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Twentynine Palms Groundwater Management Plan 2024 Update

30 July 2025

Prepared for

Twentynine Palms Water District
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KJ Project No. 2444214*00

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List of Abbreviations

AB	Assembly Bill
AF	Acre-feet
AFY	Acre-Feet per Year
As	Arsenic
bgs	Below Ground Surface
BMOs	Best Management Objectives
CASGEM	Statewide Groundwater Elevation Monitoring
CECs	Contaminants of Emerging Concern
City	City of Twentynine Palms
COC	Constituent of Concern
County	San Bernardino County
Cr-6	Hexavalent Chromium
CWSA	Community Water Systems Alliance
DDW	Division of Drinking Water
District	Twentynine Palms Water District
DWR	California Department of Water Resources
DWSAP	Drinking Water Source Assessment and Protection
EPA	US Environmental Protection Agency
ET	Evapotranspiration
F	Fluoride
GPCD	Gallons per capita per day
gpm	Gallons per minute
GWMP	Groundwater Management Plan
IRWMP	Integrated Regional Water Management Plan
JBWD	Joshua Basin Water District
LAMP	Local Agency Management Program
Marine Base	Marine Air Ground Task Force Training Command Center
MCL	Maximum Contaminant Level
mg/L	Milligrams per liter
MGD	Million gallons per day
MWA	Mojave Water Agency

NGS	National Geodetic Survey
NL	Notification Level
NOAA	National Oceanic and Atmospheric Administration
O&M	Operations and Maintenance
OWTS	Onsite Wastewater Treatment System
PCAs	Potentially Contaminating Activities
PHG	Public Health Goal
PHG	Public Health Goal
QTf	Tertiary-Quaternary Age
RL	Response Level
RWQCB	Regional Water Quality Control Board
SB	Senate Bill
SDWA	Safe Drinking Water Act
SGMA	Sustainable Groundwater Management Act
SMCL	Secondary Maximum Contaminant Level
SNMP	Salt and Nutrient Management Plan
SSME	Septic System Management Elements
SSMP	Septic System Management Program
SWP	State Water Project
SWRCB	State Water Resources Control Board
TDS	Total Dissolved Solids
TPWD	Twentynine Palms Water District
Ts	Tertiary Age
ug/L	Micrograms per liter
USGS	United States Geological Survey
UWMP	Urban Water Management Plan
WMP	Water Management Plan
WSA	Water Supply Assessment

Executive Summary

The **2024 Groundwater Management Plan (GWMP)** Update is intended to provide the Twentynine Palms Water District (TPWD or District) with a planning tool to protect the quantity and quality of groundwater within its service area. The 2024 GWMP update leverages information from:

- **2014 Groundwater Management Plan** – The 2014 characterized groundwater conditions at the time and identified best management objectives for managing the resource. The 2024 GWMP updates the 2014 plan with more current data and information.
- **2020 Urban Water Management Plan** – The 2020 UWMP is a mandated planning document that guides the actions of urban water suppliers, providing managers and the public with a broad perspective of water supply issues.
- **Ongoing Data Collection by the District** – the GWMP incorporates pumping and water quality data through 2023 and water level monitoring data up to August 2024.

The following 10 points provide an overview of the 2024 GWMP Update.

ES-1 Purpose

The **purpose** of the 2024 GWMP is to serve as a planning tool to assist the District to maintain safe, sustainable, and high-quality groundwater resources in the long term. Groundwater management is planned and coordinated locally to ensure a sustainable groundwater basin to meet future water supply needs. The **objectives** of the updated GWMP are to address issues of **groundwater sustainability, water supply reliability, aquifer health, and water quality**.

Strategic Priorities:

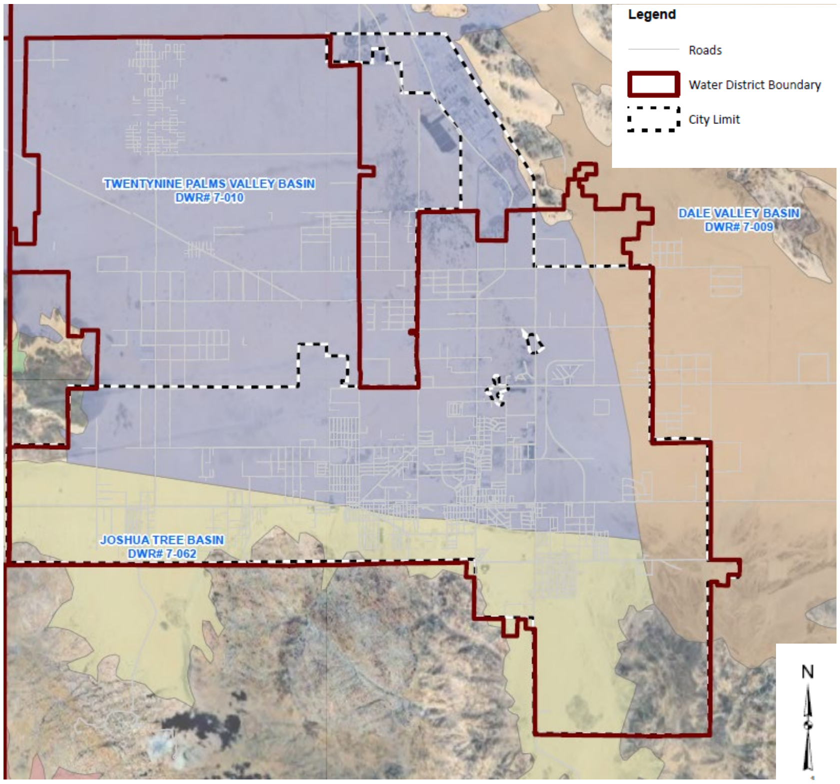
- Groundwater Sustainability
- Water Supply Reliability
- Aquifer Health
- Water Quality

The GWMP is considered a "living document" that the District intends to update periodically to report on the progress made in managing groundwater resources.

ES-2 Overview of the District

The District encompasses approximately 87 square miles and includes the City of Twentynine Palms and a portion of the areas outside the City (Figure ES-1). Groundwater is the primary source of water, with groundwater overdraft in parts of the basins due to pumping. Since 2010, pumping and water deliveries have generally leveled off, and have even decreased in recent years due to increased precipitation and groundwater recharge, as well as conservation efforts.

Figure ES-1 – Map Showing TPWD District, City Boundaries, and Groundwater Basins



ES-3 Groundwater Basins and Setting

TPWD is located within the Morongo Basin region, which has been divided into multiple groundwater basins, including three within the TPWD area (Joshua Tree, Twentynine Palms Valley, and Dale Valley) (Figure ES-1). The management area for this GWMP includes the groundwater basins and subbasins underlying the TPWD service area, which are more or less separated from one another by hydrologic barriers, including bedrock ridges, faults, and folds. Groundwater subbasins in the TPWD area are shown on Figure ES-2. The relationship between subbasins and basins is illustrated in Table ES-1.

Figure ES-2 – Groundwater Subbasins in the GWMP Management Area

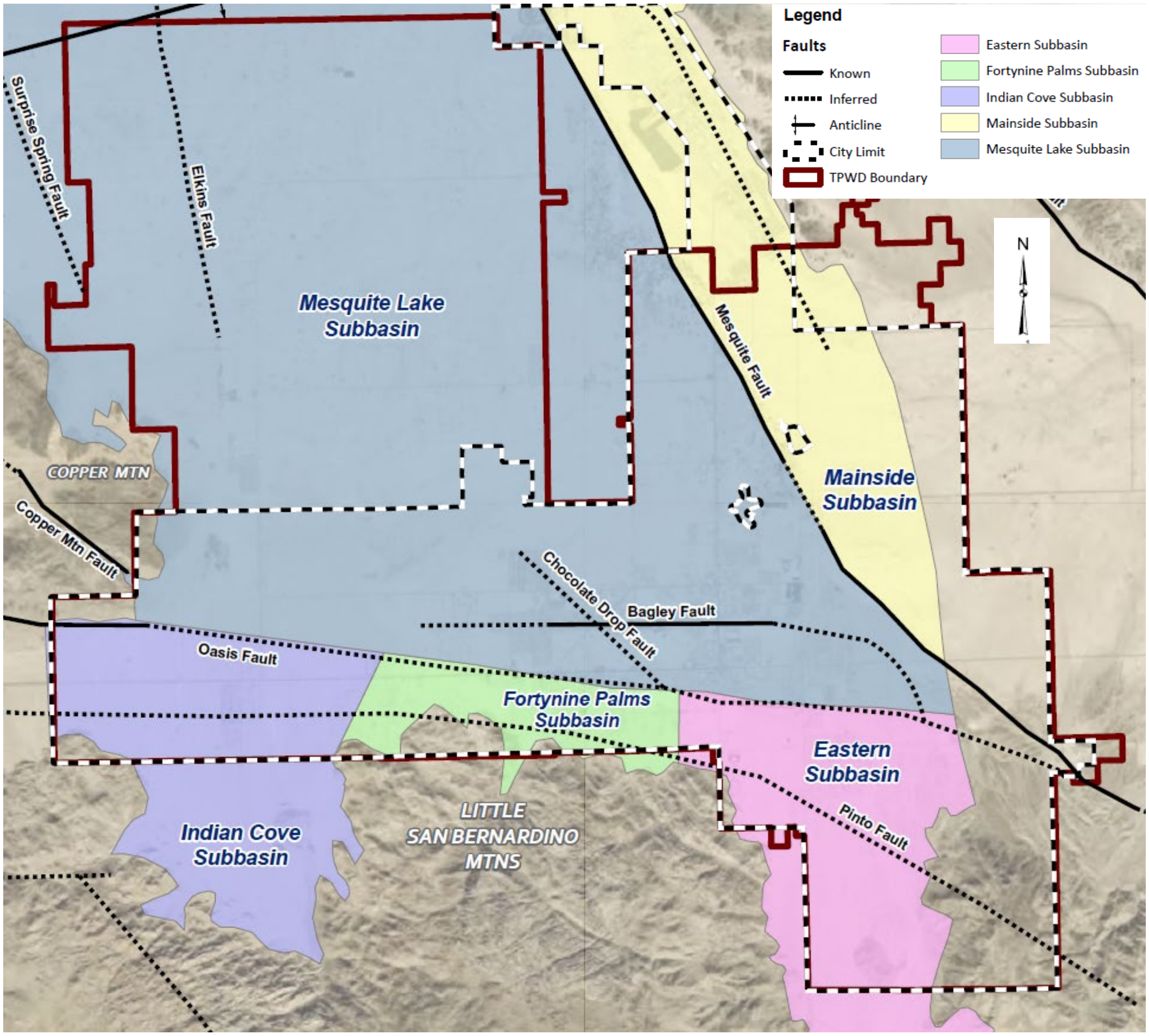
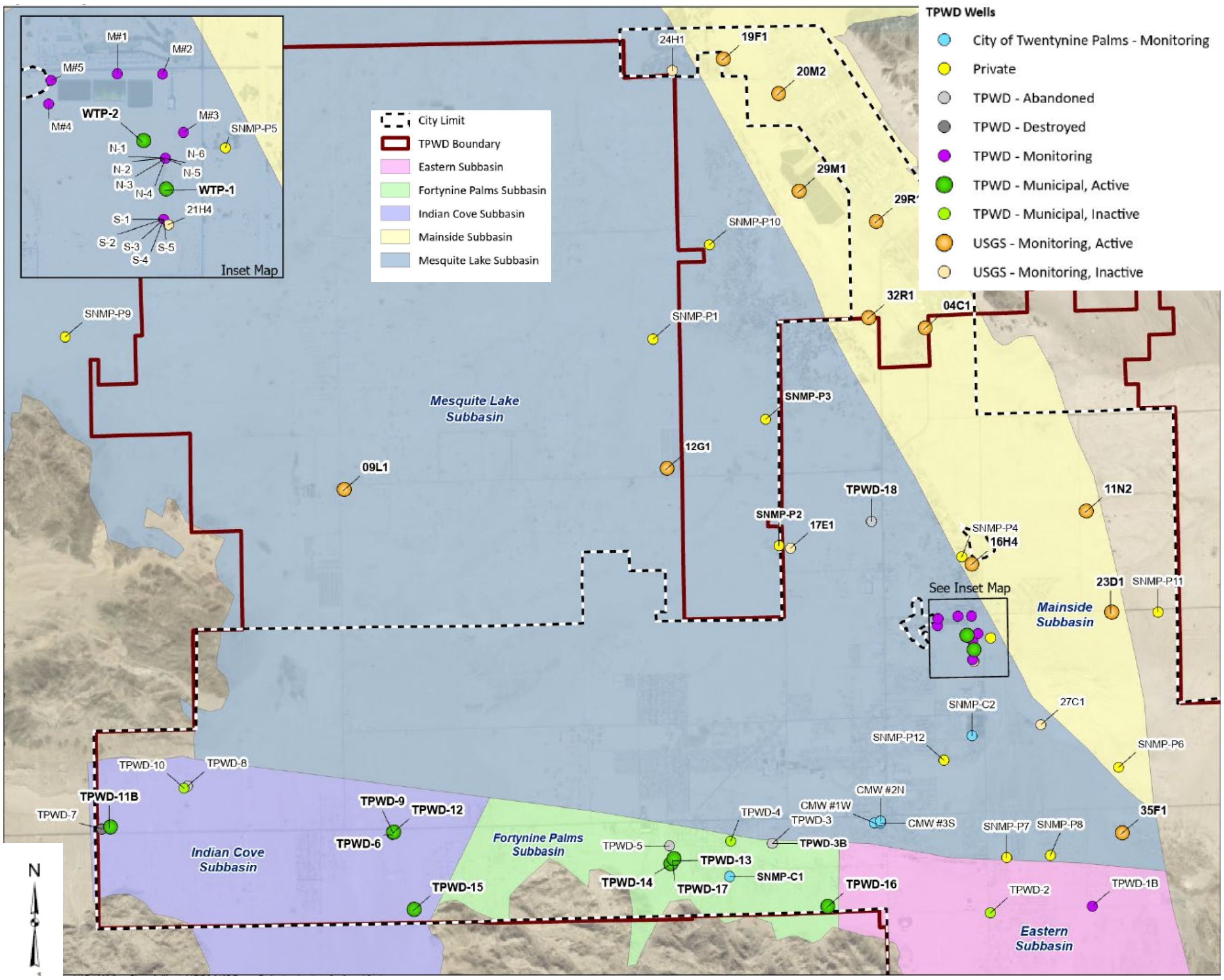


Table ES-1: Relationship Between Groundwater Basins and Subbasins in the GWMP Management Area

Groundwater Basin:	Joshua Tree Basin	Twentynine Palms Valley Basin	Dale Valley Basin
Subbasin	Indian Cove	Mesquite	Little to no pumping or historical data; not considered part of management area
	Eastern	Mainside	
	Fortynine Palms		

The District collects groundwater level, water quality, and production data in the GMWP area. In addition, the United States Geological Survey also collects groundwater level monitoring data. Production and monitoring well locations are shown on Figure ES-3. As shown, most TPWD water supply wells are located along the southern limit of the service area in the Indian Cove, Eastern, and Fortynine Palms Subbasins because of the superior water quality compared to that in the Mesquite Lake Subbasin, where fluoride concentrations are of concern.

Figures ES-3 – Wells in the GWMP Area



ES-4 Groundwater Use

Groundwater is the sole source of water supply for TPWD, thus, groundwater pumping by the District is a good indication of water use in the service area. The District has had 20 total groundwater production wells in its history. As of 2024, the District has eight active production wells and pumps from four groundwater subbasins (Indian Cove, Fortynine Palms, Eastern, and Mesquite Lake); TPWD does not currently pump groundwater from the Mainside Subbasin.

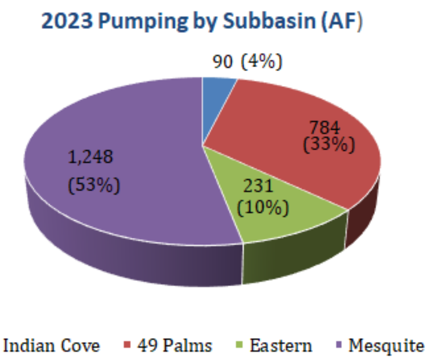


Figure ES-4 shows the annual groundwater pumping by subbasin. Groundwater pumping in 2023 was 2,352 acre-feet (AF), with 53% of the supply coming from Mesquite Subbasin; 33% from Fortynine Palms Subbasin, 10% from Eastern Subbasin; and 4% from Indian Cove Subbasin. It is noted that current pumping is limited to prevent overdraft in the Indian Cove and Fortynine Palms Subbasins. Active production wells, capacities, and pumping are summarized in Table ES-2.

Figure ES-4 – Annual Pumping by Subbasin

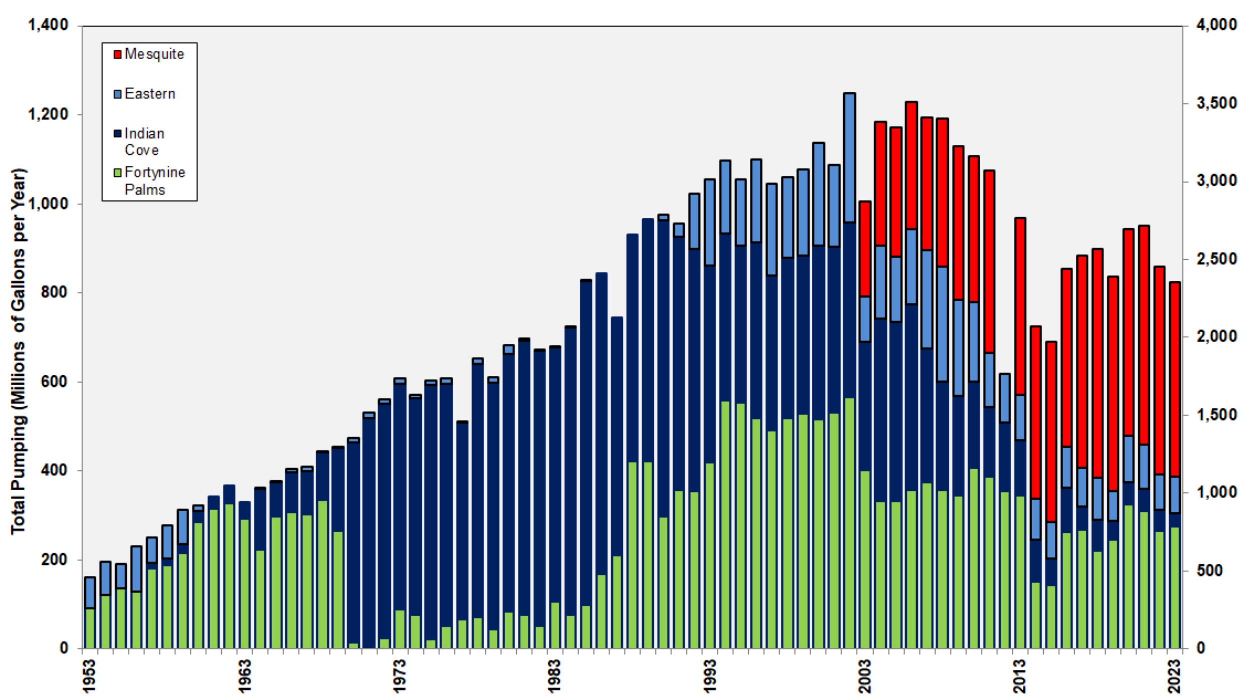


Table ES-2 - TPWD Active Production Well Capacity and Use Summary

Well Name	Pumping Capacity (gpm)	Potential Maximum Annual Extraction (AFY)	2023 Groundwater Pumped (AF)	2023 Percent of Capacity
		Indian Cove Subbasin		
TPWD-11B	400	645	15	2%
TPWD-12	385	621	75	12%
TPWD-15	100	161	0	0%
		Fortynine Palms Subbasin		
TPWD-14	700	1,129	313	28%
TPWD-17	700	1,129	470	42%
		Eastern Subbasin		
TPWD-16	500	807	231	29%
		Mesquite Lake Subbasin		
WTP-1	2,100	3,387	523	15%
WTP-2	2,100	3,387	725	21%

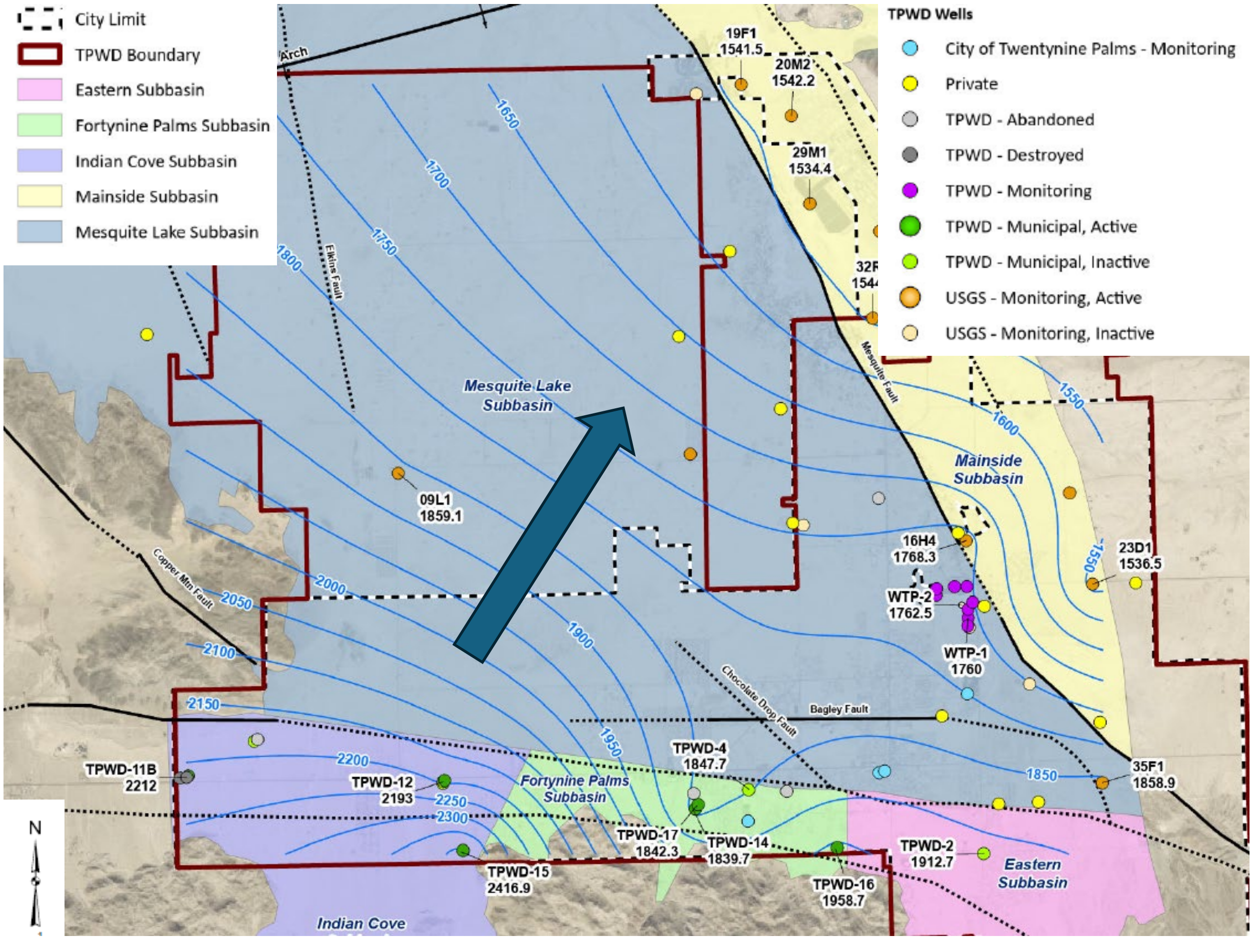
ED-5 Water Use Assessment

Water demand is anticipated to increase in response to population growth, and groundwater will continue to be the sole source for meeting demand. As reported in the District's 2020 UWMP, the 2020 population was 16,182, with a water demand of 2,449 AF; the projected population in 2045 is 24,038, with a projected water demand of 3,200 AF.

ES-6 Groundwater Conditions

Figure ES-5 presents current groundwater elevation contours across the five subbasins for "Spring"" conditions (averaged for years 2022 – 2024). Groundwater generally flows toward the northeast across the GWMP area, as shown by the blue arrow. Composite hydrographs were prepared for each subbasin to show groundwater trends through time, and these are included in the report.

Figures ES-5 – Spring (2022 – 2024) Groundwater Elevation Map



ES-7 Water Budget

A water budget is used to evaluate the health of a groundwater basin.

- **Inflows** consist of total return flow (irrigation return flow and septic return flow), groundwater inflow, and natural recharge (precipitation recharge, streamflow infiltration, mountain front recharge, and mountain block recharge).

- **Outflows** consist of groundwater pumping, natural discharge (evapotranspiration and spring flow, and groundwater outflow.

The hydrologic water balance for current conditions is shown in Table ES-3 showing an annual change in storage range of -2,484 to +1,029 AFY. **Results indicate that more groundwater is being removed from the groundwater basins** (between 2,773 to 4,422 AFY) than is entering (between 1,938 to 3,801 AFY) during an average year.

Table ES-3 Hydrologic Water Budget Summary: 2024 Conditions

	Groundwater Inflow (AFY)			Groundwater Outflow (AFY)			
Subbasin	**Total Return Flow**	**GW Inflow**	**Natural Recharge**	**GW Pumping**	**Natural Discharge**	**GW Outflow**	**Change in Storage**
Indian Cove	143	36 to 75	3 to 111	112	0	10 to 30	+40 to +207
Fortynine Palms	146	0 to 140	7 to 280	772	0	0 to 120	-739 to -206
Eastern	186	0 to 50	2 to 240	229	20 to 75	0 to 50	-166 to +227
Mesquite Lake	1,285	105 to 808	0 to 179	1,290	340 to 1630	0 to 114	-1,644 to +642
Mainside	25	0 to 115	0 to 21	0	0	0	+25 to +161
Total	**1,785**	**141 to 1,188**	**141 to 1,188**	**2,403**	**360 to 1,705**	**10 to 314**	**-2,484 to +1,029***
	Range = 1,938 – 3,801			**Range = 2,773 – 4,422**			

Note - * The lower bound of the annual change in storage range (-2,484 AFY) is equal to the sum of the minimum inflows minus the sum of the maximum outflows (1,938 AFY – 4,422 AFY). The upper bound of the annual change in storage range (1,029 AFY) is equal to the sum of the maximum inflows minus the sum of the minimum outflows (3,801 AFY – 2,773 AFY).

Long-term groundwater sustainability considers the hydrologic water balance under projected conditions in 2045. The hydrologic water balance for 2045 projected conditions shows a projected annual change in storage range of -2,893 to 620 AFY. Projections indicate that more groundwater will be removed from the groundwater basins (3,781 to 5,430 AFY) than is expected to enter (2,537 to 4,401 AFY) during an average year.

Results of this hydrologic water balance indicate potentially declining storage conditions (i.e., more groundwater pumping than groundwater recharge, than present). Under these conditions, it is anticipated that groundwater levels will continue to decline.

ES-8 Groundwater Quality

District groundwater is typically of good quality. Septic systems may affect groundwater quality, and naturally-occurring fluoride and arsenic are present in some supply wells in certain areas. Below is an overview of conditions through 2023.

Salts and Nutrients

A maximum contaminant level (MCL) is an enforceable drinking water standard for a public water system; a secondary MCL (SMCL) is for non-health based effects such as taste, odor, or color

- Nitrate as N MCL = 10 mg/L
- TDS SMCL = 500 mg/L
- Flouride MCL = 4 mg/L; SMCL = 2 mg/L
- Arsenic MCL = 10 µg/L
- Chromium-6 MCL = 10 µg/L

The historic and current use of septic systems has the potential to affect groundwater quality. The key constituents considered for monitoring septic tank influence are nitrates and total dissolved solids (TDS).

Nitrate - For the TPWD wells, nitrate (as NO_3-N) ranges from non-detect to 7.1 mg/L; all are below the MCL of 10 mg/L for nitrate.

TDS - The TDS content of groundwater ranges from about 120 to 410 mg/L in District supply wells, below the SMCL of 500 mg/L.

Fluoride

Fluoride naturally occurs in local groundwater and is a constituent of concern. Fluoride is relatively low in the Indian Cove, Fortynine Palms, and Eastern Subbasins. Several samples exceed the MCL and SMCL in the Mesquite Lake Subbasin where groundwater has a different chemical character with substantially higher fluoride concentrations. Average fluoride concentrations range from 1.2 to 6.2 mg/L. Throughout the Mesquite Lake Subbasin, concentrations vary between 5.9 and 8.6 mg/L.

Arsenic

Arsenic is a naturally occurring element in groundwater that forms from the erosion and breakdown of geologic deposits; however, arsenic is less commonly associated with contaminant plumes. Arsenic occurs naturally in the Twentynine Palms area and has been detected in concentrations up to 13 µg/L. However, the average arsenic concentration is below 10 µg/L in most District wells. Arsenic concentrations above the MCL are most prevalent in the Indian Cove Subbasin, in the Mesquite Lake Subbasin, with the highest concentration of 13 µg/L and the lowest concentration of 11 µg/. Arsenic is below the MCL in the Eastern and Fortynine Palms Subbasins. Elevated arsenic concentrations require treatment at some District wells.

Chromium-6

Hexavalent Chromium (Chromium-6) is an element that both naturally occurs from the erosion of natural chromium deposits and is produced by industrial processes. Chromum-6 above the MCL has not been detected since sampling began in 2015. Although concentrations reached within 1% of the MCL in the Indian Cove Subbasin, the average Chromium-6 concentration is below 7.7 µg/L in all of the District wells (as of 2023).

ES-9 Best Management Objectives

Basin Management Objectives or BMOs are required under the California Water Code to provide flexible guidelines for the management of groundwater resources. They describe specific actions to be taken by stakeholders to meet locally developed objectives at the basin or sub-area scale. The seven BMOs identified are listed below. Each has corresponding action items proposed in the GWMP.

- **BMO #1 – Manage Groundwater Levels to Maintain Water Supply Sustainability and Reliability**
- **BMO #2 – Maintain and Protect Groundwater Quality**
- **BMO #3 – Support Development of a Local Program for Septic Tank Management**
- **BMO #4 – Monitor and Track Groundwater Supply, Water Quality and Land Subsidence**
- **BMO #5 – Promote Public Participation and Coordination with Other Local Agencies**
- **BMO #6 – Address Planned or Potential Future Water Supply Needs and Issues**
- **BMO #7 – Identify and Obtain Funding Sources for Groundwater Projects**

ES-10 Sustainability Actions and Mitigation of Overdraft Conditions

The District employs several different practices to further enhance the long-term sustainability of water supplies for Twentynine Palms.

Shifting Groundwater Production. The District has used the practice of shifting groundwater production between subbasins to help stabilize declining groundwater levels. This process helps to provide intervals for groundwater levels to stabilize and recover, especially in the Indian Cove and Fortynine Palms Subbasins. The District has increased groundwater production in the Mesquite Lake Subbasin to reduce the amount of groundwater pumped in the Indian Cove, Fortynine Palms, and Eastern Subbasins. The Mesquite Lake Subbasin contains a large volume of groundwater, but groundwater requires treatment primarily for fluoride. The current Fluoride Removal Water Treatment Plant has a capacity of 3 MGD, but currently treats 1.2 MGD, operating at 40 percent capacity. The District plans to expand the operation of the treatment plant up its design capacity of 3.0 MGD. This will allow further pumping reductions in the other basins and provide additional capacity for the practice of shifting groundwater production between subbasins.

Water Conservation. Water conservation is an important method to reduce overdraft (ie, drought tolerant landscaping). The District utilizes public outreach to promote conservation, specifically water conservation brochures distributed in new customer packages and water bills, as well as speakers and events conducted at local schools and community events, which include poster contests and involvement in earth day activities. Additional water conservation measures are described in the 2020 UWMP.

Water Supply Assessment. In evaluating potential future growth, SB 610 and SB 221 amended state law to improve the link between information on water supply availability and certain land use decisions made by cities and counties for defined project types and thresholds. To comply, the District will continue to prepare SB 610 Water Supply Assessments for the Twentynine Palms area to assess future water supplies and control overdraft.

Section 1: Introduction

This updated Groundwater Management Plan (GWMP) was prepared in accordance with Assembly Bill 3030 (AB 3030), also called the Groundwater Management Act (Section 10750 et. seq. of the California Water Code) for the Twentynine Palms Water District (TPWD or District) to protect the quantity and quality of groundwater within its service area.

1.1 Plan Objectives

The GWMP serves as a planning tool to assist the District to maintain safe, sustainable, and high-quality groundwater resources in the long term. Groundwater management is planned and coordinated locally to ensure a sustainable groundwater basin to meet future water supply needs. The objective of the updated GWMP is to address issues of “aquifer health” and “groundwater sustainability”. These issues include:

- Maintain sustainable long-term water supplies,
- Treatment of natural water quality constituents,
- Wastewater management especially of septic tanks, and
- Providing water supply for anticipated population growth.

The GWMP is considered a “living document” that the District intends to update periodically to report on the progress made in managing groundwater resources and to reflect amendments to the California Water Code. This GWMP Update was prepared to expand further on the role of the District in the management of the local groundwater resources and water quality based on the substantial work that has been completed since the 2014 Update (Kennedy Jenks, 2014a).

1.2 Plan Requirements and Organization

The Sustainable Groundwater Management Act (SGMA) created a statutory framework for groundwater management in California, requiring government and water agencies of high- and medium-priority basins designated by the California Department of Water Resources (DWR) to bring groundwater basins to a sustainable level of pumping and recharge to mitigate overdraft. To do this, high- and medium-priority basins were required to from Groundwater Sustainability Agencies and develop Groundwater Sustainability Plans that identify how basin will reach sustainability within 20 years of plan implementation.

TPWD overlies the Dale Valley (7-009), Joshua Tree (7-062), and Twentynine Palms Valley (7-010) groundwater basins (see Section 2.3), all of which are considered very low priority by the DWR. Therefore, groundwater management of these basins is not subject to SGMA. Accordingly, this GWMP has been prepared per Assembly Bill (AB) 359 standards (DWR, 2014, 2024a).

In 1992, the State enacted AB 3030, which was intended to provide local public agencies increased management authority over groundwater resources. Any local public agency that provides water service to all or a portion of its service area and whose service area includes all or a portion of a groundwater basin may adopt a GWMP. AB 3030 was amended in 2002 with the passage of Senate Bill (SB) 1938, which required public agencies seeking groundwater-related grant funding to prepare a GWMP with additional required components. SB 1938 was then superseded in 2011 with the passage of AB 359, which directed local agencies to 1) identify and define groundwater recharge areas, and 2) submit GWMPs to DWR where they are required to be publicly available. This GWMP includes three types of components:

1) SB 1938 and AB 359 mandatory components,

2) AB 3030 and SB 1938 voluntary components, and

3) DWR Bulletin 118-2003 suggested components (DWR, 2003).

Table 1-1 identifies where in this GWMP the information addressing each of these components can be found. A GWMP is a required "baseline" document for agencies seeking State grant funding opportunities. SB 1938 requires that for an agency to be eligible for state funding from the DWR, the GWMP must incorporate the SB 1938 Mandatory Components listed in Table 1-1 (DWR, 2003).

Table 1-1. Legislative Requirements Summary

Components Section	Section
SB 1938 and AB 359 Mandatory Components	
1. Documentation of public involvement statement	Sec. 1.3, App. A
2. Basin Management Objectives (BMOs)	Sec. 6
3. Monitoring and management of groundwater elevations, groundwater quality, inelastic land subsidence, and changes in surface water flows and quality that directly affect groundwater levels or quality or are caused by pumping	Sec. 4,5.4 and 6.5, App. B
4. Plan to involve other agencies located in the groundwater basin	Sec. 6.6
5. Adoption of monitoring protocols	Sec. 6.5, App. B
6. Map of groundwater basin boundary, as delineated by DWR Bulletin 118, with agency boundaries that are subject to GWMP	Sec. 2.3
7. For agencies not overlying groundwater basins, prepare the GWMP using appropriate geologic and hydrogeologic principles	Not Applicable
8. Map identifying the substantial recharge areas to be provided to local planning agencies	Sec. 5.5
AB 3030 and SB 1938 Voluntary Components	
1. Control of saline water intrusion	Sec. 5.6.1
2. Identify and manage well protection and recharge areas	Sec 5.6.3
3. Regulate the migration of contaminated groundwater	Sec 5.6.2
4. Administer well abandonment and destruction program	Sec. 5.6.5
5. Control and mitigate groundwater overdraft	Sec. 4.5.1
6. Replenish groundwater	Sec. 4.5.3 and 6.7
7. Monitor groundwater levels	Sec. 6.5, App. B
8. Develop and operate conjunctive use projects	Sec. 4.5.3 and 6.7
9. Identify well-construction policies	Sec. 5.6.4
10. Develop and operate groundwater contamination cleanup, recharge, storage,	Sec 4.5.3
11. Develop relationships with State and federal regulatory agencies	Sec. 6.6
12. Review land use plans and coordinate with land use planning agencies to assess activities that create reasonable risk of groundwater contamination	Sec. 6.6
DWR Bulletin 118-2003 Suggested Components	
1. Manage with guidance of advisory committee	Sec. 6.6
2. Describe area to be managed under GWMP	Sec. 2
3. Create links between BMOs and goals and actions of GWMP	Sec. 6
4. Describe GWMP monitoring programs	Sec. 6.5, App. B
5. Describe integrated water management planning efforts	Sec. 6.6
6. Report of implementation of GWMP	Sec. 6.5
7. Evaluate GWMP periodically	Sec. 6.7

1.3 Plan Preparation and Adoption Process

The District Board of Directors invited public comment by publishing a summary of the proposed amendments in the Desert Trail on March 12 and March 19, 2025, and holding a public hearing on March 26, 2025 to consider adopting the intent to prepare the GWMP. The item was included on the Board agenda and was published in local media outlets in the area. After the public hearing, the Board passed Resolution 25-02 declaring the District's intention to amend the District Groundwater Management Plan. The March 26, 2025 Board agenda, minutes and Resolution 25-02 are included in **Appendix A**. For those who could not attend, the District provides a meeting link on their website where viewers can see the meeting via a YouTube Channel.

The GWMP was adopted by the District Board of Directors by passing Ordinance 104 on May 28, 2025. Ordinance 104 is presented in **Appendix A**.

1.4 Plan Sections

This GWMP is organized into six sections as follows:

- **Section 1 - Introduction** – provides an introduction to the plan and describes the plan objectives, requirements and preparation & adoption process.
- **Section 2 – GWMP Management Area** – describes the GWMP management area, including a description of the District, other regional purveyors, and groundwater basins. It also reviews the geology and hydrology of the plan area.
- **Section 3 – Groundwater Usage** – presents groundwater usage information.
- **Section 4 – Groundwater Supply Assessment** – provides a groundwater supply assessment with a focus on current conditions and long-term sustainability.
- **Section 5 – Groundwater Quality Conditions** – characterizes groundwater quality conditions and trends. It also includes a summary of management actions in the plan area.
- **Section 6 – Basin Management Objectives and Implementation Plan** – concludes with an updated list of Basin Management Objectives (BMOs) and implementation plan to achieve the BMOs.

Section 2: GWMP Management Area

This section identifies the GWMP management area and, as required, a map showing the DWR groundwater basins within and adjacent to the GWMP area, as defined by DWR Bulletin 118, along with a description of the physical structure. A more detailed description of the local groundwater conditions in the TPWD area is presented in Sections 3 and 4.

2.1 Twentynine Palms Water District

The District encompasses approximately 87 square miles and includes the City of Twentynine Palms (City) and a portion of the areas outside the City (Figure 2-1). Other local and regional entities located immediately adjacent or in the vicinity of the GWMP area are shown in Figure 2-2 and described in Section 2.2.

The management area for this GWMP includes the groundwater basins and subbasins underlying the TPWD service area (Figures 2-3 and 2-4). Within the GWMP management area, the groundwater basins are compartmentalized into a number of smaller subbasins (Figure 2-4) that are more or less separated from one another by hydrologic barriers, including bedrock ridges, faults, and folds. The degree of separation between these subbasins is dependent upon the character of the barriers separating them.

Groundwater is the primary source of water in the GWMP management area. Increased pumping to meet the needs of an increasing resident population has resulted in groundwater overdraft in parts of the basin. Prior to 1954, the Twentynine Palms area was served by three privately owned water companies: Abell Water Company, Condor Mutual Water Company, and Pacific Water Company. TPWD was formed in 1954 and immediately purchased the three water companies; their wells, storage facilities, and piping served as the initial water system for the District. Since the District's formation in the mid-1950s, historical pumping and water deliveries steadily increased until around 2010. Since 2010, pumping and water deliveries have generally leveled off, and have even decreased in recent years due to increased precipitation and corresponding groundwater recharge, as well as and conservation efforts. In the 2010s, annual pumping was on average around 928 million gallons [approximately 2,851 acre-feet per year (AFY)]. For the years 2020-2023, annual pumping was on average around 832 million gallons (approximately 2,554 AFY).

The District collects groundwater level (monthly), groundwater quality (annual), and groundwater production (monthly) data in the GWMP management area as part of Phase 1 of the District's Groundwater Monitoring Implementation Plan – 2020 Protocols and Procedures (**Appendix B**), adopted in 2019 to address the first recommendation of the Salt and Nutrient Management Plan (SNMP) (Kennedy Jenks, 2019; Kennedy Jenks, 2014b). In addition, the United States Geological Survey (USGS) currently collects groundwater level monitoring primarily associated with the Marine Base that includes several wells in the Twentynine Palms area. These are posted on the DWR Water Data Library web site at http://www.water.ca.gov/waterdatalibrary/. These data are also posted on the DWR California Statewide Groundwater Elevation Monitoring (CASGEM) web site and can be downloaded from https://casgem.water.ca.gov/.

2.2 Regional Water Purveyors

The Twentynine Palms area map, **Figure 2-1**, includes areas from the Town of Yucca Valley to Twentynine Palms where groundwater management is covered by several entities in addition to TPWD. Other local and regional entities located immediately adjacent or in the vicinity of the GWMP area are shown in **Figure 2-2**. **Figure 2-3** and **Figure 2-4** show the underlying DWR Groundwater Basins and Subbasins. Neighboring water purveyors include:

- **Mojave Water Agency** (MWA) is a regional wholesale water provider to retail water purveyors that serve a large area of the Mojave River Valley and the Morongo Basin. MWA was found in 1960 due to concerns over declining groundwater levels. MWA is one of the State Water Project (SWP) contractors and serves an area of approximately 4,900 square miles of the High Desert in San Bernardino County. Through MWA, imported water has become available for groundwater recharge in the Town of Yucca Valley and Joshua Tree.

- **Joshua Basin Water District** (JBWD) is part of MWA and lies on the western boundary of TPWD. Its service area covers a 96-square mile area between Yucca Valley, Twentynine Palms, Joshua Tree National Park, and the Marine Base. JBWD serves 5,600 connections in 2024 with local groundwater from the Joshua Tree (DWR Number 7-62) and Copper Valley Groundwater Basins (DWR Number 7-11) to the west of TPWD. The JBWD Recharge Project will create a mechanism for JBWD to use 1,000 AFY of imported SWP water for local groundwater recharge. The JBWD Recharge Project's purpose is to provide supply water while preventing nitrate and mineral concentrations from increasing beyond state or federal allowable levels. Recharge will also prevent the need for deeper well drilling at high costs.

- **The Marine Corps Air Ground Combat Center** (Marine Base) is a United States Marine Corps base that lies along the northern boundary of TPWD. The developed portion of the base covers 1.4 square miles in the Morongo Basin and had a total population of 19,711 in 2021 (DENIX, 2021). The developed portion is included within the City. The Marine Base provides its own water supply from groundwater primarily from near Surprise Springs in the Deadman Valley Groundwater Basin (DWR Number 7-13), located north of the Twentynine Palms Valley Groundwater Basin (**Figure 2-2**). The Marine Base golf course operates an irrigation well in the Twentynine Palms Valley Basin; however, no groundwater pumping records are kept, but the volume is considered small (Li and Martin, 2011).

- **Unincorporated areas** outside the District to the east are covered by the San Bernardino County Desert Groundwater Management Ordinance adopted October 29, 2002, which gives the San Bernardino County (County) jurisdiction over the management of groundwater in the unincorporated, unadjudicated desert region of the County for areas of the County east of TPWD, MWA and the Marine Base.

- **Joshua Tree National Park** lies on the southern boundary of TPWD. As a national park, much of the area is undeveloped natural space. Water supply is provided at park facilities (i.e., visitor centers, exhibits and campgrounds) and is produced locally within the park from the Joshua Tree Groundwater Basin and is not derived from within the GWMP area.

2.3 Delineation of DWR Groundwater Basins and Subbasins

TPWD is located within the geographic Morongo Basin region, which covers about 1,000-square-miles of several alluvium-filled valleys or basins surrounded by mountains. Previous investigators have divided the Morongo Basin into multiple groundwater basins. A required element of the GWMP, **Figure 2-3** shows the groundwater basin boundaries covered by this GWMP, as defined by DWR Bulletin 118, along with the basins and agencies adjacent to this GWMP management area. **Figure 2-4** shows the subbasins in the TPWD area.

This GWMP addresses the portions of groundwater basins and subbasins that underlie or are immediately adjacent to TPWD but are outside the jurisdiction of other managing agencies such as JBWD. The GWMP covers the Indian Cove, Eastern, and Fortynine Palms Subbasins of the Joshua Tree Basin, but does not cover the Joshua Tree Subbasin, which underlies JBWD (**Figure 2-3** and **Figure 2-4**). TPWD overlies large portions of the Mesquite Lake and Mainside Subbasins in the Twentynine Palms Valley Basin, and the GWMP covers both subbasins (**Figure 2-3** and **Figure 2-4**). The District overlies a portion of the Dale Valley Groundwater Basin, but there is little to no pumping or historical data from this basin. Therefore, the GWMP includes some discussion of the Dale Valley Groundwater Basin but does not consider it a part of the management area.

The Twentynine Palms Valley Groundwater Basin (Number 7-10) underlies Mesquite Lake (dry) and the City of Twentynine Palms covering a surface area of 62,400 acres (97.5 square miles) (**Figure 2-3**). The basin is bounded on the north by a structural barrier named the "transverse arch" (Schaefer, 1978; Mendez and Christensen, 1997) and on the south by the Pinto Mountain fault. The basin is bounded on the east by the southern Bullion Mountains and extends west to the flank of Copper Mountain. The basin is subdivided into the Mesquite Lake and Mainside Subbasins (**Figure 2-4**). The deposits in the region are interpreted to range to 10,000 feet in thickness (Moyle, 1984). However, in the Twentynine Palms Valley, wells have been drilled to a depth of 1,250 feet below ground surface (bgs) without encountering bedrock. Total storage capacity of the basin is estimated to be 1,420,000 acre-feet (AF) (DWR, 1984). Groundwater in storage was estimated for a 100-foot thickness of saturated sediments to be about 132,000 AF (DWR, 1984).

Most of the Joshua Tree Basin (Number 7-62), is in San Bernardino County, with small portions of the basin extending into Riverside County. The Joshua Tree Basin (Number 7-62) includes the water-bearing sediments south of the Pinto Mountain Fault and Copper Mountain beneath Joshua Tree, eastward to immediately south of the town of Twentynine Palms, which is outside the boundaries of the basin (**Figure 2-3**). The basin is bounded by crystalline basement rocks on the south, at the Little San Bernardino Mountains. The basin boundary on the east is a line extending extends from the southern tip of Mesquite Fault to an outcrop of consolidated basement rocks of the Little San Bernardino Mountains. The western boundary of the basin is coincident with a basement constriction named the Yucca Barrier that causes a change in the groundwater level gradient (DWR, 2024b). The basin is subdivided into four subbasins that include the Joshua Tree, Indian Cove, Fortynine Palms, and Eastern Subbasins (**Figure 2-4**). Estimates of storage capacity of the Joshua Tree Basin have a wide range from 480,000 to

750,000 AF (Krieger and Stewart, 1996), 975,000 AF (Whitt and Jonker, 1998), and 1,010,000 AF (DWR, 1984).

The Dale Valley Basin is located immediately to the east of the Mesquite Lake Subbasin (**Figure 2-3**). Little work has been done on the hydrogeology of the Dale Basin, as it is not a host to significant population, nor does it contain many wells. Its western boundary is the Mesquite Fault, which separates it from the Mesquite Lake Subbasin. The northern boundary is the Bullion Mountains. The southern boundary is the Pinto Mountains. The depth to bedrock in this basin is unknown. Groundwater levels within this basin have been stable since the 1960's. The District has no production wells in this basin.

The Copper Mountain Valley (DWR #7-11), Warren Valley (#7-12), Deadman Valley (DWR #7-13), and Ames Valley (DWR #7-16) Groundwater Basins lie outside of management area for this GWMP and are shown on **Figure 2-3** for reference in demonstrating that the adjoining water districts obtain water from groundwater basins separate from those used by TPWD.

2.4 Geology

The geology in the Twentynine Palms area primarily consists of Tertiary to Quaternary alluvium deposits in the basins enclosed by bedrock materials in the surrounding hills and mountains (Riley and Worts, 1953). The geology of the region is complex due to the tectonic forces that created the Morongo Basin and surrounding mountains.

2.4.1 Geologic Units

The geology of the GWMP area is typical of many extensional basins throughout the western United States. Basin-bounding ranges are fronted by normal faults along which they have risen relative to the basin floor (Riley and Worts, 1952). Over time, the basin has filled with highly heterogeneous deposits. The sediments within the basin have been buried progressively deeper as later sediments have been laid down on top of them; those at the greatest depth are more compacted than are those near the ground surface.

The geological materials in the region are grouped into stratigraphic units based on their geologic characteristics (**Figure 2-5**). The following brief description of the geologic units is summarized from earlier reports by Riley and Worts (1953), Rogers (1967), Londquist and Martin (1991), Nishikawa *et al. (*2004) and Li and Martin (2011):

- The **Bedrock units** are exposed in the mountain ranges but also underlie the groundwater basin. These units consist of Precambrian igneous and metamorphic rocks and Mesozoic-aged granitic and metamorphic rocks. The Mesozoic-aged rocks are primarily granite that intruded into the pre-existing Precambrian rocks.

- The **Tertiary alluvium** directly overlies the bedrock and is only found in the subsurface. It consists of interbedded layers of clayey sand and sandy gravel, and it is commonly consolidated with interstitial clay and calcium-carbonate cement.

- The **Quaternary alluvium** overlies the Tertiary alluvium and is mostly made up of beds of coarse sand with little clay, with the rest composed of finer-grained beds made up of very fine silty sand to clay. This unit is divided into two subunits based on their characteristics. In general, the upper subunit is more permeable than the lower because of the predominance of the coarser-grained deposits and the lack of cementation. The upper Quaternary alluvium is the primary aquifer for the region.

- **Playa lake deposits** are typically composed of very clay rich sediments formed at the playa lakes. These deposits are as much as 45 to 50 feet thick beneath the Mesquite Dry Lake.

The alluvium is highly variable both vertically and horizontally. The coarsest alluvium tends to occur along the mountain fronts and progressively finer-grained sediments are found with distance away from the mountain fronts. The sediment size grades progressively to fine sand at the lower ends of the washes and eventually to silt and clay at the playas (Riley and Worts, 1952).

2.4.2 Faults and Folding

Structural features are very important to the hydrogeology of the Twentynine Palms area, as they act as barriers that limit groundwater flow, separating the groundwater subbasins from one another. Faults crisscross this area due to an intense tectonic history (**Figure 2-5**). There are three sets of faults running through the region (Riley and Worts, 1952). Several other unnamed faults do not fall into the three fault sets described herein, but are visible on geologic maps and may be important to the hydrogeology.

1) The first set consists of normal faults that cross the basin in a generally north-northwest to northwest direction. The easternmost is the Mesquite Fault (Riley and Worts, 1952). Deadman and Mesquite Dry Lakes are located directly on top of this fault (**Figure 2-5**).

2) The second set of faults includes the Elkins and Sand Hill Faults (**Figure 2-5**) that run generally north-south, with faults most important in the southern end of the basin and dying out toward the north (Riley and Worts, 1953).

3) The third set of faults runs east-west along the southern end of the basin and includes the Oasis, Bagley, and Pinto Faults (**Figure 2-5**). The Oasis Fault (also known as the Pinto Mountain Fault in many references) was reported by Thompson (1929) as having a scarp 15 to 30 feet high next to the Oasis of Mara. The Bagley Fault is about half a mile north of the Oasis Fault in the area of Twentynine Palms, and intersects with the Oasis Fault west of the City of Twentynine Palms.

Faults make effective barriers for several possible reasons (Riley and Worts, 1952). With movement along the fault, beds of differing permeability can be juxtaposed across the fault. Groundwater flow across the fault may be reduced due to fault gouge consisting of clay or very fine particles or precipitation of calcium carbonate cement within the fault zone. The effectiveness of a fault as a barrier to groundwater flow does not require a great deal of movement along the fault (Riley and Worts, 1952). The fact that faults do act as barriers can be seen by the presence of significant areas of historical groundwater discharge as springs on the upgradient sides of some faults (e.g., Surprise Spring on the Surprise Spring Fault, Oasis of Mara on the Oasis Fault, and Mesquite Spring on the Mesquite Fault) as shown on **Figure 2-5**.

The area is seismically active as evidenced by the 7.3 magnitude Landers Earthquake in 1992, which was centered on several faults about 20 miles west of Twentynine Palms. Earthquakes have been known to change the location and character of springs, change the flow character of wells, and cause fluctuations in groundwater levels (Roeloffs *et al*., 1995). However, the groundwater characteristics of the faults bounding the groundwater subbasins in the Twentynine Palms area have experienced numerous seismic events over their geologic history. It is these events that have defined the hydrogeologic characteristics of the faults that are observed today. Therefore, it is considered unlikely that a single seismic event in the future would significantly change the hydrologic characteristics of the groundwater subbasins.

In addition to the faulting in the area, folding has played a significant role in the geology and hydrology of the region. The USGS conducted a gravity survey to better understand the structure and thickness of subsurface fill by mapping the depth to the granitic or volcanic bedrock material (Roberts *et al*., 2002, Moyle, 1984). The estimated depth to bedrock is variable across the region. Beneath Mesquite Lake area, depth to bedrock is estimated to be more than 16,000 feet deep (Roberts *et al*., 2002). In other areas of the basin, bedrock highs bring bedrock units nearer to the surface. The Transverse Arch is bedrock high that brings bedrock to within 500 feet of land surface (Londquist and Martin, 1991) and forms the northern boundary of the Twentynine Palms Valley Basin (**Figure 2-5**). A second bedrock high exists in the southern part of the Mesquite Lake Subbasin that extends under the City of Twentynine Palms. This area likely represents an extension of Copper Mountain uplift which is composed of Precambrian and Mesozoic rocks (**Figure 2-4** and **Figure 2-5**) along the western margin of the Twentynine Palms Valley Basin.

2.5 Hydrology

In the arid to semiarid environment of the Twentynine Palms area, surface water is generally rare, localized, and short-lived. The climate in the Twentynine Palms area is classified as arid, upland desert climate, with hot summers and mild winters. The Twentynine Palms area is quite dry, with average annual precipitation of approximately 3.6 inches (DWR, 2024c). Most of the annual precipitation falls either during the summer monsoon or the winter wet season.

There are no perennial streams in the region, but there are several ephemeral streams that flow during high rainfall events. The largest of these is Fortynine Palms Creek (**Figure 2-6**). When runoff is generated by a storm, streamflow typically percolates into the alluvial soils in the stream channels (Kennedy Jenks, 2008). Some areas contain caliche (layers of concentrated mineral salts), which can limit the downward movement of water, (Riley and Worts, 1953, USDA, 1994, Nishikawa *et al*., 2004).

Playa lakes (i.e., Mesquite, Coyote, Shortz Deadman) form at the lowest elevations in a number of the surface drainage basins in the region (**Figure 2-6**). These dry lakes represent topographic low points where surface water ends up if runoff is high enough. The playa lakes are typically dry; however, a playa may represent an area of groundwater discharge that is typically lost to evaporation or taken up by vegetation. Playas with discharging groundwater are typified by rough surfaces with accumulations of alkali and other mineral salts (Thompson, 1929; USDA, 1994, Nishikawa et al., 2004). Among the playa lakes, the Mesquite Dry Lake is the largest in the area and is the lowest point in the area. South of Mesquite Dry Lake is a small unnamed playa that some older maps refer to as Shortz Lake (**Figure 2-6**). Due to erosion, ephemeral streams that formerly drained into Shortz Lake now bypass the lake so that the playa area is now largely covered with sand dunes. Two smaller playas occur just east of Copper Mountain.

Springs have historically been an important hydrologic feature as the only easily available source of water in this desert region. The Oasis of Mara is a mile long line of springs that form along the Oasis Fault. Mesquite Spring (**Figure 2-6**) once consisted of at least two pools, each 3 to 4 feet across and 2 feet deep, supporting a discharge of water that flowed about 200 feet into the desert (Thompson, 1929). However, Riley and Worts (1953) noted that by 1952 there was no water at the surface at the Oasis of Mara or flowing at Mesquite Springs.

Section 3: Groundwater Usage

This section provides the required GWMP summary of historical groundwater usage data, historical and future water demands, and supplies for the TWPD service area. Local groundwater basin conditions for the GWMP area are presented in Section 4.

3.1 Historical Groundwater Pumpage by TPWD

Groundwater is the sole source of water supply for TPWD, thus, groundwater pumping by the District is a good indication of water use in the service area. The District has had 20 total groundwater production wells in its history. As of 2024, the District has eight (8) active production wells and pumps wells located in four (4) different groundwater subbasins (Indian Cove, Fortynine Palms, Eastern, and Mesquite Lake); TPWD does not currently pump water from the Mainside Subbasin. **Figure 3-1** shows the locations of the District's active and historical supply wells, as well as other known wells within the five subbasins of the GWMP management area. **Table 3-1** presents a summary of the District's wells and their construction details grouped by subbasin.

Groundwater pumping by the District increased steadily since its formation in the mid-1950s until about 2002 (**Figure 3-2**). In the 1950's, groundwater pumping ranged from 500 to 1,000 AFY. By the 1990s, groundwater pumping ranged from 2,730 to 3,145 AFY, with an average daily delivery per service connection slightly under 400 gallons. Groundwater pumping was at an all-time high in the 2000's until 2011, wherein groundwater pumping ranged from 2,871 to 3,569 AFY. Since then, groundwater pumping has not exceeded 2,767 AFY (in 2013), and has decreased steadily, with 2,352 AFY pumped in 2023.

The highest total annual groundwater pumping was 3,569 AF in 2002. Since 2002, groundwater pumping has shown a fairly consistent decline. In 2012, total groundwater pumping was 1,761 AF, which represents the lowest annual pumping volume since 2003.

Most TPWD water supply wells are located along the southern limit of the service area in the Indian Cove, Eastern, and Fortynine Palms Subbasins because of the superior water quality compared to that in the Mesquite Lake Subbasin, where fluoride concentrations are of concern. **Figure 3-2** also shows the annual groundwater pumping by subbasin. In the 1950s and 1960s, groundwater pumping was primarily in the Fortynine Palms Subbasin; in the 1970s and 1980s, pumping shifted to be primarily in the Indian Cove Subbasin; and, in the mid-1980s, groundwater pumping in the Fortynine Palms Subbasin increased in response to decreasing groundwater levels in the Indian Cove Subbasin. In 1993, groundwater pumping in the Eastern Subbasin also increased.

Table 3-1. TPWD Production Well Summary

Well Name	Total Well Depth (feet bgs)	Screened Interval (feet bgs)	Well Status	Year Drilled	Years of Operation
Indian Cove					
TPWD-6	406	195-403	Inactive	1956	1957-2010
TPWD-7	407	258-403	Destroyed	1962	1963-2005
TPWD-8	785	80-100, 140-160, 215-600	Abandoned	1965	1969-1993
TPWD-9	530	318-510	Inactive	1968	1970-2016
TPWD-10	400	145-213; 238-312; 326-335; 365-382	Inactive	1968	1969-2006
TPWD-11	400	200-400	Destroyed	1978	1966-2017
TPWD-11B	**555**	**340-390;405-500; 510-545**	**Active**	**2017**	**2017-ongoing**
TPWD-12	**410**	**310-330; 350-410**	**Active**	**1983**	**1983-ongoing**
TPWD-15	**352**	**250-350**	**Active**	**1987**	**1990-ongoing**
Fortynine Palms Subbasin					
TPWD-3	340	120-340	Abandoned	-	1953-1992
TPWD-3B	398	160-280; 300-320; 340-398	Abandoned	1992	1993-2006
TPWD-4	283	-	Inactive	1935	1953-2013
TPWD-5	-	-	Abandoned	-	1953-1996
TPWD-13	337	152-337	Abandoned	1985	1985-2004
TPWD-14	**430**	**220-420**	**Active**	**1993**	**1993-ongoing**
TPWD-17	**550**	**330-520**	**Active**	**2009**	**2010-ongoing**
Eastern Subbasin					
TPWD-1	-	-	Abandoned	-	1955-2011
TPWD-1B	520	250-500	Inactive	2011	2011-2021
TPWD-2	275	-	Inactive	-	1953-1993
TPWD-16	**320**	**0-320**	**Active**	**1988**	**1991-ongoing**
Mesquite Subbasin					
TPWD-18	-	-	Abandoned	-	2012
WTP-1	**1,010**	**350-440; 460-620**	**Active**	**1993**	**2003-ongoing**
WTP-2	**700**	**210-300; 340-450; 560-680**	**Active**	**2019**	**2023-ongoing**

Note: Data provided by TPWD. Blue indicates an active well.

In 2003, the first production well in the Mesquite Lake Subbasin (WTP-1) began providing water to TPWD, with pumped groundwater now passing through the Twentynine Palms Fluoride Removal Water Treatment Plant. In 2023, TPWD brought a second production well online (WTP-2). TPWD considered increasing groundwater pumping in the Mesquite Lake Subbasin to 3.0 million gallons per day (MGD), with a concomitant decrease in pumping in the Indian Cove, Fortynine Palms, and Eastern Subbasins (**Figure 3-2**). Pumping from the Mesquite Subbasin steadily increased since 2002 up until 2022, with zero pumping in 2012. Groundwater pumping in the Mesquite Subbasin dropped to 1,247 AFY in 2023 and looks to be similar in 2024.

Since 2003, the District has worked to balance the pumping amongst the four (4) groundwater subbasins to help reduce groundwater level declines. A more detailed discussion of groundwater levels and conditions are discussed in Section 4.

3.2 TPWD Water Use Assessment

Currently, the District serves the area solely by groundwater pumping. Water demand is anticipated to increase in response to population growth, and groundwater will continue to be the sole source for meeting demand. Population trends and water demand for the District's service area are described below for the current (2020-2024) and 2045 conditions.

The majority of land use is designated for residential development and open space residential, with a small portion made up by commercial, institutional, and industrial. Residential development is currently the single largest land use in the area served by the District. Approximately 83 percent of the residential development is single-family homes. The remaining 17 percent of land use is made up of some multi-family residential units and commercial property. Industrial property makes up a minor amount of the land use. There is no large-scale agricultural development in the management area.

As reported in the District's 2020 Urban Water Management Plan (UWMP), the population served by the District in 2020 was 16,182, and the projected population in 2045 is 24,038 (Kennedy Jenks, 2021).

Based on the 2020 UWMP, the 2020 District water demand was 2,449 AF. Based on the most recent water usage data available from the District for August 1, 2022 through August 1, 2024, total annual water use is estimated to be 2,127 AFY. While this is slightly lower than the 2010 water use of 2,449 AF presented in the 2020 UWMP, it is more representative of current conditions.

The population for 2045 is projected to be 24,038 with water use projected to increase to 3,200 AF by 2045 (Kennedy Jenks, 2021). Total residential water demand is projected to be 2,150 AF for single family and 560 AF for multi-family residential. The base daily per capita water use in 2020 was estimated to be 135 gallons per capita per day (GPCD). The District's future projected per capita water use is estimated to be 119 GPCD, for compliance with the SBX7-7 required water reduction by 2020 (Kennedy Jenks, 2021).

3.3 Groundwater Pumping Capacity

The District has a total pumping capacity of approximately 6,985 gallons per minute (gpm) (11,266 AFY). **Table 3-3** provides a breakdown of well capacity by subbasin. The 2023 total groundwater pumped utilizes about 21 percent of the current pumping capacity. Historically, total groundwater pumped has been about 18 percent higher than the annual water demand. Therefore, the estimated 2045 total groundwater volume to be extracted in order to meet demand, using the same ratio, would be about 3,776 AFY. This is approximately 34% of the District's current pumping capacity.

Table 3-2. Estimated Annual Water Demand 2010 to 2045

	Annual Water Use (AFY)						
Land Use	**2010[(a)]**	**2015[(a)]**	**2020[(a)]**	**2025[(b)]**	**2035[(b)]**	**2040[(b)]**	**2045[(b)]**
Single family	1,729	1,429	1,608	1,780	1,970	2,060	2,150
Multifamily	442	335	420	460	510	560	560
Commercial/institutional	278	232	186	240	260	260	270
Industrial	0	0	0	0	0	0	0
Landscape irrigation	125	114	133	160	180	190	200
Other (construction use/non-potable)	102	1	102	20	20	20	20
Total	**2,676**	**2,111**	**2,449**	**2,660**	**2,940**	**3,060**	**3,200**

Notes: (a) Historical water delivery data (Kennedy Jenks, 2021).
(b) Projected potable water demand data (Kennedy Jenks, 2021).

In addition, current pumping is limited by DWR's recommendations to prevent overdraft in the Indian Cove and Fortynine Palms Subbasins, as discussed further in Section 4. The District's current source capacity is 10 MGD, which adequately meets the maximum daily demand. The maximum daily demand is assumed to be 2.7 million gallons based on monthly water usage data for August 1, 2022 through August 1, 2024, as provided by the District. For reliability, the California State Water Resources Control Board (SWRCB) Division of Drinking Water (DDW) recommends that a water system be able to meet its maximum daily demand with the highest capacity source offline, which is either of the wells at the fluoride treatment plant (WTP-1 and WTP-2). With one of those wells offline, the capacity reduces to 7.1 MGD, which would meet the maximum daily demand.

Table 3-3. TPWD Active Production Well Capacity and Use Summary

Well Name	Pumping Capacity (gpm)	Potential Maximum Annual Extraction (AFY) [(a)]	2023 Groundwater Extracted (AF)	2023 Percent of Capacity
Indian Cove Subbasin				
TPWD-11B	400	645	15	2%
TPWD-12	385	621	75	12%
TPWD-15	100	161	0	0%
Fortynine Palms Subbasin				
TPWD-14	700	1,129	313	28%
TPWD-17	700	1,129	470	42%
Eastern Subbasin				
TPWD-16	500	807	231	29%
Mesquite Lake Subbasin				
WTP-1	2,100	3,387	523	15%
WTP-2	2,100	3,387	725	21%

Notes: Data provided by TPWD.

(a) Potential Maximum Annual Extraction assumes the well operating at the pumping capacity for 24 hours per day for 365 days per year.

Section 4: Groundwater Supply Assessment

This section summarizes the aquifers, groundwater basin conditions, recharge areas, hydrologic water budget, and long-term groundwater sustainability. It includes an assessment of current basin conditions as supported by monitoring results.

4.1 Aquifers

The alluvial fan deposits are the principal water-bearing unit in the region. Li and Martin (2011) divide the upper alluvial fan deposits into two subunits based on their characteristics. In general, the upper subunit is more permeable than the lower subunit because of the predominance of the coarser-grained deposits and the lack of cementation. The thickness of the upper alluvial fan deposits reaches about 400 feet in the Joshua Tree Subbasin, with a saturated thickness of 300 feet. The thickness of the lower Quaternary alluvium varies from zero along the basin margins to a maximum of 400 feet in the western Indian Cove and eastern Mesquite Lake Subbasins and throughout much of the Joshua Tree Subbasin. The maximum saturated thickness of the Tertiary alluvium in the Twentynine Palms area is about 1,700 feet along the western edge of the Indian Cove Subbasin and reaches up to 3,000 feet, according to Nishikawa *et al.* (2004). Sediments that have become deeply buried tend to be more consolidated, compacted, and cemented with depth. Therefore, the deepest sediments tend to be less transmissive than the upper sediments.

In addition to Nishikawa *et al.* (2004) and Li and Martin (2011), Kennedy Jenks (2010) contains six geologic cross sections across the GWMP area (provided as **Appendix C)**. The upper and middle aquifers shown on the cross sections correlate to subdivisions of the alluvial fan deposits of Tertiary-Quaternary age (QTf) and the Lower Aquifer correlates to the older sedimentary deposits of Tertiary age (Ts). The cross sections show the complex geology, including faulting and depth to bedrock.

4.2 Groundwater Conditions

As discussed in Section 2.3, the GWMP focuses on five (5) groundwater subbasins, which are contained within the Joshua Tree and Twentynine Palms Valley Basins. **Figure 4-1** and **Figure 4-2** present current groundwater elevation contours across the five subbasins for “Spring” and “Fall” conditions, respectively. In order to develop groundwater contours representative of the GWMP area, the most recent static groundwater elevations were used from the time period of 2022 to 2024 to collectively characterize “Spring” and “Fall” conditions. Groundwater generally flows toward the northeast across the GWMP area. Basin-specific conditions are described next.

4.2.1 Joshua Tree Basin

The Joshua Tree Groundwater Basin includes the three (3) subbasins south of the Oasis Fault (Indian Cove, Fortynine Palms, and Eastern Subbasins).

In general, groundwater flows north and east across the subbasins (**Figure 4-1** and **Figure 4-2**). The highest groundwater elevations are found along the mountain front of the Little San Bernardino Mountains to the south, which is the primary recharge area. Flow between these subbasins is considered limited due to the presence of hydrologic barriers that may consist of faults or bedrock highs. For example, the groundwater elevation in the Indian Cove Subbasin is more than 250 feet above the groundwater elevation in the Fortynine Palms Subbasin to the east, indicating that there is some barrier between the two subbasins, although its character is not defined. The groundwater elevation is approximately the same in the Fortynine Palms and Eastern Subbasins. Within the Joshua Tree Basin, long-term groundwater level declines are evident south of the Pinto Mountain Fault throughout the Indian Cove and Fortynine Palms Subbasins primarily near pumping centers. The following discussion provides additional details on groundwater level changes by subbasin.

4.2.1.1 Indian Cove Subbasin

The Indian Cove Subbasin is located directly west of the Fortynine Palms Subbasin (**Figure 3-1**). Depth to bedrock ranges from 100 to 1,200 feet bgs and generally slopes northward (Kennedy Jenks, 2010).

Pumping records date back to 1957, and pumping varied from about 30 AFY initially to a peak of 2,075 AFY in 1985. In 2023, total pumping was 90 AFY. The current production capacity for wells located within this subbasin is approximately 1,427 AFY (**Table 3-3**). Groundwater levels vary more widely in the Indian Cove Subbasin than the other subbasins.

Hydrographs for TPWD wells TPWD-11, -11B, -12, and -15) are presented on **Figure 4-3**. In the northern part of the subbasin (TPWD-11, -11B, and -12), groundwater elevations declined about 2 feet/year on average from the late 1970s to around 2007. Between 1970-1990, groundwater elevations dropped most quickly before decreasing more slowly up to the present time. However, since 2007, groundwater levels have been generally increasing at a rate of 2.4 feet/year on average. This coincides with a decline in groundwater pumping starting around the same time. TPWD-15, located south of the Pinto Fault, has not experienced similar decline in groundwater levels, suggesting fault acts as a groundwater separating the subbasin into a northern and southern subarea (**Figure 4-3**).

4.2.1.2 Fortynine Palms Subbasin

The Fortynine Palms Subbasin is located directly east of the Indian Cove Subbasin (**Figure 3-1**). Depth to bedrock is between 170 and 430 feet bgs, making this the shallowest among the subbasins (Kennedy Jenks, 2010). The Pinto Fault also traverses the southern part of this basin; however, there are no existing wells south of the fault. No other significant faults are known within this subbasin.

Pumping records go back to 1952, whereby pumping has varied from about 260 AFY in 1953 to a peak of 1,620 AFY in 2002. In 2023, total pumping in the subbasin was 784 AFY. The current production capacity for wells located within this subbasin is approximately 2,258 AFY (**Table 3-3**).

Hydrographs for TPWD wells TPWD-4, -14, and -17 are presented on **Figure 4-4**. From the 1940s to about 1970, groundwater levels declined by about 1 foot/year before leveling off until about 1990, coinciding with a pumping decline in this basin. Starting around 1990, groundwater levels declined as pumping increased in the subbasin; until 2003, when pumping was reduced and groundwater level decline decreased to a steadier rate.

4.2.1.3 Eastern Subbasin

The Eastern Subbasin is located immediately to the east of the Fortynine Palms Subbasin (**Figure 3-1**). Woodward-Clyde (1985) noted that groundwater supplies in the Eastern Subbasin appear limited due to most of the flow being confined to a shallow zone above or in the bedrock. The depth to bedrock varies from 160 to 750 feet bgs (Kennedy Jenks, 2010). Test wells drilled in 1987 encountered bedrock at depths ranging from 327 to 415 feet bgs, and the water table was inferred at depths ranging from160 to 170 feet bgs (BCI, 1988).

Pumping records go back to 1952. Since then, pumping has varied from about 200 AFY in 1953 to a peak of 829 AFY in 2002. In 2023, total pumping in the subbasin was 231 AFY. The current production capacity for wells located within this subbasin is approximately 807 AFY (**Table 3-3**).

Hydrographs of TPWD wells TPWD-1, -1B, -2, and -16 are presented on **Figure 4-5**. Prior to the startup of TPWD-16 in 1988, TPWD-1 and -2 showed groundwater elevation declines of between 0.2 and 0.8 feet/ year. Starting around 1988, water levels began declining more rapidly, at around 2.1 feet/ year, coinciding with a significant increase in pumping around this time. Measured groundwater elevations have decreased up to 80 feet from the 1940s, including about 60 feet since 1988.

4.2.2 Twentynine Palms Valley Basin

The Twentynine Palms Valley Groundwater Basin includes the Mesquite Lake and Mainside subbasins. This groundwater basin underlies much of the City of Twentynine Palms.

4.2.2.1 Mesquite Lake Subbasin

In the Mesquite Lake Subbasin, groundwater flows toward Mesquite Dry Lake from all directions (**Figure 4-1** and **Figure 4-2**). Riley and Worts (1952) noted that groundwater is confined by playa deposits along the western half of Mesquite Dry Lake. Within the Mesquite Lake Subbasin, several faults and a bedrock high form significant flow restrictions that further subdivide this subbasin into distinct groundwater zones. In the southwestern part of the subbasin, bedrock is at or near the land surface, so groundwater may flow around the southern part of this ridge. In the northwestern part of the subbasin, several faults, including the Elkins and Surprise Spring Faults, appear to form flow barriers that limit flow across this section of the subbasin. Small playas associated with these faults further support this observation, but there are few wells in this area.

TPWD has two high-capacity supply wells (WTP-1 and -2) in this subbasin (**Figure 3-1**). WTP-1 came online in 2003 and has a capacity of approximately 3,387 AFY and has pumped between 523 and 1,465 AFY since then. WTP-2 came online in 2023 and has a capacity of approximately 3,387 AFY. Otherwise, groundwater pumping in this subbasin is limited due to naturally occurring water quality issues.

Hydrographs of TPWD wells WTP-1 and -2) are presented on **Figure 4-6**. The static water level in WTP-1 has dropped by about 10 feet over the 20-year period of record. Groundwater elevation data for WTP-2 shows an almost 20-foot abrupt decline in static water level since its startup in 2020; it is unclear if this abrupt decline is accurate, or attributed to sampling discrepancies (e.g., change in datum, sampling procedure). **Figure 4-6** also presents a significant amount of historical data from various USGS monitoring wells. Most water level measurements through the past 60 years are from the eastern and southern parts of the subbasin, with limited data from the western half of the subbasin. Most wells with long records show relatively steady groundwater levels over time with total variations in ranging within 5 feet.

4.2.2.2 Mainside Subbasin

TPWD does not have production or monitoring wells in the Mainside Subbasin. However, there are USGS monitoring wells; hydrographs of these wells are presented in **Figure 4-7**. Groundwater levels have essentially been stable since about 1990, with some exceptions due to single or few anomalous water levels. Estimated pumping from the Marine Base golf course well in not measured but has been estimated to be approximately 540 AFY.

4.3 DWR Definition of Recharge Areas

As of January 1, 2013, DWR requires that the GWMP include a map identifying the recharge areas for the groundwater basins that substantially contribute to their replenishment. This map shall be provided to local planning agencies after the adoption of the GWMP.

As discussed in Section 4, natural recharge is primarily associated with storm water runoff from the Little San Bernardino Mountains that lie along the southern margin of the Joshua Tree Basin. During large summer storms, runoff in Fortynine Palms Creek can flow out across the highway toward the Twentynine Palms Valley Basin towards the Mesquite Dry Lake. The distribution of natural surface recharge shown on **Figure 4-8** reflects this pattern.

Other areas of the basin are not considered to have substantial recharge from natural surface sources. However, the highly permeable soils underlying most of the basin are susceptible to urban recharge from human activity. Urban recharge associated with return flows from septic tank leach fields, leaking water pipes, and irrigation of lawns occurs in the developed areas of the District. These return flows account for a large volume of the annual recharge in the Basin. **Figure 4-8** shows the current distribution pattern of urban recharge for the area.

4.4 Hydrologic Water Budget

The hydrologic water budget is a conservative measure of available groundwater. This Section presents a summary of the hydrologic water balance under current (2022 to 2024) conditions. It is noted that this calculation can vary based on the input data and methodology.

In this 2024 GWMP Update, the hydrologic water budget is calculated using the same methodology and assumptions as the 2014 GWMP, with the only changed parameters being septic return flow and well discharge (Kennedy Jenks, 2014a). A more detailed discussion on the data and assumptions used for each water balance component and approach used is provided in **Appendix D**, with an overview of inflows and outflows discussed next.

- **Inflows** consist of total return flow (irrigation return flow and septic return flow), groundwater inflow, and natural recharge (precipitation recharge, streamflow infiltration, mountain front recharge, and mountain block recharge). Water usage data for August 2022 – August 2024 was used to determine an average annual septic return flow (August 2022 – August 2023 and August 2023 – August 2024). The remaining inflow parameters were carried over from the 2014 GWMP based on hydrogeologic studies (see **Appendix D**).

- **Outflows** consist of groundwater pumping, natural discharge (evapotranspiration and spring flow), and groundwater outflow. Pumping data for 2022-2023 was used to determine an average annual well discharge. The remaining outflow parameters were carried over from the 2014 GWMP based on hydrogeologic studies (see **Appendix D**).

The hydrologic water balance for current conditions is shown in **Table 4-1**, showing an annual change in storage range of -2,484 to 1,029 AFY. Results indicate that more groundwater is being removed from the groundwater basins (between 2,773 to 4,422 AFY) than is entering (between 1,938 to 3,801 AFY) during an average year.

Return flows, which are a return of groundwater pumped from the basin, are the primary source of recharge. Natural recharge is limited because of the relatively low average rainfall in the area. Discharge (groundwater outflow) is primarily a result of groundwater pumping. Natural outflows include evapotranspiration (ET), groundwater outflow, and spring flow. These components vary and are affected by changes in groundwater levels due to pumping (i.e., decrease in spring flows). The net effect is that outflows exceed inflows, which is reflected in declining groundwater levels as discussed in Section 4.2.

Table 4-1. Hydrologic Water Budget Summary: 2024 Conditions

	Groundwater Inflow (AFY)			Groundwater Outflow (AFY)			
Subbasin	**Total Return Flow**	**GW Inflow**	**Natural Recharge**	**GW Pumping**	**Natural Discharge**	**GW Outflow**	**Change in Storage**
Indian Cove	143	36 to 75	3 to 111	112	0	10 to 30	+40 to +207
Fortynine Palms	146	0 to 140	7 to 280	772	0	0 to 120	-739 to -206
Eastern	186	0 to 50	2 to 240	229	20 to 75	0 to 50	-166 to +227
Mesquite Lake	1,285	105 to 808	0 to 179	1,290	340 to 1630	0 to 114	-1,644 to +642
Mainside	25	0 to 115	0 to 21	0	0	0	+25 to +161
Total	**1,785**	**141 to 1,188**	**141 to 1,188**	**2,403**	**360 to 1,705**	**10 to 314**	**-2,484 to +1,029***
	Range = 1,938 – 3,801			**Range = 2,773 – 4,422**			

Note - * The lower bound of the annual change in storage range (-2,484 AFY) is equal to the sum of the minimum inflows minus the sum of the maximum outflows (1,938 AFY – 4,422 AFY). The upper bound of the annual change in storage range (1,029 AFY) is equal to the sum of the maximum inflows minus the sum of the minimum outflows (3,801 AFY – 2,773 AFY).

4.5 Long-Term Groundwater Sustainability

This section describes the long-term sustainability of the groundwater supply.

4.5.1 Hydrologic Water Budget - 2045 Projected Conditions

This section presents a summary of the hydrologic water balance under projected conditions in 2045. Projections were prepared using 2045 projected data from the District's 2020 UWMP (Kennedy Jenks, 2021). A more detailed discussion on the data and assumptions used for each water balance component and approach used is provided in **Appendix D**.

- **Inflows** in the hydrologic water balance consist of total return flow (irrigation return flow and septic return flow), groundwater inflow, and natural recharge (precipitation recharge, streamflow infiltration, mountain front recharge, and mountain block recharge). 2020 UWMP water usage projections for 2045 were used to estimate an average annual septic return flow (Kennedy Jenks, 2021). The remaining inflow parameters were carried over from the 2014 GWMP based on hydrogeologic studies (see **Appendix D**).

- **Outflows** in the hydrologic water balance consist of groundwater pumping, natural discharge (evapotranspiration and spring flow, and groundwater outflow. 2020 UWMP well pumping projections for 2045 were used to estimate an average annual well discharge volume. The remaining outflow parameters were carried over from the 2014 GWMP based on hydrogeologic studies (see **Appendix D**).

The hydrologic water balance for 2045 projected conditions is shown in **Table 4-2**, showing a projected annual change in storage range of -2,893 to 620 AFY. Projections indicate that more groundwater will be removed from the groundwater basins (3,781 to 5,430 AFY) than is expected to enter (2,537 to 4,401 AFY) during an average year.

While natural recharge and outflows are not expected to change significantly from current values, population and water use is anticipated to increase. Increased water use will be supplied by increased groundwater pumping (3,411 AFY). Consequently, the results of this hydrologic water balance indicate potentially declining storage conditions (i.e., more groundwater pumping than groundwater recharge, than present). Under these conditions, it is anticipated that groundwater levels will continue to decline.

Table 4-2. Hydrologic Water Budget Summary: Project 2045 Conditions

	Groundwater Inflow (AFY)			Groundwater Outflow (AFY)			
Subbasin	**Total Return Flow**	**GW Inflow**	**Natural Recharge**	**GW Pumping**	**Natural Discharge**	**GW Outflow**	**Change in Storage**
Indian Cove	191	36 to 75	3 to 111	284	0	10 to 30	-84 to +83
Fortynine Palms	195	0 to 140	7 to 280	993	0	0 to 120	-911 to -378
Eastern	248	0 to 50	2 to 240	328	20 to 75	0 to 50	-203 to +190
Mesquite Lake	1,716	105 to 808	0 to 179	1,806	340 to 1,630	0 to 114	-1,729 to +557
Mainside	33	0 to 115	0 to 21	0	0	0	+33 to +169
Total	**2,384**	**141 to 1,188**	**141 to 1,188**	**3,411**	**360 to 1,705**	**10 to 314**	**-2,893 to +620***
	Range = 2,537 – 4,401			**Range = 3,781 – 5,430**			

Note - * The lower bound of the annual change in storage range (-2,893 AFY) is equal to the sum of the minimum projected inflows minus the sum of the maximum projected outflow (2,537 AFY – 5,430 AFY). The upper bound of the projected annual change in storage range (620 AFY) is equal to the sum of the maximum projected inflows minus the sum of the minimum projected outflows (4,401 AFY – 3,781 AFY).

4.5.2 Long-Term Supply Sustainability Actions

The District has employed several different practices to further enhance the long-term sustainability of water supplies for Twentynine Palms. The following summarizes several key management actions to address these issues including those of the voluntary 12 specific technical elements identified in the California Water Code that pertain to groundwater levels.

4.5.2.1 Mitigation of Overdraft Conditions

Shifting Groundwater Production. The District has used the practice of shifting groundwater production between subbasins to help stabilize declining groundwater levels to provide intervals for groundwater levels to stabilize and recover, especially in the Indian Cove and Fortynine Palms Subbasins. The District has increased groundwater production in the Mesquite Lake Subbasin to reduce the amount of groundwater pumped in the Indian Cove, Fortynine Palms, and Eastern Subbasins. The Mesquite Lake Subbasin contains a large volume of groundwater, but groundwater requires treatment primarily for fluoride. The current Fluoride Removal Water Treatment Plant has a capacity of 3 MGD, but currently treats 1.2 MGD, operating at 40 percent capacity. The District plans to expand the operation of the treatment plant up its design capacity of 3.0 MGD. This will allow further pumping reductions in the other basins and provide additional capacity for the practice of shifting groundwater production between subbasins.

Water Conservation. Water conservation is an important method to reduce overdraft. The District utilizes public outreach to promote conservation, specifically water conservation brochures distributed in new customer packages and water bills, as well as speakers and events conducted at local schools and community events, which include poster contests and involvement in earth day activities. Additional water conservation measures are addressed in the BMOs and the current and planned water management strategies targeting conservation and water savings are described in the 2020 UWMP.

Water Supply Assessment. In evaluating potential future growth, SB 610 and SB 221 amended state law to improve the link between information on water supply availability and certain land use decisions made by cities and counties for defined project types and thresholds. These statutes require detailed information regarding water availability to be provided to city and county decision-makers prior to approval of specified large development projects. To provide that information, the governing body of the water agency that will serve the development must adopt an SB 610 Water Supply Assessment (WSA). Both statutes also require this detailed information be included in the administrative record that serves as the evidentiary basis for an approval action by the city or county on such projects. The District will continue to prepare SB 610 WSAs for the Twentynine Palms area to assess future water supplies and control overdraft.

4.5.2.2 Groundwater Model Analysis of Potential Future Conditions

The 2010 Mesquite Lake Groundwater Study (Kennedy Jenks, 2010) included development of a hydrogeological conceptual model and a numerical groundwater model. The model was developed to help support informed decisions in future management of groundwater resources in a sustainable manner while meeting increased water demand. The 2010 groundwater model has not been updated since 2010; therefore, it was not used to evaluate potential future conditions. Instead, the hydrologic water budgets described previously were used to evaluate current (2022-2024) and projected (2045) conditions, respectively. It is recommended that the District update the 2010 model to provide them with a management tool that can be used to simulate and predict future groundwater conditions. This recommendation is presented in Section 6.5 BMO #4.

4.5.3 Groundwater Recharge and Storage Projects

The District does not have access to surface, imported, or recycled water sources; therefore, the options for mitigating overdraft conditions are limited. Should access to an alternative water source become available in the future, the District would initiate an assessment on how best to utilize these resources (i.e., groundwater recharge, recycled water, or conjunctive use projects).

The only source of water currently available for replenishment is the impoundment or collection of stormwater runoff. Therefore, groundwater replenishment should be increased by stormwater capture for groundwater recharge, and it is recommended that the District investigate the feasibility of implementing a stormwater capture/recharge enhancement program. For instance, this program could involve the construction of berms to capture and allow increased percolation of stormwater into the aquifer.

The District has several reservoirs for system storage, which enable the District to provide adequate service for peak demands plus fire flow and emergency reserve. TPWD regularly evaluates its distribution and storage network. As part of this process, the need for new improvements, including additional storage capacity is evaluated, and a capital improvement program is developed in order to construct the necessary improvements. Existing storage facilities are operated and maintained by District staff. There are no plans for any large-scale storage projects or conjunctive use/groundwater storage facilities at this time. In addition, the need for additional extraction facilities is evaluated and wells are incorporated into the capital improvements program. District staff operates and maintain the wells.

4.5.4 Potential of Land Subsidence

Land subsidence can occur as a result of declining groundwater levels if a compressible sediment layer is present. In certain types of geologic formations, declining groundwater levels cause water to move out of the pore space causing the sediment to compress into a smaller volume. This typically occurs in fine-grained sediments (i.e., clays, silts, and fine sands). For example, playa lake deposits, such as those found in the Mesquite Lake and Mainside Subbasins, have been noted as sources of land subsidence in Antelope Valley and other similar areas. Granular sediments, typical of the alluvial filled basins in the Twentynine Palms area, are generally not considered compressible.

Land subsidence has not been identified as an issue within the Twentynine Palms area. Nevertheless, National Geodetic Survey (NGS) Benchmarks were obtained from the National Oceanic and Atmospheric Administration (NOAA) web site. These are plotted on **Figure 4-9** along with their stability rating to show available benchmarks in the plan area.

Although not a known hazard given the underlying lithology, the District might consider using available benchmarks to establish a baseline for evaluating potential future land subsidence. This is discussed further in Section 6.5 BMO #4.

Section 5: Groundwater Quality Conditions

This section summarizes current groundwater quality conditions as supported by monitoring results and water quality management actions that have been taken. Data presented is from historical well data, including water quality data reported in the SNMP 2023 Groundwater Monitoring Report (Kennedy Jenks, 2024).

5.1 Water Quality

District groundwater is typically of good quality. The historical and current use of septic systems for wastewater disposal has an effect on groundwater quality. In addition, high levels of naturally occurring fluoride and arsenic are present in some water supply wells in certain areas.

Congress passed the Safe Drinking Water Act (SDWA) in 1974 and passed amendments to it in 1986 and 1996. The SDWA is implemented by the US Environmental Protection Agency (EPA) at the federal level and by DDW at the state level. The state can enact regulations under the SDWA that are more stringent than required by the federal rule, but they cannot enact regulations that are less stringent. Compared to other states, California DDW frequently establishes regulations that are more stringent than federal regulations, though they have accepted certain federal regulations by reference (as is) as well. The regulatory thresholds for drinking water are defined below:

- **Maximum Contaminant Levels (MCLs)** are enforceable drinking water standards for various contaminants (e.g., lead, arsenic) to be met by public water systems and ensure safe water quality. MCLs take into account not only chemical health risks, but also technologically-based factors such as analytical capabilities, available treatment technologies, benefits, and costs.

- **Secondary MCLs (SMCLs)** are established for non-health based effects such as taste, odor, or color.

- **Public Health Goals (PHGs)** are levels of chemical contaminants in drinking water that do not pose a significant risk to health. PHGs are not regulatory standards. State law requires the SWRCB set drinking water standards (MCLs) for chemical contaminants as close to the corresponding PHG as is economically and technologically feasible.

- **Notification Levels (NLs)** are health-based advisory levels for certain chemicals without MCLs established by DDW. NLs were created with the intent of providing early warning to the public of potential health effects prior to establishing of a drinking water standard.

- **Response Levels (RLs)** are established by DDW and is an advisory level at which DDW recommends the source be taken out of service.

5.1.1 Salts and Nutrients

The historic and current use of septic systems for wastewater disposal in the District service area has the potential to affect groundwater quality. The key constituents considered for monitoring septic tank influence are nitrates and total dissolved solids (TDS). The MCL is 45 milligrams per liter (mg/L) for nitrate as NO_3 or 10 mg/L for nitrate as N.

- **Nitrate** - For the TPWD production wells, nitrate (as NO_3-N) ranges from non-detect to 7.1 mg/L, as summarized in **Table 5-1**. Historical and current data are below the MCL of 10 mg/L for nitrate.

- **TDS** - The TDS content of groundwater ranges from about 120 to 410 mg/L in District supply wells, as summarized in **Table 5-1**. TDS has a SMCL of 500 mg/L. Higher levels of TDS noted in the area are typically associated with naturally occurring, higher-salinity, and shallow groundwater associated with playa deposits. Elevated TDS can also be associated with septic tank return flows.

In June 2014, the District's 2014 SNMP (Kennedy Jenks, 2014b) recognized the increased need to assess potential groundwater quality impacts from salt and nutrient sources that are derived primarily from regional septic tanks and included recommendations for mitigation of these impacts. The two recommendations in the SNMP were:

1) Implement measures to improve the overall monitoring of the groundwater. This is being addressed via a Groundwater Monitoring Implementation Plan that was approved by the Colorado River Basin Regional Water Quality Control Board (RWQCB) on 10 December 2019 (Kennedy Jenks, 2017).

2) Implement a Septic System Management Program (SSMP) to limit the further impacts to groundwater. Kennedy Jenks began preparing a draft SSMP in November 2023 on behalf of the City and District; additional information is provided in Section 5.4.

5.1.2 Natural Constituents

Naturally occurring constituents include fluoride, arsenic, and chromium.

5.1.2.1 Fluoride

Fluoride (F) naturally occurs in local groundwater and is a constituent of concern in the District service area. The Primary MCL for fluoride in drinking water is 4.0 mg/L, with a SMCL of 2.0 mg/L. Fluoride is relatively low in the Indian Cove, Fortynine Palms, and Eastern Subbasins.

However, several samples exceed the MCL and SMCL in the Mesquite Lake Subbasin (**Table 5-2**), where groundwater has a different chemical character with substantially higher fluoride concentrations. Average fluoride concentrations range from 1.2 to 6.2 mg/L. For example, fluoride measured in 2024 at WTP-1 and WTP-2 hovered around 5.9 mg/L and 6.2 mg/L, respectively. Throughout the Mesquite Lake Subbasin, concentrations vary between 5.9 and 8.6 mg/L (**Table 5-2**).

5.1.2.2 Arsenic

Arsenic (As) is a naturally occurring element in groundwater that forms from the erosion and breakdown of geologic deposits; however, arsenic is less commonly associated with contaminant plumes. The primary MCL for arsenic is 10 micrograms per liter (µg/L). Arsenic occurs naturally in the Twentynine Palms area and has been detected in concentrations up to 13 µg/L. However, the average arsenic concentration is below 10 µg/L in most District wells (**Table 5-2**). Arsenic concentrations above the MCL are most prevalent in the Indian Cove Subbasin and in WTP-2, in the Mesquite Lake Subbasin, with the highest concentration of 13 µg/L and the lowest concentration of 11 µg/. Arsenic is below the MCL in the Eastern and Fortynine Palms Subbasins. Elevated arsenic concentrations require treatment at some District wells.

5.1.2.3 Chromium-6

Hexavalent Chromium (Chromium-6 or Cr-6) is an element that both naturally occurs from the erosion of natural chromium deposits and is produced by industrial processes. The SWRCB adopted an MCL of 10 µg/L on April 17, 2024. The regulation was approved on July 24, 2024, with an effective date of October 1, 2024. Community and non-community, non-transient water systems must complete initial sampling by April 1, 2025. Systems must be in compliance with the regulation as follows: October 1, 2024 for systems with 10,000 or greater connections, October 1, 2027 for systems with 1,000 to 9,000 connections, and October 1, 2028 for systems with fewer than 1,000 connections.

Cr-6 above the MCL has not been detected since sampling began in 2015. Although Cr-6 concentrations reached within 1% of the MCL in the Indian Cove Subbasin, the current average Cr-6 concentration is below 7.7 µg/L in all of the District wells (**Table 5-3**).

5.2 Groundwater Quality Trends

Water may take thousands of years to migrate from the recharge area to its discharge point. Nishikawa *et al*. (2004) used carbon-14 dating methods to determine that groundwater in the Copper Mountain Subbasin is likely to have been in the aquifer for approximately 10,000 years. This relationship can be complicated by the environment within the aquifer; groundwater that experiences elevated temperatures dissolves aquifer minerals more readily, and additional chemicals can be added from other aquifers or the ground surface. The minerals in groundwater may also be concentrated by evaporation when the water table is close to the ground surface.

Table 5-1. Nitrates and TDS Summary for TPWD Production Wells

Well	*Nitrate (as NO3-N) (mg/L)* Primary MCL = 10 mg/L Most Recent Measurement[a]	Maximum	Minimum	*Total Dissolved Solids (TDS) (mg/L)* Secondary MCL = 500 mg/L Most Recent Measurement[a]	Maximum	Minimum	*Years of Well Sampling History* Year first sampled[b]	Year last sampled[c]
Indian Cove Subbasin								
TPWD-9	2.5	3.3	0.5	140	257	120	1968	2016
TPWD-11B	2.2	2.8	1.8	250	260	170	2020	2024
TPWD-12	2.0	3.2	2.0	160	180	129	1983	2024
TPWD-15	7.1	7.1	2.6	210	220	110	1987	2024
Summary[d]	**3.5**	**7.1**	**0.5**	**190**	**260**	**120**		
Fortynine Palms Subbasin								
TPWD-14	3.2	3.2	1.9	220	290	160	1993	2024
TPWD-17	2.0	2.0	1.1	140	330	130	2011	2024
Summary[d]	**2.6**	**3.2**	**1.1**	**180**	**330**	**130**		
Eastern Subbasin								
TPWD-16	1.5	1.9	1.5	220	280	145	1991	2024
Summary[d]	**1.5**	**1.9**	**1.5**	**220**	**280**	**145**		
Mesquite Lake Subbasin								
WTP-1	1.5	1.5	ND	400	410	320	2006	2024
WTP-2	0.68	0.7	0.56	280	280	250	2023	2024
Summary[d]	**1.1**	**1.5**	**ND**	**340**	**410**	**320**		

Notes: MCL – maximum contaminant level; red text = MCL exceedance; ND: non-detect; n/s: not sampled.
(a) Last available data is based on TPWD records made available to Kennedy Jenks
(b) Year first sampled is based on TPWD records made available to Kennedy Jenks.
(c) Year last sampled is based on TPWD records made available to Kennedy Jenks.
(d) Summary provides the average of the most recent measurements as well as the maximum and minimum of all samples in each subbasin.

Table 5-2. Fluoride and Arsenic Summary for TPWD Production Wells

Well	Fluoride (mg/L)			Arsenic (µg/L)			Years of Well Sampling History	
	Secondary MCL = 2 mg/L			Primary MCL = 10 µg/L				
	Most Recent Measurement[a]	Maximum	Minimum	Most Recent Measurement[a]	Maximum	Minimum	Year first sampled[b]	Year last sampled[c]
Indian Cove Subbasin								
TPWD-9	1.9	4.0	0.8	9.8	10.8	ND	1968	2016
TPWD-11B	1.4	2.0	1.2	4.8	8.8	4.7	2020	2024
TPWD-12	1.7	2.6	0.4	7.0	11.0	ND	1983	2024
TPWD-15	0.3	1.1	0.2	ND	ND	ND	1987	2024
Summary[d]	**1.3**	**4.0**	**0.2**	**5.9**	**11.0**	**ND**		
Fortynine Palms Subbasin								
TPWD-14	0.74	1.5	0.4	ND	3.2	ND	1993	2024
TPWD-17	0.70	1.9	0.68	2.5	3.3	2.1	2011	2024
Summary[d]	**0.72**	**1.9**	**0.4**	**2.3**	**3.3**	**ND**		
Eastern Subbasin								
TPWD-16	1.7	2.1	0.4	ND	2.7	ND	1991	2024
Summary[d]	**1.7**	**2.1**	**0.4**	**ND**	**2.7**	**ND**		
Mesquite Lake Subbasin								
WTP-1	5.9[e]	8.6	5.1	4.6	5.8	ND	2006	2024
WTP-2	6.4[e]	6.6	6.4	11[e]	13	11	2023	2024
Summary[d]	**6.2**[e]	**8.6**	**6.4**	**7.8**	**13**	**ND**		

Notes: MCL – maximum contaminant level; ND: non-detect; n/s: not sampled.
(a) Last available data is based on TPWD records made available to Kennedy Jenks
(b) Year first sampled is based on TPWD records made available to Kennedy Jenks.
(c) Year last sampled is based on TPWD records made available to Kennedy Jenks.
(d) Summary provides the average of the most recent measurements as well as the maximum and minimum of all samples in each subbasin.
(e) Data appears to be an MCL exceedance, however, groundwater pumped from WTP-1 and WTP-2 receive treatment at the Fluoride Treatment Plant. Water delivered to consumers is below the MCL.

Table 5-3. Chromium Summary for TPWD Production Wells

	Chromium (+6) (µg/L)			Years of Well Sampling History	
	Primary MCL = 10 µg/L				
Well	Most Recent Measurement[a]	Maximum	Minimum	Year first sampled[b]	Year last sampled[c]
Indian Cove Subbasin					
TPWD-9	ND	ND	ND	2015	2016
TPWD-11B	8.5	8.5	4.3	2020	2024
TPWD-12	8.3	9.9	4.0	2017	2024
TPWD-15	ND	ND	ND	2017	2024
Summary[d]	**4.7**	**9.9**	**ND**		
Fortynine Palms Subbasin					
TPWD-14	4.5	5.2	3.9	2017	2024
TPWD-17	5.4	6.6	5.1	2017	2024
Summary[d]	**5.0**	**6.6**	**3.9**		
Eastern Subbasin					
TPWD-16	5.3	6.1	4.6	2017	2024
Summary[d]	**5.3**	**6.1**	**4.6**		
Mesquite Lake Subbasin					
WTP-1	6.1	6.7	ND	2016	2024
WTP-2	9.2	9.4	9.2	2023	2024
Summary[d]	**7.7**	**9.4**	**ND**		

Notes: MCL – maximum contaminant level; red text = MCL exceedance; ND: non-detect; n/s: not sampled.
(a) Last available data is based on TPWD records made available to Kennedy Jenks
(b) Year first sampled is based on TPWD records made available to Kennedy Jenks.
(c) Year last sampled is based on TPWD records made available to Kennedy Jenks.
(d) Summary provides the average of the most recent measurements as well as the maximum and minimum of all samples in each subbasin.

Groundwater quality in the region is quite variable. Minerals are added to the groundwater as it flows through the aquifer; water that spends more time in the aquifer tends to have higher concentrations of chemical constituents than does water with a low residence time. Water near the mountain fronts, which has been recharged relatively recently, tends to be of high quality, with low concentrations of chemical constituents. This is the case in the Indian Cove, Fortynine Palms, and Eastern Subbasins, where groundwater is close to its source area. In the Mesquite Lake Subbasin, groundwater has had a longer residence time and, therefore, tends to have higher concentrations of minerals. A general summary of the spatial trends in groundwater quality are summarized below:

- The groundwater in the Mesquite Lake Subbasin is predominantly sodium sulfate character. Locally elevated levels of TDS can be found associated with the playas, but is not present in high concentrations in the District's water supply wells. TDS content ranges from about 300 to 1,300 milligrams per liter (mg/L), but reaches 3,100 mg/L (DWR, 1984). Some wells in the basin exceed the recommended levels for drinking water in fluoride, arsenic, and sulfate concentrations. Thermal waters or hot springs are also known to occur in this basin (DWR, 1984).

- The groundwater in the Indian Cove, Fortynine Palms, and Eastern Subbasins is predominantly sodium bicarbonate in character (DWR, 1984) or sodium calcium bicarbonate in character (Krieger and Stewart, 1996). TDS content ranged from 139 to 164 mg/L for water in production wells in 1994 (Krieger and Stewart, 1996). Data from 14 public supply wells show an average TDS content of 159 mg/L and a range of 117 to 185 mg/L. Fluoride concentration in water from some wells has reached 9.0 mg/L, exceeding recommended maximum concentration levels of 2.0 mg/L (DWR, 1984).

5.3 TPWD Water Treatment

The District has historically pumped water from the Indian Cove, Fortynine Palms, and Eastern Subbasins in the south due to the generally good water quality in these areas. However, the District does have to treat water from certain wells for naturally occurring constituents, including fluoride and arsenic.

- **Fluoride** - Elevated fluoride concentrations above the MCL have historically been detected in some of the District's production wells. The District was granted a variance in 1993 from the California Primary MCL for fluoride, which expired in 2023. Water from Wells WTP-1 and WTP-2 is treated for fluoride prior to distribution through the Twentynine Palms Fluoride Removal Water Treatment Plant. The District currently monitors fluoride levels per the SMCL of 2 mg/L.

- **Arsenic** - Well 11-B has wellhead treatment for arsenic removal. Arsenic is removed from wells WTP-1 and WTP-2 as part of the Twentynine Palms Fluoride Removal Water Treatment Plant process.

- **Chromium-6** - Treatment for Cr-6 is considered for the future as follows:

  1) Three production wells (Wells 4, 9, and 11A) became inactive due to concentrations greater than the MCL,

2) Well 11A was replaced with Well 11B in 2017, and

3) A wellhead Cr-6 treatment system is being considered for Well 11B.

5.4 Wastewater Management

There are two major categories of onsite wastewater treatment systems in the Twentynine Palms area – residential and non-residential. Single family and multifamily households fall under the residential category. A variety of commercial (e.g., restaurants and hotels) and institutional (e.g., school) establishments and facilities fall into the non-residential wastewater category.

There are six (6) package treatment plants with leach fields that serve both residential and non-residential wastewater treatment needs within the City's boundary. Additionally, the City installed an onsite wastewater treatment system (OWTS) that has been in operation since 2021. The OWTS consists of a septic tank and nine seepage pits as part of "Project Phoenix". This OWTS collects wastewater flows from existing commercial properties within a six-block downtown area in Twentynine Palms. Wastewater disposal from other sources within the District service area is disposed of through individual septic tank and tile field disposal systems.

To address the second recommendation of the 2014 SNMP, Kennedy Jenks began preparing a draft SSMP in November 2023 on behalf of the City and District. The main purpose of the SSMP is to develop a strategy to monitor and protect groundwater resources in the Twentynine Palms area from impacts from existing and future septic systems. The program is designed to reduce constituent of concern (COC) loading at the source before entering groundwater. The Program is defined as a series of Septic System Management Elements (SSMEs).

These SSMEs are grouped into (4) four areas that include administrative elements, operational elements, site-specific studies, and program review (Kennedy Jenks, 2014b). The SSMP provides interim actions that can be initiated immediately as Twentynine Palms begins the process of developing or adopting a Local Agency Management Program that complies with Tier 2 of the SWRCB Policy for Siting, Design, Operation, and Maintenance of Onsite Wastewater Treatment Systems (OWTS Policy), Resolution No. 2012-0032, which took effect on May 13, 2013 and was amended on April 18, 2023 (SWRCB, 2023).

The OWTS Policy covers septic tanks and small package plants for individual disposal systems, community collection and disposal systems, and alternative collection and disposal systems that use subsurface disposal. The intent of the OWTS policy is to efficiently utilize local programs for the management of OWTS systems through coordination with the RWQCB Basin Plan and state guidelines.

5.5 Water Quality Management Actions

The District undertakes several actions for the protection of the water quality of groundwater delivered to its customers. The following sections summarize several key management actions, including those of the voluntary 12 specific technical elements identified in the California Water Code that pertain to water quality.

5.5.1 Control of High-Salinity Waters

Areas near historical dry lakes, such as Mesquite and Shortz dry lakes, tend to have higher salinity contents in both the groundwater and surface water. The District's groundwater supplies do not appear affected from this phenomenon, and no action is recommended at this time. Monitoring wells near WTP-1 and WTP-2 production wells, which are located in the vicinity of the Mesquite Dry Lake, are periodically sampled for TDS to monitor for high salinity water.

5.5.2 Regulation of the Migration of Contaminated Groundwater

No contaminated groundwater from industrial or commercial sources has been identified in the District's service area. The responsibility for regulating and controlling the migration and cleanup of contaminated groundwater from industrial or commercial sources rests with various County, State, and Federal agencies, including the County of San Bernardino and the Colorado River RWQCB (Region 7).

5.5.3 Wellhead Protection Areas and Recharge Areas

The purpose of a recharge and wellhead protection area is to establish a protective zone around wells, well fields, and recharge areas to protect groundwater sources from contamination, eliminating the need for costly treatment to meet drinking water standards. The State has a formal wellhead and recharge protection program as part of the DDW Drinking Water Source Assessment and Protection (DWSAP) Program, which is being incorporated into the District's own DWSAP Program. The District is active in efforts to protect groundwater sources. In the past, they have worked with a developer, the City, and the Colorado River RWQCB (Region 7) to condition a housing tract development to incorporate a package wastewater treatment plant in an effort to protect water resources.

The District's DWSAP was completed in 2002 and indicates that the geology of the area places most of the District's wells in the moderate category (moderately vulnerable). This is because the District's wells are largely in unconfined aquifers. The DWSAP also indicates that very few potentially contaminating activities (PCAs) are located near the District's wells. PCAs that are located near the District's wells including roads and streets, wells (drinking water and/or monitoring), and golf courses, which are lower risk uses than industrial facilities.

As part of developing a wellhead protection area program, it is essential that the designated wellhead protection areas are communicated to the local land use planning agencies, namely the City and San Bernardino County, and that the land use planning agencies agree to make the necessary modifications to their zoning and/or General Plans to prevent any potentially contaminating activities from being sited within the wellhead protection areas. While the City of Twentynine Palms General Plan Update of 2012 identified actions for the general protection of groundwater from development, no wellhead protection policies were included.

5.5.4 Well Construction Policies

Improperly constructed wells can result in poor yields and contaminated groundwater. A properly constructed well can also minimize contaminant migration between aquifers. Sections 13700 through 13806 of the California Water Code require all water wells to meet certain minimum standards. DWR Bulletins 74-81 and 74-90 (DWR, 1991) describe these minimum standards.

All District groundwater extraction, injection, and monitoring wells will be constructed according to applicable county and State, including DDW regulations. Minimum state standards are specified in DWR Bulletin 74-90 (DWR, 1991). District well drilling contractors will possess an active C57 (Water Well Drilling) Contractor's license. District well construction activities will be observed and inspected by District personnel.

The construction of private wells in the District is not within the District's jurisdiction. The County is responsible for enforcing well construction standards for these types of wells. However, outreach and coordination with private well owners are identified as an important component of the SSMP implementation. This includes working with private well owners to increase data collection efforts for better supply source management and management actions related to water quality.

5.5.5 Well Abandonment and Destruction Program

The continued presence of unusable wells creates several concerns. Older wells are often screened or perforated over a long depth, allowing vertical communication between various water bearing zones, which could lead to mixing of poor and good quality groundwater and/or interzonal movement of pollutants. Rusting, corrosion, and caving can compromise the integrity of the well casing, and older wells may lack the concrete sanitary seals that meet current standards. These wells are potential conduits for ground surface pollutants to enter groundwater and create a surface hazard to people and animals.

California Well Standards, Bulletin 74-81 (DWR, 1991), and its supplements, provide minimum standards for well abandonment and destruction. The County of San Bernardino Public Health Department determines how those standards are implemented within the County. There are several methods of well abandonment and destruction in the Well Standards; the County would make a determination which method is appropriate for the particular well. Additionally, the County does require a permit for all well destruction activities. These permits are required for activities within both incorporated and unincorporated areas of the County.

The District currently adheres to these minimum well abandonment and destruction standards for its own wells. In addition to abandoning and destroying unusable wells, the District will also strive to educate private well owners of the need for proper well abandonment and their responsibility under the law. Available information from the DWR, USGS, and DWR, and the District indicate that more than 400 private wells have been constructed within the District's service area. Most of these wells are not currently operated. The District has field located and inspected approximately 250 (60 percent) of the private wells.

California Well Standards, Bulletin 74-81 and its supplements, require at least a 100 feet minimum horizontal separation of any septic tank or subsurface sewage leaching field from a well. In October 2009, a private well was tested and had an elevated nitrate concentration; however, subsequent investigation concluded that the water in the well was under the influence of wastewater from a septic system due to poor maintenance. This illustrates the need for both proper septic tank maintenance and destruction of private wells located close to septic systems, as well as the importance of educating private well owners on the matter.

Section 6: Basin Management Objectives and Implementation Plan

Basin Management Objectives (BMOs) are required under California Water Code §10753.7(a)(1) to provide flexible guidelines for the management of groundwater resources that describe specific actions to be taken by stakeholders to meet locally developed objectives at the basin or sub-area scale. SB 1938 amended existing law related to groundwater management plans requiring a public agency seeking State funds administered through DWR to prepare and implement a groundwater management plan that includes BMOs. This section establishes BMOs that are intended to help the District plan for a more reliable water supply for long-term beneficial uses in the plan area, and describes the existing or planned management actions to achieve the BMOs.

6.1 Basin Management Objectives

The overall goal of this GWMP is to maintain the quality and long-term availability of groundwater to meet the current and future demands without adversely affecting groundwater resources within the GWMP area. The objective of the updated GWMP is to address issues of “aquifer health” and “groundwater sustainability”. These key issues include:

- Sustainable long-term water supplies
- Treatment of natural water quality constituents
- Wastewater management, specifically septic tanks
- Water supply for anticipated population growth

The BMO method of groundwater management is intended to provide a flexible approach that can be adapted to changing local conditions and increased understanding of the groundwater resource as better monitoring data are collected. The more traditional way of managing groundwater basins typically focused on often difficult to define concepts such as safe yield, replenishment, and overdraft. To meet the stated goal of addressing the key issues for the District, the following BMOs are proposed for the TPWD.

- BMO #1 – Manage Groundwater Levels to Maintain Water Supply Sustainability and Reliability
- BMO #2 – Maintain and Protect Groundwater Quality
- BMO #3 – Support Development of a Local Program for Septic Tank Management
- BMO #4 – Monitor and Track Groundwater Supply, Water Quality and Land Subsidence
- BMO #5 – Promote Public Participation and Coordination with Other Local Agencies

- BMO #6 – Address Planned or Potential Future Water Supply Needs and Issues
- BMO #7 – Identify and Obtain Funding Sources for Groundwater Projects

This section presents the seven (7) District BMOs and identifies the actions necessary for BMO implementation.

6.1.1 BMO #1 – Manage Groundwater Levels to Maintain Water Supply Sustainability and Reliability

Of the two groundwater basins that underlie the District, most of the groundwater production has been from the Joshua Tree Basin because of higher groundwater quality, but this has led to long term declines in groundwater levels. The purpose of BMO #1 is to implement measures to manage the groundwater levels in a manner to increase the long-term sustainability and reliability of the water supply for TPWD in the Indian Cove, Fortynine Palms, Eastern, and Mesquite Lake Subbasins. For BMO #1, the following actions are proposed:

- **Continue adaptive management by balancing pumping between subbasins** – The District will continue the practice of shifting groundwater production between subbasins to help stabilize declining groundwater levels. This includes scheduling rest periods for groundwater wells, especially in the Indian Cove and Fortynine Palms Subbasins, to provide intervals for groundwater levels to stabilize and recover.

- **Expand groundwater production in the Mesquite Lake Subbasin** – The Mesquite Lake Subbasin contains a large volume of groundwater, but that groundwater requires water treatment primarily for fluoride. Because the fluoride is naturally occurring, treatment is the most practical and effective means to achieve drinking water quality standards. The current Fluoride Removal Water Treatment Plant is designed to handle 3.0 MGD, but currently treats 2.5 MGD, so it is operating at 83% of capacity for 4 days of the week.

  The District will plan to bring the operation of the Fluoride Removal Water Treatment Plant up to the 3.0 MGD capacity. The District installed an additional production well at the Fluoride Removal Water Treatment Plant (WTP-2) and brought it online in 2023. It is located approximately 800 feet south-southeast of WTP-1, an appropriate well spacing to minimize drawdown effects.

- **Continue and expand water conservation measures** – Water conservation reduces the overall demand for groundwater, and thus helps to sustain groundwater levels and long-term groundwater production. The District will continue to implement water conservation policies and practices to promote water conservation among customers through public outreach activities. In addition, the District will continue implementing conservation management practices including water usage audits to customers, ongoing pipeline replacement and prompt leak repairs. The District has been discussing new legislation for “Making Conservation a California Way of Life” and how they can get that word out to the public.

- **Continue assessment for future infrastructure improvements** – To better manage groundwater resources, the District will continue to assess infrastructure improvements that provide greater flexibility in operating wells to manage water quantity and quality issues. The District will assess if sufficient source capacity is available to provide adequate redundancy in the system to cover possible future system failures and to allow flexibility for adaptive management practices that shift groundwater production between the various subbasins. The District will continue to monitor aging infrastructure and develop cost-effective schedules for replacing pipeline and aging infrastructure to reduce system water loss.

  The District is in the process of constructing a Redundant Treated Water Reservoir at the Fluoride Removal Water Treatment Plant and expects it to be put into operation by 3rd or 4th Quarter 2025.

6.1.2 BMO #2 – Maintain and Protect Groundwater Quality

Groundwater in the District is typically of good quality; however, groundwater in some District wells requires treatment for fluoride and arsenic. There is no known contamination in the District, yet the use of septic systems for wastewater disposal in certain areas of the District could potentially introduce nitrate to groundwater. The purpose of BMO #2 is to implement measures that maintain and protect groundwater quality in the District in a manner so as not to impact the beneficial use of the groundwater resources. For BMO #2, the following actions are proposed:

- **Continue measures to control spread of highly saline groundwater** – Highly saline groundwater is primarily limited to the vicinity of the existing or historic playa lakes in the Mesquite Lake and Mainside Subbasins. The District will continue to employ practices to control spreading of highly saline groundwater by locating wells away from the playa lakes areas if possible and minimizing drawdown to avoid its migration into areas of higher water quality. New production wells will be designed to avoid depth intervals with highly saline groundwater near the playa lakes. The monitoring program will include monitoring wells in these areas to monitor for changes in water quality trends.

- **Continue wellhead protection measures** – California's DWSAP Program was developed to protect the State's public water systems and includes both a source water assessment and wellhead protection program. The District will continue to complete these assessments for new production wells, and also consider updating the source assessments for older wells if there has been a significant change in the land use in the vicinity of these wells. The District will also work with the City to ensure that land use policies protect critical wellhead areas.

- **Evaluate** wellhead treatment - The District is evaluating additional wellhead treatment for Well 11B due to the revised MCL for hexavalent chromium.

- **Monitor activities at environmental investigation and remediation sites** – The only environmental investigation and remediation sites that are currently being conducted are located at the Marine Base. The District will coordinate with the Colorado River RWQCB

(Region 7) to be notified if any new environmental investigation and remediation sites are opened within the District boundaries.

The District has been following the latest remediation efforts at the Building 1077 site located at the intersection of Delvalle Rd and Agate Rd at the Marine Base.

- **Continue the District's well abandonment policy** – Abandoned wells provide a conduit for migration of contaminants and poor-quality water through the aquifer. The District will continue to adhere to the requirements for well abandonment and destruction for all District-owned wells. These actions will be conducted according to County of San Bernardino Public Health Department requirements and California Well Standards, Bulletin 7481 and its supplements. Information for private well owners on proper well abandonment procedures will be available at public outreach activities and the District Office. The District may also pursue outside funding sources to assist with private well abandonment if appropriate. Since 2014,

  - The District has abandoned Well 4 due to Cr-6 but more recently discovered that it is collapsing at the bottom;

  - Well 9 was also abandoned due to Cr-6 in the last decade; and

  - The District is considering blending the water at Well 9 with Well 12 and/or Well 6.

- **Conduct groundwater quality studies** – Vertical water quality profiling involves chemically profiling periodic samples from a new well being drilled. With the information gained through profiling, wells can be better designed to block off the source of poor-quality water by sealing selected intervals during drilling, plugging the bottom of a hole, or building better surface seals. Vertical profiling on new wells will be undertaken when feasible and cost-effective including the pursuit of outside funding sources when appropriate.

  Such profiling was conducted when WTP-2 was drilled in 2022. Zone testing was conducted to support information about the water quality.

6.1.3 BMO #3 – Support Development of a Local Program for Septic Tank Management

Wastewater disposal within the District is principally through septic tanks, which are currently regulated by San Bernardino County. Septic tank return flows are a significant component of groundwater recharge; however, these return flows can add nitrate, salts, and possibly other contaminants to the groundwater. If properly managed, septic tanks return flows may not affect the beneficial use of the groundwater. The new state OWTS Policy issued in 2012 provides a mechanism for local management of septic tanks. The District and City will assess the potential for the development of a local management program for regulation of septic tanks in Twentynine Palms. For BMO#3, the following actions are proposed:

- **Implementation of the SNMP and WMP** – The District and City prepared the SNMP and Wastewater Master Plan (WMP) in 2014 to evaluate potential groundwater quality issues from existing septic tanks and whether the continued discharges from septic systems would unreasonably degrade groundwater quality and result in widespread groundwater pollution. The documents were approved by the Colorado River RWQCB (Region 7). The SNMP has been implemented, along with the Groundwater Implementation Plan that became part of it, since 2019. The District will work with the City to update the SNMP and WMP as appropriate.

- **Continue to work with City on developing a plan to address septic tank use** – The District and the City have developed the SNMP and WMP to specifically address water quality issues associated with septic tanks within the District service area. The District is a co-sponsor and will continue to participate in the development and implementation of the GWMP. The District will continue to participate in meetings and discussions regarding the septic tank issue.

- **Support development of a Local Area Management Plan** – The SNMP and WMP are intended to lead up to the possible development of a Local Agency Management Program (LAMP) under Tier 2 of the OWTS Policy for Twentynine Palms. Local regulation would provide a means to help address potential high-risk areas of nitrate loading from septic tanks and allow for continued septic tank operation in low-risk areas. The District will continue to support efforts of cooperation with the City toward development of a LAMP for Twentynine Palms.

- **Pursue outside funding sources to support abandonment of private wells** – The District service area contains hundreds of unused private wells that may act as conduits for migration of contaminants to the aquifer. Jurisdiction for well abandonment lies with the County; however, the District can provide information to private property and well owners about the need to properly destroy wells that are no longer in use. This would especially include information on wells within 100 feet of a septic tank or leach field that can be distributed to customers and/or made available at local public meetings. This proposed action is dependent on the District obtaining outside funding, preferably through a grant, to support local property owners in well abandonment. The District is unaware of any private wells being abandoned since 2014.

- **Assess methods for recycled water use** – Septic tank system return flows currently comprise a large component of recharge to the basin; therefore, recycled water should be put to an appropriate beneficial use in-lieu of groundwater if available. The District will continue to support and collaborate with the City to evaluate ways of utilizing recycled water to help reduce groundwater demand or to provide for aquifer recharge.

6.1.4 BMO #4 – Monitor and Track Groundwater Supply, Water Quality, and Land Subsidence

A key element of a GWMP is monitoring groundwater conditions. The District will maintain regular groundwater level and quality monitoring to improve the understanding of groundwater level fluctuations, potential impacts to groundwater quality and subsidence across the District.

Changes to groundwater storage will be accounted for by tracking groundwater levels. The District currently conducts water quality monitoring per the District's Implementation Plan (**Appendix B**), which is sufficient for the purpose of tracking changes in the quality of the groundwater basin. For BMO #4, the following actions are proposed:

- **Collect groundwater supply monitoring data** – The District will collect data necessary to evaluate the change in the quantity of groundwater, including the volume of groundwater pumped by the District and others, static and pumping groundwater levels from the production wells, groundwater levels from monitoring wells, and climatic data. Data will be collected according to the GWMP Monitoring Plan with appropriate field record keeping that will be maintained. Relevant data will be kept in an electronic database so that the data can be readily used to support District decision-making needs. The District will continue to coordinate with the USGS on monitoring of groundwater levels in the region and will include these data into the District's monitoring database and the DWR CASGEM Program records.

- **Collect Groundwater quality monitoring data** – The District will collect water quality samples from production wells and selected monitoring wells according to the 2014 SNMP. Emphasis will be on monitoring for regulated drinking water constituents following the DDW and EPA guidelines. Appropriate record keeping will be maintained for field records and lab reports. Relevant data will be kept in an electronic database so that the data can be readily used to support District decision-making needs.

- **Incorporate SNMP water quality monitoring data into monitoring database update** – The objective of the SNMP monitoring is focused on defining spatial and temporal trends in nitrate, TDS and contaminants of emerging concern (CECs) associated with wastewater effluent from septic tanks. The data gathered as part of the SNMP monitoring activities is being incorporated into the District database.

- **Assess change in groundwater storage** – The District will include a regular assessment of the change in groundwater storage. The results of the 2010 groundwater model provide a historical assessment of the change in groundwater storage calibrated to measured changes in groundwater levels. The District will work to bring the groundwater model up-to-date and then incorporate annual updates as part of their annual reporting activities. In turn, the groundwater model can be used as a predictive tool for groundwater management.

- **Prepare annual report and monitoring database update** – The District will produce a concise annual report of groundwater conditions based on the monitoring data. The format of the annual report will be a brief management-level summary that contains up-to-date monitoring data, a brief analysis of the data, and description of groundwater conditions in each of the subbasins in order to track progress on the groundwater management process. The results will be presented at least once a year at a public meeting to the Board of Directors, keeping them up to date on groundwater issues.

- **Establish a baseline elevation assessment for potential future land subsidence** – Land subsidence has not been identified as an issue within the Twentynine Palms area; however, playa lake deposits, such as those found in the Mesquite Lake and Mainside

Subbasins, have been noted as sources of land subsidence in Antelope Valley and other similar areas. The District will continue to employ practices to control subsidence in the Mesquite Lake Subbasin by locating wells away from the playa lakes areas when possible and minimizing drawdown to avoid the loss of aquifer storage. Therefore, the District will establish a baseline elevation assessment with historical US Geodetic Survey benchmark surveying data. Future assessments will be done periodically to verify whether land subsidence is occurring or not.

- **Expand monitoring well network to evaluate recharge and other effects of pumping on groundwater** – The District will expand its groundwater monitoring well network to include additional monitoring wells that improve the ability to track changes in groundwater storage in each of the groundwater subbasins. The various purposes of these monitoring wells would include defining drawdown effects near active pumping wells, understanding groundwater recharge potential in key recharge areas, and providing better spatial coverage to define groundwater flow. The proposed action for the installation of additional monitoring wells is dependent on the District's obtaining outside grant funding.

6.1.5 BMO #5 – Promote Public Participation and Coordination with Other Local Agencies

The District will look to continue and expand communication and coordination with local, state, and federal agencies to discuss regional water issues. The District is also committed to keeping customers up to date on groundwater issues. The GWMP process encourages coordination with other local agencies and stakeholders. For BMO #5, the following actions are proposed:

- **Coordinate with the City of Twentynine Palms, Marine Base, neighboring water districts and other local water purveyors** – The District coordinates with these agencies to discuss local water issues. Local Water Districts have gotten together to collaborate on messaging for water conservation through local radio stations and social media. Legislation issues have commonalities as well, so those topics are also discussed, and the local Water Districts are part of the Community Water Systems Alliance (CWSA). The local Water Districts have monthly CSWA meetings to discuss issues that districts are facing.

- **Participate in Integrated Regional Water Management Plan (IRWMP) Process** – The District will continue to participate in the IRWMP process within the Mojave region to coordinate with other regional water managers and to support obtaining outside funding to meet District needs. The Mojave Region IRWMP was completed in 2018. The IRWMP provides a road map for a long-term, balanced water supply in the region and evaluates potential water supply projects and programs that provide regional benefit through collaboration with local stakeholders, such as water and wastewater agencies. The IRWMP also fulfills a requirement for acquiring State and federal funding for local water supply and management projects. The District has incorporated projects into the IRWMP, such as monitoring wells for the SNMP and an Automated Meter Infrastructure project.

- **Continue coordination with local land use planning agencies** – Land use in the City is governed by the City of Twentynine Palms General Plan under the Community Development Department. One of the policies of the City's General Plan is to "maintain a consistent level of quality water service by working with the TPWD while minimizing any impacts of land development on the existing system". Land use in the unincorporated portions of the District is governed by the County of San Bernardino General Plan. The County's General Plan addresses water supply issues and recognizes the jurisdiction and authority of all agencies providing water service within the County with consideration given to the County's diverse geographic region. The District coordinates with both the City and County by using General Plan information to provide the foundation for land use and population projections for planning purposes.

- **Maintain a working relationship with local and state regulatory agencies** – The District will continue to report to and communicate with these agencies, as required by law and to support mutual goals in the region. In addition, the District will continue and expand communication and coordination with local and state regulatory agencies to discuss groundwater issues especially pertaining to water quality. The management of District groundwater resources requires establishing and maintaining communication with the following state and federal regulatory agencies:

    - State Water Resources Control Board
    - California Division of Drinking Water
    - Colorado River Regional Water Quality Control Board - Region 7
    - California Department of Water Resources
    - United States Environmental Protection Agency

- **Provide for regular public outreach opportunities** – The District provides for regular public outreach and participation through one or more public meetings. Potential public outreach includes new customer information packages and an annual presentation summarizing the annual report at a public meeting to keep the Board of Directors and public up to date on the management of the groundwater basin. The District is working on a quarterly newsletter to be distributed to the media and the City. The District will continue to provide information on water issues and water conservation through brochures, speaking at public events, and providing educational materials at local schools.

6.1.6 BMO #6 – Address Planned or Potential Future Water Supply Needs and Issues

Water supply needs and issues for the District could change due to future growth in the region, changes in regulations, or other outside factors. The District will take measures to plan for these contingencies. For BMO #6, the following actions are proposed:

- **Monitor changes to drinking water standards** – Water quality regulations are subject to change, which may include lowering an existing MCL or adding a new compound to the list of regulated compounds. This can have a significant impact on the District customers if these changes in the water quality regulation result in the addition of new water treatment in order to continue serving water from existing wells. If new treatment is required, this may result in significant capital and O&M costs to upgrade and maintain the additional water treatment.

  The 2008 change in the arsenic MCL resulted in changes in use of groundwater production wells and treatment that required capital expenditures to address. With the recently adopted CR-6 MCL, the District is currently evaluating cost-effective solutions for treatment where needed. The District will continue to monitor changes in state and federal drinking water standards and evaluate how best to address these with respect to both providing a safe water supply to customers and maintaining cost-effective District operations.

- **Review criteria for assessing water supply availability for large developments** – The District will review and update its policy on meeting the long-term water supply needs for large developments. The goal is to establish internal guidelines for consistency of evaluating SB610/SB221 requests for water supply and to assess the availability of total water supply within the District. This will include developing potential mitigation measures for developers that may include water conservation or other measures to offset the costs of increasing the water supply. No new large developments have come in since 2014.

- **Evaluate the feasibility of groundwater replenishment projects** – The desert environment limits the potential for groundwater recharge in the region; therefore, measures to maximize the use of existing local water resources are necessary, such as stormwater runoff. Stormwater capture and groundwater recharge could be achieved by construction designated recharge facilities (i.e., with berms). Groundwater recharge is most viable in the Indian Cove and Fortynine Palms Subbasins and could potentially increase the yield and/or reduce overdraft in these basins. The District will pursue grant funding to identify alternatives and evaluate the feasibility of groundwater recharge projects.

- **Evaluate the feasibility of potential new water sources** – If future growth in the Twentynine Palms area increases significantly as it has in other nearby areas in Southern California, water demand may potentially exceed the ability of the groundwater basin to provide adequate water supply without causing basin overdraft. Therefore, the District will evaluate whether there are other potential new water sources that could be developed. Potential sources may include further development of low-quality groundwater resources requiring treatment, water conservation, water reuse, groundwater storage and recovery, or imported water.

  Development of new water sources is anticipated to be more expensive than the use of current water sources; therefore, it is important to begin planning. The proposed action is dependent on the District's obtaining outside funding preferably through a grant, which the District will pursue.

- **Update the GWMP periodically to address changing needs or conditions** – The DWR guidelines include a provision for regular review and update of the GWMP to keep the BMOs, actions, and implementation plan up to date. The District practice has been to update the plan every five years with the original plan developed in 2003, with updates in 2008 and 2014. Although the previous five-year cycle was skipped, the District will continue the practice of updating the GWMP about every five years.

6.1.7 BMO #7 – Identify and Obtain Funding Sources for Groundwater Projects

BMO #7 recommends an evaluation to identify potential funding sources for future groundwater projects. For BMO #7, the following actions are proposed:

- **Define projects that could be eligible for outside funding** – Some funding opportunities require that the project be "shovel ready", which would require existing designs, CEQA and other work already be prepared. The District will evaluate the priority of projects that could be designed and put on a shelf until funding is available.

- **Develop background and supporting materials** – Many grants have a short turnaround time. The District will develop background and supporting materials to respond quickly and successfully to grant funding opportunities.

- **Identify potential funding sources** – The District will identify potential outside funding sources. The District will work through the IRWMP process and also keep track of funding opportunities through State agencies. When applicable, the District will also contact the Marine Base to determine the potential of federal grants for any joint projects to be undertaken with the Marine Base.

6.2 Implementation Plan

This section outlines a schedule to assist with the implementation and assessment of this GWMP. An important aspect of this section is the identification of the BMOs and actions that will be implemented by the District over time. The actions under these BMOs will focus on managing, maintaining, and monitoring groundwater quantity, quality, and land subsidence, coordinating with other local agencies, and addressing planned or potential future water supply options. The schedule for the implementation plan for the BMOs, plan components, and actions is presented in Table 6-1 and categorized as follows:

- **The short-term implementation** plan lists those actions that the District will plan to implement over the next five years. This includes several proposed actions under the BMOs #1, #2, #4, and #6. These BMOs and actions will focus on activities related to managing and maintaining groundwater quantity and quality, coordinating with other local agencies, and seeking funding opportunities for groundwater projects.
- **The long-term implementation plan** lists those actions that the District will plan to initiate within the next five years, but full implementation is anticipated to extend beyond the next five years. The long-term implementation plan includes several proposed actions as part of the BMOs #2, #3, and #5. These actions will focus on maintaining and

protecting groundwater quality, coordinating with other local agencies, and seeking funding opportunities for groundwater projects.

- **Projects dependent upon outside grant funding** envision that implementation of the GWMP, as well as many other groundwater management related activities, will be funded from a variety of sources, including State and Federal grant programs. This is a list of actions the District has identified that would be best accomplished through an outside funding source. This includes several proposed actions as part of the BMOs #1, #2, #3, and #5.

The GWMP is intended to be a living document, and it will be important to evaluate actions and objectives over time to determine how well they are meeting the overall goal of the GWMP. The District intends to evaluate and update the GWMP on a regular basis.

Table 6-1. GWMP Implementation Plan Summary

Standing Procedures and Ongoing Practices	
BMO #1 – Manage Groundwater Levels to Maintain Water Supply and Reliability	Continue adaptive management of balancing pumping between subbasins
	Continue and expand water conservation measures
	Continue assessment for future infrastructure improvements
BMO #2 – Maintain and Protect Groundwater Quality	Continue measures to control spread of highly saline groundwater
	Continue wellhead protection measures
	Continue the District's well abandonment policy
BMO #4 – Monitor and Track Groundwater Supply, Water Quality, and Land Subsidence	Collect groundwater supply monitoring data
	Collect groundwater quality monitoring data
BMO #5 – Promote Public Participation and Coordination with Other Local Agencies	Continue Coordination with local land use planning agencies
	Maintain a working relationship with local and state regulatory agencies
BMO #6 – Address Planned or Potential Future Water Supply Needs and Issues	Update the GWMP periodically to address changing needs or conditions
Short-Term Implementation Plan (<5 years)	
BMO #3 – Support Development of a Local Program for Septic Tank Management	Implement the SNMP and WMP
	Explore development of a Local Area Management Plan
	Continue to work with City on developing a plan to address septic tank use
BMO #4 – Monitor and Track Groundwater Supply, Water Quality, and Land Subsidence	Assess change in groundwater storage; update groundwater model and incorporate annual updates
	Prepare annual report and monitoring database update
	Establish a baseline elevation assessment for potential future land subsidence
BMO #5 – Promote Public Participation and Coordination with Other Local Agencies	Coordinate with the City of Twentynine Palms, neighboring water districts and local land use planning
	Participate in Integrated Regional Water Management Plan (IRWMP) Process
	Provide for regular public outreach opportunities

BMO #6 – Address Planned or Potential Future Water Supply Needs and Issues	Monitor changes to drinking water standards
	Review criteria for assessing water supply availability for large developments
BMO #7 – Identify and Obtain Funding Sources for Groundwater Projects	Define projects that could be eligible for outside funding
	Develop background and supporting materials
	Identify potential funding sources
Long-Term Implementation Plan (>5 years)	
BMO #2 – Maintain and Protect Groundwater Quality	Monitor activities at environmental investigation and remediation sites
BMO #3 – Support Local Regulation of Septic Tanks	Assess methods for recycled water use
BMO #4 – Monitor and Track Groundwater Supply, Water Quality, and Land Subsidence	Incorporate Groundwater Protection Plan water quality monitoring data into monitoring database update
	Establish a baseline for evaluating potential future land subsidence
BMO #6 – Address Planned or Potential Future Water Supply Needs and Issues	Evaluate the feasibility of groundwater replenishment projects
	Evaluate the feasibility of potential new water sources
	Develop plan for addressing the expiration of the fluoride variance in 2023
	Update the groundwater management plan periodically to address changing needs or conditions
Projects Dependent Upon Obtaining Outside Funding	
BMO #2 – Maintain and Protect Groundwater Quality	Conduct groundwater quality studies
BMO #3 – Support Local Regulation of Septic Tanks	Obtain funding to support abandonment of private wells
BMO #4 – Monitor and Track Groundwater Supply, Water Quality, and Land Subsidence	Expand monitoring well network to evaluate recharge and other key areas
	Obtain funding to support bringing groundwater model up to date
BMO #6 – Address Planned or Potential Future Water Supply Needs and Issues	Evaluate feasibility of groundwater replenishment projects

References

BCI Genetics, Inc. (BCI), 1990, Determination of Active Recharge to the Twentynine Palms Water District, Twentynine Palms, California, report prepared for Twentynine Palms Water District, dated November 1990, BCI Genetics, Inc., Santa Barbara, CA.

California Department of Water Resources (DWR). Southern District. 1984. *Twentynine Palms ground water study.* District Report. 109 pp.

California Department of Water Resources (DWR), California Well Standards, Bulletin 74-90, June 1991.

California Department of Water Resources (DWR), 2003. *California's Groundwater Update 2003*, California Department of Water Resources, Sacramento, CA.

California's Department of Water Resources (DWR), 2013. *California's Groundwater Update 2013*, California Department of Water Resources, Sacramento, CA.

California Department of Water Resources (DWR), Sustainable Groundwater Management Act (SGMA), 2014.

California's Department of Water Resources (DWR), 2016. *California's Groundwater Interim Update 2016*, California Department of Water Resources, Sacramento, CA.

California Department of Water Resources (DWR), 2021. *California's Groundwater Update 2020,* California Department of Water Resources, Sacramento, CA.

California Department of Water Resources (DWR), *Non-SGMA Groundwater Management*. Accessed October, 2024a. https://water.ca.gov/Programs/Groundwater-Management/Non-SGMA-Groundwater-Management

California Department of Water Resources (DWR), 2024b. SGMA Basin Prioritization Dashboard [Online Web Map]. Accessed March 20th, 2024. https://gis.water.ca.gov/app/bp-dashboard/final/

California Department of Water Resources (DWR), 2024v. 7-062 Joshua Tree Basin Boundary Description. https://data.cnra.ca.gov/dataset/fb8dff8c-6bf7-4757-b3e9-c1bf4d38a414/resource/7dd1cfa3-017d-41b7-923e-0ccfa4b356d3/download/7-062_joshua-tree_basinboundarydescription.pdf

California Department of Water Resources (DWR), 2024d. California Irrigation Management Information Systems Station No. 233 Joshua Tree. https://cimis.water.ca.gov/WSNReportCriteria.aspx

California Regional Water Quality Control Board Colorado River Region 7 (RWQCB), 2006, Water Quality Control Plan Colorado River Basin – Region 7. http://www.waterboards.ca.gov/rwqcb7/publications_forms/publications/docs/basinplan_2006.pdf.

California State Water Resources Control Board (SWRCB), 2023. Water Quality Control Policy for Siting, Design, Operation, and Maintenance of Onsite Wastewater Treatment Systems. April 18, 2023.

Haley and Aldrich, Baseline Report, 2000, Compilation of Groundwater and Wells Information within the Twentynine Palms Water District Service Area, December 2000.

Kennedy Jenks, 2008. Groundwater Management Plan Update, report prepared for Twentynine Palms Water District, Kennedy Jenks, Los Angeles, CA, 126pp.

Kennedy Jenks, 2009. Shallow Groundwater Investigation- Twentynine Palms Water Treatment Plant Revised Report of Waste Discharge, letter report prepared for Twentynine Palms Water District, dated 22 October 2009, Kennedy Jenks, Irvine, CA, 10pp.

Kennedy Jenks, 2010. Groundwater Study for the Mesquite Lake Subbasin, report prepared for Twentynine Palms Water District, dated March 2010, Kennedy Jenks, San Francisco, CA, 328 pp.

Kennedy Jenks, 2014a. Twentynine Palms Groundwater Management Plan 2014 Update, report prepared for Twentynine Palms Water District, dated 28 May 2014, Kennedy Jenks, San Francisco, CA, 107 pp.

Kennedy Jenks, 2014b. Twentynine Palms Salt and Nutrient Management Plan, prepared for City of Twentynine Palms and Twentynine Palms Water District, dated June 2014, Kennedy Jenks, Irvine, CA, 149 pp.

Kennedy Jenks, 2019. Groundwater Monitoring Implementation Program, report prepared for Twentynine Palms Water District, dated 31 December 2019, Kennedy Jenks, Murrieta, CA, 44 pp.

Kennedy Jenks, 2021. 2020 Urban Water Management Plan, report prepared for Twentynine Palms Water District, dated June 2021, Kennedy Jenks, Oxnard, CA, 433 pp.

Kennedy Jenks, 2024. SNMP 2023 Groundwater Monitoring Report, report prepared for Twentynine Palms Water District, dated 31 May 2024, Kennedy Jenks, Rancho Cordova, CA.

Krieger and Stewart, 1996, Joshua Basin Water District Groundwater Management Plan, Joshua Basin Water District, Joshua Tree, California.

Li and Martin, 2011, Geohydrology, simulation of regional groundwater flow, and assessment of water management strategies, Twentynine Palms area, California, USGS Scientific Investigations Report: 2010-5249.

Londquist, C.J. and P.R. Martin, 1991. Geohydrology and ground-water-flow simulation of the Surprise Spring basin aquifer system, San Bernardino County, California, *U.S. Geological Survey Water-Resources Investigations Report 89-4099*, U.S. Geological Survey, Sacramento, CA, 48pp.

Mendez, G.O. and A.H. Christensen. 1997. *Regional water table (1996) and water-level changes in the Mojave River, the Morongo, and the Fort Irwin ground-water basins, San Bernardino County, California.* U.S. Geological Survey Water-Resources Investigations Report 97-4160. 34 p.

MWH, 2009a. High-Desert Water District Sewer Master Plan Final Report. January 2009.

MWH, 2009b. High-Desert Water District Water Reclamation Facility Preliminary Design Report. Volume 1, January 2009.

Moyle, W.R., Jr. 1984. *Bouguer gravity anomaly map of the Twentynine Palms Marine Corps Base and vicinity, California.* U.S. Geological Survey Water-Resources Investigations Report 84-4005.

Nishikawa, T., J.A. Izbicki, J.A. Hevesi, C.L. Stamos, and P. Martin, 2004. Evaluation of geohydrologic framework, recharge estimates, and ground-water flow of the Joshua Tree area, San Bernardino County, California, *U.S. Geological Survey Science Investigations Report 2004-5267*, U.S. Geological Survey, Reston, VA, 127pp.

Riley, F.S. and G.F. Worts, Jr., 1952 [Retyped 2001]. Geologic reconnaissance and test-well drilling program, Marine Corps Training Center, Twentynine Palms, California, *U.S. Geological Survey Open-File Report 98-166*, U.S. Geological Survey, Long Beach, CA, 71pp.

Riley, F.S. and G.F. Worts, Jr., 1953 [Retyped 2001]. Geology and ground-water appraisal of the Twentynine Palms Marine Corps Training Center, California, *U.S. Geological Survey Open-File Report 98-167*, U.S. Geological Survey, Long Beach, CA, 131pp.

Roberts, C., R. Jachens, A. Katzenstein, G. Smith, and R. Johnson, 2002. Gravity map and data of the eastern half of the Big Bear Lake, 100,000 scale quadrangle, California and analysis of the depths of several basins*, U.S. Geological Survey Open-File Report 02-353*, U.S. Geological Survey, Reston, VA, 1 map.

Schaefer, D.H. 1978. *Ground-water resources of the Marine Corps Base, Twentynine Palms, San Bernardino County, California.* U.S. Geological Survey Water-Resources Investigations Report 77-37. 29 p.

Troxell, H.C. and others, 1954. Hydrology of the San Bernardino and eastern San Gabriel Mountains, California, U.S. Geological Survey Hydrologic Atlas HA 1, *U.S. Geological Survey*, Washington, D.C., 30pp.

Thompson, D.G., 1929. The Mohave Desert Region, California: a geographic, geologic, and hydrologic reconnaissance, U*.S. Geological Survey Water-Supply Paper 578*, U.S. Government Printing Office, Washington, D.C., 817pp.

U.S. Department of Agriculture (USDA), 1970. Report and General Soil Map of the Southwestern Desert Area of San Bernardino County, California, U.S. Department of Agriculture, Fort Worth, TX.

U.S. Department of Agriculture (USDA), 1994. State Soil Geographic (STATSGO) Data Base – Data Use Information, *Miscellaneous Publication No. 1492*, U.S. Department of Agriculture, Fort Worth, TX.

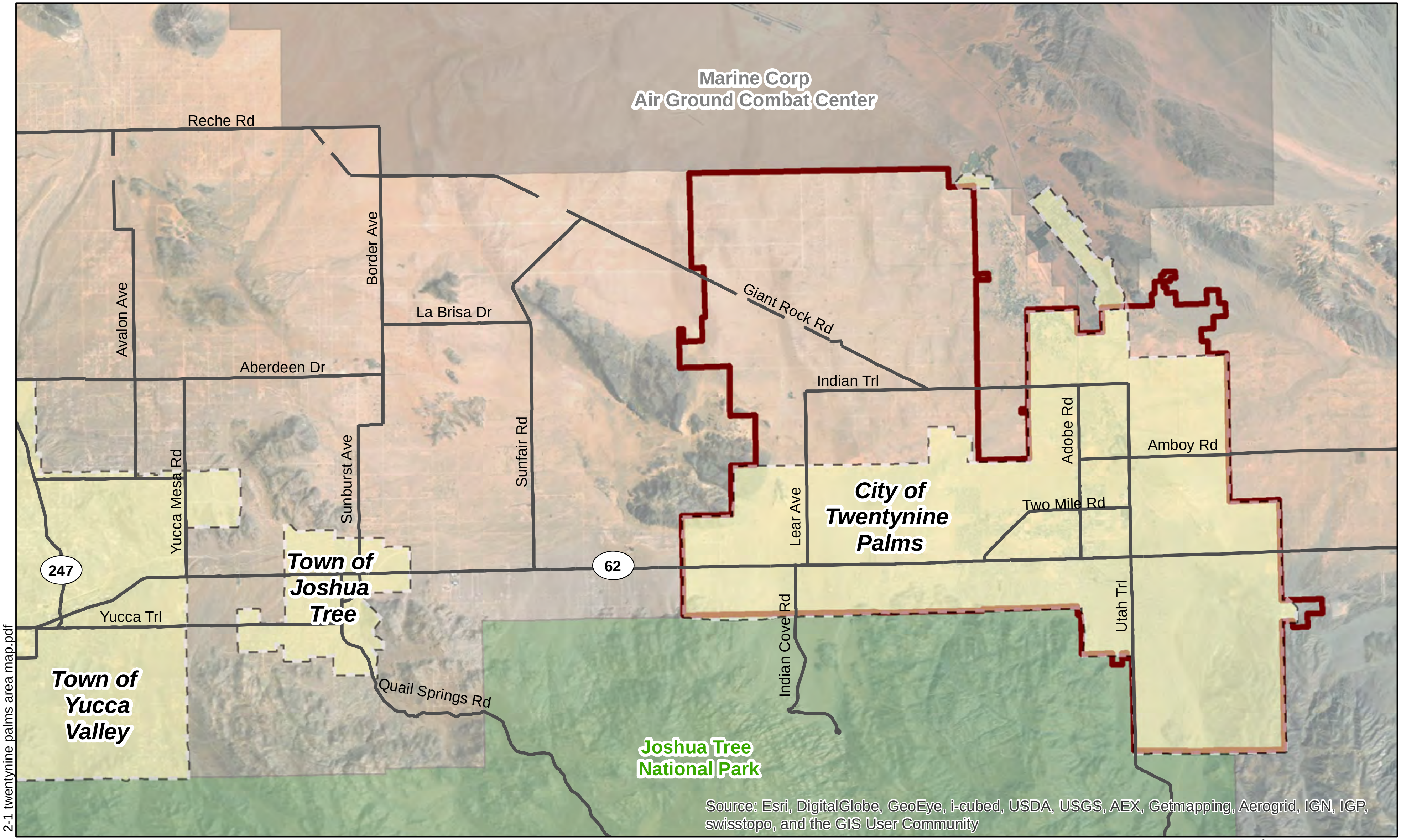
US Department of Commerce, National Oceanic and Atmospheric Administration. “National Geodetic Survey.” Accessed December 9th 2024. https://geodesy.noaa.gov/datasheets/

U.S Department of Defense Environment, Safety & Occupational Health Network and Information Exchange (DENIX), 2021. 2-Nomination Narrative-USMC-S-NCII-Twentynine-Palms_508C

Whitt, A. and K.L. Jonker, 1998. Groundwater survey of the Joshua Tree and Copper Mountain subbasins, Joshua Tree, California, Western Water Surveys report prepared for the Joshua Tree Water District.

Woodward-Clyde Consultants, 1985, Twentynine Palms Groundwater Study Final Report, report prepared for Twentynine Palms Water District, dated 6 May 1985, Woodward-Clyde Consultants, Santa Ana, CA.

Figures



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Legend

- Road
- City Limit
- Water District Boundary
- Marine Corps Base
- National Park

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Groundwater Management Plan 2024 Update
Twentynine Palms Water District

Twentynine Palms Area Map

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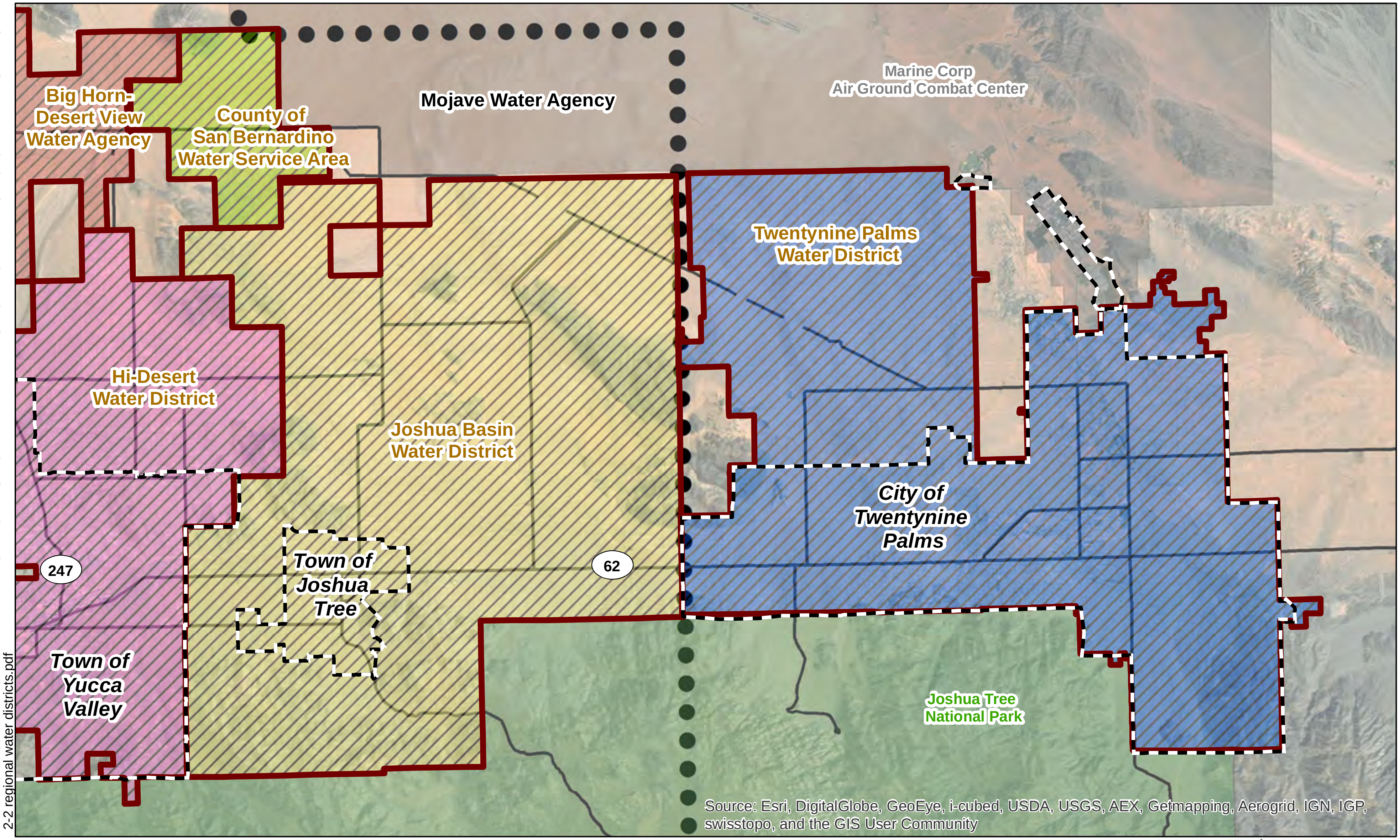
December 2024

Figure 2-1



Legend

Road	Water District Boundary	Marine Corps Base
City Limit	Mojave Water Agency	National Park

N

0 1 2

Scale: Miles

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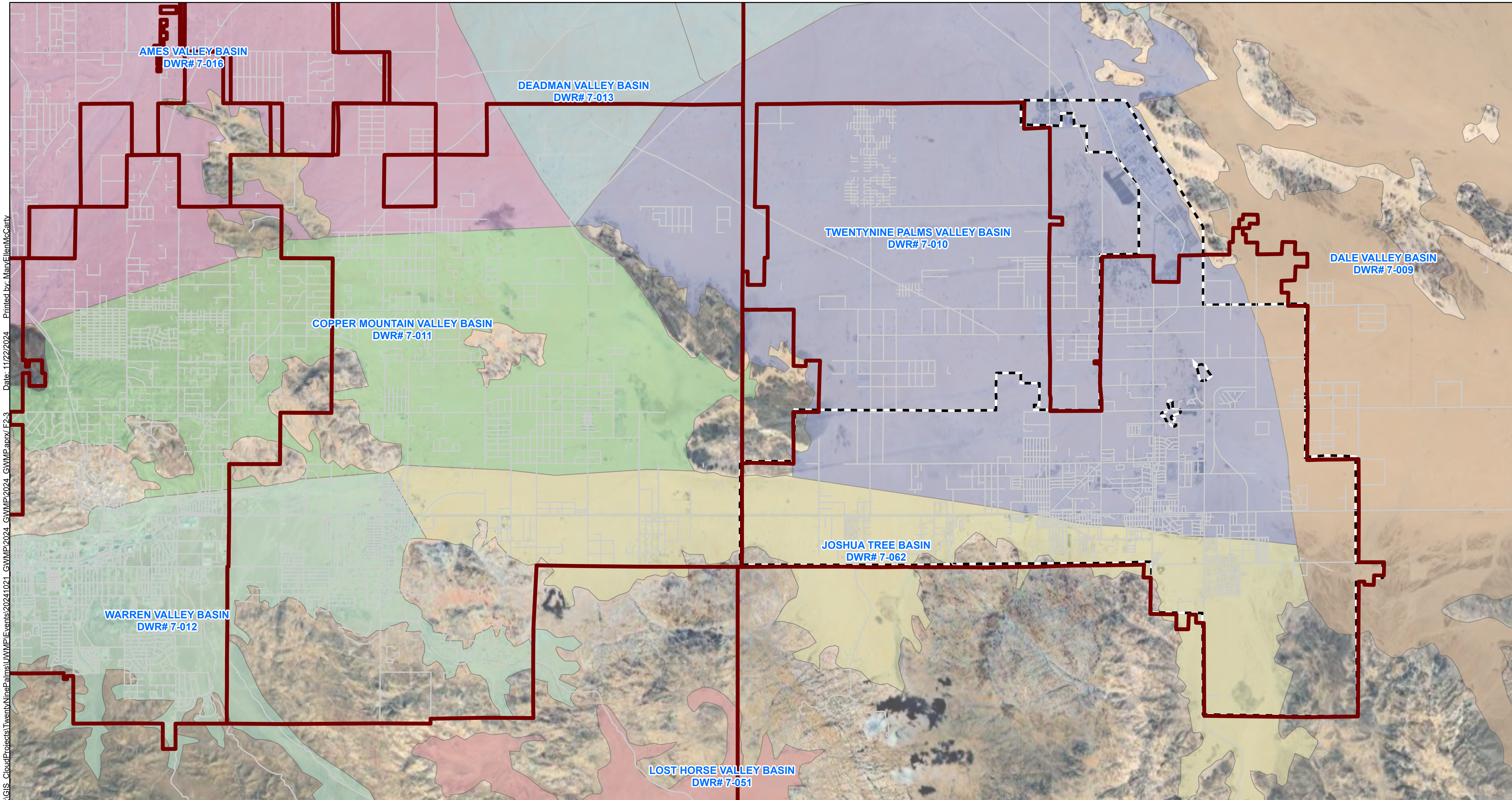
Groundwater Management Plan 2024 Update
Twentynine Palms Water District

Regional Water Districts

KJ 2444214*00
December 2024

Figure 2-2

Google Earth Satellite: Google Earth



Coordinate System: WGS 1984 Web Mercator Auxiliary Sphere Projection: Mercator Auxiliary Sphere

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Legend

Roads

Water District Boundary

City Limit

N

0 1 2

Miles

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Document Title
City, County, State

DWR Groundwater Basins

2444214*00
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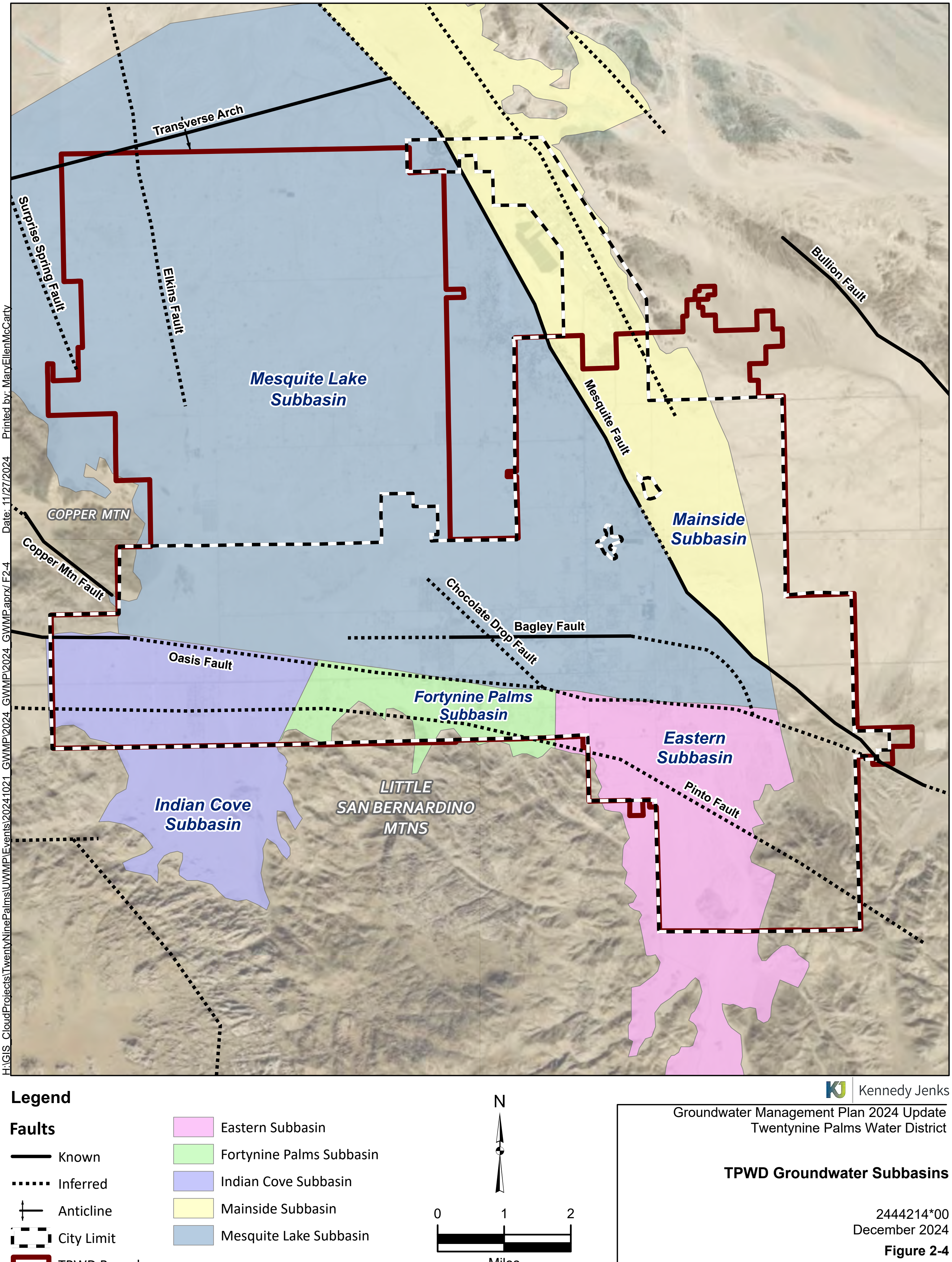
Figure 2-3

World Imagery: County of San Bernardino, Earthstar Geographics



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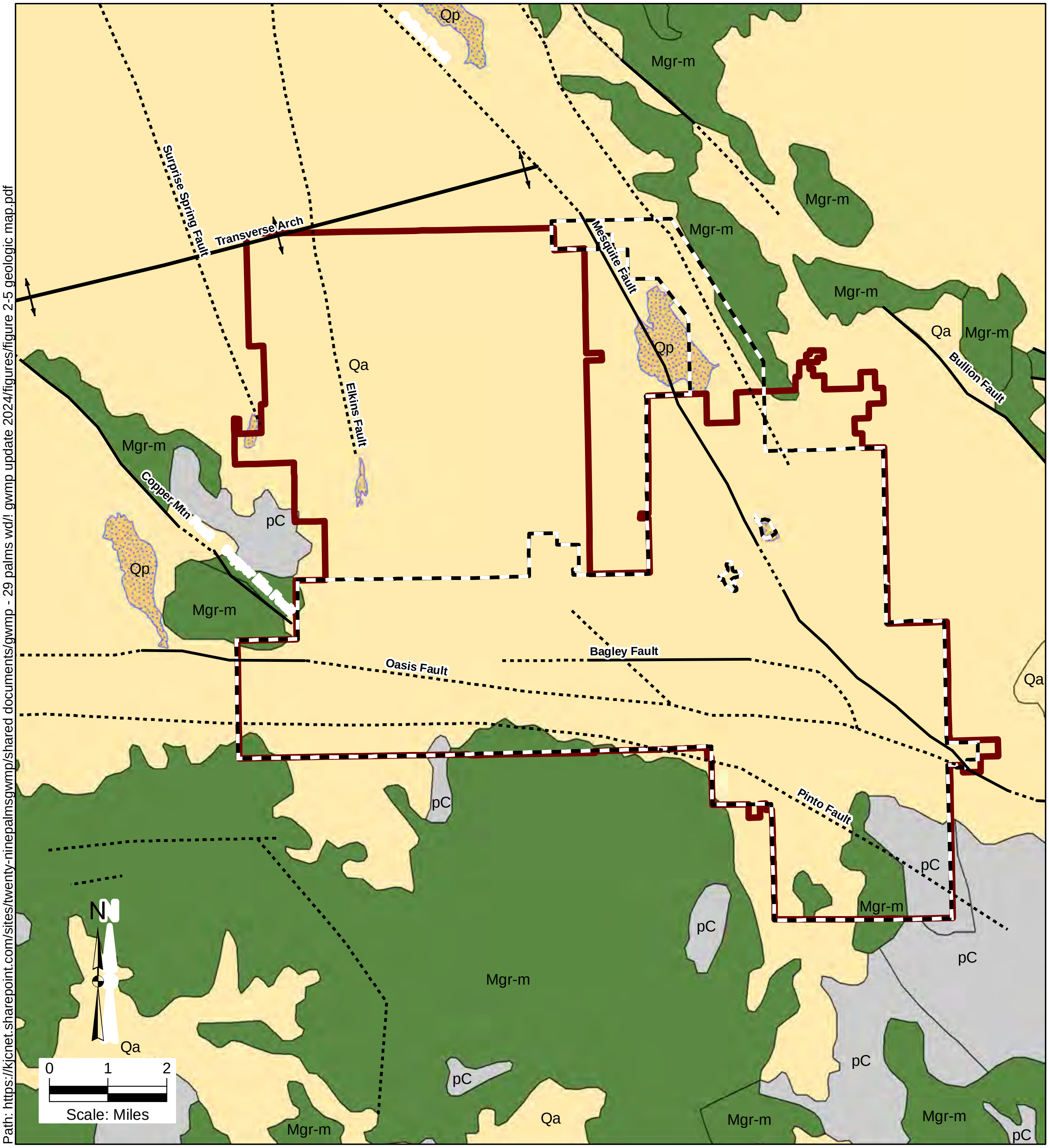
Groundwater Management Plan 2024 Update
Twentynine Palms Water District

TPWD Groundwater Subbasins

2444214*00
December 2024

Figure 2-4



Legend

City Limit

Water District Boundary

Faults

Known

Inferred

Anticline

Geologic Units

Qp: Playa lakes

Qa: Quaternary alluvium

Mgr-m: Mesozoic igneous & metamorphic rocks

pC: Precambrian igneous & metamorphic rocks

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Groundwater Management Plan 2024 Update
Twentynine Palms Water District

Geologic Map

KJ 1365022*00
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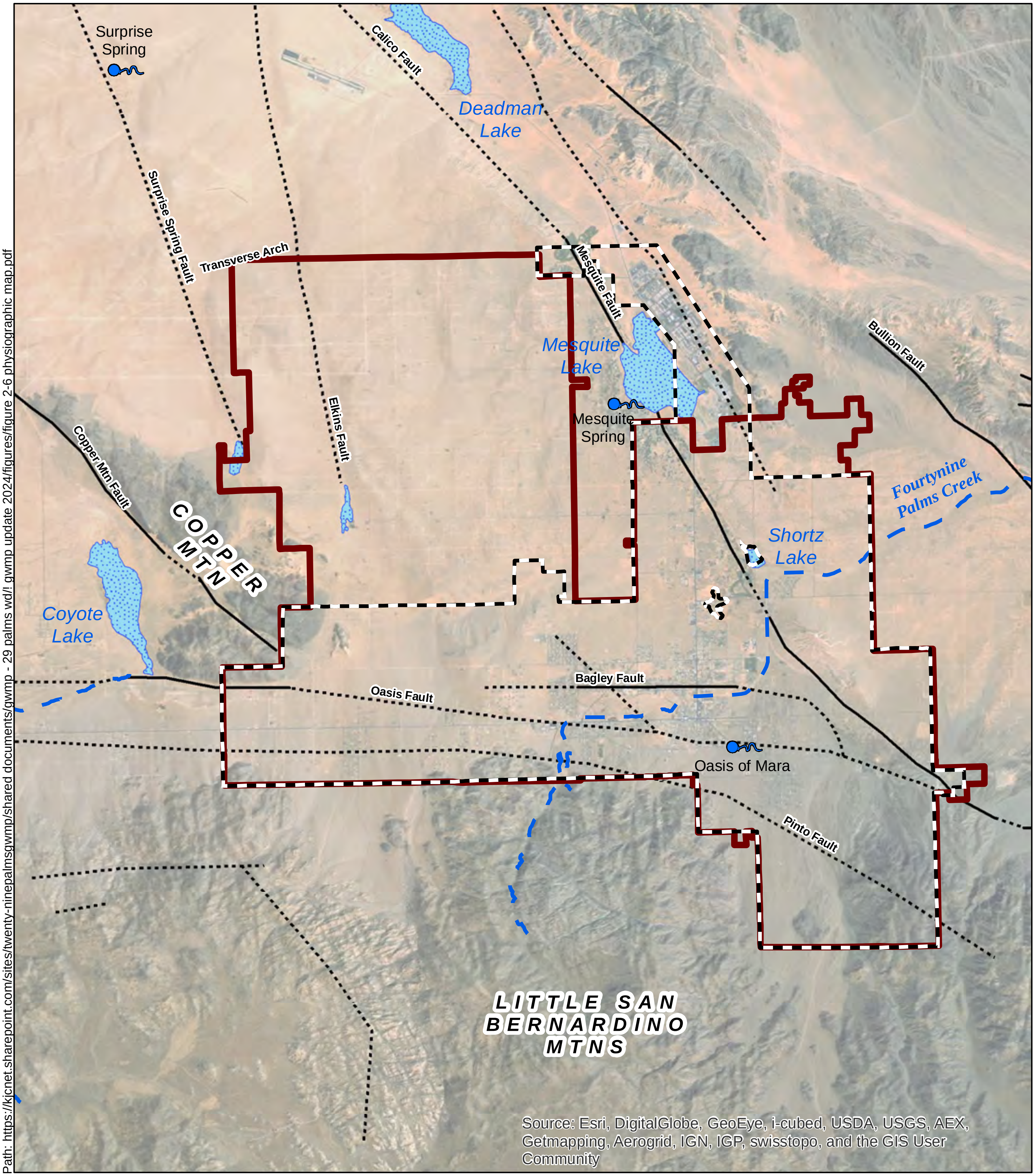
Figure 2-5



Legend

Surface Water Features

Spring

Stream

Playa Lake

City Limit

Water District Boundary

Faults

Known

Inferred

N

0 1 2

Scale: Miles

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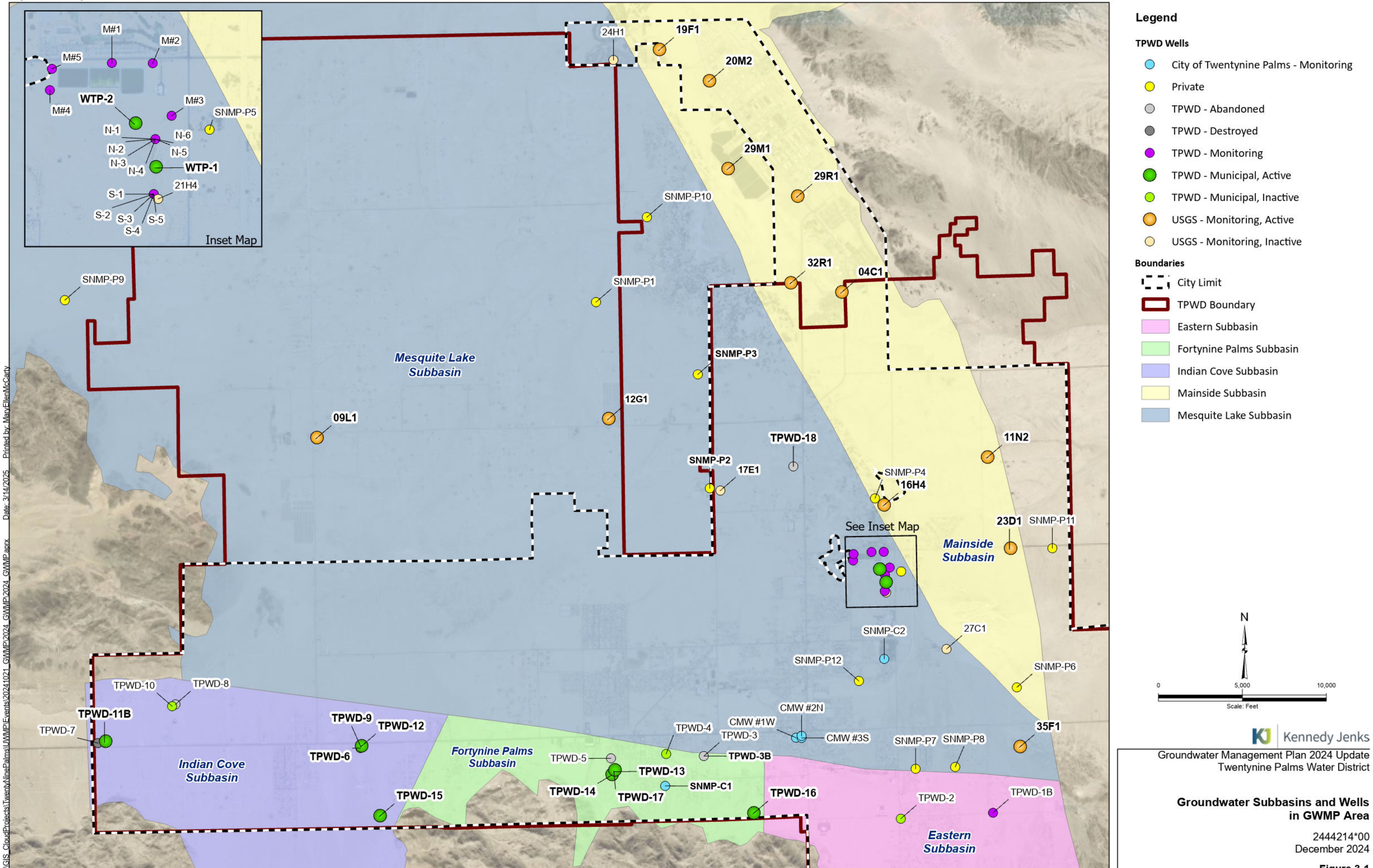
Groundwater Management Plan 2024 Update
Twentynine Palms Water District

Physiographic Map

KJ 2444214*00
December 2024

Figure 2-6

World Imagery: County of San Bernardino, Maxar
Google Earth Satellite: Google Earth



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Coordinate System: NAD 1983 StatePlane California V FIPS 0405 Feet Projection: Lambert Conformal Conic

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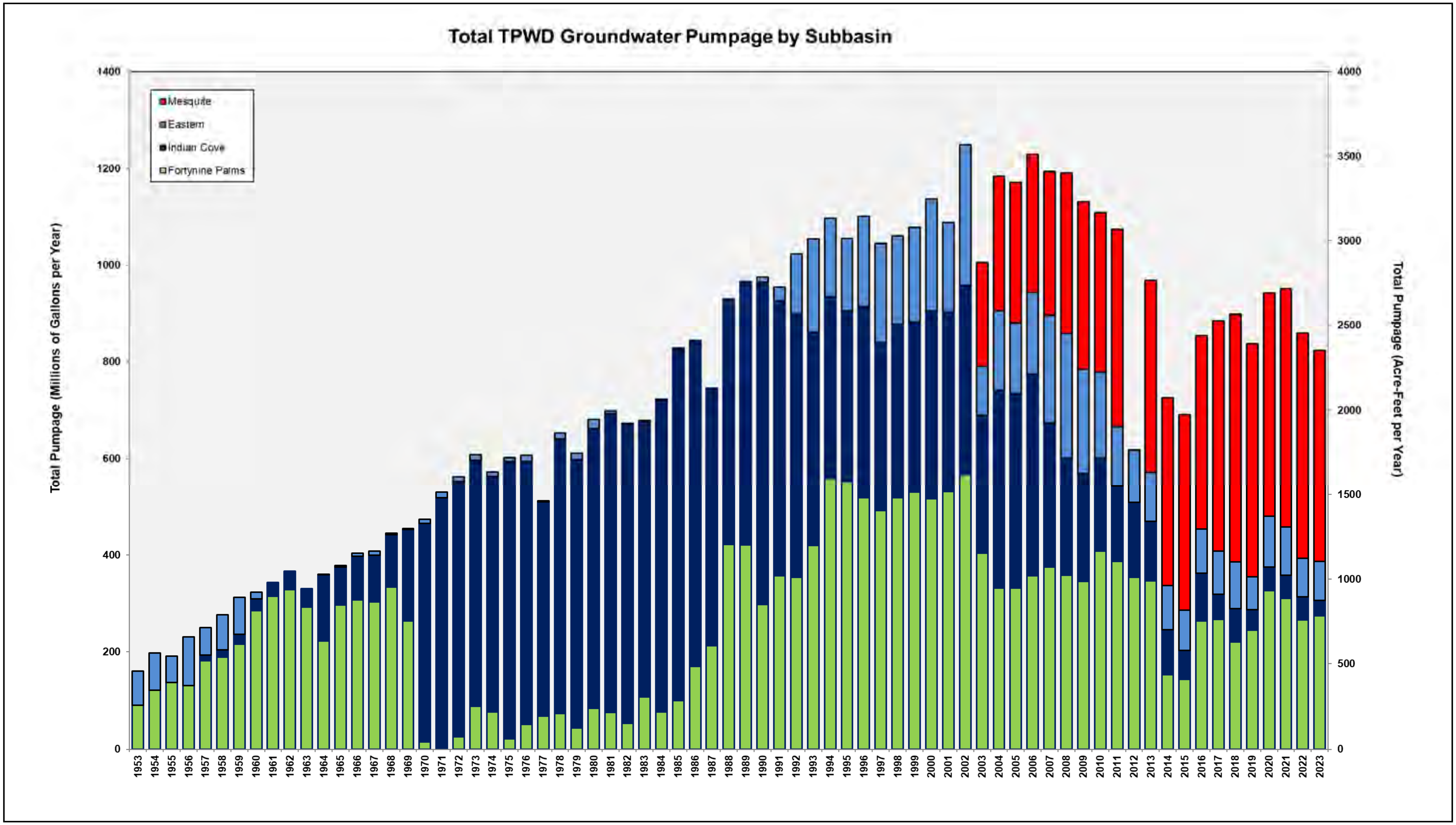
Groundwater Management Plan 2024 Update
Twentynine Palms Water District

Groundwater Subbasins and Wells in GWMP Area

2444214*00
December 2024

Figure 3-1



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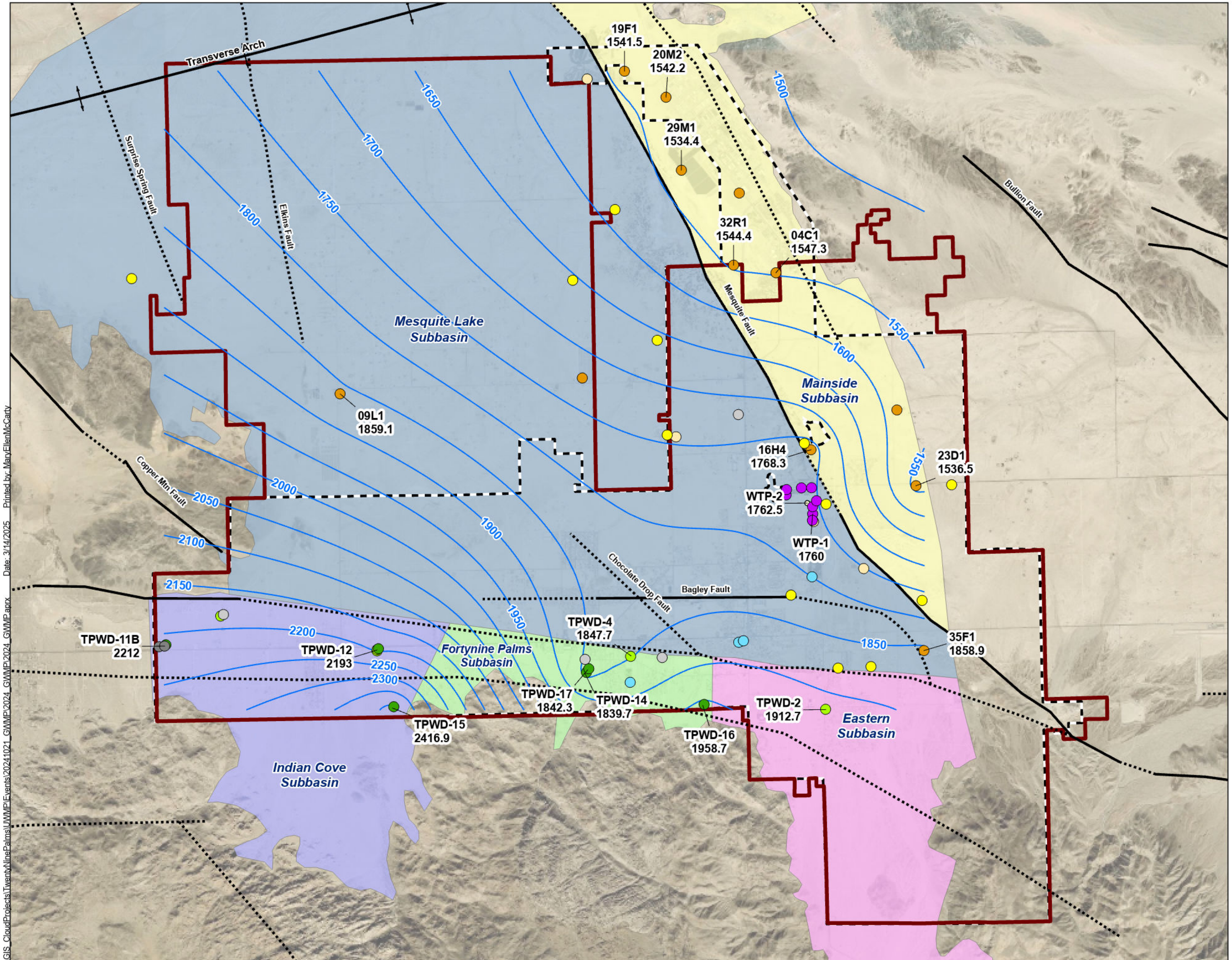
Groundwater Management Plan 2024 Update
Twentynine Palms Water District

Annual Pumping from TPWD Wells by Subbasin

KJ 2444214*00
December 2024

Figure 3-2

World Imagery: County of San Bernardino, Earthstar Geographics



Legend

Wells

- City of Twentynine Palms - Monitoring
- Private
- TPWD - Abandoned
- TPWD - Destroyed
- TPWD - Monitoring
- TPWD - Municipal, Active
- TPWD - Municipal, Inactive
- USGS - Monitoring, Active
- USGS - Monitoring, Inactive

Faults

- Known
- Inferred
- Anticline

Boundaries

- City Limit
- TPWD Boundary
- Eastern Subbasin
- Fortynine Palms Subbasin
- Indian Cove Subbasin
- Mainside Subbasin
- Mesquite Lake Subbasin

Groundwater Elevation Contours

- Contour Line

Notes:

1. Groundwater elevation contours are based on March-May TPWD and USGS static groundwater level data from 2022 to 2024.
2. Displayed groundwater elevations are in ft, MSL.

N

0 5,000 10,000

Scale: Feet

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Groundwater Management Plan 2024 Update
Twentynine Palms Water District

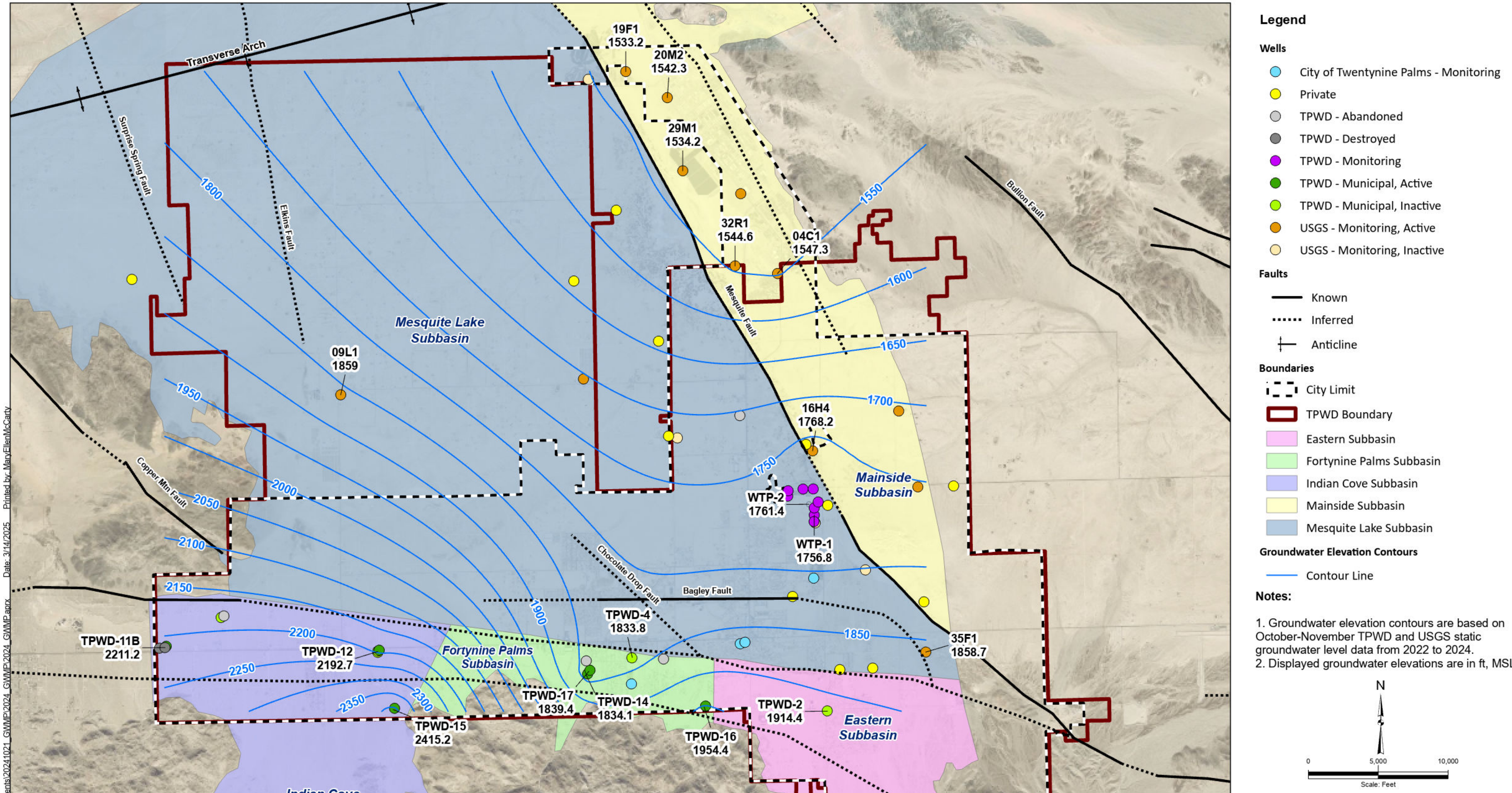
Spring Groundwater Elevation Map

2444214*00
December 2024

Figure 4-1

Coordinate System: NAD 1983 StatePlane California V FIPS 0405 Feet Projection: Lambert Conformal Conic

World Imagery: County of San Bernardino, Earthstar Geographics



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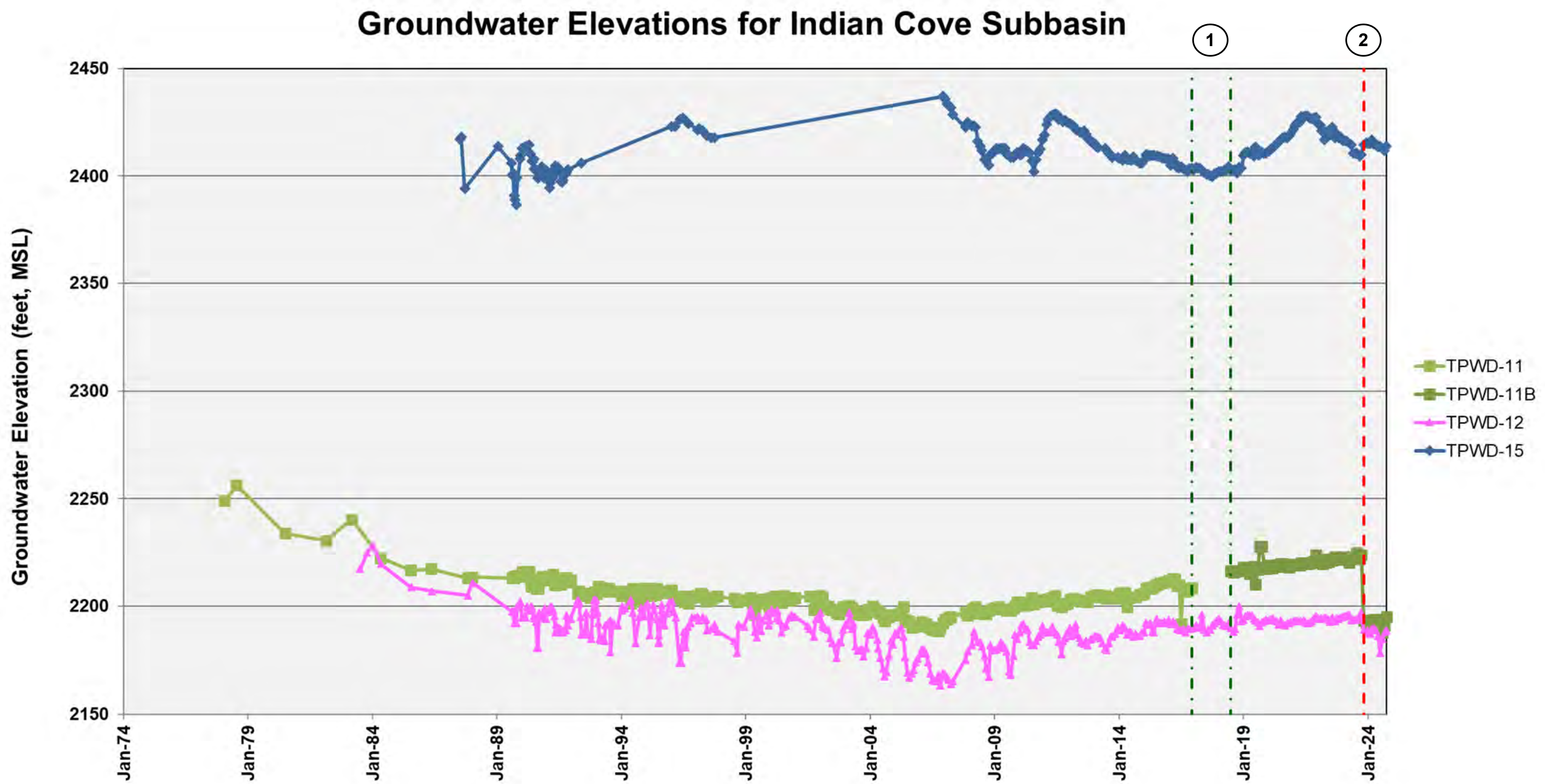
Groundwater Management Plan 2024 Update
Twentynine Palms Water District

Fall Groundwater Elevation Map

2444214*00
December 2024

Figure 4-2

Coordinate System: NAD 1983 StatePlane California V FIPS 0405 Feet   Projection: Lambert Conformal Conic



Notes:

(1) Production well TPWD-11 was replaced with production well TPWD-11B in 2017. The last TPWD-11 sample was taken on 12/6/2016 and the first TPWD-11B sample was taken on 7/3/2018.

(2) Well location surveys were conducted from September to November 2023 for TPWD active and inactive production wells. Before November 5th, 2023, groundwater elevations were calculated using assumed measuring point elevations for each TPWD production well. Starting November 5th, 2023, groundwater elevations are calculated using the respective surveyed measuring point elevations for each TPWD production well.

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Groundwater Management Plan 2024 Update
Twentynine Palms Water District

Hydrograph Showing Groundwater Elevation History for Indian Cove Subbasin

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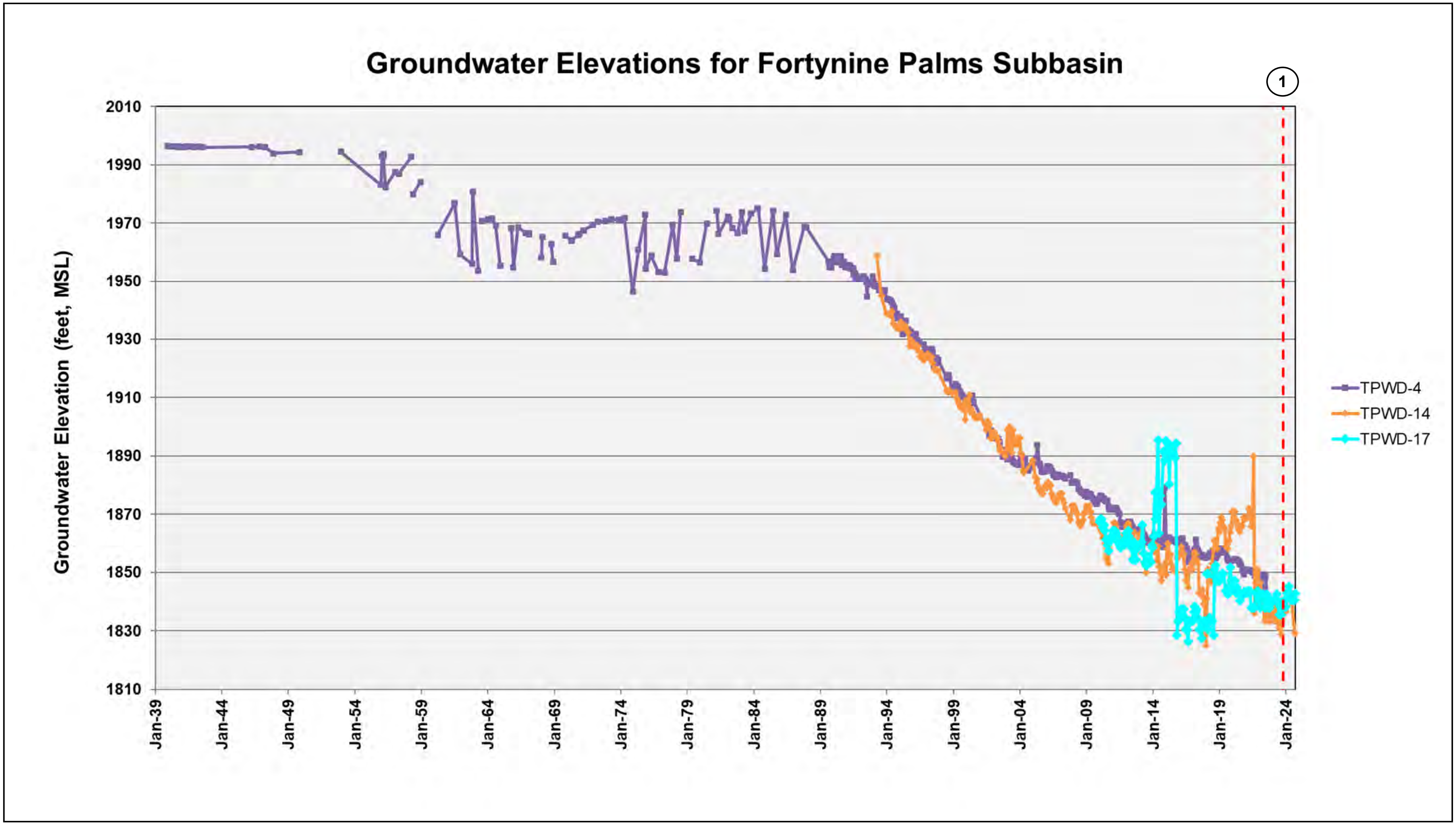
December 2024

Figure 4-3



Notes:

(1) Well location surveys were conducted from September to November 2023 for TPWD active and inactive production wells. Before November 5th, 2023, groundwater elevations were calculated using assumed measuring point elevations for each TPWD production well. Starting November 5th, 2023, groundwater elevations are calculated using the respective surveyed measuring point elevations for each TPWD production well.

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Groundwater Management Plan 2024 Update
Twentynine Palms Water District

Hydrograph Showing Groundwater Elevation History for Fortynine Palms Subbasin

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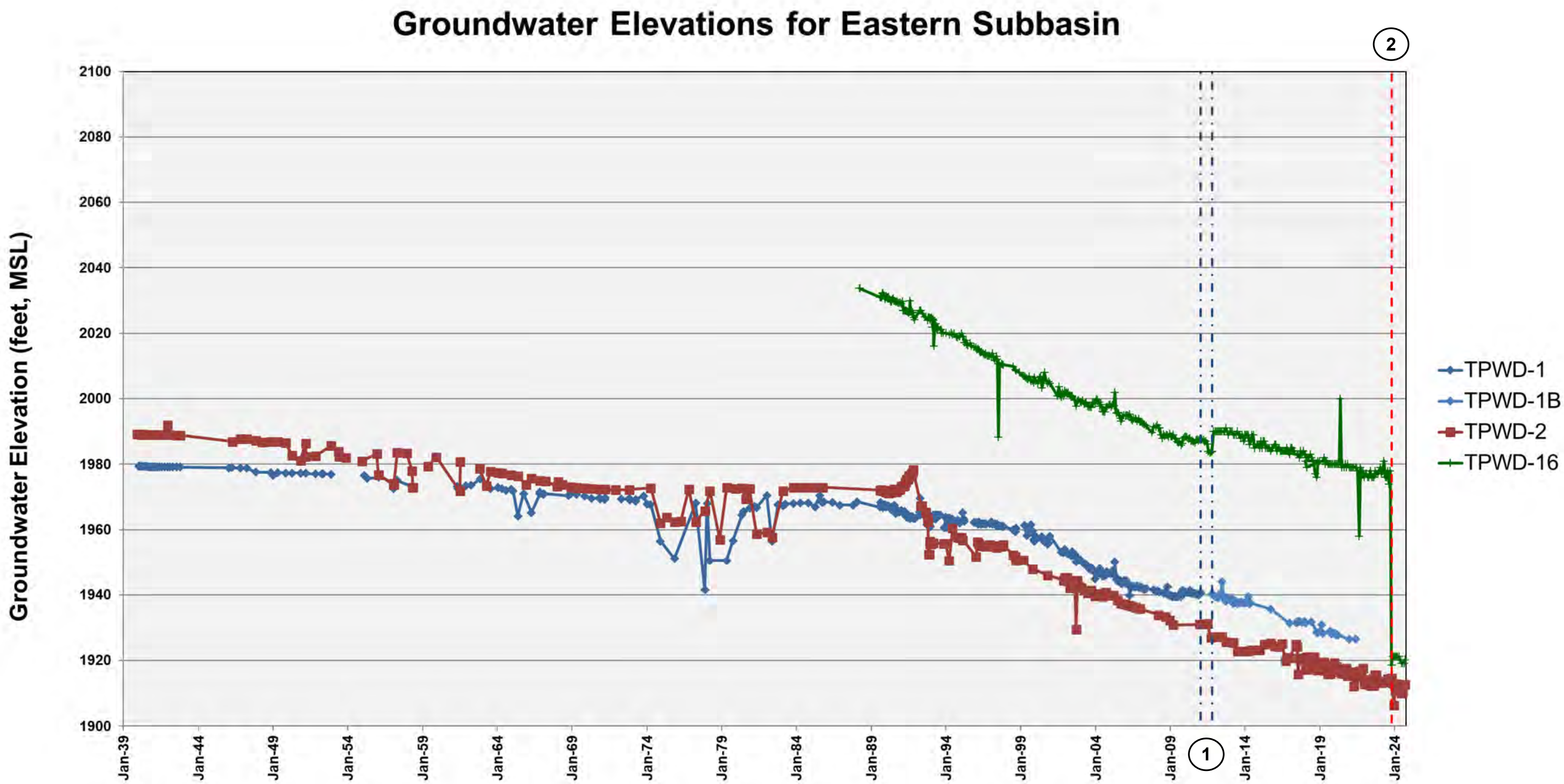
December 2024

Figure 4-4



Notes:

(1) Production well TPWD-1 was replaced with monitoring well TPWD-1B in 2011. The last TPWD-1 sample was taken on 2/2/2011 and the first TPWD-1B sample was taken on 11/1/2011. Static water depth was last measured in TPWD-1B on 6/8/2021.

(2) Well location surveys were conducted from September to November 2023 for TPWD active and inactive production wells. Before November 5th, 2023, groundwater elevations were calculated using assumed measuring point elevations for each TPWD production well. Starting November 5th, 2023, groundwater elevations are calculated using the respective surveyed measuring point elevations for each TPWD production well.

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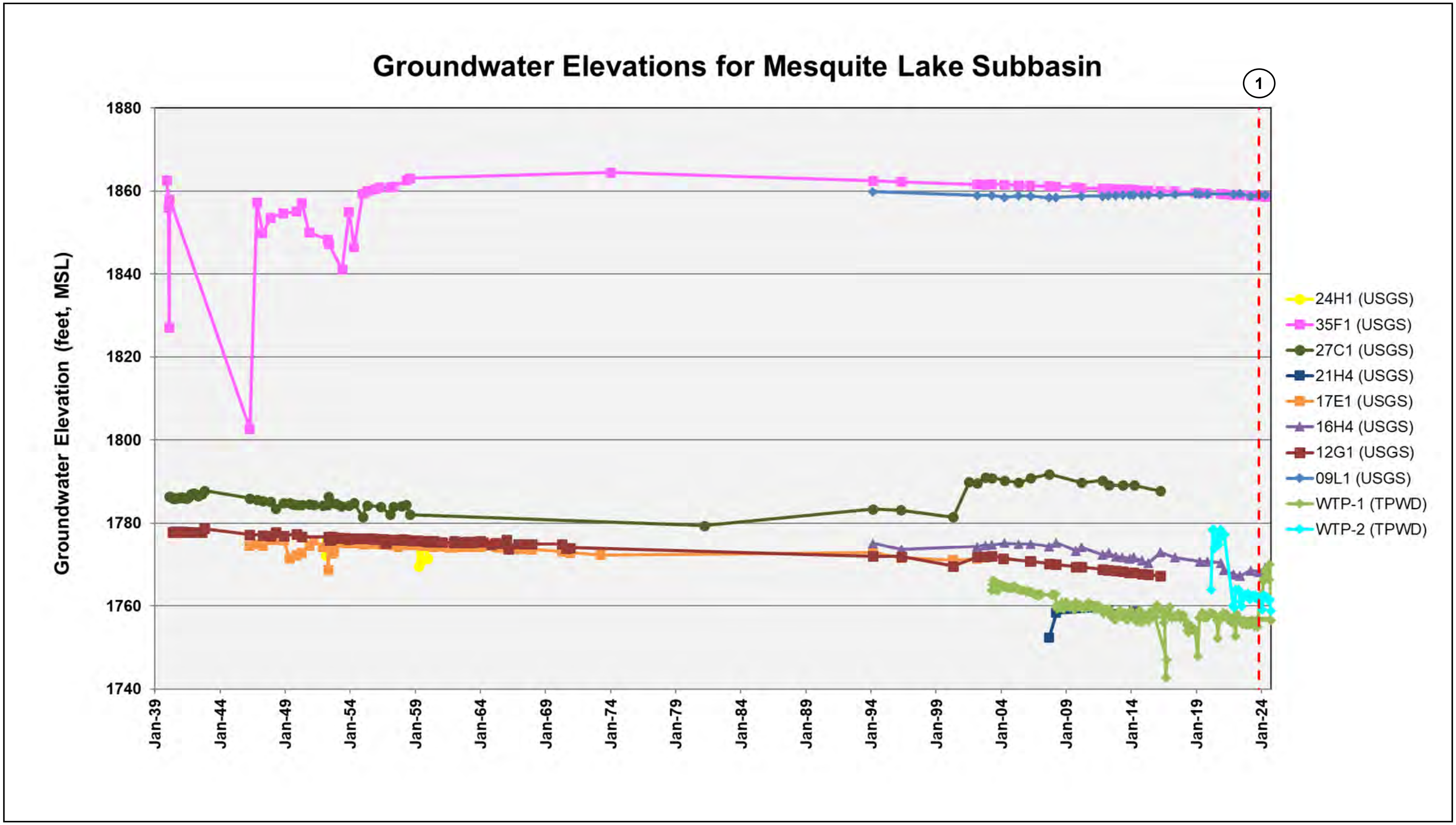
Groundwater Management Plan 2024 Update
Twentynine Palms Water District

Hydrograph Showing Groundwater Elevation History for Eastern Subbasin

KJ 2444214*00
December 2024

Figure 4-5



Notes:

(1) Well location surveys were conducted from September to November 2023 for TPWD active and inactive production wells. Before November 5th, 2023, groundwater elevations were calculated using assumed measuring point elevations for each TPWD production well. Starting November 5th, 2023, groundwater elevations are calculated using the respective surveyed measuring point elevations for each TPWD production well.

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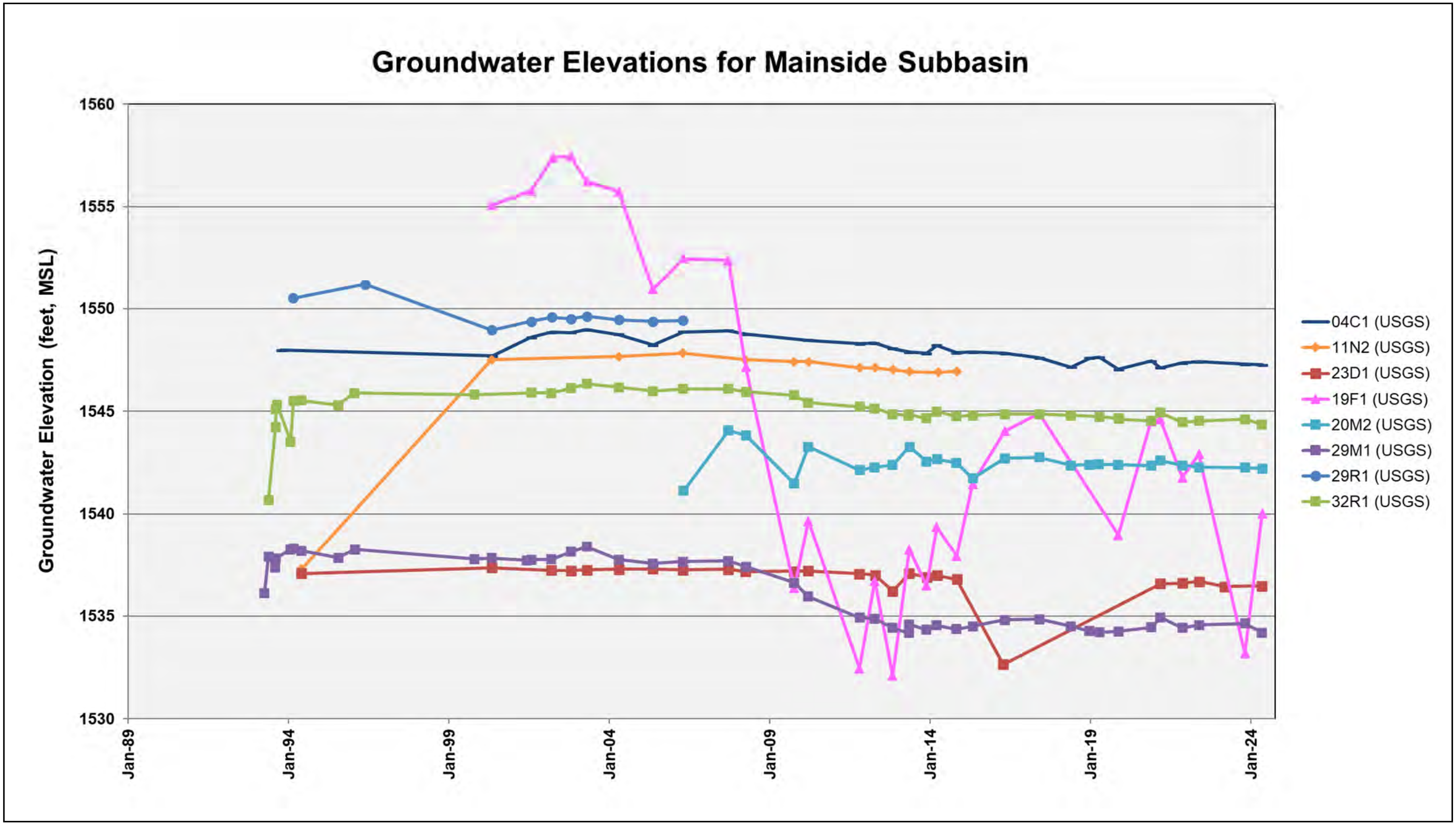
Groundwater Management Plan 2024 Update
Twentynine Palms Water District

Hydrograph Showing Groundwater Elevation History for Mesquite Lake Subbasin

KJ 2444214*00
December 2024

Figure 4-6



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Groundwater Management Plan 2024 Update
Twentynine Palms Water District

Hydrograph Showing Groundwater Elevation History for Mainside Subbasin

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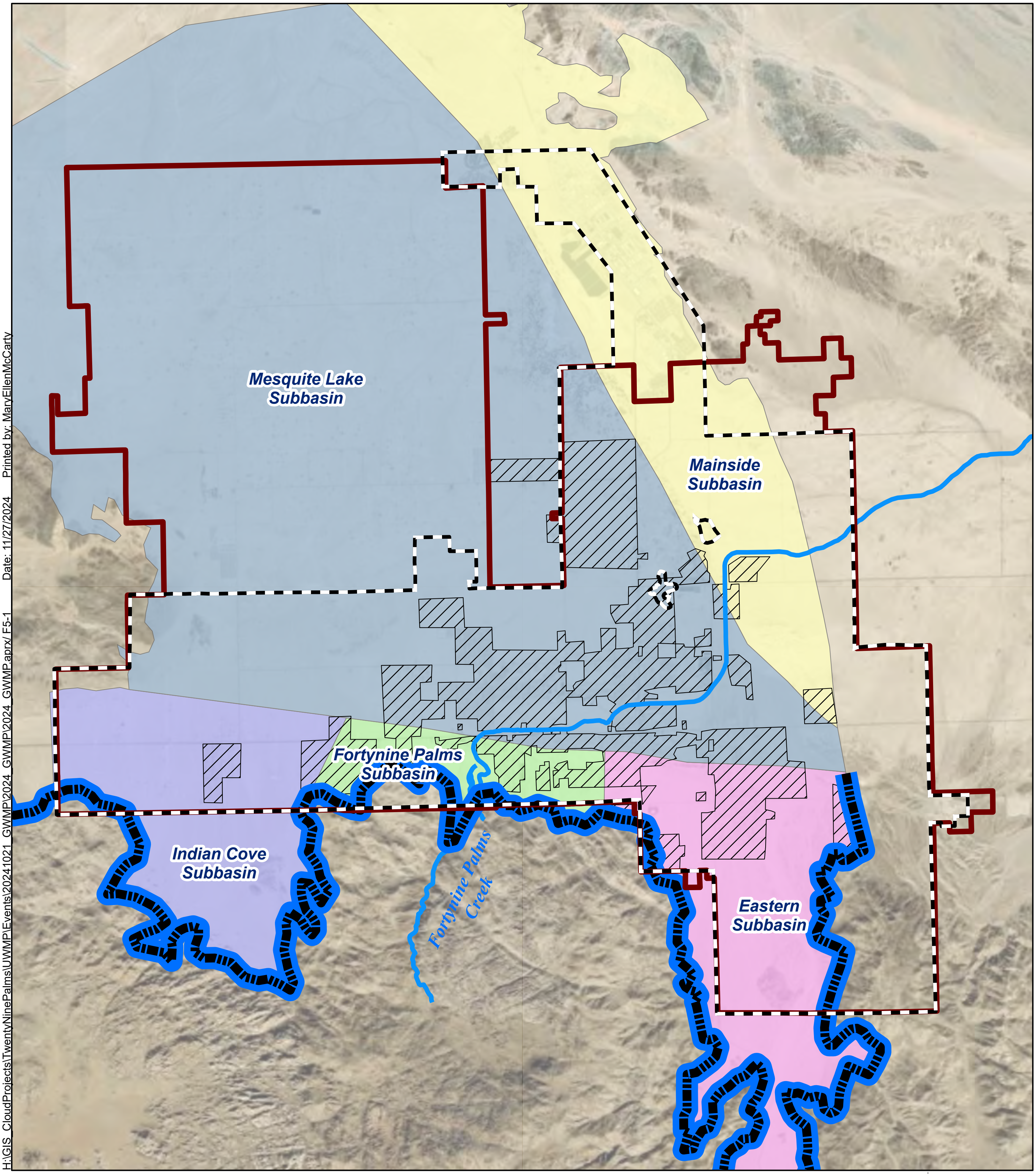
December 2024

Figure 4-7

World Imagery: County of San Bernardino, Earthstar Geographics



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Legend

Urban Recharge Zone	Eastern Subbasin
Stream Recharge Zone	Fortynine Palms Subbasin
Natural Recharge Zone	Indian Cove Subbasin
City Limit	Mainside Subbasin
TPWD Boundary	Mesquite Lake Subbasin

N

0 1 2

Miles

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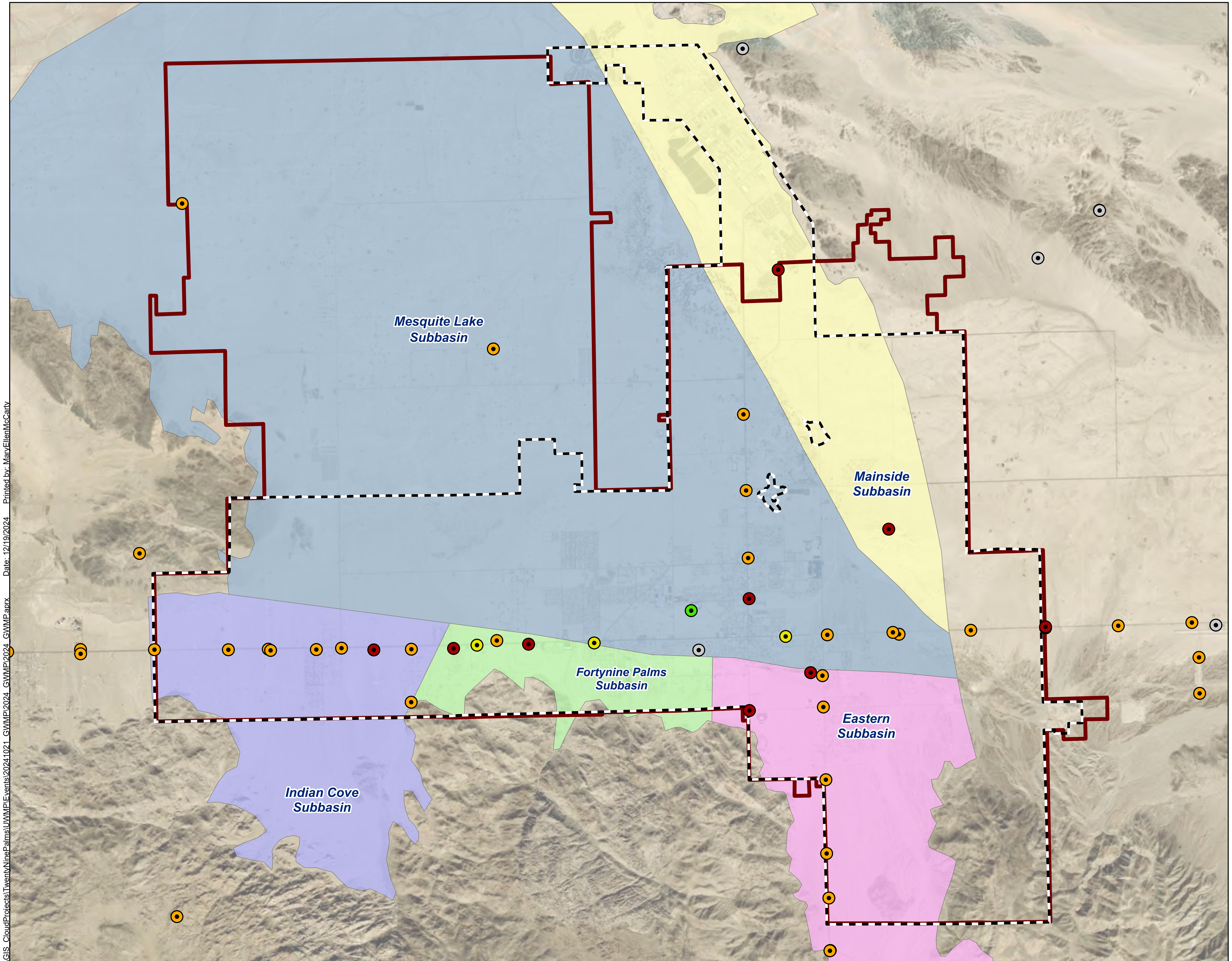
Groundwater Management Plan 2024 Update
Twentynine Palms Water District

DWR Groundwater Recharge Areas

2444214*00
December 2024

Figure 4-8

World Imagery: County of San Bernardino, Earthstar Geographics



Legend

NGS Survey Marks & Bench Marks

STABILITY

- A - Monuments of the most reliable nature which are expected to hold their position/elevation well
- B - Monuments which probably hold their positions/elevations well
- C - Monuments which may hold their positions/elevations well, but which are commonly subject to surface ground movements
- D - Monuments of questionable or unknown reliability
- Not Rated

Boundaries

- City Limit
- TPWD Boundary
- Eastern Subbasin
- Fortynine Palms Subbasin
- Indian Cove Subbasin
- Mainside Subbasin
- Mesquite Lake Subbasin

Notes:

1. NGS Survey Marks and Bench Marks geospatial data acquired from NOAA. Stability Rating description found in User's Guide for GPS Observations at Tide and Water Level Station Bench Marks, Section 3.1

N

0 5,000 10,000

Scale: Feet

Kennedy Jenks

Groundwater Management Plan 2024 Update
Twentynine Palms Water District

Subsidence Indicators

2444214*00
December 2024

Figure 4-9

H:\GIS_CloudProjects\TwentyNinePalms\UWMP\Events\20241021_GWMP\2024_GWMP\2024_GWMP.aprx Date: 12/19/2024 Printed by: MaryEllenMcCarty

Coordinate System: NAD 1983 StatePlane California V FIPS 0405 Feet Projection: Lambert Conformal Conic

Appendix A

Resolution of GWMP Adoption

A REGULAR MEETING OF THE BOARD OF DIRECTORS
OF THE TWENTYNINE PALMS WATER DISTRICT
72401 HATCH ROAD, TWENTYNINE PALMS, CA 92277

March 26, 2025 / 4:00 P.M.

AGENDA

This meeting may be viewed on the District's website at www.29palmswater.net
The Board reserves the right to discuss only or take action on any item on the agenda.

Next Resolution #25-05
Next Ordinance #104

Call to Order and Roll Call
Please make sure all cell phones are silenced.

Pledge of Allegiance

Additions/Deletions to the Agenda

Public Comments
Please complete a "Request to be Heard" form prior to the start of the meeting. The public may address the Board for 3 minutes on District-related matters. Government Code prohibits the Board from taking action on matters that are not on the agenda. However, the Board may refer matters for future consideration.

1 Public Hearing on Proposed Amendment to the District Groundwater Management Plan
   1.1 Board to Hear Public Testimony at This Time

2. Consideration of Resolution 25-02 Intent to Amend the District Groundwater Management Plan (GWMP)

3. Consideration of Resolution 25-03 Intention to Continue Currently Existing Water Availability Assessments of the Twentynine Palms Water District in the Upcoming Fiscal Year 2025/2026

4. Commending Steve Gurney for Twenty Years of Public Service

5. Approval of Kennedy Jenks Amendment #2 to the 2024-2027 Master Professional Service Agreement and Accept Proposal for Well 11B Treatment Evaluation

6. Formation of an Ad Hoc Committee for Joint City Meeting

7. Discussion on Health Benefits for the Board of Directors

8. Consent Calendar

Matters under the Consent Calendar are to be considered routine and will be enacted in a single motion. There will be no separate discussion of these items unless the Board, staff or the public requests specific items be removed for separate discussion and action before the Board votes on the motion to adopt.

- Minutes of the Regular Meeting held on February 26, 2025
- Audit List

9. Items Removed from the Consent Calendar for Discussion or Separate Action

10. Management Reports

    10.1 Maintenance

    10.2 Water Quality

    10.3 Finance

    10.4 General Manager

11. Conference With Legal Counsel-Anticipated Litigation - Initiation of litigation pursuant to paragraph (4) of subdivision (d) of Section 54956.9: (1 case)

12. Future Agenda Items and Staff Tasks/Directors' Comments and Reports

13. Adjournment

Notice of agenda was posted on or before 4:00 p.m., March 21, 2025.

Matthew Shragge, General Manager

Upon request, this Agenda will be made available in appropriate alternative formats to persons with disabilities, as required by Section 202 of the Americans with Disabilities Act of 1990. Any person with a disability who requires a modification or accommodation in order to participate in a meeting should direct such request to Cindy Fowlkes at (760) 367-7546 at least 48 hours before the meeting, if possible.

Pursuant to Government Code Section 54957.5, any writing that: (1) is a public record; (2) relates to an agenda item for an open session of a regular meeting of the Board of Directors; and (3) is distributed less than 72 hours prior to that meeting, will be made available for public inspection at the time the writing is distributed to the Board of Directors. Any such writing will be available for public inspection at the District offices located at 72401 Hatch Road, Twentynine Palms, CA 92277. In addition, any such writing may also be posted on the District's website.

MINUTES OF A REGULAR MEETING OF THE BOARD OF DIRECTORS OF THE TWENTYNINE PALMS WATER DISTRICT 72401 HATCH ROAD, TWENTYNINE PALMS, CA 92277

March 26, 2025 / 4:00 P.M.

Call to Order and Roll Call
President Bob Coghill called the Board meeting to order at 4:00 p.m. Those responding to roll call were Michael Arthur, Larry Bowden, Bob Coghill, Randy Leazer, and Amy Woods. Also present were General Manager Matt Shragge, Maintenance Superintendent Mike Minatrea, Treatment/Production Superintendent Robert Shelton, Financial Consultant Scott Nelsen, and District Secretary Cindy Fowlkes.

Pledge of Allegiance
Steve Gurney led the pledge.

Additions/Deletions to the Agenda
None

Public Comments
None

1. Public Hearing on Proposed Amendment to the District Groundwater Management Plan
   1.1 Board to Hear Public Testimony at This Time

   Director Leazer moved to open the Public Hearing at 4:01 p.m., seconded by Director Arthur, and unanimously approved.

   There being no public comment, Director Arthur moved to close the public hearing at 4:02 p.m., seconded by Director Leazer, and unanimously approved.

2. Consideration of Resolution 25-02 Intent to Amend the District Groundwater Management Plan
   Staff recommends adopting Resolution 25-02. The GWMP acts as a planning tool assisting the District in protecting the quantity and quality of groundwater within the District's service area. The data also provides useful information for the District's planning documents like the Salt Nutrient Management Plan (SNMP) and the 2025 Urban Water Management Plan.

   Director Woods moved to adopt Resolution 25-02 intent to amend the District Groundwater Management Plan, Director Arthur seconded, and the motion was approved by the following roll call vote:

Ayes:	Directors Arthur, Bowden, Leazer, Woods, and Coghill
Noes:	None
Abstain:	None
Absent:	None

3. Consideration of Resolution 25-03 Intention to Continue Currently Existing Water Availability Assessments of the Twentynine Palms Water District in the Upcoming Fiscal Year 2025/2026

The District intends to continue with the existing assessments levied on parcels within the District to which water is made available. The current fiscal budget projections stand at $592,000 for the imposed assessment.

Director Woods moved to adopt Resolution 25-03 intention to continue currently existing Water Availability Assessments for the upcoming fiscal year 2025/2026, Director Arthur seconded, and the motion was approved by the following roll call vote:

Ayes:	Directors Arthur, Bowden, Leazer, Woods, and Coghill
Noes:	None
Abstain:	None
Absent:	None

4. Commending Steve Gurney for Twenty Years of Public Service

General Manager, Matt Shragge, thanked Steve for his commitment and service to the District. Coworker, Ryan Weber, read Resolution 25-04 commending Steve for his 20 years of public service as the mechanic for the District. Steve was also recognized for serving his country for 20 years in the United States Marine Corp.

Steve thanked the District and senior staff for affording him the opportunity to grow and learn throughout his career at the District.

Director Arthur moved to adopt Resolution 25-04 commending Steve Gurney for twenty years of public service, Director Leazer seconded, and the motion was approved by the following roll call vote:

Ayes:	Directors Arthur, Bowden, Leazer, Woods, and Coghill
Noes:	None
Abstain:	None
Absent:	None

5. Approval of Kennedy Jenks Amendment #2 to the 2024-2027 Master Professional Service Agreement and Accept Proposal for Well 11B Treatment Evaluation

The project will evaluate and identify optimal treatment alternatives for the removal of arsenic, fluoride, and hexavalent chromium from Well 11B.

Director Arthur moved to approve Amendment #2 to the 2024-2027 Master Professional Service Agreement and accept proposal for Well 11B treatment evaluation, seconded by Director Bowden, and the motion was approved by the following roll call vote:

Ayes:	Directors Arthur, Bowden, Leazer, Woods, and Coghill
Noes:	None
Abstain:	None
Absent:	None

6. Formation of an Ad Hoc Committee for Joint City Meeting

After discussion, Director Woods moved to withdraw her request to have a joint meeting with the City and forgo the formation of an ad hoc committee, seconded by Director Leazer, and the motion was approved by the following roll call vote:

Ayes:	Directors Arthur, Bowden, Leazer, Woods, and Coghill
Noes:	None
Abstain:	None
Absent:	None

7. Discussion of a Health Insurance Feasibility Study for the Board of Directors

Scott Nelsen presented the Board with two scenarios for medical benefits provided through the District's insurance carrier ACWA/JPIA. The highest cost scenario for Board members to have medical insurance would cost the District $125,000 annually for an HMO plus one plan. The lowest cost scenario would be $52,000 a year for a PPO single member plan.

After discussion, the Directors decided not to move forward with a health benefit policy for the Board at this time.

8. Consent Calendar

- Minutes of a Regular Meeting held on February 26, 2025
- Audit List

Director Arthur moved to approve the Minutes and Audit List, seconded by Director Woods, and approved unanimously.

9. Items Removed from the Consent Calendar for Discussion or Separate Action

None

10. Management Reports

10.1 Maintenance

Mike reported that the District responded to 106 Underground Service Alerts, had 1 water main leak, 1 water meter leak, 0 service line leaks, 2 fire hydrant repairs/maintenance, installed 0 new services, replaced 6 customer gate valves, performed 3 leak audits, painted 0 fire hydrants, performed 4 customer pressure checks, replaced 5 water meters, Tested and exercised emergency generators and sounded wells for February. 0 water waste inquiries were received. There was a total of 517 work orders processed during the month.

10.2 Water Quality

Robert reported water production was down 14.29% as compared to the same month in 2013. 40 routine and 17 special water samples were taken. All special samples tested negative for Colilert. All current wells meet the 2.0 mg/L standard fluoride variance set by the State Water Resource Control Board. All samples tested were below the variance. Robert congratulated Steve on his retirement.

10.3 Finance

Scott Nelsen reported on January's financials. Bad debt expense is higher this month as unsettled accounts from 2020 are written off during January. The budget at 58% of the year is trending as expected with total expenditures at 54% and total revenues at 62%.

10.4 General Manager
Matt thanked Steve for his service and friendship over the years and wished him a happy retirement. Steve's 20 years of institutional knowledge will be missed at the District.

11. Conference With Legal Counsel-Anticipated Litigation - Initiation of litigation pursuant to paragraph (4) of subdivision (d) of Section 54956.9: (1 case)

Director Bowden moved to enter closed session at 5:36 p.m., seconded by Director Arthur, and unanimously approved.

The Board returned to open session at 6:20 p.m. Director Coghill announced there was no reportable action.

12. Future Agenda Items and Staff Tasks/Directors' Comments and Reports
Director Leazer would like to see a comparison of Board member benefits from other water districts.

Director Woods would like to see if a medical carve out policy is available. Director Woods thanked Steve for keeping employees of the District safe during his years of service.

13. Adjournment
On motion by Director Bowden, seconded by Director Leazer, and approved by the Board, the meeting was adjourned at: 6:23 p.m.

Bob Coghill, President
Board of Directors

Attest:

Matthew Shragge, Board Secretary
Twentynine Palms Water District

RESOLUTION 25-02

A RESOLUTION OF THE BOARD OF DIRECTORS OF THE TWENTYNINE PALMS WATER DISTRICT NOTICING A PROPOSED AMENDMENT TO THE DISTRICT GROUNDWATER MANAGEMENT PLAN

WHEREAS, the Twentynine Palms Water District ("District") is a County Water District duly formed and operating pursuant to Section 31000 et seq. of the California Water Code and has the authority to and does provide water service to customers within its service area;

WHEREAS, groundwater is a valuable resource within the State of California and particularly within the boundaries of the District, and such groundwater must be monitored and evaluated;

WHEREAS, in recognition of the value of groundwater as a resource, the California State Legislature adopted Water Code, sections 10750 et seq., which encourage local water agencies to develop and implement groundwater management plans;

WHEREAS, in keeping with this state mandate and to assist in meeting the water needs of District customers, the District adopted a groundwater management plan (GMP) in 2013;

WHEREAS, the District has now determined that it would be prudent to consider amending its GMP;

WHEREAS, as described in Water Code Section 10753.5(a) and Government Code Section 6066, notice of this public hearing, notice that a copy of the proposed amendments to the GMP are available for public review at the District office, and a summary of the proposed amendments to the GMP were published in the Desert Trail on March 12, 2025 and March 19, 2025;

WHEREAS, a public hearing was conducted on March 26, 2025 by the Board of Directors of the District in order to receive oral and written testimony on the proposed amendments to the GMP, as well as to receive any landowner protests.

NOW, THEREFORE, the Board of Directors of the Twentynine Palms Water District hereby resolves as follows:

1. Review of Draft Amendments to the GMP. The District has prepared a draft amendment to its GMP and made such amendment available for public review.

2. Publication of Notice regarding Adoption of Amendments to the GMP. Pursuant to Sections 10753.5 and 10753.6 of the California Water Code, if written protests are filed by landowners representing less than 50% of the assessed value of land within the District, the District Secretary is directed to place consideration of the amendments to the GMP on the agenda for potential adoption at the next regularly scheduled District Board meeting.

PASSED, APPROVED AND ADOPTED on this 26th day of March 2025, at a regular meeting of the Board of Directors of the Twentynine Palms Water District by the following vote:

Ayes:	Directors Arthur, Bowden, Leazer, Woods, and Coghill
Noes:	None
Abstain:	None
Absent:	None

Bob Coghill, President
Board of Directors

Attest:

Matthew Shragge, Secretary
Board of Directors

ORDINANCE NO. 104

AN ORDINANCE OF THE TWENTYNINE PALMS WATER DISTRICT ADOPTING A GROUNDWATER MANAGEMENT PLAN UPDATE PURSUANT TO WATER CODE SECTION 10750 ET SEQ. AND SUPERSEDING DISTRICT ORDINANCE 95

WHEREAS, the Board of Directors of the Twentynine Palms Water District ("District") approved Ordinance 82 on October 24, 2001, adopting a Groundwater Management Plan and establishing a Groundwater Management Program; and

WHEREAS, the District adopted updates to the Groundwater Management Plan in 2008 and 2014; and

WHEREAS, the District is a County Water District duly formed and operating pursuant to Section 31000 et seq. of the California Water Code and has the authority to provide water service to customers within its service area; and

WHEREAS, groundwater is a valuable resource within the State of California and particularly within the boundaries of the District and such groundwater must be monitored and evaluated; and

WHEREAS, in recognition of the value of groundwater as a resource, the California State Legislature enacted Water Code section 10750 et seq. ("AB 3030") and amendments thereto which encourage local water purveying agencies to manage groundwater resources within their jurisdictions and to develop and implement groundwater management plans; and

WHEREAS, the District service area overlies the Dale Valley, Joshua Tree and Twentynine Palms Valley groundwater basins, all of which have been designated by the California Department of Water Resources as very low priority and, accordingly, are not subject to the requirements of the Sustainable Groundwater Management Act; and

WHEREAS, the District's Board of Directors has determined that it is prudent to update its current Groundwater Management Plan; and

WHEREAS, as required by Water Code Section 10753.2(a) and Government Code Section 6066, a notice was published in the Desert Trail newspaper on March 12, 2025 and March 19, 2025 declaring the District's intent to update its Groundwater Management Plan; and

WHEREAS, on March 26, 2025, the Board of Directors adopted Resolution No. 25-02 Declaring an Intent to Amend the District's Groundwater Management Plan and as required by Water Code Section 10753.3 and Government Code Section 6066, Resolution 25-02 was published in the Desert Trail on May 14, 2025 and May 21, 2025 and a Groundwater Management Plan Update was subsequently prepared; and

WHEREAS, as required by Water Code Section 10753.5 and Government Code Section 6066, notice of a second public hearing was published in the Desert Trail newspaper on May 14, 2025 and May 21, 2025 and a second public hearing was conducted on May 28, 2025 by the Board of Directors of the District in order to receive and consider any protests on whether or not to adopt the Groundwater Management Plan Update. Pursuant to Water Code Section 10753.6(c)(3), the Board of Directors has determined that a majority protest has not been filed and therefore, the Board wishes to take action to adopt the Groundwater Management Plan Update.

NOW, THEREFORE, BE IT ORDAINED by the Board of Directors of the Twentynine Palms Water District as follows:

1. Adoption of the Groundwater Management Plan Update. Pursuant to Water Code Sections 10753 and 10753.6, the District hereby adopts that certain Groundwater Management Plan Update set forth as Exhibit "A" attached hereto and incorporated herein by reference. Pursuant to the 2025 Groundwater Management Plan Update, the District will also continue to implement its Groundwater Monitoring Implementation Plan 2020 Protocols and Procedures, which are attached to the Groundwater Management Plan Update as Appendix B.

2. Ordinance Shall be Superseding. All ordinances, resolutions, or administrative actions by the Board, or parts thereof that are inconsistent with any provision of this Ordinance are hereby superseded only to the extent of such inconsistency. As of the effective date of this Ordinance, Ordinance 95 shall be of no further force or effect.

3. Effective Date. This Ordinance shall be in full force and effect immediately upon adoption.

4. Publication of Ordinance. The Secretary of the District is hereby authorized and directed to publish this Ordinance in the Desert Trail within fifteen (15) days from the date of adoption. Upon written request, the Secretary shall also provide any interested persons with a copy of this Ordinance.

PASSED, APPROVED AND ADOPTED this 28th day of May 2025 by the following vote:

Ayes:	Directors Arthur, Bowden, Leazer, Woods, and Coghill
Noes:	None
Abstain:	None
Absent:	None

Bob Coghill, President
Board of Directors

Attest:

Matthew Shragge, Board Secretary
Twentynine Palms Water District

Appendix B

TPWD Groundwater Monitoring Implementation Plan (2020)

Twentynine Palms Water District
Groundwater Monitoring Implementation Plan
2020 Protocols and Procedures

The Salt and Nutrient Management Plan (SNMP) Groundwater Monitoring Implementation Plan was formally approved by the Colorado River Basin Regional Water Quality Control Board (RWQCB) via a letter submitted to Mr. Ray Kolisz of Twentynine Palms Water District from the RWQCB Executive Officer Paula Rasmussen on **December 10, 2019**.

The SNMP was submitted to the RWQCB in June 2014; comments from the Board were received in October 2015. In April 2017, RWQCB staff met with District staff and Kennedy/Jenks and it was agreed upon that an addendum to the SNMP, in the form of the enclosed phased-approach Groundwater Monitoring Implementation Plan, would provide the necessary solutions to data gaps identified within the SNMP.

Accordingly, the first annual monitoring report is due to RWQCB by **June 1, 2020**. This report outlines the necessary monitoring dates and deadlines the District must abide by to implement this plan.

The annual report should include at a minimum: summary of monitoring and data collection efforts performed; table and charts of monitoring results; and any recommended changes to the monitoring program including the implementation of Phase 3 and Phase 4 monitoring efforts.

Phase 1 – Increase Sampling Frequency of the District's Existing Production Wells

Schedule: Complete

Action: The District is currently implementing this phase of the monitoring plan and collects water quality data annually instead of every three years.

Table 1 below shows the parameters to be sampled. Table 2 identifies the wells the District is currently sampling.

TABLE 1. SAMPLING AND ANALYSIS PLAN – LIST OF PARAMETERS

Analyte	Units	EPA Test Method	Typical Lab PQL
General Minerals, Cautions, and Anions:			
Boron	mg/L	200.7	0.3
Calcium	mg/L	200.7	0.3
Total Iron	mg/L	200.7	0.05
Manganese	mg/L	200.7	0.1
Potassium	mg/L	200.7	0.2
Total Alkalinity	mg/L	310.1	0.3
Bicarbonate	mg/L	310.1	10
Carbonate	mg/L	310.1	10
Hydroxide	mg/L	310.1	10
Bromide	mg/L	300	10
Chloride	mg/L	300	1
Fluoride	mg/L	340.2	50

Analyte	Units	EPA Test Method	Typical Lab PQL
Nitrate	mg/L	300	0.1
Nitrite	mg/L	354.1	0.1
Orthophosphate	mg/L	365.2	0.01
pH	s.u.	150.1	0.2
Sodium	mg/L	200.7	0.01
Specific Conductivity	µmhos/cm	120.1	1
Sulfate	mg/L	300	1
TDS	mg/L	160.1	50
Total organic carbon	mg/L		40
Field Sampling:			
Dissolved Oxygen	mg/L	Field Probe 1	
Temperature	F	Field Probe	
Microbiological Analysis:			
Total Coliform	MPN/100 ml	SM9223B	2
Fecal Coliform	MPN/100 ml	SM9223B	2
Anthropogenic Analytes:			
Sucralose	µg/L	Non-standard	0.01
Caffeine	µg/L	8270M/SIMS	0.01
17B-estradiol	µg/L	Non-standard	0.001
NDMA	µg/L	Non-standard	0.002
Triclosan	µg/L	Non-standard	0.05
DEET	µg/L	Non-standard	0.05

TABLE 2. EXISTING GROUNDWATER MONITORING BY THE DISTRICT

Well Name	Well Type	Water Levels	Water Quality – Other Constituents	Proposed SNMP Sampling Plan
4	Inactive	Monthly	Every 3 years	Annually
6	Inactive	Monthly	Every 3 years	Annually
7	Destroyed	Monthly	Not Sampled	Annually
8	Inactive	Monthly	Every 3 years	Annually
9	Inactive	Monthly	Every 3 years	Annually
10	Inactive	Monthly	Every 3 years	Annually
11	Destroyed	Monthly	Every 3 years	Annually
12	Active water supply	Monthly	Every 3 years	Annually
14	Active water supply	Monthly	Every 3 years	Annually
15	Active water supply	Monthly	Every 3 years	Annually
16	Active water supply	Monthly	Every 3 years	Annually
17	Active water supply	Monthly	Every 3 years; quarterly for VOCs	Annually
WTP-1	Active water supply	Monthly	Every 3 years	Annually

Phase 2 – Establish a Water Quality Monitoring Well Network Using Existing Wells

Schedule: June 1, 2020

Action: Identify existing wells to sample; provide sampling operation (sample documentation, water level measurement, sampling and packaging); recommended analytical procedures; quality assurance procedures; and summary and reporting protocols.

Coordinate with USGS to obtain water quality data from wells in the Mesquite Lake and Mainside Subbasins.

Sample a representative number of wells (ex. 10-15) and evaluate results. Results will determine if additional sampling is recommended for 2021.

See Chapter 4 of the Implementation Plan, summarized below.

Sampling Implementation Plan

1.1 Monitoring Design

A preliminary subset of wells has been identified by the District as shown in Tables 3 through 7. It is recommended that wells selected for this monitoring program be sampled on an annual basis. For 2020, it is recommended to sample a representative number of the wells (ex. 10-15). All results of the monitoring will be submitted to the District for inclusion into their current water quality database. Results will determine if additional sampling is required in 2021. The District will be the responsible party for collecting samples, compiling the results in tabular form, updating/revising the Monitoring Plan and submitting it to the RWQCB.

1.2 Water Quality Parameters

See Table 1.

1.3 Monitoring Sampling Frequency

Each well to be sampled on an annual basis or until such time the data provides sufficient evidence to extend or reduce the sampling frequency.

1.4 Sampling and Monitoring Areas

Five areas of the District's service area (53 wells total) are selected to be the focus of this implementation sampling program. These areas include:

- Indian Cove Subbasin
- Fortynine Palms Subbasin
- Eastern Subbasin
- Mesquite Subbasin, and
- Mainside Subbasin

1.4.1 Indian Cove Subbasin Groundwater Monitoring Locations

Six groundwater wells will be used for sampling purposes in this area as shown in Table 3. These wells are also included in Phase 1.

TABLE 3: INDIAN COVE SUBBASIN MONITORING INFORMATION

Well Name	Well Type	Pump Installed	Owner	Total Depth
TPWD-6	Muni	Yes	TPWD	403’
TPWD-8	Muni	Yes	TPWD	785’
TPWD-9	Muni	Yes	TPWD	530’
TPWD-10	Muni	Yes	TPWD	400’
TPWD-12	Muni	Yes	TPWD	410’
TPWD-15	Muni	Yes	TPWD	352’

1.4.2 Fortynine Palms Subbasin Groundwater Monitoring Locations

There are seven groundwater wells that may be considered for sampling purposes in this area as shown in in Table 4.

TABLE 4: FORTYNINE PALMS SUBBASIN MONITORING INFORMATION

Well Name	Well Type	Pump Installed	Owner	Total Depth
TPWD-3	Muni	Yes	TPWD	340’
TPWD-3B	Muni	Yes	TPWD	398’
TPWD-4	Muni	Yes	TPWD	283’
TPWD-5	Muni	Yes	TPWD	TBD
TPWD-13	Muni	Yes	TPWD	337’
TPWD-14	Muni	Yes	TPWD	430’
TPWD-17	Muni	Yes	TPWD	TBD

1.4.3 Eastern Subbasin Groundwater Monitoring Locations

There are three groundwater wells that may be considered for sampling purposes in this area as shown in Table 5.

TABLE 5: EASTERN SUBBASIN MONITORING INFORMATION

Well Name	Well Type	Pump Installed	Owner	Total Depth
TPWD-1	Muni	Yes	TPWD	TBD
TPWD-2	Muni	Yes	TPWD	275’
TPWD-16	Muni	Yes	TPWD	320’

1.4.4 Mesquite Lake Subbasin Groundwater Monitoring Locations

There are 27 groundwater wells that maybe considered for sampling purposes in this area as shown in Table 6.

TABLE 6: MESQUITE LAKE SUBBASIN MONITORING INFORMATION

Well Name	Well Type	Pump Installed	Owner	Total Depth
WTP-1	Muni	Yes	TPWD	1,010
TPWD-18	Muni	Yes	TPWD	TBD
MW-1	Mon	No	TPWD	TBD
MW-2	Mon	No	TPWD	TBD
MW-3	Mon	No	TPWD	TBD
MW-4	Mon	No	TPWD	TBD
MW-5	Mon	No	TPWD	TBD
N1	Mon	No	TPWD	TBD
N2	Mon	No	TPWD	TBD
N3	Mon	No	TPWD	TBD
N4	Mon	No	TPWD	TBD
N5	Mon	No	TPWD	TBD
N6	Mon	No	TPWD	TBD
S1	Mon	No	TPWD	TBD
S2	Mon	No	TPWD	TBD
S3	Mon	No	TPWD	TBD
S4	Mon	No	TPWD	TBD
S5	Mon	No	TPWD	TBD
09L1	Mon	No	USGS	TBD
12G1	Mon	No	USGS	TBD
16H4	Mon	No	USGS	TBD
17E1	Mon	No	USGS	TBD
21H4	Mon	No	USGS	TBD
27C1	Mon	No	USGS	TBD
32A1	Mon	No	USGS	TBD
35F1	Mon	No	USGS	TBD
24H1	Mon	No	USGS	TBD

1.4.5 Mainside Subbasin Groundwater Monitoring Locations

Eight groundwater wells that may be considered for sampling purposes in this area as shown in Table 7.

TABLE 7: MAINSIDE SUBBASIN MONITORING INFORMATION

Well Name	Well Type	Pump Installed	Owner	Total Depth
04C1	Mon	No	USGS	UNK
11N2	Mon	No	USGS	UNK
23D1	Mon	No	USGS	UNK
19F1	Mon	No	USGS	UNK
20M2	Mon	No	USGS	UNK
29M2	Mon	No	USGS	UNK
29R1	Mon	No	USGS	UNK
32R2	Mon	No	USGS	UNK

Public Outreach

The Regional Board should be notified of the scheduled stakeholder and public outreach opportunities as they may participate in these efforts. Outreach may consist of the following:

- Website
- Branded informational flyers, templates, PowerPoint presentations
- Periodic newsletter
- SNMP related mailing lists
- Public workshops
- Press releases and guest editorials
- Existing group venues
- Outreach documentation

Other Reporting

GAMA

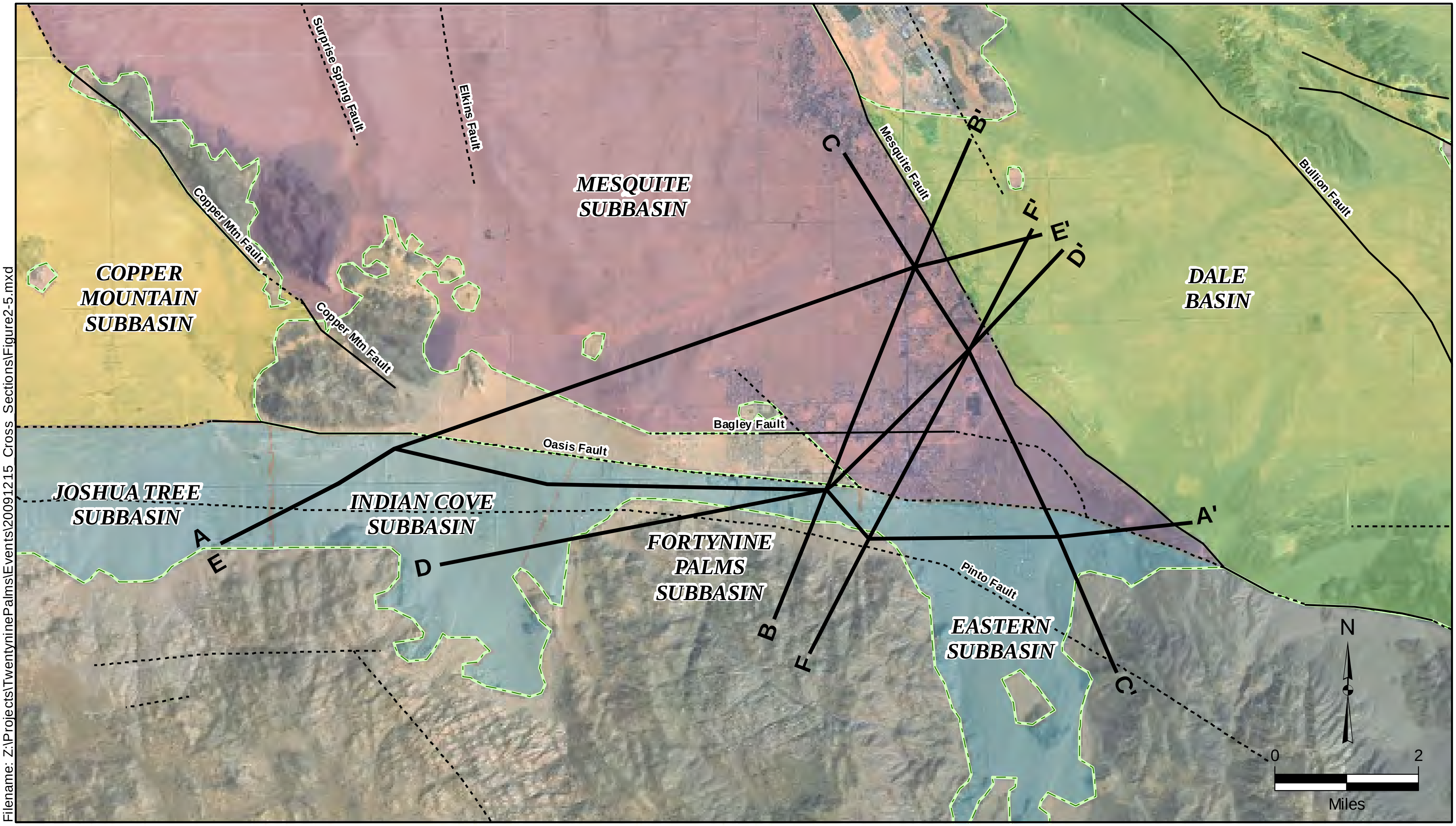
In addition, pursuant to the RWQCB and the Recycled Water Policy, all data must be electronically reported in a format that is compatible with a Groundwater Ambient Monitoring & Assessment (GAMA) information system and must be integrated into the GAMA information system or its successor.

Proposition 1 Disadvantaged Community Grant Program

In 2018, Mojave Water Agency (Agency) was awarded a grant from the California Department of Water Resources (DWR) in the amount of $407,000 (Grant Agreement No. 4600012245). Of that grant amount, $50,000 was allocated to the District to assist with the activities necessary to implement the SNMP Groundwater Monitoring Implementation Plan. Quarterly reports will be submitted, through the Agency, to DWR documenting the District’s progress on the monitoring activities. A copy of the quarterly reports will also be provided with the annual monitoring reports described herein.

Appendix C

GWMP Area Geologic Cross Sections (Kennedy Jenks, 2010)



Filename: Z:\Projects\TwentyninePalms\Events\20091215 Cross Sections\Figure2-5.mxd

Source: (c)2009 Microsoft Corporation.

Cross Section Trace

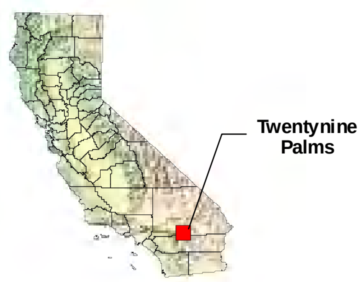
Site Boundary

Faults

Known

Inferred

Note:
The Oasis Fault is also known as the Pinto Mountain Fault.



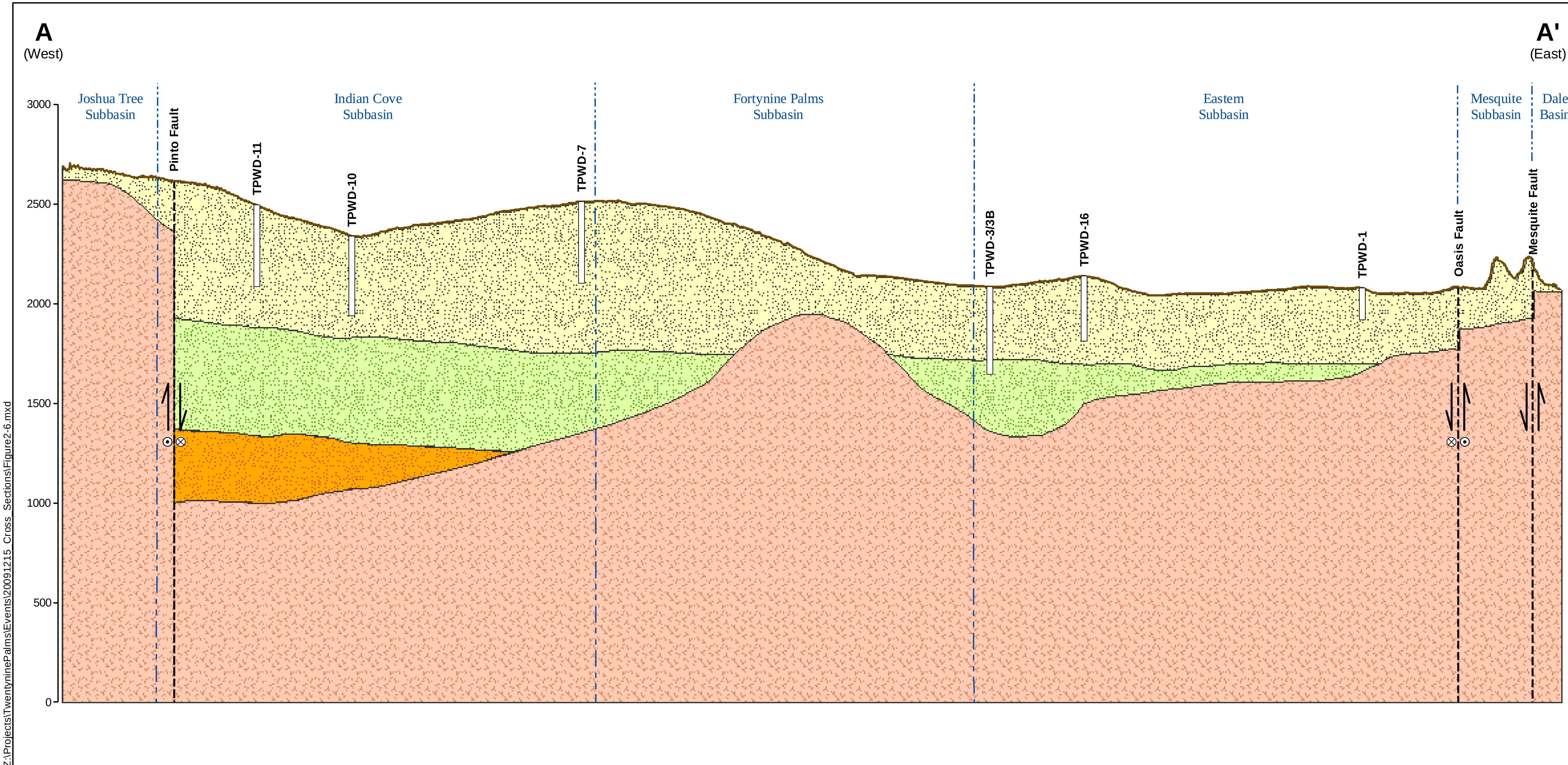
Kennedy/Jenks Consultants

Twentynine Palms
San Bernardino County, California

Cross Section Location Map

K/J 0964003*00
March 2010

Figure 2-5



Note: The Oasis Fault is also known as the Pinto Mountain Fault.

EXPLANATION

- Upper Aquifer
- Middle Aquifer
- Lower Aquifer
- Basement Rock

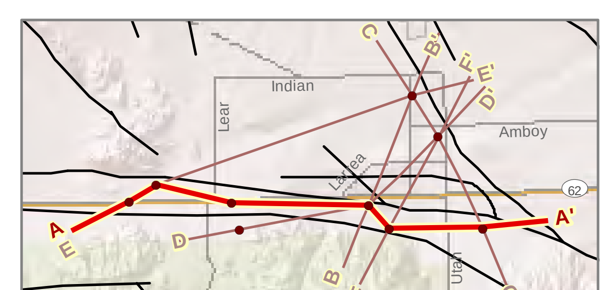
TPWD-1 — Well and Identifier

Fault (Dashed where inferred)
Arrows indicate direction of movement
Cross Circle indicates movement away from observer
Dot Circle indicates movement toward observer

Vertical Scale: 0, 250', 500' Feet

Horizontal Scale: 0, 2500', 5000' Feet

Exaggeration: 10x



Index Map

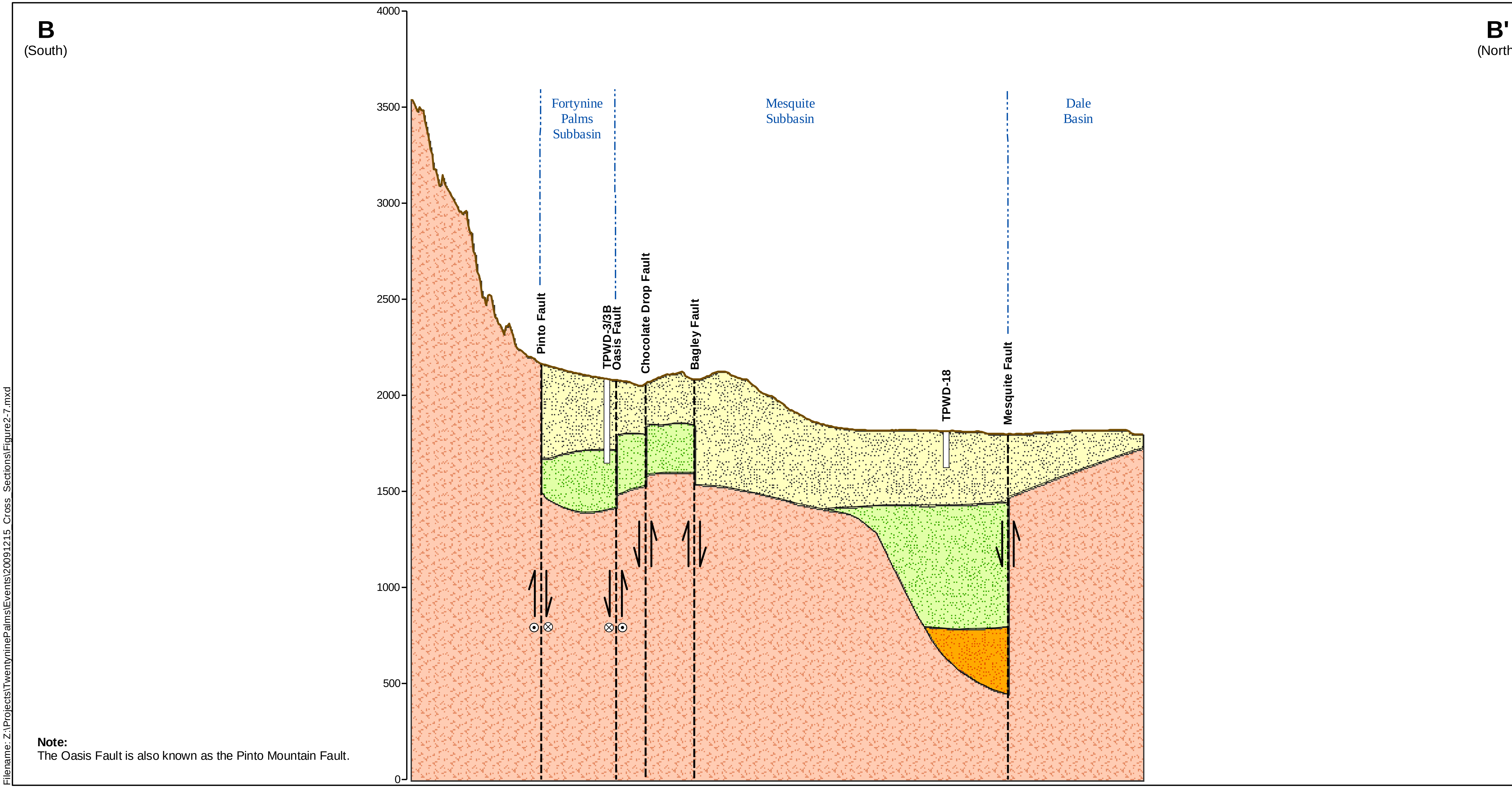
Kennedy/Jenks Consultants

Twentynine Palms
San Bernardino County, California

Geologic Cross Section A-A'

KJ 0964003*00
March 2010

Figure 2-6



Note:
The Oasis Fault is also known as the Pinto Mountain Fault.

EXPLANATION

- Upper Aquifer
- Middle Aquifer
- Lower Aquifer
- Basement Rock

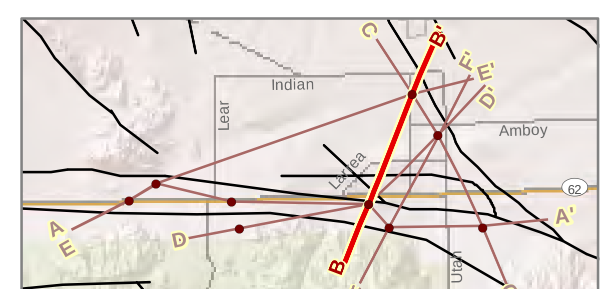
TPWD-1 — Well and Identifier

Fault (Dashed where inferred)
Arrows indicate direction of movement
Cross Circle indicates movement away from observer
Dot Circle indicates movement toward observer

Feet: 0, 250', 500' — Vertical Scale

Feet: 0, 2500', 5000' — Horizontal Scale

Exaggeration: 10x



Index Map

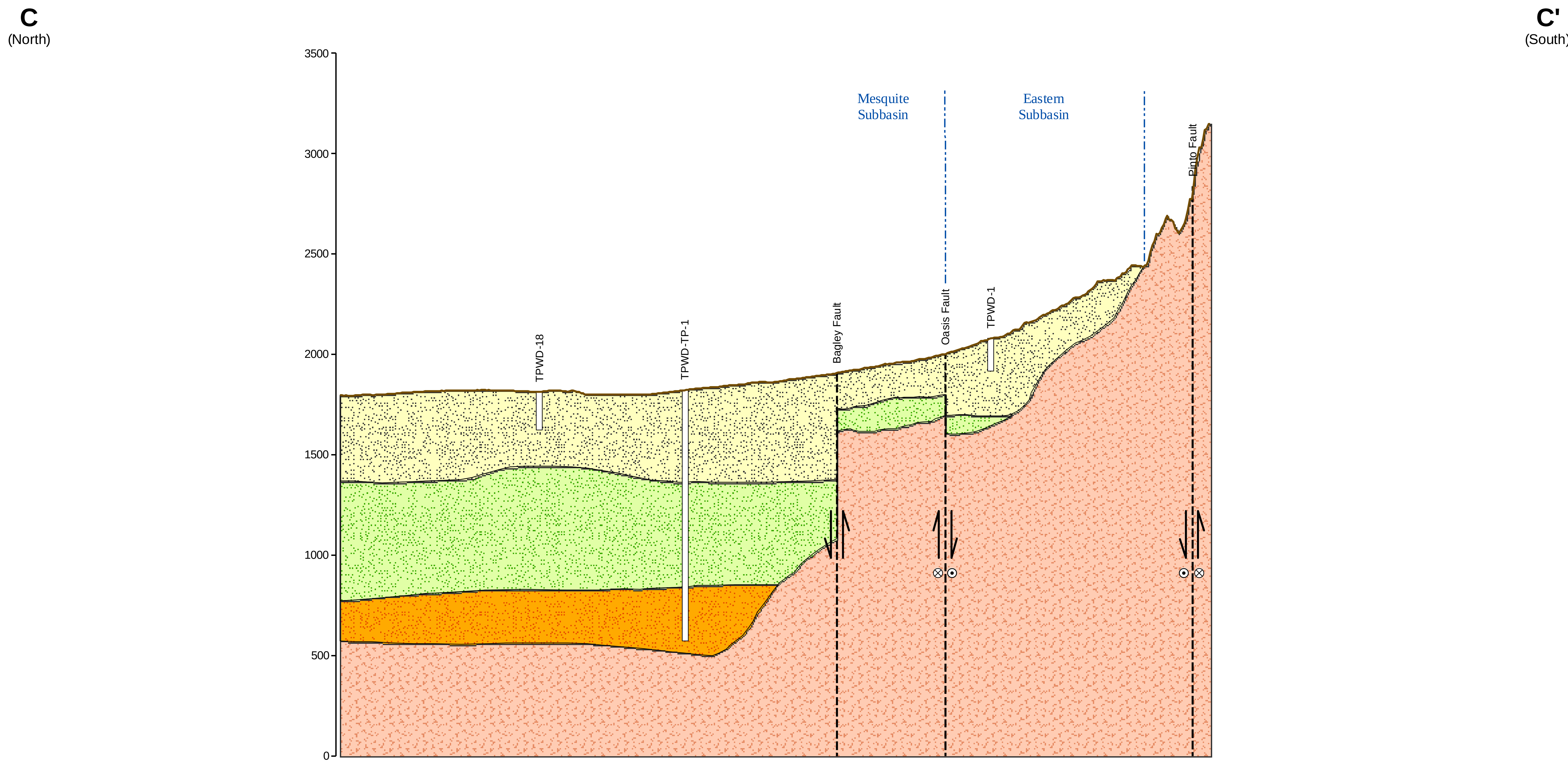
Kennedy/Jenks Consultants

Twentynine Palms
San Bernardino County, California

Geologic Cross Section B-B'

KJ 0964003*00
March 2010

Figure 2-7



Note: The Oasis Fault is also known as the Pinto Mountain Fault.

Filename: Z:\Projects\TwentyninePalms\Events\20091215_Cross_Sections\Figure2-8.mxd

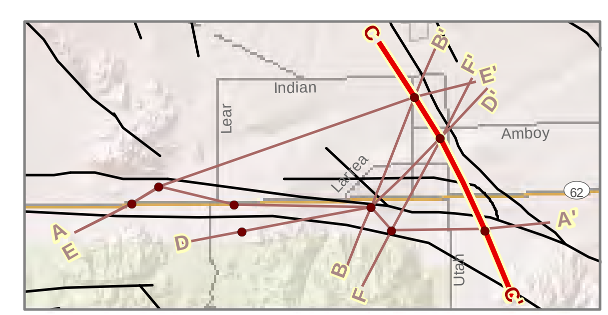
EXPLANATION

- Upper Aquifer
- Middle Aquifer
- Lower Aquifer
- Basement Rock

TPWD-1 — Well and Identifier

Fault (Dashed where inferred)
Arrows indicate direction of movement
Cross Circle indicates movement away from observer
Dot Circle indicates movement toward observer

Feet
500'
250'
Vertical Scale
0 2500' 5000' Feet
Horizontal Scale
Exaggeration: 10x



Index Map

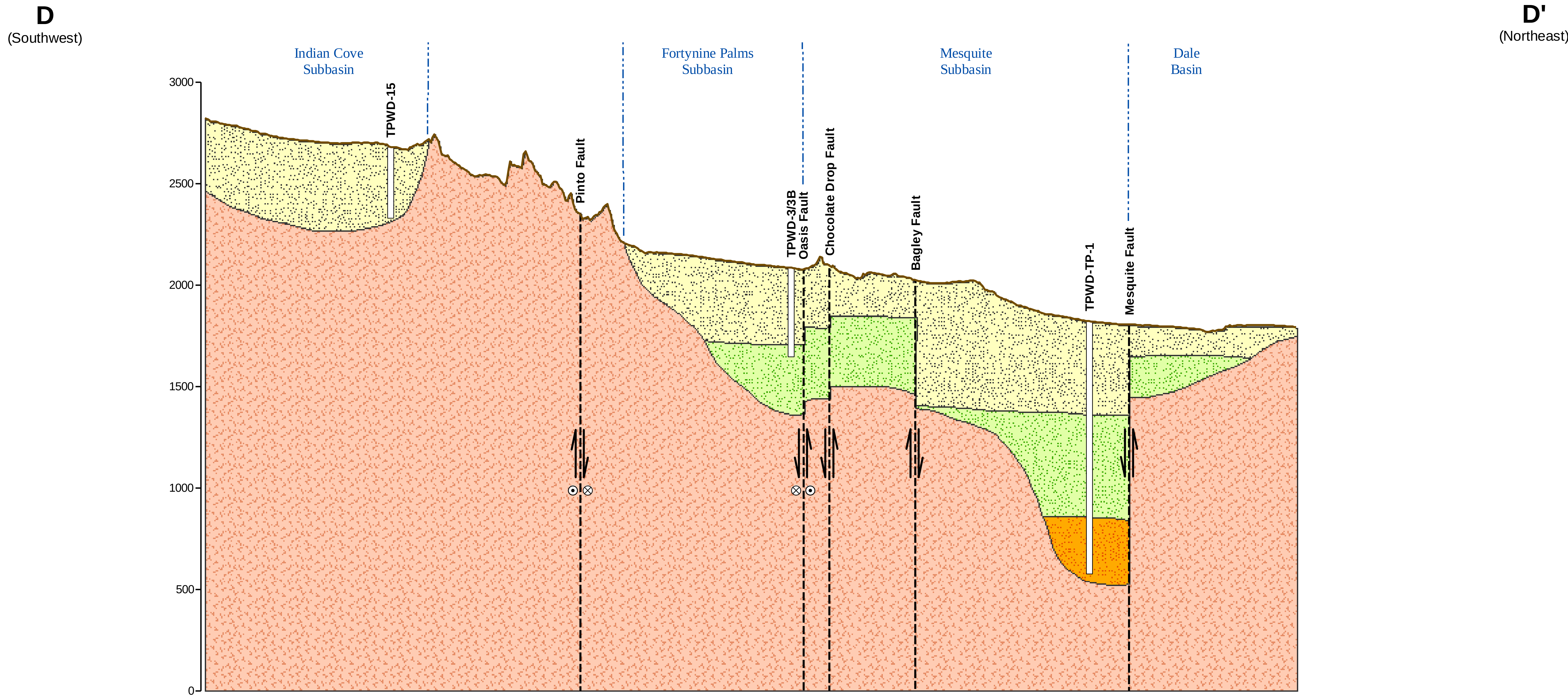
Kennedy/Jenks Consultants

Twentynine Palms
San Bernardino County, California

Geologic Cross Section C-C'

KJ 0964003*00
March 2010

Figure 2-8



Note: The Oasis Fault is also known as the Pinto Mountain Fault.

Filename: Z:\Projects\TwentyninePalms\Events\20091215_Cross_Sections\Figure2-9.mxd

EXPLANATION

- Upper Aquifer
- Middle Aquifer
- Lower Aquifer
- Basement Rock

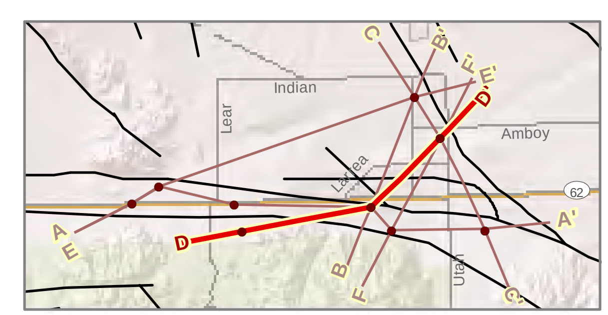
TPWD-1 — Well and Identifier

Fault (Dashed where inferred)
Arrows indicate direction of movement
Cross Circle indicates movement away from observer
Dot Circle indicates movement toward observer

Vertical Scale: 0, 250', 500' Feet

Horizontal Scale: 0, 2500', 5000' Feet

Exaggeration: 10x



Index Map

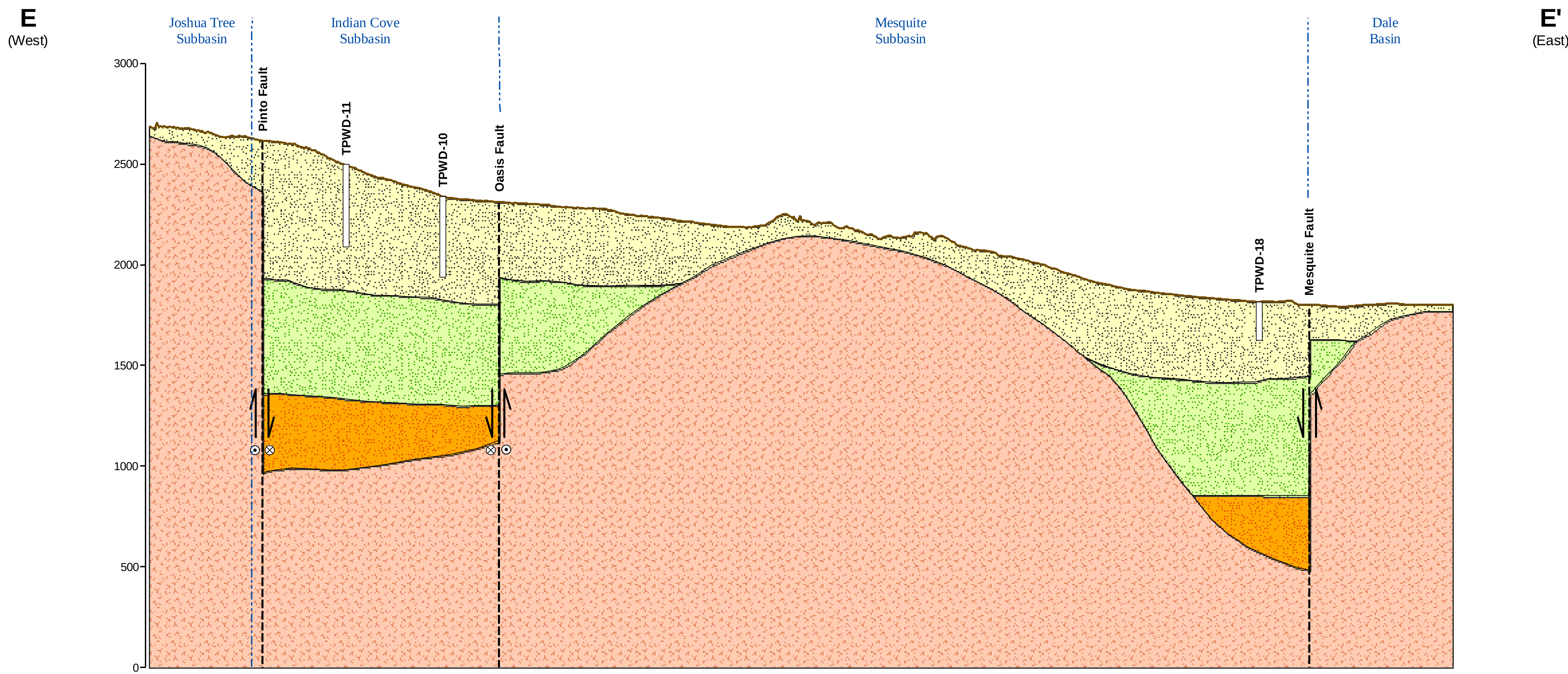
Kennedy/Jenks Consultants

Twentynine Palms
San Bernardino County, California

Geologic Cross Section D-D'

KJ 0964003*00
March 2010

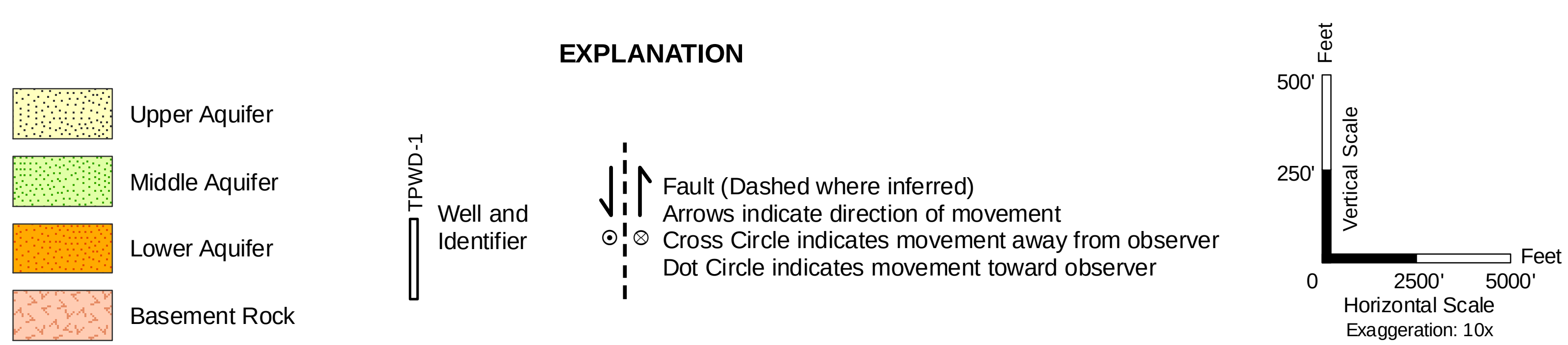
Figure 2-9

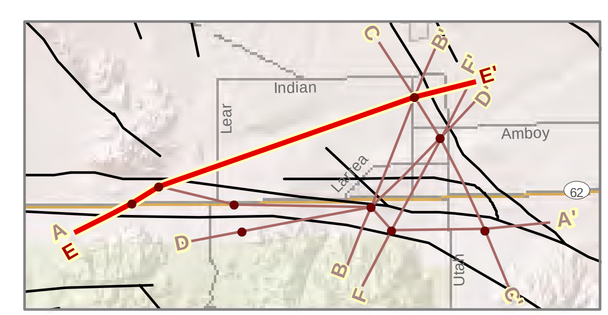


Note: The Oasis Fault is also known as the Pinto Mountain Fault.

Filename: Z:\Projects\TwentyninePalms\Events\20091215_Cross_Sections\Figure2-10.mxd

EXPLANATION





Index Map

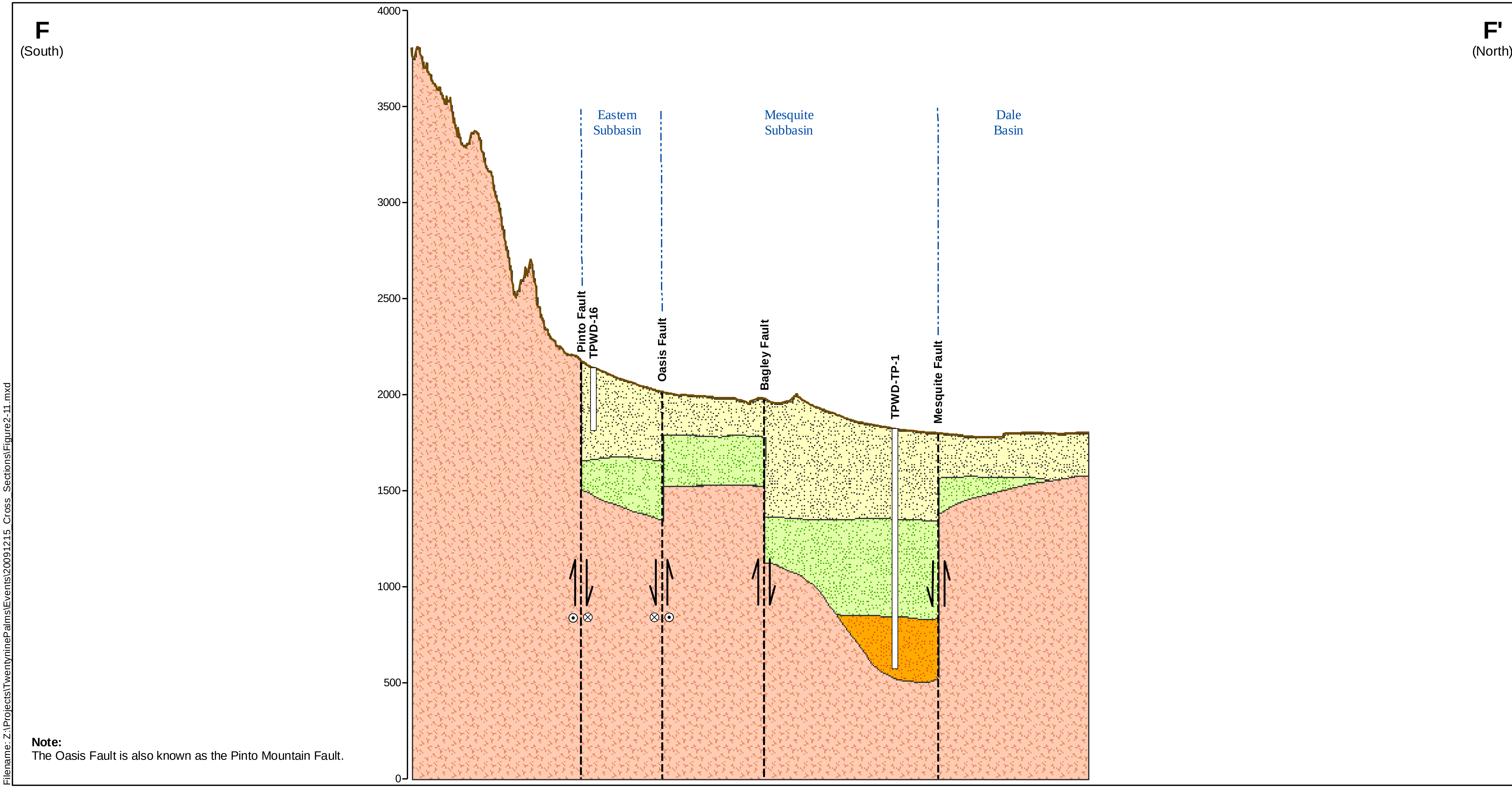
Kennedy/Jenks Consultants

Twentynine Palms
San Bernardino County, California

Geologic Cross Section E-E'

KJ 0964003*00
March 2010

Figure 2-10



Note:
The Oasis Fault is also known as the Pinto Mountain Fault.

Filename: Z:\Projects\TwentyninePalms\Events\20091215_Cross_Sections\Figure2-11.mxd

EXPLANATION

Upper Aquifer

Middle Aquifer

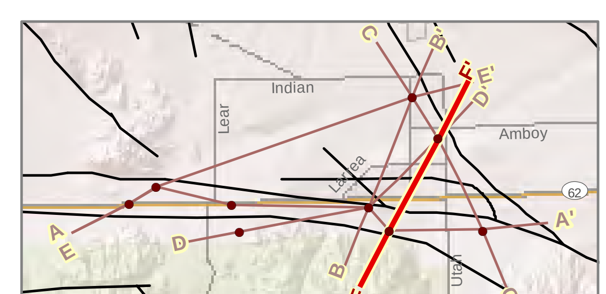
Lower Aquifer

Basement Rock

TPWD-1 Well and Identifier

Selected Fault (Dashed where inferred)
Arrows indicate direction of movement
Cross Circle indicates movement away from observer
Dot Circle indicates movement toward observer

Feet
500'
250'
Vertical Scale
0 2500' 5000' Feet
Horizontal Scale
Exaggeration: 10x



Index Map

Kennedy/Jenks Consultants

Twentynine Palms
San Bernardino County, California

Geologic Cross Section F-F'

KJ 0964003*00
March 2010

Figure 2-11

Appendix D

Hydrologic Water Balance

Appendix D: Hydrologic Water Balance

Appendix D provides a more detailed discussion of each of the components of the hydrologic water balance, as well as a more comprehensive breakdown of the hydrologic water balance calculations. This shows the level of understanding that is currently available for determining groundwater inflows and outflows and the projected change in storage.

D.1 Water Balance Summary

The water balance was performed for the groundwater basins underlying the District service area, including the portions of the Indian Cove, Fortynine Palms, Eastern, Mesquite Lake and Mainside Subbasins. The water balance was calculated for two conditions, current (2022-2024) conditions and 2045 projected conditions. The current conditions water balance characterizes TPWD groundwater basin health under present-day practices. The 2045 projected water balance characterizes the sustainability of TPWD's groundwater basins and water supply over the next 20 years, assuming population and well pumpage growth.

The current conditions hydrologic water balance calculates an annual change in storage range of -2,484 to +1,029 AFY; see **Table D-4** for a more detailed water balance calculation. The 2045 projected conditions hydrologic water balance calculates an annual change in storage range of -2,893 to +620 AFY; see **Table D-5** for a more detailed water balance calculation.

The following discussion provides background information and assumptions used for quantifying each water balance component. Also described is the background on the various components of the water balance, including the sources of data and how each component was estimated. The water balance components were estimated based on various data sources, including the hydrogeologic knowledge of the basins from previous studies, current TPWD data (2022 to present), and 2045 projected data from the District's 2020 UWMP (Kennedy Jenks, 2021). A more detailed description of the data sources can be also found in the Groundwater Study for the Mesquite Lake Subbasin (Kennedy Jenks, 2010).

D.2 Climate

Climatic factors including precipitation, temperature and evapotranspiration are the key controlling factors for the natural hydrologic water balance components. **Table D-1** provides a climatic summary per month based on data from the California Irrigation Management Information System (CIMIS) (DWR, 2024c).

The Twentynine Palms area is quite dry, with average annual precipitation of around 3.6 inches, most of which occurs during the winter months (**Table D-1**). Most of this precipitation is lost through evaporation; the total average monthly evapotranspiration (ETo) rate is 76.3 inches per year (**Table D-1**). Precipitation follows a generally bimodal distribution, with most annual precipitation falling during the summer monsoon and the winter wet season. Summer storms are intense and of relatively short duration and may lead to flash floods but are unlikely to contribute to recharge due in large part to the high potential evapotranspiration (ET) during the hot summer months and the lack of storm water retention. Winter storms are gentler and of longer duration and are more likely to contribute to recharge.

Temperatures range from 20 to 60 °F during the winter and from 80 to 110 °F degrees during the summer. Throughout the area, high temperatures tend to decrease with increasing elevation, while low temperatures do not vary greatly with elevation.

Table D-1. Climate Data

	Jan	Feb	Mar	Apr	May	Jun	
Standard Monthly Average ETo[(a)] (in)	2.7	3.8	6.1	7.9	9.3	9.8	
Average Rainfall[(b)] (in)	0.4	0.3	0.2	0.2	0.2	0.0	
Average Max. Temperature[(b)] (°F)	62.8	67.1	73.2	81.8	88.7	100.2	
Average Min. Temperature[(b)] (°F)	34.4	36.8	41.6	47.5	53.8	63.1	
	Jul	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**	**Annual**
Standard Monthly Average ETo (in)	9.8	9.0	7.2	5.2	3.3	2.3	76.3
Average Rainfall[(b)] (in)	0.6	0.6	0.3	0.2	0.2	0.3	3.6
Average Max. Temperature[(b)] (°F)	103.2	102.7	95.8	84.4	70.5	61.6	82.7
Average Min. Temperature[(b)] (°F)	71.0	70.4	63.1	50.4	38.6	32.6	50.3

Note:

(a) Standard Monthly Average ETo determined from CIMIS Station No. 200 Indio 2 (no ETo data available at CIMIS Station No. 233 Joshua Tree).

(b) Rainfall, max. temperature, and min. temperature averages determined from CIMIS Station No. 233 Joshua Tree.

D.3 Groundwater Inflows

Inflows replenish water to the aquifer system through various routes and processes. This section discusses the different types of inflow. The total inflow is discussed below.

D.3.1 Direct Precipitation Recharge

Direct recharge accounts for recharge of precipitation that falls on the basin floor, percolates downward through the vadose (unsaturated) zone, and eventually reaches the water table. Because the Twentynine Palms area is very arid, potential evapotranspiration (ET) far outstrips the actual amount of precipitation; Nishikawa et al. (2004) noted that ET is about 66.5 inches per year (in/yr) in the Joshua Tree area, while precipitation is about 4.8 in/yr (e.g. ET is nearly 14 times precipitation).

Direct recharge has been estimated in several different studies. Nishikawa et al. (2004) used a variety of methods to try to constrain direct recharge in the Joshua Tree area to the west of the study area, including temperature, matric potential, soil water chemistry, and a watershed model. The results of their physical measurements indicated that recharge probably does not occur on the basin floor away from stream channels. Their watershed model produced recharge rates of 0 to 0.0001 in/yr on the basin floor away from the stream channels, and 0.0001 to 0.01 in/yr at the Coyote Lake playa.

Kennedy Jenks (2010) used a modified Maxey-Eakin approach to estimate recharge throughout the study area. This analysis reached the same conclusion as did Nishikawa et al.: direct recharge on the basin floor is, for all intents and purposes, zero. However, the method used is a very coarse one and sets recharge to zero wherever precipitation is less than 8 inches per year, an area that includes almost the entire region aside from the highest mountains. Li and Martin (2011) reached a similar conclusion to the above two studies regarding direct recharge, stating that the amount of precipitation that falls on the basin floor is too small to induce recharge. This GWMP lumps basin floor recharge and mountain front recharge by using water budget numbers from the earlier Groundwater Study (Kennedy Jenks, 2010). The amount contributed to recharge from precipitation on the basin floor is zero.

For this GWMP, direct recharge was calculated based on the range in precipitation recharge typical of the basin floor according to the watershed model of Nishikawa et al. (2004), 0 to 0.0001 in/yr. The total area of basin floor in the five subbasins considered for this study is approximately 66,000 acres, so the range in basin floor recharge is 0 to 0.5 AFY. This estimate is not anticipated to significantly change, so it is assumed for both current and 2045 projected conditions.

D.3.2 Irrigation Return Flows

Return flow from agricultural or landscape irrigation can be a significant contributor to the water budget of a basin. Within the study area, agriculture is not present, but there are a few sites with regular and significant irrigation (Luckie Park in the Mesquite Lake Subbasin, Knott Sky Park in the Fortynine Palms Subbasin, and the Desert Winds Combat Center Golf near the intersection of the Mesquite Lake, Mainside, and Deadman Subbasins). Return flows from these locations of irrigation have not been included in any of the models to date. Li and Martin (2011) note that ignoring these return flows is a limitation in their numerical model. They also note that, until around 2000, there was no indication that return flows had yet passed through the unsaturated zone and reached the water table in the regional aquifer, meaning that the return flows must be maintained for many years before they actually can pass through the thick unsaturated zones of the study area and lead to recharge to the water table. Irrigation return flow was assumed to be effectively zero for both current and 2045 projected conditions.

D.3.3 Septic Return Flows

Some of the groundwater produced and delivered to customers returns to the subbasins through infiltration and percolation of irrigation water and of septic tank discharges. Li and Martin (2011) and Kennedy Jenks (2010) did not consider septic return flow in their models. However, as the majority of water use is from the residential development and the outdoor water use is generally small, residential indoor water use (and in turn residential wastewater) is a large contributor to septic systems. The proportion of septic return flow attributed to each subbasin is assumed as follows (Kennedy Jenks, 2014a):

- Indian Cove Subbasin: 8.0%
- Fortynine Palms Subbasin: 8.2%
- Eastern Subbasin: 10.4%
- Mesquite Lake Subbasin: 72.0%
- Mainside Subbasin: 1.4%

For current conditions, TPWD water usage data from 1 August 2022 to 1 August 2024 was used to calculate average annual water usage of approximately 2,127 AFY. Assuming an 80 percent water to sewer conversion, the total residential and commercial septic return flow for current conditions is estimated at 1,702 AFY.

For 2045 projected conditions, the 2045 projected residential and commercial demands were used to calculate a projected annual water usage of 2,980 AFY (Kennedy Jenks, 2021).

Assuming an 80 percent water to sewer conversion, the total residential and commercial septic return flow for 2045 projected conditions is estimated at 2,384 AFY.

D.3.4 Surface Water (Streamflow Infiltration)

Surface water recharge is the recharge that occurs as infiltration of streamflow through streambeds cutting across the basin floor. There are no perennial streams within the study area, but there are several large dry streambeds that experience intermittent flows. Previous studies have taken different approaches to estimating this stream infiltration.

The stream channels are ephemerally flowing streams with runoff originating in the adjoining mountains in response to the largest storms. However, very little surface flow leaves this area (Troxell et al, 1954). Nishikawa et al (2004) evaluated stream gage data in the region including the Fortynine Palms Creek. Over the period of record, Fortynine Palms Creek had measurable flow on an average of 2.4 days per year, totaling 74.3 AFY. These four gauges show streamflow to be highly intermittent, with the duration of surface flows limited to only 1 to 2 days in response to storms that primarily occurred in the summer months in response to monsoonal thunderstorms (Nishikawa et al, 2004).

Because Kennedy Jenks (2010) used the modified Maxey-Eakin approach to estimate total recharge, there is no specific estimate available for streamflow infiltration. Theoretically, the Maxey-Eakin method includes streamflow infiltration in its total basin recharge, in addition to direct recharge, mountain front recharge, and mountain block recharge.

Li and Martin (2010) used the watershed model of Nishikawa et al. (2004) to estimate streamflow infiltration into the Mesquite Lake Subbasin; this area was included in the original model but was not published in the 2004 report. Streamflow infiltration was estimated to be 165 AFY within the Mesquite Lake Subbasin, mostly along the Mesquite Lake Wash and Twentynine Palms Channel. This study implies that recharge largely results from summer streamflow. Given the seasonal discrepancy described above for the watershed model, the bulk of the recharge occurring in the summer may be more realistic.

These estimates are not anticipated to significantly change, so they are assumed for both current and 2045 projected conditions.

D.3.5 Mountain Front Recharge

Mountain front recharge (MFR) is recharge that occurs at the boundary between the alluvial basin sediments and the crystalline bedrock of the basin-bounding mountains. It must be noted that there are several different ways to define MFR, and the conceptual understanding of MFR for the purpose of this water balance is equivalent to MFR in Wilson and Guan (2004). Under this definition, MFR is made up of that water that runs off the mountains as surface runoff and enters the alluvium upon leaving the mountains.

Nishikawa et al. (2004) does not provide specific estimates of MFR from their numerical model, instead grouping it with the other recharge components. However, they do state that “simulated recharge rates between 0.1 and 0.5 in/yr occurs [sic] along the flanks of the Little San Bernardino Mountains.” They calculated recharge throughout the topographic contributing area to their groundwater model, demonstrating that higher recharge rates are present at the bedrock-alluvium interface than exist on either the exposed bedrock or basin floor. They speculate that any recharge that occurs outside of the numerical model domain (the main part of the groundwater basin) is eventually lost to evapotranspiration (ET) rather than reaching the groundwater basin, but there is no particular evidence presented for this.

As stated above, Kennedy/Jenks (2010) estimated recharge using a modified Maxey-Eakin method. The conceptual understanding of recharge for this analysis was that the recharge represents MFR as defined above. Calculated MFR varied from 0 to 54 AFY in the Indian Cove Subbasin, 7 to 212 AFY in the Fortynine Palms Subbasin, 2 to 190 AFY in the Eastern Subbasin, 0 to 8 AFY in the Mesquite Lake Subbasin, and 0 to 10 AFY in the Mainside Subbasin, for a total of 9 to 474 AFY for the subbasins.

Li and Martin (2011) do not directly address MFR because their groundwater model does not abut the major basin-bounding mountain ranges. However, they calculated that 510 AFY of groundwater inflow passes from the Indian Cove, Fortynine Palms, and Eastern Subbasins into the Mesquite Lake Subbasin, and presumably this would mostly be made up of MFR. This GWMP estimates a low recharge total of 8 AFY based on the numerical groundwater model of Kennedy Jenks (2010). As with the earlier study, this total can be assumed to represent MFR.

These estimates are not anticipated to significantly change, so they are assumed for both current and 2045 projected conditions.

D.3.6 Mountain Block Recharge

Mountain block recharge (MBR) is that portion of recharge that occurs through the bedrock of the basin-bounding mountain ranges. It discharges from the bedrock itself into the basin alluvium, rather than flowing off the bedrock on or near the surface. For this GWMP, MBR is conceptually similar to the definition of MBR in Wilson and Guan (2004). MBR has not been specifically considered in any of the previous reports discussed above. In fact, Nishikawa et al. (2004) speculated that the recharge they simulated to occur outside of the alluvial basins was largely lost to ET before it could discharge to the alluvium as MBR. However, some of this mountain block water must make its way to the alluvial basin.

Fugro West and Cleath (2002) used a Darcy's Law approach to estimate groundwater inflow from the basin-bounding mountains surrounding the Paso Robles Groundwater Basin, which can be considered to be MBR under the definition used in this report. As a first approximation, we assume that the Little San Bernardino and Pinto Mountains can be considered hydraulically equivalent to the fractured granite bounding the Paso Robles Groundwater Basin, which Fugro West and Cleath (2002) give a hydraulic conductivity of 0.1 gallons per day per square foot (gpd/ft^2), a moderate value in their estimates. Their results indicated approximately 50 ft^3 of MBR per linear foot of mountain front length. Using this value, MBR into the subbasins was calculated to be 56 AFY into the Indian Cove Subbasin, 34 AFY into the Fortynine Palms Subbasin, 49 AFY into the Eastern Subbasin, 5 AFY into the Mesquite Lake Subbasin, and 10 AFY into the Mainside Subbasin, for a total of 154 AFY. These estimates are not anticipated to significantly change, so they are assumed for both current and 2045 projected conditions.

D.3.7 Groundwater Inflow

Groundwater inflow represents water that enters a subbasin by flowing laterally within the saturated zone from another subbasin. Groundwater inflow in the study area is restricted somewhat by the presence of low-permeability faults and other barriers that help to compartmentalize the various subbasins.

Nishikawa et al. (2004) created a numerical model that included the Joshua Tree and Copper Mountain Subbasins, which border the Indian Cove and Mesquite Lake Subbasins, respectively, to the west. They allowed groundwater to leave their model along the eastern boundary of the Joshua Tree Subbasin and the far northern boundary of the Copper Mountain Subbasin. Their model indicated that 199 AFY (207 under pre-development conditions) leaves the two subbasins as groundwater outflow, and that it all flows out the northern boundary of the Copper Mountain Subbasin. They state that this groundwater flows into the Surprise Spring Subbasin, but it is unclear whether or not this would actually occur, as the Transverse Arch is still present to the north of this point. The groundwater flow could also pass east through the space between Copper Mountain and the Transverse Arch into the Mesquite Lake Subbasin, although to do so it would have to cross the Copper Mountain Fault.

Kennedy Jenks (2010) based their water budgets on all of the available USGS reports for the area. Conceptually, the Indian Cove Subbasin receives groundwater inflow from the Joshua Tree Subbasin to the west, while the Fortynine Palms and Eastern Subbasins do not receive inflow from other basins. The Mesquite Lake Subbasin receives inflow from the Indian Cove, Fortynine Palms, Eastern, Deadman Lake, Surprise Spring, and Copper Mountain Subbasins. Using a Darcy's Law approach, they estimated that the Indian Cove Subbasin receives about 36 AFY of inflow from the Joshua Tree Subbasin, while the Mesquite Lake Subbasin receives a total of about 730 AFY of inflow from the various surrounding subbasins.

Li and Martin (2011) also estimated groundwater inflow to the Mesquite Lake Subbasin. In contradiction to Nishikawa et al. (2004), they stated that 207 AFY of groundwater leaves the Copper Mountain Subbasin and flows into the Mesquite Lake Subbasin between Copper Mountain and the Transverse Arch. They also give a groundwater inflow of 8 AFY from the Deadman Lake Subbasin (and no inflow from the Surprise Spring Subbasin), much lower than the 577 AFY estimated by Kennedy Jenks (2010) for inflow from the Deadman Lake and Surprise Spring Subbasins. Groundwater inflow to the Mesquite Lake Subbasin from the three southern subbasins (Indian Cove, Fortynine Palms, and Eastern) was calculated to be about 510 AFY based on their estimates of inflow from other subbasins (Copper Mountain and Deadman) and published estimates of total ET at Mesquite Lake, and is far higher than the estimates of Kennedy Jenks (2010) from the same three subbasins (18 AFY).

These estimates are not anticipated to significantly change, so they are assumed to be the same (1,188 AFY) for both current and 2045 projected conditions.

D.4 Groundwater Outflows

Outflows remove water from the aquifer system through various routes and processes. This section defines and discusses the different types of outflows.

D.4.1 Groundwater Pumping

As development in the study area has continued, groundwater extraction by wells has become the primary outflow component. This component should be the easiest to estimate, but much of the groundwater extraction in the study area is unmetered, and hence unknown. The District provides pumping volumes, but many other groundwater users exist in the study area, and do not measure or report their pumping.

For current conditions, TPWD records and information were used to calculate average pumpage for each subbasin for the study period of 2022 to 2023; this is presented in Table D-2.

Table D-2 – Average Pumpage 2022-2023

Subbasin	Average Annual Pumpage (AFY)
Indian Cove Subbasin	112
Fortynine Palms Subbasin	772
Eastern Subbasin	229
Mesquite Lake Subbasin	1,290
Mainside Subbasin[(a)]	0
Total	**2,403**

Notes: (a) TPWD does not currently produce drinking water from the Mainside Subbasin. While there are non-TPWD wells in this subbasin, these volumes are not metered nor easily quantifiable. For the purposes of this GWMP, the pumpage in the Mainside Subbasin is assumed to be zero.

For 2045 projected conditions, 2045 projected groundwater pumping estimates were used; this is presented in Table D-3 (Kennedy Jenks, 2021).

Table D-3 – 2045 Projected Pumpage

Subbasin	Average Annual Pumpage (AFY)
Indian Cove Subbasin	284
Fortynine Palms Subbasin	993
Eastern Subbasin	328
Mesquite Lake Subbasin	1,806
Mainside Subbasin[(a)]	0
Total	**3,411**

Notes: (a) It is not anticipated that TPWD will produce drinking water from the Mainside Subbasin in 2045. While there are non-TPWD wells in this subbasin, these volumes are not metered nor easily quantifiable. For the purposes of this GWMP, the pumpage in the Mainside Subbasin is assumed to be zero.

D.4.2 Evapotranspiration

Evapotranspiration (ET) is the transformation of liquid water to water vapor through either transpiration by plants or evaporation of standing or soil water. Where the water table is close to the land surface, ET can be supplied by the saturated zone of the aquifer; where the water table is out of reach of the root zone; ET is derived only from soil moisture and has no bearing on the groundwater budget.

As noted above, water tables in the study area tend to be far beneath the land surface, so ET from the water table is limited. Kennedy Jenks (2010) used existing reports to estimate ET within the study area. They determined that ET was about 550 AFY at Mesquite Lake before development and has likely decreased to around 340 AFY due to lowering of the water table. ET at the Oasis of Mara was estimated to be up to about 75 AFY, but there has been no rigorous estimate. Concentrations of phreatophytic vegetation (vegetation directly taps the water table to survive) at the Oasis of Mara and Mesquite Dry Lake (and Mesquite Springs) within the District (Riley and Worts, 1953).

Li and Martin (2011) used earlier estimates as the basis for their conceptual understanding of ET in the Mesquite Lake Subbasin, giving a total of 890 AFY from transpiration and soil evaporation. This total was used to calibrate boundary conditions in their groundwater model, so the model cannot be used to provide an independent estimate. This GWMP estimates ET based on the results of the groundwater model of Kennedy Jenks (2010). This results in about 20 AFY of ET in the Eastern Subbasin and 1,630 AFY in the Mesquite Lake Subbasin.

Based on these previous studies, ET varies from 20 to 75 AFY at the Oasis of Mara (Eastern) and 340 to 1,630 AFY at Mesquite Lake. ET is assumed to be zero in other subbasins. These estimates are not anticipated to significantly change, so they are assumed for both current and 2045 projected conditions.

D.4.3 Groundwater Outflow

Groundwater exchanges between the southern subbasins and the Mesquite Lake Subbasin were discussed in the Groundwater Inflow section above (Section 6.4.1.6). This section only covers groundwater exchanges that leave the set of subbasins included in the study area.

Under the conceptual model of Kennedy Jenks (2010), groundwater from the three southern subbasins flowed out to the Mesquite Lake Subbasin, and groundwater from this subbasin flows out into the Dale Basin to the east. Under their water balance approach, 114 AFY flowed from the Mesquite Lake Subbasin to the Dale Basin. Their numerical model simulated a flow of 519 AFY across this boundary. Note that the Mainside Subbasin is not included in either the water budget or the numerical model.

Under the conceptual model of Li and Martin (2011), groundwater flows from the Mesquite Lake Subbasin into the Mainside Subbasin, from where it may enter the Dale Basin. However, they state that only a minor amount of groundwater flows from the Mesquite Lake Subbasin to the Mainside Subbasin.

These estimates are not anticipated to significantly change, so they are assumed for both current and 2045 projected conditions.

D.4.4 Springs

Springs are locations where the water table intersects the ground and groundwater is discharged to the surface. Once there, this water can re-infiltrate, be utilized as a water source, or be lost to ET. Because the study area is very dry, water tables are typically well below the ground surface, so springs are very rare within the alluvial basins. Prior to development, springflow occurred at the Oasis of Mara and Mesquite Springs, where faults force groundwater upward to the surface. However, there have been no rigorous estimates of flow at these springs. Because of lowered water tables, one can assume that there is no longer any flow occurring at these springs. This estimate is not anticipated to significantly change, so it is assumed for both current and 2045 projected conditions.

D.5 Hydrologic Water Budget: Current Conditions

Table D-4 presents the detailed hydrologic water budget calculations made under current conditions.

Table D-4 – Current Conditions Hydrologic Water Balance Estimates for Sub-Basins in the TPWD Service Area (AFY)

	Indian Cove		Fortynine Palms		Eastern		Mesquite Lake		Mainside		Total	
Component	Low	High	Low	High	Low	High	Low	High	Low	High	Low	High
Precipitation Recharge	0	0.5	0	0.5	0	0.5	0	0.5	0	0.5	0	2.5
Irrigation Return Flow	0	0	0	0	0	0	0	0	0	0	0	0
Septic Return Flow	143	143	146	146	186	186	1,285	1,285	25	25	1,785	1,785
Streamflow Infiltration	0	0	0	33	0	0	0	165	0	0	0	198
MFR	3	54	7	212	2	190	0	8	0	10	12	474
MBR	0	56	0	34	0	49	0	5	0	10	0	154
Groundwater Inflow	36	75	0	140	0	50	105	808	0	115	141	1,188
Total Recharge	**182**	**328**	**153**	**566**	**188**	**475**	**1,390**	**2,272**	**25**	**160**	**1,938**	**3,801**
Well Discharge	112	112	772	772	229	229	1,290	1,290	0	0	2,403	2,403
ET	0	0	0	0	20	75	340	1,630	0	0	360	1,705
Groundwater Outflow	10	30	0	120	0	50	0	114	0	0	10	314
Springflow	0	0	0	0	0	0	0	0	0	0	0	0
Total Outflow	**122**	**142**	**772**	**892**	**249**	**354**	**1,630**	**3,034**	**0**	**0**	**2,773**	**4,422**
Storage Change	**40**	**206**	**-739**	**-206**	**-166**	**226**	**-1,643**	**642**	**25**	**160**	**-2,484**	**1,028**

D.6 Hydrologic Water Budget: 2045 Projected Conditions

Table D-5 presents the detailed hydrologic water budget calculations made under 2045 projected conditions.

Table D-5 – 2045 Projected Conditions Hydrologic Water Balance Estimates for Sub-Basins in the TPWD Service Area (AFY)

	Indian Cove		Fortynine Palms		Eastern		Mesquite Lake		Mainside		Total	
Component	Low	High	Low	High	Low	High	Low	High	Low	High	Low	High
Precipitation Recharge	0	0.5	0	0.5	0	0.5	0	0.5	0	0.5	0	2.5
Irrigation Return Flow	0	0	0	0	0	0	0	0	0	0	0	0
Septic Return Flow	191	191	195	195	248	248	1,716	1,716	33	33	2,384	2,384
Streamflow Infiltration	0	0	0	33	0	0	0	165	0	0	0	198
MFR	3	54	7	212	2	190	0	8	0	10	12	474
MBR	0	56	0	34	0	49	0	5	0	10	0	154
Groundwater Inflow	36	75	0	140	0	50	105	808	0	115	141	1,188
Total Recharge	**230**	**376**	**202**	**615**	**250**	**537**	**1,821**	**2,703**	**33**	**169**	**2,537**	**4,401**
Well Discharge	284	284	993	993	328	328	1,806	1,806	0	0	3,411	3,411
ET	0	0	0	0	20	75	340	1,630	0	0	360	1,705
Groundwater Outflow	10	30	0	120	0	50	0	114	0	0	10	314
Springflow	0	0	0	0	0	0	0	0	0	0	0	0
Total Outflow	**294**	**314**	**993**	**1,113**	**348**	**453**	**2,146**	**3,550**	**0**	**0**	**3,781**	**5,430**
Storage Change	**-84**	**82**	**-911**	**-378**	**-203**	**189**	**-1,729**	**557**	**33**	**169**	**-2,893**	**620**