CHOWCHILLA SUBBASIN ANNUAL REPORT

APRIL 2024

Prepared By

Davids Engineering, Inc.

Luhdorff & Scalmanini

Chowchilla Subbasin
Groundwater Sustainability Plan (GSP)

GSP Annual Report

For Water Year 2023
(October 2022 – September 2023)

April 2024

Prepared For

Chowchilla Water District GSA

Madera County GSA – Chowchilla

Merced County GSA – Chowchilla

Triangle T Water District GSA

Prepared By

Davids Engineering, Inc.
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List of Abbreviations

AF	acre-feet
AG	agricultural
AMSL	above mean sea level
AN	above normal
BN	below normal
C	critical
CASGEM	California State Groundwater Elevation Monitoring
CCR	California Code of Regulations
cfs	cubic feet per second
CIMIS	California Irrigation Management Information System
CVP	Central Valley Project
CWD	Chowchilla Water District
D	dry
DWR	California Department of Water Resources
EO	Executive Order
ETAW	ET of applied water
ET_c	crop ET
ET_o	grass reference ET
Flood-MAR	Flood Managed Aquifer Recharge
GSA	Groundwater Sustainability Agencies
GSP	Groundwater Sustainability Plan
GWE	Groundwater Elevation
GWS	groundwater system
IM	interim milestone
InSAR	Interferometric synthetic aperture radar
MID	Madera Irrigation District
MO	measurable objective
MSL	mean sea level
MT	minimum threshold
NOAA NCEI	National Oceanic and Atmospheric Administration National Centers for Environmental Information
NV	Native Vegetation Land
PMAs	projects and management actions
PRISM	Parameter-elevation Regressions on Independent Slopes Model
RMS	Representative monitoring sites
SEBAL	Surface Energy Balance Algorithm for Land
SGMA	Sustainable Groundwater Management Act of 2014
SLDMWA	San Luis Delta-Mendota Water Authority
SMC	Sustainable Management Criteria
SVMWC	Sierra Vista Mutual Water Company
SWRCB	State Water Resources Control Board
SWS	surface water system
TTWD	Triangle T Water District
UR	Urban Land
USACE	United States Army Corps of Engineers
USBR	U.S. Bureau of Reclamation, or Reclamation
USDA	U.S. Department of Agriculture
W	wet

Introduction

The California Code of Regulations Title 23 (23 CCR) §356.2 requires that Annual Reports be submitted to the California Department of Water Resources (DWR) by April 1 of each year following the adoption of the Groundwater Sustainability Plan (GSP). This Annual Report is the fifth Annual Report for the Chowchilla Subbasin GSP, which is required to be submitted to DWR by April 1, 2024.

This Annual Report has been developed in compliance with the requirements of 23 CCR §356.2, describing conditions across the entire Chowchilla Subbasin (Subbasin) and the efforts made toward GSP implementation through April 2024.

The Subbasin is managed by four groundwater sustainability agencies (GSAs): Chowchilla Water District (CWD) GSA, Madera County GSA – Chowchilla (Madera County GSA), Merced County GSA – Chowchilla (Merced County GSA), and Triangle T Water District (TTWD) GSA. The jurisdictional areas of these four GSAs have been organized into five subregions for GSP planning and implementation efforts. These subregions include: CWD GSA, Madera County GSA – East, Madera County GSA – West, Sierra Vista Mutual Water Company (SVMWC), and TTWD GSA. The relationship between the Chowchilla Subbasin GSAs and subregions is summarized in **Table ES-1,** and shown in **Figures ES-1 and ES-2**. Each subregion represents either one entire GSA (CWD GSA, TTWD GSA), a portion of one GSA (Madera County GSA – East, Madera County GSA – West), or combined areas across more than one GSA (SVMWC).

This Annual Report provides basic information about the Subbasin plan area and presents technical information from water year 2015 (after the end of the historical water budget period) through the current reporting year (water year 2023) (23 CCR §356.2.b.5.B), including:

- Groundwater elevation data from monitoring wells
- Contour maps and hydrographs of groundwater elevations
- Total groundwater extractions
- Surface water supply used, including for groundwater recharge or other in-lieu uses
- Total water use
- Change in groundwater storage
- Progress towards implementing the GSP, including implementation of projects and management actions, as well as the status of groundwater conditions relative to the sustainable management criteria for each of the applicable sustainability indicators in the Subbasin.

The structure for the Annual Report generally follows the structure of the requirements outlined in 23 CCR §356.2. Groundwater elevation, groundwater extraction, surface water supply, and groundwater storage are summarized for the entire Subbasin, while progress towards GSP implementation is described for each subregion. The DWR water year ends on September 30th of the named year and begins on October 1st of the previous year; therefore, the period covered by this Annual Report is primarily October 1, 2022, through September 30, 2023.

Also included with this Annual Report are appendices that contain the required groundwater maps and hydrographs that must be submitted with each Annual Report. The following appendices are located at the end of this Annual Report:

- Appendix A. Contour Maps of the Different Aquifer Units.
- Appendix B. Hydrographs of Time-Series Groundwater Level Data for Groundwater Level RMS Wells.
- Appendix C. Maps of Change in Groundwater Levels and Change in Groundwater Storage in 2016 through 2022, Separated by Principal Aquifer.
- Appendix D. Maps of Annual and Cumulative Subsidence in 2015 through 2023.
- Appendix E. Status of Monitoring Efforts for RMS Wells in Chowchilla Subbasin.
- Appendix F. Interconnected Surface Water Data Gaps Workplan.

Table ES-1. Chowchilla Subbasin GSAs and Water Budget Subregions.

<table>
<tr><th>GSA</th><th>Subregion</th><th>Subregion Abbreviation</th><th>Subregion Area, Acres[1]</th></tr>
<tr><td>Chowchilla Water District GSA</td><td>Chowchilla Water District GSA</td><td>CWD GSA</td><td>85,500</td></tr>
<tr><td rowspan="3">Madera County GSA</td><td>Madera County GSA – East</td><td>Madera County GSA – East</td><td>11,200</td></tr>
<tr><td>Madera County GSA – West</td><td>Madera County GSA – West</td><td>30,500</td></tr>
<tr><td rowspan="2">Sierra Vista Mutual Water Company</td><td rowspan="2">SVMWC</td><td rowspan="2">3,800</td></tr>
<tr><td>Merced County GSA</td></tr>
<tr><td>Triangle T Water District GSA</td><td>Triangle T Water District GSA</td><td>TTWD GSA</td><td>14,700</td></tr>
<tr><td colspan="3">Total</td><td>145,700</td></tr>
</table>

[1] Subregion areas do not account for TTWD annexations. Changes to subregions that impact the Subbasin boundaries will be accounted in future Annual Reports.

Executive Summary (§356.2.a)

The Chowchilla Subbasin GSP covers the entire extent of the Subbasin (**Figures ES-1 and ES-2**). The four GSAs in the Subbasin collectively adopted and submitted the initial GSP in January 2020, and later revised and resubmitted the GSP in July 2022 to address deficiencies identified by DWR and to incorporate new information made available since 2020. Coordinated implementation of the GSP is currently underway to achieve sustainable management of the Subbasin by 2040, in compliance with the Sustainable Groundwater Management Act (SGMA).

In accordance with 23 CCR §356.2, GSAs must submit Annual Reports to DWR by April 1 each year following GSP adoption to document progress made toward GSP implementation. This Annual Report is the fifth Annual Report for the Chowchilla Subbasin GSP, which is required to be submitted to DWR by April 1, 2024. This Annual Report summarizes groundwater conditions and water use in the entire Subbasin, as well as the progress that has been made to implement projects and management actions (PMAs) and achieve interim milestones established in the GSP. Key data sources and findings of each section are summarized below for the current reporting year (2023) and are described in further detail in the associated Annual Report section.

GSP Revisions Since the Previous Annual Report

In January 2022, DWR completed a review of the Chowchilla Subbasin GSP and released an incomplete determination, initiating a 180-day consultation period between January 28, 2022, and July 27, 2022. In this determination, DWR identified three potential deficiencies that may preclude DWR's approval of the GSP: (1) insufficient information to support the selection of chronic lowering of groundwater levels sustainable management criteria, (2) insufficient information to support the selection of land subsidence sustainable management criteria, and (3) insufficient information to support the determination that interconnected surface water or undesirable results related to depletions of interconnected surface water are not present and are not likely to occur in the Subbasin. The four GSAs completed additional technical analyses and GSP revisions to address those deficiencies and developed two workplans to address remaining data gaps with regard to subsidence and interconnected surface water. The Chowchilla Subbasin Revised GSP was adopted and submitted to DWR for evaluation on July 27, 2022.

In March 2023, preceding submittal of the previous Annual Report, DWR completed its review of the revised Chowchilla Subbasin GSP and released an inadequate determination. Following the determination, the GSAs coordinated together and worked cooperatively with staff at DWR and the State Water Resources Control Board (SWRCB) to review the reasons for this determination and expeditiously complete the additional revisions necessary to receive an adequate determination. In May 2023, the GSAs transmitted a draft revised GSP to SWRCB staff. The GSAs have since continued their coordination with the SWRCB and DWR to identify a pathway back to DWR jurisdiction and local control of the Chowchilla Subbasin. While the GSAs continue to be frustrated with DWR's determination, the GSAs remain steadfast in their commitment and dedication to the long-term sustainability of the Subbasin.

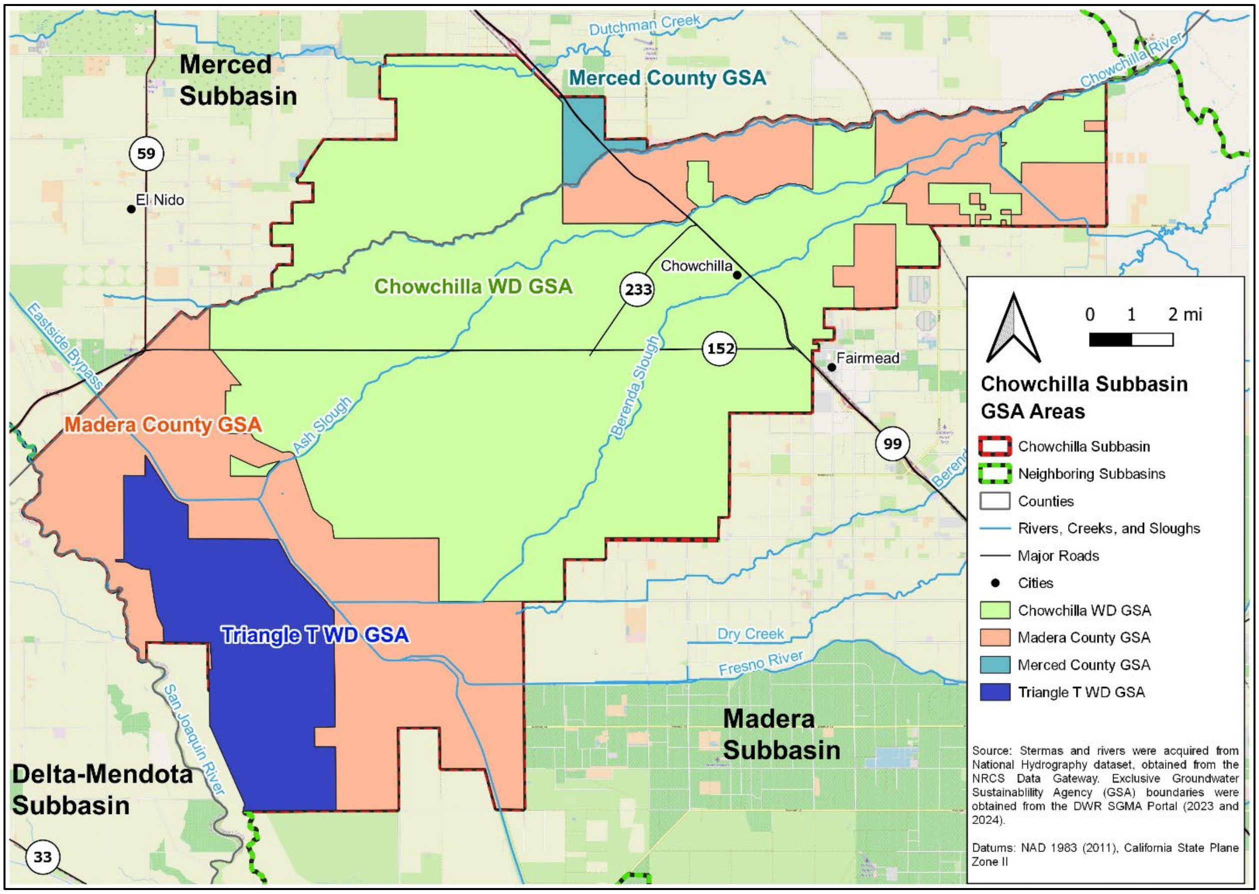

Figure ES-1. Chowchilla Subbasin GSAs Map.*

** Subregion areas do not account for TTWD annexations or other boundary changes since 2022. Changes to subregions that impact the Subbasin boundaries will be accounted in future Annual Reports.*

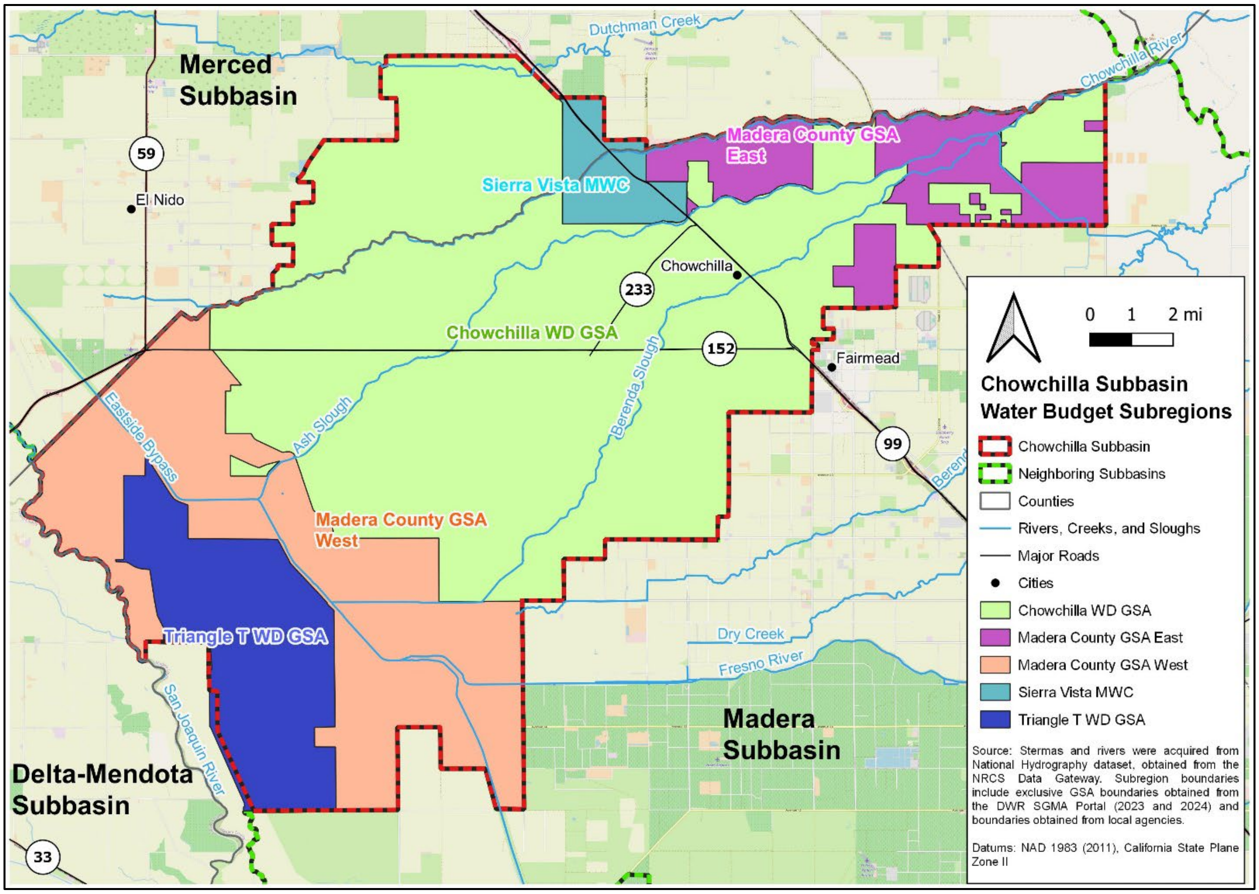

Figure ES-2. Chowchilla Subbasin Water Budget Subregions.

Groundwater Elevations (§356.2.b.1)

Groundwater level monitoring and groundwater elevations are described in **Section 1.1** of this Annual Report. Groundwater level monitoring data was assembled from publicly available and GSA-related sources for the historical period through water year 2023 and for Fall 2023. Data was collected from various entities, including: CWD, Madera County, TTWD, DWR, USBR, and GeoTracker, with some historical data assembled from wells monitored as part of the California State Groundwater Elevation Monitoring (CASGEM) program (the Madera-Chowchilla Groundwater Monitoring Group).

The GSAs conducted groundwater level monitoring for available Representative Monitoring Site (RMS) wells in Spring 2023 and Fall 2023 to evaluate seasonal high and low groundwater level conditions, respectively. During Spring 2023, groundwater elevations at available RMS wells in the Subbasin ranged from -91 ft AMSL to 111 ft AMSL. During Fall 2023, groundwater elevations at available RMS wells in the Subbasin ranged from -93 ft AMSL to 109.3 ft AMSL. Despite attempts at measurement, some RMS water level data was not available in 2023 due to continued challenges encountered during implementation of the RMS monitoring program. Additional information on these challenges is provided in **Section 7.3** and **Appendix E** of this Annual Report.

Groundwater Elevation Contour Maps (§356.2.b.1.A)

Groundwater elevation contour maps are described in **Section 1.2** and shown in **Appendix A** of this Annual Report. Spring 2023 and Fall 2023 groundwater elevation contour maps were prepared. Spring contours are intended to generally represent seasonal high groundwater levels, while fall contours are intended to generally represent seasonal low groundwater levels. Data was assembled from all known and available groundwater level information in the Subbasin, including from public sources, local GSAs, and other local entities.

In summary, general patterns seen in the Spring 2023 and Fall 2023 groundwater elevation contour maps are similar to patterns observed in previous spring and fall time periods. In the unconfined Upper Aquifer above the Corcoran Clay in the western Subbasin, spring and fall contours generally show higher groundwater elevations near the San Joaquin River with groundwater flow away from the San Joaquin River to the east towards areas of lower groundwater elevations in the southwestern portion of Subbasin. In the Lower Aquifer (within the extent of the Corcoran Clay) and undifferentiated unconfined zone outside of the Corcoran Clay, spring and fall contours generally show higher groundwater elevations in the central portion of Subbasin and lower groundwater elevations in the western and eastern portions of the Subbasin.

Groundwater Hydrographs (§356.2.b.1.B)

Groundwater hydrographs are described in **Section 1.3** and shown in **Appendix B** of this Annual Report. All available groundwater level monitoring data was used to prepare groundwater hydrographs for all years spanning the period from January 1, 2015, through the end of 2023. Between 2015 and 2023, most of these hydrographs show trends with stable or declining levels depending on the specific RMS well. It is noted that wells with 2023 measurements generally showed an increase in groundwater levels.

Groundwater Extraction (§356.2.b.2)

Groundwater extraction is summarized in **Section 3** of this Annual Report. Groundwater extraction in the Subbasin was estimated using a water budget that provides a complete accounting of all inflows and outflows from the surface water system in each subregion. Flowmeter records are reported and were used to validate these water budget estimates where available; otherwise, groundwater extraction was estimated using the best available information (sources and methods are summarized in **Section 3**).

In total, an estimated 96,100 acre-feet (AF) of groundwater was extracted for use within the Subbasin during water year 2023. Of this total, the majority was extracted for agricultural use (approximately 92,600 AF), and the remaining groundwater was extracted for urban and domestic use (approximately 3,500 AF). Total groundwater recharge from the surface water system (combined infiltration of applied water, precipitation, and surface water) was estimated to be approximately 300,000 AF in water year 2023.

Surface Water Supplies (§356.2.b.3)

Surface water supplies used or available for use are summarized in **Section 4** of this Annual Report. Surface water supplies available in the Subbasin typically include: surface water deliveries (CVP supplies from Millerton Reservoir and Buchanan Dam); transfer water to CWD from LeGrand Athlone Water District or other districts; water purchased from the San Joaquin

River Exchange Contractors, Madera Irrigation District (MID), and others; riparian and water rights diversions; and flood flows and natural flows crossing the Subbasin boundaries. In this Annual Report, surface water supplies used or available for use are assumed to be the difference between surface water inflows and surface water outflows through the Subbasin. During water year 2023, approximately 383,200 AF of surface water supplies were used in the Subbasin area (combined irrigation deliveries, recharge, infiltration, and evaporation).

Total Water Use (§356.2.b.4)

Total water use is summarized in **Section 5** of this Annual Report. In this Annual Report, total water use is assumed to equal the total combined applied water and precipitation from all sources in the Subbasin, including all consumptive water use (evapotranspiration) and non-consumptive water use (other water uses, e.g., deep percolation and runoff). During water year 2023, total water use in the Subbasin is estimated to be approximately 491,000 AF. Of this total, approximately 51% is from surface water, approximately 20% is from groundwater, and the remaining use is from precipitation. Consumptive water use in the Subbasin was estimated to be approximately 335,000 AF in water year 2023.

Change in Groundwater Storage (§356.2.b.5)

Change in groundwater storage is described in **Section 6** and shown in **Appendix C** of this Annual Report. Consistent with 23 CCR §354.18.b, annual changes in groundwater elevation were calculated for each of the principal aquifers between Spring 2022 and Spring 2023 based on the difference in annual spring groundwater elevation contours (representing seasonal high groundwater conditions). Outside of the delineated confined area, changes in groundwater levels (in both the Upper and Lower Aquifers) were multiplied by representative specific yield values to estimate change in groundwater storage. Within the delineated confined area in the Lower Aquifer, groundwater potentiometric surface changes in the Lower Aquifer were multiplied by a much smaller storage coefficient value to calculate annual changes in groundwater storage in the Lower Aquifer. The specific yield and storage coefficient values used in the analysis are derived from values in the calibrated integrated groundwater flow model (MCSim) developed and applied during the preparation of the GSP.

In summary, the combined change in groundwater storage for the GSP area was approximately 48,400 AF from Spring 2022 to Spring 2023. Positive change in storage values indicate accretion of groundwater storage, whereas negative change in storage values represent depletion of groundwater storage.

Implementation of Projects and Management Actions (§356.2.c)

GSP implementation activities, including projects and management actions (PMAs), are described in **Section 7** of this Annual Report. In the year since the last Annual Report submittal, the GSAs have continued to make significant progress in implementing existing PMAs, as well as developing and implementing new PMAs. Wet conditions in 2023 allowed the GSAs to achieve substantial recharge benefits in the Subbasin.

CWD GSA has several recharge projects in various stages of implementation. In 2023, CWD ran approximately 133,000 AF of surface water in the district’s canals and sloughs, providing substantial direct recharge while also delivering surface water for in-lieu recharge. CWD also delivered more than 6,600 AF of surface water to recharge basins and approximately 11,900 AF of surface water to customers for Flood-MAR efforts.

The Madera County GSA has continued work on various planning studies and has continued implementation of a substantial recharge program and demand management program that will collectively support achievement of the GSP sustainability goal. Over the past 18 months, since the failure of the Proposition 218 process, the Madera County GSA has continued negotiations with a group of local growers in the Subbasin to cover PMA implementation costs. Coordination is ongoing as of spring 2024. In addition to these efforts, the Madera County GSA has continued implementation of demand management efforts, including enforcement of an allocation and associated penalty beginning in 2023. Madera County GSA has also continued to implement its demand measurement program and verification project to support enforcement of demand management efforts, including efforts to track evapotranspiration of applied water (ETAW) against an ETAW allocation and efforts to analyze the consistency of applied water measurements from flow meters to the applied water estimates developed from remote sensing measurements. Finally, the Madera County GSA has continued work toward planning, designing, and constructing several recharge projects in various stages of development.

SVMWC has continued its efforts to develop recharge basins. As of late 2023, soil investigations have been completed and a topographic survey of the site has been recommended. Construction of the reservoir is planned to commence following completion of all required permitting, studies, surveys, and finalization of designs.

The TTWD GSA has several projects in various stages of implementation, including: (1) utilization of existing recharge basins and purchased surface water, (2) development of additional dedicated recharge basins (funded by a Proposition 68 grant and funding from the Natural Resource Conservation Service), (3) the Columbia Canal and Poso Canal pipelines, and (4) the Poso Canal pipeline extension project (also funded by Proposition 68). In 2023, approximately 5,200 AF of surface water was purchased and diverted for use in-lieu of groundwater in TTWD.

Interim Milestone Status (§356.2.c)

The status of groundwater conditions relative to interim milestones (IMs) established in the Chowchilla Subbasin GSP is described in **Section 7.4** of this Annual Report. For the purpose of tracking sustainability indicators in relation to the Sustainable Management Criteria (SMC) in the GSP, the status of each indicator is presented in relation to the 2025 IMs, measurable objectives (MOs), and minimum thresholds (MTs) defined in the GSP.

For chronic lowering of groundwater levels, review of the Fall 2023 groundwater level measurements that are available for 28 RMS wells indicates that groundwater levels remain well above the MTs, and all Fall 2023 RMS groundwater levels, with the exception of one well, were above the 2025 IMs. For land subsidence, in both the Western Management Area (WMA) and Eastern Management Area (EMA), groundwater level proxies are all above the IMs and generally all above MTs. In the EMA, rates of subsidence relative to critical conveyance are lower than MTs. For degraded groundwater quality, collection of sufficient groundwater quality data to establish baseline conditions is still in process and comparison to SMC is not available at this time. For depletion of Interconnected Surface Water (ISW), percent of time connected at all wells, with the exception of one, are below SMC. However, there is limited data available for some RMS wells with which to evaluate the ISW SMC.

1 Groundwater Elevations (§356.2.b.1)

1.1 GROUNDWATER LEVEL MONITORING

The groundwater level monitoring information presented in this Annual Report includes historical and recent monitoring conducted in the Subbasin by various entities, including local GSA-coordinated monitoring conducted as part of the GSP monitoring program and additional monitoring by non-GSA entities that provide useful information for interpreting groundwater conditions. Groundwater level data collected as part of GSP monitoring and additional groundwater level monitoring data available for the period through water year 2023 (plus Fall 2023) are summarized and presented in this Annual Report (**Table 1-1 and Appendices A and B)**. Formal GSP groundwater level monitoring conducted by the GSAs was initiated upon adoption and submittal of the GSP in January 2020.

Historically, groundwater level monitoring in the Subbasin has been conducted by a variety of entities including CWD, Madera County, DWR, USBR, landowners, and GeoTracker. The California State Groundwater Elevation Monitoring Program (CASGEM) was initiated in 2011, with the Madera-Chowchilla Groundwater Monitoring Group designated as the local monitoring entity. This group includes CWD and Madera County, along with entities in the Madera Subbasin. Groundwater levels have been collected and submitted each fall and spring as part of the CASGEM program, which also satisfies some of the GSP monitoring. The Chowchilla Subbasin GSAs also conducted groundwater level monitoring in select wells in advance of GSP adoption and submittal. Additional groundwater level data collection from newly installed nested monitoring wells (installed as part of a DWR grant) began in water year 2020. Groundwater level monitoring data available from the entities listed above and all GSAs were assembled for the period through the end of water year 2023 (plus Fall 2023) and are presented in this Annual Report. **Figure 1-1** includes a map presenting the well locations and most recent monitoring date for historical groundwater level monitoring conducted in the Subbasin. Semi-annual groundwater level measurements acquired for groundwater level RMS wells identified in the GSP are submitted through the Monitoring Network Module on the SGMA Portal twice a year. **Figure 1-2** illustrates the groundwater level RMS well network included in the GSP. A summary of RMS well information and recent groundwater level measurements is presented in **Table 1-1**. Despite attempts at measurement, some RMS water level data was not available in recent years due to continued challenges encountered during implementation of the RMS monitoring program or other access issues. Additional information on these monitoring challenges is provided in **Section 7.3** and **Appendix E** of this Annual Report.

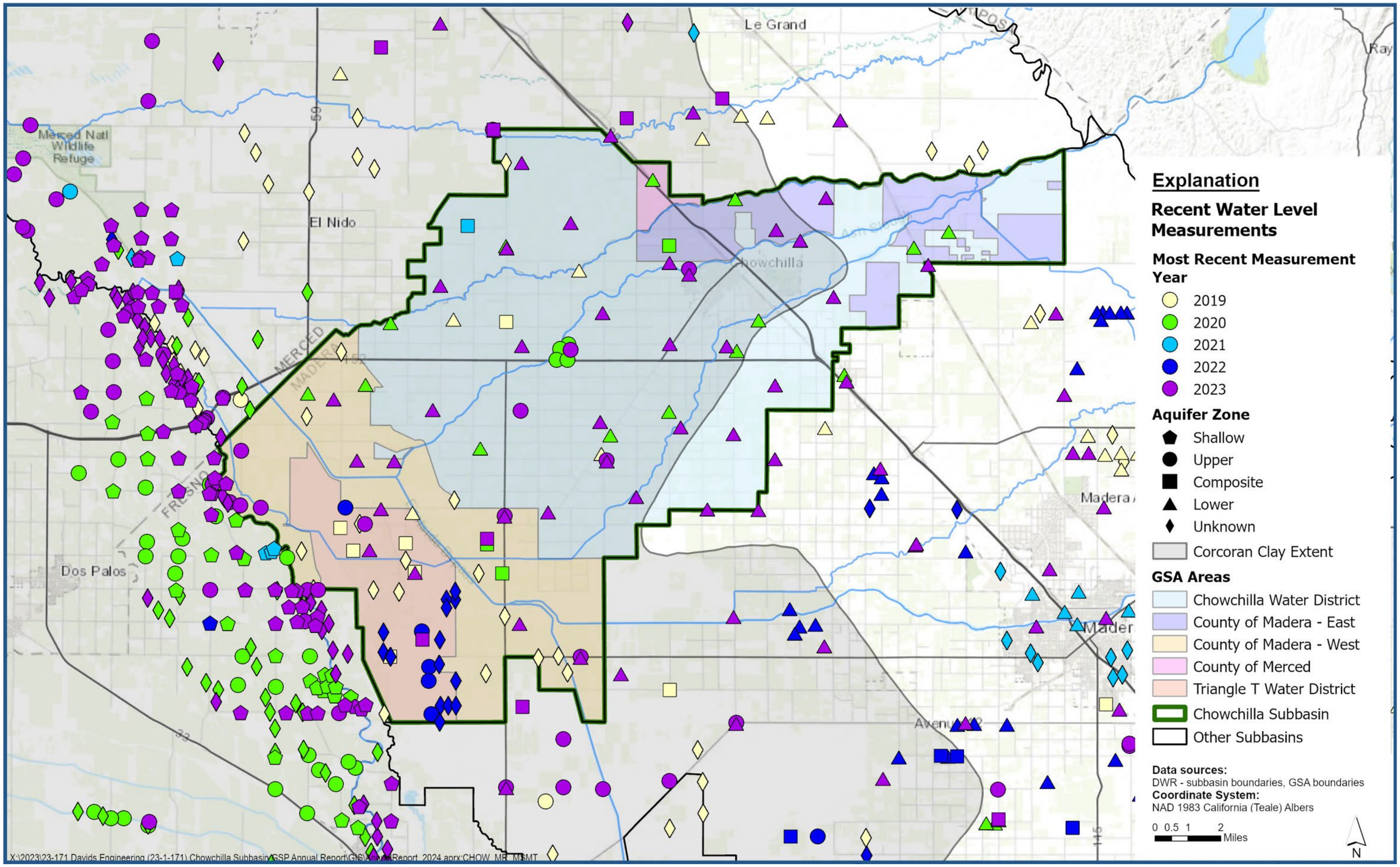

Figure 1-1. Most Recent Groundwater Level Measurement by Well.

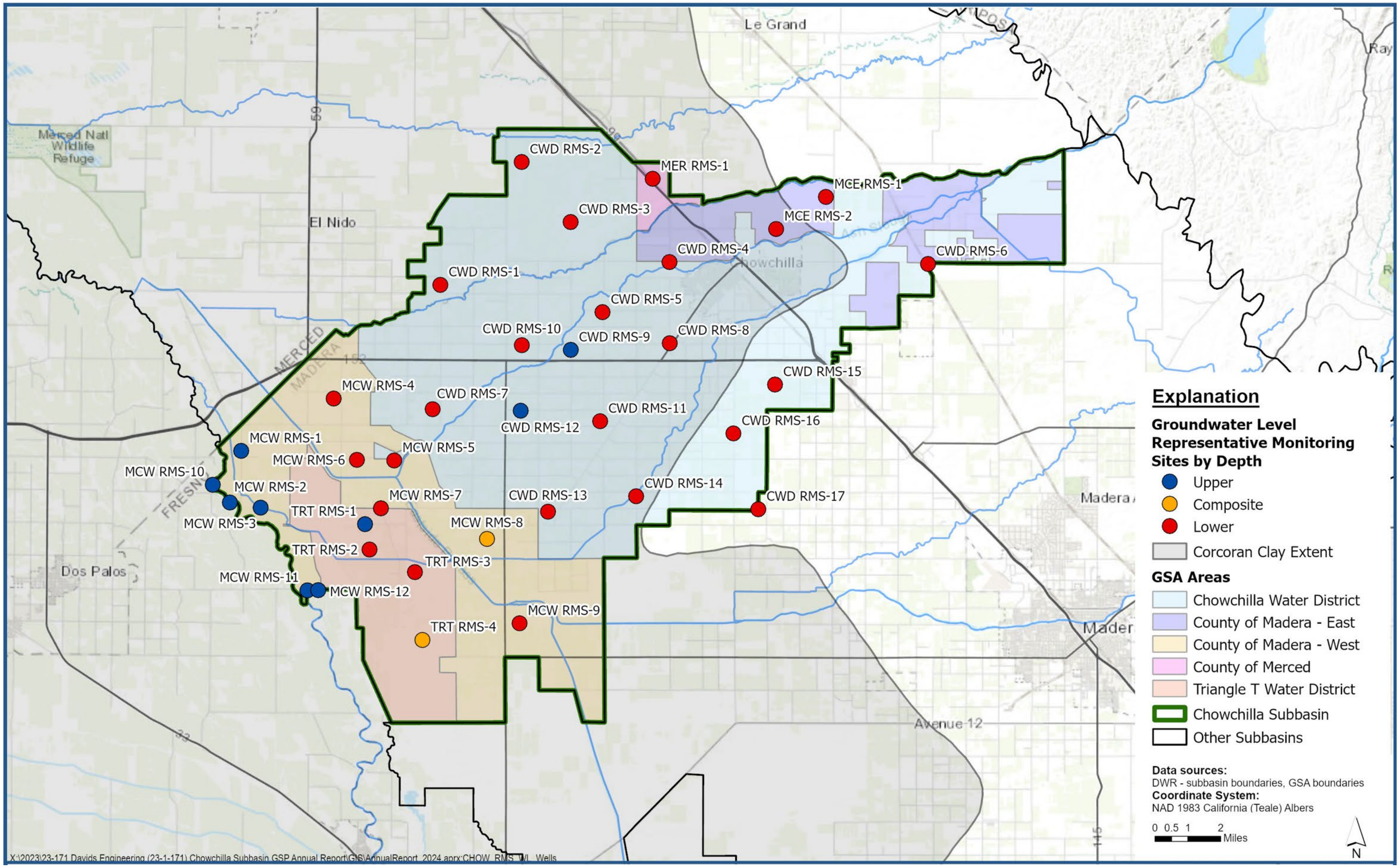

Figure 1-2. Groundwater Levels Sustainability Indicator Wells.

Table 1-1. Summary of Groundwater Level RMS Well Information and Measurements During Report Year (2023).

RMS Well I.D.	Estimated Ground Surface Elevation (msl, feet)[1]	Well Depth	Screen Top-Bottom	Aquifer Designation	Spring 2023 GWE[1]	Date of Spring 2023 Measurement	Fall 2023 GWE[1]	Date of Fall 2023 Measurement	Subregion
CWD RMS-1	171	275	160-275	Lower[2]	-11	3/20/2023	-22	10/13/2023	CWD GSA
CWD RMS-2	193	780	230-775	Lower[2]	NM[4]	3/24/2023	-41	10/13/2023	CWD GSA
CWD RMS-3	206	Unknown	Unknown	Lower[2]	-57.86	3/20/2023	-58.86	10/13/2023	CWD GSA
CWD RMS-4	225	800	320-800	Lower[2]	NM[4]	3/24/2023	-69.3	10/13/2023	CWD GSA
CWD RMS-5	207	Unknown	Unknown	Lower[2]	49.15	3/21/2023	63.15	10/13/2023	CWD GSA
CWD RMS-6	275	820	257-726	Lower[3]	-55	3/21/2023	-63	10/13/2023	CWD GSA
CWD RMS-7	169	330	135-288	Lower[2]	-17.5	3/21/2023	-35.5	10/16/2023	CWD GSA
CWD RMS-8	219	Unknown	Unknown	Lower[2]	-45.85	3/21/2023	-42.85	10/16/2023	CWD GSA
CWD RMS-9	164	97	82-97	Upper	75	3/21/2023	94	10/16/2023	CWD GSA
CWD RMS-10	182	Unknown	Unknown	Lower[2]	-55.32	3/21/2023	-55.32	10/16/2023	CWD GSA
CWD RMS-11	199	529	187-529	Lower[2]	74.68	3/22/2023	82.68	10/16/2023	CWD GSA
CWD RMS-12	176	Unknown	Unknown	Upper	60.2	3/23/2023	63.2	10/16/2023	CWD GSA
CWD RMS-13	167	Unknown	Unknown	Lower[2]	26.72	3/23/2023	37.72	10/16/2023	CWD GSA
CWD RMS-14	152	455	185-365	Lower[2]	-91	3/23/2023	-93	10/14/2023	CWD GSA
CWD RMS-15	213	955	290-935	Lower[3]	NM[4]	3/24/2023	-92.9	10/14/2023	CWD GSA
CWD RMS-16	212	Unknown	Unknown	Lower[3]	-60.8	3/24/2023	-74.8	10/14/2023	CWD GSA
CWD RMS-17	203	624	278-588	Lower[3]	-72.9	3/23/2023	-84.9	10/14/2023	CWD GSA
MCE RMS-1	276	Unknown	Unknown	Lower[3]	-56.84	3/29/2023	-68.1	10/31/2023	Madera County GSA – East
MCE RMS-2	272	466	218-464	Lower[2]	NM[4]	3/29/2023	-92.66	10/31/2023	Madera County GSA – East
MCW RMS-1	120	186	Unknown	Upper	83.57	3/28/2023	92.97	10/30/2023	Madera County GSA – West
MCW RMS-2	123	Unknown	Unknown	Upper	102.12	3/28/2023	95.12	10/30/2023	Madera County GSA – West
MCW RMS-3	122	Unknown	Unknown	Upper	106.01	3/28/2023	102.56	10/30/2023	Madera County GSA – West
MCW RMS-4	138	Unknown	Unknown	Lower[2]	NM[4]	3/28/2023	NM[4]	10/30/2023	Madera County GSA – West

RMS Well I.D.	Estimated Ground Surface Elevation (msl, feet)[1]	Well Depth	Screen Top-Bottom	Aquifer Designation	Spring 2023 GWE[1]	Date of Spring 2023 Measurement	Fall 2023 GWE[1]	Date of Fall 2023 Measurement	Subregion
MCW RMS-5	146	Unknown	Unknown	Lower[2]	NM[4]	3/28/202	NM[4]	10/30/2023	Madera County GSA – West
MCW RMS-6	139	Unknown	Unknown	Lower[2]	NM[4]	3/28/2023	NM[4]	10/31/2023	Madera County GSA – West
MCW RMS-7	138	800	290-400	Lower[2]	NM[4]	3/28/2023	QM[5]	10/30/2023	Madera County GSA – West
MCW RMS-8	142	480	160-475	Composite	NM[4]	3/28/2023	42.05	10/31/2023	Madera County GSA – West
MCW RMS-9	155	700	265-696	Lower[2]	NM[4]	3/28/2023	NM[4]	10/31/2023	Madera County GSA – West
MCW RMS-10	123	26	44129	Upper	111.02	2/16/2023	109.31	10/12/2023	Madera County GSA – West
MCW RMS-11	127	30	Unknown	Upper					Madera County GSA – West
MCW RMS-12	127	29	Unknown	Upper					Madera County GSA – West
MER RMS-1	225	Unknown	Unknown	Lower[2]					SVMWC
TRT RMS-1	134	196	158-192	Upper	36.231	3/15/2023	51.231	10/15/2023	TTWD GSA
TRT RMS-2	135	500	300-500	Lower[2]	34.5	3/15/2023	51.5	10/15/2023	TTWD GSA
TRT RMS-3	137	799	168-790	Lower[2]	-7.559	3/15/2023	5.441	10/15/2023	TTWD GSA
TRT RMS-4	141	840	190-260	Composite	9.5	3/15/2023	4.5	10/15/2023	TTWD GSA

[1] Estimated ground surface elevation and groundwater elevations (GWE) are expressed in feet above mean sea level (referenced to the NAVD88 vertical datum).
[2] Lower Aquifer wells within the Corcoran Clay extent.
[3] Lower Aquifer wells outside the Corcoran Clay extent; considered representative of undifferentiated unconfined groundwater zone.
[4] NM = No Measurement. Measurement attempted on date listed but was unsuccessful. See Appendix E for more information.
[5] QM = questionable measurement. Measurement reported but flagged as questionable. See Appendix E for more information.
[6] Fall measurements were collected slightly outside of the target time frame of mid-October to mid-November.

1.2 GROUNDWATER ELEVATION CONTOUR MAPS (§356.2.B.1.A)

Groundwater elevation contours for Spring and Fall 2023 were developed from all known and available groundwater level information in the Subbasin, including data from public sources and from local GSAs and other local entities. All contours are presented as feet above mean sea level (referenced to the NAVD 88 vertical datum).

Annual spring and fall contour maps were prepared for each year and for each of the principal aquifers in the Chowchilla Subbasin: Upper Aquifer and Lower Aquifer/Undifferentiated Unconfined Zone. Annual spring contours are intended to represent seasonal high groundwater levels, while fall contours are intended to represent seasonal low groundwater levels. For the purpose of mapping groundwater elevations, the aquifer system in areas outside the extent of the Corcoran Clay was treated as a single undifferentiated unconfined aquifer system and interpretation of groundwater levels in these areas utilized data from wells assigned to both the Upper and Lower depth zones. In areas within the extent of the Corcoran Clay, the aquifer system was separated into an Upper Aquifer unconfined system above the Corcoran Clay and a Lower Aquifer below the Corcoran Clay. The Corcoran Clay hydraulically separates the Upper and Lower Aquifer where it is present, and in areas where the Corcoran Clay is shallow, there is perched water on top of the Corcoran Clay with an unsaturated zone directly below the Corcoran Clay. As a result, in the undifferentiated unconfined zone outside of the extent of the Corcoran Clay the groundwater surface represents a continuation of the Lower Aquifer groundwater surface within the Corcoran Clay area.

To evaluate recent groundwater level conditions in the Subbasin, separate groundwater elevation contour maps were prepared for spring and fall of each year for the unconfined Upper Aquifer, where substantial saturation exists, and separately for the Lower Aquifer (within the extent of the Corcoran Clay) and the undifferentiated unconfined zone (outside of the Corcoran Clay). The groundwater elevation contour maps for the Lower Aquifer represent a combination of potentiometric elevations where the aquifer is under confined conditions and water table surface elevations where the groundwater is unconfined. Contour maps of the different aquifer units are presented in **Figure 1-3 through 1-6**, and are discussed below. For comparison to these figures for Spring 2023 and Fall 2023, contour maps for Spring 2015-2022 and Fall 2015- 2022, prepared for last year's GSP Annual Report, are included in **Appendix A**.

It may be noted on some groundwater contour maps that wells relatively close together may show significant differences in groundwater elevations. This can occur for various reasons including: differences in well construction details relative to the depth, screen intervals, and seal depths; influences from nearby and/or recent pumping; and/or hydrogeologic characteristics that affect groundwater occurrence/movement (e.g., variations in stratigraphy). Groundwater elevations commonly vary at a given location at different depths within a single aquifer (whether it be unconfined, semi-confined, or confined) due to interbedding of fine- and coarse-grained layers and uneven vertical distribution of pumping stresses. For example, vertical gradients (meaning different groundwater elevations at different depths within an aquifer) often occur as a result of higher pumping stresses within a certain depth zone of the aquifer. Wells being monitored may have been measured for groundwater elevation shortly after the measured well or a nearby well has been turned off (or possibly even a nearby well is pumping at the time of measurement);

thereby resulting in a lower groundwater elevation at that location. In addition, stratigraphy (i.e., occurrence/sequence of fine- and coarse-grained layers) in the Chowchilla Subbasin has been observed to vary significantly from one well location to another due to layer discontinuity, which may impact groundwater elevations measured in nearby wells. Development of groundwater elevation contour maps for this Annual Report involved application of computerized spatial interpolation algorithms[1] in combination with some professional judgement, recognizing some of the issues described above that can impact groundwater elevations.

1.2.1 Upper Aquifer

A seasonal high groundwater elevation contour map for the Upper Aquifer within the Corcoran Clay area was generated for Spring 2023 (**Figure 1-3**). The Spring 2023 Groundwater Elevation Contour Map (**Figure 1-3**) generally shows higher groundwater elevations near the San Joaquin River with groundwater flow away from the San Joaquin River to the east towards areas of lower groundwater elevations in the southwestern portion of the Subbasin.

A seasonal low groundwater elevation contour map for the Upper Aquifer within the Corcoran Clay area was generated for Fall 2023 (**Figure 1-4**). The Fall 2023 Groundwater Elevation Contour Map (**Figure 1-4**) generally shows higher groundwater elevations near the San Joaquin River with prevailing groundwater flow directions away from the San Joaquin River to the east towards areas of lower groundwater elevation in the south-central portion of the Subbasin.

1.2.2 Lower Aquifer and Undifferentiated Unconfined Groundwater Zone

A seasonal high groundwater elevation contour map for the Lower Aquifer was generated for Spring 2023 (**Figure 1-5**). The Spring 2023 Groundwater Elevation Contour Map for the Lower Aquifer (**Figure 1-5**) generally shows higher groundwater elevations in the central portion of Subbasin and lower groundwater elevations in the western and eastern portions of the Lower Aquifer.

A seasonal low groundwater elevation contour map for the Lower Aquifer was generated for Fall 2023 (**Figure 1-6**). Similar to the spring contour map, the Fall 2023 Groundwater Elevation Contour Map (**Figure 1-6**) generally shows higher groundwater elevations in the central portion of Subbasin, and lower groundwater elevations in the western and eastern portions of the Lower Aquifer.

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[1] Spatial interpolation methods employed in the analysis involved use of the natural neighbor method with additional consideration of results from the inverse distance weighted method. Both methods interpolate values between points using weighting of nearby point values, beginning with a map of point values (e.g., groundwater elevations at individual wells) and resulting in a raster map of estimated values for the entire area of interest, including area between points (e.g., estimates of groundwater elevations across the entire subbasin, including between wells).

1.3 GROUNDWATER HYDROGRAPHS (§356.2.B.1.B)

Hydrographs of time-series groundwater level data for groundwater level RMS wells were prepared with all available groundwater level monitoring data through water year 2023 (plus Fall 2023) and are contained in **Appendix B**. CWD GSA RMS wells generally showed stable or increasing groundwater elevations during 2023. Limited measurements are available for Madera County wells in 2023. Madera County GSA – East RMS wells show slightly decreasing groundwater elevations in 2023. Madera County GSA – West RMS wells generally showed generally increasing groundwater elevations in 2023. TTWD GSA RMS wells generally showed increasing groundwater elevations in 2023, as compared to previous years.

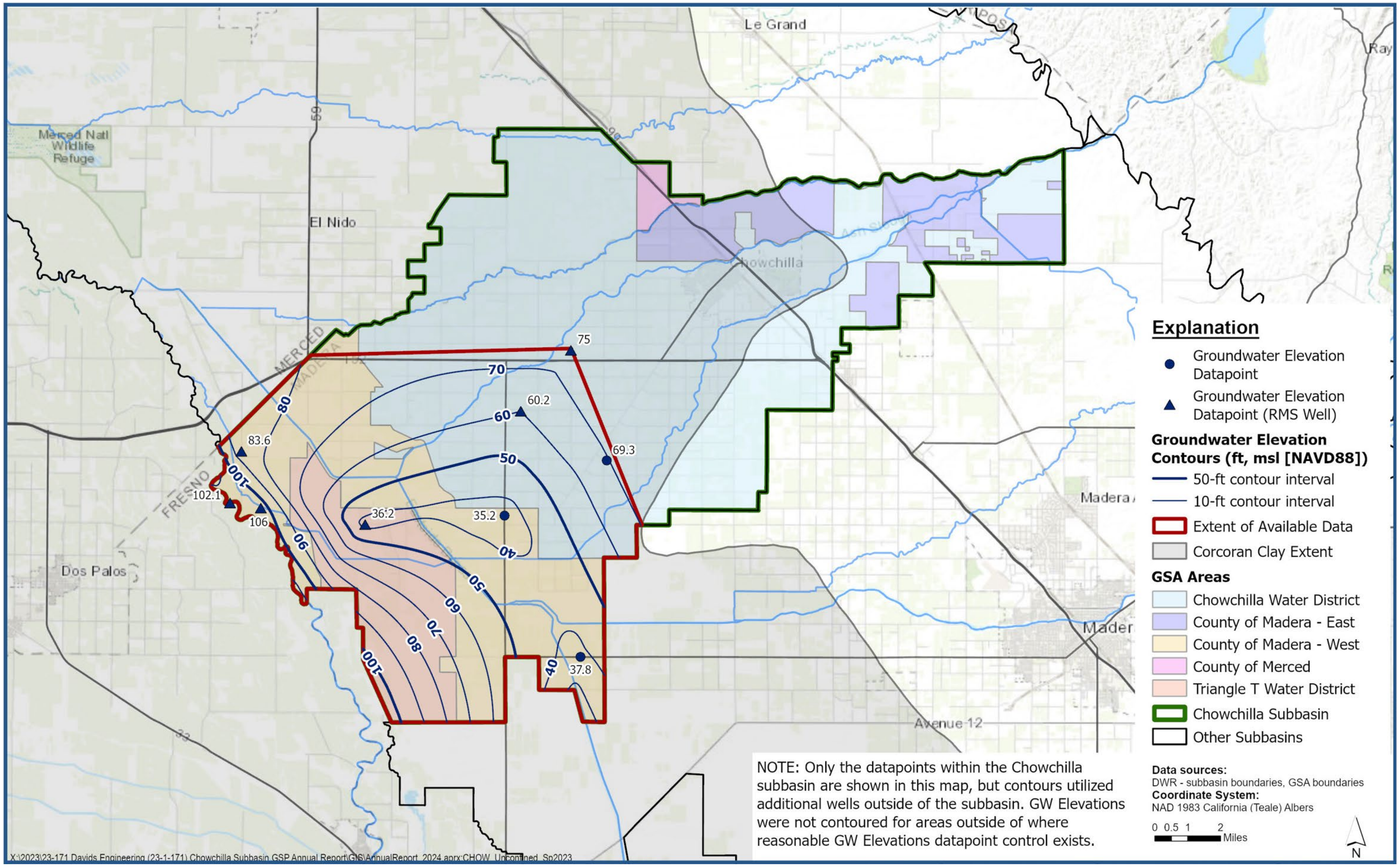

Figure 1-3. Contours of Equal Groundwater Elevation Upper Aquifer – Spring 2023.

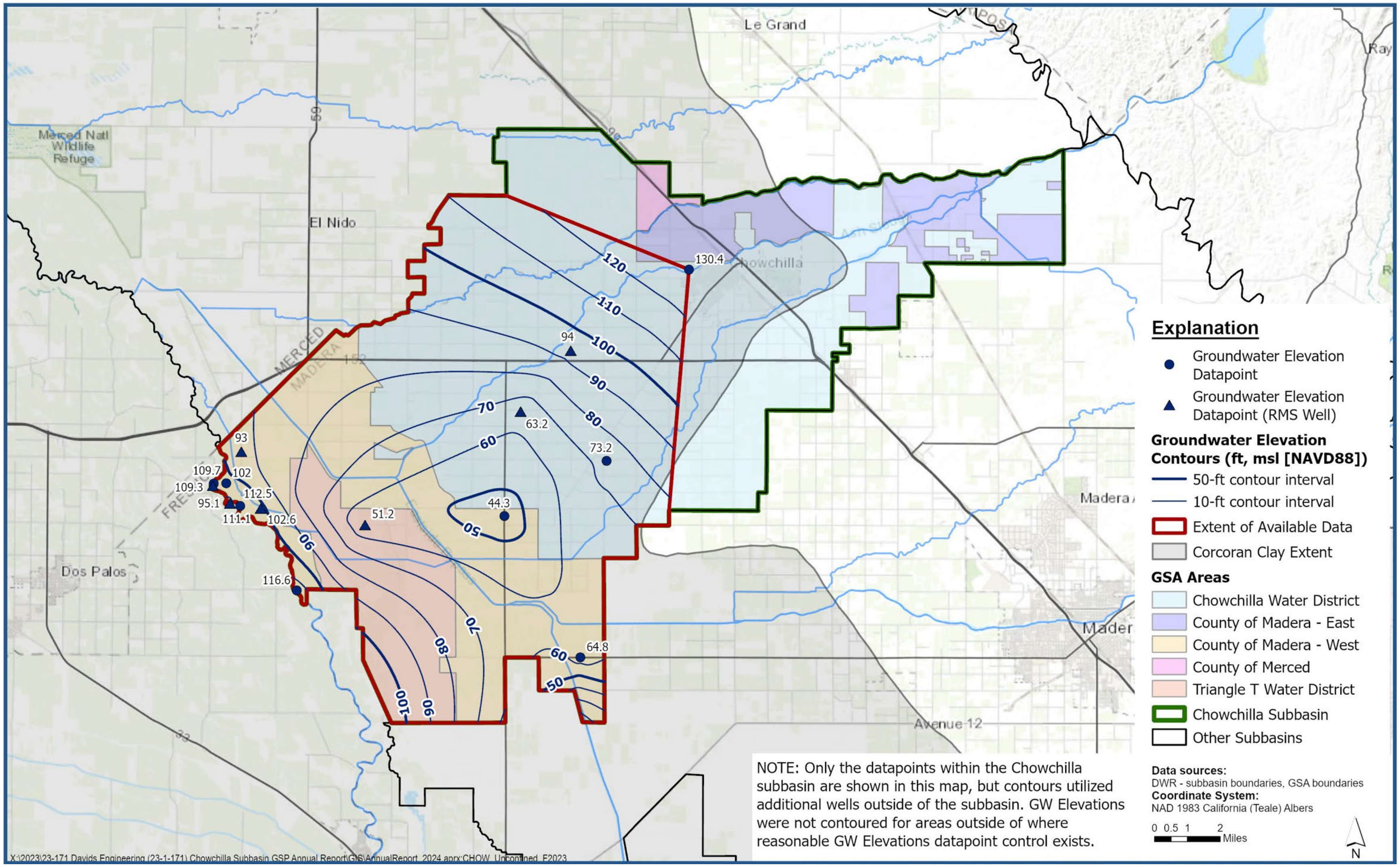

Figure 1-4. Contours of Equal Groundwater Elevation Upper Aquifer – Fall 2023.

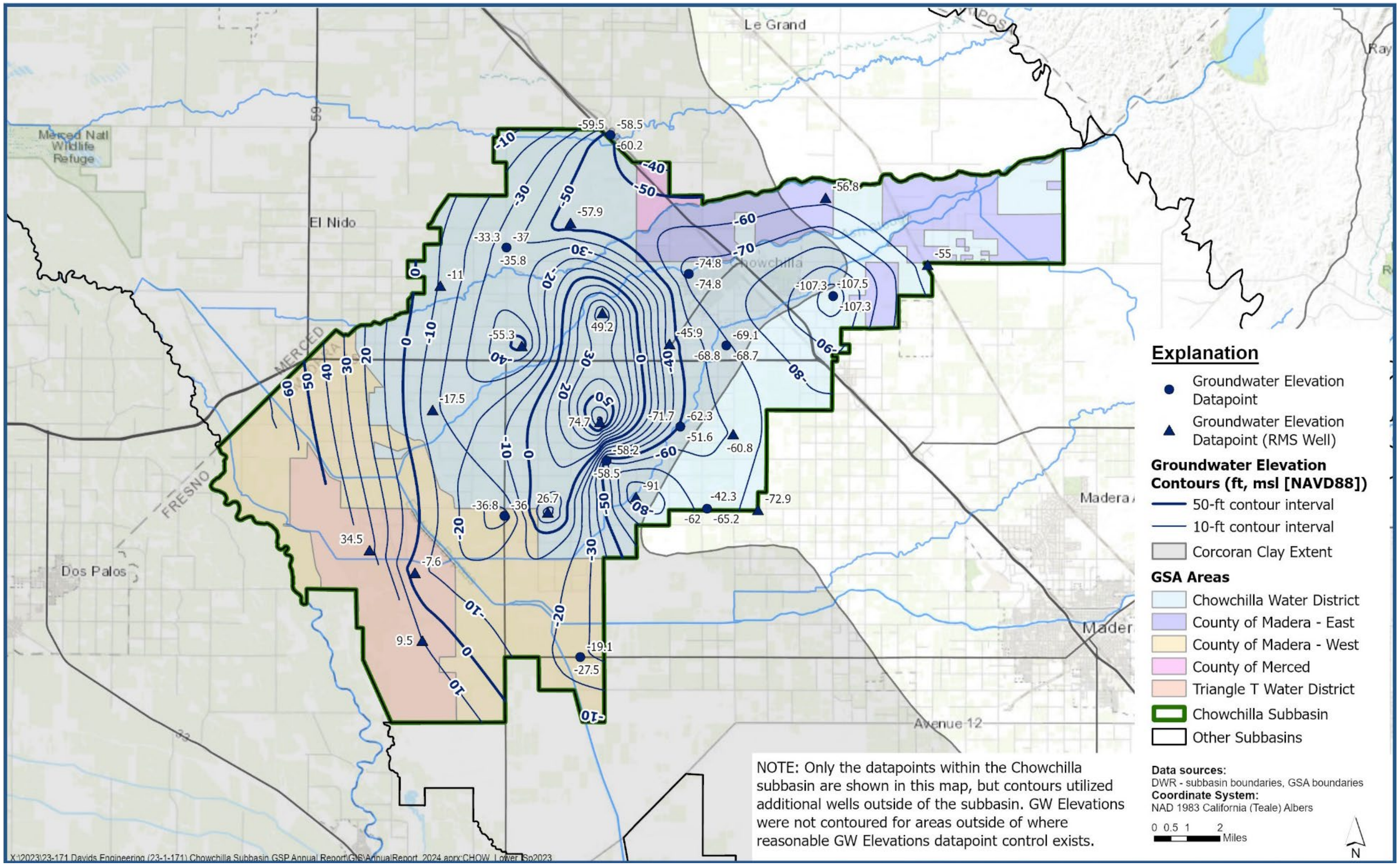

Figure 1-5. Contours of Equal Groundwater Elevation Lower Aquifer/Undifferentiated Unconfined Zone – Spring 2023.

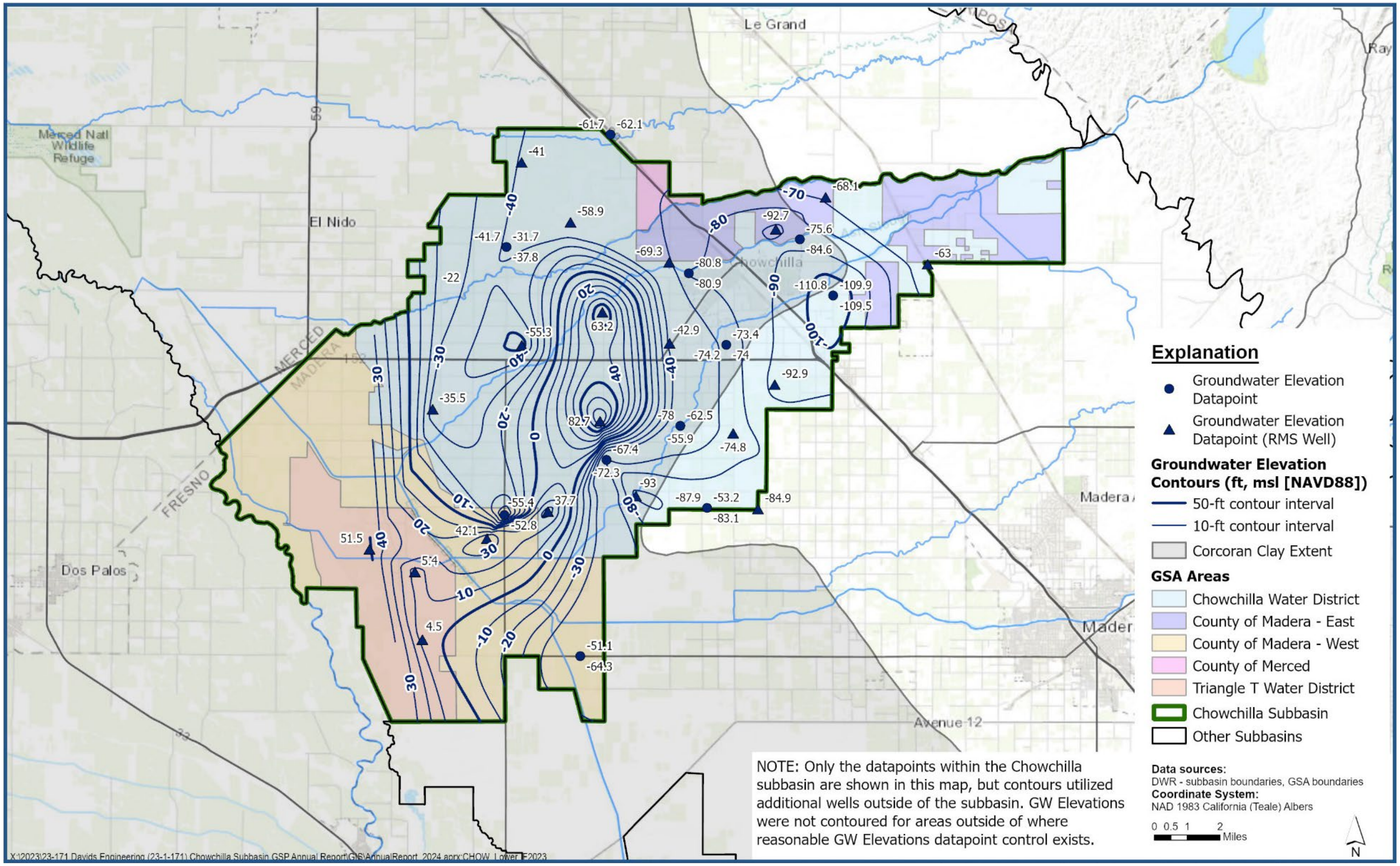

Figure 1-6. Contours of Equal Groundwater Elevation Lower Aquifer/Undifferentiated Unconfined Zone – Fall 2023.

2 Water Budget Approach for Quantifying Groundwater Extraction, Surface Water Supplies, and Total Water Use

In fulfillment of the Annual Report requirements, a water budget approach has been used to quantify groundwater extraction, surface water supply availability, and total water use in the Subbasin. This section describes the structure and uncertainties of these water budgets.

2.1 WATER BUDGET STRUCTURE

A water budget is defined as a complete accounting of all water flowing into and out of a defined volume[2] over a specified period of time. A schematic of the general water budget accounting structure is provided in **Figure 2-1**.

Water budgets presented in the GSP were prepared for the Surface Water System (SWS) and Groundwater System (GWS). The SWS represents the land surface down to the bottom of the 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. These systems are referred to as accounting centers. Flows between accounting centers and storage within each accounting center are water budget components. Separate but related water budgets were prepared for each accounting center that together represent the overall water budget for the Subbasin.

The SWS water budget accounting center was subdivided further into detailed accounting centers, including the Land Surface System that represents water use in all irrigated and non-irrigated lands. To estimate the water budget components required by the GSP regulations, the Land Surface System was 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 Subbasin and within each subregion, the water use sector accounting centers include Agricultural Land (AG), Urban Land (UR) (urban, semi-agricultural, industrial[3]), and Native Vegetation Land (NV).

During GSP development, water budgets were prepared for each subregion in the Subbasin to characterize historical, current, and projected water budget conditions. For this Annual Report, the historical water budgets for the SWS have been extended through the current reporting year to characterize historical water use through water year 2023. Information about the historical water budget development process is available in Section 2.2.3 of the Chowchilla Subbasin Revised GSP.

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[2] 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.

[3] 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.

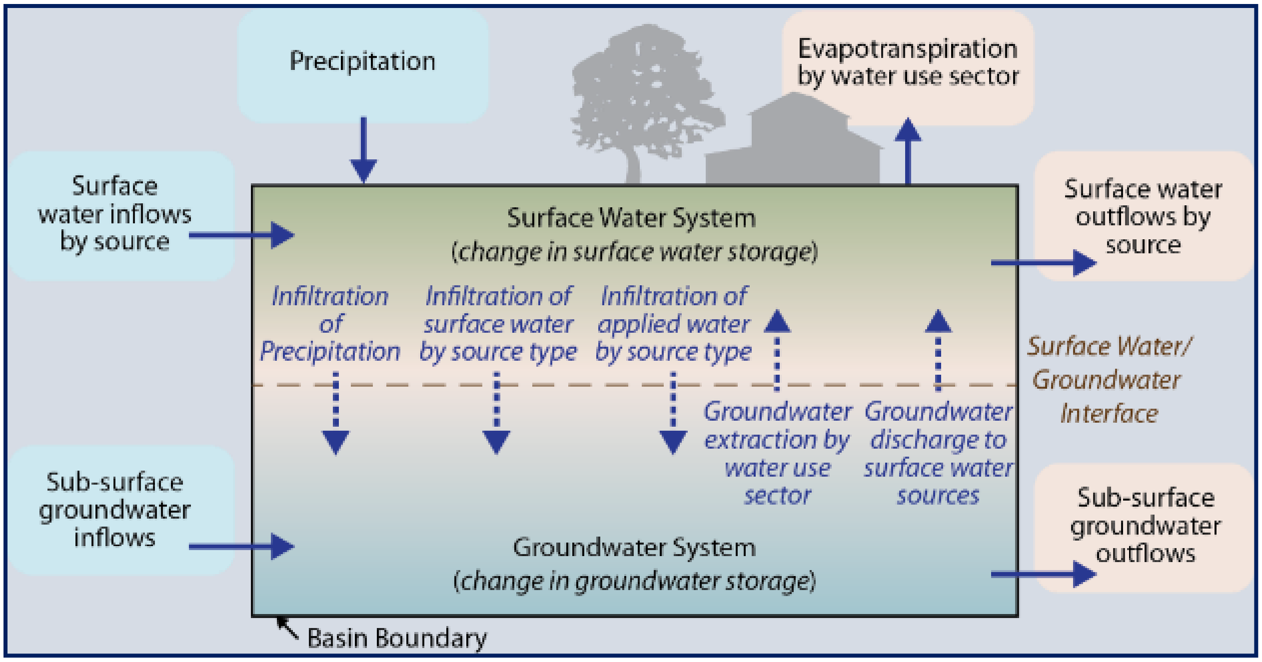


Figure 2-1. Water Budget Accounting Structure (Source: DWR, 2016).

To fulfill the Annual Report requirements, groundwater extraction, surface water supplies, and total water use have been quantified by water use sector and/or water source type. Water budgets for each water use sector were developed individually for each subregion in the Subbasin, as described in the Chowchilla Subbasin Revised GSP, in order to quantify:

- **Groundwater Extraction**: Equal to "Groundwater Extraction"
- **Surface Water Supplies (used, or available for use)**: Assumed to be equal to the difference between "Surface Water Inflows" and "Surface Water Outflows."
- **Total Water Use**: Water use is defined by ASCE (2016) as "water that is used for a specific purpose such as domestic use, irrigation, or industrial processing." This definition includes both consumptive and non-consumptive components. The total consumptive water use (the sum of "Evapotranspiration of Applied Water" and "Evapotranspiration of Precipitation") is also reported as this the volume of water that is no longer available for use within the Chowchilla Subbasin.

The data sources, calculation procedures, and results pertaining to these key water budget components are described in the sections below for the entire Subbasin.

2.2 UNCERTAINTIES IN WATER BUDGET COMPONENTS

Uncertainties associated with each water budget component have been estimated following the procedure described by Clemmens and Burt (1997), as described in the Chowchilla Subbasin Revised GSP and previous annual reports.

3 Groundwater Extraction (§356.2.b.2)

This section summarizes the measurement methods, accuracy, and volumes of groundwater extraction in the Chowchilla Subbasin for the current reporting year (water year 2023).

3.1 QUANTIFICATION AND ACCURACY

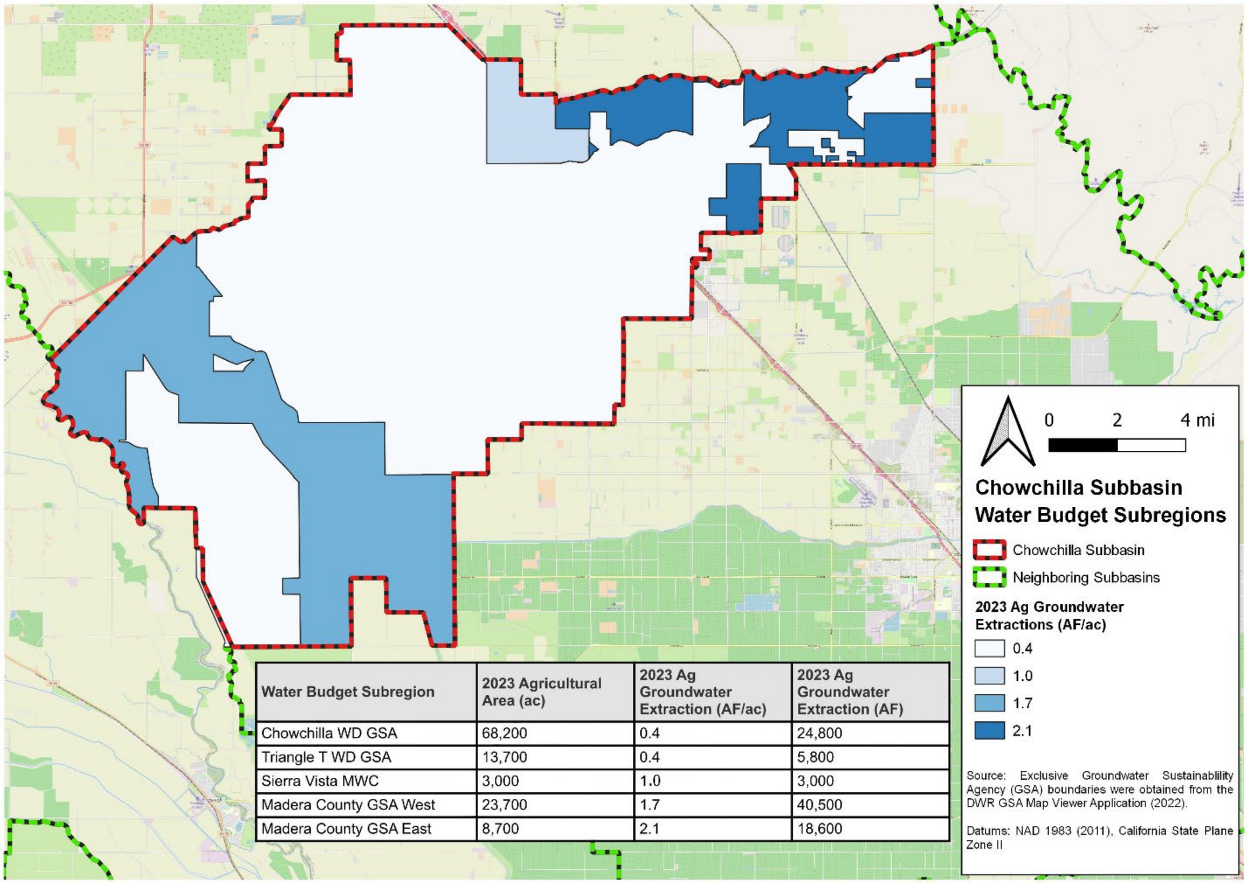
Groundwater extraction in the Subbasin was either measured directly from flowmeters or estimated as the "closure" term of each water use sector (i.e., estimated based on other inflows and outflows from the water use sector). Flowmeter records were used when available; otherwise, groundwater extraction was estimated using the best available information. **Table 3-1** summarizes groundwater extraction in water year 2023 and the associated measurement methods, by subregion and water use sector.

Figure 3-1 provides a map of the 2023 agricultural groundwater extraction volumes and average depths across agricultural areas in the five subregions. Notably, **Figure 3-1** illustrates the average estimated depth of groundwater extraction for agriculture over only the agricultural area in each subregion.

Table 3-2 further summarizes the total groundwater extraction by water use sector in the Chowchilla Subbasin between water year 1989 (the beginning of the Chowchilla Subbasin GSP historical water budget period) and water year 2023 (the current reporting year).

Table 3-1. Groundwater Extraction Volumes and Measurement Methods by Water Use Sector, and Uncertainty (2023).

Water Use Sector	Groundwater Extraction, 2023 (acre-feet, rounded)	Measurement Method	Description
Agricultural	15,440	Measured	Flowmeter records from a subset of landowners in TTWD
	77,180	Estimated	Water use sector closure, after accounting for measured pumping in TTWD
Managed Recharge	0		
Native Vegetation	0		
Urban	2,650	Measured	City of Chowchilla flowmeter records
	810	Estimated	Water use sector closure, after accounting for measured pumping in City of Chowchilla
Chowchilla Subbasin	**Groundwater Extraction, 2023 (acre-feet, rounded)**	**Estimated Uncertainty**	**Description**
Total	96,080	20%	Typical uncertainty when calculated for Land Surface System water balance closure



Water Budget Subregion	2023 Agricultural Area (ac)	2023 Ag Groundwater Extraction (AF/ac)	2023 Ag Groundwater Extraction (AF)
Chowchilla WD GSA	68,200	0.4	24,800
Triangle T WD GSA	13,700	0.4	5,800
Sierra Vista MWC	3,000	1.0	3,000
Madera County GSA West	23,700	1.7	40,500
Madera County GSA East	8,700	2.1	18,600

Figure 3-1. Agricultural Groundwater Extraction, by Subregion.*

**Area and volumes rounded to the nearest 100.*

Table 3-2. Chowchilla Subbasin Groundwater Extraction, by Water Use Sector (acre-feet, rounded).

Water Year (Type)	Agricultural	Managed Recharge	Native Vegetation	Urban and Industrial	Total
1989 (C)	251,330	0	0	3,440	254,770
1990 (C)	283,970	0	0	3,750	287,720
1991 (C)	288,060	0	0	3,820	291,880
1992 (C)	321,910	0	0	4,930	326,840
1993 (W)	214,470	0	0	3,930	218,410
1994 (C)	266,490	0	0	4,880	271,370
1995 (W)	151,330	0	0	2,640	153,970
1996 (W)	208,240	0	0	4,030	212,270
1997 (W)	245,750	0	0	6,650	252,400
1998 (W)	170,830	0	0	3,470	174,300
1999 (AN)	224,010	0	0	5,620	229,630
2000 (AN)	224,820	0	0	4,950	229,770
2001 (D)	254,620	0	0	4,830	259,450
2002 (D)	313,430	0	0	6,580	320,010
2003 (BN)	296,790	0	0	6,670	303,460
2004 (D)	347,960	0	0	8,840	356,800
2005 (W)	205,010	0	0	5,780	210,790
2006 (W)	178,220	0	0	5,830	184,050
2007 (C)	302,980	0	0	9,650	312,620
2008 (C)	307,640	0	0	9,910	317,550
2009 (BN)	259,270	0	0	10,020	269,290
2010 (AN)	177,000	0	0	5,920	182,920
2011 (W)	181,030	0	0	6,570	187,600
2012 (D)	305,780	0	0	11,110	316,890
2013 (C)	340,050	0	0	11,150	351,200
2014 (C)	399,610	0	0	10,970	410,580
2015 (C)	432,110	0	0	12,080	444,190
2016 (D)	305,980	0	0	7,470	313,450
2017 (W)	194,340	0	0	7,530	201,870
2018 (BN)	284,190	0	0	7,830	292,020
2019 (W)	203,300	0	0	6,670	209,970
2020 (D)	304,360	0	0	9,070	313,430
2021 (C)	431,220	0	0	11,900	443,120
2022 (C)	404,860	0	0	10,570	415,430
2023 (W)	92,620	0	0	3,460	96,080
Average (1989-2014)	**258,480**	**0**	**0**	**6,380**	**264,860**
Average (1989-2023)	**267,820**	**0**	**0**	**6,920**	**274,740**
W	185,930	0	0	5,140	191,070
AN	208,600	0	0	5,500	214,100
BN	280,070	0	0	8,180	288,250
D	305,350	0	0	8,000	313,350
C	335,850	0	0	8,090	343,940

3.2 DATA SOURCES

3.2.1 Measured Groundwater Extraction

Direct groundwater pumping data is available from:

- Flowmeter records provided by a subset of landowners in the TTWD GSA for years 2021-2023, reported as part of the Subsidence Control Measures Agreement (see **Section 7.2.4**). These records represent agricultural groundwater extraction from the Upper and Lower Aquifer that is used to irrigate approximately 14,000 acres of agricultural land in the Subbasin.
- Flowmeter records provided by the City of Chowchilla for years 2003-2023, representing urban groundwater extraction within the City's boundaries in CWD GSA. Available pumping records are also used as a comparison for validating the groundwater extraction estimation procedures described below.

3.2.2 Estimated Groundwater Extraction

Estimated 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 has historically been unavailable across the Subbasin. Also, groundwater extraction serves as a relatively large inflow to the Land Surface System, resulting in lower relative uncertainty (as a percent of the total volume) when calculated as a closure term compared to smaller flow paths following the procedure given by Clemmens and Burt (1997).

3.3 GROUNDWATER RECHARGE

As required by 23 CCR §354.24, the GSAs within the Chowchilla 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. The expressed sustainability goal for the Chowchilla Subbasin is "to implement a package of PMAs that will, by 2040, balance long-term groundwater system inflows with outflows..." (pg. 3-2 of the Chowchilla Subbasin Revised GSP). To track the GSAs' progress toward meeting this sustainability goal, both the GWS inflows and outflows must be quantified.

As shown in **Figure 2-1**, GWS outflows to the SWS include groundwater extraction (quantified above) and groundwater discharge (assumed to be negligible in the Chowchilla Subbasin, given the substantial depth to groundwater). GWS inflows from the SWS include infiltration of precipitation, infiltration of applied water, and infiltration of surface water. While these inflows are not required to be reported in this Annual Report, the Chowchilla Subbasin GSAs feel that they are necessary for understanding the total contribution of the SWS to groundwater sustainability.

Table 3-3 summarizes the total annual groundwater recharge from the SWS in the Chowchilla Subbasin. The components of recharge are useful for understanding and analyzing the combined effects of land surface processes on the underlying GWS. The data sources and calculations used to develop each recharge component are described in Section 2.2.3.3 of the Chowchilla Subbasin Revised GSP.

Table 3-3. Chowchilla Subbasin Groundwater Recharge (acre-feet, rounded).

Water Year (Type)	Infiltration of Applied Water	Infiltration of Precipitation	Infiltration of Surface Water[1]	Total Groundwater Recharge
1989 (C)	87,000	42,500	28,300	157,800
1990 (C)	86,200	35,600	23,400	145,200
1991 (C)	99,100	53,200	42,600	194,900
1992 (C)	93,700	29,200	32,700	155,600
1993 (W)	99,500	68,900	133,900	302,300
1994 (C)	91,200	26,400	59,100	176,700
1995 (W)	86,800	83,900	133,900	304,600
1996 (W)	88,000	42,300	120,000	250,300
1997 (W)	116,300	70,400	126,200	312,900
1998 (W)	91,000	70,200	144,000	305,200
1999 (AN)	87,700	20,600	66,300	174,600
2000 (AN)	94,400	33,000	55,400	182,800
2001 (D)	90,400	30,200	46,800	167,400
2002 (D)	95,400	28,900	31,400	155,700
2003 (BN)	92,400	23,100	34,100	149,600
2004 (D)	94,900	18,600	30,400	143,900
2005 (W)	87,700	34,500	68,600	190,800
2006 (W)	82,100	41,200	107,300	230,600
2007 (C)	89,200	14,700	36,800	140,700
2008 (C)	88,300	22,600	24,800	135,700
2009 (BN)	75,200	17,200	27,400	119,800
2010 (AN)	71,700	36,200	66,000	173,900
2011 (W)	86,800	42,500	120,800	250,100
2012 (D)	87,400	12,600	57,900	157,900
2013 (C)	89,100	22,000	23,200	134,300
2014 (C)	79,600	9,100	400	89,100
2015 (C)	84,600	11,500	4,200	100,300
2016 (D)	83,500	38,700	47,600	169,800
2017 (W)	99,300	47,500	149,200	296,000
2018 (BN)	83,100	21,000	64,400	168,500
2019 (W)	81,600	28,500	129,400	239,500
2020 (D)	78,600	15,200	59,100	152,900
2021 (C)	78,300	4,300	19,700	102,300
2022 (C)	79,000	5,300	26,400	110,700
2023 (W)	117,800	32,700	149,900	300,400
Average (1989-2014)	**89,700**	**35,700**	**63,100**	**188,500**
Average (1989-2023)	**89,100**	**32,400**	**65,500**	**187,000**
W	94,300	51,100	125,800	271,200
AN	84,600	29,900	62,600	177,100
BN	83,600	20,400	42,000	146,000
D	88,400	24,000	45,500	157,900
C	87,100	23,000	26,800	136,900

[1] Infiltration of Surface Water includes infiltration of surface water in the rivers, streams, and canals within the Chowchilla Subbasin, plus boundary seepage from the San Joaquin River.

4 Surface Water Supplies (§356.2.b.3)

This section summarizes the annual volumes and data sources for surface water supplies used, or available for use, within the Subbasin through the current reporting year (water year 2023).

4.1 QUANTIFICATION BY WATER SOURCE TYPE

Surface water supplies available in the Subbasin include surface water deliveries and surface water flowing across the Subbasin boundaries. In this Annual Report, surface water supplies used or available for use are assumed to be the difference between surface water inflows and surface water outflows from the Subbasin.

Per the GSP regulations, surface water supplies 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.*

Table 4-1 summarizes the total surface water supplies used or available for use in Chowchilla Subbasin, by water source type. The supplies included in these totals are described below.

4.1.1 Local Supplies

Local supplies historically available to water users in the Subbasin include surface water inflows and diversions from the Chowchilla Bypass; pre-1914, riparian, and prescriptive water rights diversions; and water received from LeGrand Athlone Water District or other local districts. Much of the water flowing along Chowchilla Bypass passes through the Subbasin or infiltrates into the GWS. Water rights deliveries and water received from LeGrand Athlone Water District are largely applied to irrigated land and are assumed to be completely used within the Chowchilla Subbasin.

4.1.2 CVP Supplies

Agencies with CVP contracts can receive CVP supplies in the Subbasin. CVP supplies received via the Madera Canal include Millerton Reservoir irrigation and flood releases. CVP supplies are also received from Buchanan Dam irrigation and flood releases along Chowchilla River. Some CVP supply flood releases from Hidden Dam and Millerton Reservoir also flow into the Subbasin along the Fresno River. Finally, a small amount of CVP supply is also delivered to individual irrigators in CWD from the Madera Irrigation District (MID).

4.1.3 Local Imported Supplies

Local imported supplies delivered to water users in the Subbasin include water purchased by TTWD from San Joaquin River Exchange Contractors, CWD, MID, and others.

4.1.4 Recycling and Reuse

Recycling and reuse are not currently a significant source of supply within the Subbasin. However, urban wastewater treated by the City of Chowchilla, as well as water associated with private septic systems, generally returns to the GWS within the Subbasin and has been included in the water budget.

Table 4-1. Surface Water Supplies Used (Surface Water Inflows – Surface Water Outflows), by Water Source Type (acre-feet, rounded).

Water Year (Type)	Local Supplies	CVP Supplies	Local Imported Supplies	Total
1989 (C)	0	62,600	0	62,600
1990 (C)	0	42,400	0	42,400
1991 (C)	2,300	71,000	0	73,300
1992 (C)	1,600	62,600	0	64,200
1993 (W)	40,200	183,400	0	223,600
1994 (C)	3,500	127,100	0	130,600
1995 (W)	50,900	183,200	0	234,100
1996 (W)	36,900	201,900	0	238,800
1997 (W)	29,700	214,700	0	244,400
1998 (W)	49,200	201,600	0	250,800
1999 (AN)	13,900	180,100	0	194,000
2000 (AN)	6,600	174,100	0	180,700
2001 (D)	2,500	145,300	0	147,800
2002 (D)	2,700	90,300	0	93,000
2003 (BN)	5,000	107,000	0	112,000
2004 (D)	3,000	88,200	0	91,200
2005 (W)	19,100	174,100	0	193,200
2006 (W)	46,600	203,200	0	249,800
2007 (C)	3,700	121,200	0	124,900
2008 (C)	4,000	87,900	0	91,900
2009 (BN)	2,200	109,900	0	112,100
2010 (AN)	15,500	187,000	0	202,500
2011 (W)	53,900	215,300	0	269,200
2012 (D)	3,400	157,400	0	160,800
2013 (C)	1,800	74,100	0	75,900
2014 (C)	0	400	0	400
2015 (C)	0	500	0	500
2016 (D)	3,900	106,000	0	109,900
2017 (W)	100,300	239,700	0	340,000
2018 (BN)	8,400	150,200	7,500	166,100
2019 (W)	36,600	239,900	10,400	286,900
2020 (D)	4,500	123,600	7,500	135,600
2021 (C)	300	16,600	0	16,900
2022 (C)	0	35,000	1,400	36,400
2023 (W)	102,200	275,800	5,200	383,200
Average (1989-2014)	**15,400**	**133,300**	**0**	**148,700**
Average (1989-2023)	**18,600**	**132,900**	**900**	**152,400**
W	51,500	212,200	1,400	265,100
AN	12,000	180,400	0	192,400
BN	5,200	122,300	2,500	130,000
D	3,400	118,400	1,300	123,100
C	1,500	58,500	100	60,100

4.2 DATA SOURCES

Table 4-2 summarizes the data sources and estimation procedures for all water budget components that are used to quantify surface water supplies in the Subbasin. Additional details are given below for each water budget component.

4.2.1 Surface Water Inflows and Surface Water Outflows along Rivers and Streams

The data sources for the inflows and outflows identified in **Table 4-2** are described in Section 2.2.3.3 of the Chowchilla Subbasin Revised GSP. A water budget was computed for each reach by following the procedure described in the GSP. Unless otherwise specified, all missing and inaccurate data was replaced by estimates equal to the average monthly value of available data, computed by water year type.

Table 4-2. Rivers and Streams System Water Budget Detailed Components and Estimation Techniques.

Detailed Component	Associated Source	Water Source Type	Calculation/Estimation Technique	Information Sources
Surface Inflows	Chowchilla Bypass	Local Supplies	Calculated from SLDMWA CBP station measurements adjusted downstream to the Chowchilla Subbasin boundary for estimated seepage and evaporation	SLDMWA CBP station, NRCS soil survey, Fresno State/ Madera/Madera II CIMIS Stations
	Chowchilla River	CVP Supplies	Reported Buchanan Dam flood and irrigation releases	USACE records
	Dutchman Creek	Local Supplies	Estimated as equal to received LeGrand Athlone WD water reported by CWD	CWD monthly water supply reports
	Fresno River	CVP Supplies	Calculated from MID recorder measurements (downstream of convergence with Dry Creek) adjusted downstream to the Madera-Chowchilla Subbasin boundary for estimated seepage and evaporation	MID Recorder 4, NRCS soil survey, Fresno State/Madera/ Madera II CIMIS Stations
	Madera Canal	CVP Supplies	Reported Madera Canal flood and irrigation releases	USBR records for Madera Canal Miles 33.6 and 35.6
Surface Outflows	Chowchilla River	Local Supplies	Calculated as the difference of total inflows and total outflows from the GSA Rivers and Streams water budgets. The faction of water corresponding to each waterway and water source type is estimated based on the fraction of total inflows corresponding to each water source type along each waterway.	Closure Term
	Eastside Bypass	Mixed CVP Supplies / Local Supplies		
	Fresno River			
TTWD Purchased Water	Poso Canal Pipeline and Columbia Canal Company Pipeline	Local Imported Supplies	Reported purchased water volume	TTWD purchased water annual summary
MID Deliveries to CWD	MID Conveyance System	CVP Supplies	Measured by MID, or reported from other districts' records	MID STORM[1] delivery database

[1] The water ordering and delivery management software used by MID.

5 Total Water Use (§356.2.b.4)

This section summarizes the annual volumes and data sources for total water use in the Subbasin through the current reporting year (water year 2023).

5.1 QUANTIFICATION BY WATER USE SECTOR AND WATER SOURCE TYPE

Water use is defined by ASCE (2016) as “water that is used for a specific purpose such as domestic use, irrigation, or industrial processing.” This definition includes both consumptive and non-consumptive components.

In the context of agriculture, consumptive water use is defined as “the part of water withdrawn that is evaporated, transpired, incorporated into products or crops, consumed by humans or livestock, or otherwise removed from the immediate water environment” (ASCE, 2016). As most field crops dry to a very low moisture content approaching harvest, total consumptive water use is generally equivalent to the combined evaporation and crop transpiration, together referred to as crop evapotranspiration (ET_c). Non-consumptive water use is generally equal to the remaining volume of precipitation and applied water that is not consumptively used.

Accordingly, the total water use in the Chowchilla Subbasin is assumed to be equal to the total combined precipitation, agricultural applied water, managed recharge applied water, and urban water use from all sources within the Subbasin boundaries.

Water sources available for use include applied water (surface water and groundwater) and precipitation. **Table 5-1** summarizes the total water use in the Subbasin, by water use sector and water source type from 1989 through 2023 (the current reporting year). The methodology and data sources used to develop this table are provided below.

In addition to reporting the total water use in the Subbasin, the total consumptive water use (total ET_c) is also reported below, as this represents the volume of water that is no longer available for use within the Subbasin (i.e., unavailable for reuse or groundwater extraction). **Table 5-2** summarizes the consumptive water use in the Subbasin, by water use sector and water source type from 1989 through 2023 (the current reporting year). The methodology and data sources used to develop these tables are provided below.

Table 5-1. Chowchilla Subbasin Total Water Use, by Water Use Sector and Water Source Type (acre-feet, rounded).

Water Year (Type)	Agricultural				Managed Recharge				Native Vegetation				Urban				Total			
	Total	Surface Water	Ground-water	Precipitation	Total	Surface Water	Ground-water	Precipitation	Total	Surface Water	Ground-water	Precipitation	Total	Surface Water	Ground-water	Precipitation	Total	Surface Water	Ground-water	Precipitation
1989 (C)	409,450	40,740	251,330	117,380	0	0	0	0	21,530	0	0	21,530	8,550	0	3,440	5,110	439,530	40,740	254,770	144,020
1990 (C)	420,580	27,270	283,970	109,340	0	0	0	0	20,070	0	0	20,070	8,650	0	3,750	4,900	449,300	27,270	287,720	134,310
1991 (C)	444,570	42,300	288,060	114,210	0	0	0	0	20,890	0	0	20,890	9,080	0	3,820	5,260	474,540	42,300	291,880	140,360
1992 (C)	452,030	36,910	321,910	93,210	0	0	0	0	17,060	0	0	17,060	9,360	0	4,930	4,430	478,450	36,910	326,840	114,700
1993 (W)	485,090	112,750	214,470	157,870	0	0	0	0	28,750	0	0	28,740	11,660	0	3,930	7,730	525,500	112,750	218,410	194,340
1994 (C)	432,280	76,390	266,490	89,400	10	10	0	0	16,220	0	0	16,220	9,390	0	4,880	4,510	457,900	76,400	271,370	110,130
1995 (W)	472,710	129,550	151,330	191,830	0	0	0	0	34,630	0	0	34,630	12,610	0	2,640	9,970	519,950	129,550	153,970	236,430
1996 (W)	462,010	136,480	208,240	117,290	0	0	0	0	20,960	0	0	20,960	10,290	0	4,030	6,260	493,260	136,480	212,270	144,510
1997 (W)	521,420	141,640	245,750	134,030	560	560	0	0	23,740	0	0	23,740	13,990	0	6,650	7,340	559,710	142,200	252,400	165,110
1998 (W)	459,610	127,620	170,830	161,160	420	420	0	0	28,270	0	0	28,270	12,520	0	3,470	9,050	500,820	128,040	174,300	198,480
1999 (AN)	422,050	132,660	224,010	65,380	0	0	0	0	11,360	0	0	11,360	9,380	0	5,620	3,760	442,790	132,660	229,630	80,500
2000 (AN)	462,620	131,180	224,820	106,620	0	0	0	0	18,340	0	0	18,340	11,230	0	4,950	6,280	492,190	131,180	229,770	131,240
2001 (D)	456,800	102,870	254,620	99,310	0	0	0	0	17,120	0	0	17,120	10,850	0	4,830	6,020	484,770	102,870	259,450	122,450
2002 (D)	467,860	64,300	313,430	90,130	0	0	0	0	15,200	0	0	15,200	12,370	0	6,580	5,790	495,430	64,300	320,010	111,120
2003 (BN)	453,500	77,530	296,790	79,180	0	0	0	0	13,040	0	0	13,040	12,080	0	6,670	5,410	478,620	77,530	303,460	97,630
2004 (D)	474,100	60,360	347,960	65,780	0	0	0	0	10,570	0	0	10,570	13,600	0	8,840	4,760	498,270	60,360	356,800	81,110
2005 (W)	447,220	128,760	205,010	113,450	0	0	0	0	17,770	0	0	17,770	14,470	0	5,780	8,690	479,460	128,760	210,790	139,910
2006 (W)	457,110	153,920	178,220	124,970	0	0	0	0	19,080	0	0	19,080	15,910	0	5,830	10,080	492,100	153,920	184,050	154,130
2007 (C)	440,330	86,740	302,980	50,610	0	0	0	0	7,510	0	0	7,520	13,940	0	9,650	4,290	461,780	86,740	312,620	62,420
2008 (C)	455,540	71,030	307,640	76,870	0	0	0	0	11,120	0	0	11,120	16,740	0	9,910	6,830	483,400	71,030	317,550	94,820
2009 (BN)	413,110	84,430	259,270	69,410	0	0	0	0	9,770	0	0	9,770	16,480	0	10,020	6,460	439,360	84,430	269,290	85,640
2010 (AN)	433,080	136,810	177,000	119,270	0	0	0	0	16,290	0	0	16,290	17,500	0	5,920	11,580	466,870	136,810	182,920	147,140
2011 (W)	469,370	163,230	181,030	125,110	0	0	0	0	16,360	0	0	16,360	19,180	0	6,570	12,610	504,910	163,230	187,600	154,080
2012 (D)	450,940	102,070	305,780	43,090	0	0	0	0	5,080	0	0	5,080	15,380	0	11,110	4,270	471,400	102,070	316,890	52,440
2013 (C)	467,060	53,320	340,050	73,690	0	0	0	0	7,760	0	0	7,760	18,310	0	11,150	7,160	493,130	53,320	351,200	88,610
2014 (C)	436,480	440	399,610	36,430	0	0	0	0	3,380	0	0	3,380	14,440	0	10,970	3,470	454,300	440	410,580	43,280
2015 (C)	482,810	530	432,110	50,170	0	0	0	0	4,300	0	0	4,300	16,690	0	12,080	4,610	503,800	530	444,190	59,080
2016 (D)	502,950	68,790	305,980	128,180	0	0	0	0	9,670	0	0	9,670	18,890	0	7,470	11,420	531,510	68,790	313,450	149,270
2017 (W)	510,760	191,160	194,340	125,260	16,180	16,180	0	0	8,820	0	0	8,820	18,380	0	7,530	10,850	554,140	207,340	201,870	144,930
2018 (BN)	483,150	122,950	284,190	76,010	130	130	0	0	4,950	0	0	4,950	14,280	0	7,830	6,450	502,510	123,080	292,020	87,410
2019 (W)	489,700	166,050	203,300	120,350	8,840	8,840	0	0	7,370	0	0	7,370	16,640	0	6,670	9,970	522,550	174,890	209,970	137,690
2020 (D)	462,950	95,150	304,360	63,440	0	0	0	0	3,890	0	0	3,890	14,330	0	9,070	5,260	481,170	95,150	313,430	72,590
2021 (C)	459,040	11,460	431,220	16,360	0	0	0	0	1,050	0	0	1,050	13,310	0	11,900	1,410	473,400	11,460	443,120	18,820
2022 (C)	452,800	16,780	404,860	31,160	1,060	1,060	0	0	1,380	0	0	1,380	13,110	0	10,570	2,540	468,350	17,840	415,430	35,080
2023 (W)	399,150	189,840	92,620	116,690	60,440	60,440	0	0	21,720	0	0	21,720	9,990	0	3,460	6,530	491,300	250,280	96,080	144,940
Average (1989-2014)	**452,570**	**93,130**	**258,480**	**100,960**	**40**	**40**	**0**	**0**	**16,610**	**0**	**0**	**16,610**	**13,000**	**0**	**6,380**	**6,620**	**482,220**	**93,160**	**264,870**	**124,190**
Average (1989-2023)	**457,440**	**93,830**	**267,820**	**95,790**	**2,500**	**2,500**	**0**	**0**	**14,140**	**0**	**0**	**14,140**	**13,530**	**0**	**6,930**	**6,600**	**487,610**	**96,330**	**274,750**	**116,530**
W	470,370	149,180	185,920	135,270	7,860	7,860	0	0	20,680	0	0	20,680	14,150	0	5,140	9,010	513,060	157,040	191,060	164,960
AN	439,250	133,550	208,610	97,090	0	0	0	0	15,330	0	0	15,330	12,710	0	5,500	7,210	467,290	133,550	214,110	119,630
BN	449,920	94,970	280,080	74,870	40	40	0	0	9,250	0	0	9,250	14,280	0	8,170	6,110	473,500	95,010	288,260	90,230
D	469,280	82,260	305,360	81,660	0	0	0	0	10,250	0	0	10,250	14,230	0	7,980	6,250	493,760	82,260	313,340	98,160
C	446,080	38,660	335,850	71,570	90	90	0	0	11,020	0	0	11,020	12,630	0	8,090	4,540	469,830	38,750	343,940	87,140

Table 5-2. Chowchilla Subbasin Consumptive Water Use, by Water Use Sector and Water Source Type (acre-feet, rounded).

Water Year (Type)	Agricultural				Managed Recharge				Native Vegetation				Urban				Total			
	Total	Surface Water	Ground-water	Precipitation	Total	Surface Water	Ground-water	Precipitation	Total	Surface Water	Ground-water	Precipitation	Total	Surface Water	Ground-water	Precipitation	Total	Surface Water	Ground-water	Precipitation
1989 (C)	277,060	25,660	177,930	73,470	0	0	0	0	16,730	0	0	16,730	5,960	0	2,610	3,350	299,750	25,660	180,540	93,550
1990 (C)	295,140	17,130	201,770	76,240	0	0	0	0	16,670	0	0	16,670	6,360	0	2,730	3,630	318,170	17,130	204,500	96,540
1991 (C)	290,960	26,490	203,140	61,330	0	0	0	0	14,820	0	0	14,820	5,780	0	2,690	3,090	311,560	26,490	205,830	79,240
1992 (C)	325,520	23,880	235,750	65,890	0	0	0	0	18,030	0	0	18,030	7,230	0	3,440	3,790	350,780	23,880	239,190	87,710
1993 (W)	312,470	65,830	159,170	87,470	0	0	0	0	17,220	0	0	17,220	7,080	0	2,920	4,160	336,770	65,830	162,090	108,850
1994 (C)	314,570	50,580	200,420	63,570	10	10	0	0	14,280	0	0	14,280	7,190	0	3,640	3,550	336,050	50,590	204,060	81,400
1995 (W)	293,420	73,820	116,350	103,250	0	0	0	0	16,550	0	0	16,550	6,750	0	2,210	4,540	316,720	73,820	118,560	124,340
1996 (W)	328,400	87,010	158,150	83,240	0	0	0	0	17,490	0	0	17,490	7,450	0	2,570	4,880	353,340	87,010	160,720	105,610
1997 (W)	333,910	88,250	177,390	68,270	20	20	0	0	15,470	0	0	15,470	8,070	0	3,780	4,290	357,470	88,270	181,170	88,030
1998 (W)	297,250	73,110	131,660	92,480	30	30	0	0	14,180	0	0	14,180	7,230	0	3,000	4,230	318,690	73,140	134,660	110,890
1999 (AN)	313,390	89,890	170,890	52,610	0	0	0	0	12,940	0	0	12,940	7,480	0	3,670	3,810	333,810	89,890	174,560	69,360
2000 (AN)	335,290	91,970	173,310	70,010	0	0	0	0	14,130	0	0	14,130	8,160	0	4,000	4,160	357,580	91,970	177,310	88,300
2001 (D)	335,770	71,210	194,620	69,940	0	0	0	0	15,330	0	0	15,330	8,260	0	3,610	4,650	359,360	71,210	198,230	89,920
2002 (D)	343,980	43,610	236,820	63,550	0	0	0	0	14,250	0	0	14,250	9,370	0	4,740	4,630	367,600	43,610	241,560	82,430
2003 (BN)	338,240	53,190	226,700	58,350	0	0	0	0	11,140	0	0	11,140	9,630	0	5,370	4,260	359,010	53,190	232,070	73,750
2004 (D)	364,120	42,070	271,110	50,940	0	0	0	0	11,820	0	0	11,820	11,320	0	6,710	4,610	387,260	42,070	277,820	67,370
2005 (W)	323,270	83,370	162,290	77,610	0	0	0	0	12,920	0	0	12,920	10,430	0	4,930	5,500	346,620	83,370	167,220	96,030
2006 (W)	331,270	101,240	146,190	83,840	0	0	0	0	13,790	0	0	13,790	11,180	0	4,840	6,340	356,240	101,240	151,030	103,970
2007 (C)	339,570	60,900	237,180	41,490	0	0	0	0	10,030	0	0	10,030	11,680	0	6,550	5,130	361,280	60,900	243,730	56,650
2008 (C)	342,680	48,010	239,970	54,700	0	0	0	0	10,050	0	0	10,050	13,240	0	7,780	5,460	365,970	48,010	247,750	70,210
2009 (BN)	323,520	60,870	209,080	53,570	0	0	0	0	8,170	0	0	8,170	13,500	0	8,360	5,140	345,190	60,870	217,440	66,880
2010 (AN)	323,730	89,120	149,590	85,020	0	0	0	0	11,330	0	0	11,330	12,590	0	5,540	7,050	347,650	89,120	155,130	103,400
2011 (W)	333,570	102,930	148,320	82,320	0	0	0	0	11,790	0	0	11,790	13,220	0	5,050	8,170	358,580	102,930	153,370	102,280
2012 (D)	353,050	73,040	244,010	36,000	0	0	0	0	6,230	0	0	6,230	12,310	0	7,220	5,090	371,590	73,040	251,230	47,320
2013 (C)	359,330	37,540	271,410	50,380	0	0	0	0	7,040	0	0	7,040	14,320	0	8,770	5,550	380,690	37,540	280,180	62,970
2014 (C)	347,440	310	314,800	32,330	0	0	0	0	3,400	0	0	3,400	11,990	0	8,590	3,400	362,830	310	323,390	39,130
2015 (C)	386,190	370	348,420	37,400	0	0	0	0	3,610	0	0	3,610	13,350	0	9,750	3,600	403,150	370	358,170	44,610
2016 (D)	382,950	49,680	245,060	88,210	0	0	0	0	7,160	0	110	7,050	13,710	0	6,740	6,970	403,820	49,680	251,910	102,230
2017 (W)	363,230	107,400	175,040	80,790	810	810	0	0	6,110	0	0	6,110	12,260	0	5,380	6,880	382,410	108,210	180,420	93,780
2018 (BN)	375,080	88,160	230,770	56,150	120	120	0	0	4,170	0	0	4,170	10,890	0	5,940	4,950	390,260	88,280	236,710	65,270
2019 (W)	377,420	117,650	168,100	91,670	510	510	0	0	5,870	0	0	5,870	12,780	0	5,690	7,090	396,580	118,160	173,790	104,630
2020 (D)	371,800	70,360	249,850	51,590	0	0	0	0	3,760	0	0	3,760	11,470	0	6,430	5,040	387,030	70,360	256,280	60,390
2021 (C)	378,250	8,320	354,520	15,410	0	0	0	0	1,700	0	0	1,700	11,190	0	8,670	2,520	391,140	8,320	363,190	19,630
2022 (C)	374,570	12,530	340,510	21,530	0	0	0	0	890	0	0	890	10,830	0	9,000	1,830	386,290	12,530	349,510	24,250
2023 (W)	314,250	140,220	88,500	85,530	0	0	0	0	13,750	0	0	13,750	7,180	0	3,600	3,580	335,180	140,220	92,100	102,860
Average (1989-2014)	**326,040**	**60,810**	**198,390**	**66,840**	**0**	**0**	**0**	**0**	**12,920**	**0**	**0**	**12,920**	**9,530**	**0**	**4,820**	**4,710**	**348,480**	**60,810**	**203,200**	**84,470**
Average (1989-2023)	**337,160**	**62,160**	**210,250**	**64,750**	**40**	**40**	**0**	**0**	**10,930**	**0**	**0**	**10,930**	**10,040**	**0**	**5,330**	**4,710**	**358,180**	**62,210**	**215,580**	**80,390**
W	328,040	94,620	148,290	85,130	120	120	0	0	13,200	0	0	13,200	9,420	0	4,000	5,420	350,780	94,750	152,280	103,750
AN	329,570	94,540	149,630	85,400	120	120	0	0	13,050	0	0	13,050	9,410	0	3,990	5,420	352,170	94,670	153,630	103,870
BN	324,150	90,330	164,600	69,220	0	0	0	0	12,800	0	0	12,800	9,410	0	4,400	5,010	346,350	90,330	169,000	87,020
D	345,610	67,410	222,180	56,020	40	40	0	0	7,830	0	0	7,830	11,330	0	6,550	4,780	364,820	67,450	228,740	68,630
C	358,610	58,330	240,240	60,040	0	0	0	0	9,760	0	20	9,740	11,070	0	5,910	5,160	379,440	58,330	246,170	74,940

5.2 DATA SOURCES

ET_c volumes were calculated by water use sector and water source type using a root zone water balance model as described in Section 2.2.3.3 of the Chowchilla Subbasin Revised GSP.

Daily ET_o values were computed based on weather and climate data in the study area (**Table 5-3**) and were provided as inputs to the root zone model for calculating crop consumptive use requirements. Daily precipitation inflows to each Land Surface System water use sector were calculated as the daily precipitation depth derived from weather station data (**Table 5-3**) applied over the total area of each water use sector within the Subbasin (in acres). Daily precipitation depths were provided as inputs to the root zone model to compute the fraction of ET_c that results from precipitation.

Table 5-3. Chowchilla Subbasin Weather and Climate Data Sources.

Station/Source	Station Type	Start Date	End Date	Comment
Fresno State	CIMIS	Oct. 2, 1988	May 12, 1998	CIMIS Station #80. Used before Madera CIMIS station was installed.
Madera	CIMIS	May 13, 1998	Apr. 2, 2013	CIMIS Station #145. Moved eastward 2 miles in 2013 and renamed "Madera II."
Madera II	CIMIS	Apr. 3, 2013	Jun. 23, 2018	CIMIS Station #188.
Spatial CIMIS	Spatial CIMIS	Jun. 24, 2018	Sep. 30, 2023	Used for developing ET_o time series after CIMIS station data was available.
Madera	NOAA NCEI	Jun. 24, 2018	Sep. 30, 2023	Used for developing precipitation time series after CIMIS station data was available.

6 Change in Groundwater Storage (§356.2.b.5)

6.1 CHANGE IN GROUNDWATER STORAGE MAPS

Consistent with 23 CCR §354.18.b, based on a comparison of the annual spring groundwater elevation contour maps representing seasonal high groundwater conditions, changes in groundwater elevation were calculated between Spring 2022 and Spring 2023. To calculate annual change in groundwater storage from the groundwater level contour maps, the difference in groundwater elevation between annual spring contour maps was calculated for each of the principal aquifers (Upper and Lower Aquifers). Both confined and unconfined groundwater conditions occur within the Chowchilla Subbasin. To accurately estimate change in groundwater storage from changes in groundwater levels, it is important to differentiate areas of confined groundwater conditions from unconfined conditions. Accordingly, the groundwater elevation data was reviewed to estimate an area over which the Lower Aquifer exhibits confined conditions and where the groundwater levels are representative of a potentiometric surface. This was done by comparing groundwater elevations to the elevation of the bottom of the Corcoran Clay confining geologic unit. The extent of the area where groundwater elevations in the Lower Aquifer occur above the bottom of the Corcoran Clay was delineated as the area of confined groundwater conditions for the purpose of calculating change in groundwater storage.

Outside of the delineated confined area, changes in groundwater levels (in both the Upper and Lower Aquifers) were multiplied by representative specific yield values to estimate change in groundwater storage. Within the delineated area of confinement in the Lower Aquifer, groundwater potentiometric surface changes in the Lower Aquifer were multiplied by a much smaller storage coefficient value to calculate annual changes in groundwater storage in the Lower Aquifer. The specific yield and storage coefficient values used in the analysis are derived from values in the calibrated integrated groundwater flow model (MCSim) developed and applied during the preparation of the GSP. The specific yield values in MCSim are lower than some previous values estimated for the Chowchilla Subbasin; however, recent test hole drilling and associated subsurface geologic and geophysical logging conducted at 11 nested monitoring well sites across the Chowchilla Subbasin indicate a high fraction of fine-grained sediments in many parts of the Chowchilla Subbasin, which is consistent with the relatively lower specific yield values in MCSim, especially for deeper materials within the Lower Aquifer.

Figures 6-1 and 6-2 show the spatial distribution of calculated annual change in groundwater level for the most recent reporting year between Spring 2022 and Spring 2023 for the Upper Aquifer unconfined groundwater zone and also for the Lower Aquifer. Because there was incomplete spatial coverage of groundwater elevation data within the Chowchilla Subbasin, it was not deemed appropriate to extend groundwater elevation contours into some parts of the Chowchilla Subbasin. In these areas without contour data, the average change in groundwater elevation value calculated for the area with data was applied to areas without data to estimate change in storage amounts for the Lower Aquifer. However, the portion of the Upper unconfined aquifer without groundwater contour data was assumed to have no net storage change because it is an area comprised primarily of thin saturation and perched groundwater conditions. **Tables 6-1 through 6-3** summarize the calculated annual change in groundwater storage volumes for each year and by principal aquifer for the Chowchilla Subbasin. The discussion of estimated change in storage values presented below is based on the aquifer parameter values derived from MCSim as presented in **Tables 6-1 through 6-3**. Change in storage values for both the unconfined Upper Aquifer and Lower Aquifer zones for representative specific yield and storativity values are presented in **Table 6-1**. Maps of the spatial distribution of change in storage in the principal aquifers for the most recent period from Spring 2022 to Spring 2023 are presented in **Figures 6-3 and 6-4**. All maps of change in groundwater storage utilize specific yield and storage coefficient values derived from MCSim. Maps of change in groundwater levels and change in groundwater storage for each of the years between Spring 2016 and 2022, separated by aquifer, are presented in **Appendix C**.

Using representative aquifer parameter values derived from the calibrated groundwater flow model MCSim, the calculated changes in groundwater levels in the Upper Aquifer translate to annual changes in groundwater storage of about 30,700 AF from Spring 2022 to 2023 (**Table 6-1**). Negative change in storage values indicate depletion of groundwater storage, whereas positive change in storage values represent accretion of groundwater in storage.

Between Spring 2022 and Spring 2023, the change in groundwater storage in the combined Lower Aquifer and Undifferentiated Unconfined Zone was about 17,700 AF (**Table 6-2**). Of this total, approximately 900 AF occurred in the confined zone. Since GSP implementation, groundwater extraction from the Lower Aquifer confined zone has generally declined, coinciding with implementation of the Subsidence Control Measures Agreement (Agreement). Under the Agreement, participating landowners – who collectively manage more than 14,000 acres in the Western Management Area of the Chowchilla Subbasin – have reduced their pumping from the Lower Aquifer with the goal of mitigating subsidence and preventing adverse impacts to surrounding critical infrastructure. At the same time, participants are implementing projects that increase surface water use for irrigation and groundwater recharge in the Upper Aquifer. These measures have reduced groundwater demand and allowed participating landowners to shift pumping from the Lower Aquifer to the Upper Aquifer, where recharge projects can effectively replenish groundwater storage during wetter years. Thus, some increase in groundwater usage from the Upper Aquifer, especially in dry years, may be attributable to successful implementation of these subsidence control measures, which have already successfully reduced subsidence rates in the TTWD area of the Western Management Area. Additional information about the Agreement is provided in **Section 7.2.4**, below, and in Section 3.3.3.7 of the Chowchilla Subbasin Revised GSP.

The combined change in groundwater storage for the entire Subbasin was about 48,400 AF from Spring 2022 to 2023, indicating a net recharge of groundwater storage (**Table 6-3**). Notably, there is uncertainty in this estimate, and there are also other processes that contribute to the net change in groundwater storage besides groundwater pumping (e.g., subsurface inflows and outflows). These contributing factors were considered in the MCSim groundwater model used in development of the Chowchilla Subbasin GSP and will be further evaluated in future updates to the MCSim model.

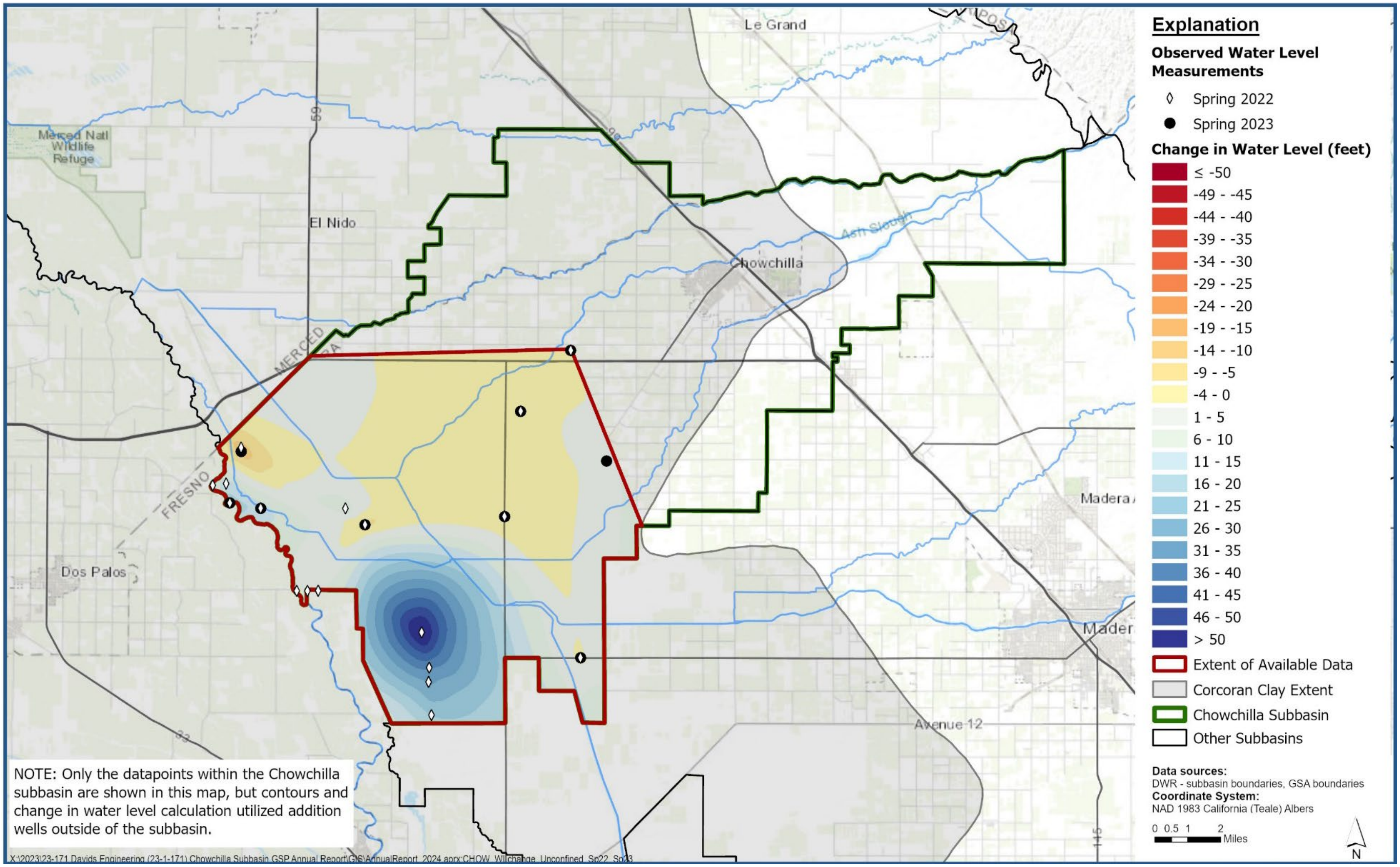


Figure 6-1. Change in Groundwater Level in the Upper Aquifer – Spring 2022 through Spring 2023.

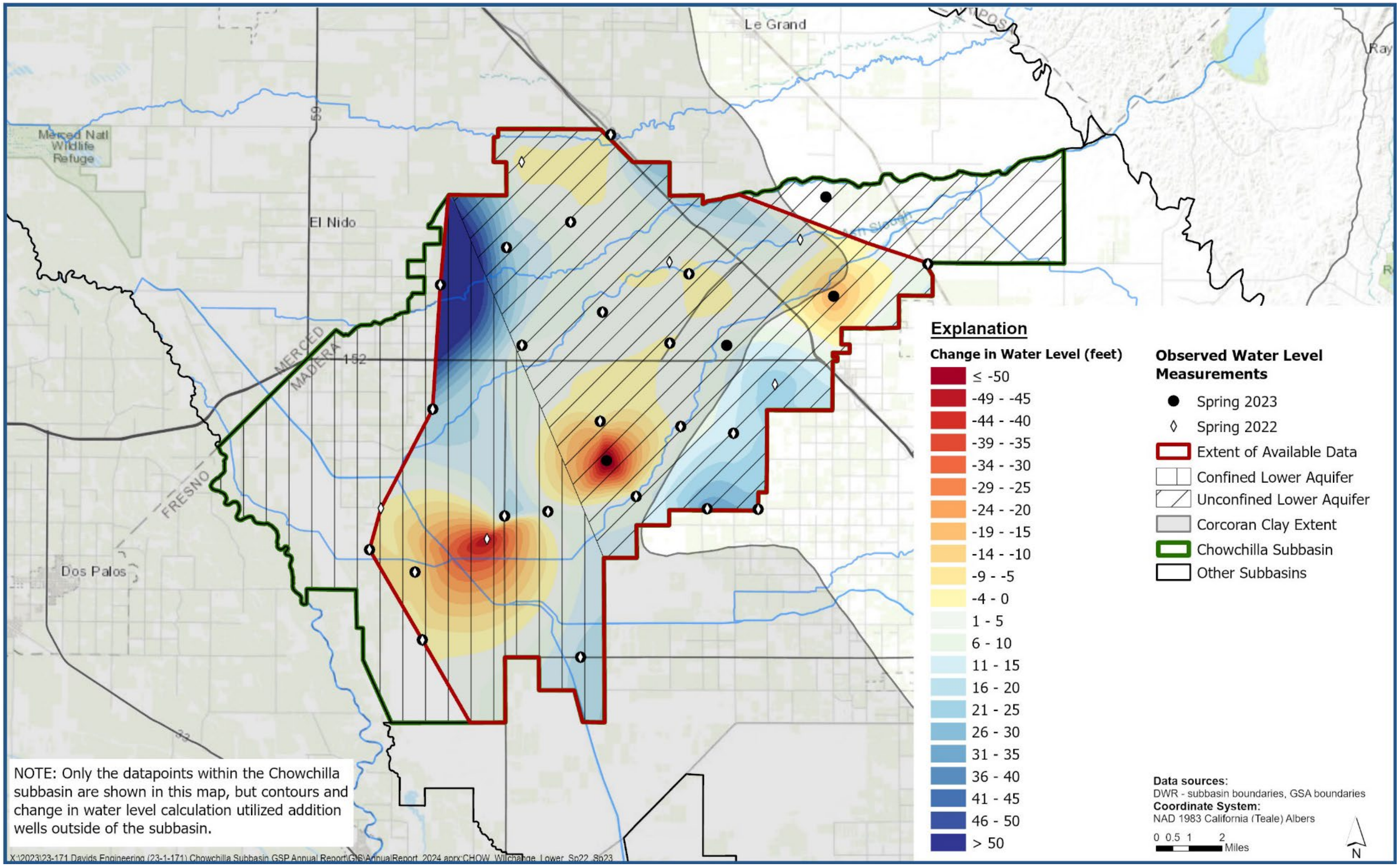


Figure 6-2. Change in Groundwater Level in the Lower Aquifer/Undifferentiated Unconfined Zone – Spring 2022 through Spring 2023.

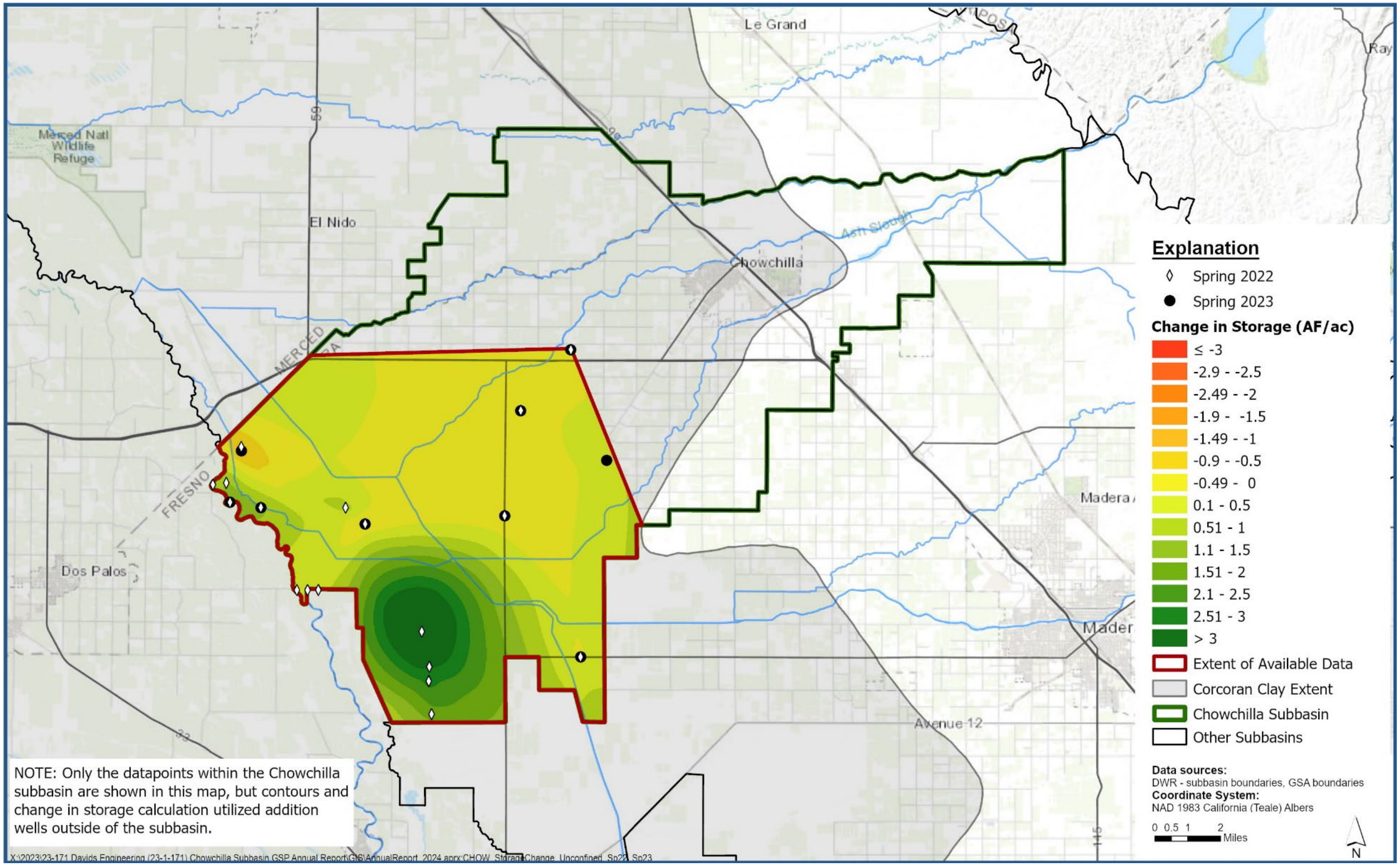


Figure 6-3. Change in Groundwater Storage in the Upper Aquifer – Spring 2022 through Spring 2023.

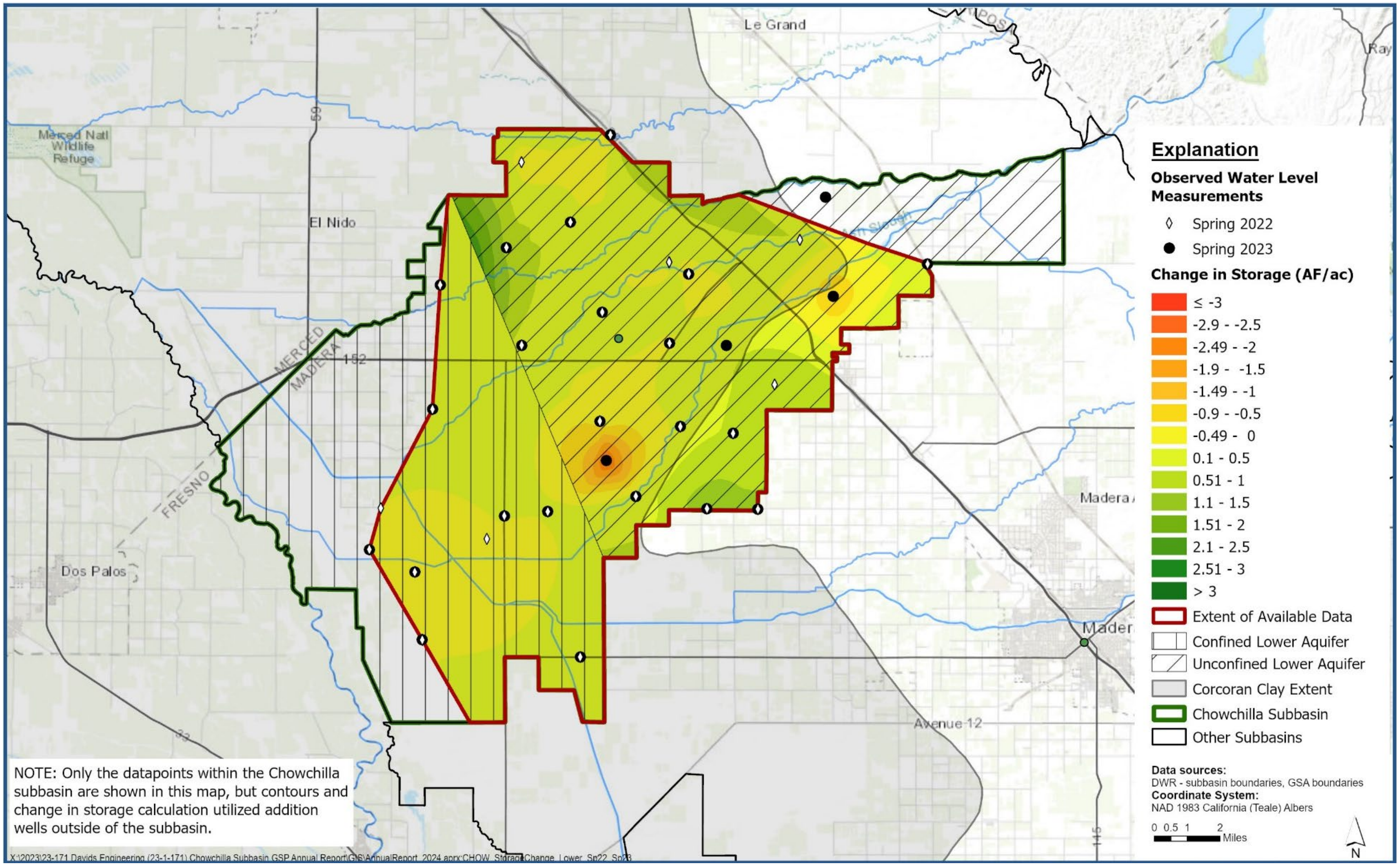


Figure 6-4. Change in Groundwater Storage in the Lower Aquifer/Undifferentiated Unconfined Zone – Spring 2022 through Spring 2023.

Table 6-1. Calculated Change in Groundwater Storage in the Upper Aquifer Zone.

Analysis Time Period	Specific Yield	Average Groundwater Elevation Change (ft)	Average Groundwater Storage Change Per Acre (AF/acre)	Area Used for Estimating Groundwater Storage Change (acres)	Total Unconfined Groundwater Storage Change in Chowchilla Subbasin (AF)	Notes on Specific Yield Basis
Spring 2022-2023	0.086	5.56	0.48	64,155	30,721	Representative value from MCSim model

Table 6-2. Calculated Change in Groundwater Storage in the Combined Lower Aquifer and Undifferentiated Unconfined Zone.

Analysis Time Period	Lower Aquifer Zone	Storage Coefficient[1]	Specific Yield[2]	Average Change in Groundwater Potentiometric Surface (ft)	Average Confined Groundwater Storage Change Per Acre (AF/acre)	Area Used for Estimating Confined Groundwater Storage Change (acres)	Total Groundwater Storage Change[3] (AF)	Notes on Storage Coefficient Basis
Spring 2022-2023	Confined	1.52x10-3		9.73	0.01	57,999	855	Representative value from MCSim model
	Unconfined		0.041	4.71	0.19	87,575	16,825	
	TOTAL					145,574	17,681	

[1] Storage Coefficient value applies to those areas below the Corcoran Clay interpreted to be confined (57,999 acres).

[2] Specific Yield value applies to those areas below the Corcoran Clay and east of Corcoran Clay extent interpreted to be unconfined (87,575 acres).

[3] Total area of the Lower Aquifer within the Chowchilla Subbasin is 145,574 acres.

Table 6-3. Total Calculated Change in Groundwater Storage in the GSP Area.

Analysis Time Period	Average Groundwater Storage Change Per Acre (AF/acre)	Total GSP Area (acres)	Total GSP Area Groundwater Storage Change (AF)
Spring 2022-2023	0.33	145,574	48,402

6.2 GROUNDWATER USE AND CHANGE IN GROUNDWATER STORAGE

Annual groundwater extraction and change in groundwater storage in the Subbasin are shown in **Figure 6-5** for water years 2015 to 2023. Groundwater extraction is estimated or directly measured following the procedures described in the corresponding section above. Change in groundwater storage is estimated based on an annual comparison of spring groundwater elevations. Change in groundwater storage is not provided for water years 2015 and 2016, as there was insufficient historical data to accurately calculate change in storage those years. Historical groundwater extraction in water years 1989 through 2014 are shown in Figure 2-89 of the Chowchilla Subbasin Revised GSP (page 2-97). Historical annual changes in groundwater storage and cumulative changes in storage are also shown in the Chowchilla Subbasin Revised GSP (Appendix D.1.a, pages A6.D-467 and A6.D-468). Historical changes in groundwater storage between 1989 and 2014 were calculated based on a water balance of the Subbasin groundwater system using the MCSim numerical groundwater flow model (described in the Chowchilla Subbasin GSP). Total annual groundwater extraction decreases in wetter years and increases in drier years, while the annual change in groundwater storage has fluctuated between approximately 279,000 AF and -150,000 AF since water year 2017 (**Figure 6-5**).

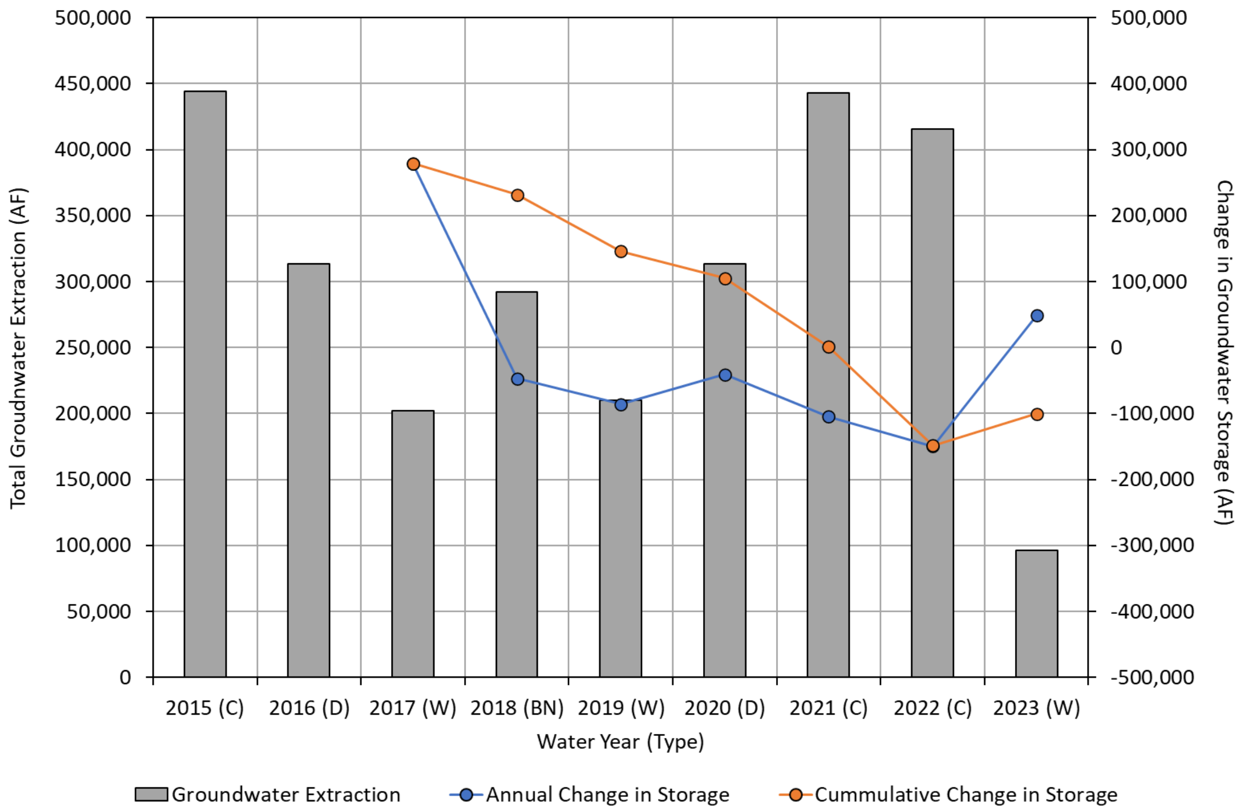


Figure 6-5. Annual Groundwater Storage Changes and Extraction.

6.3 SUBSIDENCE DATA AND MAPS

The GSP notes that subsidence data will be reviewed periodically as it becomes available. The amount and rate of subsidence in the Subbasin and surrounding areas is being tracked by various agencies using different methods. Interferometric synthetic aperture radar (InSAR) measurements from satellite data have been collected for the time period from 2015 to 2023. Maps of subsidence for the most recent seven years and cumulative for 2015 to 2023 are included in **Appendix D**.

6.3.1 Western Management Area

Review of the cumulative subsidence map over the seven-year period indicates a range of total subsidence from approximately 1.5 to 4.5 feet over this time span in the Western Management Area of Chowchilla Subbasin. However, review of the maps for individual years generally indicates more of this subsidence occurred in the early portion of the 2015 to 2022 time period than in the later portion of the time period. While there are substantial areas of missing data on these maps (indicated by white areas), it appears that much of the western portion of Chowchilla Subbasin experienced 0.6 to 1.0 feet of subsidence from March 2015 to March 2016, while most of this same area showed 0.2 to 0.4 feet of subsidence from March 2022 to March 2023. This gradual decrease in subsidence over time may reflect the lag time often associated with subsidence; in this case, a lag from low groundwater elevations experienced in 2015 at the end of the previous drought. However, data is missing in some key areas where the greatest subsidence prior to 2016 was evident, and understanding changes in the spatial distribution of subsidence will require further review as more data becomes available.

Additional subsidence data is also available for ongoing benchmark surveys performed for the San Joaquin River Restoration Project, with data now available through December 2022 (**Appendix D**). These benchmark subsidence data also indicate decreasing rates of subsidence in western Chowchilla Subbasin from 2015-2016 to 2021-2022.

6.3.2 Eastern Management Area

Review of the cumulative subsidence map over the six-year period indicates a range of total subsidence from approximately 0 to 3.5 feet over this time span in the Eastern Management Area of Chowchilla Subbasin. The InSAR maps also indicate the area of greatest subsidence appears to have shifted slightly into the Eastern Management Area, with subsidence rates ranging from 0.4 to 0.8 feet of subsidence during the March 2022 to March 2023 period.

Additionally, the San Joaquin River Restoration Project benchmark subsidence data also indicates a shift in the area of greatest subsidence to the Eastern Management Area in the most recent December 2021 to December 2022 map.

7 Groundwater Sustainability Plan Implementation Progress (§356.2.c)

7.1 IMPLEMENTATION OF PROJECTS AND MANAGEMENT ACTIONS (§356.2.C)

The implementation of projects and management actions (PMAs) is critical for achieving and maintaining groundwater sustainability, as described in the GSP. PMAs are scheduled for implementation throughout the 2020 through 2040 implementation period, with different timelines anticipated for implementation of each PMA. The estimated annual costs and benefits (i.e., increased groundwater recharge or reduced groundwater use) of PMAs proposed by the GSAs vary across this implementation period, as described in the GSP.

This section describes progress that has been made toward implementation of the GSP and specific PMAs since the previous Annual Report. First, a brief overview is given regarding the GSAs' efforts since 2022 to revise the GSP to address deficiencies identified by DWR and to develop work plans and monitoring network improvements to fill data gaps. Next, a summary is given regarding the successful development and recent implementation of the Domestic Well Mitigation Program. The remainder of this section describes the progress made in implementation of PMAs proposed by each GSA.

7.1.1 GSP Revisions, Workplans, and Monitoring Network Improvements

In January 2022, DWR completed a review of the Chowchilla Subbasin GSP and released an incomplete determination, initiating a 180-day consultation period between January 28, 2022, and July 27, 2022. The four GSAs completed additional technical analyses and GSP revisions to address the identified deficiencies and developed two workplans to address remaining data gaps with regard to subsidence and interconnected surface water. The Chowchilla Subbasin Revised GSP was adopted and submitted to DWR for evaluation on July 27, 2022.

As part of the GSP revision process, the GSAs developed two workplans to address remaining data gaps related to subsidence and interconnected surface water. The GSAs also developed a plan for enhancing the monitoring network and data collection activities by incorporating existing wells into the monitoring network, installing new multi-completing monitoring wells to fill key data gaps, and installing automated continuous monitoring equipment at key locations to improve monitoring frequency and data accessibility. Implementation of these work plans and monitoring network enhancements are expected to improve understanding of groundwater conditions in the Subbasin, fill key data gaps, and replace monitoring network sites that have become inaccessible or have been found otherwise unsuitable for monitoring conditions in the Subbasin. In December 2022, the GSAs submitted the workplans to DWR via the SGMA portal and included the workplans and monitoring network enhancements in a grant application submitted to DWR's Sustainable Groundwater Management Grant Program.

In March 2023, preceding submittal of the previous Annual Report, DWR completed its review of the revised Chowchilla Subbasin GSP and released an inadequate determination. Following the determination, the GSAs coordinated together and worked cooperatively with staff at DWR and the State Water Resources Control Board (SWRCB) to review the reasons for this determination and expeditiously complete the additional revisions necessary to receive an adequate determination. In May 2023, the GSAs transmitted a draft revised GSP to SWRCB staff. The

GSAs have since continued their coordination with the SWRCB and DWR to identify a pathway back to DWR jurisdiction and local control of the Chowchilla Subbasin. While the GSAs continue to be frustrated with DWR's determination, the GSAs remain steadfast in their commitment and dedication to the long-term sustainability of the Subbasin, and will continue their ongoing efforts to implement the Revised GSP and initiate work on the workplans and monitoring network enhancements.

7.1.2 Domestic Well Mitigation Program

A key element included and described in the Chowchilla Subbasin Revised GSP is a Domestic Well Mitigation Program to mitigate undesirable results for domestic well users that are significantly and adversely impacted by groundwater level declines during the GSP implementation period while the GSAs implement other PMAs to achieve and maintain sustainability.

Between 2019-2022, the GSAs in the Chowchilla Subbasin successfully completed an inventory of the domestic wells in the Chowchilla Subbasin as a first step toward development of the Domestic Well Mitigation Program. The GSAs applied for and received grant funding from DWR to conduct the inventory and to install nine new monitoring wells at three sites in the Chowchilla Subbasin. After issuing a request for proposals and selecting a consultant, the domestic well inventory was conducted in 2021-2022 and final documentation of the inventory was completed in spring 2022 (Revised GSP 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 Chowchilla Subbasin hydrogeology. The project will also improve understanding and management of groundwater in the Subbasin.

In summer 2022, the GSAs completed and fully executed a Domestic Well Mitigation Program Memorandum of Understanding (MOU) that clearly articulates the starting date, proportionate responsibilities, funding limits, Program organizational structure, eligibility criteria, staffing responsibilities, and principles for implementing the Domestic Well Mitigation Program, among other topics. In 2022-2023, the GSAs continued to meet to advance focused plans for creating and administering the Domestic Well Mitigation Program within the Chowchilla Subbasin.

In accordance with the MOU, the Program has been developed and funded by the GSAs as of January 2023. The Program is currently up and running and is fully-funded. The CWD GSA is administering the Program on behalf of all the GSAs in the Subbasin. The CWD GSA has augmented their organizational structure to add a new position, the Domestic Well Mitigation Program Coordinator (Program Coordinator), and has hired a dedicated staff member to actively administer the Program. The GSAs are currently under contract for development of a new Program-specific website and associated informational items intended to reach the target audience and further spread the word about Program availability and eligibility. As of early 2024, 12 applications have been sent out to interested parties, four applications have been received and processed by the Program Coordinator, and two applications have been approved for mitigation and are moving forward. The remaining two applications were denied either due to the location of the well (outside the Subbasin), or due to the nature and cause of the well issues (not impacted by groundwater level decline). In those cases, the Program Coordinator referred the well owner to other services that may offer help. In 2024, the GSAs will continue their outreach efforts and will continue reviewing and responding to requests from domestic well owners requesting services as part of the Program.

7.1.3 Summary of Projects and Management Actions

PMAs are listed and described in **Tables 7-1 through 7-4**, followed by a more detailed description of individual PMAs being implemented by each GSA. **Tables 7-1 and 7-2** provide an overview of each PMA from the GSP, its implementation status, planned activities, and updates regarding actual activities and actual benefits since implementation. The status of PMAs is generally defined as follows:

- **Implemented**: Active efforts to operate the project or management action have begun, though benefits may or may not have been achieved to date.
- **In Progress**: Active efforts needed to initiate the project or management action have begun (e.g., permitting), though development has not reached the point of operability.
- **Planned**: Early conceptual development is still in progress, though active efforts to initiate or operate the project or management action have not begun.

Tables 7-3 and 7-4 summarize the actual project costs incurred through the current reporting year (water year 2023) and the estimated overall project costs. All estimated benefits and costs are summarized from the GSP, while actual benefits and costs are presented only for those projects already implemented. These tables provide a comparison of the actual and estimated costs and benefits of PMAs, as well as a measure of the degree of implementation for PMAs that will take multiple years to fully implement. It should be noted that the estimated benefits and costs were developed for full project implementation, not partial implementation.

This Annual Report covers the fourth full year of project implementation under the GSP. Wet conditions in 2023 allowed the GSAs to achieve substantial recharge benefits in the Subbasin. The GSAs have continued to make significant progress in implementing existing PMAs, as well as developing and implementing new PMAs.

The GSAs in the Chowchilla Subbasin are committed to adaptive management of groundwater resources through this suite of identified PMAs. As PMAs are implemented and monitored, the project timelines and volume of demand management necessary will be reviewed. If adjustments are needed to meet the sustainability goal for the Subbasin, project timelines will be evaluated and adjusted. In addition to continuous monitoring and review of PMA implementation, each Annual Report represents an important milestone and opportunity to review the status of GSP implementation efforts.

Table 7-1. Project and Management Action Implementation Summary.

Subregion	Project	Project Mechanism	First Year Implemented	Status	Project Description
CWD GSA	Enhanced Management of Flood Releases for Recharge	Increase Recharge	2017	Implemented	Diverted water is spread throughout unlined portions of the distribution system and released into reaches of the Chowchilla River, Ash Slough and Berenda Slough that are not used for water distribution.
CWD GSA	Road 13 Groundwater Recharge Basin	Increase Recharge	2018	Implemented	Develop and utilize one 56[a]-acre groundwater recharge basin
CWD GSA	City Groundwater Recharge Basin	Increase Recharge	2019	Implemented	Deliver water to a storm water retention pond owned by the City of Chowchilla for groundwater recharge. *CWD has delivered water to the City Groundwater Recharge Basin since 2005, but has considered this a GSP project since GSP development in 2019.*
CWD GSA	Additional Groundwater Recharge Basins	Increase Recharge	2021	In Progress	Develop an additional 1,000 acres of groundwater recharge basins by 2040
CWD GSA	Flood-MAR (Winter Recharge)	Increase Recharge	2020	Implemented	Program with voluntary participation to divert surplus flows onto farms and fields for recharge using existing infrastructure
CWD GSA	Merced-Chowchilla Intertie	Increase Recharge or Reduce Groundwater Pumping	2035	Planned	Construct water conveyance facilities and negotiate transfer agreement between Merced ID and Chowchilla WD
CWD GSA	Buchanan Dam Capacity Increase	Increase Recharge or Reduce Groundwater Pumping	2040	Planned	Increase capacity of Buchanan Dam
CWD GSA	Road 19 Groundwater Recharge Basin	Increase Recharge	2020	Implemented	Develop and utilize 38-acre groundwater recharge basin
CWD GSA	Wood Groundwater Recharge Basin	Increase Recharge	2021	Implemented	Develop and utilize 67-acre groundwater recharge basin
CWD GSA	Acconero Groundwater Recharge Basin	Increase Recharge	2021	Implemented	Develop and utilize 65-acre groundwater recharge basin

Subregion	Project	Project Mechanism	First Year Implemented	Status	Project Description
Madera County GSA	Madera County West: Recharge Basins	Increase Recharge	2020	In Progress	Divert water from Eastside Bypass and Ash Slough into basins or fields for recharge when possible. *Since GSP adoption, this project has been further refined and is now commonly referred to as part of the Chowchilla Bypass Flood Flow Recharge Phase 1/2 projects. Please see those project descriptions for more information.*
Madera County GSA	Madera County East: Water Purchase	Increase Recharge or Reduce Groundwater Pumping	2020	In Progress	Purchase surplus water (e.g., Section 215 flood flow from the CVP Friant Division) or other water that may be available.
Madera County GSA	Demand Management	Reduce Demand	2020	In Progress	Reduce consumptive water use through actions such as water-stressing crops, shifting to lower water-using crops, reducing evaporation losses, and reducing irrigated acreage.
Madera County GSA	Water Imports Purchase	Purchase water from willing partners outside of the basin to increase recharge or reduce GW pumping	2025	In Progress	Develop partnerships and import additional water into Madera County for direct or in-lieu recharge.
Madera County GSA	Millerton Flood Release Imports	Purchase water from willing partners outside of the basin to increase recharge or reduce GW pumping	2025	In Progress	Request CVP Section 215 flood water when available for recharge.
Madera County GSA	Chowchilla Bypass Flood Flow Recharge Phase 1	Increase Recharge	2025	In Progress	Construct and operate diversion and conveyance facilities and basins to recharge an average of 12,700 AF per year.
Madera County GSA	Chowchilla Bypass Flood Flow Recharge Phase 2	Increase Recharge	2040	Planned	Construct and operate diversion and conveyance facilities and basins to recharge an average of 25,000 AF per year.
SVMWC	Recharge Basins to Capture Floodwater	Increase Recharge	2020	In Progress	Develop up to 300 acres of groundwater recharge basins; operation of recharge ponds is anticipated for 2023

Subregion	Project	Project Mechanism	First Year Implemented	Status	Project Description
TTWD GSA	Utilize Existing Recharge Basin	Increase Recharge	2017	Implemented	Program to divert surplus flows into existing recharge basin for recharge
TTWD GSA	Additional Recharge Basins to Capture Floodwater	Increase Recharge	2019	Implemented	Develop up to 310 acres of groundwater recharge basins.
TTWD GSA	Poso Canal Pipeline and Columbia Canal Company Pipeline Projects	Increase Recharge or Reduce Groundwater Pumping	2013	Implemented	Construct water conveyance pipelines for delivery of water from San Joaquin River Exchange Contractors and others. The Poso Canal Pipeline and the Columbia Canal Pipeline projects are currently operational.
TTWD GSA	Poso Canal Pipeline Extension Project	Increase Recharge or Reduce Groundwater Pumping	2022	In Progress	Construct an additional 1.52 miles of pipeline and connect two regulating reservoirs to the existing Poso Canal Pipeline, providing surface water access to approximately 3,800 acres of irrigated farmland in areas prioritized for subsidence mitigation.

[a] The GSP describes development and operation of an 80-acre recharge basin. However, the most suitable available land was a 56-acre parcel.

Table 7-2. Project and Management Action Benefit Summary.

Subregion	Project	First Year Implemented	Project Update	2023 Annual Benefit (acre-feet/year)	Gross Benefit to Date (acre-feet)	Estimated Average Annual Benefit at 2040* (acre-feet/year)
CWD GSA	Enhanced Management of Flood Releases for Recharge	2017	CWD canals and sloughs were used to convey and deliver substantial surface water to CWD customers and to the individual recharge basins reported below. The remaining water was used for enhanced recharge in CWD's canals and Flood-MAR.	133,281	150,343	9,393
CWD GSA	Road 13 Groundwater Recharge Basin	2018	Water was delivered to the Road 13 Groundwater Recharge Basin in water year 2023.	2,181	4,694	1,359
CWD GSA	City Groundwater Recharge Basin	2019	Water was delivered to the City Groundwater Recharge Basin in water year 2023.	1,000	2,812	1,661
CWD GSA	Additional Groundwater Recharge Basins	2021	*This project is being implemented through the individual groundwater recharge basins described below. Estimated benefits for those projects are listed below, and are subtracted from the estimated average annual benefit at 2040 of this project.*	*(see below)*	*(see below)*	8,800
CWD GSA	Road 19 Groundwater Recharge Basin	2020	Water was delivered to the Road 19 Groundwater Recharge Basin in water year 2023.	564	788	456
CWD GSA	Wood Groundwater Recharge Basin	2021	Water was delivered to the Wood Groundwater Recharge Basin in water year 2023.	982	1,045	804
CWD GSA	Acconero Groundwater Recharge Basin	2021	Water was delivered to the Acconero Groundwater Recharge Basin in water year 2023.	1,889	2,137	780
CWD GSA	Flood-MAR (Winter Recharge)	2020	Water was delivered for on-farm recharge in water year 2023.	11,890	14,149	5,836
Madera County GSA	Madera County East: Water Purchase	2020	Madera County requested a change in place of use in 2019 and has had multiple meetings with USBR. Madera County has written a separate letter requesting Section 215 water to be available.			3,015
Madera County GSA	Demand Management	2020	The Madera County GSA completed numerous actions toward implementation of demand management in 2023, including: development and enforcement of groundwater allocations and penalties; implementation of a demand measurement program and verification project; and development of land repurposing strategies, rules,			27,550

Subregion	Project	First Year Implemented	Project Update	2023 Annual Benefit (acre-feet/year)	Gross Benefit to Date (acre-feet)	Estimated Average Annual Benefit at 2040* (acre-feet/year)
			and criteria (on hold in 2023). Initial data shows promising reductions in ETAW from actions in 2023. However, the precise costs and benefits of these demand management efforts are still being quantified and will be given in future reports.			
Madera County GSA	Millerton Flood Release Imports	2025	Madera County requested a change in place of use in 2019 and has had multiple meetings with USBR.			7,060
Madera County GSA	Chowchilla Bypass Flood Flow Recharge Phase 1	2025	Grant-funded work continued in 2023 to support planning and design of infrastructure for diversions, deliveries, and recharge of flood water from the Chowchilla Bypass. Projects are in various stages of development, with construction of the first anticipated in in late 2024 or early 2025, following successful completion of all required permitting.			13,500
SVMWC	Recharge Basins to Capture Floodwater	2020	Soil investigations have been completed and a topographic survey of the site has been recommended. Construction of the reservoir is planned to commence following completion of all required permitting, studies, surveys, and finalization of designs.			4,344
TTWD GSA	Utilize Existing Recharge Basin	2017	The existing private 300-acre recharge basin is still being used during periods when flood water is available.		19,270	4,994
TTWD GSA	Additional Recharge Basins to Capture Floodwater	2019	The District recently annexed 3,062 acres into its boundary. Two landowners in the newly annexed areas are each in the design phase with plans to construct a 40-acre recharge basin on their land. Construction is slated to begin in fall 2024. The project is partially funded with money from the Natural Resource Conservation Service. Both basins will be served through conveyance infrastructure owned and operated by TTWD.			24,657
TTWD GSA	Poso Canal Pipeline and Columbia Canal Company Pipeline Projects	2013	Surface water was purchased and delivered in water year 2023.	5,158	32,002	7,647

Subregion	Project	First Year Implemented	Project Update	2023 Annual Benefit (acre-feet/year)	Gross Benefit to Date (acre-feet)	Estimated Average Annual Benefit at 2040* (acre-feet/year)
TTWD GSA	Poso Canal Pipeline Extension Project	2022	In early 2022, TTWD applied for and was awarded Proposition 68 funding to support the Poso Pipeline Extension project. Construction is slated to begin in fall 2024.			4,000
			Total	**156,945**	**227,240**	**125,856**

*Note: Estimates developed for full project implementation.

Table 7-3. Project and Management Action Cost Summary (2023).

Subregion	Project	First Year Implemented	Status	2023 Capital Cost ($)	Capital Cost to Date ($)	2023 Annual Operating Cost ($)
CWD GSA	Enhanced Management of Flood Releases for Recharge	2017	Implemented			
CWD GSA	Road 13 Groundwater Recharge Basin	2018	Implemented	$0	$168,699	
CWD GSA	City Groundwater Recharge Basin	2019	Implemented	$0		
CWD GSA	Flood-MAR (Winter Recharge)	2020	Implemented			
CWD GSA	Road 19 Groundwater Recharge Basin	2020	Implemented	$0	$1,037,136	
CWD GSA	Wood Groundwater Recharge Basin	2021	Implemented	$0	$1,952,713	
CWD GSA	Acconero Groundwater Recharge Basin	2021	Implemented	$0	$2,009,906	
Madera County GSA	Madera County East: Water Purchase	2020	Implemented			
Madera County GSA	Demand Management	2020	In Progress			
Madera County GSA	Millerton Flood Release Imports	2025	In Progress			
Madera County GSA	Chowchilla Bypass Flood Flow Recharge Phase 1	2025	In Progress		$308,000	
SVMWC	Recharge Basins to Capture Floodwater	2020	In Progress	$44,800	$44,800	
TTWD GSA	Utilize Existing Recharge Basin	2017	Implemented			
TTWD GSA	Additional Recharge Basins to Capture Floodwater	2019	Implemented		$273,770	
TTWD GSA	Poso Canal Pipeline and Columbia Canal Company Pipeline Projects	2013	Implemented		$6,000,000	
TTWD GSA	Poso Canal Pipeline Extension Project	2022	In Progress			

Table 7-4. Project and Management Action Cost Summary, Estimated Average for All Projects and Management Actions.

Subregion	Project	First Year Implemented	Status	Estimated Capital Cost[1] ($)	Estimated Average Annual Operating Cost[1] ($/year)
CWD GSA	Enhanced Management of Flood Releases for Recharge	2017	Implemented	$0	$0
CWD GSA	Road 13 Groundwater Recharge Basin	2018	Implemented	$168,699	$10,000
CWD GSA	City Groundwater Recharge Basin	2019	Implemented	$0	$10,000
CWD GSA	Additional Groundwater Recharge Basins	2021	Planned	$38,600,000	$150,000
CWD GSA	Flood-MAR (Winter Recharge)	2020	Implemented	$0	$200,000
CWD GSA	Merced-Chowchilla Intertie	2035	Planned	$6,700,000	$1,500,000
CWD GSA	Buchanan Dam Capacity Increase	2040	Planned	$49,200,000	$200,000
CWD GSA	Road 19 Groundwater Recharge Basin	2020	Implemented	$1,037,136	$10,000
CWD GSA	Wood Groundwater Recharge Basin	2021	Implemented	$1,952,713	$10,000
CWD GSA	Acconero Groundwater Recharge Basin	2021	Implemented	$2,009,906	$10,000
Madera County GSA	Madera County East: Water Purchase	2020	Implemented	$1,000,000	$1,100,000
Madera County GSA	Demand Management	2020	In Progress	$0	$19,600,000
Madera County GSA	Water Imports Purchase	2025	Planned	$300,000	$2,490,000
Madera County GSA	Millerton Flood Release Imports	2025	In Progress	$31,900,000	$450,000
Madera County GSA	Chowchilla Bypass Flood Flow Recharge Phase 1	2025	In Progress	$38,290,000	$224,100
Madera County GSA	Chowchilla Bypass Flood Flow Recharge Phase 2	2040	Planned	$37,190,000	$856,200
SVMWC	Recharge Basins to Capture Floodwater	2020	In Progress	$7,500,000	$200,000
TTWD GSA	Utilize Existing Recharge Basin	2017	Implemented	-	-
TTWD GSA	Additional Recharge Basins to Capture Floodwater	2019	Implemented	$24,500,000	$700,000
TTWD GSA	Poso Canal Pipeline and Columbia Canal Company Pipeline Projects	2013	Implemented	$5,200,000	$4,600,000
TTWD GSA	Poso Canal Pipeline Extension Project	2022	In Progress	$3,475,000	
			Total	**$249,023,000**	**$32,320,000**

[1] Note: Estimates developed for full project implementation. Annual operating costs include the cost of purchasing water, as applicable. These totals do not equal the totals reported in the GSP, as certain projects have been added, revised, or removed from consideration since initial GSP development. The GSAs remain committed to adaptive management of PMAs to ensure long-term sustainable management of the Chowchilla Subbasin.

[2] Since the Chowchilla Subbasin GSP was adopted, the Chowchilla Bypass Flood Flow Recharge Project Phases 1 and 2 have been reconfigured into a series of five recharge projects that are expected to undergo planning/design and construction between 2021 and 2030. Phase 1 now corresponds to Projects 1 through 3 with a revised total capital cost of $38,290,000. Phase 2 now corresponds to Projects 4 and 5, with a revised total capital cost of $37,190,000. The total combined capital cost of these projects is approximately $75 million, which is the cost that is being considered during development of the Rate Study. These costs have been refined from the initial costs identified during GSP development.

7.1.4 Chowchilla Water District GSA Projects

Since GSP adoption, the CWD GSA has proceeded with multiple recharge projects, including development and operation of groundwater recharge basins. CWD has also begun implementing the Flood Managed Aquifer Recharge (Flood-MAR) program, as well as the new Enhanced Management of Flood Releases for Recharge project and a land fallowing program (see **Section 7.2**, below).

Wet conditions in 2023 facilitated substantial recharge in CWD. CWD ran approximately 133,000 AF of surface water in the District's canals and sloughs, providing substantial direct recharge while also delivering surface water for in-lieu recharge. CWD also delivered more than 6,600 AF of surface water to recharge basins and approximately 11,900 AF of surface water to customers for Flood-MAR efforts.

Other projects planned to increase surface water availability for the CWD GSA are planned for later implementation in 2035-2040.

7.1.5 Madera County GSA Projects

Since GSP adoption, Madera County GSA has completed multiple planning studies and a rate study intended to fund GSP implementation, initiated planning and design for a recharge program, and initiated work to support the implementation and enforcement of a substantial demand management program. Adaptive implementation of PMAs will collectively support achievement of the GSP sustainability goal over the GSP implementation period. Progress that has been made in each of these efforts is described below.

7.1.5.1 Funding for GSP Implementation

The Madera County GSA collects an administrative fee of approximately $24 per acre for irrigated acres within the GSA that is used for SGMA-related administration and planning efforts. While the administrative fee is useful for supporting SGMA implementation, these funds cannot be used for implementation of GSP PMAs, including construction of recharge facilities, purchasing surface water for in-lieu recharge, voluntary land repurposing, or for domestic well mitigation efforts.

In 2022, the Madera County GSA completed a Proposition 218 process that was intended to result in an acreage-based rate for extraction of groundwater within the Madera County GSA. The rate was intended to fund implementation of PMAs. However, the Proposition 218 process resulted in a majority protest vote in the Subbasin, and thus the rates were not approved to fund implementation of the Chowchilla Subbasin GSP PMAs within the Madera County GSA and/or their portion of Subbasin-wide PMAs (Domestic Well Mitigation Program).

Despite these setbacks, the Madera County GSA continues to recognize that implementation of PMAs in accordance with the GSP is vital to achieving the Subbasin sustainability goal during the implementation period and has been working with a group of local growers to explore alternative funding mechanisms for GSP implementation. The group – the Chowchilla Subbasin Growers, Inc. – have formally been established with the expressed intent of implementing the GSP under their own authority through a Memorandum of Understanding (MOU) with the Madera County GSA to cover all lands within the Madera County GSA area. Over the past 18 months, the Madera County GSA has negotiated with the group to cover PMA implementation costs. Coordination is ongoing as of spring 2024 and updates will be provided in subsequent Annual Reports.

In addition to these efforts, the Madera County GSA continues to utilize Proposition 68 funding for PMA implementation through two grants. This funding is currently being used to support design, permitting, and construction of a portion of the Chowchilla Bypass Flood Flow Recharge Program (described below). In 2022, the Madera County GSA also approved a penalty for groundwater extraction above the allocation that is being imposed as of 2023 (described below). Funds generated from these penalties are also available to support GSP implementation as directed by the GSA Board.

7.1.5.2 Recharge Program

Since GSP adoption, Madera County has continued work on a recharge planning study to refine the costs, benefits, and schedule for recharge projects described in the GSP. The recharge planning study has refined the costs and schedule for constructing additional basins and to conduct additional Flood-MAR of winter floodwater diverted from the Chowchilla Bypass. This study has resulted in the development of the Chowchilla Bypass Flood Flow Recharge Program. A description of the recharge study and planned recharge efforts is available at: https://www.maderacountywater.com/recharge/. In 2023, the Madera County GSA continued public outreach and engagement for the recharge program, including outreach regarding Executive Order (EO) N-4-23 which allows for flood waters to be used for groundwater recharge in certain circumstances. Planned recharge efforts are coordinated together with the emergency recharge plan (described in **Section 7.2**, below).

Since 2020, Madera County GSA has continued design efforts, permitting, and construction for portions of the Chowchilla Bypass Flood Flow Recharge Program. These efforts are being funded by two Proposition 68 grants from DWR, which were based on work developed through the recharge planning study.

In 2021, the first grant proposal was awarded $4,200,000 from Proposition 68 funds. As of early 2024, those funds are being used toward planning, design, and construction of diversion infrastructure on the Chowchilla Bypass and conveyance infrastructure outside the limits of the Chowchilla Bypass that will supply flood water to recharge areas. The Madera County GSA successfully pursued and received a CEQA exemption concurrence from DWR in accordance with EO N-7-22 Action 13. The GSA has completed the majority of the required permitting efforts with the California Department of Fish and Wildlife (CDFW), the National Marine Fisheries Service (NMFS), the United States Fish and Wildlife Service (USFWS), the Lower San Joaquin Levee Control District, and others as applicable. Remaining permitting efforts are still in progress, but are expected to be completed in summer 2024. Following successful completion of all required permitting, the GSA anticipates completing the 100% design documents and initiating the construction bid process in late 2024 or early 2025. This project has been developed in close coordination with TTWD GSA and Clayton Water District landowners in Madera County who offered to use their farmland for recharge.

In 2022, the second grant proposal was awarded an additional $3.2 million from Proposition 68 funds as part of Round 1 of the 2022 SGMA Implementation Grant program. Those funds are being used toward planning, design, and construction of additional recharge facilities along the Chowchilla Bypass, expanding on work being developed through the first grant. As of early 2024, the Madera County GSA has completed the 60% design process and has submitted a request to

DWR for CEQA exemption in accordance with EO N-7-22 Action 13. The GSA is in the process of preparing and submitting applications for all required permitting processes. The GSA expects to move forward with preparing the final designs and the construction bidding process following successful completion of CEQA and permitting. This project has been developed in close coordination with local landowners in the Madera County GSA who offered to use their farmland for recharge.

The Rate Study that the Madera County GSA completed and approved in 2022 was intended to fund implementation of the recharge program, among other GSP PMAs over the GSP implementation period. Although the Rate Study failed in 2022 following a majority protest vote, the Madera County GSA is coordinating with a group of local growers – the Chowchilla Subbasin Growers, Inc. – to secure alternate local funding to successfully implement the PMAs in the GSP.

7.1.5.3 Water Imports

In addition to the recharge efforts described above, the Madera County GSA is also in the process of developing partnerships to import additional water into Madera County and to acquire CVP Section 215 flood water when it is available for recharge. MC GSA requested a change in place of use in 2019 and has since had multiple meetings with USBR. MC GSA has written a separate letter requesting Section 215 water to be available.

7.1.5.4 Demand Management

As a primary element of its efforts to achieve groundwater sustainability, Madera County GSA has continued steps toward implementation of a demand management program that will oversee a managed reduction in the volume of groundwater consumed by irrigated agriculture over the 20-year GSP implementation period. By 2040, this program is expected to result in approximately 50% reduction of estimated current consumptive use quantities as of 2015. The precise costs and benefits of these demand management efforts are still being quantified and are expected to be reported in the next GSP evaluation and updates, as well as future Annual Reports.

To implement this overall demand management program, Madera County GSA has:

- Conducted a water market study (completed in 2021),
- Implemented a Voluntary Land Repurposing Program (VLRP),
- Developed an allocation framework, and
- Continued implementing a demand measurement program and verification project.

The following sections briefly describe the VLRP, the allocation framework, and the demand measurement program and verification project.

Voluntary Land Repurposing Program (VLRP). Since initial GSP development, the Madera County GSA received grant funding to explore the feasibility of adopting a sustainable agricultural land conservation (SALC) easement program within the Madera County GSA. The SALC program has since been referred to as the Voluntary Land Repurposing Program (VLRP). The VLRP aims to develop criteria for identifying and prioritizing agricultural land for protection, and to develop an incentive structure for agricultural landowners to rest, retire, restore, or permanently protect their land via various types of water-centric conservation easements.

Madera County GSA developed the VLRP through a stakeholder-driven process in 2020-2022, involving multiple public workshops and meetings, stakeholder interviews, and outreach with conservation groups. Details about this process are documented in previous Annual Reports.

In fall-winter 2022, the Madera County GSA conducted four public workshops, as well as multiple meetings and interviews, 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 Madera County GSA in December 2022.

The Rate Study that the Madera County GSA completed and approved in 2022 was intended to fund implementation of the VLRP, among other GSP PMAs over the implementation period. However, due to the failure of the Proposition 218 process, the Madera County GSA in the Chowchilla Subbasin is unable to fund the program at this time. A Multi-Land Repurposing program has opportunities for participation in mid-2024. The Madera County GSA will continue to coordinate with a group of local growers – the Chowchilla Subbasin Growers, Inc. – to secure alternate local funding to potentially implement the PMAs in the GSP.

Allocation Framework. Since initial GSP development, the Madera County GSA has developed a groundwater allocation framework. The allocation framework was developed primarily by Madera County GSA staff through a series of public meetings with the Madera County GSA Advisory Committee. Following discussions in these meetings, the Madera County GSA Board of Directors adopted resolutions in December 2020, June 2021, and August 2021 that describe "per-acre" allocations and rules for credits. The Madera County GSA Board of Directors approved penalties for groundwater use in excess of these allocations in 2022. Links to the resolution documents are provided in the previous Annual Report.

Beginning in calendar year 2023, the allocations and associated penalties are being enforced in the Madera County GSA (within the Chowchilla, Madera, and Delta-Mendota Subbasins) through measurements of groundwater use by approved measurement methods (described in the following section). Madera County GSA has included certain refinements to the framework, allowing “farm units” (i.e., fields irrigated from the same well that are grouped and considered together in enforcement of the allocation) to be changed at the end of the calendar year, and allowing never-irrigated lands to opt-in in November of each year. Madera County GSA is in the process of developing a recharge policy that would credit recharge benefits to the allocation of areas where recharge occurred. As of early 2024, Madera County GSA has also developed recharge credit policies that would credit recharge benefits to the allocation of areas where recharge occurred. Madera County GSA recently approved two policies: one related to recharge with surface water that is purchased, and one related to recharge with water taken under EO N-4-23. Both policies have a “floor” of a 75% recharge credit and a "ceiling" of 90% recharge credit depending on data specific to the land on which the recharge occurred. Additional information about the allocation enforcement process is described as part of the demand measurement program and verification project, below.

The penalties for exceeding the allocation include $1000 per farm unit for those that have exceeded the authorized amount, in addition to a $100 per AF penalty for water use over the allocation.

Demand Measurement Program and Verification Project. Madera County GSA has continued to implement the demand measurement program in partnership with IrriWatch, a daily irrigation scheduling and crop production information service that uses Surface Energy Balance Algorithm for Land (SEBAL) model outputs to quantify actual consumptive water use from satellite imagery.

The main objective of the demand measurement program is to use the IrriWatch program to track ETAW against an allocation established in the Madera County GSA area (described in the previous section). Through the IrriWatch program portal, both the Madera County GSA and individual growers can track ETAW against the allocation. IrriWatch provides additional benefits to growers by providing information about the irrigation status of fields and irrigation recommendations, which can also be accessed remotely through a cell phone application. This information, together with the allocation, supports grower decision-making on the timing and amounts of irrigation.

Between 2020-2022, the Madera County GSA hosted trainings to inform growers about the program and then conducted two test years with IrriWatch. All irrigated parcels in the Madera County GSA have been auto-enrolled in the program.

Since 2023, the Madera County GSA is tracking groundwater use to enforce the approved allocations (described in the previous section). Three approved demand measurement options are available to growers in the Madera County GSA for allocation enforcement:

- IrriWatch approach
- Land IQ approach (similar to the IrriWatch approach, quantifying ETAW from land use and satellite imagery)
- Use of approved flowmeters

The Madera County GSA has allowed and developed an appeals process for growers who have selected to use the IrriWatch and Land IQ approaches, although there is no appeals process for those using flowmeters. Madera County GSA expects to reevaluate measurement options for the program moving forward in 2025.

As of early 2024, MC GSA has developed and approved recharge credit policies that would credit recharge benefits to the allocation of areas where recharge occurred. Madera County GSA is also working to incorporate information from the VLRP (described above) into enforcement of the allocation to ensure that participating landowners are receiving credit for land fallowing under the VLRP. Enforcement of the allocation is incorporating adjustments to account for recharge credits, land fallowing credits, and successful appeals in the future.

In 2022-2023, the Madera County GSA also conducted the Madera Verification Project to analyze the consistency of applied water measurements from flowmeters to consumptive water use estimates developed from the IrriWatch and Land IQ remote sensing measurements. Through the Madera Verification Project, the Madera County GSA has conducted extensive outreach among growers in the Chowchilla, Madera, and Delta-Mendota Subbasins who will be directly impacted by the demand measurement efforts. Through these outreach efforts, the Madera County GSA has gained substantial feedback and made changes to the demand measurement program to ensure that it is locally accurate, effective, and equitable to growers. Additional information about the Madera Verification Project is provided in the previous Annual Report.

Additional information on the demand measurement program is available on the Madera County website: https://www.maderacountywater.com/measurement/.

Demand Management. Through these many interrelated efforts, the Madera County GSA is in the process of implementing the planned demand management program described in the GSP. This management action is expected to result in a large reduction in groundwater pumping at the cost of reduced crop production and related economic activities in Madera County. Madera County GSA has observed landowner responses to the demand management program thus far, and initial data shows promising reductions in ETAW from actions in 2023. However, the precise costs and benefits of these demand management efforts are still being quantified and are expected to be reported in future GSP evaluations and updates as well as future Annual Reports.

7.1.5.5 Additional Roles.

Although neither projects nor management actions, there are number of actions that Madera County has taken towards sustainability of the Chowchilla Subbasin:

1. Madera County serves as the grantee and administrator for the current Proposition 1 and Proposition 68 grants (TTWD is serving as the grantee and administrator for the Proposition 68 grant awarded in early 2022); and
2. Madera County serves as the contractor with the consultant for the data management system.

7.1.6 Sierra Vista Mutual Water Company Projects

Sierra Vista Mutual Water Company (SVMWC), located in the Merced County GSA and Madera County GSA, is in the process of developing up to 300 acres of dedicated recharge basins.

In 2022, SVMWC applied for and was awarded Proposition 68 funding to support further development and construction of this project. As of late 2023, soil investigations have been completed and a topographic survey of the site has been recommended. Construction of the reservoir is planned to commence following completion of all required permitting, studies, surveys, and finalization of designs.

In 2023, landowners in SVMWC also diverted substantial surface water, in excess of 5,700 AF through October, providing recharge benefits to the Subbasin. Benefits of these diversions are accounted in the Subbasin water budget.

7.1.7 Triangle T Water District GSA Projects

The TTWD GSA has several projects in various stages of implementation.

Since 2017, TTWD has implemented a program to divert surplus flows into existing recharge basins within the GSA. TTWD continued to use the recharge basins during periods when flood water is available.

The estimated average annual benefits at 2040 of 4,994 AF, listed in **Table 7-2**, represent the anticipated recharge volume during GSP implementation, although the basins were utilized earlier. The existing basins have been used to recharge more than 19,000 AF to date, although no water was available for recharge in 2022 due to drought conditions.

Since 2019, TTWD has initiated work to develop additional dedicated recharge basins. This work was formerly supported under an Office of Emergency Services (OES) grant, and was formerly referred to as the OES ponds, but is now funded under Proposition 68. In 2020-2021, TTWD GSA collaborated with the Madera County GSA on the Proposition 68 grant. Two recharge basins that are currently being designed and planned for construction using those grant funds will be constructed in TTWD.

The District recently annexed 3,062 acres into its boundary. Two landowners in the newly annexed areas are each in the design phase with plans to construct a 40-acre recharge basin on their land. Construction is slated to begin in fall 2024. The project is partially funded with money from the Natural Resource Conservation Service. Both basins will be served through conveyance infrastructure owned and operated by TTWD.

TTWD is also continuing efforts to secure a permanent water rights permit on the Chowchilla Bypass. When water is available, TTWD plans to divert water to existing recharge basins (and later to the additional dedicated recharge basins). Since GSP adoption, a temporary water rights permit has been granted and additional information in support of the permanent water right has been submitted to the SWRCB. However, following the issuance of EO N-4-23 in March 2023, certain restrictions for diverting flood flows were waived with the goal of accelerating groundwater recharge and reducing the risks of local and regional catastrophic flooding. In 2023, substantial recharge occurred under the provisions of EO N-4-23 and Senate Bill 122, which opened the door to implementing recharge of flood waters in certain circumstances, in absence of an approved water right.

Since 2013, TTWD has also constructed two water conveyance pipelines, the Columbia Canal pipeline and the Poso Canal pipeline, to import additional surface water supplies to the TTWD. Both pipelines are currently operational. The Poso Canal pipeline has a 40 cubic feet per second (cfs) capacity to convey supplemental surface water to land within the TTWD boundary for direct delivery to farmland. The pipeline is owned by TTWD. The Columbia Canal pipeline has an approximate capacity of 20 cfs and is a viable conveyance pipeline to move supplemental surface water into the TTWD boundary. The surface water can be directly delivered to farmland or recharge basins. Future extensions of the Poso Pipeline are anticipated beyond the project described in the GSP. Those extensions are described in **Section 7.2**. In 2023, approximately 5,200 AF of surface water was purchased and diverted for use in-lieu of groundwater in TTWD.

In addition to the recharge basins and pipeline projects, TTWD installed six nested monitoring wells within the district area in 2021. These wells currently provide additional information about groundwater conditions in TTWD and the Western Management Area of the Subbasin.

7.2 ADDITIONAL PROJECTS IDENTIFIED SINCE GSP ADOPTION

Since GSP adoption, the GSAs and other proponents in the Subbasin have developed additional PMAs to support GSP implementation efforts.

7.2.1 Chowchilla Water District GSA Projects

Since GSP adoption, CWD GSA has adopted two additional projects.

Enhanced Management of Flood Releases for Recharge Project. In this project, CWD utilizes its existing distribution system – including district canals and sloughs – to supply recharge during periods when flood flows are available and when the distribution system is not at its operational capacity. Diverted water is spread throughout unlined portions of the distribution system, allowing for increased groundwater recharge. This project was initiated in 2017 and was conducted again in 2019, with an estimated annual recharge benefit of approximately 26,800 AF in wet years. Average annual benefits are estimated to be approximately 9,400 AF across all years, including drier years when flood flows are unavailable. More information about this project can be found in Appendix E of the GSP Annual Report submitted in 2020.

In 2023, CWD ran approximately 133,000 AF of surface water in the district's canals and sloughs, providing substantial direct recharge while also delivering surface water for in-lieu recharge (see **Section 7.1.4**)

Land Fallowing. CWD GSA has proposed a land fallowing program as one component of their overall efforts to achieve sustainable groundwater conditions in CWD's portion of the Chowchilla Subbasin. The land fallowing program would be implemented by growers on a voluntary basis. Benefits will be measured by the reduction in the total volume of groundwater previously used to irrigate the fallowed lands.

CWD planned a study in 2022 to identify landowners interested in participating in the land fallowing program. Land fallowing proposals will be created for all or a portion of a parcel, and can be implemented for one year, several years, or permanently. Proposals for land fallowing will be evaluated on an individual proposal basis. The target reduction in groundwater pumping from land fallowing is 5,000 to 10,000 AF per year. Program costs are estimated to be $1,000,000 to $2,000,000 per year. CWD may initially fund this program with general funds, although CWD may also conduct a Prop 218 election to approve assessments that would provide a funding stream for financing the program. CWD has conducted successful Prop 218 elections where stakeholders voted to approve assessments to fund programs.

Project development has continued in 2023 through on-going discussion at both a CWD Board of Directors (Board) and landowner level. Implementation is anticipated to begin following finalization of a land fallowing program and adoption by the CWD Board.

7.2.2 Triangle T Water District GSA Projects

Building on the success of the Poso Canal Pipeline, TTWD has initiated work on an extension of the existing pipeline project to deliver more purchased water for irrigation and recharge within TTWD and in adjacent areas prioritized for subsidence mitigation. The extension is expected to add an additional 1.5 miles of 20-inch pipeline with two additional turnouts, and a 2-acre regulating reservoir. In early 2022, TTWD applied for and was awarded Proposition 68 funding to support further development and extension of the Poso Canal pipeline project. Construction is slated to begin in fall 2024.

7.2.3 Jointly Implemented Projects

In addition to the ongoing development of recharge projects proposed in the Chowchilla Subbasin GSP, the Madera County GSA has initiated work on an emergency recharge plan to achieve more immediate recharge benefits from flood flows available on the Chowchilla Bypass. Under this plan, Madera County GSA and TTWD GSA have worked collaboratively to secure temporary water rights and develop a plan for installation of temporary infrastructure to divert flood flows off the Chowchilla Bypass to the extent they are available ahead of construction of permanent infrastructure. Since 2021, Madera County has initiated environmental permitting and continued development of the plan, including development of a draft technical memorandum to provide guidance for landowners participating in groundwater recharge. TTWD also resubmitted the temporary water rights application used for this project in 2022. However, following the issuance of EO N-4-23 in March 2023, certain restrictions for diverting flood flows were waived with the goal of accelerating groundwater recharge and reducing the risks of local and regional catastrophic flooding. In 2023, substantial recharge occurred under the provisions of EO N-4-23 and Senate Bill 122, which opened the door to implementing recharge of flood waters in certain circumstances, in absence of an approved water right.

In addition to these GSA-led efforts, multiple recharge efforts are being led in the Subbasin by private entities. The GSAs will continue collaborating and working with locals in the Subbasin to implement recharge efforts in the future.

7.2.4 Other Projects

7.2.4.1 Subsidence Control Measures Agreement

Since initial GSP development, additional information has been provided regarding the Subsidence Control Measures Agreement (Agreement) between certain landowners in the Western Management Area of the Chowchilla Subbasin and agencies in the Delta-Mendota Subbasin. Landowners that have entered into the Agreement collectively manage more than 14,000 acres in the Western Management Area of the Subbasin. Information about the Agreement, including restrictions on groundwater pumping and required implementation of projects to increase use of surface water for irrigation, is provided in Section 3.3.3.7 of the Chowchilla Subbasin Revised GSP.

Since the initial Agreement was signed in 2017, parties to the Agreement have successfully constructed facilities to supply and distribute surface water to users in the Subbasin. Participating landowners in the Subbasin have also reduced pumping from the Lower Aquifer to between 0.13 and 0.50 AF/ac, less than the specified limits in the initial Agreement. Use of surface water during years it has been available has also provided between 0.66 and 1.76 AF/ac of benefit to those irrigated lands, providing direct recharge to the Upper Aquifer and offsetting demand for groundwater. Efforts under the initial Agreement have already been successful for mitigating subsidence in the TTWD area of the Western Management Area. Annual vertical displacement rates in the Subbasin, as reported from InSAR data, indicate a relative decrease in the rate of subsidence within TTWD since approximately 2017, as compared with rates of subsidence in surrounding areas (see Revised GSP Section 2.2.2.4).

7.2.4.2 Other GSA Projects

Additional information about other GSA PMAs will be added to future Annual Reports as they are identified.

7.3 IMPLEMENTATION OF MONITORING AND ADDRESSING DATA GAPS

Since the GSP adoption and submittal in January 2020, the GSAs have been conducting monitoring of RMS wells (**Appendix E**), including coordination with well owners and other monitoring entities. Despite multiple attempts at measurement, some RMS water level data was not available in recent years due to continued challenges encountered during implementation of the RMS monitoring program. Loss of access to certain RMS sites has persisted for a variety of reasons, such as owners' unwillingness to participate in monitoring, or replacement of a site with another well having slightly different characteristics. The GSAs have worked to resolve these issues where possible, and have been working to install new dedicated nested monitoring wells that may be added to the monitoring network in place of lost sites. The GSAs may add those new dedicated nested monitoring wells to the Chowchilla Subbasin GSP monitoring network once more data is collected and site-specific sustainable management criteria can be appropriately established.

As part of a Proposition 1 DWR Sustainable Groundwater Management grant award to Madera County for the installation of dedicated monitoring wells in the Chowchilla Subbasin, a total of 25 new monitoring wells at nine different sites were constructed in 2019 and 2020. Information collected from the drilling, geologic and geophysical logging and ongoing groundwater quality sampling and automated groundwater level monitoring, will fill data gaps in the monitoring and conceptualization of the hydrogeology and improve understanding and management of groundwater in the Chowchilla Subbasin. As part of a Proposition 68 DWR Sustainable Groundwater Management grant award to Madera County for a domestic well inventory project, nine additional new monitoring wells at three different sites were also installed in 2022 and will provide additional information on hydrogeologic conditions and trends in areas of domestic wells within the Chowchilla Subbasin.

7.4 INTERIM MILESTONE STATUS (§356.2.C)

7.4.1 Chronic Lowering of Groundwater Levels

Sustainable management criteria for groundwater level RMS wells were updated in the Chowchilla Subbasin Revised GSP submitted in July 2022. In the Revised GSP, interim milestones (IMs) for chronic lowering of groundwater levels were also reviewed and updated at five-year intervals over the Implementation Period from 2020 to 2040, at years 2025, 2030, 2035, and 2040. IMs for groundwater levels were established through review and evaluation of measured groundwater level data and future projected fluctuations in groundwater levels utilizing the numerical groundwater flow model, which simulated implementation of PMAs. Each IM was developed based on the modeled groundwater level for the month of October in the year preceding the IM date (e.g., October 2024 for the 2025 IM). Where necessary, adjustments were made to account for occasional offsets between historically observed and modeled data.

Measurable objectives (MOs) for groundwater levels were established in accordance with the sustainability goal and provide estimates of the expected groundwater level variability due to climatic and operational variability. MOs for groundwater levels were calculated as the model-derived average groundwater levels over the Sustainability Period from 2040 to 2090, modified if necessary, to account for occasional offsets between historically observed and modeled groundwater levels.

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 multiple wells in consecutive years for one or more sustainability indicators. The GSP regulations provide that the "minimum thresholds 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" (354.28.c.1). Chronic lowering of groundwater levels in the Plan area is determined in the GSP to 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 use(s) where alternative means of obtaining sufficient groundwater resources are not technically or financially feasible.

Table 7-5 and **Figures 7-1 and 7-2** present the status of groundwater level RMS wells in relation to the 2025 IMs, MOs, and MTs defined in the GSP. Note that there are some RMS wells that do not have Fall 2023 measurements to compare with IMs, MOs, and MTs (see **Appendix E**). Review of the Fall 2023 groundwater level measurements that are available for 28 RMS wells (measurements were available for 29 RMS wells, but 1 was flagged as questionable) indicates that groundwater levels remain well above MTs, and all, with the exception of one, of groundwater levels are above the 2025 IMs.

Table 7-5. Summary of RMS Well Groundwater Levels Relative to Interim Milestones, Minimum Thresholds, and Measurable Objectives.

RMS Well I.D.	Estimated Surface Elevation[1] (msl, feet)	Aquifer Designation	2025 Interim Milestone GWE	MT GWE	MO GWE	Fall 2023 GWE	Date of Fall Measurement	2025 IM Status	MT Status
CWD RMS-1	169	Lower[2]	-59	-103	-25	-22	10/13/2023	+37	+81
CWD RMS-2	191	Lower[2]	-63	-114	-50	-41	10/13/2023	+22	+73
CWD RMS-3	206	Lower[2]	-71	-117	-32	-58.86	10/13/2023	+12.14	+58.14
CWD RMS-4	225	Lower[2]	-83	-112	15	-69.3	10/13/2023	+13.7	+42.7
CWD RMS-5	207	Lower[2]	-74	-107	-12	63.15	10/13/2023	+137.15	+170.15
CWD RMS-6	275	Lower[3]	-77	-90	-29	-63	10/13/2023	+14	+27
CWD RMS-7	162	Lower[2]	-50	-93	35	-35.5	10/16/2023	+14.5	+57.5
CWD RMS-8	219	Lower[2]	-85	-102	-9	-42.85	10/16/2023	+42.15	+59.15
CWD RMS-9	164	Upper	79	61	80	94	10/16/2023	+15	+33
CWD RMS-10	183	Lower[2]	-64	-98	-6	-55.32	10/16/2023	+8.68	+42.68
CWD RMS-11	192	Lower[2]	-69	-84	9	82.68	10/16/2023	+151.68	+166.68
CWD RMS-12	176	Upper	53	36	70	63.2	10/16/2023	+10.2	+27.2
CWD RMS-13	168	Lower[2]	-45	-69	34	37.72	10/16/2023	+82.72	+106.72
CWD RMS-14	152	Lower[2]	-132	-141	31	-93	10/14/2023	+39	+48
CWD RMS-15	213	Lower[3]	-99	-122	-17	-92.9	10/14/2023	+6.1	+29.1
CWD RMS-16	213	Lower[3]	-83	-103	1	-74.8	10/14/2023	+8.2	+28.2
CWD RMS-17	203	Lower[3]	-116	-133	32	-84.9	10/14/2023	+31.1	+48.1
MCE RMS-1	277	Lower[3]	-69	-91	-20	-68.1	10/31/2023	+0.9	+22.9
MCE RMS-2	254	Lower[2]	-97	-122	-12	-92.66	10/31/2023	+4.34	+29.34
MCW RMS-1	121	Upper	62	16	74	92.97	10/30/2023	+30.97	+76.97
MCW RMS-2	123	Upper	90	42	92	95.12	10/30/2023	+5.12	+53.12

RMS Well I.D.	Estimated Surface Elevation[1] (msl, feet)	Aquifer Designation	2025 Interim Milestone GWE	MT GWE	MO GWE	Fall 2023 GWE	Date of Fall Measurement	2025 IM Status	MT Status
MCW RMS-3	124	Upper	75	22	90	102.56	10/30/2023	+27.56	+80.56
MCW RMS-4	137	Lower[2]	-20	-79	11	NM[4]	10/30/2023		
MCW RMS-5	146	Lower[2]	-18	-69	28	NM[4]	10/30/2023		
MCW RMS-6	139	Lower[2]	-2	-58	32	NM[4]	10/31/2023		
MCW RMS-7	138	Lower[2]	6	-41	45	QM[5]	10/30/2023		
MCW RMS-8	142	Composite	-24	-52	55	42.05	10/31/2023	+66.05	+94.05
MCW RMS-9	155	Lower[2]	-47	-67	45	NM[4]	10/31/2023		
MCW RMS-10	124	Upper	115	75	109	109.31	10/12/2023	-5.69	+34.31
MCW RMS-11	127	Upper	116	80	114				
MCW RMS-12	127	Upper	112	76	110				
MER RMS-1	225	Lower[2]	-60	-118	-29				
TRT RMS-1	134	Upper	38	-18	67	51.231	10/15/2023	+13.231	+69.231
TRT RMS-2	135	Lower[2]	25	-19	59	51.5	10/15/2023	+26.5	+70.5
TRT RMS-3	137	Lower[2]	5	-29	49	5.441	10/15/2023	+0.441	+34.441
TRT RMS-4	141	Composite	-8	-39	50	4.5	10/15/2023	+12.5	+43.5

[1] Estimated surface elevation and groundwater elevations (GWE) are expressed in feet above mean sea level.
[2] Lower Aquifer wells within the Corcoran Clay extent.
[3] Lower Aquifer wells outside the Corcoran Clay extent; considered representative of undifferentiated unconfined groundwater zone.
[4] NM = no measurement. Measurement attempted but was unsuccessful.
[5] QM = questionable measurement. Measurement reported but flagged as questionable.

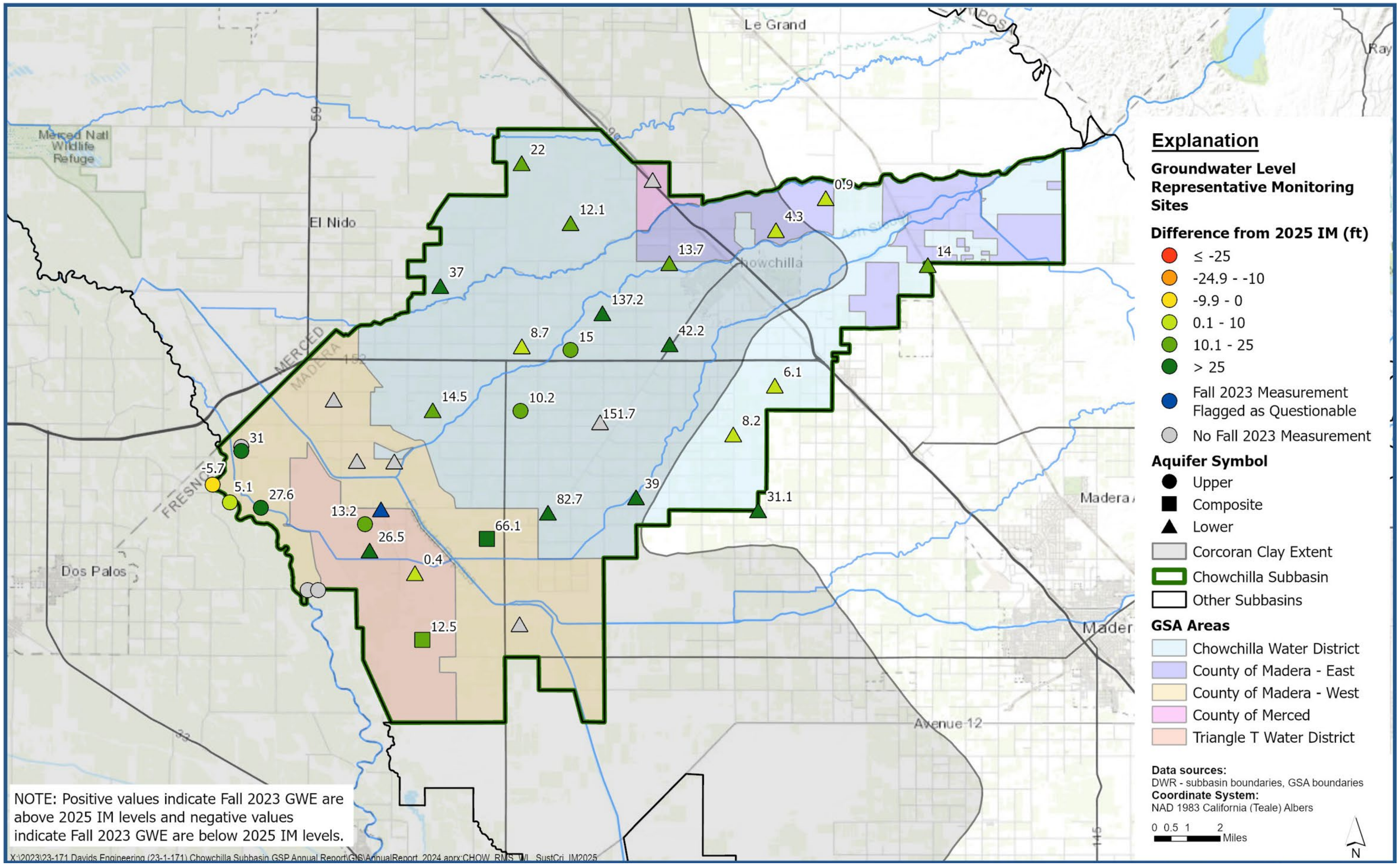


Figure 7-1. Fall 2023 Water Level Measurements at RMS Wells compared to 2025 Interim Milestone.

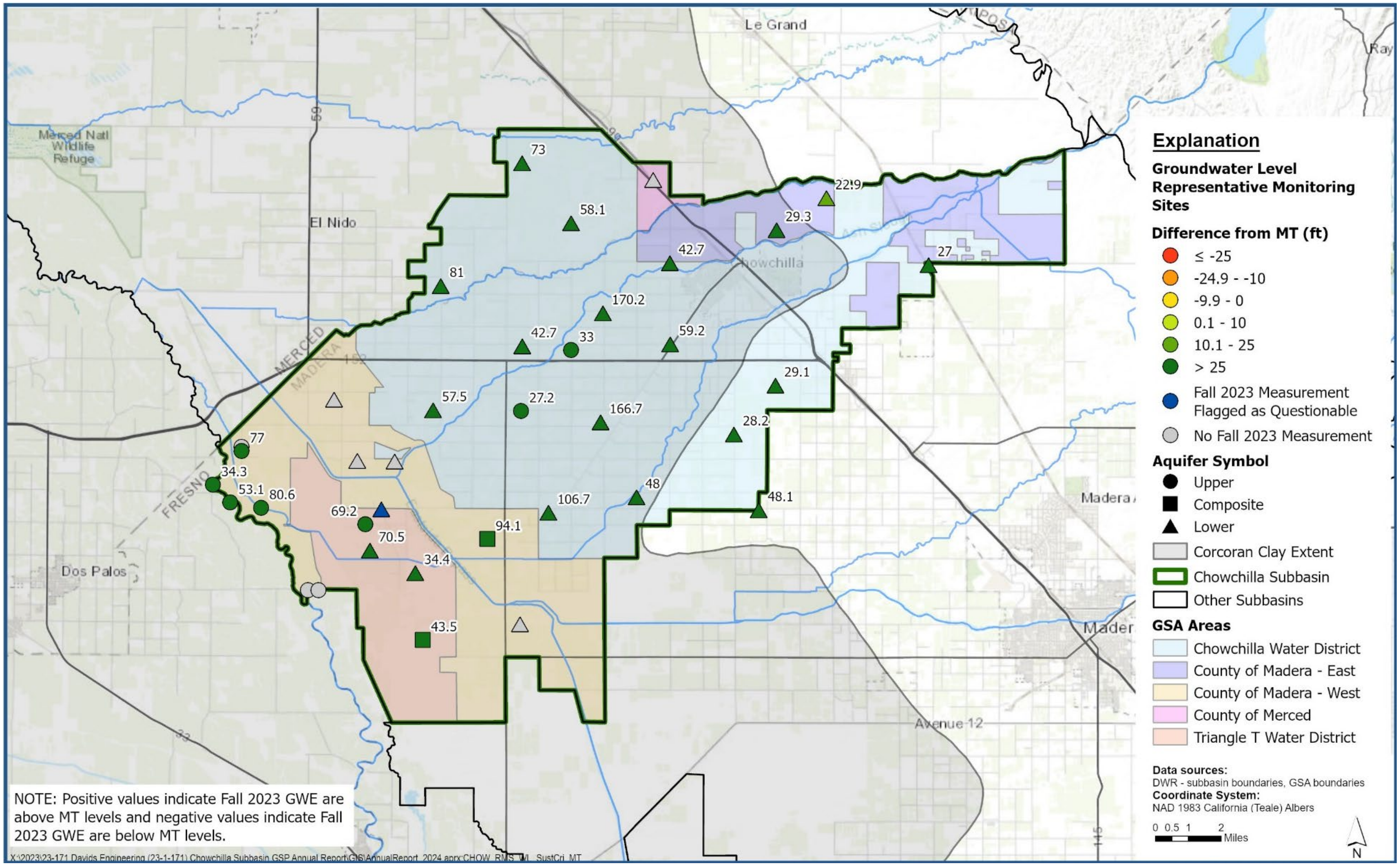


Figure 7-2. Fall 2023 Water Level Measurements at RMS Wells compared to Minimum Threshold.

7.4.2 Land Subsidence

Sustainable management criteria for land subsidence were developed related to management areas within the Chowchilla Subbasin and have been developed to avoid significant and unreasonable impacts from occurring in the future. The Western Management Area (WMA) has experienced significant subsidence and damage to infrastructure since 2005, while land subsidence has not resulted in significant and unreasonable impacts to infrastructure in the Eastern Management Area (EMA).

Measurable objectives (MOs) for land subsidence were established to avoid significant and unreasonable impacts from occurring in the future. Groundwater levels are being used as a proxy for land subsidence in the Western Management Area; therefore, the MOs for land subsidence are based on the MOs for chronic lowering of groundwater levels. In the Eastern Management Area, an amount of cumulative subsidence coupled with groundwater levels as a proxy are being used as the metrics for the subsidence sustainability indicator. The MOs for subsidence in the Eastern Management Area are based on groundwater levels and are the same as the MOs established for chronic lowering of groundwater levels. As with the MOs, groundwater levels are being used as a proxy for land subsidence interim milestones; therefore, the interim milestones for land subsidence are based on the interim milestones for chronic lowering of groundwater levels.

The cause of basin groundwater conditions that would result in significant and unreasonable land subsidence is excessive overall average annual groundwater pumping and other outflows from the Subbasin, primarily from the Lower Aquifer, that exceed average annual inflows. Undesirable results for land subsidence are significant and unreasonable adverse impacts from land subsidence on critical surface infrastructure that impair the operation and function of the infrastructure.

Subsidence MTs in the WMA were established recognizing a strong interest in limiting subsidence by avoiding activating any new subsidence in this part of the Subbasin. Therefore, using groundwater levels in the Lower Aquifer as a proxy, subsidence MTs in the WMA were set in a manner to avoid groundwater levels declining below historical lows. Subsidence in the EMA causing a reduction of the conveyance capacity from decreasing of the gradient in these features below the condition that existed prior to the occurrence of recent subsidence, is considered to represent an adverse impact on this infrastructure. The EMA subsidence MTs were established using a combination of subsidence amount (the difference in subsidence between RMS well location and surface water conveyance control point) and groundwater levels in the Lower Aquifer.

Tables 7-6 and 7-7 present the status of land subsidence RMS stations in relation to the 2025 IMs, Mos, and MTs defined in the GSP. In the WMA, there is limited data for Fall 2023, but the water levels in wells for which data is available are above both the 2025 IMs and MTs. In the EMA, 15 wells have water levels of which all are above 2025 IMs and all but 3 are above the MTs. When comparing rates of subsidence at RMS wells to the Critical Conveyance MTs, there are 11 wells with sufficient data, all of which with rates of subsidence less than the MT. Additional annual and cumulative subsidence maps are presented in **Appendix D**.

Table 7-6. Summary of Western Management Area RMS Stations Land Subsidence Rates Relative to Interim Milestones, Minimum Thresholds, and Measurable Objectives.

RMS Well I.D.	Estimated Surface Elevation[1] (msl, feet)	Aquifer Designation	2025 Interim Milestone GWE	MT GWE	MO GWE	Fall 2023 GWE	Date of Fall Measurement	2025 IM Status	MT Status
MCW RMS-4	137	Lower[2]	-20	-36	11	NM[3]	10/30/2023		
MCW RMS-5	146	Lower[2]	-18	-40	28	NM[3]	10/30/2023		
MCW RMS-6	139	Lower[2]	-2	-29	32	NM[3]	10/31/2023		
MCW RMS-7	138	Lower[2]	6	-18	45	QM[4]	10/30/2023		
MCW RMS-9	155	Lower[2]	-47	-30	45	NM[3]	10/31/2023		
TRT RMS-2	135	Lower[2]	25	-5	59	51.5	10/15/2023	+26.5	+56.5
TRT RMS-3	137	Lower[2]	5	-31	49	5.441	10/15/2023	+0.441	+36.441

[1] Estimated surface elevation and groundwater elevations (GWE) are expressed in feet above mean sea level.
[2] Lower Aquifer wells within the Corcoran Clay extent.
[3] NM = no measurement. Measurement attempted but was unsuccessful.
[4] QM = questionable measurement. Measurement reported but flagged as questionable.

Table 7-7. Summary of Eastern Management Area RMS Stations Land Subsidence Rates Relative to Interim Milestones, Minimum Thresholds, and Measurable Objectives.

RMS Well I.D.	Estimated Surface Elevation[1] (msl, feet)	Aquifer Desig-nation	Associated Critical Conveyance	Subsidence MT: Subsidence Amount (ft)	2025 Interim Milestone GWE	MT GWE	MO GWE	Fall 2023 GWE	Date of Fall Measure-ment	2025 IM Status	MT Status	Critical Conveyance Subsidence - March 2022 to 2023 (ft)	RMS Well Subsidence - March 2022 to 2023 (ft)	Subsi-dence Amount Status
CWD RMS-1	169	Lower[2]	Chowchilla River	-0.19 + subsidence Chowchilla R. @ WMA	-59	-90	-25	-22	10/13/2023	+37	+68	NA[5]	-0.66	
CWD RMS-2	191	Lower[2]	Chowchilla River	-1.46 + subsidence Chowchilla R. @ WMA	-63	-71	-50	-41	10/13/2023	+22	+30	NA[5]	-0.62	
CWD RMS-3	206	Lower[2]	Chowchilla River	-1.22 + subsidence Chowchilla R. @ WMA	-71	-77	-32	-58.86	10/13/2023	+12.14	+18.14	NA[5]	NA[5]	
CWD RMS-4	225	Lower[2]	Ash Slough	-1.88 + subsidence Ash Sl. @ WMA	-83	-87	15	-69.3	10/13/2023	+13.7	+17.7	-0.55	-0.49	+1.94
CWD RMS-5	207	Lower[2]	Ash Slough	-1.25 + subsidence Ash Sl. @ WMA	NA[4]	NA[4]	NA[4]	63.15	10/13/2023			-0.55	NA[5]	
CWD RMS-6	275	Lower[3]	Berenda Slough	-4.79 + subsidence Berenda Sl. @ WMA	-77	-73	-29	-63	10/13/2023	+14	+10	-0.5	-0.05	+5.24
CWD RMS-7	162	Lower[2]	Ash Slough	-0.33 + subsidence Ash Sl. @ WMA	-50	-87	35	-35.5	10/16/2023	+14.5	+51.5	-0.55	-0.60	+0.28
CWD RMS-8	219	Lower[2]	Berenda Slough	-2.37 + subsidence Berenda Sl. @ WMA	-85	-89	-9	-42.85	10/16/2023	+42.15	+46.15	-0.5	-0.50	+2.37

RMS Well I.D.	Estimated Surface Elevation[1] (msl, feet)	Aquifer Desig-nation	Associated Critical Conveyance	Subsidence MT: Subsidence Amount (ft)	2025 Interim Milestone GWE	MT GWE	MO GWE	Fall 2023 GWE	Date of Fall Measure-ment	2025 IM Status	MT Status	Critical Conveyance Subsidence - March 2022 to 2023 (ft)	RMS Well Subsidence - March 2022 to 2023 (ft)	Subsi-dence Amount Status
CWD RMS-10	183	Lower[2]	Ash Slough	-0.74 + subsidence Ash Sl. @ WMA	-64	-79	-6	-55.32	10/16/2023	+8.68	+23.68	-0.55	-0.50	+0.79
CWD RMS-11	192	Lower[2]	Berenda Slough	-1.54 + subsidence Berenda Sl. @ WMA	NA[4]	NA[4]	NA[4]	82.68	10/16/2023			-0.5	-0.49	+1.55
CWD RMS-13	168	Lower[2]	Berenda Slough	-0.16 + subsidence Berenda Sl. @ WMA	-45	-88	34	37.72	10/16/2023	+82.72	+125.72	-0.5	-0.56	+0.1
CWD RMS-14	152	Lower[2]	Berenda Slough	-0.75 + subsidence Berenda Sl. @ WMA	-132	-98	31	-93	10/14/2023	+39	+5	-0.5	-0.52	+0.73
CWD RMS-15	213	Lower[3]	Berenda Slough	-2.36 + subsidence Berenda Sl. @ WMA	-99	-90	-17	-92.9	10/14/2023	+6.1	-2.9	-0.5	-0.53	+2.33
CWD RMS-16	213	Lower[3]	Berenda Slough	-1.77 + subsidence Berenda Sl. @ WMA	-83	-80	1	-74.8	10/14/2023	+8.2	+5.2	-0.5	-0.54	+1.73
CWD RMS-17	203	Lower[3]	Berenda Slough	-1.51 + subsidence Berenda Sl. @ WMA	-116	-99	32	-84.9	10/14/2023	+31.1	+14.1	-0.5	-0.49	+1.52
MCE RMS-1	277	Lower[3]	Chowchilla River	-3.03 + subsidence Chowchilla R. @ WMA	-69	-63	-20	-68.1	10/31/2023	+0.9	-5.1	NA[5]	-0.03	
MCE RMS-2	254	Lower[2]	Ash Slough	-2.97 + subsidence Ash Sl. @ WMA	-97	-82	-12	-92.66	10/31/2023	+4.34	-10.66	-0.55	-0.13	+3.39

RMS Well I.D.	Estimated Surface Elevation[1] (msl, feet)	Aquifer Desig-nation	Associated Critical Conveyance	Subsidence MT: Subsidence Amount (ft)	2025 Interim Milestone GWE	MT GWE	MO GWE	Fall 2023 GWE	Date of Fall Measure-ment	2025 IM Status	MT Status	Critical Conveyance Subsidence - March 2022 to 2023 (ft)	RMS Well Subsidence - March 2022 to 2023 (ft)	Subsi-dence Amount Status
MER RMS-1	225	Lower[2]	Chowchilla River	-2.08 + subsidence Chowchilla R. @ WMA	-60	-77	-29					NA[5]	-0.25	

[1] Estimated surface elevation and groundwater elevations (GWE) are expressed in feet above mean sea level.
[2] Lower Aquifer wells within the Corcoran Clay extent.
[3] Lower Aquifer wells outside the Corcoran Clay extent; considered representative of undifferentiated unconfined groundwater zone.
[4] Groundwater elevations recorded at this well were likely representative of a zone below the Corcoran Clay when it was actively pumped, but in recent years are more representative of a shallow zone above the Corcoran Clay since it is no longer actively pumped. It is recommended this RMS well be removed from the monitoring program and replaced (if necessary) with a new RMS well for the GSP five-year update.
[5] INSAR not available at this location for this time period

7.4.3 Degraded Groundwater Quality

In the Revised GSP, interim milestones (IMs) for degraded groundwater quality were established at five-year intervals over the Implementation Period from 2020 to 2040, at years 2025, 2030, 2035, and 2040, and are the same as the MOs. IMs and MOs for groundwater quality were established to not exacerbate adverse impacts on all beneficial uses of groundwater, especially municipal and domestic supply uses since these are the most restrictive from a water quality standpoint, resulting from implementation of GSP projects or management actions.

The groundwater quality IMs and 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 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. For all groundwater quality RMS, the IM and 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 projects or management actions do not significantly adversely impact groundwater quality conditions.

The cause of basin 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 MCLs for drinking water for identified key constituents. Municipal and domestic supply (MUN) is a designated beneficial use for groundwater in the Subbasin; therefore, groundwater quality degradation 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) previously identified in Section 2 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 minimum threshold is set at the recent concentration plus 20 percent.

Table 7-8 presents a summary of groundwater quality monitoring activities to date. Sampling is currently being conducted to establish a baseline concentration to confirm and/or adjust SMC that were presented in the Revised GSP, and will be discussed in greater in the Five-Year Update. GSA efforts to bring in the remaining RMS wells listed in the GSP are ongoing; the status of monitoring efforts to date is provided in **Appendix E**.

Table 7-8. Summary of RMS Well Groundwater Quality Monitoring Activities.

	RMS ID	Arsenic		Nitrate as N		Total Dissolved Solids	
		Most Recent Sampling Date	Sample Count	Most Recent Sampling Date	Sample Count	Most Recent Sampling Date	Sample Count
GSA-Current	CWD RMS-1	10/20/2021	1	10/20/2021	1	10/20/2021	1
	CWD RMS-2	10/20/2021	1	10/20/2021	1	10/20/2021	1
	CWD RMS-4	10/21/2021	1	10/21/2021	1	10/21/2021	1
	CWD RMS-5	10/20/2021	1	10/20/2021	1	10/20/2021	1
	CWD RMS-6						
	CWD RMS-7						
	CWD RMS-9						
	CWD RMS-10	10/20/2021	1	10/20/2021	1	10/20/2021	1
	CWD RMS-11	10/21/2021	1	10/21/2021	1	10/21/2021	1
	CWD RMS-12	11/5/2021	1	11/5/2021	1	11/5/2021	1
	CWD RMS-13	10/21/2021	1	10/21/2021	1	10/21/2021	1
	CWD RMS-15						
	MCE RMS-1	7/12/2022	1	7/12/2022	1	7/12/2022	1
	MCW RMS-1						
	MCW RMS-4						
	MCW RMS-7						
	MCW RMS-9						
	TRT RMS-1						
	TRT RMS-3						
	TRT RMS-4						
	Clayton Ag Well #2						
GSA-Future	CSB01A	6/28/2023	4	6/28/2023	3	6/28/2023	4
	CSB01B	6/21/2023	4	6/21/2023	3	6/21/2023	4
	CSB01C	6/21/2022	2	6/21/2022	2	6/21/2022	2
	CSB02A	7/27/2021	3			8/5/2020	2
	CSB02B	6/21/2023	4	6/21/2023	3	6/21/2023	4
	CSB02C	6/21/2023	4	6/21/2023	3	6/21/2023	4
	CSB03A	7/27/2021	4	6/16/2021	1	6/16/2021	3
	CSB03B	6/20/2023	4	6/20/2023	3	6/20/2023	4
	CSB03C	6/20/2023	3	6/20/2023	2	6/20/2023	3
	CSB05A	6/14/2023	5	6/14/2023	3	6/14/2023	5
	CSB05B	6/14/2023	4	6/14/2023	3	6/14/2023	4
	CSB05C	6/28/2023	4	6/28/2023	3	6/28/2023	4
	CSB06A	6/14/2023	4	6/14/2023	2	6/14/2023	5
	CSB06B	6/14/2023	3	6/14/2023	2	6/14/2023	3
	CSB06C	6/14/2023	3	6/14/2023	2	6/14/2023	3

	RMS ID	Arsenic		Nitrate as N		Total Dissolved Solids	
		Most Recent Sampling Date	Sample Count	Most Recent Sampling Date	Sample Count	Most Recent Sampling Date	Sample Count
	CSB07A	6/28/2023	5	6/28/2023	2	6/28/2023	5
	CSB07B	6/28/2023	3	6/28/2023	2	6/28/2023	3
	CSB07C	6/28/2023	3	6/28/2023	2	6/13/2023	3
	CSB09A	6/14/2023	6	6/14/2023	3	6/14/2023	6
	CSB09B	6/14/2023	4	6/14/2023	3	6/14/2023	4
	CSB09C	6/14/2023	4	6/14/2023	3	6/14/2023	4
Non-GSA	2000511-001	1/13/2021	6	3/2/2023	76	1/13/2021	6
	2000597-001	6/10/2021	8	10/9/2023	41	12/17/2009	3
	2000681-002	12/13/2017	3	12/6/2022	9	5/7/2013	2
	2010001-008	7/29/2015	9	10/23/2017	26	7/27/2016	16
	2010001-010	6/2/2021	10	11/16/2023	67	6/2/2021	17
	2010001-011	2/8/2022	10	6/21/2023	31	2/8/2022	16
	2400216-001	10/14/2019	4	4/12/2021	19	8/22/2013	2
	ESJ11	7/27/2021	1			8/5/2020[1]	1 [1]

[1] Monitoring for the Irrigated Lands Regulatory Program annual monitoring includes 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.

7.4.4 Depletion of Interconnected Surface Water

In the Revised GSP, interim SMC for the depletion of interconnected surface water (ISW) were established due to limited data available to quantify the relationship between groundwater and the San Joaquin River. A workplan was developed to improve understanding of ISW in the Subbasin (**Appendix F**), but in the meantime the interim SMC will be used to evaluate this sustainability indicator.

For the purposes of establishing interim SMC for ISW along the San Joaquin River, six groundwater level 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 in order to calculate the percent of time over the historical time period from 1989 to 2015 that ISW exists at that given location. The IMs and MOs for ISW along the San Joaquin River are the same, and are 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. 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 to determine if MOs are being achieved.

Table 7-9 presents the status of ISW RMS wells in relation to the SMC defined in the GSP. Review of the 5-year rolling average over the WY 2019-2023 time period for ISW RMS wells indicates that percent of time connected is less than the SMC for all wells with the exception of MCW RMS-

10. It should be noted that MCW RMS-10 is the only ISW well currently recording measurements with a transducer, and as a result provides the most comprehensive dataset for evaluating ISW. The other ISW RMS wells have much more limited data with which to evaluate the ISW SMC. Additionally, the SMC were based on GSP analyses using a projected hydrologic sequence over the implementation period that was approximately representative of the long-term average hydrology in the area. During the initial years of the GSP implementation, the hydrology has been much drier than average. This has limited the effectiveness of recharge projects in the Chowchilla Subbasin and has also reduced the availability of natural recharge and water supply from precipitation.

Table 7-9. Summary of ISW RMS Wells Relative to Sustainable Management Criteria

RMS Well I.D.	Estimated Surface Elevation[1] (msl, feet)	Aquifer Designation	SMC[2]	Time Period	Count of GW Elevation Measurements	Count of GW Elevation Measurements that are greater than Streambed Elevation	Percent of Time that GW Elevation Measurements are greater than Streambed Elevation	SMC Status
MCW RMS-1	120	Upper	3%	2019-2023	6	0	0%	-3
MCW RMS-2	123	Upper	21%	2019-2023	11	1	9%	-12
MCW RMS-3	122	Upper	3%	2019-2023	8	0	0%	-3
MCW RMS-10	123	Upper	78%	2019-2023	1,234	969	79%	+1
MCW RMS-11	127	Upper	26%	2019-2023	50	9	18%	-8
MCW RMS-12	127	Upper	11%	2019-2023	52	0	0%	-11

[1] Estimated surface elevation and groundwater elevations (GWE) are expressed in feet above mean sea level.
[2] The SMC 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.

8 References

American Society of Civil Engineers (ASCE). 2016 Evaporation, Evapotranspiration and Irrigation Water Requirements. Manual 70. Second Edition. M. E. Jensen and R. G. Allen (eds). Am. Soc. Civ. Engrs.

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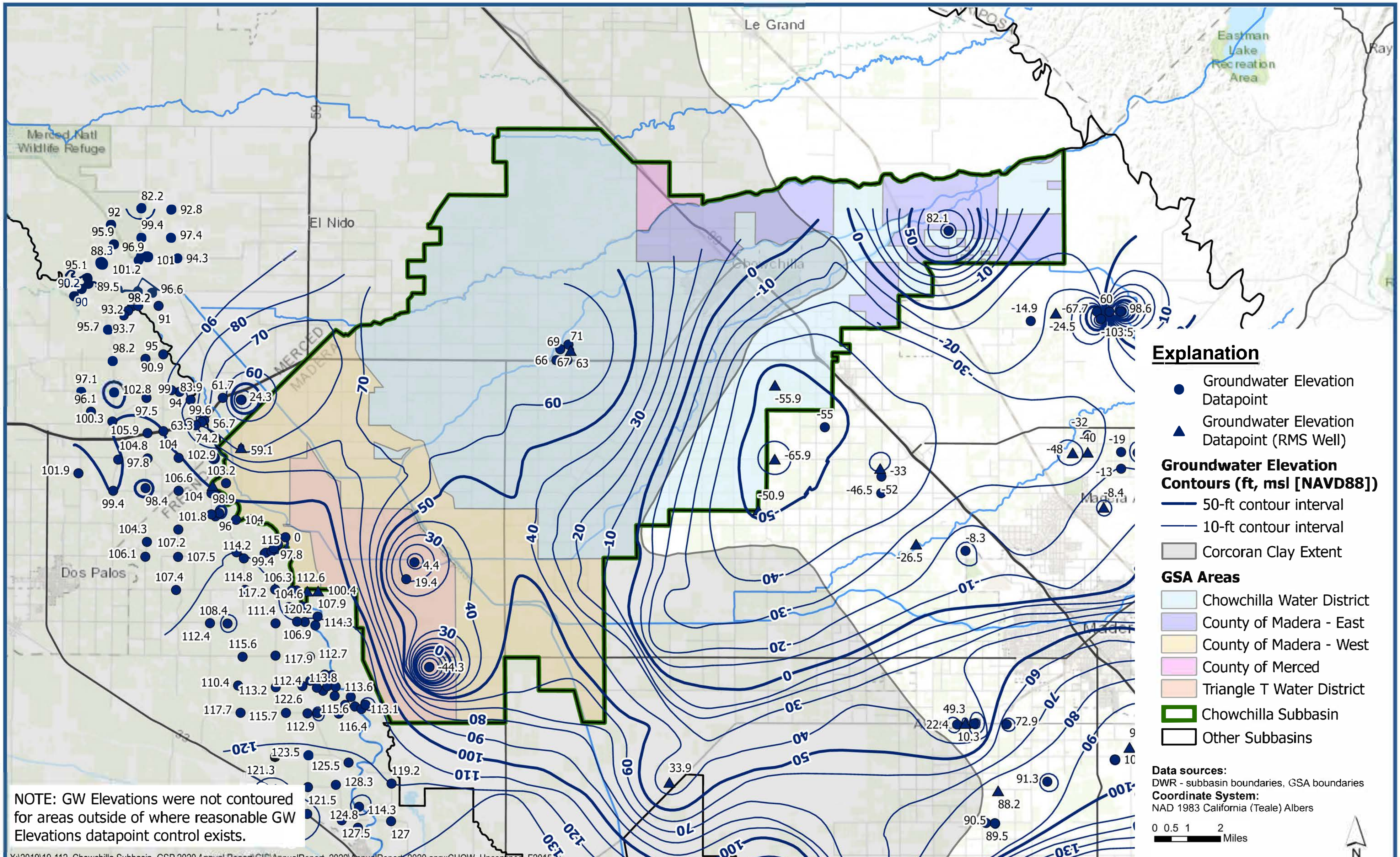
Clemmens, A. J. and C. M. Burt. 1997. Accuracy of irrigation efficiency estimates. J. Irrig. and Drain. Engng. 123(6): 443-453.

Appendix A. Contour Maps of the Different Aquifer Units.



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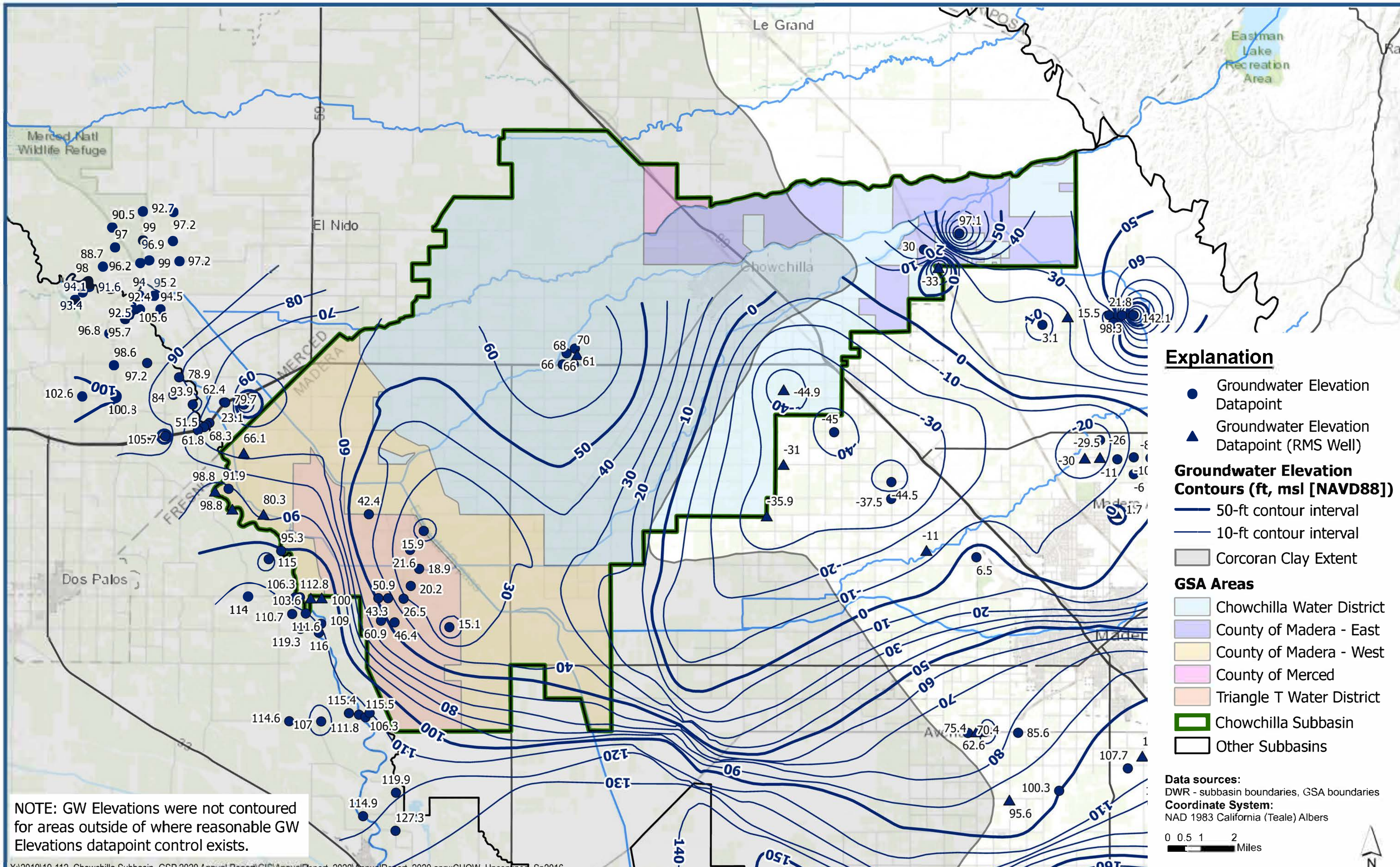
Contours of Equal Groundwater Elevation
Upper Aquifer/Undifferentiated Unconfined Zone - Fall 2015

Chowchilla Subbasin
Groundwater Sustainability Plan 2024 Annual Report

Figure A-1



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Contours of Equal Groundwater Elevation
Upper Aquifer/Undifferentiated Unconfined Zone - Spring 2016

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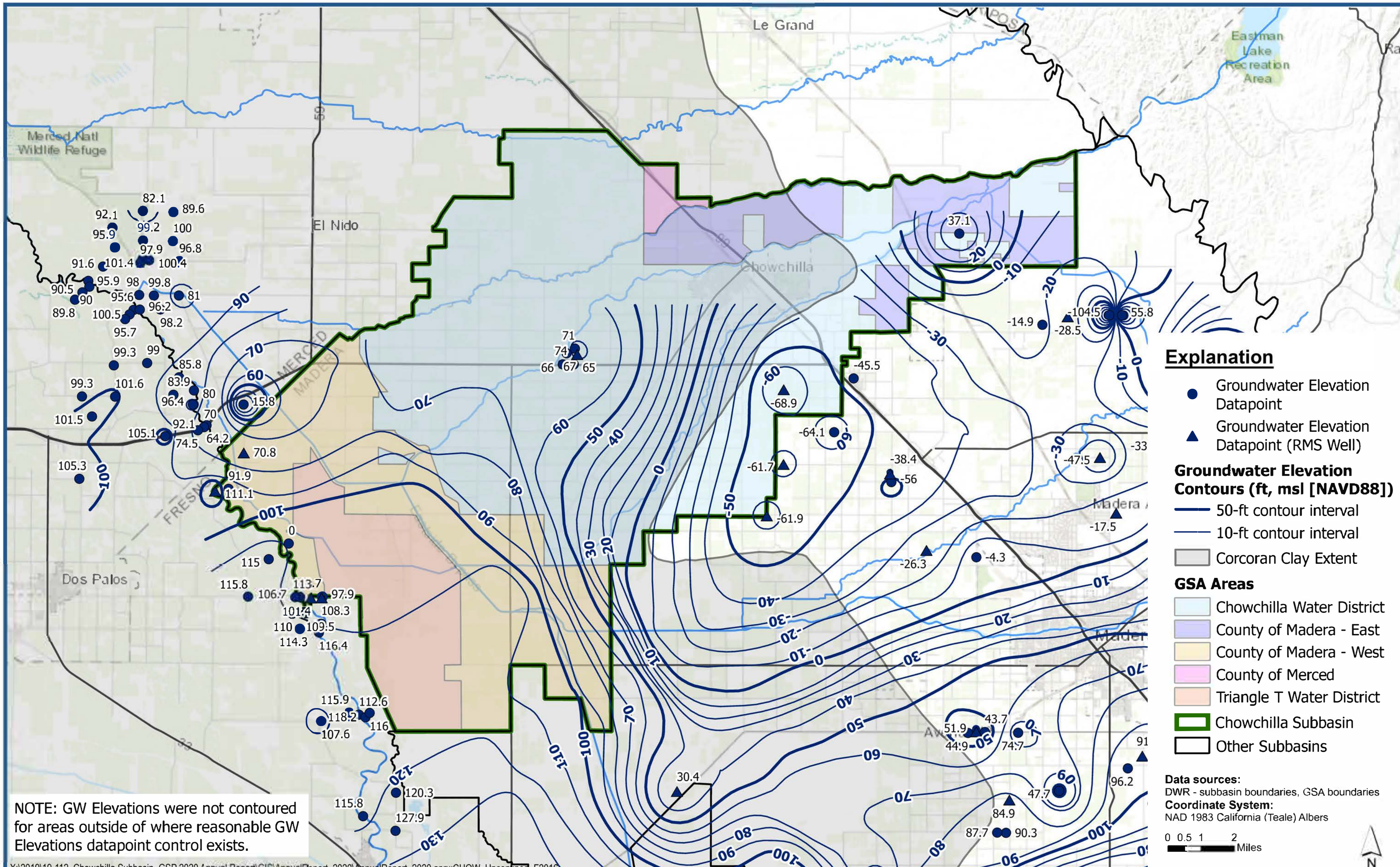
Groundwater Sustainability Plan 2024 Annual Report

Figure A-2



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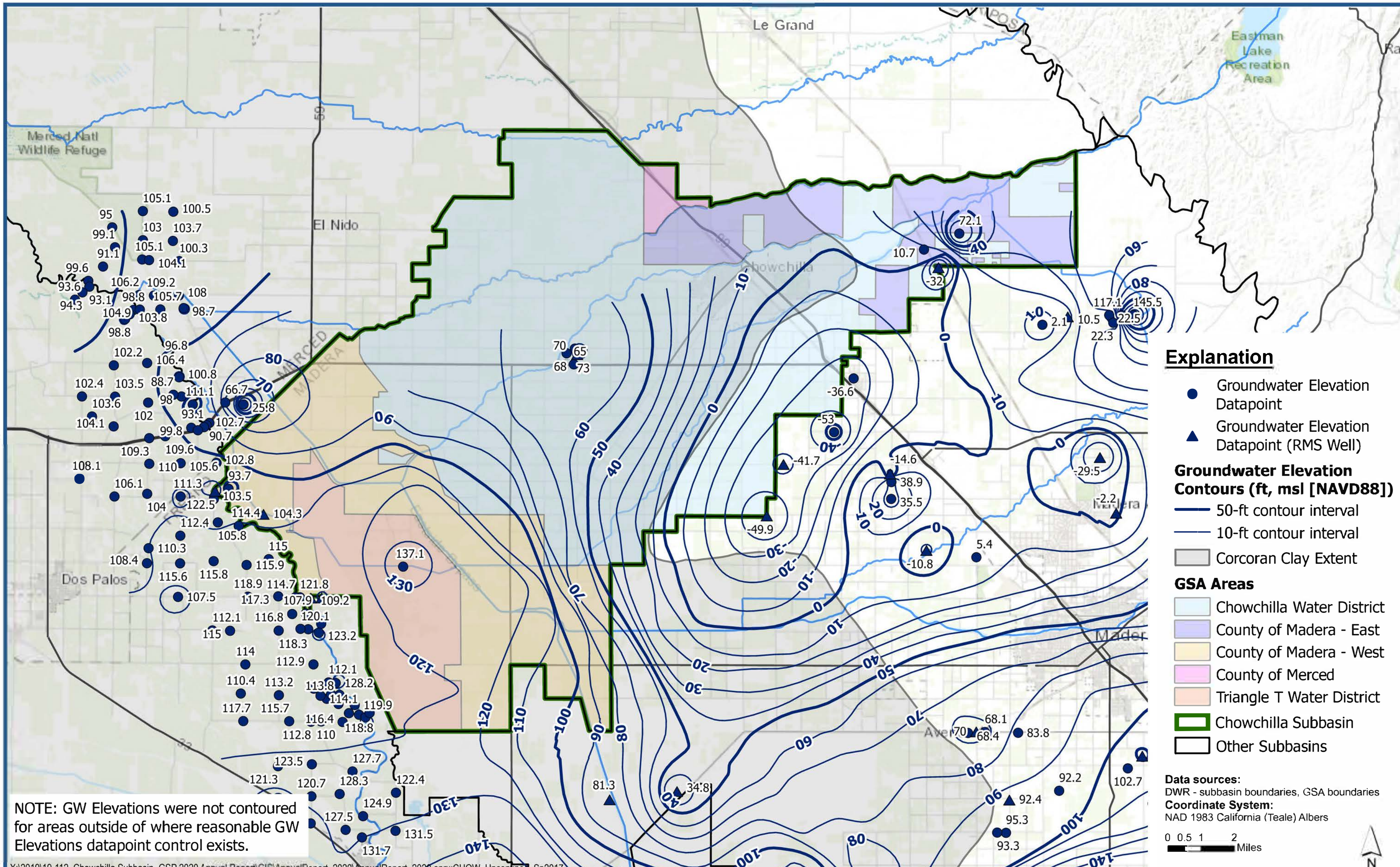
Contours of Equal Groundwater Elevation
Upper Aquifer/Undifferentiated Unconfined Zone - Fall 2016

Chowchilla Subbasin
Groundwater Sustainability Plan 2024 Annual Report

Figure A-3



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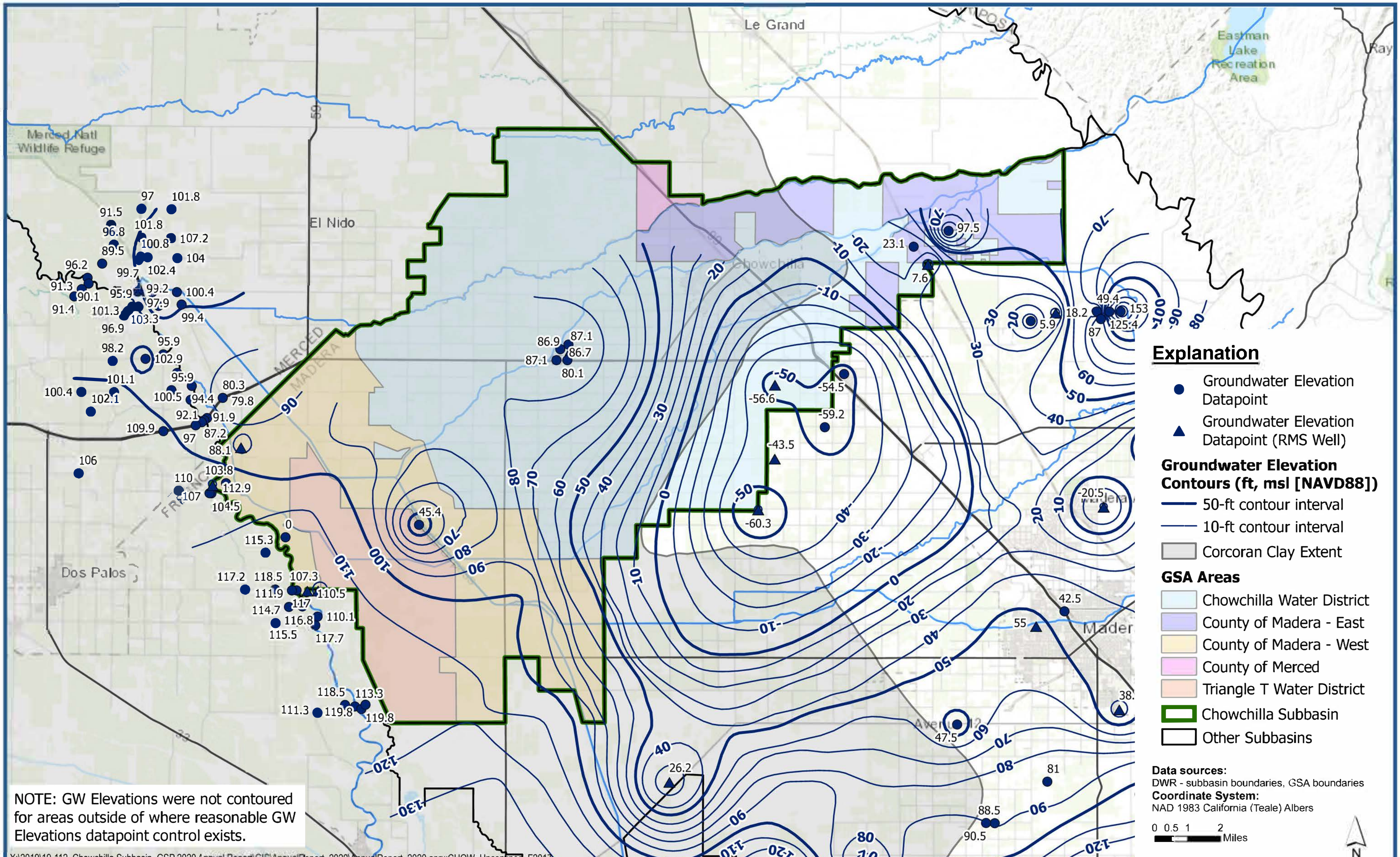
Contours of Equal Groundwater Elevation
Upper Aquifer/Undifferentiated Unconfined Zone - Spring 2017

Chowchilla Subbasin
Groundwater Sustainability Plan 2024 Annual Report

Figure A-4



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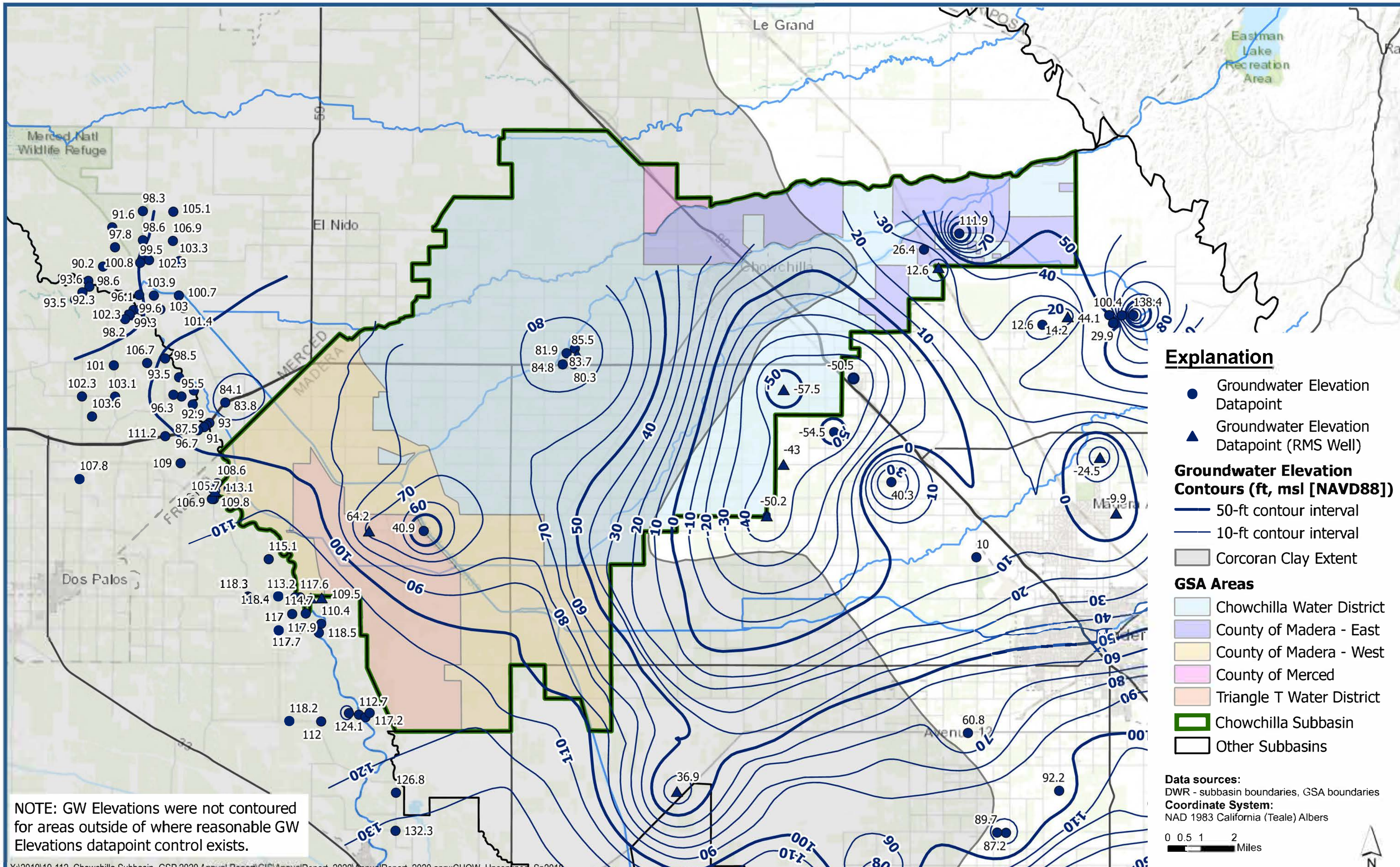
Contours of Equal Groundwater Elevation
Upper Aquifer/Undifferentiated Unconfined Zone - Fall 2017

Chowchilla Subbasin
Groundwater Sustainability Plan 2024 Annual Report

Figure A-5



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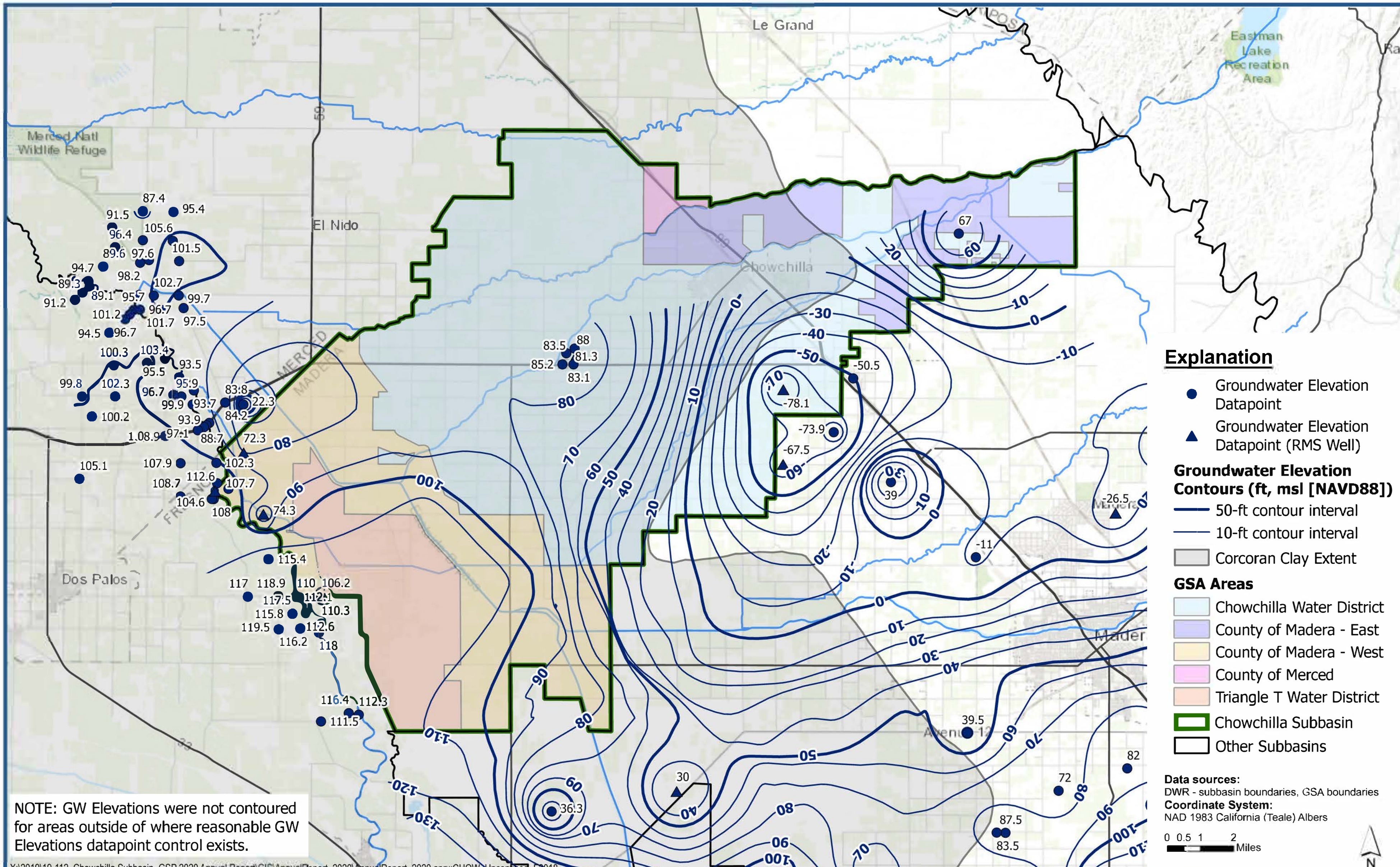
Contours of Equal Groundwater Elevation
Upper Aquifer/Undifferentiated Unconfined Zone - Spring 2018

Chowchilla Subbasin
Groundwater Sustainability Plan 2024 Annual Report

Figure A-6



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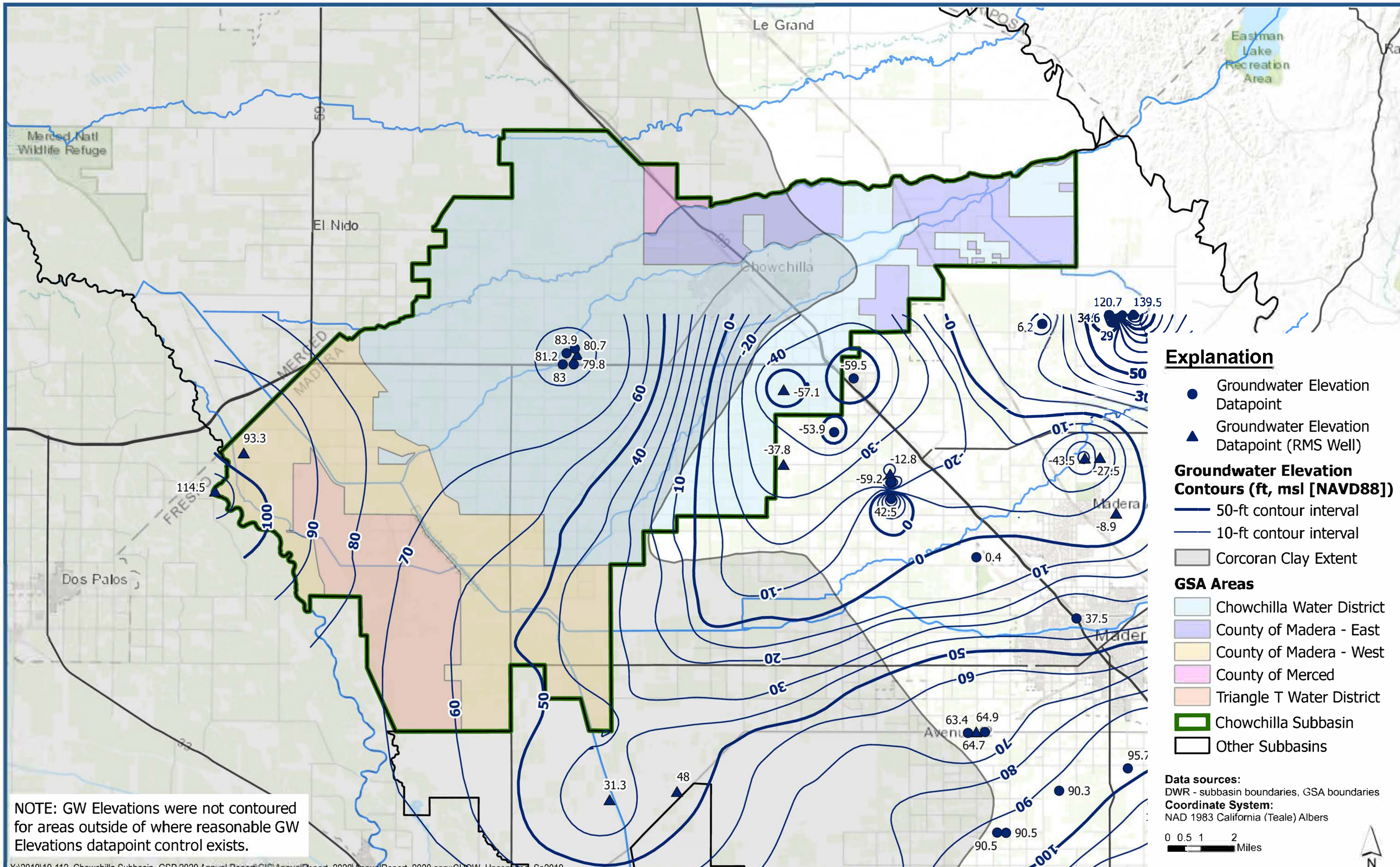
Contours of Equal Groundwater Elevation
Upper Aquifer/Undifferentiated Unconfined Zone - Fall 2018

Chowchilla Subbasin
Groundwater Sustainability Plan 2024 Annual Report

Figure A-7



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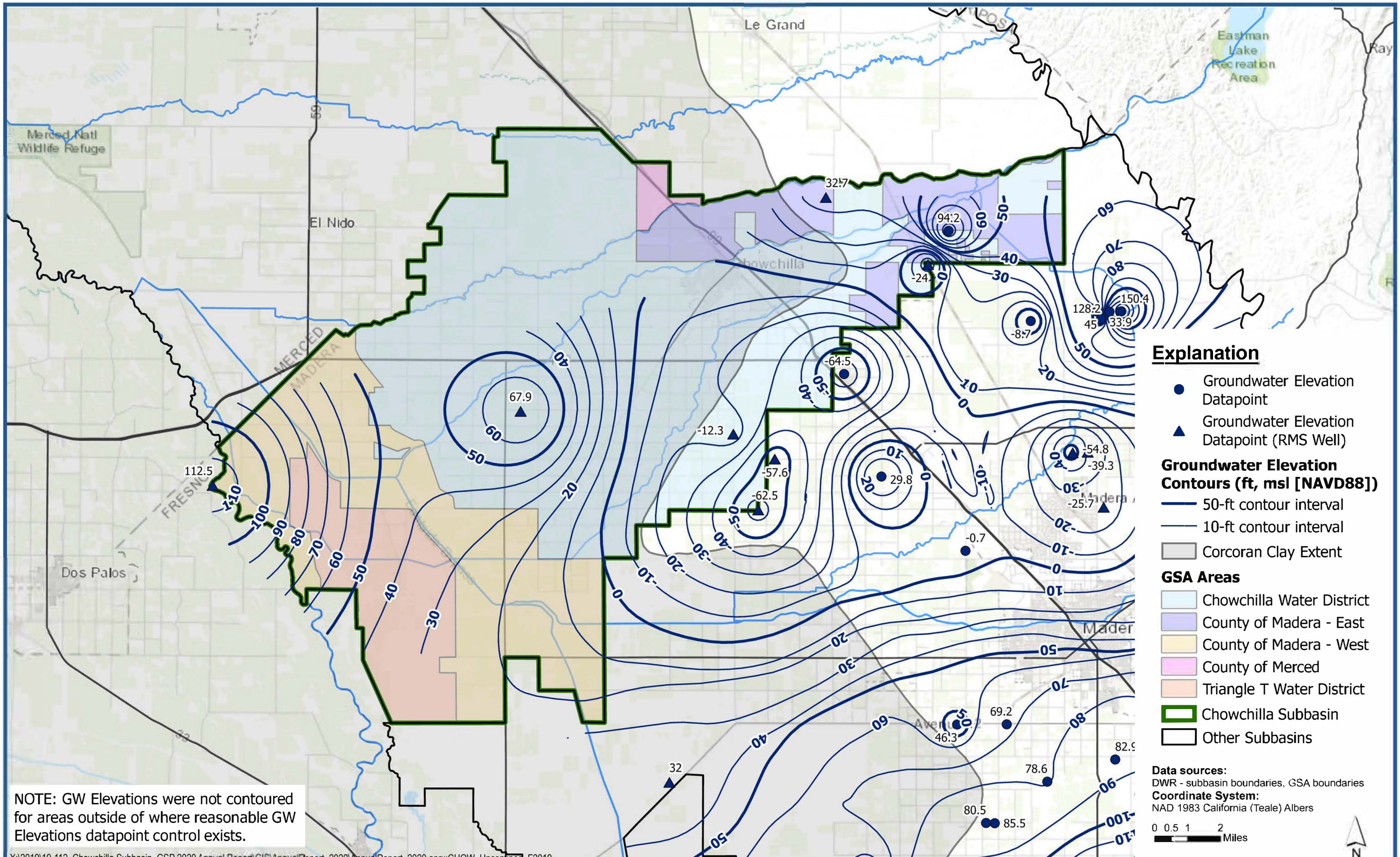
Contours of Equal Groundwater Elevation
Upper Aquifer/Undifferentiated Unconfined Zone - Spring 2019

Chowchilla Subbasin
Groundwater Sustainability Plan 2024 Annual Report

Figure A-8



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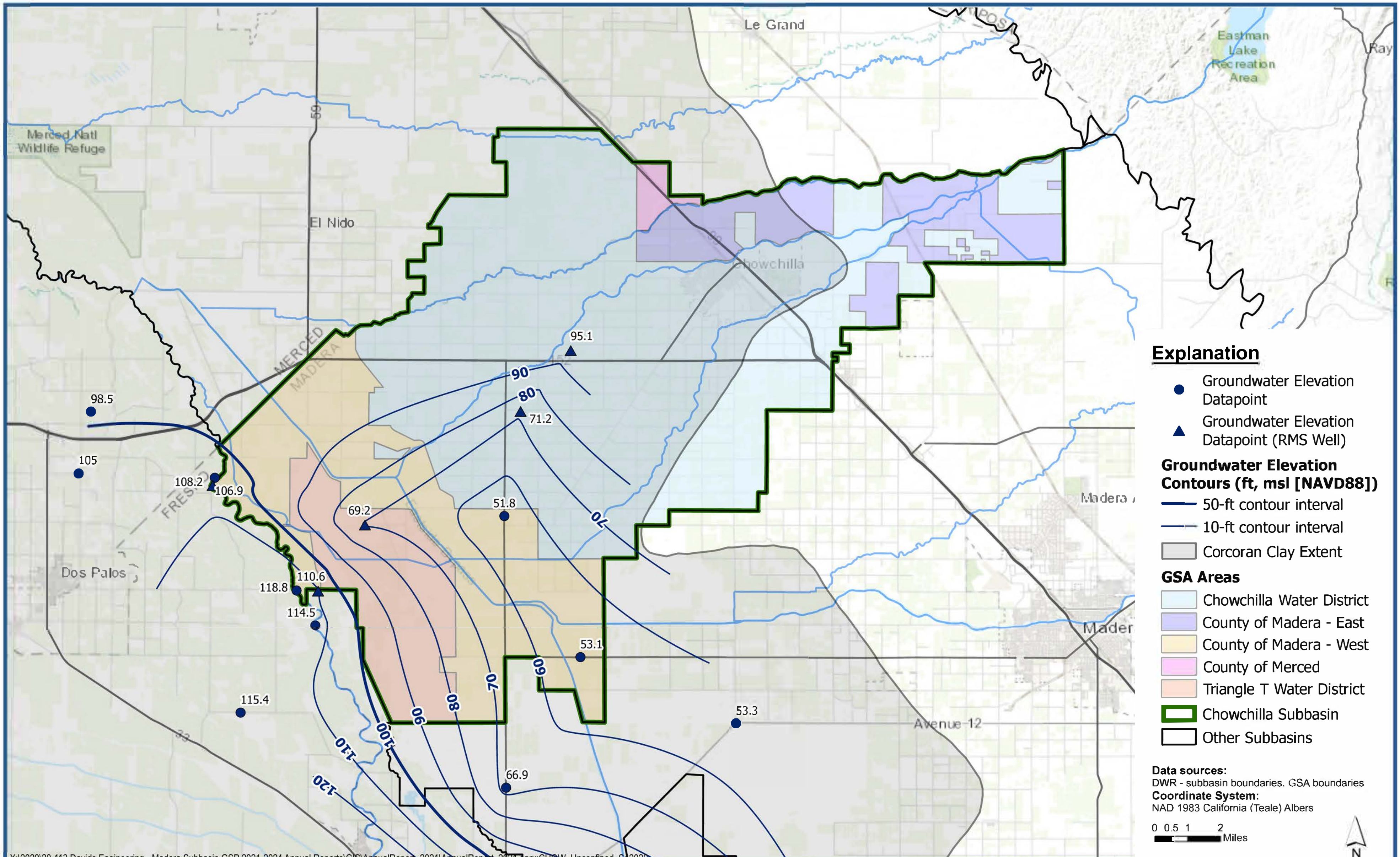
Contours of Equal Groundwater Elevation
Upper Aquifer/Undifferentiated Unconfined Zone - Fall 2019

Chowchilla Subbasin
Groundwater Sustainability Plan 2024 Annual Report

Figure A-9



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Contours of Equal Groundwater Elevation: Upper Aquifer - Spring 2020

Figure A-10

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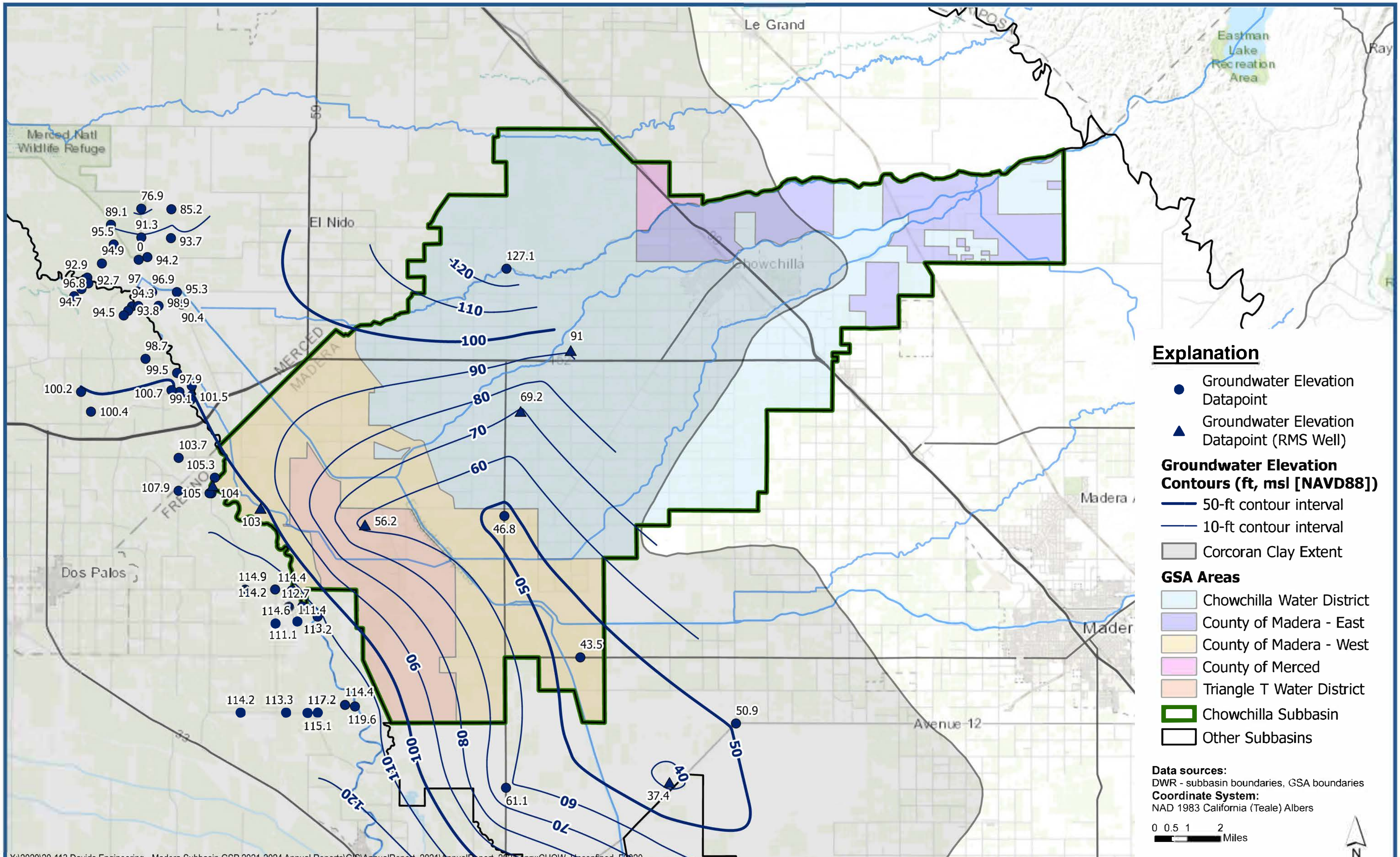
Groundwater Sustainability Plan 2024 Annual Report



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Contours of Equal Groundwater Elevation: Upper Aquifer - Fall 2020

Chowchilla Subbasin
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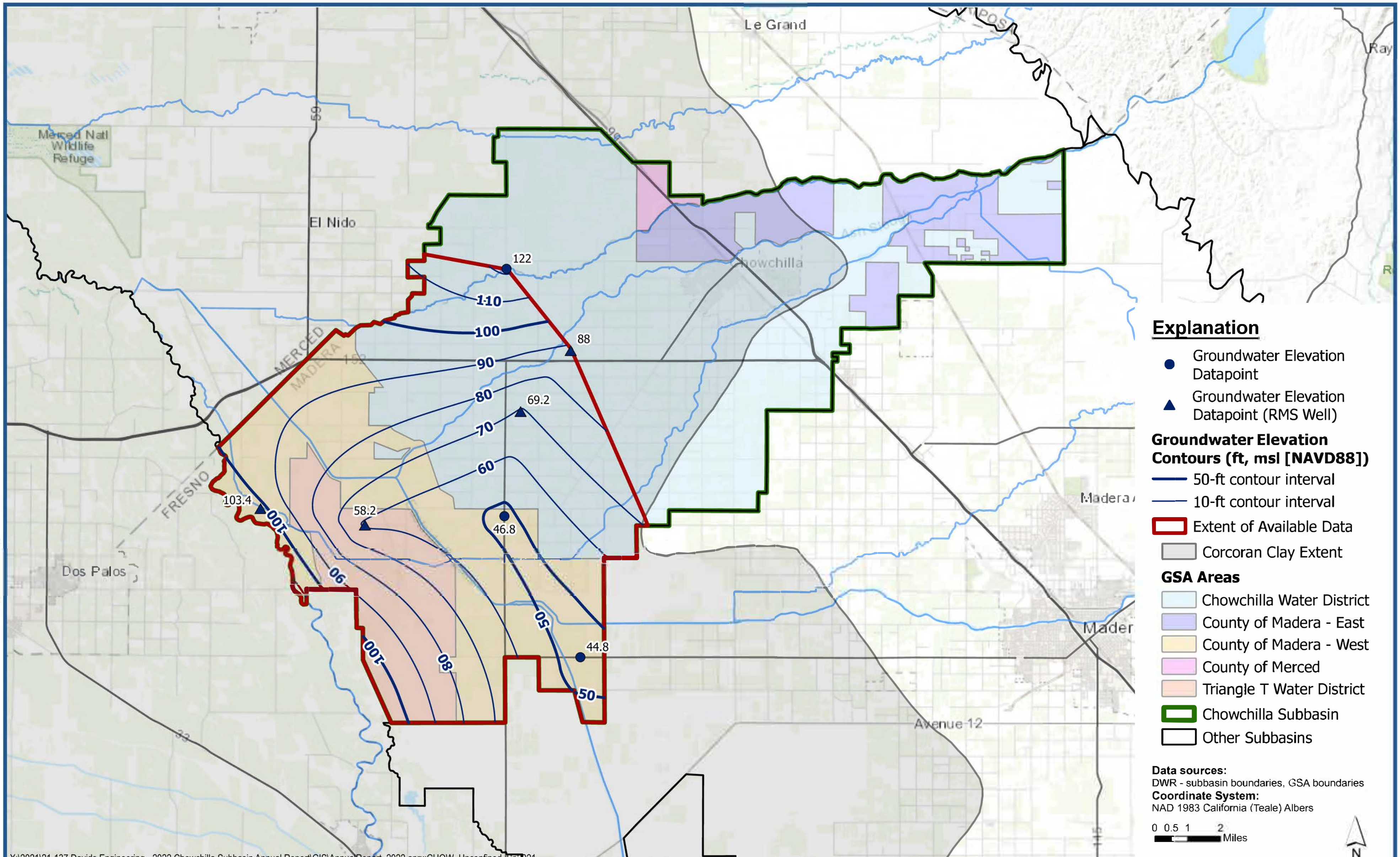
Figure A-11



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Contours of Equal Groundwater Elevation: Upper Aquifer - Spring 2021

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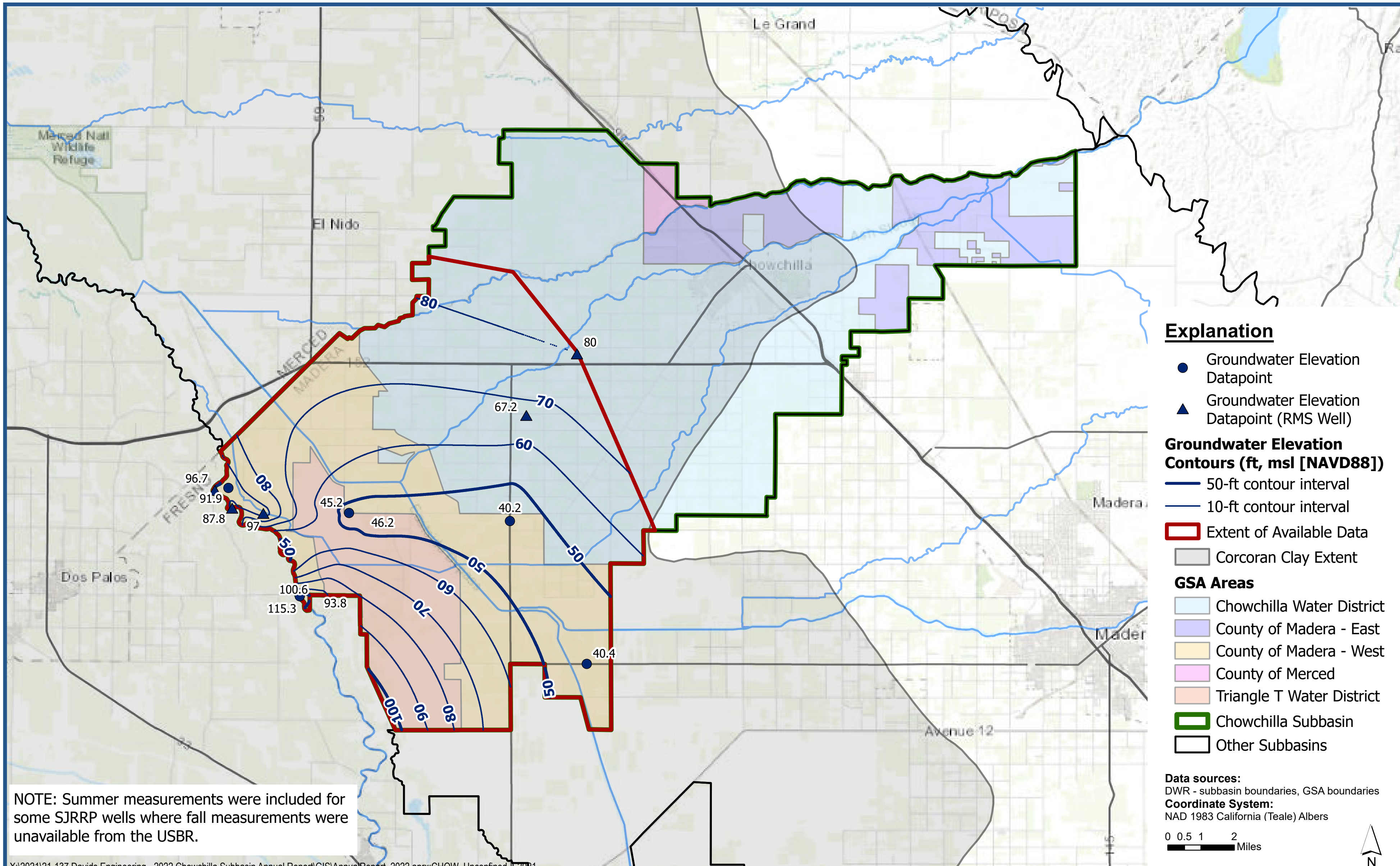
Figure A-12



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Contours of Equal Groundwater Elevation: Upper Aquifer - Fall 2021

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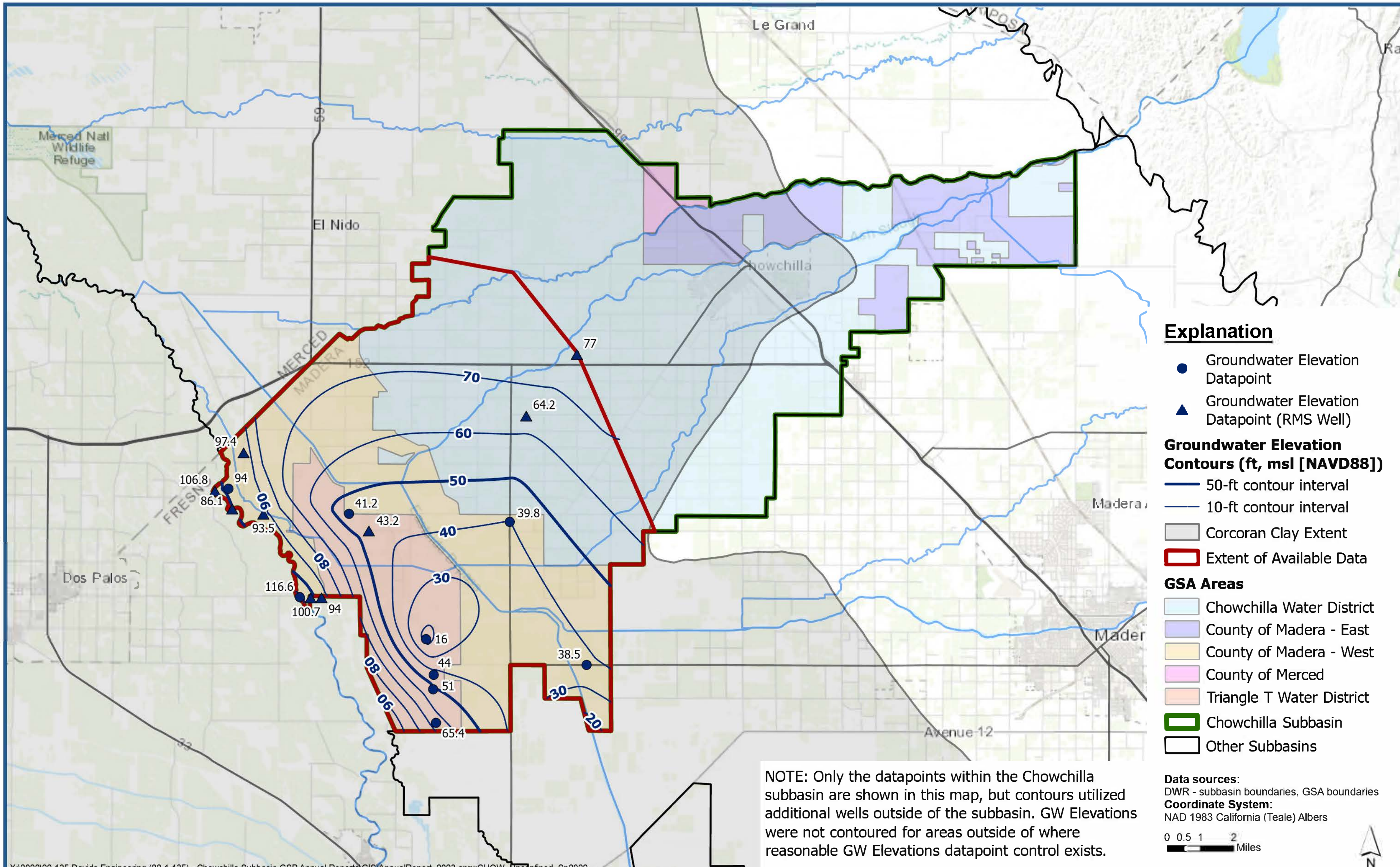
Figure A-13



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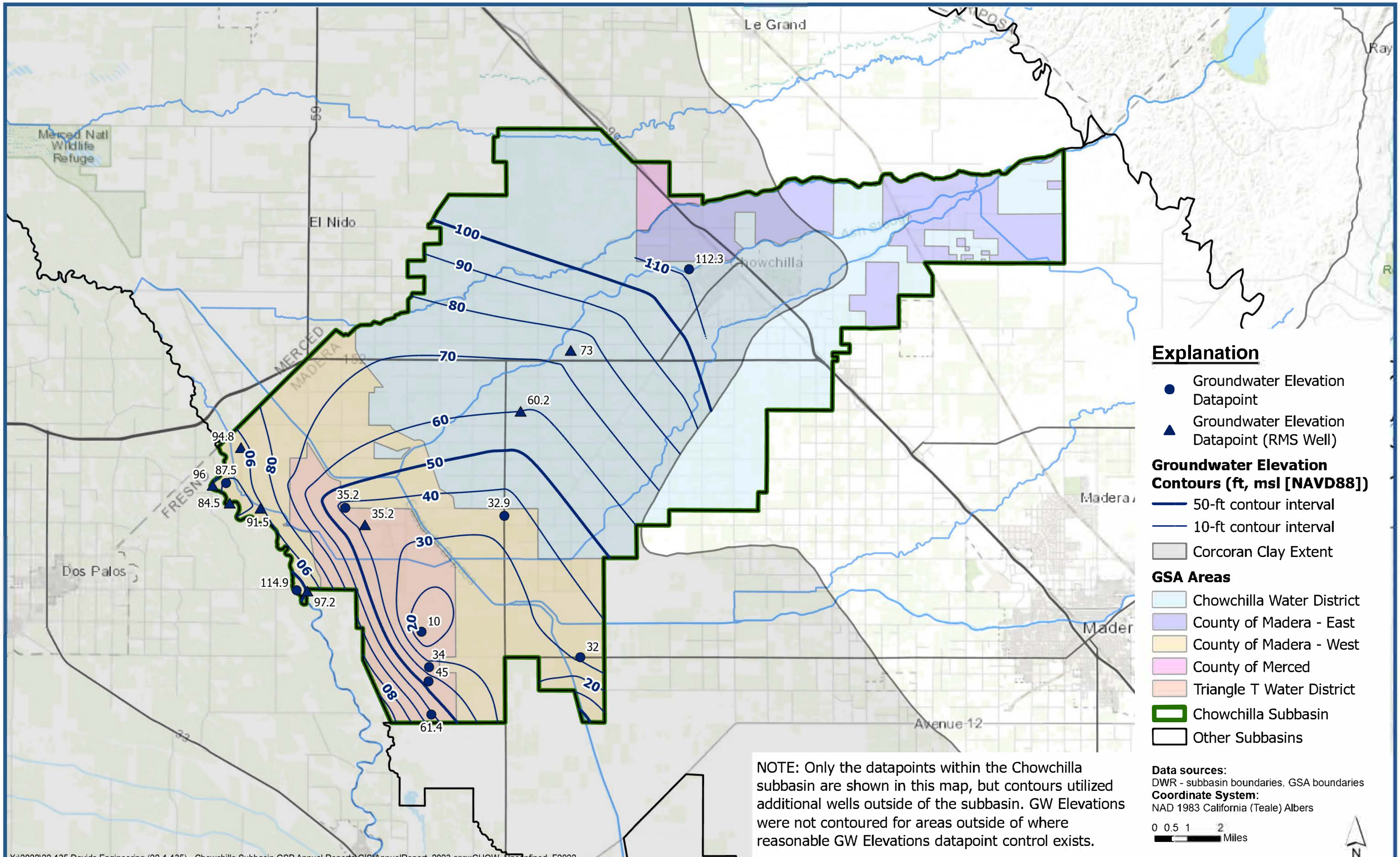
Contours of Equal Groundwater Elevation: Upper Aquifer - Spring 2022

Chowchilla Subbasin
Groundwater Sustainability Plan 2024 Annual Report

Figure A-14



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Contours of Equal Groundwater Elevation: Upper Aquifer - Fall 2022

Chowchilla Subbasin
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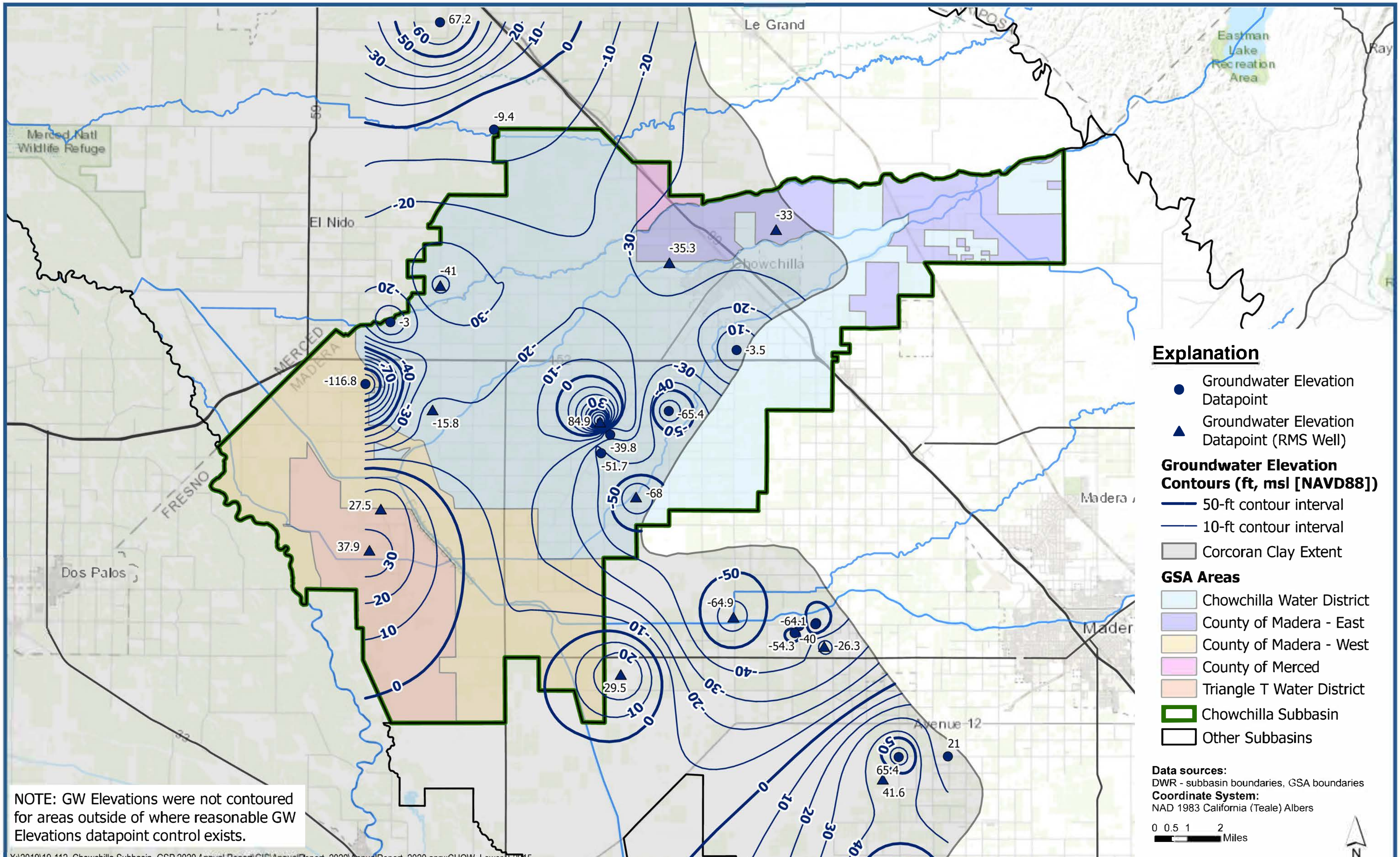
Figure A-15



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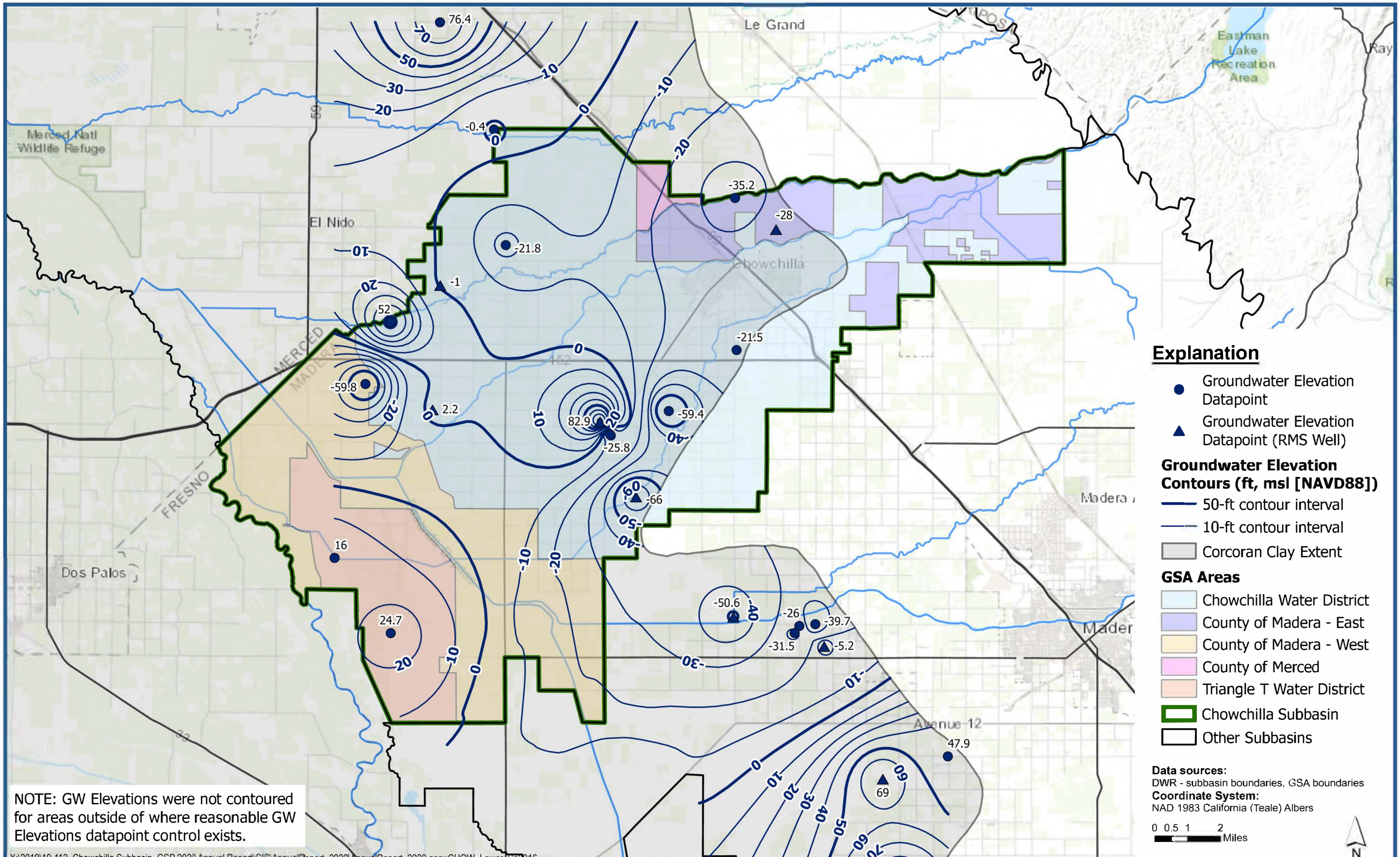
Contours of Equal Groundwater Elevation
Lower Aquifer - Fall 2015

Chowchilla Subbasin
Groundwater Sustainability Plan 2024 Annual Report

Figure A-16



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Contours of Equal Groundwater Elevation
Lower Aquifer - Spring 2016

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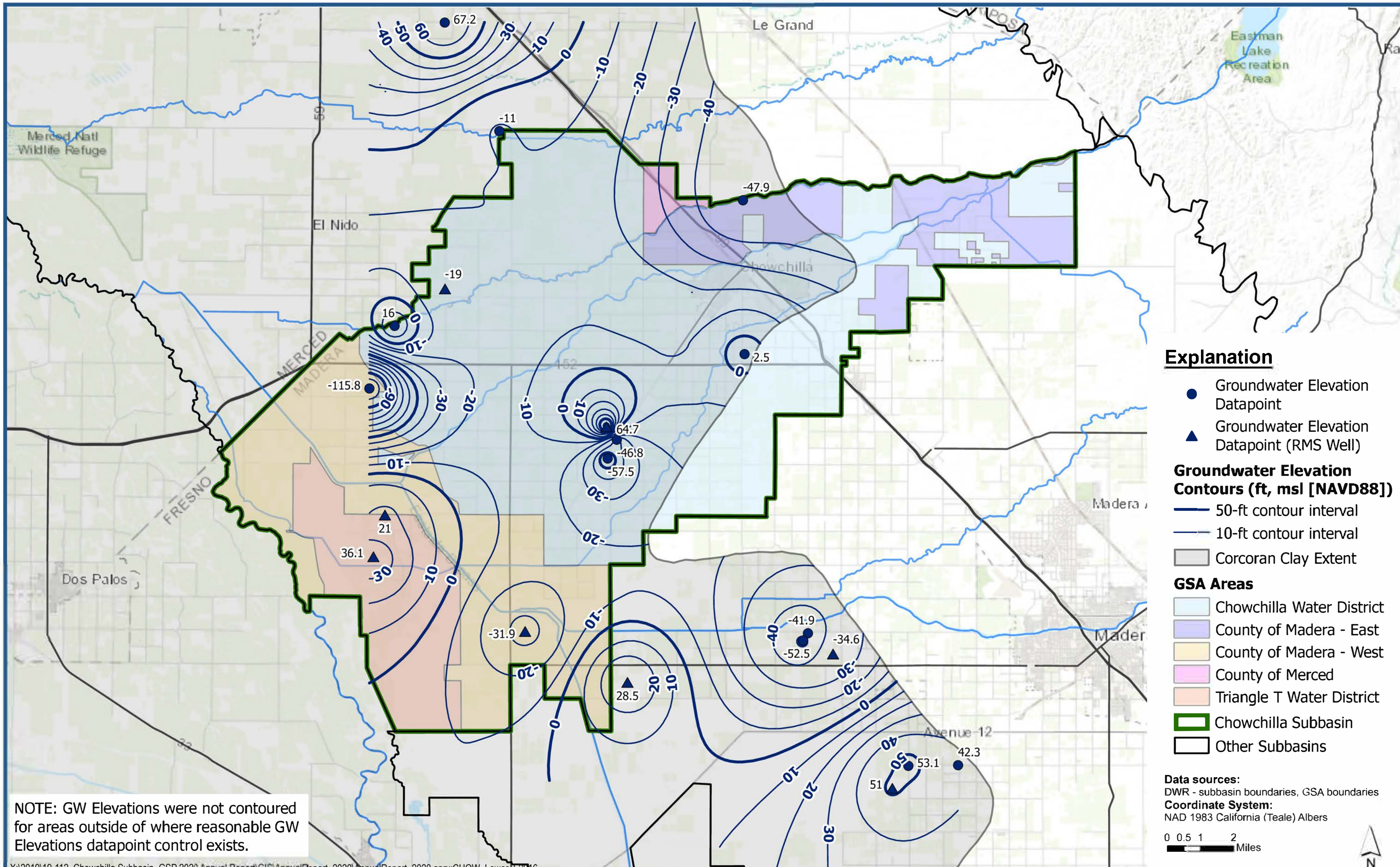
Figure A-17



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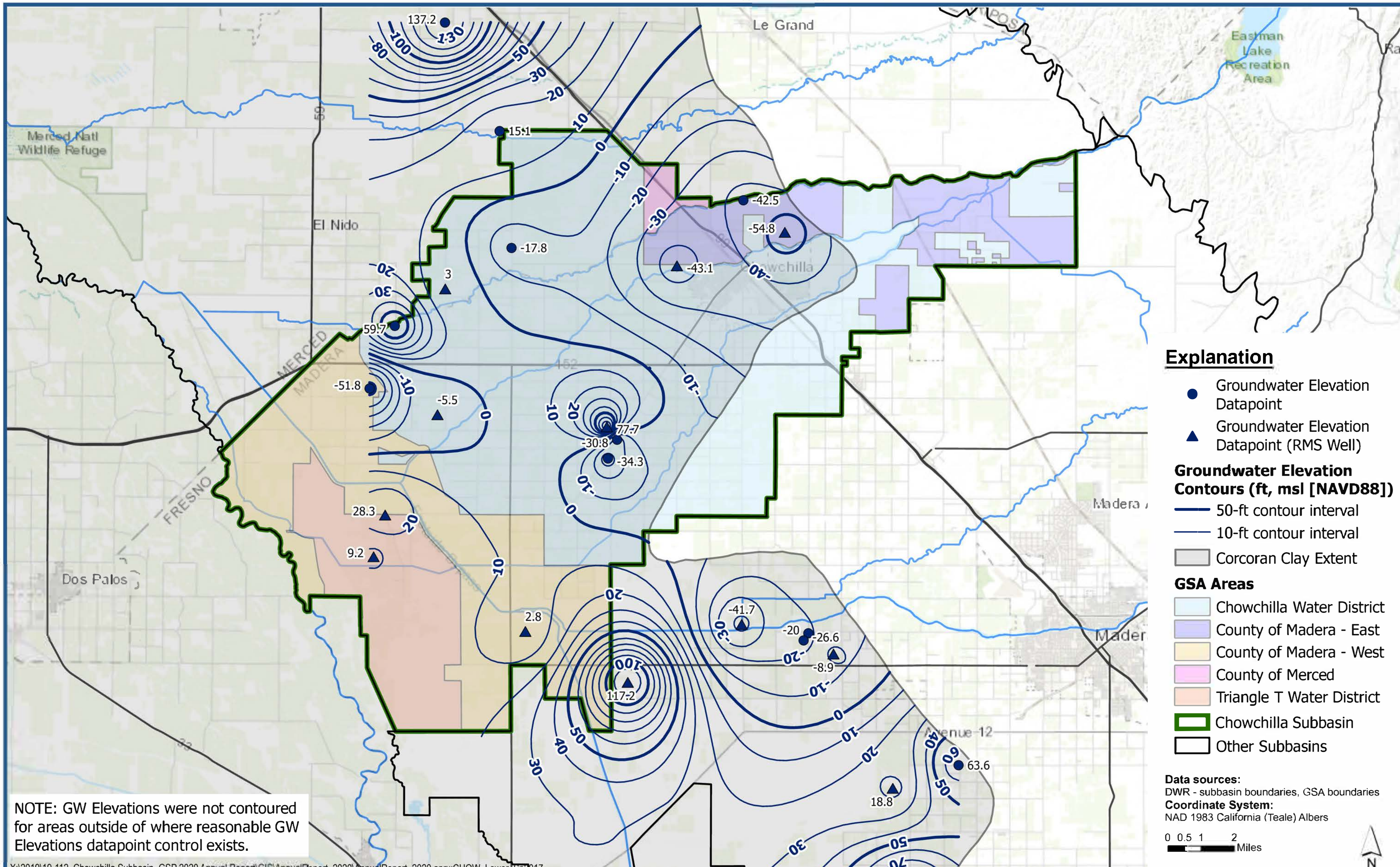
Contours of Equal Groundwater Elevation
Lower Aquifer - Fall 2016

Chowchilla Subbasin
Groundwater Sustainability Plan 2024 Annual Report

Figure A-18



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Contours of Equal Groundwater Elevation
Lower Aquifer - Spring 2017

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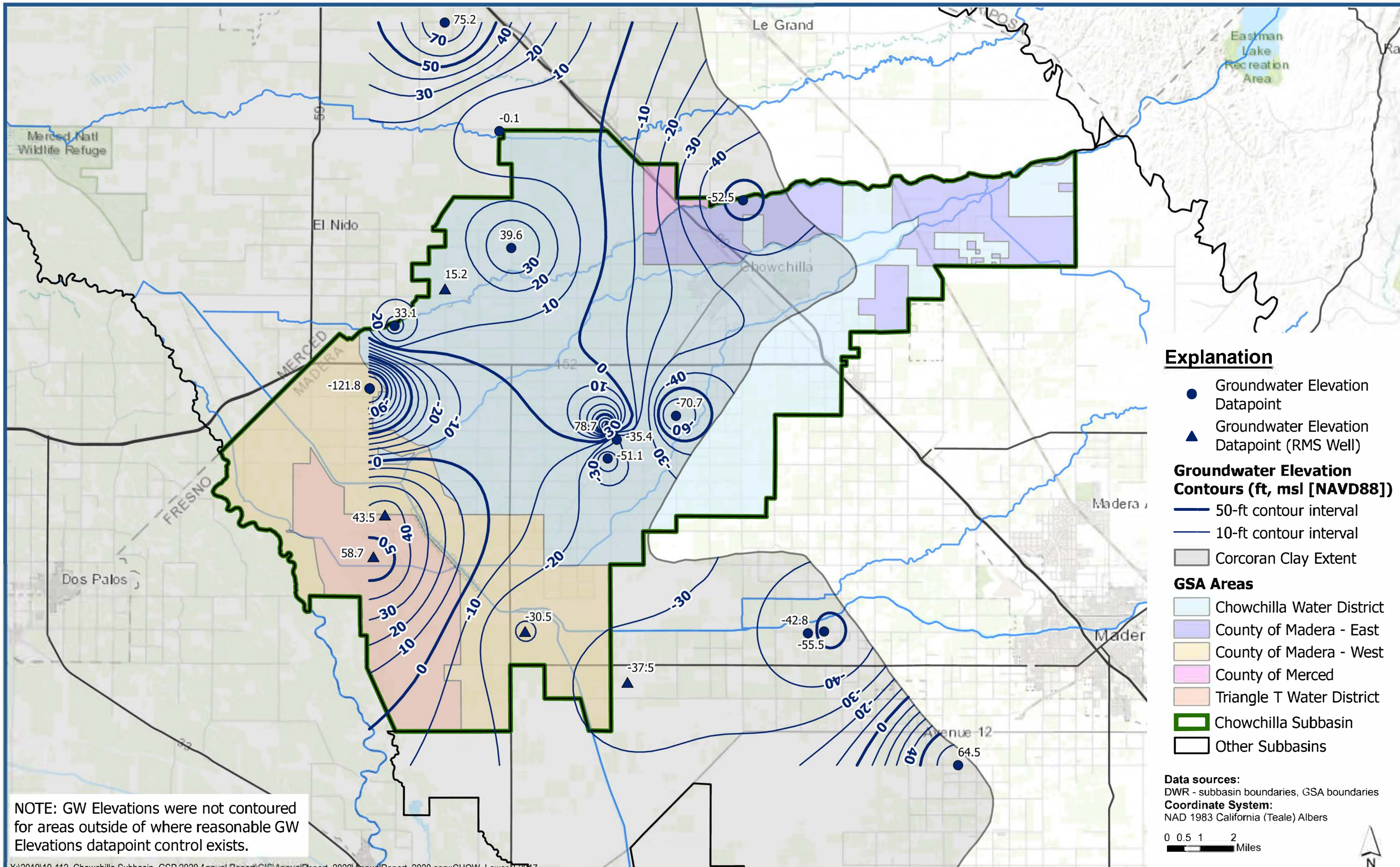
Figure A-19



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Contours of Equal Groundwater Elevation
Lower Aquifer - Fall 2017

Chowchilla Subbasin
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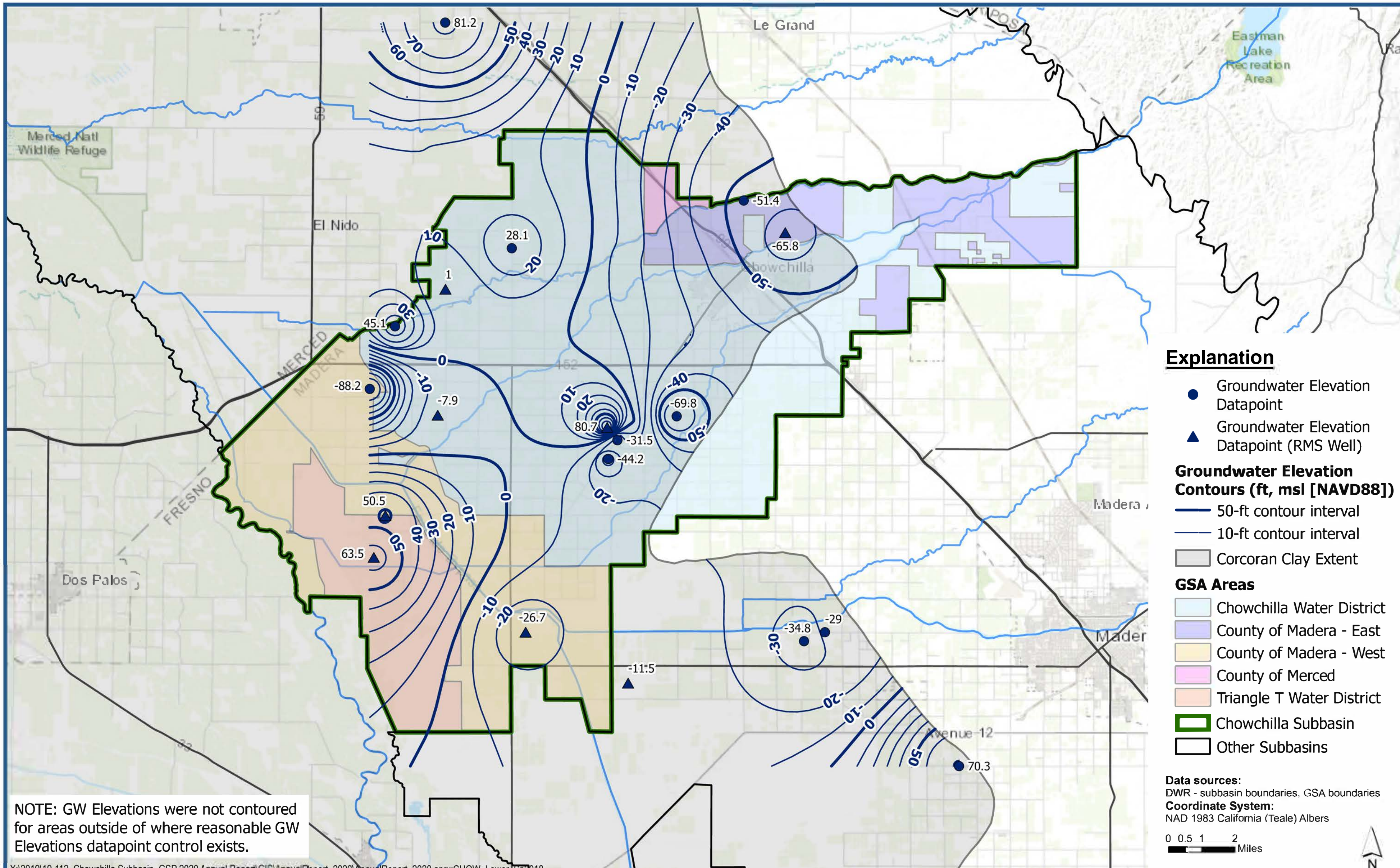
Figure A-20



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Contours of Equal Groundwater Elevation Lower Aquifer - Spring 2018

Figure A-21

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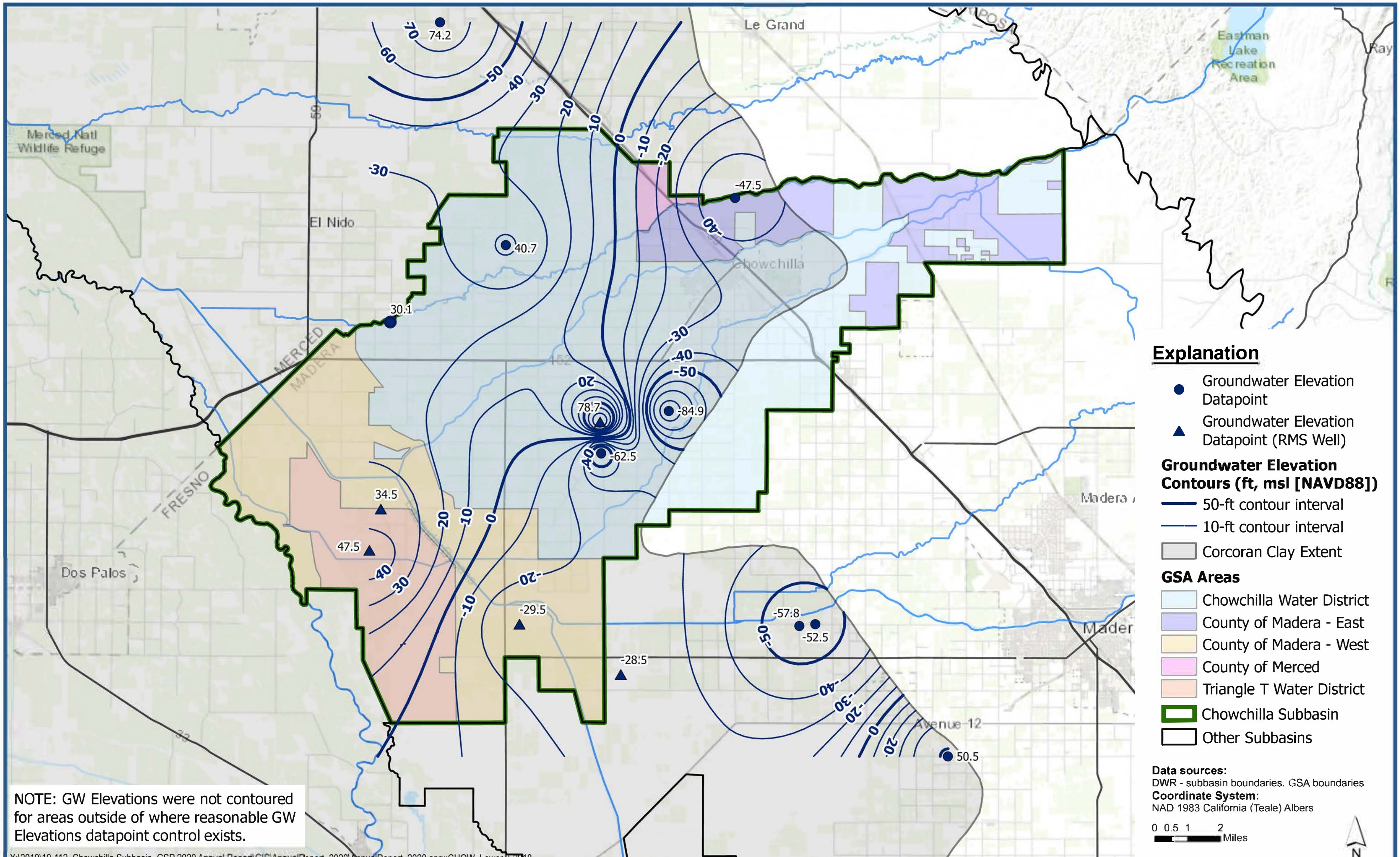
Groundwater Sustainability Plan 2024 Annual Report



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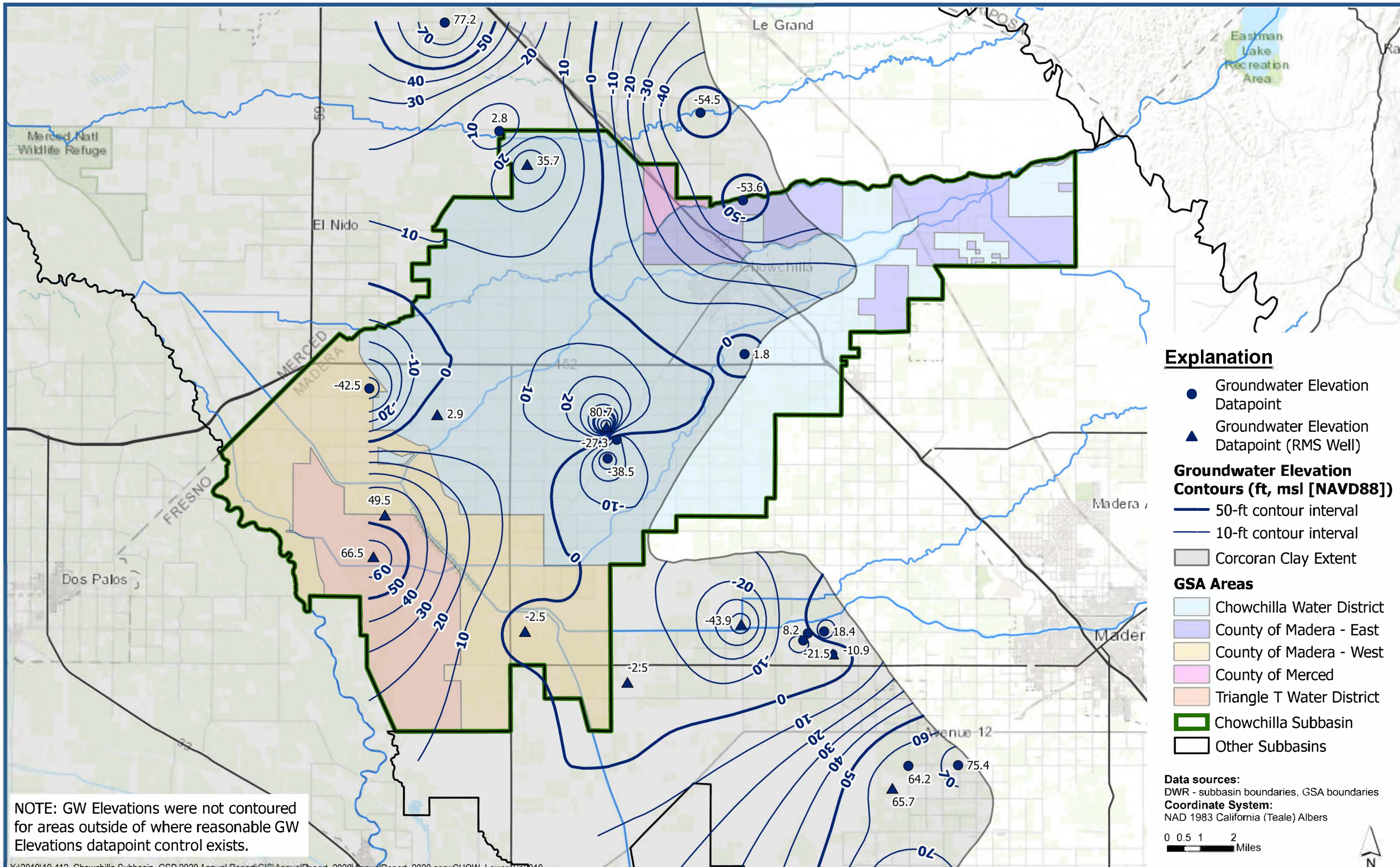
Contours of Equal Groundwater Elevation
Lower Aquifer - Fall 2018

Chowchilla Subbasin
Groundwater Sustainability Plan 2024 Annual Report

Figure A-22



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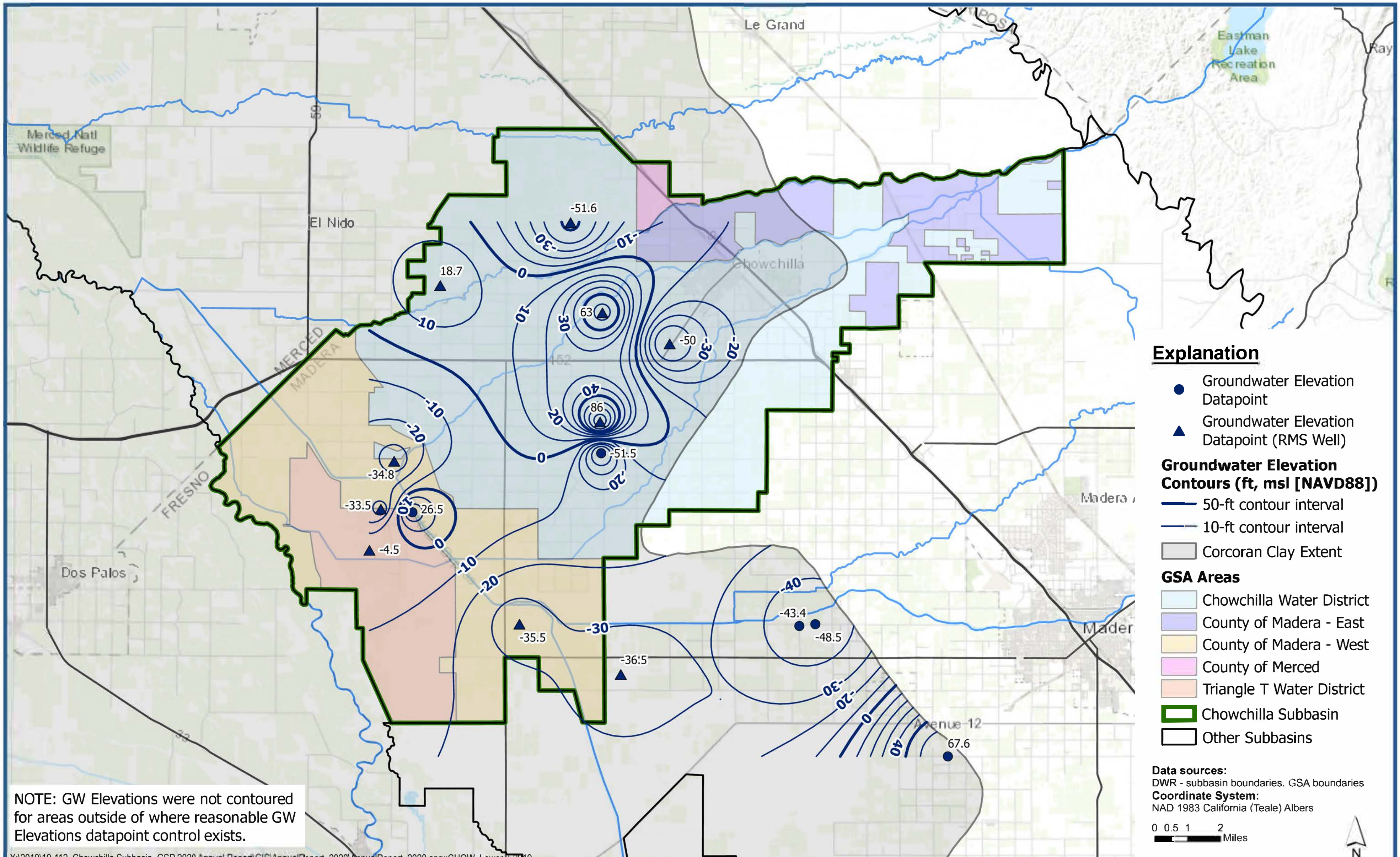
Contours of Equal Groundwater Elevation
Lower Aquifer - Spring 2019

Chowchilla Subbasin
Groundwater Sustainability Plan 2024 Annual Report

Figure A-23



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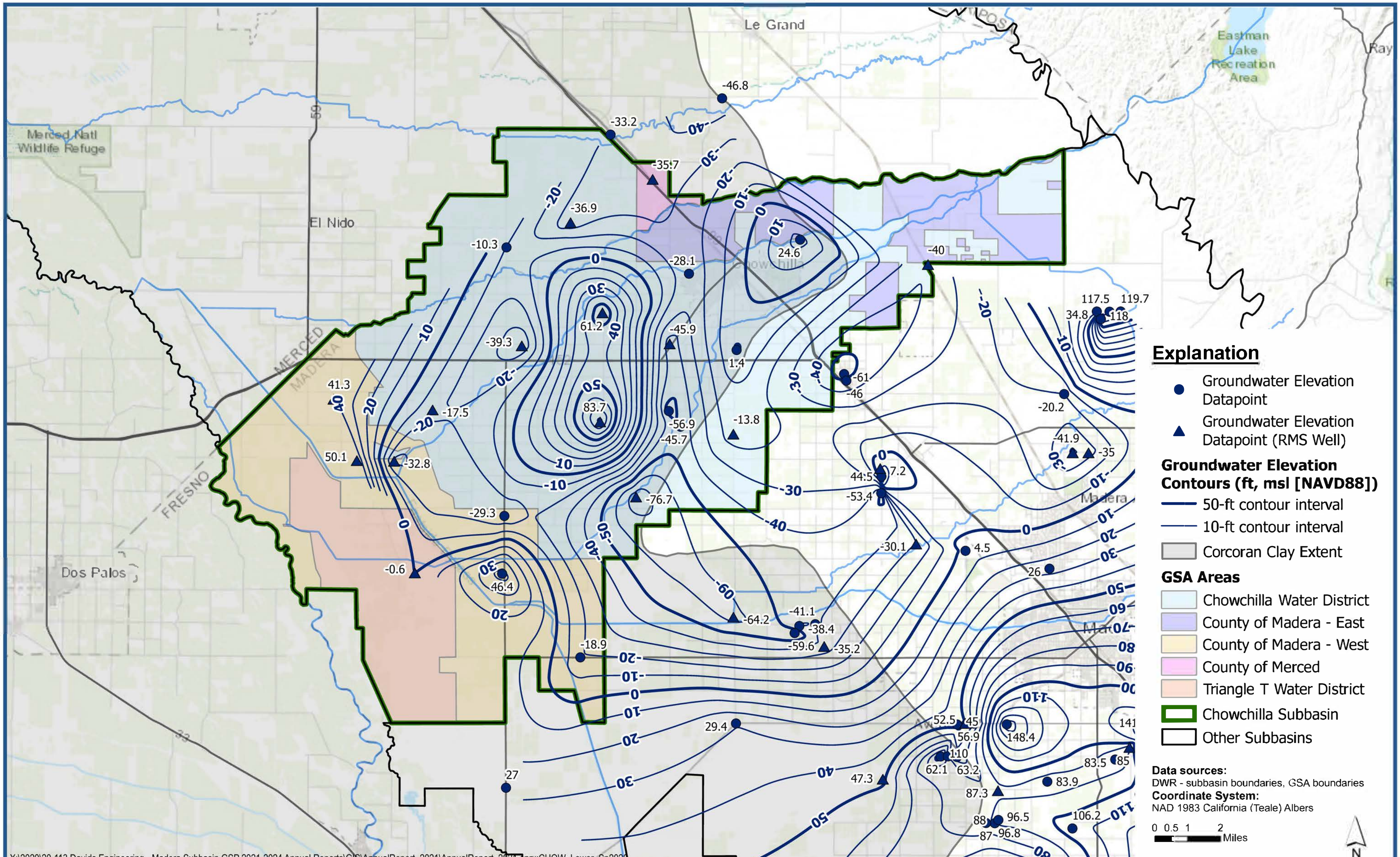
Contours of Equal Groundwater Elevation
Lower Aquifer - Fall 2019

Chowchilla Subbasin
Groundwater Sustainability Plan 2024 Annual Report

Figure A-24



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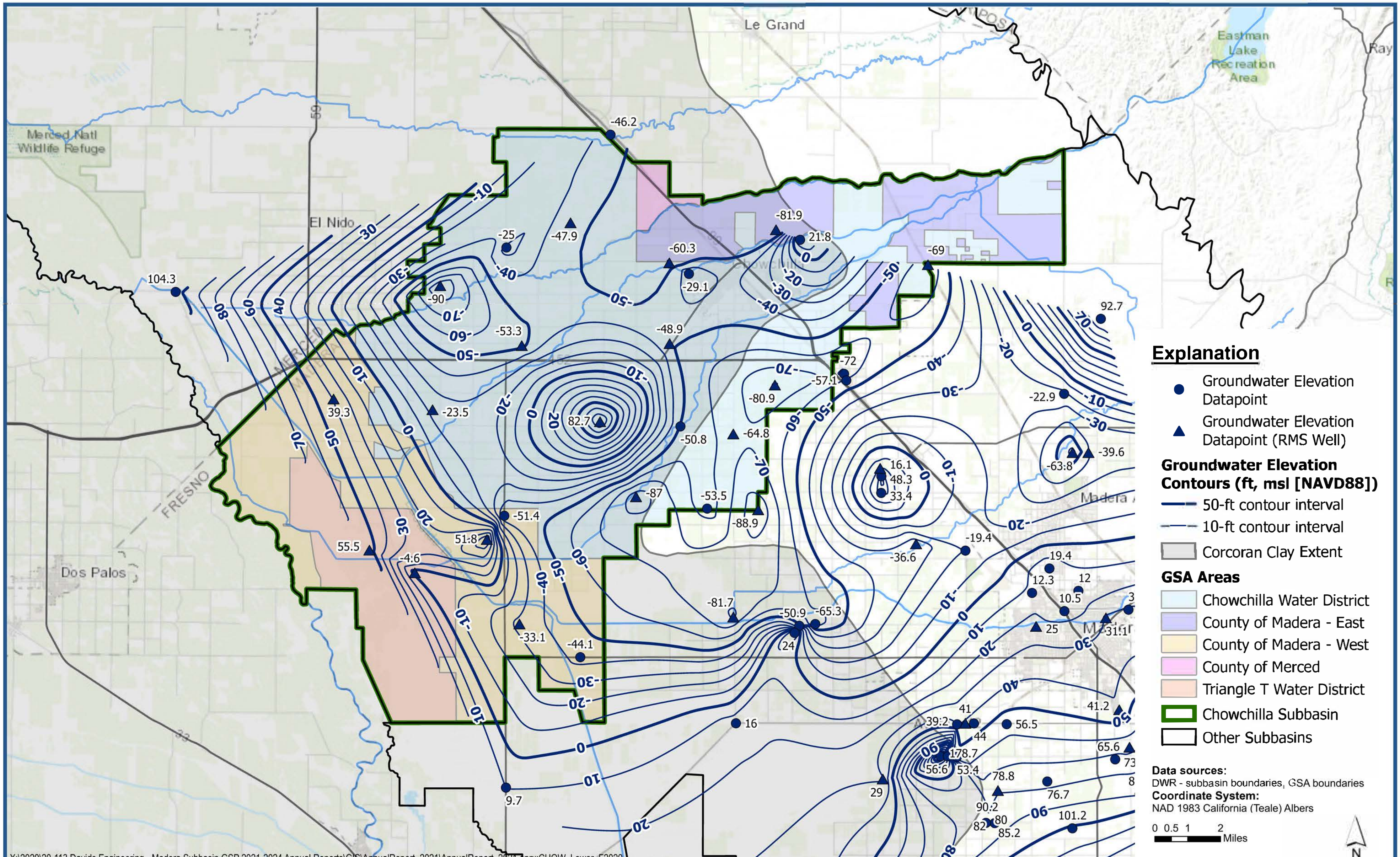
Contours of Equal Groundwater Elevation:
Lower Aquifer/Undifferentiated Unconfined Zone - Spring 2020

Chowchilla Subbasin
Groundwater Sustainability Plan 2024 Annual Report

Figure A-25



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Contours of Equal Groundwater Elevation: Lower Aquifer/Undifferentiated Unconfined Zone - Fall 2020

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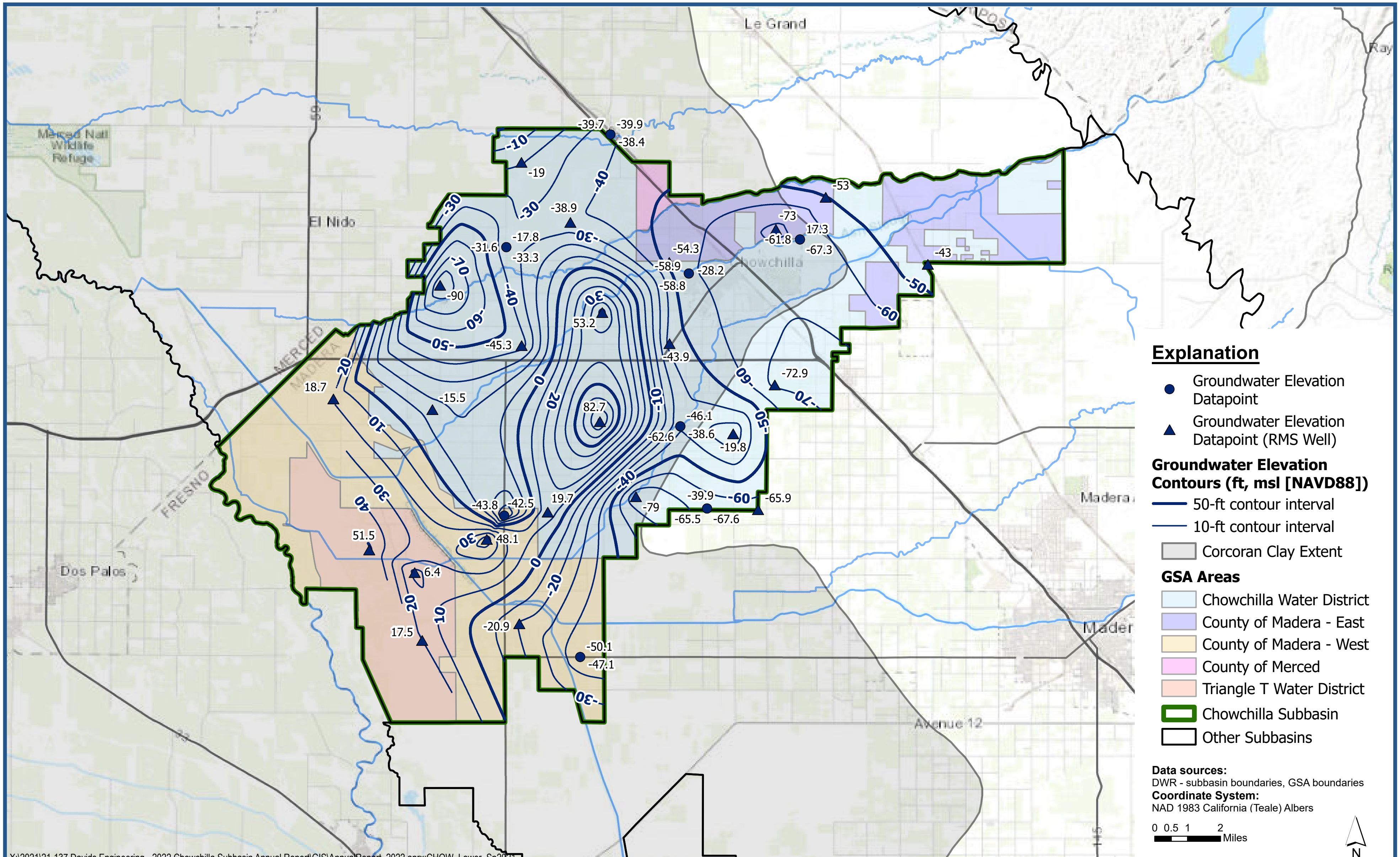
Groundwater Sustainability Plan 2024 Annual Report

Figure A-26



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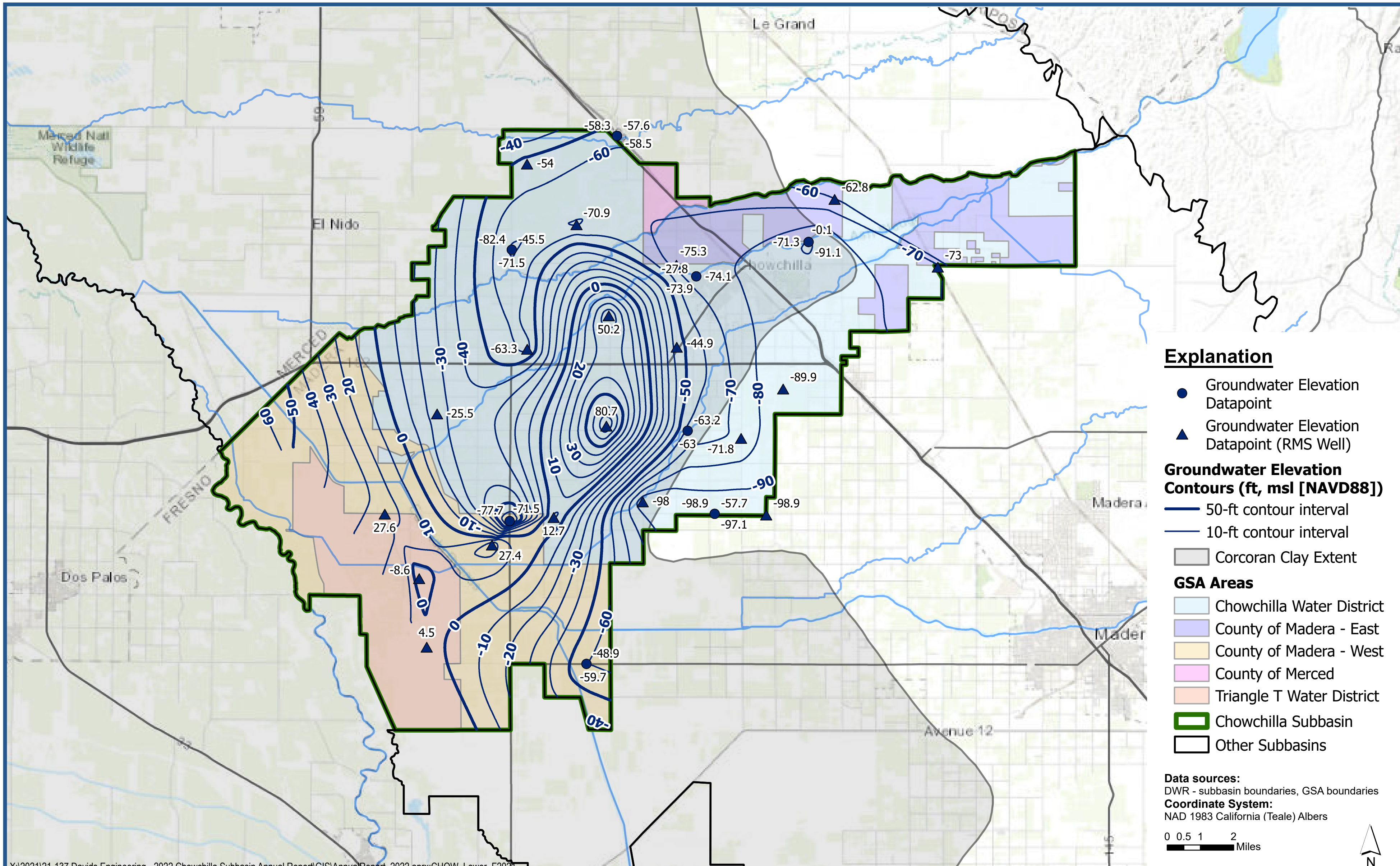
Contours of Equal Groundwater Elevation: Lower Aquifer/Undifferentiated Unconfined Zone - Spring 2021

Figure A-27

Chowchilla Subbasin
Groundwater Sustainability Plan 2024 Annual Report



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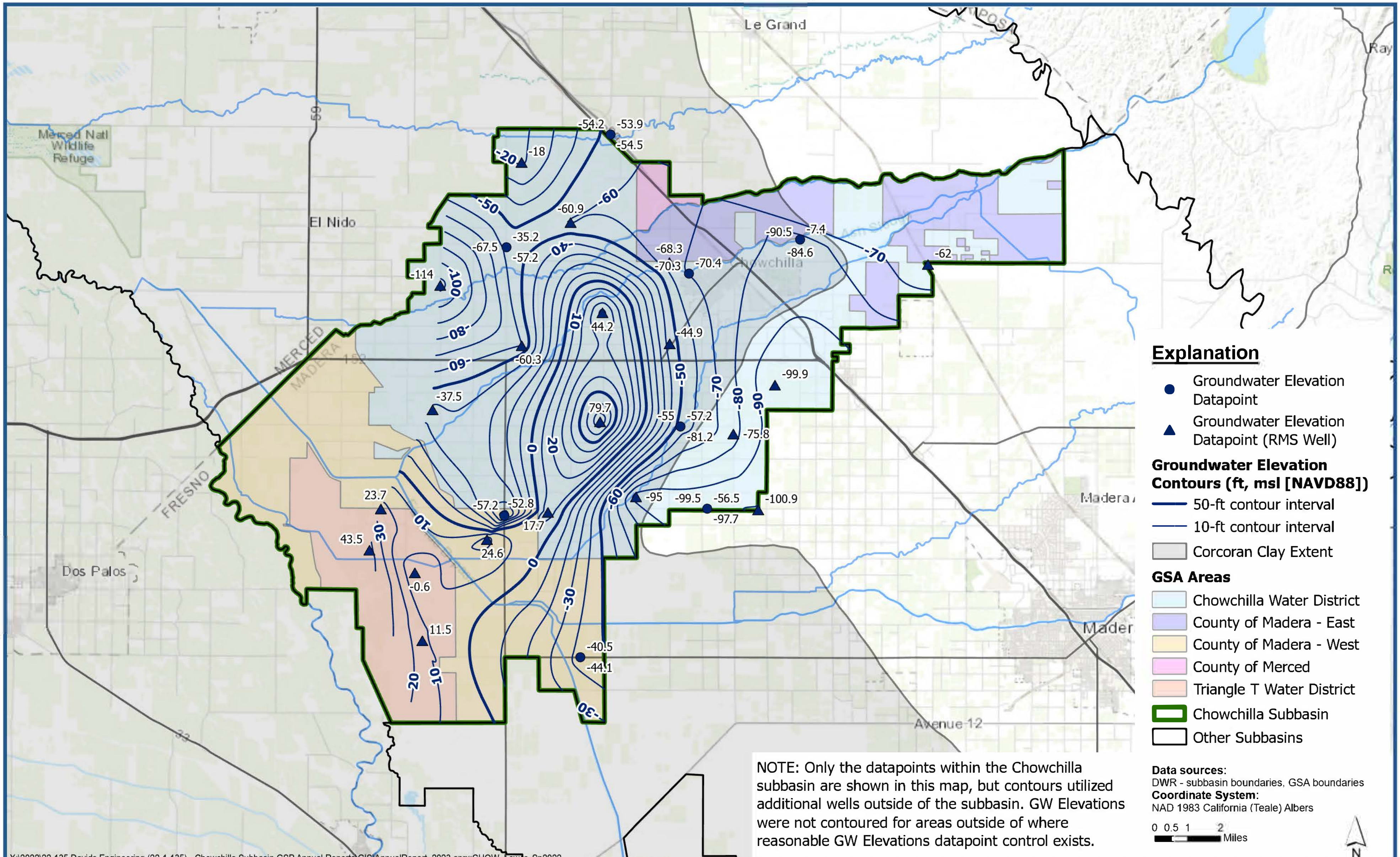
Contours of Equal Groundwater Elevation: Lower Aquifer/Undifferentiated Unconfined Zone - Fall 2021

Figure A-28

Chowchilla Subbasin
Groundwater Sustainability Plan 2024 Annual Report



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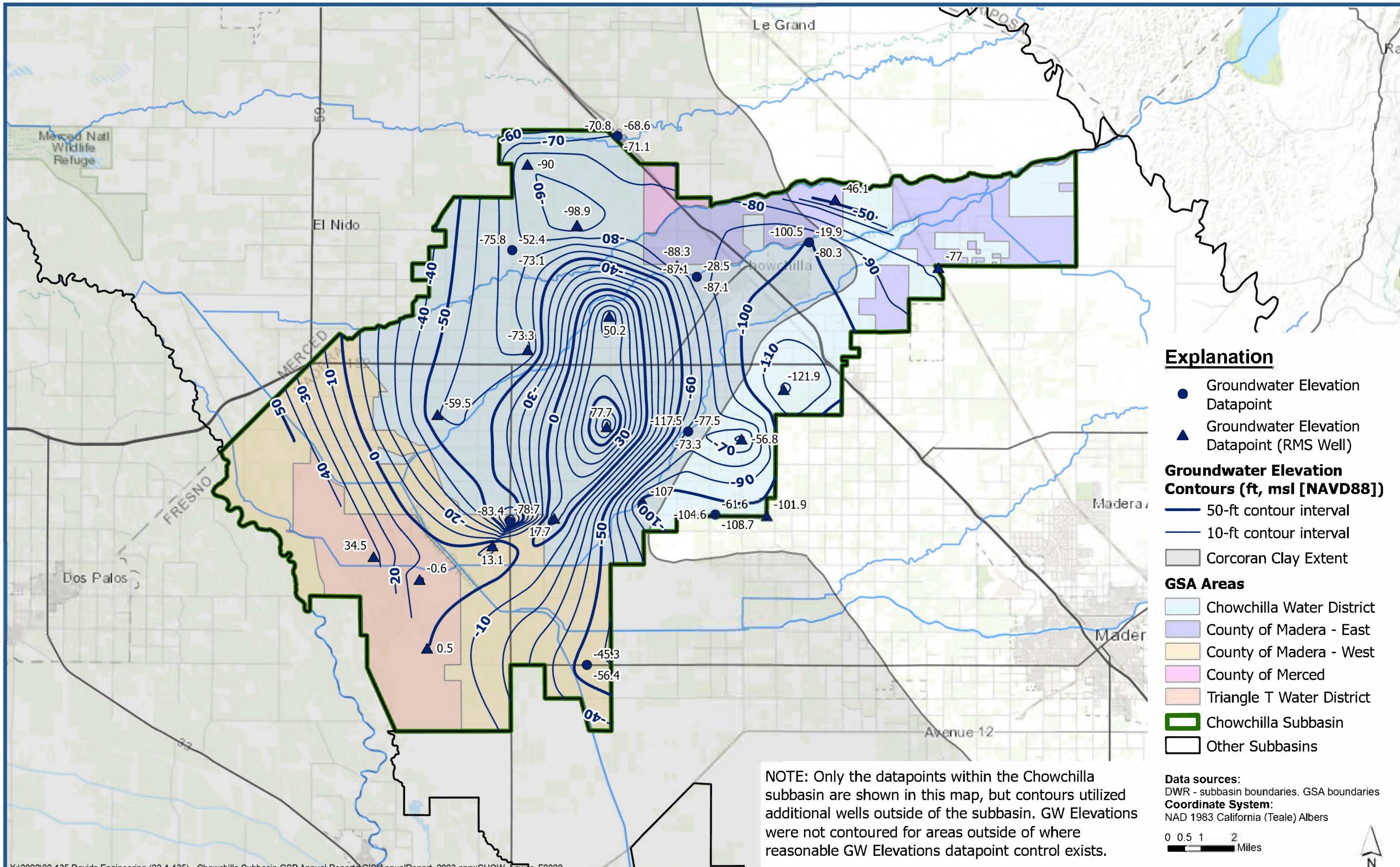
Contours of Equal Groundwater Elevation:
Lower Aquifer/Undifferentiated Unconfined Zone - Spring 2022

Chowchilla Subbasin
Groundwater Sustainability Plan 2024 Annual Report

Figure A-29



Contours of Equal Groundwater Elevation:
Lower Aquifer/Undifferentiated Unconfined Zone - Fall 2022

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Groundwater Sustainability Plan 2024 Annual Report

Figure A-30

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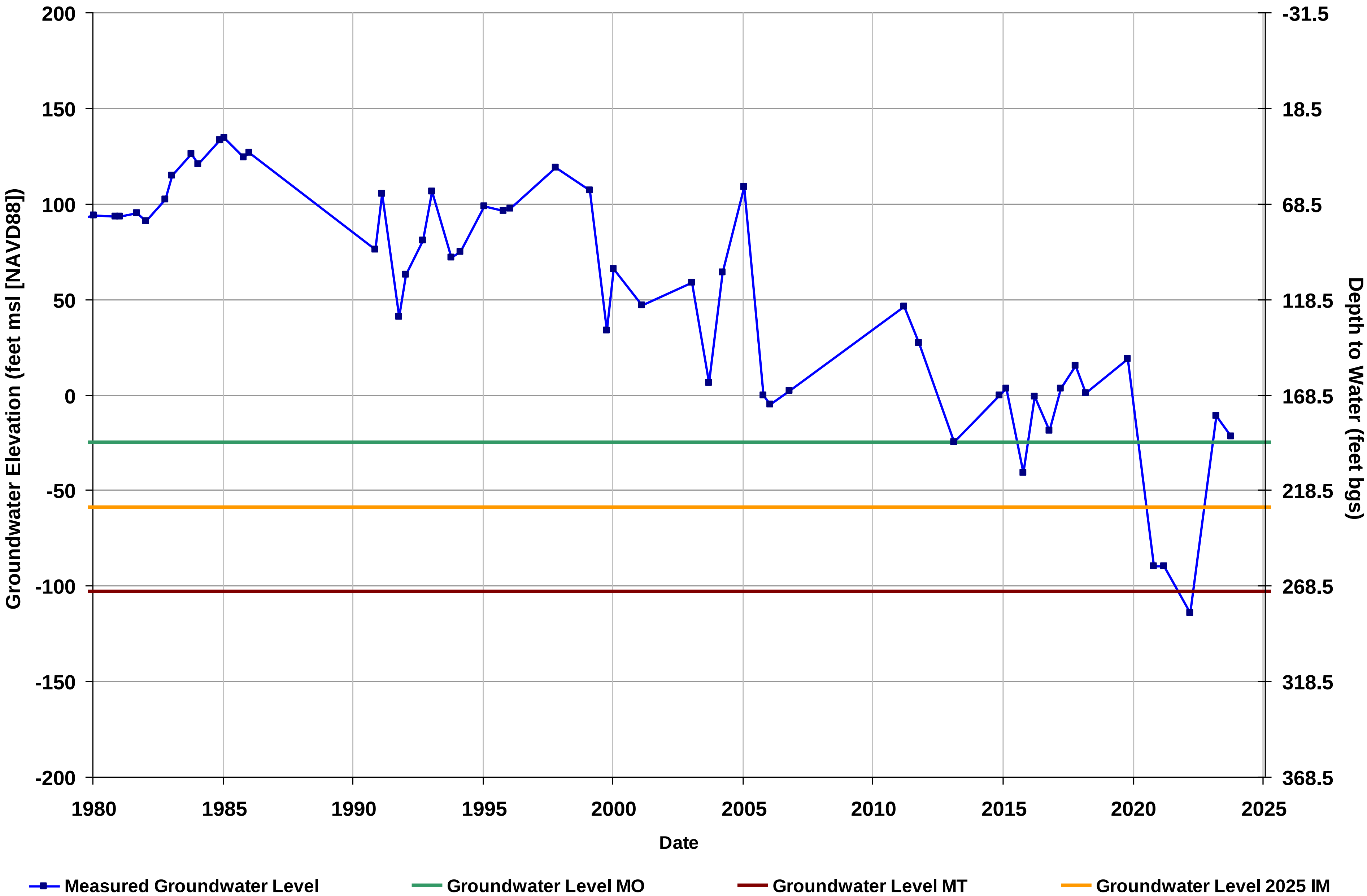
Appendix B. Hydrographs of Time-Series Groundwater Level Data for Groundwater Level RMS Wells.

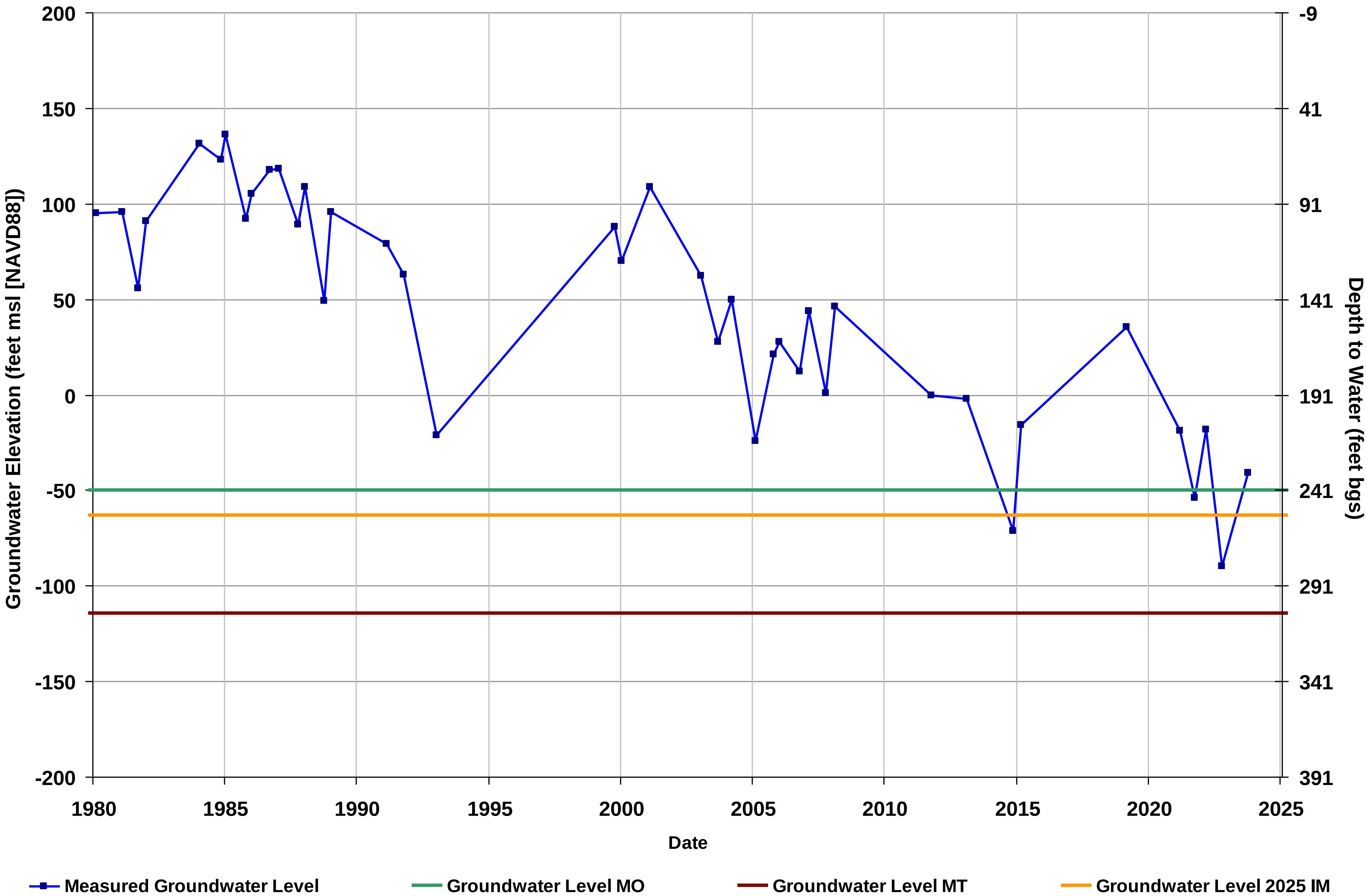
Well Name: CWD RMS-1
Depth Zone: Lower
Subbasin: Chowchilla
GSA: Chowchilla Water District

Total Depth (ft bgs): 275
Perf. Top (ft bgs): 160
Perf. Bottom (ft bgs): 275
GSE (ft, msl): 168.5



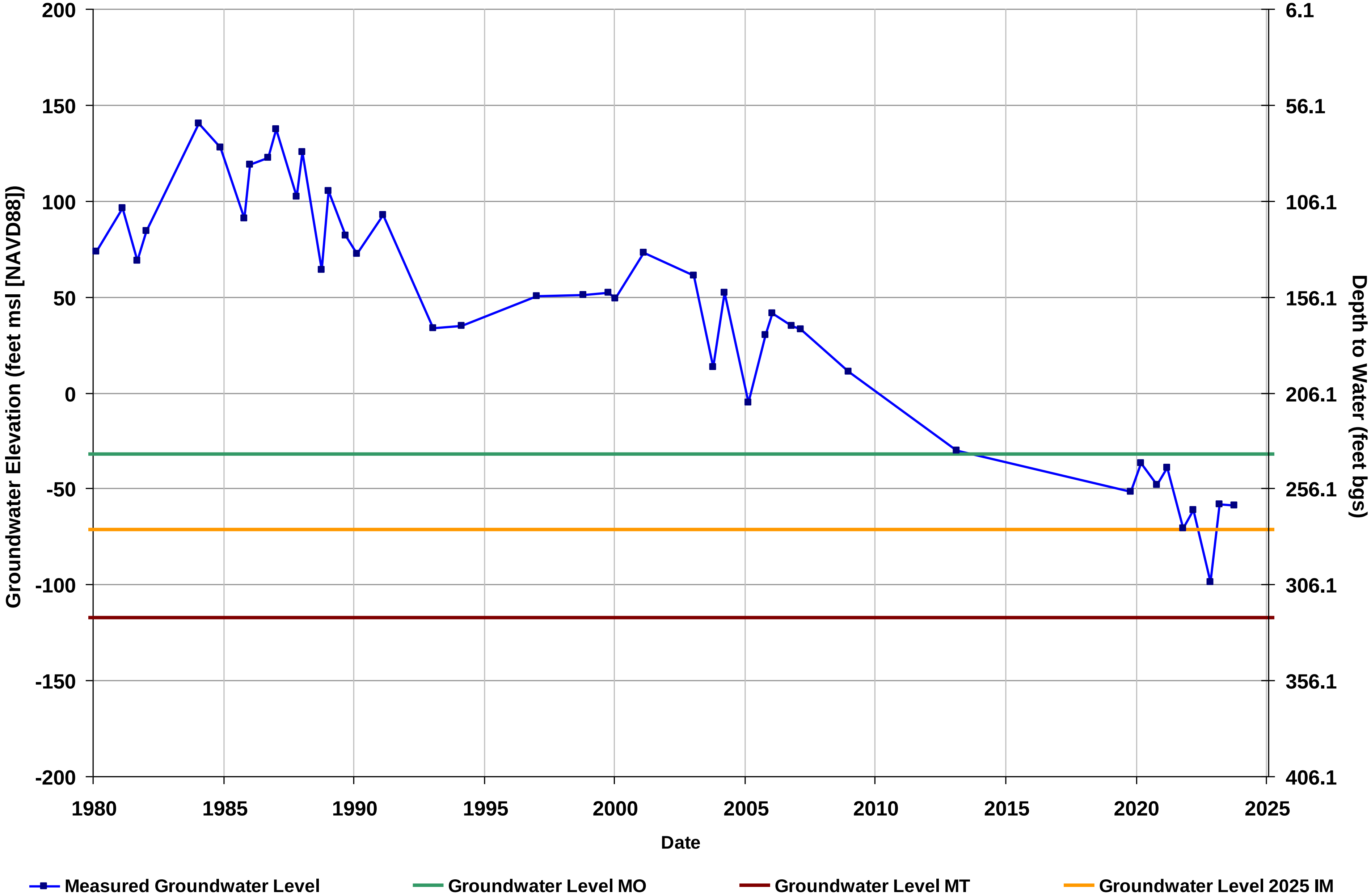
Well Name: CWD RMS-2
Depth Zone: Lower
Subbasin: Chowchilla
GSA: Chowchilla Water District

Total Depth (ft bgs): 780
Perf. Top (ft bgs): 230
Perf. Bottom (ft bgs): 775
GSE (ft, msl): 191



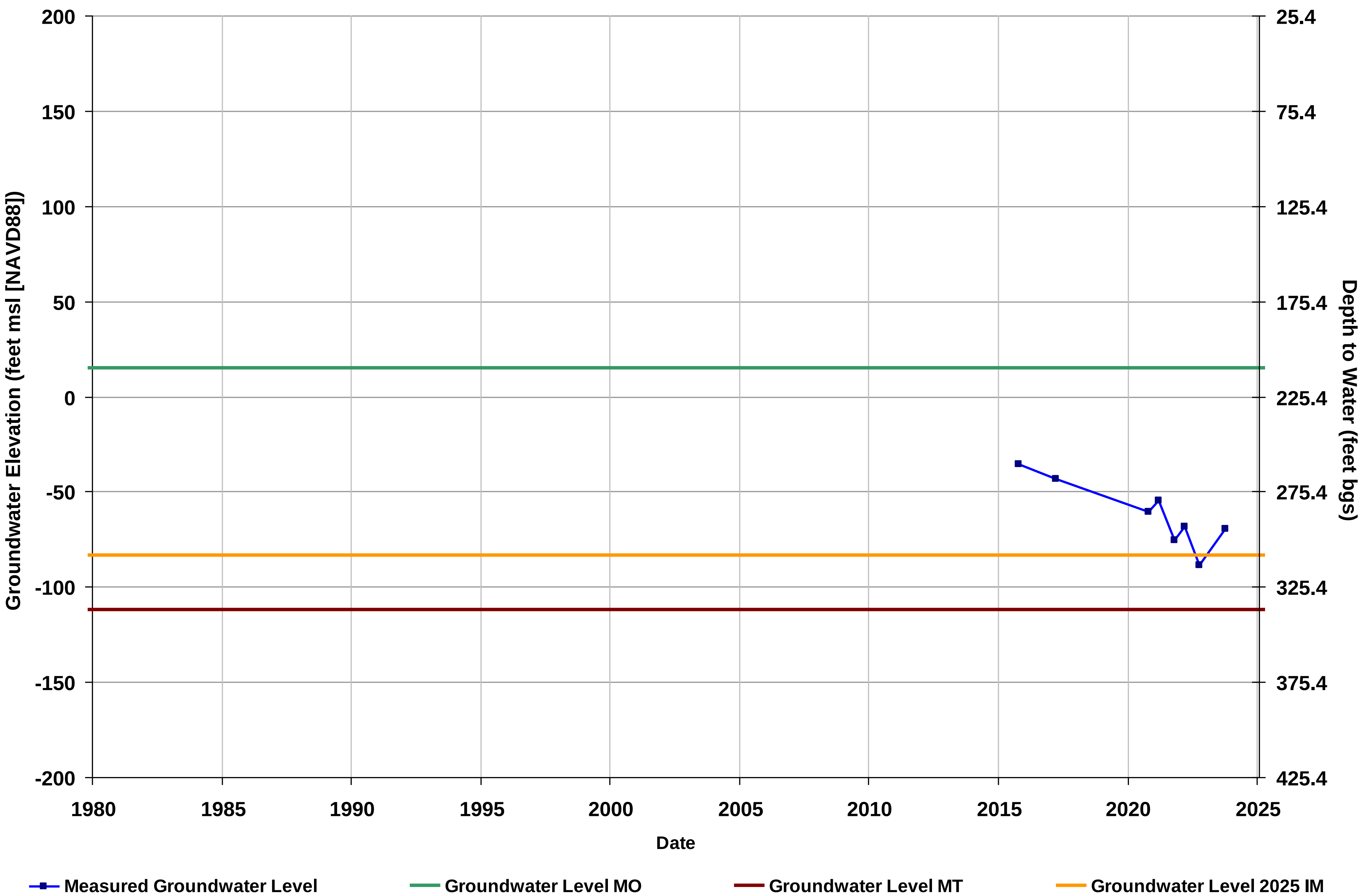
Well Name: CWD RMS-3
Depth Zone: Lower
Subbasin: Chowchilla
GSA: Chowchilla Water District

Total Depth (ft bgs):
Perf. Top (ft bgs):
Perf. Bottom (ft bgs):
GSE (ft, msl): 206.1



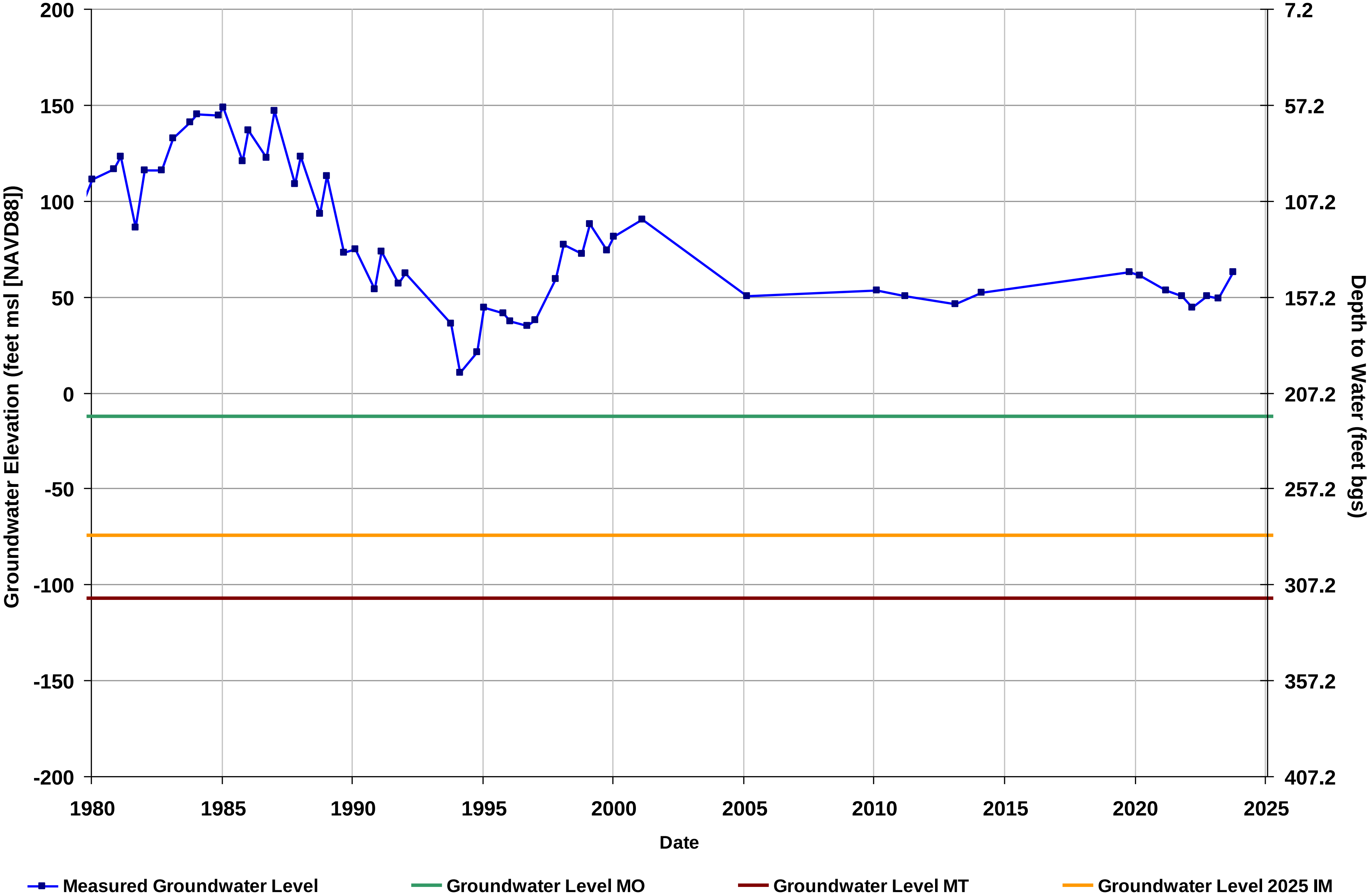
Well Name: CWD RMS-4
Depth Zone: Lower
Subbasin: Chowchilla
GSA: Chowchilla Water District

Total Depth (ft bgs): 800
Perf. Top (ft bgs): 320
Perf. Bottom (ft bgs): 800
GSE (ft, msl): 225.4



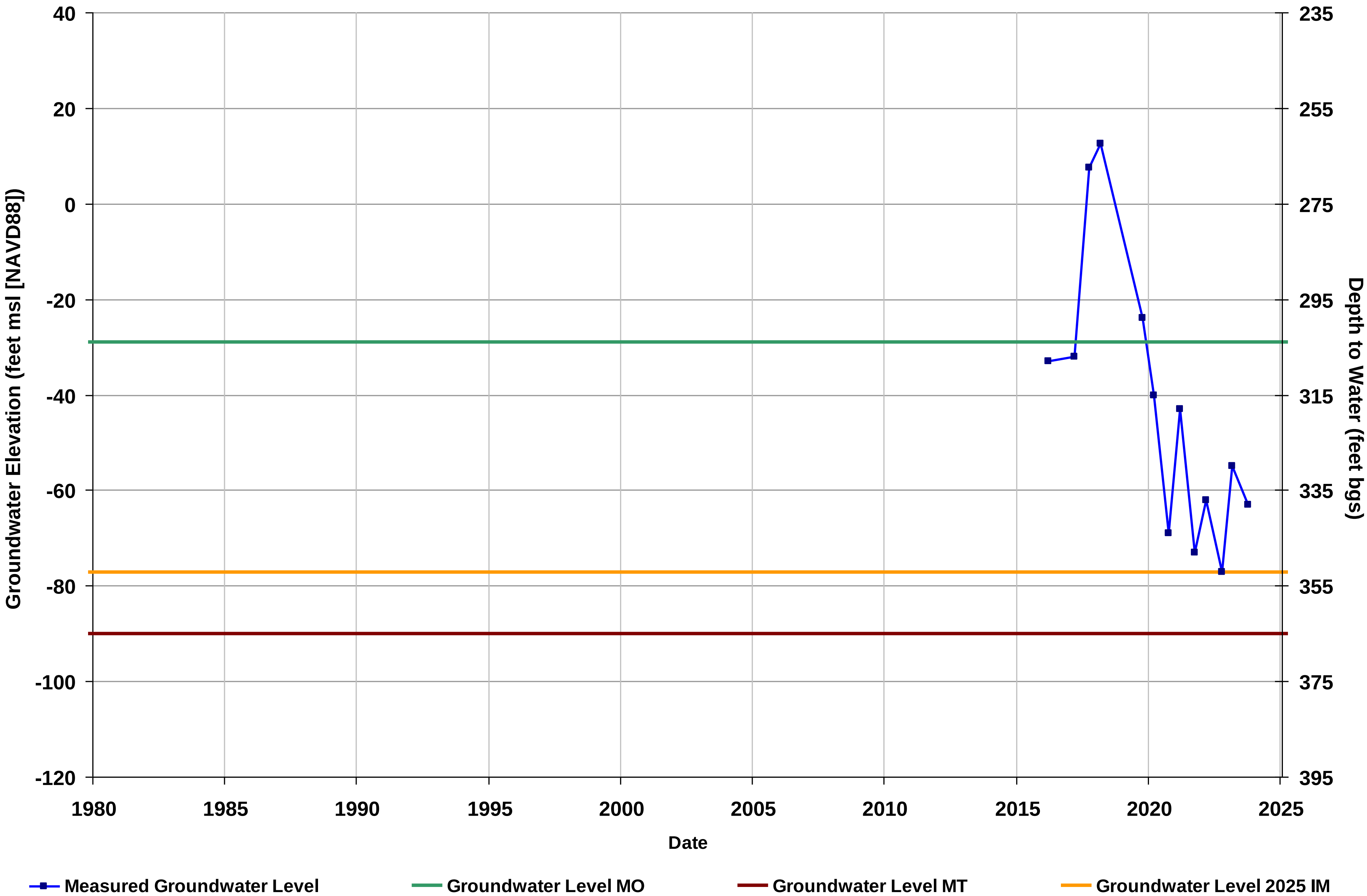
Well Name: CWD RMS-5
Depth Zone: Lower
Subbasin: Chowchilla
GSA: Chowchilla Water District

Total Depth (ft bgs):
Perf. Top (ft bgs):
Perf. Bottom (ft bgs):
GSE (ft, msl): 207.2



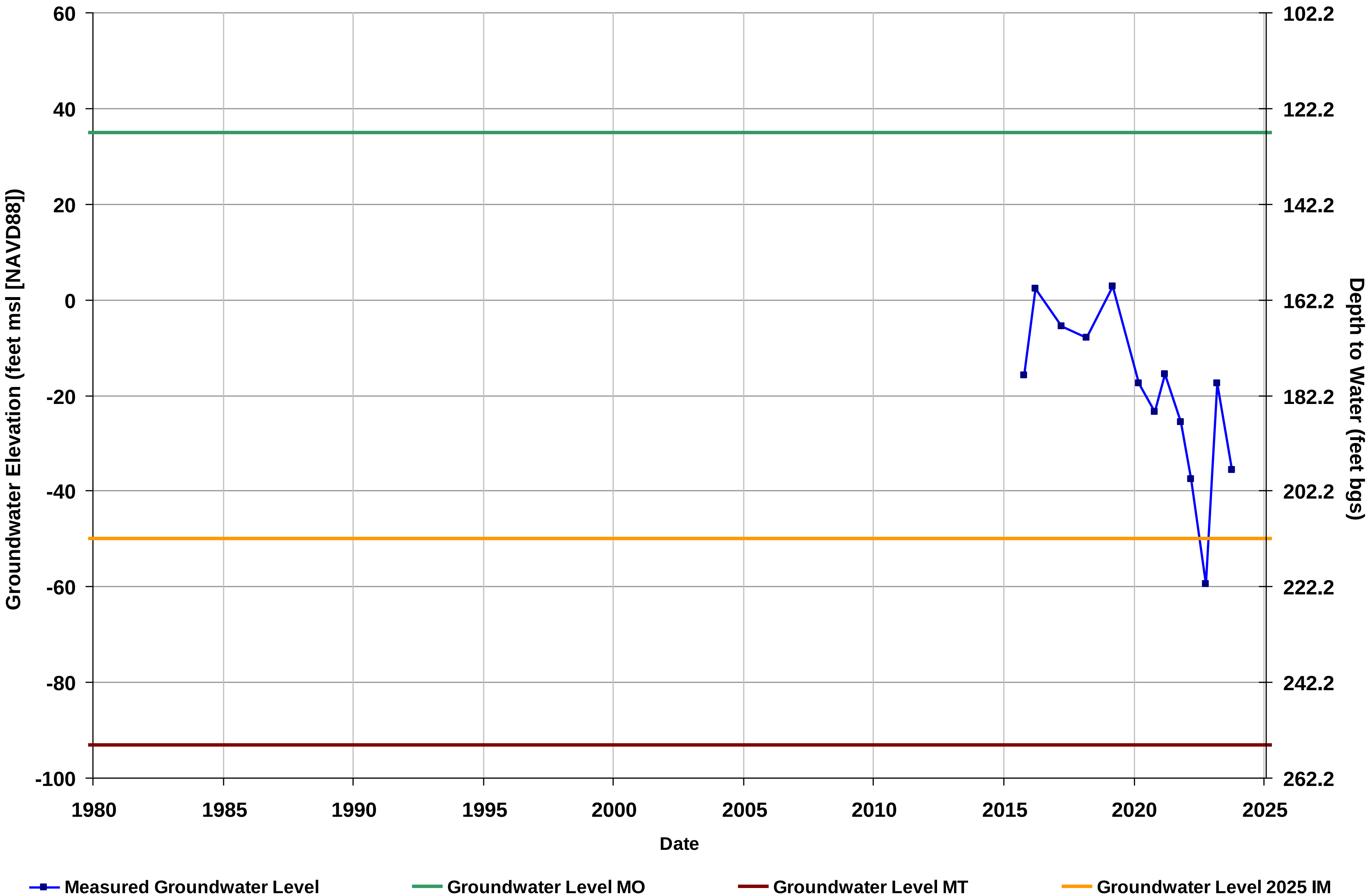
Well Name: CWD RMS-6
Depth Zone: Lower
Subbasin: Chowchilla
GSA: Chowchilla Water District

Total Depth (ft bgs): 820
Perf. Top (ft bgs): 257
Perf. Bottom (ft bgs): 726
GSE (ft, msl): 275



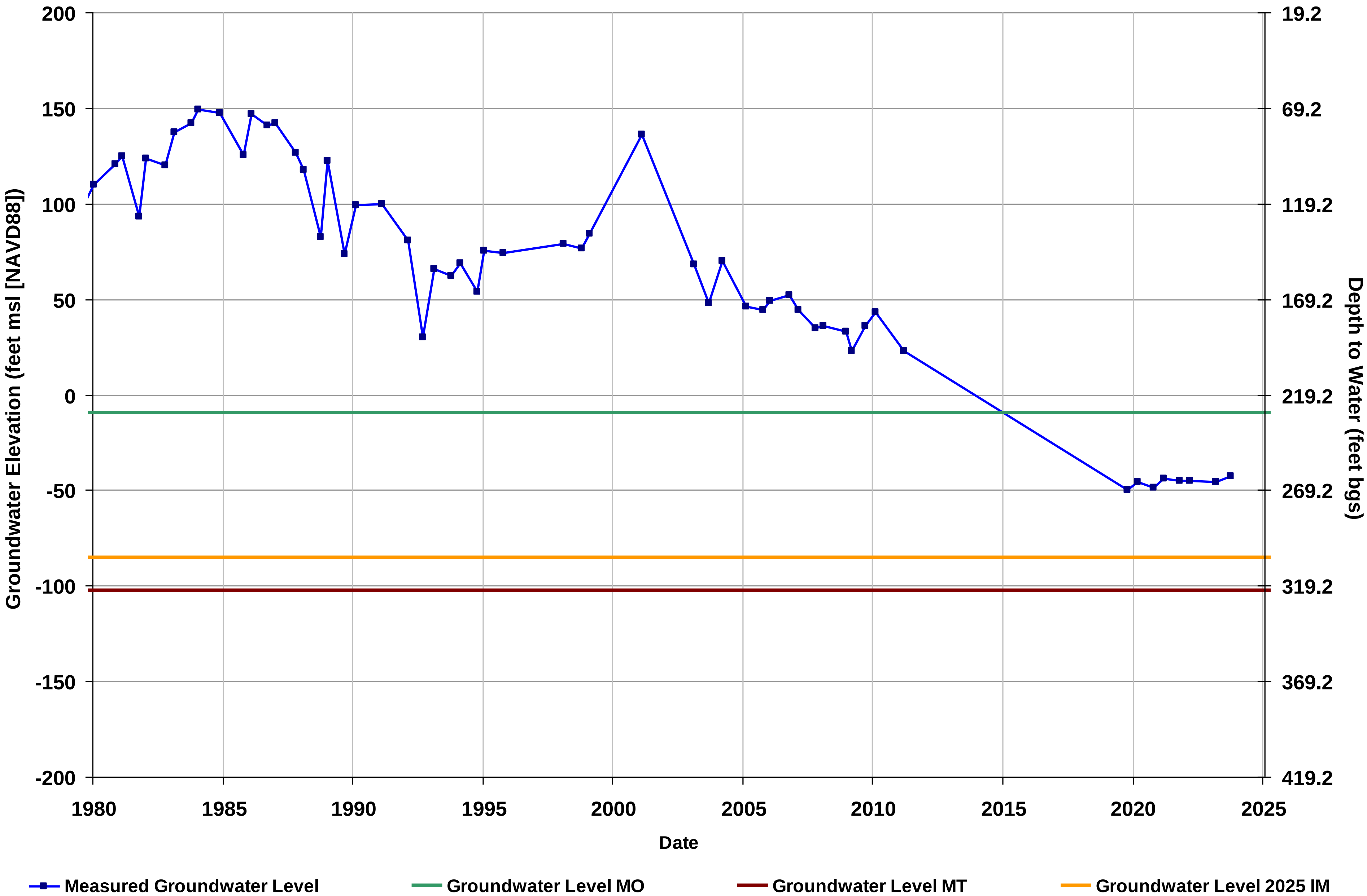
Well Name: CWD RMS-7
Depth Zone: Lower
Subbasin: Chowchilla
GSA: Chowchilla Water District

Total Depth (ft bgs): 330
Perf. Top (ft bgs): 135
Perf. Bottom (ft bgs): 288
GSE (ft, msl): 162.2



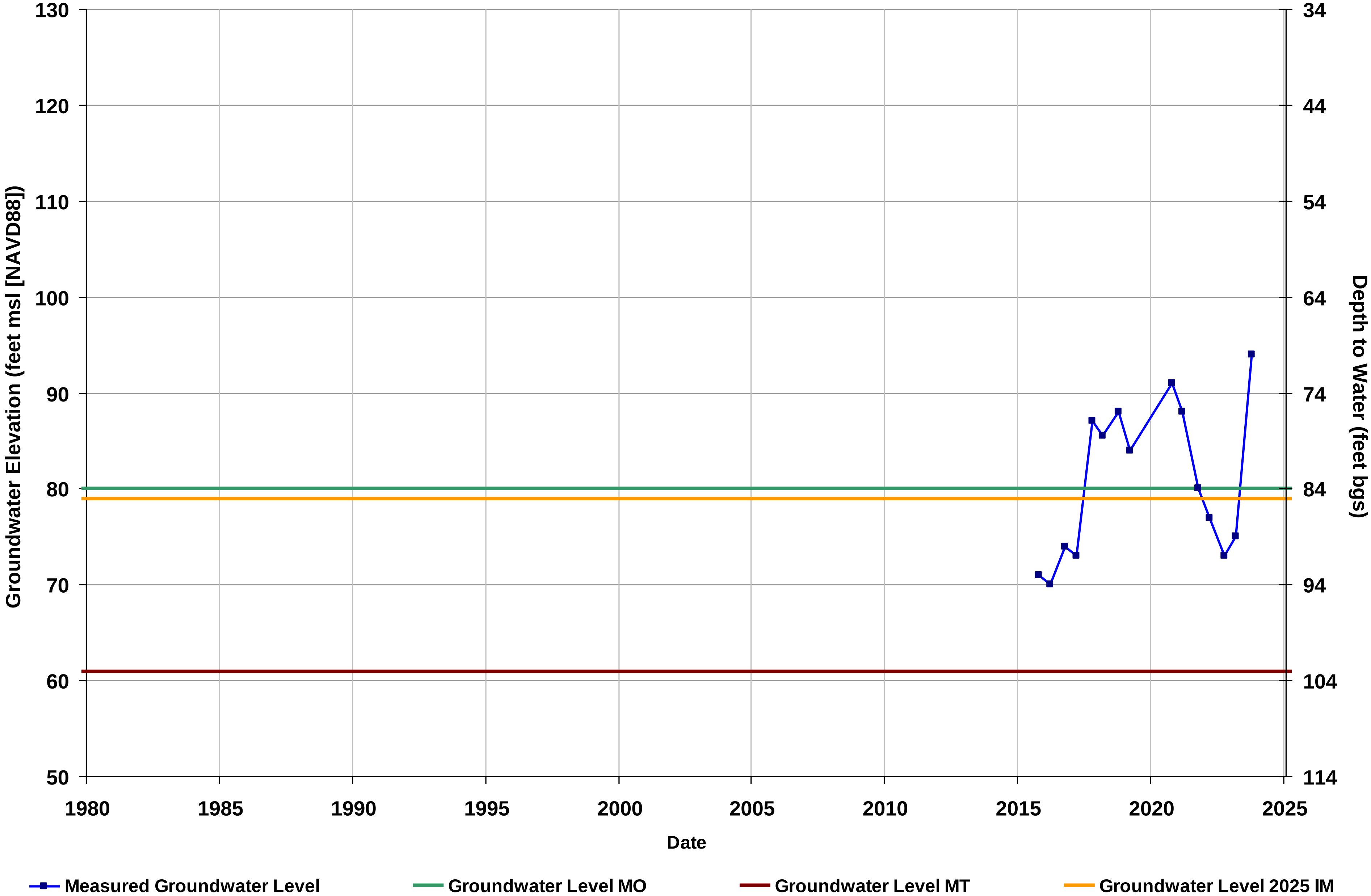
Well Name: CWD RMS-8
Depth Zone: Lower
Subbasin: Chowchilla
GSA: Chowchilla Water District

Total Depth (ft bgs):
Perf. Top (ft bgs):
Perf. Bottom (ft bgs):
GSE (ft, msl): 219.2



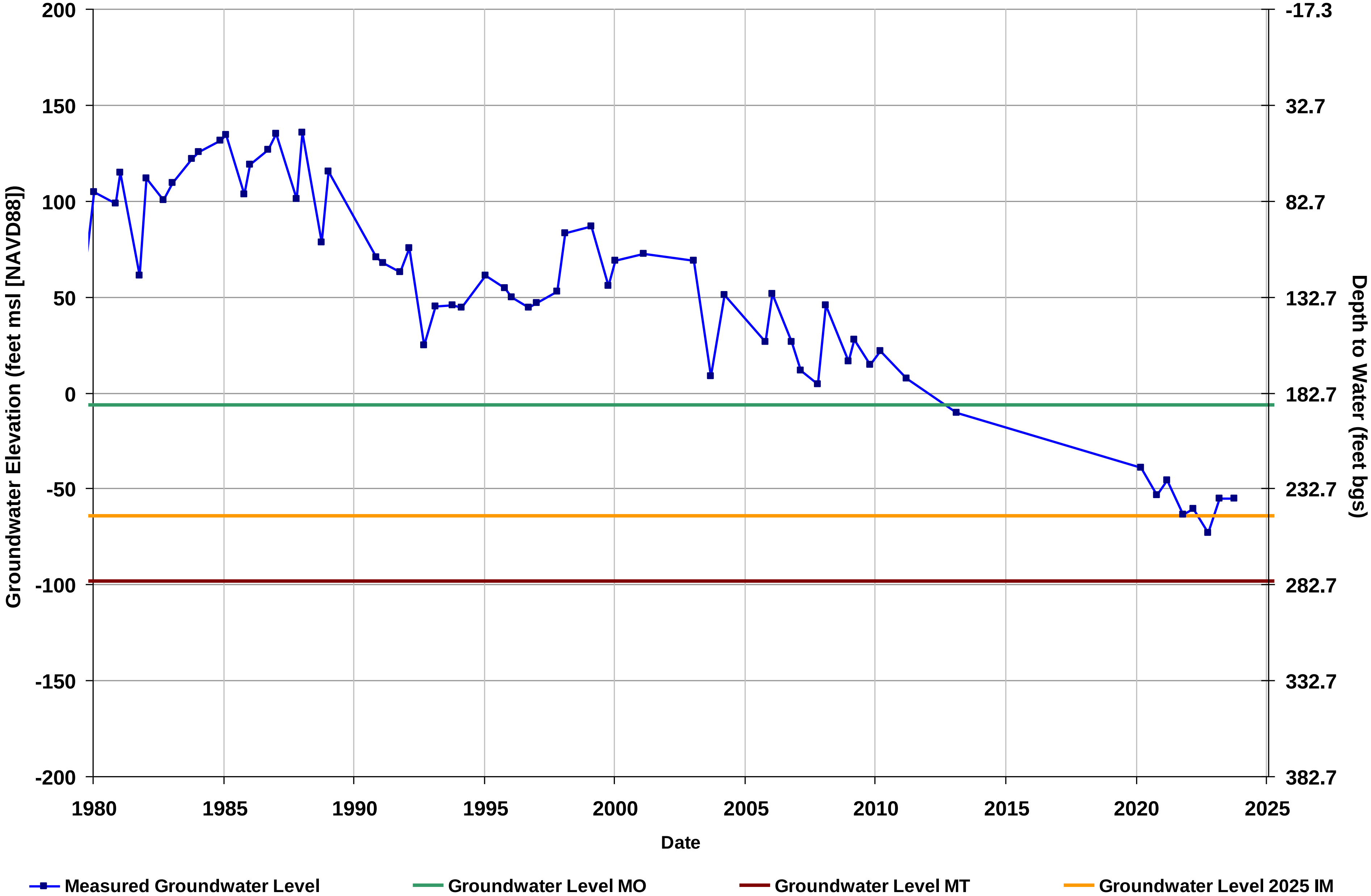
Well Name: CWD RMS-9
Depth Zone: Upper
Subbasin: Chowchilla
GSA: Chowchilla Water District

Total Depth (ft bgs): 97
Perf. Top (ft bgs): 82
Perf. Bottom (ft bgs): 97
GSE (ft, msl): 164



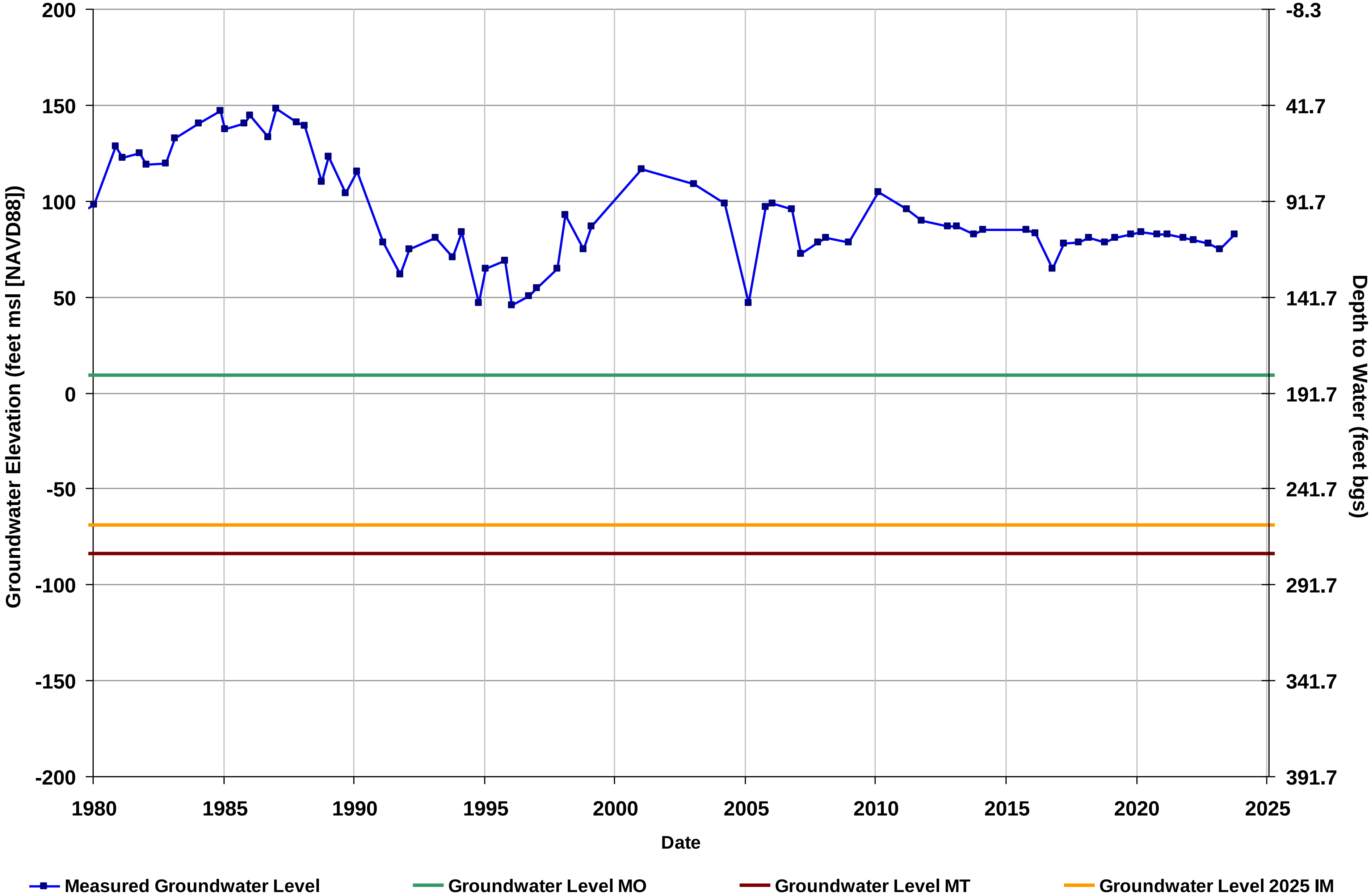
Well Name: CWD RMS-10
Depth Zone: Lower
Subbasin: Chowchilla
GSA: Chowchilla Water District

Total Depth (ft bgs):
Perf. Top (ft bgs):
Perf. Bottom (ft bgs):
GSE (ft, msl): 182.7



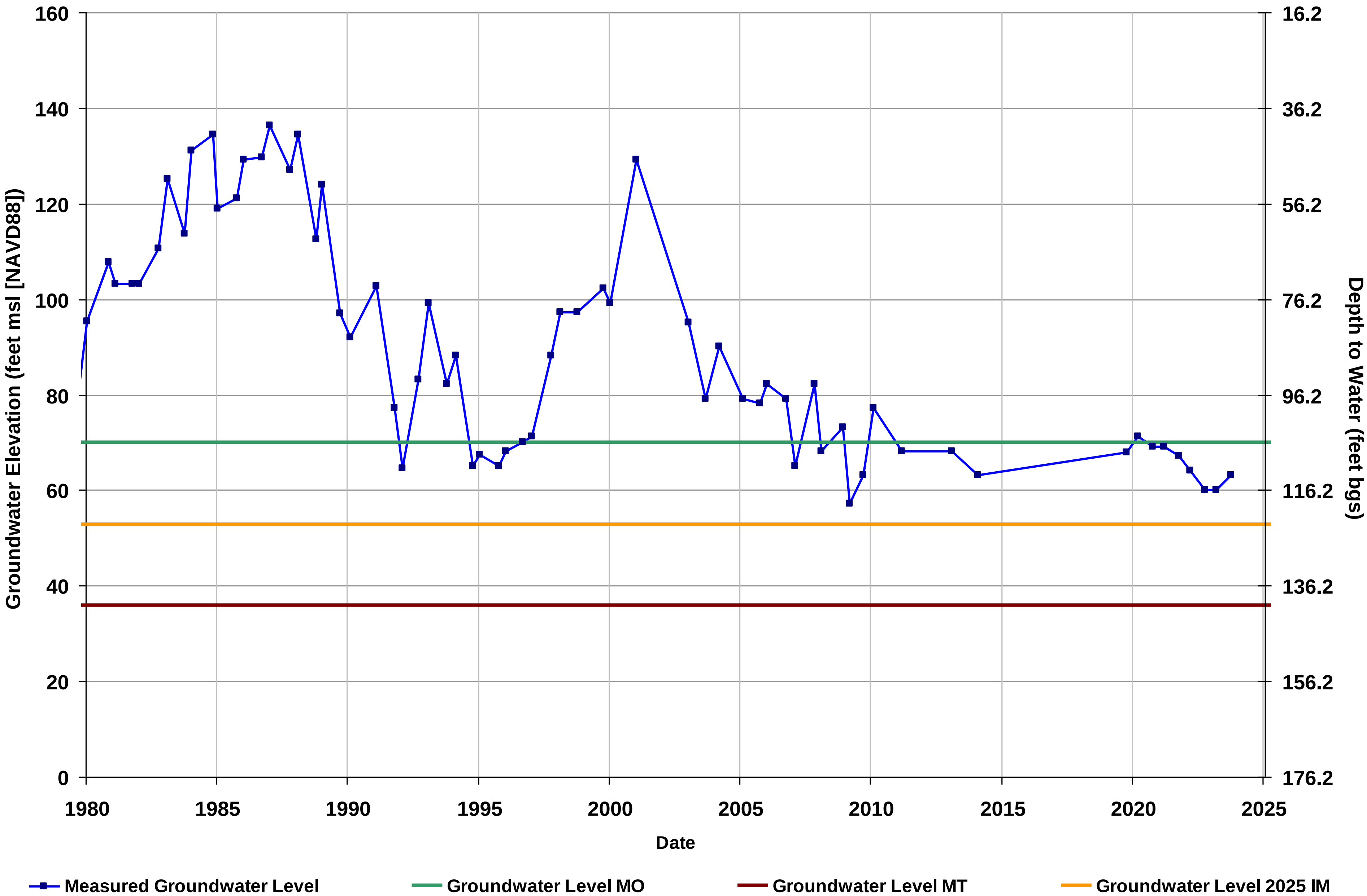
Well Name: CWD RMS-11
Depth Zone: Lower
Subbasin: Chowchilla
GSA: Chowchilla Water District

Total Depth (ft bgs): 529
Perf. Top (ft bgs): 187
Perf. Bottom (ft bgs): 529
GSE (ft, msl): 191.7



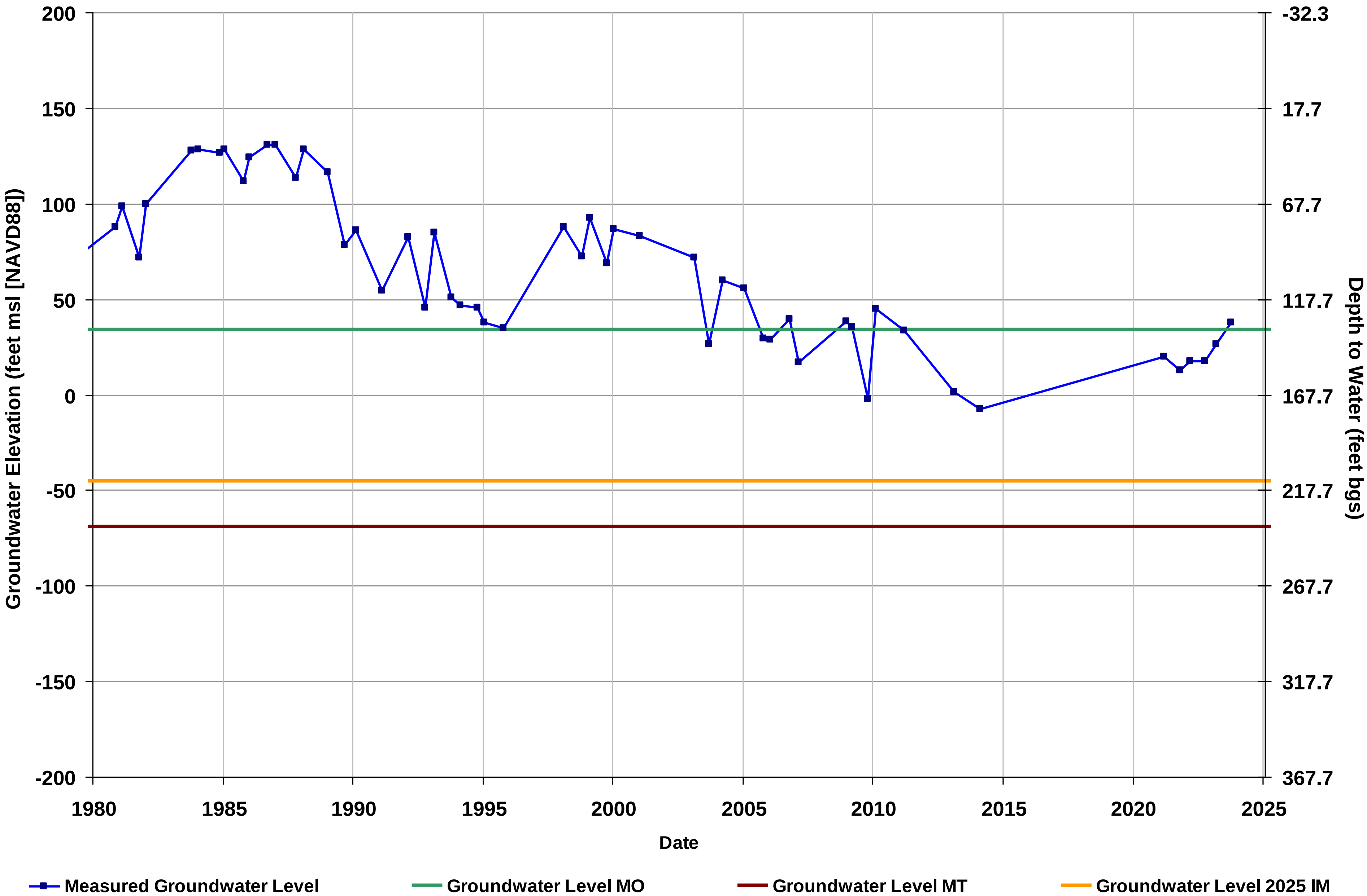
Well Name: CWD RMS-12
Depth Zone: Upper
Subbasin: Chowchilla
GSA: Chowchilla Water District

Total Depth (ft bgs):
Perf. Top (ft bgs):
Perf. Bottom (ft bgs):
GSE (ft, msl): 176.2



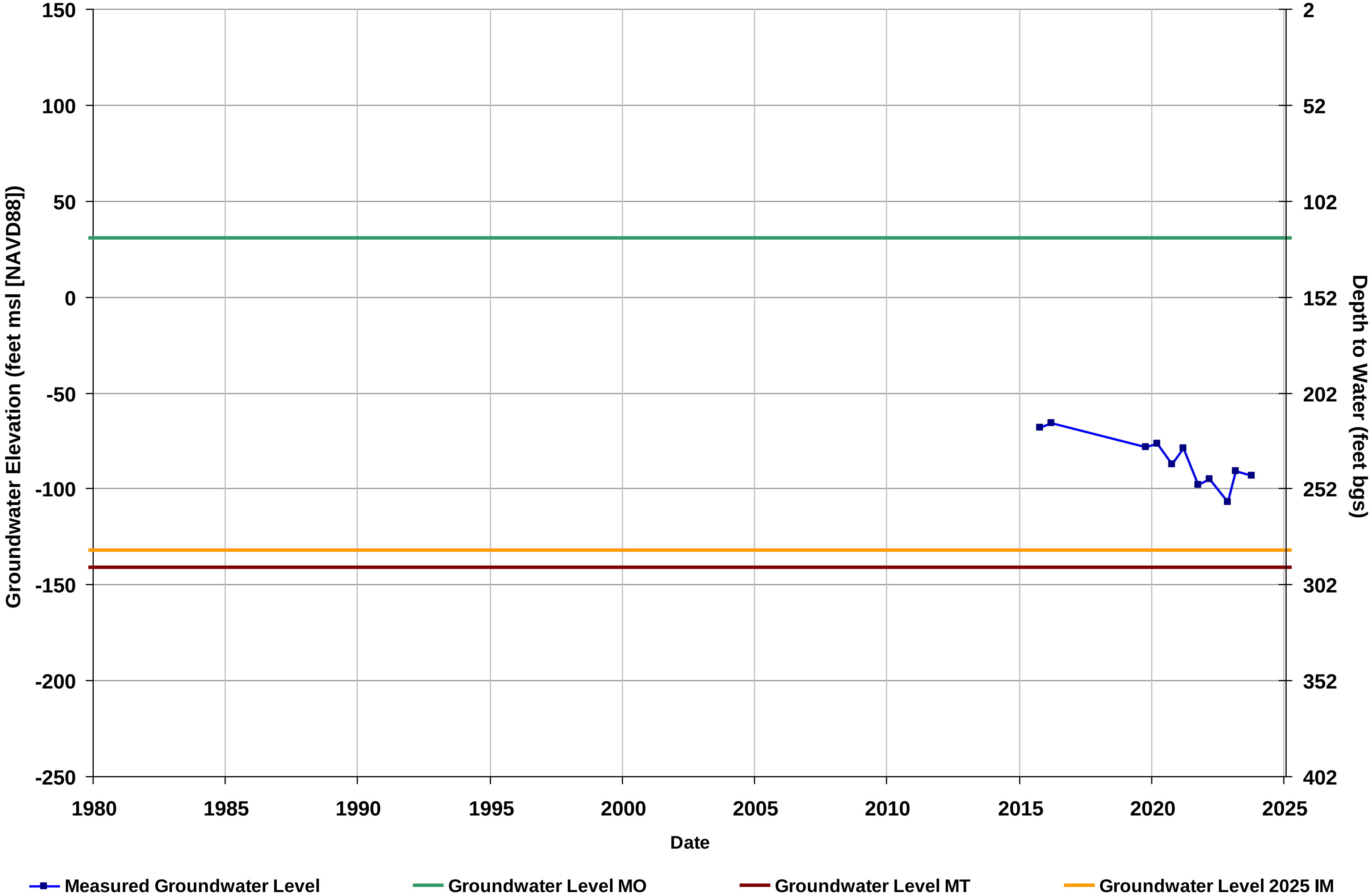
Well Name: CWD RMS-13
Depth Zone: Lower
Subbasin: Chowchilla
GSA: Chowchilla Water District

Total Depth (ft bgs):
Perf. Top (ft bgs):
Perf. Bottom (ft bgs):
GSE (ft, msl): 167.7



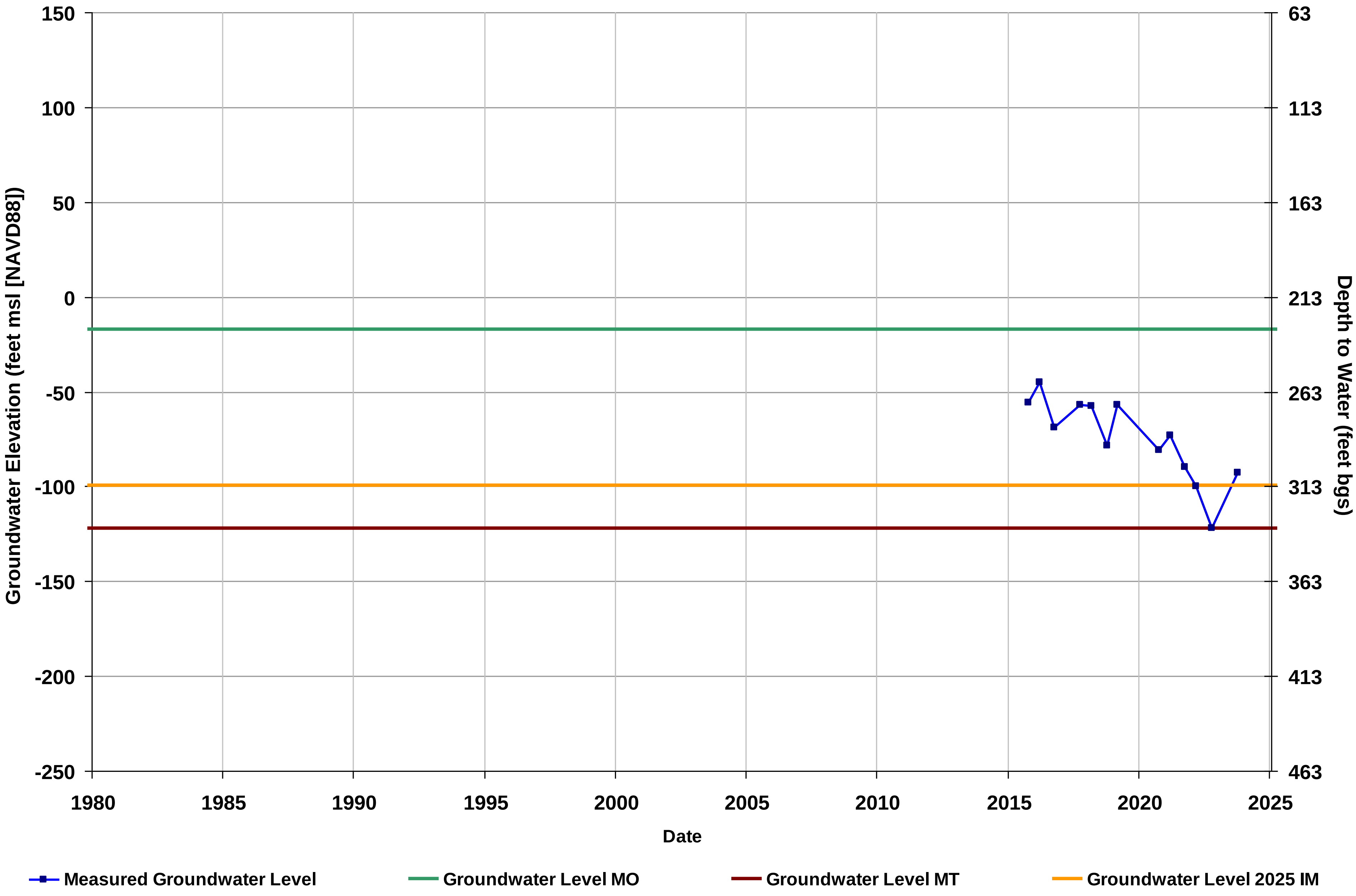
Well Name: CWD RMS-14
Depth Zone: Lower
Subbasin: Chowchilla
GSA: Chowchilla Water District

Total Depth (ft bgs): 455
Perf. Top (ft bgs): 185
Perf. Bottom (ft bgs): 365
GSE (ft, msl): 152



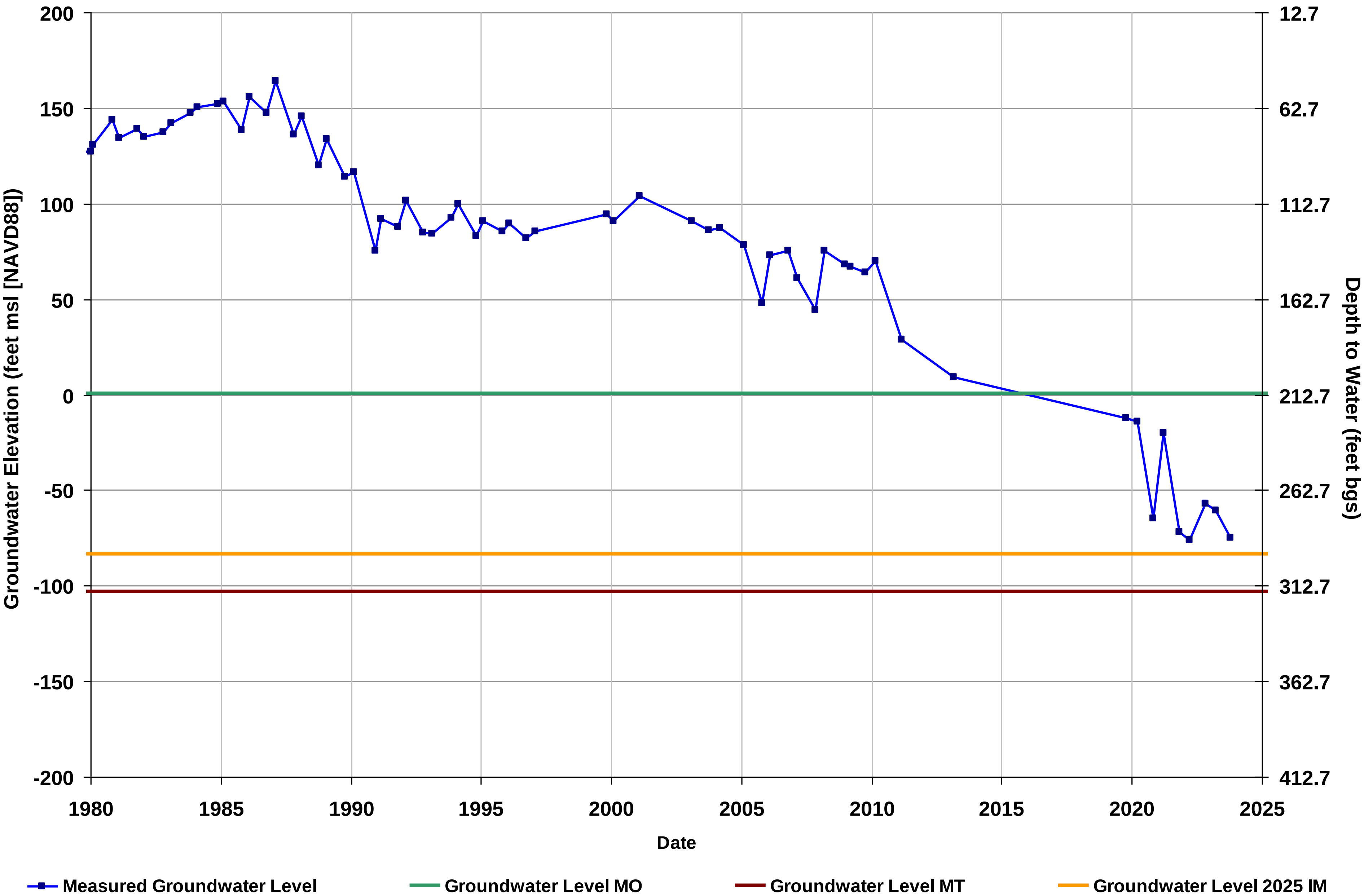
Well Name: CWD RMS-15
Depth Zone: Lower
Subbasin: Chowchilla
GSA: Chowchilla Water District

Total Depth (ft bgs): 955
Perf. Top (ft bgs): 290
Perf. Bottom (ft bgs): 935
GSE (ft, msl): 213



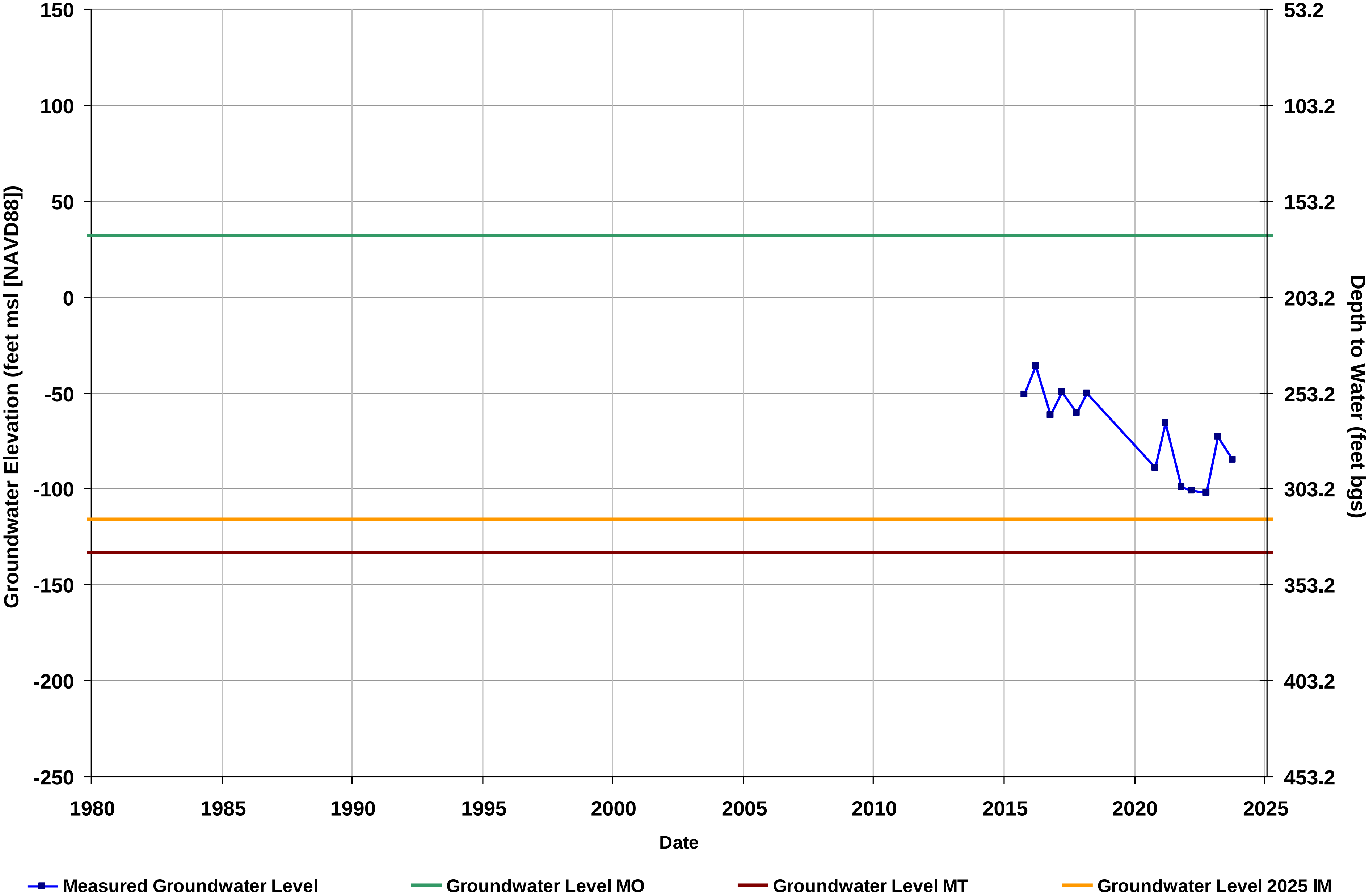
Well Name: CWD RMS-16
Depth Zone: Lower
Subbasin: Chowchilla
GSA: Chowchilla Water District

Total Depth (ft bgs):
Perf. Top (ft bgs):
Perf. Bottom (ft bgs):
GSE (ft, msl): 212.7



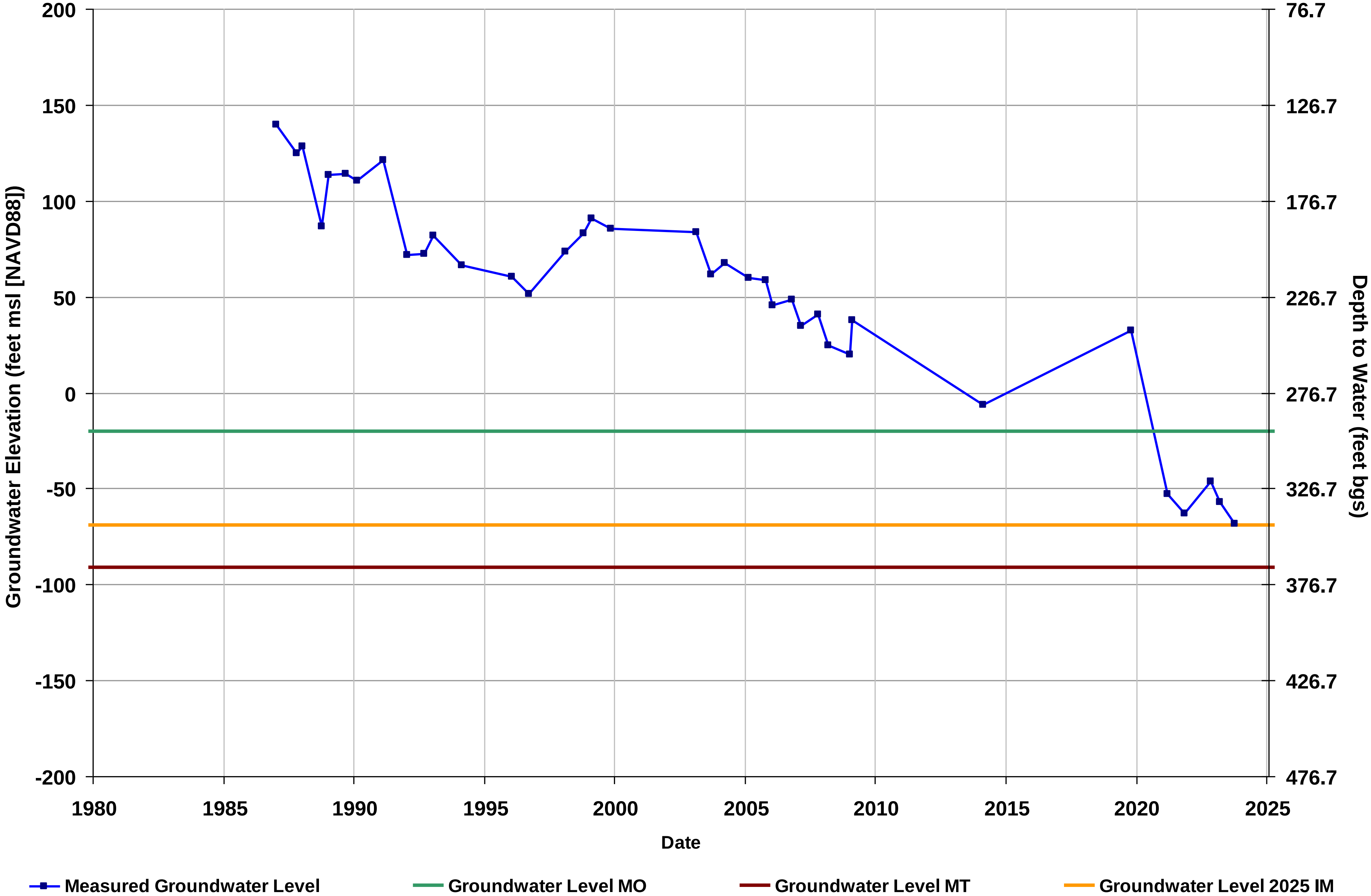
Well Name: CWD RMS-17
Depth Zone: Lower
Subbasin: Chowchilla
GSA: Chowchilla Water District

Total Depth (ft bgs): 624
Perf. Top (ft bgs): 278
Perf. Bottom (ft bgs): 588
GSE (ft, msl): 203.2



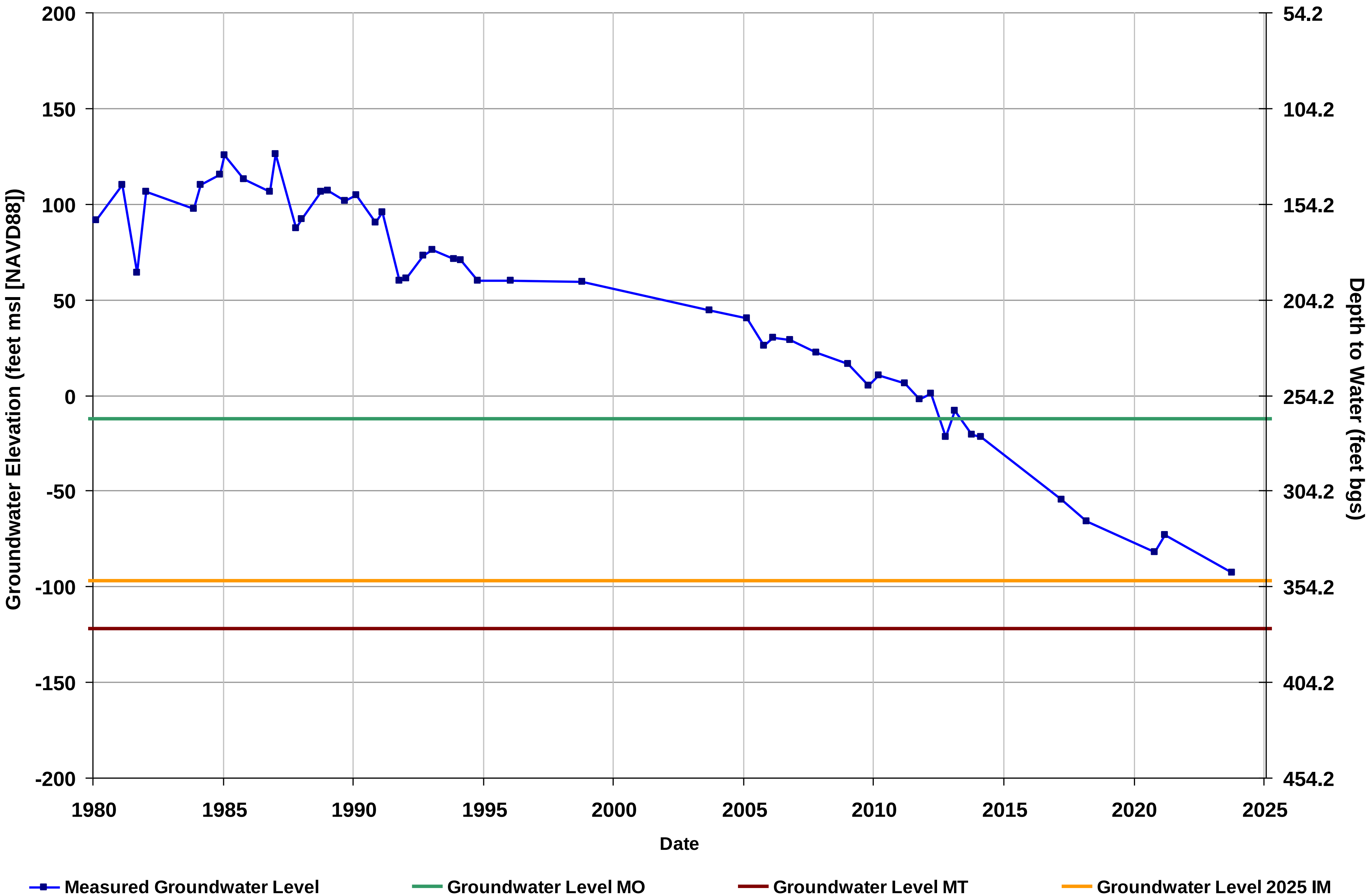
Well Name: MCE RMS-1
Depth Zone: Lower
Subbasin: Chowchilla
GSA: County of Madera - East

Total Depth (ft bgs):
Perf. Top (ft bgs):
Perf. Bottom (ft bgs):
GSE (ft, msl): 276.7



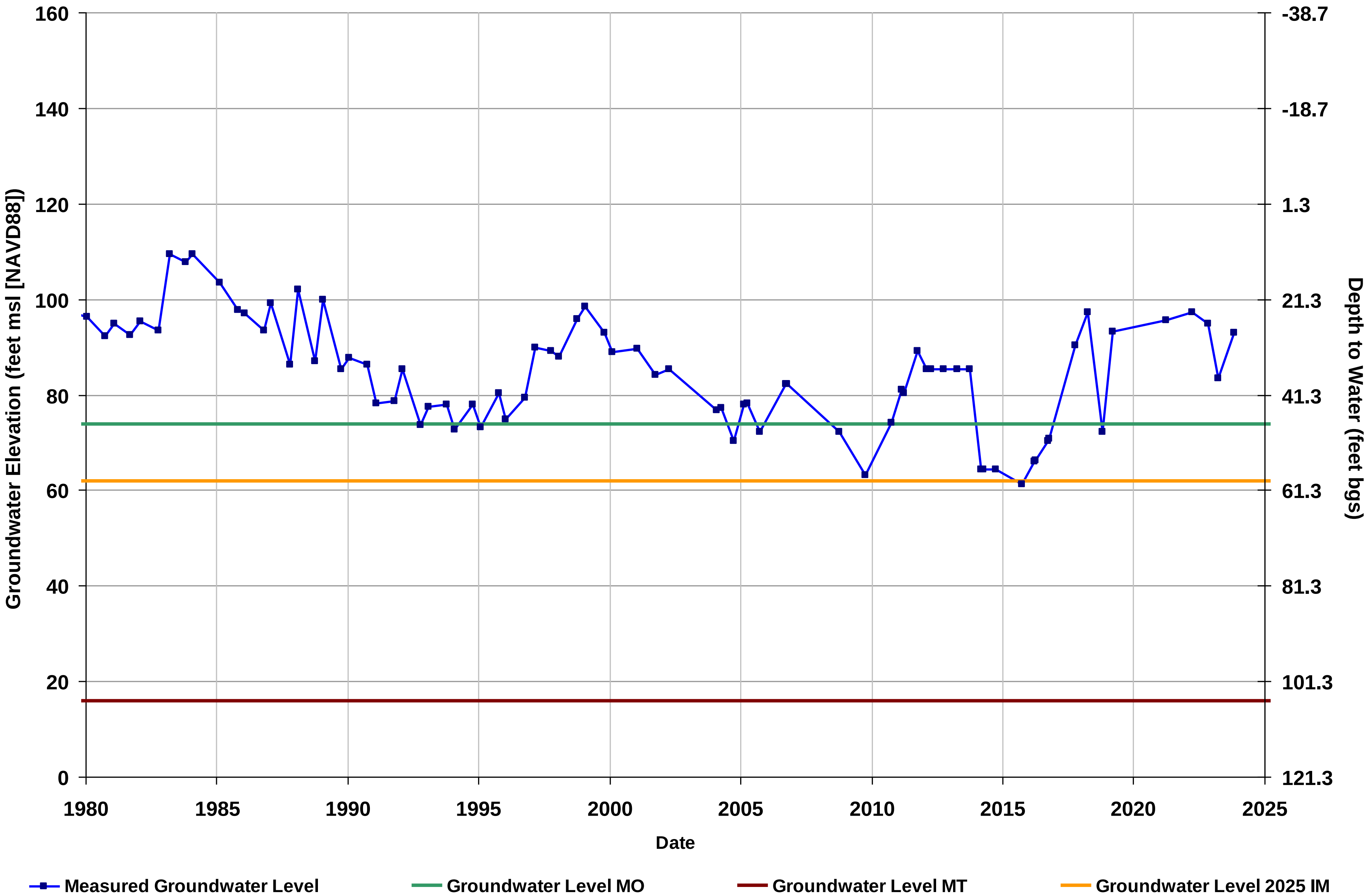
Well Name: MCE RMS-2
Depth Zone: Lower
Subbasin: Chowchilla
GSA: County of Madera - East

Total Depth (ft bgs): 466
Perf. Top (ft bgs): 218
Perf. Bottom (ft bgs): 464
GSE (ft, msl): 254.2



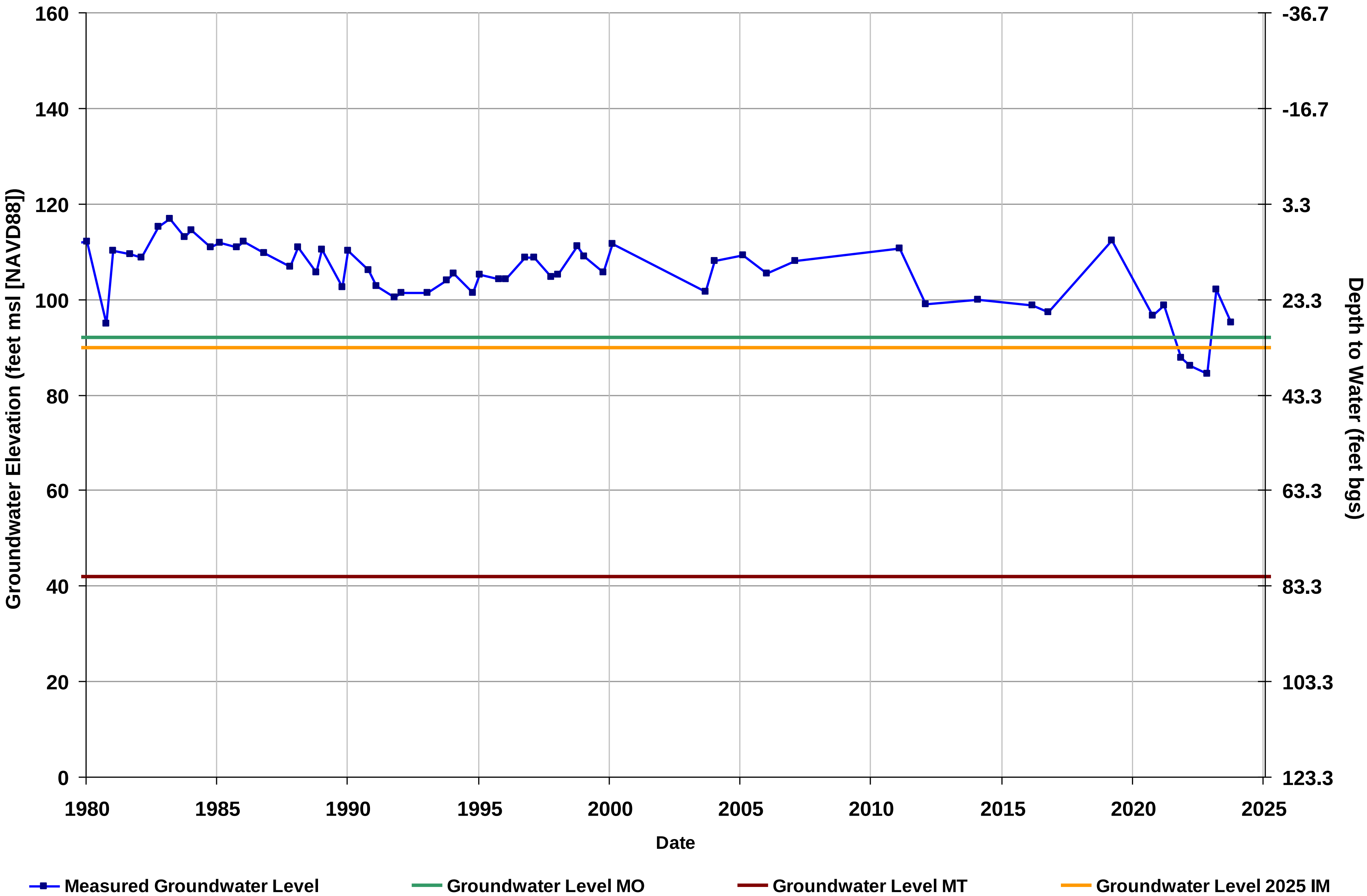
Well Name: MCW RMS-1
Depth Zone: Upper
Subbasin: Chowchilla
GSA: County of Madera - West

Total Depth (ft bgs): 150
Perf. Top (ft bgs):
Perf. Bottom (ft bgs):
GSE (ft, msl): 121.3



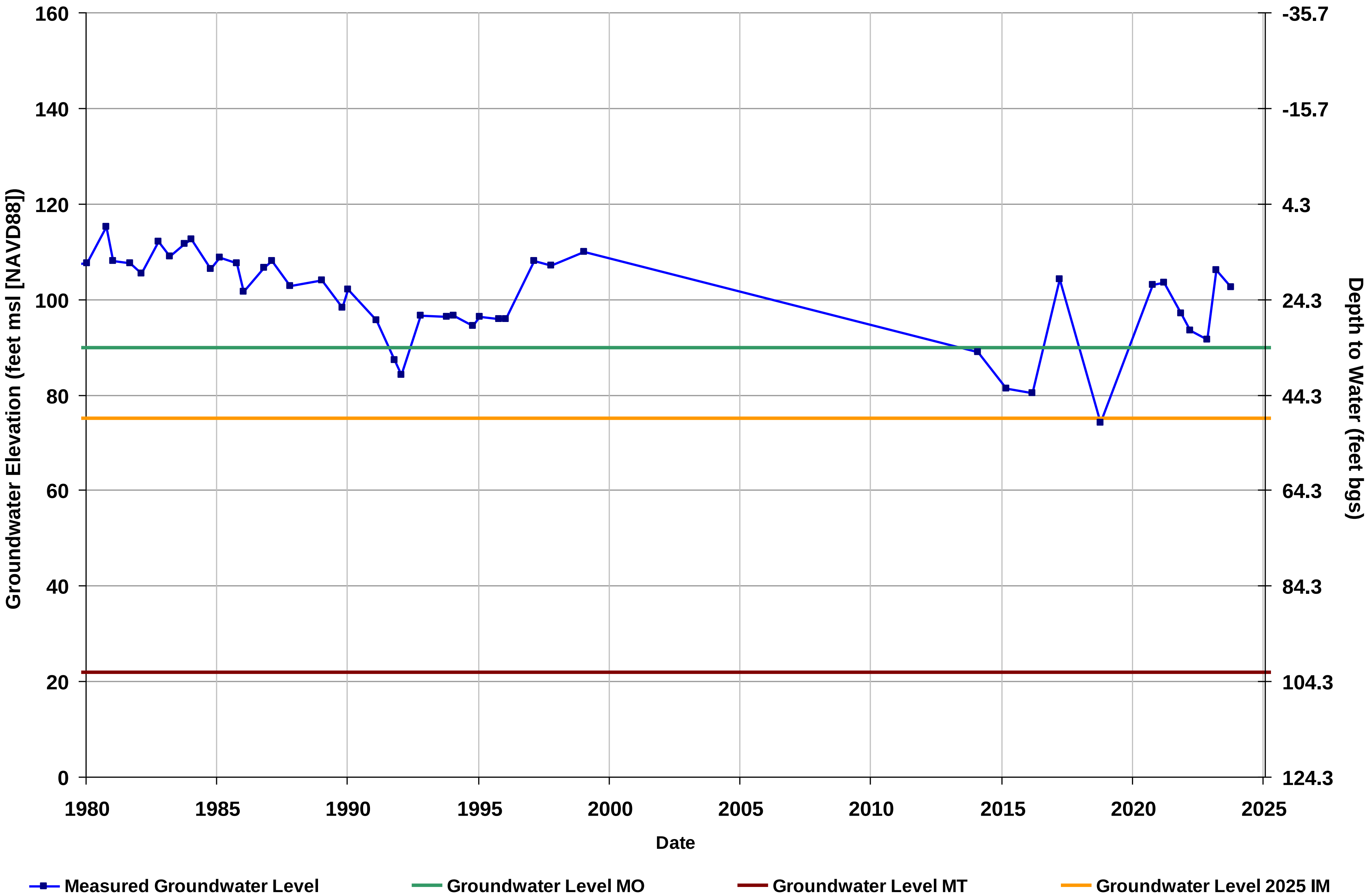
Well Name: MCW RMS-2
Depth Zone: Upper
Subbasin: Chowchilla
GSA: County of Madera - West

Total Depth (ft bgs):
Perf. Top (ft bgs):
Perf. Bottom (ft bgs):
GSE (ft, msl): 123.3



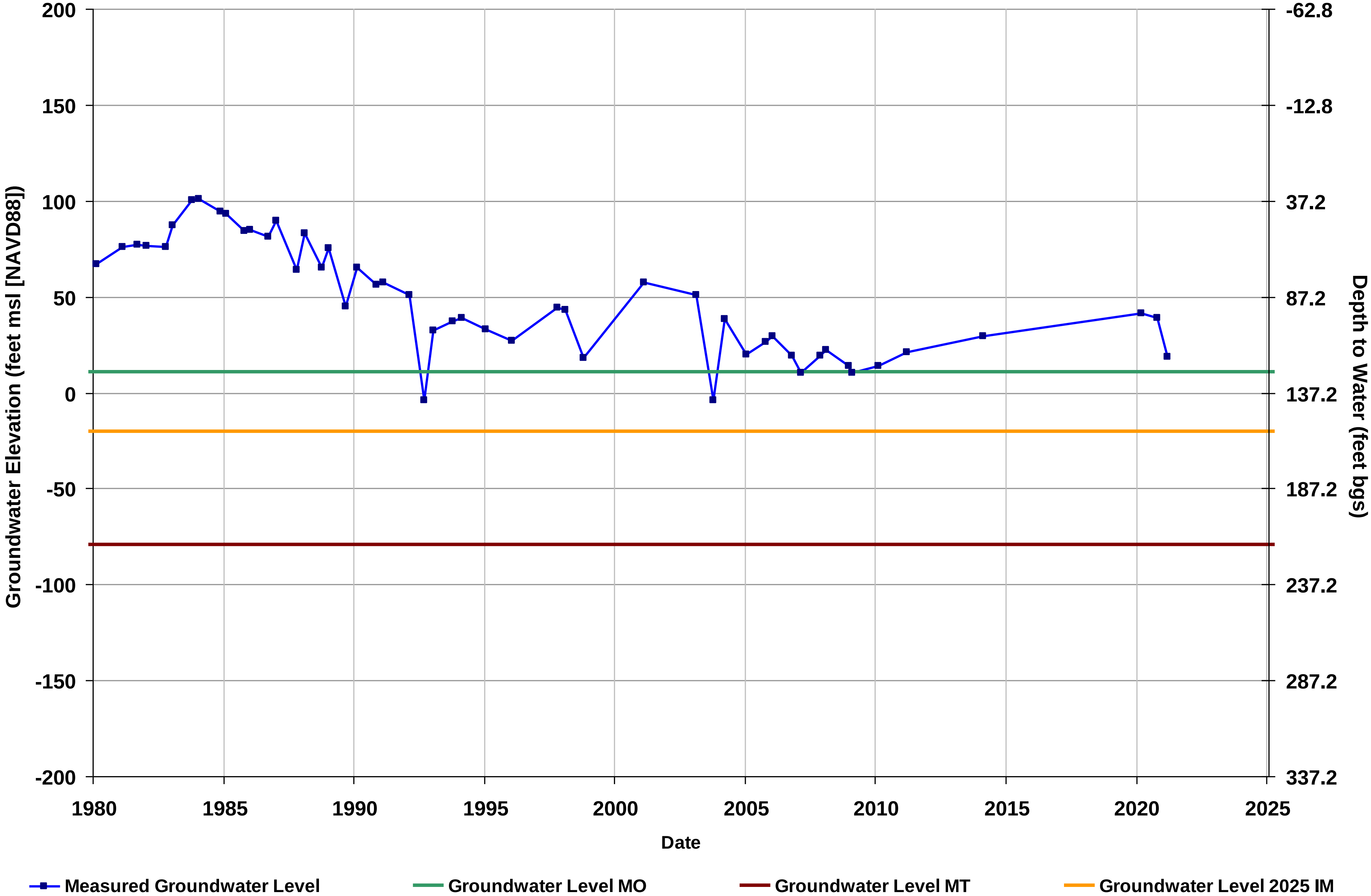
Well Name: MCW RMS-3
Depth Zone: Upper
Subbasin: Chowchilla
GSA: County of Madera - West

Total Depth (ft bgs):
Perf. Top (ft bgs):
Perf. Bottom (ft bgs):
GSE (ft, msl): 124.3



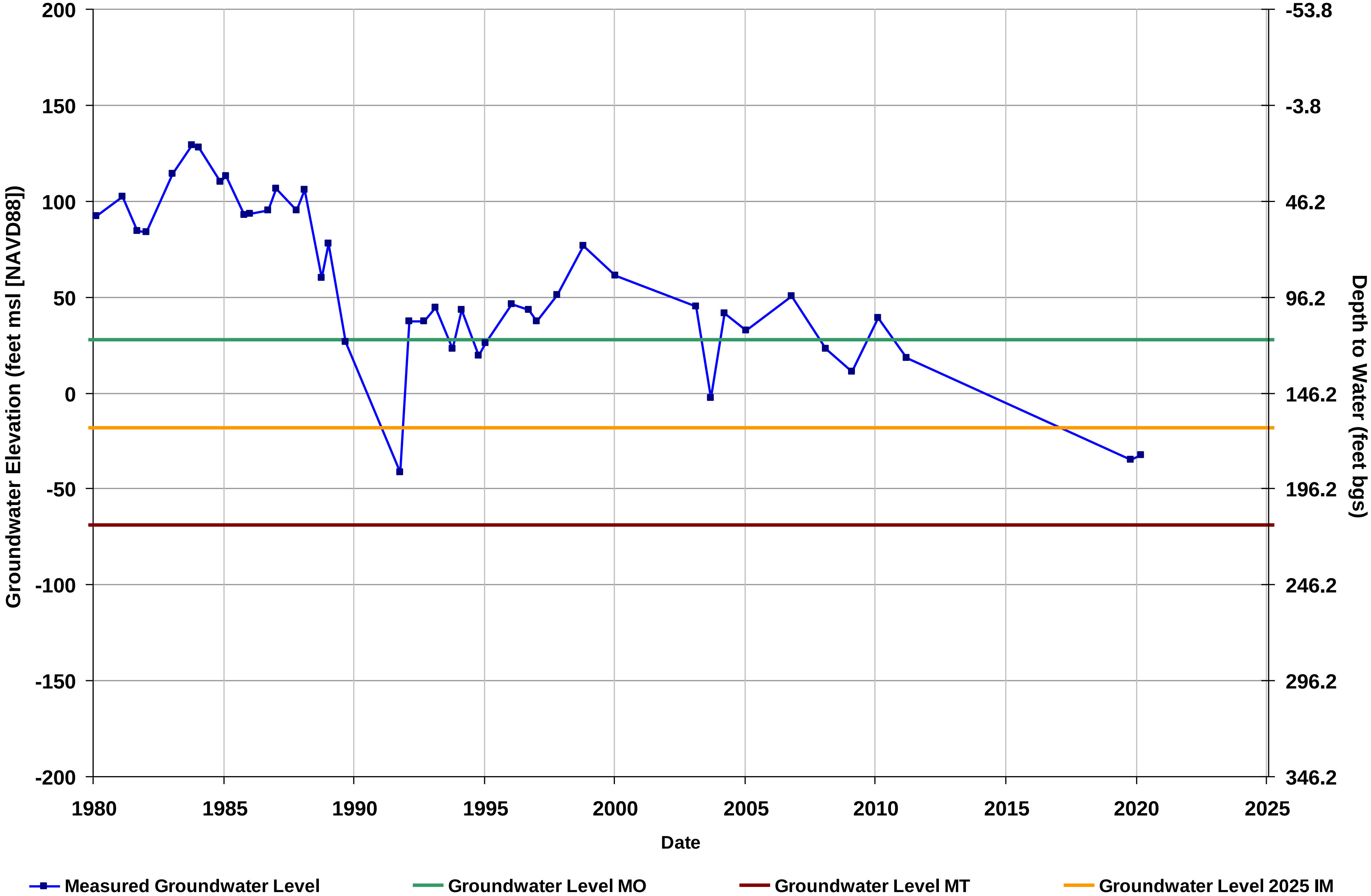
Well Name: MCW RMS-4
Depth Zone: Lower
Subbasin: Chowchilla
GSA: County of Madera - West

Total Depth (ft bgs):
Perf. Top (ft bgs):
Perf. Bottom (ft bgs):
GSE (ft, msl): 137.2



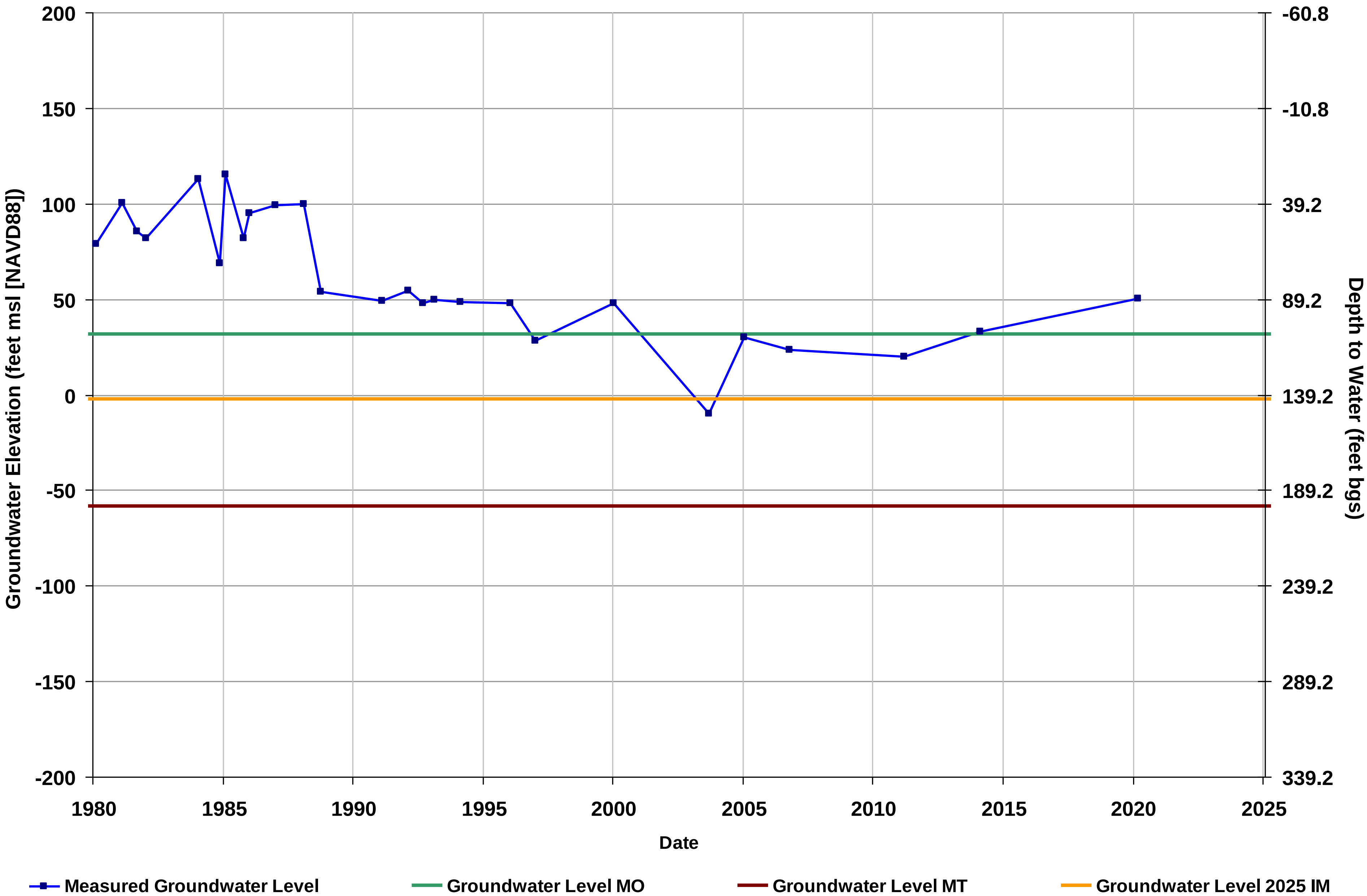
Well Name: MCW RMS-5
Depth Zone: Lower
Subbasin: Chowchilla
GSA: County of Madera - West

Total Depth (ft bgs):
Perf. Top (ft bgs):
Perf. Bottom (ft bgs):
GSE (ft, msl): 146.2



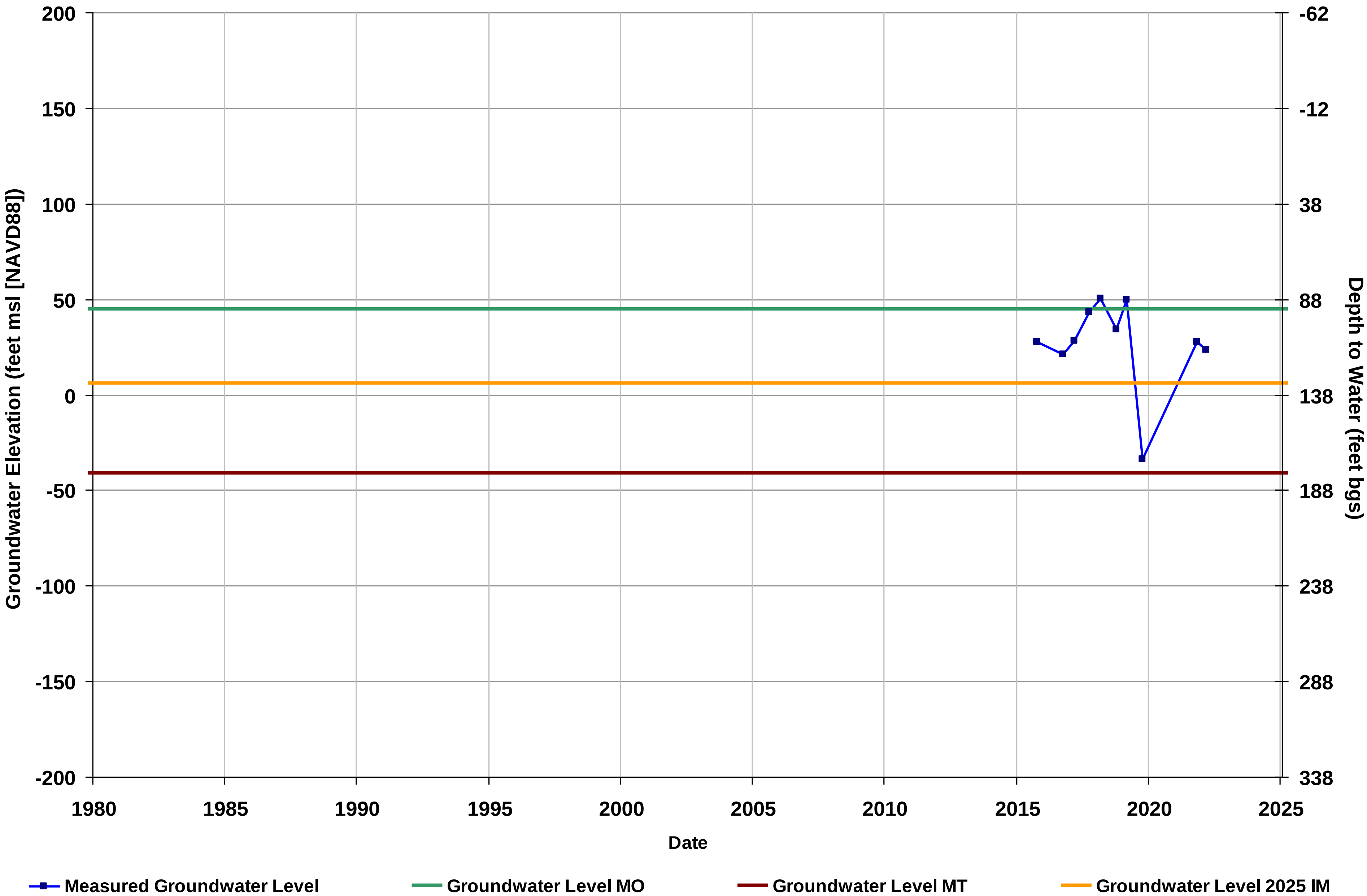
Well Name: MCW RMS-6
Depth Zone: Lower
Subbasin: Chowchilla
GSA: County of Madera - West

Total Depth (ft bgs):
Perf. Top (ft bgs):
Perf. Bottom (ft bgs):
GSE (ft, msl): 139.2



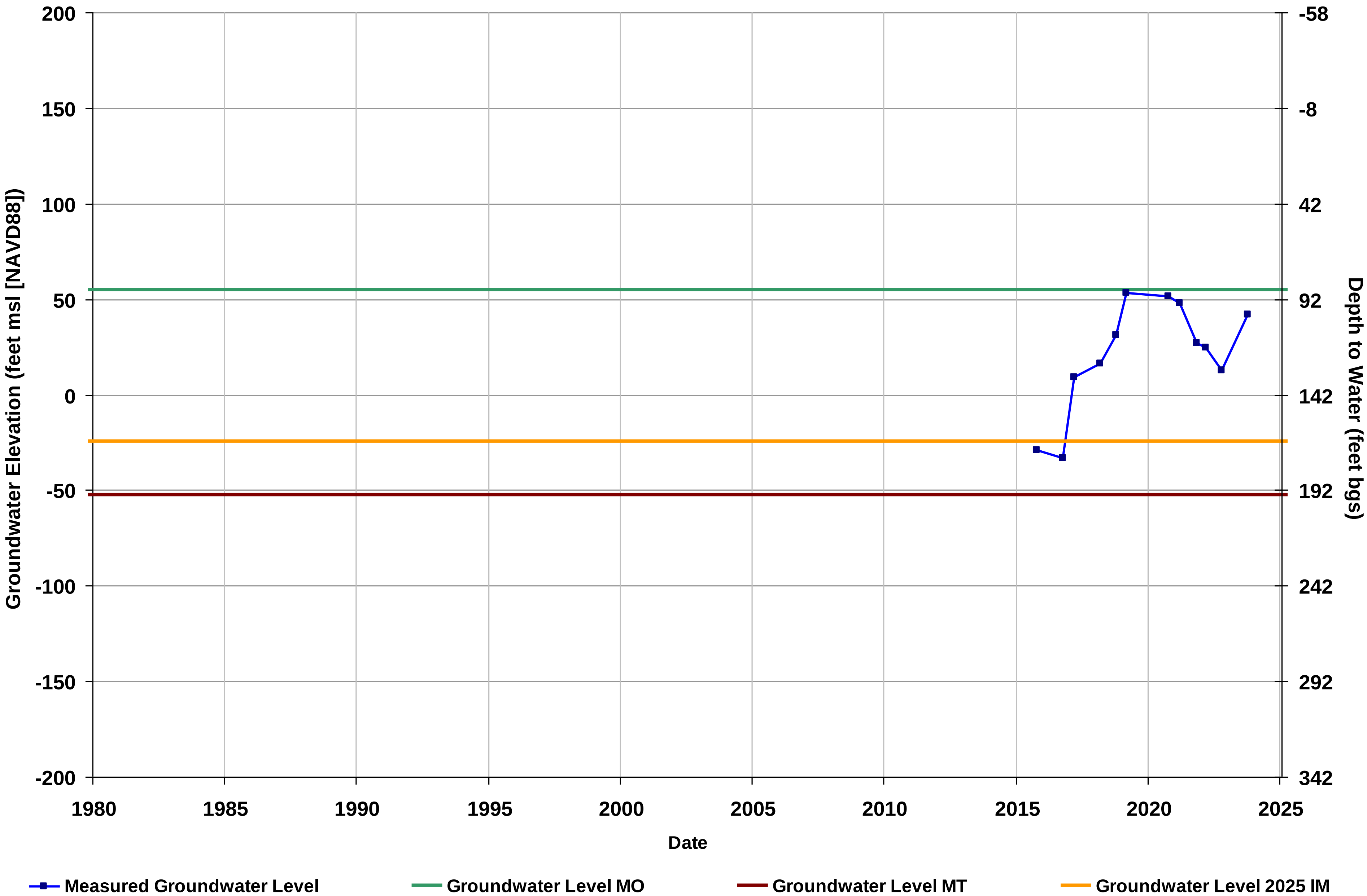
Well Name: MCW RMS-7
Depth Zone: Lower
Subbasin: Chowchilla
GSA: County of Madera - West

Total Depth (ft bgs): 800
Perf. Top (ft bgs): 290
Perf. Bottom (ft bgs): 400
GSE (ft, msl): 138



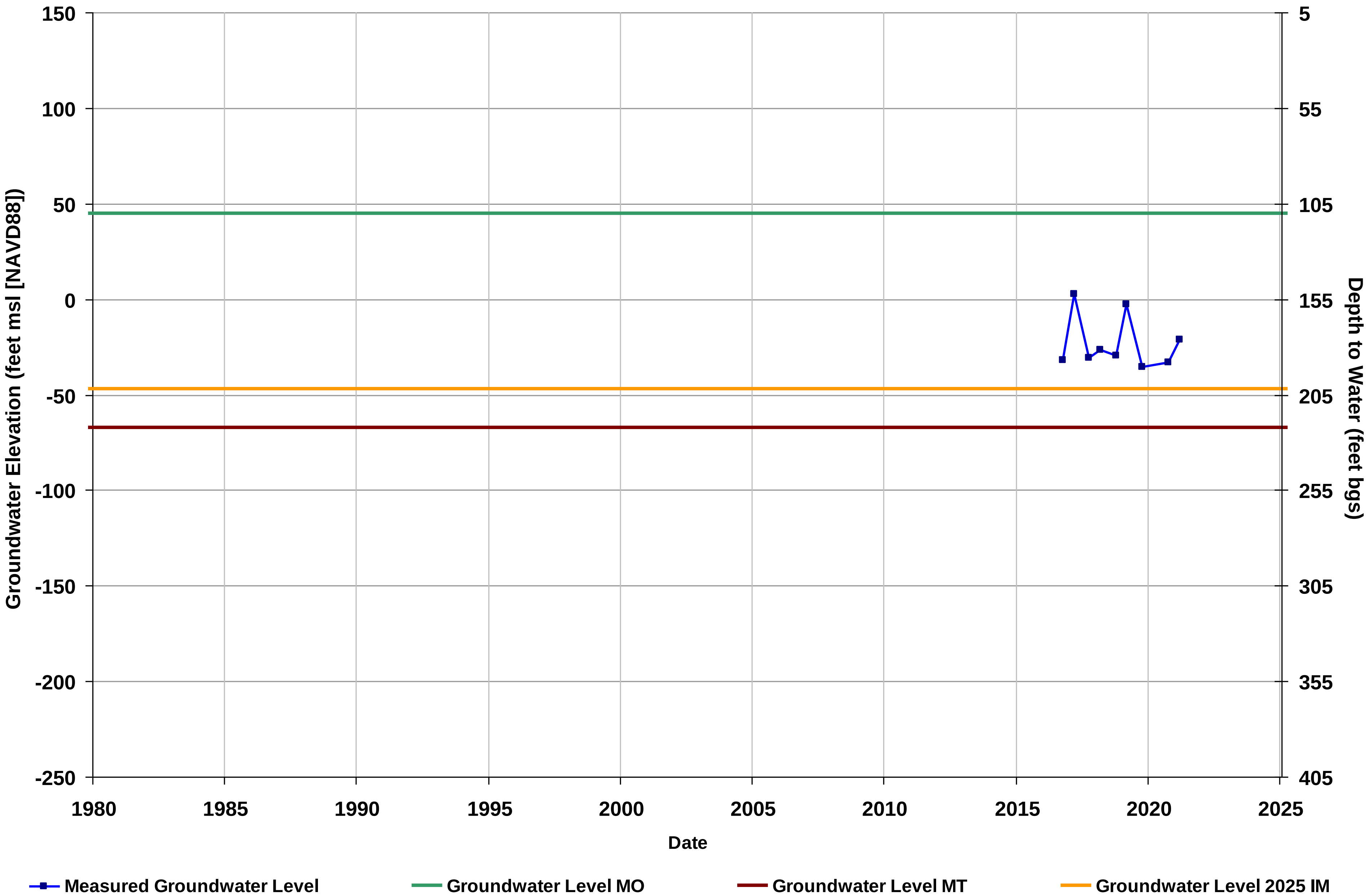
Well Name: MCW RMS-8
Depth Zone: Composite
Subbasin: Chowchilla
GSA: County of Madera - West

Total Depth (ft bgs): 480
Perf. Top (ft bgs): 160
Perf. Bottom (ft bgs): 475
GSE (ft, msl): 142



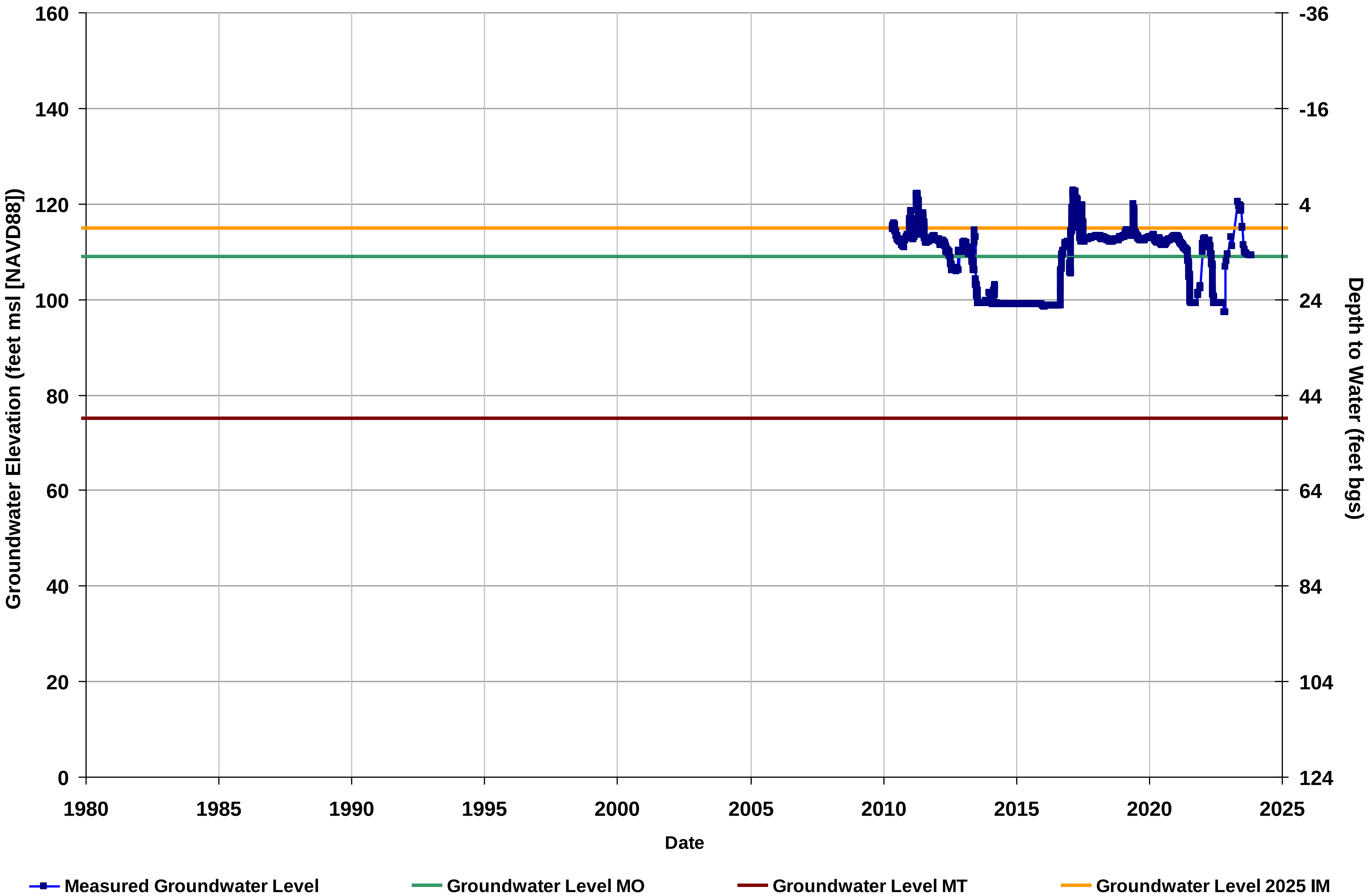
Well Name: MCW RMS-9
Depth Zone: Lower
Subbasin: Chowchilla
GSA: County of Madera - West

Total Depth (ft bgs): 700
Perf. Top (ft bgs): 265
Perf. Bottom (ft bgs): 696
GSE (ft, msl): 155



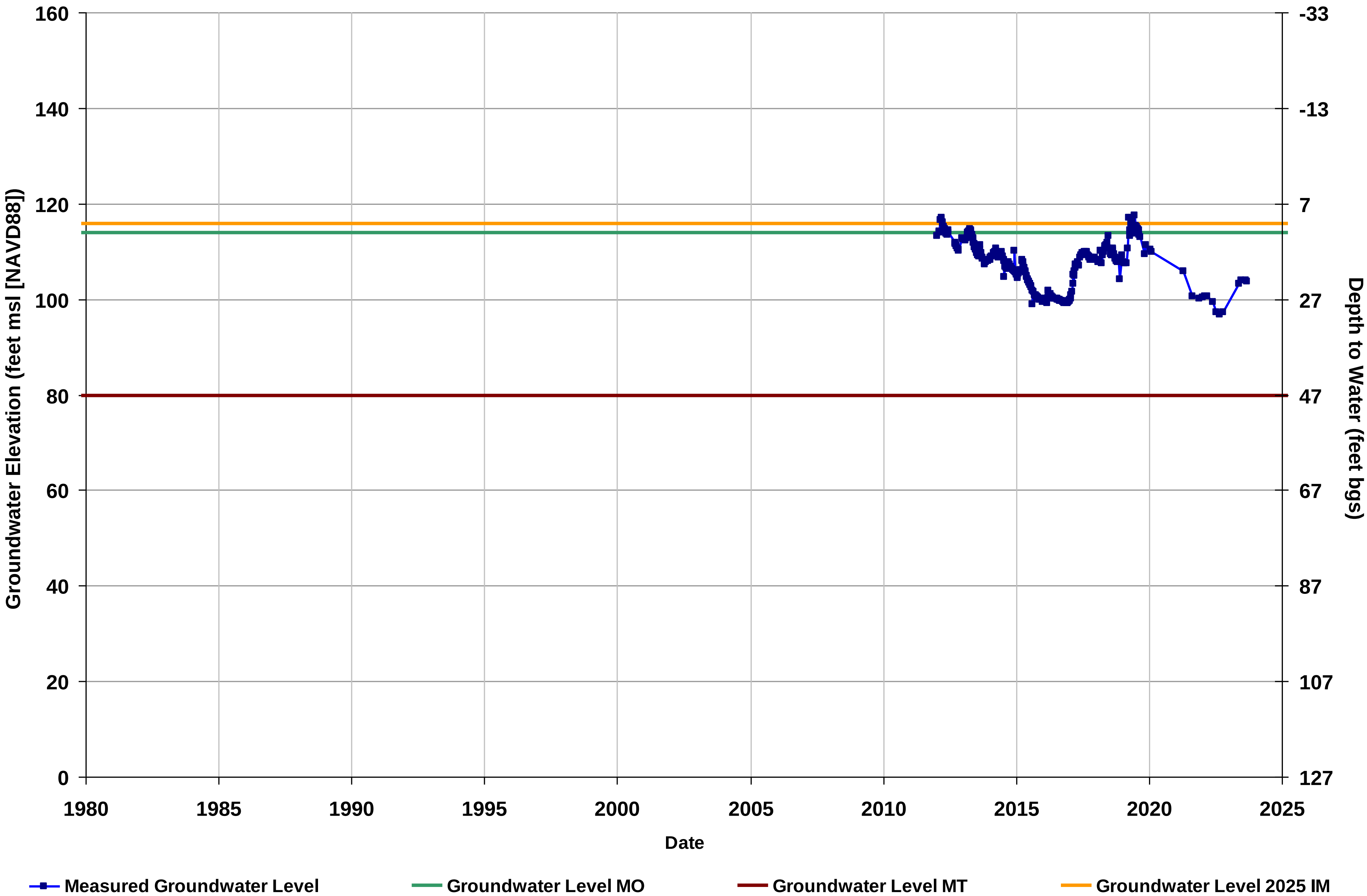
Well Name: MCW RMS-10
Depth Zone: Upper
Subbasin: Chowchilla
GSA: County of Madera - West

Total Depth (ft bgs): 26
Perf. Top (ft bgs): 10
Perf. Bottom (ft bgs): 25
GSE (ft, msl): 124



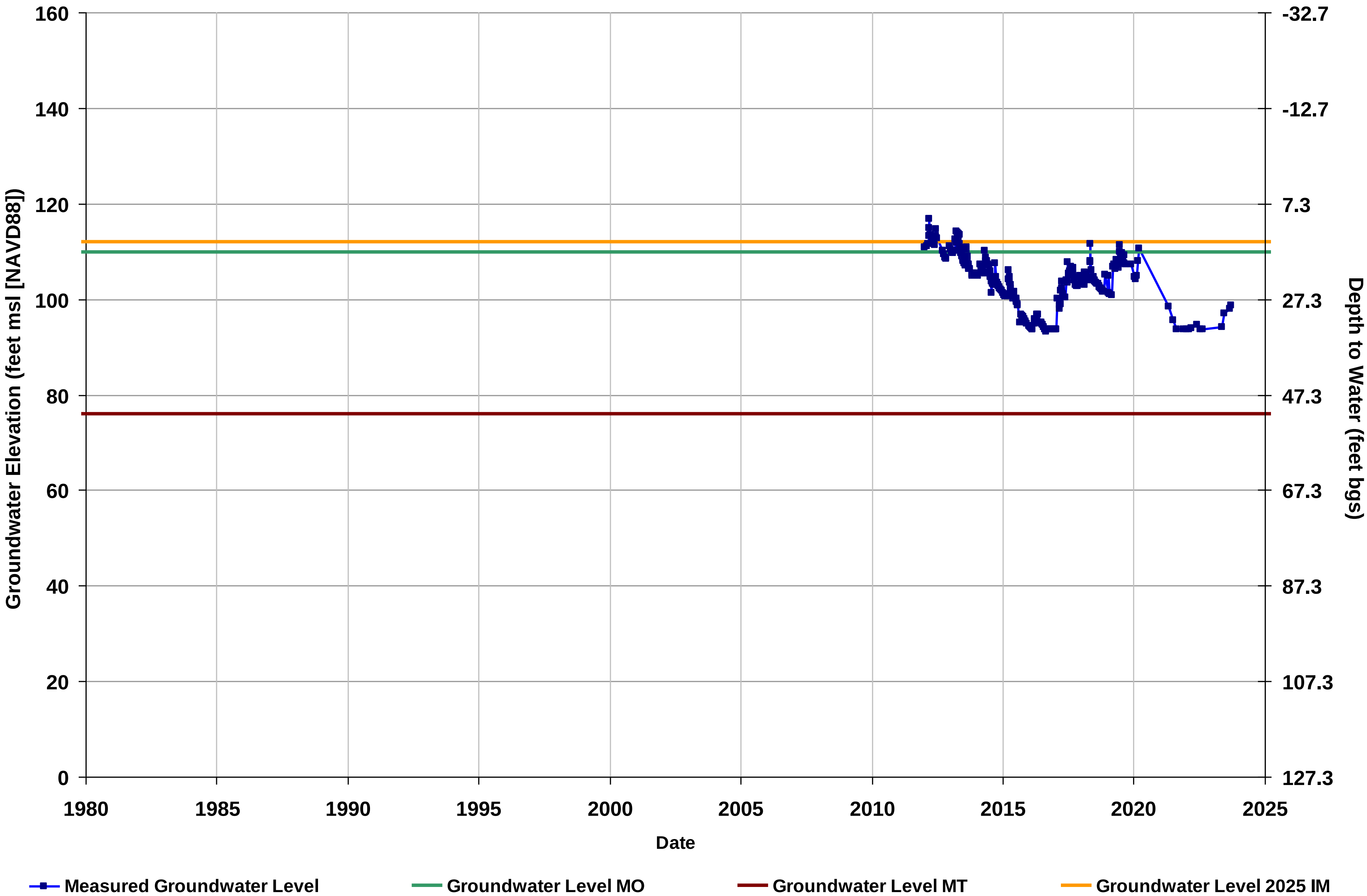
Well Name: MCW RMS-11
Depth Zone: Upper
Subbasin: Chowchilla
GSA: County of Madera - West

Total Depth (ft bgs): 30
Perf. Top (ft bgs):
Perf. Bottom (ft bgs):
GSE (ft, msl): 127



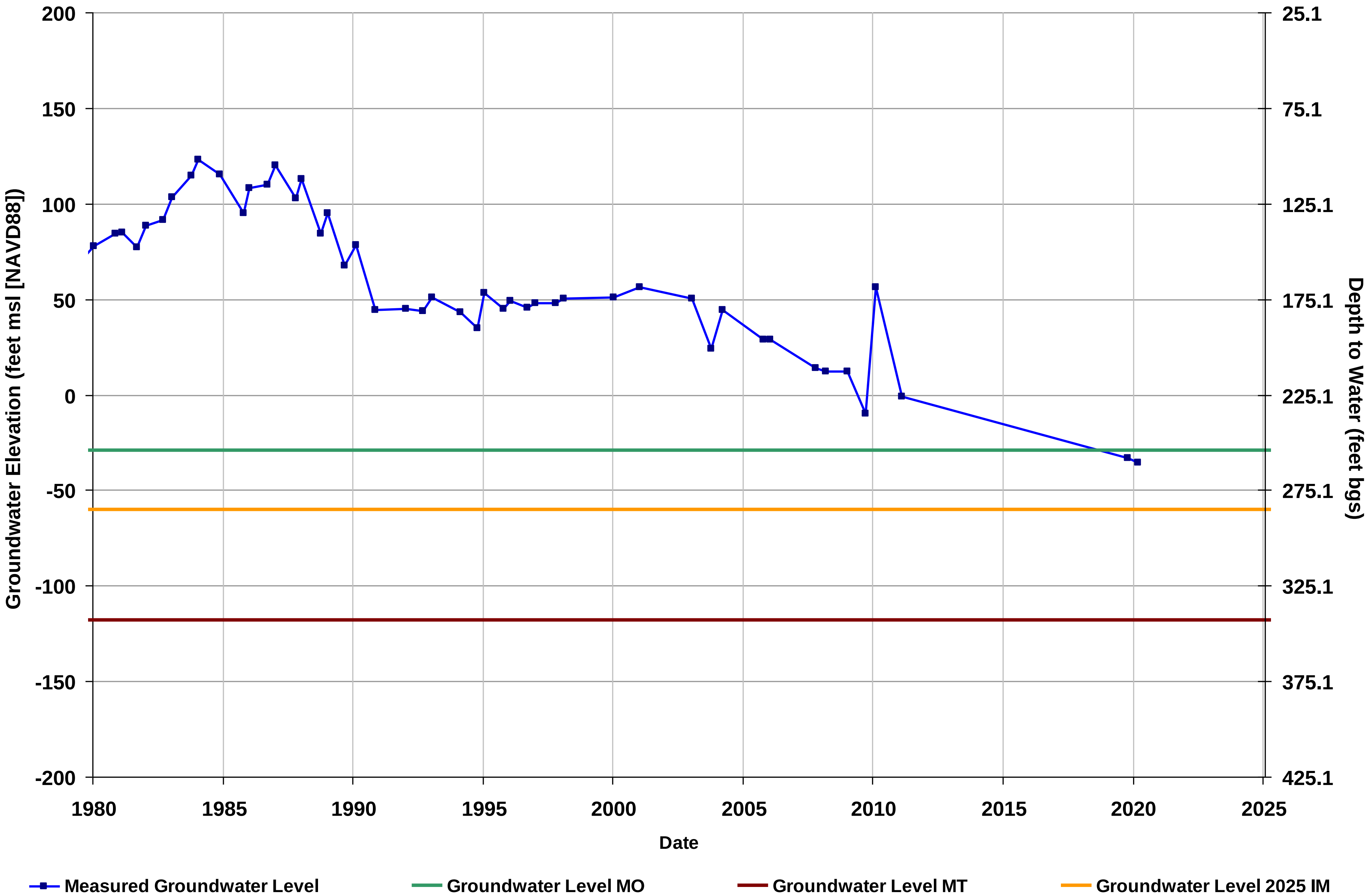
Well Name: MCW RMS-12
Depth Zone: Upper
Subbasin: Chowchilla
GSA: County of Madera - West

Total Depth (ft bgs): 29
Perf. Top (ft bgs):
Perf. Bottom (ft bgs):
GSE (ft, msl): 127.3



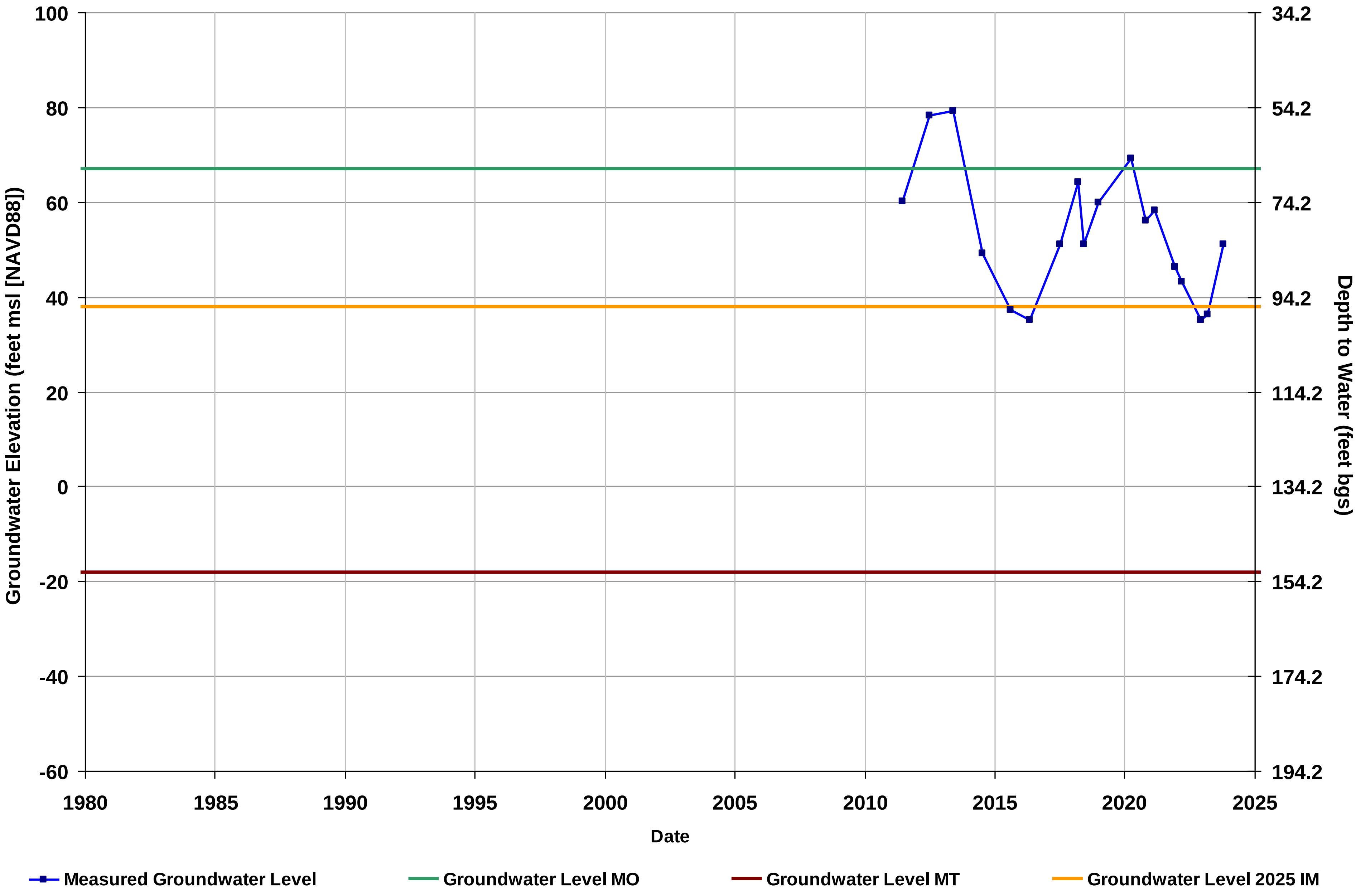
Well Name: MER RMS-1
Depth Zone: Lower
Subbasin: Chowchilla
GSA: County of Merced

Total Depth (ft bgs):
Perf. Top (ft bgs):
Perf. Bottom (ft bgs):
GSE (ft, msl): 225.1



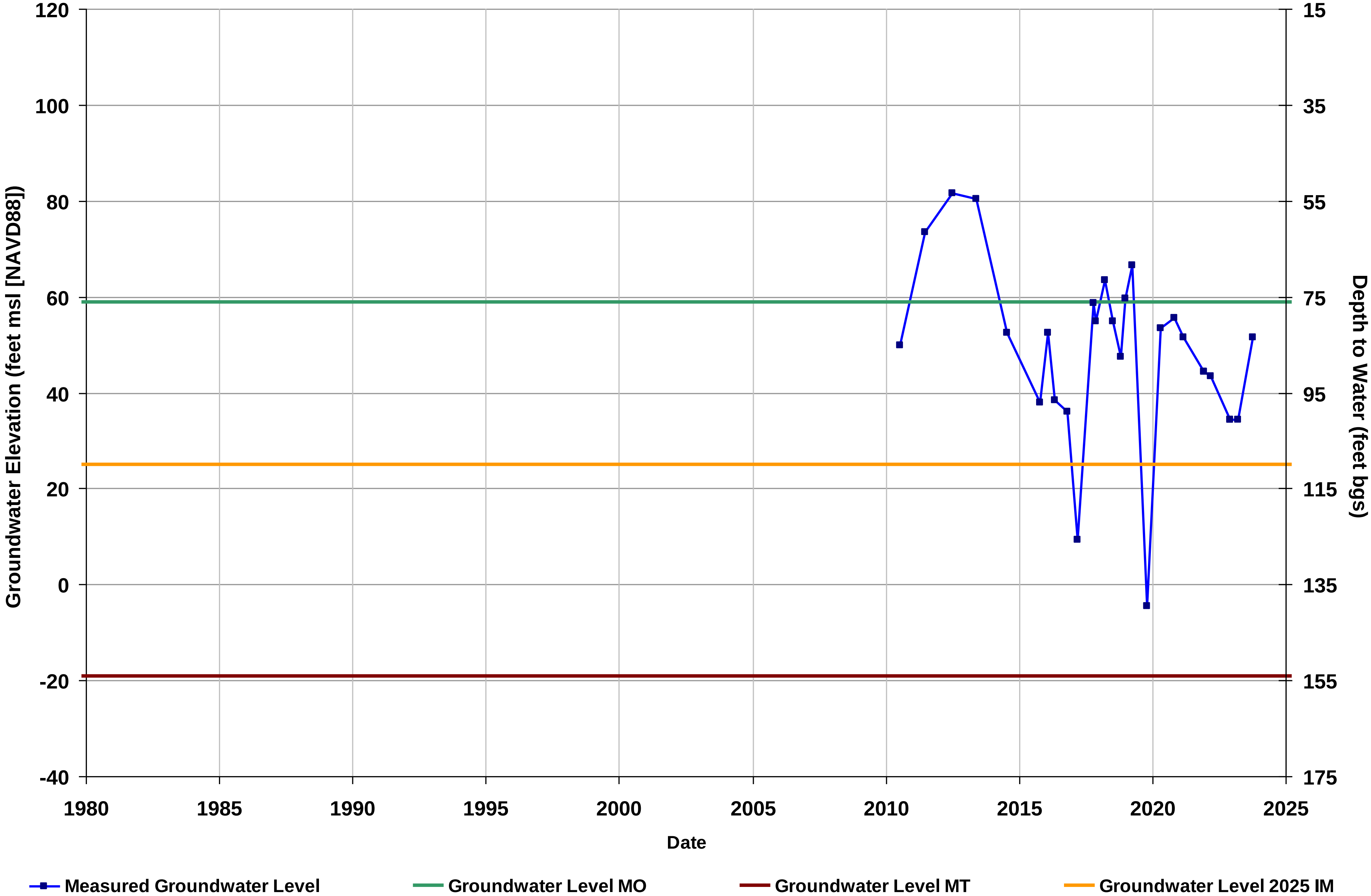
Well Name: TRT RMS-1
Depth Zone: Upper
Subbasin: Chowchilla
GSA: Triangle T Water District

Total Depth (ft bgs): 196
Perf. Top (ft bgs): 158
Perf. Bottom (ft bgs): 192
GSE (ft, msl): 134.2



Well Name: TRT RMS-2
Depth Zone: Lower
Subbasin: Chowchilla
GSA: Triangle T Water District

Total Depth (ft bgs): 500
Perf. Top (ft bgs): 300
Perf. Bottom (ft bgs): 500
GSE (ft, msl): 135

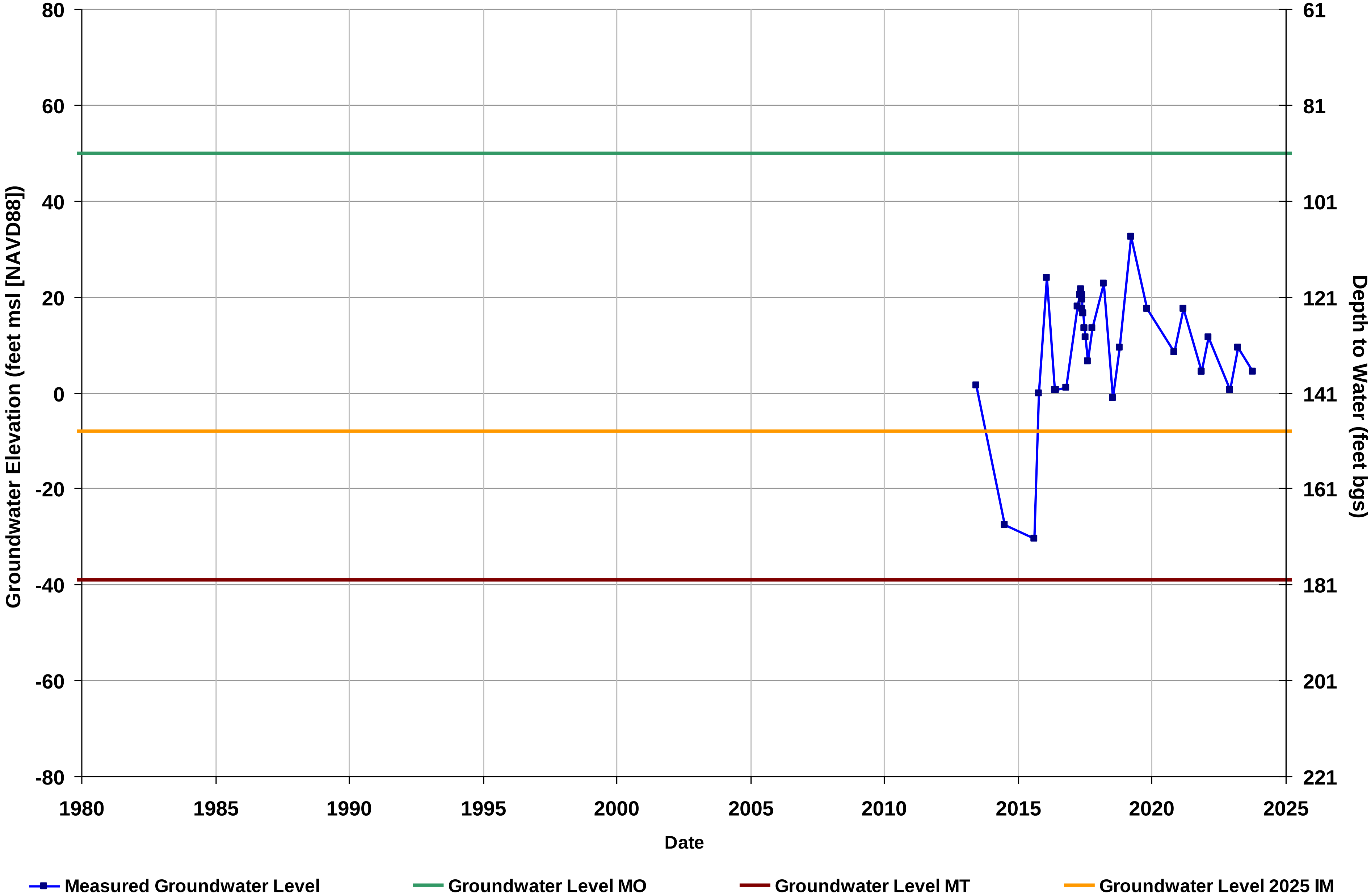


Well Name: TRT RMS-3
Depth Zone: Lower
Subbasin: Chowchilla
GSA: Triangle T Water District

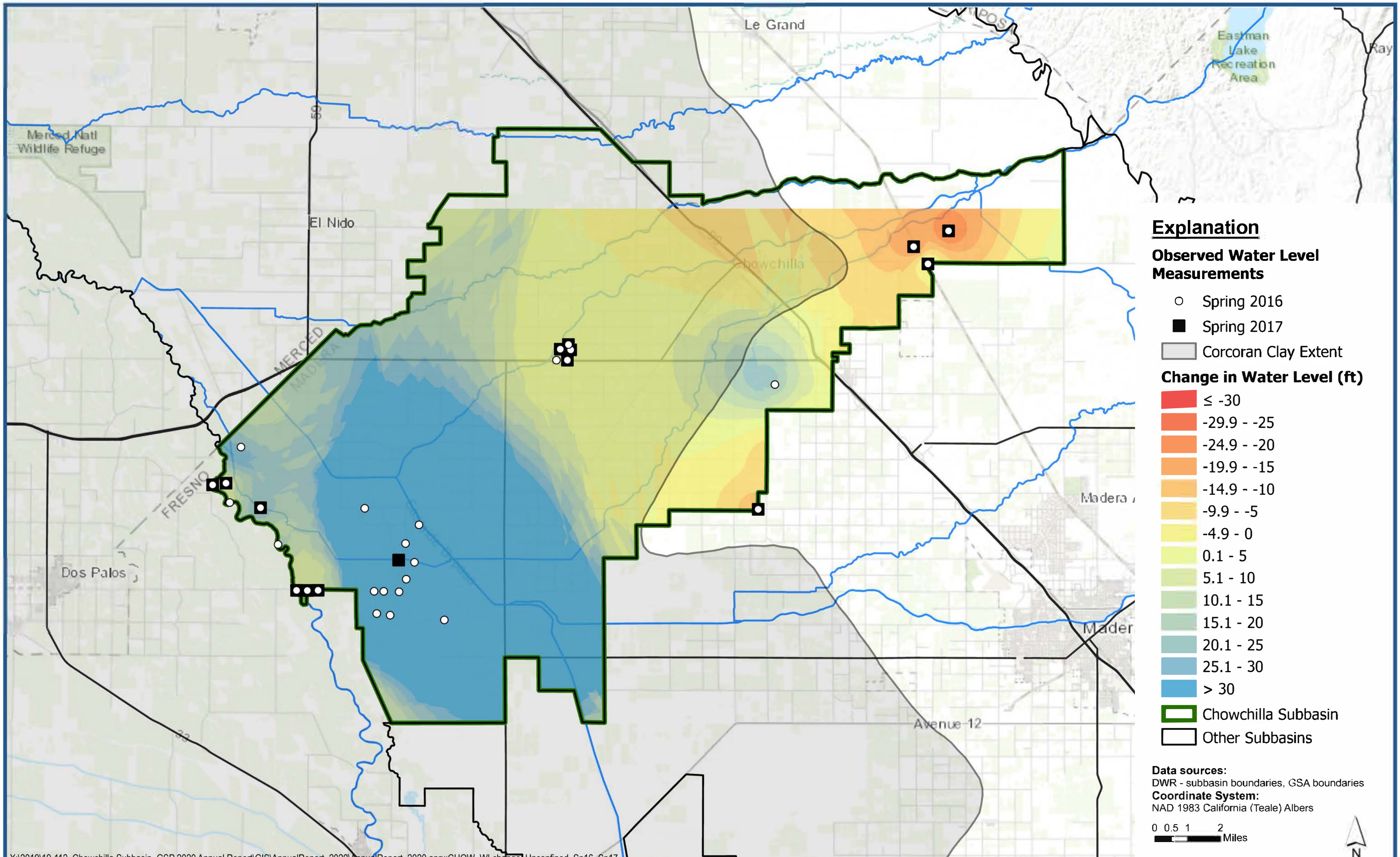
Total Depth (ft bgs): 799
Perf. Top (ft bgs): 168
Perf. Bottom (ft bgs): 790
GSE (ft, msl): 137.4

Well Name: TRT RMS-4
Depth Zone: Composite
Subbasin: Chowchilla
GSA: Triangle T Water District

Total Depth (ft bgs): 840
Perf. Top (ft bgs): 190
Perf. Bottom (ft bgs): 260
GSE (ft, msl): 141



Appendix C. Maps of Change in Groundwater Levels and Change in Groundwater Storage in 2016 through 2022, Separated by Principal Aquifer.



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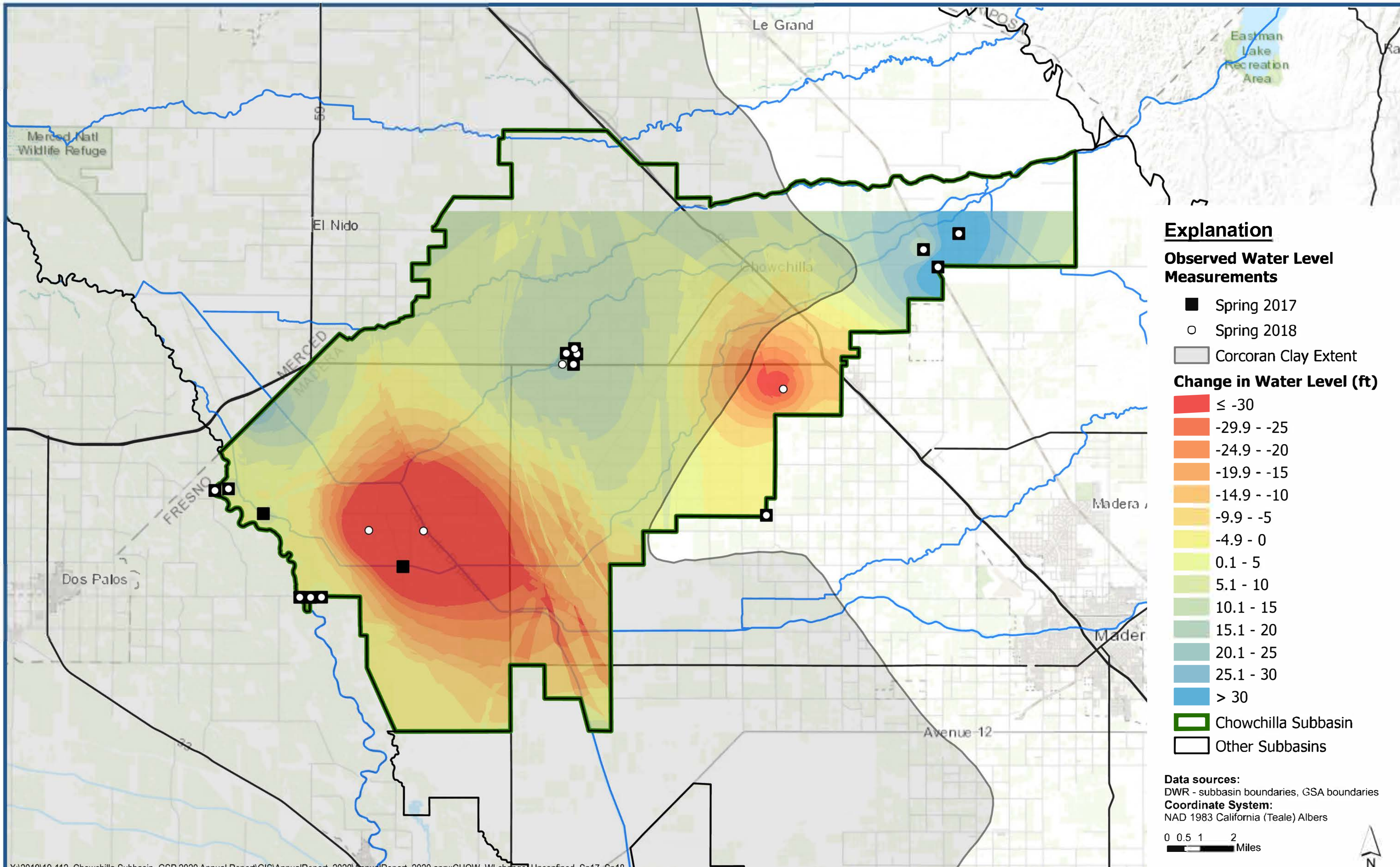
Change in Groundwater Level in the Upper Aquifer/Undifferentiated Unconfined Zone - Spring 2016 through Spring 2017

Figure C-1

Chowchilla Subbasin
Groundwater Sustainability Plan 2024 Annual Report



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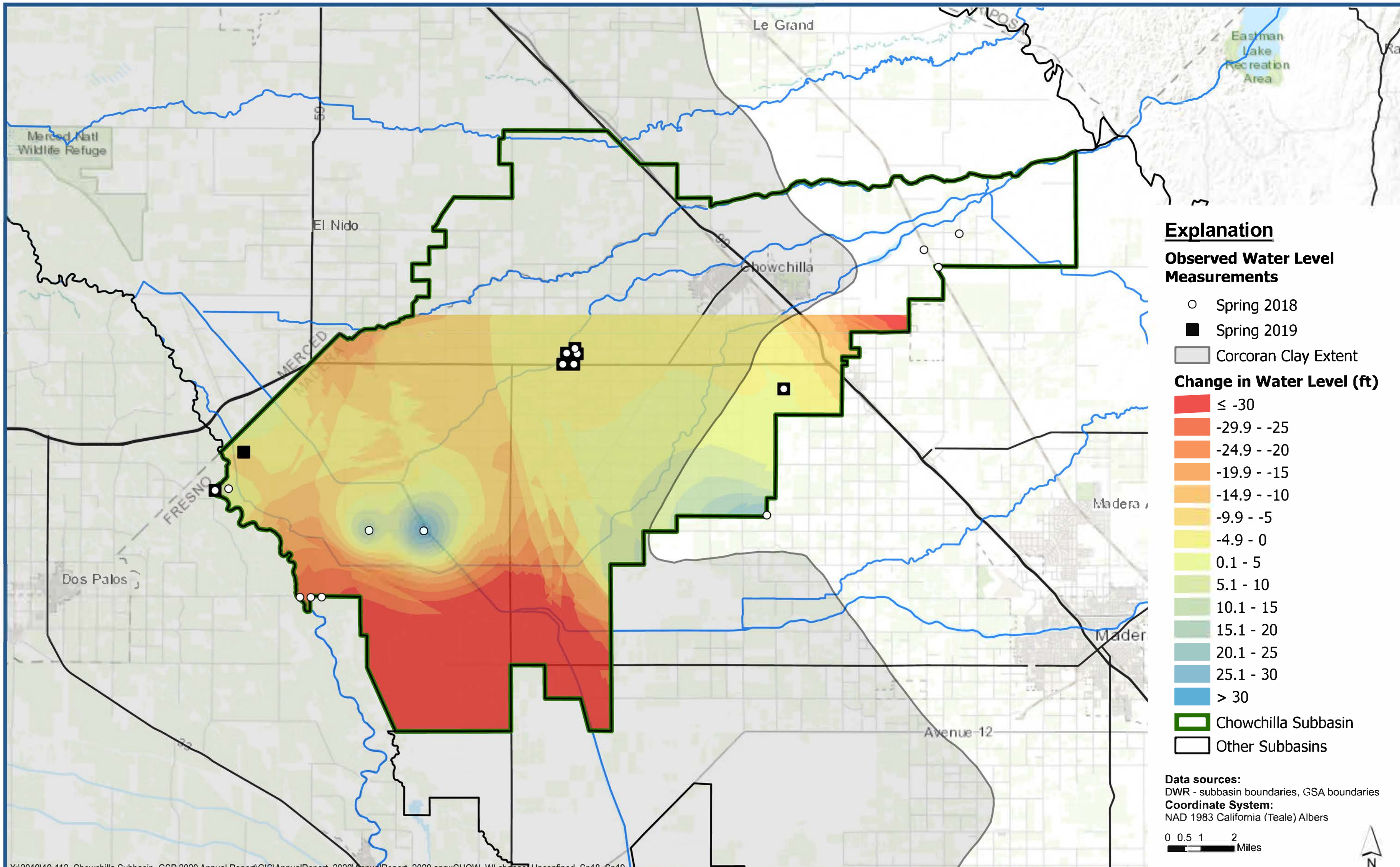
Change in Groundwater Level in the Upper Aquifer/Undifferentiated Unconfined Zone - Spring 2017 through Spring 2018

Chowchilla Subbasin
Groundwater Sustainability Plan 2024 Annual Report

Figure C-2



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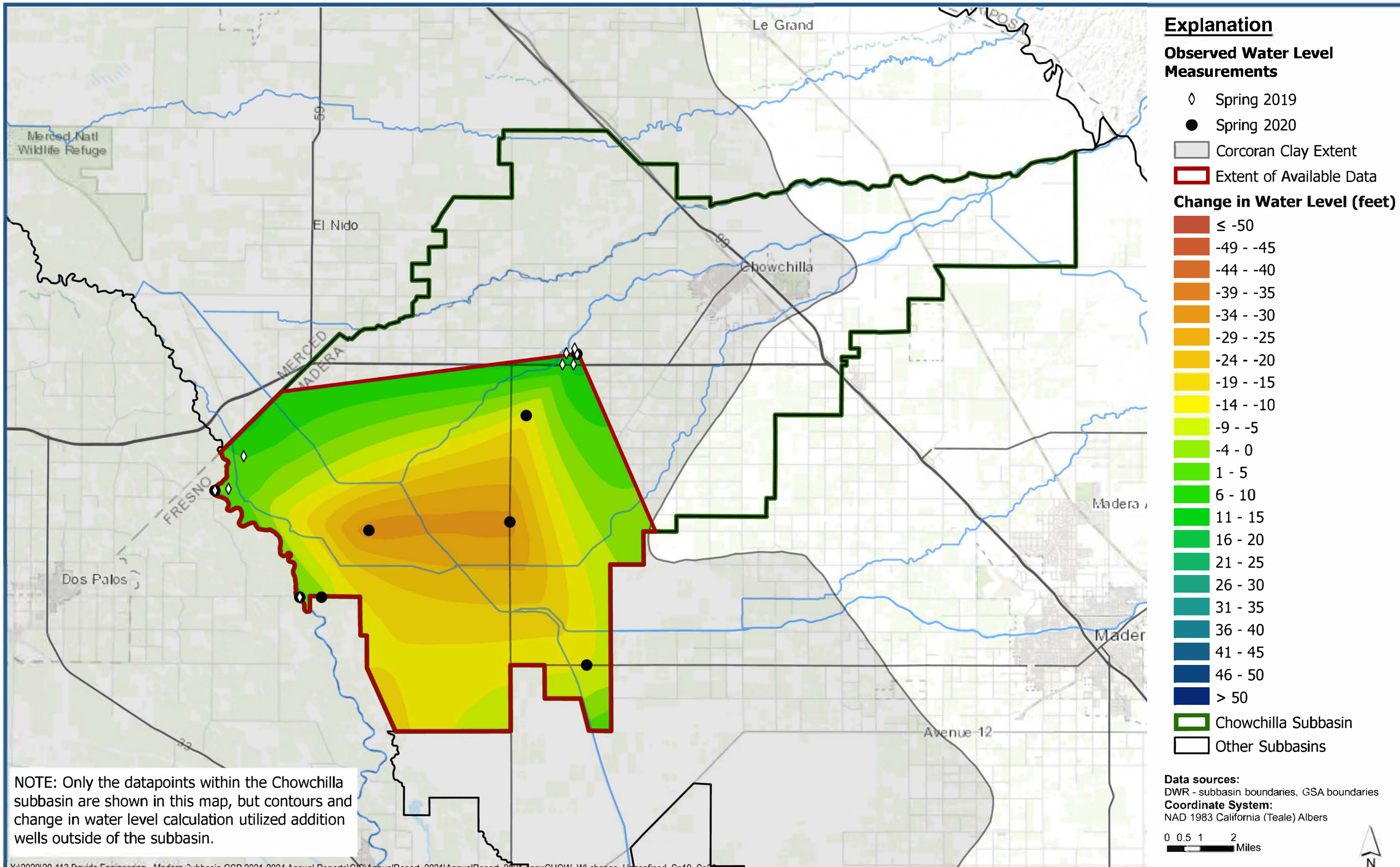
Change in Groundwater Level in the Upper Aquifer/Undifferentiated Unconfined Zone - Spring 2018 through Spring 2019

Figure C-3

Chowchilla Subbasin
Groundwater Sustainability Plan 2024 Annual Report



NOTE: Only the datapoints within the Chowchilla subbasin are shown in this map, but contours and change in water level calculation utilized addition wells outside of the subbasin.

X:\2020\20-113 Davids Engineering - Madera Subbasin GSP 2021-2024 Annual Reports\GIS\AnnualReport_2021\AnnualReport_2021.aprx:CHOW_WLchange_Unconfined_Sp19_Sp20

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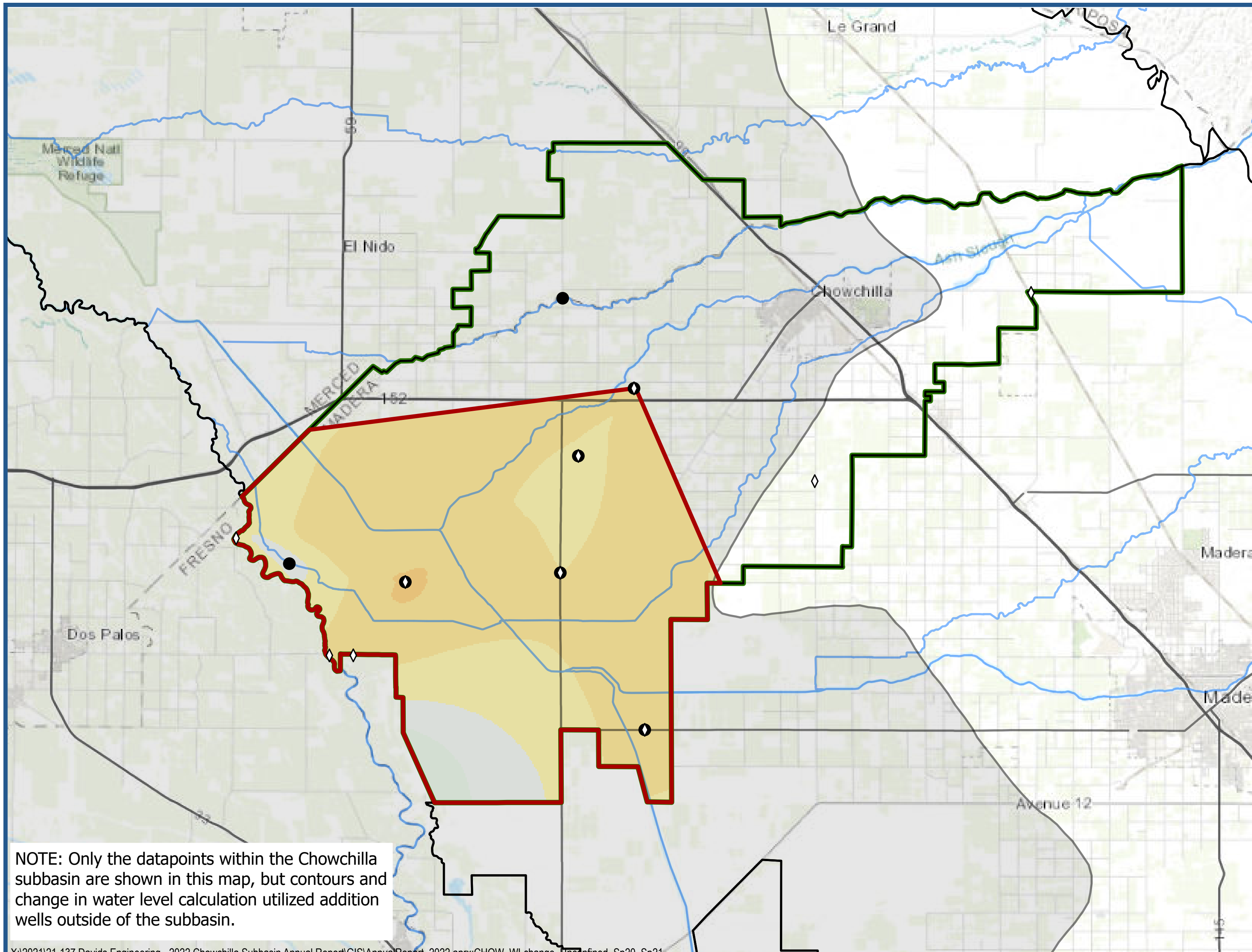
Change in Water Level in the Upper Aquifer/Undifferentiated Unconfined Zone - Spring 2019 through Spring 2020

Figure C-4

Chowchilla Subbasin
Groundwater Sustainability Plan 2024 Annual Report



NOTE: Only the datapoints within the Chowchilla subbasin are shown in this map, but contours and change in water level calculation utilized addition wells outside of the subbasin.

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Explanation

Observed Water Level Measurements

- ◊ Spring 2020
- ● Spring 2021

Change in Water Level (feet)

- ≤ -50
- -49 - -45
- -44 - -40
- -39 - -35
- -34 - -30
- -29 - -25
- -24 - -20
- -19 - -15
- -14 - -10
- -9 - -5
- -4 - 0
- 1 - 5
- 6 - 10
- 11 - 15
- 16 - 20
- 21 - 25
- 26 - 30
- 31 - 35
- 36 - 40
- 41 - 45
- 46 - 50
- > 50
- Corcoran Clay Extent
- Extent of Available Data
- Chowchilla Subbasin
- Other Subbasins

Data sources:
DWR - subbasin boundaries, GSA boundaries
Coordinate System:
NAD 1983 California (Teale) Albers

0 0.5 1 2 Miles

N

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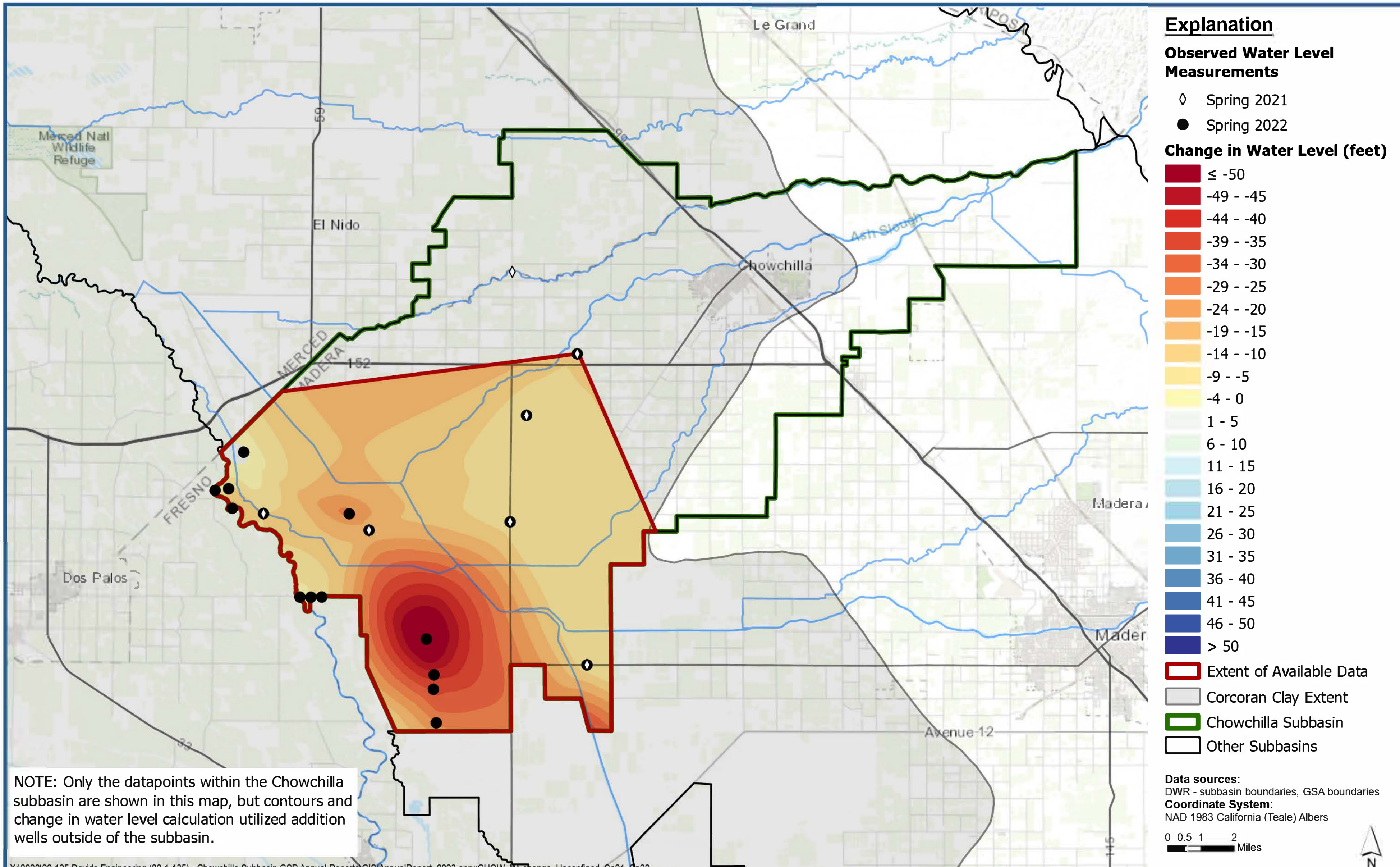
Change in Water Level in the Upper Aquifer/Undifferentiated Unconfined Zone - Spring 2020 through Spring 2021

Figure C-5

Chowchilla Subbasin
Groundwater Sustainability Plan 2024 Annual Report



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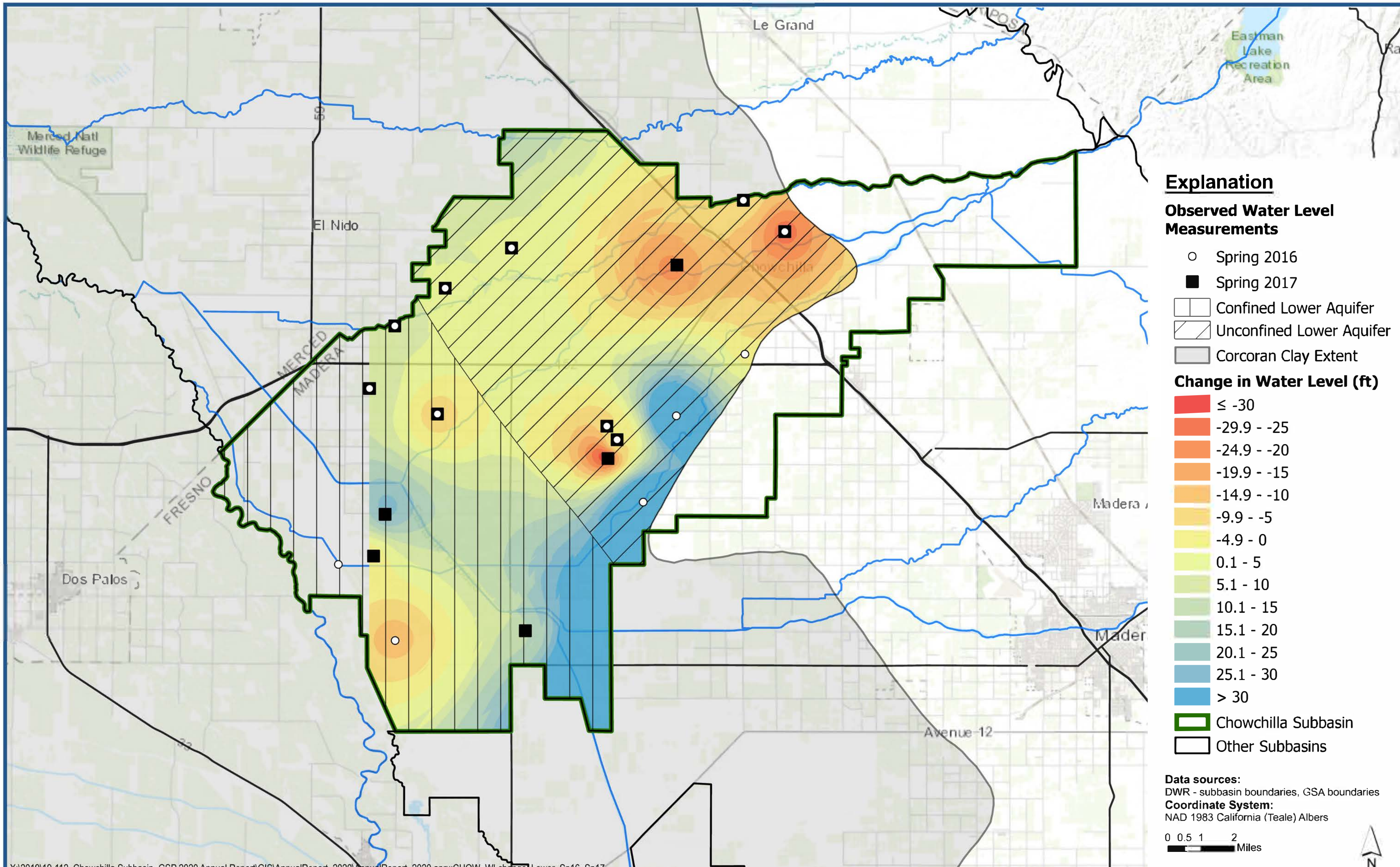
Change in Water Level in the Upper Aquifer/Undifferentiated Unconfined Zone - Spring 2021 through Spring 2022

Figure C-6

Chowchilla Subbasin
Groundwater Sustainability Plan 2024 Annual Report



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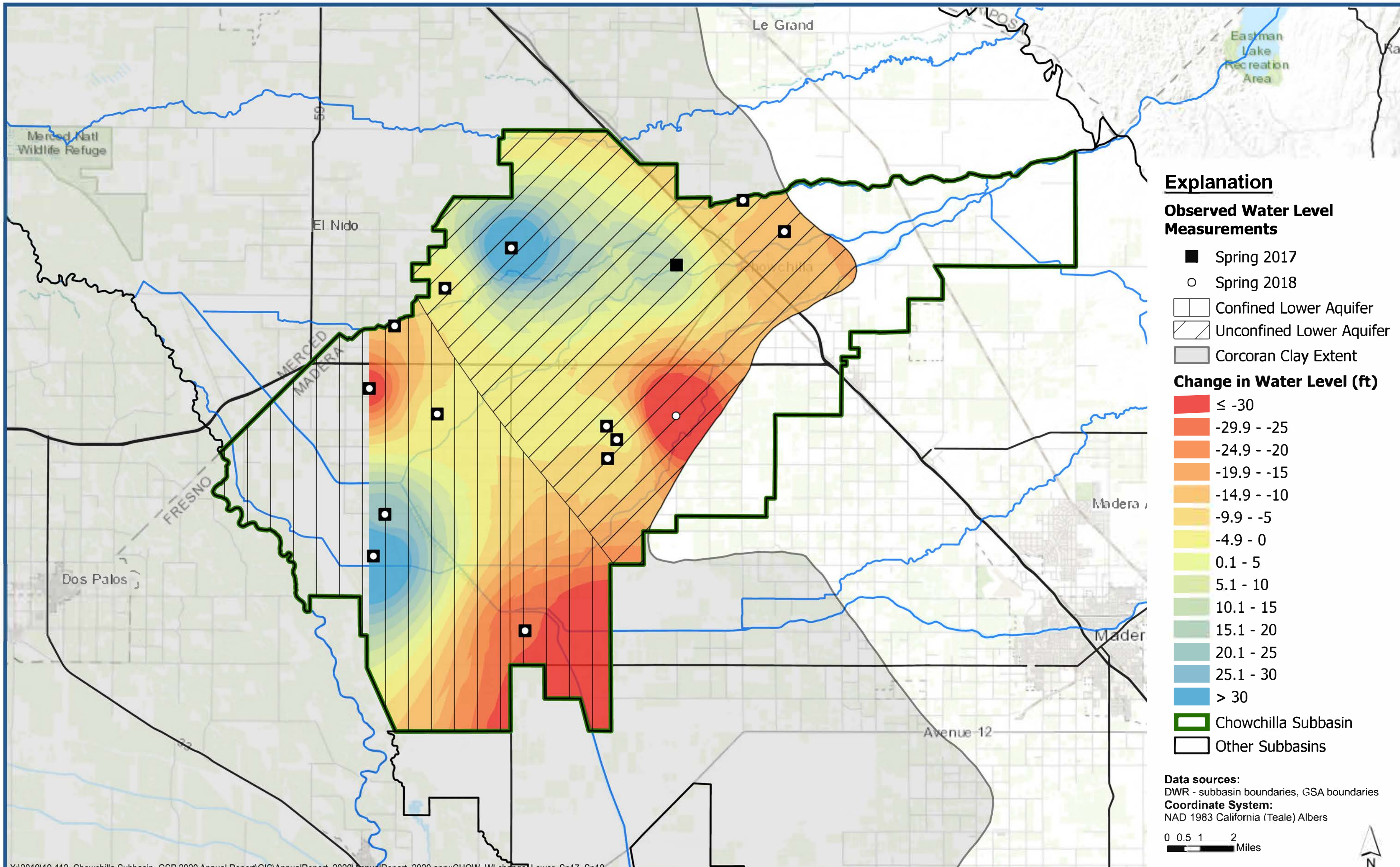
Change in Groundwater Level in the Lower Aquifer - Spring 2016 through Spring 2017

Chowchilla Subbasin
Groundwater Sustainability Plan 2024 Annual Report

Figure C-7



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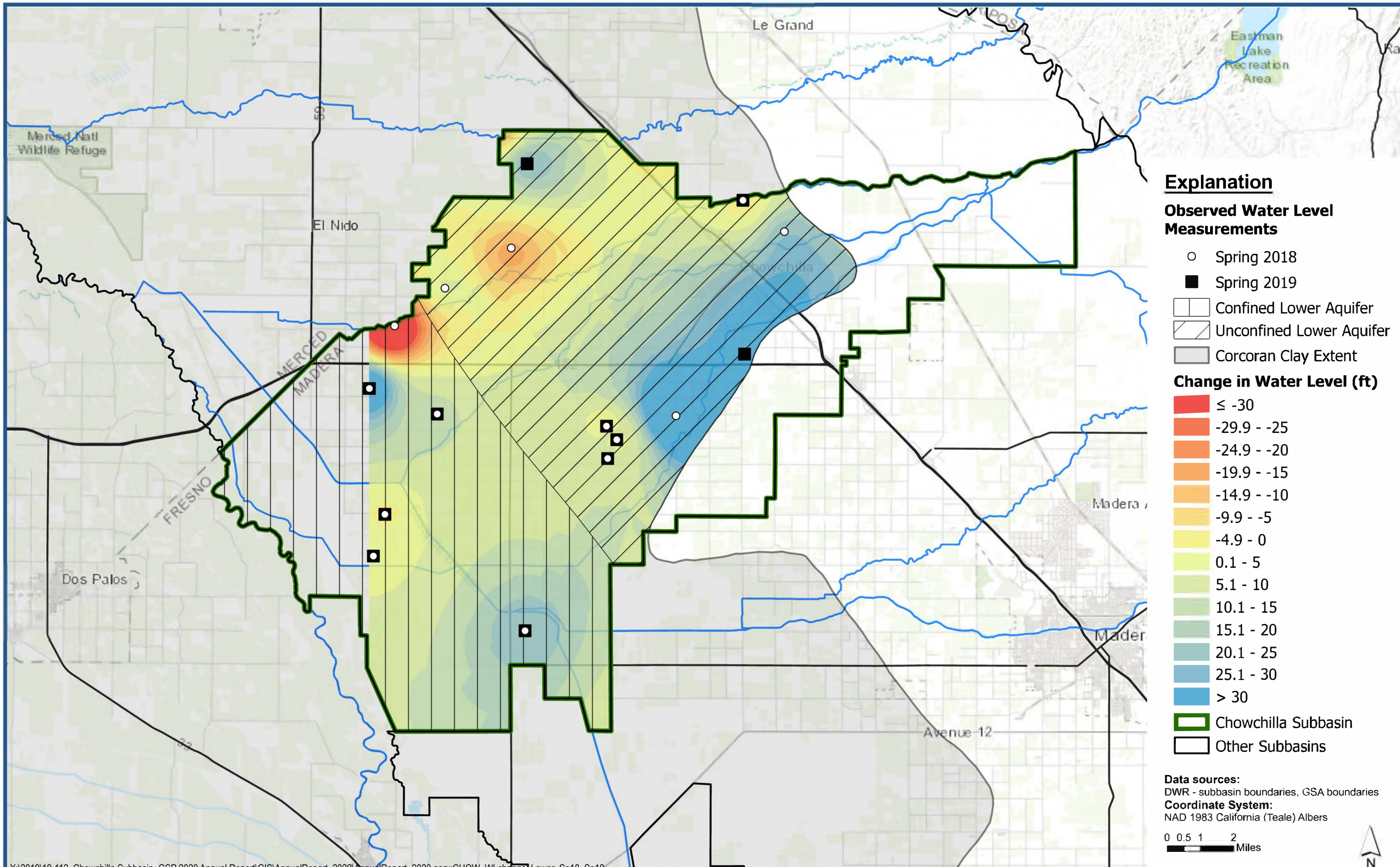
Change in Groundwater Level in the Lower Aquifer - Spring 2017 through Spring 2018

Chowchilla Subbasin
Groundwater Sustainability Plan 2024 Annual Report

Figure C-8



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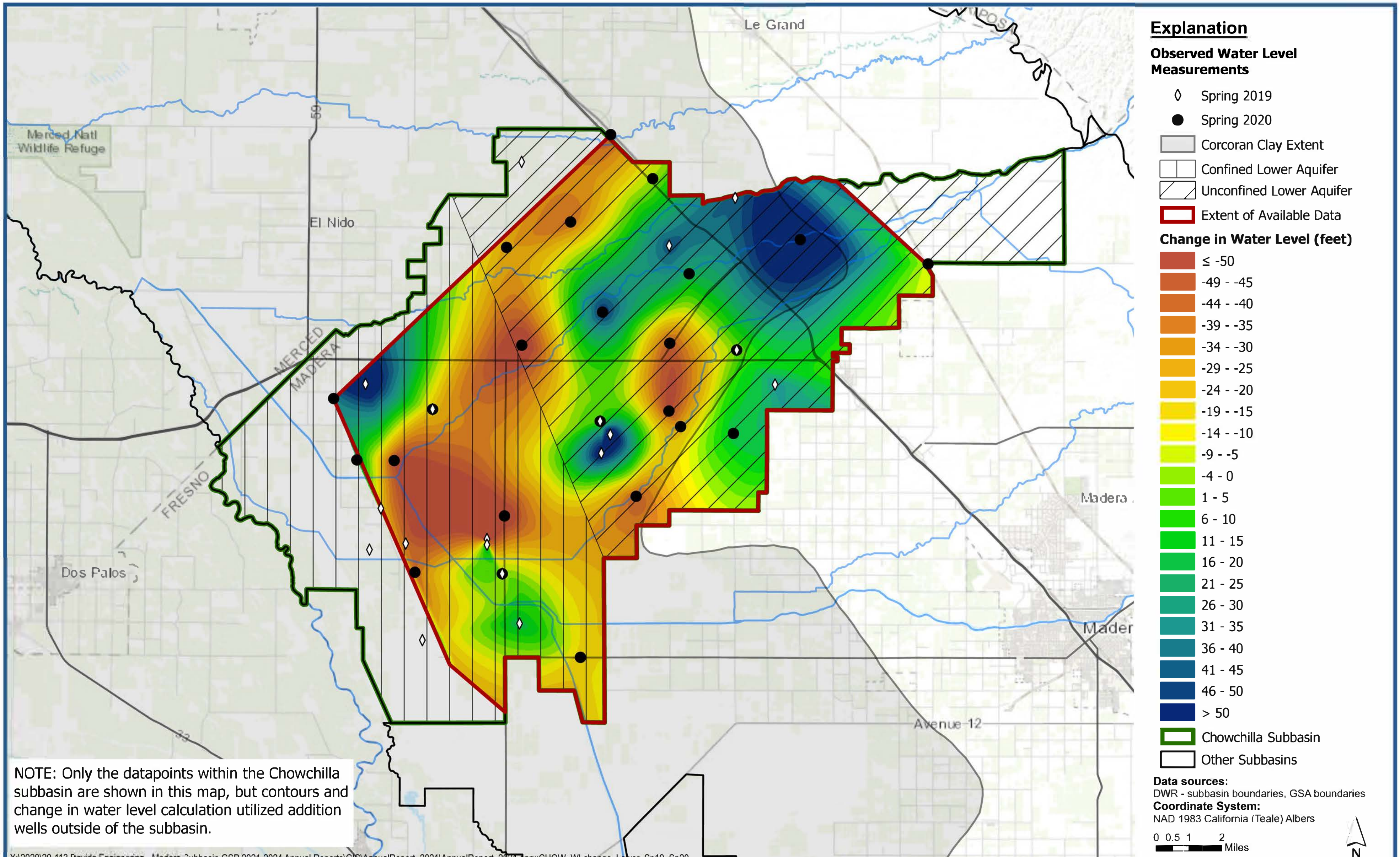
Change in Groundwater Level in the Lower Aquifer - Spring 2018 through Spring 2019

Chowchilla Subbasin
Groundwater Sustainability Plan 2024 Annual Report

Figure C-9



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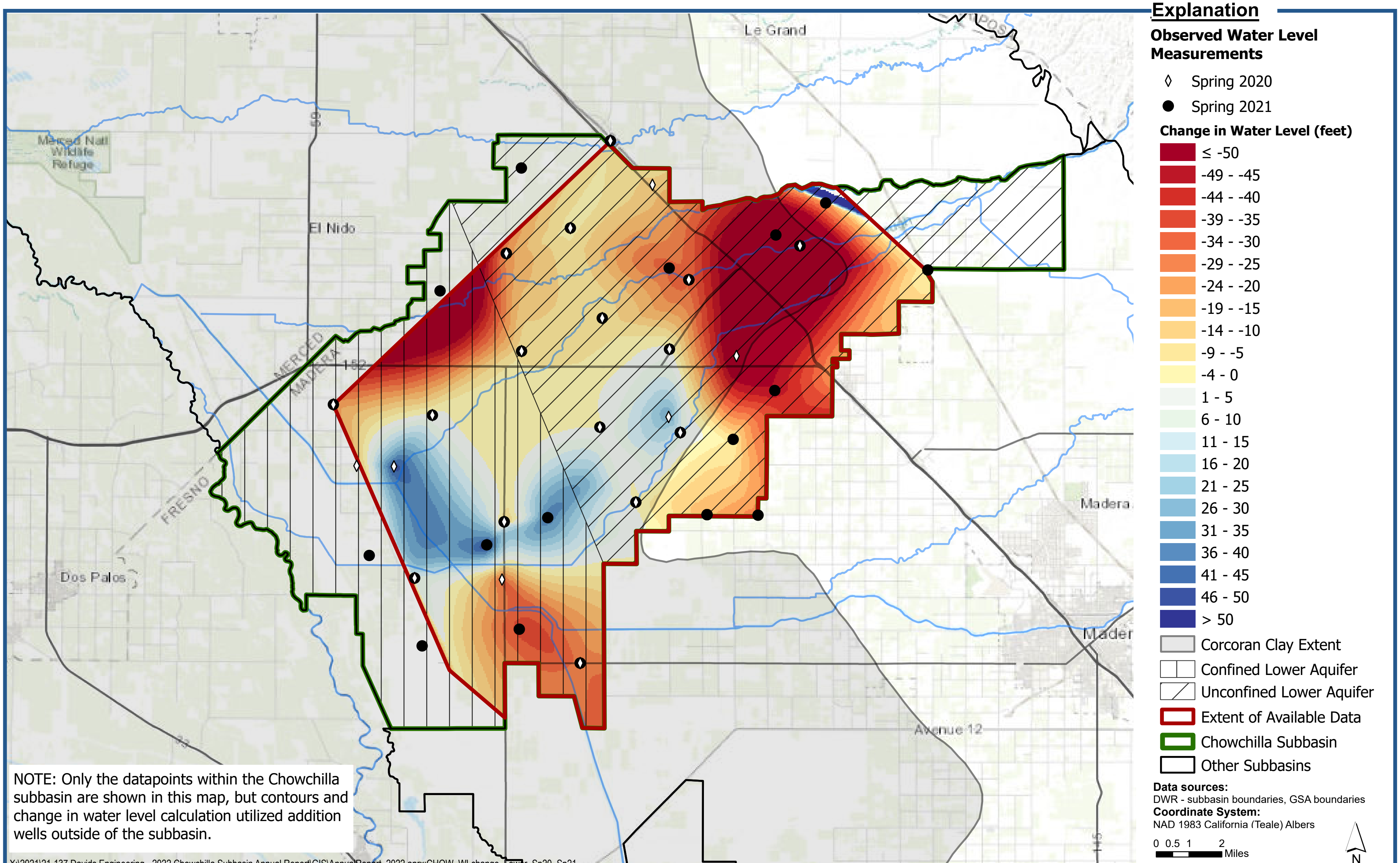
Change in Water Level in the Lower Aquifer - Spring 2019 through Spring 2020

Chowchilla Subbasin
Groundwater Sustainability Plan 2024 Annual Report

Figure C-10



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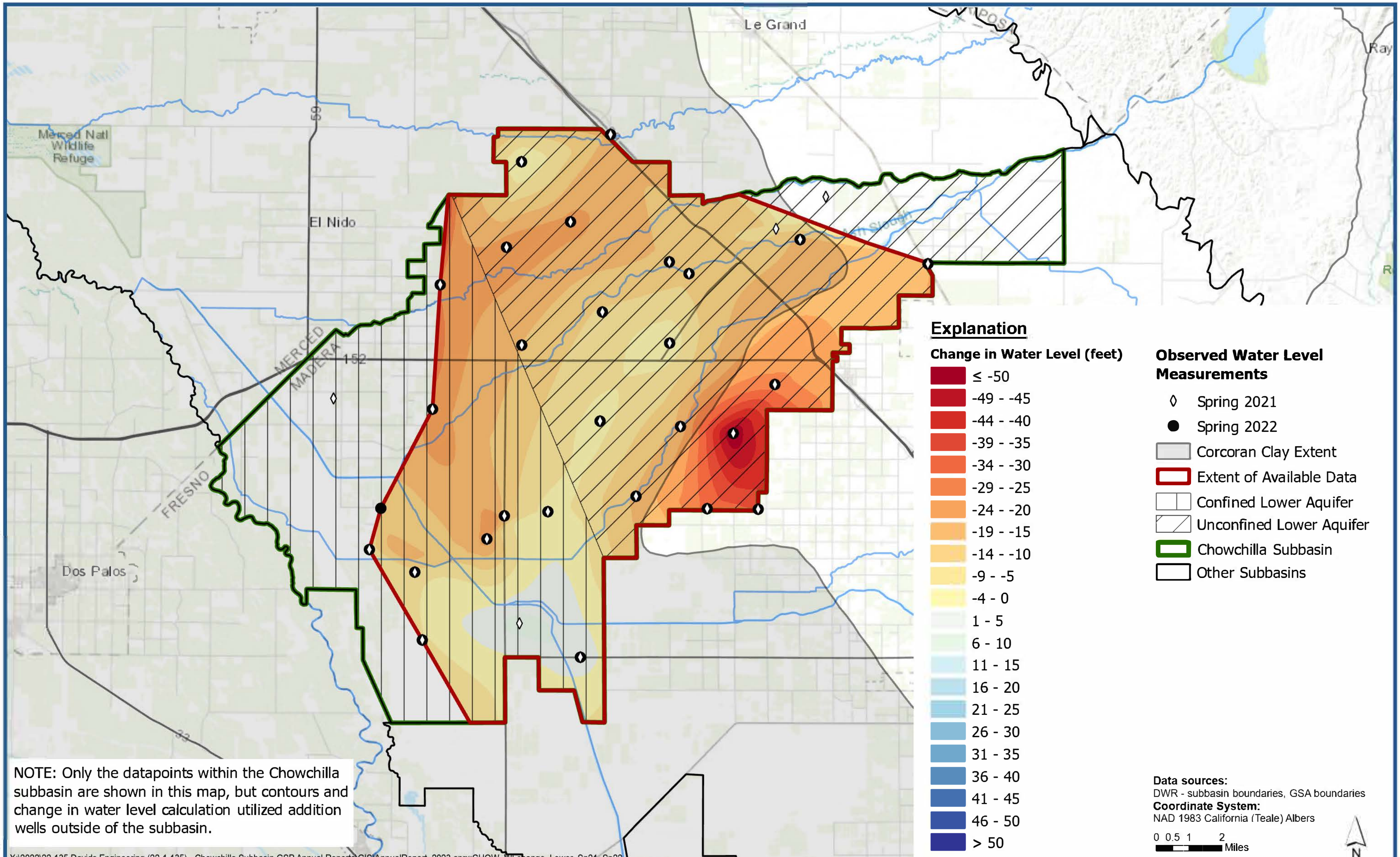
Change in Water Level in the Lower Aquifer - Spring 2020 through Spring 2021

Figure C-11

Chowchilla Subbasin
Groundwater Sustainability Plan 2024 Annual Report



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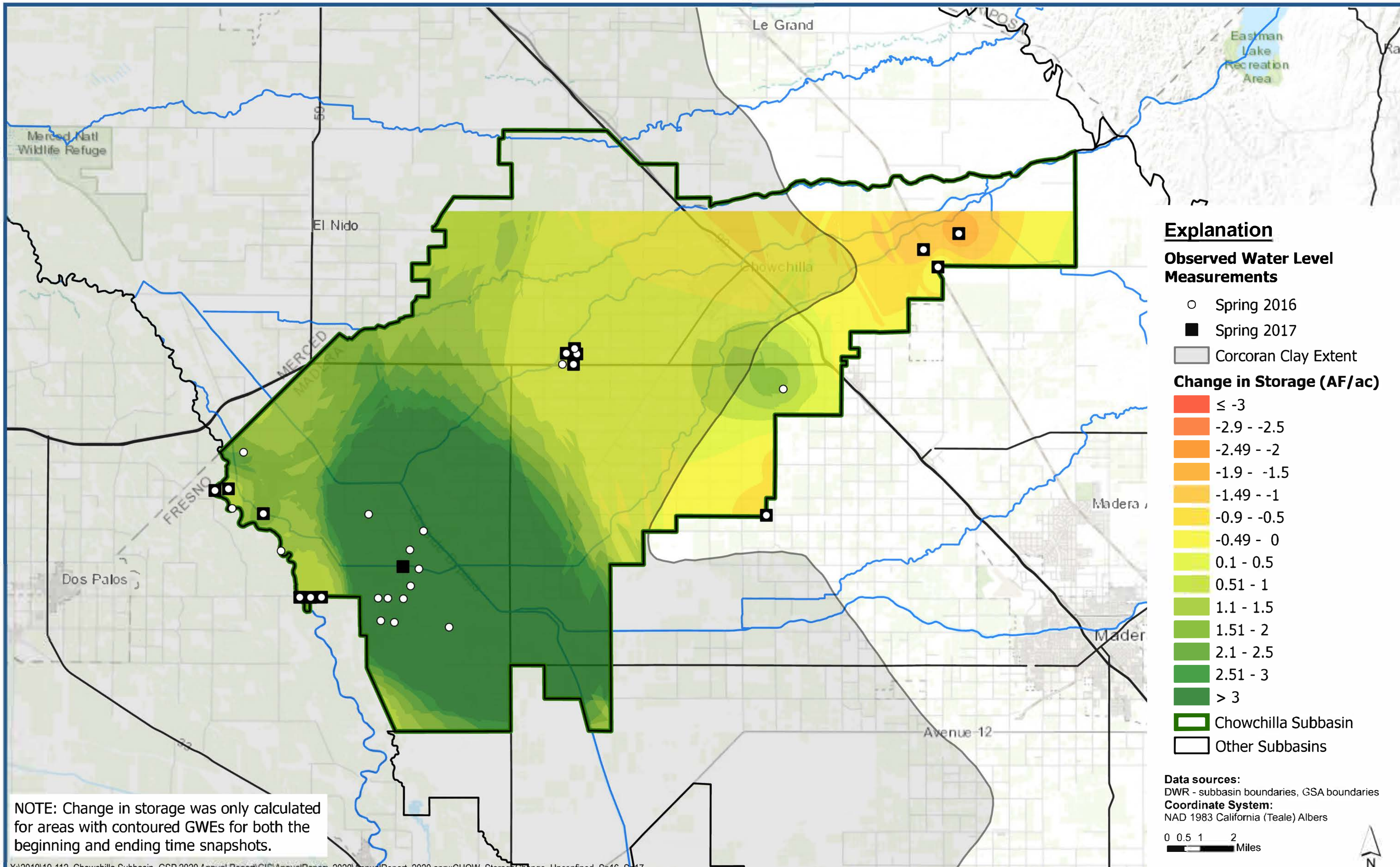
Change in Water Level in the Lower Aquifer - Spring 2021 through Spring 2022

Figure C-12

Chowchilla Subbasin
Groundwater Sustainability Plan 2024 Annual Report



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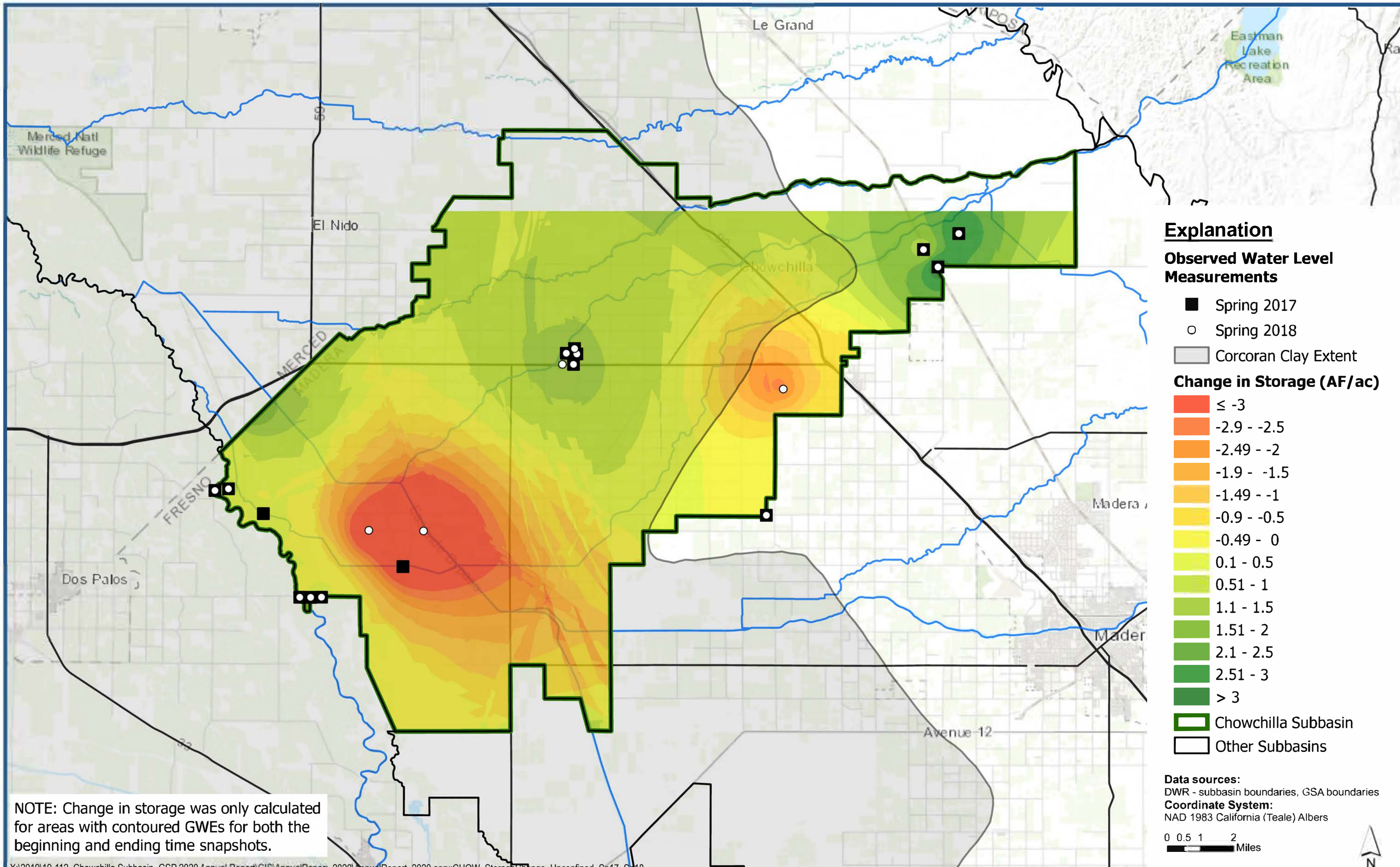
Change in Groundwater Storage in the Upper Aquifer/Undifferentiated Unconfined Zone - Spring 2016 through Spring 2017

Chowchilla Subbasin
Groundwater Sustainability Plan 2024 Annual Report

Figure C-13



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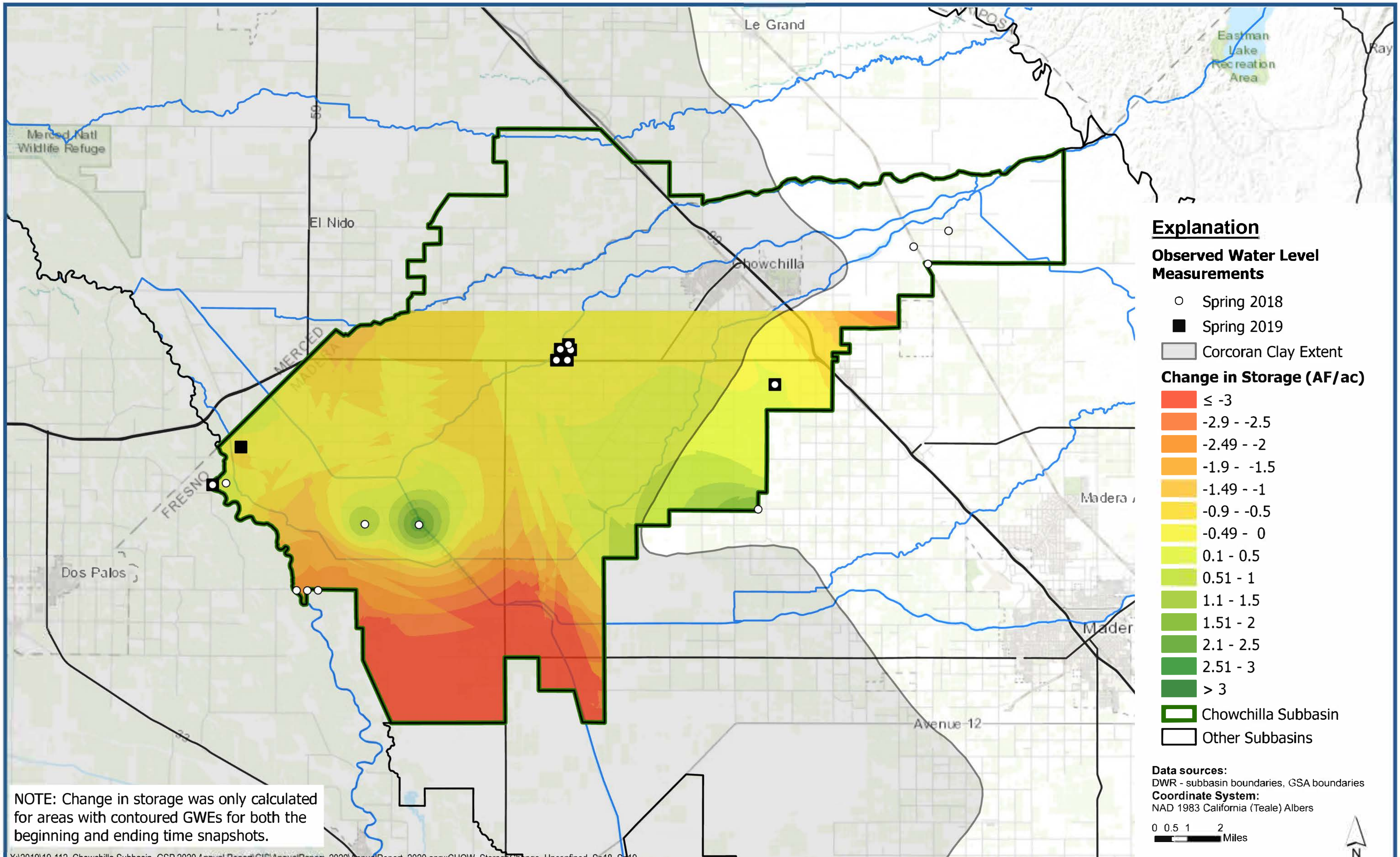
Change in Groundwater Storage in the Upper Aquifer/Undifferentiated Unconfined Zone - Spring 2017 through Spring 2018

Figure C-14

Chowchilla Subbasin
Groundwater Sustainability Plan 2024 Annual Report



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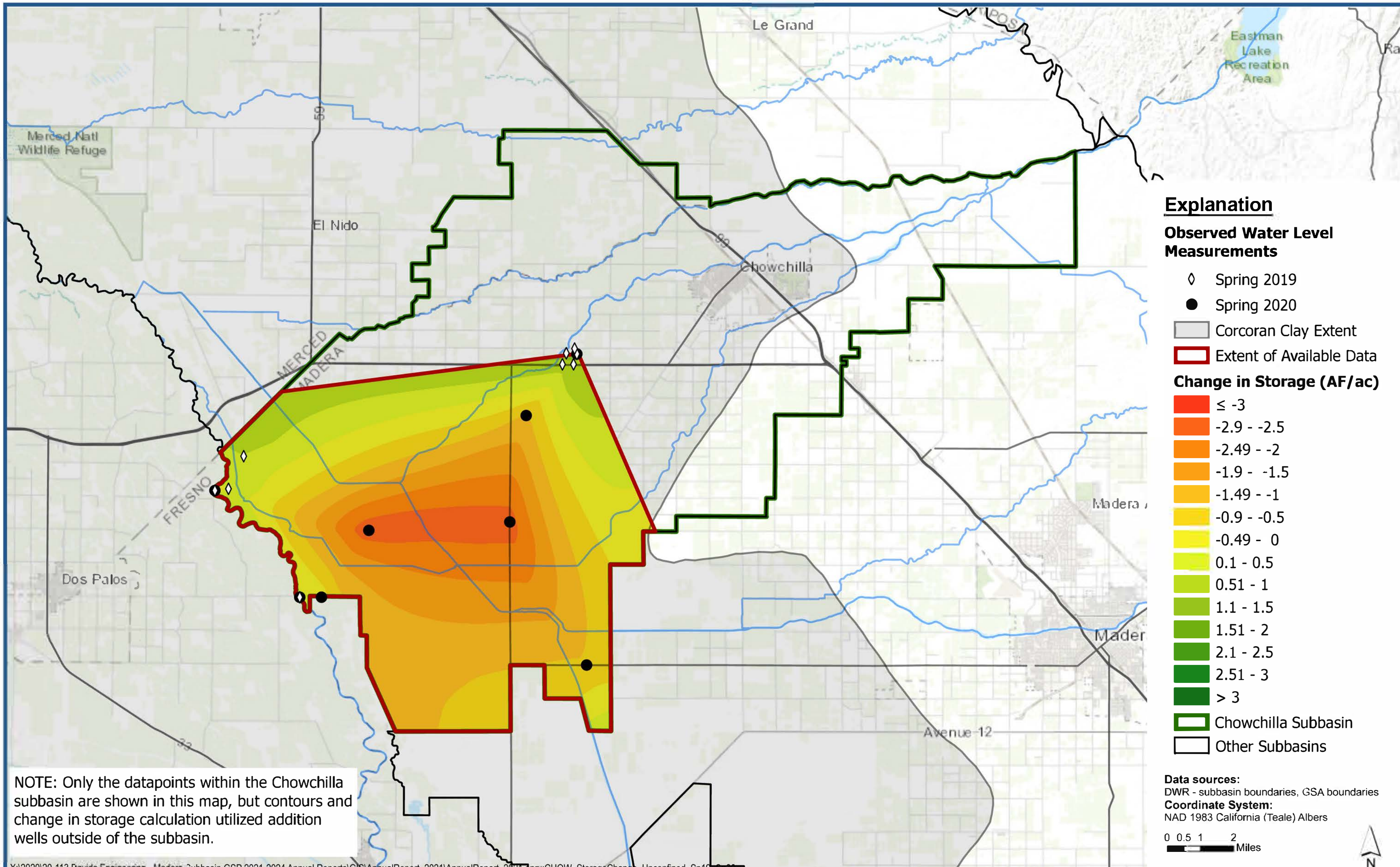
Change in Groundwater Storage in the Upper Aquifer/Undifferentiated Unconfined Zone - Spring 2018 through Spring 2019

Figure C-15

Chowchilla Subbasin
Groundwater Sustainability Plan 2024 Annual Report



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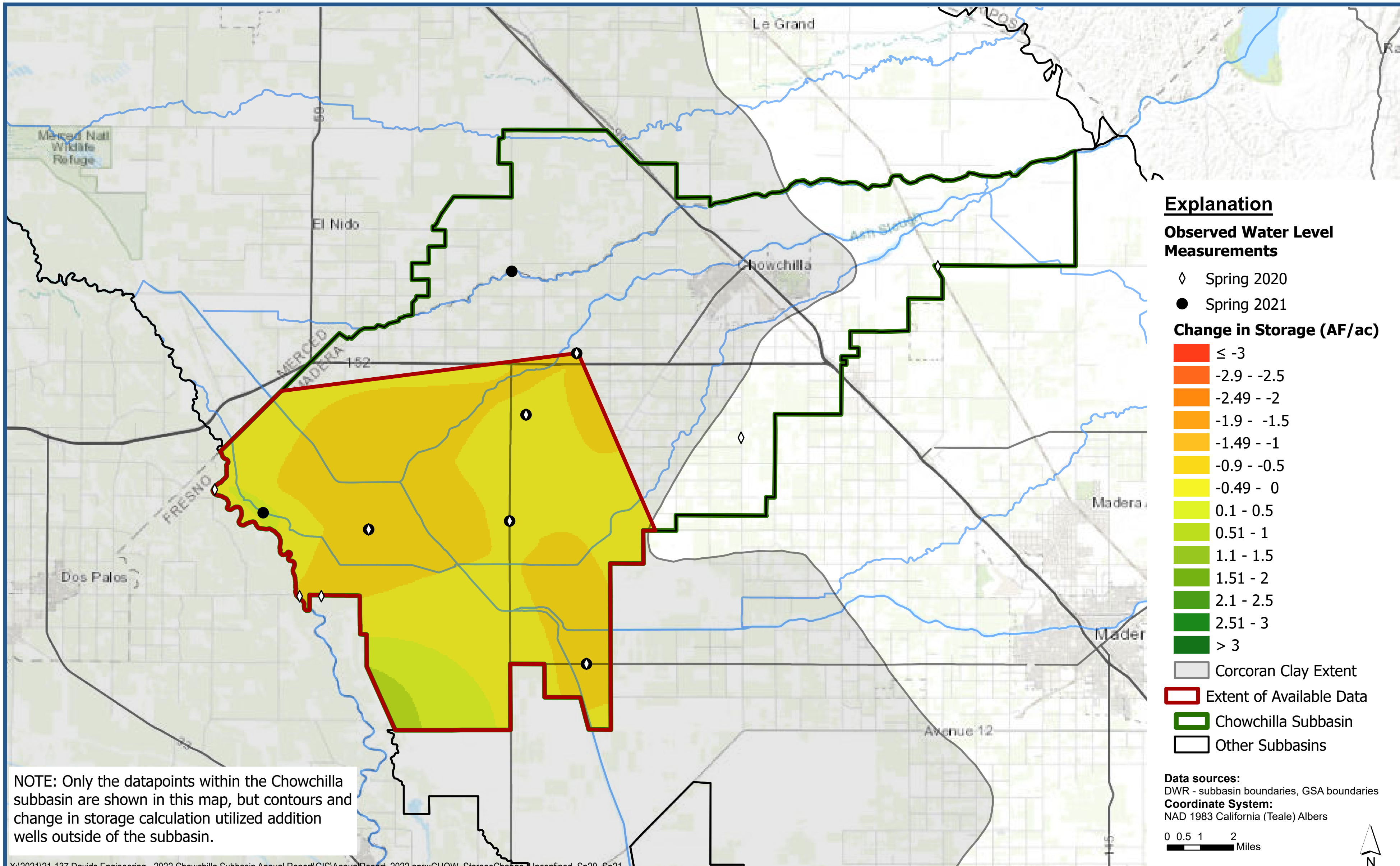
Change in Groundwater Storage in the Upper Aquifer/ Undifferentiated Unconfined Zone - Spring 2019 through Spring 2020

Chowchilla Subbasin
Groundwater Sustainability Plan 2024 Annual Report

Figure C-16



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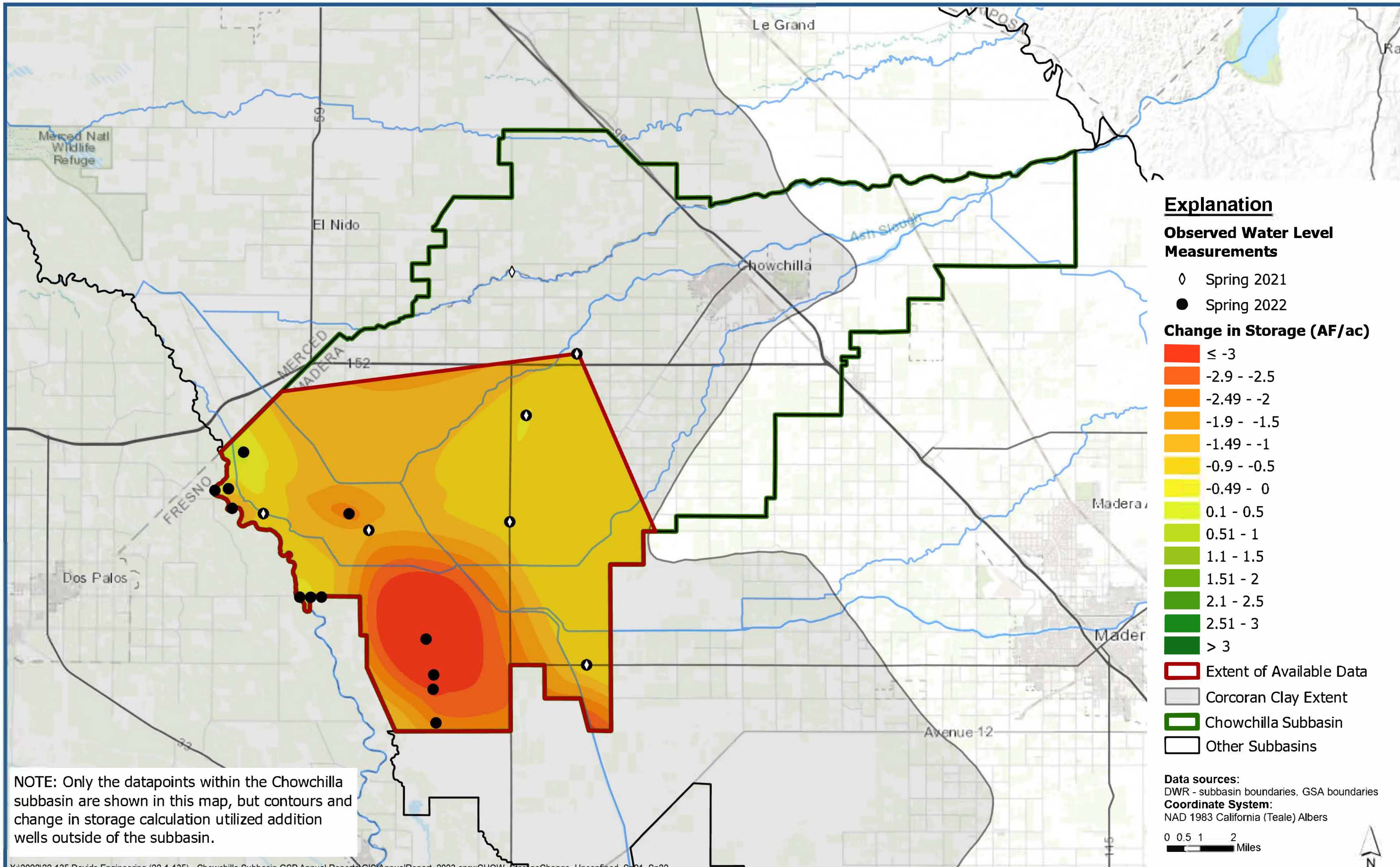
Change in Groundwater Storage in the Upper Aquifer/ Undifferentiated Unconfined Zone - Spring 2020 through Spring 2021

Figure C-17

Chowchilla Subbasin
Groundwater Sustainability Plan 2024 Annual Report



DAVIDS ENGINEERING, INC

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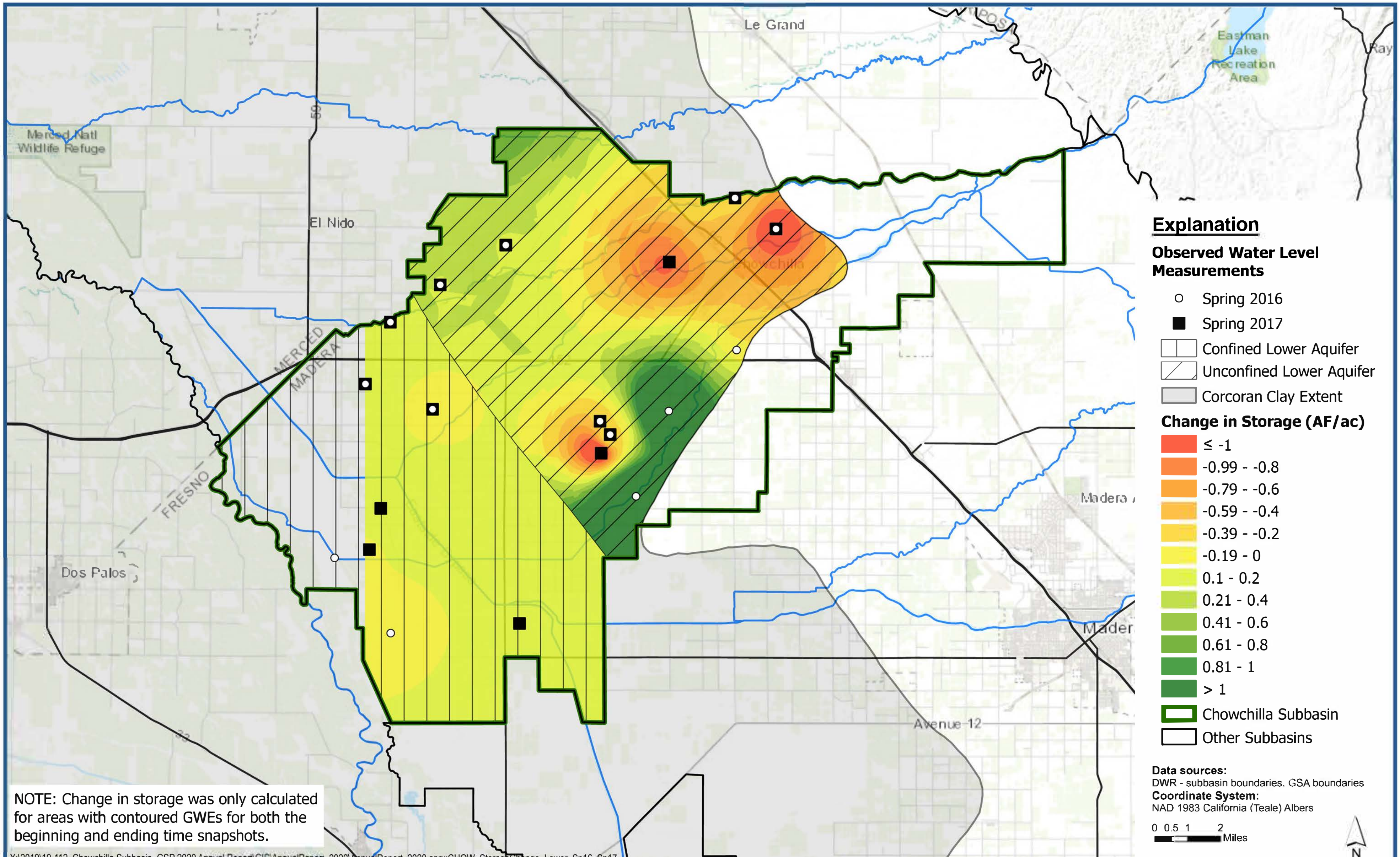
Change in Groundwater Storage in the Upper Aquifer/ Undifferentiated Unconfined Zone - Spring 2021 through Spring 2022

Chowchilla Subbasin
Groundwater Sustainability Plan 2024 Annual Report

Figure C-18



Change in Groundwater Storage in the Lower Aquifer - Spring 2016 through Spring 2017

Chowchilla Subbasin
Groundwater Sustainability Plan 2024 Annual Report

Figure C-19

DAVIDS ENGINEERING, INC
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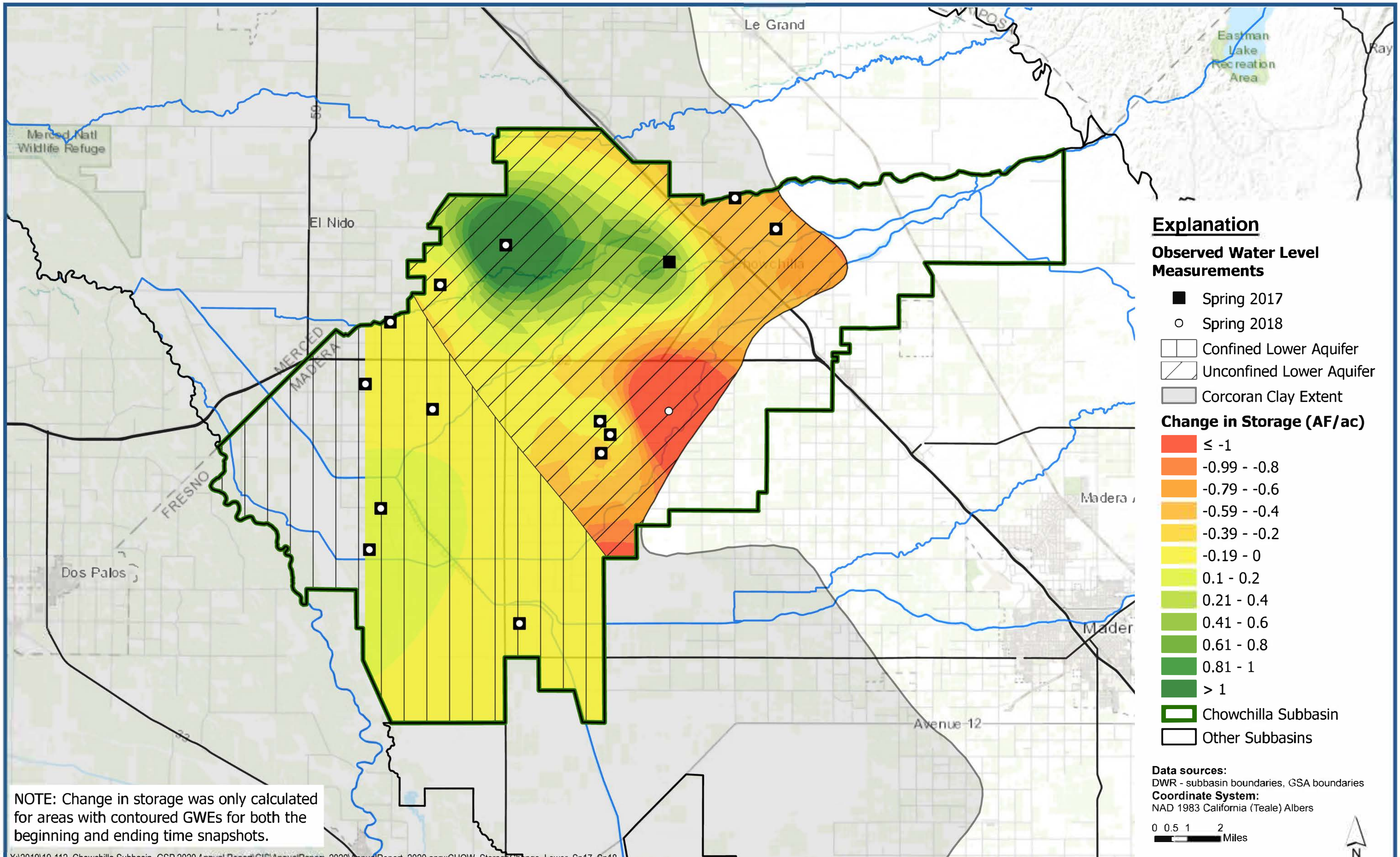

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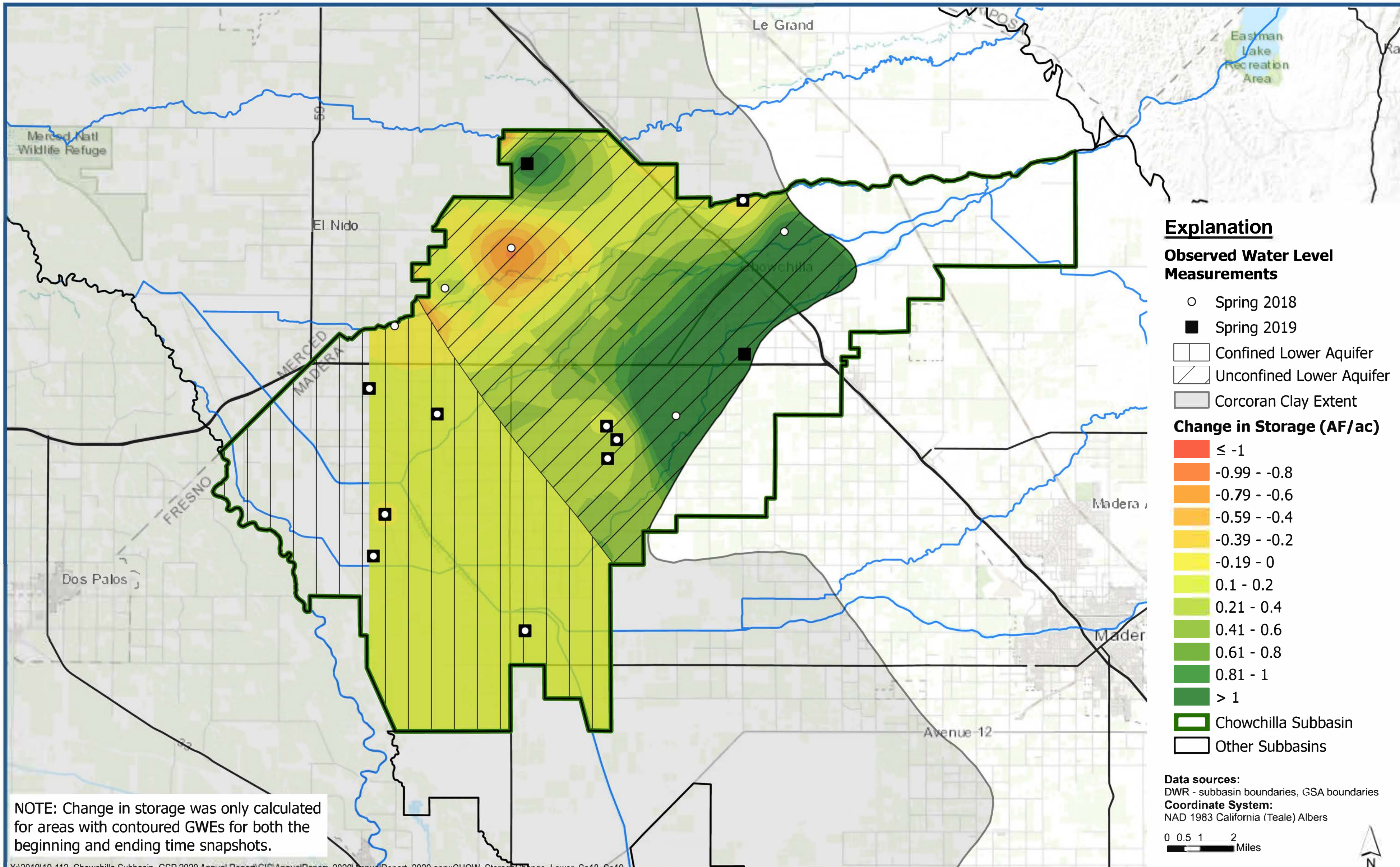
Change in Groundwater Storage in the Lower Aquifer - Spring 2017 through Spring 2018

Chowchilla Subbasin
Groundwater Sustainability Plan 2024 Annual Report

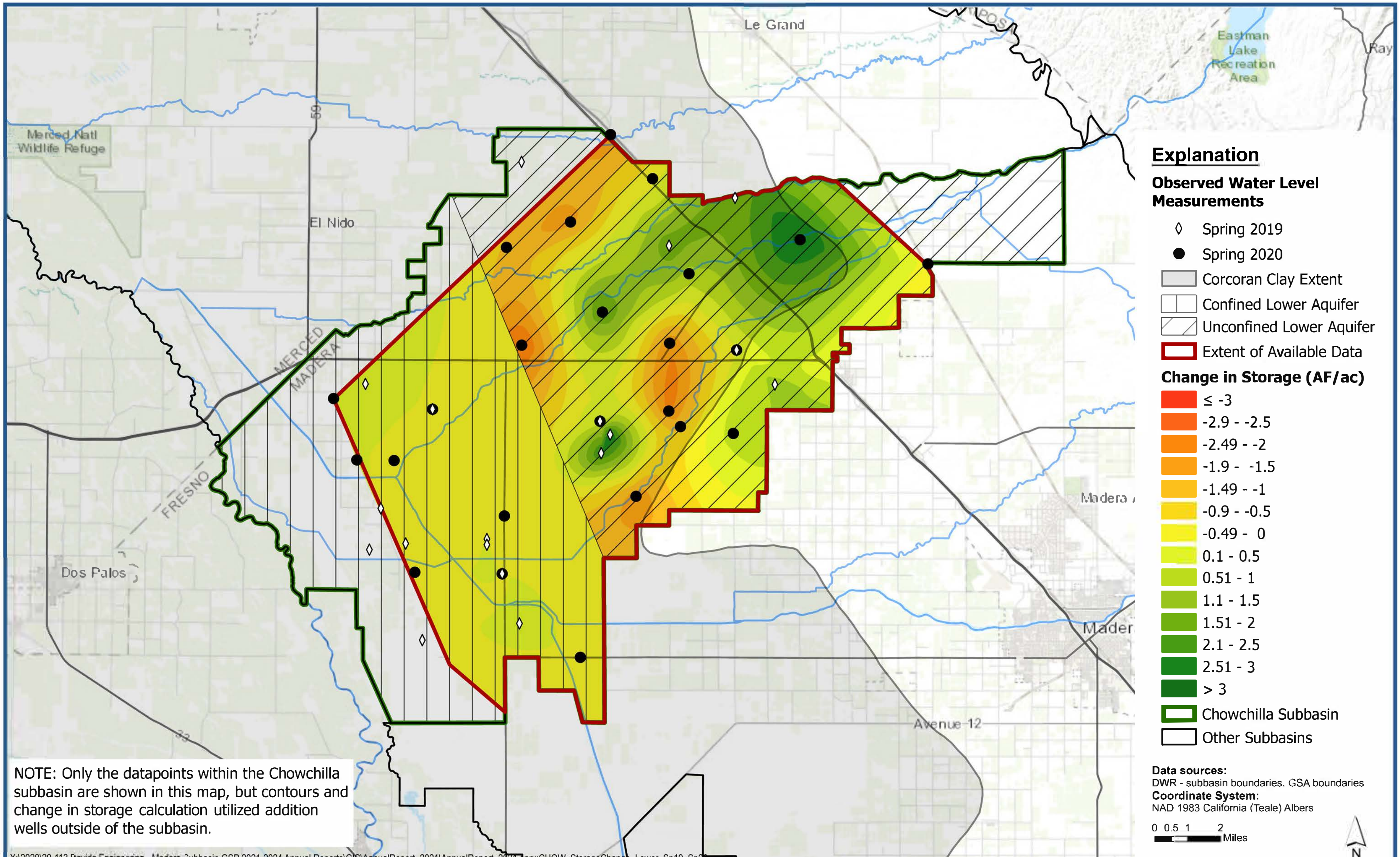
Figure C-20



Change in Groundwater Storage in the Lower Aquifer - Spring 2018 through Spring 2019

Chowchilla Subbasin
Groundwater Sustainability Plan 2024 Annual Report

Figure C-21



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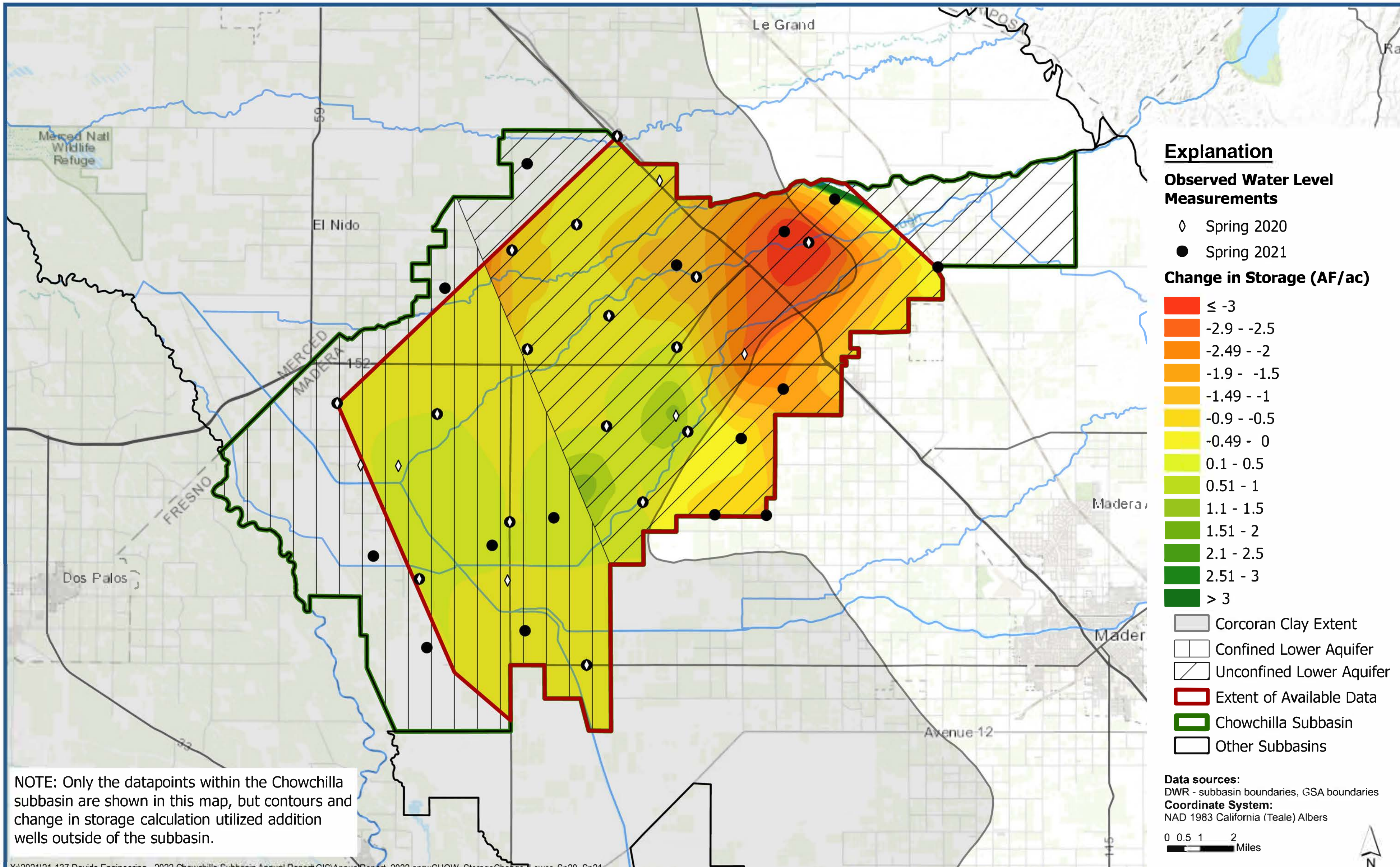
Change in Groundwater Storage in the Lower Aquifer - Spring 2019 through Spring 2020

Figure C-22

Chowchilla Subbasin
Groundwater Sustainability Plan 2024 Annual Report



DAVIDS ENGINEERING, INC

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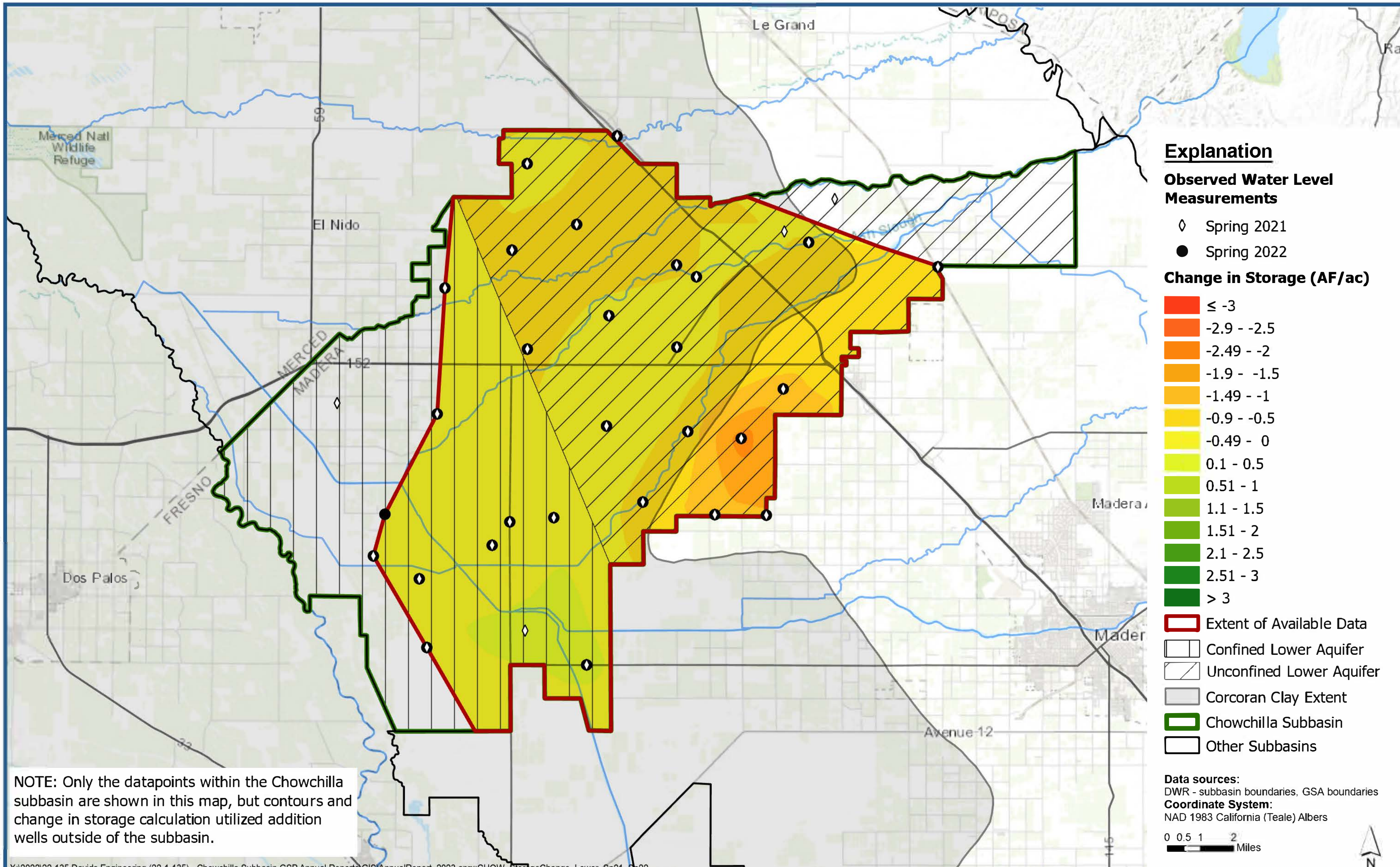
Change in Groundwater Storage in the Lower Aquifer - Spring 2020 through Spring 2021

Chowchilla Subbasin
Groundwater Sustainability Plan 2024 Annual Report

Figure C-23



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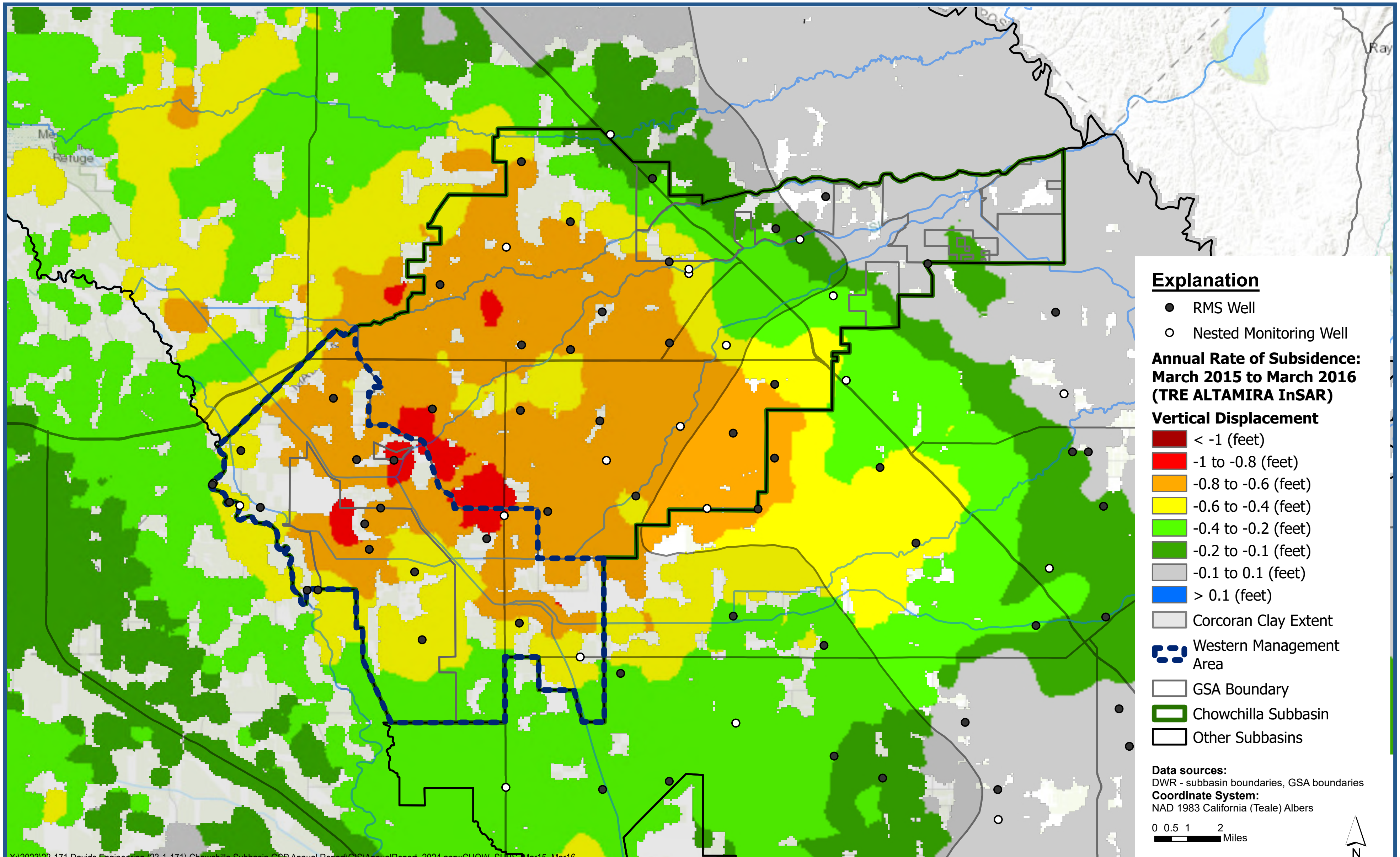
Change in Groundwater Storage in the Lower Aquifer - Spring 2021 through Spring 2022

Figure C-24

Chowchilla Subbasin
Groundwater Sustainability Plan 2024 Annual Report

Appendix D. Maps of Annual and Cumulative Subsidence in 2015 through 2023.



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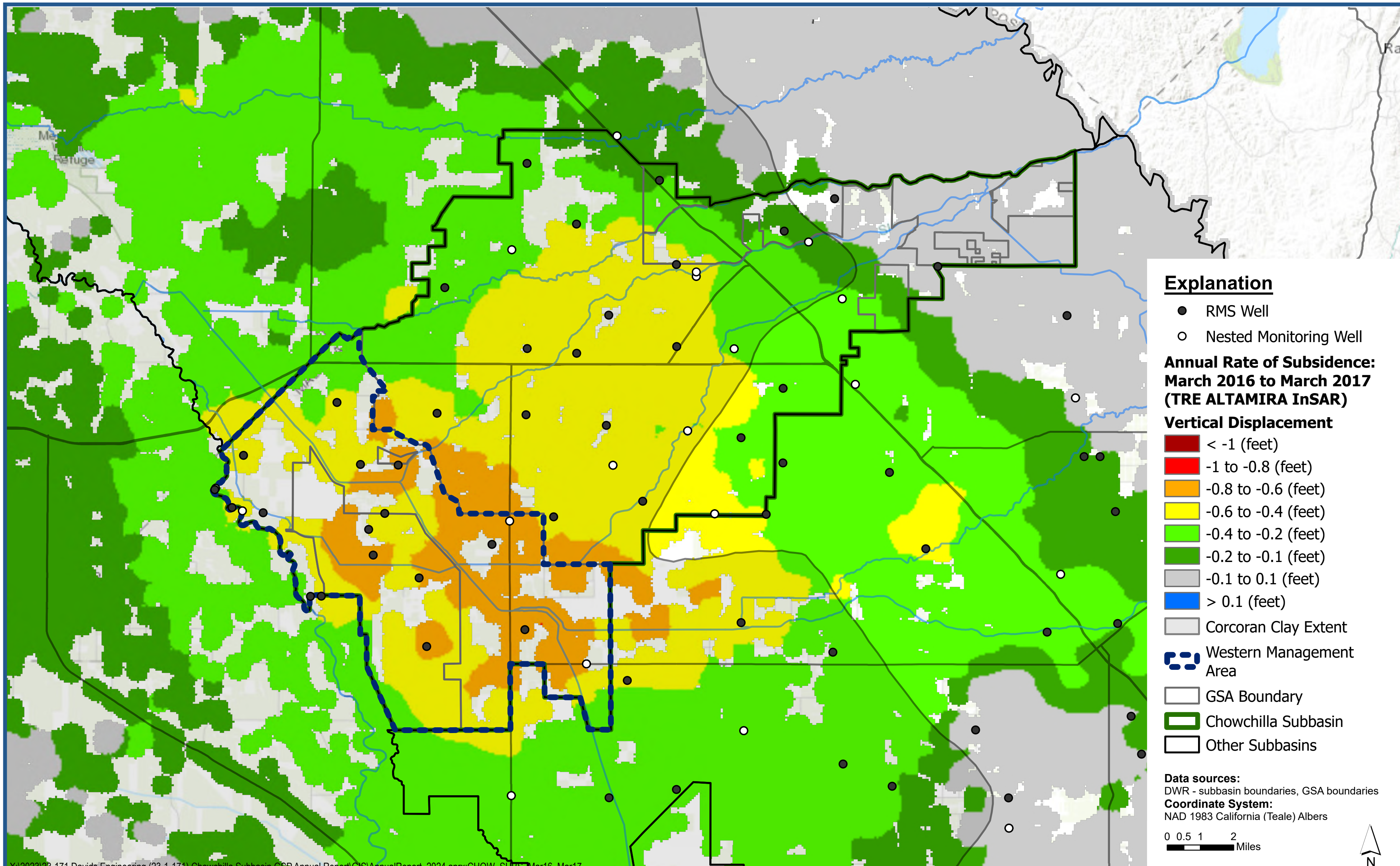
Annual Rate of Subsidence: March 2015 to March 2016 (TRE ALTAMIRA InSAR)

Chowchilla Subbasin
Groundwater Sustainability Plan 2024 Annual Report

Figure D-1



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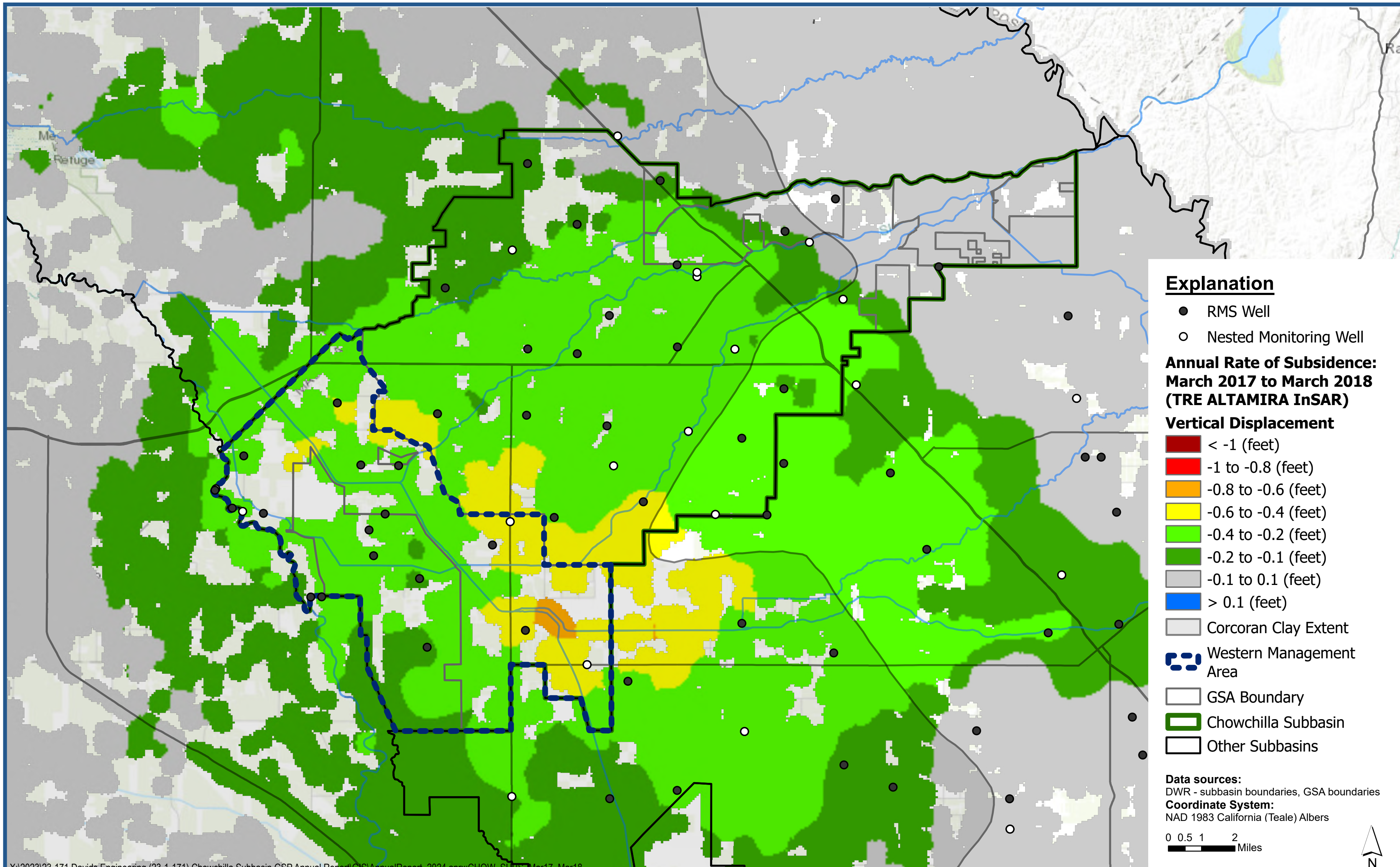
Annual Rate of Subsidence: March 2016 to March 2017 (TRE ALTAMIRA InSAR)

Chowchilla Subbasin
Groundwater Sustainability Plan 2024 Annual Report

Figure D-2



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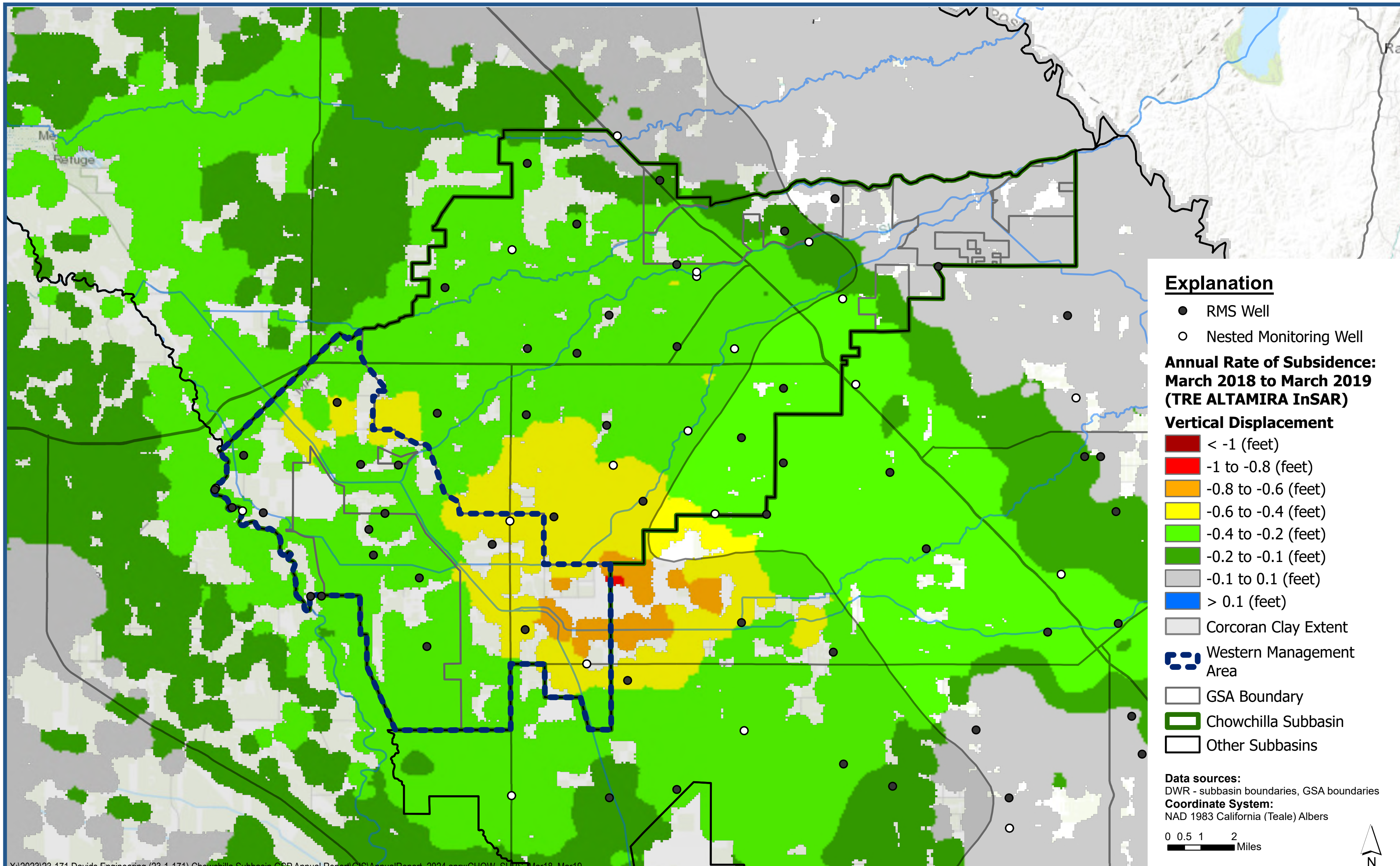
Annual Rate of Subsidence: March 2017 to March 2018 (TRE ALTAMIRA InSAR)

Chowchilla Subbasin
Groundwater Sustainability Plan 2024 Annual Report

Figure D-3



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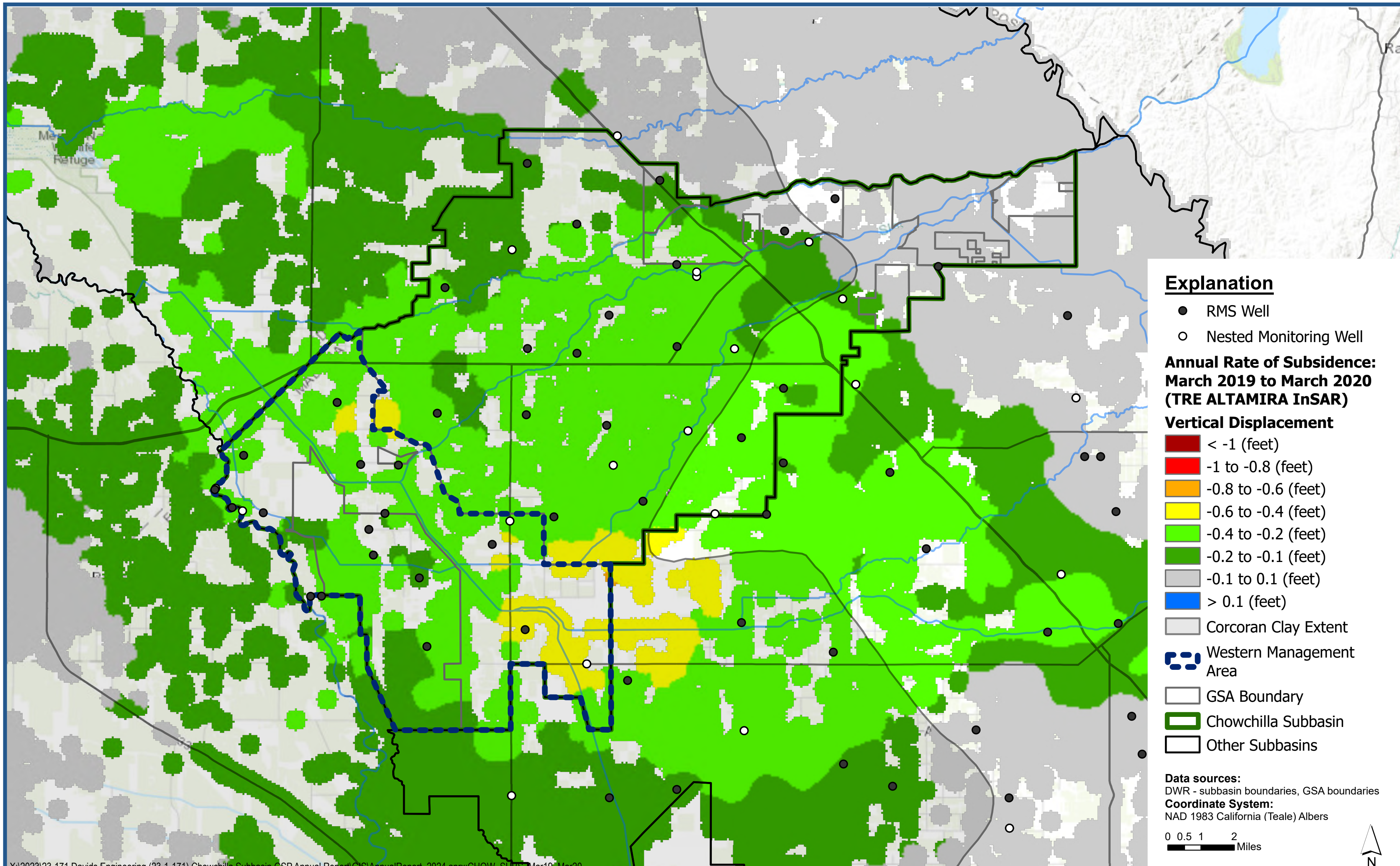
Annual Rate of Subsidence: March 2018 to March 2019 (TRE ALTAMIRA InSAR)

Chowchilla Subbasin
Groundwater Sustainability Plan 2024 Annual Report

Figure D-4



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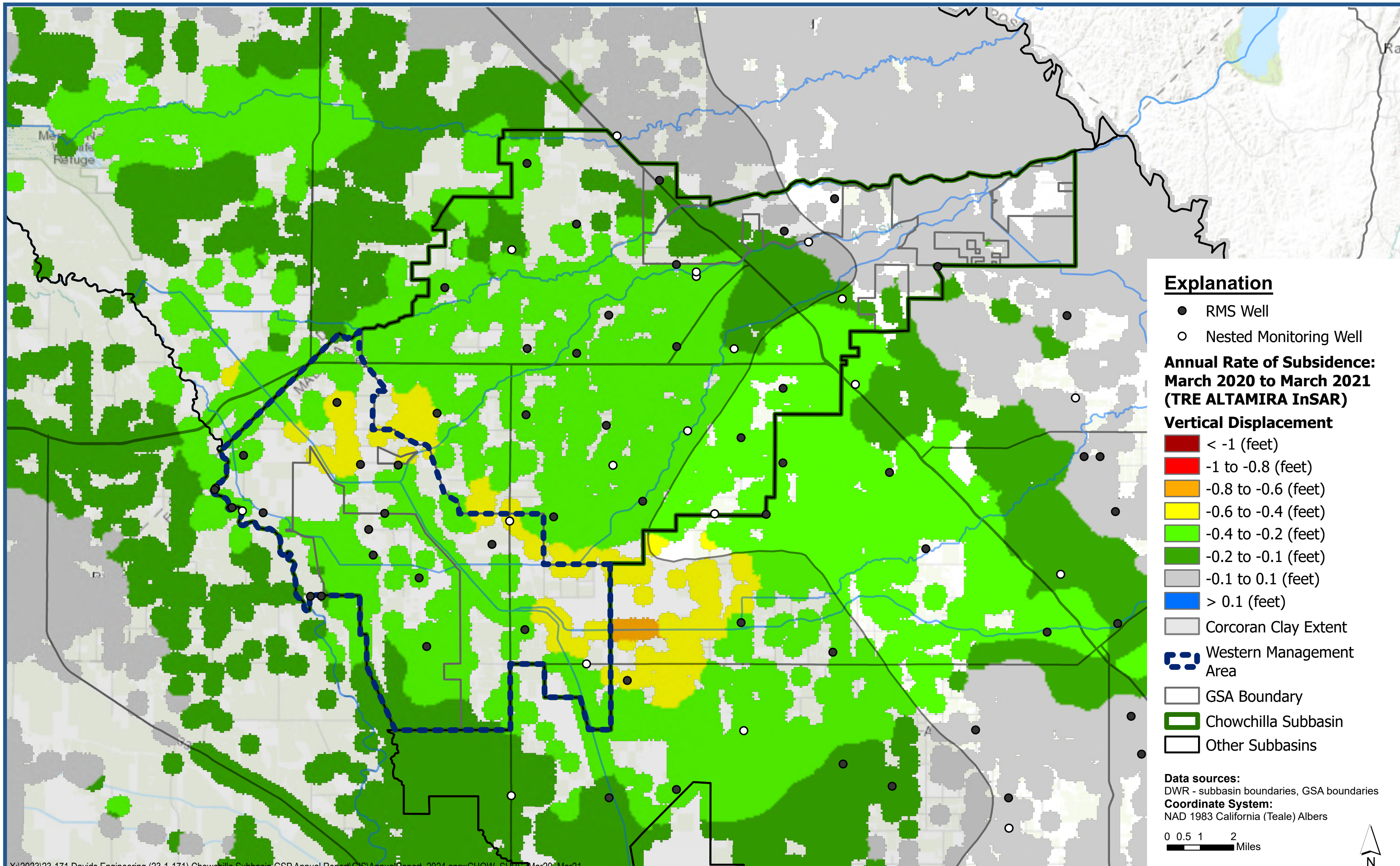
Annual Rate of Subsidence: March 2019 to March 2020 (TRE ALTAMIRA InSAR)

Chowchilla Subbasin
Groundwater Sustainability Plan 2024 Annual Report

Figure D-5



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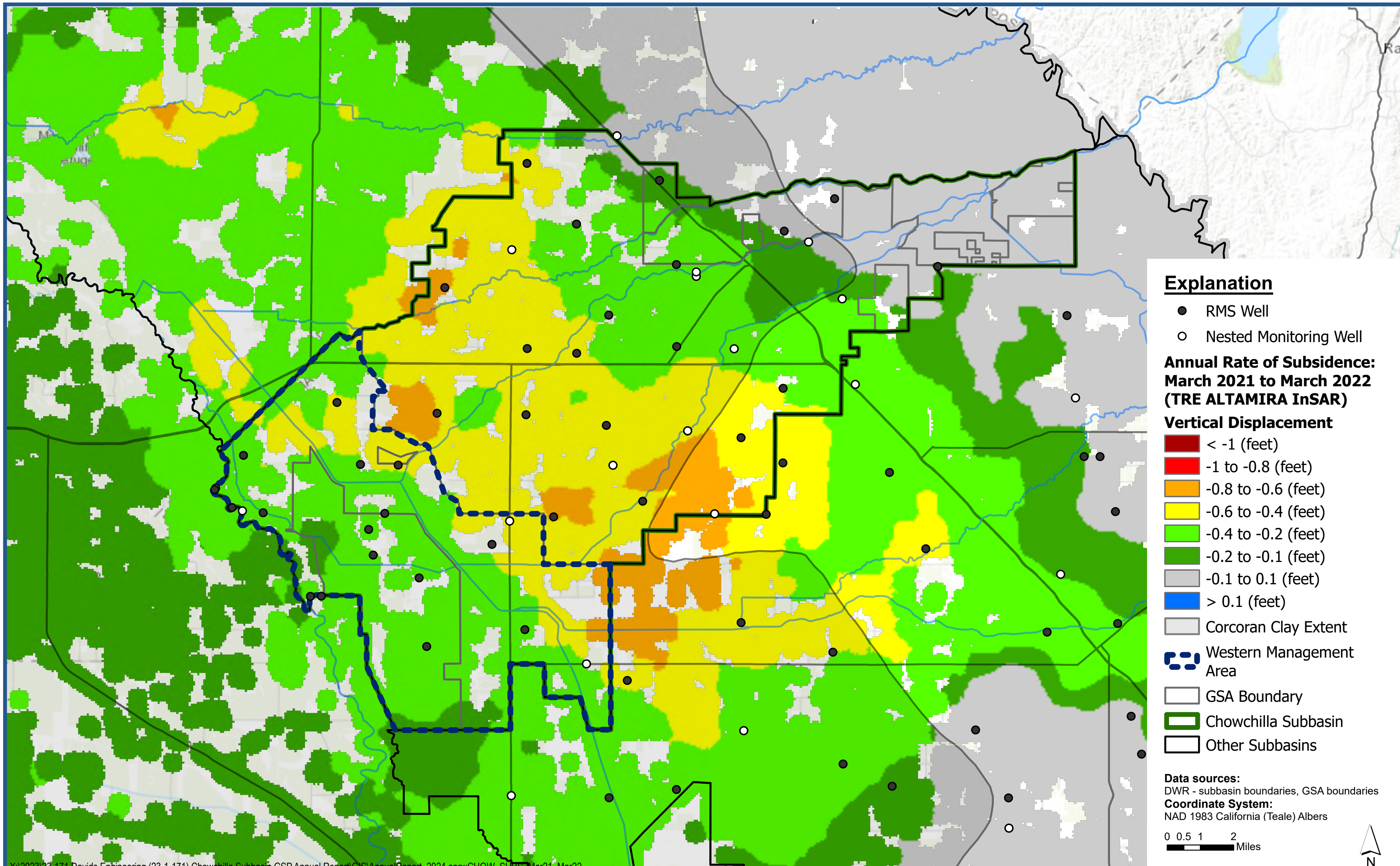
Annual Rate of Subsidence: March 2020 to March 2021 (TRE ALTAMIRA InSAR)

Chowchilla Subbasin
Groundwater Sustainability Plan 2024 Annual Report

Figure D-6



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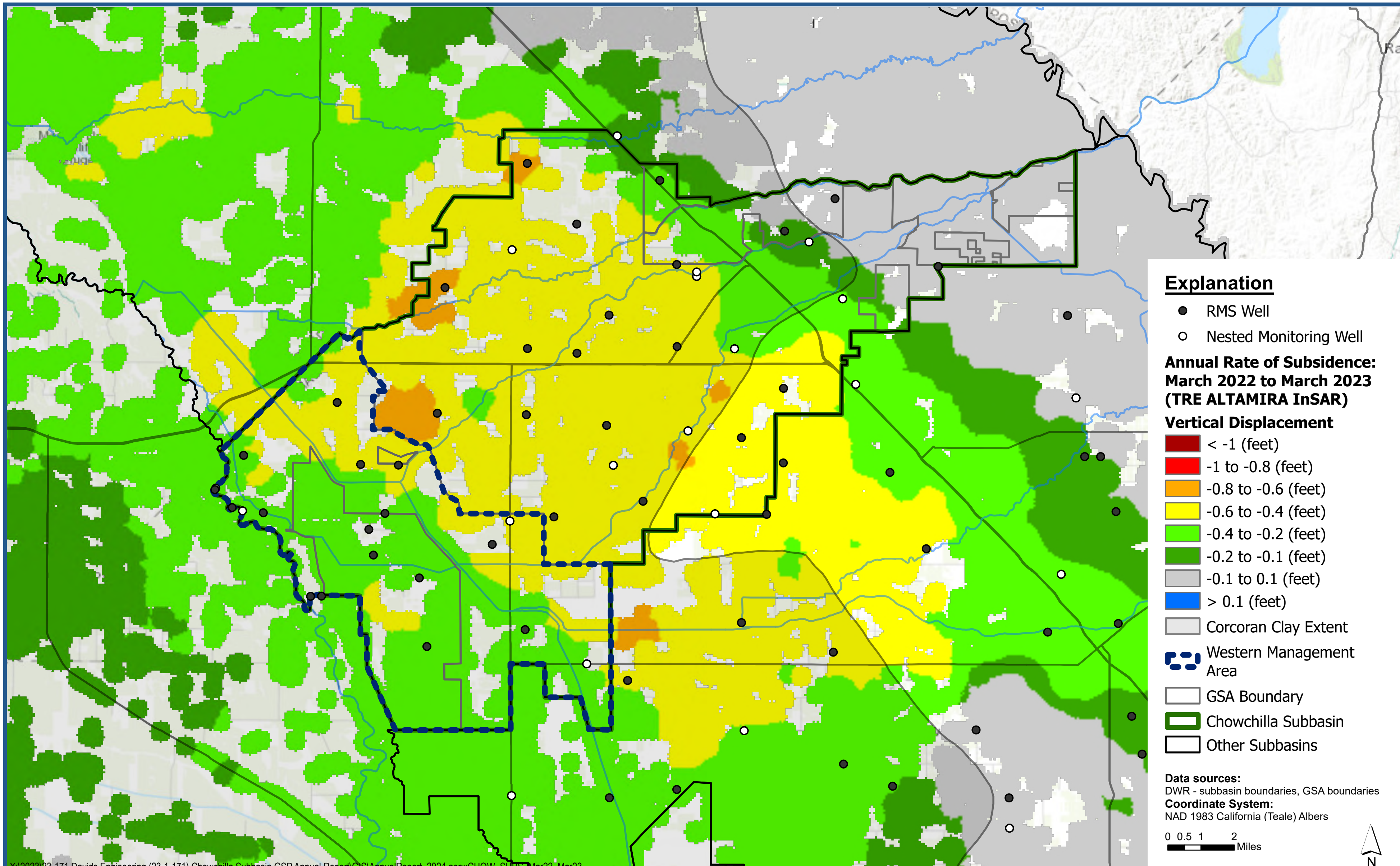
Annual Rate of Subsidence: March 2021 to March 2022 (TRE ALTAMIRA InSAR)

Chowchilla Subbasin
Groundwater Sustainability Plan 2024 Annual Report

Figure D-7



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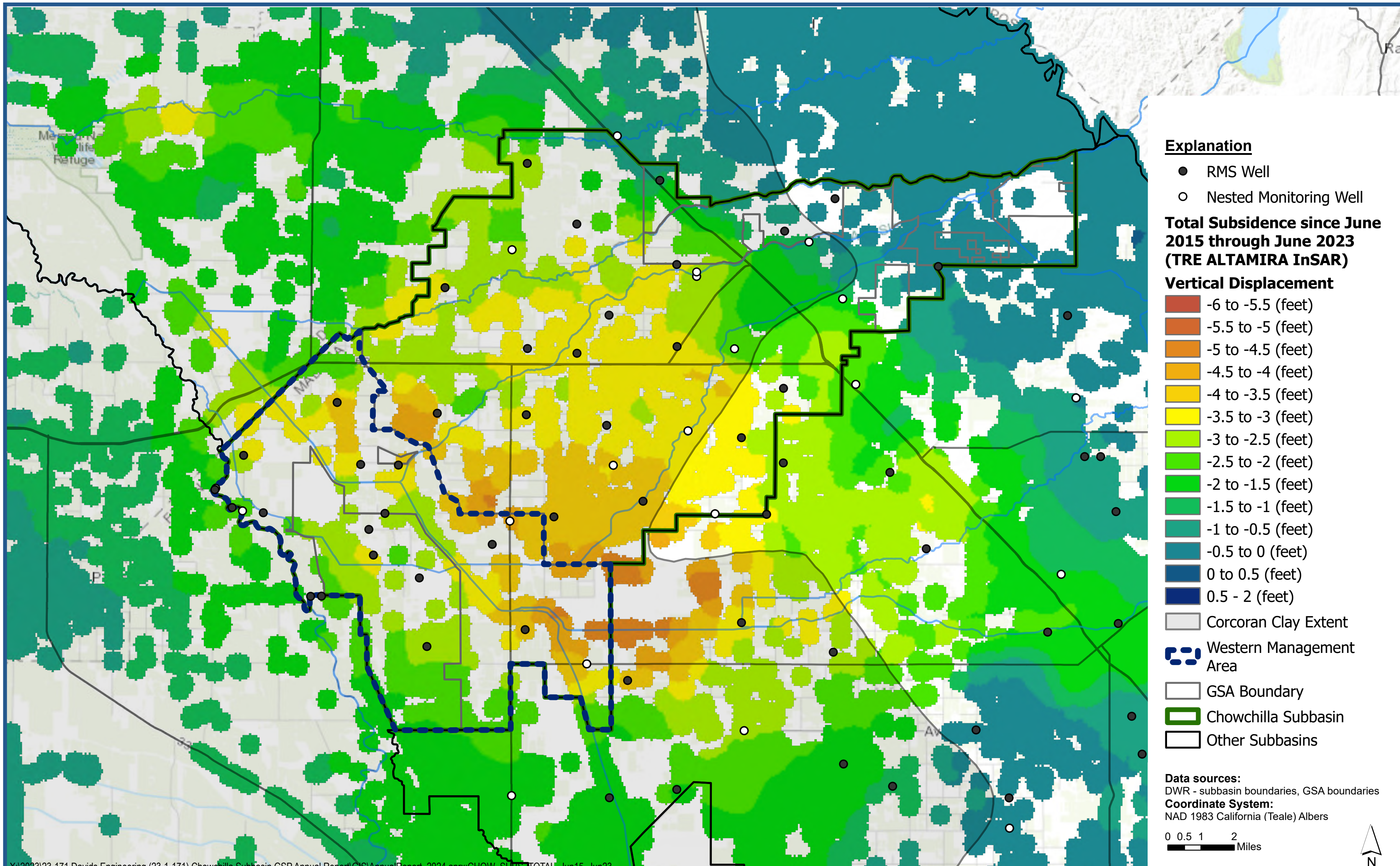
Annual Rate of Subsidence: March 2022 to March 2023 (TRE ALTAMIRA InSAR)

Chowchilla Subbasin
Groundwater Sustainability Plan 2024 Annual Report

Figure D-8



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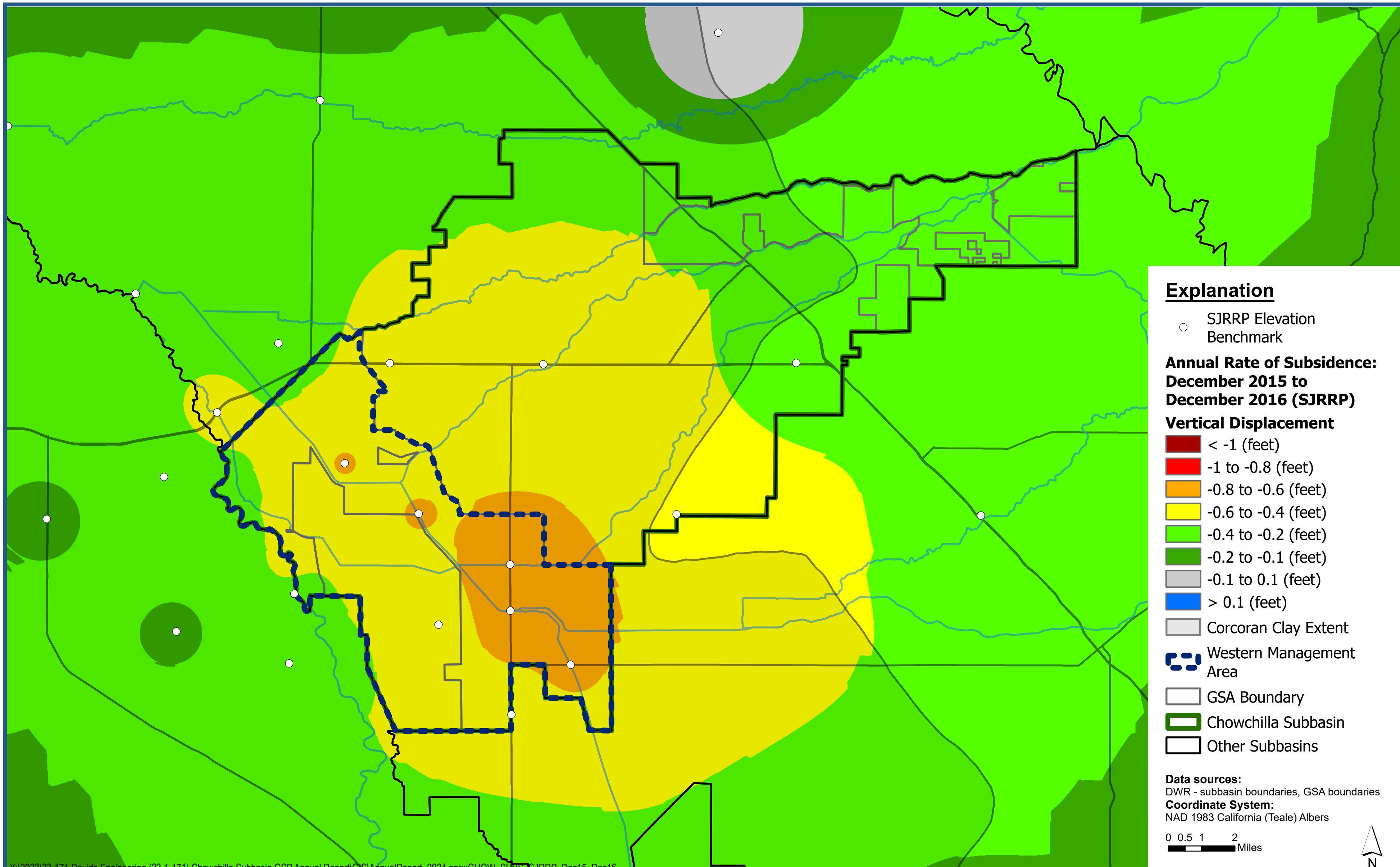
Total Subsidence since June 2015 through June 2023 (TRE ALTAMIRA InSAR)

Chowchilla Subbasin
Groundwater Sustainability Plan 2024 Annual Report

Figure D-9



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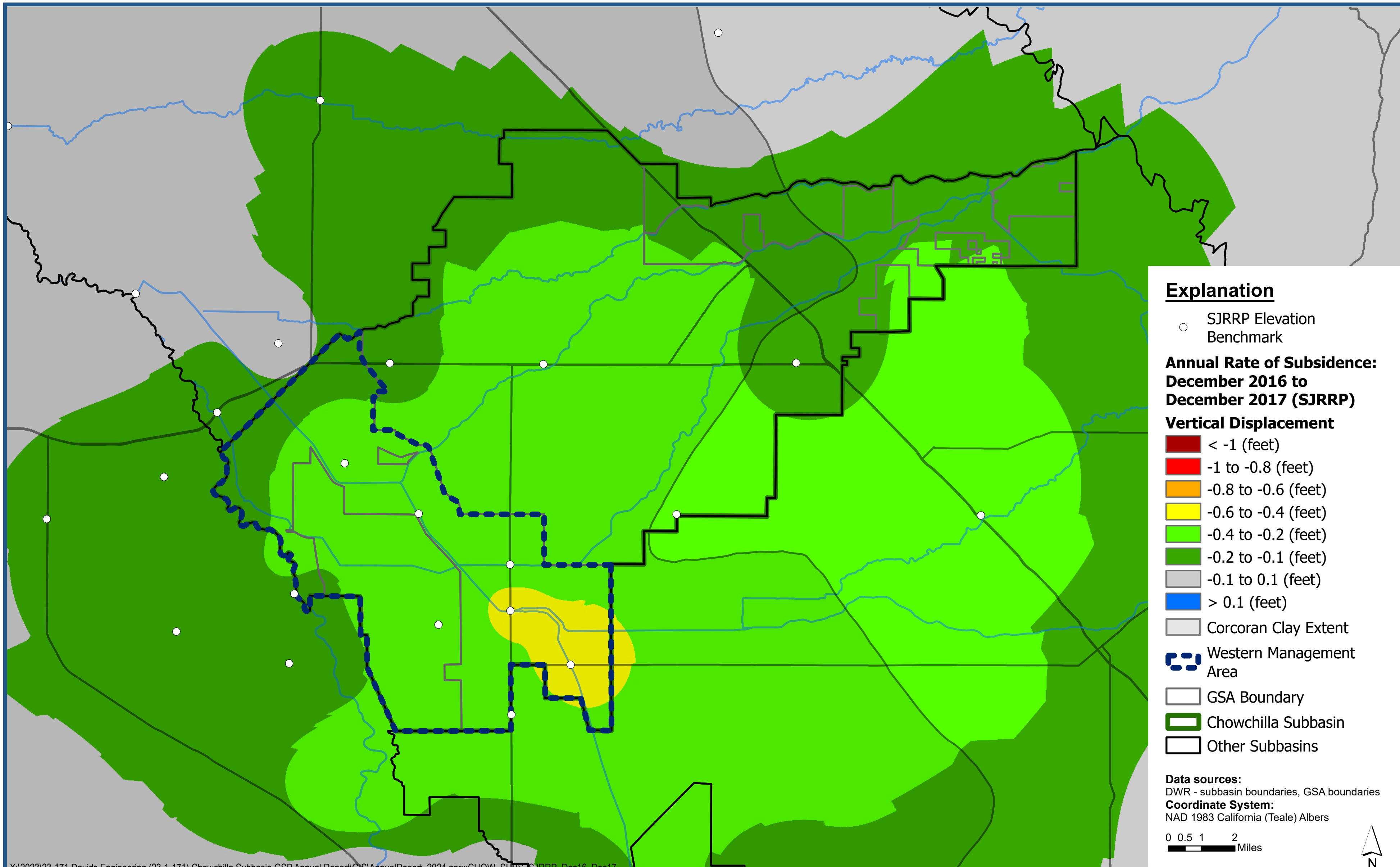
Annual Rate of Subsidence: December 2015 to December 2016 (SJRRP Elevation Benchmark)

Chowchilla Subbasin
Groundwater Sustainability Plan 2024 Annual Report

Figure D-10



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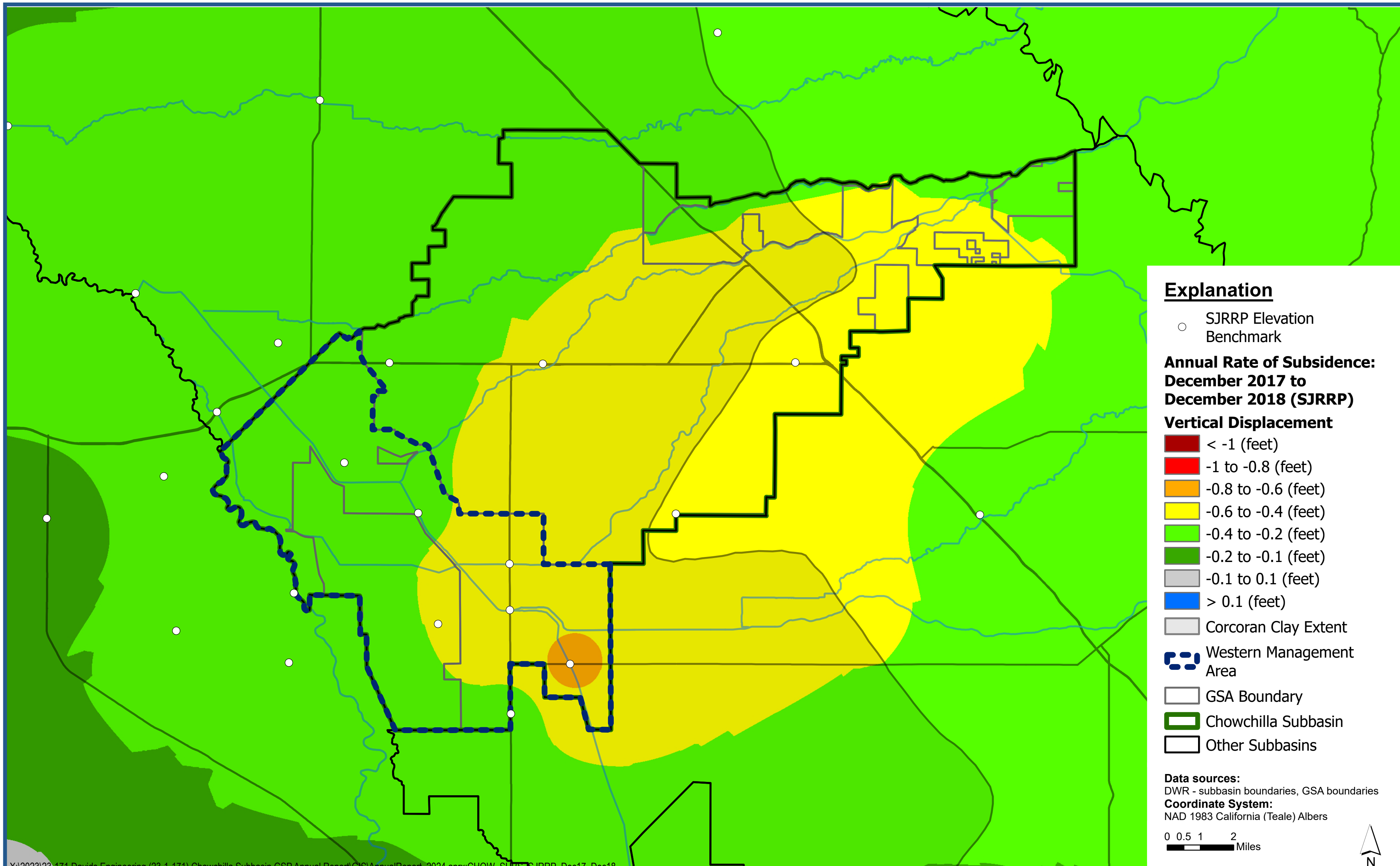
Annual Rate of Subsidence: December 2016 to December 2017 (SJRRP Elevation Benchmark)

Chowchilla Subbasin
Groundwater Sustainability Plan 2024 Annual Report

Figure D-11



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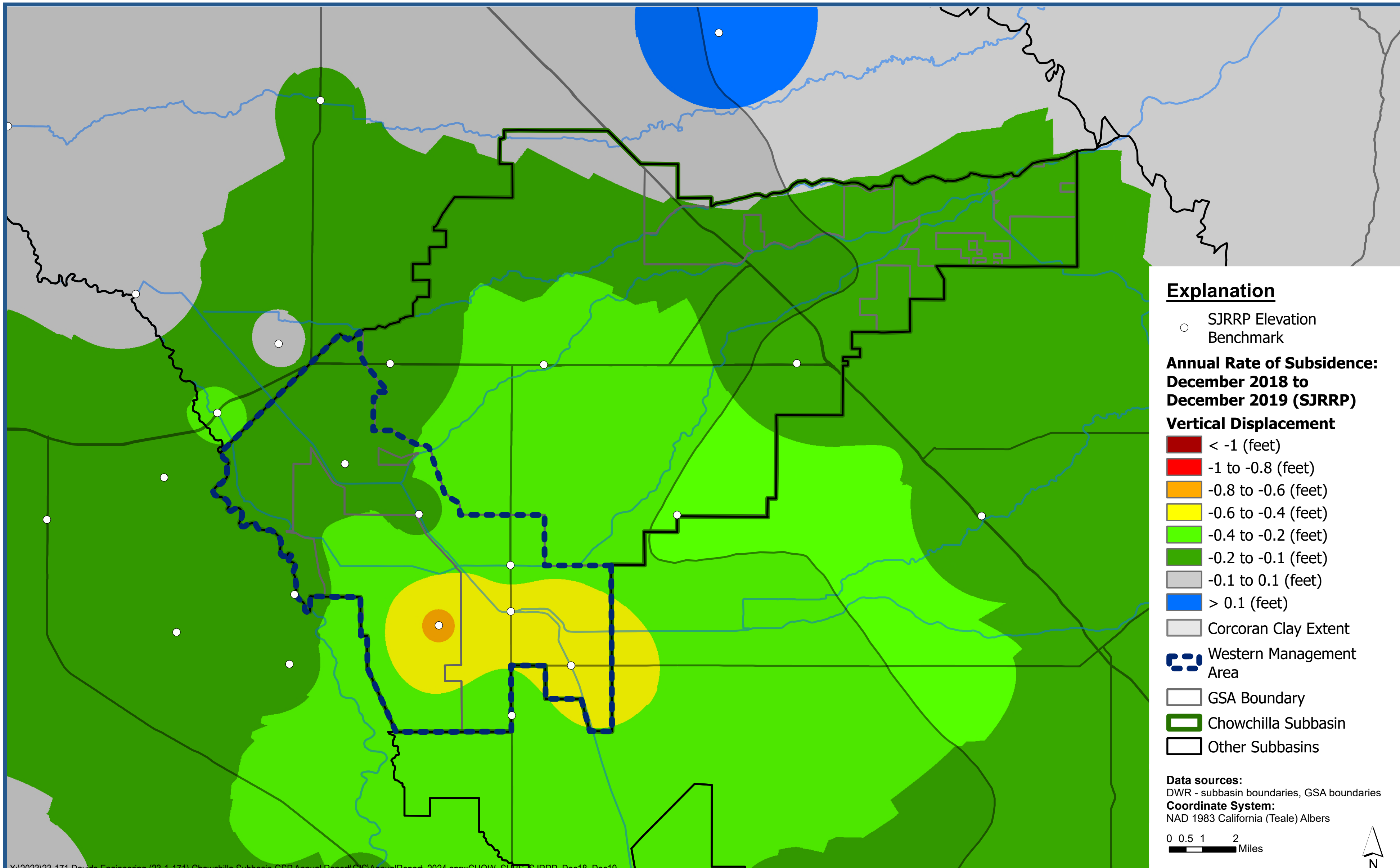
Annual Rate of Subsidence: December 2017 to December 2018 (SJRRP Elevation Benchmark)

Chowchilla Subbasin
Groundwater Sustainability Plan 2024 Annual Report

Figure D-12



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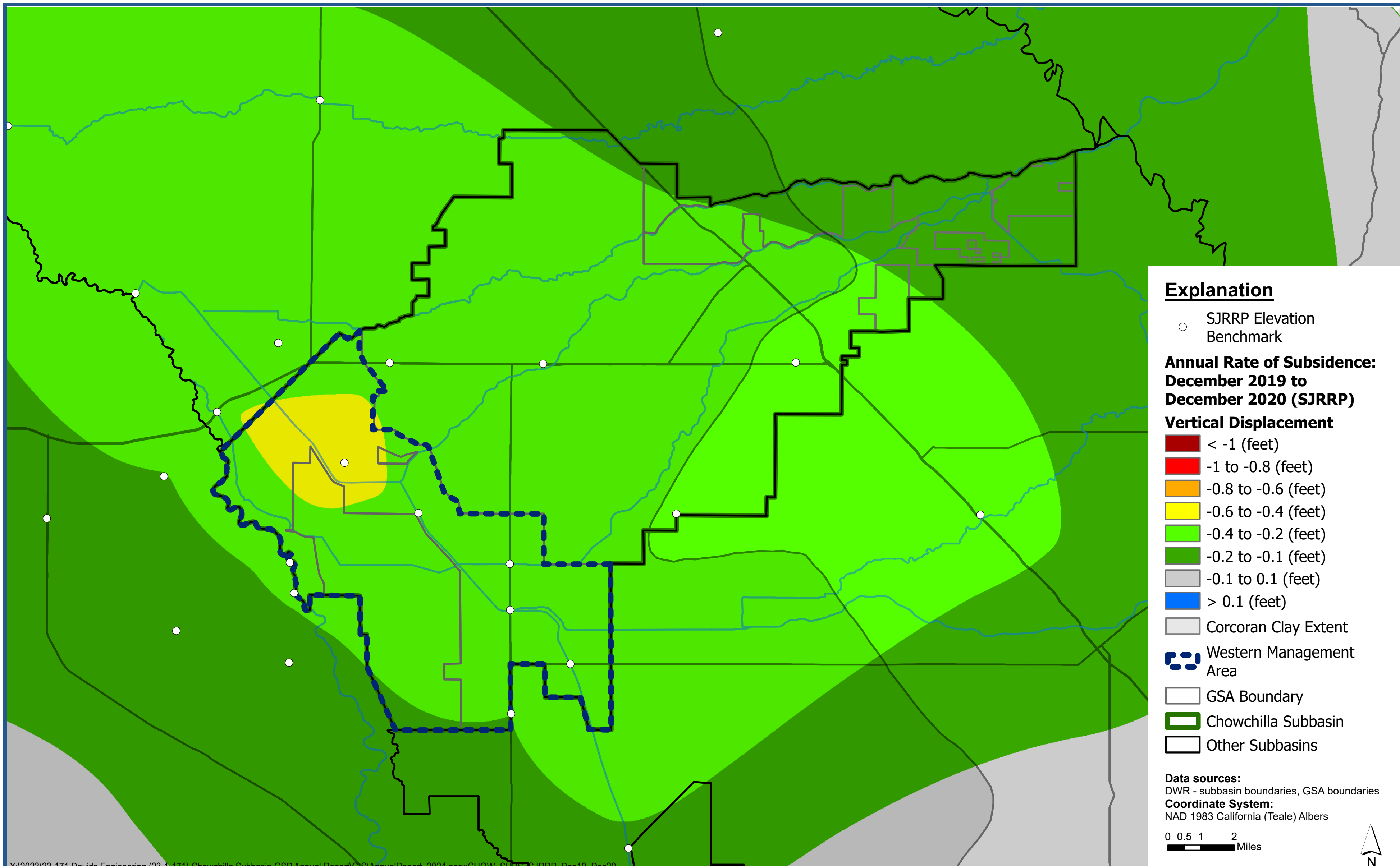
Consulting Engineers

Annual Rate of Subsidence: December 2018 to December 2019 (SJRRP Elevation Benchmark)

Chowchilla Subbasin
Groundwater Sustainability Plan 2024 Annual Report

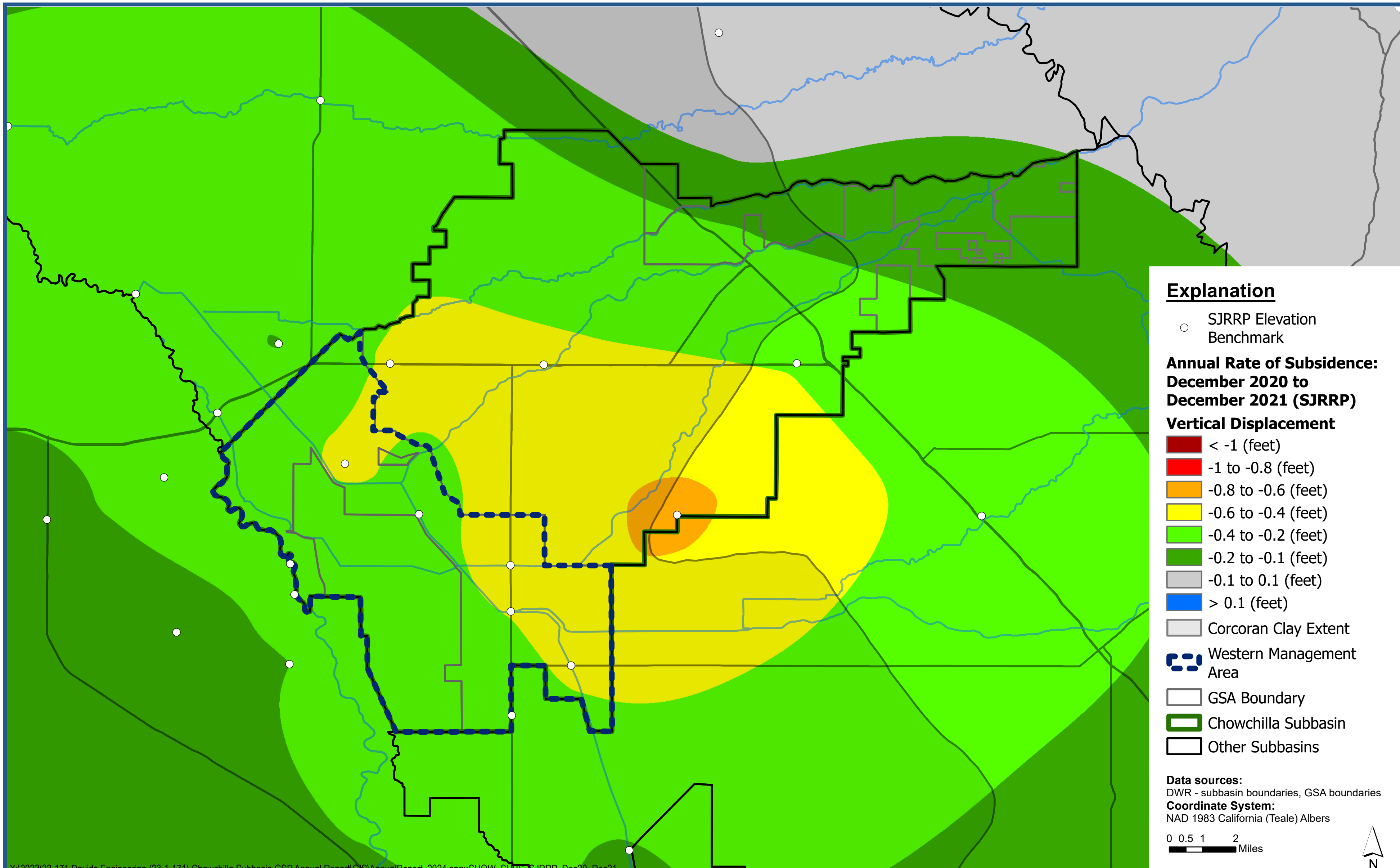
Figure D-13



Annual Rate of Subsidence: December 2019 to December 2020 (SJRRP Elevation Benchmark)

Chowchilla Subbasin
Groundwater Sustainability Plan 2024 Annual Report

Figure D-14



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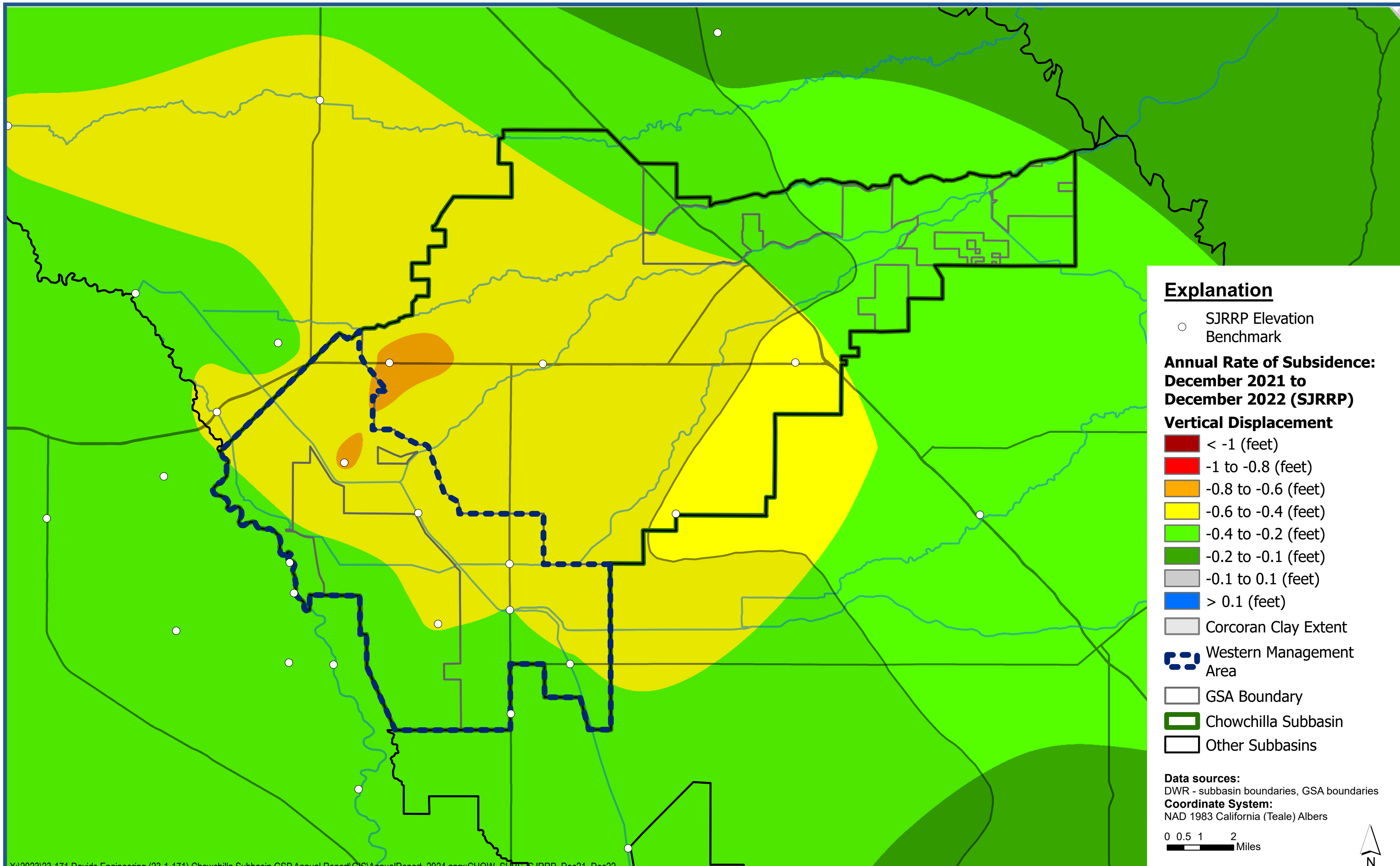
Annual Rate of Subsidence: December 2020 to December 2021 (SJRRP Elevation Benchmark)

Chowchilla Subbasin
Groundwater Sustainability Plan 2024 Annual Report

Figure D-15



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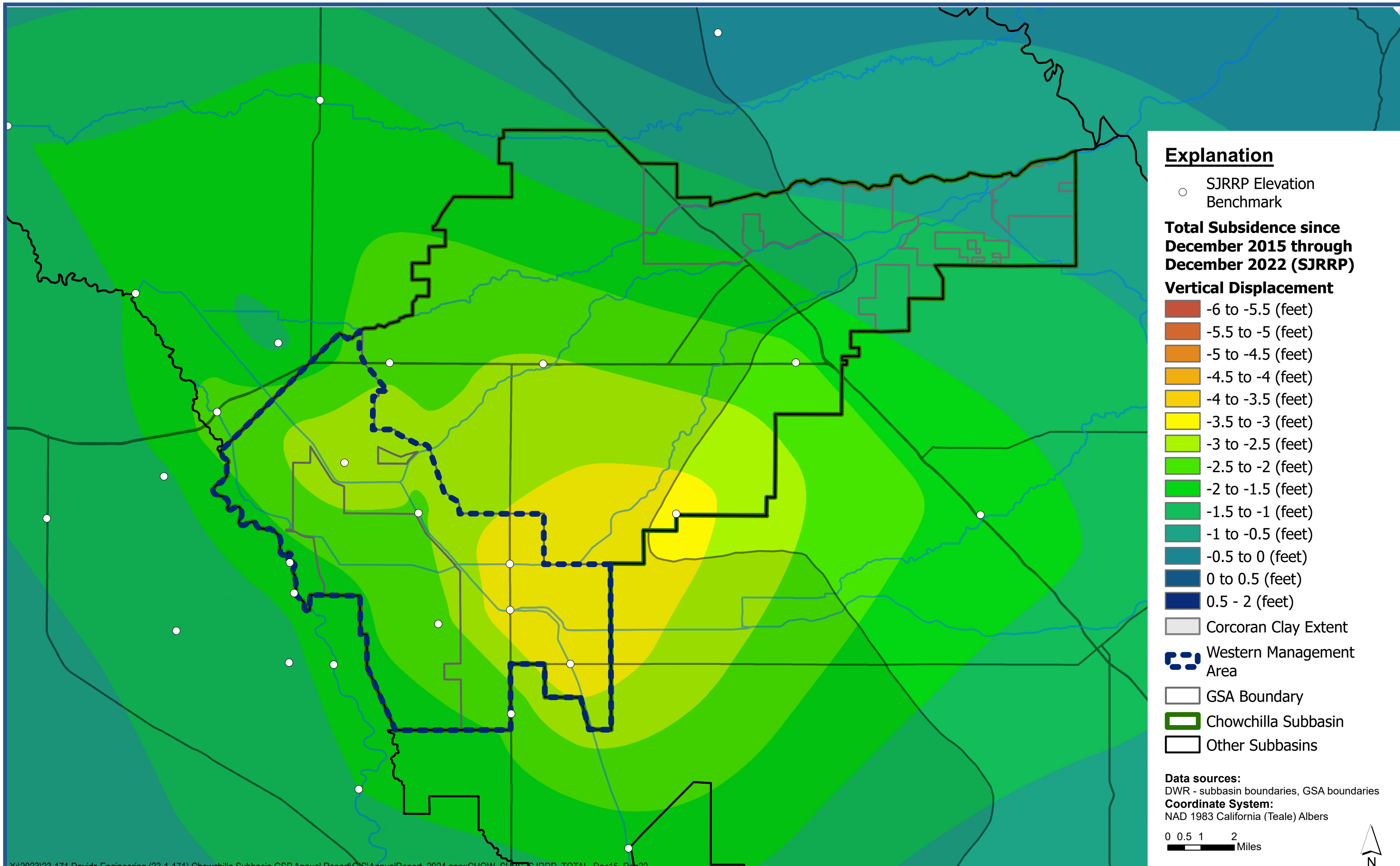
Annual Rate of Subsidence: December 2021 to December 2022 (SJRRP Elevation Benchmark)

Chowchilla Subbasin
Groundwater Sustainability Plan 2024 Annual Report

Figure D-16



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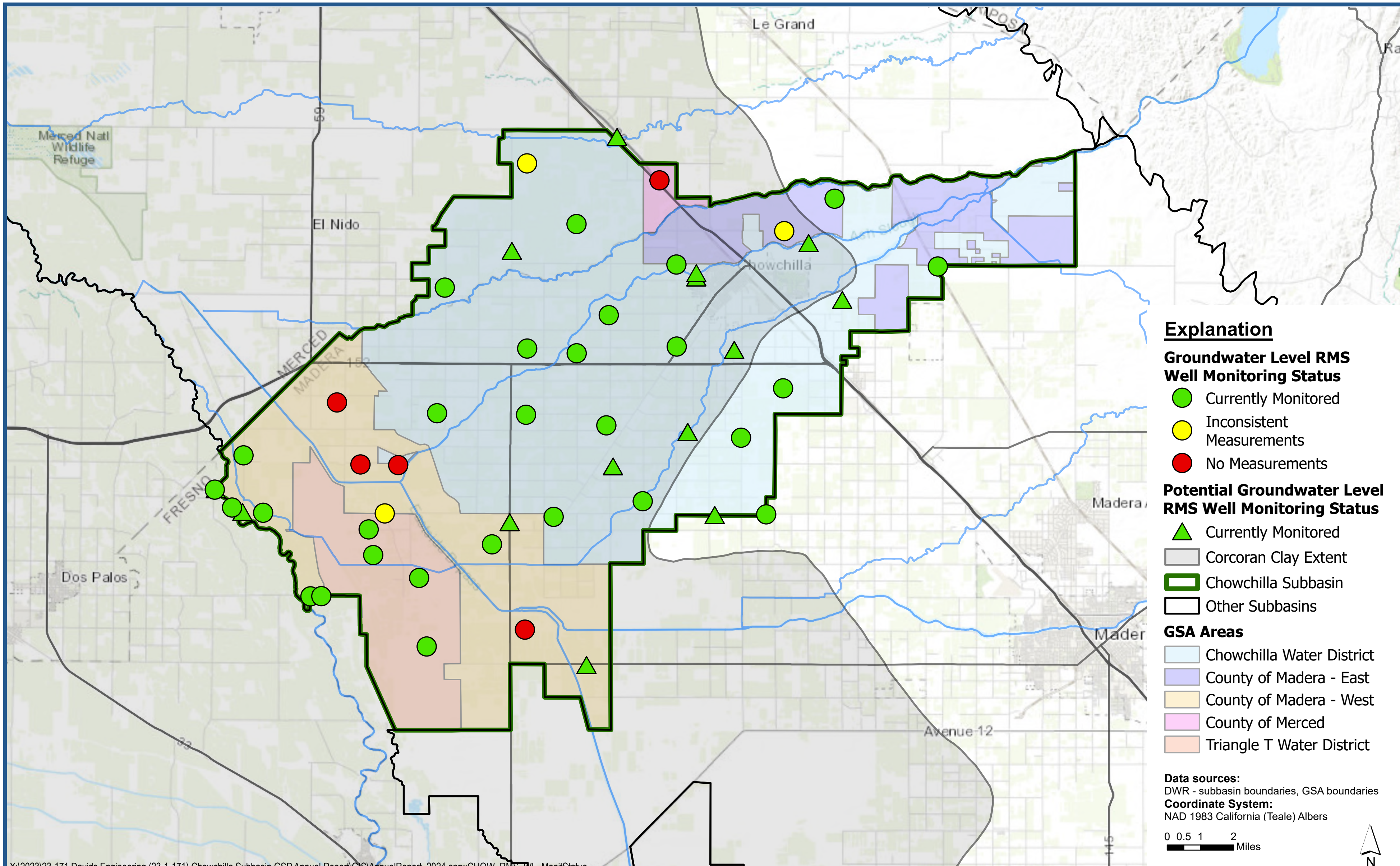
Total Subsidence since December 2015 through December 2022 (SJRRP Elevation Benchmark)

Chowchilla Subbasin
Groundwater Sustainability Plan 2024 Annual Report

Figure D-17

Appendix E. Status of Monitoring Efforts for RMS Wells in Chowchilla Subbasin



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Monitoring Status of Groundwater Level RMS Network

Chowchilla Subbasin
Groundwater Sustainability Plan 2024 Annual Report

Figure E-1

Appendix E. Table 1 - Status of Monitoring Efforts for Water Level RMS Wells in Chowchilla Subbasin

Subbasin	GSA	RMS ID	Fall 2023 Monitoring Status	Most Recent Successful WL Msmt	Most Recent Successful WL Msmt (Season)
Chowchilla	Chowchilla Water District	CWD RMS-1	Currently Monitored	10/13/2023	Fall 2023
Chowchilla	Chowchilla Water District	CWD RMS-2	Currently Monitored	10/13/2023	Fall 2023
Chowchilla	Chowchilla Water District	CWD RMS-3	Currently Monitored	10/13/2023	Fall 2023
Chowchilla	Chowchilla Water District	CWD RMS-4	Currently Monitored	10/13/2023	Fall 2023
Chowchilla	Chowchilla Water District	CWD RMS-5	Currently Monitored	10/13/2023	Fall 2023
Chowchilla	Chowchilla Water District	CWD RMS-6	Currently Monitored	10/13/2023	Fall 2023
Chowchilla	Chowchilla Water District	CWD RMS-7	Currently Monitored	10/16/2023	Fall 2023
Chowchilla	Chowchilla Water District	CWD RMS-8	Currently Monitored	10/16/2023	Fall 2023
Chowchilla	Chowchilla Water District	CWD RMS-9	Currently Monitored	10/16/2023	Fall 2023
Chowchilla	Chowchilla Water District	CWD RMS-10	Currently Monitored	10/16/2023	Fall 2023
Chowchilla	Chowchilla Water District	CWD RMS-11	Currently Monitored	10/16/2023	Fall 2023
Chowchilla	Chowchilla Water District	CWD RMS-12	Currently Monitored	10/16/2023	Fall 2023
Chowchilla	Chowchilla Water District	CWD RMS-13	Currently Monitored	10/16/2023	Fall 2023
Chowchilla	Chowchilla Water District	CWD RMS-14	Currently Monitored	10/14/2023	Fall 2023
Chowchilla	Chowchilla Water District	CWD RMS-15	Currently Monitored	10/14/2023	Fall 2023
Chowchilla	Chowchilla Water District	CWD RMS-16	Currently Monitored	10/14/2023	Fall 2023
Chowchilla	Chowchilla Water District	CWD RMS-17	Currently Monitored	10/14/2023	Fall 2023
Chowchilla	County of Madera - East	MCE RMS-1	Currently Monitored	10/31/2023	Fall 2023
Chowchilla	County of Madera - East	MCE RMS-2	Currently Monitored	10/31/2023	Fall 2023
Chowchilla	County of Madera - West	MCW RMS-1	Currently Monitored	10/30/2023	Fall 2023
Chowchilla	County of Madera - West	MCW RMS-2	Currently Monitored	10/30/2023	Fall 2023
Chowchilla	County of Madera - West	MCW RMS-3	Currently Monitored	10/30/2023	Fall 2023
Chowchilla	County of Madera - West	MCW RMS-4	NM - Can't get tape in casing	3/15/2021	Spring 2021
Chowchilla	County of Madera - West	MCW RMS-5	NM - Can't get tape in casing	11/1/2022	Fall 2022
Chowchilla	County of Madera - West	MCW RMS-6	NM - Other (missed in sampling)	11/1/2022	Fall 2022

Appendix E. Table 1 - Status of Monitoring Efforts for Water Level RMS Wells in Chowchilla Subbasin

Subbasin	GSA	RMS ID	Fall 2023 Monitoring Status	Most Recent Successful WL Msmt	Most Recent Successful WL Msmt (Season)
Chowchilla	County of Madera - West	MCW RMS-7	Currently Monitored	10/30/2023	Fall 2023
Chowchilla	County of Madera - West	MCW RMS-8	Currently Monitored	10/31/2023	Fall 2023
Chowchilla	County of Madera - West	MCW RMS-9	NM - Temporarily inaccessible	3/12/2021	Spring 2021
Chowchilla	County of Madera - West	MCW RMS-10	Currently Monitored	11/8/2023	Fall 2023
Chowchilla	County of Madera - West	MCW RMS-11	Currently Monitored	9/13/2023	Fall 2023
Chowchilla	County of Madera - West	MCW RMS-12	Currently Monitored	9/13/2023	Fall 2023
Chowchilla	County of Merced	MER RMS-1	Attempts are being made to reengage with well owner	3/12/2020	Spring 2020
Chowchilla	Triangle T Water District	TRT RMS-1	Currently Monitored	10/15/2023	Fall 2023
Chowchilla	Triangle T Water District	TRT RMS-2	Currently Monitored	10/15/2023	Fall 2023
Chowchilla	Triangle T Water District	TRT RMS-3	Currently Monitored	10/15/2023	Fall 2023
Chowchilla	Triangle T Water District	TRT RMS-4	Currently Monitored	10/15/2023	Fall 2023

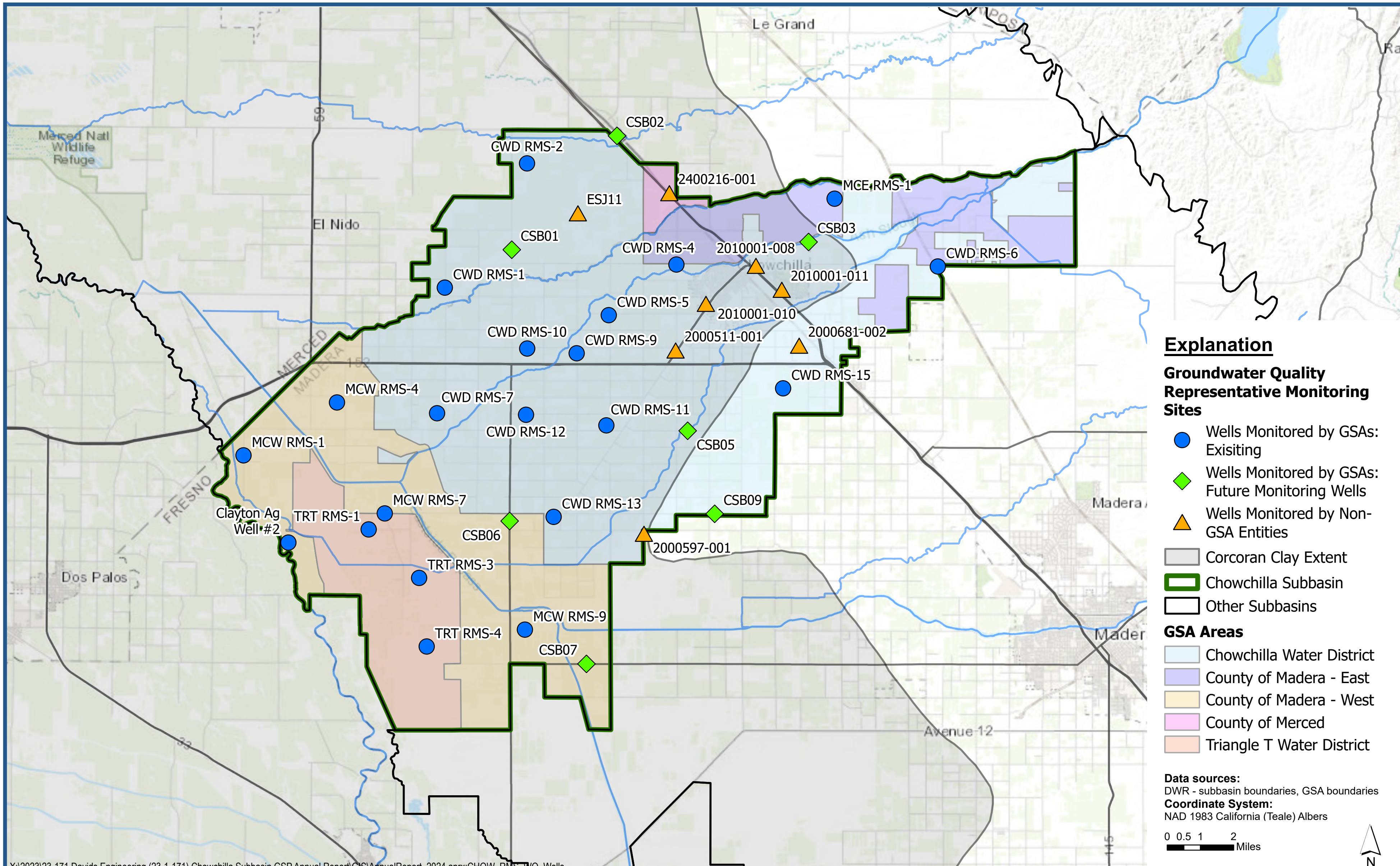
NM = no measurement. Measurement attempted but was unsuccessful.

Appendix E. Table 2 - Status of Monitoring Efforts for Potential Water Level RMS Wells in Chowchilla Subbasin

Subbasin	GSA	RMS ID	Fall 2023 Monitoring Status	Most Recent Successful WL Msmt	Most Recent Successful WL Msmt (Season)
Chowchilla	Chowchilla Water District	CSB01A	Currently Monitored	10/25/2023	Fall 2023
Chowchilla	Chowchilla Water District	CSB01B	Currently Monitored	10/25/2023	Fall 2023
Chowchilla	Chowchilla Water District	CSB01C	Currently Monitored	10/25/2023	Fall 2023
Chowchilla	Chowchilla Water District	CSB02A	NM - Well is Dry	3/28/2023	Spring 2023
Chowchilla	Chowchilla Water District	CSB02B	Currently Monitored	10/25/2023	Fall 2023
Chowchilla	Chowchilla Water District	CSB02C	Currently Monitored	10/25/2023	Fall 2023
Chowchilla	Chowchilla Water District	CSB03A	NM - Well is Dry	10/25/2022	Fall 2022
Chowchilla	Chowchilla Water District	CSB03B	Currently Monitored	10/25/2023	Fall 2023
Chowchilla	Chowchilla Water District	CSB03C	Currently Monitored	10/25/2023	Fall 2023
Chowchilla	Chowchilla Water District	CSB05A	Currently Monitored	10/26/2023	Fall 2023
Chowchilla	Chowchilla Water District	CSB05B	Currently Monitored	10/26/2023	Fall 2023
Chowchilla	Chowchilla Water District	CSB05C	Currently Monitored	10/26/2023	Fall 2023
Chowchilla	County of Madera - West	CSB06A	Currently Monitored	10/26/2023	Fall 2023
Chowchilla	County of Madera - West	CSB06B	Currently Monitored	10/26/2023	Fall 2023
Chowchilla	County of Madera - West	CSB06C	Currently Monitored	10/26/2023	Fall 2023
Chowchilla	County of Madera - West	CSB07A	Currently Monitored	10/26/2023	Fall 2023
Chowchilla	County of Madera - West	CSB07B	Currently Monitored	10/26/2023	Fall 2023
Chowchilla	County of Madera - West	CSB07C	Currently Monitored	10/26/2023	Fall 2023
Chowchilla	Chowchilla Water District	CSB08A	NM - Well is Dry	6/9/2023	Summer 2023
Chowchilla	Chowchilla Water District	CSB08B	Currently Monitored	10/25/2023	Fall 2023
Chowchilla	Chowchilla Water District	CSB08C	Currently Monitored	10/25/2023	Fall 2023
Chowchilla	Chowchilla Water District	CSB09A	Currently Monitored	10/26/2023	Fall 2023
Chowchilla	Chowchilla Water District	CSB09B	Currently Monitored	10/26/2023	Fall 2023
Chowchilla	Chowchilla Water District	CSB09C	Currently Monitored	10/26/2023	Fall 2023
Chowchilla	Chowchilla Water District	CSB10	Currently Monitored	10/25/2023	Fall 2023

Appendix E. Table 2 - Status of Monitoring Efforts for Potential Water Level RMS Wells in Chowchilla Subbasin

Subbasin	GSA	RMS ID	Fall 2023 Monitoring Status	Most Recent Successful WL Msmt	Most Recent Successful WL Msmt (Season)
Chowchilla	Chowchilla Water District	CSB11A	Currently Monitored	10/26/2023	Fall 2023
Chowchilla	Chowchilla Water District	CSB11B	Currently Monitored	10/26/2023	Fall 2023
Chowchilla	Chowchilla Water District	CSB11C	Currently Monitored	10/26/2023	Fall 2023
Chowchilla	Chowchilla Water District	CSB12A	Currently Monitored	10/26/2023	Fall 2023
Chowchilla	Chowchilla Water District	CSB12B	Currently Monitored	10/26/2023	Fall 2023
Chowchilla	Chowchilla Water District	CSB12C	Currently Monitored	10/26/2023	Fall 2023
Chowchilla	Chowchilla Water District	CSB13A	Currently Monitored	10/25/2023	Fall 2023
Chowchilla	Chowchilla Water District	CSB13B	Currently Monitored	10/25/2023	Fall 2023
Chowchilla	Chowchilla Water District	CSB13C	Currently Monitored	10/25/2023	Fall 2023
Chowchilla	County of Madera	CSB14	Currently Monitored	10/30/2023	Fall 2023
Chowchilla	County of Madera	CSB15	Currently Monitored	10/30/2023	Fall 2023
Chowchilla	County of Madera	CSB16	Currently Monitored	10/30/2023	Fall 2023



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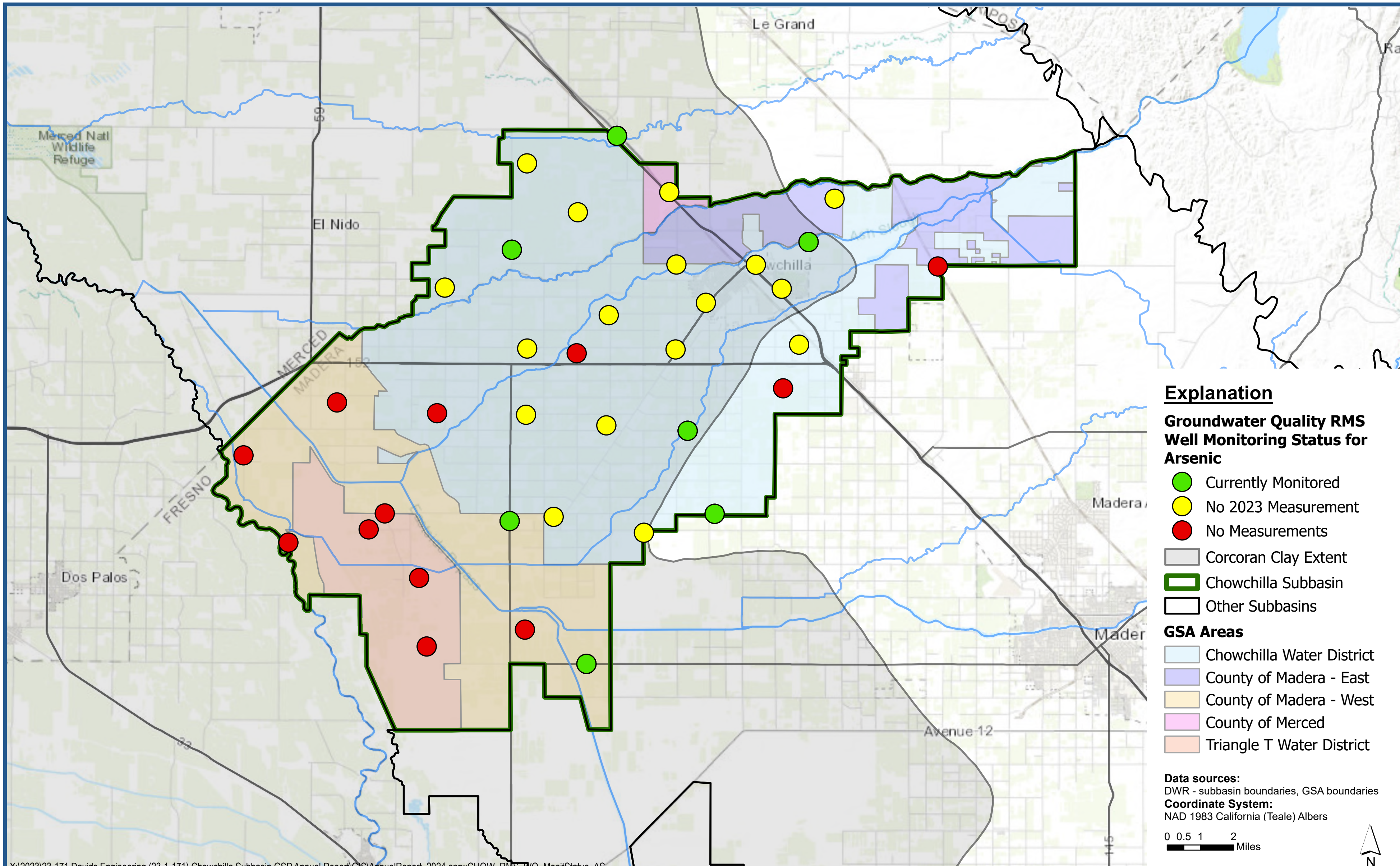
Groundwater Quality Sustainable Indicator Wells

Chowchilla Subbasin
Groundwater Sustainability Plan 2024 Annual Report

Figure E-2



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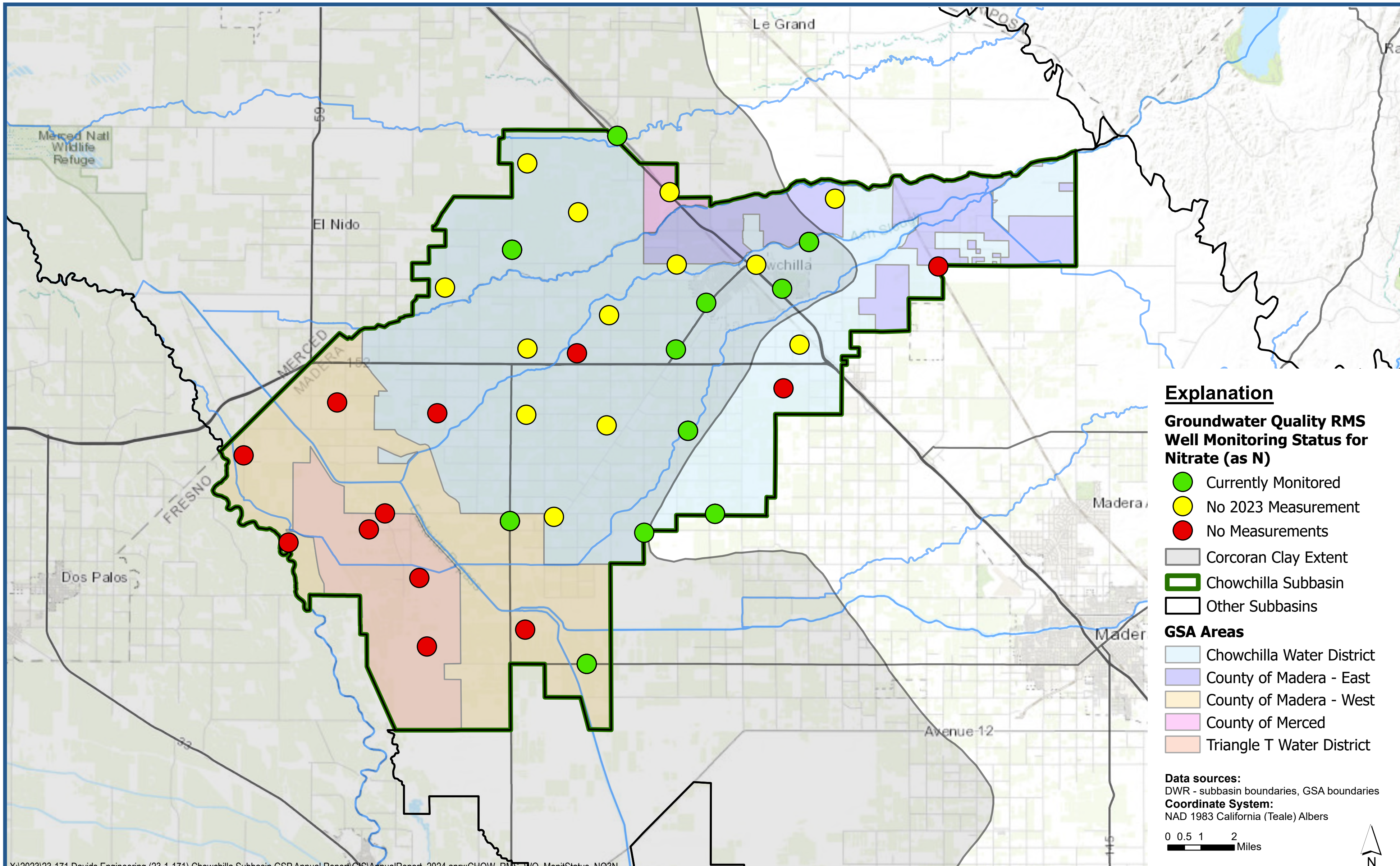
Monitoring Status of Groundwater Quality RMS Network - Arsenic

Chowchilla Subbasin
Groundwater Sustainability Plan 2024 Annual Report

Figure E-3



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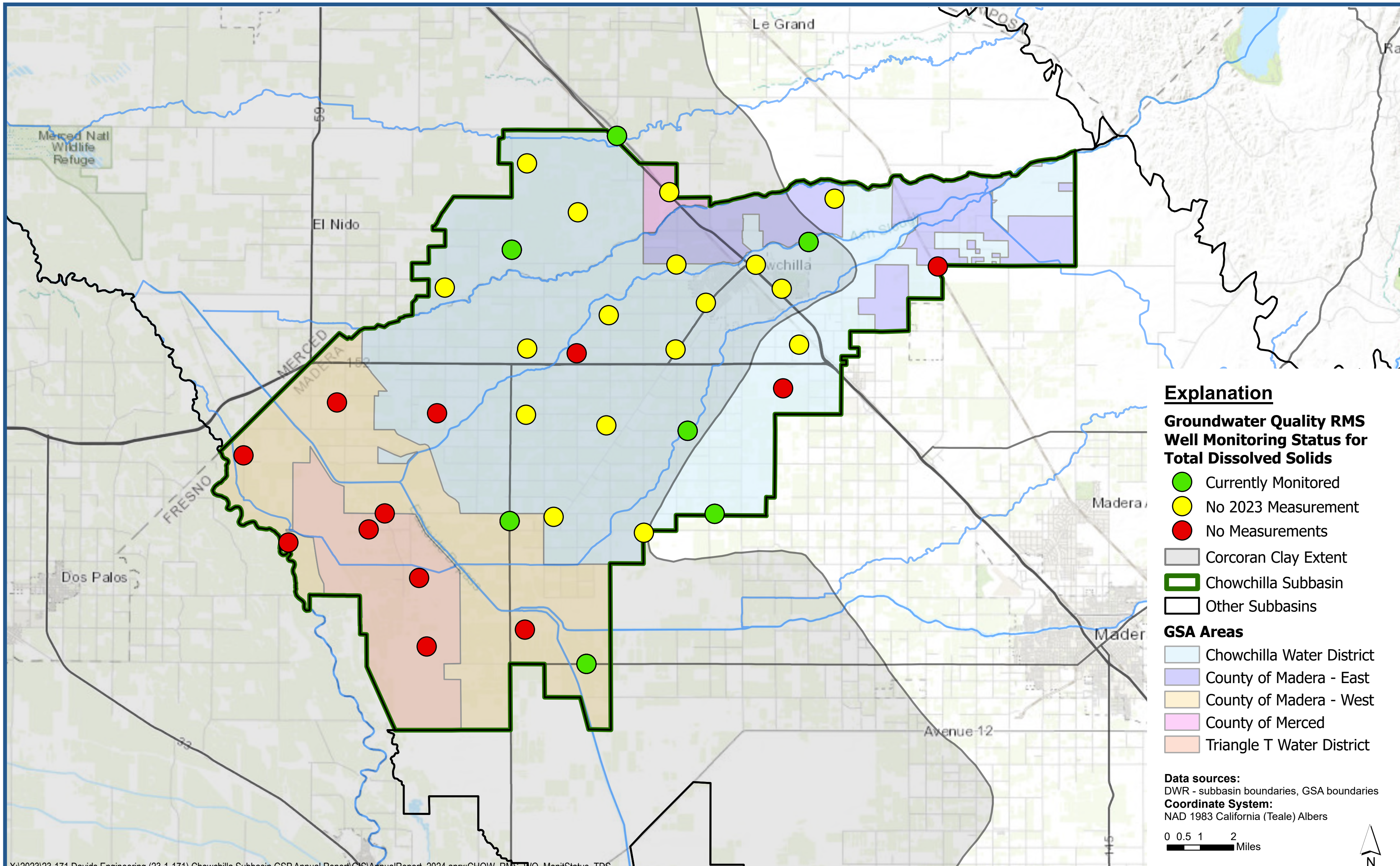
Monitoring Status of Groundwater Quality RMS Network - Nitrate (as N)

Figure E-4

Chowchilla Subbasin
Groundwater Sustainability Plan 2024 Annual Report



DAVIDS ENGINEERING, INC

Luhdorff & Scalmanini Consulting Engineers

Monitoring Status of Groundwater Quality RMS Network - Total Dissolved Solids

Chowchilla Subbasin
Groundwater Sustainability Plan 2024 Annual Report

Figure E-5

Appendix E. Table 3 - Status of Monitoring Efforts for Water Quality RMS Wells in Chowchilla Subbasin

		Arsenic		Nitrate as N		Total Dissolved Solids	
	RMS ID	Most Recent Sampling Date	Sample Count	Most Recent Sampling Date	Sample Count	Most Recent Sampling Date	Sample Count
GSA-Current	CWD RMS-1	10/20/2021	1	10/20/2021	1	10/20/2021	1
	CWD RMS-2	10/20/2021	1	10/20/2021	1	10/20/2021	1
	CWD RMS-4	10/21/2021	1	10/21/2021	1	10/21/2021	1
	CWD RMS-5	10/20/2021	1	10/20/2021	1	10/20/2021	1
	CWD RMS-6						
	CWD RMS-7						
	CWD RMS-9						
	CWD RMS-10	10/20/2021	1	10/20/2021	1	10/20/2021	1
	CWD RMS-11	10/21/2021	1	10/21/2021	1	10/21/2021	1
	CWD RMS-12	11/5/2021	1	11/5/2021	1	11/5/2021	1
	CWD RMS-13	10/21/2021	1	10/21/2021	1	10/21/2021	1
	CWD RMS-15						
	MCE RMS-1	7/12/2022	1	7/12/2022	1	7/12/2022	1
	MCW RMS-1						
	MCW RMS-4						
	MCW RMS-7						
	MCW RMS-9						
	TRT RMS-1						
	TRT RMS-3						
	TRT RMS-4						
	Clayton Ag Well #2						
GSA-Future	CSB01A	6/28/2023	4	6/28/2023	3	6/28/2023	4
	CSB01B	6/21/2023	4	6/21/2023	3	6/21/2023	4
	CSB01C	6/21/2022	2	6/21/2022	2	6/21/2022	2
	CSB02A	7/27/2021	3			8/5/2020	2
	CSB02B	6/21/2023	4	6/21/2023	3	6/21/2023	4
	CSB02C	6/21/2023	4	6/21/2023	3	6/21/2023	4
	CSB03A	7/27/2021	4	6/16/2021	1	6/16/2021	3
	CSB03B	6/20/2023	4	6/20/2023	3	6/20/2023	4
	CSB03C	6/20/2023	3	6/20/2023	2	6/20/2023	3
	CSB05A	6/14/2023	5	6/14/2023	3	6/14/2023	5
	CSB05B	6/14/2023	4	6/14/2023	3	6/14/2023	4
	CSB05C	6/28/2023	4	6/28/2023	3	6/28/2023	4
	CSB06A	6/14/2023	4	6/14/2023	2	6/14/2023	5
	CSB06B	6/14/2023	3	6/14/2023	2	6/14/2023	3
	CSB06C	6/14/2023	3	6/14/2023	2	6/14/2023	3
	CSB07A	6/28/2023	5	6/28/2023	2	6/28/2023	5
	CSB07B	6/28/2023	3	6/28/2023	2	6/28/2023	3
	CSB07C	6/28/2023	3	6/28/2023	2	6/13/2023	3
	CSB09A	6/14/2023	6	6/14/2023	3	6/14/2023	6
	CSB09B	6/14/2023	4	6/14/2023	3	6/14/2023	4
	CSB09C	6/14/2023	4	6/14/2023	3	6/14/2023	4
Non-GSA	2000511-001	1/13/2021	6	3/2/2023	76	1/13/2021	6
	2000597-001	6/10/2021	8	10/9/2023	41	12/17/2009	3
	2000681-002	12/13/2017	3	12/6/2022	9	5/7/2013	2
	2010001-008	7/29/2015	9	10/23/2017	26	7/27/2016	16
	2010001-010	6/2/2021	10	11/16/2023	67	6/2/2021	17
	2010001-011	2/8/2022	10	6/21/2023	31	2/8/2022	16
	2400216-001	10/14/2019	4	4/12/2021	19	8/22/2013	2
	ESJ11	7/27/2021	1			8/5/2020[1]	1[1]

[1] Monitoring for the Irrigated Lands Regulatory Program annual monitoring includes 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.

Appendix F. Interconnected Surface Water Data Gaps Workplan.

DRAFT TECHNICAL MEMORANDUM

DATE: December 5, 2022 Project No. 21-1-166

TO: Chowchilla Subbasin GSAs

FROM: LSCE and DE

SUBJECT: Chowchilla Subbasin Revised GSP – Interconnected Surface Water Draft Workplan

Introduction and Background

The relationship between the San Joaquin River (SJ River) and shallow groundwater along the western boundary of Chowchilla Subbasin (Subbasin) is complex and data to characterize the groundwater-surface water relationship in this area of the Subbasin are limited. Hydrogeologic conditions at shallow depths appear to vary significantly on different sides of the SJ River, resulting in very shallow groundwater levels west of the river in Delta-Mendota Subbasin and deeper groundwater levels east of the river within Chowchilla Subbasin. Available data suggest shallow clay layers are more prevalent west of and beneath the river, but these shallow clay layers may not be as extensive to the east of the river. Differences between the presence and configuration of shallow clay layers on the west and east sides of the river likely contribute to the occurrence of higher groundwater levels in the shallow zone west of and immediately adjacent to the river compared to east of the river. It may be possible to draw different conclusions regarding the occurrence of interconnected surface water (ISW) on either side of the river, but further studies should be considered 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 as part of the San Joaquin River Restoration Program (SJRRP) provide much of the existing monitoring information related to shallow groundwater adjacent to the River. These wells were initially installed to monitor for potential increases in shallow groundwater levels west of the river due to increased reservoir releases to and flows in the San Joaquin River as part of implementing the San Joaquin River Restoration Program (SJRRP). Additional field data collection and technical analyses should be considered at depths greater than 30 feet to better characterize the shallow subsurface along the SJ River at the western boundary of 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. The purpose of this scope of work 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 western 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 interconnected surface water conditions exist.

Previous Work Summarized in GSP

As summarized in the Revised Groundwater Sustainability Plan (GSP) for the Subbasin, comparison of historical maps of unconfined groundwater elevations prepared by the Department of Water Resources (DWR) and the SJ River thalweg elevation indicated a connection between groundwater and surface water likely existed from 1958 (and likely before) through 2008. Subsequent data appeared to indicate groundwater elevations below (and disconnected from) the SJ River thalweg from 2009 to 2016. This analysis was based on contour maps of unconfined groundwater elevation prepared by DWR for the following years: Spring 1958, Spring 1962, Spring 1969, Spring 1970, Spring 1976, Spring 1984, Spring 1989 through Spring 2011 (see Revised GSP Appendix 2.E), Spring 2014 (Revised GSP Figure 2-47), and Spring 2016 (Revised GSP Figure 2-48).

Maps of depths to shallowest groundwater (including perched groundwater) for 2014 and 2016 are displayed on Revised GSP Figures 2-71 and 2-72. These maps incorporate very shallow monitoring wells (i.e., less than 50 feet deep), including SJRRP wells (many of which have well screens in the upper 30 feet). Depth to shallow groundwater maps were generated by contouring groundwater surface elevation and subtracting the contoured groundwater surface from the ground surface elevation as represented by the United States Geological Survey (USGS) National Elevation Dataset Digital Elevation Model. Some of the areas in western Subbasin along/adjacent to the SJ River are underlain by the “C-clay” unit of the Tulare Formation and other shallow clay layers that occur above the more laterally and vertically extensive Corcoran Clay (“E-Clay of the Tulare Formation). These clay layers impede the vertical movement of water within the shallowest part of the groundwater system and shallow groundwater in these areas can be considered perched/mounded as a result of the shallow clay layers, although there may be no unsaturated zone beneath them as exists in what is conventionally considered a perched groundwater condition. It is likely that seepage of water from the SJ River (when water is present) combined with the presence of shallow clay layers, serves to maintain shallow groundwater levels in these areas. The depth to the Corcoran Clay becomes relatively shallow farther east in the Subbasin (Eastern Management Area), where it creates a zone of perched groundwater. While shallow perched groundwater levels may be approximately 50 to 90 feet below ground surface, the underlying regional groundwater surface is typically at depths exceeding 200 feet. This is illustrated by new monitoring wells MW-1A and MW-10 installed in the north central portion of the Subbasin near the Chowchilla River, where depths to perched groundwater above the Corcoran Clay are 60 to 70 feet below ground surface (bgs) and depths to unconfined regional groundwater below the Corcoran Clay are 200 to 230 feet bgs.

The SJRRP involves augmenting flow releases from Friant Dam with restoration flows. SJRRP restoration flows were initiated in October 2009 and referred to as "Interim" flows, while SJRRP "Restoration" flows were initiated in January 2014. The commencement of the SJRRP flows complicates the historical review and understanding of surface water – groundwater interaction and the potential effects (or lack thereof) on surface water flow from groundwater pumping. A more detailed assessment of the timing and magnitude of SJRRP flow releases and relationships to shallow groundwater levels is something that should be taken into consideration.

Review of Revised GSP Figures 2-71 and 2-72 indicates that the SJ River was disconnected from the shallow perched/mounded groundwater during these time periods (Spring 2014 and Spring 2016). The 2014 and 2016 water years were considered Critical and Dry water years, respectively, according to the San Joaquin Valley Hydrologic Index (although water year 2016 was on the border of being classified as a Below Normal year). However, review of groundwater elevation hydrographs for wells screened in the Upper Aquifer (see Revised GSP Sections 3.2.5 and 3.3.5) also indicate there may be some interconnection between shallow groundwater and the SJ River during certain discrete time periods when shallow groundwater levels are high, typically during spring in certain Wet and Above Normal index years and sometimes in spring of dry or critical years following a sequence of wet/above normal years. The relationship between stream seepage in the SJ River along the western boundary of Subbasin and groundwater pumping along this portion of the SJ River within the Subbasin (i.e., within approximately 0.75 miles of the San Joaquin River) is shown in Revised GSP Figure 2-73. The relationship between groundwater pumping from the Upper Aquifer throughout the entire Western Management Area and stream seepage is shown in Revised GSP Figure 2-74. These figures indicate no distinct and consistent relationships between the amount of groundwater pumping and stream seepage. On the other hand, the relationship between streamflow entering this reach of the SJ River and stream seepage presented in Revised GSP Figure 2-75 suggests an apparent strong relationship where increasing streamflow correlates with increasing stream seepage. This relationship between the magnitudes of streamflow and stream seepage is expected because this segment of the SJ River (known in the SJRRP as Reach 4A) has been characterized as a losing reach (United States Bureau of Reclamation (USBR), December 2020). These relationships between various factors are discussed further in Revised GSP Sections 3.2.5 and 3.3.5.

Available data and analyses (see Revised GSP Section 2.2.2.5) suggest shallow groundwater occurring along the SJ River is a result of stream seepage and regional groundwater does not support streamflow along this reach of the SJ River adjacent to the western boundary of Subbasin. Nonetheless, based on guidance received from DWR and because of limitations in available information to evaluate the interconnected nature of groundwater and surface water on the SJ River, for the Revised GSP it is assumed that conditions along the SJ River in the Subbasin constitute an ISW condition as defined by SGMA and under the GSP regulations. As a result, the Revised GSP established interim SMC for ISW until the shallow hydrogeologic conditions along the SJ River are more fully characterizing and a final determination regarding the presence/absence of ISW can be made.

In the Subbasin, an area identified as having a Groundwater Dependent Ecosystem (GDE) is located adjacent to the SJ River (see Revised GSP Figure 2-76). As noted above, the SJ River is in a net-losing condition and infiltrating surface water flows (stream seepage) likely contributes directly to the shallow groundwater system that supports the vegetation in the GDE unit (San Joaquin River GDE Unit). While it appears the source of shallow groundwater adjacent to the SJ River is stream seepage from the SJ River (when water is present) and shallow groundwater does not support surface water flows, there nevertheless is some potential for surface water flows and the shallow groundwater system supporting GDEs to be affected by regional pumping during certain times when shallow groundwater is present below the stream thalweg but within the root zone of GDEs. These GDEs/beneficial users include environmental users such as riparian vegetation along the SJ River and the wildlife habitat and ecosystem functions it provides. The potential effects on the San Joaquin River Riparian GDE Unit are presented in Revised GSP Appendix 2.B.

As summarized above, the revised Chowchilla Subbasin GSP established interim SMC for ISW based on DWR review/input received in the initial consultation letter. However, additional characterization of the relationship between groundwater and surface water along the San Joaquin River is needed to provide an improved basis for making a final determination of the nature of the interconnection and appropriate SMC (if needed). 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).

Proposed Scope of Work

The proposed scope of work involves seven main tasks including collection and analysis of existing data (beyond data compiled for the Revised GSP), installation of new monitoring facilities and collection of additional field data, completion of additional technical analyses, and completion of an updated assessment of presence/absence of ISW with recommendations for updated SMC (if necessary). The proposed scope of work is described in more detail below. It should be noted that implementation of the potential work set-forth herein is predicated on Groundwater Sustainability Agency (GSA) approval and allocation of the necessary funds as may be required (local funding and/or grants).

Task 1. Compile Additional Existing Data/Analyses (Supplemental to GSP)

Compile and Review Supplemental Existing Data

In this task, data collected during preparation of the Revised GSP will be supplemented with other newly available data related to ISW along the SJ River including:

- information presented in GSPs for other subbasins adjacent to the San Joaquin River in the area, such as the GSP prepared by the San Joaquin River Exchange Contractors;
- available data related to the Subsidence Control Measures Agreement (Subsidence Agreement);

- new data available from specific local landowners or entities previously not available for incorporation into the Revised GSP;
- DWR Well Completion Reports (WCRs) for the area immediately adjacent to the San Joaquin River (i.e., a zone extending approximately one mile on either side of the River along the western boundary of Chowchilla Subbasin);
- additional data compiled by USBR for the SJRRP for areas in the Subbasin;
- additional data from USGS and modeling information for their study of the San Joaquin River;
- and other reports and data that may now be available.

The available data will be compiled and reviewed to inform subsequent field work (Task 2) and as input for technical analyses (Task 3).

AEM Data

Data from airborne electromagnetic (AEM) surveys conducted in Spring 2022 to support additional characterization of subsurface conditions in the Subbasin and surrounding areas are expected to be available around the end of 2022. AEM data can provide helpful information on hydrogeologic conditions through measurements of the resistivity of subsurface materials. These surveys have the potential to improve the understanding of the configuration and composition of different subsurface materials. To the extent that AEM data was collected in the vicinity of the western boundary of Subbasin along the San Joaquin River, these data will be evaluated for their potential usefulness in helping to supplement the delineation of shallow stratigraphy along the portion of San Joaquin River that forms a portion of the western boundary of Subbasin. One potential application of AEM that is of particular interest related to potential interconnectedness of surface water is delineation of any shallow clay layers under and adjacent to the SJ River. A quality assurance/quality control (QA/QC) analysis of the data will be conducted by comparing AEM hydrostratigraphic interpretations to existing and new field data collected as described in this Workplan. Lithologic data from borehole logs along AEM section lines will be compared to evaluate if AEM interpretations are consistent with field data. If AEM data interpretations are found to be consistent and the resolution of shallow aquifer stratigraphy from AEM data interpretations is sufficient, the AEM data will be combined with field borehole lithologic data to develop refined hydrogeologic cross-sections along the San Joaquin River (as described below in Task 3).

Task 2. Complete Additional Field Work

Instrumentation of Existing Wells

The monitoring frequency in some of the Representative Monitoring Site (RMS) wells designated for the ISW minimum thresholds (MTs) and measurable objectives (MOs) in the Revised GSP presents some limitations for characterizing groundwater level fluctuations and development of appropriate SMC. The RMS wells related to ISW include MCW RMS-1, MCW RMS-2, MCW RMS-3, MCW RMS-10, MCW RMS-11, and MCW RMS-12 (**Figure 1**). These wells do not currently have continuous and automated groundwater level monitoring with pressure transducers. 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. If further characterization and evaluation of ISW during implementation of this Workplan determines there are important benefits to continuous monitoring of other (non-ISW SMC) RMS wells, and arrangements can be made with the well owner(s), additional well instrumentation could be prioritized for implementation. It is assumed for purposes of estimating the cost of implementing the Workplan that two additional RMS wells will be selected for instrumentation.

New Monitoring Facilities and Field Data Collection.

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 San Joaquin River. 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. Potential field efforts are described in more detail below.

Install New Monitoring Wells

Monitoring wells are recommended for installation at four locations near the San Joaquin River to augment existing groundwater level monitoring to understand dynamics between surface water conditions in the SJ River, groundwater conditions at very shallow depths where there is greater potential for interconnection between groundwater and surface water, and groundwater conditions in the regional groundwater system where groundwater is extracted by wells for irrigation and other uses. Two locations will target sites near existing SJRRP monitoring wells MCW RMS-10 and MCW RMS-11, which are approximately 30 feet deep; the new monitoring wells at these two locations will be screened slightly deeper in a coarse-grained zone between depths of 50 to 90 feet below ground surface (bgs). In addition, two new locations will be selected for installation of nested monitoring wells: one screened in the upper 30 feet and one screened at depths between 50 and 90 feet. Preliminarily identified locations for potential new nested wells are shown in **Figure 1**, pending the outcome from review of additional data and evaluation of site suitability relating to access for construction and ongoing monitoring. Target well locations may also include consideration of proximity to existing production wells that might be used in evaluating shallow groundwater level responses to pumping from deeper zones.

The monitoring wells are planned to be drilled using the hollow-stem auger drilling method with split spoon core sediment samples collected every five feet. A lithologic log of the borehole will be prepared based on samples collected and under the supervision and guidance of a Professional Geologist, who will also provide recommendations regarding well construction details such as depth intervals for placement of well screen, filter pack, blank casing, and surface sanitary seal. Preliminarily, the new monitoring wells are planned to be constructed using 2-inch diameter Schedule 40 PVC materials, which will enable installation of automated groundwater level monitoring instrumentation and also provide access for groundwater quality sampling equipment. The new monitoring wells and existing RMS wells listed above will be surveyed to a consistent elevation datum to ensure there are no recent changes in groundwater surface or reference point elevations related to any recent ISW that may have occurred in the area. Water quality samples will be collected from the new monitoring wells, and they will be outfitted with pressure transducers for ongoing automated collection of groundwater level data.

Install Stream Stage Recording Device(s)

Accurate assessment of dynamics related to surface water-groundwater interaction requires detailed information on river stage for relating to groundwater levels. There is only one currently active stream stage monitoring location along the San Joaquin River within the Chowchilla Subbasin (**Figure 2**). Installation of stream stage recorders are recommended at four locations corresponding to the locations of nested monitoring wells described in this Workplan (assuming permission/access can be obtained). Various options for instrumentation should be considered, but options include constructing the stream stage recorders from small-diameter (1- or 2-inch) PVC slotted pipe, which could be secured to the riverbank and extended into the low flow channel to enable the pipe to remain submerged during low-flow conditions and also provide access to monitoring instrumentation during higher flow conditions. A transducer would be installed in the PVC pipe for automated collection of river stage at all flow conditions. The river stage recorders will be coupled with a staff gage for periodic manual readings of stage to ensure accuracy of all data collected through automated instrumentation. The staff gage and stream stage recorder will be surveyed to the same elevation datum as the new monitoring wells.

Complete Stream Profile Surveys

Stream channel elevation profiles will improve characterization of the San Joaquin River channel elevation and shape, which relates to potential for interconnectivity between surface water and groundwater when compared with groundwater levels. To better characterize the potential surface water-groundwater interconnectivity along the San Joaquin River, stream channel elevation profiles perpendicular to the river channel orientation will be obtained at key locations through surveying, using the same elevation datum used for the monitoring wells and river stage recorders. The stream channel profiles will be conducted near each of the four new nested monitoring well locations and will extend perpendicularly from the new/existing monitoring well locations on the east side of the river and across the San Joaquin River to the opposite riverbank (and possibly to any existing nearby monitoring wells on the west side of the river). The stream channel surveys should be conducted at a time of low flow (or no flow) in the river in an effort to accurately survey as much of the streambed as possible.

Complete Aquifer Testing

One of the key aspects related to ISW that is not well characterized in the areas along the San Joaquin River includes understanding of how groundwater pumping from the regional aquifer may influence groundwater levels in the very shallow part of the groundwater system (and in turn surface water), especially in areas where the movement of water between the shallow part of the groundwater and the deeper regional groundwater system may be impeded to a great degree by the presence of clay layers. Aquifer testing conducted through pumping of existing production wells while monitoring conditions in the shallow part of the groundwater system and in the nearby SJ River would help understand the cross-communication between different depth zones of the groundwater system and potential communication between shallow groundwater and streamflow. One of the goals of the proposed aquifer testing is to evaluate how clay layers located between the top of the pumping well screen and bottom of the streambed do or do not impede a connection between groundwater pumping and streamflow. If cooperation can be obtained with one or more landowners having a suitable production well near the San Joaquin River in Chowchilla Subbasin, one or more pumping tests will be performed to evaluate pumping effects on shallow groundwater levels and streamflow. A suitable production well for this testing would be screened in the Upper Aquifer at a location sufficiently close to the San Joaquin River and to adjacent shallow monitoring wells to potentially have an effect on streamflow and shallow groundwater levels in close proximity to the River within the planned pumping duration (if there is a connection between groundwater and surface water). The timing of the test will also be important with considerations being given to performing the test at a time with higher shallow groundwater elevations (to maximize chances of having a connection between streamflow and shallow groundwater levels) while having a lower range of stream discharge (to maximize opportunity to see effects on streamflow).

If cooperation with existing production well owners cannot be obtained, consideration will be given to implementing "passive" aquifer testing. This type of testing would involve conducting continuous groundwater level monitoring in proximity to a production well to observe whether influences from normal pumping cycles can be discerned in nearby shallow groundwater and surface water. In this type of testing there will be no controlled/coordinated start and stop of pumping or attempts to maintain a consistent pumping rate, but rather the well would be operated in accordance with normal use without any coordinated pumping period.

Task 3. Technical Analyses

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, technical analyses involving construction of detailed hydrogeologic cross sections along the San Joaquin 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.

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. These cross-sections will include the most recent available data on groundwater levels, stream thalweg elevation (stream profiles conducted for this Workplan and available LiDAR data), and stream stage in conjunction with subsurface stratigraphy. The specific locations and orientation of the cross-sections will depend on where available data exist, including new data collected through Tasks 1 and 2, but are expected to include cross-sections oriented both parallel to and perpendicular to the San Joaquin River. The perpendicular cross-sections will focus on locations aligned with new monitoring well locations.

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). Available information indicates these dynamics vary over time and space depending on climatic/hydrologic conditions within a year (seasonal fluctuations) and from year to year (variations from wet years to dry years). Analyses presented in the Revised GSP based on the limited available historical data suggest that periods with greater streamflow correspond with higher rates of stream infiltration (seepage) that provide a source of water to the shallow zone resulting in higher groundwater levels where shallow clay layers are present to impede downward flow of infiltrating surface water. During time periods of no or minimal river flows, previous analyses suggest that lower rates and very little or no stream infiltration occur that reduce the available source of water to the shallow zone that and lead to rapidly declining groundwater levels in the shallow zone. 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 San Joaquin River forms the boundary of Chowchilla Subbasin to improve understanding of groundwater conditions in relation to surface water.

Task 4. Outreach

To be determined, but likely to involve NOAA-NMFS, USBR, and others.

Task 5. Groundwater Modeling (in Conjunction with 5-Year GSP Update)

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 western part of the Subbasin. The groundwater model will be used to assist in evaluation of the potential for ISW to be present along the San Joaquin River, and to further evaluate the potential for connection between regional groundwater pumping and surface water flows.

Pending the results from analyses conducted as part of Task 3 and the model update planned as part of the five-year update of the Revised GSP, it is anticipated that additional model scenarios may need to be developed to enable more detailed assessment of stream-aquifer interaction via model simulations of conditions and mechanisms across the entire Subbasin, especially the western Subbasin. Potential additional model runs could include simulation of 50 years of future hydrology while varying the amount and distribution of groundwater pumping. Comparisons between such hypothetical model runs could be used to improve understanding of the influence of groundwater pumping in the Subbasin on shallow groundwater levels, stream flow/stage, and dynamics of connectivity between groundwater and surface water, including frequency, duration, and percent of time any interconnectivity occurs. 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 San Joaquin 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 Revised GSP) under Task 5.

Task 6. Assessment of Presence of Interconnected Surface Water and Possible Revisions to SMC

The ultimate outcome from efforts conducted as part of this Workplan will be an assessment and establishment of appropriate SMC related to ISW as part of the five-year update of the Revised GSP. This will include potential refinements or modifications to interim SMC established in the Revised GSP, if determined appropriate. In conducting this assessment, the data and analyses developed through implementation of Tasks 1 through 4 of the Workplan will be used to evaluate whether ISW exists along the western boundary of Chowchilla Subbasin and if there is need to include SMC for ISW in the Revised GSP for the Chowchilla Subbasin. An important consideration related to ISW and how and whether SMC are established for ISW is that once shallow aquifer groundwater levels fall to a point where they are disconnected from the river, additional declines in groundwater levels will no longer affect the rate and amount of stream infiltration/depletion. This fact, combined with the difference between historical and current/future San Joaquin River flow releases from Friant Dam as part of the SJRRP, likely means that rate or amount of stream depletion are not appropriate metrics for defining ISW SMC, including undesirable results. Additionally, groundwater levels as a proxy for stream depletion is also not an appropriate SMC metric for two key reasons: 1) elevations of shallow groundwater levels below the threshold when groundwater and surface water become disconnected will make not affect the rate/amount of stream depletion, and 2) historical shallow groundwater level data suggest that shallow groundwater levels have commonly been below the threshold when they become disconnected from surface water and such conditions are likely to continue to occur under future conditions. As described in the Revised GSP and used as an interim ISW SMC metric in the GSP, a potential SMC metric relating to the percent of time ISW occurs based on the occurrence during historical conditions (prior to 2015), likely provides the most appropriate ISW SMC metric for future management of groundwater in the Subbasin. However, because interconnectivity of surface water may only occur under limited hydrologic circumstances (i.e., brief periods during the winter or spring and/or during wet water years) implementing this metric necessitates that ISW conditions be evaluated over an extended period of time (e.g., 5 years as currently used as part of the interim SMC or more) to ensure the SMC assessment period spans a representative range of climatic/hydrologic conditions.

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 San Joaquin River in the Subbasin under conditions prior to and after initiation of the SJRRP.

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 ISW Workplan. A Draft TM/Report will be submitted for review by the GSAs (and their technical representatives). Comments and suggested edits received from GSAs will be reviewed and incorporated as appropriate into a Final TM/Report. The Report will include documentation of all data compiled, field work completed, technical analyses performed, modeling results, and evaluation of the nature of groundwater – surface water interactions and recommended updates to SMC. In addition, the TM/Report will include a review and summary of any remaining data gaps and recommendations for future monitoring and assessment, as needed.

Schedule

The overall implementation of this Workplan is envisioned as a longer-term effort to develop important monitoring data and facilities for tracking and understanding groundwater conditions related to ISW in the Subbasin. Additional tasks are geared towards completion in time for incorporation into the first five-year update of the Revised GSP. However, some tasks described in the Workplan will likely extend beyond January 2025, including ongoing data collection. These longer-term tasks include field work involving installation of monitoring facilities, which should be phased with consideration of funding and cooperation from other entities needed to support these efforts. Implementation of the Workplan is planned to start in 2023 with commencement of the additional data review and compilation task. Similarly, field work is also planned to begin in 2023, primarily with well inventory survey efforts and review of opportunities to instrument existing wells. As a result, not all of the field work described in this Workplan is anticipated to be completed prior to January 2025 when the first five-year update of the Revised GSP is to be submitted. A general planned schedule for implementation of the Workplan is outlined below in **Table 1**.

Table 1. Summary of Proposed Schedule for Implementation of the Interconnected Surface Water Workplan		
Task No.	**Task Description**	**Task Completion Timeframe**
1	Compile Additional Existing Data/Analyses (Supplemental to GSP)	Mid 2023 - Late 2023
2	Complete Additional Field Work	Late 2023 - 2026+ (field work may be phased depending on available funding)
3	Technical Analyses	Mid 2023 - Late 2024
4	Outreach	Early 2024 - Late 2024
5	Groundwater Modeling (in Conjunction with 5-Year GSP Update)	Early 2024 - Late 2024+
6	Assessment of Presence of Interconnected Surface Water and Possible Revisions to SMC	Late 2023 - Late 2024
7	Prepare a Technical Memorandum or Report	Mid 2024 - Late 2024 for interim deliverable; 2026+ for final deliverable

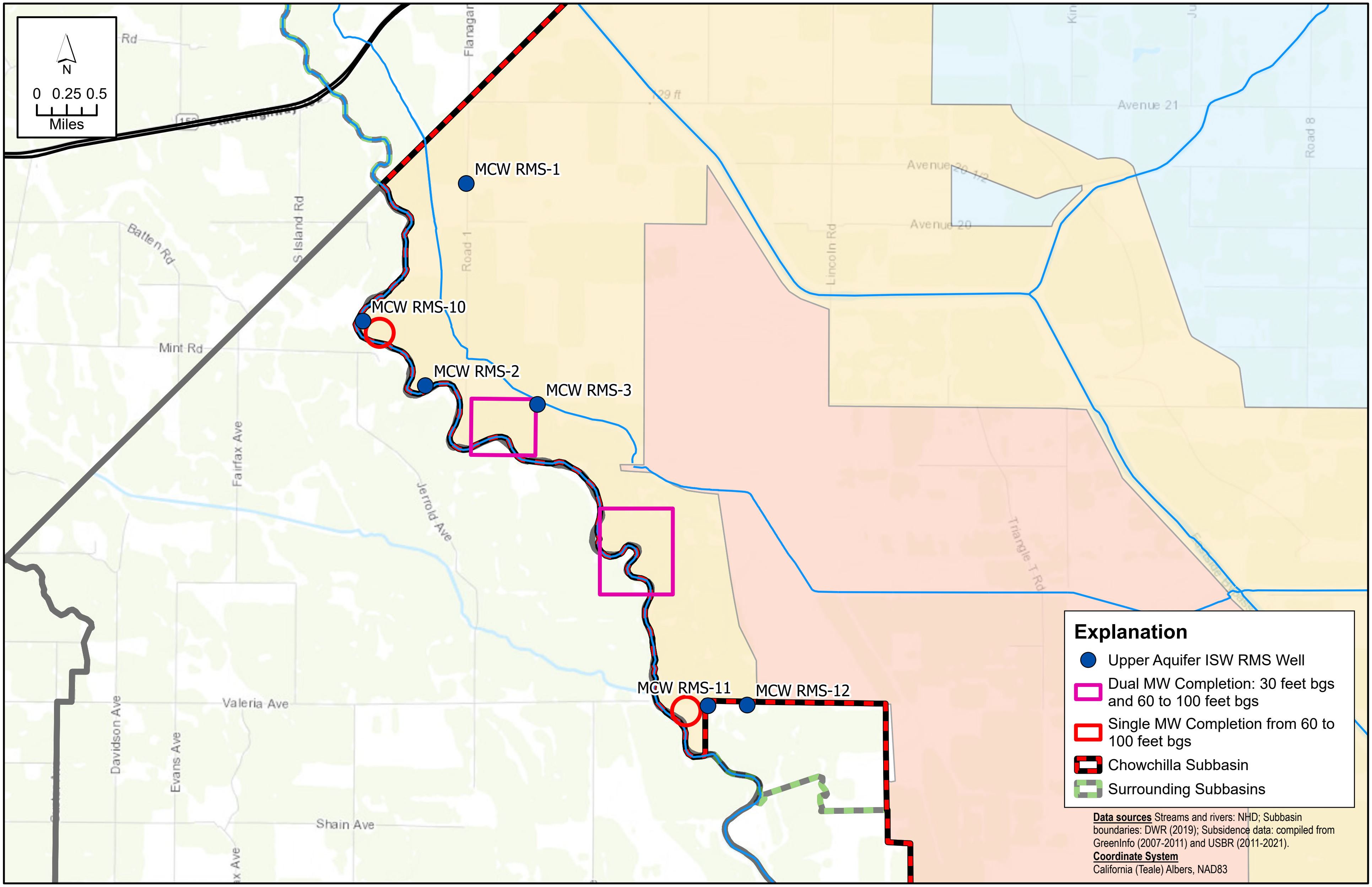


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FIGURE 1
Proposed Monitoring Well Locations for ISW Workplan

Chowchilla Subbasin
Groundwater Sustainability Plan

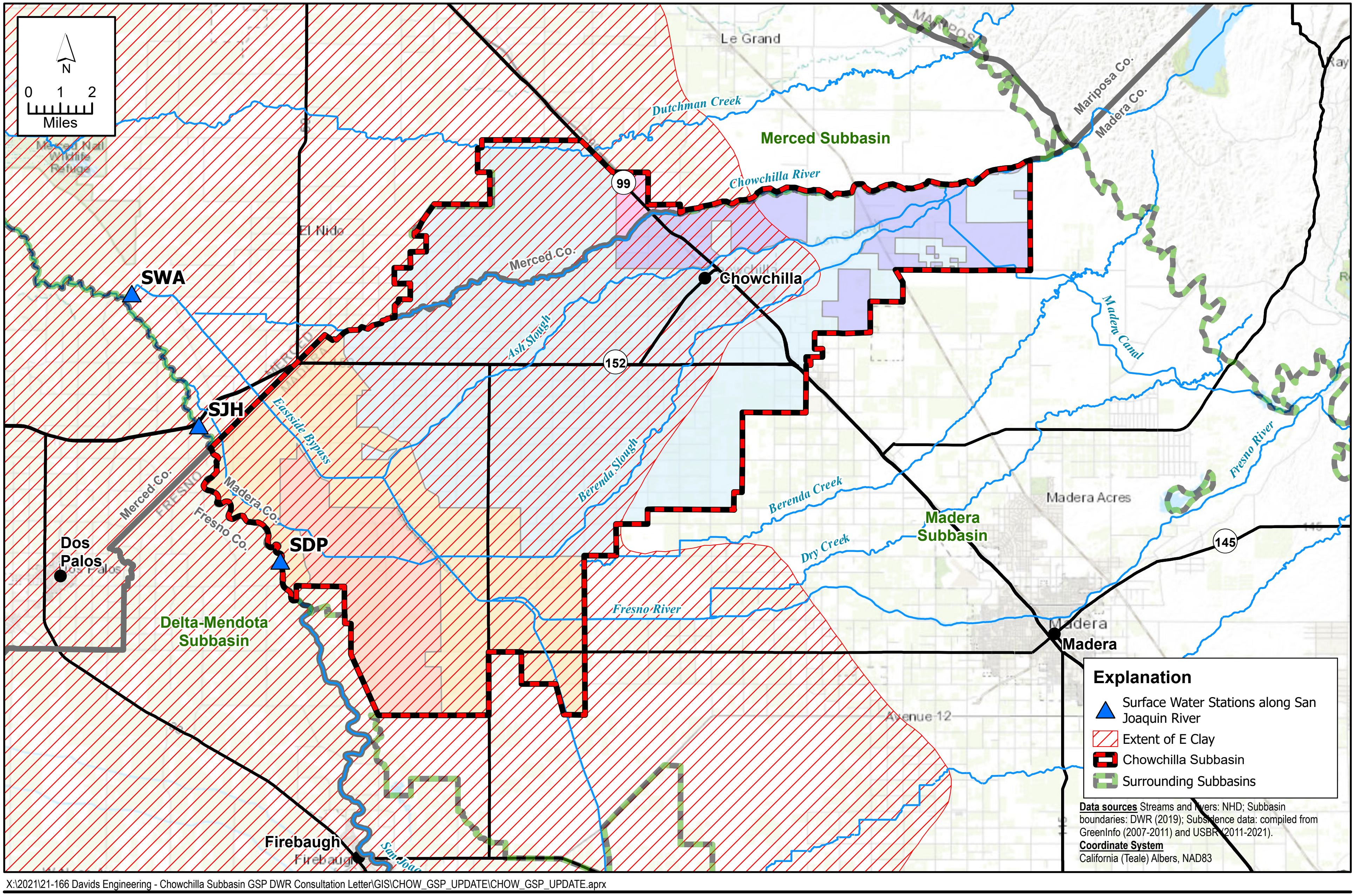

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FIGURE 2

Surface Water Stations along San Joaquin River in Madera Subbasin

Chowchilla Subbasin
Groundwater Sustainability Plan