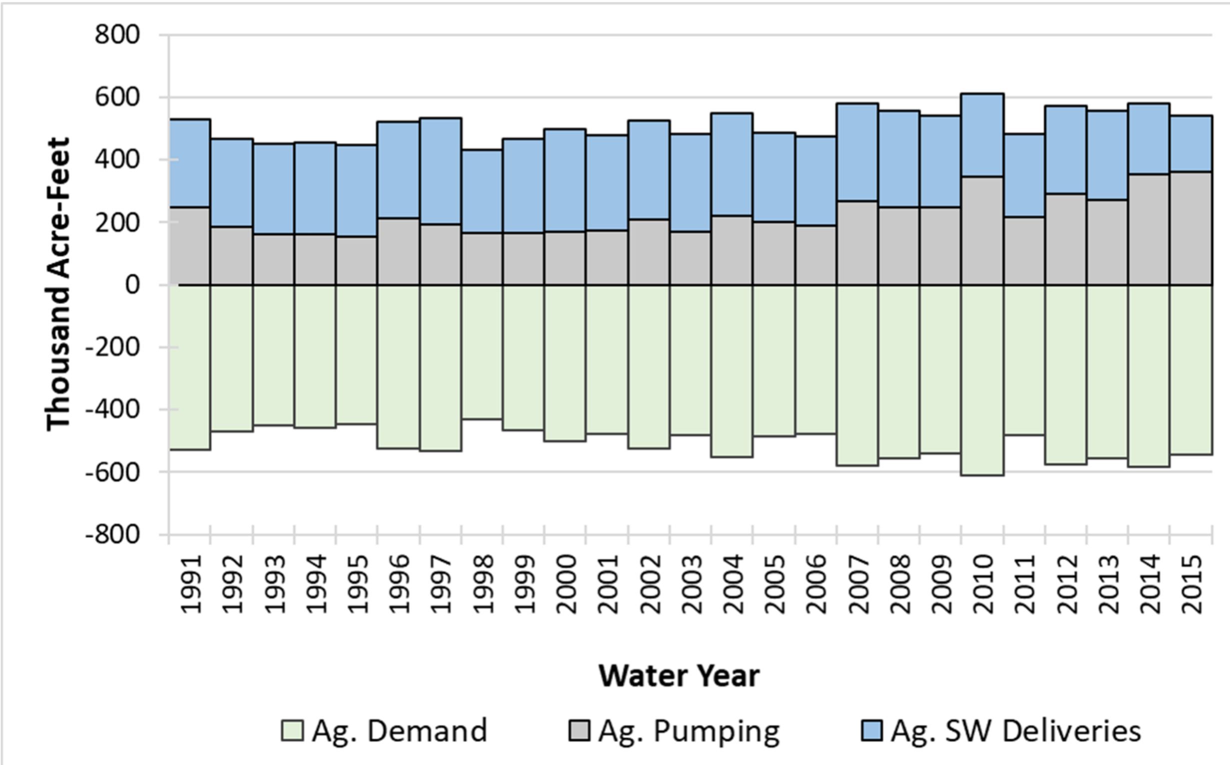
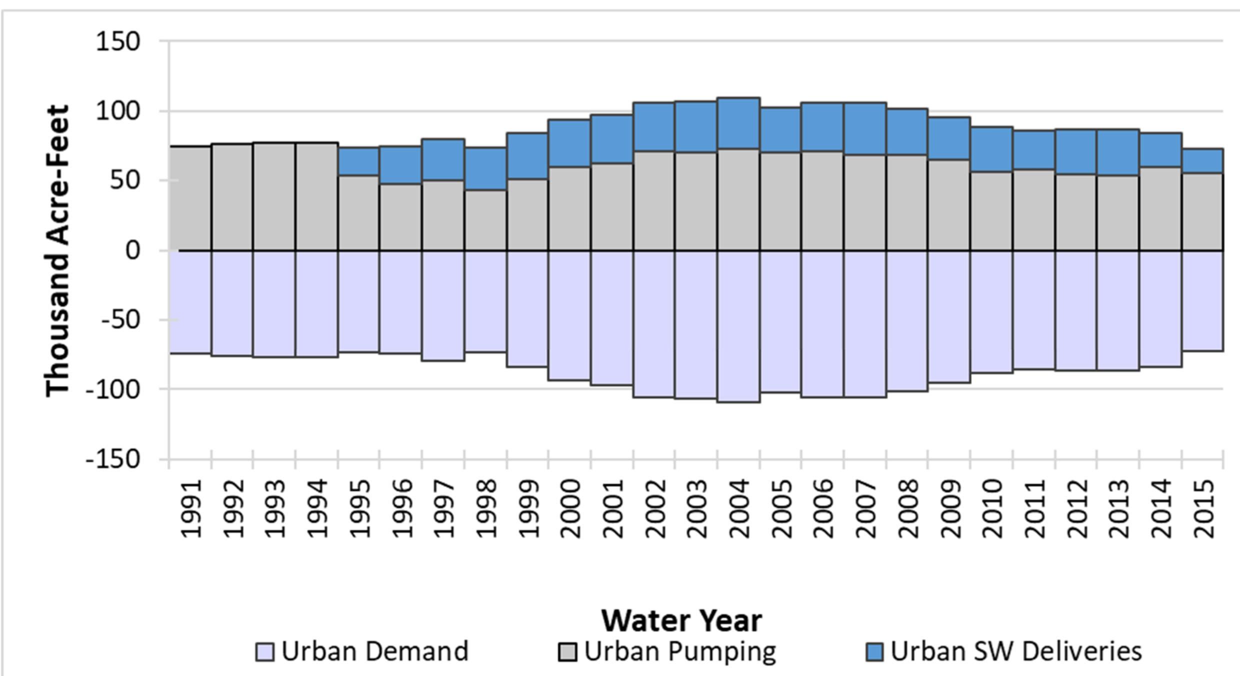


Figure 11: Modesto Subbasin Annual Urban Land and Water Use Budget



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

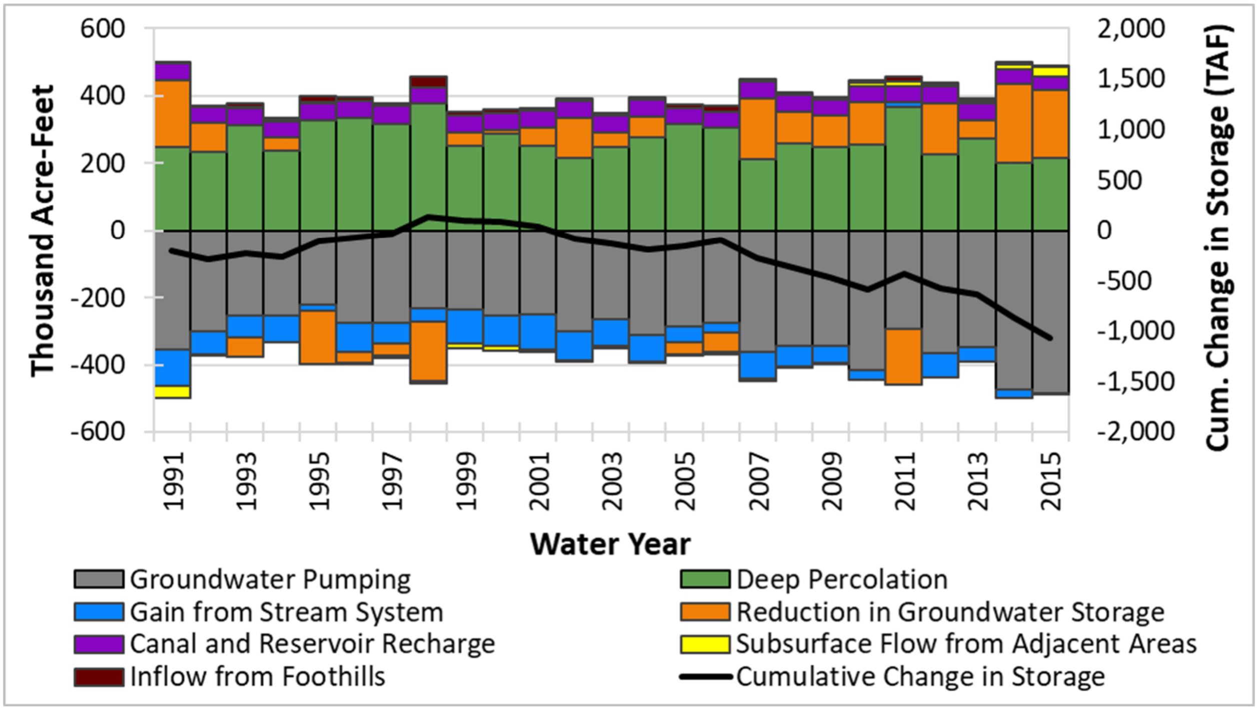
For the historical simulation of water years 1991-2015, the majority of Modesto Subbasin is irrigated agricultural land, and thus the main source of groundwater recharge is deep percolation of water from rain and applied irrigation water, which averages approximately 272,000 AFY. Seepage from canals 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

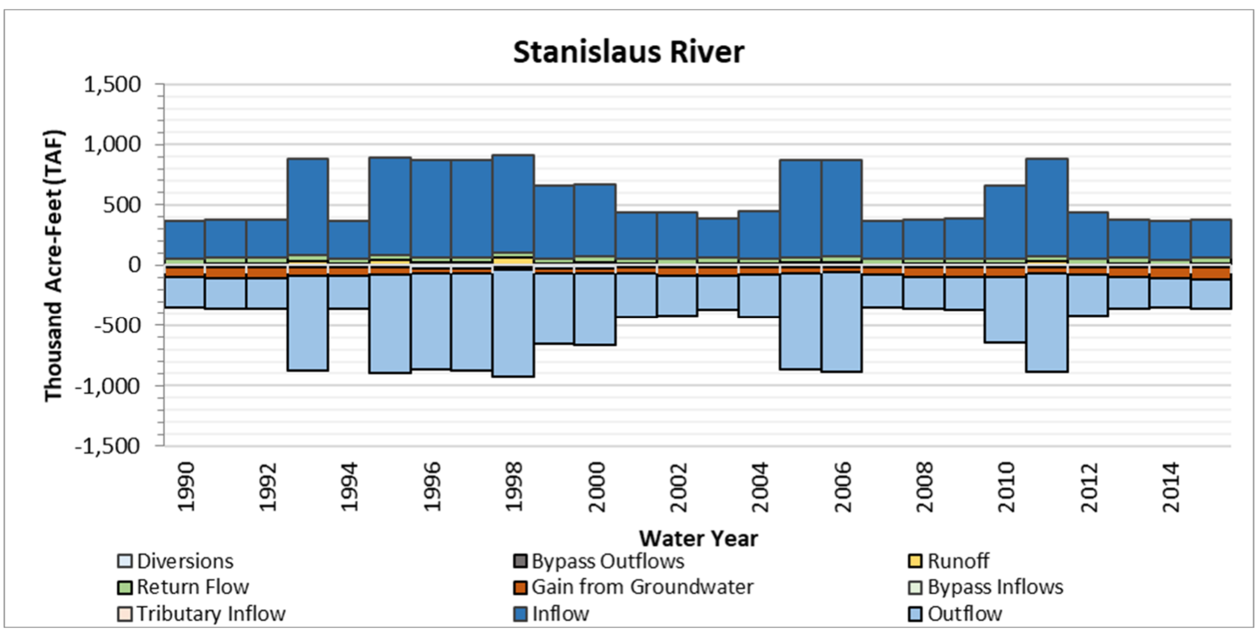
Calibration of the stream system is divided into streamflow and stream budget calibration. Stream budget calibration is principally a validation step during model calibration to ensure that the user-defined inflows and outflows are represented in model output. Within the Modesto model, these inflows 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**.

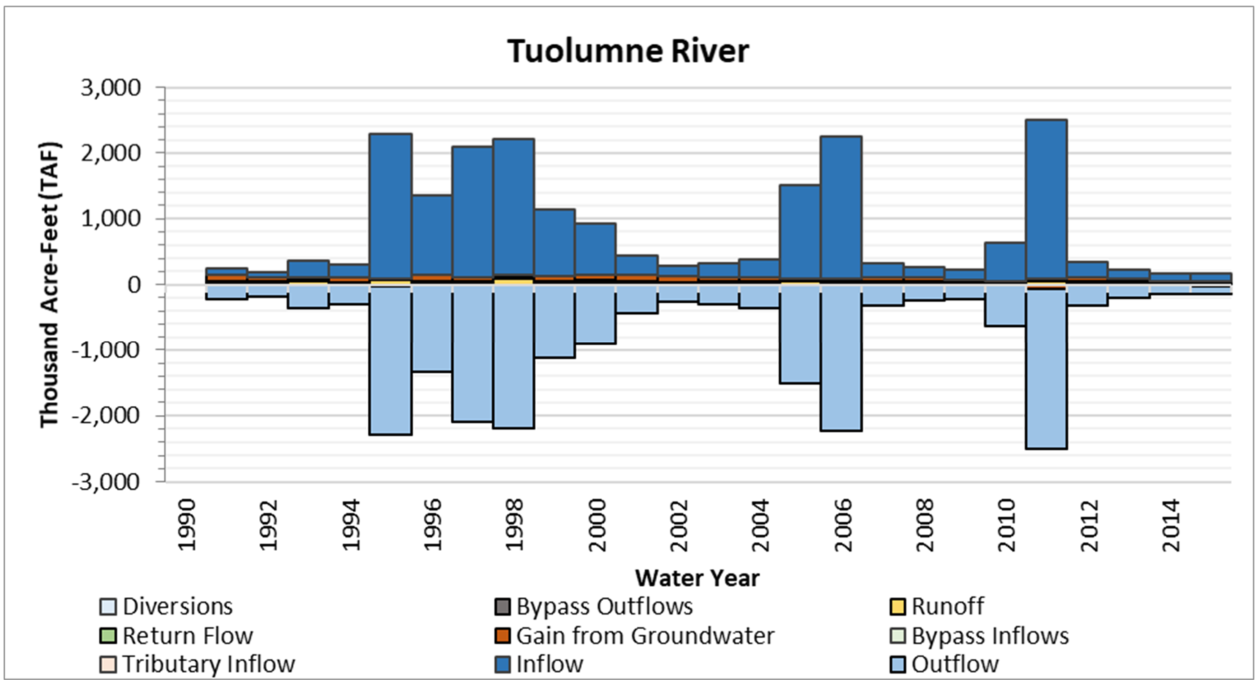
Figure 13: Stanislaus River Annual Stream Budget



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**.

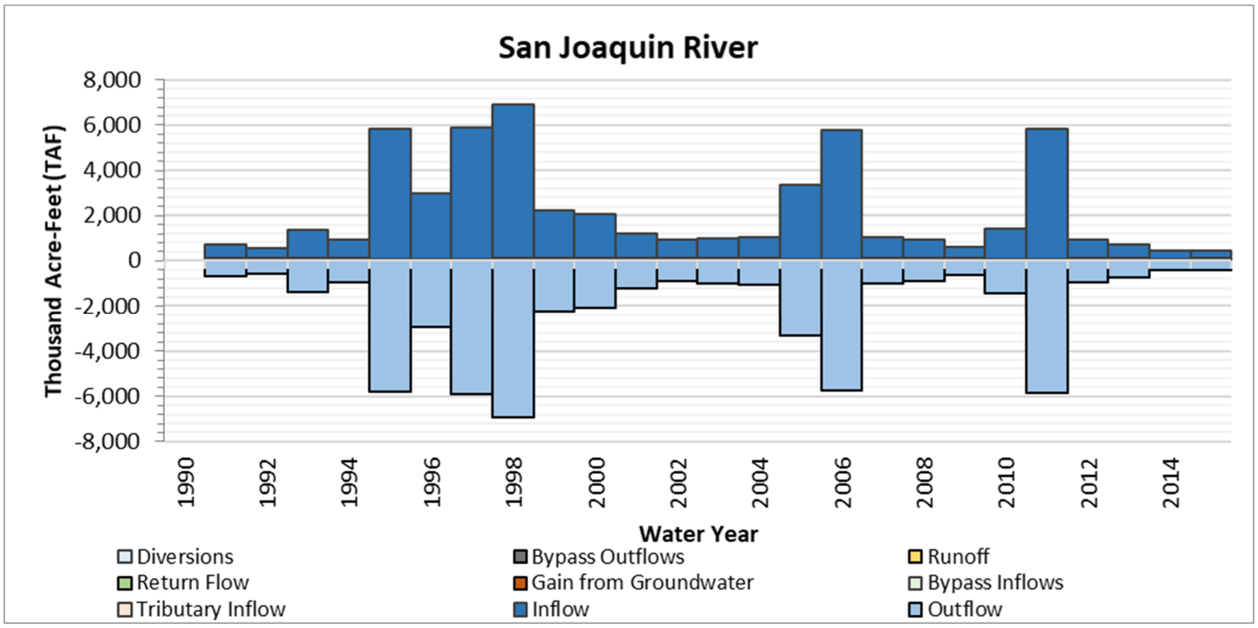
Figure 14: Tuolumne River Annual Stream Budget



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

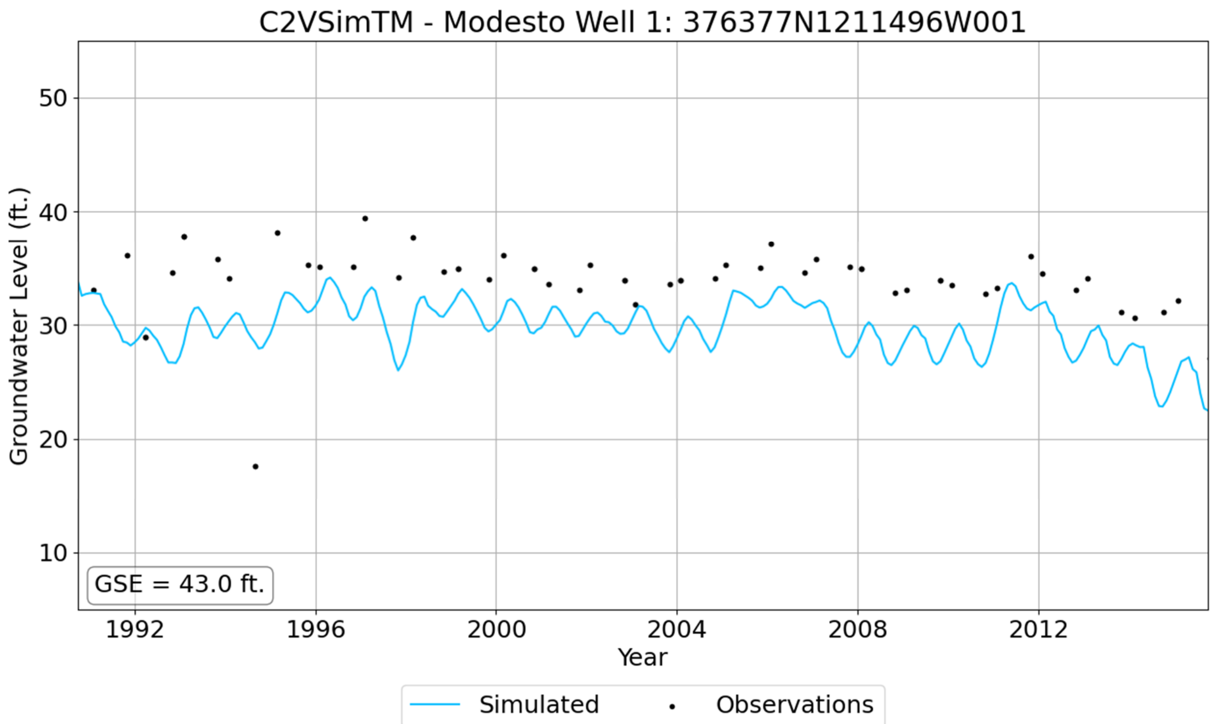


Figure 17: Modesto Calibration Well 21, Simulated and Observed

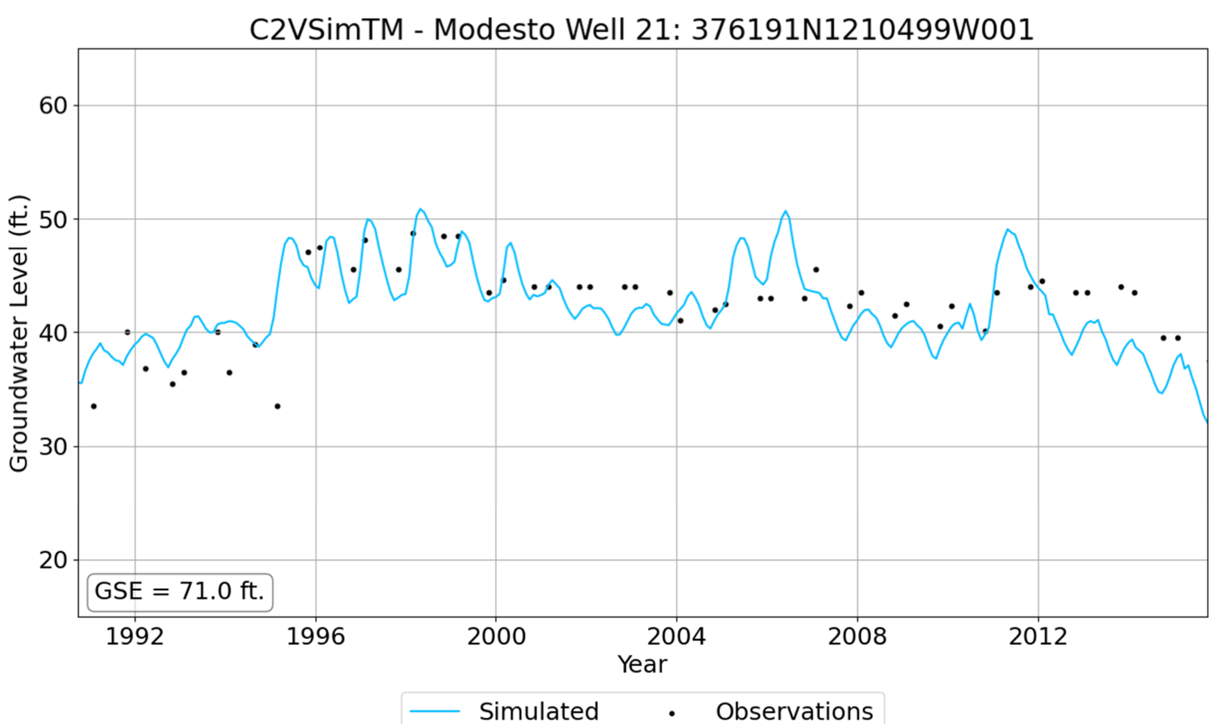


Figure 18: Modesto Calibration Well 27, Simulated and Observed

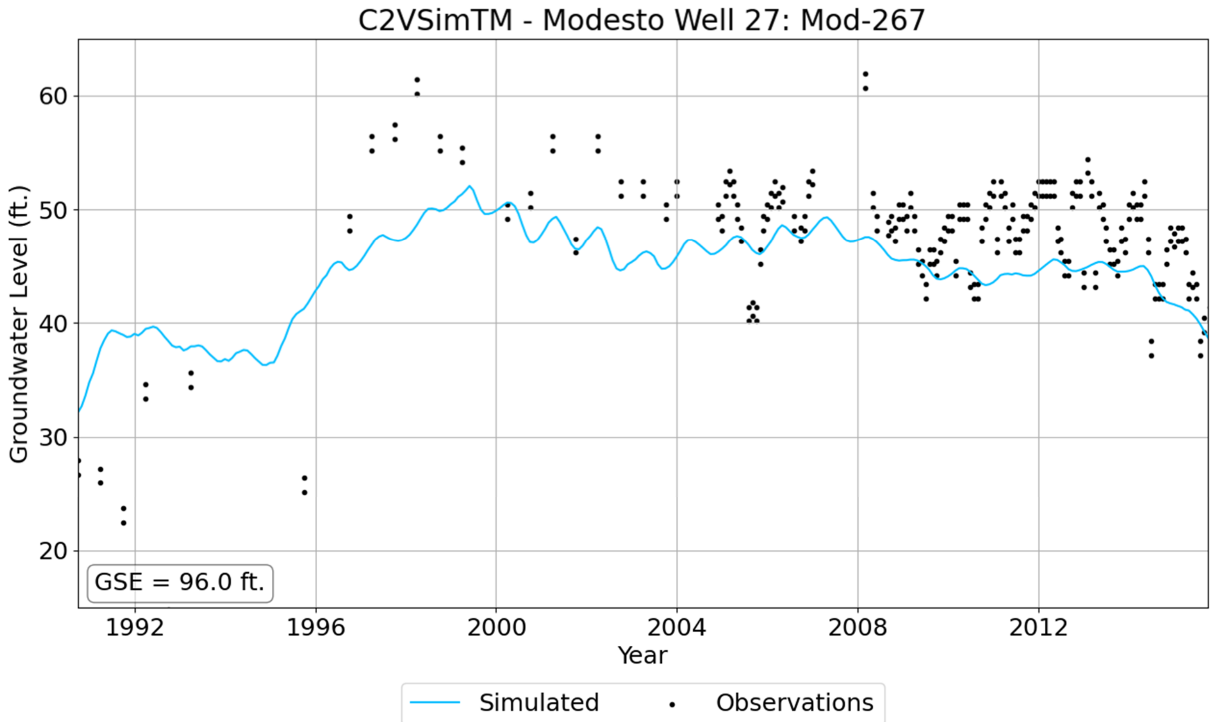


Figure 19: Modesto Calibration Well 43, Simulated and Observed

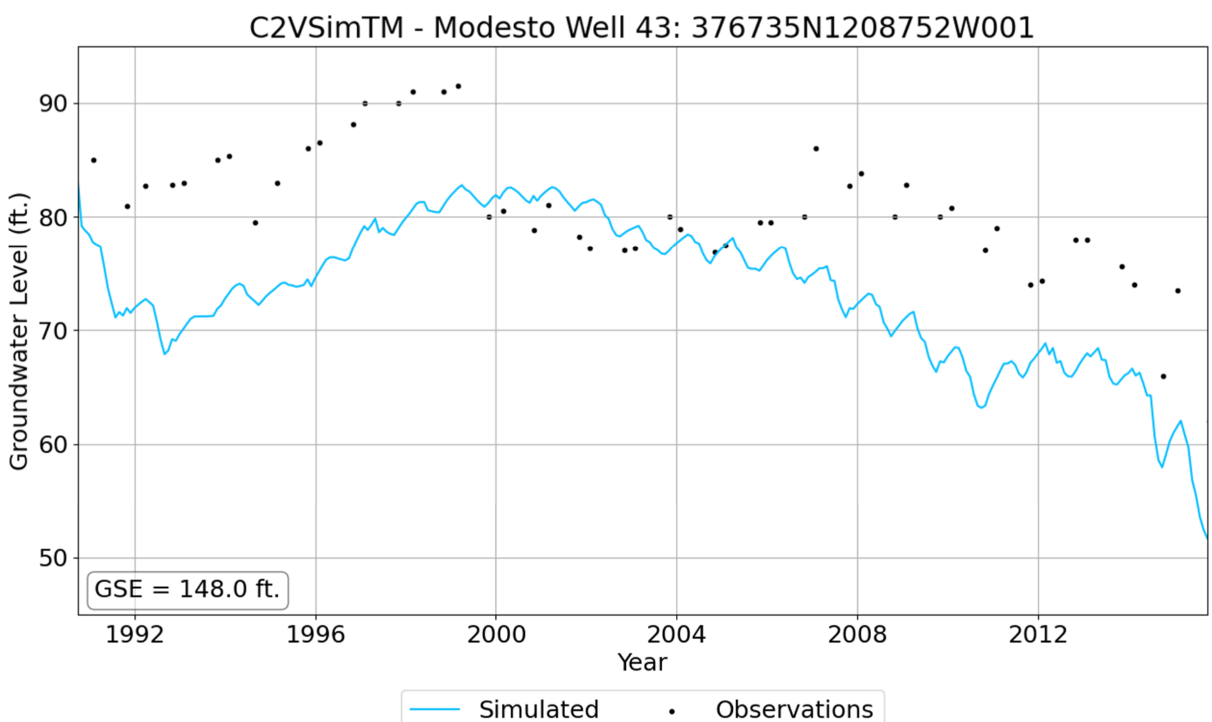


Figure 20: Modesto Calibration Well 45, Simulated and Observed

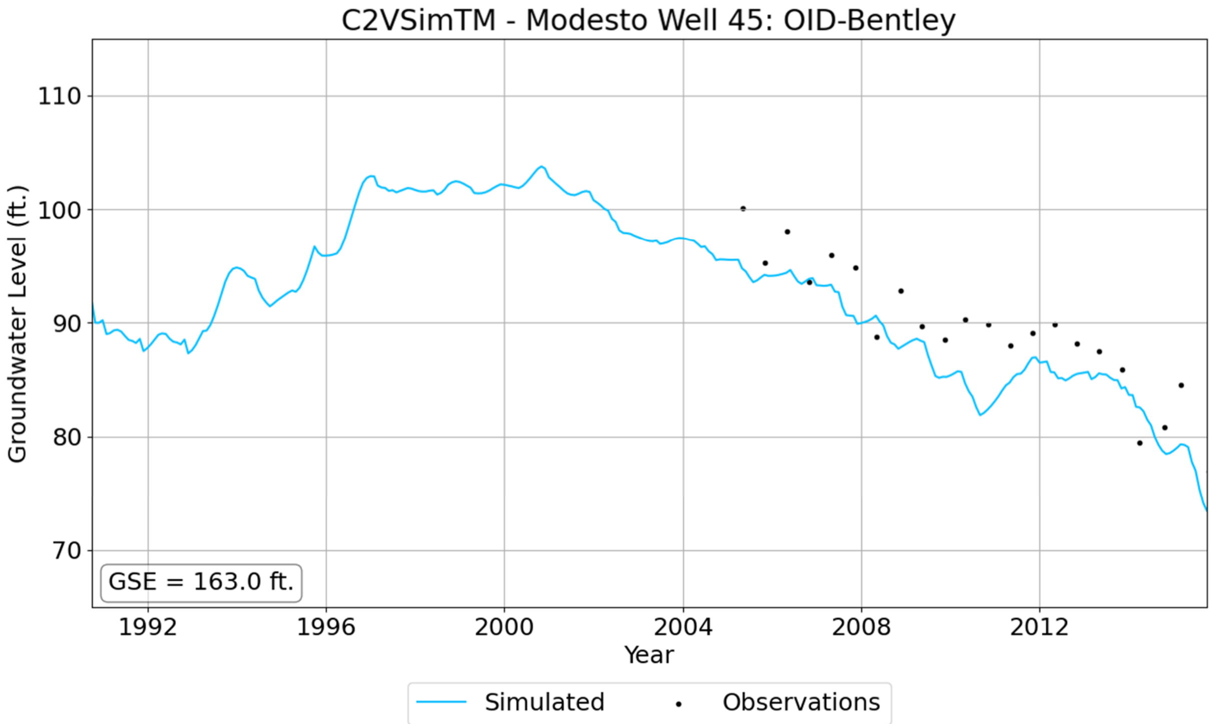


Figure 21: Modesto Calibration Well 55, Simulated and Observed

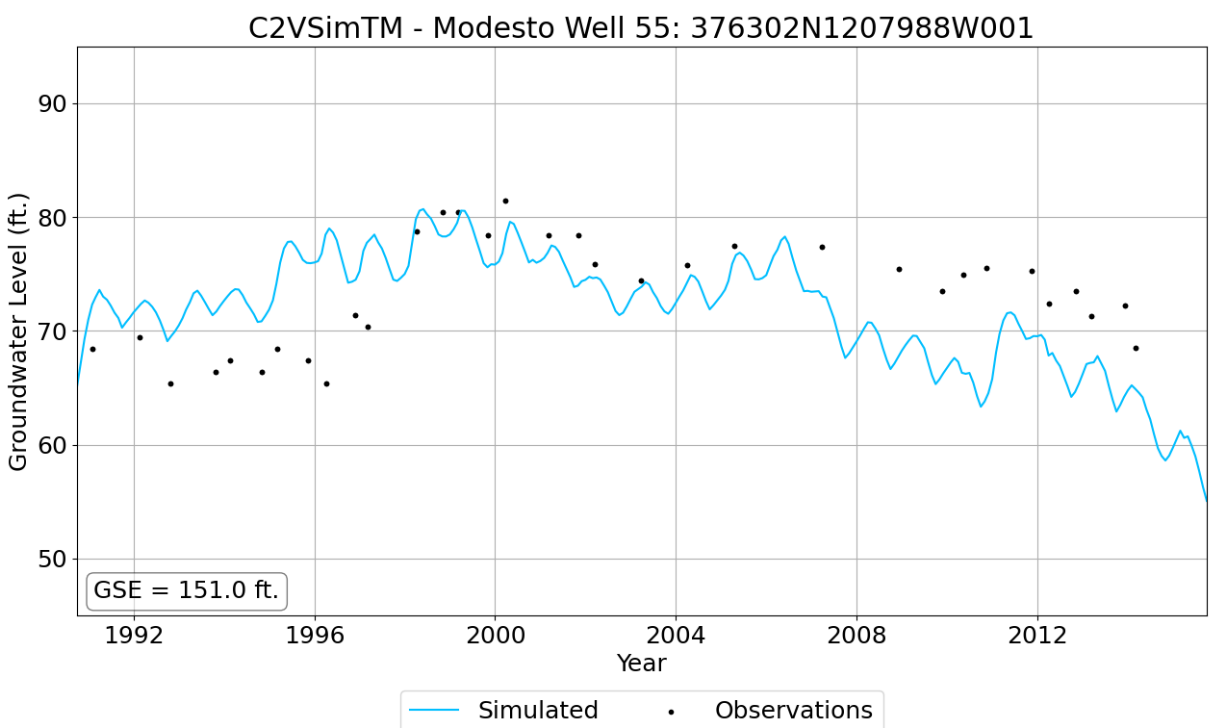


Figure 22: Modesto Calibration Well 64, Simulated and Observed

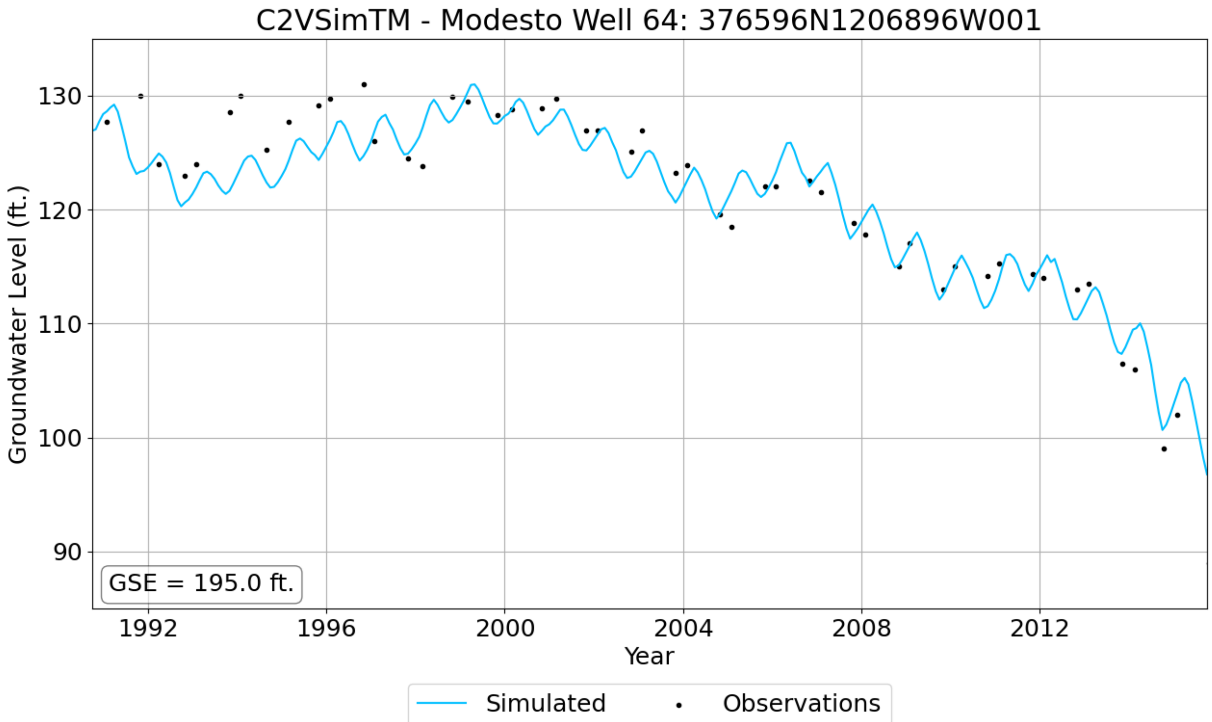
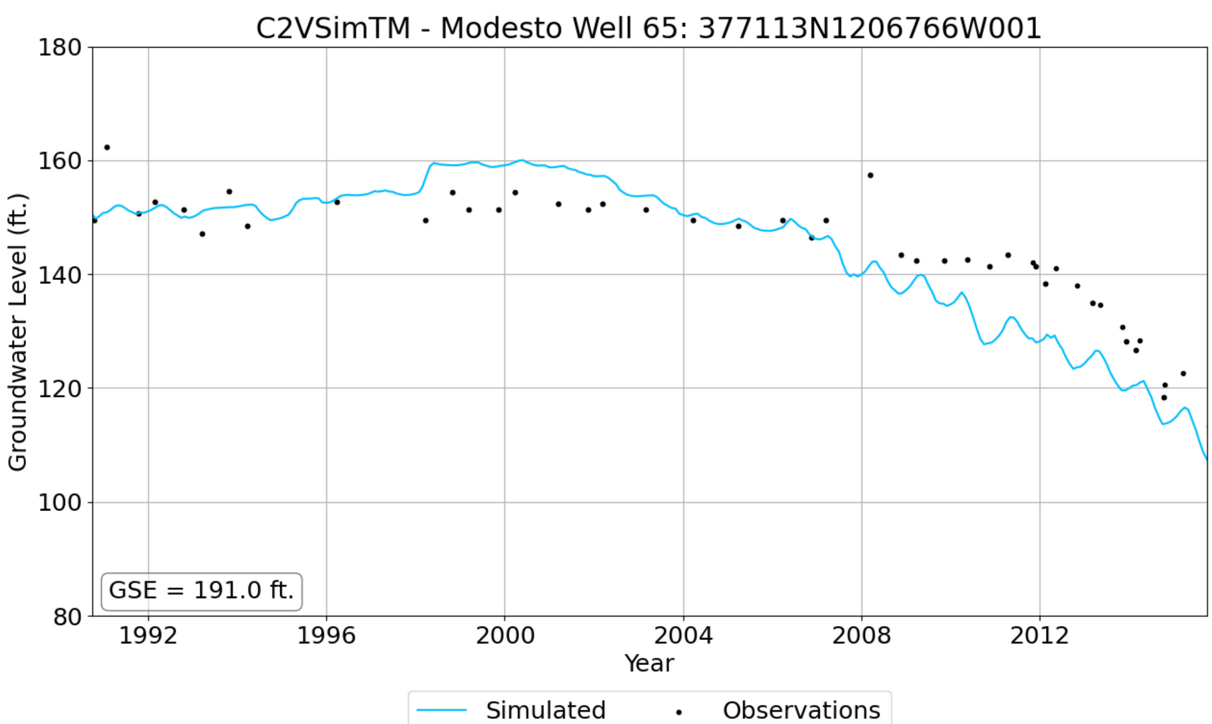


Figure 23: Modesto Calibration Well 65, Simulated and Observed



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

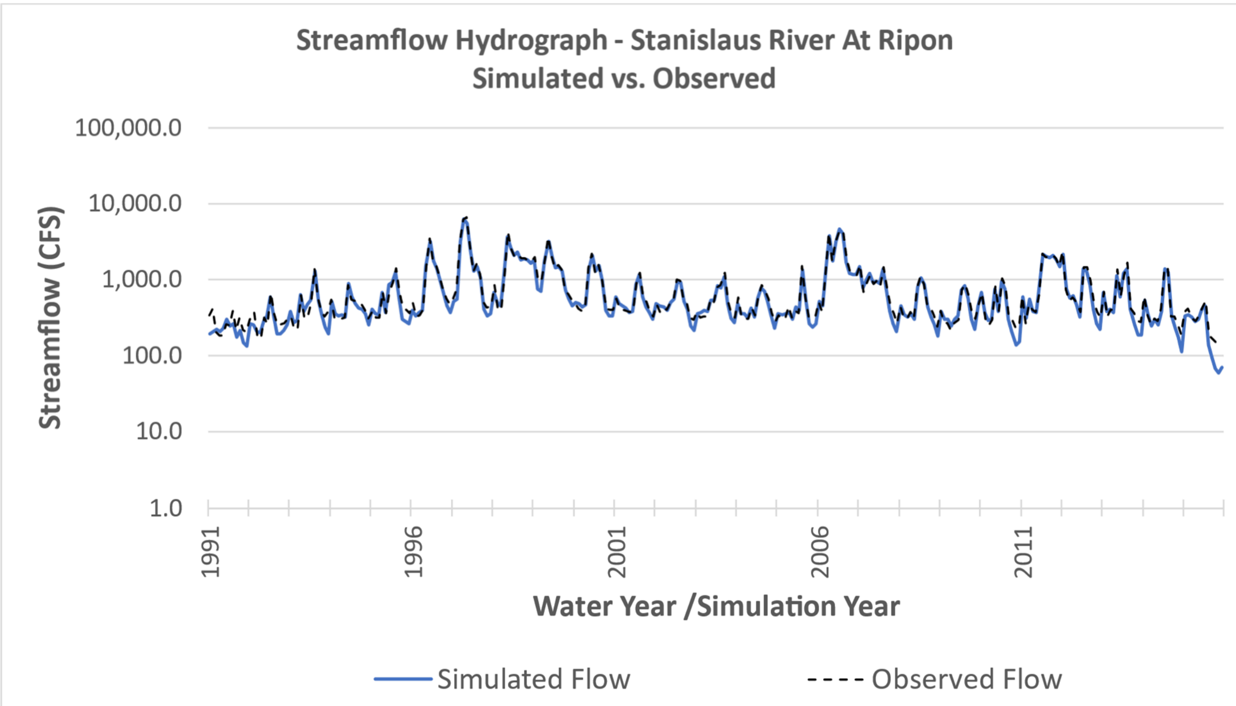


Figure 25: Streamflow Exceedance Probability for the Stanislaus River

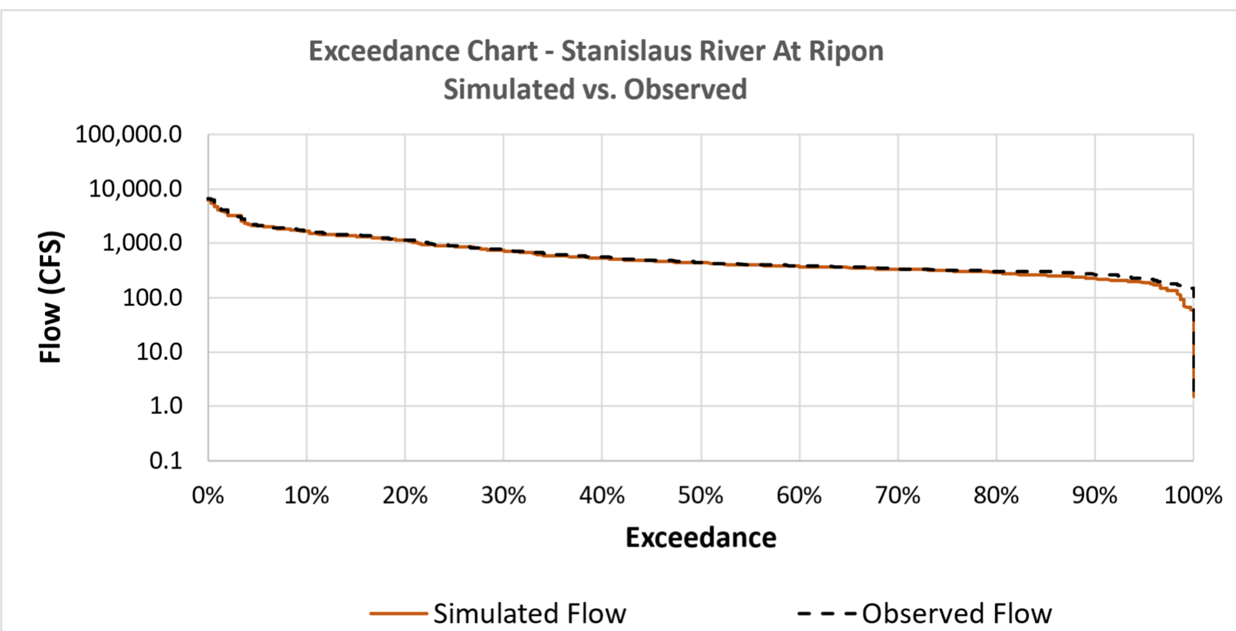


Figure 26: Observed vs. Simulated Streamflow for the Tuolumne River

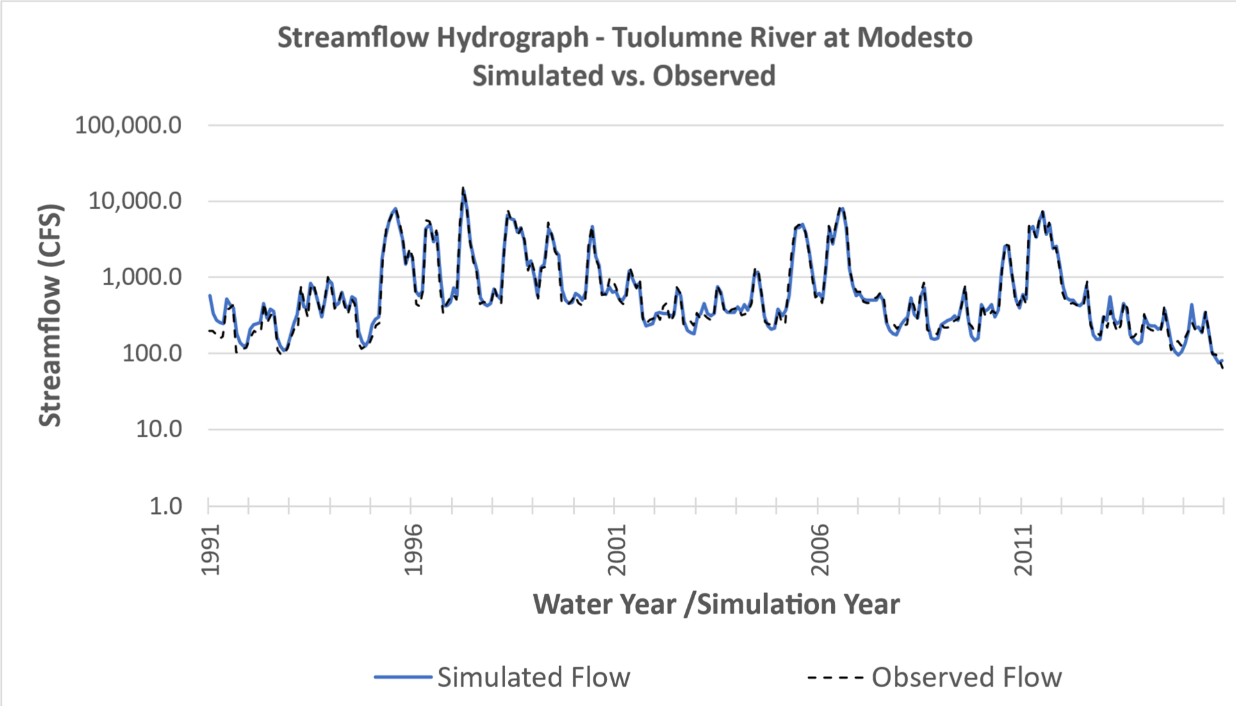


Figure 27: Streamflow Exceedance Probability for the Tuolumne River

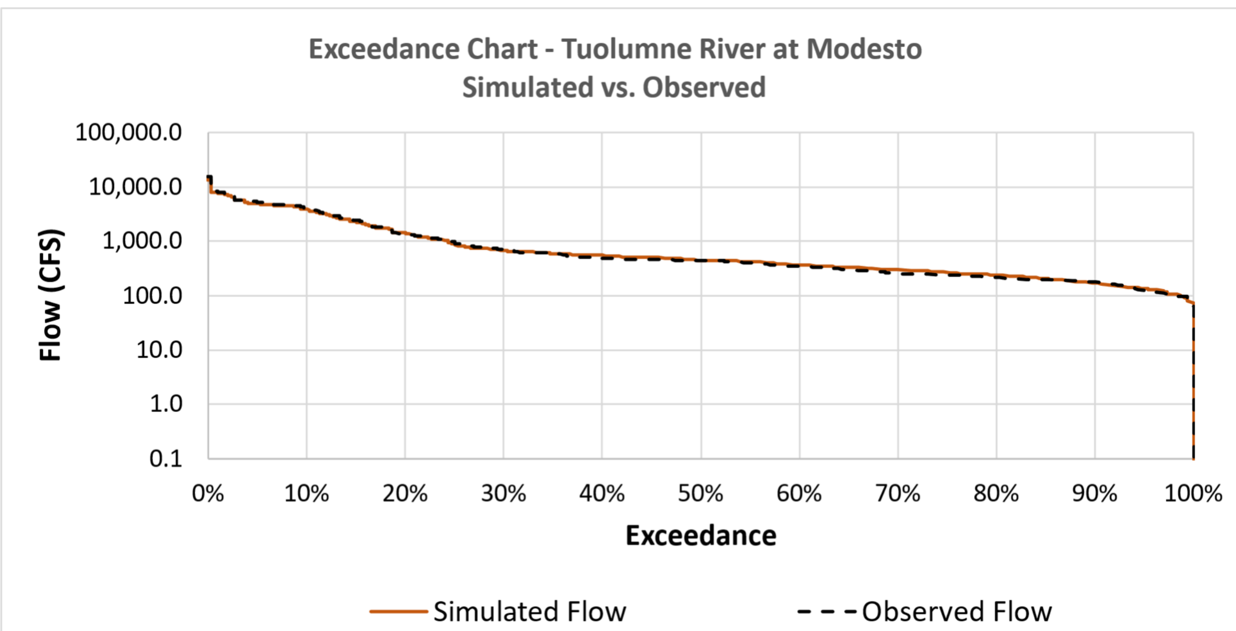


Figure 28: Observed vs. Simulated Streamflow for the San Joaquin River at Vernalis

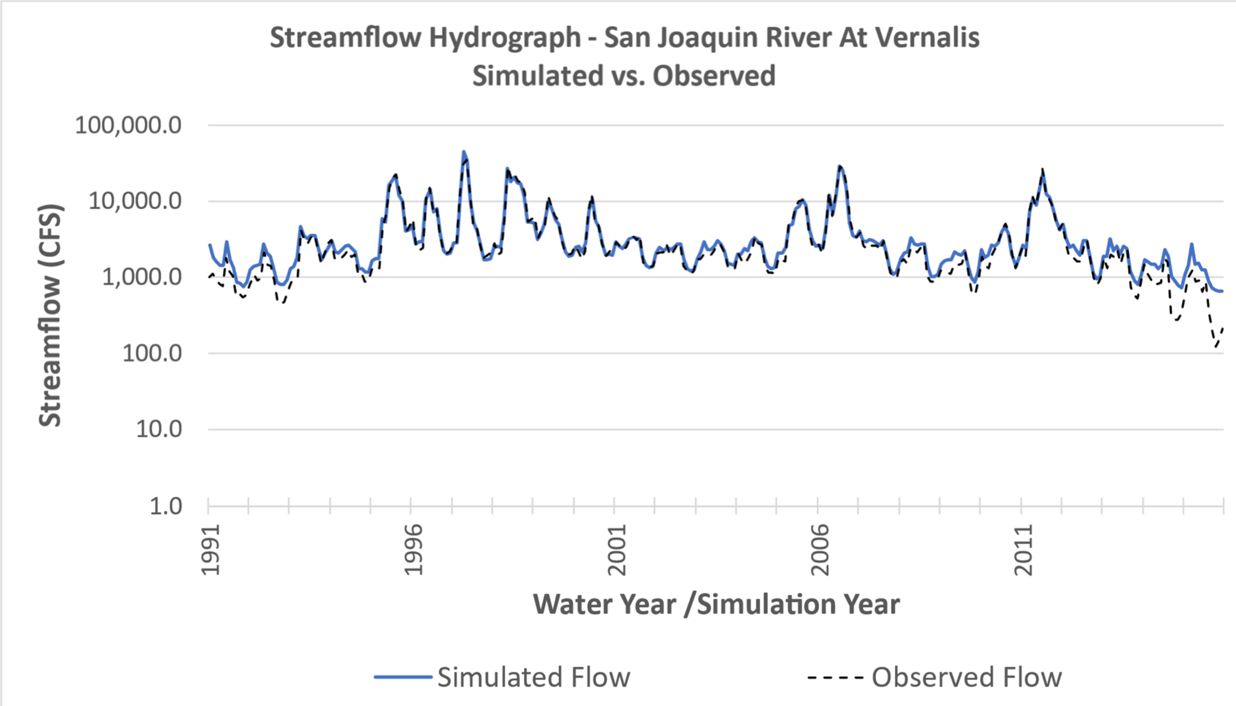
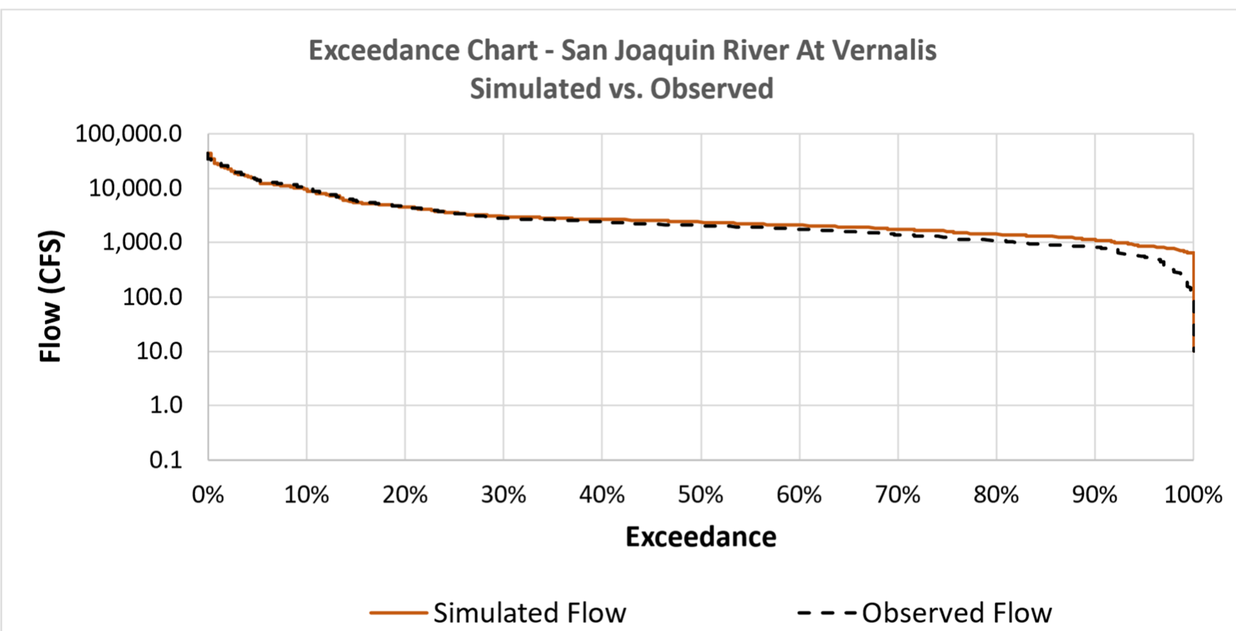


Figure 29: Streamflow Exceedance Probability for the San Joaquin River at Vernalis



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

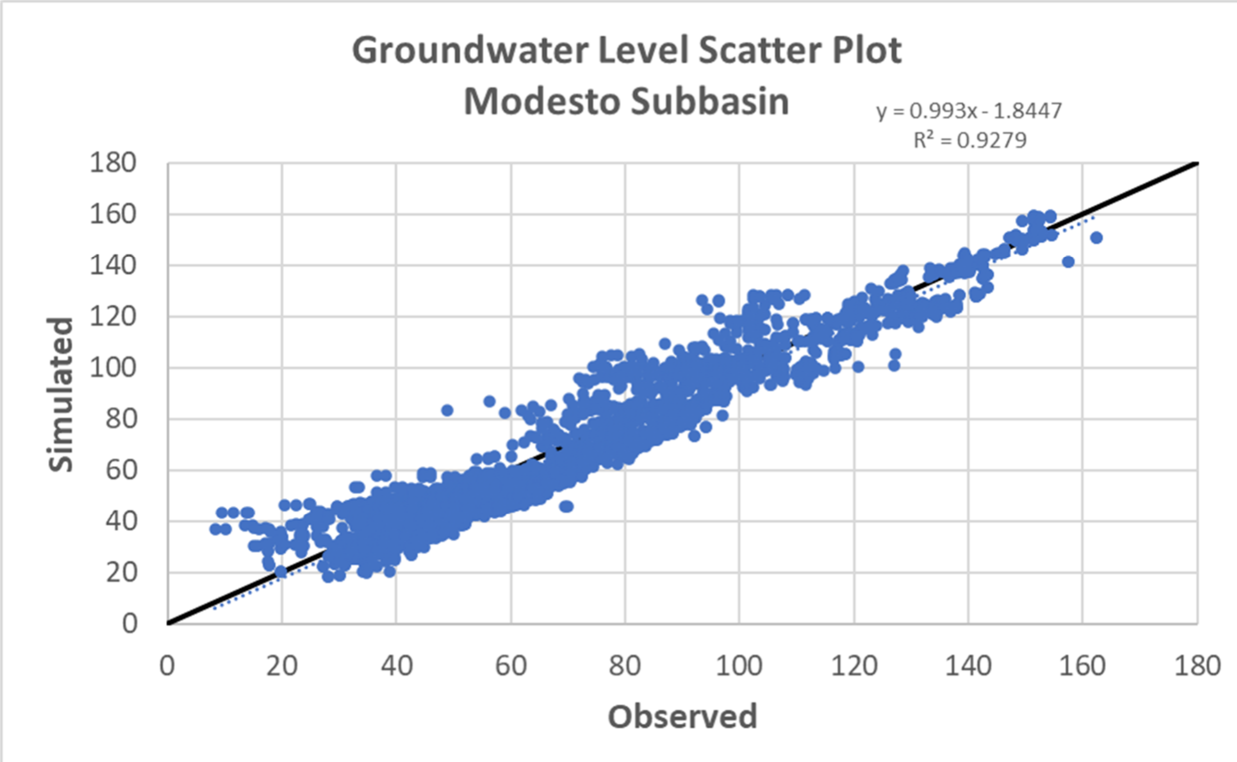
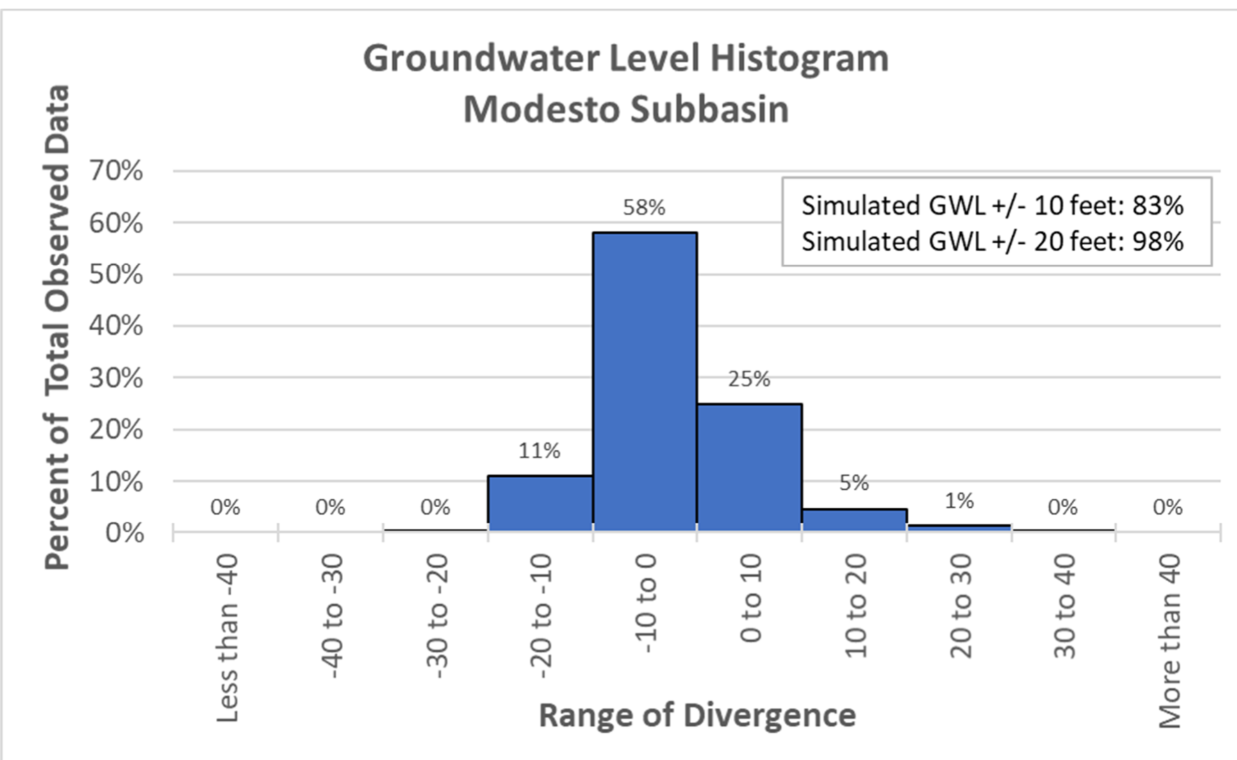


Figure 31: Modesto Subbasin Simulated vs. Observed Residual Histogram



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

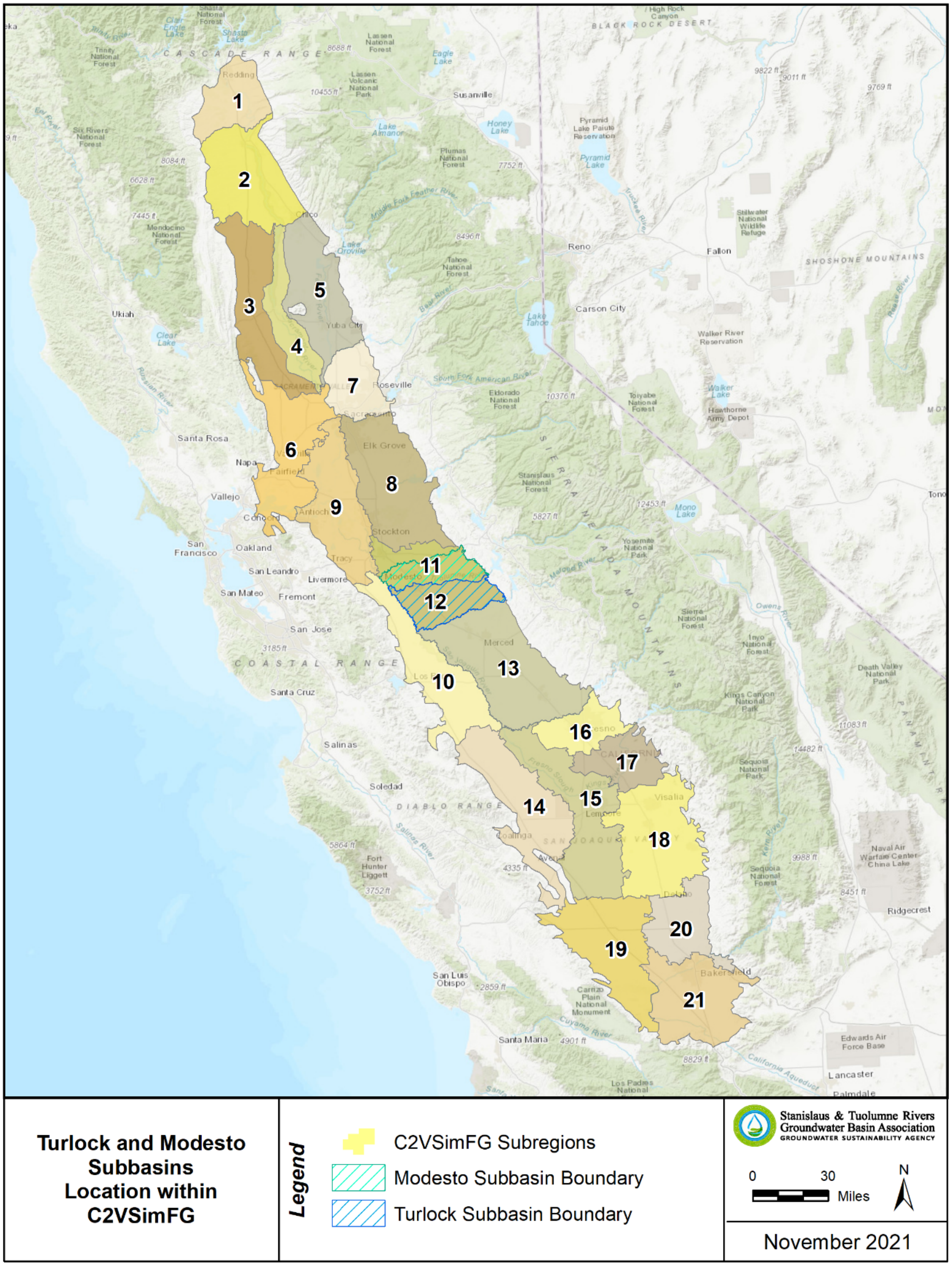


Figure M2: Modesto Subbasin

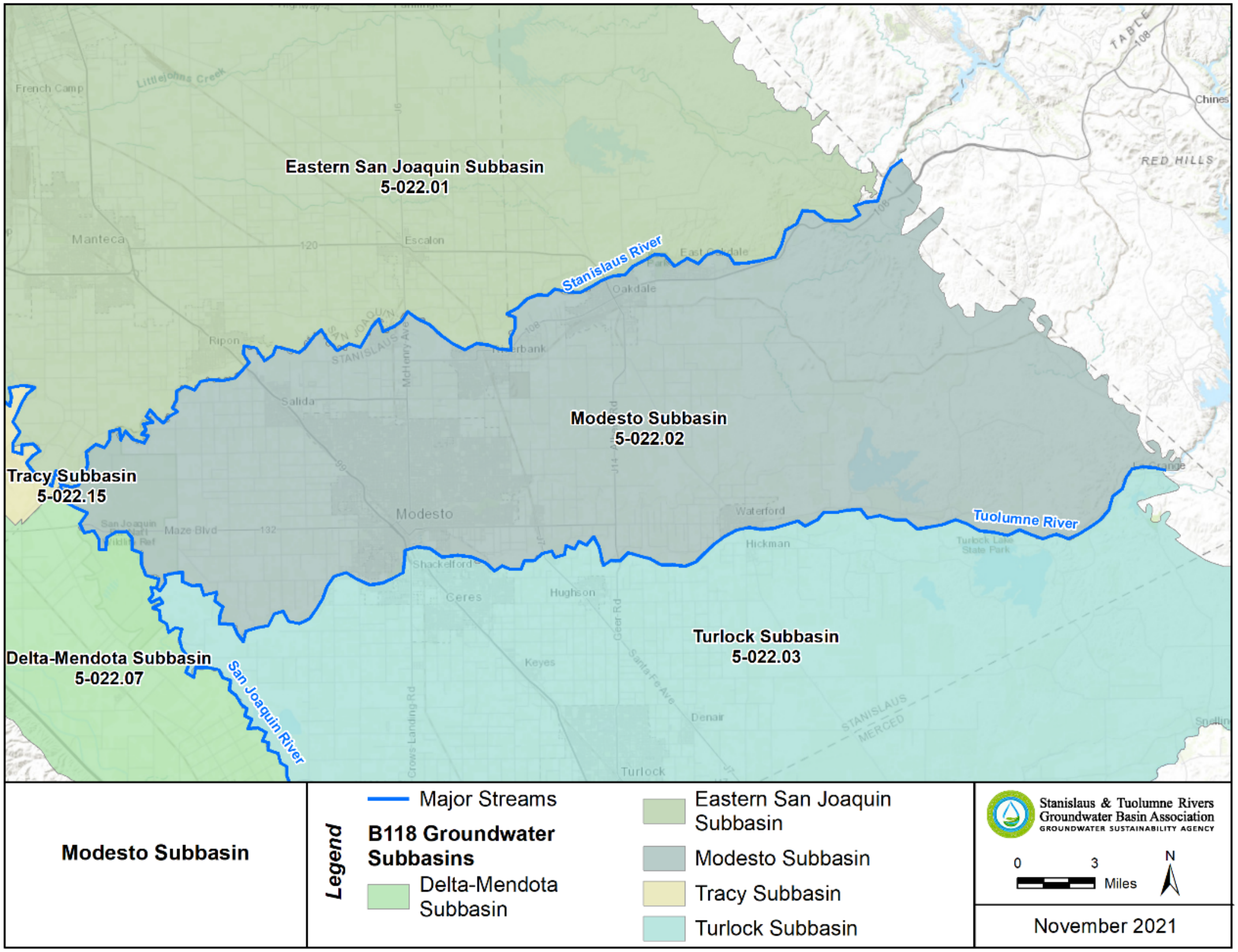


Figure M3: Modesto Subbasin Water Agencies

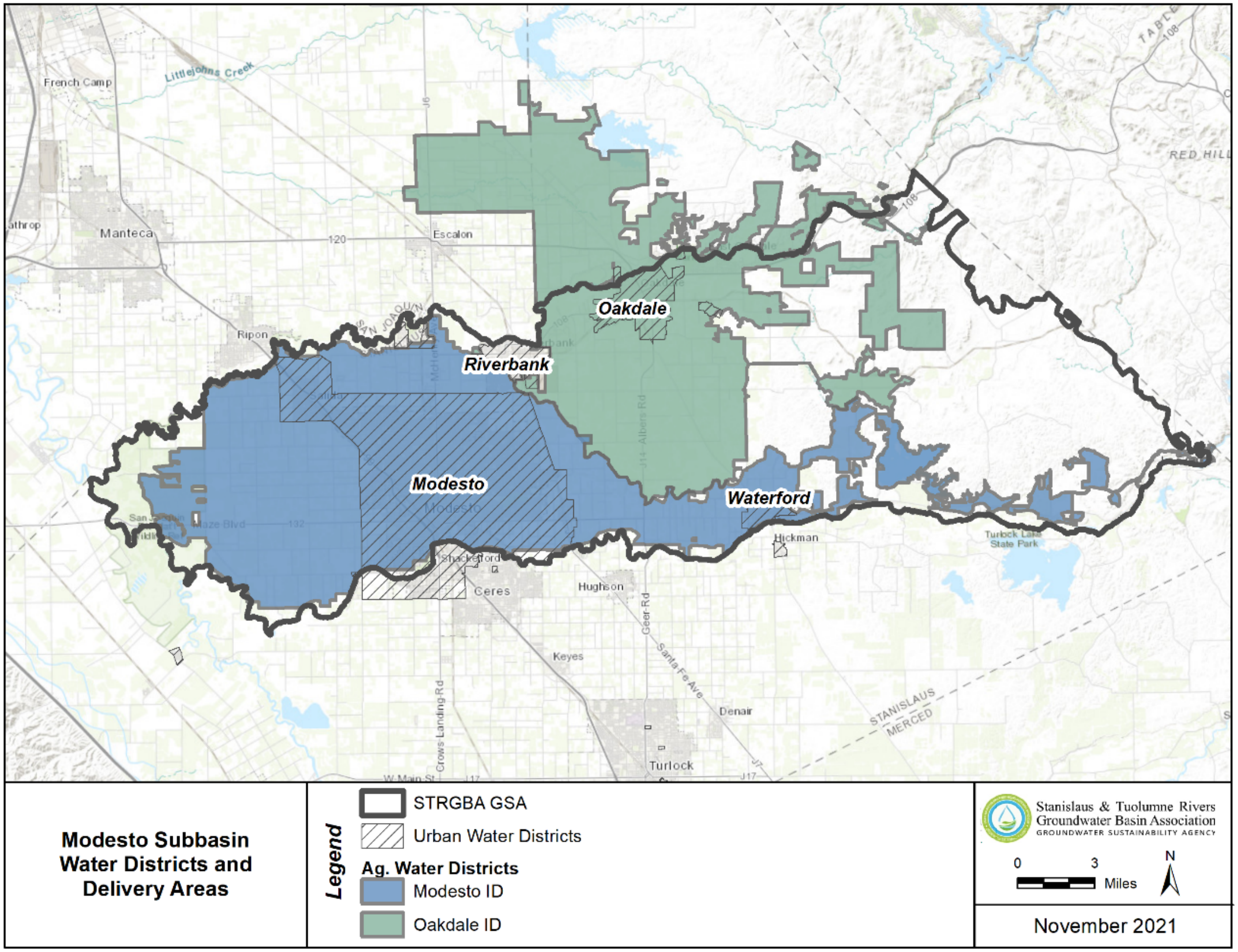


Figure M4: Modesto Subbasin Simulated Small Watersheds

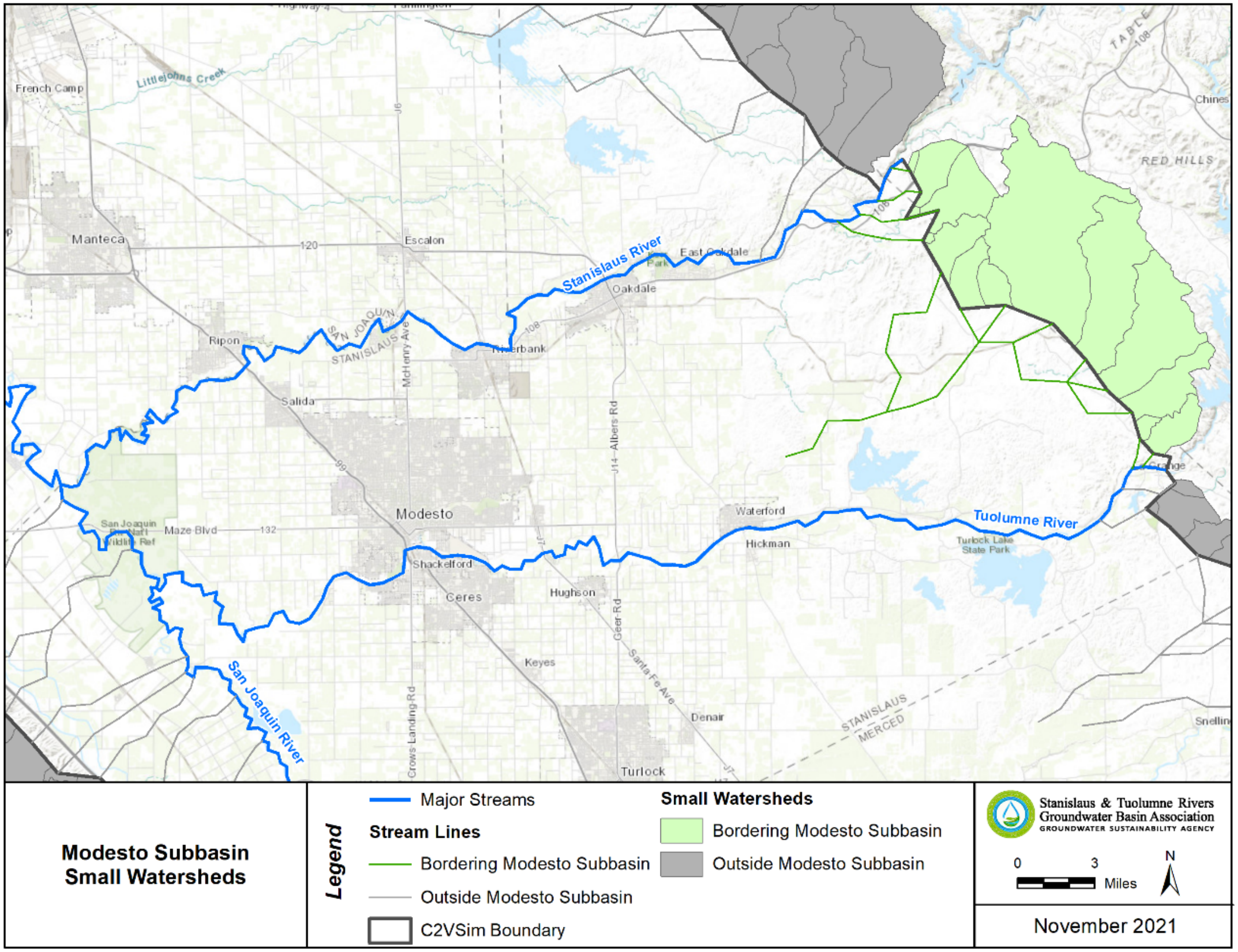


Figure M5: Modesto Subbasin Average Annual Precipitation

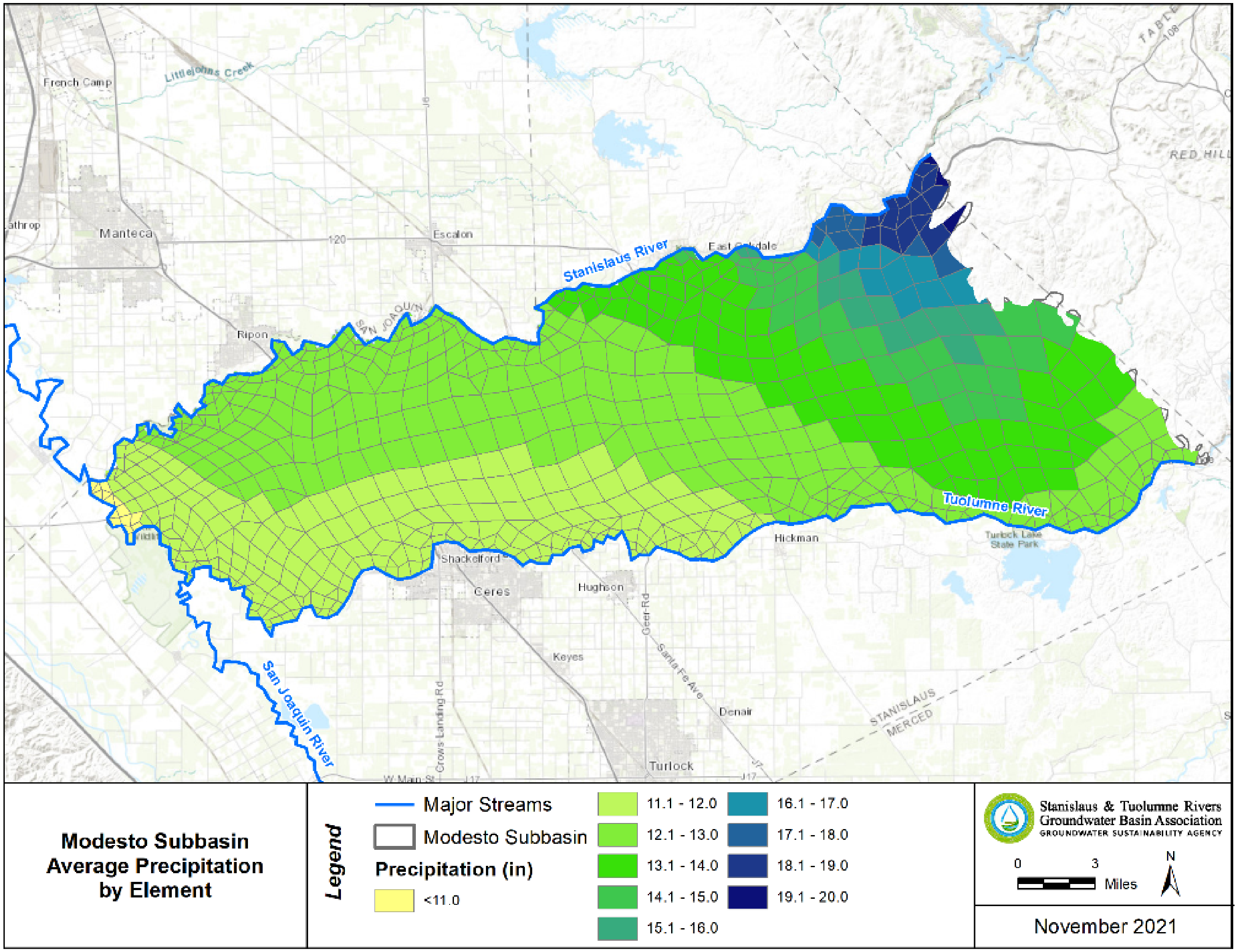


Figure M6: Modesto Subbasin Land Use, LandIQ 2014

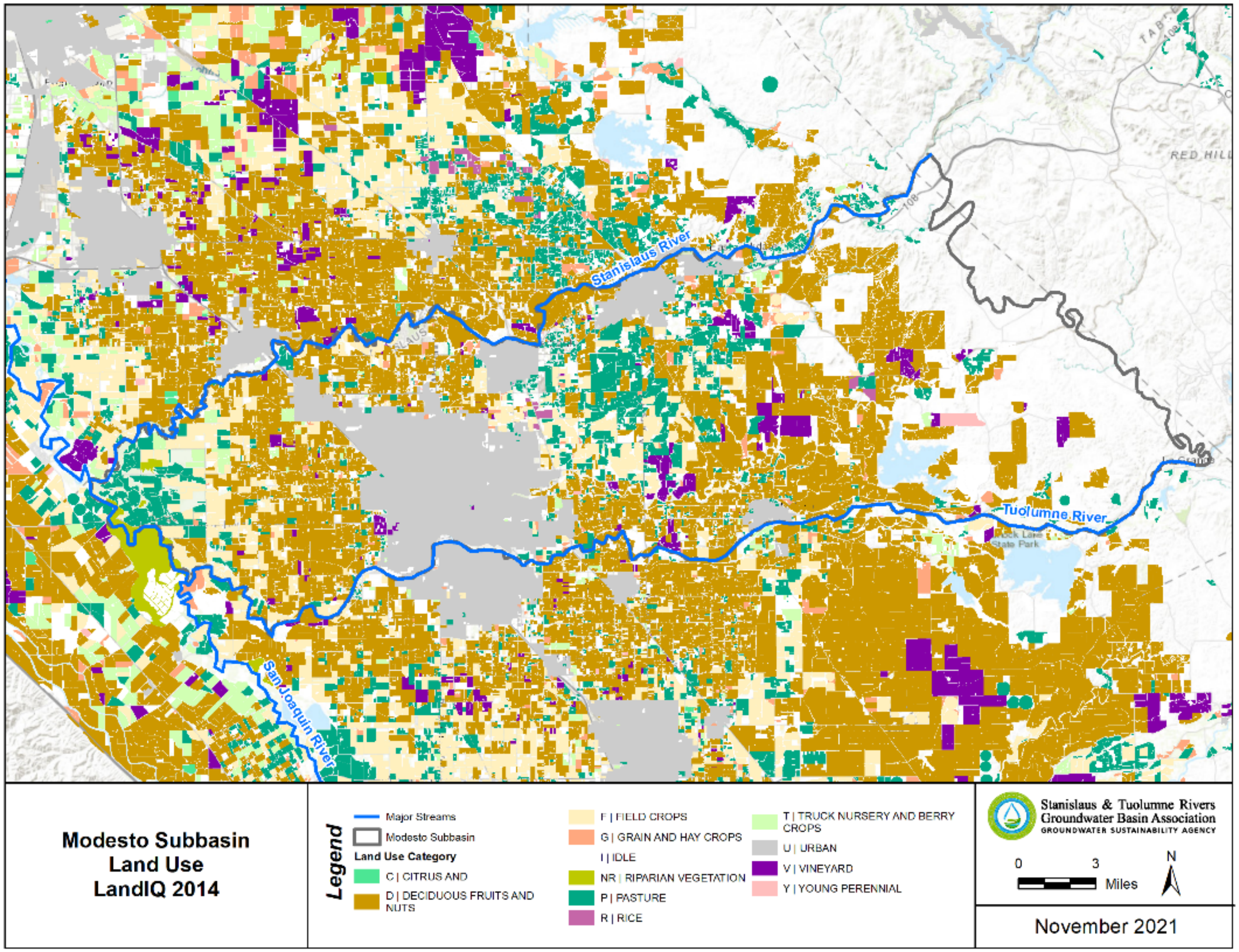


Figure M7: USDA Soil Hydrologic Groups

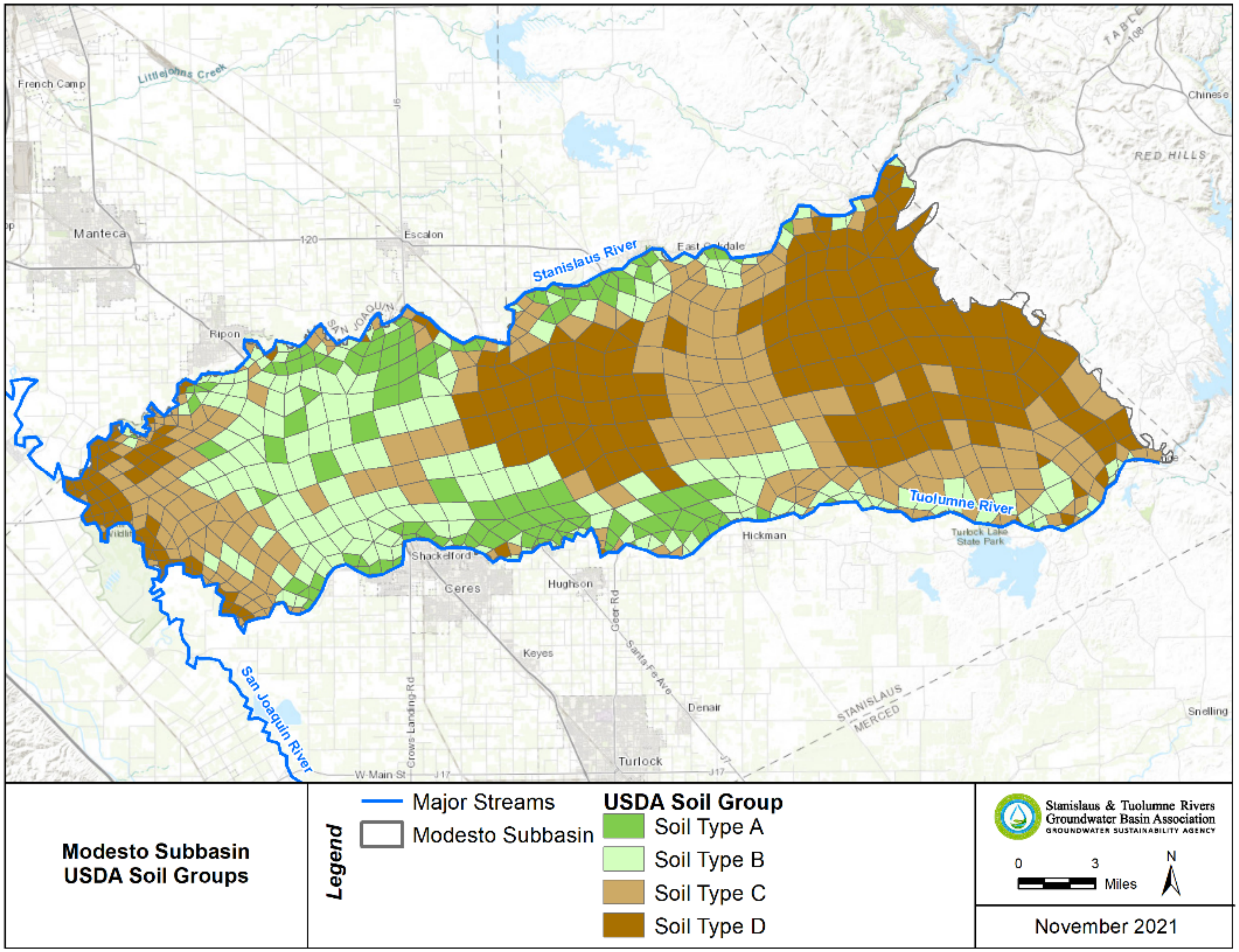


Figure M8: Modesto Model Urban Demand Areas

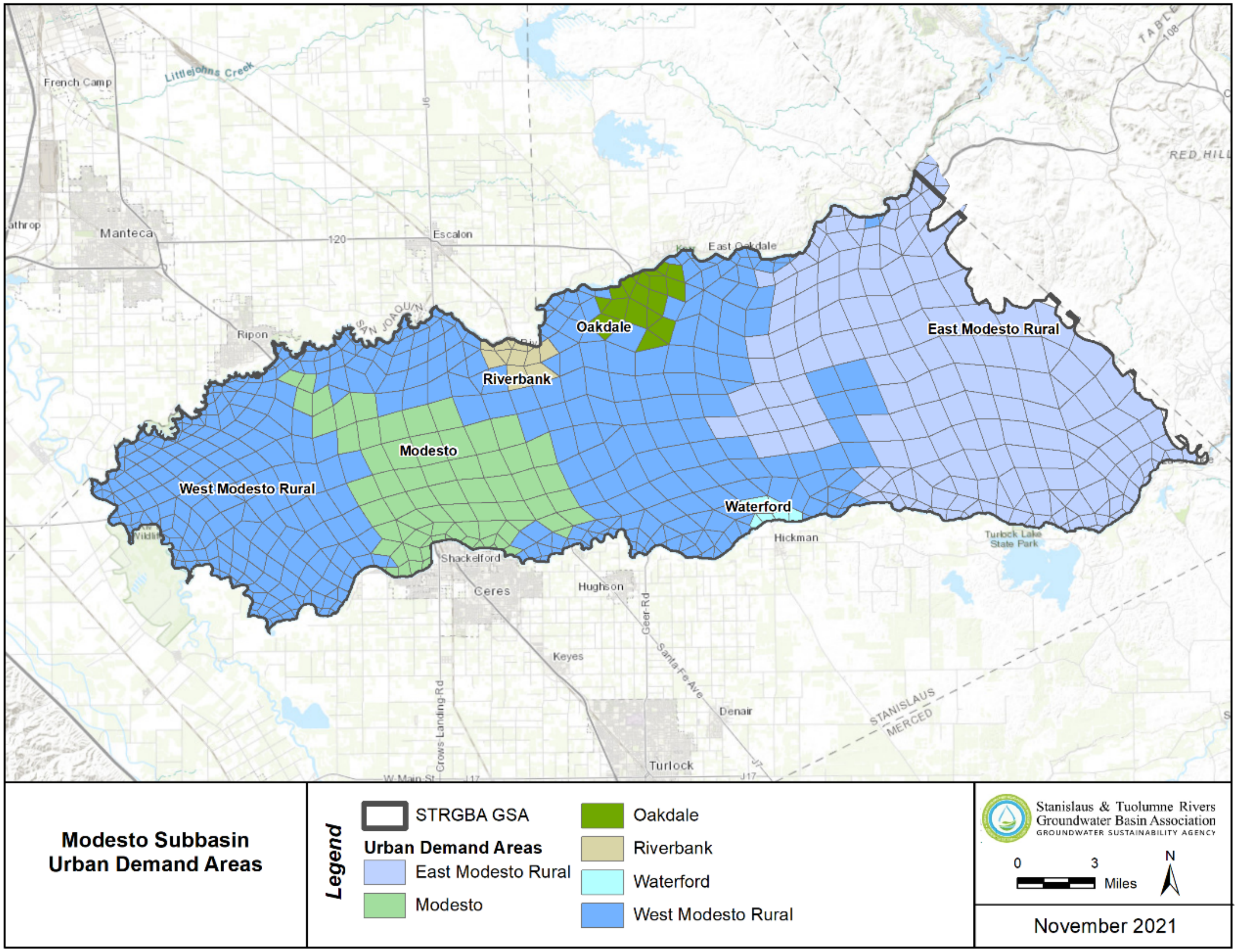


Figure M9: Modesto Model Stream Nodes and Reaches

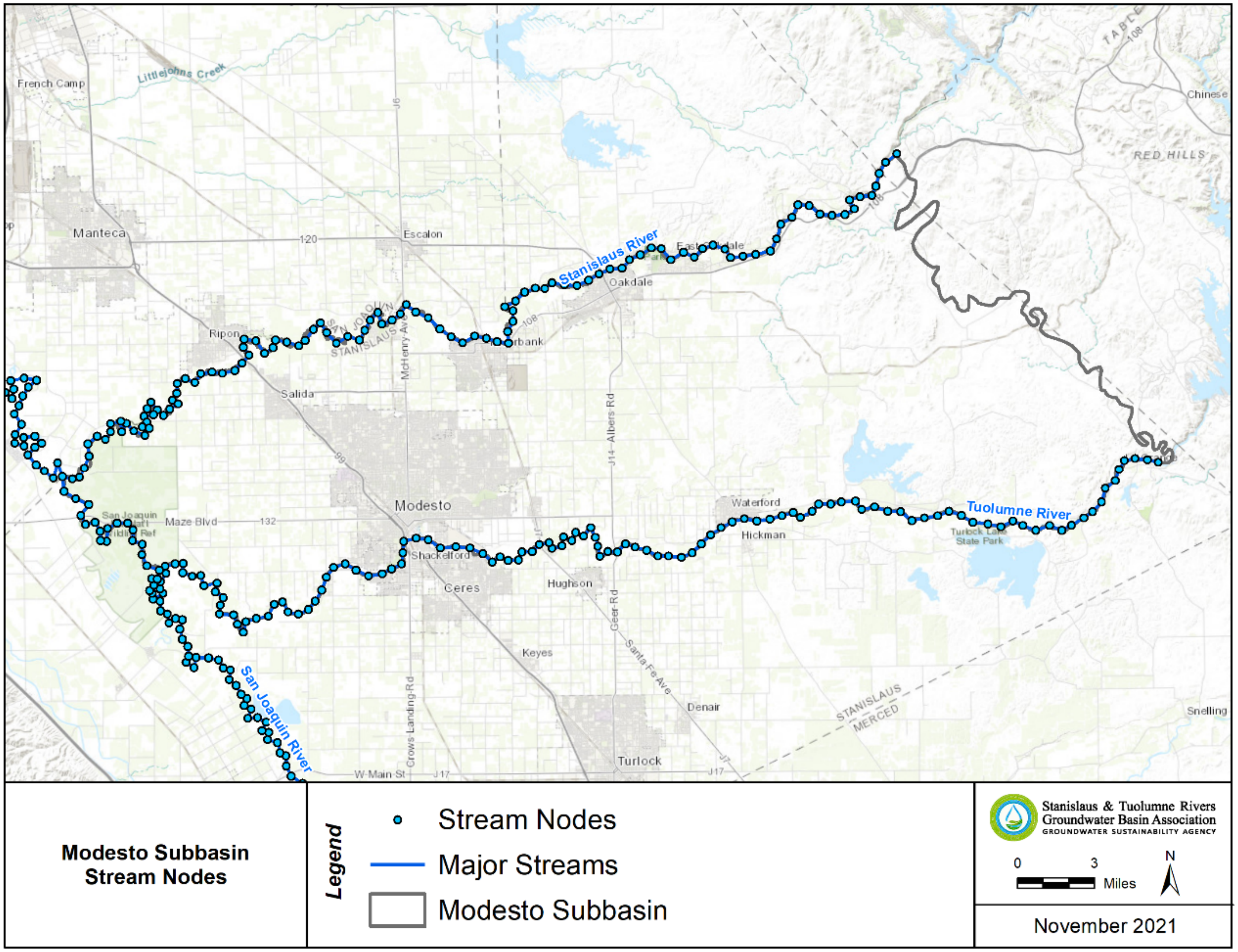


Figure M10: Modesto Model Surface Water Delivery Areas

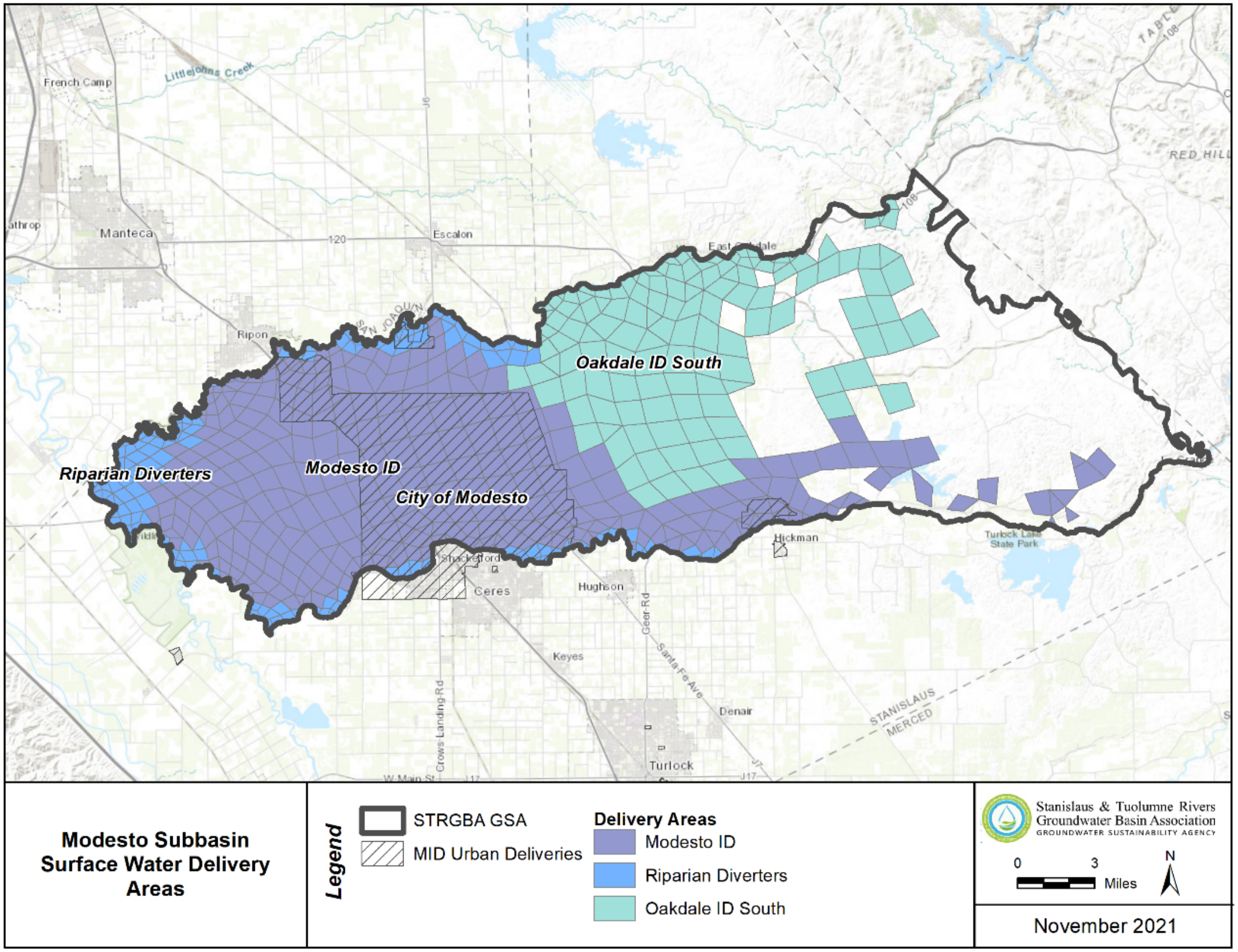


Figure M11. Stream Gauges location in the Modesto Model.

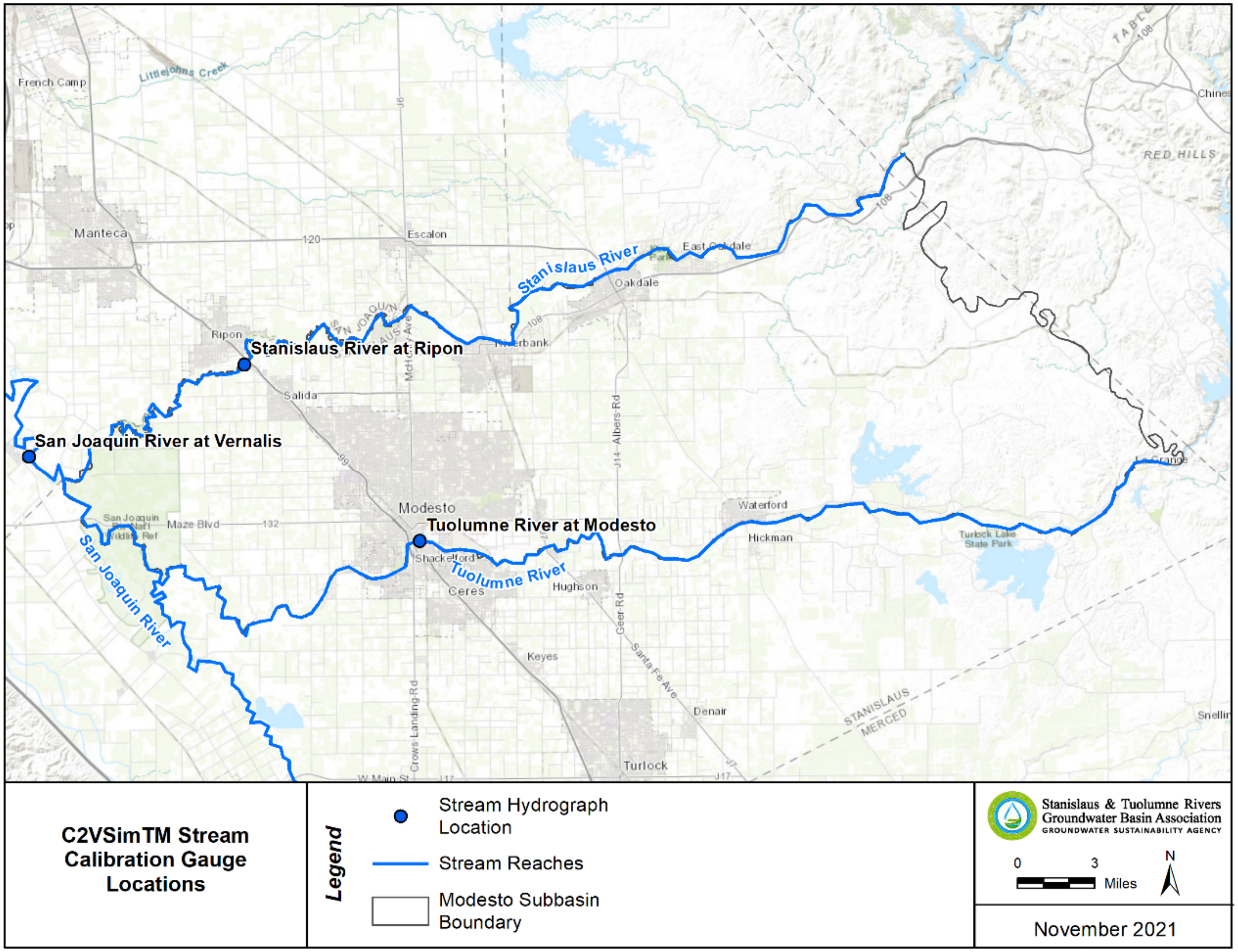


Figure M12: Modesto Model Agency Production Wells

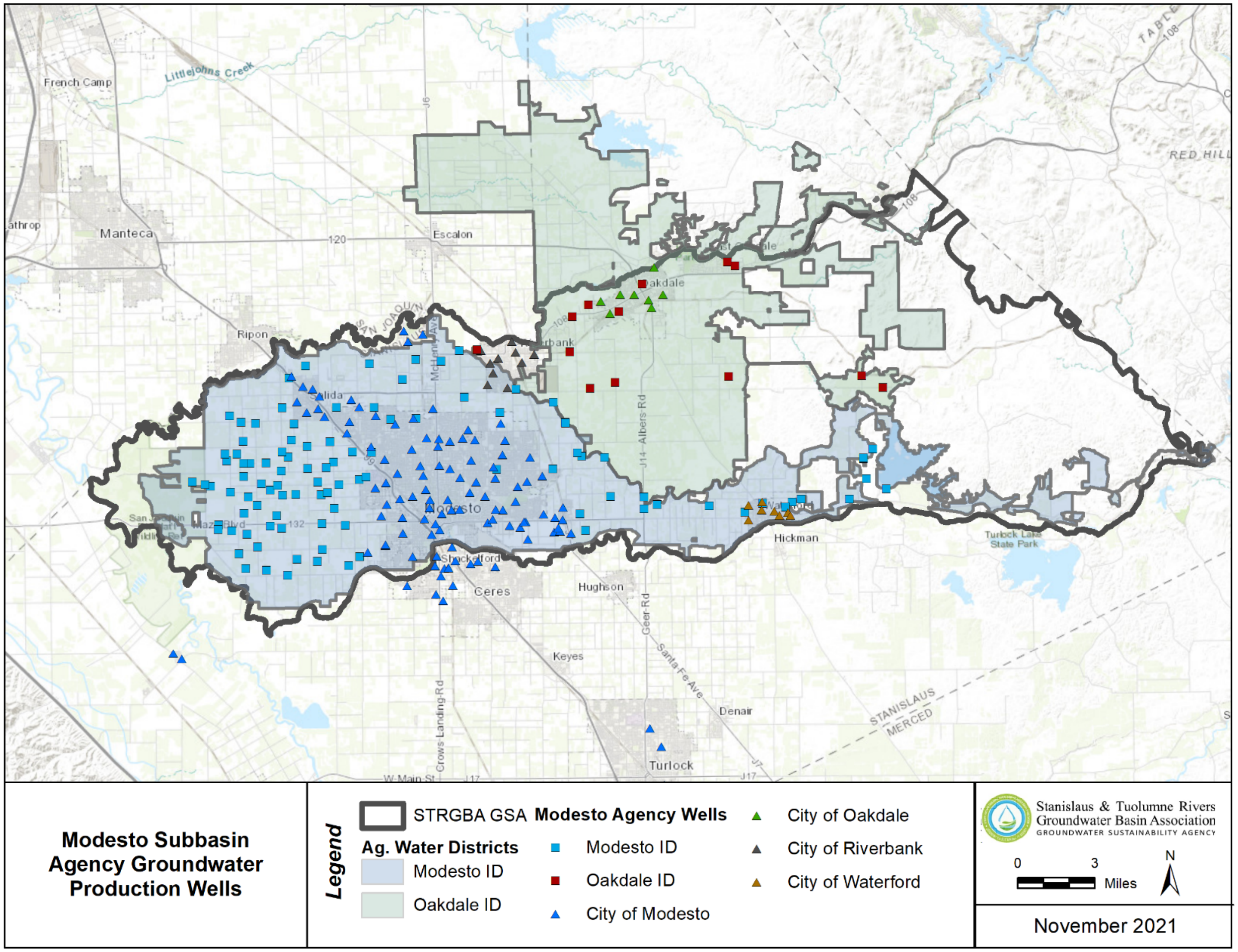


Figure M13: Modesto Model Monitoring Wells

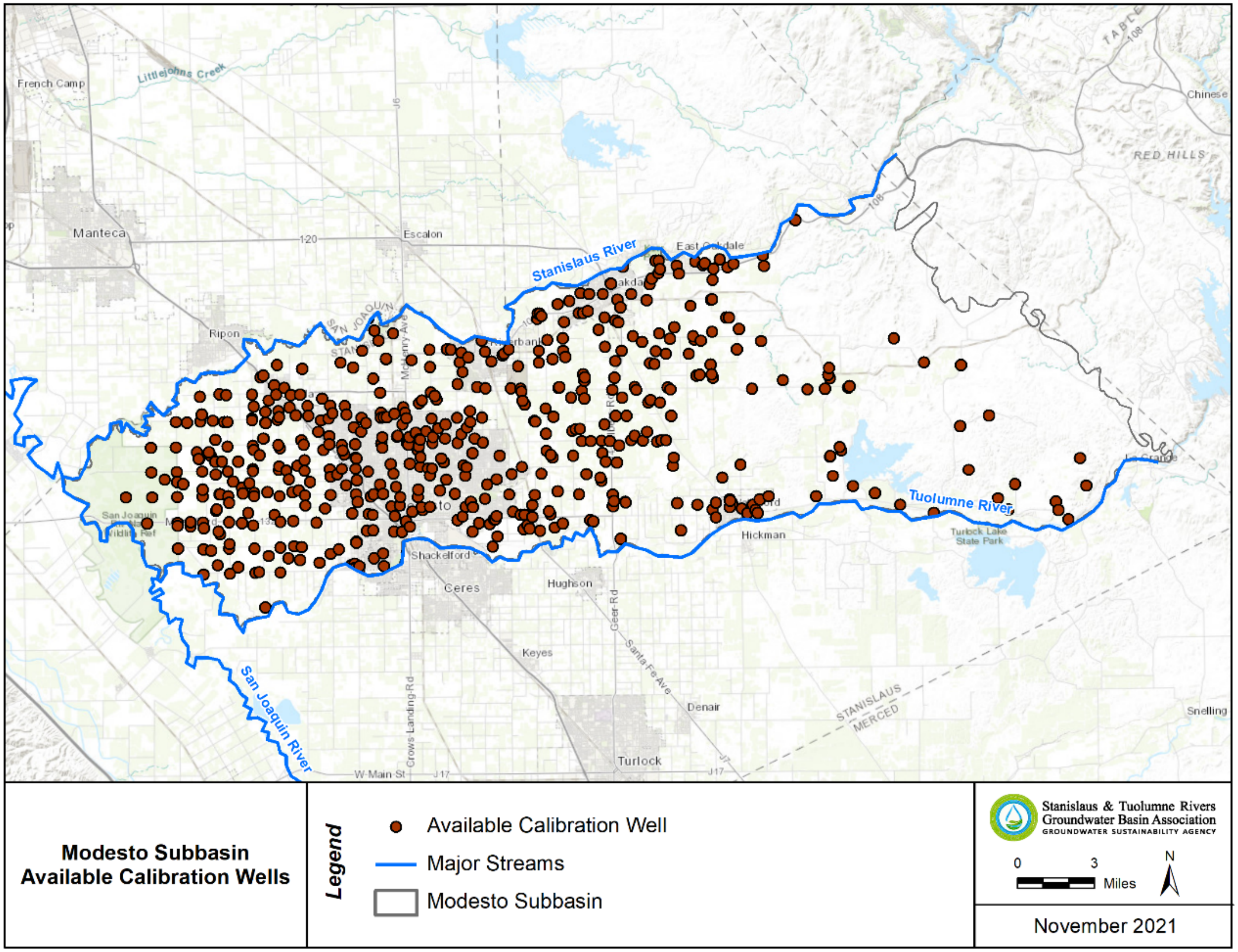


Figure M14: Modesto Model Calibration Wells

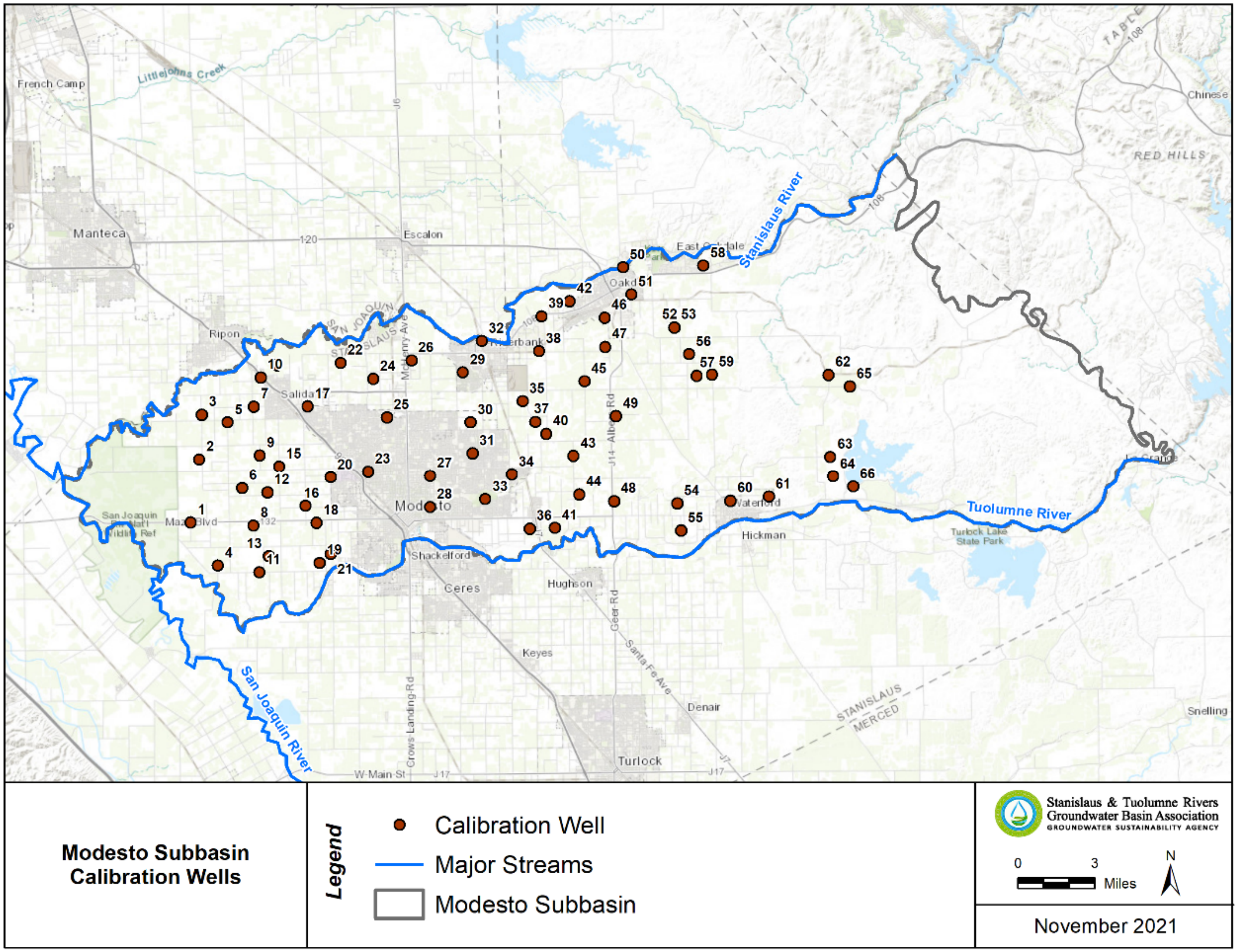


Figure M15: Initial Groundwater Heads for Layer 1

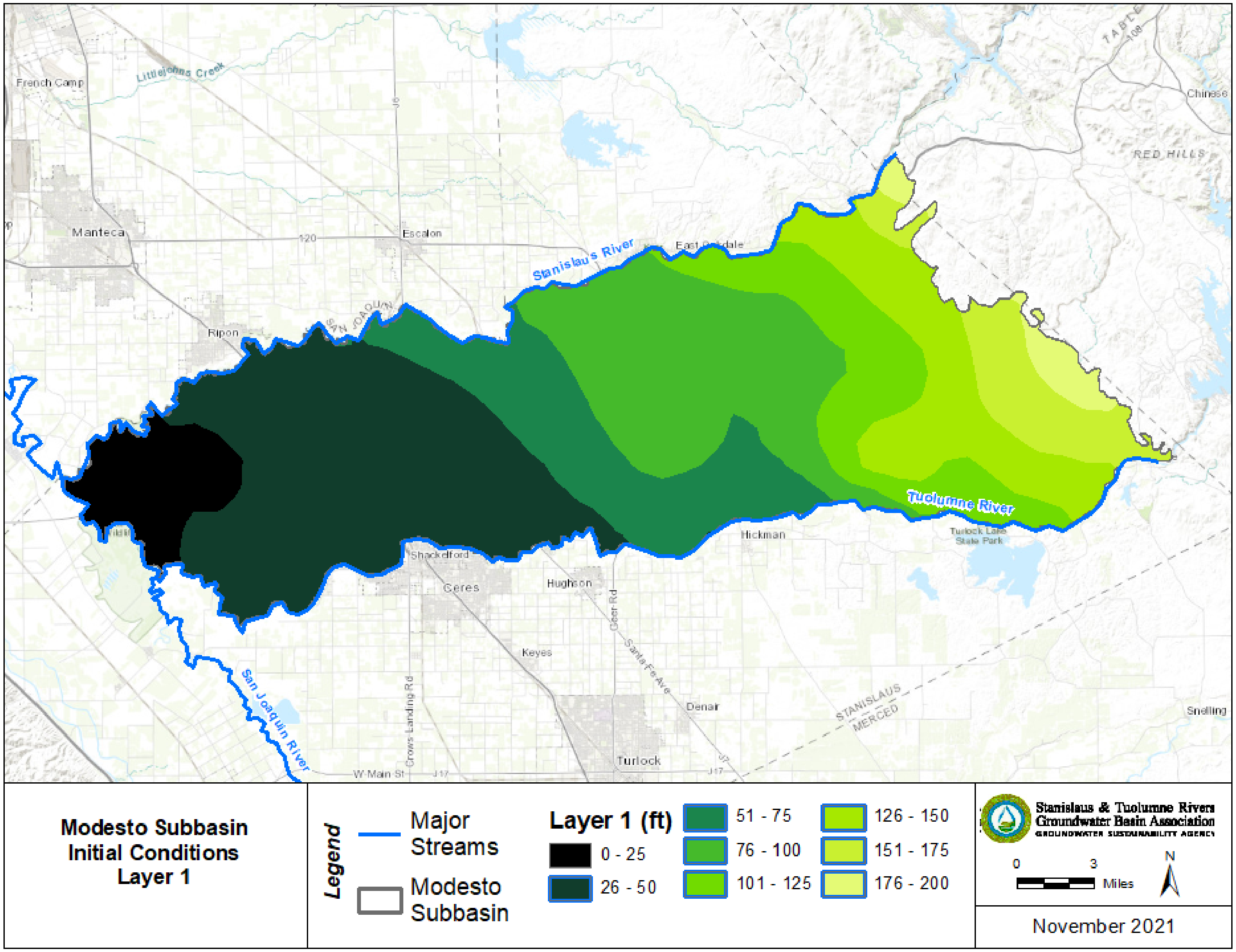


Figure M16: Initial Groundwater Heads for Layer 2

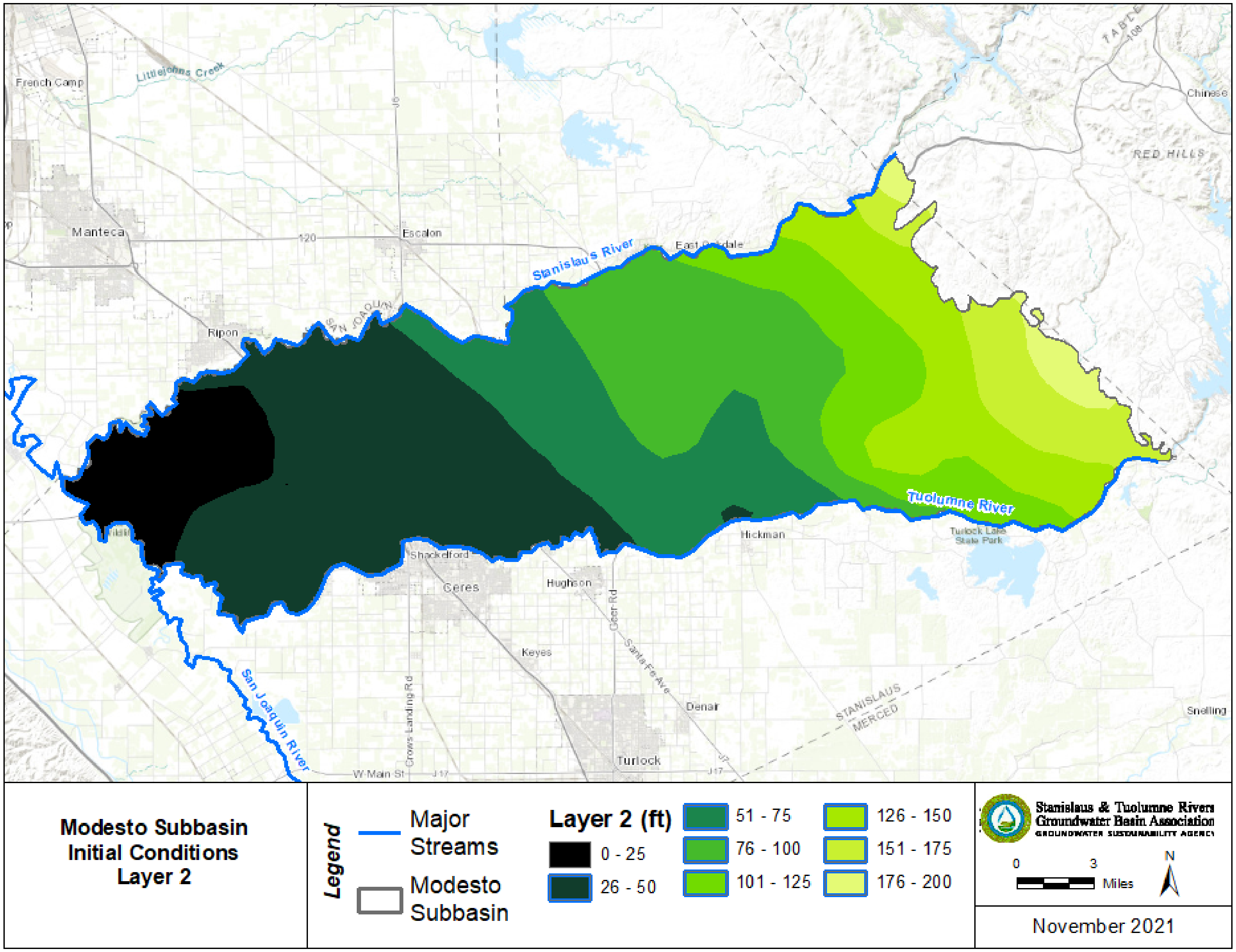


Figure M17: Initial Groundwater Heads for Layer 3

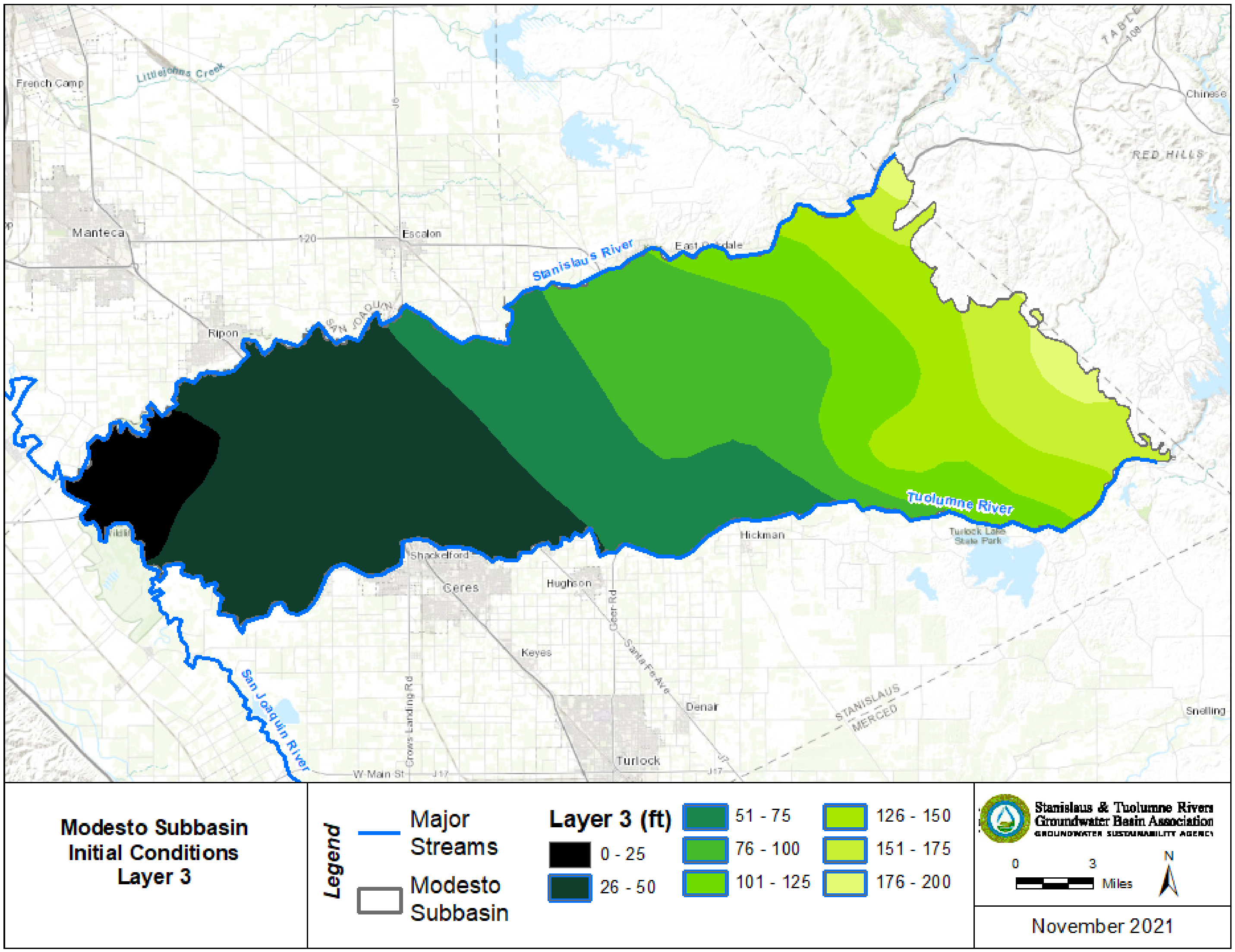


Figure M18: Initial Groundwater Heads for Layer 4

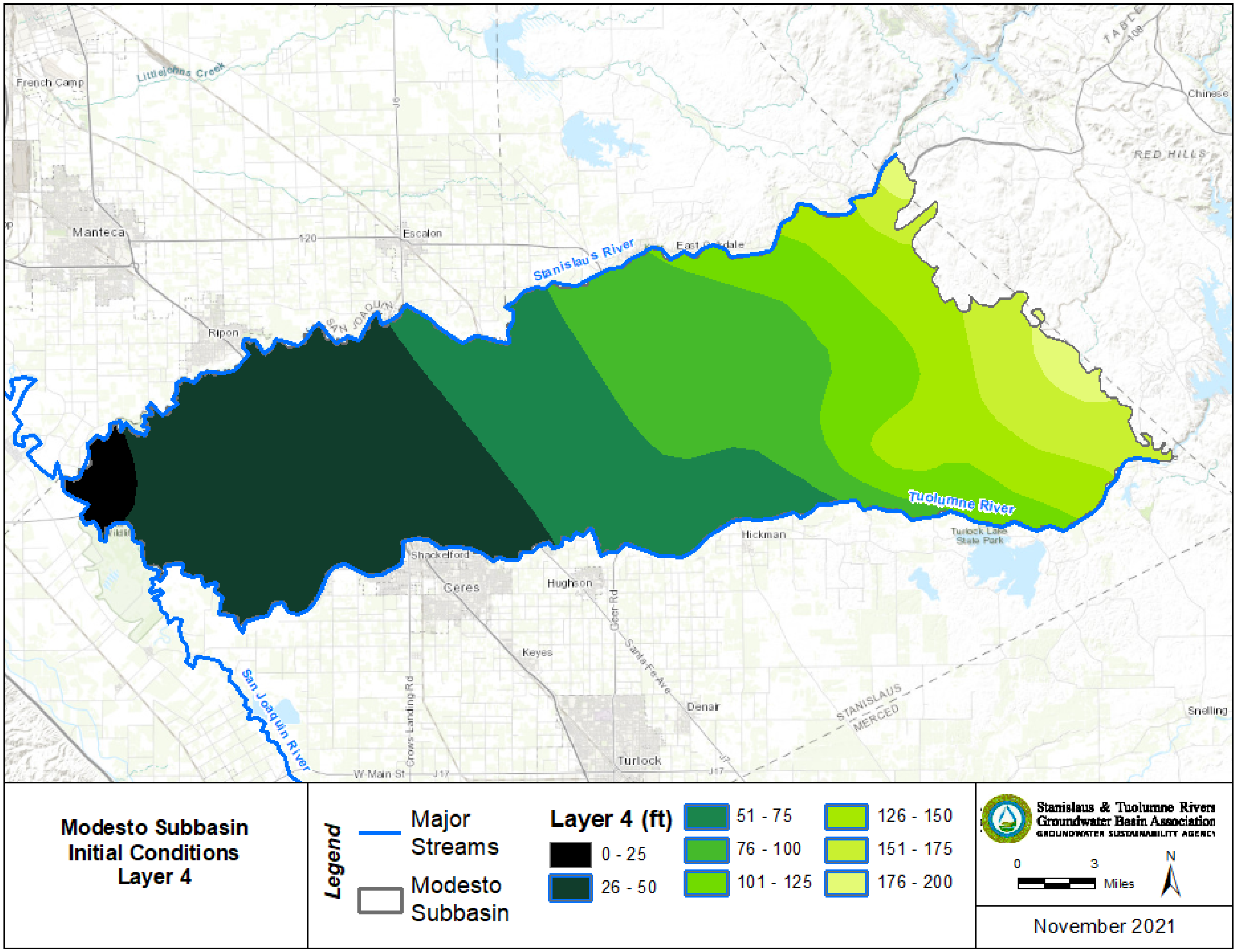


Figure M19: Modesto Model Boundary Conditions

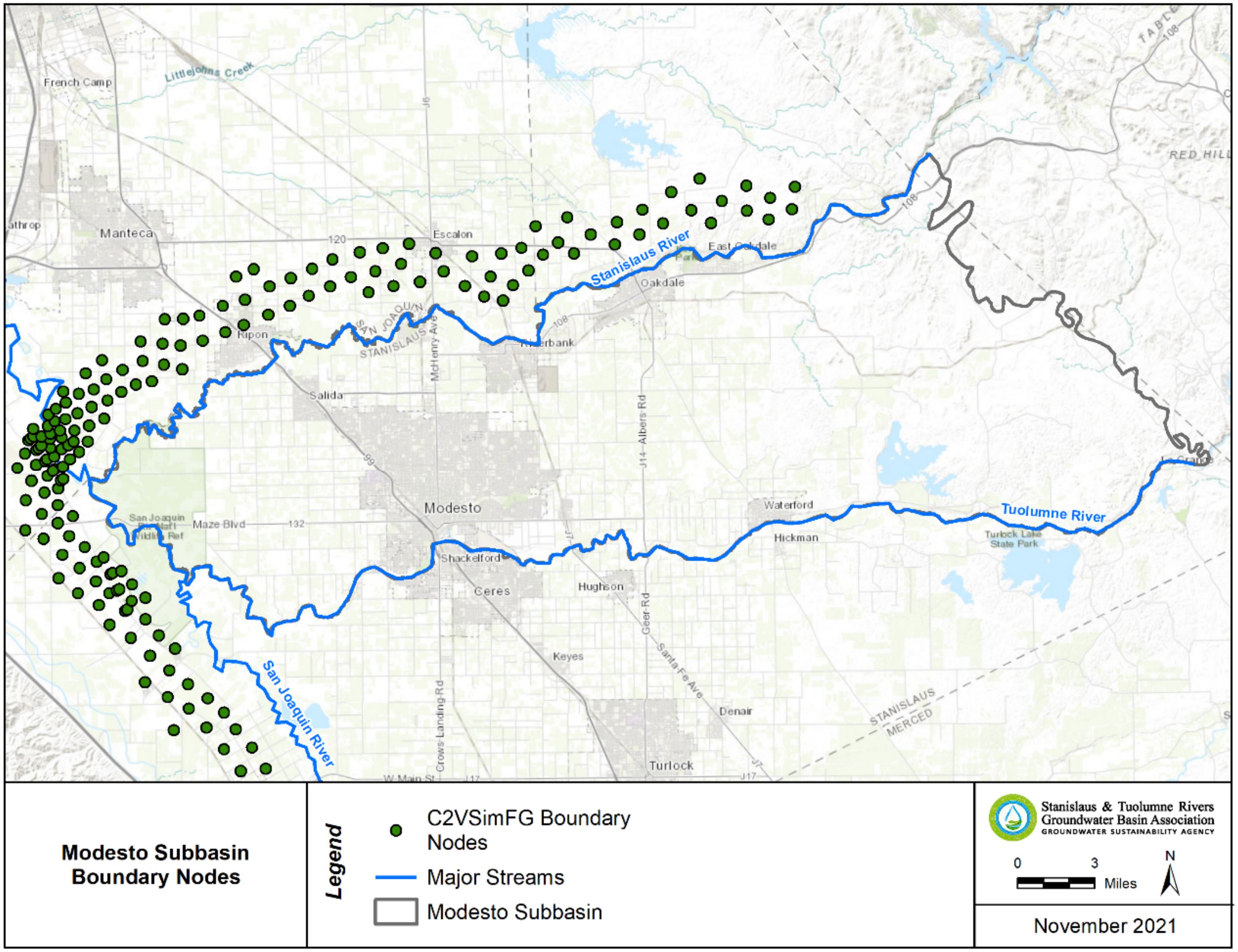


Figure M20: Modesto Model Parametric Grid

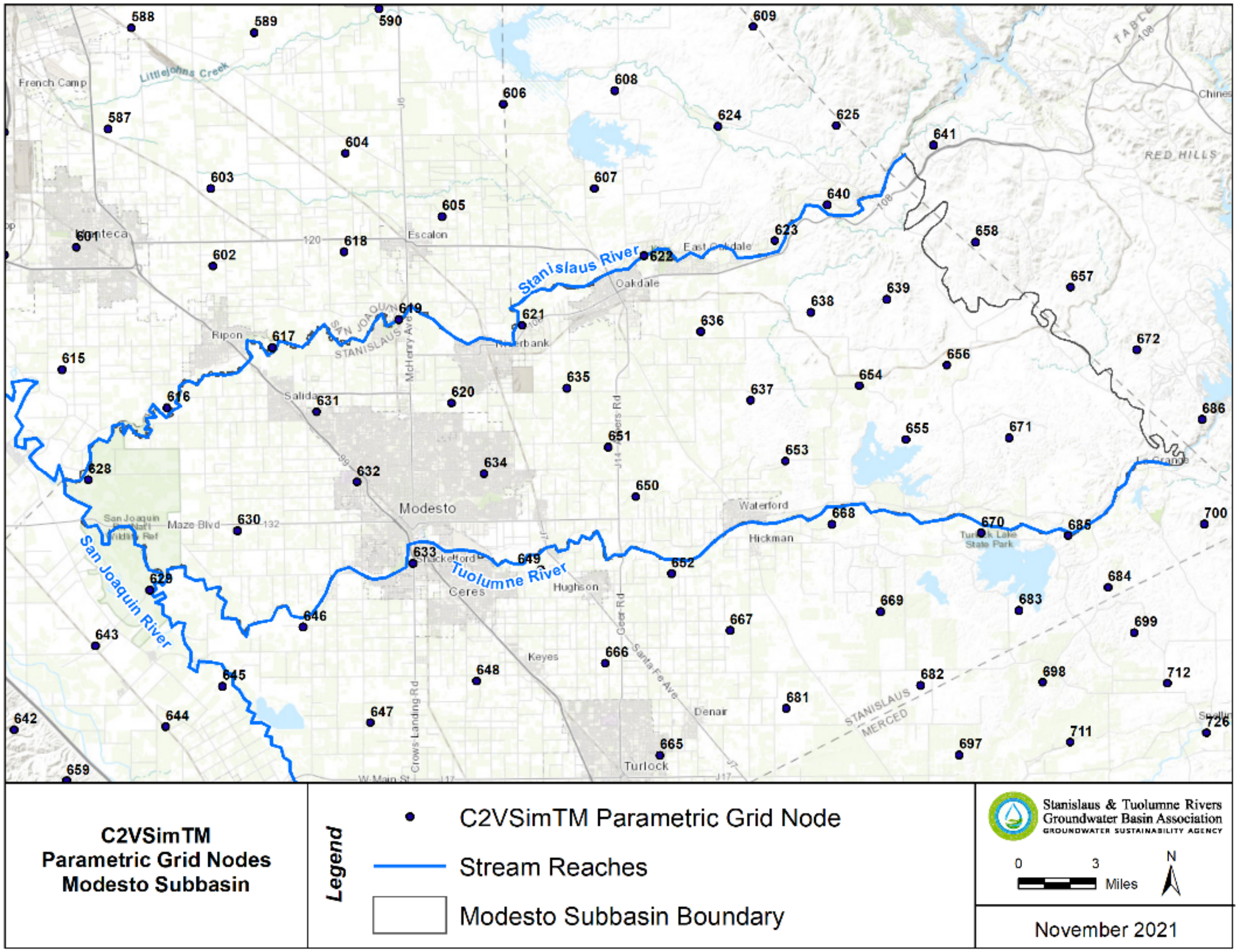


Figure M21: Modesto Subbasin Water Budget Areas

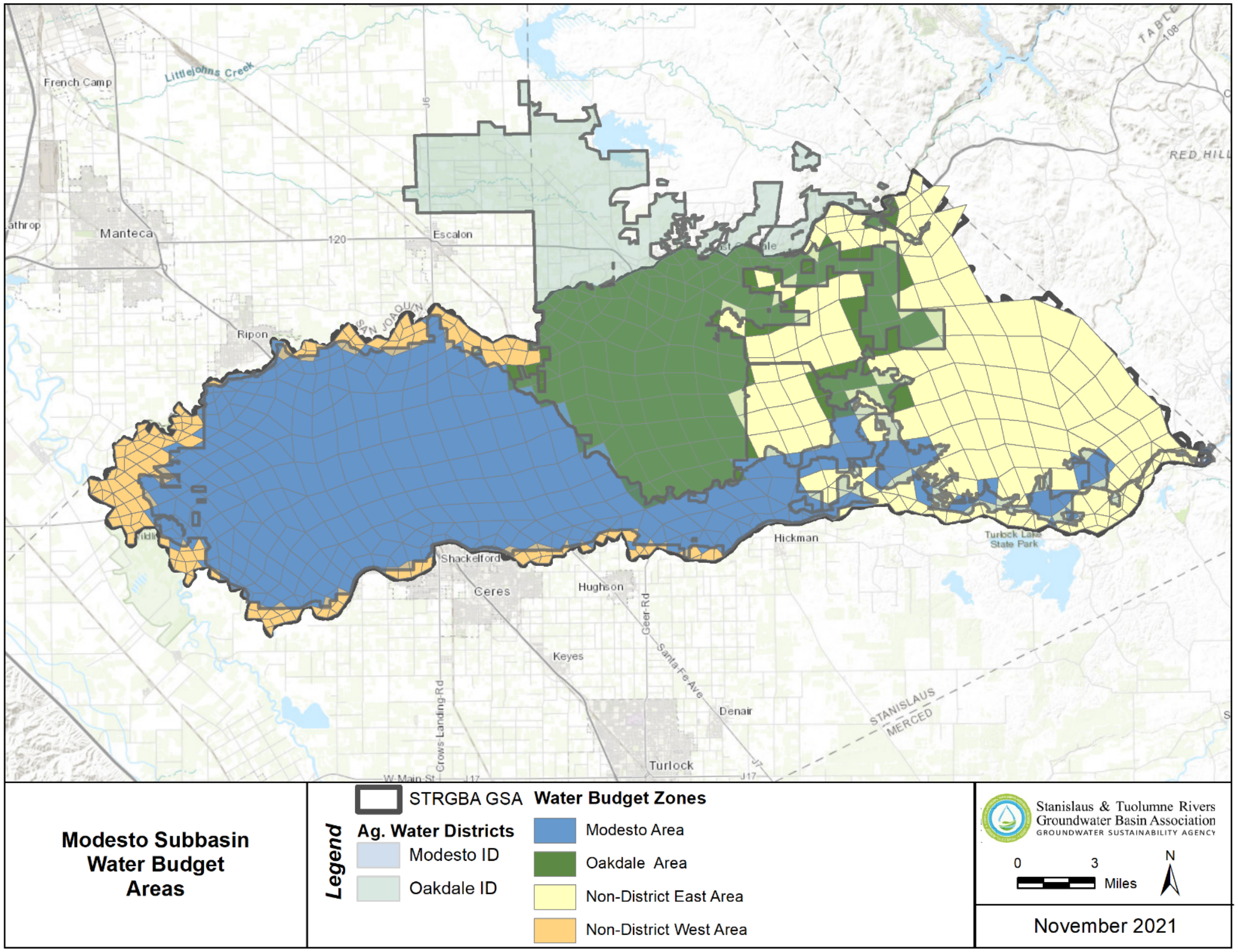


Figure M22:Modesto Model Parameters: Soil Field Capacity

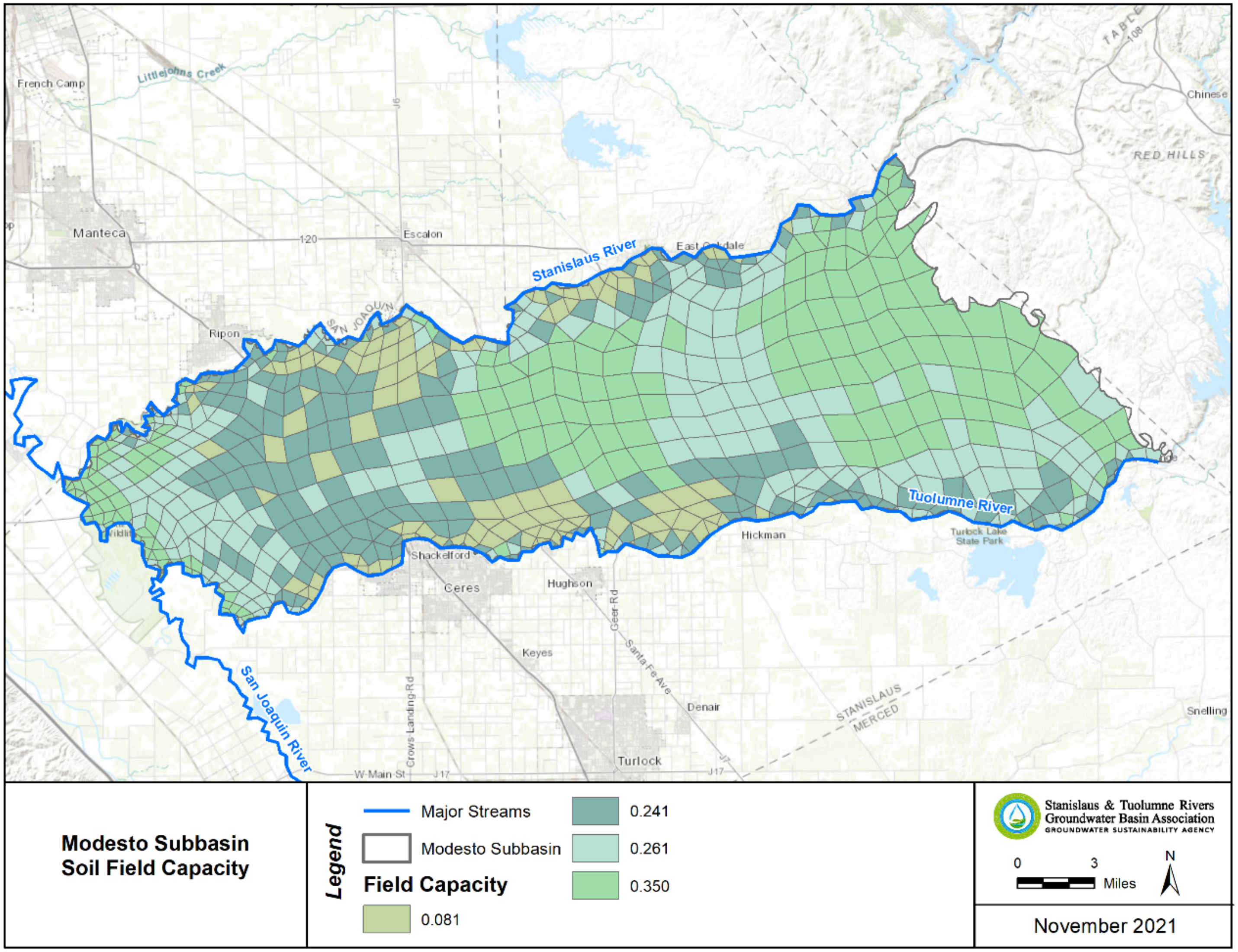


Figure M23:Modesto Model Parameters: Soil Wilting Point

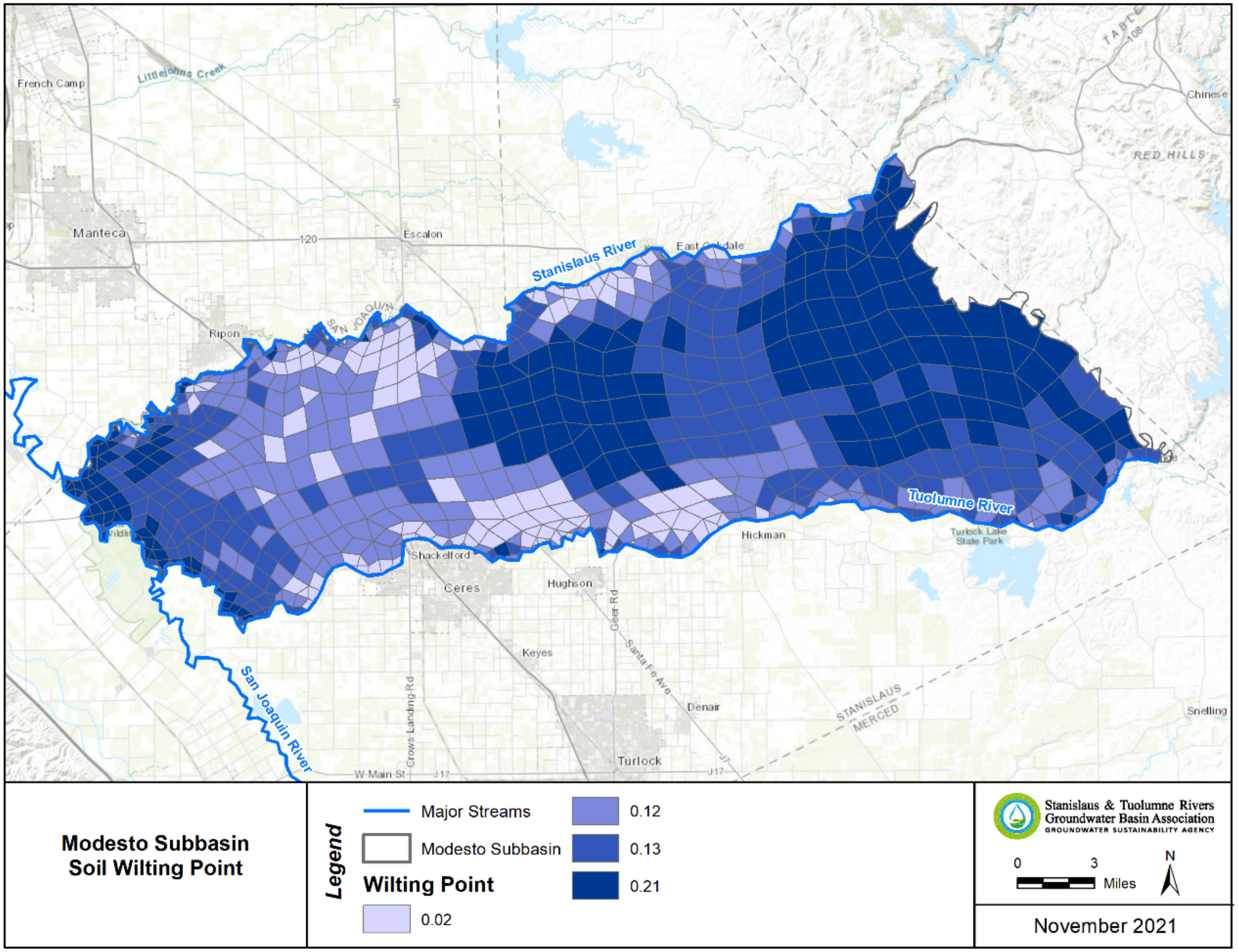


Figure M24:Modesto Model Parameters: Soil Hydraulic Conductivity

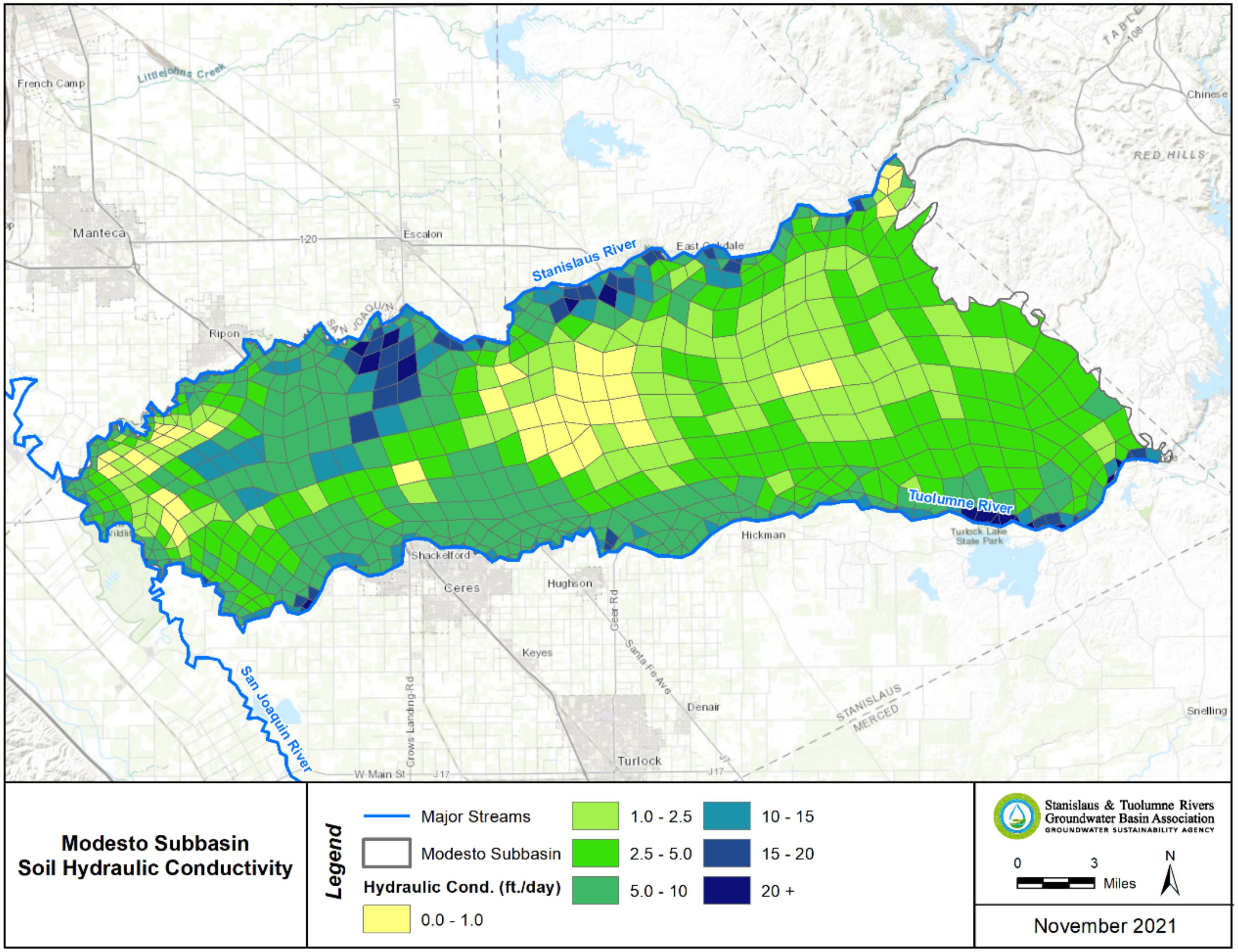


Figure M25:Modesto Model Parameters: Soil Porosity

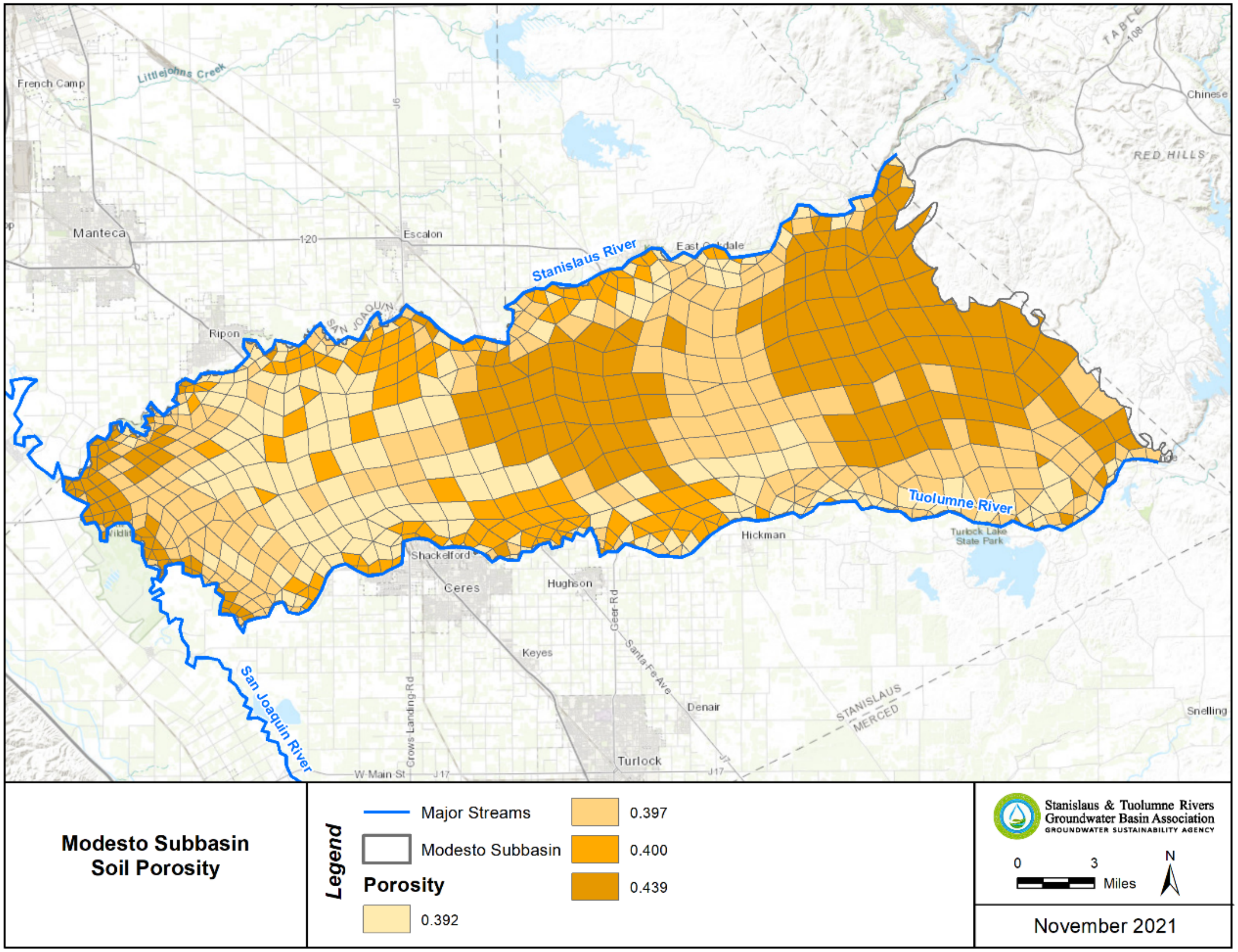


Figure M26. Groundwater Level Contours Layer 1 September 2015

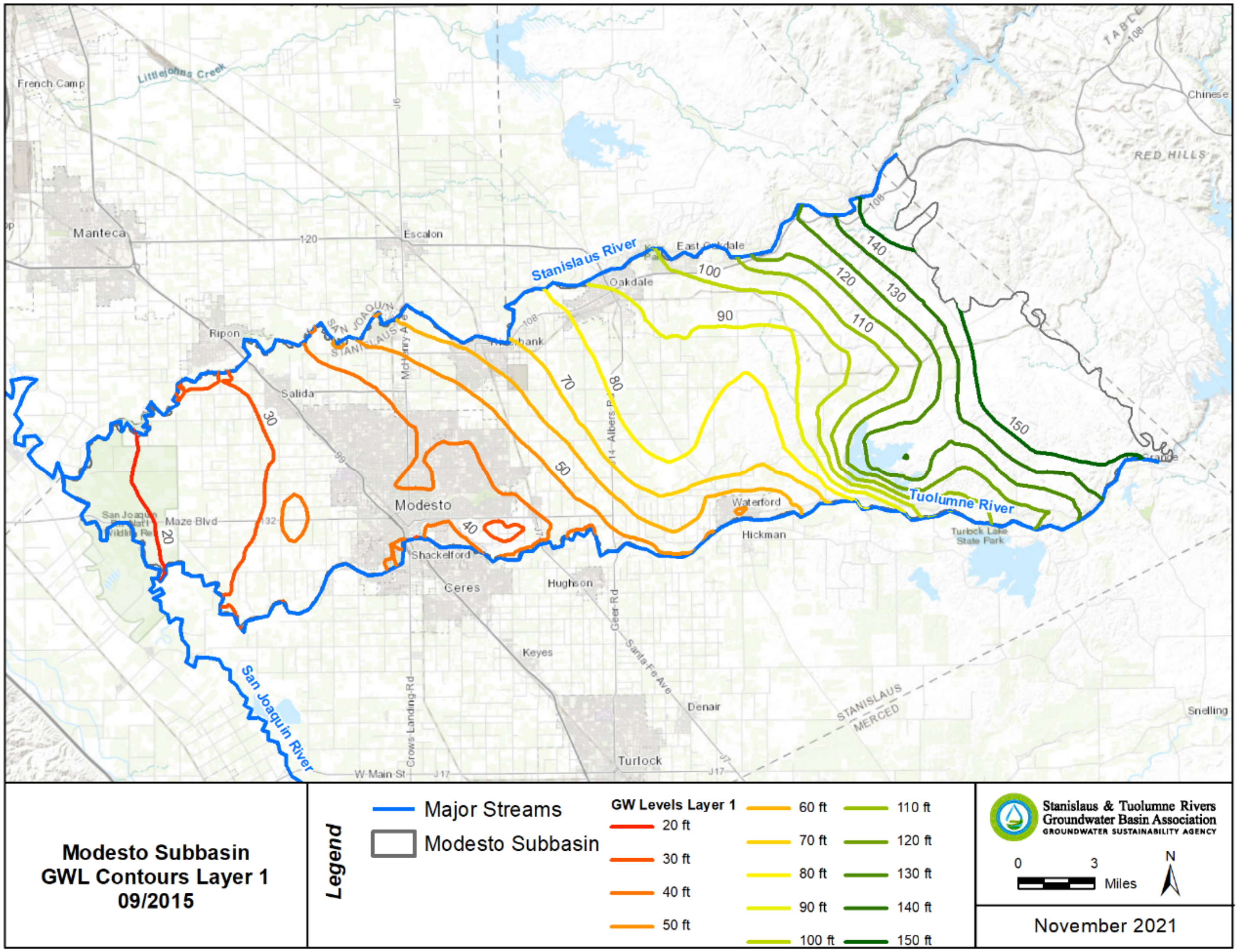


Figure M27. Groundwater Level Contours Layer 2 September 2015

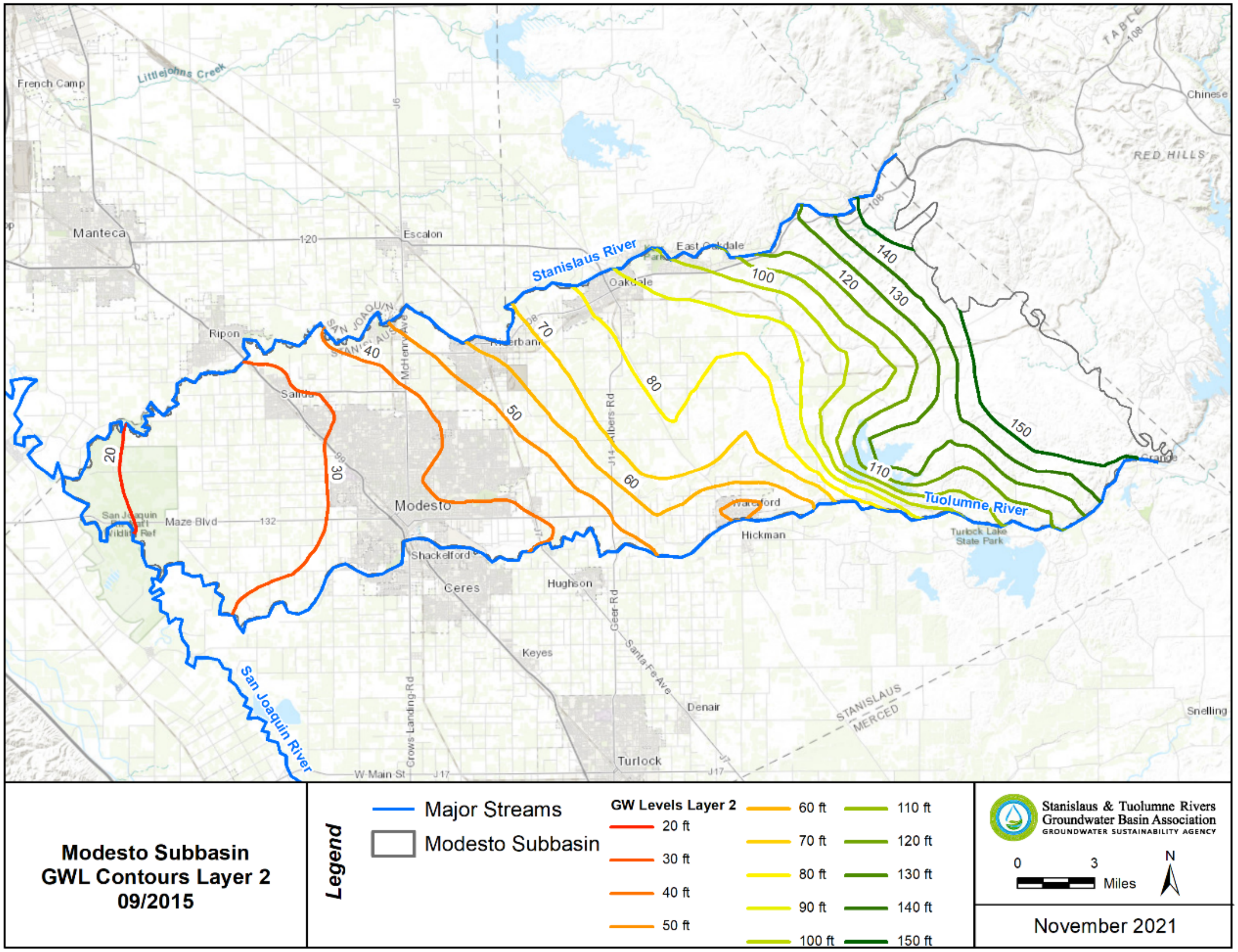


Figure M28: Calibrated Horizontal Hydraulic Conductivity of Layer 1

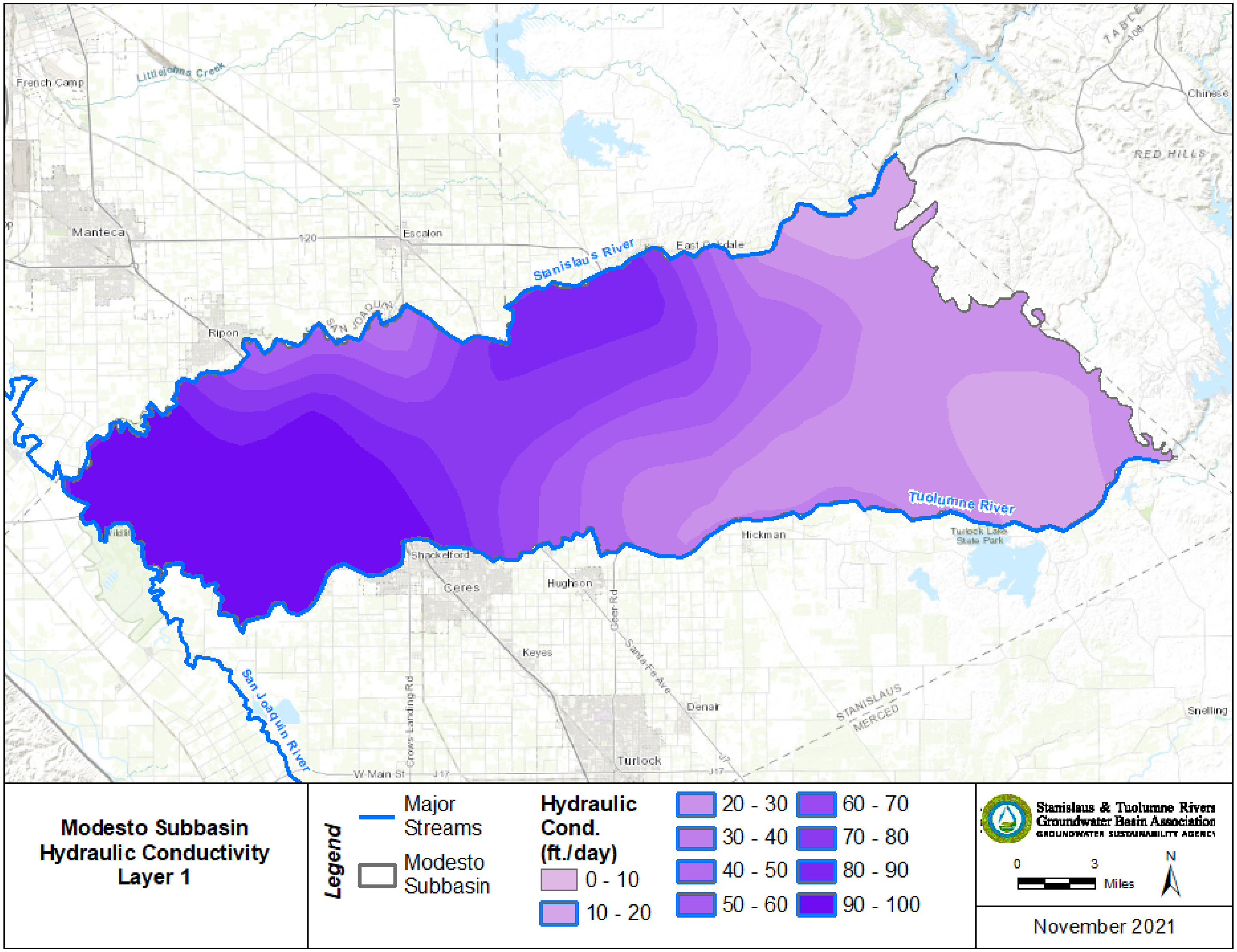


Figure M29: Calibrated Horizontal Hydraulic Conductivity of Layers 2

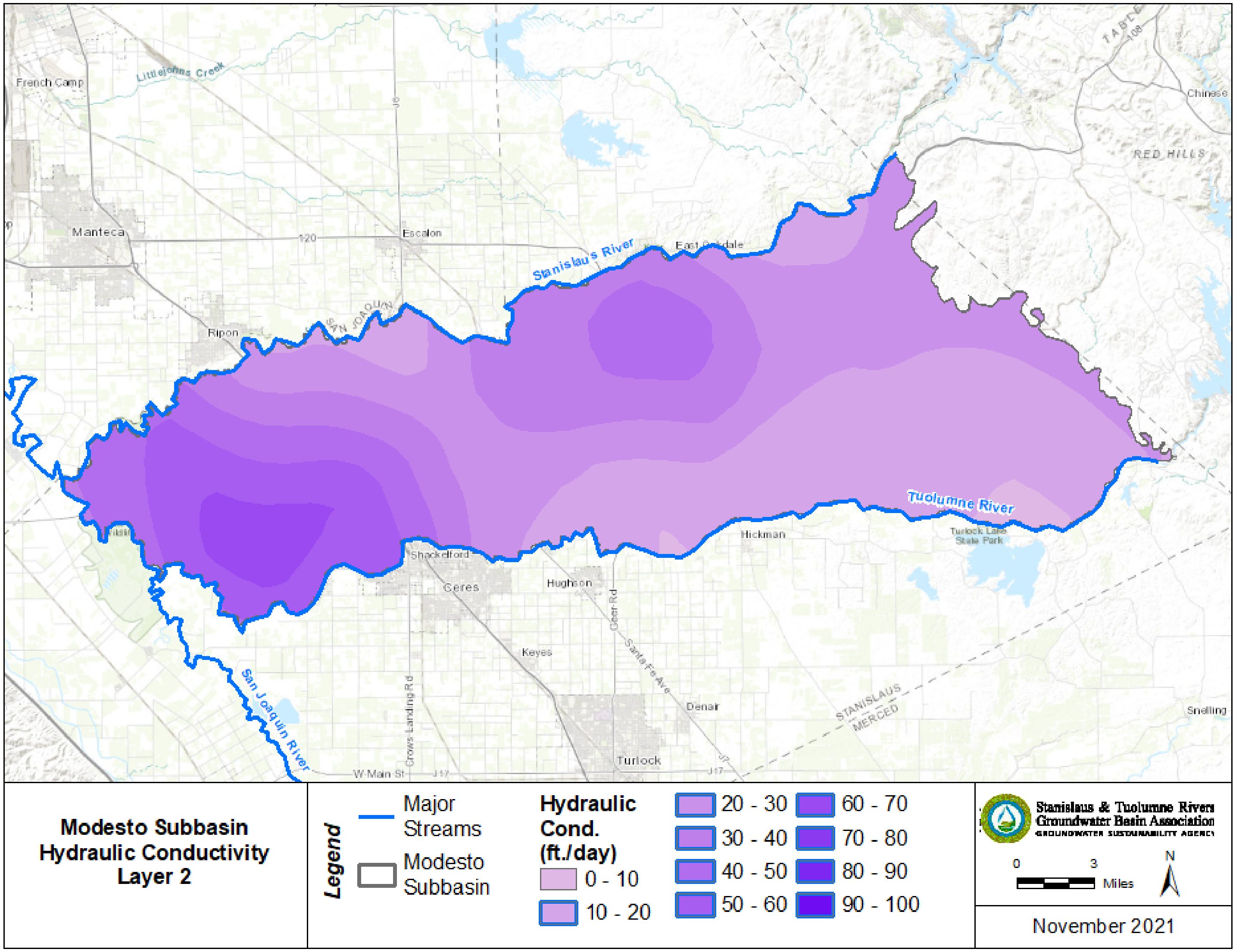


Figure M30: Calibrated Horizontal Hydraulic Conductivity of Layers 3

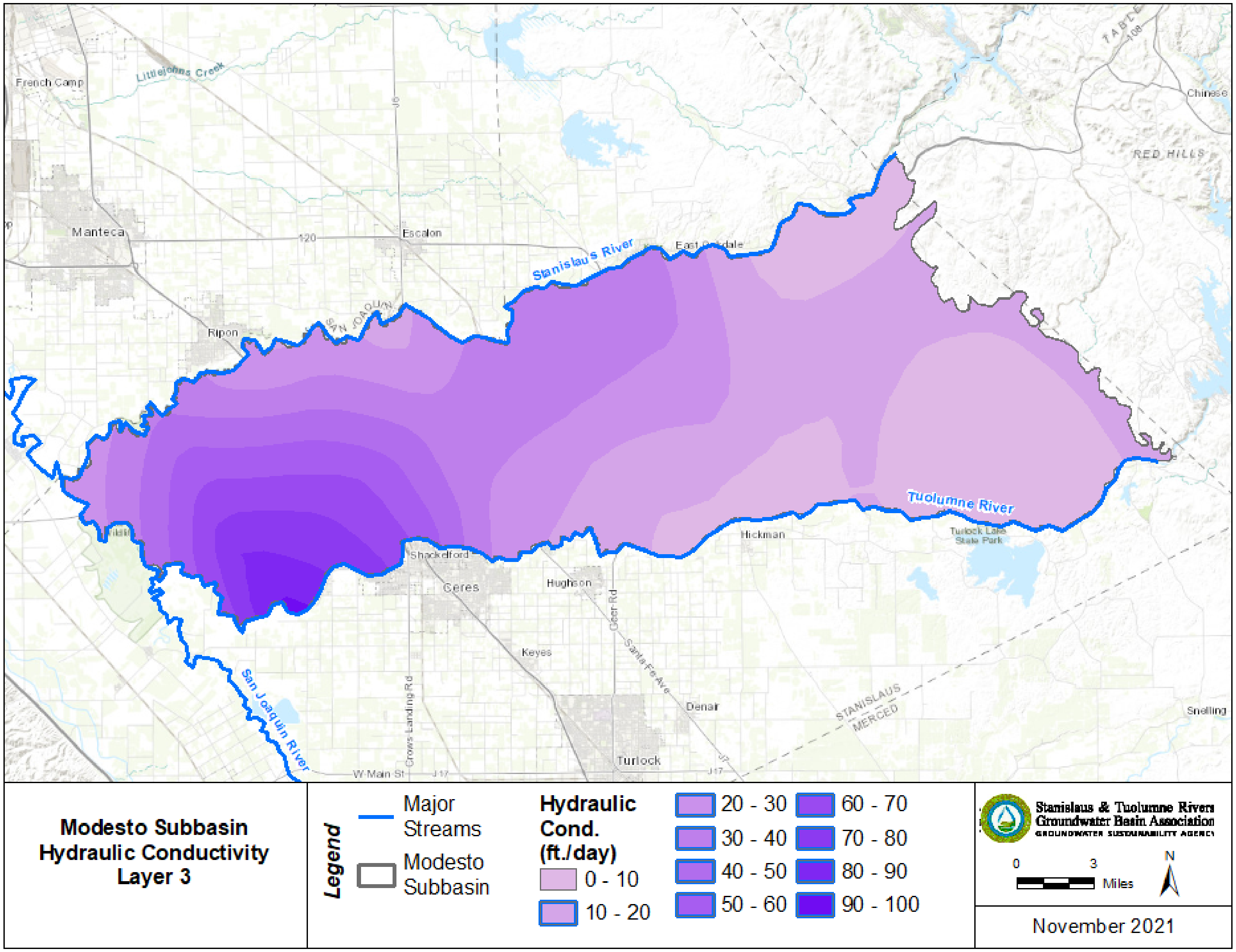
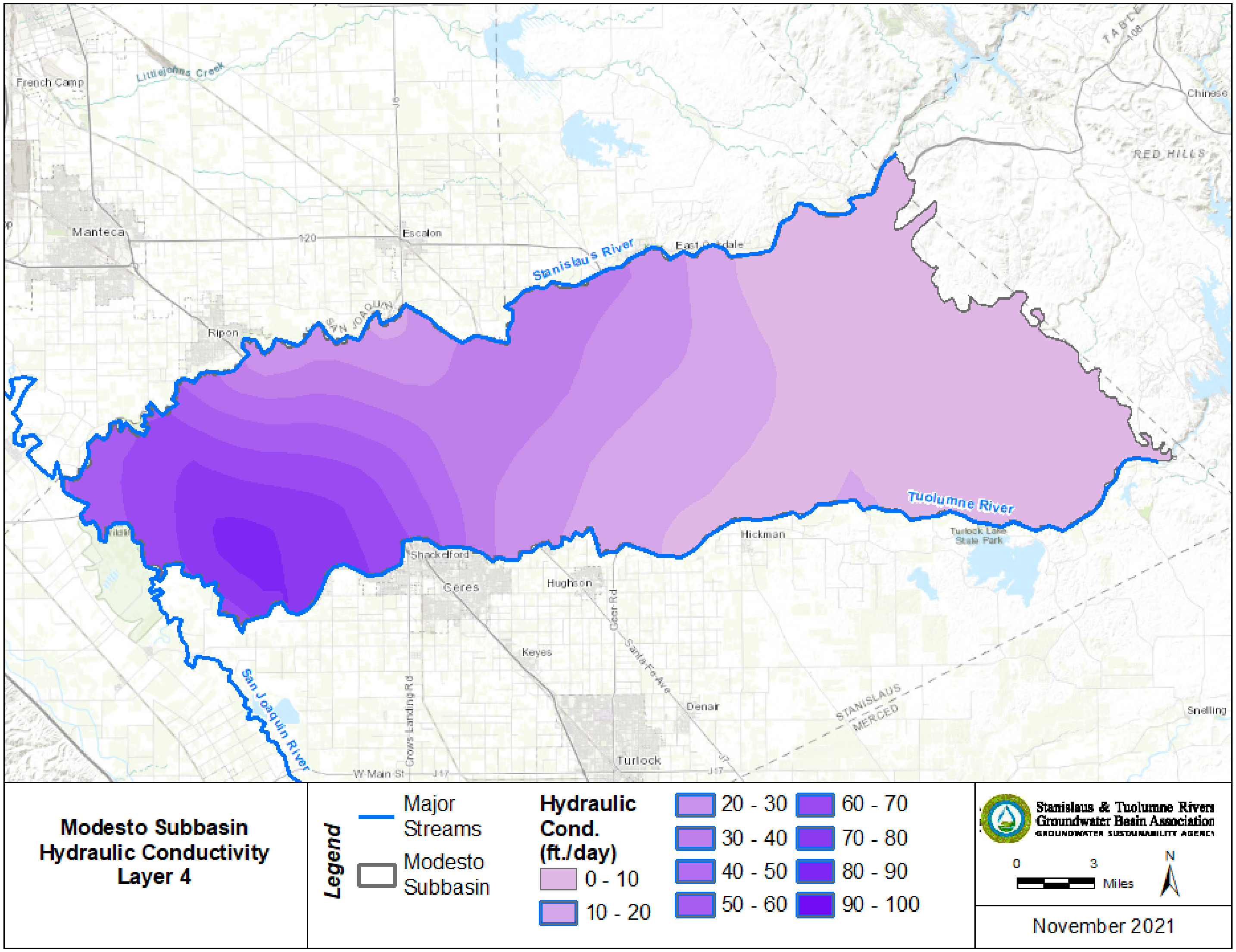
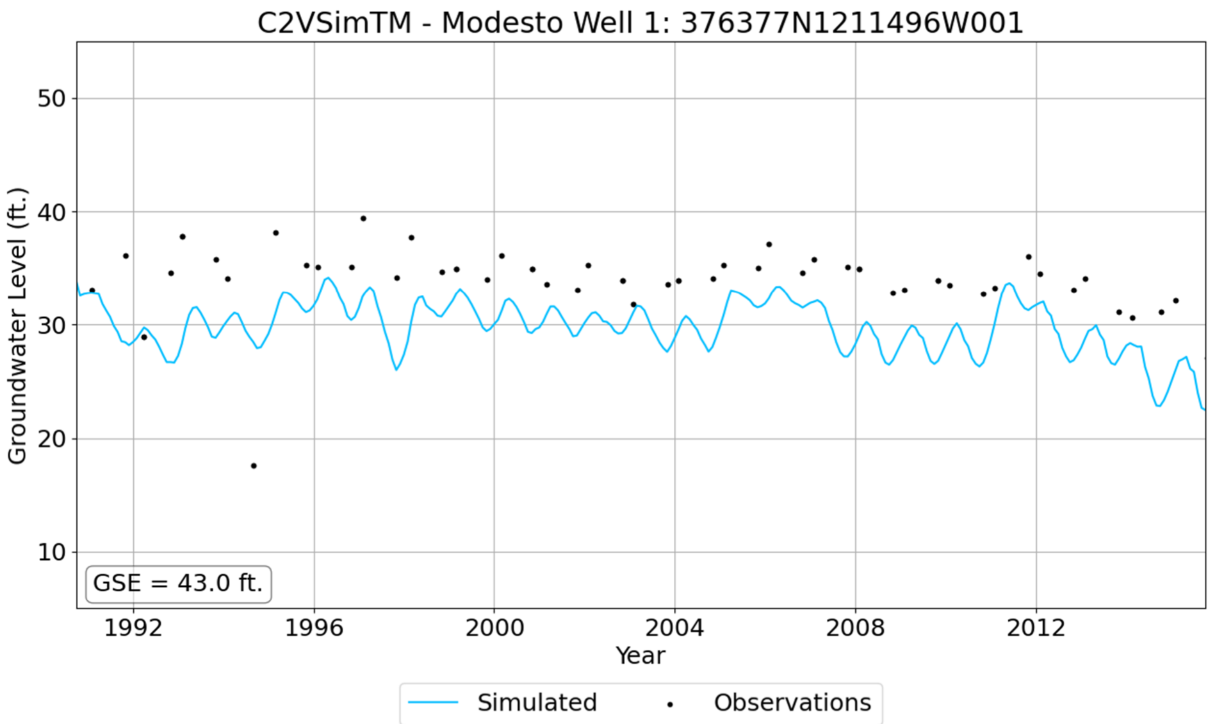


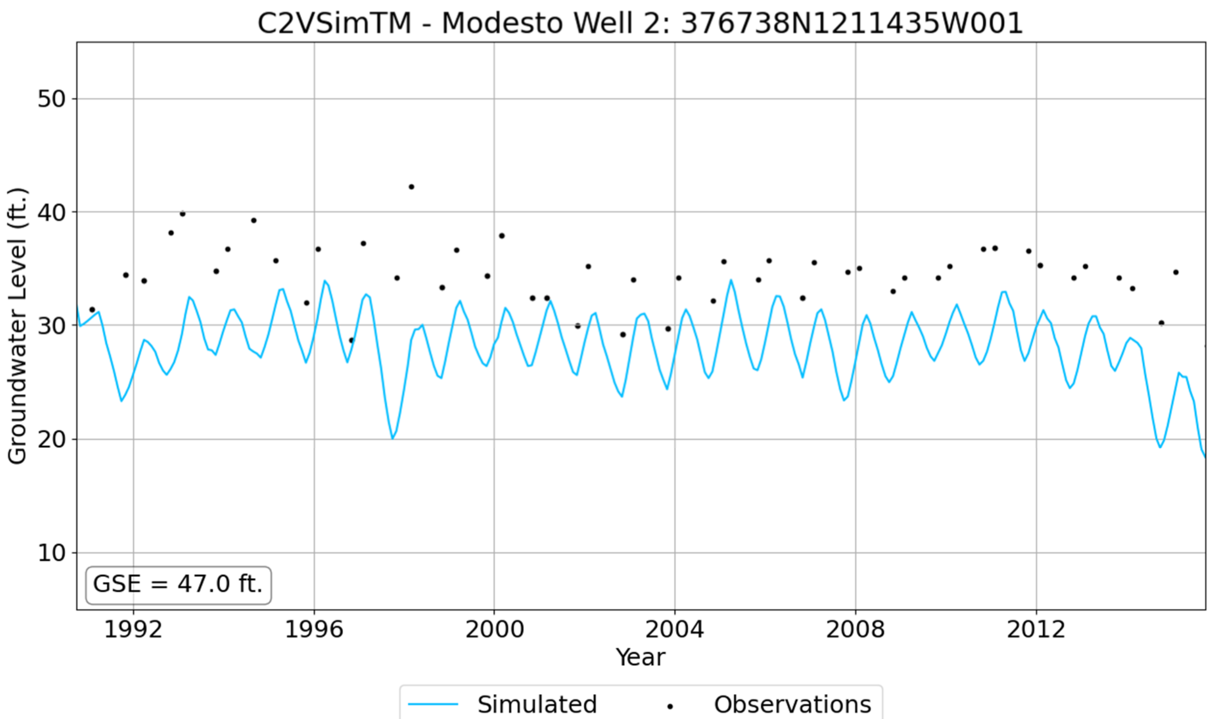
Figure M31: Calibrated Horizontal Hydraulic Conductivity of Layers 4



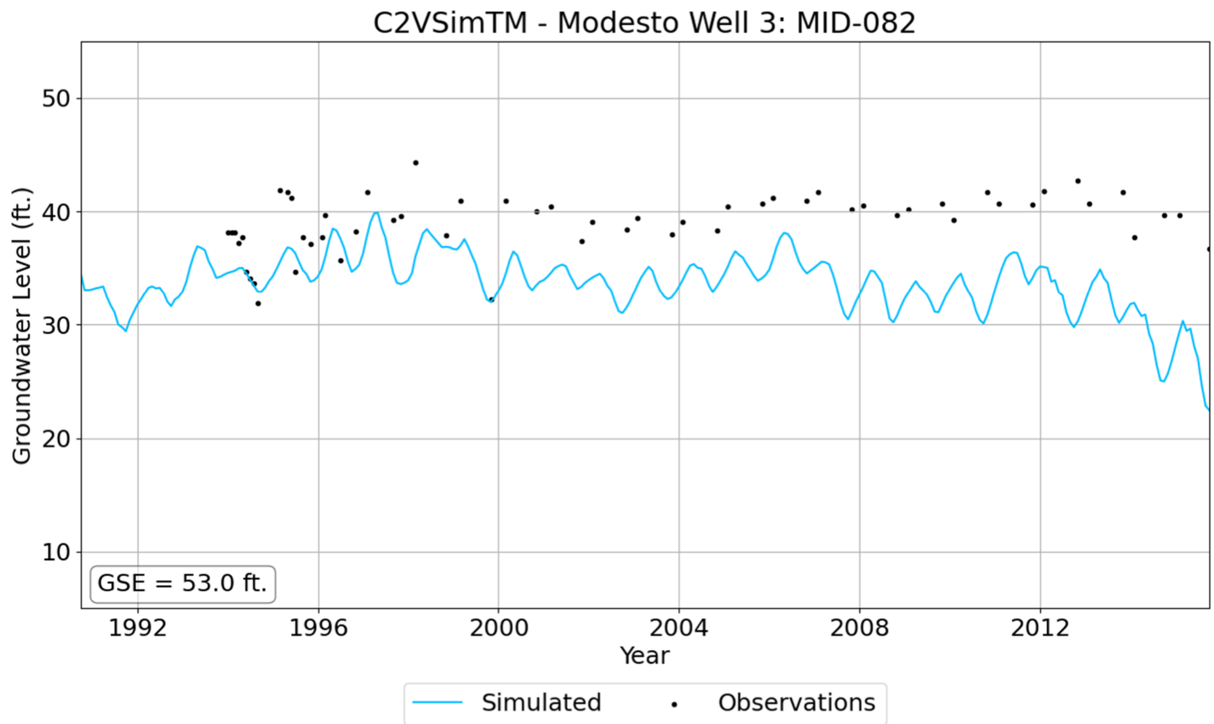
APPENDIX A: GROUNDWATER LEVEL HYDROGRAPHS



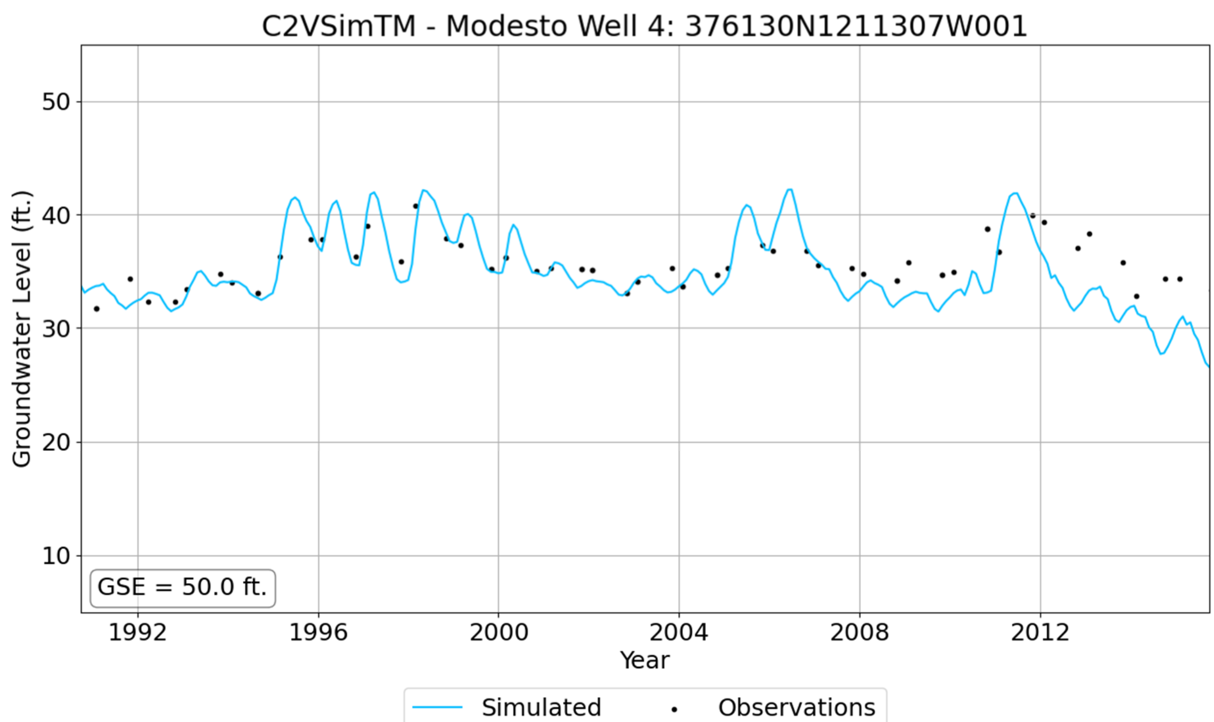
C2VSimTM - Modesto Well 1: 376377N1211496W001
Groundwater Level (ft.)
GSE = 43.0 ft.
Year
Simulated
Observations



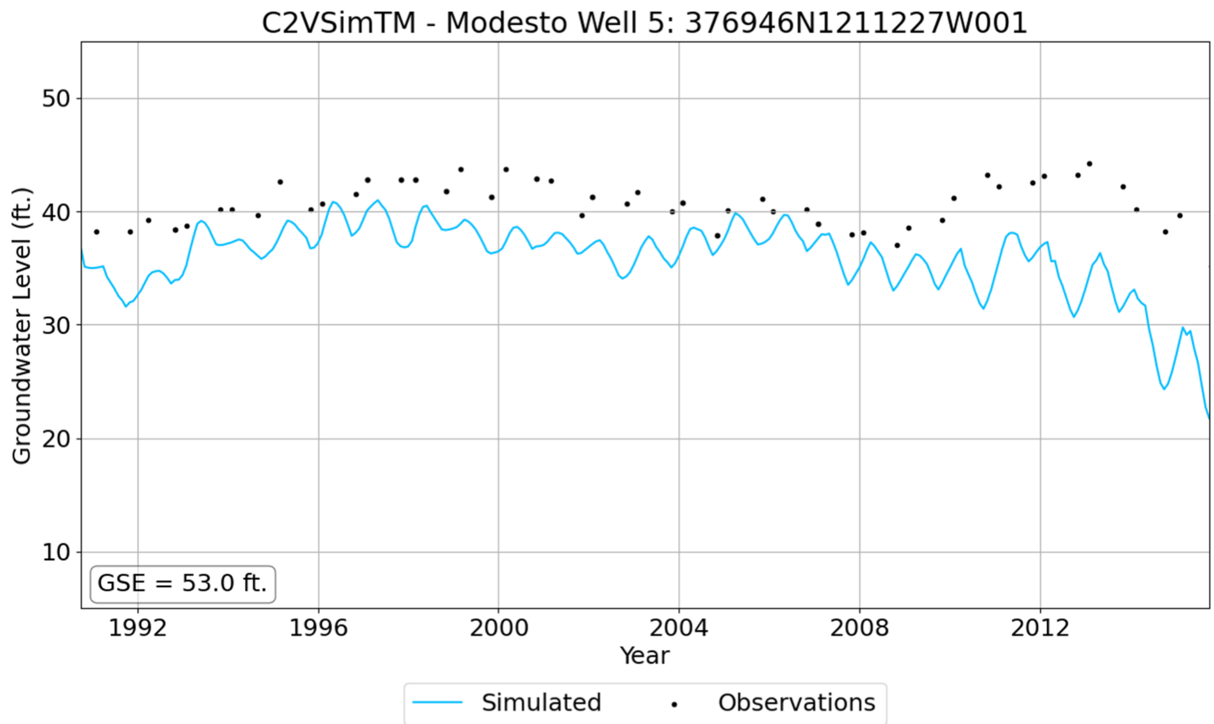
C2VSimTM - Modesto Well 2: 376738N1211435W001
Groundwater Level (ft.)
GSE = 47.0 ft.
Year
Simulated
Observations



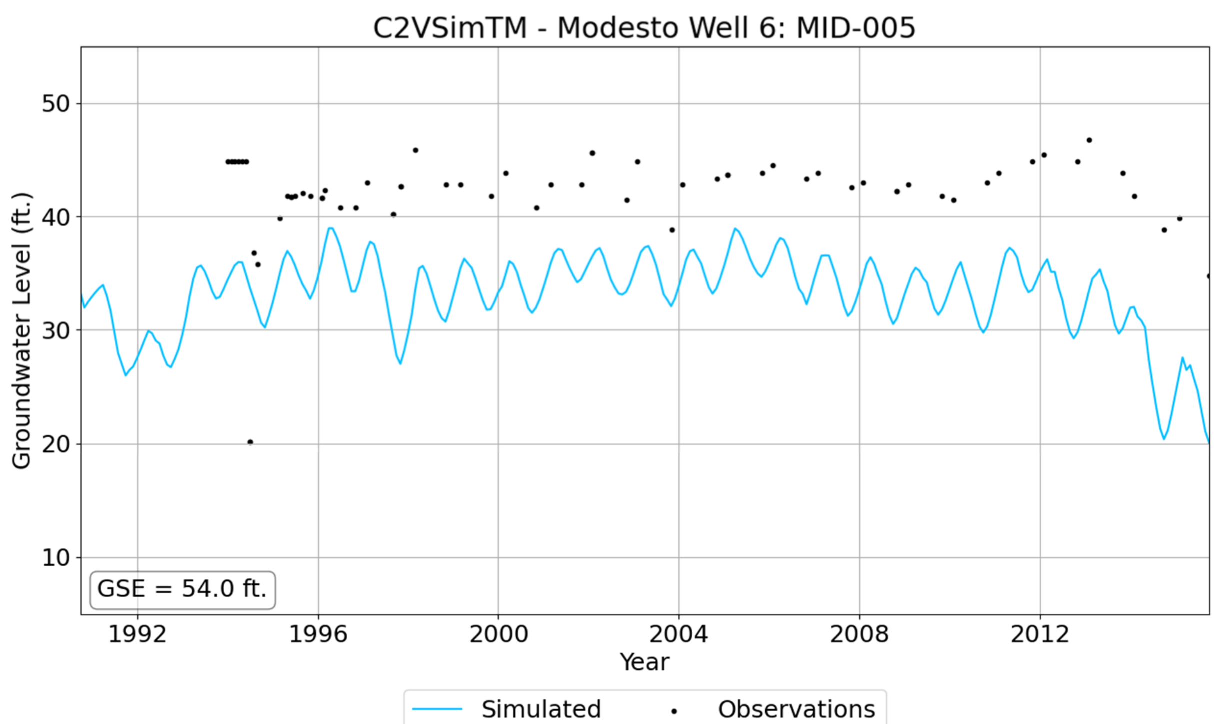
C2VSimTM - Modesto Well 3: MID-082
Groundwater Level (ft.)
50
40
30
20
10
GSE = 53.0 ft.
1992
1996
2000
2004
2008
2012
Year
Simulated
Observations



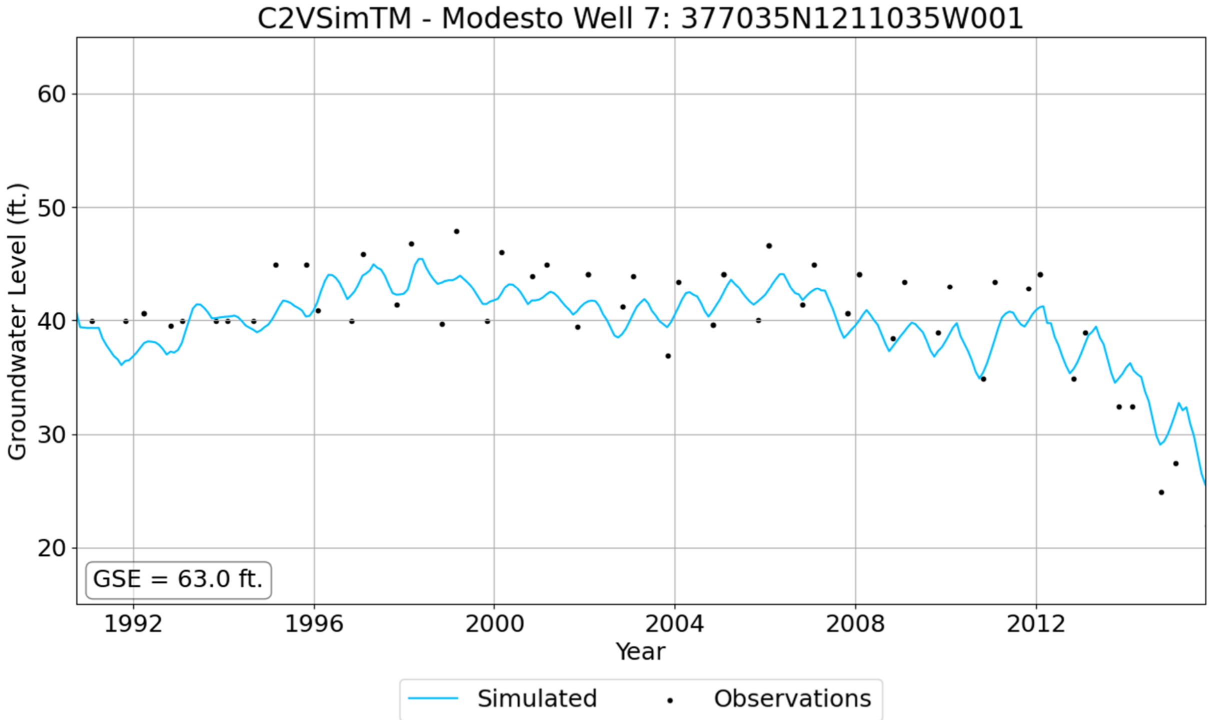
C2VSimTM - Modesto Well 4: 376130N1211307W001
Groundwater Level (ft.)
50
40
30
20
10
GSE = 50.0 ft.
1992
1996
2000
2004
2008
2012
Year
Simulated
Observations

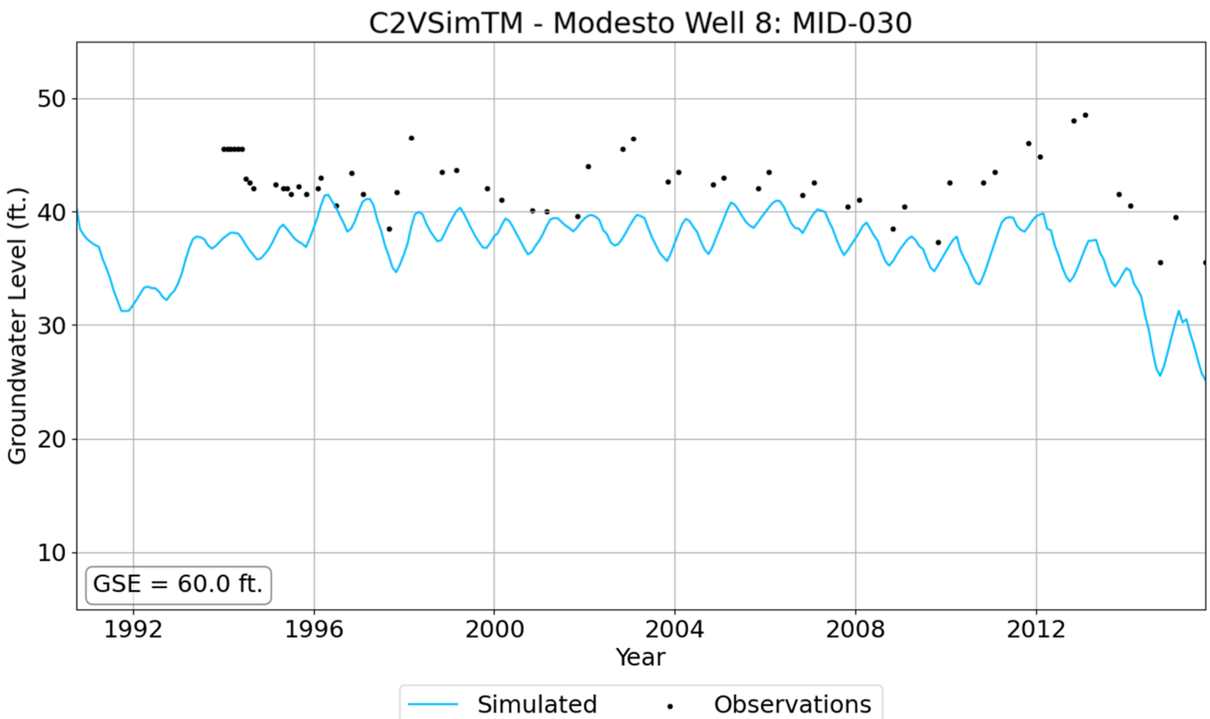


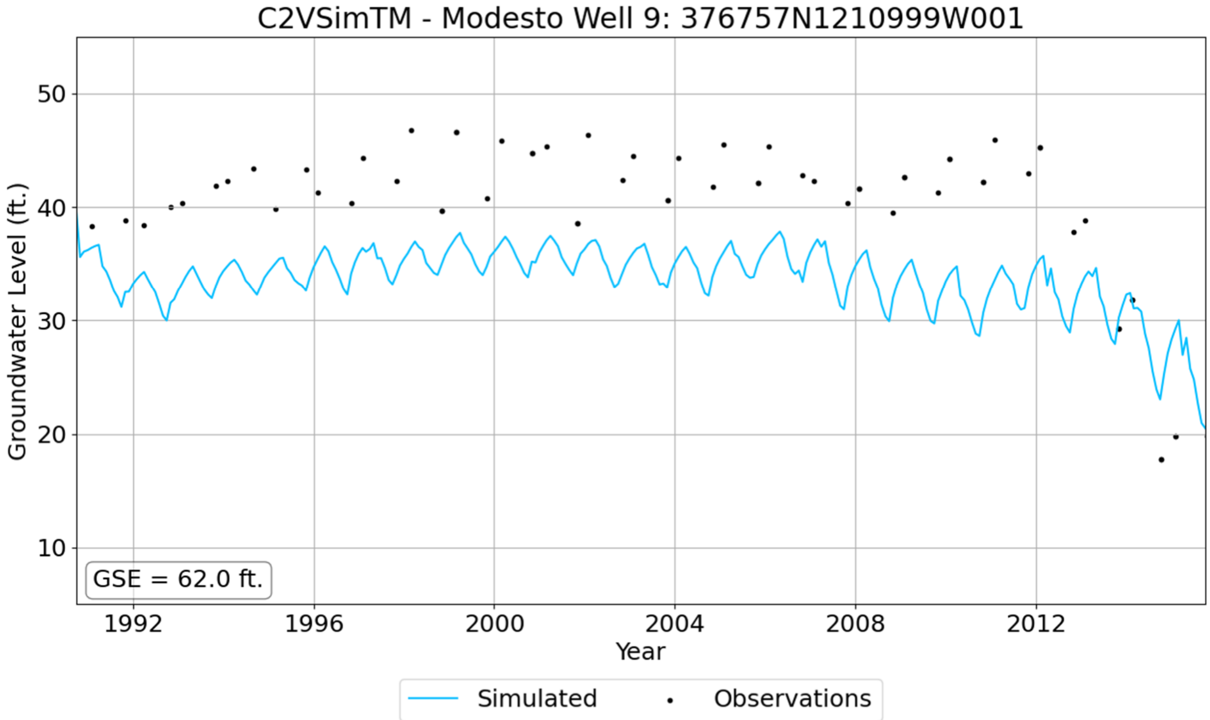
C2VSimTM - Modesto Well 5: 376946N1211227W001
Groundwater Level (ft.)
50
40
30
20
10
GSE = 53.0 ft.
1992
1996
2000
2004
2008
2012
Year
Simulated
Observations

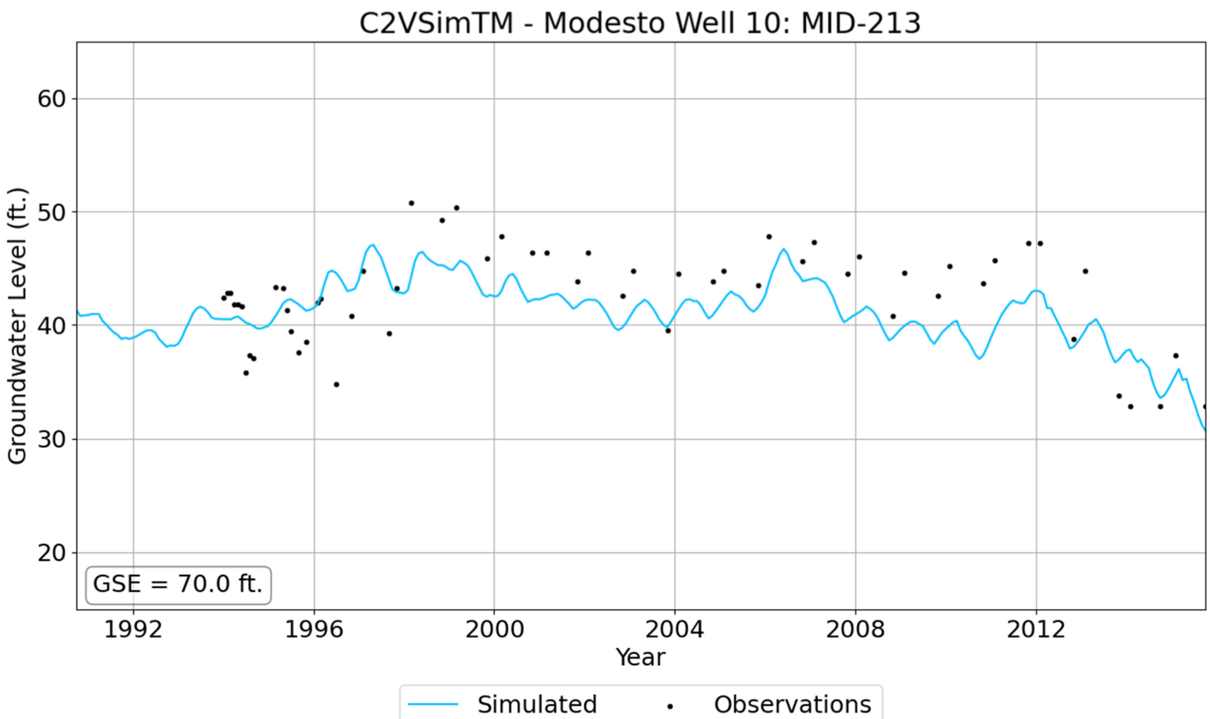


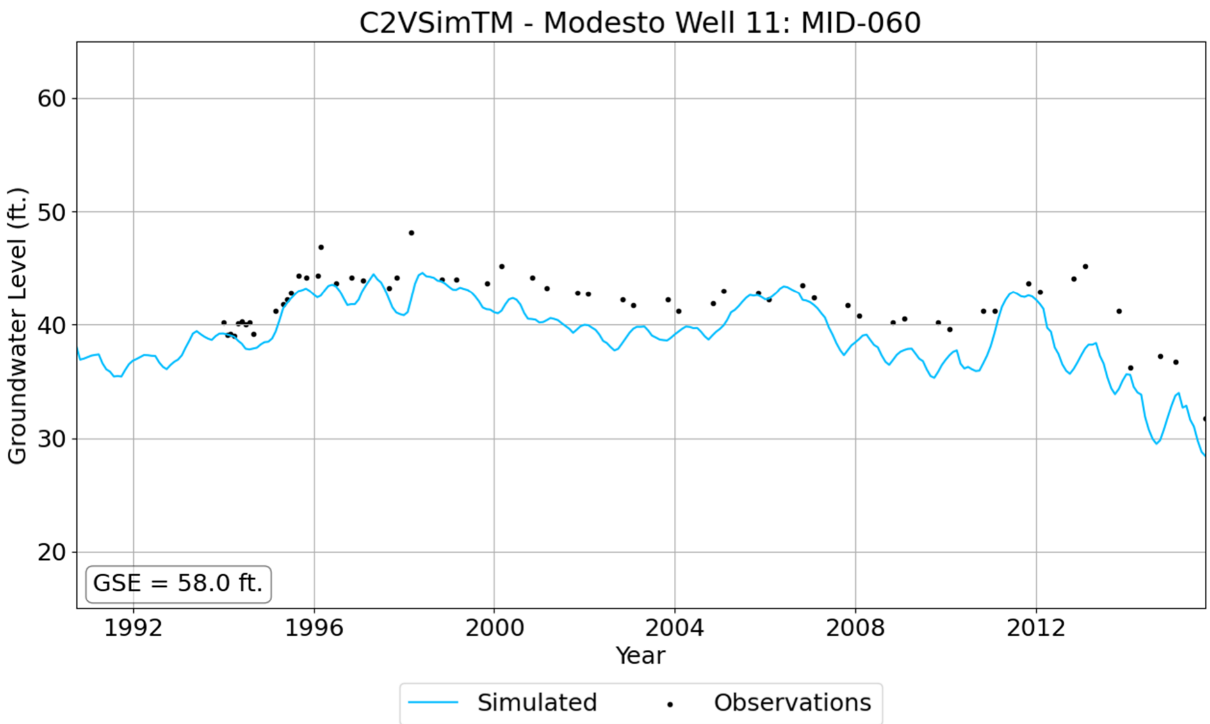
C2VSimTM - Modesto Well 6: MID-005
Groundwater Level (ft.)
50
40
30
20
10
GSE = 54.0 ft.
1992
1996
2000
2004
2008
2012
Year
Simulated
Observations

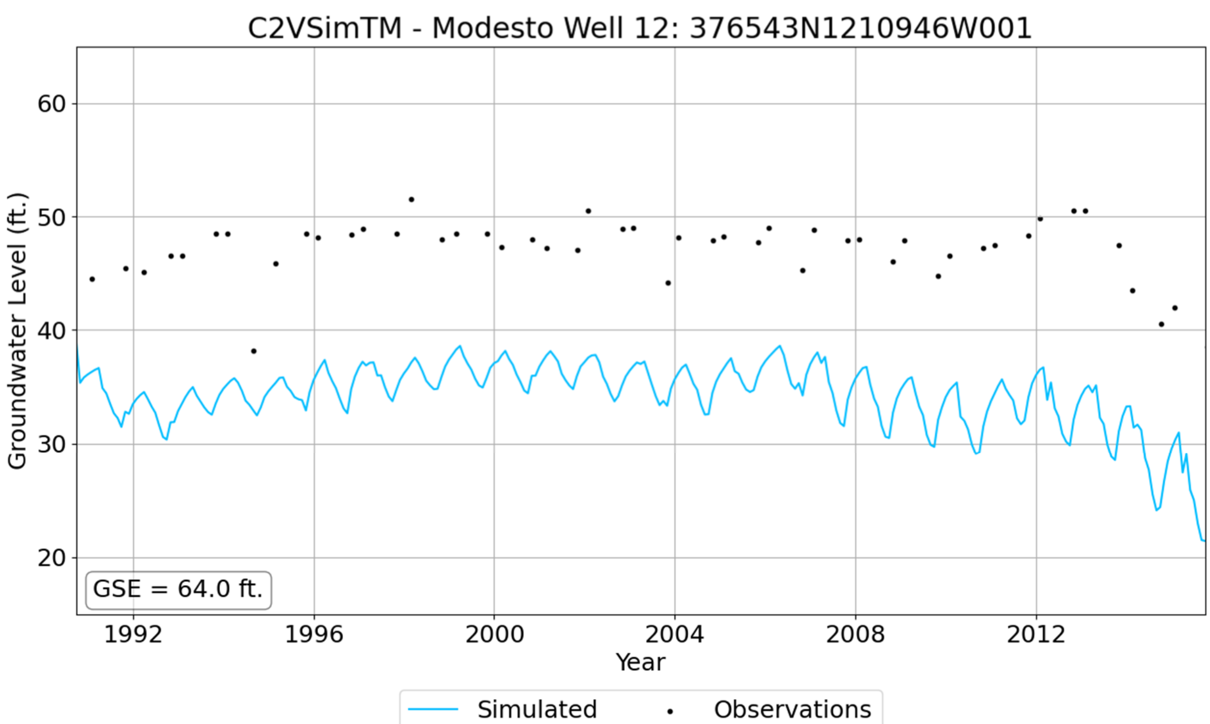

C2VSimTM - Modesto Well 7: 377035N1211035W001
Groundwater Level (ft.)
60
50
40
30
20
GSE = 63.0 ft.
1992
1996
2000
2004
2008
2012
Year
Simulated
Observations

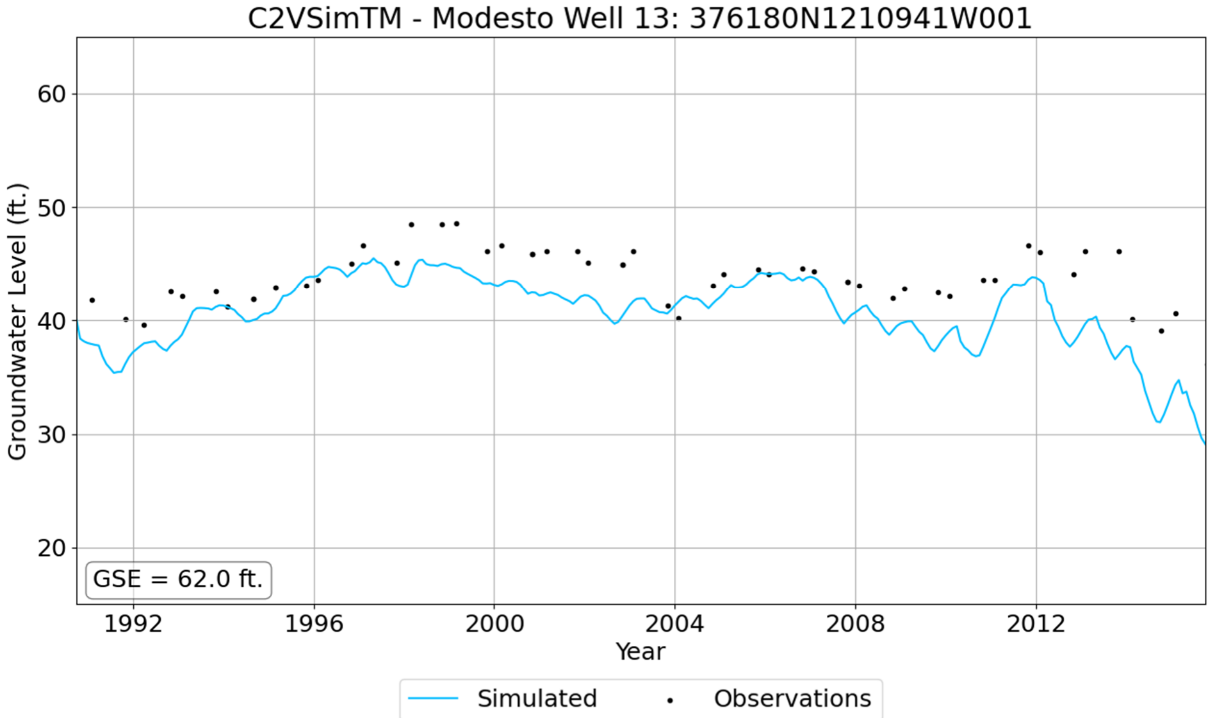

C2VSimTM - Modesto Well 8: MID-030
Groundwater Level (ft.)
50
40
30
20
10
GSE = 60.0 ft.
1992
1996
2000
2004
2008
2012
Year
Simulated
Observations

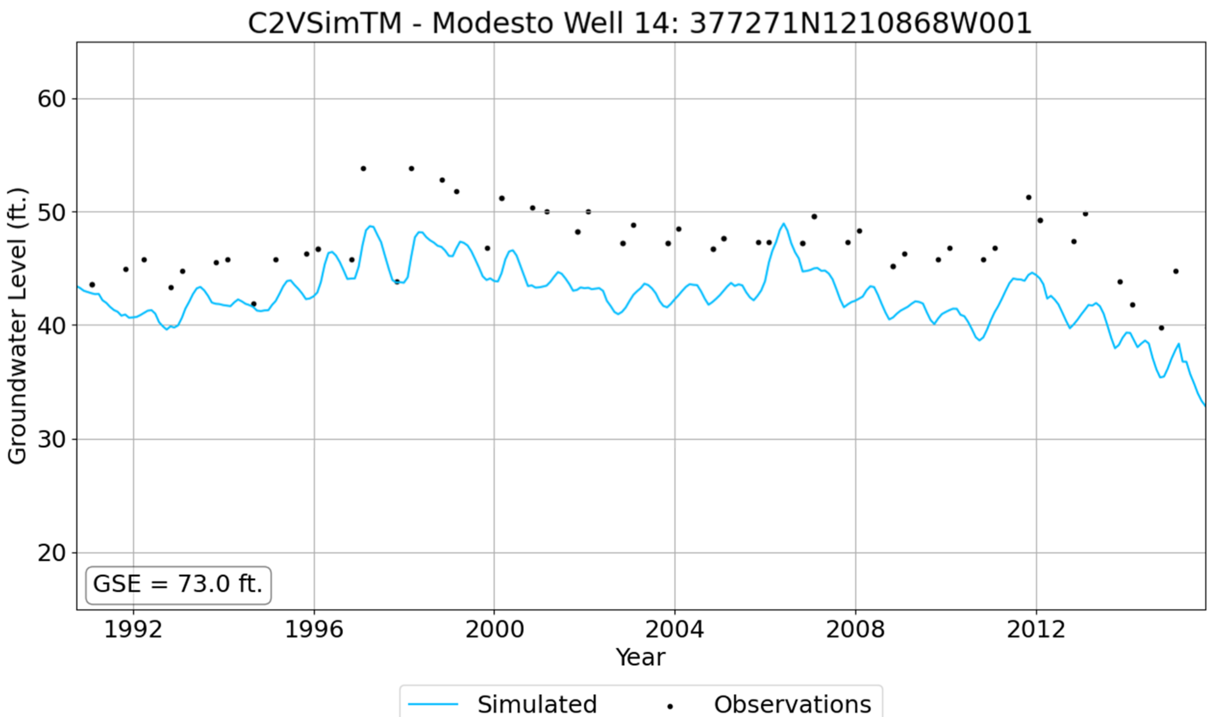

C2VSimTM - Modesto Well 9: 376757N1210999W001
Groundwater Level (ft.)
50
40
30
20
10
GSE = 62.0 ft.
1992
1996
2000
2004
2008
2012
Year
Simulated
Observations

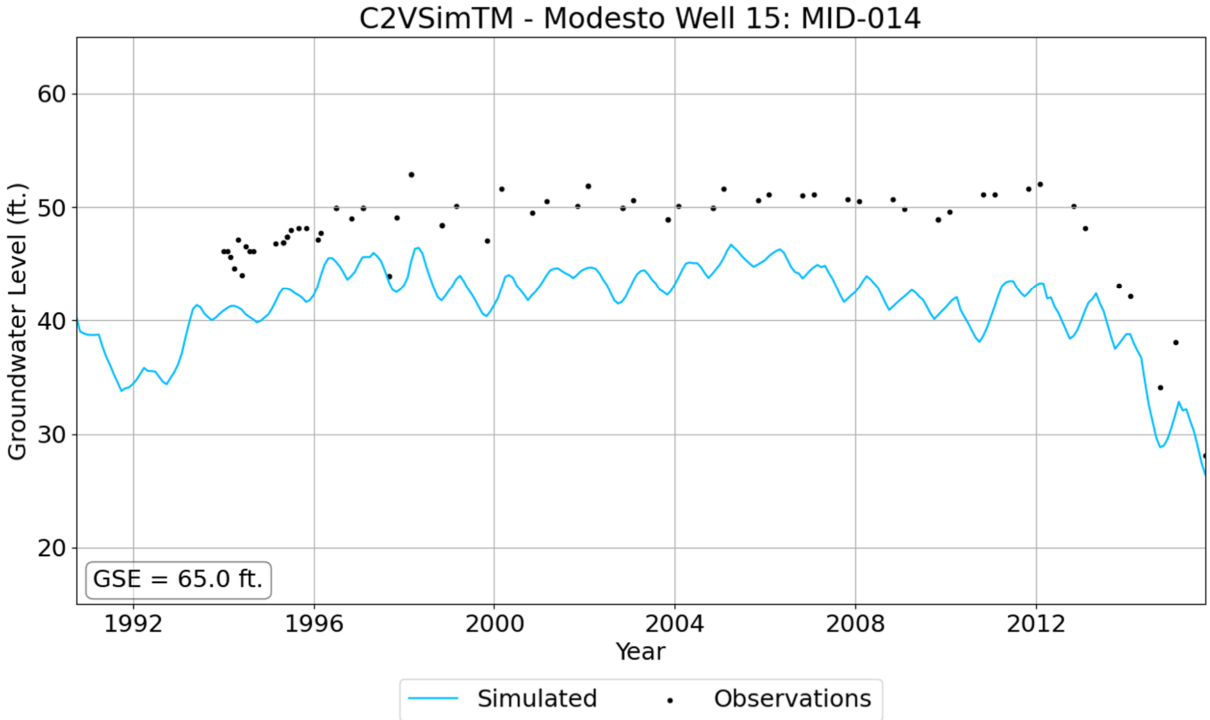

C2VSimTM - Modesto Well 10: MID-213
Groundwater Level (ft.)
60
50
40
30
20
GSE = 70.0 ft.
1992
1996
2000
2004
2008
2012
Year
Simulated
Observations

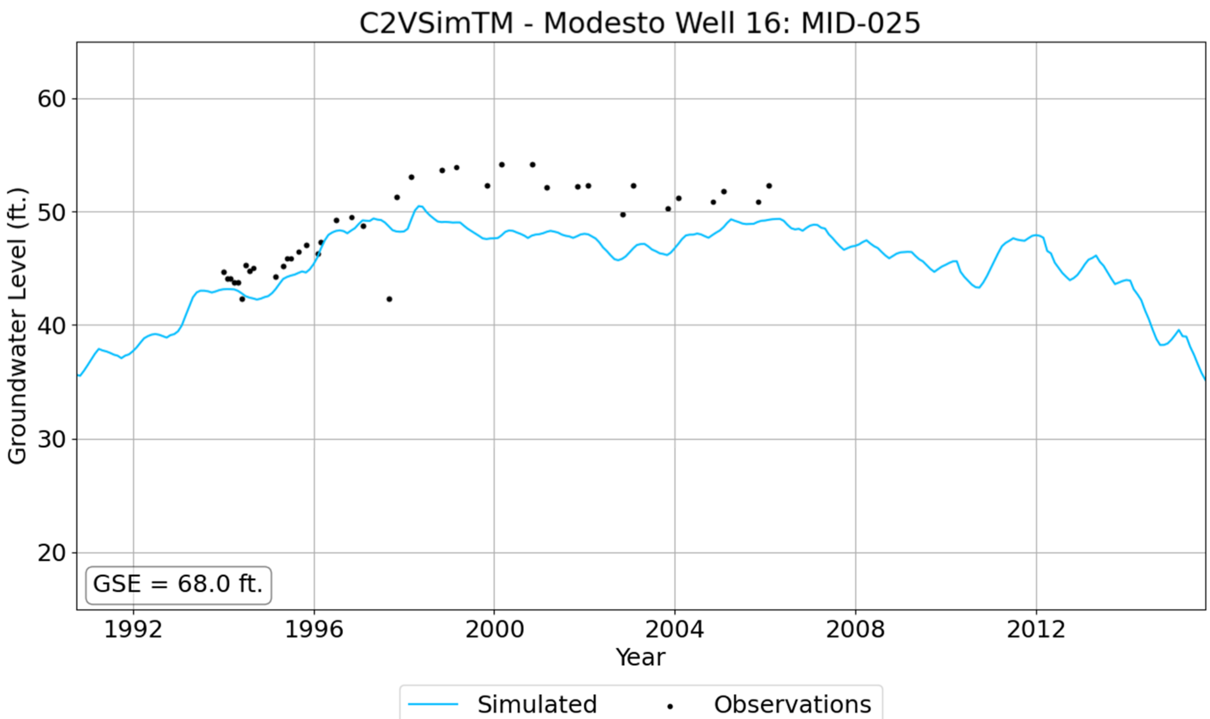

C2VSimTM - Modesto Well 11: MID-060
Groundwater Level (ft.)
60
50
40
30
20
GSE = 58.0 ft.
1992
1996
2000
2004
2008
2012
Year
Simulated
Observations

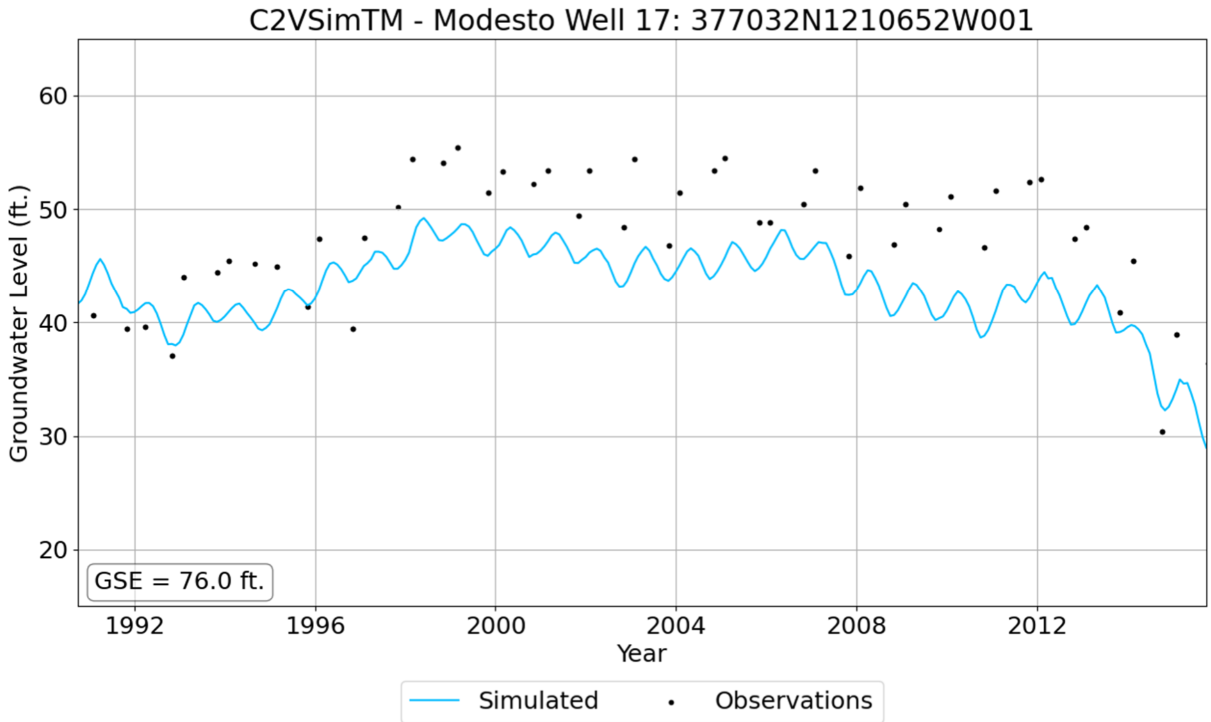

C2VSimTM - Modesto Well 12: 376543N1210946W001
Groundwater Level (ft.)
60
50
40
30
20
GSE = 64.0 ft.
1992
1996
2000
2004
2008
2012
Year
Simulated
Observations

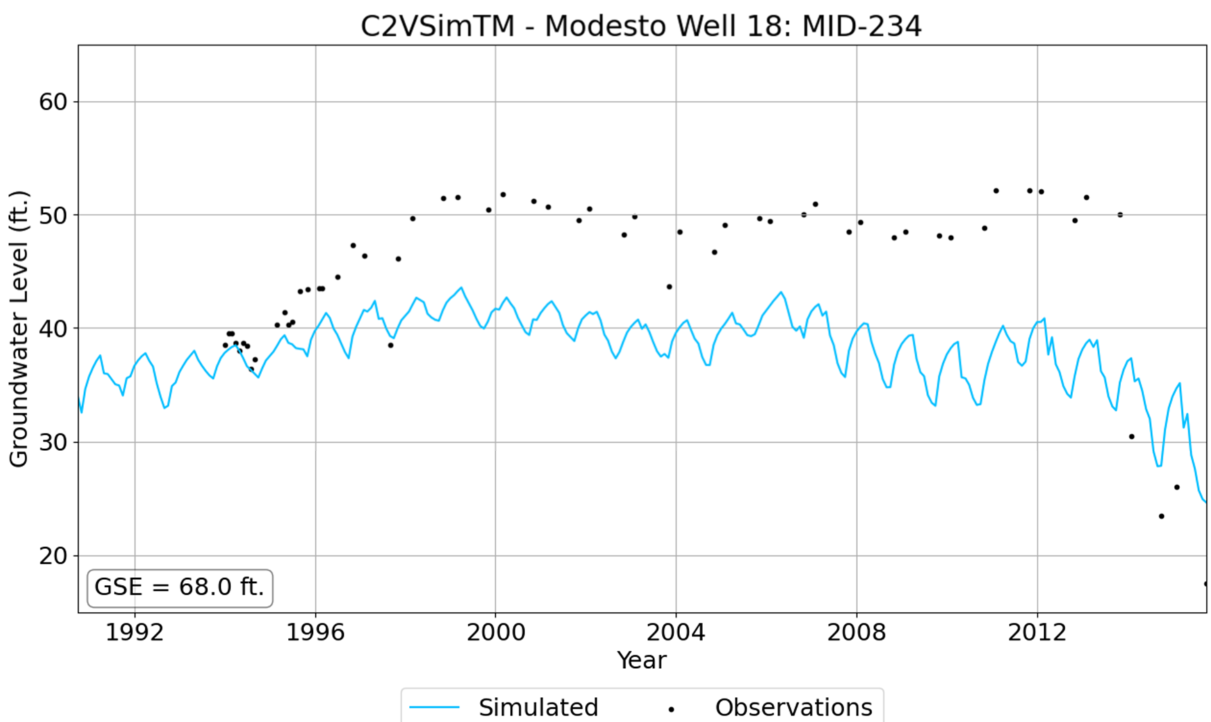

C2VSimTM - Modesto Well 13: 376180N1210941W001
Groundwater Level (ft.)
Year
GSE = 62.0 ft.
Simulated
Observations

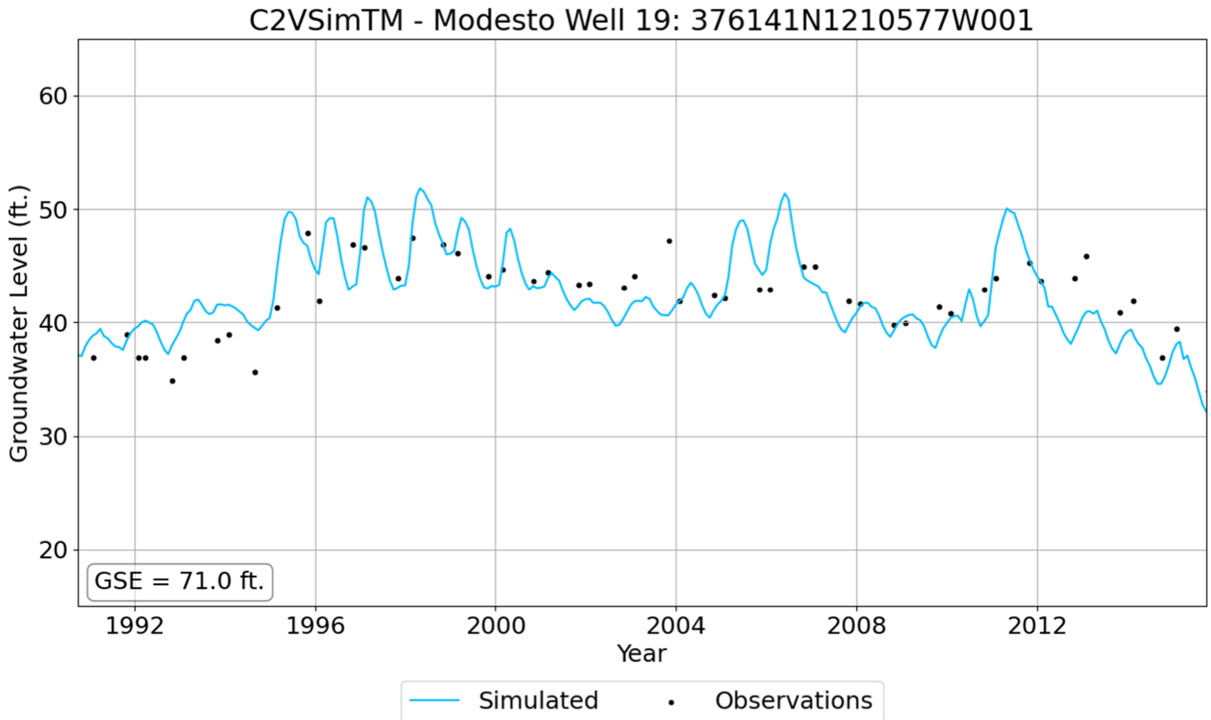

C2VSimTM - Modesto Well 14: 377271N1210868W001
Groundwater Level (ft.)
Year
GSE = 73.0 ft.
Simulated
Observations


C2VSimTM - Modesto Well 15: MID-014
Groundwater Level (ft.)
60
50
40
30
20
GSE = 65.0 ft.
1992
1996
2000
2004
2008
2012
Year
Simulated
Observations

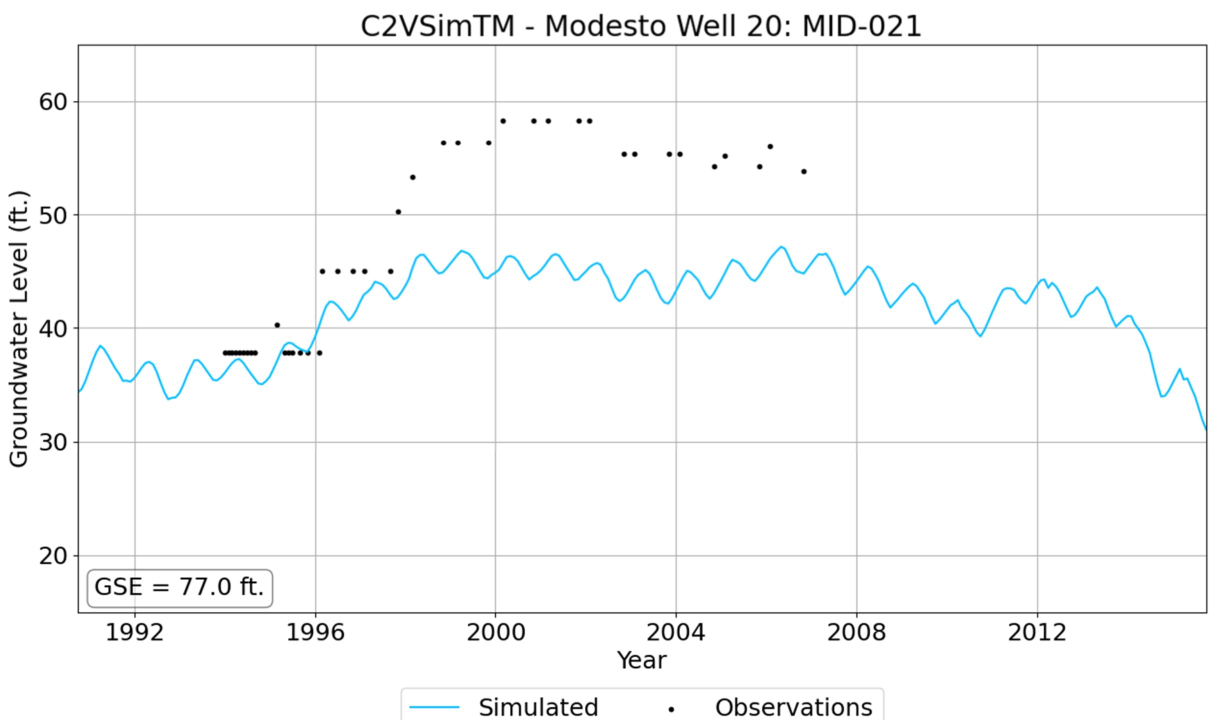

C2VSimTM - Modesto Well 16: MID-025
Groundwater Level (ft.)
60
50
40
30
20
GSE = 68.0 ft.
1992
1996
2000
2004
2008
2012
Year
Simulated
Observations


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

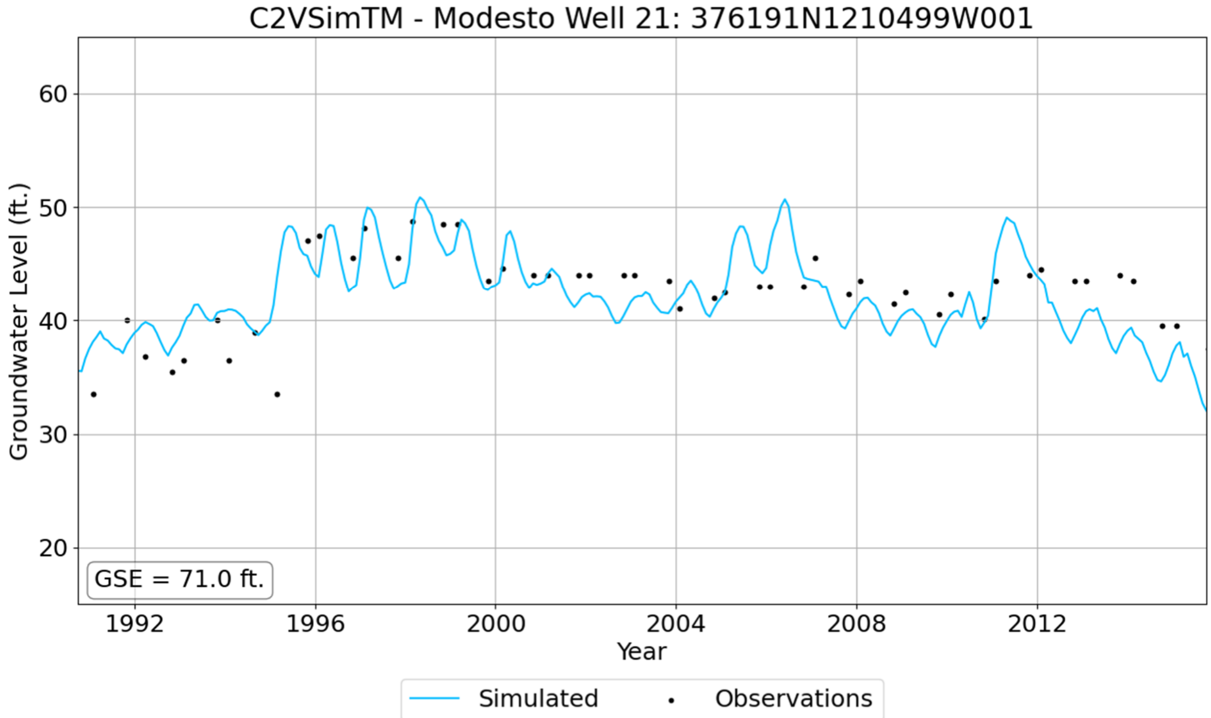

C2VSimTM - Modesto Well 18: MID-234
Groundwater Level (ft.)
60
50
40
30
20
GSE = 68.0 ft.
1992
1996
2000
2004
2008
2012
Year
Simulated
Observations

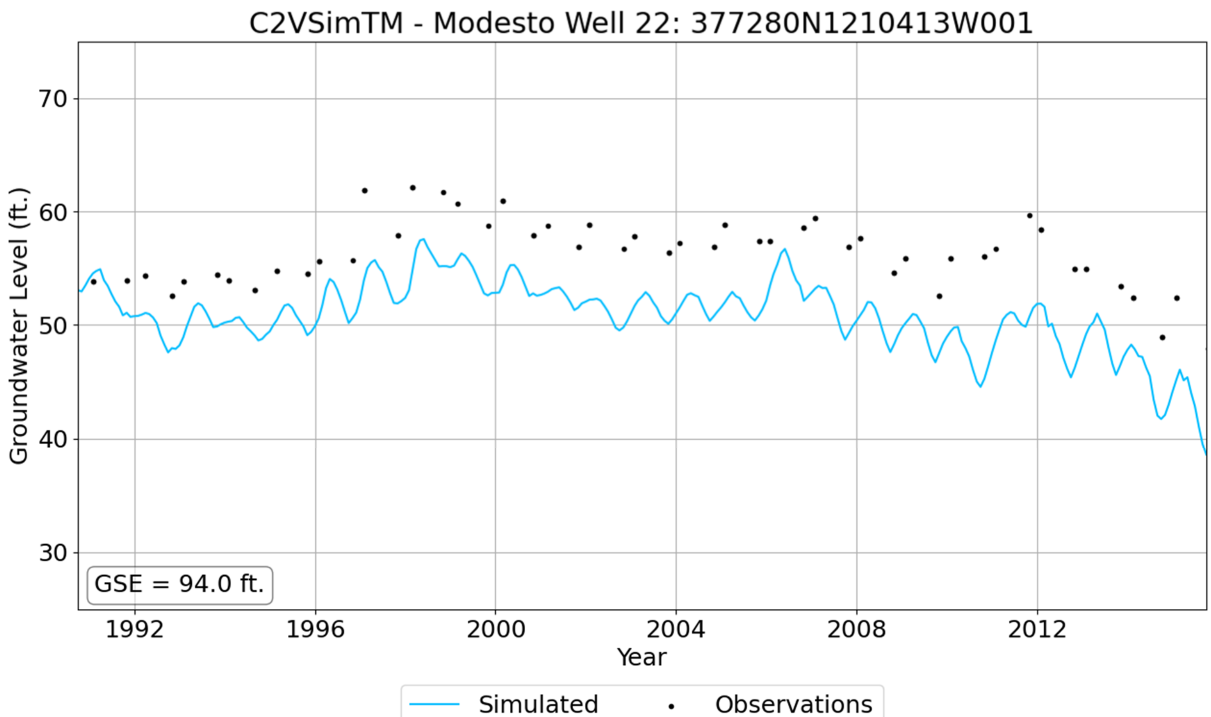


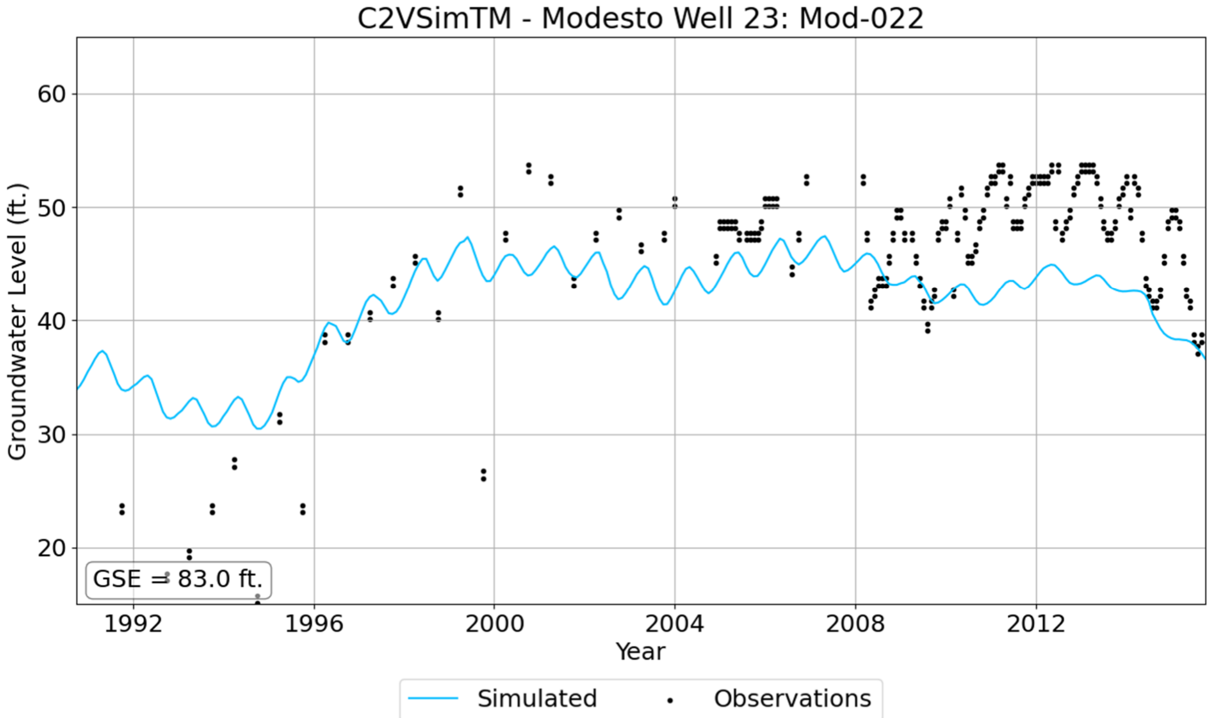
C2VSimTM - Modesto Well 19: 376141N1210577W001
Groundwater Level (ft.)
60
50
40
30
20
GSE = 71.0 ft.
1992
1996
2000
2004
2008
2012
Year
Simulated
Observations

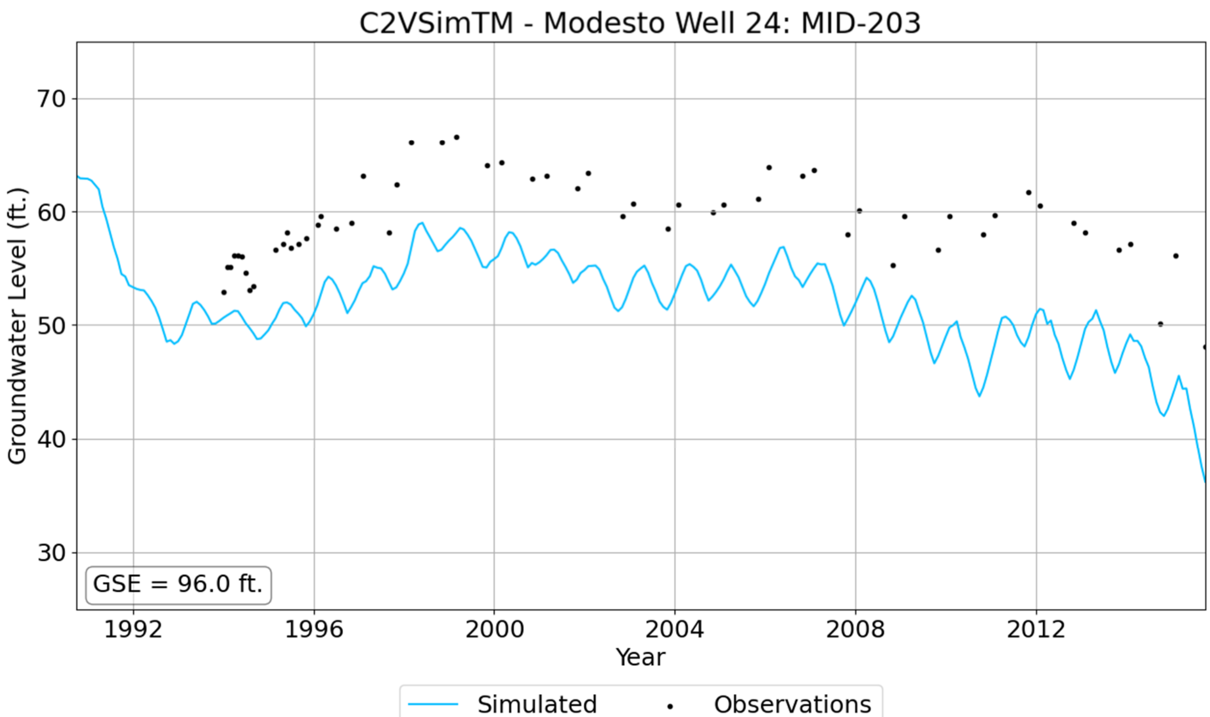


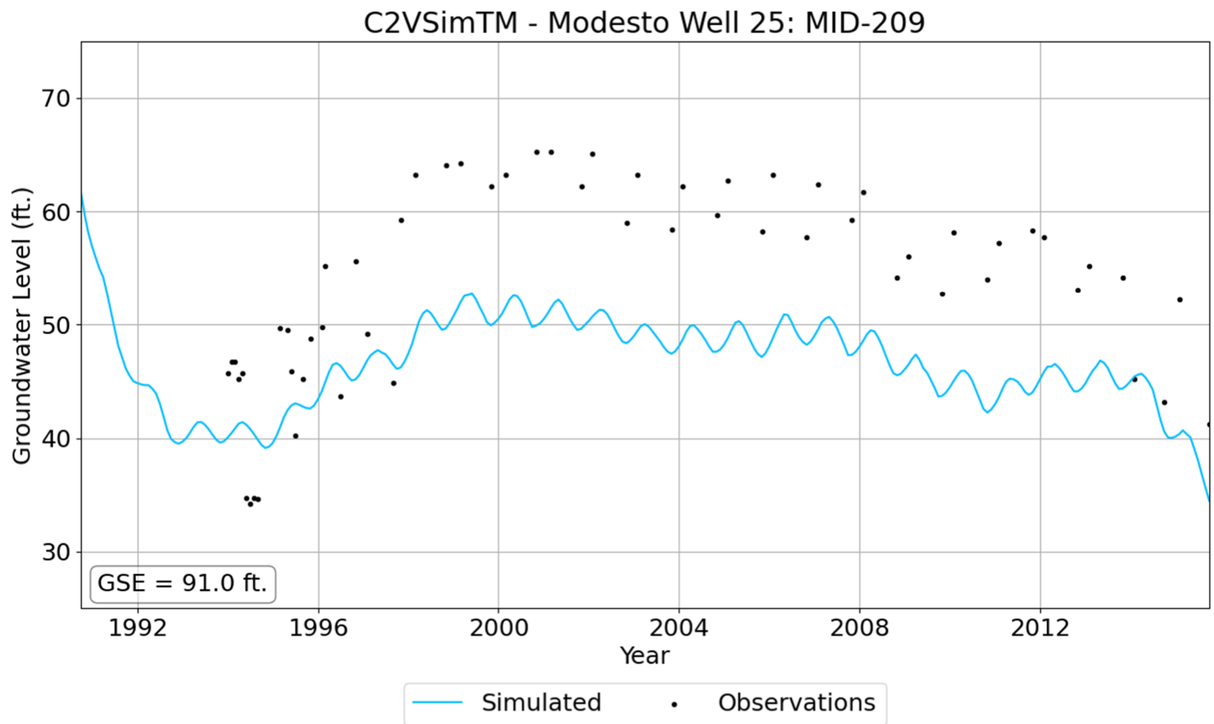
C2VSimTM - Modesto Well 20: MID-021
Groundwater Level (ft.)
60
50
40
30
20
GSE = 77.0 ft.
1992
1996
2000
2004
2008
2012
Year
Simulated
Observations

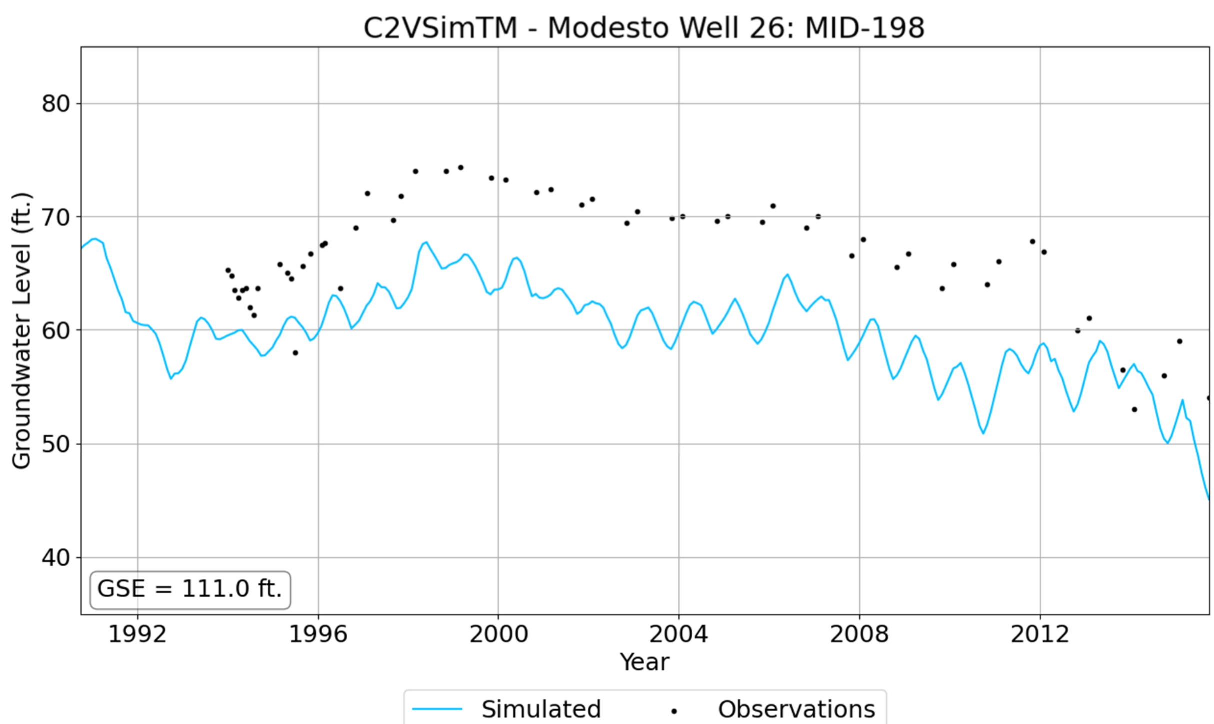

C2VSimTM - Modesto Well 21: 376191N1210499W001
Groundwater Level (ft.)
60
50
40
30
20
GSE = 71.0 ft.
1992
1996
2000
2004
2008
2012
Year
Simulated
Observations

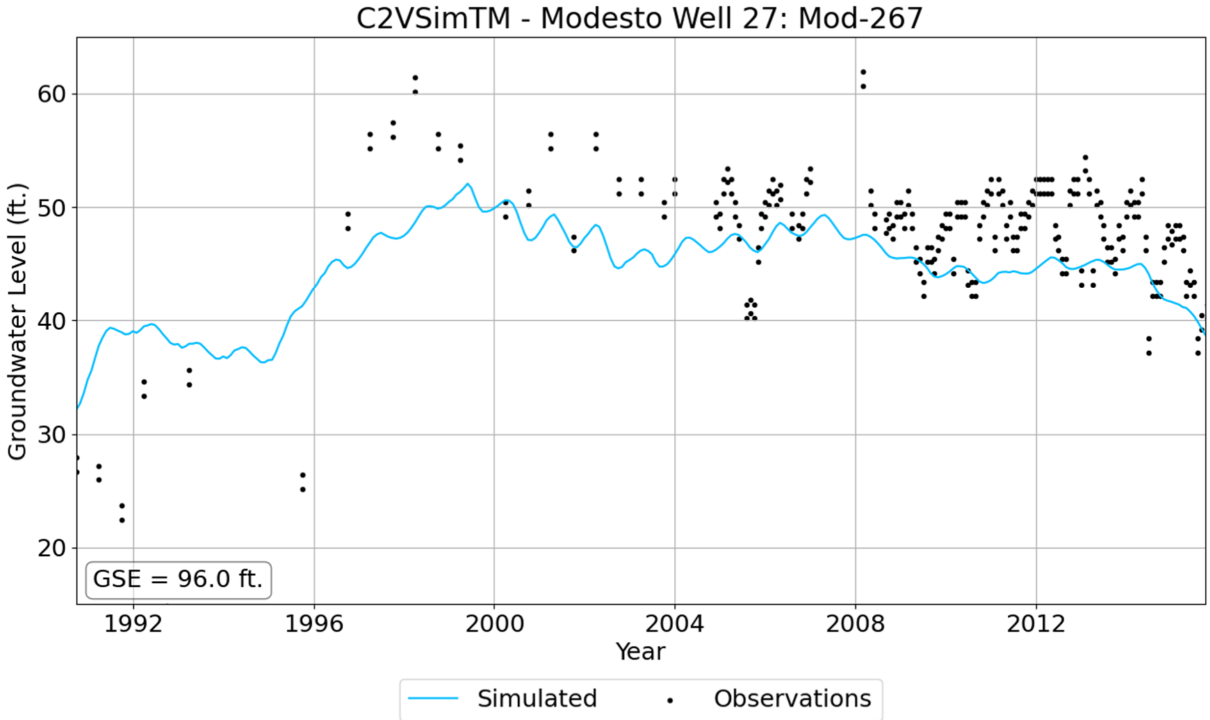

C2VSimTM - Modesto Well 22: 377280N1210413W001
Groundwater Level (ft.)
70
60
50
40
30
GSE = 94.0 ft.
1992
1996
2000
2004
2008
2012
Year
Simulated
Observations

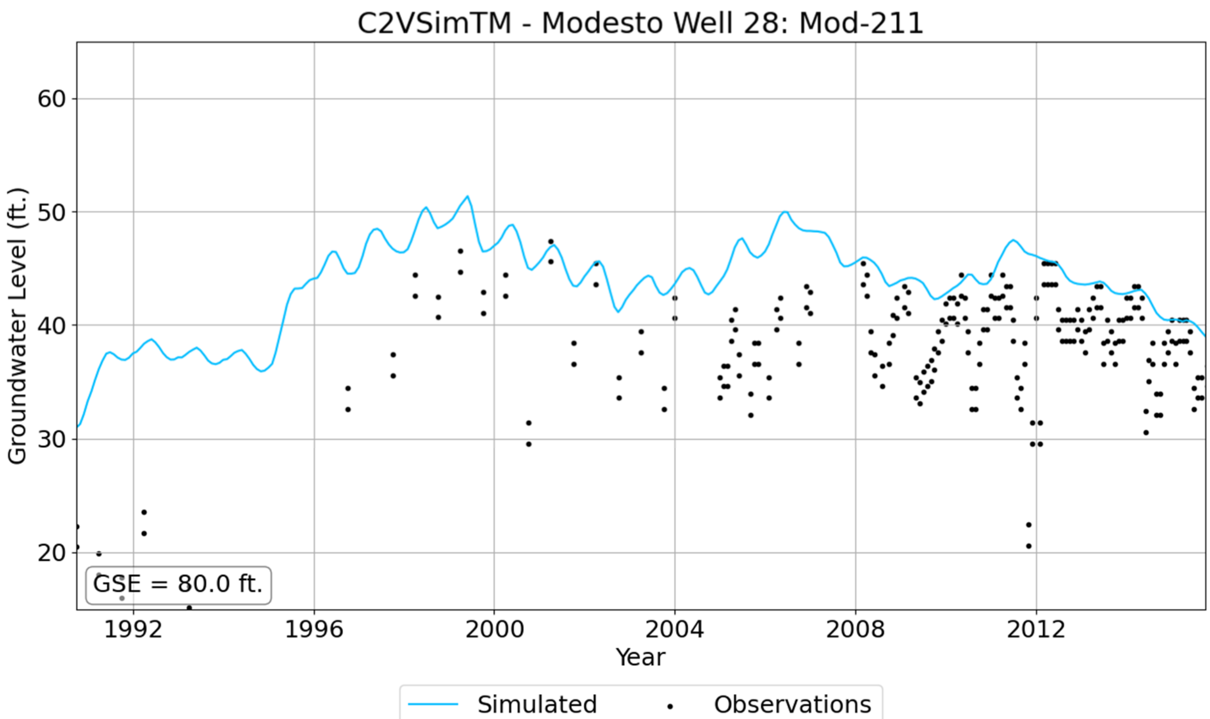

C2VSimTM - Modesto Well 23: Mod-022
Groundwater Level (ft.)
60
50
40
30
20
GSE = 83.0 ft.
1992
1996
2000
2004
2008
2012
Year
Simulated
Observations

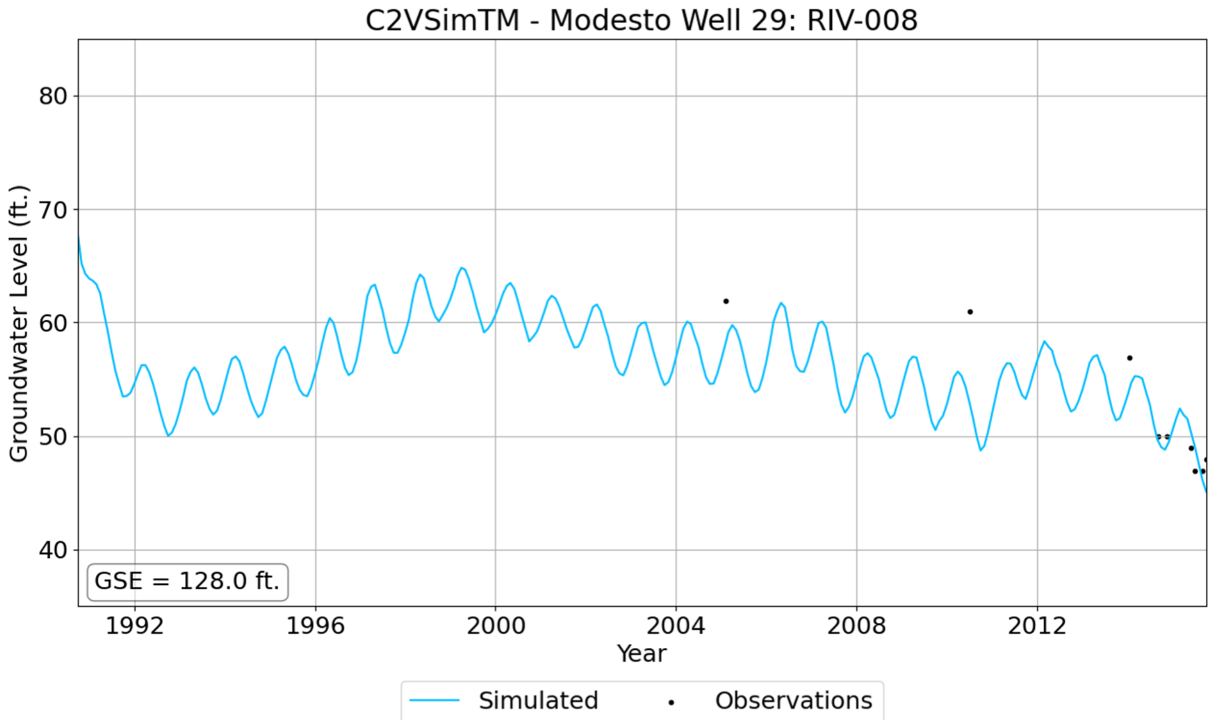

C2VSimTM - Modesto Well 24: MID-203
Groundwater Level (ft.)
70
60
50
40
30
GSE = 96.0 ft.
1992
1996
2000
2004
2008
2012
Year
Simulated
Observations

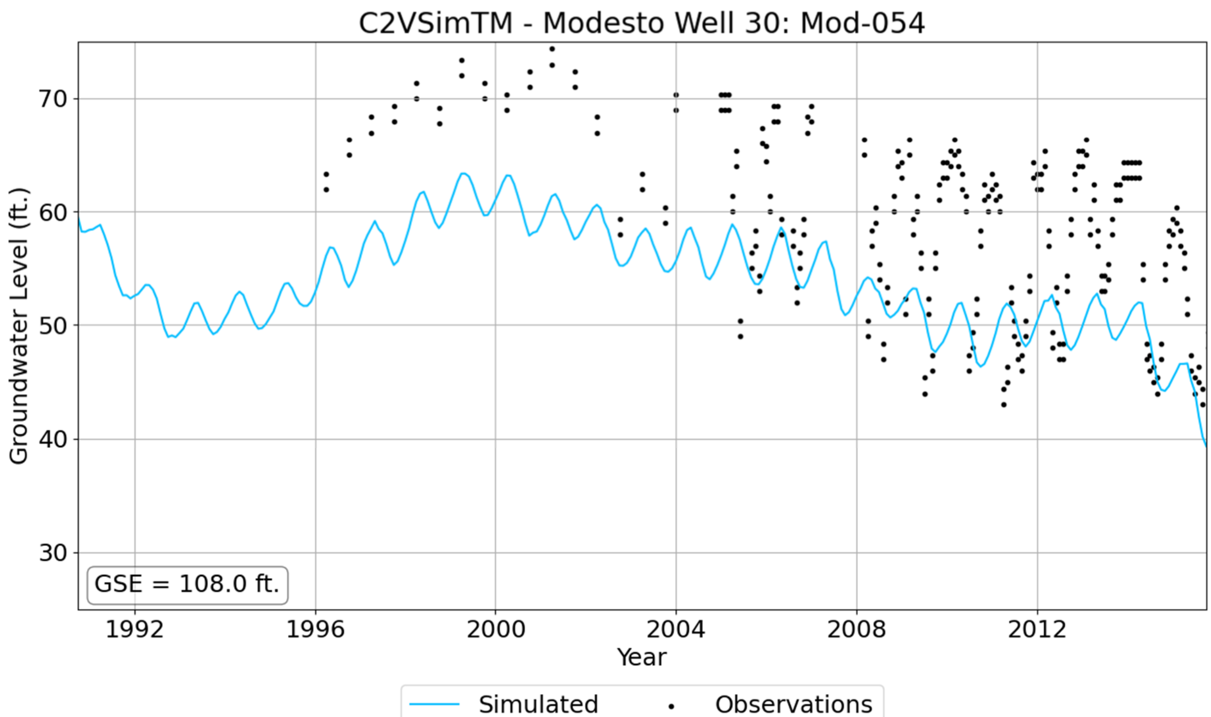

C2VSimTM - Modesto Well 25: MID-209
Groundwater Level (ft.)
Year
GSE = 91.0 ft.
Simulated
Observations

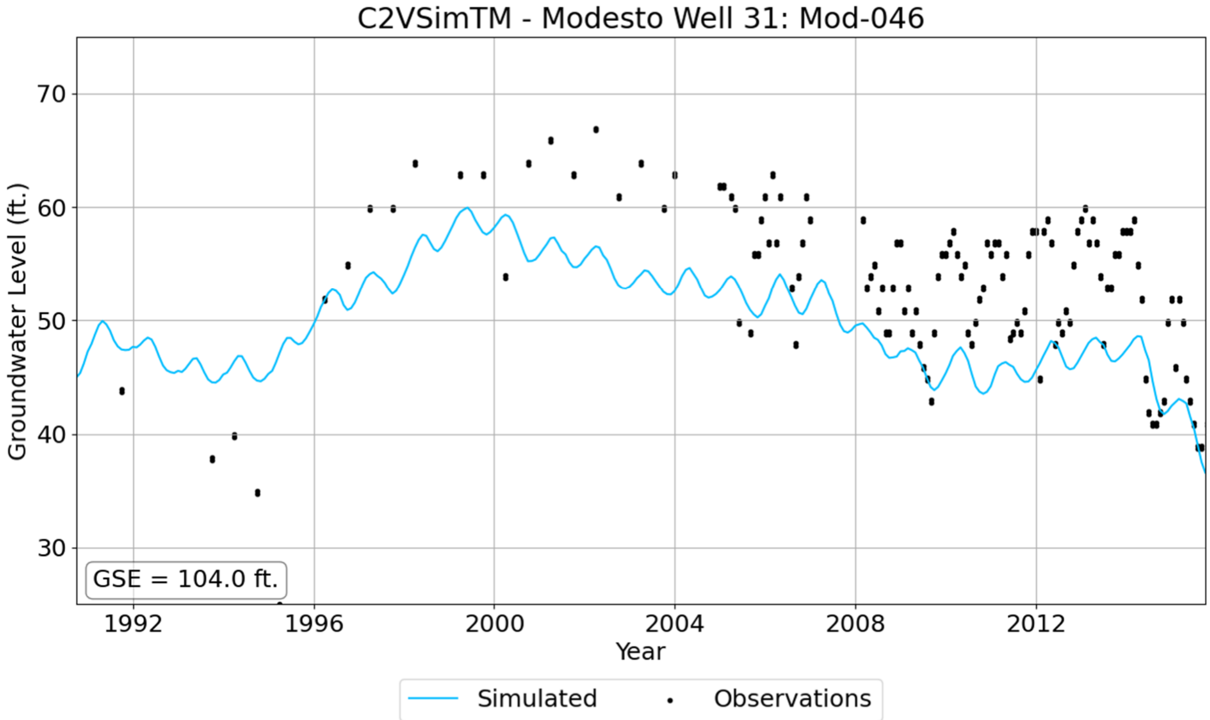

C2VSimTM - Modesto Well 26: MID-198
Groundwater Level (ft.)
Year
GSE = 111.0 ft.
Simulated
Observations


C2VSimTM - Modesto Well 27: Mod-267
Groundwater Level (ft.)
Year
GSE = 96.0 ft.
Simulated
Observations

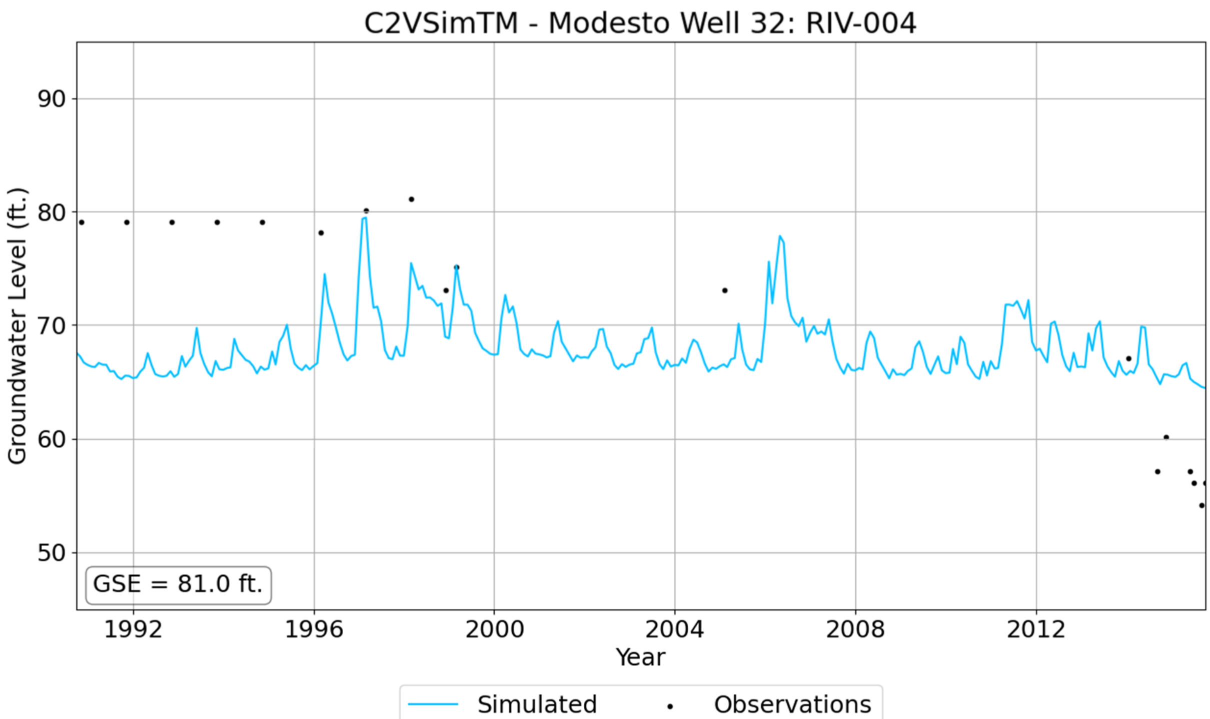

C2VSimTM - Modesto Well 28: Mod-211
Groundwater Level (ft.)
Year
GSE = 80.0 ft.
Simulated
Observations


C2VSimTM - Modesto Well 29: RIV-008
Groundwater Level (ft.)
Year
GSE = 128.0 ft.
Simulated
Observations

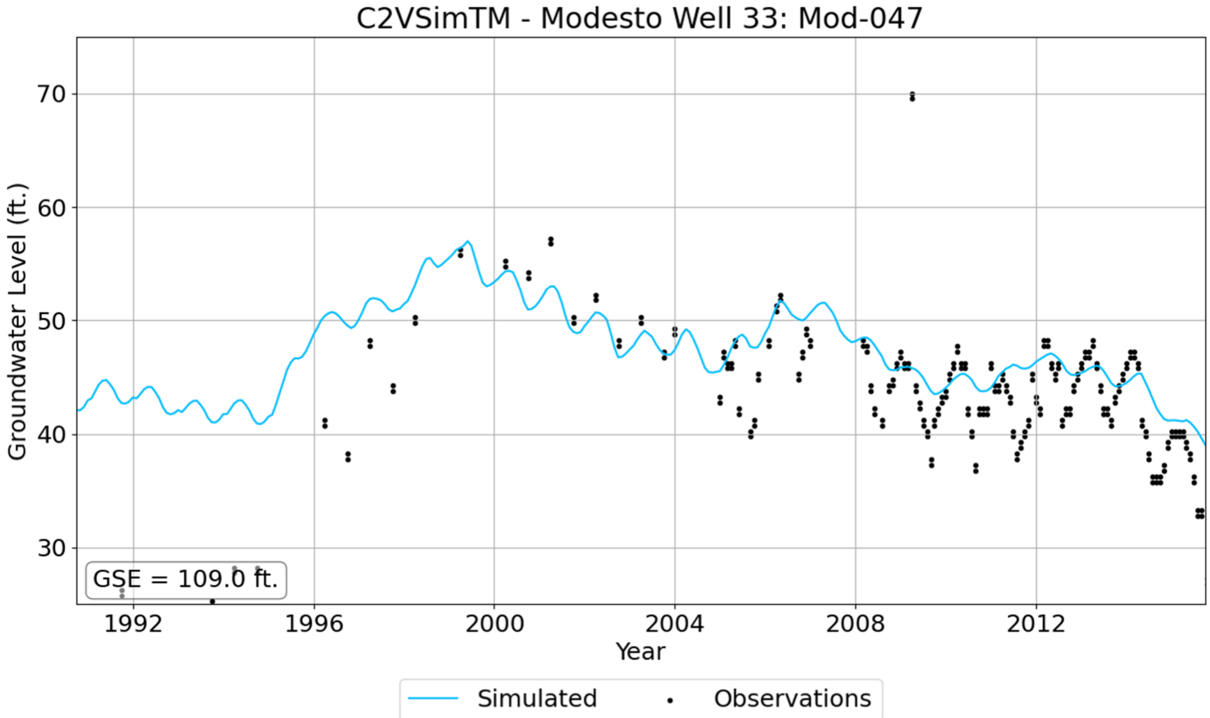

C2VSimTM - Modesto Well 30: Mod-054
Groundwater Level (ft.)
Year
GSE = 108.0 ft.
Simulated
Observations

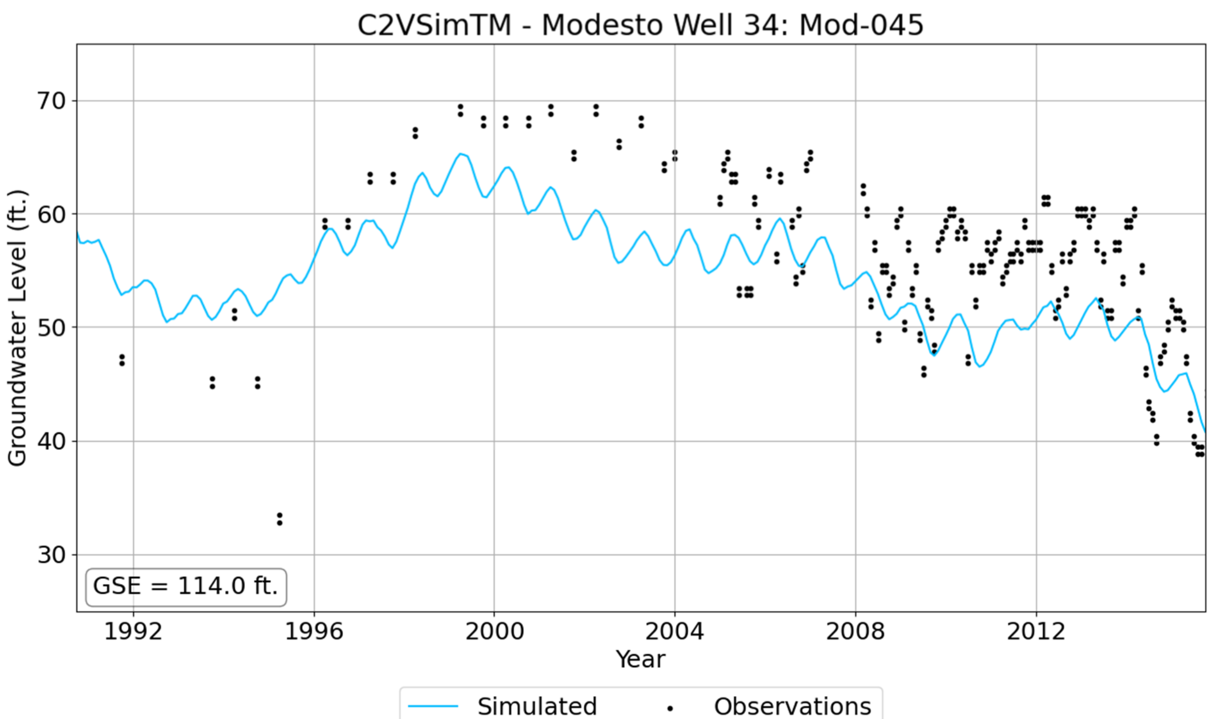


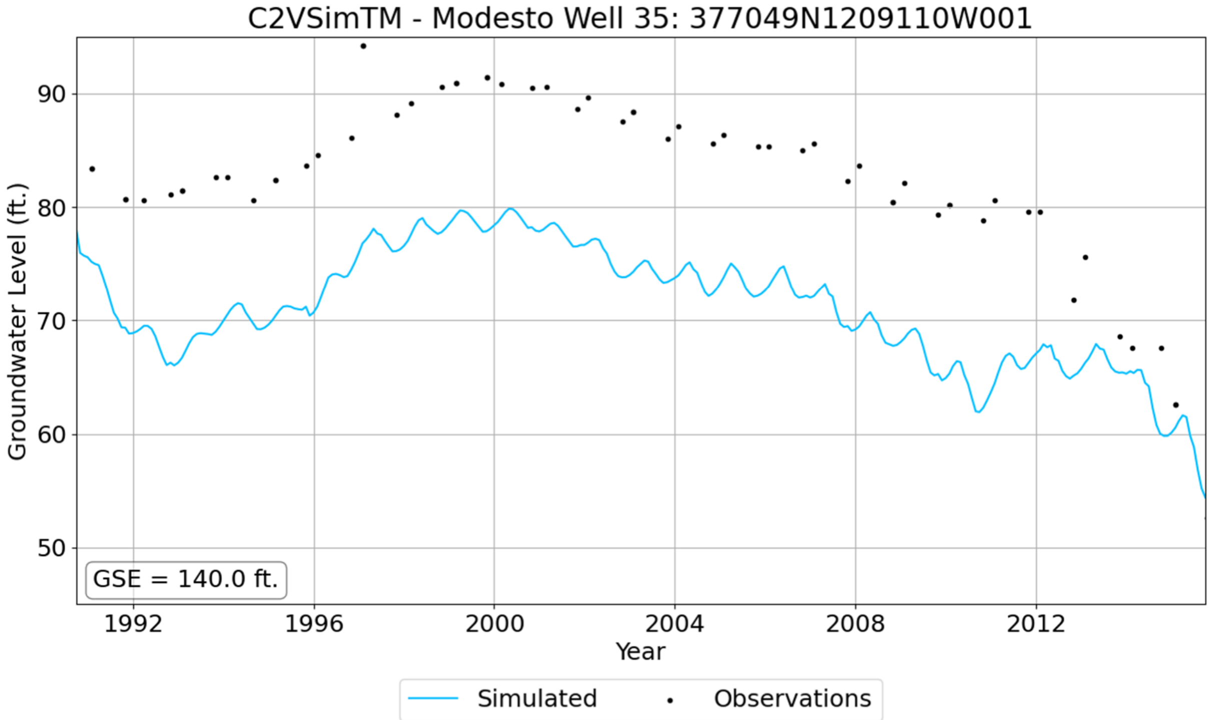
C2VSimTM - Modesto Well 31: Mod-046
Groundwater Level (ft.)
70
60
50
40
30
GSE = 104.0 ft.
1992
1996
2000
2004
2008
2012
Year
Simulated
Observations



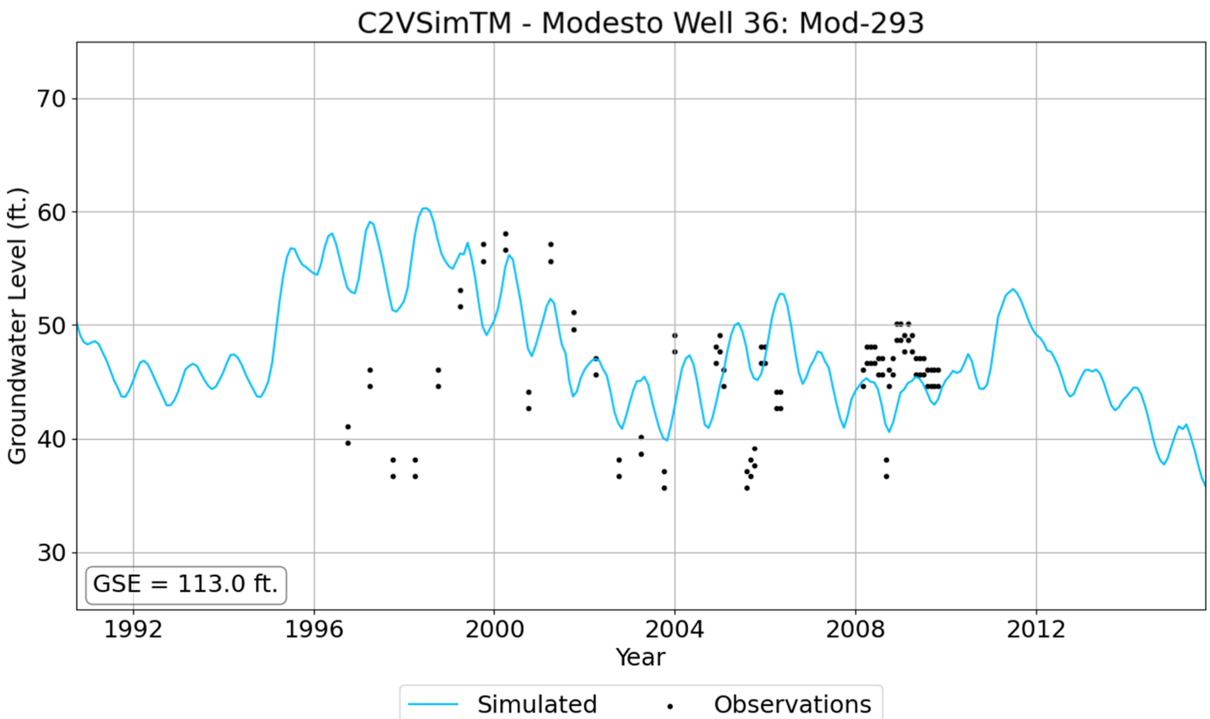
C2VSimTM - Modesto Well 32: RIV-004
Groundwater Level (ft.)
90
80
70
60
50
GSE = 81.0 ft.
1992
1996
2000
2004
2008
2012
Year
Simulated
Observations


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

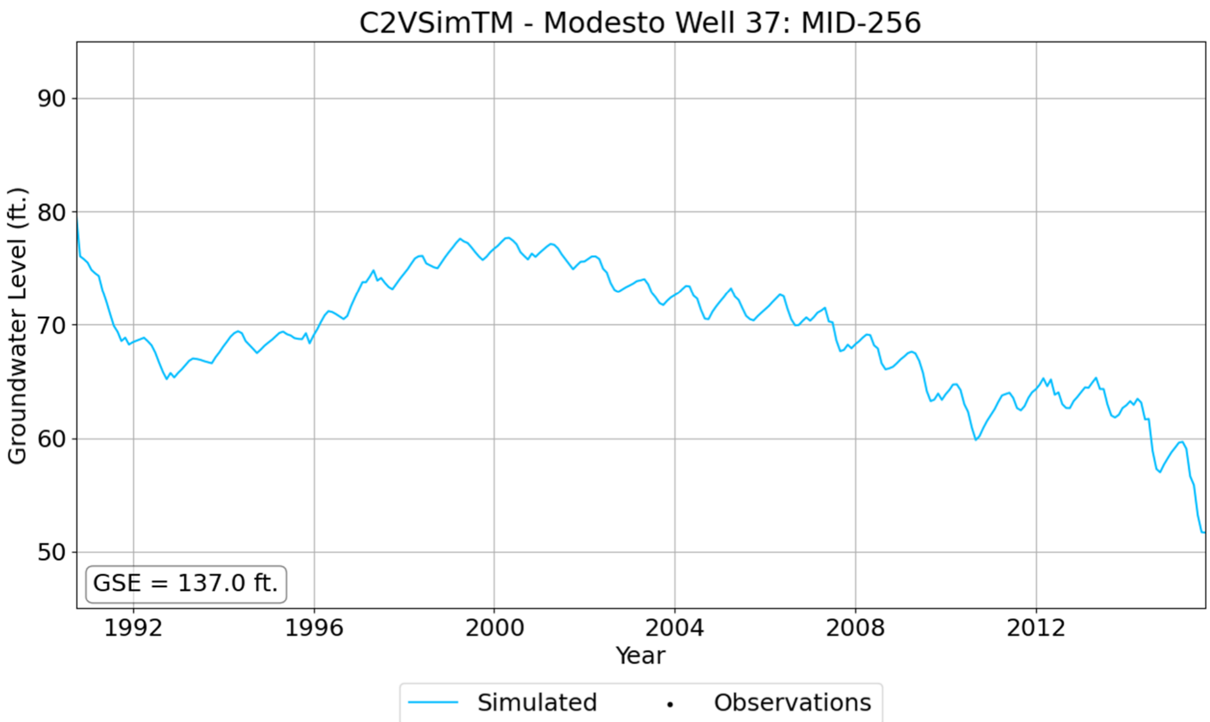

C2VSimTM - Modesto Well 34: Mod-045
Groundwater Level (ft.)
70
60
50
40
30
GSE = 114.0 ft.
1992
1996
2000
2004
2008
2012
Year
Simulated
Observations



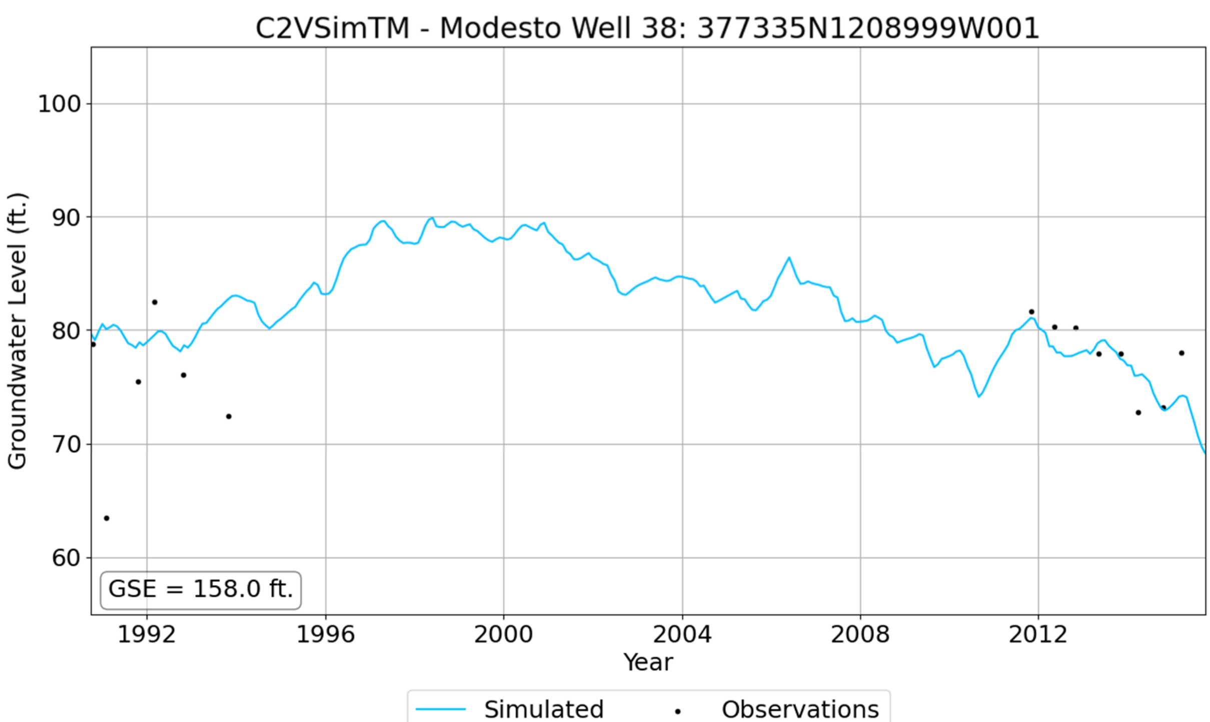
C2VSimTM - Modesto Well 35: 377049N1209110W001
Groundwater Level (ft.)
90
80
70
60
50
GSE = 140.0 ft.
1992
1996
2000
2004
2008
2012
Year
Simulated
Observations



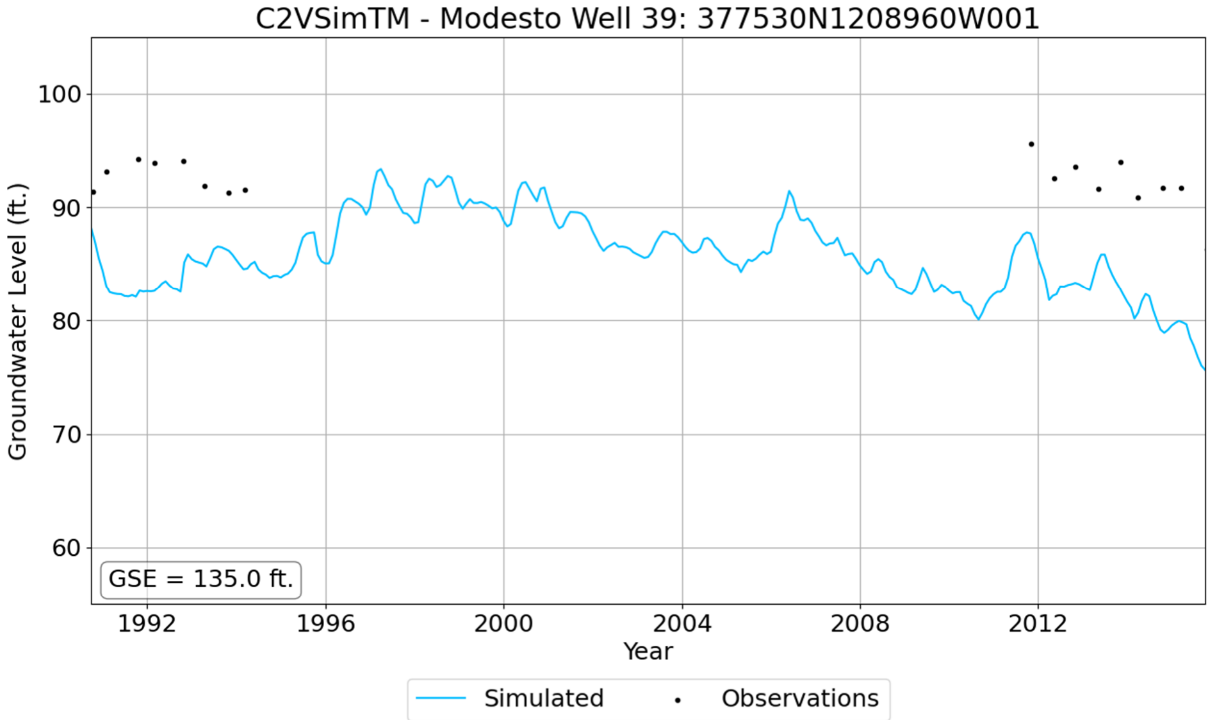
C2VSimTM - Modesto Well 36: Mod-293
Groundwater Level (ft.)
70
60
50
40
30
GSE = 113.0 ft.
1992
1996
2000
2004
2008
2012
Year
Simulated
Observations

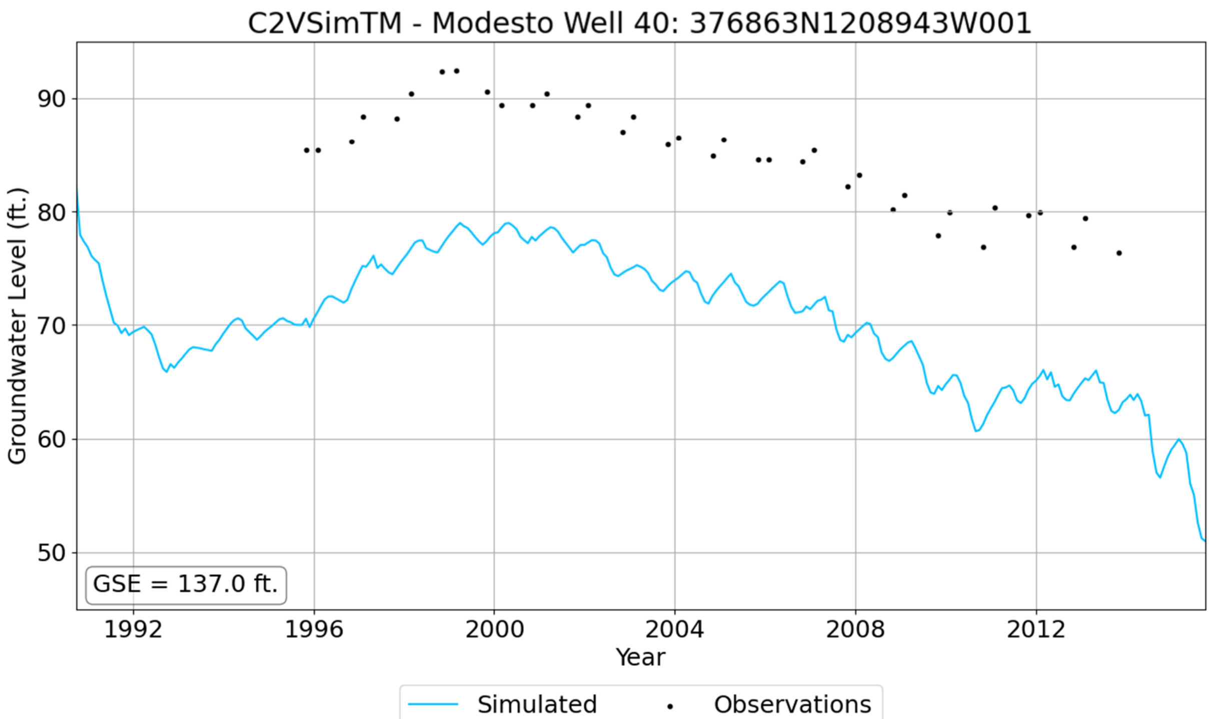


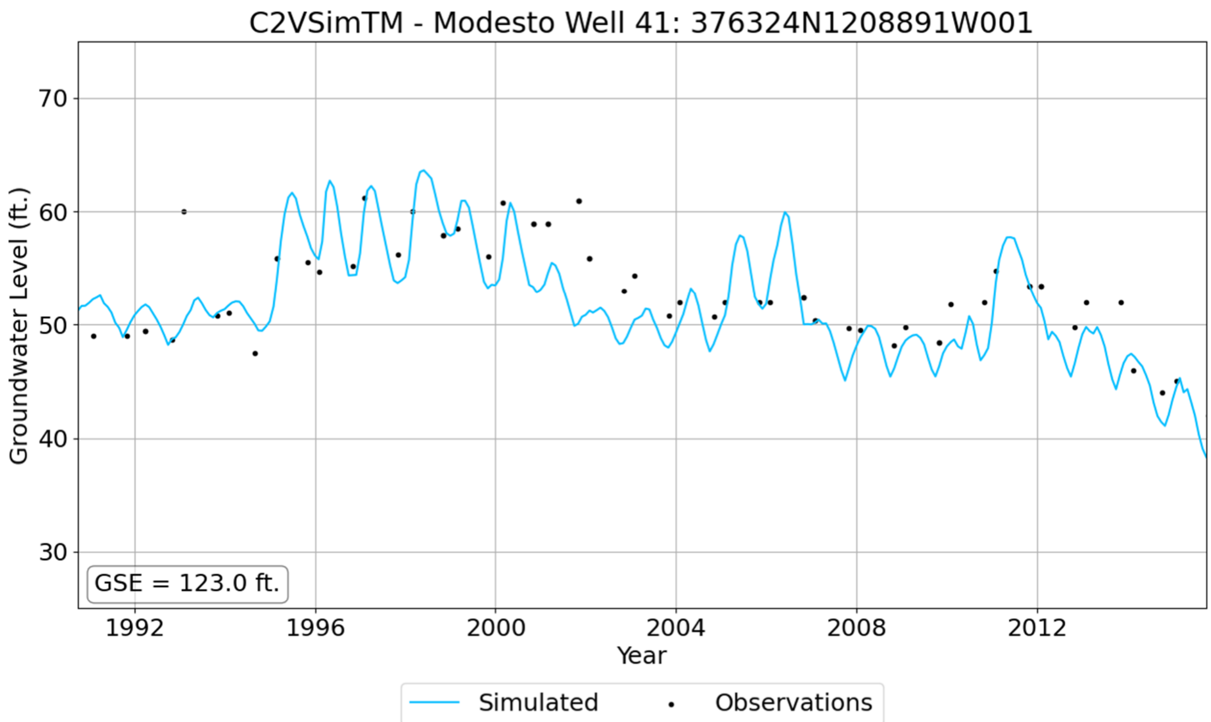
C2VSimTM - Modesto Well 37: MID-256
Groundwater Level (ft.)
90
80
70
60
50
GSE = 137.0 ft.
1992
1996
2000
2004
2008
2012
Year
Simulated
Observations



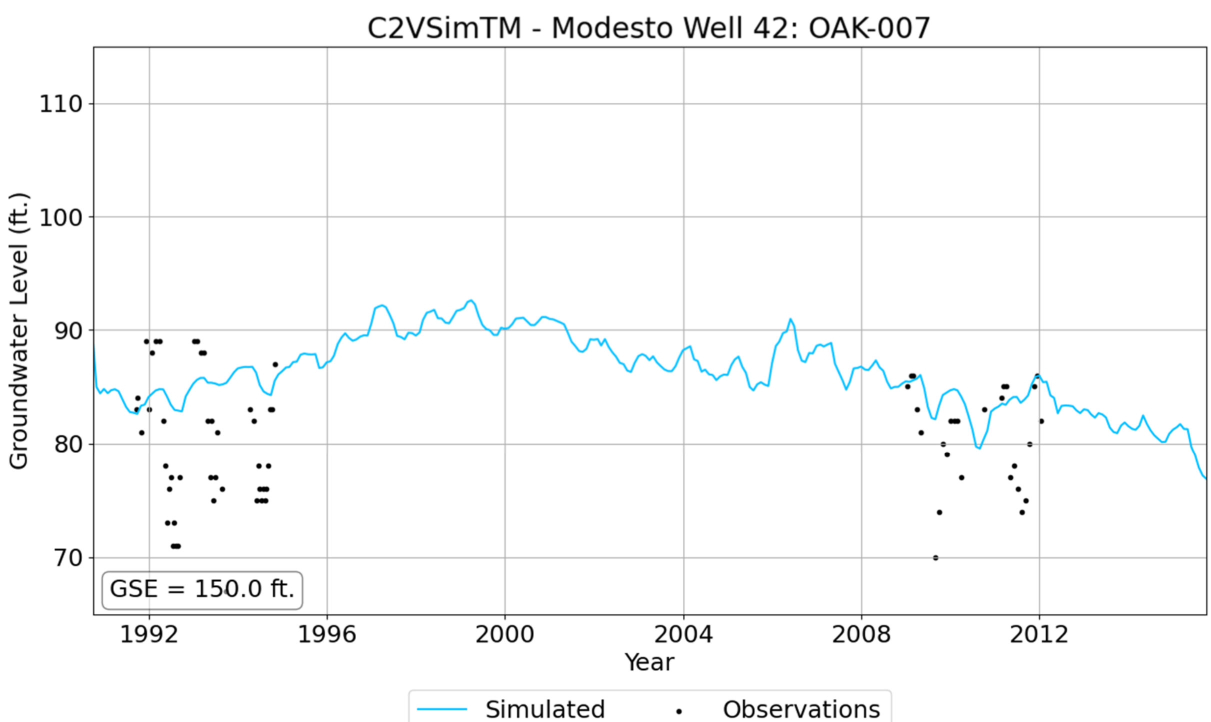
C2VSimTM - Modesto Well 38: 377335N1208999W001
Groundwater Level (ft.)
100
90
80
70
60
GSE = 158.0 ft.
1992
1996
2000
2004
2008
2012
Year
Simulated
Observations


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

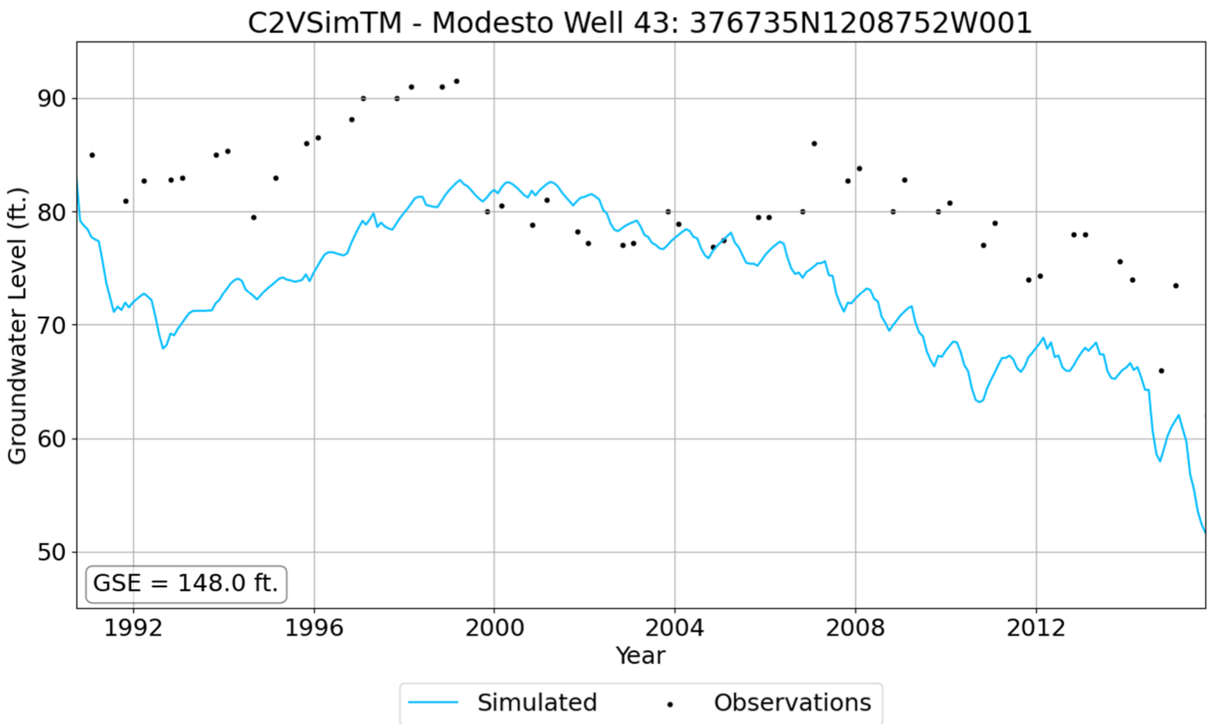

C2VSimTM - Modesto Well 40: 376863N1208943W001
Groundwater Level (ft.)
90
80
70
60
50
GSE = 137.0 ft.
1992
1996
2000
2004
2008
2012
Year
Simulated
Observations

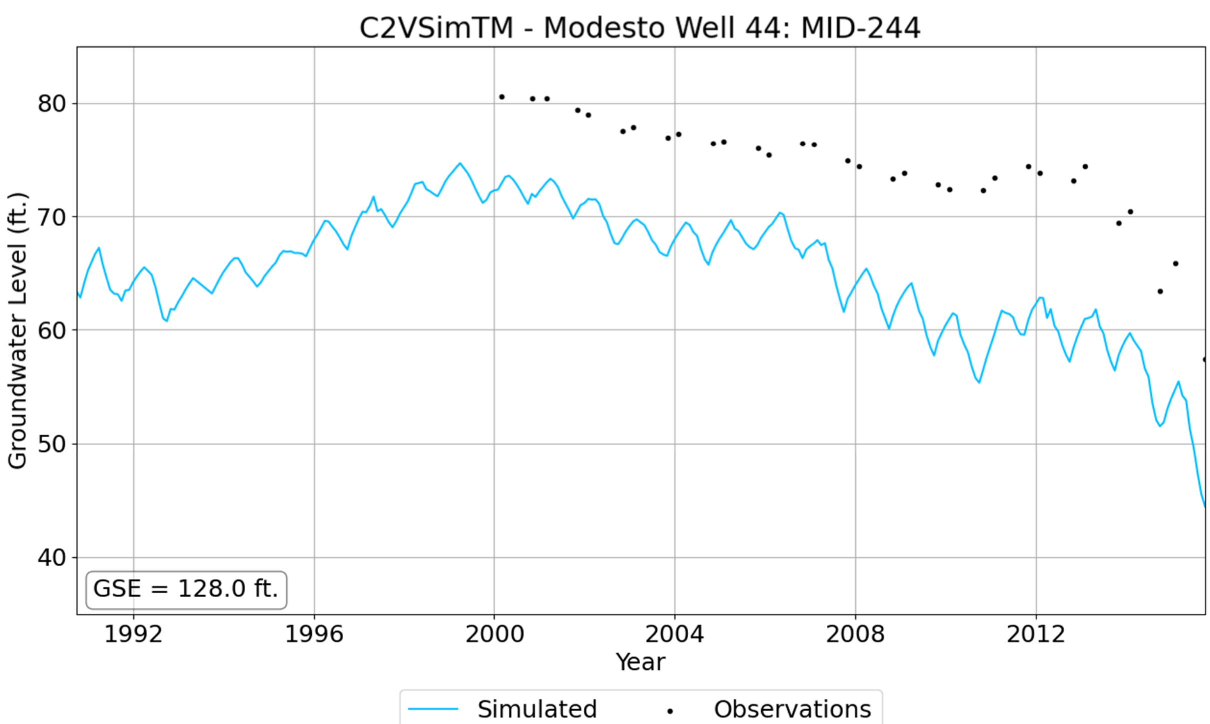


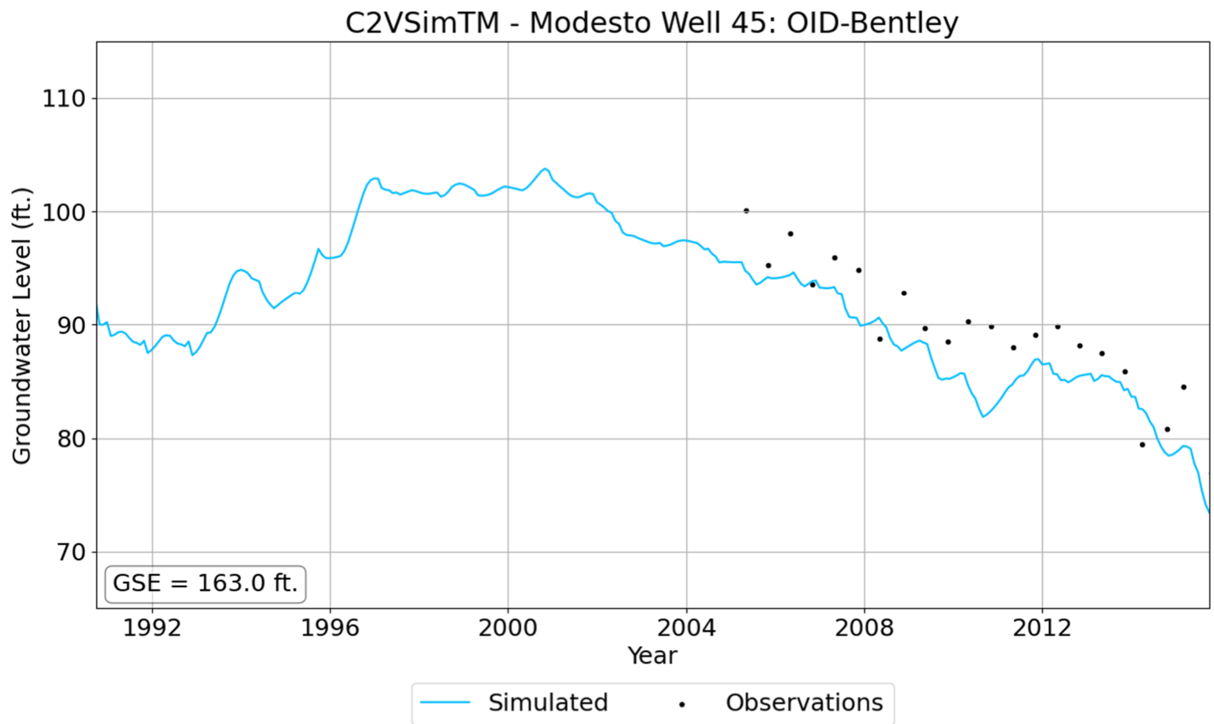
C2VSimTM - Modesto Well 41: 376324N1208891W001
Groundwater Level (ft.)
70
60
50
40
30
GSE = 123.0 ft.
1992
1996
2000
2004
2008
2012
Year
Simulated
Observations

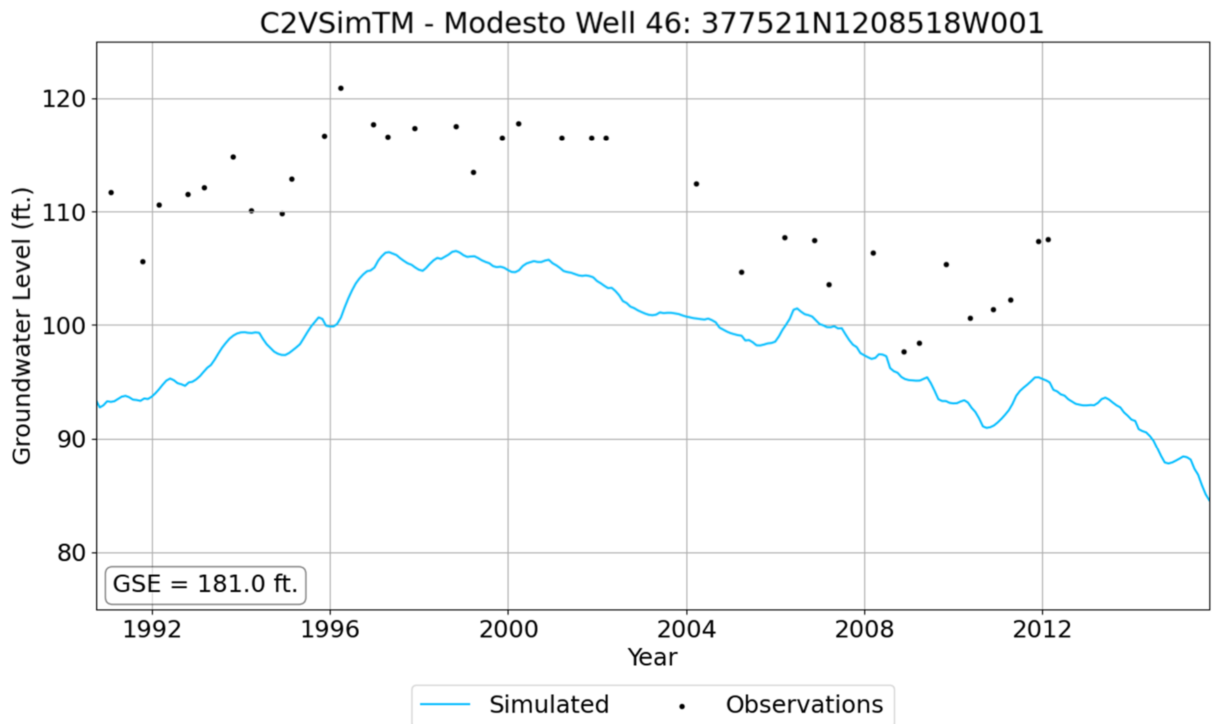


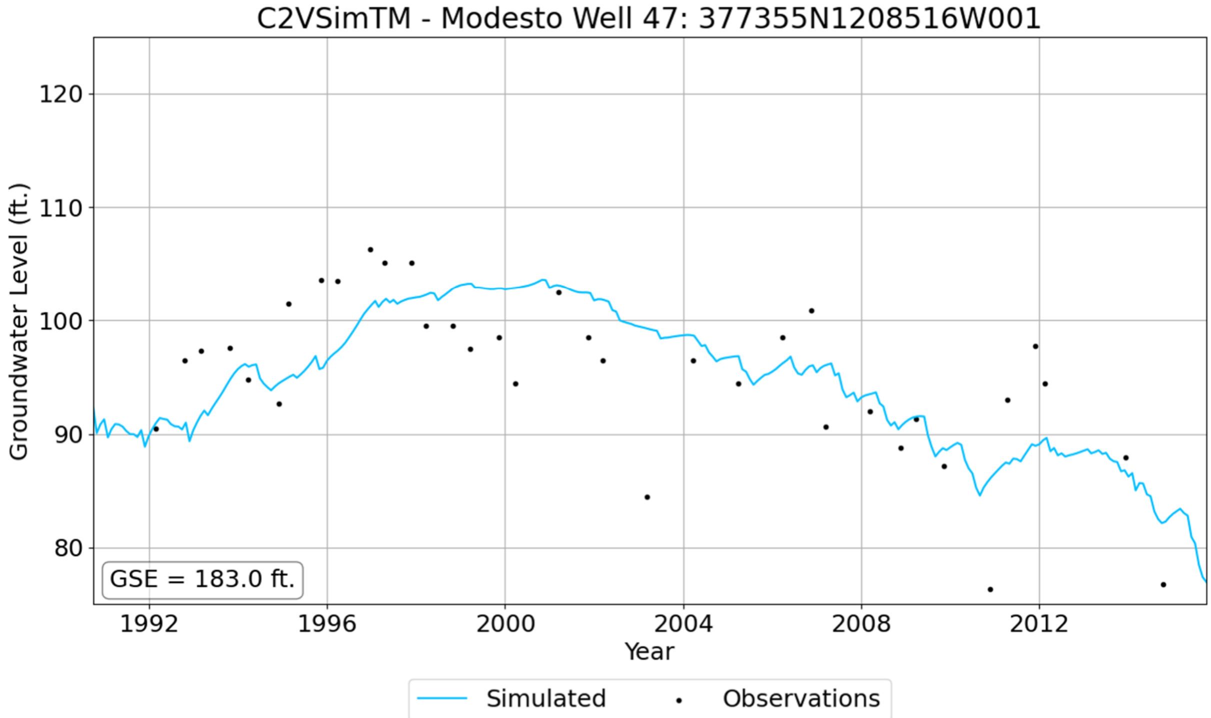
C2VSimTM - Modesto Well 42: OAK-007
Groundwater Level (ft.)
110
100
90
80
70
GSE = 150.0 ft.
1992
1996
2000
2004
2008
2012
Year
Simulated
Observations


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.)
110
100
90
80
70
GSE = 163.0 ft.
1992
1996
2000
2004
2008
2012
Year
Simulated
Observations


C2VSimTM - Modesto Well 46: 377521N1208518W001
Groundwater Level (ft.)
120
110
100
90
80
GSE = 181.0 ft.
1992
1996
2000
2004
2008
2012
Year
Simulated
Observations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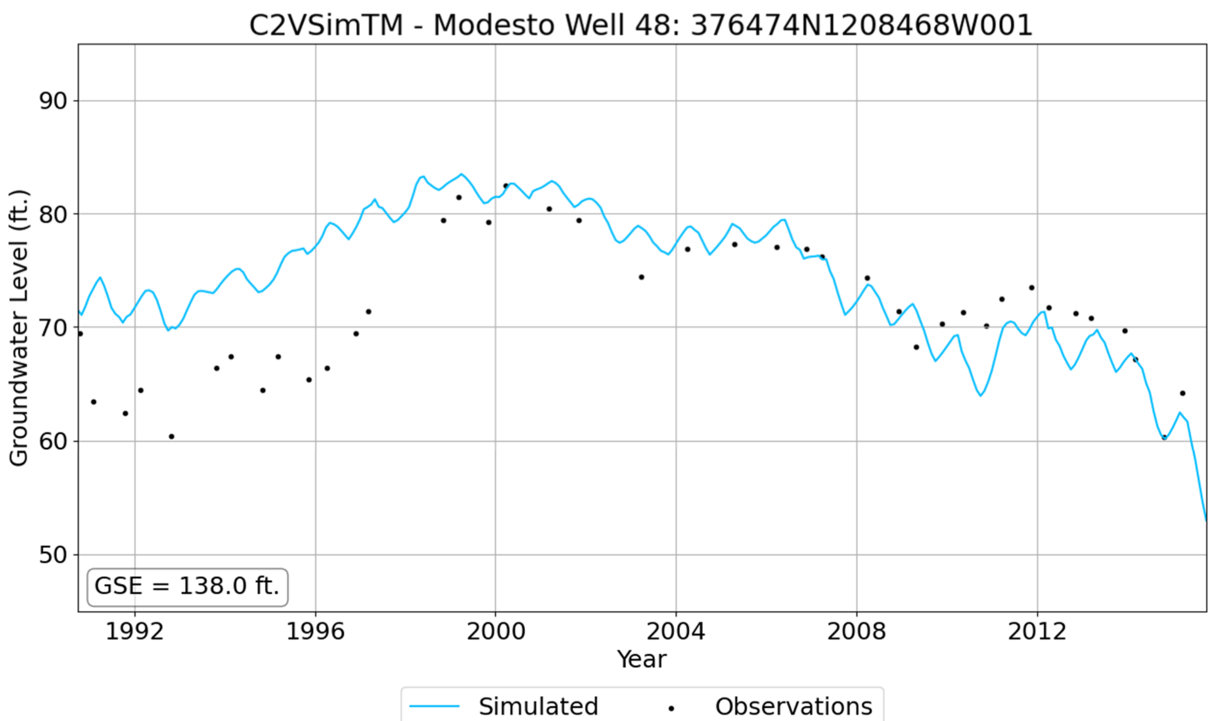
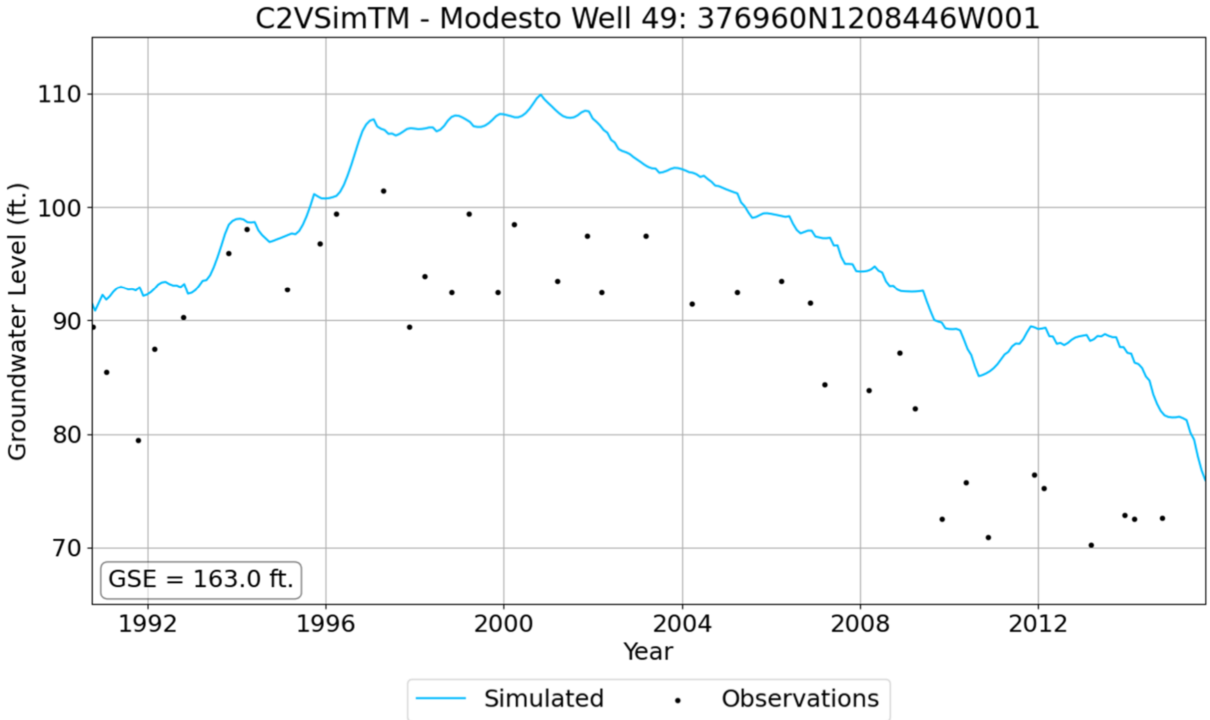
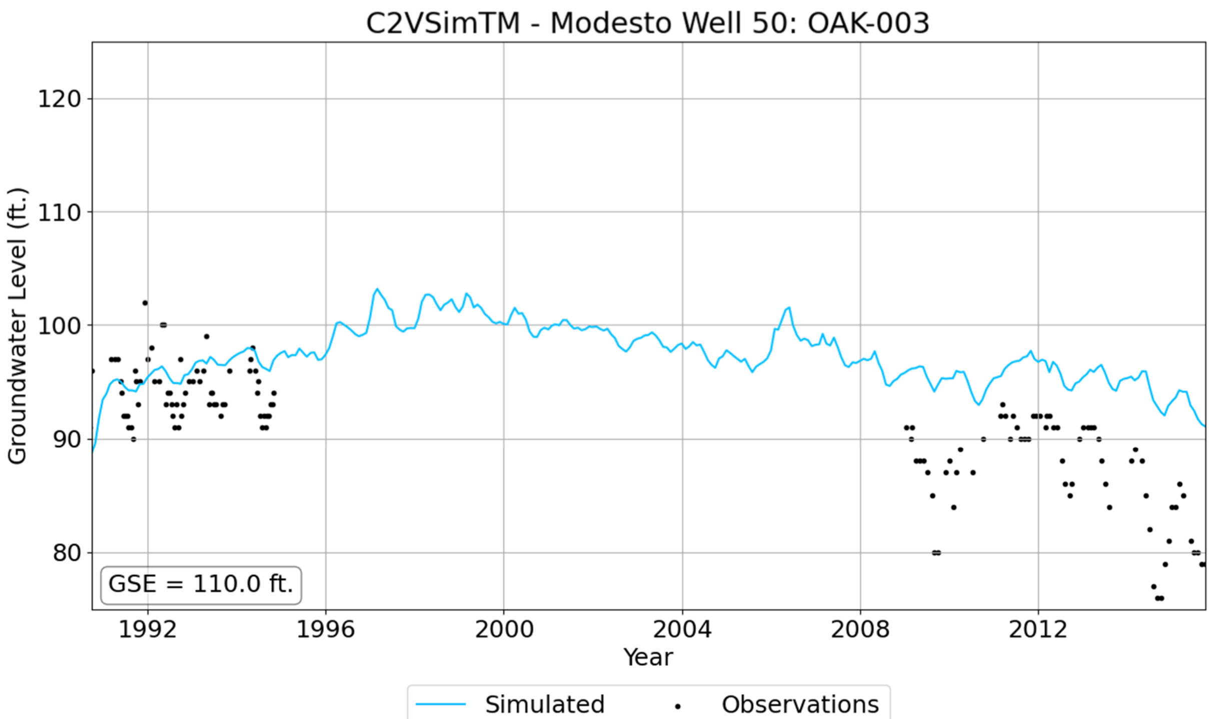
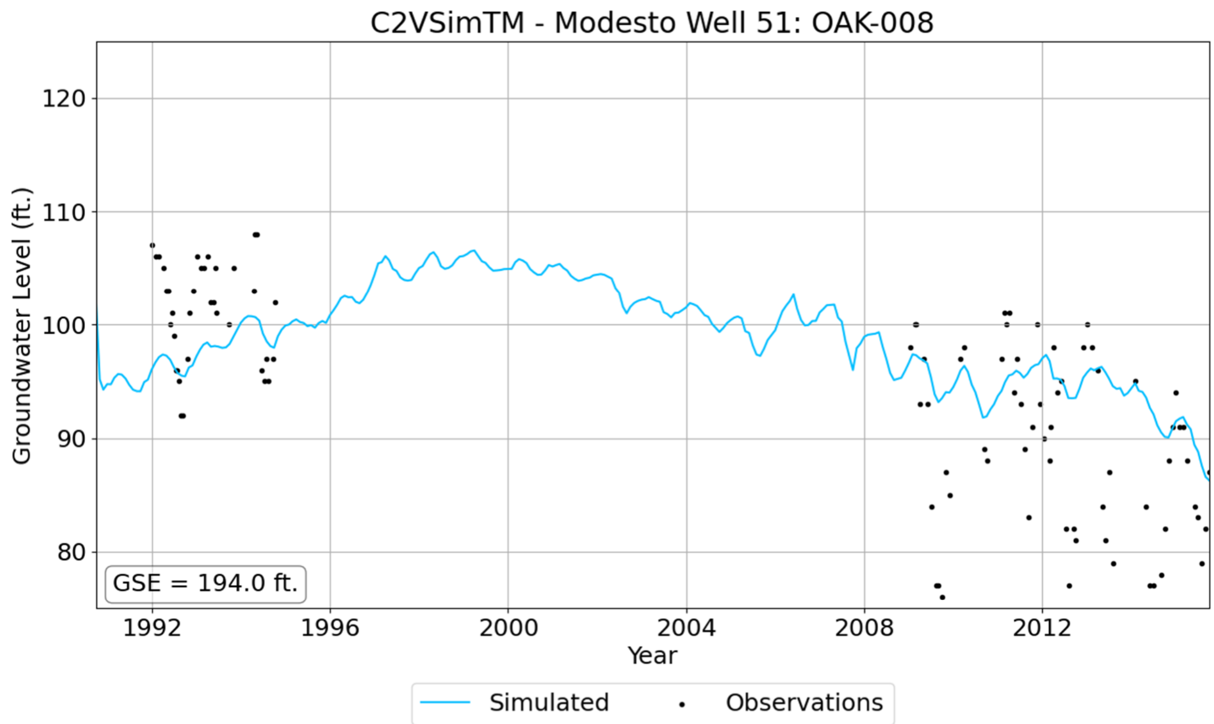
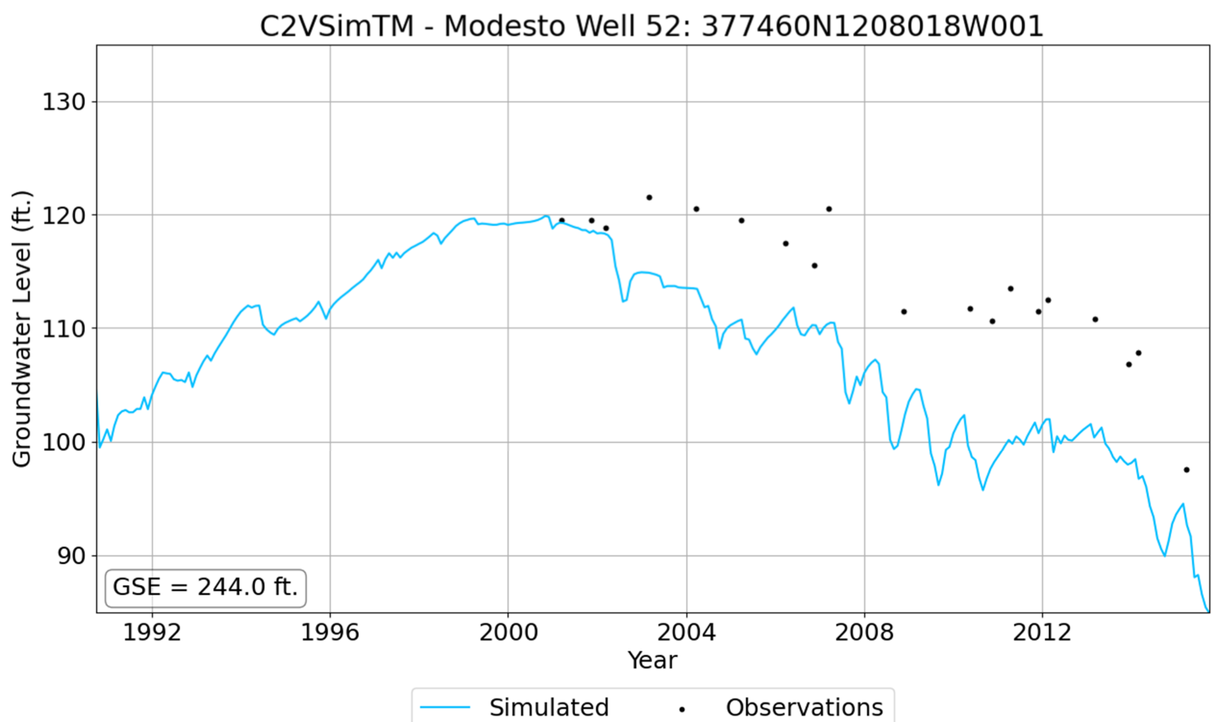
Groundwater Level (ft.)
120
110
100
90
80
GSE = 183.0 ft.
1992
1996
2000
2004
2008
2012
Year
Simulated
Observations

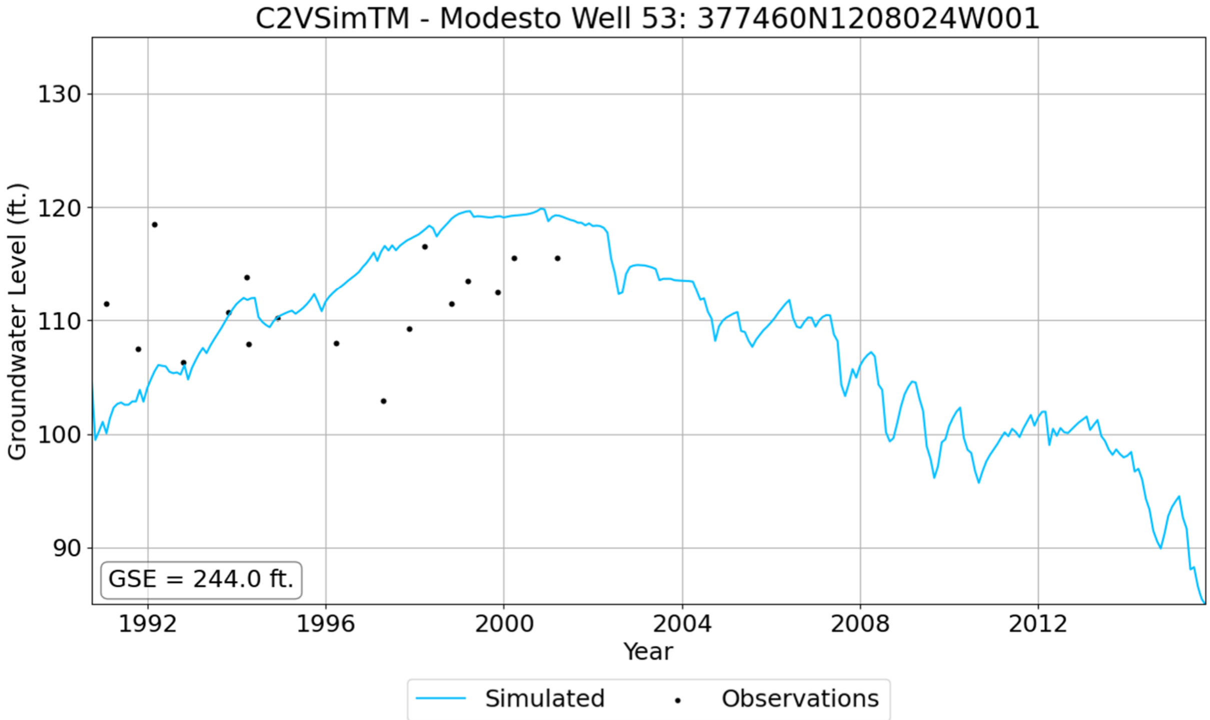

C2VSimTM - Modesto Well 48: 376474N1208468W001
Groundwater Level (ft.)
90
80
70
60
50
GSE = 138.0 ft.
1992
1996
2000
2004
2008
2012
Year
Simulated
Observations

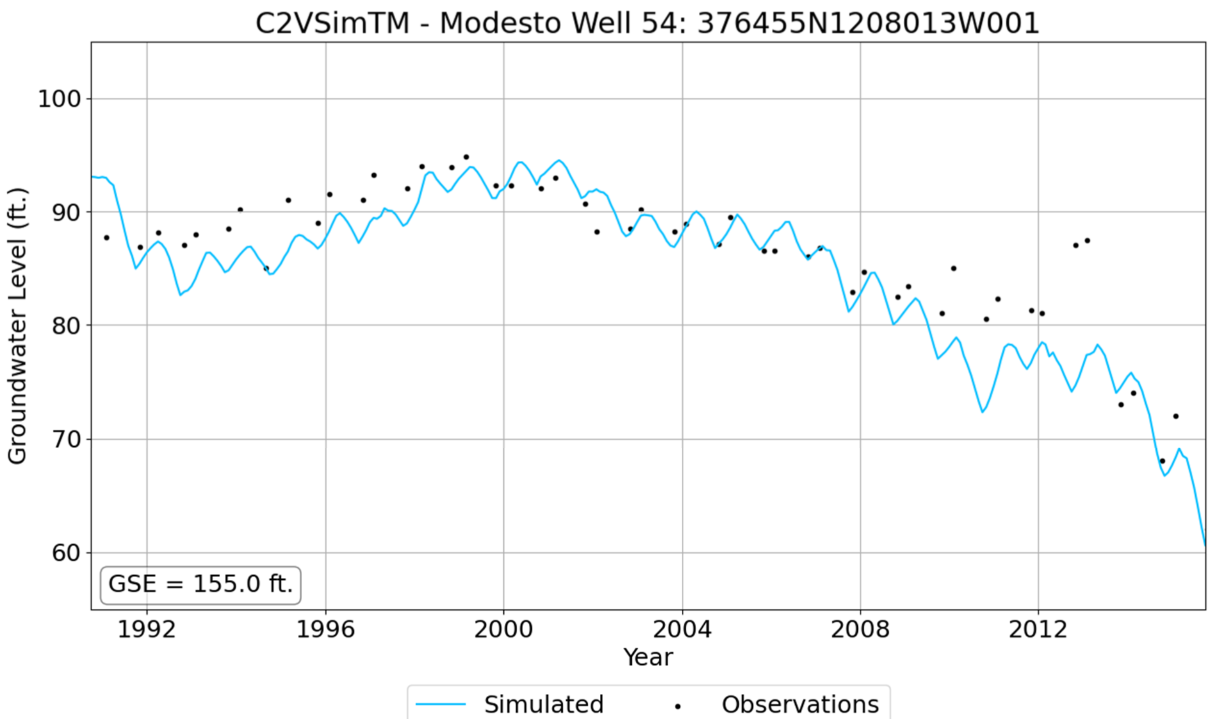

C2VSimTM - Modesto Well 49: 376960N1208446W001
110
100
90
80
70
Groundwater Level (ft.)
GSE = 163.0 ft.
1992
1996
2000
2004
2008
2012
Year
Simulated
Observations

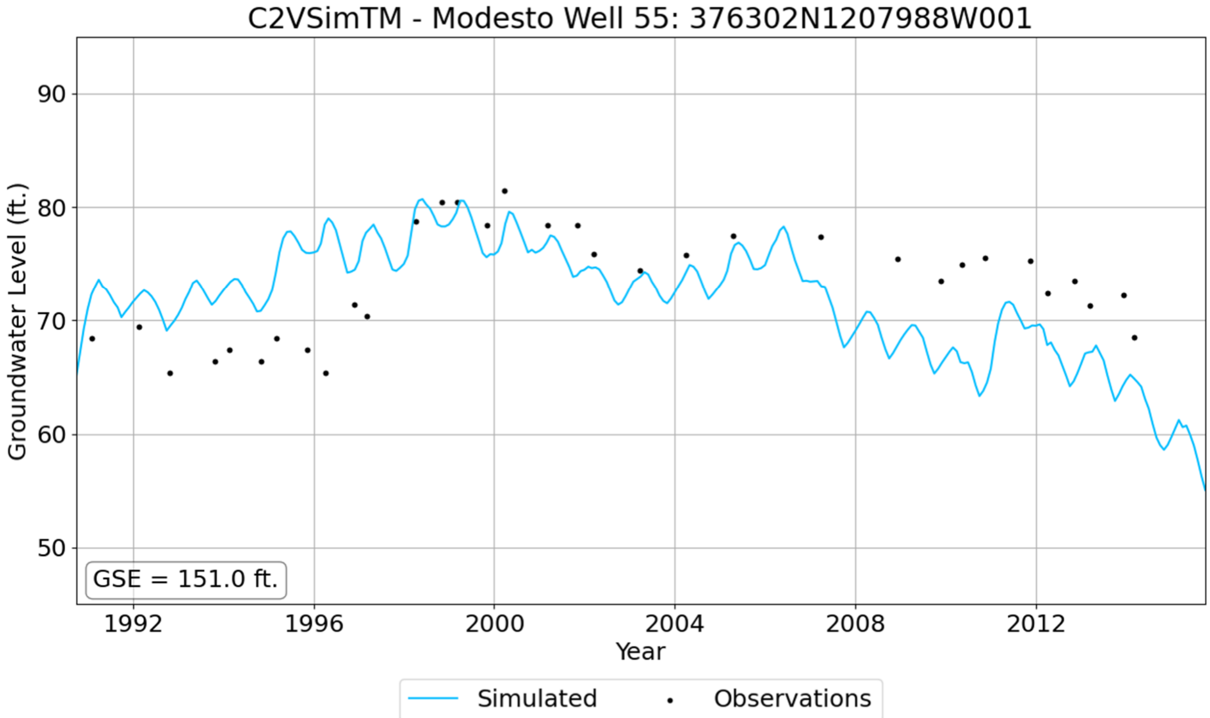

C2VSimTM - Modesto Well 50: OAK-003
120
110
100
90
80
Groundwater Level (ft.)
GSE = 110.0 ft.
1992
1996
2000
2004
2008
2012
Year
Simulated
Observations


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

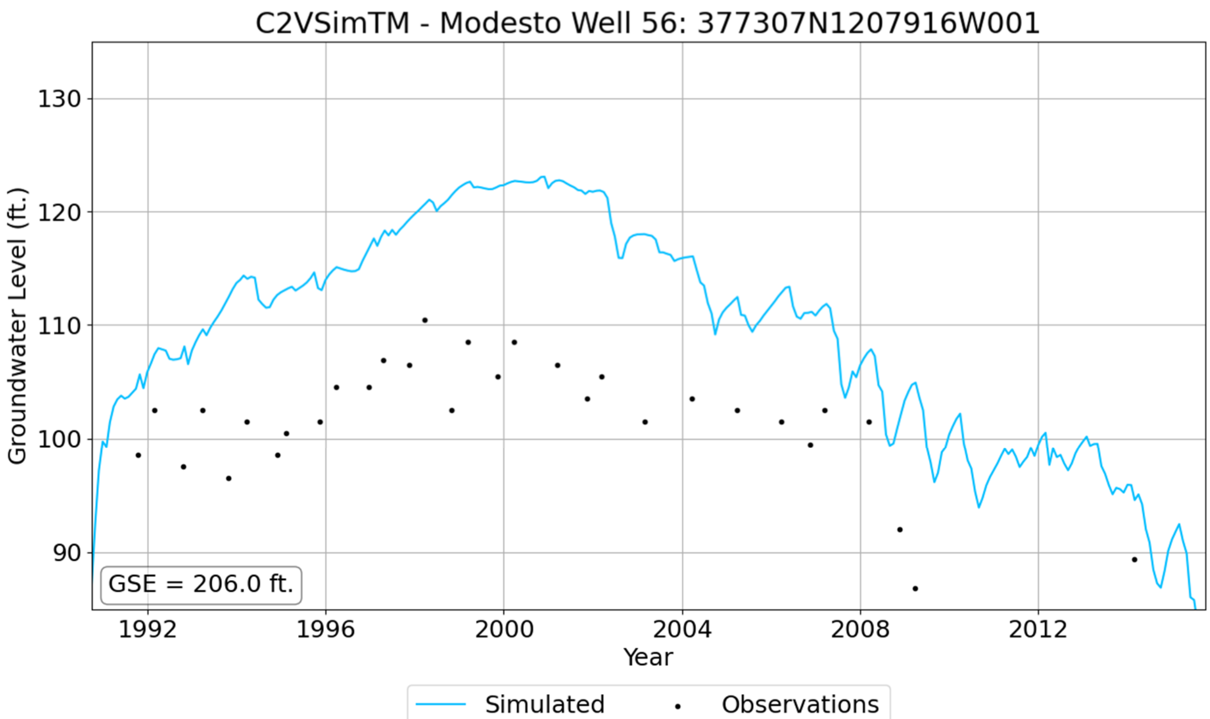

C2VSimTM - Modesto Well 52: 377460N1208018W001
Groundwater Level (ft.)
130
120
110
100
90
GSE = 244.0 ft.
1992
1996
2000
2004
2008
2012
Year
Simulated
Observations


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

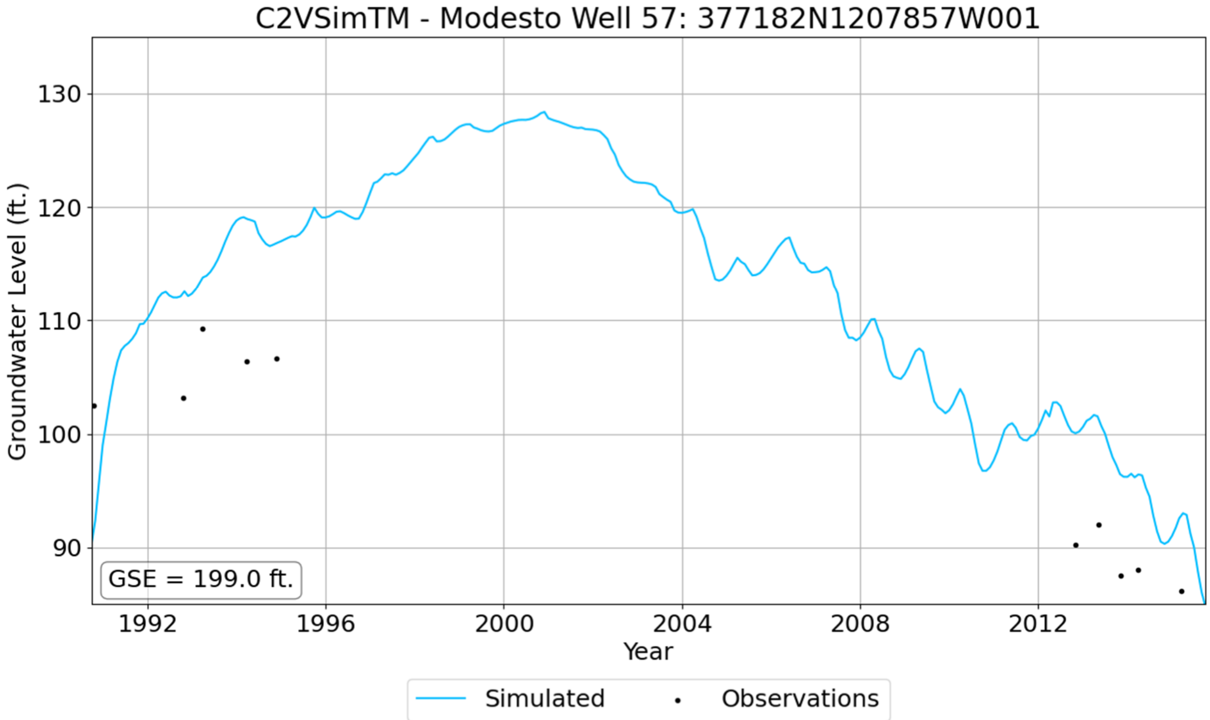

C2VSimTM - Modesto Well 54: 376455N1208013W001
Groundwater Level (ft.)
100
90
80
70
60
GSE = 155.0 ft.
1992
1996
2000
2004
2008
2012
Year
Simulated
Observations



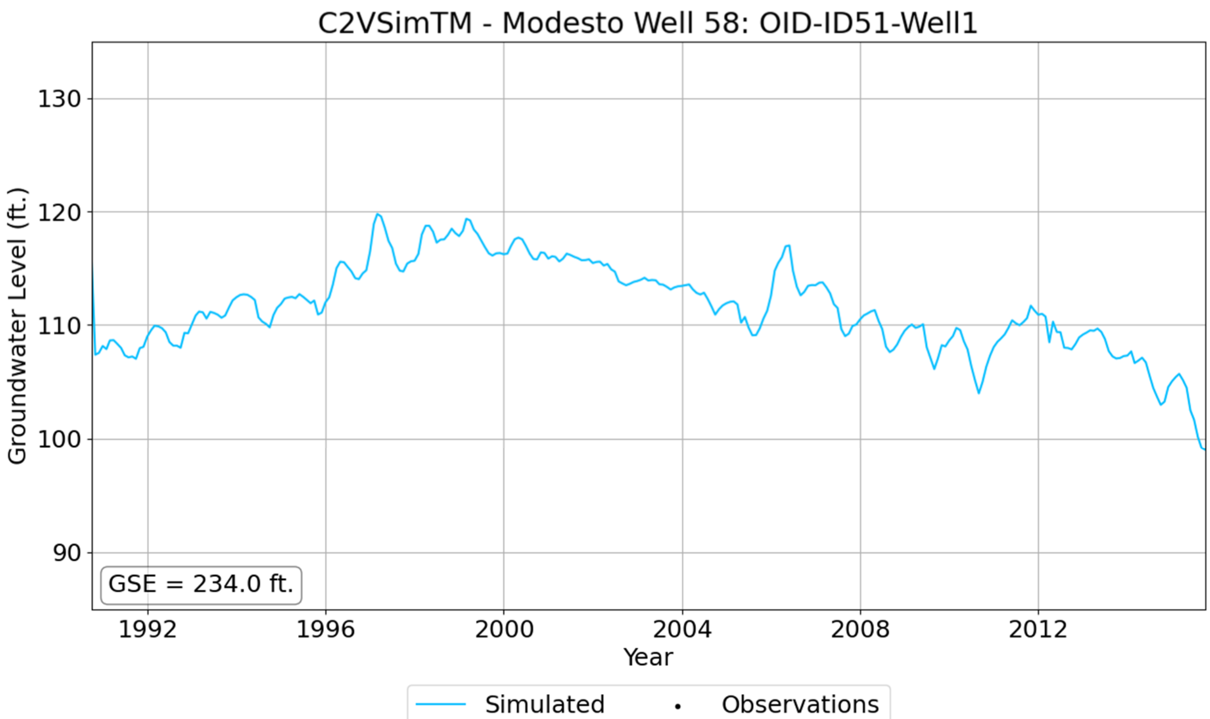
C2VSimTM - Modesto Well 55: 376302N1207988W001
Groundwater Level (ft.)
90
80
70
60
50
GSE = 151.0 ft.
1992
1996
2000
2004
2008
2012
Year
Simulated
Observations



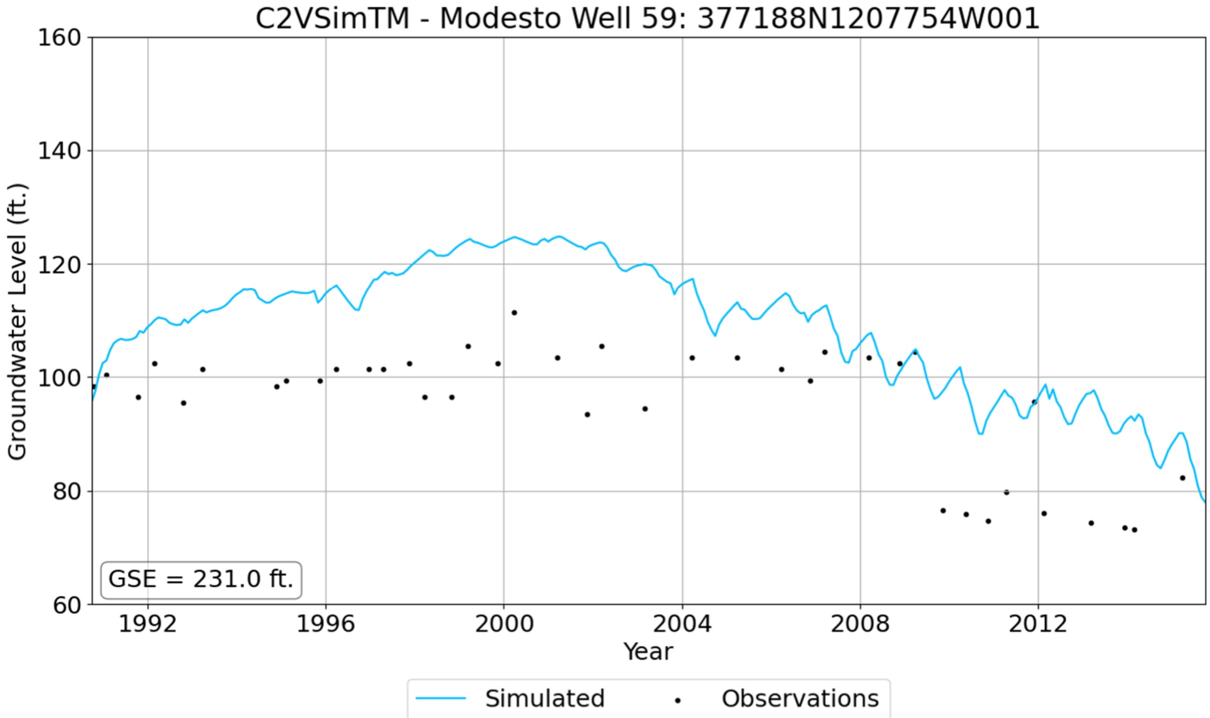
C2VSimTM - Modesto Well 56: 377307N1207916W001
Groundwater Level (ft.)
130
120
110
100
90
GSE = 206.0 ft.
1992
1996
2000
2004
2008
2012
Year
Simulated
Observations

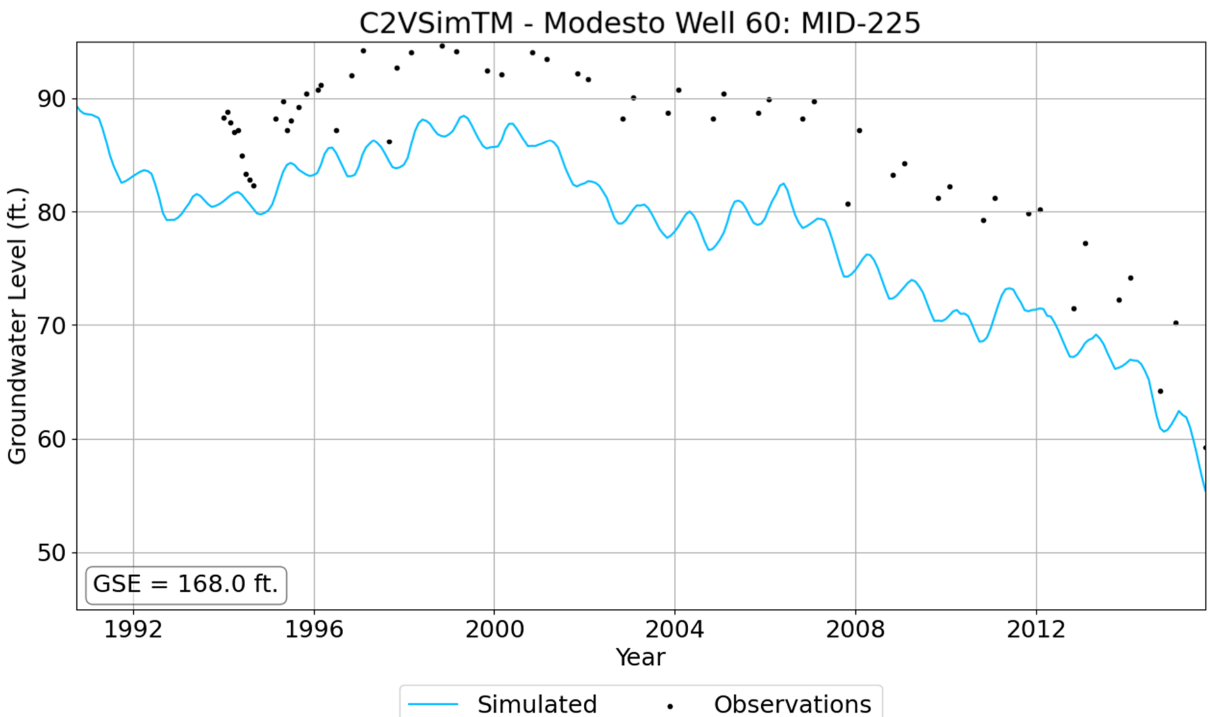


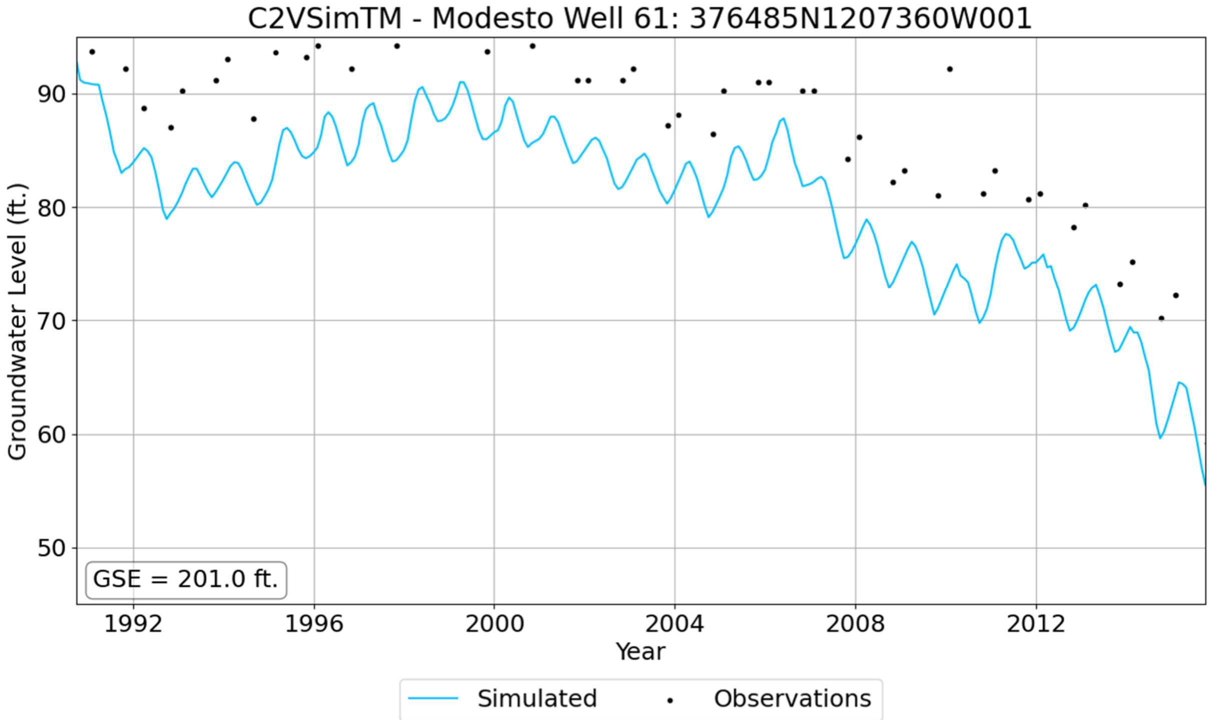
C2VSimTM - Modesto Well 57: 377182N1207857W001
Groundwater Level (ft.)
130
120
110
100
90
GSE = 199.0 ft.
1992
1996
2000
2004
2008
2012
Year
Simulated
Observations



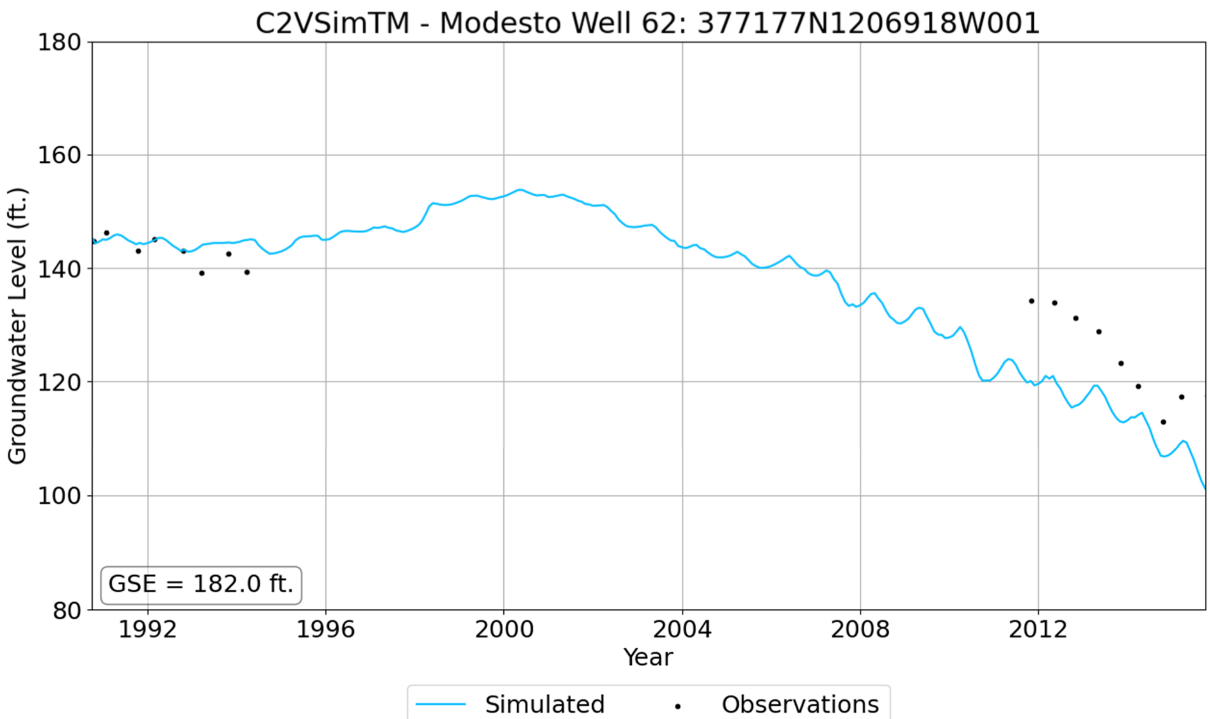
C2VSimTM - Modesto Well 58: OID-ID51-Well1
Groundwater Level (ft.)
130
120
110
100
90
GSE = 234.0 ft.
1992
1996
2000
2004
2008
2012
Year
Simulated
Observations


C2VSimTM - Modesto Well 59: 377188N1207754W001
Groundwater Level (ft.)
160
140
120
100
80
60
GSE = 231.0 ft.
1992
1996
2000
2004
2008
2012
Year
Simulated
Observations

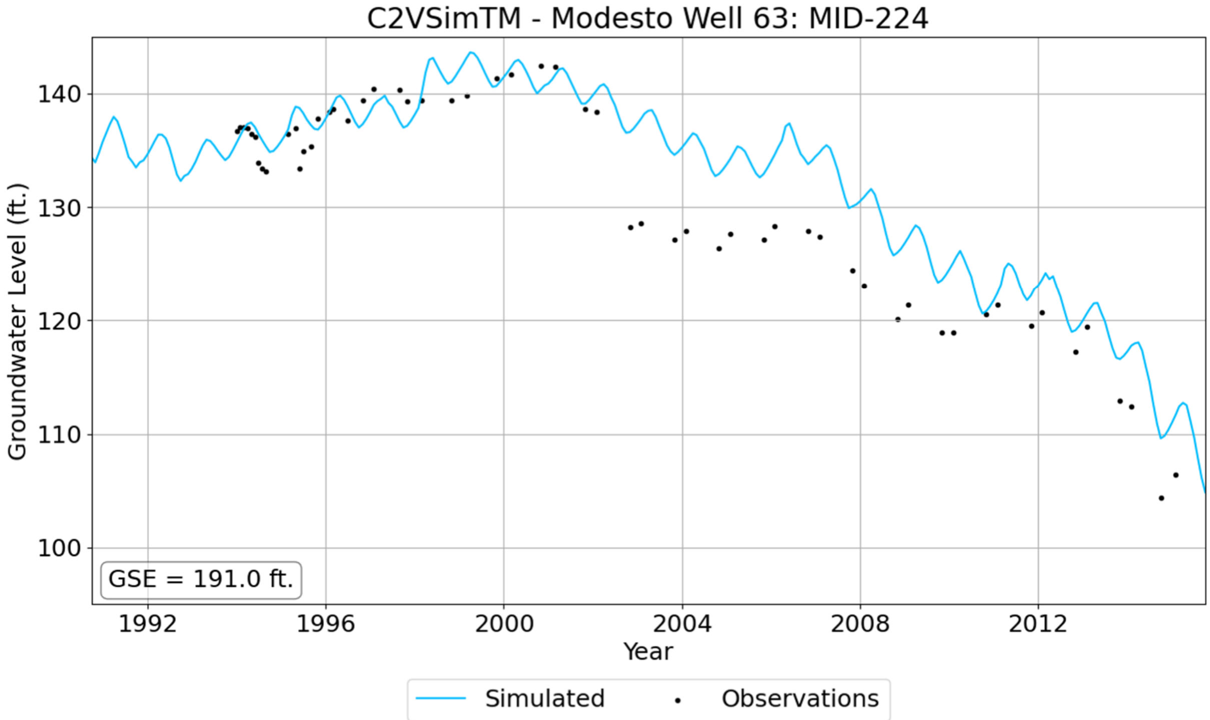

C2VSimTM - Modesto Well 60: MID-225
Groundwater Level (ft.)
90
80
70
60
50
GSE = 168.0 ft.
1992
1996
2000
2004
2008
2012
Year
Simulated
Observations

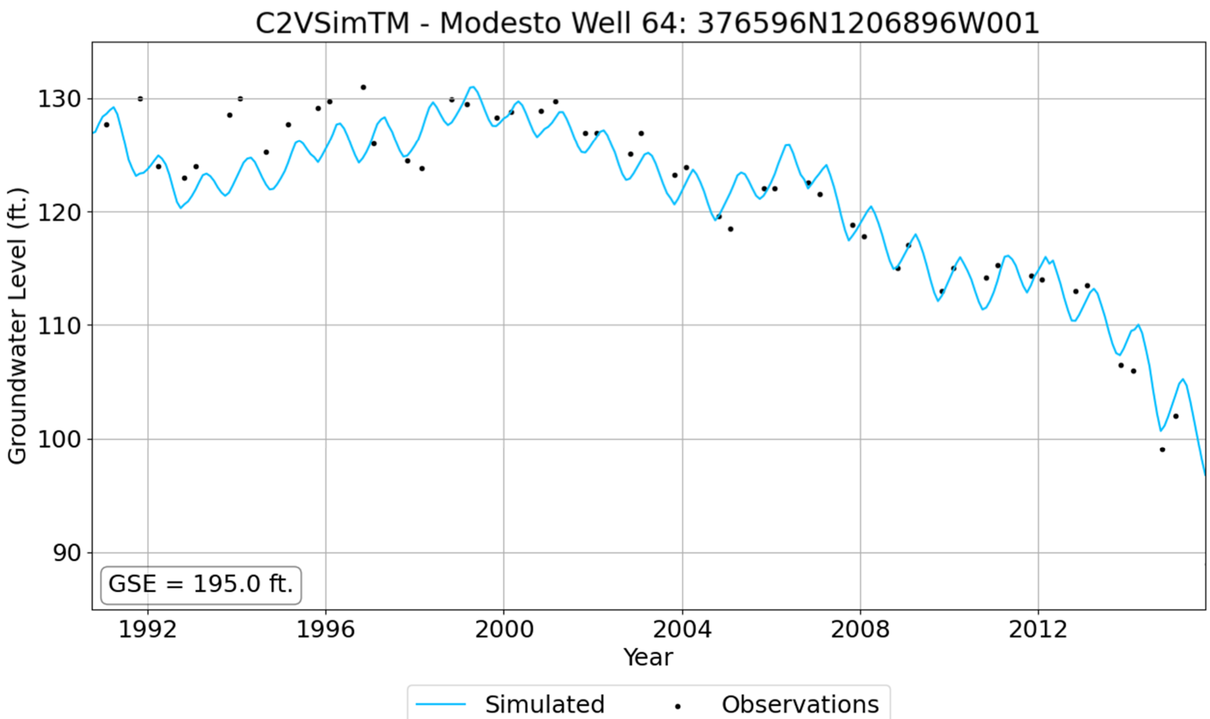


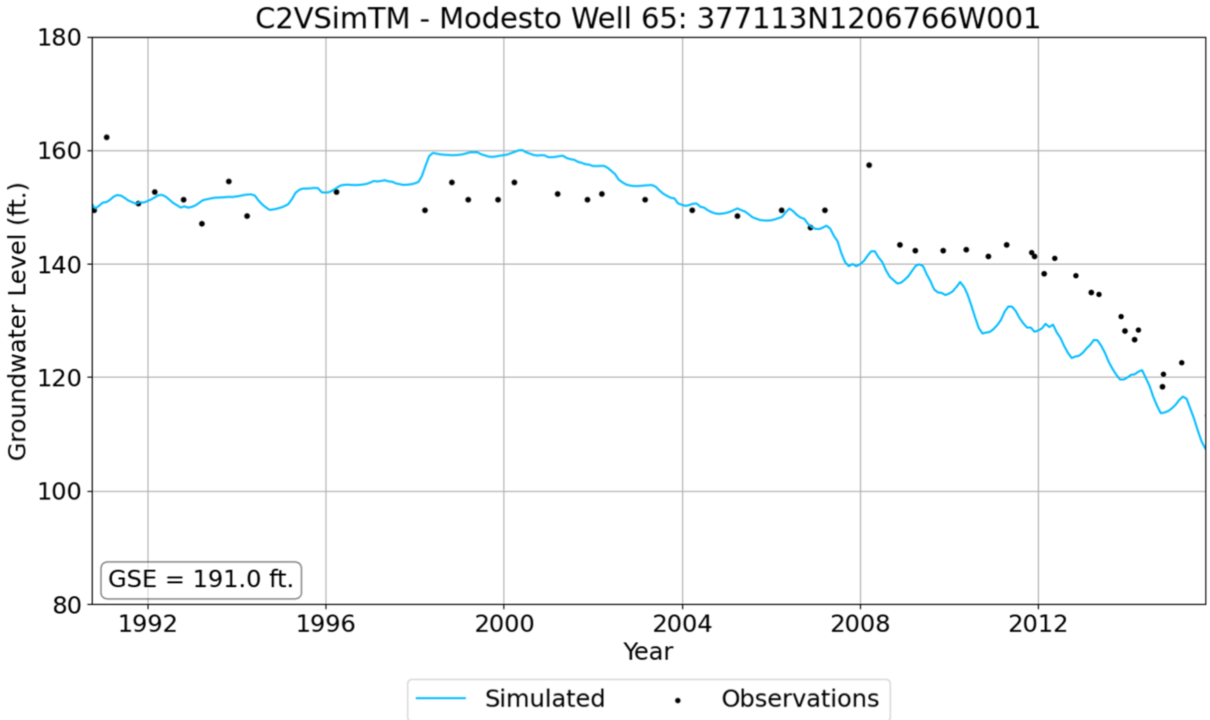
C2VSimTM - Modesto Well 61: 376485N1207360W001
Groundwater Level (ft.)
90
80
70
60
50
GSE = 201.0 ft.
1992
1996
2000
2004
2008
2012
Year
Simulated
Observations

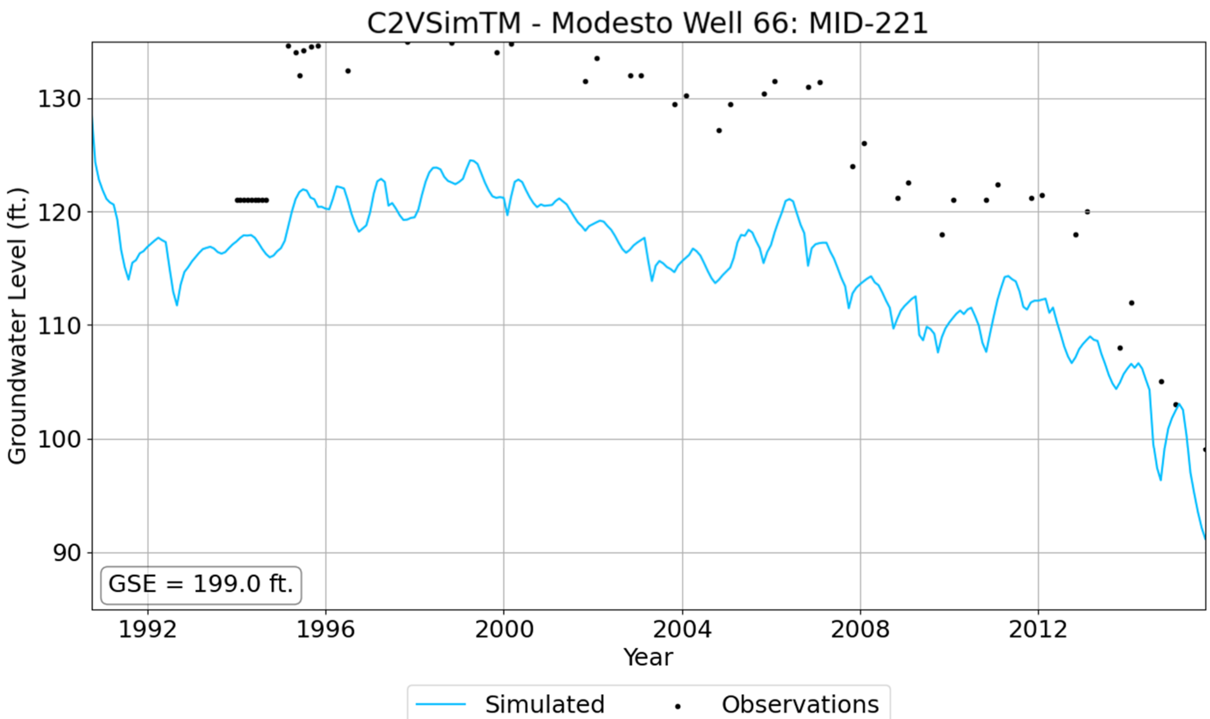


C2VSimTM - Modesto Well 62: 377177N1206918W001
Groundwater Level (ft.)
180
160
140
120
100
80
GSE = 182.0 ft.
1992
1996
2000
2004
2008
2012
Year
Simulated
Observations


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

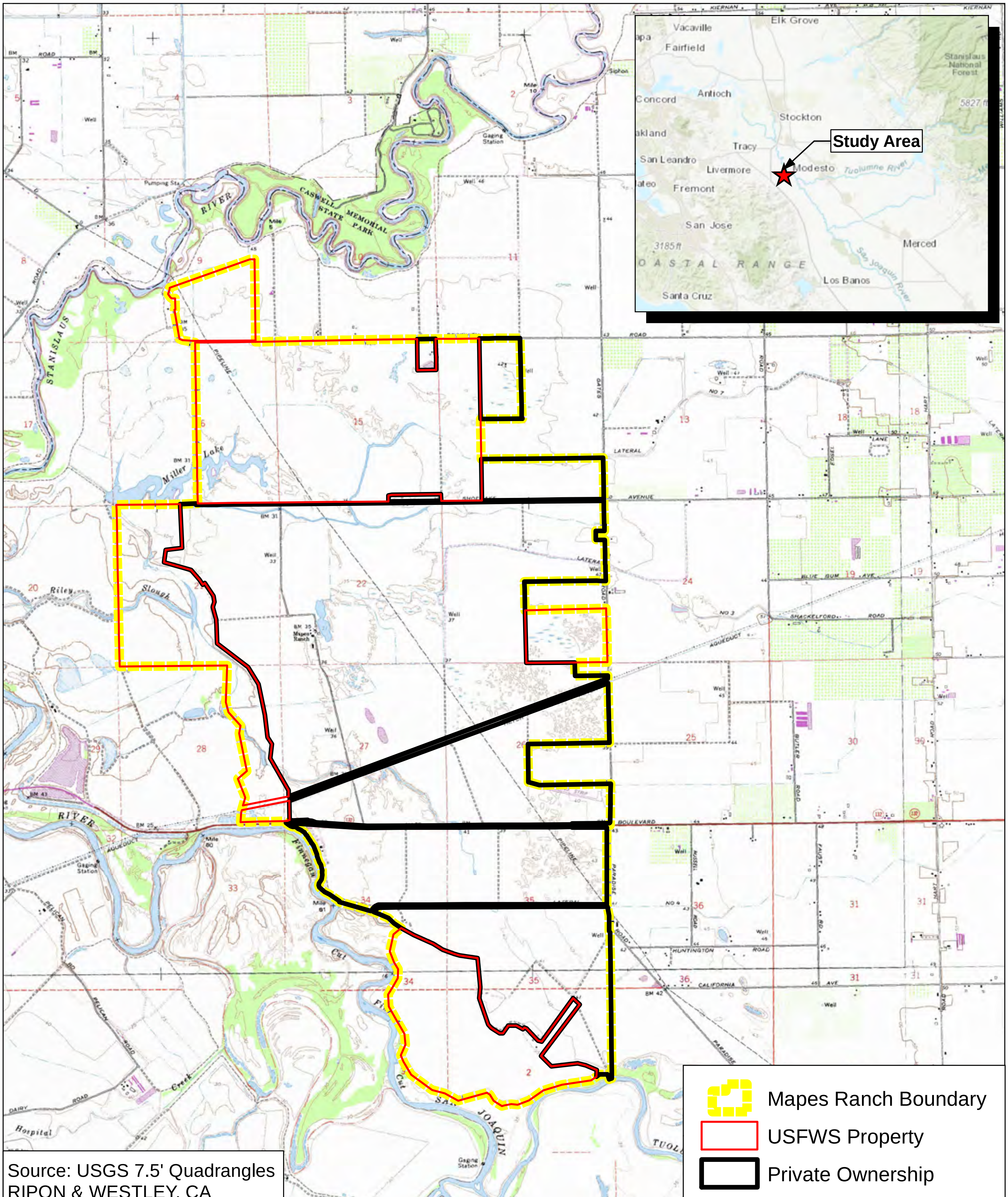

Figure 1

Moore Biological Consultants

0 2,000 4,000

N W E S

Map Date: 10/18/2021

USGS

Mapes Ranch

Stanislaus County, CA

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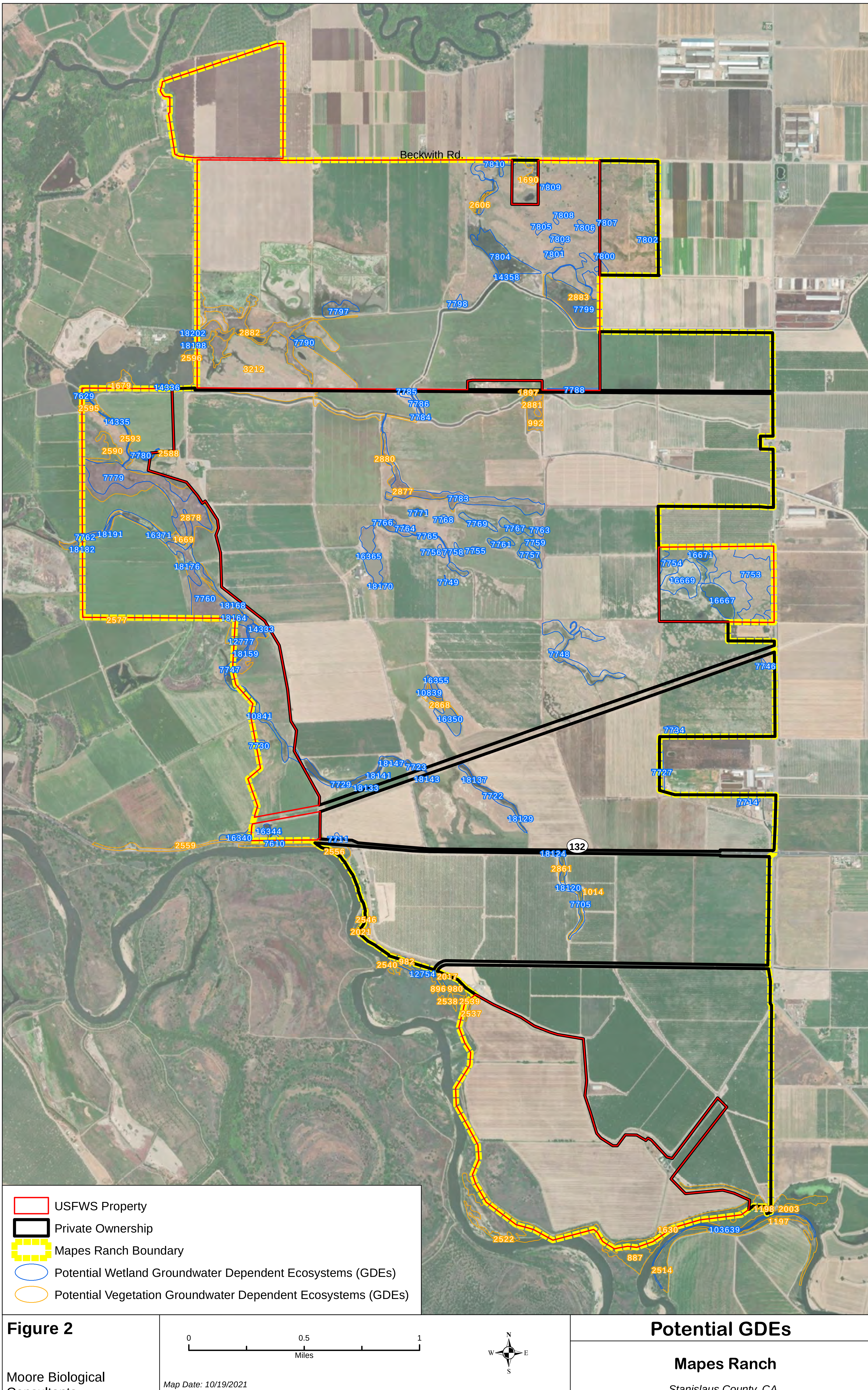

Figure 2

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.

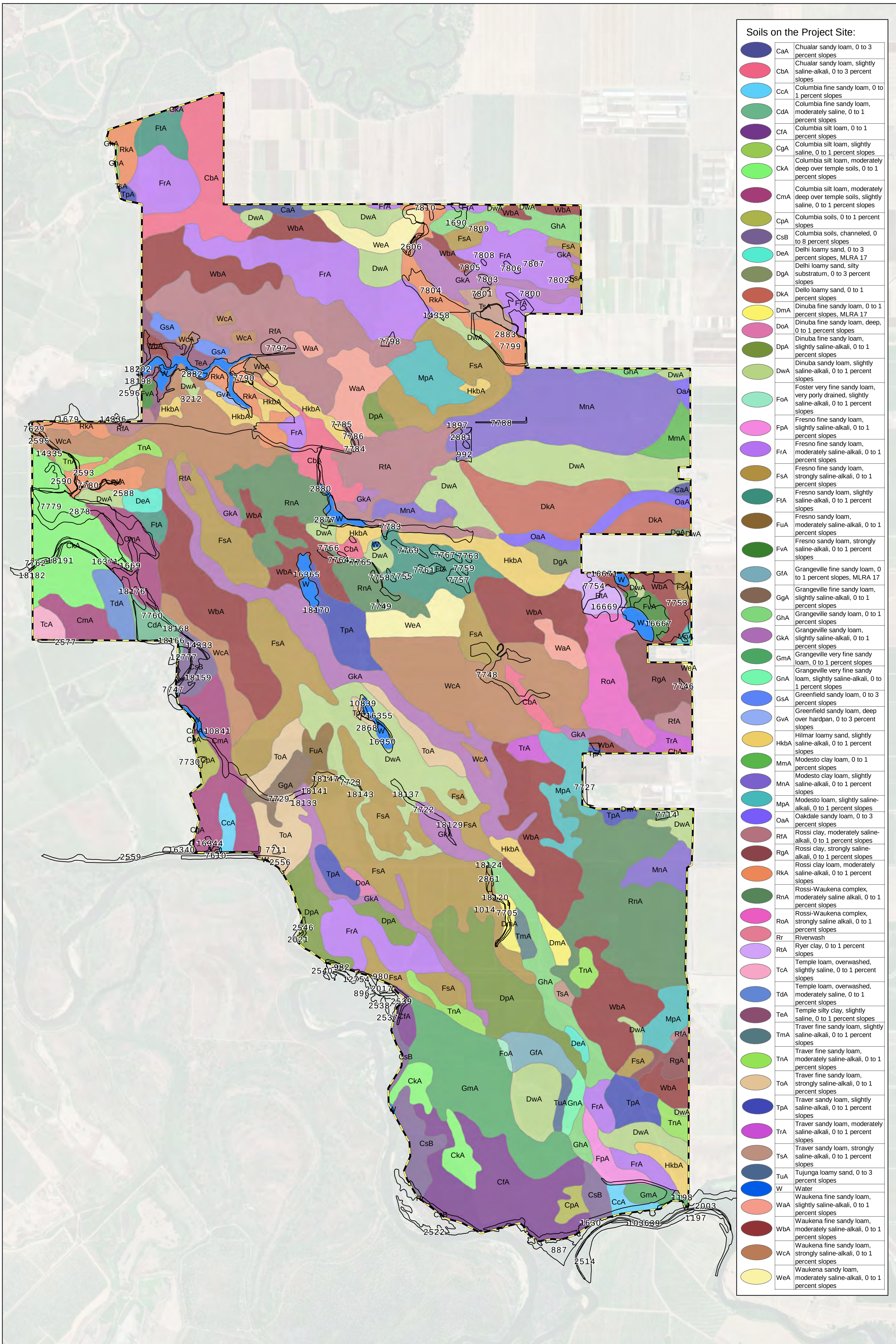

Figure 3

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

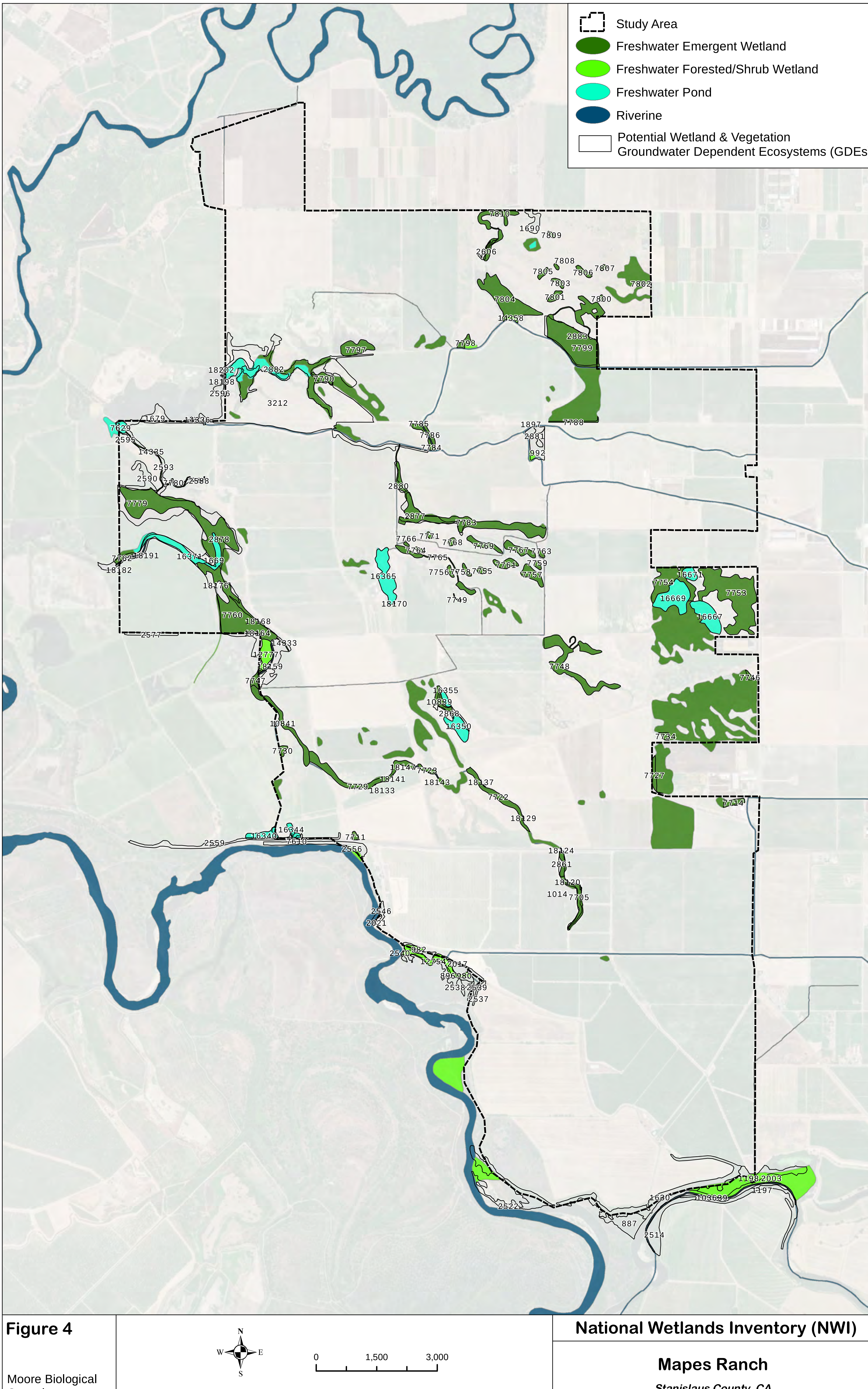

Figure 4

Moore Biological Consultants

National Wetlands Inventory (NWI)

Mapes Ranch

Stanislaus County, CA

Data Source: NWI (USFWS; 2021)
Map Date: 10/19/2021

Aerial Photo: ESRI; Maxar (2020)

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**

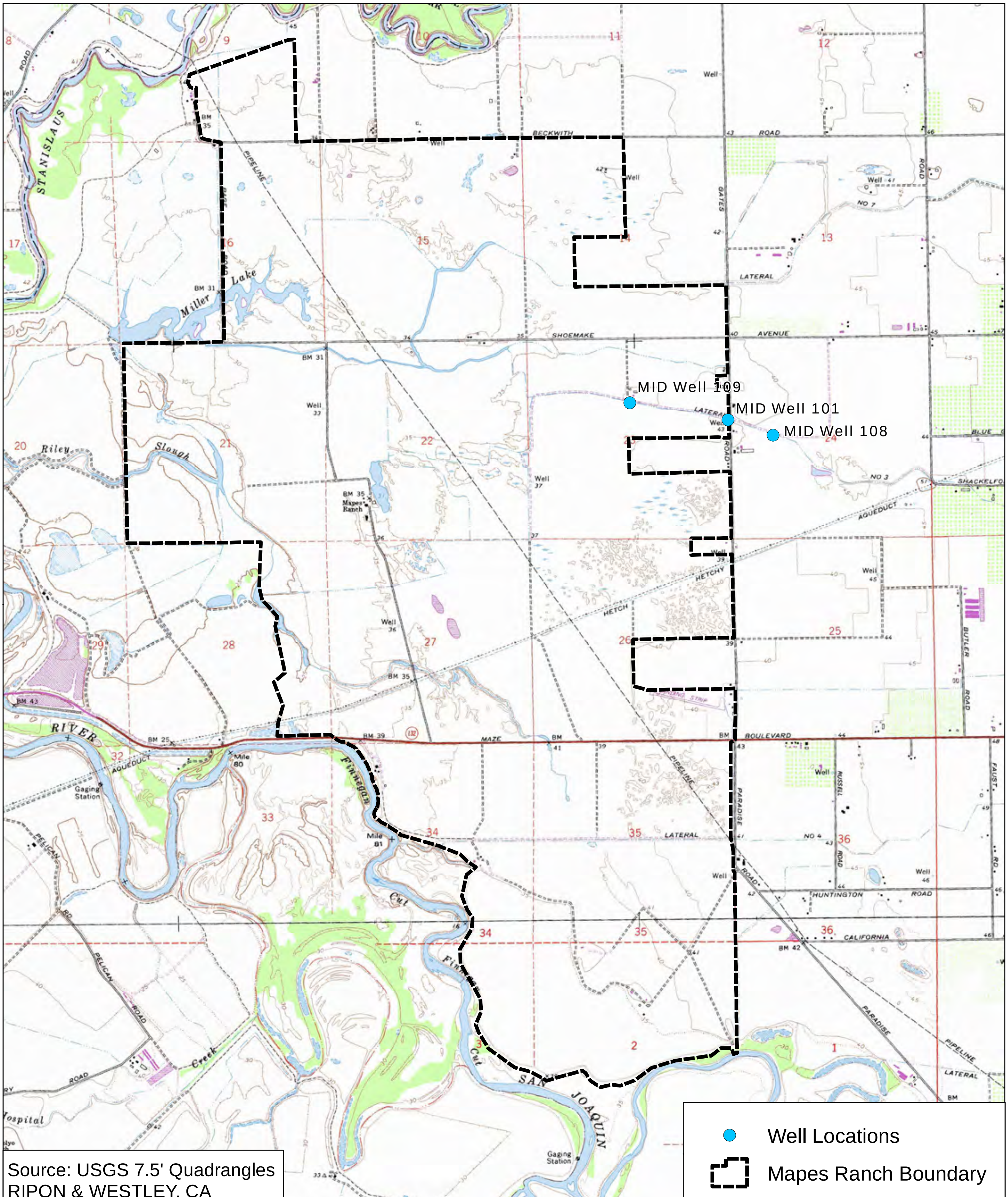

Figure 5

Moore Biological Consultants

0 2,000 4,000

N S E W

Map Date: 10/20/2021

Monitoring Wells

Mapes Ranch

Stanislaus County, CA

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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

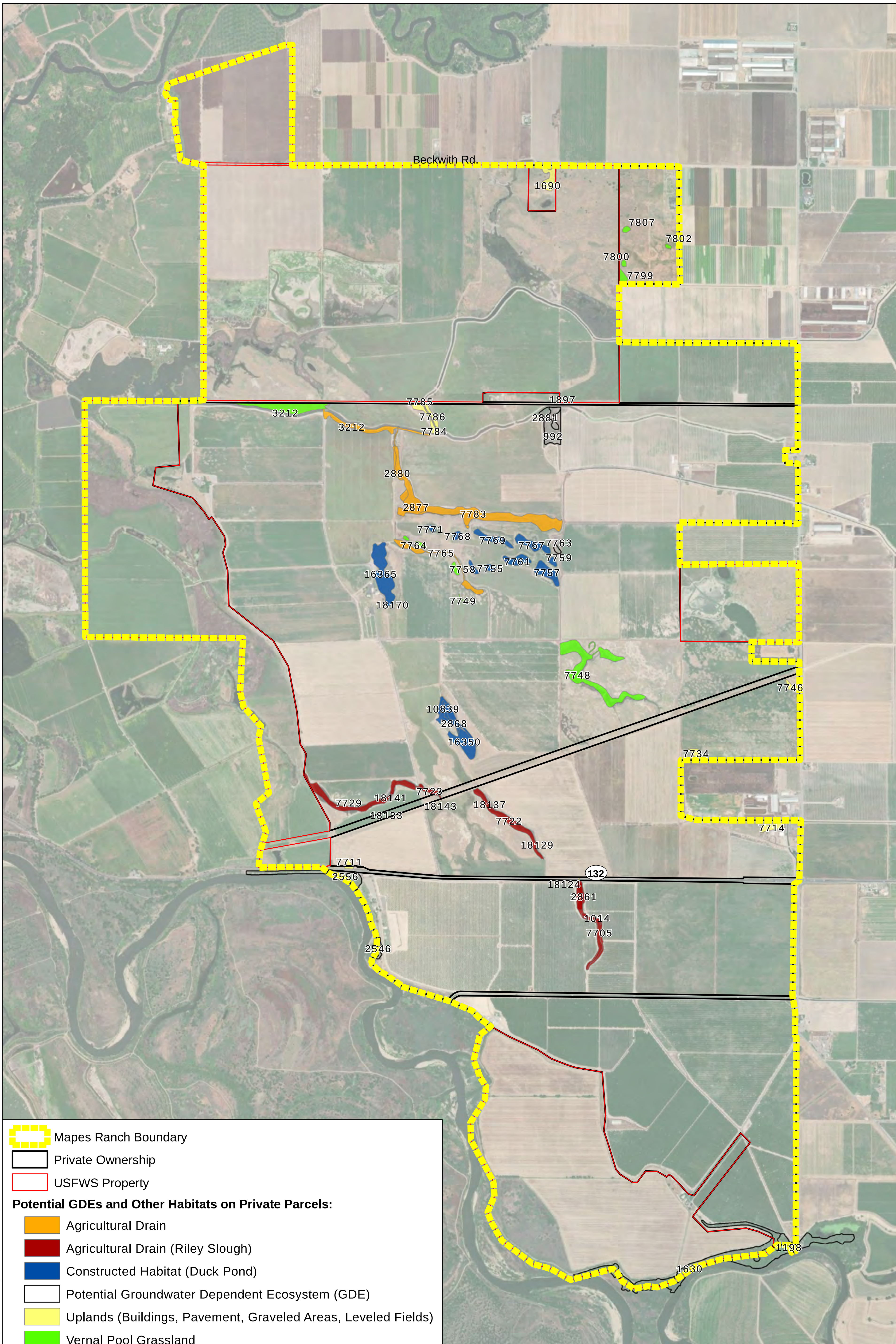

Figure 6

Moore Biological Consultants

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Miles

N W E S

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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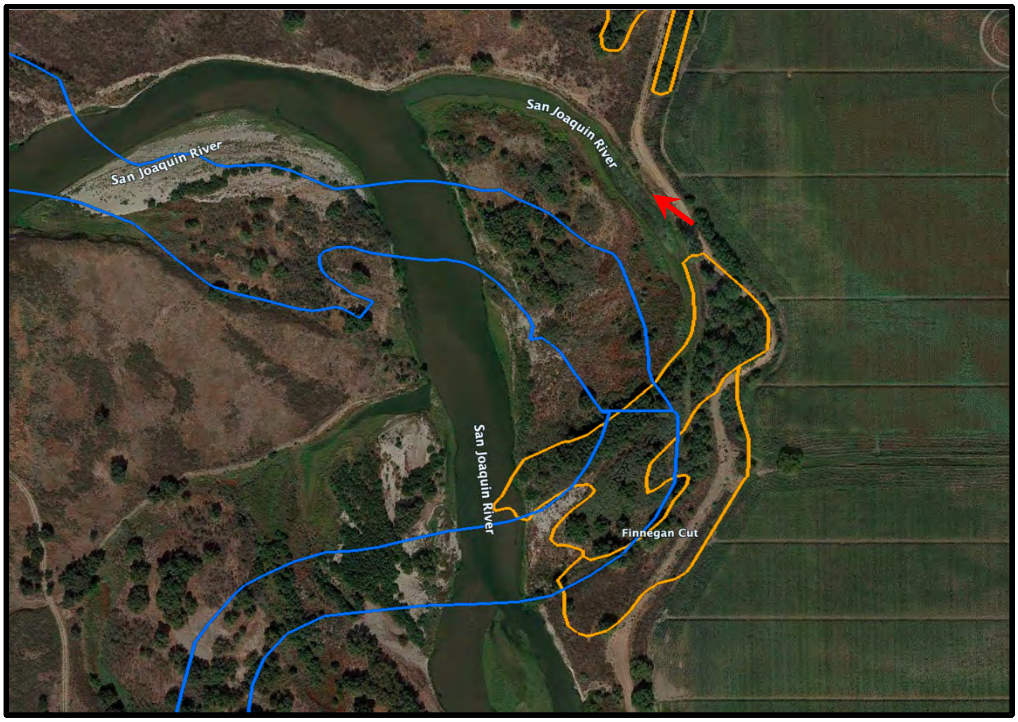
Attachment A

Photographs

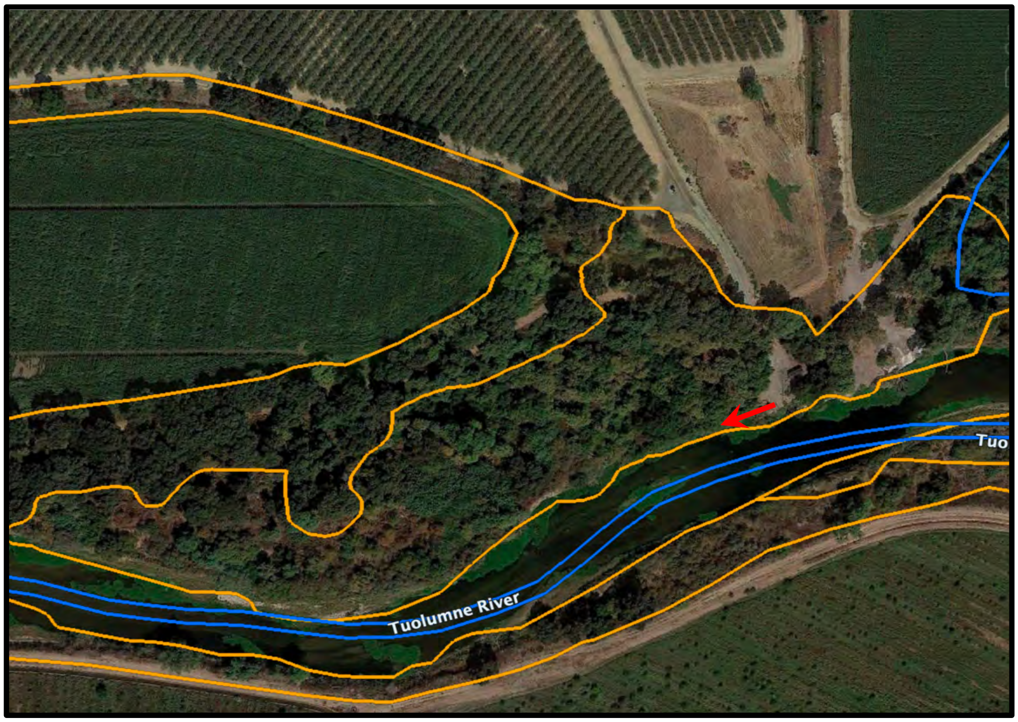
San Joaquin River, Tuolumne River, and Adjacent

Riparian Forest and Scrub Wetlands



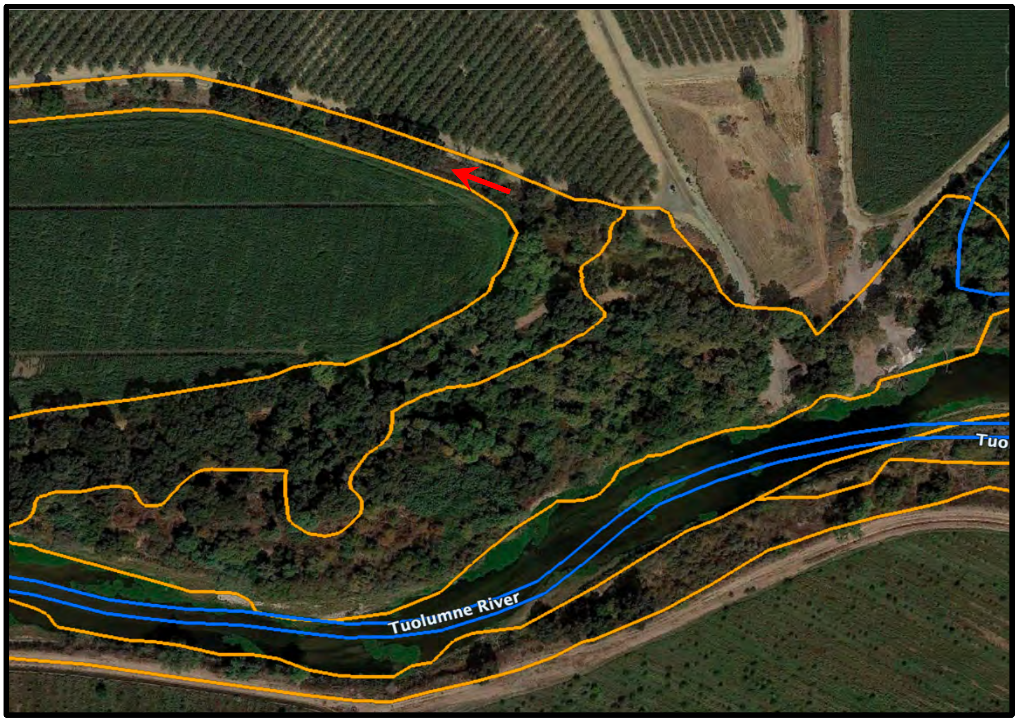
San Joaquin River just west of Mapes Ranch. The arrow notes the location and direction of the photograph below. The blue swath that is supposed to be the active channel demonstrates issues with mapping accuracy of potential GDEs in the NC DataSet.

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.

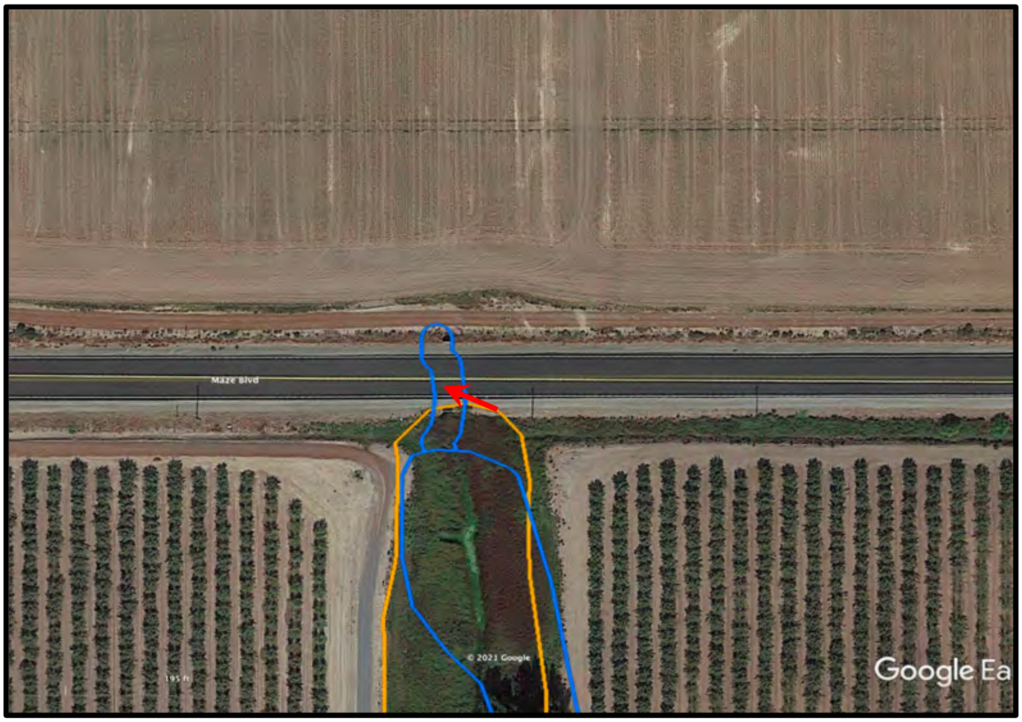
Example Uplands that are not GDEs

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.

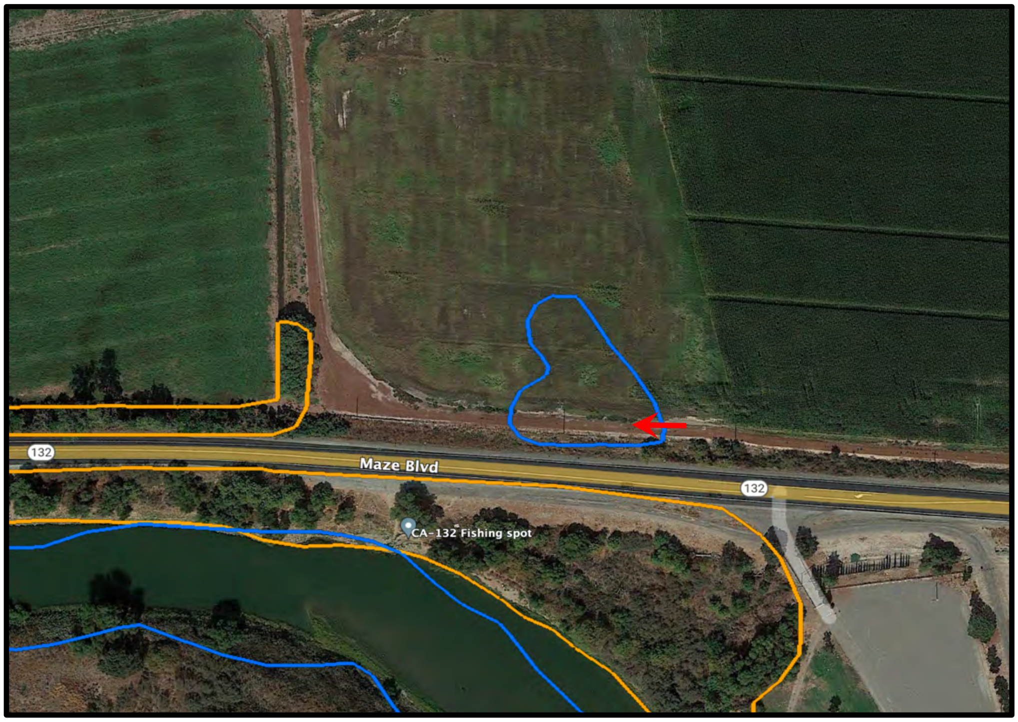
Potential GDE #7714 is a polygon just west of N. Gates Road and north of Maze Boulevard. The arrow notes the location and direction of the ground-level photograph below.

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.

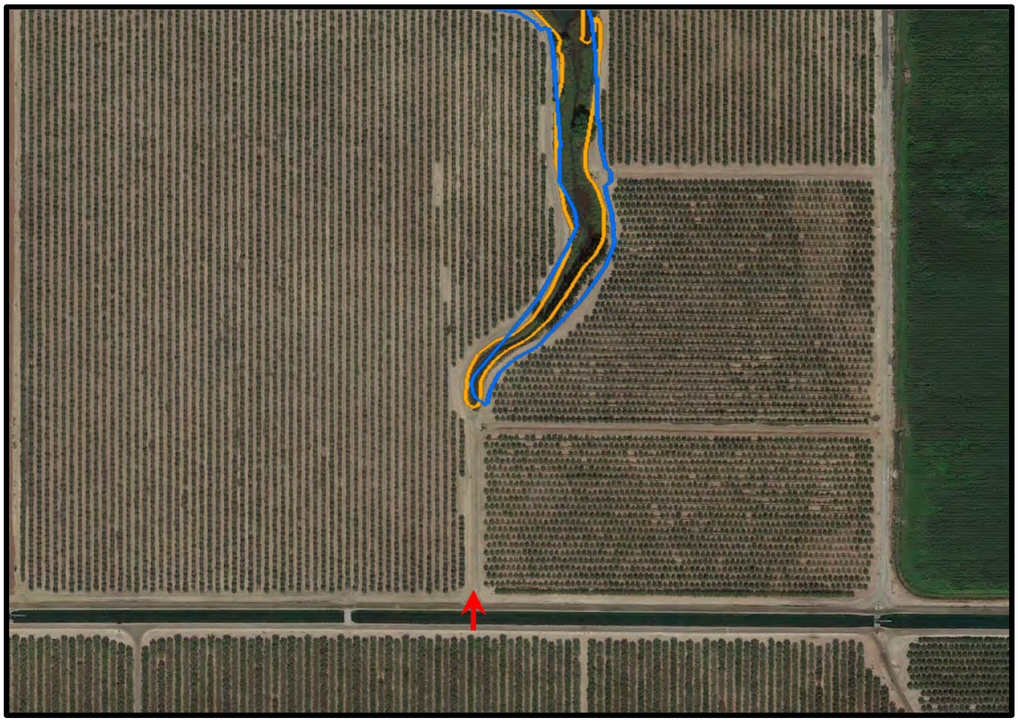
Potential GDE #7769 is a long polygon in the approximate center portion of Mape's Ranch. The arrow notes the location and direction of the ground-level photograph below.

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.

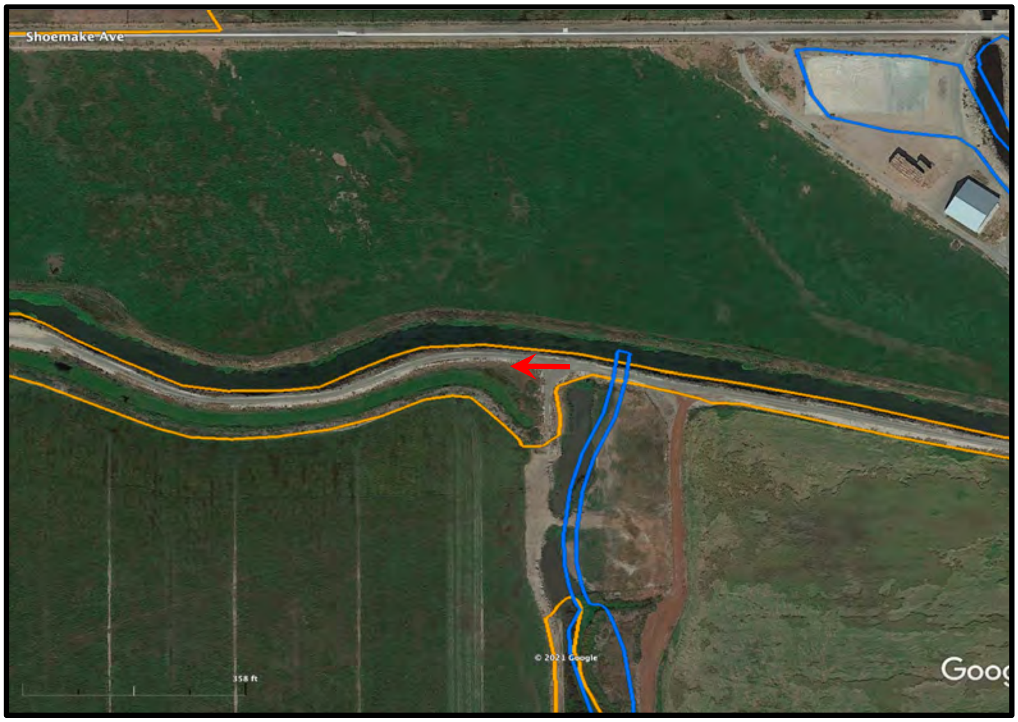
Outlet from the MID lateral and adjacent groundwater well that provide water to Riley Slough via a pipeline, looking north; 09/15/21.

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.

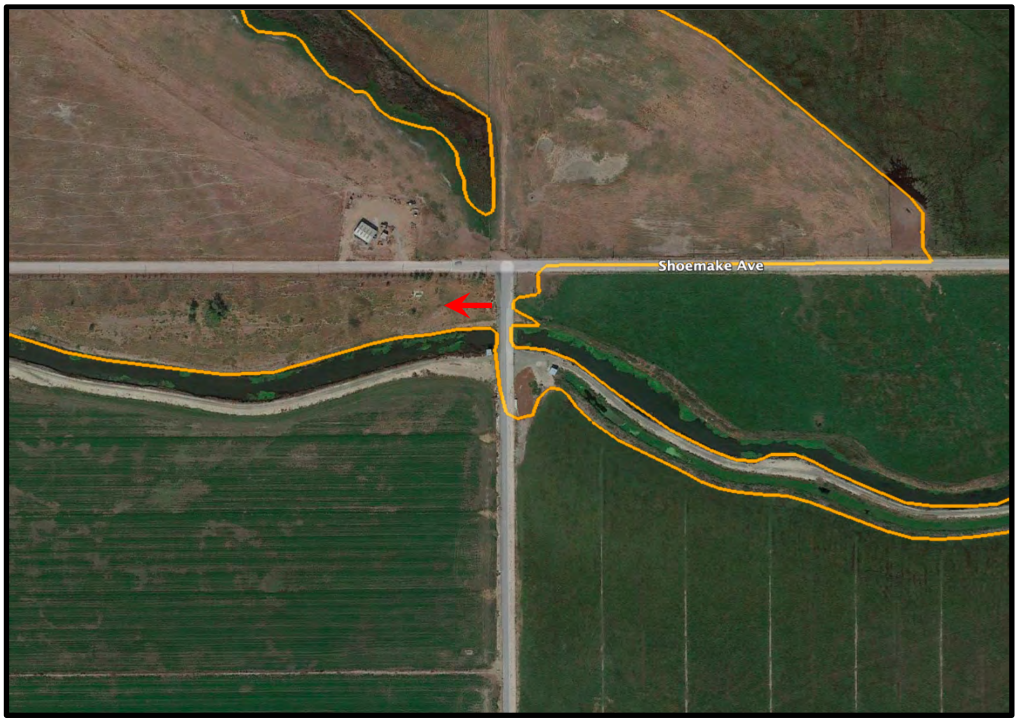
Water being conveyed from the MID lateral and/or groundwater wells via a pipeline in to potential GDE #7748, looking northwest; 09/03/21.

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.

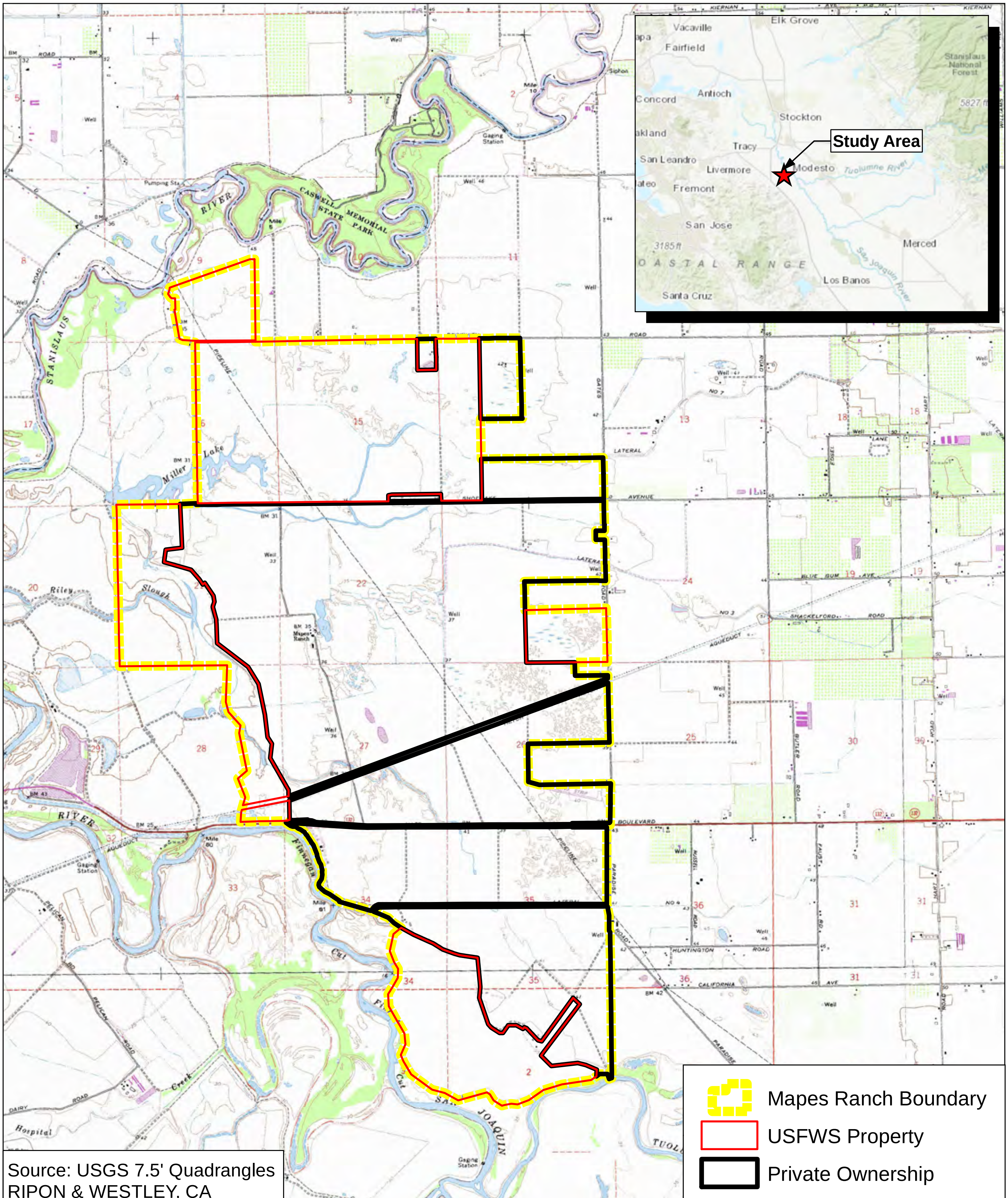


Figure 1

Moore Biological Consultants

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N W E S

Map Date: 10/18/2021

USGS

Mapes Ranch

Stanislaus County, CA

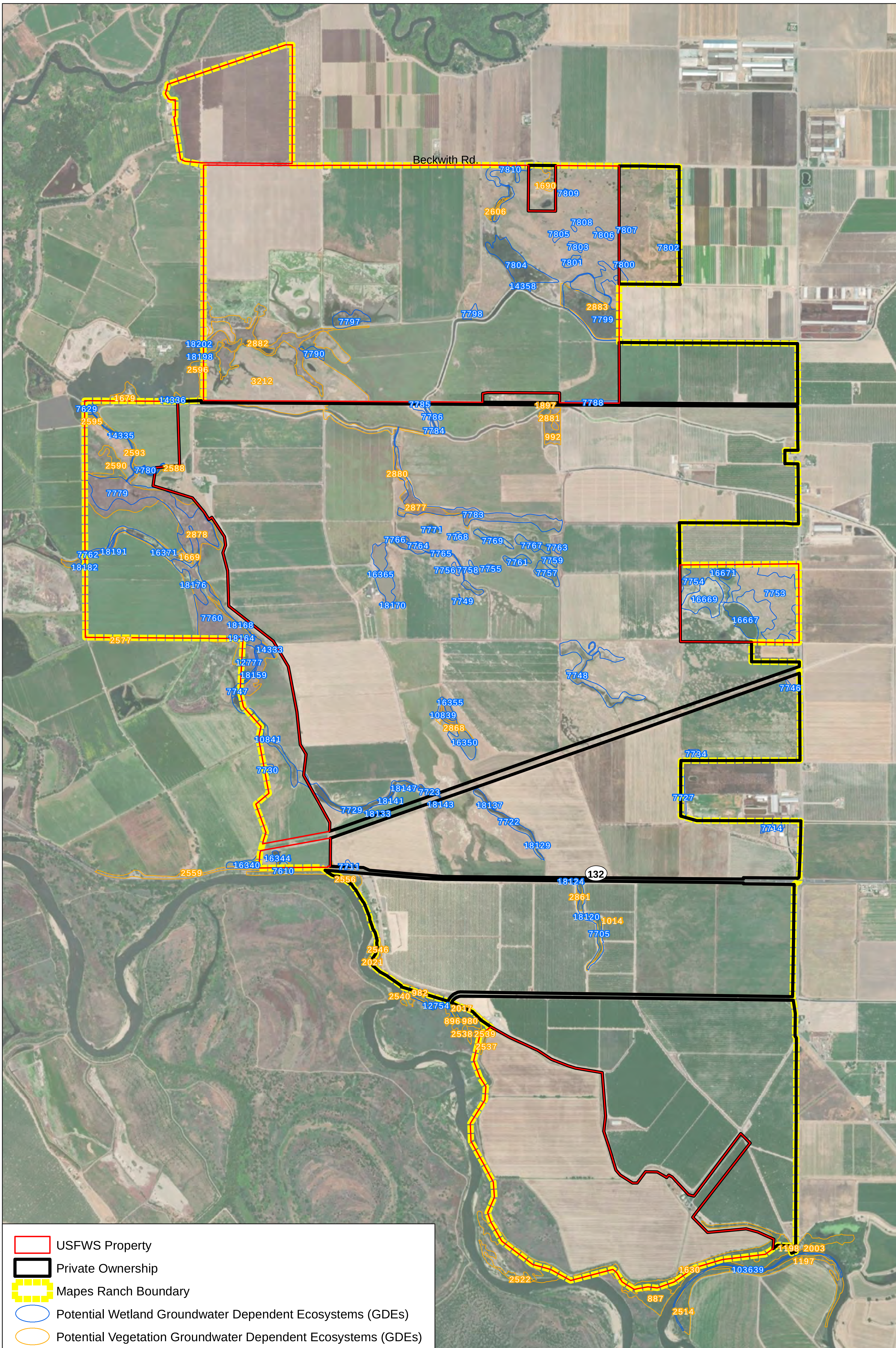


Figure 2

Potential GDEs

Mapes Ranch

Stanislaus County, CA

Moore Biological Consultants

Map Date: 10/19/2021
Aerial Source: Maxar (05/2020)

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.

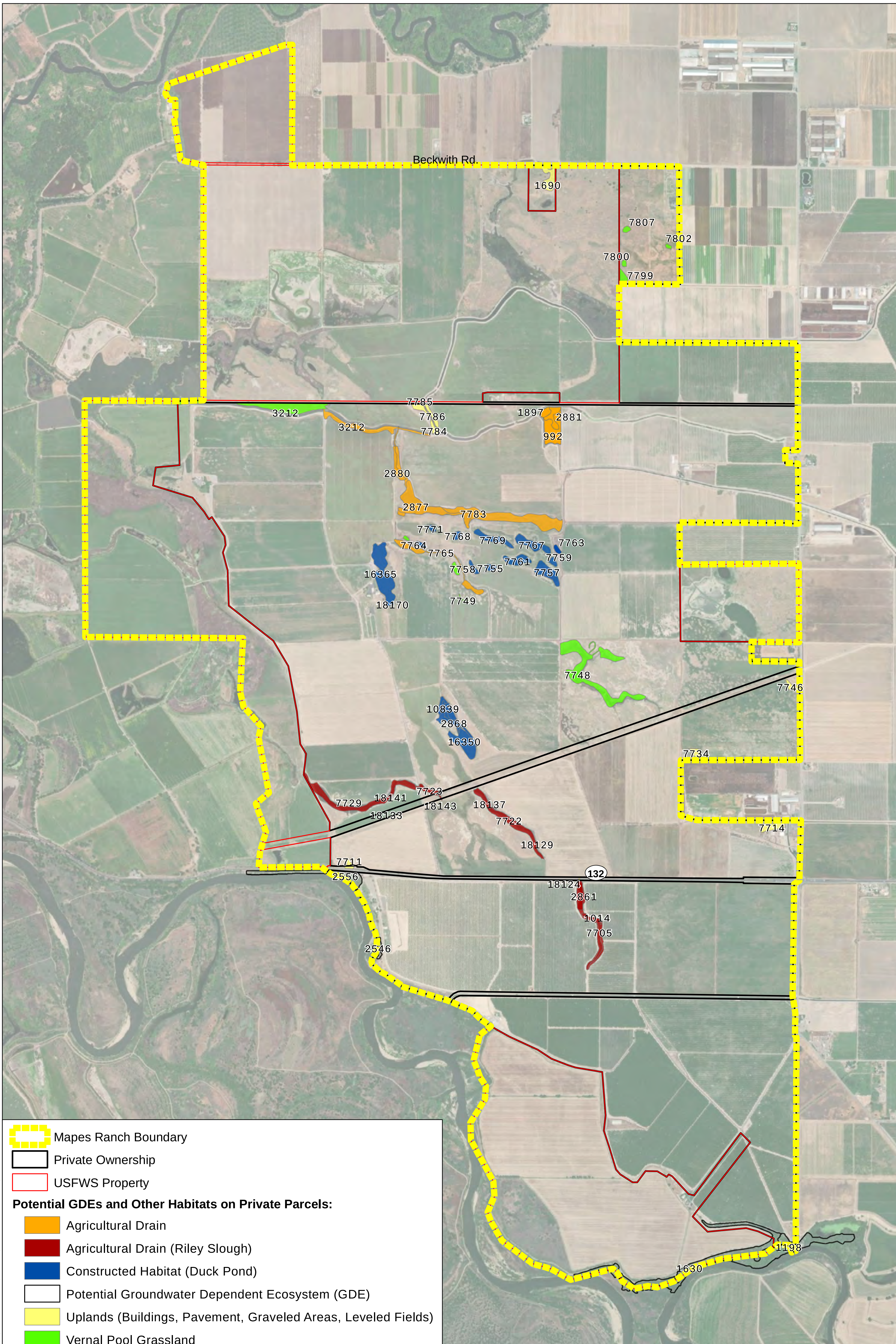


Figure 3

Moore Biological Consultants

0 0.5 1
Miles

N W E S

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

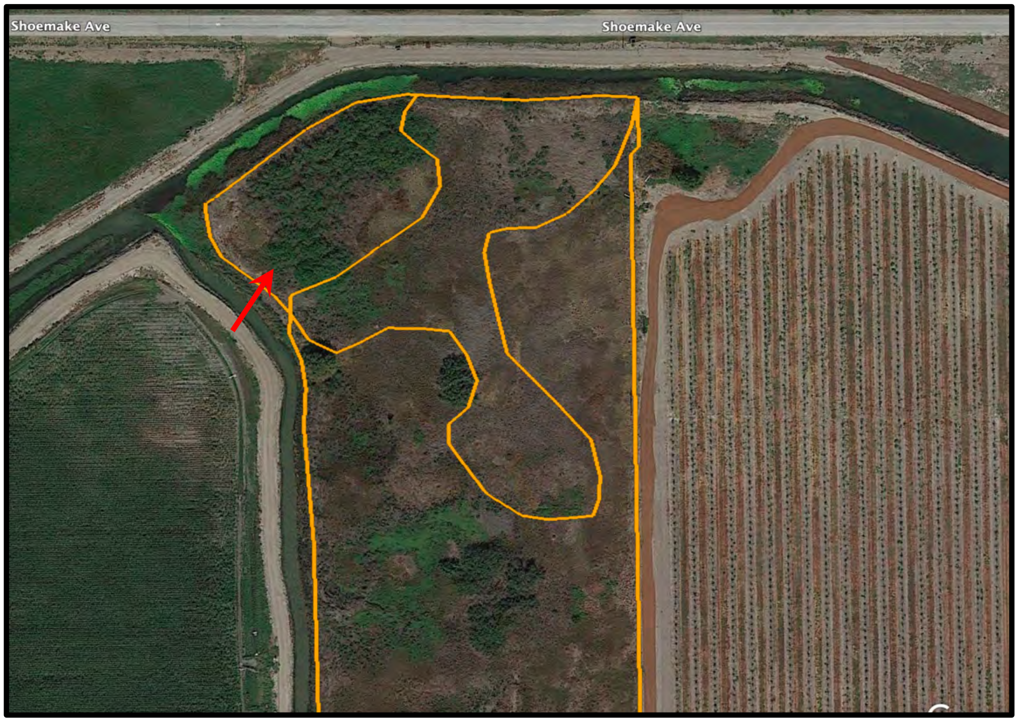
Photographs

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.

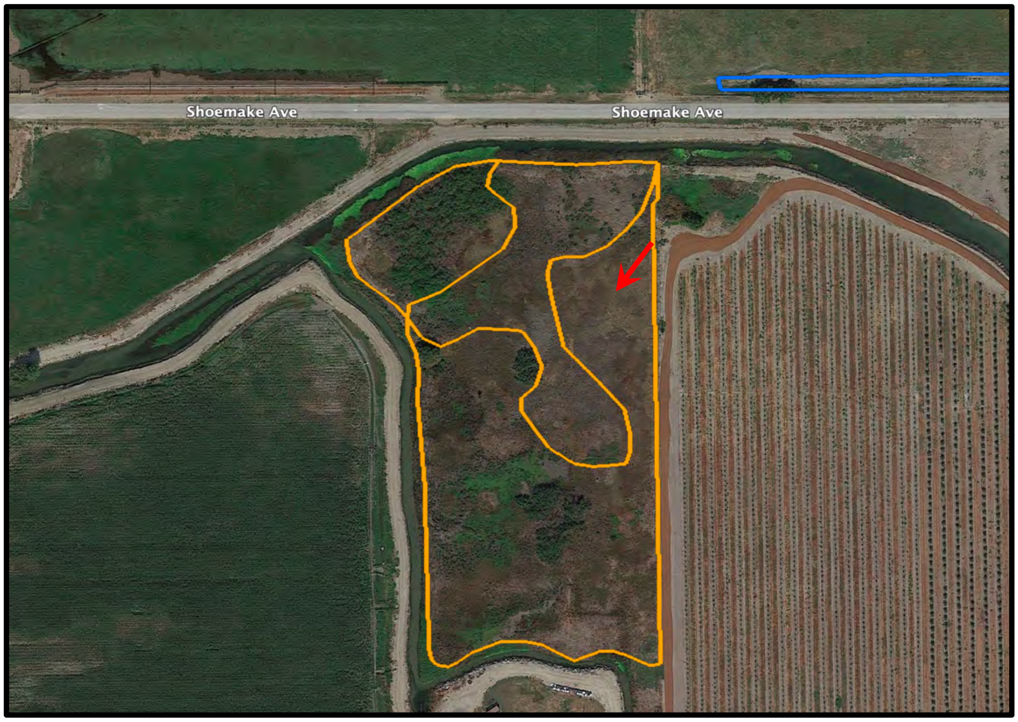
Potential GDE #7763, looking northeast; 09/03/21. This shallow basin is only a few feet deep and can be filled by opening a valve from a private lateral. This area has been graded to provide upland and wetland habitats and is managed for conservation.

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.

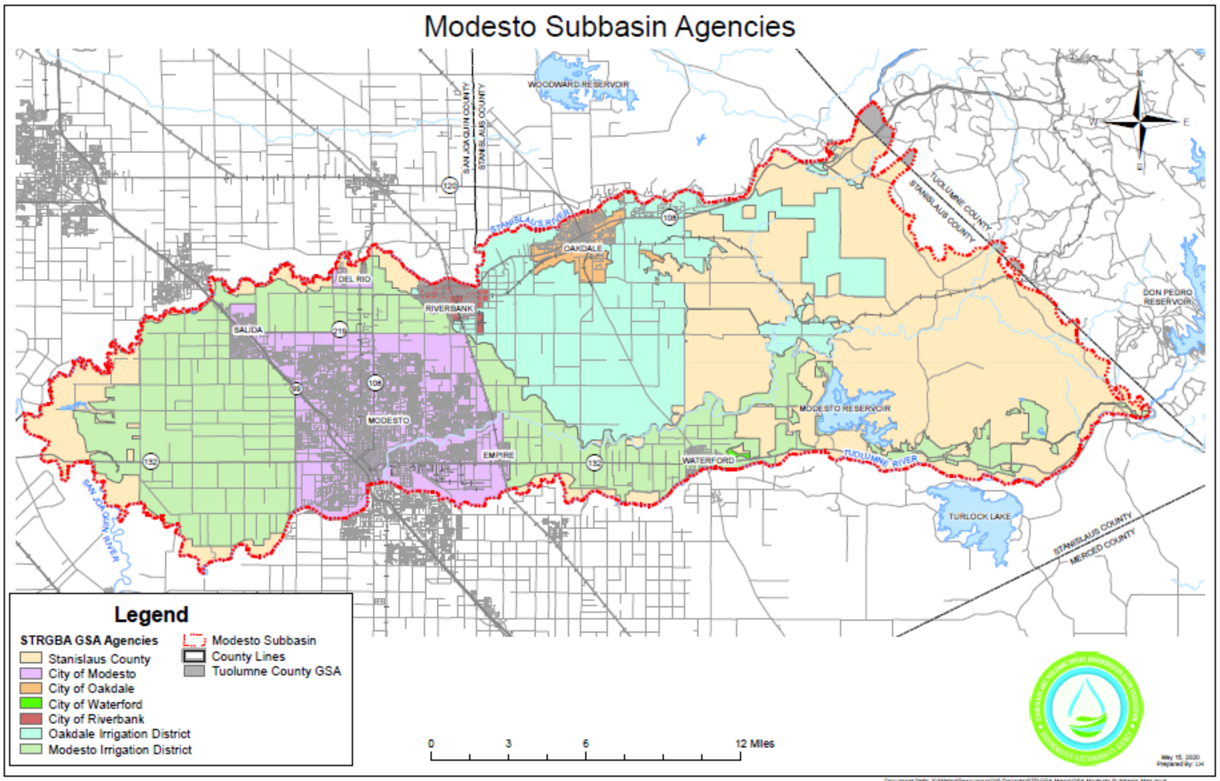

Figure 1. Map of the Modesto Subbasin Groundwater Sustainability Agencies

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.

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.

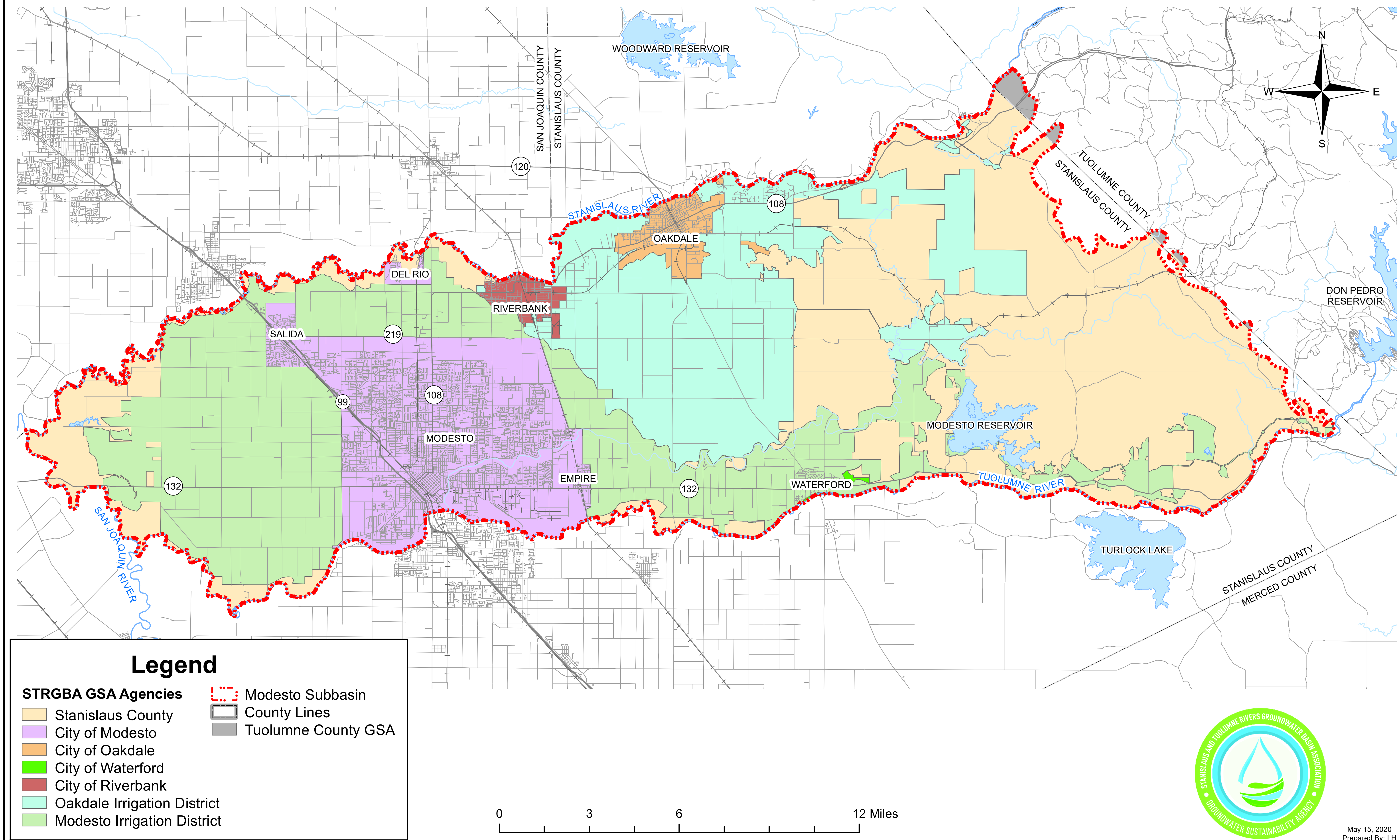
Stanislaus & Tuolumne Rivers Groundwater Basin Association
Groundwater Sustainability Agency
1231 11th Street | Modesto, CA 95354
Phone: (209) 847-0341
Email: strgba@mid.org

Sincerely,

Eric Thorburn, P.E.
STRGBA GSA Chairman

Enclosure: GSA Modesto Subbasin Map

Modesto Subbasin Agencies



Document Path: X:\Water\Resources\GIS Projects\STRGBA Maps\GSA Modesto Subbasin Map.mxd

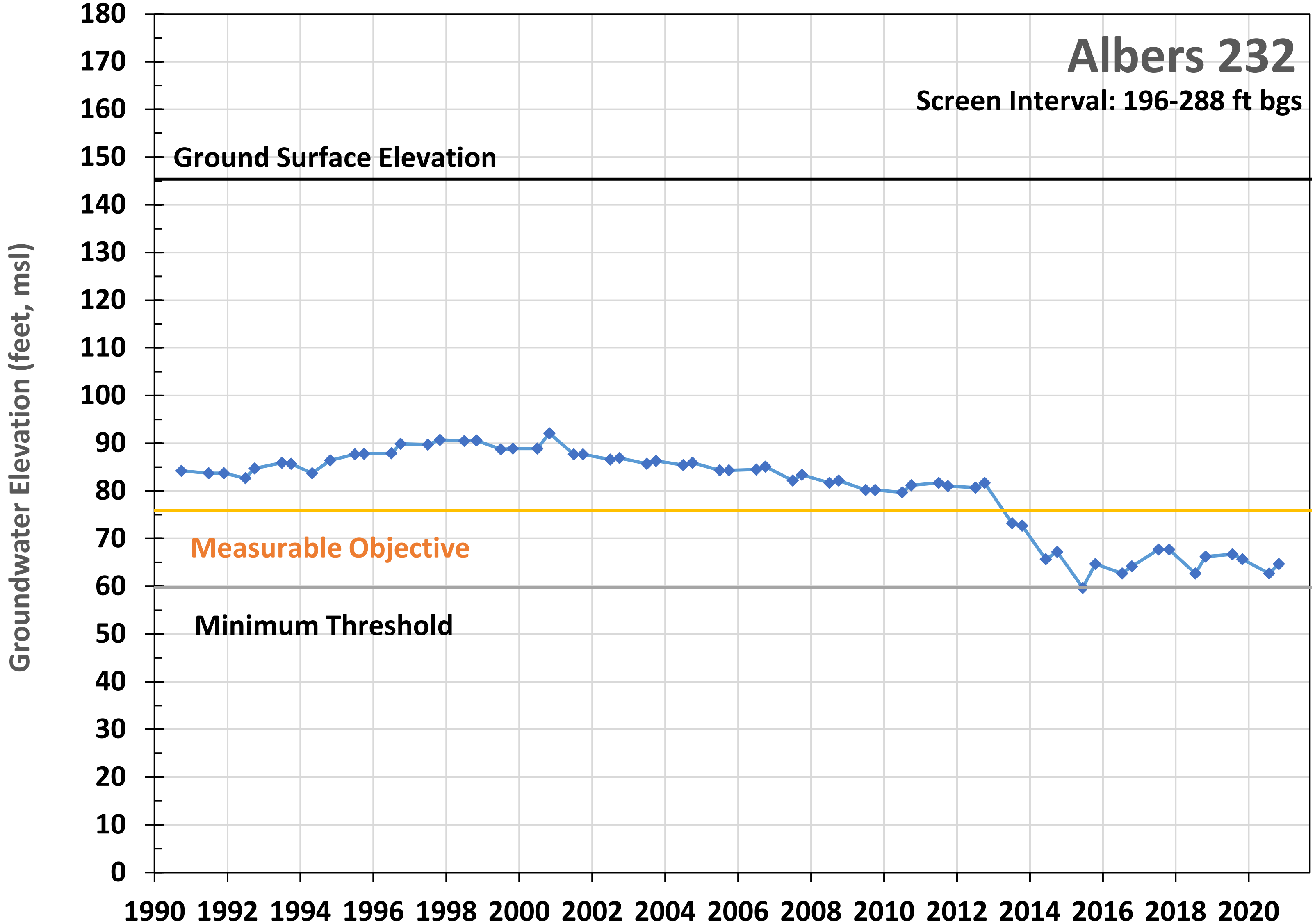
Appendix F

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)
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
1990
1992
1994
1996
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2000
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2004
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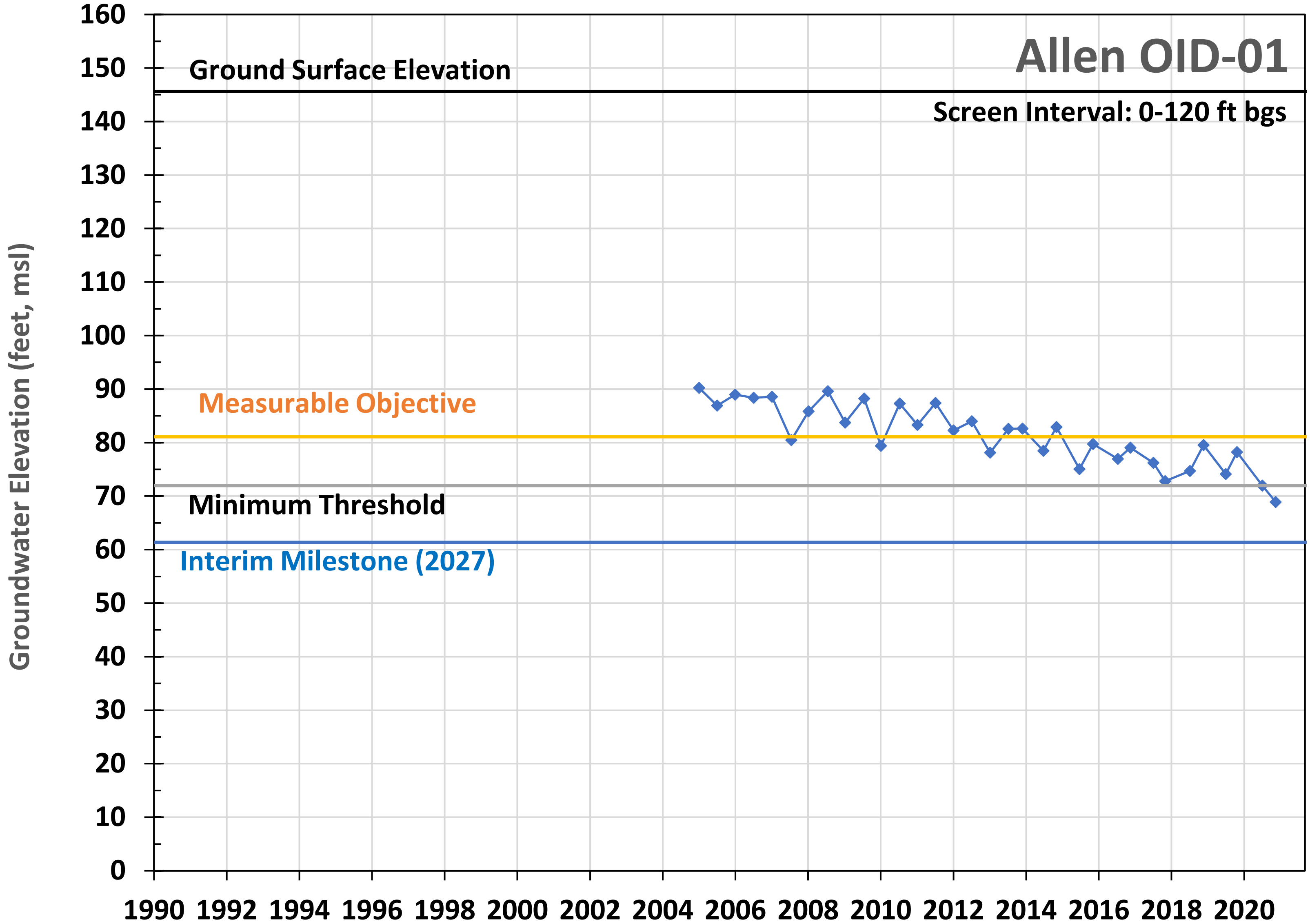
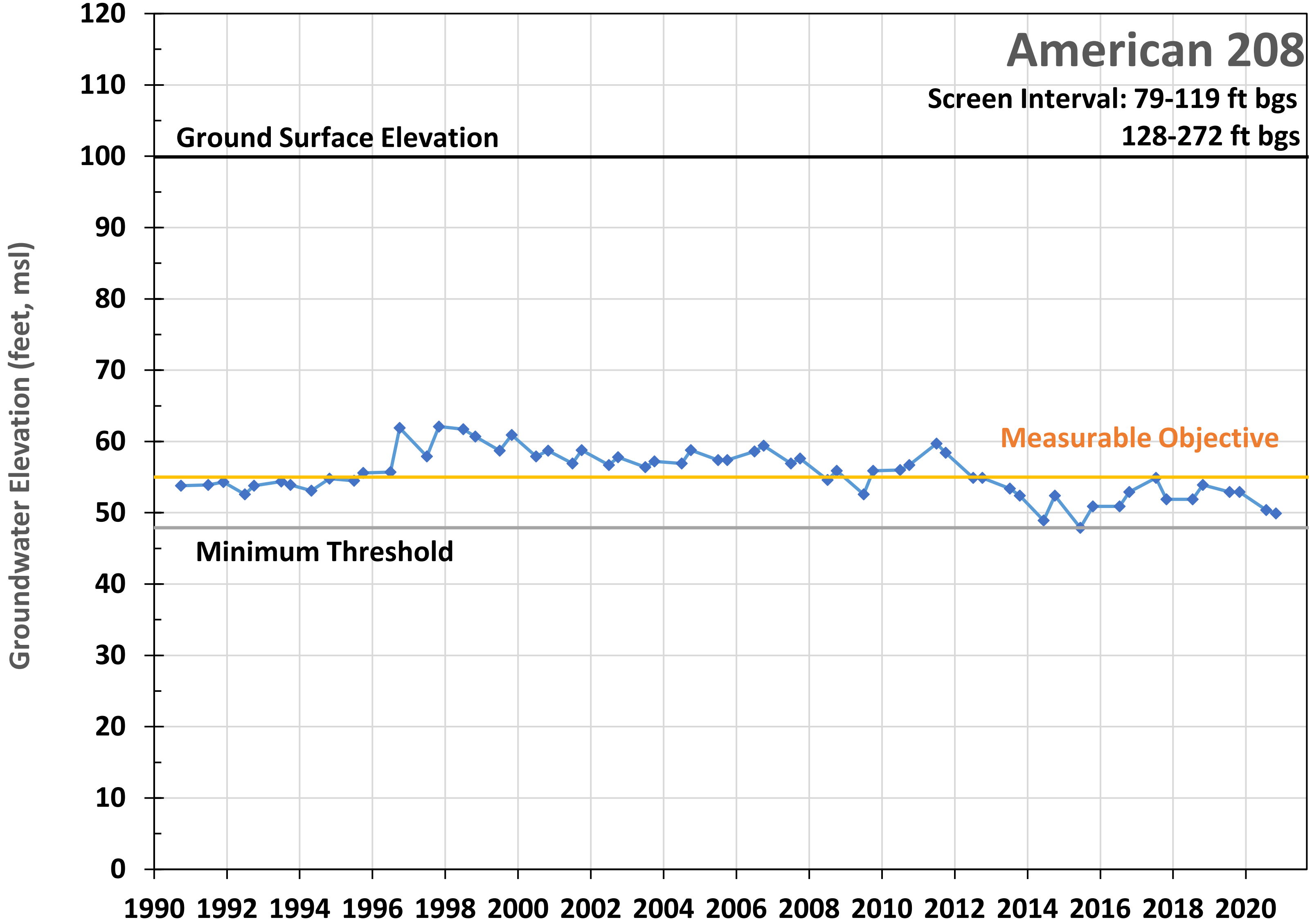
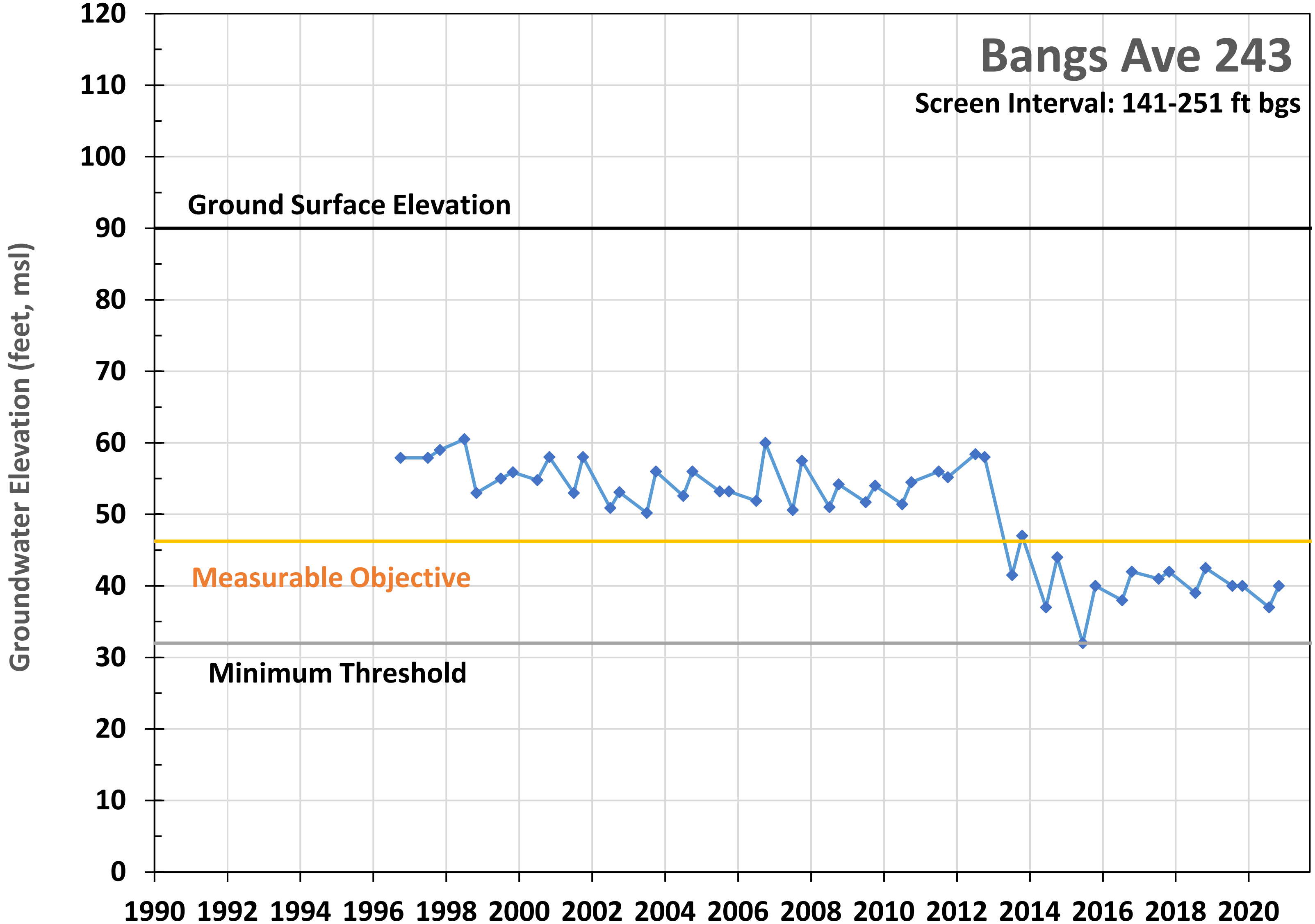
2008
2010
2012
2014
2016
2018
2020



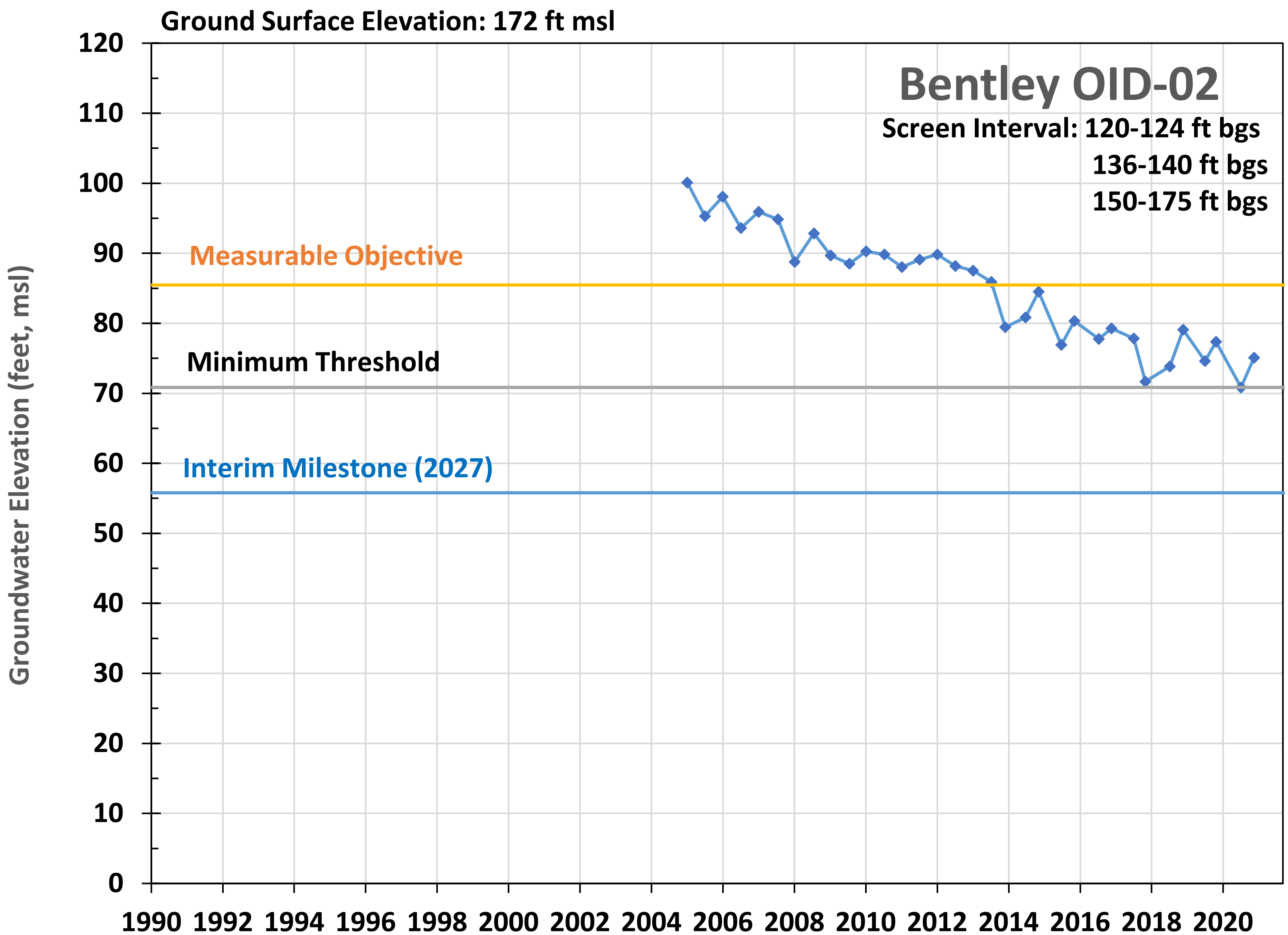
Allen OID-01
Ground Surface Elevation
Screen Interval: 0-120 ft bgs
Measurable Objective
Minimum Threshold
Interim Milestone (2027)
Groundwater Elevation (feet, msl)
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
1990 1992 1994 1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020



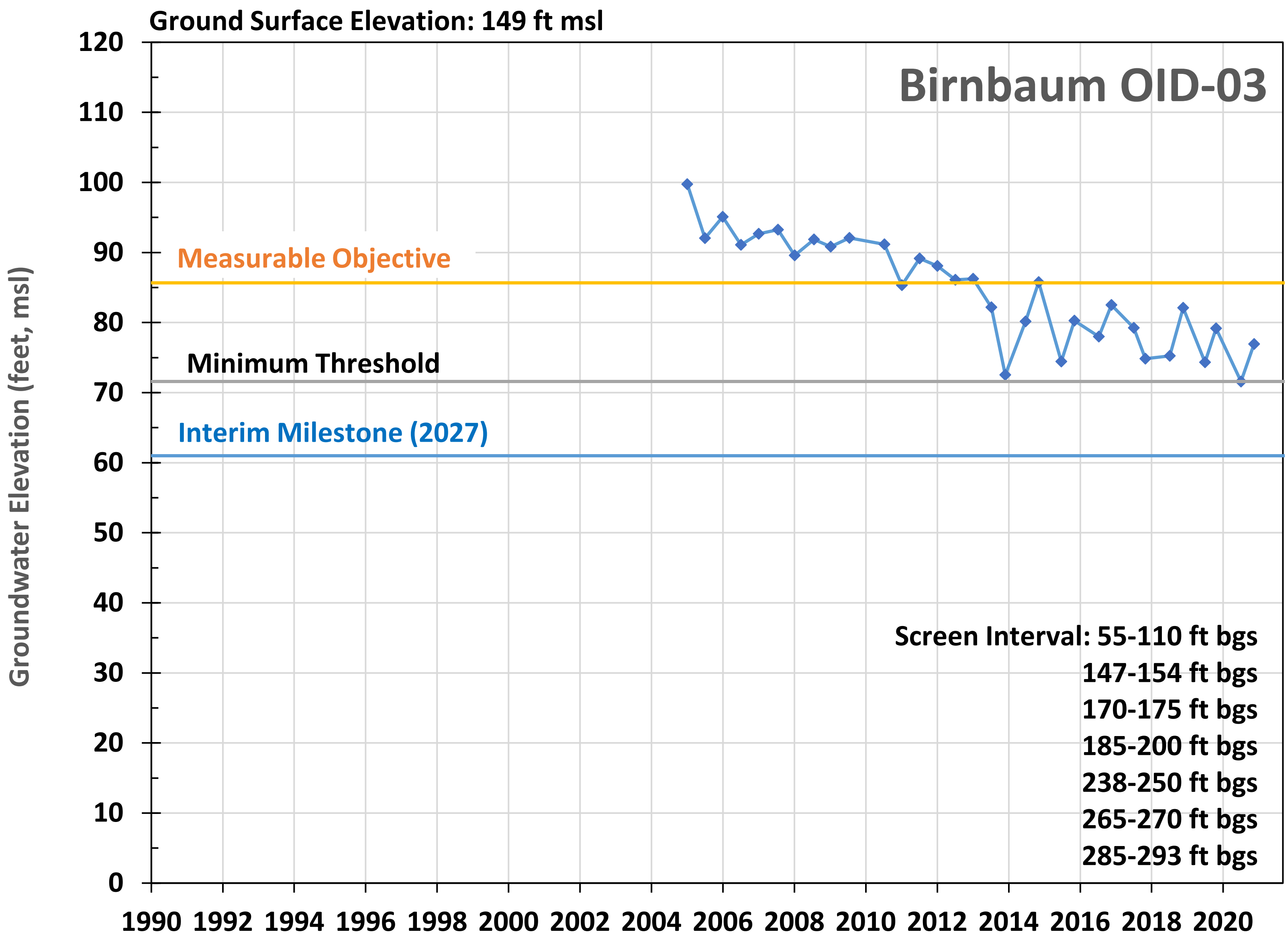
American 208
Screen Interval: 79-119 ft bgs
128-272 ft bgs
Ground Surface Elevation
Measurable Objective
Minimum Threshold
Groundwater Elevation (feet, msl)
0
10
20
30
40
50
60
70
80
90
100
110
120
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016
2018
2020



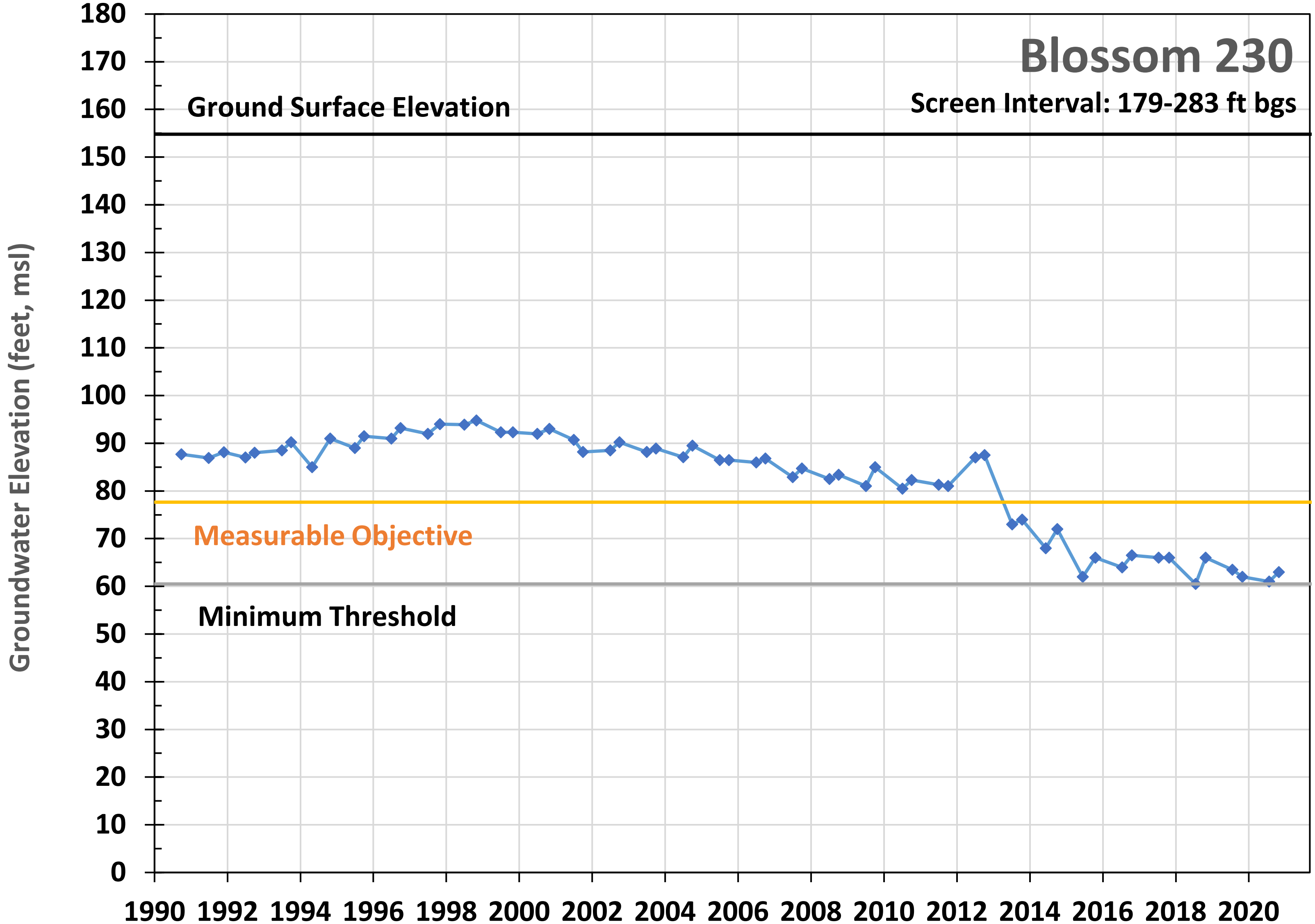
Bangs Ave 243
Screen Interval: 141-251 ft bgs
Ground Surface Elevation
Measurable Objective
Minimum Threshold
Groundwater Elevation (feet, msl)
120
110
100
90
80
70
60
50
40
30
20
10
0
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016
2018
2020



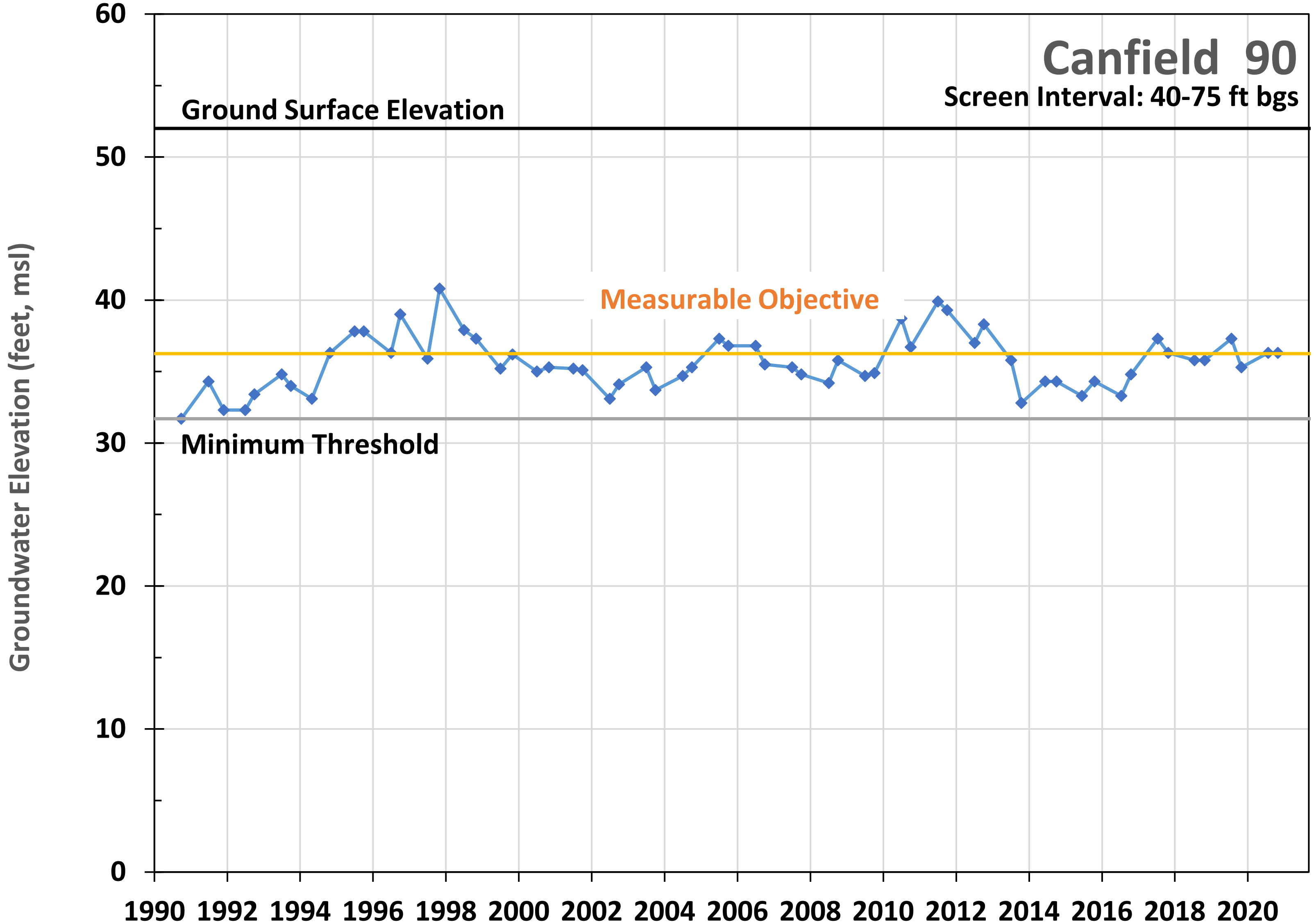
Ground Surface Elevation: 172 ft msl
Bentley OID-02
Screen Interval: 120-124 ft bgs
136-140 ft bgs
150-175 ft bgs
Measurable Objective
Minimum Threshold
Interim Milestone (2027)
Groundwater Elevation (feet, msl)
120
110
100
90
80
70
60
50
40
30
20
10
0
1990 1992 1994 1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020



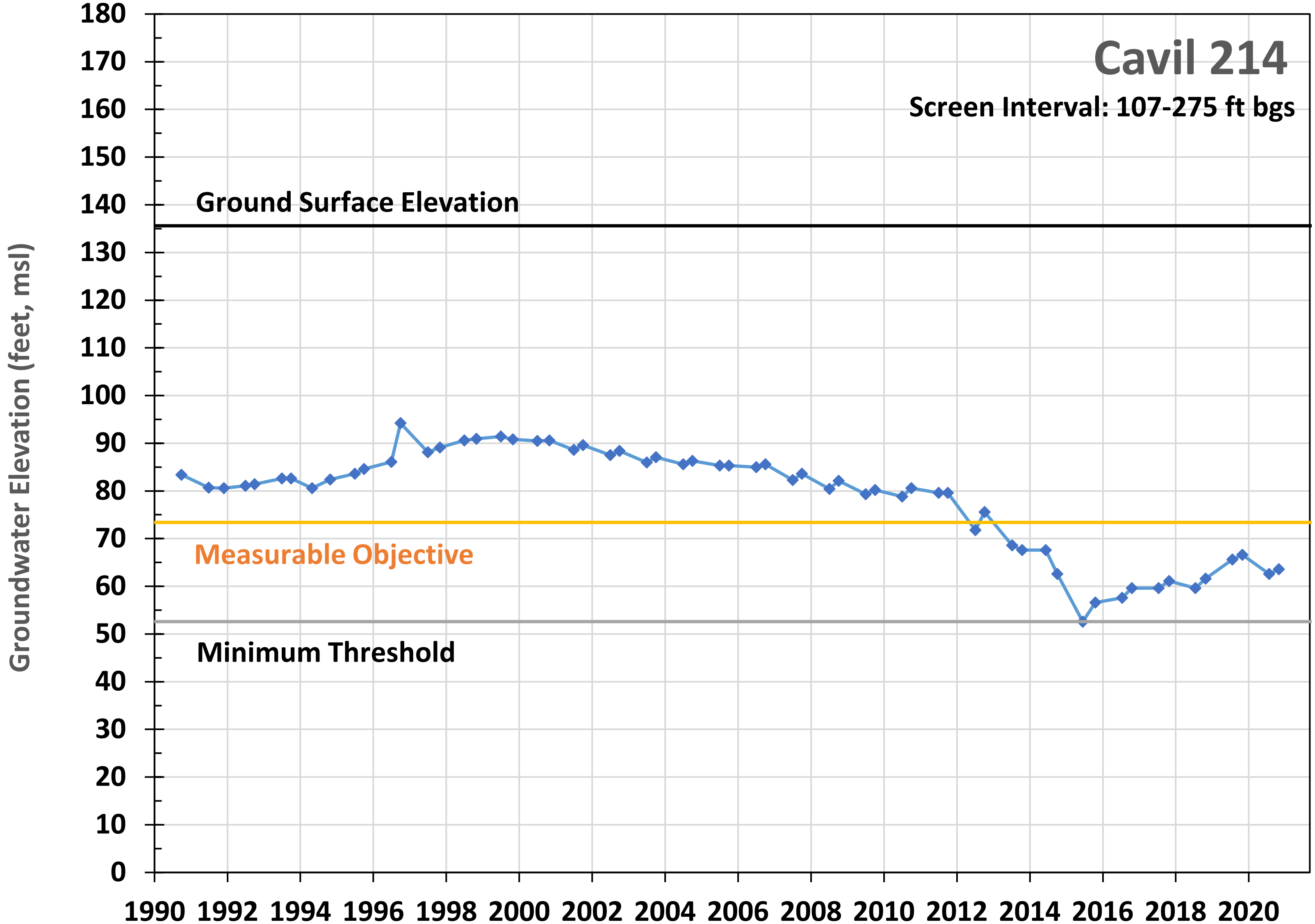
Ground Surface Elevation: 149 ft msl
Birnbaum OID-03
Measurable Objective
Minimum Threshold
Interim Milestone (2027)
Screen Interval: 55-110 ft bgs
147-154 ft bgs
170-175 ft bgs
185-200 ft bgs
238-250 ft bgs
265-270 ft bgs
285-293 ft bgs
Groundwater Elevation (feet, msl)
120
110
100
90
80
70
60
50
40
30
20
10
0
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016
2018
2020



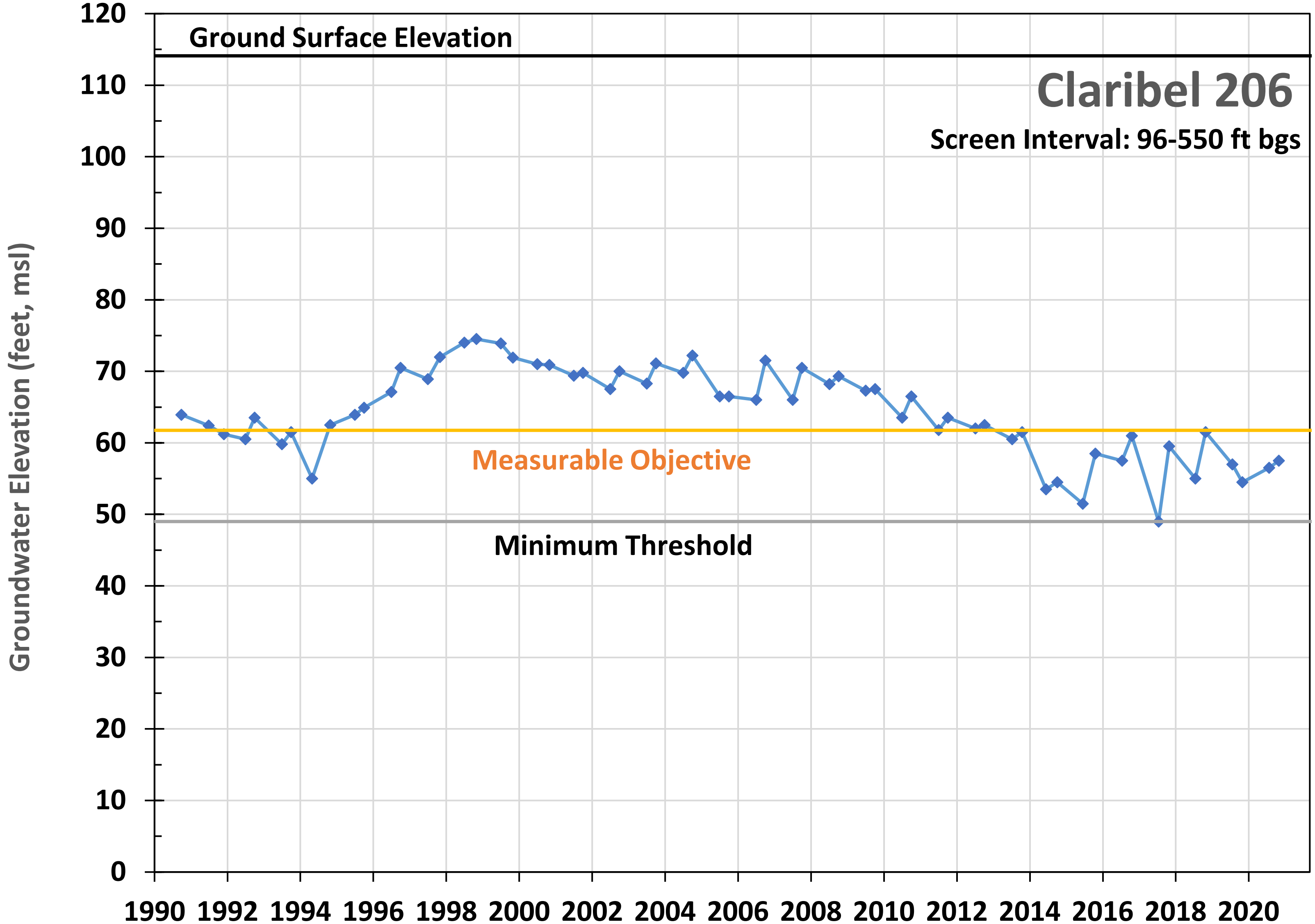
Blossom 230
Screen Interval: 179-283 ft bgs
Ground Surface Elevation
Measurable Objective
Minimum Threshold
Groundwater Elevation (feet, msl)
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016
2018
2020



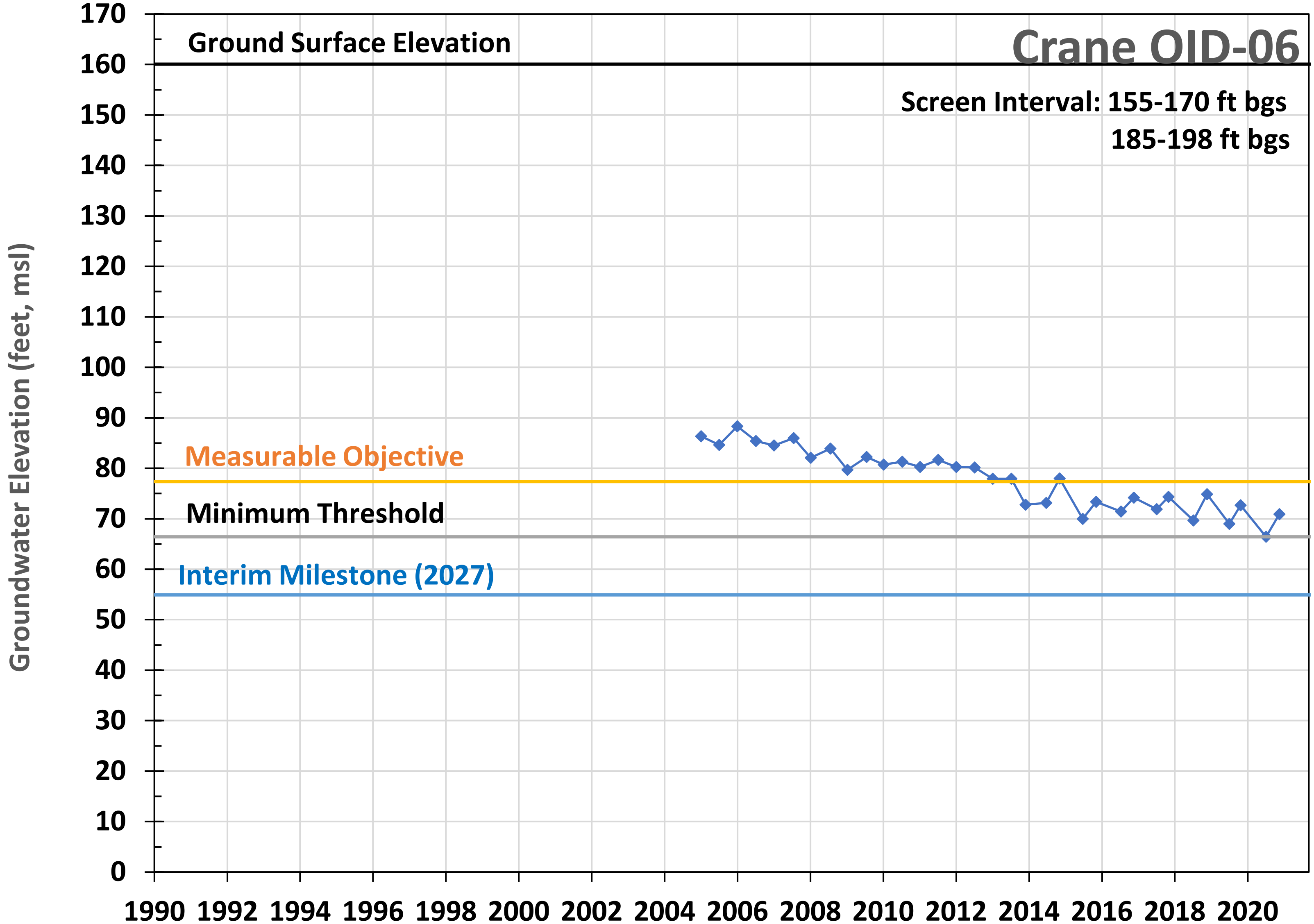
Canfield 90
Screen Interval: 40-75 ft bgs
Ground Surface Elevation
Measurable Objective
Minimum Threshold
Groundwater Elevation (feet, msl)
0
10
20
30
40
50
60
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016
2018
2020



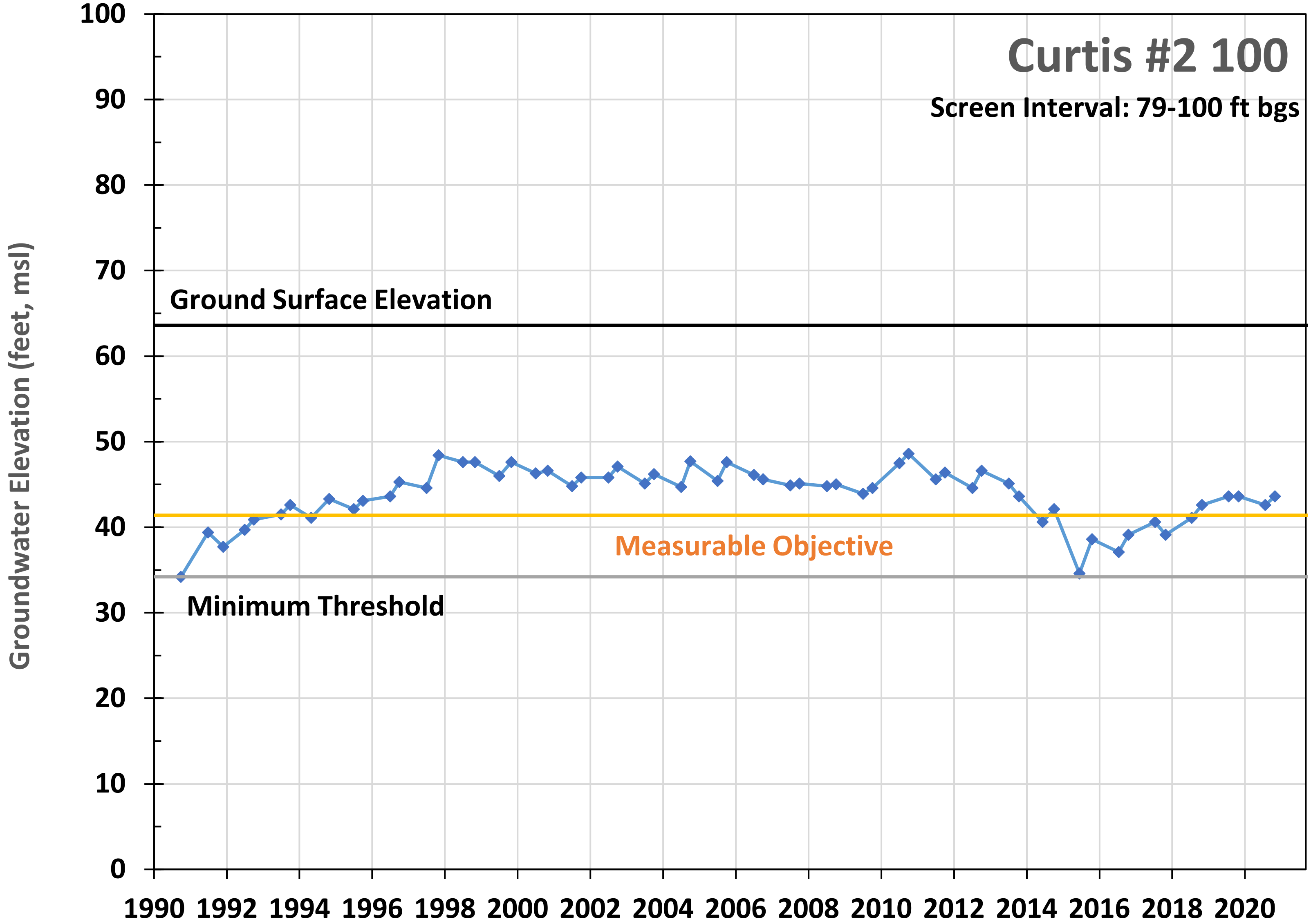
Cavil 214
Screen Interval: 107-275 ft bgs
Ground Surface Elevation
Measurable Objective
Minimum Threshold
Groundwater Elevation (feet, msl)
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016
2018
2020



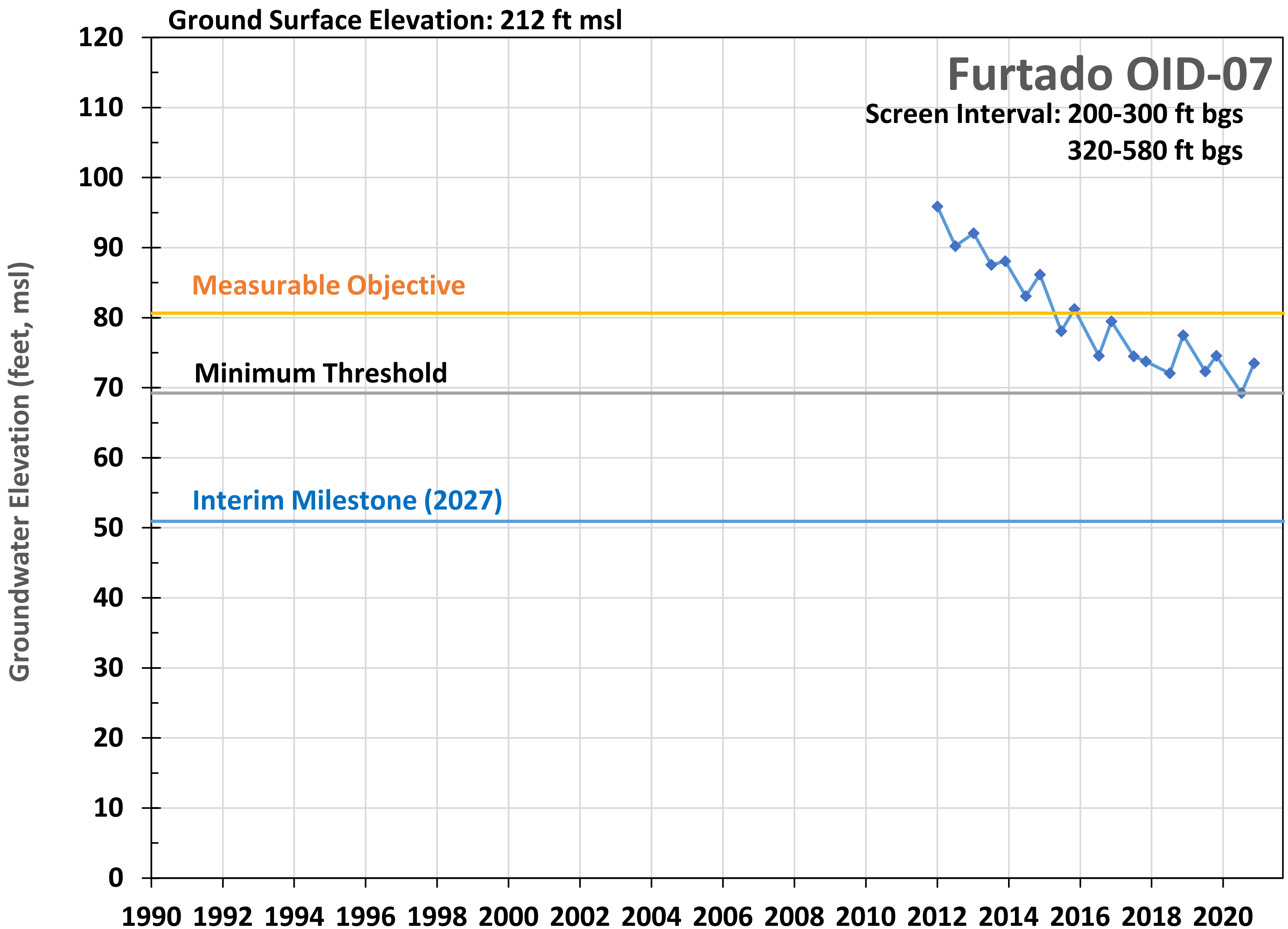
Ground Surface Elevation
Claribel 206
Screen Interval: 96-550 ft bgs
Measurable Objective
Minimum Threshold
Groundwater Elevation (feet, msl)
120
110
100
90
80
70
60
50
40
30
20
10
0
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016
2018
2020



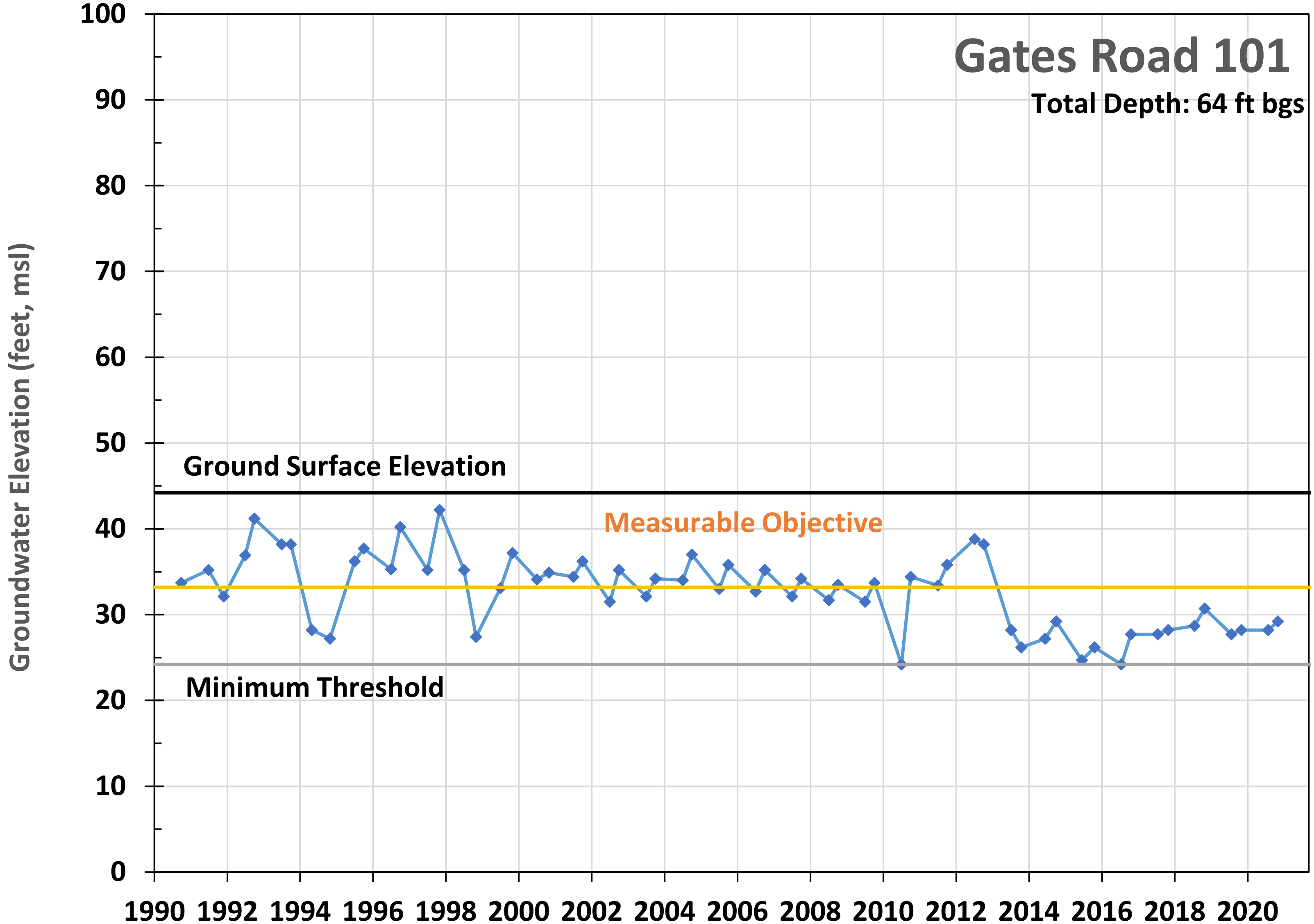
Crane OID-06
Ground Surface Elevation
Screen Interval: 155-170 ft bgs
185-198 ft bgs
Measurable Objective
Minimum Threshold
Interim Milestone (2027)
Groundwater Elevation (feet, msl)
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
1990 1992 1994 1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020



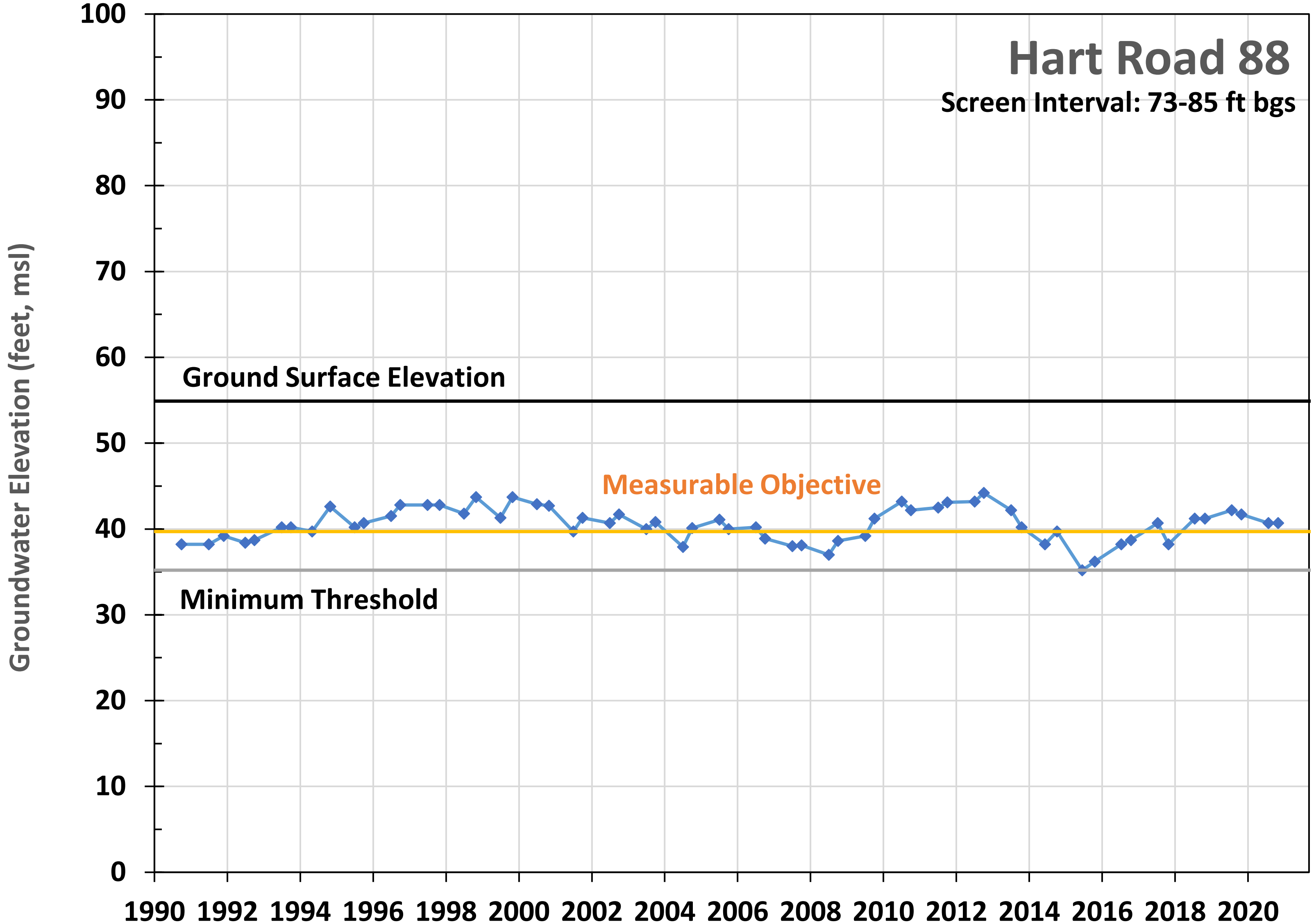
Curtis #2 100
Screen Interval: 79-100 ft bgs
Ground Surface Elevation
Measurable Objective
Minimum Threshold
Groundwater Elevation (feet, msl)
100
90
80
70
60
50
40
30
20
10
0
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016
2018
2020

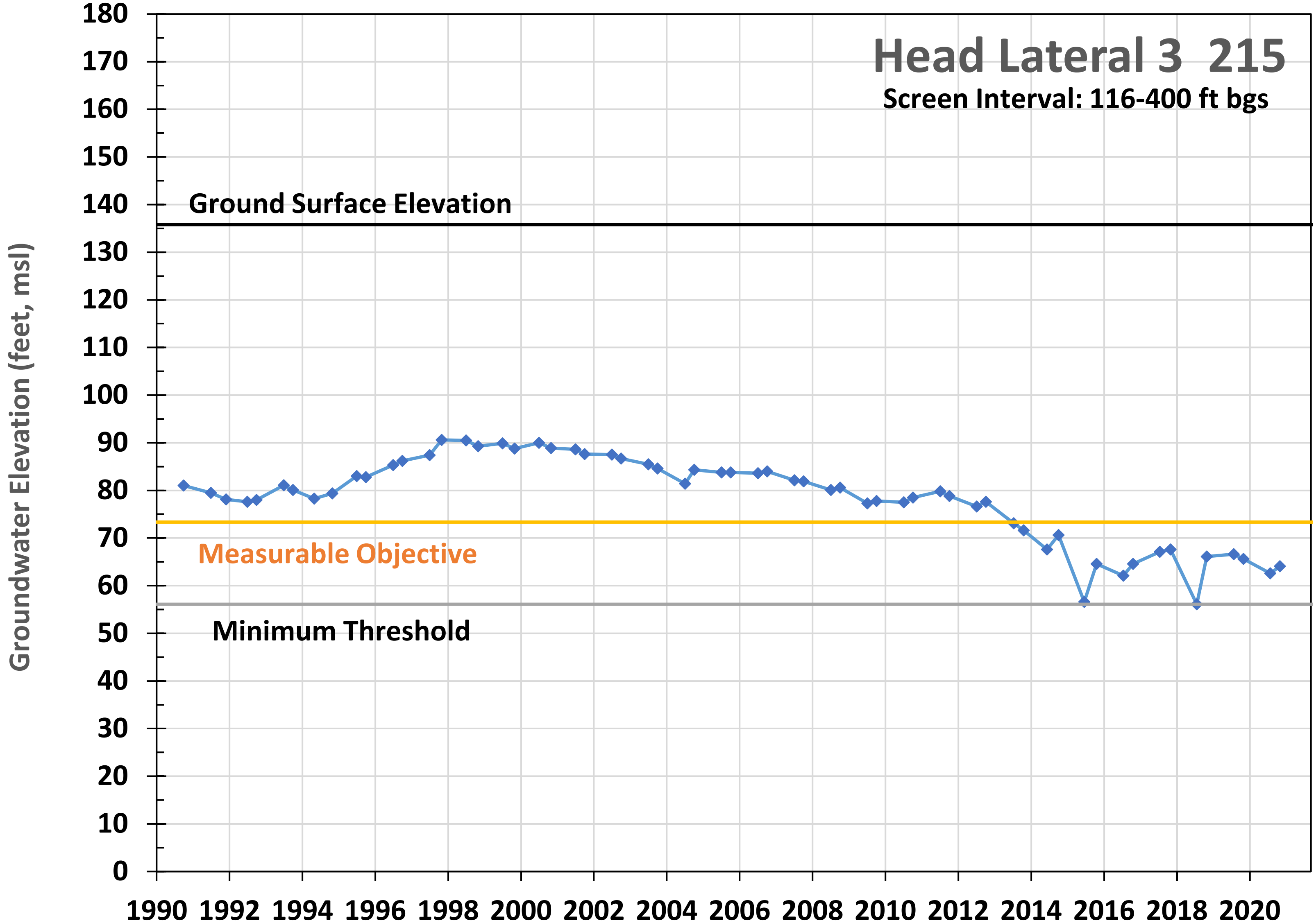


Ground Surface Elevation: 212 ft msl
Furtado OID-07
Screen Interval: 200-300 ft bgs
320-580 ft bgs
Measurable Objective
Minimum Threshold
Interim Milestone (2027)
Groundwater Elevation (feet, msl)
120
110
100
90
80
70
60
50
40
30
20
10
0
1990 1992 1994 1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020

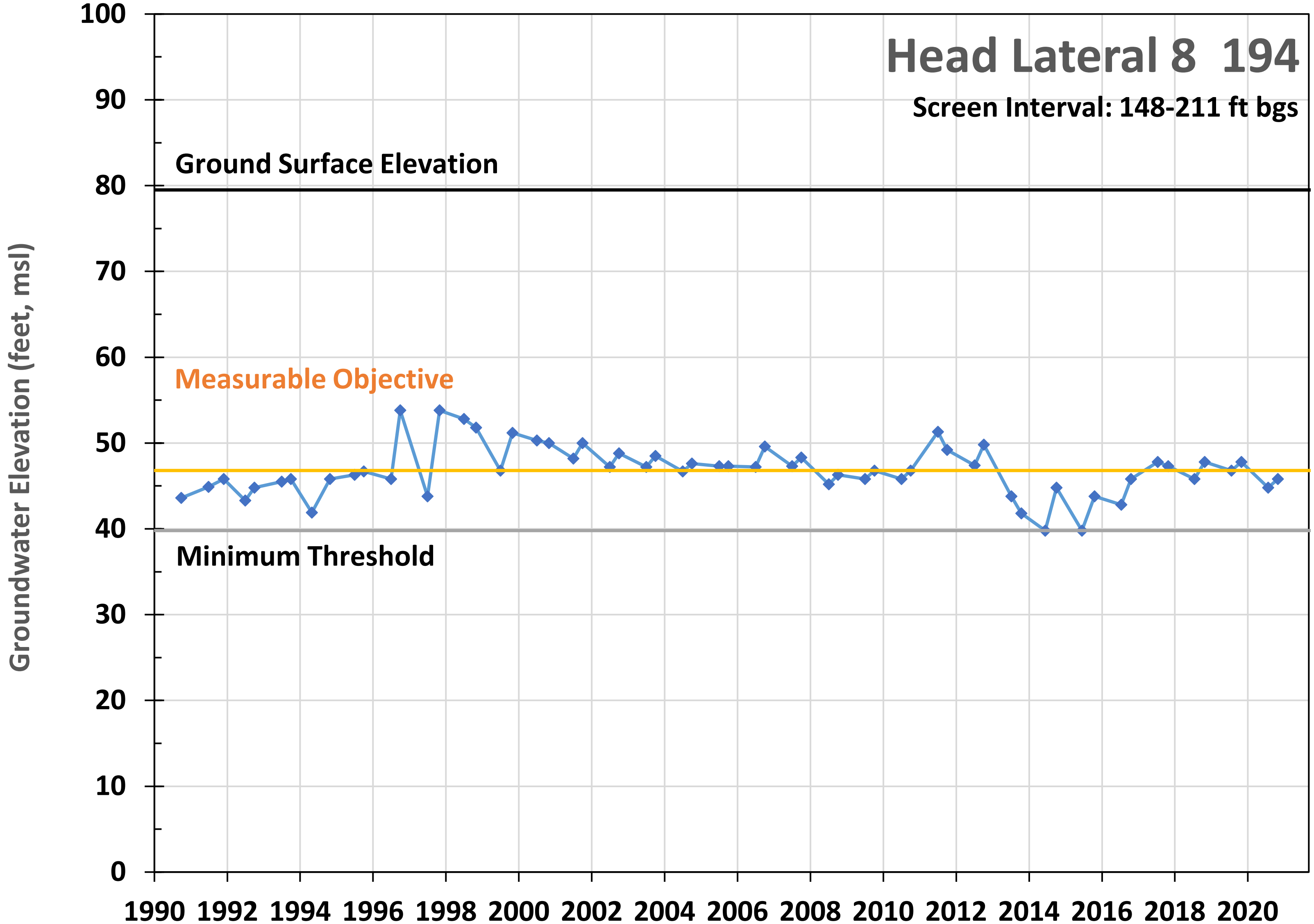


Gates Road 101
Total Depth: 64 ft bgs
Groundwater Elevation (feet, msl)
Ground Surface Elevation
Measurable Objective
Minimum Threshold
100
90
80
70
60
50
40
30
20
10
0
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016
2018
2020

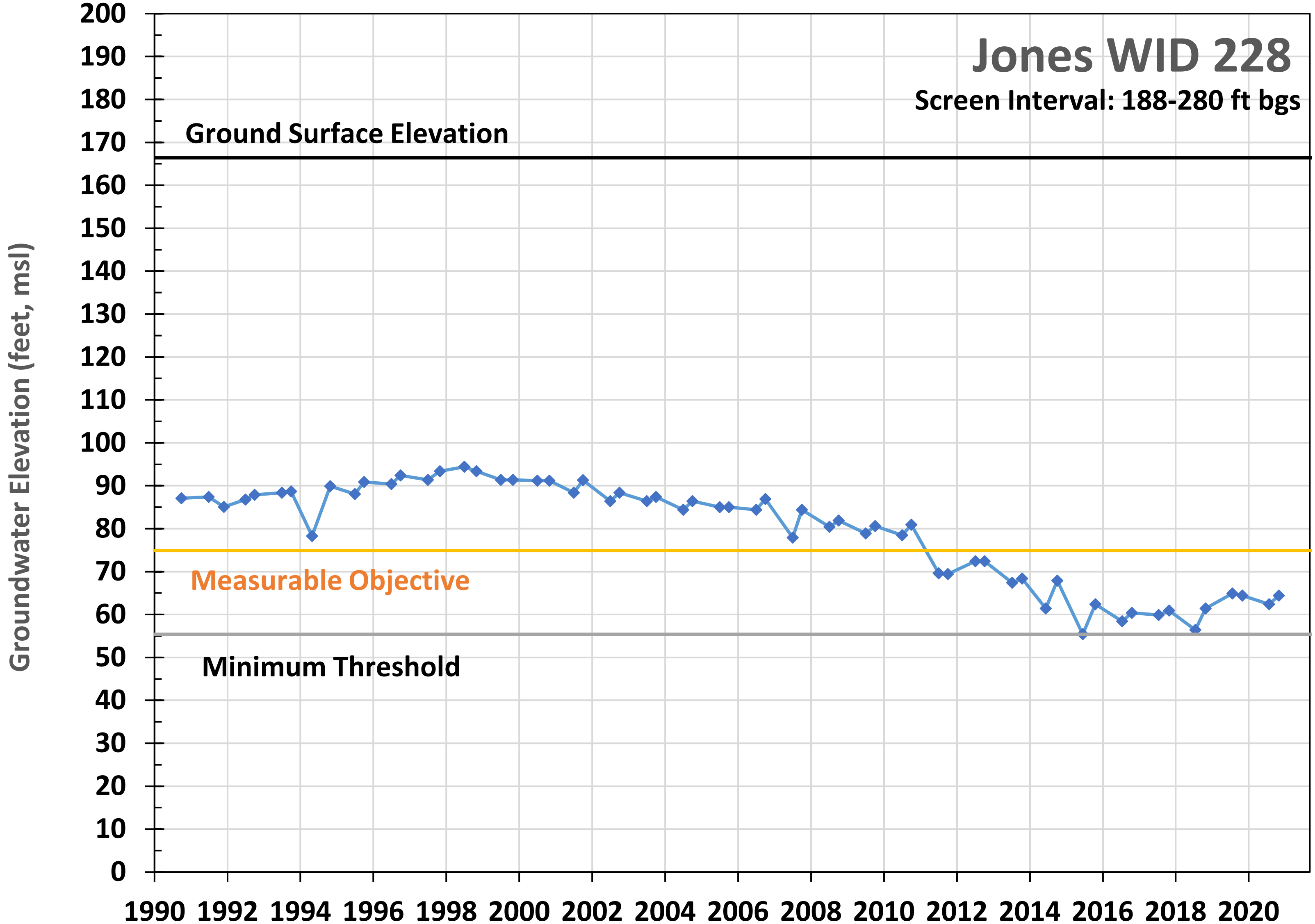

Hart Road 88
Screen Interval: 73-85 ft bgs
Ground Surface Elevation
Measurable Objective
Minimum Threshold
Groundwater Elevation (feet, msl)
100
90
80
70
60
50
40
30
20
10
0
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016
2018
2020



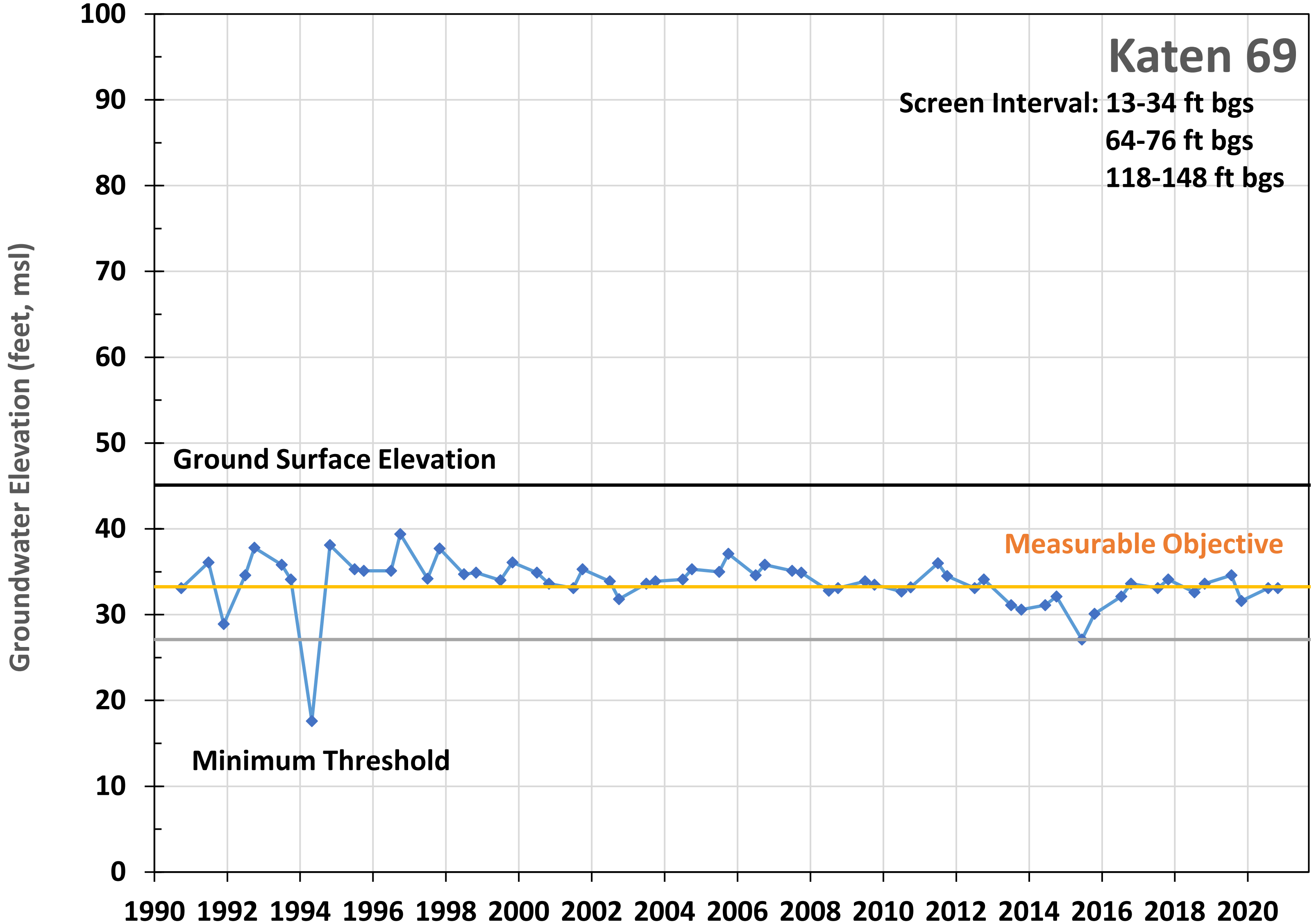
Head Lateral 3 215
Screen Interval: 116-400 ft bgs
Ground Surface Elevation
Measurable Objective
Minimum Threshold
Groundwater Elevation (feet, msl)
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016
2018
2020



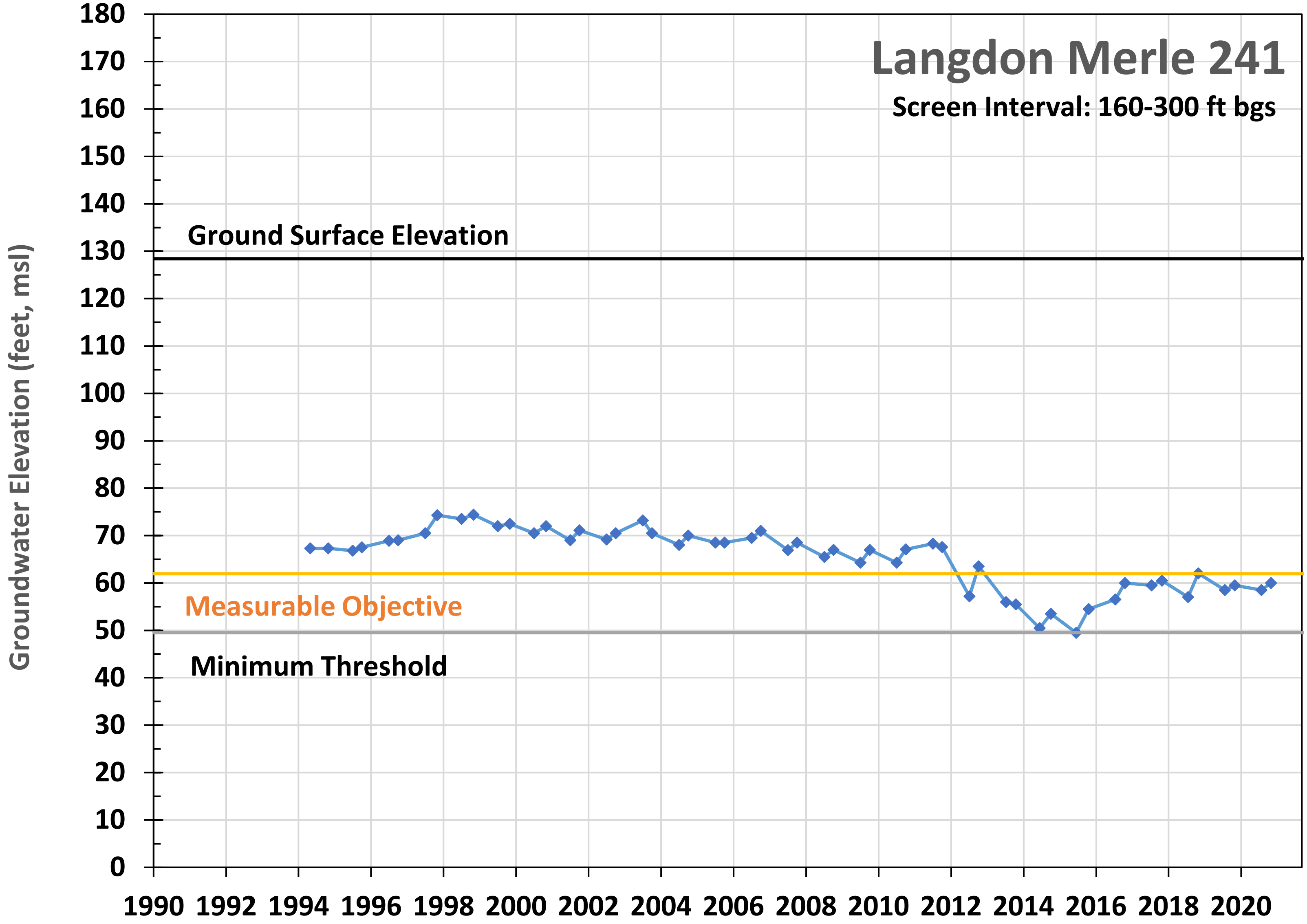
Head Lateral 8 194
Screen Interval: 148-211 ft bgs
Ground Surface Elevation
Measurable Objective
Minimum Threshold
Groundwater Elevation (feet, msl)
100
90
80
70
60
50
40
30
20
10
0
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016
2018
2020



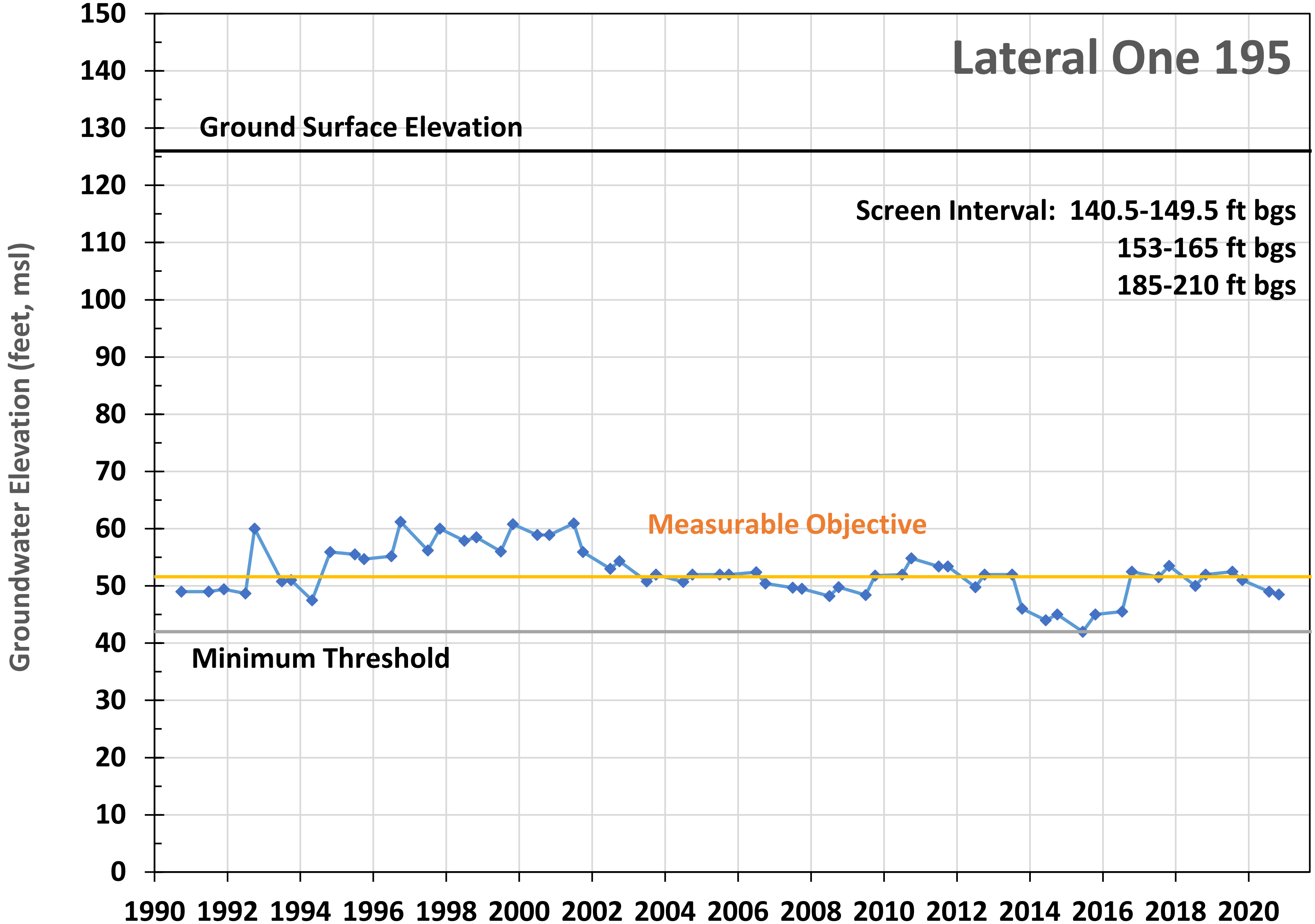
Jones WID 228
Screen Interval: 188-280 ft bgs
Ground Surface Elevation
Measurable Objective
Minimum Threshold
Groundwater Elevation (feet, msl)
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016
2018
2020



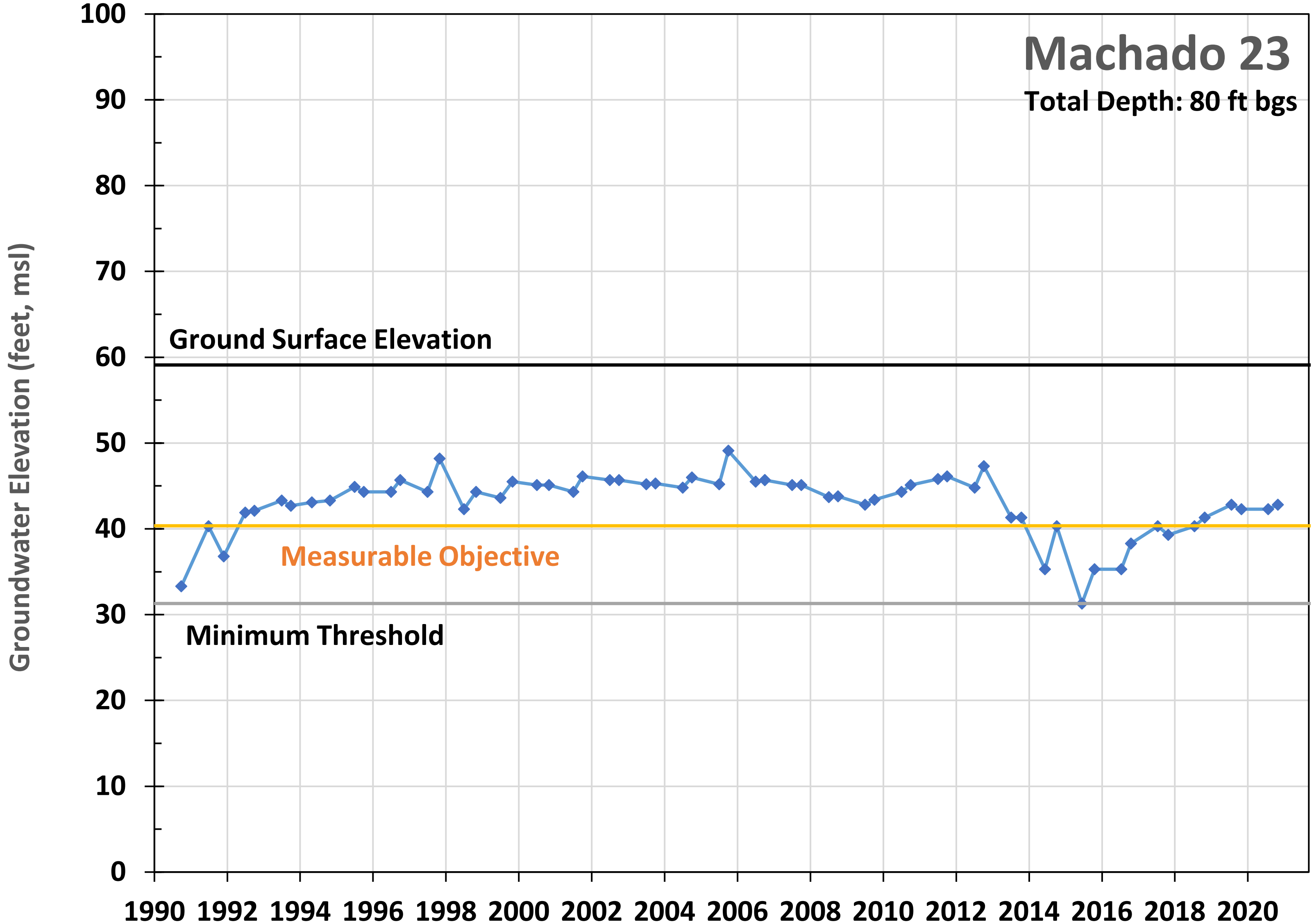
Katen 69
Screen Interval: 13-34 ft bgs
64-76 ft bgs
118-148 ft bgs
Groundwater Elevation (feet, msl)
Ground Surface Elevation
Measurable Objective
Minimum Threshold
100
90
80
70
60
50
40
30
20
10
0
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016
2018
2020



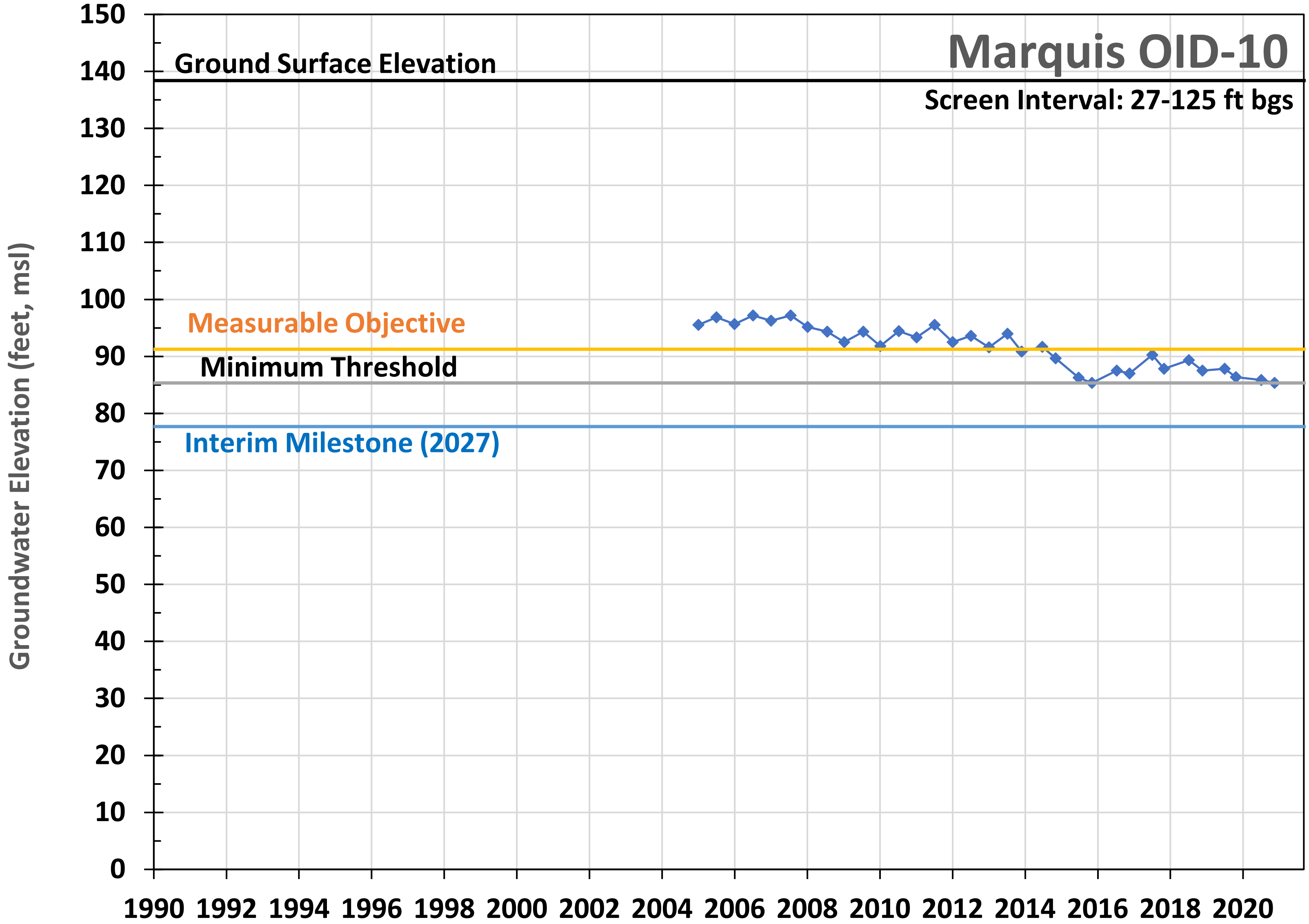
Langdon Merle 241
Screen Interval: 160-300 ft bgs
Ground Surface Elevation
Measurable Objective
Minimum Threshold
Groundwater Elevation (feet, msl)
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016
2018
2020



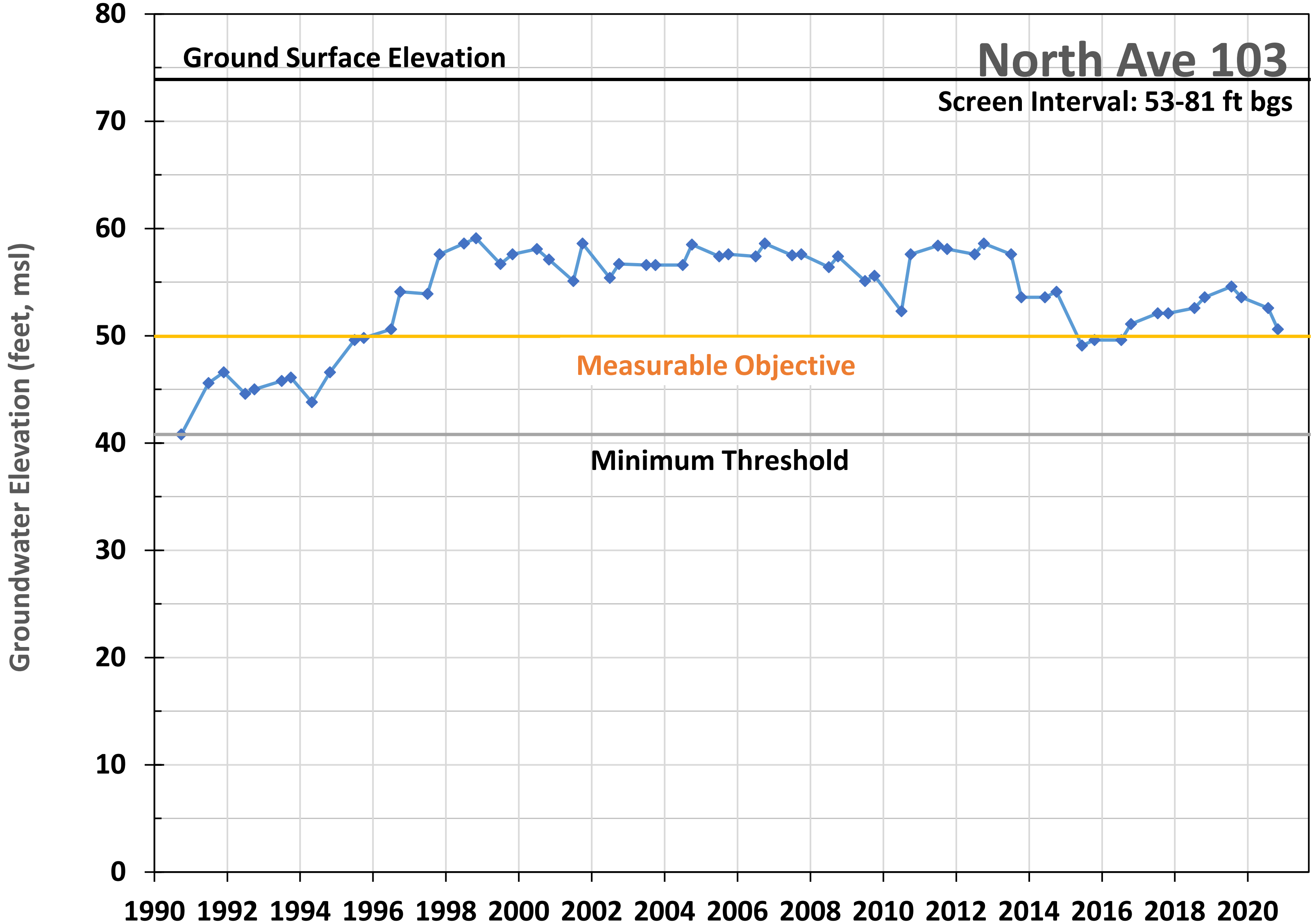
Lateral One 195
Ground Surface Elevation
Screen Interval: 140.5-149.5 ft bgs
153-165 ft bgs
185-210 ft bgs
Measurable Objective
Minimum Threshold
Groundwater Elevation (feet, msl)
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016
2018
2020

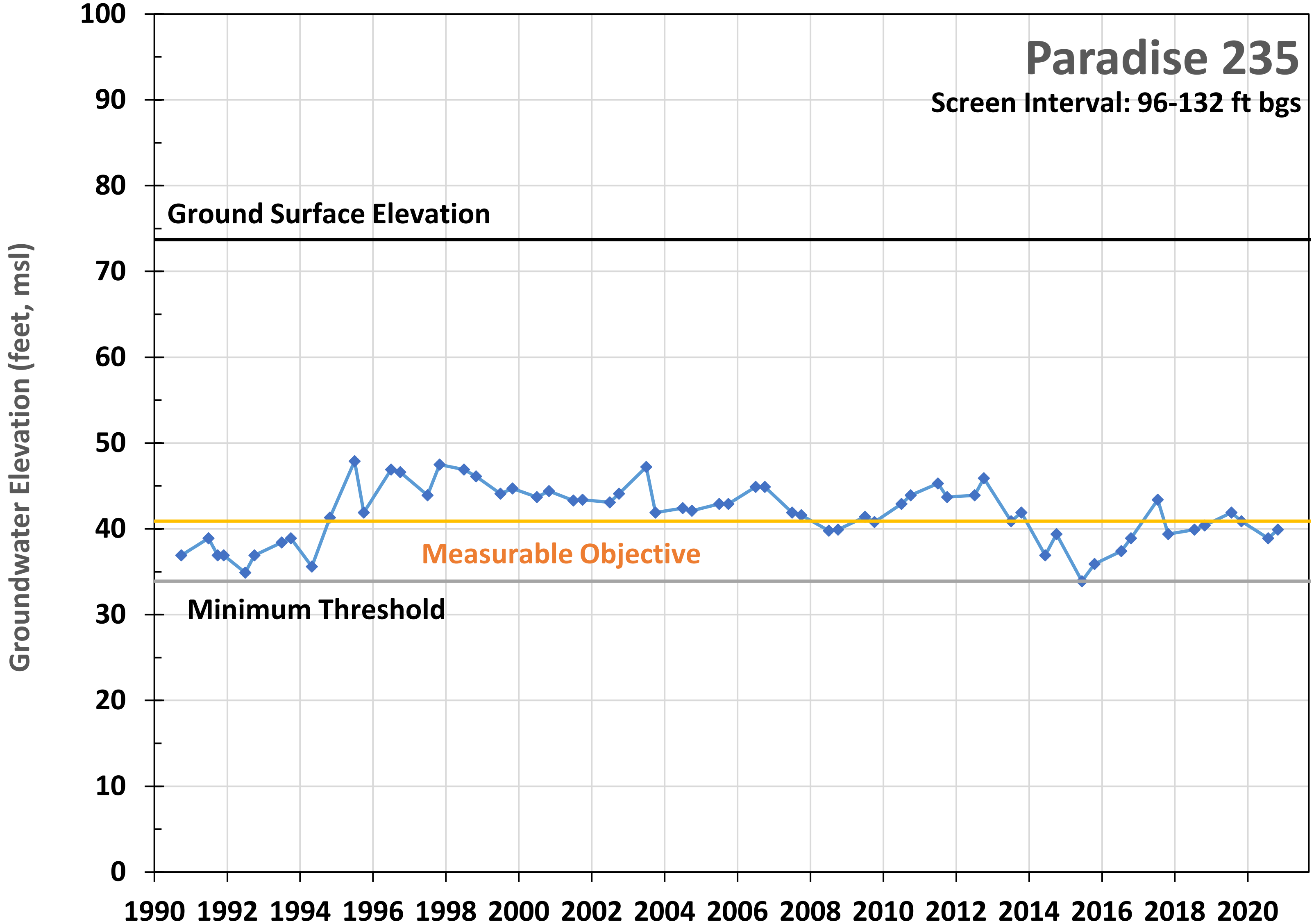


Machado 23
Total Depth: 80 ft bgs
Ground Surface Elevation
Measurable Objective
Minimum Threshold
Groundwater Elevation (feet, msl)
100
90
80
70
60
50
40
30
20
10
0
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016
2018
2020

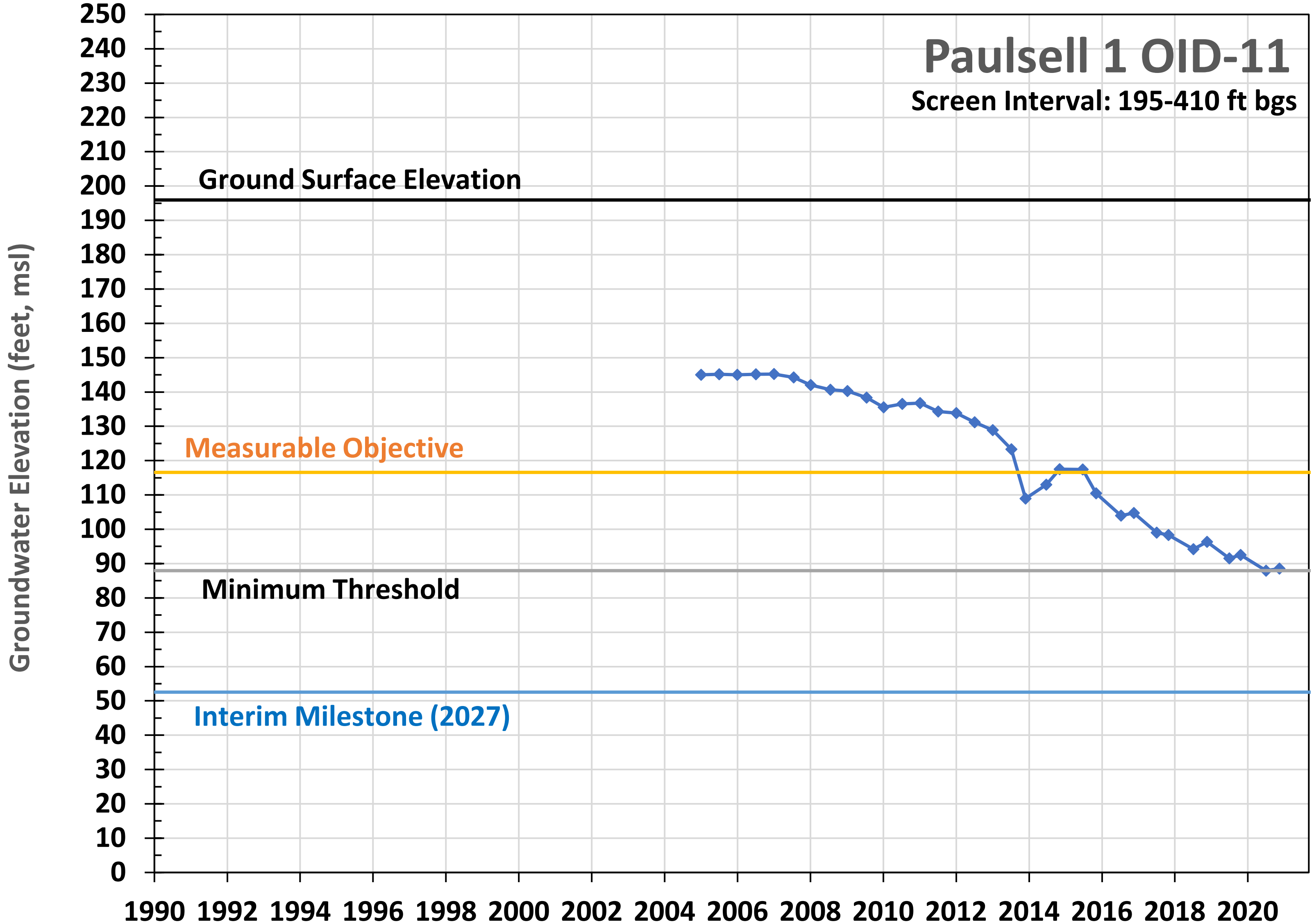


Marquis OID-10
Screen Interval: 27-125 ft bgs
Ground Surface Elevation
Measurable Objective
Minimum Threshold
Interim Milestone (2027)
Groundwater Elevation (feet, msl)
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
1990 1992 1994 1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020

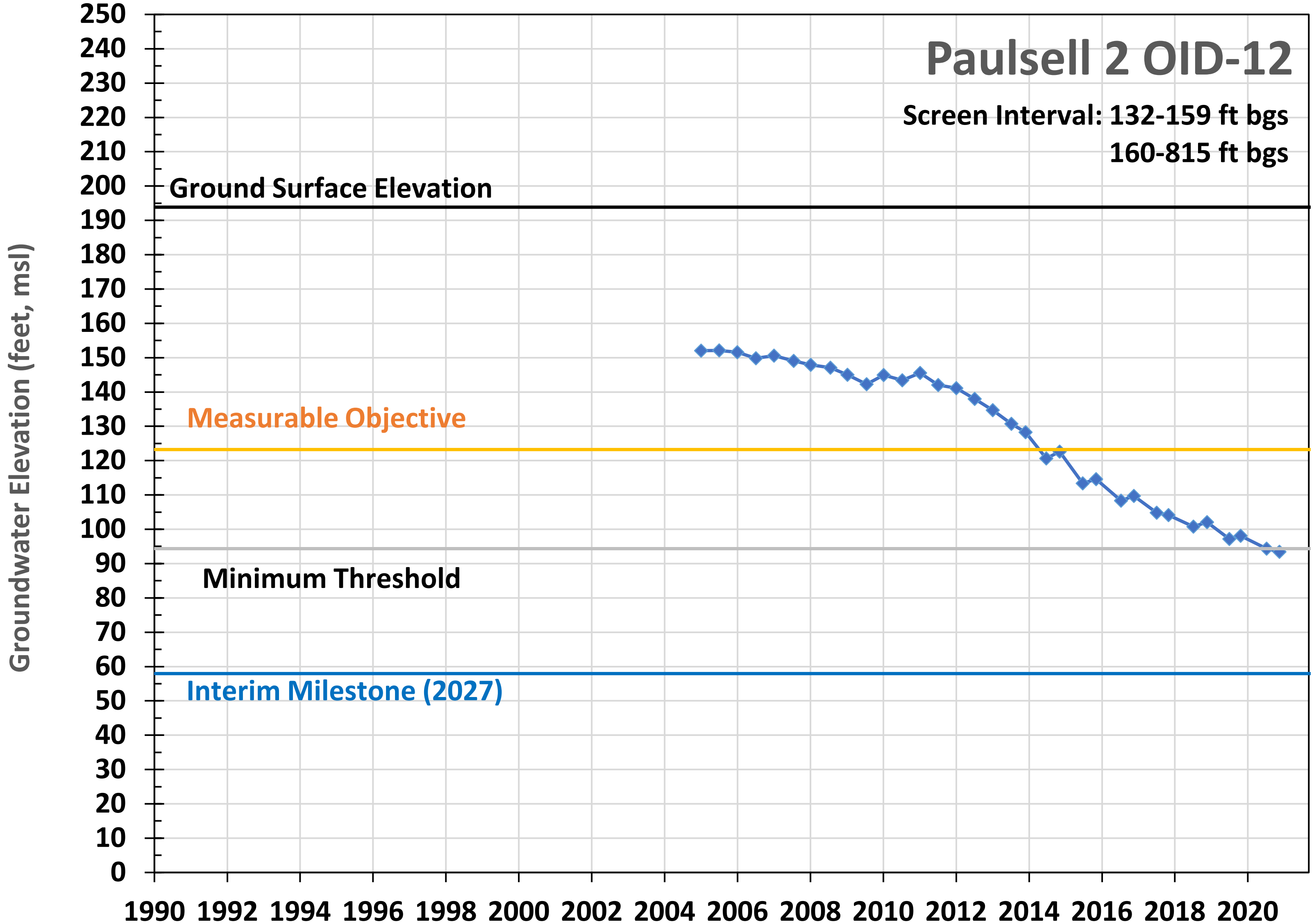

North Ave 103
Ground Surface Elevation
Screen Interval: 53-81 ft bgs
Measurable Objective
Minimum Threshold
Groundwater Elevation (feet, msl)
80
70
60
50
40
30
20
10
0
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016
2018
2020



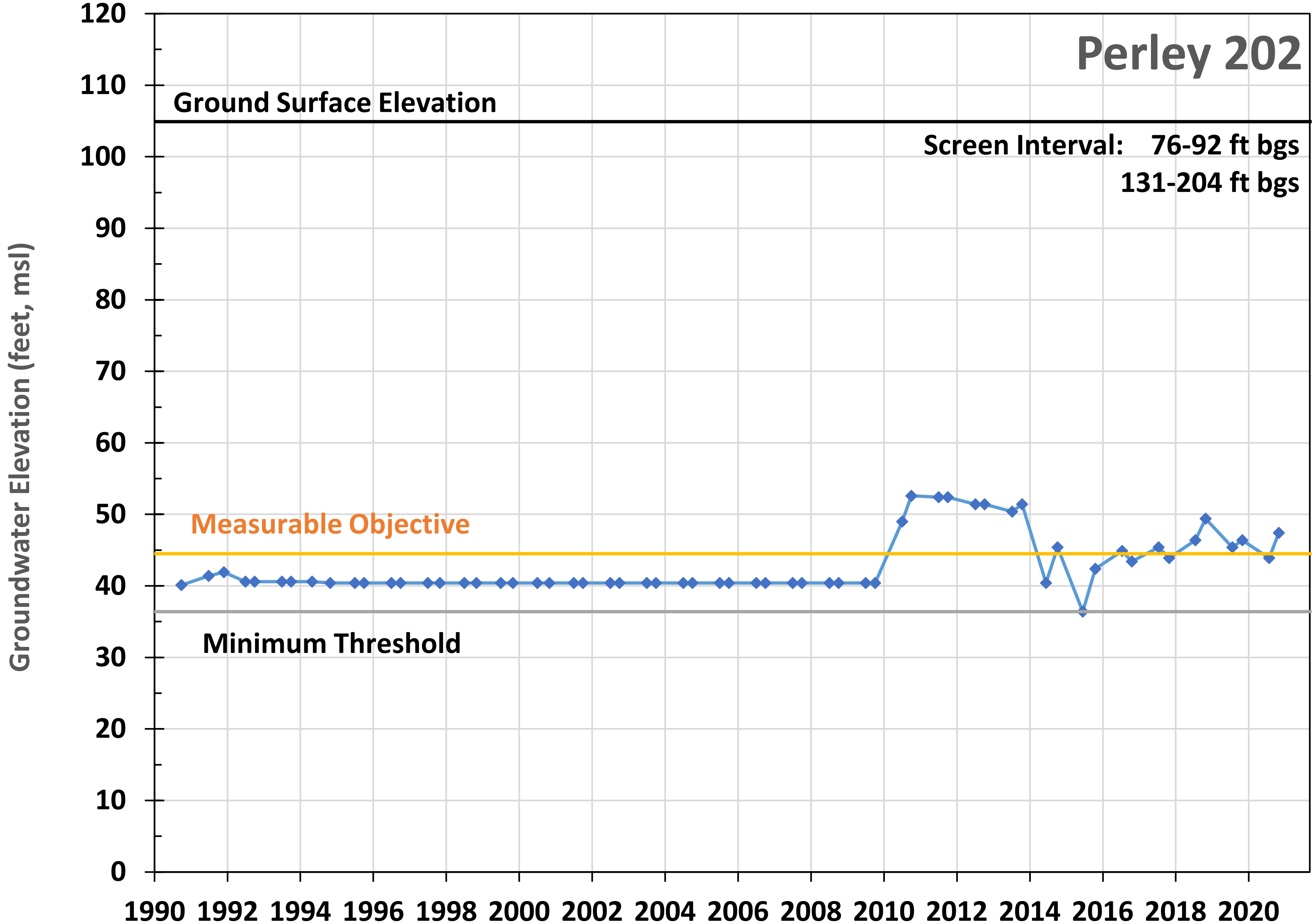
Paradise 235
Screen Interval: 96-132 ft bgs
Ground Surface Elevation
Measurable Objective
Minimum Threshold
Groundwater Elevation (feet, msl)
100
90
80
70
60
50
40
30
20
10
0
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016
2018
2020



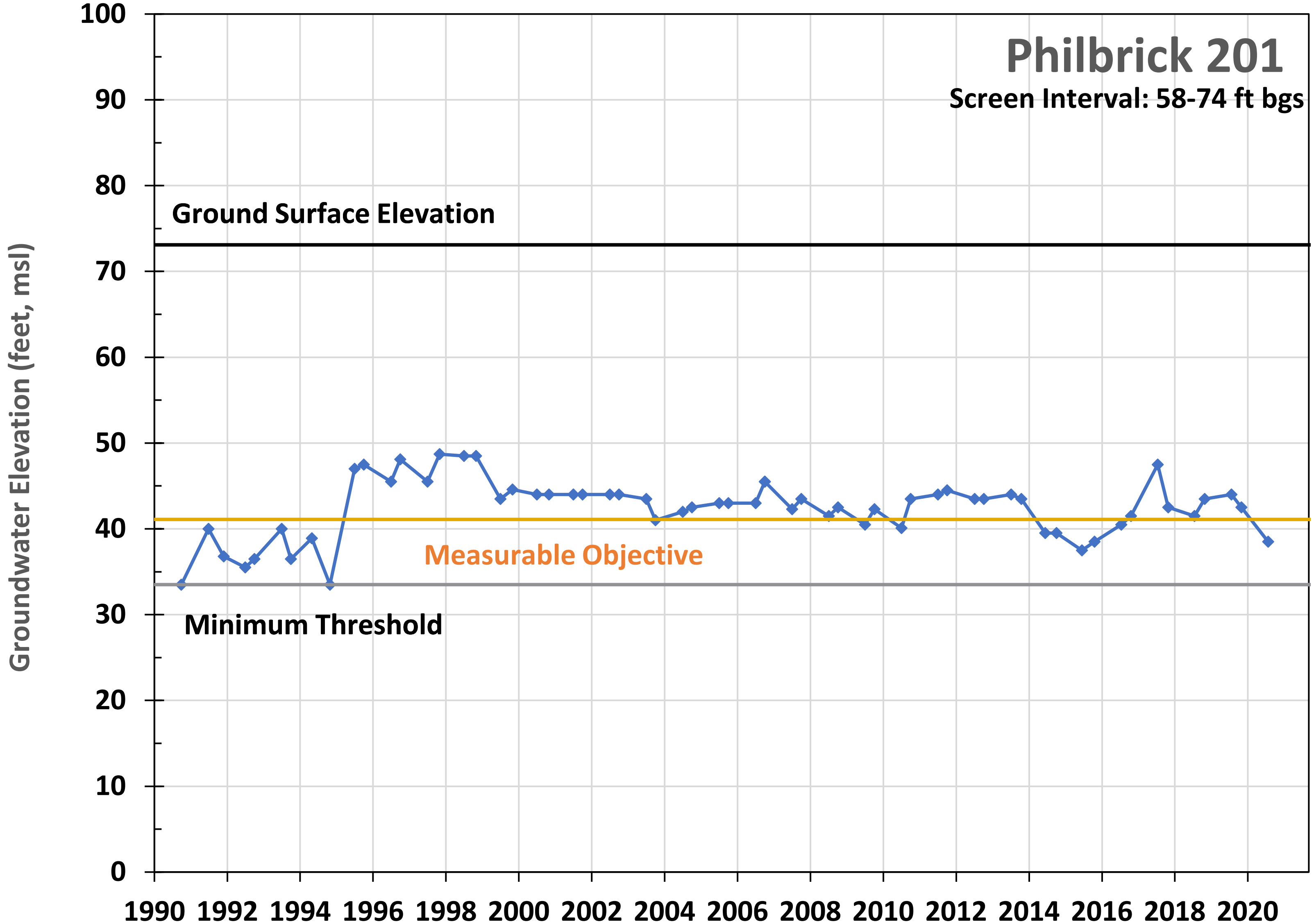
Paulsell 1 OID-11
Screen Interval: 195-410 ft bgs
Ground Surface Elevation
Measurable Objective
Minimum Threshold
Interim Milestone (2027)
Groundwater Elevation (feet, msl)
250
240
230
220
210
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016
2018
2020



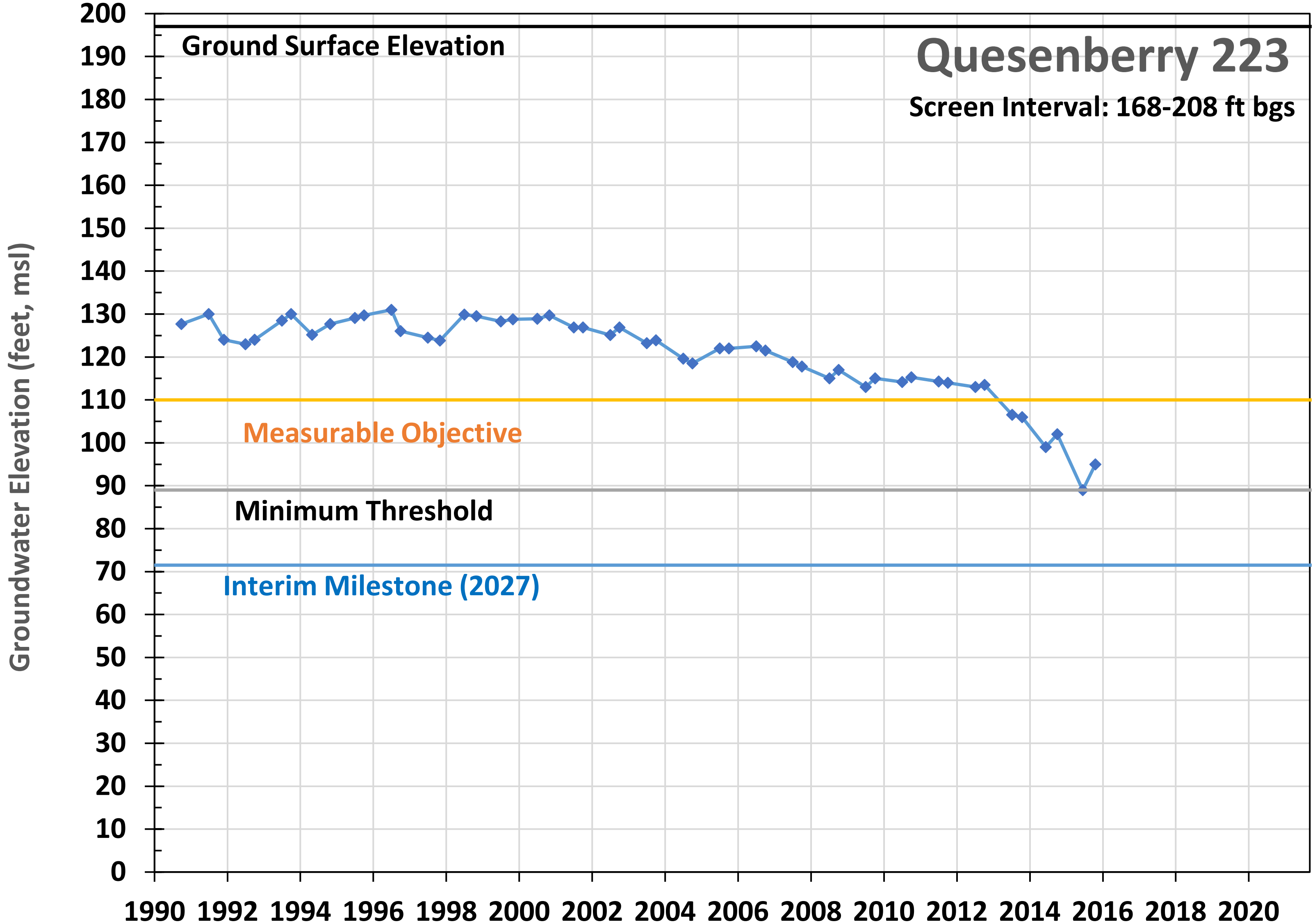
Paulsell 2 OID-12
Screen Interval: 132-159 ft bgs
160-815 ft bgs
Ground Surface Elevation
Measurable Objective
Minimum Threshold
Interim Milestone (2027)
Groundwater Elevation (feet, msl)
250
240
230
220
210
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016
2018
2020



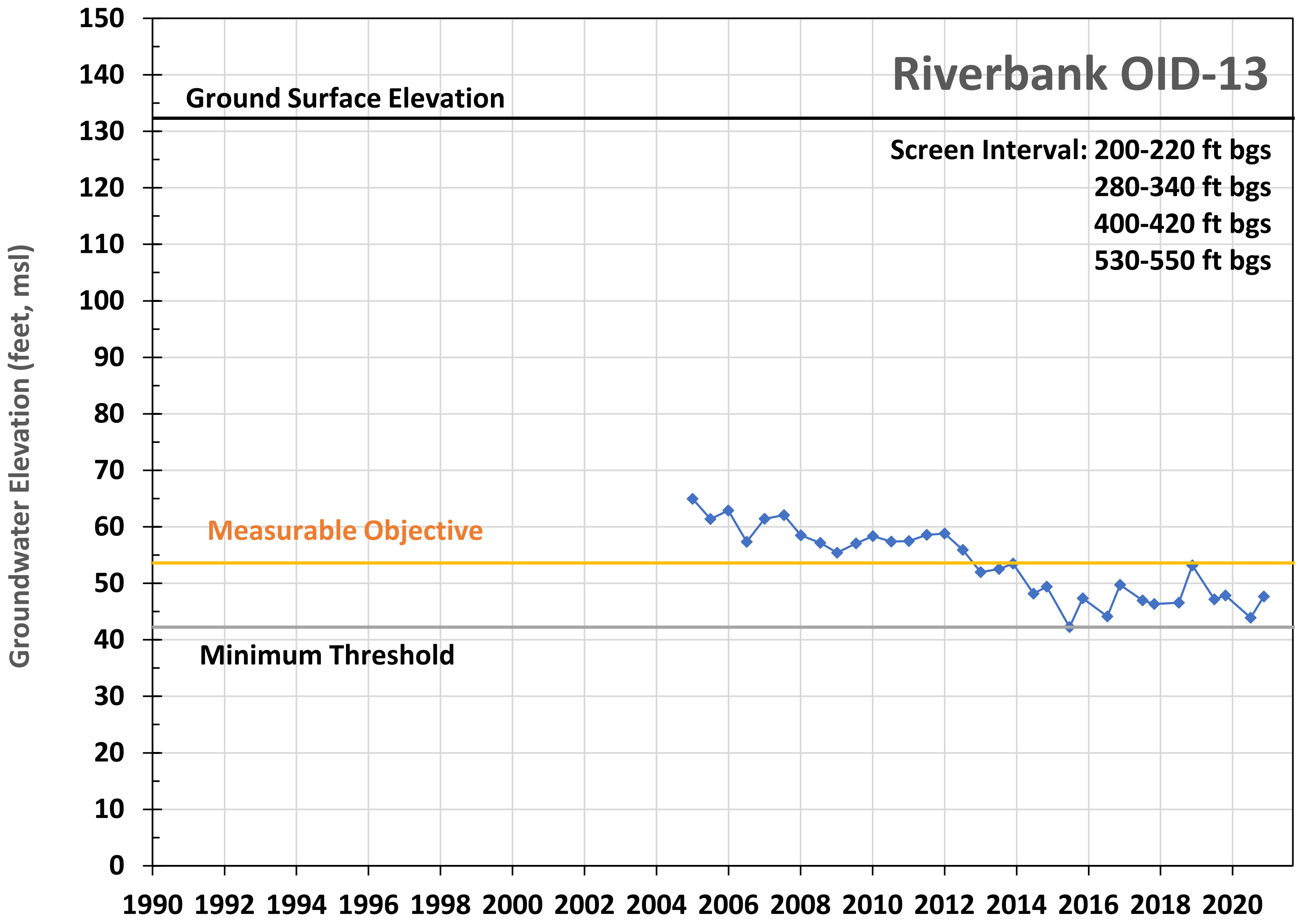
Perley 202
Ground Surface Elevation
Screen Interval: 76-92 ft bgs
131-204 ft bgs
Measurable Objective
Minimum Threshold
Groundwater Elevation (feet, msl)
0
10
20
30
40
50
60
70
80
90
100
110
120
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016
2018
2020



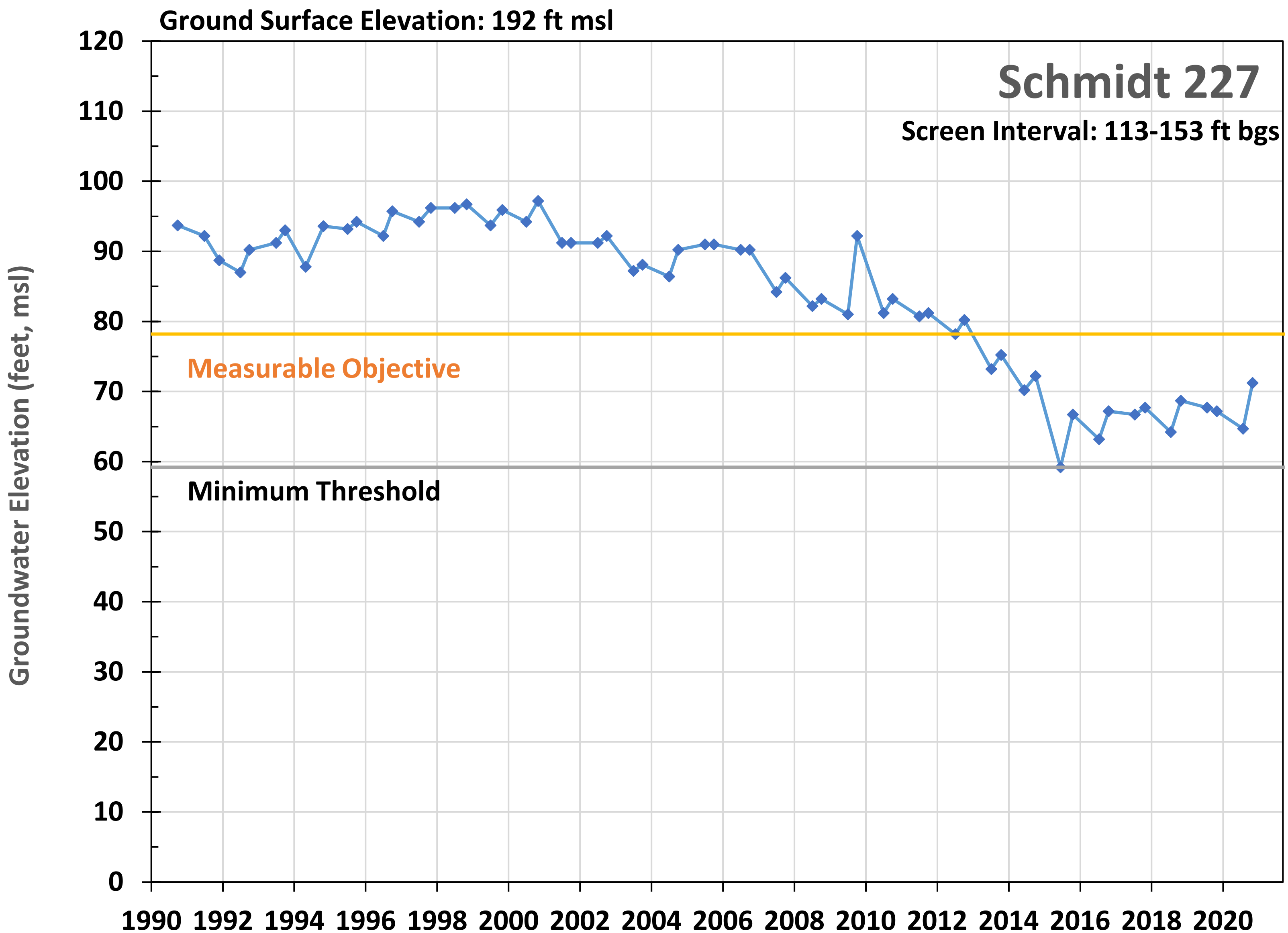
Philbrick 201
Screen Interval: 58-74 ft bgs
Ground Surface Elevation
Measurable Objective
Minimum Threshold
Groundwater Elevation (feet, msl)
100
90
80
70
60
50
40
30
20
10
0
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016
2018
2020



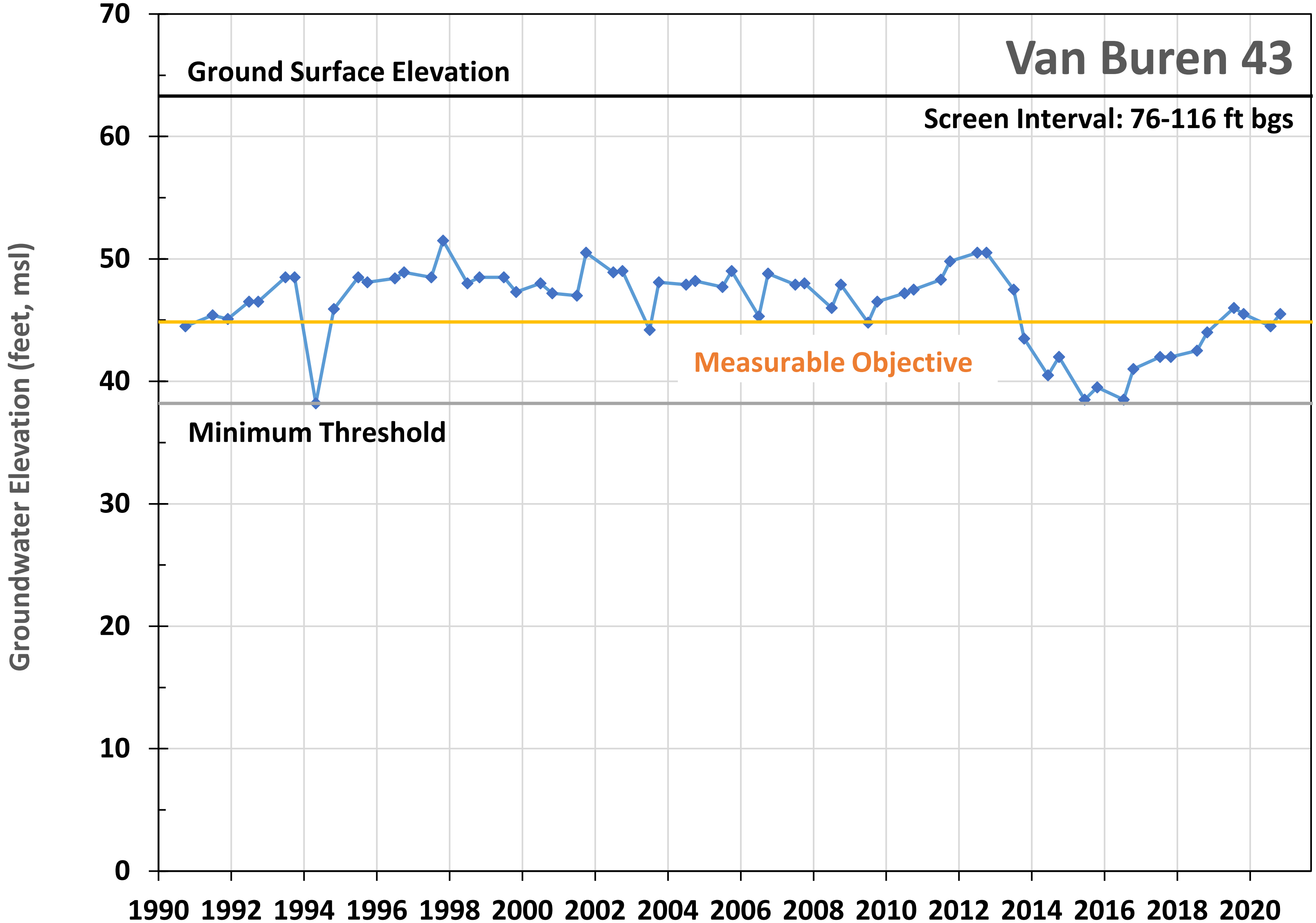
Quesenberry 223
Screen Interval: 168-208 ft bgs
Ground Surface Elevation
Measurable Objective
Minimum Threshold
Interim Milestone (2027)
Groundwater Elevation (feet, msl)
0
10
20
30
40
50
60
70
80
90
100
110
120
130
140
150
160
170
180
190
200
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016
2018
2020



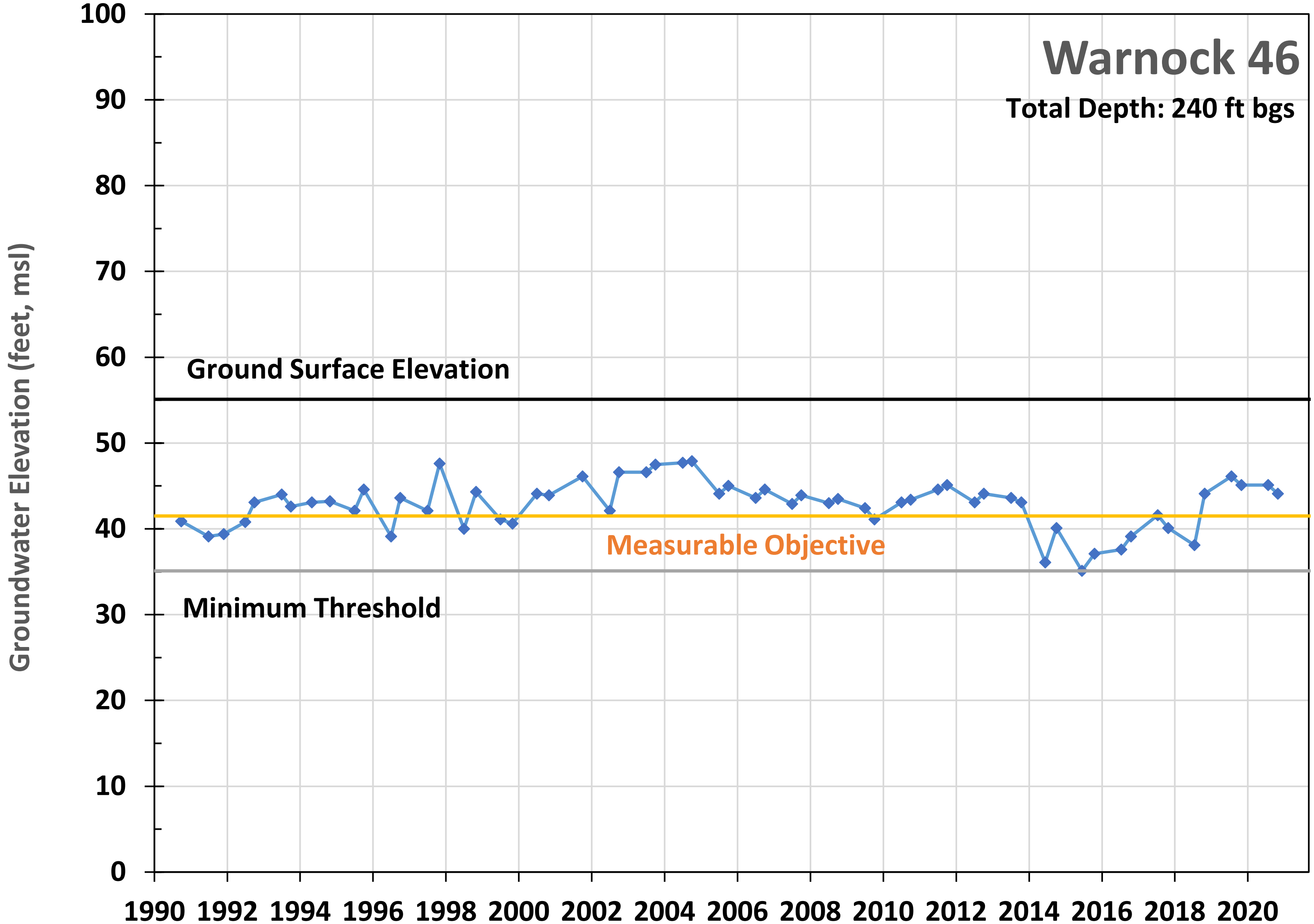
Riverbank OID-13
Ground Surface Elevation
Screen Interval: 200-220 ft bgs
280-340 ft bgs
400-420 ft bgs
530-550 ft bgs
Measurable Objective
Minimum Threshold
Groundwater Elevation (feet, msl)
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016
2018
2020

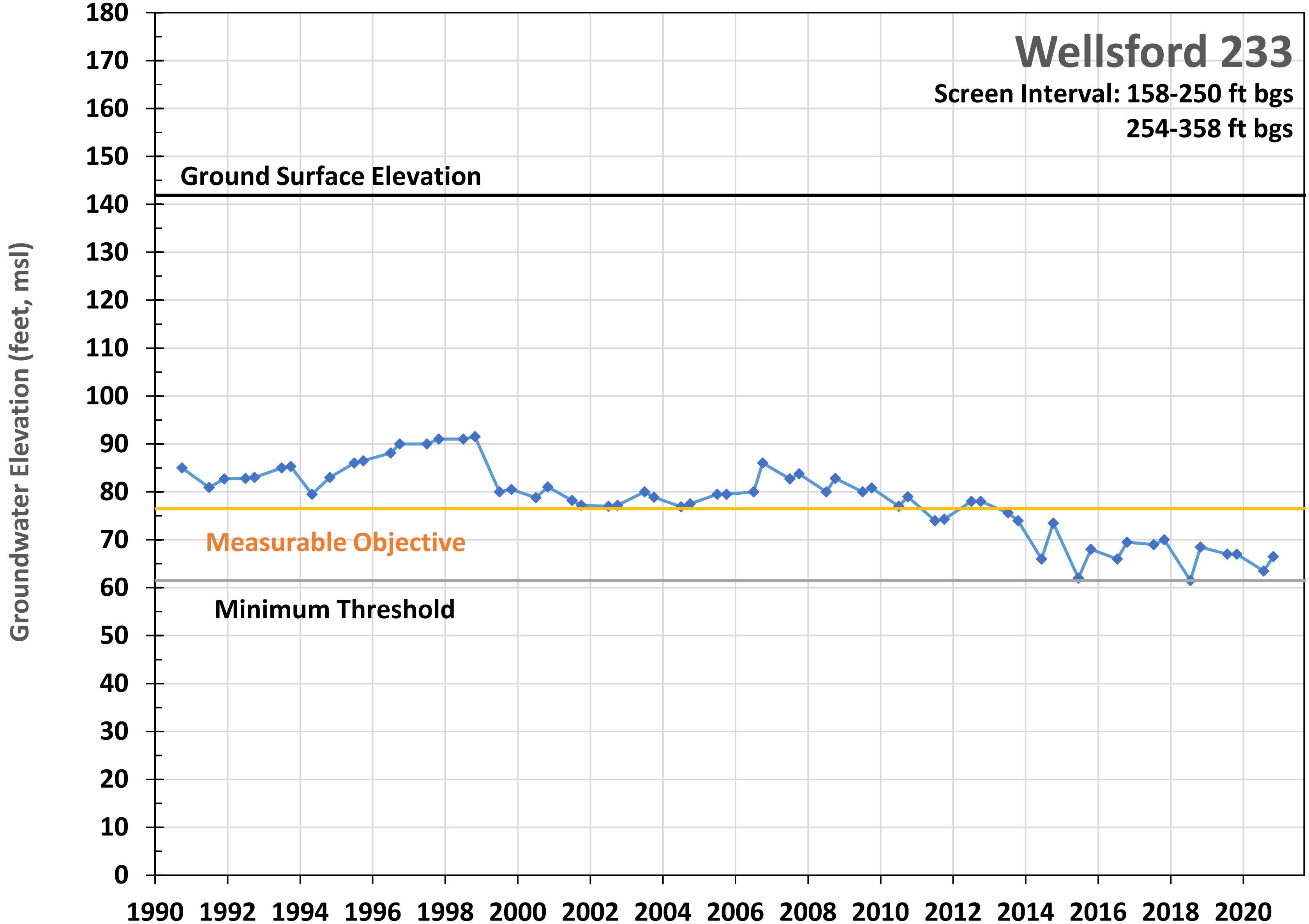


Ground Surface Elevation: 192 ft msl
Schmidt 227
Screen Interval: 113-153 ft bgs
Measurable Objective
Minimum Threshold
Groundwater Elevation (feet, msl)
0
10
20
30
40
50
60
70
80
90
100
110
120
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016
2018
2020

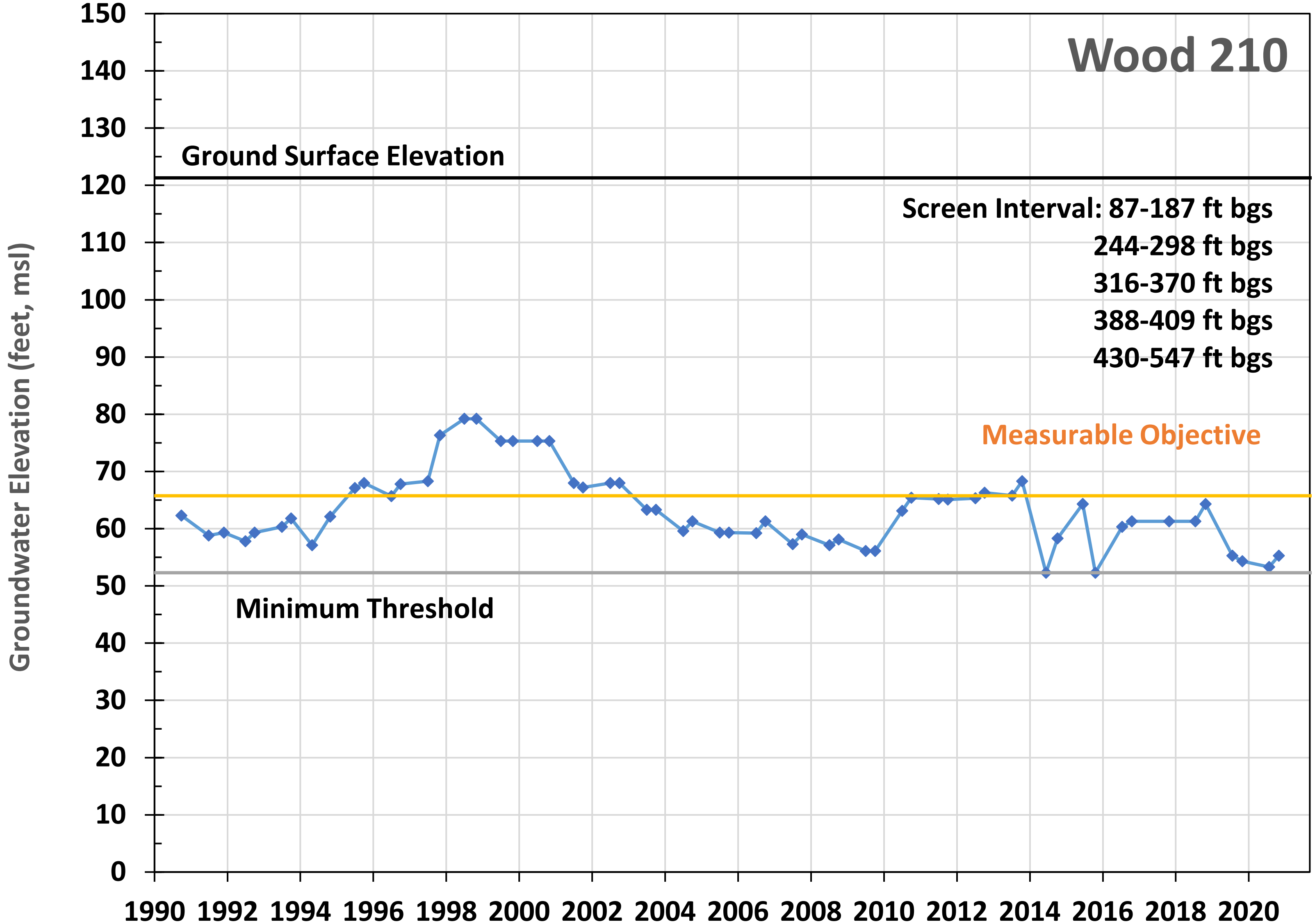


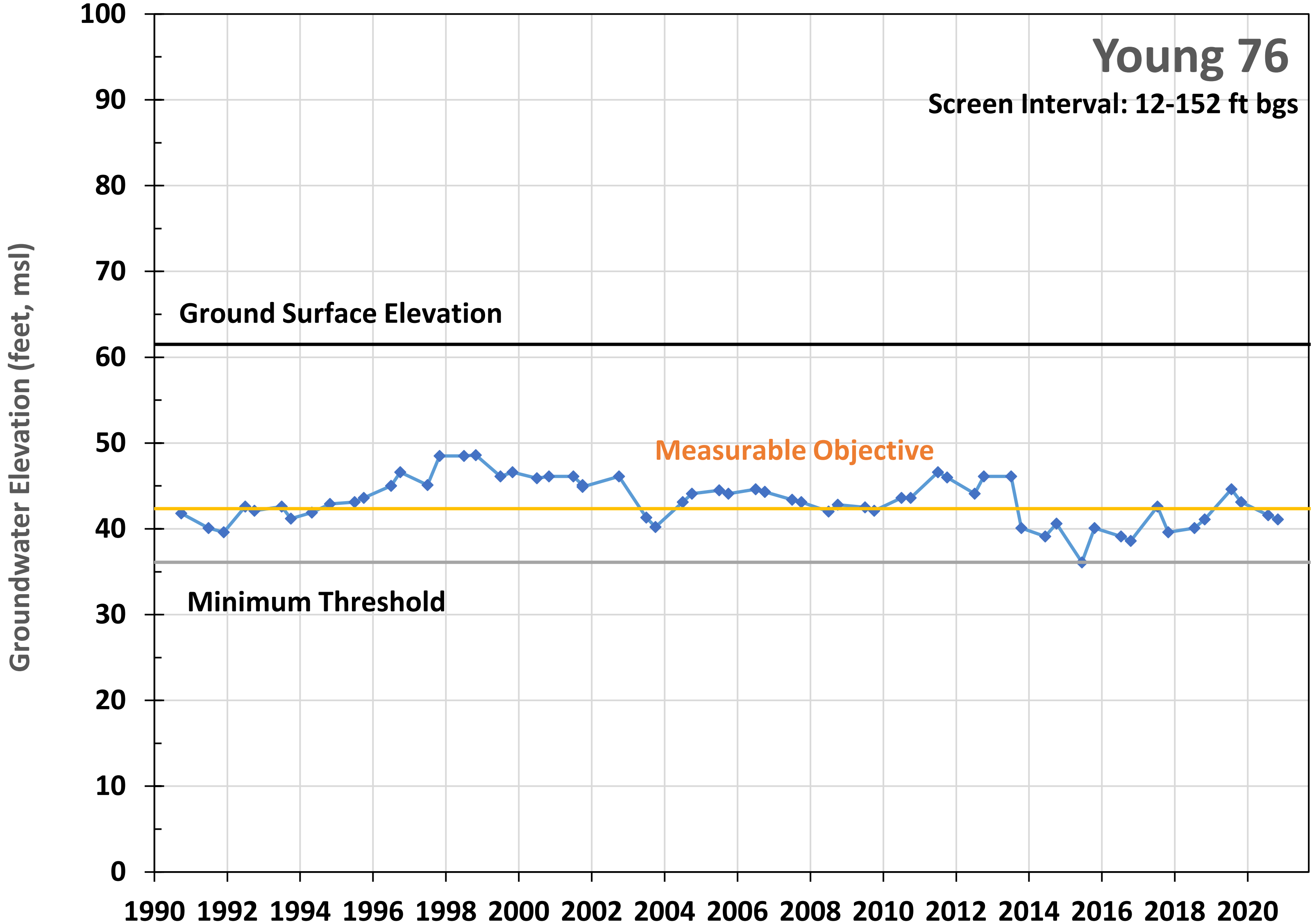
Van Buren 43
Ground Surface Elevation
Screen Interval: 76-116 ft bgs
Measurable Objective
Minimum Threshold
Groundwater Elevation (feet, msl)
70
60
50
40
30
20
10
0
1990 1992 1994 1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020


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

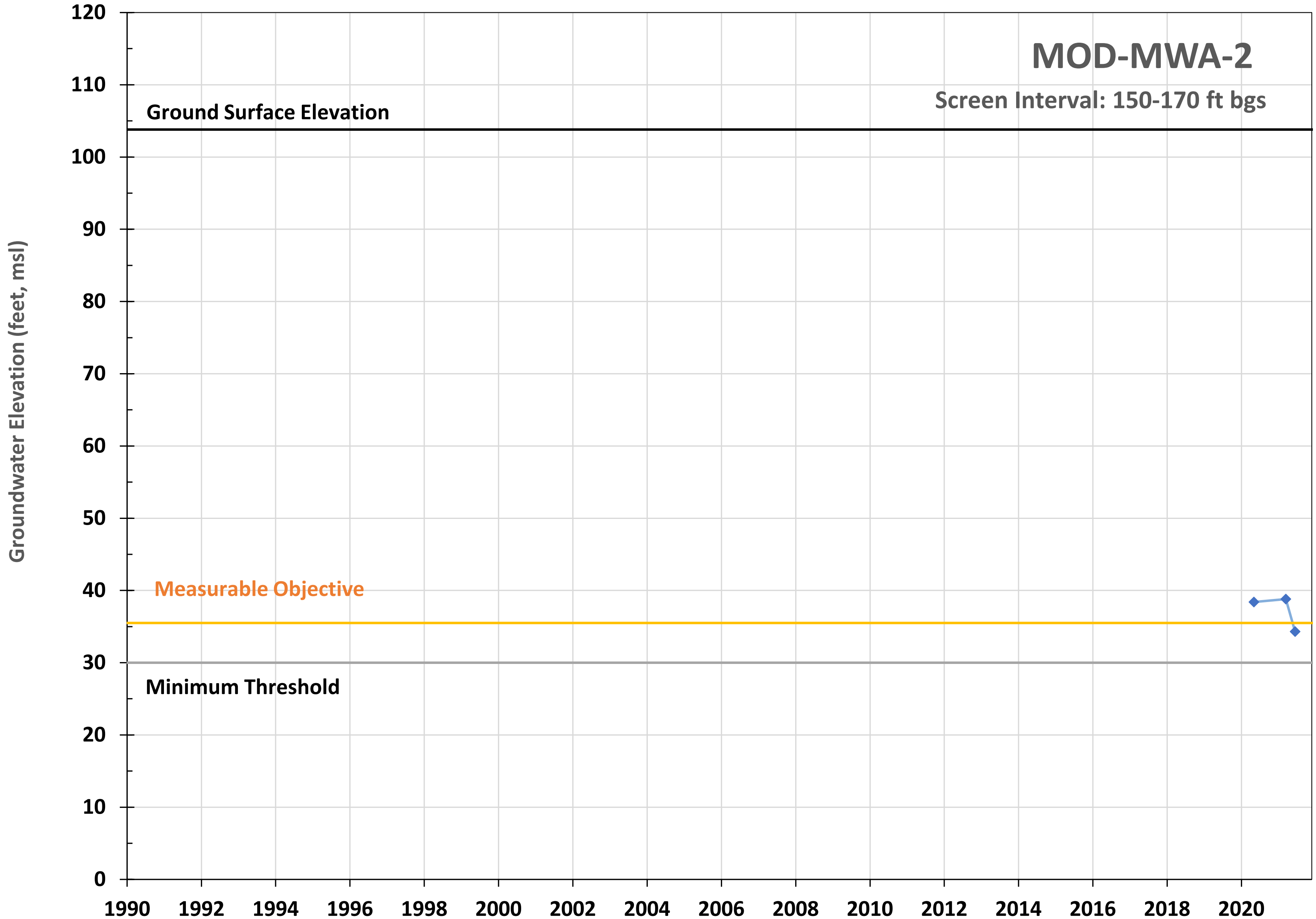


Wellsford 233
Screen Interval: 158-250 ft bgs
254-358 ft bgs
Ground Surface Elevation
Measurable Objective
Minimum Threshold
Groundwater Elevation (feet, msl)
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016
2018
2020

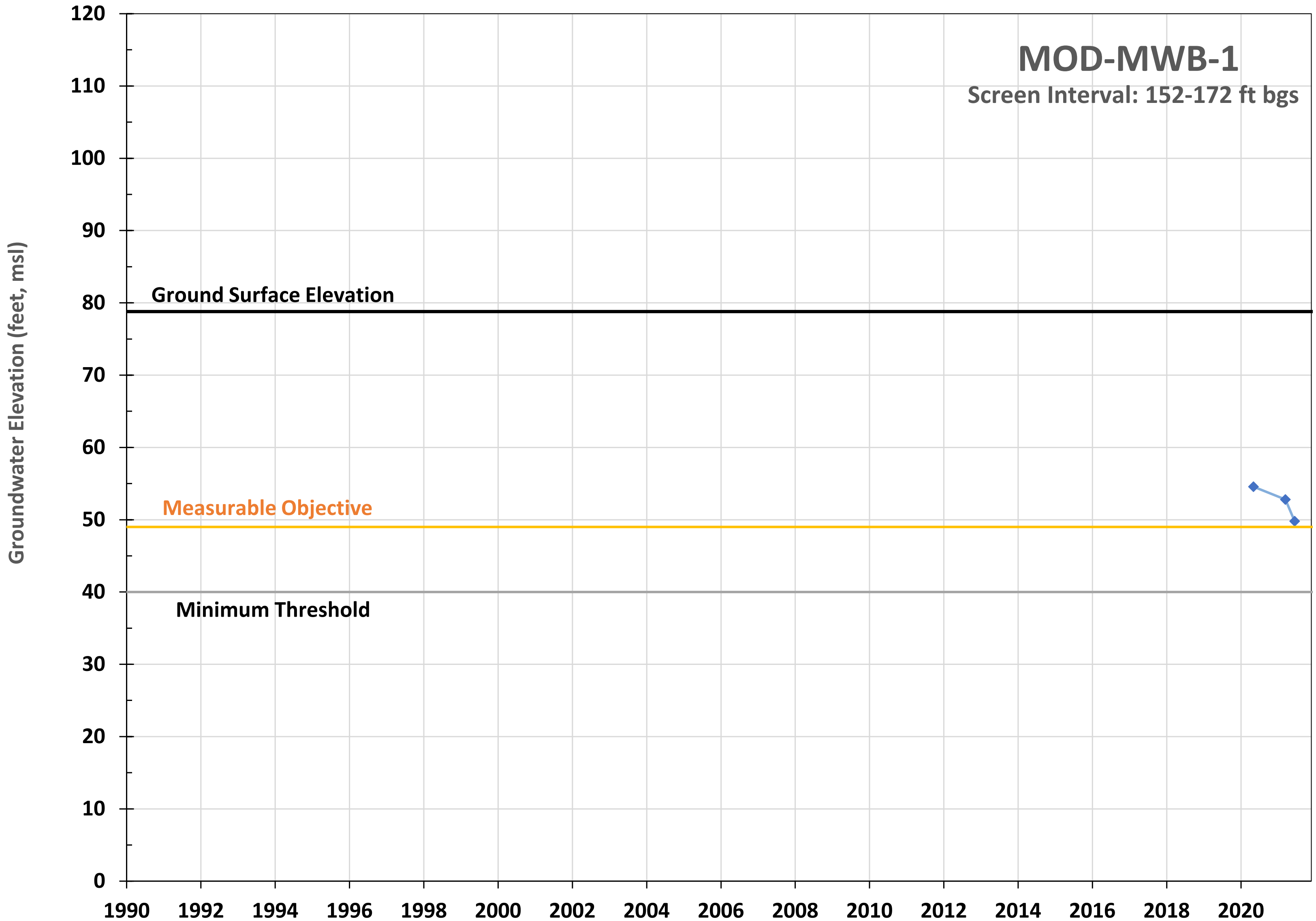

Wood 210
Ground Surface Elevation
Screen Interval: 87-187 ft bgs
244-298 ft bgs
316-370 ft bgs
388-409 ft bgs
430-547 ft bgs
Measurable Objective
Minimum Threshold
Groundwater Elevation (feet, msl)
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016
2018
2020



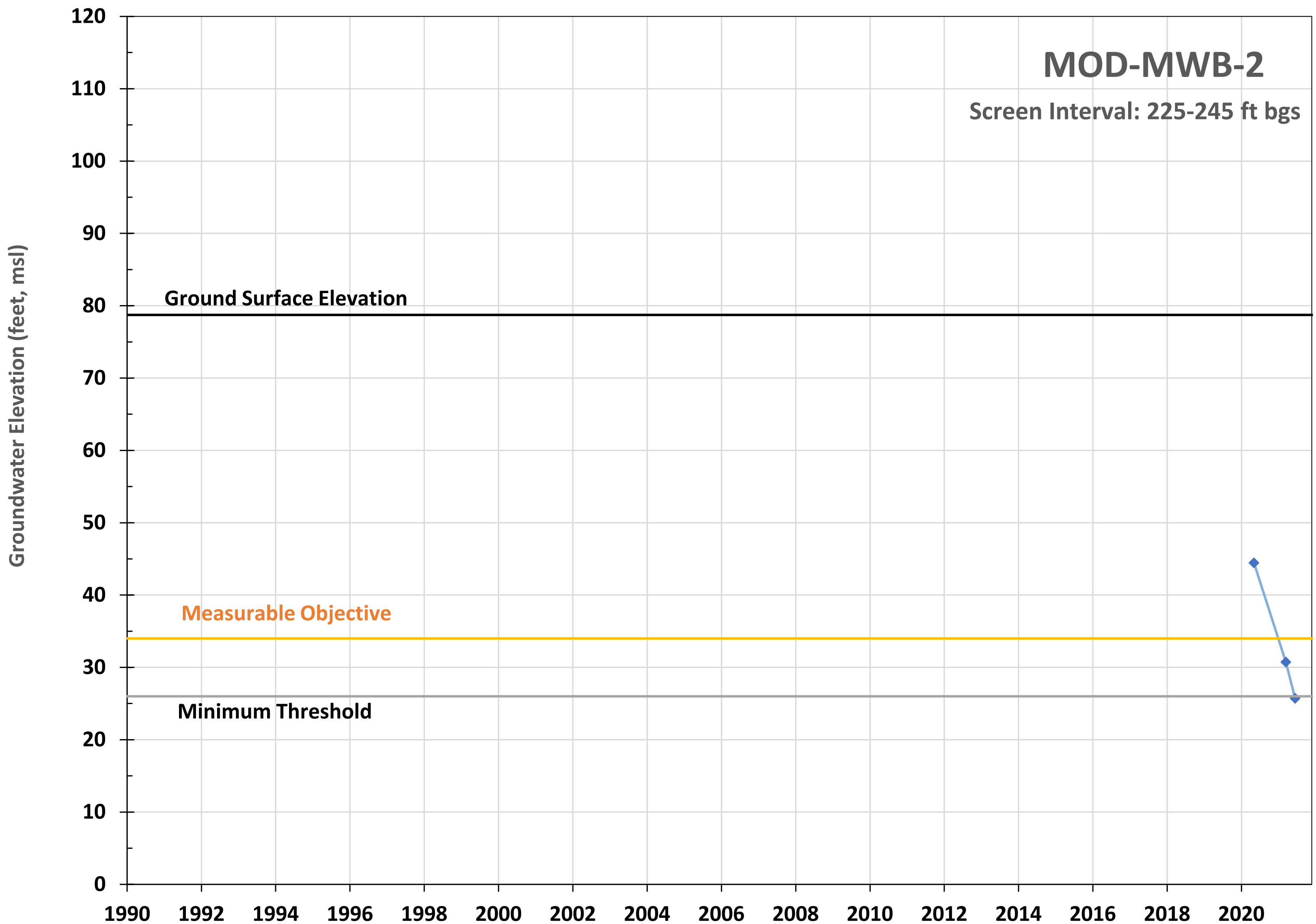
Young 76
Screen Interval: 12-152 ft bgs
Ground Surface Elevation
Measurable Objective
Minimum Threshold
Groundwater Elevation (feet, msl)
100
90
80
70
60
50
40
30
20
10
0
1990 1992 1994 1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020

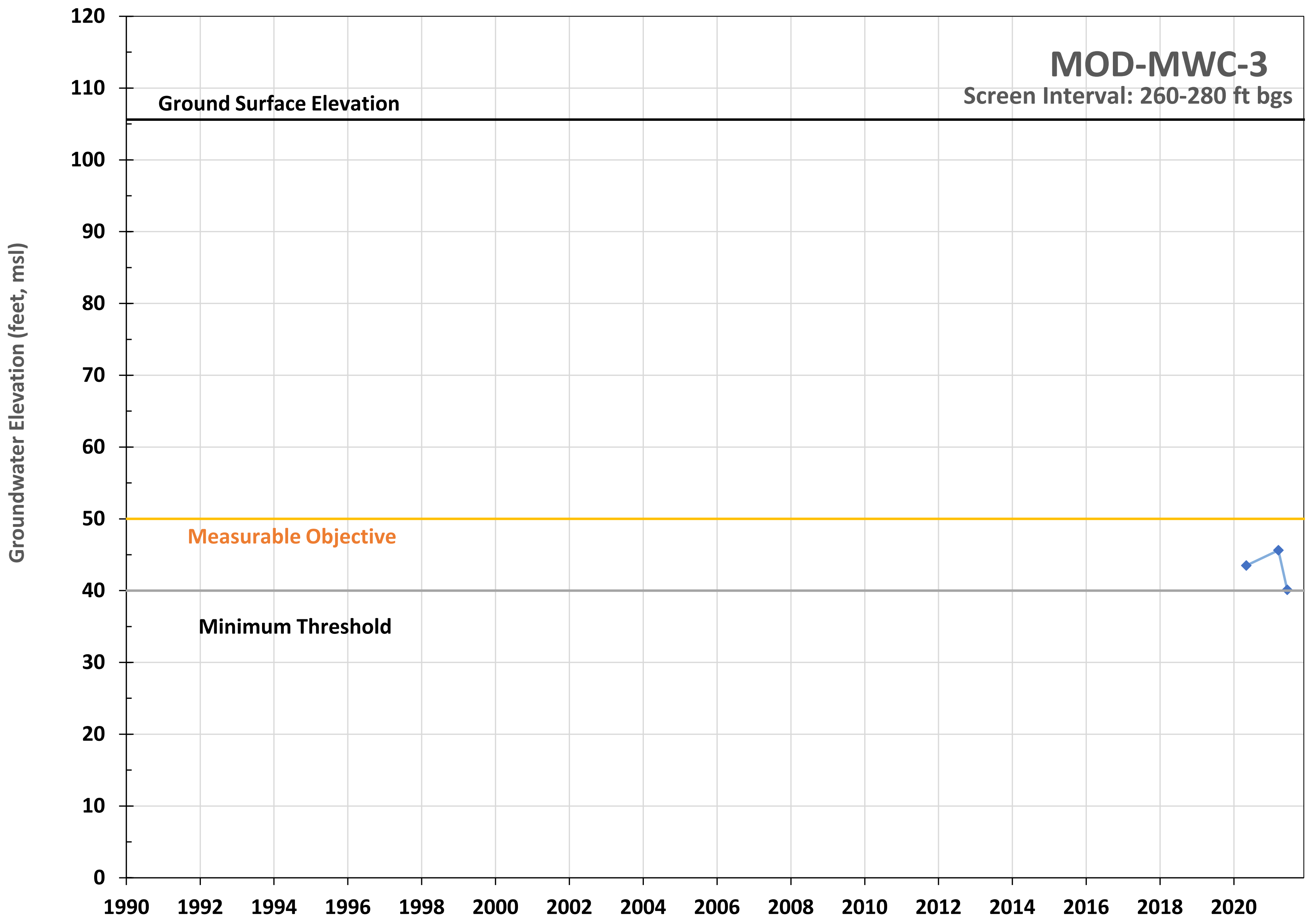


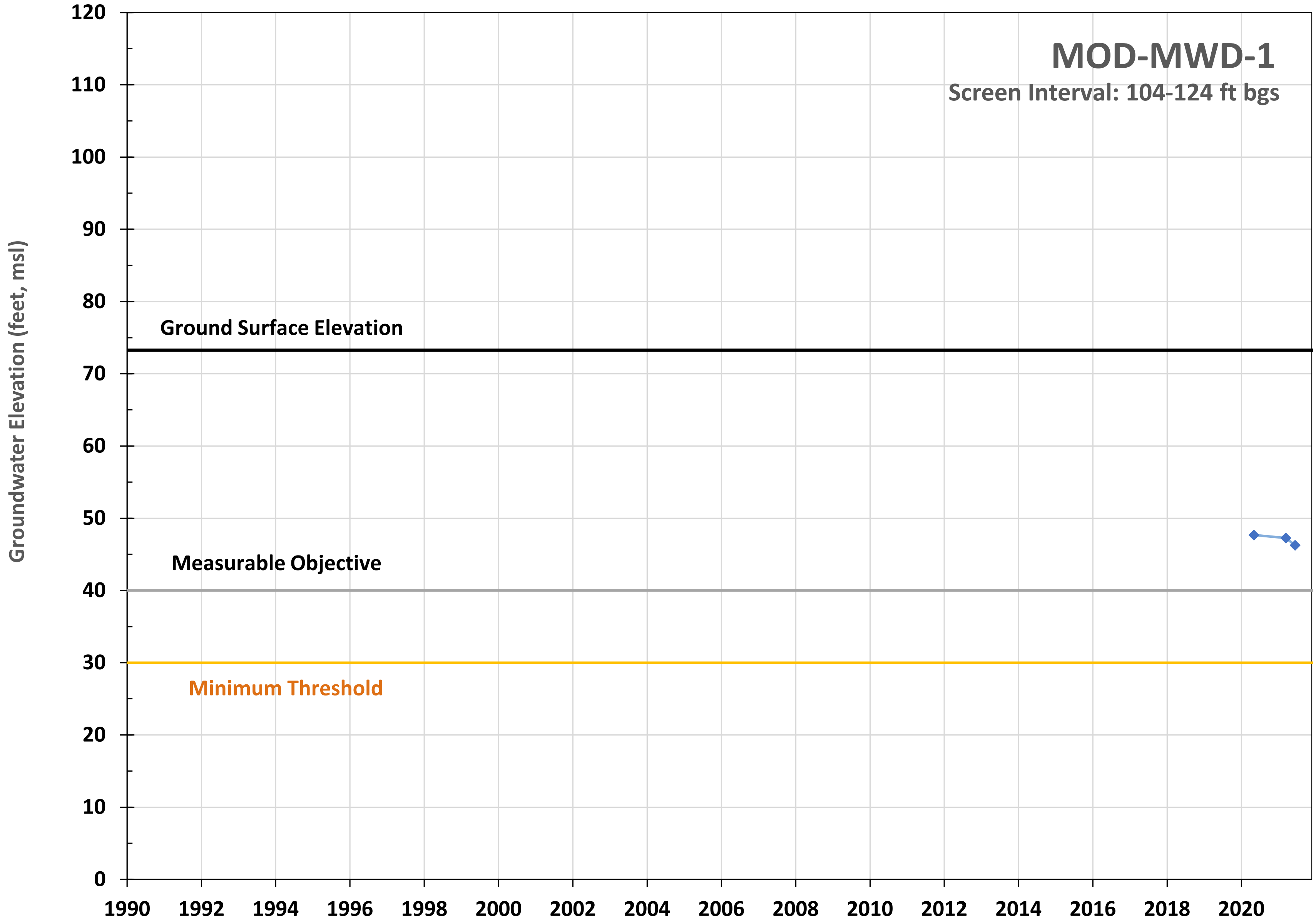
MOD-MWA-2
Screen Interval: 150-170 ft bgs
Ground Surface Elevation
Measurable Objective
Minimum Threshold
Groundwater Elevation (feet, msl)
0
10
20
30
40
50
60
70
80
90
100
110
120
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016
2018
2020



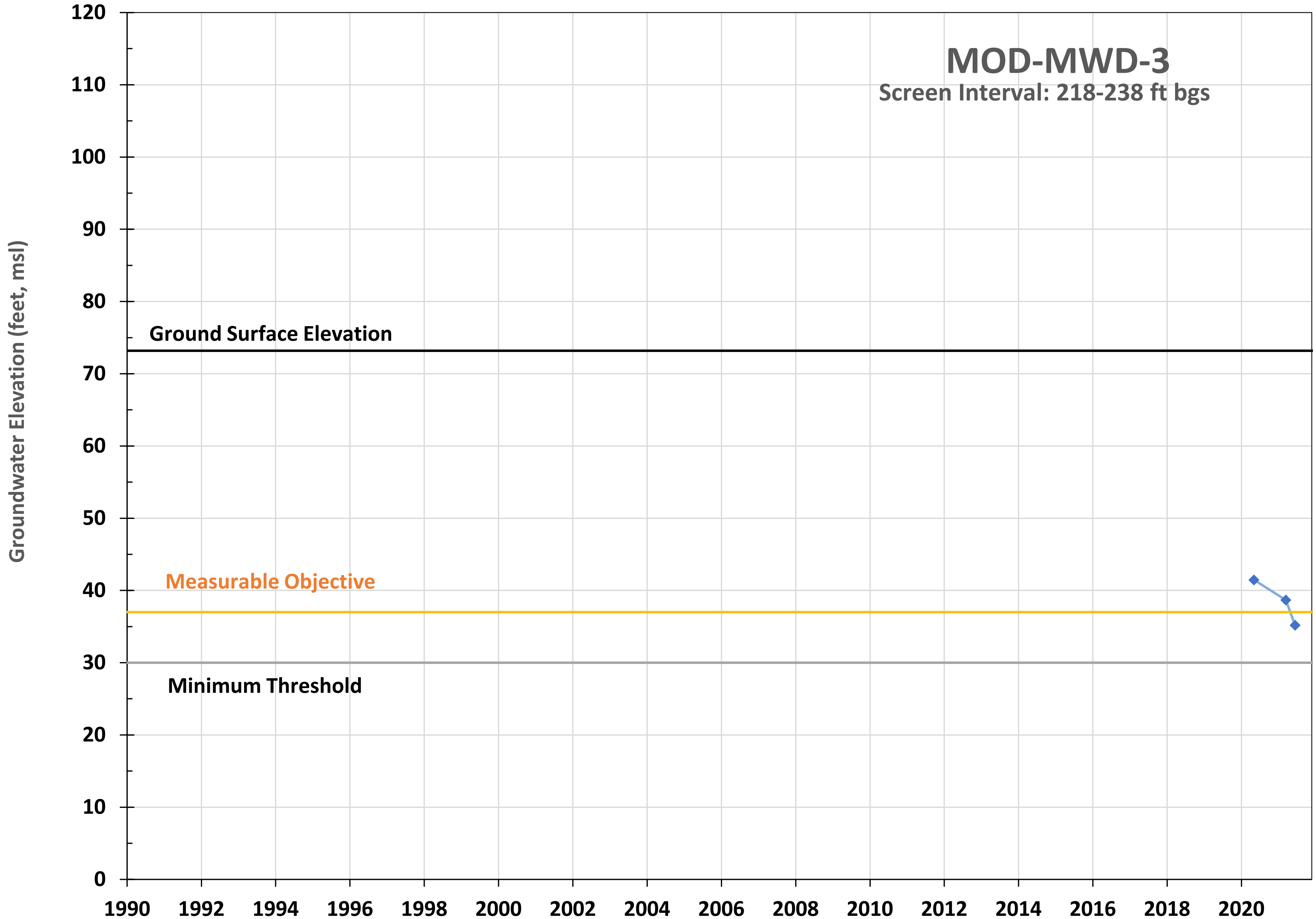
MOD-MWB-1
Screen Interval: 152-172 ft bgs
Groundwater Elevation (feet, msl)
Ground Surface Elevation
Measurable Objective
Minimum Threshold
120
110
100
90
80
70
60
50
40
30
20
10
0
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016
2018
2020

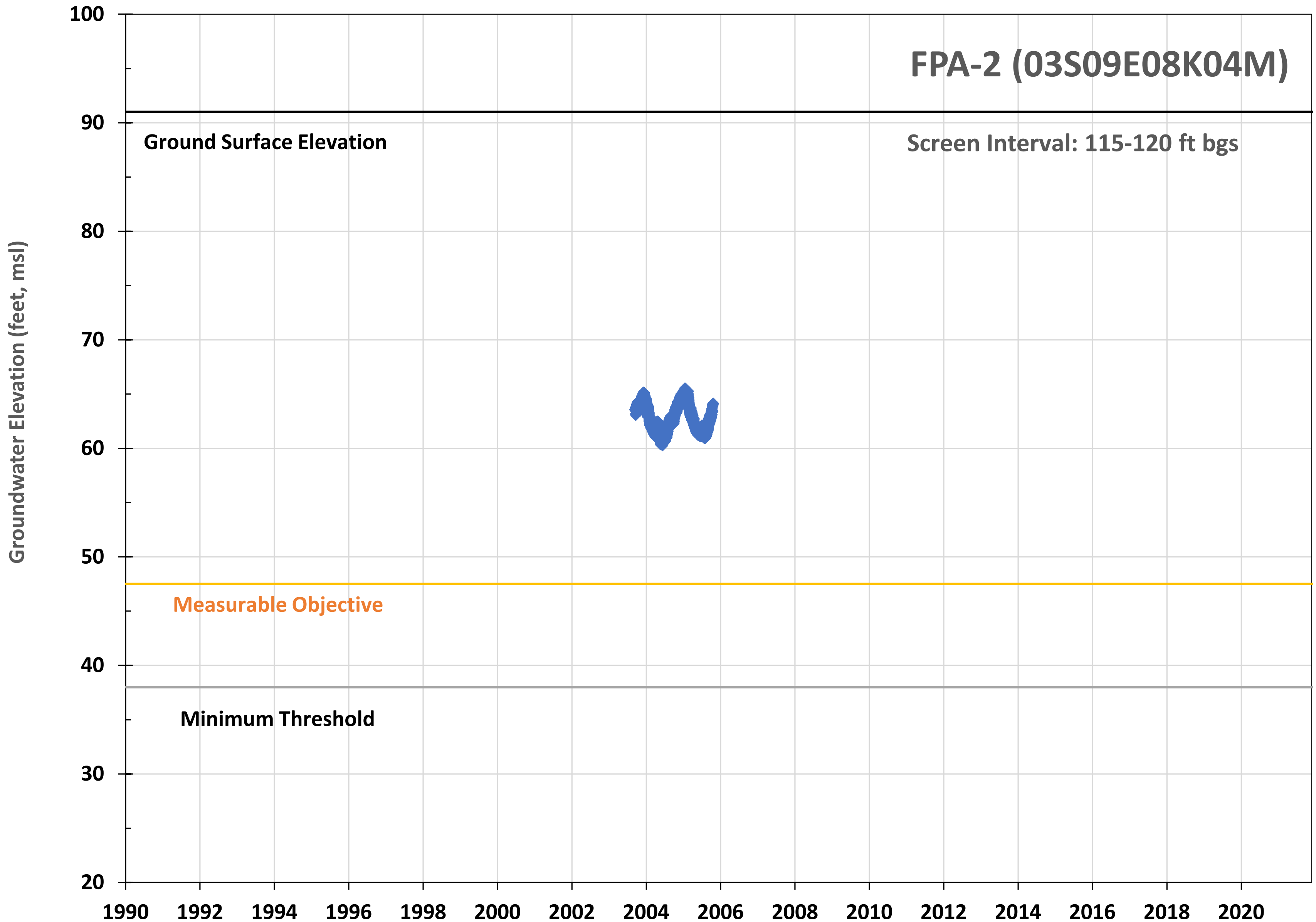

MOD-MWB-2
Screen Interval: 225-245 ft bgs
Groundwater Elevation (feet, msl)
Ground Surface Elevation
Measurable Objective
Minimum Threshold
120
110
100
90
80
70
60
50
40
30
20
10
0
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016
2018
2020

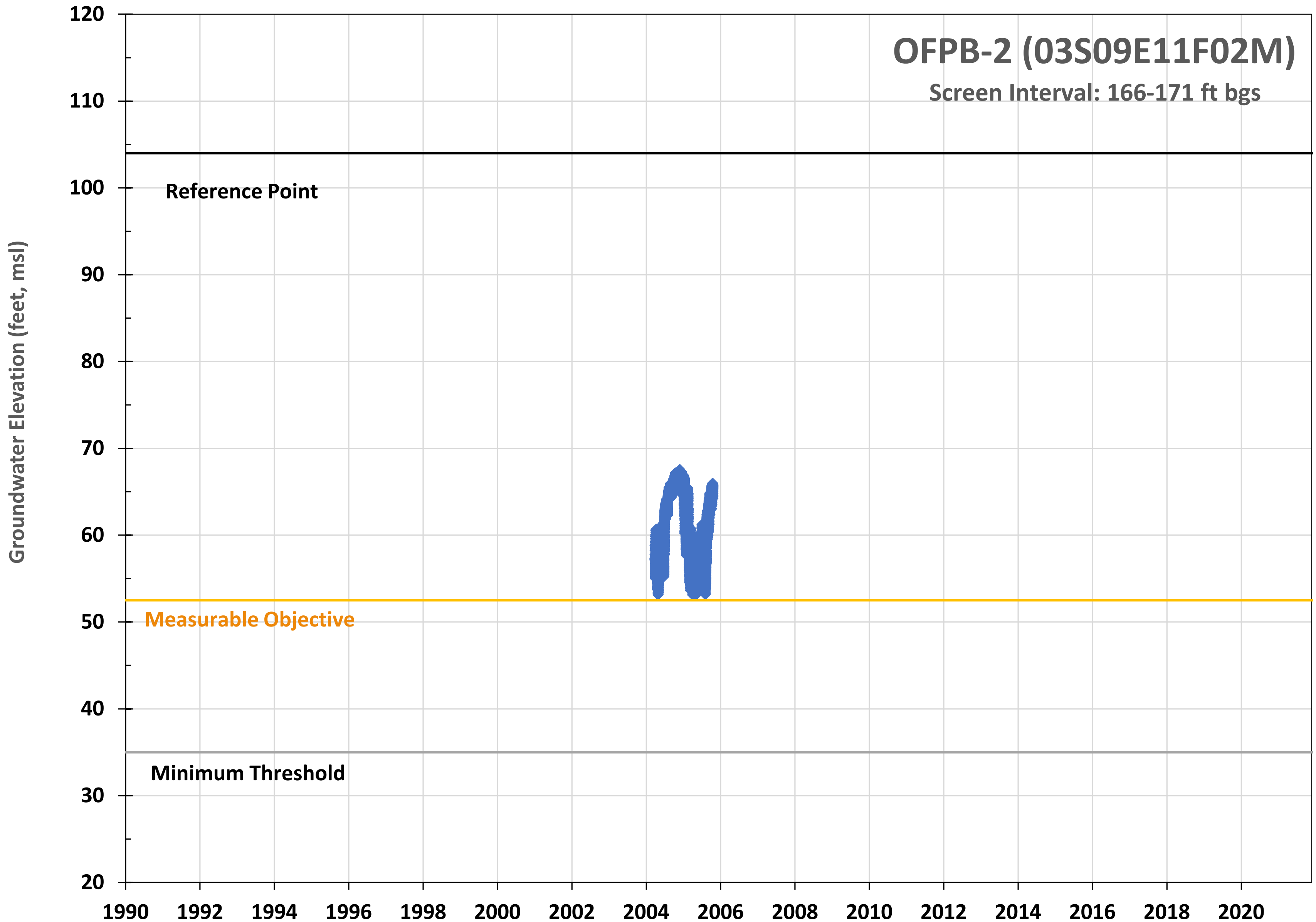

MOD-MWC-3
Screen Interval: 260-280 ft bgs
Ground Surface Elevation
Measurable Objective
Minimum Threshold
Groundwater Elevation (feet, msl)
0
10
20
30
40
50
60
70
80
90
100
110
120
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016
2018
2020



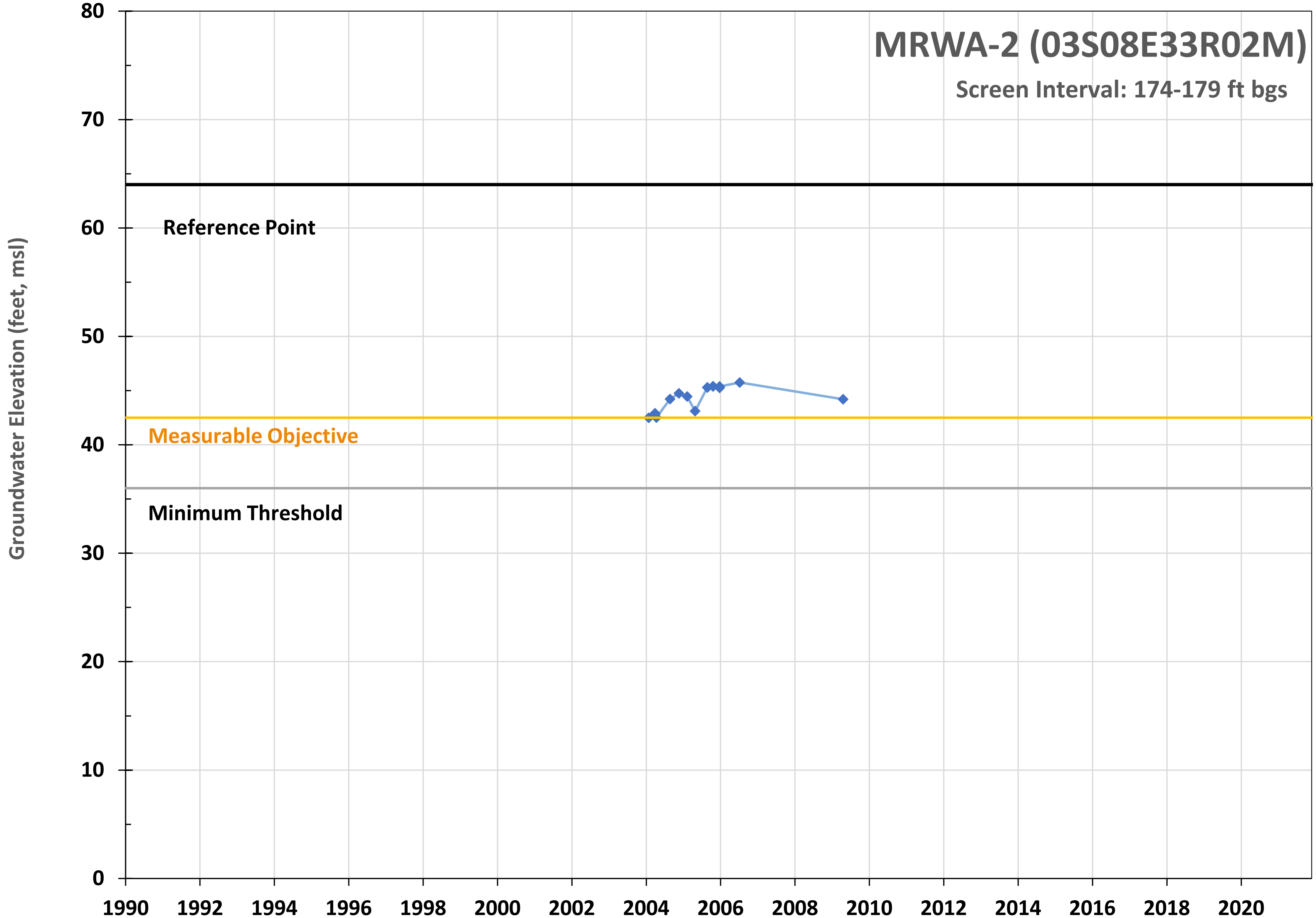
MOD-MWD-1
Screen Interval: 104-124 ft bgs
Ground Surface Elevation
Measurable Objective
Minimum Threshold
Groundwater Elevation (feet, msl)
120
110
100
90
80
70
60
50
40
30
20
10
0
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016
2018
2020


MOD-MWD-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

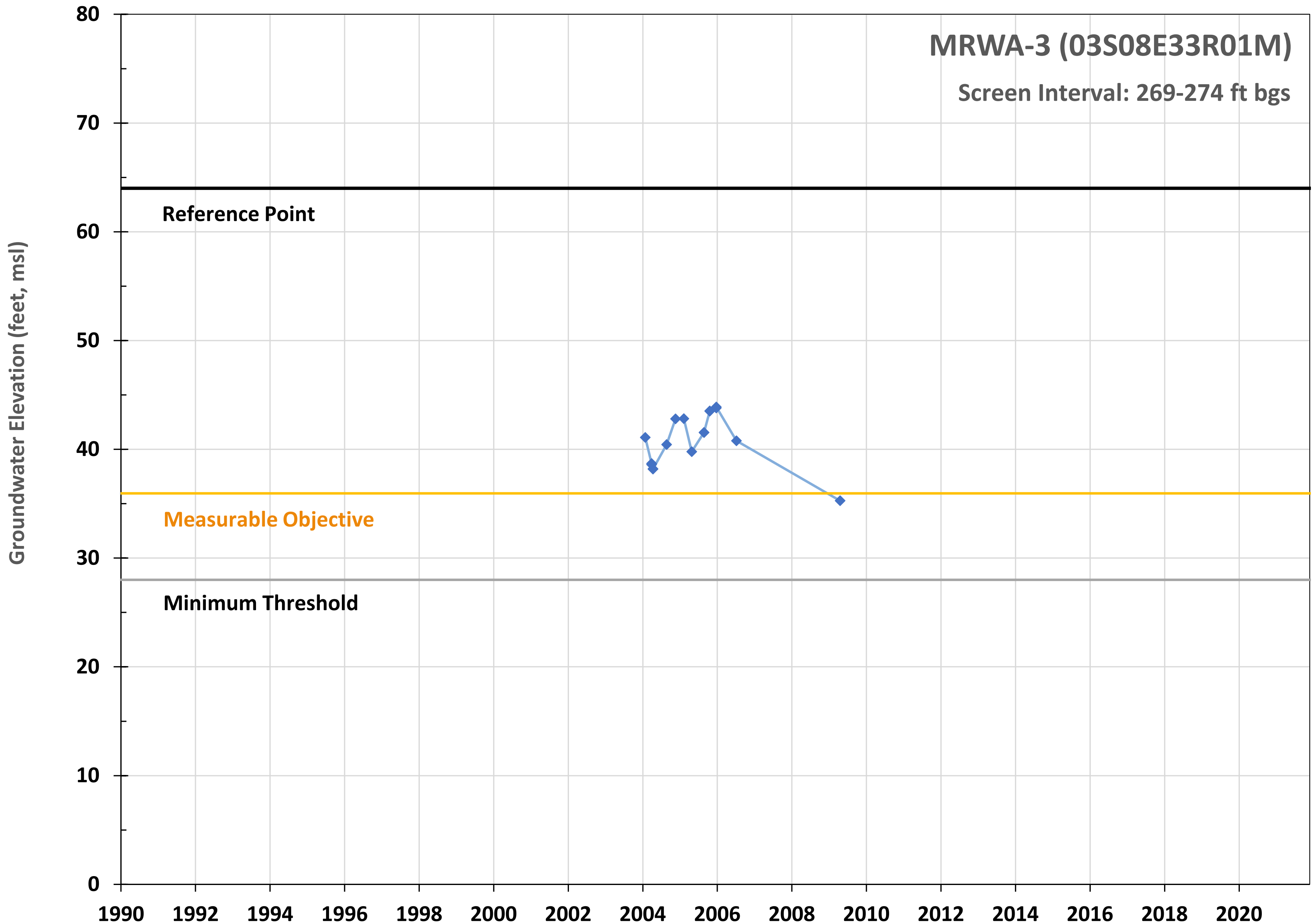

FPA-2 (03S09E08K04M)
Screen Interval: 115-120 ft bgs
Ground Surface Elevation
Measurable Objective
Minimum Threshold
Groundwater Elevation (feet, msl)
100
90
80
70
60
50
40
30
20
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016
2018
2020



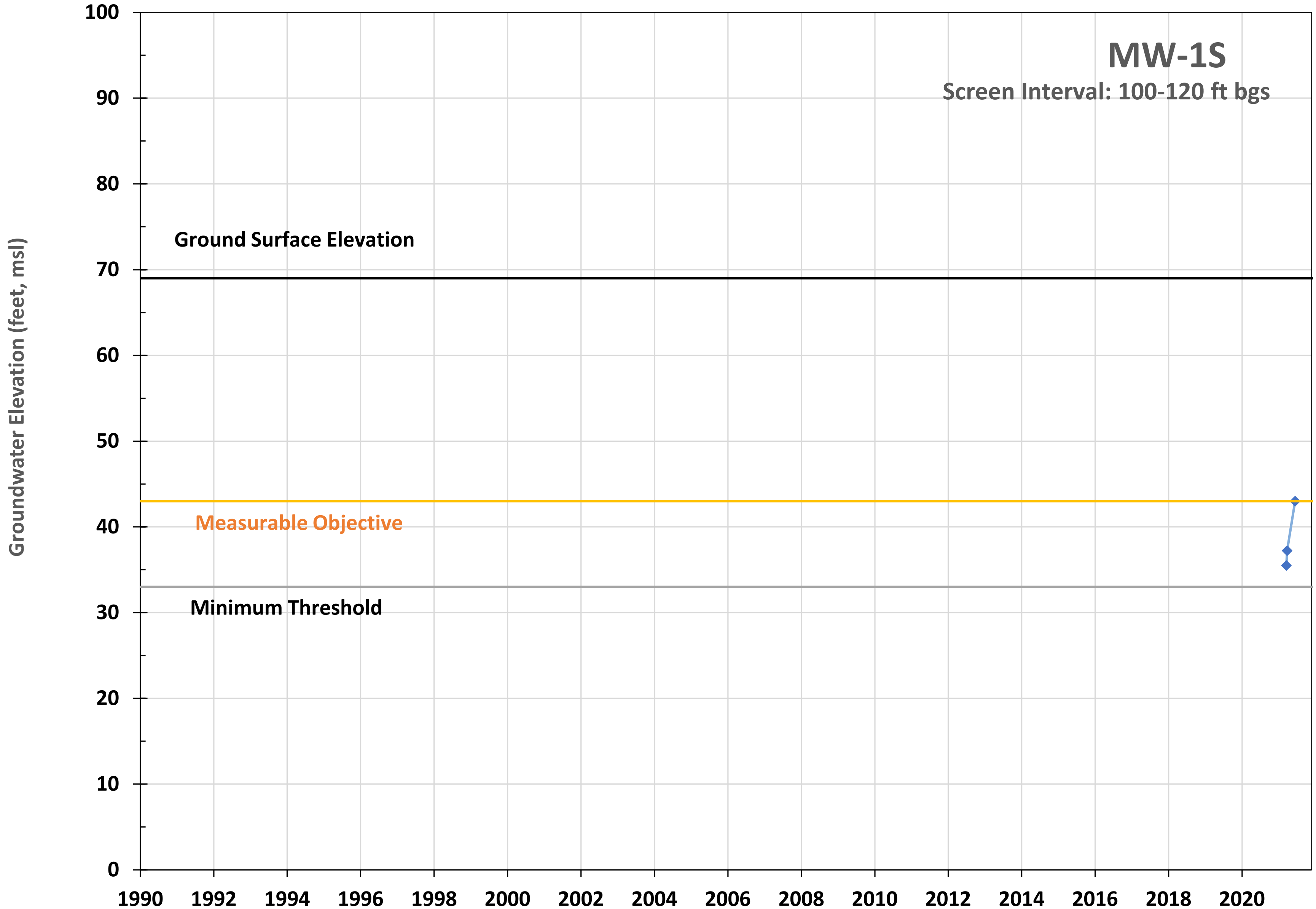
OFPB-2 (03S09E11F02M)
Screen Interval: 166-171 ft bgs
Groundwater Elevation (feet, msl)
120
110
100
90
80
70
60
50
40
30
20
Reference Point
Measurable Objective
Minimum Threshold
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016
2018
2020



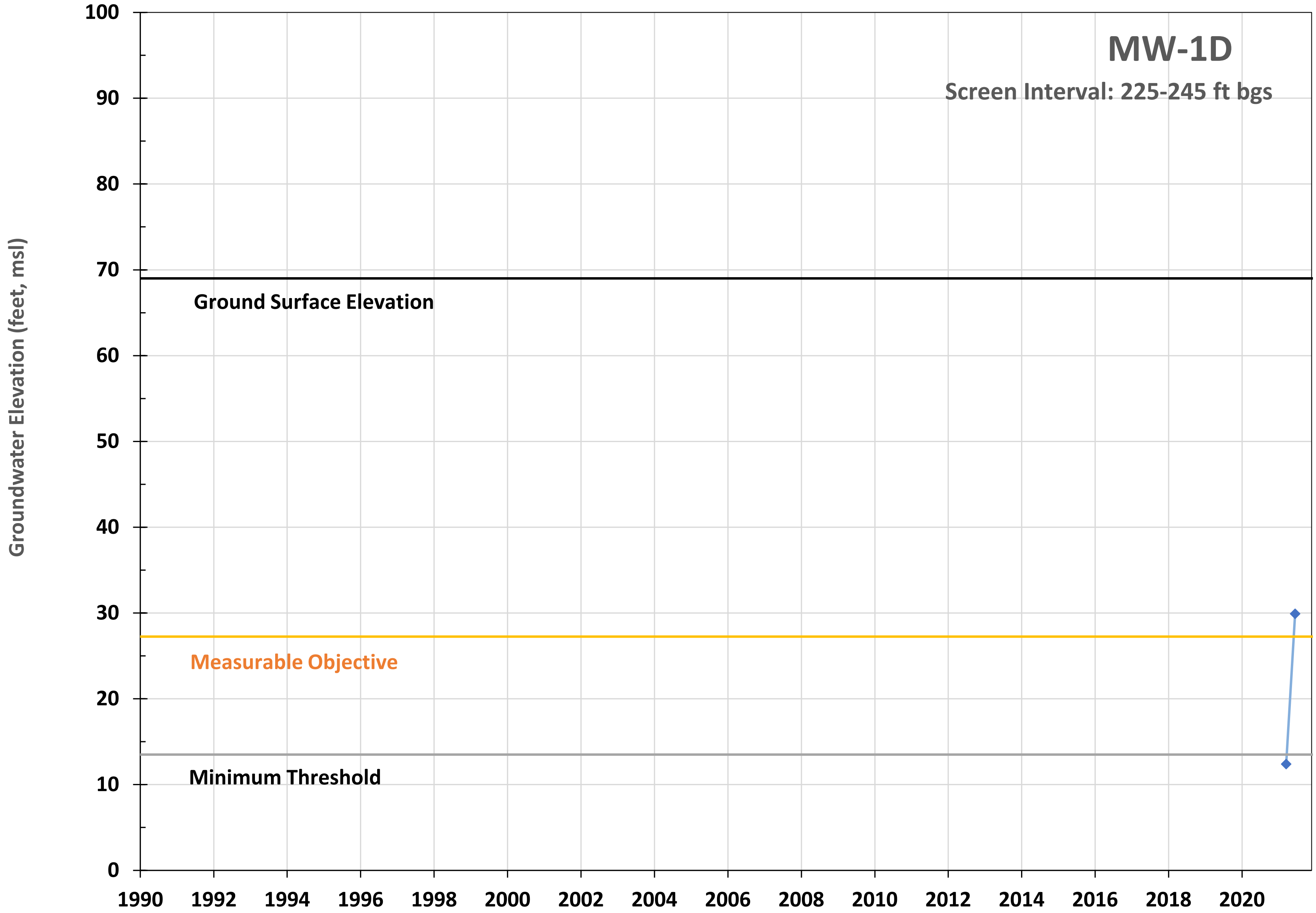
MRWA-2 (03S08E33R02M)
Screen Interval: 174-179 ft bgs
Reference Point
Measurable Objective
Minimum Threshold
Groundwater Elevation (feet, msl)
0
10
20
30
40
50
60
70
80
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016
2018
2020



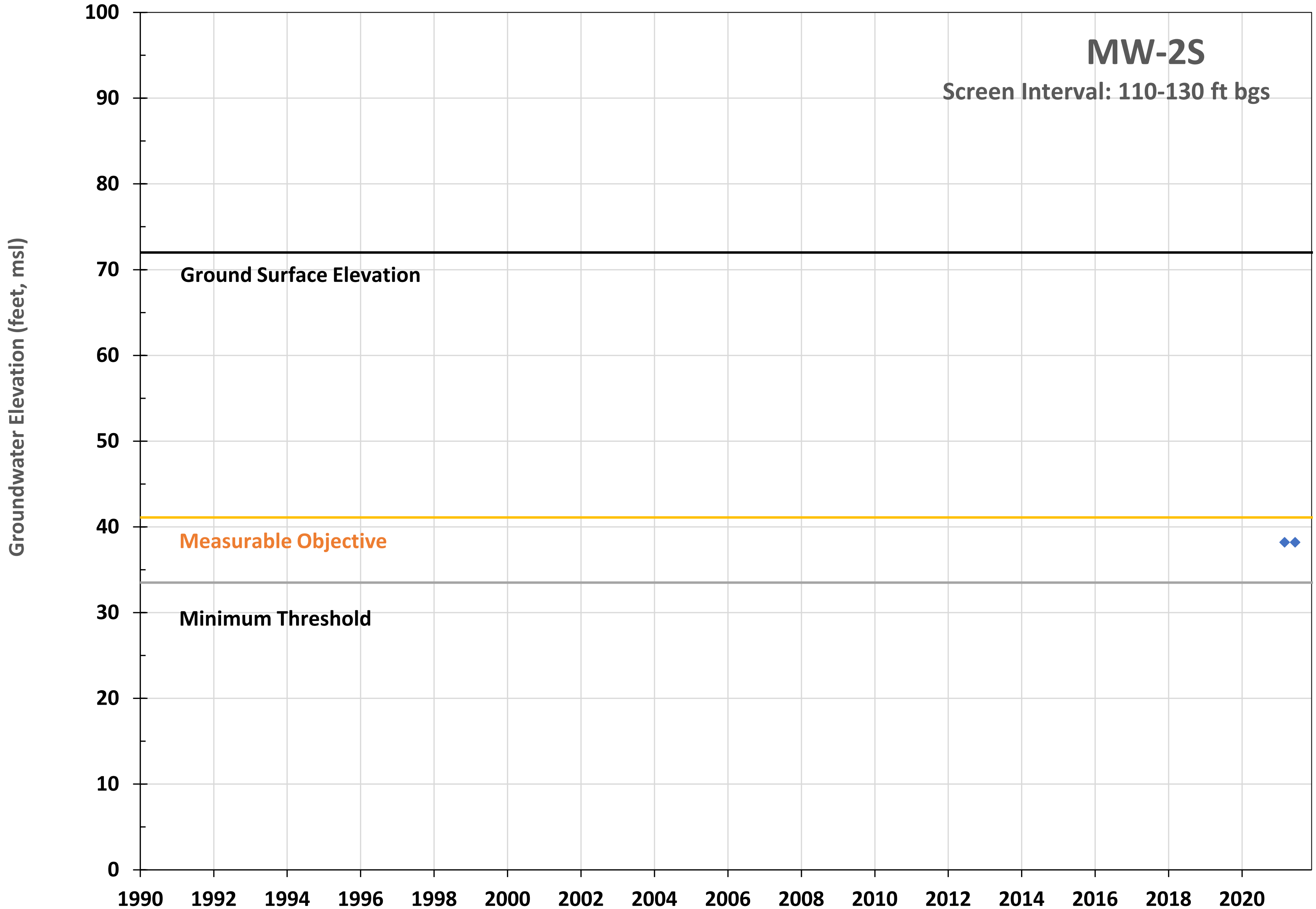
MRWA-3 (03S08E33R01M)
Screen Interval: 269-274 ft bgs
Reference Point
Measurable Objective
Minimum Threshold
Groundwater Elevation (feet, msl)
80
70
60
50
40
30
20
10
0
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016
2018
2020

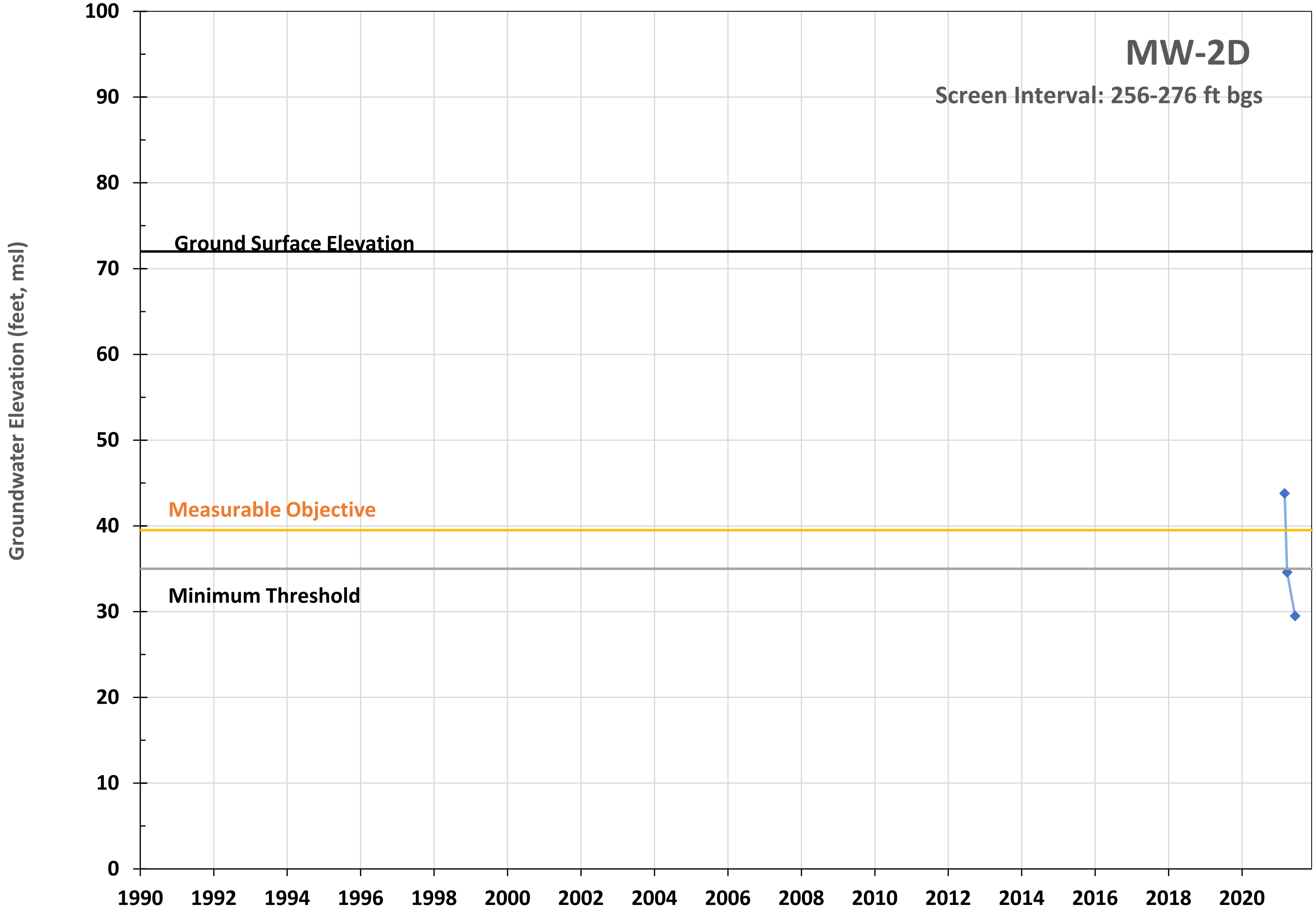


MW-1S
Screen Interval: 100-120 ft bgs
Groundwater Elevation (feet, msl)
Ground Surface Elevation
Measurable Objective
Minimum Threshold
100
90
80
70
60
50
40
30
20
10
0
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016
2018
2020

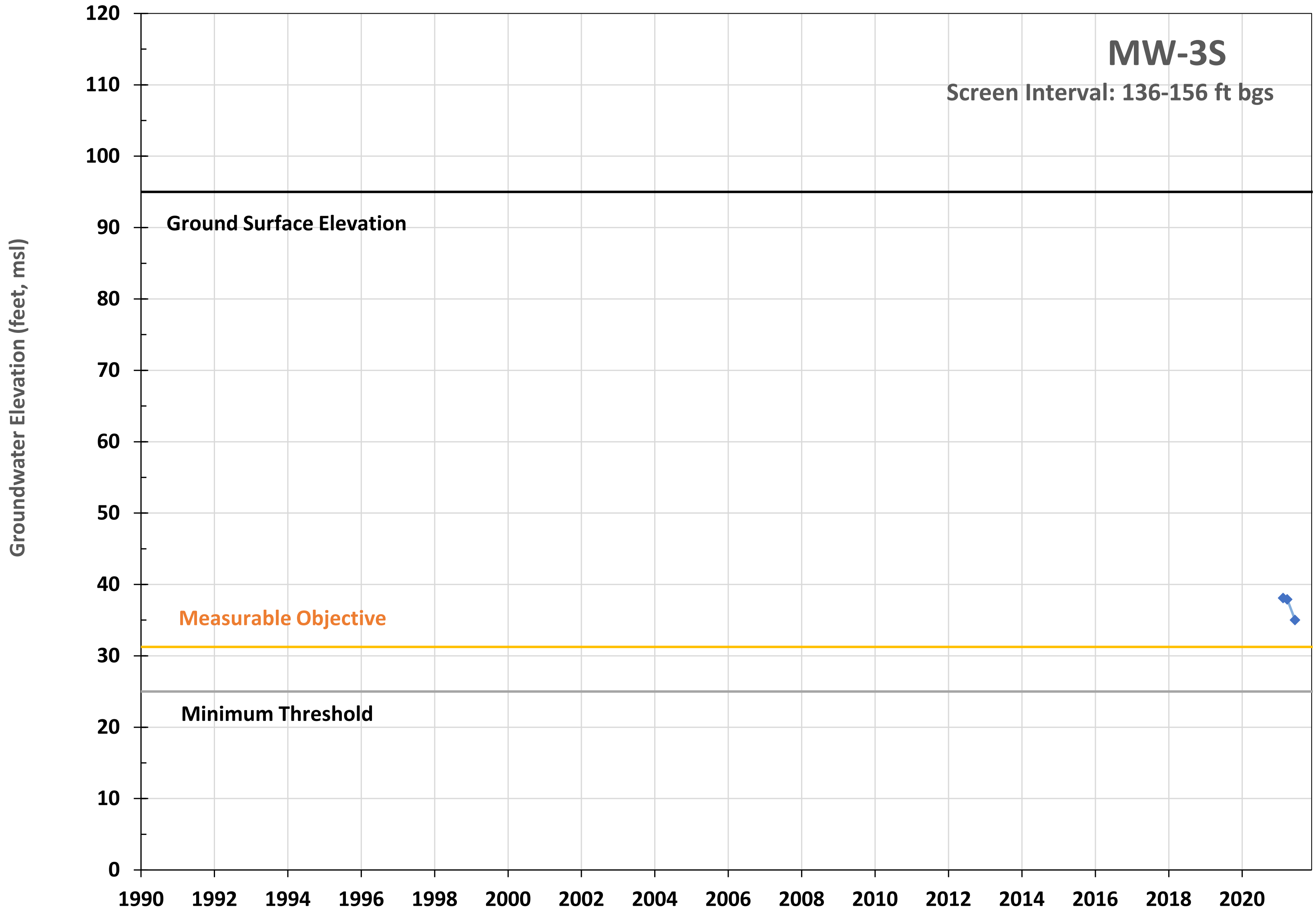


MW-1D
Screen Interval: 225-245 ft bgs
Groundwater Elevation (feet, msl)
Ground Surface Elevation
Measurable Objective
Minimum Threshold
100
90
80
70
60
50
40
30
20
10
0
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016
2018
2020

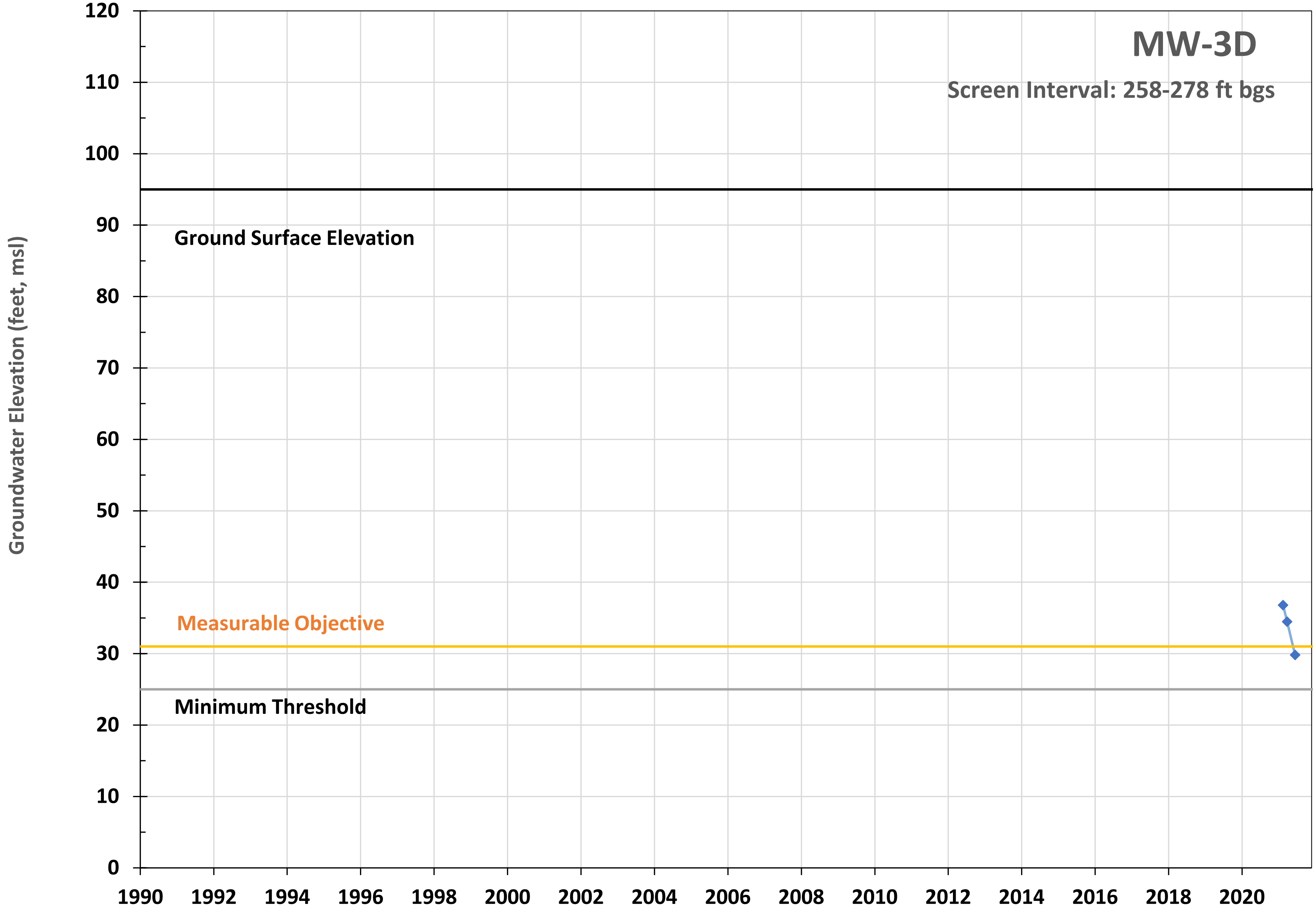

MW-2S
Screen Interval: 110-130 ft bgs
Groundwater Elevation (feet, msl)
100
90
80
70
60
50
40
30
20
10
0
Ground Surface Elevation
Measurable Objective
Minimum Threshold
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016
2018
2020

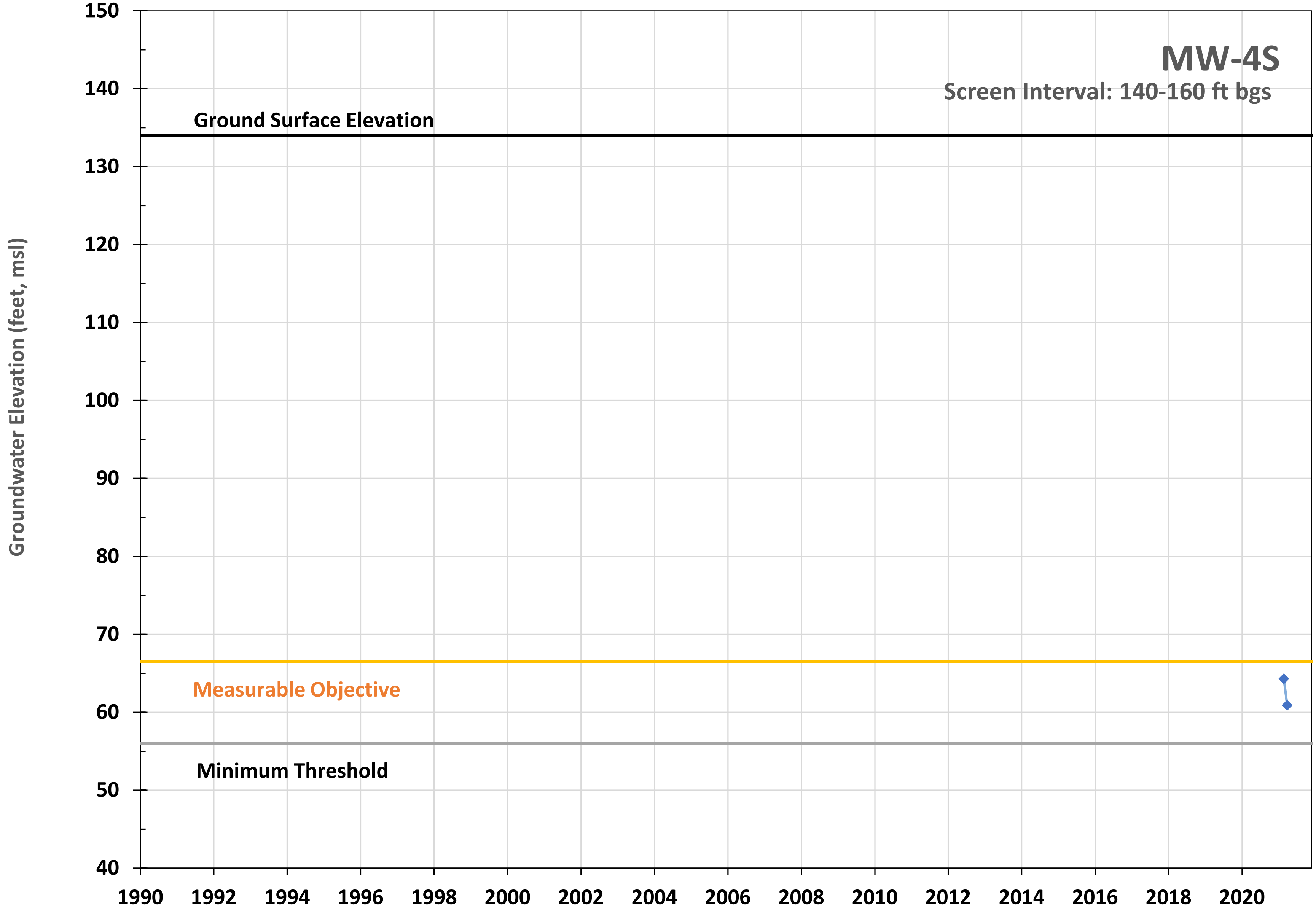


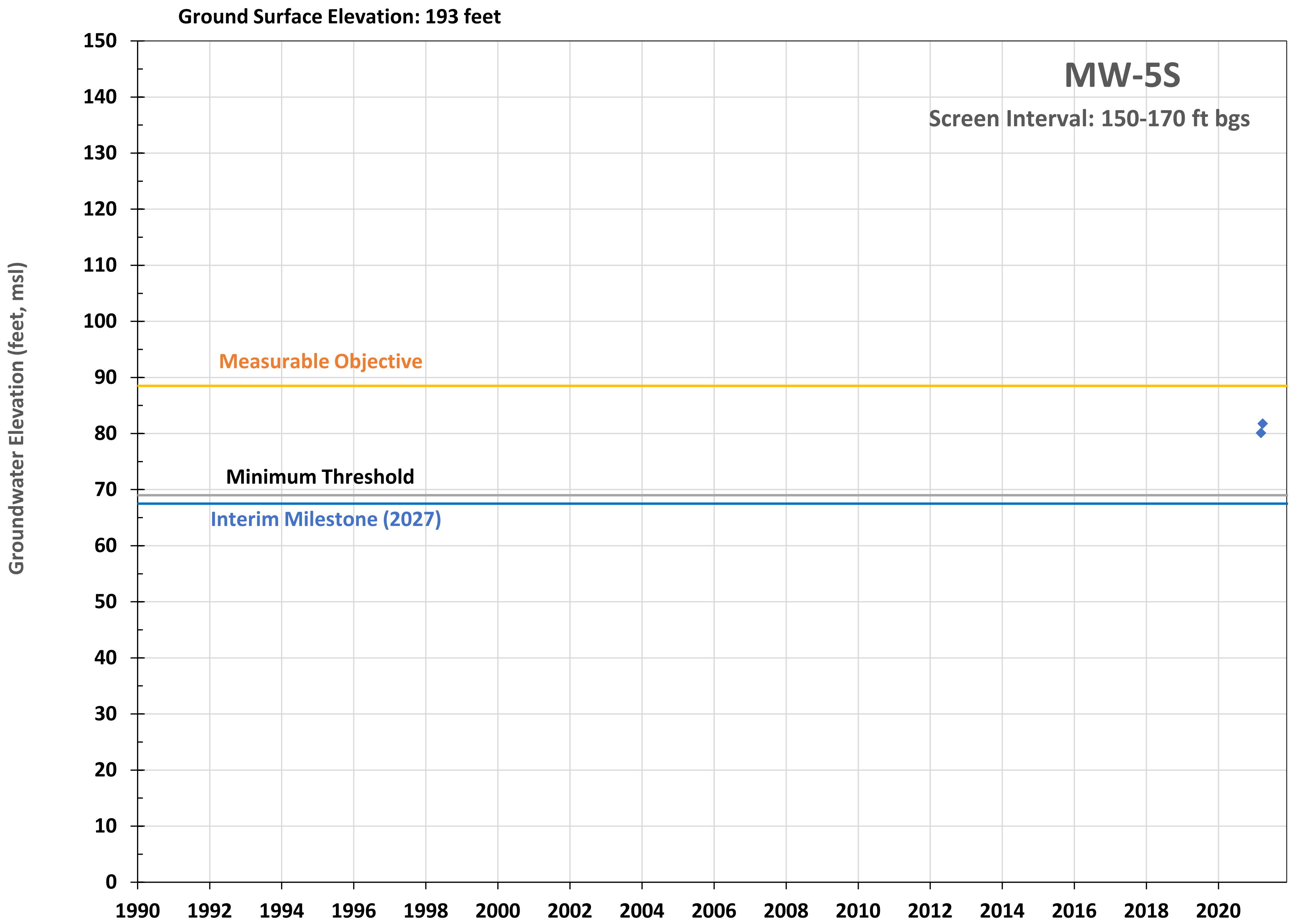
MW-2D
Screen Interval: 256-276 ft bgs
Groundwater Elevation (feet, msl)
Ground Surface Elevation
Measurable Objective
Minimum Threshold
100
90
80
70
60
50
40
30
20
10
0
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016
2018
2020



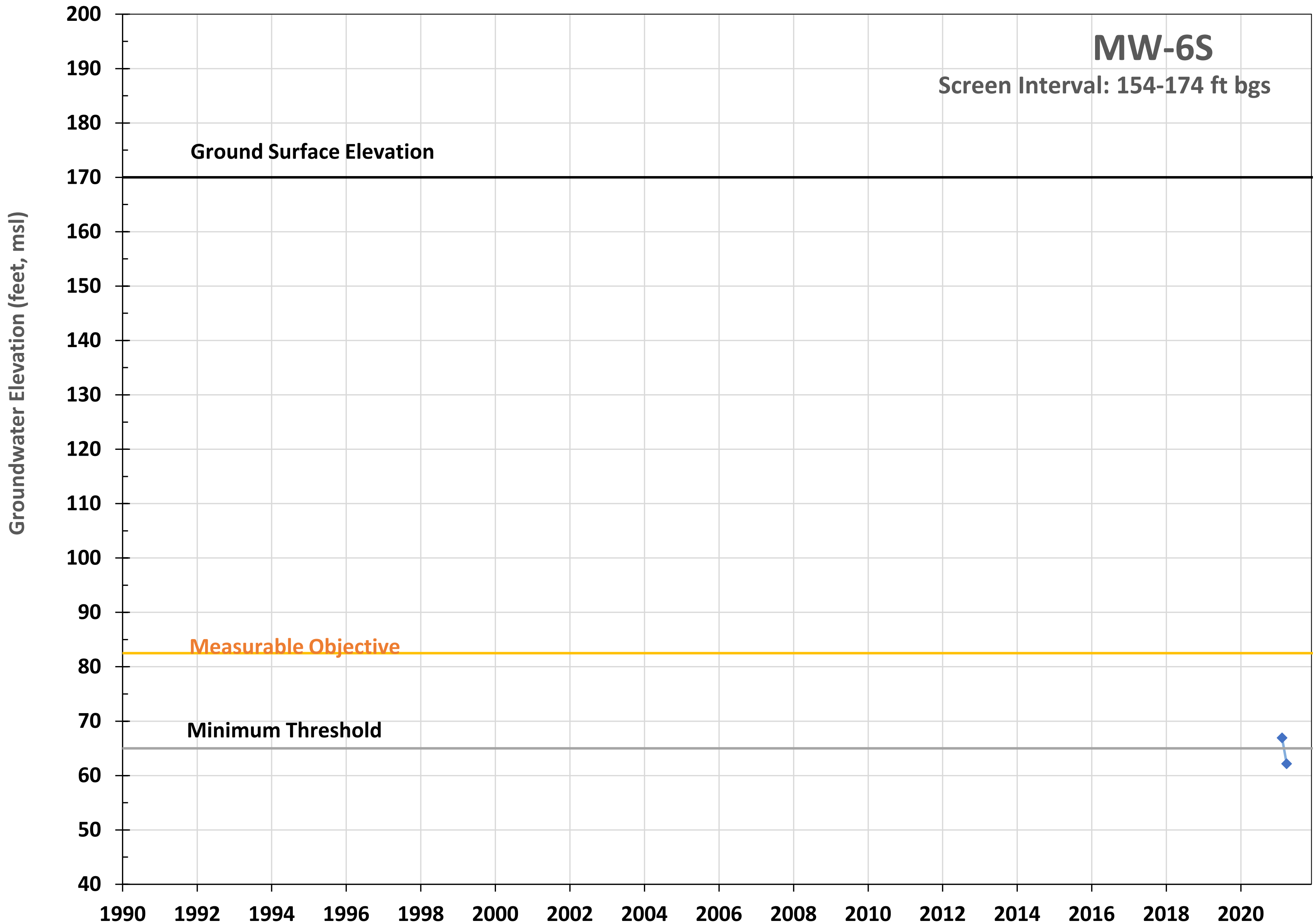
MW-3S
Screen Interval: 136-156 ft bgs
Groundwater Elevation (feet, msl)
Ground Surface Elevation
Measurable Objective
Minimum Threshold
120
110
100
90
80
70
60
50
40
30
20
10
0
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016
2018
2020


MW-3D
Screen Interval: 258-278 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

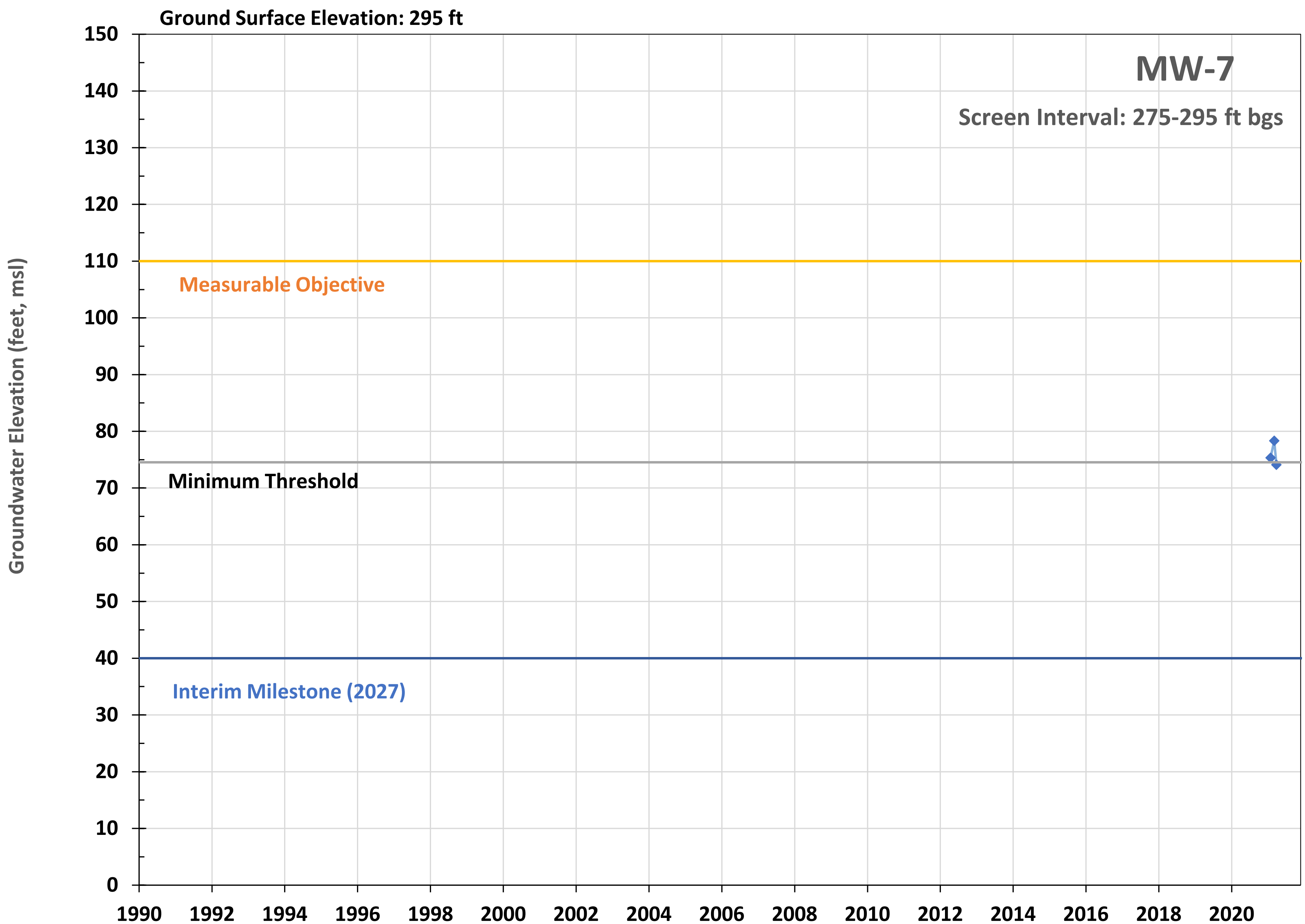

MW-4S
Screen Interval: 140-160 ft bgs
Ground Surface Elevation
Measurable Objective
Minimum Threshold
Groundwater Elevation (feet, msl)
150
140
130
120
110
100
90
80
70
60
50
40
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016
2018
2020



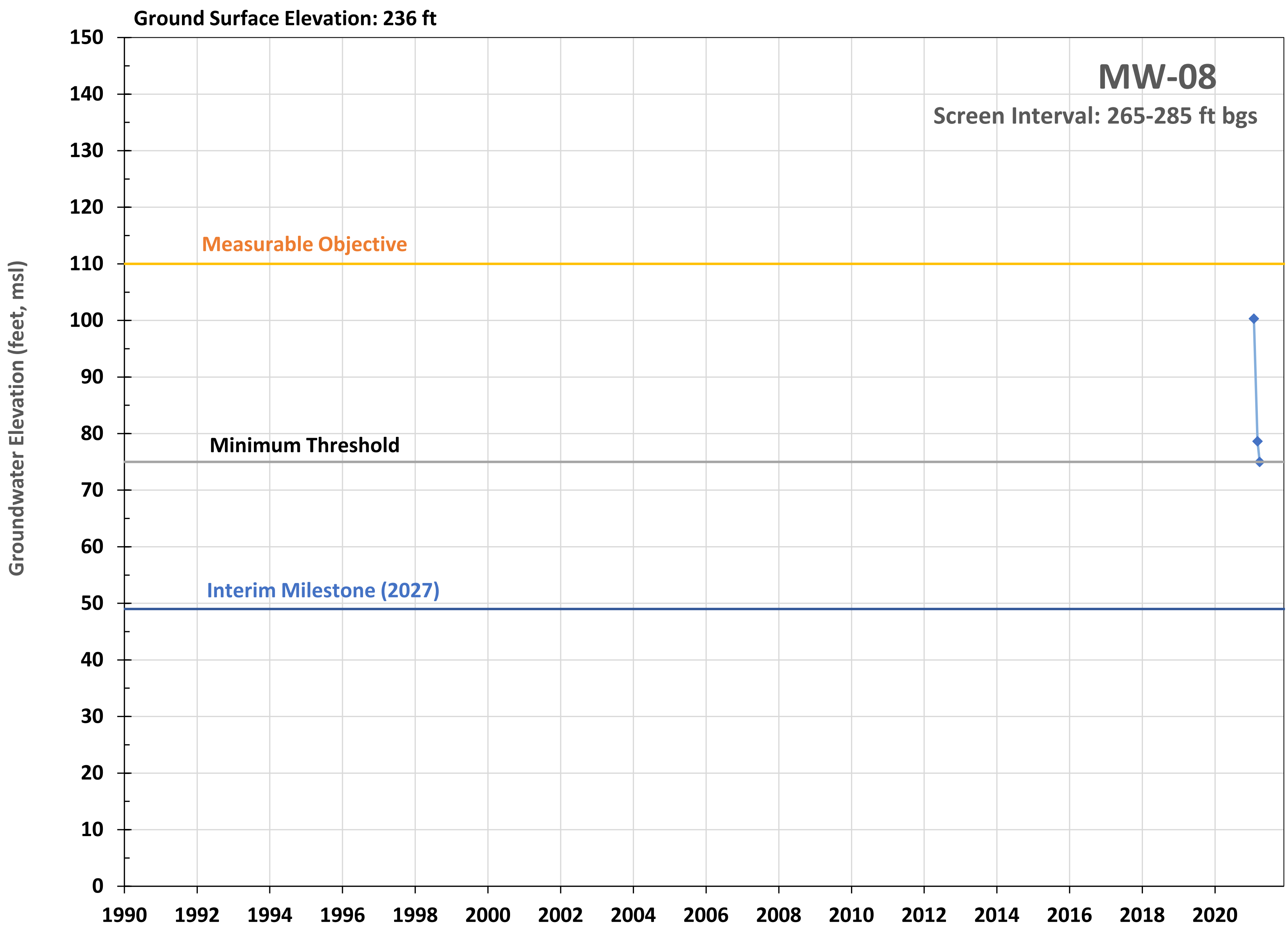
Ground Surface Elevation: 193 feet
MW-5S
Screen Interval: 150-170 ft bgs
Measurable Objective
Minimum Threshold
Interim Milestone (2027)
Groundwater Elevation (feet, msl)
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016
2018
2020



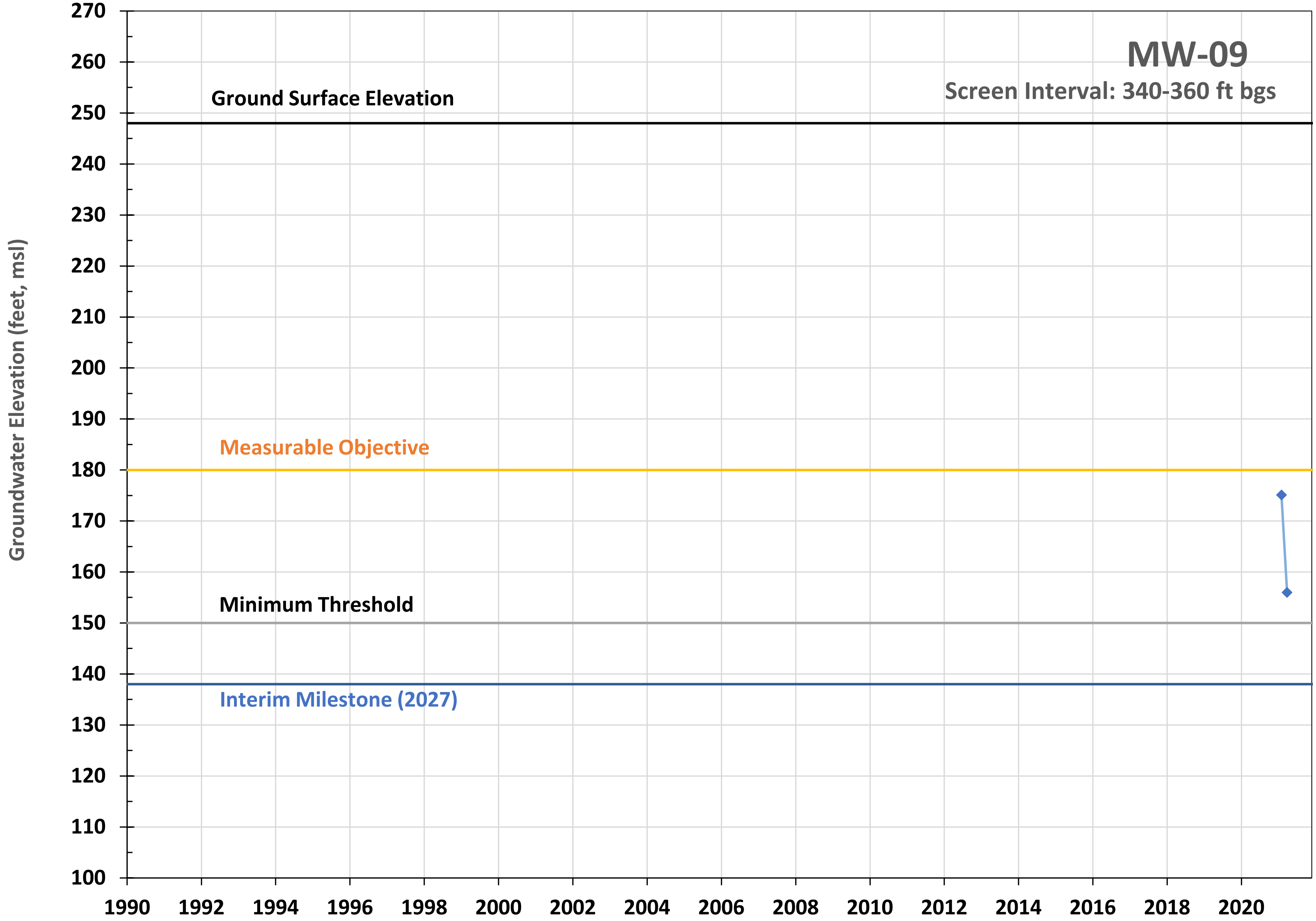
MW-6S
Screen Interval: 154-174 ft bgs
Ground Surface Elevation
Measurable Objective
Minimum Threshold
Groundwater Elevation (feet, msl)
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016
2018
2020



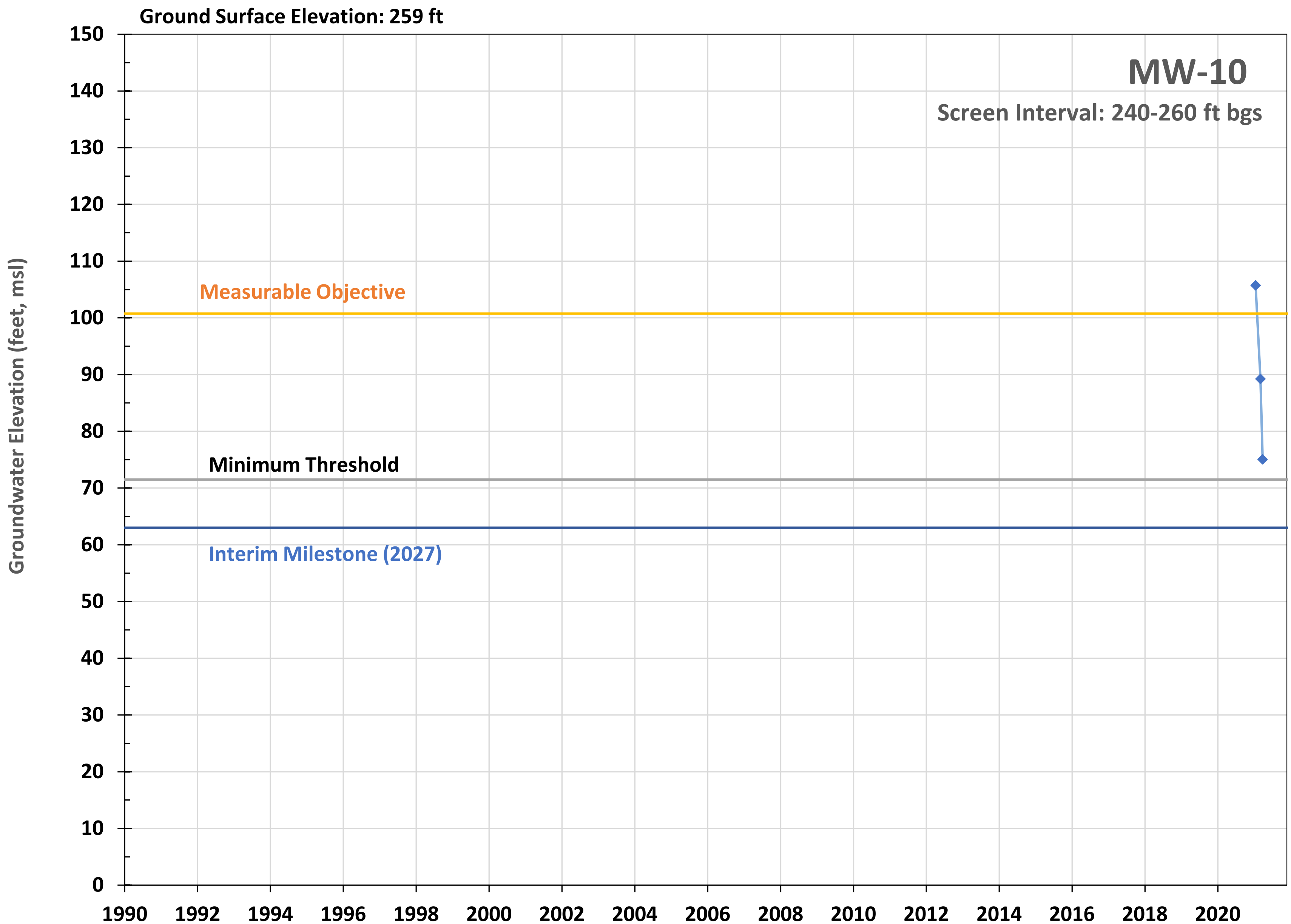
Ground Surface Elevation: 295 ft
MW-7
Screen Interval: 275-295 ft bgs
Measurable Objective
Minimum Threshold
Interim Milestone (2027)
Groundwater Elevation (feet, msl)
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016
2018
2020



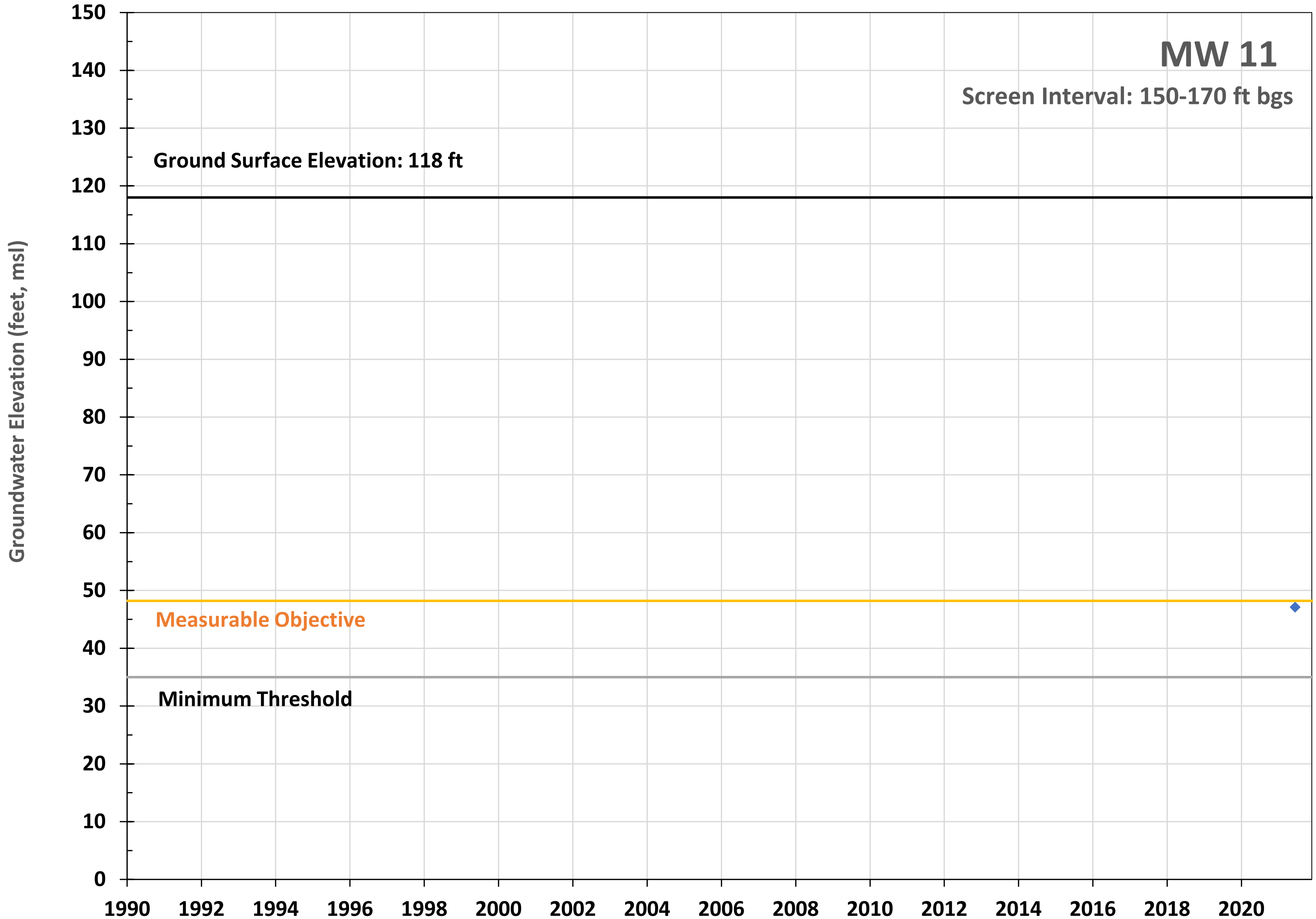
Ground Surface Elevation: 236 ft
MW-08
Screen Interval: 265-285 ft bgs
Measurable Objective
Minimum Threshold
Interim Milestone (2027)
Groundwater Elevation (feet, msl)
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016
2018
2020



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

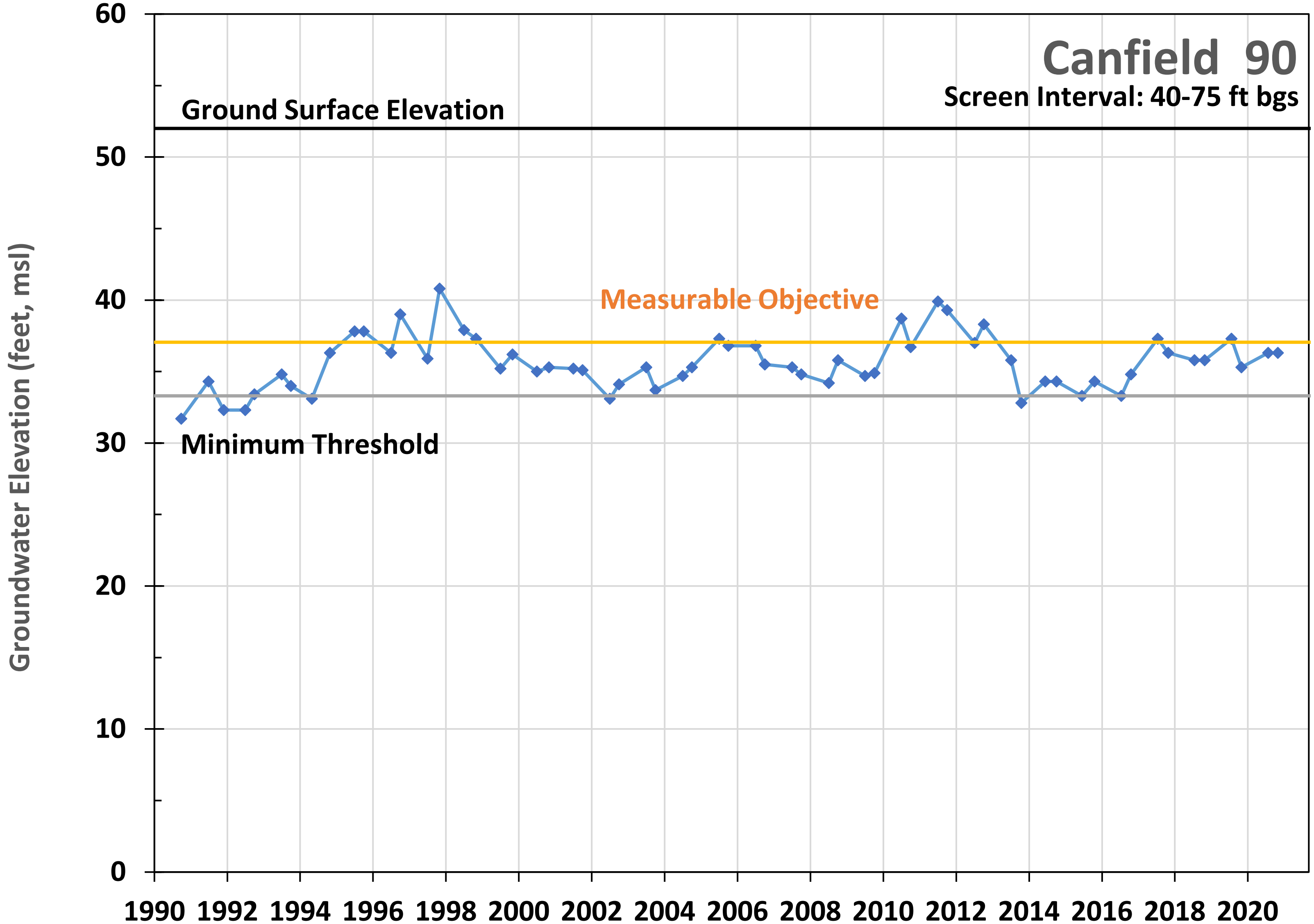


Ground Surface Elevation: 259 ft
MW-10
Screen Interval: 240-260 ft bgs
Measurable Objective
Minimum Threshold
Interim Milestone (2027)
Groundwater Elevation (feet, msl)
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016
2018
2020

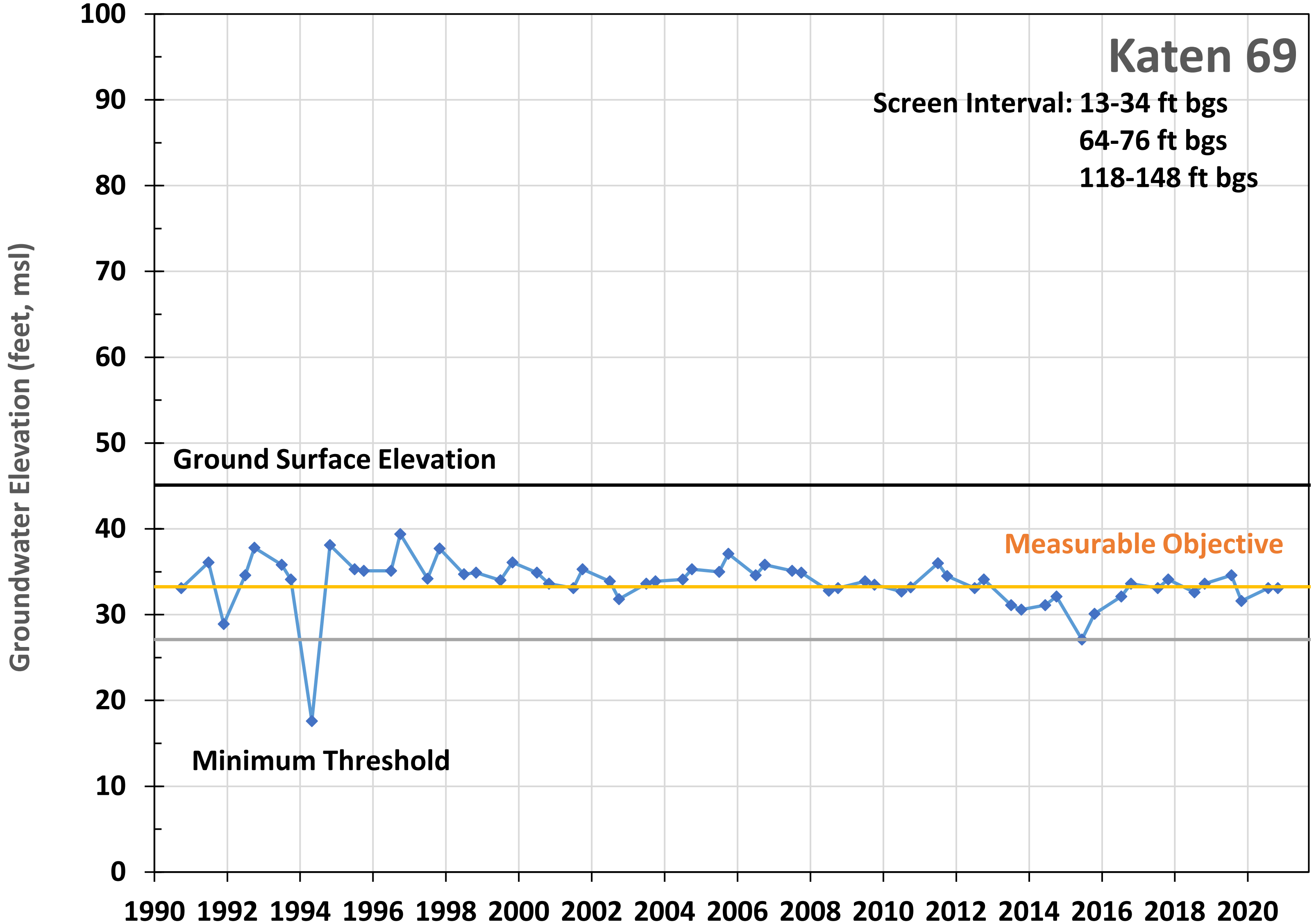

MW 11
Screen Interval: 150-170 ft bgs
Ground Surface Elevation: 118 ft
Measurable Objective
Minimum Threshold
Groundwater Elevation (feet, msl)
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016
2018
2020

Hydrographs for Wells in the Monitoring Network for Depletions of Interconnected Surface Water

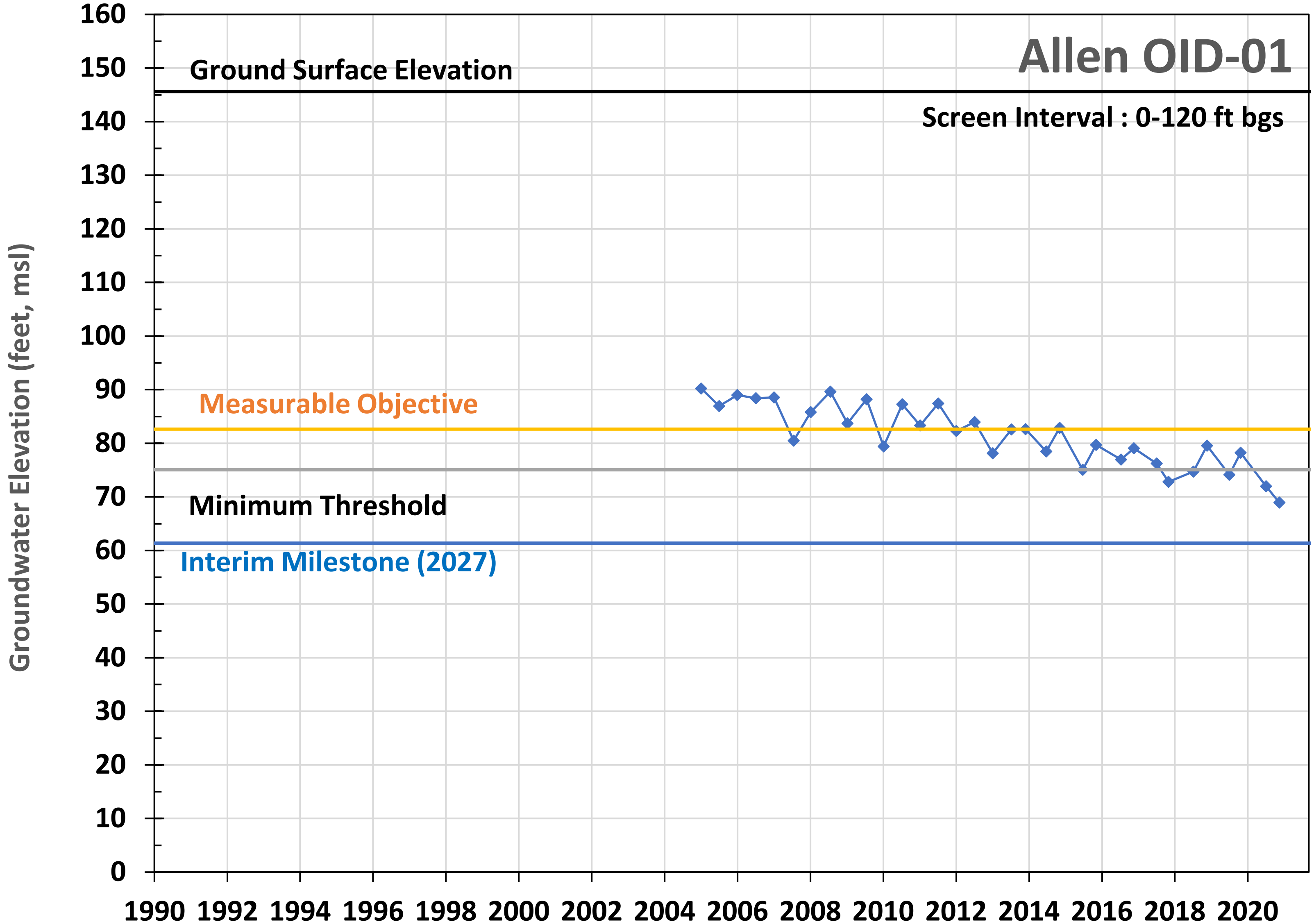
(in the order as they appear on Table 7-3)



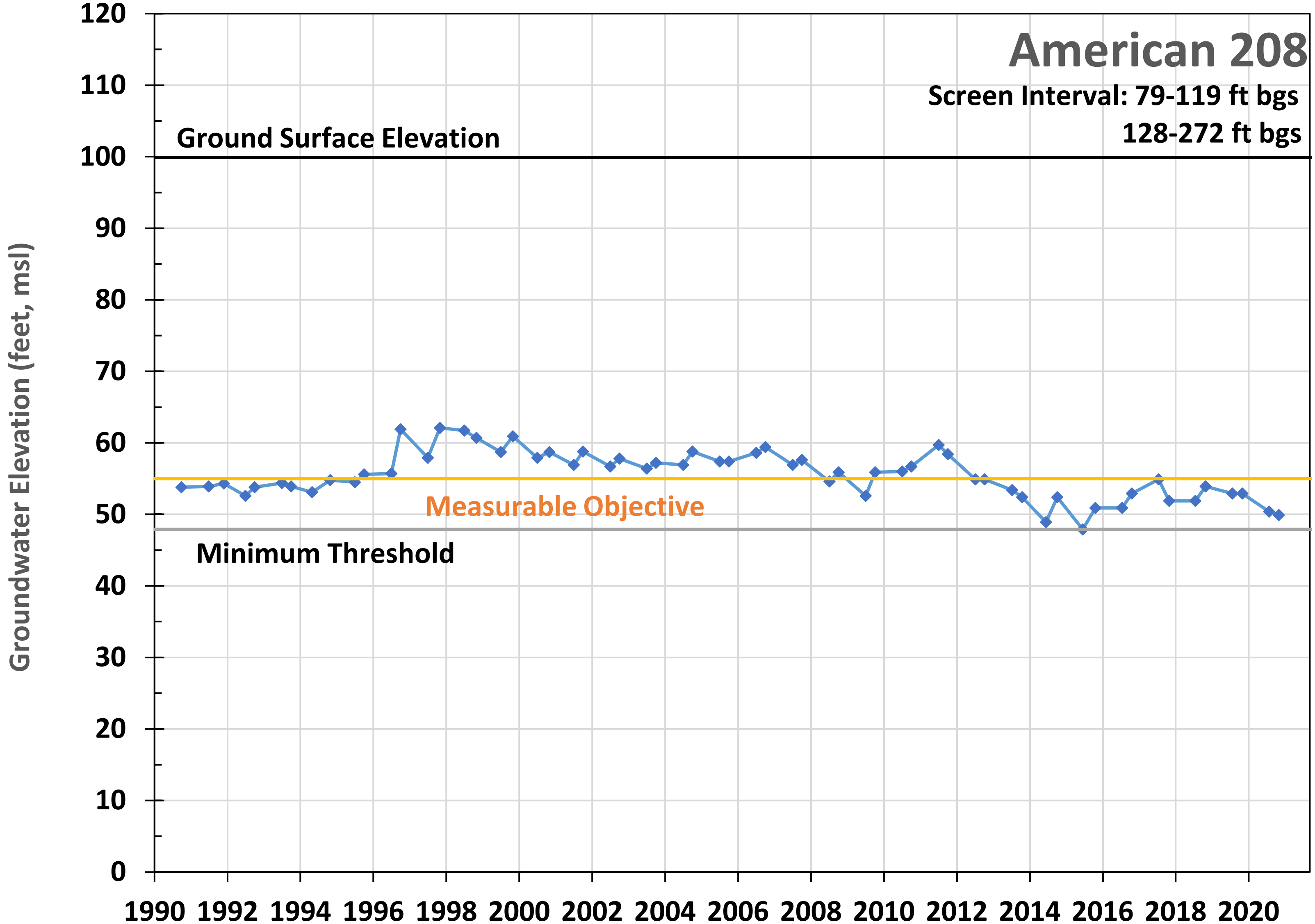
Canfield 90
Screen Interval: 40-75 ft bgs
Ground Surface Elevation
Measurable Objective
Minimum Threshold
Groundwater Elevation (feet, msl)
60
50
40
30
20
10
0
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016
2018
2020



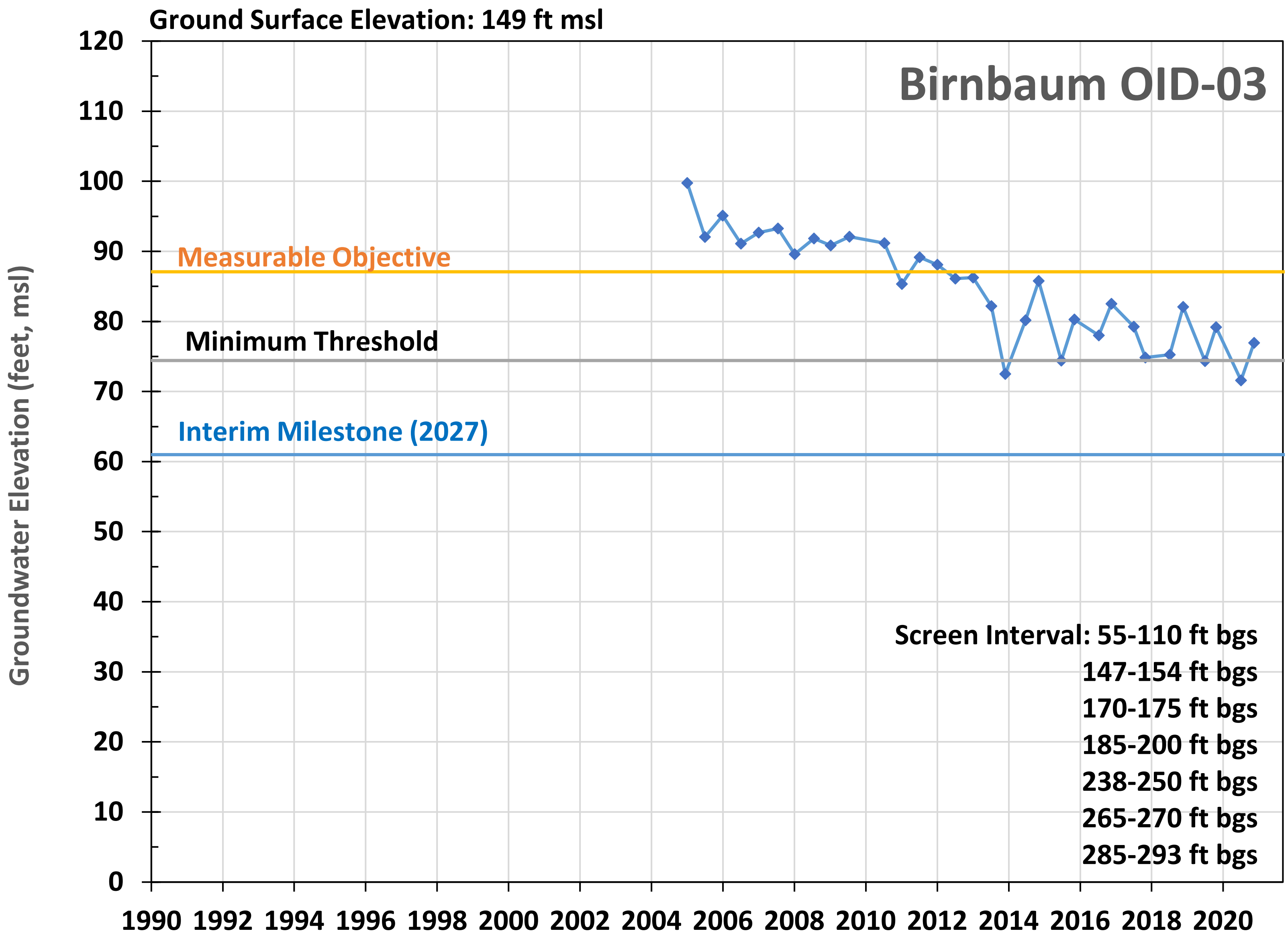
Katen 69
Screen Interval: 13-34 ft bgs
64-76 ft bgs
118-148 ft bgs
Ground Surface Elevation
Measurable Objective
Minimum Threshold
Groundwater Elevation (feet, msl)
100
90
80
70
60
50
40
30
20
10
0
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016
2018
2020



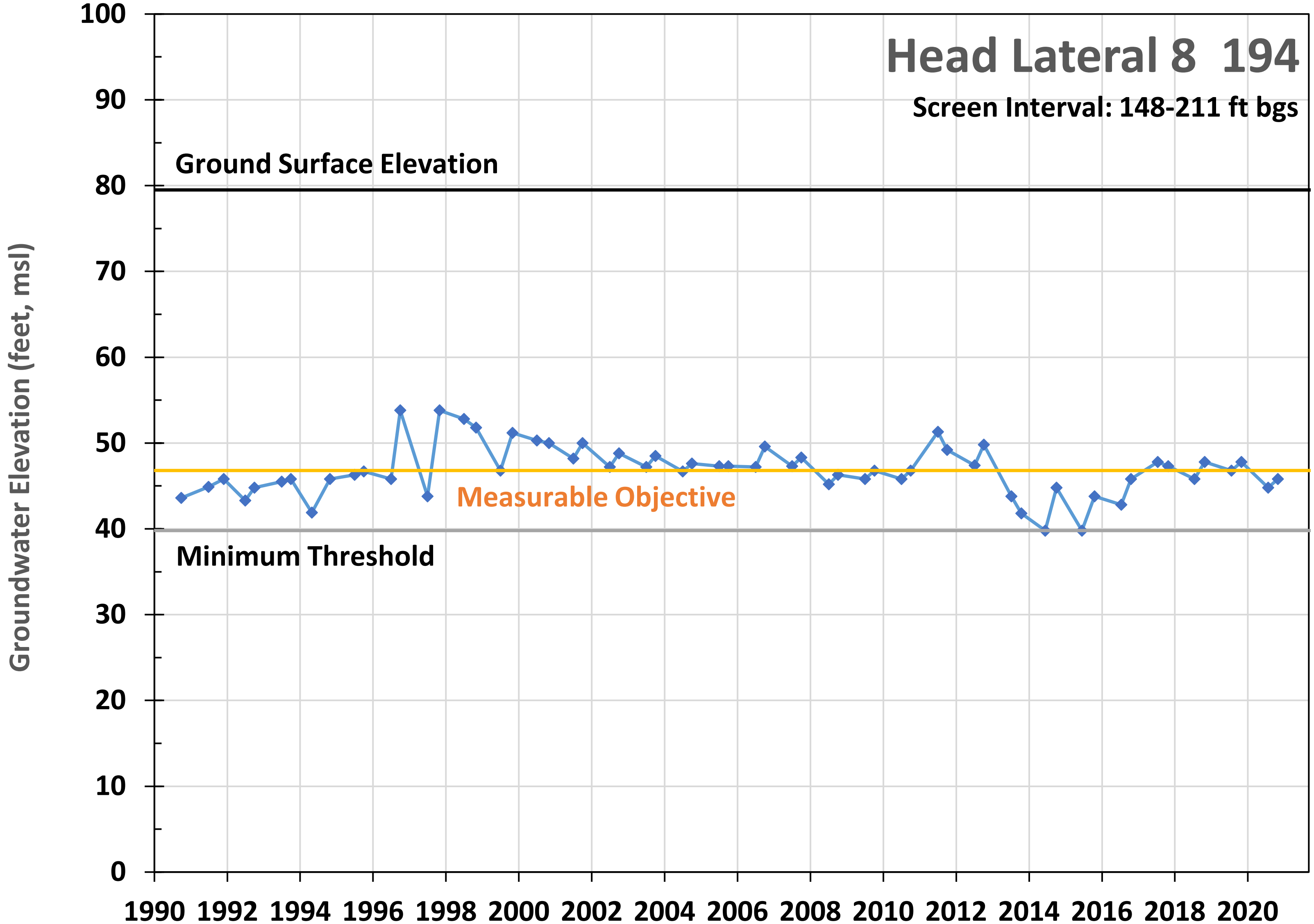
Allen OID-01
Ground Surface Elevation
Screen Interval : 0-120 ft bgs
Measurable Objective
Minimum Threshold
Interim Milestone (2027)
Groundwater Elevation (feet, msl)
0
10
20
30
40
50
60
70
80
90
100
110
120
130
140
150
160
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016
2018
2020



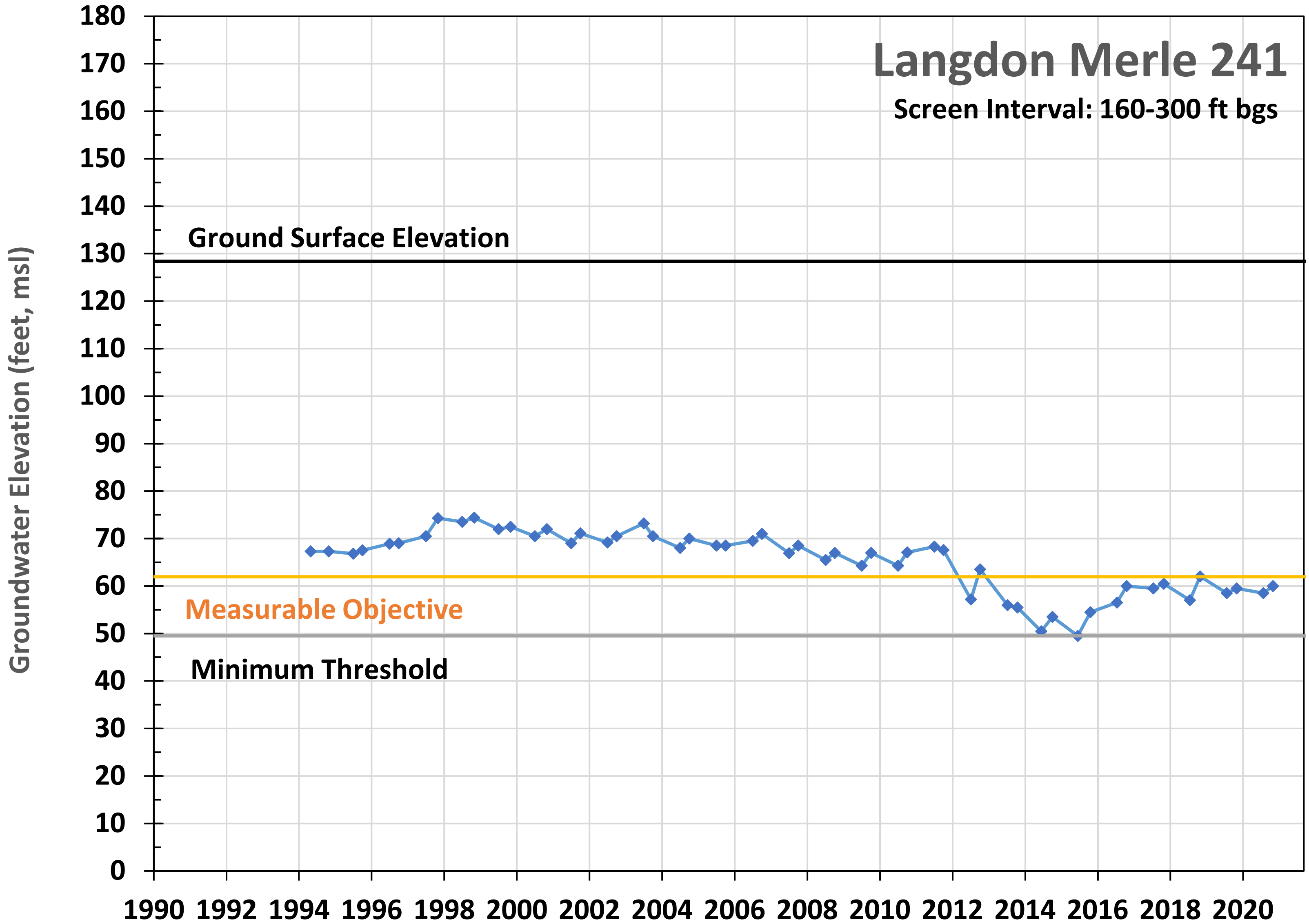
American 208
Screen Interval: 79-119 ft bgs
128-272 ft bgs
Ground Surface Elevation
Measurable Objective
Minimum Threshold
Groundwater Elevation (feet, msl)
120
110
100
90
80
70
60
50
40
30
20
10
0
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016
2018
2020



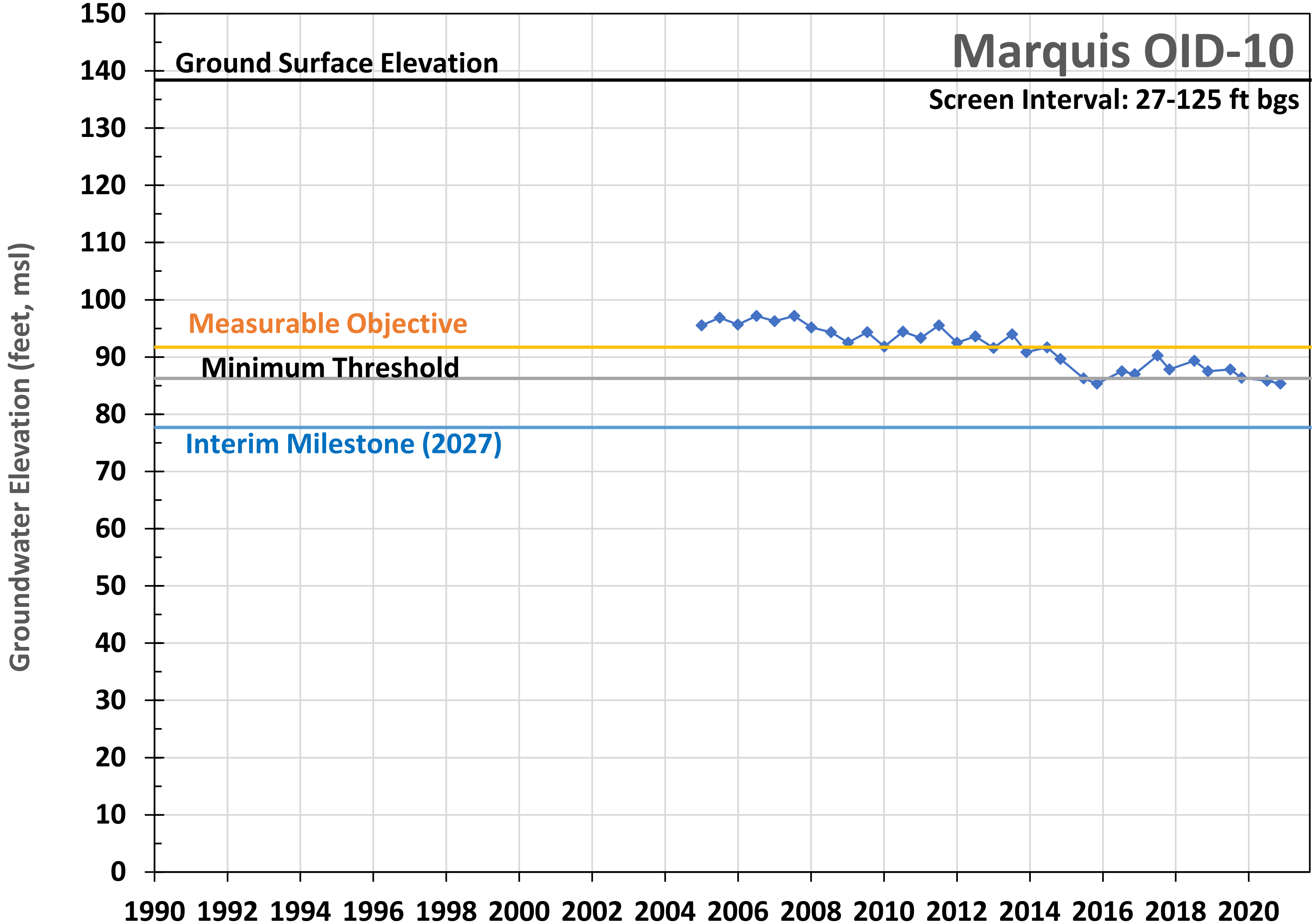
Ground Surface Elevation: 149 ft msl
Birnbaum OID-03
Measurable Objective
Minimum Threshold
Interim Milestone (2027)
Screen Interval: 55-110 ft bgs
147-154 ft bgs
170-175 ft bgs
185-200 ft bgs
238-250 ft bgs
265-270 ft bgs
285-293 ft bgs
Groundwater Elevation (feet, msl)
0
10
20
30
40
50
60
70
80
90
100
110
120
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016
2018
2020



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
Groundwater Elevation (feet, msl)
Ground Surface Elevation
Measurable Objective
Minimum Threshold
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



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
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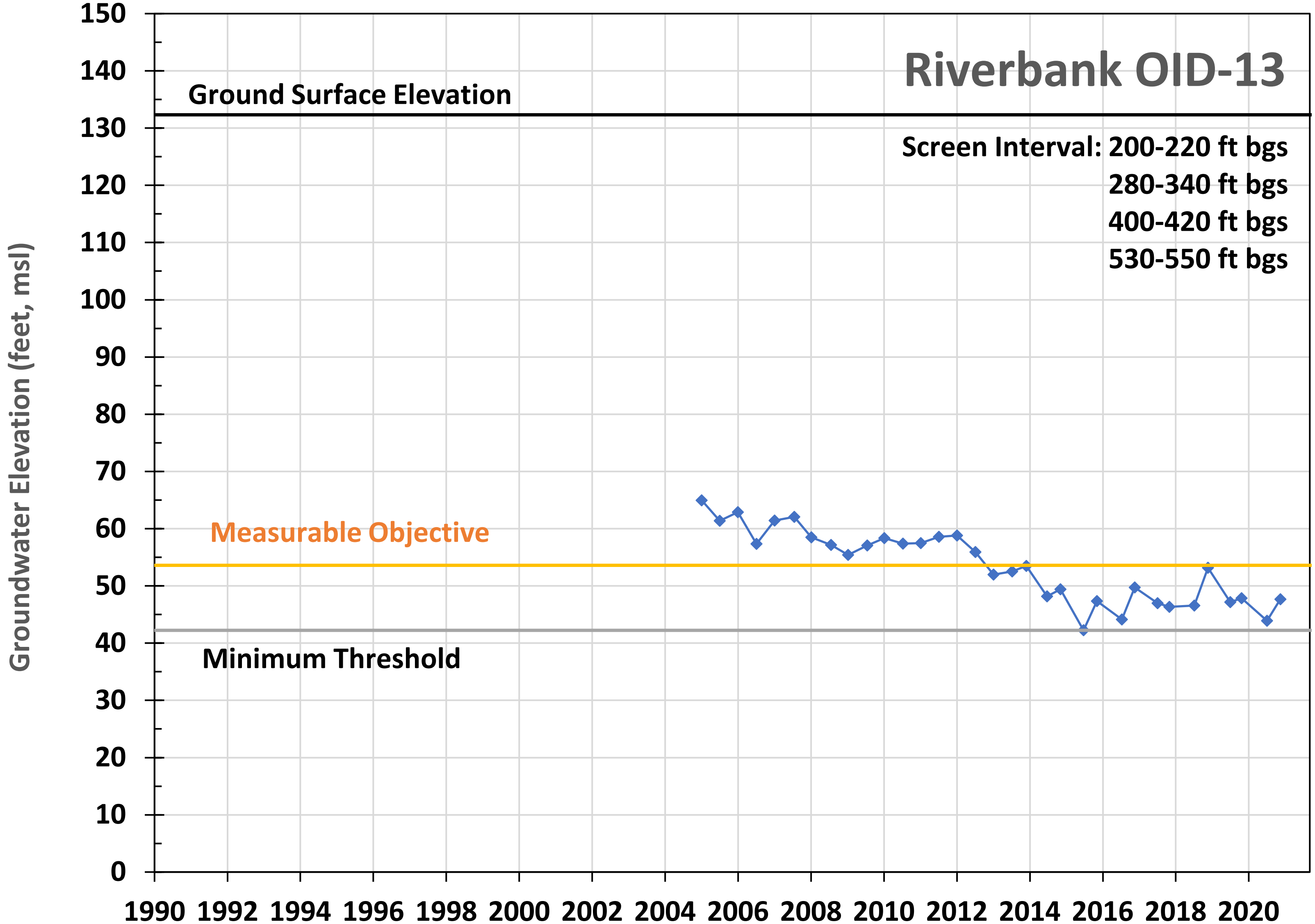
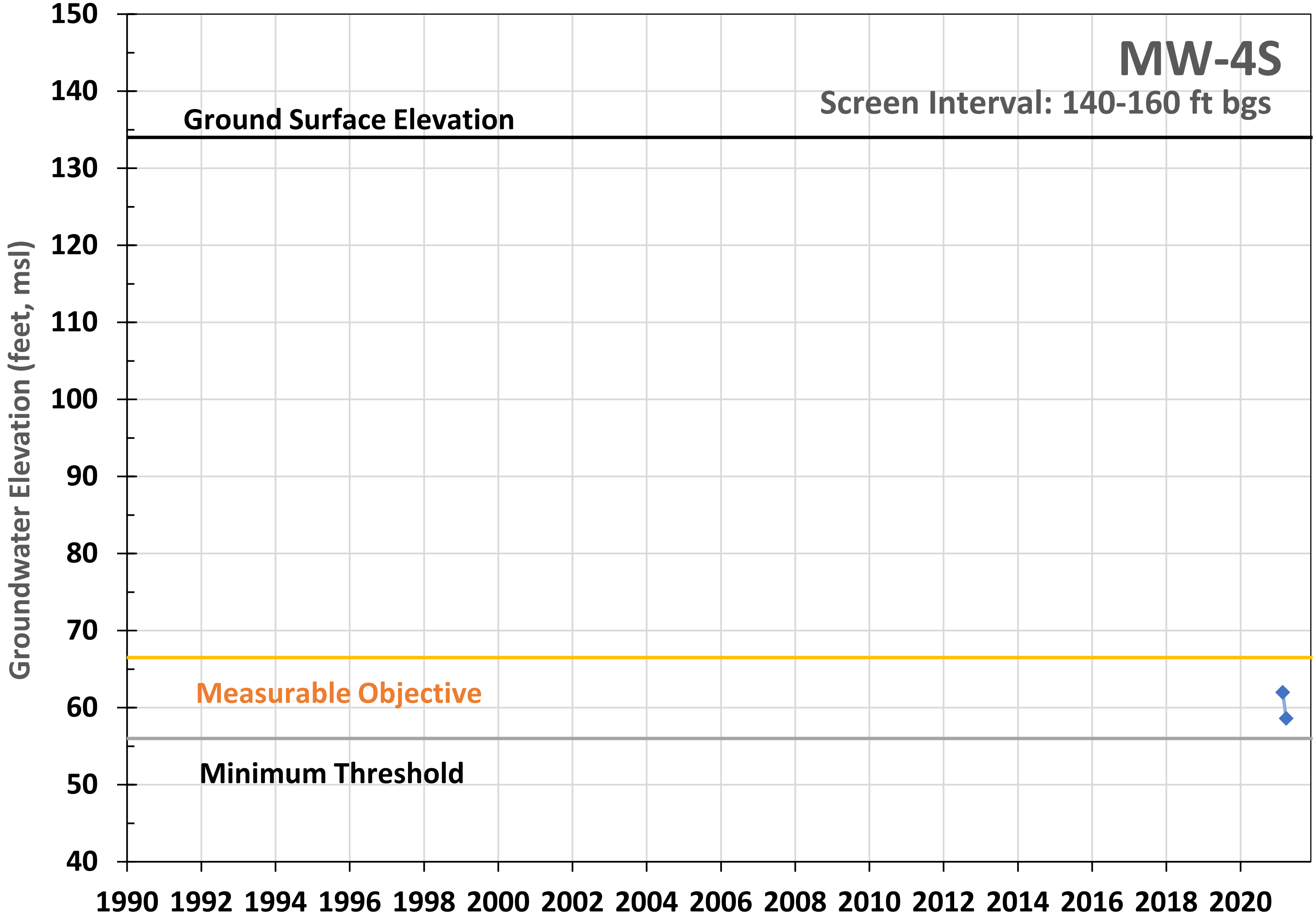
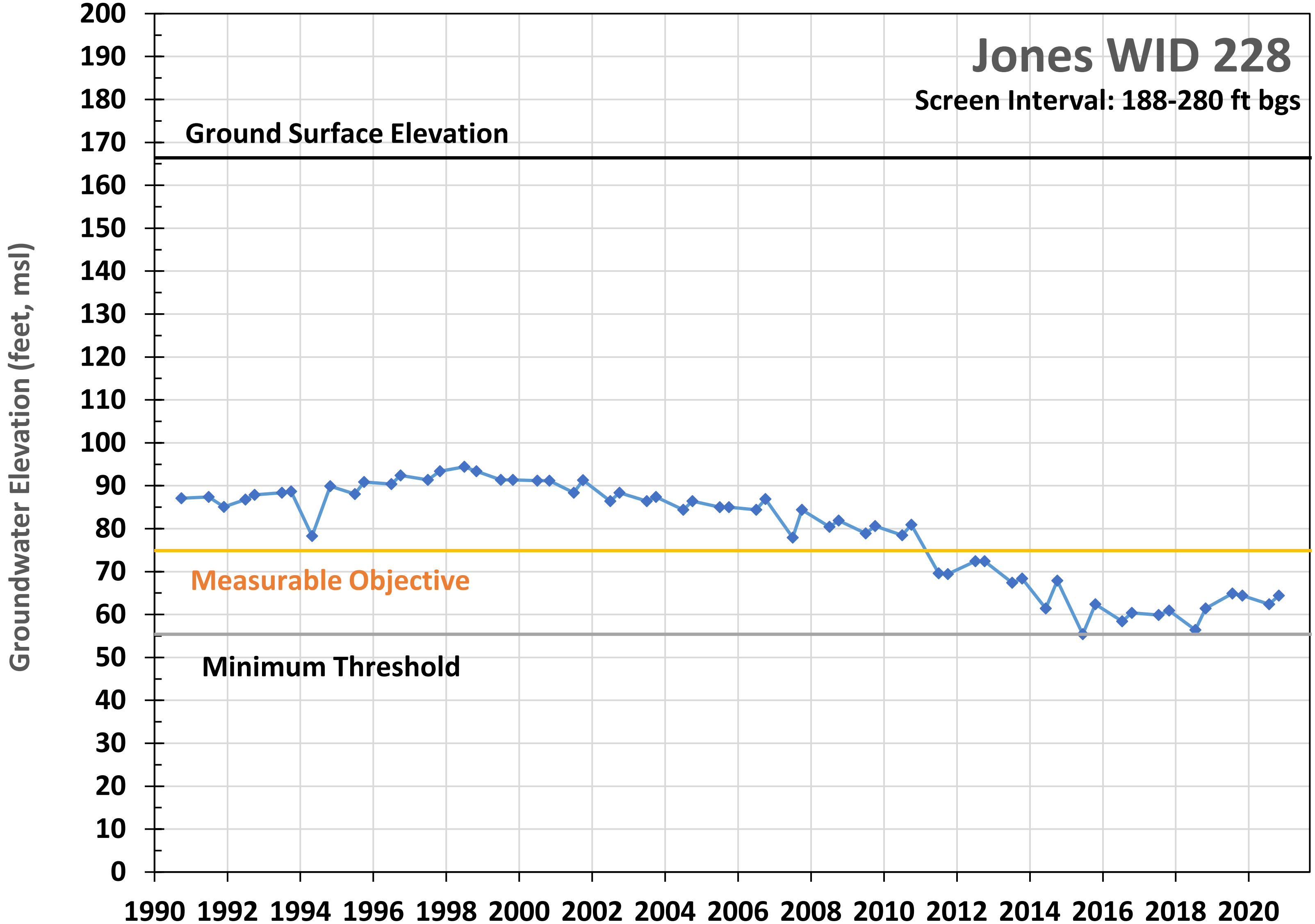
2010
2012
2014
2016
2018
2020

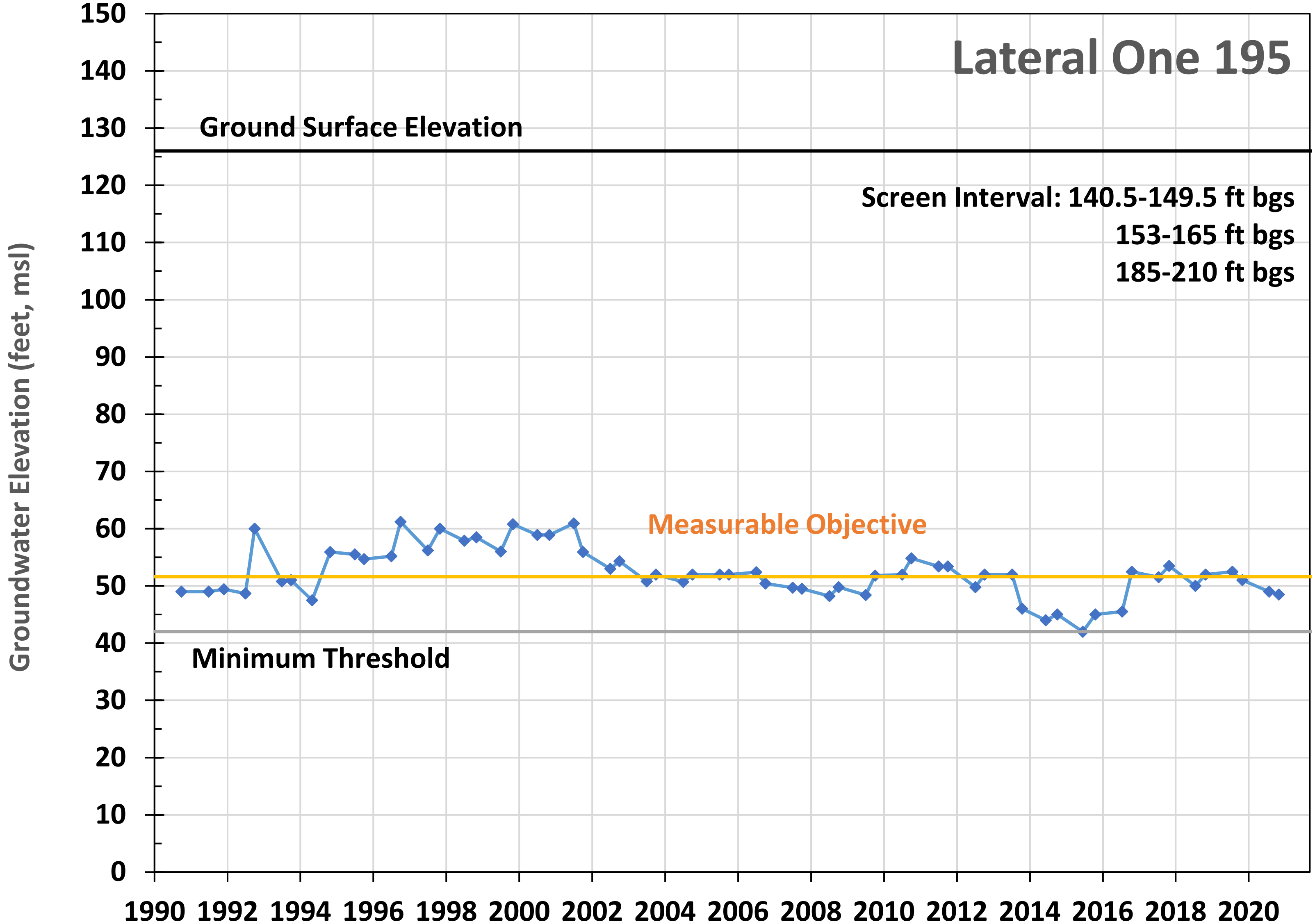

Riverbank OID-13
Ground Surface Elevation
Screen Interval: 200-220 ft bgs
280-340 ft bgs
400-420 ft bgs
530-550 ft bgs
Measurable Objective
Minimum Threshold
Groundwater Elevation (feet, msl)
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016
2018
2020

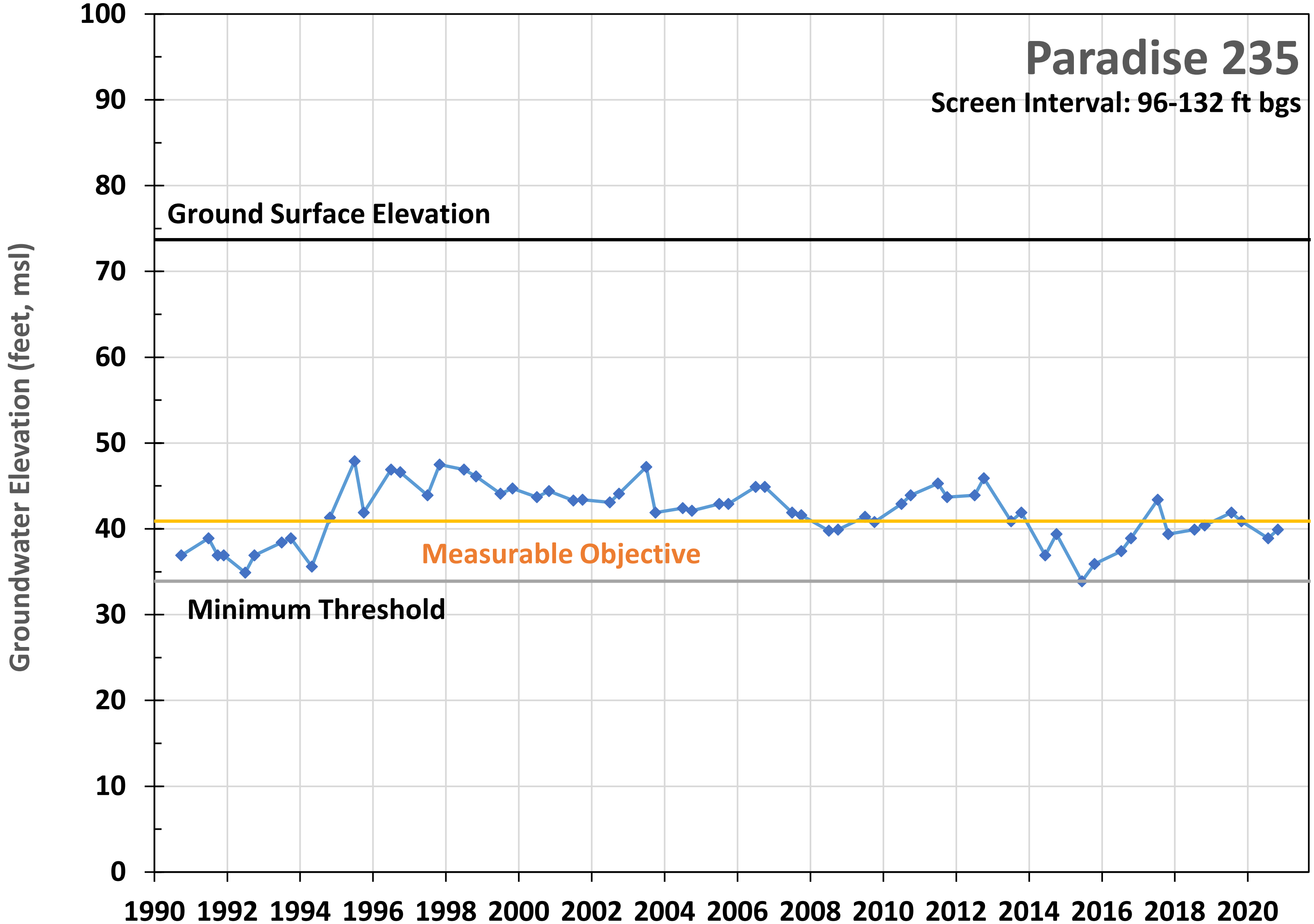


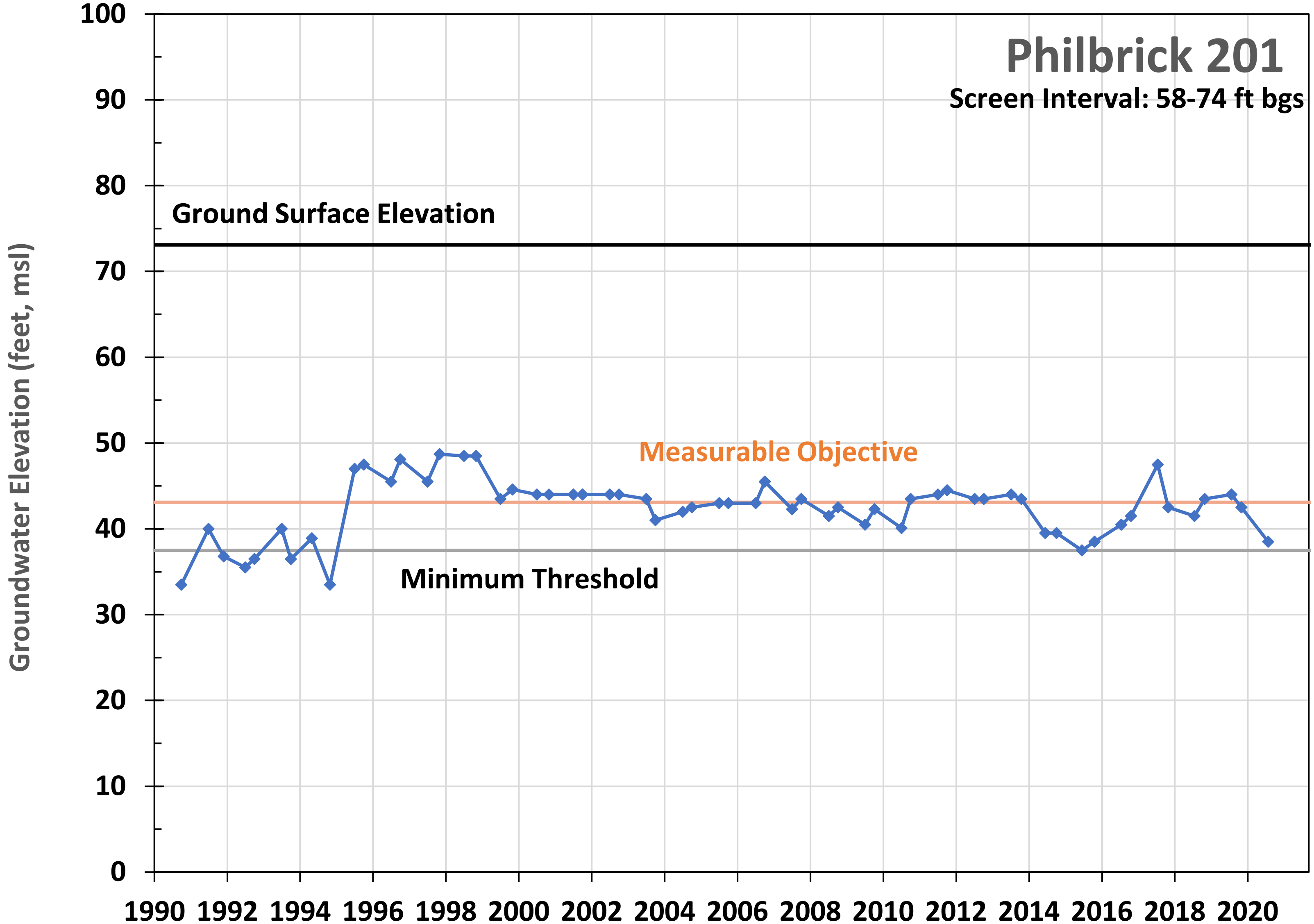
MW-4S
Screen Interval: 140-160 ft bgs
Ground Surface Elevation
Measurable Objective
Minimum Threshold
Groundwater Elevation (feet, msl)
150
140
130
120
110
100
90
80
70
60
50
40
1990 1992 1994 1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020



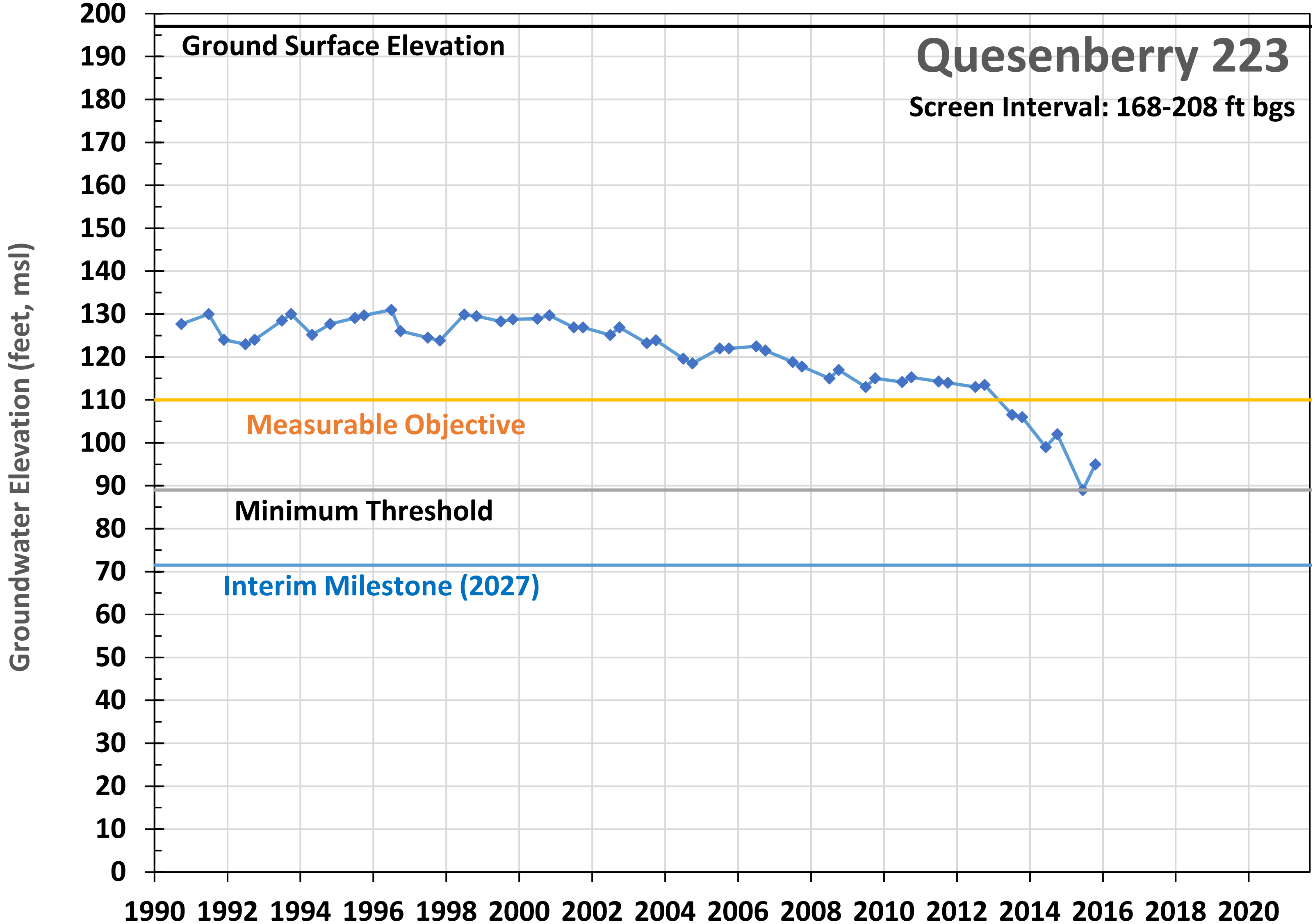
Jones WID 228
Screen Interval: 188-280 ft bgs
Ground Surface Elevation
Measurable Objective
Minimum Threshold
Groundwater Elevation (feet, msl)
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016
2018
2020


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

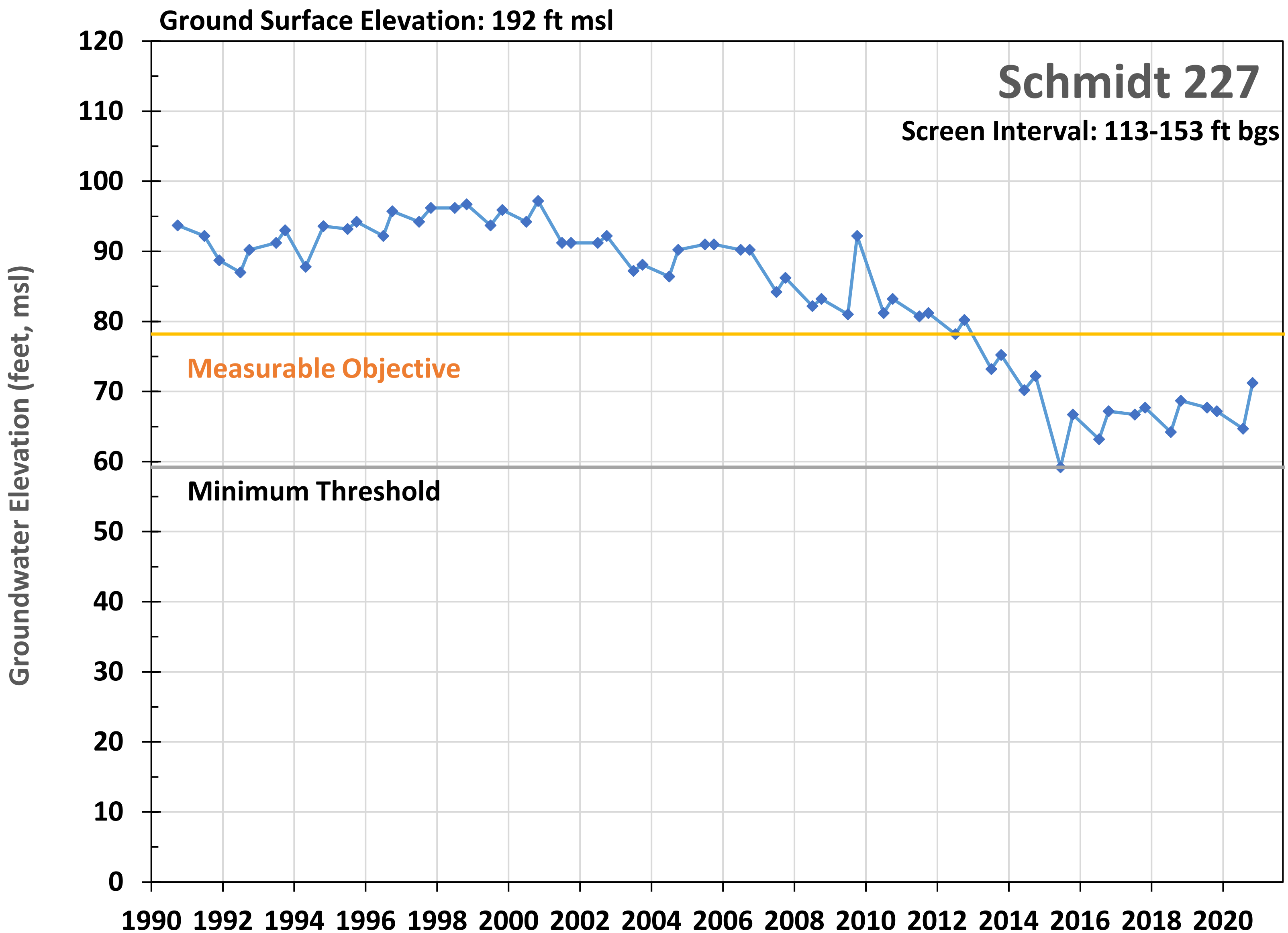

Paradise 235
Screen Interval: 96-132 ft bgs
Ground Surface Elevation
Measurable Objective
Minimum Threshold
Groundwater Elevation (feet, msl)
0
10
20
30
40
50
60
70
80
90
100
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016
2018
2020

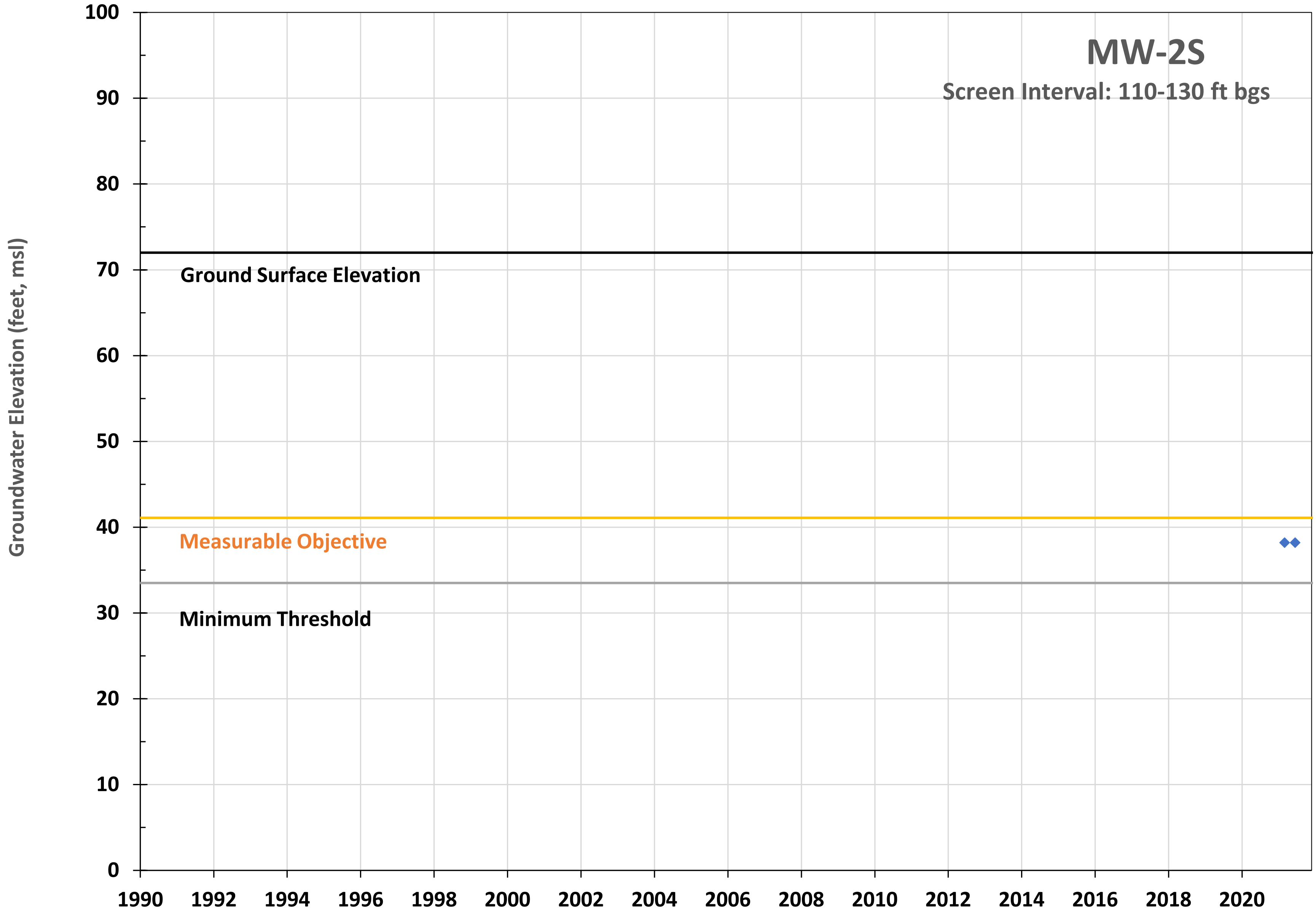


Philbrick 201
Screen Interval: 58-74 ft bgs
Ground Surface Elevation
Measurable Objective
Minimum Threshold
Groundwater Elevation (feet, msl)
100
90
80
70
60
50
40
30
20
10
0
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016
2018
2020

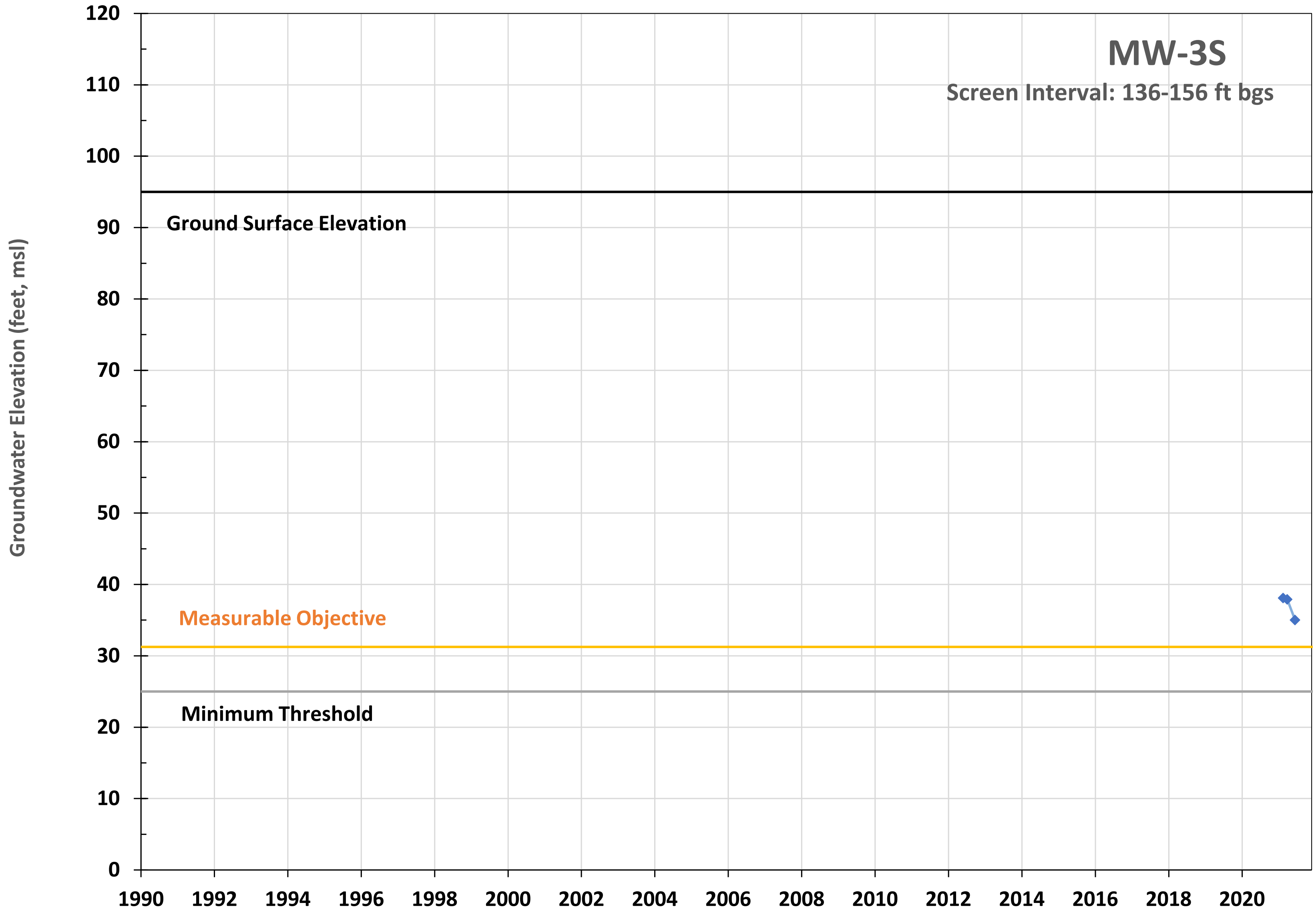


Quesenberry 223
Screen Interval: 168-208 ft bgs
Ground Surface Elevation
Measurable Objective
Minimum Threshold
Interim Milestone (2027)
Groundwater Elevation (feet, msl)
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
1990 1992 1994 1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020

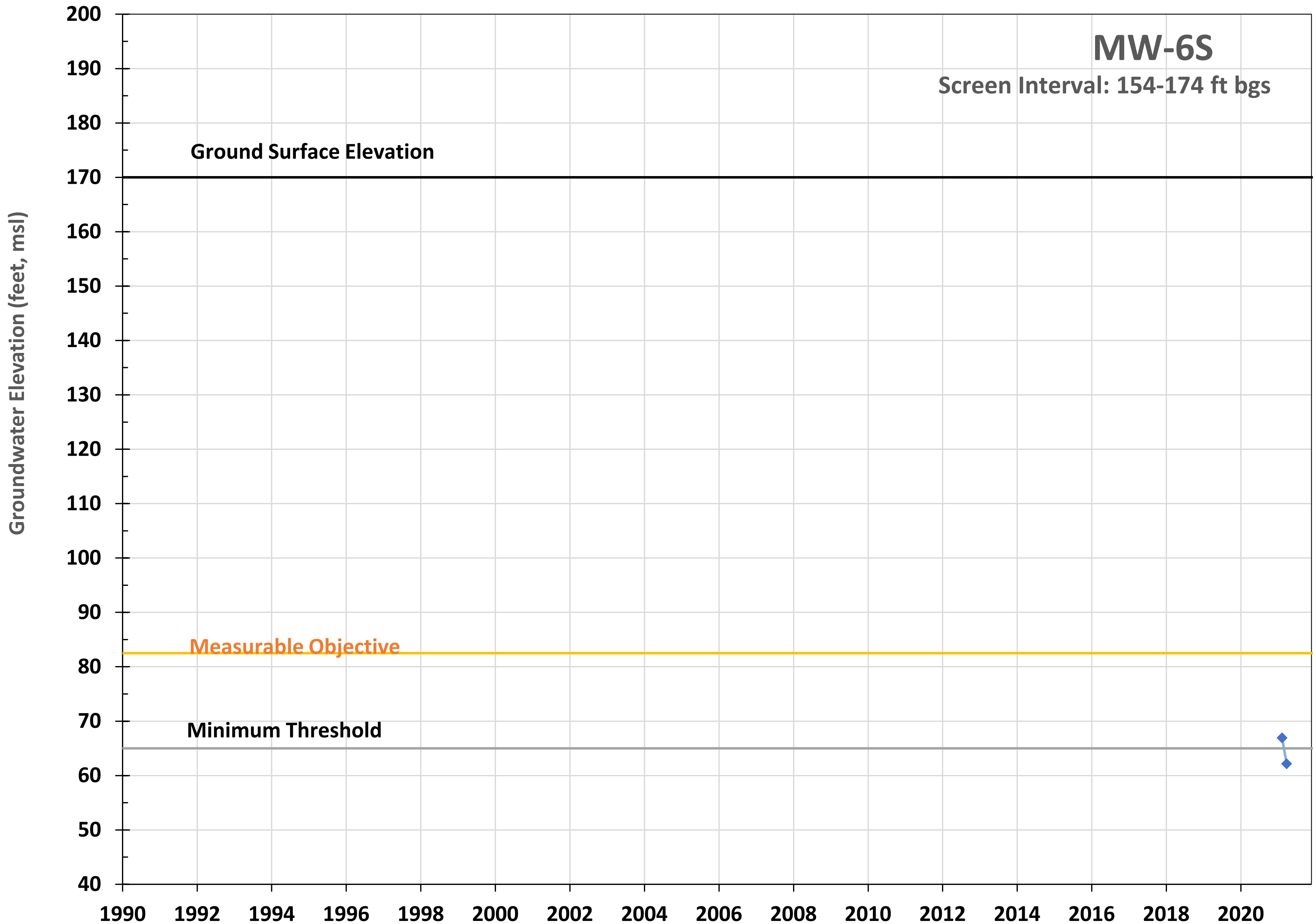

Ground Surface Elevation: 192 ft msl
Schmidt 227
Screen Interval: 113-153 ft bgs
Measurable Objective
Minimum Threshold
Groundwater Elevation (feet, msl)
0
10
20
30
40
50
60
70
80
90
100
110
120
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016
2018
2020



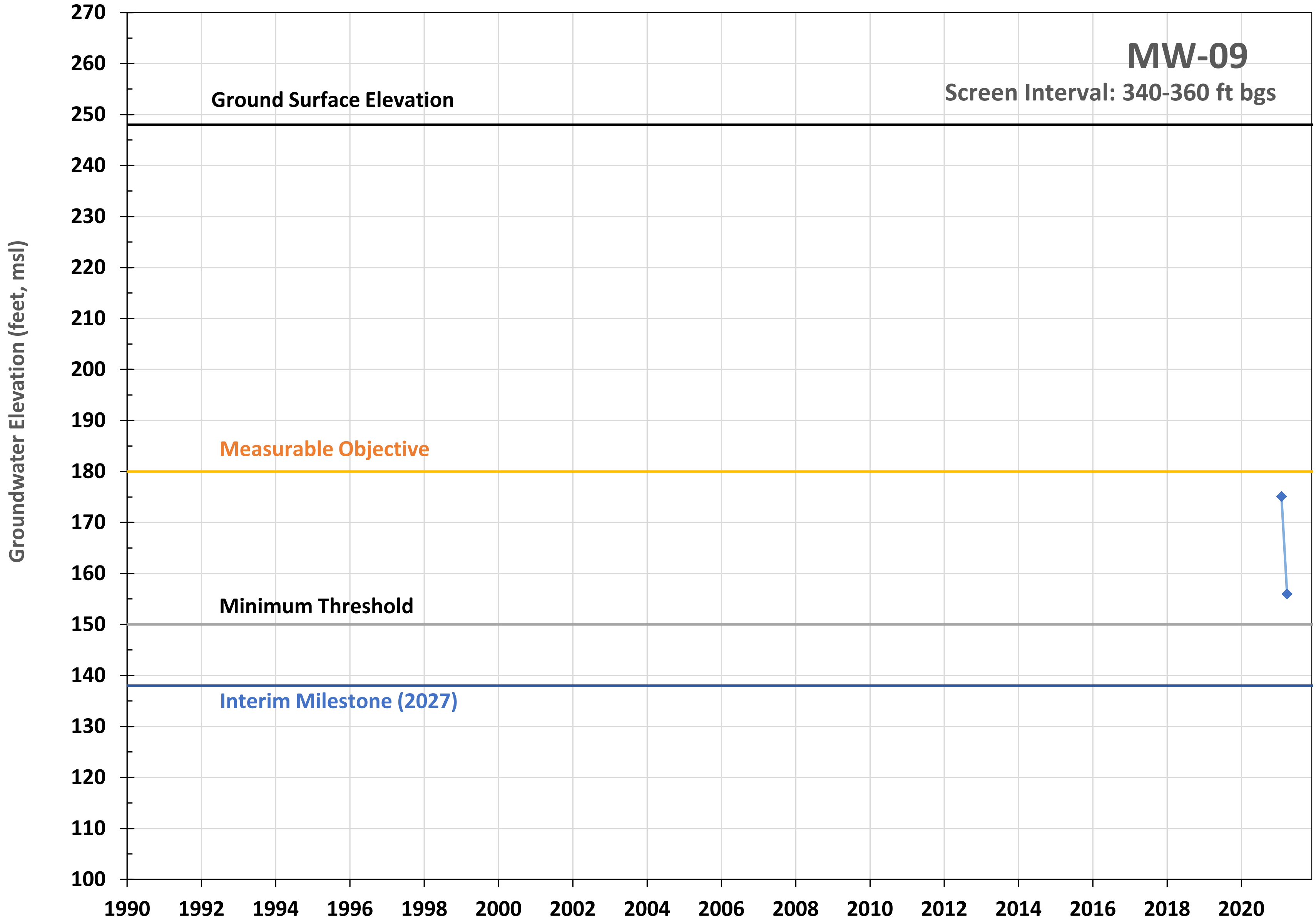
MW-2S
Screen Interval: 110-130 ft bgs
Groundwater Elevation (feet, msl)
Ground Surface Elevation
Measurable Objective
Minimum Threshold
100
90
80
70
60
50
40
30
20
10
0
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016
2018
2020



MW-3S
Screen Interval: 136-156 ft bgs
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



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

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
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					

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
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						

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

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
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