SPECIAL MEETING OF THE MADERA CITY COUNCIL AND SPECIAL MEETING OF THE MADERA CITY COUNCIL AS THE GROUNDWATER SUSTAINABILITY AGENCY

205 W. 4th Street, Madera, California 93637

NOTICE AND AGENDA

Monday, March 20, 2023
6:00 p.m.

Council Chambers
City Hall

The Madera City Council meetings are open to the public. This meeting will also be available for public viewing and participation through Zoom. Members of the public may also observe the live streamed meeting on the City's website at www.madera.gov/live. Members of the public may comment on agenda items at the meeting or remotely through an electronic meeting via phone by dialing (669) 900-6833 enter ID: 852 0691 4913#. Comments will also be accepted via email at citycouncilpubliccomment@madera.gov or by regular mail at 205 W. 4th Street, Madera, CA 93637.

CALL TO ORDER:

ROLL CALL: Mayor Santos Garcia
Mayor Pro Tem Elsa Mejia, District 5
Councilmember Cece Gallegos, District 1
Councilmember Jose Rodriguez, District 2
Councilmember Steve Montes, District 3
Councilmember Anita Evans, District 4
Councilmember Artemio Villegas, District 6

INVOCATION:

PLEDGE OF ALLEGIANCE:

APPROVAL OF AGENDA:

PUBLIC COMMENT:
Members of the public shall have an opportunity to address the City Council regarding matters on this Agenda at the time the agenda item is called. Speakers should limit their comments to three (3) minutes.

PRESENTATIONS:
1. Dolores Huerta Day Proclamation

A. PETITIONS, BIDS, RESOLUTIONS, ORDINANCES, AND AGREEMENTS:

A-1 Revised Groundwater Sustainability Plan for the Madera Subbasin

Recommendation: Approve Resolution Adopting an Amended Groundwater Sustainability Plan for the Madera Subbasin and Thereby also Approving Related First Amendment to Madera Subbasin Coordination Agreement and MOU Establishing a Domestic Well Mitigation Program for the Madera Subbasin of the San Joaquin Valley Groundwater Basin (Report by Keith Helmuth)

A-2 Community Action Partnership of Madera County (CAPMC) request to terminate the Community Development Block Grant (CDBG) 2021 Subrecipient Agreement for Services relating to the Rapid Rehousing Program and the request by City to reallocate the remaining grant funds ($342,761.46) to the 2023-2024 CDBG Capital/Public Improvements funding category

Recommendation: Adopt a Resolution:

1. Approving CAPMC request to terminate the 2021 CDBG Subrecipient Agreement for Services relating to the Rapid Rehousing Program with CAPMC relating to the Rapid Rehousing Program and
2. Approving the reallocation of the remaining grant funds in the amount of $342,761.46 to the 2023-2024 CDBG Capital/Public Improvements Allocation (Report by Anthony Forestiere)

ADJOURNMENT:

UPCOMING MEETING DATES:

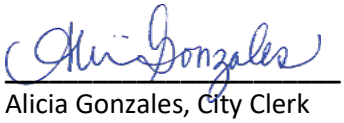
- Wednesday, April 5, 2023
- Wednesday, April 19, 2023

- The meeting room is accessible to the physically disabled. Requests for accommodations for persons with disabilities such as signing services, assistive listening devices, or alternative format agendas and reports needed to assist participation in this public meeting may be made by calling the City Clerk's Office at (559) 661-5405 or emailing cityclerkinfo@madera.gov . Those who are hearing impaired may call 711 or 1-800-735-2929 for TTY Relay Service. Requests should be made as soon as practicable as additional time may be required for the City to arrange or provide the requested accommodation. Requests may also be delivered/mailed to: City of Madera, Attn: City Clerk, 205 W. 4th Street, Madera, CA 93637. At least seventy-two (72) hours' notice prior to the meeting is requested but not required. When making a request, please provide sufficient detail that the City may evaluate the nature of the request and available accommodations to support meeting participation. Please also provide appropriate contact information should the City need to engage in an interactive discussion regarding the requested accommodation.
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- Please silence or turn off cell phones and electronic devices while the meeting is in session.
- Regular meetings of the Madera City Council are held the 1st and 3rd Wednesday of each month at 6:00 p.m. in the Council Chambers at City Hall.
- A complete agenda packet is available on the City's website and in the City Clerk's Office at least 72 hours prior to a Regular Meeting and 24 hours prior to a Special Meeting. A hard copy of any agenda

report may be requested by contacting the City Clerk's Office at (559) 661-5405 or by email at cityclerkinfo@madera.gov .

- Questions regarding the meeting agenda or conduct of the meeting, please contact the City Clerk's Office at (559) 661-5405.
- Para asistencia en español sobre este aviso, por favor llame al (559) 661-5405.

I, Alicia Gonzales, City Clerk for the City of Madera, declare under penalty of perjury that I posted the above agenda for the Special Meeting of the Madera City Council for March 20, 2023, near the front entrances of City Hall and on the City's website www.madera.gov at 5:00 p.m. on March 17, 2023.



Alicia Gonzales, City Clerk

REPORT TO CITY COUNCIL

Groundwater Sustainability Agency

Approved by:

Keith Helmuth, Department Director

for Arnoldo Rodriguez, City Manager

Council Meeting of: March 20, 2023

Agenda Number: A-1

SUBJECT:

Revised Groundwater Sustainability Plan for the Madera Subbasin

RECOMMENDATION:

Approve Resolution Adopting an Amended Groundwater Sustainability Plan for the Madera Subbasin and Thereby also Approving Related First Amendment to Madera Subbasin Coordination Agreement and MOU Establishing a Domestic Well Mitigation Program for the Madera Subbasin of the San Joaquin Valley Groundwater Basin

SUMMARY:

The City of Madera (City) is one of seven agencies that have established a Groundwater Sustainability Agency (GSA) within the boundaries of Madera Groundwater Subbasin pursuant to the 2014 Sustainable Groundwater Management Act (SGMA). The seven GSAs include the following members:

- City
- County of Madera (County)
- Madera Irrigation District (MID)
- Madera Water District (MWD)
- Gravelly Ford Water District
- Root Creek Water District and
- New Stone Water District (NWSD)

Four of those GSAs, including the City, County, MID, and MWD, prepared one joint GSP.

The original GSP was prepared in compliance with the SGMA, which requires GSAs to achieve groundwater sustainability in a subbasin by 2040. Combined, the original GSP GSAs are responsible for approximately 95 percent of the Madera subbasin.

The remaining three GSAs, Gravelly Ford Water District GSA, Root Creek Water District GSA and New Stone Water District GSA, each prepared their own individual GSPs, which, when combined with the joint GSP, collectively cover the entire Madera Subbasin as required by SGMA.

The GSAs were required to prepare, adopt and begin implementing the GSP by January 31, 2020.

DISCUSSION:

While the GSP was submitted on time, the Department of Water Resources (DWR) did not initiate their review until October 9, 2020 due to the inability of all seven GSAs to enter into a coordination agreement. The results of this review identifying four deficiencies in the GSP was sent to the Madera Subbasin Point of Contact in a letter (Letter) dated September 22, 2022. Those deficiencies included:

1. Coordination - Failure to demonstrate that the four GSPs have coordinated to address the regulatory aspects of SGMA in a manner that complies with SGMA and substantially complies with GSP regulations,

2. Chronic Lowering of Groundwater Table - GSPs did not establish minimum thresholds for chronic lowering of groundwater levels in a manner substantially compliant with the GSP regulations,

3. Land Subsidence - GSPs did not develop sustainable management criteria for land subsidence using the best available information and science,

4. Interconnected Surface Water - GSPs did not develop sustainable management criteria for the depletions of interconnected surface water using the best available information and science.

In the Letter, DWR represented that if the deficiencies were not addressed by March 21, 2023, DWR, after consultation with the State Water Resources Control Board, would determine the GSP to be inadequate. Such a designation might trigger the state intervention process outlined in SGMA.

As a result of the Letter, the GSP has been amended the GSP to address the deficiencies. A very general explanation of how the deficiencies are addressed is as follows:

- Coordination
    - Include addendum to the Coordination Agreement in the Revised GSP that addresses sustainability goal as well as current and projected water balances. A draft of this MOU is incorporated into the Revised GSP
    - Establish Domestic Well Mitigation MOU – A draft of this MOU is incorporated into the Revised GSP

- Chronic Lowering of Groundwater Table – Use Fall 2015 as basis for the Minimum Threshold. This results in minimum thresholds being higher than the original GSP

- Land Subsidence – Establish maximum rate of subsidence that decreases in 5-year increments with the initial rates based on 2014/15 annual rate of subsidence

- Interconnected Water Surface – Maintain the historical time of connection into the future

Given the time constraints imposed on this revised GSP, the Council will be approving and adopting the document based on the draft version of the revised GSP included as Attachment 2.

Preparation of the amended GSP by the GSA's consultant has adhered to Sustainable Groundwater Management Act of 2014, Water Code sections 10720-10737.8 ("SGMA") as signed into law on September 16, 2014. One of those provisions (10728.4) called for providing notice to a city or county within the area of the amendment. Within the Madera Subbasin, there is one city (Madera) and one county (Madera). Both are GSAs that are a Party to the very same amended agreement as addressed in this item. As such, has advised County that City waives notice from it and has requested County to do same.

FINANCIAL IMPACT:

There is no fiscal impact to the City's General Fund related to approval of the Agreement beyond that which was originally cited for the original approval of this agreement.

ALTERNATIVES:

Not approve the Revised GSP - To do so may result in the determining the GSP is inadequate. Such a designation might trigger the state intervention process outlined in SGMA.

ATTACHMENTS:

1. Resolution
   Exhibit A – Amended Groundwater Sustainability Plan (GSP)

Attachment 1

Resolution

RESOLUTION NO. 23-

A RESOLUTION OF THE CITY OF MADERA AND THE CITY OF MADERA, GROUNDWATER SUSTAINABILITY AGENCY BOARD ADOPTING AN AMENDED GROUNDWATER SUSTAINABILITY PLAN FOR THE MADERA SUBBASIN AND THEREBY ALSO APPROVING RELATED FIRST AMENDMENT TO MADERA SUBBASIN COORDINATION AGREEMENT AND MOU ESTABLISHING A DOMESTIC WELL MITIGATION PROGRAM FOR THE MADERA SUBBASIN OF THE SAN JOAQUIN VALLEY GROUNDWATER BASIN

WHEREAS, the Sustainable Groundwater Management Act of 2014, Water Code sections 10720-10737.8 ("SGMA") was signed into law on September 16, 2014; and

WHEREAS, SGMA requires that each groundwater basin be managed by a Groundwater Sustainability Agency ("GSA"), or multiple GSAs, and that such management be pursuant to an approved Groundwater Sustainability Plan ("GSP"), or multiple GSPs; and

WHEREAS, on August 17, 2016, the City Council (Council) elected to have the City of Madera GSA become the exclusive GSA for the portions of the Madera Subbasin that are within the geographical boundaries of the City of Madera, and not otherwise covered by another public agency; and

WHEREAS, on or about August 17, 2016, the City of Madera GSA became the exclusive GSA for portions of the Madera Subbasin within the geographical boundaries of the City of Madera; and

WHEREAS, pursuant to Water Code section 10727, SGMA requires that a GSP, or multiple GSPs, be developed and implemented by January 31, 2020 for each high-priority basin; and

WHEREAS, Madera County, City of Madera, Madera Irrigation District, and Madera Water District have developed one GSP; Root Creek Water District has developed one GSP; Gravelly Ford Water District has developed one GSP; and New Stone Water District has developed one GSP, such that the Madera Subbasin is governed by four separate GSPs unified through the Madera Subbasin Coordination Agreement; and

WHEREAS, on December 18,2019, the City of Madera GSA, adopted the Joint GSP developed by Madera County, City of Madera, Madera Irrigation District, and Madera Water District for their portion of the Madera Subbasin; and

WHEREAS, the Madera Subbasin has no adjudicated areas or areas covered by an

Alternative to a GSP as described in Water Code Section 10733.6; and

WHEREAS, on or about January 31, 2020, the Madera County, City of Madera, Madera Irrigation District, and Madera Water District GSAs submitted a GSP to the Department of Water Resources ("DWR") for review, public comment, and approval; and

WHEREAS, DWR did not initiate review of the four GSPs until October 9, 2020; and

WHEREAS, on September 22, 2022, DWR sent a letter to the Madera Subbasin Point of Contact (John Davids of Davids Engineering, Inc.) stating that the GSPs had been determined to be incomplete because the GSPs (collectively); (1) fail to demonstrate that the four GSPs have coordinated to address the regulatory aspects of SGMA in a manner that complies with SGMA and substantially complies with GSP regulations, (2) do not establish minimum thresholds for chronic lowering of groundwater levels in a manner substantially compliant with the GSP regulations, (3) did not develop sustainable management criteria for land subsidence using the best available information and science, and (4) did not develop sustainable management criteria for the depletions of interconnected surface water using the best available information and science; and

WHEREAS, in the September 22, 2022 letter, DWR represented that if the deficiencies identified in the letter were not addressed by March 21, 2023, DWR, after consultation with the State Water Resources Control Board, would determine the GSP to be inadequate, possible triggering the state intervention process outlined in SGMA; and

WHEREAS, the GSAs in the Madera Subbasin have agreed to submit revised GSPs consistent with DWRs September 22, 2022 letter; and

WHEREAS, the GSAs, in accordance with the Madera Subbasin Coordination Agreement, desire for the Coordination Workgroup, as defined in the Madera Subbasin Coordination Agreement, to meet on at least a quarterly basis, beginning in January 2023; and

WHEREAS, the GSAs recognize and agree that the GSPs revised as part of the statutorily required 2025 Update ("Update") should adequately and appropriately memorialize the changes to GSP implementation that have occurred since submission of the original GSPs in January 2020; and

WHEREAS, the Parties agree that the GSPs revised as part of the statutorily required Update shall include, among other changes as determined necessary, revised Projects and Management Actions ("PMAs") as determined necessary by each GSA consistent with the broader Sustainability Goal of the Madera Subbasin; and

WHEREAS, the GSAs agree that work shall begin as early as February 2023 on the statutorily required Update to each of the GSPs; and

WHEREAS, the Parties agree to work cooperatively with one another as part of the statutorily required Update and may consider GSP consolidation as part of the statutorily required Update; and

WHEREAS, the Madera Subbasin Sustainable Groundwater Act Joint Groundwater Sustainability Plan has been amended to address the deficiencies outlined in the September 22, 2022 letter from DWR; and

WHEREAS, Public Hearing Notice to a City or County as called for in Water Code section 10728.4 can be waived as the County of Madera is also a Party to the amended GSP; and

WHEREAS, upon adoption of Amended GSP, the City will submit the GSP to DWR for review.

WHEREAS, at its special meeting of March 20, 2023, the Council considered the City Engineer's report regarding the Amended GSP and the associated documents including the First Amendment to the Madera Subbasin Coordination Agreement and the Memorandum Of Understanding Establishing a Domestic Well Mitigation Program for the Madera Subbasin of the San Joaquin Valley Groundwater Basin; and

NOW, THEREFORE, THE CITY COUNCIL OF THE CITY OF MADERA ACTING AS THE CITY OF MADERA GSA hereby finds, orders and resolves as follows:

1. The above recitals are true and correct.

2. The Council approves the amended GSP, attached hereto as Exhibit A, including draft first amendment to the Madera Subbasin Coordination Agreement and Memorandum of Understanding Establishing a Domestic Well Mitigation Program for the Madera Subbasin of the San Joaquin Valley Groundwater Basin in the form presented at the meeting of March 20, 2023 or as may be revised by the collaborative effort between GSA staffs is hereby approved and adopted.

3. The Council authorizes the Madera City Engineer to take such other actions as may be necessary to submit the Amended GSP to the California Department of Water Resources and to implement the purpose of this resolution.

4. The City Clerk of the City of Madera GSA is hereby authorized and directed to timely provide notification of this approval and adoption to DWR, including a copy of this Resolution, the approved GSP, and any additional information required by law.

5. This resolution is effective immediately upon adoption.

* * * * * * * *

Exhibit A

Amended Groundwater Sustainability Plan (GSP)

MADERA SUBBASIN

Sustainable Groundwater Management Act (SGMA)

Joint Groundwater Sustainability Plan

City of Madera GSA
County of Madera GSA – Madera
Madera Irrigation District GSA
Madera Water District GSA

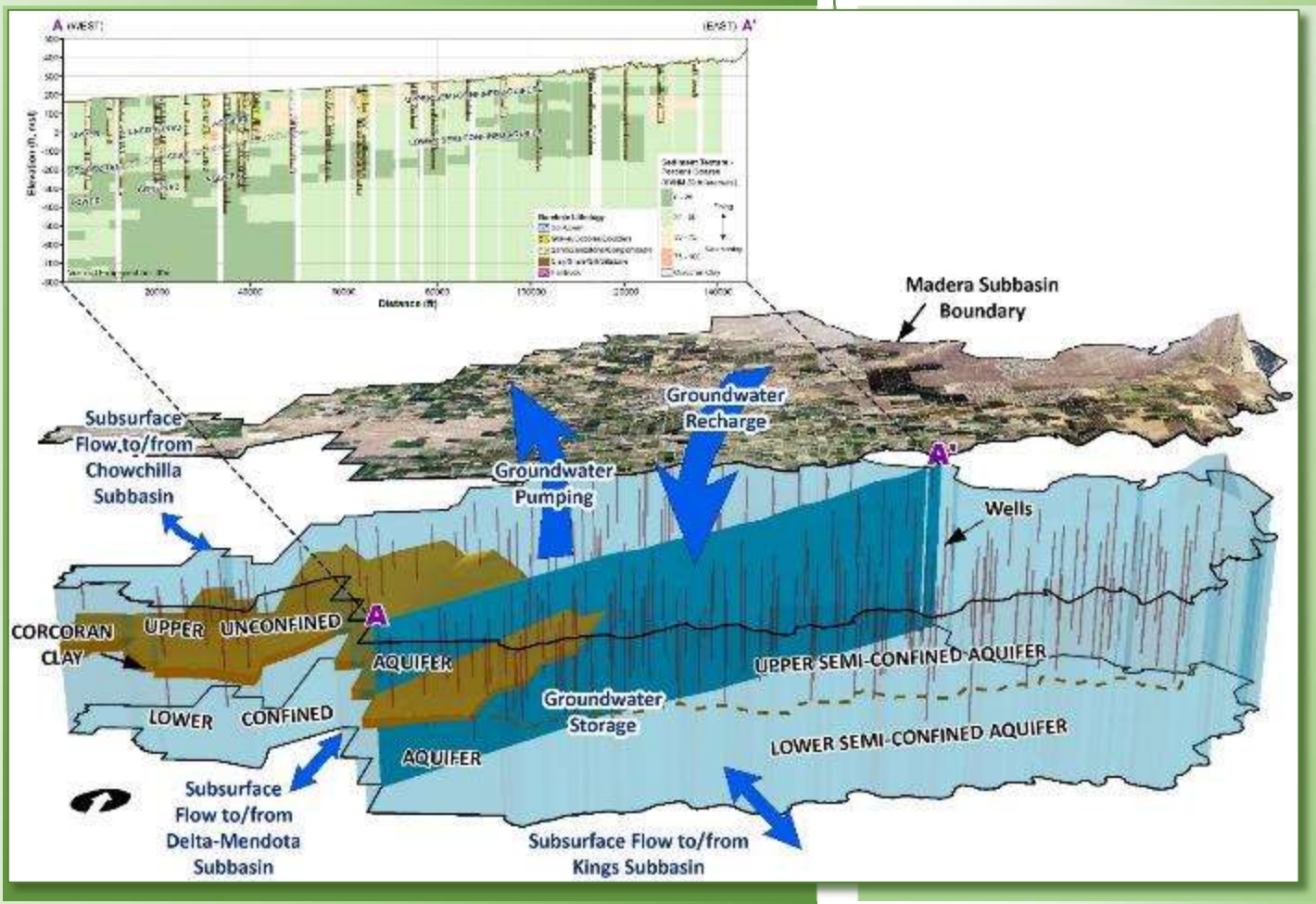
January 2020
Revised March 2023





Prepared by

Davids Engineering, Inc. *(Revised GSP)*
Luhdorff & Scalmanini *(Revised GSP)*
ERA Economics
Stillwater Sciences and
California State University, Sacramento



FINAL

Madera Subbasin

Sustainable Groundwater Management Act

Joint Groundwater Sustainability Plan

January 2020

Revised March 2023

Prepared For

Madera Subbasin Coordination Committee

Prepared By

Davids Engineering, Inc. (Revised GSP)
Luhdorff & Scalmanini (Revised GSP)
ERA Economics
Stillwater Sciences and
California State University, Sacramento

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LIST OF ABBREVIATIONS

AF	acre-feet
AFY	acre-feet/year
AG	Agricultural Land
AGR	agricultural supply
AN	above normal
AWMPs	Agricultural Water Management Plans
AWS	Automatic Weather Stations
bgs	below ground surface
BMP	Best Management Practice
BN	below normal
C	critical
C2VSim	California Central Valley Groundwater-Surface Water Simulation Model
C2VSim-FG	fine-grid version of C2VSim
CASGEM	California Statewide Groundwater Elevation Monitoring
CCP	Consensus and Collaboration Program at California State University, Sacramento
CCR	California Code of Regulations
CDEC	California Data Exchange Center
cfs	cubic feet per second
CIMIS	California Irrigation Management Information System
CM	City of Madera
CSUS	California State University, Sacramento (Consensus and Collaboration Program)
CVHM	Central Valley Hydrologic Model
CVP	Central Valley Project
CWC	California Water Code
CWD	Chowchilla Water District
D	dry
DDW	Division of Drinking Water
DE	Davids Engineering
DMS	Data Management System
DQO	data quality objectives
DTW	depth to water
DWR	California Department of Water Resources
EFH	Essential Fish Habitat
ERA	ERA Economics, LLC
ET	evapotranspiration
ET_a	actual ET
ET_{aw}	ET of applied water
ET_c	crop ET
ET_o	grass reference ET
ET_{pr}	ET of precipitation
ET_r	alfalfa reference ET
ET_{ref}	reference crop evapotranspiration
eWRIMS	Electronic Water Rights Information Management System
Flood-MAR	Flood Managed Aquifer Recharge
FTE	full-time-equivalent
GAMA	Groundwater Ambient Monitoring and Assessment
GDEs	groundwater dependent ecosystems
GFWD	Gravelly Ford Water District
GIS	geographic information system
GMP	Groundwater Management Plan
gpm	gallons per minute
GRF	Gravelly Ford
GSA	Groundwater Sustainability Agencies
GSP	Groundwater Sustainability Plan
GWE	Groundwater Elevation
GWS	Groundwater system
HCM	hydrogeologic conceptual model
HGL	hydraulic grade line
IDC	Integrated Water Flow Model Demand Calculator
iGDEs	indicators of GDEs
ILRP	Irrigated Lands Regulatory Program
IND	industrial service supply
InSAR	interferometric synthetic aperture radar
ISW	interconnected surface water
IWFM	Integrated Water Flow Model
K	hydraulic conductivity
K_h	horizontal hydraulic conductivity
K_v	vertical hydraulic conductivity

LDC	Little Dry Creek
LSCE	Luhdorff & Scalmanini Consulting Engineers
maf	millions of acre-feet
MC	Madera County
MCL	maximum contaminant level
MCDEH	Merced County Department of Public Health, Division of Environmental Health
MCWPA	Madera-Chowchilla Water and Power Authority
Merced	Merced Irrigation District
mg/L	milligrams/liter
MID	Madera Irrigation District
MO	measurable objectives
MOU	memorandum of understanding
MSL	mean sea level
MT	minimum thresholds
MUN	Municipal and domestic supply
MWD	Madera Water District
MWELO	Model Water Efficient Landscape Ordinance
NASA-JPL	National Aeronautics and Space Administration Jet Propulsion Laboratory
NCCAG	Natural Communities Commonly Associated with Groundwater
NOAA NCEI	National Oceanic and Atmospheric Administration National Centers for Environmental Information
NSWD	New Stone Water District
NV	Native Vegetation Land
NWIS	National Water Information System
O&M	operation and maintenance
ORP	oxidation-reduction potential
pCi/L	picocuries per liter
PMAs	projects and management actions
PRO	industrial process supply
PV	Present Value
Q_b	Quaternary flood-plain deposits
QT_{cd}	Quaternary continental rocks and deposits
RCWD	Root Creek Water District
redox	reduction-oxidation
RFP	Request for Proposals
RH	relative humidity
RMS	Representative monitoring sites
RPE	Reference Point Elevation
R_s	solar radiation
SAGBI	Soil Agricultural Groundwater Banking Index
SB	Senate Bill
SCADA	Supervisory Control and Data Acquisition
SCS	USDA Soil Conservation Service (renamed Natural Resources Conservation Service)
SCS-CN	SCS curve number
SEBAL	Surface Energy Balance Algorithm for Land
SGMA	Sustainable Groundwater Management Act of 2014
SJR	San Joaquin River
SJRRP	San Joaquin River Restoration Program
SJV	San Joaquin Valley
SLDMWA	San Luis Delta-Mendota Water Authority
SMC	Sustainable Management Criteria
SOPs	Standard Operating Procedures
SS	Stillwater Sciences
SWRCB	State Water Resources Control Board
SWS	surface water system
Sy	specific yield
T	transmissivity
T_a	air temperature
TAF	thousand acre-feet
TDS	total dissolved solids
TM	Technical Memorandum
TMWA	Truckee Meadows Water Authority
UR	Urban Land
USACE	U.S. Army Corps of Engineers
USBR or Reclamation	United States Bureau of Reclamation
USDA	U.S. Department of Agriculture
USEPA	U.S. Environmental Protection Agency
USGS	United States Geological Survey

UWMPs	Urban Water Management Plans	W_s	wind speed
W	wet	WYI	Water Year Index
WCRs	well completion reports	YCWA	Yuba County Water Agency
WDL	Water Data Library	Yield	net groundwater benefit
		µg/L	micrograms per liter

EXECUTIVE SUMMARY

In September 2014, the California legislature passed the Sustainable Groundwater Management Act (SGMA), establishing new measures for groundwater management and regulation statewide. SGMA provides for local control of groundwater resources while requiring sustainable management of the state's groundwater basins. Under the provisions of SGMA, local agencies must establish governance of their subbasins by forming Groundwater Sustainability Agencies (GSAs) with the authority to develop, adopt, and implement a Groundwater Sustainability Plan (GSP) for the subbasin. Under the GSP, GSAs must adequately define and monitor groundwater conditions in the subbasin and establish criteria to maintain or achieve sustainable groundwater management within 20 years of GSP adoption.

The Madera Subbasin (Subbasin) is identified by the California Department of Water Resources (DWR) as a critically overdrafted subbasin. Therefore, the Madera Subbasin GSAs must develop, adopt, and submit a GSP (or GSPs) to DWR for the entire Madera Subbasin by January 31, 2020. The Madera Subbasin is managed by seven GSAs, of which four have developed a joint GSP and three have developed individual GSPs. This Madera Subbasin Joint GSP (Joint GSP), together with the three individual GSPs, satisfies the requirements established by SGMA and DWR, and outlines the strategy by which the Madera Subbasin GSAs will achieve sustainable groundwater management by 2040.

GSP Revisions

In 2022-2023, the GSAs in the Madera Subbasin revised the four GSPs to resolve deficiencies identified by DWR in September 2022 and clarified during two consultation meetings held with DWR in November and December 2022.

On September 22, 2022, the GSAs in the Madera Subbasin received a letter from DWR documenting the incomplete determination of the four GSPs submitted for the Madera Subbasin in January 2020. The letter described deficiencies identified by DWR that may preclude approval of the submitted GSPs at this time and indicated the GSAs would have the opportunity to perform corrective actions to address the noted deficiencies within a 180-day period concluding on March 21, 2023.

In 2022-2023, the GSAs revised the four GSPs to:

- Resolve the deficiencies identified by DWR in their September 2022 incomplete determination letter and discussed during two DWR consultation meetings between November 2022 and December 2022;
- Summarize the coordinated approach that the GSAs have taken in completing the GSP revisions and planning for future GSP implementation and reporting;
- Summarize the progressive implementation actions taken by the GSAs since submission of the GSPs in January 2020;
- Recognize the GSAs' ongoing work to develop a Domestic Well Mitigation Program, including the development of a draft memorandum of understanding (MOU); and
- Reaffirm their commitment to implementing the GSPs and achieving sustainable groundwater conditions by 2040.

As of March 2023, revisions have been made in various sections of this Joint GSP and the Coordination Agreement (**Appendix 1.J**) to address these points. However, some text, estimated costs and benefits, and other analyses related to GSP implementation remain unchanged from the initial Joint GSP submitted in January 2020. Updates to GSP implementation costs, benefits, and related analyses will be reassessed and reported in future Joint GSP updates and Annual Reports as more is known.

Approach to Achieving Sustainability

A pragmatic approach to achieving sustainable groundwater management requires firm understanding of: (1) historical trends and current groundwater conditions in the Subbasin (including, but not limited to, groundwater levels, groundwater extraction, and groundwater quality), and (2) what must change in the future to ensure sustainability without causing undesirable results[1] or negatively affecting beneficial uses and users of groundwater, including potential groundwater dependent ecosystems (GDEs).

In developing this Joint GSP, a Hydrogeologic Conceptual Model (HCM) and water budgets were created to first characterize historical and current groundwater conditions in the Subbasin, with specific focus on vertical interactions between surface water and groundwater. The historical water budget identified historical trends in surface water availability and groundwater extraction and recharge, while the current water budget identified how current land use and cropping has changed groundwater demand while surface water availability did not change. These water budgets were used to calculate the average annual "net recharge from the surface water system" (net recharge), defined as the average annual sum of all groundwater extraction (negative) and groundwater recharge (positive) to and from the surface and root zone overlying the Madera Subbasin. "Shortage" was also calculated from these water budgets as the inverse of net recharge (sum of all groundwater extraction (positive) and groundwater recharge (negative) to and from the surface and root zone overlying the Madera Subbasin). Lateral subsurface inflows/outflows from/to adjacent subbasins were not considered in these water budget calculations of net recharge or shortage.

Projects and management actions (PMAs) were then developed with the goal of bringing the current net recharge into balance. A total of 25 PMAs are proposed by GSAs in this Joint GSP. Implementation of many projects has begun prior to GSP submittal (11 projects), while many more will be implemented beginning between 2020-2025 (11 PMAs). In wet years, projects will provide direct recharge of surplus surface water and in-lieu recharge from strategic and expanded use of surface water through conveyance and storage efforts. Management actions will reduce groundwater pumping through demand management. These PMAs may change over the GSP implementation period (2020-2040) as GSAs practice adaptive management while they monitor and learn more about groundwater conditions in the Madera Subbasin. In particular, the volume of groundwater pumping required through demand management may increase or decrease depending on the volume of direct recharge or in-lieu recharge provided by projects. Any changes in the PMAs will be reported in subsequent Annual Reports and/or in future Joint GSP updates

Importantly, this approach to developing PMAs identifies the average annual "shortage" (groundwater extraction in excess of groundwater recharge from the surface water system) of water required to recharge the Subbasin and balance the average annual pumping. The PMAs were developed to fill this shortage, with a preference for projects to the extent that additional surface water is available. This strategy will achieve sustainable groundwater management without relying on subsurface inflows to bring the Subbasin into balance. It is expected that subsurface inflows and outflows will decline as the Madera Subbasin and adjacent subbasins all achieve sustainability by 2040.

GSP Development and Outreach

[1] California Water Code (CWC) Section 10721(x) defines undesirable results as one of more of the following effects (summarized): chronic lowering of groundwater levels, significant and unreasonable reduction of groundwater storage, significant and unreasonable seawater intrusion, significant and unreasonable degraded water quality, significant and unreasonable land subsidence, and depletions of interconnected surface water that have significant and unreasonable adverse impacts on beneficial uses of the surface water.

This Joint GSP has been developed through extensive outreach and engagement and considers feedback received from local agencies, agricultural water users, municipal water users, Disadvantaged Community (DAC) members, and other stakeholders in the Subbasin. Public meetings and workshops have been hosted throughout GSP development, including monthly GSA meetings, Coordination Committee meetings, County Advisory Committee meetings, Madera Irrigation District Groundwater Committee meetings, Madera County Farm Bureau Water Forum meetings, and Madera County Regional Water Management Group meetings (see Section 2.1.5). During the GSP revision process in 2022-2023, the GSAs conducted further public outreach through public GSA governing body meetings and through public notices regarding the GSP revision process. The Madera Subbasin GSAs have met together regularly, and have also met multiple times with GSAs in adjacent subbasins, sharing data and information on GSP projects to ensure that implementation of the Madera Subbasin GSPs will not interfere with the ability of adjacent subbasins to also achieve sustainable groundwater management.

The f3ollowing sections in this Executive Summary provide a concise overview of the complete Joint GSP and changes made as part of the Joint GSP revisions in response to DWR's incomplete determination.

ES-1 INTRODUCTION

Groundwater serves as an important source of supply for agricultural, municipal, domestic, industrial, and environmental beneficial uses and users throughout the Madera Subbasin[2]. Agriculture in the Madera Subbasin has historically relied on about 500,000 acre-feet (AF) of groundwater annually to produce an array of commodities that contribute to the nearly $2 billion dollar Madera County agricultural economy.[3] Groundwater also supports a large portion of Madera County's population of over 156,000 people[4] and related industries. The Madera Subbasin underlies approximately 350,000 acres, all within Madera County. Thus, the sustainable management of groundwater in the Madera Subbasin is important for long-term prosperity within Madera County.

The Sustainable Groundwater Management Act of 2014 (SGMA) provides for local control of groundwater resources while requiring sustainable management of these resources. Under the provisions of SGMA, local agencies must establish governance of their subbasins by forming Groundwater Sustainability Agencies (GSAs) with the authority to develop, adopt, and implement a Groundwater Sustainability Plan (GSP) for the subbasin. Under the GSP, GSAs must adequately define and monitor groundwater conditions in the subbasin and establish criteria to maintain or achieve sustainable groundwater management within 20 years of GSP adoption.

Sustainable management of groundwater is defined under SGMA as the "management and use of groundwater in a manner that can be maintained during the planning and implementation horizon without causing undesirable results" (California Water Code (CWC) Section (§) 10721(v)). These undesirable results include significant and unreasonable lowering of groundwater levels, loss of groundwater storage and supply, degradation of water quality, land subsidence, and depletions of interconnected surface water (ISW) that have significant and unreasonable adverse impacts on beneficial uses and users of surface water. Sea water intrusion, while a SGMA-defined undesirable result, is not applicable to the Madera Subbasin.

[2] Groundwater basin number 5-022.06, part of the San Joaquin Valley Groundwater Basin, as defined by DWR Bulletin 118 (DWR, 2003) and updated in 2016.

[3] According to the Madera County Department of Agricultural Weights and Measures, the gross value of all agricultural production in the County was $1,973,449,000. (2017 Crop and Livestock Report).

[4] U.S. Census Bureau, 2017 Estimate

The Madera Subbasin has been identified by the California Department of Water Resources (DWR) as a critically overdrafted subbasin. Under SGMA, GSAs in critically overdrafted subbasins are required to prepare and adopt a GSP (or GSPs) by January 31, 2020 (CWC § 10720.7(a)(1)).

This is the coordinated Joint GSP for four GSAs that represent approximately 94% of the Subbasin area: the City of Madera (CM) GSA, the County of Madera GSA – Madera Subbasin (also referred to herein as Madera County GSA, or MC), the Madera Irrigation District (MID) GSA, and Madera Water District (MWD) GSA. These four GSAs are collectively referred to as the Joint GSP GSAs. The remaining 6% of the Madera Subbasin is managed under three (3) additional GSPs being prepared individually by Gravelly Ford Water District (GFWD) GSA, New Stone Water District (NSWD) GSA, and Root Creek Water District (RCWD) GSA (Figure ES-1). A coordination agreement has been developed by all seven GSAs in the Madera Subbasin detailing required GSA and GSP cooperation and coordination. The Madera Subbasin will satisfy SGMA requirements through the four (4) GSPs that together cover the entire Subbasin.

The purpose of this Joint GSP is to characterize groundwater conditions in the Madera Subbasin, to evaluate and report on conditions of overdraft, to establish sustainability goals, and to describe PMAs the GSAs intend to implement to achieve sustainable groundwater management by 2040. While this Joint GSP focuses on groundwater management actions by the CM GSA, MC GSA, MID GSA, and MWD GSA, these actions are considered in the context of the entire basin setting and the actions of other GSAs in the Madera Subbasin to achieve subbasin-level sustainability.

This Joint GSP also serves to comply with DWR's requirements that the Madera Subbasin GSAs prepare, adopt and implement a plan "consistent with the objective that a basin be sustainably managed within 20 years of [GSP] implementation without adversely affecting the ability of an adjacent basin to implement its [GSP] or achieve and maintain its sustainability goal over the planning and implementation horizon" as defined in the California Code of Regulations Title 23 (23 CCR), Section (§) 350.4 (f).

As mandated under 23 CCR § 354.24, GSAs within the Madera Subbasin have established a "sustainability goal for the basin that culminates in the absence of undesirable results within 20 years of the applicable statutory deadline." Specifically, this sustainability goal establishes that the Madera Subbasin will be operated within its sustainable yield by 2040, or 20 years following GSP implementation in January 2020. Sustainable yield is defined as "the maximum quantity of water, calculated over a base period representative of long-term conditions in the basin and including any temporary surplus, that can be withdrawn annually from a groundwater supply without causing an undesirable result" (CWC § 10721(w)).

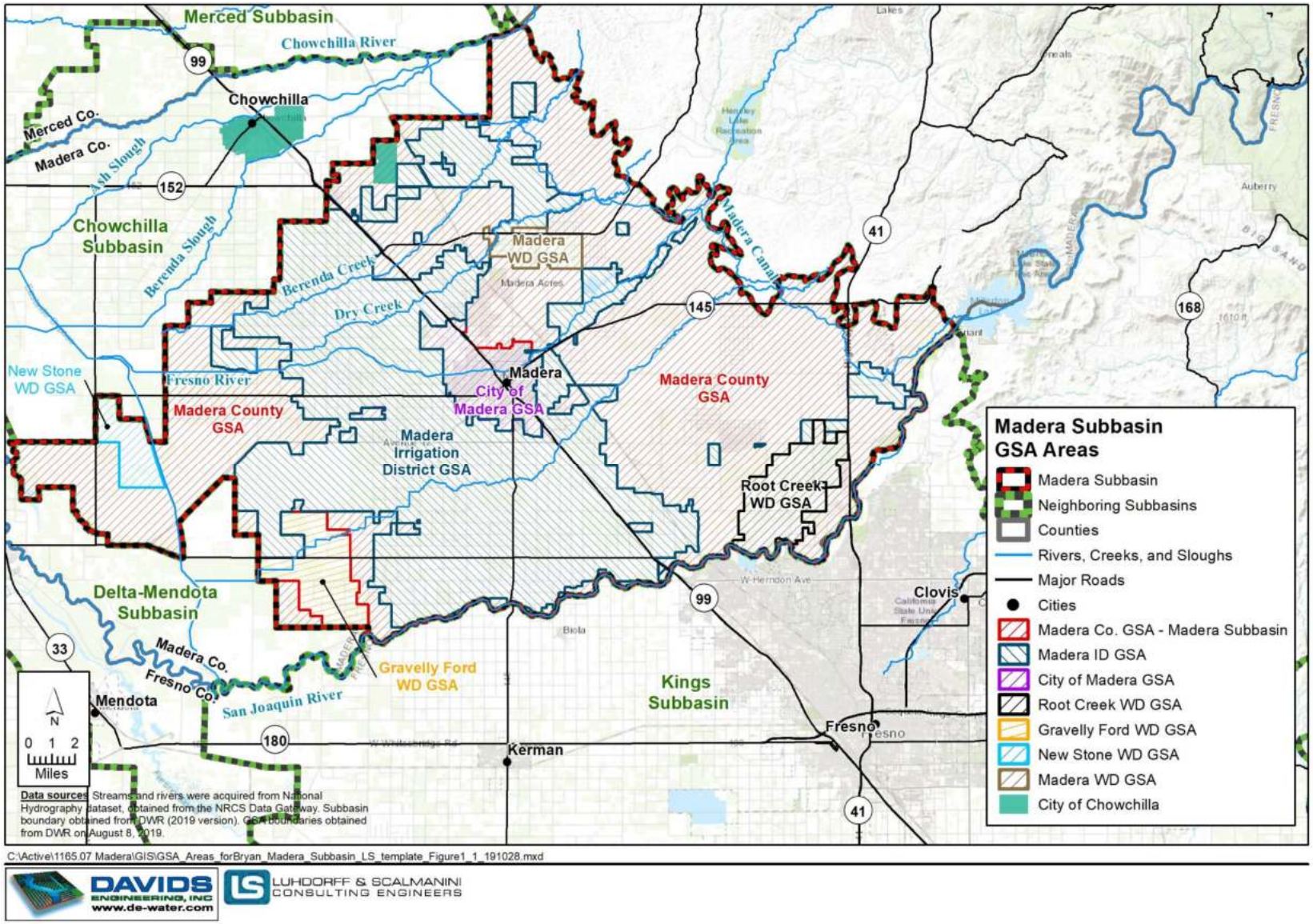


Figure ES-1. Madera Subbasin GSAs Map.

ES-2 PLAN AREA AND BASIN SETTING

The GSP Plan Area is defined as the Madera Subbasin (5-22.06), part of the San Joaquin Valley Groundwater Basin, as described in Bulletin 118 (DWR, 2016) with boundary updates approved in early 2019. The lateral extent of the Subbasin is defined by the Subbasin boundaries provided in Bulletin 118 (DWR, 2016). The Subbasin is bounded in the south by the San Joaquin River and the Kings Subbasin, in the west by the Delta-Mendota Subbasin, in the north by the Chowchilla Subbasin, and in the east by the foothills of the Sierra Nevada (Figure ES-1). The vertical boundaries of the Subbasin are the land surface (upper boundary) and the definable bottom of the basin (lower boundary). The vertical extent of the Subbasin is subdivided into a surface water system (SWS) and groundwater system (GWS). The SWS represents the land surface down to the bottom of plant root zone[5], within the lateral boundaries of the Subbasin. The GWS extends from the bottom of the root zone to the definable bottom of the Subbasin, within the lateral boundaries of the Subbasin.

Hydrogeologic Conceptual Model

The Madera Subbasin is generally comprised of relatively flat topography that slopes gently downward to the west. Topographic elevations vary from about 350 feet above mean sea level (MSL) in the east to about 150 feet above MSL in the west over a distance of about 20 miles (Figure ES-2). The major geomorphic features of the Subbasin are the alluvial fan and floodplain associated with sediment deposition from the Fresno and San Joaquin Rivers (Mitten et al., 1970). Soils with higher permeability and infiltration rates are present along river channels (Fresno River, Cottonwood Creek, and San Joaquin River) and west/south of the City of Madera (between the Fresno River and Cottonwood Creek). Another zone of higher soil permeability is present in the south central portion of the Subbasin between Cottonwood Creek and the San Joaquin River. In addition, it is recognized that hard pan, which tends to greatly limit infiltration capacity, exists in many areas at depths typically in the range of 5 to 10 feet below ground surface. However, many areas with irrigated agricultural (particularly orchards) have constructed holes through the hard pan to facilitate proper drainage.

The stratigraphy of the Madera Subbasin from the surface down is comprised primarily of Continental Deposits of Quaternary Age (Younger and Older Alluvium), Continental Deposits of Tertiary and Quaternary age, Marine and Continental sedimentary rocks, and crystalline basement rock. The Continental Deposits are unconsolidated, and underlying sedimentary and basement rocks are consolidated. It is uncertain if Mehrten and Ione Formation are present in the Madera Subbasin. Younger Alluvium is generally limited to 50 feet thickness and typically unsaturated. The Older Alluvium consists of up to 1,000 feet of interbedded clay, silt, sand, and gravel. Older Alluvium becomes finer-grained with depth and is underlain by the generally finer-grained Continental deposits of Tertiary and Quaternary age (Mitten et.al., 1970). The primary water bearing unit is Older Alluvium, although recent deeper drilling of agricultural wells is tapping into the underlying Continental Deposits of Tertiary/Quaternary age (Provost & Pritchard, 2014).

The Corcoran Clay occurs in the western portion of Madera Subbasin (Figure ES-2) within the upper portion of Older Alluvium (Mitten et al., 1970). The Corcoran Clay is also considered to be a member of the Turlock Lake Formation (Page, 1986). The depth to the top of the Corcoran Clay generally ranges from about 150 to 400 feet where present within Madera Subbasin (Provost & Pritchard, 2014). The Corcoran

[5] The depth to the bottom of the root zone varies by crop, but typically ranges from 2-7 feet (ASCE, 2016).

Clay is comprised of clay and silt ranging in thickness from 10 feet at its eastern extent to 80 feet on the western edge of Madera County (Mitten et al., 1970).

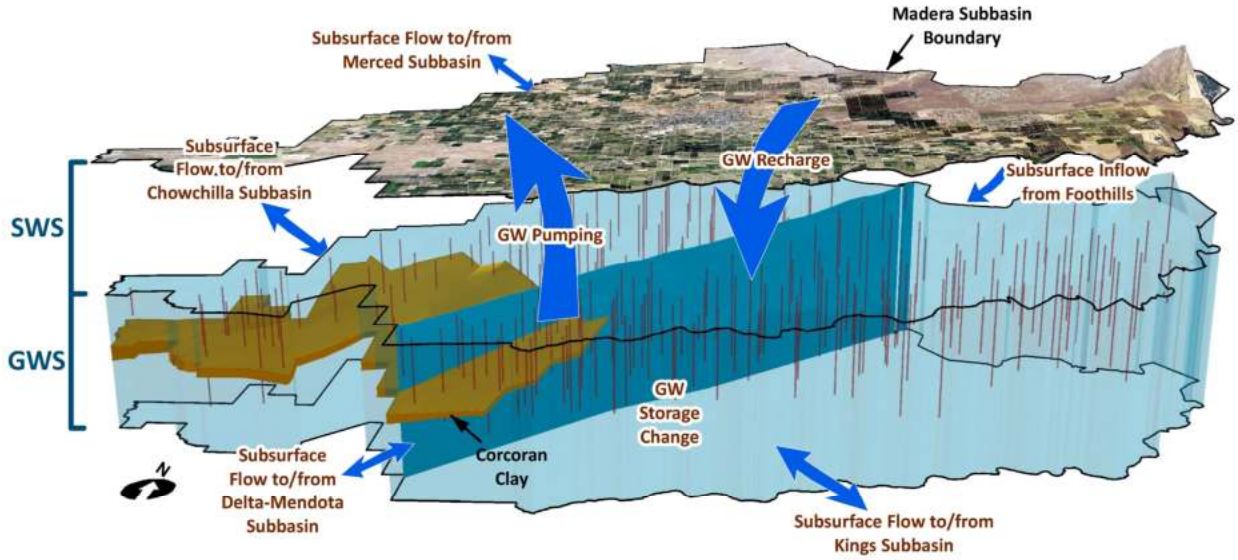


Figure ES-2. Madera Subbasin Hydrogeologic Conceptual Model.

Groundwater recharge can occur throughout the Madera Subbasin from infiltration of precipitation and applied water, streamflow percolation, and other sources. Net subsurface inflows to the Madera Subbasin from adjacent subbasins also contribute to groundwater recharge (but are not included in water budget "net recharge" or "shortage" calculations described below); however, subsurface inflows and outflows are expected to decline as the Madera Subbasin and adjacent subbasins achieve sustainability by 2040. The main areas with hydrologic group A soils located along and between Berenda and Dry Creeks, and along and between Fresno River and Cottonwood Creek. A relatively large area of hydrologic group A and B soils is located west and south of the City of Madera. There are also small areas of hydrologic group A soils in the southeastern portion of the Subbasin, along the San Joaquin River, and in the far western portion of the Subbasin. Saturated soil vertical hydraulic conductivity (K) shows a similar distribution of areas with higher infiltration potential. A relatively large area comprised of hydrologic group C soils in the south central portion of the Subbasin is indicated to have vertical soil K of 1.1 to 2.0 feet/day.

Under current and recent historical groundwater conditions, the primary groundwater discharge from the Subbasin is groundwater pumping for agricultural, municipal, domestic, and industrial uses. The majority of domestic wells are located in the central to eastern portions of the Subbasin, agricultural wells are relatively evenly distributed throughout the entire Subbasin, and public supply wells are concentrated in the central to eastern portions of the Subbasin. Domestic well depths are variable across the Subbasin, shallower wells (less than 300 feet deep) are more common to the west of Highway 99. Similarly, agricultural wells tend to be shallower (less than 500 feet) to the west of Highway 99 and deeper (500 to greater than 750 feet) to the east of Highway 99. The average well depths for domestic and agricultural wells generally reflect the greater depths to water east of Highway 99.

Groundwater Conditions

The general prevailing groundwater flow direction in the unconfined Upper Aquifer is east to west, although a few notable, localized areas of low water levels (i.e., groundwater levels) exist in the Subbasin. These local depressions cause more local variability in the groundwater flow directions including most prominently in the southeastern part of the Subbasin and in the northern part of the Subbasin between the Fresno River and Dry Creek and extending north to the Subbasin boundary.

Perched groundwater has been identified at several sites in Madera Subbasin from review and comparison of local groundwater level data from several regulated facility sites obtained from Geotracker and regional groundwater level data from the California Statewide Groundwater Elevation Monitoring (CASGEM) program and other sources.

The Winter/Spring 2014 groundwater elevation contour map for the Lower Aquifer indicates Lower Aquifer groundwater elevations of between -20 and 50 feet mean sea level (msl) in a small area of the Madera Subbasin within the extent of the Corcoran Clay. The contour map for Lower Aquifer in Winter/Spring 2016 shows relatively lower groundwater elevations between -10 and -30 feet msl in the Lower Aquifer in the same area near Dry Creek and Fresno River. Farther south, groundwater elevations in the Lower Aquifer in 2016 are higher with elevations of about 60 feet msl. Due to the limited spatial coverage of wells with Lower Aquifer water levels, evaluating groundwater flow gradients and directions within the Lower Aquifer in Madera Subbasin is challenging.

Varying levels of groundwater level decline have been observed over the historical period across the Subbasin, with wells in the more eastern parts of the Subbasin having the greatest water level declines. Over the period from the mid-1980s to 2015, rates of groundwater level decline increased. The calculated changes in groundwater levels from groundwater elevation contour maps translate to changes in groundwater storage estimated to be about -2.5 million AF between 1988 and 2014 and about -3.6 million AF between 1988 and 2016, assuming a range of specific yield values from 8 to 13 percent.

Key groundwater quality constituents of interest in the Subbasin include nitrate, total dissolved solids (TDS), and arsenic. These constituents have greater potential for presenting broader regional groundwater quality concerns extending beyond localized or site-specific contamination cases and are likely to reflect a range of potential contamination sources.

A large percentage of the wells with nitrate data have maximum historical concentrations below 7.5 milligrams per liter (mg/L) and many have concentrations below 5 mg/L. However, a number of areas of locally high nitrate concentrations above 7.5 mg/L or above 10 mg/L are apparent across the Subbasin. The higher concentrations appear to be more common in the more western parts of the Subbasin. One particular area with a high density of wells with nitrate concentrations above the maximum contaminant level (MCL) of 10 mg/L (as N) is located in the western part of the Subbasin along Highway 145, directly south of where Dry Creek joins the Fresno River. Some of the clusters of wells with high nitrate concentrations are known to be associated with regulated facilities and contamination remediation sites. Most of the higher concentrations are from wells with unknown construction information, although maps of nitrate concentrations by depth zone indicate more wells known to be screened in the Upper Aquifer with higher concentrations than in the Lower Aquifer.

Historical TDS concentrations in groundwater in the Madera Subbasin indicate relatively low salinity groundwater quality across most of the Subbasin with maximum historical TDS concentrations less than 500 mg/L in most places. Higher TDS concentrations in the western part of the Subbasin may be caused by natural salinity present in groundwater occurring within Coast Range derived sediments of marine source material.

Although there are a few wells with higher arsenic concentrations scattered throughout the Subbasin, most of the wells with arsenic concentrations above the MCL of 10 micrograms per liter (µg/L) are located northeast of Highway 99. Although a number of wells exhibit concentrations above the MCL, the dominant fraction of wells with arsenic concentrations are below 5 µg/L with many or most of these wells having concentrations below 2.5 µg/L. Few wells known to be screened in the Upper Aquifer have elevated concentrations.

Recent land subsidence has been a major concern in the northwestern portion of Madera County, primarily impacting the western portion of the adjacent Chowchilla Subbasin. However, there has been some recent subsidence occurring within Madera Subbasin. Approximately 1 to 2 feet of subsidence occurred between 1926 and 1970 in the northwestern portion of Madera Subbasin. Subsidence mapping using interferometric synthetic aperture radar (InSAR) data from 2007 to 2011 showed a maximum subsidence of 0.5 to 1 foot for that time period in the northwest part of the Madera Subbasin. Subsidence mapping between 2015 and 2017 showed 1.0 to 1.5 feet of subsidence adjacent to and north of the Fresno River in the northwestern portion of the Subbasin.

Review of available data for ISW indicates that that surface water – groundwater interactions do not occur (i.e., regional groundwater levels are relatively far below creek thalweg elevations) along Berenda Creek, Dry Creek, the Fresno River, and Cottonwood Creek in Madera Subbasin. Comparison of historical groundwater and stream thalweg elevations suggest the San Joaquin River along the southern subbasin boundary was likely connected with groundwater over the period of available data from 1958 through 1984, but groundwater levels were found to be generally below (and apparently disconnected from) the San Joaquin River by about 10 to 50 feet from 1989 through 2016.

Some areas on the southern and southwestern boundaries of Madera Subbasin and along/adjacent to the San Joaquin River may be underlain by shallow clay layers that are above the principal aquifers in the area. Shallow groundwater in these areas can likely be considered mounded in that shallow clay layers help to maintain shallow groundwater levels regardless of whether or not an unsaturated zone exists beneath them as occurs in a truly perched groundwater condition. It is likely that seepage from the San Joaquin River is the source of water combined with presence of shallow clay layers, which serves to maintain shallow groundwater levels at these locations. While groundwater levels in this perched zone appear to be approximately 10 to 30 feet below ground surface, water levels in the underlying regional groundwater system are typically much deeper, in excess of 50 feet below ground surface. Based on review of available data, characterization of hydrogeologic conditions related to the potential for ISW is currently based on very limited data.

Water Budget

A water budget is defined as a complete accounting of all water flowing into and out of a defined volume[6] over a specified period of time. When the water budget volume is an entire Subbasin, the water budget facilitates assessment of the total volume of groundwater and surface water entering and leaving the Subbasin over time, along with the change in the volume of water stored within the Subbasin. Water budgets were developed for the Subbasin to characterize historical, current, and projected water budget conditions. A numerical integrated groundwater flow model (MCSim) was developed based on the fine-grid California Central Valley Groundwater-Surface Water Simulation Model (C2VSim-FG), and was utilized to support development of water budgets.

[6] Where 'volume' refers to a space with length, width and depth properties, which for purposes of the GSP means the defined aquifer and associated surface water system.

The objective of the historical water budget is to evaluate availability or reliability of past surface water supplies and aquifer response to water supply and demand trends relative to water year type. The historical water budget was calculated for the 1989 through 2014 period, which was found to be representative of long-term average conditions in the Subbasin based on analysis of precipitation, unimpaired flows, and CVP supplies.

The objective of the current water budget is to understand the impact of current land use on water demand in the context of the Subbasin's hydrology and water supply. This requires a water budget that considers current land use conditions and average historical hydrologic and climatic conditions. The current water budget was calculated using land use data from 2015 to compute consumptive use and other root zone components in the Surface Water System water budget, and surface water supply and precipitation data for the 1989 through 2014 period. This approach accounts for changes in land use and water demand occurring over the historical period, most notably in the significant shift from pasture and alfalfa to almonds. With current land use conditions and average 1989 through 2014 hydrology, the current shortage (or shortfall) in the Madera Subbasin is estimated to be approximately 165,900 acre-feet per year (AFY) (Figure ES-3). In this context, shortage represents groundwater extraction in excess of groundwater recharge from the surface water system. Unlike overdraft, calculations of shortage do not consider lateral, subsurface groundwater flows between neighboring subbasins. The current water budget shortage is effectively the current rate of shortage if 2015 land use and water demand conditions continued in the future under average historical hydrologic conditions. PMAs described below were designed to address the current water budget shortage.

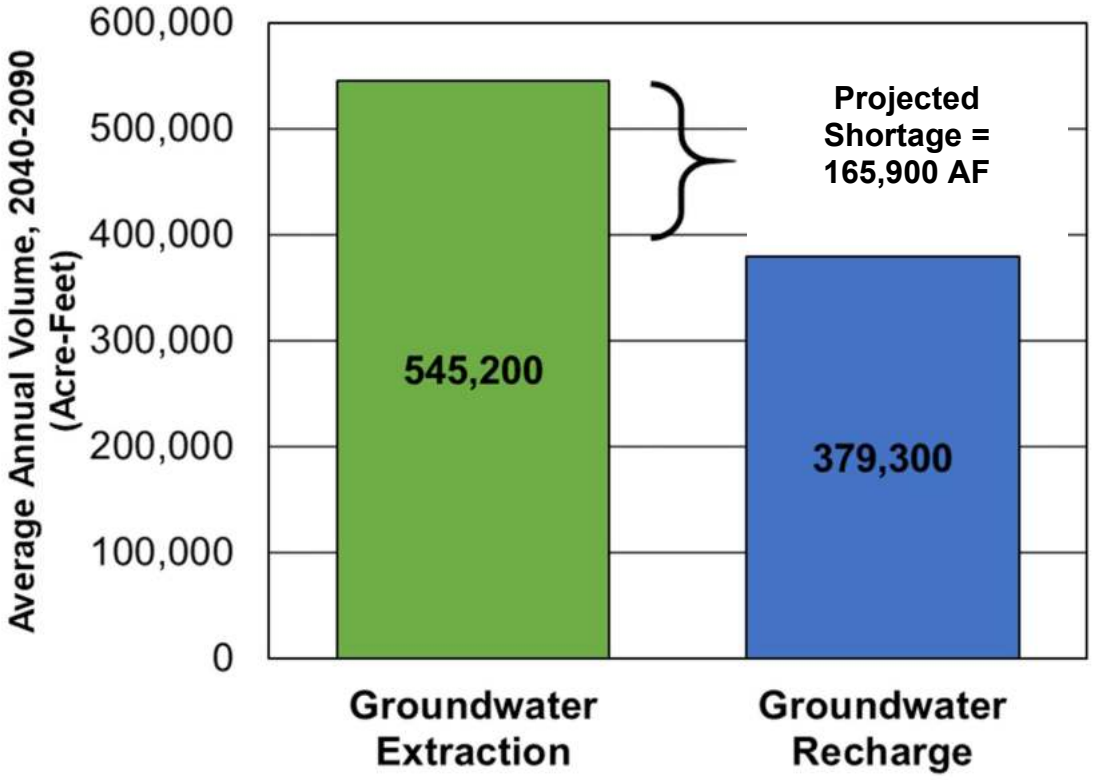


Figure ES-3. Summary Groundwater Budget for Current Subbasin Conditions (2015 Land Use).

The groundwater model was used to estimate projected water budgets over 70 years of future hydrology under different future climate scenarios and to evaluate the effects of PMAs[7] on Subbasin conditions. Two primary projected water budget scenarios were considered: one without projects (no action), and one with projects. Both of these projected scenarios were evaluated in the context of potential effects of climate change on future surface water supply and weather parameters. The climate change scenarios used climate change parameters specified by DWR, and served as a sensitivity analysis for the projected water budgets. While the climate change scenarios show the effects on groundwater resulting from reasonably foreseeable climate change impacts on precipitation, evapotranspiration, and surface water supply, the precise future impacts of climate change are unknown. Ultimately, the GSAs will need to continue adaptive management of the Madera Subbasin to address the climate change scenario that actually occurs.

Two major time periods exist in the future projected model: the implementation period (2020-2039), during which PMAs are implemented to bring the Subbasin into sustainability, and the sustainability period (2040-2090), after which PMAs have been fully implemented. The projected with projects scenario results showed no overdraft in the Madera Subbasin during the sustainability period (Figure ES-4).

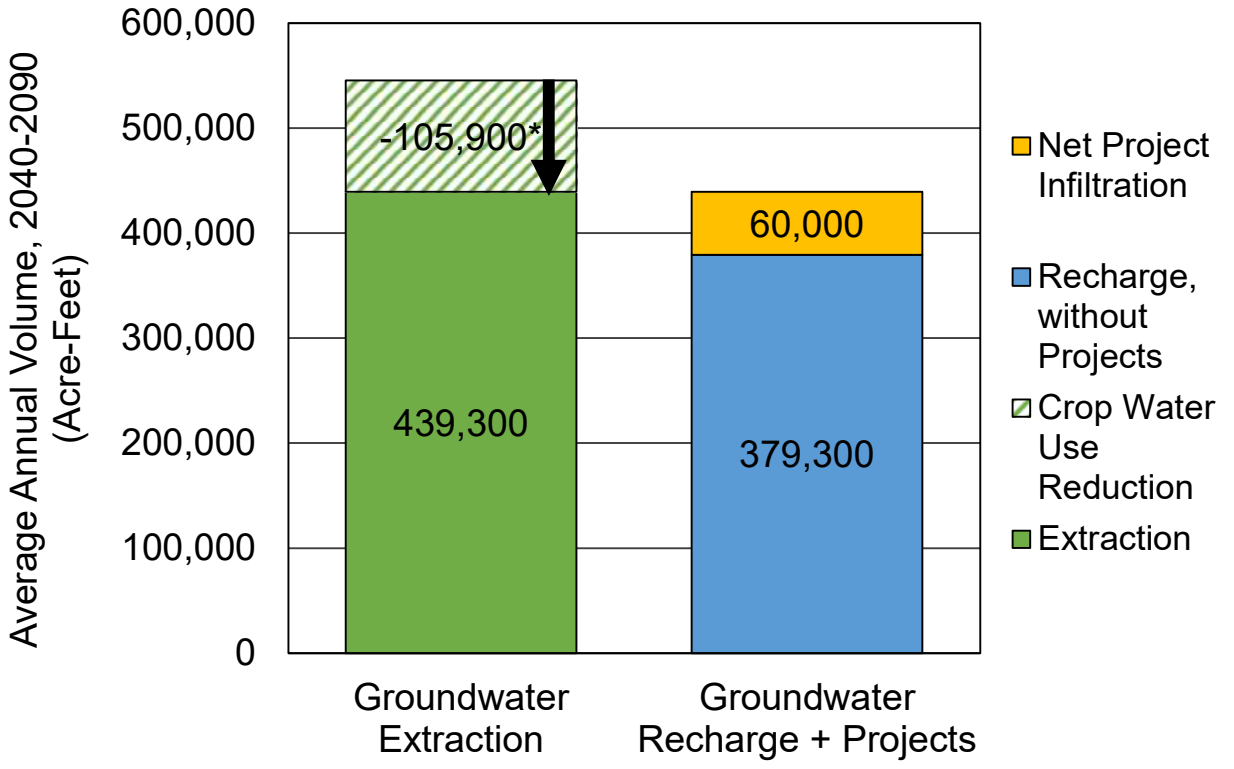


Figure ES-4. Simplified Groundwater Condition With Projects (2040-2090).

**Note: Crop Water Use Reduction Program in Madera County GSA: 90,000 AF. Remaining crop water use reduction due to permanent recharge basins replacing irrigated area and increased use of surface water in lieu of groundwater.*

[7] Projects and management actions identified to achieve sustainable operation of the Madera Subbasin are discussed in section ES-4.

The GSP regulations require the water budget to quantify the sustainable yield for the Subbasin. Sustainable yield is dependent upon conditions in existence at the time, and would therefore change during the implementation period while PMAs are being implemented. Thus, sustainable yield was calculated for the sustainability period, after all PMAs identified in the GSP are fully implemented (2040-2090).

The model results for the projected with projects scenario demonstrate that sustainability indicator minimum thresholds (MTs) and associated undesirable results are avoided during the sustainability period (2040-2090). Thus, the sustainable yield for the 2040-2090 projected period is the quantity of groundwater "…that can be withdrawn annually from a groundwater supply without causing an undesirable result" (CWC § 10721(w)). In alignment with the GSP regulations and DWR's Sustainable Management Criteria BMP (DWR, 2017), sustainable yield has been calculated for the 2040-2090 projected period (Table ES-1) with a single value of sustainable yield for the Subbasin as a whole (DWR, 2017).

The sustainable yield is estimated as the average annual groundwater extraction during the 2040-2090 period. This projected groundwater extraction equals the sum of the average annual recharge without projects and the average annual net project infiltration during the projected period. Since average vertical groundwater inflows approximately equal average vertical groundwater outflows after sustainability is reached during the 2040-2090 period, the average annual change in the groundwater storage would be close to zero over this 50-year period. Accounting for all uncertainties in GWS inflows and outflows, the sustainable yield is estimated to range between 329,500 AFY and 549,100 AFY. While a range of sustainable yield is stated above to provide some context for the uncertainty involved in such an analysis, the actual value of sustainable yield is much more likely to occur in the middle of this range. By this method, sustainable yield is estimated to be 439,300 AFY (Table ES-1).

ES-3 SUSTAINABLE MANAGEMENT CRITERIA

Sustainability Indicators

Undesirable results occur when significant and unreasonable effects for any of the six sustainability indicators defined by SGMA are caused by groundwater conditions occurring in the Subbasin. The overarching sustainability goal and the absence of undesirable results are expected to be achieved by 2040 through implementation of the PMAs. The sustainability goal will be maintained through proactive monitoring and management by the GSAs. Table ES-2 summarizes whether, for each of the six sustainability indicators, undesirable results have occurred, are occurring, or are expected to occur in the future in the Subbasin without and with GSP implementation.

Table ES-1. Summary of Sustainable Yield Estimates from Projected with Projects Water Budget (23 CCR § 354.18(b)(7)).

Quantification Method	Average Volume, 2040-2090 (AF)	Estimated Confidence Interval[1] (percent)	Average minus CI (AF)	Average plus CI (AF)
Groundwater Extraction and Change in GWS Storage[2]	439,300	25%	329,500	549,100

[1] Confidence interval source: Professional judgment based on historical calculations.

[2] Subsurface inflow is expected to decrease as the groundwater system reaches new equilibrium levels following GSP implementation.

Table ES-2. Summary of Undesirable Results Applicable to the Plan Area.

Sustainable Indicator	Historical Period (before 2015)	Existing Conditions	Future Conditions without GSP Implementation	Future Conditions with GSP Implementation (after 2040)
Chronic Lowering of Groundwater Levels	Yes	Yes	Yes	No
Reduction of Groundwater Storage	Yes	Yes	Yes	No
Land Subsidence	No	No	Possibly	No
Seawater Intrusion	Not Applicable	Not Applicable	Not Applicable	Not Applicable
Degraded Water Quality	Yes	Yes	Yes	No[1]
Depletion of Interconnected Surface Water	Yes	No[2]	No	No

[1] There may be future continued degradation of groundwater quality that is not related to GSP Projects and Management Actions.
[2] Surface water and groundwater are disconnected under existing conditions.

The regulations define undesirable results as occurring when significant and unreasonable effects are caused by groundwater conditions occurring for a given sustainability indicator. Significant and unreasonable effects occur when MTs are exceeded for one or more sustainability indicators. A summary of the sustainable management MTs, measurable objectives (MOs) and undesirable results is provided in Table ES-3. Locally defined undesirable results were based on discussion with GSA staff and technical representatives, input received from interested stakeholders and the public through public meetings, and through individual stakeholder input to various GSA representatives.

Table ES-3. Summary of Minimum Thresholds, Measurable Objectives, and Undesirable Results.

Sustainability Indicator	Minimum Threshold	Measurable Objective	Undesirable Result (in 2040)
Chronic Lowering of Groundwater Levels	Set equal to the Fall 2015 measurement, if this observed data point is available at the RMS. Otherwise, set equal to the expected Fall 2015 groundwater level determined from MCSim results, with adjustment, if necessary, to account for the offset between historical observed and modeled data.	Set equal to the Fall 2010 measurement, if this observed data point is available at the RMS. Otherwise, set equal to the expected Fall 2010 groundwater level determined from MCSim results, with adjustment, if necessary, to account for the offset between historical observed and modeled data.	Same 30 percent of wells below minimum threshold for two consecutive fall measurements.

Sustainability Indicator	Minimum Threshold	Measurable Objective	Undesirable Result (in 2040)
Reduction of Groundwater Storage	No long-term reduction in groundwater storage during the sustainability period after 2040 based on measured groundwater levels. (Groundwater levels used as a proxy.)	Same as MOs for chronic lowering of groundwater levels. (Groundwater levels used as a proxy.)	Same 30 percent of wells below minimum threshold for two consecutive fall measurements. (Groundwater levels used as a proxy.)
Land Subsidence	0 feet/year, subject to uncertainty of +/-0.16 feet/year	0 feet/year	Average subsidence across all RMS exceeding minimum threshold in an annual monitoring period.
Seawater Intrusion	Not Applicable	Not Applicable	Not Applicable
Degraded Water Quality	Nitrate = 10 mg/L or existing level plus 20% (whichever is greater) Arsenic = 10 µg/L or existing level plus 20% (whichever is greater) TDS = 500 mg/L or existing level plus 20% (whichever is greater)	Current constituent concentrations	10 percent of wells above the minimum threshold for the same constituent due to projects and/or management actions, based on average of most recent three year period
Depletion of Interconnected Surface Water	A percent of time surface water is connected to shallow groundwater that is equal to historical conditions for a similar climatic/hydrologic period.	A percent of time surface water is connected to shallow groundwater that is equal to historical conditions for a similar climatic/hydrologic period.	Greater than 30 percent of RMS wells below minimum threshold for two consecutive annual five-year rolling average annual evaluations

Chronic Lowering of Groundwater Levels

The GSP regulations provide that the "[MTs] for chronic lowering of groundwater levels shall be the groundwater level indicating a depletion of supply at a given location that may lead to undesirable results." Chronic lowering of groundwater levels in the Subbasin cause significant and unreasonable declines if they are sufficient in magnitude to lower the rate of production of pre-existing groundwater wells below that necessary to meet the minimum required to support overlying beneficial uses and users where alternative means of obtaining sufficient groundwater resources are not technically or financially feasible. In addition, groundwater levels will be managed with consideration of the minimum thresholds to ensure the major aquifers in the Plan area are not depleted in a manner to cause significant and unreasonable impacts to other sustainability indicators. At the same time, the GSAs recognize that while groundwater levels are anticipated to fall below 2015 levels during the GSP implementation period, the implementation of projects and management actions is expected to cause groundwaters to return to historical levels by 2040. Thus, the minimum thresholds have been designated with these considerations in mind.

The Madera Subbasin GSAs have proceeded with coordination and focused planning efforts to develop a Domestic Well Mitigation Program, including the development of a draft memorandum of understanding

(MOU). The Domestic Well Mitigation Program would provide assistance to domestic and municipal wells adversely impacted by declining groundwater levels that interfere with groundwater production or quality. Note that the program is not intended to mitigate well issues not caused by regional groundwater conditions nor is it intended to resolve issues related to normal wear and tear. It is expected that the Domestic Well Mitigation Program would be implemented during the GSP implementation period, as needed, and continue until groundwater sustainability is achieved. After 2040, groundwater levels will stabilize at historical levels, avoiding undesirable results for groundwater users. As of March 2023, the GSAs are developing the Program eligibility criteria, terms, and conditions and are preparing to move forward with Program implementation, as needed. The Domestic Well Mitigation Program and the draft MOU are discussed in Section 3.3.1.

The selection of SMC for chronic groundwater level decline are also intended to protect against significant and unreasonable impacts to groundwater storage volumes, land subsidence, and some groundwater quality concerns, and also included consideration of GDEs.

Reduction of Groundwater Storage

The groundwater storage reduction metric will be evaluated using groundwater levels as a proxy in conjunction with annual evaluations of the previous year's groundwater storage change and periodic evaluations of long-term groundwater level and storage changes over average climatic periods during the sustainability period. Based on considerations applied in developing the groundwater level MTs, reduction in groundwater storage MTs do not exceed any identified significant and unreasonable level of depleted groundwater storage volume.

Land Subsidence

The cause of Subbasin groundwater conditions that would result in significant and unreasonable land subsidence is excessive overall average annual groundwater pumping and other outflows from the Subbasin that exceed average annual inflows. Locally defined significant and unreasonable conditions were determined based on discussions with GSA staff and technical representatives, input received from interested stakeholders and the public through public meetings, and through individual stakeholder input to various GSA representatives. Significant and unreasonable land subsidence results in significant impacts to infrastructure. The land subsidence MT is set at a rate of 0 feet/year in order to prevent undesirable results. The MT for land subsidence is set recognizing that land subsidence within Madera Subbasin is tied to actions in neighboring subbasins, and the ability to meet these interim milestones is dependent on the successful implementation of project and management actions in neighboring subbasins. It should also be noted that while groundwater level MTs and MOs are not specifically tied to subsidence thresholds, they are consistent with the objective to limit the potential for future subsidence.

Degraded Water Quality

The cause of Subbasin groundwater conditions that would result in significant and unreasonable degraded water quality is implementation of a GSP project or management action that causes concentrations of key groundwater quality constituents to increase to concentrations exceeding the MTs, which are set at the MCLs for drinking water for identified key constituents (10 milligrams/liter (mg/L) for nitrate as nitrogen; 500 mg/L for TDS; 10 micrograms/liter (µg/L) for arsenic) or when existing or historical concentrations for the key constituents already exceed the MCL, the MT is set at the recent concentration plus 20 percent. There are no current documented large-scale contaminant plumes in the regional groundwater aquifers. Smaller more localized and shallow contaminant site plumes have been documented in parts of the Plan

Area, most notably in the vicinity of the City of Madera, although these contaminants are generally restricted to depths above the regional aquifer system. Municipal and domestic supply (MUN) is a designated beneficial use for groundwater in the Plan Area; therefore, groundwater quality degradation resulting from a GSP project or management action is considered significant and unreasonable based on adverse impacts to this beneficial use. Significant and unreasonable degradation of water quality occurs when beneficial uses for groundwater are adversely impacted by constituent concentrations increasing to levels above the drinking water MCLs for one of the key constituents (nitrate, arsenic, TDS) at indicator wells in the representative groundwater quality monitoring network due to implementation of a GSP project or management action. When existing or historical concentrations for the key constituents already exceed the MCL, the MT is set at the recent concentration plus 20 percent.

Depletion of Interconnected Surface Water

It has been determined that a direct hydraulic connection between regional groundwater and streams does not exist for streams in most of the Subbasin; therefore, the surface water depletion sustainability criteria are not applicable over most of the Subbasin. However, water levels in the shallowest groundwater zone below and along parts of the San Joaquin River at the southern boundary of Madera Subbasin periodically rise to elevations equal to or above the stream thalweg. Although it appears this shallow groundwater is associated with infiltration of streamflow from the nearby river resulting from upstream reservoir releases, interim SMC are being established for ISW along the San Joaquin River until additional field investigations, studies, evaluations, and monitoring can be completed to update and refine the hydrogeologic understanding of subsurface conditions and interactions between groundwater and surface water in this area. The interim MTs are the same as the interim MOs: to maintain the percent of time of surface water – groundwater connectivity consistent with conditions during the baseline historical time period, as measured over a rolling five-year period. The connection between regional groundwater and surface water will be reevaluated after further studies are completed and, if necessary, the interim SMC will be updated.

Seawater Intrusion

The seawater intrusion sustainability criterion is not applicable to this Subbasin.

Monitoring Networks

The GSP groundwater monitoring network was developed using existing wells in the Subbasin and will be supplemented (and/or some initial wells replaced) by new nested monitoring wells. The database for existing wells was reviewed with the following criteria in mind:

- CASGEM wells preferred;
- Known construction (screen intervals, depth) preferred;
- Long histories of water level data (including recent data) preferred;
- Relatively good match between observed and modeled water levels preferred;
- Good spatial distribution preferred;
- Representation of both Upper (where present in western portion of Plan Area) and Lower Aquifers preferred.

The selected groundwater level indicator wells, Representative Monitoring Sites (RMS), are distributed throughout the Subbasin to provide broad spatial coverage of the Subbasin, to the extent possible (Figure ES-5). The groundwater quality indicator wells represent a subset of the water level indicator wells with

additional wells included from other groundwater quality monitoring programs. The monitoring network will be periodically reviewed and modified as needed.

ES-4 SUBBASIN PROJECTS AND MANAGEMENT ACTIONS

To achieve the Subbasin sustainability goal by 2040 and avoid undesirable results through 2090 as required by SGMA regulations, various projects and management actions (PMAs) have been developed and will be implemented by the GSAs between 2020 and 2040. Projects generally refer to structural features whereas management actions are typically non-structural programs or policies designed to incentivize reductions in groundwater pumping.

The GSAs have prioritized implementation of projects that provide additional surface water supplies to the Subbasin, thereby reducing groundwater pumping. However, recognizing that access to surface water supplies is variable, the GSAs are also planning demand management to directly reduce groundwater pumping to achieve sustainability. The GSAs are also committed to an adaptive management approach to implementing PMAs that is informed by continued monitoring of groundwater conditions using the monitoring networks. As PMAs are implemented and Subbasin conditions are monitored, the GSAs will review PMA timelines, benefits, and the volume of demand management that may be necessary to achieve sustainability. If the GSAs find that adjustments are needed to meet the sustainability goal, the GSAs will evaluate and adjust plans for project implementation and, to the extent necessary, demand management. Any adjustments will be reported in subsequent annual reports and/or the five-year periodic evaluation and GSP updates. A proposed timeline for the 2025 GSP update is provided in **Appendix 5.A**. This timeline includes evaluation of projects and management actions to ensure that the Subbasin will be managed sustainably and without undesirable results by 2040.

Two main types of projects are included for implementation in the Joint GSP: recharge and conveyance. Recharge projects are designed to support sustainability by diverting floodwater or other available surface water for direct infiltration in constructed basins or spreading onto fields. Conveyance projects facilitate the delivery of additional water supplies for increased recharge or for direct use for irrigation, thereby reducing groundwater pumping (in-lieu recharge). Conveyance projects may include structural improvements, operational changes, or both. Some projects have a specific water source, but many of the recharge projects can draw from the same general sources. In addition to projects, the Joint GSP includes several proposed management actions including the Madera County GSA's planned demand management program that will reduce demand by placing restrictions on groundwater pumping, among other actions. Together, the PMAs have been developed and planned to achieve the Subbasin sustainability goal by 2040.

The cost, timing, and gross groundwater benefit (yield) of the PMAs included in the GSP vary by GSA. Table ES-4 lists all PMAs planned at the time of initial GSP development, summarized by GSA or implementing entity, and the estimated implementation timeline, capital cost, operating cost, and gross benefit of the projects. Table ES-5 further summarizes the total gross benefits and costs of all PMAs developed for each GSA or implementing entity. Updates regarding PMA implementation activities since initial GSP development are documented in Sections 4.9 and 4.10.

The gross yield across all projects at full implementation (2040) equals approximately 215,840 AFY resulting in a net yield equal to the projected shortfall of 165,900 AFY. The gross yield is larger than the projected shortfall due primarily to changes in other water budget elements when flood flows are directed to recharge. This includes the demand management program to be implemented by the Madera County GSA that will reduce net groundwater pumping by about 90,000 AFY.

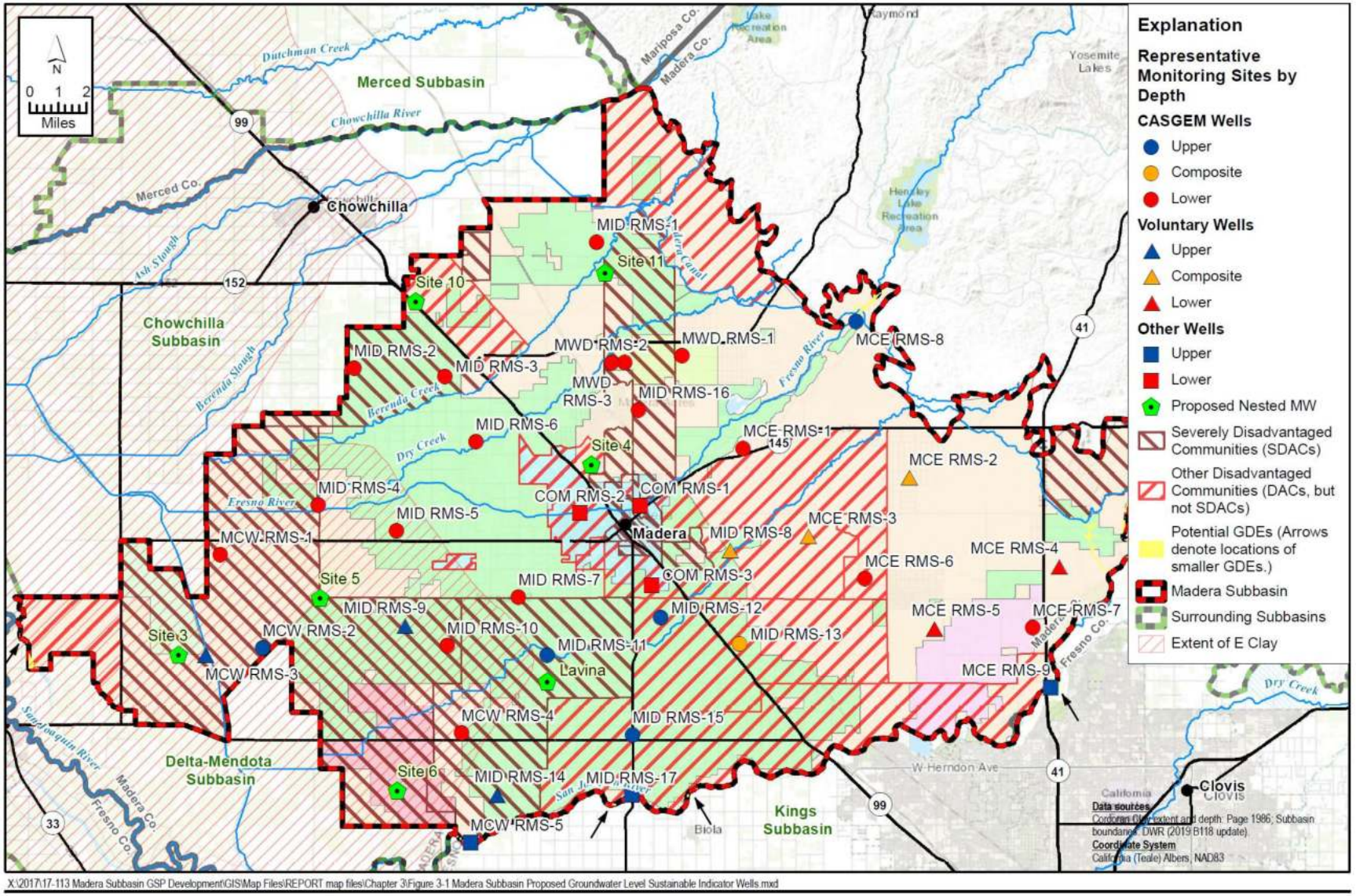


Figure ES-5. Groundwater Monitoring Network: CASGEM, Voluntary and Other Wells.

Table ES-4. Madera Subbasin Projects and Management Actions.

GSA	PMA	First Year of Implementation	Average Annual Gross Benefit at Full Implementation (AFY)	Estimated Capital Cost ($ millions)	Estimated Average Annual Operating Cost ($ millions/year)
MWD	Expanded Surface Water Purchase	2023	2,810	14.90	0.90
MID	Rehab Recharge Basins	2016	5,030	0.06	0.43
MID	Ellis Basin	2016	240	0.02	0.02
MID/City of Madera	Berry Basin	2018	20	0.02	0.00
MID	Allende Basin	2019	1,050	0.20	0.07
MID	Additional Recharge Basins Phase 1	2030	5,470	1.00	0.24
MID	Additional Recharge Basins Phase 2	2040	21,890	14.20	3.75
MID	On-Farm Recharge	2015	510	0.00	0.05
MID	Phase 2 On-Farm Recharge	2025	1,690	0.00	0.19
MID	MID Pipeline	2016	420	0.56	0.00
MID	WaterSMART Pipeline	2019	880	1.30	0.00
MID	WaterSMART SCADA	2019	1,230	1.20	0.00
MID	Water Supply Partnerships	2025	3,990	0.00	2.50
MID	Incentive Program	2022	5,010	0.00	3.08
City of Madera	Meters and Volumetric Pricing	2015	3,350	11.00	0.00
City of Madera/MID	Berry Basin	2018	20	0.02	0.00
Madera County	Water Imports Purchase	2025	3,610	0.30	2.49
Madera County	Millerton Flood Release Imports	2025	7,060	31.90	0.45
Madera County	Chowchilla Bypass Flood Flow Recharge Phase 1	2025	12,710	67.00	0.32
Madera County	Chowchilla Bypass Flood Flow Recharge Phase 2	2040	26,470	118.90	1.16
Madera County	Demand Management	2020	90,000	0.00	53.90
GFWD	Recharge Basin and Canals	2020	2,620	*See GFWD GSP*	
NSWD	Water Right Utilization	2020	5,540	*See NSWD GSP*	
RCWD	Purchased Water for In-Lieu Storage	2019	4,380	*See RCWD GSP*	
RCWD	Holding Contracts	2020	9,840	*See RCWD GSP*	
Total			**215,840**	**262.58**	**69.55**

Note: estimated project benefit values and costs are rounded.

Table ES-5. Summary of Madera Subbasin Projects and Management Actions by GSA.

GSA	Average Annual Gross Benefit at Full Implementation (AFY)	Estimated Capital Cost ($, millions)	Estimated Average Annual Operating Cost ($/year, millions)
MWD	2,810	14.90	0.90
MID	47,430	18.56	10.33
City of Madera	3,370	11.02	0.00
Madera County	139,850	218.10	58.32[1]
GFWD	2,620	*See GFWD GSP*	
NSWD	5,540	*See NSWD GSP*	
RCWD	14,220	*See RCWD GSP*	
Total	**215,840**	**262.58**	**69.55**

[1]Costs of demand management include reduced economic activities in the county, this includes approximately $53.9 million per year in direct economic impacts alone (excluding multiplier effects).

ES-5 PLAN IMPLEMENTATION

As of January 2020, administering the GSP and monitoring and reporting progress was projected to cost between $3 and $5 million dollars per year across the four Joint GSP GSAs. Costs are expected to be higher during years in which five-year periodic evaluations are required, and slightly lower during years in which annual reports are required. These total costs did not include:

- The costs of implementing the Domestic Well Mitigation Program, as needed.
- The costs of implementing the two data gaps workplans that the GSAs identified and have developed in 2022-2023. Additional information about the ISW and subsidence workplans is provided in Section 2.2.2.
- The capital and annual operating cost of PMAs.

Development of this GSP was funded through a Proposition 1 Grant, and contributions from individual GSAs (e.g., through in-kind staff time, or separately contracted consulting services). Individual GSAs are also funding additional, ancillary studies and implementation efforts. To fund GSA operations and GSP implementation, GSAs are developing a financing plan that will include one or more of the following financing approaches:

- **Grants and low-interest loans**: GSAs will continue to pursue grants and low interest loans to help fund planning studies and other GSA activities. However, grants and low-interest loans are not expected to cover most GSA operating costs for GSP implementation.
- **Groundwater extraction charge**: A charge per AF of groundwater pumped would be used to fund GSP implementation activities.
- **Other Fees and charges**: Other fees may include permitting fees for new wells or development, transaction fees associated with contemplated groundwater markets, or commodity-based fees, all directed at aiding with sustainability objectives. Depending on the justification and basis for a fee, it may be considered a property-related fee subject to voting requirements of Article XIII D of the California Constitution (passed by voters in 1996 as Proposition 218) or a regulatory fee exempt from such requirements.
- **Assessments:** Special benefit assessments under Proposition 218 could include a per-acre (or per-parcel) charge to cover GSA costs.

- **Taxes:** This could include general property related taxes that are not directly related to the benefits or costs of a service (ad valorem and parcel taxes), or special taxes imposed for specific purposes related to GSA activities.

GSAs are pursuing a combined approach, targeting available grants and low interest loans, and considering a combination of fees and assessments to cover operating and program-specific costs. As required by statute and the Constitution, GSAs would complete an engineer's report, rate study, and other analysis to document and justify any rate, fee, or assessment. For example, Madera County initiated two separate rate studies in 2019. At the time of initial GSP adoption in January 2020, the initial rate study was producing an engineering report to adequately fund an existing flood control and water conservation agency, which would allow for the agency to adequately control flood flows with existing infrastructure. In the second rate study, an engineering report was being produced for the ongoing costs associated with running the three County GSAs, which would include administration as well as sufficient planning funds for eventual project implementation.

The GSP implementation schedule allows time for GSAs to develop and implement PMAs and meets all sustainability objectives by 2040. While some projects began immediately after SGMA became law and are already contributing to Subbasin goals (Figure ES-6), the GSAs will begin implementing other GSP activities in 2020, with full implementation of PMAs to achieve sustainability by 2040. Figure ES-7 illustrates the GSP implementation schedule for PMAs implemented by each GSA. The GSP implementation schedule also shows mandatory reporting and updating for all GSAs, including annual reports and five-year periodic updates (evaluations) prepared and submitted to DWR.

The GSP implementation plan uses the best available information and the best available science to provide a road map for the Madera Subbasin to meet its sustainability goal by 2040 and comply with the SGMA regulations. During each five-year update, progress will be assessed, and the implementation plan revised as necessary, to achieve the sustainability goal by 2040 and comply with the SGMA regulations.

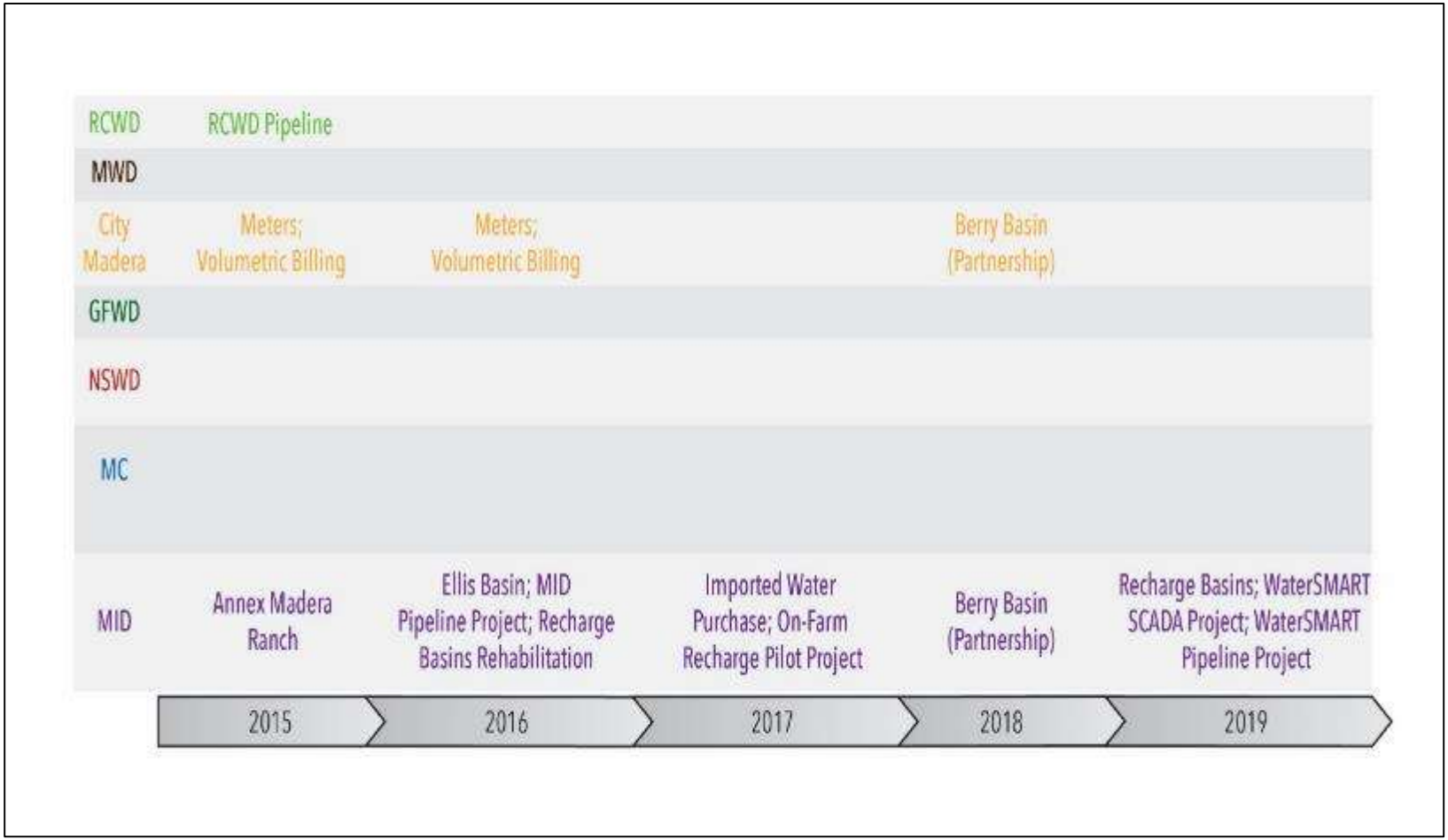


Figure ES-6. Madera Subbasin Projects in Response to SGMA (2015-2019).



Figure ES-7. Madera Subbasin Implementation Schedule (2020-2040)

1 INTRODUCTION

Groundwater serves as an important source of supply for agricultural, municipal, domestic, and industrial beneficial uses and users throughout the Madera Subbasin[8]. Agriculture in the Madera Subbasin (Subbasin) has historically relied on about 500,000 acre-feet (AF) of groundwater annually to produce an array of commodities that contribute to the nearly $2 billion dollar Madera County agricultural economy.[9] Groundwater also supports a large portion of Madera County's population of over 156,000 people[10] and related industries. The Madera Subbasin underlies approximately 350,000 acres, all within Madera County, and represents approximately 70% of the three groundwater subbasins that underlie the County. Thus, the sustainable management of groundwater in the Madera Subbasin is important for long-term prosperity within Madera County.

The Sustainable Groundwater Management Act of 2014 (SGMA) provides for local control of groundwater resources while requiring sustainable management of these resources. Under the provisions of SGMA, local agencies must establish governance of their subbasins by forming local Groundwater Sustainability Agencies (GSAs) with the authority to develop, adopt, and implement a Groundwater Sustainability Plan (GSP) for the subbasin. Under the GSP, GSAs must adequately define and monitor groundwater conditions in the subbasin and establish criteria to maintain or achieve sustainable groundwater management within 20 years of GSP adoption.

Sustainable management of groundwater is defined under SGMA as the "management and use of groundwater in a manner that can be maintained during the planning and implementation horizon without causing undesirable results" (California Water Code (CWC) Section (§) 10721(v)). These undesirable results are defined in CWC § 10721(x)[11] and include significant and unreasonable lowering of groundwater levels, loss of groundwater storage and supply, degradation of water quality, land subsidence, and depletions of interconnected surface water that have significant and unreasonable adverse impacts on beneficial uses of the surface water. Sea water intrusion, while a SGMA-defined undesirable result, is not applicable to the Madera Subbasin.

The Madera Subbasin has been identified by the California Department of Water Resources (DWR) as a critically overdrafted subbasin. Under SGMA, GSAs in critically overdrafted subbasins are required to prepare and adopt a GSP (or GSPs) by January 31, 2020 (CWC § 10720.7(a)(1)).

This is the coordinated Joint GSP for four GSAs that represent approximately 94% of the Subbasin area: the City of Madera (CM) GSA, the County of Madera GSA – Madera Subbasin (also referred to herein as Madera County GSA, or MC), the Madera Irrigation District (MID) GSA, and the Madera Water District (MWD) GSA. These four GSAs are collectively referred to as the Joint GSP GSAs. The remaining 6% of the Madera Subbasin is managed under three (3) additional GSPs being prepared individually by Gravelly Ford Water District (GFWD) GSA, New Stone Water District (NSWD) GSA, and Root Creek Water District (RCWD)

[8] Groundwater basin number 5-022.06, part of the San Joaquin Valley Groundwater Basin, as defined by DWR Bulletin 118 (DWR, 2003) and updated in 2016.

[9] According to the Madera County Department of Agricultural Weights and Measures, the gross value of all agricultural production in the County was $1,973,449,000. (2017 Crop and Livestock Report).

[10] U.S. Census Bureau, 2017 Estimate

[11] CWC §10721(x) defines undesirable results as one of more of the following effects (summarized): chronic lowering of groundwater levels, significant and unreasonable reduction of groundwater storage, significant and unreasonable seawater intrusion, significant and unreasonable degraded water quality, significant and unreasonable land subsidence, and depletions of interconnected surface water that have significant and unreasonable adverse impacts on beneficial uses of the surface water.

GSA. A coordination agreement has been developed by all seven GSAs in the Madera Subbasin detailing required GSA and GSP cooperation and coordination. The Madera Subbasin will satisfy SGMA requirements through the four (4) GSPs that together cover the entire Subbasin.

1.1 Purpose of the Groundwater Sustainability Plan

The purpose of this Joint GSP is to characterize groundwater conditions in the Madera Subbasin, to evaluate and report on conditions of overdraft, to establish sustainability goals, and to describe projects and management actions (PMAs) the GSAs will implement to achieve sustainable groundwater management by 2040. While this plan focuses on groundwater management actions by City of Madera GSA, Madera County GSA, Madera Irrigation District GSA, and Madera Water District GSA, these actions are considered in the context of the entire basin setting and the actions of other GSAs in the Madera Subbasin to achieve subbasin-level sustainability.

This Joint GSP also serves to comply with DWR's requirements that the Madera Subbasin GSAs prepare, adopt and implement a plan "consistent with the objective that a basin be sustainably managed within 20 years of [GSP] implementation without adversely affecting the ability of an adjacent basin to implement its [GSP] or achieve and maintain its sustainability goal over the planning and implementation horizon" as defined in the California Code of Regulations Title 23 (CCR), Section (§) 350.4 (f).

1.2 Sustainability Goal

As mandated under 23 CCR § 354.24, GSAs within the Madera Subbasin have established a "sustainability goal for the basin that culminates in the absence of undesirable results within 20 years of the applicable statutory deadline." Specifically, this sustainability goal establishes that the Madera Subbasin will be operated within its sustainable yield by 2040, or 20 years following GSP implementation in January 2020.

SGMA regulations define sustainable yield as "the maximum quantity of water, calculated over a base period representative of long-term conditions in the basin and including any temporary surplus, that can be withdrawn annually from a groundwater supply without causing an undesirable result" (CWC § 10721(w)). Subbasin sustainable yield must therefore be determined in the context of the complete basin setting, which includes historical, current, and projected conditions regarding groundwater, surface water, and land use.

To achieve the sustainability goal, this Joint GSP details accounting of the Madera Subbasin used to identify sustainable yield, and establishes the criteria for GSAs to operate sustainably. Finally, planned monitoring networks, projects, and management actions are proposed to achieve and verify sustainable groundwater use. To facilitate review, Table 1-1 aligns the regulations with this Joint GSP's corresponding section.

Table 1-1. Sustainability Goal Development and Associated GSP Sections.

Sustainability Goal Development	23 CCR Section	Requirement	GSP Section
Context, basis for goal	§ 354.12	Basin Setting	2.2
	§ 354.14	Hydrogeologic Conceptual Model	2.2.1
	§ 354.16	Groundwater Conditions	2.2.2
	§ 354.18	Water Budget	2.2.3
	§ 354.20	Management Areas	2.2.4
Establishment of goal	§ 354.24	Sustainability Goal	3.1
	§ 354.26	Undesirable Results	3.4
	§ 354.28	Minimum Thresholds	3.3
	§ 354.30	Measurable Objectives	3.2
Measures of ensuring goal achievement	§ 354.32	Introduction to Monitoring Networks	3.5
	§ 354.34	Monitoring Network	3.5.1, 3.5.2
	§ 354.36	Representative Monitoring	3.5.3
	§ 354.38	Assessment and Improvement of Monitoring Network	3.5.4
	§ 354.44	Projects and Management Actions	4

1.3 Agency Information

Seven local agencies have formed GSAs covering the full extent of the Madera Subbasin: City of Madera (CM) GSA, Gravelly Ford Water District (GFWD) GSA, Madera County (MC) GSA, Madera Irrigation District (MID) GSA, Madera Water District (MWD) GSA, New Stone Water District (NSWD) GSA, and Root Creek Water District (RCWD) GSA. Figure 1-1 delineates the areas managed exclusively by each GSA.

Information on each GSA's organization and management structure, jurisdictional area, irrigated lands, and water supplies are described below and summarized in Table 1-2. Information provided by each GSA to DWR pursuant to CWC § 10723.8 is included in **Appendix 1**. Additional contact information for each GSA is provided in Table 1-3.

Table 1-2. Summary of Madera Subbasin Groundwater Sustainability Agencies.

GSA	GSA Abbreviation	GSA Area, Acres	Average Irrigated Area (2015), Acres
City of Madera GSA	CM GSA	10,100	1,600
Gravelly Ford Water District GSA	GFWD GSA	8,400	7,500
County of Madera GSA – Madera Subbasin	MC GSA	177,800	84,900
Madera Irrigation District GSA	MID GSA	133,850	106,600
Madera Water District GSA	MWD GSA	3,700	3,400
New Stone Water District GSA	NSWD GSA	4,200	4,000
Root Creek Water District GSA	RCWD GSA	9,550	8,200
	Total	**347,600**	**216,200**

Table 1-3. Madera Subbasin Groundwater Sustainability Agencies' Contact Information.

Groundwater Sustainability Agency	Contact Person	Contact Title	Mailing Address	Phone Number	Email Address
City of Madera	Keith Helmuth	City Engineer, City of Madera	205 W. 4th St., Madera, CA 93637	(559) 661-5423	khelmuth@cityofmadera.com
Gravelly Ford Water District	Don Roberts	District General Manager	18811 Rd 27, Madera, CA 93638	(559) 474-1000	donroberts717@gmail.com
County of Madera – Madera Subbasin	Stephanie Anagnoson	Director of Water and Natural Resources, County of Madera	200 W. 4th St., Madera, CA 93637	(559) 598-0362	stephanie.anagnoson@ maderacounty.com
Madera Irrigation District	Thomas Greci	District General Manager	12152 Rd 28 1/4, Madera, CA 93637	(559) 673-3514	tgreci@madera-id.org
Madera Water District	Phil Janzen	Director	16943 Rd 26. Suite 103 Madera, CA 93637	(559) 479-0514	phil@agrilandfarming.com
New Stone Water District	Roger Skinner	District Representative	9500 S. De Wolf, Selma, CA 93662	(559) 834-6677	rskinner@lionraisins.com
Root Creek Water District	Julia Stornetta	General Manager	P.O. Box 27950 Fresno, CA 93729	(559) 970-8778	julia@rootcreekwd.com

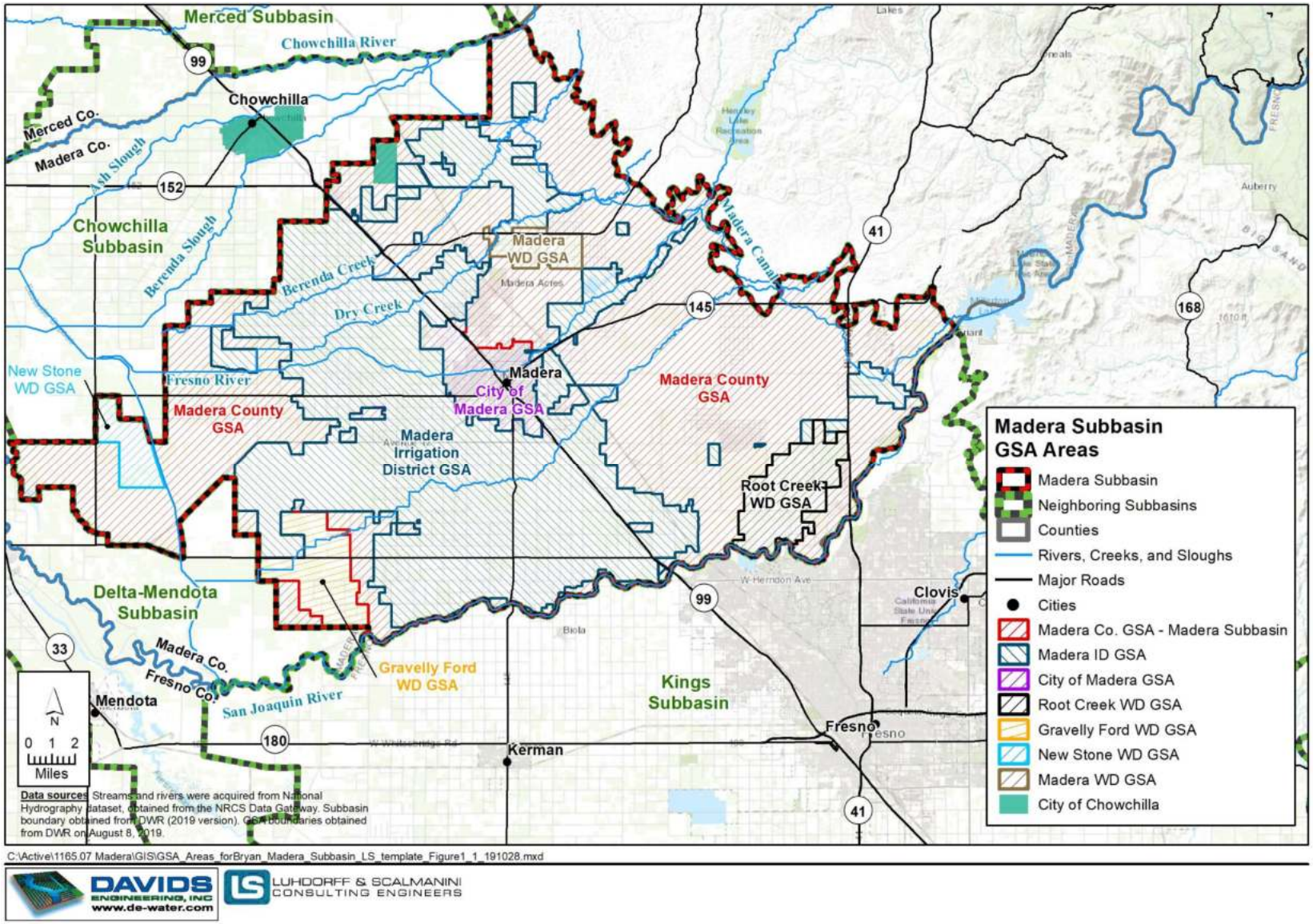


Figure 1-1. Madera Subbasin GSAs Map.

1.3.1 Organization and Management Structure of the Groundwater Sustainability Agencies

A summary is provided below for each GSA detailing its formation date, management structure, and background regarding typical land use and water supply availability.

1.3.1.1 City of Madera GSA

City of Madera (CM) GSA was formed on August 17, 2016, and manages approximately 10,100 acres of the Madera Subbasin (Figure 1-2). As of 2015, much of this area is developed land (79%), including urban, semi-agricultural, and industrial land. The remaining area is primarily agricultural land (16%), with some native vegetation (4%) and water surface (1%).

In 2015, irrigated agricultural land represented over 1,500 acres in CM GSA (Figure 1-3). Much of this area is used for cultivating grapes and almonds. The majority of irrigated agricultural lands in CM GSA are located within the boundaries of the Madera Irrigation District (MID) and have the ability to receive surface water in accordance with MID's normal operating practices. Some owners have utilized surface water from MID to meet a portion of their agricultural water needs, while others have chosen to rely solely on groundwater.

The Board of Directors for CM GSA is the Madera City Council. Joint meetings of the Madera City Council acting as the CM GSA Board of Directors are open to the public and are typically held on the first Wednesday of every month at 6:00 p.m. in the Council Chambers at Madera City Hall (205 West Fourth Street, Madera, CA 93637).

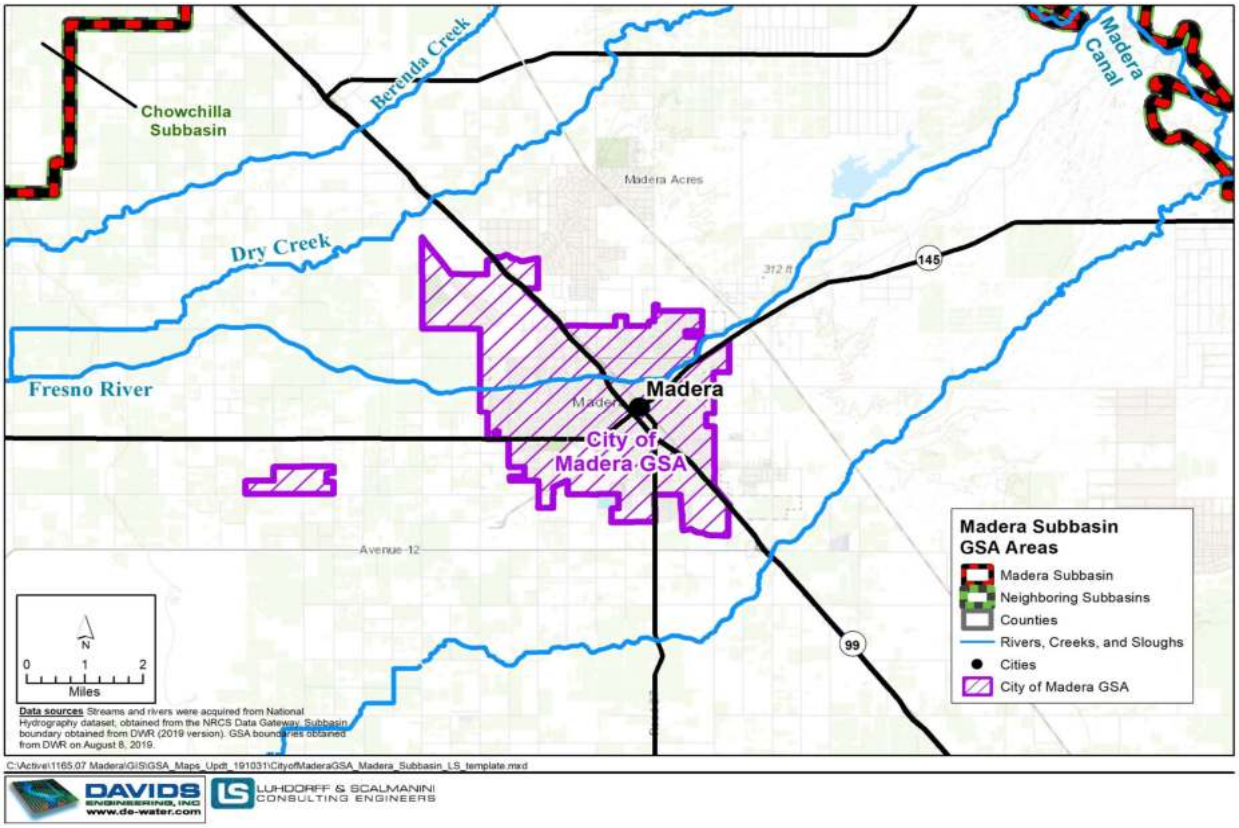


Figure 1-2. City of Madera GSA Map.



Figure 1-3. Orchard Crops in City of Madera GSA.

1.3.1.2 Gravelly Ford Water District GSA

Gravelly Ford Water District (GFWD) GSA was formed on June 8, 2016 and manages approximately 8,400 acres of the Madera Subbasin (Figure 1-4). As of 2015, this area is predominantly agricultural land (90%) and developed land (urban, semi-agricultural, or industrial land) (7%). A small portion of the GSA area is covered by native vegetation (2%) and water surface (1%).

In 2015, irrigated agricultural land represented approximately 7,500 acres in GFWD GSA. Much of this area is used for cultivating grapes, almonds, and pistachios. To support agriculture, GFWD GSA receives significant surface water supplies in the form of CVP water received from San Joaquin River (Figure 1-5) and from Madera Canal via Madera Irrigation District. The remaining agricultural water demand is GFWD GSA is fulfilled by groundwater.

The Board of Directors for GFWD GSA is the GFWD Board of Directors. Meetings of the GFWD GSA Board of Directors are held concurrently with the GFWD Board of Directors meetings typically on the third Monday of each month at 1:30 p.m. These meetings are open to the public and are held at the Schafer Ranch office (25176 Avenue 5 ½, Madera, CA, 93637).

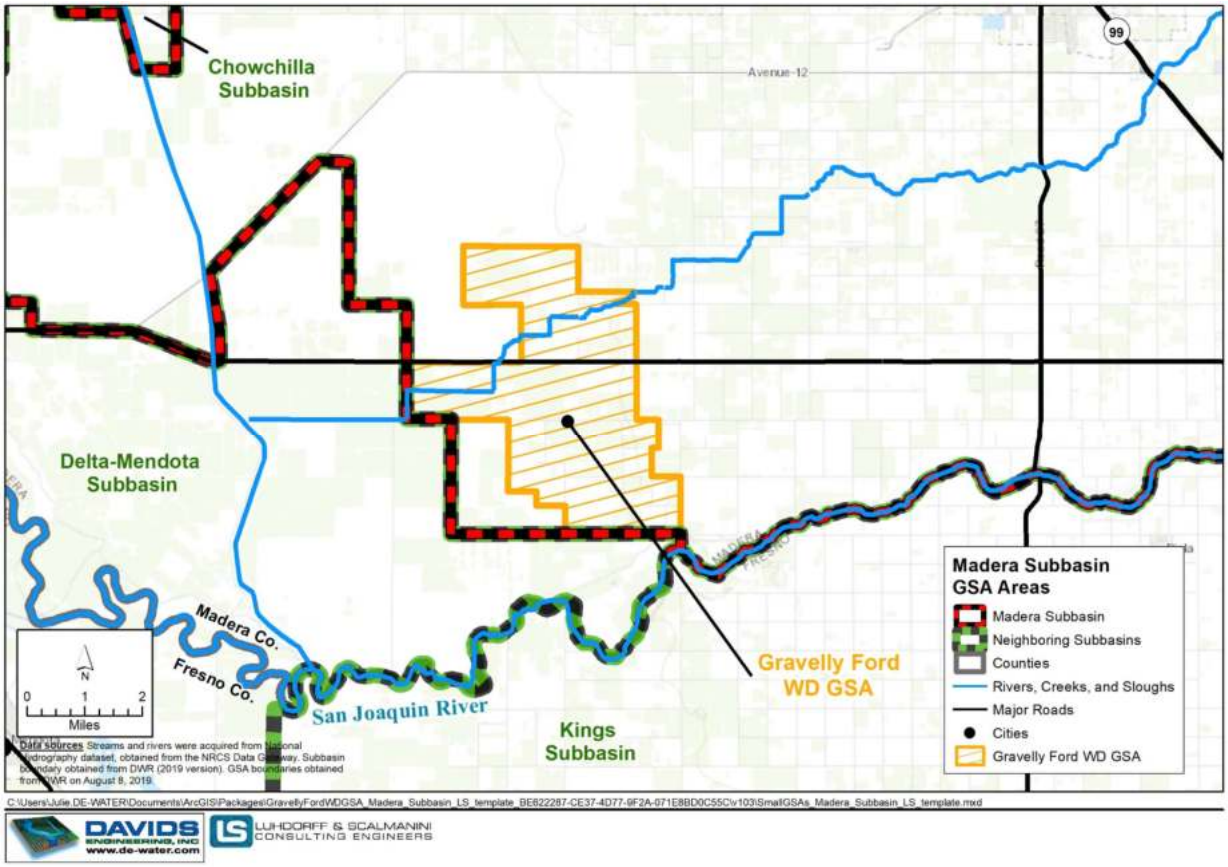


Figure 1-4. Gravelly Ford Water District GSA Map.



Figure 1-5. San Joaquin River Diversion to Gravelly Ford Water District GSA.

1.3.1.3 Madera County GSA

Madera County (MC) GSA was formed on January 27, 2017 and manages approximately 177,800 acres of the Madera Subbasin, representing the largest jurisdictional area within the Subbasin (Figure 1-6). As of 2015, the majority of this area is comprised of agricultural land (48%) or native vegetation (39%). The remaining area is primarily developed land (includes urban, semi-agricultural, and industrial land) (12%), though some water surface exists (1%).

In 2015, irrigated agricultural land represented over 82,000 acres in MC GSA. Much of this area is used for cultivating orchard crops (primarily almonds and pistachios) and grapes (Figure 1-7). Surface water supplies available for agriculture in MC GSA include riparian deliveries to water rights users along the San Joaquin River and the Fresno River, as well as a small volume of Central Valley Project (CVP) supply received under contract with the U.S. Bureau of Reclamation (Reclamation). Agricultural water demand in MC GSA is primarily fulfilled by groundwater.

The Board of Directors for MC GSA is the Madera County Board of Supervisors. As the MC GSA Board of Directors, the Board of Supervisors typically meets on the first or second Tuesday of each month at the end of the regularly scheduled Board of Supervisors Meeting. These meetings are open to the public (200 West Fourth Street, Madera, CA, 93637) and are recorded and available for public viewing on the Madera County website (maderacounty.com). Madera County GSA also has an Advisory Committee that meets bimonthly and provides feedback to the Board of Supervisors on SGMA-related matters. Members of the committee also serve as ambassadors in their communities regarding water issues.

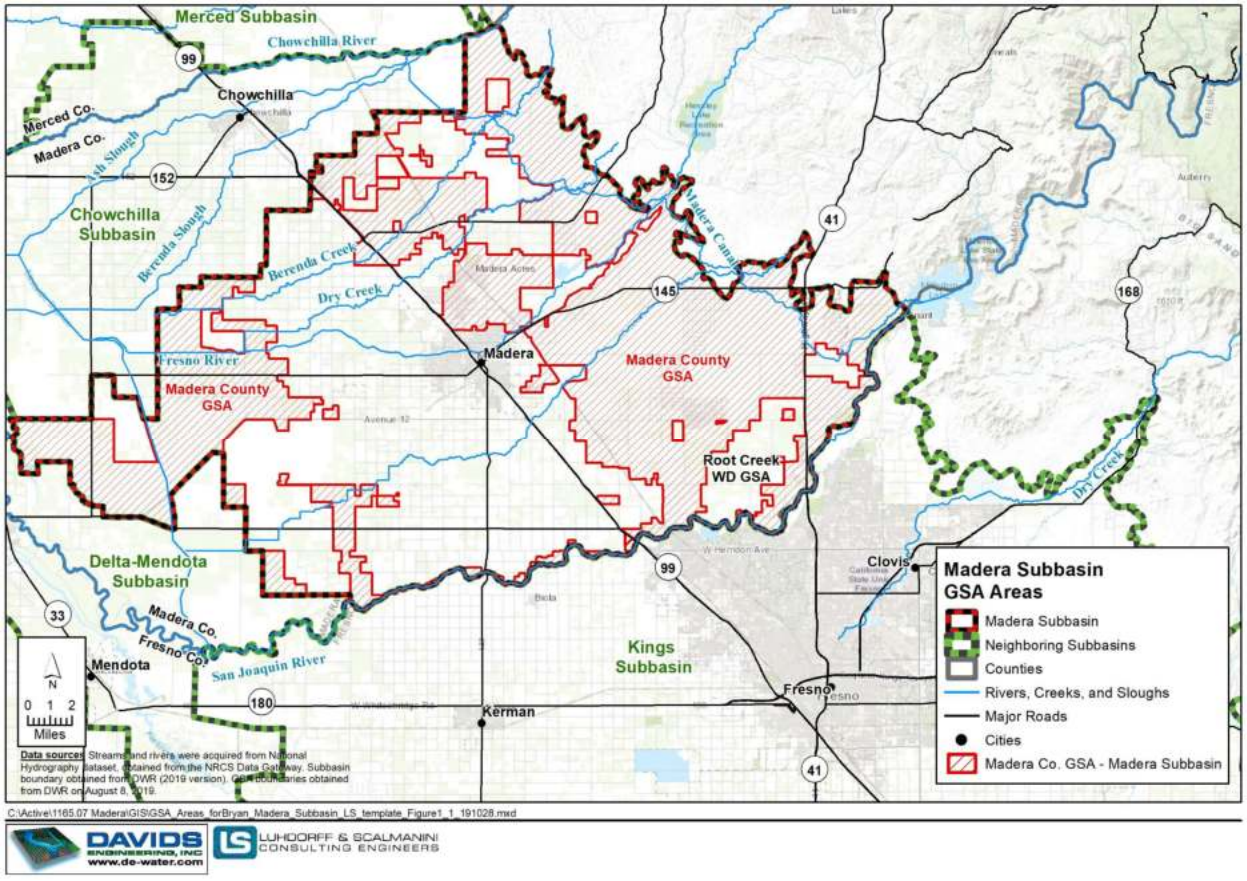


Figure 1-6. Madera County GSA Map.



Figure 1-7. Almond Orchard in the Madera Subbasin.

1.3.1.4 Madera Irrigation District GSA

Madera Irrigation District (MID) GSA was formed on March 31, 2016 and manages approximately 133,850 acres of the Madera Subbasin (Figure 1-8). As of 2015, the majority of this area is comprised of agricultural land (80%). Much of the remaining area consists of native vegetation (12%) or developed land (7%), including urban, semi-agricultural, and industrial land. A small portion of the GSA is also covered by water surfaces (1%).

In 2015, irrigated agricultural land represented over 106,600 acres in MID GSA. This area is used primarily for cultivating almonds, grapes, and pistachios. MID GSA receives substantial surface water supplies to support agriculture. These include CVP supplies received under contract with Reclamation from the Madera Canal and local supplies received from Hidden Dam releases along the Fresno River (Figure 1-9), along with the MID's Pre 1914 water rights. Remaining agricultural water demand in MID GSA is fulfilled by privately owned groundwater wells.

The Board of Directors for MID GSA is the MID Board of Directors. The MID GSA Board of Directors meetings are held concurrently with the regular MID Board of Directors meetings typically on the third Tuesday of every month at 2:00 p.m. These meetings are open to the public at the Madera Irrigation District offices (12152 Road 28 1/4, Madera, CA, 93637).

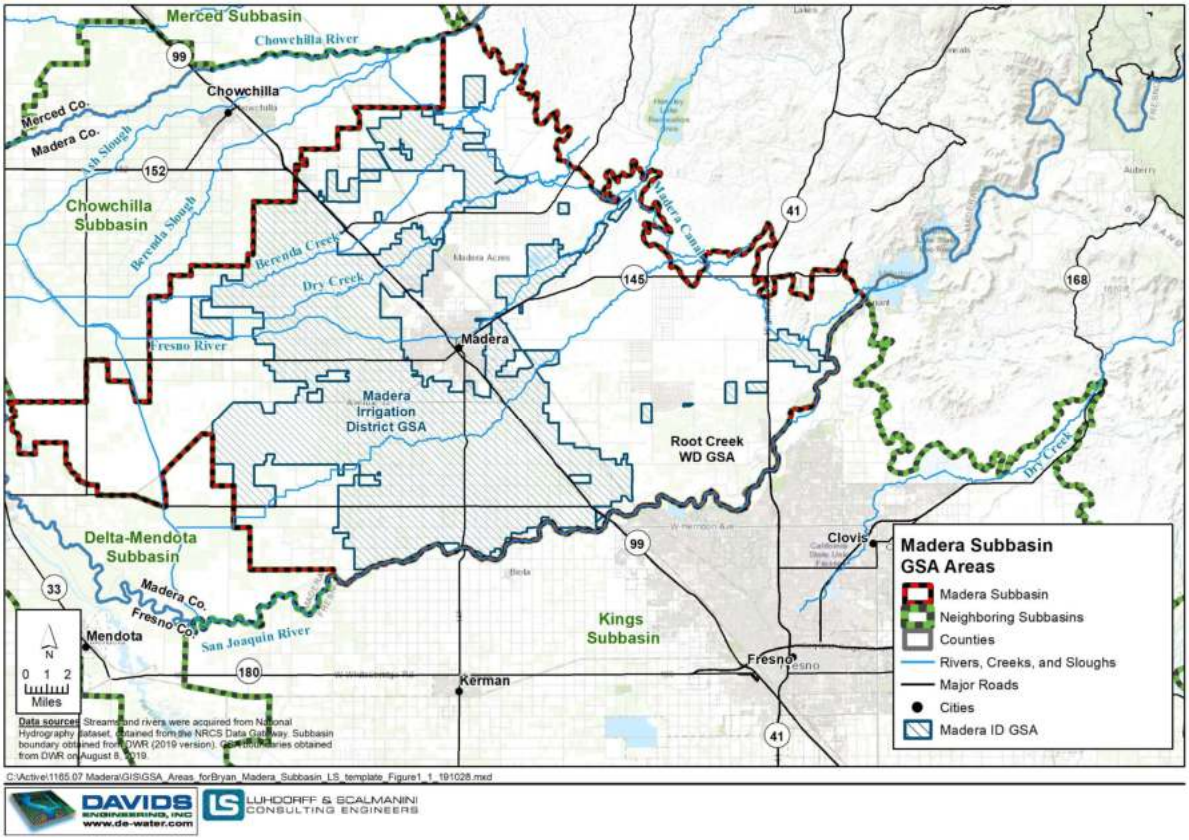


Figure 1-8. Madera Irrigation District GSA Map.



Figure 1-9. Franchi Diversion Dam along Fresno River in Madera Irrigation District GSA.

1.3.1.5 Madera Water District GSA

Madera Water District (MWD) GSA was formed on July 13, 2016 and manages approximately 3,700 acres of the Madera Subbasin (Figure 1-10). As of 2015, most of this area is comprised of agricultural land (91%) or developed land (urban, semi-agricultural, or industrial land) (8%). A small portion of the GSA is also covered by native vegetation (1%) and water surfaces (1%).

In 2015, irrigated agricultural land represented approximately 3,400 acres in MWD GSA. This area is used for cultivating pistachios. To support agriculture, MWD GSA receives surface water supplies from MID via Dry Creek (Figure 1-11). Remaining agricultural water demand in MWD GSA is fulfilled by groundwater.

The Board of Directors for MWD GSA is the MWD Board of Directors. The MWD GSA Board of Directors meetings are held concurrently with the regular MWD Board of Directors meetings typically on the second Wednesday of each month at 9:00 am. These meetings are open to the public and are held at either Madera Water District (16943 Road 26 Suite 103, Madera, CA, 93637) or at Blankenship & Company (1663 N. Schnoor Street, Suite 105, Madera, CA 93637).

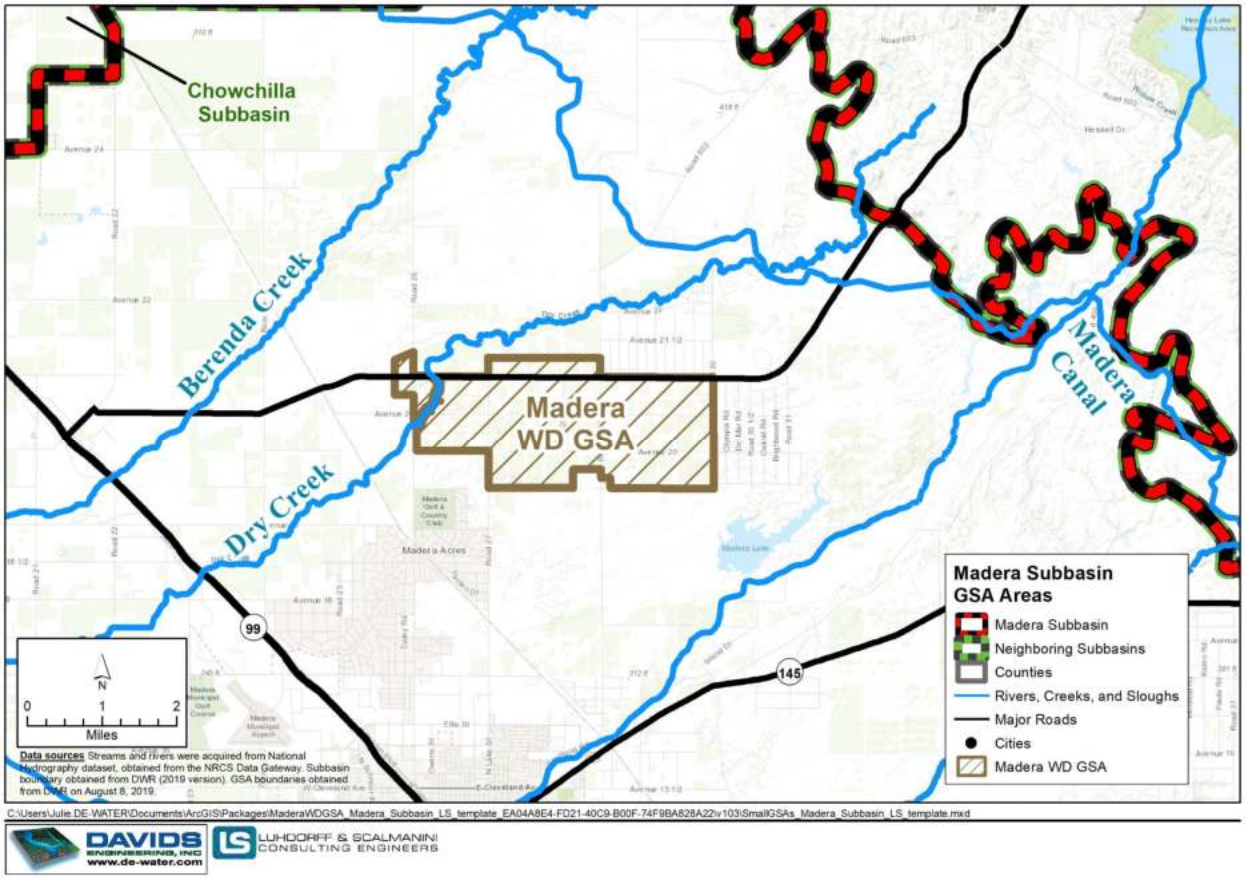


Figure 1-10. Madera Water District GSA Map.



Figure 1-11. Madera Water District Turnout Along Dry Creek.

1.3.1.6 New Stone Water District GSA

New Stone Water District (NSWD) GSA was formed on December 13, 2016 and manages approximately 4,200 acres of the Madera Subbasin (Figure 1-12). As of 2015, most of this area is comprised of agricultural land (94%) or native vegetation (4%). A small portion of the GSA is also comprised of developed land (urban, semi-agricultural, or industrial land) (1%) and water surfaces (1%).

In 2015, irrigated agricultural land represented approximately 3,900 acres in NSWD GSA. Much of this area is used for cultivating grapes (Figure 1-13). NSWD holds a water right permit to divert surface water from the Chowchilla Bypass during high-flow conditions and continues to work on necessary infrastructure to perfect the right, resulting in only nominal historic diversions. As a result, agriculture in NSWD GSA is primarily reliant on groundwater.

The Board of Directors for NSWD GSA is the NSWD Board of Directors. The NSWD GSA Board of Directors meetings are held concurrently with the NSWD Board of Directors meetings. These meetings are open to the public and are typically held quarterly in March, July, September, and December of each year.

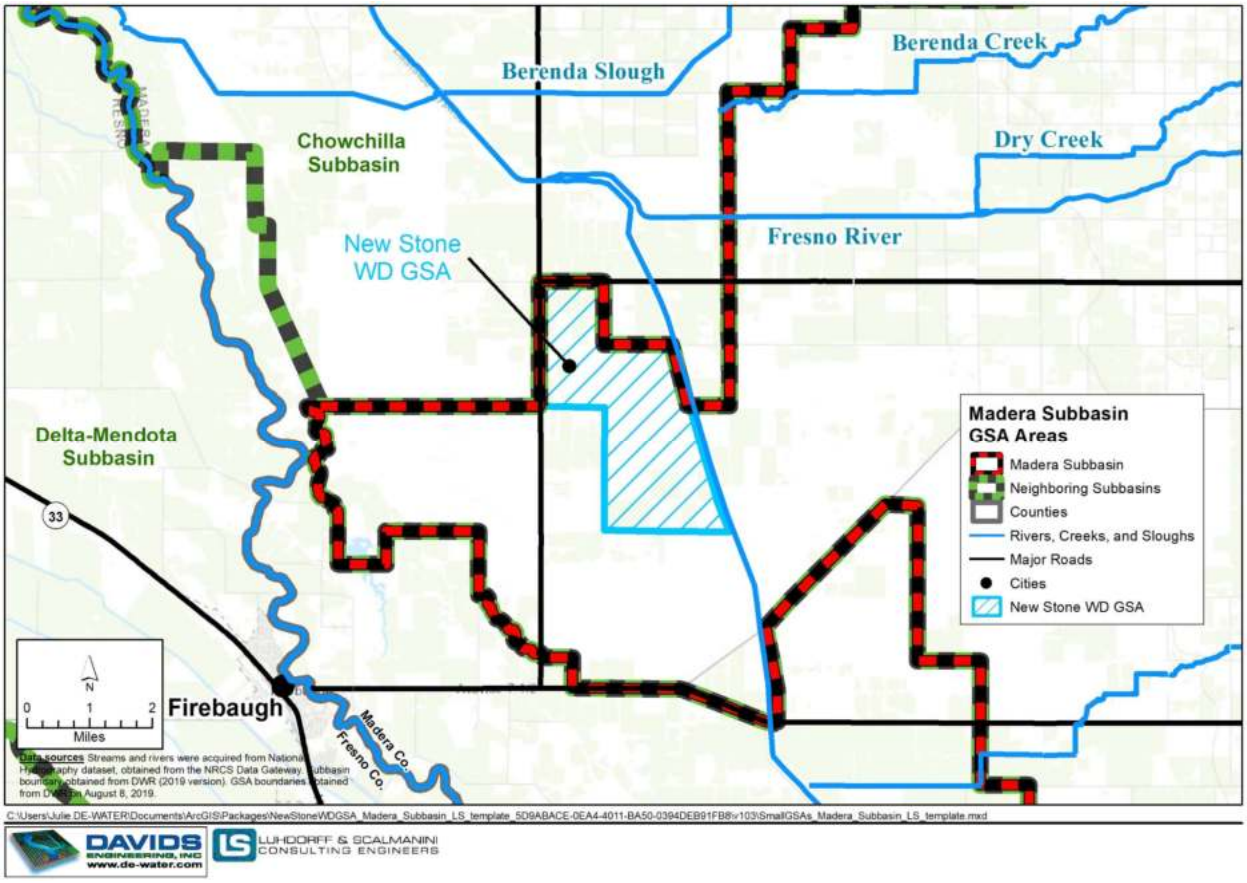


Figure 1-12. New Stone Water District GSA Map.



Figure 1-13. Viticulture in the Madera Subbasin.

1.3.1.7 Root Creek Water District GSA

Root Creek Water District (RCWD) GSA was formed on June 8, 2016 and covers approximately 9,300 acres of the Madera Subbasin (Figure 1-14). In 2018, annexations occurred increasing the size of the District to approximately 9,550 acres and the GSA boundaries reflect this change. Most of this area is comprised of agricultural land (89%) or native vegetation (8%). A small portion of the GSA is also covered by developed land (urban, semi-agricultural, or industrial land) (3%) and water surfaces (<1%), although the portion of developed land is increasing through several community development projects being constructed or planned within RCWD.

In 2015, irrigated agricultural land represented approximately 8,000 acres in RCWD GSA. This area is used for cultivating orchard, citrus, and subtropical crops (Figure 1-15). Agricultural water demand in RCWD GSA has historically been fulfilled by groundwater and supplemented with available surface water deliveries over roughly 5,400 irrigated agricultural acres. Prior to SGMA, surface water supplies available for agriculture in RCWD GSA consisted of riparian deliveries to individual water rights users, approximately 3,000 acres of holding contract lands along the San Joaquin River, and surface water supplies delivered to approximately 2,400 acres arising from water supply contracts with both public agencies and private suppliers.

The Board of Directors for RCWD GSA is the RCWD Board of Directors. The RCWD GSA Board of Directors meetings are held immediately following the regular RCWD Board of Directors meetings on the second Monday of each month at 11:00 a.m. These meetings are open to the public and are held at Riverstone Lodge (370 Lodge Road South, Madera, CA, 93636).

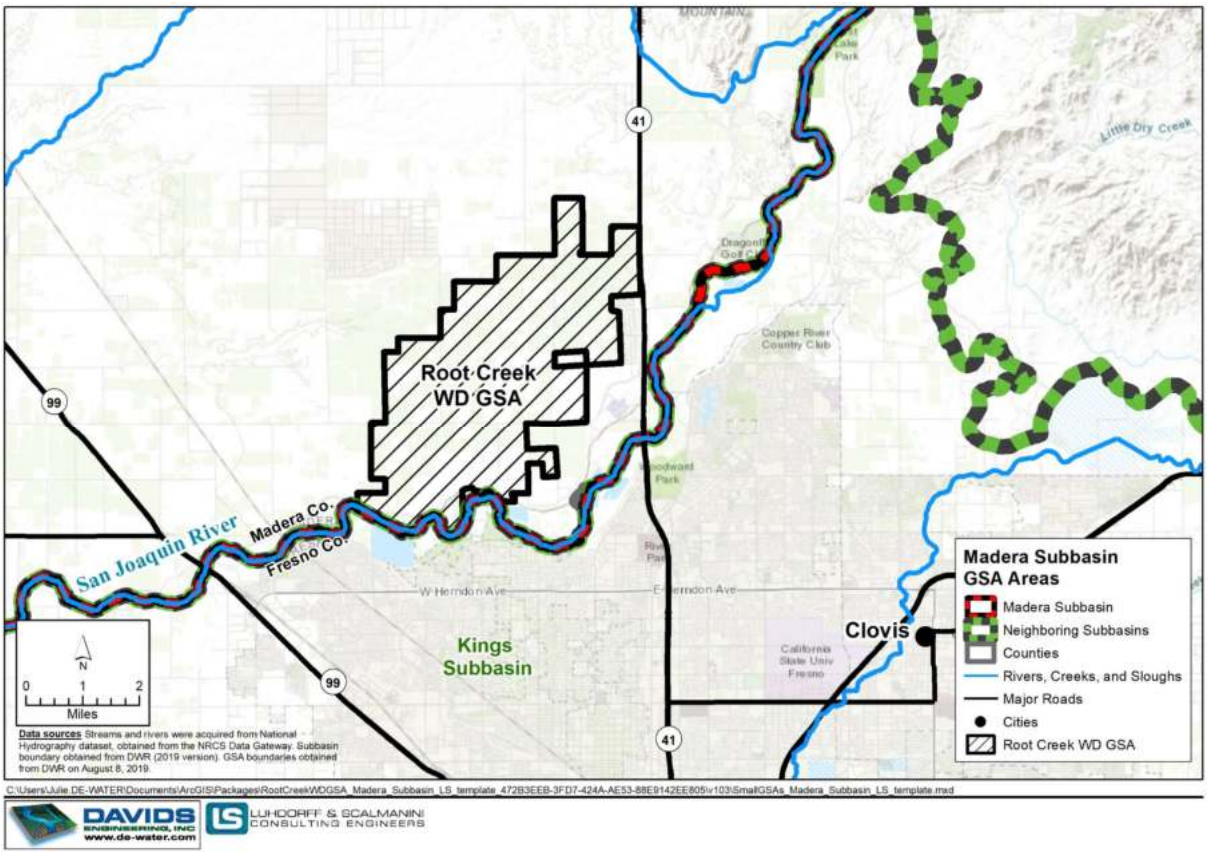


Figure 1-14. Root Creek Water District GSA Map.



Figure 1-15. Citrus Crops in the Madera Subbasin.

1.3.1.8 Madera Subbasin Coordination Committee

The Madera Subbasin GSAs have jointly formed the Madera Subbasin Coordination Committee (the "Committee"). The Committee was developed in early 2018 to serve as the coordinating body for guiding the Madera Subbasin GSAs through development of the Madera Subbasin GSP(s), as defined in the Committee charter. In this role, the Committee and Ad Hoc Work Groups advises the GSAs' governing bodies on GSP development, implementation, and public engagement consistent with each GSA's policies.

The Committee was chartered in February 2018 with six coordinating GSA member agencies: City of Madera GSA, Gravelly Ford Water District GSA, Madera County GSA, Madera Irrigation District GSA, Madera Water District GSA, and Root Creek Water District GSA. At that time, New Stone Water District GSA chose to prepare a separate individual GSP. In late 2018 and early 2019, Gravelly Ford Water District GSA and Root Creek Water District GSA, respectively, also chose to prepare separate individual GSPs.

At this time, the Committee and Ad Hoc Work Groups coordinate GSP development for the four coordinating Joint GSP GSA member agencies (Table 1-4). An intra-basin coordination agreement will be formed between these four Joint GSP GSAs and the three individual GSAs to comply with SGMA requirements that multiple GSPs developed by multiple GSAs within the same groundwater subbasin be coordinated pursuant to a single coordination agreement (CWC § 10727 (b) (3)).

The Committee consists of two (2) representatives from each coordinating GSA, including one member capable and authorized as a spokesperson for the GSA governing body to facilitate coordination efforts and one member serving as a technical expert.

The aim of the Committee and Ad Hoc Work Groups, as defined by the Committee charter, is to provide a shared forum for the GSAs to review and discuss elements of GSP development. Specifically, the Committee serves to identify elements of agreement or disagreement requiring more in-depth discussion among GSAs and makes recommendations for GSA governing bodies to consider in their decision-making

process. In this process, the Committee aims to reach varying levels of consensus among the GSAs on all interim or final recommendations. Consensus is determined by Committee members' voiced approval that is consistent with what the Committee members feel can be approved by their GSA governing bodies.

Table 1-4. Summary of Madera Subbasin Groundwater Sustainability Plans and Coordination.

Groundwater Sustainability Agency	Coordinating Body	Groundwater Sustainability Plan Type
Madera County	Madera Subbasin Coordination Committee	Joint GSP
Madera Irrigation District		
City of Madera		
Madera Water District		
Gravelly Ford Water District	N/A	Individual GSP
Root Creek Water District	N/A	Individual GSP
New Stone Water District	N/A	Individual GSP

The Committee is chartered to review or provide recommendations to the GSAs' governing bodies on the following topics:

- Development, adoption, or amendment of the GSP
- Sustainability goals and objectives
- Technical and reporting standards, including best management practices, data management and reporting
- Monitoring programs
- Annual work plans and reports (including mandatory five-year milestone reports)
- Modeling scenarios
- Inter-basin coordination activities
- PMAs to achieve sustainability
- Grant funding proposals
- Community outreach and engagement
- Local regulations to implement SGMA
- Fee proposals
- General Coordination in response to GSA inquiries

The Committee's discussions and recommendations are relayed to GSA governing bodies through (1) reports on the consensus (or other outcomes) of Committee discussions provided by the Committee Secretary, and (2) individual reports prepared by Committee members to confirm areas of agreement.

Each GSA's governing body members consider the Committee's recommendations when making policy decisions for their individual GSAs. In the event that any GSA governing body disagrees with the Committee's recommendations, that governing body is asked to provide explanation for its final decision to allow discussion and revisions to recommendations within the Committee or through the GSA Dispute Resolution process. Ultimately, GSA governing bodies have the authority to adopt and implement the GSP.

1.3.2 Legal Authority of the GSA

The GSAs involved in development of this Joint GSP have the legal authority and are pursuing the financial resources necessary to implement the GSP.

Madera County, City of Madera, Madera Irrigation District, and Madera Water District are each local agencies[12] overlying the Madera Subbasin as defined under SGMA and are therefore eligible to serve as separate GSAs within the Madera Subbasin (CWC § 10723(a)). Pursuant to CWC § 10724(a), Madera County serves as the GSA for all areas within the Madera Subbasin outside the management area of other GSAs.

The election to establish each GSA was made through meetings of the Madera Subbasin GSA Formation Committee. This committee was formed to assemble all local agencies and related parties responsible for managing groundwater resources in the Madera Subbasin, meeting quarterly between early 2015 and 2017. Voluntary participants in this committee included: Aliso Water District, City of Madera, Gravelly Ford Water District, Madera Irrigation District, Madera County, Madera Water District, New Stone Water District, and Root Creek Water District.

City of Madera, Madera County, Madera Irrigation District, and Madera Water District each elected to become a GSA pursuant to CWC § 10723.8(a) and SGMA for the portions of the Madera Subbasin identified in **Appendix 1**.

Each agency held public hearings regarding the establishment of a GSA in accordance with CWC § 10723(b). Public notice for these hearings was provided in accordance with Government Code § 6066. After holding these hearings, the governing bodies of each agency adopted resolutions to establish the associated GSAs. No new bylaws or ordinances were adopted by the GSAs in conjunction with these actions.

Pursuant to CWC § 10723.2, the aforementioned GSAs "shall consider the interests of all beneficial uses and users of groundwater, as well as those responsible for implementing groundwater sustainability plans."

1.3.3 Estimated Cost of GSP Implementation

The estimated annual costs of GSP implementation for the four Joint GSP GSAs included under this GSP are shown in Figure 1-16 (in current dollars). Additional detail is provided in Chapter 5. Also illustrated are the estimated annual operations and maintenance (O&M) costs (in current dollars) for the GSP PMAs to be implemented by the four Joint GSP GSAs together developing this GSP that are described in more detail in Chapter 4. This figure does not include the cost that the Madera County GSA demand management program would impose on growers and the County economy. Average annual operating costs for projects increase from $0.5 million per year in 2020 to over $14 million per year by 2040. Project costs will be refined by GSAs as the GSP is implemented. GSA implementation costs total about $3 million per year.

Individually, the GSAs manage their own financing, staffing, contracting, and daily operations related to GSP implementation. The approach to meeting the GSP implementation costs varies between GSAs.

[12] CWC § 10721(n): "Local agency" means a local public agency that has water supply, water management, or land use responsibilities within a groundwater basin.

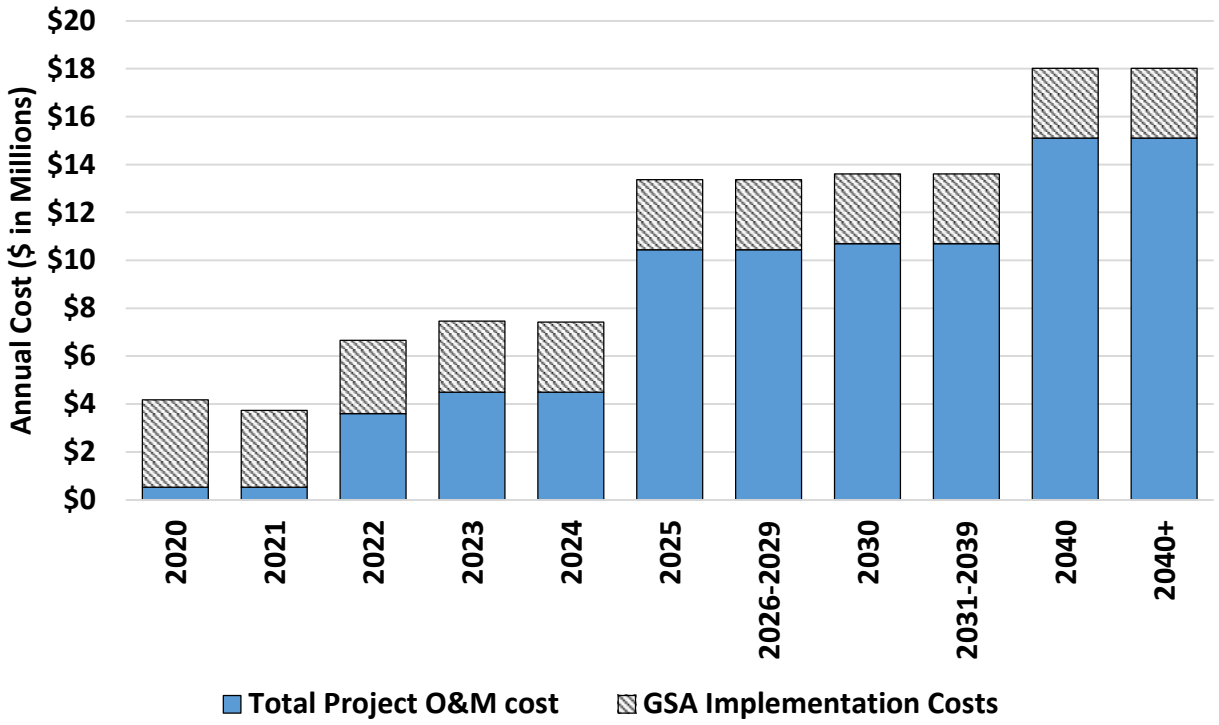


Figure 1-16. Madera Subbasin Estimated Annual Costs (in current dollars) for Project O&M and GSA Implementation

Table 1-5 provides a summary of the estimated capital costs (in current dollars) and the average annual gross recharge benefit anticipated at full implementation of each GSA's PMAs. In total, GSP PMAs are estimated to provide a gross average annual benefit of about 216,000 AF to Subbasin recharge[13] from all seven GSAs with an estimated average annual operating cost of $69,550,000 for the four Joint GSP GSAs together developing this GSP (see the GSPs developed by GFWD, NSWD and RCWD for operation costs of their projects). Annual operating costs include the direct cost of demand management (crop revenue loss from fallowing) but do not include additional indirect, or "multiplier," effects on the Madera County economy. The total capital cost of all PMAs implemented by the four Joint GSP GSAs together developing this GSP is around $260 million dollars. All costs are preliminary estimates that will be refined by the GSAs. Additional information is provided in Chapter 4.

[13] The gross yield is larger than the projected shortfall due primarily to changes in other water budget elements when flood flows are directed to recharge.

Table 1-5. Summary of Madera Subbasin Groundwater Sustainability Plan Implementation Costs.

GSA	Average Annual Gross Benefit at Full Implementation (AFY)	Estimated Capital Cost ($, millions)	Estimated Average Annual Operating Cost ($/year, millions)
MWD	2,810	14.90	0.90
MID	47,430	18.56	10.33
City of Madera	3,370	11.02	0.00
Madera County	139,850	218.10	58.32[1]
GFWD	2,620	*See GFWD GSP*	
NSWD	5,540	*See NSWD GSP*	
RCWD	14,220	*See RCWD GSP*	
Total	**215,840**	**262.58**	**69.5**

[1]Costs of demand management include reduced economic activities in the county, this includes approximately $53.9 million per year in direct economic impacts alone (excluding multiplier effects).

1.4 GSP Organization

This Joint GSP has been developed by the consulting team on behalf of City of Madera GSA, Madera County GSA, Madera Irrigation District GSA, and Madera Water District GSA. The consulting team is comprised of Davids Engineering (DE), Luhdorff & Scalmanini Consulting Engineers (LSCE), ERA Economics, LLC (ERA), Stillwater Sciences (SS), and the Consensus and Collaboration Program at California State University, Sacramento (CSUS or CCP)

The GSP is organized in accordance with 23 CCR § 354 as follows:

- Section 1 of this GSP provides an introduction to the Madera Subbasin GSAs and the development of this Joint GSP.
- Section 2 provides a detailed summary of the GSP Plan Area and development of the basin setting, including the hydrogeologic conceptual model, current and historical groundwater conditions, water budgets, and management areas (as applicable).
- Section 3 establishes the Subbasin sustainability goal to be achieved through coordination among all GSAs in the Subbasin. This section also establishes measurable objectives (MOs), minimum thresholds (MTs), and undesirable results for each sustainability indicator, followed by a description of the proposed monitoring network to track and verify progress toward the Subbasin sustainability goal.
- Section 4, PMAs are proposed for achieving the Subbasin sustainability goal.
- Section 5, proposes the GSP implementation strategy, costs, and schedule.

To facilitate DWR review and assure compliance with all applicable GSP regulations, Table 1-6 was prepared to cross-reference between sections of this Joint GSP to applicable sections and the GSP regulations. Terminology in this Joint GSP has also been used in alignment with the SGMA definitions provided in CWC § 10721 and in 23 CCR § 351. These definitions are provided as **Appendix 1.I**.

Table 1-6. Cross Reference of GSP Regulations[14] and Associated GSP Sections.

Subarticle	Section	Paragraph	Requirement	GSP Section
1. Administrative Information	4. General Information	(a)	Executive summary	Executive Summary
		(b)	List of references and technical studies	6
	6. Agency Information	-	Agency information pursuant to CWC § 10723.8, along with:	App. 1
		(a)	Agency name and mailing address	1.3
		(b)	Agency organization and management structure, persons with management authority for Plan implementation	1.3.1
		(c)	Plan manager name and contact information	1.3
		(d)	Legal authority of agency	1.3.2
		(e)	Estimate of Plan implementation costs and description of how Agency plans to meet costs	1.3.3, 5.1
	8. Description of Plan Area	(a)	Maps of Plan area	2.1.1
		(b)	Written description of Plan area	2.1.1
		(c)-(d)	Identification of existing water resource monitoring and management programs, and description of any such planned programs	2.1.2
		(e)	Description of conjunctive use programs	2.1.2
		(f)	Description of the land use elements or topic categories	2.1.3
		(g)	Description of additional Plan elements (CWC § 10727.4)	2.1.4
	10. Notice and Communication	(a)	Description of the beneficial uses and users of groundwater in the subbasin	2.1.5
		(b)	List of public meetings	2.1.5
		(c)	Comments and responses regarding the Plan	2.1.5
		(d)	Description of communication procedures	2.1.5
2. Basin Setting	12. Introduction to Basin Setting	-	Information about the basin setting (physical setting, characteristics, current conditions, data gaps, uncertainty)	2.2
	14. Hydrogeologic Conceptual Model	(a)	Description of the subbasin hydrogeologic conceptual model	2.2.1
		(b)	Summary of regional geologic and structural setting, subbasin boundaries, geologic features, principal aquifers and aquitards	2.2.1
		(c)	Cross-sections depicting major stratigraphic and structural features	2.2.1
		(d)	Maps of subbasin physical characteristics	2.2.1
	16. Groundwater Conditions	(a)-(g)	Description of current and historical groundwater conditions including: 1. Groundwater elevation 2. Change in storage 3. Seawater intrusion	2.2.2

[14] California Code of Regulations, Title 23, Division 2, Chapter 1.5, Subchapter 2 Groundwater Sustainability Plans, Article 5 Plan Contents

Subarticle	Section	Paragraph	Requirement	GSP Section
			4. Groundwater quality issues 5. Land subsidence 6. Interconnected surface water systems 7. Groundwater dependent ecosystems	
	17. Water Budget	(a)	Water budget providing total annual volume of groundwater and surface water entering and leaving the subbasin, including historical, current and projected water budget conditions, and change in storage.	2.2.3
		(b)-(f)	Development of a numerical groundwater and surface water model to quantify current, historical, and projected: 1. Total surface water entering and leaving by water source type 2. Inflow to the groundwater system by water source type 3. Outflows from the groundwater system by water use sector 4. Change in groundwater storage 5. Overdraft over base period 6. Annual supply, demand, and change in storage by water year type. 7. Estimated sustainable yield	2.2.3
	20. Management Areas	(a)	Description of management areas	2.2.4
		(b)	Describe purpose, minimum thresholds, measurable objectives, monitoring, analysis	2.2.4
		(c)	Maps and supplemental information	2.2.4
3. Sustainable Management Criteria	22. Introduction to Sustainable Management Criteria	-	Criteria by which an Agency defines conditions that constitute sustainable groundwater management for the subbasin	3
	24. Sustainability Goal	-	Description of subbasin sustainability goal, including basin setting information used to establish the goal, sustainability indicators, discussion of measures to ensure the subbasin will be operated within its sustainable yield, and an explanation of how the sustainability goal is likely to be achieved and maintained.	3.1
	26. Undesirable Results	(a)	Processes and criteria used to define undesirable results applicable to the subbasin.	3.4
		(b)-(c)	Description of undesirable results, including cause of groundwater conditions and potential effects on beneficial uses and users of groundwater.	3.4
	28. Minimum Thresholds	(a)	Establish minimum thresholds to quantify groundwater conditions for each applicable sustainability indicator.	3.3
		(b)-(d)	Describe information and criteria to select, establish, justify, and quantitatively measure minimum thresholds.	3.3
	30. Measurable Objectives	(a)-(g)	Establish measurable objectives, including interim milestones in increments of five years, to achieve and maintain the subbasin sustainability goal.	3.2

Subarticle	Section	Paragraph	Requirement	GSP Section
4. Monitoring Networks	32. Introduction to Monitoring Networks	-	Description of monitoring network, monitoring objectives, monitoring protocols, and data reporting.	3.5
	34. Monitoring Network	(a), (e)-(g)	Development of monitoring network to yield representative information about groundwater conditions.	3.5.1
		(b)-(d)	Monitoring network objectives.	3.5.1
		(h)	Maps and tables of monitoring sites.	3.5.1
		(i)	Monitoring protocols.	3.5.2
	36. Representative Monitoring	(a)-(c)	Designation of representative monitoring sites.	3.5.3
	38. Assessment and Improvement of Monitoring Network	(a)-(d)	Evaluation of monitoring network, including uncertainty, data gaps, and efforts to fill data gaps	3.5.4
		(e)	Adjustment of monitoring frequency and density to assess management action effectiveness	3.5.4
	40. Reporting Monitoring Data to the Department	(f)	Copy of monitoring data from data management system	
5. Projects and Management Actions	44. Projects and Management Actions	(a)-(c)	Description of projects and management actions to achieve and maintain the subbasin sustainability goal.	4

2 PLAN AREA AND BASIN SETTING

ALL FIGURES FOR CHAPTER TWO START AT PAGE 517

2.1 Description of the Plan Area (23 CCR § 354.8)

The GSP Plan Area (Plan Area) is defined as the Madera Subbasin (5-22.06), part of the San Joaquin Valley Groundwater Basin, as described in DWR Bulletin 118 (DWR, 2016) with boundary updates approved in early 2019.

The lateral extent of the Subbasin is defined by the Subbasin boundaries provided in Bulletin 118 (DWR, 2016). The Subbasin is bounded in the south by the San Joaquin River and the Kings Subbasin, in the west by the Delta-Mendota Subbasin, in the north by the Chowchilla Subbasin, and in the east by the foothills of the Sierra Nevada (Figure 2-1).

The vertical boundaries of the Subbasin are the land surface (upper boundary) and the definable bottom of the basin (lower boundary). The definable bottom was established as part of development of the preliminary hydrogeologic conceptual model (HCM) during previous data collection and analysis efforts conducted by DE and LSCE (2017). The vertical extent of the Subbasin is subdivided into a surface water system (SWS) and groundwater system (GWS). The SWS represents the land surface down to the bottom of plant root zone[15], within the lateral boundaries of the Subbasin. The GWS extends from the bottom of the root zone to the definable bottom of the Subbasin, within the lateral boundaries of the Subbasin.

2.1.1 Summary of Jurisdictional Areas and Other Features (23 CCR § 354.8(b))

As identified in Section 1.3, the Madera Subbasin is divided among seven GSAs for GSP development. Table 1-2 and Figure 1-1 delineate the areas managed exclusively by each GSA in this Joint GSP (CM, MC, MID, MWD), the areas managed by other GSAs in the Madera Subbasin (GFWD, NSWD, RCWD), and subbasins adjacent to the Plan Area. No area in the Subbasin is covered by an alternative. The entire Subbasin lies within the jurisdictional boundaries of Madera County. The area covered by the City of Madera General Plan is contained within the CM GSA boundaries.[16] The Madera Subbasin is not adjudicated and contains no considerable state land or federal land.[17]

[15] The depth to the bottom of the root zone varies by crop, but typically ranges from 2-7 feet (ASCE, 2016).

[16] City of Madera General Plan, October 7, 2009.

[17] Federal land includes primarily rights of way along canals conveying USBR Central Valley Project water. State land includes primarily California Department of Parks and Recreation land along San Joaquin River near Friant, California.

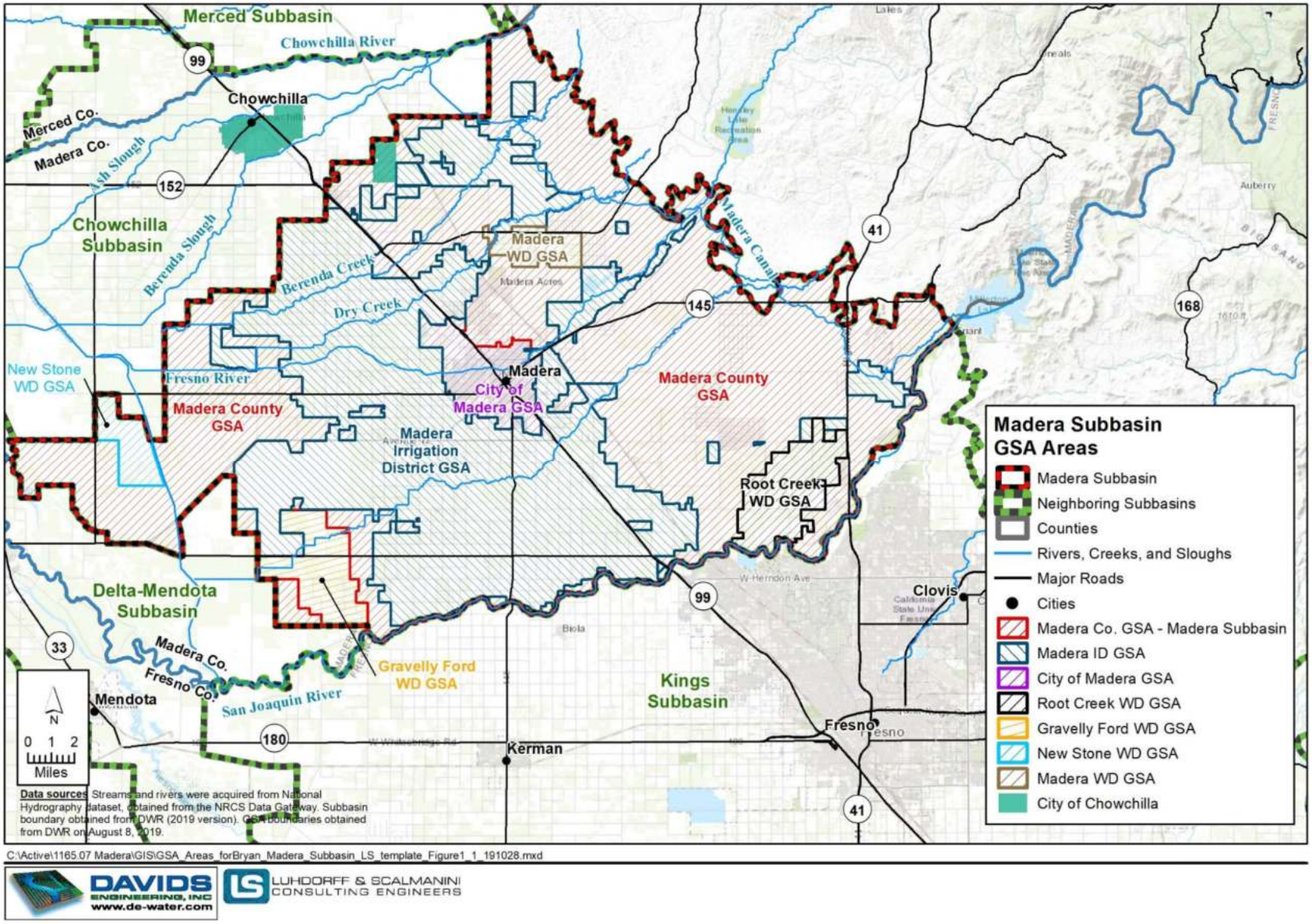


Figure 2-1. Madera Subbasin GSAs Map.

2.1.1.1 Land Uses

Land use areas in the Madera Subbasin are broadly classified across three sectors: agricultural, urban, and native vegetation. Agricultural land use (and water use) encompasses all agricultural crops reported in the Madera Subbasin, including idle agricultural land and dairies. Urban land use includes urban, industrial, and semi-agricultural land.

Figure 2-2 depicts land use in the Madera Subbasin as reported in the 2011 DWR Madera County Land Use spatial coverage[18]. Annual land use areas within Madera Subbasin were derived from DWR spatial land use surveys of Madera County, Land IQ remotely sensed land use data obtained through DWR, and Madera County Agricultural Commissioner annual crop production area reports. Additional detail for the process used to develop an annual land use database for Madera County is provided in **Appendix 2.A.**

Annual land use within each of the four sectors are summarized in Figure 2-3 and Table 2-1 for the Madera Subbasin between 1989-2015. Agricultural land use categories are further detailed in Figure 2-4 and Table 2-2. Average land use across each sector and category is provided for the 1989-2014 historical water budget period, which is described below in Section 2.2.3. Land use summaries are provided for each GSA in **Appendix 2.F.**

[18] The 2011 DWR Madera County Land Use Survey is the most recent parcel-based land use data available at the time of GSP development. Field-based data is also available in 2014 from Land IQ, LLC. The DWR Land Use interpolation tool was used to estimate spatial land use data in years without parcel-based or field-based data, including 2015.

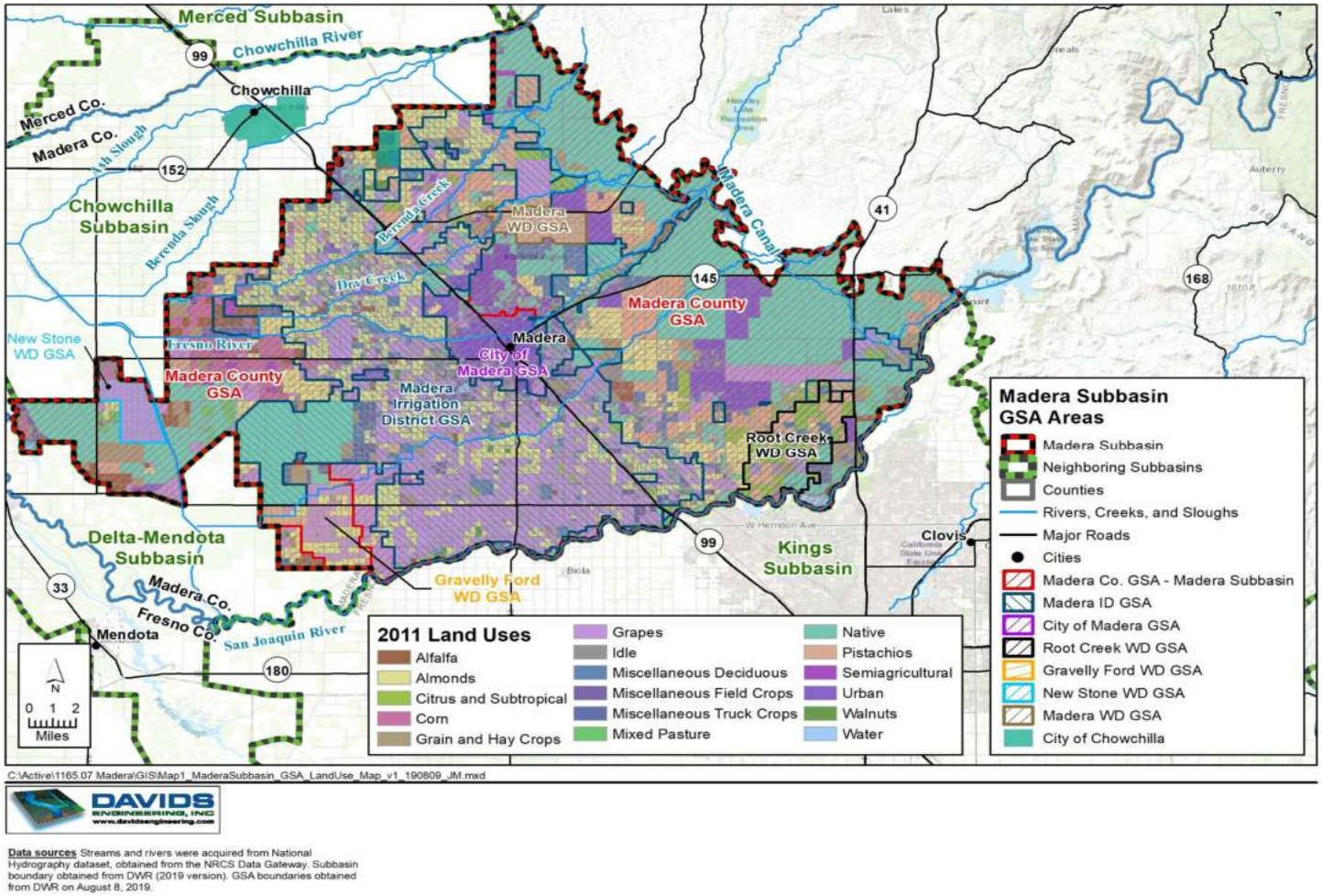


Figure 2-2. Madera Subbasin Land Use Map.[19]

[19] 2011 Land Uses extracted from the 2011 DWR spatial land use survey results.
Water Use Sectors: Native Vegetation (Native and Water land uses), Urban (Semi-agricultural and Urban land uses), and Agricultural (all other land uses).
Water Source Type: Much of the agricultural land in the Madera Subbasin has access to use of both surface water and ground water. Madera ID GSA, City of Madera GSA, Gravelly Ford WD GSA, Madera WD GSA, and localized areas in Madera County GSA have access to CVP and local surface water supplies. Root Creek WD GSA has access to local surface water supplies, and New Stone WD GSA has used nominal historic diversions of local surface water supplies. The remaining agricultural and urban water use demand is met through groundwater. The mixture of groundwater and surface water sources depends on the GSA (see **Appendices 2.F.a.** through **2.F.g**).

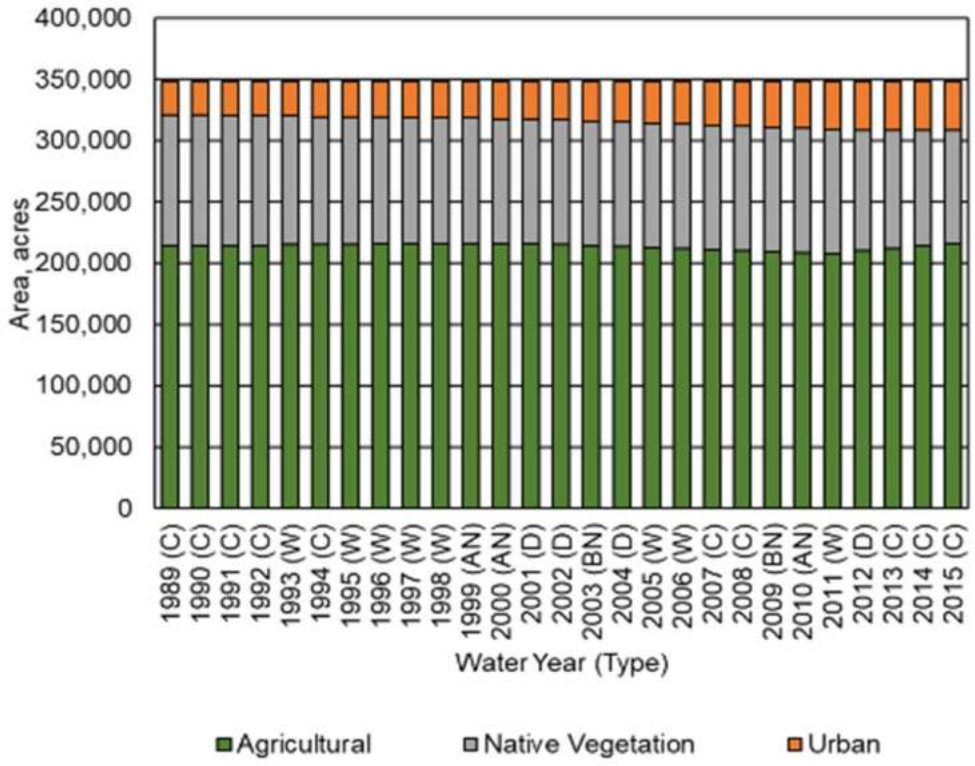


Figure 2-3. Madera Subbasin Land Use Areas.

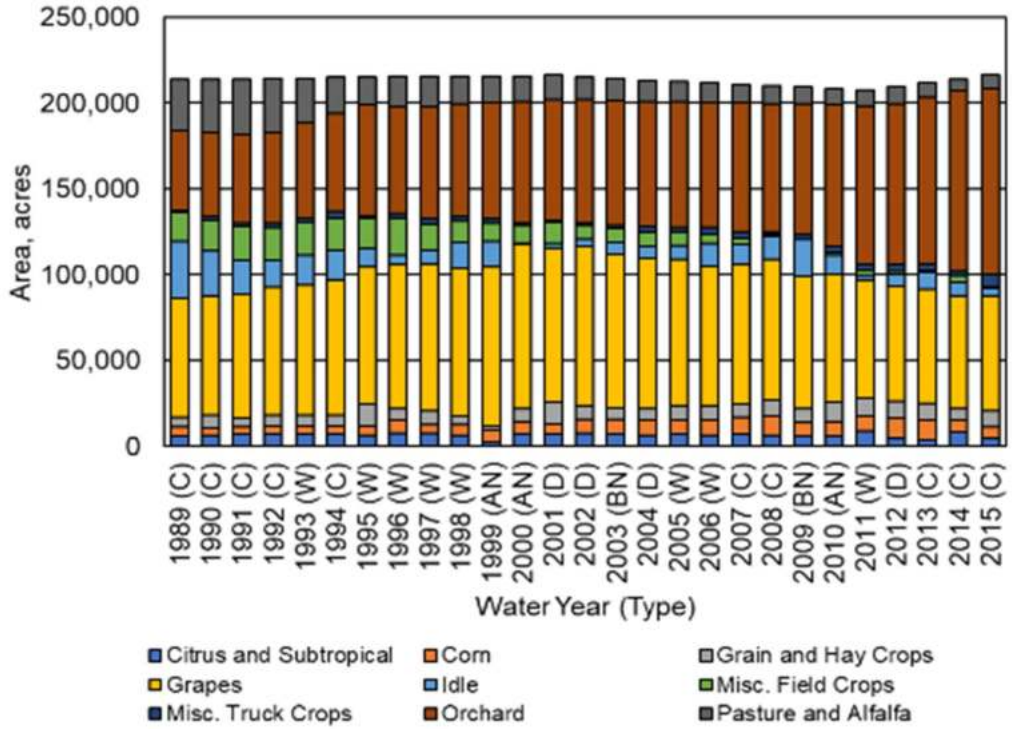


Figure 2-4. Madera Subbasin Agricultural Land Use Areas.

Table 2-1. Madera Subbasin Land Use Areas (Acres).

Water Year (Type)	Agricultural	Native Vegetation[1]	Urban[2]	Total
1989 (C)	213,924	106,906	26,742	347,572
1990 (C)	214,083	106,463	27,026	347,572
1991 (C)	214,196	106,078	27,298	347,572
1992 (C)	214,554	105,455	27,564	347,572
1993 (W)	214,757	104,987	27,828	347,572
1994 (C)	215,092	104,383	28,097	347,572
1995 (W)	215,385	103,823	28,364	347,572
1996 (W)	215,515	103,410	28,647	347,572
1997 (W)	215,649	102,993	28,930	347,572
1998 (W)	215,779	102,580	29,213	347,572
1999 (AN)	215,912	102,165	29,495	347,572
2000 (AN)	216,043	101,751	29,778	347,572
2001 (D)	216,177	101,334	30,061	347,572
2002 (D)	215,327	101,305	30,940	347,572
2003 (BN)	214,476	101,276	31,820	347,572
2004 (D)	213,626	101,247	32,699	347,572
2005 (W)	212,773	101,218	33,581	347,572
2006 (W)	211,922	101,189	34,461	347,572
2007 (C)	211,072	101,160	35,341	347,572
2008 (C)	210,222	101,130	36,220	347,572
2009 (BN)	209,369	101,101	37,101	347,572
2010 (AN)	208,519	101,072	37,981	347,572
2011 (W)	207,669	101,043	38,861	347,572
2012 (D)	209,727	98,856	38,989	347,572
2013 (C)	211,791	96,663	39,117	347,572
2014 (C)	213,852	94,475	39,245	347,572
2015 (C)	216,158	91,919	39,496	347,572
Average (1989-2014)	213,362			

[1] Area includes land classified as native vegetation and water surfaces.
[2] Area includes land classified as urban, industrial, and semi-agricultural.

Table 2-2. Madera Subbasin Agricultural Land Use Areas (Acres).

Water Year (Type)	Citrus and Subtropical	Corn	Grain and Hay Crops	Grapes	Idle	Misc. Field Crops[20]	Misc. Truck Crops[21]	Orchard[22]	Pasture and Alfalfa	Total
1989 (C)	6,071	5,266	5,548	69,562	32,783	17,189	1,217	46,219	30,069	213,924
1990 (C)	6,264	4,676	7,183	70,011	25,527	18,146	2,078	49,243	30,956	214,083
1991 (C)	6,930	4,396	5,294	71,643	19,928	20,035	2,010	51,456	32,505	214,196
1992 (C)	6,921	4,873	6,316	74,583	15,756	19,184	2,262	53,180	31,478	214,554
1993 (W)	7,032	5,199	6,270	75,780	17,182	19,291	2,657	54,973	26,372	214,757
1994 (C)	7,193	5,046	5,780	79,140	17,624	18,116	4,188	56,697	21,308	215,092
1995 (W)	6,600	5,493	12,680	79,919	10,649	17,587	1,363	65,024	16,070	215,385
1996 (W)	7,429	7,496	7,357	83,404	5,677	21,565	2,508	62,451	17,628	215,515
1997 (W)	7,485	5,356	7,759	85,931	8,133	14,880	3,146	64,874	18,085	215,649
1998 (W)	6,606	6,331	4,829	86,546	14,708	12,520	2,413	65,726	16,100	215,779
1999 (AN)	2,938	6,635	2,250	92,564	15,075	10,633	2,243	67,712	15,862	215,912
2000 (AN)	7,349	7,077	7,461	95,974	347	10,857	1,259	70,458	15,261	216,043
2001 (D)	6,880	6,584	12,438	89,443	3,096	12,556	1,258	69,992	13,929	216,177
2002 (D)	7,433	8,278	8,247	92,184	4,437	8,116	1,628	71,566	13,437	215,327
2003 (BN)	7,078	8,579	6,829	89,422	6,731	8,119	2,030	72,742	12,946	214,476
2004 (D)	6,514	8,648	7,111	87,319	6,533	8,955	3,097	72,995	12,454	213,626
2005 (W)	7,236	7,877	8,898	85,057	8,225	7,627	2,869	73,023	11,962	212,773
2006 (W)	6,719	8,556	8,461	81,573	12,806	5,463	3,792	73,082	11,470	211,922
2007 (C)	6,963	10,090	7,276	81,391	11,999	3,678	3,871	74,826	10,978	211,072
2008 (C)	6,493	11,380	8,906	82,092	13,729	947	1,486	74,703	10,487	210,222
2009 (BN)	5,738	8,352	7,911	77,005	21,763	125	2,686	75,795	9,994	209,369
2010 (AN)	5,945	8,834	10,872	74,371	11,672	1,546	2,897	82,879	9,503	208,519
2011 (W)	8,796	8,641	10,879	68,136	3,075	3,424	3,043	92,664	9,011	207,669
2012 (D)	4,827	11,432	10,029	67,291	6,493	2,312	3,527	93,783	10,033	209,727
2013 (C)	4,233	10,908	10,272	66,441	9,779	837	3,953	97,164	8,204	211,791
2014 (C)	8,260	6,955	6,741	65,594	8,231	4,001	2,328	104,985	6,757	213,852
2015 (C)	4,512	6,963	9,118	67,489	4,198	409	7,480	108,407	7,581	216,158
Average (1989-2014)	6,613	7,422	7,831	79,707	11,998	10,296	2,531	70,700	16,264	213,362

[20] Miscellaneous field crops include beans, cotton, flax, hops, millet, safflower, sorghum, sudan, sugar beets, sugar cane, and sunflowers.
[21] Miscellaneous truck crops include artichokes, asparagus, berries, broccoli, Brussels sprouts, cabbage, carrots, cauliflower, celery, cucumbers, garlic and onions, green beans, lettuce, melons, peas, peppers, potatoes, sweet potatoes, spinach, squash, tomatoes, other greenhouse crops, and flowers, and nurseries.
[22] Orchard crops include primarily almonds and pistachios, and also walnuts and miscellaneous deciduous crops.

2.1.1.2 Groundwater Wells

The densities of domestic, irrigation, and public supply wells per section within the Madera Subbasin are shown in **Figures[23] 2-5[24],2-6[25]**, and **2-7[26]** respectively. Notably, the number of wells reported by section were determined from Well Completion Report (WCR) data provided by DWR. These numbers include only reported wells and may not reflect the total number of existing or active wells in the Subbasin. The highest concentrations of reported domestic wells are centered primarily around the City of Madera and Bonadelle Ranchos-Madera Ranchos to the east. Reported irrigation wells are generally less concentrated and more evenly distributed across the Subbasin, though slightly higher concentrations are found in some sectors within rural MC GSA, MID GSA, and RCWD GSA.

2.1.2 Water Resources Monitoring and Management Programs (23 CCR § 354.8(c), (d), (e))

Existing surface water and groundwater monitoring and management programs within the Madera Subbasin are identified below following a summary of water planning documents applicable to the Subbasin GSAs.

Continued monitoring is required to track the progress of the GSP implementation plan by providing data on groundwater and surface water availability in the Subbasin. One overarching project in the implementation plan adds additional monitoring to fill data gaps (see Section 4 for more details).

2.1.2.1 Water Planning Documents

As stewards of the water resources within their jurisdictions, the local agencies that have formed each of Madera Subbasin's GSAs have prepared and adopted several water planning documents in the past. These include:

- Regional Water Plans
    - Madera Integrated Regional Water Management Plan (approved in 2008, updated in 2015)
        - This plan is a collaborative effort to improve regional coordination in management of water resources among the 17 groups and agencies forming the Madera Regional Water Management Group as well as other interested parties. These agencies include six currently organized as GSAs in the Madera Subbasin (CM, GFWD, MC, MID, MWD, RCWD). The plan establishes regional water management goals and serves as a basis for pursuing funding to accomplish these goals.
    - Madera Regional Groundwater Management Plan (adopted in 2014)
        - This plan provides a framework for regional groundwater management among six participating groups and agencies, including three currently organized as GSAs in the Madera Subbasin (CM, MC, MID). The objectives of the plan are to establish collaborative governance, stabilize and recover groundwater levels, mitigate subsidence, improve public awareness, and maintain and improve the economic viability of the Madera region.

[23] Figure titles that are bolded can be found at the end of each chapter.

[24] Based on DWR Well Completion Report data. May not represent all active domestic wells.

[25] Based on DWR Well Completion Report data. May not represent all active irrigation wells.

[26] Based on DWR Well Completion Report Data. May not represent all active public water supply wells.

- Water Management Plans
    - Gravelly Ford Water District Water Management Plan (adopted in 2012)
    - Madera Irrigation District Water Management Plan (dated 2013)
    - City of Madera Urban Water Management Plan (adopted in 2011, updated in 2017)
- Groundwater Management Plans
    - Gravelly Ford Water District Groundwater Management Plan (dated 1998)
    - Madera County Groundwater Management Plan (adopted in 2002)
    - Madera Irrigation District Groundwater Management Plan (dated 1999, amended in 2000)
    - Madera Water District Groundwater Management Plan (adopted in 1997, amended in 2014)
    - Root Creek Water District Groundwater Management Plan (dated 1997)
- Other Plans
    - Community Plans[27]:
        - Fairmead Colony (in process)
        - Gateway Village Area Plan (2006)
        - Gunner Ranch West Area Plan (1994)
        - Rio Mesa Area Plan (1995)
        - River West – Madera (in process)
        - Madera Ranchos (in process)
        - Southeast Madera County (in process)
    - General Plans:
        - City of Madera General Plan (2009)
        - Madera County General Plan (updated 2015)
    - Municipal Service Reviews:
        - City of Madera Municipal Service Review (2018)
        - Root Creek Water District Municipal Service Review (2018)
    - Other:
        - City of Madera Water System Master Plan (dated 2014)
        - Madera County Storm Water Resource Plan (2017)
        - PG&E San Joaquin Valley Operations & Maintenance Habitat Conservation Plan (HCP) (2006, permit issued 2007)[28]

Information developed for these plans regarding GSA surface water and groundwater supplies, distribution infrastructure, and monitoring programs have contributed to the development of this Joint GSP.

[27] Community plans, area plans, master plans, or enhancement plans that are adopted or in process in the Madera Subbasin. Other adopted plans in Madera County are outside the subbasin (Ahwahnee/Nipinnawasee, Coarsegold, North Fork/South Fork, Oakhurst, O'Neals, Raymond).

[28] The goal of this HCP is to "minimize, avoid, and compensate for possible direct, indirect, and cumulative adverse effects on threatened and endangered species" that could result from PG&E operations and maintenance efforts. The HCP covers all land owned by PG&E and/or associated with PG&E gas and electrical facilities, access routes, and mitigation areas, and therefore may overlap with any adjacent GDEs or ISW habitats identified in the subbasin.

GSP implementation will support all HCP goals to minimize and avoid adverse effects to threatened and endangered species in the Madera Subbasin. There are currently no Natural Community Conservation Plans that overlap with the Madera Subbasin.

Development and implementation of this Joint GSP has and will continue to consider the interests of all beneficial uses and users of groundwater, including agricultural water users, municipal water users, disadvantaged communities (DACs), interconnected surface water (ISW) habitats, groundwater dependent ecosystems (GDEs), and other stakeholders.

Implementation of this Joint GSP will support all goals for the protection of natural resources and DACs, including those established in the plans above, consistent with SGMA and GSP regulations. This includes recognition and support of:

- Madera County General Plan, SB 244 Disadvantaged Unincorporated Communities (DUC) Amendments[29]: Identification of the water service needs of DUCs in the county, including the communities of Fairmead, River Road Estates, Valley Lake Ranchos/Lake Madera County Estates in the Madera Subbasin.
- PG&E San Joaquin Valley Operations and Maintenance HCP: Establishes goals to minimize and avoid adverse effects to threatened and endangered species in the Madera Subbasin.

2.1.2.2 Surface Water Monitoring and Management Programs

Surface water flows into and within the Madera Subbasin are extensively monitored through existing federal, state, regional, and local programs. Data and spatial information from these monitoring programs have been incorporated directly into this Joint GSP to support water budget development, per 23 CCR § 354.18.

These sources and the data they provide are summarized below.

Federal, State, and Regional Programs

In support of GSP development, surface water data were collected from the following agencies and programs:

- California Data Exchange Center (CDEC)
- California State Water Resources Control Board (SWRCB)
    - SWRCB GeoTracker
- Department of Water Resources Water Data Library (WDL)
- Madera-Chowchilla Water and Power Authority (MCWPA)
- San Joaquin River Restoration Program (SJRRP) [30]
- San Luis Delta-Mendota Water Authority (SLDMWA)

[29] This Joint GSP also considers the water service and supply needs of other DACs in the subbasin not discussed in the Madera County General Plan, SB 244 DUC Amendments, including La Vina.

[30] SJRRP requires the release of flows from Friant Dam to the confluence with the Merced River to support the life-stages of salmon and other fish species. The amount of water available for the SJRRP – the Restoration Allocation – depends upon the amount of runoff in the San Joaquin River watershed above Friant Dam. The SJRRP develops Allocations and Default Flow Schedules to identify the annual volume of Restoration Flows available. Each year, the Restoration Allocation is adjusted, often many times, between the date of the initial allocation and the final allocation, based on the hydrologic conditions. In May 2019, a Restoration Allocation of over 556,5000 thousand acre-feet (TAF), as measured at Gravelly Ford (GRF), was calculated by Reclamation using the 50% exceedance forecast. For more information, see http://www.restoresjr.net/restoration-flows/flow-schedule/.

- United States Army Corps of Engineers (USACE)
- United States Bureau of Reclamation (Reclamation)
- United States Geological Survey (USGS)
    - National Water Information System (NWIS)

Key federal and state surface water monitoring stations and the agency collecting the data are identified in Table 2-3. In the Madera Subbasin, streamflow along the San Joaquin River, Fresno River, and Madera Canal is monitored by USGS stations. CDEC and WDL compile streamflow data for Chowchilla Bypass and Fresno River inflows to the Subbasin at stations managed by SLDMWA and USACE. These monitoring stations are important for monitoring surface water available to interconnected surface water (ISW) habitats and groundwater dependent ecosystems (GDEs).

Deliveries of Central Valley Project (CVP) water along Madera Canal to lands within Madera Subbasin are managed by MCWPA. Reclamation monitors and reports these deliveries as part of the CVP Friant Division.

Local Programs

Water data were also collected from the following local monitoring programs:

- The City of Madera's SCADA system and records of monthly volumes pumped from groundwater supply wells (available since 2013).
- GFWD's records of surface water diversions from the San Joaquin River, Cottonwood Creek, and MID's Lateral 6.2 (available since 2004).
- GFWD's records of deliveries to growers (available since 1982).
- Madera County's requirement to include a flow measurement device on new wells and the resulting groundwater pumping records.
- MID's extensive network of recorders (Table 2-4) and records of key inflows and outflows to waterways and the MID conveyance system (available since the 1950s).
- MID's expanding SCADA system.
- MID's records of grower deliveries in their STORM database (available since 1999).
- MWD's well monitoring program and records of pumping volumes from MWD's wells (available since 1993).
- MWD's records of surface water diversions into the District from Dry Creek (available since 1993)
- RCWD's records of surface water deliveries to parcels on the pipeline constructed to supply surface water from MID's Lateral 6.2 to RWCD (available since 2017).
- Stations and MID recorders along waterways were used to prepare time series datasets for Subbasin surface water inflows and outflows. MID recorders at spillage sites were used to prepare time series datasets for MID conveyance system outflows. Records of groundwater pumping and deliveries were used to prepare time series datasets for agricultural land inflows. These data and methodologies are described in Section 2.2.3 and **Appendix 2.F.**

Program Limitations on Operation Flexibility in Basin

Continued operation of these water monitoring programs will support tracking the progress of the GSP implementation plan by providing data on water availability and inflows and outflows from the Subbasin. Limitations on surface water deliveries will limit operational flexibility by reducing surface water supplies available for conjunctive use programs.

Table 2-3. Surface Water Monitoring Stations.

Waterway	Source	Site ID	Site Name	Available Data Period	Details
Chowchilla Bypass	CDEC	CBP	Chowchilla Bypass	1997-2018	Station operated by SLDMWA
Chowchilla Bypass	WDL	B07802	Chowchilla Bypass at Head Below Control Structure	1978-1991	
Fresno River	USGS	11258000	Fresno R Bl Hidden Dam Nr Daulton	1941-1990	
Fresno River	CDEC	HID	Hidden Dam (Hensley)	1993-2018	Station operated by USACE
Madera Canal	USGS	11249500	Madera Cn A Friant CA	1948-2016	
Madera Canal	Reclamation	Indicated by Mile	Miles 6.1, 13.06, 18.8, 24.1, 27.5, 30.4, 30.5, 32.2	1989-2018	CVP water deliveries to MID reported by Mile
San Joaquin River	USGS	11251000	San Joaquin R Bl Friant CA	1920-2018	

Table 2-4. MID Recorder Network.

Recorder Number	Recorder Name	Site Type	Available Data Period
2	Berenda Creek Spill	Streamflow	1966-2017
3	Dry Creek Spill	Streamflow	1966-2018
4	Fresno River Rd. 16	Streamflow	1951-2018
5	Dry Creek Head Flood Water	Streamflow	1966-2017
6	Head of M C and I	Canal Heading	1939-2012
7	Fresno River	Streamflow	1951-2010
9	6.2 Spill	Spillage	1964-2018
10	Cottonwood Creek Spill	Streamflow	1951-2018
11	6.2 ex. 18.4 16.9 15.9 Spill	Spillage	1964-2018
12	Madera Lake Recorder	Reservoir Level	1966-1966
13	Berenda Creek Head	Streamflow	1970-2004
14	Cottonwood Creek @ Ave. 13	Streamflow	1970-2018
15	24.2 Spill	Spillage	1972-2018
16	17.0 Spill	Spillage	1972-2018
17	24.2-13.2 Spill	Spillage	1972-2018
18	Dry Creek Lat. Spill	Spillage	1973-2017
19	24.2-17.0 End	Spillage	1973-2018
20	24.2-14.2 Spill	Spillage	1974-2009
23	Main 1 Head	Canal Heading	1979-2014
24	Rd. 9 at Fresno River	Streamflow	2005-2013
26	Rd. 9 at East Side Bypass	Streamflow	2011-2011

2.1.2.3 Groundwater Monitoring and Management Programs

There are a variety of local, state, and federal monitoring programs currently and historically conducted in Madera Subbasin related to groundwater levels, groundwater quality, and land subsidence. Each monitoring category is described in more detail in the sections below.

Groundwater Level Monitoring

Groundwater level monitoring has been conducted historically by a variety of entities in the Subbasin including Madera Irrigation District, Madera County, DWR, United States Bureau of Reclamation (USBR), and Geotracker GAMA. The California State Groundwater Elevation Monitoring Program (CASGEM) was initiated in 2011, with the Madera-Chowchilla Groundwater Monitoring Group as the local monitoring entity. This Group includes Madera Irrigation District, Madera County, Madera Water District, Gravelly Ford Water District, and Root Creek Water District, along with other entities in Chowchilla Subbasin. Groundwater levels are collected and submitted each Fall and Spring as part of the CASGEM program. **Appendix 2.E** includes a map presenting the well locations and most recent monitoring date for historical groundwater level monitoring conducted in the Subbasin.

Groundwater Quality Monitoring

Groundwater quality monitoring has historically been conducted by a variety of entities in the Subbasin including the City of Madera, Madera Valley Water Company, and other public drinking water suppliers, regulated facility operators and other contaminant site monitoring for the RWQCB, the East San Joaquin Water Quality Coalition (the third-party entity representing growers in the area) as part of the Irrigated Lands Regulatory Program (ILRP), USGS for the Groundwater Ambient Monitoring and Assessment Program (GAMA), and other programs under the direction of agencies such as the RWQCB, DPR, EPA, DTSC, USGS. Some historical groundwater quality monitoring has also been conducted by well owners in the Subbasin for other purposes.

All public drinking water supply systems must conduct groundwater quality monitoring as part of requirements for the Division of Drinking Water (DDW). The required frequency and constituents for DDW monitoring vary by water system and monitoring point. Groundwater quality monitoring is also conducted at regulated facilities and contaminant sites for the RWQCB in association with tracking and reporting on the status of groundwater contamination near these sites. More recently, groundwater quality monitoring required by the Irrigated Lands Regulatory Program has been initiated. Groundwater quality assessment and monitoring for the ILRP included preparation of a Groundwater Quality Assessment Report with five-year updates, including delineation of High Vulnerability Areas relative to groundwater quality impacts from irrigated agricultural practices and also includes development and maintenance of a network of wells for groundwater quality sampling as part of a Groundwater Quality Trend Monitoring (GQTM) program. The GQTM program includes annual monitoring results reporting and five-year evaluations of groundwater quality trends and conditions relative to irrigated agriculture. Additionally, as part of the ILRP, all domestic wells on parcels enrolled in the agricultural coalition must also be tested for nitrate. The ILRP domestic well monitoring efforts are newly underway and neither results and well locations related to this monitoring are available at the time of preparation of this report. **Appendix 2.E** includes a map presenting the well locations, monitoring programs, and most recent monitoring date for historical groundwater quality monitoring conducted in the Subbasin.

The Madera Subbasin is identified as a Priority 2 Area for nitrate control efforts to be required under the Nitrate Control Program included in the Basin Plan Amendment approved by the RWQCB in May 2018 and in the process of undergoing approval by the SWRCB (anticipated Summer or Fall 2019). After adoption of the Basin Plan Amendment, the RWQCB is expected to begin issuing notices to comply to Priority 2 areas within two to four years, which once issued will start the clock on requirements of the Nitrate

Control Program. As a requirement of the Nitrate Control Program, dischargers in the Madera Subbasin will need to develop an approach to ensure shallow groundwater is protected. The Nitrate Control Program requires development of Early Action Plans in areas where nitrate discharges to groundwater may be impacting public drinking water supplies. Once in effect, it is expected that the Nitrate Control Program will include considerable analysis and/or monitoring of groundwater quality conditions and development of actions to address groundwater quality impacts from nitrate discharges.

Land Subsidence Monitoring

Land subsidence monitoring has been conducted by various agencies including USGS, DWR, USBR, USACE, San Luis & Delta-Mendota Water Authority (SLDMWA), Central California Irrigation District (CCID), California Department of Transportation (Caltrans), National Geodetic Survey (NGS), UNAVCO, and others (MRGMP, 2014). A key ongoing subsidence program is conducted by USBR in conjunction with DWR, USGS, and USACE, which collects and publishes subsidence data twice per year as part of the SJRRP. **Appendix 2.E** includes a map presenting the monitoring sites and most recent monitoring data for historical land subsidence monitoring conducted in the Subbasin and the surrounding vicinity. Additionally, through remote sensing and similar data acquisition methods such as InSAR, maps of periodic snapshots of spatial distribution of land subsidence have been historically generated including by DWR, USGS, and The Jet Propulsion Laboratory (JPL). The frequency of such land subsidence mapping efforts has been variable but has increased in frequency and regularity since 2010 and are anticipated to continue in the future.

2.1.2.4 Conjunctive Use Programs

To support overall water management objectives, water distributors in the Madera Subbasin strategically manage their conjunctive use of surface and groundwater supplies.

MID receives surface water supplies from Millerton Reservoir (along Madera Canal) and Hensley Lake (along Fresno River). MID can also deliver or wheel water to MWD, RCWD, GFWD, City of Madera and Madera County. The districts practice conjunctive use of these surface water supplies through policies to encourage grower use of surface water when available. Additionally, some growers along the San Joaquin River, the Chowchilla and Eastside Bypass, and the Fresno River exercise surface water rights when sufficient supply is available. These combined practices reduce groundwater pumping and increase groundwater recharge in wet years providing increased groundwater supplies available for use by private or district-operated groundwater wells in dry years. For growers, the historical advantages of groundwater perceived are many and include greater flexibility in providing water for frost protection, chemigation, and fertigation and to better align irrigations with crop water demands, field activities, and harvest. Because of these many perceived advantages, policies encouraging surface water use when the water is available are important. Irrigation by surface water supplies provides the advantage of in-lieu recharge of groundwater, and brings an additional resource into the Basin to help meet crop water demands.

The City of Madera relies on groundwater for municipal and industrial uses within the City limits. Irrigated agriculture within the City limits also generally relies on groundwater pumped through private wells. The City's potable water system includes 19 wells with completion depths between 300 and 700 feet, with a total capacity of approximately 27,000 gallons per minute (gpm) to serve approximately 13,500 connections.[31] Some City agricultural users also receive surface water supplies from MID in areas surrounding the City within the bounds of MID.

[31] Madera Regional Groundwater Management Plan, December 2014. Pg. 131.

Conjunctive use programs in the Subbasin include the indirect reuse and recharge of treated wastewater and/or stormwater in City of Madera and Madera County.

In addition to encouraging growers to use surface water when available, MID utilizes a number of basins to provide groundwater recharge from captured stormwater and flood water.[32]

Madera County and MID also have an MOU to use Ellis Basin for groundwater recharge. The facility was used to recharge approximately 800 af in 2017/2018.

The City of Madera conducted a pilot study of groundwater recharge in 2009 using 300 af of floodwater purchased from MID.[33] The City also maintains stormwater recharge facilities, several of which are linked to MID irrigation distribution facilities[34]. The City of Madera and MID partnered in connecting one of the City's storm drain basins to the MID delivery system in late 2018. MID directed approximately 50 af into the basins in 2019.

The City of Madera Wastewater Treatment Plant receives and treats over five million gallons of wastewater per day, on average, and releases treated wastewater to fourteen 20-acre ponds. In Madera County, effluent from several small sewer systems is also disposed through evaporation ponds and/or spray fields. Implementation of proposed recovery wells for utilizing this water has met regulatory challenges.[35]

2.1.3 Land Use Elements or Topic Categories of Applicable General Plans (23 CCR § 354.8 (f))

The Madera Subbasin lies entirely within Madera County and the Madera County General Plan is applicable. Additionally, the City of Madera General Plan is applicable to land in the CM GSA, defined by boundaries of City of Madera.

Implementation of this Joint GSP will support the goals and policies established in these plans, consistent with SGMA and GSP regulations. Development and implementation of this Joint GSP has and will continue to consider the interests of the beneficial uses and users of groundwater, including agricultural water users, municipal water users, disadvantaged communities (DACs), interconnected surface water (ISW) habitats, groundwater dependent ecosystems (GDEs), and other stakeholders.

2.1.3.1 Madera County General Plan

In the Madera County General Plan updated in 2015[36], Madera County affirms its general land use policies to designate sufficient land for projected population growth in Madera County (Policy 1.A.2), but plans for this growth through higher-density, or infill, development in existing communities and "designated new growth areas" to minimize urban encroachment into agricultural lands and other open spaces and to consolidate infrastructure expansion (Policies 1.A.3-4, 1.B.2, 1.C.2). Furthermore, Madera County restricts development in "areas with sensitive environmental resources" (Policy 1.A.5).

With regard to agricultural land, Madera County maintains policies to encourage water conservation, re-use of reclaimed water, soil conservation practices, land improvement programs, and enrollment of agricultural land in the Williamson Act program (Policies 3.C.11-12; 5.A.6-8,12).

[32] Madera Regional Groundwater Management Plan, December 2014. Pg. 134.
[33] Madera Integrated Regional Water Management Plan, February 2015. Pg. 3-16.
[34] Madera Regional Groundwater Management Plan, December 2014. Pg. 131.
[35] Madera Regional Groundwater Management Plan, December 2014. Pg. 132-133.
[36] Madera County General, Plan Policy Document Adopted October 1995, housing element updated November 2015.

County policies regarding domestic water supply are summarized in Section 3.C (Policies 3.C.1-10). The county has policies that limit new development unless an adequate water supply is demonstrated, require supplies serving new development to meet state water quality standards, and limit development in areas with severe water table depression to uses without high water usage or to uses served by surface water supplies.

County policies regarding water resources are summarized in Section 5.C (Policies 5.C.1-9). Madera County's policies are to "protect and preserve areas with groundwater recharge capabilities" (Policy 5.C.1), minimize groundwater overdraft by utilizing surface water for urban and agricultural use where available, and support the policies of the San Joaquin River Parkway Plan (SJRPR), including maintaining a wildlife corridor along the San Joaquin River between Friant Dam and Highway 145 (Policy 5.E.11).

County policies regarding wetland and riparian areas are summarized in Section 5.D (Policies 5.D.1-8), and policies regarding fish and wildlife habitat are summarized in Section 5.E (Policies 5.E.1-11). Madera County supports the protection of "critical nesting and foraging areas, important spawning grounds, migratory routes, waterfowl resting areas, oak woodlands, wildlife movement corridors, and other unique wildlife habitats critical to protecting and sustaining wildlife populations" (Policy 5.E.1), and complies with the wetlands policies of the U.S. Army Corps of Engineers, the U.S. Fish and Wildlife Service, and the California Department of Fish and Wildlife to ensure that appropriate mitigation measures and the concerns of these agencies are adequately addressed (Policy 5.D.1).County policies regarding natural vegetation and open spaces are summarized in Section 5.F (Policies 5.F.1-8) and Section 5.H (Policies 5.H.1-5). Madera County supports the preservation of natural vegetation, land forms, and resources as open space, with permanent protection where feasible (Policy 5.H.1). Madera County also supports the preservation and protection of outstanding areas of natural vegetation (including, but not limited to, riparian areas) as well as rare, threatened, and endangered plant species (Policies 5.F.3,5).

Implementation Effects on Water Demands and Sustainability

Implementation of proposed land use developments under this general plan is not expected to shift water demands because the county has a net zero ordinance that requires developers to bring in enough water supply for the development such that it does not increase demand.

Implementation of the general plan's policies to restrict development in "areas with sensitive environmental resources" and to support preservation of natural resources provides for the protection of wetlands, aquatic resources, and other ISW habitats and GDEs. This Joint GSP supports these policies by identifying and considering the effects of GSP implementation on groundwater-surface water interactions (Section 2.2.2.5) and GDEs (Section 2.2.2.6, **Appendix 2.B**) in the Madera Subbasin. Consistent with GSP regulations, the minimum thresholds (MTs) established by this Joint GSP and the measurable objectives (MOs) monitored throughout GSP implementation will confirm the protection of wetlands, aquatic resources, and other GDEs and ISW habitats identified in the Subbasin

GSP Implementation Effects on Water Supply Assumptions

Implementation of the GSP will require the Madera Subbasin to be operated within its sustainable yield by 2040, which will include restrictions on groundwater pumping and implementation of projects to increase groundwater recharge. However, urban water use has historically represented a small fraction of all water consumption in the Subbasin and is unlikely to be as significantly affected as agricultural water use. Furthermore, some of this urban development is expected on agricultural land and will lower water use requirements. New development and retrofitted landscape water efficiency standards are governed by the Model Water Efficient Landscape Ordinance (MWELO). The MWELO increases water efficiency standards for new and retrofitted landscapes by encouraging more efficient irrigation systems, graywater usage, and onsite storm water capture, and by limiting the portion of landscapes that can be covered in

turf. Studies and reviews by Olmos and Loge (2013), Englehardt et al. (2016), and Loux et al. (2012) support the feasibility of achieving these standards through adoption of such water conservation measures in California and elsewhere, particularly when considered in early planning stages of developments.

Generally, implementation of policies related to agricultural land, water supply, water resources, wetlands, riparian areas, natural vegetation, and open spaces are in alignment with GSP planning efforts and are expected to support achievement of Subbasin sustainability.

2.1.3.2 City of Madera General Plan

In the City of Madera General Plan adopted in October 2009[37], City of Madera establishes several core principles, including that: (1) future development should be more compact and accommodate higher-density urban growth, (2) the Fresno River should be incorporated as a major feature in future development, and that (3) agricultural land outside of planned urban development areas should be protected.

In the plan, City of Madera identifies approximately 12,500 acres of agricultural land within the city's planned growth boundary. Of this, approximately 1,500 acres were within the 2015 city limits. This growth boundary is considered the physical limits of development in City of Madera (Policy LU-10). Lands within this boundary are eligible for rezoning to be consistent with planned land use, including rezoning of some agricultural land to other uses (Policy LU-1,3,32). The plan prioritizes residential infill development to reduce the rate of agricultural land conversion (Policy LU-40) but allows for lands within the growth boundary to eventually shift toward primarily residential and commercial uses, with scattered public open spaces (Policy LU-1).

However, the City of Madera plans for a greenbelt of lands classified as "Resource Conservation/Agriculture" (designated to remain agricultural land) outside the growth boundary, with a permanent greenbelt segment along the City's western edge, and "encourages the use of Williamson Act contracts and similar mechanisms to ensure the maintenance of the greenbelt" in the future (Policy LU-11,30).

Implementation Effects on Water Demands and Sustainability

Similar to the Madera County General Plan, implementation of proposed land use developments under the City of Madera General Plan is expected to reduce water demands because new developments are required to follow the MWELO.

GSP Implementation Effects on Water Supply Assumptions

Implementation of the GSP will require the Madera Subbasin to be operated within its sustainable yield by 2040, which will include restrictions on groundwater pumping and implementation of projects to increase groundwater recharge. Because the City of Madera only relies on groundwater, expanding its service as population grows will result in more groundwater use by the City. However, urban development would extend primarily into agricultural lands, which also consume significant groundwater resources. Thus, water use requirements will actually decrease under the plan, benefitting Subbasin sustainability.

Implementation of the GSP will also provide for recharge projects to achieve Subbasin sustainability. The City of Madera has opportunities for recharge, which will benefit sustainability and help to offset potential increases in water use associated with urban development.

[37] City of Madera General Plan, Adopted October 7, 2009.

2.1.3.3 Permitting Process for Wells in Madera Subbasin

Within Madera County, including the entire Madera Subbasin, the Madera County Environmental Health Division is entrusted with all permitting and enforcement for the construction, reconstruction, and destruction of wells. Wells under their oversight include, but are not limited to, agricultural wells, observation/monitoring wells, community water supply wells, and individual domestic water supply wells.

The application process for Water Well Permits is handled online through the Madera County Permits Online website: https://www.maderacounty.com/services/county-permits-online. This site allows parties to apply for a permit, submit plans, remit payment, and monitor the status of their permit. Annular seal appointments are scheduled by contacting the Madera County Water Wells Permitting Program by phone.

Madera County Environmental Health Division restricts work on all water wells to be performed only by those possessing an active C-57 Water Well Contractors License. Destruction of wells within City of Madera are handled by the City of Madera Building Department.

Pursuant to Senate Bill (SB) 252, the Madera County Environmental Health Division will begin posting all new well applications for public review beginning in 2020 on their website: https://www.maderacounty.com/government/community-economic-development-department/divisions/environmental-health/water-well-program.

GSAs in the Madera Subbasin will work with the county to ensure that future well permitting aligns with the Subbasin sustainability goal established under this Joint GSP. In alignment with the findings of California's Third Appellate District, future well permitting will also align with the requirement that counties consider the potential impacts of groundwater withdrawals on public trust resources when permitting new wells near streams with public trust uses. Furthermore, future well permitting processes will consider and address permitting steps required by local or state law or other orders.

2.1.3.4 Effects of Land Use Plans Outside Subbasin

Outside the Madera Subbasin, other land use plans have been developed as part of the general plans for Merced County and City of Chowchilla to the north and the City of Fresno to the south. These general plans are similar in scope to the Madera County and City of Madera General Plans described above.

The subbasins underlying Merced County, City of Chowchilla, and City of Fresno have also been identified by DWR as critically overdrafted and are also required to prepare and be managed under a GSP by January 31, 2020 (CWC § 10720.7(a)(1)). As such, future land use changes in these jurisdictions will also need to be managed to achieve sustainability in the subbasins adjacent to Madera Subbasin. As long as these subbasins are managed to achieve sustainability, these land use plans are not expected to affect the ability of Madera Subbasin GSAs to achieve sustainable groundwater management.

2.1.4 Additional GSP Elements (23 CCR § 354.8 (g))

There are various GSP elements to be addressed in this subsection of the GSP as described below. In some cases, the related information is provided elsewhere in the GSP and the section where the information is provided is noted. In other cases, additional information is provided below.

2.1.4.1 Control of Saline Water Intrusion

Seawater intrusion is not applicable to the Madera Subbasin as explained in Section 3.2.6. It should also be noted that the Lower Aquifer in the Subbasin is underlain by brackish water below the base of fresh water as described in Section 2.2.1.2. Upward movement of brackish water from greater depths has not been a reported problem historically or currently, but excessive pumping from the lowermost coarse-

grained layers (should it occur in the future) may have the potential to cause such upward migration of brackish water in the future. The Madera Regional Groundwater Management Plan (MRGMP) (Provost & Pritchard, Wood Rodgers, KDSA, 2014), which includes most of the Plan Area, lists no existing activities, but did include the following planning activities: 1) amend County well standards for new well designs to ensure proper sealing of test holes that penetrate below the known base of fresh water; 2) amend County well standards to require exploratory test holes to be sealed with approved materials from total depth to ground surface; and 3) use well permitting process to require use of borehole geophysical surveys in all new boreholes that have potential to penetrate the base of fresh water, which would enhance groundwater protection by aiding in the current and future design of well seals to help prevent upward migration of brackish water.

2.1.4.2 Wellhead Protection

Wellhead protection refers to both the immediate location of the well in terms of well and pump station design features (e.g., well pad, annual seal) and the broader area surrounding the well. As noted in the MRGMP, a wellhead protection area is the area surrounding a public water supply well through which contaminants are reasonably able to move towards the well (i.e., the recharge area that provides water to the well).

The Madera County and City of Madera well ordinances do not specifically address wellhead protection, but do include requirements related to placement of annual seals. The MRGMP lists existing activities as: design new wells with appropriate wellhead protection features. The MRGMP lists planned actions as: 1) manage potential sources of contamination to minimize threat to drinking water sources; 2) develop contingency plan to prepare for emergency well closing and to plan for future water supply needs; 3) encourage establishment of wellhead project areas for non-municipal wells; and 4) develop more detailed wellhead protection standards for Madera County and City of Madera.

2.1.4.3 Migration of Contaminated Groundwater

Migration of contaminated groundwater can occur through improperly constructed wells, which can become conduits for vertical flow of poor quality water between aquifers. Inadequate surface sanitary seals can allow downward migration of contaminants from ground surface into the well structure and ultimately the aquifers screened by the well. Abandoned and improperly destroyed wells are also potential conduits for migration of contaminants in the subsurface. There are also numerous types of facilities and land uses that can be potential sources of chemical constituents that migrate down through the vadose zone and into aquifers with subsequent migration to pumping wells.

The MRGMP describes the main sources of information related to groundwater contamination including: the California Water Resources Control Board (SWRCB), the Department of Toxic Substance Control (DTSC), and the Groundwater Ambient Monitoring and Assessment Program (GAMA). The MRGMP describes related existing activities as including: 1) current County regulation for new well construction permitting that requires sanitary/annular seal depths sufficient to avoid creating conduit for contamination of shallow groundwater or co-mingling of aquifers with different water quality; and 2) current County regulation to properly abandon existing wells when connecting to a municipal water system. Planned actions listed in the MRGMP included: 1) review online databases for existing plumes and ensure that existing and new well operations do not induce downward migration of contaminants; 2) during new well construction permitting - require sanitary/annular seal depths sufficient to avoid creating conduit for downward migration of shallow groundwater contamination or co-mingling of aquifers with different water quality; 3) design a well abandonment program to identify abandoned wells and develop plans to properly destroy wells.

2.1.4.4 Well Abandonment and Well Destruction Program

An existing Madera County ordinance and state law require proper abandonment of wells. Madera County is responsible for administration and enforcement of the well ordinance, and oversees well abandonment in the Subbasin, including within cities, irrigation districts, water districts, and private wells. Wells are required to be abandoned in accordance with State standards as delineated in Water Well Standards (DWR, 1981). The County requires that a property owner properly destroy any abandoned or unused wells prior to permitting construction of a new well (unless it is determined the well is appropriate for use as a monitoring well). In addition, the City of Madera requires that existing wells be destroyed per requirements of County Environmental Health Department standards prior to connecting to the City municipal water system (MRGMP, 2014). The MRGMP lists existing related activities as encouraging property owners to abandon wells in accordance with County and State standards. Planned actions listed in the MRGMP included: 1) outreach and education for property owners about well abandonment standards and proper conversion of abandoned wells to monitoring wells; 2) conduct inventory of unused/abandoned wells to identify wells for abandonment or conversion to monitoring wells; and 3) emphasize and promote to the extent possible the conversion of production wells to monitoring wells when appropriate.

2.1.4.5 Replenishment of Groundwater Extractions

The replenishment of groundwater extractions occurs through various forms of recharge. The types and amounts of historical and current recharge are described in detail in Section 2.2.3 (Water Budget Information), and future estimates of recharge are detailed in **Appendix 6.D** (Groundwater Model Documentation). Future replenishment for groundwater extractions that will occur with implementation of PMAs for this Joint GSP are described in detail in Chapter 4.

2.1.4.6 Conjunctive Use and Underground Storage

Historic and current conjunctive use operations in the Plan Area have primarily been conducted by Madera Irrigation District. MID's activities and other Subbasin conjunctive use activities are described in more detail in Section 2.1.2.4 (Conjunctive Use Programs). There have also been recent efforts by Madera Irrigation District, along with some private landowners, to conduct recharge for underground storage during wet years in 2016-17 and 2018-19, and the County and City have both recently partnered with MID to pilot mutually beneficial recharge projects. Planned future conjunctive use and underground storage operations are described in detail in Chapter 4, and simulated by the groundwater model as described in **Appendix 6.D.**

2.1.4.7 Well Construction Policies

Well construction policies are described in Section 2.1.3.3 (Well Permitting Process for Wells in Madera Subbasin).

2.1.4.8 Groundwater Contamination Cleanup, Recharge, Diversions to Storage, Conservation, Water Recycling, and Extraction Projects

Monitoring and remediation of pre-existing and historical groundwater contamination areas are primarily being addressed by various regulatory programs under the RWQCB and DTSC. Various types of projects (e.g., recharge, extraction, diversions) are described in Section 2.2.3 Water Budget Information) and in the Chapter 4 discussion of PMAs. There are no significant water recycling projects in the Plan Area, because such projects are generally not feasible in sparsely populated areas that dominate in Madera Subbasin. Water conservation projects are covered under Section 2.1.4.9 (Efficient Water Management Practices) below.

2.1.4.9 Efficient Water Management Practices

Water conservation and efficient water management practices are described in Section 2.1.3 (Land Use Elements or Topic Categories in Applicable General Plans). In addition, agricultural irrigation practices have been evolving towards use of more efficient irrigation methods such as drip irrigation and decreased use of less efficient methods such as flood irrigation.

2.1.4.10 Relationships with State and Federal Agencies

The GSAs in the Plan Area have relationships with a number of State and Federal agencies related to surface water supply, water quality, and water management. Madera Irrigation District obtains a portion of its surface water supply from Millerton Lake/Friant Dam via Madera Canal; Friant Dam is owned and operated by the United States Bureau of Reclamation (USBR). The County holds a contract with USBR for water from Millerton/Friant Dam. The USBR is also the lead agency for the San Joaquin River Restoration Project (SJRRP), which establishes instream flow requirements along the San Joaquin River between Friant Dam and the Merced River to support the life-stages of salmon and other fish species, and consequently requires current and future reductions in surface water diversions for irrigation.[38] The GSAs also apply for and occasionally receive grants from various State/Federal agencies for water-related projects; a current grant being implemented is drilling of several new monitoring wells in the Subbasin to provide better definition of Subbasin geology, water levels, and water quality; and for ultimate incorporation in the GSP monitoring network. The State Regional Water Quality Control Board (RWQCB) provides oversight of contaminant sites within the Subbasin, the Irrigated Lands Regulatory Program, and is considering potential adoption of a Basin Plan amendment related to salt and nutrient management issues. There are many other important GSA relationships with Federal/State agencies, some of which are described throughout this Joint GSP, including in Chapter 5 (Plan Implementation).

2.1.4.11 Land Use Plans and Efforts to Address Potential Risks to Groundwater Quality and Quantify

Land use plans are described in Section 2.1.3 (Land Use Elements or Topic Categories in Applicable General Plans).

2.1.4.12 Impacts on Groundwater Dependent Ecosystems

Potential impacts to groundwater dependent ecosystems (GDEs) are described in detail in various sections in Chapters 2 and 3, and in **Appendix 2.B**.

2.1.5 Notice and Communication (23 CCR § 354.10)

2.1.5.1 Overview

California's Sustainable Groundwater Management Act (SGMA) of 2014 requires broad and diverse stakeholder involvement in GSA activities and the development and implementation of GSPs for 127 groundwater basins around the state, including the Madera Subbasin. The intent of SGMA is to ensure successful, sustainable management of groundwater resources at the local level. Success will require

[38] The SJRRP develops Allocations and Default Flow Schedules to identify the annual volume of Restoration Flows available. Each year, the amount of water available for the SJRRP – the Restoration Allocation – is adjusted, often many times, between the date of the initial allocation and the final allocation, based on the hydrologic conditions. In May 2019, a Restoration Allocation of over 556,5000 thousand acre-feet (TAF), as measured at Gravelly Ford (GRF), was calculated by Reclamation using the 50% exceedance forecast. For more information, see: http://www.restoresjr.net/restoration-flows/flow-schedule/.

cooperation by all stakeholders, and cooperation is far more likely if stakeholders have consistent messaging of valid information and are provided with opportunities to help shape the path forward.

To facilitate stakeholder involvement in the GSA process, a Stakeholder Communication and Engagement Plan (**Appendix 2.C.a**) was created for the GSAs in the Madera Subbasin to:

- Provide GSAs, community leaders, and other beneficial users a roadmap to follow to ensure consistent messaging of SGMA requirements and related Madera Subbasin information and data.
- Provide a roadmap to GSAs, community leaders, and other beneficial users to ensure stakeholders have meaningful input into GSA decision-making, including GSP development.
- Ensure the roadmap demonstrates a process that is widely seen by stakeholders as fair and respectful to the range of interested parties.
- Make transparent to stakeholders their opportunities to contribute to the development of a GSP that can effectively address groundwater management within the Madera Subbasin.
- Ensure that information reaches all beneficial users who have an interest in the Basin.

This plan was originally developed in June 2018 and has been updated several times since then.

2.1.5.2 Description of Beneficial Uses and Users in the Basin

Under the requirements of SGMA, all beneficial uses and users of groundwater must be considered in the development of GSPs, and GSAs must encourage the active involvement of diverse social, cultural, and economic elements of the population. Beneficial users, therefore, are any stakeholders who have an interest in groundwater use and management in the Madera Subbasin community. Their interest may be related to GSA activities, GSP development and implementation, and/or water access and management in general.

To assist in identifying categories of beneficial uses and users in the Madera Subbasin, the Communications and Engagement Plan included a Stakeholder Engagement chart (Table 2-5).

2.1.5.3 Communications

Decision-making Processes

As noted above, the Madera Subbasin is divided among seven GSAs for GSP development. Four of the GSAs have jointly developed this coordinated Joint GSP (CM, MC, MID, MWD), while the remaining three GSAs have prepared individual GSPs (GFWD, NSWD, RCWD).

GSA Boards are the final decision-makers for the Madera Subbasin. To assist in GSP development, the GSAs convened a Technical Experts Committee made up of technical experts associated with the various Subbasin GSAs, which met many times over the course of the planning process. In addition to coordinating between the GSAs, the Technical Experts Committee developed recommendations for GSP development which were presented to the GSA boards in public meetings as well as at Subbasin-wide public meetings.

Table 2-5. Stakeholder Engagement Chart for GSP Development

Category of Interest	Examples of Stakeholder Groups [39]	Engagement purpose
General Public	• Citizens groups • Community leaders	Inform to improve public awareness of sustainable groundwater management
Land Use	• Municipalities (City, County planning departments) • Regional land use agencies	Consult and involve to ensure land use policies are supporting GSPs
Private Users	• Private pumpers (domestic and agricultural) • Domestic users • Schools and colleges • Hospitals	Inform and involve in assessing impacts to users
Urban/ Agricultural Users	• Water agencies • Irrigation districts • Municipal water companies • Resource conservation districts • Farmers/Farm bureaus	Collaborate to ensure sustainable management of groundwater
Industrial Users	• Commercial and industrial self-supplier • Local trade association or group	Inform and involve in assessing impacts to users
Environmental and Ecosystem Uses	• Federal and State agencies: CA Dept. of Fish and Wildlife • Environmental groups: The Nature Conservancy, Audubon California, American Rivers, Clean Water Action/Clean Water Fund	Inform and involve to consider/incorporate potential ecosystem impacts to GSP process
Economic Development	• Chambers of commerce • Business groups/associations • Elected officials (Board of Supervisors, City Council) • State Assembly members • State Senators	Inform and involve to support a stable economy
Human Right to Water	• Disadvantaged communities: Fairmead Community and Friends, La Vina Residents, Líderes Campesinas, etc. • Small water systems • Environmental justice groups/community-based organizations: Leadership Council for Justice and Accountability, Self-Help Enterprises, Community Water Center, etc.	Inform and involve to provide safe and secure groundwater supplies to all communities reliant on groundwater
Tribes	Federally Recognized Tribes and non-Federally Recognized Tribes with lands or potential interests in Madera Subbasin: • North Fork Rancheria of Mono Indians of California • Picayune Rancheria of Chukchansi Indians • North Fork Band of Mono Indians	Inform, involve and consult with tribal government
Federal Lands	• Bureau of Reclamation (USBR) • Bureau of Land Management	Inform, involve and collaborate to ensure basin sustainability
Integrated Water Management	• Regional water management groups (IRWM regions) • Flood agencies • Recycled water coalition	Inform, involve and collaborate to improve regional sustainability

[39] The groups and communities referenced are examples identified during initial assessment. GSA Interested Parties lists shall maintain current and more exhaustive lists of stakeholders fitting into these groups.

Public Engagement Opportunities

There were a number of different meetings at which the public had the opportunity to engage during the GSP development process:

- **GSA meetings**: Each of the seven[40] GSAs in the Madera Subbasin held regular public meetings, generally on a monthly schedule and in many cases in conjunction with standing board meetings.
- **Coordination Committee meetings:** The intent of the Coordination Committee was to provide a forum to GSAs to share perspectives and participate in review and discussion of elements for GSP development. The Coordination Committee membership included representatives from each of the coordinating GSAs and meetings were often attended by representatives from the other GSAs in the Subbasin.
- **Subbasin-wide technical workshops:** Subbasin-wide public workshops were held throughout the GSP development process to provide opportunities for the public to learn about the SGMA process and GSP components, receive updates about GSP planning activities, and provide input on GSP development. These "technical workshops" often included presentations by the GSP preparation consultants about technical aspects of GSP preparation, on topics such as basin setting, water budgets, and undesirable results. Subbasin-wide public workshops were held in varied locations and at varied hours in order to encourage participation by a wide range of stakeholders. Spanish translation was available at Subbasin-wide workshops. Numerous Subbasin-wide meetings were live-streamed, and summaries of the meetings were posted online so that anyone unable to attend the meeting in person could remain informed about the GSP.
- **County Advisory Committee**: The Madera County GSA was supported by an advisory committee which consisted of members from different demographic groups and communities, including DAC representatives. The Advisory Committee provided feedback on GSP development to the board of the Madera County GSA as well as relaying information back to the communities to which the committee members belong. The County Advisory Committee met quarterly in 2018 and bi-monthly in 2019.
- **MID Groundwater Committee**: MID GSA was supported by a groundwater committee comprised of two MID Board Members. The MID Groundwater Committee was utilized to provide input and recommendations to the MID Board of Directors and the MID GSA on matters pertaining to the GSA and GSP planning process. The MID Groundwater Committee meetings were scheduled as needed in 2017-2019.

Figure 2-8 describes the GSP process steps, including topic development, technical review, and public meetings both at the Subbasin and individual level:

[40] All GSAs held public meetings, including the four Joint GSP GSAs that have developed this coordinated Joint GSP and the three GSAs that have developed individual GSPs.

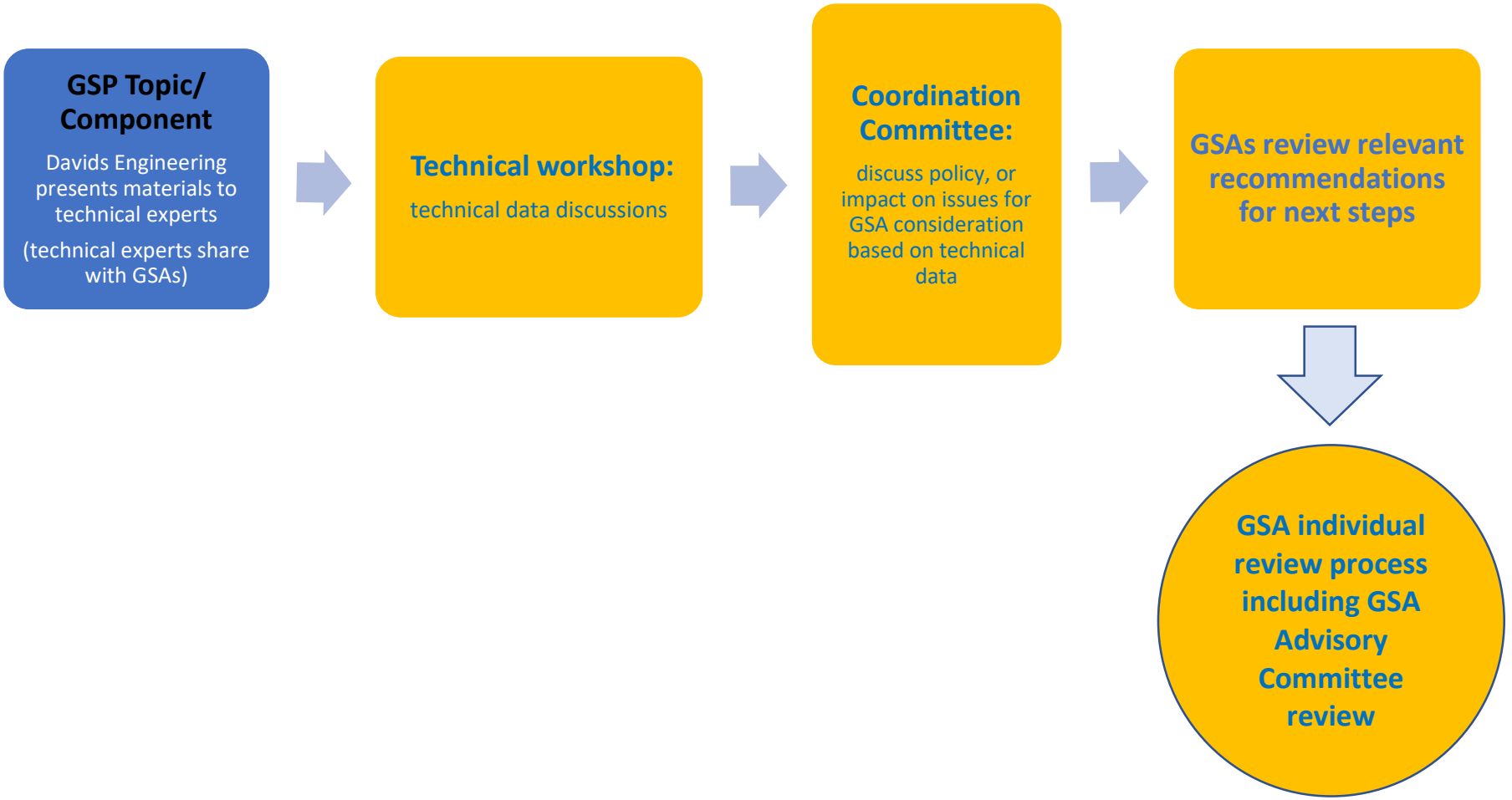


Figure 2-8. Plan Development Sequence (public meetings in yellow)

Encouraging Active Involvement

There were also activities related to encouraging involvement and building capacity for engagement. Madera County worked with Self-Help Enterprises (SHE) and the Leadership Counsel for Justice (LCJA) and Accountability, organizations that represent DAC communities, to inform DAC members about the plan and encourage their involvement. LCJA and SHE were also consulted to help determine how to participate by DAC members in outreach activities, for example by holding workshops at different times or locations. The following activities were organized in coordination with Self-Help Enterprises and the Leadership Counsel for Justice and Accountability:

- **Capacity-building workshops**: Workshops encouraged and prepared community members to participate in GSP development by providing technical information as well as information about opportunities for engagement.
- **Pop-ups**: Information about SGMA and opportunities for engagement in Madera Subbasin GSP preparation were provided through pop-up information stations in locations such as the Madera County Library to invite people to attend workshops and meetings.
- **Educational tours**: Tours provided members of the public with additional opportunities to hear about the concerns of people with differing perspectives. Tours included stops in the community of Fairmead, La Vina, a farm, and at a groundwater recharge basin.
- **Presentations in communities**: Self-Help Enterprises and the Leadership Counsel for Justice and Accountability both encouraged participation in GSP preparation through presentations held in communities around the Subbasin, including a visit by a Madera County representative.

In addition to the activities organized in coordination with Madera County, these two organizations also conducted further outreach and workshops in the communities they work in. LCJA and SHE each received grants between $750,000 to $1 million from the Department of Water Resources for outreach to promote meaningful participation of SDACs in groundwater sustainability activities in multiple subbasins in the state, including Madera Subbasin. Under the grants, they promoted community participation through community involvement, outreach, and technical assistance. The GSAs provided letters of support for SHE and LCJA's applications for this funding.

Soliciting Written Comments

In addition to soliciting feedback at GSA meetings, an opportunity was provided to offer written comments on the plan via an online comment form or letter. An informal comment period began when the draft of the first chapter of the GSP was released in April 2019, and an official 90-day comment period began on the date the full draft of the GSP was released, on August 9, 2019, and continued through November 9, 2019. In addition, a special Coordination Committee meeting was held on October 22, 2019 to solicit written comments. All comments received via the comment form or a letter were circulated to the GSAs.

The written comments and responses can be found in **Appendix 2.C.e.**

2.1.5.4 Informing the Public about GSP Development Progress

Interested Parties List

An email distribution list of Subbasin-wide stakeholders and beneficial users was developed for outreach throughout the GSP planning process. The list was maintained and updated by the County of Madera and is included in **Appendix 2.C.b**. In many cases, information was distributed in both English and Spanish. Any interested member of the public could be added to the list by signing up via the Madera County website: https://www.maderacountywater.com/join-list/.

Distribution of Flyers

Typically, before a public meeting in the Madera Subbasin, a flyer was created with key information provided in both English and Spanish. The flyer was emailed out to the Interested Party list as well as to the GSAs for electronic distribution. The flyer was also handed out at GSA meetings, other public meetings and pop-up events (Figure 2-9).

Press Outreach

Press releases were issued at key junctures and decision-making points for the Madera Subbasin, which included the execution of the Proposition 1 grant agreement, which funded the GSP development and groundwater monitoring wells, the release of Chapter One of the Madera Joint GSP.

Social Media

Information about the GSP development process, including information about public meetings, has been provided via social media. (See **Appendix 2.C** for details.)



Figure 2-9. GSA Public Event

A Centralized Madera Subbasin Website

Throughout the planning process (and beyond) the County has maintained a Subbasin website (http://www.maderacountywater.com) with information about Madera Subbasin-wide planning efforts related to SGMA.

The Madera Subbasin website contains:

- Calendar of public meetings and other events
- Information about past public meetings, including relevant meeting materials

- Links to external sites (e.g., Department of Water Resources SGMA portal) and other resources such as white papers
- Links to the websites of the other Madera Subbasin GSAs
- Information about the County GSAs and Advisory Committee
- GSP documents (Coordination Committee charter, technical memoranda, draft GSP documents)
- GSA fact sheets and Subbasin maps

Engagement Matrix

The Engagement Matrix, in **Appendix 2.C.c**, provides details about the implementation of each of the communication methods outlined above. The matrix presents each communication strategy, as required by statute or laid out in the Madera Subbasin Communication and Engagement Plan, along with details about specific instances of that strategy. For example, each public GSP-related meeting is listed with information about the date, topic, and location of the meeting as well as how it was publicized, to whom it was targeted, what opportunities for feedback were provided, and who participated.

Stakeholder Input and Responses

The engagement opportunities described above provided various avenues for stakeholders to provide input on GSP development. The matrix in **Appendix 2.C.d** summarizes the public comments received, organized by type of water user, and outlines how this input influenced decision-making in GSP development.

Public Outreach During GSP Revision Process

During the GSP revision process in 2022-2023, the GSAs conducted further public outreach through public GSA governing body meetings and through public notices regarding the GSP revision process.

2.2 Basin Setting

2.2.1 Hydrogeologic Conceptual Model (23 CCR § 354.14)

A preliminary hydrogeologic conceptual model (HCM) was developed for the Madera Subbasin (DWR Subbasin No. 5-22.06) based on existing reports/data and published in a previous report (DE/LSCE, July 2017). Various aspects of the preliminary HCM were subsequently updated for GSP efforts, and are documented in this Joint GSP. Overall, this chapter of the GSP provides the updated HCM based on a combination of previous reports/data and recent updated analyses performed as part of GSP preparation efforts.

2.2.1.1 Regional Geologic and Structural Setting

The Madera Subbasin is generally comprised of relatively flat topography that slopes gently downward to the west. Topographic elevations vary from about 350 feet above mean sea level (MSL) in the east to about 150 feet above MSL in the west over a distance of about 20 miles (**Figure 2-10**). The major geomorphic features of the Subbasin are the alluvial fan and floodplain associated with sediment deposition from the Fresno and San Joaquin Rivers (Mitten et al., 1970). A map of hydrologic soil groups in Madera Subbasin is provided in **Figure 2-11**, and a map of soil saturated hydraulic conductivity (K_{sat}) is provided in **Figure 2-12** These maps indicate that soils with higher permeability and infiltration rates are present along river channels (Fresno River, Cottonwood Creek, and San Joaquin River) and west/south of the City of Madera (between the Fresno River and Cottonwood Creek). Another zone of higher soil permeability is present in the south central portion of the Subbasin between Cottonwood Creek and the San Joaquin River. It should be noted that these soil maps are relatively general in nature, and localized areas of higher permeability/infiltration capacity may exist in areas otherwise indicated to be low

permeability/infiltration capacity in these figures and vice versa. In addition, it is recognized that hard pan, which tends to greatly limit infiltration capacity, exists in many areas at depths typically in the range of 5 to 10 feet below ground surface. However, many areas with irrigated agricultural (particularly orchards) have constructed holes through the hard pan to facilitate proper drainage.

Surface geology maps are provided in **Figures 2-13 and 2-14**. The surficial geology of the Madera Subbasin is dominated by Younger and Older Alluvium (generally equivalent to Modesto, Riverbank, and Turlock Lake Formations), which are described in more detail below. Younger Alluvium is most prevalent along the Fresno and San Joaquin Rivers and in an area immediately south and west of the City of Madera.

The Preliminary HCM Report provided some existing geologic cross-sections distributed throughout the Subbasin, which varied considerably in quality and level of detail. In addition, new cross-sections were developed as part of GSP tasks performed subsequent to publication of the Preliminary HCM Report. The existing and new geologic cross-sections are further described in the section below (and in **Appendix 2.D**) on Major Aquifers/Aquitards.

The stratigraphy of the Madera Subbasin from the surface down is comprised primarily of Continental Deposits of Quaternary Age (Younger and Older Alluvium), Continental Deposits of Tertiary and Quaternary age, Marine and Continental sedimentary rocks, and crystalline basement rock. The Continental Deposits are unconsolidated, and underlying sedimentary and basement rocks are consolidated. It is uncertain if Mehrten and Ione Formation are present in the Madera Subbasin. Younger Alluvium is generally limited to 50 feet thickness and typically unsaturated. The Older Alluvium consists of up to 1,000 feet of interbedded clay, silt, sand, and gravel. Older Alluvium becomes finer-grained with depth and is underlain by the generally finer-grained Continental deposits of Tertiary and Quaternary age (Mitten et.al., 1970). The primary water bearing unit is Older Alluvium, although recent deeper drilling of agricultural wells is tapping into the underlying Continental Deposits of Tertiary/Quaternary age (Provost & Pritchard, 2014).

The Corcoran Clay occurs in the western portion of Madera Subbasin (**Figure 2-15**) within the upper portion of Older Alluvium (Mitten et al., 1970). The Corcoran Clay is also considered to be a member of the Turlock Lake Formation (Page, 1986). The depth to the top of the Corcoran Clay generally ranges from about 150 to 400 feet where present within Madera Subbasin (Provost & Pritchard, 2014). The Corcoran Clay is comprised of clay and silt ranging in thickness (**Figure 2-16**) from 10 feet at its eastern extent to 80 feet on the western edge of Madera County (Mitten et al., 1970).

2.2.1.2 Lateral and Vertical Subbasin Boundaries

The Madera Subbasin is bordered by the Sierra Nevada Mountains to the east, Kings Subbasin to south, Chowchilla Subbasin to the north, and Delta-Mendota Subbasin to the west (**Figure 2-17**). Bedrock to the east represents a hydrogeologic boundary, whereas the other three boundaries are political/agency boundaries across which groundwater flow can and does occur. There is a small amount of fractured bedrock groundwater inflow to Madera Subbasin on the east.

The base of fresh water was evaluated by Page (1973), and was defined in this study as including water with conductivity up to 3,000 micromhos/centimeter (umhos/cm). Overall, the base of freshwater was mapped as ranging approximately from elevation -400 to -1,200 feet msl within Madera Subbasin. In general, the shallowest depths to base of fresh water were along the western boundary of the Subbasin, and the greatest depths were areas located just north of the City of Madera in the eastern portion of the Subbasin (**Figure 2-18).** This base of fresh water mapped by Page should be considered approximate and might be expected to be slightly shallower, because fresh water is generally considered to have total dissolved solids of less the 1,000 milligrams/liter (mg/L) or conductivity of less than 1,600 umhos/cm. The base of fresh water will be refined over time as more data are collected, including lithologic, geophysical,

water level, and water quality data currently being collected as part of the 2019-2020 nested monitoring well program.

Maps of the depth to basement rock (**Figure 2-19**) and elevation of basement rock (**Figure 2-20**) show increasing depths (and decreasing elevations) to basement rock from northeast to southwest across the Subbasin. The depths to bedrock range from less than 500 feet (essentially zero at the eastern Subbasin boundary) to greater than 4,000 feet at the southwestern boundary of the Subbasin. In general, the aquifer base is controlled mostly by the base of fresh water provided in **Figure 2-18** except in the far eastern portions of the Subbasin. It should also be recognized that wells drilled and screened below the currently defined base of fresh water likely will still have a hydraulic connection with the overlying fresh water zone and are considered part of the Madera Subbasin.

2.2.1.3 Major Aquifers/Aquitards

Geologic cross-sections are a key element of the HCM required in a GSP under SGMA. Related work completed for this Joint GSP included review of existing literature to extract the available geologic cross-sections and construction of additional new geologic cross-sections based on data compiled for GSP efforts. This section of the GSP (and **Appendix 2.D**) provides a general description of the existing and new cross-sections, and documents the source of available existing geologic cross-sections along with details of how the new cross-sections were developed.

Existing Geologic Cross-Sections

The geologic cross-sections derived from previous reports are presented in **Appendix 2.D** and were described in a previous report (DE/LSCE, 2017). Two of these existing cross-sections are described below to provide overall regional context for the stratigraphy of the Subbasin (Davis et al.,1959; Page, 1986). The locations of these two existing geologic cross-sections are provided in **Figure 2-21**, and the individual cross-sections are provided in **Figures 2-22 and 2-23**. A summary of the two regional geologic cross-sections is provided below.

Davis' (1959) cross-section D-D' (**Figure 2-22**) runs from southwest to northeast through the center of the Madera Subbasin, and extends to a depth of about 800 feet below ground surface (bgs). The Corcoran Clay is indicated to be present at an approximate depth of 400 feet bgs at the western edge Madera County, with depth and thickness decreasing towards the northeast (to a depth of about 200 feet at the eastern edge of the clay layer). Sediments consist primarily of sands to sandy clay and silty clay to clay and shale. Layers of gravel are present in the upper 200 feet primarily in the center of Madera County.

Page (1986) cross-section B-B' (**Figure 2-23**) runs northwest to southeast through the western edge of the Madera Subbasin, and extends down to an elevation of 9,000 feet below mean sea level (msl). Within this portion of the Madera Subbasin, the Corcoran Clay is present throughout, at an elevation of approximately -200 feet msl. Thin deposits of Quaternary flood-plain deposits (Qb) are present at the surface, underlain by Quaternary continental rocks and deposits (QTcd). A layer of Tertiary marine rocks and deposits interfinger the QTcd layer. A layer of Pre-Tertiary and Tertiary continental and marine rocks and deposits underlies these units.

New Geologic Cross-Sections

New geologic cross-sections were developed during GSP preparation efforts utilizing data collected for the GSP. A location map for new geologic cross-sections is provided in **Figure 2-21**. The new geologic cross-sections include some that do not cross Madera Subbasin, but are included here because they occur within the Model Domain for the MCSim Model developed for Madera Subbasin. The CVHM well log dataset and DWR well log database developed for this project were reviewed to select logs for relatively deep wells that had fairly detailed descriptions of geologic units encountered. Locations for screened well

logs were plotted to selected representative well logs at a reasonable spacing along each geologic cross-section line.

New geologic cross-sections C-C', D-D', E-E', and F-F' (**Figures 2-26, 2-27, 2-28, and 2-29**) extend from southwest to northeast across Madera Subbasin towards (perpendicular to) the Sierra Nevada Mountains, with C-C' being furthest north and F-F' being furthest south. Each cross-section generally shows the ground surface, the lithology associated with each well log, the Spring 2014 unconfined groundwater level, the Corcoran Clay (from C2VSim), and the base of fresh water (from Page 1986). The well logs generally range from very close to section lines to one mile of offset from the section line. The cross-sections generally illustrate the interbedded and variable nature of fine- and coarse-grained sediments both laterally and vertically. In general terms, the cross-sections tend to show a greater percentage of coarse-grained sediments in the upper 200 to 400 feet (Upper Aquifer) as compared to greater depths (Lower Aquifer). This is particularly the case in the central to western portion of the cross-sections, as illustrated in D-D'. Overall, fine-grained sediments comprise a larger percentage of the subsurface than do coarse-grained sediments. Thus, it can be expected that vertical hydraulic conductivity (Kv) values will likely be orders of magnitude lower than horizontal hydraulic conductivity (Kh) values for a given aquifer. Geologic cross-sections C-C' through F-F' also illustrate the extent of Corcoran Clay is limited to the western portion of the Subbasin, although other clay layers are prominent throughout the Subbasin. New geologic cross-sections A-A' and B-B' (**Figures 2-24 and 2-25**) are included here but not described further as they do not cross Madera Subbasin.

New geologic cross-sections G-G' through K-K' (**Figures 2-30, 2-31, 2-32, 2-33, 2-34**) were constructed parallel to the Sierra Nevada Mountain front starting from the southwestern end of Madera Subbasin and progressing towards the northeast (i.e., cross-section G-G' furthest from and parallel to the Sierra Nevada Mountain front and K-K' is closest to the mountain front). These geologic cross-sections further demonstrate and confirm the features/characteristics described above for the cross-sections perpendicular the Sierra Nevada Mountains. In particular, this set of cross-sections illustrates that general trend of higher percentages of coarse-grained sediments in the upper 200 to 400 feet, and the variability in Page's (1986) map of base to freshwater. While it is challenging to reliably correlate coarse-grained units in these cross-sections, they do illustrate well the general distribution of coarse- and fine-grained sediments both laterally and vertically. The textural analysis described in a subsequent GSP chapter for input to the groundwater model attempts to capture the somewhat disconnected distribution of coarse-grained sediments reflected in the cross-sections.

Geologic Cross-Section Summary

The existing geologic cross-sections provided in Davis et al. (1959) and Page (1986) illustrate the vertical distribution of major geologic formations, but do not provide any detail on distribution of fine- and coarse-grained sediments of the major aquifer units. The new geologic cross-sections generally illustrate in a fairly detailed manner the lateral and vertical distribution of fine- and coarse-grained sediments throughout the Subbasin. It is apparent from these cross sections that the Upper Aquifer (generally the upper 200 to 400 feet) has a higher overall percentage of coarse-grained sediments compared to deeper intervals, although significant coarse-grained intervals are present to the full depths of most borings shown on the cross sections. These cross sections further demonstrate that Kv values are likely to be orders of magnitude less than Kh values.

Groundwater System Conceptualization

The Madera Subbasin is underlain by the Corcoran Clay over approximately the western one-third of the Subbasin area. The depth to top of Corcoran Clay varies from 100 to 150 feet at its northeastern extent to in excess of 300 feet in the southwestern portion of the Subbasin (**Figure 2-15**). Where the Corcoran Clay aquitard exists, the aquifer system is subdivided into an upper unconfined aquifer above the Corcoran

Clay and a lower confined aquifer below the Corcoran Clay (**Figure 2-35**). In the central and eastern portions of the Subbasin where the Corcoran Clay does not exist, the aquifer system is generally considered to be semi-confined with discontinuous clay layers interspersed with more permeable coarse-grained units (**Figure 2-35**). For discussion purposes, in the eastern part of the Subbasin, the semi-confined aquifer can be subdivided into an upper semi-confined aquifer and a lower semi-confined aquifer at a somewhat arbitrary depth that ranges from 200 to 400 feet bgs (generally corresponding to the depth of Corcoran Clay at its eastern extent).

In addition to the generally higher percentages of coarse-grained material in the Upper Aquifer, the available cross-sections described above and provided in **Appendix 2.D** generally indicate that approximately the upper 500 feet of the Lower Aquifer are comprised of a greater percentage of coarse-grained sediments as compared to deeper zones within the Lower Aquifer. Thus, it can be anticipated that most wells will obtain close to their maximum yield within approximately the upper 800 feet of sediments. The vast majority of water wells are constructed within the upper 1,000 feet because sediments generally become finer with depth and towards the center of the valley (Provost and Pritchard, 2014).

The general occurrence of higher percentages of coarse-grained sediments at shallower depths is further illustrated by the sediment texture model developed by the United States Geological Survey (USGS) for the Central Valley Hydrologic Model (CVHM). **Figures 2-36 and 2-37** illustrate the spatial distribution of coarse-grained sediments at 50-foot depth intervals from the ground surface to a total depth of 1,400 feet. These maps indicate percentages of coarse-grained sediments are noticeably greater in the upper 400 feet compared to deeper depths.

2.2.1.4 Aquifer Parameters

A detailed summary of aquifer parameter data derived from existing reports was presented in the Preliminary HCM and is included in **Appendix 2.D**. For Madera County as a whole, the Madera Regional Groundwater Management Plan indicates the Older Alluvium generally has transmissivity values ranging from about 20,000 to 250,000 gpd/ft. Well test data indicate that wells tapping a significant thickness of coarse-grained materials in the upper 500 feet tend to have the highest specific capacities. The underlying Continental Deposits are reported to have transmissivities ranging from 10,000 to 30,000 gpd/ft (Provost and Pritchard, 2014).

Specific yield (Sy) values for Madera County were evaluated in previous studies for use in groundwater storage change calculations (Provost and Pritchard, 2014; Todd, 2002). These county-wide studies used Sy values ranging from 0.10 to 0.13. A study specific to Madera Subbasin (DWR, 2004) cited a specific yield value of 0.104 for use in calculating total groundwater in storage. Given that sediments generally become finer grained with depth, it is possible that the Sy value from DWR (2004) being on the lower end of the county-wide range is due to evaluation of specific yield to a deeper depth than in the other studies.

As part of recent GSP efforts related to the HCM, DWR well completion reports (WCRs) were reviewed to obtain additional specific capacity data from various wells throughout Madera Subbasin and the greater model domain. The details of the specific wells, well construction data, and specific capacity data are summarized in **Appendix 2.D**. The specific capacity data were converted to transmissivity values based on methodology developed by Driscoll (1986). Maps of transmissivity (T) values were prepared for the Upper Aquifer (**Figure 2-38**), Lower Aquifer (**Figure 2-39**), and for composite wells screened in both aquifers (**Figure 2-40**). There are 14 transmissivity values displayed on the map for the Upper Aquifer (**Figure 2-38**) with seven of those wells in the central portion of the Subbasin, two wells in the northwestern part of the Subbasin, and five wells in the southwestern part of the Subbasin. Transmissivity values were quite variable ranging from 25,000 to greater than 100,000 gpd/ft in the central and northwestern Subbasin areas and from less than 25,000 to greater than 100,000 in the southwestern Subbasin area.

The transmissivity map for the Lower Aquifer (**Figure 2-39**) includes data for 33 wells with clusters of 8 wells in the central portion of the Subbasin, six wells in the north central Subbasin and 19 wells in the northeastern Subbasin area. All three cluster areas showed significant variability in estimated transmissivity values from less than 25,000 to greater than 100,000 gpd/ft. Relative to the Upper Aquifer, the proportion of wells with T greater than 100,000 gpd/ft is substantially less and the proportion of wells with T less than 25,000 is substantially greater.

The map of transmissivity values for 29 composite wells (**Figure 2-40**) shows wells scattered throughout the Subbasin, but most concentrated in the western, central, and southeastern portions of the Subbasin. Most transmissivity values are in the less than 25,000 to 50,000 gpd/ft range, with about 25% of wells having T values greater than 75,000 gpd/ft.

2.2.1.5 Recharge and Discharge Areas

Groundwater recharge can occur throughout the Madera Subbasin from infiltration of precipitation and applied water, streamflow percolation, and other sources.[41] However, some areas may provide greater potential for existing recharge and future managed recharge that may occur during GSP implementation. Areas with increased recharge potential were evaluated using soil mapping data and the Soil Agricultural Groundwater Banking Index (SAGBI) index. Soils data are evaluated for infiltration potential and categorized into one of four hydrologic groups with hydrologic group A having highest infiltration potential and hydrologic group D having lowest infiltration potential (**Figure 2-11**). The map of hydrologic soil groups shows the main areas with hydrologic group A soils located along and between Berenda and Dry Creeks, and along and between Fresno River and Cottonwood Creek. A relatively large area of hydrologic group A and B soils is located west and south of the City of Madera. There are also small areas of hydrologic group A soils in the southeastern portion of the Subbasin, along the San Joaquin River, and in the far western portion of the Subbasin.

Mapping of saturated soil vertical hydraulic conductivity (K) (**Figure 2-12**) shows a similar distribution of areas with higher infiltration potential as the soil hydrologic group map with a few slight differences. One difference is that about half of the large area hydrologic group A/B soils south and west of City of Madera is indicated to have relatively low soil vertical K of 0.6 to 1.0 feet/day. Also, a relatively large area comprised of hydrologic group C soils in the south central portion of the Subbasin is indicated to have vertical soil K of 1.1 to 2.0 feet/day.

The SAGBI provides a characterization of potential for groundwater recharge on agricultural land. The SAGBI index is based on five main factors: deep percolation, root zone residence time, topography, chemical limitations, and oil surface conditions. The unmodified (by tilling) SAGBI map (**Figure 2-41**) shows the main areas of high deep percolation potential as the region located south and west of the City of Madera, and along Berenda Creek and Fresno River. The modified SAGBI map (**Figure 2-42**) shows similar results as the unmodified SAGBI map with addition of a relatively large area in the western portion of Madera Subbasin.

Another mechanism of groundwater recharge is subsurface inflow from adjacent subbasins, including Kings and Delta Mendota Subbasins. Subsurface groundwater inflows (and outflows) were evaluated with the Subbasin groundwater model and are summarized in **Appendix 6.D.** Groundwater Model Documentation.

[41] Net subsurface inflows to the Madera Subbasin from adjacent subbasins also contribute to groundwater recharge; however, subsurface inflows and outflows are expected to decline as the Madera Subbasin and adjacent subbasins achieve sustainability.

Overall, the primary areas with the highest recharge potential occur along rivers/creeks and in the central portion of the Subbasin and along the San Joaquin River, and secondary areas with greater recharge potential occur in the southeastern and western portions of the Subbasin. **Figure 2-43** shows areas of higher recharge potential if defined by mapped soils with relatively high vertical hydraulic conductivities (greater than 2 feet/day).

Under current and recent historical groundwater conditions, the primary groundwater discharge from the Subbasin is groundwater pumping for agricultural, municipal, domestic, and industrial uses. Maps of general locations of domestic, agricultural, and public supply wells are provided in **Figures 2-6, 2-7**. Maps of the average depths of domestic, agricultural, and public supply wells by section are provided in **Figures 2-44, 2-45, and 2-46**. These maps generally indicated the majority of domestic wells are located in the central to eastern portions of the Subbasin, agricultural wells are relatively evenly distributed throughout the entire Subbasin, and public supply wells are concentrated in the central to eastern portions of the Subbasin. While domestic well depths are variable across the Subbasin, shallower wells (less than 300 feet deep) are more common to the west of Highway 99. Similarly, agricultural wells tend to be shallower (less than 500 feet) to the west of Highway 99 and deeper (500 to greater than 750 feet) to the east of Highway 99. The average well depths for domestic and agricultural wells generally reflect the greater depths to water east of Highway 99. A secondary mechanism of groundwater discharge is subsurface outflow to adjacent subbasins, primarily to Chowchilla Subbasin. Subsurface groundwater outflows (and inflows) were evaluated with the Subbasin groundwater model and are summarized in **Appendix 6.D.** Groundwater Model Documentation.

2.2.1.6 Surface Water Bodies and Source/Delivery Points for Local and Imported Water Supplies

The primary surface water bodies within the boundaries of Madera Subbasin include Berenda Creek, Dry Creek, Fresno River, Cottonwood Creek, San Joaquin River, and Madera Lake. The major reservoirs within the watersheds upstream of Madera Subbasin include Hensley Lake along the Fresno River and Millerton Lake along the San Joaquin River. These surface water features are shown on several maps describing the HCM (e.g., **Figures 2-10** and **2-13**), and are described in more detail in the subsequent water budget section of Chapter 2. In addition, the sources and delivery points for local and imported water are described in detail in the water budget section.

2.2.2 Current and Historical Groundwater Conditions (23 CCR § 354.16)

2.2.2.1 Groundwater Levels

Considerable historical groundwater level data are available in the Madera Subbasin. These data include water level (i.e., groundwater level) observations in wells and groundwater elevation contour maps prepared by others. Additional groundwater elevation maps and hydrographs were generated to evaluate historical and current groundwater level conditions in the Subbasin. The existing data and maps are described below, along with updated groundwater elevation contour maps and hydrographs prepared as part of this Joint GSP. The discussion of groundwater elevation contour maps focuses on Spring season water levels (as opposed to Fall) to limit influences actively pumping wells may have on interpretations of groundwater conditions. However, available historical Fall groundwater elevation contour maps were compiled and are included in **Appendix 2.E.**

Groundwater Elevation Contours

Maps of groundwater elevation from the early 1900s indicate groundwater flow from northeast to southwest prior to significant development of groundwater in the Madera Subbasin. The western portion of the Subbasin was considered part of an “artesian zone” running through the center of the San Joaquin

Valley (Mendenhall, 2016). More recently, groundwater elevation contour maps developed by DWR are available for selected years between 1958 and 1989, and annual maps were published from 1989 to 2011 (**Appendix 2.E**). Groundwater elevation data and GIS data files of groundwater contours are also available from DWR for 2012 to 2016 (**Appendix 2.E**). Although the DWR maps are developed with water level measurements that include wells with unknown construction details, DWR has categorized these groundwater contour maps as being representative of unconfined and semi-confined aquifer groundwater levels across the Madera Subbasin. To evaluate recent groundwater level conditions in the Subbasin, separate groundwater elevation contour maps were prepared for Winter/Spring 1988, Winter/Spring 2014, and Winter/Spring 2016 for unconfined groundwater and for the Lower Aquifer within the extent of the Corcoran Clay. For the purpose of mapping groundwater elevations, the aquifer system in areas outside the Corcoran Clay was treated as a single unconfined groundwater system. In areas within the Corcoran Clay, the aquifer system was separated into an unconfined system above the Corcoran Clay and a Lower Aquifer below the Corcoran Clay. Contour maps of the different depth zones are presented and discussed below. Historical groundwater contour maps of unconfined groundwater prepared by others are referenced in the discussion below and are provided in **Appendix 2.E.**

Unconfined Groundwater

Groundwater elevation contour maps of unconfined/semi-confined groundwater from DWR for the late 1950s to early 1980s indicate primarily north or northwest to east or southeast oriented contour lines indicating generally east to west or northeast to southwest groundwater flow directions. Groundwater levels represented on these maps suggest unconfined groundwater elevations ranging from between about 100 and 140 feet msl at the northwestern edge with considerably higher elevations of 300 to 400 ft msl towards the eastern edge of the Subbasin. Groundwater elevations were also typically higher along the Fresno River through the City of Madera and along the San Joaquin River. During this time period, groundwater elevations ranged from about 170 to 220 feet msl near the City of Madera. A relatively consistent pattern of groundwater flow towards the Subbasin from the western edge near the San Joaquin River is apparent in most of the contour maps from the 1950s through early 1980s.

Contours of groundwater elevations in Winter and Spring 1988 (**Figure 2-47**) show similar patterns as historical groundwater elevations although several areas of lowered groundwater levels are evident in 1988. An area of locally lower groundwater levels is apparent in **Figure 2-47** in the southeastern part of the Subbasin and groundwater flow directions in the northern part of the Subbasin are oriented more northerly towards an area of relatively lower groundwater levels along the northern Subbasin boundary. Locally higher groundwater levels are apparent in 1988 along the Fresno River and east of the City of Madera and along the San Joaquin River. In Winter/Spring 1988 groundwater elevations near the City of Madera are between about 160 and 200 feet msl, slightly lower than during the previous decades. Groundwater elevation contours in the western part of the Subbasin suggest a groundwater flow direction into the Subbasin from the west near the San Joaquin River.

In Winter/Spring 2014, unconfined groundwater elevations in the Subbasin are lower than in 1988 with several groundwater depressions apparent in **Figure 2-48**. Although the general prevailing groundwater flow direction remains east to west, a few notable, localized areas of low water levels (i.e., groundwater levels) exist in the Subbasin. These local depressions cause more local variability in the groundwater flow directions including most prominently in the southeastern part of the Subbasin and in the northern part of the Subbasin between the Fresno River and Dry Creek and extending north to the Subbasin boundary. Although more limited water level data are available in Winter/Spring 2016, a contour map of groundwater elevation in 2016 is presented in **Figure 2-49** for comparison and illustrates similar patterns in groundwater flow and relative elevations. Groundwater elevation contours in the western part of the Subbasin continue to indicate groundwater flowing into the Subbasin from the west near the San Joaquin

River in 2014 and 2016. Considerably more groundwater level data are available along the San Joaquin River in 2014 and 2016, in part because of recent monitoring being conducted in association with the San Joaquin River Restoration Program. However, it is worth noting that many of the San Joaquin River Restoration Program monitoring wells are very shallow (less than 50 feet) and exhibit water levels that may be shallower than the regional groundwater system. In evaluating and comparing groundwater level contour maps, it can be difficult to distinguish between influences of the unique water level datapoints used for each contour snapshot from what may be actual differences in water level conditions. Some of the differences in the contour maps for 2014 and 2016 are a result of differences in the spatial distribution of water level datapoints.

Perched Aquifers

The definition of perched groundwater is shallow groundwater present above a low-permeability (e.g., clay) layer with an unsaturated zone present between the perching layer and the regional water table. Perched groundwater has been identified at several sites in Madera Subbasin from review and comparison of local groundwater level data from several regulated facility sites obtained from Geotracker and regional groundwater level data from CASGEM and other sources (Table 2-6). These regulated facilities have shallow monitoring wells that reflect shallow groundwater conditions that can differ from regional groundwater levels in the deeper zones in which groundwater supply wells are screened. It is likely that other occurrences of perched groundwater exist in the Subbasin, although their existence may not be apparent due to lack of available information on water levels at different depths. From review of available data, documented areas of perched groundwater occur at a site about six miles southeast of the City of Madera at the former MacGillis and Gibbs Pole Treating Facility, at a site within the City of Madera, and also at a site near Fairmead about ten miles northwest of the City of Madera (see Table 2-6). These sites show perched groundwater levels ranging from 3 to 27 feet below ground surface (bgs) southeast of the City of Madera, at about 100 feet bgs within the City of Madera, and between 105 and 130 feet northeast of the City of Madera. The perching layer in these areas is not the regional Corcoran Clay (which pinches out to the west of these sites), but rather more local and discontinuous clay layers. For example, at the MacGillis and Gibbs Pole Treating site, it was noted that, "…perched water occurs as separate water bearing lenses with variable gradients that are not in hydraulic communication with each other…" (TRC, 2015). Based on this review of five regulated facility sites in Madera Subbasin with sufficient groundwater level data to evaluate perched groundwater conditions and the recognition that three of the five sites indicate the presence of perched groundwater, it is believed that perched groundwater is likely to exist in many other parts of the Subbasin.

Lower Aquifer

Contouring groundwater elevations in the Lower Aquifer is challenging because of combined limited availability of groundwater level data with well construction information and wells screened exclusively in the Lower Aquifer. In contouring groundwater levels in the Lower Aquifer, water levels from wells known to be constructed in the Lower Aquifer and any water levels below the Corcoran Clay (even if well construction is not known) were used for mapping groundwater elevations.

Table 2-6. Summary of Review of Groundwater Levels at Madera Subbasin Geotracker Regulated Facility Sites

Site Name	Address	Surface Elevation	GW Level Date Range	MW Depth Range	Site Depth to GW	Site GW Elevation	Regional GW Elevation
Madera Airport	4020 Aviation Drive, Madera, CA	245-251	June 1998 to August 2009	160-220(?)	139-207	44-107 (Regional)	60-120
Madera Cleaners	321 South C St., Madera, CA	273-274	Oct. 2006 to May 2010	119-122	100-106	167-174 (Perched)	100
Crop Production Services	24778 Avenue 13, Madera, CA	251-255	Feb. 1998 to Feb. 2018	195-220	116-173	78-139 (Regional)	70-135
MacGillis and Gibbs Pole Treating	Road 32 at Avenue 11, Madera, CA	282-286	Nov. 1998 to June 2015	15-27	3-27	260-280 (Perched)	120-180
		284-287	Nov. 1998 to June 2015	134-140	110-138	147-175 (Regional)	120-180
Fairmead Landfill	21739 Road 19, Fairmead, CA	243-244	Jan. 2005 to June 2018	114-128	105-130	113-139 (Perched)	-50 to 50
		239-252	Jan. 2005 to June 2018	134-210		100-127 (Shallow)	-50 to 50
		238-249	Jan. 2005 to June 2018	214-331		-58 to 53 (Regional)	-50 to 50

A combined dataset of Winter/Spring 1988 and Winter/Spring 1989 water level measurements was used to map Winter/Spring 1988 and 1989 groundwater elevation contours. The limited spatial representation of Lower Aquifer water level data is apparent in **Figure 2-50** with only one water level datapoint available in the Madera Subbasin during the 1988 and 1989 time period. With this datapoint, groundwater elevation in the Lower Aquifer was estimated to be around 130 feet msl in Winter/Spring of 1988/1989. The pattern in Lower Aquifer groundwater elevations, including direction of groundwater flow, is difficult to interpret from the few datapoints and limited spatial representation.

More recent groundwater elevation contours for Winter/Spring 2014 and 2016 have greater spatial coverage than the 1988/1989 map, but still have relatively limited point control in the Lower Aquifer within the Madera Subbasin. The Winter/Spring 2014 groundwater elevation contour map for the Lower Aquifer is presented as **Figure 2-51** and indicates Lower Aquifer groundwater elevations of between -20 and 50 feet msl in a small area of the Madera Subbasin within the extent of the Corcoran Clay. The contour map for Lower Aquifer in Winter/Spring 2016 (**Figure 2-52**) shows relatively lower groundwater elevations between -10 and -30 feet msl in the Lower Aquifer in the same area near Dry Creek and Fresno River. Farther south, groundwater elevations in the Lower Aquifer in 2016 are higher with elevations of about 60 feet msl. Due to the limited spatial coverage of wells with Lower Aquifer water levels, evaluating groundwater flow gradients and directions within the Lower Aquifer in Madera Subbasin is challenging.

Groundwater Hydrographs

Hydrographs of time-series groundwater level data were reviewed to evaluate long-term trends in groundwater levels. Selected groundwater level hydrographs for unconfined groundwater, Lower Aquifer, and composite wells or wells with unknown construction are presented in **Figures 2-53 to 2-55** to illustrate

temporal trends in groundwater levels across the Subbasin. Overall, long-term declines and very steep recent declines (between 2012 and 2016) were prevalent in the northwestern and northeastern portions of the Subbasin. More stable areas of the Subbasin include along the San Joaquin River in the southern portion of the Subbasin and an area extending northwest and across the Subbasin from the San Joaquin River in the western portion of the Subbasin.

Select hydrographs of water levels in the unconfined groundwater (outside the Corcoran Clay or above the Corcoran Clay) are displayed in **Figure 2-53**. All of the hydrographs displayed on **Figure 2-53** exhibit long-term water level declines, with wells in the more eastern parts of the Subbasin having the greatest water level declines. The hydrographs on **Figure 2-53** show groundwater levels with seasonal and year-to-year fluctuations and in some cases a slight downward trend prior to and through the mid-1980s. In contrast, all of the hydrographs on **Figure 2-53** exhibit substantially declining water levels from the late-1980s onward. The wells in the more eastern part of the Subbasin, outside the extent of the Corcoran Clay (10S16E25F002M, 11S17E28A001M, City of Madera 24, 11S20E31P001M, 12S18E13R001M) show groundwater level declines of between 2 and 6 feet per year over the period from the late-1980s through about 2015. The two wells in the more western part of the Subbasin (12S15E11R001M, 12S17E20P001M) have smaller groundwater level declines of between 1 and 2 feet per year over this period.

Select hydrographs of water levels in the Lower Aquifer (within the extent of the Corcoran Clay) are displayed in **Figure 2-54**. As discussed above, the availability of groundwater level data known to be specific to the Lower Aquifer is limited. Only one of the wells (11S16E22K001M) shown in **Figure 2-54** has a period of record sufficiently long to interpret trends in water levels. As with the unconfined groundwater, well 11S16E22K001M exhibits more stable water levels prior to the mid- or late-1980s but exhibits a substantial decline of approximately 150 feet from the late-1980s through 2015 representing an annual groundwater level decline of about 5 feet per year. Although this decline in groundwater level is substantial, it is worth noting that groundwater in the Lower Aquifer can occur under confined conditions.

Because of limitations related to available well construction information, there are many wells with long periods of record for water levels but lacking well construction information. Select hydrographs of water levels in wells of unknown construction are presented in **Figure 2-55**. The hydrographs on **Figure 2-55** show groundwater level trends very consistent with those seen in the unconfined groundwater with substantial declines apparent over the time period between the late-1980s and 2015. Trends of more stable water levels, although slightly declining, prior to the mid-and late-1980s are apparent in most wells with greatly increased rates of groundwater level declines over the period from the late-1980s to 2015. The three northern most wells on **Figure 2-55** (11S16E03A001M, 10S18E09C001M, 11S17E16H001M) exhibit the most substantial groundwater level declines with between 100 and 150 feet of decline in groundwater levels between the mid-to late-1980s and 2015. These declines equate to annual rates of groundwater level decline between 3 and 5 feet per year. The groundwater level trends are generally similar in other parts of the Subbasin although the degree of decline is somewhat less.

Additional groundwater level hydrographs are presented in **Appendix 2.E**.

2.2.2.2 Groundwater Storage

Total Groundwater Storage

The total groundwater storage volume within the Madera Subbasin above the basement and base of freshwater is estimated to be between about 13 and 30 million AF based on an analysis using contouring of 2014 groundwater levels and an assumed average specific yield range of 5 to 12 percent. Table 2-7 summarizes the calculations of total groundwater storage in the Subbasin using a range of specific yield values, although recent groundwater modeling conducted to support development of the GSP suggests

average specific yield values for the full saturated thickness in the Subbasin (i.e., from the regional water table to the base of fresh water) may be lower than previously estimated and closer to the lower end of the values listed in Table 2-7. In Bulletin 118, DWR previously estimated the total groundwater storage in the Madera Subbasin above the base of freshwater to be about 41 million AF using 1995 groundwater levels and a specific yield value of 10.4 percent. However, DWR's Bulletin 118 estimate was for a larger area of about 394,000 acres compared to the current Madera Subbasin area of a little under 348,000 acres.

Table 2-7. Estimates of Total Groundwater Storage Above Base of Freshwater (as of 2014)

Madera Subbasin Area (acres)	Specific Yield (percent)	Total Groundwater Storage (AF)	Notes on Specific Yield Basis
347,667	5%	12,642,000	
	7%	17,699,00	
	8%	20,227,000	
	10%	25,284,000	2002 AB3030 Madera County GMP value (Todd Engineers)
	10.4%	26,295,000	DWR Bulletin 118
	12%	30,341,000	
	13%	32,869,000	2014 Regional GMP value (P&P, Wood Rodgers, KDSA)

Change in Groundwater Storage

Based on a comparison of the contour maps of unconfined groundwater elevation for Winter/Spring 1988 and the two more recent contour maps for Winter/Spring 2014 and 2016, changes in groundwater elevation were calculated between 1988 and both 2014 and 2016. **Figure 2-56** shows the calculated change in unconfined groundwater levels for 1988 to 2014 and **Figure 2-57** presents the calculated change over the period 1988 to 2016. Unconfined groundwater levels declined substantially across much of the Madera Subbasin between 1988 and both 2014 and 2016. The greatest groundwater level declines were in the central and more northern parts of the Subbasin where declines exceeded 150 feet in areas. A majority of the areas within the Subbasin show declines of greater than 50 feet with somewhat larger declines indicated from the comparison of 1988 and 2016 water levels. The areas indicated in **Figures 2-56 and 2-57** to have increasing groundwater levels are primarily a result of differences in water level data availability between the different time periods and are unlikely to be an indication of actual rising groundwater levels.

The calculated changes in groundwater levels translate to changes in groundwater storage estimated to be about -2.5 million AF between 1988 and 2014 and about -3.6 million AF between 1988 and 2016, assuming a range of specific yield values from 8 to 13 percent. This calculation, which represents the upper portion of the total saturated sediment thickness in the Subbasin, utilizes a more representative higher range of specific yield values compared to the total Subbasin groundwater storage calculation presented above. These storage decreases translate to annual decreases of about -73,000 to -118,000 AFY for 1988 to 2014 and -100,000 to -163,000 AFY for 1988 to 2016. Table 2-8 summarizes the calculations of changes in groundwater storage from 1988 to 2014 and 1988 to 2016 under different specific yield values.

Table 2-8. Calculated Change in Groundwater Storage

Analysis Time Period	Specific Yield (percent)	Total Groundwater Storage Change (AF)	Average Annual Groundwater Storage Change (AFY)	Notes on Specific Yield Basis
Change 1988 to 2014	8%	-1,891,308	-73,000	
	10%	-2,364,136	-91,000	2002 AB3030 Madera County GMP value (Todd Engineers)
	10.4%	-2,458,701	-94,500	DWR Bulletin 118
	12%	-2,836,963	-109,000	
	13%	-3,073,376	-118,000	2014 Regional GMP value (P&P, Wood Rodgers, KDSA)
Change 1988 to 2016	8%	-2,809,149	-100,000	
	10%	-3,511,437	-125,500	2002 AB3030 Madera County GMP value (Todd Engineers)
	10.4%	-3,651,894	-130,500	DWR Bulletin 118
	12%	-4,213,724	-150,500	
	13%	-4,564,868	-163,000	2014 Regional GMP value (P&P, Wood Rodgers, KDSA)

Previous estimates of groundwater storage change for Madera County include DWR (1992), Todd (2002), and Provost & Pritchard (2014). DWR (1992) estimated groundwater storage decline from 1970 to 1990 to be 74,115 AFY. Todd (2002) calculated a groundwater storage decline of 68,338 AFY for the period from 1990 to 1998. The most recent of these evaluations of groundwater level and storage change is included in the 2014 Groundwater Management Plan (Provost & Pritchard, 2014), and covers the time period from 1980 to 2011. In general, groundwater levels declined between 30 and 150 feet throughout Madera County, or an average of 1 to 5 feet per year. Groundwater storage change was not quantified by subbasin. For the Madera County area included in the plan (not including areas of Root Creek Water District, Madera Water District, Aliso Water District, or Columbia Canal Company) studied in 2014 (plus the area of Merced County included in Chowchilla Water District), groundwater storage between 1980 and 2011 was estimated to have declined at an average rate of 143,000 AFY, which equates to a total decline of 4.4 million AF over the 31-year period.

2.2.2.3 Groundwater Quality

Maps of available groundwater quality data for a variety of constituents were prepared to characterize groundwater quality in the Subbasin. Key groundwater quality constituents discussed below include nitrate, total dissolved solids (TDS), and arsenic. These constituents have greater potential for presenting broader regional groundwater quality concerns extending beyond localized or site-specific contamination cases and are likely to reflect a range of potential contamination sources. A variety of maps of other groundwater quality constituents are included in **Appendix 2.E** and highlight local areas of groundwater quality contamination that are important for consideration when evaluating GSP-related PMAs and their potential to have adverse groundwater quality impacts.

Nitrate is one of the most common groundwater contaminants and is generally the water quality constituent of greatest concern in agricultural areas where application of fertilizers containing nitrogen can lead to elevated nitrate levels in groundwater. Additionally, nitrate is a constituent of concern in groundwater near dairy or other large-scale livestock operations. Natural concentrations of nitrate in groundwater are generally low, and elevated levels usually indicate impacts from land use activities. Nitrate presents health concerns at high concentrations and is regulated in public drinking water systems.

The U.S. Environmental Protection Agency (USEPA) has established a maximum contaminant level (MCL) for nitrate (as nitrogen) of 10 mg/L under its National Primary Drinking Water Regulations; this MCL standard is established for public health reasons and is a requirement of all public drinking water systems. Total Dissolved Solids (TDS) is a general measure of salinity and overall water quality. Elevated salinity in groundwater can be a result of land use activities, but can also be naturally-occurring, especially in western parts of the San Joaquin Valley where subsurface geologic materials are derived from marine sediments. Arsenic is a naturally occurring chemical found in groundwater and has a primary MCL of 10 micrograms/liter (µg/L).

Additional maps of other groundwater quality constituents are presented in **Appendix 2.E** including maps of select chemicals typically found associated with point-source contamination including hydrocarbon products and pesticides. Several studies and maps of regional groundwater quality have also been prepared in recent years, and some of these maps are included in **Appendix 2.E**. Work for CV-SALTS (LSCE and LWA, 2016) evaluated ambient TDS and nitrate concentrations for the period 2000 to 2016 in the upper and lower zones within the Upper Aquifer. LSCE (2014) conducted groundwater quality mapping for the San Joaquin Valley for various constituents including TDS, nitrate, arsenic, vanadium, uranium, DBCP/fumigants, herbicides, solvents, and perchlorate. Maps of TDS and nitrate from the Groundwater Quality Assessment Report prepared for the East San Joaquin Water Quality Coalition (LSCE, 2014) presents groundwater quality data delineated by shallow and deep wells. Although the maps were not necessarily aquifer specific (shallow wells were distinguished from deeper wells for this study primarily based upon well use type), they do illustrate general concentrations in wells across the Subbasin. Other mapping of regional groundwater quality was included in the Regional Groundwater Management Plan (Provost & Pritchard, 2014). Typically, the major considerations for municipal/domestic and agricultural use with respect to groundwater quality include salinity (specific conductance, TDS), nutrients (nitrate), and metals (arsenic, manganese). For the purposes of their groundwater quality evaluation, Provost & Prichard (2014) defined shallow wells (0 to 400 feet), intermediate wells (400 to 600 feet), and deep wells (greater than 600 feet deep). This depth classification differs slightly from how groundwater conditions are represented in the HCM as defined in this Joint GSP, and is utilized only for the discussion of groundwater quality in this section. Groundwater quality maps from previous reports are provided in **Appendix 2.E.**

Groundwater quality data for other constituents as presented in published reports, particularly data from the USGS Groundwater Ambient Monitoring and Assessment (GAMA) Program investigations conducted for the area, are also presented in **Appendix 2.E.**

Total Dissolved Solids

Maps of maximum historical TDS concentrations in groundwater in the Madera Subbasin (**Figures 2-58 to 2-60**) indicate relatively low salinity groundwater quality across most of the Subbasin with maximum historical TDS concentrations less than 500 milligrams/liter (mg/L) in most places. Wells with historical TDS concentrations greater than 750 mg/L exist scattered across the Subbasin and a relatively small number of wells with TDS concentrations above 1,000 mg/L located mainly in the far western parts of the Subbasin. Higher TDS concentrations in the western part of the Subbasin may be caused by natural salinity present in groundwater occurring within Coast Range derived sediments of marine source material. Otherwise, there are no widely apparent and consistent spatial patterns in concentrations, although the wells exhibiting higher TDS concentrations above 1,000 mg/L are screened in the Upper Aquifer.

Regional groundwater quality mapping of TDS concentrations was conducted for the CV-SALTS project (LSCE and LWA, 2016). These analyses for the upper zone (of the Upper Aquifer) showed generally increasing TDS from east to west across Madera Subbasin. TDS concentrations ranged from less than 250 mg/L in the east to greater than 1,000 mg/L in the southwestern corner of the Subbasin. Analyses of the

lower zone (of the Upper Aquifer) showed a similar pattern of increasing TDS from east to west, but with a smaller area of high TDS groundwater (**Appendix 2.E**).

Nitrate

Maps of maximum historical nitrate concentrations in groundwater are presented by different well depth zone or other classification **Figures 2-61 to 2-63**. These maps highlight patterns in historical nitrate concentrations across the Subbasin. A large percentage of the wells with nitrate data have maximum historical concentrations below 7.5 mg/L and many have concentrations below 5 mg/L. However, a number of areas of locally high nitrate concentrations above 7.5 mg/L or above 10 mg/L are apparent across the Subbasin. The higher concentrations appear to be more common in the more western parts of the Subbasin. One particular area with a high density of wells with nitrate concentrations above the MCL of 10 mg/L (as N) is located in the western part of the Subbasin along Highway 145, directly south of where Dry Creek joins the Fresno River. Some of the clusters of wells with high nitrate concentrations are known to be associated with regulated facilities and contamination remediation sites. Most of the higher concentrations are from wells with unknown construction information, although maps of nitrate concentrations by depth zone indicate more wells known to be screened in the Upper Aquifer with higher concentrations than in the Lower Aquifer.

Regional mapping of nitrate concentrations in groundwater were also performed as part of the CV-SALTS project (LSCE and LWA, 2016). Maps of TDS concentrations in the upper zone (of the Upper Aquifer) showed a small area exceeding the MCL of 10 mg/L (as N) in the northwestern part of the Subbasin, while nitrate in the lower zone (of the Upper Aquifer) was indicated to exceed 10 mg/L in a similar but somewhat larger area in (compared to upper zone of Upper Aquifer) the northwest portion of the Subbasin (**Appendix 2.E**).

Arsenic

Maps of maximum historical arsenic concentrations in groundwater are presented in **Figures 2-64 to 2-66**. Although there are wells with high arsenic concentrations scattered throughout the Subbasin, they are more common in the eastern part of the Subbasin. Most of the wells with arsenic concentrations above the MCL of 10 µg/L are located northeast of Highway 99. Although a number of wells exhibit concentrations above the MCL, the dominant fraction of wells with arsenic concentrations are below 5 µg/L with many or most of these wells having concentrations below 2.5 µg/L. Few wells known to be screened in the Upper Aquifer have elevated concentrations and a higher number of wells known to be constructed in the Lower Aquifer have concentrations above the MCL, although most wells of the identified Lower Aquifer wells have concentrations below 5.

Other Groundwater Quality Constituents

Maps of a variety of other groundwater quality constituents are presented in **Appendix 2.E**. Many of these maps highlight distinct areas of local groundwater contamination or groundwater constituents that should be considered when evaluating potential groundwater quality impacts from implementation of PMAs to achieve sustainability. Wells with exceedances for a variety of constituents, including anthropogenic contaminants like pesticides, solvents, and petroleum-related chemicals, are displayed in maps in **Appendix 2.E**. Most notably, maps of DBCP, EDB, 1,2,3-TCP, perchlorate, PCE, and BTEX concentrations all indicate areas with wells exceeding the respective drinking water MCLs. Naturally occurring constituents such as uranium and manganese are also elevated in some wells with high uranium concentrations more apparent in the western part of the Subbasin and high manganese concentrations more common in the eastern parts of the Subbasin.

2.2.2.4 Land Subsidence

Recent land subsidence has been a major concern in the northwestern portion of Madera County, primarily impacting the western portion of the adjacent Chowchilla Subbasin. However, there has been some recent subsidence occurring within Madera Subbasin. A map of subsidence that occurred between 1926 and 1970 shows 1 to 2 feet of subsidence in the northwestern portion of Madera Subbasin (**Figure 2-67**). Subsidence mapping using InSAR data for the 2007 to 2011 time period is shown in **Figure 2-68**. A maximum subsidence of 0.5 to 1 foot for this time period occurred in the northwest part of the Madera Subbasin. The most recent map of subsidence that occurred between 2015 and 2017 (**Figure 2-69**) shows 1.0 to 1.5 feet of subsidence adjacent to and north of the Fresno River in the northwestern portion of the Subbasin. Overall, the available subsidence maps for the three time periods show up to approximately three feet of subsidence in some areas of northwestern Madera Subbasin since 1920. Specific subsidence monitoring locations are shown in **Figure 2-70**, which shows a relatively continuous monitoring record of subsidence at seven locations in the Subbasin between 2011 and 2017. Review of the subsidence monitoring location records indicate up to two feet of subsidence along the northwestern Subbasin boundary with Chowchilla Subbasin.

Other mapping of subsidence is included in **Appendix 2.D**. In northwest Madera Subbasin, subsidence from 2008 to 2010 was less than one foot. Mapping by USBR between July 2012 and December 2016 showed total subsidence ranging up to two feet in northwest Madera Subbasin. Various ongoing subsidence monitoring programs are being funded and/or conducted by DWR, USGS, USBR, and the National Aeronautics and Space Administration Jet Propulsion Laboratory (NASA-JPL).

2.2.2.5 Groundwater - Surface Water Interaction

The primary surface water features in Madera Subbasin are the Berenda Creek, Dry Creek, Fresno River, Cottonwood Creek, and San Joaquin River (**Figure 2-11**). Each of these streams is considered to be a source of recharge in the Subbasin, while also acting as conveyance features for local GSAs. A review of historical regional aquifer groundwater elevations compared to stream thalweg (deepest portion of stream channel) elevations conducted for this study show groundwater elevations well below stream thalwegs (greater than 30 to 50 feet bgs) and indicate that surface water – groundwater interactions do not occur (i.e., regional groundwater levels are relatively far below creek thalweg elevations) along Berenda Creek, Dry Creek, the Fresno River, and Cottonwood Creek in Madera Subbasin. However, comparison of historical groundwater and stream thalweg elevations suggest the San Joaquin River along the southern subbasin boundary was likely connected with groundwater over the period of available data from 1958 through 1984. Groundwater levels were generally below (and apparently disconnected from) the San Joaquin River by about 10 to 50 feet from 1989 through 2016 based on this analysis, which involved use of regional groundwater elevation contour maps for the "Unconfined Aquifer" prepared by DWR for the following years: Spring 1958, Spring 1962, Spring 1969, Spring 1970, Spring 1976, Spring 1984, and Spring 1989 through Spring 2011 (**Appendix 2.E**), and groundwater elevation contour maps for Spring 2014 and 2016 (**Figures 2-48 and 2-49**).

Maps of depths to shallow groundwater for 2014 and 2016 are displayed on **Figures 2-71 and 2-72**. These maps incorporate very shallow monitoring wells (i.e., less than 50 feet deep) not included in regional groundwater elevation contour mapping described above, including San Joaquin River Restoration Project (SJRRP) wells (many of which have well screens in the upper 30 feet) However, groundwater levels reflected in these very shallow wells may not be representative of conditions in the regional groundwater system. Depth to shallow groundwater maps were generated by contouring groundwater surface elevation and subtracting the contoured water surface from the ground surface elevation as represented by the USGS National Elevation Dataset Digital Elevation Model. Some of the areas on the southern and southwestern boundaries of Madera Subbasin and along/adjacent to the San Joaquin River may be

underlain by shallow clay layers that are above the principal aquifers in the area. Shallow groundwater in these areas can likely be considered mounded in that shallow clay layers help to maintain shallow groundwater levels regardless of whether or not an unsaturated zone exists beneath them as occurs in a truly perched groundwater condition as described above in Section 2.2.2.1 (Groundwater Levels). It is likely that seepage from the San Joaquin River is the source of water combined with presence of shallow clay layers, which serves to maintain shallow groundwater levels at these locations. While groundwater levels in this perched zone appear to be approximately 10 to 30 feet below ground surface, water levels in the underlying regional groundwater system are typically much deeper, in excess of 50 feet below ground surface.

Figures 2-70 and **2-71** illustrate how the San Joaquin River is disconnected from the shallow perched/mounded zone in most areas during these time periods.. Shallow groundwater along uppermost reaches of the San Joaquin River is located to the east and northeast of a bedrock outcrop (**Figure 2-14**), and is somewhat isolated from the rest of the subbasin by the bedrock outcrop. The depth to bedrock beneath this portion of the San Joaquin River adjacent to the Sierra Nevada Mountains is relatively shallow. Review of the limited number of DWR well completion reports (WCR) that are available for this area indicate depth to bedrock ranging from 45 to 75 feet bgs from north to south along the San Joaquin River from just below Friant Dam to a point about four miles downstream of the dam. The combination of shallow depth to bedrock beneath the San Joaquin River (45 to 75 feet bgs), bedrock occurring at the surface one to two miles west/southwest of this area of relatively shallow groundwater, and seepage along the San Joaquin River of releases from Millerton Lake accounts for the shallow occurrence of groundwater at this location. Therefore, regional groundwater pumping is unlikely to have a significant effect on groundwater levels in this area. The presence of shallow groundwater at this location shown on **Figures 2-71** and **2-72** is inferred from groundwater levels in nearby areas, topographic slope, and groundwater model results. Review of the limited number of available DWR well logs for wells in this area indicated depths to water ranging from 22 to 39 feet bgs for dates ranging from May 1960 to September 1979 (at the time of well installation). Part of the GSP Implementation Plan will be to further investigate existing wells in this area for verifying presence of shallow groundwater (i.e., less than 30 feet bgs) and inclusion of a well as a RMS, if necessary. However, review of groundwater elevation hydrographs for wells screened in the Upper Aquifer (see Sections 3.2.5 and 3.3.5) indicate that there may be some connection between shallow groundwater levels and the San Joaquin River during certain time periods (e.g., wet season of wet years).

The relationship between stream seepage in the San Joaquin River along the southern boundary of Madera Subbasin and groundwater pumping along this portion of the San Joaquin River within the Madera Subbasin (i.e., within approximately 0.75 miles of the San Joaquin River) is shown in **Figure 2-73**. The relationship between groundwater pumping within five miles of the San Joaquin River and stream seepage is shown in **Figure 2-74**. These figures suggest that at the highest end of the range of groundwater pumping (over 16,000 af/year in **Figure 2-73** and over 200,000 AF/year in **Figure 2-74**), stream seepage increases with increased groundwater pumping. However, at the low to mid-range of groundwater pumping, the relationship is inconsistent. The highest amounts of groundwater pumping generally occur during drought periods when groundwater recharge is less, groundwater levels are lower, and groundwater would not be expected to be connected to the steam bed. In non-drought periods, when groundwater levels are higher and possibly connected to the streambed, there appears to be no strong relationship between groundwater pumping and stream seepage. Additional evaluation of this relationship in the field and in the groundwater model will be conducted for the 2025 GSP Update. The relationship between streamflow entering the Subbasin at the upstream boundary of this river reach and stream seepage is shown in **Figure 2-75**. As illustrated in **Figure 2-75**, stream seepage (i.e., infiltration) occurs during Critical, Dry, and Below Normal Years. This indicates that the San Joaquin River is a losing

reach and likely not connected to groundwater at these times. During Above Normal and Wet Years, both stream seepage and groundwater discharge to streams occurs. This indicates that the San Joaquin River is connected to groundwater for some duration during these times. **Figure 2-76** displays the monthly stream seepage/groundwater discharge to streams by water year type along the San Joaquin River. This figure also indicates that the San Joaquin River is a losing reach during Critical, Dry, and Above Normal Years, but appears to have connection with groundwater during some periods during Above Normal and Wet Years. These relationships among various factors are discussed further in Sections 3.2.5 and 3.3.5.

Regardless of whether or not groundwater and surface water are interconnected along the San Joaquin River, there is at least some potential for regional groundwater pumping to impact groundwater dependent ecosystems (GDEs) with roots extending down 20 to 30 feet along the San Joaquin River. Thus, shallow groundwater areas adjacent to the San Joaquin River were further evaluated in regard to GDEs in the following section and in Chapter 3.

Further review of **Figures 2-71 and 2-72** indicates another area of shallow groundwater occurring at the eastern margin of the Plan Area adjacent to the Sierra Nevada Mountains in the area near where the Fresno River crosses the Madera Canal (Madera Canal Equalization Reservoir area)The hydrogeology in the vicinity of the Madera Canal Equalization Reservoir is characterized by shallow bedrock ranging from approximately 0 to 100 feet below ground surface. Given the extremely low permeability of fractured bedrock compared to the overlying unconsolidated alluvium, the underlying bedrock surface effectively operates as a perching layer for streamflow infiltrating down from the Fresno River/Madera Canal. The Fresno River flows through this area, with a dam/reservoir (Hensley Lake) upstream of this area. The Madera Canal also passes through this area, including the Equalization Reservoir, which is located on the Madera Canal. These man-made surface water features are the primary source of subsurface water in this area of the Subbasin adjacent to the Sierra Foothills. Because of the very steep hydraulic gradient in this area (in excess of 70 feet per mile) the nature of the hydraulic connection with the main regional groundwater system in the Subbasin is such that groundwater or infiltrating surface water in this area may flow down-gradient along the sloping bedrock surface into the main groundwater system. However, any groundwater pumping in the main groundwater basin aquifers is unlikely to impact shallow water levels in the Madera Canal Equalization Reservoir area.

Based on review of available data, characterization of hydrogeologic conditions related to the potential for interconnected surface water is currently based on very limited data. Thus, additional data collection and analyses are needed to update and refine the understanding of how surface water and GDEs may (or may not) be connected to the regional aquifers where groundwater pumping occurs. Key elements of a workplan are described in Section 2.2.2.7.4. It is anticipated that some additional data to better characterize shallow stratigraphy, groundwater levels, and interconnected surface water will be available and incorporated into the 2025 GSP Update.

2.2.2.6 Groundwater Dependent Ecosystems

Groundwater dependent ecosystems (GDEs) are defined in California's Sustainable Groundwater Management Act (SGMA) as "ecological communities of species that depend on groundwater emerging from aquifers or on groundwater occurring near the ground surface" (23 CCR § 351(m)). As described in The Nature Conservancy's guidance for GDE analysis (Rohde et al. 2018), a GDE's dependence on groundwater refers to reliance of GDE species and/or communities on groundwater for all or a portion of their water needs. Review of available groundwater level data from Winter/Spring 2014 and Winter/Spring 2016 indicates that shallow groundwater levels (i.e., within 30 feet of ground surface) exist in some portions of the Plan Area (Section 2.2.2.1). The depth to water (DTW) evaluation described in the above section for Groundwater – Surface Water Interaction also provides input for evaluation of GDEs.

A DTW of 30 feet was used as one of the primary criteria in the initial screening of potential GDEs. The use of a 30-foot DTW criterion to screen potential GDEs is based on reported maximum rooting depths of California phreatophytes[42] and is consistent with guidance provided by The Nature Conservancy (Rohde et al. 2018) for identifying GDEs. Potential GDEs were retained for further analysis if the underlying DTW in either winter/spring 2014 or winter/spring 2016 was equal to or shallower than 30 feet. The 2014 and 2016 DTW data were the most accurate and recent DTW data available for the Madera Subbasin. While the 2016 data represent conditions after the 2015 SGMA baseline, the use of shallow groundwater data from both years was deemed appropriate because it provided a more conservative (i.e., more inclusive) indicator of potential GDEs than the use of a data from a single year.

GDEs may also occur in areas where regional groundwater levels are deeper than 30 feet but shallower perched groundwater exists atop bedrock or another type of aquitard. Where DTW was greater than 30 feet, other criteria were used to determine whether potential GDEs should be subject to further analysis. For example, surface flow characteristics of rivers in the Madera Subbasin were also used to screen potential GDEs. Because the vast majority of rivers in the Subbasin are not perennial and all are in a net-losing hydrological condition (i.e., losing water to the groundwater system), this criterion excluded most of the smaller river channels and associated terrestrial vegetation from consideration as GDEs.

Four potential GDE units, the Fresno River Riparian, Friant Riparian, San Joaquin River Riparian, and Sumner Hill potential GDE units were identified in the Madera Subbasin (**Figure 2-77 through 3-80**, **Appendix 2.B**). The potential GDE units were identified using the California Department of Water Resources' (DWR) indicators of GDEs (iGDE) dataset, published online and referred to as the Natural Communities Commonly Associated with Groundwater (NCCAG) dataset (Klausmeyer et al. 2018), augmented with other relevant vegetation mapping data, aerial imagery, and hydrologic data. Field reconnaissance was conducted in portions of the unit in May 2019 to help characterize the vegetation composition and structure, document dominant plant species, and assess habitat characteristics to determine the potential for presence of special-status species.

Fresno River Riparian Potential GDE Unit

The Fresno River Riparian Potential GDE Unit is located at the eastern margin of the Madera Subbasin along the Fresno River. Approximately two-thirds of the unit is upstream of the Madera Canal along the Fresno River (**Figure 2-77**). The Fresno River flows through this area and is impounded by Hidden Dam to form Hensley Lake approximately 2.5 miles upstream of the GDE unit. Since 1968, flow in the Fresno River has been controlled by Hidden Dam. Groundwater beneath the Fresno River Riparian Potential GDE Unit was approximately 10–30 feet deep in winter/spring 2014 (i.e., the upper 10–30 feet of the subsurface was unsaturated during this time). This is too deep for the Fresno River's surface flow to be connected to groundwater, but within the 30-foot maximum rooting depth of the dominant riparian plants in the unit. The Fresno River in the Madera Subbasin has been a net losing stream since at least the 1920s (TNC 2014), with infiltrating surface flow likely contributing directly to the shallow groundwater system that supports the vegetation in the Fresno River Riparian Potential GDE Unit. The Madera Canal also passes through the GDE unit, including the Equalization Reservoir which is located along the Madera Canal. Seepage or leaks from these man-made surface water features likely provide a portion of the subsurface water in this area of the Subbasin, but the magnitude of their contribution is unknown.

The hydrogeology in the vicinity of this GDE unit is characterized by shallow bedrock ranging from approximately 0 to 100 feet below ground surface. Because of the very steep hydraulic gradient in this

[42] A phreatophyte is a deep-rooted plant that obtains its water from the phreatic zone (zone of saturation) or the capillary fringe above the phreatic zone (Rohde et al. 2018).

area (in excess of 70 feet per mile the nature of the hydraulic connection with the main regional groundwater system in the Subbasin is such that groundwater or infiltrating surface water in this area may flow down-gradient along the sloping bedrock surface into the main groundwater system, but any groundwater pumping in the main groundwater basin aquifers is unlikely to impact water levels underlying this GDE unit.

The Fresno River Riparian Potential GDE Unit is composed of a mix of riparian forest, shrub, and herbaceous habitat types totaling approximately 40 acres. Analysis of existing vegetation mapping data, color aerial imagery, and May 2019 field reconnaissance conducted in representative portions of the unit determined the quality of riparian habitat in this unit to be high, with several areas of mature riparian forest along the river floodplain (Figure 2-81). Vegetation in the unit is over 80% native cover in the shrub and tree layer. Dominant vegetation included mature stands of Fremont cottonwood and Gooding's black willow (*Populus fremontii* and *Salix gooddingii*, respectively) with sandbar willow shrubs (*Salix exigua*) lining sections of the channel. The riverine, aquatic habitat of the Fresno River is not contained within the GDE unit because available hydrologic data indicates no connection of groundwater to the surface flow in the Fresno River in this area (i.e., this reach of the Fresno River loses water and is not connected to the groundwater system).



Figure 2-81. Riparian habitat in the Fresno River Riparian Potential GDE Unit, May 1, 2019. (Stillwater Sciences).

The Fresno River Riparian Potential GDE Unit provides habitat or ecosystem support for several special-status species. These species include special-status species that satisfy one or more of the following criteria: (1) known to occur in the region and suitable habitat present in the GDE unit, (2) documented occurrence within the GDE unit, or (3) directly observed during the May 2019 reconnaissance survey conducted by Stillwater Sciences (see **Appendix 2.B**).

The Fresno River Riparian Potential GDE Unit was determined to have **high ecological value** because of: (1) the known occurrence and presence of suitable habitat for several special-status species; and (2) the vulnerability of these species and their habitat to changes in groundwater levels (Rohde et al. 2018). The vegetation composing the GDE unit was determined to be more susceptible to changes in groundwater depth (i.e., DTW) than other groundwater conditions such as groundwater quality. Analysis of current and recent historical groundwater depth underlying the GDE unit indicates that current groundwater depth is within the range of recent historical fluctuations and future changes in groundwater management are unlikely to cause it to fall outside this baseline range. Consequently, the unit is characterized as having low susceptibility to changing groundwater conditions. Reconnaissance level biological assessments, aerial photograph analysis, and NDVI/NDMI data indicate adverse impacts are not likely occurring in the Fresno River Riparian Potential GDE Unit (**Appendix 2.B**).

Friant Riparian Potential GDE Unit

The Friant Riparian Potential GDE Unit is located in the uppermost reaches of the San Joaquin River below Friant Dam, extending along the San Joaquin River from the dam approximately 5.5 miles downstream (**Figure 2-74**). Data from the limited number of DWR well completion reports that are available in this area indicate that depth to bedrock beneath the majority of the unit is relatively shallow, ranging from 45 to 75 feet bgs from north to south along the San Joaquin River. The San Joaquin River in the Madera Subbasin has been a net losing stream since at least the 1920s (TNC 2014), with infiltrating surface flow likely contributing directly to the shallow groundwater that supports the vegetation in the Friant Riparian Potential GDE Unit.

As described in Section 2.2.2.1 (Groundwater Levels), there is essentially no existing groundwater level data for the Friant Riparian Potential GDE area. This area was identified as a shallow groundwater area (DTW less than or equal to 30 feet) based on extrapolation of groundwater level data from further away. Thus, the actual depth to groundwater in this area is unknown. The combination of shallow depth to bedrock beneath the San Joaquin River in this unit and infiltration of surface flows from the San Joaquin River into the underlying alluvium largely accounts for the shallow occurrence of groundwater at this location. Therefore, groundwater pumping in the main groundwater basin aquifers is unlikely to impact water levels underlying this GDE unit.

The Friant Riparian Potential GDE Unit is composed of a mix of riparian forest, shrub, and herbaceous habitat types totaling approximately 107 acres. Analysis of existing vegetation mapping data, color aerial imagery, and May 2019 field reconnaissance conducted in representative portions of the unit determined the quality of riparian habitat in this unit to be medium. This GDE unit is characterized by pockets of mature riparian forest associated with drainages and surrounded by grasslands on the floodplain of the San Joaquin River (Figure 2-82). The canopy is stratified with a moderately open understory. Vegetation in the observed portions of the unit was over 80% native cover in the shrub and tree layer and could be less than 50% native cover in the herbaceous ground layer, with the balance occupied by non-native species. Dominant vegetation in woody plant communities included Fremont cottonwood (*Populus fremontii*), Goodding's willow (*Salix gooddingii*), and valley oak (*Quercus lobata*) in the overstory and narrow-leaved willow (*Salix exigua*) in the shrub layer, interspersed with European grass-dominated herbaceous ground cover and emergent vegetation (tules, cattails) lining the channel edge.



Figure 2-82. Riparian corridor along the San Joaquin River in the Friant Riparian Potential GDE Unit, observed from Lost Lake Park, May 1, 2019 (Stillwater Sciences).

The Friant Riparian Potential GDE Unit provides habitat or ecosystem support for several special-status species. These species include special-status species that satisfy one or more of the following criteria: (1) known to occur in the region and suitable habitat present in the GDE unit, (2) documented occurrence within the GDE unit, or (3) directly observed during the May 2019 reconnaissance survey conducted by Stillwater Sciences (see **Appendix 2.B**).

The riverine, aquatic habitat of the San Joaquin River is not contained within the GDE unit because available hydrologic data indicates no groundwater connection to the surface flow in the San Joaquin River in this area (i.e., this reach of the San Joaquin River loses water to and is disconnected from the groundwater system). However, the riparian vegetation community of the Friant Riparian Potential GDE Unit fulfills several essential ecosystem functions or provides important habitat elements, such as large wood and riparian shade, on which both semi-aquatic species of the GDE unit and aquatic species of the San Joaquin River depend for completing essential life behaviors.

This unit contains or overlaps several known protected lands, including several parcels owned or managed by the San Joaquin River Parkway and Conservation Trust, and the State-owned San Joaquin River Ecological Reserve (CPAD 2018). In addition, the adjacent San Joaquin River contains Essential Fish Habitat (EFH) for Chinook salmon which is partially dependent on riparian inputs to provide important salmon habitat elements including shade, overhead cover, nutrients, and woody material for instream cover and habitat complexity (PFMC 2014).

The Friant Riparian Potential GDE Unit was determined to have **high ecological value** because of: (1) the likely occurrence of several special-status species and presence of suitable habitat for these species in the unit; (2) the presence of protected lands in the unit; and (3) the presence of species and ecological communities considered somewhat vulnerable to slight to moderate changes in groundwater levels (Rohde et al. 2018). The vegetation composing the GDE unit was determined to be more susceptible to

changes in groundwater depth (i.e., DTW) than other groundwater conditions such as groundwater quality. Its susceptibility to changing groundwater conditions is low because pumping in the main groundwater basin aquifers is unlikely to impact water levels underlying this GDE unit and because shallow groundwater levels in this unit will be maintained in large part by continued restoration flows in the San Joaquin River under the SJRRP. Reconnaissance level biological assessments, aerial photograph analysis, and NDVI/NDMI data indicate adverse impacts are not likely occurring in the Friant Riparian Potential GDE Unit.

San Joaquin River Riparian Potential GDE Unit

The San Joaquin River Riparian Potential GDE Unit extends along the San Joaquin River from Highway 41 downstream to the point near Gravelly Ford where the San Joaquin River is no longer within the Madera Subbasin (**Figure 2-75**). Geologic cross sections show that the upper 60–80 ft under the San Joaquin River is sand and gravel/cobbles, with clay along the channel margins. The Corcoran Clay, a major aquiclude, does not occur under the San Joaquin River Riparian Potential GDE Unit. Beneath the San Joaquin River in the unit there is a perched/mounded aquifer near Gravelly Ford that occurs above the "A Clay" identified in the subsurface mapping, but there is no unsaturated zone between the perched/mounded aquifer and the underlying regional aquifer. Flow in the San Joaquin River is strongly controlled by releases from Friant Dam and water infiltrates from the channel bed into the disconnected aquifers below the reach. Groundwater elevation below the GDE is therefore strongly dependent on operations of Friant Dam.

Groundwater beneath the San Joaquin River Riparian Potential GDE Unit was approximately 20–30 feet deep in winter/spring 2014 and 2016 (i.e., the upper 20–30 feet of the subsurface was unsaturated during this time). This is too deep for the San Joaquin River's surface flow to be connected to groundwater, but within the 30-foot maximum rooting depth of the dominant riparian plants in the unit. Beneath the San Joaquin River, the groundwater is perched or mounded atop the shallow clay layer, but there is no unsaturated zone below the perched/mounded aquifer (Section 2.2.2.5). It is therefore possible that groundwater pumping in the regional aquifer could affect the shallower perched/mounded aquifer that maintains the GDE. The net-losing condition of the San Joaquin River in this area likely began in the 1920s or earlier (TNC 2014).

The San Joaquin River Riparian Potential GDE Unit is composed of several discontinuous areas of riparian vegetation along the San Joaquin River from Highway 41 to the point where the San Joaquin River leaves the Subbasin south of the intersection of Road 21 and Avenue 5 just downstream of Gravelly Ford. This unit includes portions of the riparian corridor of the San Joaquin River, supporting a mix of riparian forest, shrub, and herbaceous plant communities totaling approximately 156 acres. Analysis of existing vegetation mapping data, color aerial imagery, and May 2019 field reconnaissance conducted in representative portions of the unit determined the quality of riparian habitat in this unit to range from low to high, with overall quality considered moderately high. The reconnaissance survey of representative portions of the San Joaquin River Riparian Potential GDE Unit conducted in May 2019 identified areas of native riparian forest, riparian shrub, grassland (**Figure 2-76**). Vegetation in most of these units was over 80% native cover in the shrub and tree layer and less than 50% native cover in the herbaceous ground layer, with the balance occupied by non-native species. Dominant vegetation in woody plant communities included Fremont cottonwood (*Populus fremontii*), Goodding's willow (*Salix gooddingii*), and valley oak (*Quercus lobata*) in the overstory, narrow-leaved willow (*Salix exigua*) in the shrub layer, interspersed with European grass-dominated herbaceous ground cover. Non-native eucalyptus and arundo were observed throughout the unit.

The San Joaquin River Riparian Potential GDE Unit provides habitat or ecosystem support for several special-status species. These species include special-status species that satisfy one or more of the following criteria: (1) known to occur in the region and suitable habitat present in the GDE unit, (2)

documented occurrence within the GDE unit, or (3) directly observed during the May 2019 reconnaissance survey conducted by Stillwater Sciences (see **Appendix 2.B**).

The riverine, aquatic habitat of the San Joaquin River is not contained within the GDE unit because available hydrologic data indicates no substantial groundwater connection to the surface flow in the San Joaquin River in this area (i.e., this reach of the San Joaquin River is disconnected from and loses water to the groundwater system). However, the riparian vegetation community of the San Joaquin River Riparian Potential GDE Unit fulfills several essential ecosystem functions or provides important habitat elements, such as large wood and riparian shade, on which both semi-aquatic species of the GDE unit and aquatic species of the San Joaquin River depend for completing essential life behaviors.

This GDE unit does not include any known protected lands (CPAD 2018) or critical habitat for federally listed species (USFWS 2019, NMFS 2016) but the adjacent San Joaquin River contains Essential Fish Habitat (EFH) for Chinook salmon which is partially dependent on riparian inputs to provide important salmon habitat elements including shade, overhead cover, nutrients, and woody material for instream cover and habitat complexity (PFMC 2014).

The San Joaquin River Riparian Potential GDE Unit was determined to have **moderate ecological value** because of: (1) the likely occurrence of several special-status species and presence of suitable habitat for these species in the unit; and (2) the presence of species and ecological communities considered somewhat vulnerable to slight to moderate changes in groundwater levels (Rohde et al. 2018). The vegetation composing the GDE unit was determined to be more susceptible to changes in groundwater depth (i.e., DTW) than other groundwater conditions such as groundwater quality. While the reconnaissance level biological assessments, aerial photograph analysis, and NDVI/NDMI data indicate that certain areas of the San Joaquin River Riparian Potential GDE Unit are relatively intact and within the range of natural variability, other areas of riparian vegetation show evidence of impaired function and condition (**Appendix 2.B.**). As a result, adverse impacts could be occurring in portions of the unit. Available evidence is insufficient, however, to determine whether adverse impacts are related to groundwater management.

Sumner Hill Potential GDE Unit

The Sumner Hill Potential GDE Unit is located in the eastern portion of the Madera Subbasin, west of the San Joaquin River in the vicinity of the Friant Riparian Potential GDE Unit (**Figure 2-75**). This unit is classified as a potential GDE because its potential connection to groundwater is uncertain due to a lack of data on depth to groundwater, the source of surface water in the unit, and the connection between groundwater and surface water. The depth to bedrock immediately under the unit is not known, but the presence of the bedrock in adjacent hillslopes suggests that bedrock is directly beneath this site (i.e., there is effectively no unconsolidated alluvium beneath this GDE unit). There are no wells between Highway 41 and the San Joaquin River near Sumner Hill, so there is little data on groundwater depth. The paucity of wells also suggests that groundwater is limited at this site. Most of the unit is downstream of the Madera Canal, but the degree to which leakage from the canal contributes to the GDE in this unit is unknown. Approximately 0.8 acres of the GDE is upstream of the Madera Canal which suggests that the unit is not entirely dependent on leakage from the canal. Changes in hydraulic base level downslope (near the San Joaquin River) could potentially affect groundwater elevation near Sumner Hill if groundwater levels along the San Joaquin declined in the future.

The Sumner Hill Potential GDE Unit is located along an unnamed tributary to the San Joaquin River east of Sumner Hill in the Madera Subbasin and is composed of a mix of open water habitat, riparian forest, and emergent wetlands totaling approximately 45 acres. This site was noted during a reconnaissance visit to the Subbasin and is characterized as riparian vegetation and a freshwater emergent wetland on a high terrace fed by what is likely an intermittent drainage that connects to the San Joaquin River downstream

of the unit. Analysis of existing vegetation mapping data, color aerial imagery, and May 2019 field reconnaissance conducted in representative portions of the unit determined the quality of wetland and riparian habitat in this unit to be generally good but with habitat patches ranging from somewhat degraded to excellent quality. The reconnaissance survey of representative portions of the Sumner Hill Potential GDE Unit conducted in May 2019 identified several areas of ponded water surrounded by mature wetland and riparian vegetation (**Figure 2-75**). Vegetation in the unit was over 80% native cover in the shrub and tree layer and dominated by red willow (*Salix laevigata*), Goodding's black willow, Fremont cottonwood, rush and sedge species *(Juncus* spp. and *Carex* spp.), as well as cattails and tules (*Typha* spp*.* and *Schoenoplectus* spp.).

The Sumner Hill Potential GDE Unit provides habitat or ecosystem support for several special-status species. These species include special-status species that satisfy one or more of the following criteria: (1) known to occur in the region and suitable habitat present in the GDE unit, (2) documented occurrence within the GDE unit, or (3) directly observed during the May 2019 reconnaissance survey conducted by Stillwater Sciences (see **Appendix 2.B**).

The Sumner Hill Potential GDE Unit was determined to have **high ecological value** because of (1) the known occurrence of several special status species and presence of suitable habitat; and (2) the presence of species and ecological communities considered somewhat vulnerable to slight to moderate changes in groundwater levels (Rohde et al. 2018). The vegetation composing the GDE unit was determined to be more susceptible to changes in groundwater depth (i.e., DTW) than other groundwater conditions such as groundwater quality. Its susceptibility to changing groundwater conditions is low because pumping in the main groundwater basin aquifers is unlikely to impact water levels underlying this GDE unit. Reconnaissance level biological assessments, aerial photograph analysis, and NDVI/NDMI data indicate adverse impacts are not likely occurring in the Sumner Hill potential GDE Unit (**Appendix 2.B**).

2.2.2.7 Data Gaps in Hydrogeologic Conceptualization and Groundwater Conditions

Certain data gaps are described below. Additional information about data gaps is provided in **Section 3.5.4**.

2.2.2.7.4 Interconnected Surface Water

There is considerable uncertainty associated with the characterization of interconnectivity between groundwater and surface water along the San Joaquin River in the Subbasin. The considerable depth to groundwater in most other areas of the Subbasin indicate no interconnectivity exists along other waterways. However, available shallow groundwater level data suggest that historically there likely have been some time periods and reaches where groundwater and surface water are directly connected along the San Joaquin River within the Subbasin. Because of the limited available data to directly relate stream stage and flow with groundwater levels along the San Joaquin River in the Subbasin, additional coordinated characterization of groundwater and surface water conditions in and along the San Joaquin River would improve the understanding of the nature of any connectivity between groundwater and surface water and inform evaluations of the extent to which groundwater pumping may influence seepage from the San Joaquin River.

One of the key considerations in understanding the groundwater and surface water connectivity along the San Joaquin River in the Subbasin relates to the subsurface sediments along the San Joaquin River. The presence of shallow clay layers beneath the San Joaquin River likely play a major role in how stream seepage interacts with the groundwater system and the extent to which these clay layers create perched/mounded groundwater conditions at shallow depths hydraulically separated from the deeper zones where groundwater pumping is occurring. Improving the characterization of these shallow

subsurface sediments and identification and mapping of any perched groundwater conditions will inform the understanding of surface water and groundwater interactions along the San Joaquin River.

To address the need and interest in improving the understanding of the relationships between groundwater and surface water along the San Joaquin River in the Subbasin, the GSAs intend to develop a workplan outlining future activities related to monitoring and understanding conditions relating to groundwater and surface water connectivity along the San Joaquin River. One of the key objectives of the workplan is to develop an understanding of how groundwater pumping may influence streamflow in the San Joaquin River. An interconnected surface water workplan is included in **Appendix 3.I**. Key topics considered in the workplan include the following:

- Summary of existing surface water monitoring
- Overview of existing groundwater level monitoring in relation to surface water and surface water monitoring
- Review of groundwater pumping and monitoring
- Improvements to subsurface hydrogeologic characterization related to shallow clays and perched groundwater conditions including review of results from recently completed aerial electromagnetic surveys of the area
- Construction of shallow hydrogeologic cross-sections in the vicinity of the San Joaquin River
- Evaluation of groundwater levels at different depths and understanding of vertical hydraulic connections
- Identification of sites for additional characterization through lithologic borings, monitoring well construction, and aquifer testing activities
- Review of numerical modeling results and simulation approaches to evaluate stream seepage responses to groundwater management activities
- Recommendations and implementation plans for future surface water and groundwater monitoring
- Recommendations on future analytical activities and numerical model improvements and any associated field studies that may be needed, including thalweg surveys, rating curve development, or other activities
- Considerations related to coordination of monitoring for any new recharge projects in southern areas of the Subbasin

2.2.3 Water Budget Information (23 CCR § 354.18)

This section presents the historical and current water budgets for the entire Madera Subbasin refined with information and knowledge gained during the assembly of individual water budgets for each GSA within the Subbasin. The work to refine the preliminary water budget and prepare individual GSA water budgets was enabled by a *Counties with Stressed Basins* Grant [43] from DWR to support preparation of the Madera Subbasin GSP.

DWR has published guidance and Best Management Practice (BMP) documents related to the development of GSPs (DWR, 2016), including Water Budget BMPs. Consistent with these BMPs, this section presents the water budget development methodology and results according to the GSP regulations to describe the hydrologic systems within the study area, and includes estimates of

[43] Funded by the Water Quality, Supply, and Infrastructure Improvement Act of 204 (Proposition 1).

uncertainty for various water budget components. An estimate of the sustainable yield of the Madera Subbasin is provided at the end of this section for (1) the reference historical period (1989-2014 hydrologic conditions and land use), (2) the current period (2015 land use with 1989-2014 average hydrologic conditions), and (3) the projected future period (2041-2090)[44] following the implementation period (2020-2040) using projected future land use and historical 1965-2015 hydrologic data.

2.2.3.1 Water Budget Conceptual Model

A water budget is defined as a complete accounting of all water flowing into and out of a defined volume[45] over a specified period of time. When the water budget volume is an entire subbasin, the water budget facilitates assessment of the total volume of groundwater and surface water entering and leaving the subbasin over time, along with the change in the volume of water stored within the subbasin. When applied to a GSA, this method also facilitates assessment of the total volume of surface water entering and leaving a defined GSA boundary.

The conceptual model for the Madera Subbasin and GSA water budgets was developed during previous data collection and analysis efforts conducted by DE and LSCE (2017). This conceptual model is consistent with the GSP regulations, adhering to sound water budget principles and practices described in the Water Budget BMPs, including the use of defined water budget accounting centers covering the three-dimensional subbasin area and defined water budget components quantified according to best available information and science (DWR, 2016).

Water budgets were developed for the Subbasin to characterize historical, current, and projected water budget conditions. These water budgets were developed for the Subbasin and individual GSAs utilizing the data sources and procedures outlined in Section 2.2.3.3 below.

Study Area

The water budget study area is defined as the GSP Plan Area, described above in Section 2.1 (23 CCR § 354.8). The lateral and vertical extents of the study area are the same as those defined for the Plan Area.

Similar to the Plan Area, the vertical extent of the water budget study area is subdivided into a surface water system (SWS) and groundwater system (GWS). The SWS represents the land surface down to the bottom of plant root zone, within the lateral boundaries of the Subbasin. The GWS extends from the bottom of the root zone to the definable bottom of the Subbasin, within the lateral boundaries of the Subbasin.

During water budget development, the study area was also subdivided into seven subregions, each representing one GSA (Table 2-9). For each subregion, the SWS water budget was developed based on GSA-specific information describing land use, available surface water supplies, and other flow paths to facilitate estimation of groundwater extraction.

[44] The 2019-2090 projected water budget was used to provide a 50-year period to evaluate sustainability following the 2020-2040 project implementation period.

[45] Where 'volume' refers to a space with length, width and depth properties, which for purposes of the GSP means the defined aquifer and associated surface water system.

Table 2-9. Madera Subbasin GSAs and Water Budget Subregions.

GSA	Subregion	Subregion Abbreviation	Subregion Area, Acres
Madera County GSA	Madera County	MC	177,800
Madera Irrigation District GSA	Madera ID	MID	133,850
City of Madera GSA	City of Madera	COM	10,100
Root Creek Water District GSA	Root Creek WD	RCWD	9,550
Gravelly Ford Water District GSA	Gravelly Ford WD	GFWD	8,400
New Stone Water District GSA	New Stone WD	NSWD	4,200
Madera Water District GSA	Madera WD	MWD	3,700
		Total	**347,600**

General Water Budget Accounting Structure and Components

For accounting purposes, the water budget is divided into the Surface Water System (SWS) and Groundwater System (GWS), described above. These systems are referred to as *accounting centers*. Flows between accounting centers and storage within each accounting center represent water budget *components*. Separate but related water budgets were prepared for each accounting center that together represent the overall Subbasin water budget. A schematic of the general water budget accounting structure is provided in Figure 2-83.

For accounting water in the SWS, interrelated water budgets were prepared individually for each subregion and for the entire Subbasin. For accounting water in the GWS, a Subbasin water budget was prepared integrating components in a numerical model of both the SWS and GWS, referred to as the MCSim model. The MCSim model was developed based on the fine-grid California Central Valley Groundwater-Surface Water Simulation Model (C2VSim-FG).

A conceptual representation of the Madera Subbasin model water budget accounting centers and components is provided in Figure 2-84. Required components for each accounting center are listed in Table 2-10, along with the corresponding section of the GSP regulations. Note that precipitation is not explicitly listed as a required water budget component, though it is needed to provide complete accounting of Subbasin inflows and outflows.

Subbasin boundary inflows and outflows must be quantified according to GSP regulations, as stated in 23 CCR § 354.18(b). Inflows and outflows may cross the Subbasin boundary or may represent exchanges of water between the SWS and the underlying GWS within the Subbasin.

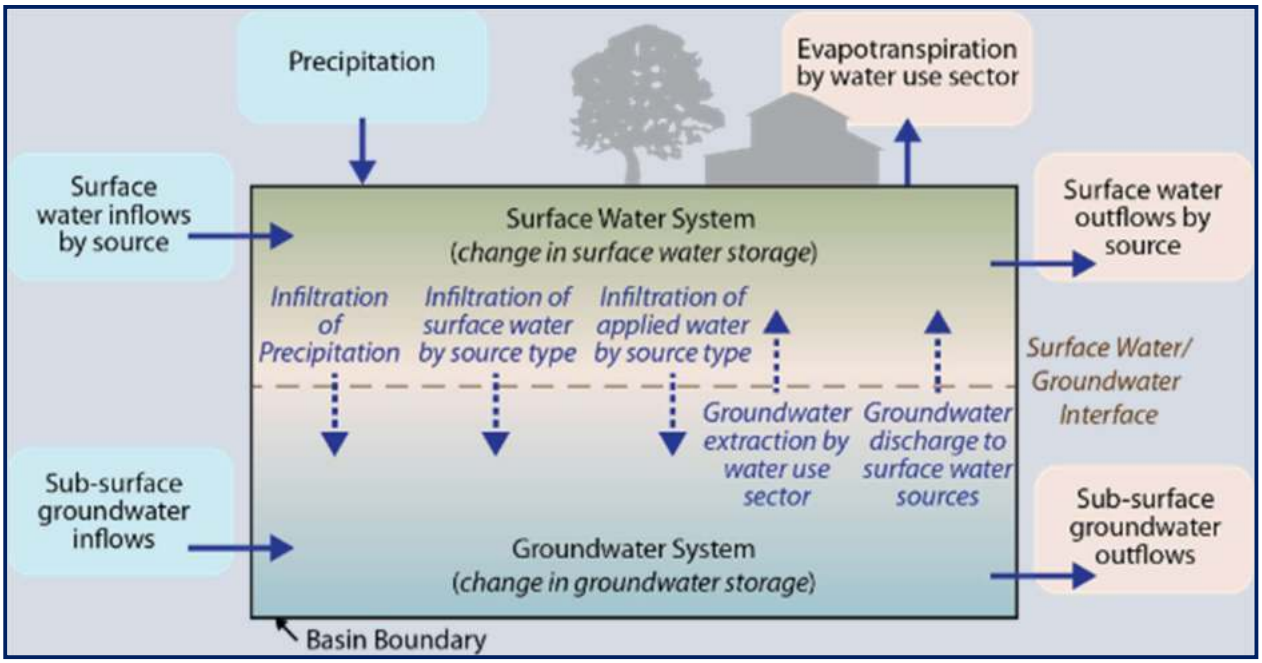


Figure 2-83. Water Budget Accounting Structure (Source: DWR, 2016).

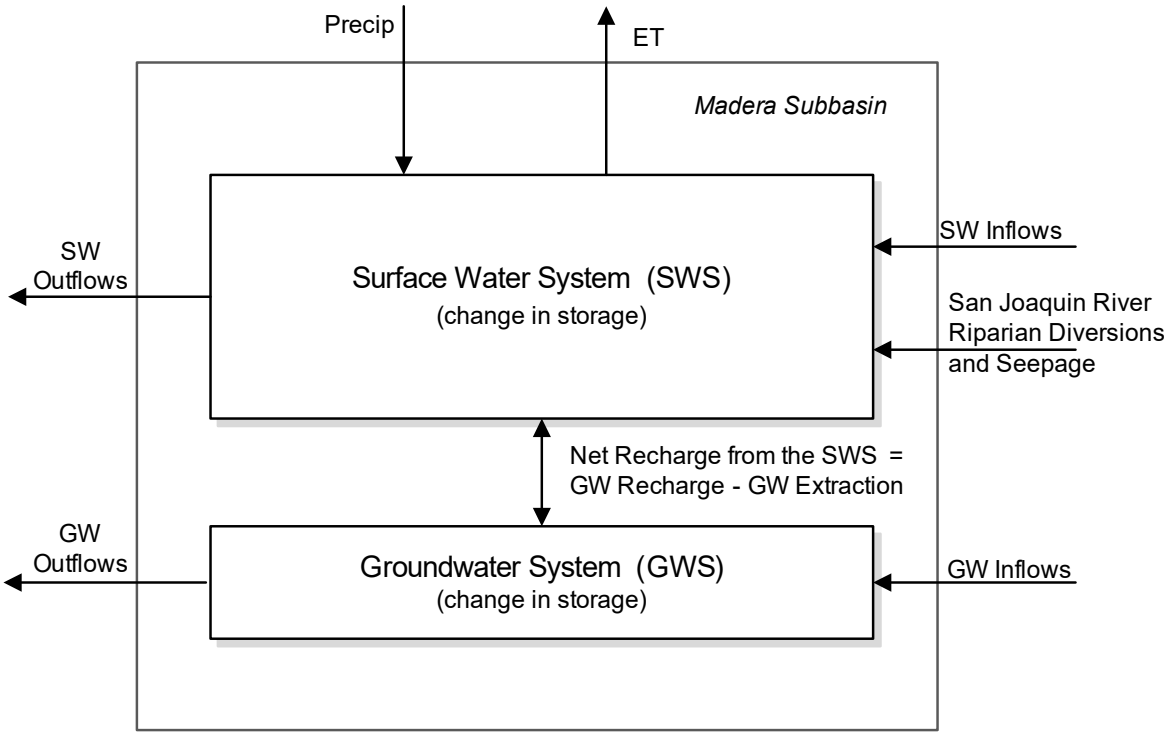


Figure 2-84. Madera Subbasin Boundary Water Budget Diagram.

Table 2-10. Water Budget Components by Accounting Center and Associated GSP Regulations.

Accounting Center	Water Budget Component (flow direction)	23 CCR Section[46]
Basin	Surface Water Inflow[1] (+)	§ 354.18(b)(1)
	Precipitation (+)	Implied
	Subsurface Groundwater Inflow (+)	§ 354.18(b)(2)
	Evapotranspiration[2] (-)	§ 354.18(b)(3)
	Surface Water Outflow[1] (-)	§ 354.18(b)(1)
	Subsurface Groundwater Outflow (-)	§ 354.18(b)(3)
	Change in Storage	§ 354.18(b)(4)
Surface Water System	Surface Water Inflow[1] (+)	§ 354.18(b)(1)
	Precipitation (+)	Implied
	Groundwater Extraction (+)	§ 354.18(b)(3)
	Groundwater Discharge (+)	§ 354.18(b)(3)
	Evapotranspiration[2] (-)	§ 354.18(b)(3)
	Surface Water Outflow[1] (-)	§ 354.18(b)(1)
	Infiltration of Applied Water[3,4] (-)	§ 354.18(b)(2)
	Infiltration of Surface Water[5] (-)	§ 354.18(b)(2)
	Infiltration of Precipitation[3] (-)	§ 354.18(b)(2)
	Change in Storage[6]	§ 354.18(a)
Groundwater System	Subsurface Groundwater Inflow (+)	§ 354.18(b)(2)
	Infiltration of Applied Water[3,4] (-)	§ 354.18(b)(2)
	Infiltration of Surface Water[5] (-)	§ 354.18(b)(2)
	Infiltration of Precipitation[4] (-)	§ 354.18(b)(2)
	Subsurface Groundwater Outflow (-)	§ 354.18(b)(3)
	Groundwater Extraction (-)	§ 354.18(b)(3)
	Groundwater Discharge (-)	§ 354.18(b)(3)
	Change in Storage	§ 354.18(b)(4)

1. By water source type.
2. By water use sector.
3. Synonymous with deep percolation.
4. Includes infiltration of applied surface water, groundwater, recycled water, and reused water.
5. Includes infiltration of lakes, streams, canals, drains, and springs. Synonymous with seepage.
6. Includes surface water streams and root zone (not groundwater system).

Boundary inflows include precipitation, surface water inflows (in various canals and streams), boundary watercourse seepage and groundwater inflows from adjoining subbasins. Outflows include evapotranspiration (ET), surface water outflows (in various canals and streams), and groundwater outflows. ET includes: ET of applied water (ET from soil and crop surfaces, of water that is derived from

[46] California Code of Regulations, Title 23, Division 2, Chapter 1.5, Subchapter 2 Groundwater Sustainability Plans, Article 5 Plan Contents

applied surface water, groundwater, recycled water, and reused water); ET of precipitation (ET from soil and crop surfaces, of water that is derived from precipitation); and evaporation from rivers, streams, canals, reservoirs, and other water bodies. ET of applied water (also identified as ET_{aw}) differs from applied water in that applied water is the volume of water that is directly applied to the land surface by irrigators (from all water sources), whereas ET_{aw} is the volume of that applied water that is consumptively used by crops, vegetation, and soil surfaces.

Also represented in Figures 2-83 and 2-84 are groundwater recharge and extraction, which are "internal" flows between the SWS and GWS. Net recharge from the SWS is defined as groundwater recharge minus groundwater extraction, and is useful for understanding and analyzing the combined effects of land surface processes on the underlying GWS. Subbasin boundary inflows and outflows are quantified on a monthly basis, including accounting for any changes in storage, such as changes is water stored in the root zone (**Equation 2-1**).

Inflows – Outflows = Change in Storage (monthly time step) [2-1]

Selection of the water budget analysis period is discussed in Section 2.2.3.2 below. The specific components of SWS inflows and outflows and the available data and calculation methodology for each component are summarized briefly in Section 2.2.3.3 below. Additional detail for inflows and outflows to each GSA is provided in **Appendix 2.F.** Inflows and outflows were calculated independently using measurements and other data or were calculated as the water budget closure term.

The Subbasin water budget was completed on a monthly time step and water year annual results are reported in Section 2.2.3.4 according to GSP regulations. Detailed SWS water budgets are reported for each individual GSA in **Appendix 2.F.a** through **Appendix 2.F.g.**

Quantification of GWS inflows and outflows is described below and in **Appendix 6.D.** The GWS water budget was completed for the entire Subbasin on a monthly time step. Some GSAs are small or are composed of noncontiguous small areas, making it difficult to accurately calculate the change in volume of groundwater stored. As a result, GWS water budgets were not calculated for individual GSAs.

Detailed Water Budget Accounting Centers and Components

To estimate the water budget components required by the GSP regulations, the SWS water budget accounting center is further subdivided into detailed accounting centers representing the Land Surface System (irrigated and non-irrigated lands), the Rivers and Streams System (natural waterways), and the Canal System.

Finally, the Land Surface System is subdivided into accounting centers representing water use sectors identified in the GSP regulations as "categories of water demand based on the general land uses to which the water is applied, including urban, industrial, agricultural, managed wetlands, managed recharge, and native vegetation" (23 CCR § 351(al)). Across the Madera Subbasin and within each subregion, the water use sector accounting centers include Agricultural Land (AG), Urban Land (UR) (urban, industrial, and semi-agricultural), and Native Vegetation Land (NV). Industrial land covers only a small area of the Subbasin, so industrial water uses have been combined with urban and semi-agricultural uses in the Urban land use sector.

Detailed water budget components are defined for each detailed accounting center. Within the Land Use Sector accounting center, detailed water budget components are also defined for each water use sector accounting center. The addition of these detailed water budget accounting centers and components facilitates the development of water budgets based on the best available data and science by facilitating the incorporation of information from agricultural water management plans (AWMPs), urban water management plans (UWMPs) and other sources.

Water budget components for each detailed accounting center within the Madera Subbasin SWS are described in Tables 2-11 through 2-13. These water budget components were independently considered for each GSA to account for unique inflows and outflows to each GSA water budget presented in **Appendix 2.F.**

Table 2-11. Land Surface System Water Budget Components.

Detailed Accounting Center	Detailed Component	Category	Description
Land Surface System *Water Use Sectors: Agricultural Land, Native Vegetation Land, Urban Land*	Deliveries	Inflow	Deliveries from canal system to customers.
	Riparian Deliveries	Inflow	Deliveries from rivers and streams system to water rights users on lands adjacent to a river or stream.
	Groundwater Extraction	Inflow	Groundwater pumping to meet water demands.
	Precipitation	Inflow	Direct precipitation on the land surface.
	Reuse	Inflow	Reuse of percolated water from the unsaturated zone[47] (considered negligible in the Madera Subbasin).
	ET of Applied Water	Outflow	Consumptive use of applied irrigation water. In wetlands and riparian areas, may represent shallow groundwater uptake.
	ET of Precipitation	Outflow	Consumptive use of infiltrated precipitation.
	Runoff of Applied Water	Outflow	Direct runoff of applied irrigation water, includes tailwater and pond drainage for ponded crops (no ponded crops are grown in the Madera Subbasin).
	Runoff of Precipitation	Outflow	Direct runoff of precipitation.
	Infiltration of Applied Water	Outflow	Percolation of applied water below the root zone.
	Infiltration of Precipitation	Outflow	Percolation of precipitation below the root zone.
	Change in Storage	Storage	Change in storage of applied water within the root zone.

[47] "The unsaturated zone is below the land surface system and represents the portion of the basin that receives percolated water from the root zone and either transmits it as deep percolation to the groundwater system or to reuse within the land surface system, or both." In *Water Budget BMP* (DWR, 2016).

Table 2-12. Rivers and Streams System Water Budget Components.

Detailed Accounting Center	Detailed Component	Category	Description
Rivers and Streams System	Surface Inflows	Inflow	Surface inflows at upper boundary of water budget area.
	Evaporation	Outflow	Direct evaporation from river and stream water surfaces.[48]
	Infiltration of Surface Water (Seepage)	Outflow	Seepage from rivers and streams to the groundwater system during times of natural flow (during the times that rivers and streams serve as conveyance for irrigation releases, seepage is considered as part of the Canal System accounting center).
	Riparian Deliveries	Outflow	Deliveries from the Rivers and Streams system to water rights users on lands adjacent to a river or stream.
	Surface Outflows	Outflow	Surface outflows at lower boundary of water budget area.

Table 2-13. Canal System Water Budget Components.

Detailed Accounting Center	Detailed Component	Category	Description
Canal System	Diversions	Inflow	Diversions from Rivers and Streams System, including lakes and reservoirs in some cases.
	Evaporation	Outflow	Direct evaporation from canal water surfaces (unlined canals are generally maintained to be weed-free, so ET from bankside vegetation is not included).
	Infiltration of Surface Water (Seepage)	Outflow	Seepage from canals to the groundwater system and seepage from rivers and streams during the times that they serve as conveyance for irrigation releases.
	Spillage	Outflow	Spillage resulting from canal operations to the Rivers and Streams System.
	Deliveries	Outflow	Deliveries from the canal system to customers.

Characterization of Water Budget Components by Hydrologic Year Type

Surface water hydrology of the San Joaquin Valley is characterized by large variability in inter-annual precipitation and runoff resulting in both drought and flooding, sometimes in the same year. In contrast, relative differences in seasonal runoff are more predictable, with rainfall runoff occurring during the winter or snowfall forming snowpack in higher elevations that runs off as it melts in the spring and early summer.

[48] Does not include evapotranspiration of riparian vegetation (accounted in Land Surface System evapotranspiration).

A key indicator of seasonal variability in inter-annual hydrology is the San Joaquin Valley Water Year Index[49] (WYI), which is used to classify individual water years as Wet (W), Above Normal (AN), Below Normal (BN), Dry (D), or Critical (C) with respect to surface water runoff in the San Joaquin River Basin. These classifications are termed "water year types." A water year is defined as the period from October 1 of the preceding calendar year to September 30 of the current calendar year. For example, the 2000 water year represents the period from October 1, 1999, to September 30, 2000.

Rivers contributing to runoff from the San Joaquin Basin include, amongst others, the San Joaquin River itself, the Tuolumne River, the Stanislaus River, and the Merced River. The WYI for each year is weighted 80 percent based on unimpaired runoff from the San Joaquin Basin for the current year and 20 percent based on unimpaired runoff from the prior year (expressed in millions of acre-feet (maf)).[50] Unimpaired runoff represents the amount of runoff that would occur in the basin absent any diversions, storage, or inter-basin imports and exports.

The San Joaquin Valley WYI for the 51-year period from 1965 to 2015 is shown in Figure 2-85, along with corresponding water year type classifications. During this period, the WYI ranged from 0.81 maf in 2015 to 7.22 maf in 1983, representing a nine-fold difference. The average WYI over this period is 3.2 maf. Historical and recent drought periods are evident in the figure. Notably, only two above normal or wet years occurred between 2007 and 2015, and only four above normal or wet years have occurred between 2001 and 2015.

The distribution of water year types was considered in selecting water budget analysis periods that appropriately represent average historical hydrologic conditions. To support evaluation of differences in water budget components related to variable hydrology, the water year type associated with each year is also shown along with the SWS water budget results reported in section 2.2.3.4 of this report.

2.2.3.2 Water Budget Analysis Period

Criteria for Base Period Selection

In accordance with GSP regulations, a base period must be selected so that the analysis of sustainable yield is performed for a representative period with minimal bias that might result from the selection of an overly wet or dry period, while recognizing changes in other conditions including land use and water demands.

Per the GSP regulations, the historical base period must include a minimum of 10 years of surface water supply information, with 30 years recommended; the current base period must include a representative recent one-year period; and the projected base period must include a minimum of 50 years of historical precipitation, evapotranspiration, and stream flow data.

[49] California Department of Water Resources, California Cooperative Snow Surveys, *Chronological Reconstructed Sacramento and San Joaquin Valley Water Year Hydrologic Classification Indices* (http://cdec.water.ca.gov/cgi-progs/iodir/WSIHIST). Last accessed on 2/22/2019.

[50] California Environmental Protection Agency State Water Resources Control Board (SWRCB). 1995. *Water Quality Control Plan for the San Francisco Bay/ Sacramento-San Joaquin Delta Estuary*, pg. 24.

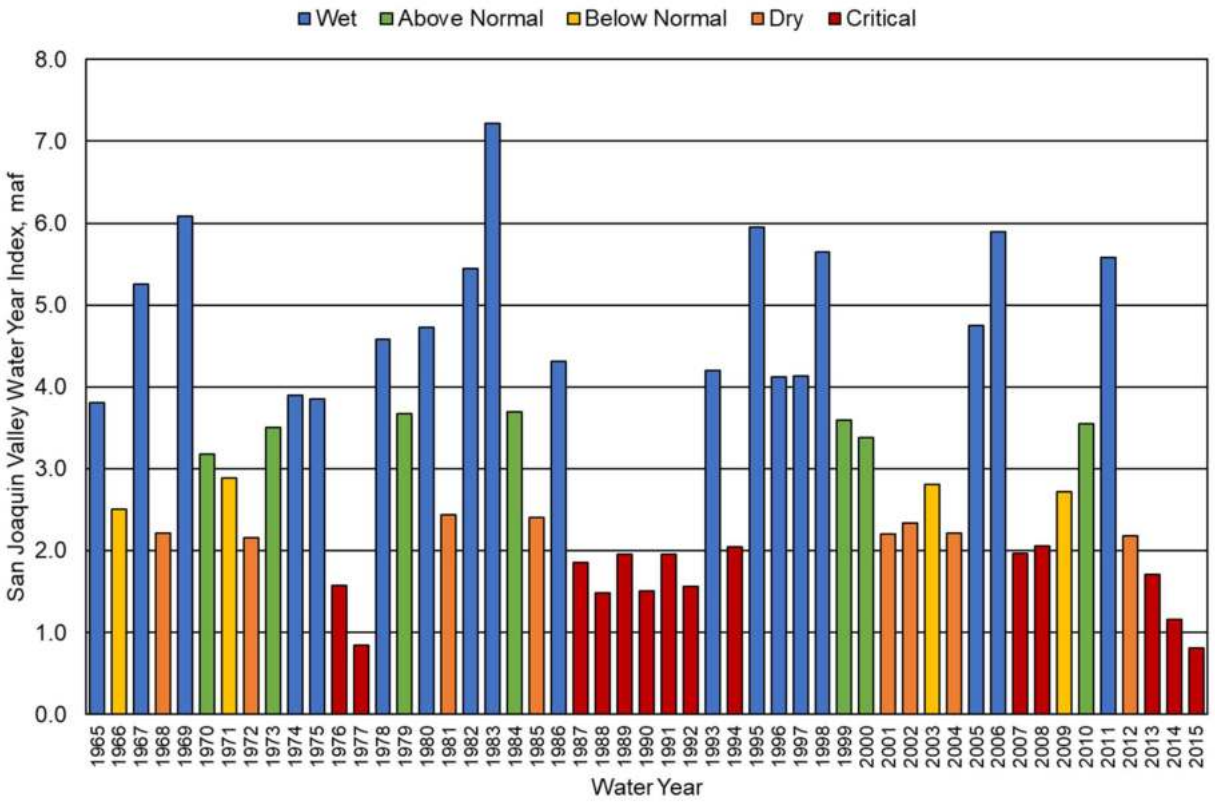


Figure 2-85. San Joaquin Valley Water Year Index, 1965-2015.

The historical, current, and projected water budget base periods were selected on a water year basis considering the following criteria: San Joaquin Valley water year type; long-term mean annual water supply; inclusion of both wet and dry periods, antecedent dry conditions, adequate data availability; and inclusion of current hydrologic, cultural, and water management conditions in the Subbasin. Historical records of precipitation, unimpaired flows along the Fresno River, and USBR Central Valley Project (CVP) supplies served as an indicator of long-term mean water supply and potential for natural groundwater recharge during evaluation of proposed periods.

Historical Period

For the Madera Subbasin GSP, a 26-year historical water budget base period of water years 1989 through 2014 was selected.

As described in the Data Collection and Analysis Technical Memorandum for Madera County (DE and LSCE, 2017), available data was sufficient to develop a historical water budget for water years 1989 through 2015. However, the 1989 through 2014 period was found to be more representative of long-term average conditions as compared to the 1989 through 2015 following analysis of precipitation, unimpaired flows, and CVP supplies. Due to the comparative dryness of 2015 and corresponding low water supplies that year, including 2015 in the historical period would result in drier average hydrologic conditions than the long-term average.

Precipitation records in Madera, including annual precipitation, mean annual precipitation, and cumulative departure[51] from mean annual precipitation, are provided in Figure 2-86. As shown, a long-term average period between the late 1920s and the late 1970s (overall flat cumulative departure curve) was followed by alternating wet and dry periods, an average period between the late 1990s and 2011, and a dry period between 2012 and 2015.

In this context, 1989 to 2014 is a relatively balanced climatic period compared to the 1929 through 2015 period with a similar number of wet and dry years and some prolonged periods of wet, dry, and average conditions, representing a reasonable base period for conducting sustainability analyses.

Historical patterns of CVP supplies and unimpaired flows[52] along the Fresno River are shown in Figures 2-87 and 2-88. Given the extremely low CVP supplies and unimpaired flows in 2015, a historical base period of water years 1989 through 2014 was selected.

This period begins in 1989, a critical year preceded by two critical years, and ends in 2014, a critical year with several prior critical or dry years, so that any water unaccounted for in the unsaturated zone is minimized[53]. Lastly, the proposed historical base period ends near the present time so that this period can also be used to assess groundwater conditions as they currently exist.

Thus, the historical base period of 1989 to 2014 provides an appropriate base period for assessing historical groundwater conditions with minimal bias from long-term land use changes or imbalances due to wet or dry conditions.

Current Period

For the current water budget, land use data from 2015 was used to calculate consumptive use and other root zone components in the Land Surface System water budget. This year was selected as most representative of current land use among years with available data at the initiation of SGMA data collection and analysis work in early 2017. To complete the current water budget, the 2015 root zone water budget components were combined with meteorological and surface water components representing average hydrologic conditions during the 1989 through 2014 historical base period, assuming the 2015 land use occurred in all years. This was considered a more accurate representation of current inflows and outflows from the Subbasin and each GSA as compared to evaluating hydrologic conditions in a single year.

[51] Cumulative departure curves are useful to illustrate long-term hydrologic characteristics and trends during drier or wetter periods relative to the mean annual precipitation or streamflow. Downward slopes of the cumulative departure curve represent drier periods relative to the mean, while upward slopes represent wetter periods relative to the mean. A steep slope indicates a drastic change in dryness or wetness during that period, whereas a flat slope indicates average conditions during that period, regardless of whether the total cumulative departure falls above or below zero.

[52] Unimpaired flow is defined as flow "that would have occurred had water flow remained unaltered in rivers and streams instead of stored in reservoirs, imported, exported, or diverted." (DWR, 2007).

[53] Antecedent (i.e., prior or left-over year) dry conditions minimize differences in groundwater in the unsaturated zone at the beginning and at the end of a study period. Given that the volume of water in the unsaturated zone is difficult to determine, particularly at the scale of a groundwater subbasin, selection of a base period with relatively dry conditions antecedent to the beginning and end of the period of record is preferable.

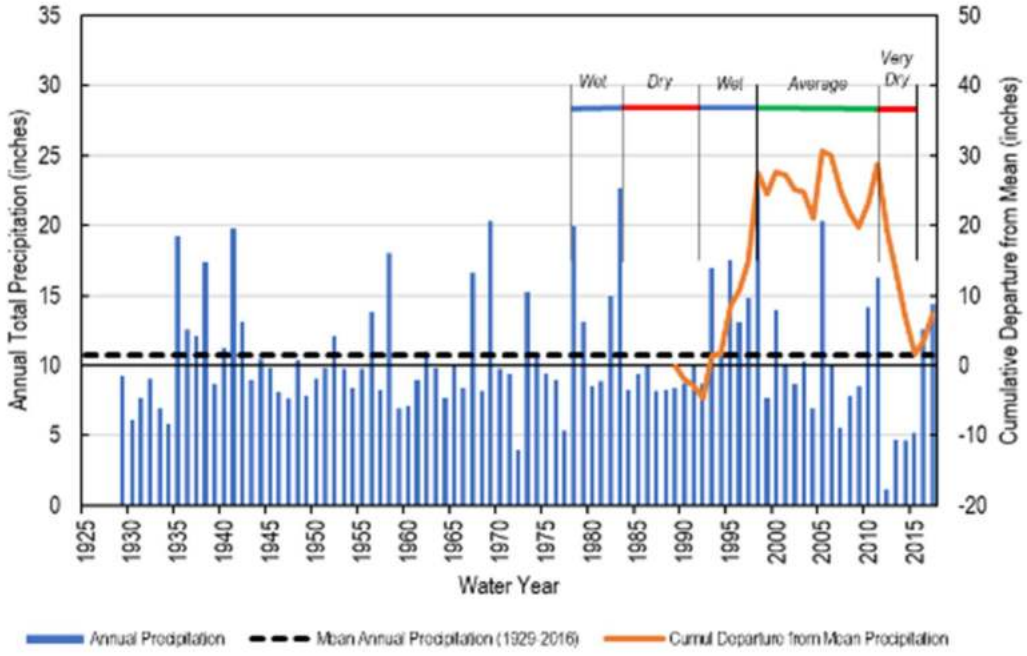


Figure 2-86. Annual Precipitation and Cumulative Departure from Mean Precipitation in Madera, CA.[54]

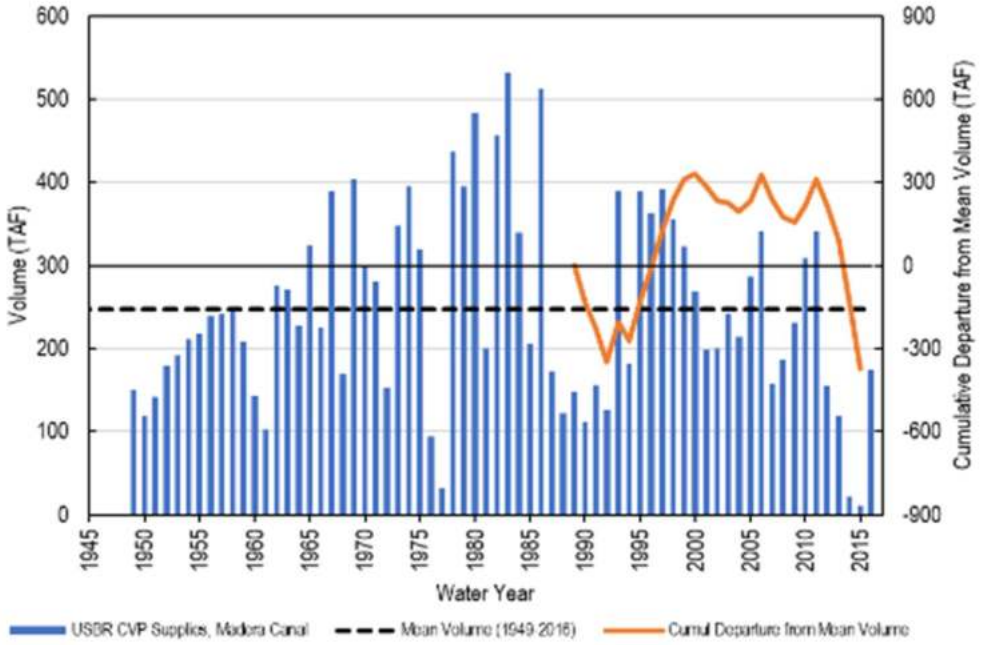


Figure 2-87. Annual CVP Supplies and Cumulative Departure from Mean CVP Supplies along Madera Canal.[55]

[54] Precipitation data from National Oceanic and Atmospheric Administration National Centers for Environmental Information (NOAA NCEI) Station 045233.

[55] Madera Canal inflows from U.S. Geologic Survey (USGS) Site 11249500 (MADERA CN A FRIANT CA).

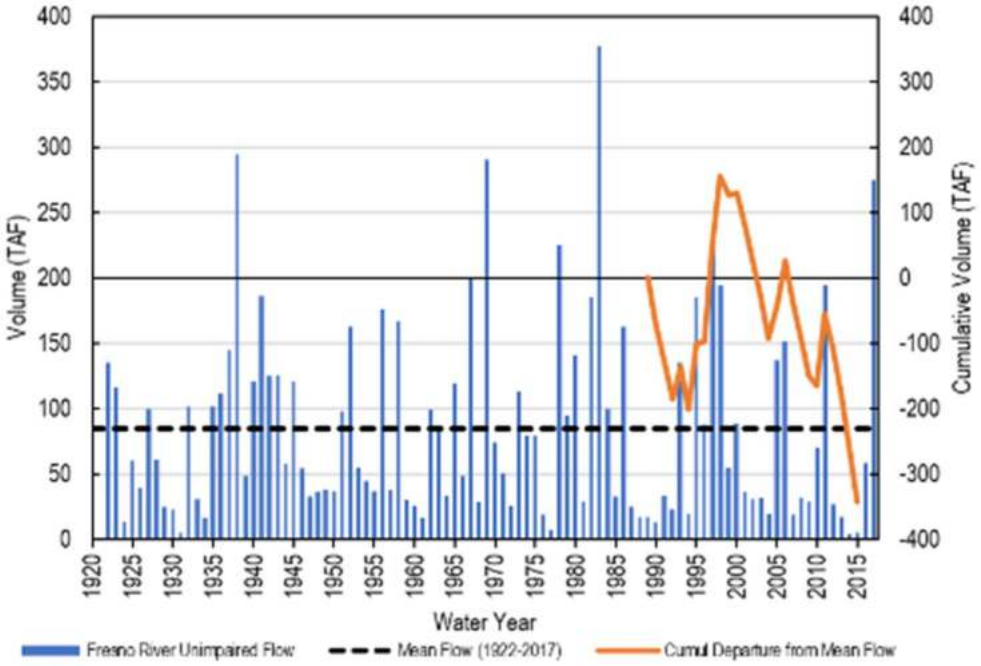


Figure 2-88. Annual Flow and Cumulative Departure from Mean Flow along Fresno River near Daulton, CA.[56]

Projected Period

For the projected water budgets used to evaluate projects, a 72-year projected period was chosen to provide a 22-year project implementation period from 2019-2040 and a 50-year period to evaluate sustainability from 2041-2090. Time series data for water years 2019-2090 were developed using:

1. Historical hydrologic data from water years 1965-2015
2. Historical water supply data from 1989-2015, with adjustment of CVP supply based on projected alteration of available Friant Releases by the San Joaquin River Restoration Program[57]
3. 2017 land use adjusted for urban area projected growth from 2017-2070 (areas were held constant from 2071-2090)[58]

The years that were used for developing the projected period hydrologic and water supply data were chosen because (1) they mostly closely matched long-term mean annual water supply, based on

[56] Fresno River unimpaired flows compiled from: 2016 Department of Water Resources, Bay-Delta Office, Natural and Unimpaired Flows for the Central Valley of California (1922-2014); California Data Exchange Center, U.S. Army Corps of Engineers (USACE) Station FHL (FRESNO R ABV HENLEY LAKE) (2015-2017).

[57] Estimated by the Friant Water Authority Report (or Friant Report): "Estimate of Future Friant Division Supplies for use in Groundwater Sustainability Plans, California" (2018). Although the Friant Report accounts for climate change, it is considered the best available estimate of projected Madera Canal deliveries under SJRRP. For comparison, projected Madera Canal deliveries under SJRRP were also estimated without account for climate change from the Steiner Report Kondolf Hydrograph (Steiner, 2005). These estimates were approximately equal to the Friant Report 2030 climate change adjusted deliveries. Thus, the Friant Report projections were used instead to maintain consistent assumptions in estimating Madera Canal deliveries across all projected simulations.

[58] Land use adjustment for urban area projected growth also accounts for changes in agricultural and municipal water use. See Section 2.2.3.3, "Crop Water Use" and "Urban Water Use."

comparative analysis with all available historical data for Madera Canal and Fresno River; (2) they included both wet and dry periods; and (3) because of data availability for a 50-year time period. In particular, the implementation period was simulated with hydrologic and water supply data from 2000-2010. This period was chosen because it represents a recent 10-year period of relatively average annual water supply (compared to the long-term mean annual water supply), with a relatively uniform distribution of water year types that begins and ends with a drier period, such that any water unaccounted for in the unsaturated zone is minimized. Other years were simulated with hydrologic and water supply data matched to each year based on expected similarities in water year indices.

To evaluate sensitivity to climate change, projected water budgets were also developed using:

1. Historical hydrologic data from water years 1965-2015 adjusted by DWR-provided 2030 mean climate change factors
2. Historical water supply data from 1989-2015 adjusted similarly by climate change factors, with additional adjustment of CVP supply based on projected alteration of available Friant Releases by the San Joaquin River Restoration Program
3. 2017 land use adjusted for urban area projected growth from 2017 through 2070 (areas were held constant from 2071 through 2090)

Water Budget Time Step

The GSP regulations specify that sustainability analyses be conducted on at least an annual time step. However, a monthly time step is recommended to support evaluation of sustainability indicators and potential PMAs. These sustainability evaluations, which may include analyses involving hydrologic modeling, require data and analyses at a time step sufficient to assess seasonal conditions and trends within an annual interval in addition to long-term trends spanning years.

Water budget calculations were performed on a monthly time step, although certain water budget components identified in Section 2.2.3.3 (e.g. runoff of precipitation) were calculated on a daily basis before being summed to monthly values. For reporting purposes, water budget results are summarized by water year.

Water Budget Reporting by Analysis Period

The historical and current water budgets were completed for the SWS outside of the MCSim model. The historical budget was used to develop model inputs and to confirm and calibrate model outputs. The current budget was used to estimate the net recharge from the SWS (net recharge), defined as the average annual sum of all groundwater extraction (negative) and groundwater recharge (positive) to and from the surface and root zone overlying the Madera Subbasin. “Shortage” was also calculated from the water budget as the inverse of net recharge (sum of all groundwater extraction (positive) and groundwater recharge (negative) to and from the surface and root zone overlying the Madera Subbasin). This “shortage” was used to inform stakeholders regarding the Subbasin status and to determine the extent of projects and/or demand management required for the Subbasin to reach sustainability.

The projected water budget was completed only in the MCSim model. The projected water budget in the MCSim model was first developed without projects. Then, the projects and/or demand reduction actions developed to bring the Subbasin to sustainability were added to the projected water budget to confirm that these projects and/or demand reduction actions were sufficient to reach sustainability by 2040.

2.2.3.3 Water Budget Components and Uncertainties

This section provides a summary of the data sources and calculations used to develop time series datasets for each component in the Subbasin SWS water budget. The datasets include surface water inflows and outflows, meteorological data used to compute reference crop evapotranspiration (ET_{ref}), land use and

cropping patterns, crop water use (evapotranspiration, or ET), surface water diversions, applied surface water volumes, and groundwater pumping volumes. Each of these datasets is summarized below by accounting center.

Land Surface System

In the Madera Subbasin, the Land Surface System encompasses all land surface area apart from rivers, streams, and canal systems. As required by the GSP regulations, the total Land Surface System is subdivided into three water budget accounting centers representing Agricultural Land (AG), Urban Land (UR) (urban, industrial, and semi-agricultural land), and Native Vegetation Land (NV) water use sectors. Water budgets for each water use sector accounting center are developed with distinct, but similar, inflow and outflow components. Water budgets for each water use sector accounting center were developed uniquely for each Madera Subbasin GSA, as described in **Appendix 2.F.**

Detailed Land Surface System water budget components are summarized in Table 2-14, including general components included in every water use sector water budget and specific components unique to individual water use sectors. This table also includes a brief description of the estimation methods and information sources for each component. Details for each component are provided in **Appendix 2.F.** for each data type used in the water budgets.

Meteorological Data

In the Land Surface System water budgets, meteorological data is used directly in calculating precipitation inflows and indirectly for estimating crop consumptive use, or evapotranspiration, and for simulating root zone characteristics over time using a root zone model (described below).

All weather data time series required for developing the Land Surface System water budget components were derived from weather station data reported by the California Irrigation Management Information System (CIMIS) and National Oceanic and Atmospheric Administration National Centers for Environmental Information (NOAA NCEI). CIMIS and NOAA NCEI data were obtained and quality controlled following the procedure described in **Appendix 2.F.h.** Table 2-15 lists the stations and periods of record used for each station. Between 1988 and 2015, CIMIS data from various stations in and around the Subbasin were used to calculate daily reference crop evapotranspiration (ET_{ref}) and develop precipitation time series for the Madera Subbasin. These stations are preferred due to their siting specifically in agricultural areas. During years in the water budget analysis periods when CIMIS data was not available, data from the Madera NOAA NCEI station was used to estimate ET_{ref} and to develop precipitation time series.

Precipitation

Daily precipitation inflows to each Land Surface System water use sector were calculated as the daily precipitation depth derived from weather station data (in feet) applied over the total area of each water use sector within the Subbasin (in acres). Daily precipitation volumes were summarized to monthly and annual volumes for water budget development. Daily precipitation depths were also provided as inputs to the root zone model to simulate precipitation availability for consumptive use, infiltration, and runoff.

Reference Evapotranspiration

Daily reference crop evapotranspiration (ET_{ref}) was determined by following the scientifically sound and widely accepted standardized Penman-Monteith (PM) method, as described by the ASCE Task Committee Report on the Standardized Reference Evapotranspiration Equation (ASCE-EWRI, 2005). The Task Committee Report standardizes the ASCE PM method for application to a full-cover alfalfa reference (ET_r) and to a clipped cool season grass reference (ET_o). The clipped cool season grass reference was selected

for this application, as it is widely used throughout California. Daily ET_o values were provided as inputs to the root zone model for simulating crop consumptive use requirements.

Table 2-14. Land Surface System Water Budget General Detailed Components and Estimation Techniques.

Detailed Component	Category	Water Use Sector	Subregion	Data Type	Calculation/Estimation Technique	Information Sources
Precipitation	Inflow	AG, UR, NV	All	Meteorological Data	Calculated as the precipitation depth over the total land area by Water Use Sector	Madera NCEI, Fresno/Madera/Madera II CIMIS, land use data
Groundwater Extraction/Upflux	Inflow	AG, UR, NV	All (except MWD AG)	Closure Term	Calculated as the difference of total inflows and total outflows from the Water Use Sector water balance	Closure Term
	Inflow	AG	MWD	Groundwater Data	Reported by historical MWD records	MWD Groundwater Management Plan (GMP)
Surface Water Deliveries	Inflow	AG	MID, MWD, GFWD	Surface Water Data	Measured by water suppliers	MID STORM delivery database, GFWD delivery records, MWD delivery records
Riparian Deliveries	Inflow	AG	MC, MID, RCWD	Surface Water Data	Reported by historical water rights and statements of diversion, estimated from streamflow and crop ET when records not available	eWRIMS, Holding Contracts
Evapotranspiration (ET) of Applied Water	Outflow	AG, UR	All	Meteorological Data, Crop Water Use (Root Zone Model)	Estimated by IDC root zone water budget using CIMIS reference ET, precipitation, estimated crop coefficients from energy balance (SEBAL) analysis, cropped area by crop type	Fresno/Madera/Madera II CIMIS, land use data
Evapotranspiration (ET) of Precipitation	Outflow	AG, UR, NV	All	Meteorological Data, Crop Water Use (Root Zone Model)	Estimated by IDC root zone water budget using CIMIS reference ET, CIMIS precipitation, estimated crop coefficients from energy balance (SEBAL) analysis, cropped area by crop type	Fresno/Madera/Madera II CIMIS, land use data
Infiltration of Applied Water	Outflow	AG, UR	All	Root Zone Model	Estimated by IDC root zone water budget using CIMIS precipitation, NRCS soils characteristics, cropped area by crop type	Fresno/Madera/Madera II CIMIS, land use data, NRCS soil survey
Infiltration of Precipitation	Outflow	AG, UR, NV	All	Root Zone Model	Estimated by IDC root zone water budget using CIMIS precipitation, NRCS soils characteristics, cropped area by crop type	Fresno/Madera/Madera II CIMIS, land use data, NRCS soil survey
Runoff of Applied Water	Outflow	AG, UR	All	Root Zone Model	Estimated as negligible in the Madera Subbasin	Fresno/Madera/Madera II CIMIS, land use data, NRCS soil survey
Runoff of Precipitation	Outflow	AG, UR, NV	All	Root Zone Model	Estimated by IDC root zone water budget using CIMIS precipitation, NRCS soils characteristics, cropped area by crop type	Fresno/Madera/Madera II CIMIS, land use data, NRCS soil survey
Change in Storage	Outflow	AG, UR, NV	All	Root Zone Model	Estimated by IDC root zone water budget as net change in root zone water due to consumption or infiltration.	Fresno/Madera/Madera II CIMIS, land use data, NRCS soil survey

Table 2-15. Madera Subbasin Weather Data Time Series Summary.

Weather Station	Station Type	Start Date	End Date	Comment
Fresno State	CIMIS	Oct. 2, 1988	May 12, 1998	Used before Madera CIMIS station was installed.
Madera	CIMIS	May 13, 1998	Apr. 2, 2013	Moved eastward 2 miles in 2013 and renamed "Madera II."
Madera II	CIMIS	Apr. 3, 2013	Dec. 31, 2015	
Madera	NOAA NCEI	Jan. 1, 1928	Dec. 31, 2017	Used for developing ET_{ref} time series for projected water budget period before CIMIS station data was available.

Root Zone Model

A daily root zone water budget model was used to develop an accurate and consistent calculation of historical crop ET (ET_c) and other water budget components that must be reported for the Land Surface System water use sectors, per the GSP regulations. A daily root zone water budget is a generally accepted and widely used method to estimate the portion of evapotranspiration attributable to rainfall (effective rainfall), versus irrigation (ASCE, 2016 and ASABE, 2007).

Flows through the root zone and plant surfaces of irrigated lands were modeled using a stand-alone tool, that can also be linked to the Integrated Water Flow Model (IWFM), known as the IWFM Demand Calculator (IDC). The physically-based IDC version 2015.0.0036 (DWR, 2015) is developed and maintained by the California Department of Water Resources (DWR). IDC uses weather data and information regarding crops, soil properties, and irrigation methods to compute the balance of inflows and outflows from the Land Surface System.

For developing SWS water budgets, a daily IDC was used as a stand-alone root zone model independent of IWFM. For developing the integrated SWS and GWS water budgets in the MCSim model, this daily IDC application was converted to a monthly application, recalibrated to match the monthly inflows and outflows in the SWS water budgets, and then integrated with the remaining components of MCSim. The IDC application thus served as the foundation for coupling the SWS water budget to the groundwater model used in GSP development.

IDC was used to develop time series estimates for the following water budget components:

- ET of applied water
- ET of precipitation
- Infiltration of applied water
- Infiltration of precipitation
- Uncollected surface runoff of applied water (estimated as negligible in the Madera Subbasin)
- Uncollected surface runoff of precipitation
- Change in root zone storage

Details regarding the improved crop coefficients used by IDC for estimating ET are described in the Crop Water Use section below. Additional details regarding development of the full IDC root zone water budget, including major inputs, are provided in **Appendix 2.F.i.**

Land Use Data

Accurate land use areas are required for determining crop consumptive use (ET) and for developing an accurate root zone model. For this Joint GSP, a land use analysis was performed to develop a Madera

County-wide annual spatial crop acreage dataset from which annual crop areas in the Madera Subbasin and each GSA were derived. The detailed procedure used for land use data development is described in **Appendix 2.A.**

Land use estimates for 1989 through 2015 corresponding to water use sectors (as defined by the GSP regulations) are summarized above in Section 2.1 Description of the Plan Area (Figure 2-3 and Table 2-1). The Urban land use category includes urban, industrial, and semi-agricultural lands. Industrial land use in the Subbasin covers only a small area, so these lands were included in the Urban water use sector. Between 1989 and 2015, the expansion of agricultural and urban lands has coincided with a reduction in native vegetation across the Subbasin.

Agricultural land uses are also detailed in Section 2.1 above (Figure 2-4 and Table 2-2). Across the Subbasin, agriculture has historically been dominated by permanent crops, including grapes and orchards. In particular, orchard acreage has more than doubled since 1989. As these crops have higher consumptive water use requirements than many other commodities grown in the Subbasin, agricultural water demand has increased in recent years. Dairy land use and water use are included in the agricultural land water balance in the Madera Subbasin, as the majority of water used by dairies is applied to crops (approximately 90%).

Detailed land use summaries are provided for each GSA in **Appendix 2.F.**

Crop Water Use

The daily IDC root zone water budget application described above was used to develop an accurate and consistent calculation of historical crop ET (ET_c) using the widely accepted crop coefficient – reference crop ET" methodology following standardized conventions established in the American Society of Civil Engineers (ASCE) Manual 70: Evaporation Evapotranspiration, and Irrigation Water Requirement (2016), and in the Food and Agriculture Organization of the United Nations (FAO) Irrigation and Drainage Paper 56 (FAO-56) (Allen, et al., 1998). In this methodology, daily evapotranspiration of a reference crop (ET_{ref}) is calculated based on local weather and climate conditions specific to the Subbasin and analysis period. Daily ET_{ref} is then adjusted to estimate daily ET_c for other crops by a specific crop coefficient (K_c) curve unique to the crop type and its development stage, growth conditions, and health.

Daily ET_o was calculated for the Madera Subbasin from weather station data, as described above. Crop coefficients were derived from actual ET (ET_a) estimated by the Surface Energy Balance Algorithm for Land (SEBAL) for 2009. Remotely sensed energy balance ET results account for soil salinity, deficit irrigation, disease, poor plant stands, and other stress factors that affect crop ET. Studies by Bastiaanssen, et al. (2005), Allen, et al. (2007 and 2011), Thoreson, et al. (2009) and others have found that when performed by an expert analyst, seasonal ET_a estimates produced by SEBAL are within plus or minus five percent of actual crop ET.

For crops grown in the Madera Subbasin, annual historic ET_c was computed by the IDC application using the quality controlled CIMIS ET_o and these local, remote sensing derived crop coefficients. The aforementioned IDC root zone model parsed these ET_c estimates into the ET of applied water and ET of precipitation estimates used in the Madera Subbasin water budgets.

Urban Water Use

Urban water use was computed in the IDC application through the urban land use module. This module simulates demands of municipal water users, including domestic well users, state small water systems, small community water systems, medium and large community water systems, and non-community water systems. Inputs to the urban module include: annual population estimates for urban and residential areas in the Subbasin; groundwater pumping records from City of Madera, when available, or estimates based

on annual population records and average per capita water use; fraction of total water used indoors versus outdoors; and parameters dictating runoff, evapotranspiration, and infiltration. Urban water use was calculated from these inputs over the area in the Subbasin representing the urban water use sector (urban, industrial, and semi-agricultural land).

Surface Water Data

In the Land Surface System, surface water inflows primarily include surface water deliveries and riparian deliveries to agricultural lands.

Surface water deliveries are reported by each GSA that distributes water for deliveries to agricultural lands. When monthly records are unavailable, annual records are distributed to monthly values in proportion to the monthly pattern of ET of applied water provided by the root zone model during the irrigation season. Missing records are estimated based on the average monthly deliveries by water year type.

Riparian deliveries are diverted directly to riparian parcels from adjacent waterways. For water budget accounting, riparian deliveries include water diverted under both appropriative water rights and riparian claims. Appropriative water rights and riparian claims along the San Joaquin River are reported by the State Water Resources Control Board's Electronic Water Rights Information Management System (eWRIMS). Riparian deliveries along Fresno River are included in the MID GSA Canal System water budget (described below) within the water budget component "Diversions from Fresno River." In the water budget, reported water rights diversions are subtracted from the total flows along their respective waterways.

Groundwater Extraction

Groundwater extraction was calculated as the Land Surface System water budget "closure" term – the difference between all other estimated or measured inflows and outflows from each water use sector. Groundwater extraction was selected as the closure term because groundwater pumping data is generally unavailable across the Subbasin (except for MWD in recent years). Also, groundwater extraction serves as a relatively large inflow to the Land Surface System, resulting in lower relative uncertainty when calculated as a closure term compared to smaller flow paths following the procedure outlined by Clemmens and Burt (1997).

Groundwater pumping was calculated as the water budget closure term for all water use sectors in all subregions with the exception of MWD agricultural lands between water years 1993 and 2014. During this period, groundwater pumping data reported in the MWD Groundwater Management Plan were used and infiltration of applied water was the closure term.

Rivers and Streams System

At the Subbasin level, the Rivers and Streams System includes all inflows and outflows from natural waterways that cross a portion of the Subbasin, including intermittent and ephemeral streams. The San Joaquin River, a perennial waterway flowing along the Subbasin boundary, was not explicitly included in the water budgets[59], although estimates of boundary seepage were included in the Subbasin and subregion estimates of net recharge from the SWS.

[59] The San Joaquin River does not cross the lateral boundaries of the Madera Subbasin, as defined above, and San Joaquin River flows are thus not considered surface water inflows to the subbasin within this water budget. A portion of infiltration of surface water from the San Joaquin River is considered to cross the subbasin boundaries into the

Detailed Rivers and Streams System water budget components are summarized for the entire Madera Subbasin in Table 2-16 along with a brief description of the estimation technique and information sources for each. Additional detailed components unique to individual subregion water balances are summarized in **Appendix 2.F.**

Surface Water Data

Surface water data includes primarily surface water inflows and surface water outflows for each of the major waterways within the Madera Subbasin. A surface hydrology map summarizing the Madera Subbasin inflows, outflows, and available data sources is provided in Figure 2-89. Surface water diverted under the surface water rights of MID and GFWD is included in those agencies' GSA water budgets found in **Appendix 2.F.**

Inflow and outflow data sources and estimation procedures are described for each waterway below. Additional detail and a description of quality control procedures can be found in **Appendix 2.F.** These procedures were used to determine the waterway inflows and outflows from Madera Subbasin.

Berenda Creek

Inflow and outflow data for Berenda Creek were assembled from records provided by MID. MID has installed a number of recorders that record flows at key inflow and outflow points, including "Recorder 13: Berenda Creek Head" and "Recorder 2: Berenda Creek Spill." Recorder 13 is located along Berenda Creek approximately 7.5 miles north of the City of Madera and approximately 13 miles inside the Subbasin boundary. Recorder 2 is located approximately 8.5 miles south of the City of Chowchilla and just over 3 miles upstream of the Subbasin boundary. Average daily flow values were provided by MID for the years 1970-2017 (Recorder 13) and 1966-2018 (Recorder 2) and summarized into monthly and annual flow volumes.

Subbasin inflows and outflows were estimated by adjusting the associated recorder data for estimated seepage and evaporation along the portion of the creek within the Subbasin but upstream or downstream of the inflow or outflow measurement point, respectively.

groundwater system and is included in the calculation of the subbasin estimates of overdraft and net recharge from SWS.

Table 2-16. Subbasin Rivers and Streams System Water Budget Detailed Components and Estimation Techniques.

Detailed Component	Category	Data Type	Waterway	Calculation/Estimation Technique	Information Sources
Surface Inflows	Inflow	Surface Water Data	Berenda Creek	Calculated from MID recorder measurements adjusted upstream to the Subbasin boundary for estimated seepage and evaporation	MID Recorder 13, NRCS soil survey, Fresno State/Madera/Madera II CIMIS Stations
			Cottonwood Creek	Calculated from MID recorder measurements adjusted upstream to the Subbasin boundary for estimated seepage and evaporation	MID Recorder 14, NRCS soil survey, Fresno State/Madera/Madera II CIMIS Stations
			Chowchilla Bypass	Calculated from SLDMWA CBP station measurements adjusted downstream to the Subbasin boundary for estimated seepage and evaporation	SLDMWA CBP station, NRCS soil survey, Fresno State/Madera/Madera II CIMIS Stations
			Dry Creek	Estimated as equal to Berenda Creek recorder measurements adjusted upstream to the Subbasin boundary for estimated seepage and evaporation	MID Recorder 13, NRCS soil survey, Fresno State/Madera/Madera II CIMIS Stations
			Fresno River	Estimated as equal to USGS measurement site along Fresno River below Hidden Dam	USGS Site 11258000 (FRESNO R BL HIDDEN DAM NR DAULTON CA)
Runoff of Precipitation	Inflow	Meteorological Data	All	Calculated in IDC root zone water budget as daily rainfall runoff using SCS curve number analysis.	Root zone simulation model, NRCS soils characteristics, CIMIS precipitation data
Evaporation	Outflow	Meteorological Data	All	Estimated from reference ET, evaporation coefficient, and estimated water surface area.	Fresno State/Madera/Madera II CIMIS Stations
Infiltration of Surface Water	Outflow	Closure Term (MC, MID), Soils Data (other GSAs)	All	Estimated from wetted area and estimated seepage coefficient by soil type	NRCS soil survey, GIS waterway attributes analysis
Riparian Deliveries[1]	Outflow	Surface Water Data	San Joaquin River	Reported riparian deliveries and estimated riparian deliveries based on estimated consumptive use of riparian parcels during streamflow	eWRIMS, Fresno State/Madera/Madera II CIMIS Stations, land use data
Surface Outflows	Outflow	Surface Water Data (MC, MID), Closure Term (other GSAs)	Berenda Creek	Calculated from MID recorder measurements adjusted downstream to the Subbasin boundary for estimated seepage and evaporation	MID Recorder 2, NRCS soil survey, Fresno State/Madera/Madera II CIMIS Stations
			Cottonwood Creek	Calculated from MID recorder measurements adjusted downstream to the Subbasin boundary for estimated seepage and evaporation	MID Recorder 10, NRCS soil survey, Fresno State/Madera/Madera II CIMIS Stations
			Chowchilla Bypass	Calculated from SLDMWA CBP station measurements adjusted downstream to the Subbasin boundary for estimated seepage and evaporation	SLDMWA CBP station, NRCS soil survey, Fresno State/Madera/Madera II CIMIS Stations
			Fresno River	Calculated from MID recorder measurements (downstream of convergence with Dry Creek) adjusted downstream to the Subbasin boundary for estimated seepage and evaporation	MID Recorder 4, NRCS soil survey, Fresno State/Madera/Madera II CIMIS Stations

[1] Riparian deliveries along Fresno River within the Madera Subbasin are included in the MID GSA Canal System water budget within "Diversions from Fresno River."

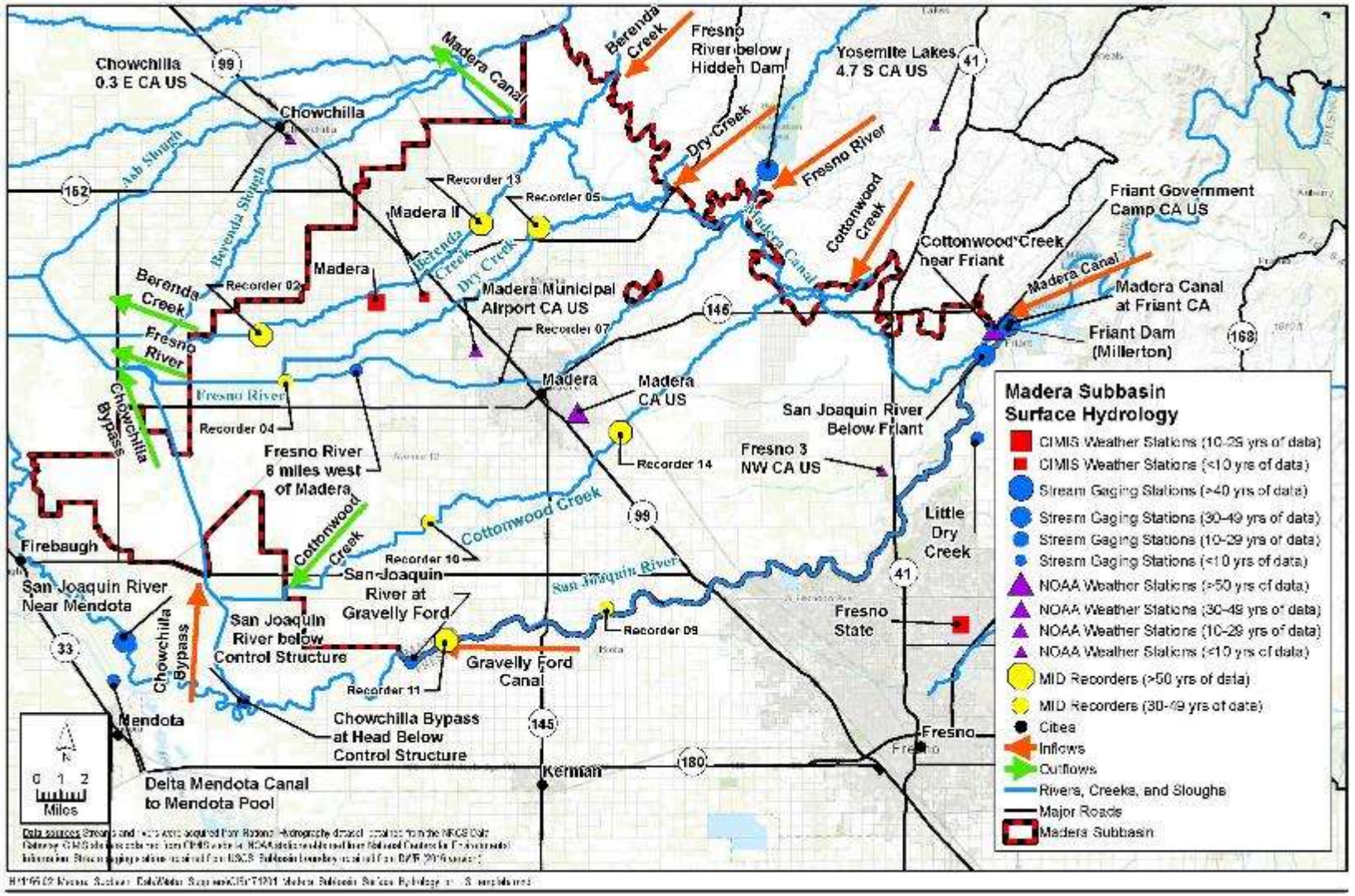


Figure 2-89. Madera Subbasin Inflows and Outflows.

Cottonwood Creek

Inflow and outflow data for Cottonwood Creek were also assembled from MID records. "Recorder 14: Cottonwood Creek Head" records historical inflows to MID on Cottonwood Creek and is located just a few miles southeast of City of Madera and approximately 11 miles from the eastern Subbasin boundary. "Recorder 10: Cottonwood Creek Spill" records outflows from MID and is located approximately 7 miles upstream of the Subbasin boundary. During the irrigation season, just over 18 miles of the creek are sometimes used as part of the MID and GFWD irrigation distribution systems. GFWD extracts water for irrigation downstream of Recorder 14. Average daily flow volumes were provided by MID for the years 1970-2016 and summarized into monthly and annual volumes.

Subbasin inflows were estimated by adjusting the Recorder 14 records for estimated seepage and evaporation along the portion of the creek within the Subbasin but upstream of the inflow measurement point. Subbasin outflows were estimated as the Recorder 10 records adjusted for GFWD diversions and estimated seepage and evaporation.

Chowchilla Bypass

The Chowchilla Bypass is located in the southwestern part of the Madera Subbasin, serving as a flood control channel operated via gates along the San Joaquin River during times when flows would exceed the San Joaquin River's downstream capacity. Inflow data for Chowchilla Bypass at its head below the control structure were assembled using a combination of DWR's Water Data Library (WDL) records (1982-1991) and California Data Exchange Center (CDEC) records (1997-2017). Daily average flow values were summarized as monthly and annual volumes. Missing data were estimated on a monthly basis based on available historical records.

Subbasin inflows were estimated by adjusting the CDEC and WDL records for estimated seepage and evaporation from the measurement point to the Madera Subbasin boundary inflow point, and Subbasin outflows were similarly estimated by adjusting inflows from the measurement point to the Madera Subbasin boundary outflow point.

Dry Creek

Inflow data for Dry Creek were assembled from MID records. "Recorder 5: Dry Creek Head Flood Water" is located along Dry Creek approximately 7 miles north of the City of Madera and approximately 8.5 miles from the eastern boundary of the Subbasin. Average daily flow values were provided for years 1966-2018, which were summarized into monthly and annual flow volumes.

Subbasin inflows were estimated by adjusting the Recorder 5 records for estimated seepage and evaporation along the portion of the creek within the Subbasin but upstream of the inflow measurement point. Dry Creek joins the Fresno River upstream of MID Recorder 4. Therefore, Dry Creek outflow is measured as part of the Fresno River outflow.

Fresno River

Inflow data for the Fresno River were assembled from records provided by both the USGS and CDEC. The USGS site number 11258000 ("FRESNO R BL HIDDEN DAM NR DAULTON CA") is located along the Fresno River near Daulton, CA, in Madera County, approximately 1 mile downstream of Hidden Dam on the Fresno River. The CDEC site, Hidden Dam (Hensley), is also located near Daulton, CA in Madera County just downstream of Hidden Dam. Both sites measure reservoir discharge into the Fresno River. Subbasin inflows were assembled from USGS (1941-1990) and CDEC (1993-2018) and summarized into monthly and annual volumes. Missing data were estimated by average monthly volumes by water year type.

During the irrigation season, approximately 10 miles of the Fresno River are used as part of the MID irrigation water distribution system. Some CVP supplies in the Madera Canal are diverted into Fresno River, serving as additional inflows to the Rivers and Streams System (described below).

Outflow data for the Fresno River was estimated from records provided by MID for "Recorder 4: Fresno River Rd. 16" for years 1951-2018. This recorder measures flow in the Fresno River where it exits the MID service area, downstream of the location where Dry Creek joins the Fresno River and approximately 4 miles upstream of the Subbasin boundary. Thus, Dry Creek outflow is measured as part of the Fresno River outflow. Surface outflows were estimated from these records with adjustment for estimated seepage and evaporation from the portion of the Fresno River inside the Subbasin but downstream of the Recorder 4 measurement site.

Madera Canal Diversions to Rivers and Streams System

The Madera Canal enters the Madera Subbasin at its southeastern corner, runs northwesterly generally along the eastern Subbasin boundary, and leaves the Subbasin almost 32 miles to the northwest. Located along the canal are delivery points to irrigation distribution infrastructure, irrigated lands, and the Fresno River.

Data for Madera Canal diversions and flood diversions to Fresno River were assembled from USBR CVP recorded irrigation deliveries and flood deliveries, respectively, at Madera Canal Mile 18.8. Daily records of irrigation deliveries and flood deliveries in cubic feet per second (cfs) were provided by MID for 1988-2018.

Riparian Deliveries

Riparian deliveries are described above in the Land Surface System components descriptions.

Spillage from MID

Excess flows in the MID conveyance system are released at spill sites into the Fresno River. Monthly spillage volumes were assembled from MID recorder data from Recorders 15 (24.2 Spill), 16 (17.0 Spill), 17 (24.2-13.2 Spill), 18 (Dry Creek Lat. Spill), 19 (24.2-17.0 End), and 20 (24.2-14.2 Spill). Recorders 9 (6.2 Spill) and 11 (16.9 - 18.4 - 6.2 Spill) record spillage from the MID conveyance system to the San Joaquin River. Monthly recorder data was available between 1972-1974 and 2003, and daily recorder data was available between 2005 and 2018.

MID Conveyance System to Cottonwood Creek

In addition to the spillage sites identified above, water is also released from the MID conveyance system into Cottonwood Creek for delivery to GFWD. Annual volumes were estimated based on MID Recorder 10 records and GFWD delivery records extracted from GFWD's 1996 Agricultural Water Management Plan for the period 1985 through 1996, and from GFWD's Water Source Summary records for the period 2004 through 2017. Monthly volumes were estimated based on the monthly pattern of agricultural ET of applied water in GFWD, assuming that MID conveyance system releases to GFWD via Cottonwood Creek only occur primarily within the irrigation season.

San Joaquin River

The San Joaquin River flows along the southern Subbasin boundary but does not cross the lateral boundaries of the Madera Subbasin. Thus, flow along the San Joaquin River was not explicitly included in surface water inflows to the Subbasin water budget. Only surface water that is diverted from the San Joaquin River to users in the Subbasin, such as riparian diversions and diversions to Gravelly Ford Water

District, is included as surface water inflows. A portion of infiltration of surface water from the San Joaquin River is also considered to cross the Subbasin boundaries into the groundwater system and is included in the Subbasin estimates of overdraft and net recharge from SWS.

To develop these seepage estimates, a San Joaquin River boundary balance was developed using measured inflows to the San Joaquin River from Friant Dam and Little Dry Creek, as well as measured outflows along the San Joaquin River near GFWD. Inflow data from Friant Dam were assembled for 1911-2018 from USGS records at Site 11251000 ("SAN JOAQUIN R BL FRIANT CA") located near the town of Friant in Fresno County, approximately 2 miles downstream of the Friant Dam. Inflow data from Little Dry Creek were assembled for 1997-2018 from CDEC records at site "Little Dry Creek (LDC)." Outflow data were assembled for 1997-2018 from CDEC records at site "San Joaquin River at Gravelly Ford (GRF)," which is located in Madera County approximately 7.5 miles northwest of the town of Kerman. Missing data was estimated as the average monthly volume by water year type. In each month, the difference between these inflows and outflows was estimated to be the total seepage along the Madera Subbasin boundary during that month. These seepage estimates were found to be consistent with San Joaquin River Restoration Study values.[60] For sections of the San Joaquin River bordering the Madera Subbasin, half of the total estimated seepage was assigned to the Subbasin.

Meteorological Data

As in the Land Surface System water budgets, meteorological data from CIMIS and NOAA NCEI weather stations was used in calculating weather-related inflows and outflows to the Rivers and Streams system. These components are summarized below.

Evaporation

Evaporation was calculated from quality controlled daily ET_o records obtained from the weather stations identified in Table 2-15 multiplied by the waterway surface area and a free water surface evaporation coefficient of 1.05 from UCCE (1989) and ASCE (2016). When, based on streamflow records and related water balances, water was estimated to be in the waterway reach, evaporation was estimated. Evaporation was calculated on a reach-by-reach basis along each waterway and summed for all waterway reaches within the Subbasin and for each GSA.

Runoff of Precipitation

Runoff of precipitation was calculated by the IDC root zone water budget as the component of total uncollected runoff attributed to precipitation. The IDC application uses a modified version of the SCS curve number (SCS-CN) method to estimate runoff of precipitation. Curve numbers are used as described in the National Engineering Handbook Part 630[61] (USDA, 2004, 2007) based on land use or cover type, surface treatments (e.g. straight rows, bare soil), hydrologic condition, and hydrologic soil group. Additional details regarding IDC root zone water budget development are provided in **Appendix 2.F.i.**

Soils Data

As in the Land Surface System water budget, soils data from SSURGO was used in calculating infiltration from the Rivers and Streams System.

[60] Friant Water Users Authority Natural Resources Defense Council. 2002. *San Joaquin River Restoration Study Background Report,* Chapter 2: Surface Water Hydrology.

[61] Table 1. Runoff curve numbers for agricultural lands.

Infiltration of Surface Water

Infiltration of surface water (seepage) was calculated based on the wetted area and seepage characteristics of each waterway reach, as determined from a detailed waterway analysis to identify reach dimensions, soil types, soil distribution, and associated seepage characteristics based on NRCS soils data. Seepage was first calculated on a reach-by-reach basis along each waterway and summed for all reaches in CM GSA, GFWD GSA, MWD GSA, NSWD GSA, and RCWD GSA. For MC GSA and MID GSA, seepage was calculated as the Subbasin Rivers and Streams System closure term, after accounting for seepage from other GSAs, and was then apportioned between MC and MID based on relative waterway wetted areas. Total Subbasin seepage was calculated as the sum of seepage from all GSAs.

Canal System

In the Madera Subbasin, the Canal System includes all canals in the MID and GFWD conveyance systems. All other GSAs either do not contain subregion-wide irrigation water distribution systems (MC, COM, NSWD) or have a piped distribution system (MWD and RCWD).

Detailed Canal System water budget components are summarized in Tables 2-17 and 2-18 for MID GSA and GFWD GSA, respectively. These tables also include brief descriptions of the estimation techniques and information sources for each component. Details for each component are briefly summarized below and are provided in detail for each GSA in **Appendix 2.F.**

Surface Water Data

Surface water data includes diversions of irrigation and flood releases from various sources and surface water outflows from canals, including spillage and deliveries.

Inflow and outflow data sources and estimation procedures are briefly described for each GSA below.

Diversions to MID

Diversions to the MID distribution system are largely from the Madera Canal downstream of the diversion point from Millerton Lake. Most diversions from the Madera Canal go directly to the MID conveyance system. At Madera Canal Mile 18.8, some water enters the Fresno River, which serves as part of the MID Canal System during the irrigation season, and is diverted into the MID canal system. These inflow data sources and calculation procedures are described below.

Diversions from Madera Canal and Flood Diversions

Data for MID's Diversions from Madera Canal and Flood Diversions were assembled from USBR CVP records of total irrigation and flood deliveries, respectively, at Madera Canal Miles 6.1, 13.06, 22.95, 24.1, 26.8, 27.5, 28.38, 28.39, 28.64, 30.4, 30.5, and 32.2. These mile markers span the Madera Canal from south to north within the Madera Subbasin and provide diversions directly to MID. Daily records in cubic feet per second (cfs) were provided by MID for 1988-2018.

Table 2-17. Madera Irrigation District Canal System Water Budget General Detailed Components and Estimation Techniques.

Detailed Component	Category	Data Type	Calculation/Estimation Technique	Information Sources
Diversions from Madera Canal	Inflow	Surface Water Data	Reported in USBR CVP irrigation delivery records at Madera Canal Miles 6.1, 13.06, 22.95, 24.1, 26.8, 27.5, 28.38, 28.39, 28.64, 30.4, 30.5, 32.2	USBR CVP delivery records
Diversions from Fresno River[1]	Inflow	Surface Water Data	Closure of Fresno River Balance	USGS Site 11258000 (FRESNO R BL HIDDEN DAM NR DAULTON CA), USBR CVP delivery records, IDC root zone water budget, NRCS soils characteristics, CIMIS precipitation data, MID recorders
Flood Diversions from Madera Canal	Inflow	Surface Water Data	Reported in USBR CVP flood delivery records at Madera Canal Miles 6.1, 13.06, 22.95, 24.1, 26.8, 27.5, 28.38, 28.39, 28.64, 30.4, 30.5, 32.2	USBR CVP delivery records
Infiltration of Surface Water (Seepage)	Outflow	Closure Term	Calculated as the difference of total inflows and total outflows from the Canal System water budget	Closure Term
Evaporation	Outflow	Meteorological Data	Estimated from reference ET, evaporation coefficient, and estimated canal surface area.	Fresno State/Madera/Madera II CIMIS Stations
Spillage	Outflow	Surface Water Data	Measured by MID recorders at spillage sites	MID Recorders 9, 11, 15-20
MID Conveyance System to Cottonwood Creek	Outflow	Surface Water Data	Measured by MID recorders	MID Recorder
Surface Water Deliveries to MID growers	Outflow	Surface Water Data	Measured by MID	MID STORM[2] delivery database
Deliveries to CWD	Outflow	Surface Water Data	Measured by MID	MID STORM delivery database
Surface Water Deliveries to GFWD	Outflow	Surface Water Data	Measured by GFWD	GFWD delivery records
Surface Water Deliveries to MWD	Outflow	Surface Water Data	Measured by MID, MWD	MID STORM delivery database, MWD delivery records
Surface Water Deliveries to RCWD	Outflow	Surface Water Data	No deliveries during historical baseline period (deliveries began in 2017).	MID STORM delivery database, RCWD delivery records

[1] Total diversions from Fresno River includes riparian deliveries from Fresno River.
[2] The water ordering and delivery management software used by Madera Irrigation District.

Table 2-18. Gravelly Ford Water District Canal System Water Budget General Detailed Components and Estimation Techniques.

Detailed Component	Category	Data Type	Calculation/Estimation Technique	Information Sources
Diversions from San Joaquin River	Inflow	Surface Water Data	Reported by GFWD	Gravelly Ford WD reports
Diversions from MID Conveyance System	Inflow	Surface Water Data	Reported by GFWD	Gravelly Ford WD reports
Diversions from Cottonwood Creek via MID	Inflow	Surface Water Data	Reported by GFWD	Gravelly Ford WD reports
Diversions from Cottonwood Creek (Natural Flow)	Inflow	Surface Water Data	Reported by GFWD	Gravelly Ford WD reports
Infiltration of Surface Water (Seepage)	Outflow	Closure Term	Calculated as the difference of total inflows and total outflows from the Canal System water budget	Closure Term
Evaporation	Outflow	Meteorological Data	Estimated from reference ET, evaporation coefficient, and estimated canal surface area.	Fresno State/Madera/Madera II CIMIS Stations
Spillage	Outflow	Surface Water Data	Estimated as zero	Gravelly Ford WD reports
Surface Water Deliveries	Outflow	Surface Water Data	Reported by GFWD	Gravelly Ford WD reports

Diversions from Fresno River

Data for MID's Diversions from Fresno River were computed as the irrigation season closure term of a monthly Fresno River boundary balance. The balance was computed for 1989 through 2018 and encompassed the extent of the waterway from the Subbasin boundary near Hidden Dam to Recorder 4 at the waterway outflow from MID. Inflows included measured Hidden Dam releases, measured diversions to Fresno River from Madera Canal Mile 18.8, runoff of precipitation estimated from the IDC root zone water budget, measured spillage from the MID conveyance system, and measured inflows from Dry Creek. Outflows included calculated seepage and evaporation following the procedures described above, and measured streamflow at MID Recorder 4, with diversions from Fresno River to MID calculated as the balance closure term. The total diversions from Fresno River to MID includes Pre-1914 water rights and riparian claims exercised by irrigators along Fresno River.

Diversions to GFWD

GFWD diverts natural flows from two waterways, the San Joaquin River and Cottonwood Creek, and also receives diversions from the Madera Canal via MID either through MID's conveyance system or through releases that MID makes into Cottonwood Creek for GFWD.

Annual volumes for all four diversions were estimated based on records obtained from GFWD's 1996 Agricultural Water Management Plan for the period 1985 through 1996, and from GFWD's Water Source Summary records for the period 2004 through 2017. Other years were estimated based on available data and agricultural ET of applied water requirements. Monthly volumes were estimated by distributing annual volumes following the monthly pattern of agricultural ET of applied water in GFWD during months with sufficient flows in the associated waterways, as determined by waterway boundary balances.

Surface Water Deliveries from MID

MID's distribution system primarily provides deliveries to MID customers. However, MID also makes deliveries to MWD along Dry Creek, deliveries to RCWD, deliveries to GFWD, and deliveries to individual customers in CWD. All deliveries since 1999 are recorded in MID's STORM delivery database with a delivery ID number, reading date, and relevant information related to the location in the system, turnout, and parcel that received the delivery. These turnout and parcel information are linked to growers in MID and other GSAs. Monthly deliveries to each GSA were summarized from STORM data for 1999 through 2017.

For 1989 through 1998, annual deliveries to MID and GFWD were summarized from MID's Water Supply and Grower Use History records. Annual deliveries to MWD were extracted from the 2014 Update to MWD's Groundwater Management Plan or estimated by the average annual deliveries during the available record period. Annual deliveries to CWD were estimated as zero prior to 1998. All annual deliveries were distributed monthly following the pattern of agricultural ET of applied water for irrigation season months in each subregion.

Surface Water Deliveries from GFWD

Unlike MID, GFWD's distribution system provides deliveries only to GFWD customers. For 1982-2006, monthly deliveries were extracted from GFWD's Summary of Water Sold from District. For 2007-2017, annual deliveries were extracted from GFWD's Water Source Summary records. During this period, monthly volumes were estimated by distributing annual volumes based on the monthly pattern of agricultural ET of applied water in GFWD.

Spillage from MID

As described above, excess flows in the MID conveyance system are released at spill sites into the Fresno River and the San Joaquin River. Monthly spillage volumes were assembled from MID records from Recorders 9, 11, and 15 through 20. Monthly recorder data was available between 1972-1974 and 2003, and daily recorder data was available between 2005-2018.

Meteorological Data

As in the Land Surface System and Rivers and Stream System water budgets, meteorological data from CIMIS and NOAA NCEI weather stations was used in calculating evaporation from the Canal Systems.

Evaporation

Evaporation was calculated from quality controlled daily ET_o records obtained from the weather stations identified in Table 2-15 multiplied by the total conveyance system surface area in each GSA and a free water surface evaporation coefficient of 1.05 from UCCE (1989) and ASCE (2016) to compute evaporation.

Soils Data

As in the Land Surface System and Rivers and Stream System water budgets, soils data from SSURGO was used in calculating seepage from the Canal Systems.

Infiltration of Surface Water

Similar to the Rivers and Streams System water budgets, infiltration of surface water (seepage) can be calculated based on the wetted area and seepage characteristics of each subregion's conveyance system. However, due to the relative uncertainty of canal wetted area characteristics and soil conditions combined with higher certainty of diversions to the canal system and deliveries from the canal system, seepage was instead calculated as the Canal System closure term.

Inflow and Outflow Data Quality Control

Quality control procedures were applied to identify data gaps and data values outside of plausible ranges. Data gaps were filled with monthly estimates based on available daily, monthly, or annual data and historical average monthly patterns of streamflow and crop water demand by hydrologic water year type according to the San Joaquin Valley WYI described in Section 2.2.3.1 above.

Surface Water Data

For months with missing surface water data, the monthly volume was estimated as the average volume of that same month calculated across all years of the same water year type. When the number of years with available data for developing water year type monthly averages was less than five, the five water year types were grouped into simply "Wet" and "Dry" years. "Wet" years were defined as wet or above normal, and the "Dry" years were defined as below normal, dry, or critical.

For years with annual stream inflow/outflow data, monthly volumes were estimated as a portion of the measured annual volume distributed by the average monthly pattern of flow observed during water years of the same type.

For years with annual deliveries or diversions data, monthly volumes were estimated as a portion of the measured annual volume distributed by the average monthly pattern of crop water demand as calculated by the IDC root zone water budget for lands receiving those deliveries.

Meteorological Data, Soils Data, and Root Zone Water Budget Inputs

Quality control procedures used applied to meteorological data, soils data, and other data prepared for IDC root zone water budget development are described in **Appendix 2.F.i.**

Uncertainties in Water Budget Components

Uncertainties associated with each water budget component have been estimated as described by Clemmens and Burt (1997) as follows:

1. The uncertainty in each independently estimated water budget component is estimated as a percentage representing approximately a 95% confidence interval. These uncertainties are estimated based on professional judgement.
2. Assuming random, normally-distributed error, the standard deviation is estimated as the confidence interval divided by 2 for each independently estimated component.
3. The variance is estimated for each component as the square of the standard deviation for each independently estimated component.
4. The variance in the closure term is estimated as the sum of variances for each independently estimated component.
5. The standard deviation in the closure term is estimated as the square root of the sum of variances.
6. The 95% confidence interval in the closure term is estimated as twice the estimated standard deviation.

Estimated uncertainties were calculated following the above procedure for the Subbasin water budgets as well as all GSA water budgets. Table 2-19 provides a summary of typical uncertainty values associated with major SWS inflows and outflows. These uncertainties provide a basis for evaluating confidence in water budget results and help to identify data needs that may be addressed during GSP implementation.

2.2.3.4 Water Budget Analysis

The conceptual water budget model for the Madera Subbasin and the GSAs identified in Table 2-10 was previously presented and discussed in Section 2.2.3.1. It is structured to include separate but related water budgets for the SWS and for the underlying GWS.

This section presents SWS water budget components within the Madera Subbasin as per GSP regulations for the historical base period (1989 through 2014) and 2015. These are followed by a summary of the water budget results by accounting center. The historical water budgets for each GSA are presented and discussed in **Appendix 2.F.** along with summaries of GSA land use data relevant to water budget development.

Surface Water Inflows

Surface water inflows include surface water flowing into the Subbasin across the Subbasin boundary. Per the Regulations, surface inflows must be reported by water source type. According to the Regulations:

> *"Water source type" represents the source from which water is derived to meet the applied beneficial uses, including groundwater, recycled water, reused water, and surface water sources identified as Central Valley Project, the State Water Project, the Colorado River Project, local supplies, and local imported supplies.*

Additionally, runoff of precipitation from upgradient areas adjacent to the subregion represents a potential source of surface water inflow.

Table 2-19. Estimated Uncertainty of Subbasin Water Budget Components.

Flowpath Direction (relative to SWS)	Water Budget Component	Data Source	Estimated Uncertainty (%)	Source
Inflows	Surface Water Inflows	Measurement	5%	Estimated streamflow measurement accuracy
	Deliveries	Measurement	6%	Estimated delivery measurement accuracy (accuracy required for Reclamation contractors)
	Precipitation	Calculation	30%	Clemmens, A.J. and C.M. Burt, 1997.
	Groundwater Extraction	Calculation	20%	Typical uncertainty when calculated for Land Surface System water balance closure;
Outflows	Infiltration of Surface Water	Calculation	15%	Estimated accuracy of daily seepage calculation using NRCS soils characteristics and measured streamflow data compared to field measurements.
	Infiltration of Applied Water	Calculation	20%	Estimated accuracy of daily IDC root zone water budget based on annual land use and NRCS soils characteristics.
	Infiltration of Precipitation	Calculation	20%	Estimated accuracy of daily IDC root zone water budget based on annual land use, NRCS soils characteristics, and CIMIS precipitation.
	Surface Water Outflows	Measurement	15%	Estimated streamflow measurement accuracy with adjustment for infiltration and evaporation.
Net Recharge from SWS		Calculation	20%	Estimated water budget accuracy; typical value calculated for Subbasin-level net recharge from SWS.

Local Supplies

Local supply inflows to the Madera Subbasin include surface water inflows along Berenda Creek, Dry Creek, Cottonwood Creek, and Chowchilla Bypass, as well as riparian deliveries from the San Joaquin River. Water is diverted from these surface water inflows under the water rights held by certain GSAs.

Local Imported Supplies

Madera Subbasin does not receive local imported supplies.

CVP Supplies

Agencies with CVP contracts can receive CVP supplies in the Madera Subbasin. CVP supplies received via Madera Canal include Millerton irrigation releases and flood releases. CVP supplies are also received from Hidden Dam releases along Fresno River. Additionally, GFWD can receive CVP supplies diverted from the San Joaquin River.

Recycling and Reuse

Recycling and reuse are not a significant source of supply within Madera Subbasin.

Other Surface Inflows

For the water budgets presented herein, precipitation runoff from outside the Subbasin is considered relatively minimal and is expected to enter the Subbasin along the waterways above as natural flows following relatively large storm events and are accounted as part of local supplies. Precipitation runoff from lands inside the Subbasin is internal to the surface water system and is thus not considered as surface inflows to the Subbasin boundary.

Summary of Surface Inflows

Surface water inflows by water year type are summarized in Figure 2-90 and Table 2-20. During the study period, surface water supplies vary greatly with water year type, with substantial local supply inflows during wet years that are reduced in above normal years and remain relatively constant during all other year types. CVP supplies remain more consistent between years. Total surface water inflows range from approximately 120 thousand acre-feet (TAF) during average critical years to over 1,000 TAF during average wet years.

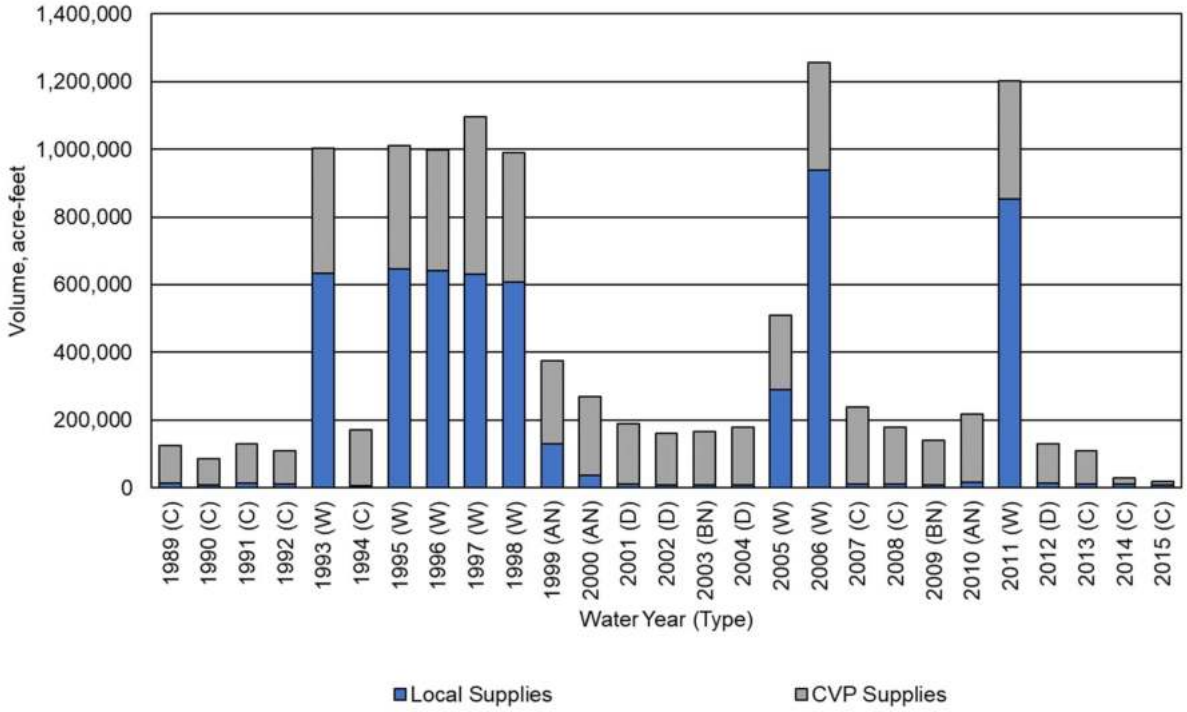


Figure 2-90. Madera Subbasin Surface Water Inflows by Water Source Type.

Table 2-20. Madera Subbasin Surface Water Inflows by Water Source Type (AF) (23 CCR § 354.18(b)(1)).

Water year (Type)	Local Supplies					CVP Supplies			Surface Water Inflows Total
	Berenda Creek	Chowchilla Bypass	Cotton-wood Creek	Dry Creek	Riparian Deliveries from San Joaquin River[1]	Madera Canal (diversions to MID and Fresno River)	Fresno River (Hidden Dam)	Diversions from San Joaquin River	
1989 (C)	1,230	0	2,553	1,230	7,500	94,921	16,408	0	123,841
1990 (C)	0	0	0	0	7,500	68,119	9,604	0	85,223
1991 (C)	1,125	0	3,535	1,125	8,200	93,362	20,389	2,225	129,961
1992 (C)	851	0	1,414	851	7,300	79,162	20,389	0	109,967
1993 (W)	7,100	588,832	24,077	7,100	7,300	216,724	140,795	10,999	1,002,926
1994 (C)	0	0	0	0	7,300	113,868	38,847	11,729	171,744
1995 (W)	10,056	589,328	30,486	10,056	7,500	218,728	134,717	10,789	1,011,660
1996 (W)	3,665	609,534	16,017	3,665	7,500	238,464	106,175	12,569	997,588
1997 (W)	13,661	561,559	35,983	13,661	7,500	224,541	226,611	11,871	1,095,387
1998 (W)	15,729	538,633	30,290	15,729	7,500	216,061	155,719	9,969	989,630
1999 (AN)	0	118,845	2,365	0	7,500	156,622	83,494	7,174	376,000
2000 (AN)	3,016	6,346	17,793	3,016	7,500	141,623	82,040	8,864	270,198
2001 (D)	542	0	1,819	542	7,500	128,939	46,313	3,707	189,361
2002 (D)	619	0	743	619	7,500	122,363	24,008	5,732	161,585
2003 (BN)	0	0	0	0	7,500	126,341	25,770	7,509	167,119
2004 (D)	0	0	0	0	7,500	137,290	23,729	11,472	179,991
2005 (W)	10,745	249,214	11,466	10,745	7,500	131,358	80,215	9,562	510,803
2006 (W)	12,159	901,256	6,542	12,159	7,500	170,396	135,179	9,730	1,254,921
2007 (C)	2,281	0	0	2,281	7,500	110,062	108,519	7,940	238,583
2008 (C)	878	0	2,512	878	7,500	106,030	52,440	7,854	178,093
2009 (BN)	0	0	0	0	7,872	117,306	12,835	2,556	140,570
2010 (AN)	2,869	0	3,919	2,869	7,723	143,035	50,684	5,965	217,066
2011 (W)	10,714	803,187	19,870	10,714	8,504	150,233	191,949	6,302	1,201,473
2012 (D)	2,697	0	0	2,697	7,723	80,897	34,364	823	129,200
2013 (C)	880	0	0	880	8,934	71,083	26,587	0	108,363
2014 (C)	875	0	0	875	8,356	15,966	3,451	0	29,524
2015 (C)	883	0	0	883	6,995	7,984	1,621	0	18,365
Average (1989-2014)	3,911	191,028	8,130	3,911	7,662	133,596	71,201	6,359	425,799
Average (1989-2014) W	10,478	605,193	21,841	10,478	7,600	195,813	146,420	10,224	1,008,049
Average (1989-2014) AN	1,962	41,730	8,026	1,962	7,574	147,093	72,073	7,334	287,754
Average (1989-2014) BN	0	0	0	0	7,686	121,824	19,302	5,032	153,844
Average (1989-2014) D	965	0	640	965	7,556	117,372	32,103	5,434	165,035
Average (1989-2014) C	900	0	1,001	900	7,708	76,056	29,825	2,975	119,366

Surface Water Outflows

Surface water outflows are summarized in Figure 2-91 and Table 2-21. These include natural flows along waterways, runoff of precipitation, and flood releases or spillage of USBR CVP deliveries. Surface outflows along Fresno River include a mixture of both local supplies and CVP supplies, while surface outflows along all other waterways include only local supplies. Overall, surface outflows are significantly higher in wet years, averaging approximately 711TAF overall.

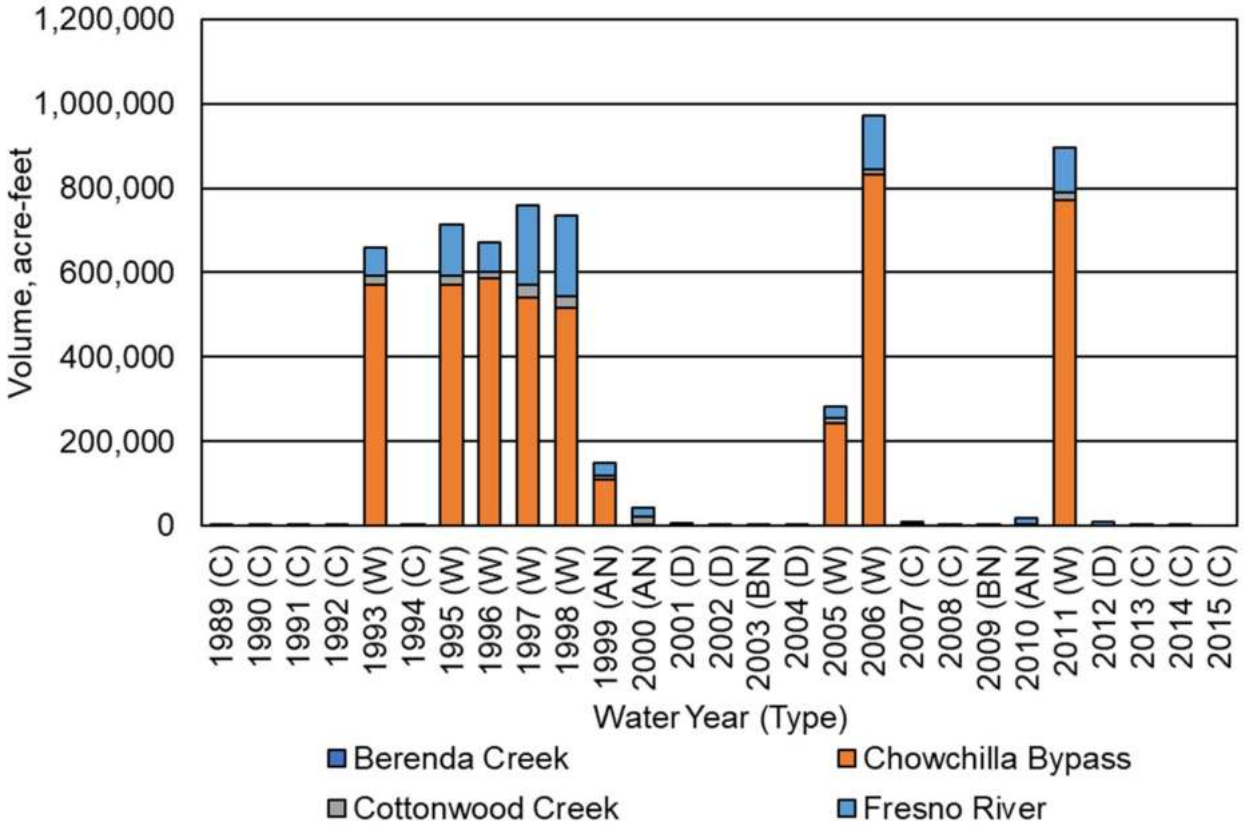


Figure 2-91. Madera Subbasin Surface Outflows by Waterway.

Table 2-21. Madera Subbasin Surface Outflows by Water Source Type (AF) (23 CCR § 354.18(b)(1)).

	Local Supplies			CVP Supplies	
Water Year (Type)	Berenda Creek	Chowchilla Bypass	Cottonwood Creek	Fresno River	Surface Water Outflows Total
1989 (C)	0	0	1,642	0	1,642
1990 (C)	0	0	426	0	426
1991 (C)	0	0	2,472	0	2,472
1992 (C)	0	0	660	0	660
1993 (W)	0	571,205	19,816	66,924	657,945
1994 (C)	0	0	1,179	174	1,353
1995 (W)	0	572,197	19,402	120,760	712,359
1996 (W)	0	587,638	12,570	71,327	671,535
1997 (W)	0	541,011	29,319	188,130	758,460
1998 (W)	0	517,240	26,913	192,104	736,257

	Local Supplies			CVP Supplies	
Water Year (Type)	Berenda Creek	Chowchilla Bypass	Cottonwood Creek	Fresno River	Surface Water Outflows Total
1999 (AN)	0	108,794	10,379	30,305	149,478
2000 (AN)	0	4,238	17,518	22,011	43,767
2001 (D)	0	0	4,381	330	4,711
2002 (D)	0	0	1,975	0	1,975
2003 (BN)	0	0	3,060	0	3,060
2004 (D)	0	0	2,779	0	2,779
2005 (W)	0	244,628	12,018	27,134	283,779
2006 (W)	0	831,930	13,408	126,759	972,098
2007 (C)	0	0	4,687	4,642	9,328
2008 (C)	0	0	1,444	0	1,444
2009 (BN)	0	0	1,882	0	1,882
2010 (AN)	0	0	4,520	13,936	18,456
2011 (W)	0	771,095	18,095	106,808	895,998
2012 (D)	0	0	1,781	8,143	9,924
2013 (C)	0	0	520	1,696	2,215
2014 (C)	0	0	528	0	528
2015 (C)	0	0	0	0	0
Average (1989-2014)	0	182,691	8,207	37,738	228,636
Average (1989-2014) W	0	579,618	18,943	112,493	711,054
Average (1989-2014) AN	0	37,677	10,806	22,084	70,567
Average (1989-2014) BN	0	0	2,471	0	2,471
Average (1989-2014) D	0	0	2,729	2,118	4,847
Average (1989-2014) C	0	0	1,506	724	2,230

Groundwater System Inflows

Estimates of groundwater system inflows are provided in Figure 2-92 and Table 2-22. These inflows include calculated inflows from the SWS and subsurface groundwater inflows from adjacent subbasins[62]. Infiltration of precipitation to the groundwater system is highly variable from year to year due to variation in the timing and amount of precipitation, while infiltration of applied water has remained comparatively steady over time. Infiltration of surface water (seepage) also exhibits substantial variability, particularly from the Rivers and Streams system, matching the annual variability of surface water inflows. Although the San Joaquin River passes along the Subbasin boundary, it provides significant infiltration to the groundwater system.

[62] Subsurface groundwater inflows to Madera Subbasin include simulated inflows from the Kings, Delta-Mendota, and Chowchilla Subbasins.

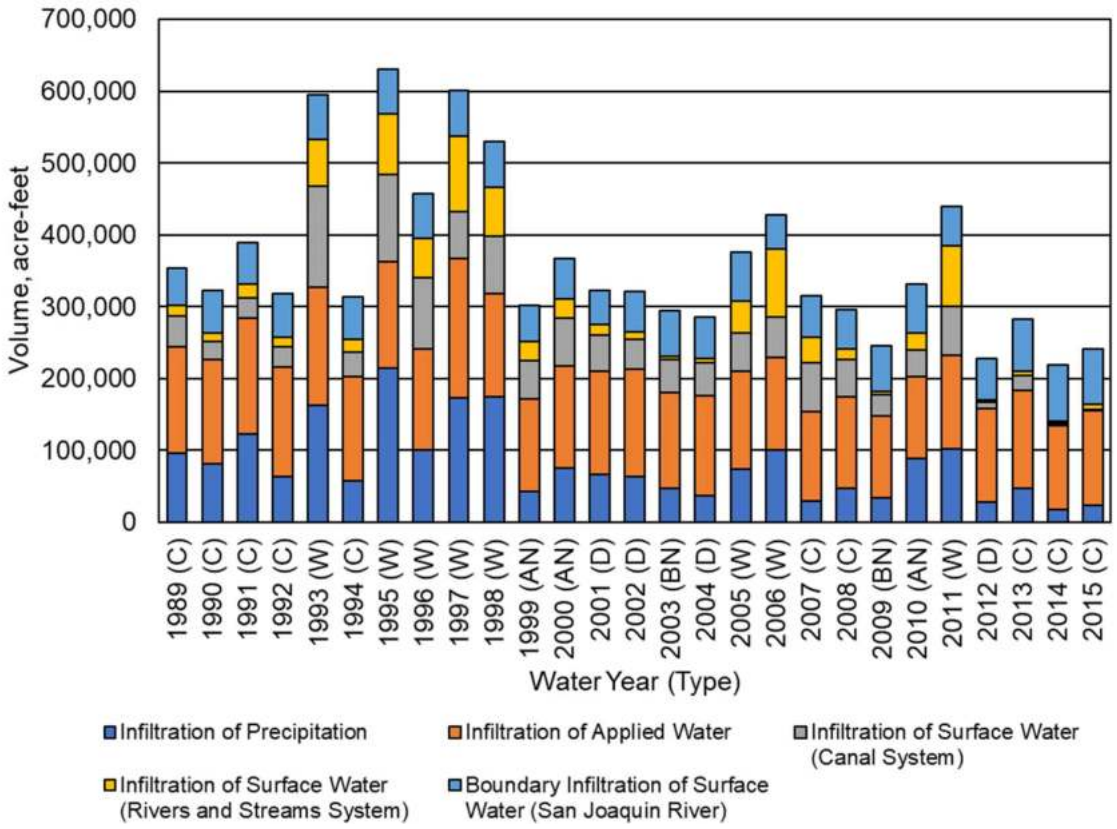


Figure 2-92. Madera Subbasin Groundwater System Inflows.

Table 2-22. Madera Subbasin Groundwater System Inflows (AF) (23 CCR § 354.18(b)(2)).

Water Year (Type)	Net Subsurface Groundwater Inflow*	Infiltration of Precipitation	Infiltration of Applied Water	Infiltration of Surface Water (Canal System)	Infiltration of Surface Water (Rivers and Streams	Boundary Infiltration of Surface Water (San Joaquin River)[1]
1989 (C)	*	96,351	148,296	42,071	14,964	52,497
1990 (C)	*	81,088	145,011	25,400	12,320	58,752
1991 (C)	*	123,511	160,316	27,970	20,263	57,288
1992 (C)	*	62,969	152,795	27,828	14,654	60,041
1993 (W)	*	162,741	164,801	140,343	65,111	62,817
1994 (C)	*	58,348	144,914	34,166	12,659	59,956
1995 (W)	*	214,231	148,228	121,657	83,646	62,817
1996 (W)	*	101,102	140,025	99,251	55,332	62,255
1997 (W)	*	173,094	193,912	65,431	105,229	62,817
1998 (W)	*	174,199	144,228	79,813	68,549	62,817
1999 (AN)	*	43,408	128,597	53,130	26,357	50,906
2000 (AN)	*	76,027	142,023	66,008	26,911	55,502
2001 (D)	*	67,345	142,660	50,232	14,993	48,148
2002 (D)	*	63,264	150,000	41,117	10,666	55,815

Water Year (Type)	Net Subsurface Groundwater Inflow*	Infiltration of Precipitation	Infiltration of Applied Water	Infiltration of Surface Water (Canal System)	Infiltration of Surface Water (Rivers and Streams	Boundary Infiltration of Surface Water (San Joaquin River)[1]
2003 (BN)	*	47,327	133,158	45,860	4,759	63,273
2004 (D)	*	36,813	139,987	45,875	5,390	57,377
2005 (W)	*	74,179	136,476	52,826	43,921	68,614
2006 (W)	*	100,804	128,548	56,357	94,406	47,623
2007 (C)	*	29,108	124,966	68,377	36,035	58,246
2008 (C)	*	46,943	127,820	52,292	13,618	55,176
2009 (BN)	*	34,229	113,925	30,106	3,610	64,000
2010 (AN)	*	89,286	113,681	37,431	23,258	67,546
2011 (W)	*	102,145	130,134	68,128	83,880	54,998
2012 (D)	*	28,501	130,087	8,543	3,596	58,013
2013 (C)	*	47,652	136,294	19,824	5,984	72,669
2014 (C)	*	18,289	117,058	2,982	2,710	78,643
2015 (C)	*	24,117	129,834	1,026	7,006	77,442
Average (1989-2014)	69,435	82,806	139,921	52,424	32,801	59,946
Average (1989-2014) W	*	137,812	148,294	85,476	75,009	60,595
Average (1989-2014) AN	*	69,574	128,100	52,190	25,509	57,985
Average (1989-2014) BN	*	40,778	123,542	37,983	4,184	63,636
Average (1989-2014) D	*	48,981	140,684	36,442	8,661	54,838
Average (1989-2014) C	*	62,695 [2]	139,719	33,434	14,801	61,474

*Year type values and averages are not reported because of the variable quality and timing of available groundwater level data and the resulting potential for biasing subsurface lateral flow calculations based on discrete snapshots of groundwater level conditions.
[1] Boundary infiltration of surface water estimated as closure of San Joaquin River boundary balance during years with available data.
[2] Average infiltration of precipitation higher in critical years due to relatively higher amounts of precipitation in 1989-1992.

Groundwater Extraction by Water Use Sector

Estimates of groundwater extraction by water use sector are provided in Figure 2-93 and Table 2-23. For agricultural and urban (urban, industrial, and semi-agricultural) lands, groundwater extraction represents pumping, while for native lands, groundwater extraction by riparian vegetation was considered to be minimal[63] because of the depth to groundwater in the Subbasin. Groundwater extraction is dominated by irrigated agriculture, varying substantially from year to year based on variability in surface water supplies and crop water demands.

[63] Groundwater extraction of native vegetation estimated by ET_{aw} from the Madera IDC application is less than 100 AF/yr.

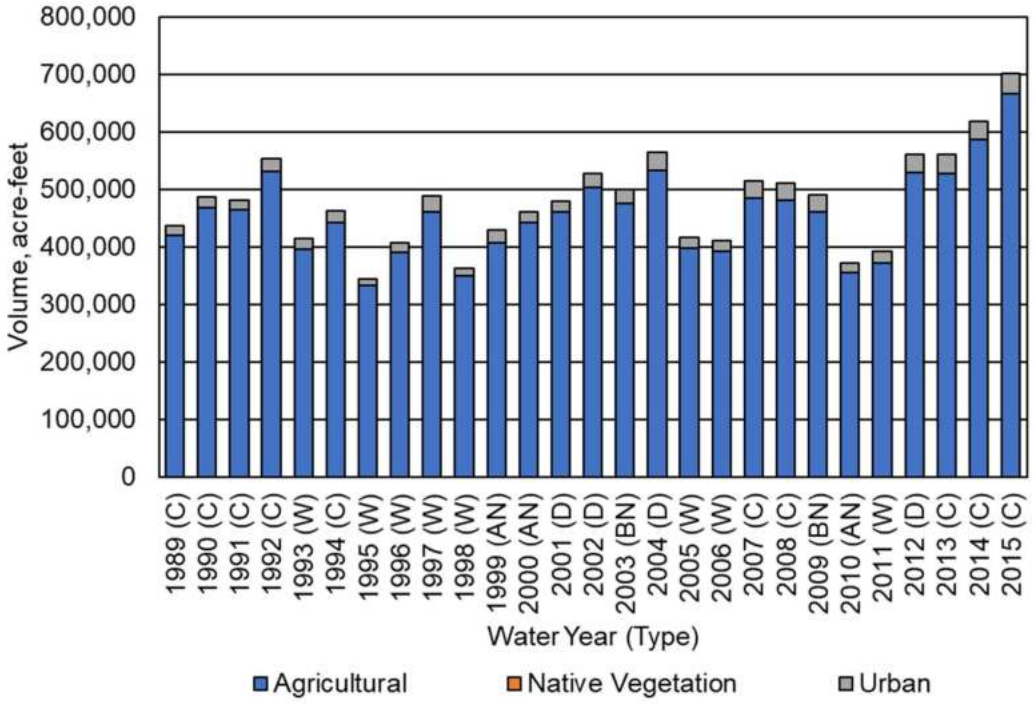


Figure 2-93. Madera Subbasin Groundwater Extraction by Water Use Sector.

Table 2-23. Madera Subbasin Groundwater Extraction by Water Use Sector (AF) (23 CCR § 354.18(b)(3)).

Water Year	Agricultural	Native Vegetation	Urban	Total
1989 (C)	420,304	0	17,047	437,350
1990 (C)	469,254	0	18,082	487,336
1991 (C)	464,476	0	17,005	481,484
1992 (C)	530,866	0	22,565	553,433
1993 (W)	396,671	0	17,788	414,458
1994 (C)	443,027	0	20,740	463,764
1995 (W)	333,246	0	11,123	344,367
1996 (W)	391,387	0	16,902	408,296
1997 (W)	461,009	0	27,067	488,076
1998 (W)	349,190	0	14,575	363,761
1999 (AN)	407,530	0	21,324	428,850
2000 (AN)	441,735	0	20,179	461,915
2001 (D)	461,191	0	18,700	479,886
2002 (D)	503,340	0	24,419	527,750
2003 (BN)	476,326	0	23,949	500,270
2004 (D)	533,786	0	31,017	564,795
2005 (W)	397,369	0	19,653	417,023
2006 (W)	391,981	0	19,106	411,093
2007 (C)	484,945	0	30,451	515,403
2008 (C)	480,879	0	30,465	511,343
2009 (BN)	461,512	0	29,792	491,300
2010 (AN)	355,071	0	17,574	372,645
2011 (W)	372,938	0	19,958	392,898

Water Year	Agricultural	Native Vegetation	Urban	Total
2012 (D)	529,719	0	31,461	561,171
2013 (C)	528,180	0	33,185	561,363
2014 (C)	586,962	0	32,286	619,252
2015 (C)	666,437	0	36,168	702,611
Average (1989-2014)	448,958	0	22,554	471,512
Average (1989-2014) W	386,724	0	18,272	404,996
Average (1989-2014) AN	401,445	0	19,692	421,138
Average (1989-2014) BN	468,919	0	26,871	495,790
Average (1989-2014) D	507,009	0	26,399	533,408
Average (1989-2014) C	489,877	0	24,647	514,524

Groundwater Discharge to Surface Water Sources

The depth to groundwater is greater than 100-200 ft across much of the Madera Subbasin. Given the substantial depth to the water table, groundwater discharge to surface water sources is negligible.

Evapotranspiration by Water Use Sector

Total evapotranspiration (ET) by water use sector is reported in Figure 2-94 and Table 2-24. Total ET varies between years, with the lowest observed in 1989, at approximately 593TAF, and greatest in 2004, at approximately 714TAF. Agricultural ET tends to increase in drier years, while native ET decreases. Total ET has remained relatively steady over time.

ET of applied groundwater is included in the total ET of applied water reported in the SWS water budget for each GSP (**Appendix 2.F**). For irrigators without access to surface water, ET of applied water is equal to ET of applied groundwater.

In addition to total ET from land surfaces, estimates of evaporation from rivers and streams are reported in Figure 2-95 and Table 2-25. Evaporation is highest in wet years when surface water inflows are typically higher, averaging approximately 10TAF overall.

Change in Storage

Estimates of average annual change in storage within the GWS are summarized for each water budget scenario in Table 2-26.

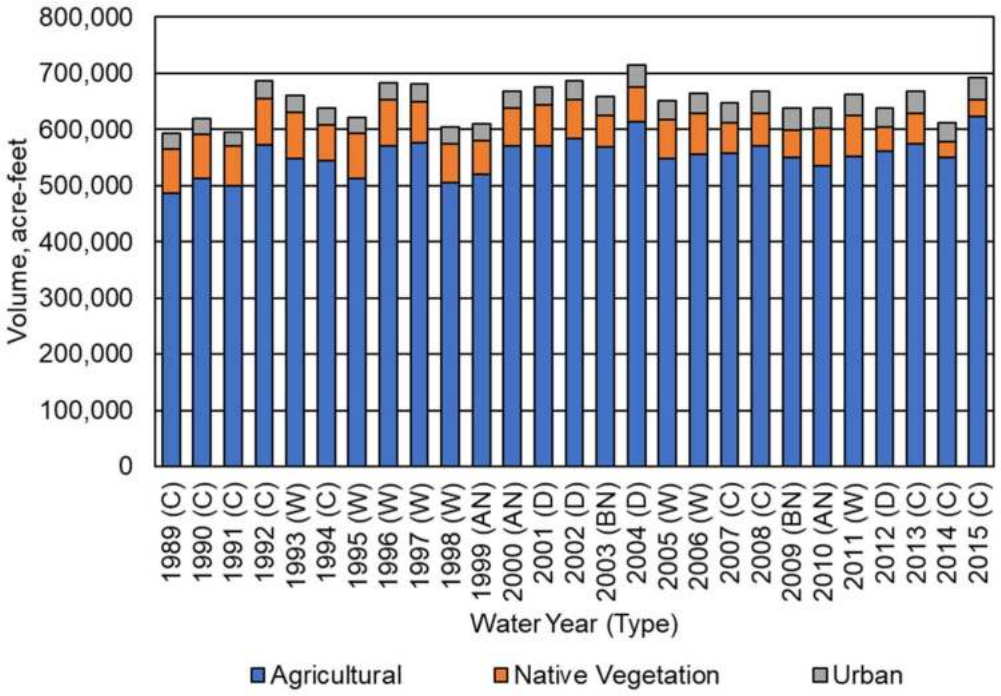


Figure 2-94. Madera Subbasin Total Evapotranspiration by Water Use Sector.

Table 2-24. Madera Subbasin Total Evapotranspiration by Water Use Sector (AF) (23 CCR § 354.18(b)(3)).

Water Year	Agricultural	Native Vegetation	Urban	Total
1989 (C)	485,824	79,935	27,122	592,881
1990 (C)	513,276	77,560	28,514	619,350
1991 (C)	500,398	69,647	25,086	595,131
1992 (C)	572,303	83,293	30,974	686,570
1993 (W)	547,892	82,461	30,067	660,420
1994 (C)	543,943	64,741	29,603	638,287
1995 (W)	512,822	79,972	27,620	620,414
1996 (W)	570,200	82,951	29,831	682,982
1997 (W)	576,285	72,430	32,057	680,772
1998 (W)	505,935	69,393	28,179	603,507
1999 (AN)	520,964	59,990	28,388	609,342
2000 (AN)	569,938	68,233	30,764	668,935
2001 (D)	571,037	73,403	30,382	674,822
2002 (D)	583,612	69,419	33,687	686,718
2003 (BN)	569,156	55,844	33,185	658,185
2004 (D)	614,494	61,530	37,972	713,996
2005 (W)	548,046	68,905	33,789	650,740
2006 (W)	554,996	74,383	34,958	664,337
2007 (C)	557,417	55,271	35,494	648,182
2008 (C)	570,515	58,525	39,372	668,412
2009 (BN)	551,063	48,169	39,169	638,401
2010 (AN)	534,575	67,984	35,739	638,298
2011 (W)	552,037	73,776	36,889	662,702
2012 (D)	562,080	42,034	34,077	638,191
2013 (C)	574,904	52,989	40,775	668,668

Water Year	Agricultural	Native Vegetation	Urban	Total
2014 (C)	550,832	27,370	34,438	612,640
2015 (C)	623,042	30,495	39,270	692,807
Average (1989-2014)	550,559	66,162	32,620	649,342
Average (1989-2014) W	546,027	75,534	31,674	653,234
Average (1989-2014) AN	541,826	65,402	31,630	638,858
Average (1989-2014) BN	560,110	52,007	36,177	648,293
Average (1989-2014) D	582,806	61,597	34,030	678,432
Average (1989-2014) C	541,046	63,259	32,375	636,680

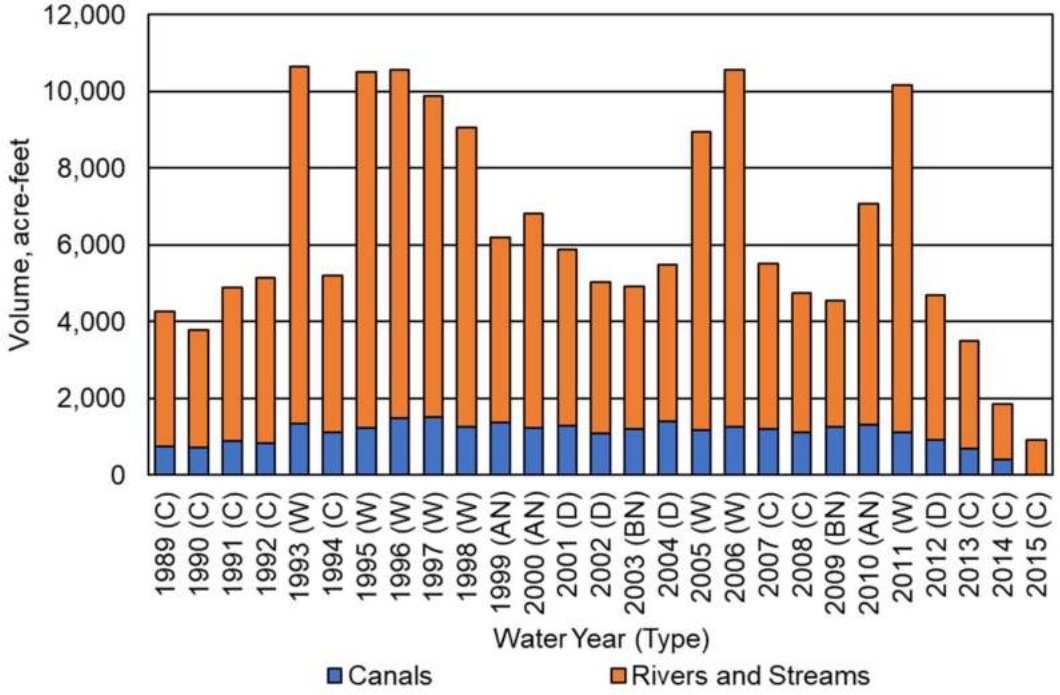


Figure 2-95. Madera Subbasin Evaporation from the Surface Water System.

Table 2-25. Madera Subbasin Evaporation from the Surface Water System (AF) (23 CCR § 354.18(b)(3)).

Water Year	Canals	Rivers and Streams
1989 (C)	754	3,511
1990 (C)	726	3,058
1991 (C)	880	4,022
1992 (C)	834	4,324
1993 (W)	1,330	9,322
1994 (C)	1,125	4,089
1995 (W)	1,230	9,283
1996 (W)	1,482	9,091
1997 (W)	1,509	8,365
1998 (W)	1,255	7,803
1999 (AN)	1,355	4,833
2000 (AN)	1,237	5,569
2001 (D)	1,278	4,607
2002 (D)	1,084	3,943
2003 (BN)	1,212	3,694
2004 (D)	1,383	4,096
2005 (W)	1,168	7,776
2006 (W)	1,254	9,322
2007 (C)	1,191	4,323
2008 (C)	1,105	3,648
2009 (BN)	1,241	3,302
2010 (AN)	1,316	5,755
2011 (W)	1,120	9,045
2012 (D)	902	3,780
2013 (C)	686	2,809
2014 (C)	397	1,461
2015 (C)	0	910
Average (1989-2014)	1,117	5,417
Average (1989-2014) W	1,294	8,751
Average (1989-2014) AN	1,303	5,386
Average (1989-2014) BN	1,227	3,498
Average (1989-2014) D	1,162	4,106
Average (1989-2014) C	855	3,472

Historical Water Budget Summary

Annual inflows, outflows, and change in storage for the Madera Subbasin SWS are summarized in Figure 2-96. Inflows are shown as positive values, while outflows and change in storage are shown as negative values. Review of the variability in component volumes across years provides insight into the impacts of hydrology on the surface water system water budget and opportunities for projects to increase groundwater recharge and the Subbasin sustainable yield.

Detailed historical water budget components in each GSA are summarized in detail in **Appendix 2.F.**

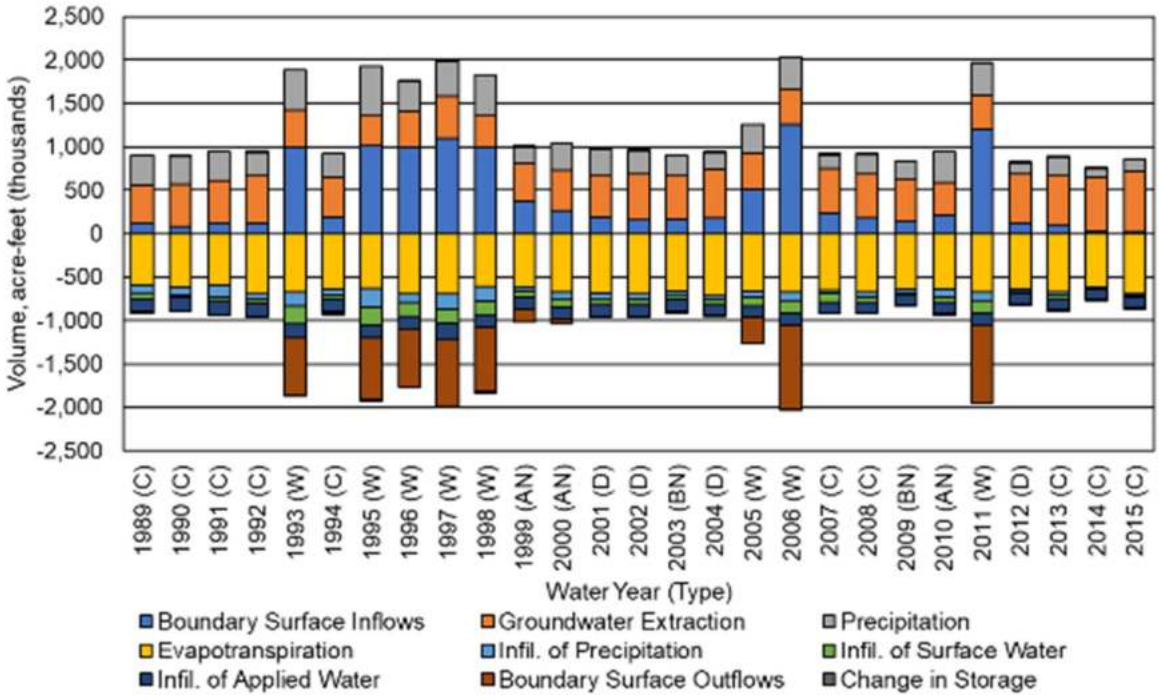


Figure 2-96. Madera Subbasin Surface Water System Historical Water Budget.

Current Water Budget Summary

Annual inflows, outflows, and change in SWS storage under current land use conditions in the Madera Subbasin SWS are summarized in Figure 2-97. Inflows are shown as positive values, while outflows and change in SWS storage are shown as negative values. Review of the variability in component volumes across years provides insight into the impacts of current land use on SWS inflows and outflows over time.

Detailed current water budget components in each subregion are summarized in detail in **Appendix 2.F.**

Projected Water Budget Development

Water budgets were projected into the future to estimate future water demands under different future scenarios and to evaluate the potential effects of different management actions and implementation of different projects.

Two primary projected water budget scenarios were considered: a projected without projects (no action) scenario, and a projected with projects scenario. Both these projected scenarios were also considered in the context of potential climate change effects on surface water supply and weather parameters.

Two major time periods exist in the future projected model: the implementation period (2020-2039), during which PMAs are implemented to bring the Subbasin into sustainability, and the sustainability period (2040-2090), after which PMAs have been fully implemented.

The development of the projected future scenarios is described in detail in **Appendix 6.D**, Groundwater Model Documentation. The development of projected time series for precipitation, evapotranspiration, and surface water flows are briefly summarized in Tables 2-27 and 2-28 below.

Comparison of Water Budget Scenarios

Table 2-26 provides a summary of the average annual inflows, outflows, change in groundwater storage, and overdraft estimated at the Subbasin-level in the historical, current, projected without projects, and projected with projects water budgets.

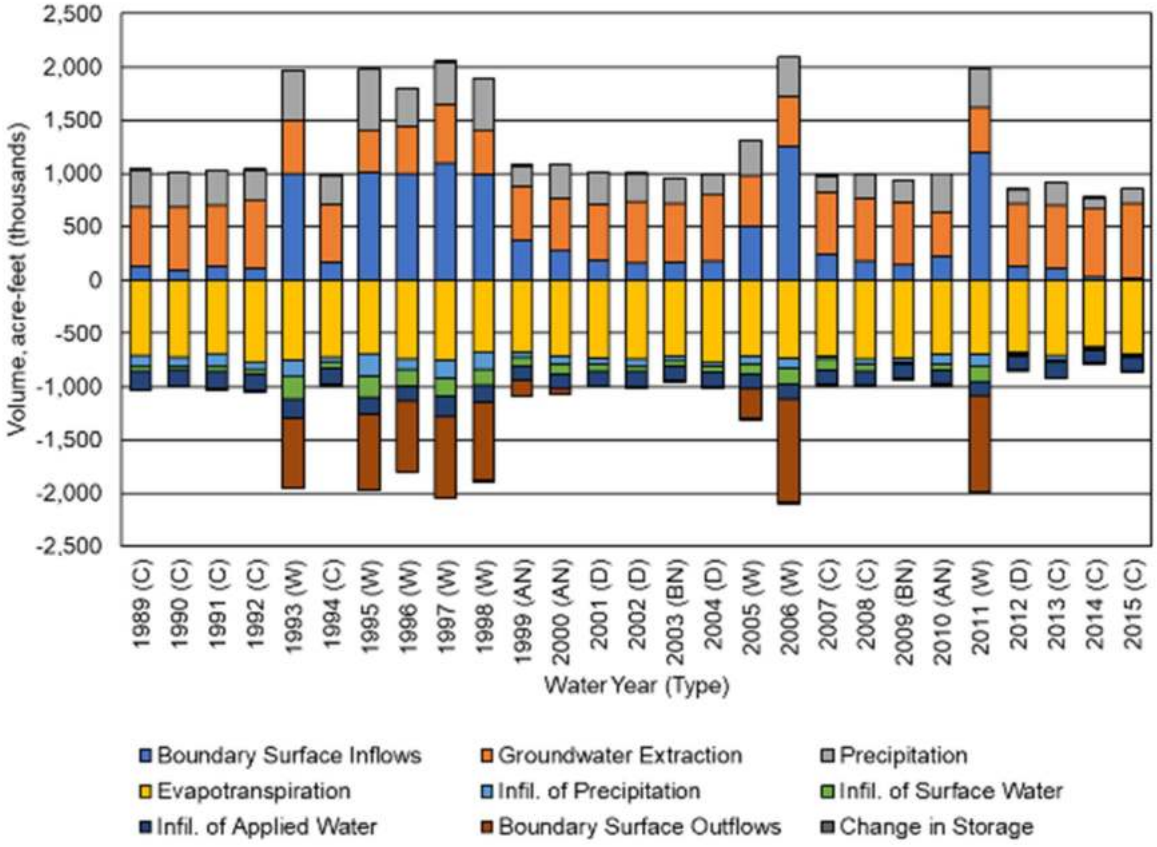


Figure 2-97. Madera Subbasin Surface Water System Current Water Budget.

Table 2-26. Comparative Summary of all Water Budget Scenarios, Annual Average Volumes by Flow Path (AF).

23 CCR Section	Flow Path Direction (Relative to GWS)	Flow Path	Water Budget Period				Reason for Difference from Historical
			Historical	Current	Projected, No Action	Projected, With Projects	
			1989-2014	2015 land use, 1989-2014 average hydrology/supply	2040-2090	2040-2090	
354.18(b)(1)	N/A (SWS flow path)	Surface Water Inflows	425,800	425,800	374,200	377,800	Decrease due to SJRRP (Projected)
		Local Supplies	*214,600*	*214,600*	*164,300*	*167,800*	Decrease in Chowchilla Bypass flows with SJRRP (Projected)
		CVP Supplies	*211,200*	*211,200*	*210,000*	*210,000*	Decrease in CVP deliveries with SJRRP (Projected)
354.18(b)(1)	N/A (SWS flow path)	Surface Water Outflows	228,600	228,600	174,000	154,700	Decrease due to decreased surface water inflows described above (Projected), GSP project diversions (With Projects)
		Local Supplies	*190,900*	*190,900*	*144,600*	*124,300*	
		CVP Supplies	*37,700*	*37,700*	*29,400*	*30,400*	
Implied	N/A (SWS flow path)	Precipitation	298,500	298,500	346,100	346,100	Increase due to higher proportion of water years anticipated in projected period (35% of years, versus 31% in historical period)
354.18(b)(2)	Inflow	Infiltration of Surface Water	145,200	144,900	162,000	217,100	Increase due to infiltration of GSP projects (With Projects)
354.18(b)(2)	Inflow	Infiltration of Applied Water	139,900	145,100	133,700	130,700	Decrease due to urban growth (Projected), demand management (with Projects)
354.18(b)(2)	Inflow	Infiltration of Precipitation	82,800	80,400	83,400	88,400	N/A
354.18(b)(3)	N/A (SWS flow path)	Evapotranspiration	655,900	715,800	704,800	638,800	Increase due to cropping (Current; Projected, No Action); Decrease due to demand management (Projected, With Projects)

23 CCR Section	Flow Path Direction (Relative to GWS)	Flow Path	Water Budget Period				Reason for Difference from Historical
			Historical	Current	Projected, No Action	Projected, With Projects	
			1989-2014	2015 land use, 1989-2014 average hydrology/supply	2040-2090	2040-2090	
354.18(b)(3)	Outflow	GW Pumping	471,500	533,100	548,000	447,400	Increase due to cropping (Current; Projected, No Action); Decrease due to demand management (Projected, With Projects)
354.18(b)(3)	Outflow	GW Discharge to Surface Water Sources	0	0	0	0	Low groundwater levels
354.18(b)(2),(3)	Inflow (Net)	Net Subsurface Inflow	69,400	N/A	108,200	21,400	Increase due to low groundwater levels (Projected, No Action); Decrease due to GSP projects and management actions used to achieve sustainability (Projected, With Projects)
354.18(b)(4)	Inflows - Outflows	Average Annual Change in Groundwater Storage	-34,200	N/A	-60,700	10,200	Decrease due to cropping and related groundwater extraction (Current; Projected, No Action); Increase due to GSP projects and management actions used to achieve sustainability (Projected, With Projects)
354.18(b)(5)	Inflows - Outflows	Average Overdraft	-34,200	N/A	-60,700	10,200	Changes due to reasons above.

[1]Net subsurface inflow not estimated for current water budget due to uncertainties in adjacent Subbasin groundwater conditions.

Table 2-27. Development of Projected Future Precipitation and Evapotranspiration Time Series.

Water Budget Component	Without Climate Change Adjustments		With Climate Change Adjustments	
	Implementation Period	Sustainability Period	Implementation Period	Sustainability Period
	(2020-2039)	(2040-2090)	(2020-2039)	(2040-2090)
Precipitation	2001-2010 historical data (2020-2029 and 2030-2039)	1965-2015 historical data (2040-2090)	2001-2010 historical data (2020-2029 and 2030-2039) adjusted by CalSim II 2030 monthly change factors by water year type	1965-2015 historical data (2040-2090) adjusted by CalSim II 2030 monthly change factors by water year type
Evapotranspiration	2001-2010 historical data (2020-2029 and 2030-2039), assuming 2017 land use adjusted for projected urban area growth from 2017-2039	1965-2015 historical data, assuming 2017 land use adjusted for projected urban area growth from 2017-2070 (urban area constant from 2071-2090)	2001-2010 historical data (2020-2029 and 2030-2039) adjusted by CalSim II 2030 monthly change factors by water year type, assuming 2017 land use adjusted for projected urban area growth from 2017-2039	1965-2015 historical data (2040-2090) adjusted by CalSim II 2030 monthly change factors by water year type, assuming 2017 land use adjusted for projected urban area growth from 2017-2070 (urban area constant from 2071-2090)

Table 2-28. Development of Projected Future Surface Water Supply Time Series.

Water Budget Component	Without Climate Change Adjustments		With Climate Change Adjustments	
	Implementation Period	Sustainability Period	Implementation Period	Sustainability Period
	(2020-2039)	(2040-2090)	(2020-2039)	(2040-2090)
Surface Water Inflow - Unimpaired Streams	2001-2010 historical data (2020-2029 and 2030-2039)	1965-2015 historical data (2040-2090)	2001-2010 historical data (2020-2029 and 2030-2039) adjusted by CalSim II 2030 monthly streamflow change factors by water year type	1965-2015 historical data (2040-2090) adjusted by CalSim II 2030 monthly streamflow change factors by water year type
Surface Water Inflow - Fresno River (Hidden Dam Releases)	2001-2010 historical data (2020-2029 and 2030-2039)	1965-2015 historical data (2040-2090)	2001-2010 data (2020-2029 and 2030-2039): 2001-2003 historical data adjusted by CalSim II 2030 climate change projections for Hensley Lake; 2004-2010 data estimated as the historical volume adjusted by the average monthly climate-adjusted volume by water year type	1965-2003 historical data (2040-2078) adjusted by CalSim II 2030 climate change projections for Hensley Lake; 2004-2015 data (2079-2090) estimated as the historical volume adjusted by the average monthly climate-adjusted volume by water year type

Water Budget Component	Without Climate Change Adjustments		With Climate Change Adjustments	
	Implementation Period	Sustainability Period	Implementation Period	Sustainability Period
	(2020-2039)	(2040-2090)	(2020-2039)	(2040-2090)
Surface Water Inflow - San Joaquin River (Friant Dam Releases)	Estimated based on the Friant Water Authority Report* (same as the implementation period with climate change adjustments**, see right)	Estimated based on the Friant Water Authority Report* (same as the implementation period with climate change adjustments**, see right)	2001-2010 data (2020-2029 and 2030-2039): 2001-2003 data provided by Friant Water Authority Report*, considering the CalSim II 2030 climate change projections and implementation of the SJRRP; 2004-2010 data estimated as the historical volume adjusted by the average Friant Report volume by month and water year type	1965-2003 data (2040-2078) provided by Friant Water Authority Report*, considering the CalSim II 2030 climate change projections and implementation of the SJRRP; 2004-2015 data (2079-2090) estimated as the historical volume adjusted by the average Friant Report volume by month and water year type
Surface Water Inflow - Chowchilla Bypass	Estimated based on the historical monthly ratio of Chowchilla Bypass (CBP) and San Joaquin River (SJR) flows, with projected SJR inflow data provided by the Friant Water Authority Report* (same as the implementation period with climate change adjustments**, see right)	Estimated based on the historical monthly ratio of CBP and SJR flows, with projected SJR inflow data provided by the Friant Water Authority Report* (same as the implementation period with climate change adjustments**, see right)	2001-2010 data (2020-2029 and 2030-2039): 2001-2003: estimated based on the historical monthly ratio of CBP and SJR flows by water year type, with projected SJR inflow data provided by the Friant Water Authority Report*, considering the CalSim II 2030 climate change projections and implementation of the SJRRP; 2004-2010: estimated based on the historical monthly ratio of CBP to SJR flows by water year type, with average projected SJR inflows calculated from 1921-2003 by month and water year type	1965-2003 (2040-2078): estimated based on the historical monthly ratio of CBP to SJR flows by water year type, with projected SJR inflow data provided by the Friant Water Authority Report*, considering the CalSim II 2030 climate change projections and implementation of the SJRRP; 2004-2015 (2079-2090): estimated based on the historical monthly ratio of CBP to SJR flows by water year type, with average projected SJR inflows calculated by month and water year type
Diversions from Madera Canal	Estimated based on the Friant Water Authority Report* (same as the implementation period with climate change adjustments**, see right)	Estimated based on the Friant Water Authority Report* (same as the implementation period with climate change adjustments**, see right)	2001-2010 data (2020-2029 and 2030-2039): 2001-2003 data provided by Friant Water Authority Report*, considering the CalSim II 2030 climate change projections and implementation of the SJRRP; 2004-2010 data estimated as the historical volume adjusted by the average Friant Report climate change volume by month and water year type	1965-2003 data (2040-2078) provided by Friant Water Authority Report*, considering the CalSim II 2030 climate change projections and implementation of the SJRRP; 2004-2015 data (2079-2090) estimated as the historical volume adjusted by the average Friant Report climate change volume by month and water year type

Water Budget Component	Without Climate Change Adjustments		With Climate Change Adjustments	
	Implementation Period	Sustainability Period	Implementation Period	Sustainability Period
	(2020-2039)	(2040-2090)	(2020-2039)	(2040-2090)
Other Diversions/ Bypasses	2001-2010 historical data (2020-2029 and 2030-2039)	1965-2015 historical data (2040-2090)	2001-2010 historical data (2020-2029 and 2030-2039)***	1965-2015 historical data (2040-2090)***

* "Estimate of Future Friant Division Supplies for use in Groundwater Sustainability Plans, California," Friant Water Authority, 2018.
** Although the Friant Water Authority Report (or Friant Report) accounts for climate change, it is considered the best available estimate of projected Madera Canal deliveries under SJRRP. For comparison, projected Madera Canal deliveries under SJRRP were also estimated without account for climate change from the Steiner Report Kondolf Hydrograph (Steiner, 2005). These estimates were approximately equal to the Friant Report 2030 climate change adjusted deliveries. Thus, the Friant Report projections were used instead to maintain consistent assumptions in estimating Madera Canal deliveries across all projected simulations.
*** Historical volumes specified in the model to ensure that GSAs can use as much surface water as is available in a given time step up to the maximum historical surface water used.

Overdraft Conditions

Overdraft is defined in DWR Bulletin 118 as "the condition of a groundwater basin or subbasin in which the amount of water withdrawn by pumping exceeds the amount of water that recharges the basin over a period of years, during which the water supply conditions approximate average conditions" (DWR, 2003). The Madera Subbasin water budget indicates that overdraft conditions occurred during the 1989-2014 historical base period. Per 23 CCR § 354.18(b)(5), the Subbasin overdraft has been quantified for this period. Overdraft is calculated as the sum of all outflows from the groundwater system, including groundwater extraction and subsurface outflow, minus the sum of all inflows to the groundwater system, including infiltration from all sources and subsurface inflow.

The average Subbasin overdraft is presented below for 1989-2014 based on the historical water budget (Table 2-29) and current land use water budget (Table 2-30).

Net Recharge from SWS

For estimates of the SWS contribution to overdraft, the term net recharge from the SWS is defined as groundwater recharge minus groundwater extraction. Net recharge from the SWS is useful for understanding and analyzing the combined effects of land surface processes on the underlying GWS.

When calculated from the historical water budget, average net recharge from the SWS represents the average recharge (when positive) or shortage (when negative) of recharge from the SWS based on historical cropping, land use practices, and average hydrologic conditions. When calculated from the current land use water budget, average net recharge represents the average recharge or shortage based on current cropping, land use practices, and average hydrologic conditions.

Table 2-29. Historical Water Budget: Average Overdraft by Water Year Type, 1989-2014 (AF) (23 CCR § 354.18(b)(5)).

Year Type	Number of Years	Net Subsurface Groundwater Inflow (a)	Infiltration of Applied Water (b)	Infiltration of Precipitation (c)	Infiltration of Surface Water (d)	Groundwater Extraction (e)	Overdraft (a+b+c+d-e)
W	8	*	148,294	137,812	221,080	404,997	*
AN	3	*	128,100	69,574	135,683	421,137	*
BN	2	*	123,542	40,778	105,804	495,785	*
D	4	*	140,684	48,981	99,941	533,401	*
C	9	*	139,720	62,695	109,709	514,525	*
Annual Average (1989-2014)	26	69,435	139,921	82,806	145,171	471,511	-34,178

* Year type values and averages are not reported because of the variable quality and timing of available groundwater level data and the resulting potential for biasing subsurface lateral flow calculations based on discrete snapshots of groundwater level conditions.

Table 2-30. Current Land Use Water Budget: Average Overdraft by Water Year Type, 1989-2014 (AF) (23 CCR § 354.18(b)(5)).

Year Type	Number of Years	Net Subsurface Groundwater Inflow (a)	Infiltration of Applied Water (b)	Infiltration of Precipitation (c)	Infiltration of Surface Water (d)	Groundwater Extraction (e)	Overdraft (a+b+c+d-e)
W	8	*	152,925	134,397	220,640	459,807	*
AN	3	*	132,331	67,635	136,545	475,307	*
BN	2	*	131,545	39,703	105,633	569,873	*
D	4	*	139,461	46,865	100,009	576,028	*
C	9	*	147,842	60,510	109,121	590,203	*
Annual Average (1989-2014)	26	69,435	145,073	80,367	144,929	533,079	-93,276

* Year type values and averages are not reported because of the variable quality and timing of available groundwater level data and the resulting potential for biasing subsurface lateral flow calculations based on discrete snapshots of groundwater level conditions.

Average net recharge from the SWS is presented below for 1989-2014 based on the historical water budget (Table 2-31) and current land use water budget (Table 2-32). Historically, average annual overdraft from the Madera Subbasin was approximately 104TAF between 1989 and 2014. Under current land use conditions, average annual overdraft from the Madera Subbasin has increased to approximately 163TAF.

Annual Supply, Demand, and Change in Groundwater Stored by Water Year Type

Annual supply, demand, and change in groundwater stored is summarized by water year type in Table 2-33 for historical, current, projected without projects (no action), and projected with projects conditions.

Table 2-31. Historical Water Budget: Average Net Recharge from SWS by Water Year Type, 1989-2014 (AF).

Year Type	Number of Years	Infiltration of Applied Water (a)	Infiltration of Precipitation (b)	Infiltration of Surface Water (c)	Groundwater Extraction (d)	Net Recharge from SWS (a+b+c-d)
W	8	148,294	137,812	221,080	404,997	102,189
AN	3	128,100	69,574	135,683	421,137	-87,779
BN	2	123,542	40,778	105,804	495,785	-225,662
D	4	140,684	48,981	99,941	533,401	-243,795
C	9	139,720	62,695	109,709	514,525	-202,401
Annual Average (1989-2014)	26	139,921	82,806	145,171	471,511	-103,613

Table 2-32. Current Land Use Water Budget: Average Net Recharge from SWS by Water Year Type, 1989-2014 (AF).

Year Type	Number of Years	Infiltration of Applied Water (a)	Infiltration of Precipitation (b)	Infiltration of Surface Water (c)	Groundwater Extraction (d)	Net Recharge from SWS (a+b+c-d)
W	8	152,925	134,397	220,640	459,807	48,154
AN	3	132,331	67,635	136,545	475,307	-138,796
BN	2	131,545	39,703	105,633	569,873	-292,992
D	4	139,461	46,865	100,009	576,028	-289,693
C	9	147,842	60,510	109,121	590,203	-272,730
Annual Average (1989-2014)	26	145,073	80,367	144,929	533,079	-162,711

Table 2-33. Comparative Summary of Annual Supply, Demand, and Change in Storage by Water Year Type (AFY) (23 CCR § 354.18(b)(6)).

Water Year Type	Water Budget Element	Water Budget Flow Paths	Water Budget Period			
			Historical	Current	Projected, No Action	Projected, With Projects
			1989-2014	2015 land use, 1989-2014 average hydrology/supply	2040-2090	2040-2090
W	Supply	Surface Water Inflows	1,008,000	1,008,000	761,400	767,700
	Supply	Precipitation	416,700	416,700	490,100	490,100
	Demand	Evapotranspiration	663,300	718,400	709,100	645,300
	Change in Storage	Change in Groundwater Storage	177,000	122,900	197,200	417,400
AN	Supply	Surface Water Inflows	287,700	287,700	281,700	289,800
	Supply	Precipitation	287,500	287,500	347,100	347,100
	Demand	Evapotranspiration	645,500	697,800	718,300	649,700
	Change in Storage	Change in Groundwater Storage	-31,700	-82,700	-60,800	-36,100
BN	Supply	Surface Water Inflows	153,800	153,800	156,500	156,300
	Supply	Precipitation	220,300	220,300	272,300	272,300
	Demand	Evapotranspiration	653,000	721,400	711,200	643,200
	Change in Storage	Change in Groundwater Storage	-163,100	-230,400	-198,500	-191,000
D	Supply	Surface Water Inflows	165,000	165,000	157,800	159,100
	Supply	Precipitation	220,600	220,600	250,500	250,500
	Demand	Evapotranspiration	683,700	729,400	722,000	650,500
	Change in Storage	Change in Groundwater Storage	-181,300	-227,200	-220,200	-248,700
C	Supply	Surface Water Inflows	119,400	119,400	108,600	108,800
	Supply	Precipitation	238,400	238,400	236,200	236,200
	Demand	Evapotranspiration	646,300	710,500	680,700	617,100
	Change in Storage	Change in Groundwater Storage	-154,600	-217,700	-261,600	-284,600

Subbasin Sustainable Yield Estimate.

The sustainable yield assessment is largely based on the balance of recharge versus discharge components in conjunction with groundwater storage change estimates for the Subbasin as a whole. In other words, undesirable results for sustainability indicators not accounted for in this preliminary analysis may lead to a lower sustainable yield estimate. While preliminary, this sustainable yield assessment does provide important insights regarding the magnitude of existing groundwater overdraft, the scale of potential projects needed to ultimately achieve sustainable Subbasin operations, and the groundwater available for extraction under sustainable Subbasin operations.

The GSP regulations require the water budget to quantify the sustainable yield for the Subbasin. Sustainable yield is defined as "the maximum quantity of water, calculated over a base period representative of long-term conditions in the basin and including any temporary surplus, that can be withdrawn annually from a groundwater supply without causing an undesirable result" (CWC §10721(w)). The sustainability goal for the Madera Subbasin is to implement a package of PMAs that will, by 2040, balance long-term groundwater system inflows with outflows based on a 50-year period representative of average historical hydrologic conditions. Therefore, the maximum quantity of water that can be withdrawn following GSP implementation is equal to the average total inflows to the groundwater system, assuming that net subsurface flows have stabilized. In addition, model results show that the schedule for project implementation together with the mitigation program for domestic wells results in MOs and related values for the sustainability indicators that avoid MTs and associated undesirable results for the 2040-2090 projected period.

In alignment with the GSP regulations and DWR's Sustainable Management Criteria BMP (DWR, 2017), sustainable yield has been estimated as part of the Subbasin historical water budget (1989-2014) and the Subbasin projected with projects water budget (2040-2090). A single value of sustainable yield has been estimated for the Subbasin as a whole during each of these analysis periods, which have been shown to be representative of long-term average hydrologic conditions. (DWR, 2017).

Preliminary sustainable yield, not accounting for undesirable results, was calculated for the 1989-2014 historical water budget using three methods, resulting in estimates of similar magnitude with differing confidence intervals (Table 2-34). The first method estimates sustainable yield as the average annual groundwater extraction minus the average annual change in groundwater storage during the 1989-2014 historical period. The second method calculates sustainable yield as the sum of the average annual inflows to the groundwater system (infiltration of applied water, infiltration of precipitation, infiltration of surface water, and subsurface groundwater inflow) during the 1989-2014 historical period. The third method calculates sustainable yield as the groundwater extraction required to achieve approximately zero overdraft following iterative reduction of ET of applied water, reducing demand. The reduction in ET of applied water results in lower demand for groundwater extraction and an associated reduction in infiltration of applied water, which both affect overdraft. The sustainable yield estimates derived from analysis of the historic water budget should be considered preliminary, as they do not fully account for all undesirable results, such as effects on groundwater dependent ecosystems (GDEs), and other SGMA-required components in the sustainable yield assessment.

Table 2-34. Summary of Sustainable Yield Estimates from Historical Water Budget (23 CCR § 354.18(b)(7)).

Quantification Method	Average Volume, 1989-2014 (AF)	Estimated Confidence Interval (percent)	Confidence Interval Source	Average minus CI (AF)	Average plus CI (AF)
Groundwater Extraction and GWS Change in Storage	437,300	25%	Calculation.	328,000	564,600
Total Inflows to GWS	437,300	19%	Calculation.	354,200	520,400
"Simulation" of Reduced Demand	423,300	25%	Professional Judgment.	317,500	529,100

Sustainable yield was also calculated for the projected period, with a specific focus on the 2040-2090 evaluation period following implementation of GSP PMAs.

Sustainable yield is dependent upon conditions in existence at the time, and therefore changes during the implementation period as projects are completed, increasing recharge or leading to reductions in demand. As such, sustainable yield was only calculated for the sustainability period during which all identified projects would be fully operational (2040-2090).

For the 2040-2090 period, model results demonstrate that sustainability indicator MTs and associated undesirable results are avoided by the combined effects of the project implementation schedule and the mitigation program for domestic wells described in this Joint GSP. Thus, the sustainable yield for this 2040-2090 projected period is the quantity of groundwater "…that can be withdrawn annually from a groundwater supply without causing an undesirable result" (CWC § 10721(w)).

Sustainable yield was calculated for the 2040-2090 projected period (Table 2-35) with a single value of a sustainable yield for the Subbasin as a whole (DWR, 2017). The sustainable yield is estimated as the average annual groundwater extraction during the projected 2040-2090 period. This projected groundwater extraction equals the sum of the average annual recharge without projects and the average annual net project infiltration during the projected period. Since average groundwater inflows approximately equal outflows during the 2040-2090 period, the average annual change in the groundwater storage would be close to zero over this 50-year period. By this method, sustainable yield is estimated to be 439,300 AFY. Accounting for all uncertainties in GWS inflows and outflows, the sustainable yield is estimated to range between 329,500 AFY and 549,100 AFY.

Table 2-35. Summary of Sustainable Yield Estimates from Projected With Projects Water Budget (23 CCR § 354.18(b)(7)).

Quantification Method	Average Volume, 2040-2090 (AF)	Estimated Confidence Interval[1] (percent)	Average minus CI (AF)	Average plus CI (AF)
Groundwater Extraction and GWS Change in Storage	439,300	25%	329,500	549,100

[1] Confidence interval source: Professional judgment based on historical calculations.

Surface Water Available for Groundwater Recharge

Implementation of the GSP will require the Madera Subbasin to be operated within its sustainable yield by 2040. To achieve this, GSAs may implement projects to restrict groundwater pumping or to increase groundwater recharge (Figure 2-98).



Figure 2-98. On-farm Recharge in Madera Irrigation District.

There are five potential sources of water available for groundwater recharge projects: Fresno River flood releases, Millerton flood releases, Chowchilla Bypass flows, additional CVP diversions, and water purchased from outside the Subbasin.

Fresno River flood releases include releases from Hidden Dam and releases from Millerton Reservoir (including Section 215 water[64] or other sources of CVP yield determined by Reclamation to be available to its contractors) that enter Fresno River at Madera Canal Mile 18.8. Available Fresno River flood releases exclude water diverted to the MID conveyance system from Fresno River at Franchi Diversion Dam. During the historical base period (1989-2014), Fresno River flood releases occurred in all eight years classified as wet by DWR's San Joaquin River Water Index. In wet years, surface water was available from Fresno River for groundwater recharge. Across the 2019-2090 projected period (using historical hydrologic and water supply data, as described in Section 2.2.3.2), surface water in Fresno River is also expected to be available for groundwater recharge during wet years.

Millerton flood releases include flood releases to the Madera Subbasin (including 16(b) water[65]) along Madera Canal and exclude releases to Fresno River at Madera Canal Mile 18.8. During the historical base

[64] Reclamation Reform Act of 1982, Section 215 allows delivery of large, temporary, and non-storable water supplies to land that is otherwise ineligible to receive federal water.

[65] San Joaquin River Restoration Settlement, Paragraph 16(b): Recovered Water Account.

period, Millerton flood releases occurred in 8 of 26 years and averaged 34TAF per year when there was a release. Seven of these years were classified as wet years (36TAF per year on average), while the remaining year was classified as above normal (15TAF). Millerton flood releases are projected to occur in an estimated 18 years out of 51 years of the 1965-2015 projected dataset used to develop the 2019-2090 projected water budgets.

Chowchilla Bypass flows include all water entering the Subbasin along Chowchilla Bypass downstream of the heading along San Joaquin River below the control structure. During the historical base period, Chowchilla Bypass flows occurred in 11 of 26 years and averaged 453TAF per year with flow. Among these years, Chowchilla Bypass flows occurred in all eight years classified as wet by DWR's San Joaquin River Water Index, averaging 605TAF per wet year. Flows also occurred in above normal years, averaging 63TAF per year. Chowchilla Bypass flows are projected to occur in 25 years out of 51 years of the 1965-2015 projected dataset used to develop the 2019-2090 projected water budgets. It is important to note that when water historically flows in the Chowchilla Bypass, the duration averages approximately 40 days.

The remaining potential sources of water available for groundwater recharge – additional CVP diversions and purchased water – are new sources of water that would be brought into the Subbasin as part of GSP projects.

2.2.4 Management Areas (23 CCR § 354.20)

SGMA regulations allow for a GSA or group of GSAs in a Subbasin to decide if designation of management areas will help facilitate implementation of the GSP. Options for use of management areas were discussed among GSA representatives and the GSP consultant team and in public meetings. The four Joint GSP GSAs preparing this joint GSP decided not to designate any management areas in the Plan Area. This decision was based upon review of the Subbasin hydrogeologic conceptual model, groundwater conditions, and water budget analyses. It was determined that there were not sufficient differences in hydrogeologic or groundwater conditions across the Subbasin to warrant designation of management areas. Water budgets are already calculated at both the Subbasin scale and for each of the four Joint GSP GSAs preparing this Joint GSP. In addition, water budgets were prepared for the three GSAs not included in this joint GSP.

The sustainable management criteria and projects/management actions for the Subbasin and each GSA are described in Sections 3 and 4, respectively. Although management areas are not used in the GSP, sustainable management criteria are specific to each RMS location as described in more detail in Section 3.

CHAPTER 2 PLAN AREA AND BASIN SETTING

Selected Figures

The following figures can be found after this page: Figures 2-5 to 2-7, Figures 2-10 to 2-80

ALL FIGURES FOR CHAPTER 3 START AT PAGE 593

3 SUSTAINABLE MANAGEMENT CRITERIA

This chapter of the GSP provides a discussion of the sustainability goals, measurable objectives (MOs), interim milestones, minimum thresholds (MTs), undesirable results, and the monitoring network for each sustainability indicator within the Plan Area encompassed by the four Joint GSP GSAs: Madera County, Madera Irrigation District, Madera Water District, and the City of Madera. These four Joint GSP GSAs (and the Plan Area) comprise approximately 325,450 acres out of the total Subbasin area of 347,600 acres, and do not include areas of the Subbasin covered by three other GSAs: Root Creek Water District, Gravelly Ford Water District, and New Stone Water District. Undesirable results occur when significant and unreasonable effects for any sustainability indicators defined by the Sustainability Groundwater Management Act (SGMA) are caused by groundwater conditions occurring in the Plan Area.

This is the fundamental chapter that defines sustainability in the Plan Area, and it addresses significant regulatory requirements. The MOs, MTs, and undesirable results presented in this chapter define the future sustainable conditions in the Plan Area and commit the associated GSAs (Madera County, Madera Irrigation District, City of Madera, and Madera Water District) to actions that will achieve these future conditions.

Defining Sustainable Management Criteria (SMC) requires considerable analysis and evaluation of many factors. This chapter presents the data and methods used to develop the SMC and demonstrates how they relate to beneficial uses and users. The SMC presented in this chapter are based on current available data and applications of the best available science.

As noted in this Joint GSP, data gaps and uncertainty exist in the characterization of the hydrogeologic conceptual model and groundwater conditions. The uncertainty was considered when developing the SMC and because of these uncertainties, the SMC presented herein are considered initial criteria. The GSAs will periodically evaluate this Joint GSP, assess changing conditions in the Plan Area that may warrant modifications of the GSP or management objectives, and may adjust components accordingly. The GSAs will focus their evaluation on determining whether the actions under the GSP are meeting the GSP management objectives and whether those objectives are meeting the sustainability goal of the Subbasin.

This chapter is organized to address all the SGMA regulations regarding SMC, and is organized in accordance with DWR's GSP annotated outline. This chapter includes a description of:

- How locally defined significant and unreasonable conditions were developed
- How MTs were developed, including:
    - The information and methodology used to develop MTs
    - The relationship between MTs and relationship of these MTs to other sustainability indicators
    - The effect of MTs on neighboring basins
    - The effect of MTs on beneficial uses and users
    - How MTs are related to relevant Federal, State or local standards
    - The method for quantifying measurable MTs
- How MOs were developed, including:
    - The methodology for setting MOs

  - Interim milestones
- How undesirable results were developed, including:
  - The criteria defining when and where the effect of the groundwater conditions cause undesirable results based on a quantitative description of the combination of MT exceedances
  - The potential causes of undesirable results
  - The effect of these undesirable results on the beneficial use and users.

The SMC presented in this chapter were developed using information from stakeholder and public input and correspondence with the GSAs, public meetings, hydrogeologic analysis, groundwater dependent ecosystem analysis, meetings with GSA technical representatives, and meetings with DWR's technical experts. The general process for establishing SMC included:

- GSA public meetings that outlined the GSP development process and introduced stakeholders to the SMC
- Conducting GSP public meetings to present proposed methodologies to establish MTs and MOs and receive additional public input. Two public meetings on SMC were held in the Plan Area
- Reviewing public input on preliminary SMC methodologies with GSA staff/technical representatives
- Providing a Draft GSP for public review and comment
- Establishing and modifying MTs, MOs, and definition of undesirable results based on feedback from public meetings, public/stakeholder review of the Draft GSP, and input from GSA staff/technical representatives.

To ensure the Plan Area meets its sustainable goal by 2040, the GSAs have proposed the PMAs described in Section 4 to address undesirable results and to achieve and maintain sustainable groundwater conditions. The PMAs expected to be implemented will include projects (e.g., recharge basins, Flood MAR, in-lieu recharge) and management actions including demand reduction. The overarching sustainability goal and the absence of undesirable results are expected to be achieved by 2040 through implementation of the PMAs. The sustainability goal will be maintained through proactive monitoring and management by the GSAs as described in this and the following chapters. Table 3-1 summarizes whether each of the six undesirable results has occurred, is occurring, or is expected to occur in the future in the Plan Area without and with GSP implementation.

3.1 Sustainability Goal *(23 CCR § 354.24)*

3.1.1 Goal Description

The sustainability goal for the Subbasin is to implement a package of PMAs that will, by 2040, balance long-term groundwater system inflows with outflows based on a 50-year period representative of average historical hydrologic conditions. The six sustainability indicators, established MOs, and MTs that will ensure no undesirable results of significant and unreasonable economic, social, or environmental impacts occur as a result of GSP activities, as defined based on local values expressed in this Joint GSP.

Table 3-1. Summary of Undesirable Results Applicable to the Plan Area

Sustainable Indicator	Historical Period (Prior to 2015)	Existing Conditions	Future Conditions without GSP Implementation	Future Conditions with GSP Implementation (after 2040)
Chronic Lowering of Groundwater Levels	Yes	Yes	Yes	No
Reduction of Groundwater Storage	Yes	Yes	Yes	No
Land Subsidence	No	No	Possibly	No
Seawater Intrusion	Not Applicable	Not Applicable	Not Applicable	Not Applicable
Degraded Water Quality	Yes	Yes	Yes	No[1]
Depletion of Interconnected Surface Water	Yes	No[2]	No	No

[1] There may be future continued degradation of groundwater quality that is not related to GSP Projects and Management Actions.
[2] Surface water and groundwater are disconnected under existing conditions.

3.1.2 Description of Measures

Recharge projects, which include projects that replace groundwater use with surface water use (in-lieu recharge), and management actions that reduce total demand, are planned to be implemented over the 20-year implementation period (2020 to 2040). Together the recharge projects and the management actions will increase groundwater inflows and decrease groundwater outflows to bring the groundwater system into balance by 2040 and will allow its operation to remain sustainable over a 50-year period representing average hydrologic conditions. If actual hydrologic conditions differ from the 50-year average (e.g., due to climate change), then additional measures may need to be taken.

3.1.3 Explanation of How the Goal Will Be Achieved in 20 Years

Implementation of recharge projects will increase inflow to the groundwater system, thus increasing groundwater levels in wet years when water is available for recharge. Implementation of projects that replace groundwater use with surface water use will reduce groundwater pumping to maximize the use of surface water, also contributing to increases or stabilization in groundwater levels. Demand reduction will decrease the consumptive use of groundwater, also contributing to increases or stabilization of groundwater levels. The combination of the increased inflows through recharge, decreased outflows through the projects that replace groundwater use with surface water use, and through the reduced demand resulting from the management actions, results in groundwater inflows equaling outflows over the sustainability period (2040 to 2090), as detailed in Section 2 (Plan Area and Basin Setting) of this Joint GSP.

3.2 Measurable Objectives *(23 CCR § 354.30)*

As detailed below, the MOs represent the expected operating conditions for the Subbasin. If the GSAs successfully operate to the MOs described, the Subbasin will be operating sustainably. MOs and interim milestones are detailed below. A description of the MOs and how they were established are provided, along with recognition of the anticipated fluctuations in Subbasin conditions around the established MOs. In addition, this section describes how the Joint GSP helps to meet each MO, how each MO is intended to achieve the sustainability goal for the Subbasin for the long-term beneficial uses, and how the interim

milestones are intended to reflect the anticipated progress toward the MOs during the 2020 to 2040 implementation period.

The GSP regulations define MOs as specific, quantifiable goals for the maintenance or improvement of specific groundwater conditions that have been included in an adopted GSP to achieve the sustainability goal for the Subbasin.

Per the GSP regulations (23 CCR § 354.30):

1. MOs shall be established, "…including interim milestones in increments of five years, to achieve the sustainability goal for the basin within 20 years of [GSP] implementation and to continue to sustainably manage the groundwater basin over the planning and implementation horizon." (§ 354.30.a)
2. "[MOs] shall be established for each sustainability indicator, based on quantitative values using the same metric and monitoring sites as are used to define the [MTs]." (§ 354.30.b)
3. "[MOs] shall provide a reasonable margin of operational flexibility under adverse conditions, which shall take into consideration components such as historical water budgets, seasonal and long-term trends, and periods of drought, and be commensurate with levels of uncertainty." (§ 354.30.c)
4. "…a representative [MO] for groundwater elevation to serve as the value for multiple sustainability indicators…" may be established where "…the Agency can demonstrate that the representative value is a reasonable proxy for multiple individual [MOs] as supported by adequate evidence." (§ 354.30.d)
5. "Each [GSP] shall describe a reasonable path to achieve the sustainability goal for the basin within 20 years of [GSP] implementation, including a description of interim milestones for each relevant sustainability indicator, using the same metric as the [MO], in increments of five years." (§ 354.30.e)

The MOs developed for each applicable sustainability indicator in this Joint GSP are based on the current understanding of the Plan Area and Basin Setting as discussed in detail in Chapter 2. Representative Monitoring Sites (RMS) are identified for monitoring of interim milestones, MOs, and MTs for each sustainability indicator, and are also known as sustainability indicator wells.

3.2.1 Chronic Lowering of Groundwater Levels

MOs and interim milestones for chronic lowering of groundwater levels are described below.

3.2.1.1 Measurable Objectives

MOs for groundwater levels were established in accordance with the sustainability goal through review and evaluation of measured groundwater level data and fluctuations in groundwater levels utilizing the numerical groundwater flow model (**Appendix 6.D.**). This analysis provides estimates of the expected groundwater level variability due to climatic and operational variability. Both annual (year to year) and seasonal (winter/spring to summer/fall) variability were considered. MOs for groundwater levels were set at Fall 2010 groundwater levels based on observed data when available. If observed data were not available, the Fall 2010 groundwater level was based on modeled results, modified if necessary, to account for offset between historically observed and modeled groundwater levels. Fall 2010 groundwater levels represent basin conditions prior to the pre-2012 to 2015 drought period, which are considered a reasonable expectation for the level at which Fall groundwater levels will fluctuate around under sustainable conditions after 2040.

MOs for groundwater levels for each sustainability indicator well or representative monitoring site (RMS) are summarized in Table 3-2, and locations of groundwater level sustainability indicator wells are shown in **Figure 3-1**[66]. These MOs are set specific to aquifer zones designated as Upper Aquifer (above the Corcoran Clay where present, and equivalent depth to the east where Corcoran Clay is not present) and Lower Aquifer. Groundwater level hydrographs showing MOs for each groundwater level sustainable indicator well are provided in **Appendix 3.A..**

3.2.1.2 Interim Milestones

Interim milestones for chronic lowering of groundwater levels were established at five-year intervals over the GSP implementation period from 2020 to 2035, at years 2025, 2030, and 2035. . Interim milestones for groundwater levels were established through review and evaluation of measured groundwater level data and future projected fluctuations in groundwater levels during the GSP implementation period utilizing the numerical groundwater flow model, which simulated implementation of projects and management actions. The lowest interim milestone was set for 2030 based on the lowest model groundwater elevations expected to occur during the GSP implementation period, while accounting for a small amount of hydrologic variability and operational flexibility with a 10-foot buffer. Offsets between historically observed and modeled data were accounted for based on Spring observed and modeled groundwater levels, and Spring to Fall groundwater level fluctuations were accounted for to develop the Fall interim milestone for each year. Interim milestones for groundwater levels for each sustainable indicator well are summarized in Table 3-3, and locations of groundwater level RMS are shown in **Figure 3-1**..

3.2.1.3 Achieving and Maintaining Sustainability

The combination of interim milestones and MOs reflect how the basin anticipates achieving and maintaining sustainability. It should be noted that future projections require assumptions about future hydrologic conditions, including the sequence of wet, average, and dry climatic years. The future climatic assumptions for the GSP implementation period used in the Joint GSP incorporate sequences of wet, average, and dry years that represent overall long-term average historical climatic conditions over the GSP implementation period, without any prolonged periods of extremely dry or extremely wet years. Under these climatic assumptions, the GSP implementation period would involve some gradual and continued decline in groundwater levels after 2020 while PMAs are being implemented. Based on the hydrologic assumptions made, the modeled groundwater levels at most well locations are anticipated to reach future lows between 2030 and 2035, before rebounding to higher levels after 2040 (when all PMAs are implemented). This overall pattern of anticipated fluctuations in groundwater levels reflects the time to design, permit, and construct projects and implement demand reduction (described in **Appendix 3.C**) that is planned to incrementally increase linearly between 2020 and 2040.

It is also important to note that review of RMS groundwater level hydrographs in **Appendix 3.A** demonstrate that average domestic well depths are generally below, the lowest predicted groundwater levels during the GSP implementation period. Review of RMS groundwater hydrographs indicates that impacts to domestic wells during the GSP implementation period will be limited to a relatively small percentage of existing domestic wells. It should further be recognized that review of data for existing wells and ongoing installation of new nested monitoring wells generally indicate that water levels in deeper wells (i.e., depths typical for agricultural and municipal wells) are generally lower than groundwater levels in shallower domestic wells. This means that comparison of observed and modeled groundwater levels for RMS wells screened in deeper zones to average domestic well depths likely shows

[66] Figure titles that are bolded can be found at the end of each chapter

a worst-case scenario (i.e., groundwater levels for most nearby domestic wells will be higher than indicated on the hydrograph for a deep zone RMS well).

Table 3-2. Summary of Groundwater Level Measurable Objectives for Representative Monitoring Sites

Well I.D.	Estimated Surface Elevation[3] (msl, feet)	Depth	Screen Top-Bottom	Model Layer(s)	Aquifer Designation	MO Depth[1]	MO Elev	GSA[2]	CASGEM Well?
MID RMS-1	308	950	320-942	4	Lower	302	6	MID	CASGEM
MID RMS-2	218	563	298-509	4	Lower	213	5	MID	CASGEM
MID RMS-3	241	516	260-507	4	Lower	231	10	MID	CASGEM
MCW RMS-1	169	800	Unknown	4	Lower	81	88	Madera County West	CASGEM
MID RMS-4	190	698	320-667	5	Lower	144	46	MID	CASGEM
MID RMS-5	204	570	270-570	5	Lower	152	52	MID	CASGEM
MID RMS-6	237	680	320-680	4,5	Lower	208	29	MID	CASGEM
MID RMS-7	237	656	290-635	4	Lower	131	106	MID	CASGEM
MCE RMS-1	332	500	420-500	4	Lower	266	66	Madera County East	Voluntary
MID-RMS-8	287	Unknown	Unknown	2,3,4	Composite	213	74	MID	CASGEM
MCE RMS-2	378	Unknown	Unknown	3,4,5	Composite	295	83	Madera County East	Voluntary
MCE RMS-3	325	Unknown	Unknown	2,3,4	Composite	249	76	Madera County East	Voluntary
MCE RMS-4	404	Unknown	Unknown	4	Lower	242	162	Madera County East	Voluntary
MCW RMS-2	173	216	205-212	3	Upper	98	75	Madera County West	CASGEM
MCW RMS-3	162	Unknown	Unknown	2,3	Upper	44	118	Madera County West	Voluntary
MID RMS-9	202	143	Unknown	3	Upper	107	95	MID	Voluntary
MID RMS-10	213	615	315-615	4,5	Lower	113	100	MID	CASGEM
MCW RMS-4	208	580	220-580	3,4	Lower	93	115	Madera County West	CASGEM
MID RMS-11	232	Unknown	Unknown	3	Upper	102	130	MID	CASGEM
MID RMS-12	262	176	Unknown	3	Upper	132	130	MID	CASGEM
MID RMS-13	271	600	228-552	3,4	Composite	148	123	MID	CASGEM
MCE RMS-5	340	Unknown	Unknown	4	Lower	232	108	Madera County East	Voluntary
MID RMS-14	214	Unknown	Unknown	2	Upper	68	146	MID	CASGEM
COM RMS-1	278	520	210-510	4	Lower	208	70	City of Madera	No
COM RMS-2	262	590	370-590	4,5	Lower	197	65	City of Madera	No
COM RMS-3	264	620	310-600	4,5	Lower	189	75	City of Madera	No
MWD RMS-1	330	500	200-500	4	Lower	315	15	Madera WD	CASGEM

Well I.D.	Estimated Surface Elevation[3] (msl, feet)	Depth	Screen Top-Bottom	Model Layer(s)	Aquifer Designation	MO Depth[1]	MO Elev	GSA[2]	CASGEM Well?
MWD RMS-2	310	537	200-537	4	Lower	315	-5	Madera WD	CASGEM
MWD RMS-3	295	800	380-800	4,5	Lower	310	-15	Madera WD	CASGEM
MID RMS-15	247	502	160-200	2,3	Upper	111	136	MID	CASGEM
MCE RMS-6	328	550	450-550	5	Lower	251	77	Madera County East	CASGEM
MID RMS-16	308	452	348-388	4	Lower	293	15	MID	CASGEM
MCE RMS-7	388	840	370-820	4,5,6	Lower	261	127	Madera County East	CASGEM
MCE RMS-8	367	92	32-92	1,2	Upper	32	335	Madera County East	CASGEM
MCE RMS-9	265	37	17-37	1	Upper	11	254	Madera County East	No
MID RMS-17	224	47	27-47	1	Upper	17	207	MID	No
MCW RMS-5	197	30	Unknown	1	Upper	18	179	Madera County West	No

[1] The actual MO is based on the groundwater elevation, but the depth to water corresponding to the surface elevation in the project database is also provided.
[2] Each GSA is responsible for collecting groundwater levels for the sustainability indicator wells within their GSA area.
[3] Ground surface elevation is based on DEM data.

Table 3-3. Summary of Groundwater Level Interim Milestones for Representative Monitoring Sites

Well I.D.	Model Layer	2025 DTW	2030 DTW	2035 DTW	2040 DTW	2025 Elev	2030 Elev	2035 Elev	2040 Elev	CASGEM Well?
MID RMS-1	4	342	343	358	352	-33	-35	-49	-43	CASGEM
MID RMS-2	4	288	280	307	291	-70	-62	-89	-72	CASGEM
MID-RMS-3	4	307	304	327	313	-66	-63	-85	-72	CASGEM
MCW RMS-1	4	122	134	131	129	47	35	38	40	CASGEM
MID RMS-4	5	191	186	202	188	-1	4	-11	2	CASGEM
MID RMS-5	5	193	190	205	195	14	17	2	12	CASGEM
MID RMS-6	4,5	266	264	284	273	-29	-27	-47	-36	CASGEM
MID RMS-7	4	168	169	184	179	70	68	53	58	CASGEM
MCE RMS-1	4	331	332	348	338	1	0	-16	-6	Voluntary
MID-RMS-8	4	281	267	281	270	17	20	6	17	CASGEM
MCE RMS-2	4	281	287	302	294	98	91	77	84	Voluntary
MCE RMS-3	4	308	304	317	302	20	23	11	26	Voluntary
MCE RMS-4	4	231	234	239	238	174	171	166	167	Voluntary
MCW RMS-2	3	97	108	106	104	76	65	67	69	CASGEM
MCW RMS-3	2,3	76	89	83	83	86	73	79	79	Voluntary
MID RMS-9	3	139	140	152	145	64	62	51	58	Voluntary
MID RMS-10	4,5	144	146	156	151	69	67	57	61	CASGEM
MCW RMS-4	3,4	103	109	113	114	105	99	96	94	CASGEM
MID RMS-11	3	133	139	149	149	99	94	84	84	CASGEM
MID RMS-12	3	170	171	180	178	93	91	83	85	CASGEM
MID RMS-13	3	173	175	183	181	98	96	89	90	CASGEM
MCE RMS-5	5	237	236	243	240	102	103	95	99	Voluntary
MID RMS-14	2	75	84	83	88	139	131	131	127	CASGEM
COM RMS-1	4	265	269	284	279	13	9	-6	-1	No
COM RMS-2	5	262	260	277	270	0	2	-15	-7	No
COM RMS-3	4,5	223	222	240	235	42	42	24	30	No
MWD RMS-1	4	359	368	386	379	-29	-38	-56	-49	CASGEM

Well I.D.	Model Layer	2025 DTW	2030 DTW	2035 DTW	2040 DTW	2025 Elev	2030 Elev	2035 Elev	2040 Elev	CASGEM Well?
MWD RMS-2	4	367	375	394	386	-57	-65	-84	-76	CASGEM
MWD RMS-3	4,5	374	379	401	391	-87	-92	-114	-104	CASGEM
MID RMS-15	2	116	123	125	129	131	124	122	118	CASGEM
MCE RMS-6	5	275	272	282	273	53	56	46	55	CASGEM
MID RMS-16	4	347	354	372	365	-39	-46	-64	-57	CASGEM
MCE RMS-7	4,5,6	238	241	246	246	150	147	142	142	CASGEM
MCE RMS-8	2	30	30	31	30	338	337	337	337	CASGEM
MCE RMS-9	1	9	9	9	8	257	257	257	257	No
MID RMS-17	1	25	25	25	25	200	200	200	200	No
MCW RMS-5	1	14	13	14	13	184	184	184	185	No

3.2.1.4 Impact of Selected Measurable Objectives on Adjacent Basins

The MOs established for Plan Area provide a good basis for evaluation of anticipated impacts on adjacent subbasins from implementation of the GSP. This is because MOs are set to reflect the expected average groundwater levels to be maintained during the sustainability period. Ultimately, the potential for impacts on adjacent subbasins will be primarily a function of average water levels in Plan Area during the sustainability period, average water levels in adjacent subbasins during the sustainability period, and natural groundwater flow conditions that would be expected to occur at Plan Area boundaries (e.g., pre-development groundwater flow conditions). The average groundwater levels expected for the Plan Area are reflected in the MOs. As indicated in the individual RMS hydrographs in **Appendix 3.A**, the MOs are higher than the MTs. Groundwater model results indicate that the anticipated groundwater levels after 2040 will result in greatly reduced net subsurface inflow to the Plan Area from surrounding subbasins compared to historical net subsurface inflow. Therefore, the projects and management actions implemented for this GSP are expected to benefit adjacent subbasins (compared to historical conditions) and not hinder the ability of adjacent subbasins to be sustainable.

3.2.2 Reduction in Groundwater Storage

MOs and interim milestones for reduction in groundwater storage are described below.

3.2.2.1 Measurable Objective

There is a direct relationship between groundwater levels and groundwater storage (see Section 3.3 for additional discussion); thus allowing groundwater levels to be used as a proxy for the groundwater storage sustainability indicator in this Joint GSP. Therefore, the MO for reduction in groundwater storage is based on the MOs for chronic lowering of groundwater levels. The MO for reduction in groundwater storage is no long-term reduction in groundwater storage within the Subbasin, during the sustainability period after 2040, which will be represented by the MOs for groundwater levels.

3.2.2.2 Interim Milestones

Groundwater levels are being used as a proxy for groundwater storage; therefore, the interim milestones for reduction in groundwater storage are based on the interim milestones for chronic lowering of groundwater levels.

3.2.2.3 Achieving and Maintaining Sustainability

The combination of interim milestones and MOs reflect how the Subbasin will achieve and maintain sustainability. Since groundwater levels serve as a practical proxy for evaluating reduction in groundwater storage, achieving and maintaining sustainability relative to this indicator is similar to that described above in the groundwater level section 3.2.1

3.2.2.4 Impact of Selected Measurable Objectives on Adjacent Basins

Groundwater model results indicate that the average groundwater levels reflected in the MOs will result in greatly reduced net subsurface inflow to the Plan Area from surrounding subbasins compared to historic net subsurface inflow. This will serve to allow more groundwater to remain in storage in adjacent subbasins. Therefore, the PMAs implemented for this Joint GSP will not hinder the ability of adjacent subbasins to be sustainable with regards to groundwater storage.

3.2.3 Land Subsidence

MOs and interim milestones for land subsidence are described below.

3.2.3.1 Measurable Objectives

A MO for subsidence of 0 feet/year was established with the goal of long-term avoidance of land subsidence. Land subsidence has historically not resulted in significant and unreasonable impacts to infrastructure in the Plan Area. Information on historical subsidence in the Subbasin is presented in the hydrogeologic conceptual model (HCM) (Chapter 2). The MO for land subsidence is set recognizing that land subsidence within Madera Subbasin is tied to actions in neighboring subbasins, and the ability to meet this MO is dependent on the successful implementation of PMAs in neighboring subbasins. It should also be noted that while groundwater level MTs and MOs are not specifically tied to subsidence thresholds, they will be consistent with the objective to limit the potential for future subsidence.

3.2.3.2 Interim Milestones

Interim milestones for land subsidence were established at five-year intervals over the GSP implementation period from 2020 to 2040, at years 2025, 2030, and 2035. Interim milestones were set recognizing the residual subsidence that may continue to occur due to historical cycles of lower groundwater levels and subsidence, and to provide adequate time for GSAs to implement PMAs. A combination of six survey benchmarks monitored by the US Bureau of Reclamation (USBR) on a semi-annual basis since 2011 as part of the San Joaquin River Restoration Program (SJRRP) and one continuous GPS station monitored daily since 2005 as part of the UNAVCO Plate Boundary Observatory (PBO) project have been selected as part of the land subsidence RMS network. Locations of subsidence RMS are shown in **Figure 3-2**. RMS stations have been separated into two groups for the purpose of establishing interim milestones for land subsidence: stations within the area of greater subsidence concern and stations within the general subsidence monitoring area (i.e., areas of lesser concern). The maximum rate of annual subsidence for each RMS station is presented in Table 3-4.

Table 3-4. Summary of Observed Maximum Rate of Land Subsidence for Representative Monitoring Sites

Station ID	Dataset	Time Period	Maximum Annual Rate of Subsidence (feet)	Group
1007R	SJRRP	Dec. 2015 to Dec. 2016	-0.54	Area of Subsidence Concern
29	SJRRP	Dec. 2014 to Dec. 2015	-0.41	Area of Subsidence Concern
127	SJRRP	Dec. 2014 to Dec. 2015	-0.22	Area of Subsidence Concern
160R	SJRRP	Dec. 2014 to Dec. 2015	-0.19	Subsidence Monitoring
P307	PBO	Dec. 2014 to Dec. 2015	-0.19	Subsidence Monitoring
141	SJRRP	Dec. 2011 to Dec. 2012	-0.12	Subsidence Monitoring
142	SJRRP	Dec. 2011 to Dec. 2012	-0.09	Subsidence Monitoring

Within each group, the initial land subsidence interim milestone for 2025 was set at a rate slightly higher than what has been observed between 2011 and 2016. This acknowledges the potential for residual

subsidence and allows time for GSAs to implement PMAs. The subsequent interim milestones have reduced subsidence rates as PMAs are implemented to address groundwater levels and subsidence.

The area of greater subsidence concern includes SJRRP Benchmark Survey points within the area of the subbasin where higher rates of subsidence have been recently observed, identified in **Section 2.2.2.4**. The interim milestones for the area of subsidence concern are defined as:

- 2025: -0.60 feet/year
- 2030: -0.40 feet/year
- 2035: -0.20 feet/year
- 2040: 0.00 feet/year

The area of subsidence monitoring includes SJRRP Benchmark Survey points and a UNAVCO PBO continuous GPS station within the area of the subbasin where subsidence has not been historically observed (or at very low rates). The interim milestones for the area of subsidence are defined as:

- 2025: -0.20 feet/year
- 2030: -0.13 feet/year
- 2035: -0.07 feet/year
- 2040: 0.00 feet/year

The interim milestones for land subsidence are set recognizing that land subsidence within Madera Subbasin is tied to actions in neighboring subbasins, and the ability to meet these interim milestones is dependent on the successful implementation of PMAs in neighboring subbasins.

3.2.3.3. Achieving and Maintaining Sustainability

The combination of interim milestones and MO reflect how the basin anticipates achieving and maintaining sustainability. The interim milestones and MO for land subsidence are set recognizing that land subsidence within Madera Subbasin is tied to actions in neighboring subbasins, and the ability to meet these interim milestones is dependent on the successful implementation of PMAs in neighboring subbasins.

3.2.4 Degraded Water Quality

Varied levels of particular constituents within the groundwater exist and affect water quality considerations throughout the Plan Area. In some cases, the levels of certain constituents have raised water quality concerns for the use of groundwater for drinking or for irrigated agriculture (Chapter 2 and **Appendix 3.B**). Effects on groundwater dependent ecosystems (GDEs) due to degraded water quality can result in visually detectable declines in the health of terrestrial vegetation. However, available data do not provide evidence of any such effects in the Plan Area (**Appendix 2.B**). Elevated concentrations of naturally occurring and existing constituent concentrations resulting from historical land use practices are present in certain areas of the Plan Area. As noted in Section 2 (HCM), elevated concentrations of nitrate are present in some wells in the Plan Area, and trends in these wells may be increasing with time. Continued increases in these concentrations may occur due to historic nitrogen loading in the unsaturated zone independent of any GSP activities. The planned PMAs are not intended to remediate or halt these trends of increasing concentrations; however, they also are not anticipated to exacerbate these trends and conditions. Rather, over the long term, the GSP anticipates that achieving sustainability will actually help the Plan Area's interested parties meet water quality objectives. Municipal and domestic supply (MUN) is a designated beneficial use for groundwater in the Plan Area; therefore, groundwater quality degradation is considered significant and unreasonable based on adverse impacts to this beneficial use. The GSAs

intend to implement planned PMAs in manners that do not further exacerbate groundwater quality impacts to beneficial uses.

3.2.4.1 Measurable Objectives

MOs for groundwater quality are established to not exacerbate adverse impacts on all beneficial uses of groundwater resulting from implementation of GSP PMAs. MOs for the groundwater quality sustainability indicator are intended to assure that GSP PMAs do not cause groundwater quality conditions to become unsuitable for any beneficial use, especially municipal and domestic supply uses since these are the most restrictive from a water quality standpoint. The groundwater quality MOs are defined for individual representative groundwater quality indicator wells (RMS) for the key water quality constituents arsenic, nitrate, and TDS based on consideration of existing or historical groundwater quality conditions and the drinking water MCLs for each of the key constituents. These key constituents were selected for assigning of MOs for groundwater quality because they currently exist at elevated concentrations in the Subbasin or reflect a range of potential groundwater quality impacts related to implementation of GSP PMAs. As discussed in Section 2 of this Joint GSP, nitrate is the most widespread water quality constituent of concern in the area, occurring at elevated concentrations in groundwater in some areas, mainly as a result of historical and agricultural practices and associated legacy groundwater quality impacts. Because of the widespread association of elevated nitrate concentrations with agricultural fertilization application, MOs for nitrate are also likely to address other groundwater quality impacts associated with agricultural activities, including for much less common groundwater contaminants such as pesticides. The MOs for arsenic and TDS are intended to address additional potential groundwater quality impacts associated with GSP PMAs that may result from lowered groundwater levels in some areas or altered groundwater flow dynamics.

The RMS consist of wells to be monitored by the GSAs along with wells being monitored by the other entities through existing groundwater quality monitoring programs for the Division of Drinking Water (DDW) or Irrigated Lands Regulatory Program (ILRP) and were selected to represent groundwater quality conditions across the Plan Area including in areas of greater domestic and public water supply well density (see **Section 2**). For all groundwater quality RMS, the MO concentrations for arsenic, nitrate, and TDS are set at levels representative of recent concentrations observed in the well with the intent to ensure that activities related to GSP PMAs do not significantly adversely impact groundwater quality conditions. Recent concentrations observed from 2015 to early 2019, as well as anticipated continued trends that this period may reflect, were used as the basis for setting the MO concentrations. The MO concentrations for wells with existing or historical water quality results are the average of the recent concentrations for each of the key constituents rounded up to the nearest full integer of concentration for arsenic (in units of µg/L) and nitrate (in units of mg/L as nitrogen) and rounded up to the nearest interval of 50 mg/L for TDS. MO concentrations for groundwater quality for each sustainability indicator well are summarized in Table 3-5, and locations of groundwater quality sustainability indicator wells are shown in **Figure 3-3**. Tables and graphs of historical results for key water quality constituents in the representative groundwater quality indicator wells are presented in **Appendix 3.B**.

Table 3-5. Summary of Groundwater Quality Measurable Objectives for Representative Monitoring Sites

Well ID	Well Type	Well Depth	Screen Top-Bottom	Aquifer Designation	MO Arsenic Concentration (µg/L)	MO Nitrate Concentration (mg/L)	MO TDS Concentration (mg/L)	Responsible Monitoring Entity	Measurement Frequency
Wells Monitored by GSP Entities: Existing									
MCW RMS-1	Other	800	Unknown	Lower	8†	8†	400†	GSP Entities	Annual
MID RMS-4	Irrigation	698	320-667	Lower	8†	8†	400†	GSP Entities	Annual
MID RMS-5	Irrigation	570	270-570	Lower	8†	8†	400†	GSP Entities	Annual
MID RMS-6	Irrigation	680	320-680	Lower	8†	8†	400†	GSP Entities	Annual
MID RMS-7	Irrigation	656	290-635	Lower	8†	8†	400†	GSP Entities	Annual
MCE RMS-1	Other	500	420-500	Lower	8†	8†	400†	GSP Entities	Annual
MCE RMS-3	Unknown	Unknown	Unknown	Composite	8†	8†	400†	GSP Entities	Annual
MCW RMS-2	Irrigation	216	205-212	Upper	8†	8†	400†	GSP Entities	Annual
MID RMS-9	Unknown	143	Unknown	Upper	8†	8†	400†	GSP Entities	Annual
MCW RMS-4	Irrigation	580	220-580	Lower	8†	8†	400†	GSP Entities	Annual
MID RMS-13	Irrigation	600	228-552	Composite	8†	8†	400†	GSP Entities	Annual
MWD RMS-1	Irrigation	500	200-500	Lower	8†	8†	400†	GSP Entities	Annual
Wells Monitored by GSP Entities: Future Monitoring Wells									
Lavina MW – Shallow	Monitoring	300*	100-300*	Upper	8†	8†	400†	ILRP/GSP Entities	Annual
Lavina MW – Middle	Monitoring	500*	300-500*	Lower	8†	8†	400†	GSP Entities	Annual
Lavina MW – Deep	Monitoring	700*	500-700*	Lower	8†	8†	400†	GSP Entities	Annual
Site 3 MW – Shallow	Monitoring	300*	100-300*	Upper	8†	8†	400†	ILRP/GSP Entities	Annual
Site 3 MW – Middle	Monitoring	500*	300-500*	Lower	8†	8†	400†	GSP Entities	Annual
Site 3 MW – Deep	Monitoring	700*	500-700*	Lower	8†	8†	400†	GSP Entities	Annual
Site 4 MW – Shallow	Monitoring	300*	100-300*	Upper	8†	8†	400†	ILRP/GSP Entities	Annual
Site 4 MW – Middle	Monitoring	500*	300-500*	Lower	8†	8†	400†	GSP Entities	Annual
Site 4 MW – Deep	Monitoring	700*	500-700*	Lower	8†	8†	400†	GSP Entities	Annual
Site 5 MW – Shallow	Monitoring	300*	100-300*	Upper	8†	8†	400†	ILRP/GSP Entities	Annual
Site 5 MW – Middle	Monitoring	500*	300-500*	Lower	8†	8†	400†	GSP Entities	Annual
Site 5 MW – Deep	Monitoring	700*	500-700*	Lower	8†	8†	400†	GSP Entities	Annual
Site 6 MW – Shallow	Monitoring	300*	100-300*	Upper	8†	8†	400†	ILRP/GSP Entities	Annual
Site 6 MW – Middle	Monitoring	500*	300-500*	Lower	8†	8†	400†	GSP Entities	Annual
Site 6 MW – Deep	Monitoring	700*	500-700*	Lower	8†	8†	400†	GSP Entities	Annual
Site 10 MW – Shallow	Monitoring	300*	100-300*	Upper	8†	8†	400†	ILRP/GSP Entities	Annual
Site 10 MW – Middle	Monitoring	500*	300-500*	Lower	8†	8†	400†	GSP Entities	Annual
Site 10 MW - Deep	Monitoring	700*	500-700*	Lower	8†	8†	400†	GSP Entities	Annual

Well ID	Well Type	Well Depth	Screen Top-Bottom	Aquifer Designation	MO Arsenic Concentration (µg/L)	MO Nitrate Concentration (mg/L)	MO TDS Concentration (mg/L)	Responsible Monitoring Entity	Measurement Frequency
Site 11 MW - Shallow	Monitoring	300*	100-300*	Upper	8†	8†	400†	ILRP/GSP Entities	Annual
Site 11 MW - Middle	Monitoring	500*	300-500*	Lower	8†	8†	400†	GSP Entities	Annual
Site 11 MW - Deep	Monitoring	700*	500-700*	Lower	8†	8†	400†	GSP Entities	Annual
Wells Monitored for Other Programs									
2000507-001	Public Supply	Unknown	372-?	Lower	5	3	400	DDW	Variable, according to DDW reqs.
2000553-001	Public Supply	Unknown	450-500	Lower	3	4	250	DDW	
2000682-002	Public Supply	Unknown	295-420	Lower	3	3	400	DDW	
2000727-001	Public Supply	Unknown	280-360	Lower	2	2	250	DDW	
2000846-002	Public Supply	Unknown	310-380	Lower	4	5	400	DDW	
2000938-001	Public Supply	Unknown	420-560	Lower	1	2	150	DDW	
2010002-014	Public Supply	Unknown	280-610	Lower	1	2	200	DDW	
2010002-032	Public Supply	Unknown	310-600	Lower	1	3	250	DDW	
2010008-005	Public Supply	Unknown	250-465	Composite	4	5	300	DDW	
2010009-002	Public Supply	Unknown	324-369	Composite	5	2	150	DDW	
2010010-007	Public Supply	Unknown	242-374	Lower	2	2	400	DDW	
2010801-001	Public Supply	Unknown	375-760	Lower	15	1	400	DDW	
2801077-001	Public Supply	Unknown	60-500	Composite	8†	1	400	DDW	
ESJ12	Domestic	276	160-172	Upper	N/A‡	5	450	ILRP	Annual‡
ESJ17	Domestic	Unknown	Unknown	Unknown	N/A‡	8†‡	400†‡	ILRP	Annual‡

* Construction details and locations for future monitoring wells are estimated; information will be updated upon completion of final site selection and well construction.
† Values will be confirmed and/or adjusted as needed based on results from initial sampling for constituents.
‡ Monitoring for the Irrigated Lands Regulatory Program does not include testing for arsenic; annual monitoring includes nitrate and specific conductance (SC), TDS is tested every five years; SC will be used as proxy for TDS in years in which TDS is not tested.

3.2.4.2 Interim Milestones

The interim milestones for the groundwater quality sustainability indicator are the same as the MOs and include ensuring that during the implementation period, GSP PMAs do not lead to degradation of existing groundwater quality conditions that would make groundwater unsuitable for the most restrictive beneficial use of municipal and domestic supply. The groundwater quality interim milestones are maintaining existing groundwater quality concentrations for arsenic, nitrate, and TDS at each sustainability indicator well over the implementation period as summarized in Table 3-6. Consistent with the MOs, groundwater quality interim milestones also include maintaining existing or historical groundwater quality conditions over the implementation period for wells in which the existing or historical conditions already exceed the MCL. The GSP does not include any plan or milestones specifically intended to improve groundwater quality conditions in wells with existing or historical MCL exceedances.

3.2.4.3 Achieving and Maintaining Sustainability

The combination of interim milestones and MOs reflect how the Subbasin will achieve and maintain sustainability by ensuring that GSP PMAs do not significantly and unreasonably degrade groundwater quality conditions or exacerbate already degraded conditions, impacting beneficial uses in the Plan Area. The network of groundwater quality sustainability indicator wells will enable tracking of groundwater quality conditions as they relate to GSP-related activities and activities unrelated to GSP actions. If evaluation of groundwater quality monitoring suggests that GSP PMAs are having adverse impacts on groundwater quality affecting beneficial uses, modifications to the GSP PMAs may be required. Evaluation of monitoring data to distinguish any groundwater quality impacts related to GSP actions from other impacts or trends that may occur unrelated to GSP implementation, will be conducted on a case-by-case basis considering information and context associated with the impact such as hydrogeologic setting, location relative to GSP projects or management actions and other land use activities, historical conditions, and other considerations, to assess the likely source or cause of any exceedances. Such an evaluation would also include consideration of analysis and reporting from other WQ monitoring programs including for ILRP and regulated facilities.

3.2.4.4 Impact of Selected Measurable Objectives on Adjacent Basins

Groundwater quality MOs are set to protect and maintain groundwater quality conditions suitable for all beneficial uses in the Plan Area, including municipal and drinking water supply, and as a result are not anticipated to impact beneficial uses for groundwater in adjacent subbasins.

Table 3-6. Summary of Groundwater Quality Interim Milestones for Representative Monitoring Sites

Well ID	Aquifer Designation	2025 Arsenic Concentration (µg/L)	2030 Arsenic Concentration (µg/L)	2035 Arsenic Concentration (µg/L)	2040 Arsenic Concentration (µg/L)	2025 Nitrate Concentration (mg/L)	2030 Nitrate Concentration (mg/L)	2035 Nitrate Concentration (mg/L)	2040 Nitrate Concentration (mg/L)	2025 TDS Concentration (mg/L)	2030 TDS Concentration (mg/L)	2035 TDS Concentration (mg/L)	2040 TDS Concentration (mg/L)	Responsible Monitoring Entity	Measurement Frequency
Wells Monitored by GSP Entities: Existing															
MCW RMS-1	Lower	8†	8†	8†	8†	8†	8†	8†	8†	400†	400†	400†	400†	GSP Entities	Annual
MID RMS-4	Lower	8†	8†	8†	8†	8†	8†	8†	8†	400†	400†	400†	400†	GSP Entities	Annual
MID RMS-5	Lower	8†	8†	8†	8†	8†	8†	8†	8†	400†	400†	400†	400†	GSP Entities	Annual
MID RMS-6	Lower	8†	8†	8†	8†	8†	8†	8†	8†	400†	400†	400†	400†	GSP Entities	Annual
MID RMS-7	Lower	8†	8†	8†	8†	8†	8†	8†	8†	400†	400†	400†	400†	GSP Entities	Annual
MCE RMS-1	Lower	8†	8†	8†	8†	8†	8†	8†	8†	400†	400†	400†	400†	GSP Entities	Annual
MCE RMS-3	Composite	8†	8†	8†	8†	8†	8†	8†	8†	400†	400†	400†	400†	GSP Entities	Annual
MCW RMS-2	Upper	8†	8†	8†	8†	8†	8†	8†	8†	400†	400†	400†	400†	GSP Entities	Annual
MID RMS-9	Upper	8†	8†	8†	8†	8†	8†	8†	8†	400†	400†	400†	400†	GSP Entities	Annual
MCW RMS-4	Lower	8†	8†	8†	8†	8†	8†	8†	8†	400†	400†	400†	400†	GSP Entities	Annual
MID RMS-13	Composite	8†	8†	8†	8†	8†	8†	8†	8†	400†	400†	400†	400†	GSP Entities	Annual
MWD RMS-1	Lower	8†	8†	8†	8†	8†	8†	8†	8†	400†	400†	400†	400†	GSP Entities	Annual
Wells Monitored by GSAs: Future Monitoring Wells															
Lavina MW - Shallow	Upper	8†	8†	8†	8†	8†	8†	8†	8†	400†	400†	400†	400†	ILRP/GSP Entities	Annual
Lavina MW - Middle	Lower	8†	8†	8†	8†	8†	8†	8†	8†	400†	400†	400†	400†	GSP Entities	Annual
Lavina MW - Deep	Lower	8†	8†	8†	8†	8†	8†	8†	8†	400†	400†	400†	400†	GSP Entities	Annual
Site 3 MW - Shallow	Upper	8†	8†	8†	8†	8†	8†	8†	8†	400†	400†	400†	400†	ILRP/GSP Entities	Annual
Site 3 MW - Middle	Lower	8†	8†	8†	8†	8†	8†	8†	8†	400†	400†	400†	400†	GSP Entities	Annual
Site 3 MW - Deep	Lower	8†	8†	8†	8†	8†	8†	8†	8†	400†	400†	400†	400†	GSP Entities	Annual
Site 4 MW - Shallow	Upper	8†	8†	8†	8†	8†	8†	8†	8†	400†	400†	400†	400†	ILRP/GSP Entities	Annual
Site 4 MW - Middle	Lower	8†	8†	8†	8†	8†	8†	8†	8†	400†	400†	400†	400†	GSP Entities	Annual
Site 4 MW - Deep	Lower	8†	8†	8†	8†	8†	8†	8†	8†	400†	400†	400†	400†	GSP Entities	Annual
Site 5 MW - Shallow	Upper	8†	8†	8†	8†	8†	8†	8†	8†	400†	400†	400†	400†	ILRP/GSP Entities	Annual
Site 5 MW - Middle	Lower	8†	8†	8†	8†	8†	8†	8†	8†	400†	400†	400†	400†	GSP Entities	Annual
Site 5 MW - Deep	Lower	8†	8†	8†	8†	8†	8†	8†	8†	400†	400†	400†	400†	GSP Entities	Annual
Site 6 MW - Shallow	Upper	8†	8†	8†	8†	8†	8†	8†	8†	400†	400†	400†	400†	ILRP/GSP Entities	Annual
Site 6 MW - Middle	Lower	8†	8†	8†	8†	8†	8†	8†	8†	400†	400†	400†	400†	GSP Entities	Annual
Site 6 MW - Deep	Lower	8†	8†	8†	8†	8†	8†	8†	8†	400†	400†	400†	400†	GSP Entities	Annual
Site 10 MW - Shallow	Upper	8†	8†	8†	8†	8†	8†	8†	8†	400†	400†	400†	400†	ILRP/GSP Entities	Annual

Well ID	Aquifer Designation	2025 Arsenic Concentration (µg/L)	2030 Arsenic Concentration (µg/L)	2035 Arsenic Concentration (µg/L)	2040 Arsenic Concentration (µg/L)	2025 Nitrate Concentration (mg/L)	2030 Nitrate Concentration (mg/L)	2035 Nitrate Concentration (mg/L)	2040 Nitrate Concentration (mg/L)	2025 TDS Concentration (mg/L)	2030 TDS Concentration (mg/L)	2035 TDS Concentration (mg/L)	2040 TDS Concentration (mg/L)	Responsible Monitoring Entity	Measurement Frequency
Site 10 MW - Middle	Lower	8†	8†	8†	8†	8†	8†	8†	8†	400†	400†	400†	400†	GSP Entities	Annual
Site 10 MW - Deep	Lower	8†	8†	8†	8†	8†	8†	8†	8†	400†	400†	400†	400†	GSP Entities	Annual
Site 11 MW - Shallow	Upper	8†	8†	8†	8†	8†	8†	8†	8†	400†	400†	400†	400†	ILRP/GSP Entities	Annual
Site 11 MW - Middle	Lower	8†	8†	8†	8†	8†	8†	8†	8†	400†	400†	400†	400†	GSP Entities	Annual
Site 11 MW - Deep	Lower	8†	8†	8†	8†	8†	8†	8†	8†	400†	400†	400†	400†	GSP Entities	Annual
Wells Monitored for Other Programs															
2000507-001	Lower	5	5	5	5	3	3	3	3	400†	400†	400†	400†	DDW	Variable, according to DDW reqs.
2000553-001	Lower	3	3	3	3	4	4	4	4	250	250	250	250	DDW	
2000682-002	Lower	3	3	3	3	3	3	3	3	200	200	200	200	DDW	
2000727-001	Lower	2	2	2	2	2	2	2	2	250	250	250	250	DDW	
2000846-002	Lower	4	4	4	4	5	5	5	5	250	250	250	250	DDW	
2000938-001	Lower	1	1	1	1	2	2	2	2	150	150	150	150	DDW	
2010002-014	Lower	1	1	1	1	2	2	2	2	200	200	200	200	DDW	
2010002-032	Lower	1	1	1	1	3	3	3	3	250	250	250	250	DDW	
2010008-005	Composite	4	4	4	4	5	5	5	5	300	300	300	300	DDW	
2010009-002	Composite	5	5	5	5	2	2	2	2	150	150	150	150	DDW	
2010010-007	Lower	2	2	2	2	2	2	2	2	150	150	150	150	DDW	
2010801-001	Lower	15	15	15	15	1	1	1	1	250	250	250	250	DDW	
2801077-001	Composite	8†	8†	8†	8†	1	1	1	1	400†	400†	400†	400†	DDW	
ESJ12	Upper	N/A‡	N/A‡	N/A‡	N/A‡	5	5	5	5	450	450	450	450	ILRP	Annual‡
ESJ17	Unknown	N/A‡	N/A‡	N/A‡	N/A‡	8†	8†	8†	8†	400†‡	400†‡	400†‡	400†‡	ILRP	Annual‡

* Construction details and locations for future monitoring wells are estimated; information will be updated upon completion of final site selection and well construction.
† Values will be confirmed and/or adjusted as needed based on results from initial sampling for constituents.
‡ Monitoring for the Irrigated Lands Regulatory Program does not include testing for arsenic; annual monitoring includes nitrate and specific conductance (SC), TDS is tested every five years; SC will be used as proxy for TDS in years in which TDS is not tested.

3.2.5 Depletion of Surface Water

As described in the HCM in Chapter 2 (Plan Area and Basin Setting), regional groundwater levels have generally been below the stream channel bottoms in Plan Area for at least the last several years, and for many decades in most of the Plan Area. Thus, the connection between regional groundwater and streams was broken prior to 2015 along most streams, and the surface water depletion sustainability criteria is not applicable for more of the Plan Area. However, at times when sufficient water is released from Millerton Lake into the San Joaquin River, shallow groundwater levels are observed along the portion of the San Joaquin River adjacent to the southern Madera Subbasin boundary. These shallow groundwater levels indicate the San Joaquin River may sometimes be connected to groundwater, even if the shallow groundwater zone in connection with the San Joaquin River is hydraulically separated from the regional groundwater system. The underlying stratigraphy and hydrogeologic relationships between groundwater in shallow zones along the San Joaquin River and deeper zones where regional pumping occurs are not well understood, and a workplan has been developed to refine and improve the hydrogeologic understanding related to interconnected surface water (ISW). The workplan is included in **Appendix 3.I**. In the meantime, interim SMC have been developed for ISW along the San Joaquin River.

Available data and analyses (see Section 2.2.2.5) indicate that while the San Joaquin River along the southern boundary of the Madera Subbasin is primarily a losing reach that may be disconnected, it is also sometimes connected to groundwater under certain hydrologic conditions. It is assumed that these conditions constitute interconnected surface water as defined by the GSP regulations and therefore the GSP outlines interim SMC while efforts continue to more fully characterize shallow hydrogeologic conditions along the San Joaquin River prior to making a final determination regarding the presence/absence of interconnected surface water.

For the purposes of establishing interim SMC for ISW along the San Joaquin River, four RMS wells screened in the Upper Aquifer in close proximity to the San Joaquin River were evaluated by comparing modeled groundwater elevations to adjacent stream thalweg elevations **(Figure 3-4** and Table 3-7**)**. It is assumed that when groundwater elevations are at or above the stream thalweg elevation interconnected surface water is present at this location, and when groundwater elevations are below the adjacent stream thalweg elevation that interconnected surface water is not present. The percent of time over a given time period when the groundwater elevations at an RMS well are at or above the stream thalweg elevation is defined as the percent of time ISW exists at that given location. As indicated in Table 3-7, the percent of time connected among the four RMS wells was 73% at MCE RMS-9, 30% at MCW RMS-5, 0% at MID RMS-14, and 100% at MID RMS-17 over the historical time period from 1989 to 2015. MID RMS-14 was eliminated form further consideration as an ISW RMS because it never shows a connection to surface water (i.e., groundwater level always remains below stream thalweg) and the percent connected time of 0% can never be violated (i.e., the MT would never be exceeded).

San Joaquin River Restoration Program began Interim Flow releases from Friant Dam into the San Joaquin River on October 1, 2009. Restoration Flows began on January 1, 2014, but were curtailed in 2014 and 2015 due to drought conditions. Restoration Flows were reinitiated in August 2016 and have continued to present. Table 3-8 presents the allocation of Program Restoration Flows.

While it remains uncertain how/if groundwater pumping from the regional aquifer affects surface water flows in the Plan area, there is at least some potential for the shallow groundwater system supporting GDEs to be affected by regional pumping. If regional pumping depletes shallow groundwater, beneficial uses and users of shallow groundwater could be negatively affected. These include riparian vegetation along the San Joaquin River and the wildlife habitat and ecosystem functions it provides. Special-status

species and their habitats are included in the analyses of potential effects on GDE Units presented in **Appendix 2.B**. However, it should be noted relative to historical conditions prior to October 2009 that the additional flows required to remain in the San Joaquin River (and not be diverted for irrigation purposes) for the San Joaquin River Restoration Program (SJRRP) will also serve to provide support for the shallow groundwater system and GDEs associated with the San Joaquin River.

There are three primary options for the metric that can be used as the basis for SMC for interconnected surface water: 1) an amount of surface water depletion; 2) shallow groundwater levels as a proxy; and 3) percent of time that a surface water – groundwater connection exists over a given time period. The metric used needs to be capable of distinguishing that an impact has occurred related to groundwater pumping in the Subbasin. Analyses described in **Section 2.2.2.5** indicate that the amount of surface water seepage is most closely related to hydrologic conditions (i.e., water year type: wet, above normal, below normal, dry, critical) in the Subbasin. Therefore, recognizing the altered flow regime in the San Joaquin River since the SJRRP, using the amount of surface water depletion as the metric for ISW SMC would not be appropriate. Similarly, review of available data indicates that shallow groundwater elevations are also closely tied to hydrologic conditions, including the SJRRP regime of flow releases; therefore, using groundwater levels as a proxy for ISW SMC would also not be appropriate. Accordingly, the most appropriate metric for ISW SMC is percent of time connected as discussed further in **Section 3.2.5.1**.

Table 3-7. Comparison of Interconnected Surface Water Representative Monitoring Sites Groundwater Elevations to Stream Thalweg Elevations – Percent of Time Connected

RMS / Period	Count of Groundwater Elevation Measurements	Count of Groundwater Elevation Measurements that are greater than the Stream Thalweg Elevation	Percent of Time that Groundwater and Surface Water are Connected
MCE RMS-9 (distance to SJR = 0.13 mi; streambed elevation = 256.22 feet; Model Layer 1)			
1989-2015	324	236	73%
2016-2019	48	48	100%
2020-2039	240	163	68%
2040-2090	612	425	69%
MCW RMS-5 (distance to SJR = 0.14 mi; streambed elevation = 184.63 feet; Model Layer 1)			
1989-2015	324	98	30%
2016-2019	48	33	69%
2020-2039	240	53	22%
2040-2090	612	217	35%
MID RMS-14 (distance to SJR = 1.06 mi; streambed elevation = 186.58 feet; Model Layer 2)			
1989-2015	324	0	0%
2016-2019	48	0	0%
2020-2039	240	0	0%
2040-2090	612	0	0%

RMS / Period	Count of Groundwater Elevation Measurements	Count of Groundwater Elevation Measurements that are greater than the Stream Thalweg Elevation	Percent of Time that Groundwater and Surface Water are Connected
MID RMS-17 (distance to SJR = 0.09 mi; streambed elevation = 197.21 feet; Model Layer 1)			
1989-2015	324	324	100%
2016-2019	48	48	100%
2020-2039	240	240	100%
2040-2090	612	612	100%

Table 3-8. History of San Joaquin River Restoration Program Restoration Allocations

Water Year (Type)	Flow Type	Restoration Allocation (TAF)
2009 (AN)	Interim Flows	261.5
2010 (AN)	Interim Flows	98.2
2011 (W)	Interim Flows	152.4
2012 (D)	Interim Flows	183.0
2013 (D)	Interim Flows	65.5
2014 (C)	Restoration Flows	0-1
2015 (C)	Restoration Flows	0
2016 (BN)	Restoration Flows	263.3
2017 (W)	Restoration Flows	556.5
2018 (BN)	Restoration Flows	280.3
2019 (W)	Restoration Flows	556.5
2020 (D)	Restoration Flows	202.2
2021 (C)	Restoration Flows	70.9
2022 (BN)	Restoration Flows	232.5

Source: SJRRP, 2022

3.2.5.1 Measurable Objective

The MO for ISW along the San Joaquin River is to maintain the percent of time the San Joaquin River is connected to shallow groundwater levels equal to or greater than existing and historical conditions at RMS wells screened in the Upper Aquifer in close proximity to the San Joaquin River. The interim MOs are established as the percent of time connected over the historical base period (1989 to 2015), as indicated in Table 3-9 for the four RMS wells screened in the Upper Aquifer near the San Joaquin River (**Figure 3-4**). However, in terms of the percent of time connected percentages that serve as a baseline for annual

comparisons in the future, these MOs may need to be adjusted to reflect an equivalent hydrologic period from the baseline to make a proper comparison to the future five-year rolling average as described below.

In order to create SMC that can be evaluated using this metric on an annual basis, a rolling average for the past five years will be used as the current conditions for percent of time connected. The five-year current rolling average will be compared to the historical base period percent of time connected (i.e., the MOs listed in Table 3-9) to determine if MOs are being achieved. It should be noted that while the 1989-2015 period is considered to represent long-term average climatic/hydrologic conditions, a given five-year rolling average may or may not represent a period with average climatic/hydrologic conditions. Therefore, an adjustment of the baseline period used for comparison to the current five-year rolling average may be needed. For example, if the last five years included in the rolling average represent drought years, the percent of time connected during the most similar period in the historical base period will be used for comparison.

3.2.5.2 Interim Milestones

Interim Milestones for ISW along the San Joaquin River are the same as the MOs described in Section 3.2.5.1.

3.2.5.3 Achieving and Maintaining Sustainability

Sustainability will be achieved and maintained through implementation of projects (e.g., dedicated recharge basins, Flood-MAR) and management actions (e.g., pumping reductions). In addition, implementation of the SJRRP since 2009 has been, and is expected to continue, changing the hydrology along the San Joaquin River. If the SJRRP is implemented as planned, it is expected that more streamflow (than would have been present without the SJRRP) will be present in the San Joaquin River along the southern boundary of Madera Subbasin under certain climatic/hydrologic conditions. To the extent that the SJRRP adds more streamflow to the system, it is expected there will be more stream seepage, higher groundwater levels in the shallow zone beneath/adjacent to the San Joaquin River, and an equal or greater percentage of time during which shallow groundwater levels and the San Joaquin River are connected. Thus, the combination of Madera Subbasin PMAs and the SJRRP are expected to achieve and maintain sustainability relative to ISW during the sustainability period.

3.2.5.4 Impact of Selected Measurable Objectives on Adjacent Basins

Maintaining a similar percent of time connected under sustainable groundwater conditions for Madera Subbasin is not expected to have any significant impacts on adjacent subbasins. However, if the percent of time connected increases significantly, whether it be through PMAs conducted by Madera Subbasins GSAs and/or due to other factors such as the SJRRP, it is possible that the downstream Delta-Mendota Subbasin may be affected by higher groundwater levels in the shallow zone.

Table 3-9. Summary of Interconnected Surface Water Measurable Objectives for Representative Monitoring Sites

Well I.D.	Surface Elevation	Well Depth	Screen Top-Bottom	Model Layer(s)	Aquifer Designation	MO[1]	GSA
MCE RMS-9	265.4	38	17-37	1	Upper	73%	Madera County East
MCW RMS-5	197.8	30	Unknown	1	Upper	30%	Madera County West
MID RMS-17	224.9	47	26-46	1	Upper	100%	Madera Irrigation District

[1] The MOs are established as the percent of time connected over the historical base period (1989 to 2015). For comparison to future five-year rolling average, baseline MOs may need to be updated to reflect climatic/hydrologic conditions represented in five-year rolling average.

3.2.6 Seawater Intrusion

The seawater intrusion sustainability criteria are not applicable to Plan Area, because it is located more than 70 miles inland and hydraulically disconnected from the ocean.

3.3 Minimum Thresholds *(23 CCR § 354.28)*

The GSP regulations define undesirable results as occurring when significant and unreasonable effects are caused by groundwater conditions occurring throughout the Plan Area for a given sustainability indicator. Significant and unreasonable effects occur when minimum thresholds (MTs) are exceeded for one or more sustainability indicators. This section describes the following for each sustainability indicator relevant to Plan Area: the methodology used to set the MT and how selected MTs avoid causing undesirable results, relationships to other sustainability indicators, impact on adjacent subbasins, impacts on beneficial use/users, comparison to relevant federal, state, local standards, and the measurement method.

3.3.1 Chronic Lowering of Groundwater Levels

The GSP regulations provide that the "[MTs] for chronic lowering of groundwater levels shall be the groundwater level indicating a depletion of supply at a given location that may lead to undesirable results." (23 CCR § 354.28.c.1) Chronic lowering of groundwater levels in the Plan Area cause significant and unreasonable declines if they are sufficient in magnitude to lower the rate of production of pre-existing groundwater wells below that necessary to meet the minimum required to support overlying beneficial uses and users where alternative means of obtaining sufficient groundwater resources are not technically or financially feasible. In addition, groundwater levels will be managed with consideration of the MTs to ensure the major aquifers in the Plan Area are not depleted in a manner to cause significant and unreasonable impacts to other sustainability indicators. At the same time, the GSAs recognize that while groundwater levels are anticipated to fall below 2015 levels during the GSP implementation period, the implementation of projects and management actions is expected to cause groundwaters to return to historical levels by 2040. Thus, the MTs have been designated with these considerations in mind.

The decisions to set MTs for chronic lowering of groundwater levels were made with consideration of the time it will take to implement PMAs that increase groundwater recharge and decrease net groundwater extraction, and with consideration for the need to balance and protect the water supply needs of all beneficial uses and users of groundwater through an approach that is both sustainable and economically reasoned and maintaining some level of operational flexibility in the Subbasin under projected future conditions.

The SMC for chronic lowering of groundwater levels have been designated with these considerations in mind, and with the GSAs' ongoing development of a Domestic Well Mitigation Program, to be implemented as needed during the GSP implementation period. Considerations for setting the MTs for chronic lowering of groundwater levels are described further in the sections below.

3.3.1.1 Domestic Well Mitigation Program

The Madera Subbasin GSAs have proceeded with coordination and focused planning efforts to develop a Domestic Well Mitigation Program (Program), including the development of a draft memorandum of understanding (MOU) (see **Appendices 3.D and 3.E**). The Domestic Well Mitigation Program would provide assistance to domestic and municipal wells adversely impacted by declining groundwater levels that interfere with groundwater production or quality. Note that the program is not intended to mitigate well issues not caused by regional groundwater conditions nor is it intended to resolve issues related to

normal wear and tear. It is expected that the Domestic Well Mitigation Program would be implemented during the GSP implementation period, as needed, and continue until groundwater sustainability is achieved. After 2040, groundwater levels will stabilize at historical levels, avoiding undesirable results for groundwater users.

Economic analyses conducted to compare costs of implementing a Domestic Well Mitigation Program versus immediately requiring full implementation of demand reduction in 2020 are provided in **Appendix 3.D**. These analyses found that immediate and substantial cutbacks in groundwater pumping would result in major impacts to the local economy and all basin stakeholders, including domestic well owners, that would be more significant than the costs of implementing a Domestic Well Mitigation Program (**Appendix 3.D**).

As of March 2023, the GSAs are developing the Program eligibility criteria, terms, and conditions and are preparing to move forward with Program implementation, as needed. The GSAs will continue to coordinate on the basic roles and responsibilities of a Program within the first 5 years of GSP implementation (by 2025), although initiation of the Domestic Well Mitigation Program will occur pending further analysis and identification of specific needs for Program implementation. The Program would benefit domestic and municipal well users, including disadvantaged communities and underrepresented communities, experiencing adverse impacts as a result of overdraft conditions. Additional details about Program development and implementation will be reported in future Annual Reports and GSP updates.

3.3.1.2 Other Considerations for Setting Minimum Thresholds

The MTs for groundwater levels and overall SMC program for this Joint GSP are also intended to protect against significant and unreasonable impacts to groundwater storage volumes, land subsidence, and some groundwater quality concerns. GDEs were also considered in setting of MTs. The four potential GDE units identified in the Plan Area are dominated by terrestrial vegetation and some wetland vegetation, which is susceptible to adverse impacts (i.e., undesirable results) if underlying groundwater levels experience chronic lowering exceeding historical lows (see **Appendix 2.B**). The development of MTs for chronic lowering of groundwater levels included review of the hydrogeologic conceptual model, climate, current and historical groundwater conditions including groundwater level trends and groundwater quality, land subsidence, and the water budget discussed in previous sections of this Joint GSP.

The MTs for chronic lowering of groundwater levels are based on selection of RMS from among existing production and monitoring wells located throughout the Plan Area and screened in both in the Upper and Lower Aquifers. The selected sustainability indicator wells are listed in Table 3-10 and shown on **Figure 3-1**. Groundwater level hydrographs showing MTs for each groundwater level RMS are provided in **Appendix 3.A.**

The RMS described in Table 3-10 and **Figure 3-1** are in locations that reflect a wide cross section of Plan Area groundwater conditions. These locations are representative of the overall Plan Area conditions because they are spatially distributed throughout the Plan Area both vertically (within the Upper and Lower Aquifers in the Corcoran Clay area) and laterally throughout the Plan Area. The distribution of designated Upper Aquifer wells is limited because the definition of Upper Aquifer used in this study (above the Corcoran Clay where present, and equivalent depth to the east where Corcoran Clay is not present), results in relatively large areas of unsaturated conditions in the Upper Aquifer in the central to eastern portions of the Plan Area. The GSAs have determined that setting the MTs at historical levels will avoid the undesirable results of chronic lowering of groundwater levels by reducing the likelihood that access to adequate water resources for beneficial users within the Plan Area will be compromised.

Table 3-10. Summary of Groundwater Level Minimum Thresholds for Representative Monitoring Sites

Well ID	Estimated Surface Elevation[3] (msl, feet)	Depth	Screen Top-Bottom (ft)	Model Layer(s)	Aquifer Designation	Reduced Deposits Depth (ft)	MT Depth[1] (ft)	MT Elev (msl, feet)	GSA[2]	CASGEM Well?	MT Rationale
MID RMS-1	308	950	320-942	4	Lower	475	383	-75	MID	CASGEM	Observed WL data limited but tracks Model Layer 4 ranging from about 15-20 above/below modeled WLs. MT accounts for offset below modeled WLs; MO based on Model Layer 4 average.
MID RMS-2	218	563	298-509	4	Lower	600	368	-150	MID	CASGEM	Observed WL data limited but tracks Model Layer 4. MO based on Model Layer 4 average.
MID-RMS-3	241	516	260-507	4	Lower	420	376	-135	MID	CASGEM	Observed WL data generally track modeled WL, ranging up to about 30 feet above/ below modeled WLs. MT accounts for 30 feet of offset. MO based on Model Layer 4 average.
MCW RMS-1	169	800	Unknown	4	Lower	NA	254	-85	Madera County West	CASGEM	Observed WL data limited but tracks Model Layer 4. MO based on Model Layer 4 average.
MID RMS-4	190	698	320-667	5	Lower	NA	290	-100	MID	CASGEM	Observed WL data limited but tracks Model Layer 5 (review possible anomalous data point). MT assumes possible anomalous data point is valid measurement (if not, MT is at Elev. -110 instead of -150). MO based on Mode Layer 5 average.
MID RMS-5	204	570	270-570	5	Lower	NA	319	-115	MID	CASGEM	Observed WL data tracks well with Model Layer 5 WL. MO based on Model Layer 5 average.
MID RMS-6	237	680	320-680	4,5	Lower	600	302	-65	MID	CASGEM	Observed WL tracks in between Model Layers 4 and 5. MO based on Model Layer 4 and 5 average.
MID RMS-7	237	656	290-635	4	Lower	NA	238	-1	MID	CASGEM	Observed WL data tracks Model Layer 4. MO based on Model Layer 4 average.
MCE RMS-1	332	500	420-500	4	Lower	600	372	-40	Madera County East	Voluntary	Observed WL limited but track Model Layer 4. Low observed level is about 10 feet below Model Layer 4. MT accounts for observed offset; MO based on Model Layer 4 average.
MID RMS-8	287	Unknown	Unknown	2,3,4	Composite	500	287	0	MID	CASGEM	Observed WL spans Model Layers 2, 3, 4. MT/MO based on Model Layer 4.
MCE RMS-2	378	Unknown	Unknown	3,4,5	Composite	420	353	25	Madera County East	Voluntary	Observed WL data span Model Layers 3, 4, 5. MO based on Model Layer 4 average.
MCE RMS-3	325	Unknown	Unknown	2,3,4	Composite	650	330	-5	Madera County East	Voluntary	Observed WL spans Model Layers 2, 3, 4. MT/MO based on Model Layer 4.
MCE RMS-4	404	Unknown	Unknown	4	Lower	450	284	120	Madera County East	Voluntary	Observed WL data tracks Model Layer 4. MO based on Model Layer 4 average.
MCW RMS-2	173	216	205-212	3	Upper	NA	183	-10	Madera County West	CASGEM	Observed WL data tracks about 20-50 feet below Model Layer 3. MT accounts for maximum offset. MO set 35 feet below Model Layer 3 average.
MCW RMS-3	162	Unknown	Unknown	2,3	Upper	NA	157	5	Madera County West	Voluntary	Observed WL data limited but tracks between Model Layers 2 and 3. MO based on average of Model Layers 2 and 3.
MID RMS-9	202	144	Unknown	3	Upper	NA	192	10	MID	Voluntary	Observed WL data track about 20 feet below Model Layer 3 WLs. MT/MO account for offset.
MID RMS-10	213	615	315-615	4,5	Lower	NA	213	0	MID	CASGEM	Observed WL data limited but tracks Model Layers 4 and 5. MO based on average of Model Layers 4 and 5.
MCW RMS-4	208	580	220-580	3,4	Lower	NA	178	30	Madera County East	CASGEM	Observed WL data limited but tracks Model Layers 3 and 4 (with exception of one data point about 20 feet below modeled WLs). MO based on Model Layer 3 and 4 average.
MID RMS-11	232	Unknown	Unknown	3	Upper	NA	167	65	MID	CASGEM	Observed WL data track Model Layer 3 WLs well. MO based on Model Layer 3 average.
MID RMS-12	262	176	Unknown	3	Upper	550	187	75	MID	CASGEM	Observed WL data track Model Layer 3 WLs well. MO based on Model Layer 3 average.
MID RMS-13	271	600	228-552	3,4	Composite	525	196	75	MID	CASGEM	Observed WL data limited but tracks Model Layer 3 and 4 WLs. MO based on Model Layer 3 average.
MCE RMS-5	340	Unknown	Unknown	4	Lower	600	305	35	Madera County East	Voluntary	Observed WL data track Model Layer 4 WLs. MO based on Model Layer 4 average.
MID RMS-14	214	Unknown	Unknown	2	Upper	NA	119	95	MID	CASGEM	Observed WL data track Model Layer 2 WLs. MO based on Model Layer 2 average.
COM RMS-1	278	520	210-510	4	Lower	490	313	-35	City of Madera	No	Observed WL data track Model Layer 4 WLs, with up to 20 feet of offset. MT accounts for offset and additional buffer (20 feet) needed to cover IP anticipated low WL. MO based on Model Layer 4 average.

Well ID	Estimated Surface Elevation[3] (msl, feet)	Depth	Screen Top-Bottom (ft)	Model Layer(s)	Aquifer Designation	Reduced Deposits Depth (ft)	MT Depth[1] (ft)	MT Elev (msl, feet)	GSA[2]	CASGEM Well?	MT Rationale
COM RMS-2	262	590	370-590	4,5	Lower	600	317	-55	City of Madera	No	Observed WL data tracks Model Layers 4 and 5. MO based on average of Model Layers 4 and 5.
COM RMS-3	264	620	310-600	4,5	Lower	700	284	-20	City of Madera	No	Observed WL data tracks Model Layers 4 and 5. MO based on average of Model Layers 4 and 5.
MWD RMS-1	330	500	200-500	4	Lower	450	425	-95	Madera WD	CASGEM	Observed water levels range up to 20 feet below modeled water levels for Model Layer 4. MT accounts for offset plus additional buffer (35 feet) needed to account for anticipated IP low WL. MO is set at 20 feet below Model Layer 4 average.
MWD RMS-2	310	537	200-537	4	Lower	450	440	-130	Madera WD	CASGEM	Observed water levels range up to 40 feet below modeled water levels for Model Layer 4. MT accounts for offset plus additional buffer (20 feet) needed to account for anticipated IP low WL. MO is set at 20 feet below Model Layer 4 average (offset ranges from 0 to 40 feet).
MWD RMS-3	295	800	380-800	4,5	Lower	450	435	-140	Madera WD	CASGEM	Observed WLs limited but track between Model Layers 4 and 5. MT includes additional buffer (50 feet) to account for anticipated IP low. MO is based on Model Layers 4 and 5 average.
MID RMS-15	247	502	160-200	2,3	Upper	NA	132	115	MID	CASGEM	Observed WL data limited, but tracks Model Layer 2. MO based on Model Layer 2 average.
MCE RMS-6	328	550	450-550	5	Lower	600	343	-15	Madera County East	CASGEM	Observed WL data limited, but tracks Model Layer 5. MO based on Model Layer 5 average.
MID RMS-16	308	452	348-388	4	Lower	600	408	-100	MID	CASGEM	Observed WLs range up to 25 feet below Model Layer 4 WLs. MT accounts for offset plus additional buffer (40 feet) to account for anticipated IP low WL. MO is set 15 feet below Model Layer 4 average (offset ranges from 0 to 25 feet).
MCE RMS-7	388	840	370-820	4,5,6	Lower	600	313	75	Madera County East	CASGEM	Observed WLs range across Model Layers 4, 5, and 6 (and up to 10 feet below Layer 6 WLs), over which the well is screened. MT accounts for 10 feet offset from Layer 6. MO based on average of Model Layers 4, 5, and 6.
MCE RMS-8	367	92	32-92	1,2	Upper	NA	57	310	Madera County East	CASGEM	Observed WLs are consistently below Model Layer 1 and fluctuate above and below Model Layer 2 WLs. MT is based on Model Layer 2 and offsets from observed data.
MCE RMS-9	265	37	17-37	1	Upper	NA	20	245	Madera County East	No	Observed WLs are about 5 feet below Model Layer 1 water levels. MT is based on 2012 to 2015 drought and observed water level trends, and accounts for offset of observed from modeled water levels.
MID RMS-17	224	47	27-47	1	Upper	NA	29	195	MID	No	Observed WLs are about 7-8 feet above Model Layer 1 water levels. MT is based on 2012 to 2015 drought and observed water level trends, and accounts for offset of observed from modeled water levels.
MCW RMS-5	197	30	Unknown	1	Upper	NA	27	170	Madera County West	No	Observed WLs are about 5 feet below Model Layer 1 water levels. MT is based on 2012 to 2015 drought and observed water level trends, and accounts for offset of observed from modeled water levels.

1 The actual proposed MT is based on the groundwater elevation, but the depth to water corresponding to the surface elevation in the project database is also provided.
2 Each GSA is responsible for collecting groundwater levels for representative monitoring sites within their GSA area.
3 Ground surface elevation is based on DEM data.

3.3.1.3 Methodology

The methodology to develop MTs for groundwater levels was based on discussion with GSA staff and technical representatives, input received from interested stakeholders and the public through public meetings, individual public/stakeholder input to various GSA representatives, meetings with GSA technical experts for other Madera Subbasin GSPs, and meetings with DWR.[68] Stakeholder input has included substantial verbal and written comments from representatives of disadvantaged communities, which has been meaningfully considered in development of this GSP.[69] There were several steps involved with determination of groundwater level MTs as follows:

- Review available wells with regard to several variables/criteria (e.g., is well in CASGEM program, known well construction details, preference for wells with relatively long history of observed water levels, availability of recent water level data, good spatial distribution) and select appropriate representative monitoring sites;
- For each selected representative monitoring site, review/evaluate the fluctuation of observed vs. modeled historical groundwater levels;
- Set the groundwater level MT equal to the Fall 2015 measurement, if this observed data point is available at a given RMS;
- If no Fall 2015 groundwater level measurement is available, utilize groundwater model results to determine the expected Fall 2015 groundwater level, with MT adjustments up or down to account for offset between historical observed and modeled data, if necessary;
- Adjust groundwater level MT to address other sustainability indicators, if necessary.

Example hydrographs showing the initial steps in determining MTs based on available Fall 2015 groundwater level measurements are provided in **Figure 3-5**. The hydrographs for Representative Monitoring Sites MID RMS-5 (**Figure 3-5a**) and COM RMS-2 (**Figure 3-5b**) demonstrate the MT determination based on observed Fall 2015 data. In these cases, groundwater model results are not needed and MTs are set based on observed data. Example hydrographs illustrating additional MT determination steps related to use of groundwater model results are provided in **Figure 3-6**. The hydrograph for Representative Monitoring Site MCW RMS-2 demonstrates application of the groundwater model to help determine MTs when Fall 2015 observed data are not available (**Figure 3-6a**). The consideration of offset of observed vs. modeled data is intended to reflect cases where observed data are either consistently above or below modeled water levels, or situations where observed water levels occasionally spike below seasonal low modeled water levels. Overall, the purpose of adjusting for differences between observed and modeled data is to obtain the most representative value for the expected Fall 2015 measurement had it been collected. The hydrograph for Representative Monitoring Site MID RMS-12 further illustrates use of the groundwater model when the necessary observed data are not available, which reflects GSA and stakeholder input and discussions with DWR (**Figure 3-6b**).

The GSAs are developing a Domestic Well Mitigation Program to address potential declines in groundwater levels during the implementation period, as needed, while PMAs are being implemented to

[68] During initial GSP development, a meeting was held on May 1, 2019 in DWR offices in Fresno between GSA representatives and DWR staff, including Amanda Peisch-Derby, Chris Olvera, Chris Montoya, and Dane Mathis. During the GSP revisions process, GSA representatives met with DWR staff two (2) times: on November 10, 2022 (to discuss coordination among GSAs and across GSPs) and on December 8, 2022 (to discuss deficiencies related to groundwater levels, subsidence, and interconnected surface water).

[69] Communications received from representatives of disadvantaged communities included a letter dated June 27, 2019 from the Leadership Council.

achieve sustainability by 2040. The Domestic Well Mitigation Program and the draft MOU are discussed in Section 3.3.1.

It should be noted that groundwater level MTs (and MOs) were set based on Fall groundwater levels, which are more protective of domestic wells than using Spring groundwater levels.

3.3.1.4 Relationship to Other Sustainability Indicators

Groundwater elevation MTs can influence other sustainability indicators. The groundwater elevation MTs were set to avoid undesirable results for other sustainability indicators as described below.

1. Reduction in groundwater storage. A significant and unreasonable condition for change in groundwater storage is pumping groundwater in excess of the sustainable yield for an extended period of years during the sustainability period. Pumping at or less than the sustainable yield will maintain or raise average groundwater elevations in the Plan area. The groundwater elevation MTs are set at Fall 2015 groundwater elevations, consistent with avoiding long-term declines in groundwater storage. Therefore, the groundwater elevation MTs established for this GSP will not result in long term significant or unreasonable change in groundwater storage.
2. Subsidence. A significant and unreasonable condition for land subsidence is measurable permanent (inelastic) subsidence that significantly damages existing infrastructure. Inelastic subsidence is caused by reduction in pore pressure and compaction of clay-rich sediments in response to declining groundwater levels. There have been small amounts of land surface elevation fluctuation/subsidence that have been recorded across the Plan area; however, these levels of recent historical fluctuation/subsidence have not yet resulted in any known significant impacts to infrastructure. Nonetheless, a zero MT for subsidence has been set for the Subbasin to avoid potential future subsidence impacts as well. The groundwater level MT set equal to Fall 2015 groundwater levels is consistent with the subsidence MT established for the Subbasin.
3. Degraded water quality. Protecting groundwater quality is critically important to all who depend upon the groundwater resource, particularly drinking water and agricultural uses. A significant and unreasonable condition of degraded water quality is exceeding regulatory limits for constituents of concern in wells due to actions proposed in the GSP. Water quality could be affected through three processes:
    a. Low groundwater elevations in an area could cause deeper, poor-quality groundwater to flow upward into existing wells. Groundwater elevation MTs are generally set well above depths to reduced sediments that may provide poorer quality water with respect to naturally occurring constituents (e.g., arsenic), thereby minimizing opportunities for poor quality groundwater flowing into wells. To the extent that temporary declines during the GSP implementation period may result in domestic wells previously below the arsenic MCL to be above the MCL as a direct result of declining groundwater levels after 2020, a proposed Domestic Well Mitigation Program would help to address this issue (**Appendices 3.D and 3.E**). Therefore, the combination of the groundwater elevation MTs and Domestic Well Mitigation Program will avoid poor-quality water (resulting directly from GSP actions) from impacting existing wells.
    b. Changes in groundwater elevation as a result of PMAs implemented to achieve sustainability could change groundwater gradients, which could cause poor quality groundwater (i.e., contaminant plumes) from documented contaminant sites to flow towards wells that would not have otherwise been impacted. These groundwater gradients, however, are dependent on differences between groundwater elevations, not

in the groundwater elevations themselves. Therefore, the MT for groundwater elevations do not directly lead to significant and unreasonable degradation of groundwater quality in wells. Although distributed areas of degraded groundwater quality from non-point source contamination exist in the Plan area (most notably elevated nitrate concentrations), there are no current documented large-scale contaminant plumes of concern in the regional groundwater aquifers. Smaller localized and shallow contaminant site plumes have been documented in parts of the Plan area, although these contaminants are generally restricted to very shallow depths above the regional aquifer system. RWQCB files for existing and potential new documented contaminant site plumes will be reviewed every five years for potential changes in contaminant movement that may be related to GSP PMAs, and adaptive management implemented as necessary.

c. GSP PMAs include a number of recharge basins and Flood MAR programs that will recharge surface water available in wet years through the vadose zone (unsaturated zone about the regional water table) to the water table. Such PMAs have the potential to flush existing constituents of concern (i.e., TDS, nitrates) from the vadose zone to the water table. While such flushing has been occurring and will continue to occur naturally (e.g., via rainfall recharge, excess irrigation recharge) without such GSP PMAs, it may be the case that GSP PMAs temporarily increase the rate of vadose zone flushing and result in temporarily higher constituent concentrations in groundwater prior to eventual dilution (due to recharge of higher quality water) and a reduction in these constituent concentrations. Overall, it is anticipated that there will likely be an overall net benefit to groundwater quality from GSP PMAs; however, the overall groundwater monitoring program developed for this GSP plus additional site-specific monitoring if determined to be needed (e.g., additional groundwater or potentially soil sampling), will be utilized to evaluate need for adaptive management related to GSP recharge projects.

4. Depletion of interconnected surface waters. The assessment of surface water flows and groundwater levels indicate that there are likely time periods with interconnected surface waters in the Plan area. The interim MT for interconnected surface water require that the future percent of time with connected between surface water and shallow groundwater be maintained. Therefore, the MT for interconnected surface water is consistent with the groundwater elevation MTs being equal to historical Fall 2015 groundwater elevations.

3.3.1.5 Impact of Selected Minimum Thresholds to Adjacent Basins

The potential for impacts on adjacent subbasins will primarily be a function of average water levels in the Plan area during the sustainability period, average water level in adjacent subbasins during the sustainability period, and natural groundwater flow conditions that would be expected to occur along subbasin boundaries (e.g., pre-development groundwater flow conditions). The average groundwater levels expected for the Plan Area are reflected in the MOs. Therefore, the impact to adjacent subbasins is described in more detail under the section on MOs.

3.3.1.6 Minimum Thresholds Impact on Beneficial Uses and Users

Groundwater level MTs are likely to have several effects on beneficial uses, users, land use, and property owners. Those expected to be impacted include agricultural land use and users, urban land use and users, domestic land use and users, and ecological land use and users. Overall agricultural land use and users will be significantly impacted in terms of increased costs to design and construct recharge projects and in terms of reduced crop yields from required reductions in consumptive use for irrigation. While conversion of current agricultural lands to urban areas that may occur in the future will tend to reduce per acre water

demands, it is likely that urban water users will need to continue water conservation efforts due to limited water supplies. Domestic well owners may experience declining groundwater levels during the initial 10 to 15 years of the GSP implementation period, followed by stabilization of water levels during the latter portion of the GSP implementation period and some potential recovery in groundwater levels after 2040. However, significant adverse impacts to domestic wells from declining groundwater levels are expected to be addressed through a Domestic Well Mitigation Program, as needed (**Appendices 3.D and 3.E**). The economic analyses conducted to compare costs of implementing a Domestic Well Mitigation Program versus immediately requiring full implementation of demand reduction in 2020 are provided in **Appendix 3.D**.

Potential ecological impacts are limited to small areas along the eastern and southern margins of the Plan Area, related to groundwater levels in the shallowest aquifer within the upper 50 feet of sediments. The Fresno River Riparian, Friant Riparian, and San Joaquin River Riparian potential GDE units are composed of vegetation which may access shallow groundwater within approximately 30 feet of the surface. The Sumner Hill potential GDE Unit includes open water wetland as well as emergent wetland vegetation and riparian vegetation which also depend in part on shallow groundwater within approximately 30 feet of the surface. The potential for impacts in each GDE unit is summarized as follows:

- Fresno River Riparian potential GDE Unit – Shallow groundwater levels in this GDE unit are represented by well MCE RMS-8 (see Figure 6 in **Appendix 2.B**). Its susceptibility to impacts related to groundwater management is considered low because current and future groundwater conditions are projected to be within the baseline range (i.e., not exceeding historical lows from 1989-2015) and because pumping in the main groundwater basin aquifers is unlikely to impact water levels underlying this GDE unit.

- Friant Riparian potential GDE Unit – There are no shallow groundwater wells in the vicinity of this GDE unit and thus measured no data representing baseline or projected future shallow groundwater levels. Review of the model data indicates that estimated future groundwater levels are within a similar range as historical groundwater levels. The susceptibility of this GDE unit to impacts related to groundwater management is considered low because pumping in the main groundwater basin aquifers is unlikely to impact water levels underlying the GDE unit and because shallow groundwater levels in this unit are largely dependent on and expected to be maintained by releases from Friant Dam and restoration flows in the San Joaquin River under the SJRRP.

- San Joaquin River Riparian potential GDE Unit – Shallow groundwater levels in this GDE unit are represented by wells MCE RMS-9 (Figure 9 in **Appendix 2.B**), MID RMS-17 (Figure 10 in **Appendix 2.B**), and MCW RMS-5 (Figure 11 in **Appendix 2.B**). Although the perched/mounded shallow groundwater associated with this unit has a potential connection with the regional aquifer and could be affected by groundwater pumping, current and projected future trends in depth to water indicate stable groundwater conditions in the unit within the historical baseline range (i.e., not exceeding historical lows from 1989-2015). These stable trends persist for current and projected conditions with deeper pumping occurring within the regional aquifer. This suggests that this GDE unit's susceptibility to impacts related to groundwater management is low.

- Sumner Hill potential GDE Unit – There are no shallow groundwater wells in the vicinity of this GDE unit (likely because geologic maps suggest minimal unconsolidated alluvium beneath this GDE) and thus no data representing baseline or projected future shallow groundwater levels. The susceptibility of this GDE unit to impacts related to groundwater management is considered low because this GDE unit appears to essentially lie directly on top of bedrock and pumping in the main groundwater basin aquifers is unlikely to impact water levels underlying the GDE unit.

Overall, sustainable groundwater management in the Madera Subbasin is expected to maintain the health and resiliency of the vegetation communities composing the potential GDE units and adverse impacts are not expected.

3.3.1.7 Comparison between Minimum Thresholds and Relevant State, Federal or Local Standards

There are no Federal, State (except SGMA), or local standards that exist for chronic lowering of groundwater levels.

3.3.1.8 Minimum Thresholds Measurement Method

Groundwater level MTs will be directly measured for existing and new monitoring wells. The groundwater level monitoring will be conducted in accordance with the monitoring plan and protocols outlined in Section 3.5. Furthermore, the groundwater level monitoring will meet the requirements of the technical and reporting standards included in the SGMA regulations. As noted in Section 3.5, the current groundwater monitoring network includes 11 wells in the Upper Aquifer and 22 wells in the Lower Aquifer (plus four additional composite wells). Madera County is also planning to install seven new nested monitoring wells (with two or three separate wells at each site) in the subbasin at the beginning of the implementation period, which will subsequently be incorporated in the monitoring program.

3.3.2 Reduction in Groundwater Storage

The cause of Subbasin groundwater conditions that would result in significant and unreasonable reduction in groundwater storage is excessive overall annual average groundwater pumping and other outflows from the Subbasin that exceed average annual inflows. Locally defined significant and unreasonable conditions were determined based on discussion with GSA staff and technical representatives, input received from interested stakeholders and the public through public meetings, and through individual stakeholder input to various GSA representatives. Significant and unreasonable reduction in groundwater storage occurs when there is: 1) Long term reduction in groundwater storage during the sustainability period (i.e., after 2040), or 2) Interference with other sustainability indicators.

3.3.2.1 Methodology

The methodology to develop MTs for reduction in groundwater storage was based on discussion with GSA staff and technical representatives, input received from interested stakeholders and the public through public meetings, and through individual stakeholder input to various GSA representatives, and a meeting with DWR.

The selected methodology of using groundwater levels as a proxy involves field measurement of groundwater levels in the RMS monitoring well network and comparison to established groundwater level MTs. To the extent that groundwater levels are collectively (on average) maintained above MTs, groundwater storage would be considered not to exceed its MT. A key benefit of this approach is that it is the simplest and most direct approach to ensuring that groundwater storage MTs align with groundwater level MTs. In addition, groundwater levels are the fundamental underlying field data required to implement any method of quantifying groundwater storage.

Given that the MT is no long-term reduction in groundwater storage during the sustainability period, periodic evaluations of changes in groundwater storage will be conducted after 2040. Annual reporting will involve evaluation and comparison of groundwater levels over a period of average climatic conditions that occurs within the sustainability period after 2040. Groundwater level contour maps will be developed for the beginning and ending year of the analysis period (of average climatic conditions) and the beginning

year contour map is then "subtracted" from the ending year contour map. If the net result of this process is essentially no change in levels/storage or a net positive gain in levels/storage, then there is no long-term reduction in groundwater storage. If there is a significant net negative change in groundwater levels/storage, then there may be a reduction in groundwater storage. This method evaluates changes in groundwater storage and most specifically addresses the concept of a reduction in groundwater storage. It should be noted that this calculation relies on contouring groundwater levels using RMS that will not provide coverage of the entire Subbasin such as would be important for a total Subbasin-wide groundwater storage calculation. However, this calculation is not as reliant upon accurate assumptions for key variables (e.g., specific yield, depth of fresh water, area of calculation) as a total Subbasin groundwater storage calculation. Rather, the main purpose is to determine the representative relative change in storage for the Subbasin and the spatial distribution of RMS should be adequate for that purpose.

The groundwater storage reduction metric will be evaluated using groundwater levels as a proxy in conjunction with annual evaluations of long-term groundwater level changes over average climatic periods during the sustainability period. Based on considerations applied in developing the groundwater level MTs, reduction in groundwater storage MTs do not exceed any identified significant and unreasonable level of depleted groundwater storage volume.

3.3.2.2 Relationship to Other Sustainability Indicators

The representative monitoring sites described in Table 3-10 and **Figure 3-1** are in locations that reflect a wide cross section of Plan Area groundwater conditions. These locations are representative of the overall Plan Area conditions because they are spatially distributed throughout the Plan Area both vertically (across the Upper and Lower Aquifer) and spatially. The distribution of Upper Aquifer wells is limited because the definition of Upper Aquifer used in this study (above the Corcoran Clay where present, and equivalent depth to the east of where Corcoran Clay is present), results in relatively large areas of unsaturated Upper Aquifer in the central to eastern portions of the Plan Area. The GSAs have determined that use of the groundwater level MTs at each of the listed wells will help avoid the undesirable result of reduction in groundwater storage because it will minimize the chance that access to adequate water resources for beneficial users within the Plan Area will be compromised.

The reduction in groundwater storage MT can influence other sustainability indicators.

- Chronic Lowering of Groundwater Levels. Because groundwater elevation will essentially be used as a proxy for estimating changes in groundwater storage, the reduction in groundwater storage would not cause undesirable results for this sustainability indicator.
- Subsidence. Because future average groundwater levels will be stable under the reduction in groundwater storage MT, they will not induce subsidence.
- Degraded water quality. The MT proxy of stable groundwater levels for reduction in groundwater storage will not directly lead to a degradation of groundwater quality.
- Depletion of interconnected surface waters. The assessment of surface water flows and groundwater levels indicate that there are not interconnected surface water bodies in the Plan Area. Therefore, there are no current MTs or undesirable results that could be affected by the reduction in groundwater storage MT. The potential for reduction in groundwater storage to impact GDE areas is covered under chronic lowering of groundwater levels.

3.3.2.3 Impact of Selected Minimum Thresholds to Adjacent Basins

A MT that does not allow for reduction in groundwater storage during the sustainability period will not have negative impacts on adjacent subbasins. A MT for reduction in groundwater storage tied to

evaluation of changes in groundwater storage over a long-term period with average climatic conditions during the sustainability period will be protective of adjacent subbasins.

3.3.2.4 Minimum Thresholds Impact on Beneficial Uses and Users

The reduction in groundwater storage MT is maintaining stable average groundwater elevations during the sustainability period and will require some amount of reduction in groundwater pumping in the Plan Area. Reduced pumping may impact beneficial uses and users of groundwater in the Plan Area. Those expected to be most impacted by pumping reductions are agricultural land use and users. In general, agricultural land use/users will be negatively impacted by pumping reductions since it is their pumping that will be reduced, while other users may benefit from agricultural pumping reductions. Most domestic well pumping is considered de minimis and will not be subject to pumping reductions. These impacts will be similar to those described above for chronic lowering of groundwater levels. Beneficial uses and users will also be impacted during the implementation period by gradual increases in required groundwater pumping reductions over the time period from 2020 to 2040.

3.3.2.5 Comparison between Minimum Thresholds and Relevant State, Federal or Local Standards

There are no Federal, State, or local standards that exist for reduction in groundwater storage.

3.3.2.6 Minimum Thresholds Measurement Method

The MTs for groundwater storage reduction are based on groundwater levels being measured for the groundwater level MT methodology. The representative wells use the groundwater level MTs for avoidance of reduction in groundwater storage.

3.3.3 Land Subsidence

The cause of Subbasin groundwater conditions that would result in significant and unreasonable land subsidence is excessive overall average annual groundwater pumping and other outflows from the Subbasin that exceed average annual inflows. Locally defined significant and unreasonable conditions were determined based on discussions with GSA staff and technical representatives, input received from interested stakeholders and the public through public meetings, and through individual stakeholder input to various GSA representatives. Significant and unreasonable land subsidence results in significant impacts to infrastructure.

3.3.3.1 Methodology

The MT for land subsidence was selected to prevent undesirable results. Within the Madera Subbasin, while an increased rate of subsidence has been observed in recent years in some areas of the Subbasin, no significant impacts to infrastructure have been noted to date in the Plan Area. As discussed in **Section 2.2.2.4.3** of this GSP, some amount of residual subsidence is assumed to be occurring and will likely occur for some time into the future. Given the lack of historical undesirable results experienced in Madera Subbasin, combined with the expectation of some future residual subsidence that is already occurring due to past cycles of lower groundwater levels and land subsidence, interim milestones were set to manage subsidence during GSP implementation. Interim milestones for subsidence are described in **Section 3.2.3.2** of this GSP.

The land subsidence MT is set at a rate of 0 feet/year. However, compliance with this threshold will take into consideration the level of uncertainty associated with survey measurements. SJRRP has reported that survey measurements have a vertical accuracy of +/-2.5 centimeters (Reclamation, 2011). With two

measurements necessary to calculate a rate (before and after), the total uncertainty in the subsidence rate value is 5 centimeters, or approximately -0.16 feet/year. Therefore, a rate of subsidence of less than -0.16 feet/year (values that are less negative) are considered to be within the uncertainty of the measurement and would be considered compliant with the MT of 0 feet/year.

The MT for land subsidence is set recognizing that land subsidence within Madera Subbasin is tied to actions in neighboring subbasins, and the ability to meet these interim milestones is dependent on the successful implementation of project and management actions in neighboring subbasins. It should also be noted that while groundwater level MTs and MOs are not specifically tied to subsidence thresholds, they are consistent with the objective to limit the potential for future subsidence.

This MT may require modification in the future if residual subsidence continues to be seen approaching the end of the 20-year GSP implementation period.

3.3.3.2 Relationship to Other Sustainability Indicators

Although there are potential relationships between land subsidence and other sustainability indicators, setting of a MT of 0 feet/year for land subsidence does not conflict with other sustainability indicators and associated MTs. It should also be noted that while land subsidence MTs and MOs are not specifically tied to groundwater levels, PMAs to halt declines, stabilize, and possibly raise groundwater levels will limit the potential for future subsidence along with serving to prevent chronic lowering of groundwater levels.

3.3.3.3 Impact of Selected Minimum Thresholds to Adjacent Basins

The MT for land subsidence is set to prevent significant and unreasonable impacts to infrastructure, and are therefore not likely to impact adjacent subbasins or their ability to achieve sustainability.

3.3.3.4 Minimum Thresholds Impact on Beneficial Uses and Users

Given that no significant impacts to infrastructure have been noted to date in the Plan Area, MTs set to prevent any future impacts will not have any impacts on beneficial uses or users.

3.3.3.5 Comparison between Minimum Thresholds and Relevant State, Federal or Local Standards

There are no Federal, State, or local standards that exist for land subsidence.

3.3.3.6 Minimum Thresholds Measurement Method

Subsidence will continue to be monitored twice a year at SJRRP survey benchmarks by the UBSR and daily at the continuous GPS station by UNAVCO. Subsidence MTs will be evaluated on an annual (December to December) basis.

3.3.3.7 Other Considerations for Setting Minimum Thresholds

Infrastructure Sensitivity Assessment

The GSAs completed an infrastructure assessment to evaluate the characteristics of critical infrastructure in the Madera Subbasin, including its proximity, orientation, and relative vulnerability to adverse effects of land subsidence. The assessment is documented in **Appendix 3.G.** and has been used to inform development of SMC in the Madera Subbasin with the goal of protecting this critical infrastructure from undesirable results of groundwater conditions during GSP implementation.

Proposed Subsidence Control Measures

The GSAs in the Madera Subbasin plan to couple their GSP PMAs and implementation efforts with provisions that complement and are consistent with the Subsidence Control Measures Agreement (Agreement) that is currently in effect in parts of the Chowchilla Subbasin near the Madera Subbasin boundary.

The Agreement was initially executed in 2017 between certain landowners in the Western Management Area of the Chowchilla Subbasin, the Central California Irrigation District, and San Luis Canal Company. Among other goals, the Agreement is intended to reduce groundwater pumping from the Lower Aquifer. Loss of groundwater storage and associated reduction in pore pressures in clay layers in the Lower Aquifer (indicated by lowering groundwater levels) is understood by all parties to lead to conditions that cause and/or exacerbate land subsidence. The relationship between loss of groundwater storage and associated reduction in pore pressures in clay layers, lowering groundwater levels, and land subsidence is a central and common point of understanding between all parties who signed the Agreement, including the Expert Panel established under the Agreement. Under the Agreement, parties in the Chowchilla Subbasin are required, among other provisions, to restrict the amount of groundwater they pump from the Lower Aquifer and to report, under penalty of perjury, the amounts of groundwater pumped, the source of that groundwater (Upper Aquifer or Lower Aquifer), the amounts recharged, the amounts of surface water used for irrigation, and other information about their irrigated acreage and crops. Parties in the Chowchilla Subbasin are also required to implement projects that increase use of surface water for irrigation (providing in-lieu recharge benefits to the Lower Aquifer) and increase use of surface water for direct recharge (increasing storage in the Upper Aquifer to support sustainable use of groundwater from the Upper Aquifer instead of the Lower Aquifer). The initial Agreement was in effect from 2017-2021, and the parties are currently working under a one-year extension through 2022 with the goal of signing a new five-year extension in 2023.

In the Madera Subbasin, GSAs are considering PMAs and policies that similarly:

- Increase the use of surface water for irrigation (providing in-lieu recharge benefits to the Lower Aquifer),
- Increase the use of surface water for direct recharge (increasing storage in the Upper Aquifer to support sustainable use of groundwater from the Upper Aquifer instead of the Lower Aquifer),
- Potentially restrict the amount of groundwater they pump from the Lower Aquifer, encouraging conjunctive use of groundwater recharge from the Upper Aquifer.

For example, Madera County GSA and Madera Irrigation District GSA are developing groundwater recharge projects that will enhance groundwater storage in the Upper Aquifer. For projects that will require agreements with participating landowners, the GSAs are considering provisions that only permit the recovery of project groundwater recharge benefits from wells in the Upper Aquifer, where the recharge from the projects will be occurring. These provisions will effectively reduce groundwater extraction from the Lower Aquifer and shift extraction to the Upper Aquifer, similar to the Agreement, and are anticipated to reduce subsidence rates in areas where the projects occur. While development of these groundwater recharge projects is ongoing, the GSAs will continue to coordinate and review the progress and subsidence mitigation benefits of the Agreement in areas along the northwestern boundary of the Madera Subbasin. These findings will be used to inform development of Lower Aquifer groundwater pumping restrictions or other efforts to mitigate subsidence in the Madera Subbasin.

Limitations on groundwater pumping from the Lower Aquifer may also be achieved through well permitting provisions in response to Executive Order N-7-22 or by other means determined by the GSAs.

Based on the results of the "Projected, With Projects" water budget scenario modeled in MCSim[72], it is expected that shifts in pumping practices, paired with implementation of the planned PMAs, will help to achieve sustainable groundwater conditions in the Madera Subbasin. Updates and outcomes of other subsidence mitigation measures will be reported in future GSP updates and Annual Reports. Together, landowners and GSAs are making consistent efforts to achieve and maintain groundwater sustainability in the Madera Subbasin.

3.3.4 Degraded Water Quality

The cause of subbasin groundwater conditions that would result in significant and unreasonable degraded water quality is implementation of a GSP project or management action that causes concentrations of key groundwater quality constituents to increase to concentrations exceeding the MTs, which are set at the MCLs for drinking water for identified key constituents (10 mg/L for nitrate as nitrogen; 500 mg/L for TDS; 10 µg/L for arsenic) or when existing or historical concentrations for the key constituents already exceed the MCL, the MT is set at the recent concentration plus 20 percent. Although distributed areas of degraded groundwater quality from non-point source contamination exist in the Plan Area (most notably elevated nitrate concentrations), there are no current documented large-scale contaminant plumes in the regional groundwater aquifers. Smaller more localized and shallow contaminant site plumes have been documented in parts of the Plan Area, most notably in the vicinity of the City of Madera, although these contaminants are generally restricted to depths above the regional aquifer system. Municipal and domestic supply (MUN) is a designated beneficial use for groundwater in the Plan Area; therefore, groundwater quality degradation resulting from a GSP project or management action is considered significant and unreasonable based on adverse impacts to this beneficial use. Locally defined significant and unreasonable conditions were determined based on discussion with GSA staff and technical representatives, and input received from interested stakeholders and the public through public meetings and through individual stakeholder input to various GSA representatives. Significant and unreasonable degradation of water quality occurs when beneficial uses for groundwater are adversely impacted by constituent concentrations increasing to levels above the drinking water MCLs for one of the key constituents (nitrate, arsenic, TDS) previously identified in Chapter 2 (Plan Area and Basin Setting) of the GSP at indicator wells in the representative groundwater quality monitoring network due to implementation of a GSP project or management action. When existing or historical concentrations for the key constituents already exceed the MCL, the MT is set at the recent concentration plus 20 percent.

The MTs for degraded water quality apply to RMS selected from among existing and proposed future wells located throughout the Plan Area and screened in both in the Upper and Lower Aquifers. The RMS for groundwater quality include a combination of irrigation, public supply, domestic, and monitoring wells to be sampled and analyzed by the Plan Area GSAs together with wells that are sampled by others as part of other groundwater quality monitoring programs. The selected RMS for groundwater quality are listed in Table 3-11 and shown on **Figure 3-3**.

3.3.4.1 Methodology

The methodology to develop MTs for groundwater quality is based on the objective of protecting all designated beneficial uses from significant and unreasonable adverse impacts from implementation of

[72] See **Appendix 6.D**, Section 3.3.5.2. In the MCSim projected model, pumping specifications in certain areas were shifted such that approximately 90 percent of groundwater pumping was simulated from the Upper Aquifer and approximately 10 was simulated from the Lower Aquifer. These shifts were made to mitigate for potential subsidence impacts.

GSP PMAs. In accordance with the Water Quality Control Plan (Basin Plan) for the Sacramento and San Joaquin River Basins (RWQCB, 2018), groundwater in the Plan Area is considered suitable or potentially suitable for municipal and domestic water supply (MUN), agricultural supply (AGR), industrial service supply (IND), and industrial process supply (PRO) beneficial uses. From a groundwater quality standpoint, the municipal and domestic supply beneficial use is the most restrictive with Basin Plan water quality objectives linked to drinking water MCLs. As a result, the MTs for groundwater quality set for each of the three identified key water quality constituents (nitrate, arsenic, TDS) are the respective MCL values, except for cases where existing or historical concentrations for these constituents already exceed the MCL. When existing or historical concentrations for the key constituents already exceed the MCL, the MT is set at the recent concentration plus 20 percent. When current or historical water quality for the key constituents has not been measured, the MT will be set as the MCL and will be adjusted if needed after the GSP groundwater quality monitoring program commences (see Section 3.5.1.4). The applicable MTs for groundwater quality in the GSP apply to degraded groundwater quality as a direct result of impacts from projects/MAs under the GSP that cause an exceedance to occur. Future exceedances of the MT may occur due to activities or conditions unrelated to the GSP, in which case they would not constitute an MT exceedance that contributes to an undesirable result.

3.3.4.2 Relationship to Other Sustainability Indicators

Although there are potential relationships between groundwater quality and other sustainability indicators, setting of MTs for groundwater quality does not conflict with other sustainability indicators and associated MTs. Management of groundwater for other sustainability indicators and associated MTs may not ensure that impacts on groundwater quality are avoided.

Table 3-11. Summary of Groundwater Quality Minimum Thresholds for Representative Monitoring Sites

Well ID	Well Type	Well Depth	Screen Top-Bottom	Aquifer Designation	MT Arsenic Concentration (µg/L)	MT Nitrate Concentration (mg/L)	MT TDS Concentration (mg/L)	Responsible Monitoring Entity	Measurement Frequency
Wells Monitored by GSP Entities: Existing									
MCW RMS-1	Other	800	Unknown	Lower	10†	10†	500†	GSP Entities	Annual
MID RMS-4	Irrigation	698	320-667	Lower	10†	10†	500†	GSP Entities	Annual
MID RMS-5	Irrigation	570	270-570	Lower	10†	10†	500†	GSP Entities	Annual
MID RMS-6	Irrigation	680	320-680	Lower	10†	10†	500†	GSP Entities	Annual
MID RMS-7	Irrigation	656	290-635	Lower	10†	10†	500†	GSP Entities	Annual
MCE RMS-1	Other	500	420-500	Lower	10†	10†	500†	GSP Entities	Annual
MCE RMS-3	Unknown	Unknown	Unknown	Composite	10†	10†	500†	GSP Entities	Annual
MCW RMS-2	Irrigation	216	205-212	Upper	10†	10†	500†	GSP Entities	Annual
MID RMS-9	Unknown	143	Unknown	Upper	10†	10†	500†	GSP Entities	Annual
MCW RMS-4	Irrigation	580	220-580	Lower	10†	10†	500†	GSP Entities	Annual
MID RMS-13	Irrigation	600	228-552	Composite	10†	10†	500†	GSP Entities	Annual
MWD RMS-1	Irrigation	500	200-500	Lower	10†	10†	500†	GSP Entities	Annual
Wells Monitored by GSP Entities: Future Monitoring Wells									
Lavina MW - Shallow	Monitoring	300*	100-300*	Upper	10†	10†	500†	ILRP/GSP Entities	Annual
Lavina MW - Middle	Monitoring	500*	300-500*	Lower	10†	10†	500†	GSP Entities	Annual
Lavina MW - Deep	Monitoring	700*	500-700*	Lower	10†	10†	500†	GSP Entities	Annual
Site 3 MW - Shallow	Monitoring	300*	100-300*	Upper	10†	10†	500†	ILRP/GSP Entities	Annual
Site 3 MW - Middle	Monitoring	500*	300-500*	Lower	10†	10†	500†	GSP Entities	Annual
Site 3 MW - Deep	Monitoring	700*	500-700*	Lower	10†	10†	500†	GSP Entities	Annual
Site 4 MW - Shallow	Monitoring	300*	100-300*	Upper	10†	10†	500†	ILRP/GSP Entities*	Annual
Site 4 MW - Middle	Monitoring	500*	300-500*	Lower	10†	10†	500†	GSP Entities	Annual
Site 4 MW - Deep	Monitoring	700*	500-700*	Lower	10†	10†	500†	GSP Entities	Annual
Site 5 MW - Shallow	Monitoring	300*	100-300*	Upper	10†	10†	500†	ILRP/GSP Entities	Annual
Site 5 MW - Middle	Monitoring	500*	300-500*	Lower	10†	10†	500†	GSP Entities	Annual
Site 5 MW - Deep	Monitoring	700*	500-700*	Lower	10†	10†	500†	GSP Entities	Annual
Site 6 MW - Shallow	Monitoring	300*	100-300*	Upper	10†	10†	500†	ILRP/GSP Entities	Annual
Site 6 MW - Middle	Monitoring	500*	300-500*	Lower	10†	10†	500†	GSP Entities	Annual
Site 6 MW - Deep	Monitoring	700*	500-700*	Lower	10†	10†	500†	GSP Entities	Annual
Site 10 MW - Shallow	Monitoring	300*	100-300*	Upper	10†	10†	500†	ILRP/GSP Entities	Annual
Site 10 MW - Middle	Monitoring	500*	300-500*	Lower	10†	10†	500†	GSP Entities	Annual
Site 10 MW - Deep	Monitoring	700*	500-700*	Lower	10†	10†	500†	GSP Entities	Annual
Site 11 MW - Shallow	Monitoring	300*	100-300*	Upper	10†	10†	500†	ILRP/GSP Entities	Annual
Site 11 MW - Middle	Monitoring	500*	300-500*	Lower	10†	10†	500†	GSP Entities	Annual
Site 11 MW - Deep	Monitoring	700*	500-700*	Lower	10†	10†	500†	GSP Entities	Annual

Well ID	Well Type	Well Depth	Screen Top-Bottom	Aquifer Designation	MT Arsenic Concentration (µg/L)	MT Nitrate Concentration (mg/L)	MT TDS Concentration (mg/L)	Responsible Monitoring Entity	Measurement Frequency
Wells Monitored for Other Programs									
2000507-001	Public Supply	Unknown	372-?	Lower	10	10	500	DDW	Variable, according to DDW reqs.
2000553-001	Public Supply	Unknown	450-500	Lower	10	10	500	DDW	
2000682-002	Public Supply	Unknown	295-420	Lower	10	10	500	DDW	
2000727-001	Public Supply	Unknown	280-360	Lower	10	10	500	DDW	
2000846-002	Public Supply	Unknown	310-380	Lower	10	10	500	DDW	
2000938-001	Public Supply	Unknown	420-560	Lower	10	10	500	DDW	
2010002-014	Public Supply	Unknown	280-610	Lower	10	10	500	DDW	
2010002-032	Public Supply	Unknown	310-600	Lower	10	10	500	DDW	
2010008-005	Public Supply	Unknown	250-465	Composite	10	10	500	DDW	
2010009-002	Public Supply	Unknown	324-369	Composite	10	10	500	DDW	
2010010-007	Public Supply	Unknown	242-374	Lower	10	10	500	DDW	
2010801-001	Public Supply	Unknown	375-760	Lower	18	10	500	DDW	
2801077-001	Public Supply	Unknown	60-500	Composite	10†	10	500†	DDW	
ESJ12	Domestic	276	160-172	Upper	N/A‡	10	500	ILRP	Annual‡
ESJ17	Domestic	Unknown	Unknown	Unknown	N/A‡	10†‡	500†‡	ILRP	Annual‡

* Construction details and locations for future monitoring wells are estimated; information will be updated upon completion of final site selection and well construction.
† Values will be confirmed and/or adjusted as needed based on results from initial sampling for constituents. If existing levels exceed the MCL, then the MT is set at the existing concentration plus 20 percent.
‡ Monitoring for the Irrigated Lands Regulatory Program does not include testing for arsenic; annual monitoring includes nitrate and specific conductance (SC), TDS is tested every five years; SC will be used as proxy for TDS in years in which TDS is not tested.

3.3.4.3 Impact of Selected Minimum Thresholds to Adjacent Basins

The MTs for groundwater quality established for the Plan Area are intended to protect all beneficial uses within the Plan Area, including municipal and domestic water supply uses, from groundwater quality degradation caused by projects or management actions included in the GSP, and are therefore not likely to impact adjacent subbasins or their ability to achieve sustainability.

3.3.4.4 Minimum Thresholds Impact on Beneficial Uses and Users

Municipal and domestic supply is the most restrictive beneficial use standard for groundwater quality with water quality objectives equal to drinking water MCLs. Setting the groundwater quality MTs for key constituent concentrations at respective drinking water MCLs, or within a tolerance for no more than a 20 percent increase above historical concentrations when existing or historical concentrations already exceed the MCL, is intended to limit degradation of groundwater quality caused by GSP PMAs in order to protect municipal and domestic supply beneficial uses. Protection of municipal and domestic beneficial uses is also protective of all other groundwater beneficial uses.

3.3.4.5 Comparison between Minimum Thresholds and Relevant State, Federal or Local Standards

The Federal and State drinking water quality standards are represented through MCLs that are applicable to public drinking water supplies and provide reasonable guidance on water quality for safe drinking water in non-public supplies. As described above, the State of California drinking water MCLs for arsenic, nitrate, and TDS are being used to define MTs for groundwater quality degradation caused by GSP PMAs, except in cases where existing or historical groundwater quality conditions already exceed these levels.

3.3.4.6 Minimum Thresholds Measurement Method

Groundwater quality will be monitored on an annual basis at identified representative groundwater quality monitoring indicator wells presented in Table 3-11 and **Figure 3-3**. Monitoring will be conducted through sampling of groundwater quality conducted for the GSP monitoring along with evaluation of groundwater quality data reported for other monitoring programs. All groundwater quality sampling and analysis will be conducted in accordance with the monitoring protocols and procedures described in the GSP. The monitoring network and monitoring protocols for groundwater quality are described in Section 3.5 (Monitoring Network and Monitoring Protocols for Data Collection).

3.3.5 Depletion of Surface Water

As described in the HCM in Chapter 2, regional groundwater levels have been below the stream channel bottoms in the Plan Area for at least the last several years, and for many decades in most of the Plan Area. It has been determined that a direct hydraulic connection between regional groundwater and streams does not exist for streams in most of the Subbasin; therefore, the surface water depletion sustainability criteria are not applicable over most of the Subbasin. However, water levels in the shallowest groundwater zone below and along parts of the San Joaquin River at the southern boundary of Madera Subbasin periodically rise to elevations equal to or above the stream thalweg. Although it appears this shallow groundwater is associated with infiltration of streamflow from the nearby river resulting from upstream reservoir releases, interim SMC are being established for ISW along the San Joaquin River until additional field investigations, studies, evaluations, and monitoring can be completed to update and refine the hydrogeologic understanding of subsurface conditions and interactions between groundwater and surface water in this area. The interim MTs are the same as the interim MOs: to maintain the percent

of time of surface water – groundwater connectivity consistent with conditions during the baseline historical time period, as measured over a rolling five-year period.

3.3.5.1 Methodology

As described in the HCM in Section 2 and in the discussion the MOs in Section 3.2.5, interim SMC are being established for interconnected surface water along the San Joaquin River. It is intended to put the interim SMC in place with submittal of this GSP, with final SMC pending further data collection and analysis to make a more informed assessment of whether or not interconnected surface water is present at this location and, if so, to refine SMC if necessary based on the improved understanding of hydrogeologic conditions. The interim MTs are the same as the interim MOs: to maintain the percent of time with surface water – groundwater connection over a given time period as equal to or greater than the percent of time connected over the baseline time period. Therefore, the MTs for each RMS well shown in **Figure 3-7** and Table 3-12 are the same as those shown for MOs and shown in Table 3-11.

3.3.5.2 Relationship to Other Sustainability Indicators

The interim MTs established for ISW along the San Joaquin River will be evaluated independent of other sustainability indicators. The other sustainability indicator most closely related to ISW is chronic decline of groundwater levels as described in Section 3.3.1. However, the MTs for chronic groundwater level decline are based on potential impacts relative to wells going dry, whereas MTs for interconnected surface water are established in relation to maintaining a certain percentage of time with connection to the San Joaquin River. While it may be the case that the four RMS wells being assigned MTs for both chronic decline in groundwater levels and ISW may produce different conclusions regarding undesirable results when groundwater levels in these wells are at a certain elevation (e.g., UR for ISW but no UR for chronic groundwater level decline), the assignment of independent MTs for two different sustainability indicators at the same well will inform basin stakeholders if a conclusion that an undesirable result has occurred is related to chronic groundwater level declines (and therefore caused too many wells to go dry and impacting well users) vs. being related to interconnected surface water (and having potential impacts on surface water flows or GDEs).

3.3.5.3 Impact of Selected Minimum Thresholds to Adjacent Basins

Maintaining a similar percent of time connected for interconnected surface water along the San Joaquin River under sustainable groundwater conditions for Madera Subbasin is not expected to have any significant impacts on adjacent subbasins. However, if the percent of time connected increases significantly, whether it be through PMAs conducted by Madera Subbasins GSAs and/or due to other factors such as the SJRRP, it is possible that the downstream Delta-Mendota Subbasin may be affected by higher groundwater levels in the shallow zone.

3.3.5.4 Minimum Thresholds Impact on Beneficial Uses and Users

Interconnected surface water MTs may have effects on certain beneficial uses, users, land use, and property owners. Those with potential to be impacted include agricultural land use and users, ecological land use and users, and downstream surface water rights holders. Overall, agricultural land use and users will be impacted in terms of increased costs to design and construct recharge projects and in terms of reduced crop yields from required reductions in consumptive use for irrigation. Ecological beneficial users and downstream surface water rights holders are expected to benefit from implementation of MTs for interconnected surface water.

3.3.5.5 Comparison between Minimum Thresholds and Relevant State, Federal or Local Standards

There are no relevant state, federal, or local standards for comparison related to this sustainability criterion.

3.3.5.6 Minimum Thresholds Measurement Method

Interconnected surface water will be monitored on an annual basis by measuring groundwater levels at identified representative ISW RMS wells presented in Table 3-12 and **Figure 3-7**. The groundwater level monitoring will be conducted in accordance with the monitoring plan and protocols outlined in Section 3.5. Furthermore, the groundwater level monitoring will meet the requirements of the technical and reporting standards included in the SGMA regulations.

Table 3-12. Summary of Interconnected Surface Water Minimum Thresholds for Representative Monitoring Sites

Well I.D.	Surface Elevation	Well Depth	Screen Top-Bottom	Model Layer(s)	Aquifer Designation	MT[1]	GSA
MCE RMS-9	265.4	38	17-37	1	Upper	73%	Madera County East
MCW RMS-5	197.8	30	Unknown	1	Upper	30%	Madera County West
MID RMS-17	224.9	47	26-46	1	Upper	100%	Madera Irrigation District

[1] The MTs are established as the percent of time connected over the historical base period (1989 to 2015). For comparison to future five-year rolling average, baseline MTs may need to be updated to reflect climatic/hydrologic conditions represented in five-year rolling average.

3.3.6 Seawater Intrusion

The seawater intrusion sustainability criterion is not applicable to Madera Subbasin.

3.4 Undesirable Results *(23 CCR § 354.26)*

The regulations define undesirable results as occurring when significant and unreasonable effects are caused by groundwater conditions occurring throughout the Subbasin for a given sustainability indicator during the sustainability period. This section provides a description of undesirable results for the relevant sustainability indicators, including:

- Cause of groundwater conditions that would lead to undesirable results
- Criteria used to define undesirable results based on MTs
- Potential effects on the beneficial uses and users of groundwater, on land uses and property interests, and other potential effects that may occur or are occurring from undesirable results

A summary of criteria used to define undesirable results is provided below in Table 3-13 and detailed discussion of each sustainability indicator is provided in subsequent sections of this Chapter.

Table 3-13. Summary of MTs, MOs, and Undesirable Results.

Sustainability Indicator	Minimum Threshold	Measurable Objective	Undesirable Result (in 2040)
Chronic Lowering of Groundwater Levels	Set equal to the Fall 2015 measurement, if this observed data point is available at the RMS. Otherwise, set equal to the expected Fall 2015 groundwater level determined from MCSim results, with adjustment, if necessary, to account for the offset between historical observed and modeled data.	Set equal to the Fall 2010 measurement, if this observed data point is available at the RMS. Otherwise, set equal to the expected Fall 2010 groundwater level determined from MCSim results, with adjustment, if necessary, to account for the offset between historical observed and modeled data.	Same 30 percent of wells below minimum threshold for two consecutive fall measurements.
Reduction of Groundwater Storage	No long-term reduction in groundwater storage during the sustainability period after 2040 based on measured groundwater levels. (Groundwater levels used as a proxy.)	Same as MOs for chronic lowering of groundwater levels. (Groundwater levels used as a proxy.)	Same 30 percent of wells below minimum threshold for two consecutive fall measurements. (Groundwater levels used as a proxy.)
Land Subsidence	0 feet/year, subject to uncertainty of +/-0.16 feet/year	0 feet/year	Average subsidence across all RMS exceeding minimum threshold in an annual monitoring period.
Seawater Intrusion	Not Applicable	Not Applicable	Not Applicable
Degraded Water Quality	Nitrate = 10 mg/L or existing level plus 20% (whichever is greater) Arsenic = 10 µg/L or existing level plus 20% (whichever is greater) TDS = 500 mg/L or existing level plus 20% (whichever is greater)	Current constituent concentrations	10 percent of wells above the minimum threshold for the same constituent due to projects and/or management actions, based on average of most recent three year period
Depletion of Interconnected Surface Water	A percent of time surface water is connected to shallow groundwater that is equal to historical conditions for a similar climatic/hydrologic period.	A percent of time surface water is connected to shallow groundwater that is equal to historical conditions for a similar climatic/hydrologic period.	Greater than 30 percent of RMS wells below minimum threshold for two consecutive annual five-year rolling average annual evaluations

3.4.1 Chronic Lowering of Groundwater Levels

The cause of Subbasin groundwater conditions that would result in significant and unreasonable lowering of groundwater levels is excessive overall average annual groundwater pumping and other outflows from the Plan Area that continue to exceed average annual inflows. Locally defined significant and unreasonable conditions were determined based on discussion with GSA staff and technical

representatives, input received from interested stakeholders and the public through public meetings, and through individual stakeholder input to various GSA representatives. Significant and unreasonable lowering of groundwater levels are those conditions that: 1) Cause significant financial burden to local agricultural interests or other beneficial uses and users who rely on the Subbasin's groundwater resources, 2) Cause groundwater level conditions at private domestic wells that cannot be mitigated, and 3) Interfere with other sustainability indicators.

As described in Section 3.3.1, the Madera Subbasin GSAs have proceeded with coordination and development of a Domestic Well Mitigation Program, including the development of a draft MOU. As of March 2023, the GSAs are developing the Program eligibility criteria, terms, and conditions and are preparing to move forward with Program implementation, as needed.

The chronic lowering of groundwater levels undesirable result is a quantitative combination of groundwater elevation MT exceedances. A MT exceedance for a given RMS is two consecutive Fall measurements (assumed to be collected in October) that are both below the MT level. For the Joint GSP GSAs, a groundwater elevation undesirable result is defined to occur when greater than 30% of the representative monitoring sites each exceed the groundwater level MTs for the same two consecutive Fall readings.

The definition of undesirable results under SGMA provides flexibility in defining sustainability. Increasing the percentage of allowed MT exceedances provides more flexibility but may lead to significant and unreasonable conditions for a number of beneficial users. Reducing the percentage of allowed MTs exceedances ensures strict adherence to MTs but reduces flexibility due to due to uncertainty in characterizing hydrogeologic conditions and the uncertainty inherent in any analytical or numerical tool used for future predictions of water levels. The undesirable result for groundwater levels is defined as more than 30 percent of RMS exceeding their MTs for the same two consecutive Fall readings. The 30 percent criterion was selected to balance the interest of beneficial use with the practical aspect of groundwater management uncertainty. Given a total of 37 RMS sites, a total of 12 or more the initial RMS would need to exceed MTs as defined above to constitute an undesirable result for chronic lowering of groundwater levels. As the number of RMS evolves over time (e.g., adding nested monitoring well sites), the total number of RMS that have to exceed their MTs will change accordingly.

Conditions other than excessive regional basin-wide pumping (plus other outflows) greater than average annual inflows that may lead to an undesirable result include extensive and unanticipated drought. MTs were established based on historical groundwater levels and reasonable estimates of future groundwater levels (including a future drought longer than historic droughts). Extensive, unanticipated droughts (beyond that accounted for already, or earlier in the implementation period or sustainability period than assumed herein) may lead to excessively low groundwater levels and undesirable results.

3.4.2 Reduction in Groundwater Storage

The cause of Subbasin groundwater conditions that would result in significant and unreasonable reduction in groundwater storage is excessive overall groundwater pumping and other outflows from the Plan Area that exceed average annual inflows. Locally defined significant and unreasonable conditions were determined based on discussion with GSA staff and technical representatives, input received from interested stakeholders and the public through public meetings, and through individual stakeholder input to various GSA representatives. Significant and unreasonable reduction in groundwater storage occurs when there is: 1) Long term reduction in groundwater storage during the sustainability period (i.e., after 2040), or 2) Interference with other sustainability indicators.

Reduction of groundwater storage in the Plan Area has the potential to impact the beneficial uses and users of groundwater by limiting the volume of groundwater available for agriculture, municipal, industrial and domestic use. The undesirable results of reduction in groundwater storage are the same as those previously described for chronic lowering of groundwater levels. Continuing the current rate of loss of groundwater in storage could also impact other sustainability indicators such as groundwater quality. Reduction in groundwater storage is significant and unreasonable if its sufficient in magnitude to lower the rate of production in pre-existing groundwater wells below that needed to meet the minimum required to support overlying beneficial users and where means of obtaining sufficient groundwater or imported resources are not technically or financially feasible for the well owner to absorb, either independently or with assistance from the GSA or other available assistance (grants). As described in Section 3.3.1, the Madera Subbasin GSAs have proceeded with coordination and development of a Domestic Well Mitigation Program, including the development of a draft MOU. As of March 2023, the GSAs are developing the Program eligibility criteria, terms, and conditions and are preparing to move forward with Program implementation, as needed.

Conditions that may lead to an undesirable result for the reduction in groundwater storage sustainability indicator include extensive, unanticipated drought. Similar to groundwater levels, which act as a proxy for the groundwater storage sustainability indicator, MTs were established based on historical groundwater levels and reasonable estimates of future groundwater elevations that would occur with the GSP PMAs, and accounting for a future drought longer than historic droughts. Extensive, unanticipated droughts (beyond that accounted for already, or earlier in the implementation period or sustainability period than assumed herein) may lead to excessively low groundwater elevations and undesirable results.

The practical effect of the reduction in groundwater storage undesirable result is that it encourages no net change in average groundwater elevations and storage during average hydrologic conditions and over the long-term during the sustainability period. Therefore, during average hydrologic conditions and over the long-term, beneficial uses and users will have access to the same amount of groundwater in storage that exists in a subbasin with average inflows equal to average outflows, and the undesirable result will not have a negative effect on the beneficial users and uses of groundwater. Pumping at the long-term sustainable yield during dry years will temporarily lower groundwater elevations and reduce the amount of groundwater in storage. Groundwater storage would then be replenished during wet years. Therefore, Subbasin groundwater users can expect significant fluctuations in groundwater levels, but such fluctuations are expected to remain above the established MTs.

3.4.3 Land Subsidence

The cause of Subbasin groundwater conditions that would result in significant and unreasonable land subsidence is excessive overall average annual groundwater pumping and other outflows from the Plan Area that exceed average annual inflows and results in groundwater levels that decline to a level that, combined with clay layers having certain properties conducive to compaction, result in significant land subsidence. Locally defined significant and unreasonable conditions were determined based on discussion with GSA staff and technical representatives, input received from interested stakeholders and the public through public meetings, through individual stakeholder input to various GSA representatives, and in meetings with technical representatives from all GSAs in Madera Subbasin. Significant and unreasonable land subsidence results in significant impacts to infrastructure. A survey of critical infrastructure in Madera Subbasin was conducted and is provided in **Appendix 3.G**.

Conditions that may lead to an undesirable result of a significant and unreasonable amount for land subsidence have historically occurred during periods with groundwater pumping in excess of sustainable

yield in areas where critical infrastructure exists. This is of particular concern in the Lower Aquifer where the Corcoran Clay exists. Conditions that may lead to an undesirable result include the following:

- Localized pumping. Even if regional pumping is maintained within the sustainable yield, cluster (or pumping centers) of high capacity wells pumping below the Corcoran Clay may cause excessive localized drawdowns that lead to undesirable results in specific areas
- Extensive, unanticipated drought. Extensive, unanticipated droughts may lead to excessively low groundwater elevations and subsidence.

3.4.4 Degraded Water Quality

The cause of Subbasin groundwater conditions that would result in significant and unreasonable degraded water quality is implementation of a GSP project or management action that causes levels of key groundwater quality constituents to increase to concentrations exceeding the MCLs for drinking water. Municipal and domestic supply (MUN) is a designated beneficial use for groundwater in the Plan Area; therefore, groundwater quality degradation is considered significant and unreasonable based on adverse impacts to this beneficial use. Locally defined significant and unreasonable conditions were determined based on discussion with GSA staff and technical representatives, input received from interested stakeholders and the public through public meetings, and through individual stakeholder input to various GSA representatives. Significant and unreasonable degradation of water quality occurs when beneficial uses for groundwater are adversely impacted by constituent concentrations increasing to levels above the drinking water MCLs for one of the key constituents of interest previously identified in **Section 2** of the GSP (nitrate, arsenic, TDS) at indicator wells in the representative groundwater quality monitoring network due to implementation of a GSP project or management action. One of the most notable groundwater quality constituents of concern in the Plan Area is nitrate and distributed areas of elevated nitrate concentrations in groundwater occur within the Plan Area as a result of historic activities. Exacerbating existing nitrate concentrations in groundwater quality and ongoing (current and future) increasing trends in nitrate concentrations related to continued impacts from these historic land use activities is an important consideration in the implementation of GSP PMAs. There are no known significant and large-scale groundwater quality contamination plumes (i.e., point-source contaminant site plumes) in the regional aquifers within the Plan Area; therefore, exacerbating plume migration or impacting the ability to contain localized contamination plumes is not a significant concern for GSP PMAs, but will also be considered in GSP implementation.

Degraded water quality is significant and unreasonable if the magnitude of degradation precludes the use of groundwater for existing beneficial use(s). Therefore, an undesirable result for degraded groundwater quality occurs when groundwater quality exceeds an established MCL and MT for arsenic, nitrate, or TDS for a significant duration of time and at a significant number of representative monitoring sites and is the direct result of projects or management actions undertaken as part of the GSP implementation. An exceedance of a MT at a given representative monitoring site is defined based on the average concentration for a given key constituent over a three-year monitoring period. An undesirable result for degraded groundwater quality is greater than 10 percent of representative groundwater quality monitoring wells exceeding a MT for a given constituent related to GSP actions.

Notable conditions that may lead to an undesirable result for degraded groundwater quality sustainability indicator include the following:

- Localized Pumping - Even if regional pumping is maintained within the sustainable yield, clustered areas (or pumping centers) of high capacity wells may cause excessive localized drawdowns that

lead to undesirable results related to groundwater quality in specific areas, especially areas prone to elevated arsenic concentrations occurring at greater pumping water level depths. While an undesirable result for groundwater quality degradation would require 10 percent of RMS to have exceedances, the Domestic Well Mitigation Program would likely address eligible wells that go from arsenic below the MCL to arsenic exceeding the MCL due to groundwater level declines during GSP implementation.

- Enhanced Groundwater Recharge - Active recharging of groundwater through use of recharge basins or Flood-MAR activities could cause localized mounding of groundwater near recharge sites resulting in altered flow directions and potentially movement of chemical constituents towards wells in concentrations that exceed relevant water quality standards. Enhanced groundwater recharge activities may also impact groundwater quality by leaching of constituents from the unsaturated zone and into groundwater. This mechanism may be of particular importance when considering enhanced groundwater recharge on actively or formerly cultivated lands where high residual concentrations of nutrients, especially nitrogen, may exist in the unsaturated zone and may be susceptible to leaching into the groundwater resulting in degraded groundwater quality conditions. Water of poor quality characteristics should not be used for enhanced recharge activities. Altered chemical conditions from enhanced recharge projects could also lead to changes in groundwater chemistry.

3.4.5 Depletion of Surface Water

The occurrence of shallow groundwater levels during certain time periods along the San Joaquin River at the southern boundary of the Madera Subbasin, combined with extensive data gaps related to hydrogeologic conditions affecting characterization of interconnected surface water in this area, require that interim SMC be established pending further data collection and studies. The SMC for interconnected surface water along the San Joaquin River are based on a metric for the percent of time shallow groundwater levels are connected to the San Joaquin River (i.e., groundwater elevations at RMS wells are at/above stream thalweg elevations). An undesirable is defined as greater than 30 percent of RMS wells exceeding their MTs for two consecutive five-year rolling averages (e.g., two of the current 4 RMS wells).

Current evidence is unclear regarding the effect of groundwater pumping from the regional aquifer on San Joaquin River flows in the Subbasin. However, the shallow groundwater system underlying the portion of the San Joaquin River that supports the San Joaquin River Riparian potential GDE Unit does have at least the potential to be affected by regional groundwater pumping (because some roots may extend below the thalweg of the San Joaquin River). Therefore, hydrologic and biological GDE monitoring are incorporated as discussed elsewhere in this chapter. Characteristics of the hydrogeology in the Friant Riparian potential GDE unit suggests a low likelihood that groundwater pumping in the regional aquifer would affect river surface flows or the shallow groundwater associated with this GDE unit. Likewise, the hydrogeology in the area of the Sumner Hill potential GDE Unit suggests that pumping in the regional aquifer is unlikely to affect surface water or shallow groundwater in the unit. Accordingly, monitoring of these two potential GDE units will be focused on biological GDE monitoring. Seawater Intrusion

The seawater intrusion sustainability criterion is not applicable to this Subbasin.

3.5 Monitoring Network

This section describes the monitoring network and includes the following subsections:

- Description of Monitoring Network
- Monitoring Protocols for Data Collection and Monitoring

- Representative Monitoring
- Assessment and Improvement of Monitoring Network

3.5.1 Description of Monitoring Network *(23 CCR § 354.34)*

This subsection on the monitoring network is intended to:

- Describe how the monitoring network is capable of collecting sufficient data about groundwater conditions to evaluate GSP implementation
- Describe monitoring network objectives
- Describe how monitoring network demonstrates progress towards achieving MOs, monitors impacts to beneficial uses/users, monitors changes in groundwater conditions, and quantifies annual changes in water budget components
- Describe how monitoring network allows documentation of groundwater occurrence, flow, and hydraulic gradients, calculation of annual groundwater storage change, rate and extent of subsidence, and groundwater quality trends
- Describe how monitoring network provides adequate coverage of sustainability indicators
- Describe monitoring network density and measurement frequency
- Describe monitoring network site selection rationale
- Describe data and reporting standards
- Provide map(s) with location and types of monitoring sites

The GSP groundwater level monitoring network was initially developed using existing wells in the Plan Area, and will be supplemented (and/or some initial wells replaced) by new nested monitoring wells installed by 2020. The database for existing wells was reviewed with the following criteria in mind:

- CASGEM wells preferred;
- Known construction (screen intervals, depth) preferred;
- Long histories of water level data (including recent data) preferred;
- Relatively good match between observed and modeled water levels preferred;
- Good spatial distribution preferred;
- Representation of both Upper (where present in western portion of Plan Area) and Lower Aquifers preferred.

To the extent possible, the network was composed of wells known to represent either the Upper or Lower Aquifer, but not screened in both. However, this was not always possible due to need to consider all the criteria above. Matching of modeled to observed data was used to some extent to initially assign wells with unknown construction details to a given aquifer. The network will enable the collection of data to assess sustainability indicators, the effectiveness of management actions and projects to achieve sustainability, and evaluate the MOs and MTs of each applicable sustainability indicator (i.e., chronic lowering of groundwater levels, reduction in groundwater storage, and degraded water quality). The Subbasin is isolated from the Pacific Ocean and is not threatened by seawater intrusion; therefore, this Joint GSP does not provide monitoring for the seawater intrusion sustainability indicator. For depletion of interconnected surface waters, available data indicate that streams in the Plan Area do not have direct connections to the regional groundwater system; therefore, this Joint GSP does not provide monitoring for the surface water depletion sustainability indicator.

As described above, for the purposes of the GSP monitoring program, a subset of existing wells was identified that best meet certain criteria. Not all the criteria were satisfied for each well, but this effort resulted in 37 wells to represent the Plan Area, with 11 wells in the Upper Aquifer and 22 wells in the

Lower Aquifer, and 4 composite wells – referred to as the representative monitoring sites. Due to incomplete well construction information for some of these wells, the portion of the aquifer being monitored could not be determined with certainty for all wells, but was initially classified based on match to model results where construction data is unknown.

These wells are distributed throughout the Plan Area to provide coverage of the entire area to the extent possible. This initial coverage generally allows for the collection of data to evaluate groundwater gradients and flow directions over time and the annual change in storage over most of the Plan Area for the Lower Aquifer. The spatial coverage for the Upper Aquifer is currently limited to the southwestern portion of the Plan Area due to availability of existing wells and the general lack of Upper Aquifer saturation in the eastern portion of the Plan Area (installation of nested monitoring wells by 2020 is expected to expand the area of coverage for the Upper Aquifer). Furthermore, the monitoring frequency of the representative monitoring sites will allow for the monitoring of seasonal highs and lows. For wells that have relatively long historical data records, future groundwater data will be able to be compared to historical data. The monitoring network is expected to evolve over time as new wells are drilled and water level data histories are developed (included DWR grant funded nested monitoring wells to be installed by 2020). The monitoring network will be periodically reviewed and improvements made where possible.

3.5.1.1 Groundwater Level Monitoring Program

The MTs and MOs for the chronic lowering of groundwater levels sustainability indicator are evaluated by monitoring groundwater levels. The SGMA regulations require a network of monitoring wells sufficient to demonstrate groundwater occurrence, flow direction and hydraulic gradients between principal aquifers and surface water features. The overall proposed monitoring network for groundwater levels, comprised of wells monitored for CASGEM, by GSAs, and by USBR is provided in **Appendices 3.A and 3.J**.

The objectives of the groundwater level monitoring program include the following:

- Improve the understanding of the occurrence and movement of groundwater; monitor local and regional groundwater levels including seasonal and long-term trends; and identify vertical hydraulic head differences in the aquifer system and aquifer-specific groundwater conditions, especially in areas where short- and long-term development of groundwater resources are planned;
- Detect the occurrence of, and factors attributable to, natural (e.g., direct infiltration of precipitation), irrigation, and surface water seepage to groundwater or recharge PMAs (recharge basins, Flood MAR) that affect groundwater levels and trends;
- Establish a monitoring network to aid in the assessment of changes in groundwater storage; and
- Generate data to better estimate groundwater Subbasin conditions and assess local current and future water supply availability and reliability; update analyses as additional data become available.

A map of the Plan Area showing the overall groundwater level monitoring network is provided in **Appendix 3.J**, along with a table listing each well. **Figures 3-8** and **3-9** illustrate the locations of the wells selected as representative monitoring sites for monitoring of groundwater levels in the Upper and Lower Aquifers, respectively (composite wells are included in **Figure 3-1**). Tables 3-14 and 3-15 list the well identification, location, monitoring frequency, well construction data, and measurement years, and number of measurements for the Upper and Lower Aquifer, respectively. Similar information for composite wells is provided in Table 3-16.

In order to assist GSAs with the preparation of their GSP's, DWR released a series of best management practices. The best management practices document for monitoring networks provides guidance on

determining an appropriate number of monitoring wells for a given area. The method developed by Hopkins (1984) was applied to the Plan Area. This methodology states that for districts pumping more than 10,000 ac-ft/yr per 100 square miles, they should have four monitoring wells for every 100 square miles. The Madera Subbasin area occupies an area of approximately 543 square miles, yielding 22 monitoring wells. Subtracting the areas of the three GSAs not included in this Joint GSP yields an area of approximately 509 square miles and minimum of 20 monitoring wells. This number was taken to be the minimum number of monitoring wells for the Plan Area and additional wells were added based on informational needs resulting from management actions and historical trends in groundwater levels. This Joint GSP includes 37 existing RMS with a potential for future addition of up to 21 monitoring wells from the 2019 nested well installation program. The selection rationale for all water level monitoring wells is summarized in Tables 3-14 through 3-16.

3.5.1.2 Reduction in Groundwater Storage Monitoring Program

The objectives of the monitoring program to calculate changes in groundwater storage include the following:

- Improve the understanding of the occurrence of groundwater; monitor Upper and Lower Aquifer groundwater levels including seasonal and long-term trends in the aquifer system to calculate changes in groundwater storage on an annual basis and in areas where management actions and projects are planned;

Because changes in groundwater storage are directly dependent on changes in groundwater levels, this Joint GSP adopts groundwater levels as a proxy for assessing change in storage, as described previously in this section. The wells selected for monitoring changes in groundwater storage will be the same wells used for groundwater level monitoring. **Figures 3-8** and **3-9** illustrate the locations of the wells selected for monitoring of groundwater levels for the Upper and Lower Aquifers, respectively. Tables 3-14 and 3-15 list the well identification, location, monitoring frequency, well construction data, and measurement years, and number of measurements for the Upper and Lower Aquifer wells, respectively. Because the same wells for water level monitoring are being used for groundwater storage monitoring, the selection process and rationale for selection is also the same (Tables 3-13 and 3-14).

3.5.1.3 Land Subsidence Monitoring Program

The sustainability management criteria for the land subsidence sustainability indicator will be evaluated by monitoring land subsidence.

The objectives of the monitoring program to calculate changes in land subsidence include the following:

- Monitor vertical displacement of the land surface to improve the understanding of the potential occurrence of land subsidence.

The proposed monitoring network, shown in **Figure 3-10**, is comprised of all benchmark survey points monitored by the United States Bureau of Reclamation (USBR) as part of the SJRRP and local continuous GPS stations monitored by UNAVCO as part of the Plate Boundary Observatory (PBO) Project. Additional monitoring stations located outside of the Subbasin are included in the network to provide regional context. The control points selected for inclusion in the monitoring network are currently monitored for other purposes. As a result, control points may be added or removed from the monitoring network as they are added or removed from the various programs currently maintaining these networks.

Table 3-14. Summary of Upper Aquifer Groundwater Level Monitoring Network Wells

Well I.D.	Latitude	Longitude	Frequency	First Year Data	Last Year Data	Years Measured	Number Measurements	Selection Rationale
MCW RMS-2	36.8980	-120.2918	Spring/Fall	1976	2019	43	74	CASGEM well; known well construction; long history of WL data; spatial/vertical distribution
MCW RMS-3	36.8943	-120.3285	Spring/Fall	2012	2019	7	9	CASGEM voluntary well; spatial/vertical distribution
MID RMS-9	36.9093	-120.2010	Spring	2012	2014	2	3	CASGEM voluntary well; known well depth; spatial/vertical distribution
MID RMS-11	36.8946	-120.1107	Spring*	1962	2014	52	86	CASGEM well; long history of WL data; spatial/vertical distribution
MID RMS-12	36.9149	-120.0385	Spring	2012	2014	2	3	CASGEM well; known well depth; spatial/vertical distribution
MID RMS-14	36.8232	-120.1421	Spring/Fall	1936	2014	78	140	CASGEM well; long history of WL data; spatial/vertical distribution
MID RMS-15	36.8541	-120.0561	Spring/Fall	2015	2019	4	7	CASGEM well; known well construction; spatial/vertical distribution
MCE RMS-8	37.0646	-119.9138	Spring/Fall	1958	2015	57	100	CASGEM well, known well construction; long history of WL data; spatial/vertical distribution; GDE monitoring
MCE RMS-9	36.8780	-119.7899	Weekly	2016	2018	2	208	SJRRP well, known well construction; spatial/vertical distribution; GDE monitoring
MID RMS-17	36.8235	-120.0565	Weekly	2016	2018	2	194	SJRRP well, known well construction; spatial/vertical distribution; GDE monitoring
MCW RMS-5	36.7991	-120.1592	Weekly	2016	2018	2	144	SJRRP well, known well depth; spatial/vertical distribution; GDE monitoring

*Fall measurements are sporadic in recent years

Table 3-15. Summary of Lower Aquifer Groundwater Level Monitoring Network Wells

Well I.D.	Latitude	Longitude	Frequency	First Year Data	Last Year Data	Years Measured	Number Measurements	Selection Rationale
MID RMS-1	37.1052	-120.0791	Spring/Fall	2015	2019	4	8	CASGEM well; known well construction; spatial/vertical distribution
MID RMS-2	37.0406	-120.2342	Spring/Fall	2015	2019	4	8	CASGEM well; known well construction; spatial/vertical distribution
MID-RMS-3	37.0366	-120.1760	Spring/Fall	1954	2019	65	110	CASGEM well; known well construction; long history of WL data; spatial/vertical distribution
MCW RMS-1	36.9455	-120.3188	Spring/Fall	2015	2019	4	7	CASGEM well; known well depth; spatial/vertical distribution
MID RMS-4	36.9709	-120.2568	Spring/Fall	2015	2019	4	5	CASGEM well; known well construction; spatial/vertical distribution
MID RMS-5	36.9582	-120.2110	Spring*	1958	2014	56	94	CASGEM well; known well construction; long history of WL data; spatial/vertical distribution
MID RMS-6	37.0033	-120.1561	Spring/Fall	2015	2019	4	5	CASGEM well; known well construction; spatial/vertical distribution
MID RMS-7	36.9246	-120.1291	Spring	2012	2014	2	3	CASGEM well; known well construction; spatial/vertical distribution
MCE RMS-1	37.0001	-119.9856	Spring/Fall	2015	2019	4	8	CASGEM Voluntary well; known well construction; spatial/vertical distribution
MCE RMS-4	36.9396	-119.7843	Spring/Fall	1964	2019	55	82	CASGEM Voluntary well; long history of water level data; spatial/vertical distribution
MID RMS-10	36.8996	-120.1742	Spring/Fall	2015	2019	4	5	CASGEM well; known well construction; spatial/vertical distribution
MCW RMS-4	36.8550	-120.1649	Spring/Fall	2015	2019	4	5	CASGEM well; known well construction; spatial/vertical distribution
MCE RMS-5	36.9082	-119.8641	Spring/Fall	1978	2019	41	65	CASGEM Voluntary well; long history of water level data; spatial/vertical distribution
COM RMS-1	36.9708	-120.0513	Spring/Fall	1983	2016	33	29	Known well construction; long history of water level data; spatial/vertical distribution
COM RMS-2	36.9670	-120.0898	Spring*	1996	2016	20	19	Known well construction; long history of water level data; spatial/vertical distribution
COM RMS-3	36.9303	-120.0440	Spring/Fall	2006	2016	10	14	Known well construction; long history of water level data; spatial/vertical distribution
MWD RMS-1	37.0472	-120.0248	Spring/Fall	2011	2019	4	8	CASGEM well; known well construction; spatial/vertical distribution
MWD RMS-2	37.0436	-120.0610	Spring/Fall	2011	2019	4	8	CASGEM well; known well construction; spatial/vertical distribution
MWD RMS-3	37.0436	-120.0697	Spring/Fall	2011	2019	4	8	CASGEM well; known well construction; spatial/vertical distribution
MCE RMS-6	36.9337	-119.9080	Spring/Fall	2015	2019	4	7	CASGEM well; known well construction; spatial/vertical distribution
MID RMS-16	36.0196	-120.0526	Spring/Fall	2011	2019	8	14	CASGEM well; known well construction; spatial/vertical distribution
MCE RMS-7	36.9087	-119.8012	Spring/Fall	2015	2018	3	6	CASGEM well; known well construction; spatial/vertical distribution

*Fall measurements are sporadic in recent years

Table 3-16. Summary of Composite Groundwater Level Monitoring Network Wells

Well I.D.	Latitude	Longitude	Frequency	First Year Data	Last Year Data	Years Measured	Number Measurements	Selection Rationale
MID RMS-8	36.9480	-119.9938	Spring/Fall	1960	2011	51	84	CASGEM well; long history of WL data; spatial/vertical distribution
MCE RMS-2	36.9852	-119.8799	Spring/Fall	1979	2019	40	62	CASGEM voluntary well; long history of WL data; spatial/vertical distribution
MCE RMS-3	36.9552	-119.9441	Spring/Fall	1964	2011	47	79	CASGEM voluntary well; long history of WL data; spatial/vertical distribution
MID RMS-13	36.9003	-119.9879	Spring/Fall	2015	2019	4	5	CASGEM well; known well construction; spatial/vertical distribution

3.5.1.4 Groundwater Quality Monitoring Program

The sustainability indicator for degraded water quality is evaluated by monitoring groundwater quality at a network of wells.

The objectives of the groundwater quality monitoring program for the Plan Area include the following

The objectives of the groundwater quality monitoring program for the Plan Area include the following as they relate to the implementation of GSP PMAs:

- Evaluate groundwater quality conditions in the various areas of the Subbasin, and identify differences in water quality spatially between areas and vertically in the aquifer system;
- Detect the occurrence of and factors attributable to key constituents of interest as represented by nitrate, arsenic, and TDS;
- Assess the changes and trends in groundwater quality; and
- Identify the natural and human factors that affect changes in water quality.

For the purpose of monitoring groundwater quality conditions and potential impacts from GSP PMAs, a network of representative monitoring sites selected from among existing and proposed future wells located throughout the Joint GSP GSAs and screened in both in the Upper and Lower Aquifers. The representative monitoring sites for groundwater quality include a combination of irrigation, public supply, domestic, and monitoring wells to be sampled and analyzed by the Joint GSP GSAs together with wells that are sampled by others as part of other groundwater quality monitoring programs. The selected RMS for groundwater quality are listed in Table 3-11 and shown on **Figure 3-3**. Information on well construction and historical groundwater quality monitoring for each of the indicator wells is included in **Appendix 3.B**.

The network of groundwater quality representative monitoring sites includes 12 existing wells that are also part of the water level monitoring indicator well network and will also be sampled for groundwater quality by the Joint GSP GSAs. Additionally, seven future nested monitoring well sites are in the process of being constructed in the Joint GSP GSAs and each of the three individual monitoring wells at each site will be sampled for groundwater quality by the Joint GSP GSAs. Ongoing groundwater quality monitoring being conducted by other entities for the State Water Resources Control Board (SWRCB) Division of Drinking Water (DDW) program of 13 selected public supply wells will also be incorporated into the representative groundwater quality monitoring in the Plan Area. Available results from groundwater quality sampling conducted by the monitoring entities for these public supply wells will be acquired and incorporated into the ongoing evaluation of groundwater quality monitoring as part of implementing the GSP. Monitoring and assessment of groundwater quality is also being conducted for the Irrigated Lands Regulatory Program (ILRP), currently including sampling of two domestic wells and future incorporation of the new monitoring wells described above as part of the Groundwater Quality Trend Monitoring program for the East San Joaquin Water Quality Coalition. The two current domestic wells will also be included in the representative groundwater quality monitoring network. As details of GSP PMAs are refined, the groundwater quality monitoring network will be reviewed and modified if needed to ensure that the network is sufficient to achieve the objective of monitoring for groundwater quality impacts caused by GSP PMAs.

In addition to the regular monitoring of groundwater quality using the selected sustainability indicator wells, ongoing assessment of groundwater quality conditions for the ILRP is also occurring and involves annual sampling of a regional network of relatively shallow wells, evaluation of trends in groundwater quality related to irrigated agricultural practices, and also includes additional compilation and analysis of

groundwater quality trends and conditions at five-year intervals based on readily available public data. Under the ILRP Waste Discharge Requirements for the East San Joaquin Water Quality Coalition (Coalition), growers in the Plan Area also must sample and report groundwater quality domestic wells on parcels enrolled in the Coalition. Data and reports on groundwater quality conditions developed through the ILRP will be considered and evaluated as part of assessing the groundwater quality sustainability indicator and relationships with GSP PMAs. Additionally, many more public water supply wells exist with recent groundwater quality monitoring for the three key constituents of interest. Some of these wells are incorporated as part of the representative groundwater quality monitoring network; however, data for other wells will also be considered in evaluating any potential groundwater quality impacts from GSP PMAs.

Groundwater quality impacts from activities unrelated to specific GSP PMAs are under the purview of separate regulatory programs including the ILRP or other regulatory programs overseeing waste discharges to groundwater and groundwater contamination sites.

3.5.1.5 Interconnected Surface Water Monitoring Program

The sustainability indicator for interconnected surface water is evaluated by monitoring groundwater levels at a network of wells screened in the Upper Aquifer near the San Joaquin River. Streamflow data from gaging stations is also collected and will be used in future studies and evaluations of interconnected surface water.

The objectives of the groundwater level and streamflow monitoring programs related to interconnected surface water include the following:

- Improve the understanding of the occurrence and movement of shallow groundwater; monitor groundwater levels relative to the nearby stream thalweg to evaluate the percent of time groundwater levels are above vs. below the thalweg;
- Track and improve understanding of streamflows, including seasonal and year to year variability, and potential changes to the hydrologic regime related to the San Joaquin River Restoration Program;
- Detect the occurrence of, and factors attributable to surface water seepage to groundwater in the San Joaquin River where it forms the southern boundary of Madera Subbasin; and
- Generate data to better estimate groundwater basin conditions related to interconnected surface water; update analyses as additional data become available.

For the purpose of monitoring interconnected surface water conditions and potential impacts from GSP PMAs and groundwater pumping, a network of representative monitoring sites was selected from among existing RMS wells screened in the Upper Aquifer and located near the San Joaquin River. The representative monitoring sites for interconnected surface water include a combination of irrigation and monitoring wells to be monitored by the Subbasin GSAs. The selected RMS for interconnected surface water are listed in Table 3-12 and shown on **Figure 3-4**. Information on well construction and historical groundwater levels for each of the indicator wells is included in **Appendix 3.A**.

3.5.2 Monitoring Protocols for Data Collection and Monitoring *(23 CCR § 352.2)*

This section is intended to provide a description of technical standards, methods, and procedures/protocols to ensure comparable data and methodologies for data collection and monitoring. All field monitoring activities will follow established Standard Operating Procedures (SOPs) for the Plan Area, which will be developed to reflect the standards, methods, and procedures described below.

3.5.2.1 Groundwater Level Monitoring Program

The protocols for measuring groundwater levels include the following:

- Measure depth to water in the well using procedures appropriate for the measuring device. Equipment must be operated and maintained in accordance with manufacturer's instructions. Groundwater levels should be measured to the nearest 0.01 foot (or at least to the nearest 0.1 foot at a minimum) relative to the Reference Point (RP). Measurements and RPs should not be recorded in feet and inches.
- For measuring wells that are under pressure, allow a period of time for the groundwater levels to stabilize. In these cases, multiple measurements should be collected to ensure the well has reached equilibrium such that no significant changes in water level are observed. Every effort should be made to ensure that a representative stable depth to groundwater is recorded. If a well does not stabilize, the quality of the value should be appropriately qualified as a questionable measurement. In the event that a well is artesian, site specific procedures should be developed to collect accurate information and be protective of safety conditions associated with a pressurized well. In many cases, an extension pipe may be adequate to stabilize head in the well. Record the dimension of the extension and document measurements and configuration.
- The groundwater elevation should be calculated using the following equation.

  GWE= RPE−DTW

  Where:

  GWE = Groundwater Elevation in NAVD88 datum

  RPE = Reference Point Elevation in NAVD88 datum

  DTW = Depth to Water
- The well caps or plugs should be secured following depth to water measurement.
- Groundwater level measurements are to be made on a semi-annual basis at a minimum during periods which will capture seasonal highs and lows.
- The sampler should record the well identifier, date, time (24-hour format), RPE, height of RP above or below ground surface, DTW, GWE, and comments regarding any factors that may influence the depth to water readings such as weather, oil in the well, nearby irrigation, flooding, or well condition. Of particular concern may be pumping of nearby irrigation wells or time since pumping stopped in the well being monitored; such conditions should be specifically identified and noted to the extent possible. If there is a questionable measurement or the measurement cannot be obtained, it should be noted. Standardized field forms will be used for all data collection.
- The sampler should have a record of previous measurements in the field for each well to compare with the current measurements being recorded. If a current measurement appears anomalous compared to previous measurements it should be checked again and verified.
- All data should be entered into the GSP data management system (DMS) as soon as possible. Care should be taken to avoid data entry mistakes and the entries should be checked by a second person.

3.5.2.2 Installing Pressure Transducers and Downloading Data

The following procedures will be followed in the installation of a pressure transducer and periodic data downloads

- The sampler must use an electronic sounder or chalked steel tape and follow the protocols listed above to measure the groundwater level and calculate the groundwater elevation in the

monitoring well to properly program and reference the installation. It is recommended that transducers record measured groundwater level to conserve data capacity; groundwater elevations can be calculated at a later time after downloading.

- The sampler must note the well identifier, the associated transducer serial number, transducer range, transducer accuracy, and cable serial number.
- Transducers must be able to record groundwater levels with an accuracy of at least 0.1 foot. Professional judgment will be exercised to ensure that the data being collected is meeting the data quality objectives (DQO) and that the instrument is capable of meeting DQO. Consideration of the battery life, data storage capacity, range of groundwater level fluctuations, and natural pressure drift of the transducers should be included in the evaluation.
- The sampler must note whether the pressure transducer uses a vented or non-vented cable for barometric compensation. Non-vented units are preferred (generally less expensive, require less maintenance than vented units, and are less prone to failure) and provide accurate data if properly corrected for natural barometric pressure changes. This requires the consistent logging of barometric pressures to coincide with measurement intervals.
- Follow manufacturer specifications for installation, calibration, data logging intervals, battery life, correction procedure (if non-vented cables used), and anticipated life expectancy to assure that DQOs are being met for the GSP.
- Secure the cable to the well head with a well dock or another reliable method. Mark the cable at the elevation of the reference point with tape or an indelible marker. This will allow estimates of future cable slippage.
- The transducer data should be periodically checked against hand measured groundwater levels to monitor electronic drift or cable movement. This should happen during routine site visits, at least annually to maintain data integrity.
- The data should be downloaded as necessary to ensure no data is lost and entered into the Subbasin's DMS following the QA/QC program established for the GSP. Data collected with non-vented data logger cables should be corrected for atmospheric barometric pressure changes, as appropriate. After the sampler is confident that the transducer data have been safely downloaded and stored, the data should be deleted from the data logger to ensure that adequate data logger memory remains.

3.5.2.3 Groundwater Storage Reduction Monitoring Program

The monitoring protocols for evaluating change in groundwater storage are the same as the protocols described above for groundwater levels.

3.5.2.4 Land Subsidence Monitoring Program

Subsidence monitoring will include the following protocols:

- Download and review subsidence data collected by the USGS, DWR, the SJRRP, and other entities. This data will be input into the DMS following QA/QC.
- Groundwater level data collected as part of the subsidence monitoring program will follow the same protocols as described above for groundwater level monitoring.

3.5.2.5 Groundwater Quality Monitoring Program

Annual monitoring of groundwater quality will include sampling and laboratory analysis of key parameters of interest as indicated on Table 3-17 to be conducted by GSAs as presented in Tables 3-5, 3-6, and 3-11. Additional groundwater quality results reported by monitoring entities to DDW (in accordance with DDW testing requirements) for indicator public supply wells (and also wells monitored for the IRLP) will be

obtained for evaluation as part of the groundwater quality monitoring program, although the sampling of these wells will not necessarily be performed by the GSAs. Water quality parameters may be added to the groundwater quality monitoring program in the future, if appropriate. During sampling events conducted by the GSAs, measurement of select water quality parameters will take place in the field. These field parameters should be measured at an annual frequency and include specific conductance at 25 °C (SC) in µS/cm, pH, temperature (in °C), oxidation-reduction potential (ORP) in millivolts, and dissolved oxygen (DO) in mg/L. The annual testing is summarized in Table 3-17.

3.5.2.6 Interconnected Surface Water Monitoring Program

The protocols for measuring groundwater levels are described above in Section 3.5.2.1. Streamflow monitoring protocols would be addressed by the various agencies monitoring streamflow in the Subbasin.

Table 3-17. Summary of Groundwater Quality Monitoring Constituents and Measurement Frequency for Representative Monitoring Sites

Well ID	Responsible Monitoring Entity	Well Type	Field Measurements					Laboratory Measurements										
			Specific Conductance	pH	Dissolved Oxygen	ORP	Temperature	Nitrate (as nitrogen)	Arsenic	Total dissolved solids (TDS)	Carbonate	Bicarbonate	Chloride	Sulfate	Calcium	Sodium	Magnesium	Potassium
Wells Monitored by GSP Entities: Existing																		
MCW RMS-1	GSP Entities	Other	Annual	Annual	Annual	Annual	Annual	Annual	Annual	Annual	Five-Year	Five-Year	Five-Year	Five-Year	Five-Year	Five-Year	Five-Year	Five-Year
MID RMS-4	GSP Entities	Irrigation	Annual	Annual	Annual	Annual	Annual	Annual	Annual	Annual	Five-Year	Five-Year	Five-Year	Five-Year	Five-Year	Five-Year	Five-Year	Five-Year
MID RMS-5	GSP Entities	Irrigation	Annual	Annual	Annual	Annual	Annual	Annual	Annual	Annual	Five-Year	Five-Year	Five-Year	Five-Year	Five-Year	Five-Year	Five-Year	Five-Year
MID RMS-6	GSP Entities	Irrigation	Annual	Annual	Annual	Annual	Annual	Annual	Annual	Annual	Five-Year	Five-Year	Five-Year	Five-Year	Five-Year	Five-Year	Five-Year	Five-Year
MID RMS-7	GSP Entities	Irrigation	Annual	Annual	Annual	Annual	Annual	Annual	Annual	Annual	Five-Year	Five-Year	Five-Year	Five-Year	Five-Year	Five-Year	Five-Year	Five-Year
MCE RMS-1	GSP Entities	Other	Annual	Annual	Annual	Annual	Annual	Annual	Annual	Annual	Five-Year	Five-Year	Five-Year	Five-Year	Five-Year	Five-Year	Five-Year	Five-Year
MCE RMS-3	GSP Entities	Unknown	Annual	Annual	Annual	Annual	Annual	Annual	Annual	Annual	Five-Year	Five-Year	Five-Year	Five-Year	Five-Year	Five-Year	Five-Year	Five-Year
MCW RMS-2	GSP Entities	Irrigation	Annual	Annual	Annual	Annual	Annual	Annual	Annual	Annual	Five-Year	Five-Year	Five-Year	Five-Year	Five-Year	Five-Year	Five-Year	Five-Year
MID RMS-9	GSP Entities	Unknown	Annual	Annual	Annual	Annual	Annual	Annual	Annual	Annual	Five-Year	Five-Year	Five-Year	Five-Year	Five-Year	Five-Year	Five-Year	Five-Year
MCW RMS-4	GSP Entities	Irrigation	Annual	Annual	Annual	Annual	Annual	Annual	Annual	Annual	Five-Year	Five-Year	Five-Year	Five-Year	Five-Year	Five-Year	Five-Year	Five-Year
MID RMS-13	GSP Entities	Irrigation	Annual	Annual	Annual	Annual	Annual	Annual	Annual	Annual	Five-Year	Five-Year	Five-Year	Five-Year	Five-Year	Five-Year	Five-Year	Five-Year
MWD RMS-1	GSP Entities	Unknown	Annual	Annual	Annual	Annual	Annual	Annual	Annual	Annual	Five-Year	Five-Year	Five-Year	Five-Year	Five-Year	Five-Year	Five-Year	Five-Year
Wells Monitored by GSP Entities: Future Monitoring Wells																		
Lavina MW - Shallow	ILRP/GSP Entities	Monitoring	Annual	Annual	Annual	Annual	Annual	Annual	Annual	Annual	Five-Year	Five-Year	Five-Year	Five-Year	Five-Year	Five-Year	Five-Year	Five-Year
Lavina MW - Middle	GSP Entities	Monitoring	Annual	Annual	Annual	Annual	Annual	Annual	Annual	Annual	Five-Year	Five-Year	Five-Year	Five-Year	Five-Year	Five-Year	Five-Year	Five-Year
Lavina MW - Deep	GSP Entities	Monitoring	Annual	Annual	Annual	Annual	Annual	Annual	Annual	Annual	Five-Year	Five-Year	Five-Year	Five-Year	Five-Year	Five-Year	Five-Year	Five-Year
Site 3 MW - Shallow	ILRP/GSP Entities	Monitoring	Annual	Annual	Annual	Annual	Annual	Annual	Annual	Annual	Five-Year	Five-Year	Five-Year	Five-Year	Five-Year	Five-Year	Five-Year	Five-Year
Site 3 MW - Middle	GSP Entities	Monitoring	Annual	Annual	Annual	Annual	Annual	Annual	Annual	Annual	Five-Year	Five-Year	Five-Year	Five-Year	Five-Year	Five-Year	Five-Year	Five-Year
Site 3 MW - Deep	GSP Entities	Monitoring	Annual	Annual	Annual	Annual	Annual	Annual	Annual	Annual	Five-Year	Five-Year	Five-Year	Five-Year	Five-Year	Five-Year	Five-Year	Five-Year
Site 4 MW - Shallow	ILRP/GSP Entities	Monitoring	Annual	Annual	Annual	Annual	Annual	Annual	Annual	Annual	Five-Year	Five-Year	Five-Year	Five-Year	Five-Year	Five-Year	Five-Year	Five-Year
Site 4 MW - Middle	GSP Entities	Monitoring	Annual	Annual	Annual	Annual	Annual	Annual	Annual	Annual	Five-Year	Five-Year	Five-Year	Five-Year	Five-Year	Five-Year	Five-Year	Five-Year
Site 4 MW - Deep	GSP Entities	Monitoring	Annual	Annual	Annual	Annual	Annual	Annual	Annual	Annual	Five-Year	Five-Year	Five-Year	Five-Year	Five-Year	Five-Year	Five-Year	Five-Year
Site 5 MW - Shallow	ILRP/GSP Entities	Monitoring	Annual	Annual	Annual	Annual	Annual	Annual	Annual	Annual	Five-Year	Five-Year	Five-Year	Five-Year	Five-Year	Five-Year	Five-Year	Five-Year
Site 5 MW - Middle	GSP Entities	Monitoring	Annual	Annual	Annual	Annual	Annual	Annual	Annual	Annual	Five-Year	Five-Year	Five-Year	Five-Year	Five-Year	Five-Year	Five-Year	Five-Year
Site 5 MW - Deep	GSP Entities	Monitoring	Annual	Annual	Annual	Annual	Annual	Annual	Annual	Annual	Five-Year	Five-Year	Five-Year	Five-Year	Five-Year	Five-Year	Five-Year	Five-Year
Site 6 MW - Shallow	ILRP/GSP Entities	Monitoring	Annual	Annual	Annual	Annual	Annual	Annual	Annual	Annual	Five-Year	Five-Year	Five-Year	Five-Year	Five-Year	Five-Year	Five-Year	Five-Year
Site 6 MW - Middle	GSP Entities	Monitoring	Annual	Annual	Annual	Annual	Annual	Annual	Annual	Annual	Five-Year	Five-Year	Five-Year	Five-Year	Five-Year	Five-Year	Five-Year	Five-Year

Well ID	Responsible Monitoring Entity	Well Type	Field Measurements					Laboratory Measurements										
			Specific Conductance	pH	Dissolved Oxygen	ORP	Temperature	Nitrate (as nitrogen)	Arsenic	Total dissolved solids (TDS)	Carbonate	Bicarbonate	Chloride	Sulfate	Calcium	Sodium	Magnesium	Potassium
Site 6 MW - Deep	GSP Entities	Monitoring	Annual	Annual	Annual	Annual	Annual	Annual	Annual	Annual	Five-Year	Five-Year	Five-Year	Five-Year	Five-Year	Five-Year	Five-Year	Five-Year
Site 10 MW - Shallow	ILRP/GSP Entities	Monitoring	Annual	Annual	Annual	Annual	Annual	Annual	Annual	Annual	Five-Year	Five-Year	Five-Year	Five-Year	Five-Year	Five-Year	Five-Year	Five-Year
Site 10 MW - Middle	GSP Entities	Monitoring	Annual	Annual	Annual	Annual	Annual	Annual	Annual	Annual	Five-Year	Five-Year	Five-Year	Five-Year	Five-Year	Five-Year	Five-Year	Five-Year
Site 10 MW - Deep	GSP Entities	Monitoring	Annual	Annual	Annual	Annual	Annual	Annual	Annual	Annual	Five-Year	Five-Year	Five-Year	Five-Year	Five-Year	Five-Year	Five-Year	Five-Year
Site 11 MW - Shallow	ILRP/GSP Entities	Monitoring	Annual	Annual	Annual	Annual	Annual	Annual	Annual	Annual	Five-Year	Five-Year	Five-Year	Five-Year	Five-Year	Five-Year	Five-Year	Five-Year
Site 11 MW - Middle	GSP Entities	Monitoring	Annual	Annual	Annual	Annual	Annual	Annual	Annual	Annual	Five-Year	Five-Year	Five-Year	Five-Year	Five-Year	Five-Year	Five-Year	Five-Year
Site 11 MW - Deep	GSP Entities	Monitoring	Annual	Annual	Annual	Annual	Annual	Annual	Annual	Annual	Five-Year	Five-Year	Five-Year	Five-Year	Five-Year	Five-Year	Five-Year	Five-Year
Wells Monitored for Other Programs																		
2000507-001	DDW	Public Supply	Frequency and schedule for constituent testing in public supply wells being monitored by non-GSA entities will be in accordance with monitoring entity and DDW schedule and requirements.															
2000553-001	DDW	Public Supply																
2000682-002	DDW	Public Supply																
2000727-001	DDW	Public Supply																
2000846-002	DDW	Public Supply																
2000938-001	DDW	Public Supply																
2010002-014	DDW	Public Supply																
2010002-032	DDW	Public Supply																
2010008-005	DDW	Public Supply																
2010009-002	DDW	Public Supply																
2010010-007	DDW	Public Supply																
2010801-001	DDW	Public Supply																
2801077-001	DDW	Public Supply																
ESJ12	ILRP	Domestic	Annual	Annual	Annual	Annual	Annual	Annual	Not tested*	Five-Year	Five-Year	Five-Year	Five-Year	Five-Year	Five-Year	Five-Year	Five-Year	Five-Year
ESJ17	ILRP	Domestic	Annual	Annual	Annual	Annual	Annual	Annual	Not tested*	Five-Year	Five-Year	Five-Year	Five-Year	Five-Year	Five-Year	Five-Year	Five-Year	Five-Year

* Arsenic is not among the constituents required for the ILRP.

The GSP monitoring program will utilize the following protocols for collecting groundwater quality samples.

- Prior to sampling, the analytical laboratory will be contacted to schedule laboratory time, obtain appropriate sample containers, and clarify any sample holding times or sample preservation requirements.
- Each well used for groundwater quality monitoring will have a unique identifier. This identifier will appear on the well housing or the well casing to verify well identification.
- In the case of wells with dedicated pumps, samples should be collected at or near the wellhead following purging.
- Prior to sampling, the sampling port and sampling equipment will be cleaned of any contaminants. The equipment will be decontaminated after purging and collection of water samples at each site to avoid any cross-contamination between wells.
- The groundwater elevation in the well should be measured following appropriate protocols described above in the groundwater level measuring protocols.
- For any well not equipped with low-flow or passive sampling equipment, an adequate volume of water should be purged from the well to ensure that the groundwater sample is representative of ambient groundwater and not stagnant water in the well casing. Purging three well casing volumes is generally considered adequate. Professional judgment should be used to determine the proper configuration of the sampling equipment with respect to well construction such that a representative ambient groundwater sample is collected. If pumping causes a well to be evacuated (go dry), document the condition and allow well to recover to within 90% of original level prior to sampling.
- Field parameters of pH, electrical conductivity, pH, temperature, and turbidity should be collected periodically during purging and prior to the collection of each sample. Field parameters should be evaluated during the purging of the well and should stabilize prior to collection of the water sampling. Measurements of pH values should occur in the field since the short hold times for laboratory pH analysis are typically unachievable. Other parameters, such as oxidation-reduction potential (ORP), dissolved oxygen (DO) (in situ measurements preferable), or turbidity, may also be useful for assessing purge conditions. All field instruments should be calibrated daily and evaluated for drift throughout the day.
- Sample containers should be labeled prior to sample collection. The sample label must include: sample ID (often well ID), sample date and time, sample personnel, sample location, preservative used, and analytes and analytical method.
- Samples should be collected under laminar flow conditions. This may require reducing pumping rates prior to sample collection. Alternatively, the flow rate from the sampling tap should correspond to laminar flow conditions when possible.
- All samples requiring preservation must be preserved as soon as practically possible, ideally at the time of sample collection. Ensure that samples are appropriately filtered as recommended for the specific analyte. Entrained solids can be dissolved by preservative leading to inconsistent results of dissolve analytes. Specifically, samples to be analyzed for metals should be field-filtered prior to preservation; do not collect an unfiltered sample in a preserved container.

- Samples should be chilled and maintained at 4 °C to prevent degradation of the sample. The laboratory's Quality Assurance Management Plan should detail appropriate chilling and shipping requirements.
- Samples must be shipped under chain of custody documentation to the appropriate laboratory promptly to avoid violating holding time restrictions.
- Ensure the laboratory uses appropriate reporting limits that are at or below levels needed for the objectives of the monitoring.
- Groundwater quality samples are to be collected annually for key constituents and every five years for all other constituents.
- For wells monitored by other entities, obtain results and associated information on sampling activities through coordination and communication directly with the monitoring entity or through public databases such as SWRCB Geotracker where these data are available.

All groundwater quality data and other information from sampling activities should be entered into the DMS as soon as possible and in accordance with established QA/QC procedures. Care should be taken during any data entry to avoid mistakes and data entered into the database should be checked for accuracy and completeness.

3.5.2.7 GDE Monitoring Program

The GDE monitoring program will include monitoring of groundwater levels and biological monitoring. Groundwater level monitoring being conducted for the overall GSP includes three RMS wells adjacent to the San Joaquin River Riparian potential GDE Unit along the San Joaquin River in the southern Plan Area, and one RMS well near the Madera Canal Equalization Reservoir in close proximity to the Fresno River Riparian GDE Unit. Reconnaissance-level biological surveys were conducted in May 2019 and additional monitoring will be conducted every five years to document ecological condition of each GDE unit, including the Sumner Hill potential GDE Unit. Biological data will be analyzed in conjunction with hydrological data, where available, to assess potential ecological effects related to changes in groundwater levels and the relative degree of influence on GDE conditions exerted by stream flows and groundwater levels associated with each potential GDE.

3.5.3 Representative Monitoring *(23 CCR § 354.36)*

This section of Chapter 3 is intended to provide the following:

- Description of representative sites
- Demonstration of adequacy of using groundwater elevations as proxy for other sustainability indicators
- Adequate evidence demonstrating the representative monitoring sites reflect general conditions in the area

Groundwater level data are collected from a large network of CASGEM and USBR wells (**Appendices 3.A and 3.J**). Representative monitoring sites (RMS) are defined in the SGMA regulations as a subset of monitoring sites that are representative of conditions in the Plan Area. All the monitoring sites in this section are considered RMS utilizing methods of selection consistent with best management practices described above under the groundwater level protocols. Groundwater level monitoring will be used to determine changes in groundwater storage and to assist in monitoring subsidence. As previously stated, reduction in groundwater storage is directly dependent on measuring changes in groundwater levels. In the case of subsidence, there are various entities monitoring for subsidence adjacent to and within the

Plan Area. Although land subsidence has not yet been identified to cause significant impacts to infrastructure in the Plan Area and no specific land subsidence MTs have initially been set, water level monitoring wells are being utilized to supplement review of ongoing subsidence surveys to determine if adaptive management is needed in the future to address land subsidence. Changes in water levels can be used in combination with subsidence surveys to develop the relationship/correlation between groundwater levels and amount/rate of subsidence.

3.5.4 Assessment and Improvement of Monitoring Network *(23 CCR § 354.38)*

This section of the GSP is intended to provide the following:

- Review and evaluation of the monitoring network
- Identification and description of data gaps
- Description of steps to fill data gaps
- Description of monitoring frequency and density of sites

As described in 23 CCR § 354.38, the monitoring network is required to be analyzed for improvements as follows:

- Review the monitoring network and include an evaluation in the GSP and each five-year assessment, including a determination of uncertainty and whether there are data gaps that could affect the ability of the GSP to achieve the sustainability goal for the Subbasin.
- Identify data gaps wherever the Subbasin does not contain a sufficient number of monitoring sites, does not monitor sites at a sufficient frequency, or utilizes monitoring sites that are unreliable, including those that do not satisfy minimum standards of the monitoring network adopted by the GSP.
- If the monitoring network contains data gaps, the GSP shall include a description of the following:
    - The location and reason for data gaps in the monitoring network
    - Local issues and circumstances that limit or prevent monitoring.
- The GSP shall describe steps that will be taken to fill data gaps before the next five-year assessment, including the location and purpose of newly added or installed monitoring sites.
- The GSP shall adjust the monitoring frequency and distribution of monitoring sites to provide an adequate level of detail about site-specific surface water and groundwater conditions and to assess the effectiveness of management actions under circumstances that include the following:
    - MT exceedances
    - Highly variable spatial or temporal conditions
    - Adverse impacts to beneficial uses and users of groundwater
- The potential to adversely affect the ability of an adjacent subbasin to implement its GSP or impede achievement of sustainability goals in an adjacent subbasin.

3.5.4.1 Review and Evaluation of the Monitoring Network

The monitoring networks described above for each of the applicable sustainability indicators will be evaluated on a yearly basis. This evaluation will involve a review of the described MTs and MOs and their comparison to observed trends in the networks. Furthermore, a more comprehensive review of the monitoring networks will be conducted every five years. During this review, management actions and projects will be evaluated and the monitoring networks will be assessed for their efficacy in tracking progress based on the actions and projects. These evaluations and assessments will also highlight any additional data gaps and recommended changes to the monitoring networks.

3.5.4.2 Identification and Description of Data Gaps

Identification and description of data gaps for the monitoring networks described above for each of the applicable sustainability indicators are described below.

Groundwater Elevation

Groundwater elevation data has been extensively collected within the Plan Area over the past several decades. However, despite this data collection effort, spatial data gaps still exist. Specifically, in the Upper Aquifer in the northern portion of the Plan Area, and the Lower Aquifer in the south central and extreme eastern and western portions of the Plan Area are lacking in monitoring wells. These gaps are evident in the designed monitoring network as no existing wells represent the areas described. In addition to these spatial gaps, temporal data collection gaps also exist at some of the monitoring network sites. Many times the lack of measurements is due to the inaccessibility of the monitoring wells or active pumping, or relatively recent inclusion in a monitoring program. Some of the spatial data gaps will be filled with installation of the nested monitoring wells by 2020 - particularly for the Upper Aquifer and extreme western portion of the Lower Aquifer. Temporal data gaps will begin to be filled by more regular collection of data as part of the GSP, and installation of transducers in new nested monitoring wells.

Data gaps relative to GDEs can be characterized as incomplete information on the extent to which the vegetation composing the Fresno River Riparian and San Joaquin River Riparian GDE units may be impacted by occurrence of temporary short-term declines in shallow groundwater levels below historical lows. Additionally, uncertainty exists with respect to the source of shallow groundwater supporting the wetlands and vegetation composing the Sumner Hill potential GDE Unit and its potential to be affected by changes in future groundwater conditions. Biological monitoring, recommended every five years, will be used to evaluate potential beneficial or adverse effects on GDEs that may be related to changes in future groundwater conditions during the implementation and sustainability periods.

Groundwater Storage

Groundwater storage data gaps are described in the groundwater elevation section as water levels are being used as a proxy for groundwater storage.

Subsidence

While some subsidence has occurred in the Plan Area since 2005, it has not yet had significant impacts on Plan Area infrastructure. Subsidence surveys for the SJRRP and more directly related to subsidence occurring in adjacent subbasins (e.g., Chowchilla and Delta Mendota Subbasins) have included some degree of delineation of subsidence in the Madera Subbasin as well. In terms of correlation of subsidence surveys with groundwater level data, the existing and future (with incorporation of nested monitoring wells installed since 2019) monitoring network for groundwater levels in the Lower Aquifer (which is most important for subsidence monitoring) is generally adequate for initial monitoring in regions of the Plan Area of most interest relative to subsidence (i.e., the western and northern areas). However, a Subsidence Workplan has been developed and is included with this GSP (see **Appendix 3.H**) to help develop a more robust subsidence monitoring program.

Groundwater Quality

Considerable historical groundwater quality data exist for the Plan Area although the spatial distribution and association of well construction information with groundwater quality observations present limitations. Some of the wells in the proposed groundwater quality sustainability indicator monitoring network have not historically been monitored for groundwater quality. The addition of these wells and

the monitoring wells currently being constructed together with other groundwater quality monitoring being conducted for public supply wells and the ILRP help provide a sufficient network for monitoring of groundwater quality and impacts from GSP projects and managements actions. As GSP PMAs are implemented and the planned locations for these activities are better known, the groundwater quality monitoring network should be reviewed and modified if needed to provide sufficient groundwater quality monitoring to meet the stated objectives.

3.5.4.3 Interconnected Surface Water

Significant data gaps exist for adequately characterizing interconnected surface water along the San Joaquin River along the southern boundary of Madera Subbasin. The relationships between occurrence of shallow groundwater levels, streamflow, and pumping need an improved understanding. Whether or not (and to what degree) shallow groundwater levels that occur along the San Joaquin River may be impacted by regional groundwater pumping is yet to be determined, and requires an improved understanding of shallow subsurface stratigraphy, groundwater elevations in various depth zones, and potential variations in streamflow along this reach of the San Joaquin River.

3.5.4.4 Description of Steps to Fill Data Gaps

Data gaps have been presented in the groundwater level, groundwater storage, land subsidence, and groundwater quality monitoring networks. The following steps will be taken to address these data gaps:

- Madera County is in process of adding seven new nested monitoring well sites with up to three well completions at each site (total of up to 27 new monitoring wells) within the Subbasin. These new wells will address many of the data gaps described in the Upper and Lower Aquifers for groundwater level and quality data (**Figures 3-1** and **3-3**).
- The GSAs will install sampling taps (as needed) on groundwater level wells designated for groundwater quality monitoring. These wells will then be sampled for both groundwater elevation data and groundwater quality data.
- Sampling events will be coordinated with well owners to prevent pumping and access issues.

In addition to these steps, the monitoring networks will be evaluated on a yearly and five-year basis. If additional data gaps arise, the GSA will consider the implications of these gaps, associated costs, and importance to the continued implementation of the GSP and take appropriate actions to address the gaps.

3.5.4.5 Description of Monitoring Frequency and Density of Sites

Monitoring frequency and density of sites for all sustainability indicators are described in previous sections in Chapter 3 of this report.

CHAPTER 3 SUSTAINABLE MANAGEMENT CRITERIA

Selected Figures

The following figures can be found after this page: Figures 3-1 to 3-10

4 SUBBASIN PROJECTS AND MANAGEMENT ACTIONS

To achieve the Madera Subbasin sustainability goal by 2040 and continue to manage sustainably to 2090, as required by the GSP regulations, various projects and management actions (PMAs) have been developed and will be implemented by the GSAs between 2020 and 2040. This chapter describes the types of PMAs that have been and are expected to be implemented by each GSA in the Madera Subbasin to meet sustainability objectives. "Projects" generally refer to structural features that supplement and expand available water supplies, whereas "management actions" are typically programs or policies designed to reduce groundwater use – with both integrated into the Subbasin's sustainable water management.

Subbasin PMAs are described in accordance with 23 CCR § 354.42 and § 354.44 of the GSP regulations. For projects, the estimated groundwater recharge benefit along with capital, operating, and maintenance costs for each project is shown. Project cost information is limited for many projects because a detailed feasibility assessment has not been completed. Other projects have cost estimates that were developed several years ago and may not reflect current conditions. To the extent possible, project costs are adjusted and reported on a consistent basis. For example, a consistent water purchase price is applied across all projects that would purchase and import water from other Subbasins (unless a specific cost is already provided in an existing agreement). All costs are indexed using an appropriate index (the Implicit Price Deflator or Engineering News Report Construction Cost Index) and reported in 2019 dollars. GSAs will further develop PMAs during the GSP implementation period and refine estimated costs.

Costs to acquire water for projects are based on the following assumptions. Water available as local surplus or flood flow has no direct acquisition cost[73]. Water received as CVP Section 215 delivery is assumed to cost $38.54 per acre-foot, based on Reclamation's 2019 Special Water Rates for irrigation 215 water that includes charges for conveyance, water marketing, restoration fund, and Friant surcharge. The cost to purchase water from other water users or from new projects elsewhere in the Central Valley assumes market purchase prices. These acquisition costs per acre-foot, by water year type and region, were developed in the Technical Reference for the Water Storage Investment Program (California Water Commission, 2016) and range from $270 per acre-foot in wet years to over $1,100 in critical years. Cost to deliver water using existing district facilities is assumed to be $25 per acre-foot[74]. For water delivered to farms for recharge on fields (On-Farm Recharge, or Flood-MAR), a cost of $25 per acre-foot is assumed for farmers to manage the water.

GSAs will identify sources of funding to cover project development, capital, and operating costs, including but not limited to, groundwater extraction fees, increasing water rates, grants, low interest loans, and other assessments. The exact funding mechanism will vary by project and the legal authority of each GSA. A general description of how each GSA expects to cover the cost of all PMAs it will implement is presented after the description of PMAs for each GSA.

The GSAs have prioritized implementation of projects that provide additional surface water supplies to the Subbasin, thereby reducing groundwater pumping. However, recognizing that access to surface water supplies is variable, the GSAs are also planning demand management to directly reduce groundwater

[73] Surplus water can have costs associated with it, depending on the timing and source of the supply. These costs will be assessed in detail as part of future GSA project planning.

[74] Actual delivery costs vary by GSA and will be assessed as part of future project planning. For example, MID's current wheeling rate is around $160 per acre-foot.

pumping to achieve sustainability. The GSAs are also committed to an adaptive management approach to implementing PMAs that is informed by continued monitoring of groundwater conditions using the monitoring networks. As PMAs are implemented and Subbasin conditions are monitored, the GSAs will review PMA timelines, benefits, and the volume of demand management that may be necessary to achieve sustainability. If the GSAs find that adjustments are needed to meet the sustainability goal, the GSAs will evaluate and adjust plans for project implementation and, to the extent necessary, demand management. Any adjustments will be reported in subsequent annual reports and/or the five-year periodic evaluation and GSP updates. A proposed timeline for the 2025 GSP update is provided in **Appendix 5.A**. This timeline includes evaluation of projects and management actions to ensure that the Subbasin will be managed sustainably and without undesirable results by 2040.

PMAs are summarized for all GSAs in the Madera Subbasin. This Joint GSP covers Madera Irrigation District, Madera County, City of Madera, and Madera Water District and PMAs for these GSAs are described in accordance with 23 CCR § 354.42 and § 354.44 of the GSP regulations. Gravelly Ford Water District, Root Creek Water District, and New Stone Water District are preparing separate GSPs. The operation and gross benefit of PMAs for these GSAs are summarized in this chapter because the sustainability of the Subbasin depends in part on these PMAs. More detailed project descriptions, costs, and uncertainties are described in each of those GSA's respective GSP.

Two main types of projects are included for implementation in the Joint GSP: recharge and conveyance (Table 4-1). Recharge projects are designed to support sustainability by diverting floodwater or other available surface water for direct infiltration in constructed basins or spreading onto fields. Conveyance projects facilitate the delivery of additional water supplies for increased recharge or for direct use for irrigation, thereby reducing groundwater pumping (in-lieu recharge). Conveyance projects may include structural improvements, operational changes, or both. A section at the end of this chapter describes and quantifies available water from the potential sources.

In addition to projects, several GSAs in the Madera Subbasin have developed and will implement management actions. Gravelly Ford Water District will implement a program to monitor groundwater extractions and use that data to more efficiently manage its water supply. Madera Irrigation District will develop incentive structures to encourage its growers to use more surface water and reduce groundwater pumping. Madera County GSA is also planning a demand management program that will reduce demand by placing restrictions on groundwater pumping, among other actions. The Madera County GSA's planned program will provide groundwater users a flexible way to meet any future pumping restrictions. Other GSAs within the Subbasin may also implement similar programs if needed to attain sustainability. Together, the PMAs have been developed and planned to achieve the Subbasin sustainability goal by 2040.

The cost, timing, and groundwater benefit (yield) of the PMAs included in the GSP vary by GSA. Table 4-2 lists all the PMAs planned at the time of initial GSP development, summarized by GSA or implementing entity, and the estimated implementation timeline, capital cost, operating cost, and gross benefit of the projects. Recharge basins, a common project, may also provide environmental benefits that are not quantified in the table. Table 4-3 further summarizes the total benefits and costs of all PMAs developed for each GSA or implementing entity. Updates and new PMAs implemented since initial GSP development are documented in Section 4.10.

The gross yield across all projects at full implementation (2040) is estimated to generate an average annual yield of over 200,000 acre-feet (AF). This includes the Madera County demand management program implemented by the Madera County GSA that reduces net groundwater pumping by about 90,000 acre-feet per year (AFY) by 2040, based on current pumping estimates. The gross yield is larger

than the projected shortfall primarily due to changes in other water budget elements when flood flows are directed to recharge.

The remaining subsections of this chapter provide additional details about:

- Plans for implementation of PMAs by each GSA or agency, including anticipated costs and benefits.
- The amount of water available for recharge by projects, and
- Actual PMA implementation efforts that have been completed as of the latest GSP Annual Report (water year 2022).

Table 4-1. Projects and Management Actions and Water Sources Considered in the Madera Subbasin.

GSA	PMA type	PMA Mechanism	Water Source			
			Fresno River Flood Releases	Millerton Flood Release and 215 water	Chowchilla Bypass flows	Purchase
Recharge						
All	Recharge Basins	Increase Recharge	X	X	X	X
All	On-Farm Recharge (Flood-MAR)	Increase Recharge	X	X	X	X
Conveyance						
MID	MID Pipeline Project, Main I-Road 23 Project	Reduces evaporation and GW Pumping				
MID	WaterSMART Pipeline Project	Reduces evaporation and GW Pumping				
MID	WaterSMART SCADA Project	Reduces evaporation and GW Pumping				
MID, MC, MWD	Water Supply Development-Partnerships	Purchase water from willing partners outside of the basin to increase recharge or reduce GW pumping	X	X	X	X
MWD, RCWD	Water Supply Development-Partnerships	Purchase water from willing partners in the basin to reduce GW pumping				X
NSWD	Water Right Utilization	Divert flood flow from Chowchilla Bypass, under existing water right			X	
Management Actions						
GFWD	Groundwater monitoring and well meters	Collect, analyze, and report data on conditions and use to improve management.				
MC	Demand Management	Reduce demand by limiting groundwater pumping				
MID	Explore new fee structures and incentive-based programs to use surface water	Encourage more use of district SW; reduce GW pumping				

Table 4-2. Madera Subbasin Projects and Management Actions.

GSA	PMA	First Year of Implementation	Average Annual Gross Benefit at Full Implementation (AFY)	Estimated Capital Cost ($ millions)	Estimated Average Annual Operating Cost ($ millions/year)
MWD	Expanded Surface Water Purchase	2023	2,810	14.90	0.90
MID	Rehab Recharge Basins	2016	5,030	0.06	0.43
MID	Ellis Basin	2016	240	0.02	0.02
MID/City of Madera	Berry Basin	2018	20	0.02	0.00
MID	Allende Basin	2019	1,050	0.20	0.07
MID	Additional Recharge Basins Phase 1	2030	5,470	1.00	0.24
MID	Additional Recharge Basins Phase 2	2040	21,890	14.20	3.75
MID	On-Farm Recharge	2015	510	0.00	0.05
MID	Phase 2 On-Farm Recharge	2025	1,690	0.00	0.19
MID	MID Pipeline	2016	420	0.56	0.00
MID	WaterSMART Pipeline	2019	880	1.30	0.00
MID	WaterSMART SCADA	2019	1,230	1.20	0.00
MID	Water Supply Partnerships	2025	3,990	0.00	2.50
MID	Incentive Program	2022	5,010	0.00	3.08
City of Madera	Meters and Volumetric Pricing	2015	3,350	11.00	0.00
City of Madera/MID	Berry Basin	2018	20	0.02	0.00
Madera County	Water Imports Purchase	2025	3,610	0.30	2.49
Madera County	Millerton Flood Release Imports	2025	7,060	31.90	0.45
Madera County	Chowchilla Bypass Flood Flow Recharge Phase 1	2025	12,710	67.00	0.32
Madera County	Chowchilla Bypass Flood Flow Recharge Phase 2	2040	26,470	118.90	1.16
Madera County	Demand Management	2020	90,000	0.00	53.90
GFWD	Recharge Basin and Canals	2020	2,620	*See GFWD GSP*	
NSWD	Water Right Utilization	2020	5,540	*See NSWD GSP*	
RCWD	Purchased Water for In-Lieu Storage	2019	4,380	*See RCWD GSP*	
RCWD	Holding Contracts	2020	9,840	*See RCWD GSP*	
Total			**215,840**	**262.58**	**69.55**

Note: estimated project benefit values and costs are rounded.

Table 4-3. Summary of Madera Subbasin Projects and Management Actions by GSA.

GSA	Average Annual Gross Benefit at Full Implementation (AFY)	Estimated Capital Cost ($, millions)	Estimated Average Annual Operating Cost ($/year, millions)
MWD	2,810	14.90	0.90
MID	47,430	18.56	10.33
City of Madera	3,370	11.02	0.00
Madera County	139,850	218.10	58.32[1]
GFWD	2,620	*See GFWD GSP*	
NSWD	5,540	*See NSWD GSP*	
RCWD	14,220	*See RCWD GSP*	
Total	**215,840**	**262.58**	**69.55**

[1]Costs of demand management include reduced economic activities in the county, this includes approximately $53.9 million per year in direct economic impacts alone (excluding multiplier effects).

4.1 Madera Water District GSA

The Madera Water District GSA (MWD) has identified one project to include in the GSP to help the Subbasin meet sustainability goals. The project is an expanded surface water purchase program where MWD would secure new surface water supplies for use in its service area. Although expanded surface water purchases are considered one project, to obtain those additional deliveries, there will be various infrastructure components implemented by MWD.

At the time of initial GSP development, project planning was still in development, so complete information on project planning, operations, costs, and other details were not finalized. Sections 4.9 and 4.10 summarize PMA implementation efforts and updates from the time of initial GSP development through the latest GSP Annual Report (water year 2022). A description of how all the PMAs operate as part of the overall Joint GSP is provided in Chapter 5, Plan Implementation.

4.1.1 MWD Surface Water Purchase Program

The MWD surface water purchase program provides in-lieu recharge benefits by providing growers with additional surface water supplies imported from inside or outside of the Subbasin. The program is an extension of current MWD practices of purchasing surface water when it is available, but access to surface water has been limited by the diversion facilities currently available to MWD. As part of the GSP development process, MWD has been investigating the ability to access additional surface water supplies.

4.1.1.1 Project Overview

The surface water purchase program includes a series of improvements to expand MWD's ability to purchase additional surface water supply. Improvements include upgrades to the Dry Creek turnout and pump stations, and additional conveyance capacity from the installation of a new pipeline connecting Madera Lake, both MID facilities, to the MWD's existing distribution system. To maximize the use of surface supplies, storage reservoirs will be constructed to store water for later delivery as irrigation demands occur. These improvements will enable MWD to purchase higher quantities of water in Wet and Above Normal years than it has been able to purchase historically. By expanding its ability to access additional surface water supplies, MWD expects to increase its in-lieu recharge volumes when supplies are available, which is typically in wetter years. However, even in extremely dry years MWD has often been able to purchase water from Madera Irrigation District (MID) for delivery out of Dry Creek.

4.1.1.2 Implementation

MWD will expand water purchases, particularly in Wet and Above Normal years. In addition, it has identified a set of facilities that will allow greater purchases. These facilities include:

- Improvements to the MWD Dry Creek Pump Station to support flow increases of about 2,000 gpm (4.5 cfs), from 10,500 (23.4 cfs) to 12,500 gpm (27.8 cfs),
- A new pipeline connection to Madera Lake sized for 6,000 gpm (13.4 cfs) with 4,000 gpm (8.9 cfs) capacity to Madera Water District,
- The construction of storage reservoirs within or near the District with capacity of 3,000 AF or more.

Permitting and environmental studies are expected to begin in late 2019 or 2020, with construction to begin in 2021. The new facilities will be operational in 2023.

Table 4-4. MWD Surface Water Purchase Program Implementation Timeline.

Phase	Start	End
Permitting and environmental documentation	2019 for Madera Lake pipeline; 2020 for other projects	2023
Financing	2019	2025
Construction	2021	2023
Operation	2023	2075

Construction activities and requirements

As described under Project Overview and Implementation, MWD will construct a new turnout, pump stations, pipeline, and storage reservoirs. Specific construction activities, scheduling, and more detailed cost estimation will be developed as part of final design of the project.

Water source

MWD intends to purchase surface water from CVP Friant Division contractors within or outside the Subbasin to the extent available. If surface water is not available from these partners, then MWD will seek supplies from other CVP contractors. Since any purchased water will need to be wheeled through MID's system, MWD will coordinate with MID to evaluate and address potential capacity limitations.

Conditions or constraints on implementation

Continued and expanded water purchases by MWD will depend on the cost and availability of water from willing sellers.

Permitting process and agencies with potential permitting and regulatory control

Potential permitting and regulatory control over the various projects will include the U.S. Bureau of Reclamation, Madera County, MID, DWR's Division of Safety of Dams, California Department of Fish and Wildlife, and the U.S. Fish and Wildlife Service.

MWD has already contacted many of these agencies for preliminary permit review as part of its due diligence on the various facilities. MWD will obtain needed permits for construction of new reservoirs, including grading permits from Madera County. Water transfer agreements will need to be developed

along with any related CEQA/NEPA documentation for anticipated water purchases. However, since most water transfers will be on a year-to-year basis and/or involve flood or excess waters, the environmental documentation is anticipated to be minimal.

4.1.1.3 Project Operations and Monitoring

With the exception of one private domestic well, all the wells in MWD are owned by MWD, under its control and metered. Groundwater extractions will continue to be metered and managed by MWD as directed by the Board of Directors. Surface water supplies that are brought into MWD are also metered and under the direct management of MWD.

4.1.1.4 Project Benefits

There is limited recharge potential within the MWD service area. Therefore, surface water would be stored in reservoirs and delivered to meet crop demand in lieu of groundwater pumping, providing in-lieu recharge benefits. The in-lieu recharge benefits of this project are expected to benefit groundwater levels, groundwater storage, subsidence, groundwater quality, and interconnected surface water by increasing surface water use and reducing groundwater pumping.

The hydrologic time series selected to establish benefits is 1993-2014. Table 4-5 shows the planned delivery schedule based on this hydrologic series for the additional surface water supplies that are proposed to be purchased and brought into the District. These amounts are in addition to historical purchases which are presumed to be able to continue in the future. Surface water will be purchased in any water year type that it is available, though supplies are likely only in Below Normal (BN), Above Normal (AN), or Wet (W) years. MID may have capacity constraints in both the Madera Canal and Dry Creek during the peak months of June, July, and August depending on the status of improvements to its diversion facilities, the water year type, and the weather. The proposed Madera Lake pipeline could provide deliveries during these summer months.

Table 4-5. Estimated Average Additional Surface Water Purchased, by Year Type.

Year Type	Total Annual Volume	% of Years	Weighted Avg.
W	6,000	35%	2,118
AN	4,500	14%	618
BN	1,000	8%	78
D	0	16%	0
C	0	27%	0
Avg. Annual			**2,814**

The construction of additional turnout pumping capacity to increase Dry Creek deliveries would increase MWD's ability to import surface water via Dry Creek from about 10,000/10,500 gpm to 12,500 gpm (when MID is able to provide capacity). In addition, improvements are proposed to be made to Dry Creek to allow for reliable flow delivery to meet increased turnout capacity. These improvements will require regulatory approvals.

MWD also intends to evaluate the construction of reservoirs within or adjacent to MWD's boundaries and the installation of additional water lines connecting the reservoirs to MWD's current distribution system. Initial plans are to construct up to six 500-AF reservoirs for total storage of 3,000 AF, along with pipeline

connections to the existing distribution system. Water purchased and stored in the reservoirs would be used throughout the entire District. The District's plan is to fill the reservoirs during the fall and winter months, so the water is available to be used during the summer months when capacity issues restrict flows.

Figure 4-1 illustrates the expected schedule for delivering and storing water from surface water and groundwater, including planned new supplies, for a wet and above normal water year. Crop demand is based on a total irrigated area of 3,486 acres with an average applied water rate of about 2.68 AF/acre, resulting in an average demand of 9,338AF/year (for year 1989 to 2014). The assumed native groundwater yield is 0.5 AF/acre per year for 1,875 AF/year. In a wet and above normal water supply year, the cumulative storage at the end of the year In storage reservoirs is positive and would be available (minus losses) for the next crop year.

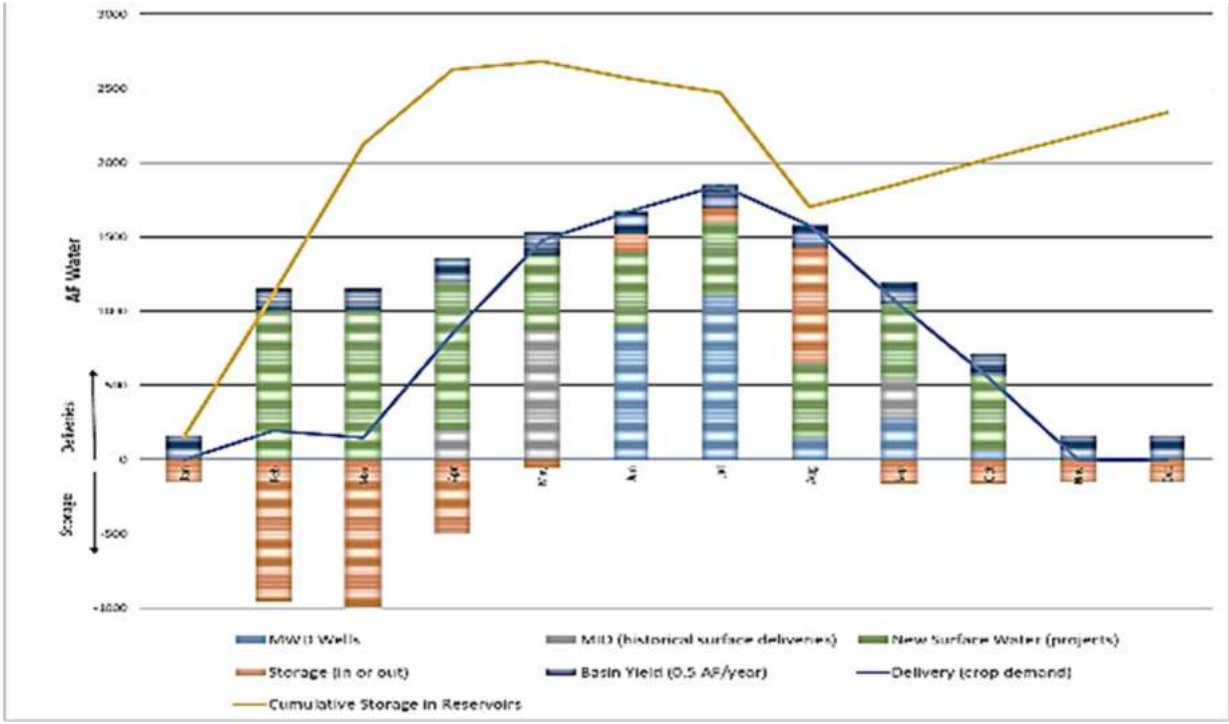


Figure 4-1. MWD Wet and Above Normal Year Water Supply Plan

Based on the planned additional surface water supply projects and associated infrastructure, charts for the 2020 – 2040 (Figure 4-2) and 2020 – 2070 (Figure 4-3) projected water budget periods have been created. The projected water budgets are described in Section 2.2.3 of the GSP and were prepared for 2020 – 2090 based on historical hydrologic data from 1965 – 2015, historical water supply data from 1965 – 2015 (with adjustment of CVP supplies based on projected Friant Releases under SJRRP), and projected land use. The running balance trend for both water budgets shows positive slope, with Figure 4-2 showing the GSA being sustainable in 2040. The groundwater trend line is positive in Figure 4-2 and Figure 4-3.

The reliability of the surface water purchase program will depend on how much excess water is available to purchase and the price of the surface water. However, MWD has historically been able to purchase surface water supplies from MID even in dry years such as 2015. Since MWD has only permanent crops, fallowing on a year to year basis is not practicable. However, MWD's Board of Directors has discussed the

potential for land retirement as trees planted within MWD are removed due to aging/low yields or parcels are available for sale.

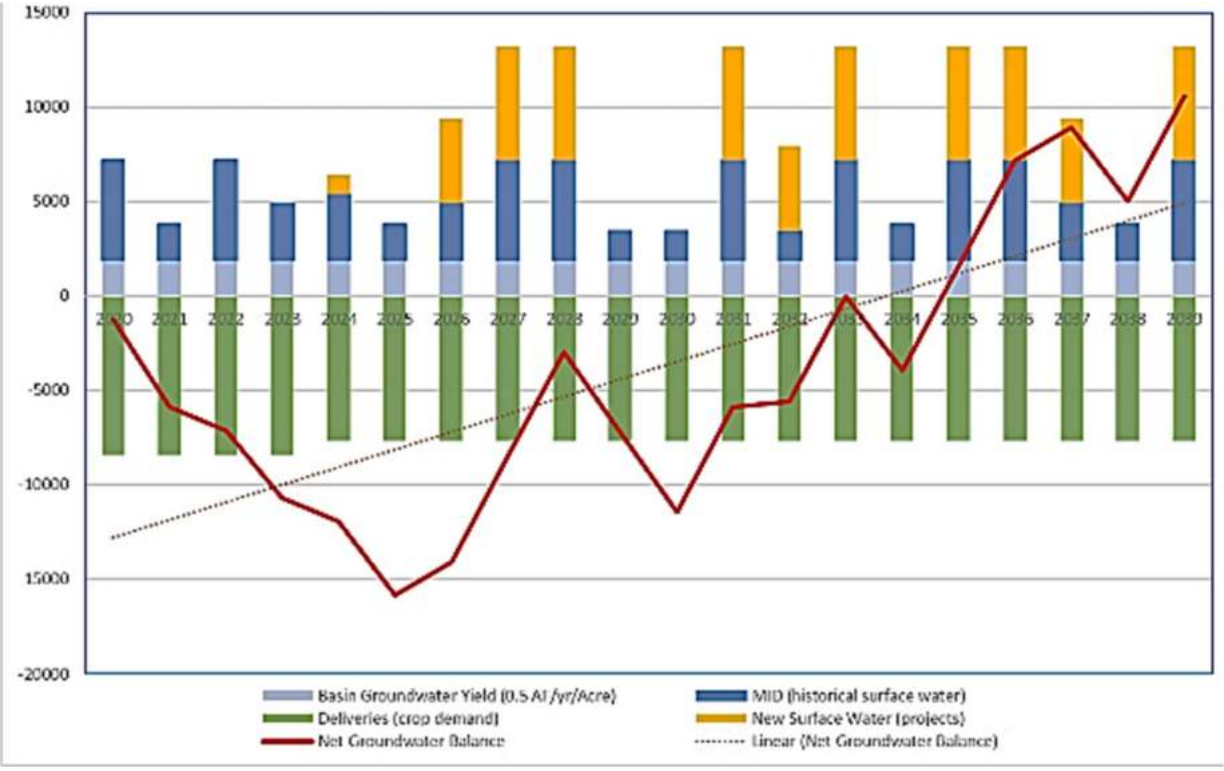


Figure 4-2. Madera Water District Water Budget, 2020–- 2040

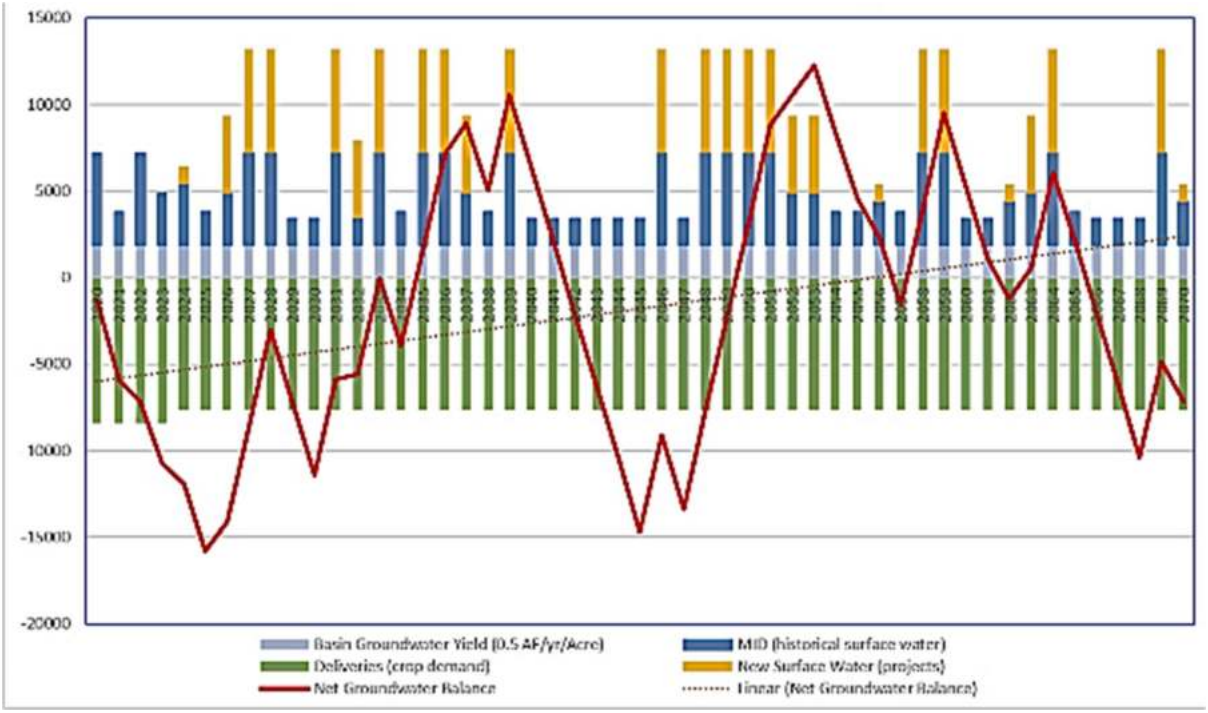


Figure 4-3. Madera Water District Water Budget, 2020–- 2070

4.1.1.5 Project Costs

Table 4-6 summarizes estimated project costs. Capital costs are estimated by MWD and include land acquisition, planning, permitting, and construction. Annual costs will be incurred to acquire water from other water suppliers, so the cost reflects estimated market prices averaged over the year types in which water is acquired.

Table 4-6. Project Cost Summary Table.

Item	Total Cost	Year Incurred	Notes
Capital Costs			
Project planning and development	$14.9 million	Start of project	
O&M Costs			
Water supply cost	$825,000	Annual average	Average annual water purchase cost to acquire water in W, AN, and BN years; costs are incurred in years when water is available.
Other O&M cost	$70,500	Annual average	Conveyance O&M assumed to be $25 per acre-foot; costs are incurred in years when water is available.

4.1.2 Project Financing

MWD will finance capital costs of the projects using cash reserves and, as needed, borrowing. Debt service on any borrowed funds plus ongoing O&M will be paid by MWD landowners. MWD imposes an annual assessment and charges its growers volumetrically for water. MWD holds a public hearing each year to set the annual water rate. MWD has also been building its cash reserves to pay for the cost of physical improvements to MWD facilities. If needed, MWD will also go through the Proposition 218 process to request an increase in land-based assessments.

4.1.3 Coordination with Other GSAs and Planning Agencies

This Joint GSP is the coordinated GSP for the four Joint GSP GSAs in the Madera Subbasin (City of Madera GSA, Madera Irrigation District GSA, Madera County GSA, and Madera Water District GSA). A coordination agreement will be executed by the coordinating GSAs with the other three GSAs in the Subbasin (Gravelly Ford Water District GSA, New Stone Water District GSA, and Root Creek Water District GSA) detailing required GSA and GSP cooperation.

MID has historically conveyed water to Subordinate MID landowners in MWD. MID and MWD have been coordinating on the development of long-term projects to improve surface deliveries to MWD such as a new water supply agreement and the Madera Lake pipeline. MWD is continuing to discuss new water supply agreements with MID, including wheeling agreements, water purchase agreements, and the cost of water available for purchase.

4.2 Madera Irrigation District GSA

The Madera Irrigation District GSA (MID) has identified several projects to include in the GSP to help MID achieve sustainability. These include new or expanded recharge capacity, increased operational flexibility, additional capacity to move water available from other areas, incentives to encourage MID growers to reduce groundwater pumping, and other management actions to bring the Subbasin into sustainability.

MID invested in several projects after passage of the SGMA legislation but prior to GSP development that help to bring MID into sustainability. Full implementation of these projects was achieved after 2015, the end of the historical hydrologic sequence used to develop the GSP, so the effects of implementing these projects are not included in the baseline MID water budgets described in Chapter 2. MID will continue to operate and pay for these projects and they are included as part of its PMAs.

The MID project descriptions are based on information available during the initial Joint GSP development process from MID and, where applicable, other studies. Water available for these projects is evaluated in combination with other projects in the Subbasin.

At the time of initial GSP development, planning for the PMAs was at varying stages of development, so complete information on construction requirements, operations, costs, permitting requirements, and other details are not uniformly available. Sections 4.9 and 4.10 summarize PMA implementation efforts and updates from the time of initial GSP development through the latest GSP Annual Report (water year 2022). A description of how all the MID PMAs operate as part of the overall Joint GSP is provided in Chapter 5, Plan Implementation.

4.2.1 Groundwater Recharge Basins

Recharge basins are artificial ponds of varying size that are filled with water supply that would have otherwise left the Subbasin, which instead percolates into the groundwater system. The size, location, and performance of a recharge basin depends on site-specific characteristics that will be assessed by MID and its partners in the process of developing recharge basin projects.

The following subsections describe multiple[75] groundwater recharge basin projects that have been or will be implemented by MID to generate groundwater recharge benefits.

4.2.1.1 Project Overview

MID has identified five (5) individual groundwater recharge projects that it has already developed or will develop under the GSP. This includes one rehabilitation project where MID refurbished existing recharge basins that have been underutilized and were in a state of disrepair. MID developed three new recharge basins, including the Ellis Basin, Berry Basin, and Allende Basin. Finally, MID will acquire land and develop approximately 90 acres of new recharge basins by 2030 and another 260 acres by 2040, if needed. Locations and sizes of these new basins will be selected based on land uses, access to delivery facilities, and soils having appropriate percolation rates. Recharge basins are generally distributed throughout the MID service area.

MID recharge projects are similar in operation and implementation. A general description of the projects is provided. Detailed expected recharge benefits, operational descriptions, and estimated costs are provided for each individual project.

Recharge Basin Rehabilitation

MID rehabilitated and upgraded six (6) of its recharge facilities in 2015 and 2016. The facilities were underutilized by MID for many years. The upgrades included facility connections and metering for

[75] MID recharge basins include the Berry Basin project, which is a joint project with the City of Madera GSA and the Ellis Basin project, which is a joint project with Madera County. Project benefits are split with the City of Madera (Section 4.3) and Madera County (Section 4.4), respectively.

managing groundwater recharge purposes. The basins range in size from 3 acres to 220 acres with capacity of 20 to 2,300 AF.

Ellis Basin

MID and Madera County worked cooperatively to construct a 180-ft. pipeline to connect MID's Lateral 24.2 canal to the County's Ellis Street Basin in early 2016 for recharge purposes. When water is available, a lift pump is used to convey the water through a meter to Madera County's basin. The benefits are shared equally by MID and Madera County at a 50:50 ratio.

Berry Basin

The Berry Basin project conveys surface water from an existing MID canal to an existing City of Madera stormwater basin to increase opportunities for groundwater recharge in the Madera Subbasin. The project installed approximately 120 feet of 15-inch pipeline from the MID facilities, Lateral 24.2-14.2 Canal, to the City of Madera facilities, a City-owned and operated storm water basin located on parcels APN 006-380-006 and 006-380-011. The project was completed in 2018. The benefits are shared equally by MID and City of Madera at a 50:50 ratio.

Allende Basin

MID purchased the Allende Basin, APN 047-310-039, in 2018 for the purposes of increasing recharge benefits. MID estimates that the basin storage equals 250 AF. MID will manage the parcel as a permanent basin because of the benefits it provides for MID canal operations and regional groundwater recharge. By utilizing multiple MID surface water supplies, irrigation and flood water can be conveyed to the Allende Basin through the adjacent canal and existing basin turnout structure.

New Recharge Basin Development

MID will evaluate and acquire additional land for groundwater recharge basin development. This includes two additional projects: approximately 90 acres of recharge basins developed by 2030, and an additional 260 acres developed by 2040, if needed. Land suitable for recharge will be strategically located throughout the MID service area to maximize regional groundwater recharge benefits and district operations.

4.2.1.2 Implementation

Implementation will be staged based on the existing development of each groundwater recharge basin or new recharge basin, since 2015 and continuing through 2040 (Table 4-7). Implementation for each of the MID recharge projects is as follows:

- **Recharge Basin Rehabilitation**. Upgrades to existing recharge basins were completed by the end of 2016.
- **Ellis Basin**. The Ellis Basin project was developed in 2016 and is currently operational.
- **Berry Basin**. The Berry Basin project was developed in 2018 and is currently operational.
- **Allende Basin**. The Allende Basin parcel was acquired by MID in 2018 and is currently operational
- **New Recharge Basin Development**. MID will continue to identify additional sites that are good locations for construction of groundwater recharge ponds. Permitting and environmental documentation will be initiated, and financing will be identified and secured for the recharge basins. Construction of the first 90 acres of basins will be complete by 2030, and if necessary, an additional 260 acres of basins will be completed by 2040, if needed.

Table 4-7. MID Groundwater Recharge Basins Implementation Timeline.

Phase	Start	End
Permitting and environmental documentation	2015	2040
Financing	2015	2040
Construction	2015	2040
Operation	2016	On going

Construction activities and requirements

Construction activities include acquiring land suitable for recharge, developing that land for recharge, and acquiring and/or delivering water supplies to that land for recharge benefits. Construction activities vary by recharge basin site. General activities include survey, initial feasibility assessment, permitting, environmental review, land purchase, earthwork, site development, water supply development, and operating infrastructure. Details on construction activities, schedule, and project costs will be developed as part of final project design for each recharge basin developed by MID.

Water source

Water for recharge is expected to be available from one or more of the following sources:

- MID has a contract for CVP Class 1 and Class 2 water, and it can receive CVP surplus flows when available.
- Fresno River flood releases from Hensley Lake.
- Other water supplies that MID currently has access to or may be available in the future, including potential via exchange through the larger Friant system and delivered by Madera Canal.

The analysis of benefits below considers the source of water for each recharge project specified by MID. It does not account for other potential sources nor for any changes in operations elsewhere in the CVP system that might affect availability of surplus water. Water sources for each recharge project include:

- **Recharge Basin Rehabilitation**. MID diverts flood flows and other available water supplies in Wet, Above Normal, and Below Normal water years to the rehabilitated recharge basins.
- **Ellis Basin**. MID delivers flood flows and other available water supplies to the Ellis Basin project in Wet, Above Normal, and Below Normal water year conditions.
- **Berry Basin**. MID delivers flood flows and other available water supplies to the Berry Basin project in Wet, Above Normal, and Below Normal water year conditions.
- **Allende Basin**. MID delivers flood flows and other available water supplies to the Allende Basin project in Wet, Above Normal, and Below Normal water year conditions.
- **New Recharge Basin Development**. MID will deliver flood flows and other available water supplies to newly developed groundwater recharge basins in Wet, Above Normal, and Below Normal water year conditions. Depending on future conditions in MID, it may also purchase additional supplies from partners that will be identified to increase recharge benefits in other water year conditions.

Conditions or constraints on implementation

The groundwater recharge basins implemented by MID are planned projects of the GSP. MID groundwater recharge basin development does not depend on the performance of other projects or activities.

However, MID may develop additional recharge basins if the yield of other projects is lower than anticipated in order to meet its sustainability objectives.

Permitting process and agencies with potential permitting and regulatory control

The following agencies have potential permitting roles for the project: Madera County and Reclamation

Some recharge basin projects may require an environmental review process under CEQA. This would require either an Environmental Impact Report, and Negative Declaration, or a Mitigated Negative Declaration.

Depending on the source of water, projects may require coordination with Reclamation for scheduling the storage and delivery of water within Millerton or to facilitate exchanges of water acquired from other Federal Contractors.

4.2.1.3 Project Operations and Monitoring

Recharge will be conducted by MID in groundwater recharge basins. Extraction of recharged groundwater will be done by water users in MID through individual, private wells.

MID expects that water will be available for recharge in all W, AN, and BN years, to be delivered using existing canals and laterals. Water may be available in other years depending on water supply conditions in the region and MID's ability to purchase additional supplies from partners. Delivery to rehabilitated recharge basins, as well as the Ellis, Berry, and Allende basins has already begun. During years in which water is available for recharge, MID expects to deliver sufficient water to recharge the basins for most of the year. Operation of new recharge basins developed by MID will start in 2030 and 2040, or potentially before, and patterns of recharge will be dictated by water availability but are expected to be generally similar to existing recharge basins.

4.2.1.4 Project Benefits

Groundwater recharge provided by the recharge basins will contribute to groundwater sustainability in the Subbasin by replenishing groundwater supplies. The direct recharge benefits of this project are expected to benefit groundwater levels, groundwater storage, subsidence, groundwater quality, and interconnected surface water by augmenting groundwater supplies in the Subbasin..

Based on a hydrologic and operations analysis covering the historical period, 1989-2014, and the resulting frequency and amount of recharge, the average annual gross recharge benefits for each of the recharge projects that will be implemented by MID is as follows:

- **Recharge Basin Rehabilitation**. 5,029 AF.
- **Ellis Basin**. 243 AF.
- **Berry Basin**. 48 AF (24 AF credited to MID and 24 AF credited to City of Madera).
- **Allende Basin**. 1,045 AF.
- **New Recharge Basin Development**. 5,474 AF by 2030 and another 21,894 AF by 2040 if necessary.

Tables 4-8 through 4-13 below summarize the average annual water supply benefits, shown as the average delivery year type. The average annual benefit of each project is the water year-type probability weighted average. Wet, Above Normal, Below Normal, Dry, and Critical year types have historically occurred with a probability of 35%, 14%, 8%, 16%, and 27%, respectively.

The reliability of the source water is based on historical hydrology being a good projection of future hydrology. In addition, the reliability depends on future water supply management, including changes to

the CVP system and the San Joaquin River Restoration Program, as well as diversions of other flood flows or sources of water by other GSAs or other entities with rights to that water.

Table 4-8. MID Estimated Average Deliveries by Year Type, in AF per Year – Recharge Basin Rehabilitation Project.

Year Type	Total Annual Volume	% of Years	Weighted Avg.
W	11,000	35%	3,882
AN	5,500	14%	755
BN	1,500	8%	118
D	0	16%	0
C	1,000	27%	275
Avg. Annual			**5,029**

Table 4-9. MID Estimated Average Deliveries by Year Type, in AF per Year – Ellis Basin Project.

Year Type	Total Annual Volume	% of Years	Weighted Avg.
W	550	35%	194
AN	300	14%	41
BN	100	8%	8
D	0	16%	0
C	0	27%	0
Avg. Annual			**243**

Table 4-10. MID Estimated Average Deliveries by Year Type, in AF per Year – Berry Basin Project.

Year Type	Total Annual Volume	% of Years	Weighted Avg.
W	55	35%	19
AN	30	14%	4
BN	10	8%	1
D	0	16%	0
C	0	27%	0
Avg. Annual			**24**

Table 4-11. MID Estimated Average Deliveries by Year Type, in AF per Year – Allende Basin Acquisition.

Year Type	Total Annual Volume	% of Years	Weighted Avg.
W	2,365	35%	835
AN	1,290	14%	177
BN	430	8%	34
D	0	16%	0
C	0	27%	0
Avg. Annual			**1,045**

Table 4-12. MID Estimated Average Deliveries by Year Type, in AF per Year – New Recharge Basins Constructed by 2030.

Year Type	Total Annual Volume	% of Years	Weighted Avg.
W	12,650	35%	4,465
AN	6,350	14%	872
BN	1,750	8%	137
D	0	16%	0
C	0	27%	0
Avg. Annual			**5,474**

Table 4-13. MID Estimated Average Deliveries by Year Type, in AF per Year – New Recharge Basins Constructed in 2040.

Year Type	Total Annual Volume	% of Years	Weighted Avg.
W	50,600	35%	17,859
AN	25,400	14%	3,486
BN	7,000	8%	549
D	0	16%	0
C	0	27%	0
Avg. Annual			**21,894**

Recharge basins may also provide environmental benefits by creating seasonal or perennial habitat for wildlife including waterfowl, amphibians, and reptiles and serve as drinking water sources and foraging habitat for mammals. Groundwater that may be flowing laterally from recharge basins to nearby rivers, particularly the San Joaquin River, may also support beneficial uses by providing an additional source of relatively cold water to support riparian vegetation and both cold and warmwater aquatic habitat including migration habitat for special-status salmonids.

4.2.1.5 Project Costs

Estimated project costs are based on actual costs (for projects that were already developed) and estimated costs for development of a typical recharge basin (Table 4-14). Costs for each basin will vary based on site characteristics and market conditions affecting land, construction, and material costs at that time. Capital costs include site survey, soil sampling, land purchase costs, earthwork, pumps, fencing, and power connection. Additional development costs include project administration, legal, permitting, and environmental review. Actual project costs may be lower than estimated costs if some of these activities are not required. O&M costs are expressed as annual averages but will vary annually according to year type and water availability. Estimated project costs do not include groundwater extraction costs (which would be borne by private pumpers in MID). All costs are reported in current 2019 dollars.

4.2.2 On-Farm Recharge (Flood-MAR)

MID is developing an On-Farm Recharge Program (referred to as Flood Managed Aquifer Recharge, Flood-MAR, by DWR). This program diverts flows that would have otherwise left the Subbasin onto farms and fields of willing participants (growers) to percolate into the aquifer and provide recharge benefits for the Subbasin. It requires that the GSA has capacity to capture and divert water to growers and requires willing growers to participate in the program. The MID On-Farm Recharge project assumes that growers would operate existing irrigation systems on their fields when MID is able to provide water.

Table 4-14. MID Groundwater Recharge Basin Project Costs.

Item	Total Cost	Year Incurred	Notes[1]
Recharge Basin Rehabilitation			
Capital Costs	$64,000	Complete	Cost to rehab existing basin
O&M costs			
Purchase Water	$308,500 per year	Annual average	$38.54 per AF, incurred when water is available
Conveyance O&M	$126,000 per year	Annual average	$25 per AF cost to convey, incurred when water is available;
Ellis Basin			
Capital Costs	$24,000	Complete	Does not include land acquisition
O&M costs			
Purchase Water	$9,500 per year	Annual average	$38.54 per AF, incurred when water is available
Conveyance O&M	$6,000 per year	Annual average	$25 per AF cost to convey, incurred when water is available
Berry Basin			
Capital Costs	$15,000	Complete	Does not include land acquisition
O&M costs			
Purchase Water	$950 per year	Annual average	$38.54 per AF, incurred when water is available
Conveyance O&M	$600 per year	Annual average	$25 per AF cost to convey, incurred when water is available
Allende Basin Acquisition			
Capital Costs	$200,000	Complete	Does not include land acquisition
O&M costs			
Purchase Water	$40,500 per year	Annual average	$38.54 per AF, incurred when water is available
Conveyance O&M	$26,000 per year	Annual average	$25 per AF cost to convey, incurred when water is available
New Recharge Basins Constructed in 2030			
Capital Costs	$1.0 million	2028-2029	For basins to recharge up to 1,150 AF per month
O&M costs			
Purchase Water	$105,500 per year	Annual average	Assume half is CVP 215, half is other flood flow, incurred when water is available
Conveyance O&M	$137,000 per year	Annual average after 2040	$25 per AF cost to convey, incurred when water is available
New Recharge Basins Constructed in 2040			
Capital Costs	$14.2 million	2038-2039	For basins to recharge up to 12,000 AF per month
O&M costs			
Purchase Water	$3.2 million per year	Annual average	Assume half is acquired from other users, half is other flood flow, incurred when water is available
Conveyance O&M	$547,500 per year	Annual average after 2040	$25 per AF cost to convey, incurred when water is available

Notes: (1) MID O&M costs will be greater than $25 per AF and will be assessed as part of more detailed project development.

On-Farm Recharge imposes additional management costs on the GSA and additional operating costs on the grower to divert water, manage fields, and operate irrigation systems. MID will evaluate incentive structures to encourage growers to participate in the program.

MID has been and will implement two On-Farm Recharge projects in its service area to increase groundwater recharge. This includes a Phase 1 project that is already operating and a Phase 2, enhanced, project, where MID will also explore incentives to encourage more growers to participate in the program.

4.2.2.1 Project Overview

MID's On-Farm Recharge program would deliver available flood water to agricultural or other suitable land for percolation to groundwater. The project is distinct from dedicated recharge basins (Section 4.1.1) because existing land uses would be maintained, no basins would be constructed, and existing delivery facilities would be used.

MID, in cooperation with Sustainable Conservation, has been researching and implementing the Phase 1 program since 2015. Preliminary feedback indicated that the program could be an affordable and practical water management tool that can assist in moving groundwater basins, including the Madera Subbasin, toward a sustainable balance. Since 2015, interest among MID landowners has continued. MID has signed up close to 150 landowners in the program, many of which own multiple parcels in MID.

MID has been evaluating grower reluctance to participate in the program, including concerns about crop damage and costs, and is evaluating ways to incentivize more growers to participate in the program. Once these incentives are defined MID will implement the Phase 2 program in which additional acres will participate in the program.

4.2.2.2 Implementation

The implementation timeline for MID's On-Farm Recharge program is provided in Table 4-15. Because new facilities are not needed, the project can be implemented relatively quickly. MID implemented the program initially in 2015 and has signed up close to 150 landowners, many of which own multiple parcels throughout MID. The Phase 2 program will be implemented starting in 2025, or as soon as additional incentives and mechanisms are developed by MID.

Construction activities and requirements

On-Farm Recharge requires MID to secure water supply and manage deliveries. Growers make the decision to participate and are required to manage their own fields and operate their own irrigation systems. However, no large-scale construction projects or significant capital outlays are required.

Table 4-15. MID On-Farm Recharge Implementation Timeline.

Phase	Start	End
Permitting and environmental documentation	2015	2025
Financing	NA	NA
Construction	NA	NA
Operation	2015	2040

Water source

Water for recharge is expected to be available from one or more of the following sources:

- Fresno River supplies from Hensley Lake
- CVP supplies from Millerton Lake
- Other water available to MID or purchased by MID

The analysis of benefits below does not account for other potential sources nor for any changes in operations elsewhere in the CVP system that might affect availability of surplus water.

The Phase 1 and Phase 2 projects will compete for water with recharge basins developed by MID, and potentially, other GSAs. However, a preliminary assessment indicates that in very high runoff years water is available for all recharge projects. The GSP analysis of potential yield (benefit) to the entire Subbasin includes the joint effect of all proposed GSA PMAs and therefore already accounts for these interactions.

Conditions or constraints on implementation

On-Farm Recharge requires MID to secure water supply and manage deliveries. Growers are required to manage fields and operate irrigation systems. However, no large-scale construction projects or significant capital outlays are required. Deliveries of flood flows will need to be coordinated with maintenance activities on canals and other delivery facilities, both within MID and, if applicable, Madera Canal operations. The diversions are expected to occur during periods when flow exceeds beneficial or environmental uses.

The Phase 2 program will explore incentives to encourage additional participation. The general incentive structure would need to provide a greater benefit to the landowner than the total cost (including risk) to the grower. MID will evaluate options as it further develops the Phase 2 program.

Permitting process and agencies with potential permitting and regulatory control

MID has legal authority to deliver water to its customers. It could develop additional incentive structures and agreements (Phase 2).

Additional percolation of water on agricultural lands can affect movement of nitrates or other constituents into groundwater.

Project Operations and Monitoring

It is anticipated that the water will be delivered to participating lands that have high percolation rates in the initial program. The Phase 2 program will deliver water to additional acres of suitable farmland. The program can be scaled based on grower interest, water availability, and Subbasin needs for sustainability.

4.2.2.3 Project Benefits

On-farm groundwater recharge will contribute to groundwater sustainability in the Subbasin by replenishing groundwater supplies. The direct recharge benefits of this project are expected to benefit groundwater levels, groundwater storage, subsidence, groundwater quality, and interconnected surface water by augmenting groundwater supplies in the Subbasin.

Groundwater recharge benefits are estimated using available flood flow over the historical water balance period of 1989-2014. This period is representative of long-term average hydrologic conditions in the Subbasin. Based on the analysis, flood releases are expected to occur in approximately 1 out of 3 years. MID may be able to encourage grower participation in the program in drier year conditions, depending on the availability of water supplies and district operations. The average annual benefit is the water year-

type probability weighted average. Based on the probabilities, the expected average annual delivery of water is 510 AF in the Phase 1 program (Table 4-16).

Table 4-16. MID Estimated Average Deliveries by Year Type for Phase 1 On-Farm Recharge Project, in AF per Year.

Year Type	Total Annual Volume	% of Years	Weighted Avg.
W	1,250	35%	441
AN	500	14%	69
BN	0	8%	0
D	0	16%	0
C	0	27%	0
Avg. Annual			**510**

MID will increase grower participation in the Phase 2 program. The program will scale-up the current On-Farm Recharge initiative and is expected to be implemented around 2025. The average annual benefit is the water year-type probability weighted average. Wet, Above Normal, Below Normal, Dry, and Critical year types have historically occurred with a probability of 35%, 14%, 8%, 16%, and 27%, respectively. The average annual yield of the Phase 2 program equals 1,686 AF (Table 4-17).

Table 4-17. MID Estimated Average Deliveries by Year Type for Phase 2 On-Farm Recharge Project, in AFY.

Year Type	Total Annual Volume	% of Years	Weighted Avg.
W	4,000	35%	1,412
AN	2,000	14%	275
BN	0	8%	0
D	0	16%	0
C	0	27%	0
Avg. Annual			**1,686**

Based on the historical hydrology and assuming no other changes to system operations, the average annual yield of the Phase 1 program equals 510 AF. The average annual yield of the Phase 2 program equals 1,686 AF. The combined MID On-Farm Recharge program will generate an additional 2,196 AFY starting in 2025 and continuing through the GSP implementation timeline.

4.2.2.4 Project Costs

Estimated project costs for Phase 1 and Phase 2 of the MID On-Farm Recharge program are summarized in Table 4-18. Capital costs of the MID On-Farm Recharge program are expected to be minimal because the project uses existing MID facilities and grower irrigation systems. No construction or land acquisition costs are currently anticipated. It is also assumed that no additional permitting costs would be incurred.

Recharge volumes are estimated using existing delivery facilities. Operating costs anticipated with this project are the cost of the water, pumping costs, and labor to irrigate. Table 4-18 provides estimates of these costs for the Phase 1 and Phase 2 projects. Water costs in the table represent CVP 215 water costs, though the programs will likely acquire a mix of CVP 215 water, other flood flow at a potentially low acquisition cost, and water acquired from other water suppliers at much higher market prices.

Table 4-18. Estimated Project Costs for MID On-Farm Recharge Project.

Item	Total Cost	Year Incurred	Notes[1]
Phase 1 Project			
Capital Costs	none	NA	Project uses existing district facilities and grower systems
O&M Costs			
Purchase Water	$20,000 per year	Annual average.	Assume cost of CVP 215 water, though water may be a mix of sources; incurred when water is available
District conveyance and grower costs	$25,500	Annual average	$25 per AF District charge to convey, plus $25 per AF to compensate for grower costs, incurred when water is available
Phase 2 Project			
Capital Costs	none	NA	Project uses existing district facilities and grower systems
O&M Costs			
Purchase Water	$65,000 per year	Annual average.	Assume cost of CVP 215 water, though water may be a mix of sources; incurred when water is available
District conveyance and grower incentive	$126,500 per year	Annual average	$25 per AF District charge to convey, plus $50 per AF incentive payment to compensate for grower costs, incurred when water is available

Notes: (1) MID O&M costs will be greater than $25 per AF and will be assessed as part of more detailed project development.

For the Phase 1 program, costs include an assumed $25 per acre-foot for district conveyance, pumping, and maintenance, plus $25 per acre-foot incurred by growers to manage the water on their fields. MID will assess actual O&M and water purchases costs as the program is more fully developed. This may include additional incentives under the Phase 2 Flood-MAR program.

4.2.3 MID System Improvements and Programs

MID will implement a series of projects to improve operations and better manage ground and surface water supply within its service area. This includes capital projects, some of which are partially funded through grants and many of are completed or are currently under development, as well as new programs to evaluate incentives and other changes to better manage surface water within MID.

4.2.3.1 Project Overview

The MID system improvements and programs project includes five separate activities that MID will implement as part of the GSP:

- **MID Pipeline Project**. Rehabilitate aging pipelines to reduce losses.
- **WaterSMART Pipeline Project**. Rehabilitate additional pipelines to reduce losses and allow MID to deliver water later in the irrigation season.
- **WaterSMART SCADA Project**. Improve MID water management, reduce losses, and allow MID to deliver water later in the irrigation season.
- **Water Supply Partnerships Project**. MID will identify and purchase or exchange additional water supplies from partnering districts.
- **Increase MID grower utilization of surface water supplies**. MID will explore incentives to encourage more MID growers to take district surface water and reduce groundwater pumping.

MID system improvement projects and programs are similar in operation and implementation. A general description of the projects is provided. Detailed expected benefits, operational descriptions, and estimated costs are provided for each individual project.

MID Pipeline Project

MID Main I Canal crossings at Road 23, Avenue 11, Avenue 10-1/2, and Avenue 10 were originally constructed in the early 1970s and have been patched numerous times over the years due to excessive cracks and leaking. These Techite pipe crossings have reached the end of their service lives and needed replacement. The project provides benefits to the Subbasin by reducing system losses.

Historically, the tail end of the Main I Canal, which conveys most of the City of Madera stormwater, had been subject to multiple canal breaks during the flood season because of the close proximity to Cottonwood Creek, Road 23 shoulder, and the Lateral 24.2 spill pipeline. The canal also had operational issues and constraints related to MID deliveries and created unnecessary losses. The 36-inch pipeline replaced the four failing road crossings, two check structures, and eliminated the risk of canal breaks and improved operations between Avenues 10 and 11. The pipeline design and construction were completed in-house by MID staff in 2016.

WaterSMART Pipeline Project

In January 2016, MID staff prepared an application for two projects under the U.S. Bureau of Reclamation (USBR) WaterSMART: Water and Energy Efficiency grant program. One project was titled "Lateral 24.2-17.0 Pipeline Improvement Project." MID was awarded funding for the project.

The project redeveloped approximately 6,500 feet of the existing Lateral 24.2-17.0 canal into a 36-inch pipeline to reduce losses and improve operational efficiency. The project extends the irrigation season for growers and prevents spills leaving the Subbasin, which allows growers to utilize more surface water thereby pumping less groundwater.

WaterSMART SCADA Project

In January 2016, MID staff prepared an application for two projects under the U.S. Bureau of Reclamation (USBR) WaterSMART: Water and Energy Efficiency grant program. One project was titled "Irrigation Water Conservation and Canal Automation Improvement Project." MID was awarded funding for the project.

The project expands the District's existing Supervisory Control and Data Acquisition (SCADA) system by installing 14 new solar-powered automated gates and meters throughout the District. The gates and meters can be remotely monitored and controlled by smart phones and are programmed to automatically open and close to maintain a constant flow within +/- 2.5% accuracy, regardless of varying upstream water level. The project extends the irrigation season for growers and prevents spills leaving the Subbasin, which allows growers to utilize more surface water thereby pumping less groundwater.

Water Supply Partnerships

MID will obtain additional water through win-win exchanges and partnerships both within and outside of the Subbasin. MID is continually evaluating potential partnership opportunities. This will provide benefits by increasing water supply in the MID service area, both for direct irrigation use and groundwater recharge. MID recognizes that competition for water supply partnerships will increase as GSPs are implemented by its partner agencies. MID will continue to monitor the market to assess partnerships and increasing water purchase costs.

Incentive Programs

MID will evaluate programs to encourage more MID growers to utilize surface water supplies instead of groundwater. MID will be conducting studies to identify potential incentive structures and assess the relative costs and benefits of different alternatives. The project benefits MID by reducing groundwater pumping.

4.2.3.2 Implementation

Implementation will be staged based on the existing development of each of the projects, having already begun and continuing through 2030. Implementation for each of the MID operation and incentive projects is as follows:

- **MID Pipeline**. Upgrade of crossing and canal completed 2016.
- **WaterSMART Pipeline**. The WaterSMART pipeline upgrade completed in 2019.
- **WaterSMART SCADA**. SCADA upgrades, funded in part with the WaterSMART grant, completed in 2019.
- **Supply Partnerships**. MID has started working with partners to bring new water supply into the Subbasin. MID will expand this program in the future.
- **Incentive Programs**. MID will conduct a study to identify appropriate incentive structures to encourage more growers to utilize surface water. Findings of the study will be implemented immediately thereafter, and Subbasin water supply benefits will be realized starting in 2022.

Timeline

Table 4-19 summarizes the implementation timeline for all operation and incentive projects implemented by MID. Acquisition, permitting, and documentation started in 2016 or earlier will continue through 2022. MID pipeline upgrades have been operational since 2016. WaterSMART system upgrades to pipelines and SCADA were completed in 2019. Additional water purchases will start in 2020 and the MID incentive program will start in 2022.

Table 4-19. MID System Improvements and Programs Implementation Timeline.

Phase	Start	End
Permitting and environmental documentation	2016	2040
Financing	2016	2040
Construction	2016	2040
Operation	2016	2040

Construction activities and requirements

Construction activities vary by project. General activities include initial feasibility assessment, permitting, environmental review, earthwork, pipes, and installation. Details on construction activities, schedule, and project costs will be developed as part of final project design for each project by MID.

MID does not anticipate construction activities under the partnership project and incentive program beyond standard maintenance of existing facilities.

Water source

Additional water for the pipeline and SCADA projects, as well as the grower incentive initiative, is expected to be available from existing MID sources. MID has a contract for CVP Class 1 and Class 2 water, and it can receive CVP surplus flows when available, along with other supplies available to MID. Partnership opportunities will increase purchases from other water suppliers across the state. Water sources for each recharge project include:

- **MID Pipeline**. During the irrigation season the project will reduce losses and provide additional water to fields by lengthening the season, increasing the use of available water supplies. MID expects the project will provide water in all year types.
- **WaterSMART Pipeline**. During irrigation season the project will reduce losses and provide additional water to fields by lengthening the season, increasing the use of available water supplies. MID expects the project will provide water in all year types.
- **WaterSMART SCADA**. During irrigation season the project would lead to longer season by allowing growers to receive more water than before, reducing losses and spill which leaves the Subbasin. MID expects the project will provide water in all year types, increasing the use of available water supplies.
- **Supply Partnerships**. Purchases from partner agencies will be identified by MID. Supplies are generally available under all water year conditions, although the cost can increase significantly in Dry and Critically Dry years.
- **Incentive Programs**. MID anticipates that water supply for the incentive program would be available under all water year types. MID estimates that even in Dry and Critically Dry years its growers could pump less groundwater and use more MID surface water.

Conditions or constraints on implementation

All the operations and incentive projects implemented by MID are planned to be implemented by 2040. Implementation of this set of projects does not depend on the performance of other projects or activities. However, the water supply source for each project does depend on the performance of other MID projects or activities. For example, purchased water may be used for recharge or additional surface water deliveries under a MID incentive program.

Permitting process and agencies with potential permitting and regulatory control

The following agencies have potential permitting roles for different projects: Madera County, US Bureau of Reclamation, other entities depending on agencies with authority over water supply available to MID trading partners. Water transfers with willing partners will require satisfying requirements to transfer water which will depend on the source of the supply and nature of the transfer. Incentive programs may require a rate study to justify any fees or financial incentives offered by MID.

4.2.3.3 Project Operations and Monitoring

MID will operate and monitor the MID Pipeline, WaterSMART Pipeline, and WaterSMART SCADA projects within existing district operations. The three projects provide additional operational flexibility to MID, allowing it to deliver surface water to growers longer into the season and preventing losses. MID will operate the projects in coordination with the rest of its system to maximize surface water supply deliveries to growers. In turn, growers will pump less groundwater, and this results in a benefit to the Subbasin. MID will not monitor the specific performance of the projects but will continue to monitor and manage its water supplies with these integrated projects. MID expects these projects to provide water supply benefits in all water year types.

Incentive programs to encourage growers to use MID surface water in lieu of pumping groundwater will be developed by MID. MID will initiate studies in 2020 and implement programs as they are developed. Incentive programs could include pricing mechanisms to make MID surface water less expensive or other financial incentives. MID will identify, implement, and monitor any programs that it develops. The incentive program will be designed to provide water under all year types.

MID is planning to identify and purchase water from willing partners under all water year types. Water purchase costs are expected to be significantly higher in Dry and Critically Dry years. MID will provide any purchased water supplies directly to growers (in lieu of groundwater pumping), or depending on the timing and availability, use the purchased water for groundwater recharge. MID will monitor the program by tracking and reporting how water purchased from willing partners is used within the District.

4.2.3.4 Project Benefits

MID's system improvements and program projects provide groundwater benefits in different ways. Pipeline projects provide in-lieu recharge benefits by allowing MID to deliver surface water to growers longer into the season, and by reducing losses of available surface water. The SCADA project also provides in-lieu recharge benefits by improving MID's operational flexibility and allowing MID to deliver more surface water to growers. MID incentive programs will encourage growers to use more surface water and pump less groundwater. The in-lieu recharge benefits of these projects are expected to benefit groundwater levels, groundwater storage, subsidence, groundwater quality, and interconnected surface water by increasing surface water use and reducing groundwater pumping.

Based on an analysis of MID operations and project implementation developed by MID, the average annual gross benefit of each operation and incentive project is as follows:

- **MID Pipeline**. 420 AF.
- **WaterSMART Pipeline**. 875 AF.
- **WaterSMART SCADA**. 1,225 AF.
- **Supply Partnerships**. 3,990 AF (1,995 AF by 2020 and another 1,995 by 2025).
- **Incentive Programs**. 5,005 AF.

These expected values are averages over all year types (Wet, Above Normal, Below Normal, Dry, and Critical), weighted by the probability of each year type. Tables 4-20 through 4-24 below summarize average annual water supply benefits, shown as the average delivery by year type. The reliability of the source water is based on historical hydrology being a good projection of future hydrology. In addition, the reliability depends on future water supply management, including changes to the CVP system and the San Joaquin River Restoration Program that may affect MID operations.

Table 4-20. MID Estimated Average Yield by Year Type, in AFY — MID Pipeline Project.

Year Type	Total Annual Volume	% of Years	Weighted Avg.
W	420	35%	148
AN	420	14%	58
BN	420	8%	33
D	420	16%	66
C	420	27%	115
Avg. Annual			**420**

Table 4-21. MID Estimated Average Yield by Year Type, in AFY — WaterSMART Pipeline Project.

Year Type	Total Annual Volume	% of Years	Weighted Avg.
W	875	35%	309
AN	875	14%	120
BN	875	8%	69
D	875	16%	137
C	875	27%	240
Avg. Annual			**875**

Table 4-22. MID Estimated Average Yield by Year Type, in AFY — WaterSMART SCADA Project.

Year Type	Total Annual Volume	% of Years	Weighted Avg.
W	1,225	35%	432
AN	1,225	14%	168
BN	1,225	8%	96
D	1,225	16%	192
C	1,225	27%	336
Avg. Annual			**1,225**

Table 4-23. MID Estimated Average Supply by Year Type, in AFY — Water Supply Development-Partnerships.

Year Type	Total Annual Volume	% of Years	Weighted Avg.
Completed by 2020			
W	1,995	35%	704
AN	1,995	14%	274
BN	1,995	8%	156
D	1,995	16%	313
C	1,995	27%	548
Avg. Annual			**1,995**
Additional Completed by 2025			
W	1,995	35%	704
AN	1,995	14%	274
BN	1,995	8%	156
D	1,995	16%	313
C	1,995	27%	548
Avg. Annual			**1,995**

Table 4-24. MID Estimated Average Yield by Year Type, in AFY — Incentive Programs.

Year Type	Total Annual Volume	% of Years	Weighted Avg.
W	5,005	35%	1,766
AN	5,005	14%	687
BN	5,005	8%	393
D	5,005	16%	785
C	5,005	27%	1,374
Avg. Annual			**5,005**

4.2.3.5 Project Costs

Estimated project costs for MID system improvements and program projects are shown in Table 4-25. MID is continuing to develop many of these projects. Costs will be refined under ongoing development efforts. All project costs have been indexed to current (2019) dollars for consistency of comparison.

The pipeline and SCADA projects are complete or nearly complete. Capital costs shown for these projects reflect estimated material costs (pipeline) and total project costs (including Reclamation cost share) for both WaterSMART projects (pipeline and SCADA).

The water supply partnerships and incentive programs will deliver additional water acquired from willing sellers. MID does not anticipate any capital expenditures under these projects. Costs include MID O&M to deliver the water plus the cost to acquire the water at market prices that vary by year type. The water prices paid are averages weighted by year type. Future market conditions and the terms of agreements that MID can reach with its partners will determine the actual cost. MID will continue to work with partners to identify opportunities.

4.2.4 Project Financing

Pursuant to 23 CCR §354.44 and §354.6, MID has evaluated and described the ability to cover project costs. Some projects are complete and other projects are still being assessed, and feasibility studies are being refined or developed, a general description of how MID will cover project costs is presented. MID will conduct economic and fiscal feasibility studies as part of its ongoing planning efforts to better understand willingness and ability to pay for the projects included in the GSP.

MID will pursue available state and federal grants or loans to help construct projects. This may include grant funding for planning studies to support the development of proposed management actions, including its On-Farm Recharge program and incentives to increase surface water deliveries within the district. Operation and maintenance costs will be paid using revenues raised through water rates and/or fees and assessments. MID will conduct the necessary studies and decision processes (including Proposition 218 elections if necessary) to approve rates, fees, or assessments to provide the required funding. MID water users have, in the past, approved assessments to fund projects.

Table 4-25. MID System Improvements and Programs Costs.

Item	Total Cost	Year Incurred	Notes[1]
MID Pipeline Project			
Capital Costs	$556,000	2016-2020	The project is complete
O&M costs	none		No additional O&M cost
WaterSMART Pipeline Project			
Capital Costs	$1.3 million	Complete	Operation to begin in 2019; Includes Reclamation and MID costs
O&M costs	none		No additional O&M cost
WaterSMART SCADA Project			
Capital Costs	$1.2 million	Complete	Operation to begin in 2019; Includes Reclamation and MID costs
O&M costs	none		No additional O&M cost
Water Supply Partnerships Completed by 2020			
Capital Costs	none		
O&M costs			
Purchase Water	$1.2 million per year	Annual average	Include water purchase cost from willing sellers, weighted by year type
Conveyance O&M	$50,000 per year	Annual average	$25 per AF cost to convey, incurred when water is available
Water Supply Partnerships Completed by 2025			
Capital Costs	none		
O&M costs			
Purchase Water	$1.2 million per year	Annual average	Include water purchase cost from willing sellers, weighted by year type
Conveyance O&M	$50,000 per year	Annual average	$25 per AF cost to convey, incurred when water is available
Incentive Programs			
Capital Costs	none		
O&M costs			
Purchase Water	$2.95 million per year	Annual average	$590 per AF acquired from willing sellers, weighted by year type
Conveyance O&M	$125,000 per year	Annual average	$25 per AF cost to convey, incurred when water is available

Notes: (1) MID O&M costs will be greater than $25 per AF and will be assessed as part of more detailed project development.

4.2.5 Coordination with Other GSAs and Planning Agencies

This Joint GSP is the coordinated GSP for the four Joint GSP GSAs in the Madera Subbasin (City of Madera GSA, Madera Irrigation District GSA, Madera County GSA, and Madera Water District GSA). A coordination agreement will be executed by the coordinating GSAs with the other three GSAs in the Subbasin (Gravelly Ford Water District GSA, New Stone Water District GSA, and Root Creek Water District GSA) detailing required GSA and GSP cooperation.

In addition, MID works cooperatively with other districts to develop, provide, and manage water supply. For example, MID and MWD have been coordinating on the development of long-term projects to improve surface deliveries to MWD such as a new water supply agreement and the Madera Lake pipeline (see Section 4.1).

4.2.6 MID Projects Already Implemented: Madera Ranch Annexation

MID has been proactive in developing projects to help sustainably manage groundwater within the MID service area. All the projects that MID has already implemented were completed after the historical base period used in the GSP to develop the historical and current water budgets (post 2015), thus provide additional groundwater benefit to MID. One project that does not provide any new water to the Subbasin but is important to acknowledge is the Madera Ranch Annexation.

In 2015, MID annexed 18 parcels, totaling 10,485 acres, owned by the District since 2005 within the area known as Madera Ranch. The annexation provided MID with jurisdiction over the parcels.

The Madera Ranch is located in Madera County, approximately 5 miles southwest of the City of Madera and 10 miles northwest of the City of Fresno. The Fresno River is located to the north and the San Joaquin River is located to the south of the project site. The subject property is located east of Firebaugh Boulevard and south of Avenue 12. The subject property adjoins the existing boundaries of the MID and Gravelly Ford Water District. Adjacent land uses surrounding the property are agricultural with various agricultural zoning designations. Currently, the project site is used for cattle grazing and the project maintains the existing, non-irrigated land use and zoning designations. The project has helped to limit groundwater demand in the Subbasin by retaining non-irrigated land uses on the project site. By limiting groundwater demand, the project provides benefits to groundwater levels, groundwater storage, and subsidence.

4.3 City of Madera GSA

The City of Madera GSA has developed two projects for the GSP, one that is already complete and another that is currently being implemented. The project that is fully complete, Berry Basin, is a recharge basin implemented in cooperation with Madera Irrigation District. The project involves delivering water to the basin in wet, above normal, and below normal years. The expected recharge averaged over all years is 48 AFY, with half credited to the City of Madera and half to MID.

A detailed description of the project, pursuant to 23 CCR § 354.44 and § 354.6, is provided above under MID projects (Section 4.2). Table 4-26 summarizes the expected annual benefit of the project that accrues to the City of Madera.

At the time of initial GSP development, project planning was still in development, so complete information on project planning, operations, costs, and other details were not finalized. Sections 4.9 and 4.10 summarize PMA implementation efforts and updates from the time of initial GSP development through the latest GSP Annual Report (water year 2022). A description of how all the PMAs operate as part of the overall Joint GSP is provided in Chapter 5, Plan Implementation.

Table 4-26. City of Madera Estimated Average Recharge in Berry Basin by Year Type, in AFY.

Year Type	Total Annual Volume	% of Years	Weighted Avg.
W	55	35%	19
AN	30	14%	4
BN	10	8%	1
D	0	16%	0
C	0	27%	0
Avg. Annual			**24**

4.3.1 Installation of Water Meters and Volumetric Billing

The City of Madera GSA installed water meters between2011 and 2018 and implemented a volumetric billing process for single-family users in 2015. The City of Madera water deliveries on a per capita basis for 2017 to average per capita water deliveries from 1999 through 2012 are significantly less for both inside and outside uses (Table 4-27).

Table 4-27. City of Madera Water Deliveries.

Days	Month	Gallons per Day per Capita (GPDC)					Gallons (2017 pop.)		AF (2017 pop.)	
		Baseline (1999-2012)	Future (2017-2018)	Savings	Savings Indoor	Savings Outdoor	Savings Indoor	Savings Outdoor	Savings Indoor	Savings Outdoor
31	1	115	74	41	41	0	82,884,157	0	254	0
28	2	115	79	36	36	0	65,666,360	0	202	0
31	3	140	78	62	40	22	81,361,654	42,997,652	250	132
30	4	185	99	86	40	46	78,737,084	89,152,185	242	274
31	5	254	148	106	40	66	81,361,654	134,039,273	250	411
30	6	312	160	152	40	112	78,737,084	217,696,436	242	668
31	7	338	183	155	40	115	81,361,654	231,704,936	250	711
31	8	324	167	157	40	117	81,361,654	235,380,469	250	722
30	9	284	146	138	40	98	78,737,084	190,677,719	242	585
31	10	214	119	95	40	55	81,361,654	109,179,746	250	335
30	11	152	95	57	40	17	78,737,084	33,233,600	242	102
31	12	121	78	44	44	0	88,498,763	0	272	0
Avg/Total		213	119	94	40	54	958,805,886	1,284,062,016	2,946	3,940
Ratio Indoor/Outdoor									43%	57%

The City of Madera has installed approximately 13,000 meters, with an additional 250 that will be installed over the coming years. The total cost of the project equals $11 million. The City of Madera expects to complete installation of meters on unmetered services including City medians, parks, facilities and landscape districts. This includes up to 200 private accounts and approximately 50 public water services. Many older parcels have cross connections that will also be addressed thereby increasing individual accountability for water usage and ideally leading to lower water usage. Cost estimates range from $400,000 to $600,000 for the additional meters.

The outdoor savings in applied water includes reductions in turf consumptive use and deep percolation. Assuming 85 percent efficiency, 591 AF of the applied water savings is reduced deep percolation. The remaining 3,350 AF is reduction in consumptive use, or a reduction in the water that leaves the Subbasin.

The project provides in-lieu recharge benefits by reducing consumptive use, and consequently reducing demand for groundwater – the water supply source used within the City of Madera. The in-lieu recharge benefits of the project are expected to benefit groundwater levels, groundwater storage, subsidence, groundwater quality, and interconnected surface water by reducing demand for additional groundwater pumping.

4.4 Madera County GSA

Madera County GSA (Madera County) has identified four projects and a substantial demand management program that it will implement as part of the GSP.

A water purchase program would seek to acquire water from outside Madera County and provide direct or in-lieu recharge benefits to the Subbasin. A second project would use flood flows from Millerton releases to spread onto participating lands for flood managed aquifer recharge (Flood-MAR). Two additional projects would construct basins to recharge winter floodwater diverted from the Chowchilla Bypass. For purposes of evaluating the timing of the projects, one would be constructed in 2025 and the other in 2040.

As a primary element of its efforts to become sustainable, Madera County will implement a demand management program that would oversee a managed reduction in the volume of groundwater consumed by irrigated agriculture during the 20-year GSP implementation period – terminating in about a 50% reduction from estimated current consumptive use quantities. This will be achieved through programs that will be developed and implemented during the first year following adoption of the GSP, and may impose groundwater pumping limits, allocate pumping credits to parties based on those limits, and potentially allow groundwater users to buy, sell, or carry over pumping credits. This section provides a general overview of demand management and how it could be implemented by Madera County GSA and potentially by other GSAs in the Subbasin to achieve sustainability objectives. Madera County is currently working with stakeholders to develop program-specific parameters.

The PMA descriptions are based on information developed during the initial GSP development process and, where applicable, other studies. Water available for these PMAs is evaluated in combination with other projects in the GSP.

At the time of initial GSP development, planning for the PMAs was at varying stages of development, so complete information on construction requirements, operations, costs, permitting requirements, and other details were not available. Sections 4.9 and 4.10 summarize PMA implementation efforts and updates from the time of initial GSP development through the latest GSP Annual Report (water year 2022). A description of how these PMAs fit and coordinate with other Subbasin PMAs is provided in Chapter 5, Plan Implementation.

4.4.1 Water Purchase for Direct or In-Lieu Recharge

Madera County will develop partnerships and import additional water into Madera County for direct or in-lieu recharge. The project would purchase additional water supplies that would be delivered to Madera County parcels near existing Reclamation and Madera Irrigation District (MID) facilities. Madera County will work with Reclamation, MID, and other potential partners to identify sources of supply, costs, and wheeling agreements.

4.4.1.1 Project Overview

Madera County would directly acquire or facilitate the acquisition of new surface water supplies that would be available for diversion from Millerton Lake or other sources during the irrigation season. Madera County estimates that 3,500 to 9,000 AF could be acquired in one year, but on average the project would provide about 3,600 AFY in in-lieu recharge.

The project water would be acquired from a water supplier with rights/contracts for water from Millerton, or from another water supplier whose supply can be exchanged with water from Millerton. The water would be conveyed to Madera County parcels that are near an existing major water delivery system (e.g.

Madera Canal, MID delivery system, natural stream course). Water would be conveyed to the various locations under a conveyance agreement, as may be appropriate. Diversion and conveyance facilities would be constructed to serve the lands not currently within the delivery system of a district.

4.4.1.2 Implementation

The County will contact (either directly or in coordination with MID) potential sellers of water delivered from Millerton and, if necessary, with other sellers of water that can be delivered from Millerton via exchange agreements. Diversion and conveyance facilities would be constructed to serve the lands. The County will negotiate operation and conveyance agreements to deliver the water to parcels within the Madera County area east of Highway 99. The exact parcels to receive the water have yet to be identified. To minimize costs, Madera County intends to serve parcels with irrigation systems accessible within ¼ mile of a conveyance pathway (e.g. Madera Canal, MID channel, or natural stream course).

The implementation timeline for this project is summarized in Table 4-28. Madera County has already started working with partners to identify potential purchases. Implementation of the project would start immediately in 2020 and continue through full development of the project by 2025.

Table 4-28. Water Purchase for Direct or In-Lieu Recharge Implementation Timeline.

Phase	Start	End
Permitting and environmental documentation	2020	2022
Financing	2022	2023
Construction	2023	2024
Operation	2025	On going

Construction activities and requirements

Construction would be required to divert water from existing canals or streams and convey the water to served lands. Depending on the expected frequency and duration of diversions, both temporary and permanent diversion structures could be used. Madera County will work with MID to identify parcels that are located near existing MID facilities and build necessary infrastructure to serve each parcel. This would include conveyance and all other necessary agreements. Madera County will also work directly with Reclamation to identify and potentially convey to parcels directly adjoining Reclamation owned facilities.

Water source

The project intends to acquire water from Millerton by agreement with an existing CVP contractor, or from other sources that could result in water supplies available in Millerton for delivery. This could include any water that can be conveyed to the County via exchange agreements, including water from potential new projects such as Sites Reservoir.

Conditions or constraints on implementation

A necessary requirement for this project is the availability of water for purchase. Construction of the diversion facilities would not be justified without reasonable access to water. The cost of the water to growers receiving the water could also be an impediment to participation. Delivery of acquired water must be within the capability of existing facilities and reasonably assured by conveyance agreements.

Permitting process and agencies with potential permitting and regulatory control

The project will require conveyance and other agreements to allow the use of facilities to route the water to the new diversion locations. The project will require coordination with Reclamation for scheduling the storage and delivery of water within Millerton or to facilitate exchanges of water acquired from more distant parts of the Central Valley.

The following agencies have potential permitting roles for the project: Madera County, Madera Irrigation District, and US Bureau of Reclamation. Depending on construction requirements for needed delivery infrastructure, an environmental review process under CEQA and/or NEPA could be required. Water transfers with willing partners will require satisfying requirements to transfer water which will depend on the source of the supply and nature of the transfer.

4.4.1.3 Project Operations and Monitoring

Between 3,500 and 9,000 AF would be targeted for acquisition in all year types except wet years, adjusted as appropriate for hydrologic conditions that affect water supply availability. The water would be delivered during the irrigation season using existing conveyance facilities, focusing on the early and later portions of the season when capacity in conveyance facilities may be more available. To minimize costs, Madera County intends to serve irrigated lands accessible within ¼ or ½ mile of a conveyance pathway (e.g. Madera Canal, MID facilities, or natural stream course). The surface water would be provided directly for irrigation, thereby providing in-lieu recharge of groundwater that would otherwise have been pumped. Future extraction of the in-lieu recharged groundwater will be done by water users within Madera County. If allocation of the in-lieu recharged groundwater is determined to be necessary, groundwater extraction will be monitored and enforced by Madera County with meters installed on individual wells.

4.4.1.4 Project Benefits

Table 4-29 summarizes the expected water purchases by year type. Expected average annual water purchases equal 3,608 AF. To the extent the delivered water substitutes for groundwater, it provides in-lieu recharge equal to the net amount of avoided pumping (gross pumping minus return percolation from the pumped water) plus the percolation from applying the surface water. Therefore, the total recharge (in-lieu plus direct percolation) is equal to the amount of surface water purchased and delivered. The in-lieu recharge benefits of this project are expected to benefit groundwater levels, groundwater storage, subsidence, groundwater quality, and interconnected surface water by increasing surface water use and reducing groundwater pumping.

Table 4-29. Madera County Estimated Average Deliveries by Year Type for Water Purchases, in AFY.

Year Type	Total Annual Volume	% of Years	Weighted Avg.
W	0	35%	0
AN	5,000	14%	686
BN	7,000	8%	549
D	9,000	16%	1,412
C	3,500	27%	961
Avg. Annual			**3,608**

4.4.1.5 Project Costs

The estimated costs of this project are summarized in Table 4-30. Project capital costs will include the cost of delivery infrastructure to Madera County parcels. It is assumed that the turnout consists of a canal gate and an open flow propeller meter. If it is necessary to pump water to the field, capital costs may include an in-line propeller meter or mag meter. Madera County is working with partners to define the specific parameters of the project and refine initial project cost estimates. An estimated capital cost of $300,000 for a total of six turnouts and limited conveyance infrastructure is assumed for initial planning purposes.

Annual operating costs of the water purchase project include wheeling agreement cost, other delivery costs (if pumping water is required), and the water purchase cost. The value of water supply is high in this region, especially in critical years. Current estimates of water purchased from existing users under SGMA implementation range from $270 per acre-foot in wet years to over $1,100 in critical years. The weighted average water purchase cost equals $2.4 million per year. An additional cost of $25 per acre-foot is included to convey the water to the fields. All costs are reported in current 2019 dollars.

Table 4-30. Estimated Project Costs for Madera County Water Purchases for Direct or In-Lieu Recharge.

Item	Total Cost	Year Incurred	Notes
Capital Costs	$300,000		Assuming six turnouts and limited conveyance infrastructure
O&M Costs			
Purchase Water	$2.4 million	Annually	Water purchase cost averaged over different year types.
Conveyance O&M	$90,000	Annually	Assume $25 per AF charge to convey including wheeling and delivery

4.4.2 Madera County Import and Recharge of Millerton Flood Releases

The import and recharge of Millerton flood releases project is similar to the Madera County water purchase project (Section 4.4.1), except Madera County would target water (CVP Section 215 supply) that is less expensive than direct transfer agreements with partners, and the water would likely be used for direct recharge, rather than in-lieu of pumped groundwater for direct irrigation events.

4.4.2.1 Project Overview

Through modifications to its existing CVP contract, Madera County would request CVP Section 215 flood water when available, either on its own or partnered with another contractor (Reclamation has previously indicated 215 water would be available in 10,000 acre-foot blocks). Between 2,000 and 10,000 AF per month would be targeted for acquisition when available in wet and above normal years. A total of 20,000 AF would be targeted during wet years, and the expected benefit, averaged over all year types, is about 7,000 AFY.

The water would be conveyed to Madera County recharge basins or irrigated parcels (Flood-MAR) that are near an existing major water delivery system (e.g. Madera Canal, MID delivery system, natural stream course). Water would be conveyed to the various locations under a conveyance agreement, as may be appropriate. Turnouts and conveyance facilities would be constructed to deliver water to these parcels, potentially using the same facilities that serve surface water during the irrigation season (see prior project).

4.4.2.2 Implementation

Project implementation includes securing water supply, partnerships, wheeling agreements, and building delivery facilities and recharge ponds (where necessary). Madera County will negotiate operation and conveyance agreements to deliver the water to parcels. The exact parcels to receive the water have yet to be identified. To minimize costs, Madera County intends to serve parcels within ¼ or ½ mile of a conveyance pathway (e.g. Madera Canal, MID channel, or natural stream course) that can either construct recharge basins or participate in Flood-MAR programs.

The timeline for implementation of this project is summarized in Table 4-31. Madera County would construct necessary basins, dry-wells, and conveyance facilities to deliver the water for recharge. The exact mix of facilities used for recharge will be determined during project planning in 2020 and 2021. The project will be fully operational by 2025.

Table 4-31. Import and Recharge of Millerton Flood Releases Implementation Timeline.

Phase	Start	End
Permitting and environmental documentation	2020	2022
Financing	2022	2023
Construction	2023	2024
Operation	2025	On going

Construction activities and requirements

Construction would be required to divert water from an existing canal and convey the water to served lands, basins, or recharge wells. Construction of recharge basins and appurtenant facilities would be required to the extent those are determined to be incorporated into the project. The project description and costs presented herein assume that Madera County would construct dedicated recharge basins for the water.

Water source

Water will be Section 215 CVP water from Millerton, obtained through the County's CVP contract with Reclamation, or through partnership with another CVP Contractor, and delivered through existing facilities utilizing necessary conveyance agreements with MID or others.

Conditions or constraints on implementation

A requirement for this project is the availability of Section 215 water for Madera County. Madera County will use its existing contract with Reclamation and/or an agreement with a contractor willing and able to deliver Section 215 water. Delivery of acquired water must be within the capability of existing facilities and reasonably assured by conveyance agreements.

Permitting process and agencies with potential permitting and regulatory control

Reclamation will have authority over the sale of the Section 215 water, and MID or other parties will require conveyance agreements to allow delivery, in addition to all other necessary agreements. Coordination with the State Water Board may be needed to verify the right to divert the water and avoid potential third-party impacts. Additional percolation of water on agricultural lands can affect movement of nitrates or other constituents into groundwater. Coordination with the Central Valley RWQCB's

Irrigated Lands Regulatory Program (ILRP) may be needed. The project may require an environmental review process under CEQA and would require compliance with NEPA prior to Reclamation selling the water to the County.

4.4.2.3 Project Operations and Monitoring

Between 2,000 and 10,000 AF per month would be targeted for acquisition when water is available in wet and above normal years. For purposes of estimating the benefit this project may provide to the overall Subbasin sustainability goal, water is assumed to be available only in wet years. The water would be conveyed to recharge facilities using existing channels and facilities to the extent feasible. New conveyance would be constructed where needed.

4.4.2.4 Project Benefits

Table 4-32 summarizes the results of an integrated hydrologic analysis of water potentially available by year type and month for this project. All deliveries represent new supplies. Over time, the average delivery, weighted by the probability of different year types, would be about 7,000 AFY.

Surface water supplies made available through this project would provide in-lieu and direct recharge benefits. The recharge benefits of this project are expected to benefit groundwater levels, groundwater storage, subsidence, groundwater quality, and interconnected surface water by increasing surface water use, reducing groundwater pumping, and enhancing groundwater recharge.

Table 4-32. Madera County Estimated Average Deliveries by Year Type for CVP Section 215 Purchases, in AFY.

Year Type	Total Annual Volume	% of Years	Weighted Avg.
W	20,000	35%	7,059
AN	0	14%	0
BN	0	8%	0
D	0	16%	0
C	0	27%	0
Avg. Annual			**7,059**

Recharge basins may also provide environmental benefits by creating seasonal or perennial habitat for wildlife including waterfowl, amphibians, and reptiles and serve as drinking water sources and foraging habitat for mammals.

4.4.2.5 Project Costs

The estimated costs of this project are summarized in Table 4-33. Project capital costs will include the cost of a turnout and other conveyance required to deliver the water to Madera County parcels, in addition to recharge basins that would in total be able to handle up to 10,000 AF per month. Madera County is working with partners to define the specific parameters of the project and refine initial project cost estimates. Project capital costs may be lower if Madera County is able to identify existing recharge areas or find sites suitable for Flood-MAR closer to existing conveyance systems.

Annual operating costs of the Millerton flood release project include wheeling agreement cost, other delivery costs (if pumping water is required), and the water purchase cost. Project O&M costs are shown as annual averages. Costs will vary annually according to year type and availability of water in those years.

Table 4-33. Estimated Project Costs for Recharge of Millerton Flood Releases.

Item	Total Cost	Year Incurred	Notes
Capital Costs	$31.9 million	2023	Basins to recharge up to 10,000 AF per month
O&M Costs			
Purchase Water	$272,000 per year for CVP Section 215 water	Annual average	$38.40 per AF for CVP 215, incurred when water is available
Conveyance O&M	$176,500	Annual average	$25 per AF District charge to convey, incurred when water is available

4.4.3 Madera County Chowchilla Bypass Flood Water Recharge Basins

Madera County will construct additional recharge basins or work with landowners to develop a Flood-MAR program to divert flood flows from the Chowchilla Bypass (Bypass) onto lands in western portions of Madera County. The project will provide benefits by increasing recharge in this area of Madera County.

4.4.3.1 Project Overview

Madera County will divert water from the Bypass into recharge basins, primarily during wet years but also in other years when water is available. The project proceeds in two phases.

The first phase of the project will develop recharge ponds that would be operational by 2025. Basins would have a capacity to recharge up to 36,000 AF in a wet year (12,000 AF per month from February through April). Madera County would construct diversions, delivery facilities, and recharge basins sized to accommodate this recharge rate. The average annual recharge produced will be about 12,700 AF.

The second phase of the project will develop recharge ponds that would be operational by 2040. Basins would be sized to recharge up to 75,000 AF in a wet year (25,000 AF per month from February through April). The average annual recharge produced by the second set of facilities will be about 26,500 AF.

4.4.3.2 Implementation

Implementation for the first set of basins will be staged over a five-year period, beginning in 2020 (Table 4-34). Madera County will conduct a study to identify appropriate recharge sites. Permitting and environmental documentation will be initiated in 2020, and financing for construction will be identified and secured. Construction will occur in 2023 and 2024.

The second set of recharge basins will follow a similar implementation pattern, beginning in 2035. Construction of facilities will begin in 2038. Basins will be operational by 2040.

Table 4-34. Basins to Recharge Floodwater Implementation Timeline.

Phase	First Set of Basins (2030)		Second Set of Basins (2040)	
	Start	End	Start	End
Permitting and environmental documentation	2020	2022	2035	2037
Financing	2022	2023	2037	2038
Construction	2023	2024	2038	2039
Operation	2025	On going	2040	On going

Construction activities and requirements

Construction activities will include building diversions from the Bypass, conveyance to recharge basins, and the recharge basins themselves. The initial set of basins will be in operation by 2025. The second set of basins will begin operation in 2040. Land used for the basins will be selected based on location and suitability for recharge and will likely include land that is currently farmed.

Water source

Flood flow from the Bypass will be diverted during wet years or other periods of high excess flow. This may require new water rights to allow diversion during high flow conditions.

Conditions or constraints on implementation

The projects rely on the availability of flood flow in the Bypass and the availability of suitable land to construct recharge basins. The second set of recharge basins are planned for operation beginning in 2040. This lead time will provide substantial new information on groundwater conditions and trends, allowing for possible re-evaluation of the need for, scale, and best location of future basins.

Permitting process and agencies with potential permitting and regulatory control

The following agencies have potential permitting or partnership roles for the project: Madera County, the Regional Water Quality Control Board, U.S. Bureau of Reclamation, and other partner agencies. It will be necessary to obtain grading permits for construction of the recharge basins. Madera County will coordinate with others to apply for permits required from the State Water Board for diversion of water into the recharge basins.

4.4.3.3 Project Operations and Monitoring

During periods of winter flood flow, water will be diverted into recharge basins or onto lands participating in Flood-MAR. Based on hydrologic analysis, the initial basins will recharge up to 36,000 AF in wet years, about one out of three years. The second set of basins will recharge up to 75,000 AF in wet years, also about one out of three years. Delivery would typically occur during the winter and early spring but could occur any time that surplus water is available.

Extraction of recharged groundwater will be done by water users within Madera County. If allocation of groundwater recharge credits is determined to be necessary, groundwater extraction will be monitored and enforced by Madera County.

4.4.3.4 Project Benefits

Groundwater recharge provided by the project will contribute to groundwater sustainability in the Subbasin by replenishing groundwater supplies. The direct recharge benefits of this project are expected to benefit groundwater levels, groundwater storage, subsidence, groundwater quality, and interconnected surface water by augmenting groundwater supplies in the Subbasin. Based on a hydrologic and operations analysis covering the historical period, the gross yield would average about 12,700 AFY for the first basins and about another 26,500 AFY from the second set of basins (Table 4-35).

Recharge basins may also provide environmental benefits by creating seasonal or perennial habitat for wildlife including waterfowl, amphibians, and reptiles and serve as drinking water sources and foraging habitat for mammals.

The reliability of source water is based on the use of historical hydrology as an indicator of future hydrology. In addition, the reliability depends on future water supply management, including changes to

the CVP system and the San Joaquin River Restoration Program, as well as diversions of other flood flows or sources of water by other GSAs or other entities with rights to that water.

4.4.3.5 Project Costs

The estimated costs of this project are summarized in Table 4-36. Project capital costs will include the cost of a turnout and other conveyance required to deliver the water to Madera County parcels. Details regarding the development of these capital costs are provided in **Appendix 4.A**. Recharge basins would require permitting, land acquisition, earthwork, and site development to connect to the conveyance. Madera County is working with partners to define the specific parameters of the project and refine initial project cost estimates. An estimated capital cost of $67 million for the first phase of recharge basins and $119 million for the second phase of recharge basins (in current 2019 dollars) is used for initial planning purposes.

Annual operating costs include the cost to deliver water to recharge basins and maintain the system. O&M costs may be lower if limited energy costs are required to move water to recharge basins. Madera County is evaluating options and will continue to refine O&M cost estimates.

Table 4-35. Madera County Estimated Average Deliveries by Year Type for Recharge Basins, in AFY.

First Set of Basins			
Year Type	**Total Annual Volume**	**% of Years**	**Weighted Avg.**
W	36,000	35%	12,706
AN	0	14%	0
BN	0	8%	0
D	0	16%	0
C	0	27%	0
Avg. Annual			**12,706**
Second Set of Basins			
Year Type	**Total Annual Volume**	**% of Years**	**Weighted Avg.**
W	75,000	35%	26,471
AN	0	14%	0
BN	0	8%	0
D	0	16%	0
C	0	27%	0
Avg. Annual			**26,471**

Table 4-36. Estimated Project Costs for Basins to Recharge Flood Water from Chowchilla Bypass.

Item	Total Cost	Year Incurred	Notes
First Set of Basins			
Capital Costs	$67 million	2023-2024	For diversion and conveyance facilities and basins to recharge up to 12,000 AF per month
O&M costs			
Conveyance O&M	$318,000 per year	Annual average after 2025	$25 per AF cost to convey, incurred when water is available
Second Set of Basins			
Capital Costs	$118.9 million	2038-2039	For diversion and conveyance facilities and basins to recharge up to 25,000 AF per month
O&M costs			
Conveyance O&M	$1,160,000 per year	Annual average after 2040	$25 per AF cost to convey plus contingency costs, incurred when water is available

4.4.4 Management Action: Demand Management

Madera County has determined that its potential projects are unlikely to generate enough new water to offset the estimated current and projected future overdraft conditions in its GSA. It has decided to implement a management action to gradually reduce groundwater pumping over the GSP implementation period, achieving significant reductions in the consumptive use of groundwater by 2040.

The management action is a demand management (water use reduction) program. In broad terms, demand management can include any water management activity that reduces the diversion, conveyance, or use of irrigation water. However, to be effective for purposes of sustainable groundwater management, demand management must result in a decline in the consumptive use of groundwater pumped and applied for irrigation (pumping net of recharge). Activities that, for example, reduce canal seepage or reduce deep percolation from irrigation will not be effective. They may decrease quantity of water diverted or applied but they also reduce recharge to usable groundwater, so do not improve the net pumping from the aquifer.

Madera County is continuing to work with stakeholders to develop the specific details of the program. A general overview of the proposed program and summary of decisions that had been made as of late May 2019 are summarized in this section.

4.4.4.1 Program Overview

The Madera County demand management program will reduce consumptive water use (measured as evapotranspiration, ET) over the GSP implementation period. Demand management actions that reduce consumptive use can include changing to lower water-using crops, water-stressing crops (providing less water than the crop would normally consume for full yield), reducing evaporation losses, and reducing irrigated acreage. However, Madera County will not dictate which of those reduction methods growers would implement. Madera County's primary approach to demand management is to set demand reduction targets for the GSA service area as a whole, based on conditions in the Subbasin. Achieving the targets can be approached through a variety of methods, including groundwater allocations, internal groundwater markets (e.g. limited to within the GSA), fee structures, and fallowing programs. The County seeks a balance of individual flexibility and GSA-wide accountability. The Madera County GSA is considering various methods, including satellite observations, to monitor and enforce pumping limits to ensure compliance with the demand reduction targets and sustainability objectives. California Water

Code §10726.4 (a)(2) provides the Madera County GSA with the authority to control groundwater extractions by regulating, limiting, or suspending extractions from individual groundwater wells or extractions from groundwater wells in the aggregate.

The following principles are guiding development of the demand management program. These are in no order of preference and Madera County recognizes tradeoffs exist among these principles.

- Minimize the economic impacts of any demand management required in Madera County
- Maintain established water rights
- Incentivize investment in water supply infrastructure
- Incentivize economically efficient water use
- Incentivize recharge in aggregate, and in specific regions
- Allow sufficient program flexibility for groundwater pumpers to adjust over time
- Ensure access to domestic water supply (de minimis domestic use as defined by SGMA is less than 2 AF annually per user)

4.4.4.2 Implementation

Madera County is currently evaluating a range of demand management program options. All options impose a limit on groundwater pumping that will initiate upon adoption of the GSP. Madera County is continuing to work with stakeholders to develop a program that is implementable, is consistent with the guiding principles, and achieves sustainability objectives in the Subbasin. The demand management program may include one or more of the following approaches:

- **Allocations**. Madera County would implement a groundwater allocation program that would directly relate to the overall demand reduction goals necessary to achieve anticipated reductions by 2040. Allocations could be tied to a crop-type or historic use, or could be evenly distributed among existing irrigators or over all lands. Various approaches have differing effects on grower flexibility, County management and administration, and perceptions of equality.
- **Water trading program (water market, cap and trade)**. Madera County would establish a local groundwater credit system and allow trading of those credits among groundwater users. The program would establish a full accounting of available groundwater supply, allocation of that water supply to local stakeholders, and a record-keeping system that facilitates and records all trades. Additional conditions on location and timing of the use of traded credits may be needed, and in fact, are likely to be required in many areas.
- **Easements**. Madera County would identify potential easement programs and other sources of funding to incentivize fallowing of irrigated lands.

The Madera County demand management program may impose groundwater pumping limits starting in 2020 (Table 4-37). At this time, based on the expected yield of the projects identified under Section 4.2.1 and 4.2.2, the Madera County demand management program will, by 2040, reduce average annual groundwater pumping by 90,000 AF. However, if Madera County project yields are lower than initially estimated, Madera County will increase the level of demand management.

Madera County plans to gradually phase-in demand management between now and 2040. Starting in 2020 and continuing through 2025, average annual groundwater pumping will be reduced by 2% (of the total demand reduction amount) per year, for a total cumulative reduction of 10% by 2025. Groundwater pumping will be reduced by 6% per year starting in 2026 and continuing through 2040. Figure 4-4 illustrates the annual reduction in pumping by year between 2020 and 2040. The annual reduction in pumping in Madera County will equal 90,000 AF by 2040. The second axis on the right shows the

corresponding reduction in crop ET_{aw}, consumptive use, under the demand management program. Crop ET_{aw} will be reduced to about 64% of the current ET_{aw} in the Madera County area by 2040.

Table 4-37. Madera County Demand Management Program Implementation Timeline.

Phase	Start	End
Permitting and environmental documentation	2020	On going
Financing	2020	On going
Construction	N/A	N/A
Operation	2020	On going

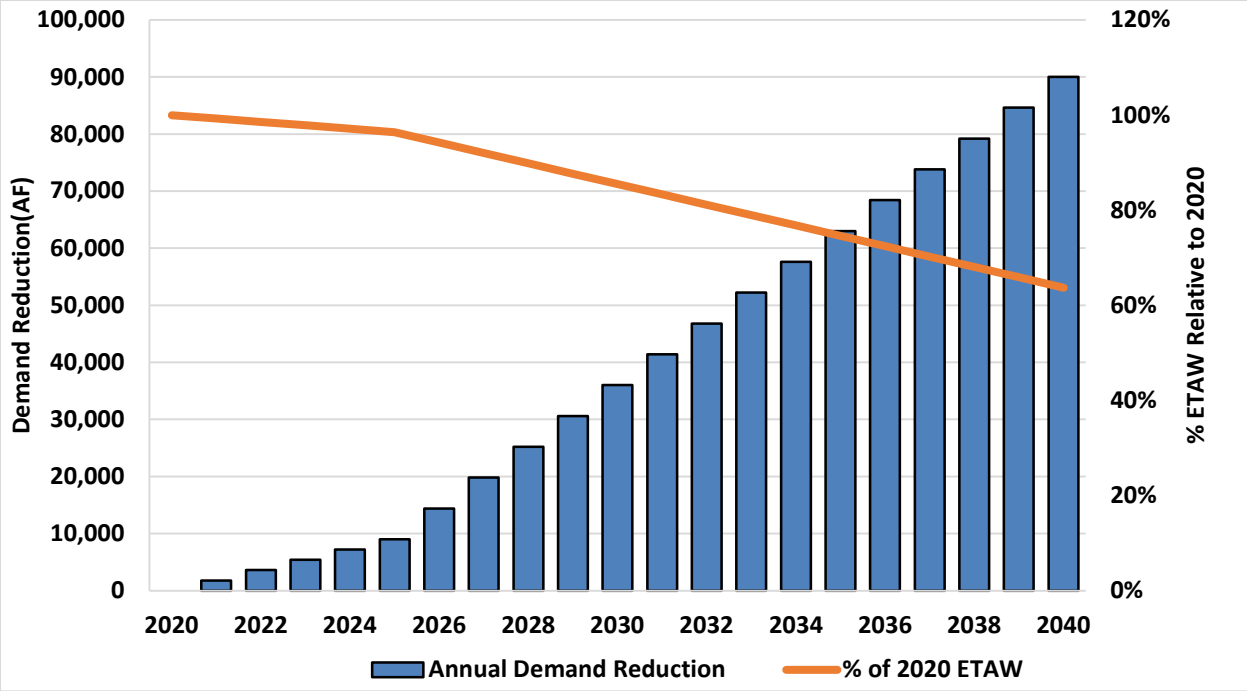


Figure 4-4. Madera County Demand Management Program

The fundamental requirements of any demand management program include establishing a full accounting of available groundwater supply, a method for allocating the supply, and a system for monitoring and enforcement to ensure that the allocation is not exceeded by any individual or in the aggregate. Madera County is currently working with stakeholders to develop the initial guidelines of the demand management program. Important events and preliminary decisions relevant to the demand management program include:

- June 27 – 29, 2018 – The County of Madera met with representatives in Ventura County to tour recharge facilities and discuss Fox Canyon Groundwater Management Agency water market approaches that could apply to Madera County.
- July 17, 2018 – Following several weeks of development, the County of Madera submitted a proposal for a US Bureau of Reclamation WaterSMART grant to fund a study to evaluate water trading strategies.

- September 24, 2018 – The County of Madera met with the Pajaro Valley Groundwater Management Agency to discuss groundwater management options that may apply to Madera County.
- October 5, 2018 – The County of Madera was notified that it received funding for its US Bureau of Reclamation WaterSMART proposal to develop a groundwater marketing strategy for Madera County.
- November 11, 2018 – The County of Madera held a water marketing workshop to allow stakeholders to discuss water trading approaches that could be implemented under the demand management program.
- December 17, 2018 – The County of Madera held a second water marketing workshop to allow stakeholders to discuss water trading approaches that could be implemented under the demand management program, and test alternative market rules.
- February 12, 2019 – The Madera County Advisory Committee for GSAs recommended that as part of the GSP, native groundwater should be allocated equally across irrigated and unirrigated land within the County GSAs. The vote was 10-1.
- March 7, 2019 – The Madera County Advisory Committee for GSAs recommended that as part of the initial modeling efforts, groundwater pumping in the County GSAs decrease over time decreased at approximately 2% a year from 2020 to 2040 (see Figure 4-4 for example implementation schedule). The vote was 11-0.
- April 12, 2019 – The Madera County Advisory Committee for GSAs recommended that credits be given only for activities that introduce new water into the Subbasin (new water is water that would not otherwise be part of the Subbasin water supplies). The vote was 8-0.
- April 12, 2019 – The Madera County Advisory Committee for GSAs recommended that credits be evaluated by an outside entity to establish the quantity of water to be credited. The vote was 8-0.

Madera County will continue to work with stakeholders to further develop the demand management program. Implementation will start immediately and continue indefinitely.

The following subsections describe the demand management program activities and costs assuming that the Madera County demand management program includes groundwater trading.

Construction activities and requirements

No new physical water storage or conveyance facilities are required to operate a demand management program. The program could require investment in well meters or other monitoring approaches (e.g. remote sensing) to ensure pumpers comply with pumping limits.

The demand management program will require significant outreach, planning, and strategy development efforts. A groundwater market, if established, would require measurement of groundwater pumping and development of accounting software to manage trades and pumping credits. Individual water users may incur costs to manage their demand and participate in trading, but such costs are borne by individual users, may include voluntary activities, and do not require funding by the GSA.

Water source

No new water is provided. The existing groundwater use is capped, and annual reductions are managed under the demand management program.

Conditions or constraints on implementation

The demand management program is a mandatory program for Madera County groundwater users. If Madera County implements a groundwater market, participation in the market (trading) would be voluntary. Successful implementation of a trading program does not depend on all users participating, but the success of the program does depend on other factors, including:

- Any trading program must establish definitive limits on groundwater pumping and be able to enforce conditions.
- Any trading program must have an accounting mechanism to monitor pumping (or allocate credits) and an acceptable method for reviewing and ensuring compliance with the program.
- Any trading program must implement rules and constraints to ensure that the program is consistent with the GSP goals.

Permitting process and agencies with potential permitting and regulatory control

The County will likely have the primary and only regulatory control for the GSA's demand management program.

Additional regulatory or permitting processes or control are not anticipated to be necessary under this component of the Madera County GSA's sustainability program.

4.4.4.3 Program Operations and Monitoring

Madera County is currently working with GSA stakeholders and other GSAs in the Subbasin to define the demand management program, including the potential for a within-GSA groundwater market. The County has recently received a U.S. Bureau of Reclamation WaterSMART grant to investigate the functionality and viability of a groundwater market, anticipating results from that effort to further inform development of the demand management program.

Tasks that are funded by the WaterSMART grant include:

1. Defining opportunities with potential partners
2. Obtaining input from potential partners regarding concerns and priorities
3. Assessing economic, social, and environmental impacts of a water marketing strategy
4. Analyzing legal opportunities and constraints regarding a water marketing system
5. Developing monitoring, quantification, mitigation and standards for assessment of future needs
6. Developing finalized water marketing strategy framework through the grant program
7. Conducting a pilot water market demonstration

The County recognizes a critical element of success for this program will be on-going monitoring of groundwater use across the entire GSA management area. Madera County is currently evaluating potential measurement methods including:

- Meters on wells.
- Water use based on established crop factors.
- Remote-sensing measures of ET with additional analysis to determine ET_{aw}.

4.4.4.4 Program Benefits

The demand management program allows Madera County GSA and groundwater users to achieve the sustainability targets in a flexible and cost-effective way. Coupled with the Madera County projects to augment supplies, demand must be reduced to meet the sustainability goals.

The program will provide in-lieu recharge benefits by reducing consumptive use, and consequently reducing demand for groundwater pumping. The in-lieu recharge benefits of the demand management program are expected to benefit groundwater levels, groundwater storage, subsidence, groundwater quality, and interconnected surface water by reducing demand for additional groundwater pumping.

4.4.4.5 Program Costs

Madera County is currently developing the demand management program and assessing potential costs. Since the details are still under development, project costs cannot be estimated at this time, but demand management is anticipated to require substantial County administration and implementation budgets.

Costs to measure pumping and monitor groundwater conditions are part of overall GSP management and not imposed by this program.

The most significant cost of the demand management program falls on agricultural groundwater pumpers (growers) and the regional economy. An economic impact analysis of the demand management program has estimated average annual direct economic costs at $53.9 million per year. This represents reduced net returns to crop production resulting from demand management. It does not include indirect and induced economic impacts to other businesses, employees, and the Madera County regional economy.

4.4.5 Other Potential Projects

Three other projects have been identified by Madera County to either increase recharge or reduce consumptive use of water. These ideas are in early stages of discussion, so complete details about project features, yields, and costs have not yet been developed. Potential project yields are not included in the GSP.

4.4.5.1 Arundo Removal

Madera County has identified areas within Madera Subbasin where an invasive plant called *Arundo donax* (Arundo) could be controlled or removed, potentially saving a significant amount of consumptive water use. Arundo is a non-native, fast growing, and dense reed that purportedly has high water consumption. It currently grows primarily in stream channels. The Nature Conservancy (TNC) has provided a literature review of Arundo's consumptive use and other impacts on native ecosystems (TNC, 2019). Studies of its consumptive use show an extremely wide range of estimates, from 1 acre-foot per acre per year to as much as 48 AF per acre per year, depending on how consumptive use is estimated and the plants' location, size, and access to water. In the Madera Subbasin, consumptive use is likely on the lower end of the range of estimates because the water courses where Arundo grows are often dry for much of the year.

Based on preliminary estimates, approximately 500 acres of Arundo exists in concentrated stretches of Berenda, Cottonwood, and Dry Creeks. Details on acreage of infestation, water use, the potential for reduction, and the cost would be developed before a removal/control plan is prepared.

4.4.5.2 Private, Small-Scale Recharge Projects

Several private, direct or in-lieu groundwater recharge projects have been implemented or proposed by landowners. These projects are similar to Madera County GSA recharge projects, though much smaller in

scale. Up to 20 AF per day would be recharged. The water would either be used in lieu of groundwater pumping for irrigation or be recharged through drywells.

Typical project components would include permits and environmental documents, planning and design, and construction of the diversion structure, pump, and conveyance.

4.4.5.3 Dry Well Groundwater Recharge

Drywells have been installed in various areas of Madera County. Located on private residential property, dry wells are typically constructed 2 feet in diameter and 50 feet in depth and have served to recharge areas with running and standing water. In recent tests, the drywell size was increased to 3 feet in diameter by 75 feet deep in order to increase the recharge capacity and potentially reduce the unit cost of recharge.

Test results are still being evaluated and potential groundwater recharge volumes resulting from dry well installation has yet to be evaluated. Thus, the evaluation of dry wells as a potential groundwater recharge program is still in the early stages of evaluation and discussion.

Projects that comply with the existing Madera County Dry Well detail located on residential parcels may be permitted through the Madera County Environmental Health Department. Drywells that are larger than the 2-foot diameter, 50-foot depth are registered with the Environmental Protection Agency (EPA) as a Class V Injection well.

Because drinking water quality is of critical importance, Madera County is working with the Regional Water Quality Control Board to develop a process for evaluating the potential of deeper injection wells.

To be useful in meeting sustainability goals, any dry well project would need to demonstrate a right to the water source and that the source is new to the Subbasin (e.g. not just recharging water already present that would otherwise recharge through other means).

4.4.6 Project Financing

Pursuant to 23 CCR §354.44 and §354.6, Madera County has evaluated and described the ability to cover project costs. Since most projects are still being assessed, and feasibility studies are being refined or developed, a general description of how Madera County will cover project costs is presented. Madera County will conduct economic and fiscal feasibility studies as part of its ongoing planning efforts to better understand willingness and ability to pay for the projects included in the GSP. Demand management program costs will likely be covered through fees on groundwater pumpers.

To help with projected costs for projects and demand management, Madera County will continue to pursue available state and federal grants or loans for actions such as planning studies, construction projects, fallowing easements, and monitoring. Generally, construction costs will be financed through issuance of bonds, to be repaid from revenues raised through water fees and other assessments. Operation and maintenance costs will be paid using revenues raised through water fees and other assessments. Madera County will conduct the necessary studies and decision processes (including Proposition 218 elections) to approve fees or assessments to provide the required funding.

4.4.7 Coordination with Other GSAs and Planning Agencies

This Joint GSP is the coordinated GSP for the four Joint GSP GSAs in the Madera Subbasin (City of Madera GSA, Madera Irrigation District GSA, Madera County GSA, and Madera Water District GSA). A coordination agreement will be executed by the coordinating GSAs with the other three GSAs in the Subbasin (Gravelly Ford Water District GSA, New Stone Water District GSA, and Root Creek Water District GSA) detailing required GSA and GSP cooperation.

At this time, no trading of pumping credits across GSA boundaries is anticipated. To the extent that trading within Madera County GSA may affect groundwater conditions at the boundary between it and a neighboring GSA, additional coordination may be needed.

4.5 Gravelly Ford Water District GSA

Gravelly Ford Water District GSA (GFWD) is developing its own GSP. However, it falls within the Madera Subbasin, so its projects are included here to describe their effects on the groundwater and overall water balance of the Subbasin. Additional details are provided in the GFWD GSP.

GFWD has identified three PMAs for its GSP implementation. One is a recharge project that will provide additional groundwater recharge and two projects provide improved measurement of pumping and monitoring of groundwater conditions. All three projects support the goals of groundwater sustainability and improved overall water management in GFWD.

4.5.1 Recharge in Canals and Basin

GFWD will develop recharge basins. Water will be diverted from Cottonwood Creek into basins where it will percolate into the deep aquifer. The size, location, and performance of the recharge basins depends on site-specific characteristics that are currently being assessed by GFWD.

The project will use an existing basin to recharge water either purchased or available as excess flow. The basin is in the northern half of GFWD, just south of Cottonwood Creek and west of the Gravelly Ford Canal. Historically, flood and storm flows have been routed through Cottonwood Creek or GFWD facilities and discharged from the District. Instead, this water will be held in the recharge basin or distribution canals in order to recharge the groundwater. In addition, water may be purchased and delivered to the basin for recharge.

The project will also implement improved measurement of the flood and storm flows through the District and the incidental recharge associated with them.

4.5.1.1 Implementation

GFWD is responsible for developing and implementing the recharge project. It will modify its operations as needed beginning in 2020 to divert available flood flows or storm water flows into the basin or hold them in the distribution system for recharge (Table 4-38). Purchased water would be delivered to the basin if and when it is available.

The recharge basin and other needed conveyance facilities are in place, so the project can start immediately. No additional permitting or construction is needed. Actual operation will begin when flood or storm water (or purchased water) is available.

The primary water source will be flood flows in the San Joaquin River or in Cottonwood Creek. Purchased water will also be recharged when available. GFWD will coordinate with Reclamation and the State Water Board for any pumping of water from the two natural channels. No additional permitting requirements are expected. The District currently receives or purchases water through its permitted facilities on the San Joaquin River and Cottonwood Creek. The project will modify operations of existing facilities to capture and recharge flood and stormwater flows and, when available, purchased water.

Table 4-38. GFWD Recharge in Canals and Basin Implementation Timeline.

Phase	Start	End
Permitting and environmental documentation	Not applicable (NA)	NA
Financing	**NA**	NA
Construction	NA	NA
Operation	2020	On going

4.5.1.2 Project Benefits

The water diverted into the basin will percolate and recharge groundwater. Surplus winter and spring flows are expected to be available in some wet, above normal, and below normal years. Purchased water, if and when available, could be delivered during any year and month. The project will contribute to groundwater sustainability in the Subbasin by replenishing groundwater supplies. The direct recharge benefits of this project are expected to benefit groundwater levels, groundwater storage, subsidence, groundwater quality, and interconnected surface water by augmenting groundwater supplies in the Subbasin.

The recharge benefits of the project will vary annually depending on the available flood flows. Table 4-39 summarizes the expected average amounts available by year type and month. See GFWD's GSP for description of benefits, how the project works with other projects, and costs.

Recharge basins may also provide environmental benefits by creating seasonal or perennial habitat for wildlife including waterfowl, amphibians, and reptiles and serve as drinking water sources and foraging habitat for mammals.

Table 4-39. GFWD Recharge Basins Estimated Average Annual Additional Flood Flow Available, by Year Type.

Year Type	Total Annual Volume	% of Years	Weighted Avg.
W	4,956	35%	1,749
AN	4,956	14%	680
BN	2,478	8%	194
D	0	16%	0
C	0	27%	0
Avg. Annual			**2,624**

The expected flood flows shown in the table are based on available winter flows during the period October – March over the historical period 1965-2015. Expected monthly benefits by water year type are changes in stored groundwater (or reduced groundwater overdraft). Initial volumes will be determined based on results from pilot testing or percolation testing. On-going measurement of benefits to groundwater storage will be integrated into the overall GSP monitoring and measurement program.

4.5.2 Groundwater Pumping Measurement

GFWD staff will assist landowners/customers (owners) to install flow meters on groundwater wells used for crop production within the District. Various wells in the District already have meters and those that do not will be outfitted with the new meters, at the owner's expense. The owner will provide monthly and annual pumping volumes from the well. GFWD will collect and process the data and report the aggregate (not specific to individual wells) annual volume pumped from the local aquifer.

The project's first measurements and evaluations of the proposed 24 wells in the GFWD boundary will start this year (2019). The project will be reviewed by the Board of Directors and notice sent out to the owners in the GFWD service area.

Installation of new meters will be the responsibility of the owners. GFWD staff will assist those that currently do not have a flow meter, to assure that it is installed correctly. Staff will provide a standard reporting form for the monthly and annual report to GFWD.

No permitting is required from other agencies for this effort. The District will receive permission from each owner for the reporting of the well flow data.

The project will not provide new water supply, but it will allow GFWD to measure groundwater use, monitor conditions, and better understand the overall water balance within the District. It will support GFWD's efforts to manage groundwater sustainably as part of the Madera Subbasin GSP. The meters will also assist the growers to make more informed irrigation management decisions.

4.5.3 Groundwater Monitoring Program

GFWD's hydrogeologist has selected 24 wells to measure and record the standing water level. Measurements would be taken twice a year, one in the spring (February or March) prior to the irrigation season and another measurement in the fall (October or November). These levels will be tracked, and the data will be charted and analyzed to determine long-term trends and annual patterns related to water year types.

The project's first measurements and evaluations of the proposed 24 wells in the District boundary will start this year. The project will be implemented by the Hydrogeologist for the District and will continue under his direction. The Hydrogeologists' staff will take the measurements or train District staff to take the measurement.

No permitting is required from other agencies for this effort. GFWD will receive permission from owners for access to wells and reporting of the monitoring data.

The project will not provide new water supply, but it will allow GFWD to measure groundwater levels and better understand the overall condition and trends in levels within its boundaries. It will support GFWD's efforts to manage groundwater sustainably as part of the Madera Subbasin GSP. GFWD will use this data to improve the distribution and application of water to properties in its service area.

4.5.4 Coordination with Other GSAs and Planning Agencies

This Joint GSP is the coordinated GSP for the four Joint GSP GSAs in the Madera Subbasin (City of Madera GSA, Madera Irrigation District GSA, Madera County GSA, and Madera Water District GSA). A coordination agreement will be executed by the coordinating GSAs with the other three GSAs in the Subbasin (Gravelly

Ford Water District GSA, New Stone Water District GSA, and Root Creek Water District GSA) detailing required GSA and GSP cooperation.

GFWD is preparing its own GSP, and it has cooperated with the coordinating GSAs in developing this Madera Subbasin GSP. The Madera Subbasin GSP establishes the requirements and process for monitoring groundwater conditions, and GFWD will comply with these requirements. Data collected from individual wells will be used to verify consistency with the sustainability goals of the GSP. No other coordination agreements are needed to implement these projects.

4.6 New Stone Water District GSA

New Stone Water District GSA (NSWD) is developing its own GSP. However, it falls within the Madera Subbasin, so its projects are included here to explain their effects on the groundwater and overall water balance of the Subbasin. Additional details can be found in the NSWD GSP.

4.6.1 Water Right Utilization

NSWD GSA has an appropriative water right along the Chowchilla Bypass (referred to as Eastside Bypass/Chowchilla Canal in its water rights permit number 19615) of 15,700 AF/year. Currently, NSWD does not use this water right. With the implementation of SGMA, NSWD intends to fully use the water right and bring 15,700 AF of surface water into NSWD. The water is expected to be available during times of flood flows in the Chowchilla Bypass, about one year out of three. The water may be recharged directly or used for irrigation, thereby providing in-lieu groundwater recharge.

4.6.1.1 Implementation

NSWD intends to begin diverting water as soon as it is available (Table 4-40). NSWD already has the water rights permit and diversion facilities, so no further documentation or permitting requirements are anticipated.

Table 4-40. NSWD Water Right Utilization Implementation Timeline.

Phase	Start	End
Permitting and environmental documentation	2019	2020
Financing	Not applicable (NA)	NA
Construction	NA	NA
Operation	2020	On going

Water will be diverted from the Chowchilla Bypass during times of available flood flow. NSWD will coordinate as needed with the State Water Board and local agencies as needed when it is diverting water.

4.6.1.2 Project Benefits

The water diverted into the basin will percolate and recharge groundwater. Surplus winter and spring flows are expected to be available in some wet, above normal, and below normal years. Purchased water, if and when available, could be delivered during any year and month. The project will contribute to groundwater sustainability in the Subbasin by replenishing groundwater supplies. The direct recharge benefits of this project are expected to benefit groundwater levels, groundwater storage, subsidence, groundwater quality, and interconnected surface water by augmenting groundwater supplies in the Subbasin.

The quantity will vary from year to year depending on the available flood flows. Table 4-41 summarizes the expected average amounts available by year type and month.

The expected available flood flows are based on winter flows in the Chowchilla Bypass during the period January – June over the historical period 1965-2015. Expected monthly benefits by water year type are changes in stored groundwater (or reduced groundwater overdraft).

Benefits to groundwater will be determined based on measured diversions from the Bypass and monitoring of groundwater conditions as part of GSP implementation.

4.6.2 Coordination with Other GSAs and Planning Agencies

This Joint GSP is the coordinated GSP for the four Joint GSP GSAs in the Madera Subbasin (City of Madera GSA, Madera Irrigation District GSA, Madera County GSA, and Madera Water District GSA). A coordination agreement will be executed by the coordinating GSAs with the other three GSAs in the Subbasin (Gravelly Ford Water District GSA, New Stone Water District GSA, and Root Creek Water District GSA) detailing required GSA and GSP cooperation. NSWD is preparing its own GSP for its portion of the Subbasin but is participating in the broader SGMA planning efforts for the Subbasin.

4.7 Root Creek Water District GSA

Root Creek Water District GSA (RCWD) is developing its own GSP. However, it falls within the Madera Subbasin, so its projects are included here to explain their effects on the groundwater and overall water balance of the Subbasin. Additional details can be found in the RCWD GSP.

Table 4-41. NSWD Estimated Average Flood Flow Available, in AF by Year Type

Year Type	Total Annual Volume	% of Years	Weighted Avg.
W	15,700	35%	5,541
AN	0	14%	0
BN	0	8%	0
D	0	16%	0
C	0	27%	0
Avg. Annual			**5,541**

4.7.1 Distribution of Purchased Water for In-Lieu Storage

In 2014, RCWD received a grant to help pay for a turnout and pipeline from MID Lateral 6.2 to bring surface water supplies into the north side of RCWD. The purpose of the pipeline is to mitigate groundwater overdraft by using surface water, when available, in place of groundwater in the 3,000-acre service area. This project will enable RCWD to utilize its surface water contracts with MID, Westside Mutual, and Reclamation, thus decreasing groundwater pumping. Since project completion, about 8,000 AF of surface supplies have been brought into the District. Existing facilities include a 48-inch diameter main line that runs south for about 2.7 miles and has approximately 5.4 miles of laterals. The design maximum capacity of the system is approximately 50 cfs with 17.6 cfs discharge into Root Creek.

Some agricultural land in the northeast corner of the District that is currently served by the pipeline and laterals is planned for a housing development. Therefore, as that land is taken out of production, this project will expand the distribution system to replace the acreage.

4.7.1.1 Implementation

RCWD is responsible for developing and implementing the project. It will modify its operations as needed to bring in additional surface water supplies. Project construction is already complete and RCWD expects the project to be operational starting in 2019 (Table 4-42).

Table 4-42. RCWD Purchased Water Project Implementation Timeline.

Phase	Start	End
Permitting and environmental documentation	Not applicable (NA)	NA
Financing	NA	NA
Construction	2014	2014 (already complete)
Operation	2019	On going

4.7.1.2 Project Benefits

RCWD has contracts with MID, Westside Mutual, and Reclamation for surface water. The contract with MID states that RCWD may purchase water in excess of MID water demands, up to 10,000 AF in any one year. Since this water is dependent on how much water MID receives based on their CVP Class I and Class II allocation, it will likely only be seen by Root Creek in wet years at a much lower volume. The agreement with USBR will allow RCWD to use Section 215 water, or flood flow, when available. The ability of RCWD to take the water will depend on time of year for irrigation demand and capacity of Lateral 6.2 to carry the water. Lastly, the contract with Westside Mutual is a dependable supply, up to 7,000 AFY. However, this is the most expensive source of water and will likely only be used in dry years when other sources are not available. All contract water mentioned above will come from the San Joaquin River and Millerton Lake.

This project has been completed with the intent of bringing RCWD into a condition of sustainable groundwater management. Conditions for implementation included the recognition of continued overdraft, as mentioned in the 2012 update of the Groundwater Management Plan and a funding opportunity.

The project will use existing facilities that include a 48-inch diameter main line that runs south for about 2.7 miles and has approximately 5.4 miles of laterals. In addition, new distribution laterals will be built to replace service area that is expected to be lost to new development. Water acquired from one or more of the sources described above will be delivered as irrigation water via MID Lateral 6.2, pipeline, and distribution laterals, thereby providing in-lieu recharge. The in-lieu recharge benefits of the project are expected to benefit groundwater levels, groundwater storage, subsidence, groundwater quality, and interconnected surface water by increasing surface water use and reducing groundwater pumping.

Water supply may be provided in all year types, but benefits are generally expected in non-critical years. Up to 9,100 AF could be delivered when water is available in wet years (Table 4-43). On average, the project is expected to provide about 4,400 AFY of surface supply, resulting in reduced pumping and increased recharge from percolation of the surface water.

Table 4-43. RCWD Estimated Average Water Purchase, in AF by Year Type.

Year Type	Total Annual Volume	% of Years	Weighted Avg.
W	9,100	35%	3,212
AN	5,100	14%	700
BN	3,000	8%	235
D	1,500	16%	235
C	0	27%	0
Avg. Annual			**4,400**

4.7.2 RCWD Holding Contracts

RCWD holds a historical right to divert water from the San Joaquin River to irrigate 3,000 acres. It has diverted water under this holding contract in the past and intends to make greater use of it to increase its surface water supply. RCWD intends to establish this as a permanent water source, diverting an average of 9,840 AFY in every year type.

4.7.3 Coordination with Other GSAs and Planning Agencies

This Joint GSP is the coordinated GSP for the four Joint GSP GSAs in the Madera Subbasin (City of Madera GSA, Madera Irrigation District GSA, Madera County GSA, and Madera Water District GSA). A coordination agreement will be executed by the coordinating GSAs with the other three GSAs in the Subbasin (Gravelly Ford Water District GSA, New Stone Water District GSA, and Root Creek Water District GSA) detailing required GSA and GSP cooperation. RCWD is preparing its own GSP for its portion of the Subbasin but is participating in the broader SGMA planning efforts for the Subbasin.

4.8 Subbasin Water Available for Recharge Used by Projects

Four primary sources of water are available for the projects: flood releases and 215 water from Millerton Lake, Chowchilla Bypass flows, Fresno River Flood Releases from Hensley Lake, and water purchases. A summary of the total projected water available, the projected water committed to projects, and the expected water remaining after the projects recharge or use the water committed is provided below for each water source.

4.8.1 Flood Releases and 215 Water from Millerton Lake

The first source of water available for projects in the Madera Subbasin is the flood releases and 215 water from Millerton. Table 4-44 summarizes the volume of flood releases and 215 water released from Millerton Lake along Madera Canal and the San Joaquin River that is potentially available for recharge projects in the Madera Subbasin.

Table 4-44. Average Flood Releases and 215 Water from Millerton Lake Committed to Madera Subbasin Recharge Projects, by Water Year Type (2019-2090).

Year Type	Total Annual Volume (AF)	% of Years	Weighted Avg. Volume (AF)
W	85,400	35%	29,900
AN	47,600	14%	6,700
BN	21,500	8%	1,700
D	8,000	16%	1,300
C	8,100	27%	2,200
Avg. Annual			41,700

4.8.2 Chowchilla Bypass

The second source of water available for projects in the Madera Subbasin is flows along Chowchilla Bypass. Table 4-45 summarizes the average water available to projects by water year type. Table 4-46 summarizes the volume of water along Chowchilla Bypass that is potentially available for recharge projects in the Madera Subbasin. Table 4-47 summarizes the volume of water estimated to be remaining in the Chowchilla Bypass after the projects have taken water.

4.8.3 Fresno River Flood Releases

The third source of water available for projects in the Madera Subbasin is flood releases from Hensley Lake along Fresno River. Table 4-48 summarizes the volume of flood releases along Fresno River that is potentially available for recharge projects in the Madera Subbasin.

Table 4-45. Average Projected Chowchilla Bypass Water Available to Madera Subbasin Recharge Projects, by Water Year Type (2019-2090).

Year Type	Total Annual Volume (AF)	% of Years	Weighted Avg. Volume (AF)
W	404,100	35%	141,400
AN	47,900	14%	6,700
BN	4,600	8%	400
D	6,500	16%	1,000
C	6,200	27%	1,700
Avg. Annual			151,200

Table 4-46. Average Chowchilla Bypass Water Committed to Madera Subbasin Recharge Projects, by Water Year Type (2019-2090).

Year Type	Total Annual Volume (AF)	% of Years	Weighted Avg. Volume (AF)
W	99,100	35%	34,700
AN	0	14%	0
BN	0	8%	0
D	0	16%	0
C	0	27%	0
Avg. Annual			41,700

Table 4-47. Average Available Chowchilla Bypass Water Remaining After Madera Subbasin Recharge Projects, by Water Year Type (2019-2090).

Year Type	Total Annual Volume (AF)	% of Years	Weighted Avg. Volume (AF)
W	305,000	35%	106,700
AN	47,900	14%	6,700
BN	4,600	8%	400
D	6,500	16%	1,000
C	6,200	27%	1,700
Avg. Annual			116,500

Table 4-48. Average Fresno River Flood Releases Committed to Madera Subbasin Recharge Projects, by Water Year Type (2019-2090).

Year Type	Total Annual Volume (AF)	% of Years	Weighted Avg. Volume (AF)
W	28,600	35%	10,000
AN	22,100	14%	3,100
BN	8,000	8%	600
D	0	16%	0
C	2,500	27%	700
Avg. Annual			14,400

4.8.4 Water Purchases

The fourth source of water available for projects is water acquired from willing sellers. This supply is constrained by the capacity to move it from its source to a location of use in Madera County, via existing natural channels or the Madera Canal. Imported water could be purchased from any willing seller anywhere in the Central Valley provided the water can be delivered to Madera County using existing or proposed conveyance facilities, including via exchanges involving three or more parties. For example, water offered for sale from the Sites JPA could be imported via exchanges through CVP contractors and facilities. Beyond this, purchases are also limited by other factors including market considerations of availability and price.

Table 4-49 summarizes the average water purchases and additional CVP diversions committed to recharge projects in the Madera Subbasin by water year type.

Table 4-49. Average New Water Purchases Committed to Madera Subbasin Recharge Projects, by Water Year Type (2019-2090).

Year Type	Total Annual Volume (AF)	% of Years	Weighted Avg. Volume (AF)
W	26,200	35%	9,200
AN	26,200	14%	3,700
BN	22,600	8%	1,800
D	22,000	16%	3,500
C	15,100	27%	4,100
Avg. Annual			22,200

4.9 GSA Commitments to GSP Implementation

The Joint GSP GSAs are each committed to implementing the GSP and PMAs that are needed to achieve the Subbasin sustainability goal. This section summarizes the Joint GSP GSAs' GSP implementation efforts thus far, identifying their commitment to GSP implementation. Additional details are provided in **Section 4.10**, below, as well as the Annual Reports. Updates will continue to be provided in future Annual Reports.

4.9.1 Madera Water District GSA

- MWD (the District) continues to purchase surface water whenever it has been available, having done so each year since 1993. Since SGMA was passed in 2014, the District has purchased over 30,000 AF of surface water through the Dry Creek connection to Madera Irrigation District. Unfortunately, the water available is often less than what the District could use. Since the GSP has been submitted in 2020, the District has purchased about 3,500 AF to date mainly due to the lack of surface water from drought.
- In Fall 2022, the Madera Water District GSA received a $3.7 million grant from DWR through the SGM Grant Program for the construction of the Madera Lake Pump & Pipeline Project. The project will allow additional surface water supplies to be brought into the District when available off the Fresno River. The following activities have been completed to further advance the project:
  - ✓ CEQA has been completed.
  - ✓ Permit applications have been submitted to the California Department of Fish and Wildlife for a 1602 agreement and Incidental Take Permit; the Regional Water Quality Control Board for a Water Quality Certification (401 permit received); and the US Army Corps of Engineers for construction in a Water of the US (404 permit).
  - ✓ Construction plans have been developed to about a 60% level, including civil, structural and electrical components.
  - ✓ Right-of-way documents are being finalized for the improvements.
- The District has been pumping less groundwater than the 30-year average of 6,260 AF (calendar years 1993-2022). For the past three years, the District has averaged about 4,820 AF of groundwater pumping. All of the District's wells and associated groundwater pumping continues to be metered.
- In 2023, MWD took title to a 10-acre parcel in the District. As part of the District's commitment to develop regulation/storage basins as part of the GSA projects under the GSP, the site is being investigated for use to store surface water in wet months for use in the peak irrigation season.

4.9.2 Madera Irrigation District GSA

4.9.3 City of Madera GSA

- The City of Madera (City) has two projects included as part of the Madera Subbasin Groundwater Sustainability Plan (GSP). One project, the Berry Basin, is complete. The City and MID cooperatively operate the Berry Basin for the purpose of groundwater recharge The Berry Basin, with an estimated annual benefit of 20 acre-feet per year has had intermittent usage due to the drought but has proven effective in years with heavy rainfall. As of this time, recharge had occurred in 2019, and in the 2022/2023 time frame.
- The second is a Meters and Volumetric Pricing project with a goal of reducing evaporation and ground water pumping through installation of water meters and implementation of volumetric

billing. The installation of water meters is roughly 95% complete. To date, the estimated average annual benefits have been 3,350 AF per year. The City continues to move forward with investigation and installation of remaining missing meter locations. To that end, the City anticipates an award in March for 46 large diameter (3-inch or greater) meters to be installed this Spring with the remining approximate 700 meters (less than 3-inch by the end of the year.

- With completion of these two projects, the City will have fulfilled its commitment to projects included in the Madera Subbasin GSP.
- In addition to the two projects formally included in the GSP, MID and the City also worked cooperatively to develop the Golf Course Basin project. In 2021, MID facilities were connected to a golf course basin in the City GSA for future groundwater recharge benefits to both MID and the City GSAs. A total of $50,000 in associated capital costs were incurred by MID in 2021 with the City paying to operate and maintain the Golf Course Basin in the future through its lease to a private party that is operating the golf course. This basin was successfully filled for the first time in January of 2023 following the recent storms.

4.9.4 Madera County GSA

4.9.4.1 Demand Management

- As the GSA with the greatest share of overdraft, the Madera County GSA (County GSA) began developing an allocation in 2019 with the County GSA Advisory Committee. Over the course of 2019 and 2020, an allocation approach was developed and allocations were set. Allocations were in place in 2021 as a "dry run" and in 2022 as well with a penalty adopted for implementation in 2023. To date, preliminary findings indicate that the County GSA is under its allocated water in the Subbasin.

4.9.4.2 Funding Challenges

- Prior to the adoption of the Joint GSP, the County GSA was able to conduct a rate study for administrative and planning charges (GSA Fee) associated with managing a GSA. The rate study and resolution adopting the fee were adopted in November of 2019 and provide funding for critical activities that keep the GSA in compliance with SGMA, including planning activities and an annual report.
- Using grants and funds from the GSA Fee, the County GSA began, among other planning and implementation tasks, an extensive rate study to quantify costs and benefits for projects including recharge, domestic well mitigation, purchases of water, and land repurposing. With exhaustive public outreach, many meetings, and additional mailings over and above the legally required Prop 218 notice, three public hearings were held for rates (GSP Fee) in the Madera, Chowchilla and Delta-Mendota subbasins. There was a majority protest in the Chowchilla Subbasin, so no rates could be adopted. In the Madera and Delta-Mendota Subbasins, there was not a majority protest from affected landowners, so rates were adopted to fund projects. In fall 2022, the County GSA was sued by a small group of landowners who objected to the GSP Fee. In December of 2022, a local court put a temporary injunction on the collection of the GSP fee until the matter could be heard at trial. The funding for implementation of projects is pending resolution of this case.
- Despite this set-back on the rates, the County GSA continues to move ahead with implementation of the defined PMAs through grants. These PMAs include recharge project development and implementation (temporary and permanent), land repurposing, and implementation of an aggressive demand management program. The County GSA is the only GSA in the Subbasin with a groundwater allocation.

4.9.4.3 Grants and Progress Toward GSP Implementation

To date, the County GSA has been highly successful in writing and receiving grants. Grants and progress towards groundwater sustainability include:

- Land Repurposing
  - $200,000 Strategic Agricultural Land Conservation (2020 to 2022)
  - $10 million for multi-benefit land repurposing around clusters of domestic wells in all GSAs in the County
  - $9.3 million for LandFlex for land repurposing around clusters of domestic wells in the Madera Subbasin, County GSA
- Recharge
  - $4.2 million + $500,000 for the Madera Subbasin, County GSA in Prop 68 Round 1 and 2
  - $180,188 for Fairmead Groundwater Resilience Project – California Resilience Challenge
- Domestic Well Mitigation
  - Lead and coordinate County-wide Drought Work Group; assist Office of Emergency Services; Serve as a liaison with Self-Help Enterprises
- Water Purchases
  - Continued discussions with Sites about long-term water transfers from existing contractors
  - Letter of Agreement with Bureau of Reclamation to expand Section 215 area

4.10 Implementation of Projects and Management Actions Since Initial GSP Development

The implementation of PMAs is critical for achieving and maintaining groundwater sustainability. Since the development of the initial GSP, the Joint GSP GSAs have made substantial progress toward implementing the PMAs described in the sections above. Updates to these PMAs are summarized in each of the GSP Annual Reports. Implementation of all PMAs described below provides benefits to all applicable sustainability indicators in the Subbasin by providing groundwater recharge, supporting in-lieu recharge, or otherwise reducing demand and contributing to groundwater sustainability.

The sections below summarize the PMA implementation efforts and updates from the time of initial GSP development through the latest GSP Annual Report (water year 2022).

4.10.1 Domestic Well Mitigation Program

A key element of the Joint GSP is a proposed Domestic Well Mitigation Program to mitigate undesirable results for domestic well users that are significantly and adversely impacted by groundwater levels during the GSP implementation period while the GSAs implement other projects and management actions to achieve and maintain sustainability.

Between 2019-2022, the GSAs successfully completed an inventory of the domestic wells in the Subbasin as a first step toward development of the Domestic Well Mitigation Program. The GSAs applied for and were awarded a Proposition 68 grant from DWR to conduct a domestic well inventory and install six new monitoring wells at two sites in the Subbasin. The MC GSA applied for the grant on behalf of the Madera Subbasin and has led the project since its inception. After issuing an RFP and selecting a consultant, the domestic well inventory was conducted in 2021-2022 and final documentation of the inventory was completed in spring 2022 (**Appendix 2.G**). The new nested monitoring wells were installed in 2022. In addition to an updated and more accurate domestic well inventory, information collected during this project from the drilling, geologic and geophysical logging, groundwater quality sampling, and automated

groundwater level monitoring will continue to aid the GSAs in filling data gaps in the monitoring and conceptualization of the Madera Subbasin hydrogeology. The project will also improve understanding and management of groundwater in the Madera Subbasin.

During 2022-2023, the GSAs continued to meet to develop the Domestic Well Mitigation Program for implementation, as needed. To date, the GSAs have developed a draft memorandum of understanding (MOU) that describes, among other things, the responsibilities and principles that will guide administration of the program. The draft MOU is included in **Appendix 3.E.** In accordance with the draft MOU, the Program will continue to be developed by the GSAs and will be implemented as needed.

Additional information about the Domestic Well Mitigation Program is described in Section 3.3.1.1.

4.10.2 Madera Water District GSA

Updates to the implementation of PMAs proposed and planned by the MWD GSA are summarized below. Additional details are provided in the Annual Reports.

4.10.2.1 Updates in the Water Year 2019 Annual Report

- In 2019, MWD had an opportunity to substantially increase its purchase of surface water to preserve groundwater supplies. MWD's per acre groundwater demand was substantially reduced compared to previous years.
- Approximately one acre of pistachio trees within MWD was removed to build a new small reservoir, providing for water regulation and storage.
- MWD continued to move forward on the Madera Lake Project by: obtaining an easement for the proposed MWD facilities; contracting with a consultant for environmental, permitting, and design; and initiating discussions with applicable regulatory and permitting agencies.

4.10.2.2 Updates in the Water Year 2020 Annual Report

- In 2020, MWD was able to purchase surface water as part of their efforts to preserve groundwater supplies. MWD's per acre groundwater demand was substantially reduced compared to previous years
- MWD continued to move forward on the Madera Lake Project by initiating necessary permitting and regulatory processes and preparing preliminary level engineering designs.
- MWD performed an elevation survey of the reference points and surrounding ground to a known vertical datum on each of the RMS wells in the MWD GSA.

4.10.2.3 Updates in the Water Year 2021 Annual Report

- In 2021, despite dry conditions, MWD was able to purchase nearly 800 AF of surface water for in-lieu recharge as part of their efforts to preserve groundwater supplies.
- MWD continued to move forward on the Madera Lake Project. Since the last Annual Report, the project plans progressed to a 60% level of design and an administrative draft of required CEQA documents were prepared.
- In early 2022, the MWD GSA applied for and was awarded Proposition 68 funding to support further development and construction of the Madera Lake Project by 2025.
- MWD also continues to move forward on the Madera Lake Project. Since the last Annual Report, the project plans have progressed to a 60% level of design. An administrative draft of California Environmental Quality Act (CEQA) documents have been prepared. In early 2022, the MWD GSA

applied for and was awarded Proposition 68 funding to support further development and construction of this project by 2025.

4.10.2.4 Updates in the Water Year 2022 Annual Report

- In 2022, despite dry conditions, MWD was able to purchase and deliver nearly 1,300 AF of surface water to its customers to facilitate in-lieu recharge and preserve groundwater supplies.
- MWD continued to move forward on the Madera Lake Project. Since the last Annual Report MWD circulated CEQA documents and started the various permitting processes required for project implementation through the USACE, Regional Water Quality Control Board, the California Department of Fish & Wildlife.
- In 2022, MWD was awarded approximately $3.7 million in grant funding for the Madera Lake Project through DWR's SGM Grant Program.

4.10.3 Madera Irrigation District GSA

Updates to the implementation of PMAs proposed and planned by the MID GSA are summarized below. Additional details are provided in the Annual Reports.

4.10.3.1 Updates in the Water Year 2019 Annual Report

- MID operated Ellis Basin in partnership with MC, with a total recharge benefit of 306 AF in 2019.
- MID operated Berry Basin in partnership with CM, with a total recharge benefit of 929 AF in 2019.
- MID operated Allende Basin intensively to recharge 3,088 AF in 2019.
- MID operated an additional six dedicated recharge facilities that were recently rehabilitated and upgraded, with a total recharge benefit of 3,683 AF in 2019.
- MID administered an on-farm recharge program, resulting in 3,000 AF of recharge in 2019.
- MID continued to upgrade infrastructure (pipelines and SCADA systems) to reduce conveyance losses, with cumulative average annual benefits of 2,530 AF as of 2019.
- In line with the incentive program, in 2019 MID utilized nearly 250,000 AF of surface water through grower deliveries and groundwater recharge, including making water available free of charge and at a reduced rate for specific periods during the year to encourage surface water use.
- In 2018, 320 acres were detached from the MID GSA and joined the Root Creek Water District GSA. This reduced the consumptive use within the MID GSA by about 1,020 AF.

4.10.3.2 Updates in the Water Year 2020 Annual Report

- MID continued operating the Ellis Basin in partnership with MC, although no surface water was delivered for recharge in 2020.
- MID continued operating the Berry Basin in partnership with CM, although no surface water was delivered for recharge in 2020.
- MID continued operating Allende Basin to recharge 31 AF in 2020.
- MID continued operating an additional six dedicated recharge facilities that were recently rehabilitated and upgraded, with a total recharge benefit of 269 AF in 2020.
- MID administered an on-farm recharge program, resulting in 3,000 AF of recharge in 2020.
- MID continued to upgrade infrastructure (pipelines and SCADA systems) to reduce conveyance losses, with cumulative average annual benefits of 2,530 AF as of 2020.
- In line with the incentive program, in 2020 MID utilized approximately 100,000 AF of surface water through grower deliveries and groundwater recharge.

- MID continued implementing other tools and policies, including the Water User Software Platform (UI).

4.10.3.3 Updates in the Water Year 2021 Annual Report

- MID continued operating the Ellis Basin in partnership with MC, although no surface water was delivered for recharge in 2021 due to drought conditions.
- MID continued operating the Berry Basin in partnership with CM, although no surface water was delivered for recharge in 2021 due to drought conditions.
- MID continued operating Allende Basin and six other dedicated recharge facilities, although no surface water was delivered for recharge in 2021 due to drought conditions.
- MID worked to expand the existing recharge basins by approximately 60,000 cubic yards, expanding their overall capacity by approximately 40 AF. This additional capacity results in much higher recharge potential for the basins in future years.
- MID began work on the phase 1 project to construct additional recharge basins. MID acquired three (3) parcels in 2021 as sites for future recharge basins, and took 73 acres out of irrigated agricultural production.
- MID and CM worked cooperatively to develop the Golf Course Basin.
- MID continued to upgrade infrastructure (pipelines and SCADA systems) to reduce conveyance losses.
- In 2021, MID submitted a WaterSMART grant application intended to fund installation of additional SCADA equipment, automated gates, and new meters.
- MID began work to develop water supply partnerships with partners outside of the Subbasin through coordination with other agencies with contracts for supplies from Friant Dam.
- MID has continued with demand reduction through: annexation of rangeland into MID; acquisition of 73 acres of vineyard and irrigated pasture to be taken out of production and replaced with new recharge basins (described above); and detachment of 320 acres from the GSA.
- MID began developing an incentive program to encourage surface water use and conducted outreach to growers.
- MID implemented an intensive groundwater use policy that supports the goals of the incentive program and the overall Subbasin sustainability goal.
- MID continued implementing other tools and policies reported in previous Annual Reports.

4.10.3.4 Updates in the Water Year 2022 Annual Report

- MID continued operating the Ellis Basin in partnership with MC, although no surface water was delivered for recharge in 2022 due to drought conditions.
- MID continued operating the Berry Basin in partnership with CM, although no surface water was delivered for recharge in 2022 due to drought conditions.
- MID continued operating nine other dedicated recharge facilities, including two new recharge basins. Approximately 50 AF of surface water was delivered to these basins for recharge in 2022.
- MID worked to expand the existing recharge basins by approximately 70,000 cubic yards, expanding their overall basin capacity by approximately 43 AF. This additional capacity results in much higher recharge potential for the basins in future years.
- As part of MID's phase 1 project to construct additional recharge basins, MID completed construction of two new recharge basins in 2022 on the three (3) parcels acquired and taken out of production in 2021.
- MID and CM worked cooperatively to develop the Golf Course Basin and Airport Basin.

- MID continued to upgrade infrastructure (pipelines and SCADA systems) to improve MID's water management, reduce system losses, and enhance flexibility of surface water deliveries to growers.
- In early 2023, the WaterSMART Initiative announced $1.5 million in funding for MID landowners to support conservation practices and infrastructure improvements such as irrigation water management, irrigation pipelines, structures for water control, pumps, micro irrigation systems, cover crops, and other practices.
- MID continued work to develop water supply partnerships with partners outside of the Subbasin through coordination with other agencies with contracts for supplies from Friant Dam.
- MID continued developing an incentive program to encourage surface water use and conducted outreach to growers.
- In 2022, MID partnered with the NRCS and was selected as a pilot program area for investigating the benefits of implementing new recharge practices. MID conducted public outreach and workshops to promote program participation within MID. MID also offered an additional financial incentive of 15% of the project costs as a future water purchase offset to incentivize landowners to participate and utilize surface water in the future. The program has been a success, with more than 25 parcels in MID participating in recharge activities. Approximately $62,000 in program costs have been incurred thus far.
- MID continued implementing other tools, policies, and demand management efforts reported in previous Annual Reports.

4.10.4 City of Madera GSA

Updates to the implementation of PMAs proposed and planned by the CM GSA are summarized below. Additional details are provided in the Annual Reports.

4.10.4.1 Updates in the Water Year 2019 Annual Report

- CM operated the Berry Basin in partnership with MID.
- CM continued implementing a project to install water meters and a volumetric billing process. As of 2019, the installation of water meters was roughly 98% complete and the average annual benefits were 3,350 AFY.

4.10.4.2 Updates in the Water Year 2020 Annual Report

- CM continued operating the Berry Basin in partnership with MID.
- CM continued implementing a project to install water meters and a volumetric billing process. As of 2020, the installation of water meters remained roughly 98% complete and the average annual benefits were 3,350 AFY.
- CM applied as a Local Project Sponsor in cooperation with Madera's Proposition 1 Round 1 IRWM grant for funding to install meters on the remaining unmetered services and to replace failing meters on higher volume services.

4.10.4.3 Updates in the Water Year 2021 Annual Report

- CM continued operating the Berry Basin in partnership with MID.
- CM and MID worked cooperatively to develop the Golf Course Basin.
- CM continued implementing the water metering and a volumetric billing project. As of 2021, the installation of water meters remained roughly 98% complete and the average annual benefits were 3,350 AFY.

- CM applied as a Local Project Sponsor in cooperation with Madera's Proposition 1 Round 1 IRWM grant for funding to install meters on the remaining unmetered services and to replace failing meters on higher volume services. The final grant agreement was approved in 2021, and the CM began moving forward with investigation and installation of remaining missing meter locations.

4.10.4.4 Updates in the Water Year 2022 Annual Report

- CM continued operating the Berry Basin in partnership with MID.
- CM and MID worked cooperatively to develop the Golf Course Basin and Airport Basin.
- CM continued implementing the water metering and a volumetric billing project. As of 2022, the installation of water meters remained roughly 98% complete and the average annual benefits were 3,350 AFY.
- Through funding from Madera's Proposition 1 Round 1 IRWM grant, CM investigated and identified 646 residential, industrial, commercial, and institutional locations to be metered. Plans, specifications, and estimates were prepared in 2022 for planned installation in 2023.

4.10.5 Madera County GSA

Updates to the implementation of PMAs proposed and planned by the MC GSA are summarized below. Additional details are provided in the Annual Reports.

4.10.5.1 Updates in the Water Year 2019 Annual Report

- MC operated the Ellis Basin in partnership with MID.
- MC began work to initiate recharge projects in the western portion of the Subbasin along the Chowchilla Bypass and Fresno River through discussions with local landowners and DWR's Flood MAR project team.
- MC coordinated with USBR to modify its CVP contract to enable access to additional CVP supplies (e.g., Section 215 water).
- As of 2019, MC was in the initial stages of implementing demand management efforts. Updates related to demand management were as follows:
    - MC GSA received grant funding to explore the feasibility of adopting an agricultural easement process within Madera County. The project was formerly referred to as the Sustainable Agricultural Lands Conservation (SALC) project but is currently referred to as the Voluntary Land Repurposing Program (VLRP). MC issued a request for proposals (RFP) to obtain a consultant to assist with the work.
    - MC GSA applied for a grant to inventory domestic wells in the Subbasin to better understand how to protect and mitigate potential undesirable effects on disadvantaged communities during GSP implementation.
    - MC GSA applied for and was awarded a grant from USBR to develop a comprehensive water marketing strategy. An RFP was issued, a contractor was selected, and the contractor initiated an economic analysis to support development of a comprehensive water marketing strategy, in coordination with MC, stakeholders, and technical experts.

4.10.5.2 Updates in the Water Year 2020 Annual Report

- MC initiated work on a rate study by contracting with a consultant to quantify implementation costs and move through a Proposition 218 process for a water rate for extraction of groundwater.
- MC continued operating the Ellis Basin in partnership with MID.

- MC initiated a recharge planning study to refine the costs and benefits and schedule for recharge projects described in the GSP. This study resulted in a grant application submitted on behalf of the Madera Subbasin to build a recharge basin and turnouts on the MID distribution system to supply Flood-MAR on farmland. This project was developed in close coordination with MID and Root Creek Water District GSAs and landowners in Madera County who offered their farmland for recharge.
- MC continued development of demand management efforts. Updates related to demand management were as follows:
    - MC continued work on the VLRP planning project to explore the feasibility of adopting a sustainable agricultural conservation easement program. In 2020, MC conducted stakeholder interviews to provide feedback on the structure of the VLRP. Feedback was summarized, presented at a stakeholder meeting in January 2021. Feedback has been used to inform GSA and County decisions about the timing, flexibility, incentives, and areas for the VLRP.
    - MC applied for and was awarded a Proposition 68 DWR grant to conduct a domestic well inventory and install 6 new monitoring wells at two sites in the Subbasin. Additional information and updates after water year 2020 are described in Section 4.10.1.
    - MC continued work to develop a comprehensive water marketing strategy. In 2020, three partner workshops were held to define opportunities, understand concerns, and develop solutions. Interviews were conducted with local stakeholders to voice opinions and concerns. Legal frameworks were also developed. In January 2021, a virtual pilot water market was initiated, with the goal of testing the effectiveness and implications of the potential market rules over a multi-year time period. Sixty local landowners from the Madera and Chowchilla Subbasin signed up for the virtual pilot program.
    - MC initiated a demand measurement program in 2020. MC selected the IrriWatch program to measure consumptive water use on irrigated acres. MC hosted trainings to inform growers about the program. On January 1, 2021, IrriWatch began calculating and making data available to the MC GSA and growers who signed up for the program.
    - MC developed a groundwater allocation framework through a series of public meetings with the Madera County GSA Advisory Committee. The MC GSA Board of Directors adopted the allocation framework at their December 2020 meeting.

4.10.5.3 Updates in the Water Year 2021 Annual Report

- MC continued development of a rate study that would result in a water rate for extraction of groundwater within the MC GSA. The rate study was anticipated to fund GSP implementation activities, including certain planned PMAs.
- MC continued operating the Ellis Basin in partnership with MID.
- MC continued the recharge planning study to refine the costs and benefits and schedule for recharge projects described in the GSP. This study resulted in two grant applications to DWR:
    - In 2021, the first grant proposal was awarded more than $4 million total from Proposition 68 funds to support Flood-MAR on farmland in MC GSA. MC GSA began work to plan, design, and construct planned recharge infrastructure and surveyed sites.
    - In early 2022, the second grant proposal – a spending plan that would fund implementation of phase 2 of the recharge program – was submitted to DWR and approved for funding as part of Round 1 of the 2022 SGMA Implementation Grant program.

- MC continued development of demand management efforts. Updates related to demand management were as follows:
    - MC continued work on the VLRP planning project. In 2021, MC continued stakeholder outreach to gain feedback on the structure of the VLRP. Feedback has been used to inform GSA and County decisions about the timing, flexibility, incentives, and areas for the VLRP.
    - MC continued work to develop a comprehensive water marketing strategy. A virtual pilot water market simulation occurred between January 2021 and November 2021, with the goal of testing the effectiveness and implications of the potential market rules over a multi-year time period. The simulation was jointly implemented by the MC GSA in both the Madera and Chowchilla Subbasins. A total of 57 unique participants from the Madera and Chowchilla Subbasins were enrolled in the overall simulation, with about 25 regular participants each month.
    - MC continued work on the demand measurement program. Growers completed a test year with IrriWatch in 2021. To date, all irrigated parcels in the Madera County GSA have been auto-enrolled in the program, representing nearly 120,000 irrigated acres across the Chowchilla, Madera, and Delta-Mendota Subbasins.
    - MC continued work to develop a groundwater allocation framework through a series of public meetings with the Madera County GSA Advisory Committee. The MC GSA Board of Directors adopted resolutions in December 2020, June 2021, and August 2021 that describe "per-acre" allocations and rules for credits.

4.10.5.4 Updates in the Water Year 2022 Annual Report

- In 2022, MC completed the development of a rate study that was intended to result in an acreage-based rate for extraction of groundwater within the MC GSA. The GSA Board approved a rate package in spring 2022. Under a Proposition 218 process, the rate package was approved and adopted in Madera County Resolution 2022-086. However, following an injunction issued by the Madera County Superior Court in December 2022, the MC GSA was ordered to restrain from imposing and/or collecting any fees, rates, and/or GSP Project Fees enacted under Madera County Resolution 2022-086 against landowners in the Madera Subbasin, beyond any fees that have already been voluntarily paid, reserving jurisdiction regarding fees already paid. Updates regarding the injunction will be provided in future Annual Reports.
- MC continued operating the Ellis Basin in partnership with MID. In late 2022 and early 2023, MC completed various site improvements, including establishment of on-site electrical service and on-site pump installation to improve future operation of the Ellis Basin.
- MC continued the recharge planning study to refine the costs and benefits and schedule for recharge projects described in the GSP. In 2022, the MC GSA continued public outreach and engagement for the recharge program through ongoing solicitation of interested landowner participants and through a public workshop held in November 2022 to discuss the framework for landowner-initiated recharge operations. This study resulted in two grant applications to DWR, resulting in funding for two related projects:
    - The first grant-funded project, initiated in 2021 through Proposition 68 funds, is supporting Flood-MAR on farmland in MC GSA. In 2022-2023, recharge sites were surveyed and 60% designs were completed and reviewed by participating landowners. CEQA and permitting efforts were initiated, although MC is pursuing a CEQA exemption in accordance with Executive Order N-7-22 Action 13.
    - The second grant-funded project, initiated in 2022 through Proposition 68 funds, is planning and designing additional recharge facilities along the Chowchilla Bypass,

expanding on work being developed through the first grant. In 2022-2023, MC developed 30% designs and surveyed recharge areas.

- MC is working on the Fairmead Groundwater Resilience Project, and has received approximately $180,000 in grant funding as part of the California Resilience Challenge to support that effort.
- MC continued development of demand management efforts. Updates related to demand management were as follows:
    - MC continued work on the VLRP planning project. In 2022, MC GSA conducted four public workshops and meetings to review the VLRP development process as well as eligibility criteria, monitoring strategies, contracting processes, incentives, land management strategies, and other planned contract provisions. Rules and criteria for implementing the VLRP were approved by the MC GSA in December 2022. The MC GSA in the Madera Subbasin was awarded a $9.3 million grant from DWR for LandFlex, in coordination with the California Department of Food and Agriculture.
    - MC completed work to on a WaterSMART-funded project to develop a comprehensive water marketing strategy. A final report describing the water market development process, findings, and conclusions was completed in December 2021.
    - MC continued work on the demand measurement program. Growers completed a second test year with IrriWatch in 2022. The MC GSA conducted the Madera Verification Project in 2022 to analyze the consistency of applied water measurements from flowmeters to the applied water estimates developed form the IrriWatch remote sensing measurements. Findings and conclusions from the Madera Verification Project are provided in a final report completed in spring 2023.
    - MC continued work to develop and enforce a groundwater allocation. In 2022, the MC GSA Board of Directors approved penalties for groundwater use in excess of approved allocations through Madera County Resolution 2022-145. Beginning in calendar year 2023, the penalties are being enforced in the MC GSA (within the Chowchilla, Madera, and Delta-Mendota Subbasins) through measurements of groundwater use by approved measurement methods.

4.10.6 Other GSAs in the Madera Subbasin

Updates to PMAs implemented by the Gravelly Ford Water District GSA, New Stone Water District GSA, and Root Creek Water District GSA are summarized in each GSA's respective Annual Reports.

5 PLAN IMPLEMENTATION

To achieve the Subbasin sustainability goal by 2040 and avoid undesirable results through 2090 as required by SGMA and the GSP regulations, various PMAs have been developed and will be implemented by the GSAs. Chapter 4: PMAs describes each GSAs PMAs, gross benefit, and operations. In addition, Chapter 4 provides an estimate of the project-specific capital and operating costs for the PMAs. This chapter describes:

- Costs for GSAs to administer GSP activities (not including the project-specific costs described in Chapter 4), as required by 23 CCR §354.6(e)
- Financing approaches.
- Timeline and roadmap for implementing all GSA PMAs between 2020 and 2040.
- Monitoring and reporting, including the contents of annual reports and five-year periodic evaluations that must be provided to the California Department of Water Resources (DWR) (23 CCR § 356.2 and § 356.4)
- and data management.

5.1 Estimate of GSA Implementation Costs

Total GSP implementation costs include both project-specific costs and costs for GSA's to administer and operate all other aspects of the GSP. The four Joint GSP GSAs implementing the Joint GSP will incur costs for managing the GSP, planning and studies, monitoring implementation, and providing general administration. Projected capital and operating costs of PMAs are summarized in Chapter 4 and are not repeated in this chapter. For the purposes of this chapter, each GSAs implementation costs are aggregated into six (6) categories including GSA administration, GSP studies, GSP implementation and updates, project planning, monitoring, and contingency to cover any unanticipated costs. The following subsections describe the general types of costs that could fall under each category. In practice, each GSA will allocate GSP implementation costs to cost categories that are consistent with its internal bookkeeping and accounting practices.

5.1.1 GSA Administration

Administration of the GSP will be conducted by the four Joint GSP GSAs working together and with GSAs for other GSPs under the Subbasin coordination agreement (as required under 23 CCR § 357.4). Administrative costs generally include coordination meetings, reporting, record keeping, bookkeeping, legal advice, continued outreach to stakeholders, and government relations. GSAs will also need to continue to monitor PMAs to assess their benefit, economic feasibility, and coordinate with stakeholders and other GSAs if modification of PMAs is necessary to ensure the Subbasin meets sustainability objectives.

The four Joint GSP GSAs implementing the Joint GSP anticipate that significant coordination of administrative tasks will be required. Many GSP projects require coordination between one or more GSAs, and overall Subbasin sustainability depends on continued coordination, planning, and evaluation of groundwater conditions. In general, it is anticipated that most administrative tasks will have a lead GSA. The lead GSA for each administrative task will keep the other GSAs informed through periodic updates to stakeholders and other GSAs.

Each GSA will conduct public outreach/engagement to provide timely information to stakeholders regarding GSP progress and Subbasin conditions. Most GSAs will develop and maintain a website that will

be used to post data, reports, and meeting information. In addition, each GSA will conduct general business administration including record keeping, bookkeeping, and general management.

5.1.2 GSP Studies

GSP implementation will require various planning, technical, and economic/fiscal studies. These are additional costs that are not covered by the cost of specific PMAs (see Chapter 4), including for example, more detailed evaluation of proposed projects and assessment of overall cost-effectiveness of GSP implementation strategies.

Planning Studies. GSAs will continue to develop planning studies to integrate the GSP with other regional water management efforts, monitor Subbasin conditions, and update the GSP to ensure that the Subbasin meets all sustainability objectives. GSAs will continue to evaluate Subbasin conditions and adjust short- and long-term Subbasin planning efforts accordingly. Other planning studies may include evaluating projects and developing other programs to support sustainable management.

Technical Evaluations. Subbasin GSAs are required to prepare annual updates and five-year periodic evaluations for DWR (23 CCR § 354.2 and § 354.4). These reports will require additional technical analysis. GSAs will continue to monitor groundwater levels in the Subbasin to document progress toward sustainability objectives. Additional monitoring wells may be installed, and GSAs will evaluate and report groundwater conditions, water use, and change in groundwater storage as required by DWR. GSAs will continue to evaluate data gaps and implement programs to improve data availability.

Economic/Fiscal Analyses. GSAs will develop economic and fiscal studies to support implementation of projects and managements and the overall GSP. This may include cost-effectiveness assessments and preliminary investigations of proposed projects. Fiscal analyses are expected to include rate studies and other analysis required to implement fees or assessments, willingness to pay, and ability to pay studies. GSAs will engage legal and technical experts to help develop the required studies. Economic impact studies will be developed to evaluate GSP implementation, understand distribution of costs to different stakeholder groups, and identify methods for reducing those costs during the implementation period.

5.1.3 GSP Implementation and Updates

GSP implementation costs include internal GSA coordination, meetings, and document preparation. This cost category includes costs not covered by GSA Administration and GSP Studies, in addition to costs incurred to comply with annual updates and five-year periodic evaluations.

Annual reports. 23 CCR § 356.2 requires GSAs to prepare and submit annual reports to DWR. GSAs will prepare any required technical analysis, data, summary material, and provide a report on sustainable management objectives. GSAs expect that annual reports will also require inter- and intra-GSA coordination as well as stakeholder outreach.

Periodic evaluations. 23 CCR § 356.4 requires GSAs to prepare and submit five-year evaluation reports. In contrast to the annual report, this report requires additional evaluation of sustainability conditions, objectives, monitoring, and documentation of new information that is available since the last update to the GSP. GSAs expect that periodic evaluations will also require significant inter- and intra-GSA coordination and stakeholder outreach.

5.1.4 Project Planning

GSAs will incur additional costs for project planning. Project capital and operating and maintenance costs for projects that are included in the GSP are already summarized in Chapter 4. However, GSAs expect to evaluate other project ideas proposed by stakeholders, assess cost-effectiveness of proposed projects, and evaluate the joint implementation of multiple projects to ensure the GSP continues to meet sustainability objectives. Technical studies may include feasibility assessments, environmental studies, water rights evaluations, coordination with permitting agencies, and other project planning efforts. GSAs may evaluate land acquisition and easements, pursue grant applications, administer grants, and engage other legal and technical services.

As needed, the GSAs will coordinate on the specific studies and analyses necessary to improve understanding of Subbasin conditions. The GSAs will use new information on Subbasin conditions to improve PMAs to achieve sustainability. Evaluations and updates will occur annually (annual report) and every five-years (periodic evaluation) as required by the GSP regulations, but GSAs anticipate that planning, coordination, and studies will be continuous and ongoing during the 2020 to 2040 implementation period.

5.1.5 Monitoring

GSAs will implement programs to monitor groundwater extractions, measure elevations, and track total water use. Monitoring activities will include data management, installing and measuring monitoring wells, maintaining existing wells, and deploying other technology.

GSAs will oversee monitoring programs outlined in Chapter 3. This will include tracking Subbasin conditions and sustainability indicators. Data from the monitoring programs will be routinely evaluated to ensure progress is being made toward sustainability and to identify whether undesirable results are occurring.

5.1.6 Contingency

An additional contingency cost is included for planning purposes. This may include actions needed to respond to critically dry years or if Subbasin conditions start trending towards MT levels in any area.

5.2 GSA Implementation Costs

The following subsections summarize estimated costs for each GSA to implement non-project-specific costs of the GSP. Costs are presented for each of the six cost categories identified above. However, GSAs manage costs and expenses in different ways and as such may record costs in different categories. In addition, some GSAs are still developing operating budgets and expect to issue requests for proposals to engage additional consultant technical services, but these costs are not known at this time.

This Joint GSP covers the Madera County GSA, Madera Irrigation District GSA, City of Madera GSA, and Madera Water District GSA. Other GSAs in the Madera Subbasin include Gravelly Ford Water District, Root Creek Water District, and New Stone Water District. Implementation costs for these GSAs can be found in the separate GSPs being developed by these GSAs.

5.2.1 Madera Irrigation District GSA

The Madera Irrigation District GSA (MID) estimates that annual implementation costs (excluding the costs of specific projects) will be approximately $560,000 per year over the next five years. Most (approximately half) of the annual budget is allocated to project planning. These costs do not include the cost of annual reports (costs for the five-year periodic evaluation are included) or for development of additional projects or management actions that may be required if MID determines that its sustainability objectives are not being met.

MID will recover GSP implementation costs through grants and local revenues that are yet to be determined. MID is currently evaluating options. Section 5.3 provides a general description of how MID and other GSAs may recover GSP implementation costs.

Table 5-1. Madera Irrigation District GSA Implementation Costs

Cost Category	FY 2019	FY 2020	FY 2021	FY 2022	FY 2023	FY 2024
GSA Administration	$70,000	$70,000	$70,000	$70,000	$70,000	$70,000
GSP Studies	$20,000	$150,000	$150,000	$20,000	$20,000	$20,000
GSP Implementation and Updates	$130,000	$30,000	$30,000	$30,000	$30,000	$130,000
Project Planning	$300,000	$300,000	$300,000	$300,000	$300,000	$300,000
Monitoring	$0	$20,000	$20,000	$20,000	$20,000	$20,000
Contingency	$52,000	$57,000	$57,000	$44,000	$44,000	$54,000
Total	**$572,000**	**$627,000**	**$627,000**	**$484,000**	**$484,000**	**$594,000**

5.2.2 Madera County GSA

The Madera County GSA estimates that its implementation costs for the Madera Subbasin (excluding the costs of specific projects) would total $13.3 million through 2024, or an average of about $2.2 million per year. GSA administration will include administration of the GSP, Subbasin coordination, communications, and government relations. Studies will include rate studies, Proposition 218 processes, and legal and technical support. Implementation and updates will include preparing and implementing the initial GSP, internal GSA coordination, meetings, guidance document preparation, costs for periodic updates to the GSP, and coordination and agreements for future updates. Project planning would include, as needed, feasibility and environmental studies, costs to plan any new programs or projects not included in Chapter 4, and grant applications. Monitoring costs include equipment costs and maintenance for well monitoring, and data management. Contingency costs would cover cost overruns and unanticipated activities such as litigation.

Table 5-2. Madera County GSA Implementation Costs

Cost Category	FY 2019	FY 2020	FY 2021	FY 2022	FY 2023	FY 2024
GSA Administration	$0	$456,000	$456,000	$456,000	$456,000	$456,000
GSP Studies	$0	$865,000	$472,000	$472,000	$472,000	$472,000
GSP Implementation and Updates	$1,652,000	$79,000	$79,000	$79,000	$79,000	$79,000
Project Planning	$315,000	$393,000	$393,000	$393,000	$393,000	$393,000
Monitoring	$0	$590,000	$590,000	$590,000	$590,000	$590,000
Contingency	$0	$197,000	$197,000	$197,000	$197,000	$197,000
Total	**$1,967,000**	**$2,580,000**	**$2,187,000**	**$2,187,000**	**$2,187,000**	**$2,187,000**

5.2.3 City of Madera GSA

The City of Madera GSA estimates that its implementation costs for SGMA (excluding the capital and O&M costs of specific projects discussed in Chapter 4) would total less than $1 million through 2024, with a range of about $73,000 to $180,000 per year depending on the activities anticipated to occur. GSA administration will include administration of the GSP, Subbasin coordination, communications, and government relations. Studies will include engineering reports, Proposition 218 processes if needed, and legal and technical support. Implementation and updates will include preparing and implementing the initial GSP, internal GSA coordination, meetings, costs for periodic updates to the GSP, and coordination and agreements for future updates. Project planning would include, as needed, new feasibility studies to plan any new programs or projects as well as the environmental/engineering processes for existing proposed projects. Monitoring costs include setting up the monitoring systems, twice annual monitoring of groundwater levels, sensor equipment costs for well monitoring, and data management. Contingency costs would cover cost overruns and unanticipated activities that may occur.

Table 5-3. City of Madera GSA Implementation Costs

Cost Category	FY 2019	FY 2020	FY 2021	FY 2022	FY 2023	FY 2024
GSA Administration	20,000	20,000	20,000	20,000	20,000	20,000
GSP Studies	10,000	50,000	50,000	50,000	10,000	10,000
GSP Implementation and Updates	50,000	15,000	15,000	15,000	15,000	15,000
Project Planning	25,000	50,000	50,000	50,000	50,000	5,000
Monitoring	5,000	30,000	3,000	3,000	3,000	3,000
Contingency	20,000	20,000	20,000	20,000	20,000	20,000
Total	130,000	185,000	168,000	168,000	118,000	73,000

5.2.4 Madera Water District GSA

The Madera Water District GSA estimates that its implementation costs for SGMA (excluding the capital and O&M costs of specific projects discussed in Chapter 4) would total almost $1.1 million through 2024, with a range of about $61,000 to $250,000 per year depending on the activities anticipated to occur. GSA

administration will include administration of the GSP, Subbasin coordination, communications, and government relations. Studies will include engineering reports, Proposition 218 processes if needed, and legal and technical support. Implementation and updates will include preparing and implementing the initial GSP, internal GSA coordination, meetings, costs for periodic updates to the GSP, and coordination and agreements for future updates. Project planning would include, as needed, new feasibility studies to plan any new programs or projects as well as the environmental/engineering processes for existing proposed projects. Monitoring costs include setting up the monitoring systems, twice annual monitoring of groundwater levels, sensor equipment costs for well monitoring, and data management. Contingency costs would cover cost overruns and unanticipated activities that may occur (15% assumed).

Table 5-4. Madera Water District GSA Implementation Costs

Cost Category	FY 2019	FY 2020	FY 2021	FY 2022	FY 2023	FY 2024
GSA Administration	20,000	20,000	20,000	20,000	20,000	20,000
GSP Studies	10,000	50,000	50,000	50,000	10,000	10,000
GSP Implementation and Updates	100,000	15,000	15,000	15,000	15,000	15,000
Project Planning	25,000	100,000	100,000	100,000	100,000	5,000
Monitoring	5,000	30,000	3,000	3,000	3,000	3,000
Contingency	24,000	32,250	28,200	28,200	22,200	7,950
Total	184,000	247,250	216,200	216,200	170,200	60,950

5.3 GSP Financing

Administering the GSP and monitoring and reporting progress is projected to cost between $3 and $5 million per year across the four Joint GSP GSAs that are jointly preparing this Joint GSP. Costs are expected to be higher during years in which five-year periodic evaluations are required, and slightly lower during years in which annual reports are required. This does not include the capital and annual operating cost of PMAs (see Chapter 4).

Development of this Joint GSP was funded through a Proposition 1 Grant, and contributions from individual GSAs (e.g. through in-kind staff time, or separately contracted consulting services). Individual GSAs are also funding additional, ancillary studies and implementation efforts. To fund GSA operations and GSP implementation, GSAs are developing a financing plan that will include one or more of the following financing approaches:

- **Grants and low-interest loans**: GSAs will continue to pursue grants and low interest loans to help fund planning studies and other GSA activities. However, grants and low-interest loans are not expected to cover most GSA operating costs for GSP implementation.
- **Groundwater extraction charge**: A charge per acre-foot pumped would be used to fund GSP implementation activities.
- **Other Fees and charges**: Other fees may include permitting fees for new wells or development, transaction fees associated with contemplated groundwater markets, or commodity-based fees, all directed at aiding with sustainability objectives. Depending on the justification and basis for a fee, it may be considered a property-related fee subject to voting requirements of Article XIII D of

the California Constitution (passed by voters in 1996 as Proposition 218) or a regulatory fee exempt from such requirements.

- **Assessments:** Special benefit assessments under Proposition 218 could include a per-acre (or per-parcel) charge to cover GSA costs.
- **Taxes:** This could include general property related taxes that are not directly related to the benefits or costs of a service (ad valorem and parcel taxes), or special taxes imposed for specific purposes related to GSA activities.

GSAs are pursuing a combined approach, targeting available grants and low interest loans, and considering a combination of fees and assessments to cover operating and program-specific costs. As required by statute and the Constitution, GSAs would complete an engineer's report, rate study, and other analysis to document and justify any rate, fee, or assessment. For example, Madera County has initiated two separate rate studies in 2019. In the first-rate study, an engineering report is being produced to adequately fund an existing flood control and water conservation agency, which would allow for the agency to adequately control flood flows with existing infrastructure. In the second rate study, an engineering report is being produced for the ongoing costs associated with running the three County GSAs, which would include administration as well as sufficient planning funds for eventual project implementation.

Some cost recovery approaches will affect the cost of water for specific uses in the Subbasin. This will affect business (farm) income and incentivize changes in cropping decisions and farming practices in the Subbasin. As cropping and other land use adjusts, GSAs will monitor and adjust fees/assessments, and modify the GSP accordingly.

5.4 Schedule for Implementation

The GSP implementation schedule allows time for GSAs to develop and implement PMAs and meets all sustainability objectives by 2040. While some sustainability projects began immediately after SGMA became law and are already contributing to Subbasin goals, the GSAs will begin implementing all other GSP activities in 2020, with full implementation of PMAs to achieve sustainability by 2040. Figure 5-1 illustrates the GSP implementation schedule for PMAs that have already been implemented by each GSA (including GSAs not covered under this Joint GSP but within the Madera Subbasin). Figure 5-2 illustrates the GSP implementation schedule for PMAs that will be implemented by each GSA. The GSP implementation schedule also shows mandatory reporting and updating for all GSAs, including annual reports and five-year periodic updates (evaluations) prepared and submitted to DWR.

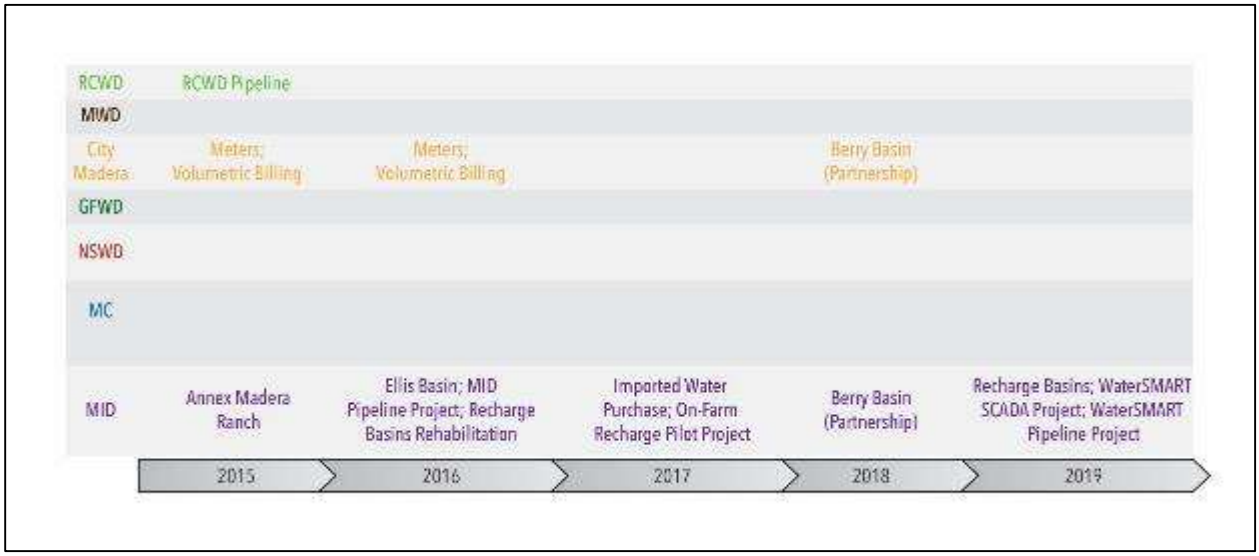


Figure 5-1. Madera Subbasin GSP Completed Projects, 2015 – 2019



Figure 5-2. Madera Subbasin GSP Implementation Schedule, 2020 - 2040

The Madera Subbasin GSP implementation plan for PMAs recognizes that projects will take several years to plan and develop, and planned demand reduction programs will incrementally expand until reaching planned targets by 2040. The Subbasin economy, which is heavily reliant on agriculture, needs time to adjust to sustainability. Important adjustments include higher water costs and limited water supplies in some areas that will result in cropping changes and land idling and affect farming, linked agricultural industries, and all residents in the county. The implementation plan is phased in order to lessen impacts to businesses, individuals, and disadvantaged communities in Madera County.

Implementing PMAs to achieve the sustainability objectives specified in the GSP will increase irrigation water costs and limit the quantity of water available for farming in some parts of the Madera Subbasin. This will impact agriculture and create ripple effects across all sectors of the Madera County economy, including County tax revenues and jobs that support many of the County's disadvantaged communities. The GSP implementation schedule, especially for the Madera County GSA's planned demand management program, allows time for the Madera County economy to adjust in order to minimize economic impacts to disadvantaged communities, businesses, and other individuals in the region.

Figure 5-3 illustrates the conceptual GSP implementation plan, showing the gross benefit (measured in average AFY) of projects and the County's demand management program to meet the Subbasin sustainability objective by 2040. Many GSAs have already started to implement PMAs. The gross annual benefit to the Subbasin from the projects described in Chapter 4 is expected to equal approximately 38,000 AF in 2020, increasing to around 200,000 AF by 2040 when the Subbasin will achieve all sustainability objectives. Gross benefit values shown in **Figure 5-3** include the demand management program implemented by the Madera County GSA, which anticipates an additional 90,000 AF of benefit (demand reduction) by 2040 – nearly double the benefit of other planned PMAs.

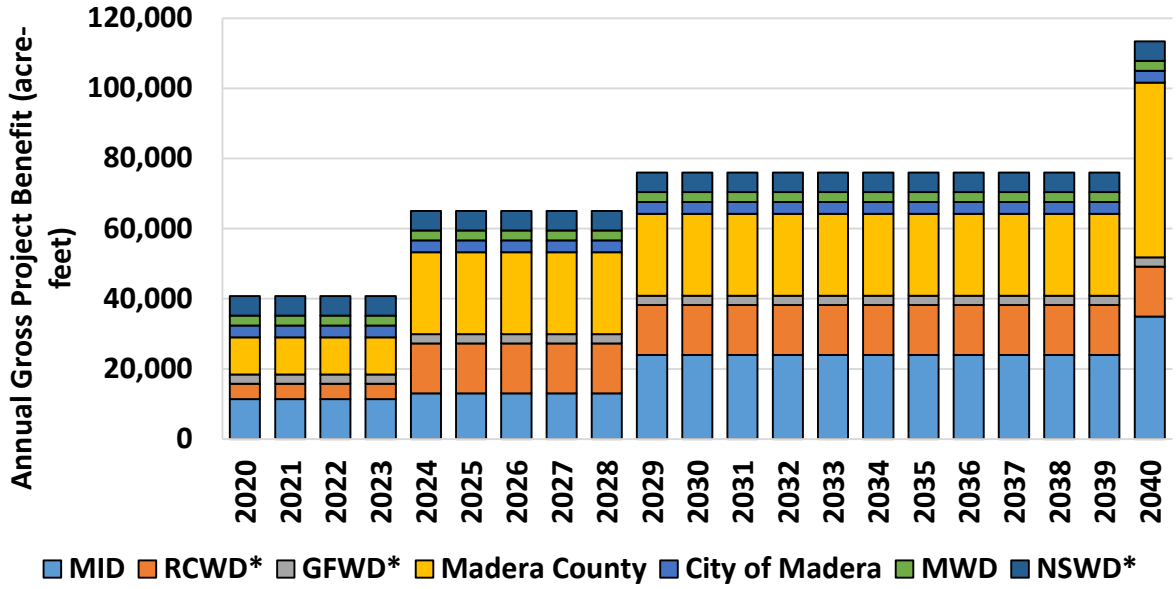


Figure 5-3. Madera Subbasin Project Gross Benefit Timeline (* indicates GSAs not covered by Joint GSP)

In addition to funding GSA activities, GSP updates, and ongoing monitoring and reporting, GSA's will develop and implement PMAs to provide groundwater benefits for the Subbasin (see Figure 5-3). The annual gross benefit increases until it nearly reaches the projected shortfall in 2039 and then in 2040

additional projects come online. Progress will be evaluated in 2035 and each following year and the additional projects adjusted to meet the sustainability objective. Thus, the 2040 annual gross project benefit will be revised to meet the sustainability objective. The capital cost of each project and management action is summarized in Chapter 4. Figure 5-4 illustrates the capital outlay required to implement all of the projects specified in the GSP. The figure indicates the year that the projects would be completed and begin operation, not when all the capital cost would be incurred. The total capital cost of all projects equals approximately $260 million. The GSP implementation plan includes significant outlays in 2025 and 2040, when large recharge projects are planned for development by multiple GSAs. The need for the large recharge projects planned for 2040 will be reviewed during the 2035 GSP update to determine their required size. These capital costs do not include the cost of developing the Madera County GSA demand management program or the cost to growers and the economy of demand management (economic impacts from land idling and crop switching) under that program.

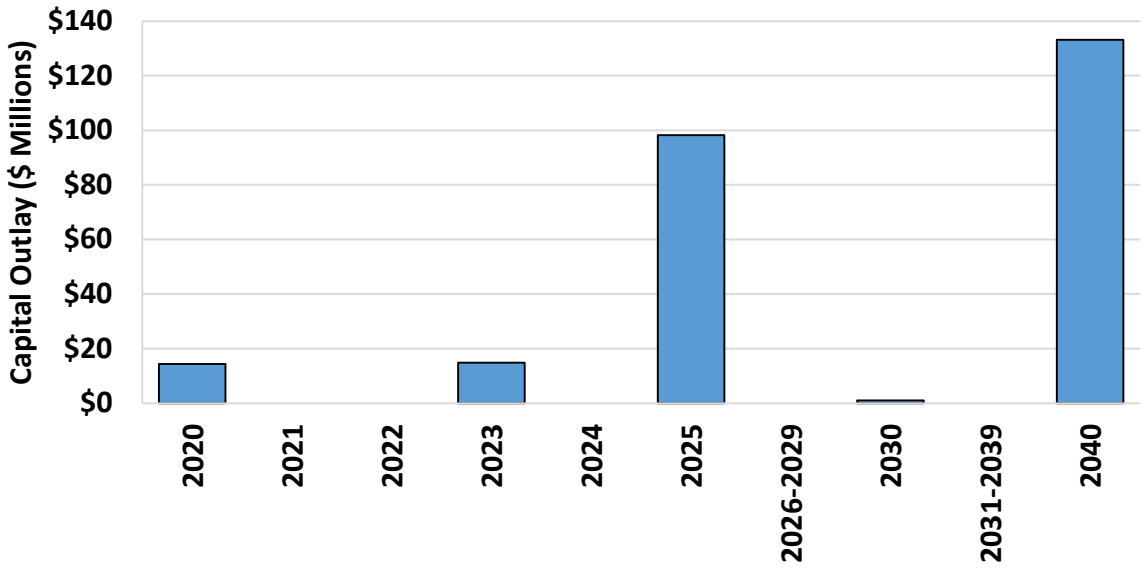


Figure 5-4. Madera Subbasin Estimated Capital Outlay for Projects Only

As projects are implemented, GSAs will incur additional operation and maintenance (O&M) costs. Figure 5-5 illustrates the estimated annual O&M costs (in current dollars) for all GSP projects described in Chapter 4 and the annual costs of GSA implementation described in Section 5.2. This figure does not include the cost that the Madera County GSA demand management program would impose on growers and the County economy. Average annual operating costs for projects increase from $0.5 million per year in 2020 to over $15 million per year by 2040. Project costs will be refined by GSAs as the GSP is implemented. GSA implementation costs total about $3.1 million per year.

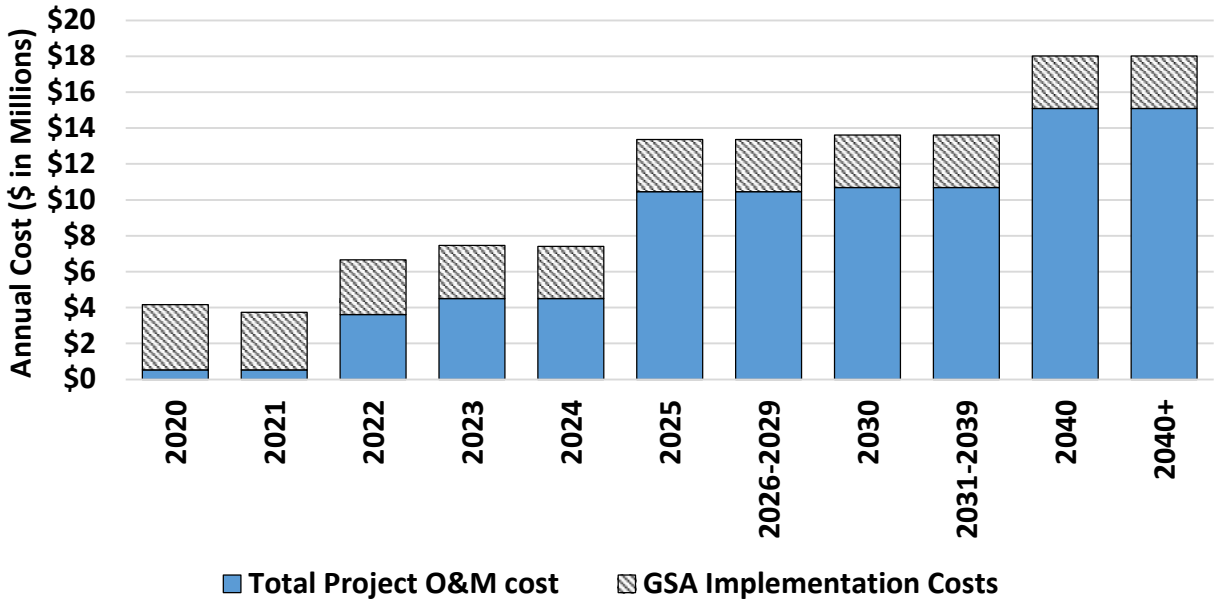


Figure 5-5. Madera Subbasin Estimated Annual Costs for Project O&M and GSA Implementation

5.5 Annual Reports

23 CCR § 356.2 requires annual reports to be submitted to DWR by April 1 of each year following the adoption of the GSP. GSAs will prepare annual reports that comply with the requirements of 23 CCR § 356.2. It is anticipated that GSAs will need to develop independent analyses and data (e.g. for surface water use by a particular GSA) as well as joint analyses (e.g. estimating the Subbasin-wide change in groundwater storage) in order to develop annual reports. GSAs will work together under the Subbasin coordination agreement to complete annual reports. Annual reports must provide basic information about the Subbasin in addition to technical information including:

- Groundwater elevation data from monitoring wells
- Hydrographs of groundwater elevations
- Total groundwater extractions for the prior year
- Surface water supply used in the prior year, including for groundwater recharge or other in-lieu uses
- Change in groundwater storage
- Progress towards implementing the GSP

The following subsections provide a general outline of what information will be provided in the annual report. The annual report provided to DWR will fully comply with the requirements of 23 CCR § 356.2.

5.5.1 General Information (23 CCR § 356.2(a))

General information will include an executive summary that highlights the key content of the annual report. This will include a description of the sustainability goals and provide a description of GSP projects, an updated implementation schedule, and a map of the Subbasin. Any important changes or updates since the last annual report will be noted and described.

5.5.2 Subbasin Conditions (23 CCR § 356.2(b))

The Subbasin conditions section of the annual report will provide an update on groundwater and surface water conditions in the Subbasin.

Current groundwater conditions with respect to the sustainability goals in the Subbasin will be described. GSAs will summarize the groundwater monitoring network data and report current and change in groundwater elevation. This will include groundwater elevation contour maps for each aquifer in the Subbasin tailored to specific hydrogeologic conditions across the region. This will show seasonal high and low conditions within the current season and show historical data from at least January 1, 2015.

Total groundwater extractions will be summarized (in tabular and map form) by water use sector and the method of measurement will be identified (e.g. metering, satellite analysis, crop-based ET estimates, etc.). All data and methods used to characterize extractions and levels will follow best practices and be described in the annual report.

Total ET_{aw} in the Subbasin will be summarized and parsed into ET_{aw} of surface water and ET_{aw} of groundwater using the information on applied surface water. Surface water data will show whether it was used for direct or in-lieu recharge and identify all sources for each GSA.

The groundwater system balance will be used to estimate the change in groundwater storage. Change in storage will be summarized in tabular form and as a map for each aquifer in the Subbasin. A graph will show the water year type, groundwater use, change in storage, and cumulative change in storage for the Subbasin using historical data from no later than January 1, 2015.

5.5.3 Plan Implementation Progress (23 CCR § 356.2(b))

The annual report will summarize GSP implementation of PMAs and other GSA-related activities and describe progress toward established interim milestones and planned sustainability objectives. It will summarize sustainability conditions in the Subbasin.

5.6 Periodic Evaluation (Five-Year Updates)

DWR will review the GSP's progress toward meeting its sustainability goals at least every five years. GSAs will prepare the periodic evaluation to summarize GSP implementation, whether the GSP is meeting sustainability goals, and summarize implementation of PMAs. An evaluation will also be made whenever the GSP is amended. A summary of the general information that will be included in the five-year periodic evaluation required by 23 CCR § 356.4 is provided in the following subsections.

5.6.1 Sustainability Evaluation (23 CCR § 356.4(a) - § 356.4(d))

The evaluation will summarize current groundwater conditions for each sustainability indicator and describe overall progress towards sustainability. A summary of interim milestones and MOs will be included, along with an evaluation of groundwater elevations in relation to MTs. If any MTs are found to be exceeded, the GSAs will investigate probable causes and implement actions to correct conditions, as warranted. However, exceedance of a MT does not automatically trigger corrective action, as the exceedance may be due to factors beyond the control of the GSA.

Implementation of PMAs will be documented and used to adaptively manage the Subbasin. This will include a summary of actual implementation timelines compared to the proposed timeline (Figure 5-1 and Figure 5-2) and implementation schedule described in Chapter 4, and evaluation of the project contribution to improving conditions. If conditions are improving faster or slower than projected, the

reason for the difference from the projection will be evaluated. If conditions are improving slower than projected because any projects or management actions are not implemented according to the specified timeline, the deviation from the original plan will be documented and to the extent possible, corrective actions to speed implementation will be taken. This may include imposing limits on groundwater pumping more broadly than described in Chapter 4, or at a more rapid rate. Similarly, if conditions are improving faster than projected, the scale or timeline of some projects or management actions (notably demand management) may be re-evaluated and revised.

The evaluation will analyze and describe the effect of PMAs on Subbasin sustainability indicators and compare that to the estimated gross benefits of the PMAs presented in Chapter 4. If differences are identified, these will be described in the periodic evaluation. If projects or management actions are not performing as expected, the update will describe steps the GSAs will take to implement additional projects or reduce pumping, if warranted. Any changes to the implementation schedule of PMAs will be described in the periodic evaluation.

As GSP PMAs are implemented, monitoring data may indicate unanticipated effects. Also, land uses and economic conditions will change in ways that cannot be anticipated at this time. For example, the GSP has not developed an economic analysis to consider the effect of higher water costs and lower water supply availability on farm profitability and regional crop mix. As such, it may be necessary to revise the GSP to account for these changes. The elements of the GSP including the basin setting, management areas, undesirable results, MTs, and MOs will be reconsidered by the GSAs during the periodic evaluations. Any proposed revisions will be documented in the periodic evaluation.

5.6.2 Monitoring Network Description (23 CCR § 356.4(e))

Chapter 3 details the planned monitoring network and protocols. The effectiveness of the monitoring network and overall GSP implementation depends on timely, accurate, and comprehensive data. The GSP includes Data Management System (DMS) protocols, as well as expanded monitoring wells and data collection. However, as described in Chapter 3, data gaps still exist in the Subbasin that will require expanding the network. If data gaps are identified, a plan will be developed to improve the monitoring network, consistent with 23 CCR § 354.38.

GSAs expect that additional data gaps may be identified in future GSP updates. The periodic evaluations of the GSP will assess changes to the monitoring program needed to acquire additional data sources, and how the new information will be used and incorporated into any future GSP updates. The installation of new data collection facilities and analysis of new data will be prioritized in the GSP.

5.6.3 New Information (23 CCR § 356.4(f))

GSAs are continuing to monitor Subbasin conditions and additional monitoring wells are being installed under a Proposition 1 grant. In addition, the DMS will allow GSAs to identify additional data gaps and implement procedures to secure additional data. Land use and economic incentives for farming and other water uses in the Subbasin will continue to change as the GSP is implemented. GSAs expect that new information about groundwater conditions, PMAs, and sustainability objectives will continue to be available. An adaptive management approach will be applied to identify, review, and incorporate all new information into the GSP. Periodic evaluations will indicate whether new information warrants changes to any aspect of the GSP, including the basin setting, MOs, MTs, or undesirable results.

5.6.4 GSA Actions (23 CCR § 356.4(g) - § 356.4(h))

GSAs are continuing to monitor, manage, and collaborate to meet the sustainability goals specified in the GSP. Within their allowed authorities, GSAs are evaluating new regulations or ordinances that could be implemented to help achieve sustainability objectives. Any changes in regulations or ordinances will be summarized in the periodic update. The effect on any aspect of the GSP, including the basin setting, MOs, MTs, or undesirable results will be described.

The five-year periodic evaluation will include a summary of state laws and regulations or local ordinances related to the GSP that have been implemented since the previous periodic evaluation and address how these may require updates to the GSP. Enforcement or legal actions taken by the GSAs in relation to the GSP will be summarized in this section along with how such actions support sustainability in the Subbasin.

5.6.5 Plan Amendments, Coordination, and Other Information (23 CCR § 356.4(i) - § 356.4(k))

Any proposed or completed amendments to the GSP will be described in the periodic evaluation. This will also include a summary of amendments that are being considered or developed at that time. This may include changes to the basin setting, MOs, MTs, or undesirable results.

Any changes to the GSA coordination agreement, or other Subbasin coordination agreements will be documented and summarized. GSAs will summarize any other information deemed appropriate to support the GSP and provide required information to DWR for review of the GSP.

5.7 Data Management System (23 CCR § 352.6)

The Madera Subbasin Data Management System (DMS) has been developed as an integrated network of databases and linked programs and tools. Each element is directly or indirectly linked to the central water budget database, which organizes and calculates the Subbasin water budget (Figure 5-6). Inputs to the water budget database are organized into inputs that are managed and implemented at the Subbasin-level and inputs that are managed at the GSA-level. Subbasin-level inputs include:

- **Time series**: time series data managed in a database structure and used to quantify surface water inflows/outflows and groundwater levels
    - USGS and USACE station data
    - DWR-compiled data (WDL and CDEC)
- **Weather:** weather data managed in a database structure and used to quantify reference evapotranspiration and precipitation, and to support root zone water budget calculations (crop evapotranspiration, infiltration, runoff)
    - CIMIS station data
    - NCEI (NOAA) station data
    - PRISM data
- **eWRIMS**: water rights diversions records managed publicly in a database structure and used to quantify surface water supply utilized for irrigation
- **GIS:** spatially-defined geographic data managed in GIS and used to support land use analyses and spatial water use by sector
    - DWR spatial data (Subbasin boundaries, GSA boundaries, land use survey spatial coverages, Land IQ land cover classification and analysis)

    - DWR interpolation tool results (spatial and temporal interpolation of spatial coverages, using Ag Commission reports)
    - Local land use data comparison and validation
- **IWFM IDC**: daily root zone water budget results estimated by the IWFM IDC program and used to quantify crop evapotranspiration, infiltration, runoff, and change in SWS storage (see Section 2.2.3.3)

Inputs to the Subbasin water budget that are managed at the GSA-level include:

- **Time series:** time series data relating to GSA-specific inflows that are managed in a database structure and used to quantify surface water inflows/outflows
- **Local Data:** local data managed in spreadsheets and used to quantify GSA-specific inflows/outflows (diversions and deliveries not recorded in Subbasin-level data sources)
- **Deliveries**: Water district delivery data managed in a database structure and used to quantify surface water supply utilized for irrigation

All GSAs will manage data related to GSP project implementation within their boundaries. GSAs are continually working to refine data, identify data gaps, and incorporate additional information characterizing groundwater conditions in the Subbasin.

GSAs are currently developing a Request for Proposals (RFP) to secure a database development contractor to develop a database system to store, manage, and retrieve data. This will formalize the DMS, which will be developed to meet the requirements in the GSP regulations, including 23 CCR §352.4, §352.6, and §354.4. As described previously, the data will be managed so that appropriate tables, graphs, and maps supporting the GSP annual reports and periodic evaluations can be queried and provided to DWR.

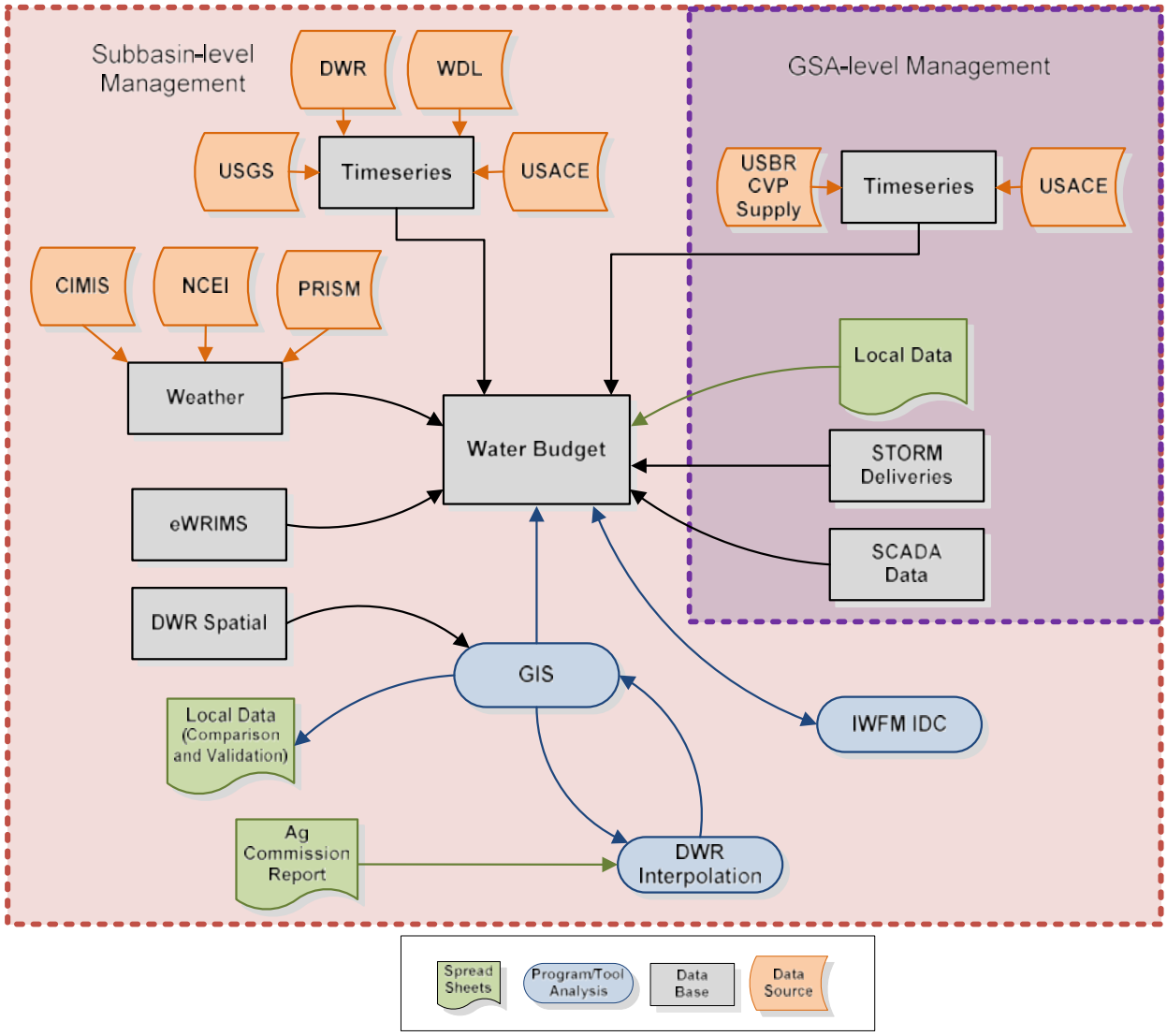


Figure 5-6. Madera Subbasin Data Management System Structure

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APPENDEX ITEM 1.J

FIRST AMENDMENT TO THE MADERA SUBBASIN COORDINATION AGREEMENT

FIRST AMENDMENT TO THE MADERA SUBBASIN COORDINATION AGREEMENT

This FIRST AMENDMENT (AMENDMENT) to the MADERA SUBBASIN COORDINATION AGREEMENT ("Agreement") is entered into the_____day of March 2023 (the "Effective Date"), by and between the Groundwater Sustainability Agencies of the COUNTY OF MADERA ("County"), the CITY OF MADERA ("City"), the MADERA IRRIGATION DISTRICT ("MID"), the ROOT CREEK WATER DISTRICT ("RCWD"), the MADERA WATER DISTRICT ("MWD"), the GRAVELLY FORD WATER DISTRICT ("GFWD"), and the NEW STONE WATER DISTRICT ("NSWD"), collectively hereinafter referred to as the "Parties," or individually as the "Party."

RECITALS

A. **WHEREAS**, groundwater and surface water resources within the Madera Subbasin of the San Joaquin Valley Groundwater Basin (DWR Bulletin 118 No. 5-22.06) (Subbasin) are vitally important resources, in that they provide the foundation to maintain and fulfill current and future environmental, agricultural, domestic, municipal, and industrial needs, and to maintain the economic viability, prosperity, and sustainable management of the Subbasin; and

B. **WHEREAS**, agriculture has been prominent in making Madera County one of the world's foremost agricultural areas and plays a major role in the economy of Madera County; and

C. **WHEREAS**, in 2014 the California Legislature passed a statewide framework for sustainable groundwater management, known as the Sustainable Groundwater Management Act, California Water Code § 10720-10737.8 (SGMA), pursuant to Senate Bill 1168, Senate Bill 1319, and Assembly Bill 1739, which was approved by the Governor on September 16, 2014. and went into effect on January 1, 2015; and

D. **WHEREAS**, the Subbasin has been designated by the California Department of Water Resources (DWR) as a high-priority subbasin in a condition of critical groundwater overdraft and is subject to the requirements of SGMA; and

E. **WHEREAS**, SGMA requires that all medium and high priority groundwater basins in California be managed by a Groundwater Sustainability Agency (GSA), or multiple GSAs, and that such management be implemented pursuant to an approved Groundwater Sustainability Plan (GSP), or multiple GSPs; and

F. **WHEREAS**, County, City, MID, and MWD have developed one GSP; RCWD has developed one GSP; GFWD has developed one GSP; and NSWD has developed one GSP, such that the Subbasin is governed by four separate GSPs unified through the Subbasin Coordination Agreement; and

G. **WHEREAS**, in January 2020, the Parties submitted four GSPs to DWR; and

H. **WHEREAS**, in January of 2020, the Parties entered into the Agreement.

DRAFT

I. **NOW, THEREFORE**, in consideration of the mutual promises, covenants and conditions contained herein and these Recitals, which are hereby incorporated herein by this reference, the Parties agree as required by DWR and limited to that set-forth herein, to amend the Agreement as follows:

AGREEMENT

1. **SUSTAINABILITY GOAL.** The Parties agree that the Sustainability Goal for the Subbasin shall be:

   "The sustainability goal for the Madera Subbasin is to implement a package of projects and management actions that will, by 2040, balance long-term groundwater system inflows and outflows based on a 50-year period representative of average historical hydrologic conditions."

2. **SUBBASIN SUSTAINABLE YIELD ESTIMATE.** The Parties agree that the Sustainable Yield Estimates from the Historical Water Budget and Projected with Projects Water Budget as initially developed during initial GSP development are as set-forth in Exhibit A.

3. **CURRENT AND PROJECTED WATER BALANCES.** The Parties agree that the current and projected water budgets for the Parties as initially developed during initial GSP development are as set-forth in Exhibit B. The Parties further recognize that additional discussion, consensus, and model refinement is necessary as part of the 2025 GSP update to ensure accurate portrayal of Holding Contract surface water supplies.

4. **NOTICES**. All notices required or permitted by the Amendment shall be made in writing, and may be delivered in person (by hand or by courier) or may be sent regular, certified, or registered mail or U.S. Postal Service Express Mail, with postage prepaid, or by facsimile transmission, or by electronic transmission (email) and shall be deemed sufficiently given if served in a manner specified in this Section 16. The addresses and addressees noted below are the Party's designated address and addressee for deliver or mailing notices.

To County:	County of Madera Stephanie Anagnoson 200 W 4th Street, 4th Floor Madera, CA 93637
To MID:	Madera Irrigation District Thomas Greci 12152 Road 28 1/4 Madera, CA 93637

DRAFT

To RCWD:	Root Creek Water District Julia Stornetta PO Box 27950 Fresno, CA 93729
To GFWD:	Gravelly Ford Water District Don Roberts 18811 Road 27 Madera, CA 93638
To City:	City of Madera Keith Helmuth 428 East Yosemite Avenue Madera, CA 93638
To NSWD:	New Stone Water District Roger Skinner 9500 South DeWolf Avenue Selma, CA 93662
To MWD:	Madera Water District Melanie J. Aldridge 1663 N. Schnoor Street, Suite 105 Madera, CA 93638

Any Party may, by written notice to each of the other Parties, specify a different address for notice. Any notice sent by registered or certified mail, return receipt requested, shall be deemed given on the date of delivery shown on the receipt card, or if no delivery date is shown, three days after the postmark date. If sent by regular mail, the notice shall be deemed given 48 hours after it is addressed as required in this section and mailed with postage prepaid. Notices delivered by United States Express Mail or overnight courier that guarantee next day delivery shall be deemed given 24 hours after delivery to the Postal Service or overnight courier. Notices transmitted by facsimile transmission or similar means (including email) shall be deemed delivered upon telephone or similar confirmation of delivery (conformation report from fax machine is sufficient), provided a copy is also delivered via personal delivery or mail. If notice is received after 4:00 p.m. or on a Saturday, Sunday or legal holiday, it shall be deemed received on the next business day.

IN WITNESS WHEREOF, the Parties have caused this AMENDMENT to be executed, each signatory hereto represents that he/she has been appropriately authorized to enter into this AMENDMENT on behalf of the Party whom he/she signs.

DRAFT

County of Madera

_____ _____

Date

Madera Irrigation District

_____ _____

Thomas Greci Date

Root Creek Water District

_____ _____

Julia Stornetta Date

Gravelly Ford Water District

_____ _____

Don Roberts Date

City of Madera

_____ _____

Date

New Stone Water District

_____ _____

Roger Skinner Date

DRAFT

Madera Water District

Phil Janzen

Date

DRAFT

EXHIBIT A

Subbasin Sustainable Yield Estimate

Summary of Sustainable Yield Estimate from Historical Water Budget

Table 2-34. Summary of Sustainable Yield Estimates from Historical Water Budget (23 CCR § 354.18(b)(7)).

Quantification Method	Average Volume, 1989-2014 (AF)	Estimated Confidence Interval (percent)	Confidence Interval Source	Average minus CI (AF)	Average plus CI (AF)
Groundwater Extraction and GWS Change in Storage	437,300	25%	Calculation.	328,000	564,600
Total Inflows to GWS	437,300	19%	Calculation.	354,200	520,400
"Simulation" of Reduced Demand	423,300	25%	Professional Judgment.	317,500	529,100

Summary of Sustainable Yield Estimate from Projected With Projects Water Budget

Table 2-35. Summary of Sustainable Yield Estimates from Projected With Projects Water Budget (23 CCR § 354.18(b)(7)).

Quantification Method	Average Volume, 2040-2090 (AF)	Estimated Confidence Interval[1] (percent)	Average minus CI (AF)	Average plus CI (AF)
Groundwater Extraction and GWS Change in Storage	439,300	25%	329,500	549,100

[1] Confidence interval source: Professional judgment based on historical calculations.

Sustainable yield was calculated for the 2040-2090 projected period (Table 2-35) with a single value of a sustainable yield for the Subbasin as a whole (DWR, 2017). The sustainable yield is estimated as the average annual groundwater extraction during the projected 2040-2090 period. This projected groundwater extraction equals the sum of the average annual recharge without projects and the average annual net project infiltration during the projected period. Since average groundwater inflows approximately equal outflows during the 2040-2090 period, the average annual change in the groundwater storage would be close to zero over this 50-year period. **By this method, sustainable yield is estimated to be 439,300 AFY.**

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EXHIBIT B

Current and Projected Water Budgets[1,2,3]

CURRENT

GSA	Current Water Budget Average Net Recharge from SWS (AF)
CM	-3,300
MID	-23,600
GFWD	-1,700
MC	-110,700
MWD	-5,200
NSWD	-4,100
RCWD	-14,200
Total	-162,800

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[1] The Parties recognize there are certain non-significant variances in the calculations of the impact of various sources of recharge and intend to develop further data or information through the DMS to further narrow such variances. Such additional data will help to refine, prove or disprove models and/or presumptions included in the respective GSPs.

[2] Current water budget values for each GSA have been calculated using 2015 land use and the 1989-2014 hydrology.

[3] The Parties recognize that additional discussion, consensus, and model refinement is necessary as part of the 2025 GSP update to ensure accurate portrayal of Holding Contract surface water supplies.

PROJECTED

MCSim Projected with Projects Water Budget by GSA
Madera Subbasin

	Average Annual Water Budget (AF/m)							
	City of Madera		Madera County		Gravelly Ford Water District		Madera Irrigation District	
	Implementation Period, 2020-2039	Sustainability Period, 2040-2090	Implementation Period, 2020-2039	Sustainability Period, 2040-2090	Implementation Period, 2020-2039	Sustainability Period, 2040-2090	Implementation Period, 2020-2039	Sustainability Period, 2040-2090
Total Stream Seepage	729	1,456	52,942	75,636	12,517	15,694	96,752	120,771
In-Channel Seepage	*729*	*1,456*	*39,394*	*38,862*	*125*	*155*	*17,209*	*15,781*
Conveyance Losses	*0*	*0*	*13,548*	*36,775*	*12,391*	*15,539*	*79,543*	*104,989*
Deep Percolation	9,401	13,896	78,701	82,195	7,231	7,719	88,002	97,426
General Head Boundary Conditions	0	0	0	0	0	0	0	0
Small Watershed Baseflow	0	0	313	148	0	0	0	0
Small Watershed Percolation	0	0	0	0	0	0	0	0
Groundwater Pumping	-8,956	-12,703	-219,207	-175,069	-16,128	-15,146	-220,066	-221,149
Total Subsurface Inflow	-2,072	-2,082	71,234	23,487	-4,280	-8,395	23,054	6,169
Average Annual Change in Storage	-898	568	-16,018	6,397	-660	-128	-12,259	3,217
Total Cumulative Change in Storage	-17,969	28,946	-320,352	326,255	-13,204	-6,519	-245,173	164,069

	Average Annual Water Budget (AF/m)					
	Madera Water District		New Stone Water District		Root Creek Water District	
	Implementation Period, 2020-2039	Sustainability Period, 2040-2090	Implementation Period, 2020-2039	Sustainability Period, 2040-2090	Implementation Period, 2020-2039	Sustainability Period, 2040-2090
Total Stream Seepage	286	462	2,012	3,032	546	-54
In-Channel Seepage	*286*	*462*	*572*	*-622*	*-309*	*-913*
Conveyance Losses	*0*	*0*	*1,441*	*3,654*	*855*	*859*
Deep Percolation	3,241	3,647	3,831	5,469	8,222	8,738
General Head Boundary Conditions	0	0	0	0	0	0
Small Watershed Baseflow	0	0	0	0	0	0
Small Watershed Percolation	0	0	0	0	0	0
Groundwater Pumping	-5,660	-4,283	-7,665	-7,623	-14,084	-11,389
Total Subsurface Inflow	1,685	318	808	-676	4,929	2,554
Average Annual Change in Storage	-448	144	-1,014	202	-386	-151
Total Cumulative Change in Storage	-8,953	7,324	-20,270	10,305	-7,728	-7,683

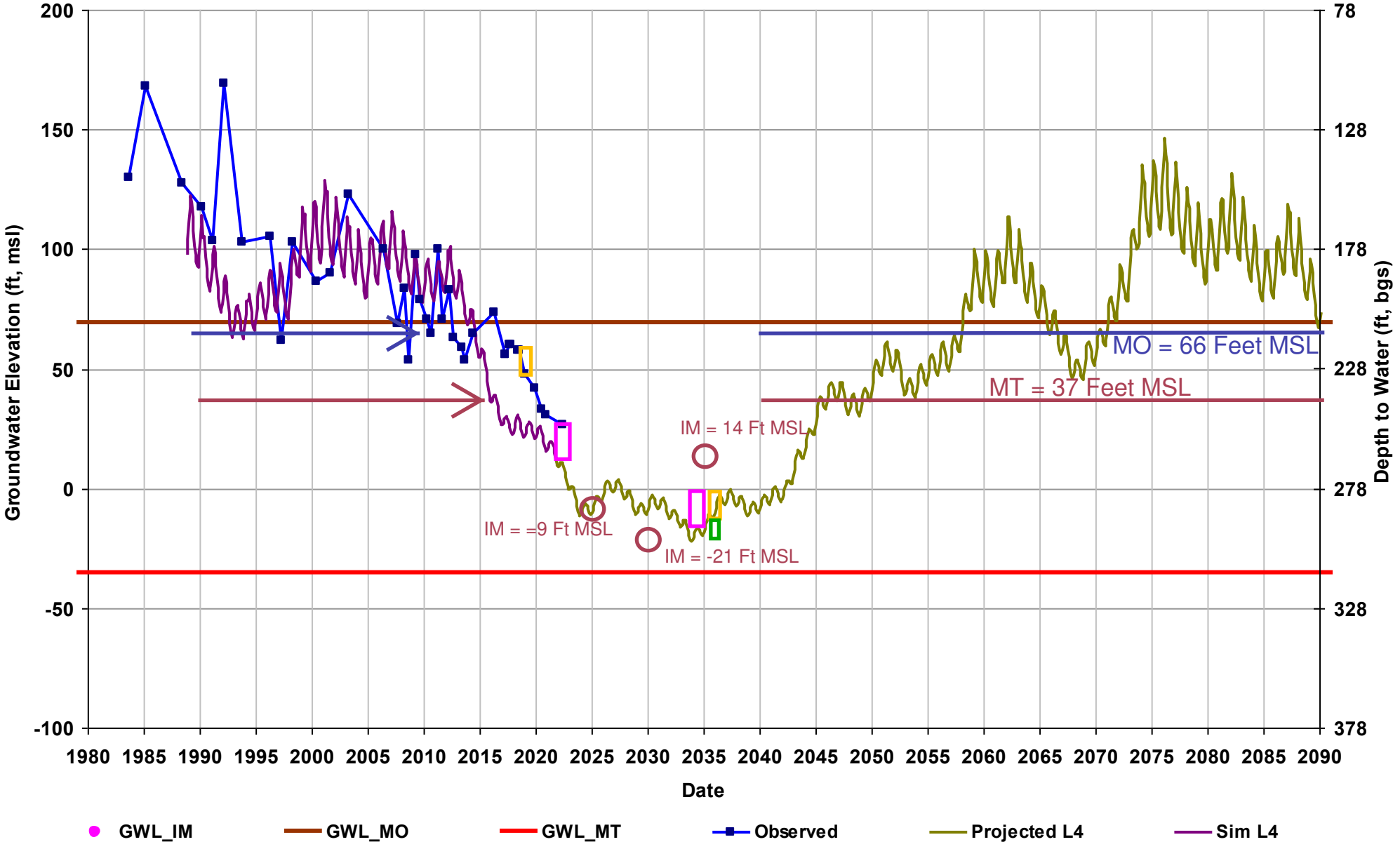
	City of Madera	Madera County	Gravelly Ford Water District	Madera Irrigation District	Madera Water District	New Stone Water District	Root Creek Water District	Total (AF)
	Sustainability Period, 2040-2090	Sustainability Period, 2040-2090	Sustainability Period, 2040-2090	Sustainability Period, 2040-2090	Sustainability Period, 2040-2090	Sustainability Period, 2040-2090	Sustainability Period, 2040-2090	
Groundwater Pumping (AF)	-12,703.00	-175,069.00	-15,146.00	-221,149.00	-4,283.00	-7,623.00	-11,389.00	-447,362.00
Total Cumulative Change in Storage (AF)	28,946.00	326,255.00	-6,519.00	164,069.00	7,324.00	10,305.00	-7,683.00	522,697.00
Difference (AF)								75,335.00

APPENDEX ITEM 2.E.b

GROUNDWATER ELEVATION HYDROGRAPHS

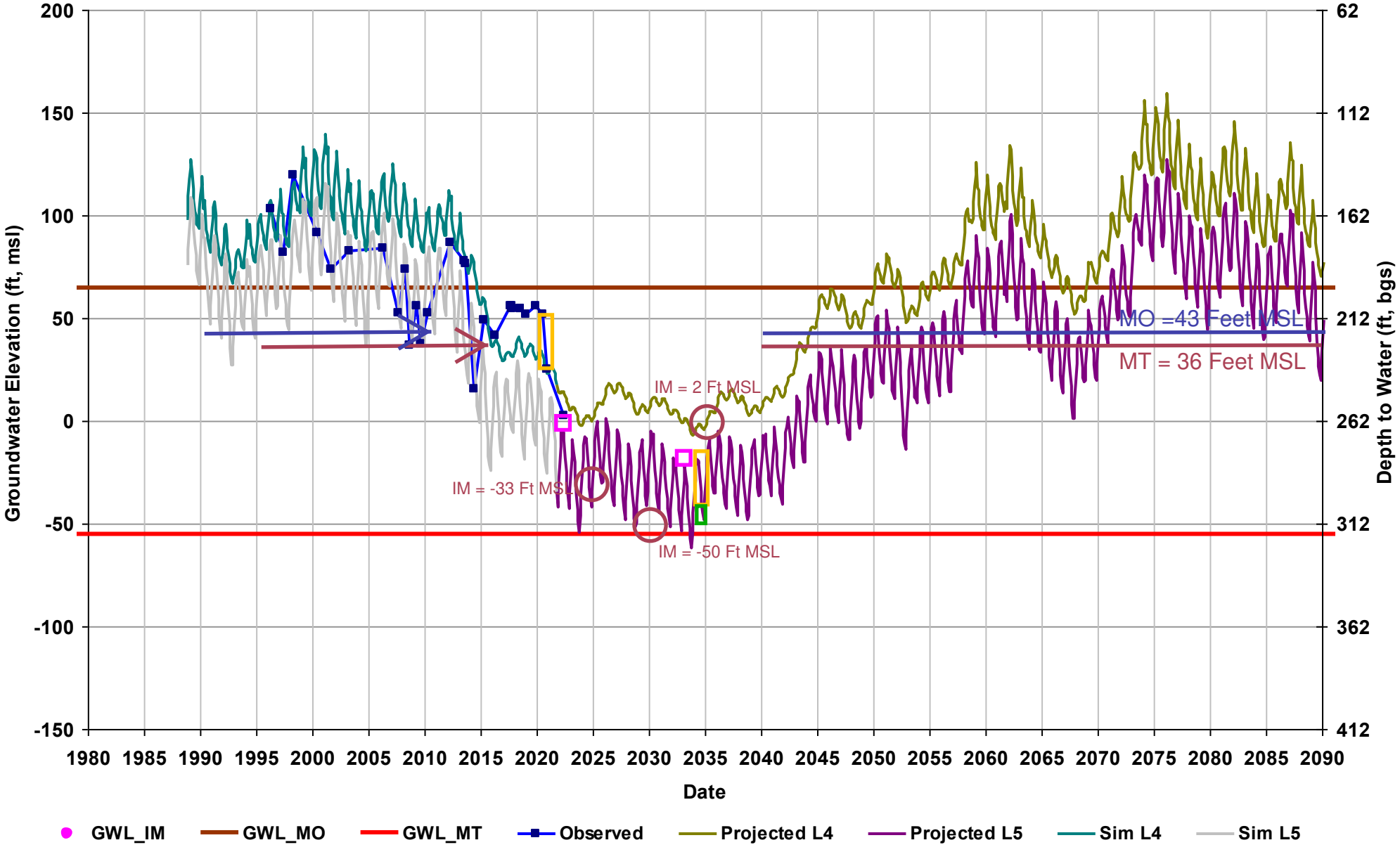
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GSE (ft, msl): 278

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Bottom Model Layer: 4



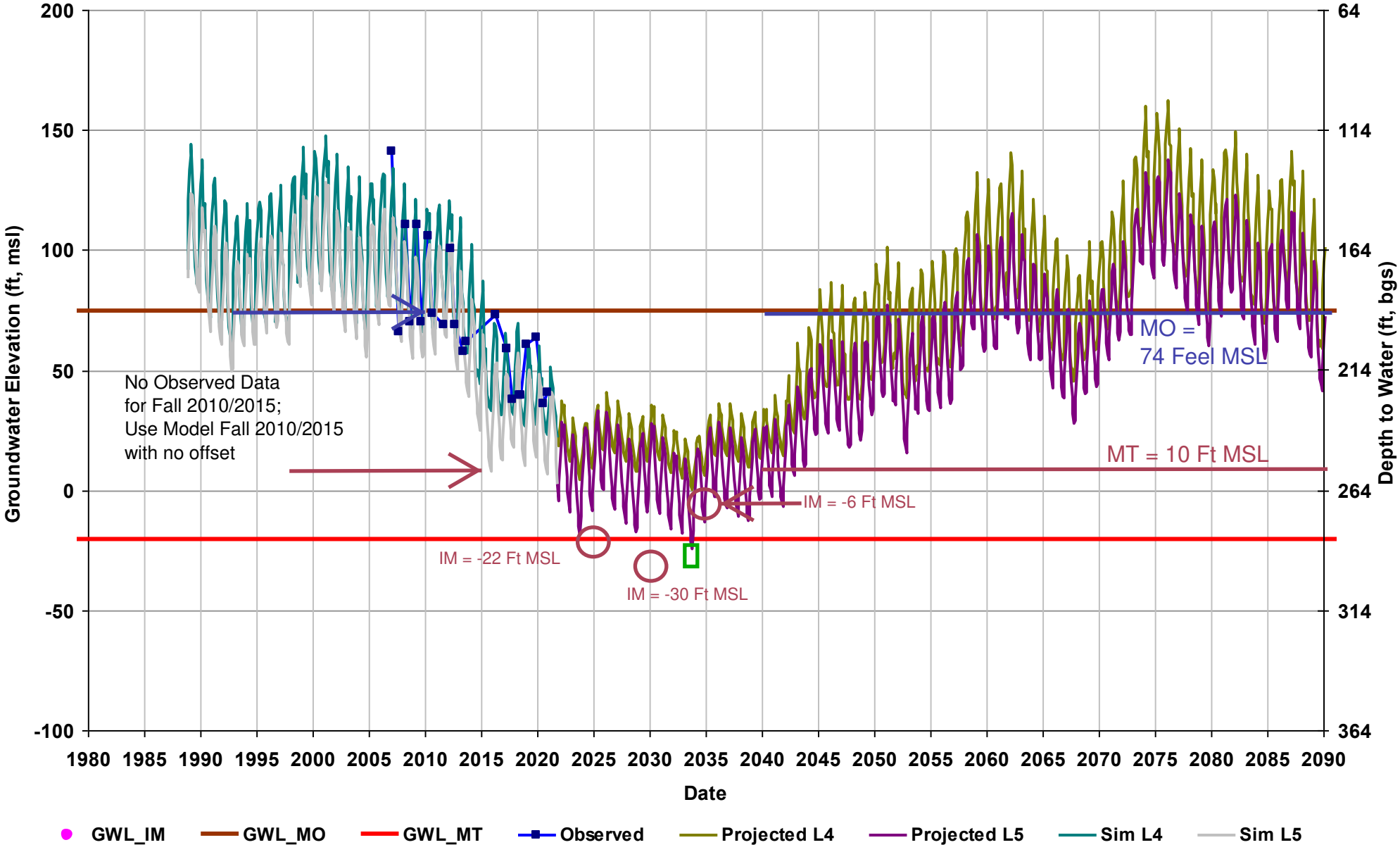
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Subbasin: Madera
GSE (ft, msl): 262

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Perf. Bottom (ft bgs): 590
Top Model Layer: 4
Bottom Model Layer: 5



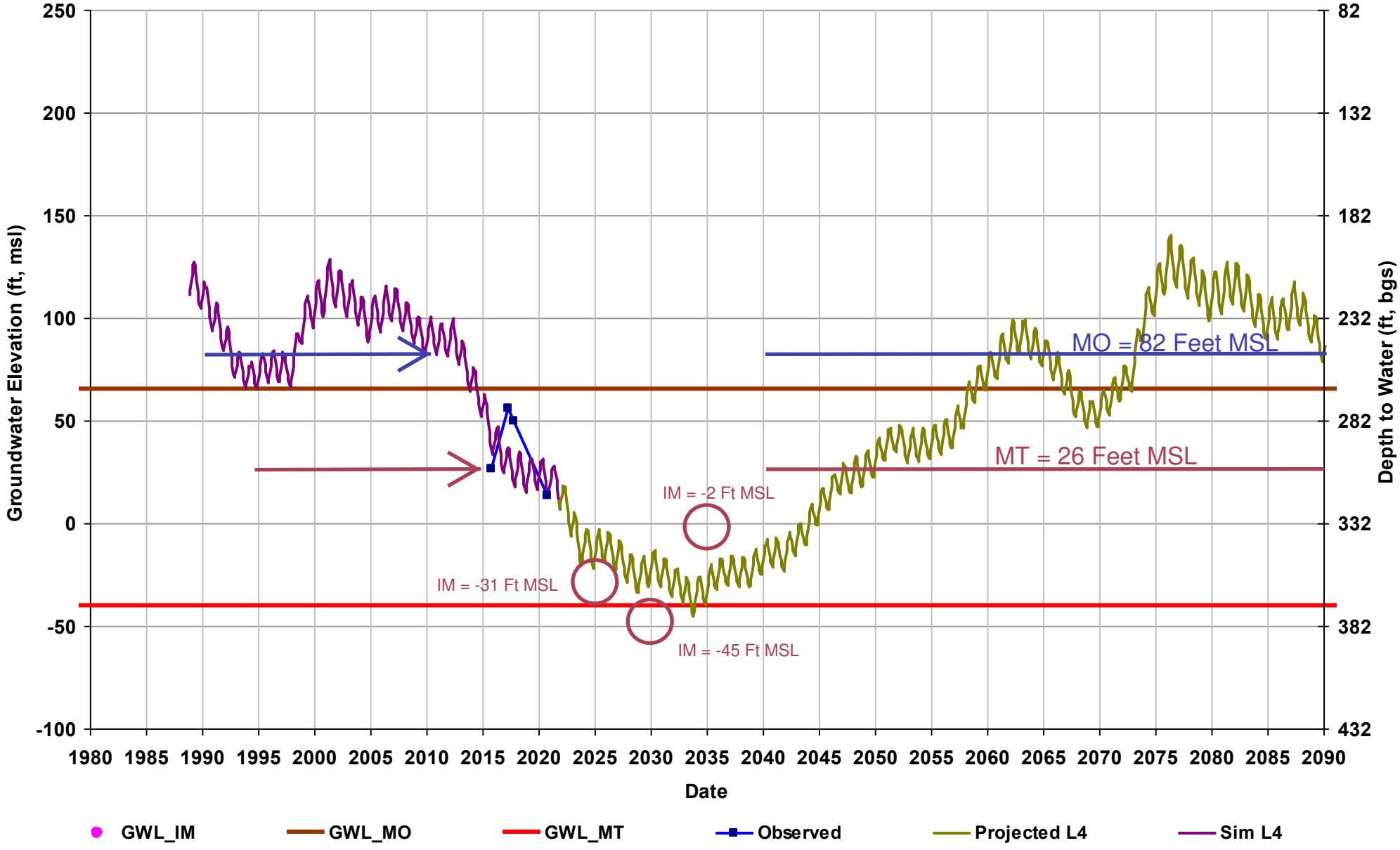
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Depth Zone: Lower
Subbasin: Madera
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Top Model Layer: 4
Bottom Model Layer: 5



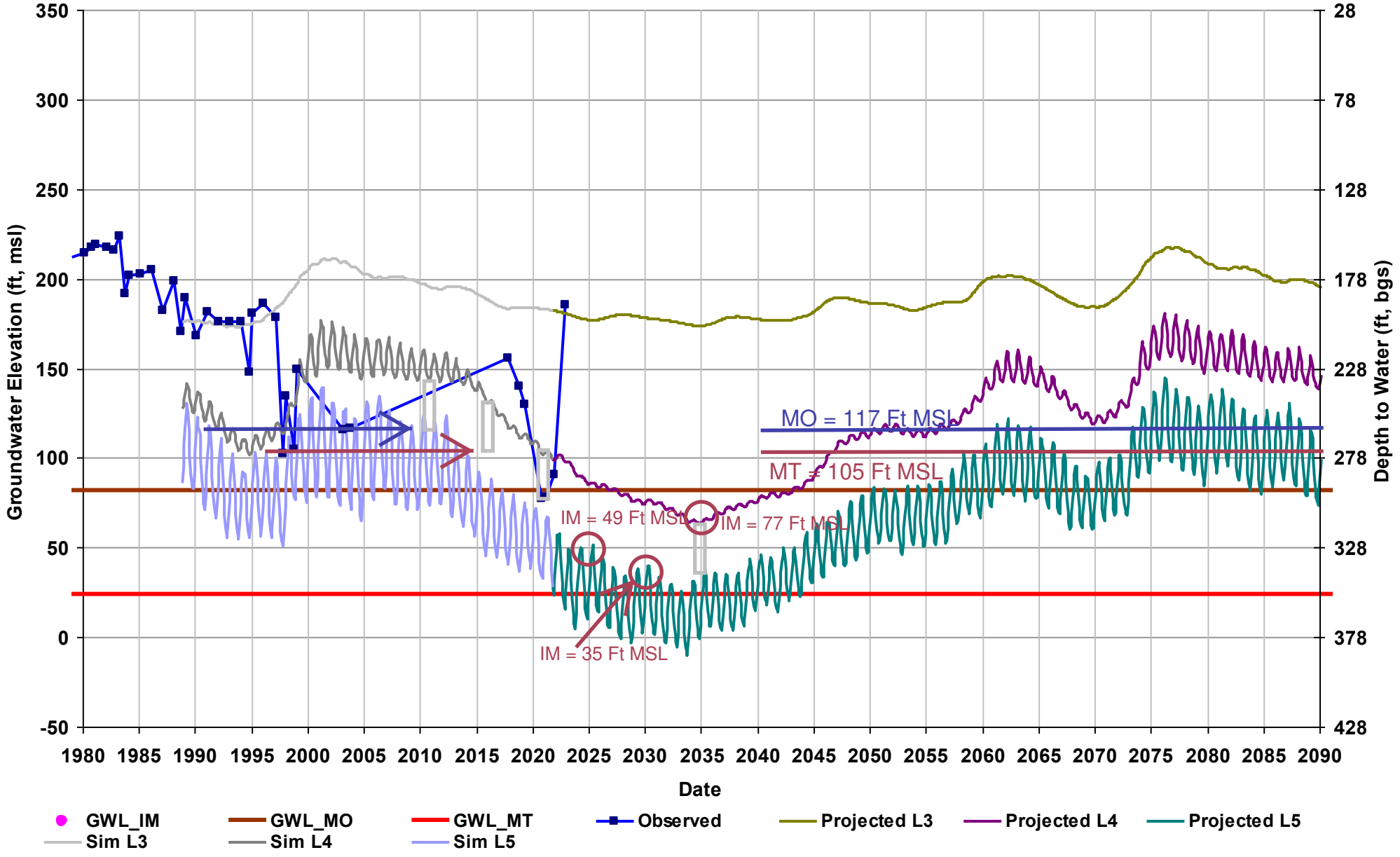
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Subbasin: Madera
GSE (ft, msl): 332

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Perf. Bottom (ft bgs): 500
Top Model Layer: 4
Bottom Model Layer: 4



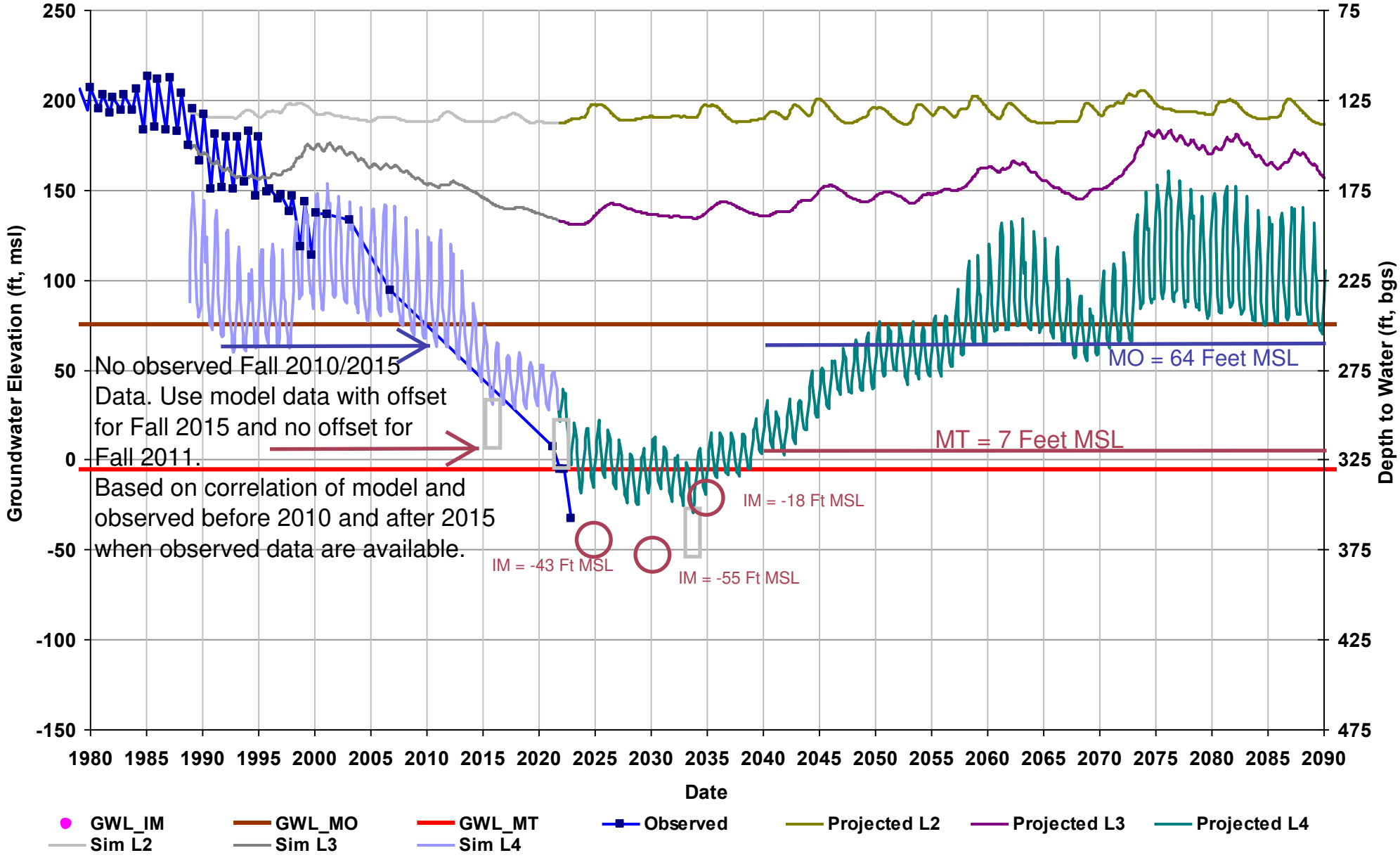
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Subbasin: Madera
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Perf. Bottom (ft bgs):
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Bottom Model Layer: 5



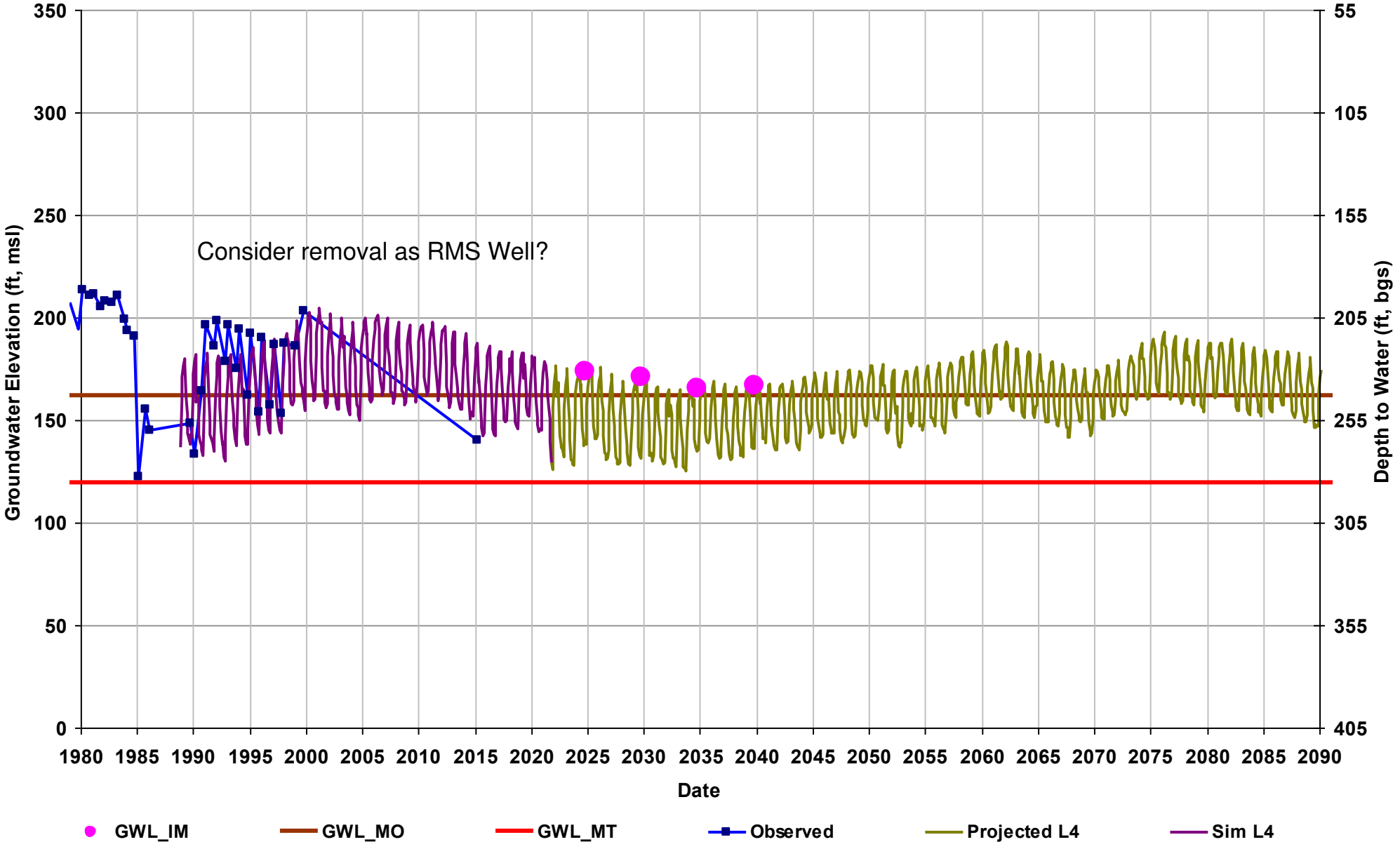
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Subbasin: Madera
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Perf. Bottom (ft bgs):
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Bottom Model Layer: 4



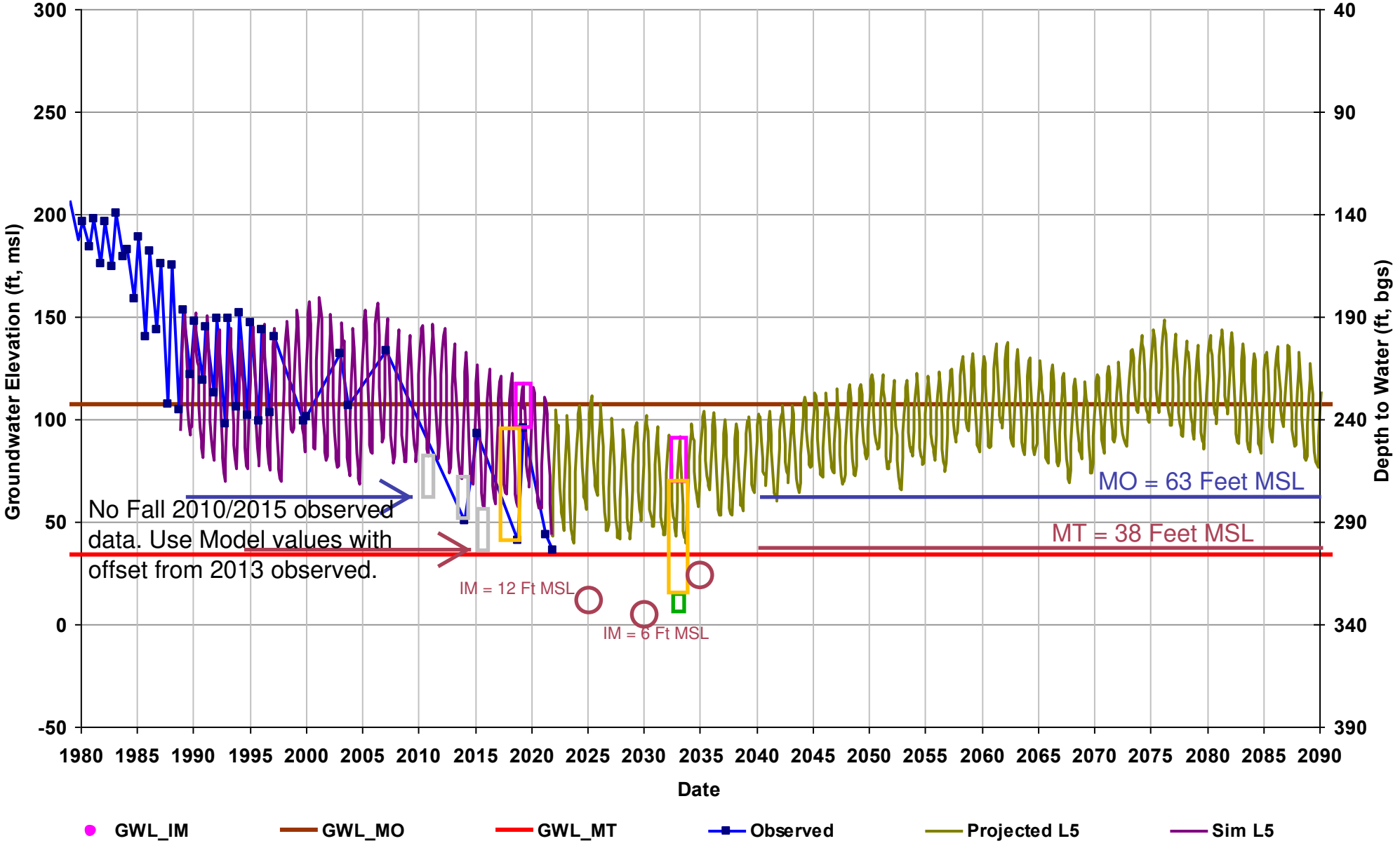
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Depth Zone: Lower
Subbasin: Madera
GSE (ft, msl): 404

Total Depth (ft bgs):
Perf. Top (ft bgs):
Perf. Bottom (ft bgs):
Top Model Layer: 4
Bottom Model Layer: 4



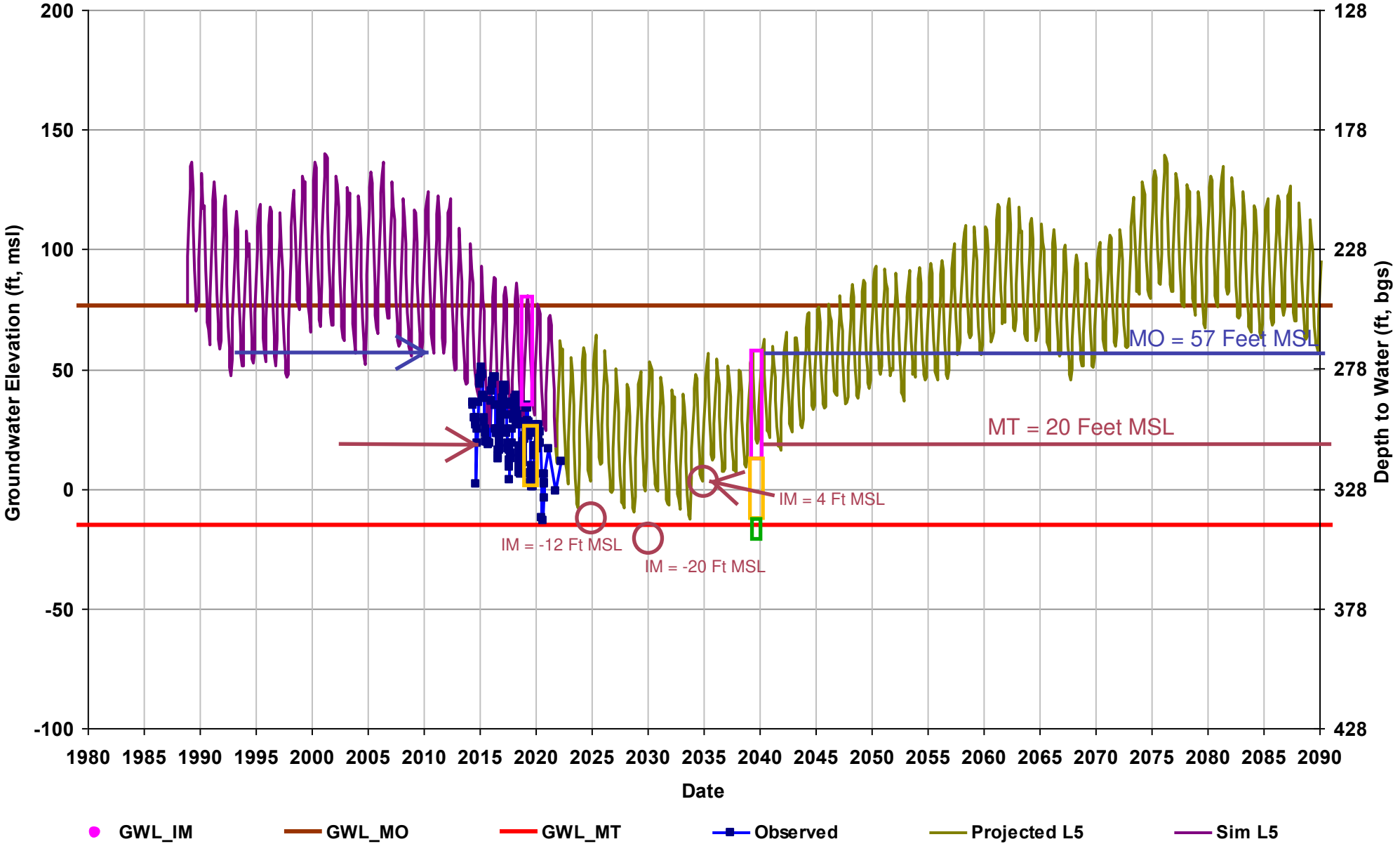
Well Name: MCE RMS-5
Depth Zone: Lower
Subbasin: Madera
GSE (ft, msl): 340

Total Depth (ft bgs):
Perf. Top (ft bgs):
Perf. Bottom (ft bgs):
Top Model Layer: 5
Bottom Model Layer: 5



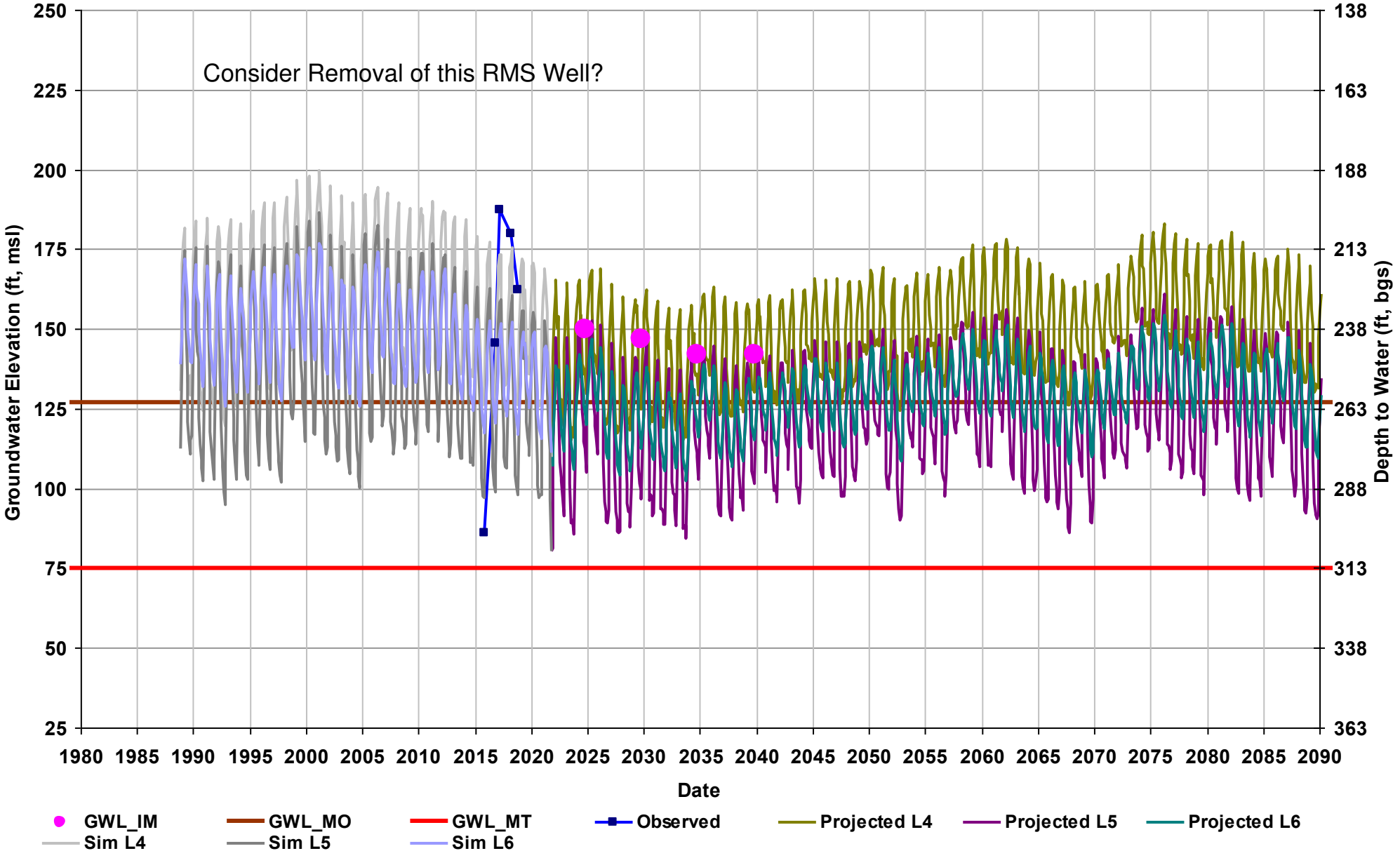
Well Name: MCE RMS-6
Depth Zone: Lower
Subbasin: Madera
GSE (ft, msl): 328

Total Depth (ft bgs): 550
Perf. Top (ft bgs): 450
Perf. Bottom (ft bgs): 550
Top Model Layer: 5
Bottom Model Layer: 5



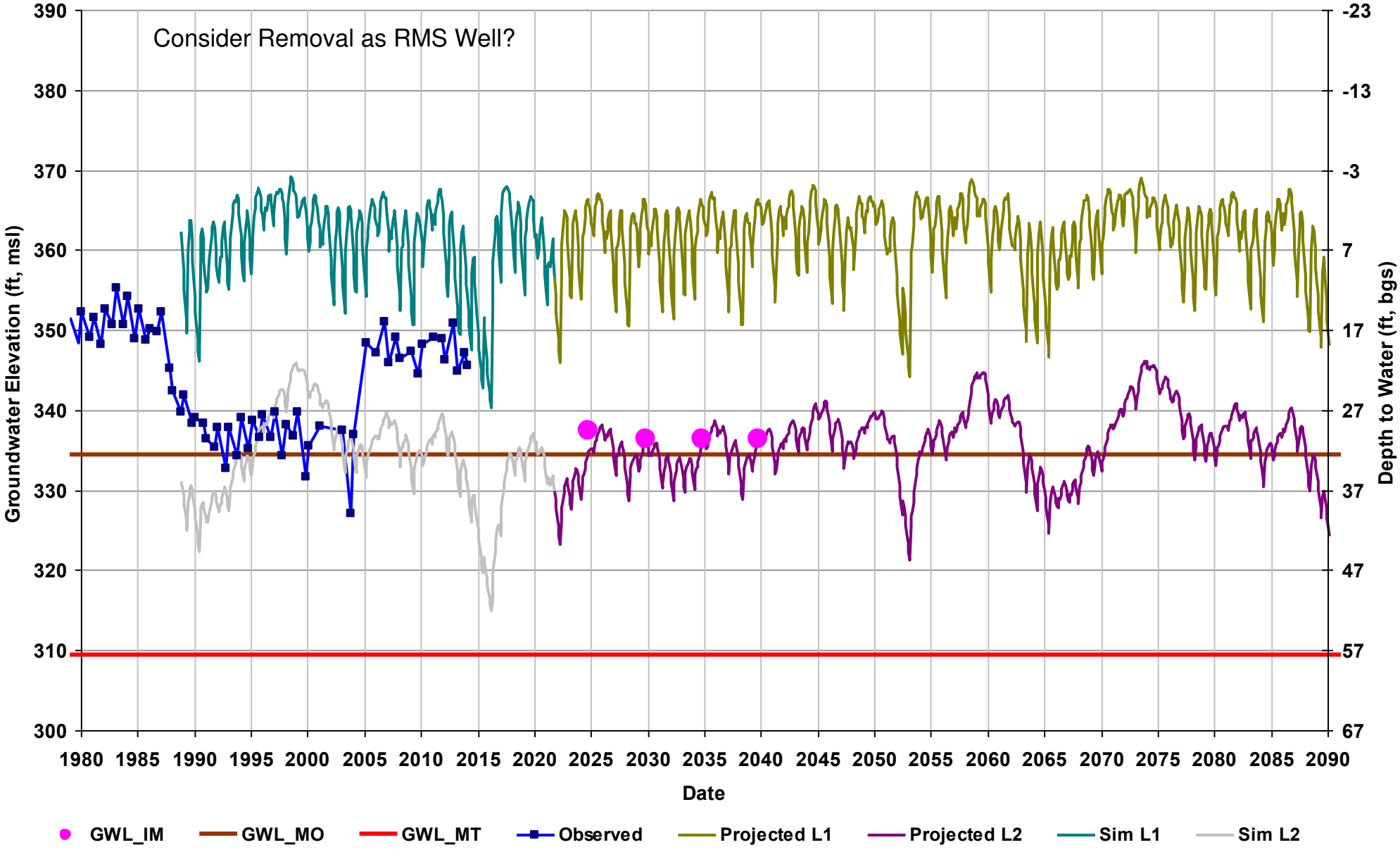
Well Name: MCE RMS-7
Depth Zone: Lower
Subbasin: Madera
GSE (ft, msl): 388

Total Depth (ft bgs): 840
Perf. Top (ft bgs): 370
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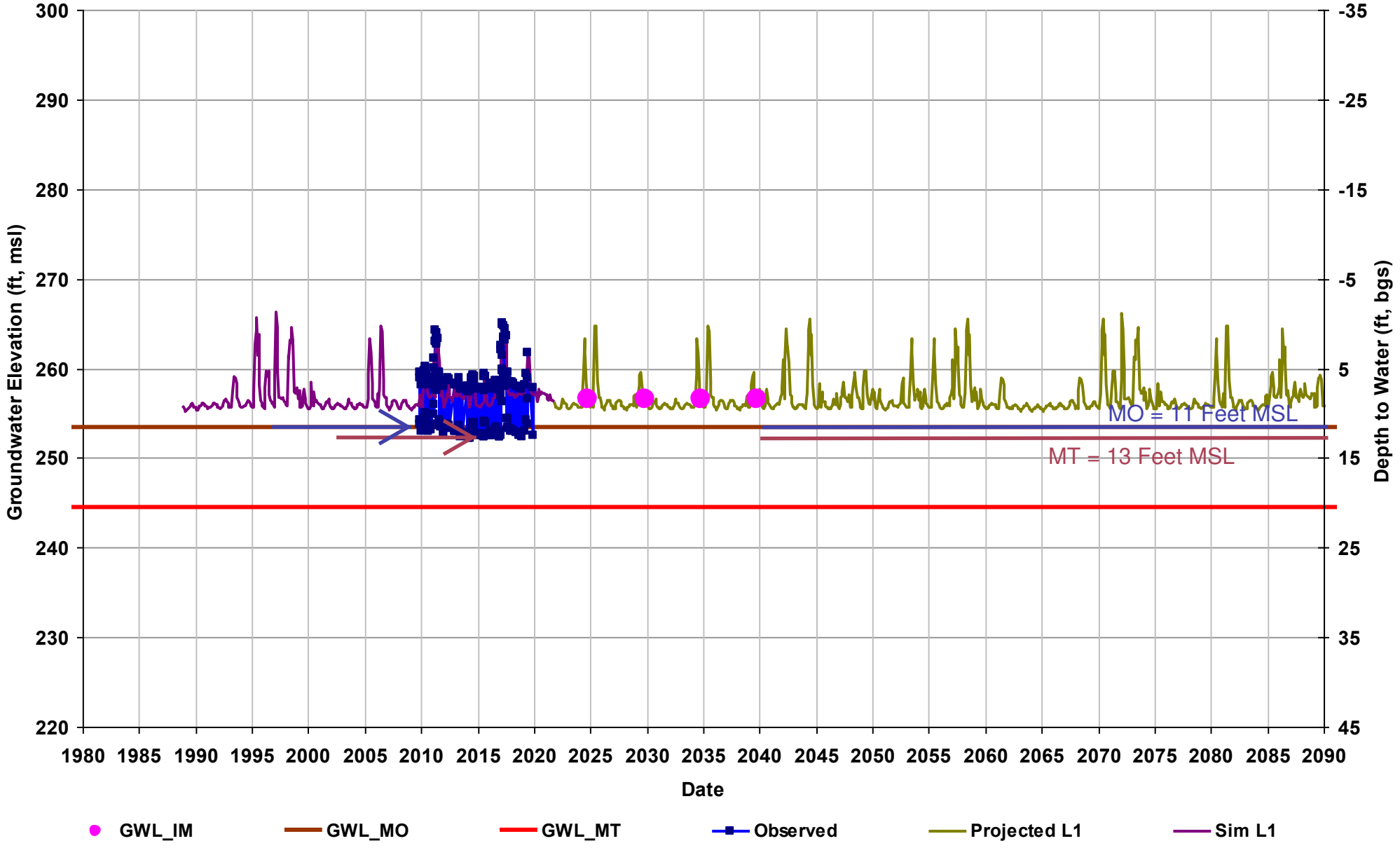
Well Name: MCE RMS-8
Depth Zone: Upper
Subbasin: Madera
GSE (ft, msl): 367

Total Depth (ft bgs): 92
Perf. Top (ft bgs): 32
Perf. Bottom (ft bgs): 92
Top Model Layer: 1
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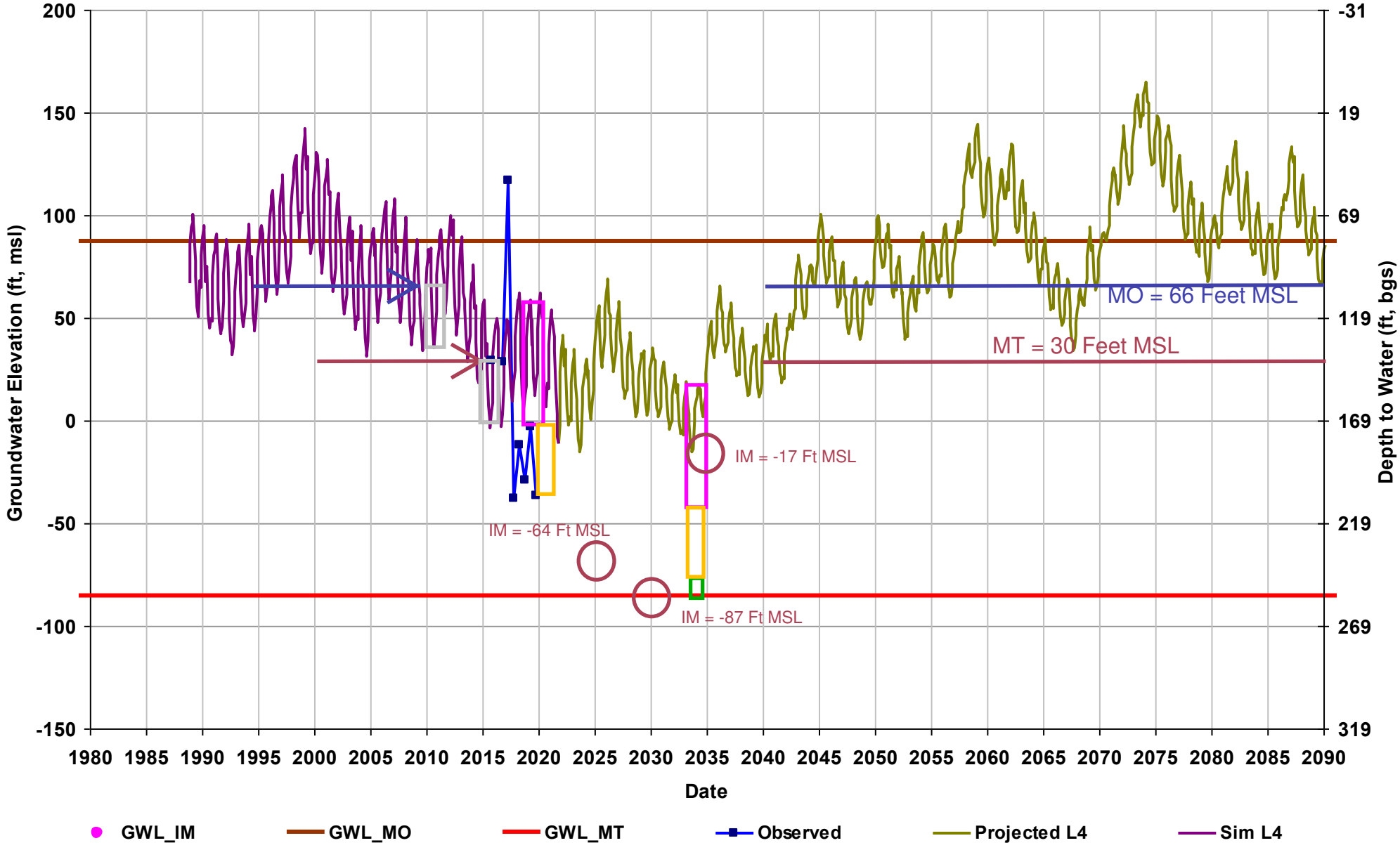
Well Name: MCE RMS-9
Depth Zone: Upper
Subbasin: Madera
GSE (ft, msl): 265

Total Depth (ft bgs): 37
Perf. Top (ft bgs): 17
Perf. Bottom (ft bgs): 37
Top Model Layer: 1
Bottom Model Layer: 1



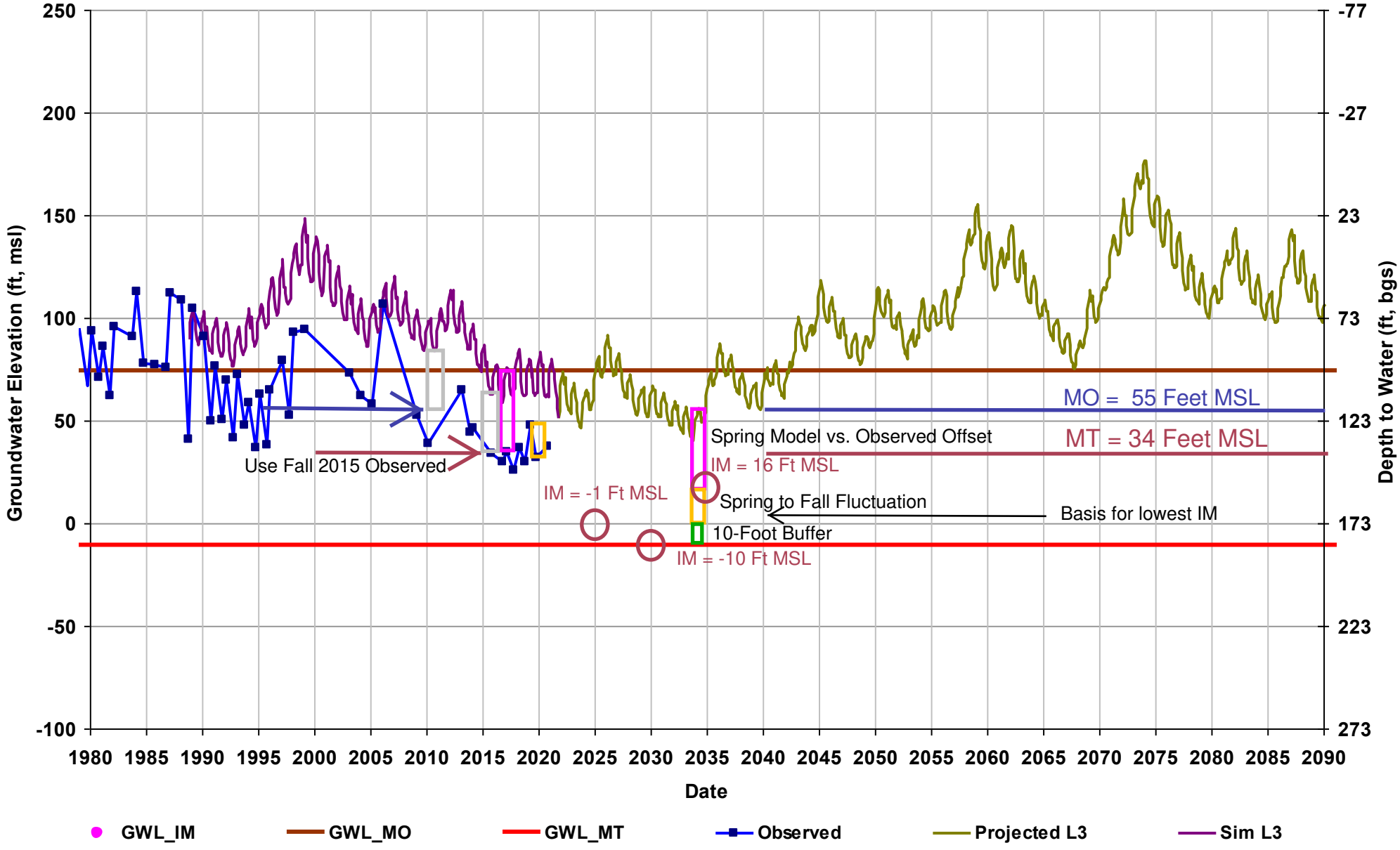
Well Name: MCW RMS-1
Depth Zone: Lower
Subbasin: Madera
GSE (ft, msl): 169

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Perf. Top (ft bgs):
Perf. Bottom (ft bgs):
Top Model Layer: 4
Bottom Model Layer: 4



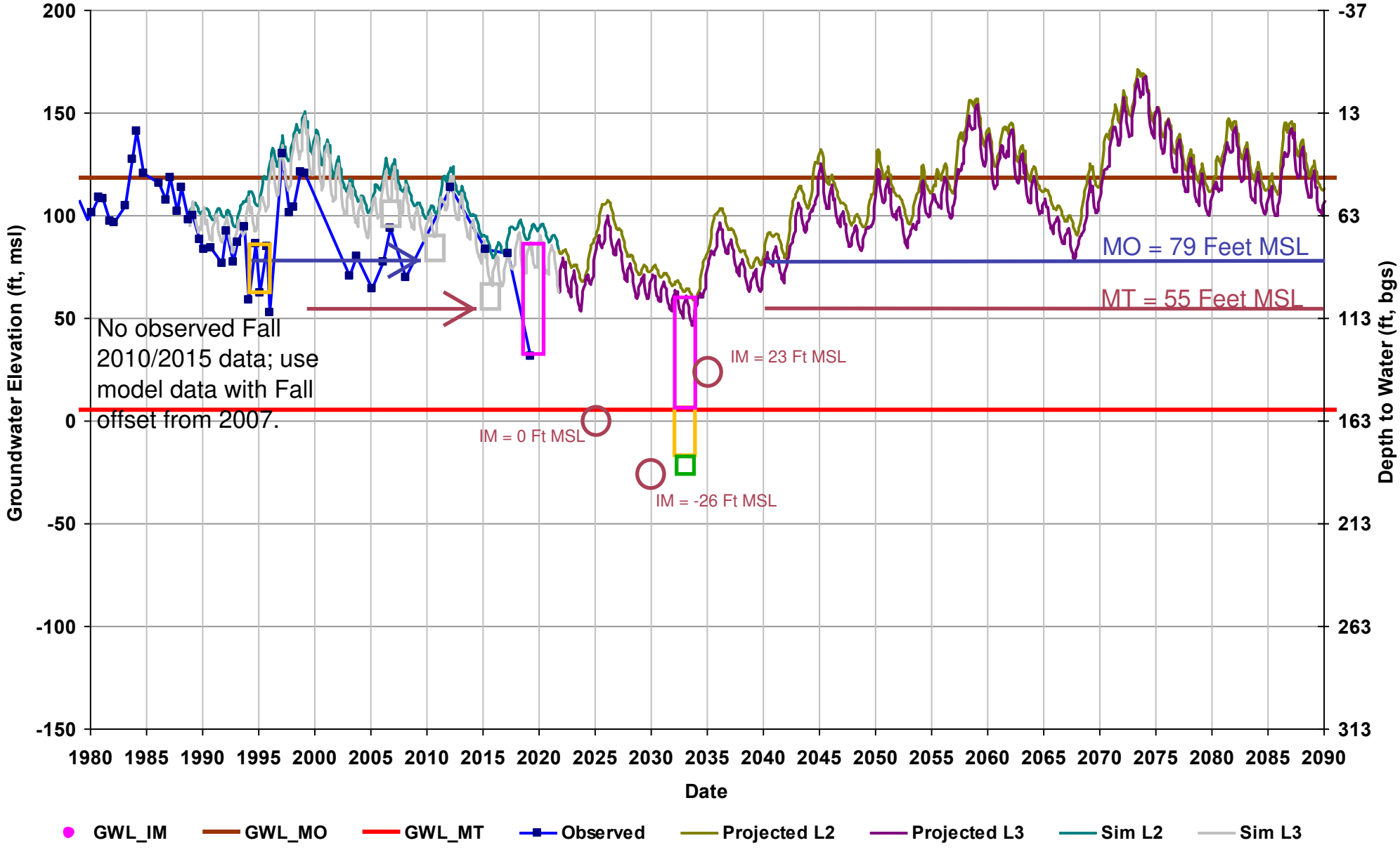
Well Name: MCW RMS-2
Depth Zone: Upper
Subbasin: Madera
GSE (ft, msl): 173

Total Depth (ft bgs): 216
Perf. Top (ft bgs): 205
Perf. Bottom (ft bgs): 212
Top Model Layer: 3
Bottom Model Layer: 3



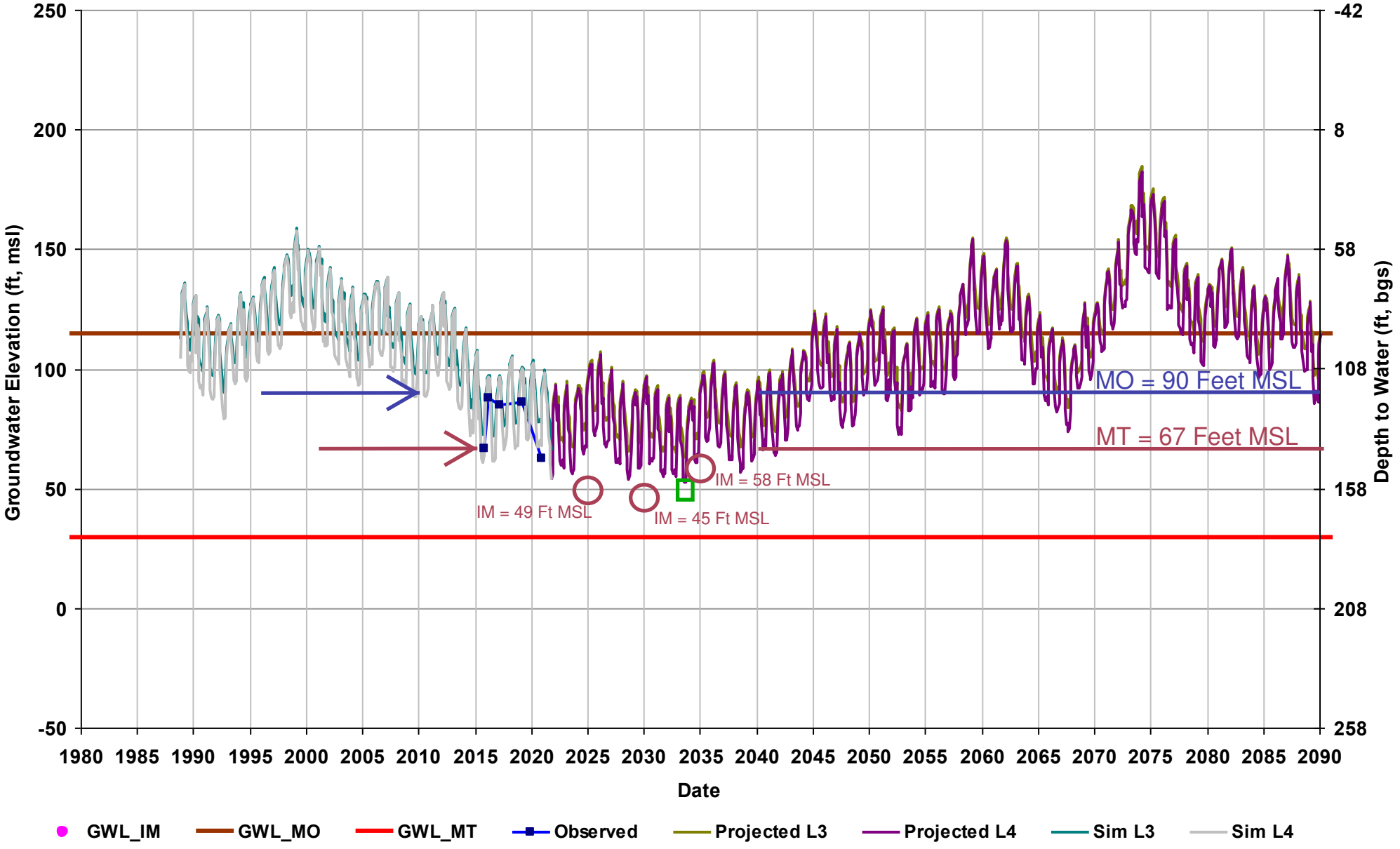
Well Name: MCW RMS-3
Depth Zone: Upper
Subbasin: Madera
GSE (ft, msl): 162

Total Depth (ft bgs):
Perf. Top (ft bgs):
Perf. Bottom (ft bgs):
Top Model Layer: 2
Bottom Model Layer: 3



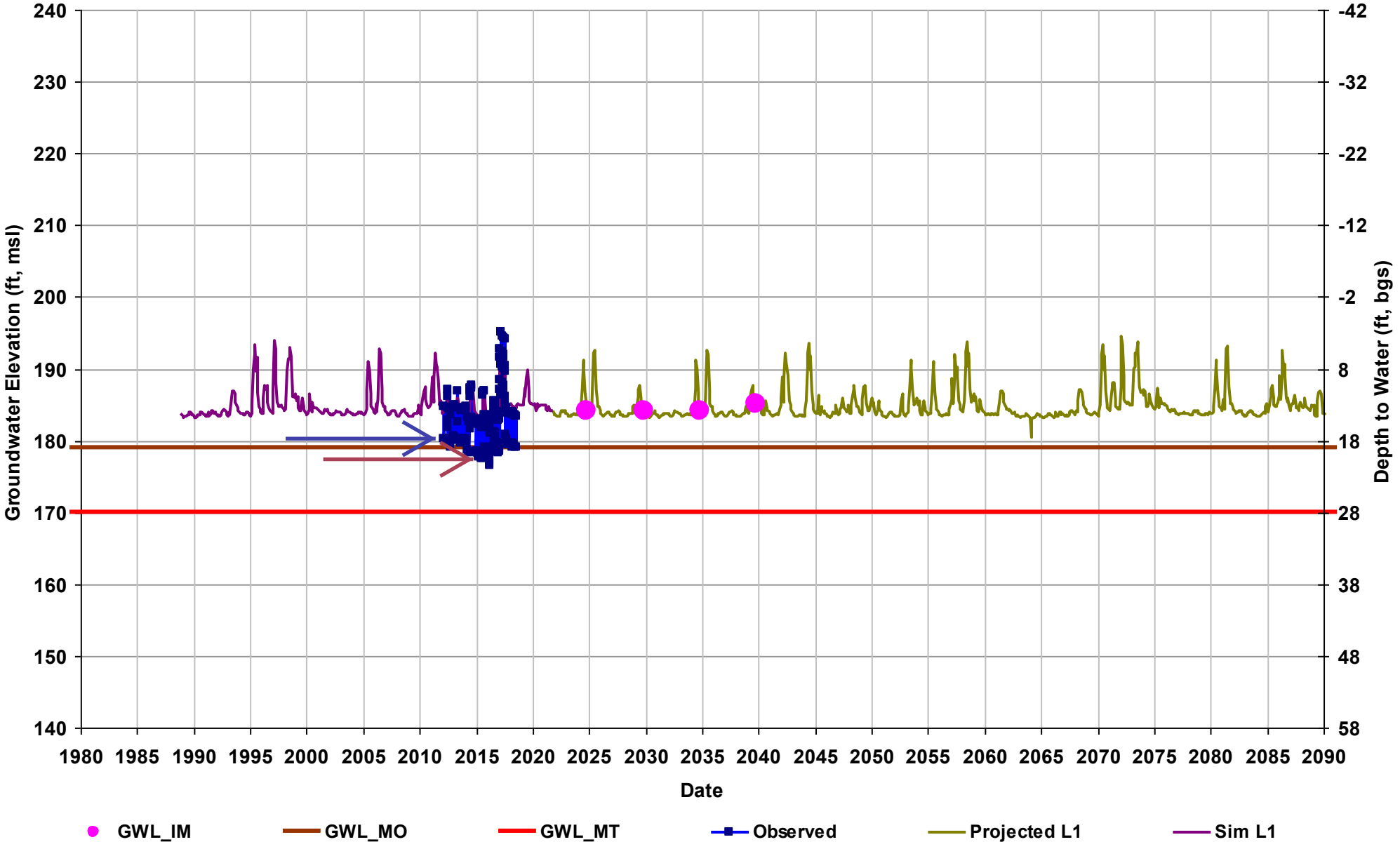
Well Name: MCW RMS-4
Depth Zone: Lower
Subbasin: Madera
GSE (ft, msl): 208

Total Depth (ft bgs): 580
Perf. Top (ft bgs): 220
Perf. Bottom (ft bgs): 580
Top Model Layer: 3
Bottom Model Layer: 4



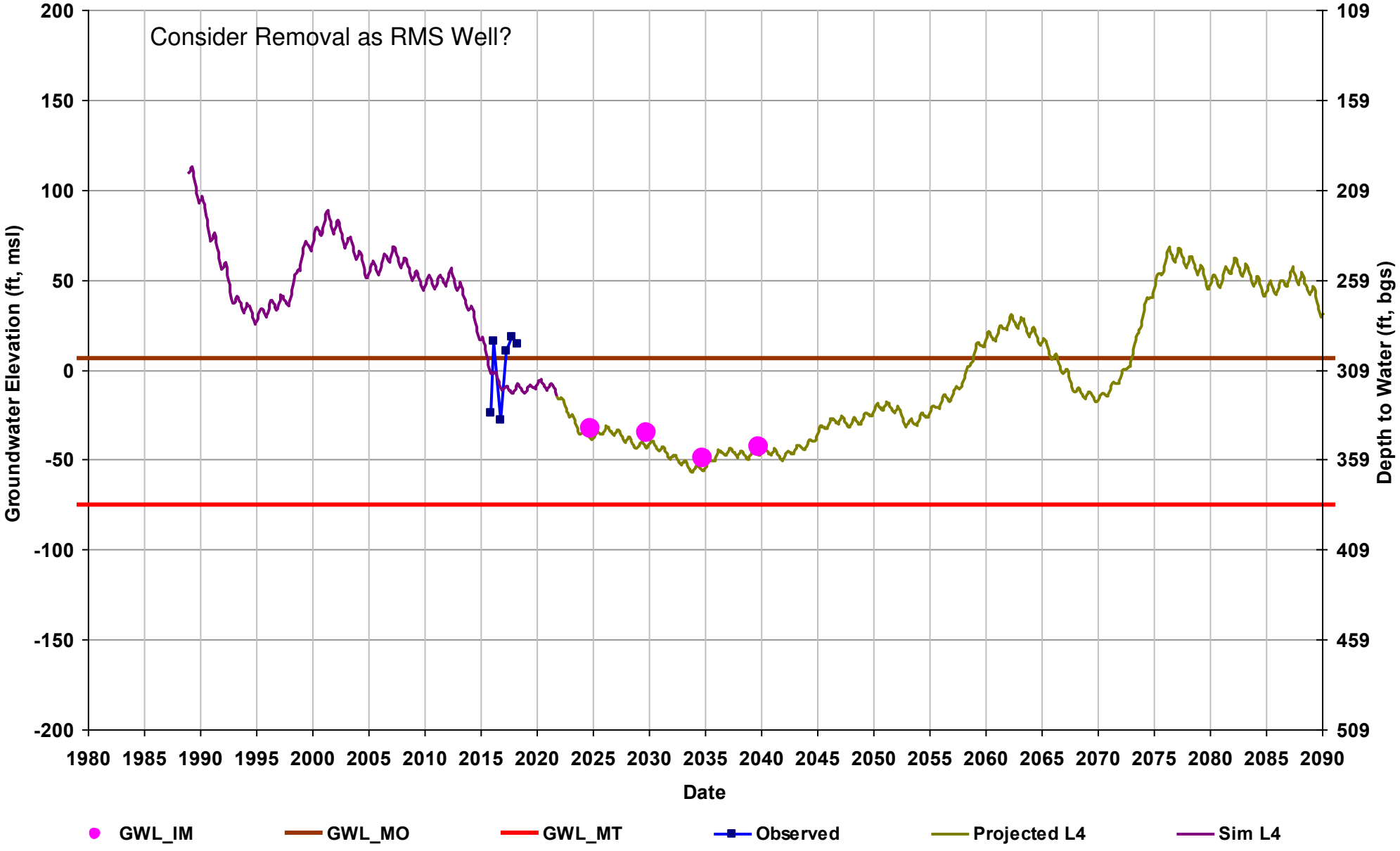
Well Name: MCW RMS-5
Depth Zone: Upper
Subbasin: Madera
GSE (ft, msl): 197

Total Depth (ft bgs): 30
Perf. Top (ft bgs):
Perf. Bottom (ft bgs):
Top Model Layer: 1
Bottom Model Layer: 1



Well Name: MID RMS-1
Depth Zone: Lower
Subbasin: Madera
GSE (ft, msl): 308

Total Depth (ft bgs): 950
Perf. Top (ft bgs): 320
Perf. Bottom (ft bgs): 942
Top Model Layer: 4
Bottom Model Layer: 4



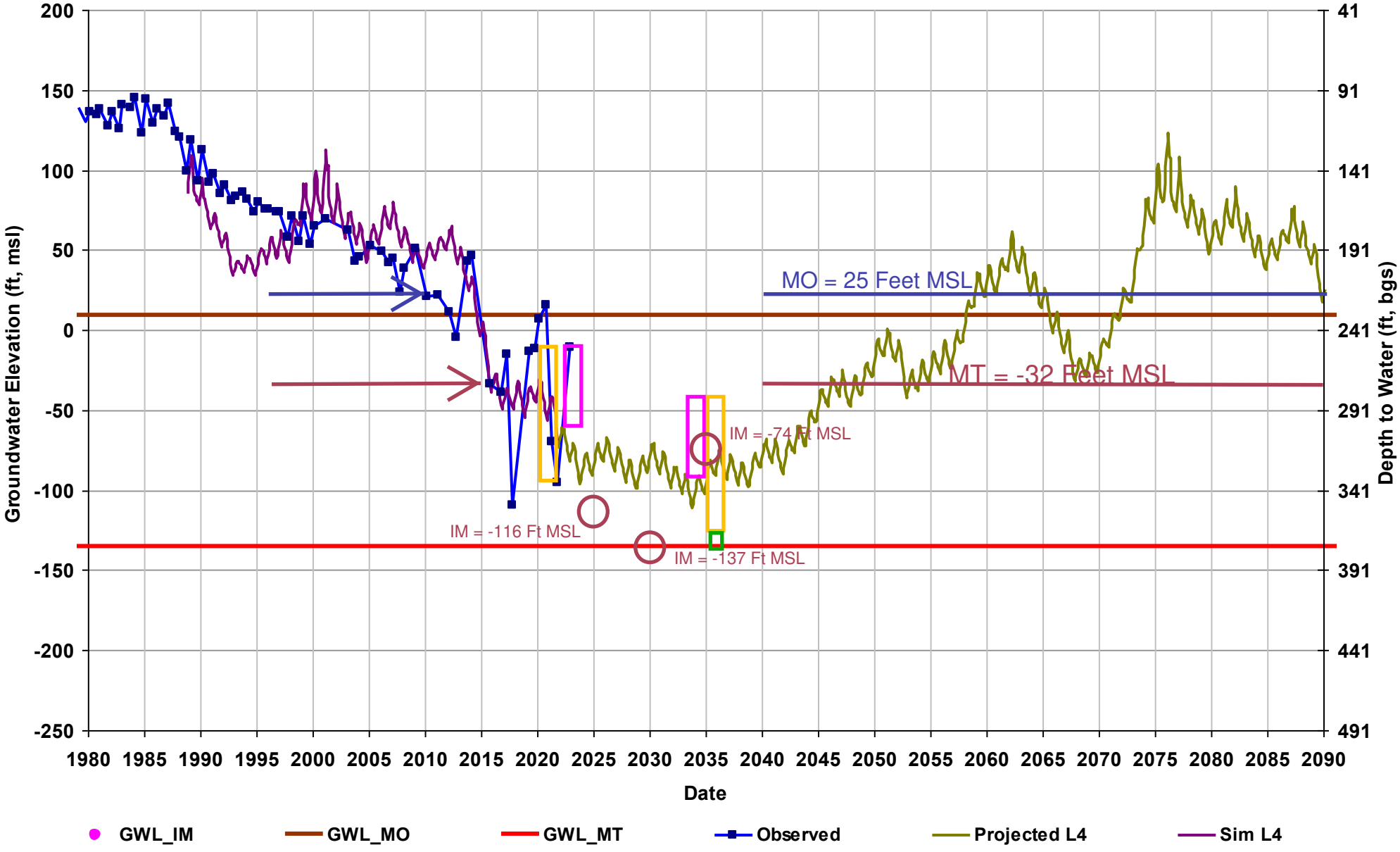
Well Name: MID RMS-2
Depth Zone: Lower
Subbasin: Madera
GSE (ft, msl): 218

Total Depth (ft bgs): 563
Perf. Top (ft bgs): 298
Perf. Bottom (ft bgs): 509
Top Model Layer: 4
Bottom Model Layer: 4



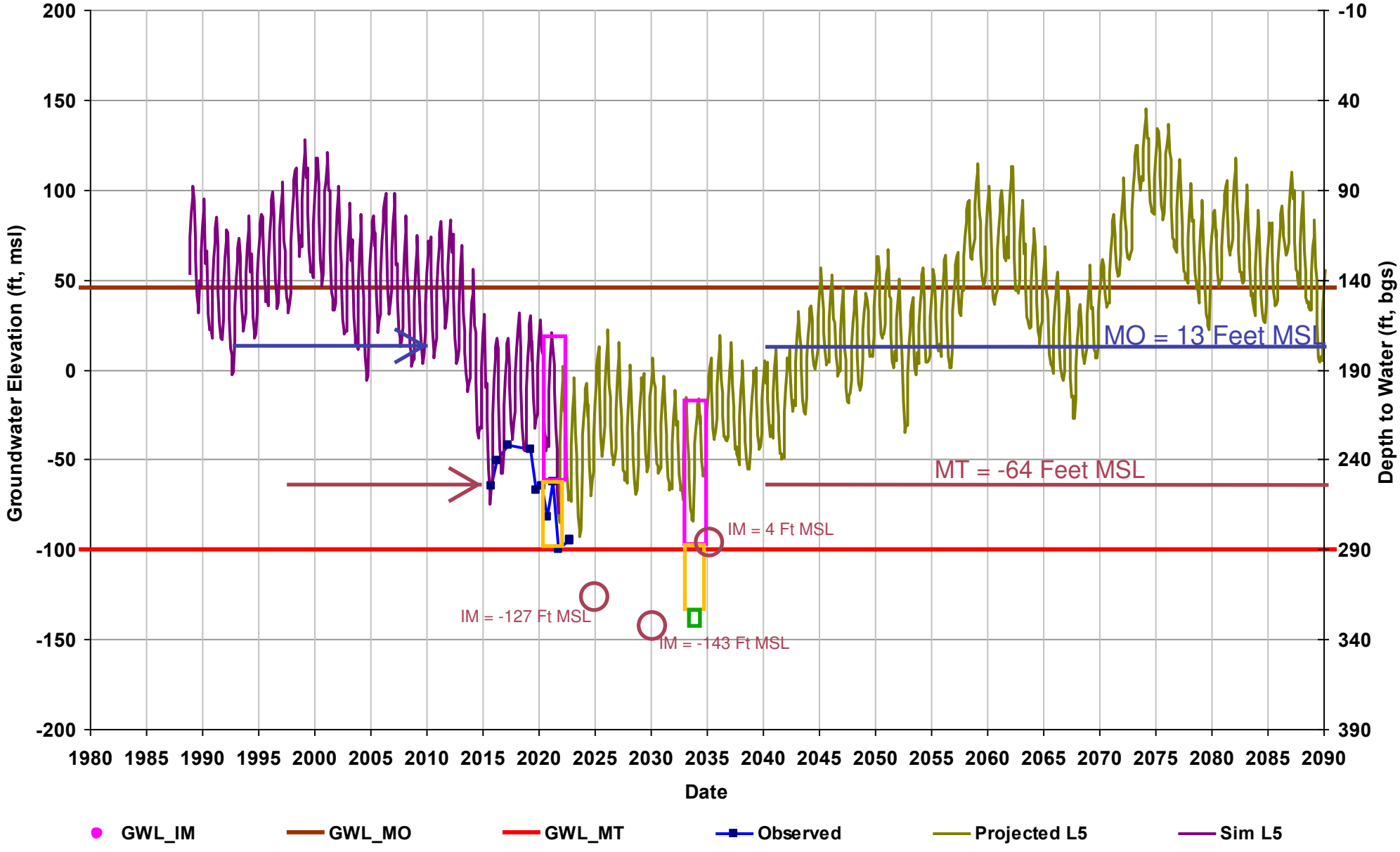
Well Name: MID RMS-3
Depth Zone: Lower
Subbasin: Madera
GSE (ft, msl): 241

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Perf. Top (ft bgs): 260
Perf. Bottom (ft bgs): 507
Top Model Layer: 4
Bottom Model Layer: 4



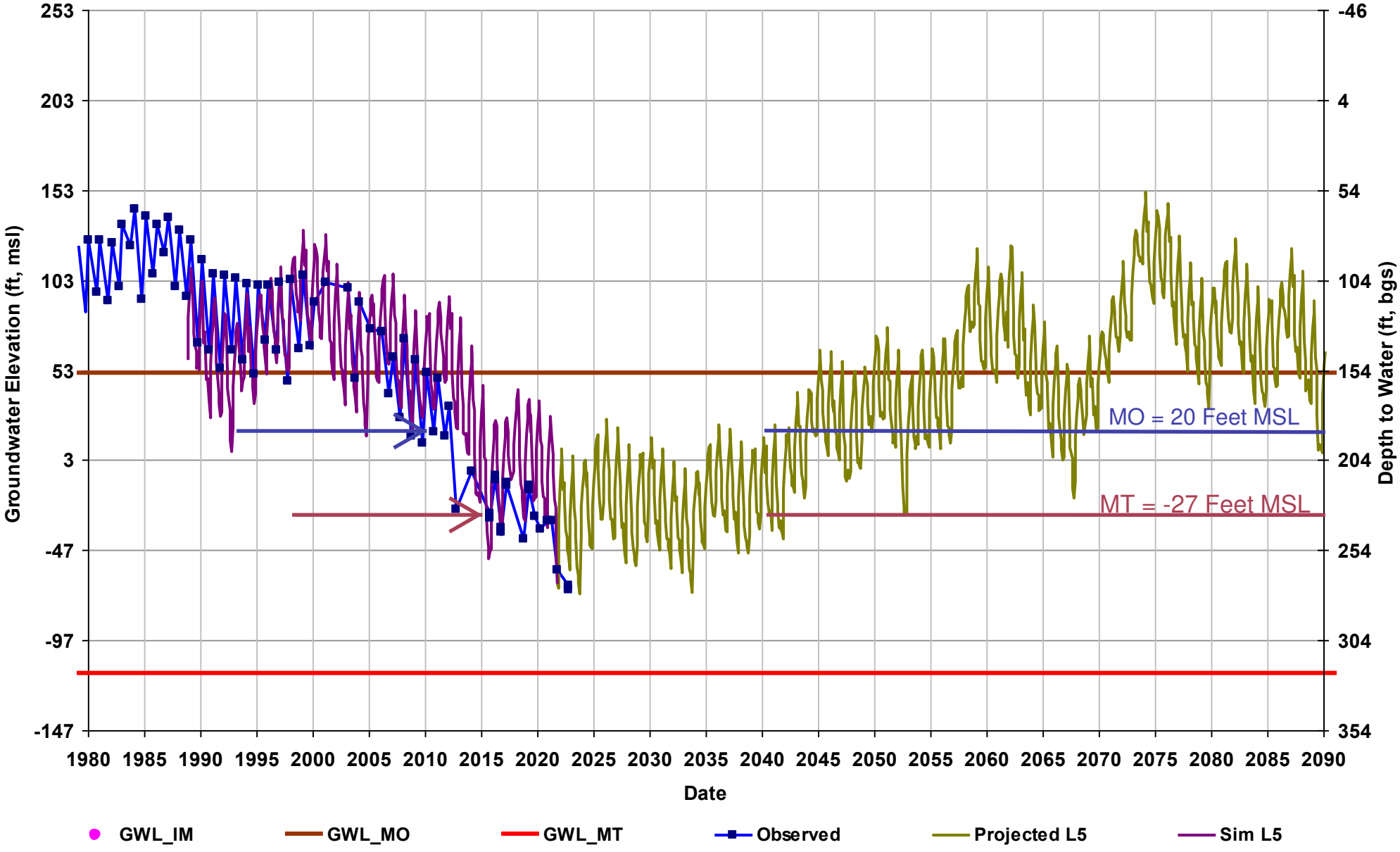
Well Name: MID RMS-4
Depth Zone: Lower
Subbasin: Madera
GSE (ft, msl): 190

Total Depth (ft bgs): 698
Perf. Top (ft bgs): 320
Perf. Bottom (ft bgs): 667
Top Model Layer: 5
Bottom Model Layer: 5



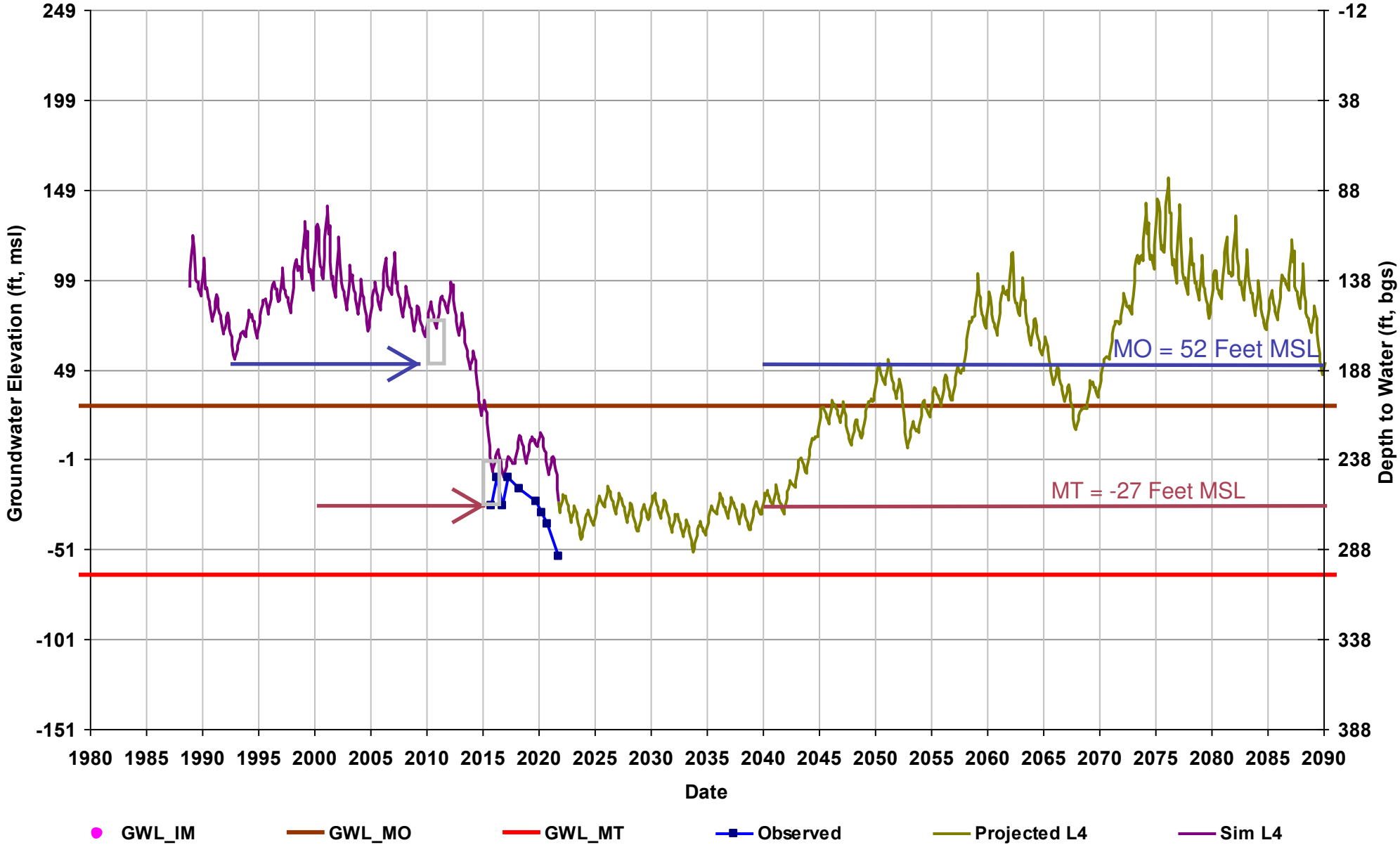
Well Name: MID RMS-5
Depth Zone: Lower
Subbasin: Madera
GSE (ft, msl): 207

Total Depth (ft bgs): 570
Perf. Top (ft bgs): 270
Perf. Bottom (ft bgs): 570
Top Model Layer: 5
Bottom Model Layer: 5



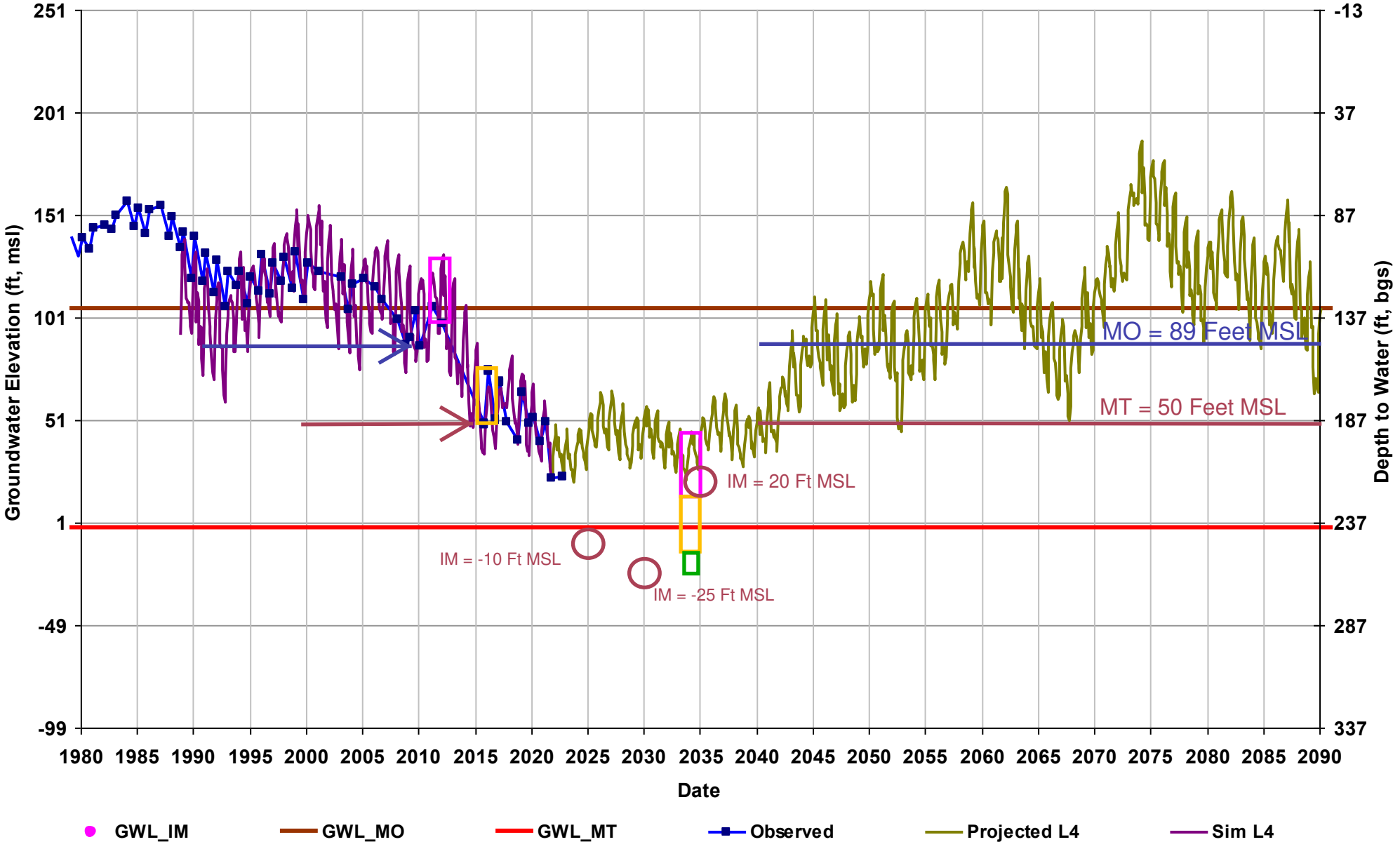
Well Name: MID RMS-6
Depth Zone: Lower
Subbasin: Madera
GSE (ft, msl): 237

Total Depth (ft bgs): 680
Perf. Top (ft bgs): 320
Perf. Bottom (ft bgs): 680
Top Model Layer: 4
Bottom Model Layer: 4



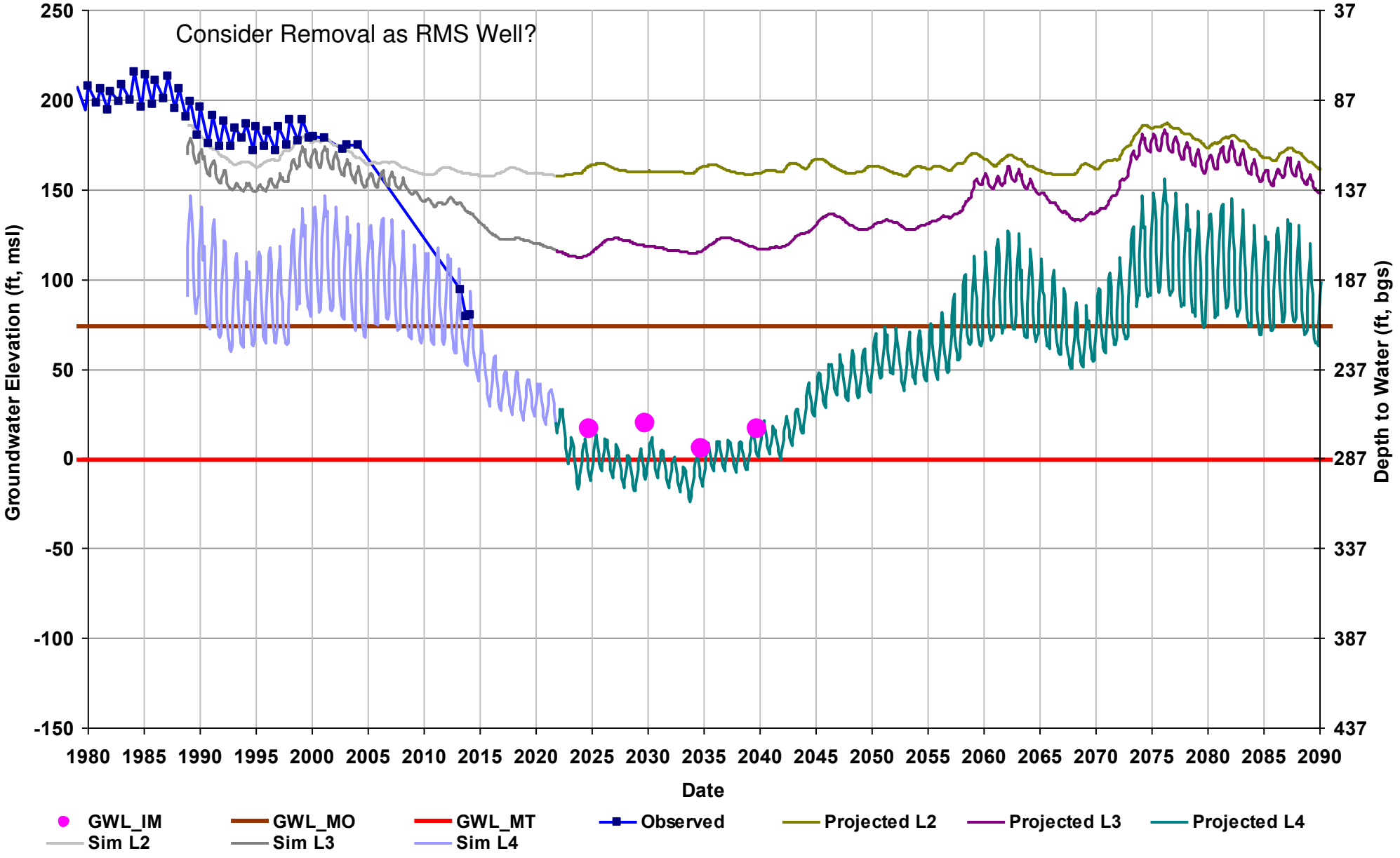
Well Name: MID RMS-7
Depth Zone: Lower
Subbasin: Madera
GSE (ft, msl): 238

Total Depth (ft bgs): 656
Perf. Top (ft bgs): 290
Perf. Bottom (ft bgs): 635
Top Model Layer: 4
Bottom Model Layer: 4



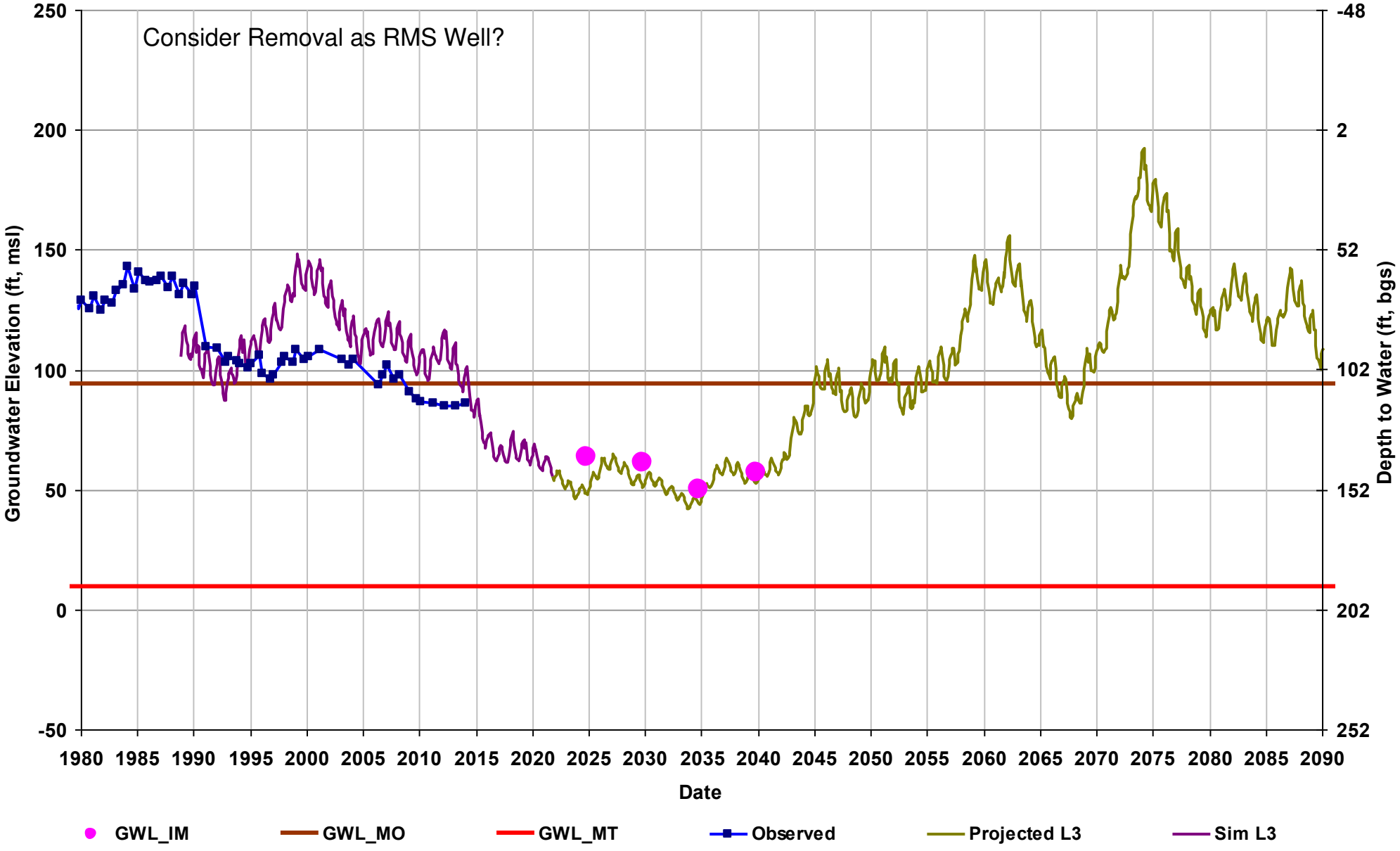
Well Name: MID RMS-8
Depth Zone: Composite
Subbasin: Madera
GSE (ft, msl): 287

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Perf. Top (ft bgs):
Perf. Bottom (ft bgs):
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Bottom Model Layer: 4



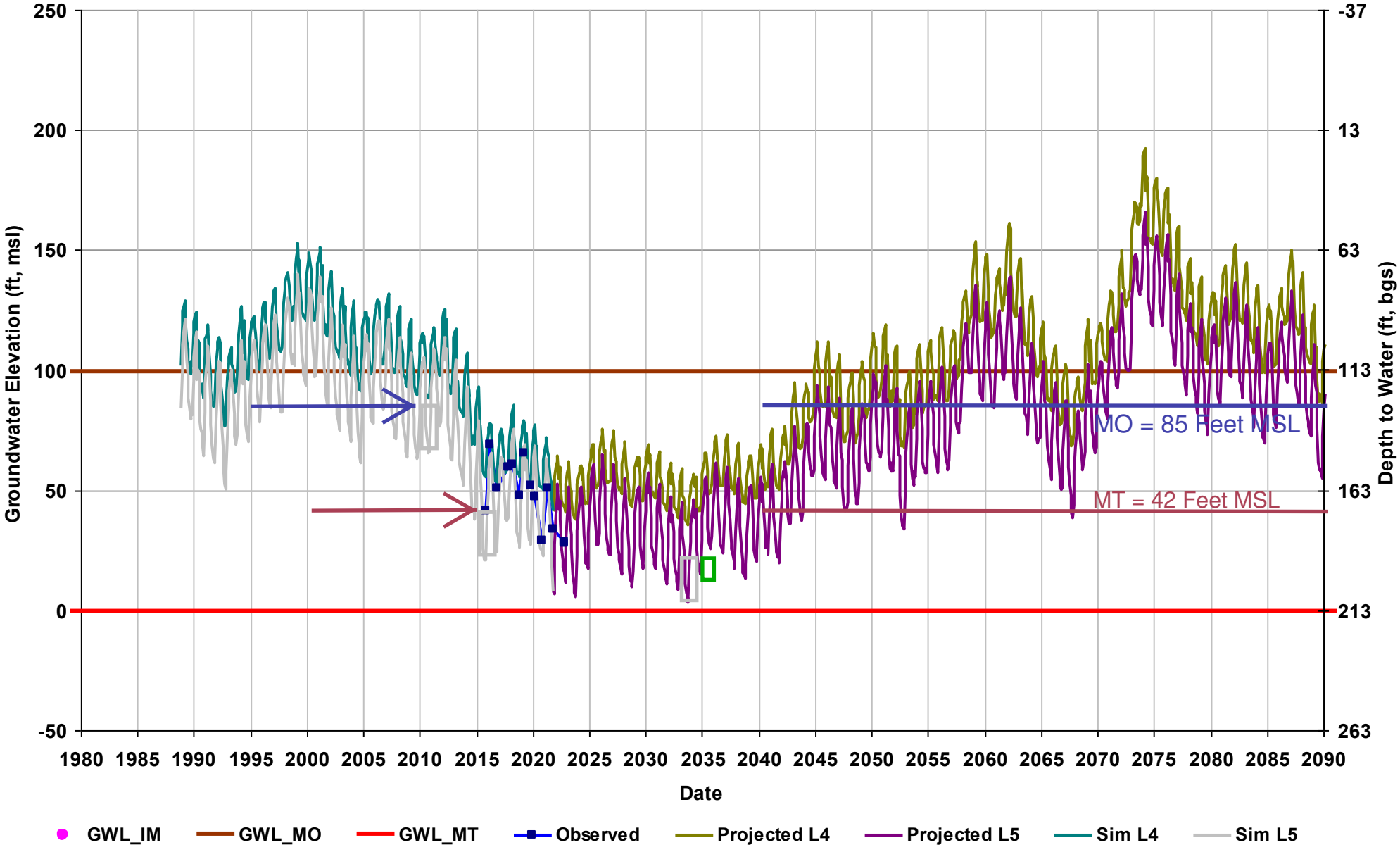
Well Name: MID RMS-9
Depth Zone: Upper
Subbasin: Madera
GSE (ft, msl): 202

Total Depth (ft bgs): 144
Perf. Top (ft bgs):
Perf. Bottom (ft bgs):
Top Model Layer: 3
Bottom Model Layer: 3



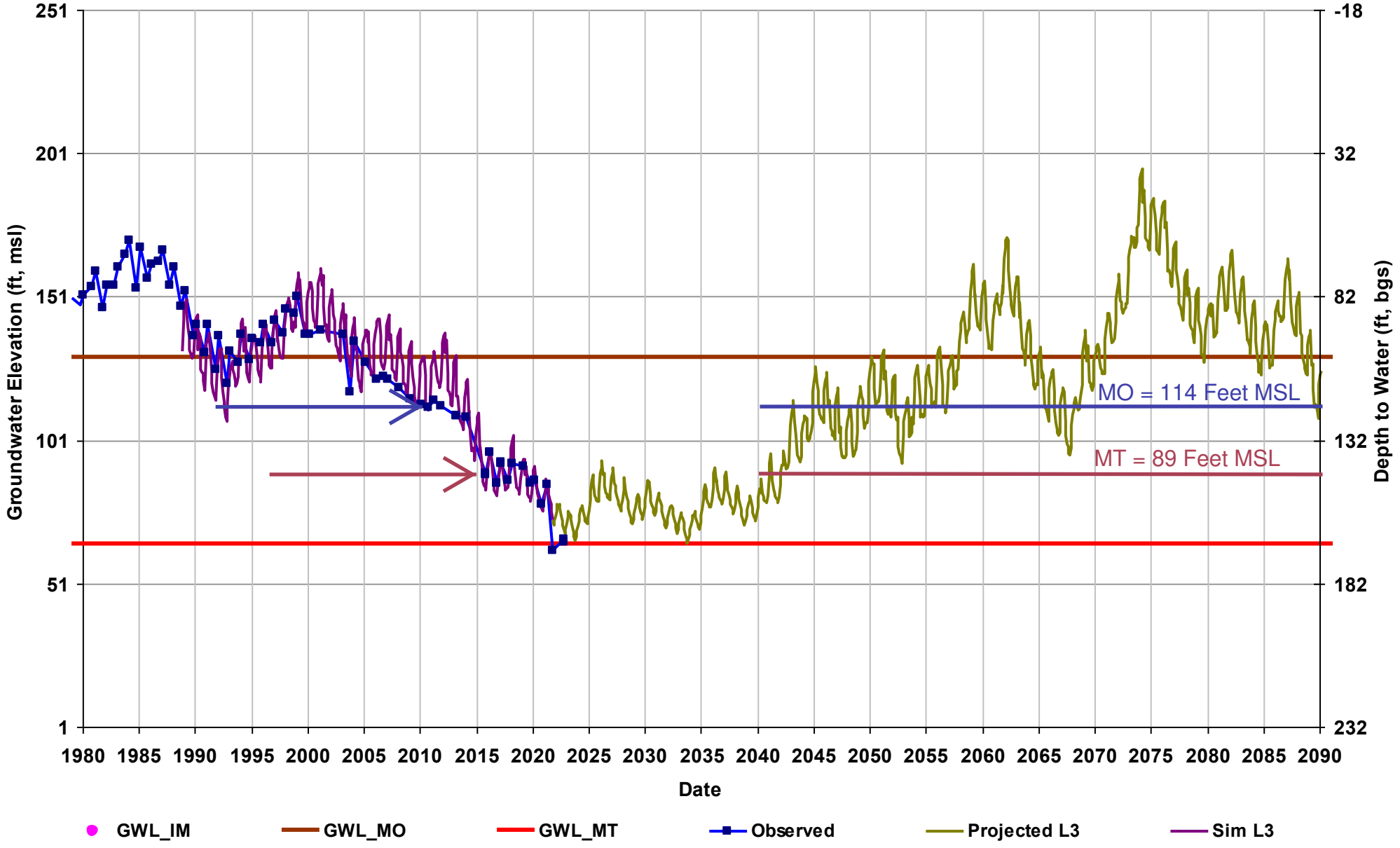
Well Name: MID RMS-10
Depth Zone: Lower
Subbasin: Madera
GSE (ft, msl): 213

Total Depth (ft bgs): 615
Perf. Top (ft bgs): 315
Perf. Bottom (ft bgs): 615
Top Model Layer: 4
Bottom Model Layer: 5



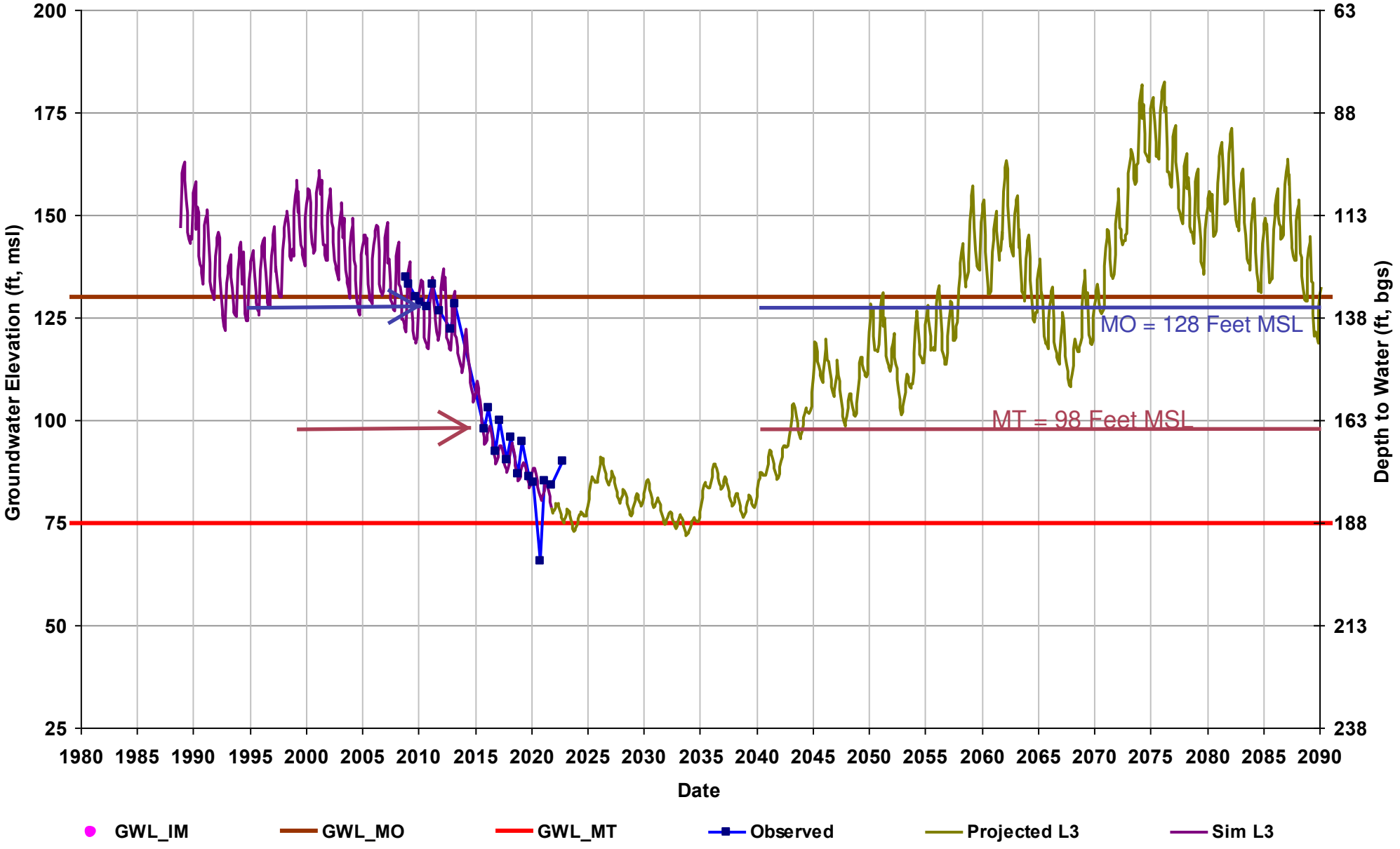
Well Name: MID RMS-11
Depth Zone: Upper
Subbasin: Madera
GSE (ft, msl): 233

Total Depth (ft bgs): 315
Perf. Top (ft bgs):
Perf. Bottom (ft bgs):
Top Model Layer: 3
Bottom Model Layer: 3



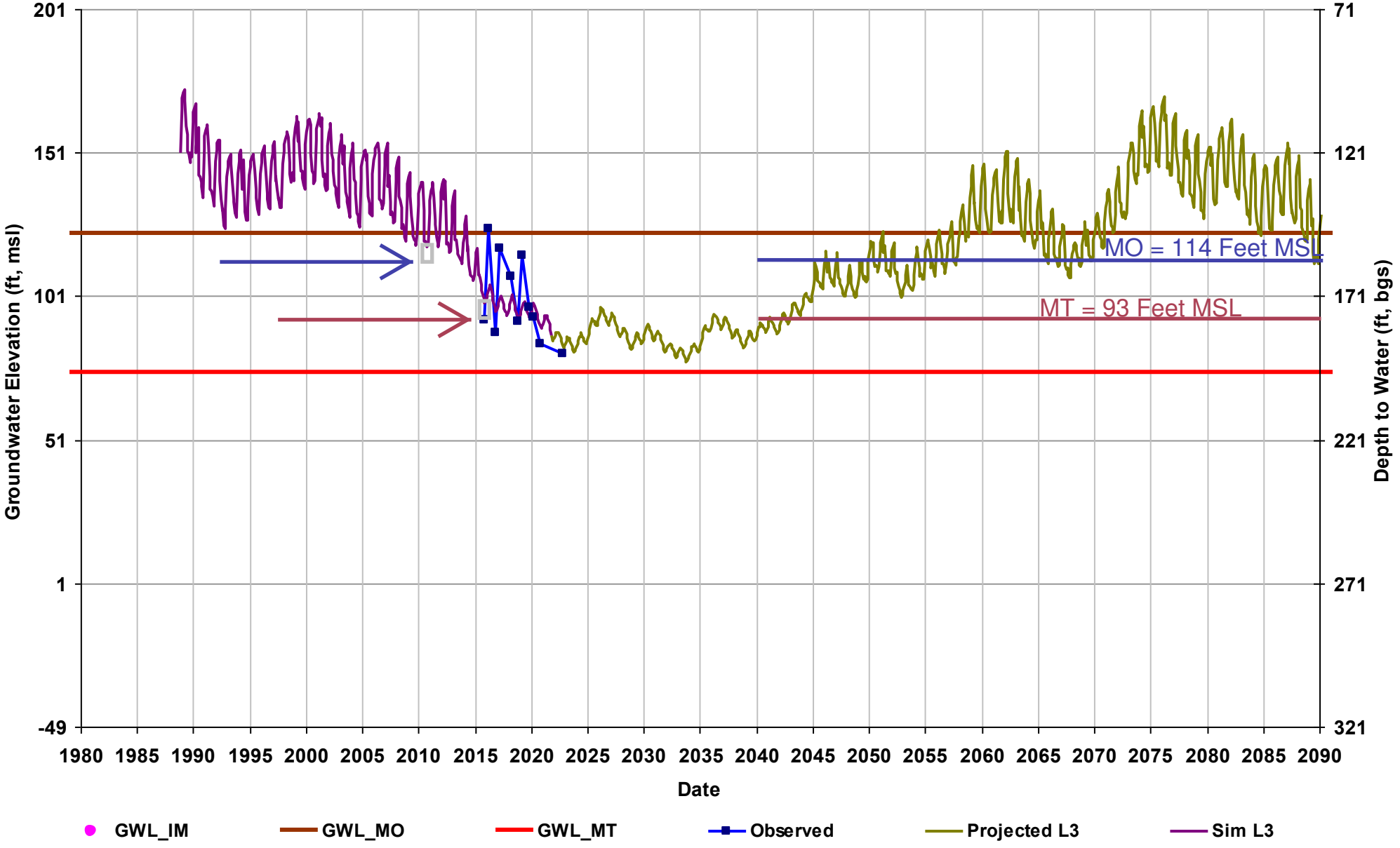
Well Name: MID RMS-12
Depth Zone: Upper
Subbasin: Madera
GSE (ft, msl): 263

Total Depth (ft bgs): 176
Perf. Top (ft bgs):
Perf. Bottom (ft bgs):
Top Model Layer: 3
Bottom Model Layer: 3



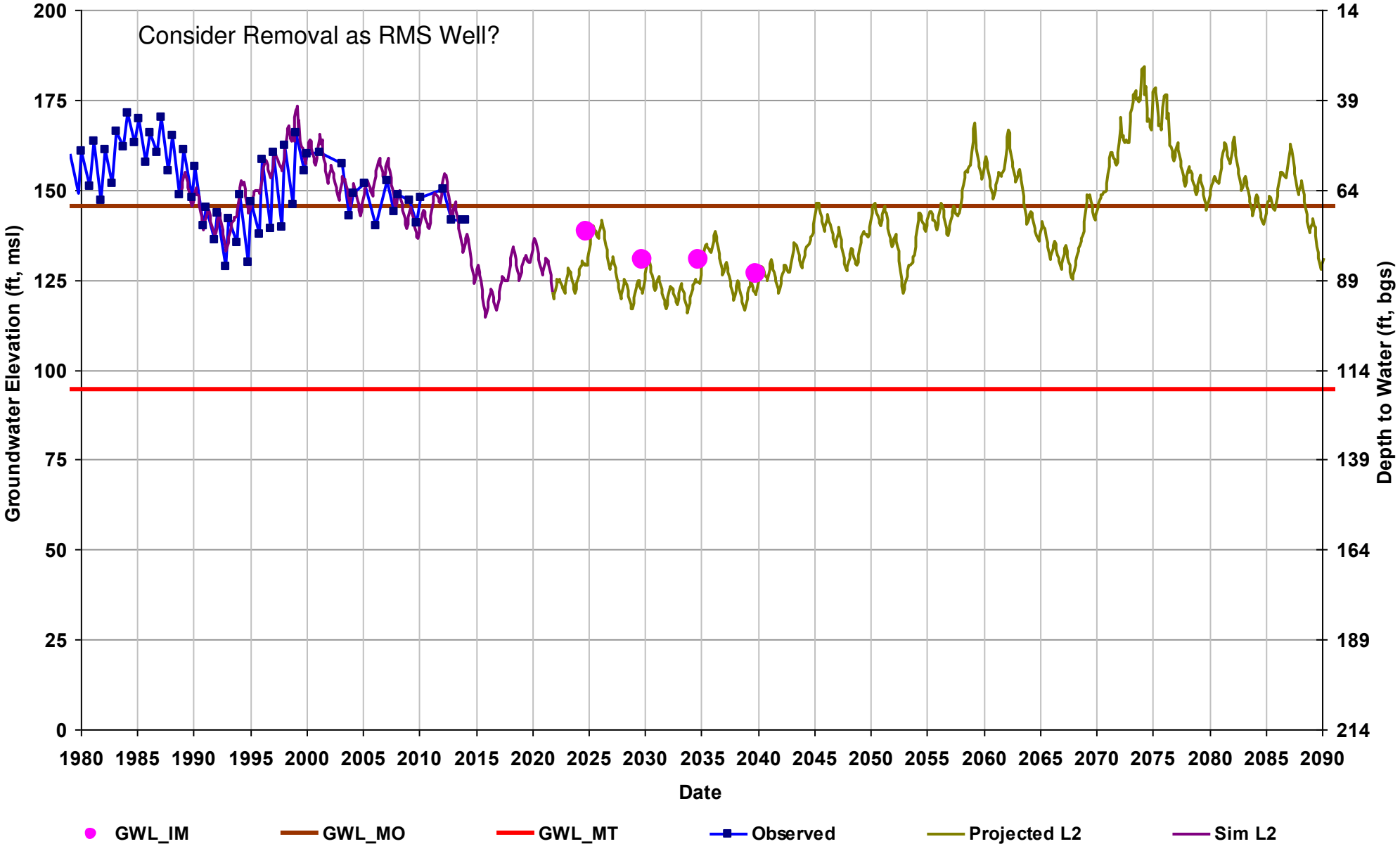
Well Name: MID RMS-13
Depth Zone: Composite
Subbasin: Madera
GSE (ft, msl): 272

Total Depth (ft bgs): 600
Perf. Top (ft bgs): 228
Perf. Bottom (ft bgs): 552
Top Model Layer: 3
Bottom Model Layer: 3



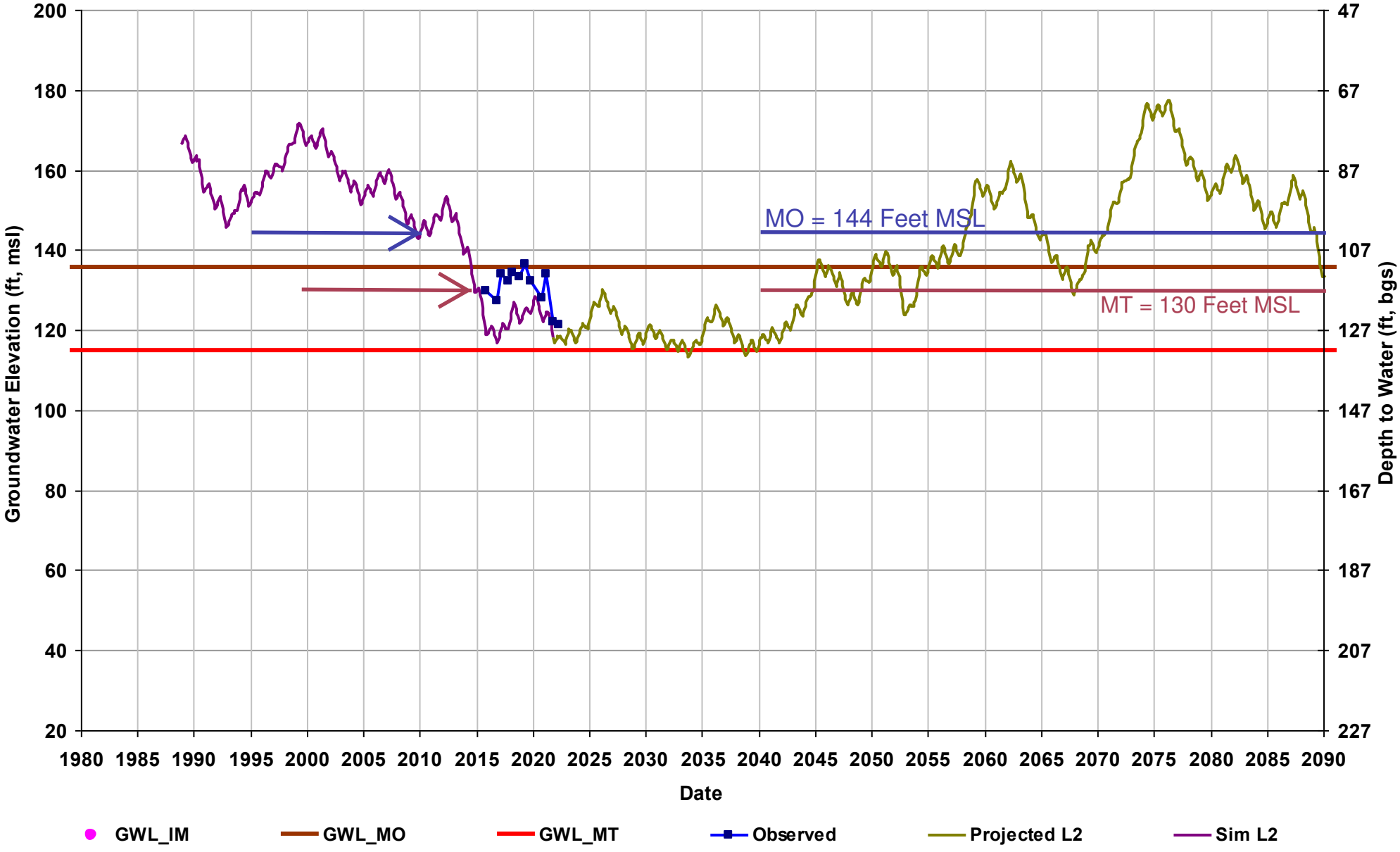
Well Name: MID RMS-14
Depth Zone: Upper
Subbasin: Madera
GSE (ft, msl): 214

Total Depth (ft bgs):
Perf. Top (ft bgs):
Perf. Bottom (ft bgs):
Top Model Layer: 2
Bottom Model Layer: 2



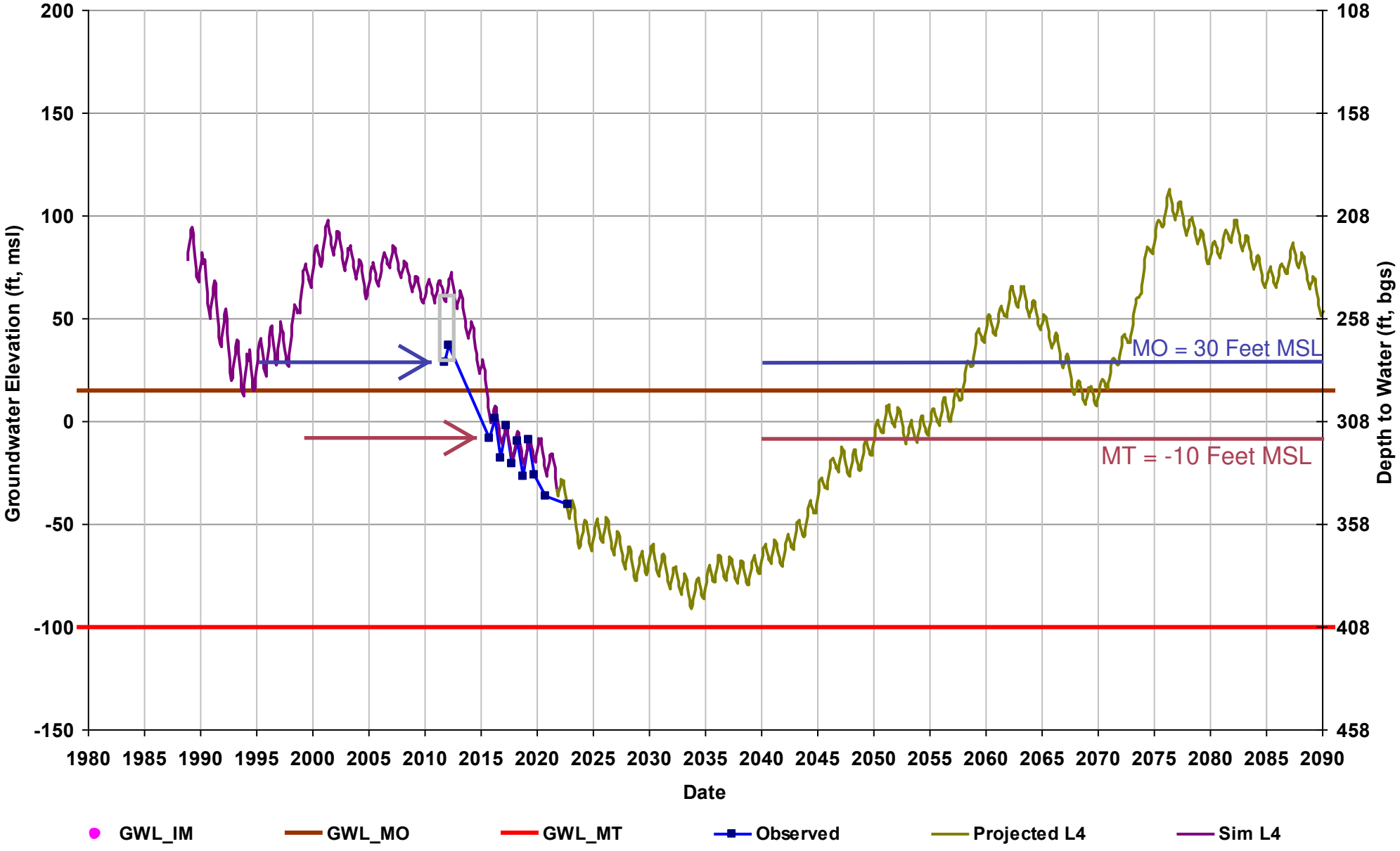
Well Name: MID RMS-15
Depth Zone: Upper
Subbasin: Madera
GSE (ft, msl): 247

Total Depth (ft bgs): 502
Perf. Top (ft bgs): 160
Perf. Bottom (ft bgs): 200
Top Model Layer: 2
Bottom Model Layer: 2



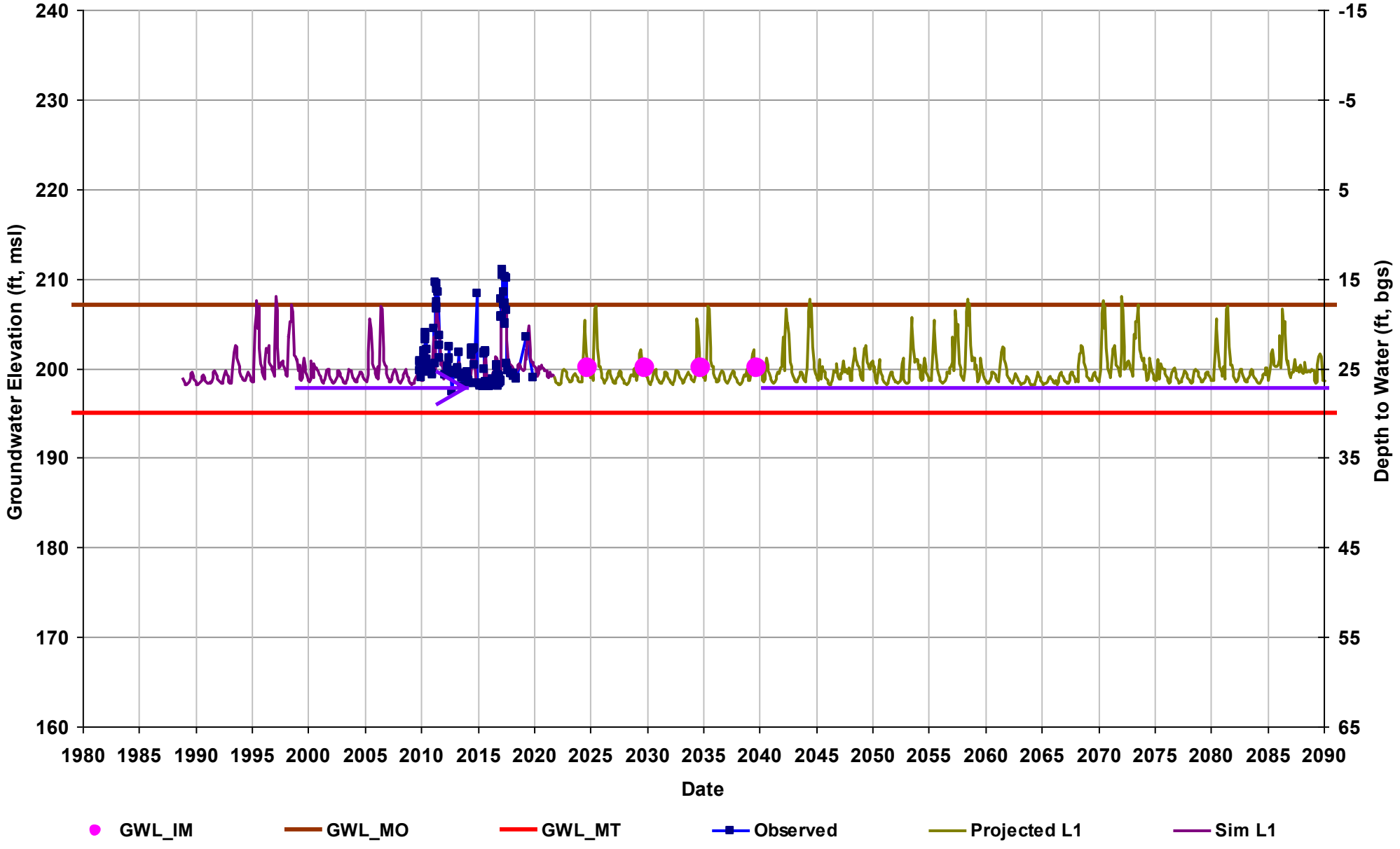
Well Name: MID RMS-16
Depth Zone: Lower
Subbasin: Madera
GSE (ft, msl): 308

Total Depth (ft bgs): 452
Perf. Top (ft bgs): 348
Perf. Bottom (ft bgs): 388
Top Model Layer: 4
Bottom Model Layer: 4



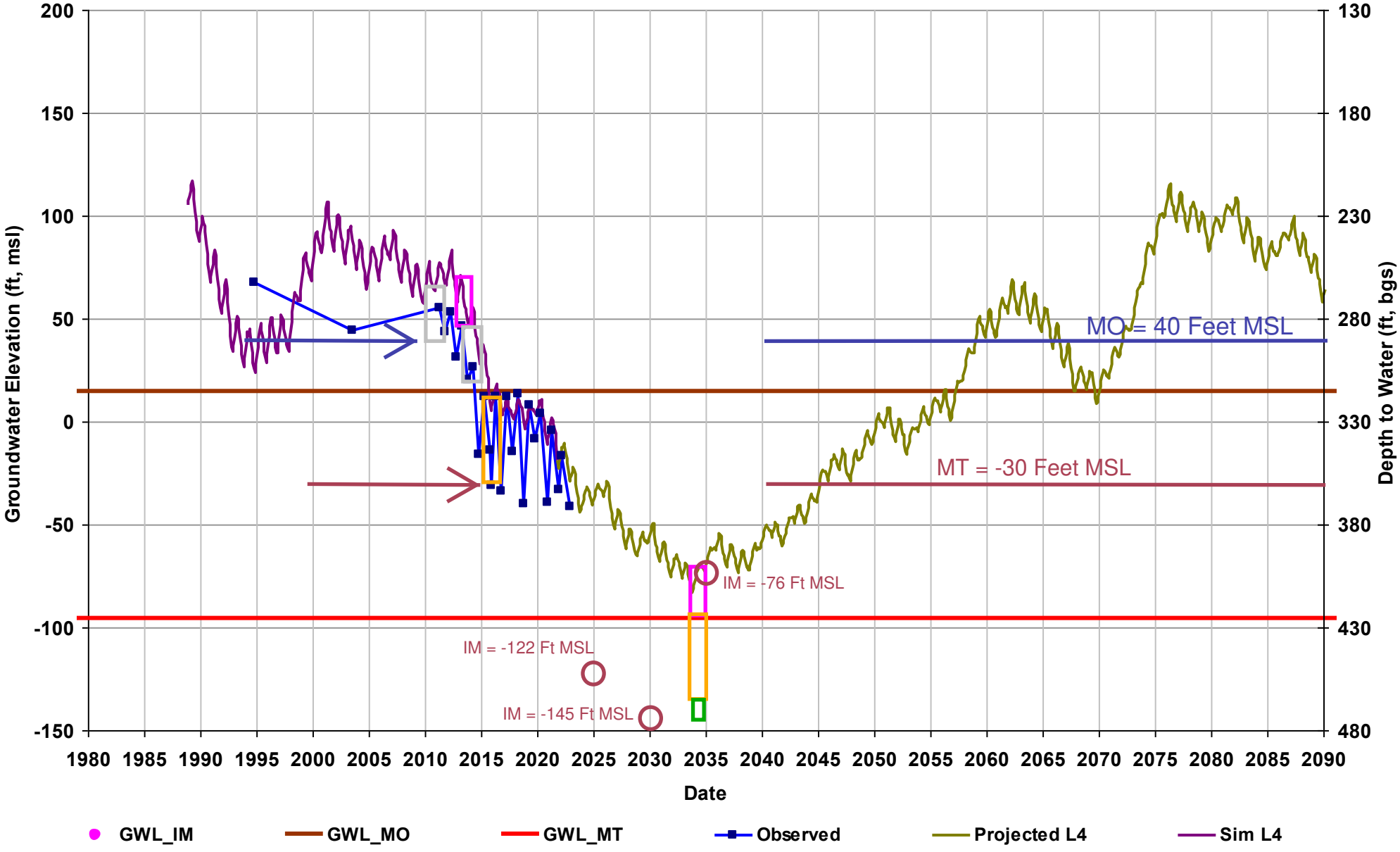
Well Name: MID RMS-17
Depth Zone: Upper
Subbasin: Madera
GSE (ft, msl): 224

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Perf. Bottom (ft bgs): 46.5
Top Model Layer: 1
Bottom Model Layer: 1



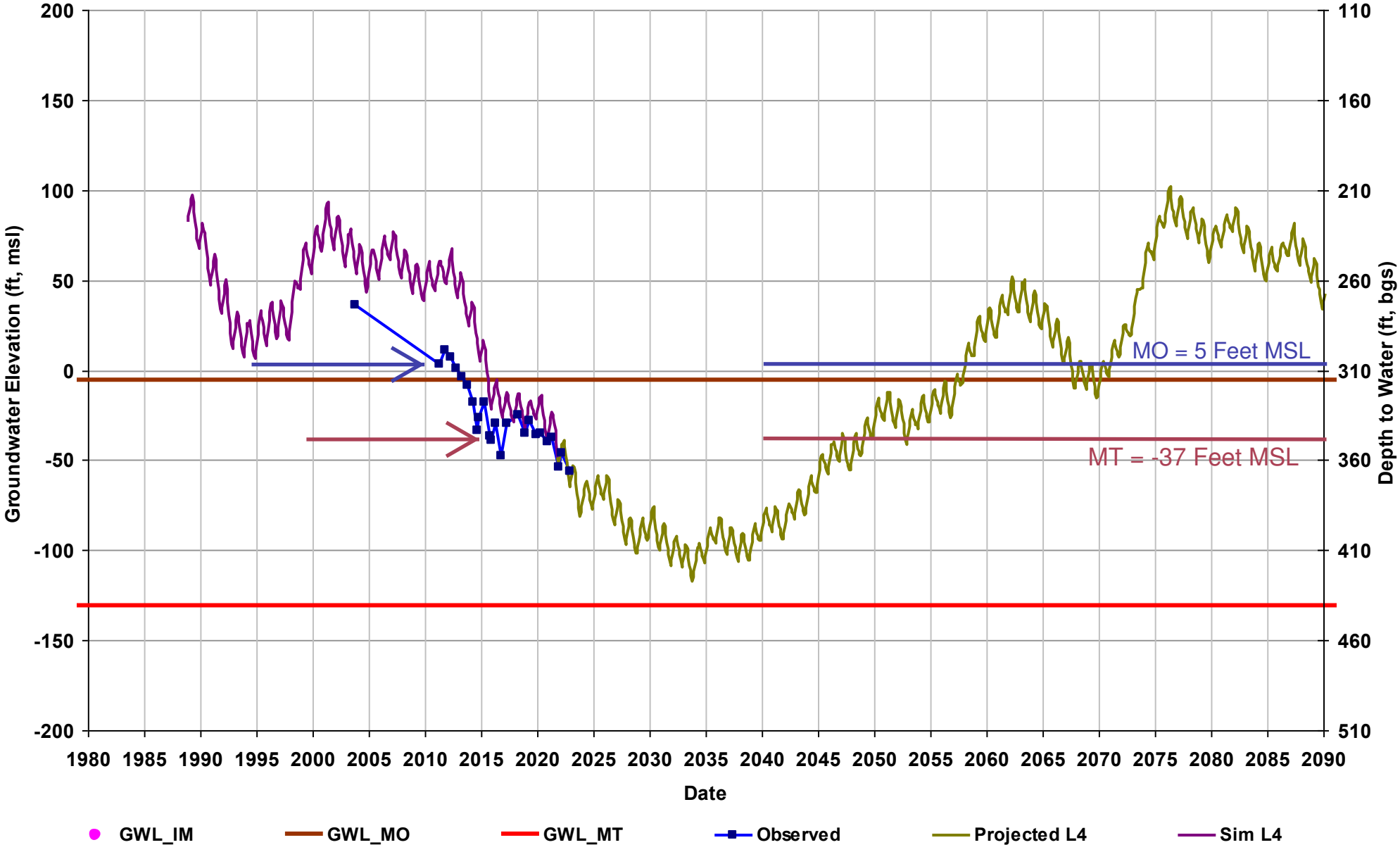
Well Name: MWD RMS-1
Depth Zone: Lower
Subbasin: Madera
GSE (ft, msl): 330

Total Depth (ft bgs): 500
Perf. Top (ft bgs): 200
Perf. Bottom (ft bgs): 500
Top Model Layer: 4
Bottom Model Layer: 4



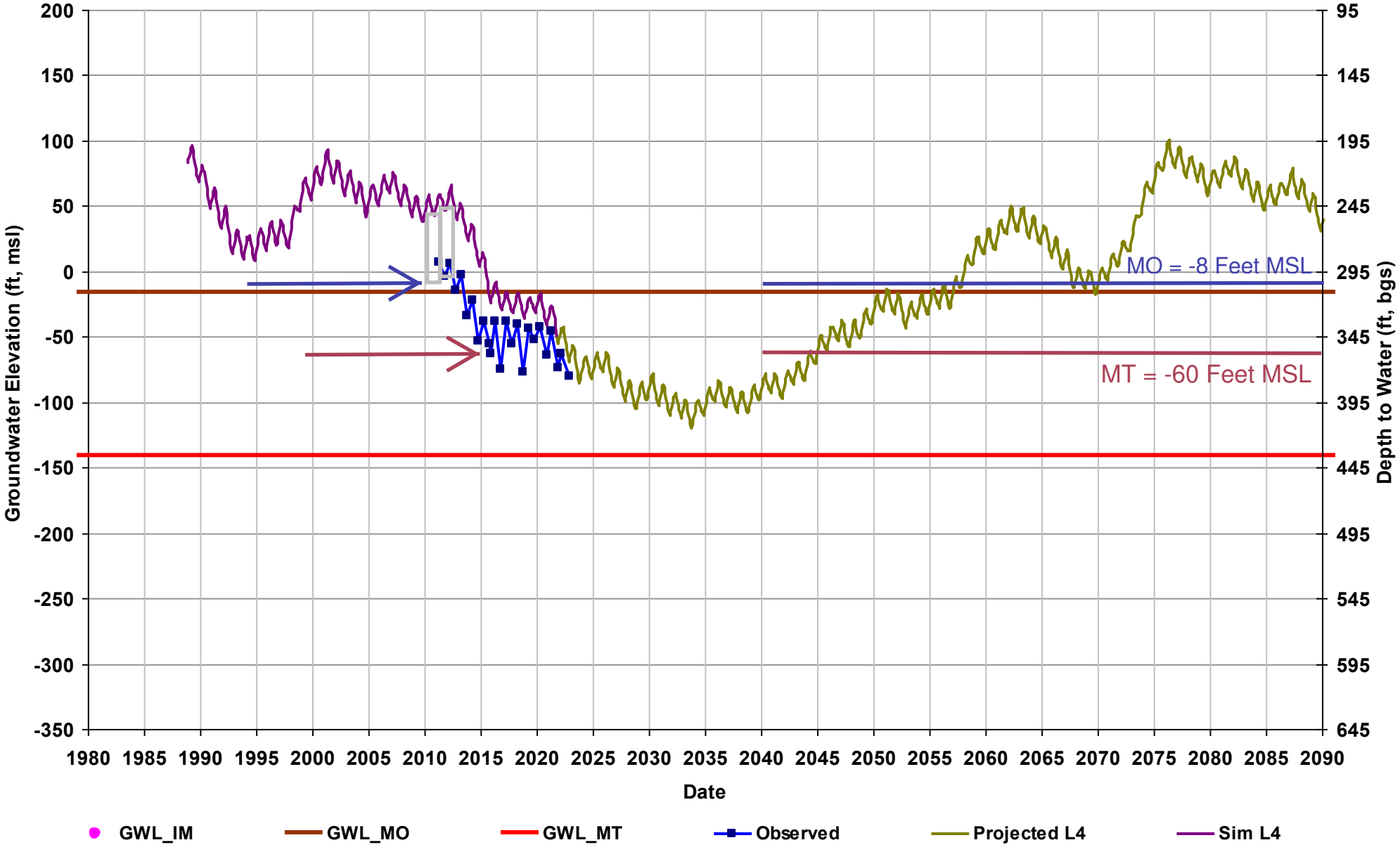
Well Name: MWD RMS-2
Depth Zone: Lower
Subbasin: Madera
GSE (ft, msl): 310

Total Depth (ft bgs): 537
Perf. Top (ft bgs): 200
Perf. Bottom (ft bgs): 537
Top Model Layer: 4
Bottom Model Layer: 4



Well Name: MWD RMS-3
Depth Zone: Lower
Subbasin: Madera
GSE (ft, msl): 295

Total Depth (ft bgs): 800
Perf. Top (ft bgs): 380
Perf. Bottom (ft bgs): 800
Top Model Layer: 4
Bottom Model Layer: 4



APPENDEX ITEM 2.G

MADERA SUBBASIN DOMESTIC WELL INVENTORY

Technical Memorandum:

Domestic Well Inventory for the Madera Subbasin

Prepared for Madera County and the
Madera Subbasin Groundwater Sustainability Agencies

April 2022

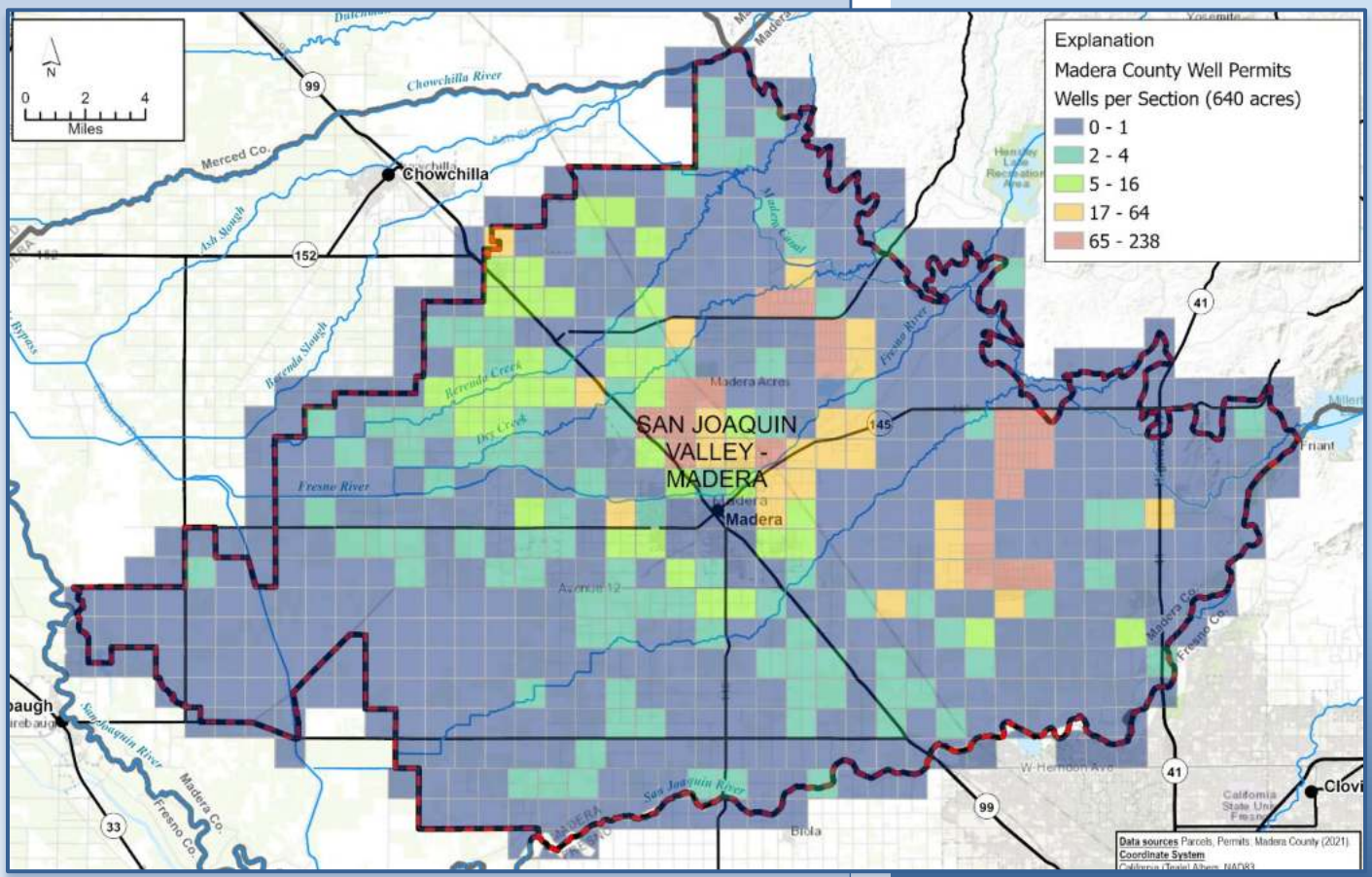






Prepared by

Luhdorff & Scalmanini
Consulting Engineers



Technical Memorandum:

Domestic Well Inventory for the Madera Subbasin

This memorandum was prepared for Madera County and the Madera Subbasin Groundwater Sustainability Agencies to support implementation of the Madera Subbasin Groundwater Sustainability Plan.

Luhdorff and Scalmanini Consulting Engineers conducted the Domestic Well Inventory project for the Madera Subbasin and prepared this technical memorandum with assistance from ERA Economics.

Madera County and the Madera Subbasin Groundwater Sustainability Agencies appreciate and acknowledge funding received from the California Department of Water Resources under the Sustainable Groundwater Planning Grant Program, authorized by the California Drought, Parks, Climate, Coastal Protection, and Outdoor Access for All Act of 2018 (Proposition 68). This grant funding supported the completion of the Madera Subbasin Domestic Well Inventory project.

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ATTACHMENTS

1. Domestic Well Replacement Economic Analysis – Madera Subbasin Update
2. Madera Subbasin – Evaluation of DWR Household Water Supply Shortage Reports and Self-Help Enterprises Tank Water Participants

LIST OF ABBREVIATIONS & ACRONYMS

Acronym	Meaning
APN	Assessor Parcel Number
CDP	Census-Designated Place
CDWR	California Department of Water Resources
CEHTP	California Environmental Health Tracking Program
DAC	Disadvantaged Communities
DDW	Division of Drinking Water
DTW	depth to water
GPS	Global Positioning Satellite
GSP	Groundwater Sustainability Plan
LSCE	Luhdorff & Scalmanini, Consulting Engineers
LSWS	Local Small Water System
MCSIM	groundwater model
MD	Maintenance District
MHI	median household income
OSWCR	Online System for WCRs
PLSS	Public Land Survey System
PWS	Public Water System
SDAC	Severely Disadvantaged Communities
SDWIS	Safe Drinking Water Information System
SGMA	Sustainable Groundwater Management Act
SHE	Self-Help Enterprises
SSWS	State Small Water System
SSWS	State Small Water System
SWRCB	State Water Resources Control Board
TM	Technical Memorandum
WCR	Well Completion Report

1 INTRODUCTION

The Madera Subbasin Groundwater Sustainability Plan (GSP) includes maps, figures, analysis, and discussion of domestic wells and potential impacts from continued decline in regional groundwater levels during the GSP Implementation Period. The GSP provided the background and data analyses to illustrate the need for a Domestic Well Mitigation Program in Madera Subbasin and described how it is the most economically viable way to transition from current overdraft conditions to sustainable conditions in 2040. However, there was insufficient time during GSP development to conduct the more thorough inventory of domestic wells and the potential range of impacts to domestic wells under various scenarios of future groundwater conditions. This study supplements domestic well information provided in the GSP and provides an updated analysis that includes anticipated impacts to domestic wells during the GSP Implementation Period.

Madera County was successful in applying for a DWR grant under Prop 68 to conduct a more detailed well inventory, which is documented in this Technical Memorandum (TM). In addition, the grant funding provides for drilling and installation of nested monitoring wells at two sites in proximity to clusters of domestic wells to provide monitoring of current and future groundwater levels and groundwater quality. This TM includes recommendations for locations of these two nested well sites.

To prepare this domestic well inventory, approximations of the number, depths, and locations of domestic wells were developed from multiple available data sources. The total number of domestic wells indicated to be present according to the various data sources were reviewed and compared. Domestic well depths were then compared to historical, current, and predicted future local groundwater depths based on observed and modeled data from the groundwater model (MCSIM) developed for and described in the 2020 Madera Subbasin GSP. Due to the uncertainty in future climatic conditions for the GSP Implementation Period; two primary scenarios were evaluated to bracket the range of domestic wells that are estimated to go dry during the GSP Implementation Period. Estimated costs to replace domestic wells are also included in this TM.

This TM documents the available data sources for estimating numbers and locations of domestic wells, domestic well construction details, occurrence of domestic wells inside and outside of public and small community water systems, analyses to estimate the number of domestic wells that may go dry through 2040 based on two different climatic sequences, and sensitivity analyses to evaluate how various assumptions impact estimates of the number of dry wells. Using the results from the domestic well inventory and analysis, an updated economic analysis was also conducted comparing the tradeoffs of implementing a Domestic Well Mitigation Program during the Implementation Period versus immediately implementing demand reduction in the Subbasin to avoid significant and unreasonable adverse impacts on domestic well users. This economic analysis is included as **Attachment 1** (Domestic Well Replacement Economic Analysis) and provides an update to Appendix 3.D of the Madera Subbasin GSP. **Attachment 1** incorporates the latest results from the domestic well inventory relative to the total number of domestic wells estimated to go dry during the GSP Implementation Period. The economic analysis evaluated the difference in costs for implementing a Domestic Well Mitigation Program

concurrent with gradual reductions in groundwater pumping over the twenty-year Implementation Period compared to not having a Domestic Well Mitigation Program and immediately implementing demand management and other PMAs to eliminate the overdraft in the Subbasin.

2 DOMESTIC WELL INVENTORY DATA SOURCES AND COMPILATION

Data from a variety of public agencies were assembled for consideration in the project. Compiled datasets included the following.

- Well Completion Report (WCR) Database from California Department of Water Resources (CDWR) Online System for WCRs (OSWCR)
- Madera County well permit database (records since 1990)
- Madera County Assessor's Parcel data
- Public Water System (PWS) service area boundaries and PWS well locations from State Water Resources Control Board (SWRCB) Division of Drinking Water (DDW)
- State Small Water System (SSWS) service area boundaries from Madera County
- Census block-level household counts from the US Census Bureau
- Disadvantaged Community boundaries from DWR

With the exception of the Madera County well permit database, all of the above-listed datasets were available in geospatial (e.g., GIS) formats. The well permit database was provided as tabular data, which was converted to geospatial information as described below.

2.1 DWR WCR Database

The primary source for well construction data in the subbasin is the CDWR WCR database (CDWR, 2020). Well drillers are required to submit a WCR to DWR for all wells drilled and constructed in the State of California. DWR has tabulated information from WCRs for the State, including data from WCRs dating as far back as the early 1900s. The tabulated WCR information include well type and construction characteristics such as the intended use of the well, well depths, and screened intervals along with location, construction date, permit information, and other details included on the WCR. Although completed WCRs commonly include additional notes on borehole lithology and a variety of other types of information, lithology and some other well information included on WCRs is not entered or maintained in the DWR WCR database. It is notable that many well attributes in the WCR database are blank or incomplete because of missing or illegible information provided on the WCRs. Additionally, well locations in the WCR database are commonly only provided to the center of the Public Land Survey System (PLSS) section in which it is located, which translates to a locational accuracy of approximately +/- 0.5 mile.

2.1.1 Domestic Well WCRs

As part of the project, initial quality checks were conducted on the WCR database to identify obvious inconsistencies in well data, including conflicting well locations (e.g., latitude, longitude, PLSS coordinates) and construction (e.g., well depths, top and bottom of screens). Such questionable information and records were flagged for additional consideration during subsequent analyses. For the purpose of this

domestic well inventory project, only WCRs indicated to be domestic water supply wells were included in the analysis. To limit potential double counting of domestic wells, only WCRs for new well construction (i.e., not well repairs/modification or destruction) were included in the domestic well inventory.

The number of well records within the Madera Subbasin in the WCR database exhibit a notable increase starting in about 1970 as indicated by domestic WCR counts by decade presented in **Table 1**. This shift may be partly due to changes in the Water Code relating to well data collection methods and reporting requirements that were instituted in 1969. The number of WCRs for domestic wells in the Madera Subbasin increased by a factor of six times around 1970, from around 100 WCRs in the 1960s to over 600 in the 1970s.

2.1.2 WCR Dates

The typical lifespan of a small water well is estimated to be 30 to 50 years based on the durability and longevity of typical domestic well materials, which are commonly constructed of PVC casing. Wells drilled prior to 1970 are also unlikely to still be in operation because of long-term trends in groundwater levels in the Subbasin.

For these reasons, only WCRs for wells with dates on or after 1970, were included in the domestic well inventory and associated analyses. DWR's WCR database includes 265 domestic well new construction WCRs located in the Madera Subbasin that do not have any recorded installation or permit dates. For this well inventory and analysis, these 265 wells were included in the analysis even though some fraction of them may have been constructed prior to 1970. A total of 4,822 domestic wells constructed since 1970 were considered in the project based on WCR records.

2.1.3 WCR Locations

Wells with WCRs marked as domestic were selected and mapped based on one of four geolocation methods, depending on what information was available in the tabulated data. Only wells with installations in 1970 or later were considered, or those with no available date of installation. The geolocation methods, in order of priority, are as follows:

1. Global Positioning Satellite (GPS) – 4 wells
2. Assessor Parcel Number (APN) – 2387 wells
3. Address – 1397 wells
4. Public Land Survey System (PLSS) – 1034 wells

A total of 4,822 domestic wells were located within the Madera Subbasin using these methods (**Figure 1a**). Wells located by PLSS are typically placed at the center of the section in which they are located, and thus may be out of position by as much as about 0.5 mile (half the typical width of a section). Other sources of location error include changes in APNs over time; poorly matched addresses; and incorrect WCR entries for PLSS values, GPS coordinates, APNs, or addresses. Since many of the location dots for domestic wells plot on top of each other in **Figure 1a**, the locations of domestic wells in the Subbasin by Township/Range/Section mapping are displayed in **Figure 1b**.

2.2 Well Permit Records

Under county regulation, a well permit is required prior to drilling and constructing a domestic well. Records of well permits were provided by Madera County as a tabular dataset (Madera County Environmental Health, 2020); no GIS data were initially available for the well permits. The period of record for the well permits begins in 1990. Limited information on individual wells is available in the well permit dataset, although most well permits include APNs or well addresses, which can be used for locating wells. Well uses in the permit dataset were inconsistently entered and required considerable review and modification to standardize well uses for identifying likely domestic well permits.

2.2.1 Domestic Well Permits

A subset of 7,505 permits for all of Madera County was identified as likely domestic wells based on the indicated well use. The well uses retained as representative of likely domestic wells include the following:

1. Domestic (7300 permits),
2. Domestic Replacement (25 permits),
3. Shared (54 permits),
4. Dairy (36 permits),
5. No Use listed (90 permits).

"Shared" wells are typically domestic wells that are also used for irrigation. "Dairy" wells are typically used for semi-industrial, and irrigation uses on a dairy, but in some cases can also be used for domestic water supply. Wells without a listed use were included in an effort to be conservative in the domestic well inventory.

2.2.2 Locating Well Permits

Of the 7,505 domestic well permits (7,362 with APNs) for all of Madera County, the portion applicable to Madera Subbasin were identified based on APNs associated with them. Multiple permits refer to the same APN in some cases with only 6,498 unique APNs listed as having domestic well permits in the database. Domestic well permits in the County well permit database were located by matching the listed APN with the county parcel data when possible. Following this approach, 4,115 domestic well permits were matched to 3,605 unique parcels located within the Madera Subbasin. For the 143 well permits without APNs, 79 permits were expected to be located within the Subbasin based on the fraction of permits with APNs that were determined to be within the Subbasin.

In addition to APNs, the well permit database includes site addresses for most (7,323) of the wells. Through geocoding of addresses in the well permit database, 95 of the well permits without APNs were located within the Subbasin.

Though locating of well permits based on APNs and site addresses, approximate locations for all but one of the 7,505 domestic well permits were determined. Using these locations, the total number of domestic well permits in the Subbasin was determined to be 4,210 (at 3,700 unique locations) out of 7,505 domestic well permits in the database. A map of the domestic well permits located in the Madera Subbasin is presented in **Figure 2a**. Since many of the location dots for domestic wells plot on top of each other in **Figure 2a**, the count of domestic wells in the Subbasin by Township/Range/Section mapping is displayed in **Figure 2b**. The relationship between County well permits and WCRs is summarized in **Table 2** and described further in Section 3.2.3.3 Scaling Estimates.

2.3 County Assessor Parcel Data

County Assessor parcel GIS data were provided by Madera County (Madera County Assessor's Office, 2020), including land use and other characteristics for each APN indicating the presence of a dwelling. The parcels dataset includes 34,365 unique APNs within the Madera Subbasin. Of those, 24,192 are listed as having dwellings associated with them (**Figure 3**). Although the County parcel dataset does not include records related to the presence of domestic wells on parcels, the presence of a dwelling on a parcel is interpreted to suggest the presence of a drinking water supply, including in some areas the potential for a domestic well to exist. This includes parcels that are included within a public water system service area.

2.4 Water System Data

Public Water System, State Small Water System (SSWS), and Local Small Water System (LSWS) service area boundaries from State and local data sources were used to map and evaluate where and how many inferred well locations occur inside of a water system service area and therefore may not be supplied by a domestic well. Water system boundaries are a key dataset for comparing with potential domestic well locations identified through analysis of WCRs, parcels, and permits. The service area boundaries for water systems identified in the Subbasin are presented on **Figure 4** based on the evaluation of PWS, SSWS, and LSWS boundaries as described below.

2.4.1 State Regulated Systems

The PWS boundaries are part of an archived dataset developed by the California Environmental Health Tracking Program (CEHTP) and now maintained by the SWRCB DDW (SWRCB, 2021). This dataset is a publicly available GIS feature class of system boundaries provided voluntarily by water system operators over the period from 2012 to 2019. Previous assessments of this dataset suggest it includes approximately 85 percent of community water systems, although this can vary by region within the state. Of the state regulated PWS boundaries, 21 were identified to have service areas within Madera Subbasin.

2.4.2 County Regulated Systems

The PWS service area dataset from DDW is not intended to include county-regulated systems. Madera County Public Works representatives reviewed the PWS boundaries and provided additional service area boundary data for county-regulated water systems (Madera County Environmental Health, 2021). The County provided 12 water system boundaries that are within the Madera Subbasin. Of these, 8 were for water systems that already had boundaries in the CEHTP dataset. In cases where boundaries were available from DDW and Madera County, the union of the two boundaries was retained for use in the analysis. The resulting addition of four new systems increased the total number of water systems in the Subbasin to 25. County staff reviewed the combined water system boundaries and stated it appears complete.

2.4.3 Public Water System Wells

PWS well locations were downloaded from the SWRCB GAMA website (SWRCB, 2021) and used to check for any water system wells in areas not covered by the water systems service area boundaries data. All PWS wells were located within previously delineated water system service area boundaries.

2.5 Community Data

2.5.1 Census

United States Census data (US Census, 2016) were used for cross-checking and comparison with domestic well WCRs, domestic well permits, and parcels with dwellings in the Subbasin. The Census data include counts of households by Census area (e.g., block, tract, designated place). The Census data were evaluated to assess whether they could inform the count and locations of domestic wells in the Subbasin. To approximate the number of households that might have a domestic well, Census block area were converted to randomly located points within each block equal in number to the count of households per block. The resulting 28,695 points represent an estimate of the number of households within the Subbasin that might have a domestic well (**Figure 5**). This number is slightly higher than the number of parcels with dwellings in the Subbasin (24,192), a result which might be expected because multiple households can occupy a single parcel. This includes households that are included within a public water system service area.

2.5.2 Disadvantaged Communities

DWR defines Disadvantaged Communities (DACs) as communities with an annual median household income (MHI) less than 80 percent of the Statewide annual MHI (PRC Section 75005(g)), and SDACs as communities with an annual MHI less than 60 percent of the Statewide annual MHI. The statewide median household income (MHI) for the Census American Community Survey (ACS): 2014-2018 dataset is $71,228. Therefore, a community where the MHI is less than $56,982 meets the DAC threshold and a community where the MHI is less than $42,737 meets the SDAC threshold.

DWR provides a standardized GIS layer of Disadvantaged Communities and Severely Disadvantaged Communities (DACs, SDACs) (DWR, 2021). These data are available as Census Designated Places, Census Tracts, or Census Blockgroups. The Tract-level data are simply aggregated from the Blockgroup-level data and were not used in the current analysis. Place-level data are not congruent with Blockgroups or Tracts, typically following established neighborhood boundaries. Place-level data provide a more focused description of the regions that qualify as DAC or SDAC; however, the Place-level data is only available in Census-Designated Places (CDPs), and these do not capture more diffuse residential neighborhoods. DACs and SDACs are found in both urban and rural areas in Madera Subbasin. **Figure 6** shows the locations of the Census Designated Places identified as DACs or SDACs by the definition above.

3 ANALYSIS AND RESULTS

Estimates of domestic wells were developed through analysis and comparison of the data sources discussed above. Estimates of the number and locations of domestic wells in Madera Subbasin were made using four different sources of data and approaches: from WCRs, well permits, parcels with dwellings, and Census households. Domestic well WCRs and well permits provide a more direct indication of the existence (past or present) of a domestic well whereas the parcel data and Census data provide a basis for inferring the existence of domestic wells. The County well permit database is believed to provide the most accurate estimate of the numbers and locations of domestic wells constructed during the available data record (since 1990).

The completeness of the well records in County well permit data are expected to be greater than the WCR database because although regulations state that WCRs are required to be submitted to DWR for all constructed wells, there has historically been little or no verification at the County or State level that a well driller submits a WCR to DWR after a well is completed. In cases where a WCR is submitted, the time elapsed between when a well is drilled and when a WCR is submitted to DWR can be highly variable and information provided on WCRs may not be complete. There are also additional steps involved in entering WCRs into DWR's database after receiving a WCR, which may also introduce timing delays or data entry errors. In contrast, although there is generally no information about a given well's design provided in the County well permit database, there is a fee to obtain a well permit and permits are typically obtained by the driller immediately prior to starting work on a project. Therefore, it is believed that most permitted wells are constructed even if a corresponding WCR is never submitted to DWR by the well driller.

The locational accuracy of well permit records are also believed to be better because most well permit records include data on the parcel where the well is permitted. Many of the WCR records only indicate location by the PLSS section in which the well is located.

Although the well permit data are believed to be more complete and provide better locational accuracy of wells, only the WCR data have information on well depths and other well construction details (**Figure 7a, Figure 7b**). Additionally, while WCRs and well permits generally have a date associated with each record indicating the approximate date of well construction, the parcel and Census datasets do not. However, estimates of well counts based on parcel and Census data do provide a sense for the

maximum possible number of domestic wells, and also a comparative check on the relative spatial density of domestic wells in the Subbasin.

Water system service area boundaries were used to refine domestic well estimates derived from parcel and Census household counts, with the expectation that all parcels and households within a water system boundary are served water by the water system and therefore do not rely on a domestic well. The locations and count of permits and WCRs were assumed to be correct, regardless of their location relative to a PWS service area.

With this information, estimated locations and counts of domestic wells in the Subbasin were developed and well depths were compared to historical groundwater levels and model-simulated future groundwater levels (based on the modeling conducted during GSP development) to evaluate potential impacts to domestic wells from changing groundwater levels in the Subbasin. The methods and results from these analyses are described below.

3.1 Analysis of Domestic Well Locations and Counts

3.1.1 Domestic Well WCRs

The domestic well WCRs since 1970 were compared with water system boundaries. Because the WCRs are records of actual wells that were constructed, those located within a water system service area are assumed to be correctly located. It is possible that wells that pre-existed the establishment of a water system in an area may remain in use after the water system is operational; however, the frequency of this occurring is not known.

Of the 4,822 domestic wells represented by WCRs in the Subbasin, 559 are located within the known water system boundaries (**Figure 8**). This represents approximately 11 percent of the domestic well WCRs in the Subbasin. Some of these domestic well WCRs may be associated with wells that no longer actively supply domestic drinking water. Nevertheless, WCRs within a water service area boundary were still considered in the domestic well inventory and analysis described below, which is a conservative assumption relative to likely domestic well counts.

3.1.2 Domestic Well Permits

Similar to the WCR estimate, permits are expected to accurately identify well locations, but domestic well permits may exist for wells drilled and constructed prior to the operation of a water system in an area. The use of such wells may have been discontinued when a residence was hooked up to a water system, although this may not always be the case and some domestic wells within water system service areas may still be operational.

In contrast to the WCR dataset, which relies on submittal and entry of a WCR in DWR's database, the County well permit dataset is expected to be a more comprehensive representation of the wells drilled in the County for the period over which it spans (1990 to present). Although the comparisons across different datasets described below highlight differences between data sources and the estimates of domestic wells derived from each, this study did not attempt to assess the accuracy of the well permit database in relation to actual domestic wells.

Of the 4,210 domestic well permits in the Subbasin, 333 are located within known water system boundaries. This represents approximately eight percent of the domestic well permits in the Subbasin. Some of these domestic well permits may be associated with wells that no longer actively supply domestic drinking water. Nevertheless, domestic well permits within a water service area boundary were still considered in the domestic well inventory and analysis described below.

3.1.3 Parcels with Dwellings

For the purpose of assessing the maximum possible number of domestic wells in the Subbasin, all parcels with a dwelling but not within a water system service area were counted. In this approach, a parcel is considered within a water system service area if its centroid is within the service area.

Based on these criteria, within the Madera Subbasin there are a total of 24,192 parcels with dwellings, 5,898 of which are outside of the service area boundaries of all 29 PWS and County-regulated systems serving residential parcels. These 5,898 parcels representing potential domestic well locations are presented on **Figure 9**. There are several areas within the Madera Subbasin with a high density of parcels with dwellings that are not covered by a water system boundary.

3.1.4 Census households

Due to the irregular shape of Census blocks and the inconsistent alignment of blocks with other important boundaries in the Subbasin (e.g., Subbasin, water service areas) the Census data provided limited utility for the inventorying of domestic wells, although they do provide an approximate check on the maximum overall number of potential domestic wells in the Subbasin. Conversion of the Census household counts to points and comparing to water system service areas provides estimates between 7,109 and 7,393 potential households outside of the water system service areas. Although the total number of parcels and total number of households within the Subbasin are reasonably consistent, the number of households estimated to be outside of the water system service areas is considerably higher than the number of parcels outside of the water system service areas and is not believed to be an accurate metric for inventorying domestic wells.

3.1.5 Comparisons of Domestic Well Location Information Sources

3.1.5.1 Domestic Wells Within PWS Service Areas

While most residences within a PWS service area are supplied with drinking water by that PWS, it is not unusual for wells that were drilled prior to the creation of the PWS to be retained and used for part, or all, of a residence's use, including for drinking water or landscape irrigation.

Of the 4,822 WCRs since 1970 located in the Madera Subbasin, 559 are located within a water system service area. Of the 4,210 permits (since 1990) located within the Madera Subbasin, 310 were located within a water system service area. These represent approximately 12 percent and seven percent, respectively, of the wells identified from these data sources.

Of the 24,192 parcels with dwellings noted in the APN dataset, 18,294 are within a water system boundary. Similarly, of the 28,708 households in the Subbasin indicated by the 2010 Census data, 21,503 are within a water system service area.

The count of known locations of permits and WCRs within water systems, when compared to the number of residences within those systems based on parcel and Census data, represent between one and three percent of the number of residences within those service areas. This suggests that the number of domestic well permits and WCRs located within water system boundaries is a small fraction of the number of likely residences within those water system areas. Accordingly, this comparison suggests that neither the WCR nor well permit data identify a large number of domestic wells within water system boundaries. Although this does not speak to the accuracy of the WCR and well permit data in locating wells in other areas of the Subbasin, they do not appear to identify an unreasonable number of domestic wells within areas covered by water systems.

3.1.5.2 Comparing WCR Locations to Well Permits

The Madera County well permits dataset is believed to be more complete in representing wells drilled in the County, but it only extends back to 1990. To provide an appropriate comparison between the WCR dataset and the well permit dataset, a subset of the WCRs since 1990 (those dated after 1989), were considered. In the Madera Subbasin, roughly two-thirds of domestic well WCRs have construction dates after 1989. For this analysis, WCR records without construction dates are assumed to be drilled in 1990.

The subset of domestic wells with WCRs since 1990 has many similar characteristics as the dataset for WCRs since 1970, with several noteworthy differences. As shown in **Table 3**, proportionally, the WCR dataset since 1990 has fewer WCR records located in water system service areas. This is reasonable, as it is consistent with the understanding that many of the domestic well WCRs located within water system service areas are for wells drilled prior to the creation or expansion of those water systems.

There is no direct linkage between WCRs and well permits on record (i.e., WCRs commonly do not indicate well permit numbers) for majority of the wells, and the available method for geolocating records for a given well present in both datasets may differ. However, it was determined that 2,691 of the parcels associated with permit locations coincided with WCR locations for domestic wells (**Figure 10**).

This relatively low rate of coincidence is most likely a function of poor accuracy of the WCR locations. The permit location error is generally related to the area of the parcel within which they are located and is commonly less than half the distance of the maximum parcel dimension. As parcel size decreases, the accuracy of the locating of well permits tends to increase. Many WCR locations have much higher error, especially those that rely on locations from the PLSS section centroid.

3.1.5.3 Comparing Domestic Well Permits with Parcel Characteristics

Of the 95 well permit locations produced by geocoding addresses in the well permit database, 62 did not fall within a parcel. Such locations generally occur between parcels on streets. For these locations, the attributes from the nearest parcel were used to compare. The parcel Use Codes for the 3,700 unique locations are summarized here:

1. One residence: 88%
2. Two residences: 7%
3. Urban Non-Residential: 3%
4. Agricultural: 2%

Of the 4,210 domestic well permits (at 3,700 unique locations), 3,672 permits (87 percent of permits) at 3,205 unique locations (87 percent of unique locations) were in parcels with dwellings, as indicated on the parcel dataset, suggesting that a residence is present on the parcel associated with the well permit (**Figures 11a and 11b**).

3.1.5.4 Comparisons of Parcels with Dwellings and WCRs

Of the 5,898 parcels listed as having dwellings in the Madera Subbasin, and not within a water system boundary, 1,901 coincide with the location of WCRs located as described above. A total of 285 parcels with dwellings located within water systems also coincided with WCR locations (**Figure 12**). Nearly all the dwelling parcels within water system boundaries and also intersecting WCRs are located in the Maintenance District (MD) 10 – Madera Ranchos water system.

3.1.6 Final Domestic Well Count and Location Estimates

The County permit database includes 4,210 domestic (or considered domestic for this analysis) wells installed since 1990. For providing a direct comparison of the domestic well counts from the WCR database, the count of WCRs was limited to WCRs with dates since 1990 (3,446 domestic well WCRs) to allow for direct comparison to available County permits. This comparison yields a ratio of 1.22 between the domestic well permit count and the domestic well WCR count. Well permits are believed to provide a more complete representation of wells constructed in the Subbasin, but these permit records do not contain information on well perforations and depths and only date back to 1990. As a result, the ratio of well permits to WCRs for the period since 1990 provides a useful metric for scaling of results derived during the evaluation of potential impacts on domestic wells from changing water levels, an analysis which relies heavily on well construction information available only on WCRs. The domestic well impacts analysis is described below.

3.2 Evaluation of Potential Domestic Well Impacts

A key consideration in the implementation of the GSP for the Madera Subbasin is the potential occurrence of impacts to domestic well users due to declining water levels. As part of implementing the GSP, the Subbasin is in the process of evaluating and designing a Domestic Well Mitigation Program targeting domestic wells that may be impacted by future declines in groundwater levels. To support this effort, the effects of historical and future groundwater levels on domestic wells in the Subbasin were evaluated.

This analysis involved comparing domestic well perforation and depth information to historical groundwater levels and potential future groundwater levels, as simulated by the groundwater model (MCSIM) utilized during the GSP development. Simulated groundwater level conditions from MCSim were used to estimate the number of domestic wells that may go dry during the GSP implementation period from 2020 through 2040, the period during which the Subbasin will be working towards achieving sustainability as required by the Sustainable Groundwater Management Act (SGMA). WCR records for domestic wells (and the well construction information provided on WCRs) were used to estimate well depth information for evaluating impacts. The ratio of well permits to WCRs (1.22) was used to upscale the results derived from these analyses conducted using WCR data.

3.2.1 WCR Domestic Well Construction Information

Of the 4,822 domestic well WCRs in the Madera Subbasin, 4,524 included some information on perforated interval (top of bottom of perforations) or total depth. As mentioned earlier, several inconsistencies in construction information were noted in the initial WCR dataset (e.g., total well depth less than depth to top of perforations, depth to bottom of perforations less than top of perforations), so multiple levels of quality checks were conducted on the well construction data in the WCR database to assess the reliability of the information. Only WCR records determined to have sufficiently reliable well construction information (i.e., lack of obviously conflicting information on the well construction) were included in the summary and analyses relating to domestic well construction in the Subbasin. In analyses using well perforations (screens), where data for bottom of perforations was not available, the reported total well depth was used. A total of 3,834 WCRs included top of screened interval information. For wells lacking information for either bottom of perforations or top of perforations, the average values for wells in the same section were used. Where a section had fewer than three wells with reported depth or top of screen data, the average values from wells in the same section and the eight surrounding sections were used. This resulted in estimates of top and bottom of perforated Intervals for all 4,822 domestic well WCRs in the Subbasin. **Figure 7a** and **Figure 7b** show the depth of domestic wells in the Subbasin based on these estimates.

3.2.2 Domestic Well Impacts Analysis Methods

Simulated groundwater levels output from the MCSim model developed by Luhdorff & Scalmanini, Consulting Engineers (LSCE) and described in the 2020 GSP for Madera Subbasin were queried to produce depth to water (DTW) datasets for the Subbasin for the period from 1989 through 2070. MCSim is a multi-layered model and based on review of the well data and consideration of the hydrogeologic conceptual model and groundwater conditions described in the GSP, model layers 3 and 4 were determined to most appropriately correspond with the production zones for most domestic wells in the Subbasin. The simulated DTW datasets for model Layers 3 and 4 were used to extract DTW values for different time periods at all WCR locations; DTW values at each domestic well WCR location were compared with the top and bottom of perforations (screens) values for each WCR. Based on this comparison, the wells were assigned DTW values for either model Layer 3 or 4. If a well was screened at least 50 percent in Layer 4 or deeper, the well was assigned DTW values for Layer 4. If more than 50 percent of the screened interval was above Layer 4 (in Layer 3 or shallower) then Layer 3 DTW values were assigned to the well.

Simulated depth to water model output for Layers 3 and 4 for the years from 1989 to 2039 were then compared to the screened intervals for each domestic well (WCR) to assess if each well was wet or dry during each year. For each year, the fall simulated DTW (on October 31st) in layers 3 and 4 of the model were assessed for each well location.

The analysis was performed using different analysis periods and methods. Generally, the analysis was conducted using five-year analysis periods, with the first analysis period starting in 1989 and extending to 2014 or 2015 followed by shorter five-year intervals thereafter. Analyses included comparisons based on snapshots of DTW conditions at the end of each analysis interval (generally five-year analysis periods) and separate comparisons based on the maximum depth to water found during each analysis period. Variations of analyses were also performed using simulated model output from the projected model run used in the GSP and also separately on a model run utilizing a projected future hydrology that included drier conditions during the early years of the GSP Implementation Period, conditions that are more consistent with the recent hydrology experienced in the area. In all analyses, if the simulated DTW in the assigned model Layer at a well location falls below the required minimum level of saturation in relation to the depth of the well, either at the end of each analysis period (or in the year within each five-year period that generally had the lowest water levels) for the maximum DTW scenario), the well was considered to have gone dry during the analysis period. Once a well was concluded to have gone dry in an analysis scenario, it was removed from the pool of potential wells that could go dry in subsequent years. The sensitivity of model results to different assumptions, analysis periods, and WCR data restrictions were tested and evaluated.

The parameters used in the analysis are defined as follows:

P = the base year for the analysis periods. This defines the end of the initial historical analysis period (after 1989) during which wells were evaluated for historically having gone dry. This is generally Fall 2019, indicating a historical analysis period of 1989-2019, but 2018 was also used as the ending year for the historical period during sensitivity analyses (because groundwater levels in 2018 were generally lower than in 2019).

S = minimum saturation threshold above the well total depth for a well to remain wetted. This is assumed to be 10 feet in the baseline analysis, but the sensitivity of analysis results to varying this value was conducted to evaluate the influence of this parameter on analysis results.

E = the earliest year of installation for the WCRs considered. This reflects the cutoff year for the construction date on WCRs intended to reflect wells that may have been active at the time of the base year considered based on typical domestic well life expectancy.

Appropriate scaling of the results of these impacts analyses based on WCR was also considered based on the ratio (1.22) of domestic well permits to domestic well WCRs determined previously. This ratio is developed from a direct comparison of domestic well permits and WCRs with dates since 1990. The scaling ratio is developed for the entire Subbasin and is assumed to have limited spatial or temporal bias across the Subbasin or across the period since 1990. The potential for bias in the ratio has not been evaluated.

The baseline analysis scenario of potential domestic well impacts involved the parameters listed below.

- Snapshots of DTW at the end of each analysis period
- The ending year for historical analysis is 2019, with historical analysis period 1989-2019 (P = 2019). Corresponding analysis periods as follows:
    - 1989-2019
    - 2020-2024
    - 2025-2029
    - 2030-2034
    - 2035-2039

  The analysis periods were selected to correspond with the dates of the Interim Milestones and preparation of Five=Year Update Reports.

- Minimum well saturation threshold of 10 feet (S = 10).
- Using projected model run from GSP (without early sequence of dry years).
- Wells analyzed based on the WCR count of wells installed since 1970 (E = 1970).

Because the early years of the projected model period, including during the early GSP implementation period, have been dry, an alternative analysis scenario evaluated potential domestic well impacts based on simulated groundwater levels from a model run that starts with a drier sequence of years. This analysis involved the same parameters as the baseline analysis (described above) but used simulated groundwater levels from a different projected model run with an early dry period.

3.2.3 Results of Domestic Well Impacts Analyses for Baseline GSP Climate Scenario

In the baseline analysis scenario described above, a total of 739 of the 4,822 domestic wells (from WCRs) analyzed are indicated to have gone dry during years prior to 2020. A total of 772 wells are projected to go dry between 2020 and 2039 (**Table 4a**); the analysis suggests 287 dry wells of the total of 772 occurring during the period 2020-2024. **Table 5a** includes the results for this analysis when scaled up by a multiplier of 1.22 based on the ratio of well permits to WCRs.

3.2.3.1 Spatial Distribution of Dry Wells

Figures 13a to **13e** show the distribution of dry wells (and remaining wetted wells) in each of the analysis years for the baseline analysis. The predicted dry wells are clustered in the eastern parts of the Subbasin, with a greater number of dry wells predicted along and to the east of Highway 99. There are two higher-density clusters located north of the Fresno River and south of Dry Creek, and an especially large cluster in the Madera Ranchos area south of highway 145 and north of Avenue 12 in the southeastern part of the Subbasin.

Most of the domestic wells that are predicted to go dry over the 20-Year GSP Implementation Period in the Base Case occur in the 2020-2024 and 2030-2034 five-year intervals (**Tables 4a and 5a**). Groundwater levels stabilize and begin to recover after 2035 and no additional wells are predicted to go dry in the Base Case after 2035. The timing of domestic wells going dry is closely related to the assumed sequence of average, dry, and wet years applied for the Base Case, which is based on a historical sequence of years that represent overall average conditions for the 20-Year period.

3.2.3.2 Impacts on Disadvantaged Communities

Some dry domestic wells are predicted to occur in DAC and SDAC areas. The Fairmead area and City of Madera area SDACs are predicted to see significant numbers of wells going dry during the implementation period. In addition, the Valley Lake Ranchos, Lake Madera Country Estates, and Bonadelle Ranchos 5 neighborhoods, all located in Census blockgroups east of the City of Madera that qualify as DACs, are predicted to see significant numbers of wells going dry (**Figure 13f**).

Nonetheless, based on the analysis presented here, DACs and SDACs will not be disproportionately impacted by declining groundwater levels. Rather, these neighborhoods will see impacts proportional to the number of domestic wells and the depth of decline in water levels in their regions, as with any other wells examined in non-DAD/SDAC areas. DACs and SDACs in the Madera Subbasin are primarily located near urban centers, and thus near existing water system service areas. Opportunities for annexation or consolidation of DACs and SDACs into existing State- or County-regulated systems may provide better value than efforts to deepen existing wells in these areas.

3.2.3.3 Scaling Estimates

The previous analyses are all based on WCR counts of wells drilled since 1970 or 1990. A more accurate number of wells, however, is more likely the number of Permits in the permit database provided by Madera County.

Figure 14 shows that the spatial distributions of the two datasets are similar. As shown in that figure, the areas with large differences between the WCR and Permit datasets (shown as red and blue in the figure) are smaller areas that are peripheral in the Subbasin. The largest portion of the Subbasin is represented by ratios near 1:1 (from 0.8:1 to 1.2:1). The region of the Subbasin near the City of Madera and to the north has a higher ratio of permits to WCRs, and this is an expected outcome due to the denser population and presence of municipal water systems in that area. Therefore, simply scaling the count of wells up for each period should be adequate. The number of Permits for wells installed since 1990 is 122% of the number of WCRs for wells in the same period, averaged over the Subbasin (**Table 2**).

Scaling the results up to match the expected number of wells based on the Permits-to-WCRs ratio of 1.22:1 yields 942 wells going dry between 2020 and 2040 (**Table 5a**).

3.2.4 Results of Domestic Well Impacts Analyses for Alternative Dry-Start Climate Scenario

The same analysis was conducted as described above for the GSP Climate Scenario, but instead using an alternative climate sequence for the GSP Implementation Period with more dry years at the beginning of the 20-Year climate sequence. In the alternative analysis scenario, a total of 755 of the 4,822 domestic

wells (from WCRs) analyzed are indicated to have gone dry during years prior to 2020. A total of 1,294 wells are projected to go dry between 2020 and 2039 (**Table 4b**); the analysis suggests 350 dry wells of the total of 1294 occurring during the period 2020-2024. **Table 5b** includes the results for this analysis when scaled up by a multiplier of 1.22 based on the ratio of well permits to WCRs.

3.2.5 Sensitivity Analyses on Potential Domestic Well Impacts

To understand influences from different analysis assumptions and parameters, sensitivity analyses were conducted on a number of aspects of the analysis. These sensitivity analyses evaluated different approaches to evaluating the DTW at well locations over each analysis period (e.g., DTW at end of period vs maximum DTW during analysis period), the required minimum saturation threshold for concluding a well is dry, and different cutoff dates for WCRs included in the analysis.

3.2.5.1 Snapshot of Depth at End of Reporting Period vs. Maximum Depth During Reporting Period

The baseline analysis described above compares domestic well depths to groundwater levels at the end of each Five-Year Update reporting period using the years 2019, 2024, 2029, 2034 and 2039. As noted previously, these baseline analysis periods were selected because the final year of each period aligns with the IM and Five-Year Update reporting periods. However, if the lowest groundwater levels do not align with the end of each analysis period, this method may not capture the full extent of potential impacts on domestic wells.

By choosing analysis period ending years as 2023, 2028, 2033, and 2038, the lowest groundwater levels in each five-year period will typically be captured along with the lowest pre-2020 groundwater levels (generally occurring in 2015 or 2018). Therefore, a separate analysis was performed using the maximum DTW in each five-year period. This analysis results in a small decrease (23 wells) in the total number of wells (749) expected to go dry between 2020 and 2040 compared to the Base Case (**Table 6**). The reason for the decrease of dry well occurrence between 2020 and 2040 is this analysis results in more wells going dry prior to the start of the GSP implementation period in 2020 due to the lowest pre-2020 groundwater levels occurring prior to Fall 2019, (which is the year used in the Base Case to determine well going dry prior to 2020). Therefore, the base case with a greater number of wells going dry between 2020 and 2040 is used for further sensitivity analyses described below because it is a more conservative estimate of dry wells.

3.2.5.2 Minimum Saturation Threshold

The baseline analysis comparing DTW and total well depths included a minimum well saturation threshold that a well is considered dry when the groundwater levels falls below a level less than 10 feet above the bottom of the well. This baseline assumption was based on the expectation that the required saturation in a domestic well is not great because of the generally low pumping rates required for domestic wells. The sensitivity of analysis results for this minimum saturation assumption were evaluated using alternative minimum well saturation levels. Sensitivity to the minimum saturation threshold was tested by varying the parameter (S) and observing the change in the count of wells going dry in each analysis period (**Table 7**).

The number of wells going dry over the period from 2020 to 2039 increases as the minimum saturation threshold is increased from 0 feet to 30 feet and then decreases with greater minimum saturation thresholds (**Figure 15**). The reason for this pattern is that at minimum saturation thresholds exceeding 30 feet, more wells are considered to be going dry before 2020 relative to after 2020 for those greater thresholds (i.e., the threshold applies both before and after 2020). The number of dry wells at the saturation threshold of 10 feet is 772, it increases to 890 at 30 feet, and at 50 feet it declines to 735. This analysis suggests that the number of wells expected to go dry is sensitive to the saturation threshold applied, but the relationship between saturation threshold and number of dry wells predicted after 2019 varies depending on how many wells go dry before 2020. Considering the results of this sensitivity analysis and the previous discussion regarding saturation needed to support typical domestic well pumping rates, the application of a minimum saturation threshold of 10 feet is interpreted to be a reasonable threshold for estimating the potential number of domestic wells that may go dry during the GSP implementation period.

3.2.5.3 WCR Cutoff Dates

The influence on results from varying the earliest year of WCR records used in the dry well analysis was also evaluated. As expected, the average well depths for older wells tend to be shallower than younger wells, likely because of the declining water levels that have occurred in the area and the resulting need to drill to greater depths to ensure reliable water supply. This trend towards deeper wells is illustrated in a comparison of the average total well depths for WCRs since 1970 and those since 1990, as presented in **Table 3.**

The changes in the numbers of total wells analyzed and the resulting numbers of dry wells drop as the cutoff date for WCRs is increased. The change from a WCR cutoff year of 1970 to 1975 has minimal (less than 10 percent) impact on all counts, but as this cutoff date in increased further the dry well count drops faster than the total well count (**Table 8**). The implication of this trend is that as the WCR cutoff date is moved forward in time from 1970, older wells that would be counted as going dry are not included in the analysis, resulting in a smaller number of wells predicted to go dry. Although many wells constructed since 1970 likely are no longer in existence or actively use, the 1970 WCR cutoff date provides an appropriately conservative estimate of wells predicted to go dry during the implementation period.

3.2.6 Potential Replacement Costs for Wells Impacted

The potential costs for addressing domestic well issues were evaluated in some detail. These costs were largely based on discussions with drillers who install domestic wells and replace pumps on a regular basis. These costs are summarized in **Table 9**, and include lowering a domestic well pump ($1,000 to $2,000), replacing a domestic well pump ($5,000 to $7,000), and drilling/installing a new domestic well to replace an existing well ($25,000 to $35,000). Estimates of total costs for a Domestic Well Mitigation Program were based on estimates of total number of dry wells expected to occur between 2020 and 2039, with WCRs scaled to the number of County well permits and considering both the GSP climate scenario and the alternative dry-start climate scenario for the GSP Implementation Period.

3.2.7 Updated Economic Analysis

As described in the Introduction, **Attachment 1** (Domestic Well Replacement Economic Analysis) incorporates updated estimates provided in this TM for the number of dry domestic wells into an economic analysis intended to replace Appendix 3.D of the Madera Subbasin GSP with newer information. The economic analysis evaluated the difference in costs for implementing a Domestic Well Mitigation Program concurrent with gradual reductions in groundwater pumping over a twenty-year period vs. not having a Domestic Well Mitigation Program and immediately implementing demand management and other PMAs to eliminate the overdraft in the subbasin to avoid significant and unreasonable adverse impacts on domestic well users. The overall conclusion remains consistent with the GSP: the cost of implementing a Domestic Well Mitigation Program is significantly less than the alternative.

3.3 Public Water System Wells

PWS wells data are maintained by the State Water Resources Control Board Division of Drinking Water in the Safe Drinking Water Information System (SDWIS); however, these data are incomplete at this time. In the Madera Subbasin, only 7 PWS wells are listed in SDWIS. Therefore, the WCR database was queried for PWS wells. There were 82 wells drilled in 1970 or later and tagged as "Municipal" or "Public". This discrepancy is due, in part, to the fact that WCRs do not typically distinguish between Public Water Systems and other residential water systems serving more than one household. When a well driller fills out the WCR, the "Municipal" box is checked if the well is to be used for any purpose other than irrigation, industrial processes, or domestic single-household use. These can include PWS wells but can also include Local Small and State Small Water System wells (LSWS and SSWS, respectively), and wells used for drinking water at facilities such as rest stops, churches, schools, and other locations that sometimes are not supplied by a local PWS. The wells identified here are shown in **Figure 16**.

Depth to the bottom of perforated interval ranged from 30 to 1000 feet below ground surface in these wells. Of the 82, 10 were drilled prior to 1970 and are not considered here. These wells were compared to the snapshots of Depth to Water for the model years 2019, 2024, 2029, 2034, and 2039, with the GSP climate scenario. **Table 10** shows the results of this analysis.

Based on the comparison with the modeled depths to groundwater at these 5-year intervals, 10 PWS or other municipal wells are expected to have gone dry by 2020, and another 3 over the implementation period. Further analysis with data provided by individual well-operators would be required to identify specific water systems that are vulnerable.

3.4 Comparison of Estimated Domestic Well Impacts to Online Databases

The estimated numbers and locations of dry wells described in this TM (modeled dry wells) were compared to two available datasets related to reported domestic well supply issues: DWR's Household Water Supply Shortage Reporting System, and Self-Help Enterprises (SHE) Tank Water Program participants (**Attachment 2**). While the assumptions underlying the estimates of modeled dry wells in this TM differ in some regards to the well issues included in these two datasets, the spatial patterns in

modeled dry wells are very similar to the spatial patterns in the DWR and SHE datasets. Overall, the total numbers of modeled dry wells estimated in this TM are greater than the number of well issues included in the DWR and SHE datasets; however, it is likely that not all dry wells have been reported in these other two datasets. More details on the DWR Household Water Supply Shortage Reporting System dataset and the SHE Tank Water Program participants dataset and comparisons of these datasets to modeled dry wells presented in this TM are provided in **Attachment 2**.

4 PRIORITIZATION OF AREAS FOR ADDITIONAL MONITORING

Expansion of the monitoring network is important for areas of the Subbasin with higher densities of domestic drinking water wells. In addition, the dry well analysis performed above was used as a guide to locating areas that should be more closely monitored. The monitoring network should consider the presence of vulnerable populations, such as those reliant on groundwater and DAC/SDAC areas. Another key variable was to consider the locations of existing nested monitoring wells installed recently at seven locations throughout the Madera Subbasin.

The domestic well inventory analysis conducted for this study illustrates that domestic wells are most concentrated along and east of Highway 99, and that dry domestic wells are predicted to be most prevalent east of Highway 99. There are two existing nested monitoring wells located along Highway 99 in the northern portion of Madera Subbasin and one nested monitoring well located east of Highway 99 about mid-way between the eastern subbasin boundary and Highway 99 in the northern portion of Madera Subbasin. The two most dense clusters of domestic wells occur east of Highway 99 along Avenue 21 (Valley Lake Ranchos and Lake Madera Country Estates) and immediately south of Highway 145 (Madera Ranchos area). These are considered primary areas for siting of new nested monitoring wells (**Figure 17**). Four secondary areas for potential consideration of monitoring well siting were also identified in areas of significant but less dense domestic well clusters; these locations would fill gaps between existing nested monitoring wells and improve overall spacing and density of nested well monitoring sites in Madera Subbasin.

5 REFERENCES

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6 TABLES

Table 1. Summary of domestic well WCRs by decade.

WCR Date Range	WCRs in Date Range	Cumulative WCRs since Beginning of Date Range
Pre-1950	1	4721 (4986)
1950-1959	57	4720 (4985)
1960-1969	106	4663 (4928)
1970-1979	614	4557 (4822)
1980-1989	762	3943 (4208)
1990-1999	1323	3181 (3446)
2000-2009	1444	1858 (2123)
2010-2019	381	414 (679)
2020-Plus	33	33 (298)
Unknown	265	(265)

Table 2. Comparisons between different estimation methods.

	WCR (Installed Since 1970)	WCR (Installed Since 1990)	Permits (Records back to 1990)	Parcels	Census
Total Domestic Well Count or Estimate	4822	3446	4210	5898	7205
Domestic Well Count Excluding Wells Located within Water System Boundaries	4263	3099	3877	5898	7205
Domestic Well Count Inside Water System Boundaries	559	347	333	0 (parcels within WS excluded)	0 (blocks within WS excluded)
Domestic Well Percent of WCR-Based Count (1990-plus)			122%	138%	169%
With Depth Recorded	4522 (94%)	3249 (94%)	0	0	0
Location Precision	Varies	Varies	Parcel	Parcel	Census Block

Table 3. Relative Similarity Between Wells Recorded Since 1970 and Those Recorded Since 1990.

	Count of WCRs within the Madera Subbasin		1990 Set Percent of 1970 Set
	Since 1970	Since 1990	
Total Count	4822	3446	71%
Count within PWS	559	347	62%
Count Outside of PWS	4263	3099	73%
Count with Total Depth	4522	3249	72%
Average Total Depth	341 feet	365 feet	n/a

Table 4a. Summary of Dry Wells for Base Case. Wells drilled in 1970 or later, based on snapshot of depth to groundwater at end of period. Assumes 10 feet of well saturation above bottom of screen.

Year Range	New Wells Drilled	Total Wetted Wells Year Start	**Wells Going Dry**	Total Wetted Wells Year End	Sum Of Dry Wells
2020 to 2024	97	4083	**287**	3796	287
2025 to 2029	0	3796	**152**	3644	439
2030 to 2034	0	3644	**333**	3311	772
2035 to 2039	0	3311	**0**	3311	772
During the period 1989 to 2019, prior to the implementation period, the model suggests 739 wells went dry.				Total	**772**

Table 4b. Summary of Dry Wells for Dry Start Case. Wells drilled in 1970 or later, based on snapshot of depth to groundwater at end of period. Assumes 10 feet of well saturation above bottom of screen.

Year Range	New Wells Drilled	Total Wetted Wells Year Start	**Wells Going Dry**	Total Wetted Wells Year End	Sum Of Dry Wells
2020 to 2024	97	4083	**350**	3717	350
2025 to 2029	0	3796	**834**	2883	1184
2030 to 2034	0	3644	**110**	2773	1294
2035 to 2039	0	3311	**0**	2773	1294
During the period 1989 to 2019, prior to the implementation period, the model suggests 755 wells went dry.				Total	1294

Table 5a: Adjusted estimates of dry wells for Base Case based on WCRs since 1970 upscaled using ratio of permits to WCRs (1.22).

Year Range (Oct 31st Minimums)	New Wells Drilled	Total Wetted Wells Year Start	**Wells Going Dry**	Total Wetted Wells Year End	Sum Of Dry Wells
2020 to 2024	118	4981	350	4631	350
2025 to 2029	0	4631	185	4446	536
2030 to 2034	0	4446	406	4040	941
2035 to 2039	0	4040	0	4040	941
During the period 1989 to 2019, prior to the implementation period, the model suggests 902 wells went dry.				Total	**941**

Table 5b: Adjusted estimates of dry wells for Dry Start Case based on WCRs since 1970 upscaled using ratio of permits to WCRs (1.22).

Year Range (Oct 31st Minimums)	New Wells Drilled	Total Wetted Wells Year Start	**Wells Going Dry**	Total Wetted Wells Year End	Sum Of Dry Wells
2020 to 2024	118	4962	427	4535	427
2025 to 2029	0	4535	1017	3518	1443
2030 to 2034	0	3518	134	3384	1578
2035 to 2039	0	3384	0	3383	1578
During the period 1989 to 2019, prior to the implementation period, the model suggests 921 wells went dry.				Total	1578

Table 6: Dry Well Summary Based on Snapshots of Groundwater Depth at End of Periods ending in 2015, 2018, 2023, 2028, 2033, and 2038.

Year Range (Oct 31st Minimums)	New Wells Drilled	Total Wetted Wells Year Start	**Wells Going Dry**	Total Wetted Wells Year End	Sum Of Dry Wells Based on 5-Year Minimum
2019 to 2023	150	4015	**248**	3767	248
2024 to 2028	0	3767	**167**	3600	415
2029 to 2033	0	3600	**334**	3266	749
2034 to 2038	0	3266	**0**	3266	749
During the period 1989 to 2018, prior to the period described in this table, the model suggests 807 wells went dry.				Total	749

Table 7: Effect of Varying Saturation requirement on Dry Well Counts.

Saturation Setting	Dry Wells Total After 2019
0	539
10	605
20	642
30	682
40	625
50	569
60	543
70	554
80	518
90	394
100	325

Table 8: Effect of Varying Minimum Installation Year on Counts of Wells and Dry Wells.

Well Counts	Earliest Installation Year						
	1970	1975	1980	1985	1990	1995	2000
Total Count of WCRs in Comparison	4822	4690	4208	3972	3446	2625	2123
Fraction of 1970 (Total Count of Wells)	1.00	0.97	0.87	0.82	0.71	0.54	0.44
Total Count of Dry Wells	1511	1444	1289	1198	1001	711	534
Fraction of 1970 (Dry Wells)	1.00	0.96	0.85	0.79	0.66	0.47	0.35
Count of Dry Wells Prior to 2020	739	688	580	518	396	251	186
Fraction of 1970 (Dry Prior to 2020)	1.00	0.93	0.78	0.70	0.54	0.34	0.25
Count of Dry Wells from 2020 to 2039	772	756	709	680	605	460	348
Fraction of 1970 (Dry Wells 2020 to 2039)	1.00	0.98	0.92	0.88	0.78	0.60	0.45

Table 9: Summary of Domestic Pump and Well Costs.

Issue	Type of Problem	Solution	Related to GSP	Typical Cost
Water level in well below pump setting depth	**Pump**	**Lower Pump**	**Yes/No**	**$1,000 to $2,000**
Pump not working (old age or pump-related issue)	**Pump**	**Replace Pump and Equipment**	**No**	**$5,000 to $7,000**
Well casing/screen failure (due to old age)	**Well**	**Replace Well**	**No**	**$25,000 to $35,000**
Water level below bottom of well	**Aquifer**	**Replace Well**	**Yes**	**$25,000 to $35,000**

Table 10: PWS and other Municipal Wells - Dry Well Summary Based on Snapshots of Groundwater Depth at End of Periods ending in 2019, 2024, 2029, 2034, and 2039.

Year Range (Oct 31st Minimums)	New Wells Drilled	Total Wetted Wells Year Start	**Wells Going Dry**	Total Wetted Wells Year End	Sum Of Dry Wells
2020 to 2024	1	62	2	60	2
2025 to 2029	0	60	0	60	2
2030 to 2034	0	60	1	59	3
2035 to 2039	0	59	0	59	3.
During the period 1989 to 2019, prior to the implementation period, the model suggests 10 wells went dry.				Total	3

7 FIGURES

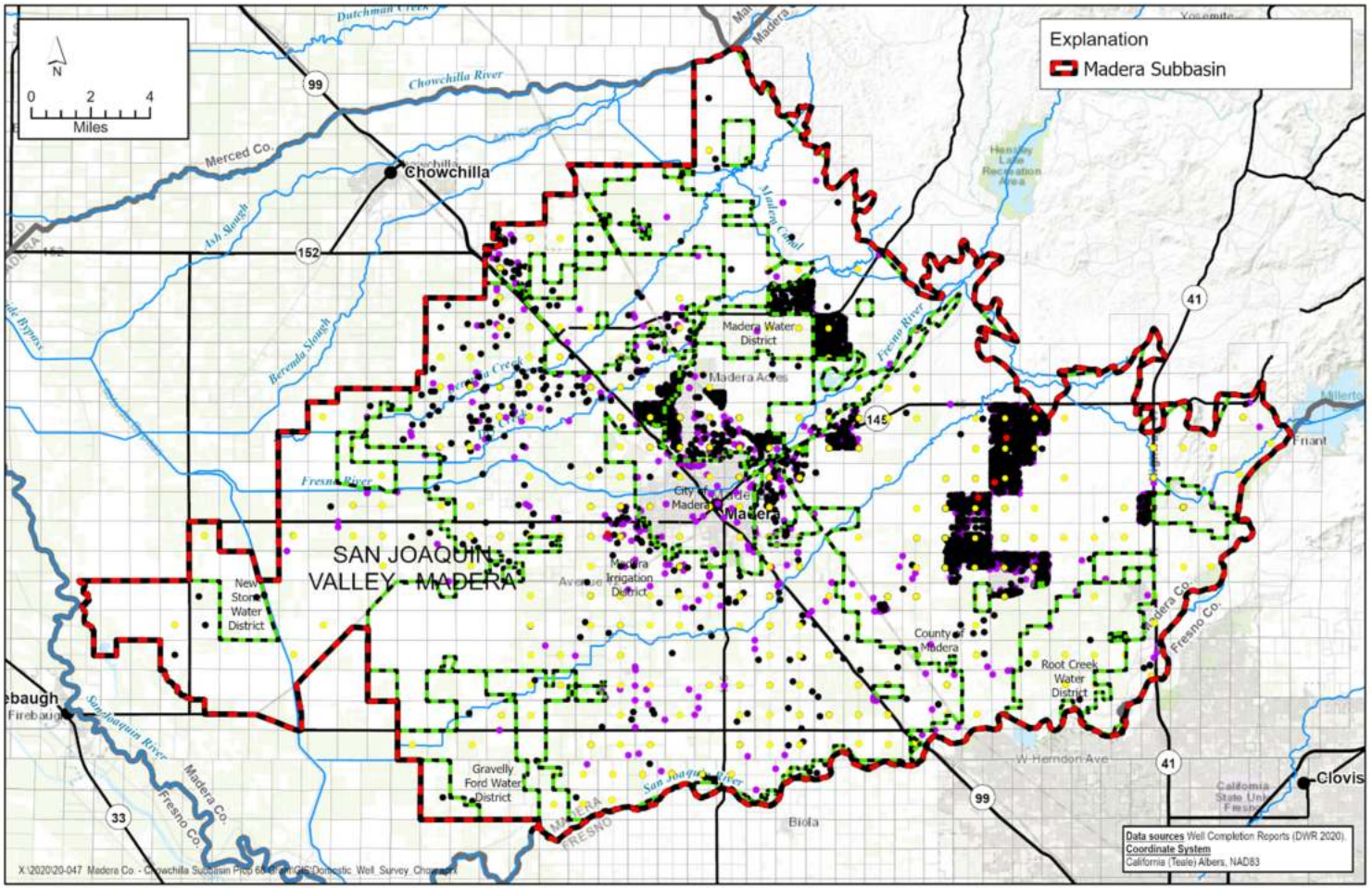


Figure 1a. Well Permits for new construction domestic wells located by best available method.

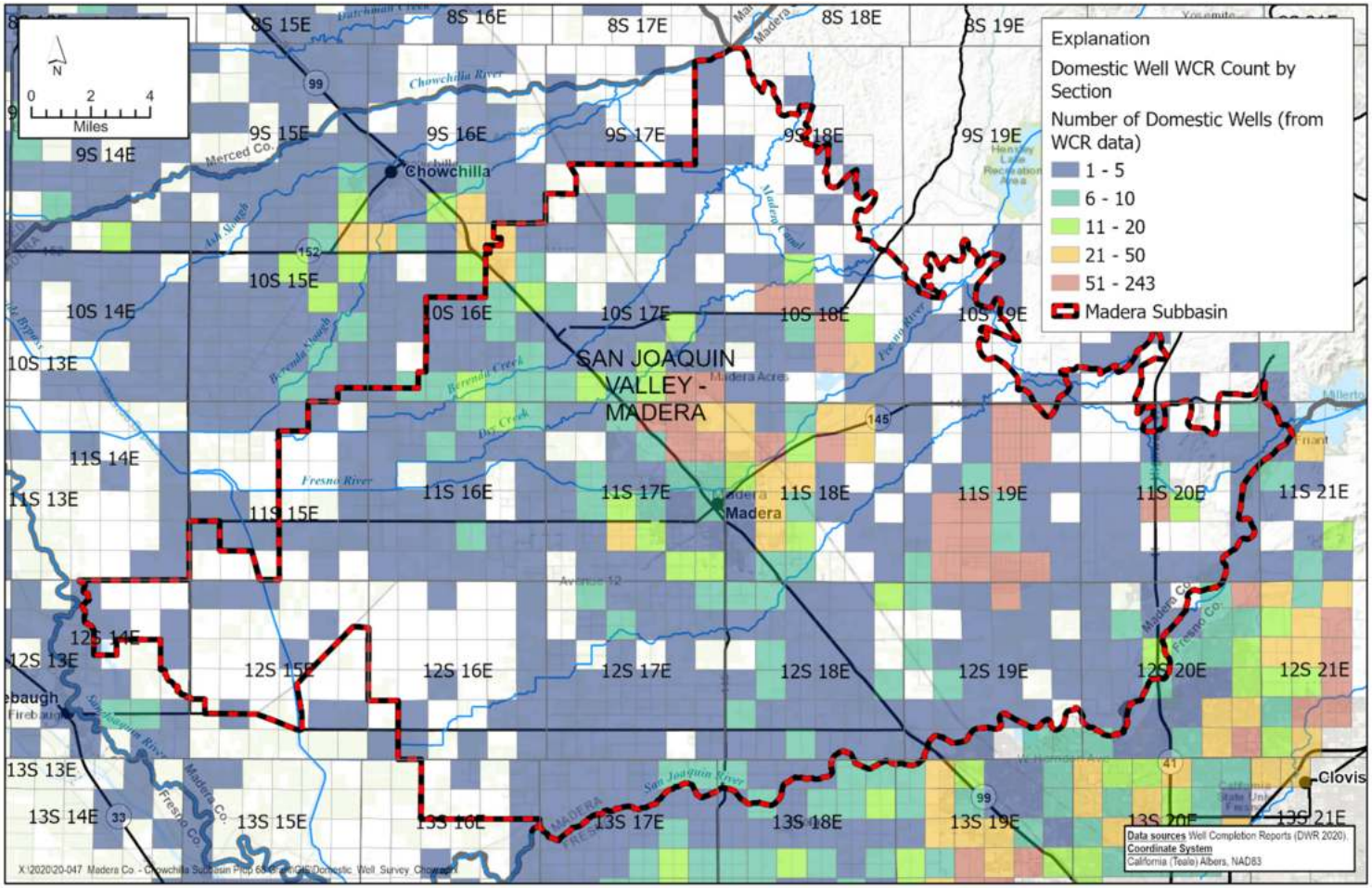


Figure 1b. Well Completion Report new construction domestic well counts by Section.

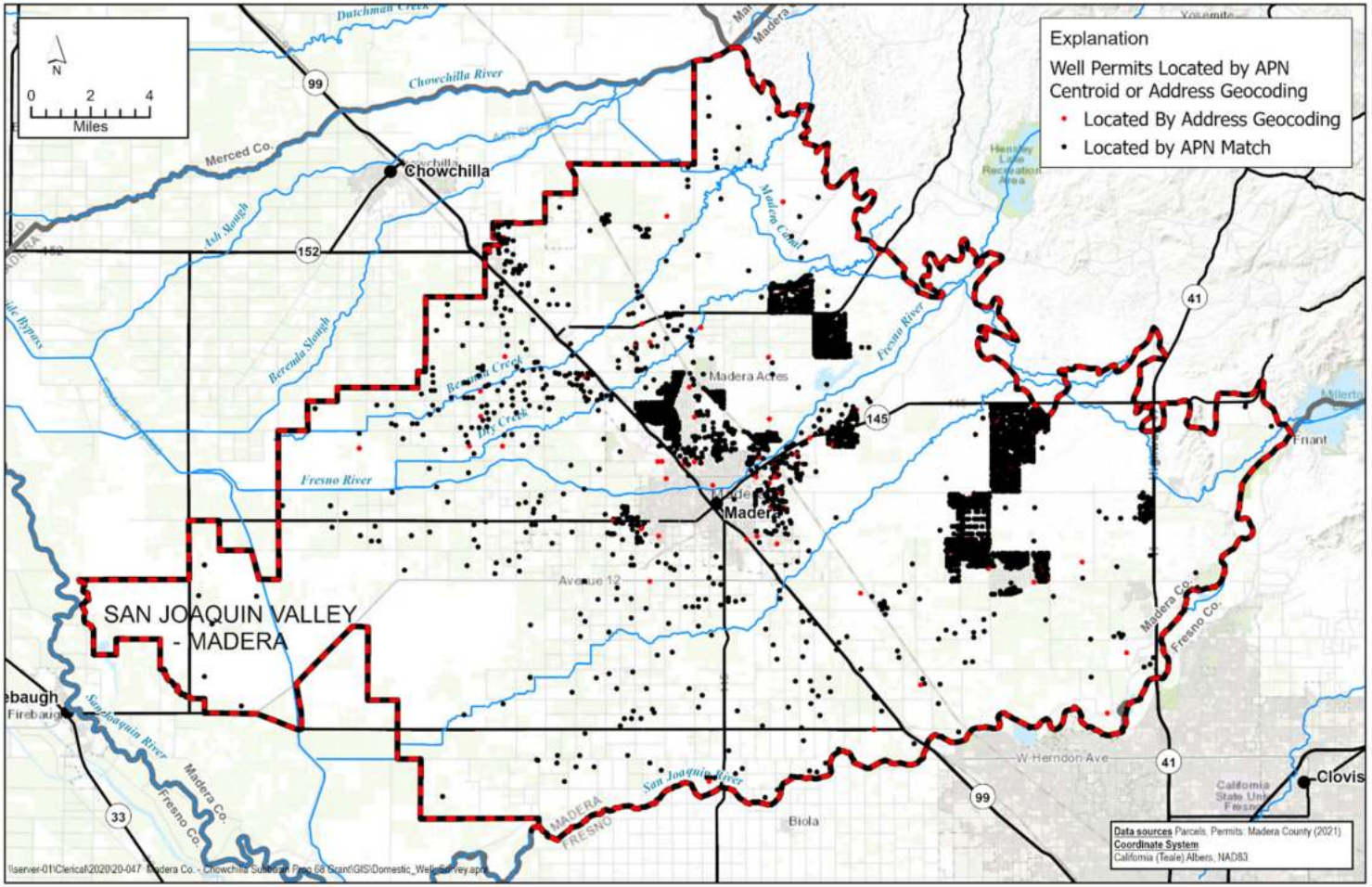


Figure 2a: Permit locations and geolocation method in Madera Subbasin.

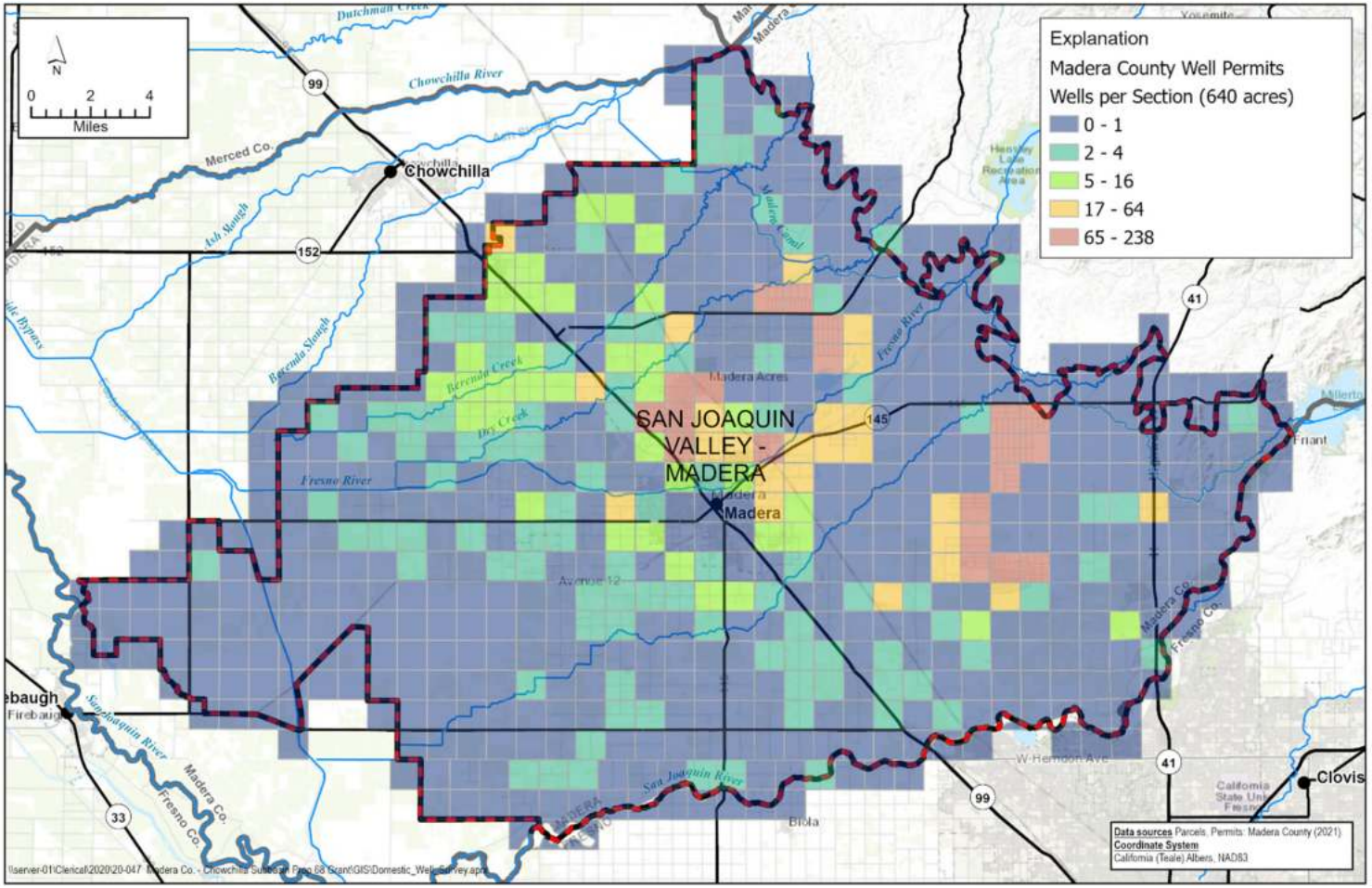


Figure 2b. Permit location counts by Township/Range/Section.

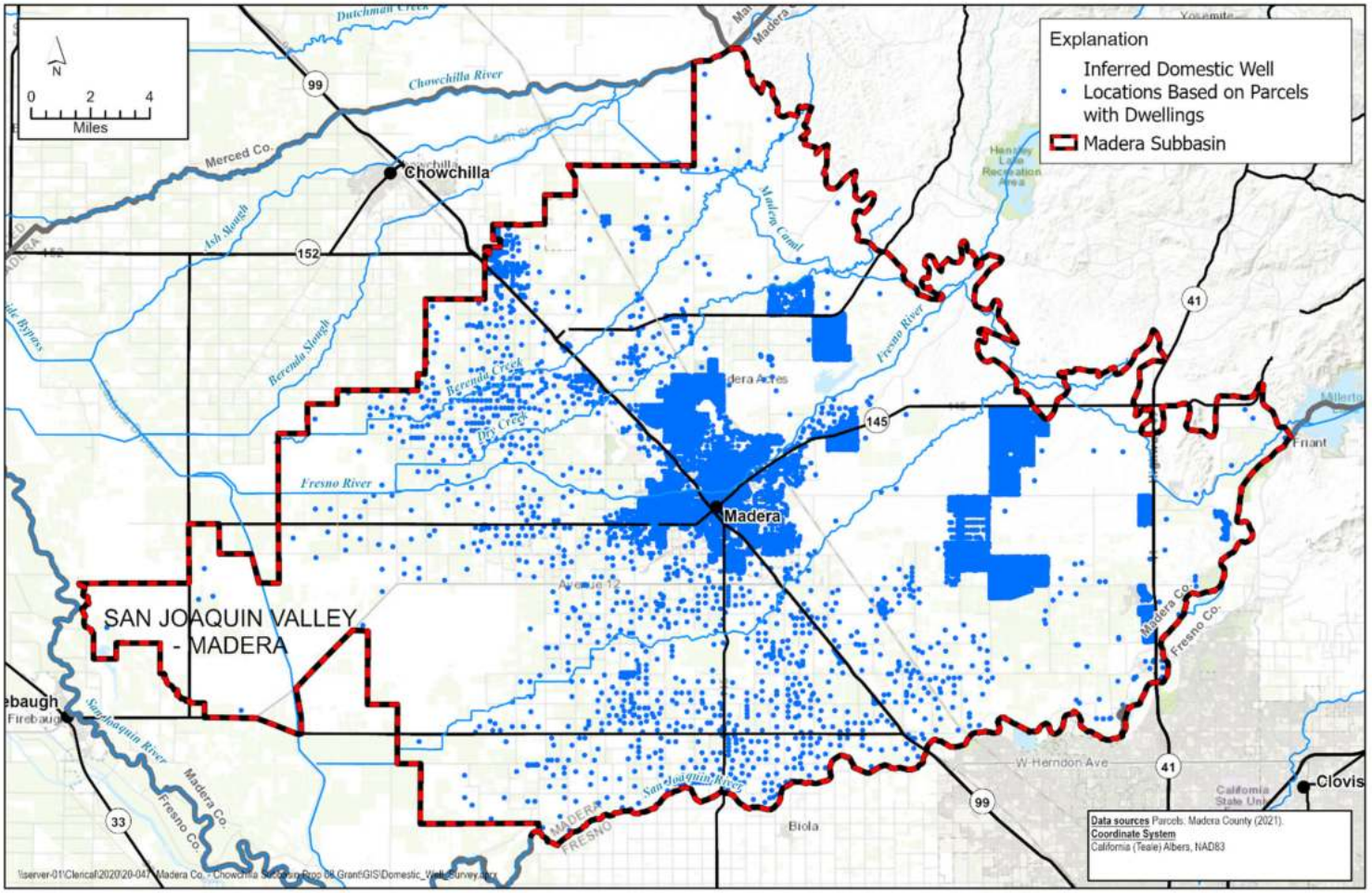


Figure 3: Inferred well locations based on Parcel Dwelling Status.

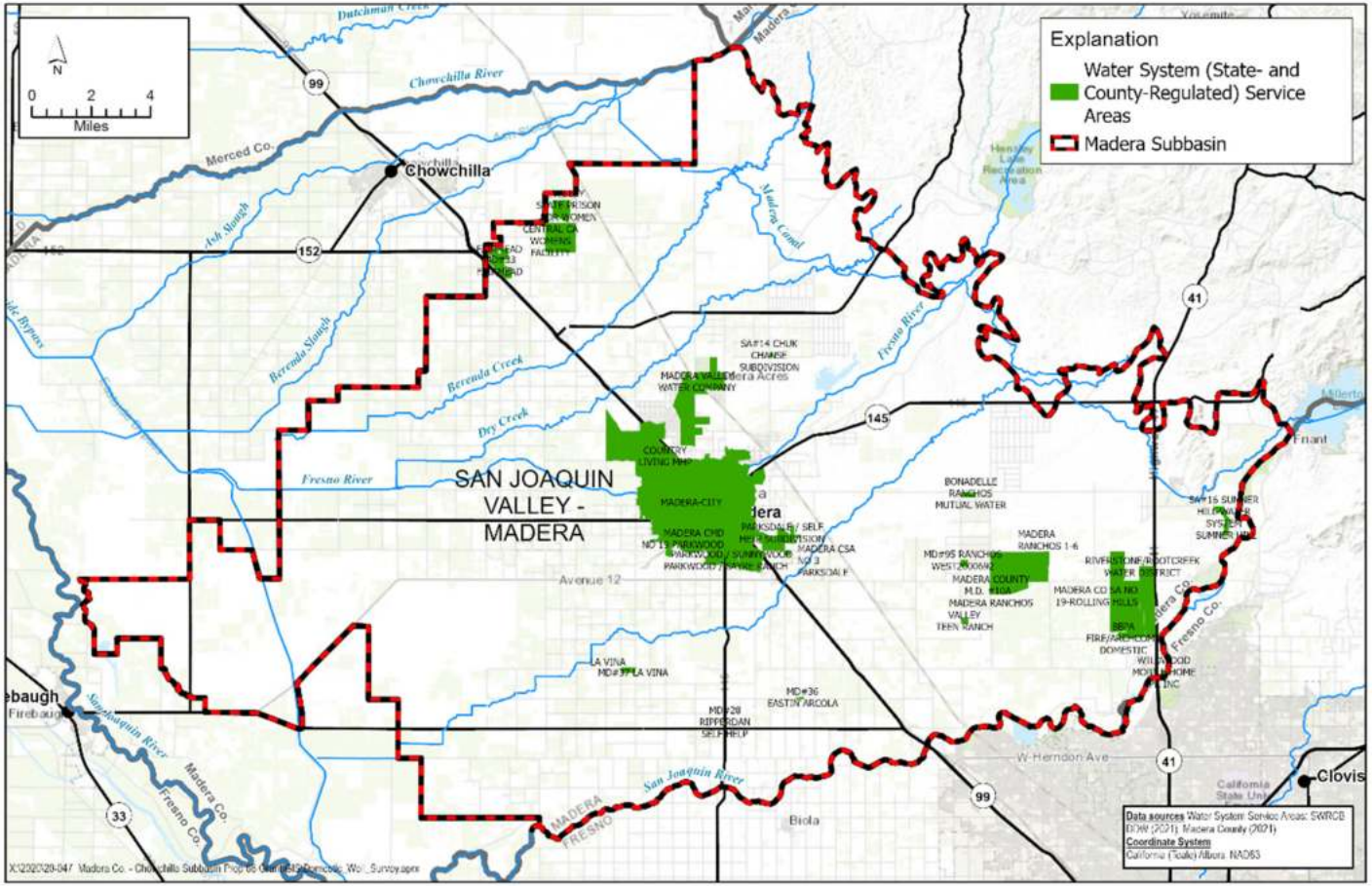


Figure 4: Water System Boundaries in Madera County.

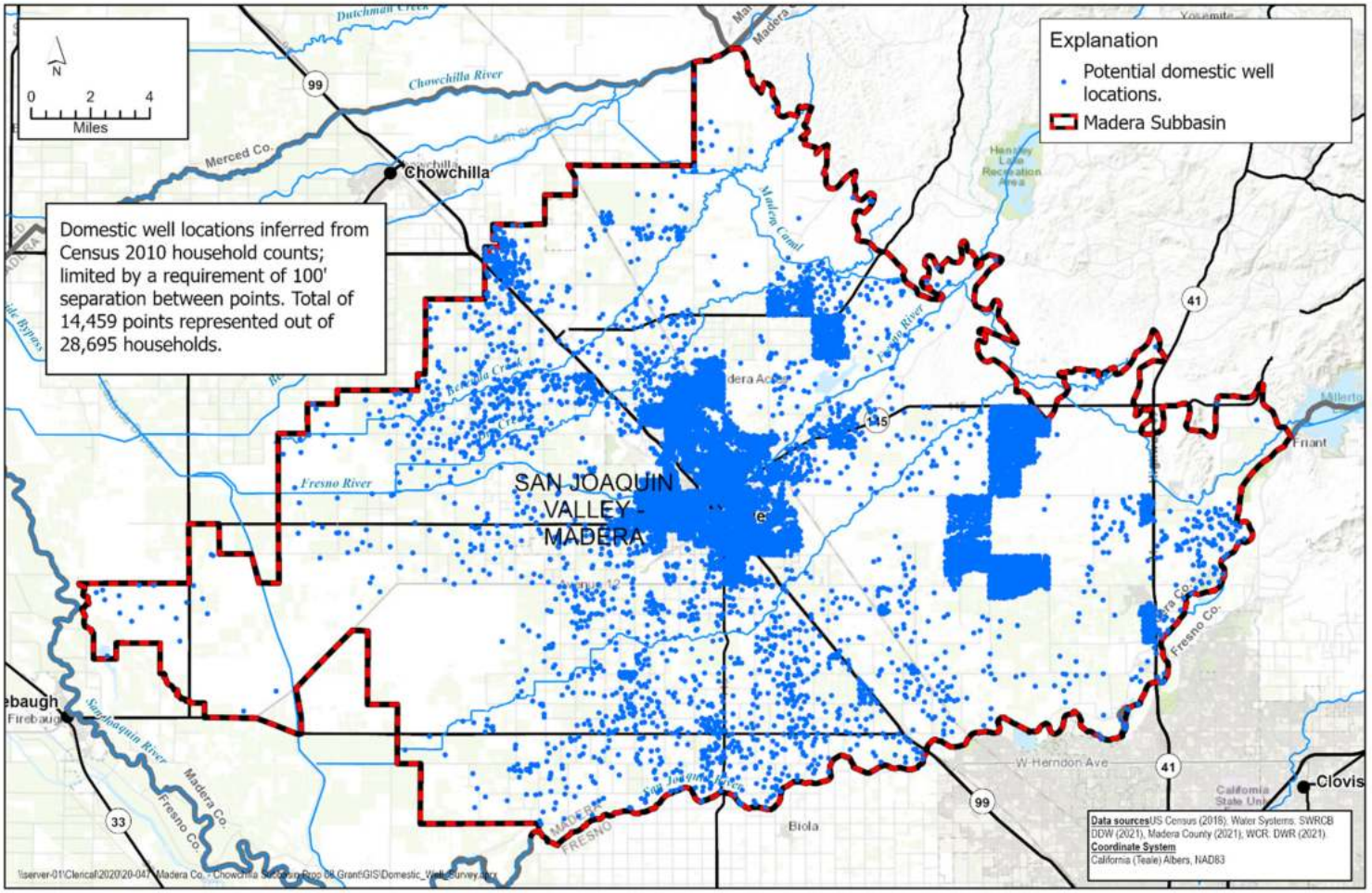


Figure 5: Inferred well locations based on 2010 Census Household counts.

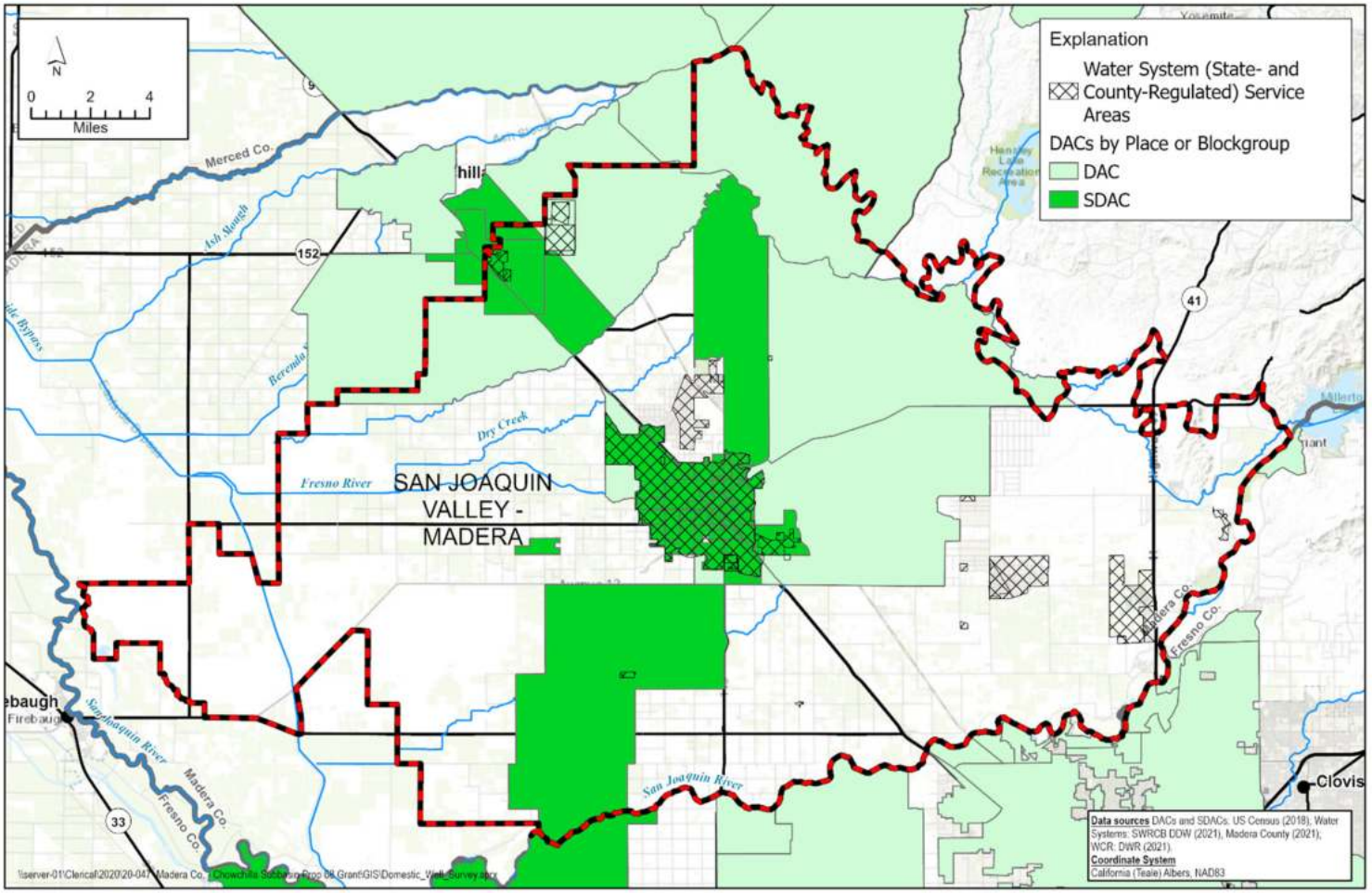


Figure 6: DACs and SDACs in the Madera Subbasin.

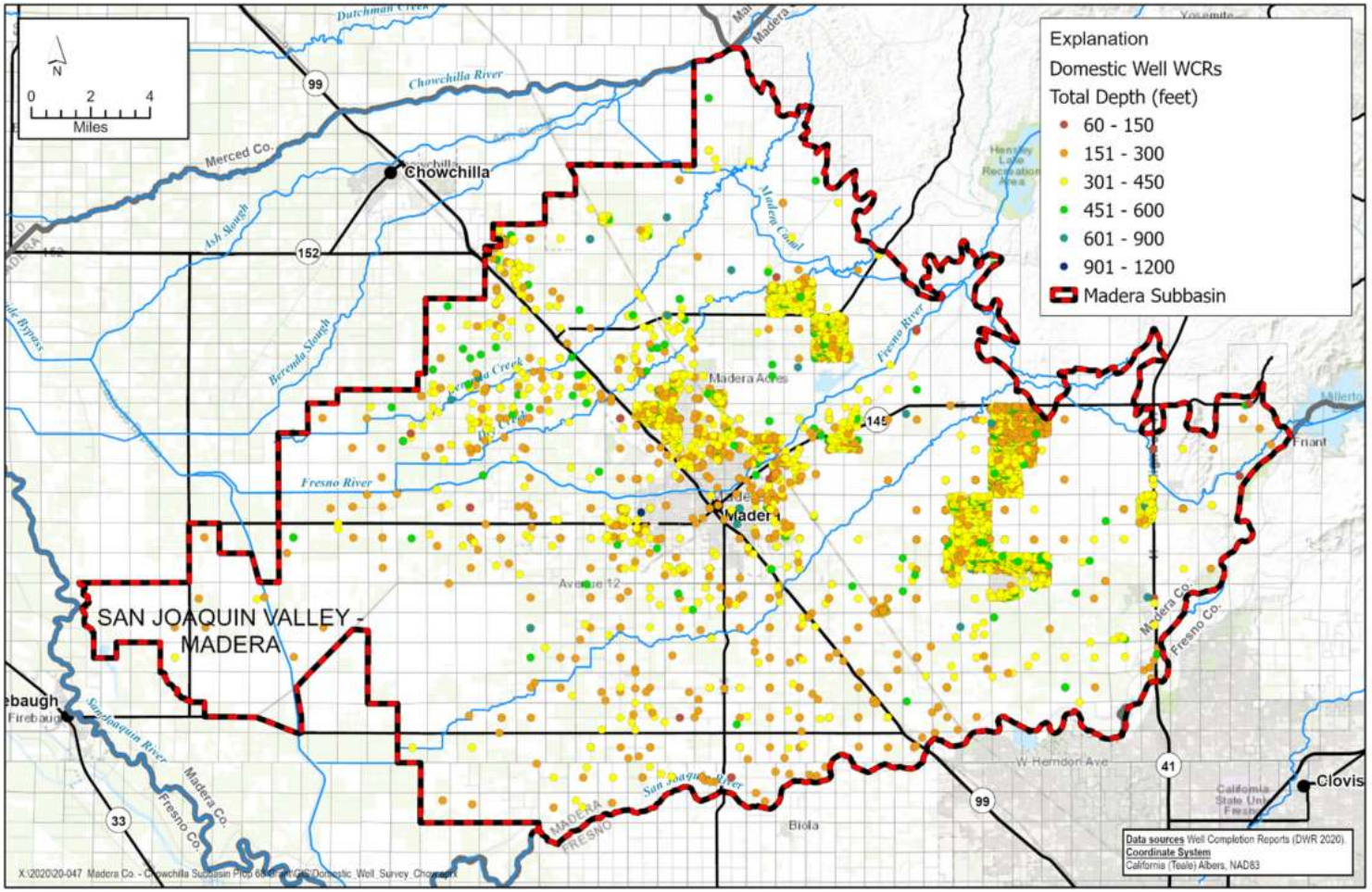


Figure 7a: Domestic wells in Madera Subbasin with depth from WCR.

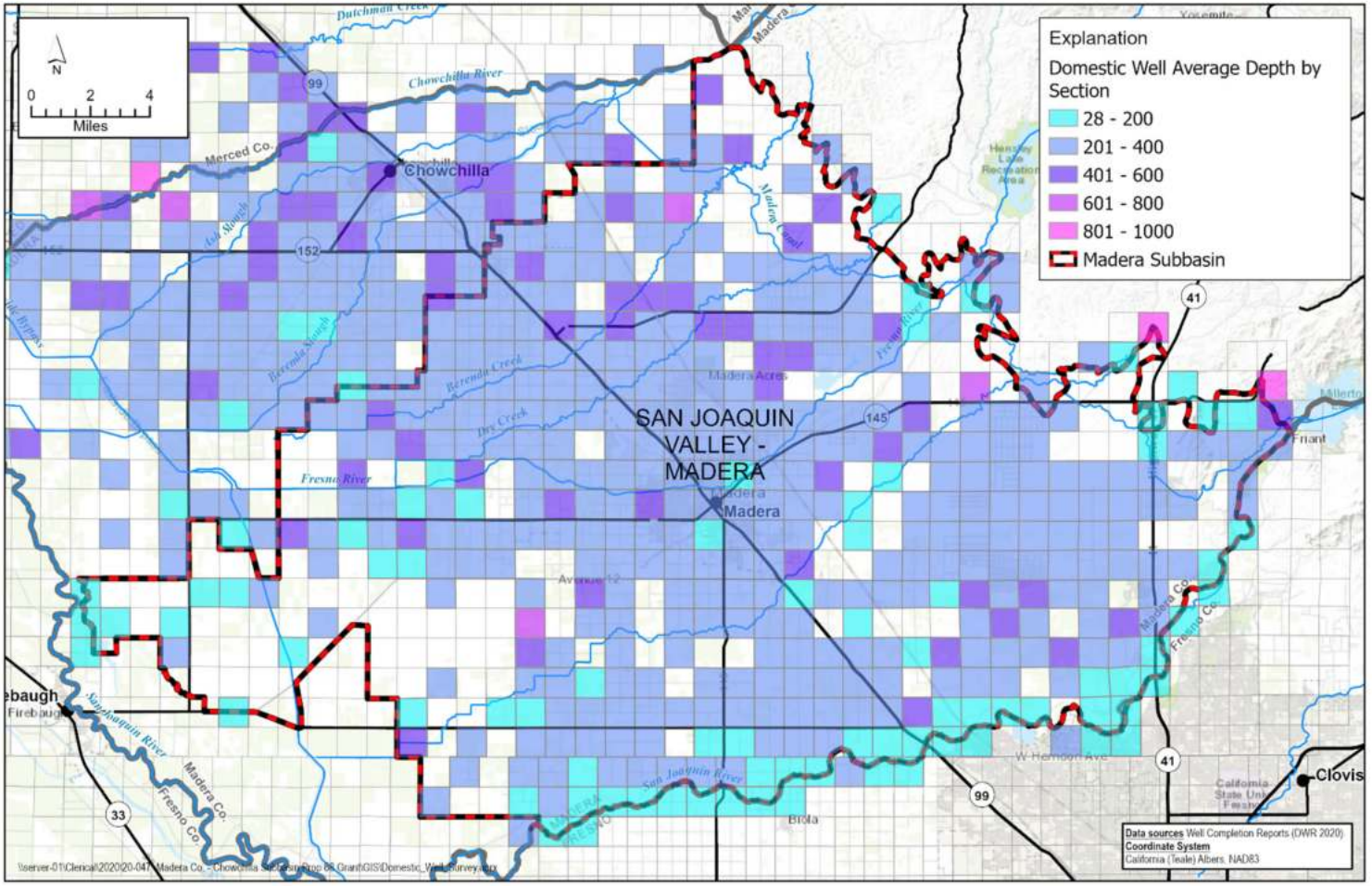


Figure 7b. Domestic Wells in Madera Subbasin with Average Depth by Township/Range/Section.

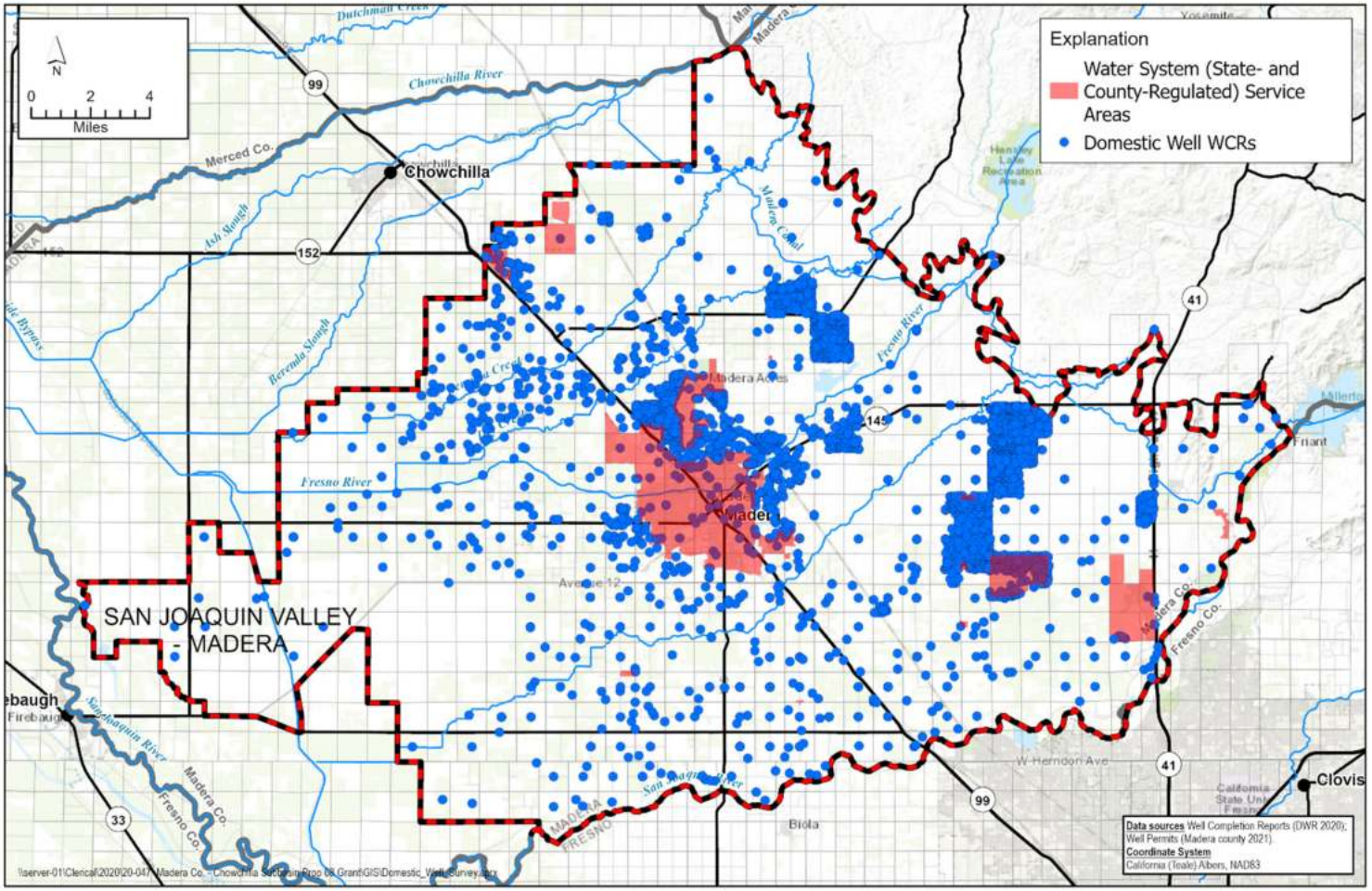


Figure 8: Domestic WCRs compared with Community PWS, County Maintenance Districts, and Community Service Areas.

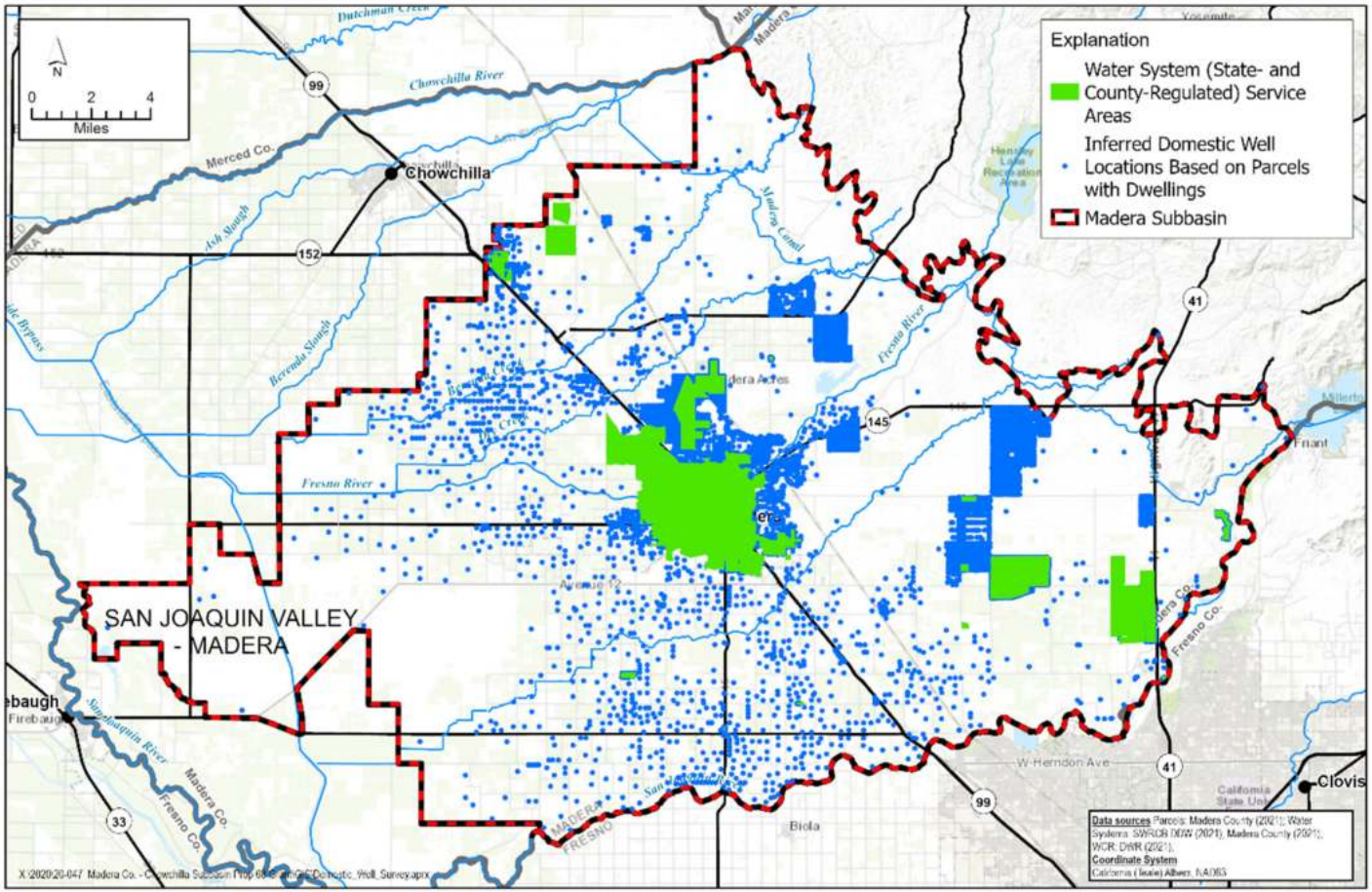


Figure 9: Parcels with Dwellings as Inferred Well Locations. With Community PWS, County Maintenance Districts, and Community Service Areas.

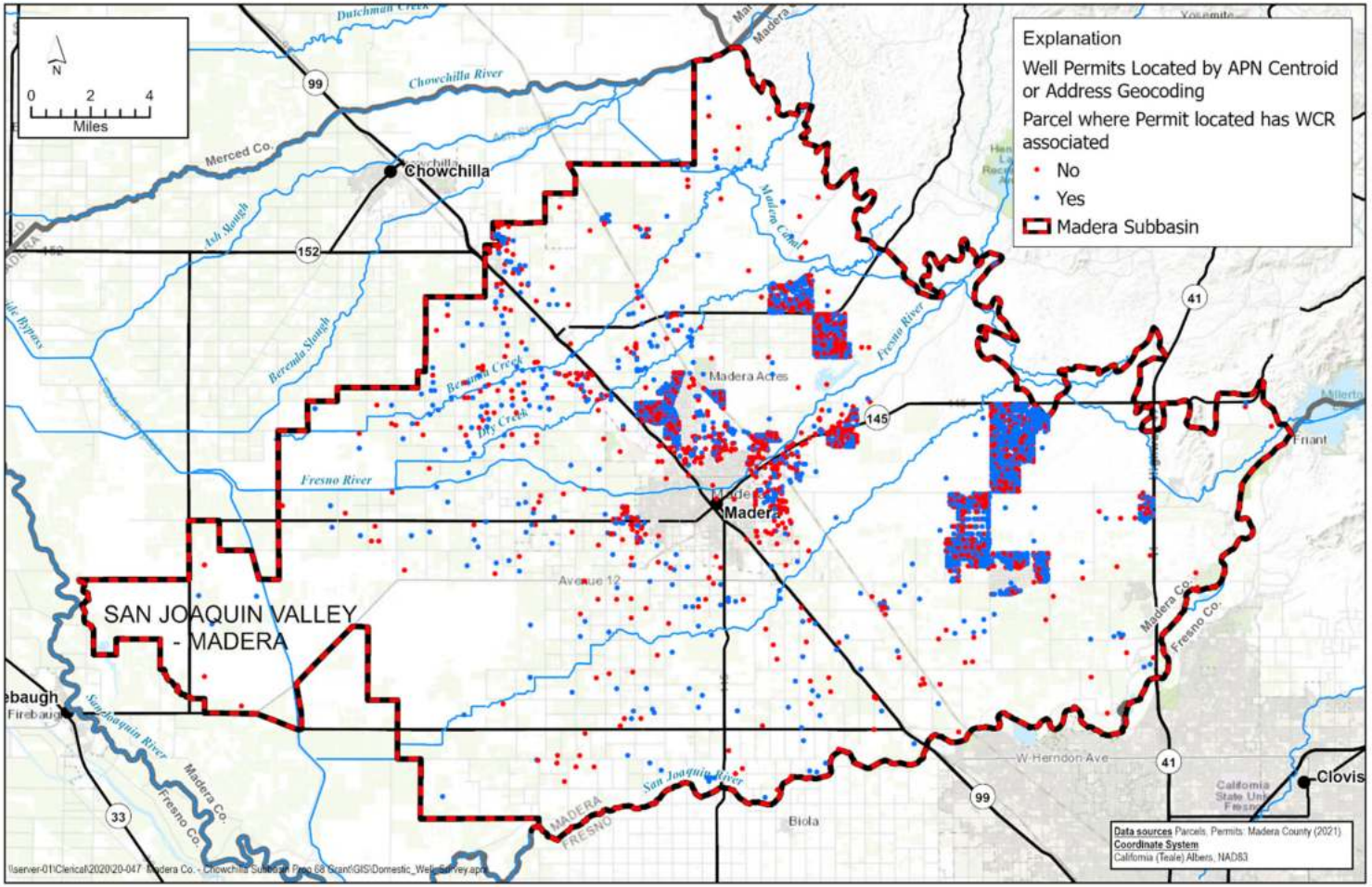


Figure 10: Permit locations with colocated WCRs.

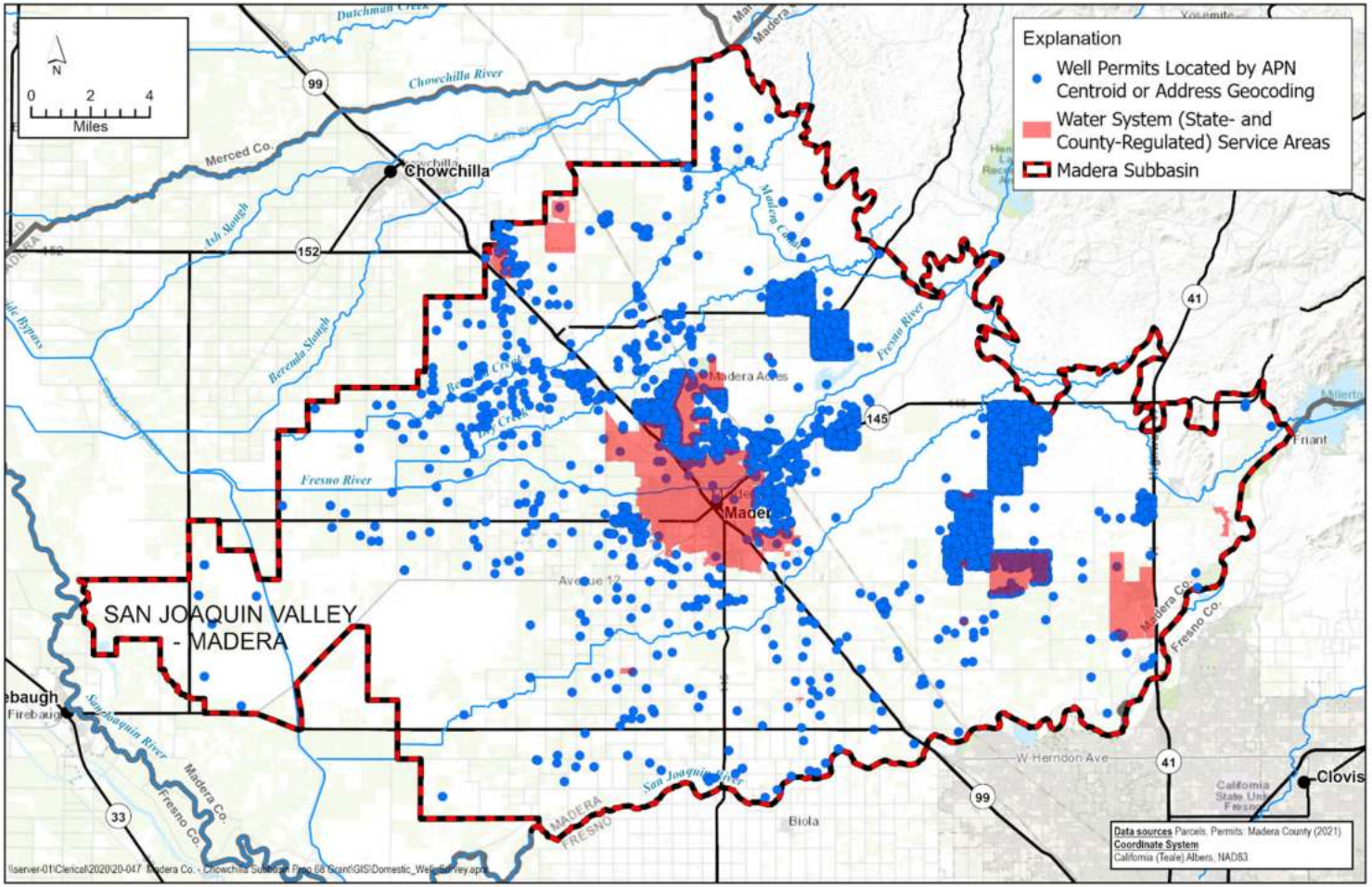


Figure 11a: Domestic Well Permits Compared with PWS, Community Service Districts and County Maintenance Districts.

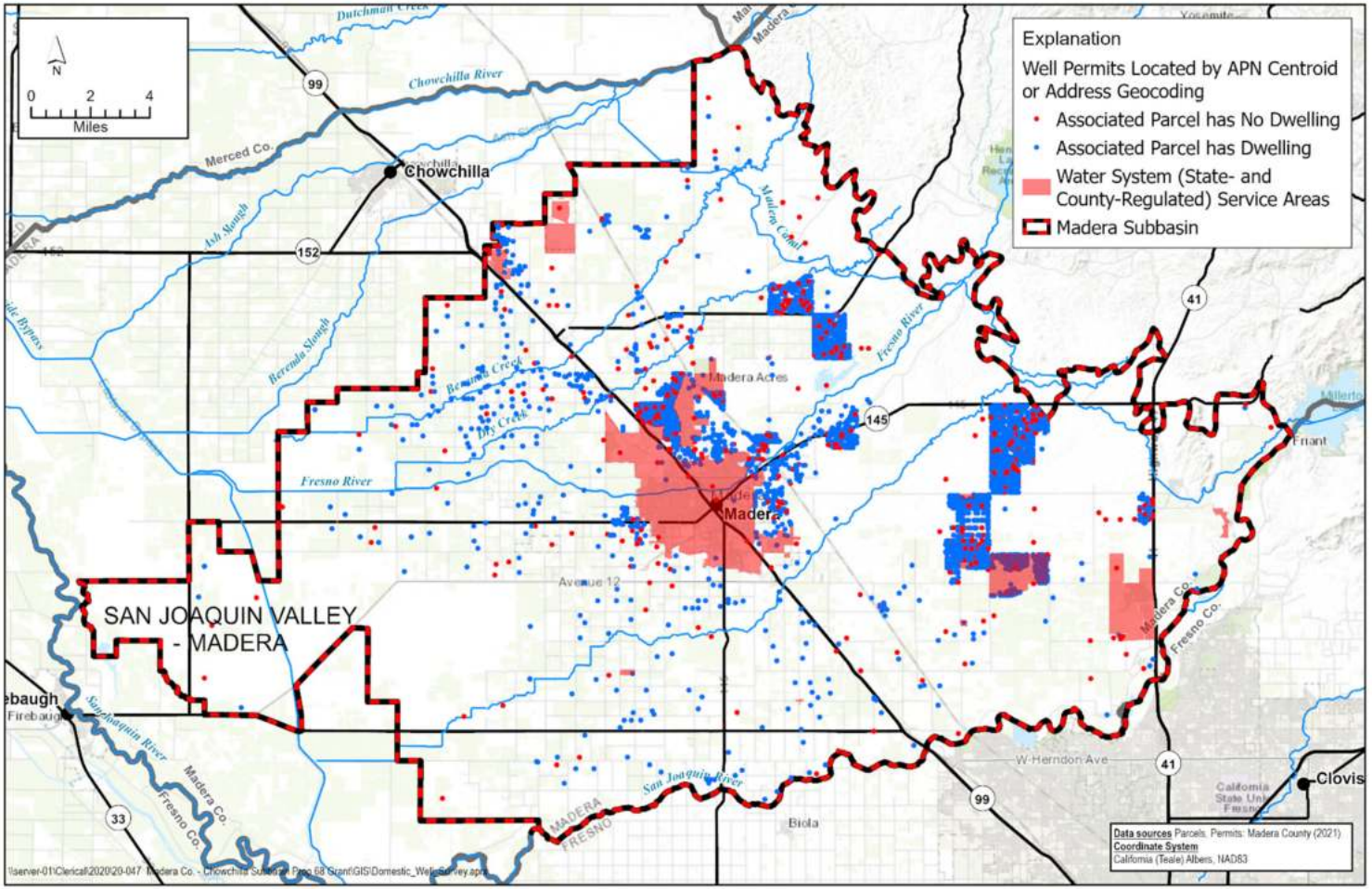


Figure 11b: Domestic Well Permits Compared with Parcel Characteristics.

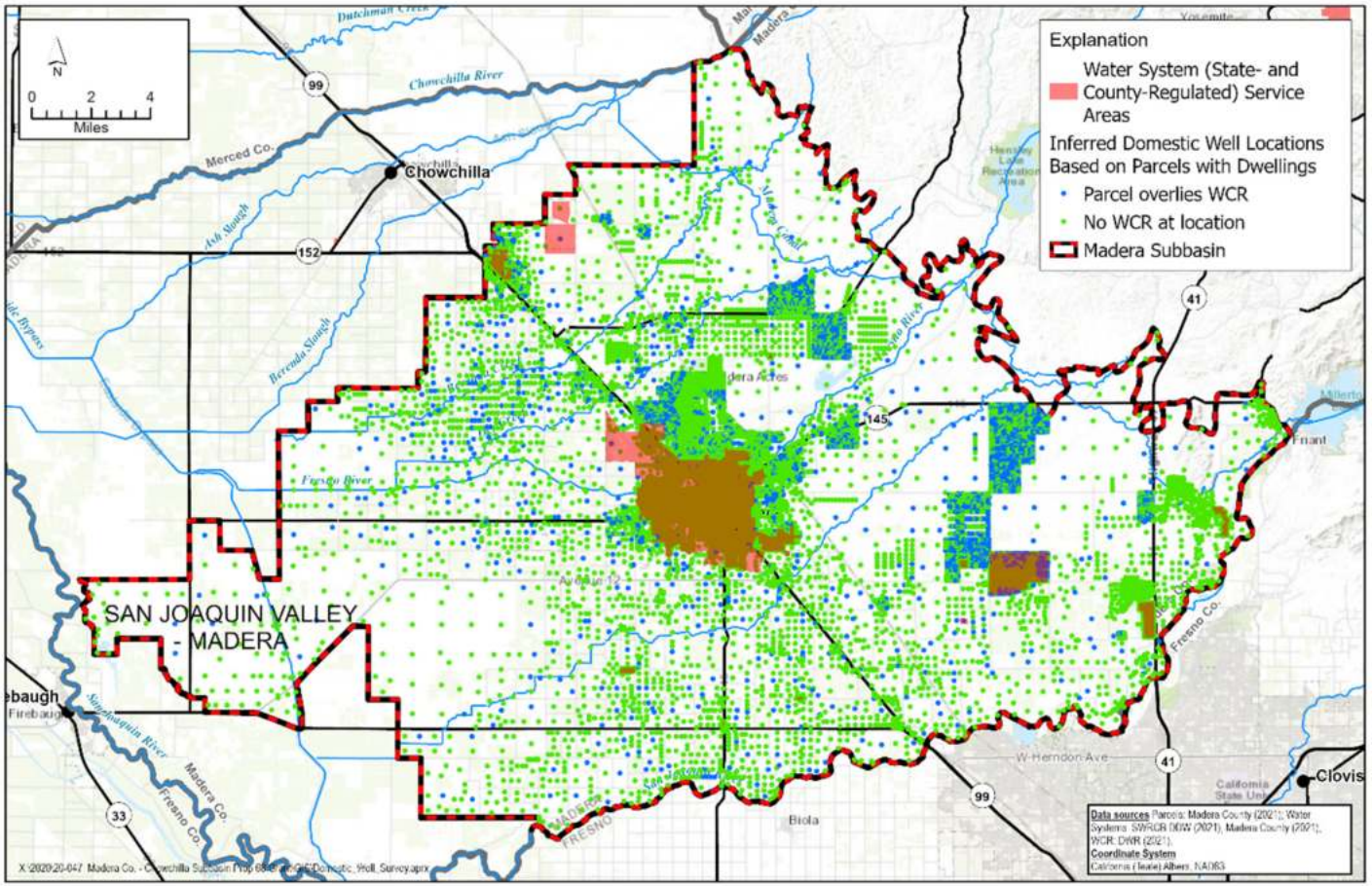


Figure 12: Inferred Domestic Well locations based on Parcels with Dwellings, with Water Systems and presence/absence of WCRs on parcel.

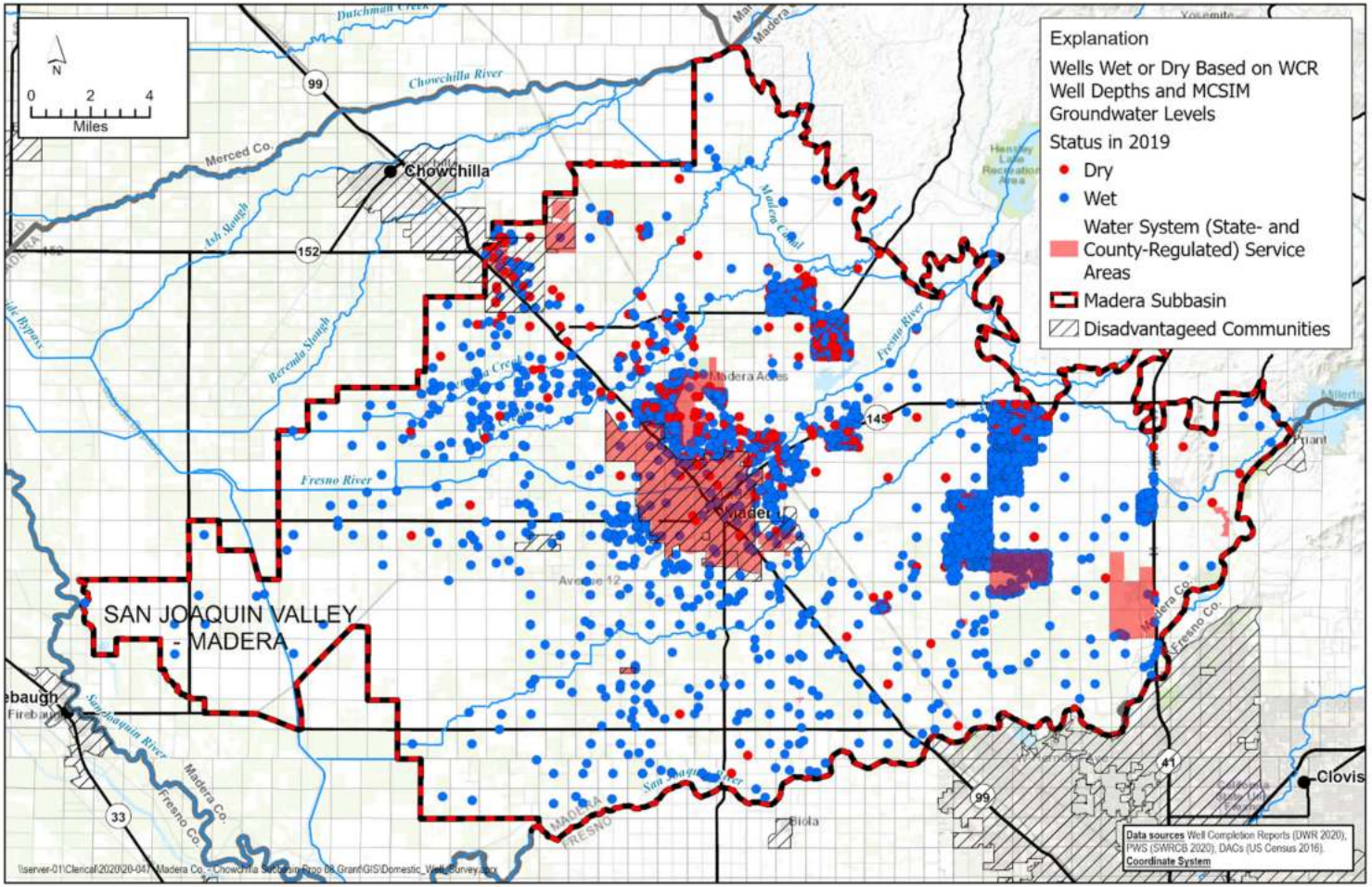


Figure 13a: Status of domestic wells in 2019 - Based on WCR well depths and locations compared to MCSIM groundwater depths.

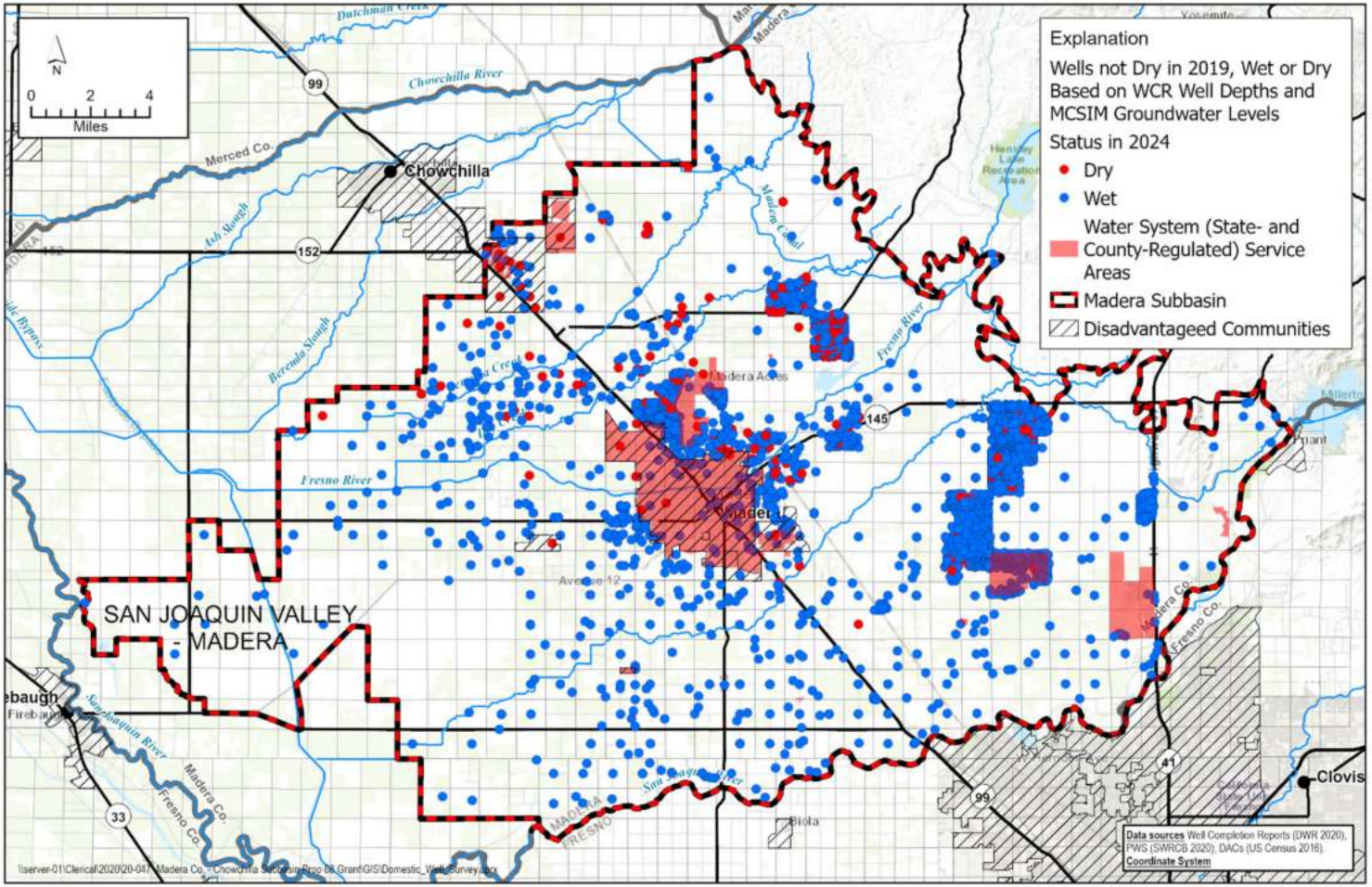


Figure 13b: Status of Wells in 2024 - Based on WCR Well Depths and Locations Compared to MCSIM Groundwater Depths.

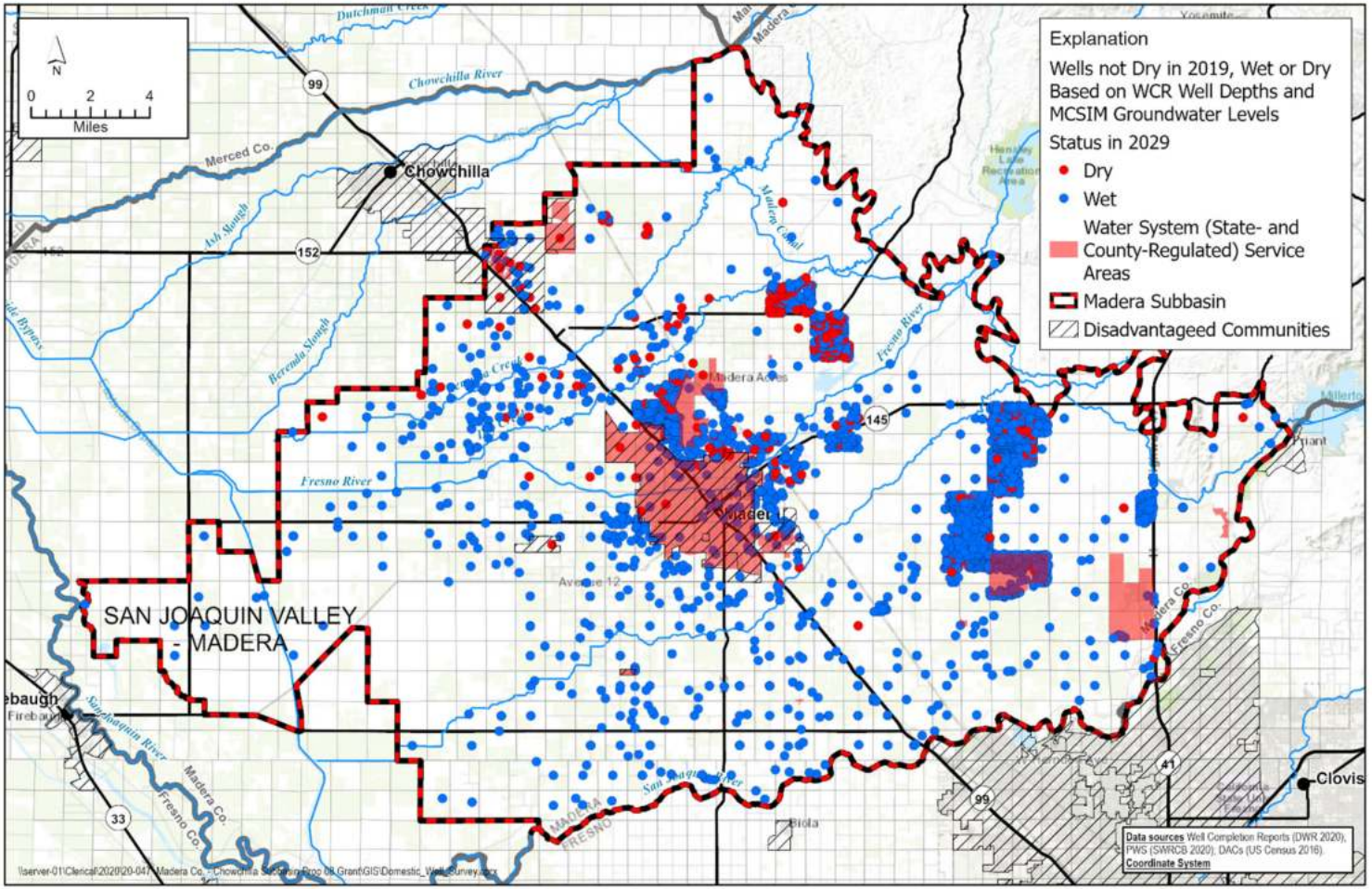


Figure 13c: Status of Wells in 2029 - Based on WCR Well Depths and Locations Compared to MCSIM Groundwater Depths.

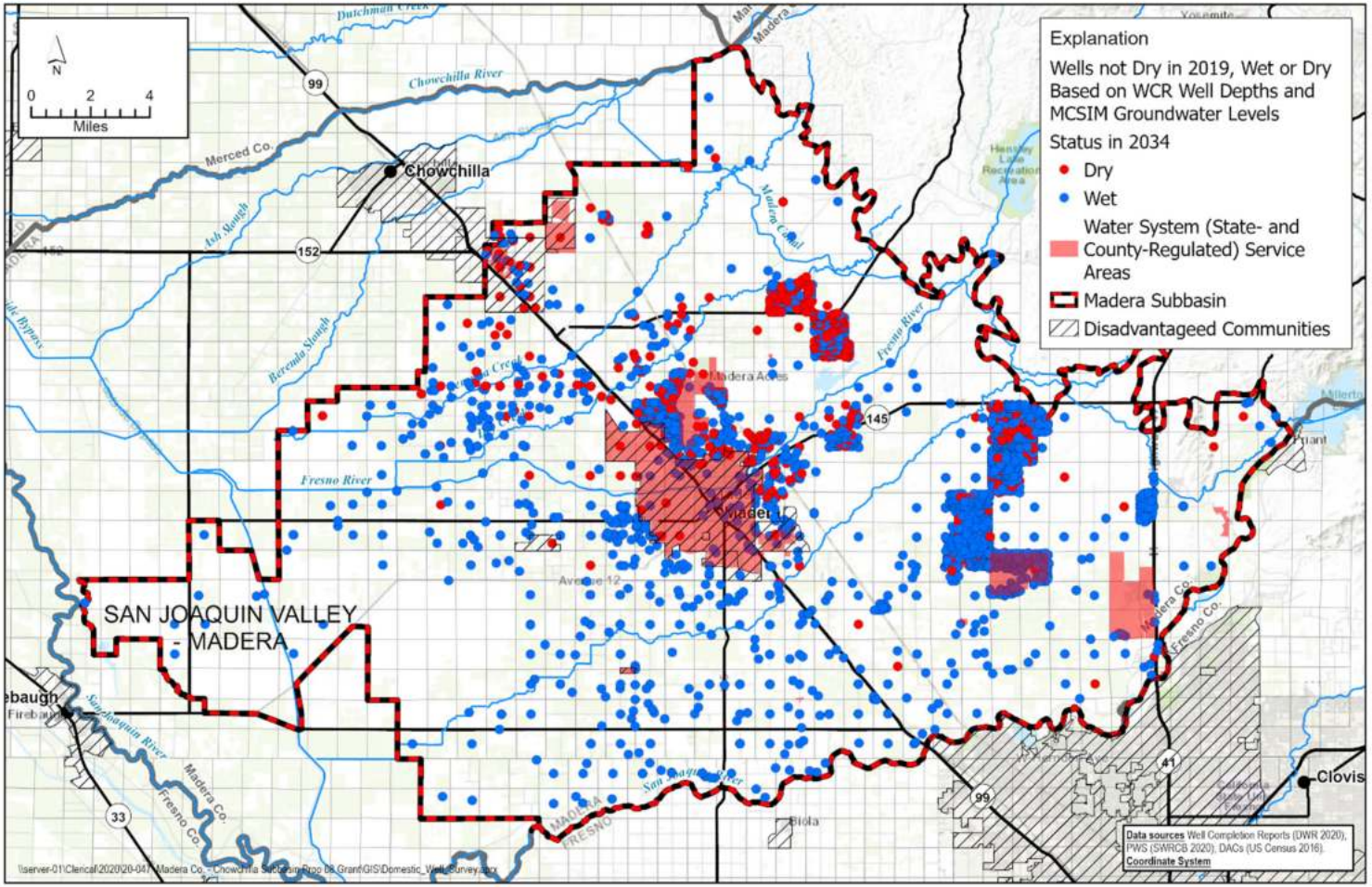


Figure 13d: Status of Wells in 2034 - Based on WCR Well Depths and Locations Compared to MCSIM Groundwater Depths.

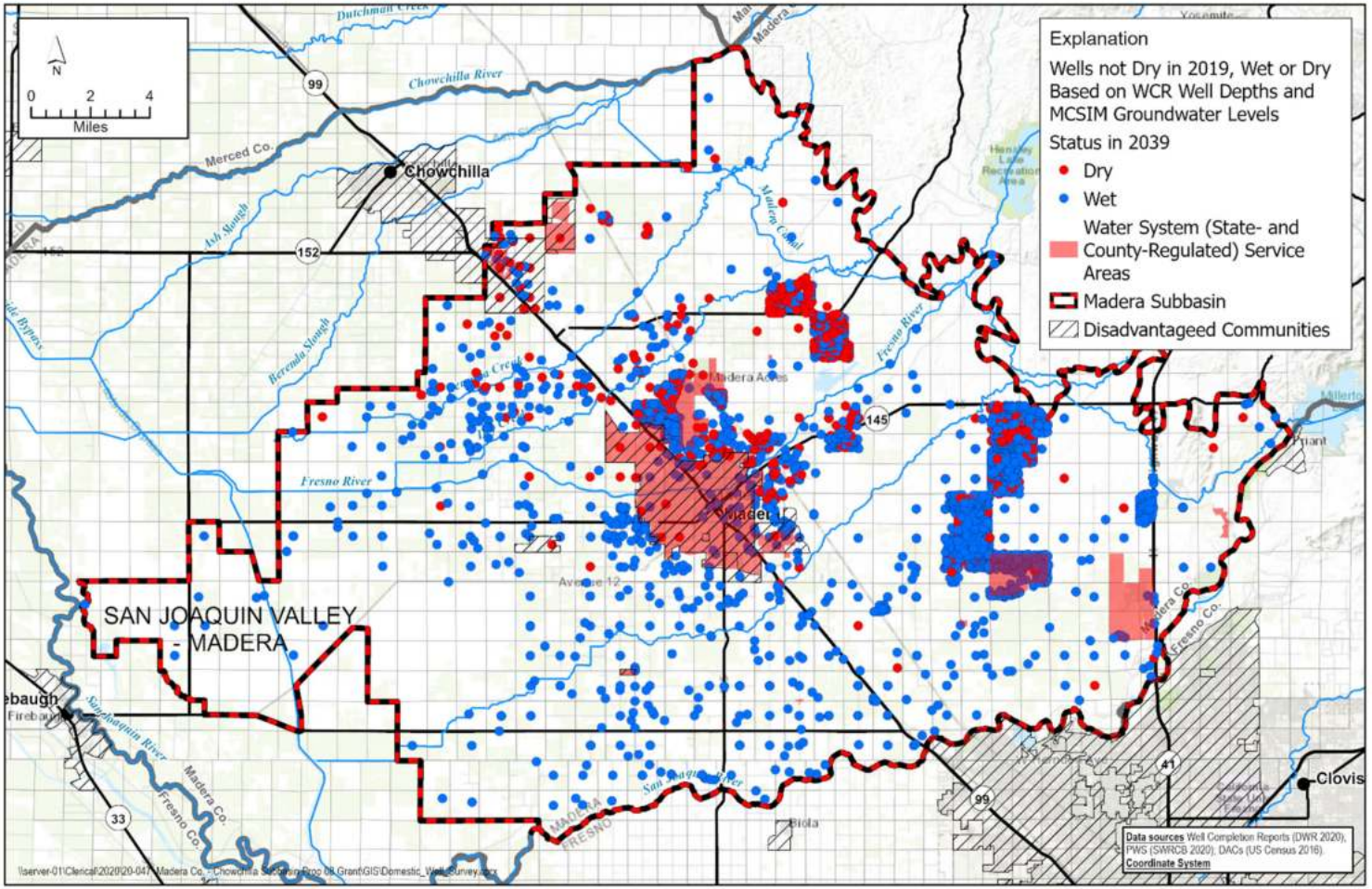


Figure 13e: Status of Wells in 2039 - Based on WCR Well Depths and Locations Compared to MCSIM Groundwater Depths.

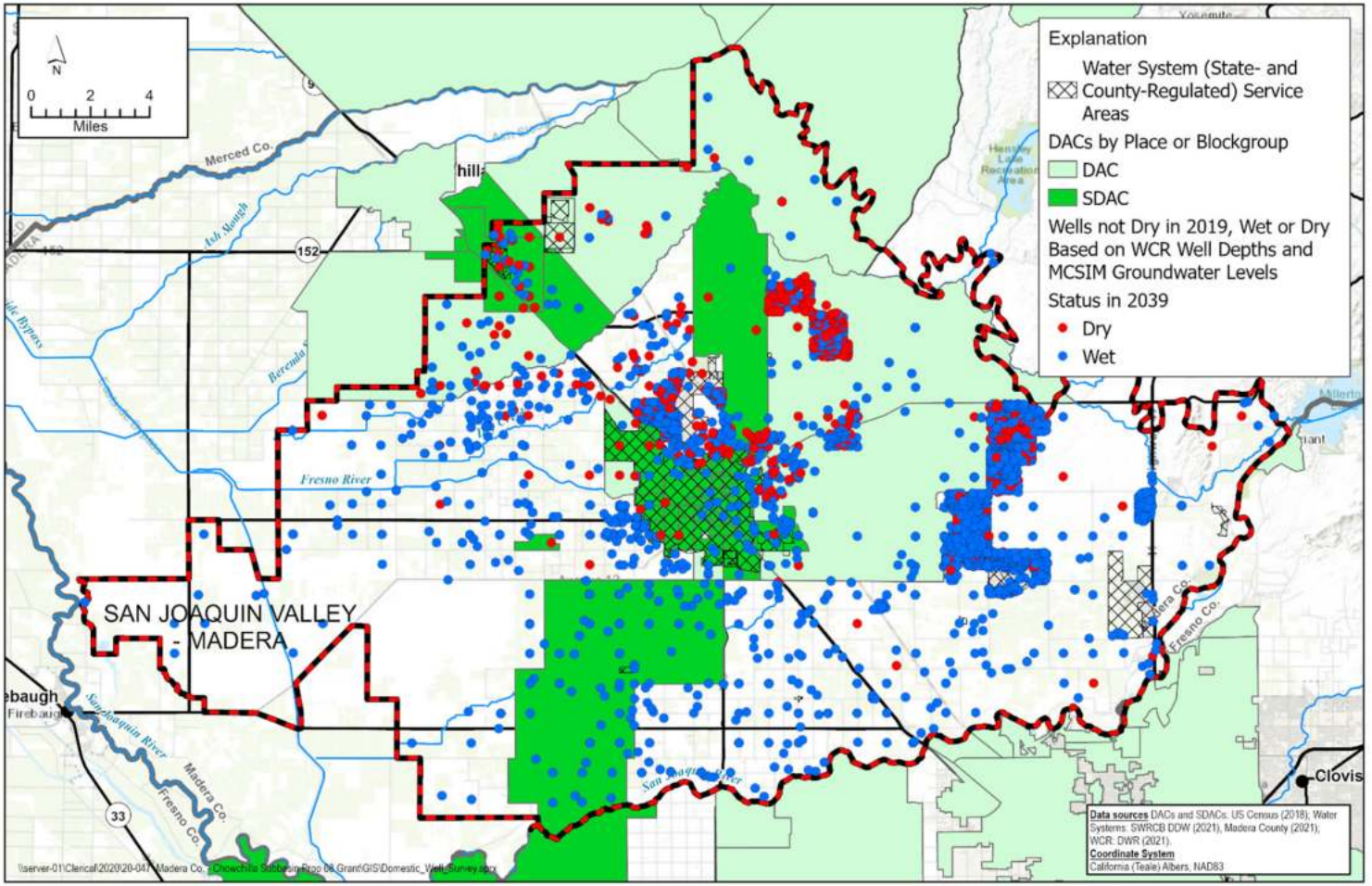


Figure 13f: DACs and SDACs with WCR-Based Wells and Predicted 2039 Status.

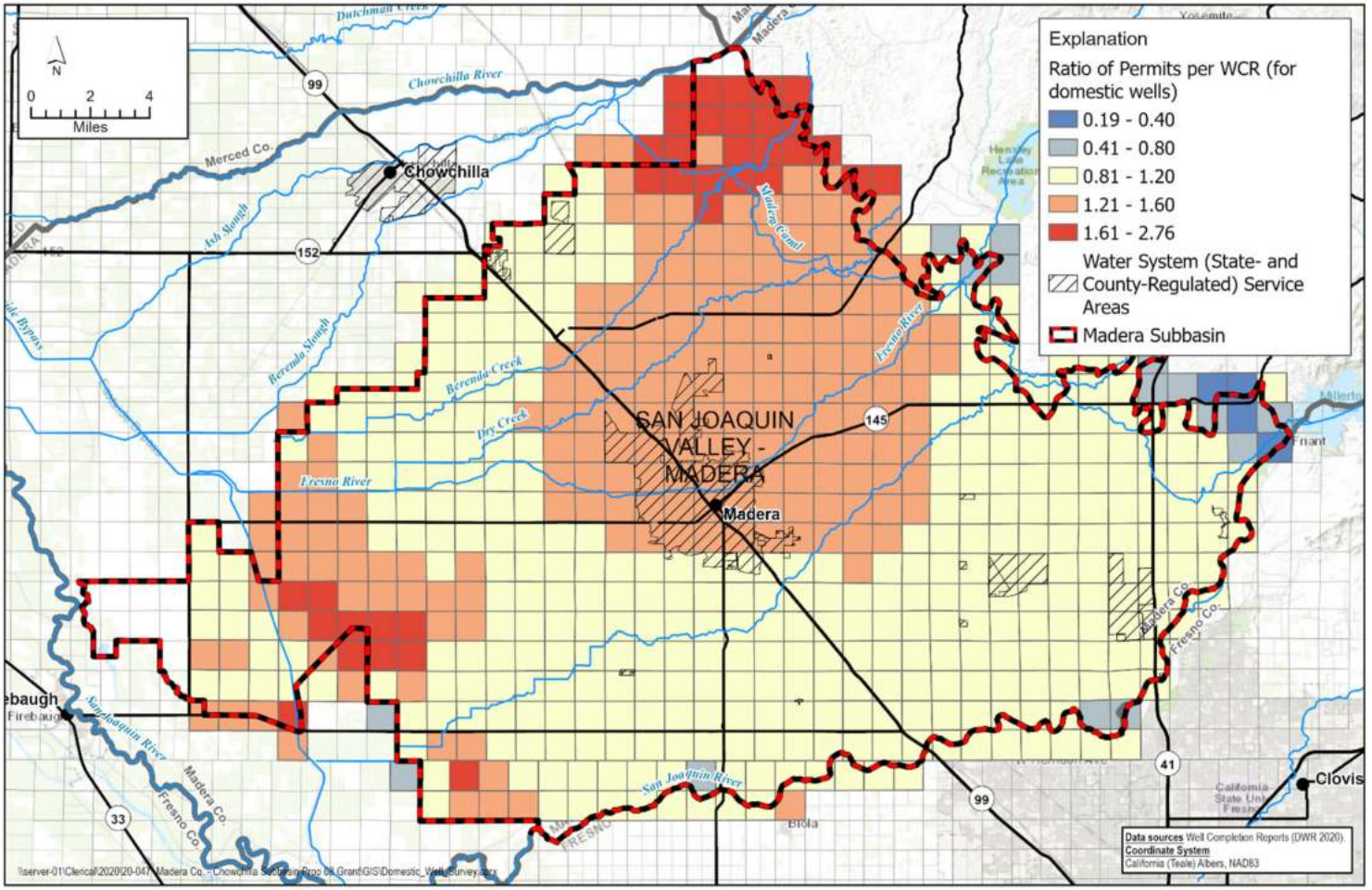


Figure 14: Map of domestic well Permits compared to domestic well WCR (from 1990 and later) locations.

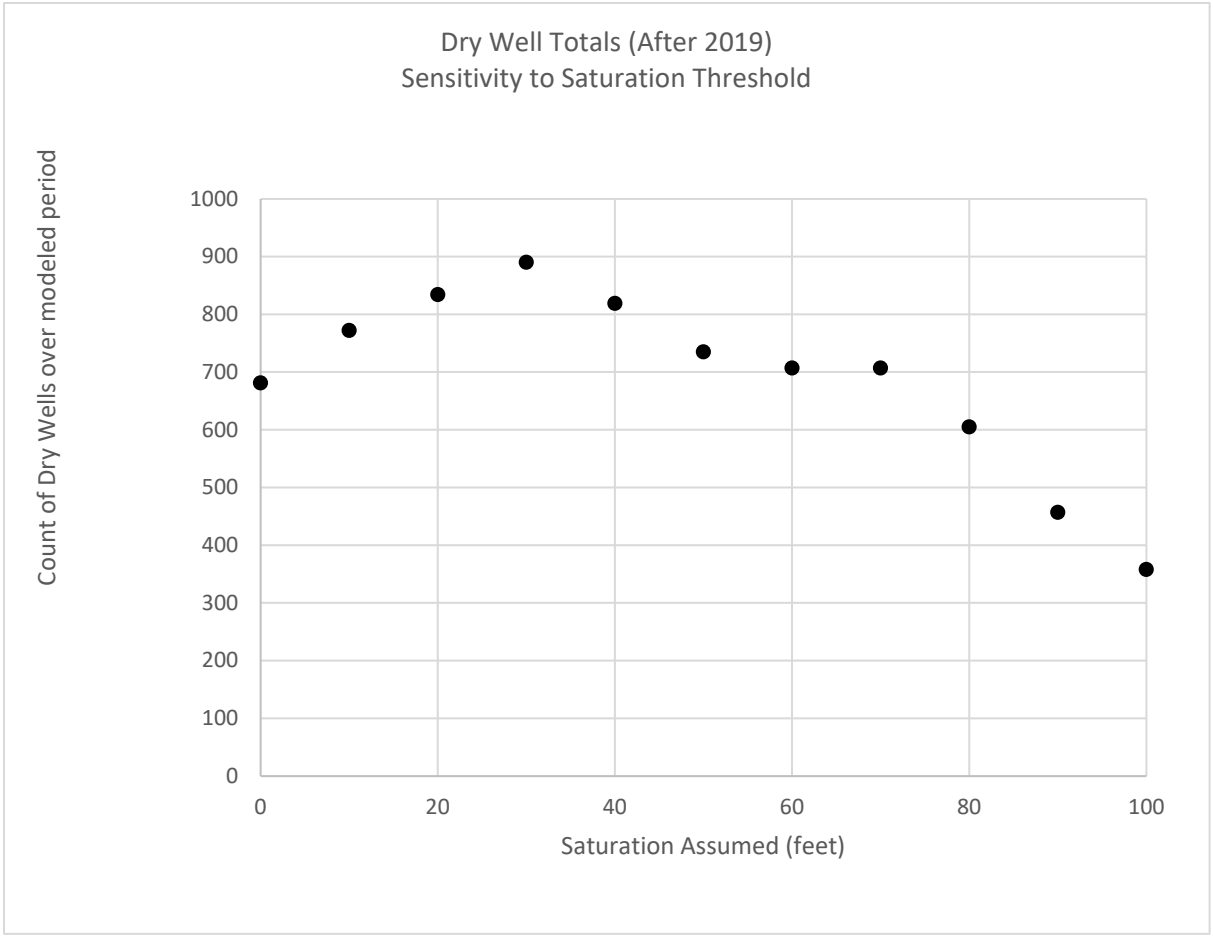


Figure 15: Counts of Dry Wells after 2019 as a Function of Minimum Saturation Threshold.

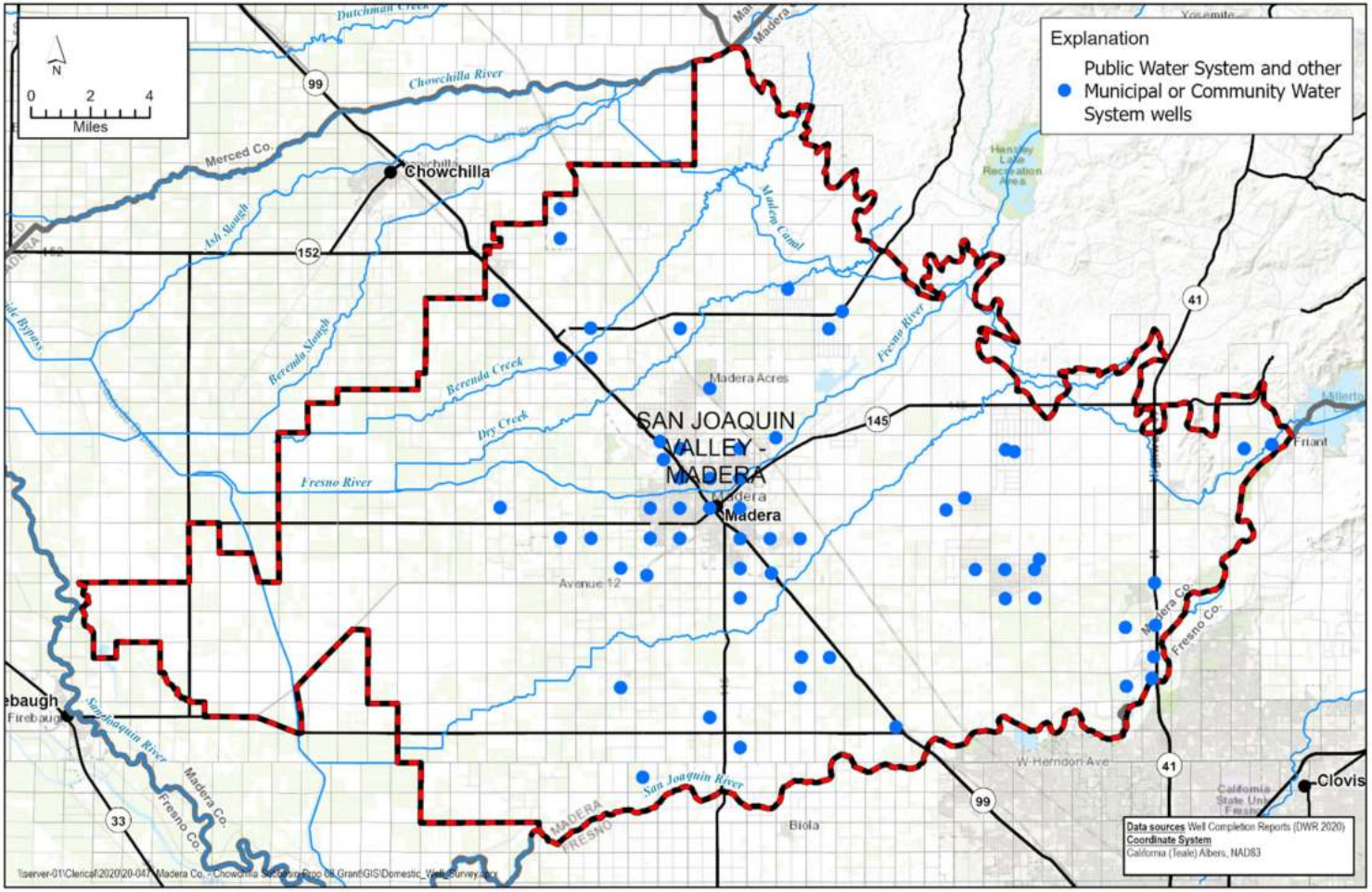


Figure 16: Public Water System and other Municipal or Community Water System wells. Based on WCR data.

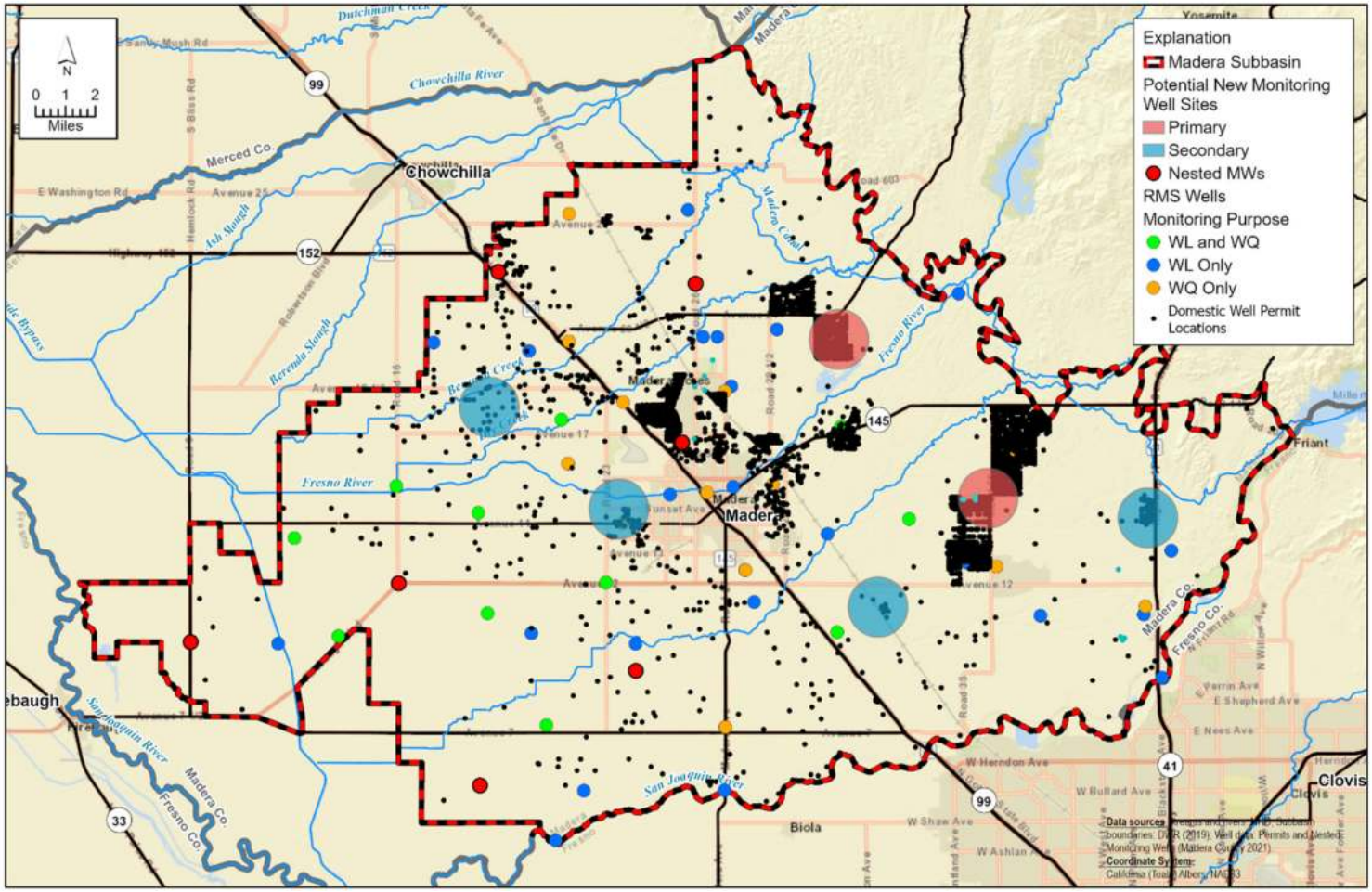


Figure 17: Map of Proposed New Monitoring Well Sites.

ATTACHMENT 1

Domestic Well Replacement Economic Analysis – Madera Subbasin Update

ERA Economics
Environment • Resources • Agriculture

ERA Economics
1111 Kennedy Place, Suite #4
Davis, CA 95616

Technical Memorandum

Subject: Domestic Well Replacement Economic Analysis – Madera Subbasin Update

By: ERA Economics

To: LSCE and the Madera County GSA

Date: January 10, 2022

Purpose and Background

In June 2019 ERA provided a technical memorandum (TM) estimating the cost and benefit of more rapid implementation of demand management under the Madera Subbasin Joint GSP. The economic analysis was included as Appendix 3D to the Madera Subbasin Joint GSP. The analysis was prepared with the best available data and information at that time. After finalizing the GSP, the LSCE and DE consultant teams have continued to assist the Madera Subbasin GSAs with GSP implementation and annual GSP reporting. LSCE was engaged by the Madera County GSA to prepare an updated domestic well inventory for the subbasin.

The economic analysis included as Appendix 3D to the Madera Subbasin Joint GSP estimated the total cost of replacing domestic wells potentially impacted by declining groundwater levels under baseline conditions without SGMA and under the draft proposed GSP implementation plan (so-called "with-SGMA" scenario).

This technical memorandum (TM) serves as an update to those estimates by: (i) updating the project and demand management schedule to reflect the adopted allocation in the Madera Subbasin, (ii) incorporating updated data and analysis on potentially impacted wells from the domestic well inventory, (iii) updating all costs and benefits to current dollars (e.g., well replacement costs), and (iv) refining the economic analysis to compare the cost and benefit of accelerating demand management specified in the GSP. That is, the 2019 analysis compared the draft proposed GSP implementation to baseline conditions without SGMA, whereas this analysis compares the proposed plan with phased implementation of projects and management actions (PMAs) to an accelerated, immediate implementation of PMAs, notably with immediate, full demand management to avoid further domestic well impacts.[1]

These updates to the data affect the resulting economic analysis and results. The 2019 estimate of domestic wells needing to be replaced without increased demand management was 228 wells, which at that time was doubled to account for potential under-reporting. In addition, a sensitivity calculation as

[1] Whereas the cost of immediate demand management implementation has been included, the effect on cost of accelerating recharge and supply projects has not yet been estimated. A full cost estimate of projects for all GSAs in the subbasin is still under development. If this additional cost were included, it would strengthen the conclusion of this analysis.

part of the earlier analysis verified that the conclusions would have held even if the number of affected wells were substantially larger. The updated domestic well inventory puts the number of domestic wells potentially needing replacement between 1,260 and 1,578 over the 20-year GSP implementation period. This TM briefly summarizes the updated analysis, results, and summary conclusions.

Summary Conclusions

Results of this updated analysis comparing the cost of accelerated PMA implementation to the benefit of avoided domestic well replacement costs support the general conclusion of the 2019 analysis. The loss in agricultural value from more rapid demand management still greatly exceeds domestic well replacement costs even though the estimated number of potentially dewatered domestic wells has increased and the cost of replacement for each domestic well has increased by 20 percent. That is, the results of the economic analysis show that the additional cost of more rapid demand management is substantially greater than the cost of replacing potentially dewatered domestic wells and paying higher pumping costs due to lower water levels. This supports the phased implementation schedule and domestic well mitigation program defined in the GSP.

Updated Assumptions

Assumptions and results below are summarized for each of the cost categories considered. All costs (or savings) are expressed as constant 2021 dollars converted to present value using a 3.5 percent real (inflation-free) discount rate[2]. The two implementation scenarios compared are referred to as *GSP implementation* (the phased implementation as described in the GSP) scenario and the *immediate demand reduction* (full demand reduction to eliminate overdraft from 2021 onward) scenario.

1. **Number of dewatered wells needing replacement**. Revised estimates of dewatered wells are calculated and described in the Technical Memorandum prepared by LSCE for the Madera Subbasin Domestic Well Inventory. For this analysis, a total of 1,578 wells were estimated to be dewatered, spread across four 5-year periods. The cost analysis further assumed that well impacts would be evenly divided by year within each 5-year period[3]. For the comparison scenario with immediate demand reduction, it was assumed that none of those wells would need replacement.
2. **Costs to replace dewatered domestic wells**. The 2019 estimate of an average $25,000 per replaced domestic well is updated to $30,000 per domestic well.
3. **Groundwater pumping depth to water (DTW).** The average DTW for the GSP implementation scenario was provided from groundwater model projections described in the Madera Subbasin Joint GSP. The immediate demand reduction scenario is intended to represent immediate elimination of average annual overdraft. A time series was created that followed the

[2] The current federal discount rate for water projects is 2.25%, but a real rate of 3.5% better reflects borrowing conditions in Madera County. A 1.5% increase or decrease in the real discount rate does not affect the conclusions of the analysis.
[3] The timing of the well replacement within each 5-year period does not affect the conclusions of this analysis.

general hydrologic variation estimated for the GSP implementation scenario but held the DTW the same on average during the 2021-2040 implementation period. The ending (2040) difference in DTW between the two scenarios was then carried forward beyond 2040. These pumping depth differences are the basis for the estimated annual pumping cost savings.

4. **Changes in variable costs to pump groundwater, for both domestic and agricultural users.** Energy prices, estimated using a mix of PG&E's latest electricity rates for agricultural pumping, have increased substantially. The analysis now uses an average of PG&E's 2021 AG-B and AG-C peak and off-peak summer rates, resulting in an estimate of $0.40 per acre-foot per foot of lift for the variable cost to pump groundwater. As a result, more rapid demand management provides greater savings (avoided pumping lift) for domestic and agricultural pumping. All agricultural and domestic groundwater pumping in the basin would receive this avoided lift benefit from faster demand reduction.
5. **Costs of demand management under GSP implementation.** Costs of demand reduction have been revised based on the latest estimates of the net return to agricultural water use developed for planning the SALC program. In addition, pumping volumes have been updated to reflect current conditions and the planned ramp-down adopted in the Madera County GSA groundwater allocation ordinance (applicable to the GSP implementation scenario only). These values do not represent average returns to all lands and crops in the subbasin but rather the lands and crops more likely to participate in a demand reduction program. For purposes of this analysis, the lost net return from demand reduction is valued at $230 per acre-foot[4].

Results

The following discussion compares costs between the GSP implementation scenario and the (alternative) immediate demand management scenario. General observations are:

- Demand management costs are greater in the immediate implementation scenario because demand management would be implemented sooner (immediately) and for more years during the GSP implementation period. Recharge and supply projects' costs have not been included in this analysis, but their present value costs would also increase because they would be implemented sooner.
- Pumping costs are lower in the immediate demand reduction scenario because, by definition, the average annual overdraft is eliminated immediately. The effect (smaller DTW and lower pumping cost) is carried throughout the remaining years of GSP implementation and in perpetuity.
- Well replacement costs occur in the GSP implementation scenario but are not required in the immediate demand reduction scenario.

[4] The value of water depends on future crop market conditions. Note that a higher value (greater than $230 per acre-foot applied in this TM) would further increase the cost of accelerated demand management relative to avoided well replacement and additional pumping costs.

- The net effect of these differences in costs results in the GSP implementation scenario having a substantial cost advantage (by about $120 million in present value, or 27 percent) over the immediate demand reduction scenario. In other words, the Madera Subbasin is better off (i.e., realizes benefits that exceed costs) implementing its phased GSP implementation plan and developing/funding the domestic well mitigation program to replace impacted wells than it is if it were to implement immediate demand reduction to avoid dewatering any domestic wells.

Table 1 summarizes the results of the economic analysis. All values are expressed in present value terms. The first two rows show the number of and cost to replace wells estimated to go dry in each scenario. The next rows present the pumping cost savings of the immediate demand reduction scenario relative to the GSP implementation scenario, broken down by domestic pumping and agricultural pumping. The next row shows the demand management costs. For the GSP implementation scenario, demand management is phased in at two percent per year initially, increasing to 6 percent per year until full demand management is reached by 2040. In contrast, the immediate demand reduction scenario implements the full demand management required in 2020, resulting in substantially higher demand management costs.

Table 1. Costs of GSP Implementation Scenario Compared to Costs of Immediate Demand Reduction Scenario - Summary Results for Madera Subbasin, Present Value ($ in Millions)

	GSP Implementation with Well Replacement	Immediate Demand Reduction	Difference
Domestic Well Replacement			
Number	1,578	0	1578
Cost, PV	$38.64	$0.0	$38.64
Pumping Cost (Savings), PV			
Domestic	NA	-$6.41	$6.41
Agricultural	NA	-$86.11	$86.11
Demand Mgmt. Cost, PV	$449.76	$701.74	-$251.98
Total Cost, PV*	$488.41	$609.23	-$120.82

* Totals may not add exactly due to rounding.

Discussion

Results indicate that the cost of implementing demand management on a faster trajectory (in this case, in year one of the implementation period) would not be cost effective from a subbasin-wide perspective. The avoided costs (fewer domestic wells requiring replacement) would be small ($39 million) relative to the additional lost agricultural net return[5] from immediate implementation ($252 million) for the Madera Subbasin, even after accounting for pumping cost savings ($93 million). The general conclusions are robust to the assumptions used. That is, results are not sensitive to reasonable ranges in key assumptions,

[5] Note that demand management would result in additional economic impacts to other county businesses and industries. These additional indirect impacts are not considered in this updated analysis but would only further support its conclusions.

including the loss in net return per acre-foot of demand management, the total level of demand management, when demand management begins to scale in, or the cost of replacing a domestic well.

This analysis only compares the cost of well replacement to net costs of immediate demand management implementation; it has not considered the timing of other projects such as new surface water supplies or groundwater recharge. That comparison is not possible with current information, and the GSP implementation schedule already reflects an aggressive timeline for project implementation. The cost (in present value) of accelerating implementation of projects has also not been included here. The additional cost of accelerating a recharge project by, say five years, would be the increased present value of the project's capital and O&M cost stream. Costs of new supply and recharge projects have not been accelerated, so the present value of costs for immediate implementation is underestimated. Simply stated, including these additional costs would further support the conclusions of this analysis.

ATTACHMENT 2

Madera Subbasin – Evaluation of DWR Household Water Supply Shortage Reports and Self-Help Enterprises Tank Water Participants

Luhdorff & Scalmanini
Consulting Engineers

TECHNICAL MEMORANDUM

DATE: February 7, 2022 Project No. 20-2-153

TO: File – Madera Subbasin Domestic Well Inventory

FROM: Pete Leffler, PG, CHG; Nick Watterson, PG; Aaron King

SUBJECT: Madera Subbasin - Evaluation of DWR Household Water Supply Shortage Reports and Self-Help Enterprises Tank Water Participants

INTRODUCTION

To support efforts related to implementing the Madera Subbasin Groundwater Sustainability Plan (GSP), the Subbasin completed a Domestic Well Inventory project that identified potential domestic wells in the Subbasin and analyzed potential impacts to domestic wells caused by lowering of groundwater levels historically and during the 20-year GSP implementation period starting in 2020. The Domestic Well Inventory for the Madera Subbasin compiled information on domestic wells in the Subbasin from Well Completion Reports and County well permit datasets and compared these data to modeled groundwater levels in the Subbasin from the GSP over the period from 2014 through 2040. During development of the GSP, historical and future groundwater levels throughout the Subbasin were modeled based on historical conditions and projected future conditions. This memorandum summarizes a review of records in the Department of Water Resources (DWR) Household Water Supply Shortage Reporting System and also participants in the Self-Help Enterprises (SHE) Tank Water Program and includes a comparison of these two datasets with the results from analyses of domestic well impacts conducted as part of the Madera Subbasin Domestic Well Inventory.

DWR HOUSEHOLD WATER SUPPLY SHORTAGE REPORTING SYSTEM

Overview of the Household Water Supply Shortage Reporting System

The DWR Household Water Supply Shortage Reporting System (https://mydrywell.water.ca.gov/report/) is a site for reporting of problems with private (self-managed, not served by public water system) household water supplies. The site was initially created in 2014 as part of drought emergency response efforts and continues to be used to collect information on household water supply shortages from private well or surface water sources. The data in the reporting system reflect information on water supply shortage issues voluntarily submitted by private, local, state, federal, and non-governmental individuals

and organizations. Because the data do not undergo review or quality control by DWR, the reported information is not suggested to be complete in its accounting for all water supply shortages and it is also noted by DWR that there may be errors and omissions in data, duplicate entries, and records for non-household related water supply issues. Furthermore, during review of the data, many incomplete and inconsistent records were noted, with many reports providing very little detail for use in understanding the cause of the issue reported. There are a variety of potential causes for issues related to the quantity or quality of water produced by a well, and this can include issues related to the well pump, water distribution system, or the well structure, without relationship to groundwater conditions in the aquifer.

The submission of information to the Household Water Supply Shortage Reporting System is done through completion of a report submittal form (https://mydrywell.water.ca.gov/report/public/form), which includes questions related to the issue, including required entries on the following:

- Type of shortage: a) Dry well, b) low streamflow, or c) other
- Description of the water issue: a) well is dry (no longer producing water), b) reduction in water pressure/lower flows, c) well pumping sand/muddy water, d) well is catching air (have to wait to be able to pump, e) reduction in water quality, or f) other
- Primary use of the well or creek: a) household, b) agriculture/irrigation, c) combination of household/agriculture, or d) other
- Approximate date problem started
- County

As of January 2022, the reporting system included 3,769 entries across the state of California, with dates when the problem started spanning the period from 2012 through 2021.

Household Water Supply Shortage Records within Madera Subbasin

The Household Water Supply Shortage Reporting System contains a total of 46 reports with locations in the Madera Subbasin. The reports within the Subbasin were grouped into four categories according to the type of water supply issue indicated: 1) dry wells, 2) reduced flow or impaired water quality, 3) collapsed well, and 4) surface water problem or inadequate explanation of issue. Figure 1 presents the number of reported well-related issues by year within the Madera Subbasin. Of the 406 reports within Madera Subbasin, 330 were categorized as a dry well issue, 62 were categorized as reduced flow or impaired water quality issues, and six were surface water problem/inadequate explanation of issue or collapsed well. As illustrated on Figure 1, most water supply issues in the system were reported to have started in 2014, 2015, and 2021, with relatively fewer during other years. The greatest number of reports occurred during 2015 after multiple years of drought conditions in the area. Figure 2 shows the locations of the water supply issue reports in the system. Most water shortage reports in the Subbasin are located in the eastern areas of the Subbasin, mainly northeast of Highway 99 in clustered areas north and east of the City of Madera.

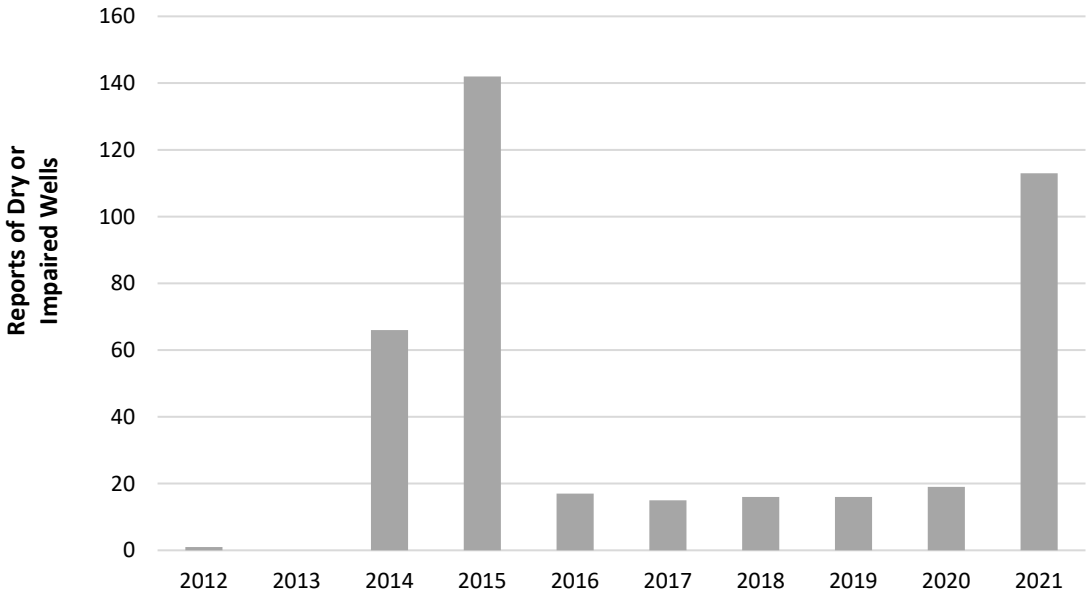
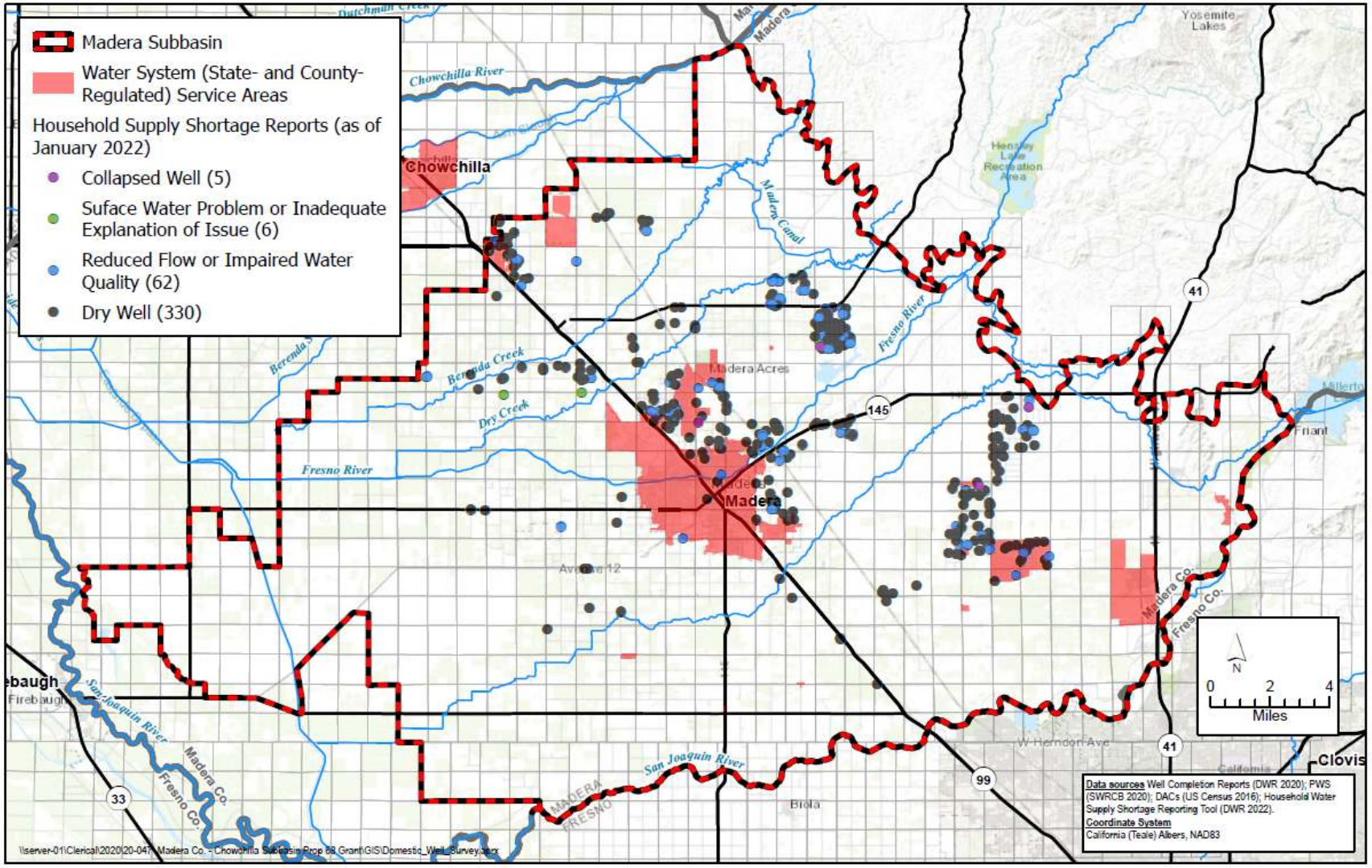


Figure 1. Chart of Household Water Supply Shortage Report Records in Madera Subbasin



Luhdorff & Scalmanini
Consulting Engineers

Figure 2
DWR Household Water Supply Shortage Reporting Data

Madera Subbasin
Groundwater Sustainability Planning

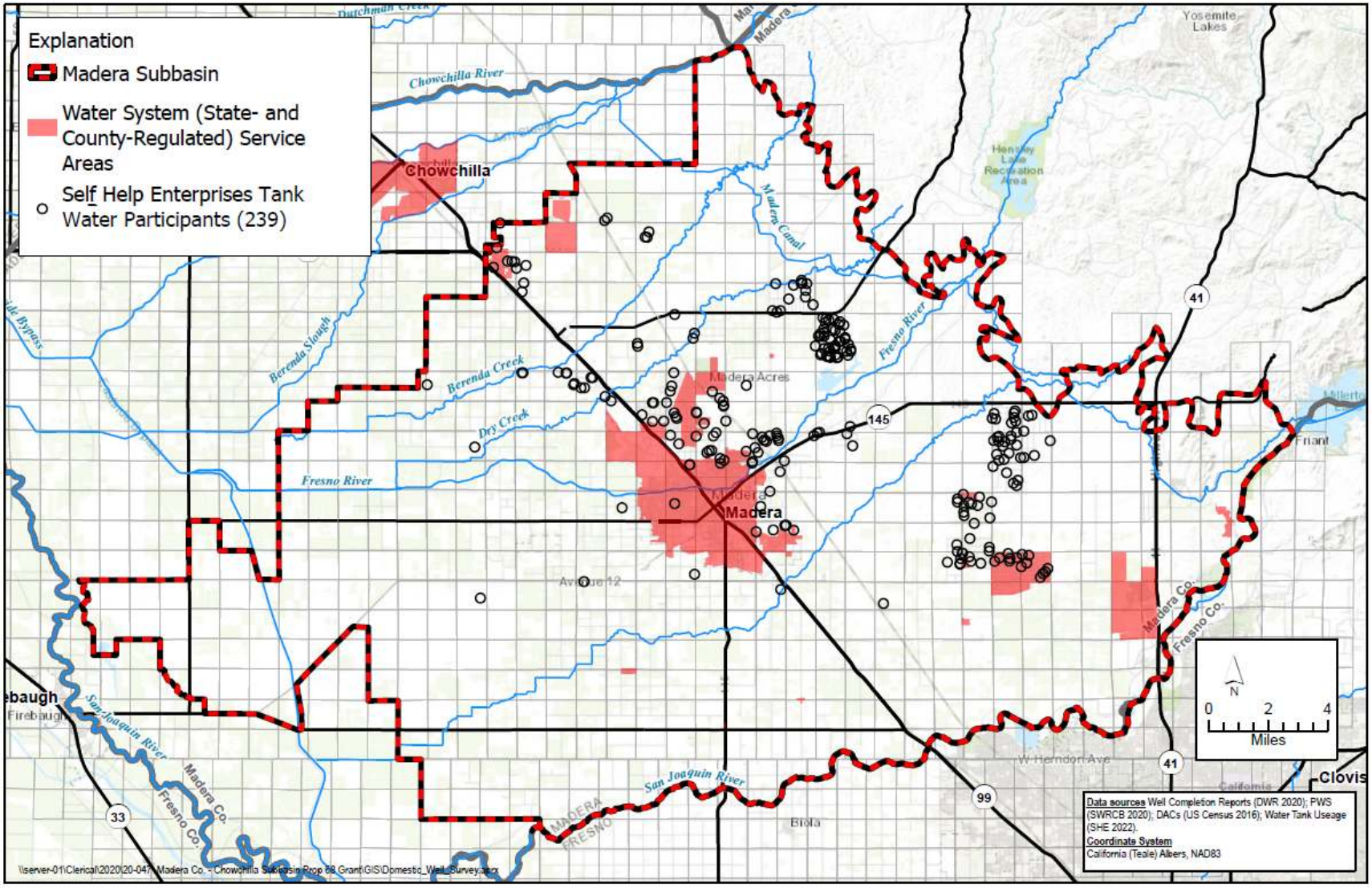
SHE TANK WATER PROGRAM PARTICIPANT DATA

Overview of the SHE Tank Water Participant Data

The SHE Tank Water Program provides a temporary water supply solution for households experiencing a well water shortage in eight counties in and adjacent to the San Joaquin Valley: Fresno, Kern, Kings, Madera, Mariposa, Merced, Stanislaus, and Tulare. The SHE Water Tank Program assists households experiencing well water shortages by installing a water tank and hauling water and filling the tank to restore access to water for the home. The SHE Tank Water Program is intended as a short-term solution to provide participants access to water for one year while working towards a long-term solution. Data on participants in the SHE Water Tank Program as of January 2022 were provided by SHE (https://www.arcgis.com/home/webmap/viewer.html?webmap=377849cbc9c54046917d864a635e9674&extent=-120.0525,34.8083,-117.2593,36.0392). As of January 2022, the SHE Tank Water Program includes 769 participants in the eight-county area served by the program. The available Tank Water Program participant data only provide locations for participants without other attributes indicating the date or type of issue necessitating the reliance on tank water. There are a variety of potential causes for issues related to the quantity or quality of water produced by a well, and this can include issues related to the well pump, water distribution system, or the well structure, without relationship to groundwater conditions in the aquifer.

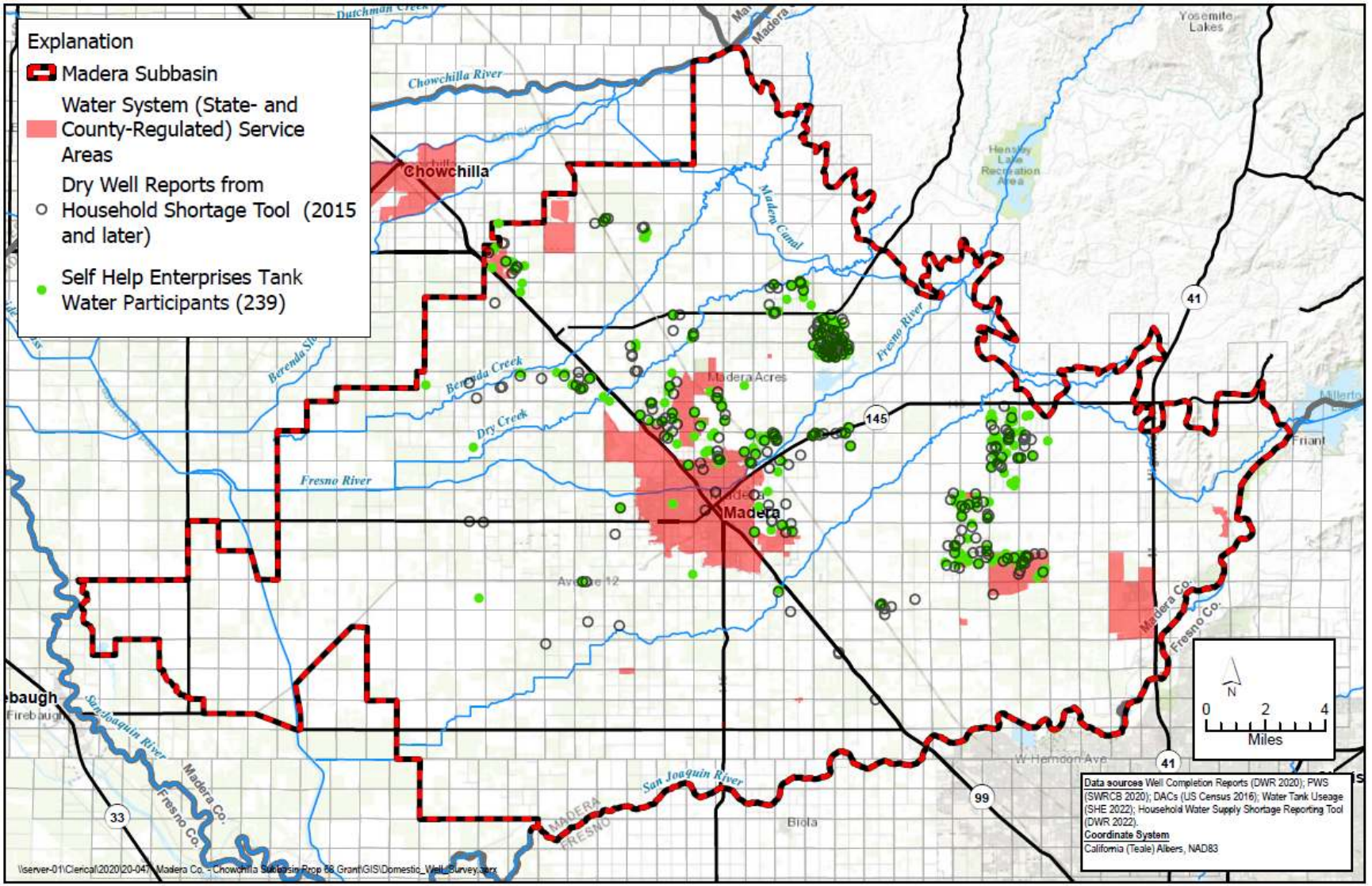
SHE Tank Water Participants within Madera Subbasin

The SHE Tank Water Program covers eight counties within the San Joaquin Valley, along with some areas located outside of the San Joaquin Valley and outside of DWR-designated groundwater basins (e.g., foothill areas). The SHE Tank Water Program includes 239 participants within the Madera Subbasin. Figure 3 presents a map of the Tank Water Program participants within the Madera Subbasin. As illustrated on Figure 3, most of the Tank Water Program participants in the Madera Subbasin are located in clustered areas generally north and east of the City of Madera. Figure 4 is a map comparing the locations of SHE Tank Water participants and dry wells in the DWR Household Water Supply Shortage dataset. The spatial distribution of Tank Water participants and dry wells reported in the DWR dataset are very similar and likely include some of the same wells, although no information is available to evaluate such direct relationships in the two datasets.



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Consulting Engineers

Figure 3
Locations of Self Help Enterprises Tank Water Participants
Madera Subbasin
Groundwater Sustainability Planning



Luhdorff & Scalmanini
Consulting Engineers

Figure 4
Comparison of SHE Tank Water Participants and DWR Dry Well Reports
Madera Subbasin
Groundwater Sustainability Planning

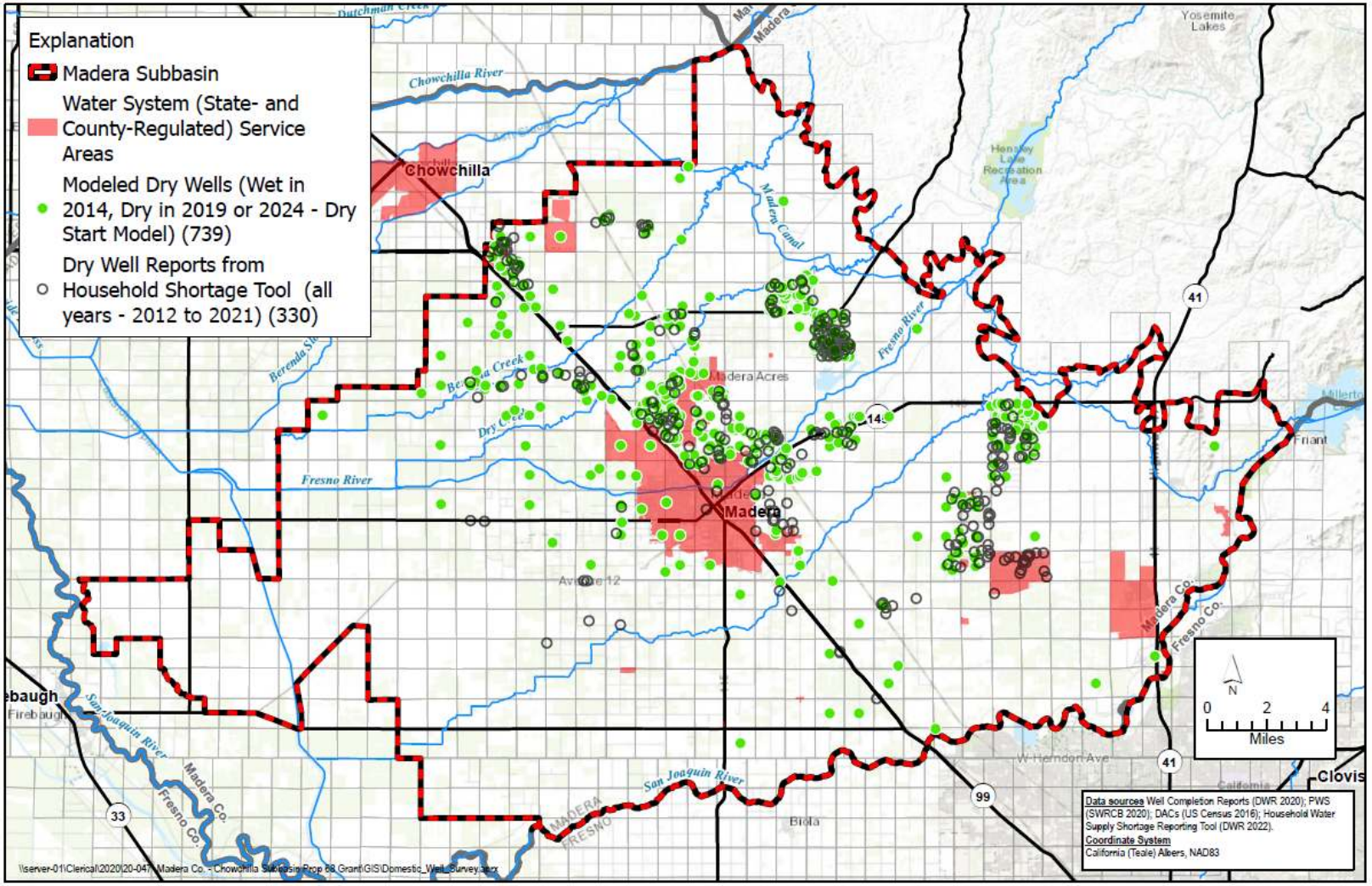
COMPARISONS OF DWR DRY WELL RECORDS AND SHE TANK PARTICIPANTS WITH ANALYSES OF DRY WELLS FROM THE DOMESTIC WELL INVENTORY

Analyses of potential domestic well impacts in the Domestic Well Inventory were conducted at five-year intervals based on modeled groundwater levels across the Subbasin. To understand differences between dry wells reported to the Household Water Supply Shortage Reporting System and also SHE Tank Water Program participants in relation to estimates of potential dry wells from the Madera Subbasin Domestic Well Inventory analyses, the spatial distribution of dry wells in the Household Water Supply Shortage Reporting System dataset and Tank Water Participants were compared with modeled dry wells over the period from 2015 through 2024.

The comparisons presented in this TM are intended to provide a general sense for the spatial distribution of the different datasets, recognizing the datasets present different types of information related to domestic well issues. As noted above, there are a variety of potential causes for a well experiencing issues related to the quantity of water produced by a well that may be unrelated to groundwater conditions in the aquifer. Some of these issues may be reflected in the DWR Water Supply Shortage Reports and SHE Tank Water Program participants list. It is also likely that many households with wells that have gone dry have not reported such occurrences to the DWR Household Water Supply Shortage Reporting System and many of these households have also not participated in the SHE Tank Water Program. As described in the technical memorandum summarizing the Madera Subbasin Domestic Well Inventory, analyses of potential dry domestic wells in the Domestic Well Inventory are based only on the relationship between available well construction (e.g., screen depth and total well depth) and simulated groundwater levels at each domestic well location.

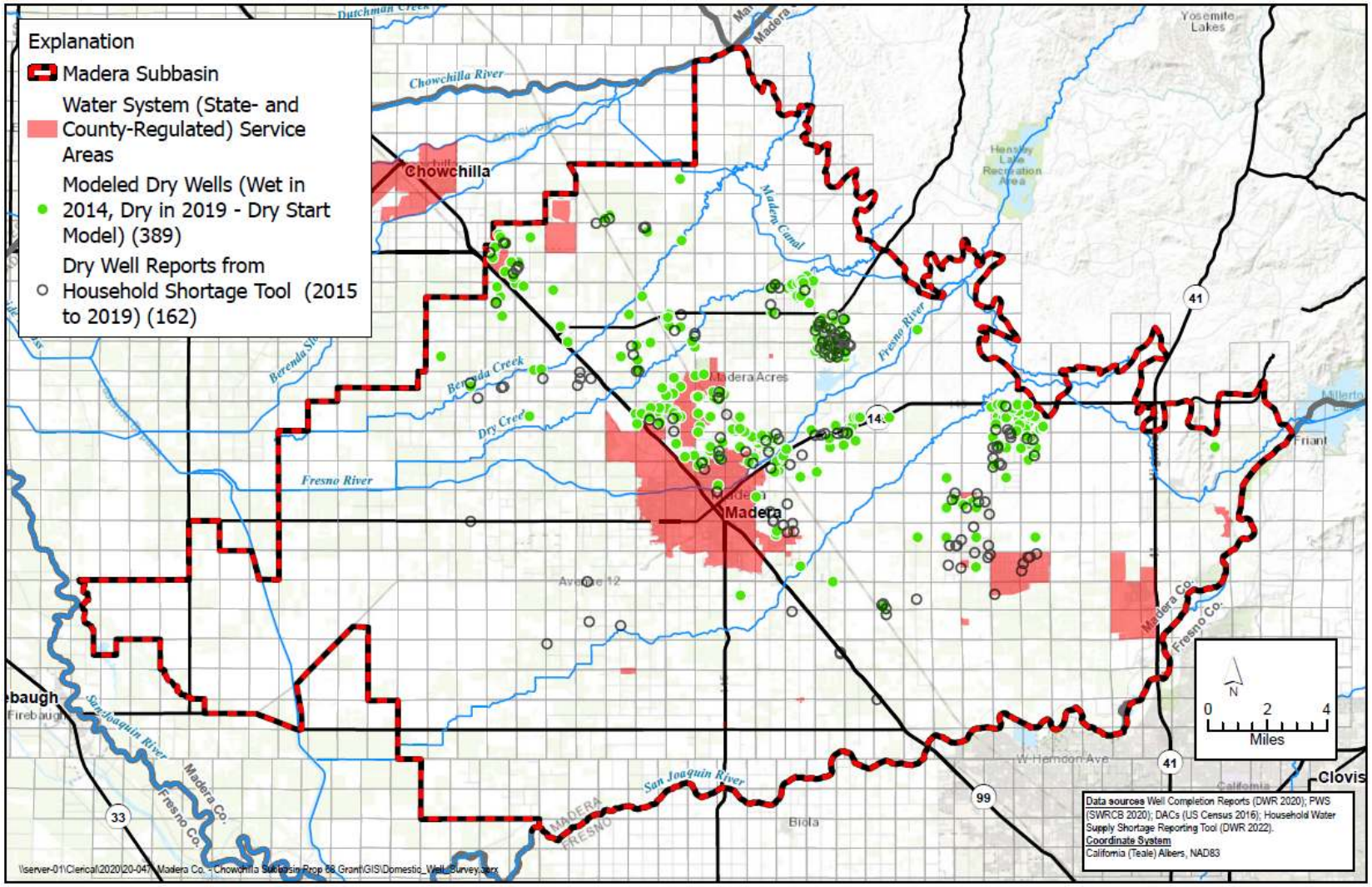
Comparison of DWR Dry Well Records with Modeled Dry Wells in the Domestic Well Inventory

Maps comparing dry well records in DWR's Household Water Supply Reporting System with dry wells modeled as part of the Domestic Well Inventory are presented in Figures 5 and 6. Figure 5 presents a comparison of all reported dry wells in DWR's system (2012 through 2021) with modeled dry wells estimated for the period 2015 through 2024 in the Domestic Well Inventory. Figure 6 presents a comparison of reported dry wells during the years 2015 through 2019 in DWR's system with modeled dry wells between 2015 and 2019 in the Domestic Well Inventory. Figure 6 provides a more direct spatial comparison of dry wells in the two datasets over the same five-year period, whereas Figure 5 presents an overview of the spatial relationship between the two datasets spanning a longer timeframe. Although there are considerably more modeled dry wells than reports of dry wells in DWR's system in either comparison, the spatial patterns in the two datasets show many similarities, with most modeled dry wells and reports of dry wells occurring in clustered areas to the north and east of the City of Madera. Some of the differences in locations between the modeled dry wells and reported dry wells in Figures 5 and 6 are likely a result of differing resolutions of locational information available in the two datasets.



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Consulting Engineers

Figure 5
Comparison of DWR Dry Well Reports with Modeled Dry Wells Between 2015 and 2024
Madera Subbasin
Groundwater Sustainability Planning



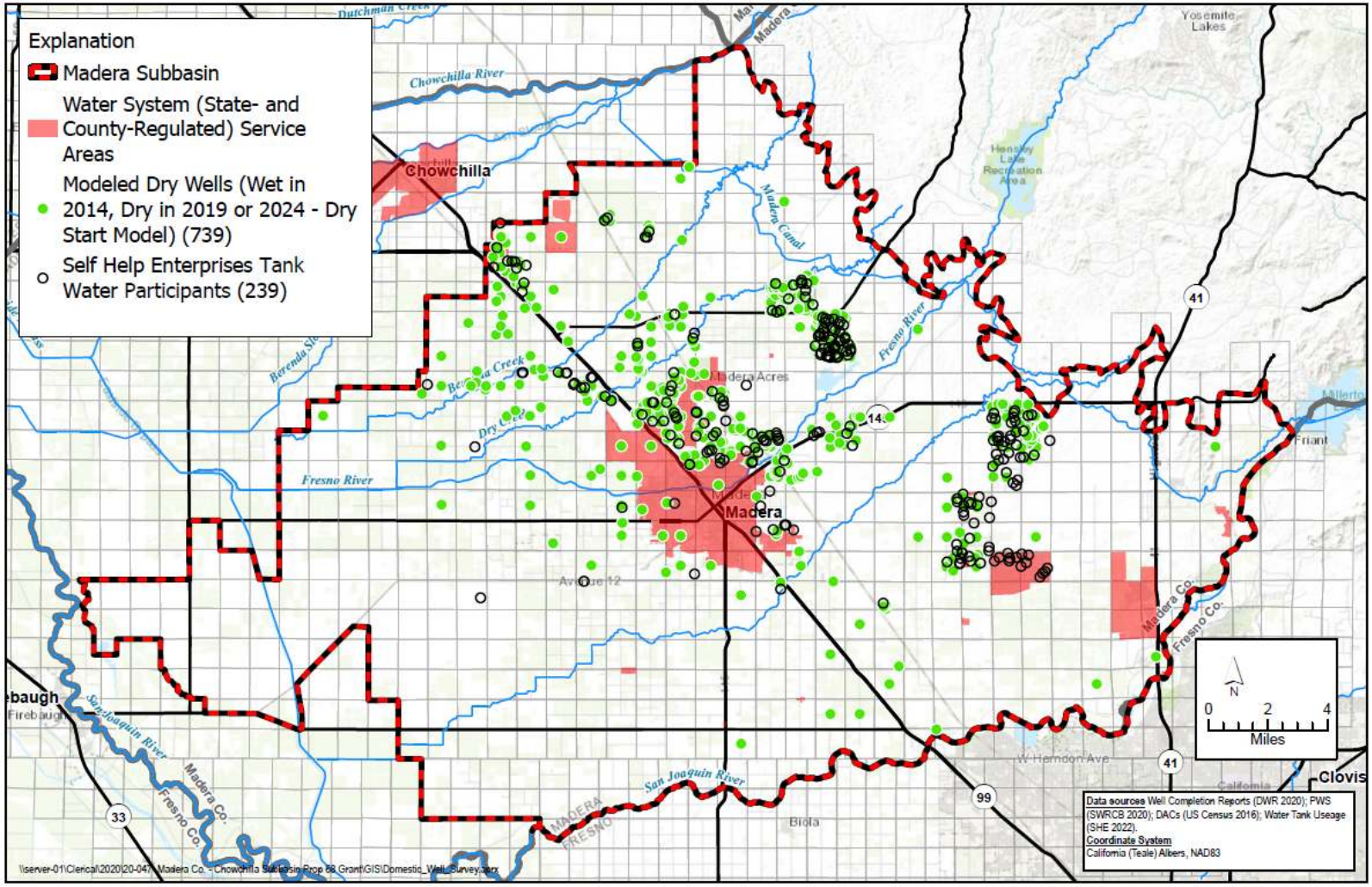
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Consulting Engineers

Figure 6
Comparison of DWR Dry Well Reports with Modeled Dry Wells Between 2105 and 2019

Madera Subbasin
Groundwater Sustainability Planning

Comparison of SHE Tank Water Participants with Modeled Dry Wells in the Domestic Well Inventory

A map comparing SHE Tank Well Participants with dry wells modeled as part of the Madera Subbasin Domestic Well Inventory are presented in Figure 7. Figure 7 presents a comparison of all SHE Tank Water Program participants in the Subbasin as of January 2022 with modeled dry wells estimated for the period 2015 through 2024 in the Domestic Well Inventory. Although there are considerably more modeled dry wells than Tank Water Participants (as is the case with dry well reports in the DWR's Household Water Supply Shortage System), the spatial patterns in the two datasets show many similarities, with most modeled dry wells and SHE Tank Water Participants occurring in areas north and east of the City of Madera.



Luhdorff & Scalmanini
Consulting Engineers

Figure 7
Comparison of SHE Tank Water Participants with Modeled Dry Wells Between 2015 and 2024
Madera Subbasin
Groundwater Sustainability Planning

APPENDEX ITEM 3.E

MADERA SUBBASIN DOMESTIC WELL MITIGATION PROGRAM DRAFT MEMORANDUM OF UNDERSTANDING

MEMORANDUM OF UNDERSTANDING ESTABLISHING A DOMESTIC WELL MITIGATION PROGRAM FOR THE MADERA SUBBASIN OF THE SAN JOAQUIN VALLEY GROUNDWATER BASIN

This Memorandum of Understanding ("MOU") is entered into this___day of _____2023 (the "Effective Date"), by and between the Groundwater Sustainability Agencies of the COUNTY OF MADERA ("COUNTY"), the CITY OF MADERA ("CITY"), the MADERA IRRIGATION DISTRICT ("MID"), the ROOT CREEK WATER DISTRICT ("RCWD"), the MADERA WATER DISTRICT ("MWD"), the GRAVELLY FORD WATER DISTRICT ("GFWD"), and the NEW STONE WATER DISTRICT ("NSWD"), collectively hereinafter referred to as the "Parties," or individually as the "Party."

RECITALS

A. **WHEREAS**, groundwater and surface water resources within the Madera Subbasin of the San Joaquin Valley Groundwater Basin (DWR Bulletin 118 No. 5-22.06) (Subbasin) are vitally important resources, in that they provide the foundation to maintain and fulfill current and future environmental, agricultural, domestic, municipal, and industrial needs, and to maintain the economic viability, prosperity, and sustainable management of the Subbasin; and

B. **WHEREAS**, agriculture has been prominent in making Madera County one of the world's foremost agricultural areas and plays a major role in the economy of Madera County; and

C. **WHEREAS**, in 2014 the California Legislature passed a statewide framework for sustainable groundwater management, known as the Sustainable Groundwater Management Act, California Water Code § 10720-10737.8 (SGMA), pursuant to Senate Bill 1168, Senate Bill 1319, and Assembly Bill 1739, which was approved by the Governor on September 16, 2014. and went into effect on January 1, 2015; and

D. **WHEREAS**, the Subbasin has been designated by the California Department of Water Resources (DWR) as a high-priority subbasin in a condition of critical groundwater overdraft and is subject to the requirements of SGMA; and

E. **WHEREAS**, SGMA requires that all medium and high priority groundwater basins in California be managed by a Groundwater Sustainability Agency (GSA), or multiple GSAs, and that such management be implemented pursuant to an approved Groundwater Sustainability Plan (GSP), or multiple GSPs; and

F. **WHEREAS,** there are seven GSAs within the Subbasin as set-forth in Exhibit A; and

G. **WHEREAS**, County, City, MID, and MWD have developed one GSP; RCWD has developed one GSP; GFWD has developed one GSP; and NSWD has developed one GSP, such that the Subbasin is governed by four separate GSPs unified through the Subbasin Coordination Agreement; and

H. **WHEREAS**, in January 2020, the Parties submitted four GSPs to DWR; and

I. **WHEREAS**, the Parties agree, and as SGMA allows, a transition to sustainability over the 20-year GSP Implementation Period is in the best overall interest of the Subbasin, although this approach is expected to result in some continued groundwater level declines during the GSP Implementation Period; and

J. **WHEREAS**, the Parties agree that as a result of the continued decline in groundwater levels anticipated to occur over the GSP Implementation Period, there may be adverse impacts to some domestic and municipal wells in the Subbasin; and

K. **WHEREAS**, the Parties acknowledge that the number of domestic and municipal wells dewatered during implementation of the GSP (prior to 2040) is heavily dependent on precipitation and snowpack during that time period; and

L. **WHEREAS**, the Parties acknowledge that wet conditions may result in few dewatered wells; and

M. **WHEREAS**, the Parties acknowledge that substantial numbers of domestic and municipal wells may be dewatered if prolonged drought occurs during implementation of the GSP, while project and management actions are still being developed and implemented; and

N. **WHEREAS**, the Parties acknowledge that they cannot control groundwater conditions not caused by regional groundwater conditions; and

O. **WHEREAS**, the Parties do not intend to resolve or otherwise mitigate for issues related to normal wear and tear; and

P. **WHEREAS**, the Parties as part of their future analysis agree to review potential impacts to both domestic and municipal wells in the Subbasin; and

Q. **WHEREAS**, the Parties have reviewed and considered the content and recommendations set-forth by Self-Help Enterprises, Leadership Counsel for Justice and Accountability, and the Community Water Center in their publication titled, “Framework for a Drinking Water Well Impact Mitigation Program.”

R. **NOW, THEREFORE**, in consideration of the mutual promises, covenants and conditions contained herein and these Recitals, which are hereby incorporated herein by this reference, the Parties agree to review and consider mitigation for domestic and municipal well impacts resulting from declining groundwater levels that occur from groundwater management activities outlined in the four GSPs through development of a Domestic Well Mitigation Program (Program) as follows:

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AGREEMENT

1. **POTENTIAL PROGRAM MITIGATION MEASURES.** Potential Program mitigation measures may include, but are not limited to:

    a. Short-term solutions in emergencies, such as delivery of bottled water and/or water tanks.
    b. Setting well pump at deeper depths, replacement of well pump, or well replacement.
    c. Residential water treatment equipment.
    d. Connection to or development of public water systems to serve impacted communities.
    e. Municipal service connections.

2. **PROPORTIONATE RESPONSIBILITY**. The Parties agree to work cooperatively together to determine the proportionate responsibility of each Party.

3. **FUNDING**. The Parties agree to fund the Program on an annual basis consistent with the final determination of each Party's proportionate responsibility. Each Party shall undertake a funding analysis and Proposition 218 hearing as determined necessary to fund the Program.

4. **PROGRAM DEVELOPMENT COMMITTEE**. The Parties shall establish a Program Development Committee (Committee) that will oversee Program development. The Committee shall include at least one technical staff representative from each of the Parties. The Committee will define the purpose, objectives, roles, responsibilities, requirements, and potential outcomes of the Program. Items for consideration and development by the Committee include, but are not limited to:

    a. Definitions
    b. Property eligibility
    c. Property owner eligibility
    d. Program application process
    e. Preferred contractors
    f. Preliminary inspection process
    g. Program form development
    h. Priority
    i. Eligible mitigation
    j. Non-eligible mitigation
    k. Maximum mitigation award
    l. Recordation of mitigation award

5. **PROGRAM ORGANIZATIONAL STRUCTURE**. To aid the Committee in Program development and implementation, a DRAFT Program organizational structure is as

shown in Exhibit B. That shown in Exhibit B is only a DRAFT and shall not limit or otherwise constrain the Committee in their analysis.

6. **PROGRAM IMPLEMENTATION.** To aid the Committee in Program development and implementation, a DRAFT implementation flowchart is as shown in Exhibit C. That shown in Exhibit C is only a DRAFT and shall not limit or otherwise constrain the Committee in their analysis.

7. **TERM**. The Program shall be developed within the first 5 years of GSP implementation (by 2025) and upon implementation, shall continue for the duration of the GSP Implementation Period, until groundwater sustainability is achieved and/or as otherwise directed by the Parties.

8. **PROGRAM MANAGEMENT**. Program management shall be facilitated by one of the Parties. If one of the Parties doesn't elect to program management duties and through recommendation of the Coordination Workgroup and approval of the Parties, Program management shall be facilitated through a third party.

9. **ENVIRONMENTAL REVIEW**. The Parties agree to cooperatively complete any environmental review as may be determined necessary for Program implementation. Any costs associated with environmental review shall be per the proportionate share as set-forth in this MOU.

10. **NOTICES**. All notices required or permitted by the MOU shall be made in writing, and may be delivered in person (by hand or by courier) or may be sent regular, certified, or registered mail or U.S. Postal Service Express Mail, with postage prepaid, or by facsimile transmission, or by electronic transmission (email) and shall be deemed sufficiently given if served in a manner specified in this Section 16. The addresses and addressees noted below are the Party's designated address and addressee for deliver or mailing notices.

To Madera County:	County of Madera Stephanie Anagnoson 200 W 4th Street, 4th Floor Madera, CA 93637
To MID:	Madera Irrigation District Thomas Greci 12152 Road 28 1/4 Madera, CA 93637
To RCWD:	Root Creek Water District Julia Stornetta PO Box 27950 Fresno, CA 93729

To GFWD:	Gravelly Ford Water District Don Roberts 18811 Road 27 Madera, CA 93638
To City:	City of Madera Keith Helmuth 428 East Yosemite Avenue Madera, CA 93638
To NSWD:	New Stone Water District Roger Skinner 9500 South DeWolf Avenue Selma, CA 93662
To MWD:	Madera Water District Melanie J. Aldridge 1663 N. Schnoor Street, Suite 105 Madera, CA 93638

Any Party may, by written notice to each of the other Parties, specify a different address for notice. Any notice sent by registered or certified mail, return receipt requested, shall be deemed given on the date of delivery shown on the receipt card, or if no delivery date is shown, three days after the postmark date. If sent by regular mail, the notice shall be deemed given 48 hours after it is addressed as required in this section and mailed with postage prepaid. Notices delivered by United States Express Mail or overnight courier that guarantee next day delivery shall be deemed given 24 hours after delivery to the Postal Service or overnight courier. Notices transmitted by facsimile transmission or similar means (including email) shall be deemed delivered upon telephone or similar confirmation of delivery (conformation report from fax machine is sufficient), provided a copy is also delivered via personal delivery or mail. If notice is received after 4:00 p.m. or on a Saturday, Sunday or legal holiday, it shall be deemed received on the next business day.

IN WITNESS WHEREOF, the Parties have caused this MOU to be executed, each signatory hereto represents that he/she has been appropriately authorized to enter into this MOU on behalf of the Party whom he/she signs.

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County of Madera

_____ _____

Date

Madera Irrigation District

_____ _____

Thomas Greci Date

Root Creek Water District

_____ _____

Julia Stornetta Date

Gravelly Ford Water District

_____ _____

Don Roberts Date

City of Madera

_____ _____

Date

New Stone Water District

_____ _____

Roger Skinner Date

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Madera Water District

Phil Janzen

Date

DRAFT

EXHIBIT A

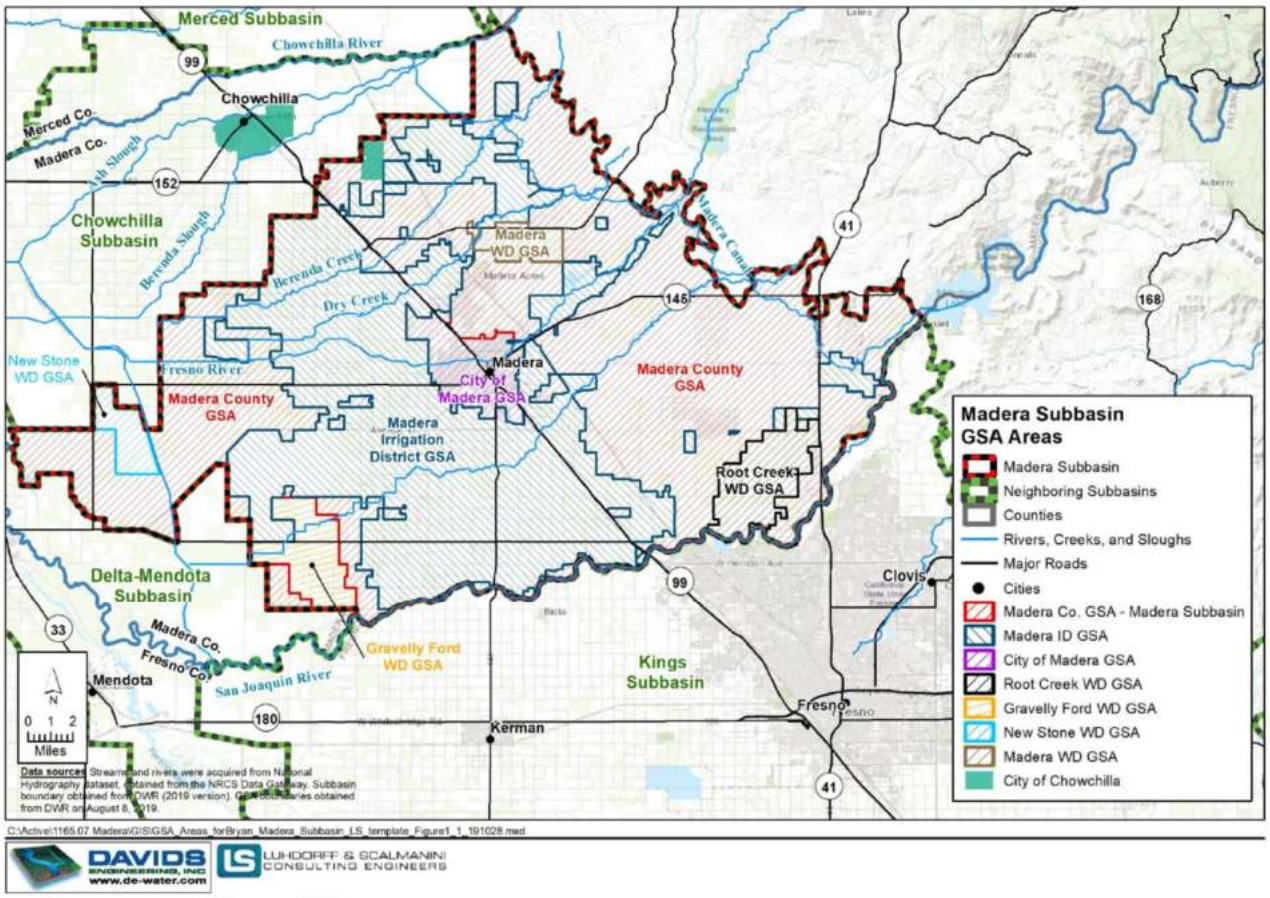

Merced Subbasin
Chowchilla River
Chowchilla
Merced Co.
Madera Co.
Ash Slough
Chowchilla Subbasin
Berenda Slough
Berenda Creek
Dry Creek
Madera WD GSA
Madera Canal
New Stone WD GSA
Fresno River
Madera County GSA
Madera City of Madera GSA
Madera Irrigation District GSA
Madera County GSA
Root Creek WD GSA
Delta-Mendota Subbasin
Gravelly Ford WD GSA
Kings Subbasin
San Joaquin River
Mendota
Kerman
Fresno
Clovis
99
41
145
168
152
33
180
0 1 2 Miles
Madera Subbasin GSA Areas
Madera Subbasin
Neighboring Subbasins
Counties
Rivers, Creeks, and Sloughs
Major Roads
Cities
Madera Co. GSA - Madera Subbasin
Madera ID GSA
City of Madera GSA
Root Creek WD GSA
Gravelly Ford WD GSA
New Stone WD GSA
Madera WD GSA
City of Chowchilla
Data sources: Stream and river were acquired from National Hydrography dataset, obtained from the NRCS Data Gateway. Subbasin boundary obtained from DWR (2019 version). GSA boundaries obtained from DWR on August 8, 2019.
C:\Active\1165.07 Madera\GIS\GSA_Areas_forBryan_Madera_Subbasin_LS_template_Figure1_1_191028.mxd
DAVIDS ENGINEERING, INC www.de-water.com
LUHDORFF & SCALMANINI CONSULTING ENGINEERS

EXHIBIT B

DRAFT

Madera Subbasin – Domestic Well Mitigation Program Organizational Structure
March 5, 2023



Notes:
1. That shown herein is subject to revision by the Parties.
2. Public Outreach and Engagement is a necessary component as outlined by Self-Help Enterprises, Leadership Counsel for Justice and Accountability, and the Community Water Center in their publication titled, "Framework for a Drinking Water Well Impact Mitigation Program."
3. The Madera Subbasin Coordination Workgroup is defined in the Madera Subbasin Coordination Agreement entered into January 22, 2020.

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EXHIBIT C

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Madera Subbasin – Domestic Well Mitigation Program Implementation Flowchart
March 5, 2023



Notes:

1. Steps shown herein are intended to demonstrate critical decision points and is not intended to be indicative of all steps tha t may be required.
2. That shown herein is subject to revision by the Madera Subbasin GSAs.
3. The GSAs have reviewed and considered the content and recommendations set -forth by Self-Help Enterprises, Leadership Counsel for Justice and Accountability, and the Community Water Center in their publication titled, "Framework for a Drinking Water Well Impact Mitigation Program."

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APPENDEX ITEM 3.G

MADERA SUBBASIN INFRASTRUCTURE SENSITIVITY ASSESSMENT

Technical Memorandum

Date: 03/01/2023
To: Madera Subbasin Joint GSP GSAs
From: Davids Engineering, Inc.
Topic: Madera Subbasin Infrastructure Assessment

1 Introduction

This Infrastructure Assessment (Assessment) is intended to document insights about the characteristics of critical infrastructure in the Madera Subbasin, including the proximity, orientation, and relative vulnerability of infrastructure to adverse effects of land subsidence (referred to herein as "subsidence"). The assessment considers critical infrastructure and historical subsidence[1] throughout the entire Madera Subbasin, although the Assessment was prepared specifically to support development of the Madera Subbasin Revised Joint Groundwater Sustainability Plan (GSP). This information has been used by the Madera Subbasin Joint GSP Groundwater Sustainability Agencies (GSAs) to design subsidence-related Sustainable Management Criteria (SMC) with the goal of protecting this critical infrastructure from Undesirable Results (URs) of groundwater conditions during implementation of the Revised Joint GSP.

This Assessment first identifies the location and characteristics of critical infrastructure that must be considered when developing SMC in the Madera Subbasin, and then identifies recent subsidence conditions in areas of the Madera Subbasin that may create risks of adverse impacts to the beneficial uses and users of those critical infrastructure.

Critical infrastructure in the Madera Subbasin that were considered in this Assessment include:

- Roads and highway infrastructure
- Railroad infrastructure
- Waterways and surface water conveyance infrastructure
- Groundwater wells, including agricultural wells, domestic wells, and public supply wells
- Wastewater infrastructure

The Assessment considers how communities in and around the Madera Subbasin access and use critical infrastructure, how subsidence has or could affect those uses and users, and

[1] This assessment reviews historical subsidence conditions from 2015-2022. However, the GSAs recognize that residual subsidence has been observed in many areas of the San Joaquin Valley and is likely to occur to some extent in the Madera Subbasin in areas where historical subsidence was observed. Residual subsidence is associated with delayed compaction that occurs after groundwater levels have declined to a low point (the preconsolidation head), following a lag time of several years to decades in some cases.

identifies areas where subsidence has recently occurred and where critical infrastructure may be vulnerable to URs from subsidence in the future.

This Assessment has been developed based on the information available during the GSP revisions process in 2022-2023. However, the GSAs have developed a work plan to fill subsidence-related data gaps between 2023-2026. The work plan is discussed in Section 2.2.2.7 of the Madera Subbasin Revised Joint GSP. The GSAs are pursuing proposition 68 grant funds through the California Department of Water Resources (DWR) Sustainable Groundwater Management (SGM) Grant Program that would help to support implementation of the work plan. As the GSAs implement the work plan and more is learned about subsidence conditions in the Madera Subbasin, those findings and implications for critical infrastructure will be documented in Annual Reports and GSP updates.

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2 Overview of Critical Infrastructure in the Madera Subbasin

This section provides a brief overview of critical infrastructure categories that were considered when establishing subsidence-related SMC in the Madera Subbasin. The locations of all critical infrastructure categories were considered with respect to the Madera Subbasin boundaries and the GSAs' boundaries (**Figure 1**). The orientation of all critical infrastructure categories was also considered with respect to the overall topography of the Madera Subbasin (**Figure 2**), where the ground surface elevation generally slopes downward from northeast (highest elevation) to southwest (lowest elevation).

Each subsection below generally summarizes what is encompassed in each critical infrastructure category, the general location and characteristics of that critical infrastructure (including its structure and orientation), and other core considerations for the beneficial uses and users of that infrastructure. Maps referenced in these subsections are provided at the end of the Assessment.

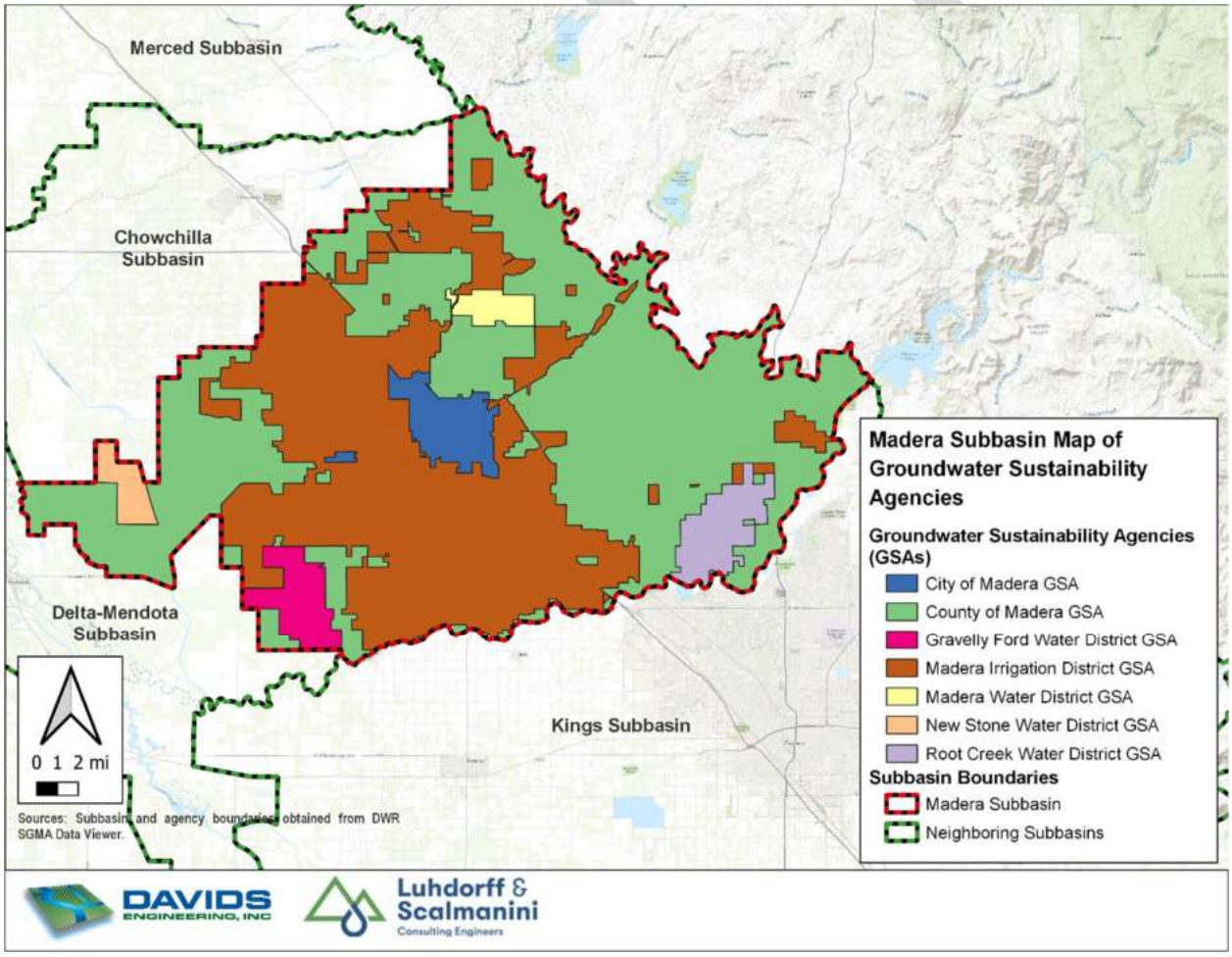


Figure 1. Map of Groundwater Sustainability Agencies in the Madera Subbasin.

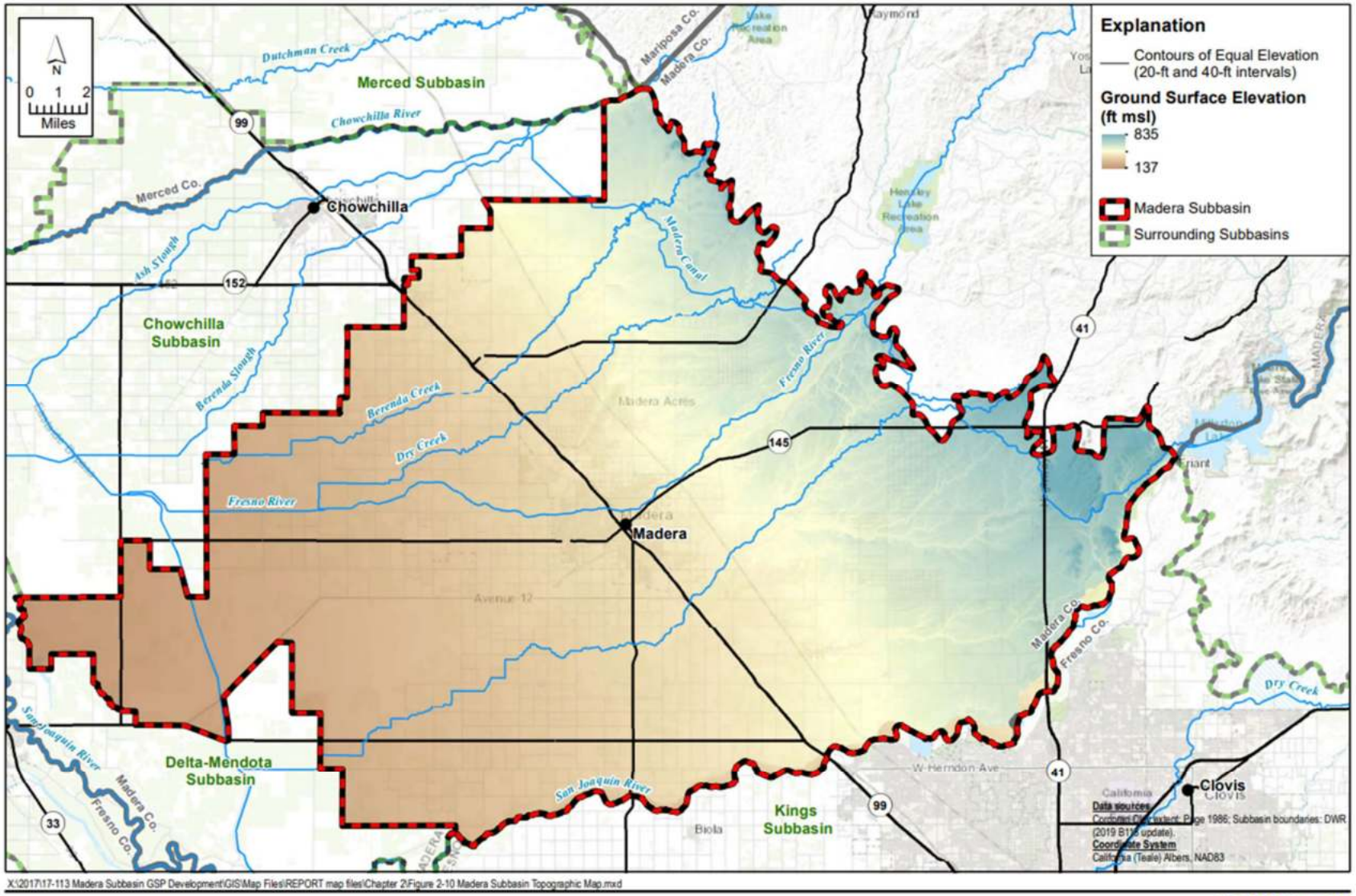


Figure 2. Madera Subbasin Topographic Map (Source: Madera Subbasin Revised Joint GSP, Figure 2-10).

2.1 Roads and Highway Infrastructure

Road and highway infrastructure considered when setting subsidence-related SMC in the Madera Subbasin primarily includes roadways and bridges within the boundaries of the Madera Subbasin. Maintaining the integrity of road and highway infrastructure is important for securing transportation and freight corridors within and through the Madera Subbasin.

Figure 3 shows the locations of major highways and highway bridges in the Madera Subbasin, and **Figure 4** shows the annual average daily traffic volumes on those major highways. The largest highway corridors in the Madera Subbasin include California State Routes (SR) 99, 145, and 41. SR 99 crosses the center of the Madera Subbasin, passing through the City of Madera following a northwest-southeast path. SR 145 follows a north-south path to the south of the City of Madera, and follows a southwest-northeast path to the east of the City of Madera until it connects to SR 41 near the eastern edge of the Madera Subbasin. SR 41 crosses the eastern portion of the Madera Subbasin in a north-south path. Other smaller, local roadways are generally located in the City of Madera or traverse rural areas of the Madera Subbasin.

According to data available from the California Department of Transportation (Caltrans), SR 99 features the majority of highway bridges in the Madera Subbasin (29 of 43), and also experiences the majority of traffic (typically serving more than 40,000 vehicles per day, on average). Off of SR 99, traffic on SR 145 ranges from approximately 7,000-15,000 vehicles per day, on average, with higher volumes nearer to the City of Madera. On the eastern side of the Madera Subbasin, traffic on SR 41 ranges from approximately 16,000-18,000 vehicles per day.

2.2 Railroad Infrastructure

Railroad infrastructure was also considered in setting subsidence-related SMC in the Madera Subbasin. Like road and highway infrastructure, maintaining the integrity of railroad infrastructure is important for securing transportation and freight corridors through the Madera Subbasin. **Figure 5** shows the location of railroad infrastructure in the Madera Subbasin summarized from available Caltrans data. The Madera Subbasin contains two main railways: one that crosses the central portion of the Madera Subbasin and passes through the City of Madera following a northwest-southeast path, and the second following a roughly parallel path to the northeast of the first. A third short railway, the North Madera Industrial Lead, also branches off from the first railway within the City of Madera, following a short southwest-northeast path.

2.3 Waterways and Surface Water Conveyance Infrastructure

Waterways and surface water conveyance infrastructure considered when setting subsidence-related SMC in the Madera Subbasin are shown in **Figure 6**. Maintaining the integrity of waterways and surface water conveyance infrastructure is important for flood protection, irrigation, recharge, and other beneficial uses and users of surface water in and around the Madera Subbasin. More specific considerations for waterways and surface water conveyance infrastructure are described below.

2.3.1 General Flow Characteristics

Most waterways that flow into and through the Madera Subbasin begin in upslope lands east and northeast of the Madera Subbasin and flow downslope in a westerly direction. Besides the San Joaquin River, which flows along the southern edge of the Subbasin, waterways in the Madera Subbasin are considered intermittent or ephemeral streams, and have historically remained dry for at least several months each year.

The Madera Canal and reaches of the Fresno River, Berenda Creek, Cottonwood Creek, and Dry Creek within the Madera Subbasin are used for conveyance of surface water (generally in March-October at times when surface water supplies are available). Virtually all surface water flows on these waterways originate from either Hensley Lake releases at Hidden Dam or from Millerton Reservoir releases at Friant Dam that are delivered via the Madera Canal. These waterways are typically dry during the non-irrigation season except during storm runoff events and during periods when flood releases occur from the upstream reservoirs.

Flows on the San Joaquin River along the southern boundary of the Madera Subbasin originate from various upstream sources, including Millerton Reservoir releases at Friant Dam. Streamgage data from the United States Geological Survey (USGS)[2] shows flows along the San Joaquin River during most times of year, with greater flows typically occurring during spring months of wet water years.

2.3.2 Waterways within the Purview of the Central Valley Flood Protection Board

Core considerations for waterways within the purview of the Central Valley Flood Protection Board (CVFPB) are the freeboard and design profile, as defined in the corresponding Federal and State Operation and Maintenance Manuals (O&M Manuals).

In their comments to the Madera Subbasin GSAs, the CVFPB noted that any reduction in the freeboard or change to design profile, beyond the design criteria given in the O&M Manuals, may lead to increased flood risk and damage to Federal-State flood control facilities, and is considered unlawful for waterways in their purview.

The GSAs have recognized and considered the following design criteria of waterway reaches in the Madera Subbasin when establishing the subsidence-related SMC for the Madera Subbasin:

- Fresno River:
  - Bank levees freeboard of 3 feet
  - Design flows of 5,000 cubic feet per second (cfs)
- San Joaquin River:
  - Bank levees freeboard of 3 feet
  - Design flows of 8,000 cfs
- Chowchilla Bypass:
  - Bank levees freeboard of 4 feet

[2] USGS 11251000 SAN JOAQUIN R BL FRIANT CA. https://waterdata.usgs.gov/nwis/uv?site_no=11251000.

- Design flows of 5,500 cfs

2.4 Groundwater Wells

Groundwater well infrastructure in the Madera Subbasin encompasses the infrastructure of multiple types of wells, including agricultural wells, domestic wells, and public supply wells. Sustaining access to groundwater is crucial to upholding the Human Right to Water (as set forth in California Water Code § 106.3) and is also important to maintaining the economic vitality of the Madera Subbasin.

Figure 7 through **Figure 9** show the general locations of groundwater wells of each type (agricultural, domestic, and public supply), aggregated by section from Well Completion Report (WCR) data available from the California Department of Water Resources (DWR). WCR data includes only wells with well completion reports that have been submitted to DWR since 1970, and thus typically underestimates the total number of wells in each section. However, the data is expected to provide a reasonably accurate understanding of the relative location and distribution of wells in the Madera Subbasin. Agricultural wells are the most uniformly distributed across the entire Madera Subbasin, while domestic wells and public supply wells are distributed most densely in a strip generally following SR 99, especially in sections surrounding the City of Madera, and in sections around Bonadelle Ranchos-Madera Ranchos. Agricultural wells in the Madera Subbasin are typically deeper than domestic and public supply wells (see the Madera Subbasin Revised Joint GSP Figures 2-44 through 2-46).

2.5 Wastewater Infrastructure

Wastewater infrastructure in the Madera Subbasin primarily includes the wastewater treatment plant operated within the City of Madera. Like other municipal infrastructure, maintaining the integrity of wastewater infrastructure is important to maintaining sanitary conditions in urban communities. The importance of functional wastewater infrastructure is closely tied to the Human Right to Water.

3 Relationship between Subsidence Conditions and Infrastructure Concerns

This section summarizes the potential URs to critical infrastructure that may result from subsidence, and then evaluates the relationship between recent historical subsidence that has occurred in the Madera Subbasin and the potential vulnerability of critical infrastructure in the Madera Subbasin. Maps referenced in these subsections are provided at the end of the Assessment. It is noted that the Joint GSP GSAs have set the subsidence minimum thresholds (MTs) at 0.00 feet/year in 2040. Subsidence conditions at 2040 are not expected to trigger undesirable results for any of the critical infrastructure.

Figure 3 through **Figure 9** show the location of critical infrastructure and the historical cumulative subsidence between 2015-2020 in the Madera Subbasin. These figures show

cumulative subsidence conditions (reported as total vertical displacement from InSAR[3] data) starting with the first available InSAR data (June 2015) and extending through June 2020. **Figure 10** through **Figure 16** similarly show the location of critical infrastructure and the historical cumulative subsidence between 2015-2022 in the Madera Subbasin, extending the summary of subsidence conditions through the most recently available InSAR data available at the time of this analysis (through June 2022). The subsections below summarize relevant findings related to each figure, in addition to other pertinent findings from other studies and surveys of subsidence impacts in the Madera Subbasin.

3.1 Roads and Highway Infrastructure

In general, subsidence has the potential to cause URs to users of road and highway infrastructure by causing deterioration or loss of access and use of that infrastructure through fractures, unevenness, or other issues with structural integrity.

There is currently no known subsidence-related issue that has resulted in loss of access and use of road and highway infrastructure in the Madera Subbasin. As shown in **Figure 3, Figure 4**, **Figure 10**, and **Figure 11**, SR 99 – the roadway with the greatest number of bridges and the highest volume of traffic in the Madera Subbasin – is located in the central and eastern portion of the Madera Subbasin where subsidence rates have generally been lower. Between 2015-2020, the total cumulative subsidence along SR 99 ranged from virtually zero subsidence (southeast of the City of Madera) to, at most, approximately 2 feet of total cumulative subsidence (less than approximately 0.4 feet per year over approximately five years). Along SR 145, the total cumulative subsidence from 2015-2020 was less than 1 foot (approximately 0.2 feet per year over approximately five years). Along SR 41, the total cumulative subsidence from 2015-2020 was less than approximately 0.5 feet (.1 feet per year over approximately five years).

As described in Section 3.4.3 of the Madera Subbasin Revised Joint GSP, the GSAs are planning to mitigate subsidence, as needed, in the Madera Subbasin and do not expect residual subsidence conditions to cause URs to beneficial uses and users of roads and highway infrastructure. However, the GSAs will continue to monitor conditions and will adapt GSP implementation if URs are found to occur. Future findings and adaptations to GSP implementation will be described in Annual Reports, as applicable.

3.2 Railroad Infrastructure

Similar to roads and highways, subsidence has the potential to cause URs to users of railroads by causing deterioration or loss of access and use of railways and related infrastructure through fractures, unevenness, or other issues with structural integrity.

[3] Interferometric Synthetic Aperture Radar (InSAR) data provides measurements of vertical ground surface displacement, and is available from the California Department of Water Resources (DWR) beginning in June 2015. https://data.cnra.ca.gov/dataset/tre-altamira-insar-subsidence.

There is currently no known subsidence-related issue that has resulted in loss of access and use of railroad infrastructure in the Madera Subbasin. As shown in **Figure 5** and **Figure 12**, railroads in the Madera Subbasin are located in the northern and eastern portions of the Madera Subbasin where the cumulative subsidence from 2015-2020 was between 0.0 to 2 feet (approximately 0.0 to 0.4 feet per year over approximately five years). As described in Section 3.4.3 of the Madera Subbasin Revised Joint GSP, the GSAs are planning to mitigate subsidence, as needed, in the Madera Subbasin and do not expect residual subsidence conditions to cause URs to beneficial uses and users of railroad infrastructure. However, the GSAs will continue to monitor conditions and will adapt GSP implementation if URs are found to occur. Future findings and adaptations to GSP implementation will be described in Annual Reports, as applicable.

3.3 Waterways and Conveyance Infrastructure

Subsidence in the Madera Subbasin has the potential to cause URs to uses and users of waterways and conveyance infrastructure by potentially causing changes in the design profile and slope of gravity flow channels, affecting freeboard and channel capacity. Changes that reduce capacity can impact the ability of surface water suppliers to use those conveyance channels to meet demands. Changes that reduce capacity and diminish freeboard can also cause flooding along waterways during times of peak flow. The GSAs considered potential impacts to waterways in the Madera Subbasin resulting from subsidence in relation to the channel design criteria described in the respective O&M Manuals, including the channel freeboard and design profile.

3.3.1 East-West Oriented Waterways

As shown in **Figure 6** and **Figure 13**, the majority of waterways in the Madera Subbasin flow generally from east to west, in the same general direction as the cumulative "subsidence gradient" that has historically occurred in the Madera Subbasin. Along these "east-west" oriented waterways – including the Fresno River, Berenda Creek, Cottonwood Creek, and Dry Creek – higher subsidence rates in the western portion of the Madera Subbasin have increased the existing slope of the ground surface (**Figure 2**), functionally increasing the capacity of those channels. Thus, despite there being higher rates of subsidence in the western portion of the Madera Subbasin where these waterways flow – as much as 3.0 feet in some areas between 2015-2020 (approximately 0.6 feet per year) and as much as 4.5 feet in some areas along the Chowchilla Subbasin boundary between 2015-2022 (approximately 0.9 feet per year) – the GSAs do not anticipate that subsidence conditions will cause URs to beneficial uses and users of these east-west oriented waterways in the Madera Subbasin in the near future.

For subsidence to substantially impact the freeboard and design profile of those east-west oriented waterways in opposition to the O&M Manuals, subsidence rates in the eastern portion of the Madera Subbasin would need to significantly increase relative to the western portion of the Madera Subbasin and reduce the existing ground surface slope. Considering historical subsidence conditions and differences in the underlying geologic structure of the Madera Subbasin from east-to-west, the GSAs consider URs to beneficial uses and users of the east-

west oriented waterways to be unlikely. Nevertheless, as described in Section 3.4.3 of the Madera Subbasin Revised Joint GSP, the GSAs will continue to monitor conditions and will adapt GSP implementation if URs are found to occur. Future findings and adaptations to GSP implementation will be described in Annual Reports, as applicable.

3.3.2 Madera Canal

Besides those east-west oriented waterways that are used for conveyance of surface water supplies (Fresno River, Berenda Creek, Cottonwood Creek, Dry Creek), the primary conveyance infrastructure in the Madera Subbasin is the Madera Canal.

The Madera Canal flows along the far northeastern portion of the Madera Subbasin where the cumulative subsidence from 2015-2022 remained less than 0.5 feet in total (less than 0.1 feet per year). There is currently no known subsidence-related issue with capacity or flows along Madera Canal in the Madera Subbasin. The GSAs consider any future URs to the Madera Canal to be highly unlikely in view of the Madera Subbasin's topography and the location of the Madera Canal relative to where subsidence has historically occurred.

3.3.3 Chowchilla Bypass and San Joaquin River

During development of the Madera Subbasin GSPs and the Revised GSPs, the Madera Subbasin GSAs reviewed past analyses of subsidence-related capacity concerns conducted by DWR in May 2018 for the San Joaquin River Restoration Program (SJRRP). These analyses are documented in a report titled "Evaluation of the Effect of Subsidence on Flow Capacity in the Chowchilla and Eastside Bypasses, and Reach 4A of the San Joaquin River" (DWR, 2018). The analyses were conducted to evaluate the subsidence-related impacts to the flow capacity of the Chowchilla Bypass, the Eastside Bypass, and the San Joaquin River under recent historical subsidence conditions (as of 2016) and projected future subsidence conditions through 2026. Flows under the different subsidence-related topography changes were simulated using HEC-RAS[4] with consideration for the channel design criteria in the O&M Manuals (described in Section 2.3.2, above).

Table 3 of the analysis (shown in **Table 1**, below) summarizes the estimated flow capacity in:

- Chowchilla Bypass (segment from the bifurcation structure at the San Joaquin River to the Fresno River; this segment flows primarily within the Madera Subbasin),
- Eastside Bypass (four segments from the end of the Chowchilla Bypass to the Mariposa Bypass; these segments primarily flow outside the Madera Subbasin)
- San Joaquin River (Reach 4A, which flows along the boundaries of the Chowchilla Subbasin, and the San Slough Connector Channel; these segments primarily flow outside the Madera Subbasin)

[4] United States Army Corps of Engineers Hydrologic Engineering Center's River Analysis System (HEC-RAS). Available at: https://www.hec.usace.army.mil/software/hec-ras/.

Results of the analysis were calculated assuming a fixed freeboard set according to the design criteria in the O&M Manuals. The extent of each reach considered in the analysis is shown in **Figure 17**, below. These analyses found that:

- Flow capacity in all reaches of the Chowchilla Bypass (within the Madera Subbasin) and two reaches of the Eastside Bypass (from Fresno River to Ash Slough, directly downstream of the Madera Subbasin) were within design flows in all historical and projected scenarios considered.
- Flow capacity in the San Joaquin River Reach 4A (outside the Madera Subbasin) and in the Eastside Bypass from Ash Slough to Sand Slough (outside the Madera Subbasin) were already considered to be below the design capacity beginning in the scenario considering historical subsidence conditions as of 2016.

These findings suggest that:

- The design profile and freeboard of the Chowchilla Bypass (within the Madera Subbasin) and upstream reaches of the Eastside Bypass (directly downstream of the Madera Subbasin) were not adversely impacted by subsidence conditions as of 2016, and were not anticipated to be impacted by future subsidence through 2026 (under the assumptions given below).
- The design profile and freeboard of the San Joaquin River Reach 4A (outside the Madera Subbasin) and the Eastside Bypass from Ash Slough to Sand Slough (outside the Madera Subbasin) were already impaired relative to the design criteria given in the O&M Manuals as of 2016. These impairments are far outside the boundaries of the Madera Subbasin and are not understood to be directly impacted by subsidence conditions within the Madera Subbasin. Additionally, these impairments precede the formation of the GSAs and the GSP implementation period in both the Madera Subbasin and neighboring subbasins.

The GSAs do recognize certain assumptions and limitations given for these analyses (DWR, 2018), mainly:

- Flows were modeled using HEC-RAS, and were validated by flows in 2017 (assuming that those flows were close to design flows). Flow capacities were evaluated for two conditions: a run-of-the-river condition in which there were no concurrent tributary flows, and a backwater condition in which there were concurrent flows in tributary channels that added to downstream flows. Tributary flows to the Chowchilla/Eastside Bypass from Ash Slough, Berenda Slough, and other waterways were assumed to concurrently reach their design flows (per the O&M Manuals) in backwater model scenarios. The GSAs cannot be sure of the validity of the model or these assumptions.
- Projected future subsidence rates through 2026 were estimated using the average annual subsidence rates reported by the United States Bureau of Reclamation from 2011 to 2017. Those subsidence rates may not accurately reflect the actual rates observed from InSAR data in 2017-2020 in the Madera Subbasin and neighboring areas of the Chowchilla Subbasin. For instance, certain landowners in the southwestern portion of the Chowchilla Subbasin (near the Madera and Delta-Mendota Subbasins)

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entered into a Subsidence Control Measures Agreement in 2017 and have since made significant progress to reduce subsidence by reducing pumping from the Lower Aquifer. Those efforts have resulted in significantly reduced subsidence rates in the vicinity of the Chowchilla Bypass, Eastside Bypass, and the San Joaquin River, as compared to rates prior to 2017 (see Section 3.3.3 of the Chowchilla Subbasin Revised GSP).

- The conclusions of DWR's study are planning-level modeled estimates that do not consider factors besides subsidence (e.g., sediment transport). Sediment deposition is another factor that affects capacity, although sediment management and maintenance of the Chowchilla Bypass, Eastside Bypass, and the San Joaquin River is not the responsibility of the GSAs.

Considering these findings, the GSAs do not expect that subsidence conditions in the Madera Subbasin will impair the design profile or freeboard of the Chowchilla Bypass in the Madera Subbasin during the GSP implementation period. The GSAs also do not expect subsidence conditions in the Madera Subbasin to impair the design profile or freeboard of the Eastside Bypass or the San Joaquin River directly downstream of the Madera Subbasin beyond what conditions were already present prior to 2016.

Nevertheless, as described in Section 3.4.3 of the Madera Subbasin Revised Joint GSP, the GSAs will continue to monitor conditions and will adapt GSP implementation if URs are found to occur. Future findings and adaptations to GSP implementation will be described in Annual Reports, as applicable.

3.4 Groundwater Wells

In general, subsidence has the potential to cause URs to users of groundwater well infrastructure by causing deterioration or loss of access and use of that infrastructure through casing damage, collapse, or other issues with structural integrity. These potential issues are also affected or exacerbated by other factors besides subsidence, such as well age, construction, and materials.

As shown in **Figure 7** and **Figure 14**, agricultural wells are generally distributed evenly throughout the Madera Subbasin, in areas where both higher and lower rates of subsidence have occurred. A survey of agricultural well owners in portions of Madera County in spring 2022 found that wells near the Madera/Chowchilla Subbasin border were beginning to collapse, particularly in areas that have experienced approximately 3 feet of subsidence or more. However, the agricultural well owners that were surveyed also indicated that these effects and the costs of well deepening and replacement were considered a necessary side effect of maintaining the economic viability of their businesses during the current drought and early GSP implementation efforts, while projects and management actions – including demand management – ramp up. Those agricultural well owners surveyed did not consider these effects to be "undesirable results." The GSAs will continue to monitor conditions and engage with stakeholders, and will adapt GSP implementation if URs are found to occur. Future findings and adaptations to GSP implementation will be described in Annual Reports, as applicable.

As shown in **Figure 8**, **Figure 9**, **Figure 15**, and **Figure 16**, domestic wells and public supply wells in the Madera Subbasin are distributed most densely in the vicinity of SR 99, especially in sections surrounding the City of Madera, and in sections around Bonadelle Ranchos-Madera Ranchos. While these areas of the Madera Subbasin have historically experienced lower rates of subsidence, domestic wells in various parts of the Madera Subbasin have already experienced URs from loss of access to groundwater. SMC and GSP implementation efforts have been designed to directly address these issues and preserve the Human Right to Water, as described in Section 3.4.3 of the Madera Subbasin Revised Joint GSP.

Discussions and stakeholder input during public GSP development meetings indicated a clear desire to balance the water supply needs of all beneficial uses and users of groundwater to the greatest extent practicable. Stakeholders expressed clear intent to protect domestic well users that rely on groundwater, but also expressed a desire to protect the local agricultural economy – the economic lifeblood of the region – while GSP implementation ramps up. The GSAs considered many groundwater management approaches to achieve these goals of balancing diverse beneficial user interests. The minimum thresholds (MTs) established for groundwater levels in the Madera Subbasin reflect the outcome of this balanced approach, allowing groundwater use for agricultural production to continue, albeit at a gradually reducing rate, while GSP implementation ramps up, and recognizing that this would likely result in lowered groundwater levels impacting some well users in the Madera Subbasin. This approach was considered preferable to alternatives that would require immediate and substantial cutbacks in agricultural groundwater pumping in order to avoid significant and unreasonable adverse impacts on well users, especially domestic wells. Such an alternative would result in major economic impacts to the local communities and all stakeholders in the Madera Subbasin, including domestic well users and disadvantaged communities. The GSAs re-evaluated the economic tradeoffs of these alternatives in 2022 (Appendix 3.D of the Madera Subbasin Revised Joint GSP), and determined that the avoided costs resulting from immediate demand reduction (i.e., fewer domestic wells requiring replacement) would be comparatively small ($38.64 million) relative to the additional lost agricultural net return ($251.98 million) in the Madera Subbasin, even after accounting for the pumping cost savings ($92.52 million). These analyses considered the impacts of immediate demand reduction only on agricultural net return, but in reality the economic impacts would spread to other county businesses and industries, significantly increasing the net effect on all beneficial uses and users of groundwater in the Madera Subbasin, including domestic well owners.

With these findings, the GSAs determined that implementing a Domestic Well Mitigation Program would provide the best and most economically reasonable outcome for beneficial uses and users of groundwater in the Madera Subbasin by preserving the local economy and protecting domestic well users' access to groundwater. For this reason, the GSAs have elected to mitigate for potential impacts to domestic well users during the GSP implementation period or until groundwater sustainability is achieved. Implementation of the Domestic Well Mitigation

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Program will allow the GSAs to establish lower MTs that avoid URs to other groundwater users, while still preserving access to critical water supplies for domestic well users.

The GSAs have expressed and formalized their clear commitment to fund and implement the Program beginning no later than January 1, 2024. GSA staff and representatives have already made substantial and material progress toward Program development and implementation by creating and executing a Domestic Well Mitigation Program Memorandum of Understanding (MOU).

3.5 Wastewater Infrastructure

Subsidence has the potential to cause URs to users of wastewater infrastructure by causing deterioration or loss of functionality of the gravity flow characteristics of those systems and by causing other issues with structural integrity.

There is currently no known subsidence-related issue that has resulted in loss of functionality of wastewater infrastructure in the Madera Subbasin. The cumulative subsidence in the City of Madera service area (**Figure 1**) was approximately 1.5 feet or less between 2015-2022 (approximately 0.2 feet per year or less over approximately seven years). As described in Section 3.4.3 of the Madera Subbasin Revised Joint GSP, the GSAs are planning to mitigate subsidence, as needed, in the Madera Subbasin and do not expect residual subsidence conditions to cause URs to beneficial uses and users of wastewater infrastructure. However, the GSAs will continue to monitor conditions and will adapt GSP implementation if URs are found to occur. Future findings and adaptations to GSP implementation will be described in Annual Reports, as applicable.

4 References

DWR. 2018. Evaluation of the Effect of Subsidence on Flow Capacity in the Chowchilla and Eastside Bypasses, and Reach 4A of the San Joaquin River. May 2018. In Technical Memorandum: Channel Capacity Report 2018 Restoration Year. San Joaquin River Restoration Program. January 2019.

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5 Figures and Tables

Figure 3 through **Figure 17** and **Table 1** are provided below.

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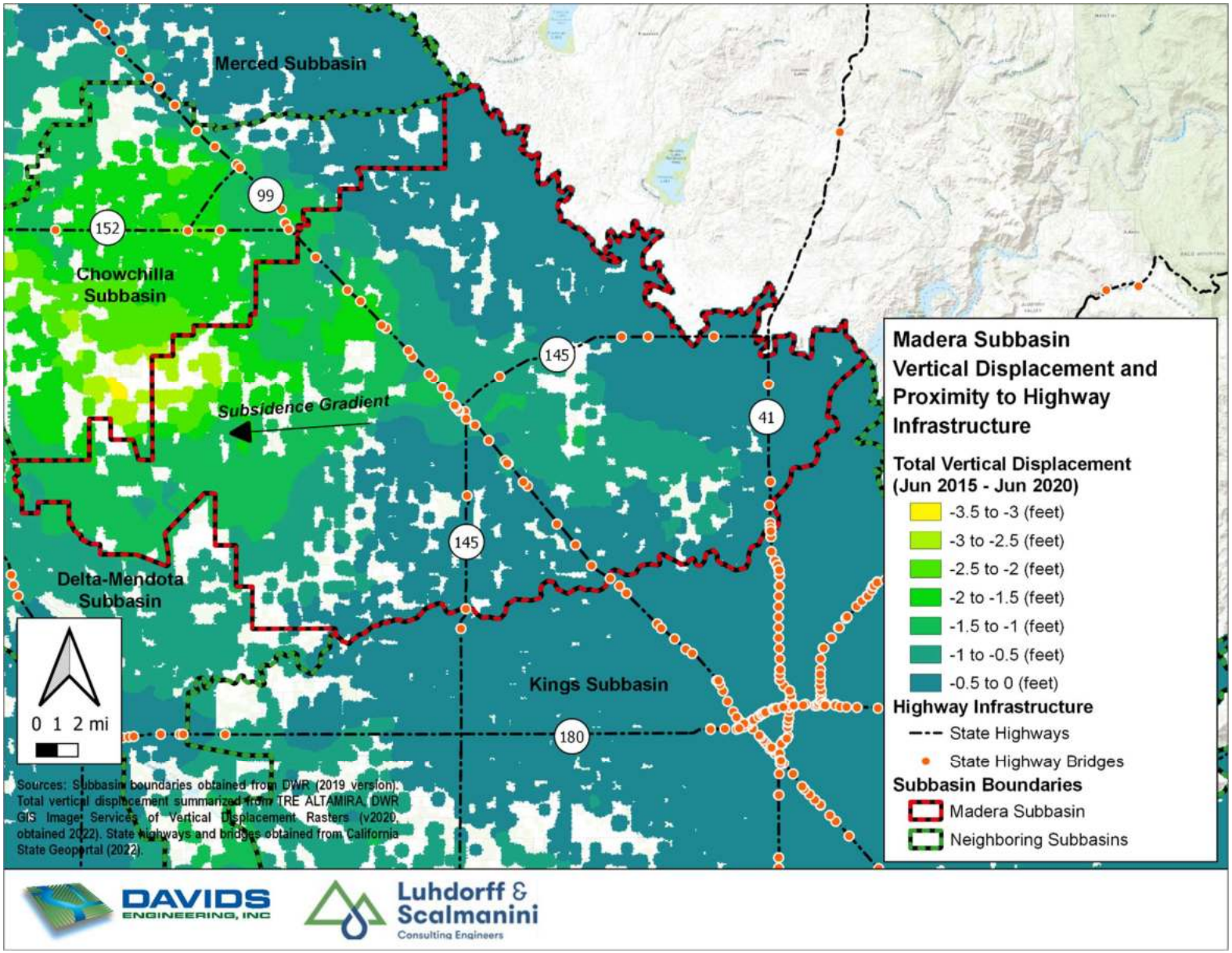


Figure 3. Vertical Displacement (June 2015 - June 2020) and Proximity to Highway Infrastructure.

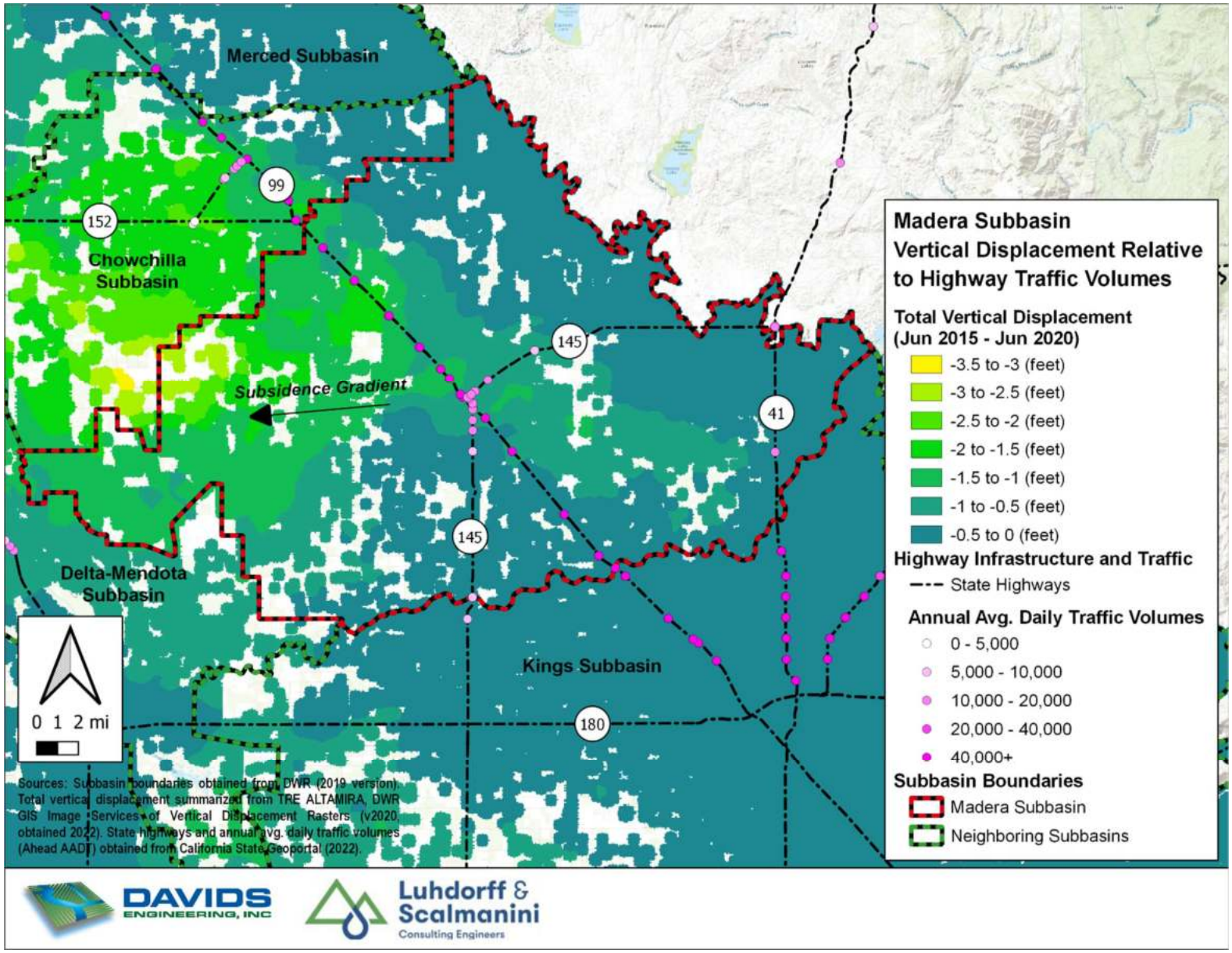


Figure 4. Vertical Displacement (June 2015 - June 2020) Relative to Highway Traffic Volumes.

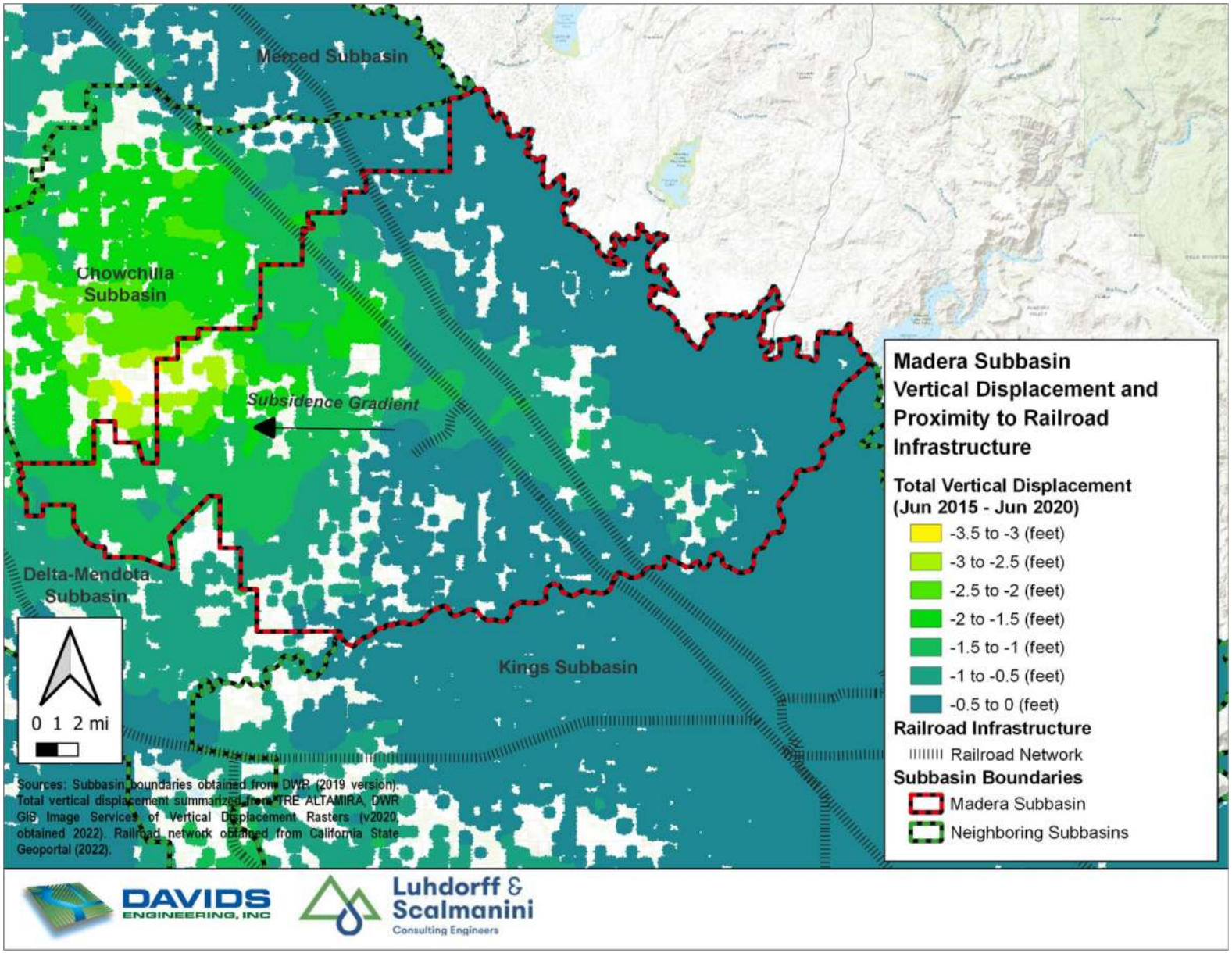


Figure 5. Vertical Displacement (June 2015 - June 2020) and Proximity to Railroad Infrastructure.

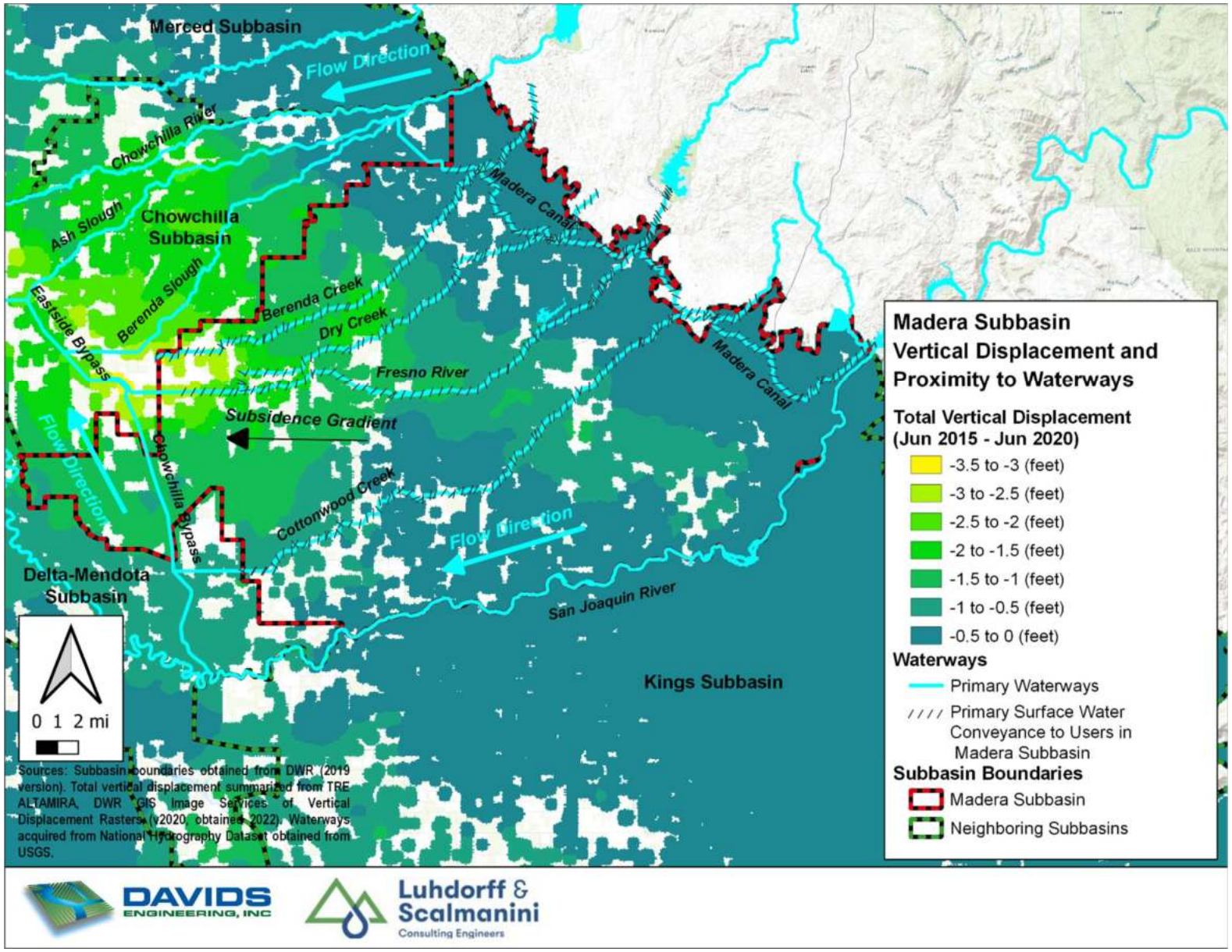


Figure 6. Vertical Displacement (June 2015 - June 2020) and Proximity to Waterways and Surface Water Conveyance Infrastructure.

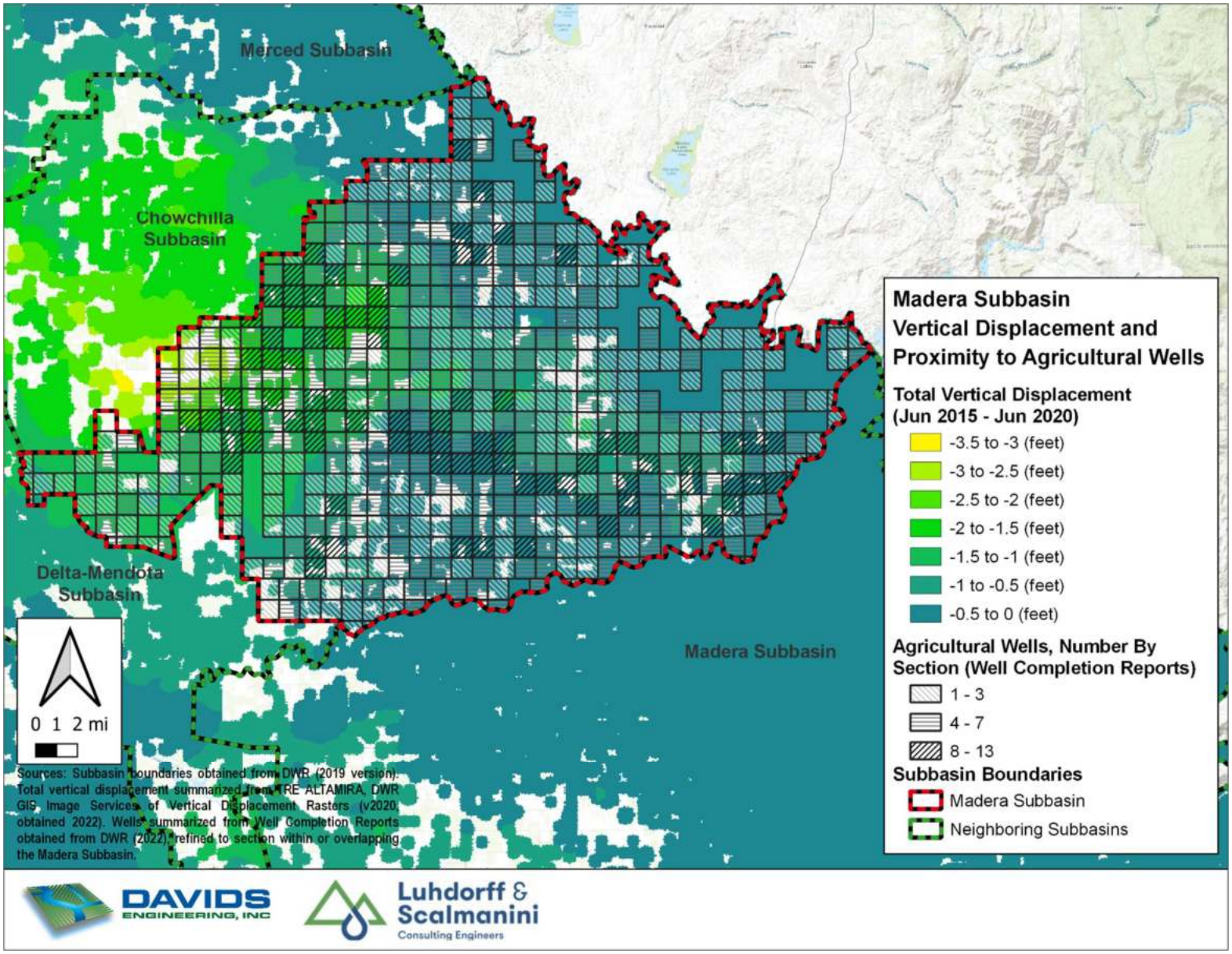


Figure 7. Vertical Displacement (June 2015 – June 2020) and Proximity to Agricultural Wells.

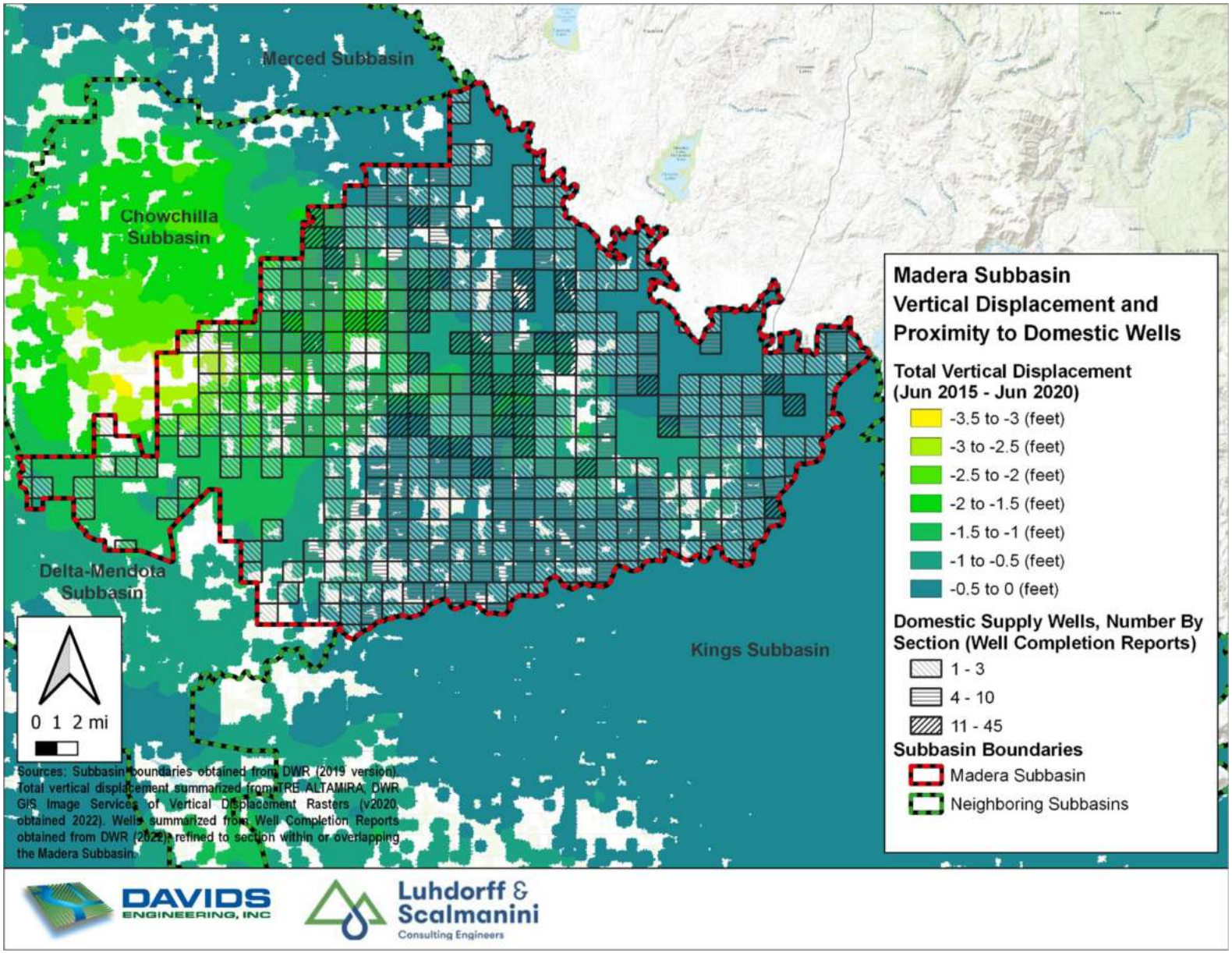


Figure 8. Vertical Displacement (June 2015 – June 2020) and Proximity to Domestic Wells.

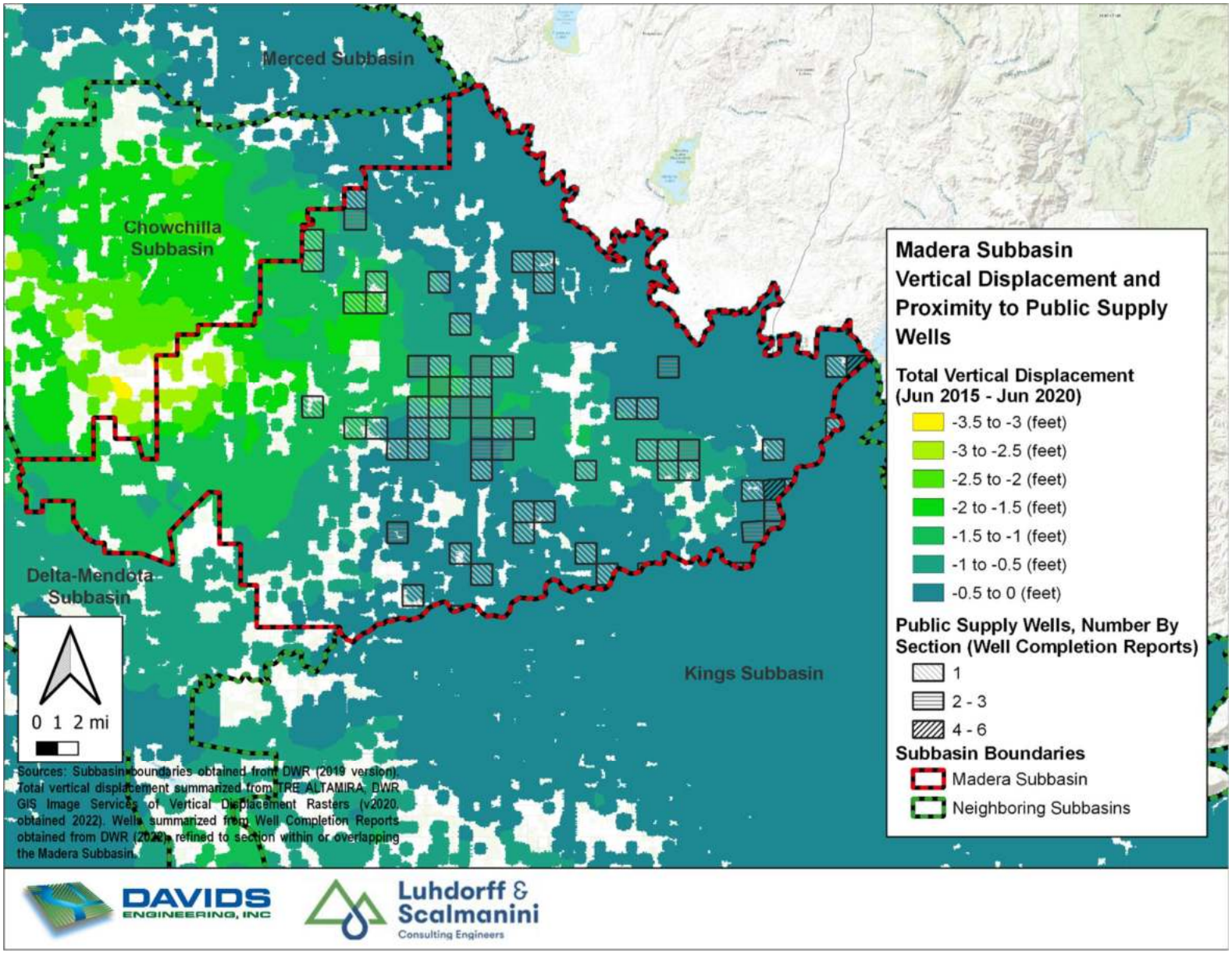


Figure 9. Vertical Displacement (June 2015 – June 2020) and Proximity to Public Supply Wells.

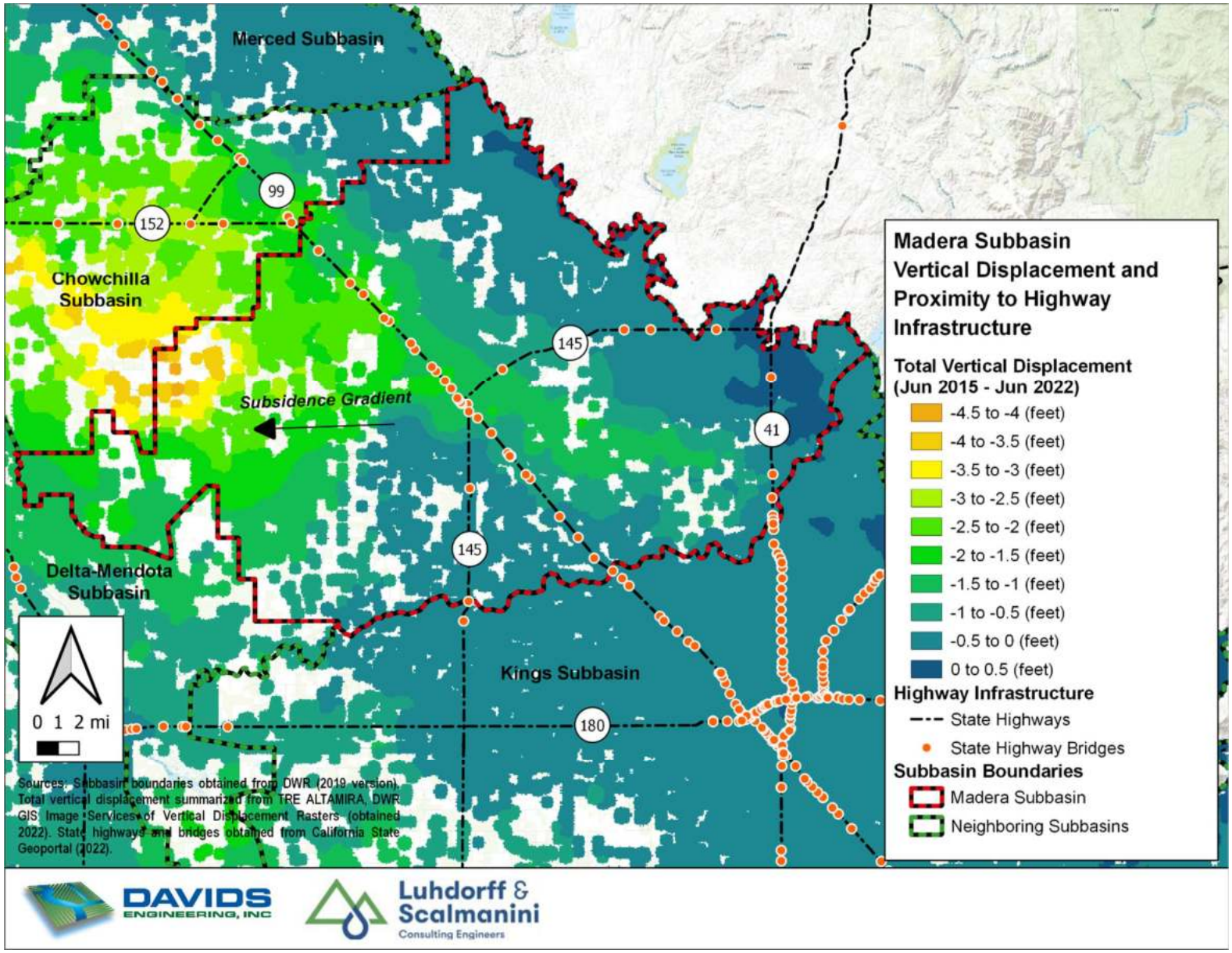


Figure 10. Vertical Displacement (June 2015 – June 2022) and Proximity to Highway Infrastructure.

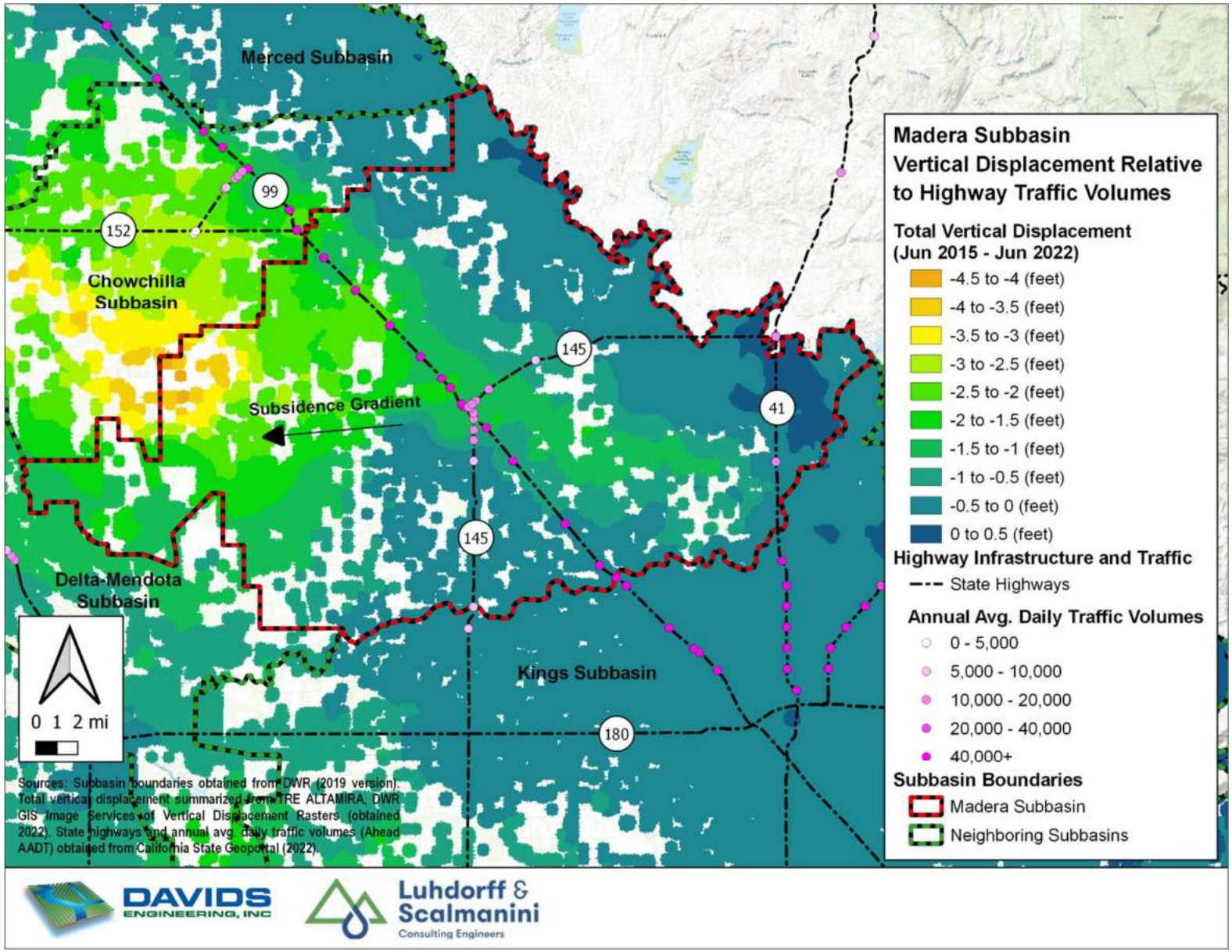


Figure 11. Vertical Displacement (June 2015 – June 2022) Relative to Highway Traffic Volumes.

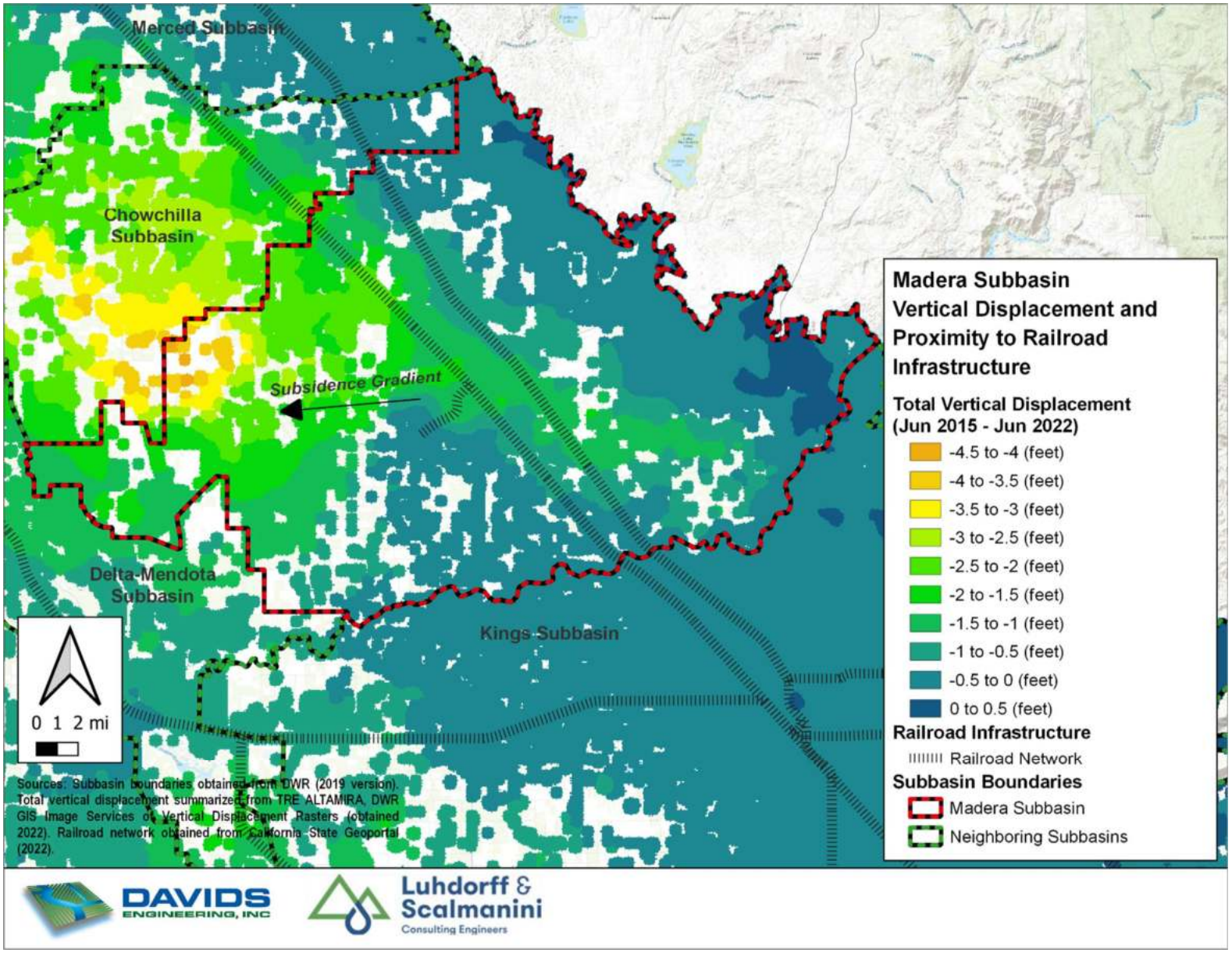


Figure 12. Vertical Displacement (June 2015 – June 2022) and Proximity to Railroad Infrastructure.

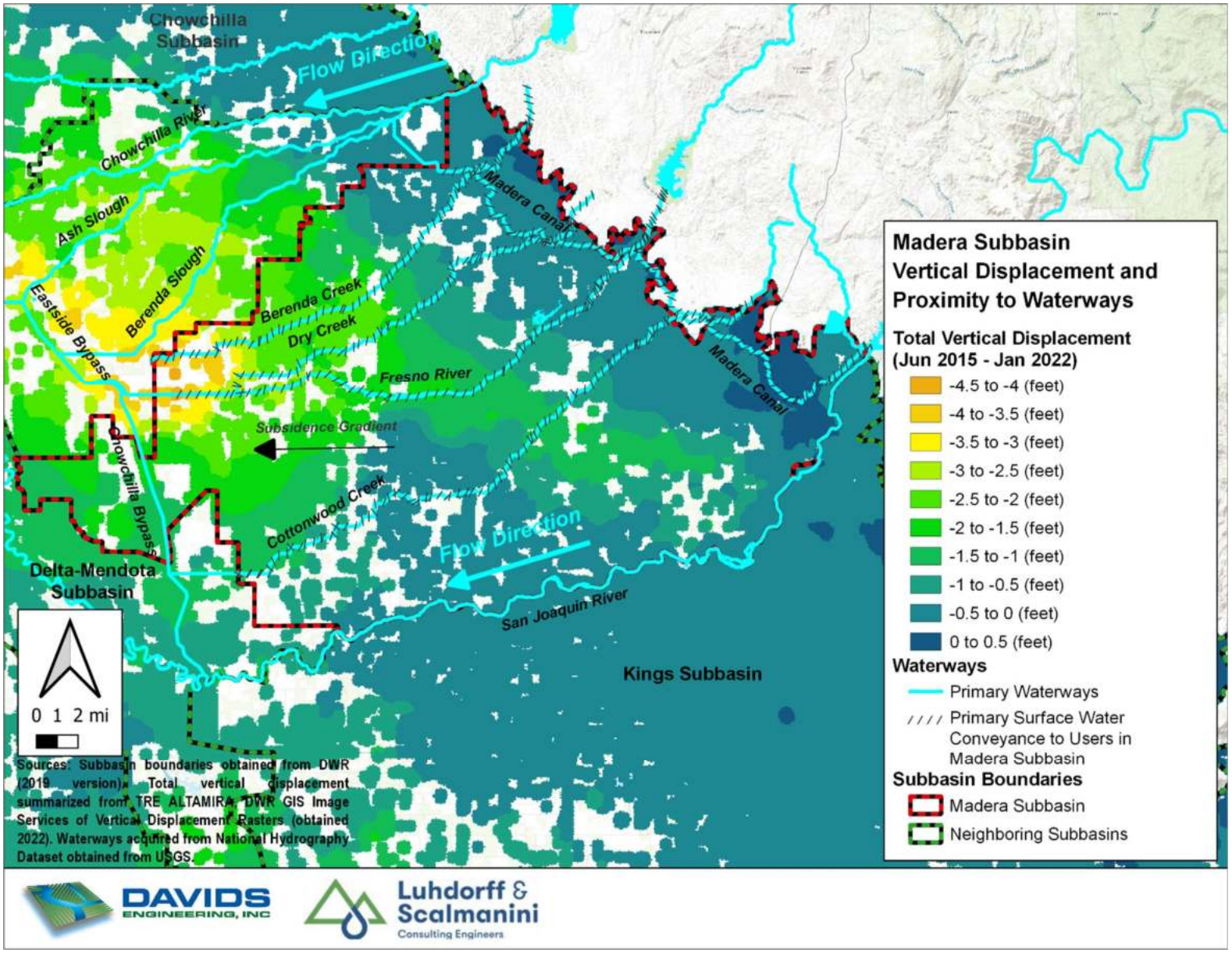


Figure 13. Vertical Displacement (June 2015 – June 2022) and Proximity to Waterways and Surface Water Conveyance Infrastructure.

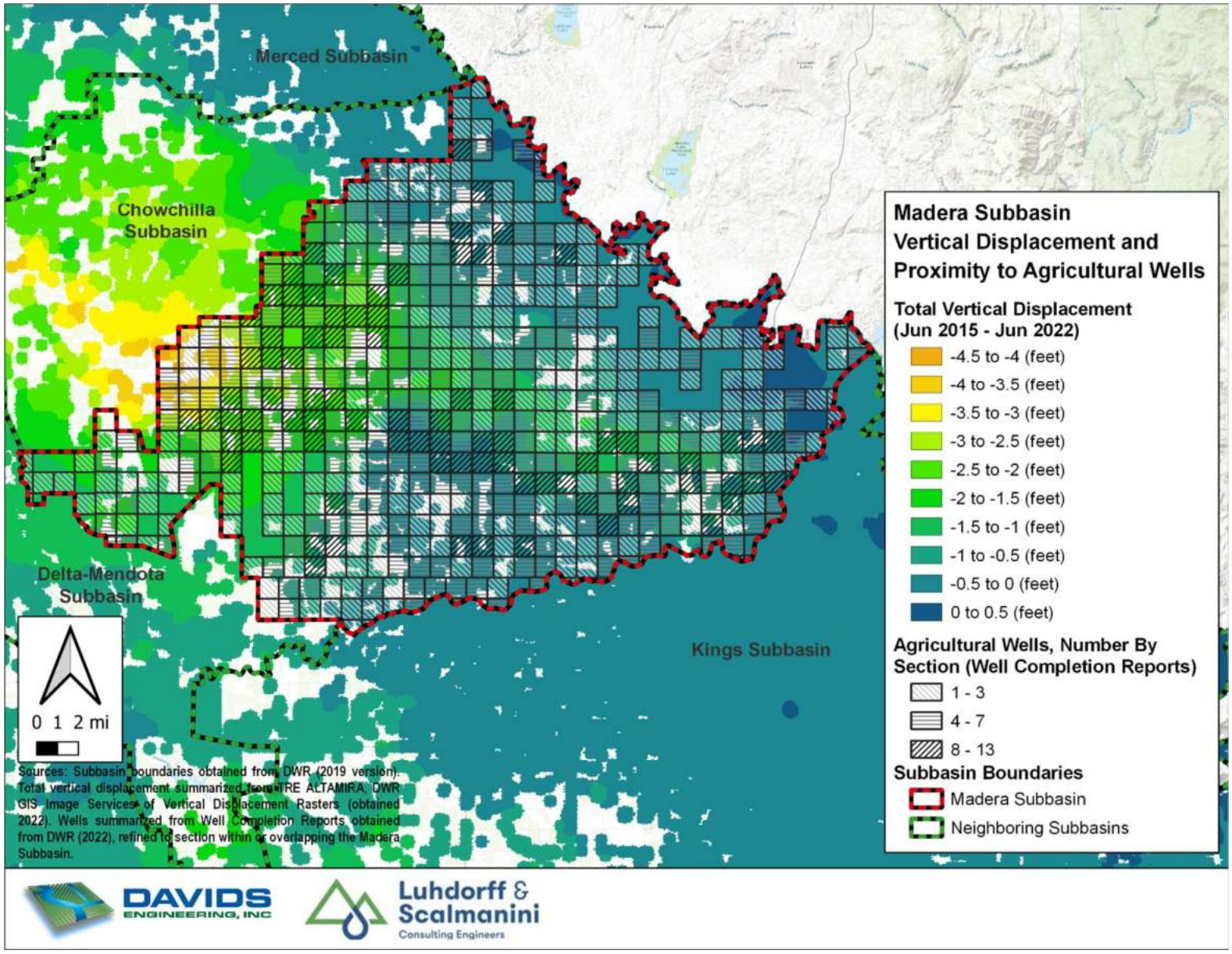


Figure 14. Vertical Displacement (June 2015 - June 2022) and Proximity to Agricultural Wells.

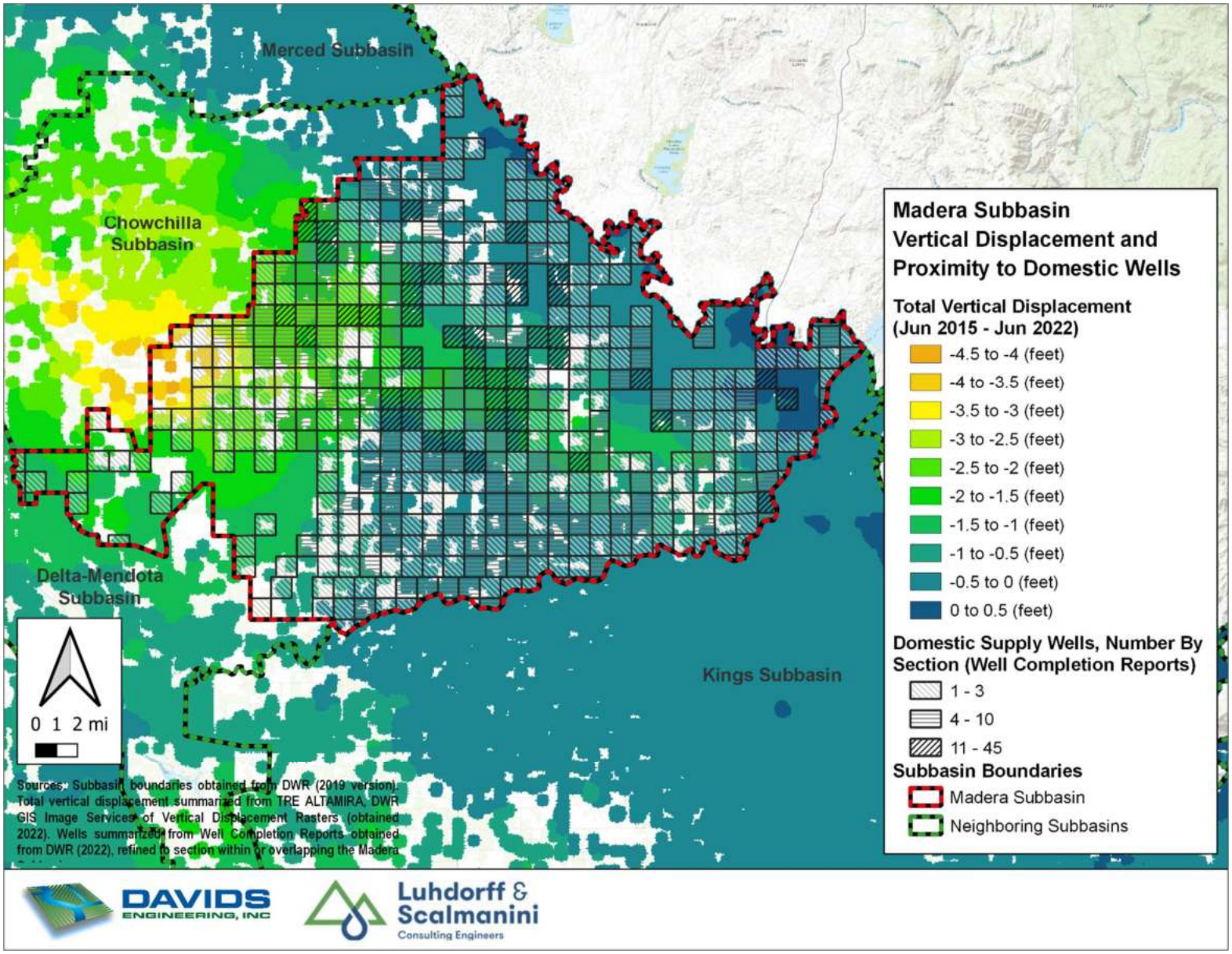


Figure 15. Vertical Displacement (June 2015 - June 2022) and Proximity to Domestic Wells.

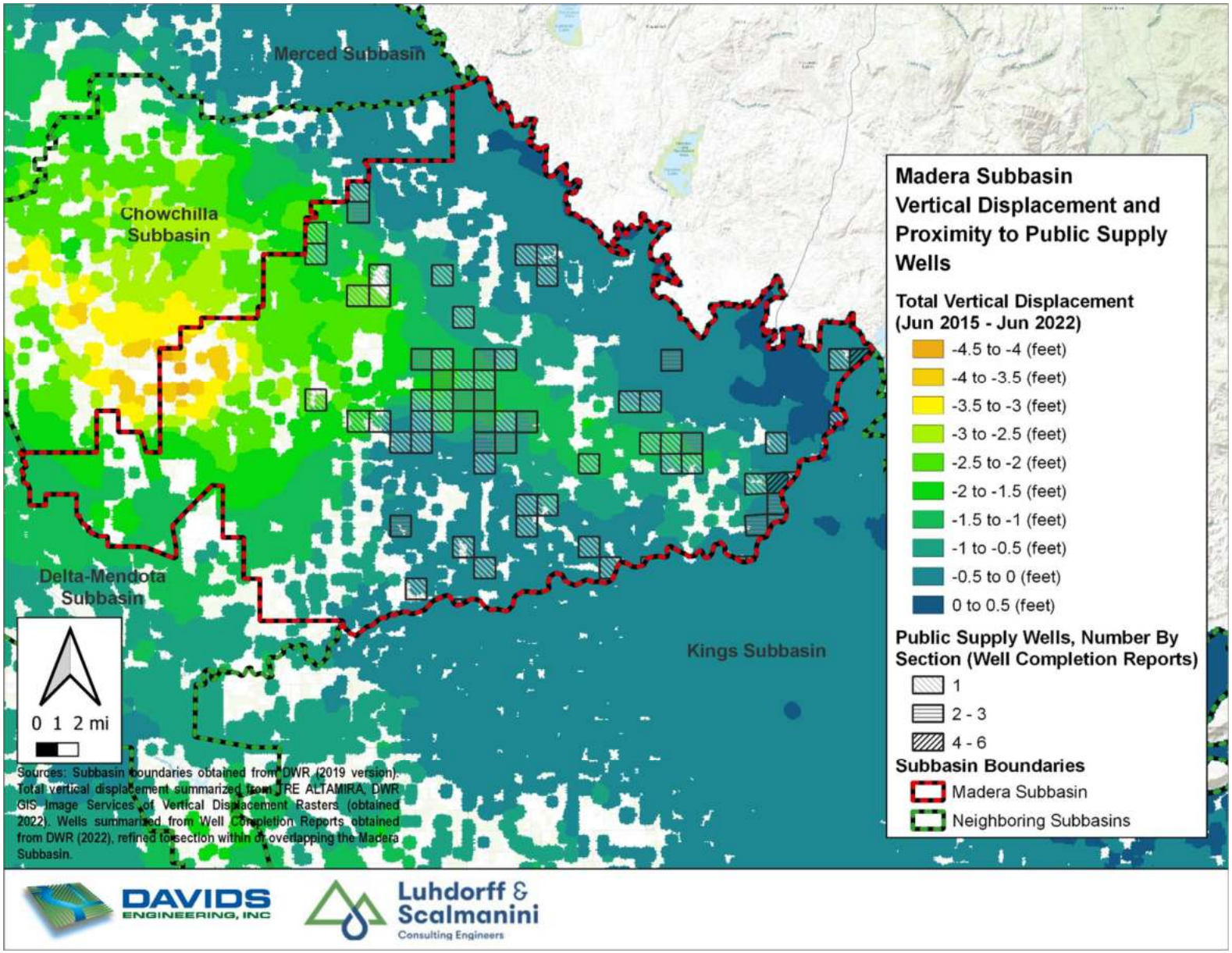


Figure 16. Vertical Displacement (June 2015 - June 2022) and Proximity to Public Supply Wells.

Figure 1 Study Area

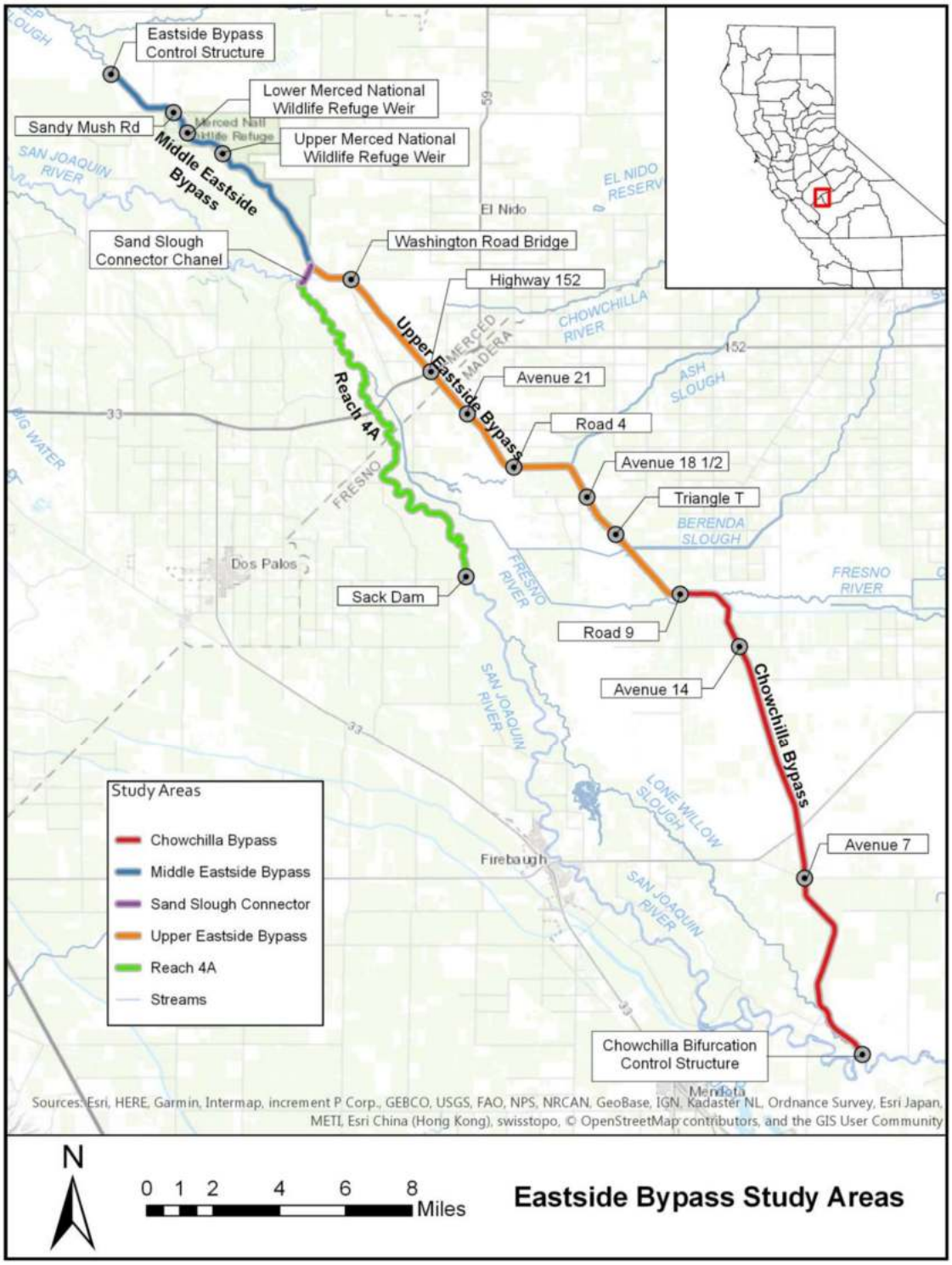


Figure 17. DWR Analysis Study Area, from "Evaluation of the Effect of Subsidence on Flow Capacity in the Chowchilla and Eastside Bypasses, and Reach 4A of the San Joaquin River" (DWR, 2018). A section of the Chowchilla Bypass flows through the eastern reach of the Madera Subbasin.

Table 1. DWR Analysis Results, from "Evaluation of the Effect of Subsidence on Flow Capacity in the Chowchilla and Eastside Bypasses, and Reach 4A of the San Joaquin River" (DWR, 2018). A portion of the Chowchilla Bypass flows through the eastern reach of the Madera Subbasin.

Table 3 Estimated Flow Capacity in Reach 4A and the Chowchilla and Eastside Bypasses based on Freeboard Criteria (in cfs)

Channel Segment	Flood Design Flow[a]	2008[b]	2011[b]	2016	2026
Chowchilla Bypass					
Bifurcation Structure to Fresno River	5,500	>5,500	>5,500	>5,500	>5,500
Eastside Bypass					
Fresno River to Berenda Slough	10,000	>10,000	>10,000	>10,000	>10,000
Berenda Slough to Ash Slough	12,000	>12,000	>12,000	>12,000	>12,000
Ash Slough to Sand Slough	17,500	9,500[c] – 12,500	7,500[c] – 11,500	5,700[c] – 9,500	3,400[c] - 7,500
Sand Slough to Mariposa Bypass[d]	16,500	16,000	14,500	12,500	9,800
San Joaquin River					
Reach 4A	4,500	ND	ND	3,700[e] – 4,300	2,500[e] – 3,800
Sand Slough Connector Channel	ND	ND	ND	2,100[e] – > 4,500	0[e] – > 4,500

Notes: cfs = cubic feet per second, ND = not determined as part of this study

[a] Referenced from the Lower San Joaquin River Flood Control Project Operation and Maintenance Manual.

[b] Results obtained from a previous study done by DWR in 2013.

[c] Reduced capacity assumes contribution of 4,500 cfs from Reach 4A of the San Joaquin River (creating backwater conditions).

[d] Capacity assumes diversions into the Mariposa Bypass based on the O&M Manual operating rules.

[e] Reduced capacity assumes contribution of 12,000 cfs through the Bypass Channel (creating backwater conditions).

APPENDEX ITEM 3.H

SUBSIDENCE DATA GAPS WORKPLAN

A.2 Component 3: Subsidence Workplan Implementation

Some areas of the Madera Subbasin (Subbasin) have experienced land subsidence in recent years, as documented in the four GSPs developed for the Subbasin (see Att4 Fig. 1-11). Much of the historical land subsidence in the Subbasin is believed to be caused by declining groundwater levels or piezometric head within the Lower Aquifer below the Corcoran Clay, and associated release of water from fine-grained sediments, ultimately resulting in compaction of these fine-grained sediments. In other areas of the San Joaquin Valley with long-term historical monitoring of both land subsidence and groundwater levels, land subsidence has been correlated with declining groundwater levels in the Lower Aquifer. Furthermore, considerable lag time between declining groundwater levels and land subsidence has been observed in other areas of the San Joaquin Valley. Within the Subbasin, limited long-term data are available for relating groundwater levels and land subsidence. Although there is considerable historical monitoring of land subsidence in the Subbasin, most of this monitoring has occurred at infrequent temporal intervals and with varying spatial resolution and distribution. As a result, there are gaps in the understanding of mechanisms and conditions related to land subsidence in the Subbasin, especially as it relates to how historical groundwater level decline may continue to cause ongoing residual land subsidence in the Subbasin, even as groundwater levels stabilize or rise in the future, as is planned for in the different GSPs. Att4 Fig. 1-13a through 1-13d show the spring and fall 2021 groundwater elevations in the upper/undifferentiated and lower aquifers.

The GSPs do not establish sustainable management criteria (SMC) for land subsidence. However, revisions to the GSPs (planned for completion in April 2023) will seek to provide additional information on subsidence and further consideration of land subsidence SMC in light of DWR review and input received in the initial consultation letter related to DWRs evaluation of the GSPs. Additional characterization of the relationship between groundwater levels and land subsidence and mechanisms for mitigating future land subsidence are important for considering as the land subsidence SMC are reviewed and revised in response to the DWR consultation letter. The Subbasin intends to develop a Subsidence Workplan that will outline future steps important for addressing land subsidence monitoring and management in the Subbasin. Implementation of the Subsidence Workplan is intended to provide additional field data and technical analyses as input to better characterizing land subsidence for informing the five-year updates to the Subbasin GSPs, starting in 2025. Additionally, information and monitoring facilities developed through completion of this component will inform adaptive management of groundwater in the Subbasin, including ongoing evaluation of projects and management actions necessary to achieve and maintain sustainable groundwater management.

This component consists of a series of tasks relating to implementation of the Subsidence Workplan for the Subbasin that is being planned in coordination with revisions to the GSPs that are currently being prepared. Implementation of the Subsidence Workplan will involve effort to compile and evaluate additional data, install additional monitoring facilities, conduct technical and modeling analyses, perform assessments to support development of policies to mitigate future subsidence in the Madera Subbasin (as needed), and evaluate subsidence SMC to be established in the revised GSP and in updates to the GSPs performed every five years.

The Subsidence Workplan will outline future efforts intended to address data gaps identified during revisions to the Subbasin GSPs through enhanced monitoring and improving understanding of relationships between groundwater conditions and land subsidence in the Subbasin. Implementing the Subsidence Workplan will also include tasks to further evaluate sustainable management criteria (SMC) for land subsidence and support development of a coordinated approach to implementation of projects and management actions (PMAs) presented in the Subbasin GSPs to address land subsidence and achieve sustainable groundwater management.

Key aspects of land subsidence in the Subbasin that are not well understood or quantified relate to:

- Residual land subsidence, specifically differentiating residual land subsidence caused by historical conditions from new land subsidence caused by current conditions, and
- The mechanisms and conditions causing land subsidence in the Subbasin, including the relationship between land subsidence and declining groundwater levels, especially in the Lower Aquifer, within the local context of the Subbasin.

Robust land subsidence monitoring coupled with well-defined groundwater level monitoring will be important for tracking the different mechanisms related to land subsidence.

Potential opportunities and benefits related to improving the understanding of relationships between groundwater levels and land subsidence will come from:

- Continued monitoring of existing benchmarks, including the many land subsidence benchmarks in the Subbasin that are monitored by the United States Bureau of Reclamation (USBR) as part of the SJRRP, and
- Coupling groundwater level monitoring in the vicinity of sites with historical and ongoing land subsidence monitoring.

This Workplan will outline a proposed scope of work to compile and review additional data and reports pertaining to land subsidence in the Subbasin, improve understanding of active production wells, establish or construct additional monitoring facilities, and conduct additional technical analyses. The Workplan will consider comments and guidance provided by DWR during the initial GSP review and consultation stages. The purpose of implementation of the Subsidence Workplan is to provide sufficient data and analyses to:

- Enhance monitoring and understanding of relationships between land subsidence and groundwater levels at different depths within the western part of the Subbasin;
- Refine mapping of geologic conditions related to land subsidence, including the thickness and extent of the Corcoran Clay and other clay units;
- Improve quantification of groundwater pumping within each of the two principal aquifers (Upper and Lower Aquifer) in the western part of the Subbasin;
- Develop estimates of the amount of expected residual land subsidence caused by historical groundwater conditions that cannot be avoided; and
- Assess the adequacy of the PMAs and sustainable management criteria (SMC) in the GSPs in addressing undesirable results related to land subsidence in the Subbasin, including evaluating groundwater level metrics used as a proxy for land subsidence.

The scope of work involved in implementation the Subsidence Workplan includes seven tasks described below.

Task 1: Compile Additional Existing Data and Update Assessment of Available Data

This task includes several aspects involving compiling and reviewing of supplemental existing data for incorporation in analyses and characterization of conditions relating to subsidence in the Subbasin. Additional available existing data will be compiled and reviewed from the following sources: other GSPs, specific local landowners, DWR Well Completion Reports, US Bureau of Reclamation San Joaquin River Restoration Project (SJRRP), USGS SJRRP modeling data, other reports and data, InSAR data provided by DWR, and aerial electromagnetic (AEM) surveys completed by DWR. The available data will be compiled and reviewed to inform subsequent field work and used as inputs for technical analyses. This task can be performed in coordination with similar efforts planned as part of implementation of the Interconnected Surface Water (ISW) Workplan proposed for the Subbasin.

Task 2: Complete Additional Field Work

Enhancements to groundwater level monitoring facilities and activities, specifically in proximity to sites with historical land subsidence monitoring (e.g., SJRRP benchmarks), are important for improving the understanding of the relationships between groundwater levels and land subsidence across the Subbasin. Developing continuous groundwater level monitoring at finer temporal scales and at different depths in key areas where land subsidence monitoring is conducted will support understanding of the relationship between groundwater levels at different depths and any associated land subsidence, and will help differentiate residual land subsidence caused by historical groundwater conditions from active land subsidence related to current and future conditions. This task will include identification and instrumentation of existing wells with automated and continuous groundwater level monitoring equipment. Additionally, the field work will include identifying and installing new monitoring wells in key areas of the Subbasin where data gaps exist. As many as five potential monitoring well sites are anticipated to be included in the Subsidence Workplan in locations where increasing amounts of recent subsidence have occurred (see Att4 Fig. 1-11) or where information on groundwater conditions is limited. The selection of sites for monitoring facilities to be installed through implementation of this component will be coordinated with any other monitoring enhancements occurring through completion of other components, including the ISW Workplan and Monitoring Network Enhancements efforts. This task will also include efforts to refine existing information on active wells in the western part of the Subbasin through completion of an inventory of active wells. This would be conducted through a combination of preliminary desktop analysis with field verification. The refinement of information on active wells will help in quantification of pumping by aquifer zone in the western part of the Subbasin.

Task 3: Technical Analyses

In this task, technical analyses will be conducted to synthesize the available information on dynamics between groundwater levels and land subsidence by evaluating fluctuations in groundwater levels and land subsidence and by evaluating relationships between groundwater pumping and land subsidence. This task will be completed in coordination with and utilizing new information from compilation of additional available data and field work related to additional monitoring and characterization of groundwater conditions and land subsidence. Field and monitoring data will be evaluated relative to the relationship between groundwater levels in both the Upper and Lower Aquifers and land subsidence and consideration of ongoing residual land subsidence. Technical analyses will consider information developed from monitoring of land subsidence in relation to groundwater levels in adjacent subbasins, especially in Chowchilla Subbasin to the north where greater amounts of historical subsidence have occurred. The technical work will also include conducting refinements to existing available information on the mapped extent and thickness of the Corcoran Clay and other clay layers.

Task 4: Groundwater Modeling

Distinguishing between residual land subsidence resulting from historical groundwater conditions and active land subsidence caused by current conditions is a challenging aspect of evaluating appropriate metrics for ensuring sustainable groundwater management. Modeling techniques represent one of the most robust approaches available for evaluating this aspect of groundwater conditions. Key objectives of the modeling to be conducted under this task include 1) estimating the amount, rate, and duration of residual land subsidence likely to occur resulting from historical groundwater conditions, and 2) estimating total anticipated future land subsidence. Two potential modeling approaches would help in evaluating historical

and projected land subsidence in the Subbasin and differentiation of residual land subsidence from active land subsidence. One modeling approach involves use of the existing numerical model developed for the Subbasin (MCSim) with incorporation of updates to simulate subsidence. Another approach includes use of a more simplified one-dimensional model to quantify residual and active subsidence. Both of these approaches will be considered during implementation of the groundwater modeling task of the Subsidence Workplan.

Task 5: Stakeholder Outreach and Interbasin Coordination

Implementation of the Workplan should involve outreach and coordination with key stakeholders and interested parties. Outreach efforts should focus on efforts related to the need and benefit from additional groundwater level or land subsidence monitoring and prioritization of efforts to expand monitoring. An additional objective of outreach efforts includes coordination related to the understanding of critical land subsidence thresholds related to damage to infrastructure or other adverse impacts to infrastructure. Furthermore, outreach efforts may also benefit considerations related to the feasibility of potential PMAs to achieve sustainability.

Task 6: Assess the Adequacy of Revised GSP SMC

An important outcome from efforts conducted as part of this Workplan will be an assessment of the adequacy of current land subsidence SMC and the associated RMS network and need for any revisions to these SMCs as part of updates and revisions to the GSPs. The assessment will consider data and analyses developed through implementation of Tasks 1 through 5 of this component and relationships between groundwater levels and land subsidence and the differentiation of residual land subsidence from new active subsidence established through that work. The review and assessment of SMC completed under this task will inform decisions on revisions to land subsidence SMC for incorporation in updates and revisions to the GSPs.

Task 7: Prepare a Technical Memorandum or Report

A technical memorandum (TM) or report will be prepared to document all the tasks completed as part of implementation of the Subsidence Workplan. An interim TM/Report deliverable will be prepared to inform the five-year GSP update efforts occurring prior to January 2025. A Final TM/Report will be prepared and submitted at the time of completion of all field work outlined in the Workplan.

Summary of Component Benefits

The **goal** of this component is to enhance the characterization of subsidence within the Subbasin. The **objectives** are to fill data gaps, improve and expand monitoring activities, engage stakeholders, and synthesize new and existing subsidence data. The **needs** for this component, in addition to funding, include support from GSA staff and participation by the Madera Subbasin community and stakeholders. The component will meet the goals, objectives and needs by implementing the scope of work, providing there is sufficient funding, based on the budget request, herein.

This component will provide benefits for Underrepresented Communities (URCs) in the Subbasin (Att4 Fig. 1-1 and 1-2) The Madera Subbasin includes URCs: Disadvantaged Communities (DACs) in Madera, Parksdale, and Parkwood, and a Severely Disadvantaged Community (SDAC) in the Fairmead area (shown in Att4 Fig. 1-1 and 1-12). This component would benefit these URCs by reducing risks associated with unsustainable groundwater conditions and improving management of groundwater resources through informed decision making and robust monitoring. Funding support for this component will reduce the financial burden on URCs in the Subbasin to fund the activities necessary to implement the GSPs, including implementation of the Subsidence Workplan. This component will also directly affect measurable objectives (MOs) and minimum thresholds (MTs) established for subsidence by informing the assessment of the sustainable management criteria and metrics included in the Subbasin GSPs. The work completed through this component will also support development of management actions and projects necessary to mitigate impacts from future land subsidence and avoid undesirable results in the Subbasin. Notably, information and monitoring facilities developed through implementation of the Subsidence Workplan will inform adaptive management of groundwater in the Subbasin to ensure sustainability is achieved and maintained. Implementation of this component will be completed by April 2026 and is **feasible** if funded. The component **benefits** include enhanced well and water information so the GSA can better manage the subbasin and stakeholder engagement to support monitoring and mitigation activities. Additionally, the component will assist in the GSP implementation, since it will improve characterization of subsidence and provide more robust monitoring data, both land subsidence and groundwater, for the Subbasin.

APPENDEX ITEM 3.I

INTERCONNECTED SURFACE WATER DATA GAPS WORKPLAN

A.1 Component 2: Interconnected Surface Water Workplan Implementation

This component consists of a series of tasks designed to enhance the interconnected surface water (ISW) dataset available within the Madera Subbasin (Subbasin). The relationship between the San Joaquin River (SJR) and shallow groundwater along the southern boundary of the Subbasin is complex and data to characterize the groundwater-surface water relationship in this area of the Subbasin are limited. Implementation of the Interconnected Surface Water Workplan (Workplan) is expected to better characterize the following conditions:

- Shallow subsurface conditions,
- The relationship between streamflow and fluctuations of shallow groundwater levels, and
- The relationship between groundwater pumping and streamflow.

Shallow monitoring wells (typically less than 30 feet deep, although some extend to greater depths) installed in areas along the San Joaquin River (SJ River) as part of the San Joaquin River Restoration Program (SJRRP) provide much of the existing monitoring information related to shallow groundwater adjacent to the SJ River. Monitoring of these wells has been inconsistent since 2018, and part of implementation of this work plan will involve reengagement with well owners to restart monitoring of these wells. Additional field data collection and technical analyses will be completed at depths greater than 30 feet to better characterize the shallow subsurface along the SJ River along the southern boundary of the Subbasin, which is likely to improve overall understanding of the relationship between groundwater in the (upper 30 feet), the zone between 30 and 100 feet below ground surface (bgs), and the remaining portion of the Upper Aquifer below a depth of 100 feet where most groundwater pumping currently occurs.

This Workplan outlines potential plans and a related scope of work to compile and review existing data and reports pertaining to the study area, construct/install new monitoring facilities, collect additional field data, and conduct additional technical analyses, all of which are consistent with the Workplan developed as part of the Revised GSP. The purpose of this Workplan is to provide sufficient data and analyses to:

- Make a more informed determination of whether or not ISW is present along the SJ River at the southern boundary of the Subbasin;
- Improve understanding of the relationship between streamflow and fluctuations in shallow groundwater levels;
- Improve understanding of the relationship between shallow groundwater and regional groundwater pumping from deeper zones within the Upper Aquifer that may be separated from shallowest groundwater by intervening clay layers;
- Improve understanding of the relationship between streamflow and regional groundwater pumping; and
- Provide an improved basis for setting sustainable management criteria (SMC) if it is determined that ISW conditions exist.

Additional characterization of the relationship between groundwater and surface water along the SJ River is needed to provide an improved basis for making a final determination of the nature of the interconnection and appropriate Sustainable Management Criteria (SMC). Implementation of this Workplan is intended to provide additional field data and technical analyses as input to better characterizing ISW for the 2025 GSP Update (and beyond).

The scope of work involved in implementation of the Workplan includes seven tasks described below.

Task 1: Compile Additional Existing Data and Update Assessment of Available Data

This task includes several aspects involving compiling and reviewing of supplemental existing data for incorporation in analyses and characterization of conditions relating to ISW in the Subbasin. Additional available existing data will be compiled and reviewed from the following sources: other GSPs, specific local landowners, DWR Well Completion Reports, US Bureau of Reclamation San Joaquin River Restoration Project (SJRRP), USGS SJRRP modeling data, other reports and data, and aerial electromagnetic (AEM) surveys completed by DWR. The available data will be compiled and reviewed to inform subsequent field work and used as inputs for technical analyses. This task can be performed in coordination with similar efforts planned as part of implementation of the Subsidence Workplan proposed for the Subbasin.

Task 2: Complete Additional Field Work

Enhancements to groundwater level and surface water monitoring facilities and activities, specifically along the SJ River, are important for improving the understanding of the relationships between groundwater levels and surface water in the Subbasin. Additional field work tasks fall into two categories: instrumentation of existing wells, and new monitoring facilities and field data collection.

The monitoring frequency in Representative Monitoring Site (RMS) wells that may potentially be designated for the ISW minimum thresholds (MTs) and measurable objectives (MOs) in the upcoming revised GSP presents some limitations for characterizing groundwater level fluctuations and development of appropriate SMC. Developing continuous groundwater level monitoring at finer temporal scales and at different depths in key areas along the SJ River will support understanding of the relationship between groundwater levels at different depths and any potential associated ISW. This task involves working with the owners of key RMS wells to prioritize and implement instrumentation of wells with transducers for collecting

continuous groundwater data. As part of this task, if the assessment and monitoring of ISW would benefit from more continuous monitoring at other RMS well locations, other RMS wells could be considered and prioritized for automated monitoring.

Several key data gaps related to ISW in the Subbasin include coupled monitoring of groundwater levels at different depths within the Upper Aquifer (including very shallow groundwater and more regional groundwater zone) and stream conditions of stage, flow, and channel configuration at locations adjacent to the SJ River (shown in Att4 Fig. 1-8 through 1-10). Construction of new monitoring facilities and additional field data collection efforts are anticipated to focus on, but are not limited to: supplemental monitoring wells; stream stage and flow; stream elevation profile/thalweg profiles; and possible aquifer or well pump testing if cooperation can be obtained from landowners with wells at suitable locations near the SJ River.

Task 3: Complete Technical Analyses

In this task, technical analyses will be conducted to synthesize the available information on the potential for interconnectivity between groundwater and surface water involving construction of detailed hydrogeologic cross sections along the SJ River, evaluation of fluctuations in shallow groundwater levels and river stage/flow, and evaluating relationships between groundwater pumping and streamflow are also planned to synthesize the available information and groundwater-surface water dynamics along the River. This task will be completed in coordination with and utilizing new information from compilation of additional available data and field work related to additional monitoring and characterization of surface and subsurface conditions related to the potential for interconnectivity between groundwater and surface water. Hydrogeologic cross-sections will be constructed using geologic/lithologic logs, geophysical logs, and AEM data relating to the stratigraphy within the Upper Aquifer, with particular focus on the upper 100 feet where there is potential for interconnectivity between groundwater and surface water. Field data will be evaluated relative to the dynamic relationship between surface water and groundwater levels within the Upper Aquifer (in both the shallow and deeper zones of the Upper Aquifer). These additional technical analyses will focus on providing further assessment of the surface water-groundwater dynamics along four key profiles perpendicular to the river (at new monitoring well locations) where the SJ River forms the boundary of Madera Subbasin to improve understanding of groundwater conditions in relation to surface water.

Task 4: Perform Outreach

Implementation of the Workplan will involve outreach and coordination with key stakeholders and interested parties. A key outreach effort is needed to restart consistent monitoring of SJRRP wells along the SJ River selected as RMS wells in the GSP. Additional outreach efforts will focus on efforts related to the need and benefit from additional groundwater level or surface water monitoring and prioritization of efforts to expand monitoring. In particular, there will be outreach and coordination with the adjacent Kings Subbasin, which is expected to be performing similar efforts related to ISW. In addition, it is anticipated there will be outreach to various entities that are likely to have interest in Madera Subbasin efforts related to ISW, including National Marina Fisheries Service (NMFS), United States Bureau of Reclamation (USBR), and The Nature Conservancy (TNC). The various outreach efforts may also benefit considerations related to the feasibility of potential PMAs to achieve sustainability.

Task 5: Complete Groundwater Modeling

The groundwater model developed for the GSP (MCSim) will be updated and recalibrated as necessary as part of the 5-Year Update Report. This updated modeling will be used to further evaluate ISW conditions, both historically as well as current and expected future conditions, with the objective of characterizing groundwater-surface water interaction at a broader spatial scale within the southern part of the Subbasin. The groundwater model will be used to assist in evaluation of the potential for ISW to be present along the SJ River, and to further evaluate the potential for connection between regional groundwater pumping and surface water flows. A key aspect of additional groundwater model simulations will be to further evaluate the percentage of time connectivity between groundwater and surface water existed along the SJ River prior to 2015 compared to current and expected future conditions with implementation of projects and management actions (PMA) and the ongoing SJRRP. These analyses will directly support the evaluation and determination of appropriate SMC related to ISW (as described in the GSP) under Task 6.

Task 6: Assess the Adequacy of Revised GSP SMC

An important outcome from efforts conducted as part of this Workplan will be an assessment of the need for ISW SMC and the associated RMS network that would be needed to support ISW SMC that is likely to be included as part of updates to the Revised GSP (to be submitted April 2023). The assessment will consider data and analyses developed through implementation of Tasks 1 through 5 of the Workplan to evaluate whether ISW exists along the southern boundary of Madera Subbasin and confirm if there is a need to include SMC for ISW in the GSP for the Madera Subbasin. While this work would be conducted ahead of and/or in parallel with DWR's development of guidance related to ISW, this analysis will include review and consideration of any guidance that may be provided by DWR related to ISW to the extent possible depending on the timing of any ISW guidance that may be provided.

Establishing final SMC for ISW for inclusion in the five-year update of the Revised GSP will draw upon the most recent data and technical analyses developed through implementation of this Workplan with consideration for the complexities of the

dynamic relationship between groundwater and surface water along the SJ River in the Subbasin under conditions prior to and after initiation of SJ River flow releases from Friant Dam as part of the SJRRP. In addition, this analysis will include review of beneficial uses and users and will describe how planned SMC will be protective of beneficial uses and users relative to potential impacts that have the potential to occur.

Task 7: Prepare a Technical Memorandum or Report

A technical memorandum (TM) or report will be prepared to document all the tasks completed as part of implementation of the Workplan. An interim TM/Report deliverable will be prepared to inform the five-year GSP update efforts occurring prior to January 2025. A Final TM/Report will be prepared and submitted at the time of completion of all field work, monitoring, and analyses outlined in the Workplan.

The **goal** of this component is to enhance the characterization of ISW along the SJ River within the Subbasin. The **objectives** are to fill data gaps, improve and expand monitoring activities, and synthesize new and existing ISW data. The **needs** for this component, in addition to funding, include the dedicated GSA staff and participation by the Madera Subbasin community. The component will meet the goals, objectives and needs by implementing the scope of work, providing there is sufficient funding, based on the budget request, herein.

This component will directly affect measurable objectives (MOs) and minimum thresholds (MTs) for ISW. This component should be completed before the April 2026 and is **feasible** if funded. The component **benefits** include enhanced well and water information so the GSAs can better manage the subbasin and will assist in the GSP implementation, since it will improve characterization of ISW and provide more robust monitoring data, both surface water and groundwater, for the Subbasin. Lastly, this component would provide benefits for Underrepresented Communities (URCs) throughout the Madera Subbasin (Att4 Fig. 1-1 and 1-2). The Madera Subbasin includes URCs: Disadvantaged Communities (DACs) in Madera, Parksdale, and Parkwood, and a Severely Disadvantaged Community (SDAC) in Fairmead (Att4 Fig. 1-1 and 1-8). This component would benefit these URCs by minimizing risks and improving groundwater resources through informed decision making and robust monitoring resulting from monitoring enhancements.

APPENDEX ITEM 5.A

MADERA SUBBASIN REVISED GSP AND 5-YEAR UPDATE TIMELINE AGREEMENT

MADERA SUBBASIN REVISED GSP AND 5-YEAR UPDATE TIMELINE AGREEMENT

February 9, 2023

This MADERA SUBBASIN REVISED GSP AND 5-YEAR UPDATE TIMELINE AGREEMENT ("Agreement") has been prepared at the direction of the Groundwater Sustainability Agencies of the County of Madera ("County"), the City of Madera ("City"), the Madera Irrigation District ("MID"), the Root Creek Water District ("RCWD"), the Madera Water District ("MWD"), the Gravelly Ford Water District ("GFWD"), and the New Stone Water District ("NSWD"), collectively hereinafter referred to as the "Parties," or individually as a "Party."

RECITALS

WHEREAS, on September 16, 2014, the Governor of the State of California signed the Sustainable Groundwater Management Act ("SGMA") into law, consisting of Senate Bills 1168 and 1319, and Assembly Bill 1739 collectively, codified at Water Code sections 10720, et seq.; and

WHEREAS, each Party overlies the Madera Groundwater Subbasin ("Subbasin"), which is defined by the California Department of Water Resources ("DWR") in Bulletin 118 as Basin Number 5-22.06, and may be modified from time to time in accordance with Water Code section 10722.2; and

WHEREAS, the Subbasin has been designated by DWR as a high-priority basin in a state of "critical overdraft"; and

WHEREAS, SGMA requires that California groundwater basins and subbasins be managed by a Groundwater Sustainability Agency ("GSA") or multiple GSAs, and that such management be implemented pursuant to an approved Groundwater Sustainability Plan ("GSP"), or multiple coordinated GSPs; and

WHEREAS, County, City, MID, and MWD have developed one GSP; RCWD has developed one GSP; GFWD has developed one GSP; and NSWD has developed one GSP, such that the Subbasin is governed by four separate GSPs unified through the Subbasin Coordination Agreement; and

WHEREAS, the Subbasin has no adjudicated areas or areas covered by an Alternative to a GSP as described in Water Code Section 10733.6; and

WHEREAS, the Parties agree to submit revised GSPs consistent with the Department of Water Resources (DWR) "Incomplete" Determination dated September 22, 2022, no later than March 21, 2023; and

WHEREAS, the Parties, in accordance with the Subbasin Coordination Agreement, desire for the Coordination Workgroup, as defined in the Subbasin Coordination Agreement, to meet on at least a quarterly basis, beginning in January 2023; and

WHEREAS, the Parties recognize that for a variety of reasons, many outside the control of the Parties, GSP implementation within the Subbasin has changed or otherwise been altered from that

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which was outlined in each of the four GSPs within the Subbasin as submitted in January of 2020; and

WHEREAS, the Parties have been and shall continue to document changes to GSP implementation in their respective Annual Reports; and

WHEREAS, the Parties recognize and agree that the GSPs revised as part of the statutorily required 2025 Update ("Update") should adequately and appropriately memorialize the changes to GSP implementation that have occurred since submission of the original GSPs in January 2020; and

WHEREAS, the Parties agree that the GSPs revised as part of the statutorily required Update shall include, among other changes as determined necessary, revised Projects and Management Actions ("PMAs") as determined necessary by each Party consistent with the broader Sustainability Goal of the Subbasin; and

WHEREAS, the Parties agree that work shall begin as early as February 2023 on the statutorily required Update to each of the GSPs; and

WHEREAS, the Parties agree to work cooperatively with one another as part of the statutorily required Update.

NOW THEREFORE, in consideration of the mutual promises, covenants and conditions contained herein and these Recitals, which are hereby incorporated herein by this reference, the Parties agree to the following draft Update timeline:

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February 2023	Initiate activities on the statutorily required Update.
March 21, 2023:	Submit revised GSPs.
April 13, 2023:	Finalize recommended changes to draft Update timeline. Initiate development of Update workplans, including assignments for individual GSAs and consultants, and request input on changes to the Coordination Agreement.
May 2023:	Finalize Update workplans, enter into contract(s) necessary for Update, and initiate data request for comprehensive groundwater model and water balance update.
June 2023:	Data submission complete, comprehensive groundwater model and water budget update to commence. Initiate implementation of Subsidence and Interconnected Surface Water (ISW) Workplans. Begin discussion on revised, new, and/or modified PMAs, inclusive of existing/potential funding sources.

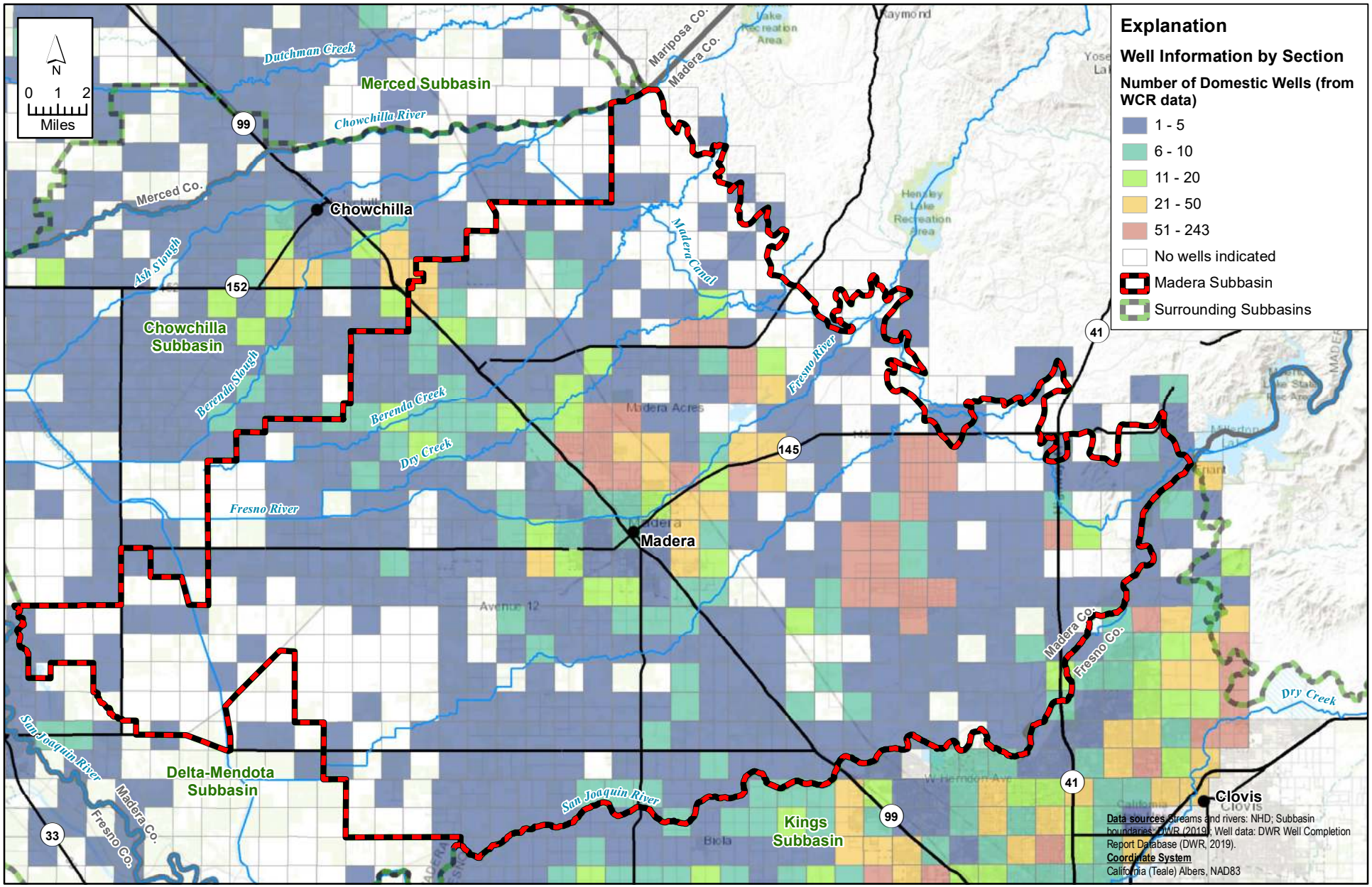
July 2023:	Develop Draft Stakeholder Communication and Engagement Action Plan. Identify any missing data necessary for comprehensive groundwater model and water budget update.
August 2023:	Additional data request complete. Continue discussion on revised, new, and/or modified PMAs, inclusive of existing/potential funding sources.
September 2023:	Conduct expedited review of DWR comments and recommended actions on revised GSPs (dependent on DWR). Coordinate meeting with DWR to review comments and recommended actions. Finalize Stakeholder Communication and Engagement Action Plan.
October 2023:	Finalize review of DWR comments and recommended actions and incorporate into Update workplans. Finalize Update workplans including specific assignments for individual GSAs and consultant tasks. Schedule meeting with DWR to discuss Update process and procedures. Continue discussion on revised, new, and/or modified PMAs, inclusive of existing/potential funding sources.
November 2023:	Review preliminary comprehensive groundwater model and water budget results. Provide direction on potential model revisions. Begin implementation of Stakeholder Communication and Engagement Action Plan.
December 2023:	Begin refinement of Sustainable Management Criteria (SMC) for each sustainability indicator.
March 2024:	Revise monitoring network and protocols. Review updated comprehensive groundwater model and historical water budget results. Finalize comprehensive groundwater model update and historical water budgets (model documentation will not be complete and will be included as an appendix with the draft Update). Continue discussion on revised, new, and/or modified PMAs, inclusive of existing/potential funding sources. Begin projected water budget analysis. Begin GSP revisions and written assessment of GSP implementation in compliance with 23 CCR § 356.4. Begin Coordination Agreement revisions.
May 2024:	Review projected water budget results. Modify and finalize draft revised, new, and/or modified PMAs, inclusive of existing/potential funding sources. Continue implementation of Stakeholder Communication and Engagement Action Plan. Continue refinement of SMC. Continue GSP revisions and written assessment of GSP implementation in compliance with 23 CCR § 356.4 . Continue Coordination Agreement revisions.

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June 2024:	Finalize projected water budgets. Incorporate early results from Subsidence and ISW Workplans. Continue implementation of Stakeholder Communication and Engagement Action Plan. Continue GSP revisions and written assessment of GSP implementation in compliance with 23 CCR § 356.4. Continue Coordination Agreement revisions.
July 2024:	Finalize SMC and revised, new, and/or modified PMAs. Continue implementation of Stakeholder Communication and Engagement Action Plan. Finalize monitoring network and protocols. Continue GSP revisions and written assessment of GSP implementation in compliance with 23 CCR § 356.4. Continue Coordination Agreement revisions. Schedule meeting with DWR to discuss status of Update.
August 2024:	Continue implementation of Stakeholder Communication and Engagement Action Plan. Finalize draft Coordination Agreement revisions. Continue GSP revisions and written assessment of GSP implementation in compliance with 23 CCR § 356.4 .
September 2024:	Final approval of Update.
Sept./Oct. 2024:	Begin public notices, public hearings, and formal approval at individual GSA level.
January 2025:	Submit Update, including written assessment of GSP implementation, other appendices, and Coordination Agreement in compliance with 23 CCR § 356.4.

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CHAPTER TWO FIGURES



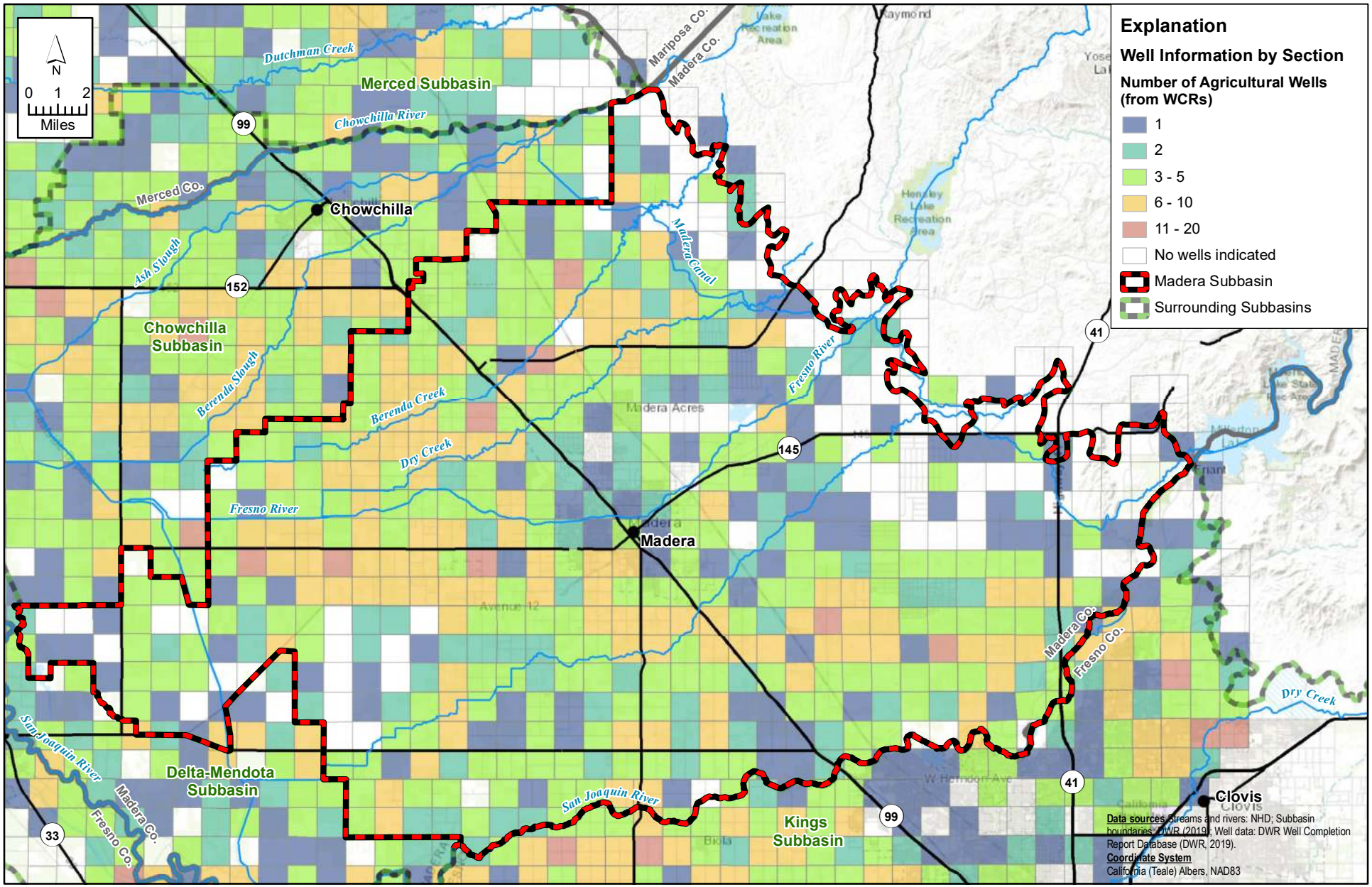
X:\2017\17-113 Madera Subbasin GSP Development\GIS\Map Files\REPORT map files\Chapter 2\Figure 2-5 Madera Subbasin Wells By Section Dom Well Count.mxd

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FIGURE 2-5
Map of Well Information by Section: Number of Domestic Wells (from WCR data)

Madera Subbasin
Groundwater Sustainability Plan



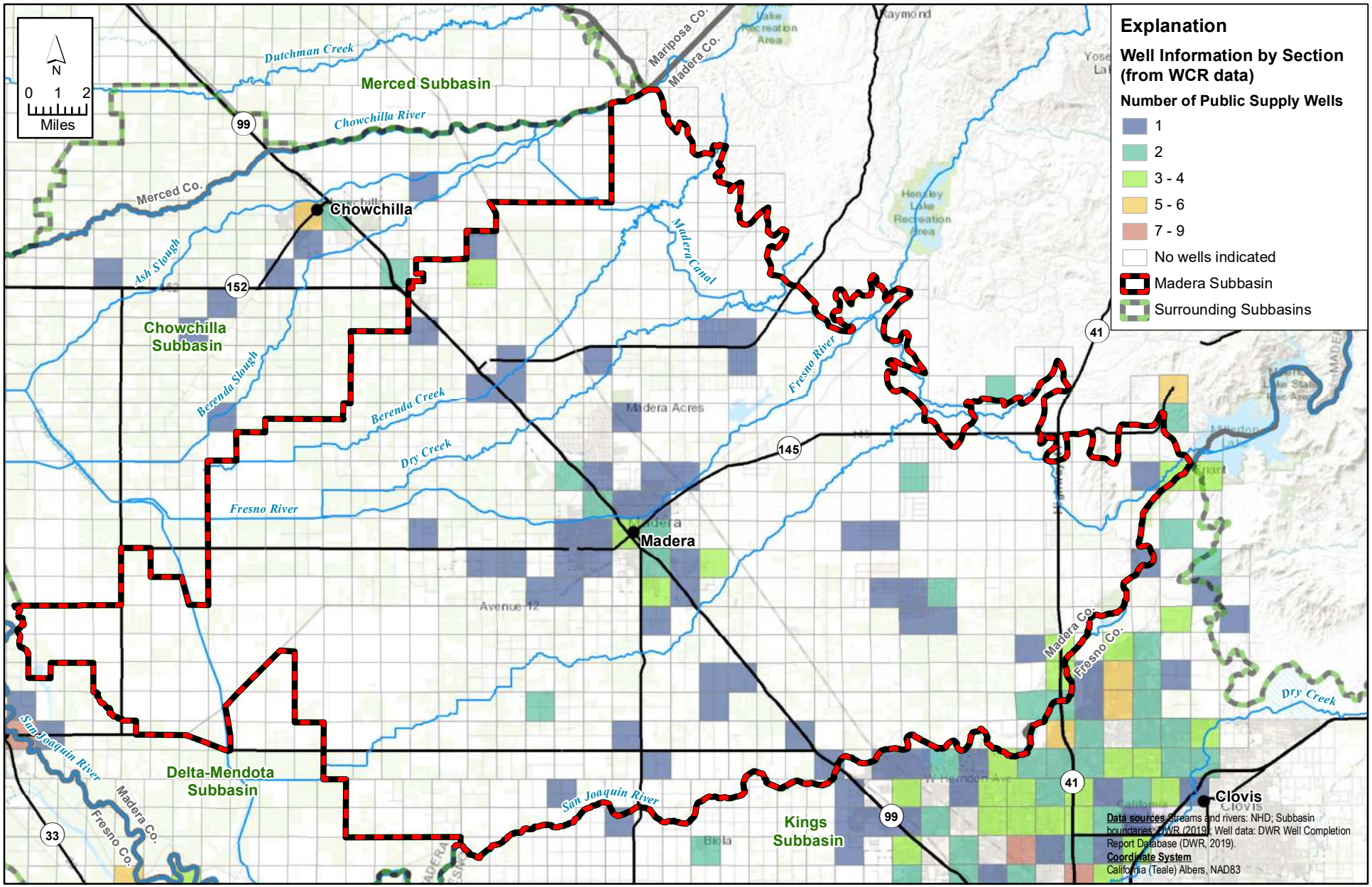
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FIGURE 2-6
Map of Well Information by Section: Number of Agricultural Wells (from WCR data)

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Groundwater Sustainability Plan



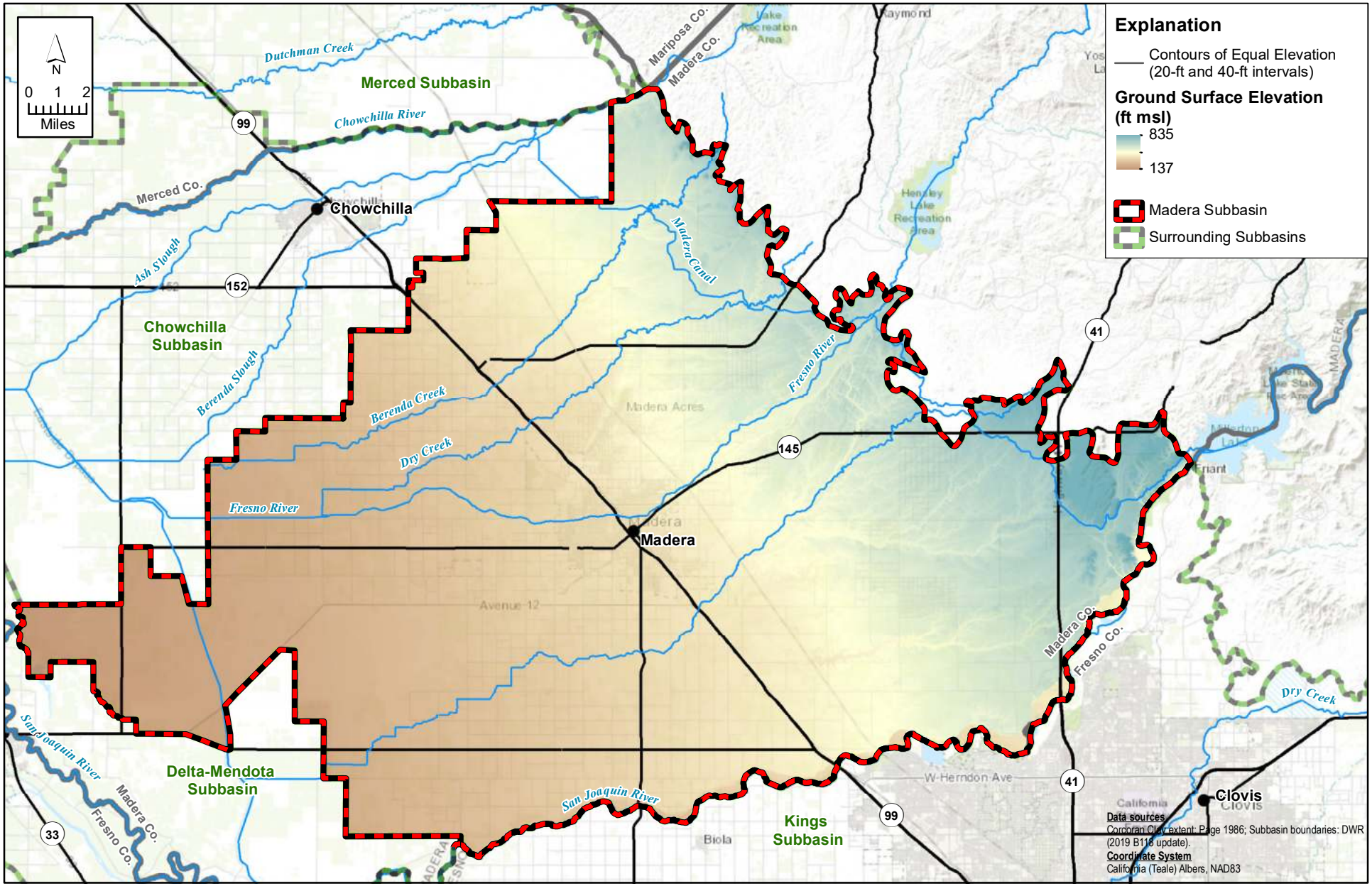
X:\2017\17-113 Madera Subbasin GSP Development\GIS\Map Files\REPORT map files\Chapter 2\Figure 2-7 Madera Subbasin Wells By Section PWS Well Count.mxd

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FIGURE 2-7
Map of Well Information by Section: Number of Public Supply Wells (from WCR data)

Madera Subbasin
Groundwater Sustainability Plan



X:\2017\17-113 Madera Subbasin GSP Development\GIS\Map Files\REPORT map files\Chapter 2\Figure 2-10 Madera Subbasin Topographic Map.mxd

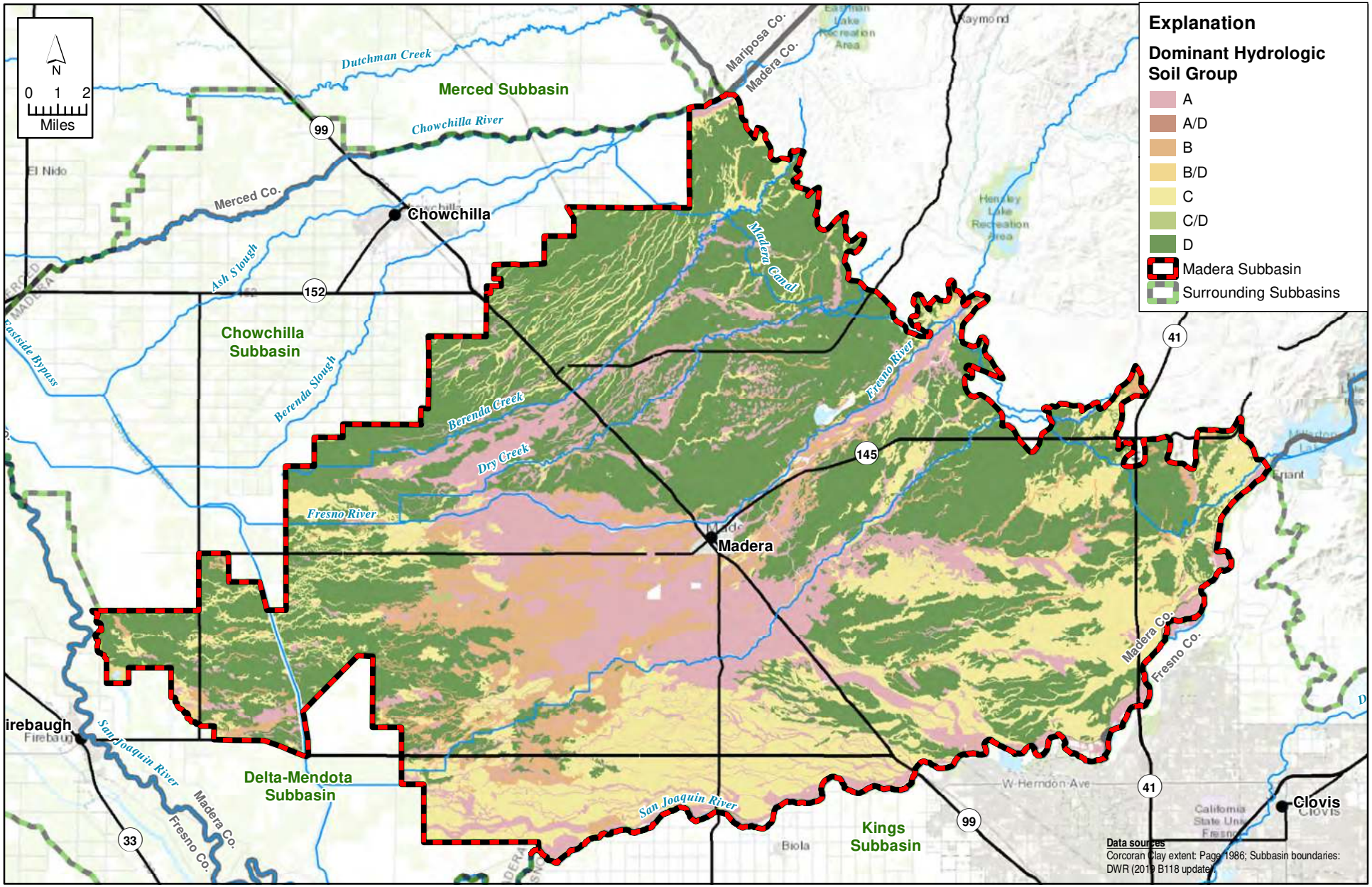
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FIGURE 2-10

Topographic Map

Madera Subbasin
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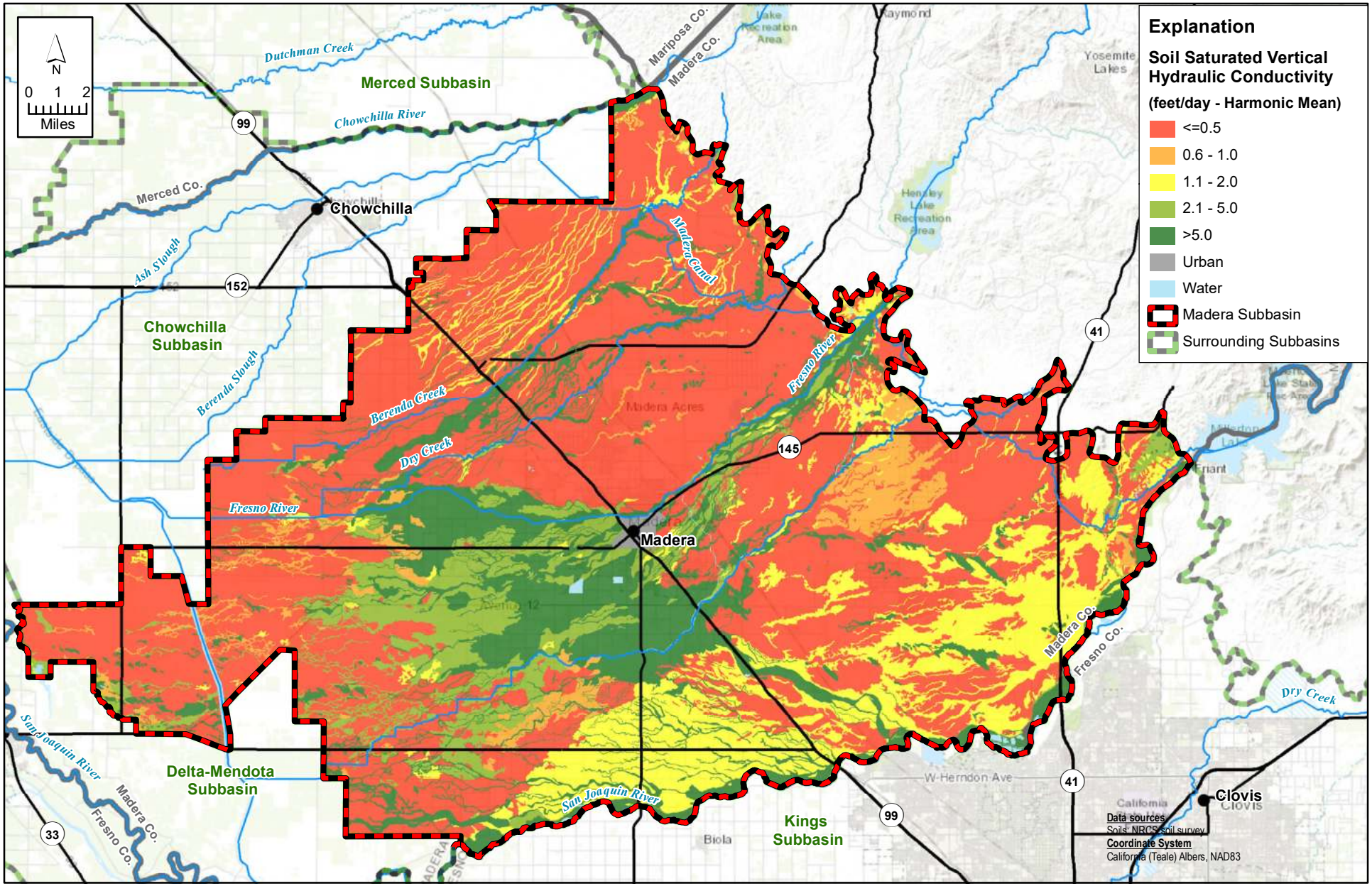
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FIGURE 2-11

Soil Hydrologic Units Map

Madera Subbasin
Groundwater Sustainability Plan



X:\2017\17-113 Madera Subbasin GSP Development\GIS\Map Files\REPORT map files\Chapter 2\Figure 2-12 Madera Subbasin Soil Hydraulic Conductivity Map.mxd

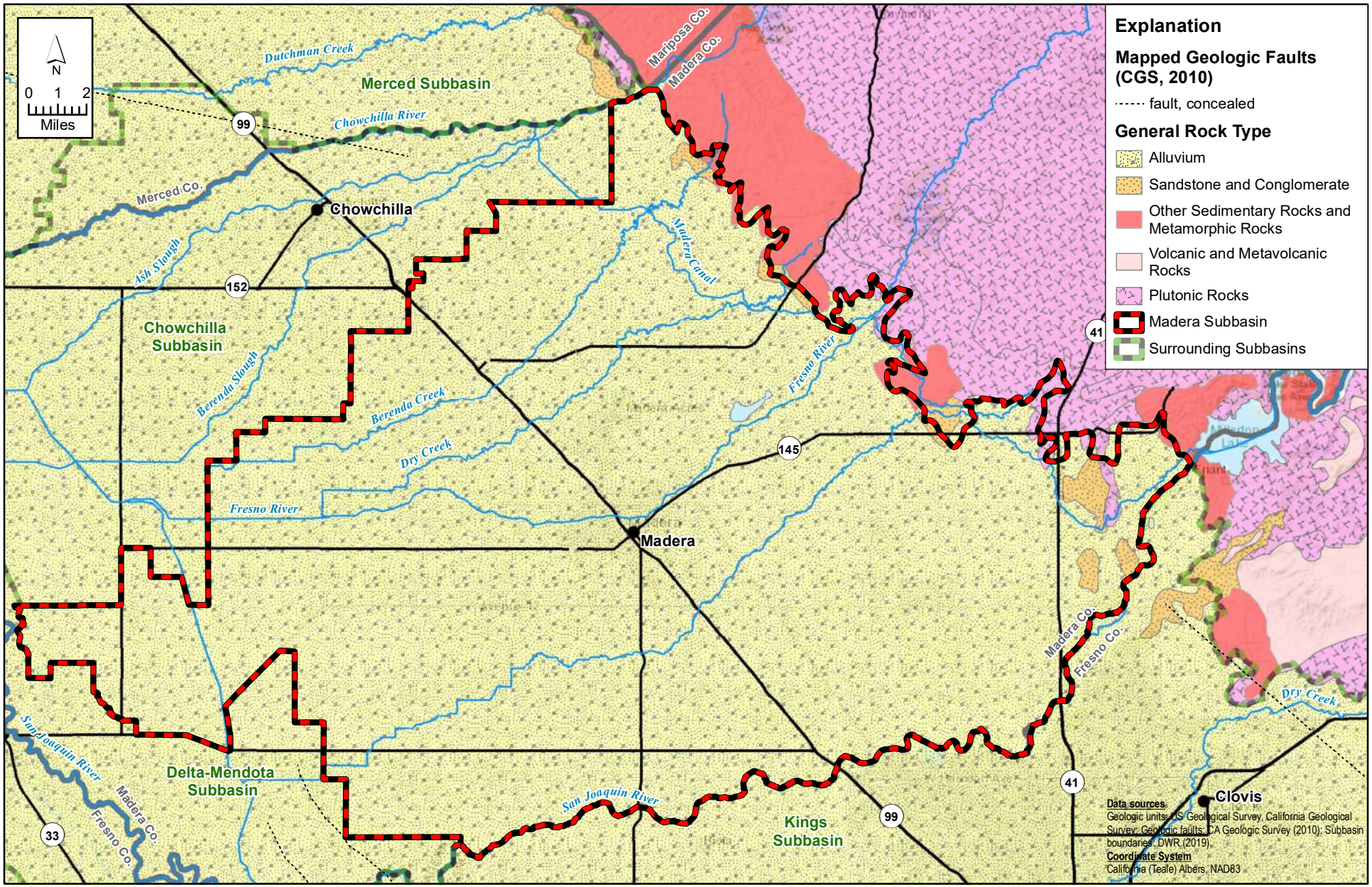
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FIGURE 2-12

Soil Hydraulic Conductivity Map

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Groundwater Sustainability Plan



X:\2017\17-113 Madera Subbasin GSP Development\GIS\Map Files\REPORT map files\Chapter 2\Figure 2-13 Madera Subbasin General Geologic Map.mxd

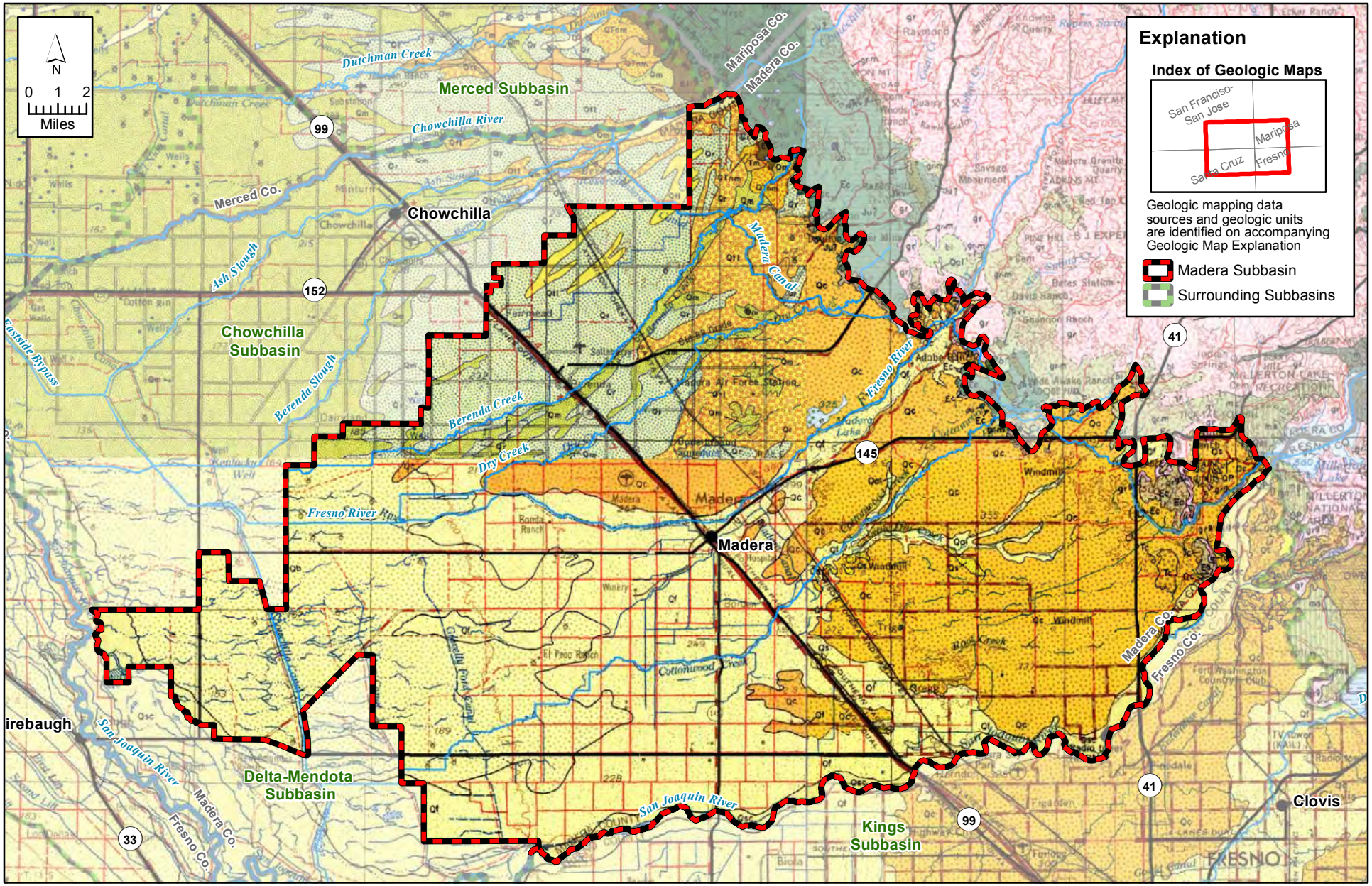
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FIGURE 2-13

General Geologic Map

Madera Subbasin
Groundwater Sustainability Plan



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FIGURE 2-14

Surficial Geology Map

Madera Subbasin
Groundwater Sustainability Plan

Compiled Geologic Map Explanation
San Francisco - San Jose Quadrangle

- Q — Alluvium
- Qdp — Dos Palos Alluvium
- Qf — Alluvial fan deposits
- Qsl — San Luis Ranch Alluvium
- Qp — Patterson Alluvium
- Qtl — Turlock Lake Formation *(Nonmarine sand, silt, and gravel)*
- Pl — Laguna Formation *(Consolidated alluvium)*
- Qm — Modesto Formation
- Qr — Riverbank Formation
- Qlb — Los Banos Alluvium
- QTnm — North Merced Gravel *(Thin pediment veneer)*
- Jjp — Jasper Point Formation *(Chert, tuff, pillow basalt; marine)*
- ms — Metasedimentary rocks*
- ls — Crystalline limestone and dolomite*
- Pzcc — Calaveras Complex *(Metasedimentary rocks)*
- mv — Metavolcanic rocks*
- Mtm — Table Mountain Latite
- Tm — Mehrten Formation *(Andesitic conglomerate)*
- Tvs — Valley Springs Formation *(Rhyolitic tuff and sedimentary rocks)*
- Ei — Ione Formation *(Quartzose sandstone and kaolinitic clay; mostly nonmarine)*
- Tg — "Auriferous" Gravels
- Pl — Locatelli Formation *(Marine sandstone and conglomerate)*
- Kl — Lower Cretaceous marine sandstone and shale
- Mzg — Granitic rocks
- Mzgb — Gabbroic rocks
- um — Ultramafic rocks
- Jm — Mariposa Formation *(Slate, graywacke, and conglomerate; marine)*
- Jsm — Salt Springs and Merced Falls Slates
- Jms — Jurassic(?) metasedimentary rocks
- Jch — Copper Hill Volcanics
- Jlr — Logtown Ridge Volcanics
- Jgo — Gopher Ridge Volcanics
- Jpb — Penon Blanco Volcanics
- Jmv — Jurassic metavolcanic rocks

Santa Cruz, Mariposa, and Fresno Quadrangles

- Qal — Alluvium
- Qsc — Stream channel deposits
- Qf — Fan deposits
- Qb — Basin deposits

  (GREAT VALLEY)
- Qc — Pleistocene nonmarine
- QP — Plio-Pleistocene nonmarine
- Qpv — Pleistocene volcanic: Q_{pv}^{r} —rhyolite; Q_{pv}^{a} —andesite; Q_{pv}^{b} —basalt; Q_{pv}^{p} —pyroclastic rocks
- Tc — Tertiary nonmarine
- Rv — Permian metavolcanic rocks
- Ec — Eocene nonmarine
- E — Eocene marine
- Tv — Tertiary volcanic: T_v^{r} —rhyolite; T_v^{a} —andesite; T_v^{b} —basalt; T_v^{p} —pyroclastic rocks
- Ju — Upper Jurassic marine
- m ls — Pre-Cretaceous metamorphic rocks (ls = limestone or dolomite)
- ms — Pre-Cretaceous metasedimentary rocks
- gr-m — Pre-Cenozoic granitic and metamorphic rocks
- PPv — Paleozoic metavolcanic rocks
- Cv — Carboniferous metavolcanic rocks

Geologic Map compiled from:

1. Wagner, D.L., Bortugno, E.J., and Mc Junkin, R.D., 1991, Geologic Map of the San Francisco - San Jose Quadrangle, California Geological Survey, Regional Geologic Map No. 5A, 1:250,000 scale.
2. Jennings, C.W. and Strand, R.G., 1958, Geologic Atlas of California - Santa Cruz Quadrangle, California Geological Survey, Geologic Atlas of California Map No. 020, 1:250,000 scale.
3. Strand, R.G., 1967, Geologic Atlas of California - Mariposa Quadrangle, California Geological Survey, Geologic Atlas of California Map No. 009, 1:250,000 scale.
4. Matthews, R.A. and Burnett, J.L., 1965, Geologic Atlas of California - Fresno Quadrangle, California Geological Survey, Geologic Atlas of California Map No. 005, 1:250,000 scale.

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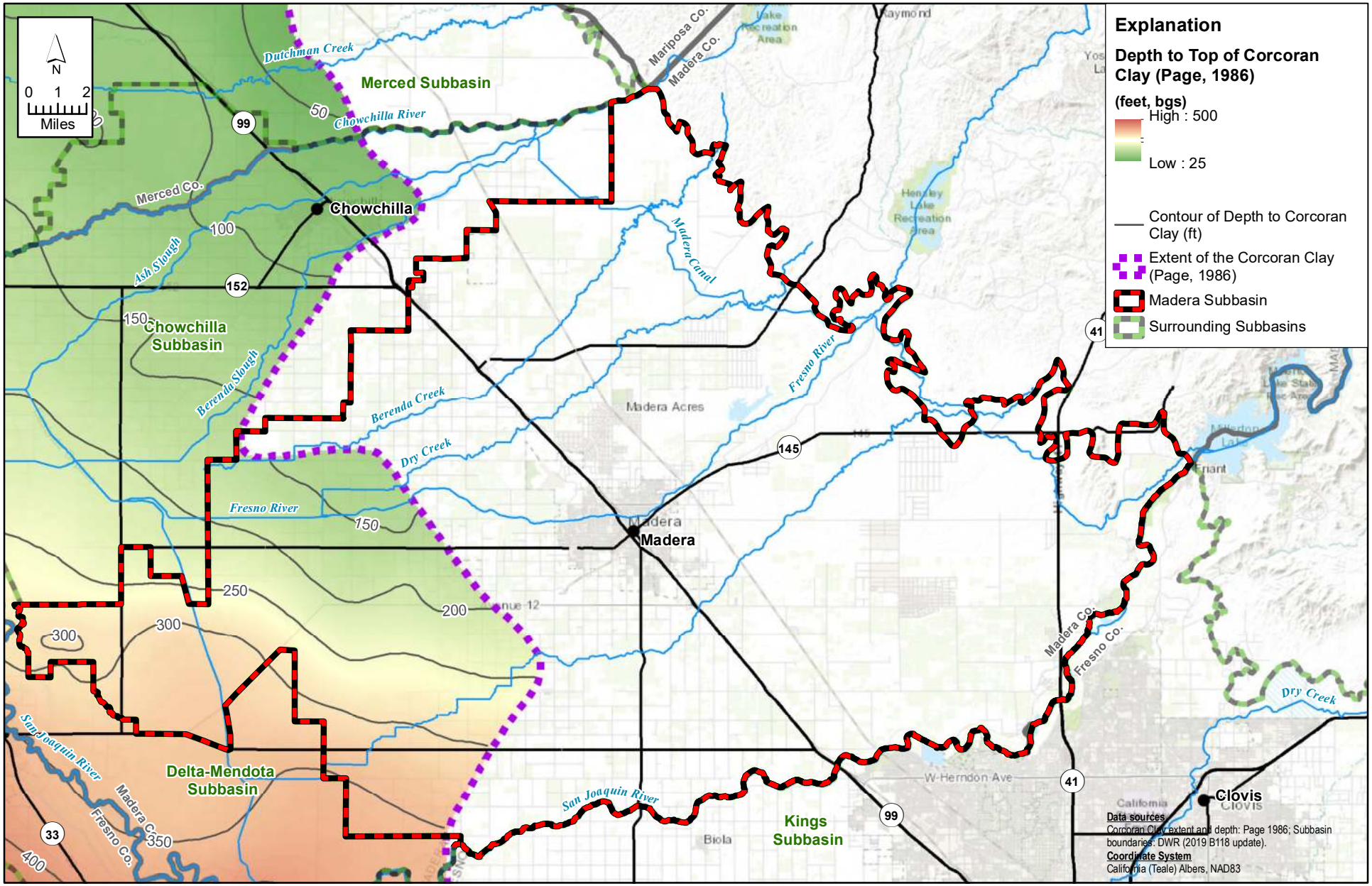
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FIGURE 2-14 EXPLANATION

Surficial Geology Map Explanation

Madera Subbasin
Groundwater Sustainability Plan



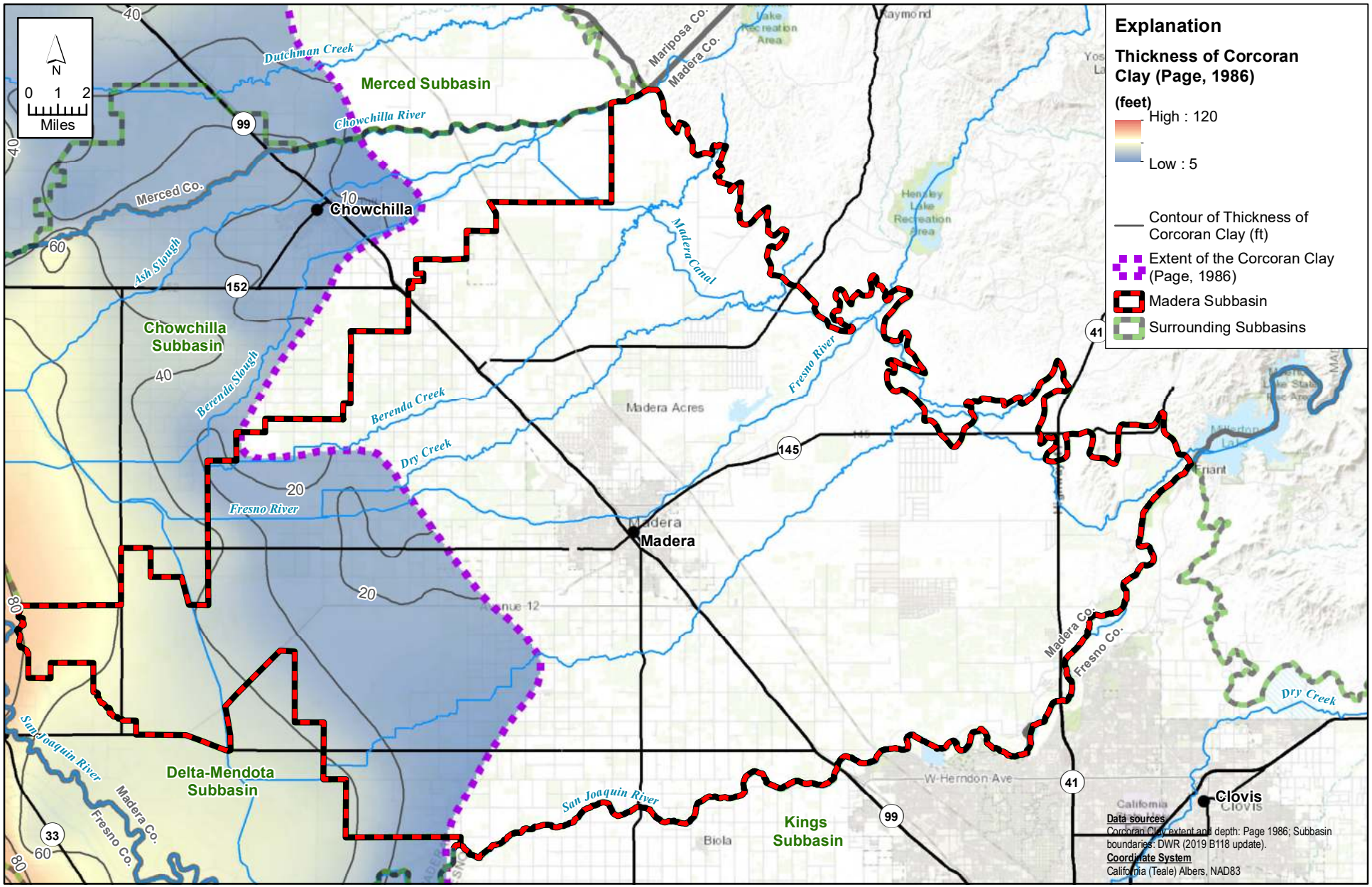
X:\2017\17-113 Madera Subbasin GSP Development\GIS\Map Files\REPORT map files\Chapter 2\Figure 2-15 Madera Subbasin Extent and Depth of Corcoran Clay.mxd

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FIGURE 2-15
Extent and Depth of the Corcoran Clay: After Page (1986)

Madera Subbasin
Groundwater Sustainability Plan



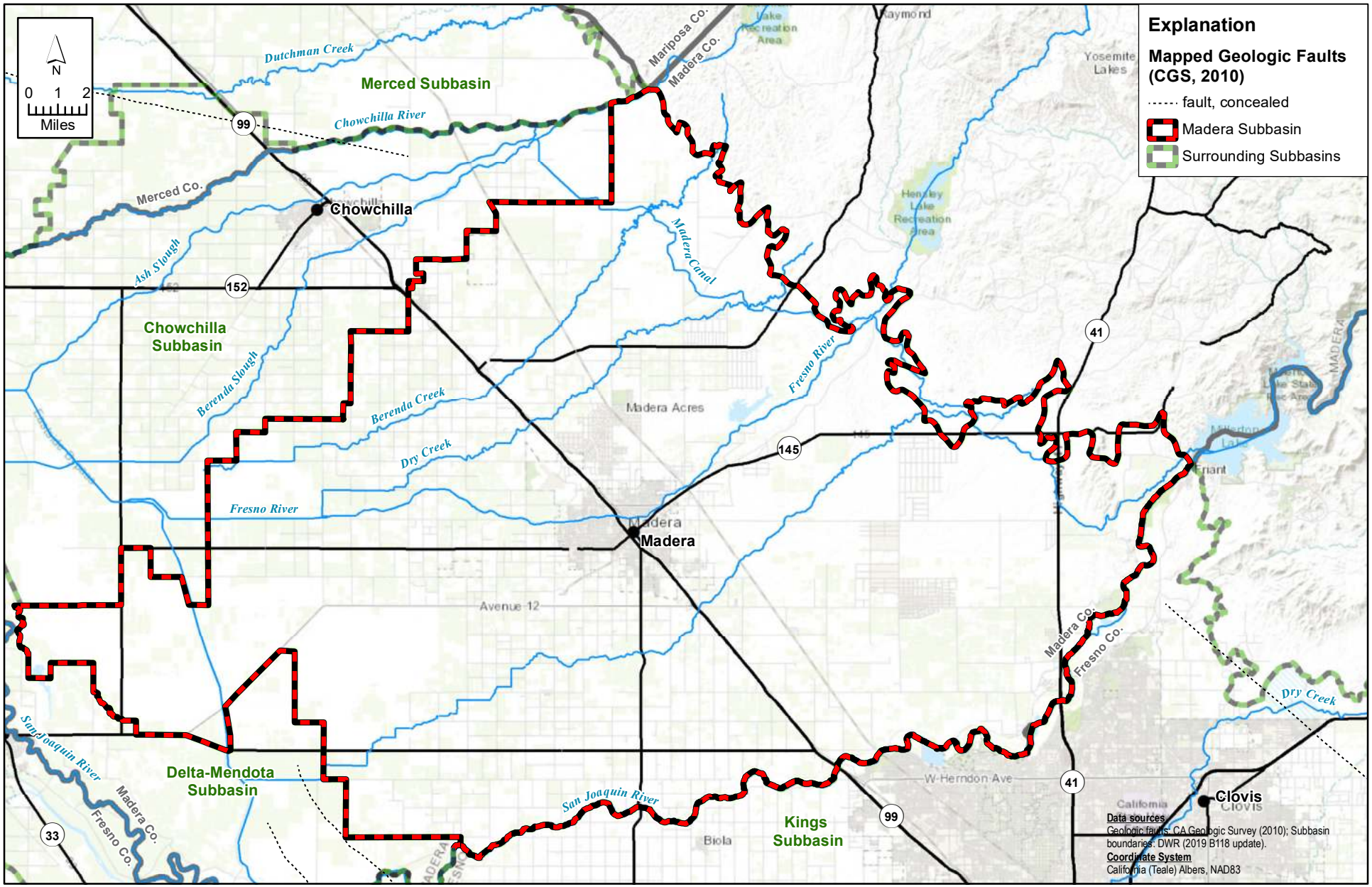
X:\2017\17-113 Madera Subbasin GSP Development\GIS\Map Files\REPORT map files\Chapter 2\Figure 2-16 Madera Subbasin Thickness of Corcoran Clay.mxd

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FIGURE 2-16
Thickness of the Corcoran Clay: After Page (1986)

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Groundwater Sustainability Plan



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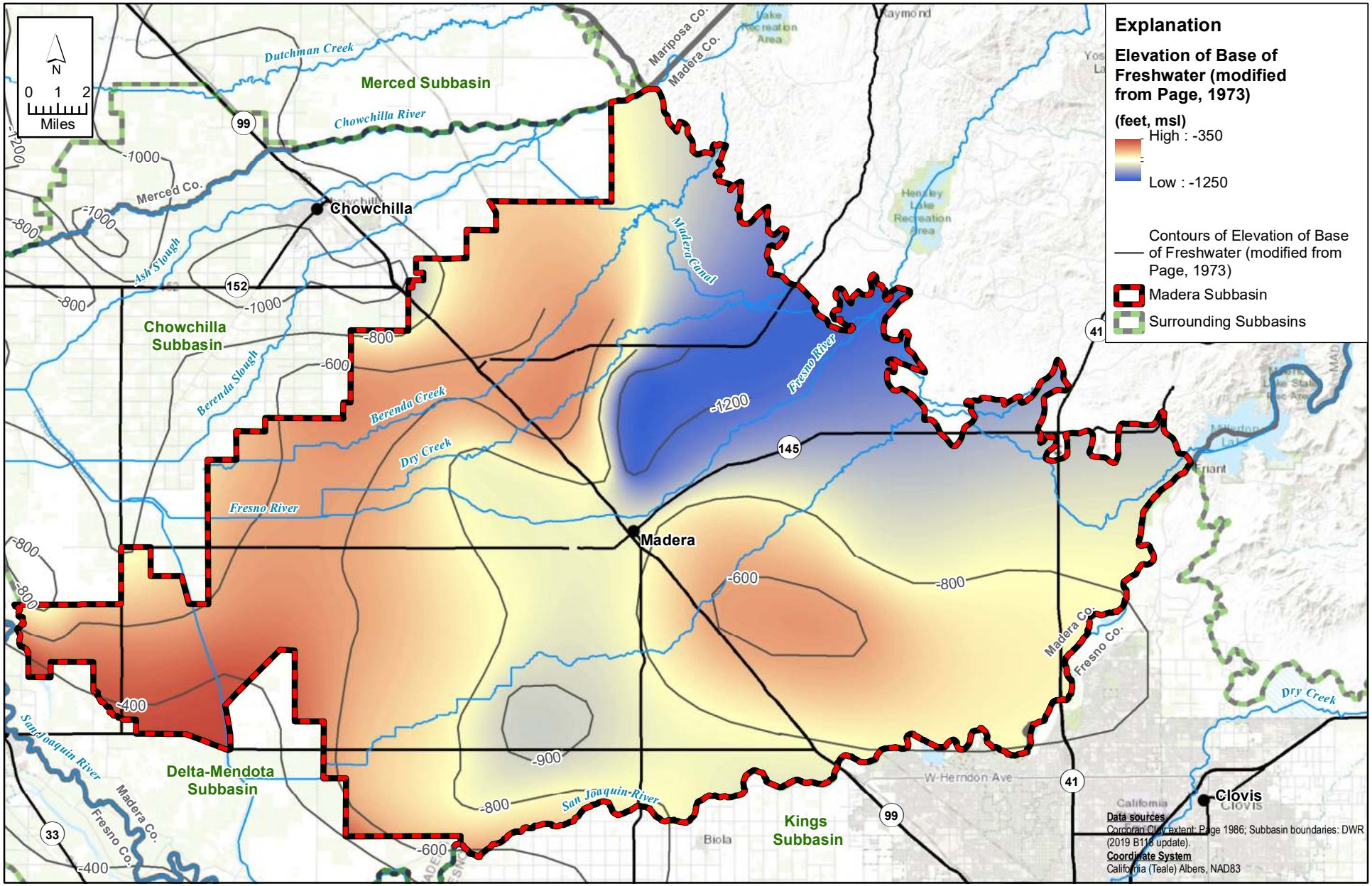
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FIGURE 2-17

Geologic Fault Map

Madera Subbasin
Groundwater Sustainability Plan



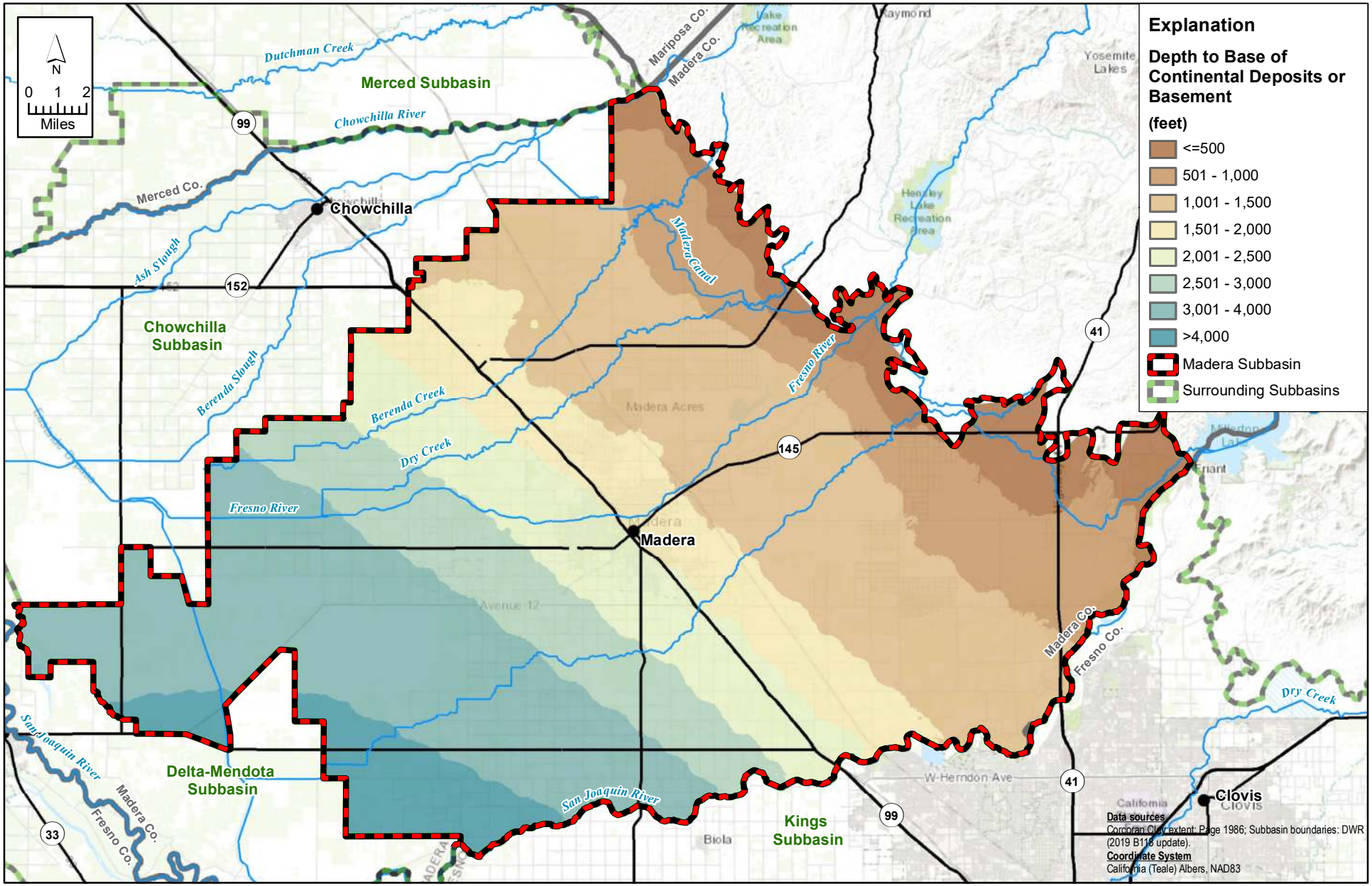
X:\2017\17-113 Madera Subbasin GSP Development\GIS\Map Files\REPORT map files\Chapter 2\Figure 2-18 Madera Subbasin Base of Freshwater Map.mxd

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FIGURE 2-18
Elevation of Base of Freshwater: Modified from Page (1973)

Madera Subbasin
Groundwater Sustainability Plan



X:\2017\17-113 Madera Subbasin GSP Development\GIS\Map Files\REPORT map files\Chapter 2\Figure 2-19 Madera Subbasin Depth to Basement Map.mxd

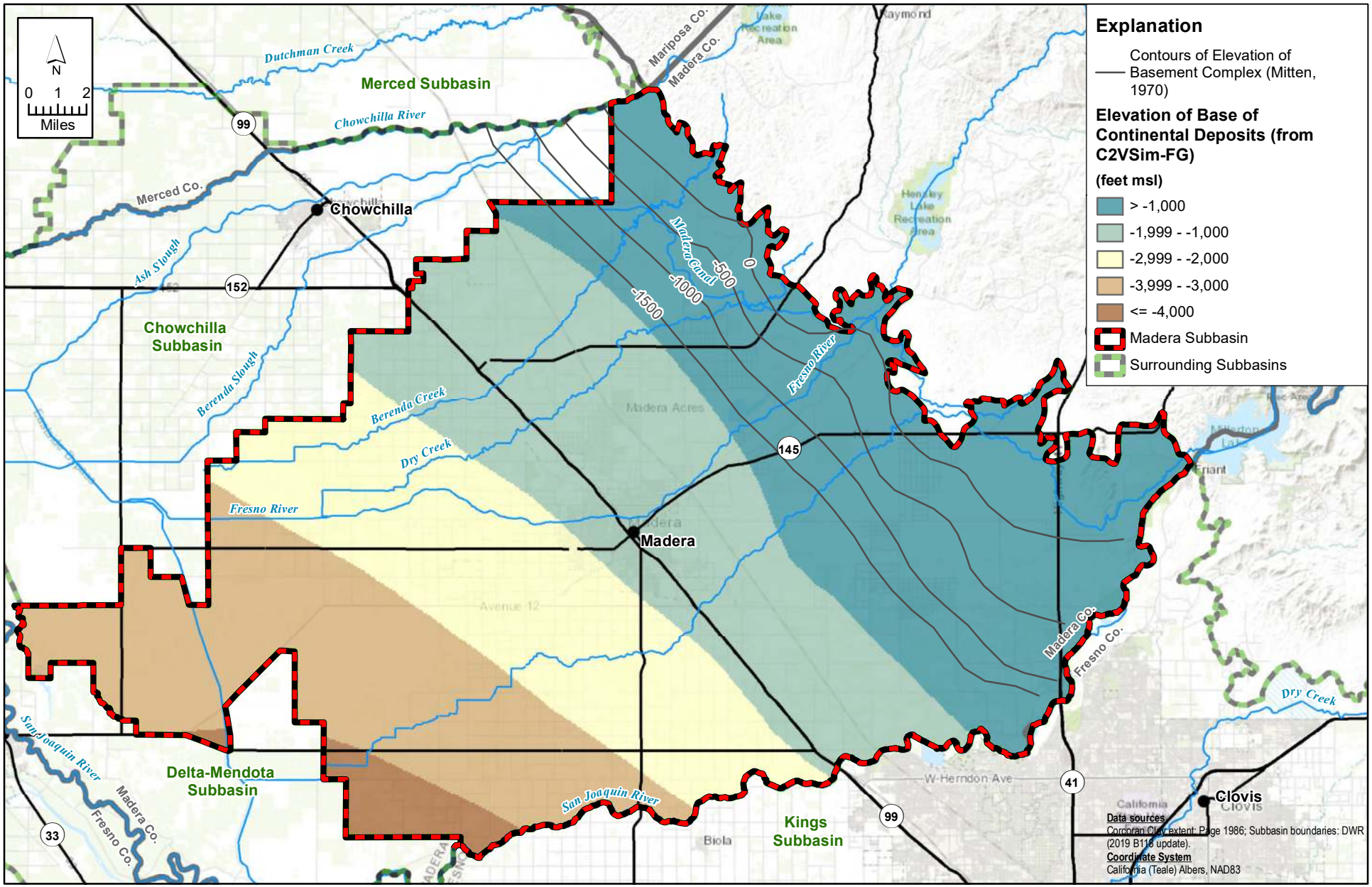
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FIGURE 2-19

Depth to Base of Continental Deposits or Basement Complex

Madera Subbasin
Groundwater Sustainability Plan



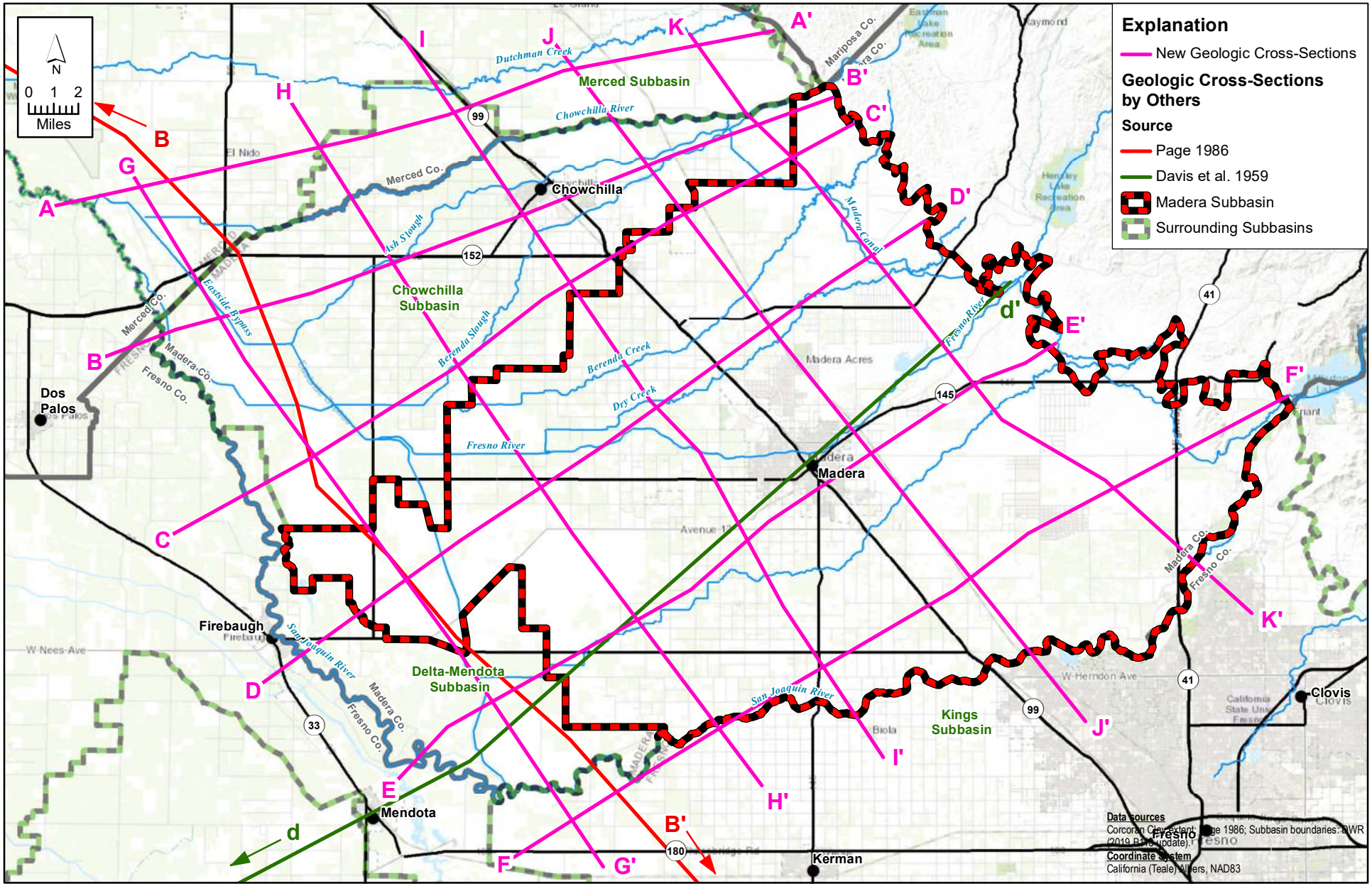
X:\2017\17-113 Madera Subbasin GSP Development\GIS\Map Files\REPORT map files\Chapter 2\Figure 2-20 Madera Subbasin Elevation of Basement Complex Map.mxd

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FIGURE 2-20
Elevation of Top of Basement Complex (from Mitten, 1970) and Bottom of Continental Deposits (from C2VSim-FG, 2018)

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FIGURE 2-21

Geologic Cross-Section Location Map

Madera Subbasin
Groundwater Sustainability Plan

Madera Subbasin

MENDOTA

MADERA

FRESNO SLOUGH

SAN JOAQUIN RIVER

FRESNO RIVER

15/12-23Q1 | 15/13-18N1 | 15/13-5M1 | 14/13-21N1 | 14/13-26N1 | 14/13-12N1 | 14/14-18N1 | 14/14-9M1 | 14/14-12N2 | 14/15-16D1 | 13/15-35E1 | 13/16-2C | 12/16-36L2 | 12/17-31D1 | 12/17-29C1 | 12/17-7L1 | 12/17-8G | 12/17-4C1 | 12/17-3H1 | 11/17-20A2 | 12/17-1C1 | 11/17-26J1 | 11/17-25J1 | 11/17-13Q1 | 11/18-20A1 | 11/18-8F | 11/18-3D1 | 10/18-14C

d — d'

700′ 600′ 500′ 400′ 300′ 200′ 100′ Sea level 100′ 200′ 300′ 400′ 500′ 600′ 700′ 800′

Approximate position 1952 1936 1945 1952

Oxidized sediments

Reduced sediments

Diatomaceous clay

Marine sedimentary rocks of Tertiary age

Gravelly deposits of the San Joaquin River

Oxidized sediments

Reduced sediments

Oxidized sediments

Crystalline basement complex of the Sierra Nevada

See plate 3 for location of wells

GEOLOGIC SECTION d-d'

2 0 10 Miles

Vertical scale 104 times horizontal scale

EXPLANATION

Gravel

Gravel and sand

Sand

Sandy clay, silt, silty sand

Clay, silty clay, shale

Volcanic ash

Crystalline bedrock

Well log plotted from interpretation of electric log is indicated by vertical line through log; generalized interpretation from electric log, as follows:

Well-sorted sand and coarser materials

Poorly sorted sand, sandy clay, sandy silt, and silt

Clay and silty clay

WATER-LEVEL PROFILES

1952
1921
Profile of water table
Unconfined or semiconfined water, for year indicated

1952
Profile of piezometric surface
Confined water, for year indicated

BLUE
Driller's log
Color only

468433 O - 59 (In pocket)

X:\2017\17-113 Madera Subbasin GSP Development\GIS\Map Files\REPORT map files\Chapter 2\Figure 2-22 CrossSection_Davis1959_d.mxd

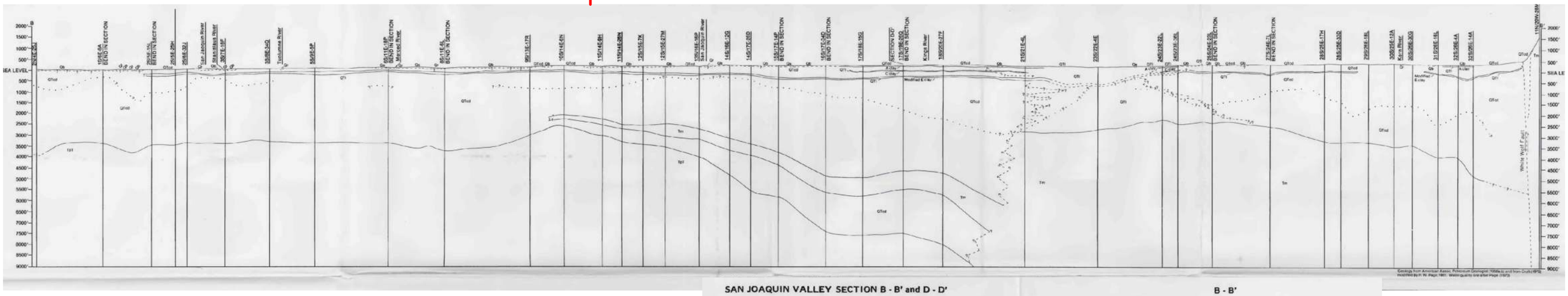
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FIGURE 2-22
Geologic Cross-Section:
Davis et al. (1959) Section d-d'

Madera Subbasin
Groundwater Sustainability Plan

Madera Subbasin



SAN JOAQUIN VALLEY SECTION B - B' and D - D'

		B - B'
Qs	**Sand dunes (Holocene)** Windblown sand and dune sand	Description at left
Qb	**Flood-basin deposits (Holocene)** Clay, silt, and some sand;	Near northern end of section consist of muck, peat, and other organic soils
Qr	**River deposits (Holocene)** Gravel, sand, silt, and minor amounts of clay; deposited along channels, flood plains, and natural levees of main streams.	Description at left
QTl	**Lacustrine and marsh deposits (Pliocene to Holocene)** Clay, silt, and some sand; in subsurface include three widespread clays: A clay (Pleistocene and Holocene?), C clay (Pleistocene); and modified E clay (Pleistocene), includes Corcoran Clay Member of Tulare Formation	Description at left
QTcd	**Continental rocks and deposits (Oligocene to Holocene)** Heterogenerous mix of generally poorly sorted clay, silt, sand, and gravel, some beds of claystone, siltstone, sandstone, and conglomerate...	On this section, principal unit, continental rocks and deposits (Miocene to Holocene): in northern part of section may include continental rocks and deposits (Miocene and Pliocene)--mostly Mehrten Formation or an equivalent, and continental rocks and deposits (Oligocene and Miocene) -mostly Valley Springs Formation or an equivalent. Include continental rocks and deposits (Miocene and Pliocene)--chiefly the Chanac Formation (Miocene) at extreme southern end of section, and the Zilch Formation of informal subsurface usage, which is considered to be the continental equivalent of the Marine Temblor Formation (Oligocene and Miocene)
Tm	**Marine rocks and deposits (Eocene, Oligocene, Miocene, and Pliocene)** Sand, clay, silt, sandstone, shale, mudstone, and siltstone. On these section include marine rocks and deposits of Miocene and Pliocene age only	Description at left
TpT	**Continental and marine rocks and deposits (Pre-Tertiary to Oligocene)** Continental rocks and deposits of clay, shale, sand, sandstone and conglomerate; marine rocks and deposits of clay, shale, sandstone, and conglomerate...	On this section include marine rocks and deposits of Eocene and Oligocene age, also include some Paleocene marine rocks. Include continental rocks and deposits (Eocene to Miocene)-- chiefly Walker Formation (Eocene to Miocene) at depths off the section - greater than 13,000ft, where the Walker Formation underlies Eocene, marine sediments. Include marine rocks (Pre-Tertiary)
pTgm	**Granitic and metamorphic rocks (Pre-Tertiary)** Granitic rocks with some mafic intrusive rocks, and metasedimentary and metavolcanic rocks. Include granitic rocks (Pre-Tertiary) and metamorphic rocks (Pre-Tertiary)	Not present

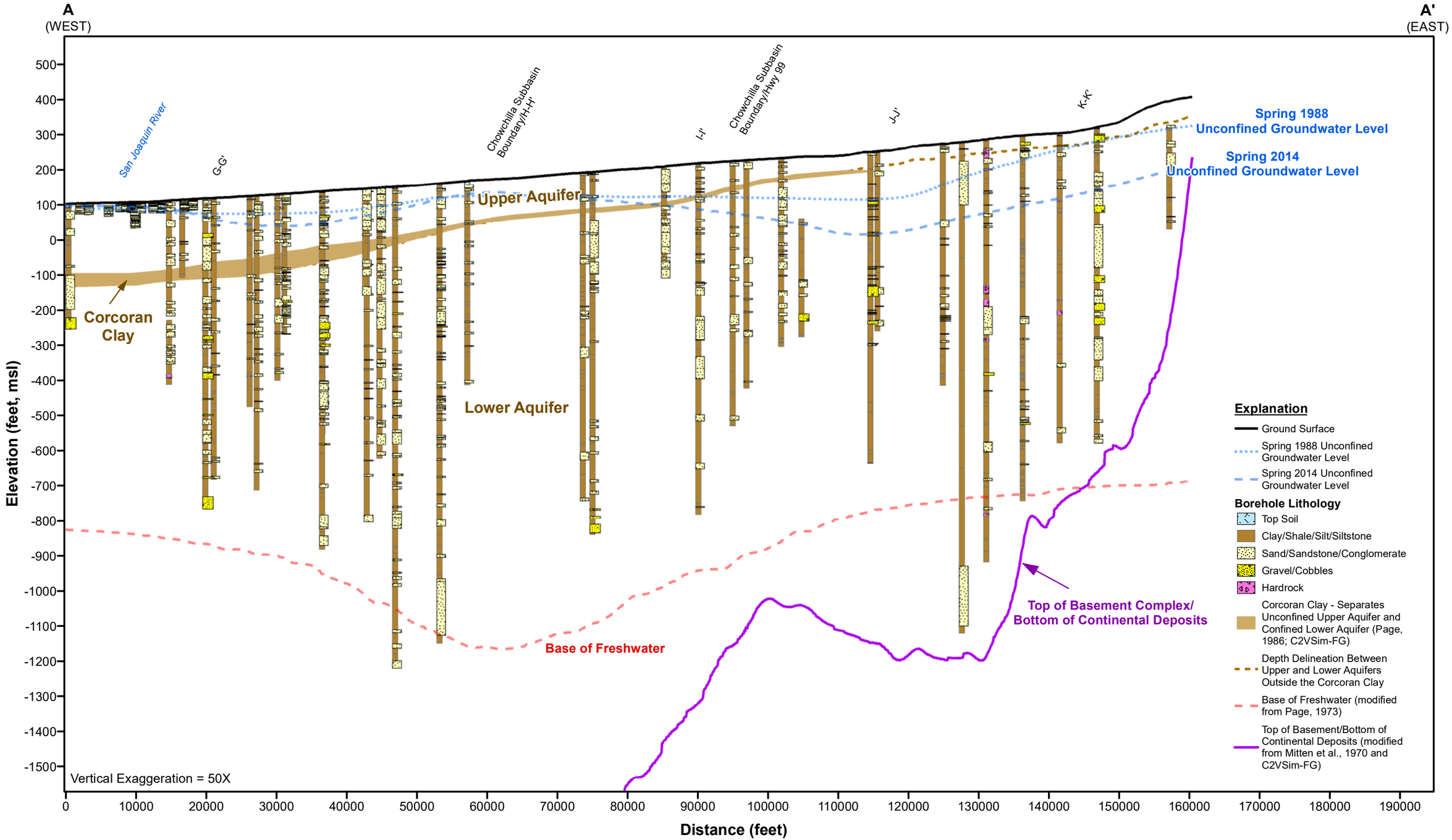
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FIGURE 2-23
Geologic Cross-Section: Page (1986) Section B-B'

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Groundwater Sustainability Plan



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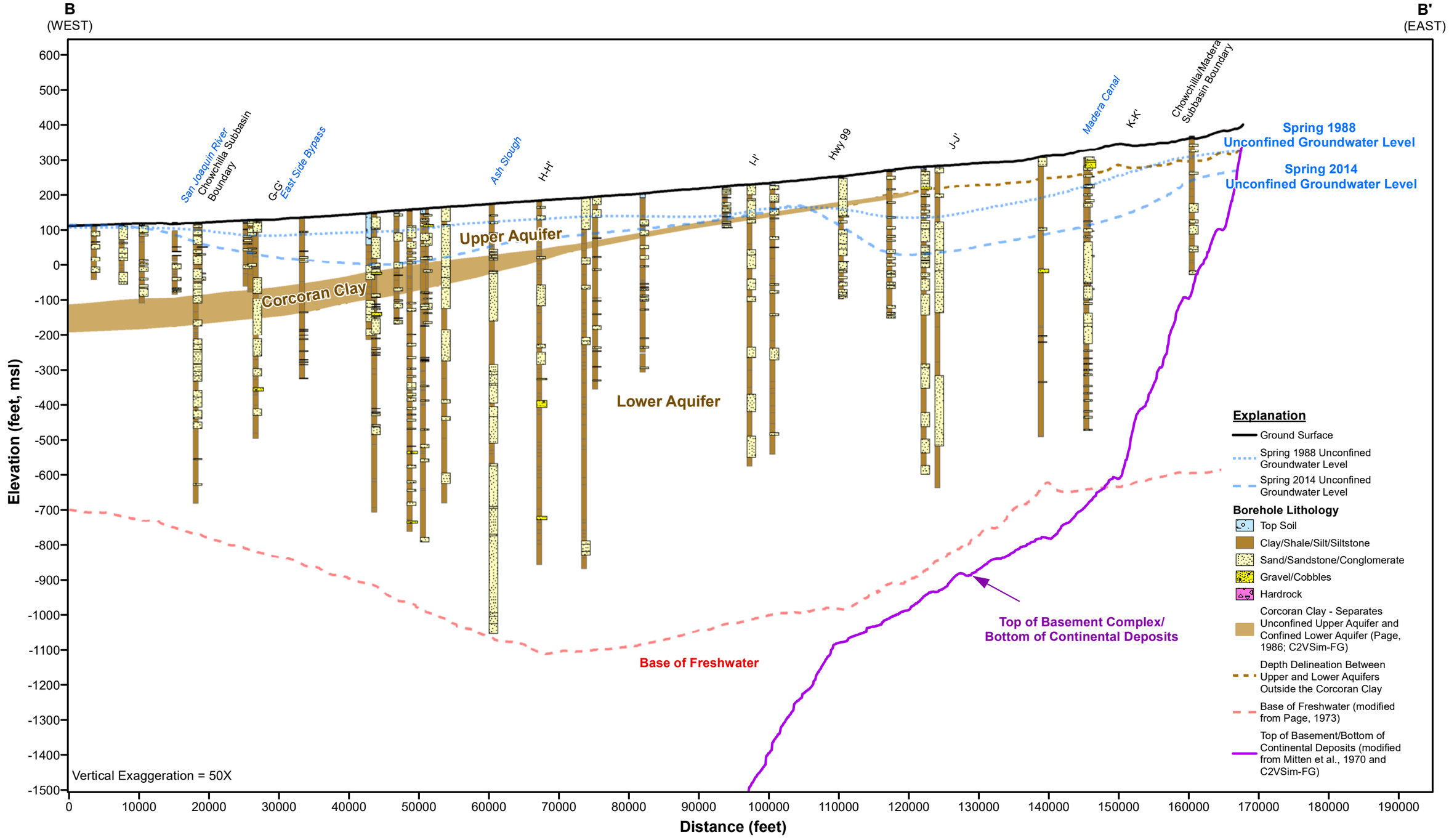
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FIGURE 2-24

Madera County Geologic Cross-Section A

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Groundwater Sustainability Plan



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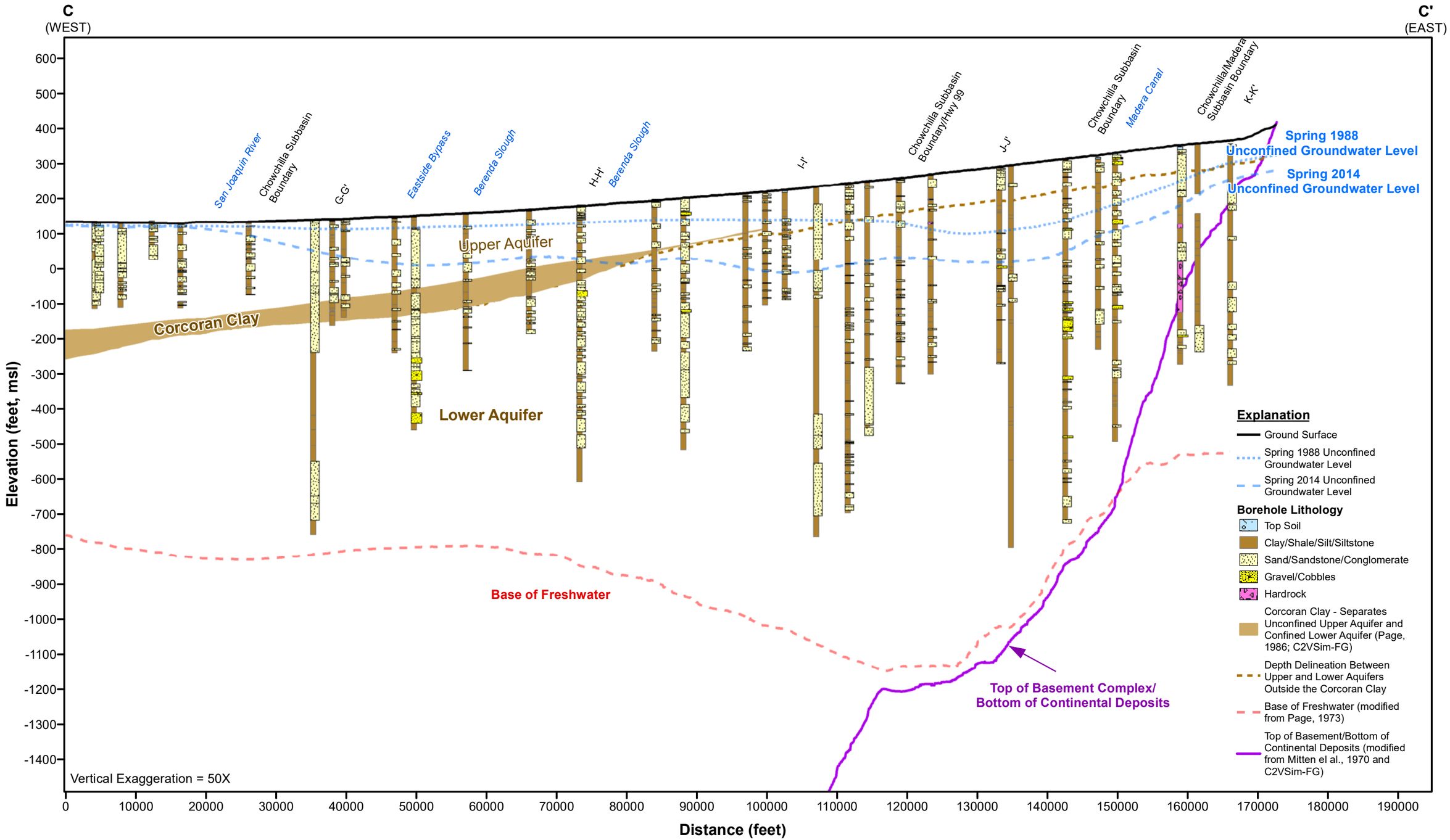
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FIGURE 2-25

Madera County Geologic Cross-Section B

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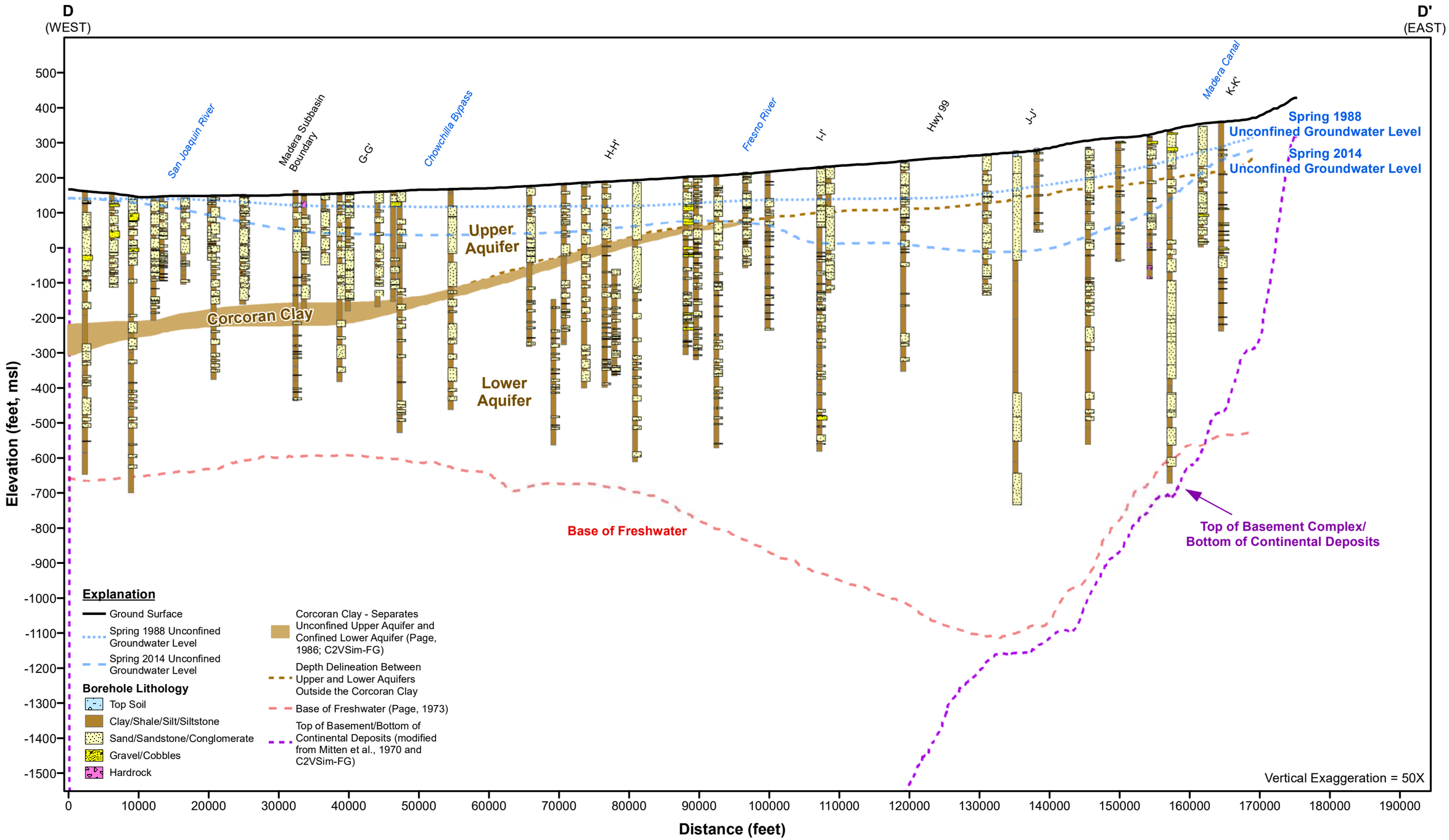
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FIGURE 2-26

Madera County Geologic Cross-Section C

Madera Subbasin
Groundwater Sustainability Plan



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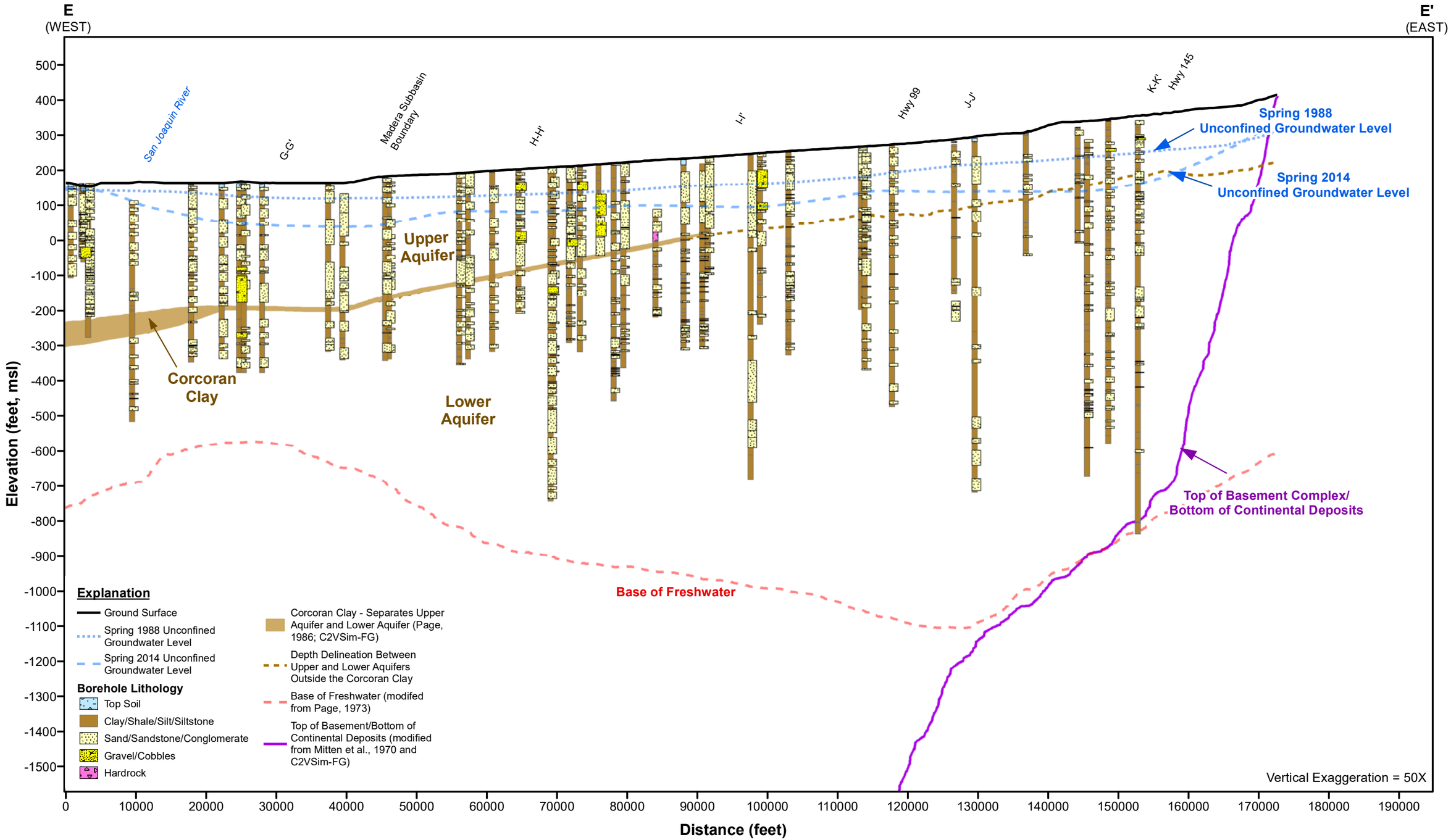
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FIGURE 2-27

Madera County Geologic Cross-Section D

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Groundwater Sustainability Plan



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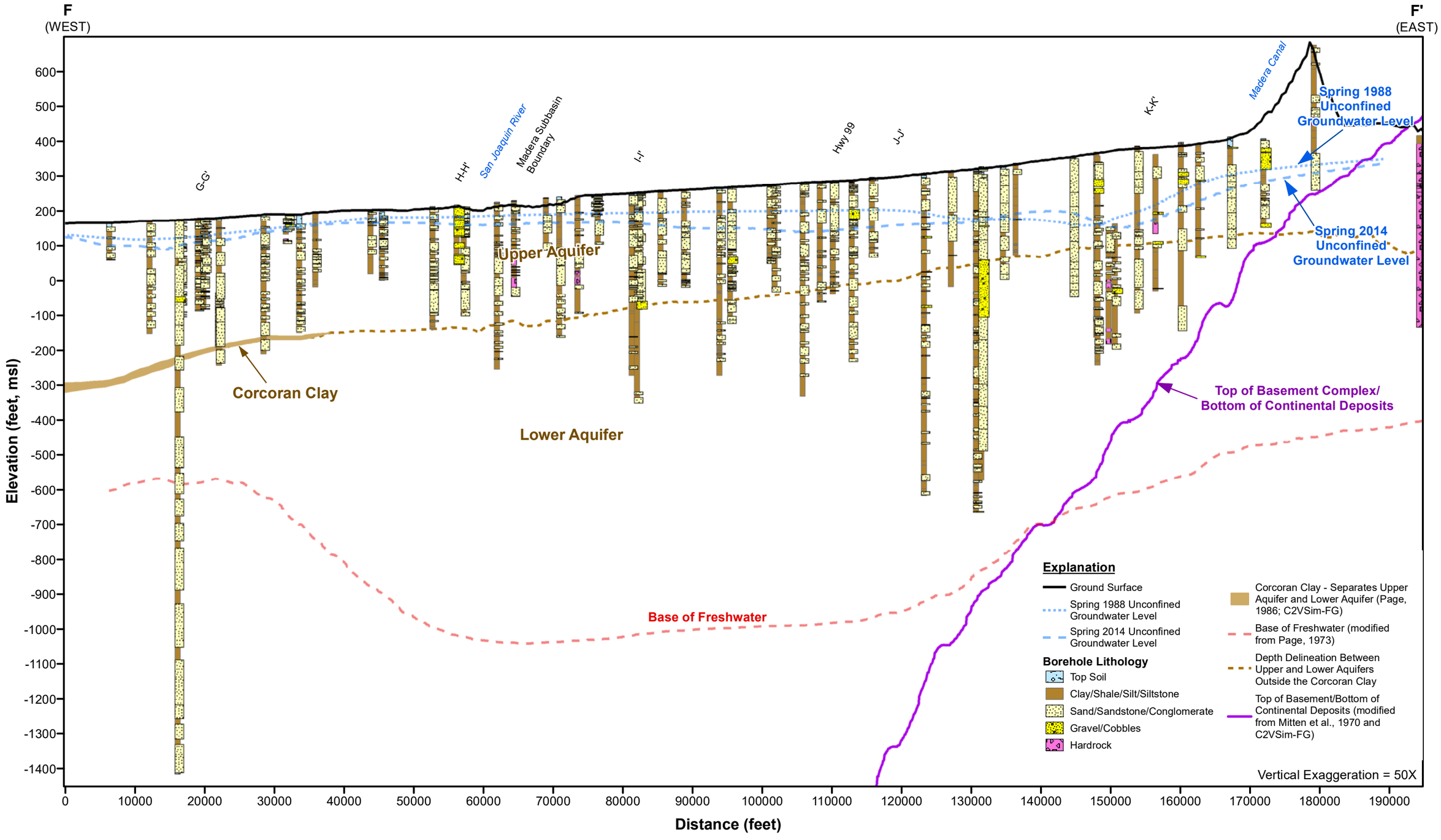
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FIGURE 2-28

Madera County Geologic Cross-Section E

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Groundwater Sustainability Plan



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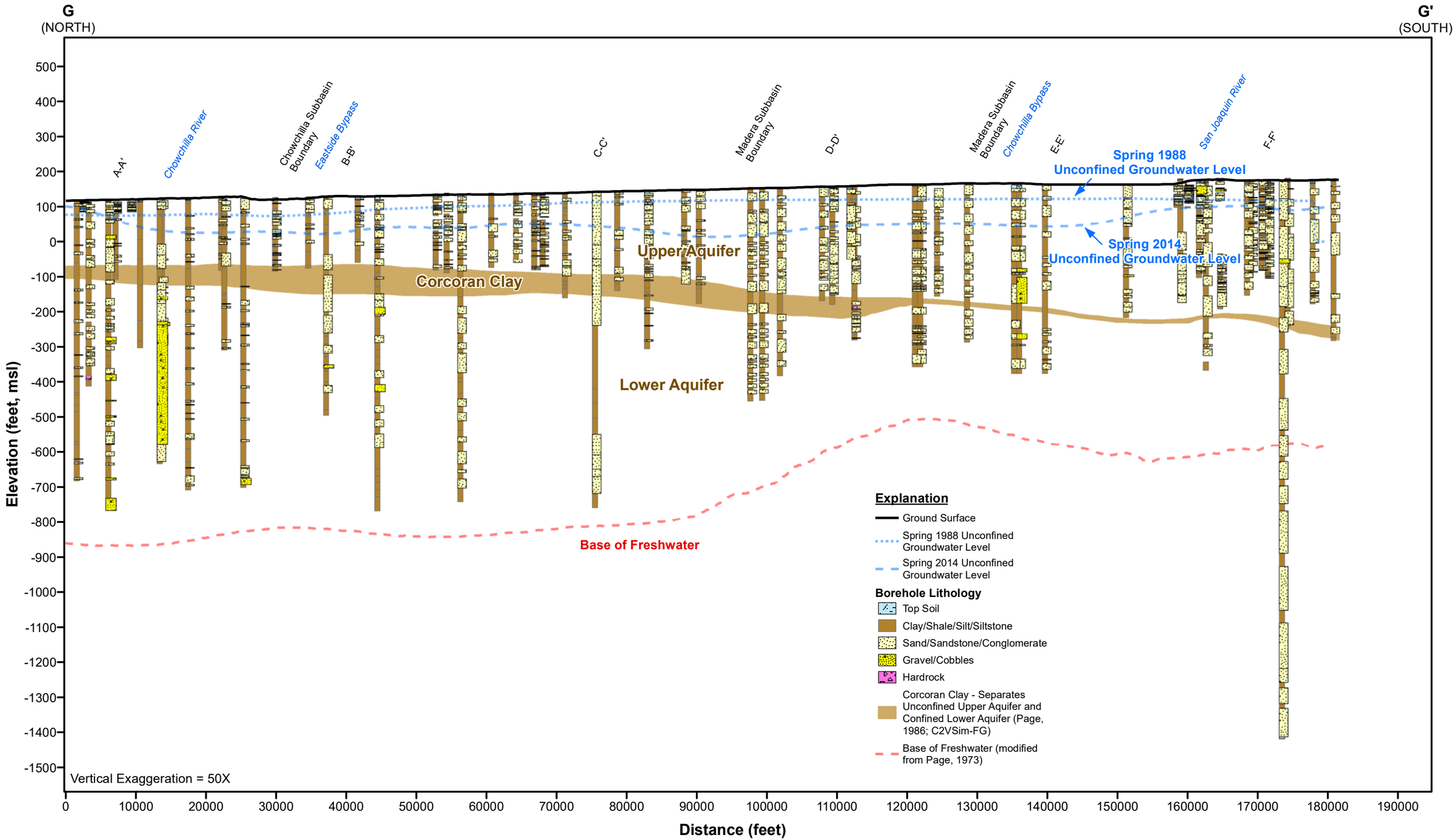
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FIGURE 2-29

Madera County Geologic Cross-Section F

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Groundwater Sustainability Plan



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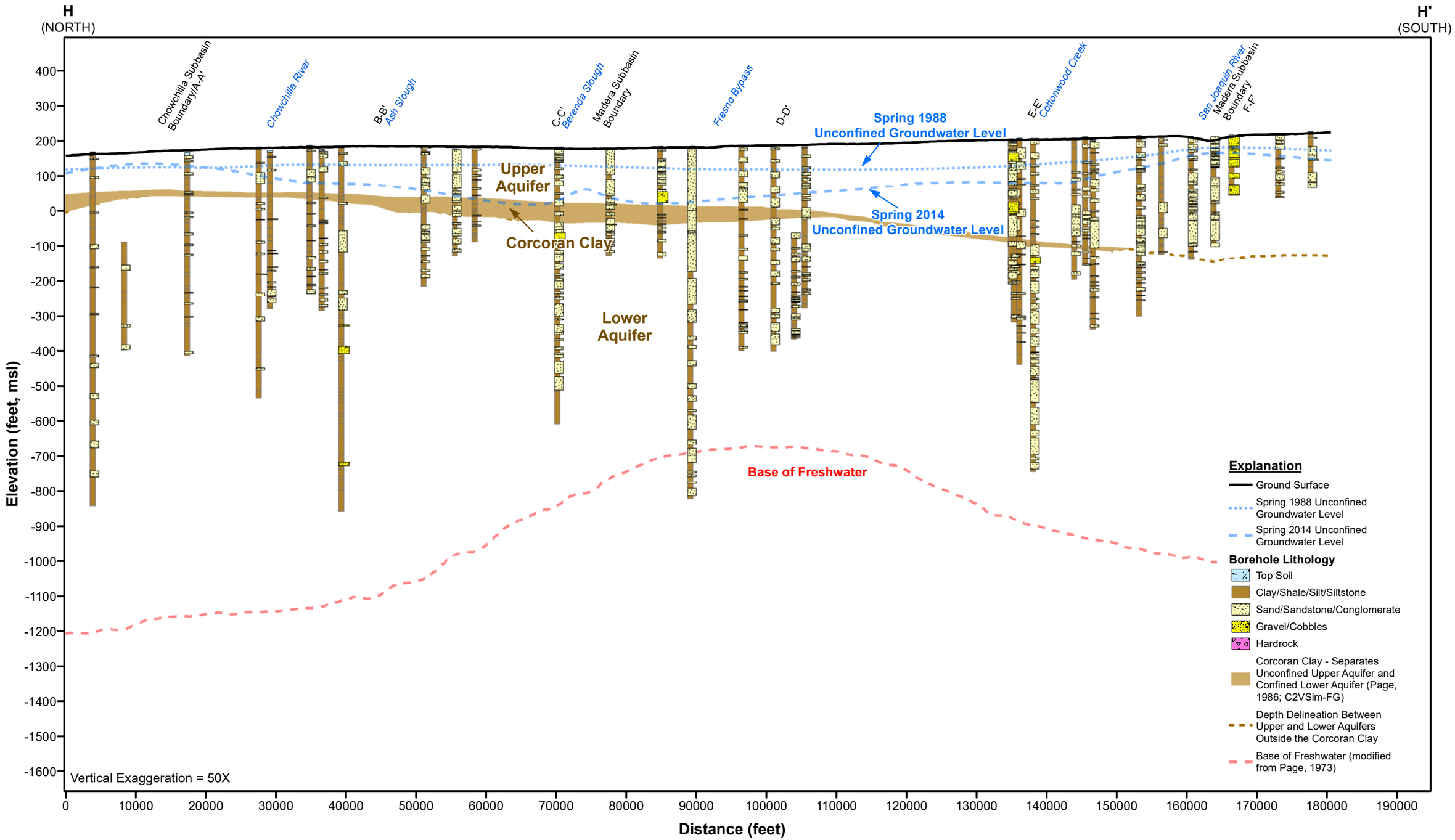
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FIGURE 2-30

Madera County Geologic Cross-Section G

Madera Subbasin
Groundwater Sustainability Plan



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FIGURE 2-31

Madera County Geologic Cross-Section H

Madera Subbasin
Groundwater Sustainability Plan

I (NORTH)

I' (SOUTH)

Chowchilla Subbasin Boundary

Deadman Creek

A-A'

Chowchilla River

Ash Slough

B-B'

Berenda Slough

C-C'

Chowchilla/Madera Subbasin Boundary

Berenda Creek

Dry Creek

D-D'

Fresno River

E-E'

Cottonwood Creek

F-F'

San Joaquin River

Madera Subbasin Boundary

Spring 1988 Unconfined Groundwater Level

Upper Aquifer

Corcoran Clay

Spring 2014 Unconfined Groundwater Level

Lower Aquifer

Base of Freshwater

Top of Basement Complex/ Bottom of Continental Deposits

Vertical Exaggeration = 50X

Elevation (feet, msl)

500
400
300
200
100
0
-100
-200
-300
-400
-500
-600
-700
-800
-900
-1000
-1100
-1200
-1300
-1400
-1500

0
10000
20000
30000
40000
50000
60000
70000
80000
90000
100000
110000
120000
130000
140000
150000
160000
170000
180000
190000

Distance (feet)

Explanation

- Ground Surface
- Spring 1988 Unconfined Groundwater Level
- Spring 2014 Unconfined Groundwater Level

Borehole Lithology

- Top Soil
- Clay/Shale/Silt/Siltstone
- Sand/Sandstone/Conglomerate
- Gravel/Cobbles
- Hardrock
- Corcoran Clay - Separates Upper Aquifer and Lower Aquifer (Page, 1986; C2VSim-FG)
- Depth Delineation Between Upper and Lower Aquifers Outside the Corcoran Clay
- Base of Freshwater (modified from Page, 1973)
- Top of Basement/Bottom of Continental Deposits (modified from Mitten et al., 1970 and C2VSim-FG)

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FIGURE 2-32

Madera County Geologic Cross-Section I

Madera Subbasin
Groundwater Sustainability Plan

J (NORTH)

J' (SOUTH)

Deadman Creek
A-A'
Chowchilla River
Chowchilla Subbasin Boundary
B-B'
Ash Slough/ Berenda Slough
C-C'
Chowchilla/Madera Subbasin Boundary
Berenda Creek
D-D'
Dry Creek
Fresno River
E-E'
Cottonwood Creek
F-F'
San Joaquin River
Madera Subbasin Boundary

Spring 1988 Unconfined Groundwater Level

Spring 2014 Unconfined Groundwater Level

Upper Aquifer

Lower Aquifer

Base of Freshwater

Top of Basement Complex/ Bottom of Continental Deposits

Vertical Exaggeration = 50X

Elevation (feet, msl)

600
500
400
300
200
100
0
-100
-200
-300
-400
-500
-600
-700
-800
-900
-1000
-1100
-1200
-1300
-1400

0
10000
20000
30000
40000
50000
60000
70000
80000
90000
100000
110000
120000
130000
140000
150000
160000
170000
180000
190000

Distance (feet)

Explanation

- Ground Surface
- Spring 1988 Unconfined Groundwater Level
- Spring 2014 Unconfined Groundwater Level

Borehole Lithology

- Top Soil
- Clay/Shale/Silt/Siltstone
- Sand/Sandstone/Conglomerate
- Gravel/Cobbles
- Hardrock

- Base of Freshwater (modified from Page, 1973)
- Depth Delineation Between Upper and Lower Aquifers Outside the Corcoran Clay
- Top of Basement/Bottom of Continental Deposits (modified from Mitten et al., 1970 and C2VSim-FG)

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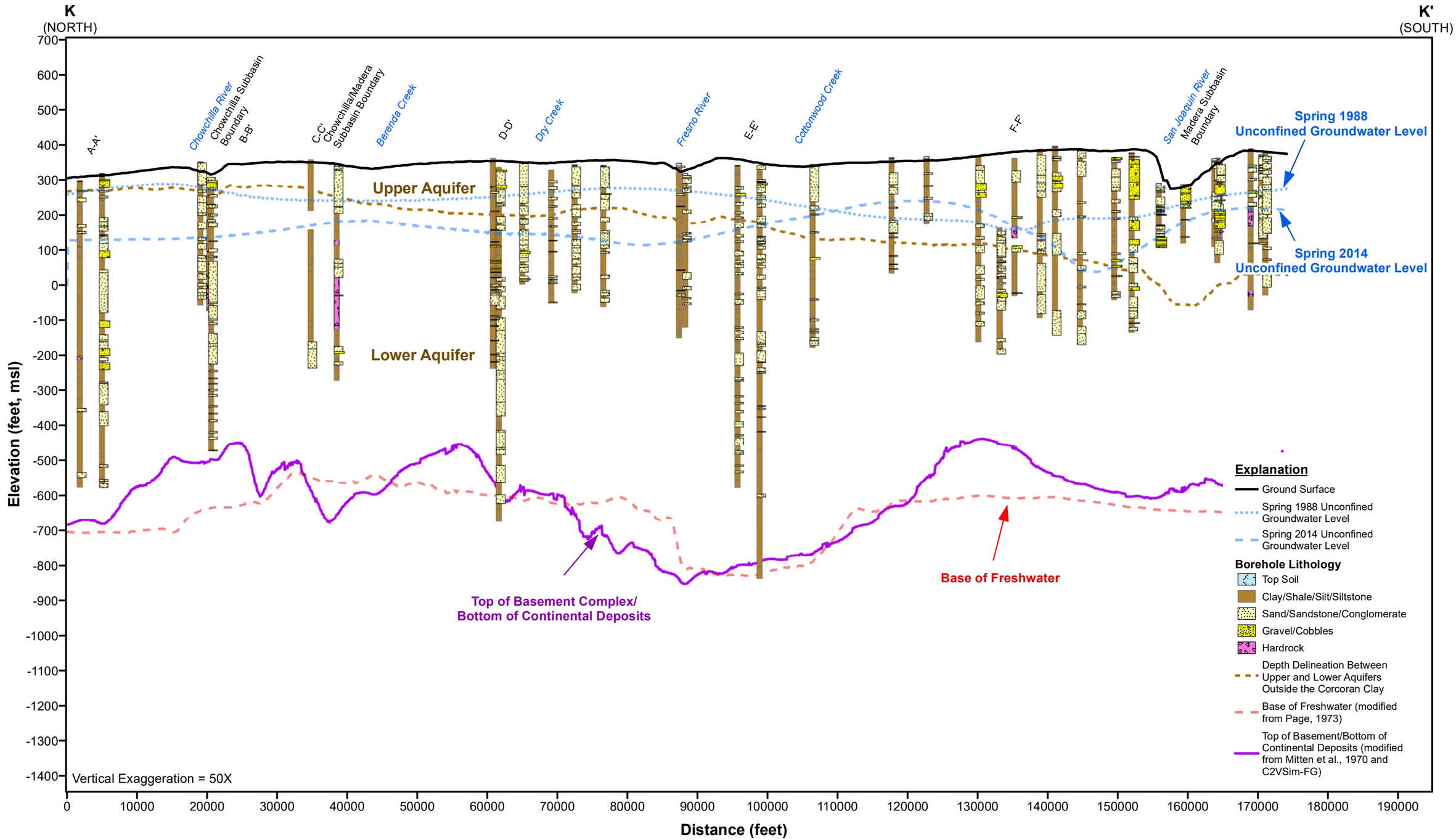
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FIGURE 2-33

Madera County Geologic Cross-Section J

Madera Subbasin
Groundwater Sustainability Plan



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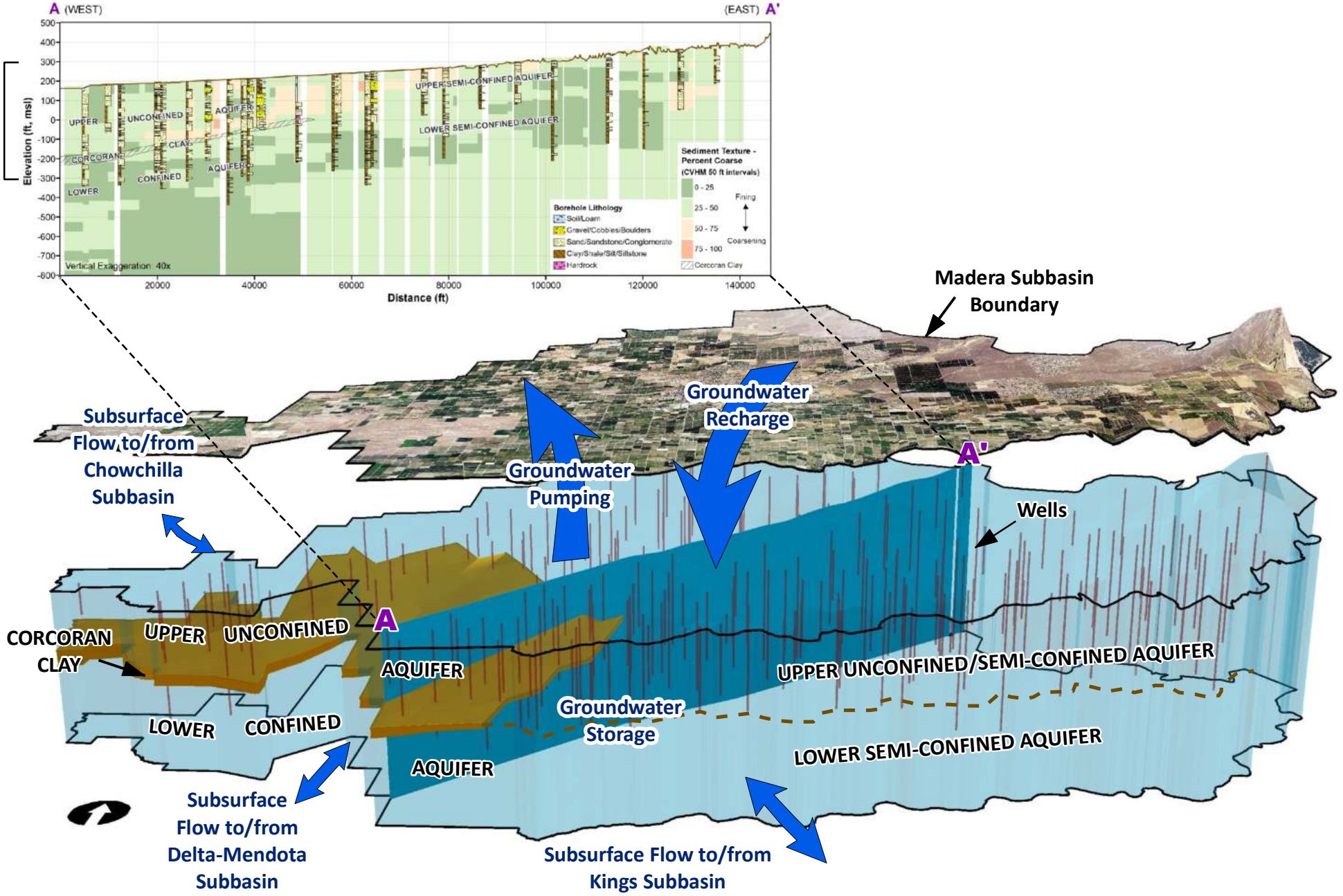
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FIGURE 2-34

Madera County Geologic Cross-Section K

Madera Subbasin
Groundwater Sustainability Plan



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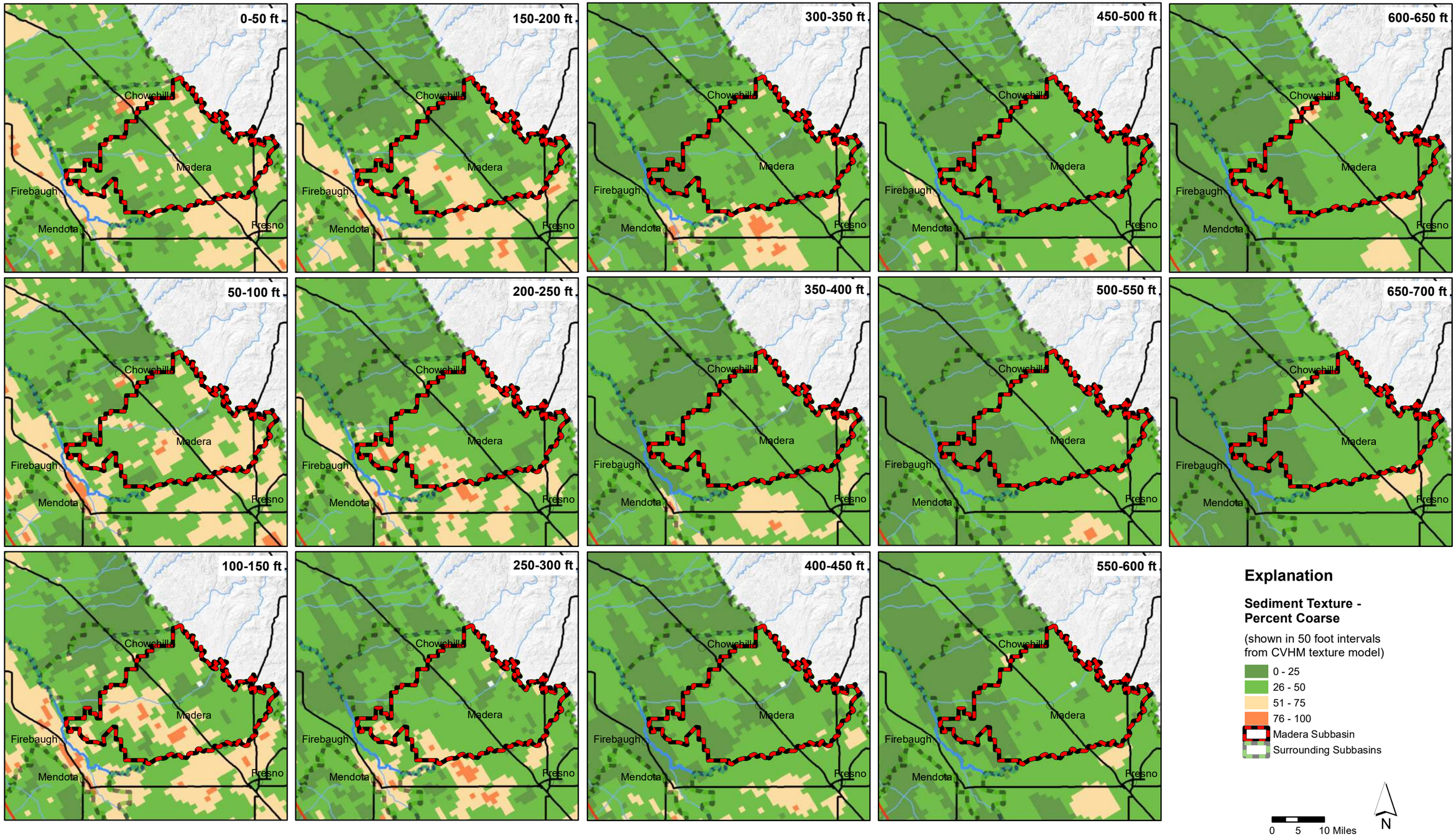
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FIGURE 2-35

Conceptual Hydrogeologic System

Madera Subbasin
Groundwater Sustainability Plan



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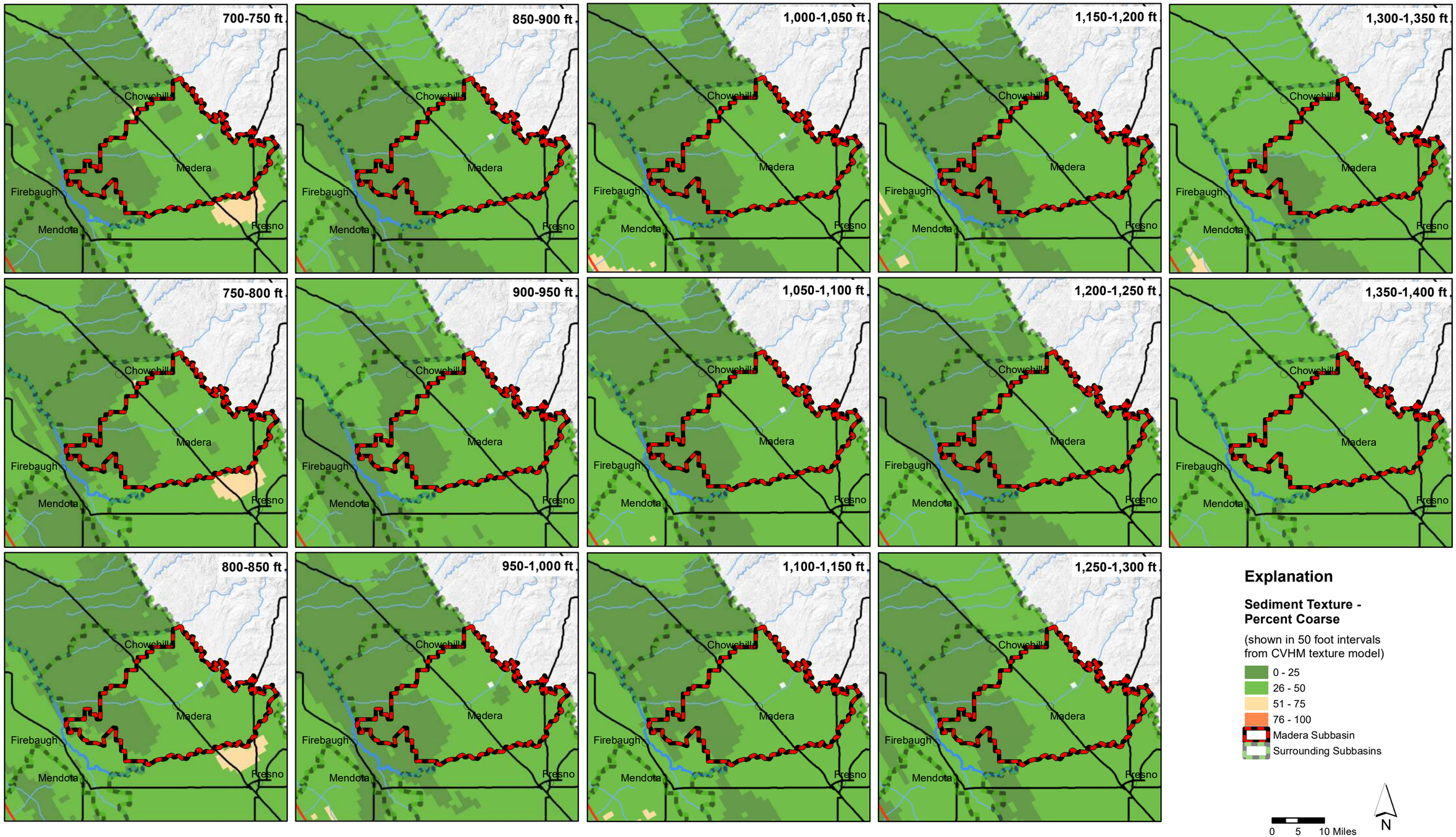
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FIGURE 2-36

CVHM Sediment Texture Model: 0 to 700 feet

Madera Subbasin
Groundwater Sustainability Plan



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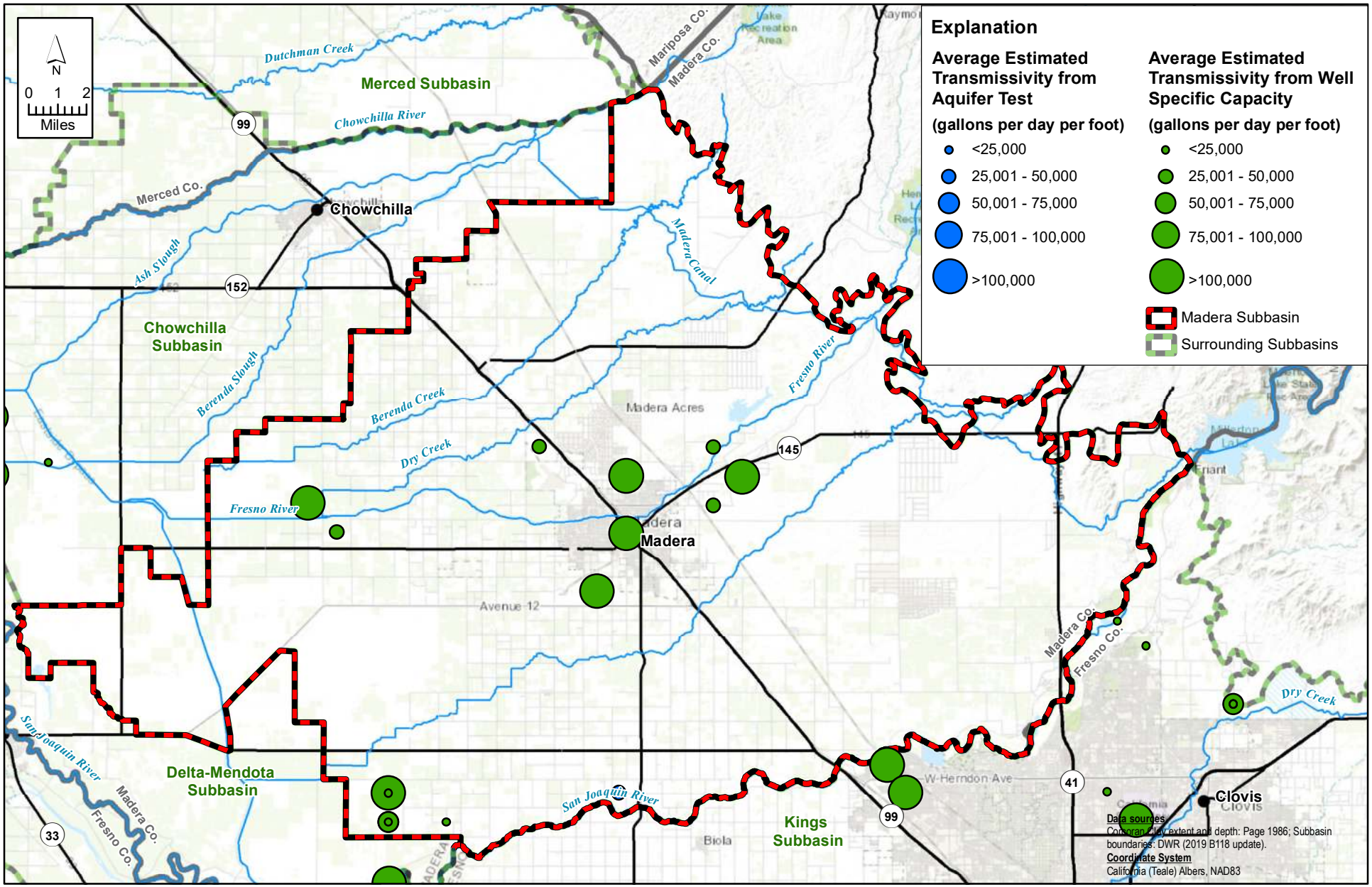
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FIGURE 2-37

CVHM Sediment Texture Model: 700 to 1,400 feet

Madera Subbasin
Groundwater Sustainability Plan



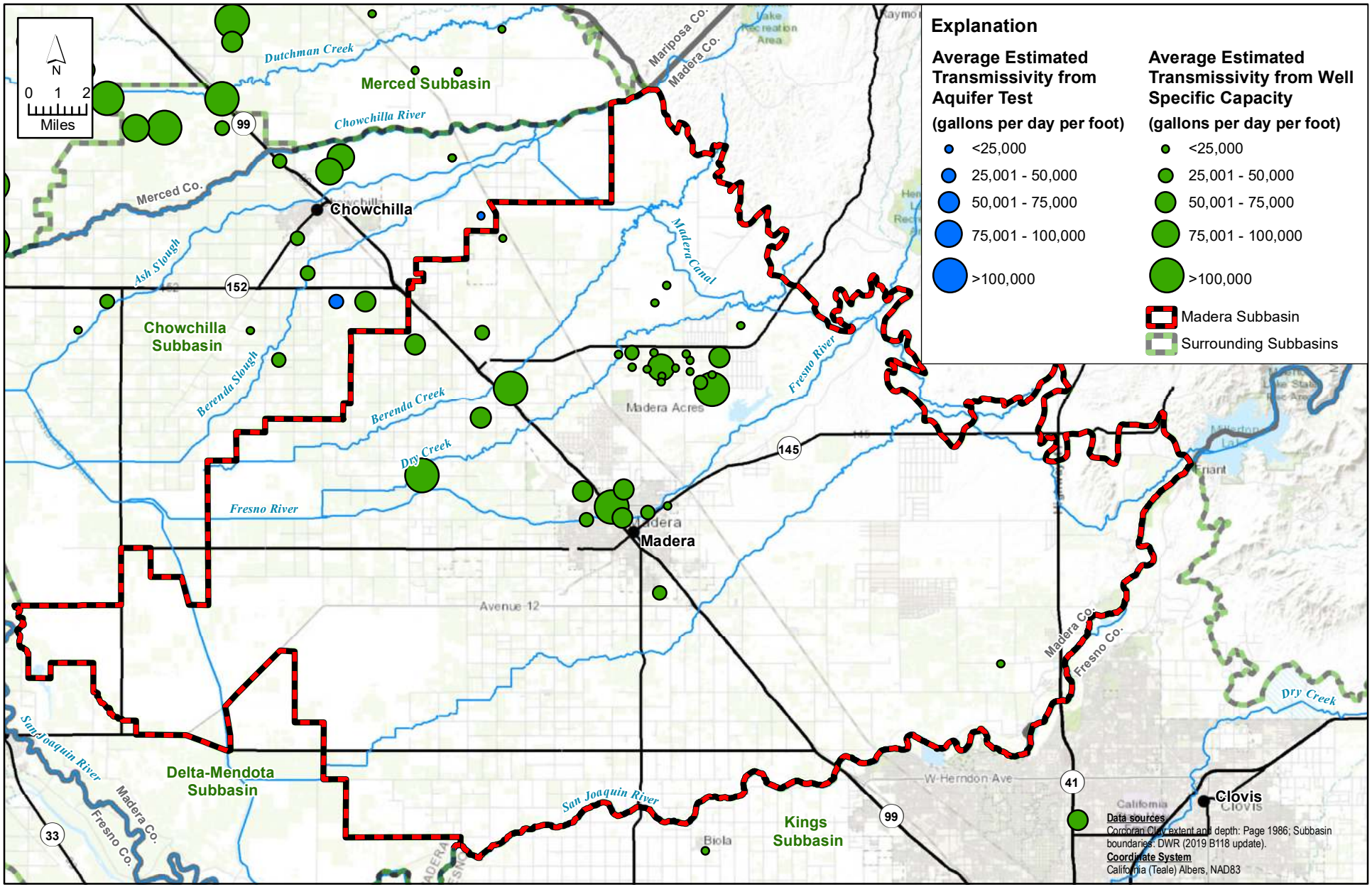
X:\2017\17-113 Madera Subbasin GSP Development\GIS\Map Files\REPORT map files\Chapter 2\Figure 2-38 Madera Subbasin Aquifer Property Data_Upper.mxd

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FIGURE 2-38
Map of Well Test Aquifer Property Data: Upper Aquifer

Madera Subbasin
Groundwater Sustainability Plan



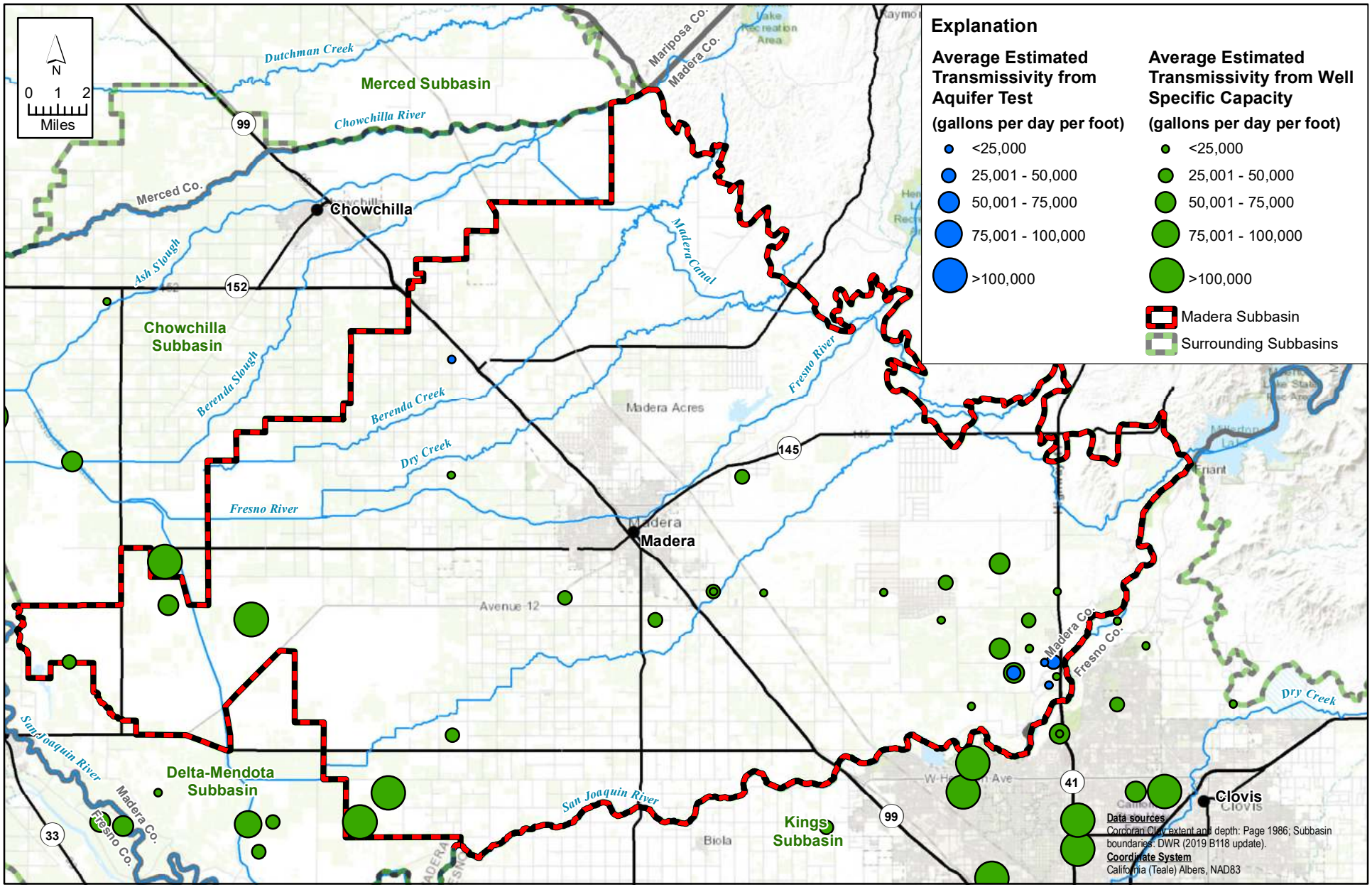
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FIGURE 2-39
Map of Well Test Aquifer Property Data: Lower Aquifer

Madera Subbasin
Groundwater Sustainability Plan



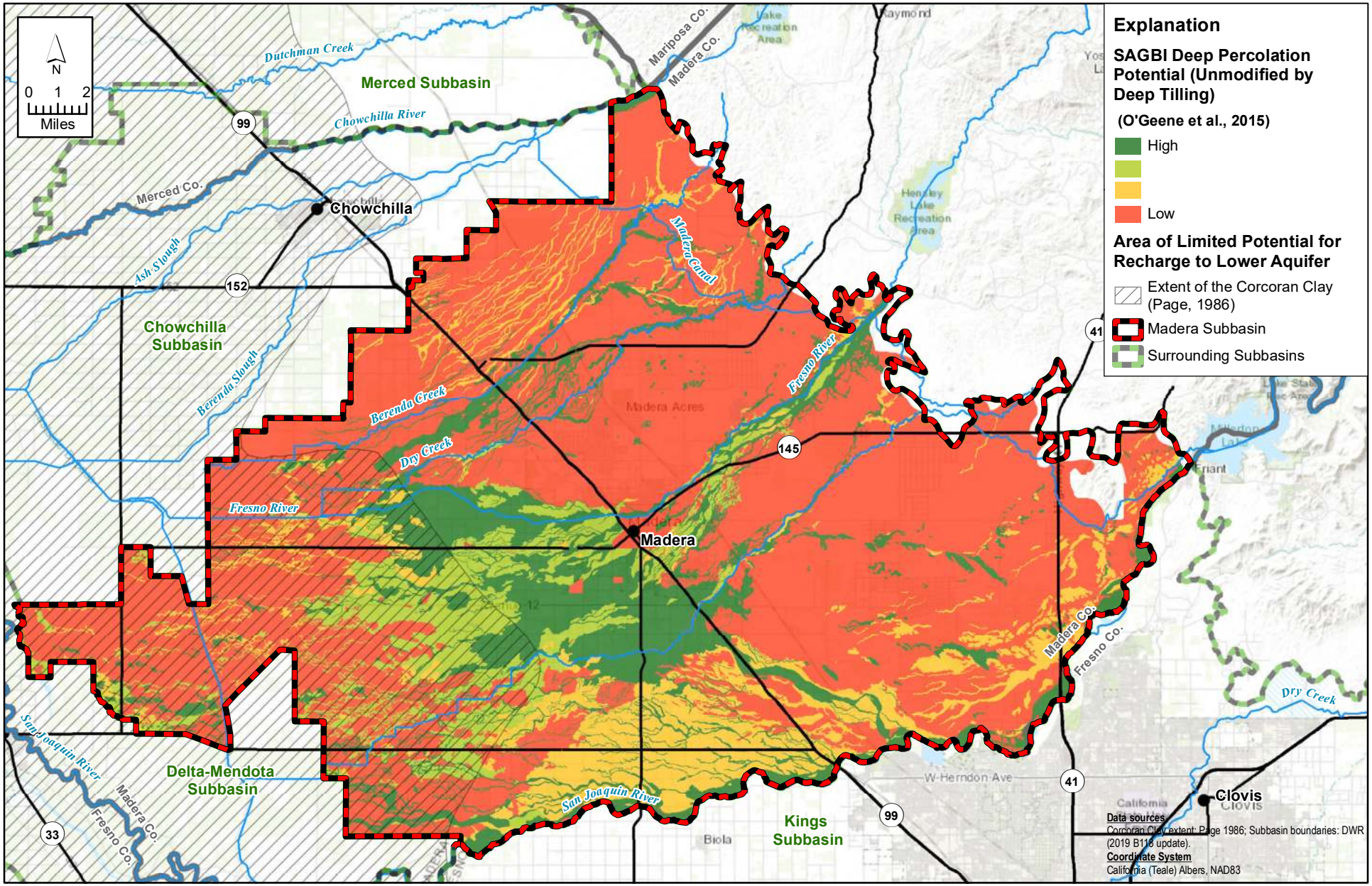
X:\2017\17-113 Madera Subbasin GSP Development\GIS\Map Files\REPORT map files\Chapter 2\Figure 2-40 Madera Subbasin Aquifer Property Data_CompositeUnknown.mxd

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FIGURE 2-40
Map of Well Test Aquifer Property Data: Composite Wells or Unknown Depth

Madera Subbasin
Groundwater Sustainability Plan



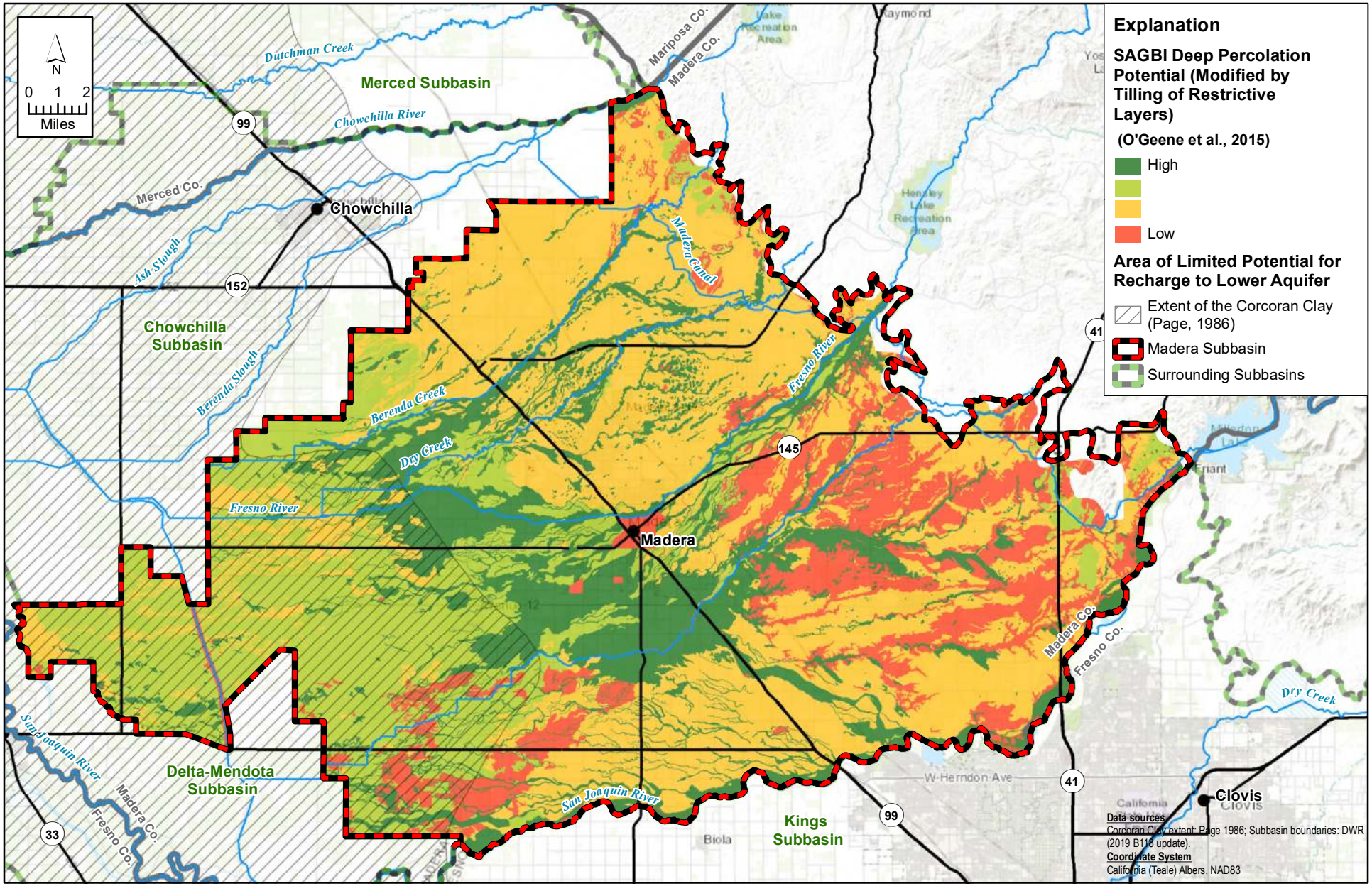
X:\2017\17-113 Madera Subbasin GSP Development\GIS\Map Files\REPORT map files\Chapter 2\Figure 2-41 Madera Subbasin SAGBI Higher Recharge Potential Areas_unmodified.mxd

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FIGURE 2-41
SAGBI Deep Percolation Potential: Unmodified by Tilling

Madera Subbasin
Groundwater Sustainability Plan



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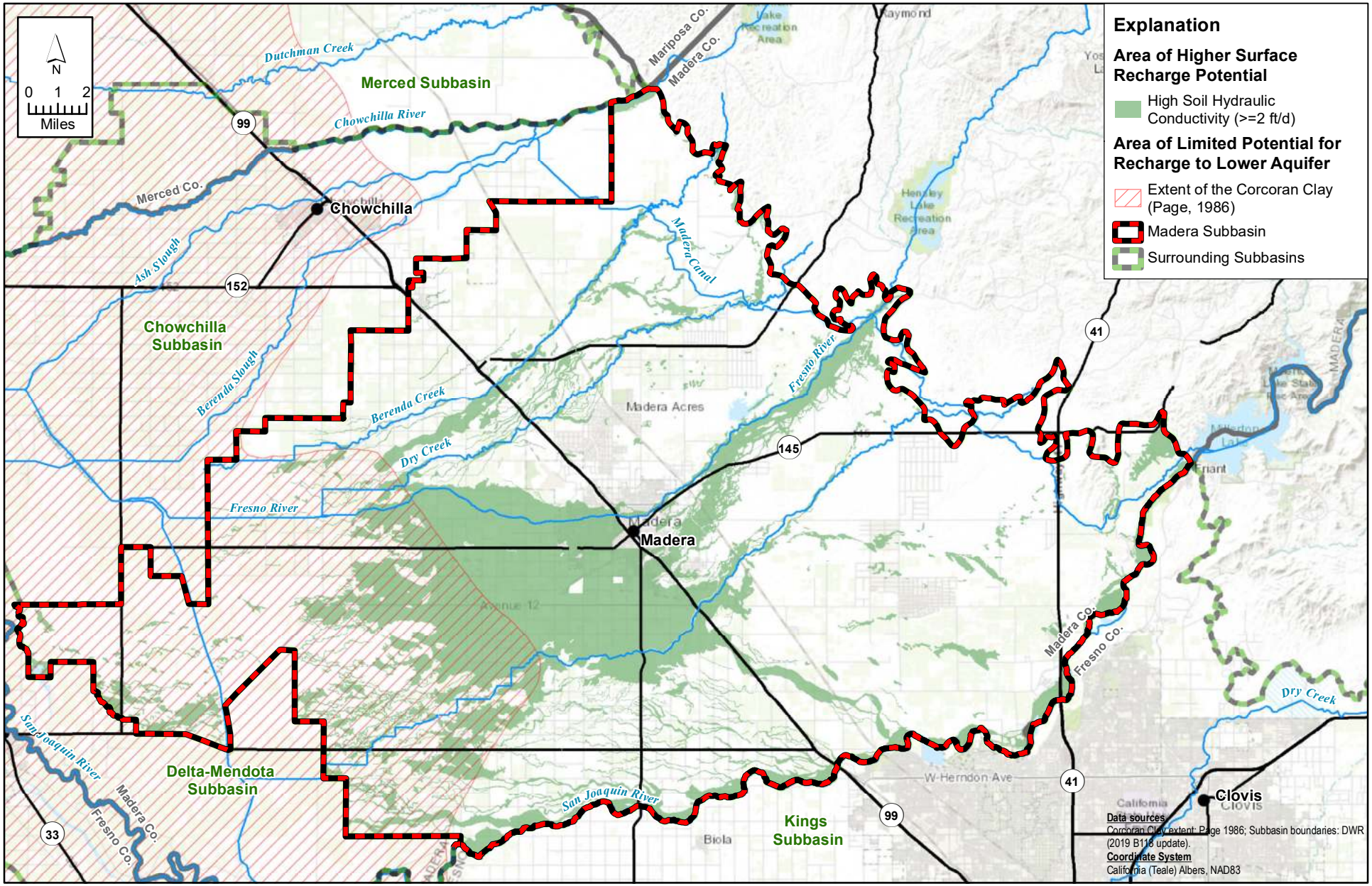
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FIGURE 2-42

SAGBI Deep Percolation Potential: Modified by Tilling of All Restrictive Layers

Madera Subbasin
Groundwater Sustainability Plan



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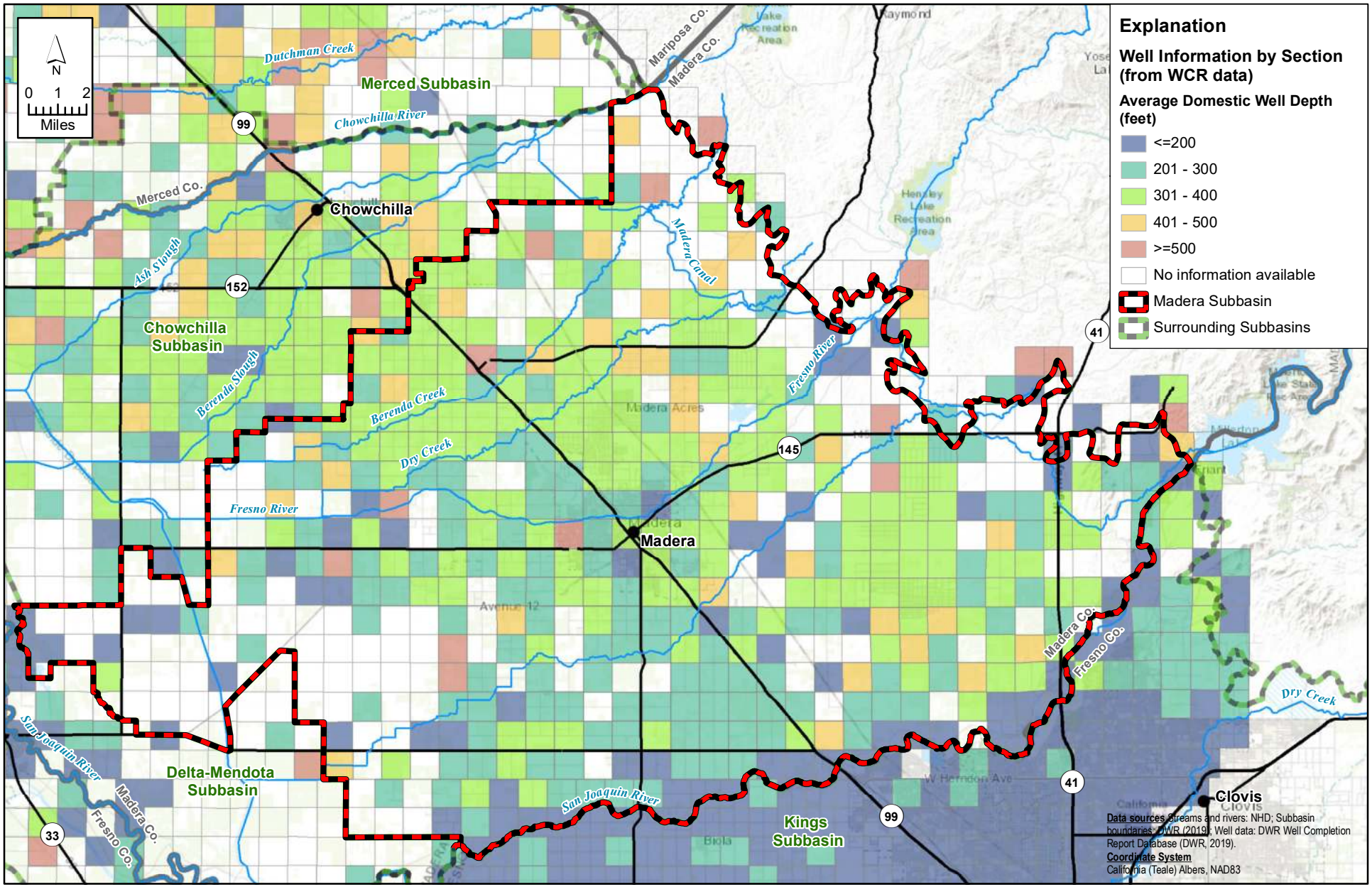
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FIGURE 2-43

Areas of Higher Recharge Potential

Madera Subbasin
Groundwater Sustainability Plan



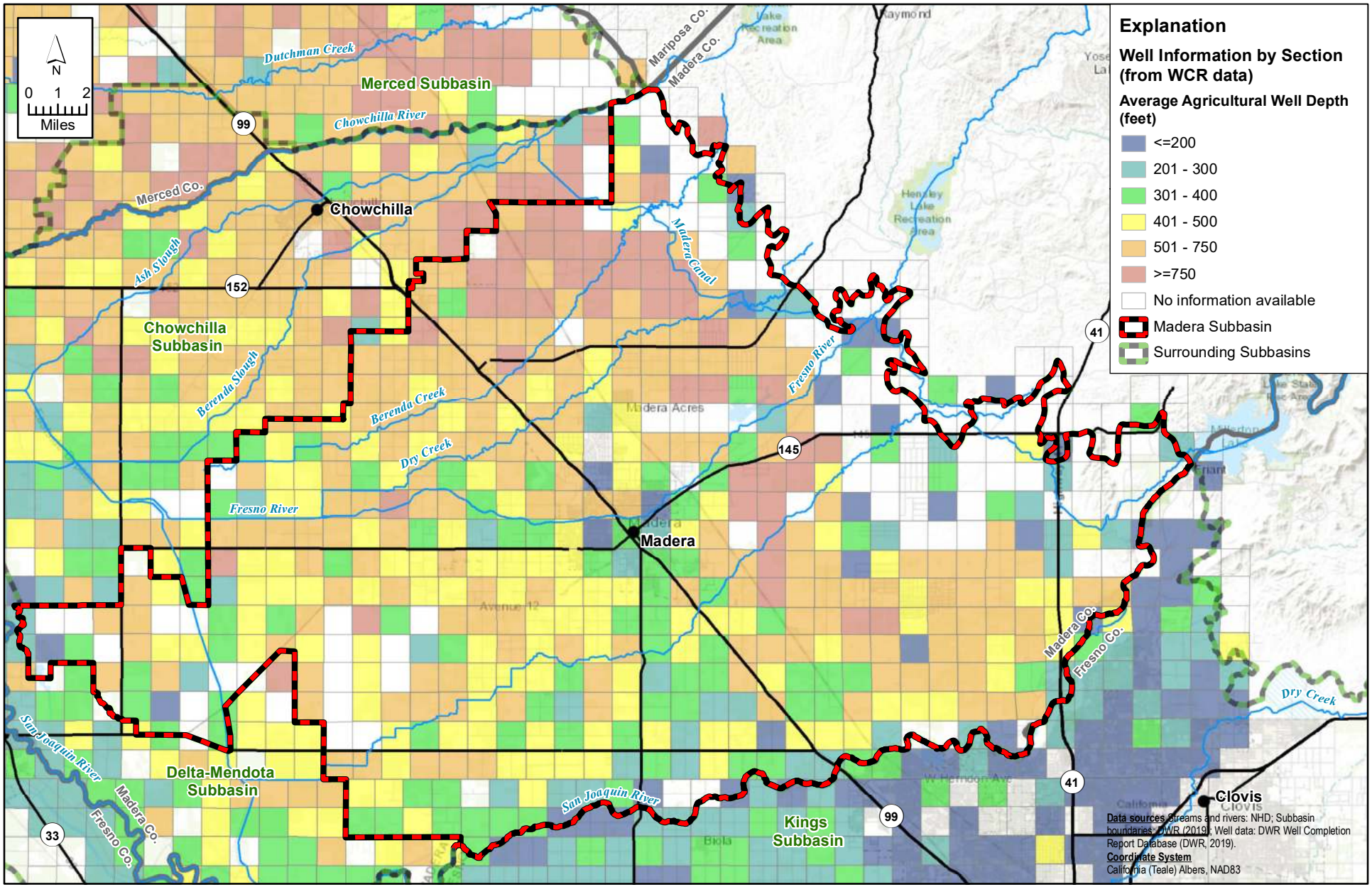
X:\2017\17-113 Madera Subbasin GSP Development\GIS\Map Files\REPORT map files\Chapter 2\Figure 2-44 Madera Subbasin Wells By Section Dom Well Depth.mxd

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FIGURE 2-44
Map of Well Information by Section: Average Domestic Well Depth (from WCR data)

Madera Subbasin
Groundwater Sustainability Plan



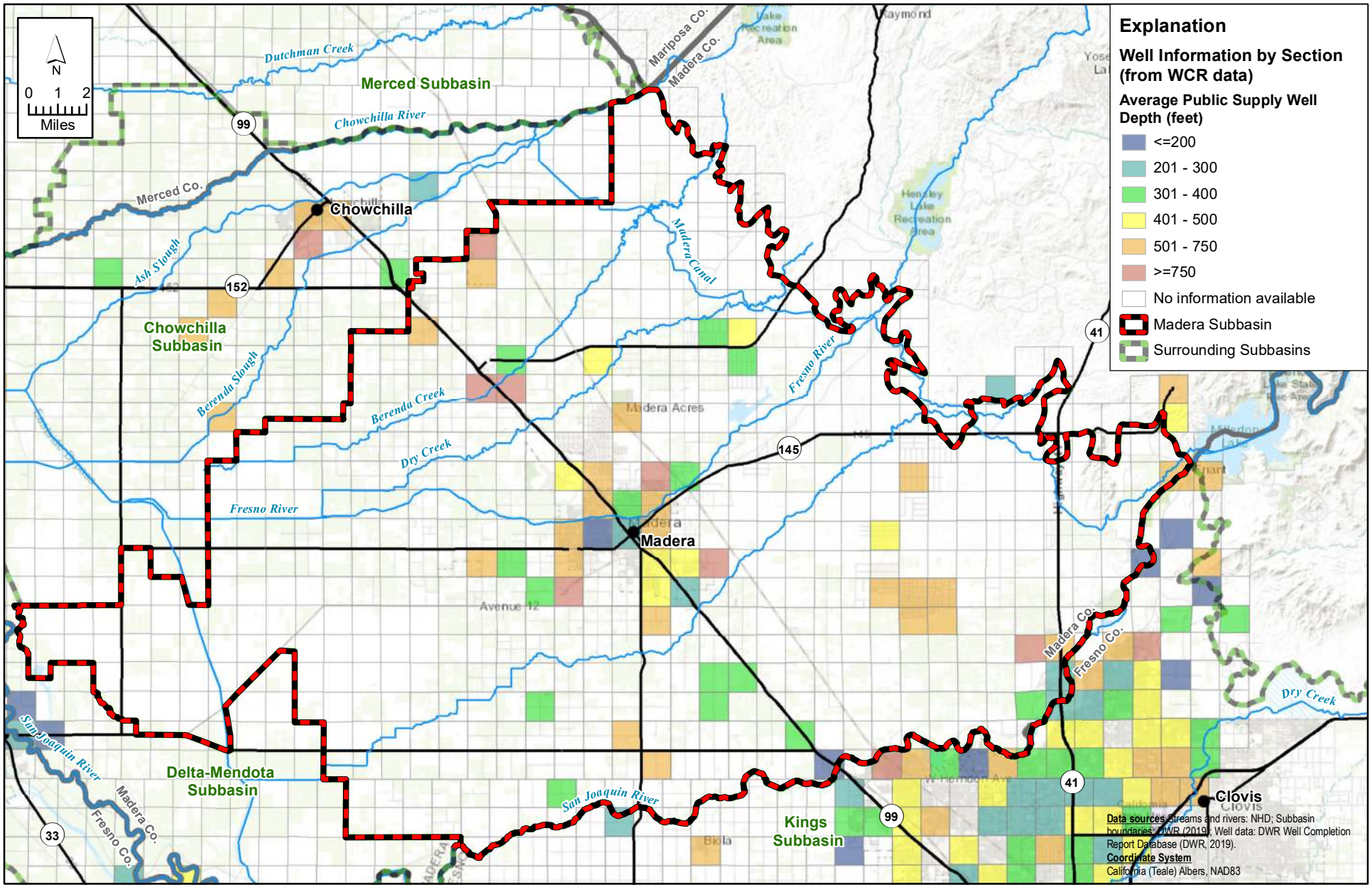
X:\2017\17-113 Madera Subbasin GSP Development\GIS\Map Files\REPORT map files\Chapter 2\Figure 2-45 Madera Subbasin Wells By Section Ag Well Depth.mxd

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FIGURE 2-45
Map of Well Information by Section: Average Agricultural Well Depth (from WCR data)

Madera Subbasin
Groundwater Sustainability Plan



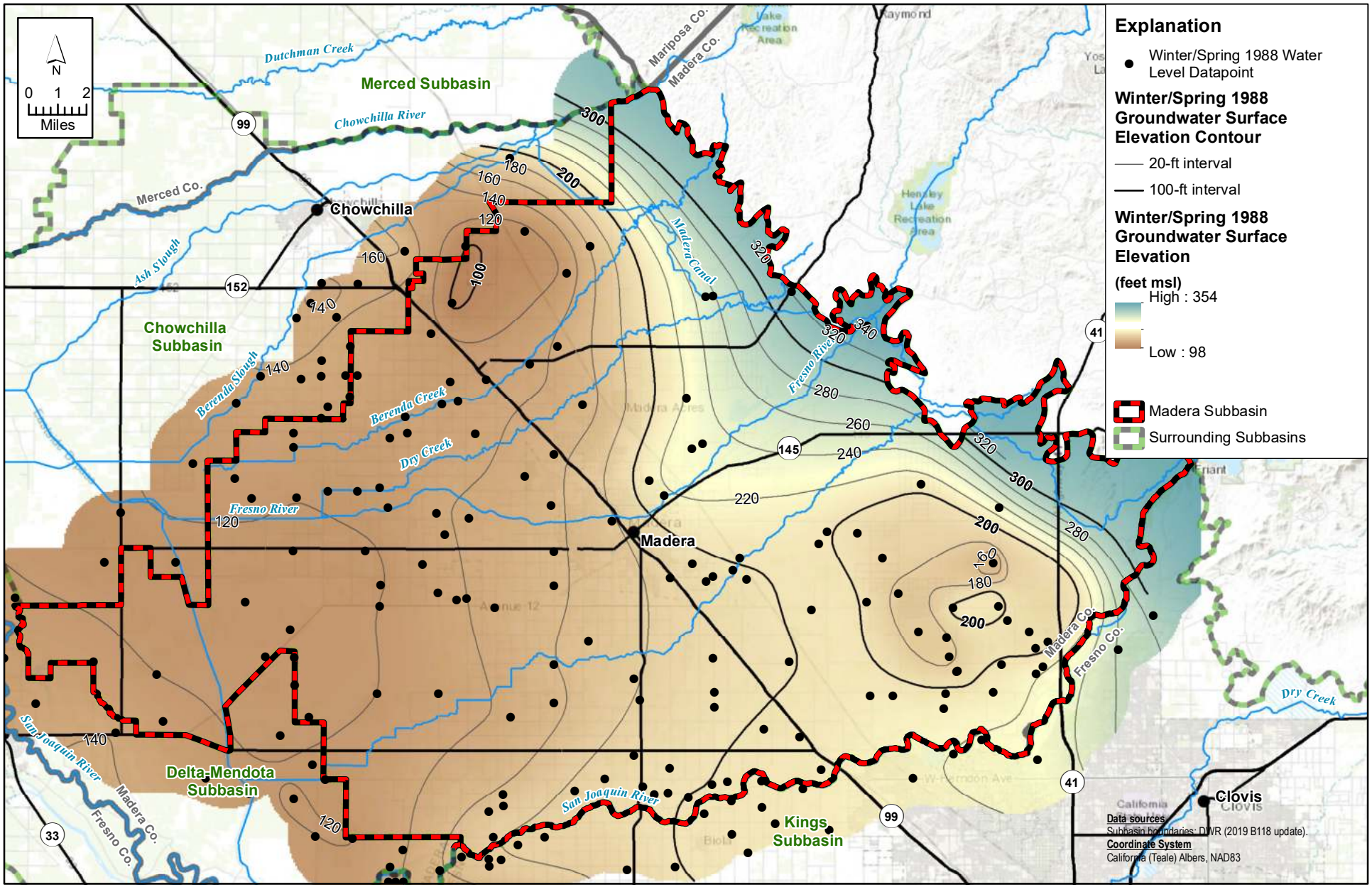
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FIGURE 2-46
Map of Well Information by Section: Average Public Supply Well Depth (from WCR data)

Madera Subbasin
Groundwater Sustainability Plan



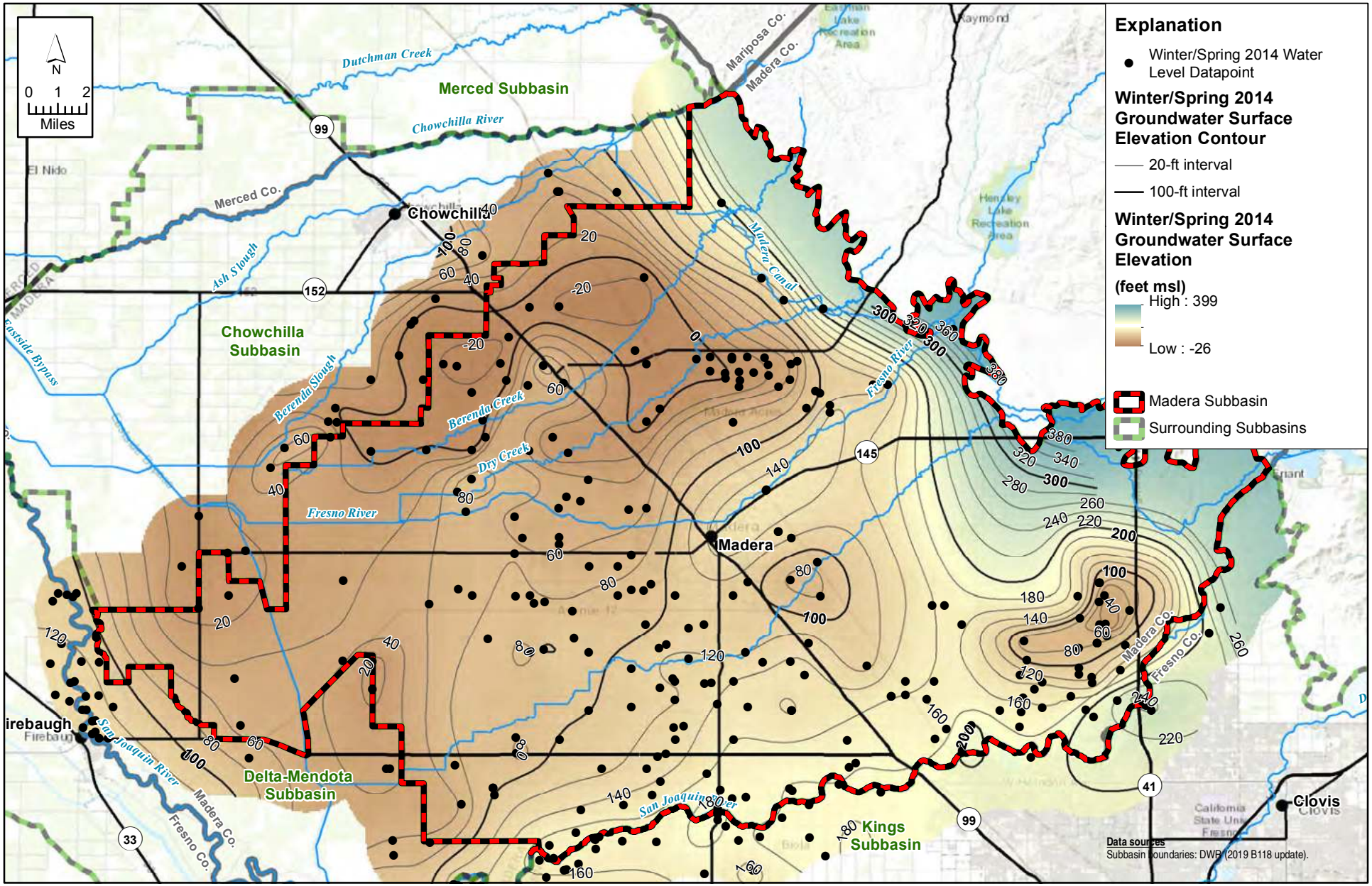
X:\2017\17-113 Madera Subbasin GSP Development\GIS\Map Files\REPORT map files\Chapter 2\Figure 2-47 Madera Subbasin SpW1988 GWEL Contours_Unconfined.mxd

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FIGURE 2-47
Groundwater Surface Elevation Map: Winter/Spring 1988 - Unconfined Groundwater

Madera Subbasin
Groundwater Sustainability Plan



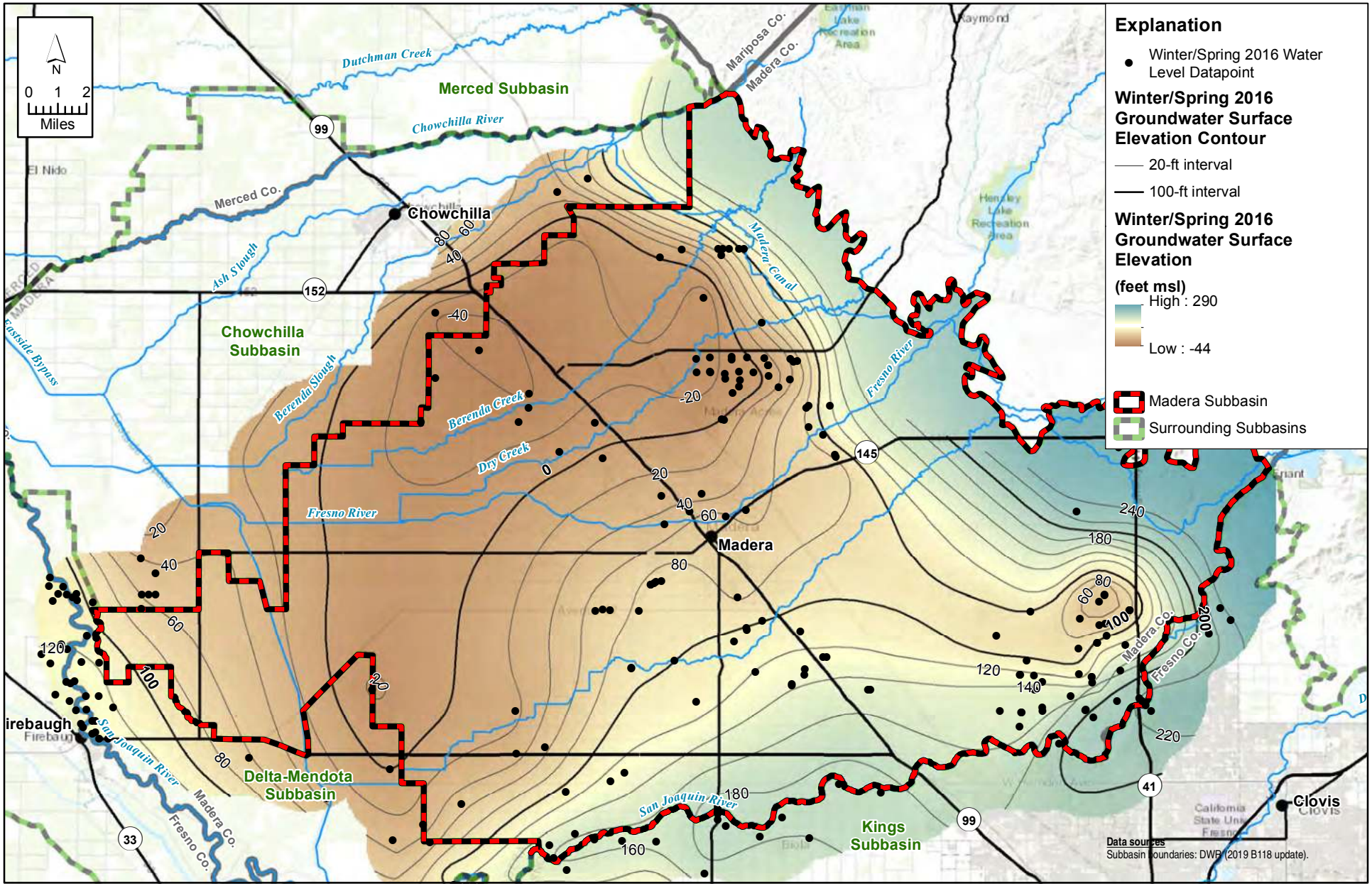
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FIGURE 2-48
Groundwater Surface Elevation Map: Winter/Spring 2014 - Unconfined Groundwater

Madera Subbasin
Groundwater Sustainability Plan



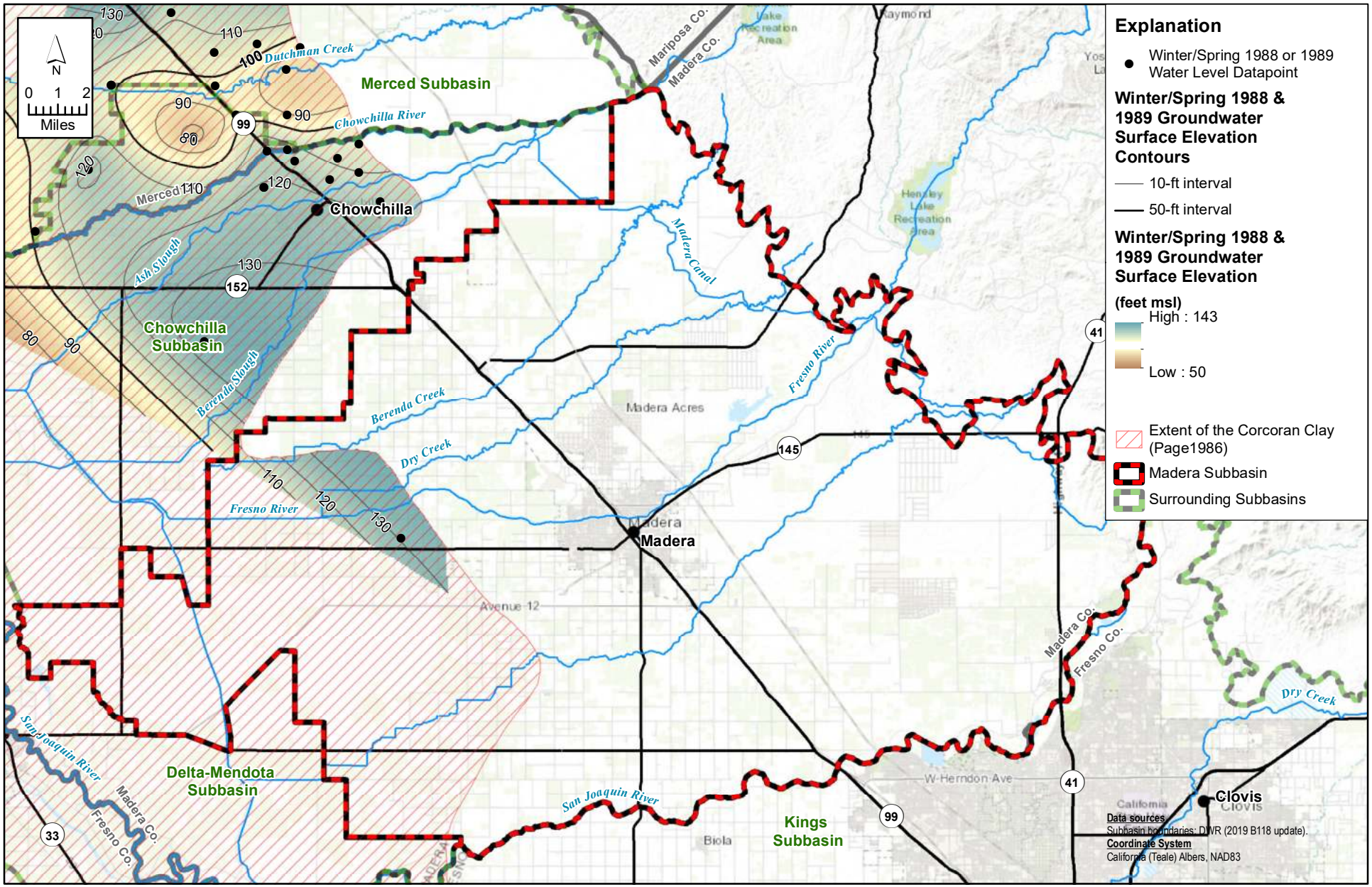
X:\2017\17-113 Madera Subbasin GSP Development\GIS\Map Files\REPORT map files\Chapter 2\Figure 2-X Madera Subbasin SpW2016 GWEL Contours_Unconfined.mxd

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FIGURE 2-49
Groundwater Surface Elevation Map: Winter/Spring 2016 - Unconfined Groundwater

Madera Subbasin
Groundwater Sustainability Plan



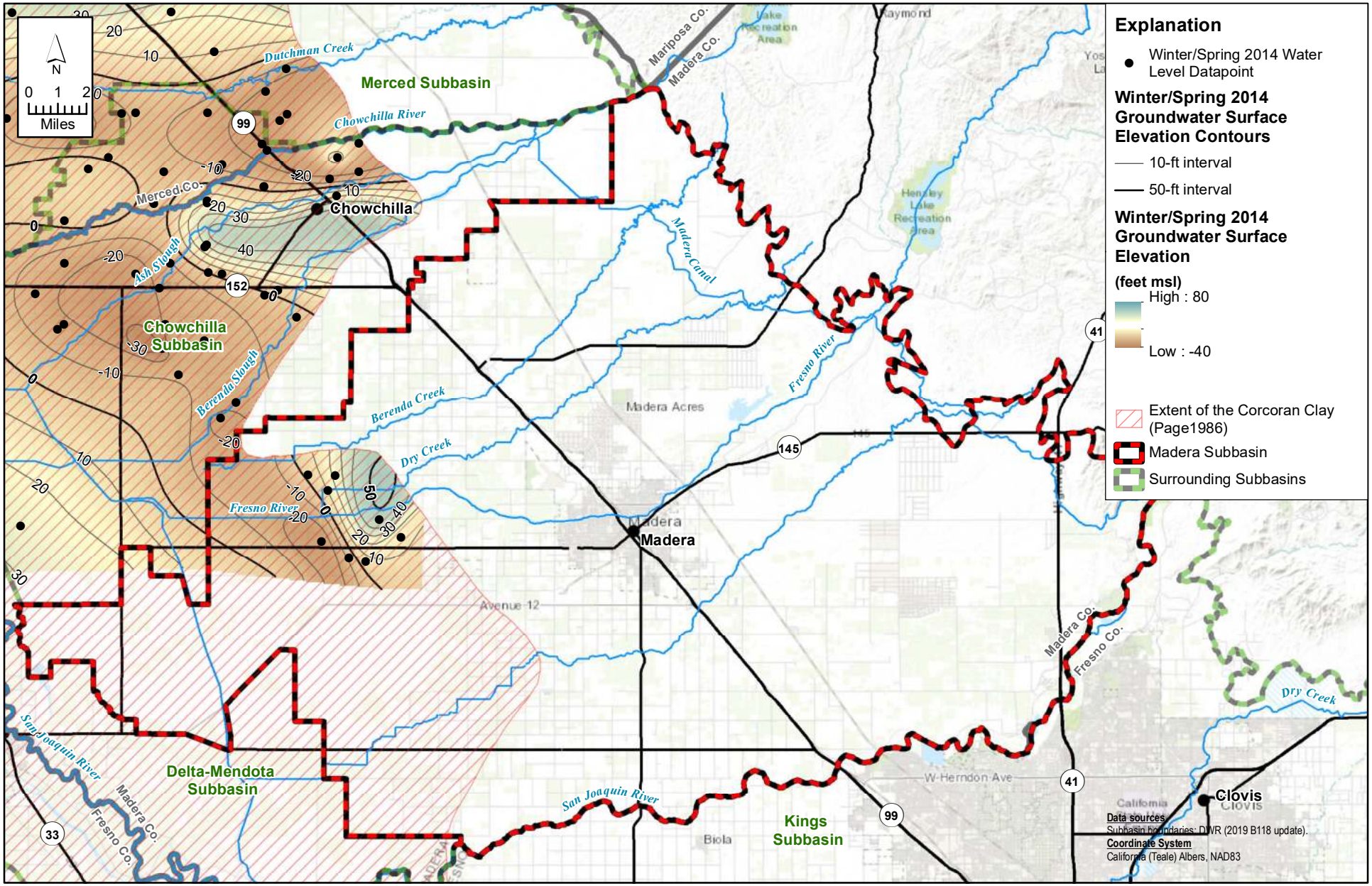
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FIGURE 2-50
Groundwater Surface Elevation Map:
Winter/Spring 1988 and 1989 - Lower Aquifer within Corcoran Clay

Madera Subbasin
Groundwater Sustainability Plan



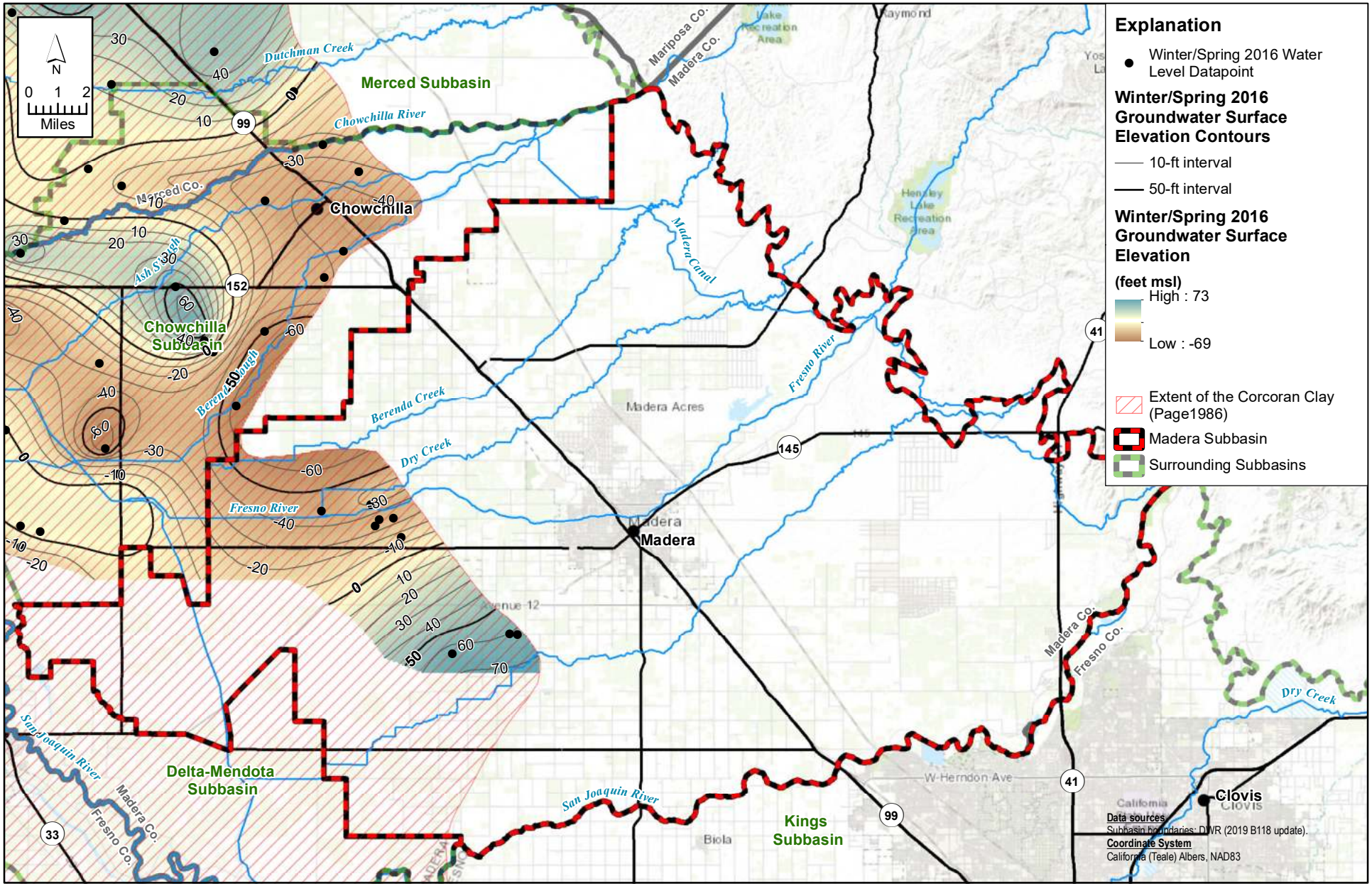
X:\2017\17-113 Madera Subbasin GSP Development\GIS\Map Files\REPORT map files\Chapter 2\Figure 2-51 Madera Subbasin SpW2014 GWEL Contours_Lower.mxd

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FIGURE 2-51
Groundwater Surface Elevation Map:
Winter/Spring 2014 - Lower Aquifer within Corcoran Clay

Madera Subbasin
Groundwater Sustainability Plan



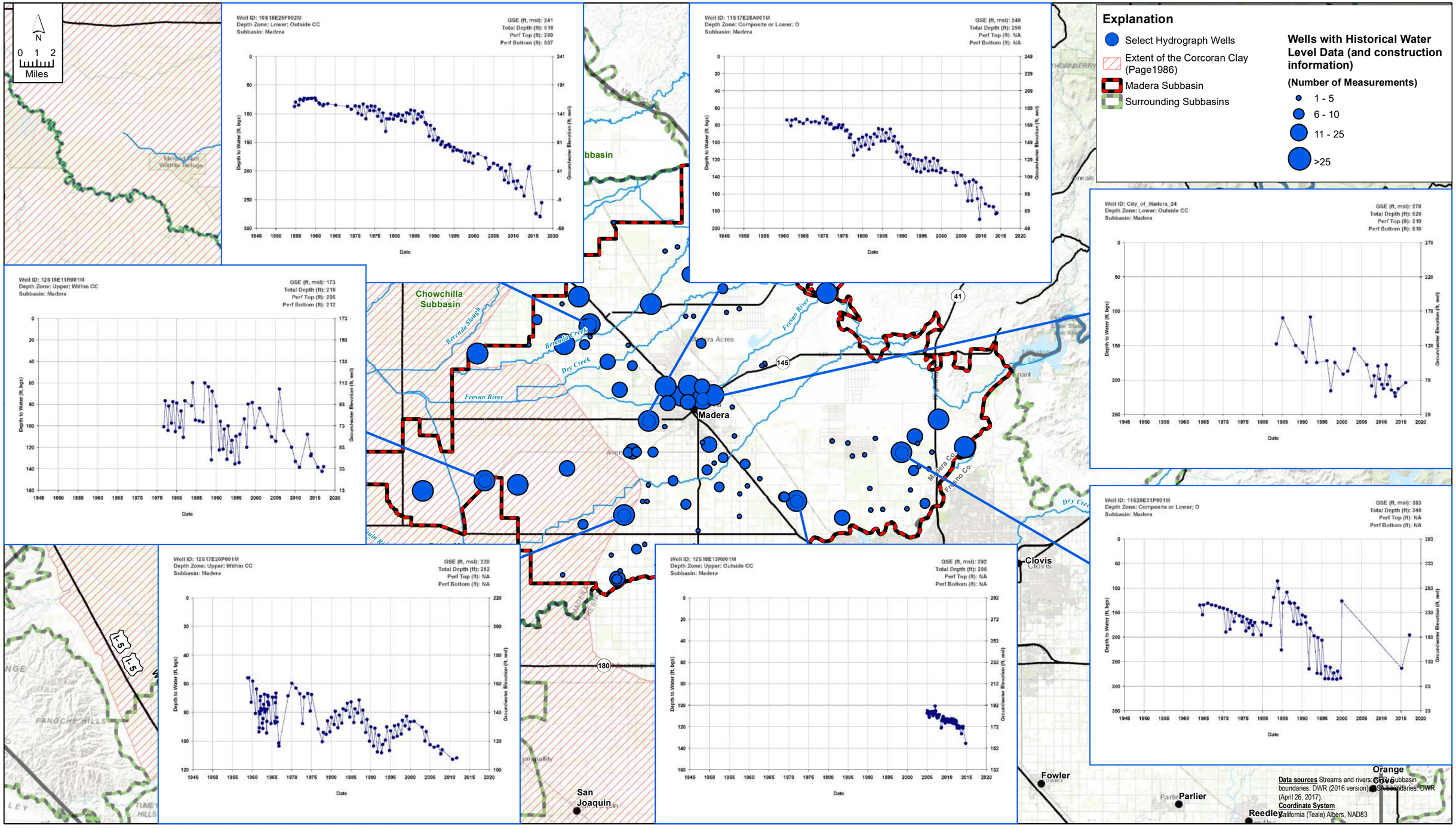
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FIGURE 2-52
Groundwater Surface Elevation Map:
Winter/Spring 2016 - Lower Aquifer within Corcoran Clay

Madera Subbasin
Groundwater Sustainability Plan



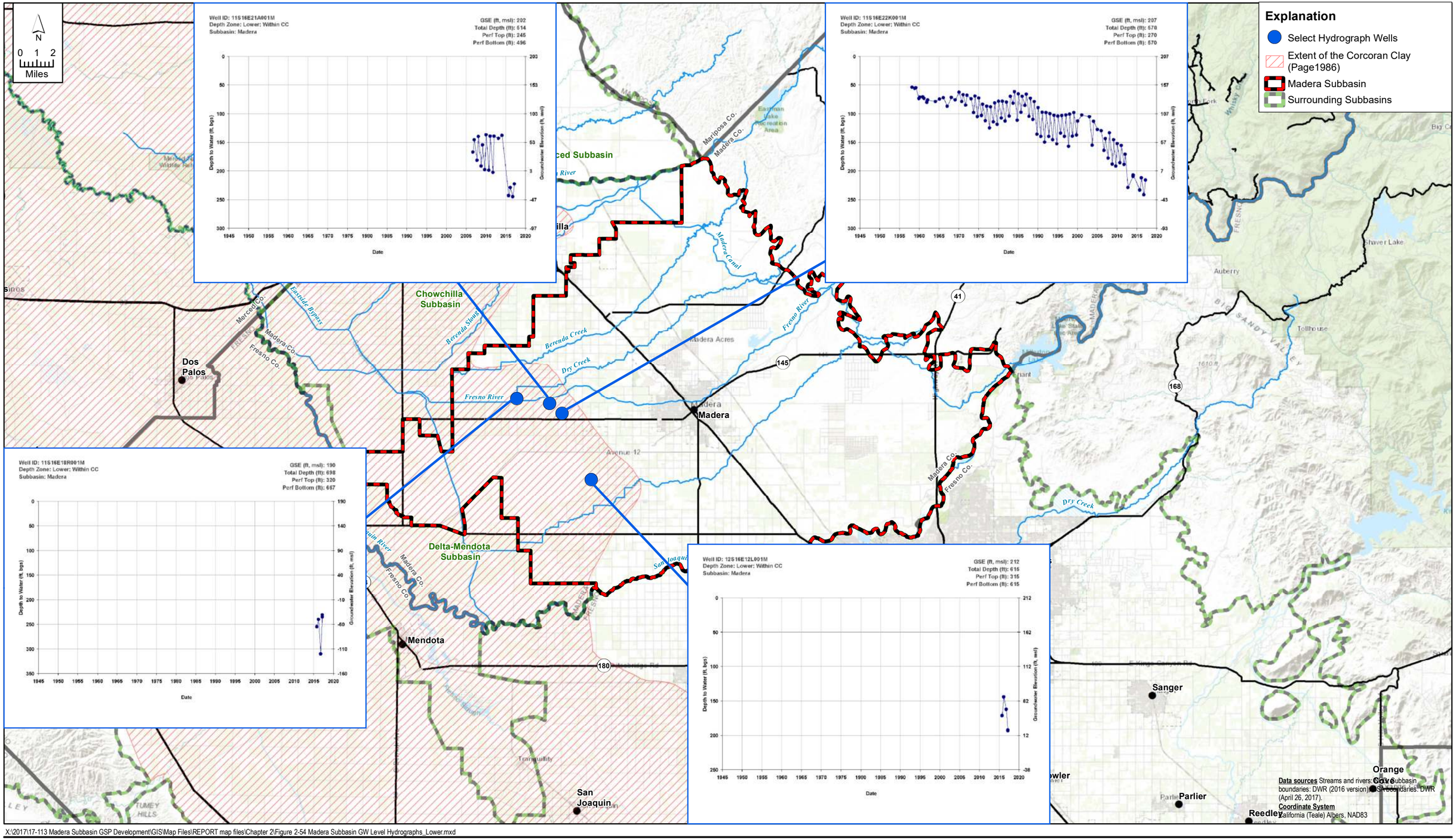
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FIGURE 2-53
Select Groundwater Level Hydrographs:
Outside the Corcoran Clay or Upper Aquifer within the Corcoran Clay

Madera Subbasin
Groundwater Sustainability Plan



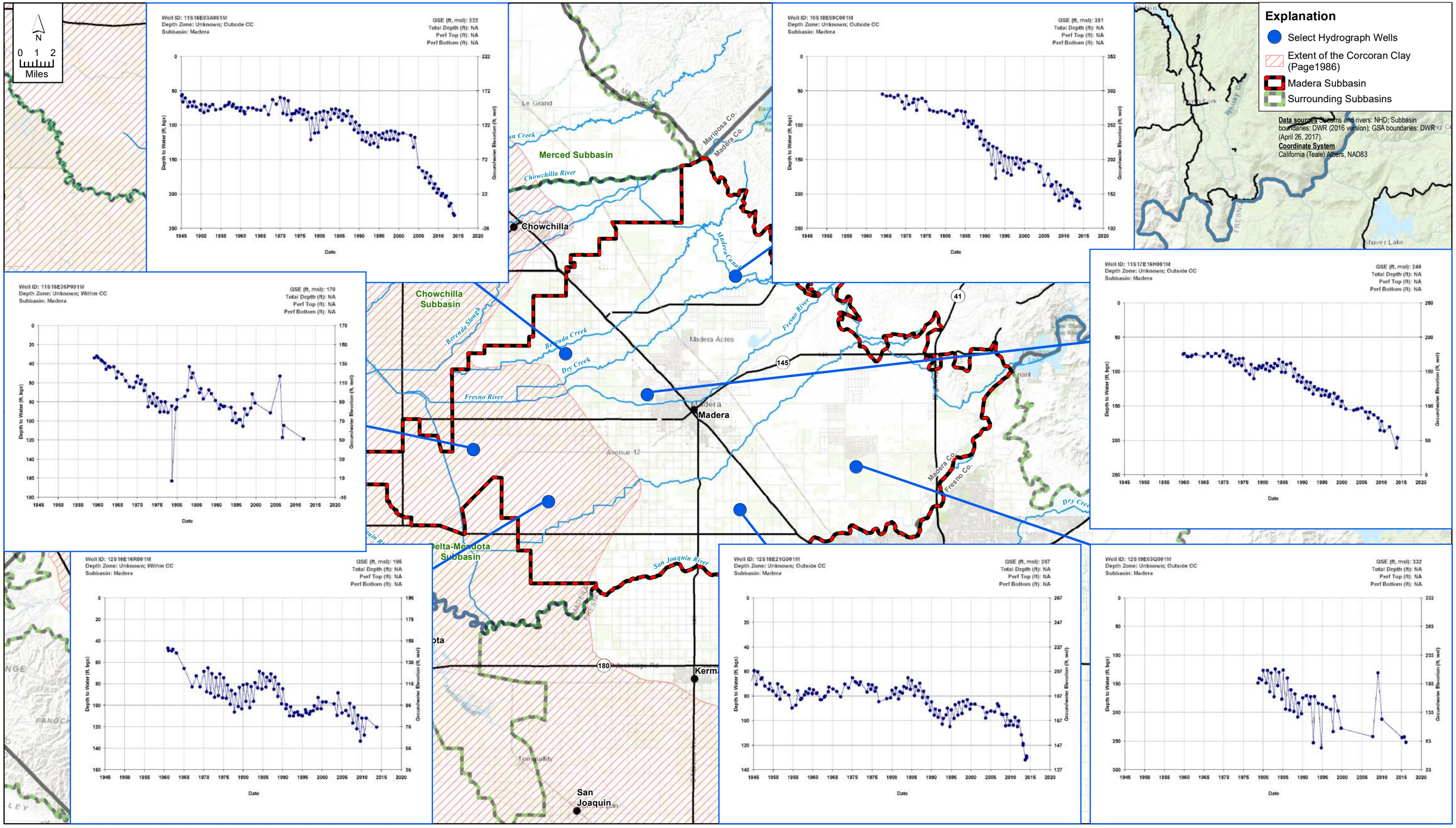
X:\2017\17-113 Madera Subbasin GSP Development\GIS\Map Files\REPORT map files\Chapter 2\Figure 2-54 Madera Subbasin GW Level Hydrographs_Lower.mxd

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FIGURE 2-54
Select Groundwater Level Hydrographs: Lower Aquifer within the Corcoran Clay

Madera Subbasin
Groundwater Sustainability Plan



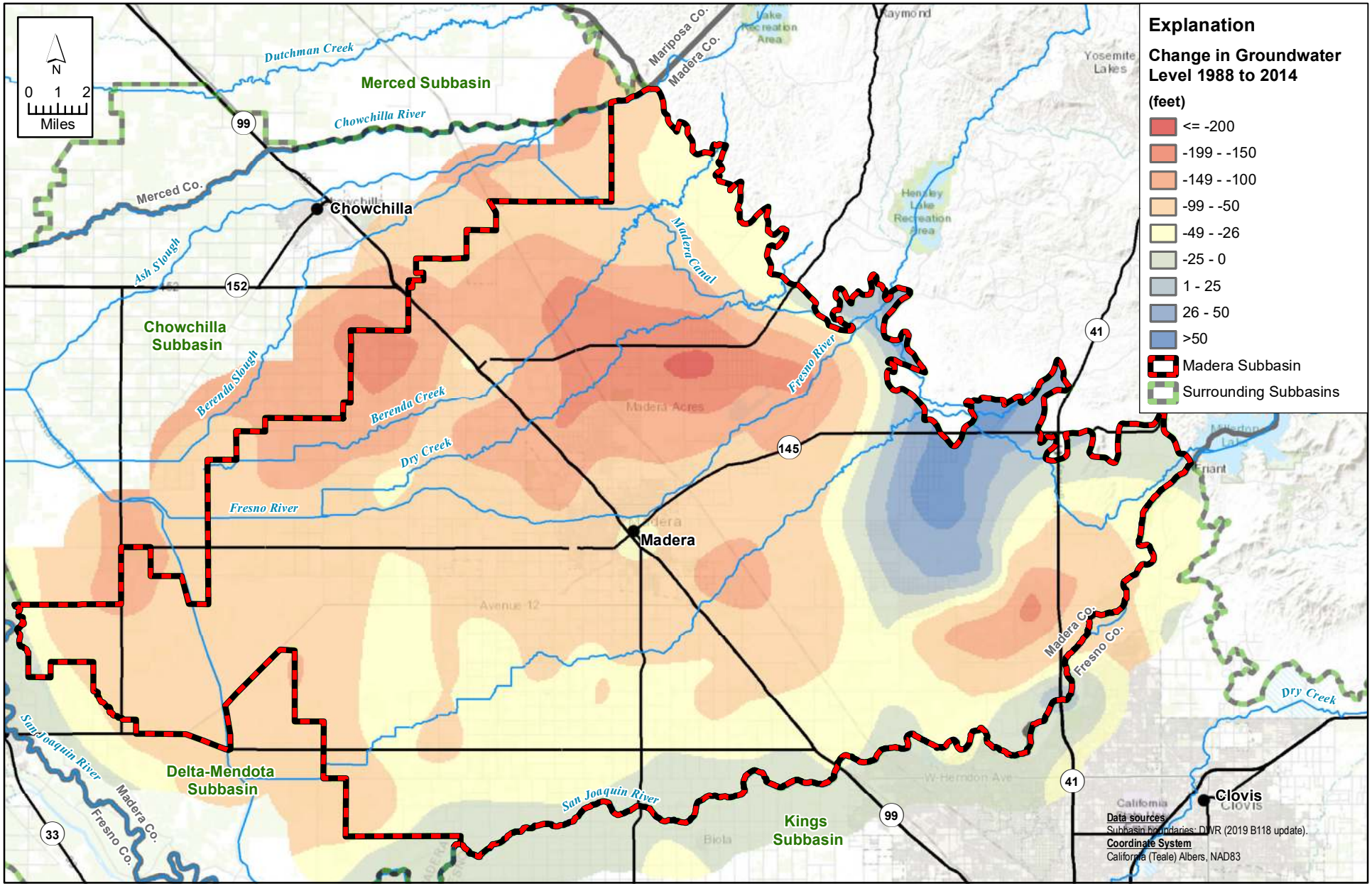
X:\2017\17-113 Madera Subbasin GSP Development\GIS\Map Files\REPORT map files\Chapter 2\Figure 2-55 Madera Subbasin GW Level Hydrographs_Unknown.mxd

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FIGURE 2-55
Select Groundwater Level Hydrographs: Wells of Unknown Construction

Madera Subbasin
Groundwater Sustainability Plan



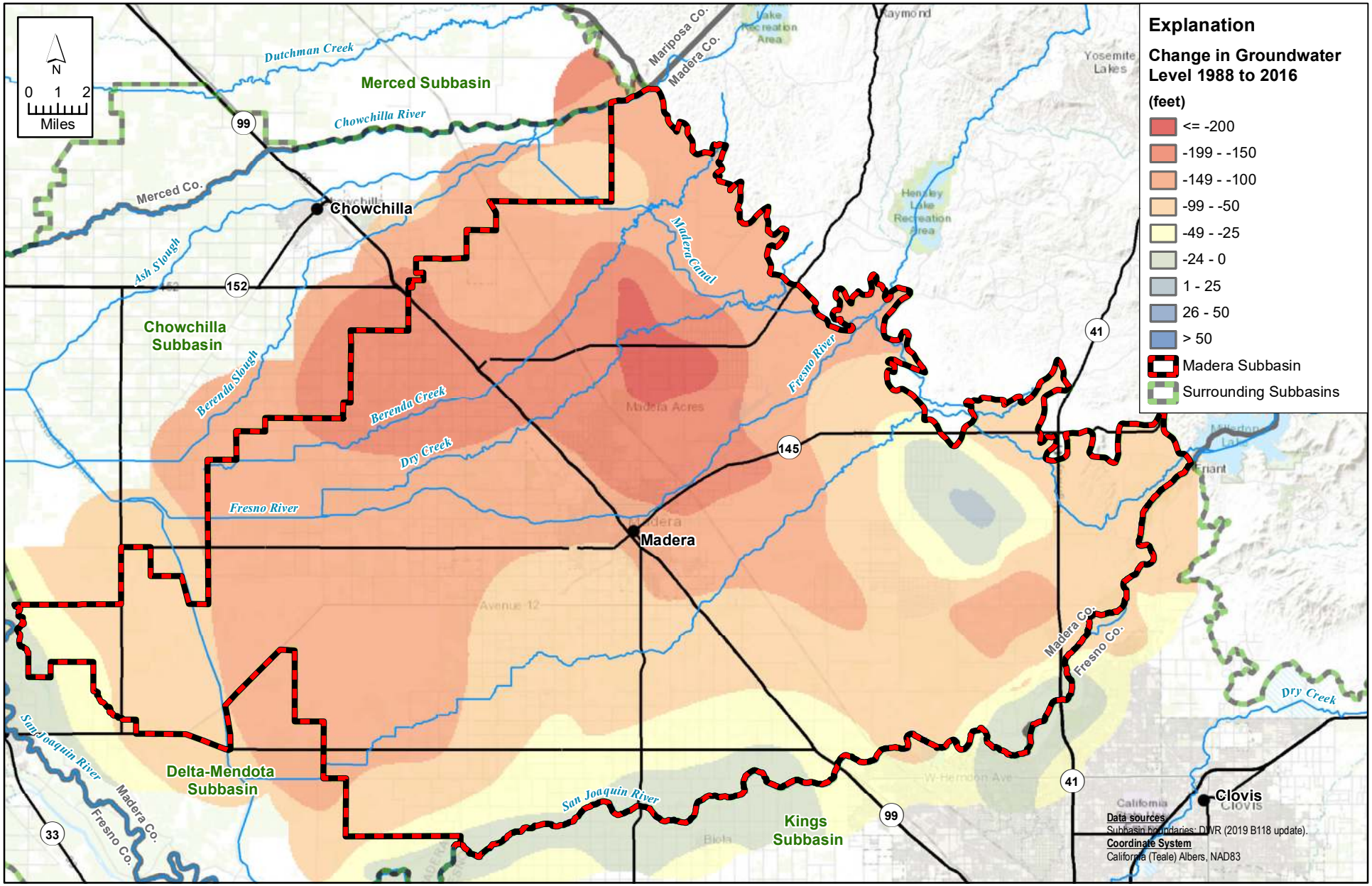
X:\2017\17-113 Madera Subbasin GSP Development\GIS\Map Files\REPORT map files\Chapter 2\Figure 2-56 Madera Subbasin SpW1988 to 2014 GWEL Change_Unconfined.mxd

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FIGURE 2-56
Groundwater Level Change Map:
Winter/Spring 1988 to 2014 - Unconfined Groundwater

Madera Subbasin
Groundwater Sustainability Plan



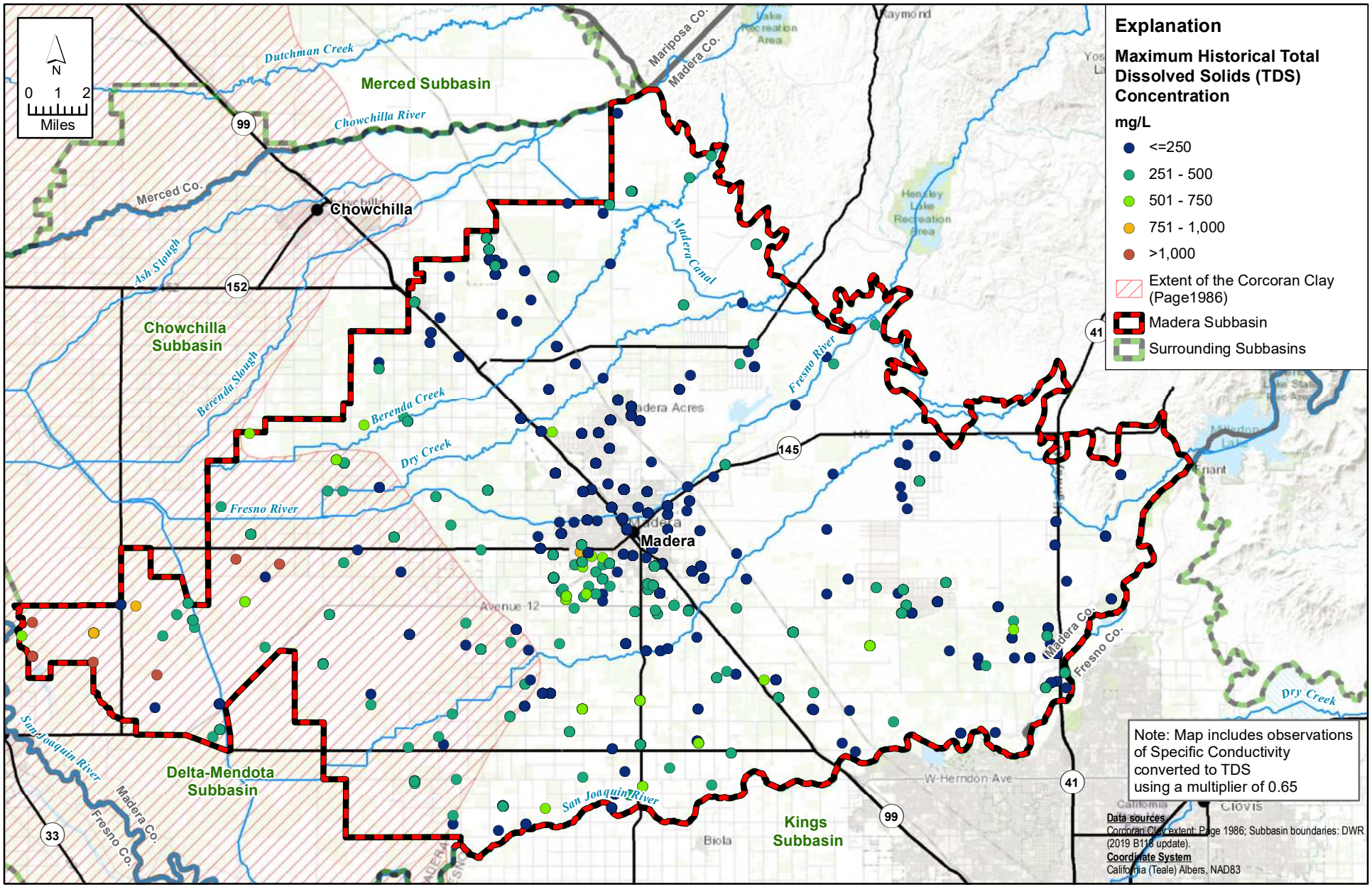
X:\2017\17-113 Madera Subbasin GSP Development\GIS\Map Files\REPORT map files\Chapter 2\Figure 2-57 Madera Subbasin SpW1988 to 2016 GWEL Change_Unconfined.mxd

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FIGURE 2-57
Groundwater Level Change Map:
Winter/Spring 1988 to 2016 - Unconfined Groundwater

Madera Subbasin
Groundwater Sustainability Plan



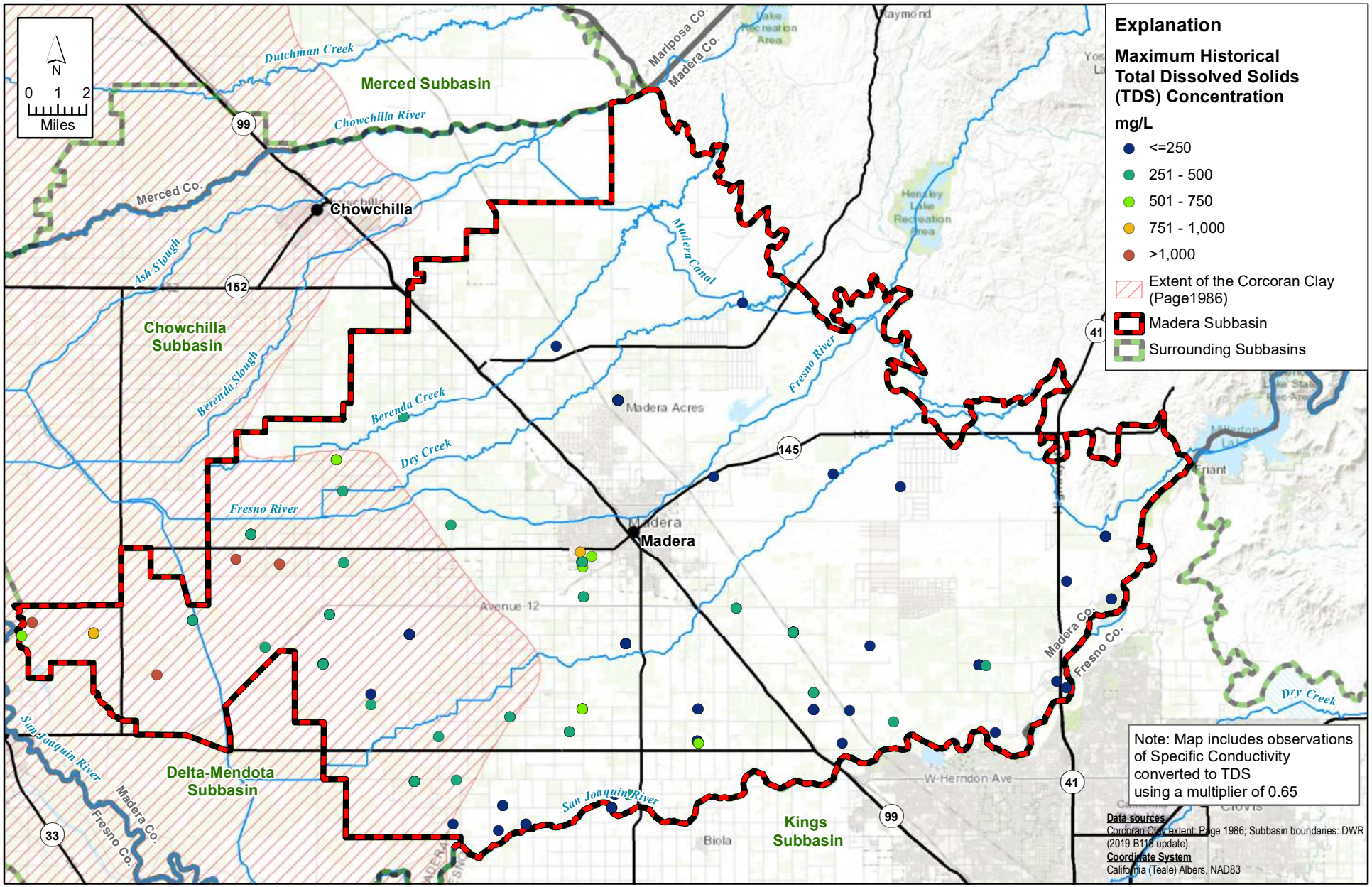
X:\2017\17-113 Madera Subbasin GSP Development\GIS\Map Files\REPORT map files\Chapter 2\Figure 2-58 Madera Subbasin GW Quality Map TDS All Wells_20190708.mxd

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FIGURE 2-58
Groundwater Quality Map: Total Dissolved Solids Concentrations in All Wells

Madera Subbasin
Groundwater Sustainability Plan



X:\2017\17-113 Madera Subbasin GSP Development\GIS\Map Files\REPORT map files\Chapter 2\Figure 2-59 Madera Subbasin GW Quality Map TDS Upper_20190708.mxd

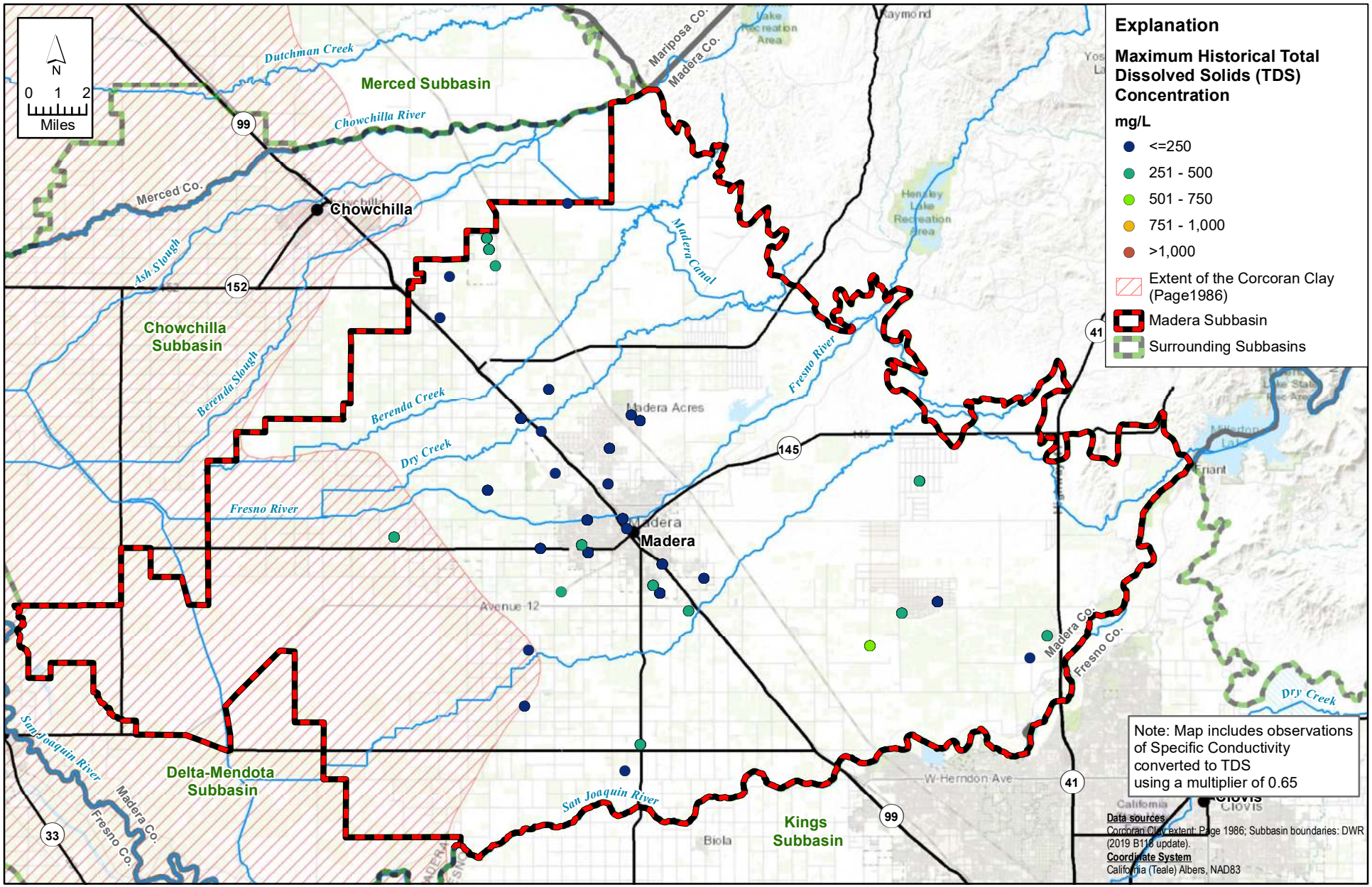
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FIGURE 2-59

Groundwater Quality Map: Total Dissolved Solids Concentrations in Upper Aquifer Wells

Madera Subbasin
Groundwater Sustainability Plan



X:\2017\17-113 Madera Subbasin GSP Development\GIS\Map Files\REPORT map files\Chapter 2\Figure 2-60 Madera Subbasin GW Quality Map TDS Lower_20190708.mxd

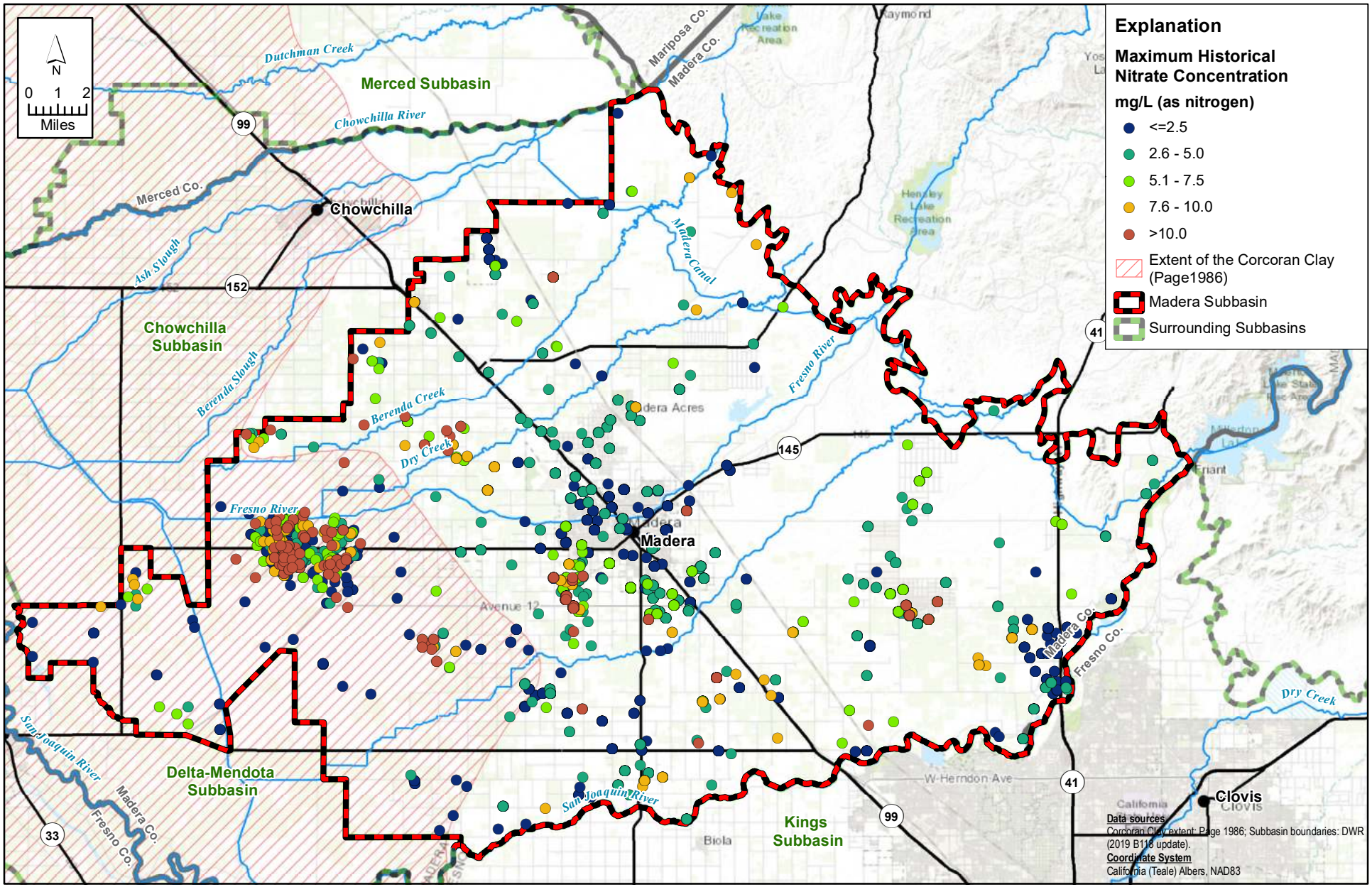
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FIGURE 2-60

Groundwater Quality Map: Total Dissolved Solids Concentrations in Lower Aquifer Wells

Madera Subbasin
Groundwater Sustainability Plan



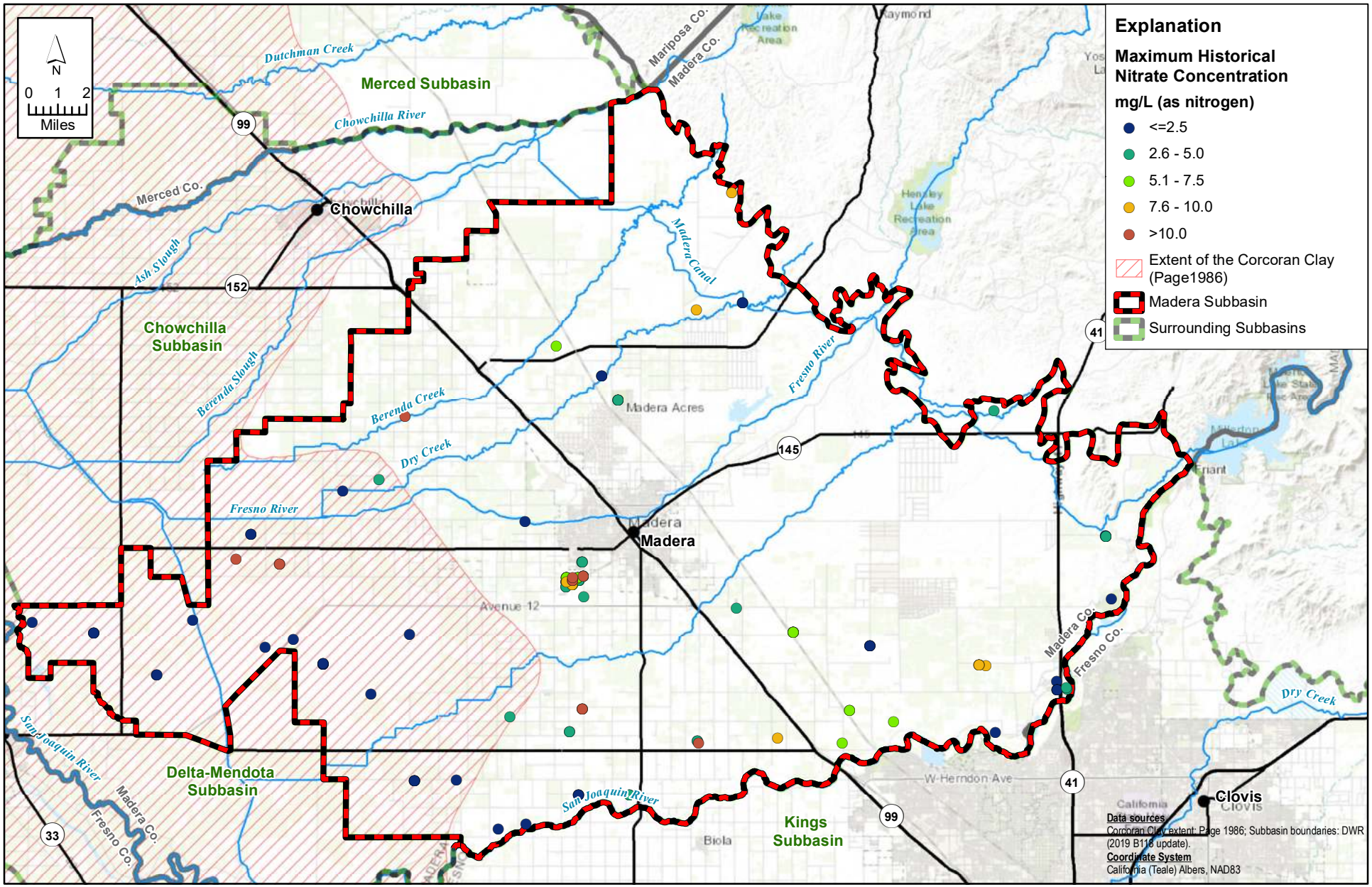
X:\2017\17-113 Madera Subbasin GSP Development\GIS\Map Files\REPORT map files\Chapter 2\Figure 2-61 Madera Subbasin GW Quality Map Nitrate All Wells_20190708.mxd

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FIGURE 2-61
Groundwater Quality Map: Nitrate Concentrations in All Wells

Madera Subbasin
Groundwater Sustainability Plan



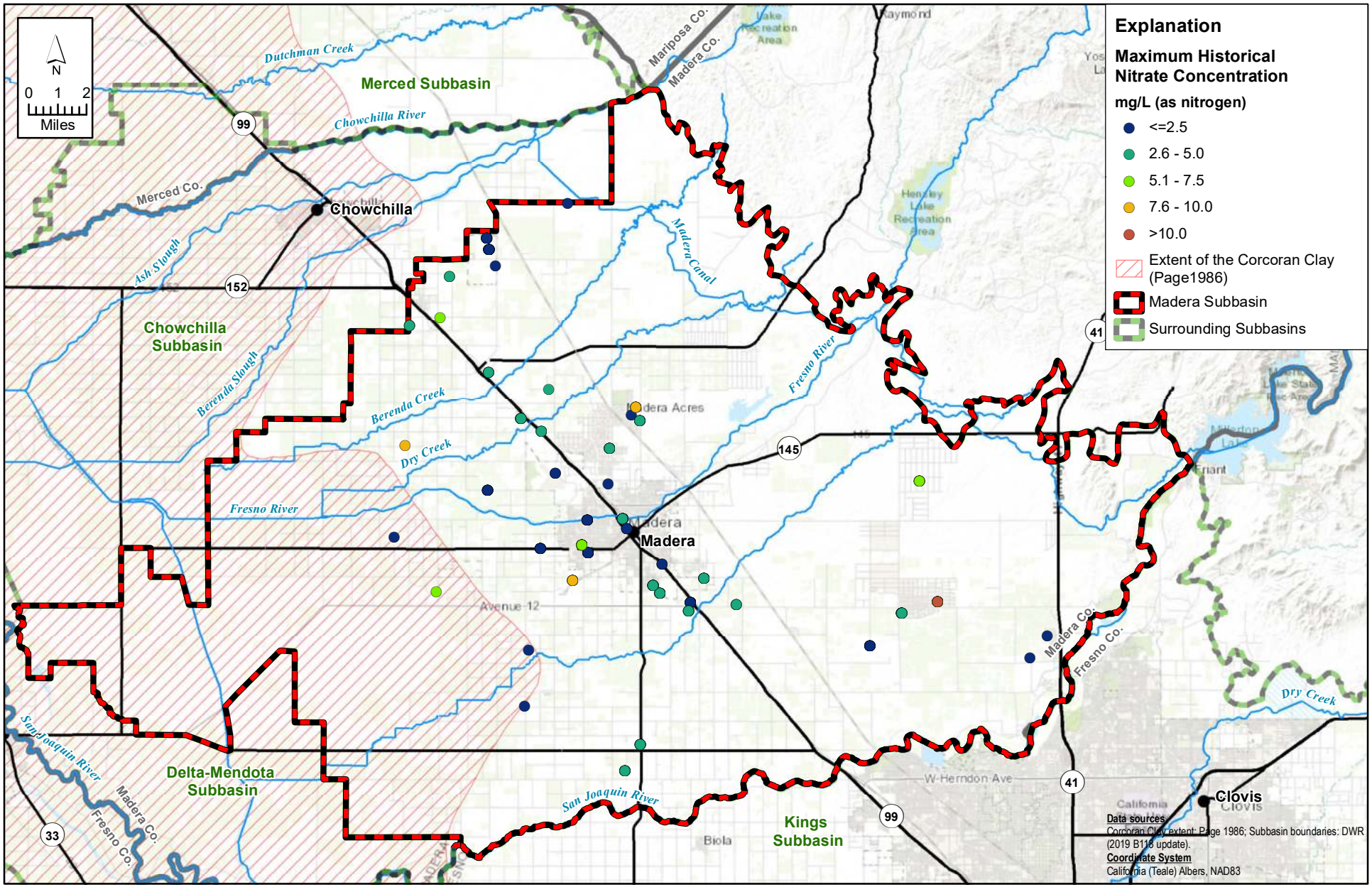
X:\2017\17-113 Madera Subbasin GSP Development\GIS\Map Files\REPORT map files\Chapter 2\Figure 2-62 Madera Subbasin GW Quality Map Nitrate Upper_20190708.mxd

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FIGURE 2-62
Groundwater Quality Map: Nitrate Concentrations in Upper Aquifer Wells

Madera Subbasin
Groundwater Sustainability Plan



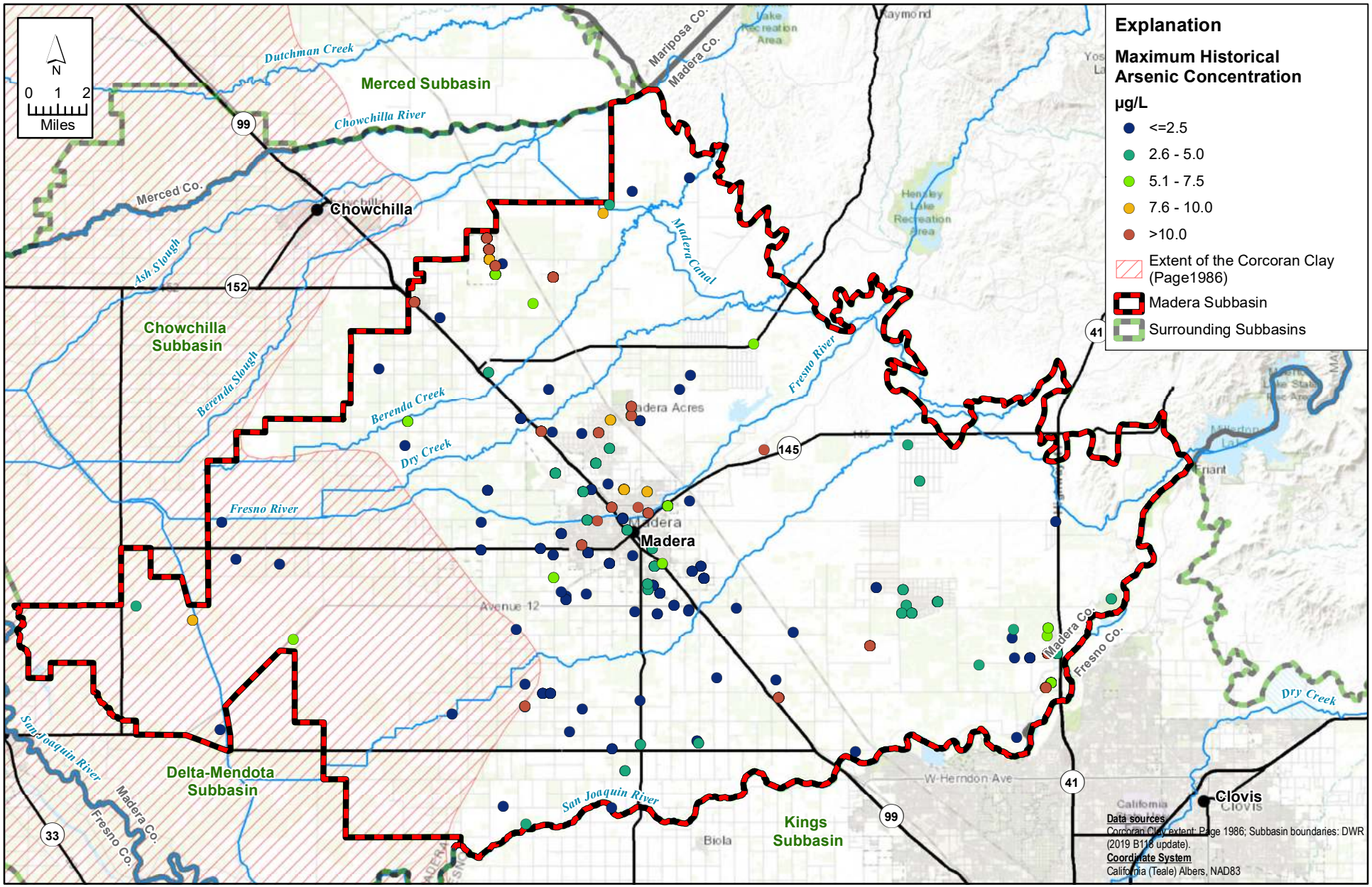
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FIGURE 2-63
Groundwater Quality Map: Nitrate Concentrations in Lower Aquifer Wells

Madera Subbasin
Groundwater Sustainability Plan



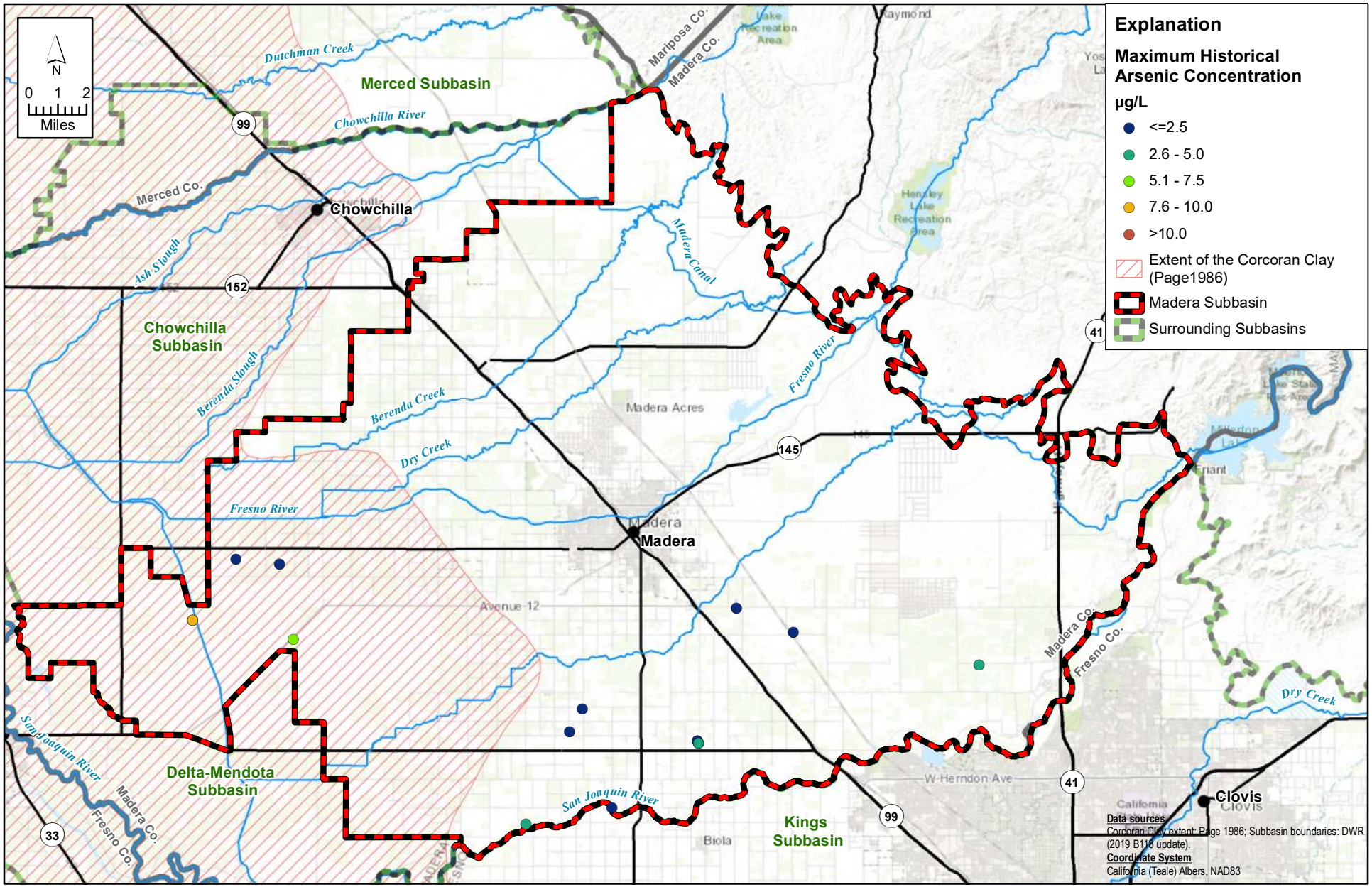
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FIGURE 2-64
Groundwater Quality Map: Arsenic Concentrations in All Wells

Madera Subbasin
Groundwater Sustainability Plan



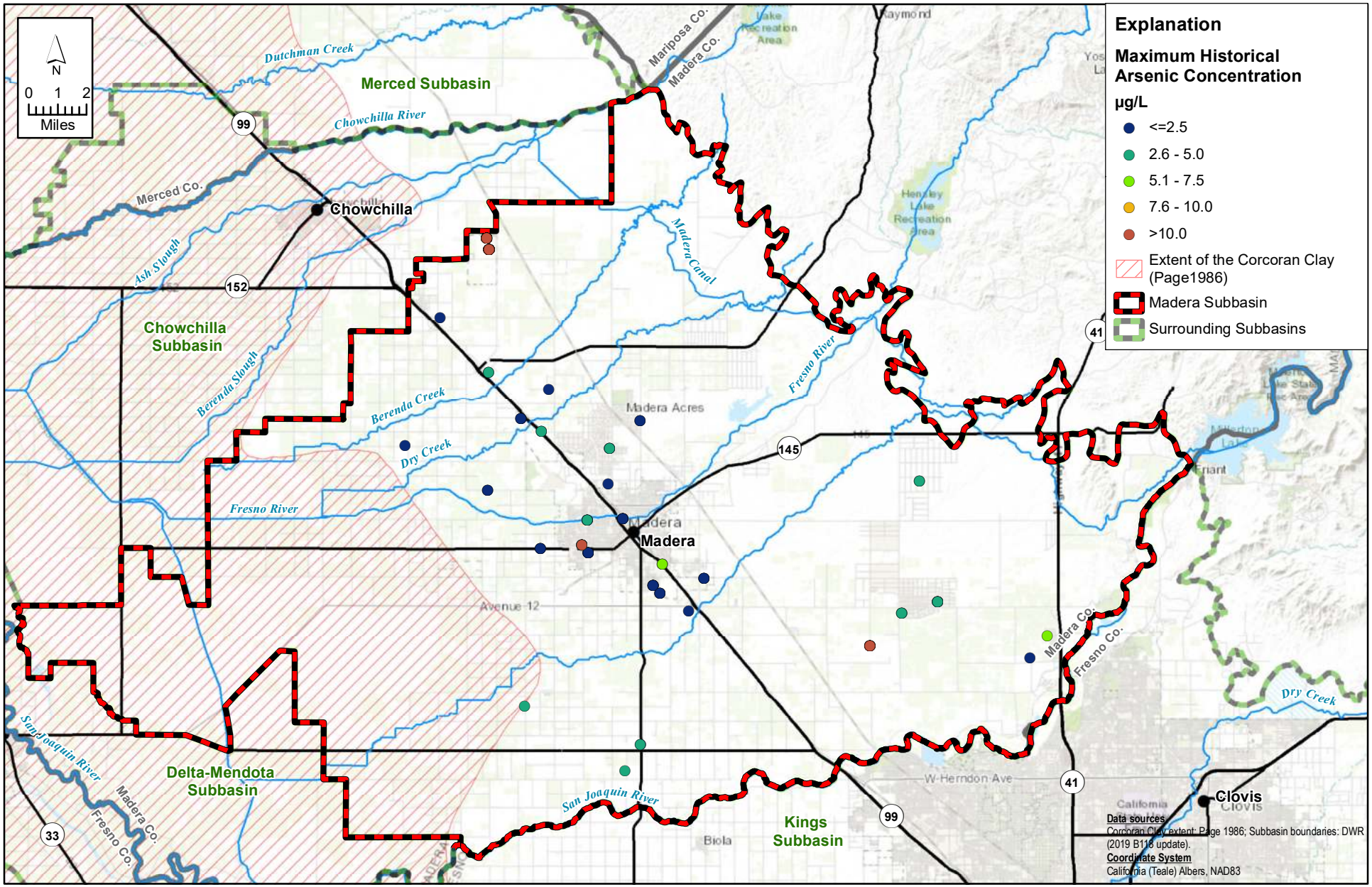
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FIGURE 2-65
Groundwater Quality Map: Arsenic Concentrations in Upper Aquifer Wells

Madera Subbasin
Groundwater Sustainability Plan



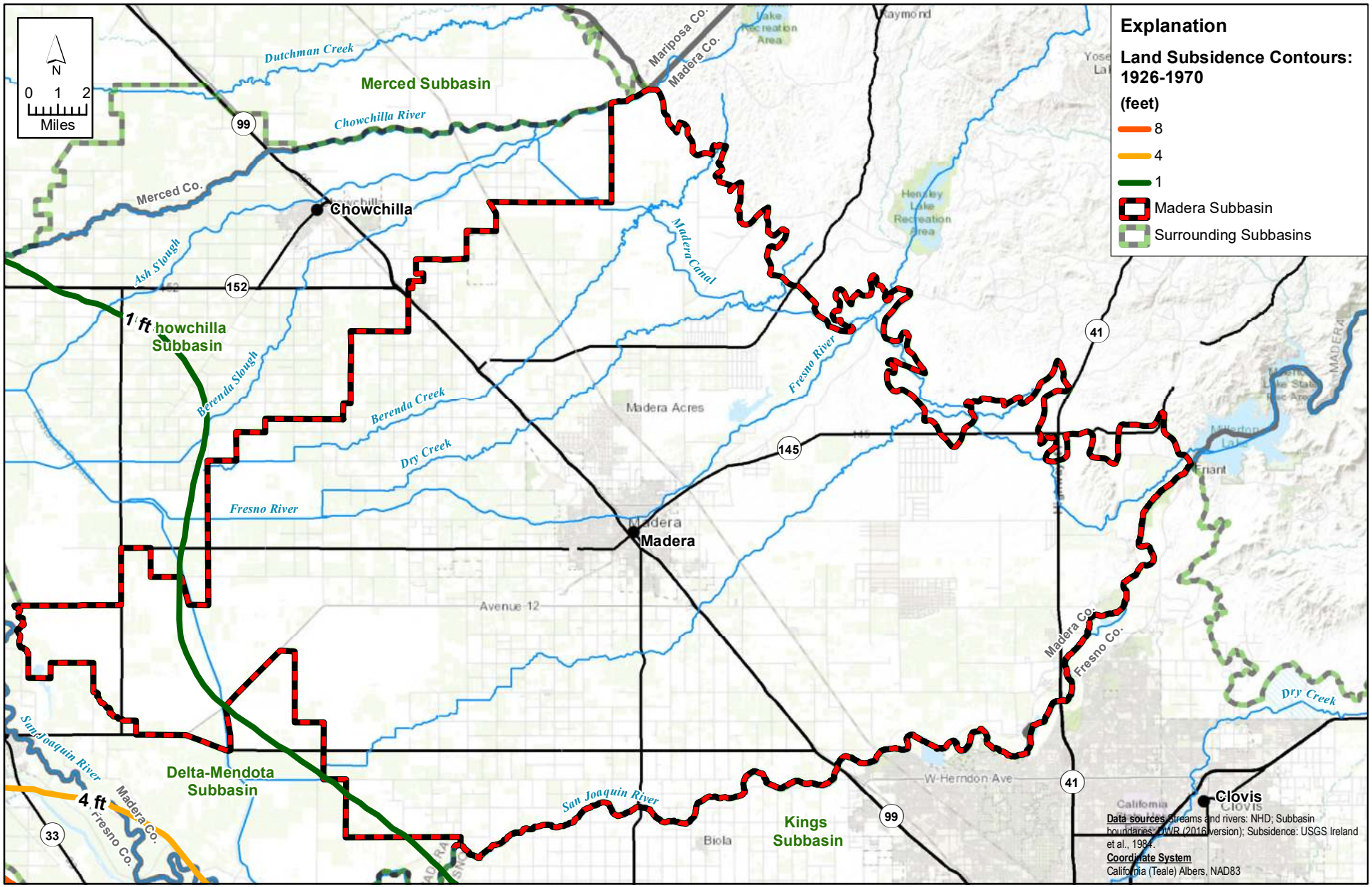
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FIGURE 2-66
Groundwater Quality Map: Arsenic Concentrations in Lower Aquifer Wells

Madera Subbasin
Groundwater Sustainability Plan

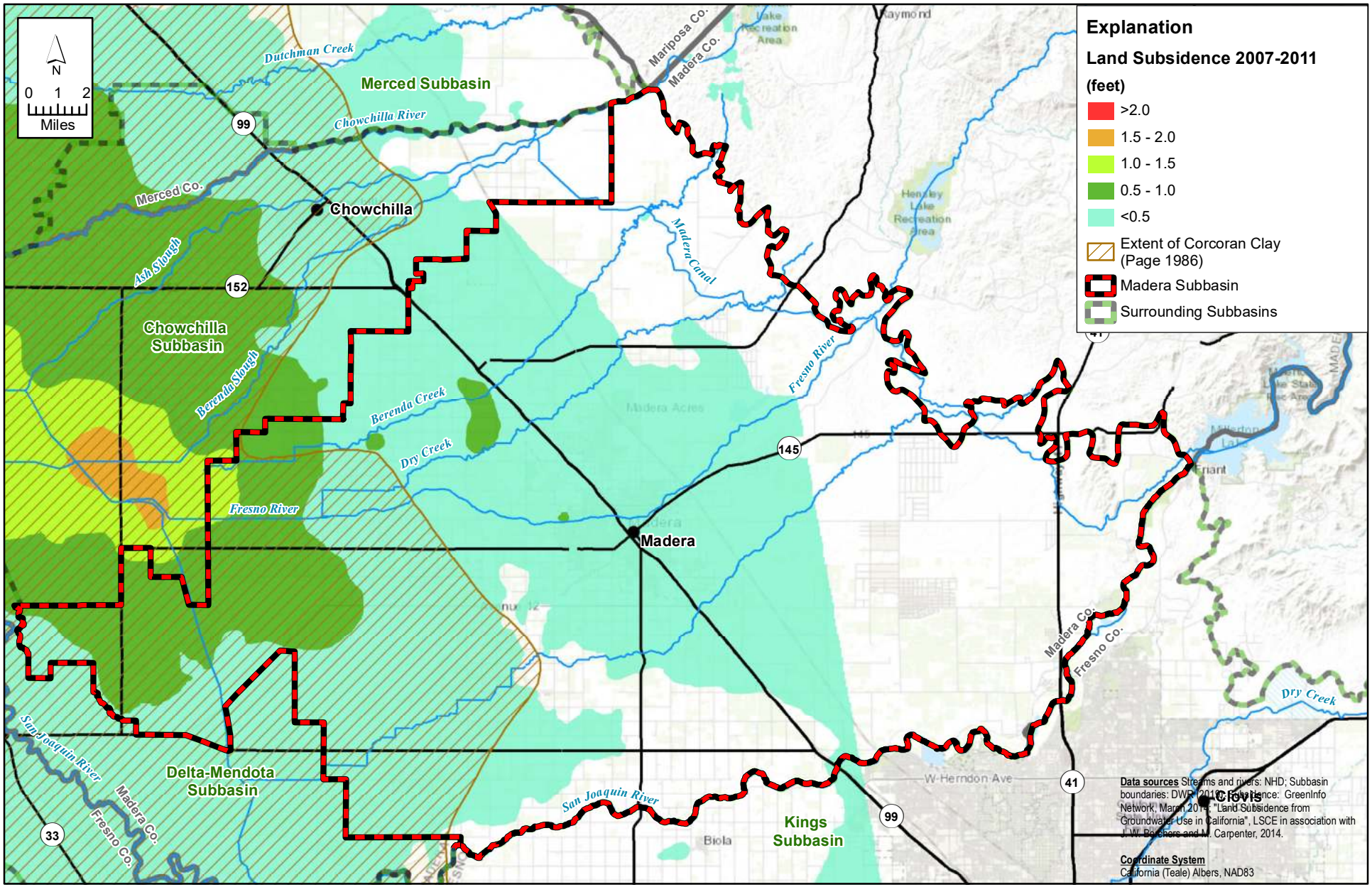


X:\2017\17-113 Madera Subbasin GSP Development\GIS\Map Files\REPORT map files\Chapter 2\Figure 2-67 Madera Subbasin Land Subsidence 1926-1970.mxd

FIGURE 2-67

Map of Historical Land Subsidence Contours: 1926-1970

Madera Subbasin
Groundwater Sustainability Plan



X:\2017\17-113 Madera Subbasin GSP Development\GIS\Map Files\REPORT map files\Chapter 2\Figure 2-68 Madera Subbasin Land Subsidence 2007-2011.mxd

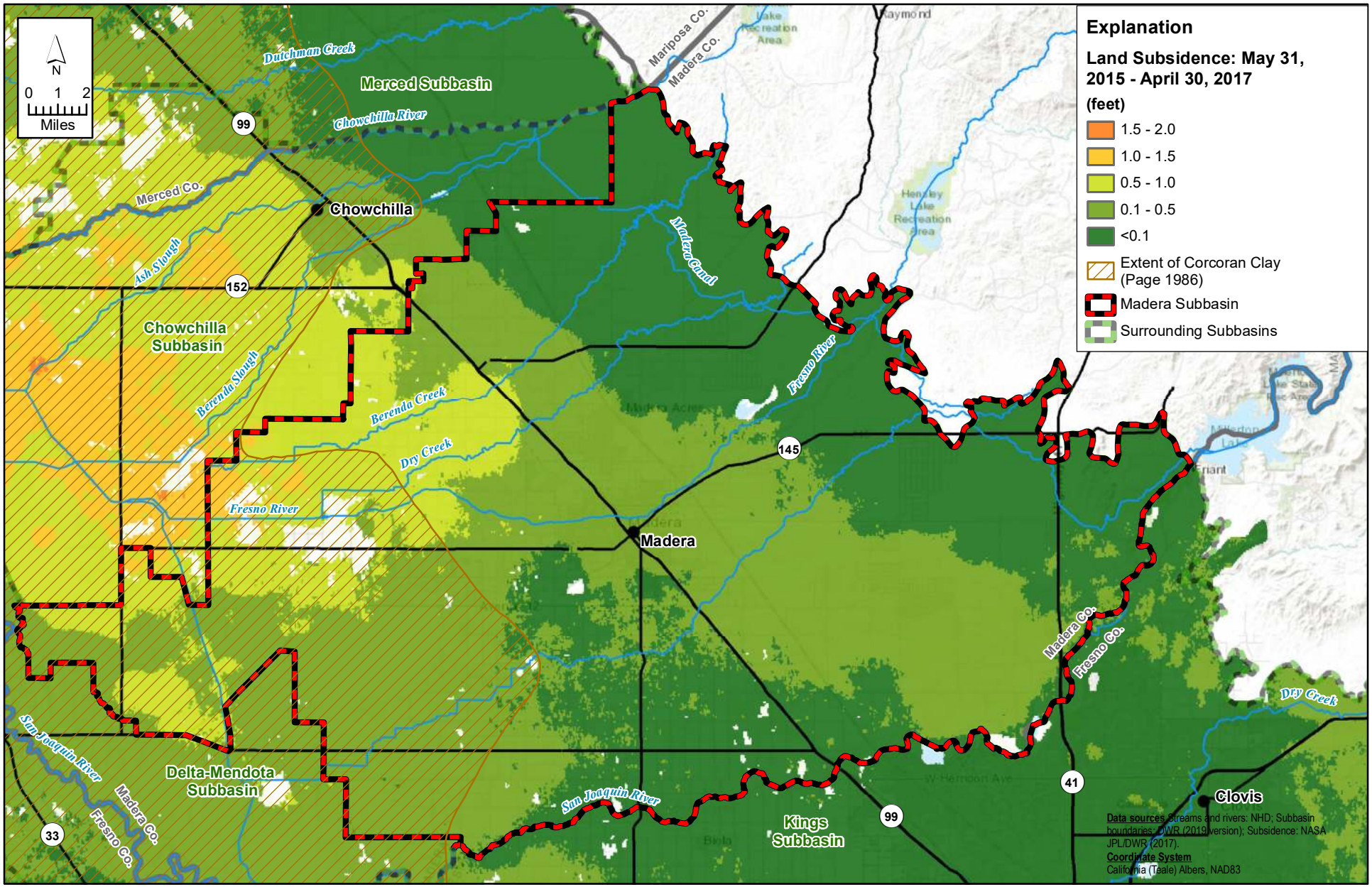
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FIGURE 2-68

Map of Historical Land Subsidence: 2007-2011

Madera Subbasin
Groundwater Sustainability Plan



X:\2017\17-113 Madera Subbasin GSP Development\GIS\Map Files\REPORT map files\Chapter 2\Figure 2-69 Madera Subbasin Land Subsidence 2015-2017.mxd

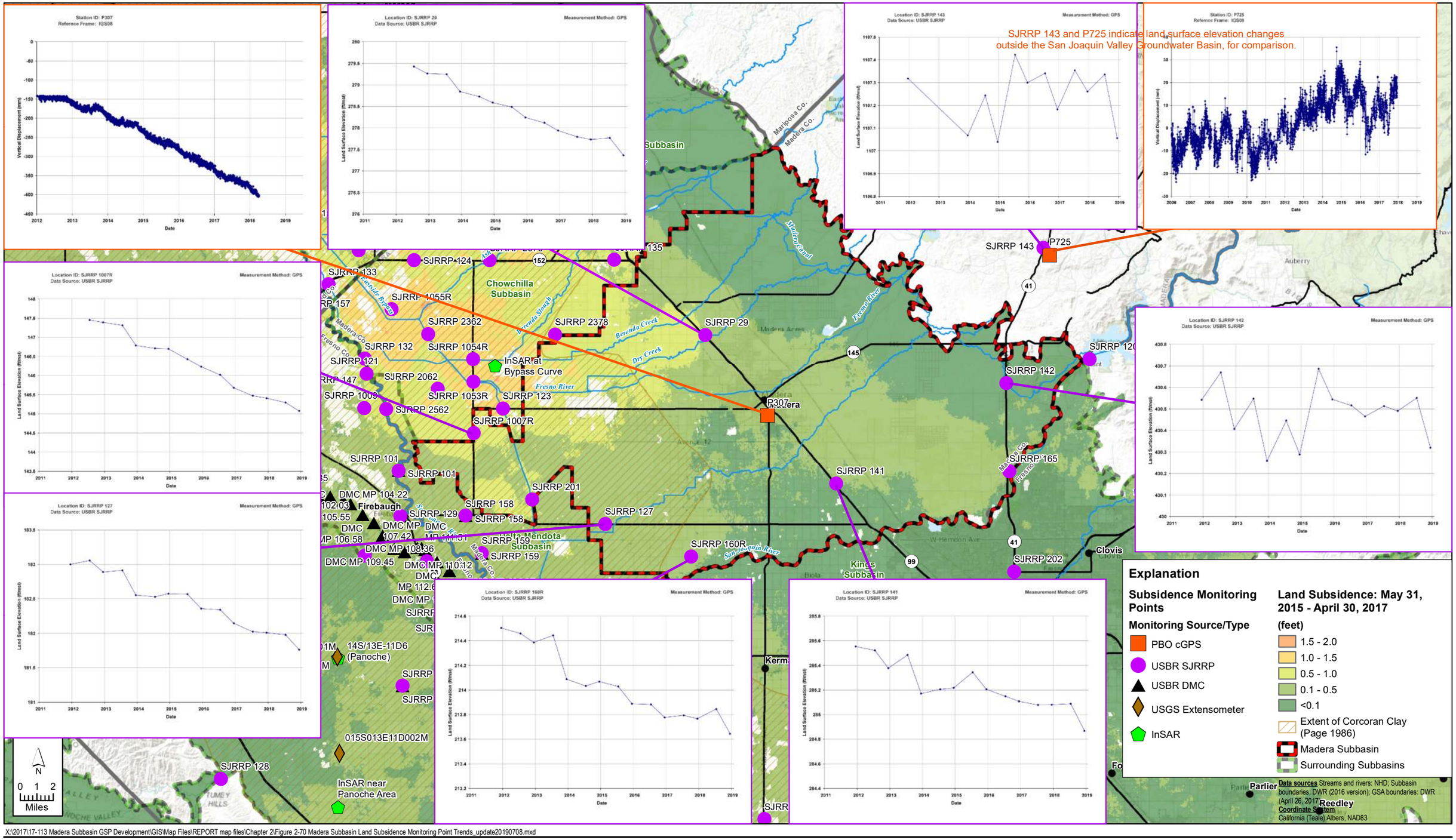
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FIGURE 2-69

Map of Land Subsidence: 2015 to 2017

Madera Subbasin
Groundwater Sustainability Plan



X:\2017\17-113 Madera Subbasin GSP Development\GIS\Map Files\REPORT map files\Chapter 2\Figure 2-70 Madera Subbasin Land Subsidence Monitoring Point Trends_update20190708.mxd

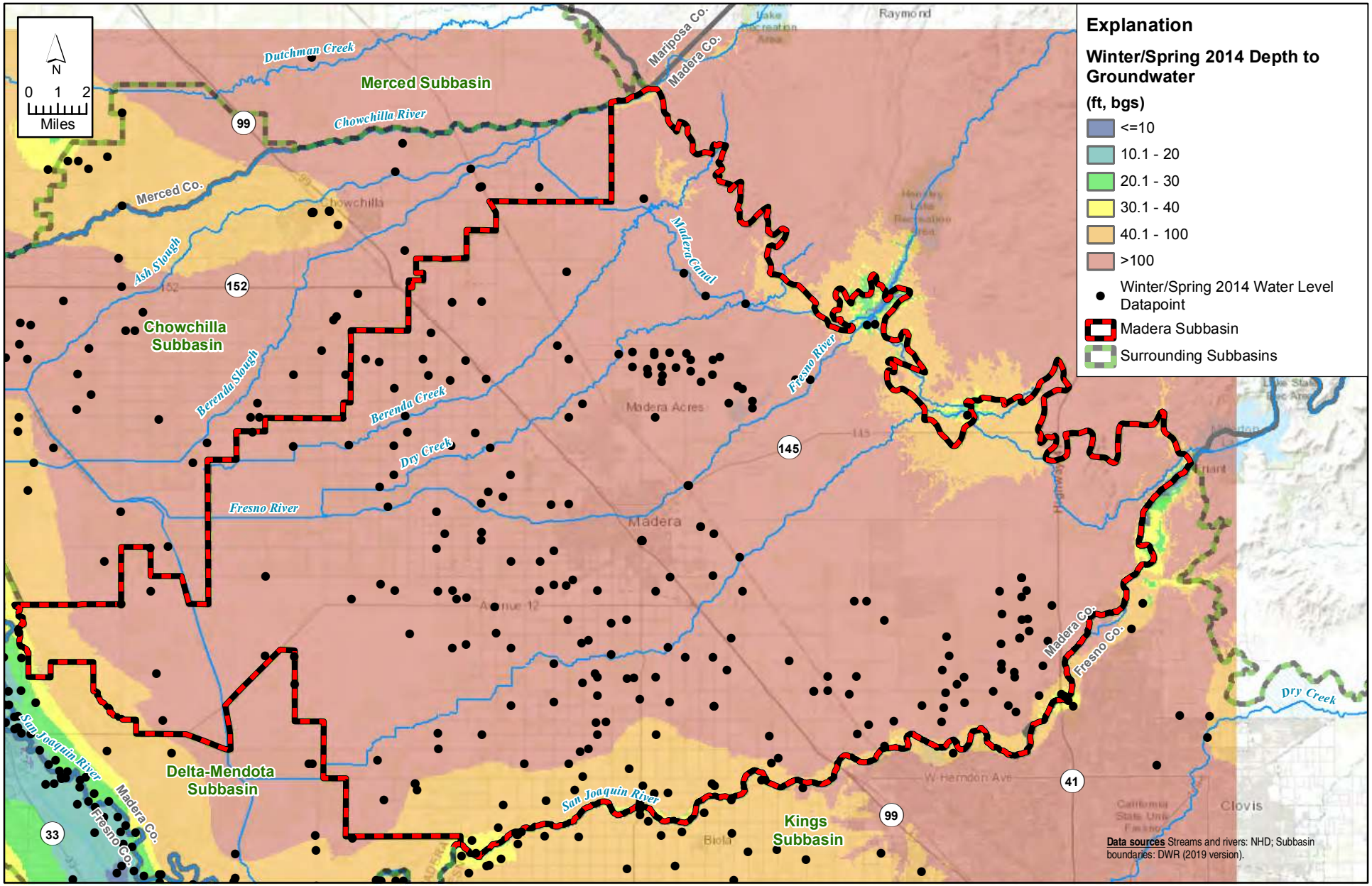
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FIGURE 2-70

Map of Subsidence Monitoring Locations

Madera Subbasin
Groundwater Sustainability Plan



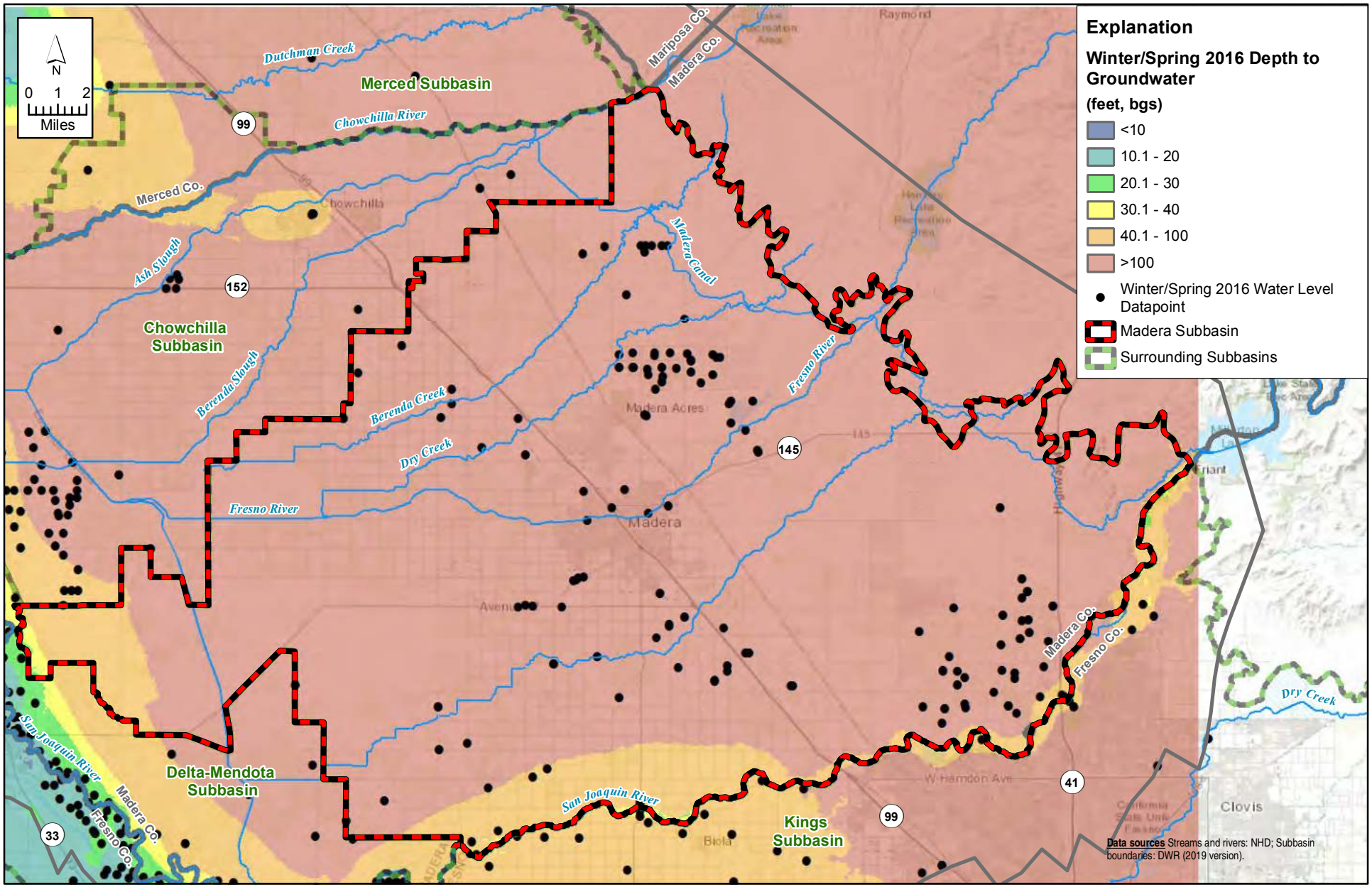
X:\2017\17-113 Madera Subbasin GSP Development\GIS\Map Files\REPORT map files\Chapter 2\Figure 2-71 Madera Subbasin Unconfined Depth to Water SpringWinter 2014.mxd

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FIGURE 2-71
Map of Depth to Groundwater: Winter/Spring 2014 - Unconfined Groundwater

Madera Subbasin
Groundwater Sustainability Plan



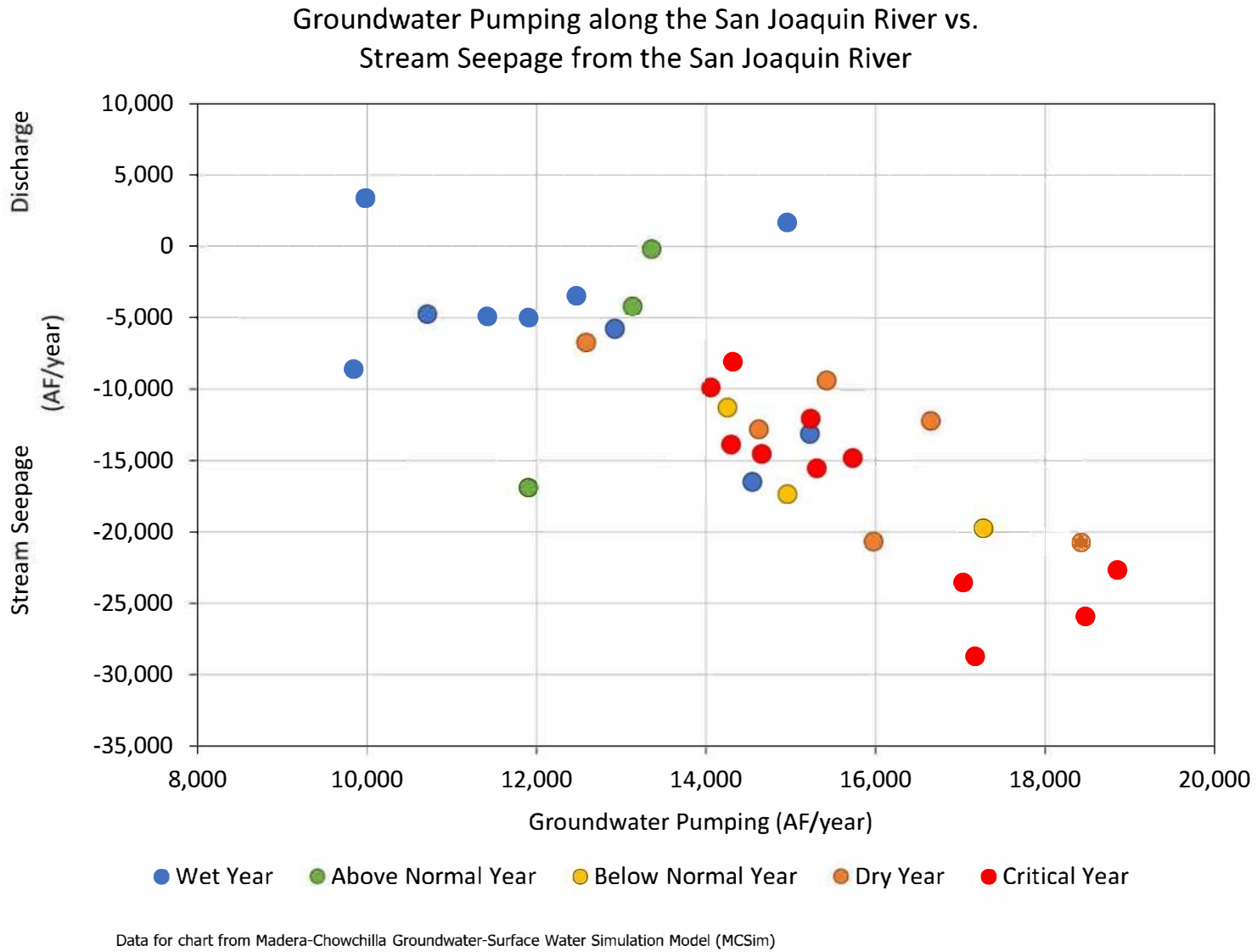
X:\2017\17-113 Madera Subbasin GSP Development\GIS\Map Files\REPORT map files\Chapter 2\Figure 2-72 Madera Subbasin Unconfined Depth to Water SpringWinter 2016.mxd

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FIGURE 2-72
Map of Depth to Groundwater: Winter/Spring 2016 - Unconfined Groundwater

Madera Subbasin
Groundwater Sustainability Plan



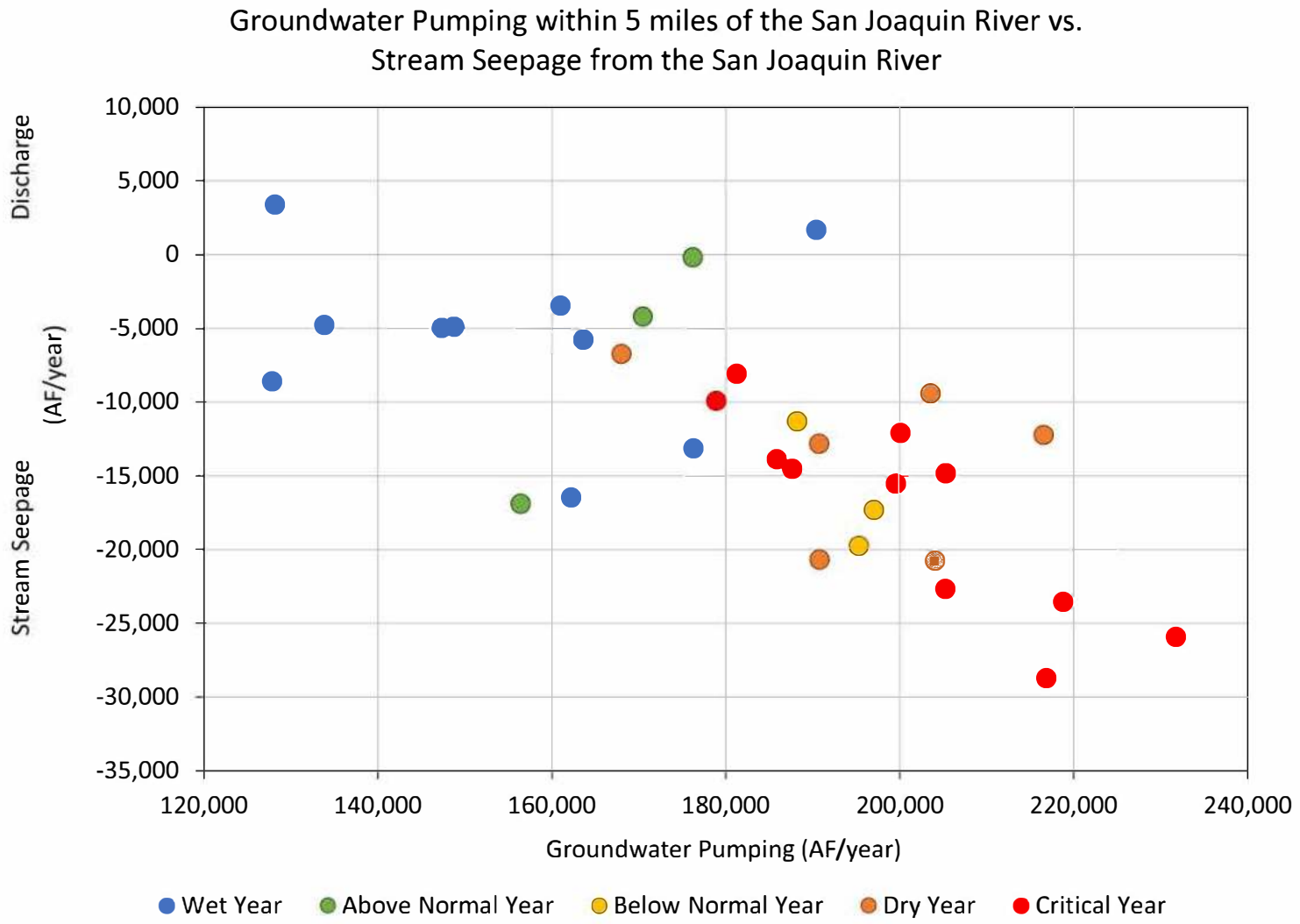
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FIGURE 2-73
Groundwater Pumping along the San Joaquin River vs. Stream Seepage from the San Joaquin River

Madera Subbasin
Groundwater Sustainability Plan



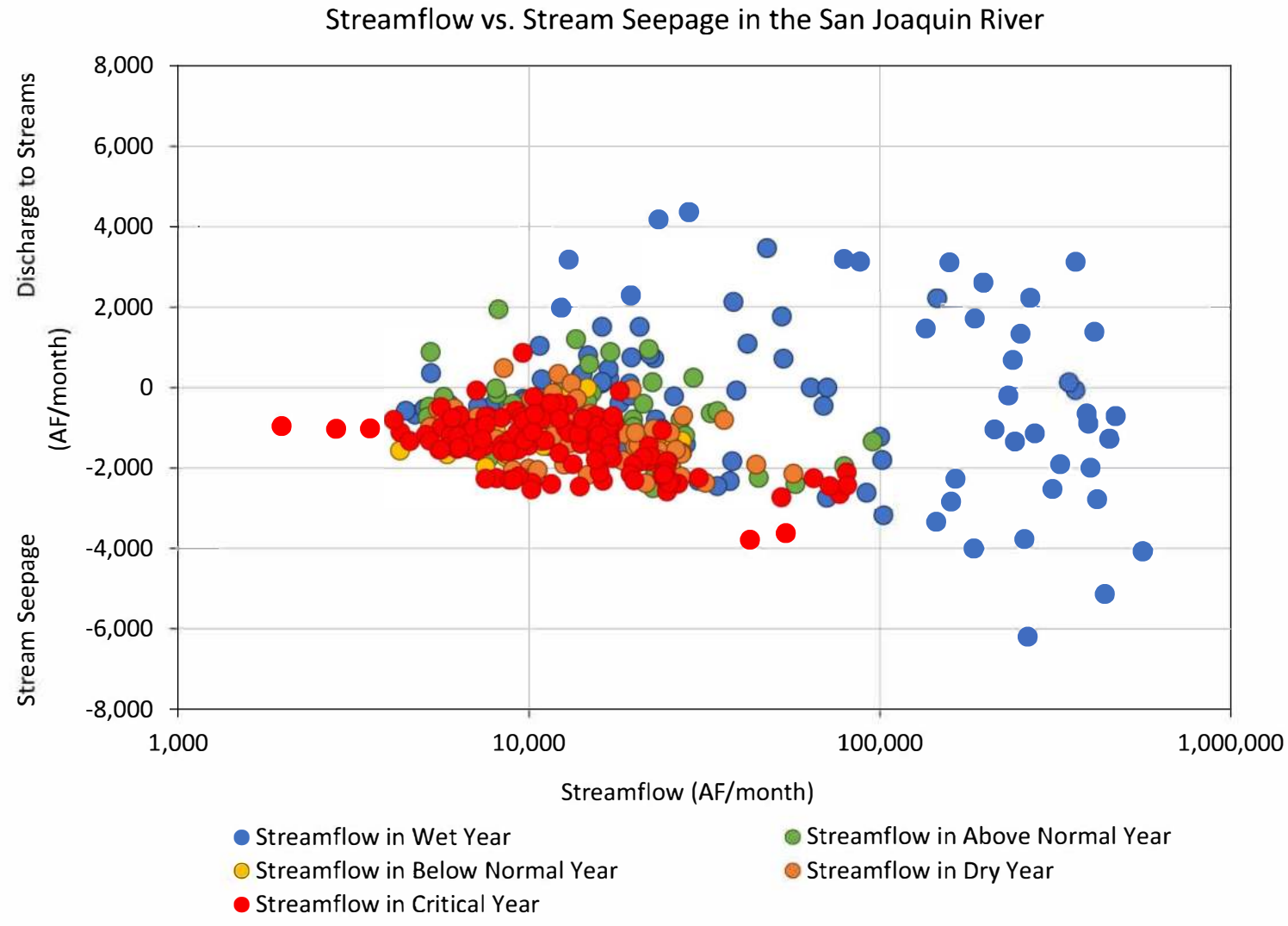
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FIGURE 2-74
Groundwater Pumping in the Western Management Area vs. Stream Seepage from the San Joaquin River

Madera Subbasin
Groundwater Sustainability Plan



Data for chart from Madera-Chowchilla Groundwater-Surface Water Simulation Model (MCSim)

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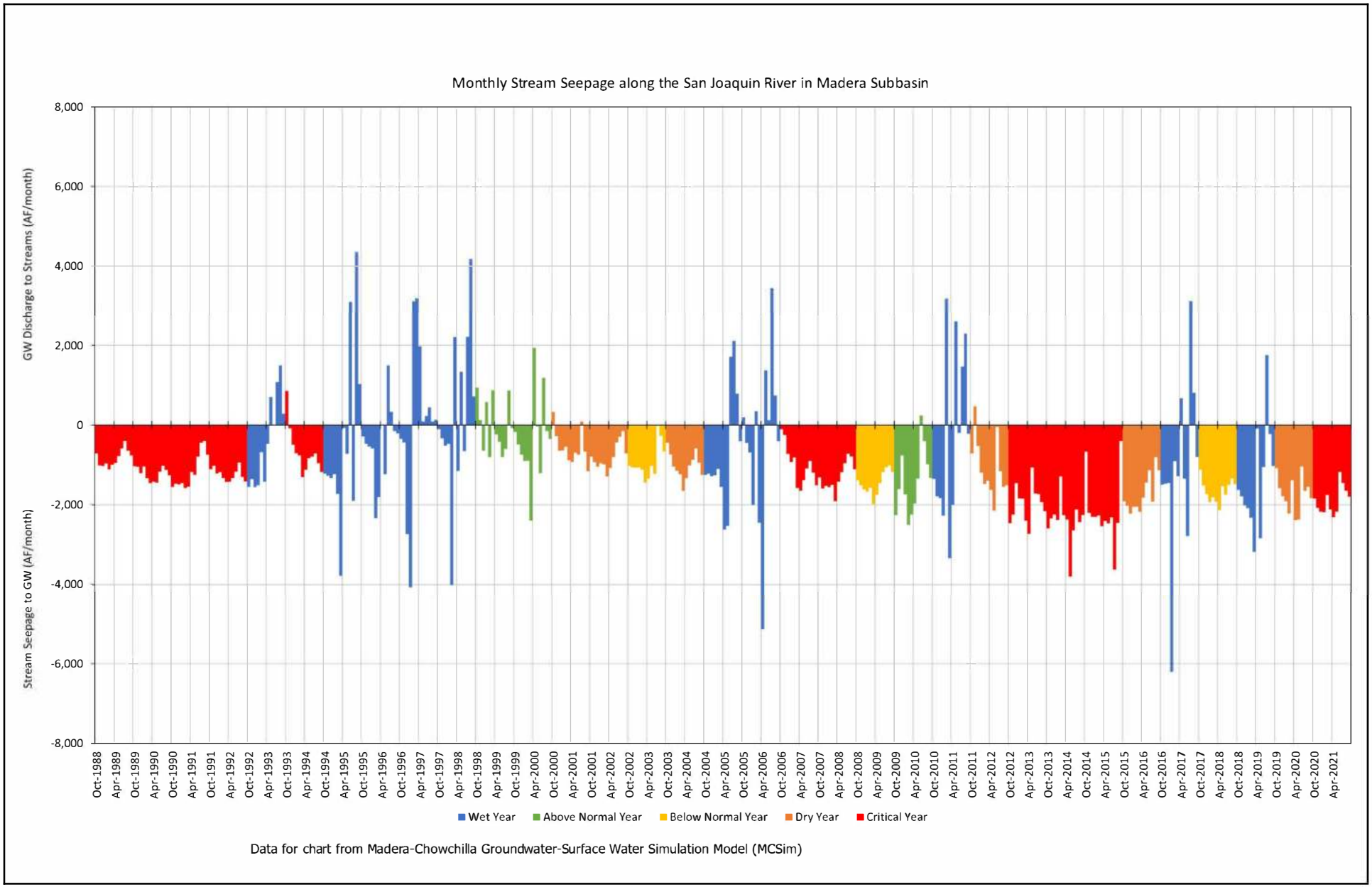
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FIGURE 2-75

Streamflow vs. Stream Seepage in the San Joaquin River

Madera Subbasin
Groundwater Sustainability Plan



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FIGURE 2-76

Stream Seepage in the San Joaquin River in Madera Subbasin

Madera Subbasin
Groundwater Sustainability Plan

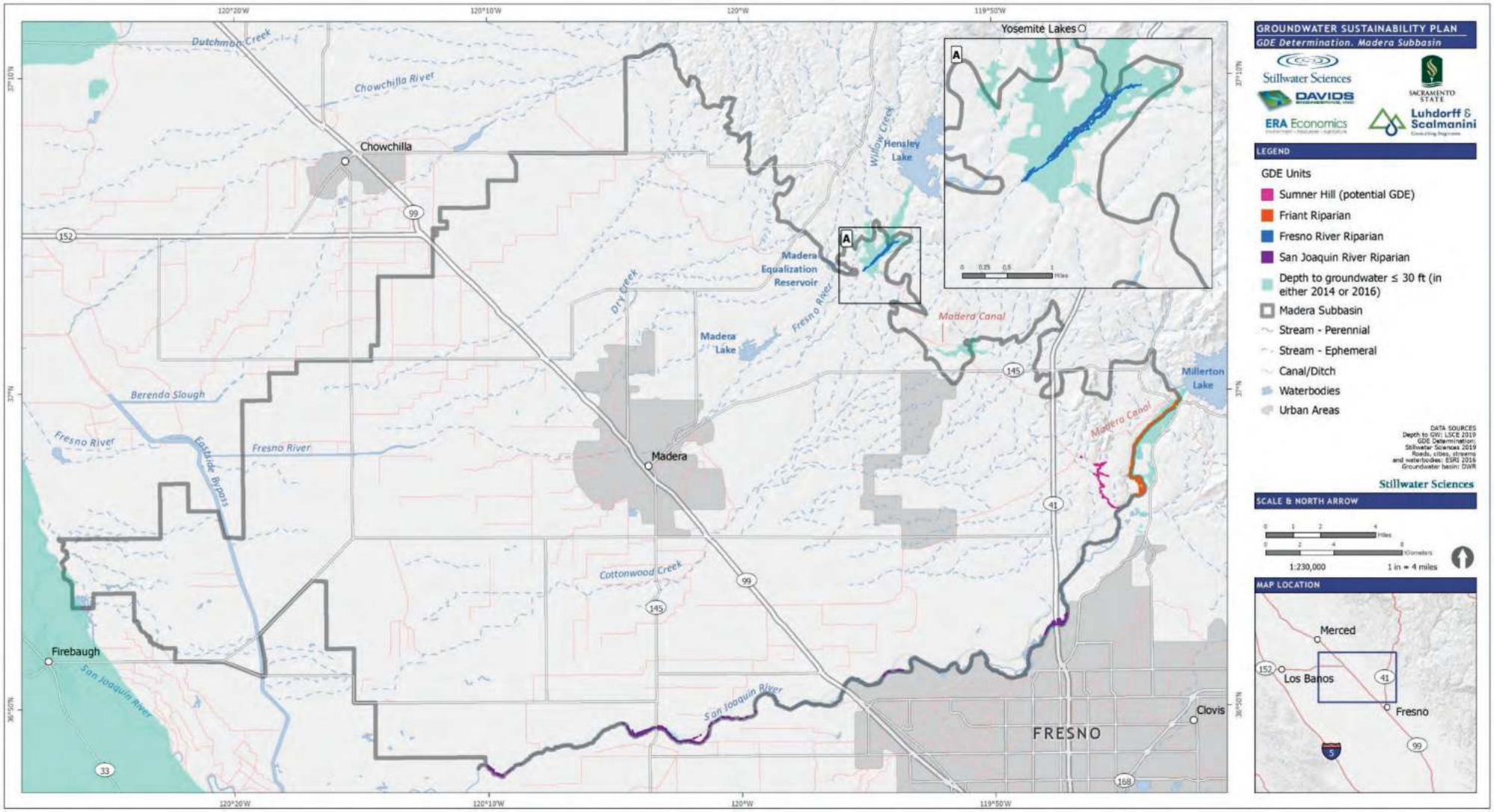


Figure 2-77. GDE units and depth to groundwater in the Madera Subbasin.

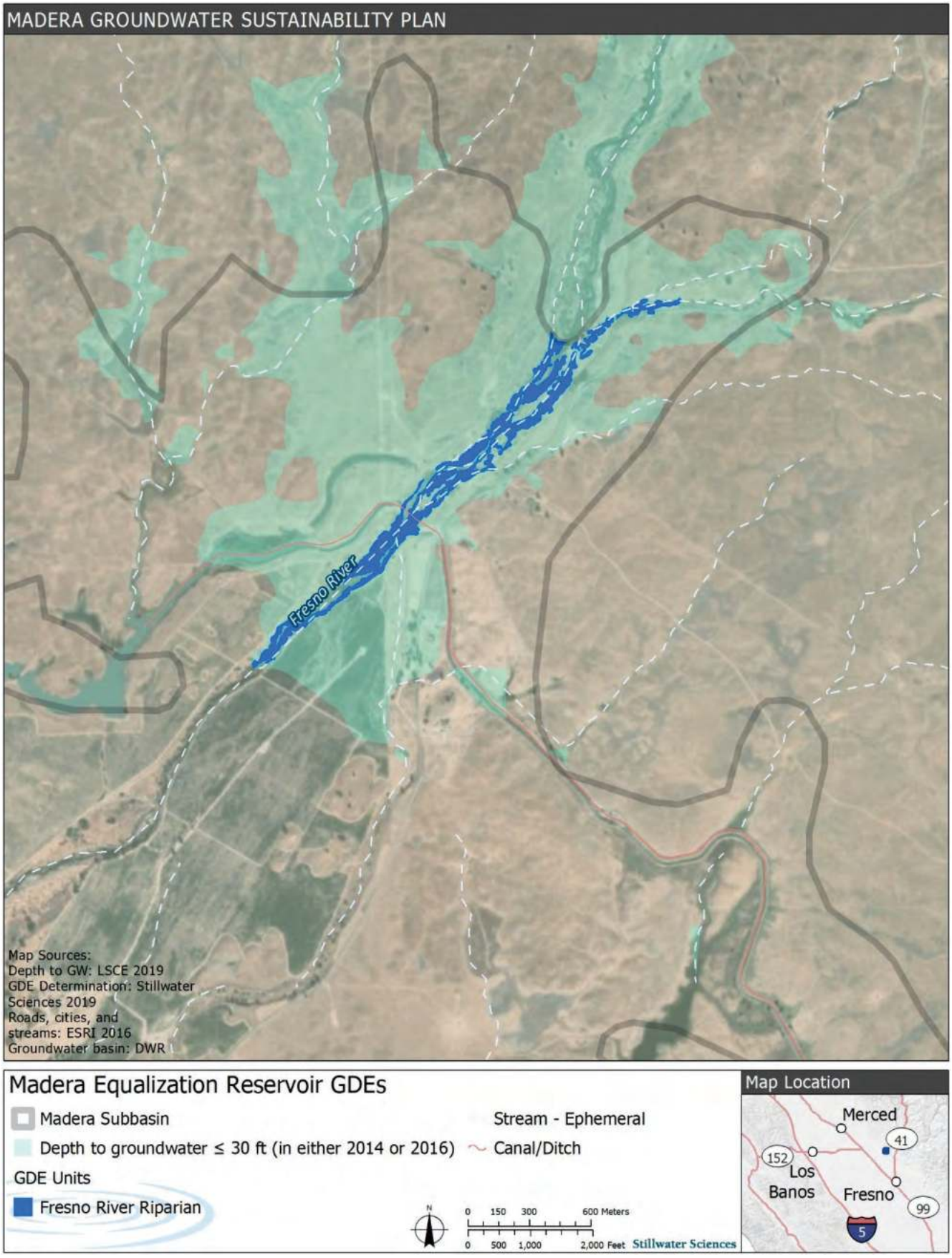


Figure 2-78. Fresno River Riparian GDE Unit.

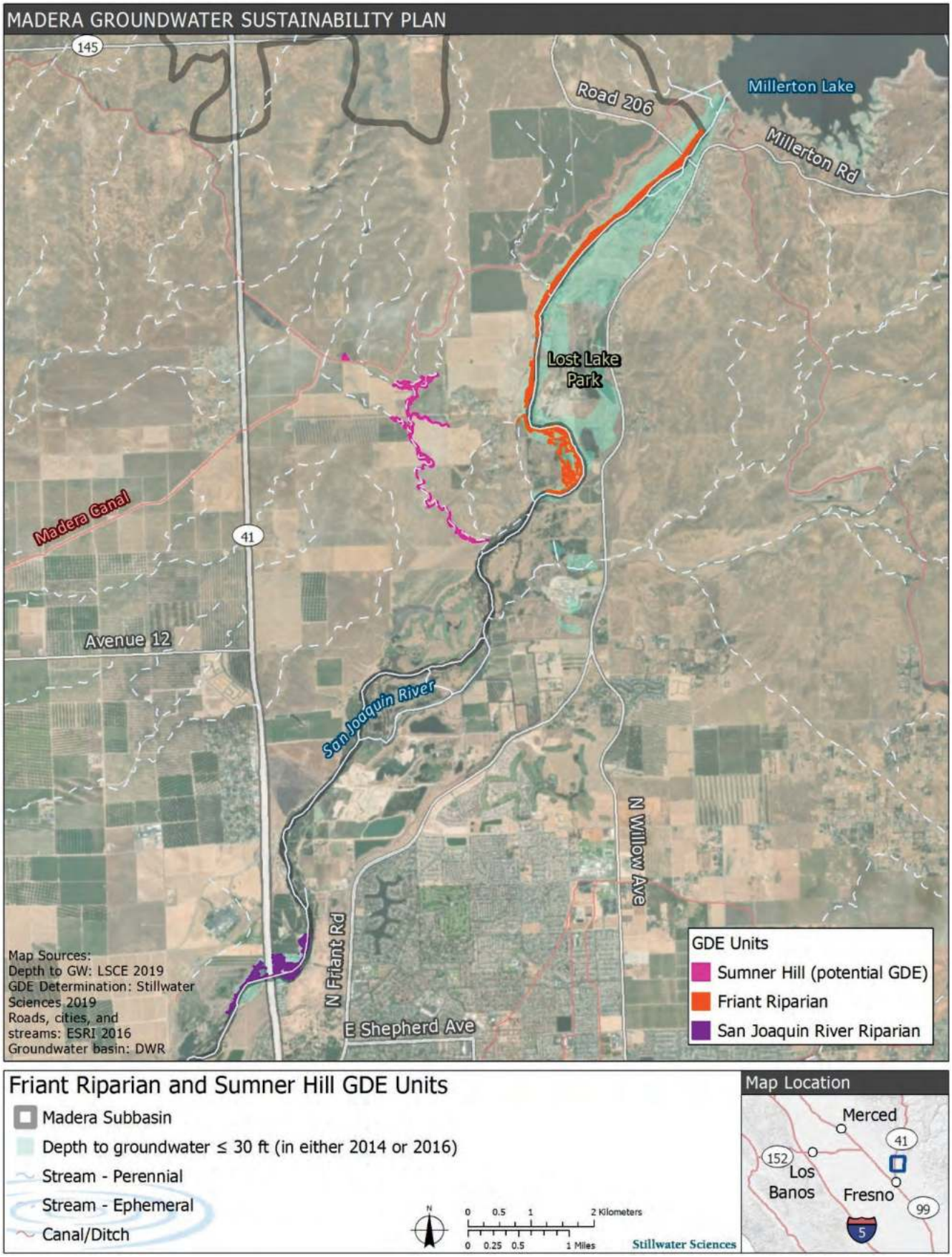


Figure 2-79. Sumner Hill potential GDE Unit, Friant Riparian GDE Unit, and upstream portion of San Joaquin River Riparian GDE Unit.

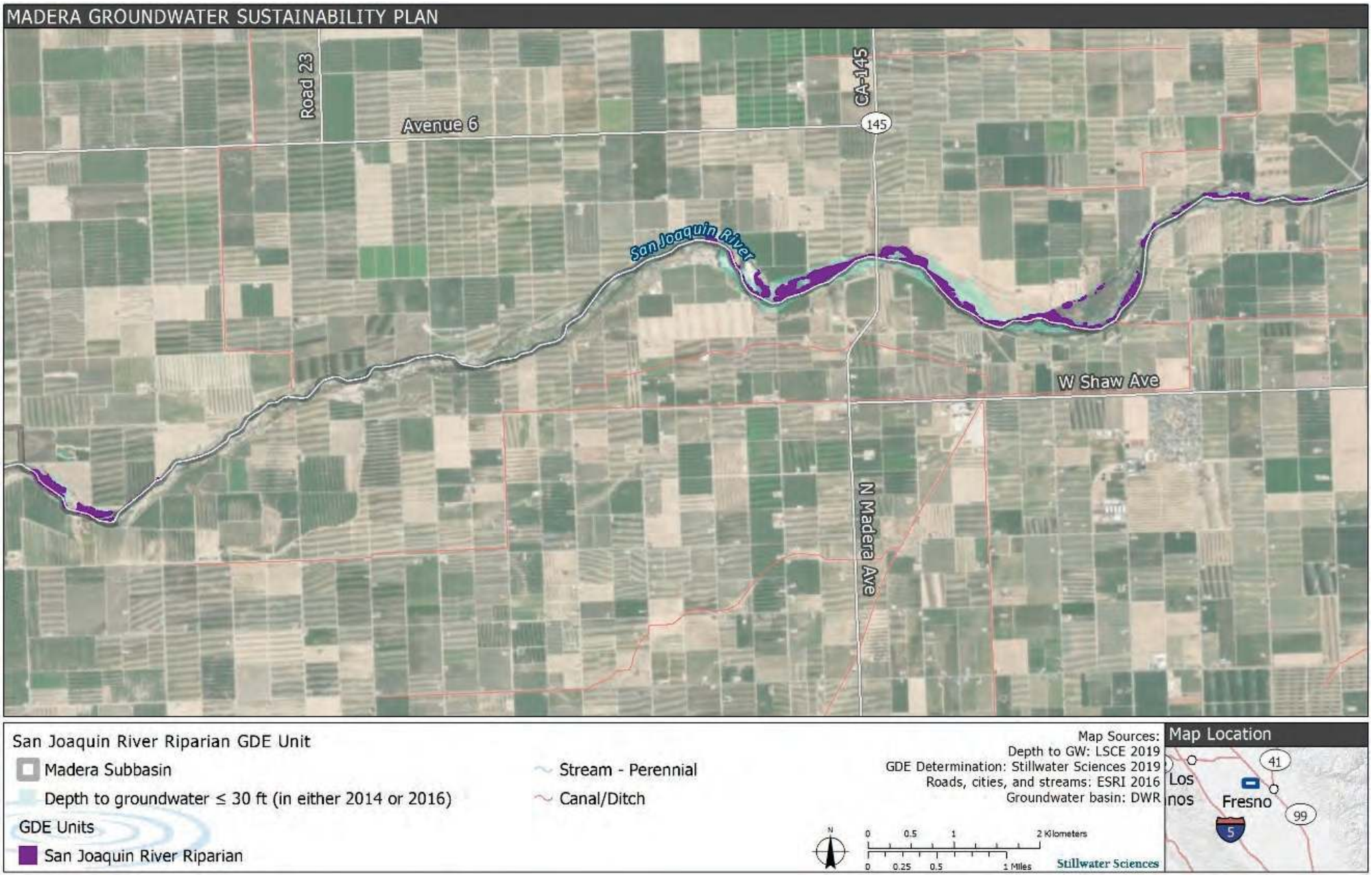
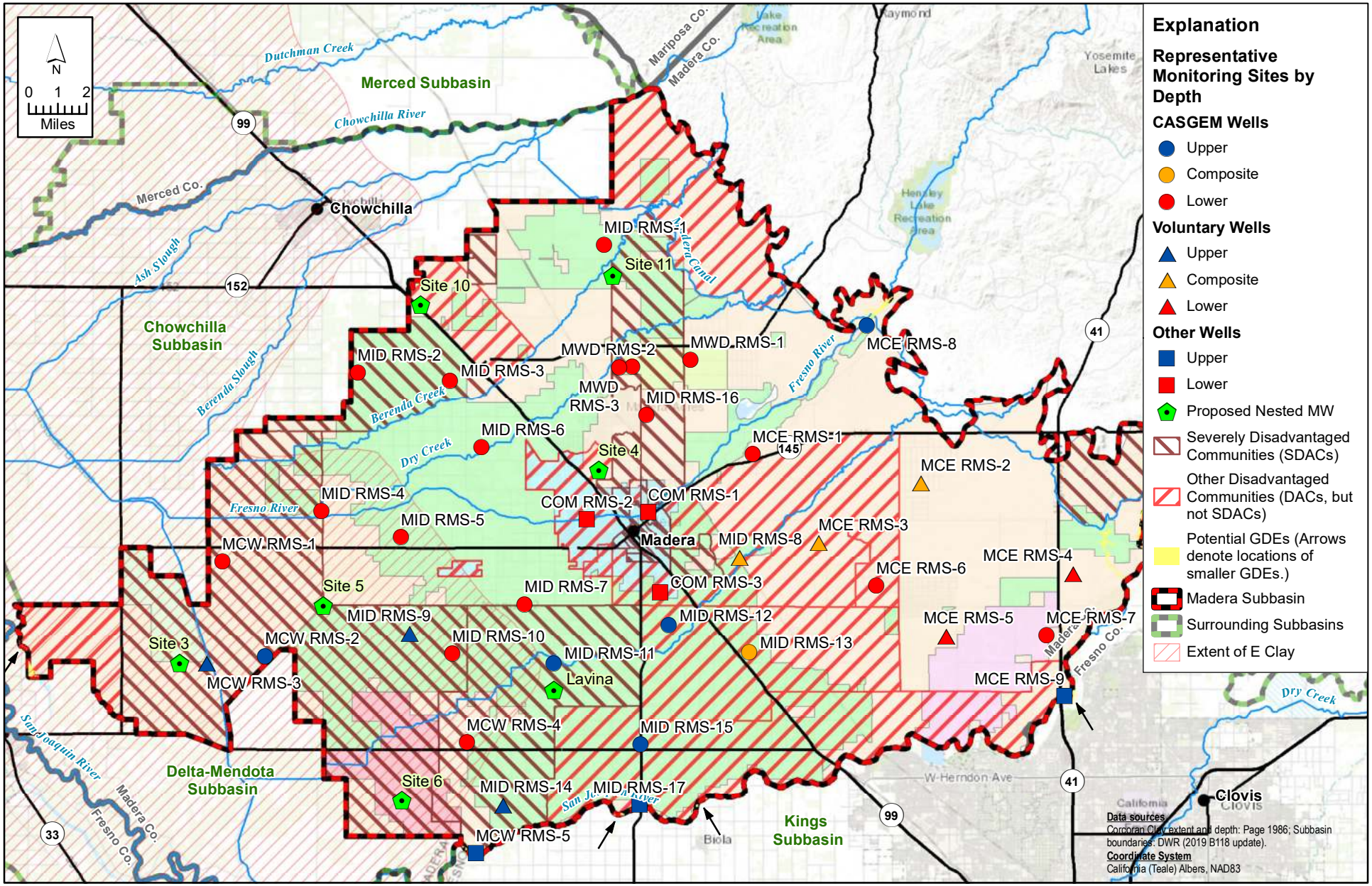


Figure 2-80. San Joaquin River Riparian GDE Unit, downstream portion.

CHAPTER THREE FIGURES

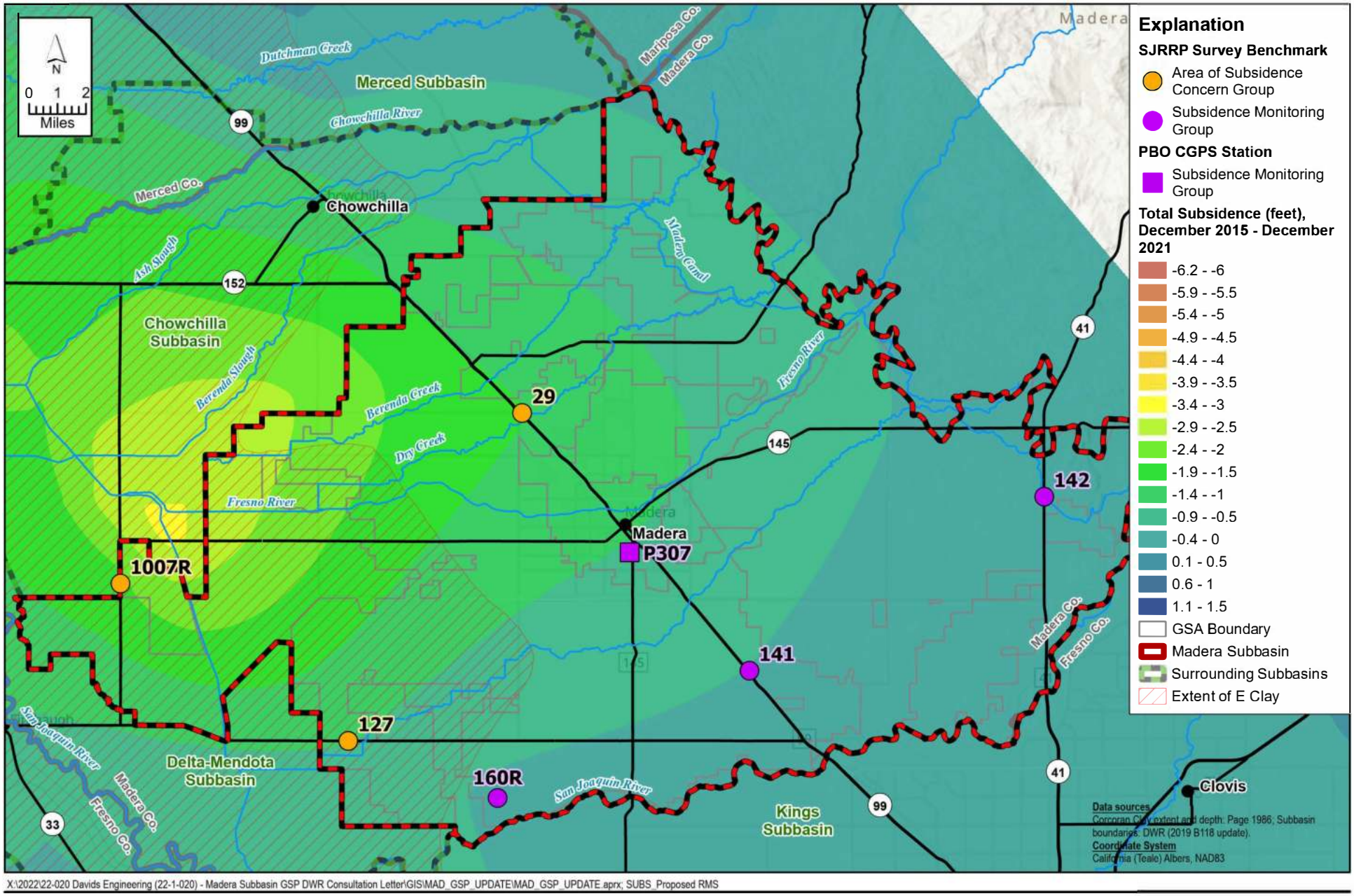


X:\2017\17-113 Madera Subbasin GSP Development\GIS\Map Files\REPORT map files\Chapter 3\Figure 3-1 Madera Subbasin Proposed Groundwater Level Sustainable Indicator Wells.mxd

FIGURE 3-1

Proposed Groundwater Level Sustainable Indicator Wells

Madera Subbasin
Groundwater Sustainability Plan



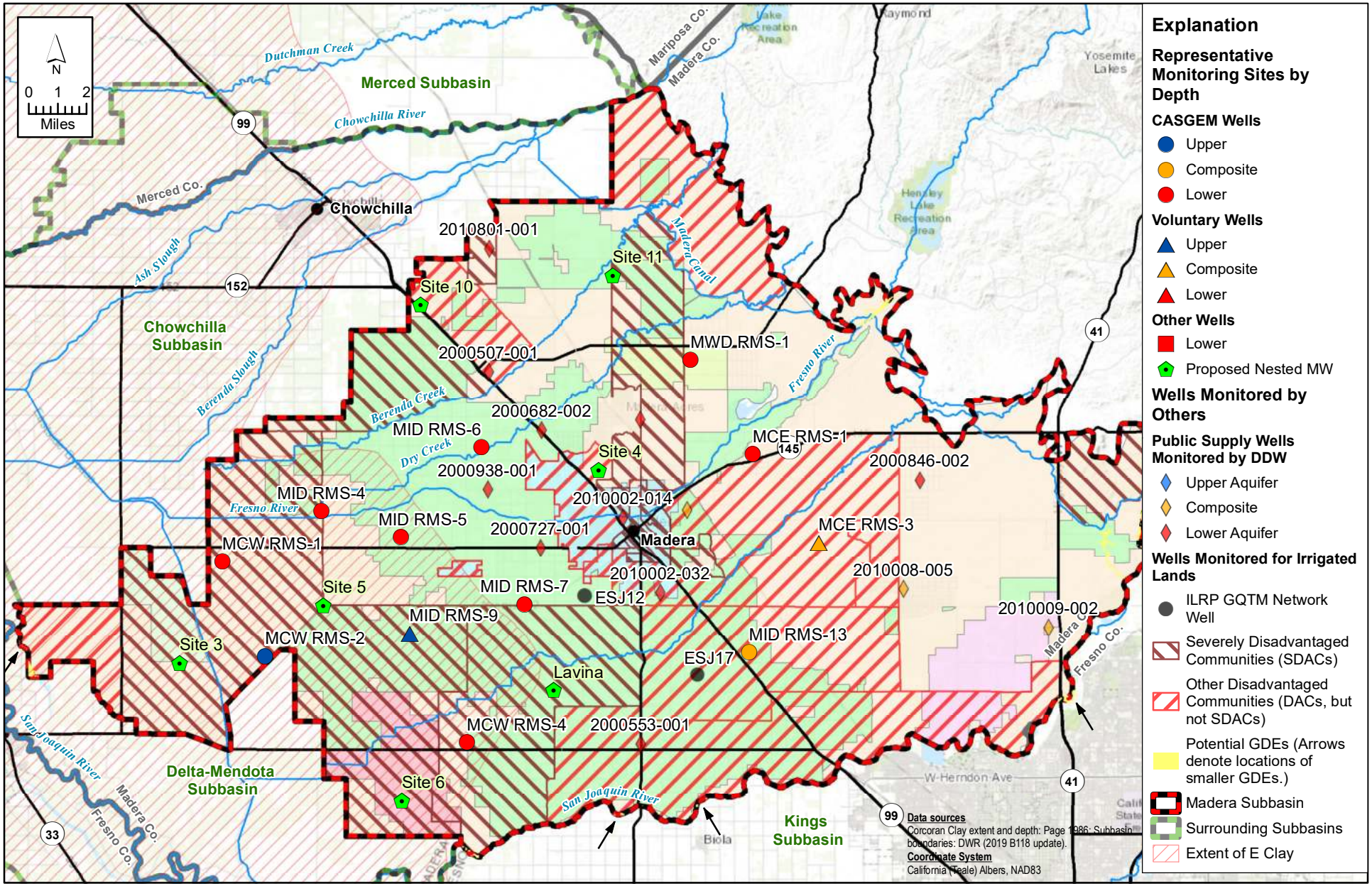
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FIGURE 3-2
Proposed Subsidence Sustainability Indicator Representative Monitoring Sites

Madera Subbasin
Groundwater Sustainability Plan



X:\2017\17-113 Madera Subbasin GSP Development\GIS\Map Files\REPORT map files\Chapter 3\Figure 3-2 Madera Subbasin Proposed Groundwater Quality Sustainable Indicator Wells.mxd

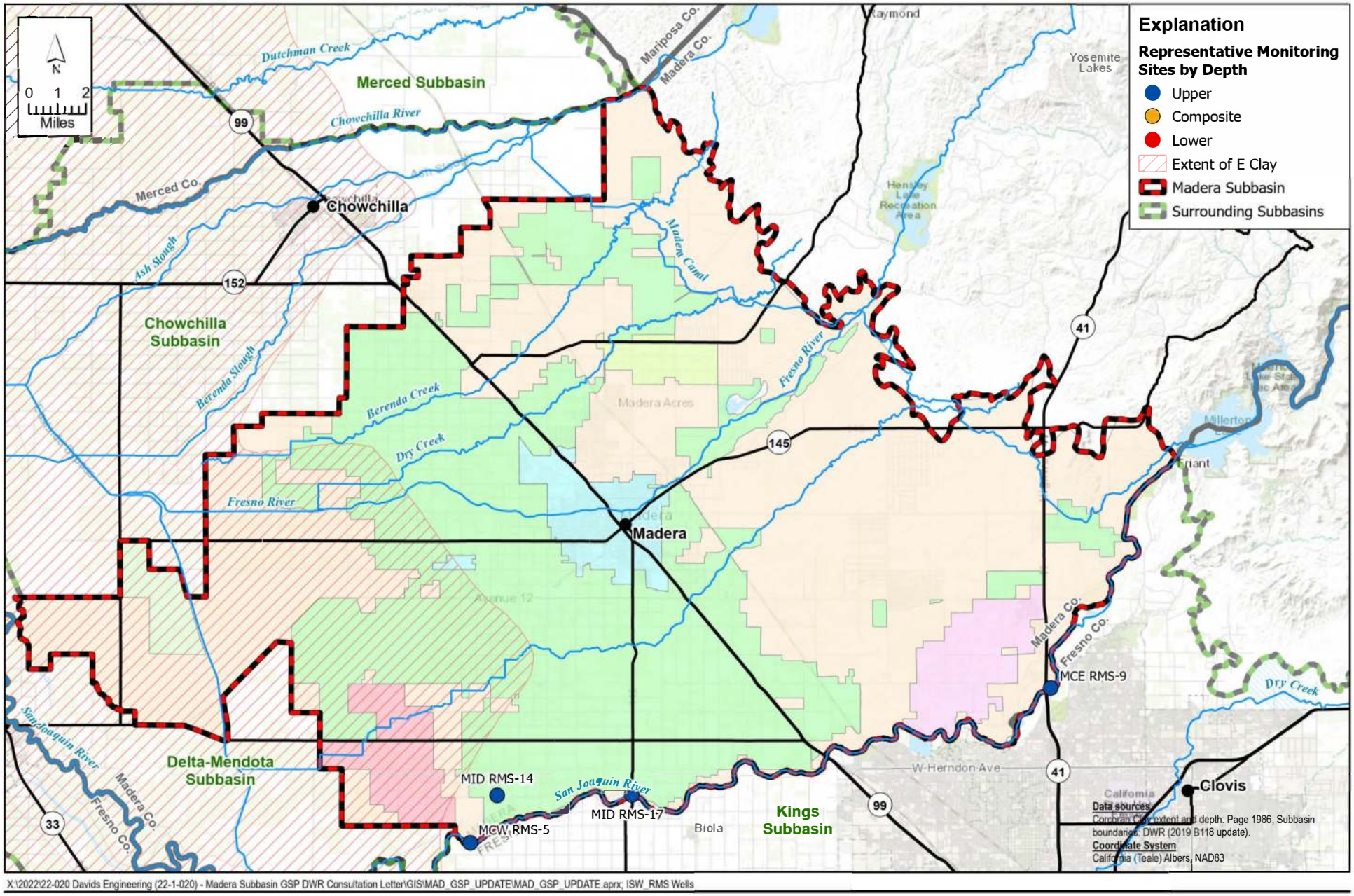
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FIGURE 3-3

Proposed Groundwater Quality Sustainable Indicator Wells

Madera Subbasin
Groundwater Sustainability Plan



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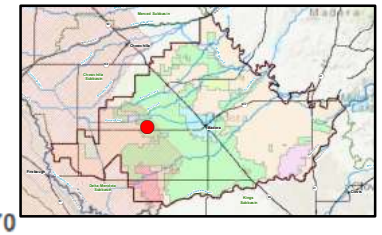
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FIGURE 3-4

Proposed Interconnected Surface Water Sustainability Indicator Representative Monitoring Sites

Madera Subbasin
Groundwater Sustainability Plan

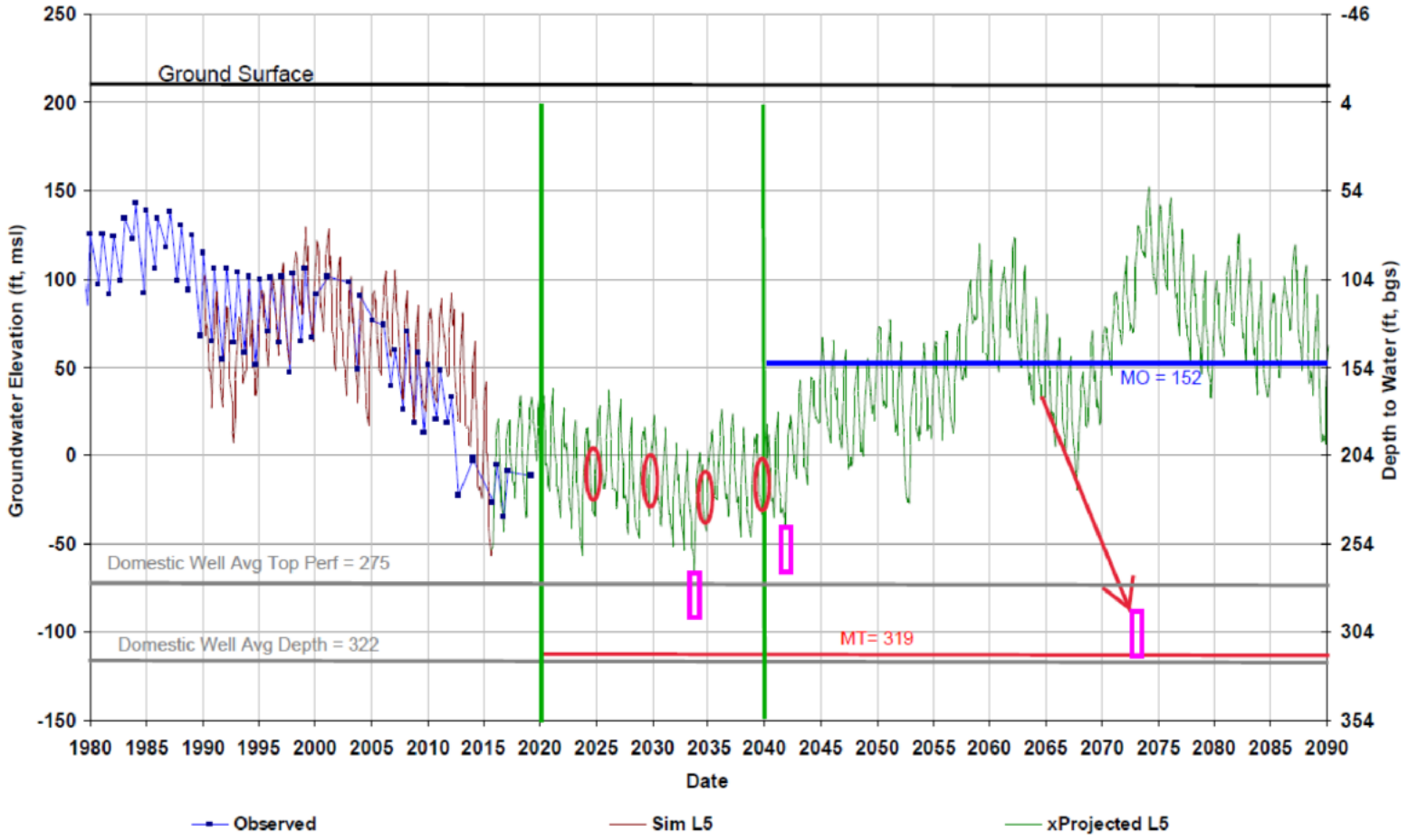


Well Name: MID RMS-5
Depth Zone: Lower; Within CC
Subbasin: Madera
GSE (ft, msl): 204

Domestic Well Data: *Total Sections Included: 8*

Total Depth Count: 21	Top Perf. Count: 12
Total Depth Average: 322	Top Perf. Average: 275
Total Depth Minimum: 253	Top Perf. Minimum: 224
Total Depth Maximum: 389	Top Perf. Maximum: 333

Total Depth (ft): 570
Perf Top (ft): 270
Perf Bottom (ft): 570
Top Model Layer: 5
Bottom Model Layer: 5



X:\2017\17-113 Madera Subbasin GSP Development\GIS\Map Files\REPORT map files\Chapter 3\Figure 3-3a Madera Subbasin Example Groundwater Level Hydrographs (Steps 1-4).mxd

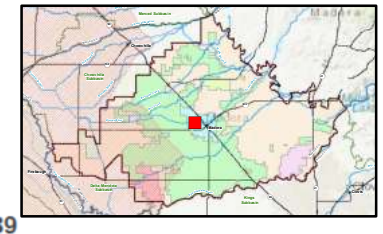
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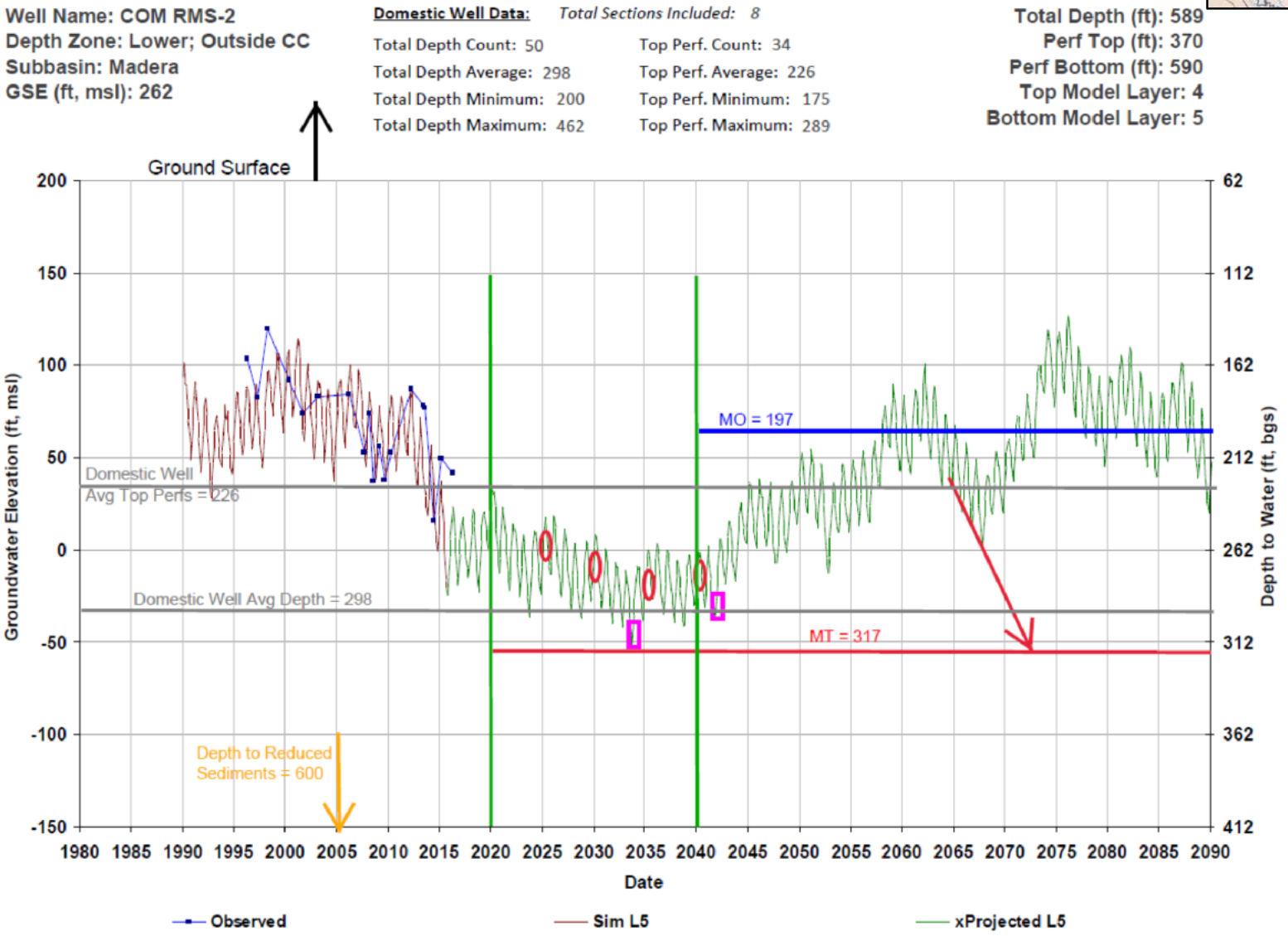
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FIGURE 3-5A

Example Groundwater Level Hydrographs (Steps 1-4)

Madera Subbasin
Groundwater Sustainability Plan



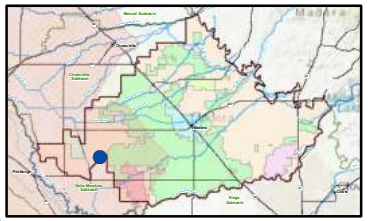


X:\2017\17-113 Madera Subbasin GSP Development\GIS\Map Files\REPORT map files\Chapter 3\Figure 3-3b Madera Subbasin Example Groundwater Level Hydrographs (Steps 1-4).mxd

FIGURE 3-5B

Example Groundwater Level Hydrographs (Steps 1-4)

Madera Subbasin
Groundwater Sustainability Plan

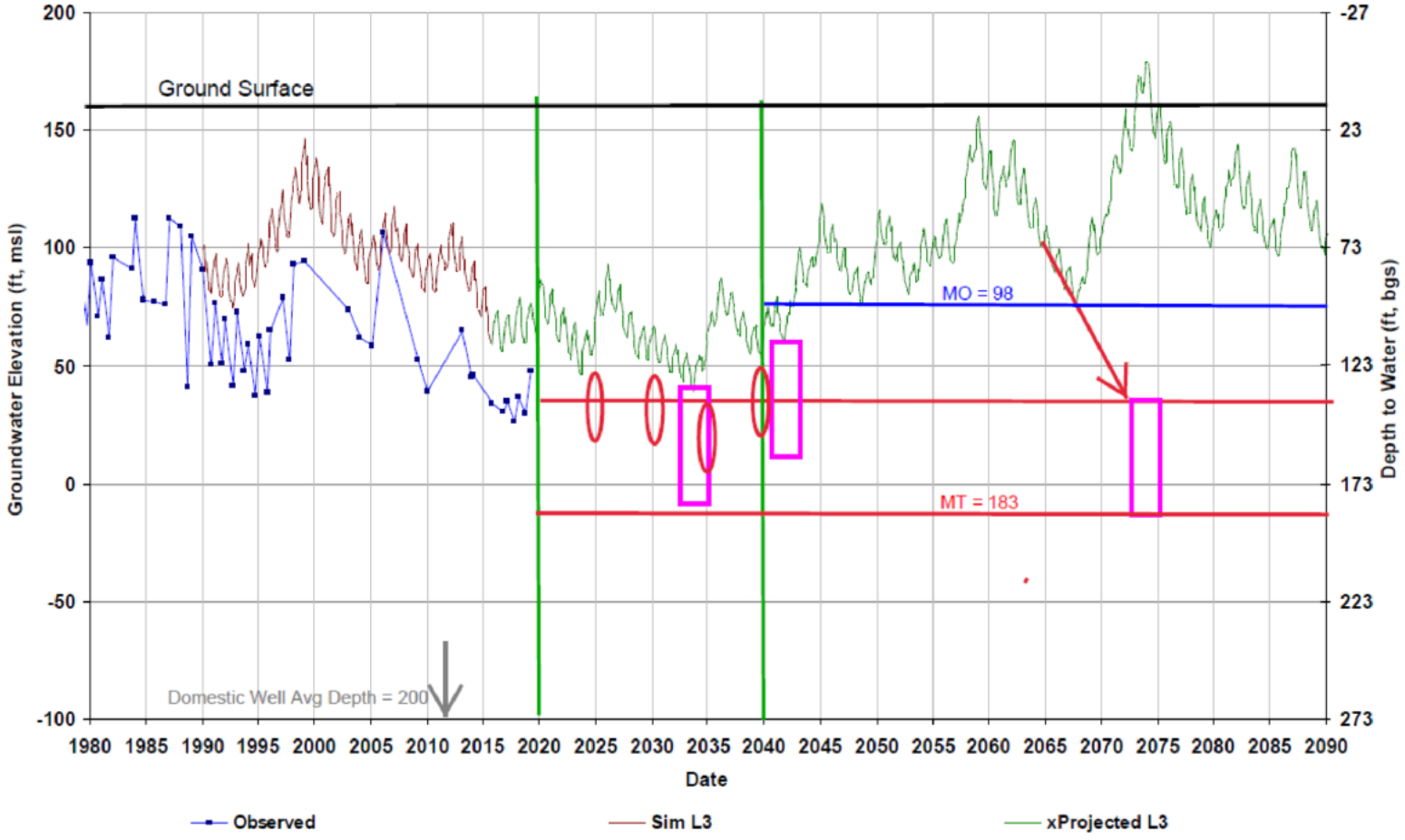


Well Name: MCW RMS-2
Depth Zone: Upper; Within CC
Subbasin: Madera
GSE (ft, msl): 173

Domestic Well Data: *Total Sections Included: 8*

Total Depth Count: 1	Top Perf. Count: 0
Total Depth Average: 200	Top Perf. Average: 0
Total Depth Minimum: 200	Top Perf. Minimum: 0
Total Depth Maximum: 200	Top Perf. Maximum: 0

Total Depth (ft): 216
Perf Top (ft): 205
Perf Bottom (ft): 212
Top Model Layer: 3
Bottom Model Layer: 3



X:\2017\17-113 Madera Subbasin GSP Development\GIS\Map Files\REPORT map files\Chapter 3\Figure 3-4a Madera Subbasin Example Groundwater Level Hydrographs (Steps 5-6).mxd

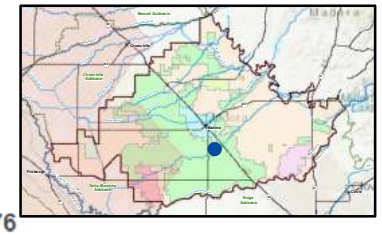
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FIGURE 3-6A

Example Groundwater Level Hydrographs (Steps 5-6)

Madera Subbasin
Groundwater Sustainability Plan

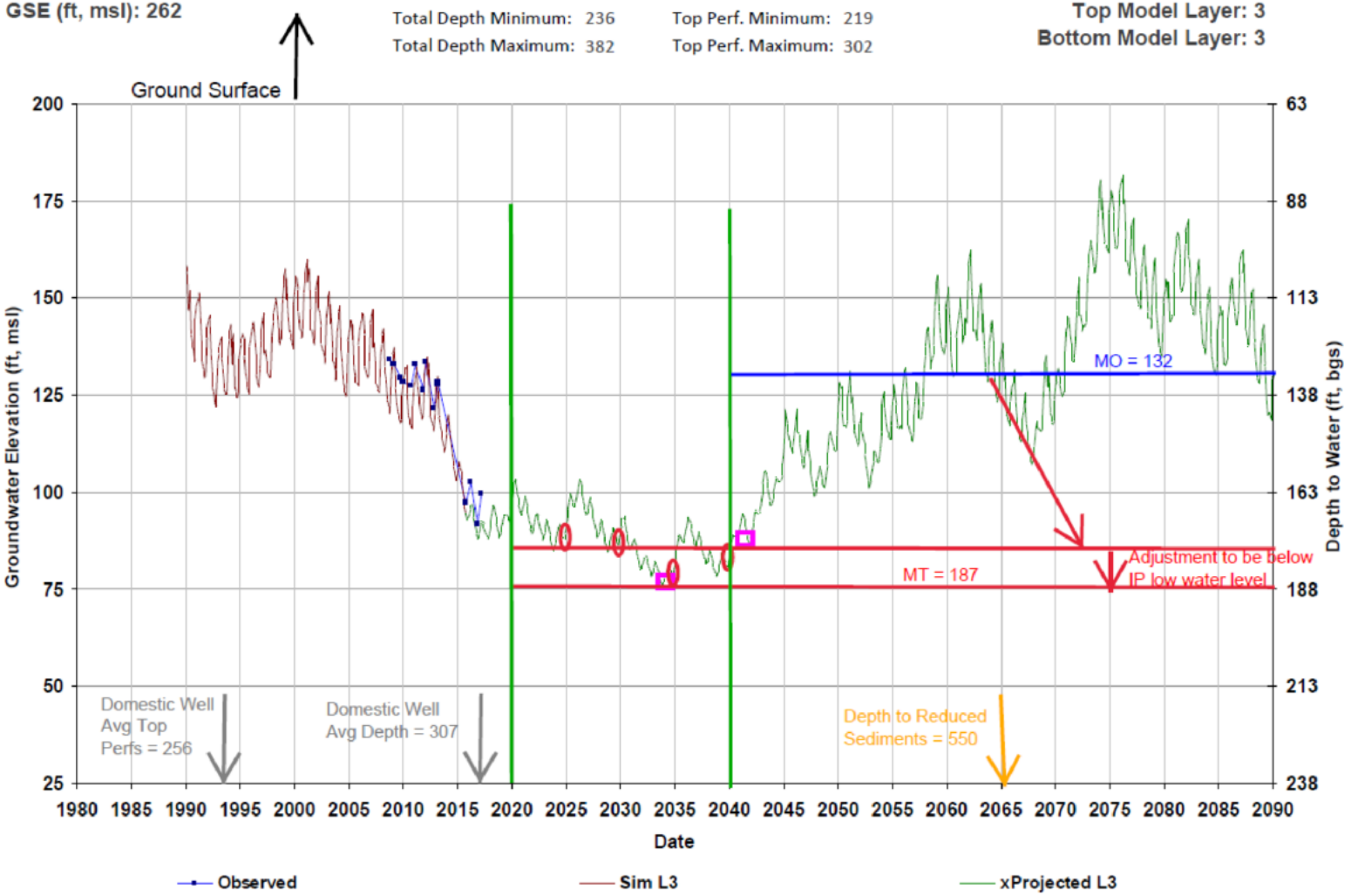


Well Name: MID RMS-12
Depth Zone: Upper; Outside CC
Subbasin: Madera
GSE (ft, msl): 262

Domestic Well Data: *Total Sections Included: 8*

Total Depth Count: 43	Top Perf. Count: 26
Total Depth Average: 307	Top Perf. Average: 256
Total Depth Minimum: 236	Top Perf. Minimum: 219
Total Depth Maximum: 382	Top Perf. Maximum: 302

Total Depth (ft): 176
Perf Top (ft):
Perf Bottom (ft):
Top Model Layer: 3
Bottom Model Layer: 3



X:\2017\17-113 Madera Subbasin GSP Development\GIS\Map Files\REPORT map files\Chapter 3\Figure 3-4b Madera Subbasin Example Groundwater Level Hydrographs (Steps 5-6).mxd

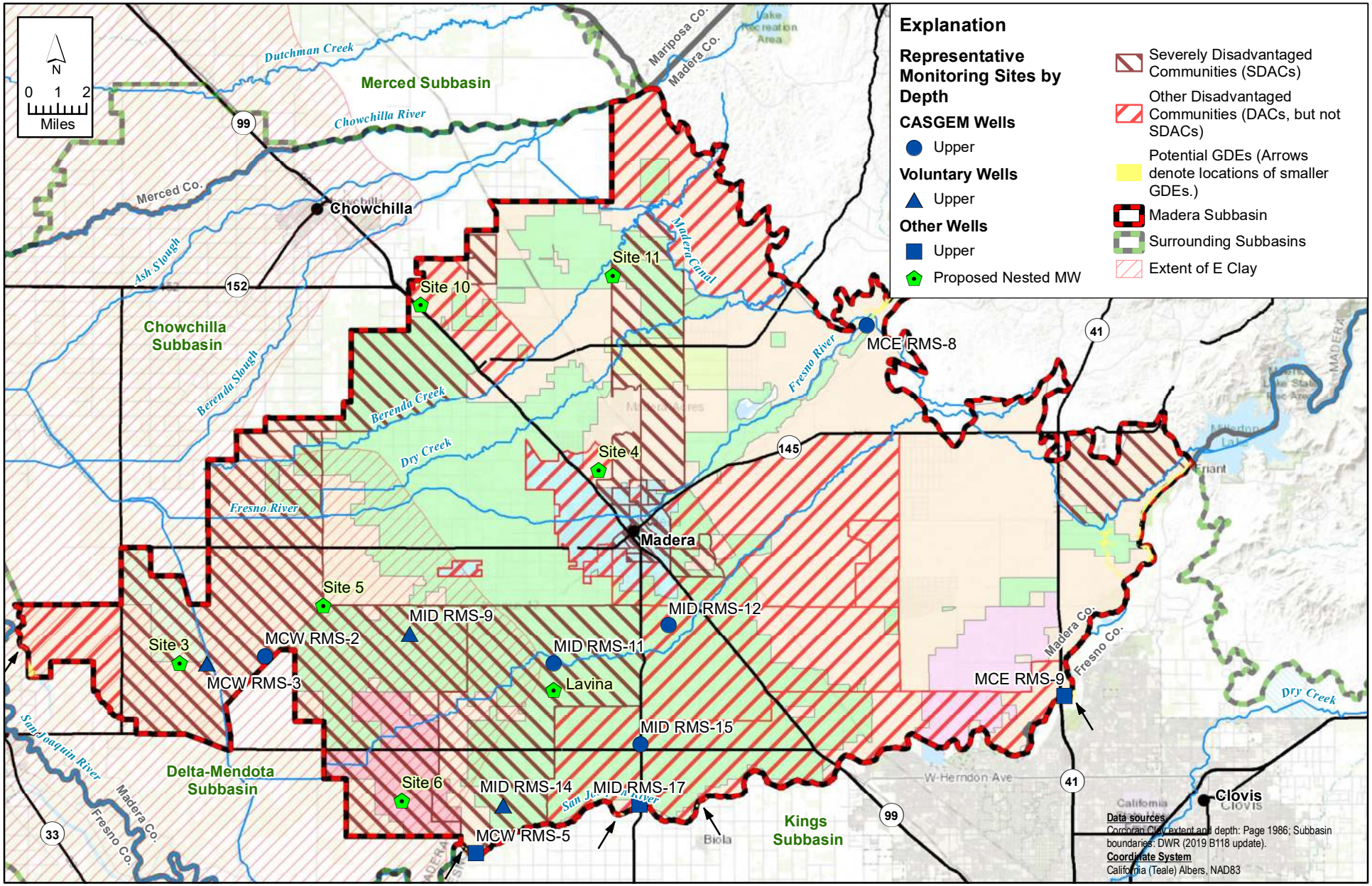
DAVIDS ENGINEERING, INC

Luhdorff & Scalmanini Consulting Engineers

FIGURE 3-6B

Example Groundwater Level Hydrographs (Steps 5-6)

Madera Subbasin
Groundwater Sustainability Plan



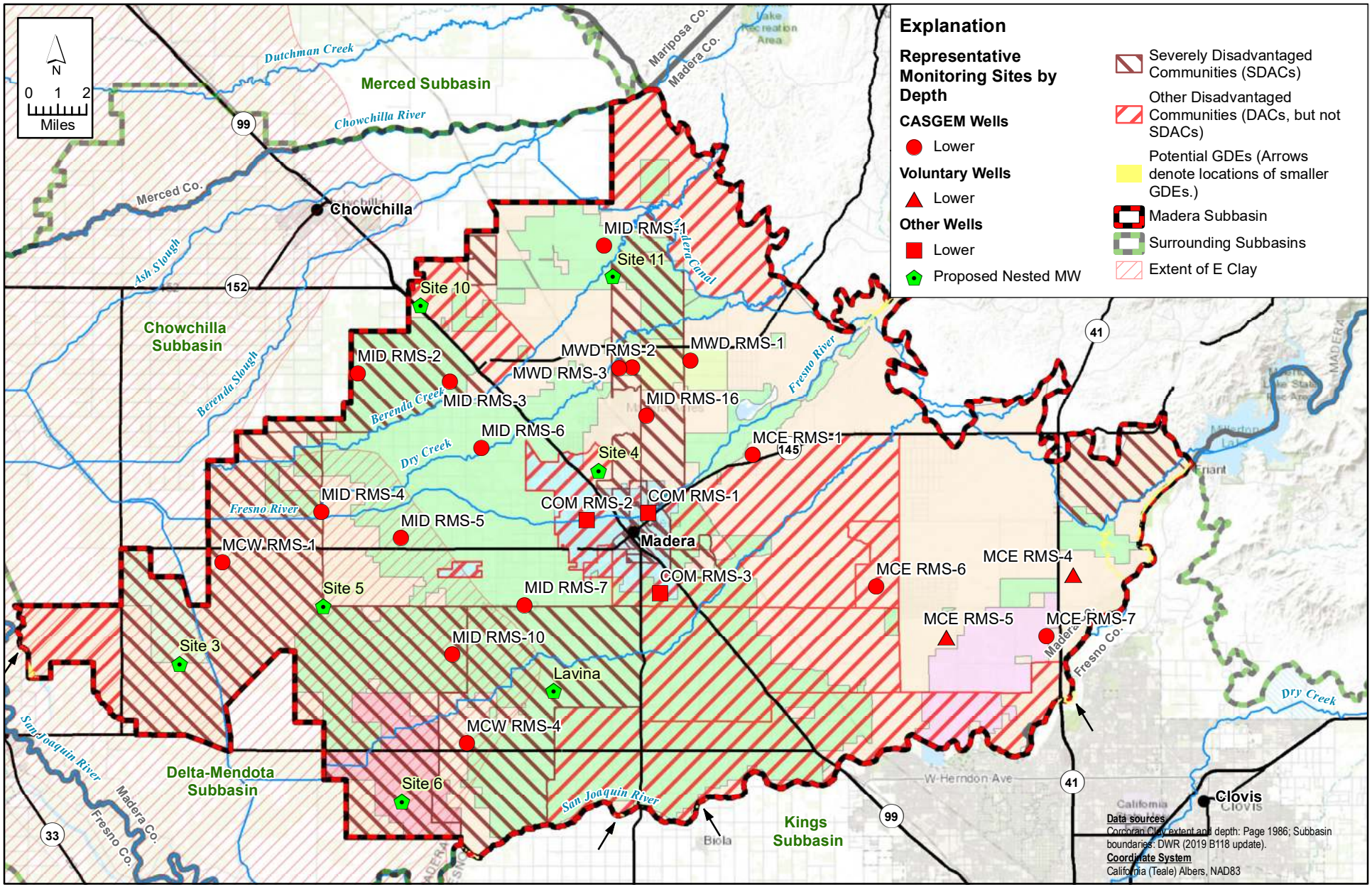
X:\2017\17-113 Madera Subbasin GSP Development\GIS\Map Files\REPORT map files\Chapter 3\Figure 3-5 Madera Subbasin Proposed Groundwater Level Sustainable Indicator Wells, Upper Aquifer.mxd

DAVIDS ENGINEERING, INC

Luhdorff & Scalmanini Consulting Engineers

FIGURE 3-7
Proposed Groundwater Level Sustainable Indicator Wells
Upper Aquifer

Madera Subbasin
Groundwater Sustainability Plan



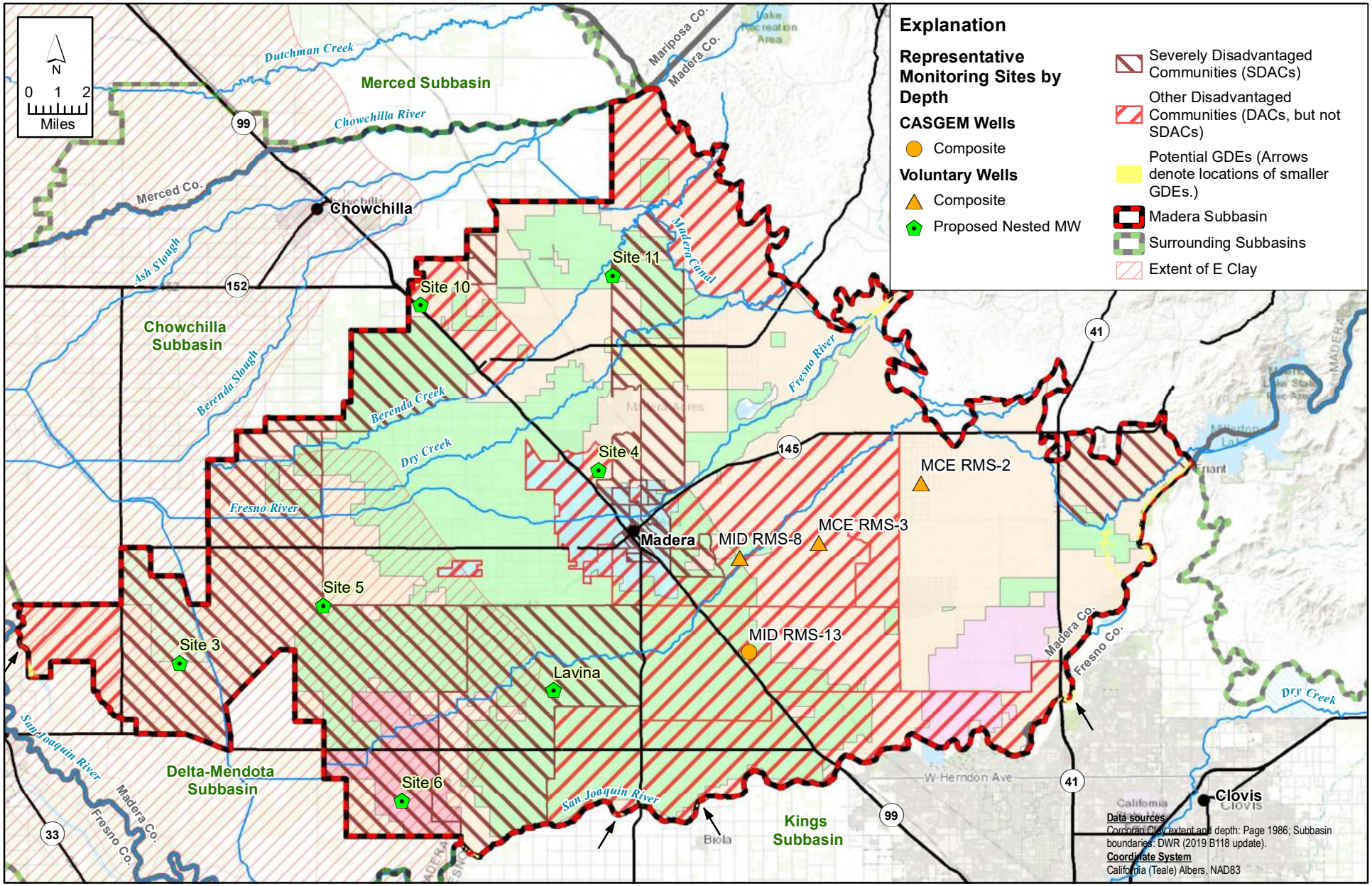
X:\2017\17-113 Madera Subbasin GSP Development\GIS\Map Files\REPORT map files\Chapter 3\Figure 3-6 Madera Subbasin Proposed Groundwater Level Sustainable Indicator Wells, Lower Aquifer.mxd

DAVIDS ENGINEERING, INC

Luhdorff & Scalmanini Consulting Engineers

FIGURE 3-8
Proposed Groundwater Level Sustainable Indicator Wells
Lower Aquifer

Madera Subbasin
Groundwater Sustainability Plan



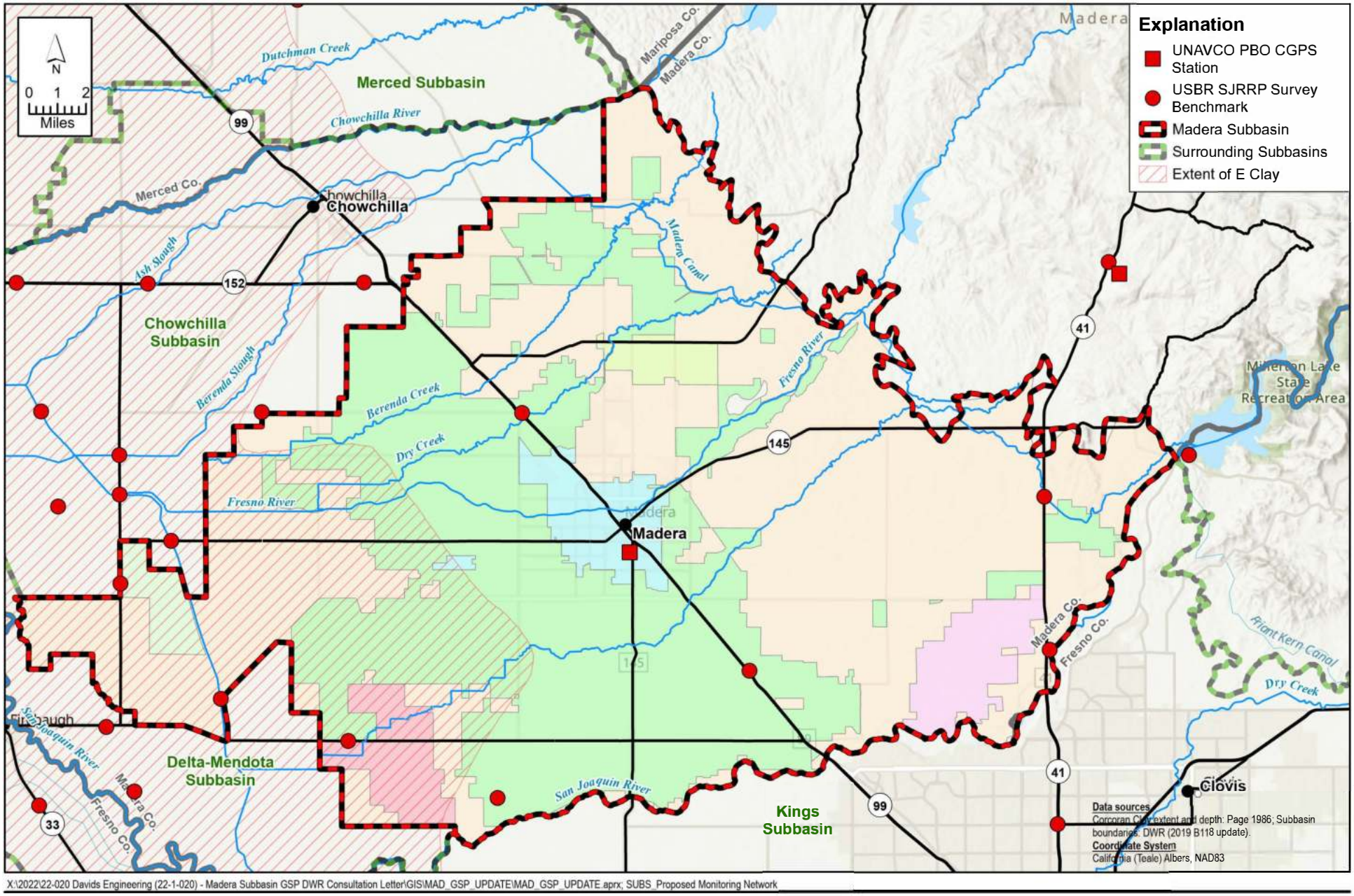
X:\2017\17-113 Madera Subbasin GSP Development\GIS\Map Files\REPORT map files\Chapter 3\Figure 3-7 Madera Subbasin Proposed Groundwater Level Sustainable Indicator Wells, Composite.mxd

DAVIDS ENGINEERING, INC

Luhdorff & Scalmanini Consulting Engineers

FIGURE 3-9
Proposed Groundwater Level Sustainable Indicator Wells Composite

Madera Subbasin
Groundwater Sustainability Plan



X:\2022\22-020 Davids Engineering (22-1-020) - Madera Subbasin GSP DWR Consultation Letter\GIS\MAD_GSP_UPDATE\MAD_GSP_UPDATE.aprx; SUBS_Proposed Monitoring Network

DAVIDS ENGINEERING, INC

Luhdorff & Scalmanini Consulting Engineers

FIGURE 3-10

Proposed Subsidence Monitoring Network

Madera Subbasin
Groundwater Sustainability Plan

REPORT TO CITY COUNCIL

Approved by:

Marcela Zuniga

Marcela Zuniga, Grant Administrator

Marcela Zuniga

Arnoldo Rodriguez, City Manager

Council Meeting of: March 20, 2023

Agenda Number: A-2

SUBJECT:

Community Action Partnership of Madera County (CAPMC) request to terminate the Community Development Block Grant (CDBG) 2021 Subrecipient Agreement for Services relating to the Rapid Rehousing Program and the request by City to reallocate the remaining grant funds ($342,761.46) to the 2023-2024 CDBG Capital/Public Improvements funding category.

RECOMMENDATION:

Adopt a Resolution:

1. Approving CAPMC request to terminate the 2021 CDBG Subrecipient Agreement for Services relating to the Rapid Rehousing Program with CAPMC relating to the Rapid Rehousing Program and
2. Approving the reallocation of the remaining grant funds in the amount of $342,761.46 to the 2023-2024 CDBG Capital/Public Improvements Allocation

SUMMARY:

On May 13, 2021, the City received notification from the U.S. Department of Housing and Urban Development (HUD) that it was eligible to receive an allocation for the CDBG 2021-2022 Action Plan funds, in the amount of $949,042.

CAPMC applied for a housing assistance grant. The application submitted by CAPMC proposed:

- Serving transitional youth ages 18-24 years old.
- Leasing four 3-bedroom units to house homeless individuals or families through a modified rapid rehousing program.
- Serving a minimum of 12 clients.
- Securing leases on behalf of the client; Entering into to a sub-lease with the client.
- Providing case management services.

On July 28, 2022 by City Council Resolution 21-102, Council approved the CDBG Subrecipient Agreement for Services with CAPMC in the amount of $345,027.

At this time, CAPMC seeks consent to terminate the 2021 CDBG Subrecipient Agreement for Services relating to the Rapid Rehousing Program which provides in relevant part:

> "Upon thirty (30) days written notice to the other party, either party may terminate this Agreement without cause. Notice shall be deemed served upon mailing."

As a result of that request and if Council approves, staff seeks approval for the remaining grant funds.

DISCUSSION:

CAPMC staff has maintained the City abreast on their challenges in finding affordable housing options for transitional youth ages 18-24. In an effort to mitigate this challenge, CAPMC requested a slight change to their original scope of work. Rather than leasing individual units, CAPMC considered entering a master lease with the owners of a building under renovation located at 322 W. 6th Street in Madera. All outcomes originally outlined in the application would remain the same; therefore, in accordance with the Agreement, the City approved the modification to the scope of work and a one-year extension to complete the work through December 31, 2023. However, the renovation of said building continues and the expected date of completion is undetermined.

On February 24, 2023 CAPMC notified the City of their intentions to terminate the 2021 CDBG Subrecipient Agreement for Services relating to the Rapid Rehousing Program. CAPMC has requested a minimum amount of reimbursement for this grant. A total of $2,265.54 has been requested for reimbursement. The remaining project balance is $342,761.46.

HUD requires compliance with timely performance in carrying out its program. Timeliness is measured by the rate of expenditure funds from the grantees Line of Credit (LOC). A CDBG Entitlement grantee, in accordance with the CDBG regulations at 24 CFR 570.902, must have a balance no greater than one and one-half times its annual grant remaining in the LOC, 60 days prior to the end of the program year. HUD has a longstanding policy of reducing the next year's grant allocation of a grantee that performs untimely. In the case of unused CDBG funds, the grantee has the option to reallocate funds rather than leave them in the LOC.

The City is a CDBG entitlement jurisdiction which receives an annual funding allocation. On February 27, 2023, HUD announced the 2023-2024 CDBG funding allocations. The City was awarded $981,730 for Program Year 2023. On January 20, 2023, the City opened the 2023-2024 application period. Projects are categorized into either Administration, Public Service, or Capital/Public Improvements. HUD requires a cap on Administration (20%) and Public Services (15%). The maximum amounts allowed per funding category are as follows:

- Administration - $196,346
- Public Services - $147,259

- Capital/Public Improvements – No cap, remaining allocation total is $638,125

The City is currently in the process of reviewing the 2023-2024 applications and seeks Council approval to increase the available funds for Capital/Public Improvements for the current applicants. The City is requesting to reallocate the unused funds in the amount of $342,761.46 from the 2021 CDBG Subrecipient Agreement for Services with CAPMC relating to the Rapid Rehousing Program into its 2023-2024 CDBG entitlement award, Capital/Public Improvement funding category.

FINANCIAL IMPACT:

The termination of the CDBG Subrecipient Agreement for Services with CAPMC has no financial impact to the City's General Fund. However, failure to comply with the HUD Timeliness requirement may result in the reduction and/or loss of future CDBG Entitlement Allocations.

ALTERNATIVES:

As an alternative, Council may:

1. Decline the recommendation and direct staff to allow the Agreement to sunset on December 31, 2023.

ATTACHMENTS:

1. Attachment A – Resolution
2. Attachment B – Subrecipient Agreement
    a. Exhibit A – Written 30-Day Notice to Terminate Subrecipient Agreement for Services

RESOLUTION NO. _____

A RESOLUTION OF THE CITY COUNCIL OF THE CITY OF MADERA, CALIFORNIA AUTHORIZING THE TERMINATION OF A 2021/22 COMMUNITY DEVELOPMENT BLOCK GRANT (CDBG) SUBRECIPIENT AGREEMENT FOR SERVICES ($345,027) WITH COMMUNITY ACTION PARTNERSHIP OF MADERA COUNTY, INC AND REALLOCATE THE REMAINING GRANT FUNDS ($342,761.46) TO THE 2023/24 CDBG CAPITAL/PUBLIC IMPROVEMNENTS FUNDING CATEGORY

WHEREAS, the City Council approved Resolution 21-102 approving the 2021/22 Community Development Block Grant Subrecipient Agreement with Community Action Partnership of Madera County, Inc. in the amount of $345,027 ("Agreement"); and

WHEREAS, a copy of the Agreement is attached hereto as Attachment B; and

WHEREAS, the Community Action Partnership of Madera County, Inc. provided a written 30-Day notice in conformance with the Agreement to terminate services is attached hereto as Exhibit A; and

WHEREAS, the City is requesting Council approve the request to terminate the Agreement; and

WHEREAS, City staff is requesting Council approval to reallocate the remaining funds ($342,761.46) to the CDBG 2023-2024 Capital/Public Improvements funding category.

NOW, THEREFORE, THE COUNCIL OF THE CITY OF MADERA does hereby find, resolve, and order:

1. The above recitals are true and correct.
2. Council approves the request to terminate the Agreement.
3. Council approves the reallocation of remaining funds ($342,761.46) to the CDBG 2023-2024 Capital/Public Improvements funding category.
4. This resolution shall be effective immediately upon adoption.

****

RESOLUTION NO. 21-102

A RESOLUTION OF THE CITY COUNCIL, OF THE CITY OF MADERA, CALIFORNIA, APPROVING A 2021/22 COMMUNITY DEVELOPMENT BLOCK GRANT SUBRECIPIENT AGREEMENT FOR SERVICES ($345,027) WITH COMMUNITY ACTION PARTNERSHIP OF MADERA COUNTY, INC.

WHEREAS, the City Council has considered approval of the 2021/22 Community Development Block Grant Subrecipient Agreement with Community Action Partnership of Madera County, Inc. in the amount of $345,027 ("Agreement"); and

WHEREAS, a copy of the Agreement is attached hereto as Exhibit 1 and incorporated by reference.

NOW, THEREFORE, the City Council of the City of Madera finds, determines, resolves and orders as follows:

1. The recitals listed above are true and correct.
2. The Council approves the Agreement between the City and Community Action Partnership of Madera County, Inc.
3. This resolution is effective upon receipt of written confirmation from the U.S. Department of Housing and Urban Development of the City of Madera 2021/22 Action Plan approval.
4. The Director of Financial Services is hereby authorized to take such action to implement the terms of the Resolution.
5. This resolution is effective immediately upon adoption.

*****

PASSED AND ADOPTED by the City Council of the City of Madera this 21st day of July 2021 by the following vote:

AYES:	Mayor Garcia, Councilmembers Gallegos, Montes, and Villegas.
NOES:	None.
ABSTENTIONS:	None.
ABSENT:	Councilmember Rodriguez, Evans, and District 5 is currently vacant.

APPROVED:

SANTOS GARCIA, Mayor

ATTEST:

ALICIA GONZALES, City Clerk

CITY OF MADERA INCORPORATED March 27, 1907 CALIFORNIA

COMMUNITY DEVELOPMENT BLOCK GRANT
SUBRECIPIENT AGREEMENT
BETWEEN THE CITY OF MADERA AND COMMUNITY ACTION PARTNERSHIP OF MADERA COUNTY, INC.

This Community Development Block Grant Subrecipient Agreement ("Agreement") is entered into, effective on the date of July 22, 2021, by and between the City of Madera ("City") and Community Action Partnership of Madera County, Inc., hereafter referred to as "SUBRECIPIENT."

RECITALS

A. This Agreement sets forth the responsibilities of City and Subrecipient in accomplishing the objectives of the United States Department of Housing and Urban Development (HUD) Community Development Block Grant as set forth in the Housing and Community Development Act of 1974, (hereinafter referred to as "CDBG"), as amended.

B. The City has been designated as the sponsoring agency to administer and implement the program for the Community Development Block Grant (CDBG) activities of the CITY, and in accordance with the provisions of Title I of the Housing and Community Development Act of 1974, as amended, and the laws of the State of California.

C. Under the CDBG regulations the City may grant the CDBG funds to nonprofit organizations or public agencies for certain purposes.

D. City agrees to engage the services of Subrecipient, and Subrecipient agrees to perform the services for CITY hereinafter described, for the compensation, during the term, and otherwise subject to the covenants and conditions hereinafter set forth.

AGREEMENT

1. Services

The Subrecipient shall provide all services and responsibilities as set forth in the project design, which is attached to this Agreement, marked as Exhibit "A," and incorporated herein by reference.

2. Funding and Method of Payment

a. Compensation

Payments shall be made after receipt and verification of actual expenditures incurred by the Subrecipient in the performance of this Agreement and shall be documented to the City by the

tenth (10th) day of the month following the end of each month. Allowable expenditures under this Agreement are specifically established, attached, and incorporated by reference as Exhibit "B".

The total obligation of the City under this Agreement shall not exceed $345,027.19 in fiscal year 2021-2022. Any compensation not consumed by expenditures of the SUBRECIPIENT by the expiration of this Agreement shall automatically revert to the CITY.

b. Public Information

The Subrecipient shall disclose in all public information its funding source.

c. Lobbying Activity

The Subrecipient shall not directly or indirectly use any of the funds provided under this Agreement for publicity, lobbying, or propaganda purposes designed to support or defeat legislation pending before the Congress of the United States or the Legislature of the State of California.

d. Political Activity

The Subrecipient shall not directly or indirectly use any of the funds under this Agreement for any political activity or to further the election or defeat of any candidate for public office.

3. Fiscal Compliance

The SUBRECIPIENT shall be subject to the same fiscal regulations imposed on CITY by the U. S. Department of Housing and Urban Development for the use of CDBG funds.

4. Program Income

SUBRECIPIENT shall report quarterly all program income as required under 24 CFR 570.503(b)(3) generated by activities carried out with CDBG funds made available under this Agreement. The use of program income by the SUBRECIPIENT shall comply with the requirements set forth at 24 CFR 570.504. By way of further limitations, the Subrecipient may use such income during the contract period for activities permitted under this Agreement and shall reduce requests for additional funds by the amount of any such program income balance on hand. All unexpended program income shall be returned to City at the end of the contract period. Any interest earned on cash advances from the U.S. Treasury and from funds held in a revolving fund account is not program income and shall be remitted promptly to City.

5. Compliance with Laws

If the SUBRECIPIENT receives CDBG funding under this Agreement, SUBRECIPIENT shall comply with all rules and regulations established pursuant to the Housing and Community Development Act of 1974 and its amendments and Uniform Administrative Requirements under 24 CFR 570.503(b)(4). The Subrecipient and any subcontractors shall comply with all applicable local, State and Federal regulations, including but not limited to those requirements listed in Community Development Block Grant certifications attached hereto and incorporated herein by reference as Exhibit "D".

6. Administrative Requirements/Financial Management/Accounting Standards

Subrecipient agrees to comply with 24 CFR 84.21-28 and agrees to adhere to the accounting principles and procedures required therein, utilize adequate internal controls, and maintain necessary source documentation for all costs incurred.

7. Costs Principles

Subrecipient shall administer its program in conformance with OMB Uniform Guidance. These principles shall be applied for all costs incurred whether charged on a direct or indirect basis.

8. Contract Administration

City shall retain the right to administer this Agreement to verify that Subrecipient is performing its obligations in accordance with the terms and conditions of this Agreement. Subrecipient and City shall comply with all applicable provisions of law and the rules and regulations, if any, of governmental authorities having jurisdiction over matters the subject thereof.

9. Period of Performance

The Subrecipient shall commence performance under this Agreement on July 1, 2021, and shall end its performance December 31, 2022, unless terminated sooner as provided for elsewhere in this Agreement. The subrecipient may request a written extension of the Agreement, and this agreement provides authority to the Grants Administrator to approve or deny the request.

10. Records

a. Record Establishment and Maintenance

Subrecipient shall establish and maintain records in accordance with those requirements prescribed by City, with respect to all matters covered by this Agreement. Subrecipient shall retain all fiscal books, account records, and client files for services performed under this Agreement for at least three (3) years from the date of the final payment under this Agreement or until all State and Federal audits are completed for that fiscal year, whichever is later. Pursuant to State and Federal law, it is the intent of the parties to this Agreement that the Subrecipient shall be reimbursed for actual costs incurred in the performance of this Agreement but that no profit is to accrue to the Subrecipient on account of such performance.

SUBRECIPIENT shall maintain all records required by the Federal regulations specified in 24 CFR 570.506 that are pertinent to the activities to be funded under this Agreement. Such records shall include but not be limited to:

1. Records providing a full description of each activity undertaken;
2. Records demonstrating that each activity undertaken meets one of the National Objectives of the CDBG program;
3. Records required to determine the eligibility of activities;
4. Records required to document the acquisition, improvement, use or disposition of real property acquired or improved with CDBG assistance;
5. Records documenting compliance with the fair housing and equal opportunity components of the CDBG program;
6. Financial records as required by 24 CFR 570.502, and 24 CFR 84.21-28; and
7. Other records necessary to document compliance with 24 CFR 570.503(b)(5).

b. Reports/Required Notifications

The Subrecipient shall submit reimbursement claims with substantiating invoices and time-cards signed by both the employee and applicable Authorizing Official of the Subrecipient. Reports shall consist of the Quarterly Reporting Form. This form is contained in Exhibit "C" attached hereto and incorporated herein by reference.

The Subrecipient shall also furnish to the City such statements, records, reports, data, and information as the City may request pertaining to matters covered by this Agreement. In the event that the Subrecipient fails to provide such reports, it shall be deemed sufficient cause for the City to withhold payments until there is compliance. In addition, the Subrecipient shall provide written notification and explanation to the CITY within five (5) days of any funds received from another source to conduct the same services covered by this Agreement.

City shall notify Subrecipient in writing within thirty (30) days of any potential State or Federal exception discovered during an examination. Where findings indicate that program requirements are not being met and State and Federal participation in this program may be imperiled in the event that corrections are not accomplished by Subrecipient within thirty (30) days, written notification shall constitute City's intent to terminate this Agreement.

Subrecipient shall report to City promptly and in written detail, each notice of claim of copyright infringement received by Subrecipient with respect to all subject data delivered under this Agreement. Subrecipient shall not affix any restrictive markings upon any data. If markings are affixed, City shall have the right at any time to modify, remove, obliterate, or ignore such markings.

c. CDBG Reporting Requirements

The City will inform Subrecipient in writing if CDBG funds are provided under this Agreement, which require Subrecipient to submit an application or to complete a record as an integral part of receiving these funds.

Subrecipient shall submit with each monthly invoice copies of paid invoices/receipts, copies of cash receipts or checks used to pay each invoice submitted, copies of timecards and related pay stubs for reimbursement.

11. Assignment

Subrecipient may not assign or transfer their obligation of this Agreement or any rights hereunder without the prior written consent of the other party.

12. Subcontracts

If the Subrecipient should propose to subcontract with one or more third parties to carry out a portion of those services described in Exhibit "A" insofar as it deems proper or efficient, any such subcontract shall be in writing and approved by the CITY prior to execution and implementation. Any such subcontract, together with all other activities performed, or caused by the Subrecipient, shall not allow compensation greater than the total project budget contained in Exhibit "B." An executed copy of any such subcontract shall be submitted to the City before any implementation and shall be retained by the City.

The Subrecipient shall be responsible to the City for the proper performance of any subcontract. Any subcontractor shall be subject to all of the same terms and conditions that the Subrecipient is subject to under this Agreement. No officer or director of the Subrecipient shall have any direct monetary interest in any subcontract made by the Subrecipient. A direct monetary interest contrary to this paragraph shall be deemed to exist, if an officer or director of the Subrecipient is also an owner, officer, or director of a corporation, association, or partnership subcontracting with the Subrecipient.

In addition, if the Subrecipient receives CDBG funds under this Agreement, the subcontractor shall be subject to CDBG federal regulations, including those listed in Exhibit "D".

13. Conflict of Interest

No officer, employee, or agent of the City who exercises any function or responsibility for planning and carrying out of the services provided under this Agreement shall have any direct or indirect personal financial interest in this Agreement. The Subrecipient shall comply with the provisions of 24 CFR 570.611 with respect to conflicts of interest and covenants hat it presently has no financial interest, direct or indirect, which would conflict in any manger or degree with the performance of this Agreement. The Subrecipient further covenants that in the performance of this Agreement, no person having such a financial interest shall be employed or retained by Subrecipient.

14. Discrimination

a. Eligibility for Services

The Subrecipient shall prepare and make available to the CITY and to the public all eligibility requirements to participate in the program plan set forth in Exhibit "A." No person shall, on the grounds of race, color, national origin, sex, religion, age, or disability status, be excluded from participation in, and denied the benefits of, or be subjected to discrimination with respect to the services funded under this Agreement.

The Subrecipient's services shall be accessible to the physically disabled, and the services of a translator, signer or assistive listening device shall be made available. Subrecipient, in its marketing materials, shall specify assistance to access its services is available for deaf and hard-of-hearing persons by calling 711 or 1-800-735-2929 and, for voice users, 1-866-735-2922 for TTY Relay Services. Subrecipient shall comply with requirements set forth in Exhibit E, Accessibility for Persons with Disabilities to Non-Housing Programs funded by Community Development Block Grant Funds – Section 504 of the Rehabilitation Act of 1973, the Americans With Disabilities Act, and the Architectural Barriers Act.

b. Employment Opportunity

The Subrecipient shall comply with the CITY policy, the Community Development Block Grant regulations, and the Equal Employment Commission guidelines, which forbids discrimination against any person on the grounds of race, color, national origin, sex, religion, age, familial status, disability status, or any other status protected by law in employment practices. Such practices include retirement, recruitment advertising, hiring, layoff, termination, upgrading, demotion, transfer, rates of pay or other forms of compensation, use of facilities, and other terms and conditions of employment.

c. Suspension of Compensation

If an allegation of discrimination occurs, the City shall withhold all further funds until the Subrecipient can show by clear and convincing evidence to the satisfaction of the City that funds

provided under this Agreement were not used in connection with the alleged discrimination.

d. Nepotism

Except by written consent of the City, no person shall be employed by the Subrecipient who is related by blood or marriage or who is a member of the Board of Directors or an officer of the Subrecipient. In the event HUD determines a CDBG-funded Subrecipient's organization/agency operations violate federal rules and regulations with regard to nepotism and/or conducts business and a conflict of interest issue arises, then Subrecipient shall accept all responsibility to return any CDBG funds received from City.

15. Termination

a. This Agreement may be immediately terminated by City for cause where in the determination of City, any of the following conditions exist: (1) an illegal or improper use of funds, (2) failure to comply with any terms of this Agreement, (3) a materially incorrect or incomplete report, (4) an improper performance of services.

b. Any one of or combination of the above conditions will constitute grounds for suspension or termination of the Agreement. In no event shall any payment by the City hereunder constitute a waiver by the City of any breach of this Agreement or any default which may then exist on the part of the Subrecipient, nor shall such payment impair or prejudice any remedy available to the City with respect to the breach of default. When there is a breach of this Agreement, as defined by this section, the City may, in its sole discretion, immediately suspend or terminate this Agreement.

c. City shall have the option to terminate this Agreement without obligation of City to reimburse Subrecipient from the date the Federal or State Government withholds or fails to disburse funds to City. In the event such government withholds or fails to disburse funds, City shall give Subrecipient notice of such funding limitation or termination within a reasonable time after City receives notice of same.

d. Upon thirty (30) days written notice to the other party, either party may terminate this Agreement without cause. Notice shall be deemed served upon mailing.

16. Amendments

Adjustment of any line item within the total approved budget contained in Exhibit "B" or changes in the nature or scope of the program plan set forth in Exhibit "A" may be approved in writing by the City Manager, or his designee.

17. Administration

The City of Madera Grants Administration Department shall administer this Agreement.

18. Evaluation

The City shall monitor and evaluate the performance of the Subrecipient under this Agreement to determine to the best possible degree the success or failure of the services provided under this Agreement and the adequacy of the program plan contained in Exhibit "A." The Subrecipient shall participate in evaluation of the program.

Subrecipient shall cooperate fully with City, State and Federal agencies, which shall have the right to monitor and audit all work performed under this Agreement.

Subrecipient shall also agree to on-site monitoring and personal interviews of participants, Subrecipient's staff, and employees by appropriate City staff on at least a quarterly basis.

19. Governing Law

Any controversy or claim arising out of or relating to this Agreement which cannot be amicably settled without court action shall be litigated only in Madera, California. The rights and obligations of the parties and all interpretations and performance of this Agreement shall be governed in all respects by the laws of the State of California.

20. Reversion of Assets

The Subrecipient must obtain prior written approval from the City whenever there is any modification or change in the use of any property acquired or improved, in whole or in part, using CDBG funds. If any real or personal property acquired or improved with CDBG funds is sold and/or is utilized by the Subrecipient for a use which does not qualify under the CDBG program, the Subrecipient shall reimburse the City in an amount equal to the current fair market value of the property, less any portion thereof attributable to expenditures of non-CDBG funds. These requirements shall continue in effect for the life of the property. In the event the CDBG program is closed-out, the requirements of this Section shall remain in effect for activities or property funded with CDBG funds, unless action is taken by the Federal government to relieve the City of these obligations.

21. Breach of Agreement

In the event the SUBRECIPIENT fails to comply with any of the terms of this Agreement, the CITY may, at its option, deem the SUBRECIPIENT's failure as a material breach of this Agreement and utilize any of the remedies set forth in 24 CFR 85.43 or that it deems appropriate. Should the CITY deem a breach of this Agreement material, the CITY shall immediately be relieved of its obligations to make further payment as provided herein. In addition to the Agreement being

terminated by the CITY in accord with a material breach of this Agreement by the SUBRECIPIENT, this Agreement may also be terminated for convenience by the CITY in accord with 24 CFR 85.44.

22. No Third-Party Beneficiaries

This Agreement is not intended to create and does not create any rights in or benefits to any third party, nor will it be deemed to confer rights or remedies upon any person or legal entity not a party to this Agreement.

23. Indemnification

Subrecipient shall indemnify, defend, and hold harmless the City, and its officers, employees, and agents ("City indemnitees"), from and against any and all causes of action, claims, liabilities, obligations, judgments, or damages, including reasonable legal counsels' fees and costs of litigation ("claims"), arising out of the Subrecipient's performance of its obligations under this agreement or out of the operations conducted by Subrecipient, including the City's active or passive negligence, except for such loss or damage arising from the sole negligence or willful misconduct of the City. In the event the City indemnitees are made a party to any action, lawsuit, or other adversarial proceeding arising from Subrecipient's performance of this agreement, the Subrecipient shall provide a defense to the City indemnitees, or at the City's option, reimburse the City indemnitees their costs of defense, including reasonable legal counsels' fees, incurred in defense of such claims.

24. Independent Contractor

Subrecipient and its subcontractors shall perform this Agreement as independent contractors and not as officers, employees, agents or volunteers of City. Nothing contained in this Agreement shall be deemed to create any contractual relationship between City and Subrecipient's employees or subcontractors, nor shall anything contained in this Agreement be deemed to give any third party, including but not limited to Subrecipient's employees or subcontractors, any claim or right of action against City.

25. Insurance Requirements for Service Providers

Without limiting Subrecipient's indemnification of City, and prior to commencement of Work, Subrecipient shall obtain, provide, and continuously maintain at its own expense during the term of the Agreement, and shall require any and all Subcontractors and Subconsultants of every Tier to obtain and maintain, policies of insurance of the type and amounts described below and in form satisfactory to the City.

Minimum Scope and Limits of Insurance

Subrecipient shall maintain limits no less than:

- $1,000,000 **General Liability** (including operations, products and completed operations) per occurrence, $2,000,000 general aggregate, for bodily injury, personal injury and property damage, including without limitation, blanket contractual liability. Coverage shall be at least as broad as Insurance Services Office (ISO) Commercial General Liability coverage form CG 00 01 General liability policies shall be endorsed using ISO form CG 20 10 that the City and its officers, officials, employees and agents shall be additional insureds under such policies.
- $1,000,000 **Automobile Liability** combined single limit per accident for bodily injury or property damage at least as broad as ISO Form CA 00 01 for all activities of Service Provider arising out of or in connection with Work to be performed under this Agreement, including coverage for any owned, hired, non-owned or rented vehicles. Automobile Liability policies shall be endorsed to provide that the City and its officers, officials, employees and agents shall be additional insureds under such policies.
- **Worker's Compensation** as required by the State of California and $1,000,000 **Employer's Liability** per accident for bodily injury or disease.

Maintenance of Coverage

Subrecipient shall procure and maintain, for the duration of the contract, insurance against claims for injuries to persons or damages to property, which may arise from or in connection with the performance of the Work hereunder by Subrecipient, its agents, representatives, employees, subcontractors or subconsultants as specified in this Agreement.

Proof of Insurance

Subrecipient shall provide to the City certificates of insurance and endorsements, as required, as evidence of the insurance coverage required herein, along with a waiver of subrogation endorsement for workers' compensation. Insurance certificates and endorsements must be approved by the City prior to commencement of performance. Current evidence of insurance shall be kept on file with the City at all times during the term of this Agreement. Agency reserves the right to require complete, certified copies of all required insurance policies, at any time.

Acceptable Insurers

All insurance policies shall be issued by an insurance company currently authorized by the Insurance commissioner to transact business of insurance in the State of California, with an assigned policyholders' Rating of A- (or higher) and a Financial Size Category Class VII (or larger), in accordance with the latest edition of Best's Key Rating Guide.

Enforcement of Contract Provisions (non estoppel)

Service Provider acknowledges and agrees that any actual or alleged failure on the part of the Agency to inform Service Provider of non-compliance with any requirement imposes no additional obligations on the City, nor does it waive any rights hereunder.

Specifications not Limiting

Requirements of specific coverage features or limits contained in this Section are not intended as a limitation on coverage, limits or other requirements, or a waiver of any coverage normally provided by any insurance. Specific reference to a given coverage feature is for purposes of clarification only as it pertains to a given issue and is not intended by any party or insured to be all inclusive, or to the exclusion of other coverage, or a waiver of any type. If Service Provider maintains higher limits than the minimums required above, the entity shall be entitled to coverage at the higher limits maintained by Subrecipient.

Notice of Cancellation

Service Provider agrees to oblige its insurance agent or broker and insurers to provide to the City with thirty (30) calendar days' notice of cancellation (except for nonpayment for which ten (10) calendar days' notice is required) or nonrenewal of coverage for each required coverage.

Self-insured Retentions

Any self-insured retentions must be declared to and approved by the City. The City reserves the right to require that self-insured retentions be eliminated, lowered or replaced by a deductible. Self-insurance will not be considered to comply with these specifications unless approved by the City's Risk Manager.

Timely Notice of Claims

Subrecipient shall give the City prompt and timely notice of claims made or suits instituted that arise out of or result from Service Provider's performance under this Agreement, and that involve or may involve coverage under any of the required liability policies.

Additional Insurance

Service Provider shall also procure and maintain, at its own cost and expense, any additional kinds of insurance, which in its own judgement may be necessary for its proper protection and prosecution of the Work.

26. Violation of Federal Rules and Regulations

In the event HUD determines a CDBG-funded Subrecipient has violated Federal rules and regulations and HUD requires repayment of CDBG funds, then Subrecipient shall repay any CDBG funds within 90 days of a written request from CITY.

27. General Provisions

a. Entire Agreement

This Agreement constitutes the entire agreement between Subrecipient and City with respect to the subject matter hereof and supersedes all previous negotiations, proposals, commitments, writings, advertisements, publications and understandings of any nature whatsoever unless expressly included in this Agreement.

b. Notice.

Any notice, demand, request, document, consent, approval, or communication either party desires or is required to give to the other party or any other person shall be in writing and either served personally or sent by prepaid first-class mail:

To the City:
City of Madera – Grants Department
205 W. Fourth St.
Madera CA 93637

To the Subrecipient:
Community Action Partnership of Madera County, Inc.
1225 Gill Ave
Madera, CA 93637

at his/her address by notifying the other party of the change of address in writing. Notice shall be deemed communicated at the time personally delivered or in seventy-two (72) hours from the time of mailing if mailed as provided in this Section.

c. Interpretation.

The terms of this Agreement shall be construed in accordance with the meaning of the language used and shall not be construed for or against either party by reason of the authorship of this Agreement or any other rule of construction which might otherwise apply.

d. Severability.

In the event that any one or more of the phrases, sentences, clauses, paragraphs, or sections contained in this Agreement shall be declared invalid or unenforceable by a valid judgment or decree of a court of competent jurisdiction, such invalidity or unenforceability shall not affect any of the remaining phrases, sentences, clauses, paragraphs, or sections of this Agreement that are hereby declared as severable and shall be interpreted to carry out the intent of the parties hereunder unless the invalid provision is so material that its invalidity deprives either party of the basic benefit of their bargain or renders this Agreement meaningless.

e. Execution in Counterparts.

This Agreement may be executed in counterparts such that the signatures may appear on separate signature pages. A copy or an original, with all signatures appended together, shall be deemed a fully executed Agreement.

IN WITNESS WHEREOF, the parties hereto have caused this Agreement to be executed by and through their respective officers thereunto duly authorized on the date first written above.

CITY OF MADERA:

By: _____
Santos Garcia, Mayor

Date: 07/22/21

Community Action Partnership of Madera County, Inc.:

By: Mattie Mendez
Mattie Mendez, Executive Director

Date: 7/6/2021

ATTEST:

By: _____
Alicia Gonzales, City Clerk

Date: 07/22/21

APPROVED AS TO LEGAL FORM:

By: Hilda Cantú Montoy
Hilda Cantú Montoy, City Attorney

Date: 7/28/21

CITY OF MADERA INCORPORATED March 27, 1907 CALIFORNIA

Exhibit A

CDBG 2021/2022 GRANT APPLICATION
CAPITAL PROJECTS/PUBLIC IMPROVEMENTS
COVER SHEET

Application due date: On or before **May 28, 2021 by 5:00 PM** City of Madera CDBG Contact: Alex Estrada (559-661-3690)

(For office use only) **DATE & TIME SUBMITTED: May 28, 2021 5:00 PM**
Applicant Name: Community Action Partnership of Madera County
Physical Address: 1225 Gill Avenue, Madera, CA 93637
Mailing Address: 1225 Gill Avenue, Madera, CA 93637
Program Name: CDBG 2021-2022 Housing Stabilization Program
If you have Non-profit Internal Revenue Code Section 501(c)(3) status, enter your organization's Federal Tax ID Number: 94-1612823
Grant Administrator (Principal contact) First & Last Name and Title: Mattie Mendez, Executive Director Telephone Number and Email Address: 559-675-5749 mmendez@maderacap.org
Program/Project Administrator (Manages Day-to-Day Tasks of Program) First & Last Name and Title: Elizabeth Wisener, Community Services Program Manager Telephone Number and Email Address: 559-675-5742 ewisener@maderacap.org
Amount Requested: $ 400,000

CDBG APPLICATION SUBMITTAL CHECKLIST

(To Be Submitted with Application)

For All CDBG Applicants (Include all of the following in your application)

1 original completed application ☒Font: 12 point ☒Paper: 8 1/2 x 11 ☒Single-sided No double Sided pages. Single-spaced and numbered consecutively ☒One-inch top. bottom, left and right margins ☒Emailed applications should be submitted as a PDF document (not in Microsoft Word format)	☒Grant Application Coversheet
	☒Program/Project Narrative (Background, Need, Work Plan Narrative, Evaluation, Significance & Applicability)
	☒Program/Project Timeline
	☒Budget Table
	☒Supporting Documentation (Staff Work Experience/Knowledge/Education Narrative for Key Staff Including Project Lead
	☒Marketing/Outreach Plan
	☒Client Eligibility/Income Verification Plan (If Not Assumed Benefit)
	☒References

Submittal Option

1. Email to:
   aestrada@madera.gov

CITY OF MADERA

COMMUNITY DEVELOPMENT BLOCK GRANT (CDBG)
2021/2022 CAPITAL PROJECT/PUBLIC IMPROVEMENTS
PROPOSAL APPLICATION

Community Development Block Grant (CDBG) is administered by the U.S. Department of Housing and Urban Development (HUD). HUD distributes annual CDBG allocations to entitlement communities such as City of Madera. For fiscal year 2021/2022 the City of Madera's CDBG allocation is $935,259. This amount allows up to $187,052 for Administration proposals (20%), $140,289 for Public Services (15%) proposals to low- and moderate-income households (according to household size by total gross annual income) and approximately $607,918 for Capital Projects/Public Improvements.

Each year, an Annual Action plan is developed by the City of Madera. An Action Plan is an assessment of the community needs that are most pressing in the community. It is data and community-based driven, includes extensive input from different groups in as well as individuals, and ultimately provides guidance for City of Madera staff on how to utilize these funds to respond to the identified needs in the community. The 2021-2022 Action Plan was developed as follows:

Needs Identification Methods 2021/2022
The Priority Needs were developed after the data was collected using four complementary methods:

- Secondary Data Analysis
- Interviews
- Group Video Discussions
- Community-wide Quantitative Survey

The community needs that were identified by participants and survey respondents were prioritized based, in part, on approaches supported by The Office of Community Planning and Development of the U.S. Department of Housing and Urban Development (HUD), the Centers for Disease Control and Prevention, the National Community Development Association and others.

Needs Prioritization and Funding Criteria
The prioritization process suggests that on an annual basis, funded projects will:

- Address at least one of the identified Top Need Areas;
- Address one or more of the Target Services; and/or
- Continue services recognized by the community as essential.

Applications for Funding
Applications for funding through the City of Madera CDBG program shall adhere to CDBG funding criteria. The City of Madera's internal departments and not-for-profit agencies will adhere to the following criteria.

- All (100%) of the funds received from the City of Madera must serve Madera residents.

Funding will be denied if it is found that this requirement is not met.

- ☐ Address at least one of the identified Top Needs Areas. (See Attachment A)

Applicant must respond to all the following sections. Refer to the Scoring Rubric for point allocation per section:

A. GENERAL INFORMATION

1. Name of Department/Organization: Community Action Partnership of Madera

   County Address: 1225 Gill Avenue, Madera, CA 93637

   Contact Person: Elizabeth Wisener

   Concurrence: Mattie Mendez Mattie Mendez, Executive Director
   Signature/Authorizing Official (Grant Administrator/Department Head)

B. ACTIVITY DESCRIPTION

1. Summary description of proposed project and anticipated accomplishment. (If desired, include diagram of the area within this section or you can attach, but any referenced attachment will be counted within the 6-pg. limit):

   CAPMC proposed to lease four 3-bedroom units to house homeless individuals or families though a modified rapid rehousing program. The program will provide housing for at least 12 clients. Some of the challenges to securing housing are poor rental history, criminal background, and lack of employment, both mental and physical disabilities. CAPMC plans to secure the leases and then enter into sub-leases with program participants. Program participants will pay rent of 30% of their income. Those who have no income will not pay rent. CAPMC utilizes the Fresno Madera Continuum of Care's Homeless Coordinated Entry System to prioritize who receives services first. Interested parties will be asked to complete an assessment called the Vulnerability Index Specialized Program Decision Assessment Tool (VI-SPDAT). Those who receive the highest score are considered the most vulnerable. Because this is a transitional program candidates will be referred to it based on their ability to earn enough income in the future to pay for their own rent. Income threshold is based on HUD's Uniform Act Income Limit for Madera California. Homeless eligibility is based on clients living in an emergency shelter or a place not meant for human habitation.

   Madera County lacks any housing programs that serve the transitional youth ages 18-24. Because of this, applicants in this age group will receive a higher priority.

   CAPMC will hire two Housing Case Workers. One will be assigned to provide case management of the 12 clients with the goal of helping the individuals connect to as many wrap around services as possible. Some examples of services provided are as follows: assisting in applying for Social Security disability benefits, assistance in applying for General Assistance, Cal-Fresh, assistance in helping to get connected

to Medi-Cal, dental, vision, and mental health services, assistance in helping to get connected to obtain a GED, apply for college or a trade school, access services offered by Madera County Workforce Development, and or any other supportive services that may be available to them.

2. Need (Explain why project is needed.):

The results of the most recent Homeless Point-In-Time Count conducted in January 2020 enumerated 345 unsheltered homeless in the City of Madera, and 45 in the remainder of Madera County, for a total of 390. Although Madera County does not have a huge homeless population compared to larger cities, housing solutions continue to be limited, especially for permanent supportive housing programs for men. There are also no housing programs in Madera County for transitional age youth ages 18-24.

The biggest challenge to addressing the homelessness in Madera County is the lack of affordable housing. There is almost a 0% vacancy rate in rental properties. Homeless individuals often have poor credit, poor job skills, and evictions on their record. When a vacancy becomes available, they cannot compete with individuals and families that do not have these barriers to housing.

A total of at least 390 additional housing units are needed to house those who were enumerated during the 2020 Homeless Point-In-Time Count. Most of the homeless need either subsidized housing or permanent supportive housing and this would be quite costly.

According to Worldpopulationreview.com, in 2021, there are approximately a half a million homeless individuals in the United States. California has the highest homeless population of all the states with about 151,278 homeless individuals. Madera County's location on the Highway 99 corridor makes it easy for homeless people to travel north and south along the highway. CAPMC's Homeless Outreach Workers have indicated that they see people they have never seen before every time they go out. In 2020, CAPMC helped 19 homeless individuals who had gotten stranded in Madera County with transportation cost to help them get reunited with family who lived outside of the area.

The Homeless Engagement for Living Program (HELP) Center was established by CAPMC in 2020. The center serves as a one-stop shop for homeless individuals who are seeking housing and other services to come and receive the assistance needed. As of May 25, 2021, the Help Center staff are currently working with 85 different individuals to help them get document ready to apply for housing. One of the unmet needs is for a full-time staff person to serve as a landlord engagement specialist who will work on building relationships with landlords who will give homeless clients a fresh opportunity for housing.

3. Estimated cost of project and source of estimate (if available): $400,000. Please

identify other sources of funds to implement this project. If funds other than CDBG are proposed, please provide supporting documentation/letters of commitment.

CDBG funds will be leveraged with Homeless Housing Assistance Program Funds, AB109 Funds, Community Services Block Grant – Cares funding, Emergency Solutions Grant funds, Shunammite Place Funds, and PATH Funds. Please see the attached documents. When an applicant contacts the HELP Center to ask for housing assistance staff use all available resources to find a funding source that will best serve the client's needs.

4 Timetable (assuming a start date of July 1, 2021). Will your proposal meet these goals in one year? Give starting date for activity and significant milestone completion timeframes. (Insert any timeline attachment you desire, or refer to an attachment to be counted as part of the 6-pg. limit)

Community Action Partnership of Madera County plans to operate an 18-month program. Please see the proposed timeline.

5. What measurable goals will your program deliver?

Goal #1 – Provide housing to homeless by providing transitional housing.

Goal #2 – Increase the number of landlords who are willing to work with the homeless population in Madera.

6. What are the project's expected outcomes? How are the outcomes assessed?
Project Outcomes

Outcome #1 – Provide transitional housing for 12 individuals.

Outcome #2 – 100% of participants will become enrolled in a health insurance plan.

Outcome #3 – 100% participants will receive at least 5 wrap around services from the list provided in B.1 above.

Outcome #4 – 50% of participants will enroll in education program, trade school, college, or become gainfully employed.

Outcome #5 – 80% of the clients will exit to permanent housing at the end of the contract period.

Outcome #6 – Housing Case Worker – Landlord Engagement Specialist will secure 4 rentals for the transitional housing program then one rental unit /month for 15 of 18 months for homeless clients on the HELP Center waiting list to rent.

7. What HUD National Objective does your program meet?

Benefit low to moderate income persons.

8. How does your proposal support the Vision Plan Madera 2025 Action Plan?

This project meets primary needs under homeless supportive services of the Vision 2025 Plan.

C. ENVIRONMENTAL IMPACTS:

1. Historical:

   a. How old is the affected structure? **The structures were built in 2007.**

   b. Will this project affect an historically significant (or potentially historic) structure? **No**

2. Archeological:

   a. Will this project involve any ground disturbance? **No**

   b. If so, how deep will excavation be and what is the volume of earth to be moved?

3. Water:

   a. Does this project involve a sewer or water system? **No**

D. PROGRAM ELIGIBILITY:

To be eligible for funding, a project must either benefit low and moderate-income persons or prevent/eliminate slums or blight. Indicate how the proposed project meets this requirement. Projects that primarily benefit handicapped or senior citizens meet the criteria for benefiting low and moderate-income persons.

1. Primarily benefits low and moderate-income persons.
   a. Number of persons served annually: 12 individuals in transitional housing, and an additional 15 over 18 months

   b. Service Area: City of Madera

      Number of City residents served annually: 12

      Number of persons with disabilities or seniors served: 9

2. How will the proposed project prevent or eliminate slums or blight?

In May 2021, over thirty tons of trash was removed from the Fresno River. As individuals move out of the riverbed, trash will be reduced.

E. CITIZEN PARTICIPATION:

Project proposals should include evidence of citizen support for activity.

1. What was done to receive public input/participation? Please provide details. What were the outcomes? Include documentation of support for the proposal such as meeting minutes, letters and petitions.

   CAPMC recently conducted a Community Needs Assessment where information was gathered at focus groups, community meetings, and surveys about what people see is the most important unmet needs in the community. A total of 85 responses were received. The top 5 priorities were affordable housing, access to health care, employment, food, and homeless services. All of these priorities are address in this grant proposal.

2. Note complaints that have been received, etc.

3. Evidence of collaboration with other agencies within the community.

   CAPMC collaborates with homeless service providers through the Homeless Connection meeting that meet every other Wednesday morning. The meeting is used to share about open homeless cases and to collaborate regarding how to best serve them. The CDBG-Capital Projects Grant proposal was shared at the May 26, 2021 meeting. There were 25 individuals in attendance and all were in favor of CAPMC submitting the application.

Please see Priority Needs for the 2021/2022 Action Plan (Attachment A) and eligible CDBG Census Tracts (Attachment B) map. Public Service recipients shall be a minimum of 51% or more designated as low- to moderate-income. Public Service recipients may be qualified as Presumed Benefit (homeless persons, persons with disabilities and seniors.

F. REFERENCES

Please provide the name, title, company/agency, phone and email address for three references.

Staff will contact references and obtain "Yes" and "No" responses for the following:

o Was your experience working with this agency successful? o Have you seen at least one very successful project developed by this organization/agency? o Do you think they are doing a good job in Madera?

All responses were yes.

Name	Title	Company/Agency	Phone	Email Address
Julie Morgan	Assistant Director	Madera County Behavioral Health	559-673-3598 x 1279	Julie.morgan@maderacounty.com
Ryan McWherter	Director	Madera County Food Bank	559-975-3515	rmcwherter.maderafoodbank@gmail.com
Jesse Chavez	Director	Madera Rescue Mission	559-675-8321	jchevez@maderarescue.org

Transitional Housing Timeline		Landlord Engagement Timeline
Weekly case management with client and staff to assist in goal accomplishments.	Dec 2021	1 Client housed as a result of landlord engagement Housing caseworker to build relationships with landlords to secure open units for clients.
Weekly case management with client and staff to assist in goal accomplishments.	Nov 2021	1 Client housed as a result of landlord engagement Housing caseworker to build relationships with landlords to secure open units for clients.
Weekly case management with client and staff to assist in goal accomplishments. 2 Sept Leases Occupied	Oct 2021	13 clients housed as a result of landlord engagement Housing caseworker to build relationships with landlords to secure open units for clients.
Weekly case management with client and staff to assist in goal accomplishments. 2 units leased. Aug Lease Occupied Review selection of homeless candidates	Sep 2021	Housing caseworker to build relationships with landlords to secure open units for clients.
1 Unit Leased July Lease Occupied 1 Housing Caseworker Hired Review selection of homeless candidates	Aug 2021	Housing caseworker to build relationships with landlords to secure open units for clients.
1 Unit Leased Housing caseworker Hired	July 2021	

Weekly case management with client and staff to assist in goal accomplishments.	June 2022	1 Client housed as a result of landlord engagement Housing caseworker to build relationships with landlords to secure open units for clients.
Weekly case management with client and staff to assist in goal accomplishments.	May 2022	1 Client housed as a result of landlord engagement Housing caseworker to build relationships with landlords to secure open units for clients.
Weekly case management with client and staff to assist in goal accomplishments.	Apr 2022	1 Client housed as a result of landlord engagement Housing caseworker to build relationships with landlords to secure open units for clients.
Weekly case management with client and staff to assist in goal accomplishments.	Mar 2022	1 Client housed as a result of landlord engagement Housing caseworker to build relationships with landlords to secure open units for clients.
Weekly case management with client and staff to assist in goal accomplishments.	Feb 2022	1 Client housed as a result of landlord engagement Housing caseworker to build relationships with landlords to secure open units for clients.
Weekly case management with client and staff to assist in goal accomplishments.	Jan 2022	1 Client housed as a result of landlord engagement Housing caseworker to build relationships with landlords to secure open units for clients.

Clients exit to permanent housing Weekly case management with client and staff to assist in goal accomplishments.	**Dec 2022**	1 Client housed as a result of landlord engagement Housing caseworker to build relationships with landlords to secure open units for clients.
Clients start looking for permanent Weekly case management with client and staff to assist in goal accomplishments.	**Nov 2022**	1 Client housed as a result of Housing caseworker to build relationships with landlords to secure open units for clients.
Clients start looking for permanent housing Weekly case management with client and staff to assist in goal accomplishments.	**Oct 2022**	1 Client housed as a result of landlord engagement Housing caseworker to build relationships with landlords to secure open units for clients.
Clients start looking for permanent housing Weekly case management with client and staff to assist in goal accomplishments.	**Sep 2022**	1 Client housed as a result of landlord engagement Housing caseworker to build relationships with landlords to secure open units for clients.
Clients start looking for permanent housing Weekly case management with client and staff to assist in goal accomplishments.	**Aug 2022**	1 Client housed as a result of landlord engagement Housing caseworker to build relationships with landlords to secure open units for clients.
Weekly case management with client and staff to assist in goal accomplishments.	**Jul 2022**	1 Client housed as a result of landlord engagement Housing caseworker to build relationships with landlords to secure open units for clients.

FY 2021-22 CDBG PROJECT

AGENCY: Community Action Partnership of Madera County_

PROJECT NAME: CDBG 2021/2022 Housing Stabilization Program

MISCELLANEOUS PROJECT COSTS:

Administrative Costs (not to exceed 10% of total grant)	
Supplies	$9,420
Postage	$101
Consultant Services	$500
Maintenance/Repair	$3,880
Publications/Printing	$200
Transportation/Travel Required for Business	$2,445
Rent (portion allocated to this program)	$13,680
Equipment Rental	$550
Insurance	$1,038
Utilities	$2,340
Telephone	$4,300
Other Expenses (Specify):	
Salaries Program Manager and Housing Case Workers	$142,306
Benefits Program Manager and Housing Case Workers	$42,924
Fees & Licenses	$1,960
Hiring Costs	$390
Client Direct Benefits (Rent & Utilities)	$117,320
Client Furnishings	$5,082
Client Emergency Shelter	$18,000
Client Food	$200
Indirect rate @ 9.10%	$33,364

CIP REQUESTS ONLY:

Lead-based paint assessment/abatement
Construction/Renovation

Consultant/Professional Services Construction Management Other Expenses (Specify):

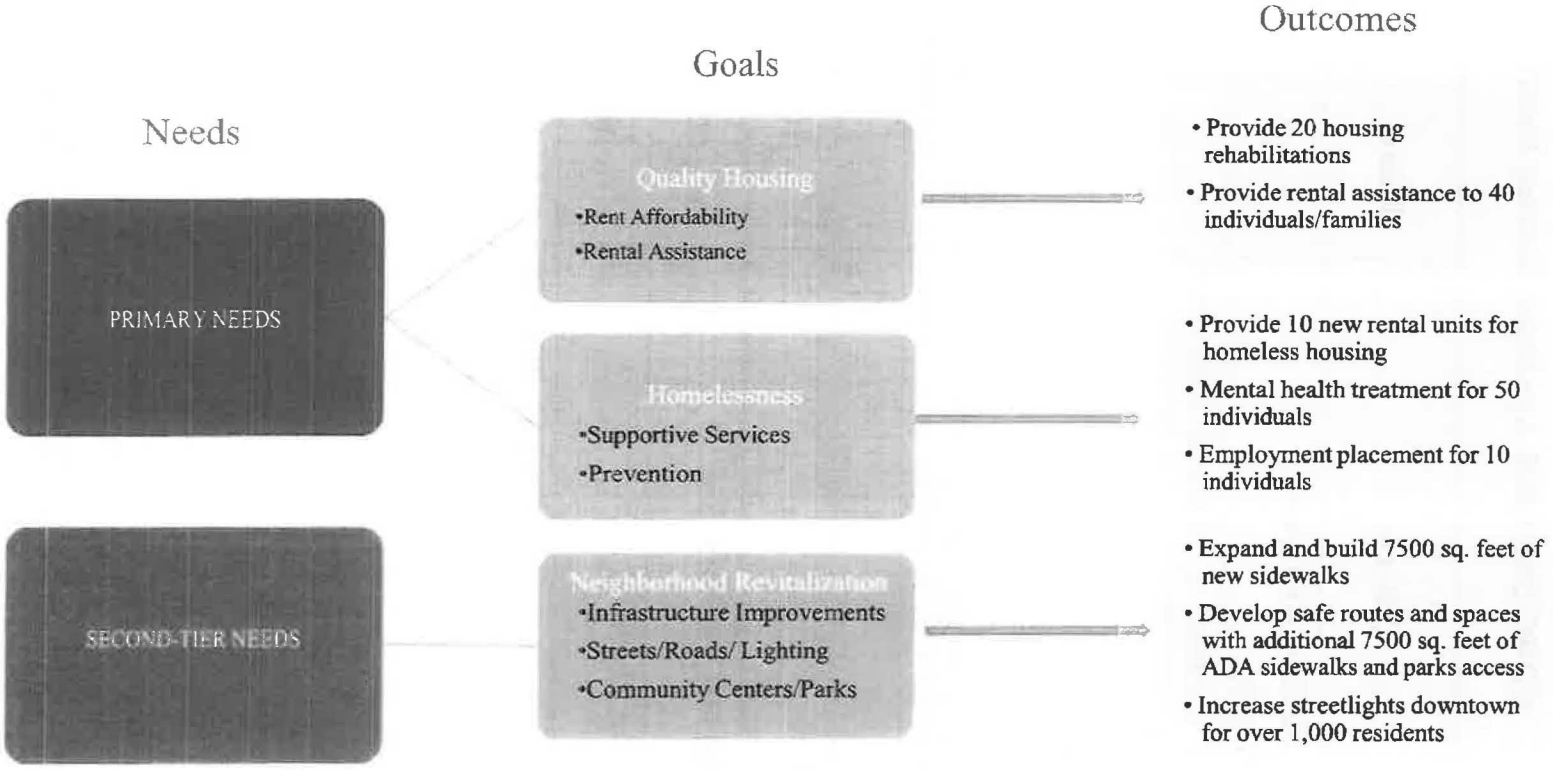
Consultant/Professional Services Construction Management Other Expenses (Specify):

TOTAL CDBG PROJECT BUDGET: $400,000

CDBG 2021/2022 Applicant Scoring Rubric		
Criteria	**Points**	**Committee Member Ranking**
Ability to Address Community Need or Priority	20	
Ability to Address a National Objective with Measurable Outcomes and Meets a Priority Need	30	
References	10	
Ability to Locate Other Funds	5	
Schedule	10	
Work Plan and Capacity	15	
Public Input Received	10	
TOTAL POINTS	100	

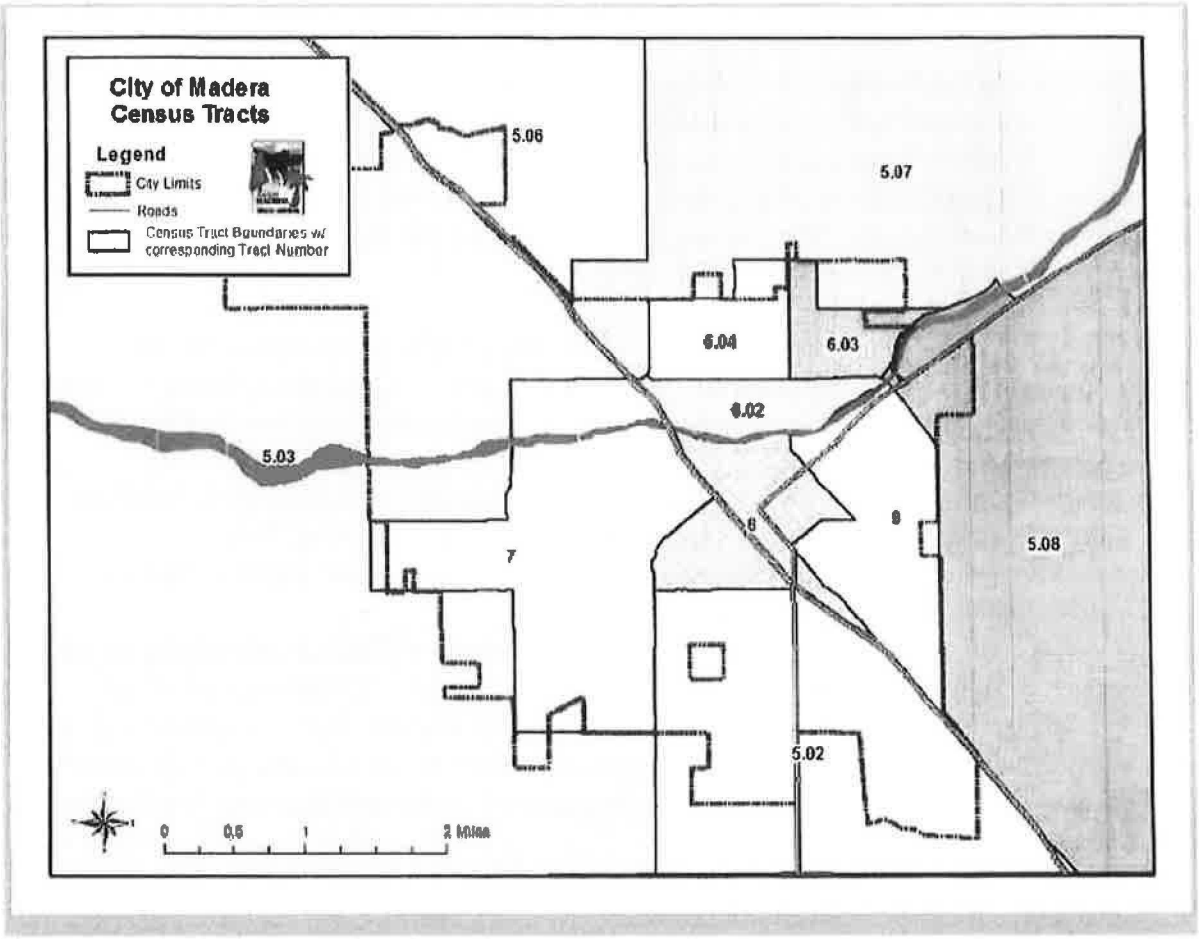
Attachment A

City of Madera Five-Year Consolidated Plan 2020-2024 Priorities



ATTACHMENT B

ELIGIBLE CDBG CENSUS TRACTS ARE: 5.02 (to the north), 6.02, 6.03, 6.04 8 AND 9
THESE ARE THE ELIGIBLE TRACTS WHERE CDBG
PROGRAMS AND PROJECTS MUST OCCUR



Marketing Plan
For
Community Development Block Grant CARES
Housing Stabilization Program

The Community Action Partnership of Madera County (CAPMC) plans to send information about the program to community partners, CAPMC's website, and other groups such as Neighborhood Watch that are located in the designated Census Tracks. When CAPMC launches new programs, Madera County residents are one of our best sources of spreading the information to the community. Once we begin to serve households, each one served will tell their neighbors and thus opens a floodgate of applicants.

CAPMC's goal of the Housing Stabilization Program outreach efforts is to ensure that all persons – regardless of race, color, national origin, age, religion, sex, disability, family status or English proficiency are aware of the affordable housing opportunities generated by CAPMC.

Methods used for informing the public of The Housing Stabilization Program Marketing Plan.

1. CAPMC will be responsible for implementing the CDBG Marketing Plan.
2. CAPMC will continue to collaborate with Housing and Urban Development to reduce discrimination in housing in the area.
3. CAPMC will develop an outreach plan each year, which will include advertising on the agency website, public service announcements, distribution of literature, community presentations and outreach activities to inform the community about fair housing rights.
4. Provide advertising in the language the group is most familiar with and provide a contact person who can answer questions in the language primarily spoken by that target group.
5. Target ethnic groups underrepresented.
6. Send flyers to homeless, advocacy groups, and other organizations, which serve groups that need special assistance for housing.
7. Target areas that are within in the Madera City census tract and households that are low to moderate income and in financial crisis.
8. Housing Case Worker will conduct outreach to property management companies and attend any meetings where they may be present.



COMMUNITY NEEDS ASSESSMENT

Data About the Demographics, Economic Features, and Resources in Madera County

Attached please find excerpts from the recent Community Needs Assessment. It is anticipated the Assessment will be approved by CAPMC's Board of Directors during the June 10, 2021 Board of Directors meeting.

June 2021

COMMUNITY ACTION PARTNERSHIP OF MADERA COUNTY, INC.
1225 GILL AVENUE, MADERA, CA 93637

COMMUNITY INPUT

An integral part of the Community Needs Assessment is listening to Madera County residents, both those affected by the conditions of poverty, and those attempting to reduce them. CAPMC held the following Focus Groups and Survey Opportunities to hear from differing parts of Madera County:

- Online Surveys Distributed from April 1-April 26 to General Madera County population
- Head Start Parent Meeting on Thursday, April 15 at 2pm
- Shunammite Place Focus Group on Friday, April 23 at 9am
- Community Partner WebEx Forum on Friday, April 23 at 11am

TABLE 50

NEEDS PRIORITIZED BY INPUT GROUP

Name	Online Survey	Head Start Parent Meeting	Shunammite Place Focus Group	Community Partner WebEx Forum
Date	*April 1-26*	*April 15 at 2pm*	*April 23 at 9am*	*April 23 at 11am*
Participants	62	6	9	8
Target Population	Those who work or live in Madera County	Fairmead/Chowchilla Residents, Spanish Speaking	Homeless, Recipients of CAPMC Services	Community Partners
Priorities	Affordable Housing	*Responses Included in Survey Data*	Health	Homeless
	Food		Affordable Housing	Mental Health
	Employment		Transportation	Resources for At-Risk 12-17 Youth
	Health		Employment	Housing
	Community Events & Parks		Shopping/Stores	Employment
	Homeless		Homeless	Education/Schools
	Financial Health		Child Care	Rehab/Recovery for Drug Abuse
	Transportation		Education/Schools	
	Child Care			
	Mental Health			

PRIORITIZATION PROCESS

The Community Needs Assessment Team has collected the most current information available for more than 40 indicators in three impacted areas: demographic economic, and quality of life conditions. Each impacted area has a set of indicators that provide information about the magnitude of certain needs, social problems or contributing factors; and the overall performance in the community in addressing issues, needs or problems.

ALIGNMENT WITH LIVE WELL MADERA COUNTY

The Madera County Public Health Department's accreditation process prompted the need to conduct a Community Health Assessment. This process began with a convening of individuals led by Madera County Public Health Department, representing various community-based organizations, faith-based organizations, private sector, public sector, and educational institutions. The group became known as the Mobilizing for Action through Planning and Partnerships (MAPP) Steering Committee in 2017, and now has been renamed Live Well Madera County. CAPMC is proud to have representatives in both the Steering Committee and Executive Committee.

The result of the data is the 2017 Community Health Assessment, which documented four priorities and needs in the community, confirmed by the 2017 Madera County Health Rankings Report. The four priorities are:

- Obesity & Diabetes
- Mental Health
- Alcohol & Drug Use
- Child Abuse & Neglect

The 2019-2021 Community Health Improvement Plan monitored progress in two identified strategic health priorities: Diabetes and Obesity, and Child Abuse and Neglect, and strategies are under way to address those issues.

The CAPMC Community Needs Assessment aims to show linkage between data found from the Live Well Madera County Steering Committee and data found from CAPMC to help together address the priorities and factors contributing to these. Many of the contributing factors and effects of the priorities are being addressed by CAPMC services and program

CAPMC Priorities

When deciding which needs to prioritize, an understanding of root causes is important. Poverty is so widespread throughout Madera County and has been for many years, it almost seems endemic. However, by truly understanding the stories of our residents, root causes can begin to be addressed. Most of the priorities listed below are root causes of poverty and contribute to the lineage of poverty that is often passed from one generation to the next.

Staff reviewed the concerns listed from the community focus groups, public hearings, community surveys, and then organized the data into categories or themes. Each time a participant mentioned an issue, it was tallied, and those were totaled together to form a list of the top needs in Madera County.

Coordinating priorities is essential when collaborating with local agencies. Although the priorities below look distinctively different in verbiage from those identified through LiveWell Madera, CAPMC will be addressing root causes of the four priority areas of the Live Well Madera Steering Committee (Obesity & Diabetes, Mental Health, Alcohol & Drug Use, and Child Abuse & Neglect). This collaboration, inclusive of strategic planning and a community-based approach, allows for collaboration, partnerships, and increased efficiency and effectiveness to serve the low-income residents and overall entire population of Madera County.

CAPMC Identified Community Priorities
Affordable Housing
Access to Health Care
Employment
Food
Homeless Services
Transportation
Community Activities/Parks
Financial Health
Child Care
Mental Health

Affordable Housing means both the ability to secure affordable rental housing and the ability to become homeowners. CAPMC offers permanent supportive housing at the Shunammite Place.

Access to Health care – CAPMC does not provide health care services but assistance in obtaining Medi-Cal insurance is provided.

Employment – CAPMC offers volunteer opportunities and this often leads to employment.

Food – CAPMC assists clients in signing up for Cal-Fresh benefits and in helping clients access food supplies offered by Madera County Food Bank.

Homeless Services – CAPMC provides an array of services to support the homeless.

Transportation – CAPMC provides limited transportation for homeless individuals and families.

Community Activities/Parks – CAPMC does not build parks. This information has been forwarded to the City of Madera Parks & Recreation Department.

Financial Health – CAPMC provides Budget Development classes and Credit Repair classes for the Shunammite Place residents.

Child Care – CAPMC provides assistance in both finding quality child care, and in paying for child care with Alternative Payment Program. CAPMC's Head Start program is also offered in Madera County.

Mental Health – CAPMC supports this priority by assisting clients with connecting to mental health services offered in Madera County.

Exhibit B

FY 2021-22 CDBG PROJECT

AGENCY: Community Action Partnership of Madera County

PROJECT NAME: CDBG 2021/2022 Housing Stabilization Program

MISCELLANEOUS PROJECT COSTS:

Administrative Costs (not to exceed 10% of total grant)	
Supplies	$9,420
Postage	$101
Consultant Services	$500
Maintenance/Repair	$3,880
Publications/Printing	$200
Transportation/Travel Required for Business	$2,445
Rent (portion allocated to this program)	$13,680
Equipment Rental	$550
Insurance	$1,038
Utilities	$2,340
Telephone	$4,300
Other Expenses (Specify):	
Salaries Program Manager and Housing Case Workers	$142,306
Benefits Program Manager and Housing Case Workers	$42,924
Fees & Licenses	$1,960
Hiring Costs	$390
Client Direct Benefits (Rent & Utilities)	$117,320
Client Furnishings	$5,082
Client Emergency Shelter	$18,000
Client Food	$200
Indirect rate @ 9.10%	$33,364

CIP REQUESTS ONLY:

Lead-based paint assessment/abatement

Construction/Renovation

Consultant/Professional Services Construction Management Other Expenses (Specify):

Exhibit C

CITY OF MADERA

Quarterly Activity Report

Contract Period: July 2021 to June 30, 2022

NAME OF ORGANIZATION: **Community Action Partnership of Madera County, Inc.**
1225 Gill Ave
Madera, CA 93637

PROJECT TITLE: Housing Stabilization Program

MONTH/QUARTER AND YEAR OF REPORT: _____, 20__

I. CLIENT INFORMATION:

1. **Total number of clients receiving service this month: _____**

2. **Number of unduplicated individuals provided service this month: _____**

3. **Number of unduplicated individuals provided services year-to-date: _____**

4. **Number of people refused services this month: _____**

   Reason(s) services were denied: _____
   _____
   _____
   _____

DEMOGRAPHIC INFORMATION OF THE UNDUPLICATED CLIENTS SERVED THIS MONTH:

5. **Female Head of Household:** _____

6. **Income Level by Family Size:**

Family Size	1	2	3	4	5	6	7	8
Maximum Annual Income	$39,150	$44,750	$50,350	$55,900	$60,400	$64,850	$69,350	$73,800
Minimum Annual Income	$14,700	$16,800	$18,900	$20,950	$22,650	$24,350	$26,000	$27,700
Total								

II. LONG RANGE OBJECTIVES:

III. SHORT RANGE OBJECTIVES:

IV. SPECIFIC ACTIVITIES:

V. OUTCOMES ACHIEVED:

ACTIVITY REPORTS ARE DUE OCTOBER 15, JANUARY 15, APRIL 15 AND JULY 15. RETURN THE REPORTS TO:

Alex Estrada
Program Manager - Grants
CITY OF MADERA
205 West Fourth Street Madera,
CA 93637
Phone: (559) 661-3690
Fax: (559) 674-2972
Email: aestrada@madera.gov

REPORT PREPARED BY: _____

Date: _____

Date

Type of Assistance

Ethnic Categories*	Select One
Hispanic or Latino	
Not-Hispanic or Latino	
Racial Categories*	**Select All that Apply**
American Indian or Alaska Native	
Asian	
Black or African American	
Native Hawaiian or Other Pacific Islander	
White	
Other	

***Definitions of these categories may be found on the reverse side.**

Signature

Public reporting burden for this collection is estimated to average 10 minutes per response, including the time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing the collection of information. This information is authorized by the U.S. Housing Act of 1937 as amended, the Housing and Urban Rural Recovery Act of 1983 and Housing and Community Development Technical Amendments of 1984. This information is needed to be in compliance with OMB-mandated changes to Ethnicity and Race categories for recording the 50059 Data Requirements to HUD. This information is considered non-sensitive and does not require any special protection.

INSTRUCTIONS for the RACE and ETHNIC DATA REPORTING FORM

A. General Instructions

This form is to be completed by individuals wishing to be served (applicants) in programs assisted by the Department of Housing and Urban Development.

1. The two ethnic categories you should choose from are defined below. You should check one of the two categories.

    1. **Hispanic or Latino.** A person of Cuban, Mexican, Puerto Rican, South or Central American, or other Spanish culture or origin, regardless of race. The term "Spanish origin" can be used in addition to "Hispanic" or "Latino."

    2. **Not Hispanic or Latino.** A person not of Cuban, Mexican, Puerto Rican, South or Central American, or other Spanish culture or origin, regardless of race.

2. The five racial categories to choose from are defined below. You should check as many as apply to the individual.

    1. **American Indian or Alaska Native.** A person having origins in any of the original peoples of North and South America (including Central America), and who maintains tribal affiliation or community attachment.

    2. **Asian.** A person having origins in any of the original peoples of the Far East, Southeast Asia, or the Indian subcontinent including, for example, Cambodia, China, India, Japan, Korea, Malaysia, Pakistan, the Philippine Islands, Thailand and Vietnam.

    3. **Black or African American.** A person having origins in any of the black racial groups of Africa. Terms such as "Haitian" can be used in addition to "Black" or "African American."

    4. **Native Hawaiian or Other Pacific Islander.** A person having origins in any of the original peoples of Hawaii, Guam, Samoa, or other Pacific Islands.

    5. **White.** A person having origins in any of the original peoples of Europe, the Middle East or North Africa.

Exhibit D

COMMUNITY DEVELOPMENT BLOCK GRANT CERTIFICATIONS

A. Federal Common Rule Requirements, including, but not limited to, Executive Order 11246, as amended by Executive Orders 11375 and 120860 and implementing regulations issued at 41 CFR Chapter 60; Davis-Bacon Act as amended (40 U.S.C. 276 a to a-7 and 29 CFR, Part 5); Copeland "Anti-Kick Back" Act (18 U.S.C. 874 and 29 CFR, Part 3); Sections 103 and 107 of the Contract Work Hours and Safety Standards Act (40 U.S.C. 327-330 and 29 CFR, Part 5); Section 306 of the Clean Air Act (42 U.S.C. 0857 (h); Section 506 of the Clean Water Act (33 U.S.C. 1368); Executive Order 11738; Environmental Protection Agency Regulations (40 CFR Part 15); and applicable sections of 24 CFR 85. Also in the common rule are mandatory standards and policies relating to energy efficiency which are contained in the state energy conservation plan issued in compliance with Energy Policy and Conservation Act (Pub L. 94 - 163).

B. Office of Management and Budget Circulars No. -21, A-102 revised, A-87, A-110, A-122 and A-128 as they relate to the acceptance and use of Federal funds under this program.

C. Executive Order 11063, as amended by Executive Order 11259, and implementing regulations at 24 CFR Part 107, as they relate to non-discrimination in housing.

D. The Architectural Barriers Act of 1968 (42 U.S.C. 4151).

E. Clean Air Act of 1970 (42 U.S.C. 7401 et seq.) and the Federal Water Pollution Control Act (33 U.S.C. 1251 et seq.).

F. Bidding requirements contained in the California Public Contracts Code.

G. The relocation requirements of Title II and the acquisition requirements of Title III of the Uniform Relocation Assistance and Real Property Acquisition Policies Act of 1970 (Uniform Act) and HUD implementing regulations, 24 CFR Part I as it relates to prohibiting discriminatory action under any activity receiving Federal funds.

H. Provisions of the California Water Code Section 55350 et. sequens.

I. Title VI of the Civil Rights Act of 1964 (Pub. L. 88-352) and implementing regulations 24 CFR Part I as it relates to prohibiting discriminatory action under any activity receiving Federal funds.

J. Title VIII of the Civil Rights Act of 1968, (Pub. L. 90-284) as amended and implementing regulations 24 CFR 107 as it relates to fair housing.

K. Section 504 of the Rehabilitation Act of 1973 (Pub. L. 93-112) as amended and implementing regulations when published for effect as they relate to non-discrimination against the handicapped.

L. The Age Discrimination Act of 1975, (Pub. L. 94-135) as amended, and implementing regulations contained in 10 CFR Part 1040 and 45 CFR Part 90.

M. The lead based paint requirements of 24 CFR Part 35 Subpart B issued pursuant to the Lead-Based Paint Poisoning Prevention Act (42 U.S.C. 4801 et.seq.).

N. Section 109 of the Housing and Community Development Act of 1974, as amended, and the regulations issued pursuant thereto (24 CFR Section 570.601) as it relates to prohibiting discriminatory actions and activities funded by Community Development Funds.

O. Section 3 of the Housing and Urban Development Act of 1968, as amended and implementing regulations at 24 CFR Part 135.

P. Executive Order 11988 relating to the evaluation of flood hazards and Executive Order 11288 relating to the prevention, control, and abatement of water pollution.

Q. The flood insurance purchase requirements of Section 102(a) of the Flood Disaster Protection Act of 1973 (Pub. L. 93-234).

R. No member, officer or employee of the Grantee, or its designees or agents, no member of the governing body of the locality in which the program is situated, and no other public official of such locality or localities who exercises any functions or responsibilities with respect to the program during his/her tenure or for one year thereafter, shall have any interest, direct or indirect, in any contract or subcontract, or the proceeds thereof, and that it shall incorporate, or cause to be incorporated, in all such contracts or subcontracts a provision prohibiting such interest pursuant to the purposes of this certification.

S. Additionally, all conflict requirements noted in 24 CFR 570.611 shall be complied with by all parties.

T. Title I of Section 104(b)(5) of the Housing and Community Development Act as amended and implementing regulations at 24 CFR 570.200 relating to Special Assessments.

U. Section 106 of the National Historic Preservation Act and implementing regulations at 36 CFR Part 800.

V. The Endangered Species Act of 1973, as amended, and implementing regulations at 50 CFR Part 402.

W. Title I of the Housing and Community Development Act of 1974, as amended, and implementing regulations contained in 24 CFR Part 570 and in 24 CFR Part 85.

X The use of CDBG funds by a religious organization shall be subject to those conditions as prescribed by HUD for the use of CDBG funds by religions organizations in accordance with Section 570.200(j) of the Federal CDBG regulations.

Y. All contracts shall include a "Certification Regarding Debarment, Suspension, Ineligibility and Voluntary Exclusion-Lower Tier Covered Transactions" as required by 29 CFR Part 98.

Exhibit E

U.S. Department of Housing and Urban Development
COMMUNITY PLANNING AND DEVELOPMENT

Special Attention of:
All Secretary's Representatives
All State/Area Coordinators
All CPD Office Directors
All FHEO Field Offices
All CDBG Grantees

Notice CPD- 00-10

Issued: December 26, 2000
Expires: December 26, 2001

Subject: Accessibility for Persons with Disabilities to Non-Housing Programs funded by Community Development Block Grant Funds -- Section 504 of the Rehabilitation Act of 1973, the Americans With Disabilities Act, and the Architectural Barriers Act

I. Purpose

The purpose of this Notice is to remind recipients of Federal funds under the Community Development Block Grant (CDBG) Program of their obligation to comply with Section 504 of the Rehabilitation Act of 1973, HUD's implementing regulations (24 CFR Part 8), the Americans with Disabilities Act, (ADA) and its implementing regulations, (28 CFR Parts 35, 36), and the Architectural Barriers Act (ABA) and its implementing regulations (24 CFR Parts 40, 41) in connection with recipients' non-housing programs. This Notice describes key compliance elements for non-housing programs and facilities assisted under the CDBG programs. However, recipients should review the specific provisions of the ADA, Section 504, the ABA, and their implementing regulations in order to assure that their programs are administered in full compliance.

Applicability

This Notice applies to all non-housing programs and facilities assisted with Community Development Block Grant Funds (e.g. public facilities and public improvements, commercial buildings, office buildings, and other non-residential buildings) and facilities in which CDBG activities are undertaken (e.g., public services). A separate Notice is being issued concerning Federal accessibility requirements for housing programs assisted by recipients of CDBG and HOME program funds.

II. Section 504 of the Rehabilitation Act of 1973

Section 504 of the Rehabilitation Act of 1973, as amended, provides "No otherwise qualified individual with a disability in the United States ... shall, solely by reason of his or her disability, be excluded from the participation in, be denied the benefits of, or be subjected to discrimination under any program or activity receiving Federal financial assistance...". HUD's regulations implementing the Section 504 requirements can be found at 24 CFR Part 8.

Part 8 requires that recipients ensure that their programs are accessible to and usable by persons with disabilities. Part 8 also prohibits recipients from employment discrimination based upon disability.

The Section 504 regulations define "recipient" as any State or its political subdivision, any instrumentality of a State or its political subdivision, any public or private agency, institution organization, or other entity or any person to which Federal financial assistance is extended for any program or activity directly or through another recipient, including any successor, assignee, or transferee of a recipient, but excluding the ultimate beneficiary of the assistance. (24 CFR §8.3) For the purposes of Part 8, recipients include States and localities that are grantees and subgrantees under the CDBG program, their subrecipients, community-based development organizations, businesses, and any other entity that receives CDBG assistance, but not low and moderate income beneficiaries of the program. CDBG grantees are responsible for establishing policies and practices that they will use to monitor compliance of all covered programs, activities, or work performed by their subrecipients, contractors, subcontractors, management agents, etc.

Non-housing Programs

New Construction -- Part 8 requires that new non-housing facilities constructed by recipients of Federal financial assistance shall be designed and constructed to be readily accessible to and usable by persons with disabilities. (24 CFR §8.21(a))

Alterations to facilities -- Part 8 requires to the maximum extent feasible, that recipients make alterations to existing non-housing facilities to ensure that such facilities are readily accessible to and usable by individuals with disabilities. An element of an existing non-housing facility need not be made accessible, if doing so, would impose undue financial and administrative burdens on the operation of the recipients program or activity. (24 CFR §8.21 (b))

Existing non-housing facilities - A recipient is obligated to operate each non-housing program or activity so that, when viewed in its entirety, the program or activity is readily accessible to and usable by persons with disabilities. (24 CFR §8.21 (c))

Recipients are not necessarily required to make each of their existing non-housing facilities accessible to and usable by persons with disabilities if when viewed in its entirety, the program or activity is readily accessible to and usable by persons with disabilities. 24 CFR §8.21(c)(1) Recipients are also not required to take any action that they can demonstrate would result in a fundamental alteration in the nature of its program or activity or cause an undue administrative and financial burden. However, recipients are still required to take other actions that would not result in such alterations, but would nevertheless ensure that persons with disabilities receive the benefits and services of the program. (24 CFR §8.21(c)(iii))

Historic Preservation - Recipients are not required to take any actions that would result in a substantial impairment of significant historic features of an historic property, However, in such cases where a physical alteration is not required, the recipient is still obligated to use alternative means to achieve program accessibility, including using audio-visual materials and devices to depict those portions of

an historic property that cannot be made accessible, assigning persons to guide persons with disabilities into or through portions of historic properties that cannot be made accessible, or otherwise adopting other innovative methods so that individuals with disabilities can still benefit from the program. (24CFR §8.21(c)(2)(ii))

Accessibility Standards

Design, construction, or alteration of facilities in conformance with the Uniform Federal Accessibility Standards (UFAS) is deemed to comply with the accessibility requirements for nonhousing facilities. Recipients may depart from particular technical and scoping requirements of UFAS where substantially equivalent or greater accessibility and usability is provided. (24 CFR §8.32) For copies of UFAS, contact the HUD Distribution Center at 1-800-767-7468; deaf, hard of hearing, or speech-impaired persons may access this number via TTY by calling the Federal Information Relay Service at 1-800-877-8339.

Where a property is subject to more than one law or accessibility standard, it is necessary to comply with all applicable requirements. In some cases, it may be possible to do this by complying with the stricter requirement, however, it is also important to ensure that meeting the stricter requirement also meets both the scoping and technical requirements of overlapping laws or standards.

Employment

Section 504 also prohibits discrimination based upon disability in employment. See 24 CFR Part 8, Subpart B.

Section 504 Self Evaluations

The Section 504 regulations required recipients of Federal financial assistance to conduct a self-evaluation of their policies and practices to determine if they were consistent with the law's requirements. This self evaluation was to have been completed no later than July 11, 1989. Title II of the ADA imposed this requirement on all covered public entities. The ADA regulations required that ADA self evaluations be completed by January 26, 1993, although those public entities that had already performed a Section 504 self evaluation were only required to perform a self-evaluation on those policies and practices that had not been included in the Section 504 review.

The regulatory deadlines are long past. However, self-evaluation continues to be an excellent management tool for ensuring that a recipient's current policies and procedures comply with the requirements of Section 504 and the ADA.

Involving persons with disabilities in the self-evaluation process is very beneficial. This will assure the most meaningful result for both the recipient and for persons with disabilities who participate in the recipient's programs and activities. It is important to involve persons and/or organizations representing persons with disabilities, and agencies or other experts who work regularly with accessibility standards.

Important steps in conducting a self-evaluation and implementing its results include the following:

- Evaluate current policies and practices and analyze them to determine if they adversely affect the full participation of individuals with disabilities in its programs, activities and services. Be mindful of the fact that a policy or practice may appear neutral on its face, but may have a discriminatory effect on individuals with disabilities.

- Modify any policies and practices that are not or may not be in compliance with Section 504 or Title II and Title III of the ADA regulations. (See 24 CFR Part 8 and 28 CFR Parts 35, 36.)

- Take appropriate corrective steps to remedy those policies and practices which either are discriminatory or have a discriminatory effect. Develop policies and procedures by which persons with disabilities may request a modification of a physical barrier or a rule or practice that has the effect of limiting or excluding a person with a disability from the benefits of the program.

- Document the self-evaluation process and activities. The Department recommends that all recipients keep the self-evaluation on file for at least three years, including records of the individuals and organizations consulted, areas examined and problems identified, and document modifications and remedial steps, as an aid to meeting the requirement at 24 CFR Part 8.55.

The Department also recommends that recipients periodically update the self-evaluation, particularly, for example, if there have been changes in the programs and services of the agency. In addition, public entities covered by Title II of the ADA should review any policies and practices that were not included in their Section 504 self-evaluation and should modify discriminatory policies and practices accordingly.

III. The Americans With Disabilities Act of 1990

The Americans With Disabilities Act of 1990 (ADA) guarantees equal opportunities for persons with disabilities in employment, public accommodations, transportation, State and local government services, and telecommunications. Unlike Section 504 which applies only to programs and activities receiving Federal financial assistance, the ADA applies even if no Federal financial assistance is given.

The U.S. Department of Justice enforces Titles I, II, and III of the ADA, although the Equal Employment Opportunity Commission investigates administrative complaints involving Title I.

Title I prohibits discrimination in employment based upon disability. The regulations implementing Title I are found at 29 CFR Part 1630. The Equal Employment Opportunity Commission (EEOC) offers technical assistance on the ADA provisions applying to employment.

These can be obtained at the EEOC web site www.eeoc.gov, or by calling 800-669-3362 (voice) and 800-800-3302 (TTY).

Title II prohibits discrimination based on disability by State and local governments. Title II essentially extended the Section 504 requirements to services, programs, and activities provided by States, local governments and other entities that do not receive Federal financial assistance from HUD or another Federal agency. CDBG grantees are covered by both Title II and Section 504. The Department of Justice Title II regulations are found at 28 CFR Part 35.

Title II also requires that facilities that are newly constructed or altered, by, on behalf of, or for use of a public entity, be designed and constructed in a manner that makes the facility readily accessible to and usable by persons with disabilities. (28 CFR §35.151 (a) & (b)) Facilities constructed or altered in conformance with either UFAS or the ADA Accessibility Guidelines for Buildings and Facilities (ADAAG) (Appendix A to 28 CFR Part 36) shall be deemed to comply with the Title II Accessibility requirements, except that the elevator exemption contained at section 4.1.3(5) and section 4.1.6(1)(j) of ADAAG shall not apply. (28CFR §35.151 (c))

Title II specifically requires that all newly constructed or altered streets, roads, and highways and pedestrian walkways must contain curb ramps or other sloped areas at any intersection having curbs or other barriers to entry from a street level or pedestrian walkway and that all newly constructed or altered street level pedestrian walkways must have curb ramps at intersections . Newly constructed or altered street level pedestrian walkways must contain curb ramps or other sloped areas at intersections to streets, roads, or highways. (28CFR §35.151 (e))

The Title II regulations required that by January 26, 1993, public entities (State or local governments) conduct a self-evaluation to review their current policies and practices to identify and correct any requirements that were not consistent with the regulation. Public entities that employed more than 50 persons were required to maintain their self-evaluations on file and make it available for three years. If a public entity had already completed a self-evaluation under Section 504 of the Rehabilitation Act, then the ADA only required it to do a self-evaluation of those policies and practices that were not included in the previous self-evaluation. (28 CFR §35.105)

The Department of Justice offers technical assistance on Title II through its web page at **www.usdoj.gov/crt/ada/taprog.htm**, and through its ADA Information Line, at **202 514-0301 (voice and 202-514-0383 (TTY).** The Department of Justice's technical assistance materials include among others, the Title II Technical Assistance Manual with Yearly Supplements, the ADA guide for Small Towns, and an ADA Guide entitled The ADA and City Governments: Common Problems.

Title III prohibits discrimination based upon disability in places of public accommodation (businesses and non-profit agencies that serve the public) and "commercial" facilities (other businesses). It applies regardless of whether the public accommodation or commercial facility is operated by a private or public entity, or by a for profit or not for profit business. The Department of Justice Title III regulations are found at 28 CFR Part 36. The Department of Justice also offers technical assistance concerning Title III through the web page cited above and the ADA Hotline cited above.

Justice also offers technical assistance concerning Title III through the web page cited above and the ADA Hotline cited above.

IV. The Architectural Barriers Act of 1968

The Architectural Barriers Act of 1968 (ABA) (42 U.S.C. 4151-4157) requires that certain buildings financed with Federal funds must be designed, constructed, or altered in accordance with standards that ensure accessibility for persons with physical disabilities. The ABA covers any building or facility financed in whole or in part with Federal funds, except privately-owned residential structures. Covered buildings and facilities designed, constructed, or altered with CDBG funds are subject to the ABA and must comply with the Uniform Federal Accessibility Standards (UFAS). (24 CFR 570.614) In practice, buildings built to meet the requirements of Section 504 and the ADA, will conform to the requirements of the ABA.

V. HUD Resources Available Concerning Section 504

Further information concerning compliance with Section 504 may be obtained through the HUD web page **(http://www.hud.gov/fhe/504/sect504.html).** Additional assistance and information may be obtained by contacting the local Department of Housing and Urban Development Office of Fair Housing and Equal Opportunity field office. Below is a list of the phone numbers for these offices.

	CPD	FHEO
Boston, MA	617 565-5345	617 565-5310
Hartford, CT	806 240-4800 x3059	860 240-4800
New York, NY	212 264-0771 x3422	212 264-1290
Buffalo, NY	716 551-5755 x5800	716 551-5755
Newark, NJ	973 622-7900 x3300	973 622-7900
Philadelphia, PA	215 656-0624 x3201	215 656-0661
Pittsburgh, PA	412 644-2999	412 355-3167
Baltimore, MD	410 962-2520 x3071	410 962-2520
Richmond, VA	804 278-4503 x3229	804 278-4504
Washington, DC	202 275-0994 x3163	202 275-0848
Atlanta, GA	404 331-5001 x2449	404 331-1798
Birmingham, AL	205 290-7630 x1027	205 290-7630
South Florida	305 536-4431 x2223	305 536-4479
Jacksonville, FL	904 232-1777 x2136	904 232-1777
San Juan, PR	787 766-5400 x2005	787 766-5400
Louisville, KY	502 582-6163 x214	502 582-6163 x230
Jackson, MS	601 965-4700 x3140	601 965-4700 x2435
Knoxville, TN	865 545-4391 x121	865 545-4379
Greensboro, NC	336 547-4005	336 547-4050
Columbia, SC	803 765-5564	803 765-5936
Chicago, IL	312 353-1696 x2702	312 353-7776
Minneapolis, MN	612 370-3019 x2107	612 370-3185

Detroit, MI	313 226-7908 x8055	313 226-6280
Milwaukee, WI	414 297-3214 x8100	414 297-3214
Columbus, OH	614 469-5737 x8240	614 469-5737 x8170
Indianapolis, IN	317 226-6303 x6790	317 226-7654
Little Rock, AK	501 324-6375	501 324-6296
Oklahoma City, OK	405 553-7569	405 553-7426
Kansas City, KS	913 551-5485	913 551-5834
Omaha, NE	402 492-3181	402 492-3109
St. Louis, MO	314 539-6524	314 539-6327
New Orleans, LA	504 589-7212 x3047	504 589-7219
Fort Worth, TX	817 978-5934 x5951	817 978-5870
San Antonio, TX	210 475-6820 x2293	210 475-6885
Albuquerque, NM	505 346-7271 x7361	505 346-7327
Denver, CO	303 672-5414 x1326	303 672-5437
San Francisco, CA	415 436-6597	415 436-6569
Los Angeles, CA	213 894-8000 x3300	213 894-8000 x3400
Honolulu, HI	808 522-8180 x264	808 522-8180
Phoenix, AZ	602 379-4754	602 379-6699 5261
Seattle, WA	206 220-5150 x3606	206 220-5170
Portland, OR	503 326-7018	503 326-3349
Manchester, NH	603 666-7640 x7633	
Anchorage, AK	907 271-3669	
Houston, TX		713 313-2274

Exhibit A

March 17, 2023

Marcela Zuniga, MSOL
City Grants Administrator
City of Madera Administration
205 West 4th Street
Madera, CA 93637

RE: 2021 – 2022 City of Madera Community Development Block Grant (CDBG) Capital Improvement Project (CIP) Rapid Rehousing Subrecipient Agreement 30-day notice of intent to terminate

Dear Ms. Zuniga,

Please accept this letter as 30-day notice of intent to terminate the 2021 – 2022 City of Madera CDBG CIP – Rapid Rehousing Subrecipient Agreement between the City of Madera and Community Action Partnership of Madera County, Inc., (CAPMC). It is well known that multifamily housing has been increasingly difficult to attain due to lack of inventory. CAPMC has done its due diligence to identify a multifamily complex for the purpose of direct service delivery; unfortunately, the construction of this complex has been stalled for some time. The completion date for this project is unknown. CAPMC has not been able to identify any comparable alternatives at this time.

Should additional questions arise, please do not hesitate to contact me.

Sincerely,

for MM

Mattie Mendez
Executive Director
Main: (559) 673-9173
Direct: (559) 675-5748
Email: mmendez@maderacap.org