GROUNDWATER QUALITY ASSESSMENT REPORT

CAWELO WATER DISTRICT COALITION

17207 Industrial Farm Road
Bakersfield, CA 93308

May 4, 2015

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EXECUTIVE SUMMARY

The Cawelo Water District Coalition (CWDC) has prepared a Groundwater Quality Assessment Report (GAR) as required by the Waste Discharge Requirements General Order for Growers within the Tulare Lake Basin Area that are Members of a Third-Party Group, R5-2013-0120 (General Order).

The objective of the GAR is to provide a groundwater quality assessment using all available, applicable and relevant data and to determine high and low vulnerability areas where discharges from irrigated agriculture may degrade groundwater quality. Additionally, this GAR is to provide a basis for establishing priorities for groundwater quality trend monitoring work plans, evaluation of effective management practices and groundwater quality management plans in the high vulnerability areas.

The GAR provides a background of the CWDC area including general information, geological descriptions, hydrology and agricultural land use along with irrigation practices. The GAR also provided a summary of the existing groundwater quality data and current groundwater monitoring programs.

The focus of the GAR was the nitrate constituent complemented with a review of the groundwater salinity and other factors that may describe irrigated agriculture's potential to impact groundwater quality. The protection of groundwater as a source of drinking water for urban, rural and disadvantaged communities was a key component of the assessment and a fundamental factor in determining high vulnerability areas.

The high vulnerability areas were established using Geographic Information System (GIS) tools to spatially overlay data and information onto a map of CWDC and evaluate the groundwater vulnerability of each parcel throughout the CWDC area. **Figure ES1** provides a map of the designated CWDC high vulnerability areas. The same process provided the method to determine the priorities within the high vulnerability areas and those priorities are presented in Figure ES2.

By default, the remaining areas within CWDC, that are not designated high vulnerability areas, were designated low vulnerability areas. Areas that were not classified as High Priority or Medium Priority areas were designated Low Priority.

The General Order provides an option to address groundwater quality impacts in the designated high vulnerability areas by developing a Comprehensive Groundwater Quality Management Plan (CGQMP). Due to the extent of the designated High vulnerability areas, CWDC has prepared a CGQMP.

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Figure ES1 – High Vulnerability Area

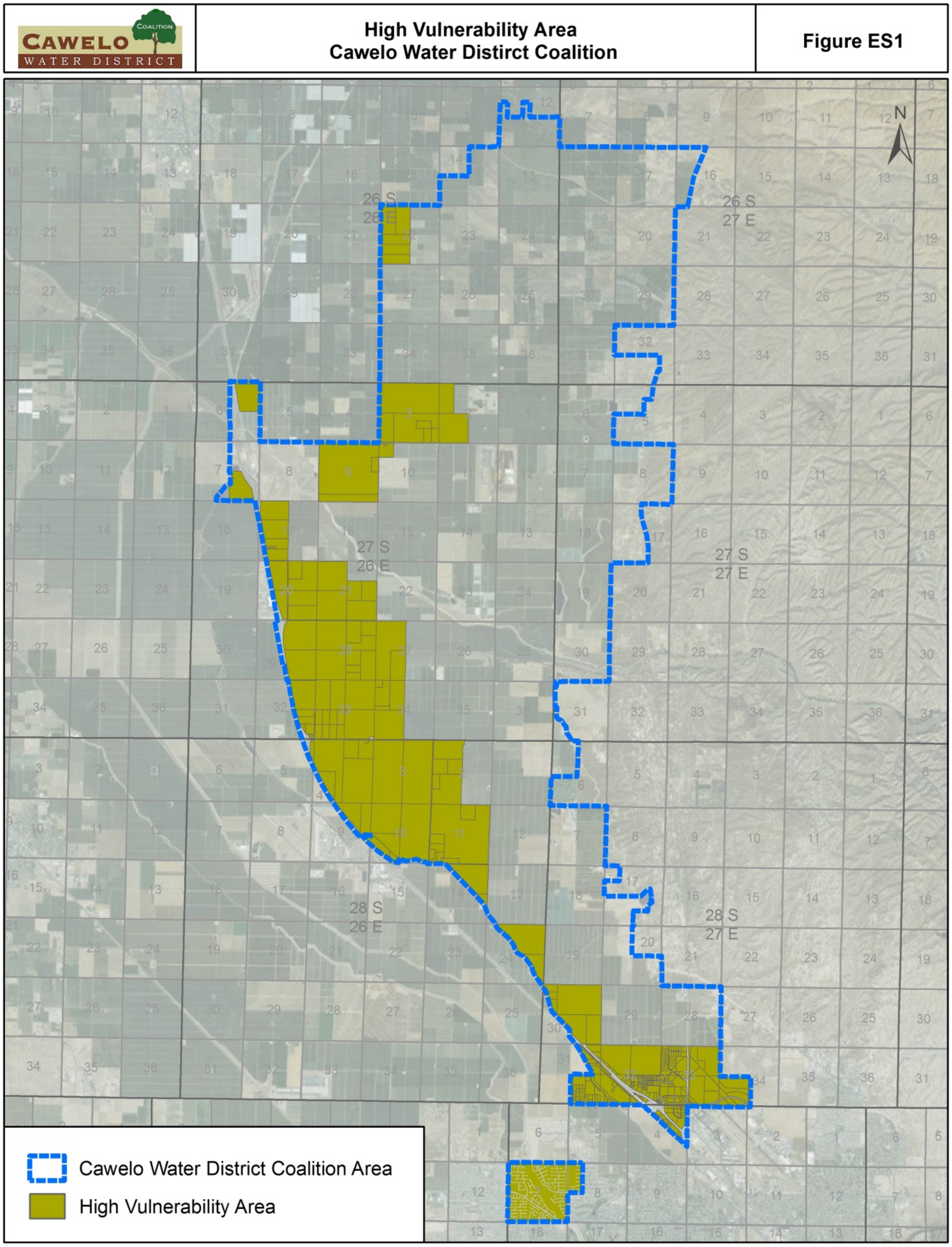

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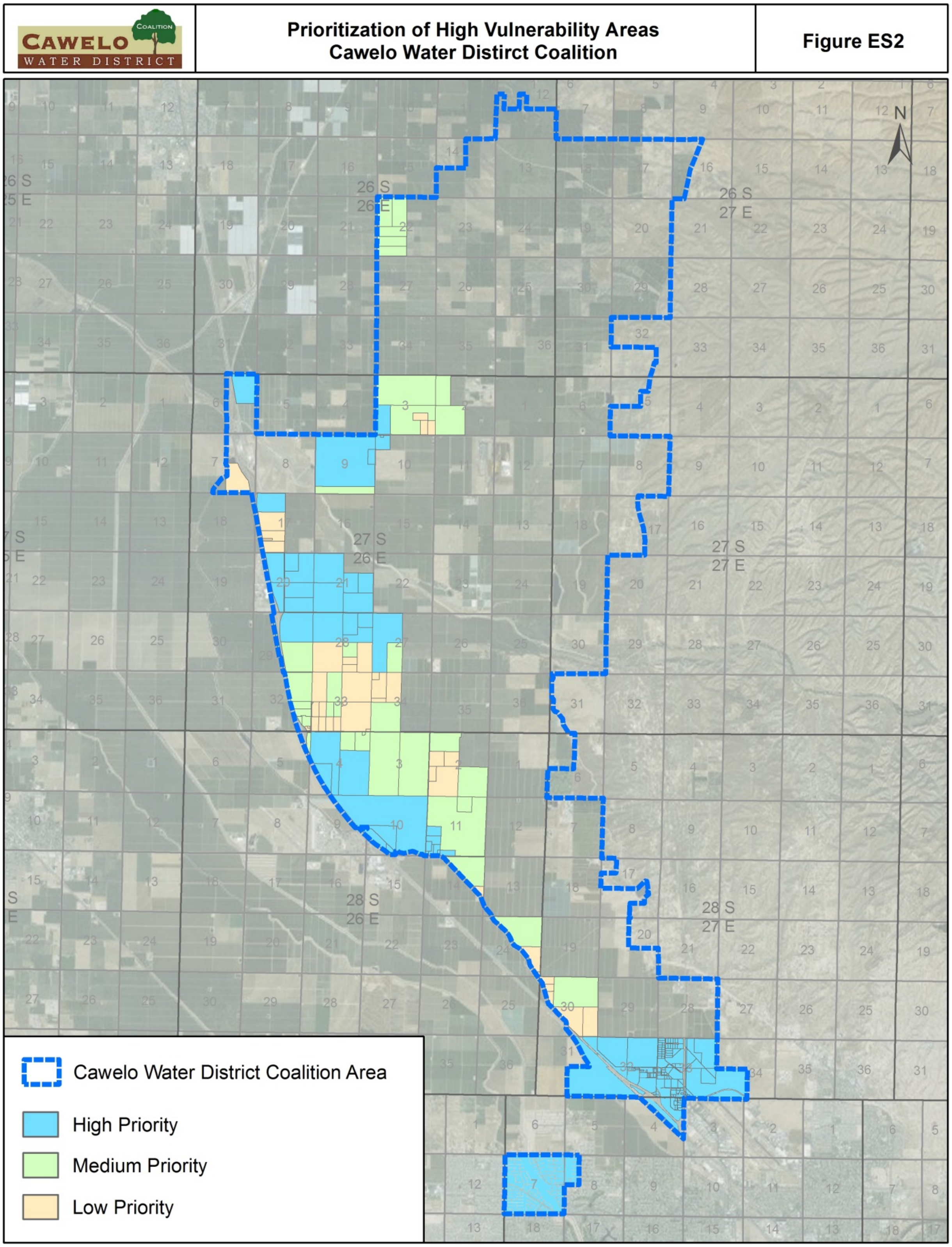
Figure ES2 – Prioritization of High Vulnerability Areas



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17207 Industrial Farm Road, Bakersfield, CA 93308
Ph. (661) 393-6072 Fx. (661) 393-6073

I. INTRODUCTION

The Cawelo Water District Coalition (CWDC) was created to represent the growers in the Cawelo Water District (District) area and to assist with compliance of with the Waste Discharge Requirements General Order for Growers within the Tulare Lake Basin Area that are Members of a Third-Party Group, R5-2013-0120 (General Order).

As required by the General Order, CWDC has prepared a Groundwater Quality Assessment Report (GAR) to provide an assessment of the groundwater quality in the CWDC area and to establish areas that are potentially vulnerable to overlying agricultural practices on the surface. The GAR provides the basis for future studies and requirements of the General Order

A. Background

The General Order was adopted by the State of California Central Valley Regional Water Quality Control Board (Regional Board) on September 19, 2013 and replaced previous Order No. R5-2006-0053, Coalition Group Conditional Waiver of Waste Discharge Requirements from Irrigated Lands or alternatively known as the Ag Waiver Program.

Under the Ag Waiver Program, the Southern San Joaquin Valley Water Quality Coalition (SSJVWQC) acted as the third-party group representing growers with the potential to discharge irrigation water to surface waters of the State. The SSJVWQC included four sub-watersheds, the Kaweah River, Kern River, Kings River and Tule River, with each conducting their respective surface water monitoring obligations per the SSJVWQC Monitoring and Reporting Program. Reports and data submissions were consolidated and submitted by the SSJVWQC

1. Cawelo Water District Coalition Area

Under the new General Order, the CWDC received a Notice of Applicability (NOA) dated April 25, 2014 from the Central Valley Regional Water Quality Control Board (Regional Board) authorizing CWDC to act as the third-party group or coalition representing growers of Cawelo Water District for compliance under the General Order.

The CWDC coverage area is essentially the Cawelo Water District boundary and encompasses roughly 45,000 acres. CWDC area is located in the north-central portion of Kern County, between U.S. Highway 99 on the West and State Highway 65 on the East, with the community of Oildale to the south and the community of McFarland to the north. Poso Creek crosses the CWDC coverage area bifurcating it into approximately two halves creating a northern and southern area. The CWDC also provides coverage for growers in an additional Supplemental Coverage Area (SCA) which encompasses the upstream portion of the Poso Creek watershed to the east of the CWDC area. The SCA is approximately 200,000 acres with almost no irrigated agriculture. The coverage area boundaries are shown in **Figure 1.**

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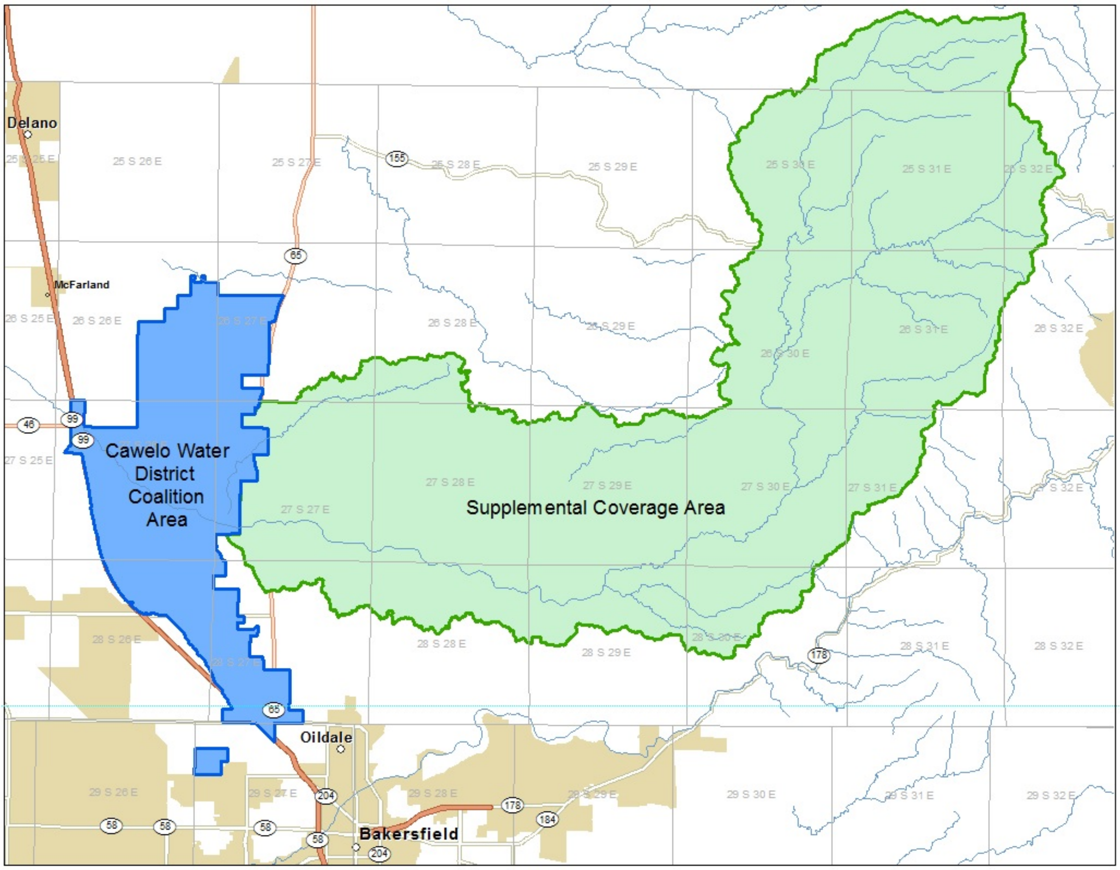
Figure 1 - Cawelo Water District Coalition and Supplemental Coverage Area



2. General Order Requirements

The General Order identifies many different requirements for the Third-Party groups and their members. The General Order's strategy for evaluating the groundwater quality and protection consist of:

- GAR
- Management Practices Evaluation Program (MPEP)
- Groundwater Quality Trend Monitoring Program (GQTMP)

Each of these elements has its own specific objectives with the GAR providing the basis for development and implementation for the MPEP and GQTMP.

The GAR is required to be submitted within one year after a third-party group received their NOA. CWDC received a NOA on April 25, 2014 and therefore the GAR is due one year later on April 27, 2015 (the first business day after April 25, 2015).

B. Objectives of the Groundwater Quality Assessment Report (GAR)

The objectives of the GAR are to provide an assessment of the groundwater conditions in the CWDC area and to determine the high and low vulnerable areas that may or may not be

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Ph. (661) 393-6072 Fx. (661) 393-6073

impacted by irrigated agriculture. In Section VIII.D of the General Order, it is specified that the GAR must include:

- An assessment of all available, applicable and relevant data and information to determine the high and low vulnerability areas where discharges from irrigated lands may result in groundwater quality degradation;
- Establish priorities for implementation of monitoring and studies with high vulnerability areas;
- Provide a basis for establishing workplans to assess groundwater quality trends;
- Provide a basis for establishing workplans and priorities to evaluate the effectiveness of agricultural management practices to protect groundwater quality; and
- Provide a basis for establishing groundwater quality management plans in high vulnerability areas and priorities for implementation of those plans.

The General Order describes the requirements of the GAR and information to be incorporated into the GAR. The following is a summary of the key elements required:

- Data review of publicly available groundwater data
- Geological, soil and hydrological information
- Land use information
- Groundwater contour maps
- Groundwater recharge
- Agricultural practices
- Shallow groundwater issues
- Current groundwater monitoring
- Known groundwater quality impacts
- Incorporation of data and data sources
- Process and designation of high and low vulnerability areas
- Prioritization of work efforts in high vulnerability areas
- Recommendations for future General Order studies and requirements

II. PHYSICAL SETTING

A. CWDC Location

CWDC area covers roughly 45,000 acres and located in the north-central portion of Kern County, between U.S. Highway 99 on the West and State Highway 65 on the East, the community of Oildale to the south and the community of McFarland to the north. Poso Creek crosses the CWDC coverage area bifurcating it into approximately two halves creating a northern and southern area. The SCA is approximately 200,000 acres with almost no irrigated agriculture.

The CWDC area predominately lies on the southeast portion of the southern San Joaquin Valley floor with some lower level foothills within the eastern CWDC boundary. The area is relatively flat with ground elevations ranging between 450 feet to 600 feet on the valley floor area with elevations rising to about 800 feet in the foothill areas.

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The Kern River Watershed Coalition Authority (KRWCA) is the largest third-party group that provides coverage for growers in the remaining areas of the valley floor within Kern County and their primary coverage area shares a common boundary to the north, west and south of CWDC.

B. Climate

The climate of the region is semi-arid with summers that are typically hot and dry with no significant precipitation. The winters are cooler characterized by fog and minor precipitation with an annual average of 6 inches in the CWDC area. As the elevation increases heading to the east leaving the CEDC area and into the foothills and upper Poso Creek watershed area in the Sierra Nevada Mountains, the precipitation increases ranging from 6 to 30 inches.
During the summer months the high temperatures average in the high 90's with lows averaging in the high 60's. During the winter months the high temperatures generally drop to the low 60's or high 50's with the lows averaging around 40 degrees Fahrenheit. The monthly average temperatures and precipitation are summarized in **Table 1**.

Table 1 - Average Monthly Temperatures and Precipitation for the CWDC Area

Average Monthly Temperatures and Precipitation for CWDC Area													
	Jan	Feb	March	April	May	June	July	Aug	Sept	Oct	Nov	Dec	Annual
Average High (°F)	56.2	62.8	68.7	75.0	83.5	90.9	97.1	95.8	90.0	79.4	65.7	56.6	76.8
Average Low (°F)	39.3	42.4	46.5	50.2	57.5	64.2	70.5	69.0	64.0	55.0	44.6	39.0	53.5
Precipitation (Inches)	1.2	1.2	1.2	0.5	0.2	0.1	0.0	0.0	0.1	0.3	0.6	1.0	6.47

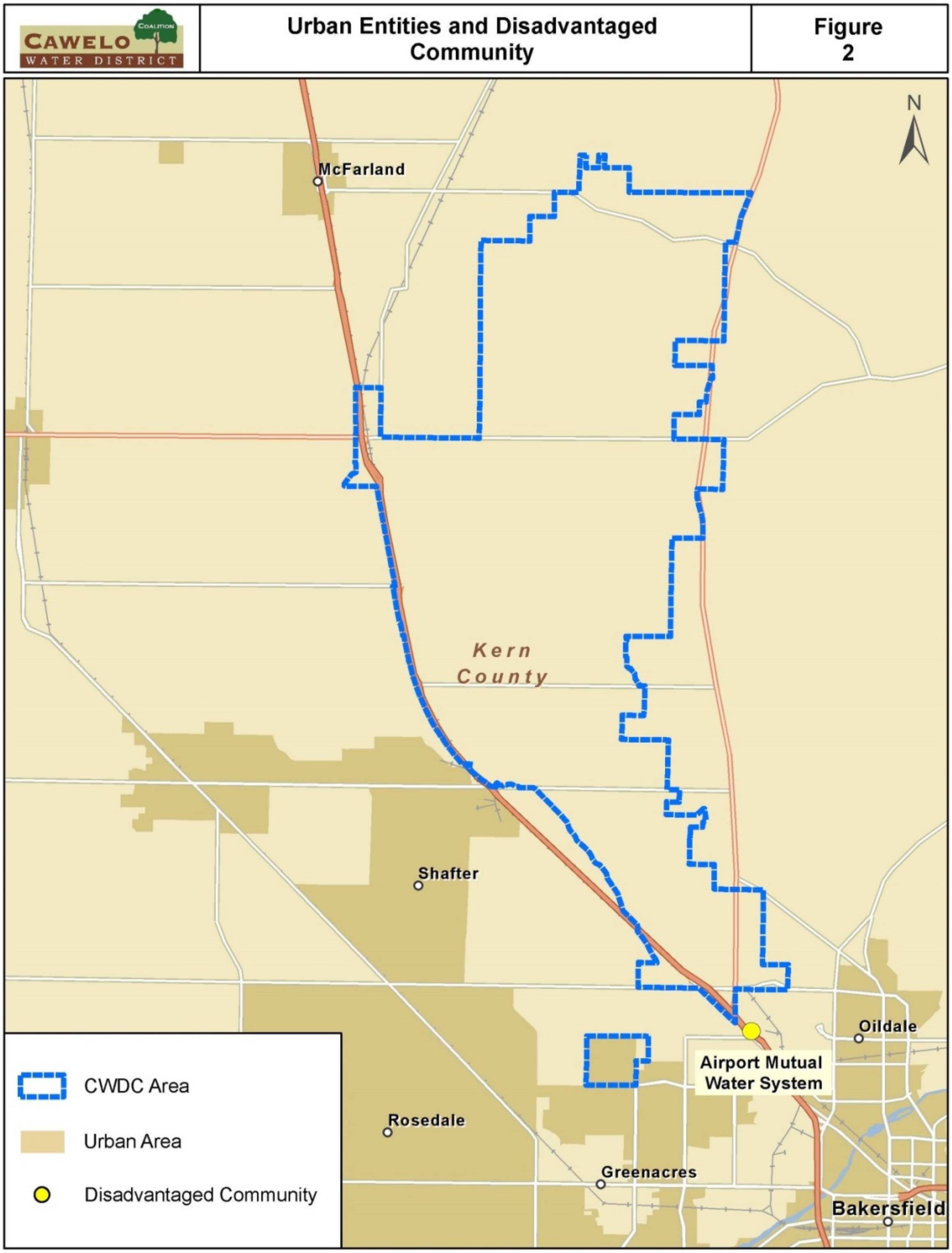
Source: National Weather Service, Bakersfield Data

C. Urban Entities

The CWDC area is approximately 45,000 acres with approximately 34,500 acres of irrigated agriculture. The remaining areas are classified as fallow land, commercial, industrial, reservoirs or groundwater recharge facilities. The only urban areas within CWDC are in Section 7 and 8 of Township 29 South and Range 27 East at the southern end. This area is almost entirely residential with no irrigated agriculture. There are no other urban entities within the CWDC boundary and no disadvantaged communities as identified by the California Department of Water Resources (DWR, 2014) and as identified by the Disadvantaged Community Water Study for the Tulare Lake Basin (Provost & Pritchard, 2014).

There are, however, urban entities and a DAC in the vicinity of CWDC. CWDC generally is located just north of the City of Bakersfield with the City of Shafter immediately to the west of CWDC, Oildale to the south and McFarland to the northwest. The Disadvantaged Community Water Study for the Tulare Lake Basin indicates the Airport Mutual Water System DAC is approximately within 2 miles of the CWDC boundary. **Figure 2** describes the location of the urban entities and the DAC.

Figure 2 – Urban Entities and Disadvantaged Community



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III. GEOLOGY

A. Geological Setting

Within the San Joaquin Valley Groundwater Basin, the CWDC is located in the Kern County Groundwater Subbasin (Kern Subbasin). The Kern Subbasin is bounded on the north by the Kern County line and the Tule Groundwater Subbasin, in the east and southeast by granitic bedrock of the Sierra Nevada foothills and Tehachapi mountains, and on the southwest and west by the marine sediments of the San Emigdio Mountains and Coast Ranges (DWR, 2003).

The San Joaquin Valley represents the southern portion of the Great Central Valley of California. The San Joaquin Valley is a structural trough up to 200 miles long and 70 miles wide filled with up to 32,000 feet of marine and continental sediments deposited during periodic inundation by the Pacific Ocean and by erosion of the surrounding mountains, respectively. Continental deposits shed from the surrounding mountains form an alluvial wedge that thickens from the valley margins toward the axis of the structural trough. This depositional axis is below to slightly west of the series of rivers, lakes, sloughs, and marshes that mark the current and historic axis of surface drainage in the San Joaquin Valley (DWR, 2003).

Sediments that comprise the shallow to intermediate depth water-bearing deposits in the groundwater subbasin are primarily continental deposits of Tertiary and Quaternary age. **Figure 3** describes the geology for the CWDC area. From oldest to youngest, the deposits include the Olcese and Santa Margarita Formations; the Tulare Formation and Kern River Formation; older alluvium/stream deposits; and younger alluvium and coeval flood basin deposits (DWR, 2003)

B. Soil Types

Soil Properties are a significant factor in consideration of agricultural management practices, groundwater management plans and the MPEP.

Within the CWDC area, there are over 20 different soil types and are described by the Soil Survey of Kern County Northwestern Part (CA666) and the Soil Survey of Kern County, California Northeastern Part and Southeastern Part of Tulare County, California (CA668). Geographic Information System (GIS) soil survey data was downloaded from the USDA and NRCS Web Soil Survey to map the soil types and locations within the CWDC area and are shown in **Figure 4**. The Map Unit Key is provided **in Figure 5**.

The map units represent the various soil types in the CWDC area and are described in **Attachment 1 – NRCS Soil Survey, Map Unit Descriptions.** The provided descriptions were obtained from the Soil Survey of Kern County Northwestern Part and the Soil Survey of Kern County, California Northeastern Part and Southeastern Part of Tulare County, California.

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Figure 3 – Sediment Age within the Cawelo Water District Coalition

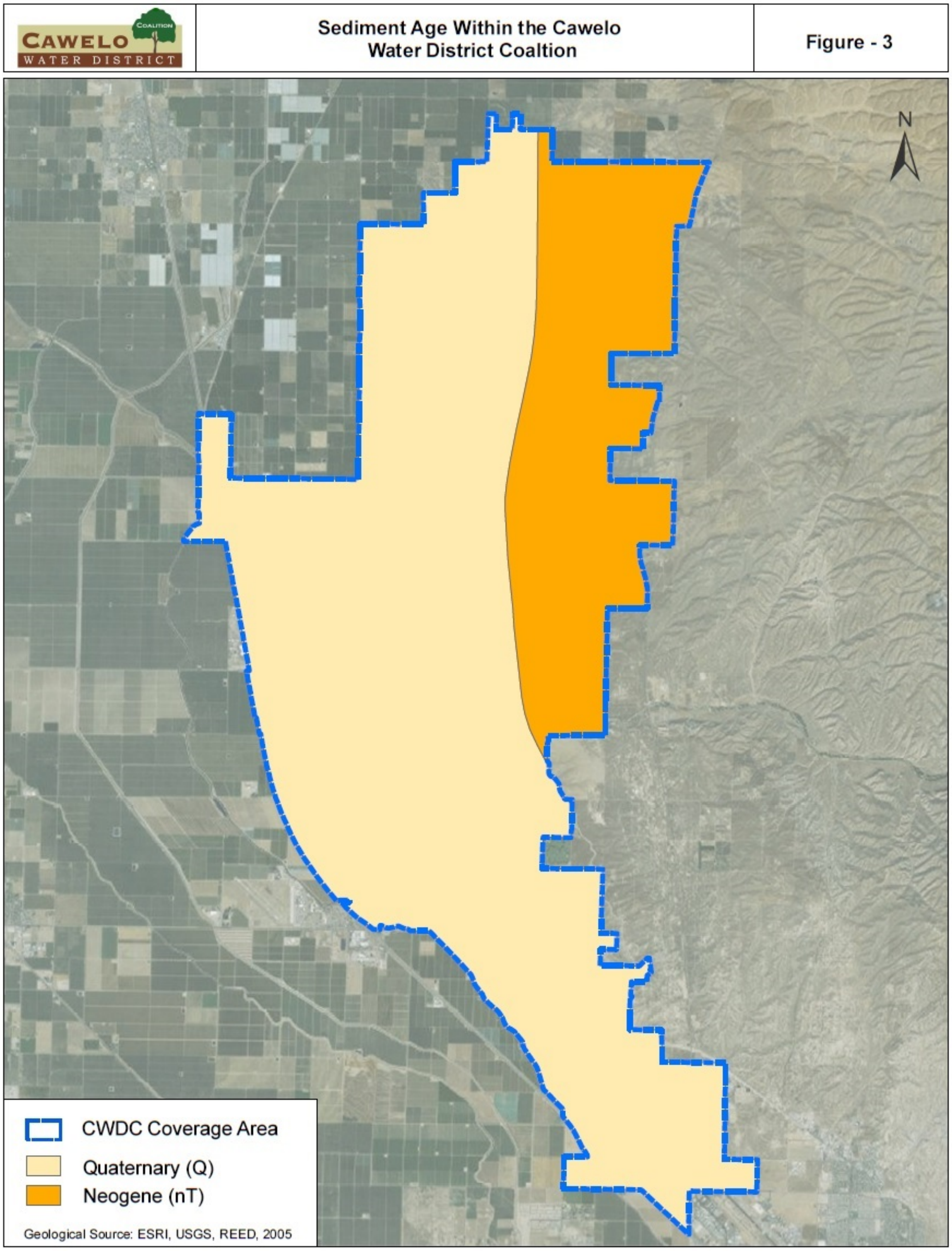

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Figure 4 – NRSC Soil Survey

	NRCS Soil Survey Cawelo Water District Coaltion	Figure - 4

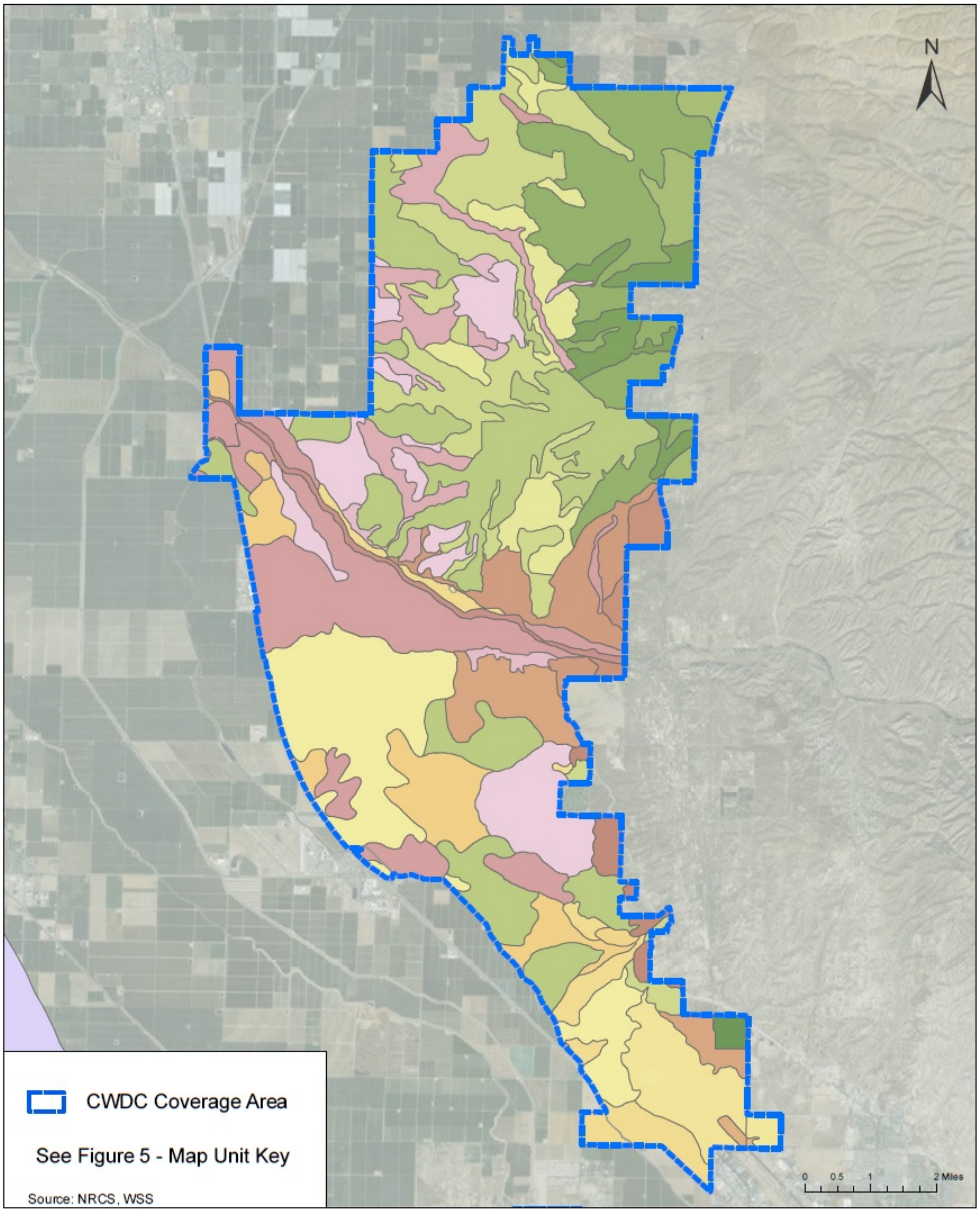

Figure 5 – NRCS Soil Survey, Map Unit Key

NRCS Soil Survey, Map Unit Key, Figure 5

Soil Survey of Kern County, Northwestern Part (CA666)

128ne	Capay silty clay, 2 to 9 percent slopes
130	Chanac clay loam, 2 to 9 percent slopes
131	Chanac clay loam, 9 to 15 percent slopes
132	Chanac clay loam, 15 to 30 percent slopes
138	Delano sandy loam, 0 to 2 percent slopes
139	Delano sandy loam, 2 to 5 percent slopes
140	Delano sandy loam, 5 to 9 percent slopes
145	Driver coarse sandy loam, 0 to 2 percent slopes
146	Delano sandy loam, 1 to 5 percent slopes (CA668)
146ne	Elkhills sandy loam, 9 to 50 percent slopes, eroded
154	Exeter sandy loam, 0 to 2 percent slopes
174	Kimberlina fine sandy loam, 0 to 2 percent slopes
175	Kimberlina fine sandy loam, 2 to 5 percent slopes
184	Lewkalb sandy loam, 0 to 2 percent slope
192	McFarland loam
200	Urban land –Delano complex, 0 to 2 percent slopes (CA668)
200ne	Millsholm Variant-Montara complex, 15 to 30 percent slopes
222	Premier coarse sandy loam, 2 to 5 percent slopes
223	Premier coarse sandy loam, 5 to 9 percent slopes
224	Premier coarse sandy loam, 9 to 15 percent slopes
225	Premier-Durothids association, 9 to 15 percent slopes
229	Riverwash
243	Wasco sandy loam
254	Zerker loam, 2 to 5 percent slopes
255	Zerker loam, 5 to 9 percent slopes
256	Zerker sandy clay loam, 02 to 2 percent slopes

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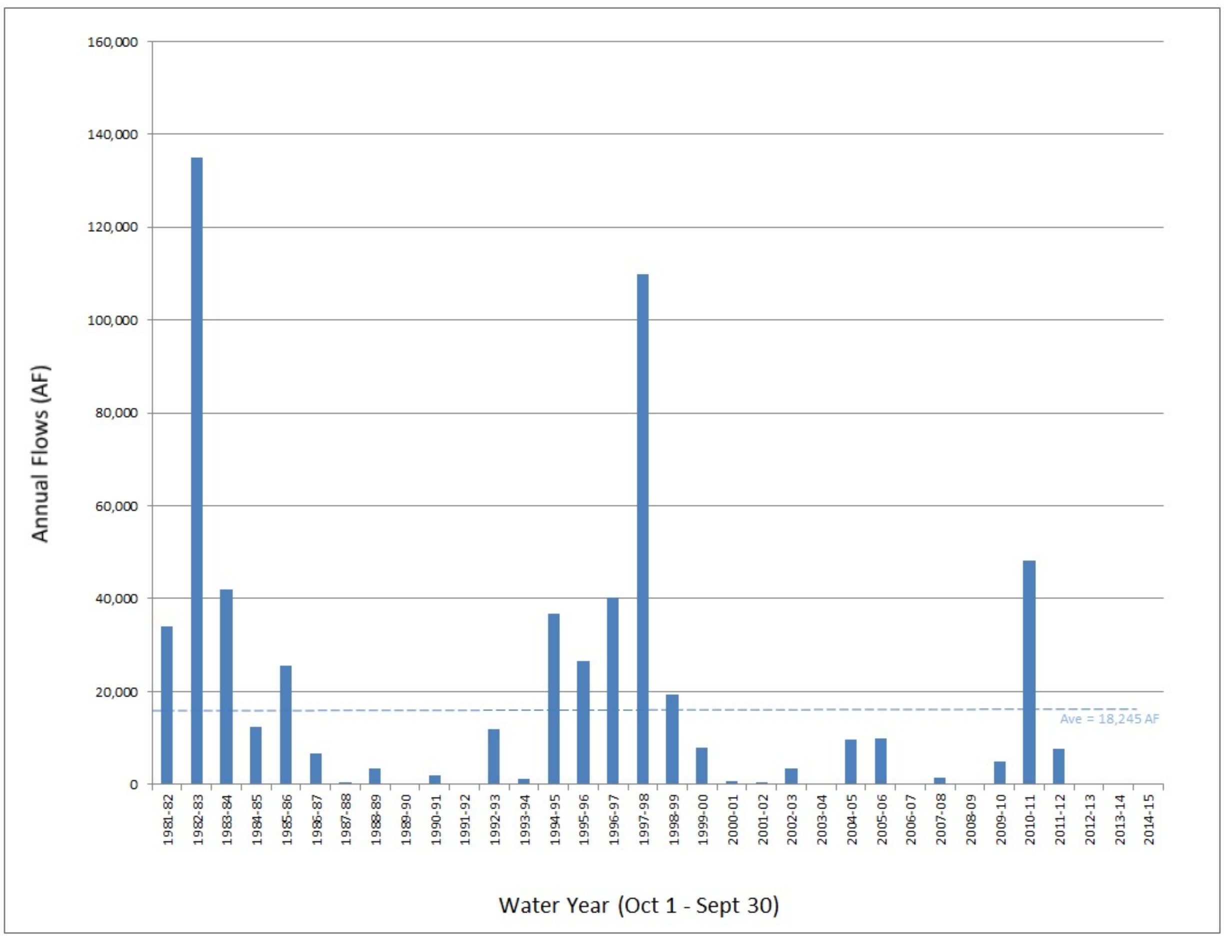
IV. HYDROLOGY

A. Poso Creek

The climate of the region is semi-arid with summers with no significant precipitation. The winters are cooler characterized by fog and minor precipitation. The average annual precipitation in the CWDC coverage area is approximately 6" dating back to 1998 as reported by the California Irrigation Management Information System station ID No. 138, Famoso Station. As the elevation increases heading to the east leaving the CWDC area and into the foothills and upper Poso Creek watershed area in the Sierra Nevada Mountains, the precipitation increases ranging from 6 to 30 inches.

The Poso Creek Watershed covers more than 250,000 acres and drains southwest into the Central Valley through the CWDC area. Poso Creek is an intermittent stream and the only significant natural surface water source that enters the CWDC area. The average annual flow entering the CWDC area is approximately 18,245 AF/year as illustrated in **Figure 6**.

FIGURE 6 – Poso Creek Annual Flows



B. Depth and Elevation of Groundwater

The Cawelo Water District (District) has been monitoring the groundwater levels in the CWDC area for over 30 years. The CWDC area is located in the eastern portion of the southern central valley floor where there are no clay layers and this area of the Kern Subbasin is an unconfined aquifer. There are no shallow groundwater tables in the CWDC area.

Groundwater level data is collected from agricultural production wells and domestic wells. The water levels are measured under static conditions and collected from approximately 150 to 200 wells throughout the area. The availability of wells for groundwater level measurements can vary from year to year depending on the operational status of the well or access to the well.

District staff collects the groundwater level data and provides the information to R.L. Schafer & Associates to compile the data and create groundwater depth and elevation contour maps. For the purposes of this report, the groundwater contour maps created by R.L. Schafer and Associates has been incorporated.

1. Current Groundwater Conditions

The State of California is currently experiencing historical drought conditions and in the Kern Subbasin the groundwater pumping to meet agricultural and urban water use demands were at an all-time high for 2014. The extreme drought conditions continue for 2015 and the summer season will see the same pumping demands.

Groundwater level monitoring is conducted throughout the district area but is grouped into two areas, north of Poso Creek and South of Poso Creek. Annual average groundwater levels are computed for these two areas and for the full Cawelo Water District.

In the Fall of 2014, the average groundwater depths were 531.6 feet below ground level (BGL) for the north area and 486.5 feet BGL for the south area. The average depth to groundwater was 531.6 feet BGL for the entire district. The shallowest and deepest levels recorded for 2014 was 170 feet and 697 feet, respectively. **Figure 7** presents the Fall 2014 information using contours lines of equal depth to groundwater**. Figure 8** presents the Fall 2014 information in lines of equal elevation of groundwater.

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Figure 7- Lines of Equal Depth, Fall 2014

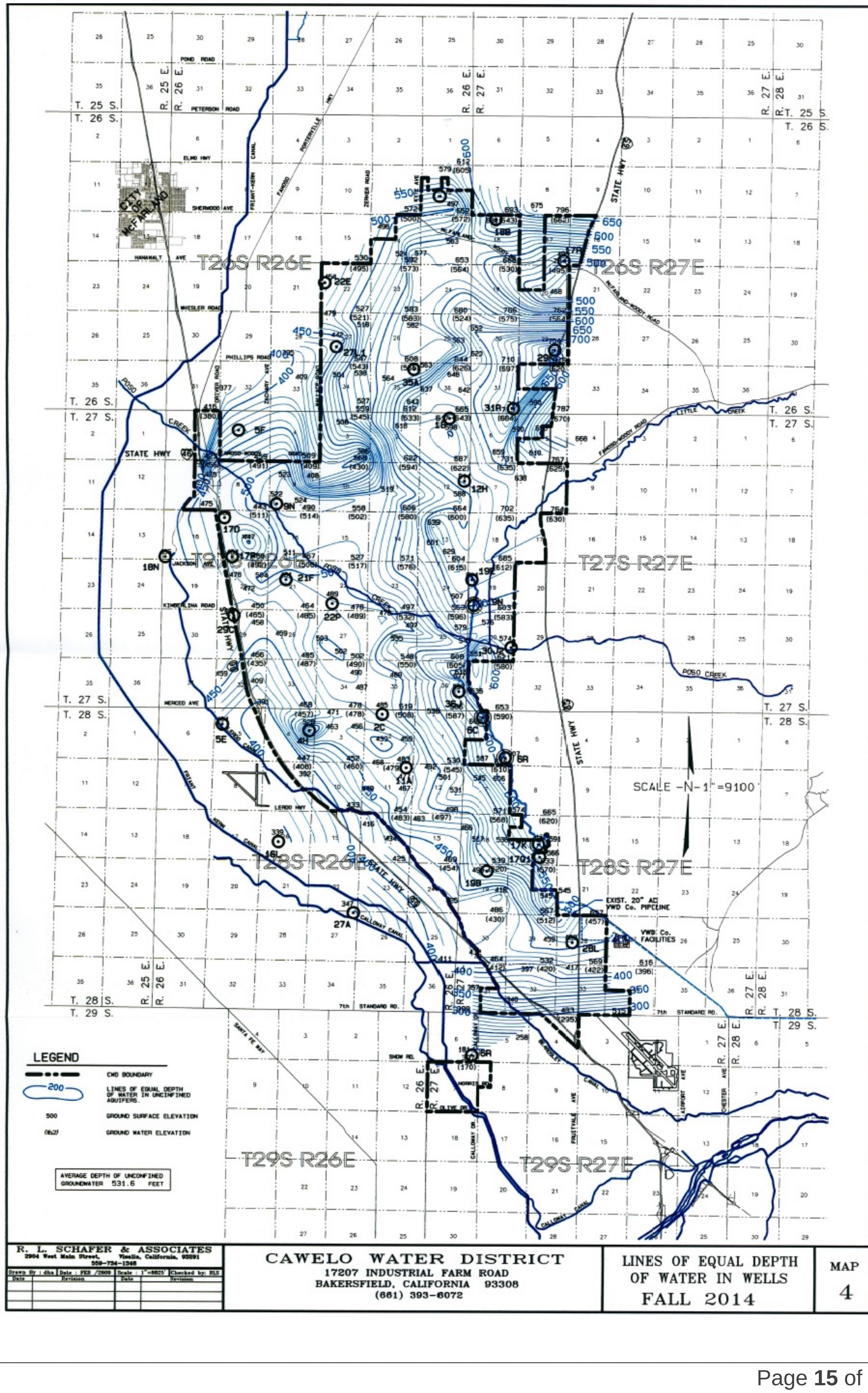
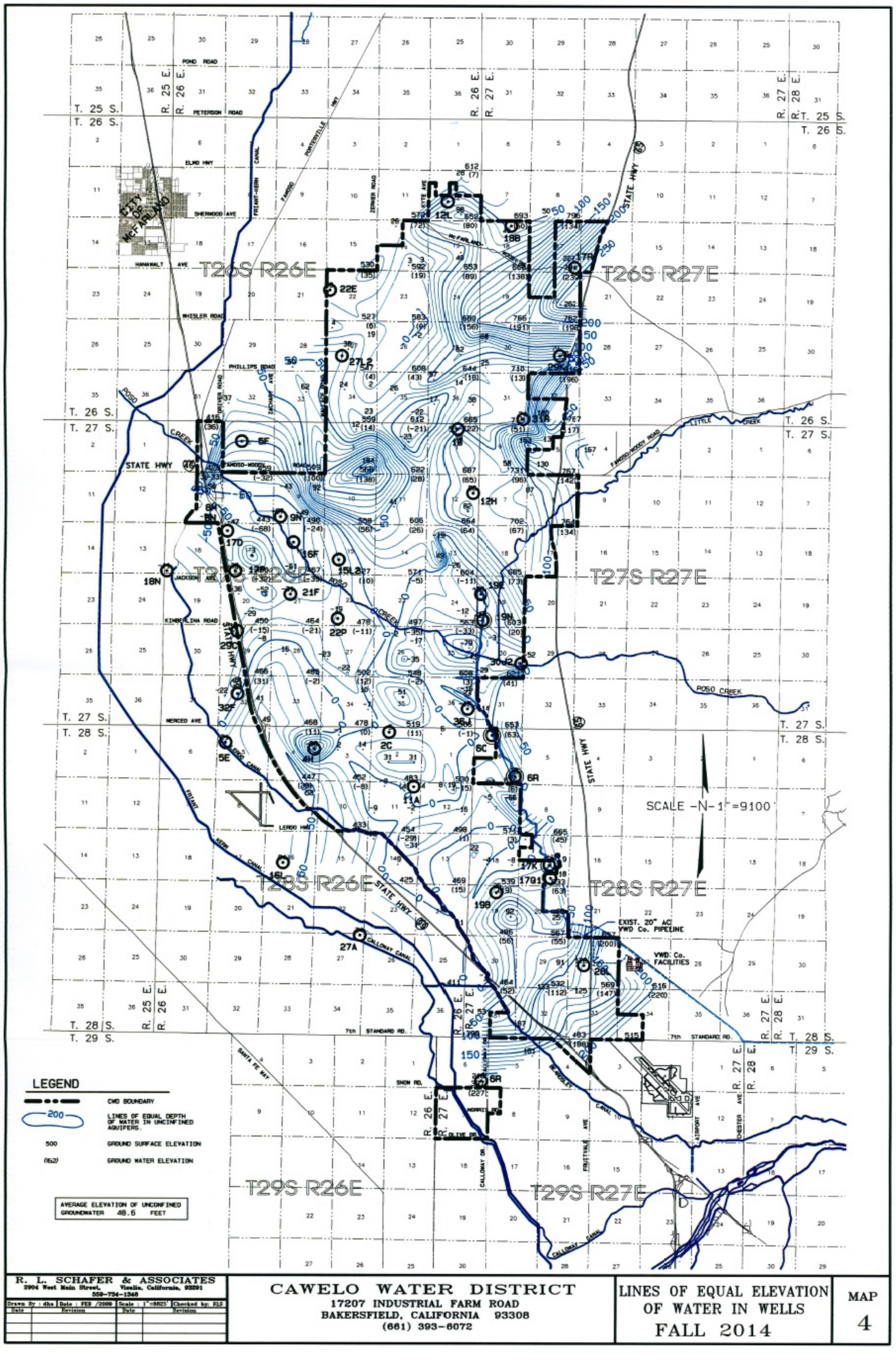


Figure 8 – Lines of Equal Elevation, Fall 2014



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2. Historical Levels and Trends
The Cawelo Water District has been monitoring the groundwater levels in the CWDC area for over 30 years. **Table 2** provides a summary of the annual average water levels for the north area, south area and for the District. **Figure 9, Figure 10 and Figure 11** describes the historical groundwater level trends for the different areas of CWDC.

Table 2 – Annual Depth to Groundwater Averages

Annual Depth to Groundwater (Feet), Fall Averages Cawelo Water District			
Year	North	South	District
1979	509.8	402.6	461.0
1980	523.5	398.2	466.4
1981	533.3	411.0	477.6
1982	505.5	394.6	455.0
1983	499.2	385.1	447.2
1984	479.3	377.5	432.9
1985	475.3	359.9	422.7
1986	464.4	353.3	413.8
1987	464.4	358.1	416.0
1988	480.4	367.4	428.9
1989	468.0	367.7	422.3
1990	502.9	402.5	457.0
1991	504.5	419.7	465.7
1992	509.5	431.3	473.8
1993	488.6	405.8	450.8
1994	506.4	426.9	470.1
1995	476.0	406.1	444.5
1996	479.5	397.8	442.6
1997	475.2	391.9	437.6
1998	467.6	383.6	429.6
1999	464.4	379.6	426.1
2000	462.8	381.4	426.1
2001	481.2	395.0	442.3
2002	479.8	394.8	441.4
2003	482.7	398.9	444.7
2004	494.6	414.3	458.2
2005	479.6	394.8	441.1
2006	471.5	395.6	436.7
2007	495.3	412.0	457.1
2008	529.4	433.1	485.2
2009	509.4	419.9	468.3
2010	487.6	417.9	455.6
2011	478.9	404.8	444.9
2012	501.5	421.4	464.7
2013	551.2	468.0	513.0
2014	569.9	486.5	531.6

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Figure 9 – Historical Annual Fall Average Groundwater Levels, North

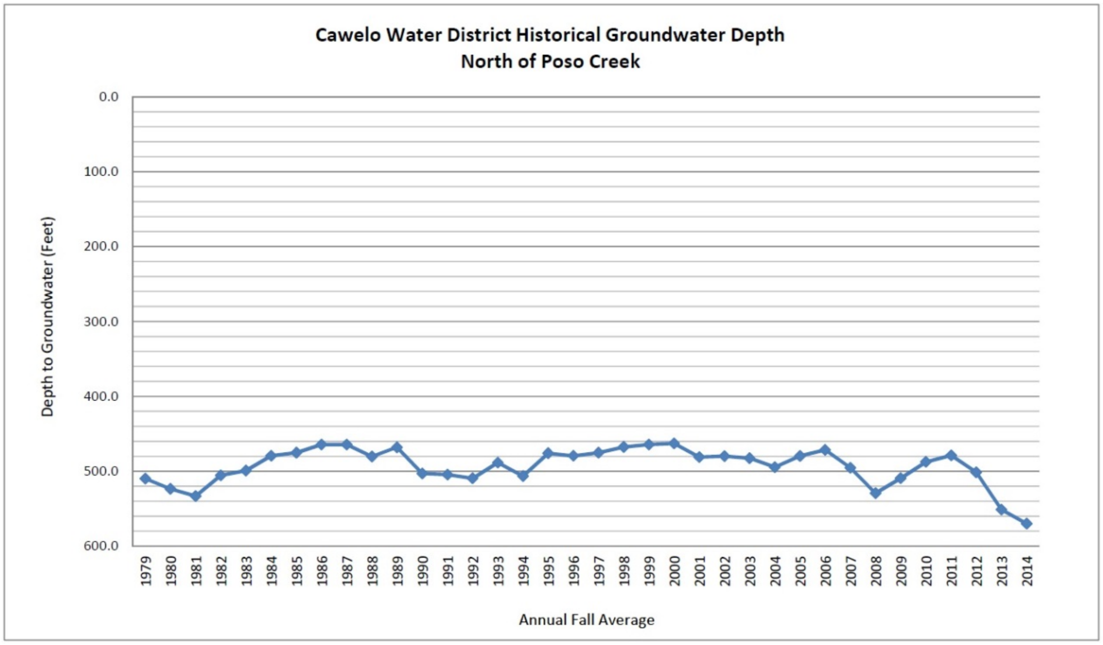

Figure 10 – Historical Annual Fall Average Groundwater Levels, South

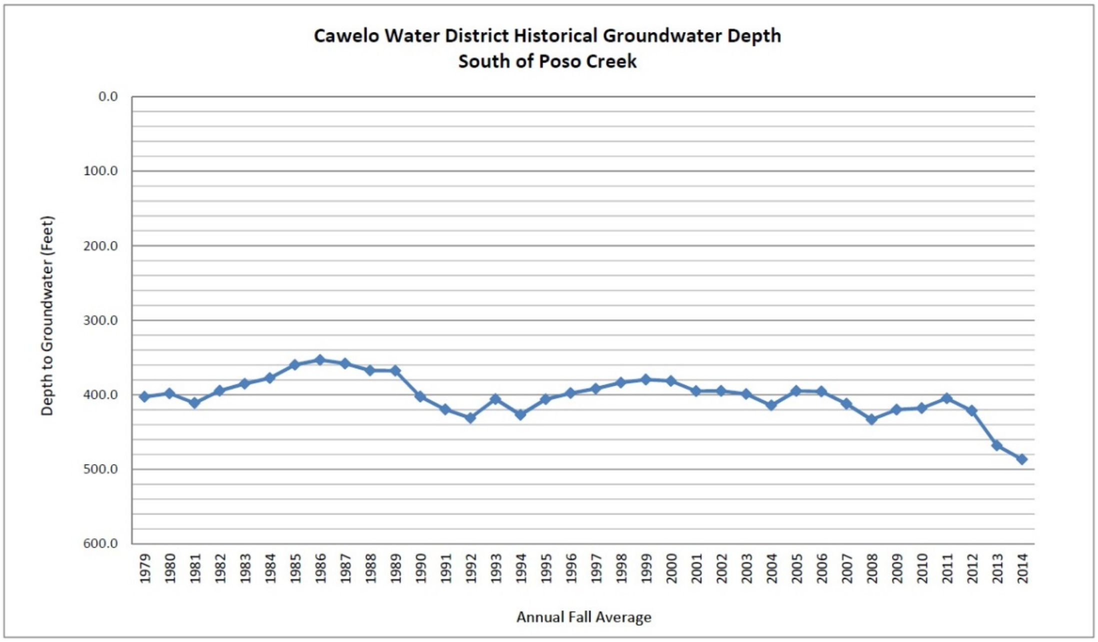

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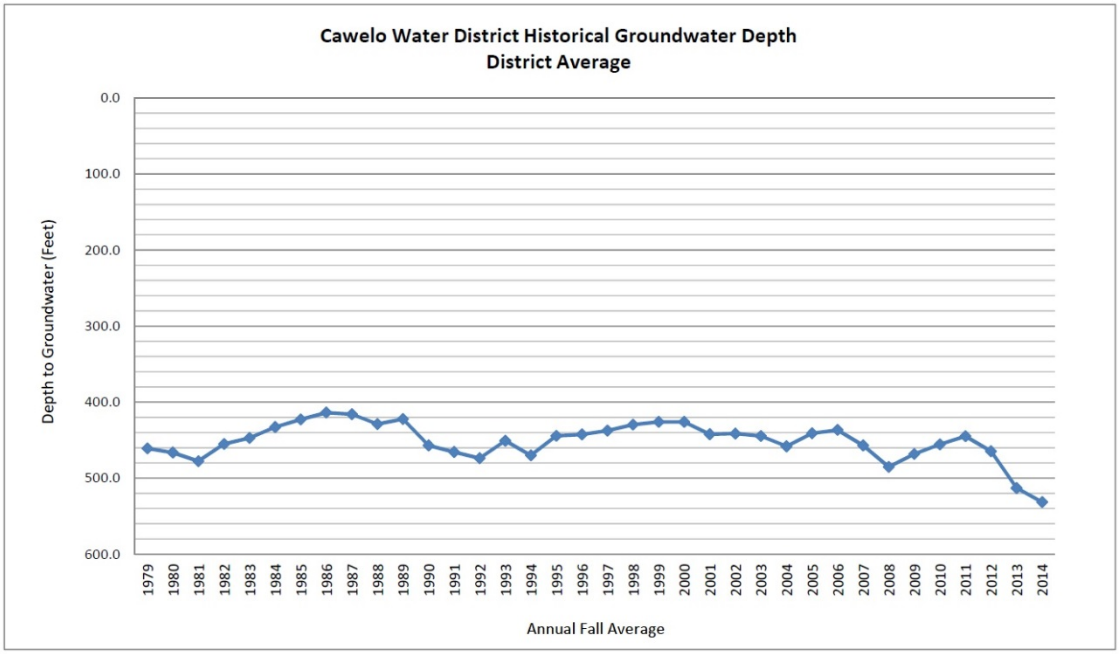
Figure 11 – Historical Annual Fall Average Groundwater Levels, District



For reference, **Figure 12** is provided to present the contours lines of equal depth to groundwater from a decade prior in the Fall of 2004**.**

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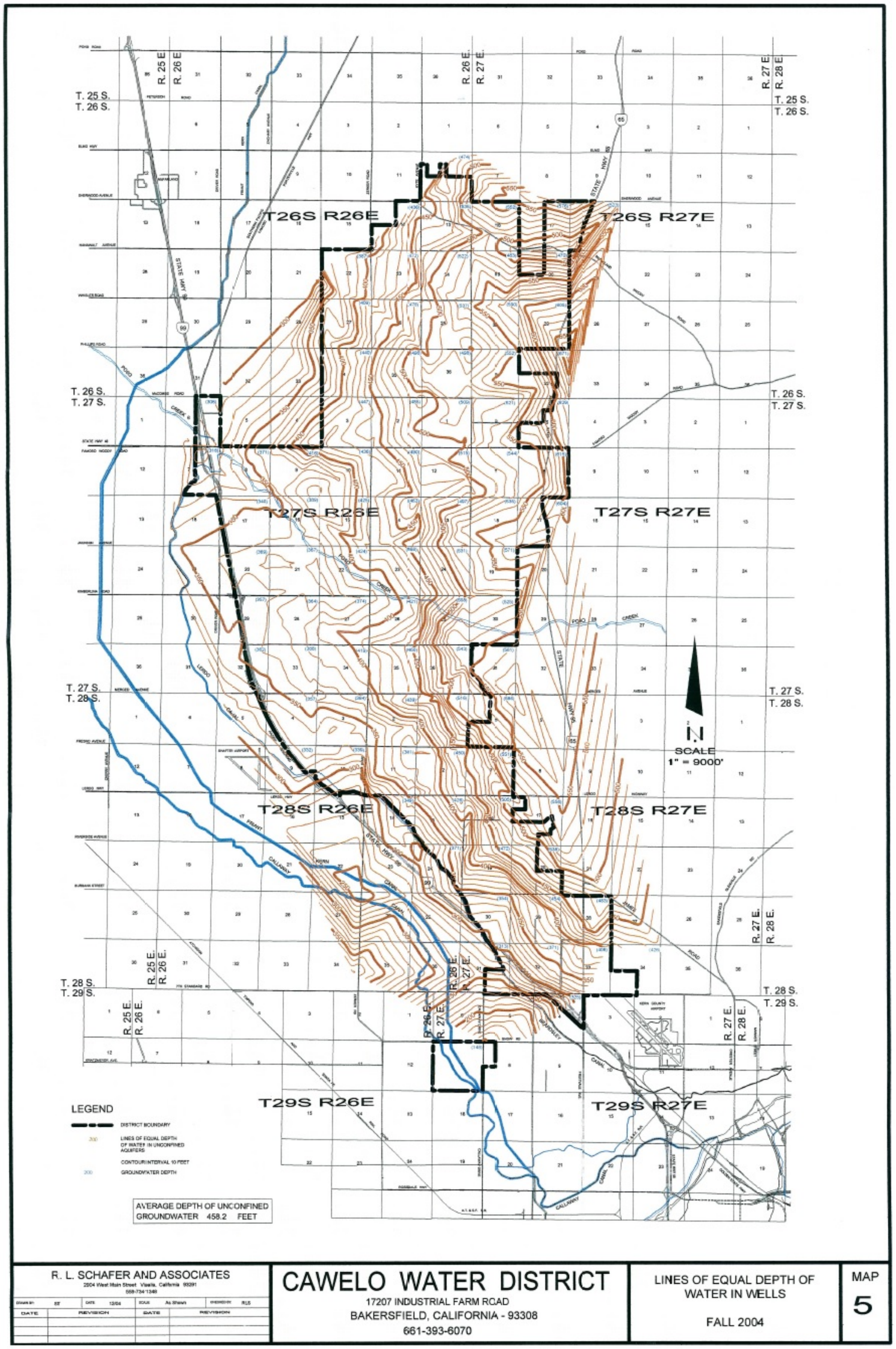
Figure 12 – Lines of Equal Depth, Fall 2014



C. Sources of Water

There are several different water sources that provide surface water to the CWDC area. The Cawelo Water District receives surface water from natural sources in the region, contracted water from State and Federal systems, and oilfield produced waters. When surface water supplies are insufficient to meet agricultural irrigation demands then groundwater is pumped to meet the irrigation requirements.

Poso Creek and the Kern River are natural streams in the Kern Subbasin that provide surface water on an intermittent basis. The Poso Creek channel enters and exits the CWDC area and provides an intermittent source of water from the Poso Creek Watershed. **Figure 6** provides a summary of the historical flows into the CWDC area. The water quality of Poso Creek flows are generally considered good with the Total Dissolved Solids (TDS) range typically within the 120 to 230 mg/L range.

The Cawelo Water Districts has historically participated in water management programs that often bring Kern River water to the area. Kern River water is considered very good quality water generally with TDS levels around 100 mg/L.

Water from the State Water Project can be delivered to the CWDC area from the California State Aqueduct via a series of canals and pumps lifting the water roughly 130 feet in elevation. The Department of Water Resources regularly monitors the water quality at several locations along the Aqueduct. The typical TDS values are on the order of 250 to 350 mg/L.

In years of surplus, the CWDC area benefits from being in the vicinity of the Friant-Kern Canal and can receive Federal water that is typically considered very good quality water. The United States Bureau of Reclamation also conducts routine water quality testing and the TDS values are typically below 100 mg/L.

Under existing Waste Discharge Requirement (WDR) permits, Cawelo Water District is authorized to receive oilfield produced water for irrigation and delivery to groundwater recharge basins. The Typical TDS range for the different oilfield produced waters can range from 400 to 600 mg/L TDS and requires other water sources for blending purposes to meeting agricultural and WDR requirements.

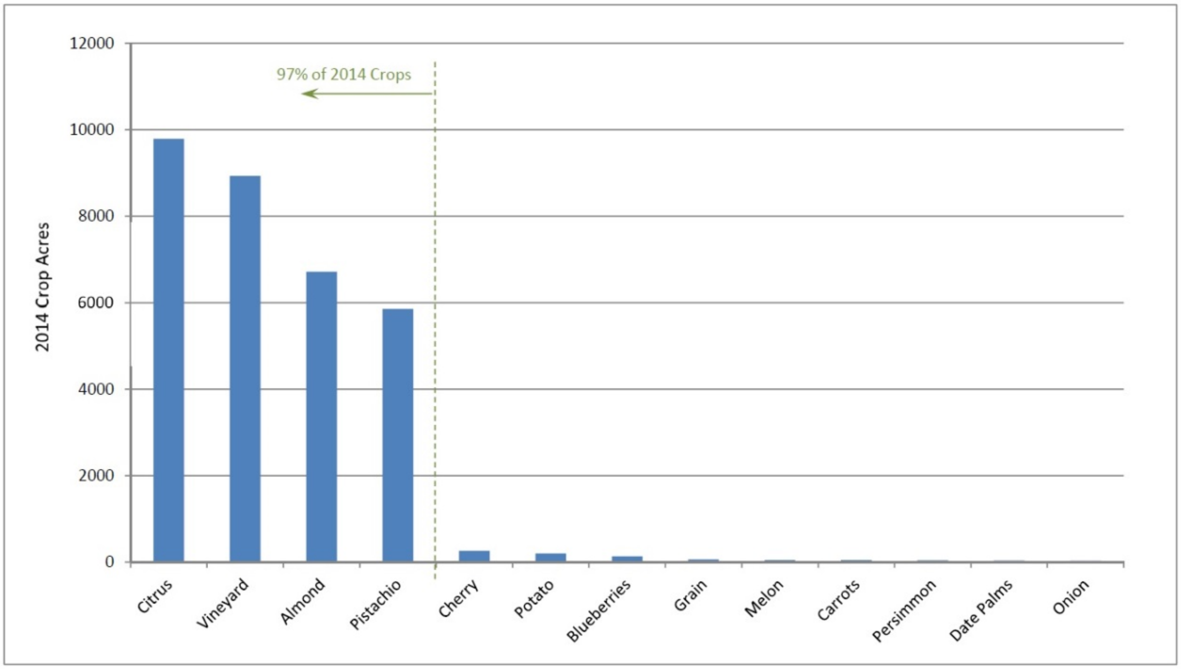
V. LAND USE

A. General Agriculture

The primary land use within the CWDC area is agriculture with approximately 70% of the area being irrigated agriculture in 2014. About 17% of the area is fallow and approximately 5% is used for general commercial purposes. The remaining portions are attributed to residential, roadways, reservoirs and other miscellaneous non-agricultural uses.

The primary crops grown in the CWDC area are the permanent crops citrus, vineyards, almonds and pistachios, and comprise 97% of all the crops grown in the CWDC area in 2014. The crop acres are summarized **in Figure 13**.

Figure 13 – 2014 Crop Acreages



B. Current Land Use

Figure 14 shows the distribution of the primary crops described in the previous section along with the remaining agriculture, industrial, and other non-agricultural land uses.

C. Historical Land Use

Crop survey information for the Cawelo Water District is available dating back to 1979. In 1979, the primary crops were citrus, vineyards, almonds and cotton. Almost 10,000 acres of cotton were planted that year and was the largest single crop. **Figure 15** is a historical crop survey map representing the main agricultural commodities of 1979. The brown shaded areas represent citrus, green represent almonds, red represents vineyards and the blue shaded areas are cotton.

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Ph. (661) 393-6072 Fx. (661) 393-6073

Figure 14 – 2014 Crop Survey

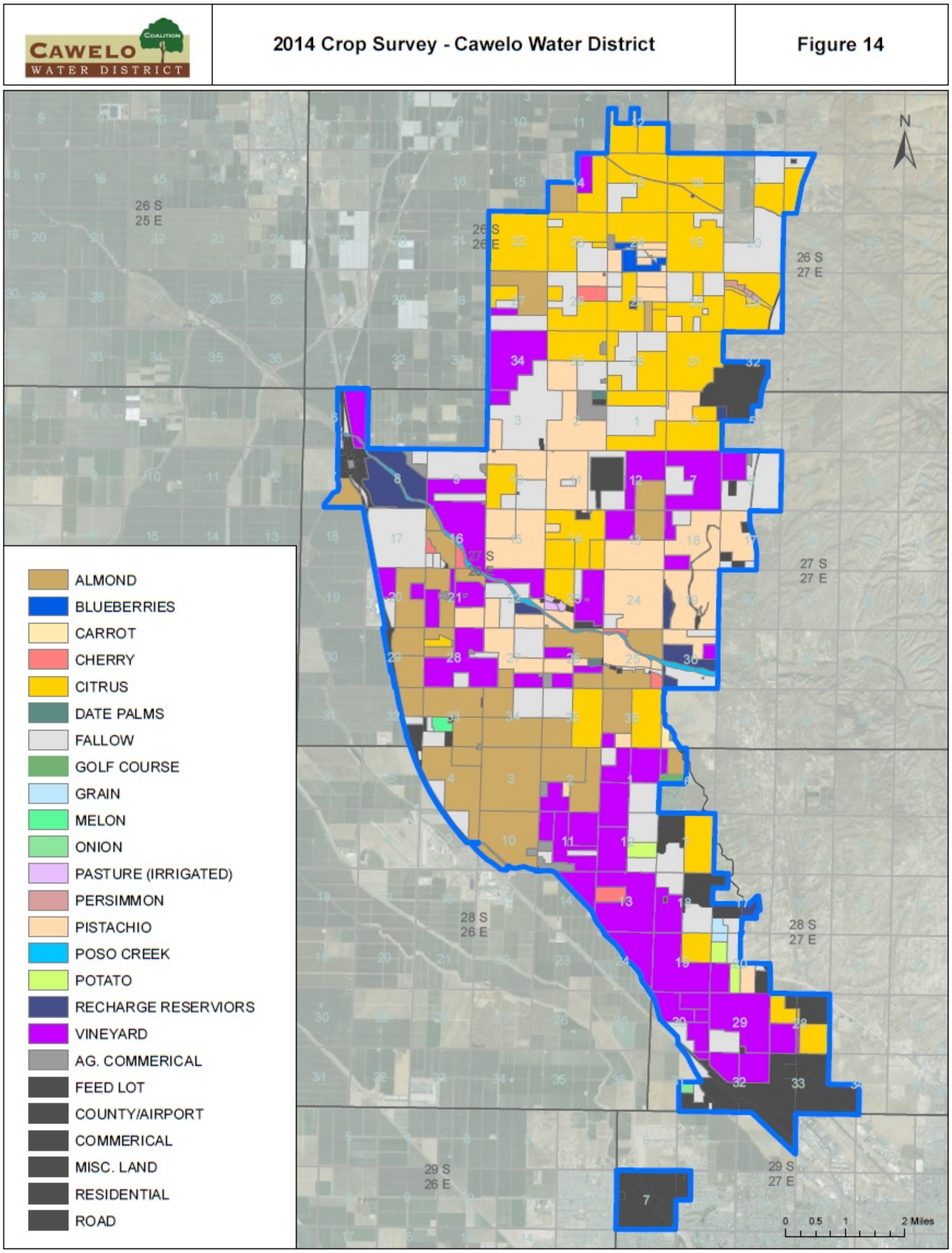

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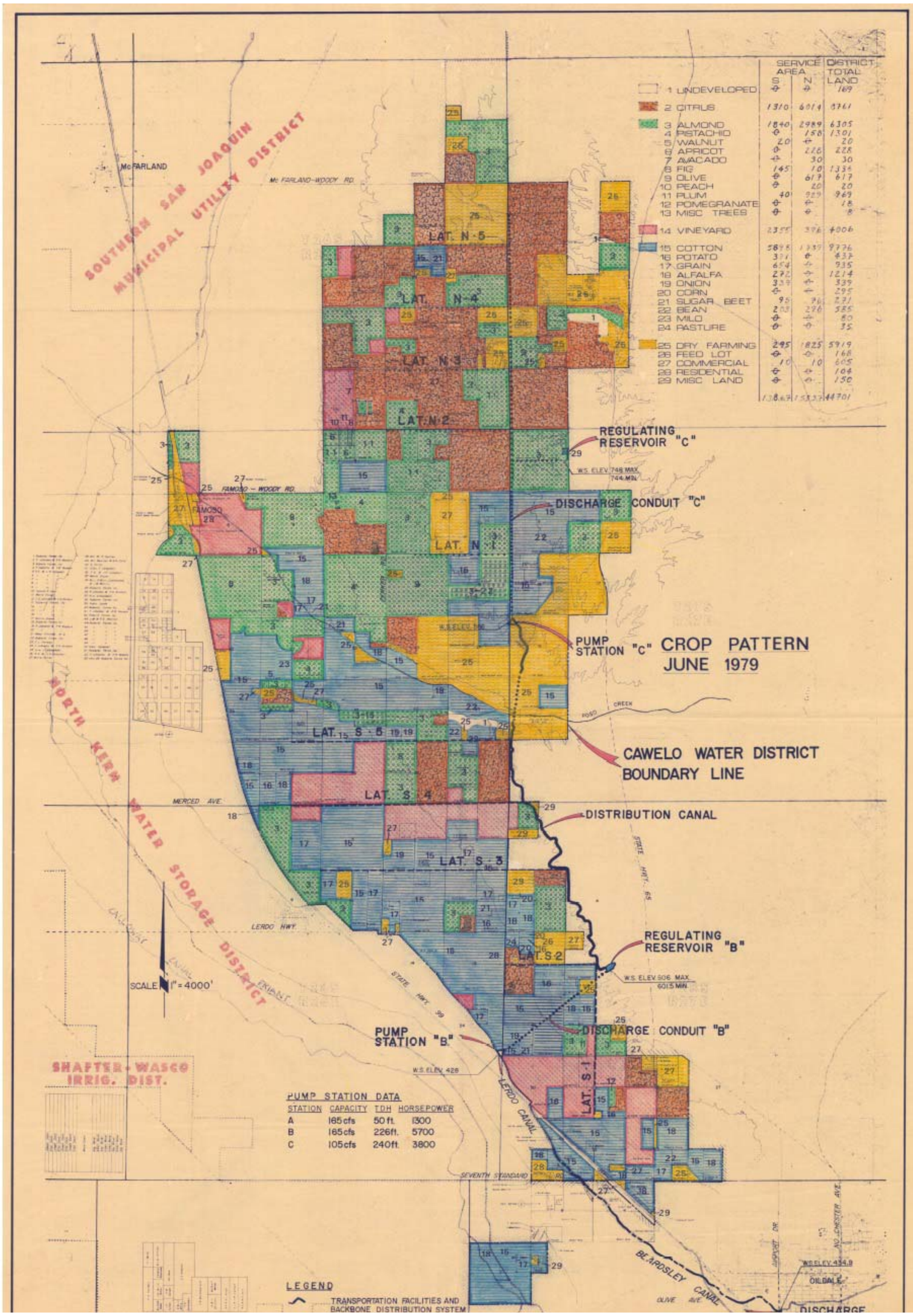
Figure 15 – Crop Pattern, 1979



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Since 1979, the citrus acreage has increased approximately by 20% and the almonds have remained relatively consistent for over three decades. In the following 5 to 8 years after 1979, cotton saw a sharp decline in total acreage which corresponds to the rapid increase of grapes in the same general time period. Cotton completely disappeared from the District in 1997 with minor acreage showing up again in 2002 and has been absent in the following years. Pistachios began to see a steady increase since 1979 and maintained that rate into recent years, increasing the total acreage by over 70%. Within 7 years, vineyards increased by over 60% and then saw minor relative changes in the total number of acres. **Figure 16, Figure 17, Figure 18, Figure 19** and **Figure 20** summarizes the annual crop acres for each of the crops discussed.

Figure 16 – Historical Citrus Crop Acreage

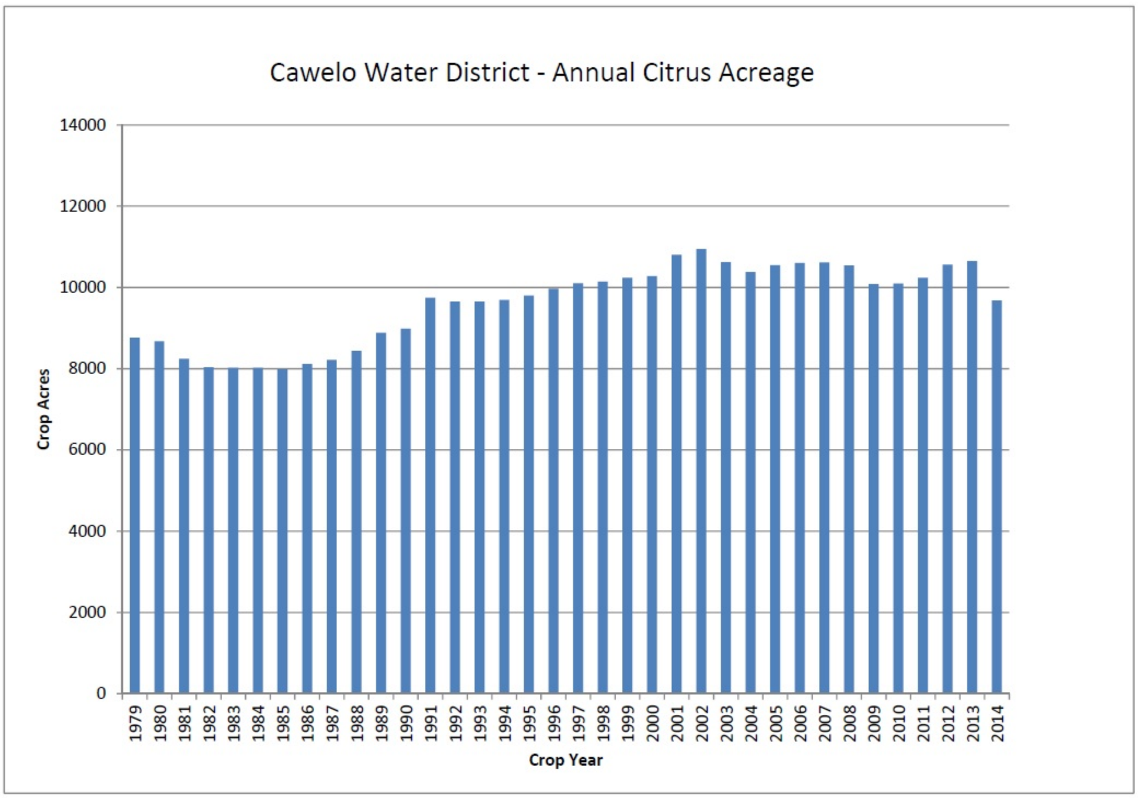

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Figure 17 – Historical Almond Crop Acreage

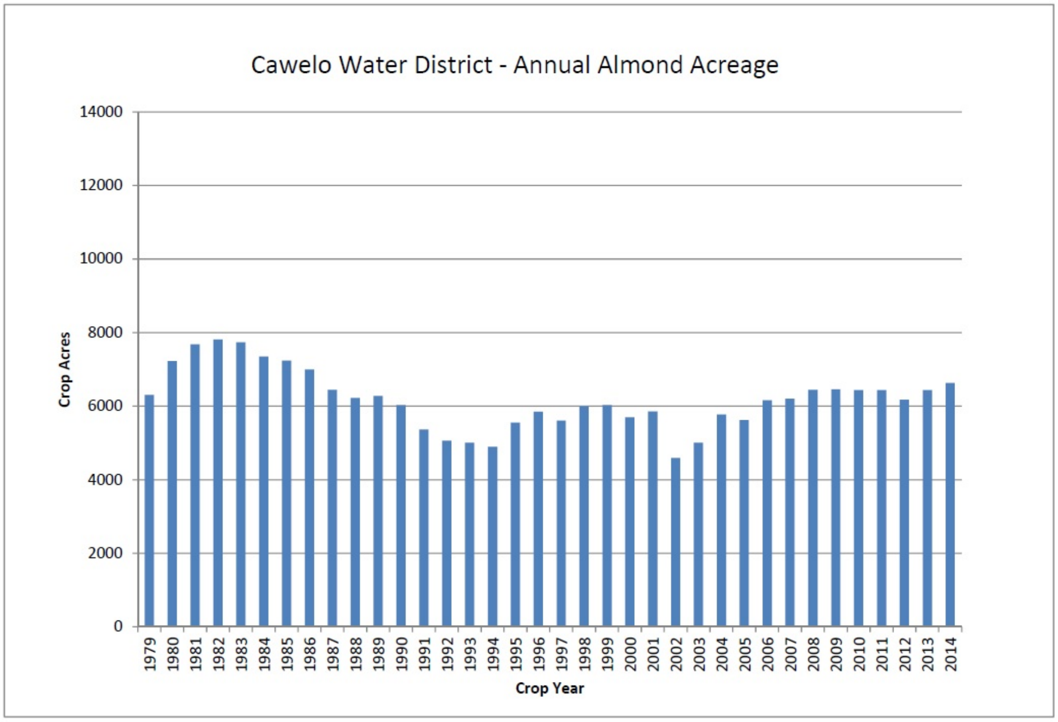

Figure 18 – Historical Cotton Crop Acreage

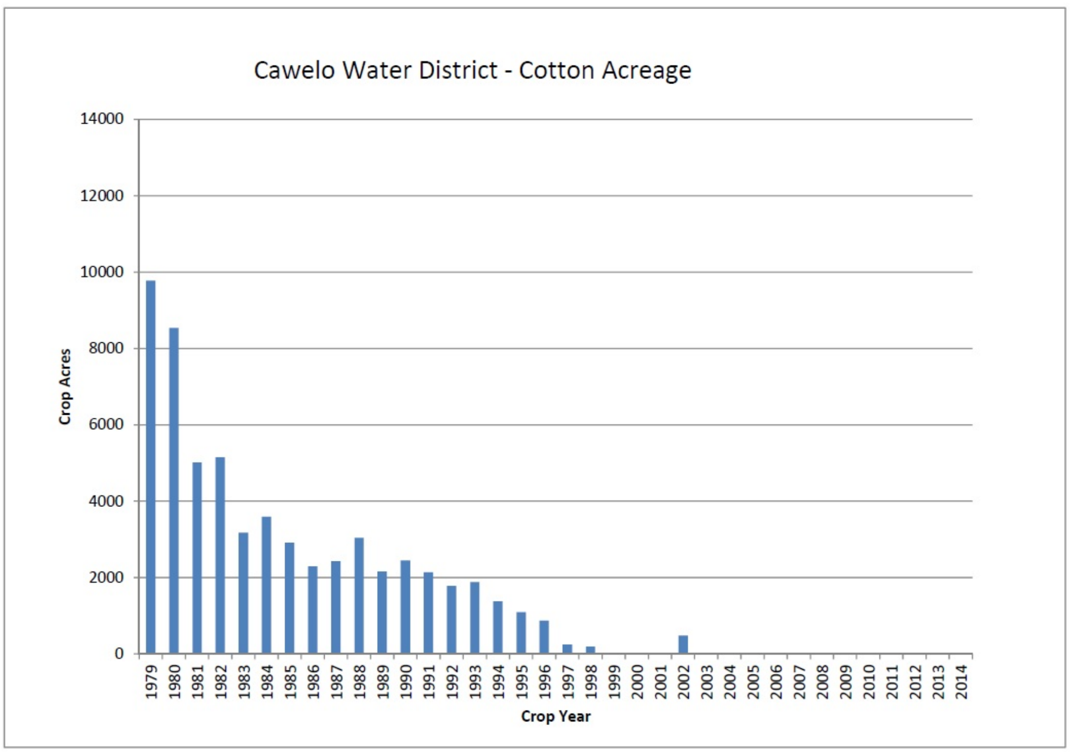

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Figure 19 – Historical Pistachio Crop Acreage

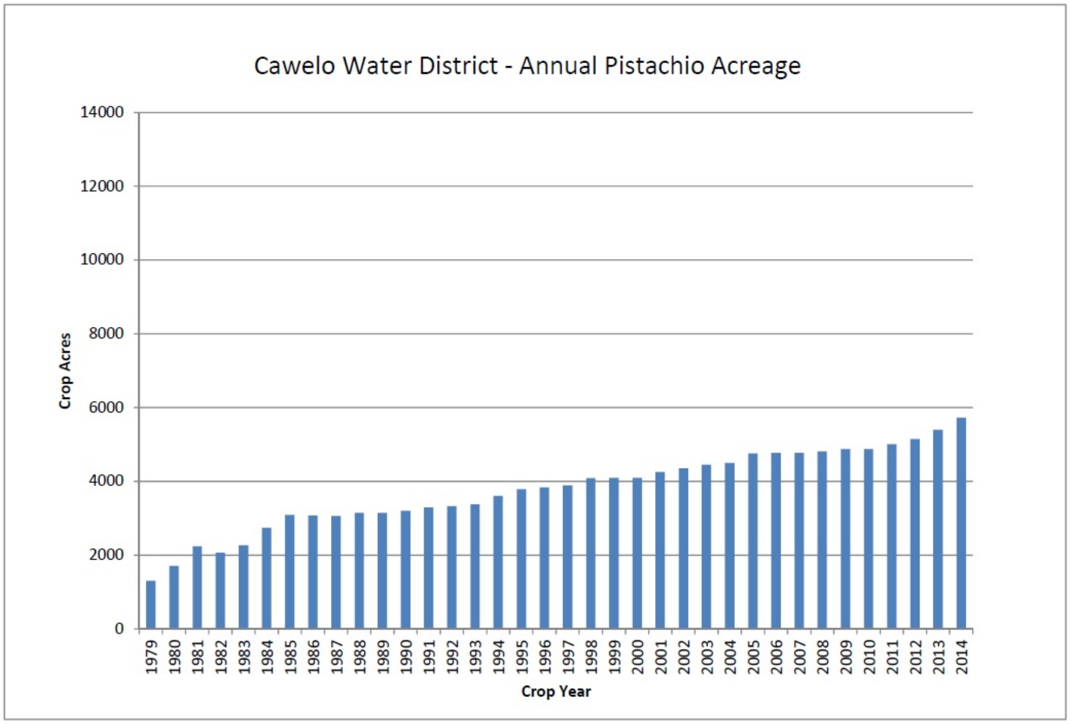
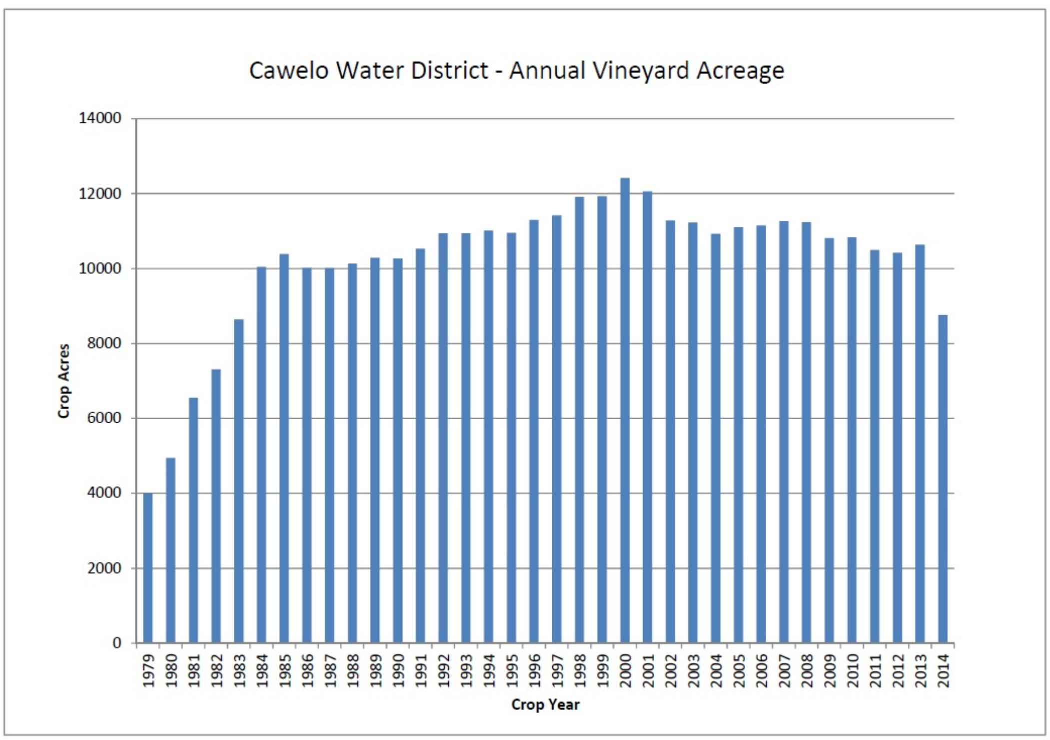


Figure 20 – Historical Vineyard Crop Acreage



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D. Soil Amendments Associated with Crops

Due to the location of the District, the cost to irrigate crops is relatively expensive largely due to the need to pump surface water uphill for delivery to District farmers. The District does not have Kern River water rights and Poso creek provides very little water that can be utilized to meet irrigation demands. Additionally, groundwater levels are relatively deep as compared to most areas in the Kern Subbasin and therefore pumping costs are higher.

The economic factors affecting farming in the CWDC area has forced farmers to employ a high level of agricultural management practices that include fertilizer and irrigation practices. The economic impacts are the primary reason cotton was replaced with permanent crops and is no longer grown in this area. Permanent crops with drip or micro-sprinkler systems dominate the area.

Fertigation is a common practice associated with high efficient irrigation systems such and drip and micro-sprinklers and is a process where liquid fertilizers are delivered to the crop mixed with the irrigation water.

Fertilizers are available in many different types for crop applications and commonly include nitrogen, phosphorus, and potassium. Nitrogen application in the agricultural industry is a primary focus of the General Order and nitrogen practices vary between different crops and vary between different growers. Typical nitrogen applications can vary greatly within a single commodity and are dependent on target yields, irrigations systems, and application schedules. Some of the typical annual application ranges for the four primary crops in the CWDC area are: Citrus – 80 to 125 lbs/acre; Almonds – 200 to 275 lbs/acre; Pistachios – 125 to 150 lbs/acre; and Vineyards – 30 to 50 lbs/acre.

VI. IRRIGATION PRACTICES

The District provides irrigation water to farmers by means of a distribution system that includes a manmade surface channel, several reservoirs, and numerous pumps to move the water around the district and to pressurize an underground network of pipelines that deliver water directly to farmer turnouts.

Nearly all growers in the CWDC area utilize a pressurized irrigation system, typically drip or micro-sprinkler, to irrigate their crops. There are few areas that use flood or row irrigation methods which total approximately 1% of all CWDC irrigation systems.

A. Current Irrigation Practices

Figure 21 presents the irrigations systems used throughout the CWDC area in 2014.

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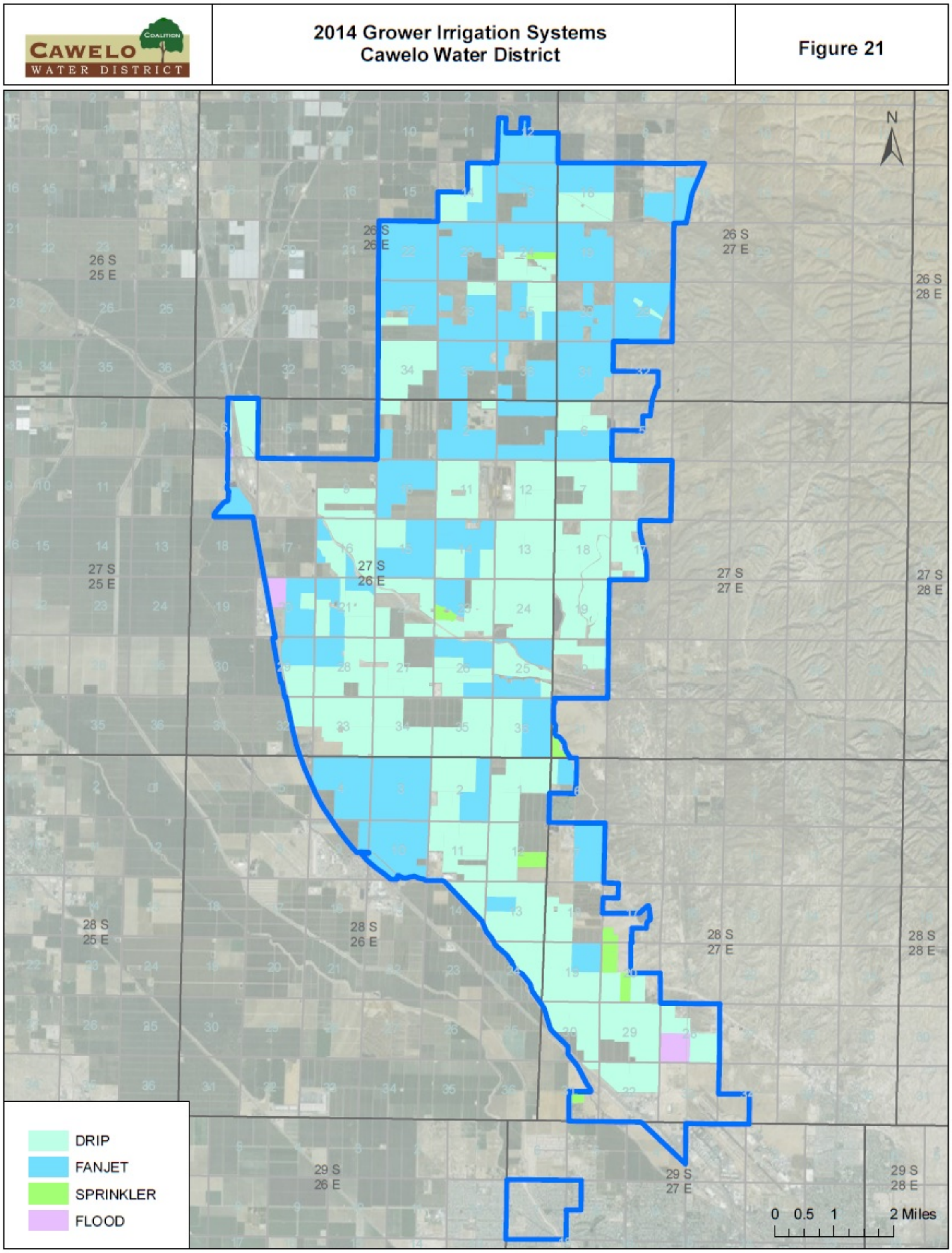
Figure 21 – On-Farm Irrigation Systems



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B. Historical Irrigation Practices

In 1979 cotton was planted more than any other single crop that year and row irrigation was prominent and the typical irrigation practice, along with flood irrigation, for the remaining growers in the moderately flat areas. Areas of the District in the northeast that are rolling hills and low level foothills required higher efficiency irrigations systems because flood and row irrigation was not feasible. Approximately 60-67% of the District was flood or row irrigated in 1979.

In the late 80’s and early 90’s, the cost of irrigation water was significantly increasing and impacting farming operations. The economics of that period drove growers away from cotton and other row or flood irrigated crops to the high value permanent crops that warranted investments in efficient irrigation systems.

VII. GROUNDWATER RECHARGE

A. General Groundwater Recharge

Groundwater recharge in the CWDC area comes from several different sources with varying water qualities. Natural recharge occurs when there are flows present in Poso Creek or during periods of significant precipitation. Groundwater recharge also occurs from agricultural irrigation that percolates past the root zone. Additionally, the Famoso Groundwater Banking Project was developed to capture or store surplus surface water in wet years and percolate the water using holding ponds.

B. Poso Creek

The Poso Creek channel within the CWDC area is comprised of sandy soils and water seepage occurs at a high rate when flows are present in the channel. Flows that contribute to significant groundwater recharge are present roughly every 5 out of 10 years, generally no more than a few months within a single year. The annual average of water losses in this section of the channel is approximately 7800 which is attributed to seepage and evaporation losses.

C. Irrigation Return Flows

The agricultural irrigation return flows occur when excess water is applied beyond the needs and evapotranspiration rates of the crop. Water that percolates beyond the roots zone passing thorough the vadose zone and reaching the saturated zone is considered the return water. Irrigation systems for the primary crops in the CWDC are some of the most efficient systems available for agricultural irrigation. Drip and micro irrigation efficiencies are 90% or better for almonds, vineyards and citrus (Kimmelshue and Tillman, 2013). In the CWDC area, roughly 15,000 acre-feet of irrigation water is returned to the aquifer per year.

D. Groundwater Recharge Basins

The CWDC area has 2 different recharge basins for water percolation, the Famoso Groundwater Basins and the Poso Creek Basin. They are both located adjacent to Poso Creek and are utilized when surplus water is available to the District. They are specifically designed to pool water at the

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surface, create conditions for percolation to occur and were constructed in areas where soils have high percolation rates. Over the last 13 years, an average of approximately 5800 acre-feet per year of water have been delivered to the basins.

VIII. EXISTING GROUNDWATER MONITORING

The District conducts a groundwater monitoring programs to satisfy the requirements of previously existing WDR permits that authorize the District to receive oilfield produced waters for the purposes of irrigation and groundwater recharge. Water samples are annually collected from designated wells and analyzed for typical constituents of concern including nitrates, salinity, and arsenic. This information is compiled and reported to the Regional Board per the requirements of the WDR's.

Additionally, groundwater level measurements are taken from anywhere from 150 to 250 different wells to monitor groundwater levels.

IX. GROUNDWATER QUALITY

The focus of this groundwater quality assessment is primarily on the Nitrate (NO3) constituent with a review and evaluation of the Electrical Conductivity (EC) in the same area. Nitrate and Electrical Conductivity levels in groundwater can be affected by natural sources but have been identified as parameters that may indicate potential impacts from irrigated agriculture.

A. Sources of Ground Water Quality Data

Publicly available groundwater data was obtained from the State Water Resources Control Board's Groundwater Ambient Monitoring and Assessment Program (GAMA). The GAMA database includes data from the California Department of Public Health, California Department of Pesticides Regulation, USGS GAMA Priority Basin and GAMA Domestic Wells.

Other data sources include the Kern County Water Agency and Cawelo Water District groundwater monitoring data.

There are no dairies or shallow groundwater levels in the CWDC area so data for either condition was not available for the purposes of this groundwater assessment.

B. Constituent Prioritization

As noted earlier, Nitrates are the primary focus along with a review of the Electrical Conductivity for the groundwater quality assessment in the CWDC area. The Regional Board has demonstrated concern for all constituents that have the potential to degrade groundwater quality but have placed a priority on nitrates. Nitrates will provide the foundation for groundwater quality assessment with an evaluation of Electrical Conductivity to supplement the Nitrate information and to assist with prioritization of the high vulnerability area.

C. Groundwater Quality Data

Groundwater quality data was obtained either in GIS shapefile format or in database format to create a GIS shapefile. The nitrate data points for each well, from each data set, were spatially located within the CWDC area boundary. All available data was considered for this assessment including wells with water quality analysis performed over 30 years ago. Additionally, the maximum known value of nitrate for each well source was used for GIS mapping purposes. The

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date of the sampling events, number of sampling events, trends and vicinity to other well data locations will be considered in the assessment of the groundwater quality and determination of high vulnerability areas.

Individual maps were created to display nitrate data from each data source and a map that combines all the well data points for nitrates. Please see **Figure 22, Figure 23, Figure 24, Figure 25** and **Figure 26.**

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Figure 22 – GAMA Data, Nitrate Levels

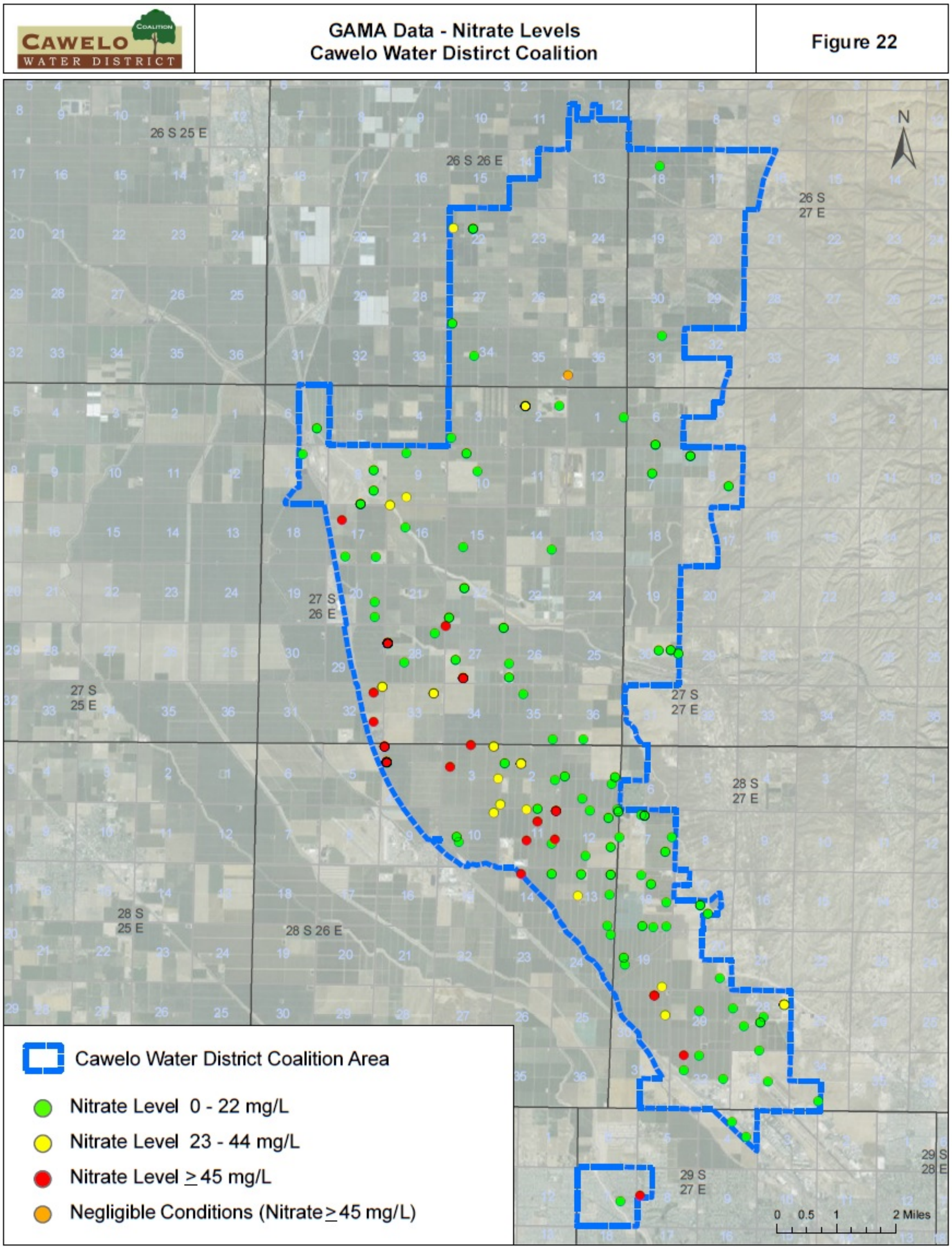

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Figure 23 – KCWA Data, Nitrate Levels

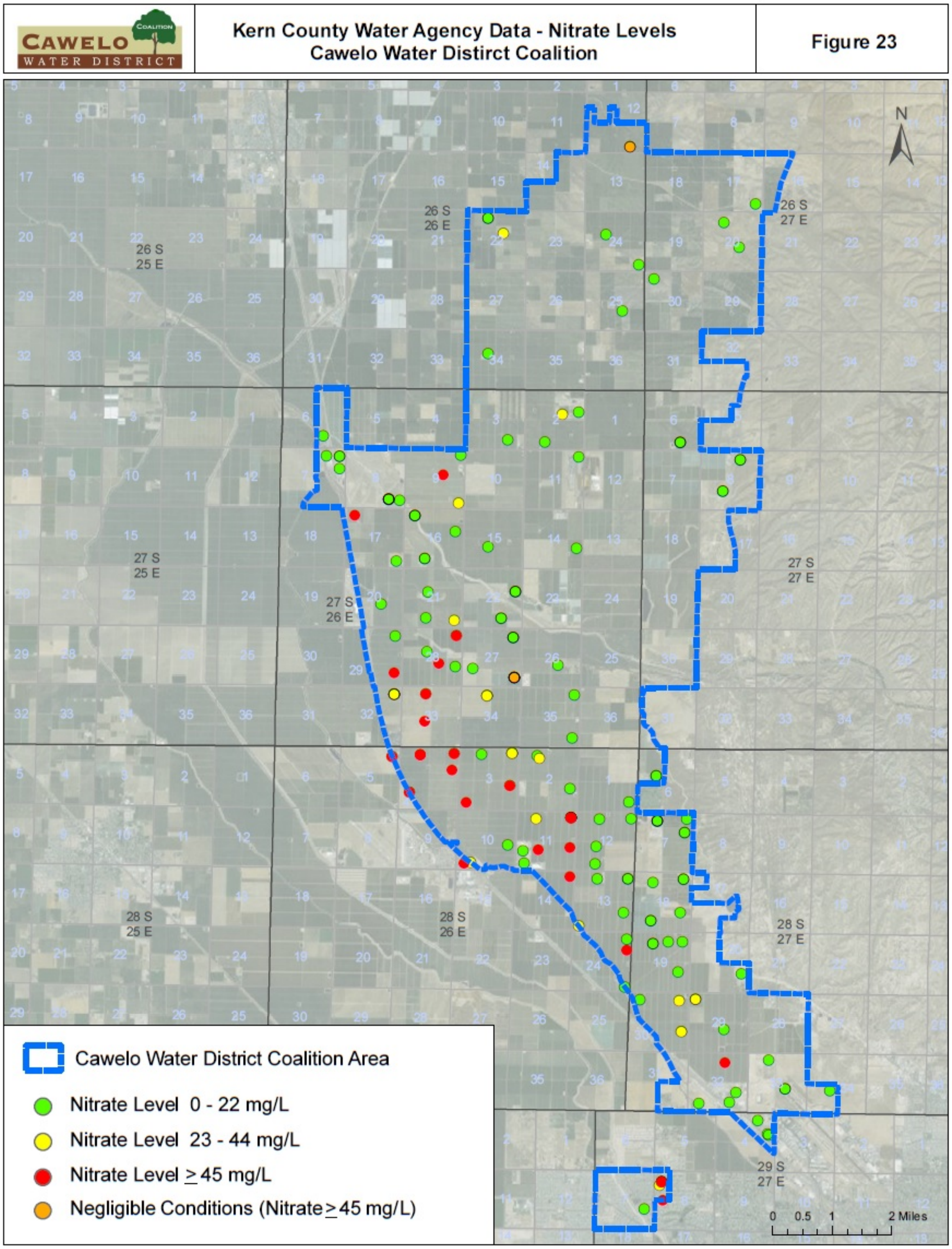

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Figure 24 – Famoso Basin Data, Nitrate Levels

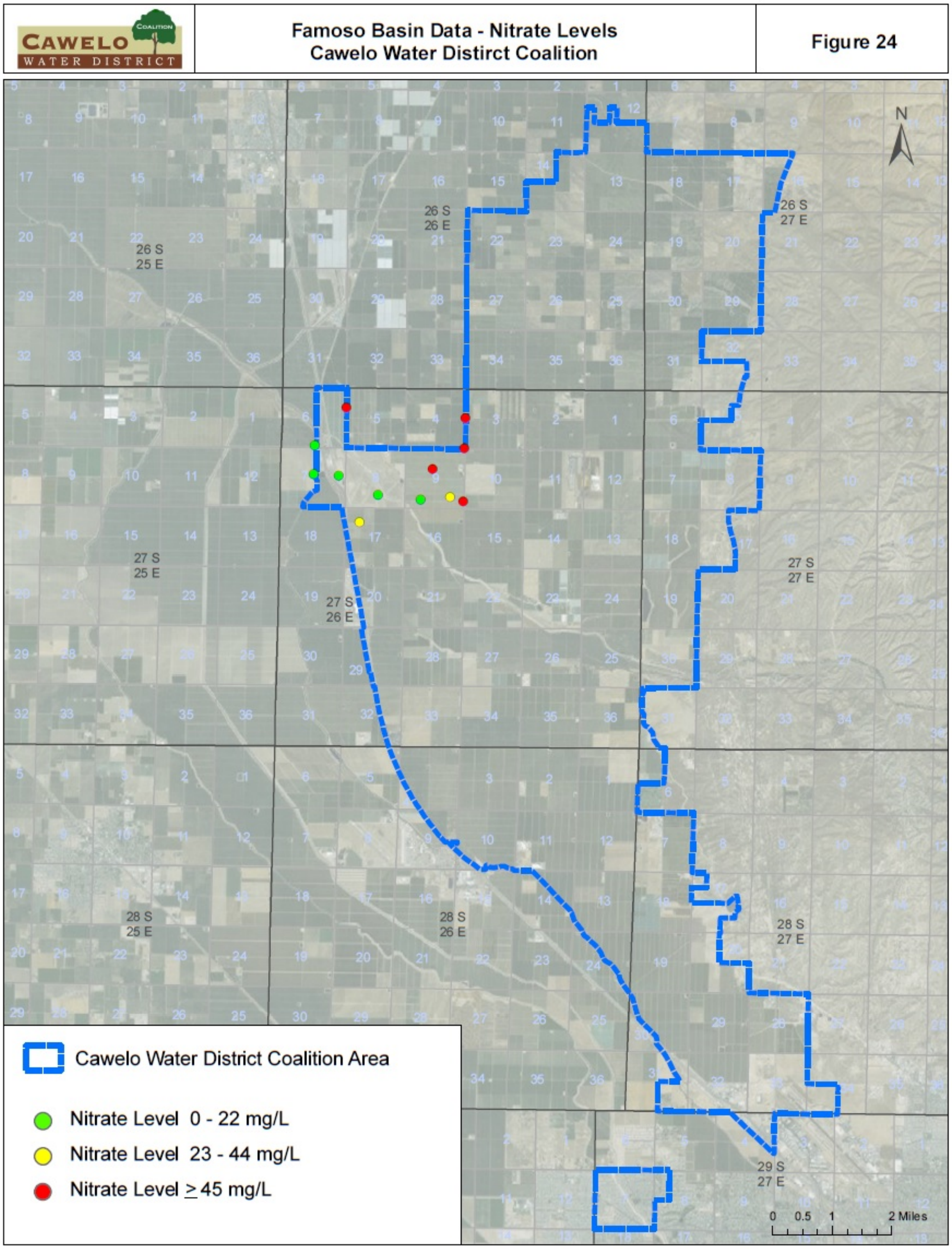

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Figure 25 – WDR Well Study Data, Nitrate Levels

CAWELO WATER DISTRICT COALITION	WDR Well Study Data - Nitrate Levels Cawelo Water Distirct Coalition	Figure 25

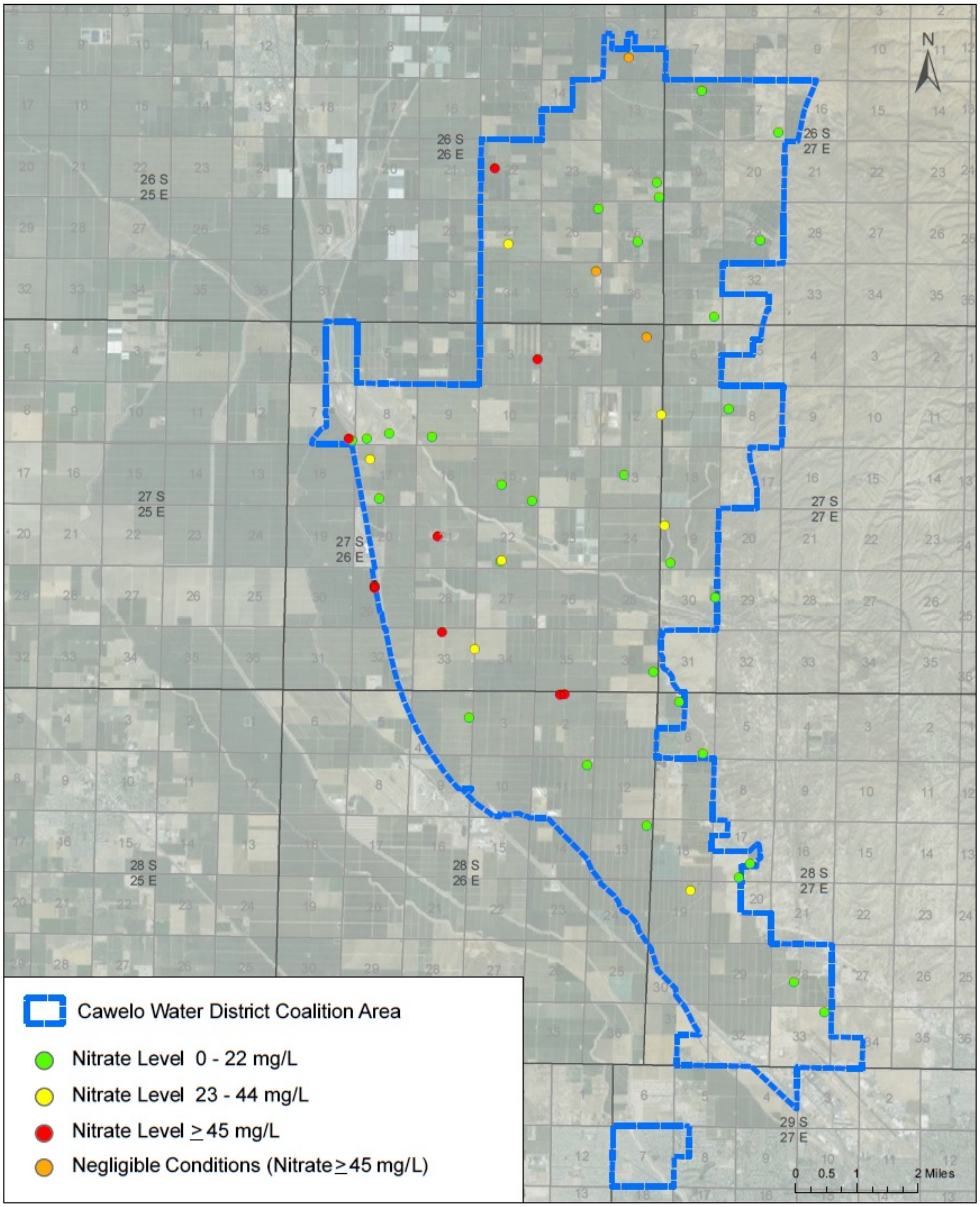

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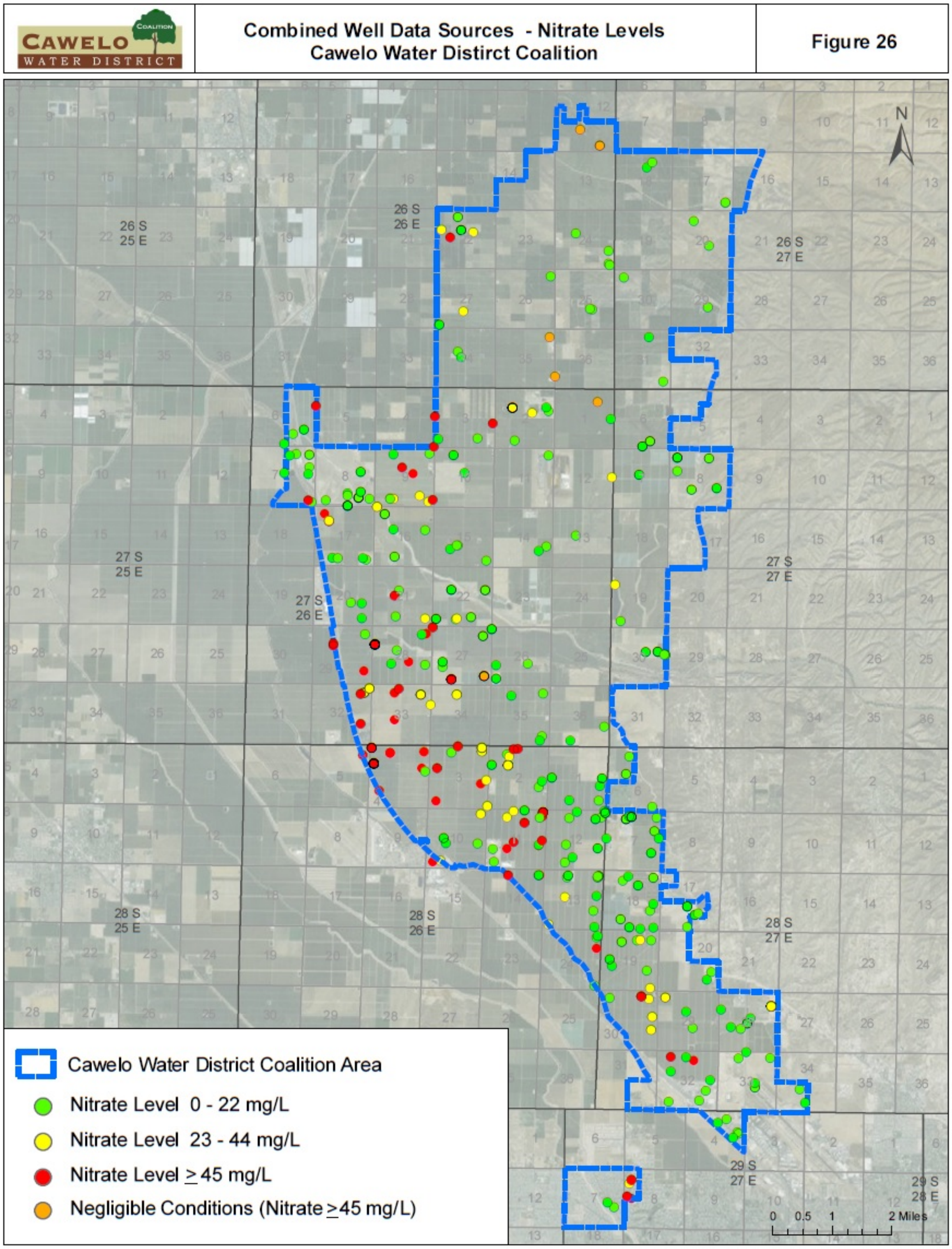
Figure 26 – All Well Data, Nitrate Levels



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The Electrical Conductivity data was obtained from the same GAMA data source and mapped along with the data available from the WDR Well Study and Famoso Basin data set. **Figure 27** provides representation of the well data points and the corresponding average Electrical Conductivities.

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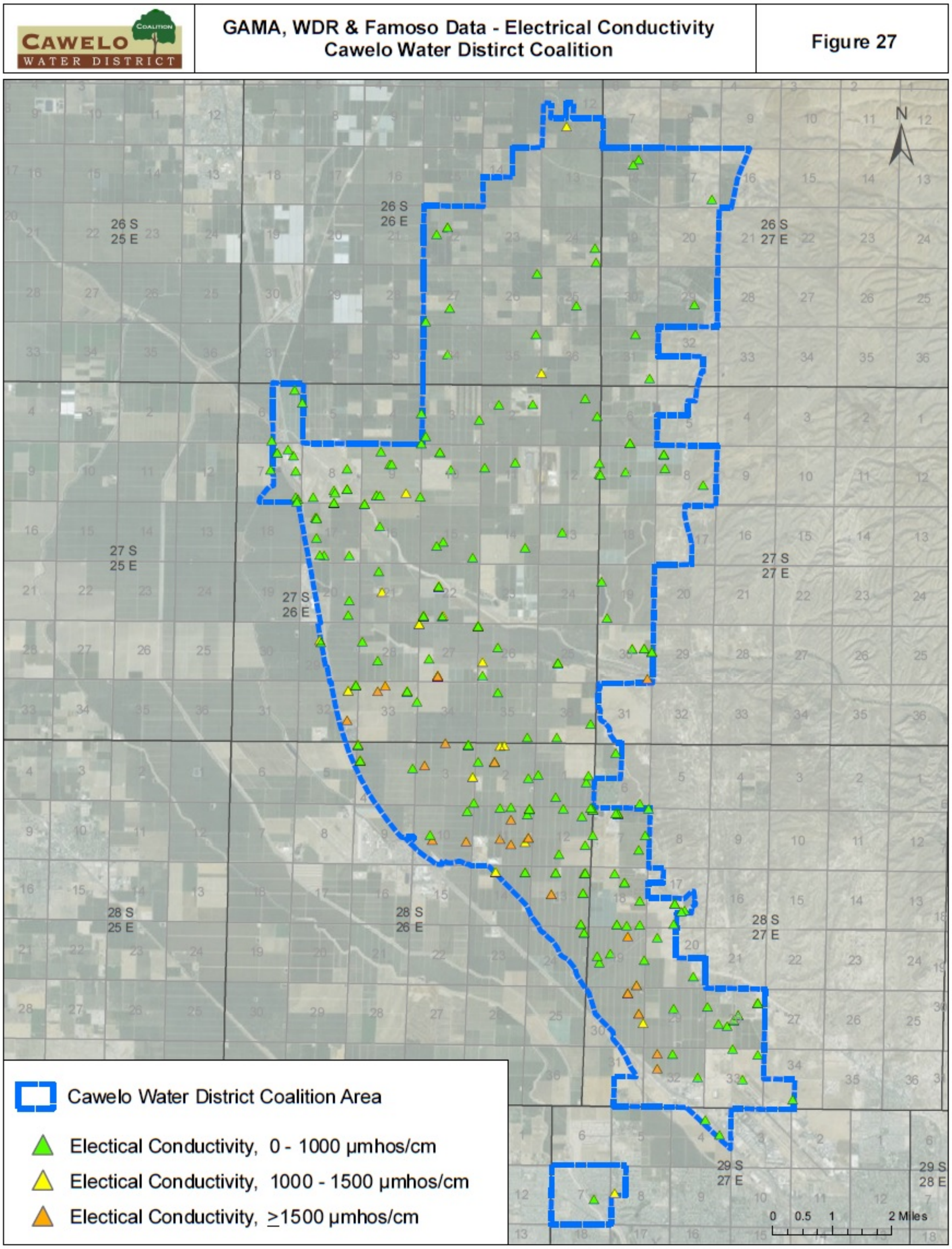
Figure 27 – Electrical Conductivity in the CWDC Area



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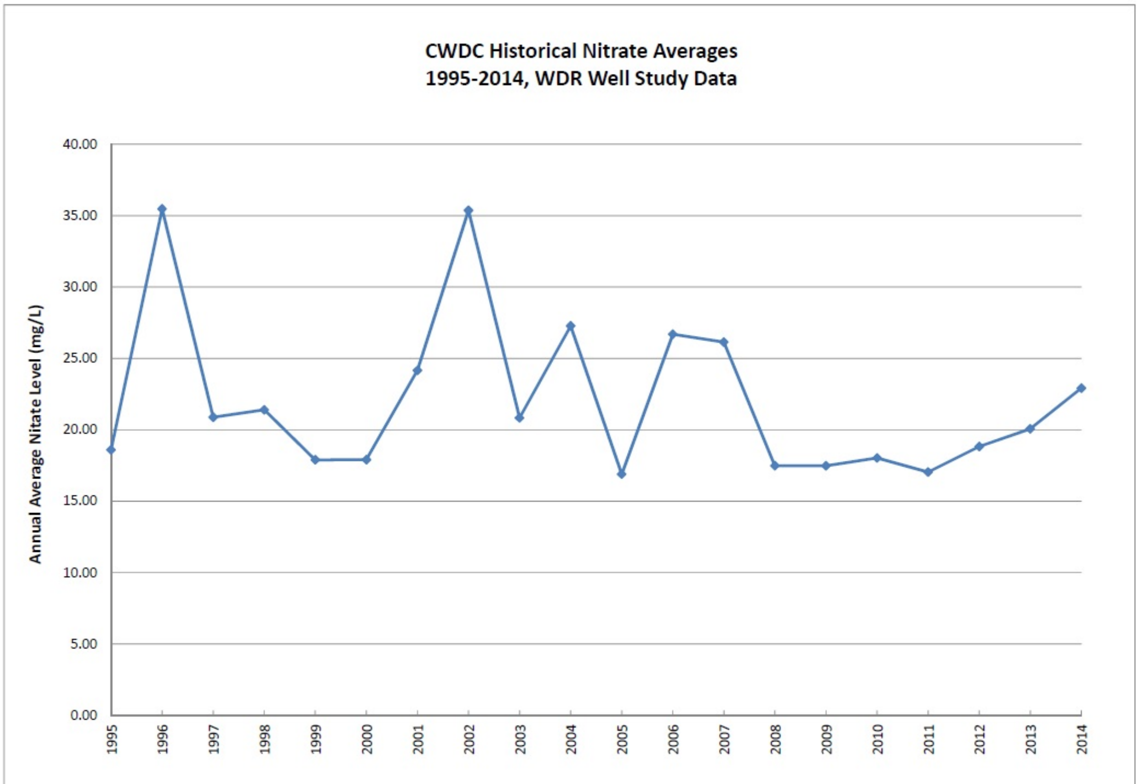
D. Historical Trends

The WDR Well Study data set was used to express the historical trend of nitrates in groundwater in the CWDC area. This data set provides data covering nearly a 20 year period and approximately 50 different wells were used to calculate the overall annual nitrate averages. **Figure HT** indicates a neutral trend over a period of 20 years for the CWDC area.

Figure HT – CWDC Historical Nitrate Averages, 1995-2014



X. DATA REVIEW AND ANALYSIS

The focus of the groundwater quality assessment is primarily on the NO3 constituent with a review and evaluation of the Electrical Conductivity (EC) in the same study area. Nitrate and Electrical Conductivity levels in groundwater can be affected by natural sources but have been identified as parameters that may indicate potential impacts from irrigated agriculture.

The Regional Board has expressed concern for all constituents that have the potential to degrade groundwater quality but have placed a priority on nitrates. Nitrates will provide the foundation for the groundwater quality assessment along with an evaluation of Electrical Conductivity to supplement the water quality assessment and help determine prioritization of the high vulnerability areas.

In addition to NO3 and EC, additional parameters will also be considered as part of the groundwater quality assessment.

A. Methodology and Rationale for Determining High Vulnerability Areas

1. Approach

GIS tools were utilized to create two-dimensional maps of available, applicable and relevant data and then applied in an overlay approach to designate the high vulnerability areas. The significance of the maps and data points was weighted according to their significance and impact to the overall goals of the GAR. The primary map layer or base layer is the map created to describe the locations of the available groundwater nitrate data and categorizes the reported nitrate levels into 4 different categories:

- Reported NO3 levels up to 22 mg/L
- Reported NO3 levels between 23 and 44 mg/L
- Reported NO3 levels at 45 mg/L or above
- Reported NO3 levels at 45 mg/L or above with qualifying conditions

The mapped data provided a process to evaluate measured nitrate levels at their corresponding locations within the CWDC area and to determine regional or localized trends of nitrate levels in the groundwater. Generally, applicable nitrate data location that indicated a well that had a NO3 exceedance of the Maximum Contaminant Limit (MCL) of 45 mg/L were designated to be a high vulnerability area.

The remaining maps were applied as supplemental data to the base layer and provided additional information to further evaluate NO3 data and to support the final high vulnerability designations. Additionally the supplemental maps provided a basis for prioritization of the high vulnerability areas for Groundwater Quality Management Plans, the Management Practices Evaluation Program and the Groundwater Quality Trend Monitoring Program. The supplemental maps, including non-GIS formatted maps, include data for Urban or DAC areas, EC, groundwater levels, soil characteristics and irrigation and nutrient practices.

The rationale for designating applicable wells with known nitrates exceedances as high vulnerability area is supported and justified by the priority placed on groundwater quality concerns regarding nitrates. Other parameters and conditions considered in this report were applied to refine the final designated high vulnerability areas but primarily the wells with known nitrate MCL exceedances defined the designated area.

Several different options were considered to define the boundary lines for the high vulnerability areas such as using the Township and Range sections or creating freeform boundary lines similar to contour lines. Ultimately, all methods to establish a boundary would effectively resolve to the parcel level. Regardless of the defined boundary, and due to typical farming units that operate over entire county defined parcels, any parcel which the boundary line crossed or overlapped would be considered high vulnerability area and therefore ultimately establishes the high vulnerability boundary at a parcel boundary.

Due to this inherent process of boundary lines resolving to the parcel level, the boundary edge of the high vulnerability areas were established along existing parcel boundaries.

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2. Water Quality Objects

The General Order states that the water quality objective for NO3 is 45 mg/L in the Tulare Lake Basin area and for the purposes of this report, a MCL of 45 mg/L was the threshold to identify wells that have NO3 impacted water.

The water quality objectives for EC are not numerical and a narrative objective is provided in the Water Quality Control Plan for the Tulare Lake Basin. For the purposes of this report, EC levels are classified into three different categories:

- EC levels up to 1000 µmhos/cm
- EC levels between 1000 and 1500 µmhos/cm
- EC levels above 1500 µmhos/cm

3. Water Quality Levels

When considering maximum recorded NO3 levels for each well and combining well data from each data source, there are a total of:

- 209 wells with maximum NO_3 levels at 22 mg/L or below (green dots)
- 40 wells with maximum NO_3 levels between 23 and 44 mg/L (yellow dots)
- 54 wells with maximum NO_3 levels at or above 45mg/L (red dots)
- 6 wells with maximum NO_3 levels above 45mg/L with qualifying conditions (orange dots)

4. Depth to Groundwater

Figure 7 provides information regarding the depth to groundwater throughout the CWDC area in 2014. Generally, the depth to groundwater was approximately 400 feet on the western edge of the CWDC area and deepens to roughly 600 feet below ground along the eastern edge. Average depths vary from year to year depending on the regional hydrology and averages can range from 300 to 400 feet on the western side and 500 to 600 feet in the eastern area.

Depth to groundwater is a significant factor when considering potential water quality impacts from agricultural activities on the surface. Percolation rates through the vadose zone can vary due to soil type and conditions. There are no known deep vadose zone percolation studies done in the CWDC area but in a study conducted at a site with detailed geological, chemical and hydrological properties typical for the alluvian fans of the eastern San Joaquin Valley, transport of nitrates associated with low irrigation efficiencies were determined to travel through the vadose zone at an approximate rate of 14.8 feet per year and higher irrigation efficiencies would result in significantly longer travel time (Botros, 2012). Under low irrigation efficiency senarios, transport of nitrates applied at the surface could take over 20 years to reach the saturated zone in the western areas of CWDC. With high efficiency irrigations systems, such as those used in the CWDC area, it may take over 30 years to reach the aquifer in most areas of the CWDC.

Under conditions of multi decade transportation times, groundwater tables over several hundred feet deep and efficient irrigation systems, the potential impacts from current agricultural practices on the surface will not be evident in the underlying groundwater for a minimum of 20 to 30 years. The current groundwater qualities in the CWDC area cannot be

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directly attributed to current agricultural practices. Other potential pathways for groundwater contamination or impacts, such as improperly equipped or abandoned wells, should be evaluated, however, discussions regarding the depth to groundwater are considered separate issues.

Clearly the potential transportation time for nitrates to reach the saturated zone should be considered for a groundwater quality assessment and designation of high vulnerability areas. What is not clear are what impacts the agricultural activities may have when considering nitrate storage or loading in the root or vadose zones, denitrification, or other factors that ultimately all influence the groundwater quality. For the purposes of this report, the depth to groundwater was considered and supplemental to the well nitrate level data in determining the high vulnerability areas and prioritization.

5. Soil Type

Soil information was downloaded from the USDA, NRCS Web Soil Survey and a map of the detailed soil types are provided in **Figure 4**.

The soil types in the CWDC area can be grouped into 6 different categories according to soil permeability as described by the NRCS Soil Survey Map Unit Descriptions. As described in **Table 3,** approximately two-thirds of the CWDC area has moderately slow soil permeability and less than a quarter is considered moderately rapid or rapid. The predominate permeability description in the region north of Poso Creek is moderately slow and areas of increased permeability rates generally are located along creek channels and in the areas south of Poso Creek. The locations of the soil permeability types are described in **Figure 29**.

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Table 3 – Soil Permeability Distribution, CWDC

Soil Permeability Distribution, CWDC		
Permeability Description	**Acres**	**% of CWDC**
Slow	164	0.4%
Moderately Slow	30,989	67.1%
Moderate	1,786	3.9%
Moderately Rapid	10,811	23.4%
Moderately Rapid (Surface), Slow (Lower Cemented Layer)	2,036	4.4%
Rapid	395	0.9%
Total	46,181	100%

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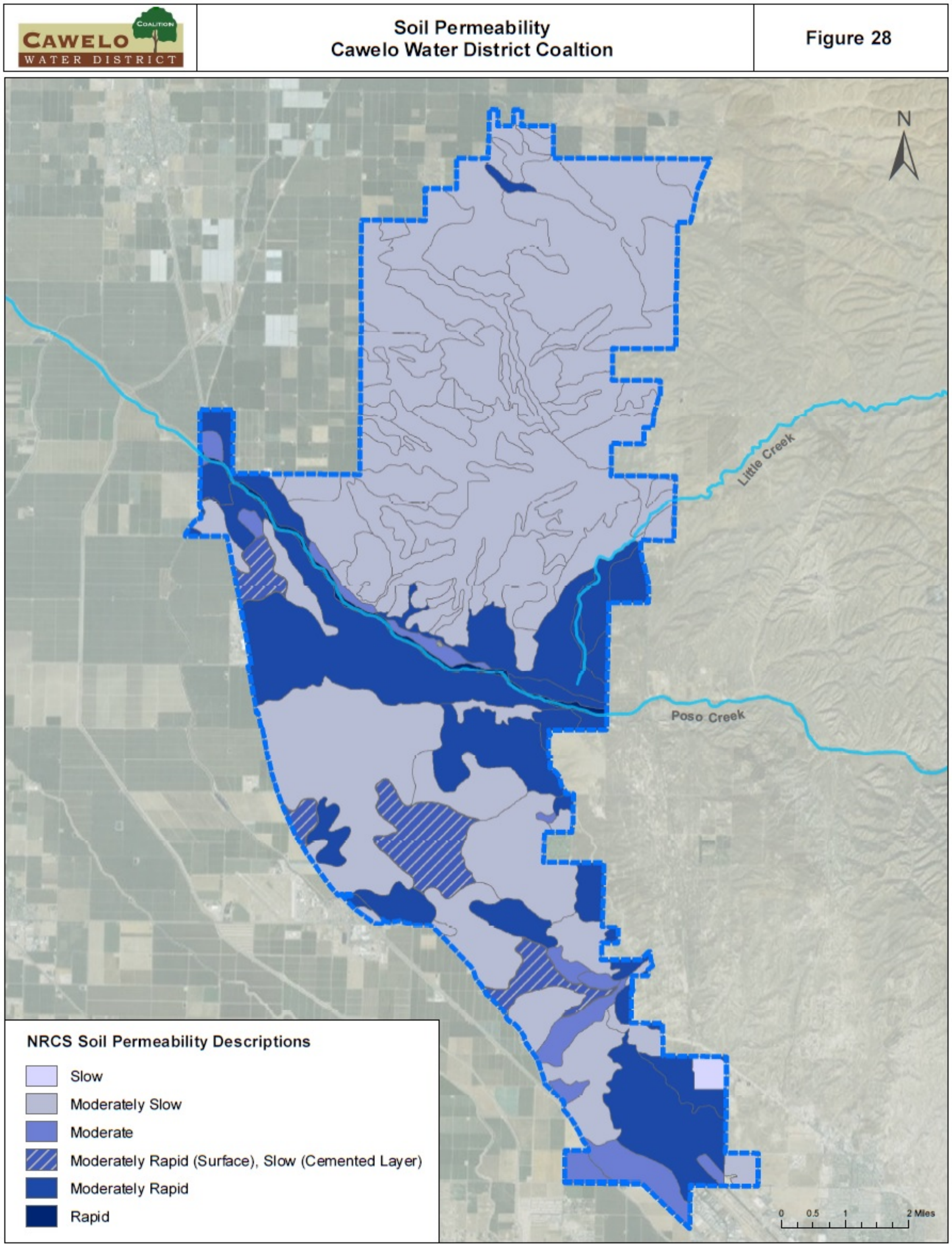
Figure 28 – Soil Permeability, Cawelo Water District Coalition



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The permeability characteristics of the soils were considered as part of the determination for prioritization of the High Vulnerability areas.

6. Surface Irrigation Practices

Figure 21 represents the various irrigation systems used throughout the CWDC area. Almost all growers in the CWDC area utilize a pressurized irrigation system, typically drip or micro-sprinkler, to irrigate their crops. There are a few growers that use flood or row irrigation methods which total approximately 1% of all CWDC irrigation systems.

Generally, irrigation is carefully planned and efficiently applied in the CWDC area due the relatively high cost of irrigation water available. Drip and micro-sprinkler systems are commonly considered the most efficient irrigation systems where row irrigation and flood irrigation are generally considered to be of lower efficiencies. Nearly all irrigation systems in CWDC are either micro-sprinkler or drip which correlate to the 4 primary crops which total 97% of all crops grown in 2014.

Areas of lower efficient irrigation practices were considered when determining prioritization of the high vulnerability areas.

7. Nitrogen Management Practices

In addition to the high cost of irrigation water, nutrient applications are conducted at a high level of management to improve effectiveness and to reduce cost. Operating drip or micro-sprinkler irrigation systems allow the growers to use fertigation and deliver liquid fertilizer to the crop in the irrigation water. This provides a precise method to deliver nutrients to the crops and provide it at a schedule that can maximize the crop up-take of the nutrients.

High efficiency nutrient applications can be achieved with row or flood irrigation methods with prudent planning and scheduling and fertigation can be possible. Generally, this method of irrigation and associated nutrient applications are considered less efficient than management practices associated with drip or micro-sprinkler. These areas of CWDC were considered as part of the evaluation of the irrigation practices.

8. Existing Monitoring Programs

The District conducts groundwater monitoring programs to satisfy the requirements of WDR permits which authorize the District to receive oilfield produced waters for the purposes of irrigation and groundwater recharge. Water samples are collected annually from designated wells and analyzed for typical irrigation constituents of concern including nitrates, salinity, and arsenic. This information is compiled and reported to the Regional Board per the requirements of the WDR's.

The District has been monitoring groundwater quality for nearly 20 years and has an extensive database that provided important and meaningful information to help assess the

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groundwater quality and determine the high vulnerability areas. The current monitoring programs will also play an important role for future monitoring and management programs.

B. Determination of High Vulnerability Area

GIS tools were utilized to create two-dimensional maps of available, applicable and relevant data and then applied in an overlay approach to designate the High Vulnerability areas. The significance of the maps and data points was weighted according to their significance and impact to the overall goals of the GAR. The primary map layer or base layer is the map created to display the locations of the available groundwater nitrate data and categorizes the reported nitrate levels into 4 different categories:

- Reported NO3 levels up to 22 mg/L
- Reported NO3 levels between 23 and 44 mg/L
- Reported NO3 levels at 45 mg/L or above
- Reported NO3 levels at 45 mg/L or above with qualifying conditions

The mapped data provided a process to evaluate measured nitrate levels at their corresponding locations within the CWDC area and to determine regional or localized trends of nitrate levels in the groundwater. Generally, applicable nitrate data that indicated a well that had a NO3 exceedance of the MCL of 45mg/L were considered impacted wells and designated a high vulnerability area.

The remaining maps were applied as supplemental data to the base layer and provided additional information to further evaluate NO3 data and to support the final High Vulnerability designations. Additionally, the supplemental maps provided a basis for prioritization of the high vulnerability areas for Groundwater Quality Management Plans, the Management Practices Evaluation Program and the Groundwater Quality Trend Monitoring Program. The supplemental maps, including non-GIS formatted maps, included data for EC, groundwater levels, soil characteristics, irrigation and nutrient practices.

1. Initial High Vulnerability Area

Figure 29 displays the location of all of the available NO3 data in the CWDC area. The map includes the GAMA, KCWA and District data.

An examination of the map revealed it is evident there is a primary region in the CWDC area where groundwater quality is impacted by NO3. Additionally, there are indications of smaller potential sub-regions that are also impacted by NO3. Wells with known NO3 impacts in the areas noted on **Figure 30** were noted as high vulnerability regions and provided the basis for developing the high vulnerability areas.

The remaining isolated well locations with MCL exceedances did not support an approach to defining regional NO3 groundwater impacted waters as a result of a review of the supplemental data associated with each well location. An analysis of the wells identified in **Figure 31** is provided in the following sections.

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Figure 29 – Combine Well Data Sources, Nitrate Levels

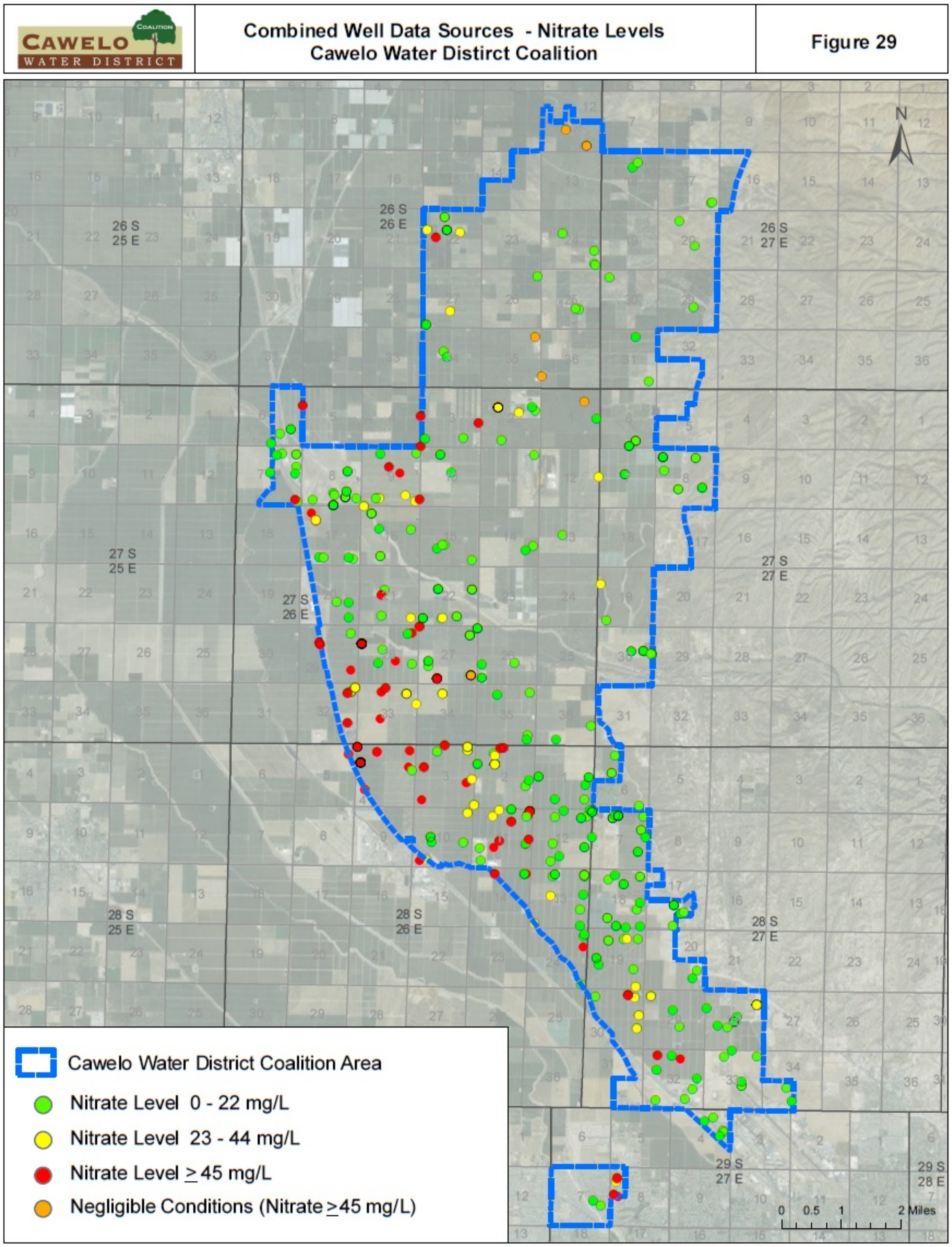

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Figure 30 – Areas of NO3 Impacted Groundwater

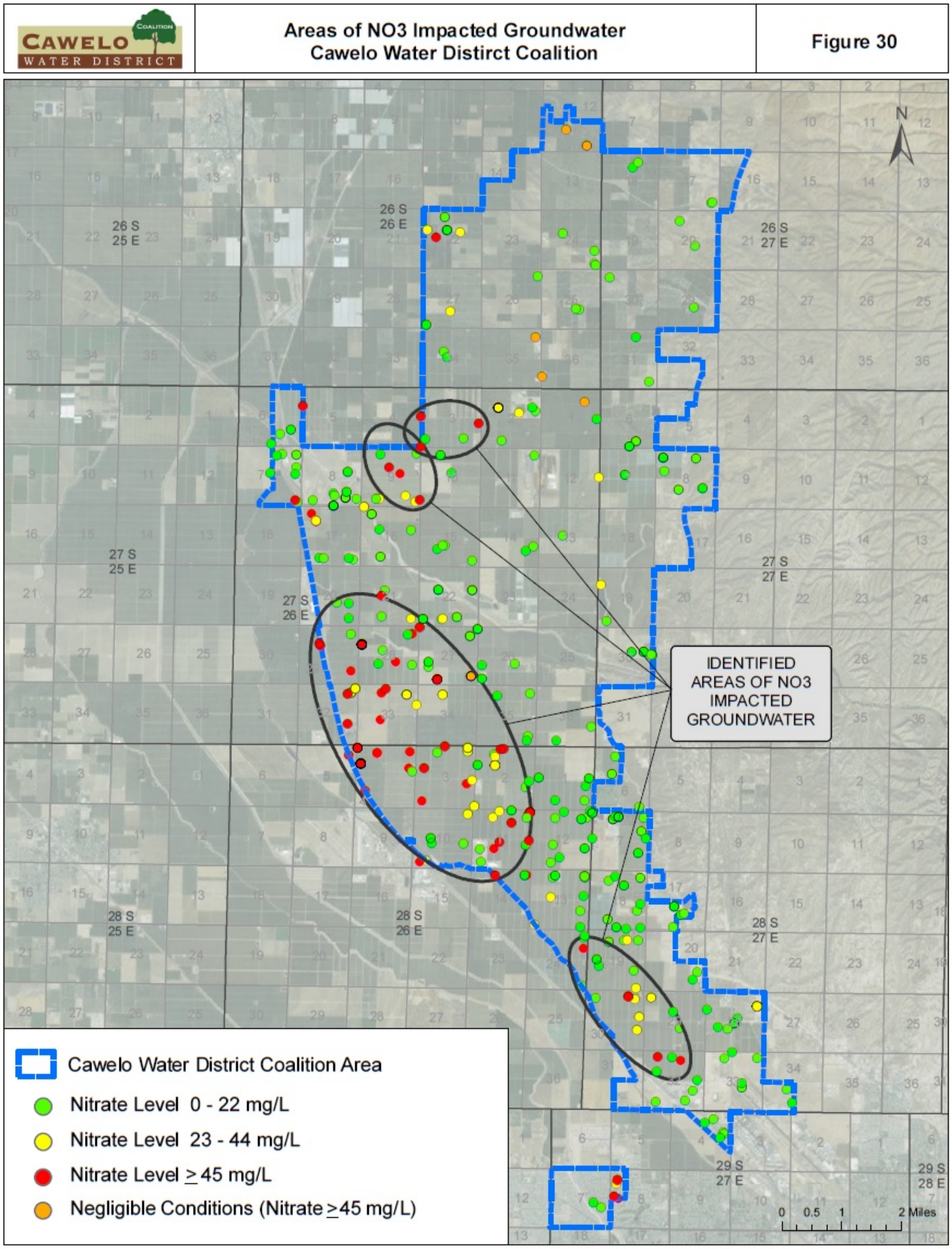

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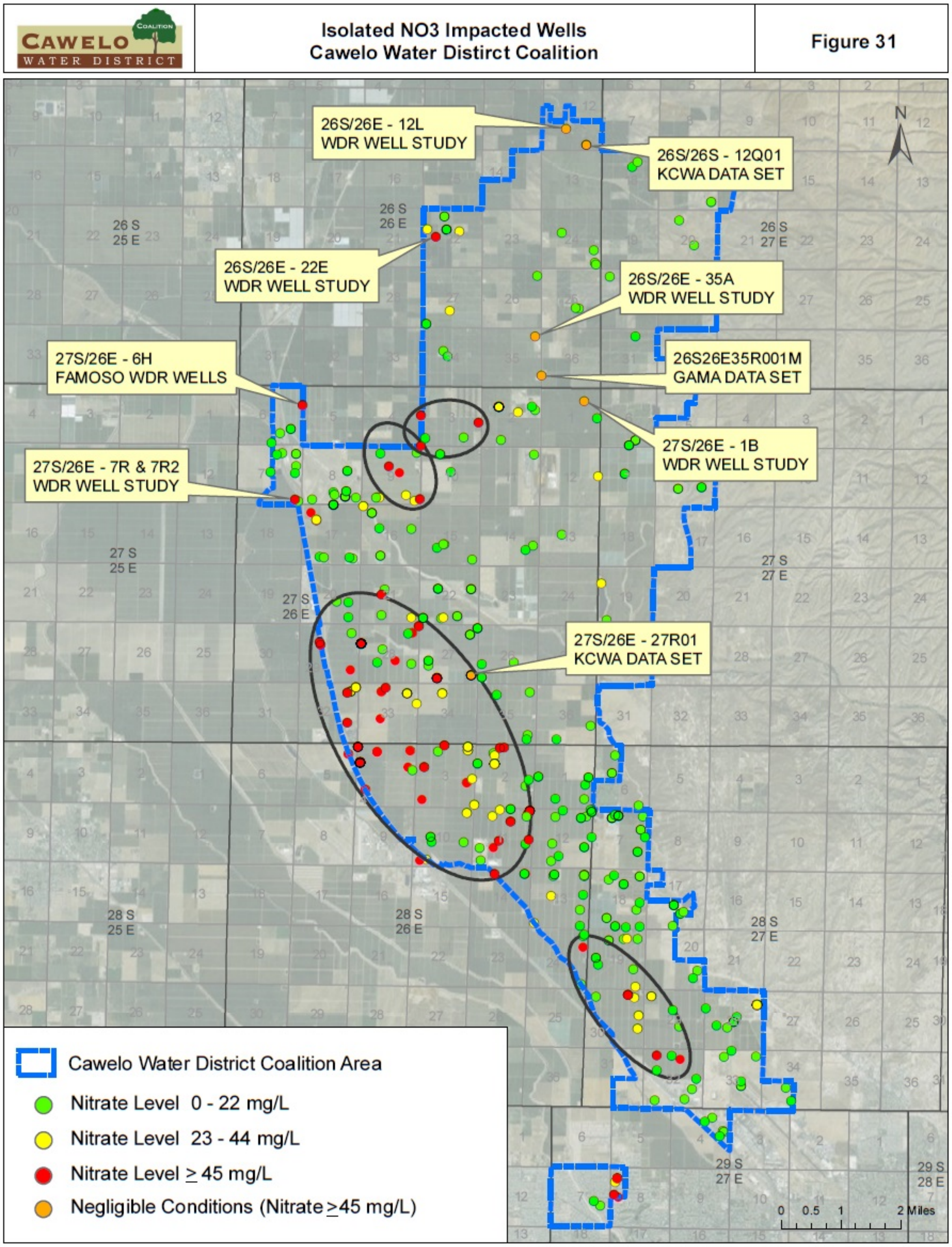
Figure 31 – Isolated NO3 Impacted Wells



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The supplemental data was applied and reviewed to each of the isolated NO3 impacted wells in **Figure 31**. Where data was available, each of the following additional layers were considered for further analysis of each of the wells:

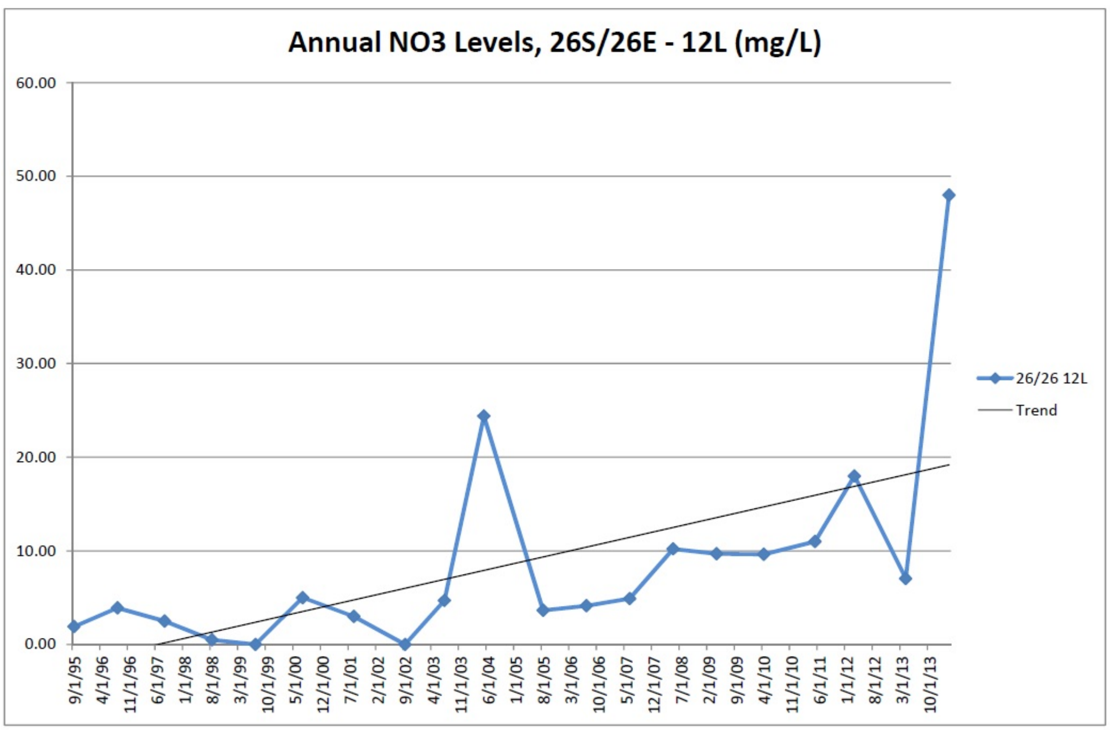
a) Historical monitoring and current monitoring programs
b) Historical trend
c) Vicinity of Urban areas or DAC
d) Salinity
e) Depth to groundwater
f) Soil Permeability
g) Irrigation practices

<u>Detailed Review of Well 26S/26E – 12L (WDR Well Study)</u>

a) Well 26S/26E – 12L (Well 12L) is a well that is annually monitored as part of the WDR Well Study with NO3 information dating back to 1995.

b) **Figure 32** is a chart summarizing the historical NO3 levels reported on an annual basis and provides a trend over a period of nearly 20 years.

Figure 32 – Annual NO3 Levels, 26S/26E – 12L



It was reported that Well 12L had a NO3 level of 48.0 mg/L in 2014 and is the only year that reported a NO3 exceedance of the MCL. The data indicates an increasing trend in the groundwater NO3 levels at this well location with a NO3 average of 8.61 mg/L.

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c) There are no urban entities or DAC's in the vicinity of Well 12L. The nearest urban entity is McFarland approximately 5 miles to the west.
d) The average EC value calculated for Well 12L is 1027 µnmhos/cm and is above the salinity objective of 1000 µnmhos/cm.
e) The average depth to groundwater measured for Well 12L is 505 feet.
f) The SCS of the USDA describes the soil permeability at this vicinity as moderately slow.
g) The irrigation system used in this area is a fan jet (micro-sprinkler) system.

See **Figure 33** for a review map of Well 12L.

Exclusion from High Vulnerability Area: Well 12L is currently part of an extensive groundwater quality monitoring program that has been conducted for nearly 20 years. The last reported NO3 level exceeded the MCL but historical data demonstrates values well below 50% of the MCL. The trend indicates an increasing average level of NO3 however it remains below 50% of the MCL. Due to the priorities placed on the protection of drinking water for the urban areas or DAC's, this well would have been considered for high vulnerability designation however there are no urban entities or DAC's in the vicinity of the well location. The average EC levels marginally exceed the objective threshold and along with the trend and last reported NO3 level, Well 12L warrants continued monitoring and continued analysis in subsequent reports however, due to the current well monitoring program, isolation from regional groundwater NO3 impacted areas and DAC's, moderately slow soil permeability, 505 feet to groundwater and highly efficient irrigation systems in the area, this data location exhibits qualifying conditions that exclude it from a high vulnerability designation.

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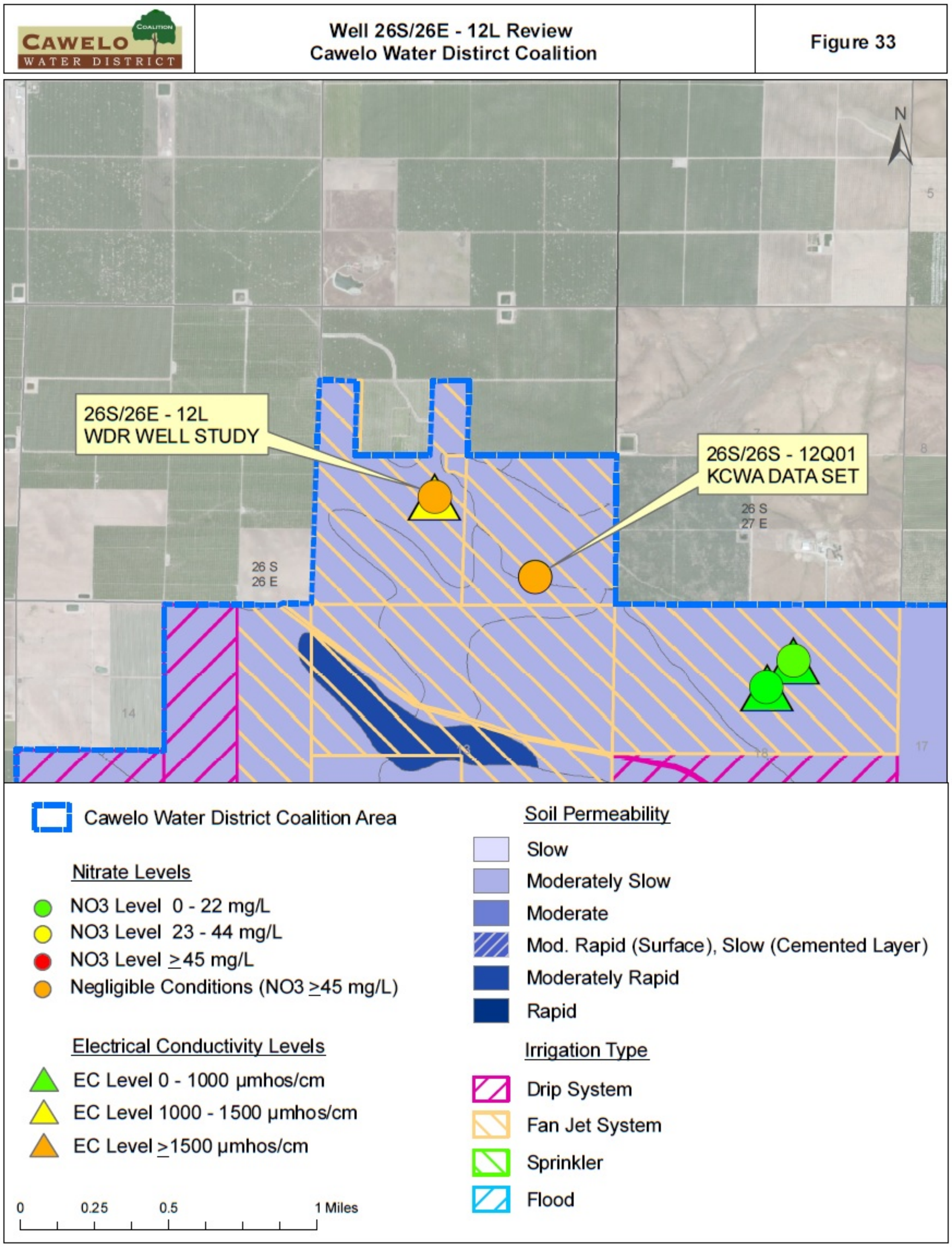
Figure 33 – Well 26S/26E – 12L Review



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Detailed Review of Well 26S/26E – 12Q01 (KCWA Data Set)

a) The data for Well 26S/26E – 12Q01 (Well 12Q01) was obtained from the KCWA and records indicate there are only two NO3 data results for this well. There are no known current or historical monitoring programs for this well.
b) There are only two records for reported NO3 levels for this well:
   Year 1984 NO3 = 65.6 mg/L
   Year 1986 NO3 = 0
   The NO3 levels reported for 1984 exceeds the MCL.
c) There are no urban entities or DAC's in the vicinity of Well 12Q01. The nearest urban entity is McFarland approximately 5 miles to the west.
d) The average EC value in the vicinity of Well 12Q01 is 1027 µnmhos/cm and is above the salinity objective of 1000 µnmhos/cm.
e) The average depth to groundwater in the vicinity of Well 12Q01 is approximately 500 feet.
f) The SCS of the USDA describes the soil permeability at this vicinity as moderately slow.
g) The irrigation system used in this area is a fan jet (micro-sprinkler) system.

See **Figure 34** for review map of Well 12Q01.

Exclusion from High Vulnerability Area: The data available for Well 12Q01 was collected 30 years ago and does not provide any valid trend information or any level of consistency. There are no urban entities or DAC's in the vicinity of the well location however the average EC reported for the vicinity does marginally exceed the objective threshold. Similar to Well 12L, this well is isolated from regional groundwater NO3 impacted areas and DAC's, has moderately slow soil permeability, groundwater is approximately 500 feet deep and a highly efficient irrigation system is used in the area. The information provided are qualifying conditions that exclude it from a high vulnerability designation.

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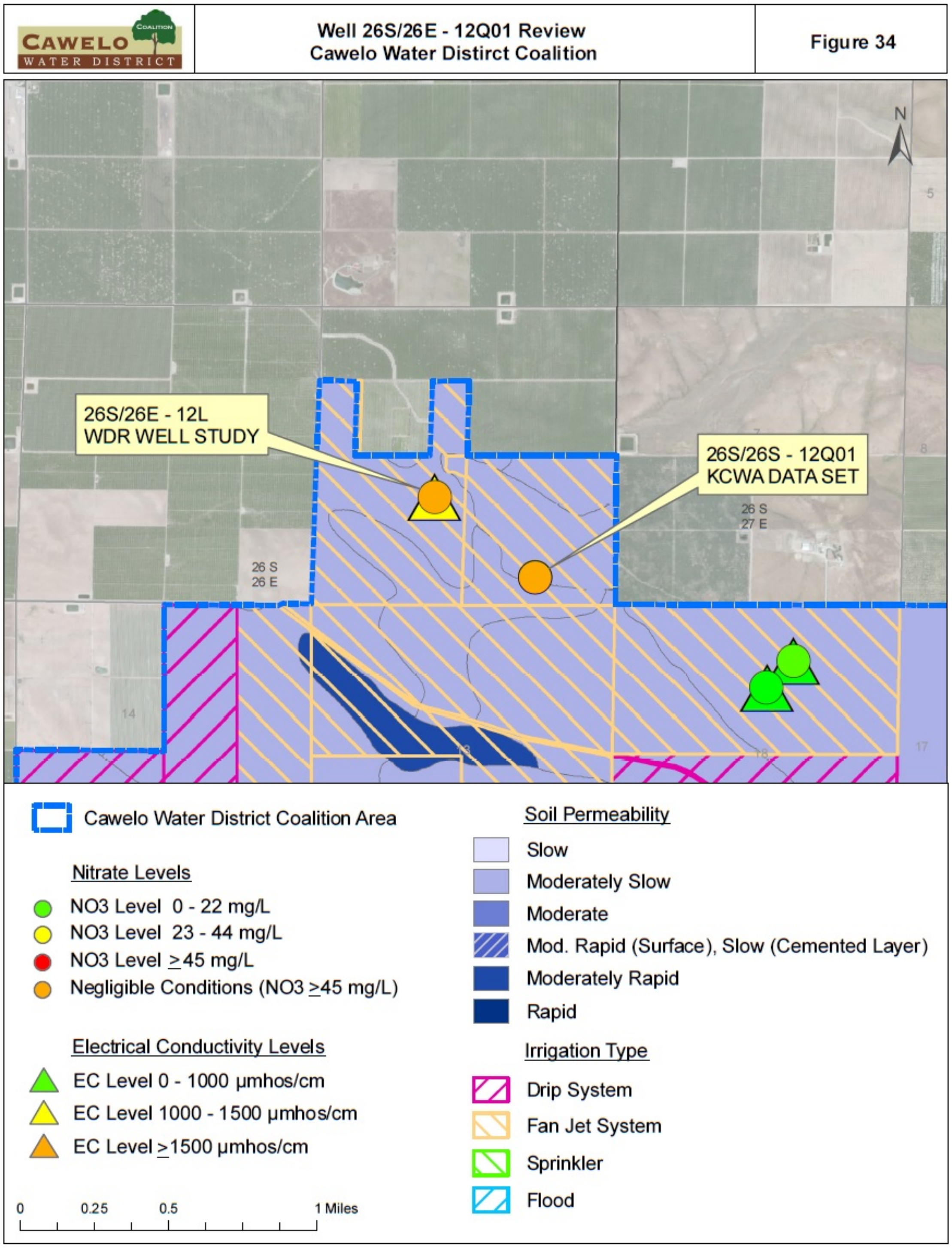
Figure 34 – Well 26S/26E – 12Q01 Review



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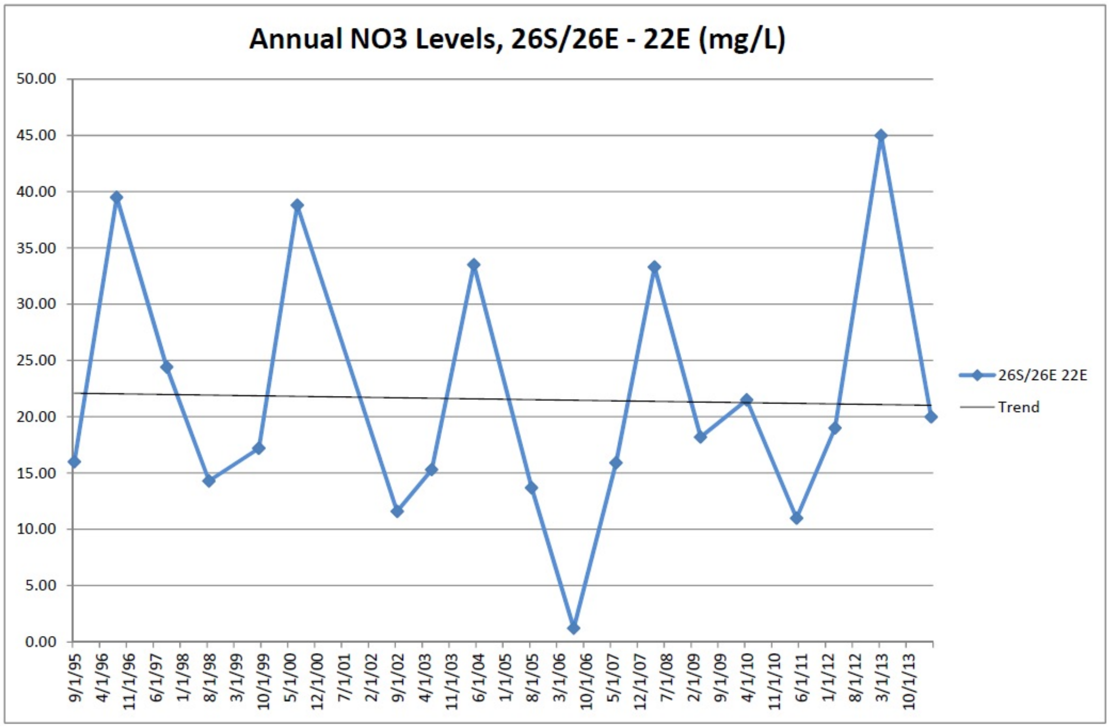
Detailed Review of Well 26S/26E – 22E (WDR Well Study)

a) Well 26S/26E – 22E (Well 22E) is a well that is annually monitored as part of the WDR Well Study with NO3 information dating back to 1995.
b) **Figure 35** is a chart summarizing the historical NO3 levels reported on an annual basis and provides a trend over a period of nearly 20 years.

Figure 35 – Annual NO3 Levels, 26S/26E – 12L



It was reported that Well 22E had a NO3 level of 45.0 mg/L in 2013 which equals the NO3 MCL. The data indicates a neutral or negligible decreasing trend with an average of 21.55 mg/L. In 6 of the 19 years NO# levels were reported to be within 50% of the MCL.

c) There are no urban entities or DAC's in the immediate vicinity of Well 22E. The nearest urban entity is McFarland just over 3 miles to the west.
d) The average EC calculated for Well 22E is 768 µnmhos/cm and is below the salinity objective of 1000 µnmhos/cm.
e) The average depth to groundwater measured for Well 22E is 381 feet.
f) The SCS of the USDA describes the soil permeability at this vicinity as moderately slow.
g) The irrigation system used in this area is a fan jet (micro-sprinkler) system.

See **Figure 36** for a review map of Well 22E.

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Designated in High Vulnerability Area: Well 22E is currently part of an extensive groundwater quality monitoring program that has been conducted for nearly 20 years. In 2013, the reported NO3 level equaled the MCL and historical data indicate 6 different sampling events reported levels within 50% of the MCL and 5 of those were within approximately 25% of the MCL. Historical information generally indicates a neutral trend with the average approximately at 50% of the MCL. The elevated levels occur on a relatively consistent basis over the last 19 year on roughly a 4 to 5 year cycle. Along with consideration of the current well monitoring program, the additional information associated with Well 22E, warranted serious consideration for exclusion of a high vulnerability designation. The EC levels, depth to groundwater, soil permeability and irrigations systems suggest this area is a low threat to groundwater quality however historical data from the WDR Well Study demonstrates a consistent pattern of elevated NO3 levels near or at the MCL. The well will continued to be monitored as part of the current monitoring program but is also designated to be in a high vulnerability area.

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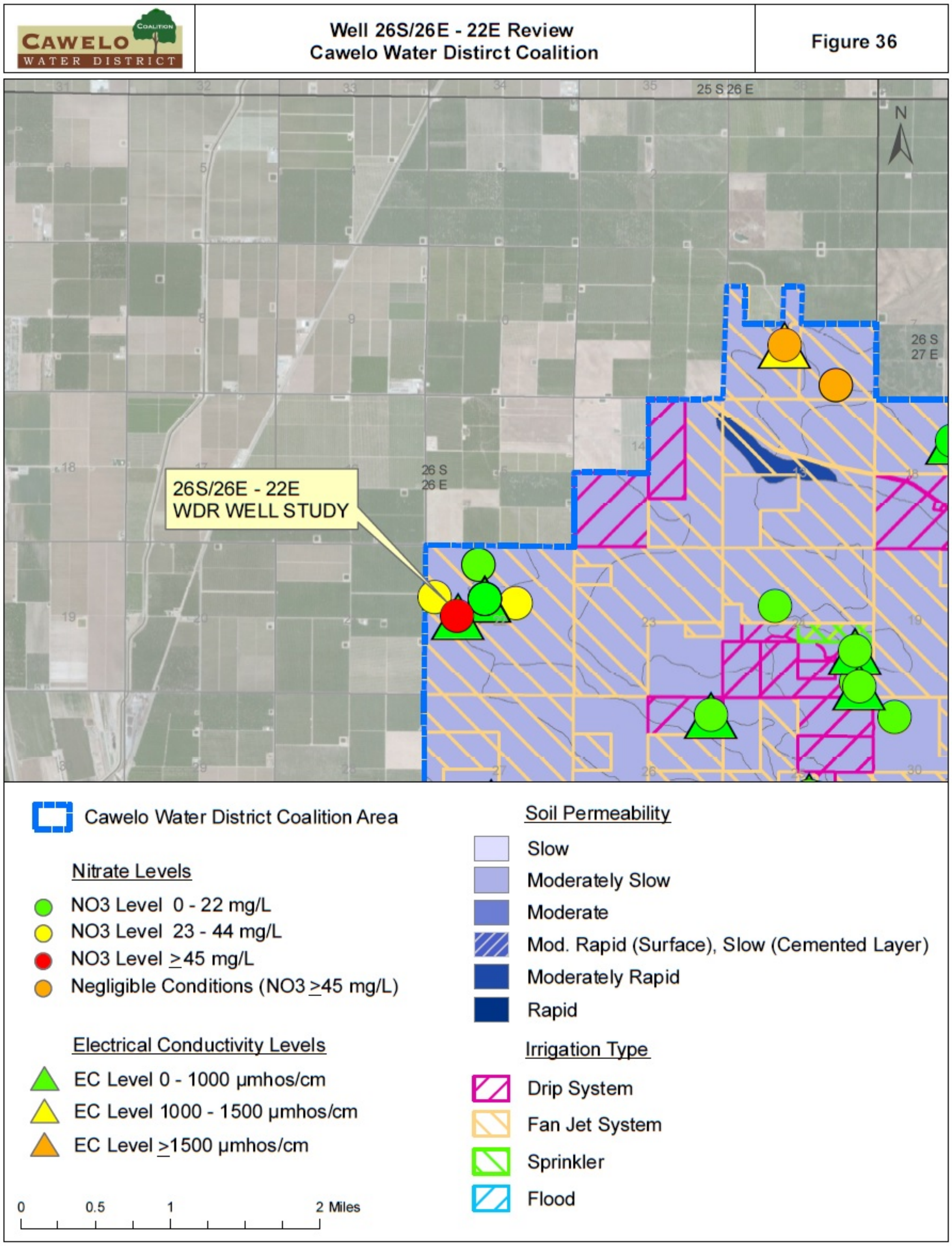
Figure 36 – Well 26S/26E-22E Review



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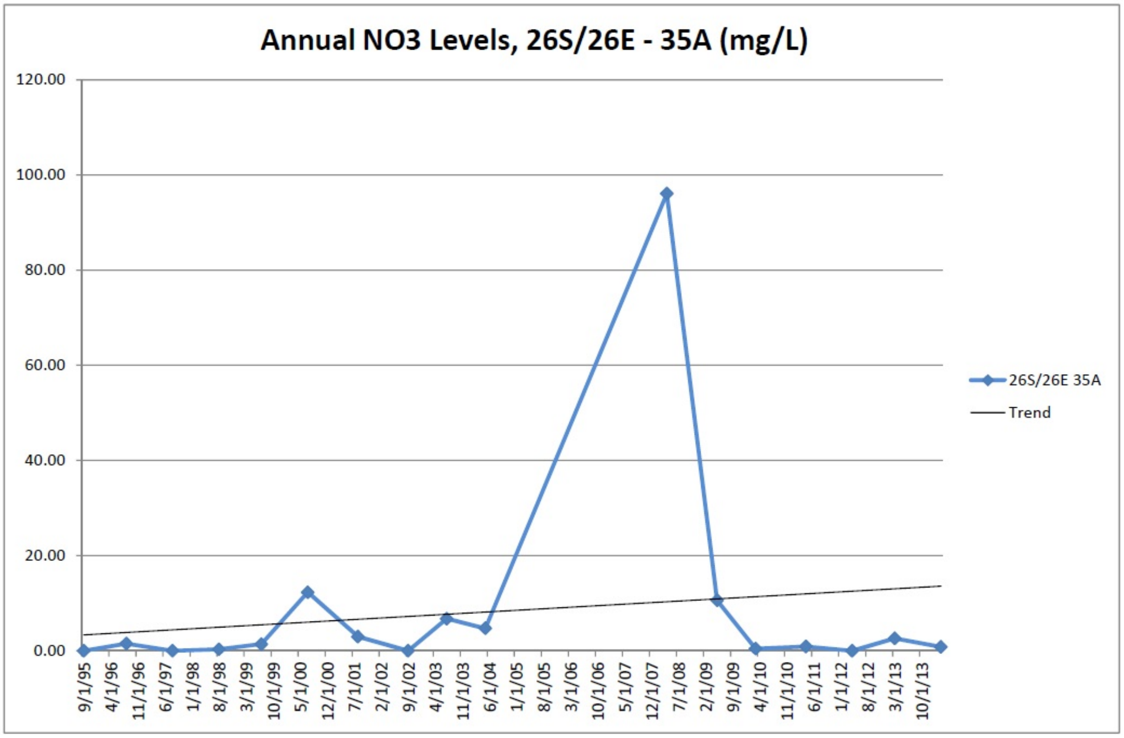
Detailed Review of Well 26S/26E – 35A (WDR Well Study)

a) Well 26S/26E – 35A (Well 35A) is a well that is annually monitored as part of the WDR Well Study containing NO3 information dating back to 1995.

b) **Figure 37** is a chart summarizing the historical NO3 levels reported on an annual basis and provides a trend over a period of nearly 20 years.

Figure 37 – Annual NO3 Levels, 26S/26E – 35A



It was reported that Well 35A had a NO3 level of 96.1 mg/L in 2008 and is the only year in exceedance of the MCL. The data indicates a neutral or negligible increasing trend with an average NO3 levels at 10.1 mg/L.

c) There are no urban entities or DAC's in the vicinity of Well 35A. The nearest urban entity is McFarland approximately 6 miles to the northwest and commercial entities approximately 4 miles west located at Famoso Road and Freeway 99.

d) The average EC value calculated for Well 35A is 803.4 µnmhos/cm and is below the salinity objective of 1000 µnmhos/cm.

e) The average depth to groundwater measured for Well 35A is 518 feet.

f) The SCS of the USDA describes the soil permeability at this vicinity as moderately slow.

g) The irrigation system used in this area is a fan jet (micro-sprinkler) system.

See **Figure 38** for a review map of Well 35A.

Exclusion from High Vulnerability Area: Well 35A is currently part of an extensive groundwater quality monitoring program that has been ongoing for nearly 20 years. The

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NO3 level reported in 2008 exceeded the MCL but historical data demonstrates values well below 50% of the MC. The data suggest a neutral or negligible increasing trend and all NO3 levels but one reported below 13 mg/L. The additional information associated with Well 35A indicate conditions that minimize risk to groundwater quality. The data reveals a history of low level of detected NO3 and for purposes of the report the exceedance reported in 2008 was considered an anomaly. Well 35A will continue to be monitored as part of the current well monitoring program however, this data location exhibits qualifying conditions that exclude it from a high vulnerability designation.

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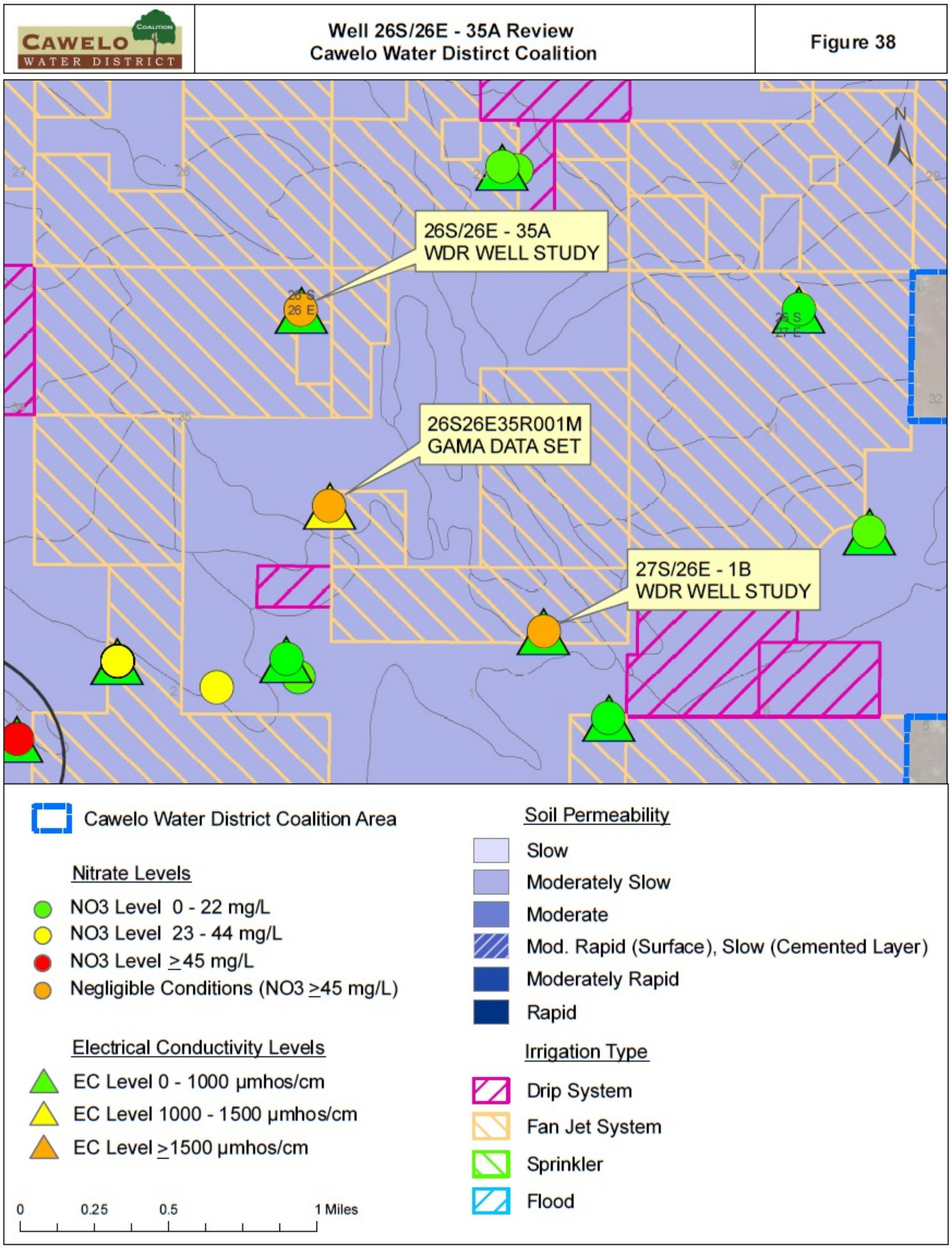
Figure 38 – Well 26S/26E-35A Review



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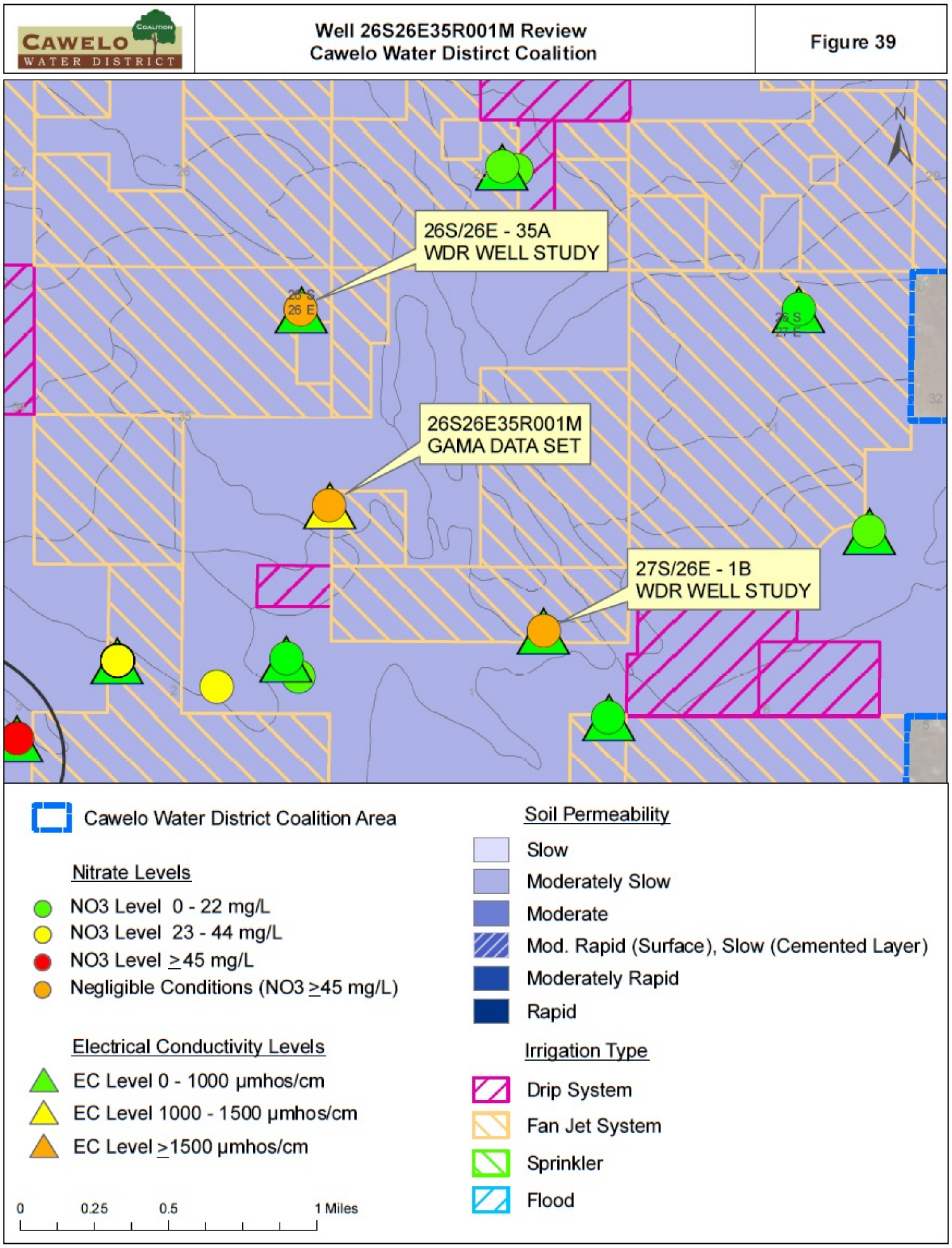
Detailed Review of Well 26S26E35R001M (GAMA Data Set))

a) The data for Well 26S26E35R001M (Well 35R001) was obtained from the GAMA Data Set and records indicate there was only one NO3 data result reported in 1990. There are no known current or historical monitoring programs for this well.
b) There is no trend information available for this well and the only historical information is from one sampling event:
   Year 1990 NO3 = 59 mg/L
   This reported NO3 levels exceeded the MCL.
c) There are no urban entities or DAC's in the vicinity of Well 35R001. The nearest urban entity is McFarland approximately 6 miles to the northwest and commercial entities approximately 4 miles west located at Famoso Road and Freeway 99.
d) The 1990 reported EC value for Well 35R001 was 1070 µnmhos/cm and is above the salinity objective of 1000 µnmhos/cm.
e) In the Fall of 2014, the approximate depth to groundwater in the vicinity of Well 35R001 was 630 feet.
f) The SCS of the USDA describes the soil permeability at this vicinity as moderately slow.
g) The irrigation system used in this area is a fan jet (micro-sprinkler) system along with drip and fallow land in the immediate area.

See **Figure 39** for review map of Well 35R001.

Exclusion from High Vulnerability Area: The data available for Well 35R001 was collected nearly 15 years ago and does not provide any valid trend information or provide a level of consistency. There are no urban entities or DAC's in the vicinity of the well location however the average EC reported for the vicinity does marginally exceed the objective threshold. This well is isolated from regional groundwater NO3 impacted areas and DAC's, has moderately slow soil permeability, groundwater is approximately 630 feet deep and highly efficient irrigation systems are used in the area. The information provided are qualifying conditions that exclude it from a high vulnerability designation.

Figure 39 – Well 26S26E35R001M Review



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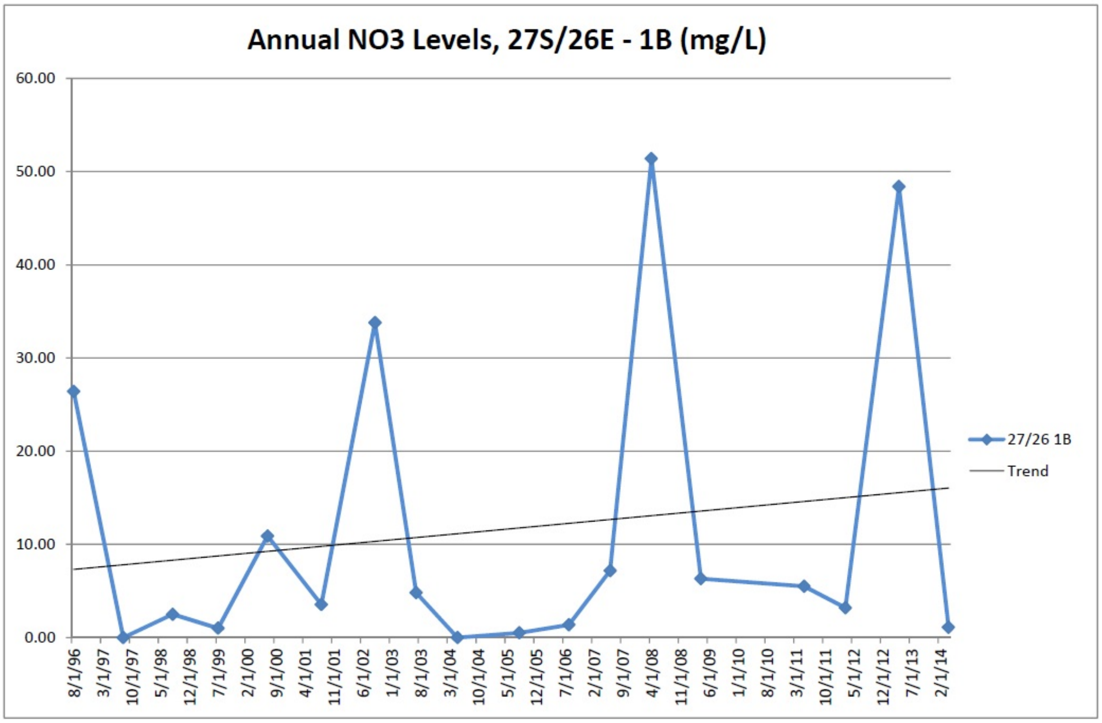
Detailed Review of Well 27S/26E – 1B (WDR Well Study)

a) Well 27S/26E – 1B (Well 1B) is a well that is annually monitored as part of the WDR Well Study with NO3 information dating back to 1995.
b) **Figure 40** is a chart summarizing the historical NO3 levels reported on an annual basis and provides a trend over a period of nearly 20 years.

Figure 40 – Annual NO3 Levels, 2&S/26E – 1B



It was reported in 2008 and 2013 that NO3 levels exceeded the MCL with levels 51.4 mg/L and 48.4 mg/L, respectively. The data indicates an increasing trend in the groundwater NO3 levels with a historical average of 13.0 mg/L.

c) There are no urban entities or DAC's in the vicinity of Well 1B. The nearest urban entity is McFarland approximately 7 miles to the northwest and commercial entities approximately 5 miles west located at Famoso Road and Freeway 99.
d) The average EC value for Well 1B is 563 µnmhos/cm and is below the salinity objective of 1000 µnmhos/cm.
e) The average depth to groundwater measured for Well 1B is 495 feet.
f) The SCS of the USDA describes the soil permeability at this vicinity as moderately slow.
g) The irrigation system used in this area is fan jet (micro-sprinkler) system with fallow land in the immediate area.

See **Figure 41** for a review map of Well 1B.

Exclusion from High Vulnerability Area: Well 1B is currently part of an extensive groundwater quality monitoring program that has been conducted for nearly 20 years. There are two reported NO3 levels that exceeded the MCL however historical data demonstrates an average value well below 50% of the MCL. The data indicates an increasing trend that also remains below 50% of the MCL. Due to the priorities placed on the protection of drinking water for the urban areas or DAC's, this well would have been considered for high vulnerability designation however there are no urban entities or DAC's in the vicinity of the well location. The average EC levels are well below the objective threshold and along with the trend and 2 reported high NO3 levels, Well 1B warrants continued monitoring and continued analysis in subsequent reports. However, due to the current well monitoring program, isolation from regional groundwater NO3 impacted areas and DAC's, moderately slow soil permeability, 563 feet to groundwater and highly efficient irrigation systems in the area, this data location exhibits qualifying conditions that exclude it from a high vulnerability designation.

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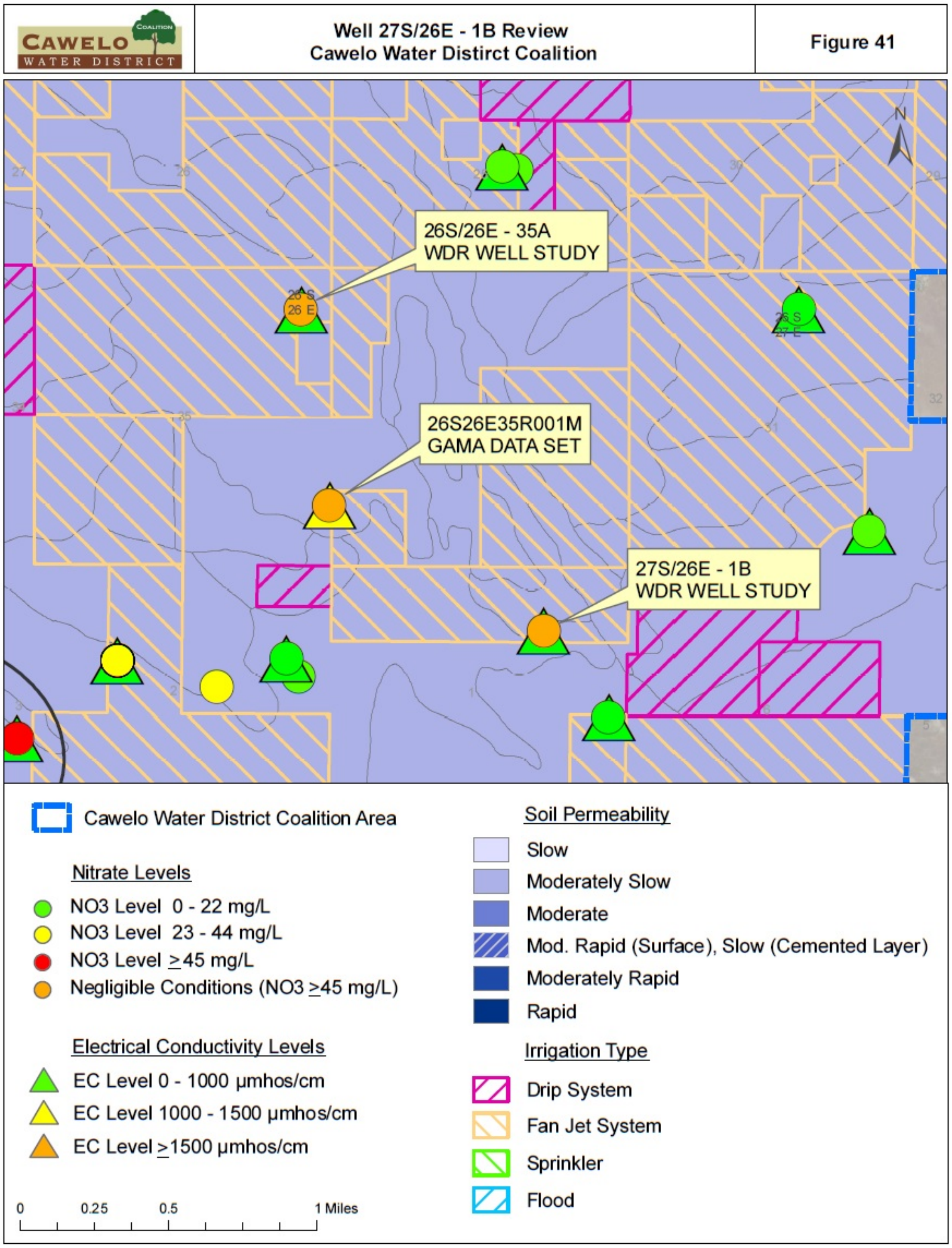
Figure 41 – Well 27S/26E – 1B Review



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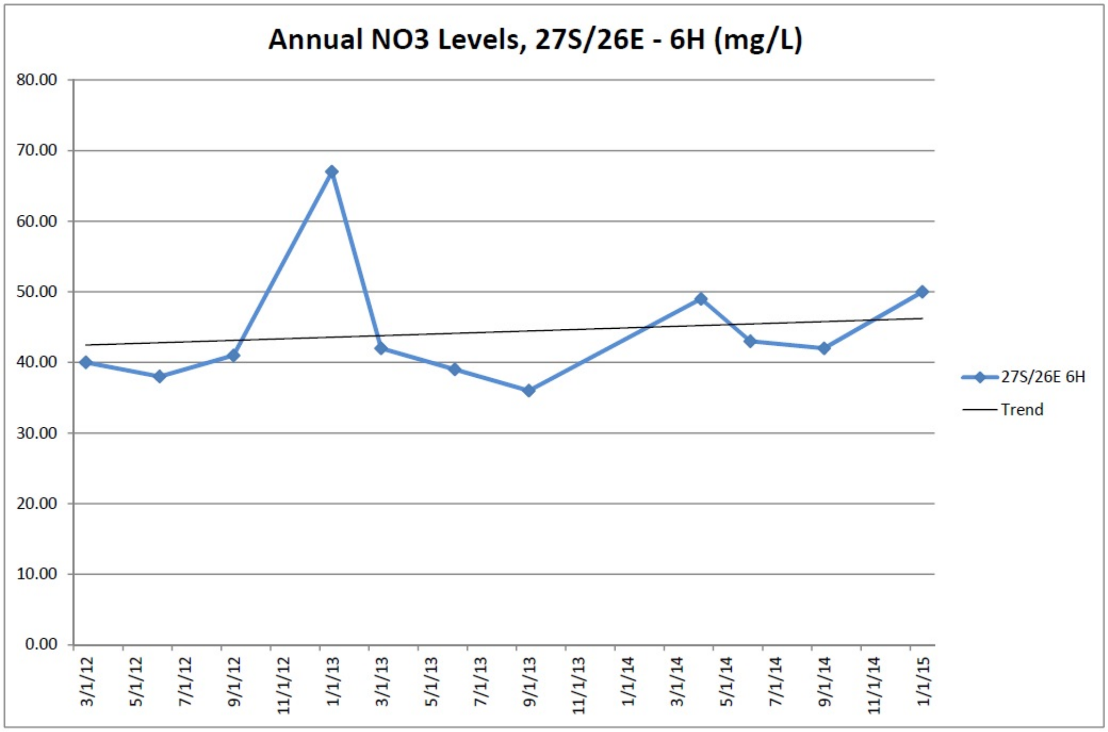
Detailed Review of Well 27s/26E – 6H (Famoso WDR Wells)

a) Well 27S/26E – 6H (Well 6H) is a well that is monitored quarterly as part of the Famoso WDR Wells monitoring program with NO3 information dating starting in 2012.
b) **Figure 42** is a chart summarizing the historical NO3 levels reported on a quarterly basis and provides a trend over a period of 11 quarters.

Figure 42 – Quarterly NO3 Levels, 27S/26E – 6H



On 3 occasions Well 6H had reported levels of NO3 that exceeded the MCL. The data indicates a neutral or negligible increasing trend with an average of 44.3 mg/L. All reported levels are within 50% of the MCL.

c) There are no urban entities or DAC's in the immediate vicinity of Well 6H. The nearest urban entity is McFarland approximately 4 miles north.
d) The average EC for Well 6H is 646 µnmhos/cm and is below the salinity objective of 1000 µnmhos/cm.
e) The average depth to groundwater measured for Well 6H is 315 feet.
f) The SCS of the USDA describes the soil permeability at this vicinity as moderately rapid.
g) The irrigation system used in this area is a drip system.

See **Figure 43** for a review map of Well 6H.

Designated in High Vulnerability Area: Well 6H is currently part of an ongoing groundwater quality monitoring program that started in 2012. There are 3 reported exceedances of the NO3 MCL and the average is 44.3 mg/L which is nearly equal to the MCL. All reported NO3 levels are within 50% of the MCL. Together with the moderately rapid permeability of the soil, this data supports a designation in a high vulnerability area. The well will continued to be monitored as part of the current monitoring program but is also designated a high vulnerability area.

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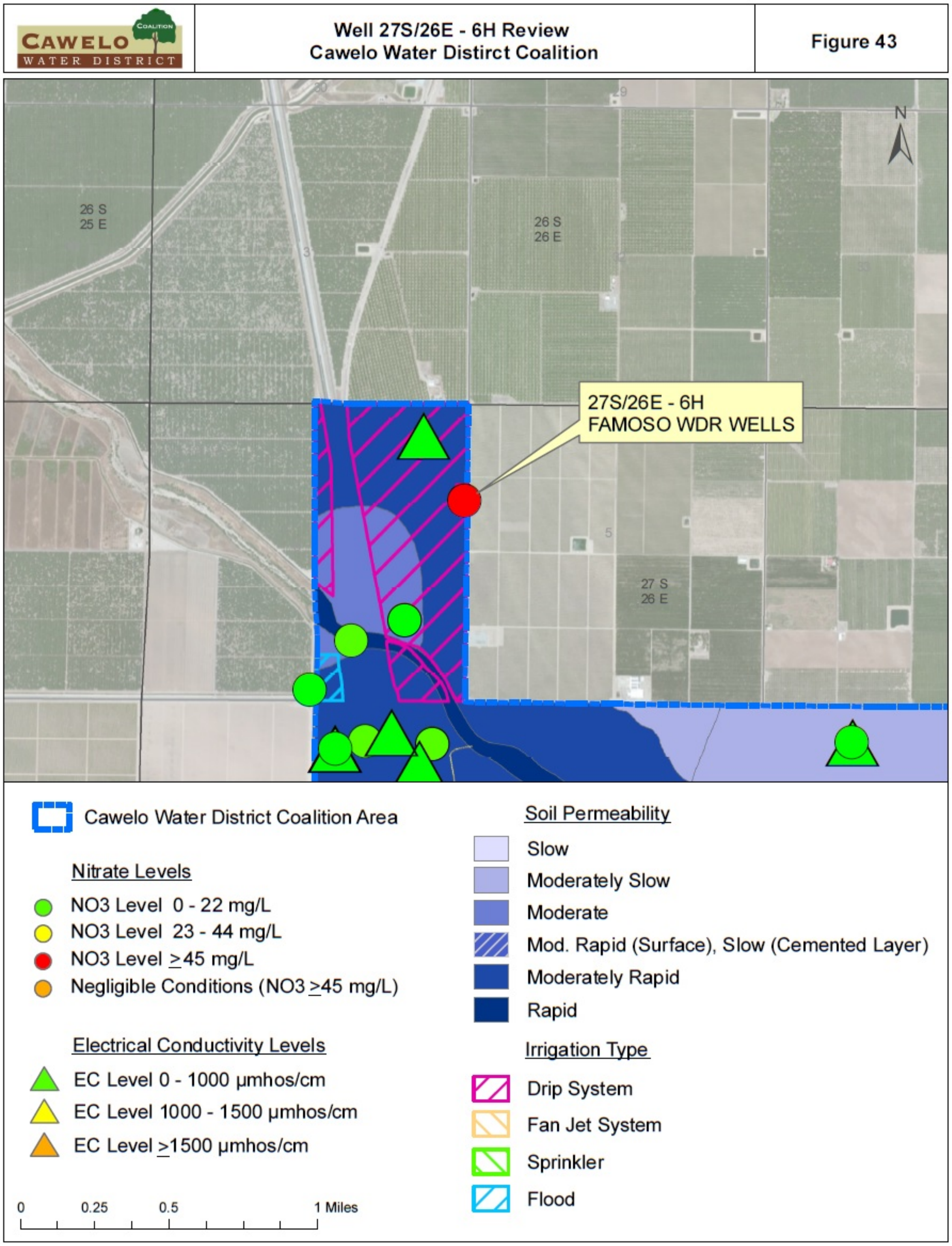
Figure 43 – Well 27S/26E – 6H Review



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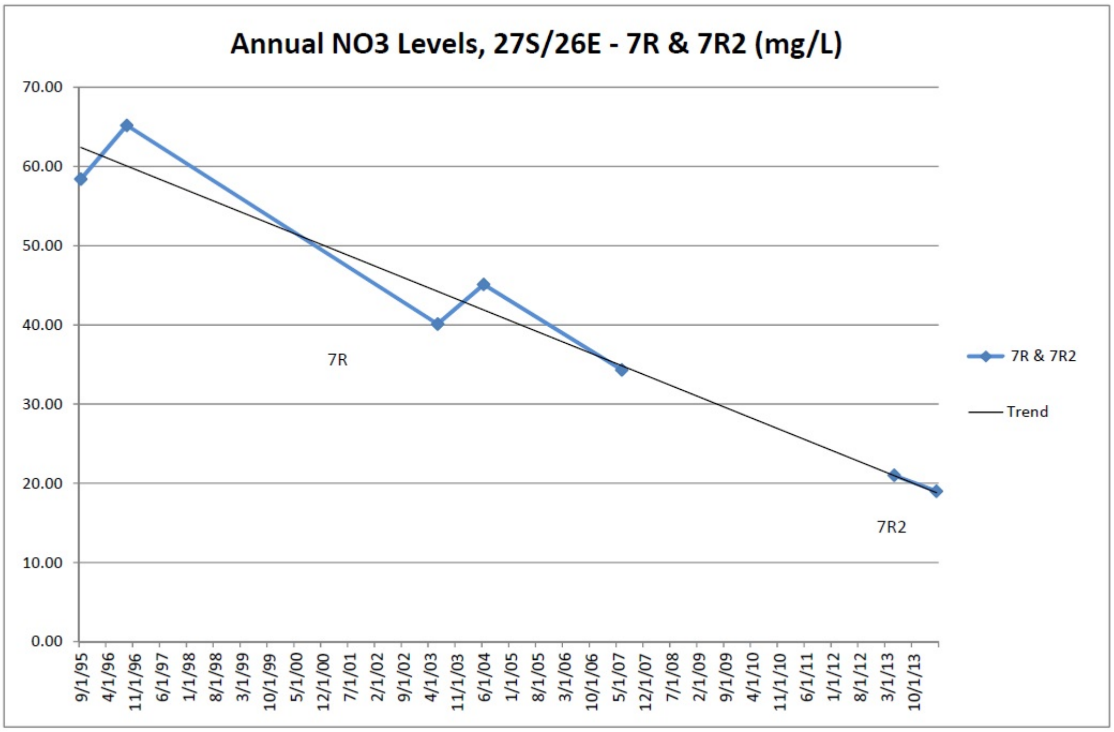
Detailed Review of Well 27S/26E – 7R & 7R2 (WDR Well Study)

a) Well 27S/26E – 7R (Well 7R) was monitored as part of the WDR Well Study and data was collected between 1991 and 2007. However, this well was not available for water quality analysis on a regular basis and after 2007 the well was no longer available, eventually being replaced with well 27S/26E – 7R2 (Well 7R2) in 2013.

b) **Figure 44** is a chart summarizing the historical NO3 levels reported on an annual basis and provides a trend over a period of nearly 20 years.

Figure 44 – Annual NO3 Levels, 27S/26E – 7R & 7R2



Well 7R had 3 occurrences of NO3 levels exceeding the MCL. Although there are relatively few data points over the 20 year period, the data indicates a decreasing trend in nitrate levels when considering both Well 7R and Well 7R2. A more specific analysis of the trend information requires detailed information of the locations of the wells with respect to each other and well completion information. The average NO3 level is 40.4 mg/L.

c) There are no urban entities or DAC's in the vicinity of Well 7R & 7R2. The nearest urban entity is McFarland which is over 5 miles to the north and commercial entities are within 1 mile.
d) The average EC for Wells 7R & 7R2 is 785 µnmhos/cm and is below the salinity objective of 1000 µnmhos/cm.
e) The average depth to groundwater measured for Wells 7R & 7R2 is 364 feet.
f) The SCS of the USDA describes the soil permeability at this vicinity as moderately slow however soil described as moderately rapid is present in the immediate vicinity.
g) The irrigation system used in this area is a fan jet (micro-sprinkler) system.

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See **Figure 45** for a review map of Well 7R and 7R2.

Undetermined Designation: Wells 7R was and Well 7R2 is currently part of an extensive groundwater quality monitoring program that has been ongoing for nearly 20 years. Unfortunately, the extent of the historical data gaps puts into question the validity of any trend information or average values to be obtained from the data. There are no DAC's in the general area of concern however the commercial entities are within 1 mile of the well area. The groundwater depth is typical for the area as so are the soil permeability characteristics. There is insufficient information to soundly make a determination to exclude this well location from high vulnerability designation however there are indications the groundwater quality is not impacted by NO3. Additional information is required to render a determination.

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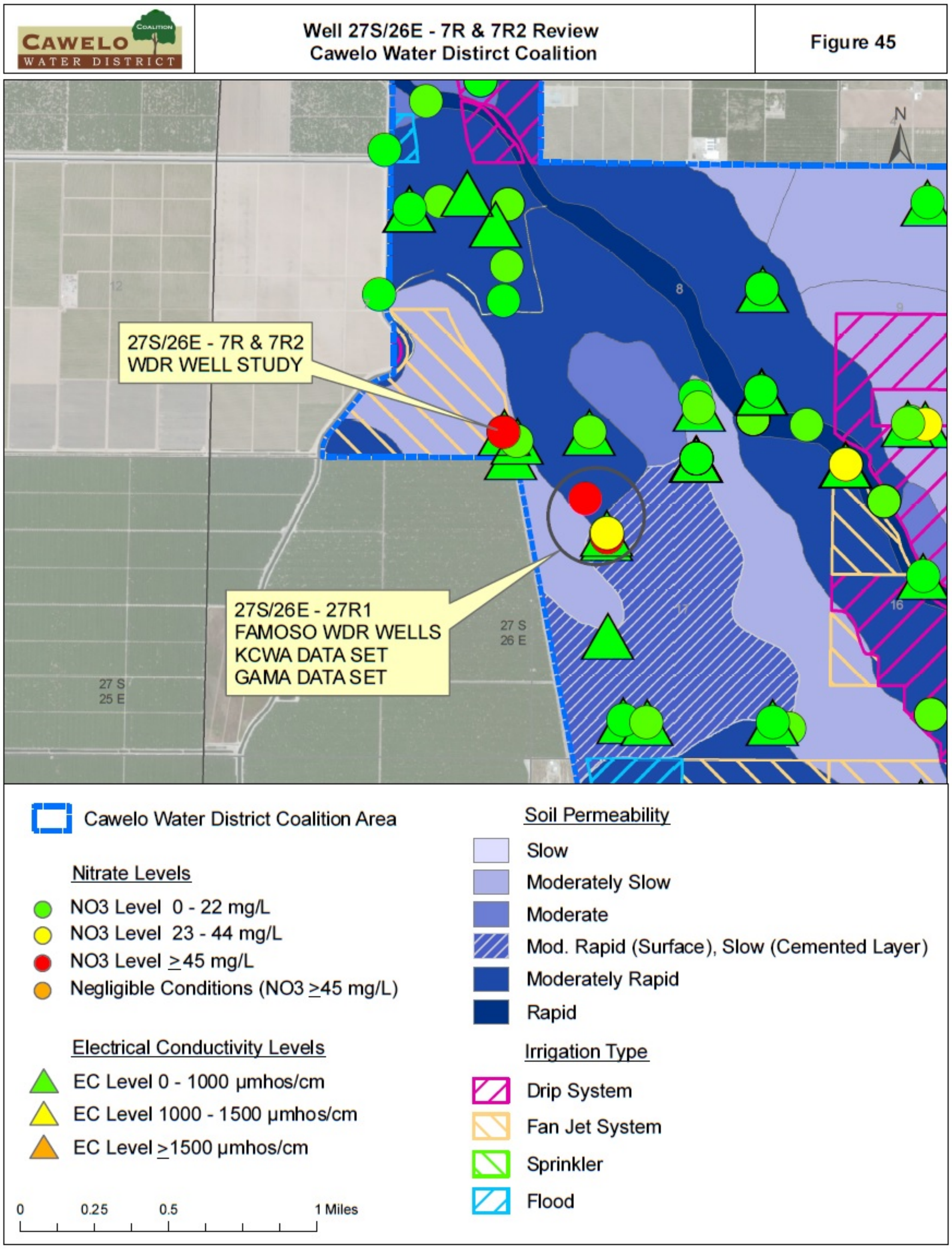
Figure 45 – Well 27S/26E – 7R & 7R2 Review



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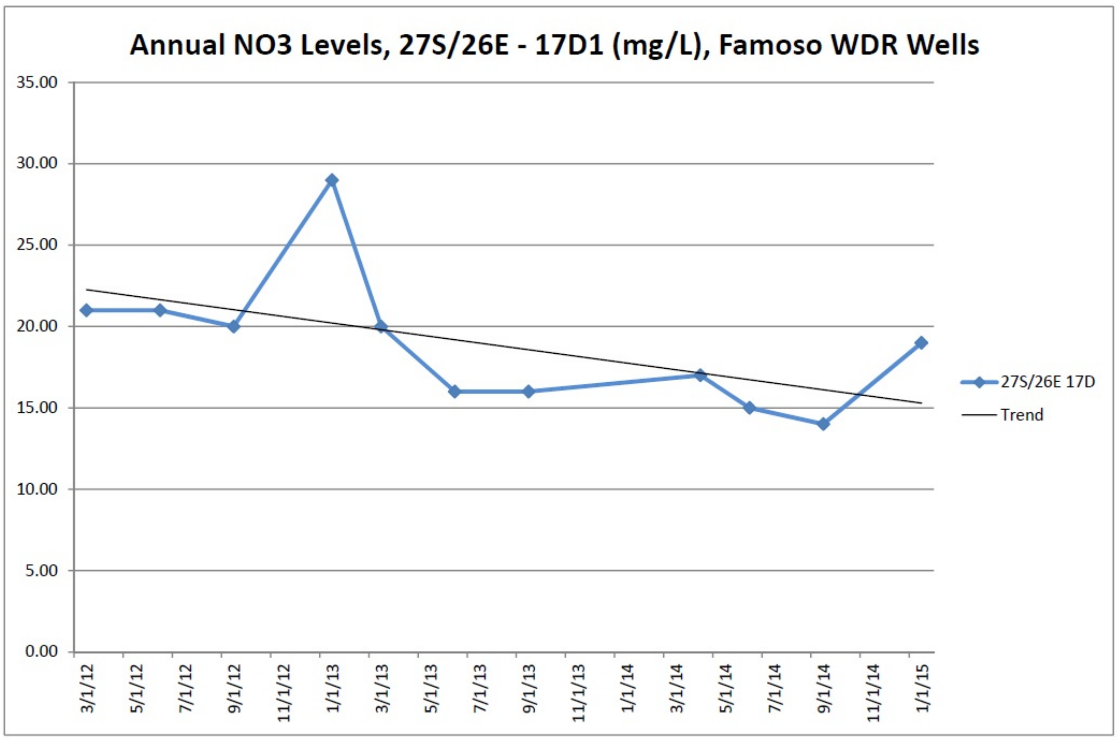
Detailed Review of Well 27S/26E – 17D (Famoso WDR Wells)

a) Well 27S/26E – 17D (Well 17D) is a well that is monitored quarterly as part of the Famoso WDR Wells monitoring program with NO3 information starting in 2012. Additionally, The GAMA Data Set and the KCWA Data Set have a common record for the same well reporting a NO3 level at 49 mg/L in 1971.
b) **Figure 46** is a chart summarizing the historical NO3 levels reported on a quarterly basis and provides a trend over a period of 11 quarters. The chart does not include the 1971 data.

Figure 46 – Annual NO3 Levels, 27S/26E – 17D



Well data from the Famoso WDR Wells data set reported no MCL exceedances with only one reported level within 50% of the MCL. The average NO3 level was 18.9.0 mg/L which is not within 50% of the MCL. It is noted that NO3 was reported to be 49 mg/L in 1971.

c) There are no urban entities or DAC's in the vicinity of Well 17D. The nearest urban entity is McFarland which is over 5 miles to the north and commercial entities are approximately within 1 mile.
d) The average EC value for Well 17D is 724 µnmhos/cm and is below the salinity objective of 1000 µnmhos/cm.
e) The average depth to groundwater measured for Well 17D is 340 feet.
f) There are 3 different soil types in the immediate area and the SCS of the USDA describes them as moderately slow, moderately rapid and moderately rapid in the top layer then slow in the cemented layer.

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g) In 2014 this area was fallow with no functional irrigation system. Previously this area was planted with stone fruit and irrigated with a drip and fan jet systems. As of April 2015, the area in the immediate vicinity of Well 17D has been planted with new pistachios with a drip irrigation system.

See **Figure 47** for a review map of Well 17D.

Exclusion from High Vulnerability Area: Well 17D is currently part of an ongoing groundwater quality monitoring program that started in 2012. There are no reported NO3 levels that exceeded the MCL from the Famoso WDR Wells data however previous data from 1971 reported a level at 49 mg/L. There are no DAC's in the general area of concern however the commercial entities are approximately 1 mile from the well area and the EC levels in the area are below the objective levels. There are newly planted pistachios with a drip irrigation system in the vicinity of the well location and there is a combination of different soil permeabilityies. There have been 11 different water quality reports for this well location and they clearly indicate there are no current NO3 groundwater quality impacts at this location. This well will continue to be monitored as part of the Famoso WDR Wells monitoring program and exhibits qualifying conditions that exclude it from a high vulnerability designation.

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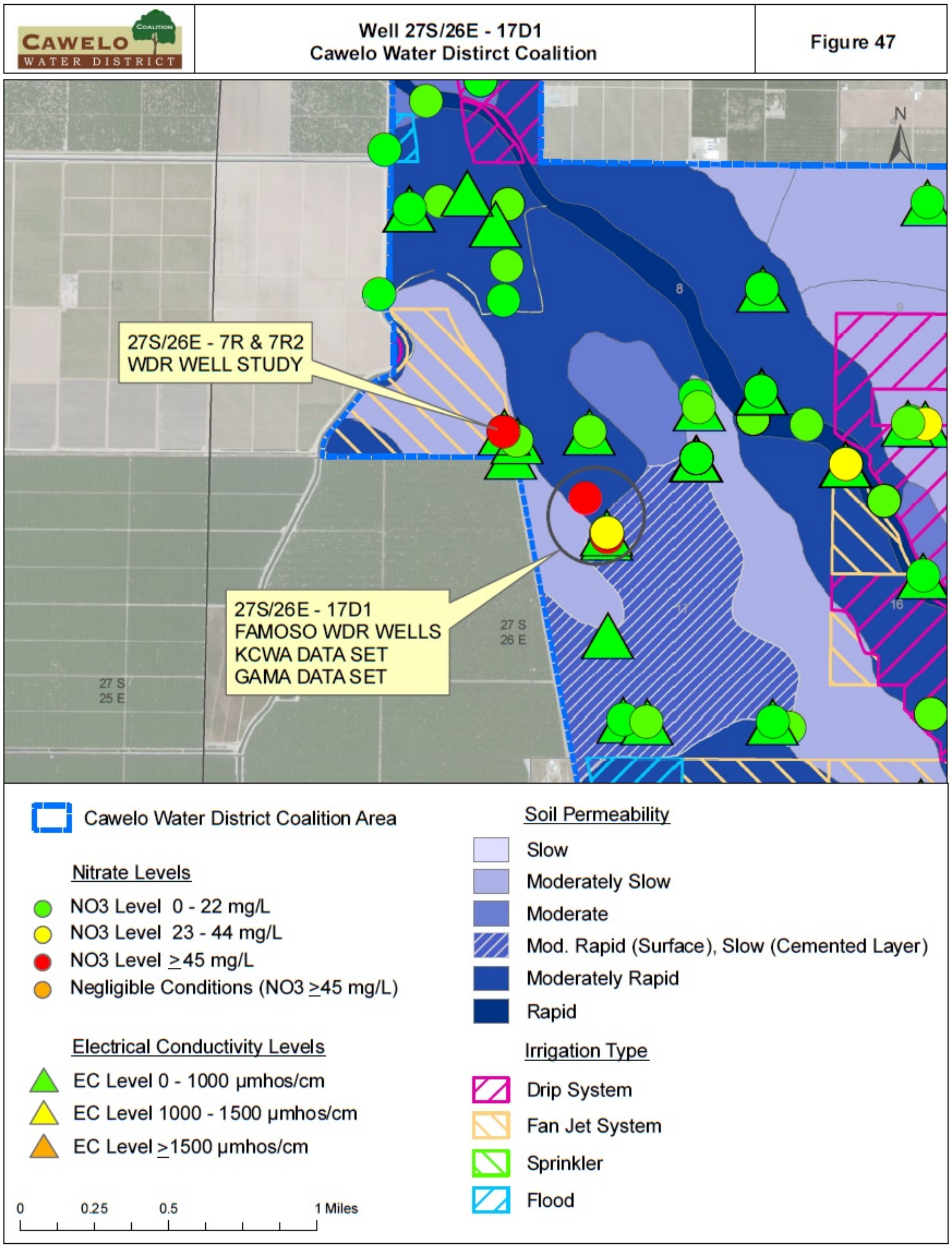
Figure 47 – Well 27S/26E – 17D1 Review



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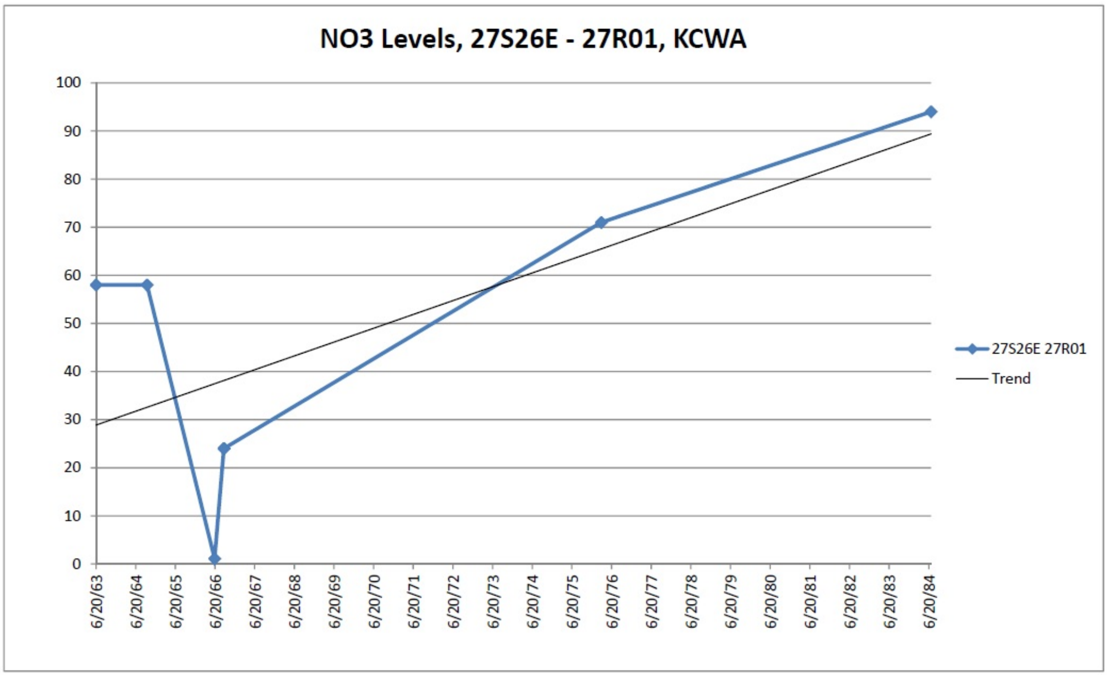
Detailed Review of Well 27S/26E – 27R01 (KCWA Data Set)

a) The data for Well 27S/26E – 27R01 (Well 27R01) was obtained from the KCWA and records indicate there are 7 different sampling results. Reported data spans the period from 1963 to 1984. There are no known current or historical monitoring programs for this well.
b) **Figure 48** is a chart summarizing the historical NO3 levels obtained from the data set. There are 2 data entries in 1996 that were recorded as being sampled on September 9 and September 10 and both report a NO3 level of 24 mg/L. These data points are separated by one day and report the same results and therefore these 2 data points will be review as a single data result.

Figure 48 – Annual NO3 Levels, 27S/26E – 27R01



The average of the reported NO3 levels is 51.0 mg/L with 4 data points exceeding the MCL. There is insufficient data to produce a valid trend analysis however the data generally indicates an increase in NO3 levels between 1963 and 1984.

c) There are no urban entities or DAC's in the vicinity of Well 27R01 however there is an commercial and industrial area approximately 3 miles to the south located at Lerdo Highway and Freeway 99. The nearest urban entity is Shafter approximately 6 miles to the southwest.
d) The available EC data in the vicinity of the well is from 1956 and 1976 with reported levels of 351 and 1200 μnmhos/cm. The information is antiquated and did not provide relevant information for the salinity levels.
e) The approximate depth to groundwater for the area of Well 27R01 is is 500 feet.
f) The SCS of the USDA describes the soil permeability at this vicinity as moderately slow.
g) The irrigation system used in this area is drip system.

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See **Figure 49** for a review map of Well 27R01.

Exclusion from High Vulnerability Area: The data available for Well 27R01 was collected approximately 30 years ago and does not provide any valid trend information or provide a level of consistency. There are no urban entities or DAC's in the vicinity of the well location and the EC information reflects groundwater conditions from approximately 30 years ago. There are no DAC's in the area of Well 27R01 and the soil permeability is moderately slow with a highly efficient irrigation system in the area. The information provided are qualifying conditions that exclude it from a high vulnerability designation.

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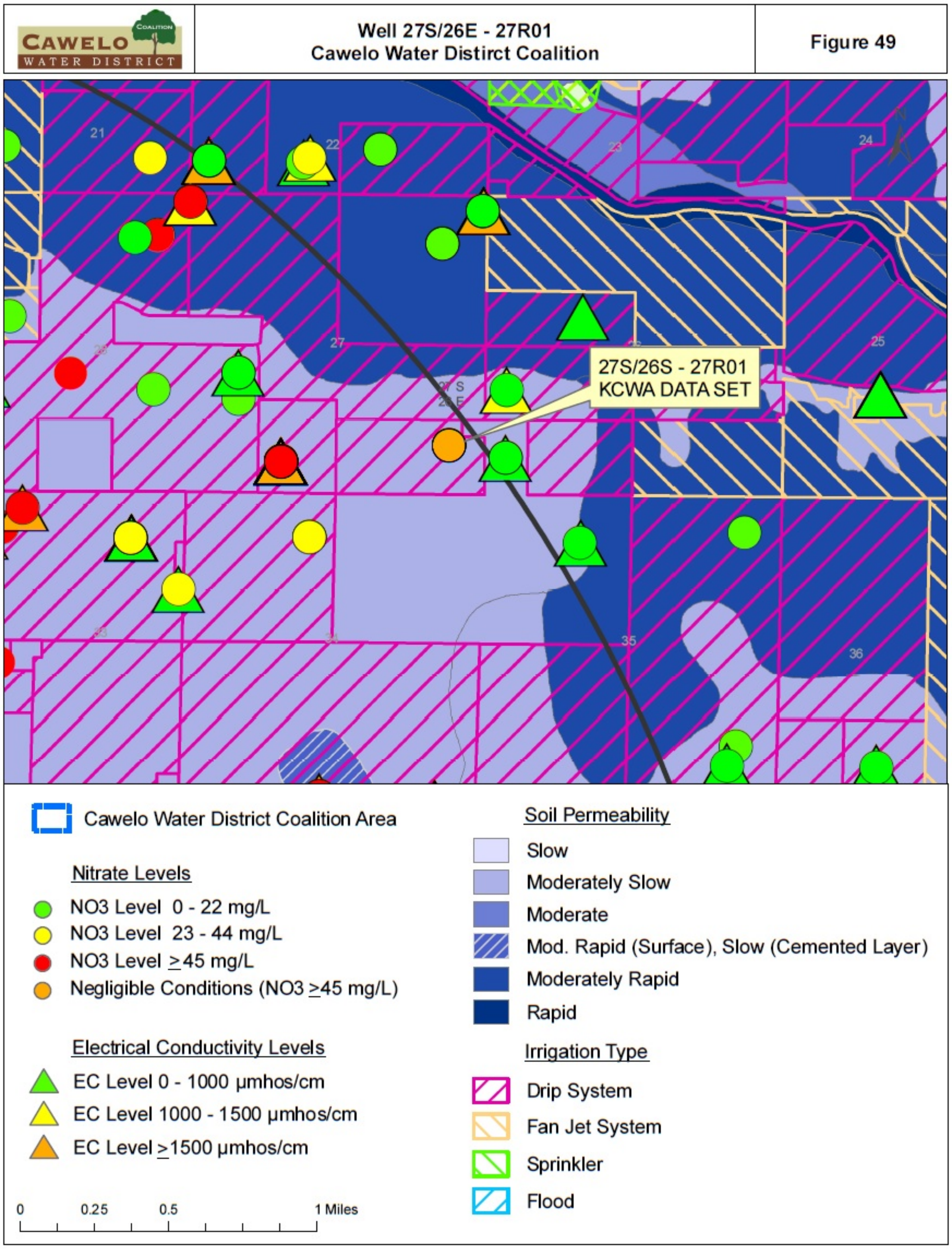
Figure 49 – Well 27S/26E – 27R01 Review



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Ph. (661) 393-6072 Fx. (661) 393-6073

2. Defining High Vulnerability Areas

Initial High Vulnerability Parcels

After further review and analysis of the isolated wells considered outside of the regional impacted groundwater quality areas, each parcel encompassing a well that was deemed to be designated high vulnerability area was highlighted and displayed on map in **Figure 50**. In instances where high vulnerability area wells were on or near parcel boundaries, the adjacent parcels were considered for high vulnerability designations. Parcels identified in this process are identified as Initial High Vulnerability Parcels.

This initial step created a fragmented or inconsistent high hulnerability area at the parcel scale. The intent of using parcel boundaries was not to reduce High Vulnerability areas to those lands in the immediate vicinity of the wells but as a means to having a process to define a boundary for high vulnerability areas and make clear which parcels are designated as such.

Gap Parcels

Subsequently, the next step was to review the areas earlier identified as Areas of NO3 Impacted Groundwater **in Figure 30**. These areas were designated areas within CWDC that exhibited impacts at the regional scale. This information was reviewed along with the Initial high vulnerability Parcels to determine any additional parcels that address the regional aspect of the impacted groundwater quality and is presented in **Figure 51**. These parcels are identified as Gap Parcels.

Community Buffer Parcels

The Regional Board places a priority on protecting the groundwater to provide urban, rural and disadvantaged communities access to safe drinking water. The report recognizes the importance of safe drinking water and incorporates this priority in the determination of High Vulnerability areas. Individual parcels were further reviewed and parcels in the vicinity of urban or rural communities or DAC's were designated high vulnerability. **Figure 52** presents the additional parcels identified as Community Buffer Parcels.

Regional Continuity

The concluding step was to evaluate continuity of designated High Vulnerability areas with the neighboring KRWCA which shares the CWDC boundary. The KRWCA submitted their GAR to the Regional Board on February 4, 2015 and provided a high vulnerability map. The KRWCA high vulnerability map is included as **Attachment 2** and the high vulnerability information was adapted to the CWDC map as presented in **Figure 53**.

As presented and characterized by CWDC, the KRWCA high vulnerability information shown on Figure 53 is not a fully accurate representation of the designated areas as provided by KRWCA and in no way should be construed as information or data that can be used to support studies, reports or other activities outside of CWDC. The information presented in Figure 53 was created by CWDC based on the KRWCA map and is merely an illustration to

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indicate the areas along the common boundaries that have been designated high vulnerability. For this purpose, Figure 53 is appropriate for evaluation of designation continuity.

Jointly, the high vulnerability areas for each coalition generally form a defined regional high vulnerability area that spans the western CWDC boundary from approximately Poso Creek to the south tip of CWDC. One significant area of conflict is exhibited in Section 17 and 20 of Township 27 South, Range 26 East and potentially the southeast corner of Section 7 in the same area. Minor areas of conflict are exhibited in the southern area in Sections 24 and 30 of Township 28 South, Range 26 East.

The CWDC assessment of these sections demonstrated that either wells with qualifying conditions or undetermined designations were present or the area had an absence of reported NO3 exceedances. These areas were not initially designated high vulnerability and created an inconsistency with the assessment conducted by KRWCA. The information presented in this assessment provides a strong argument to define the high vulnerability as presented in Figure 52 using the collective parcels described as Initial High Vulnerability Parcels, Gap Parcels and Community Buffer Parcels. However, in an effort to reduce areas of potential conflict and coalition level regional inconsistencies in high vulnerability designations, CWDC will take a conservative approach and designate additional parcels in the areas of concern. For purposes of the prioritization process and determination, these final parcels will be deemed lowest priority.

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Figure 50 – Parcels with High Vulnerability Area Designated Wells

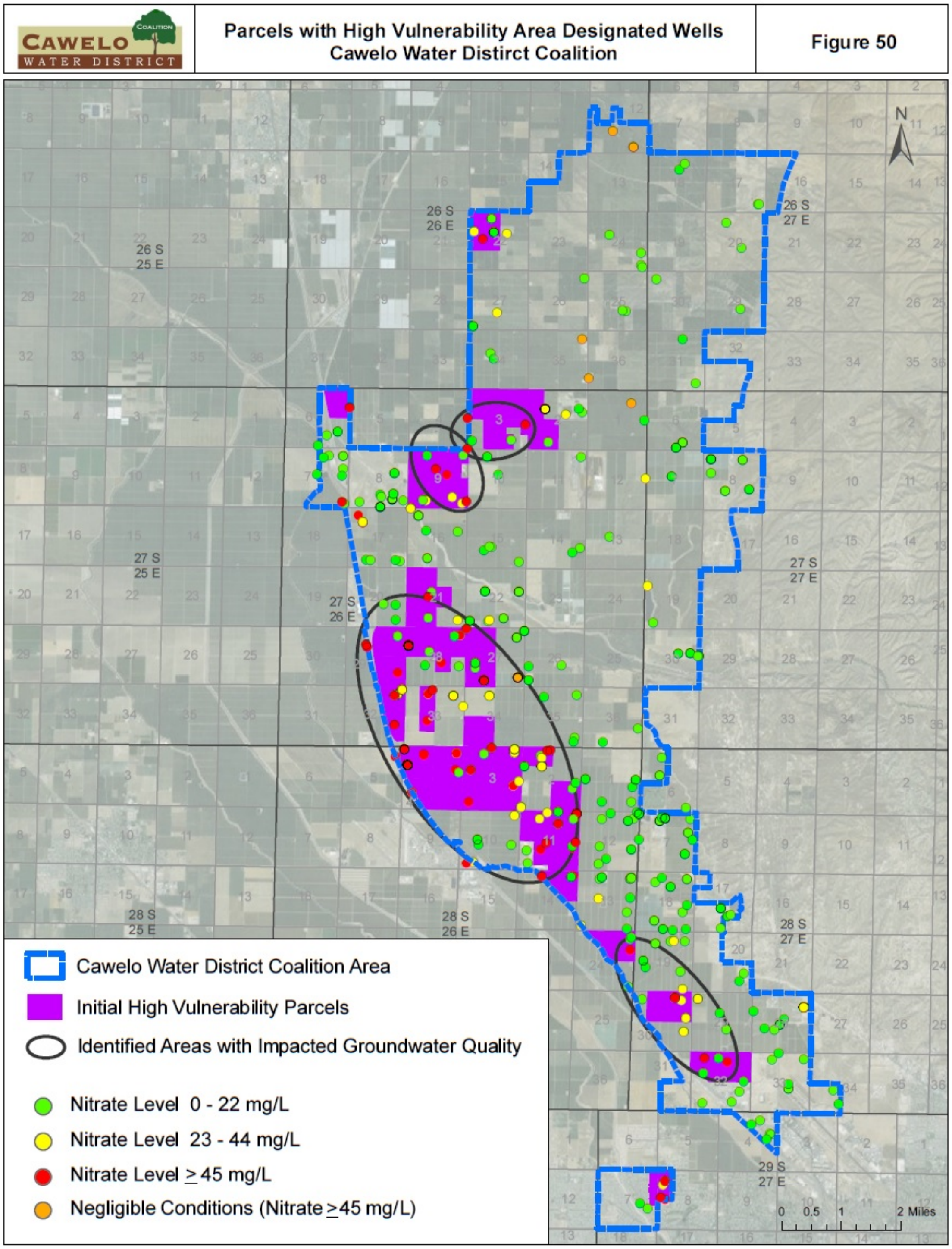

Figure 51 – Initial High Vulnerability Parcels and Gap Parcels

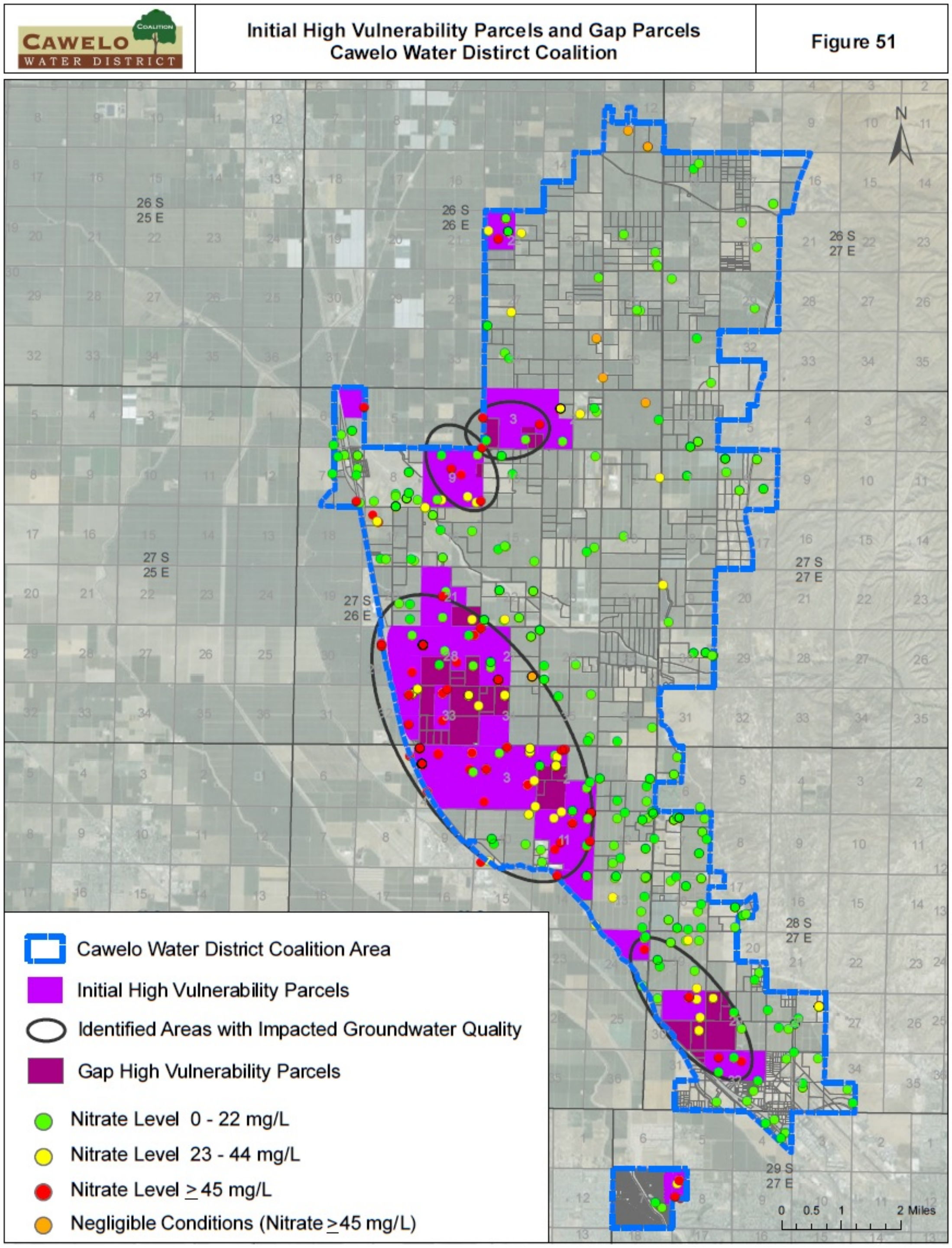

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Figure 52 – Community Protection Parcels

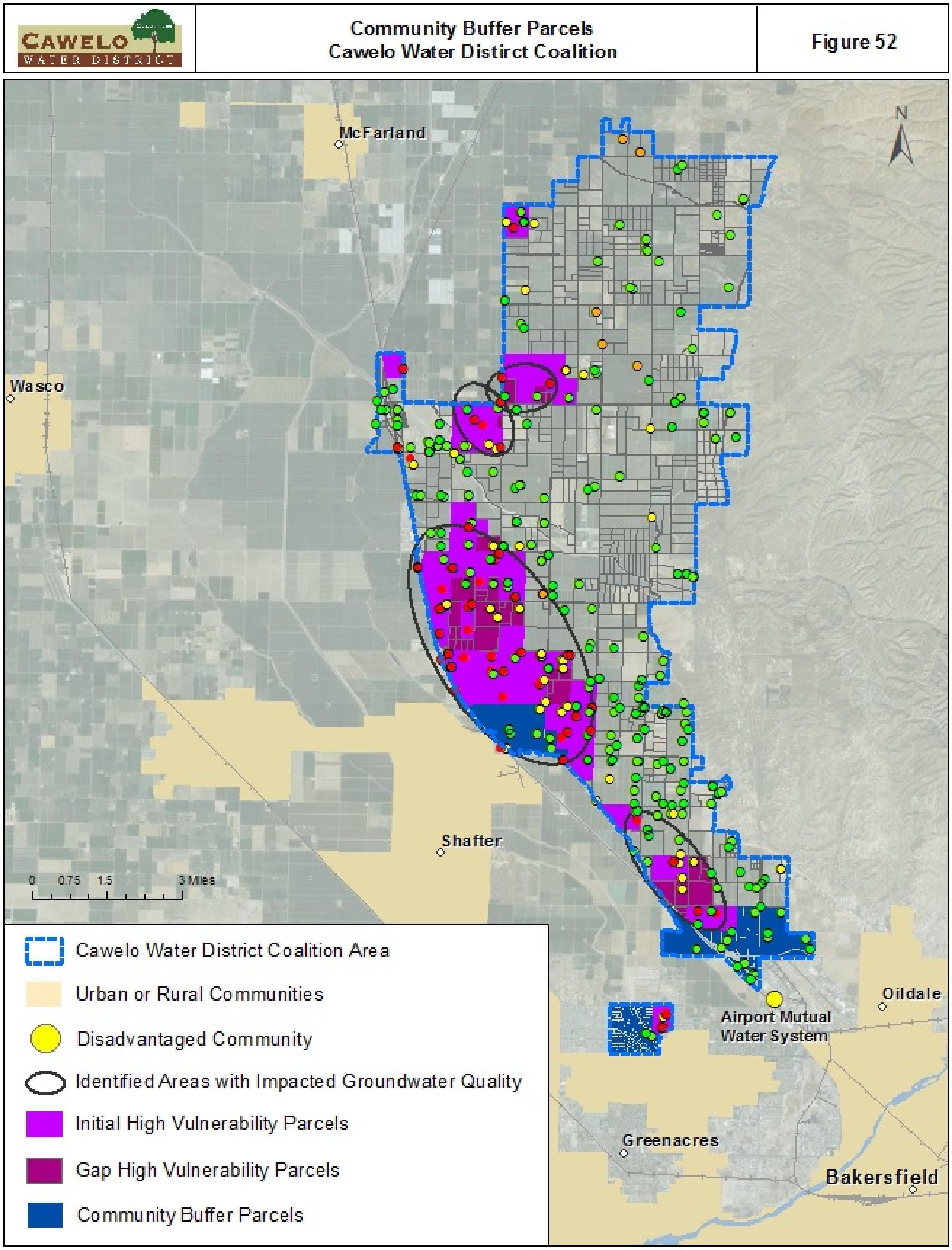

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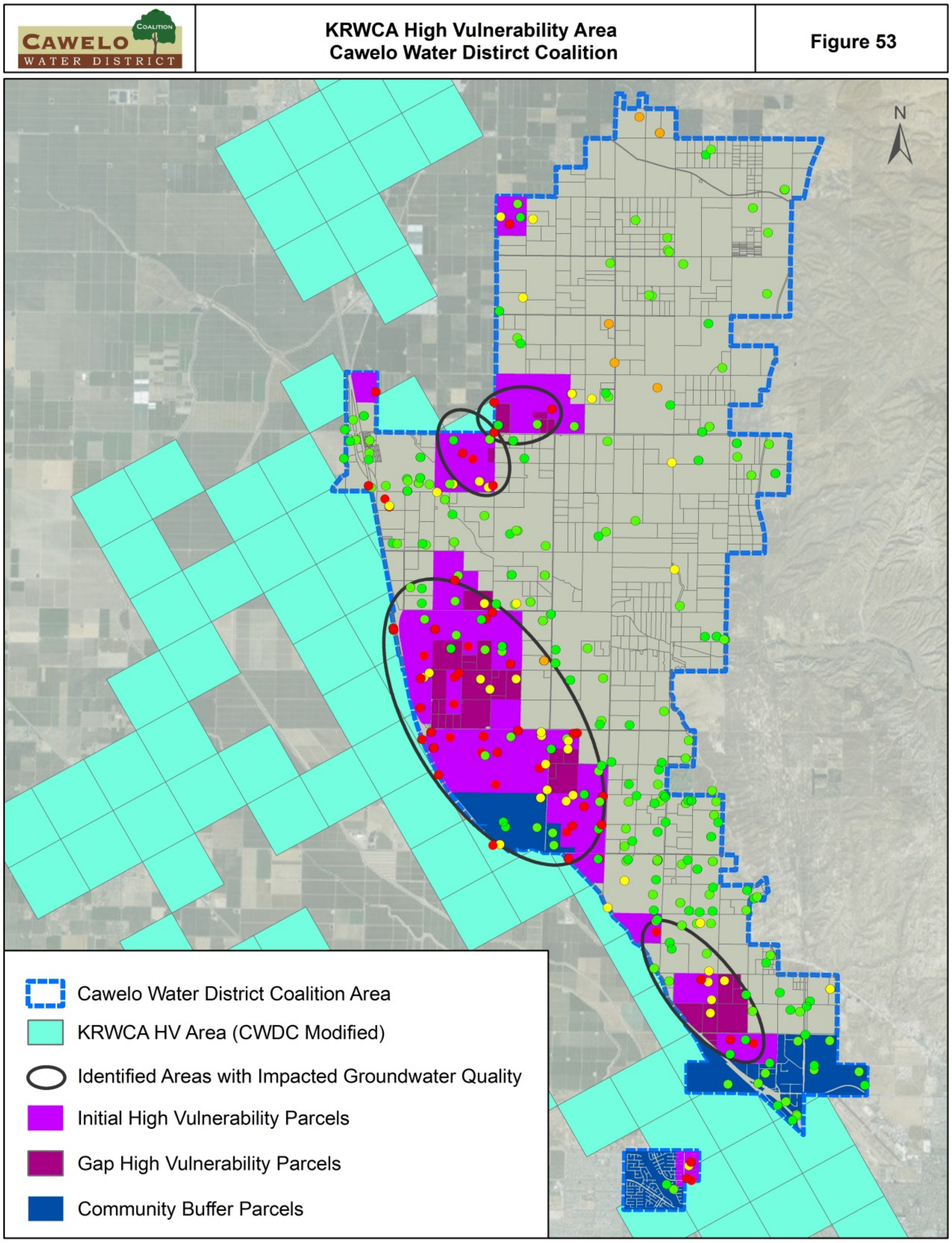
Figure 53 – KRWCA High Vulnerability Area



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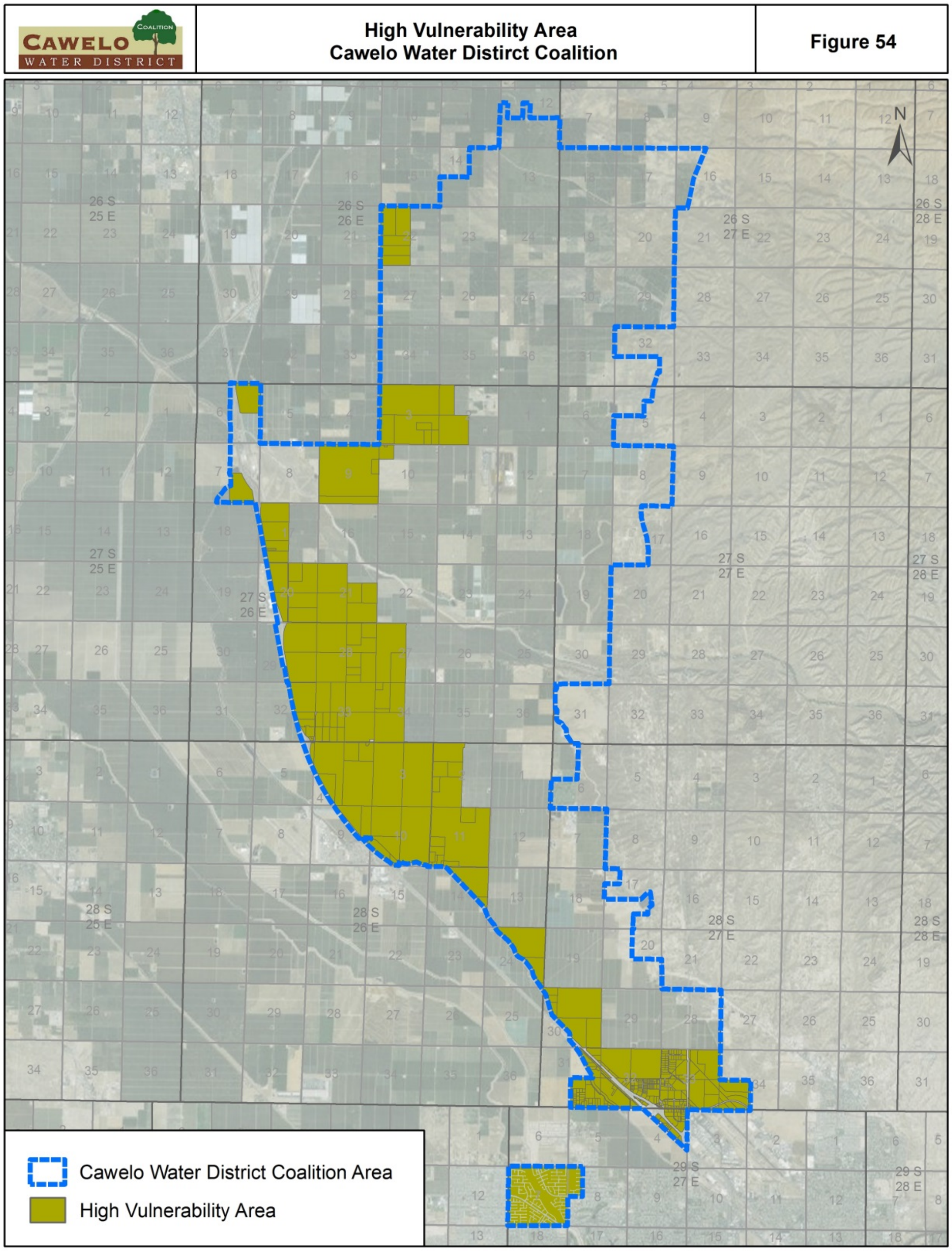
3. High Vulnerability Area Map
   Figure 54 describes the final designations for High Vulnerability areas in CWDC.

Figure 54 – High Vulnerability Area



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Ph. (661) 393-6072 Fx. (661) 393-6073

C. Prioritization of High Vulnerability Areas

In order to help focus the efforts of future groundwater quality monitoring and agricultural management plans in high vulnerability areas in the CWDC area, all designated high vulnerability areas in CWD will be prioritized into either a High, Medium, or Low priority. The factors to be considered are:

- Proximity to urban and rural communities
- Significant NO3 exceedances
- Commodity types and irrigation systems
- Soil Permeability

1. Proximity to Urban and Rural Communities
The Regional Board places a high priority on protecting the groundwater to provide urban, rural and disadvantaged communities access to safe drinking water. Areas with high vulnerability designations in the vicinity of urban and rural communities will be generally classified and High Priority. Parcels identified as Community Buffer Parcels in **Figure 52** are classified as High Priority. Additionally, parcels identified as Initial High Vulnerability Parcels that are in equal proximity to the communities as the Community Buffer Parcels are classified as High Priority.

2. Significant NO3 Exceedances
Wells with NO3 levels reported in year 2000 or later with a minimum of one occurrence of NO3 being reported greater than twice the MCL or 90mg/L or above is considered High Priority.

3. Commodity Types
Over 97% of crops reported for 2014 were almonds, citrus, pistachios and vineyards and are noted as the primary crops in CWDC. These four crops employ highly efficient irrigation systems and utilize efficient agricultural management practices. Although these commodities comprise almost the entirety of the CWDC agricultural activities, they do not warrant a classification based on commodity due to current practices. However, areas that use inefficient irrigations systems such row for flood irrigation will be classified at High Priority. Parcels identified as Initial High Vulnerability Parcels with one of the primary crops with be classified as Medium Priority.

4. Soil Permeability
Parcels in the High Vulnerability areas that have soils with permeability described as moderately rapid or rapid will be classified as High Priority. As a guideline, parcels must have a minimum of roughly 33% of the soil types to be classified as High Priority.

The remaining high vulnerability areas will be classified as Low Priority and **Figure 55** presents the prioritization of the high vulnerability areas in CWDC.

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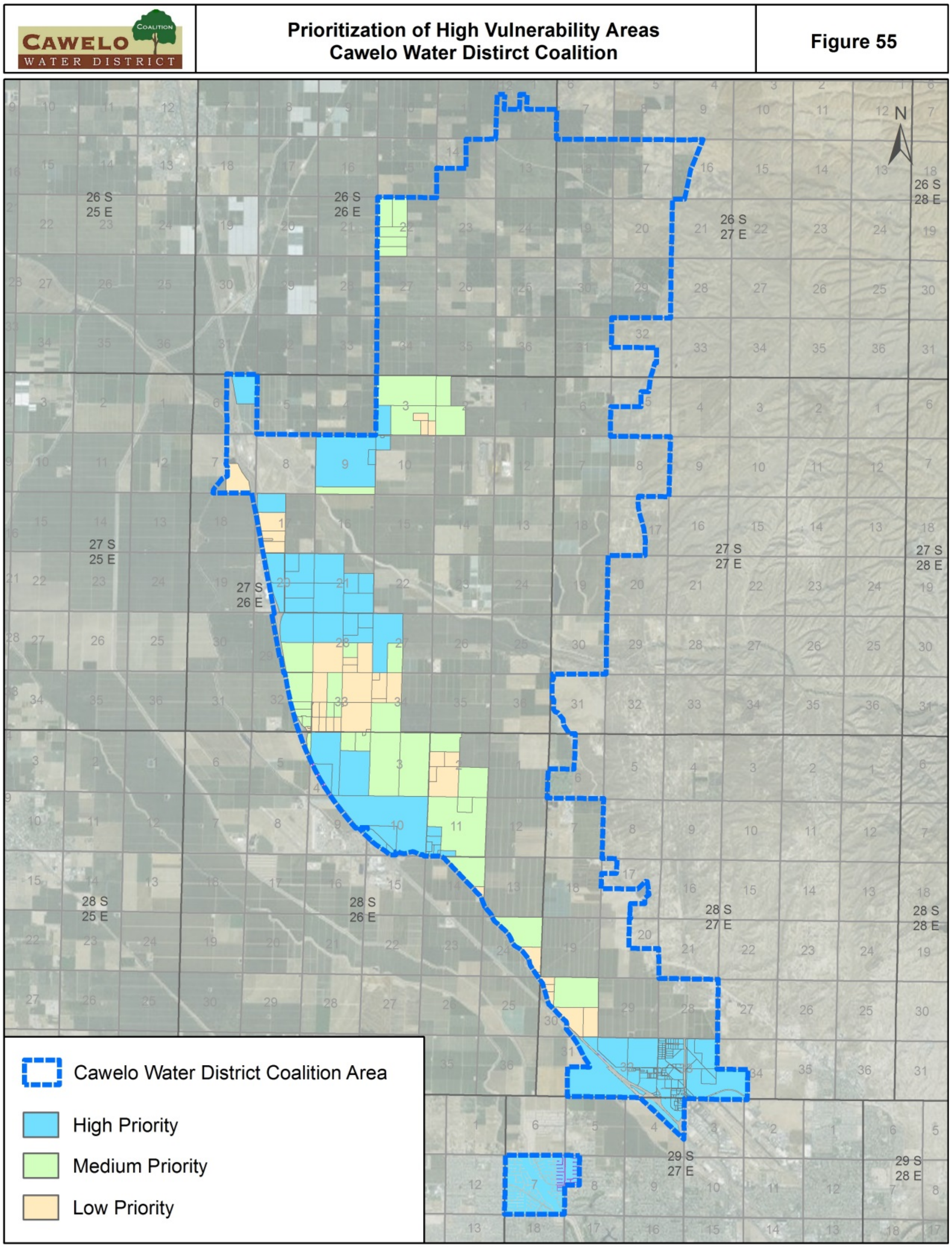
Figure 55 – Prioritization of High Vulnerability Areas



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17207 Industrial Farm Road, Bakersfield, CA 93308
Ph. (661) 393-6072 Fx. (661) 393-6073

XI. GROUNDWATER QUALITY MANAGEMENT PLAN

CWDC has prepared and will submit a Comprehensive Groundwater Quality Management Plan (CGQMP) to address the areas designated as high Vulnerability. The implementation of the CGQMP will focus on irrigation and nutrient management practices through an outreach and education program. Largely due to the depth to groundwater and potential transportation time of nitrates to reach the water table, it is impractical to quantify the effectiveness of management practices though groundwater quality monitoring. The CGQMP will incorporate and apply appropriate data, studies, and management practices developed through the MPEP and other appropriate programs.

XII. GROUNDWATER QUALITY TREND MONITORING PROGRAM

The purpose of the Groundwater Quality Trend Monitoring Program (GQTMP) is to develop long-term groundwater quality information to evaluate the regional effects of irrigated agriculture. CWDC has an extensive ongoing groundwater monitoring program that has collected data for approximately 20 years.

A. Approach for Trend Monitoring Plan

The approach is to select a groundwater monitoring network from the existing wells incorporated in the currently ongoing monitoring program. Wells selected will be representative of the impacted areas in the high vulnerability areas and additional wells outside of the high vulnerability Areas will be evaluated to address areas of potential concern. By selecting these wells, the historical data will provide a foundation for an extensive trend monitoring program.

B. Integration of Existing Monitoring Plans

The existing groundwater monitoring programs will be reviewed and evaluated for applicable integration into the GQTMP. Sampling schedules and frequencies will be considered along with the advantages of historical data available. District, GAMA, California Statewide Groundwater Elevation Monitoring Program (CASGEM) and other potential programs will be considered.

C. Basis for Development of Plan

The designated high vulnerability area in the CWDC will provide the basis to developing a groundwater monitoring plan. Wells to be monitored will focus on the High Priority areas and NO3 as the primary constituent of concern. Specific well information and characteristics will also determine well selection for the monitoring network.

A minimum of 3 wells well be selected per Township with a priority of locating wells within the High Priority areas. If this well density cannot be sufficiently defined within the High Priority areas then wells in the Medium Priority areas will be evaluated for the monitoring network. Additionally, potential well locations may be evaluated outside of the high vulnerability area if appropriate or to incorporate aspects of neighboring KRWCA's monitoring network. At minimum, wells will be sampled on an annual basis.

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17207 Industrial Farm Road, Bakersfield, CA 93308
Ph. (661) 393-6072 Fx. (661) 393-6073

XIII. SUMMARY AND RECOMMENDATIONS

A. Summary of Methodology and Determination of High Vulnerability Areas

The process of determining the high vulnerability areas established NO3 as the primary constituent of concern and parcels with known applicable NO3 exceedances automatically were designated a high vulnerability area. The CWDC area was review at the regional level to determine areas of regional groundwater quality impacts and parcels in the apparent areas of impact were also designated high vulnerability areas.

Additional parameters were consider such as EC, vicinity of communities, trends, soil types, depth to groundwater, irrigation practices and high vulnerability designations outside of the CWDC boundary to assist in developing the designations.

This information was provided or developed in GIS format to spatial analyze the different parameters and to present the information in a clear and informative manner.

B. Review of High Vulnerability Map

Figure 54 presents the high vulnerability areas within the CWDC area. The high vulnerability areas are located in the western areas of CWDC and generally south of Poso Creek. Approximately 27% of the parcels are designated high vulnerability areas. Roughly half of those parcels are classified as High Priority parcels.

C. Recommendations

The GAR provides a thorough assessment of the groundwater quality conditions within the CWDC area using available, applicable and relevant data and information to determine the high and low vulnerability areas. It is recommended that this report serves as the basis for developing the MPEP and GQTMP and CWDC continues to evaluate groundwater quality information provided from current and future monitoring programs. New and additional data or information should be reviewed and considered for GAR updates as required.

Cawelo Water District Coalition
17207 Industrial Farm Road, Bakersfield, CA 93308
Ph. (661) 393-6072 Fx. (661) 393-6073

XIV. REFERENCES

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Cawelo Water District Coalition
17207 Industrial Farm Road, Bakersfield, CA 93308
Ph. (661) 393-6072 Fx. (661) 393-6073

ATTACHMENT 1

NRCS SOIL Survey – Map Unit Descriptions

The map unit descriptions below were obtained from the Soil Survey of Kern County, California Northwestern Part document (CA666) for the Cawelo Water District Coalition area. Where noted, certain map unit descriptions were obtained from the Soil Survey of Kern County, Northeastern Part, and Southeastern Part of Tulare County, California document (CA668).

128[ne]-Capay silty clay, 2 to 9 percent slopes. This deep, moderately well drained soil is on alluvial plains and in narrow mountain valleys. It formed in alluvium derived dominantly from shale. The vegetation in areas not cultivated is mainly annual grasses and forbs. Elevation is 1,400 to 2,100 feet. The average annual precipitation is about 10 inches, the average annual temperature is about 60 degrees F, and the average frost-free season is 200 to 240 days. Typically, the surface layer is very dark grayish brown silty clay about 23 inches thick. The underlying material to a depth of 64 inches is dark brown and brown silty clay. In some areas the surface layer is clay loam or clay. Included in this unit are small areas of Nacimiento silty clay loam and Aido clay. Included areas make up about10 percent of the total acreage. Permeability of this Capay soil is slow. Available water capacity is high. Runoff is medium, and the hazard of water erosion is slight. Effective rooting depth is 60 inches or more. Most areas of this unit are used for dryfarmed grain. This unit is poorly suited to dryfarmed grain. It is limited mainly by low rainfall and the fine texture of the soil. Use of a cropping system that includes crop rotation or a cover crop, return of crop residue, and proper tillage improves soil tilth and increases water infiltration. Leaving crop residue on or near the surface helps to conserve moisture, maintain tilth, and control erosion. Because precipitation is not sufficient for annual cropping, a cropping system of grain, fallow, and then volunteer pasture is most suitable. Plants that tolerate drought are best suited because the available moisture is not adequate for good growth of most other plants.

130-Chanac clay loam, 2 to 9 percent slopes. This deep, well drained soil is on older alluvial fans and terraces. It formed in alluvium derived dominantly from granitic rock. The vegetation in areas not cultivated is mainly annual grasses and forbs. Elevation is 575 to 900 feet. The average annual precipitation is about 9 inches, the average annual temperature is about 64 degrees F, and the average frost-free season is 225 to 275 days. Typically, the surface layer is brown clay loam about 18 inches thick. The subsoil is brown sandy clay loam and sandy loam about 28 inches thick. The substratum to a depth of 60 inches or more is light brown sandy loam. In some areas the surface layer is loam or sandy loam. Included in this unit are small areas of Zerker loam and soils that are similar to this Chanac soil but do not have a subsoil. Included areas make up about 20 percent of the total acreage. Permeability of this Chanac soil is moderately slow. Available water capacity is high. Runoff is medium, and the hazard of water erosion is moderate. Effective rooting depth is 60 inches or more. Most areas of this unit are used for irrigated crops, mainly almonds, lemons, oranges, and pistachios. Among the other crops grown are dryfarmed barley and wheat. Some areas are used for livestock grazing. This unit is suited to irrigated crops. It is limited mainly by undulating to rolling slopes and the moderate hazard of erosion. Use of a cropping system that includes crop rotation or a cover crop, return of crop residue, and proper tillage improves soil tilth and increases fertility and the water intake rate. Leaving crop residue on or near the surface helps to conserve moisture, maintain tilth, and control erosion. Erosion can be reduced by planting a close growing cover crop. Diversions and grassed waterways may be needed. Because of the slope, sprinkler or drip irrigation is most suitable for orchard crops. Use of these methods permits the even, controlled application of water, reduces runoff, and minimizes the risk of erosion. Irrigation water needs to be applied at a rate that ensures optimum production without increasing deep percolation, runoff, and erosion. This unit is suited to dryfarmed grain. The main limitations are low rainfall and the hazard of erosion. Because precipitation is not sufficient for annual cropping, a cropping system of grain, fallow, and then volunteer pasture is most suitable. All tillage should be on the contour or across the slope to reduce the hazard of erosion. This unit is well suited to livestock grazing. If the range is overgrazed, the proportion of preferred forage plants decreases and the proportion of less preferred forage plants increases; therefore, livestock grazing should be managed so that the desired balance of species is maintained in the plant community. Proper grazing use increases the water intake rate, promotes plant growth early in the season, and protects the soil from erosion.

131-Chanac clay loam, 9 to 15 percent slopes. This deep, well drained soil is on older alluvial fans and terraces. It formed in alluvium derived dominantly from granitic rock. The vegetation in areas not cultivated is mainly annual grasses and forbs. Elevation is 575 to 1,000 feet. The average annual precipitation is about 9 inches, the average annual temperature is about 64 degrees F, and the average frost-free season is 225 to 275 days. Typically, the surface layer is brown clay loam about 18 inches thick. The subsoil is brown sandy clay loam and sandy loam about 28 inches thick. The substratum to a depth of 60 inches or more is light brown sandy loam. In some areas the surface layer is loam or sandy loam. Included in this unit are small areas of Delano Variant clay loam, Cuyama loam, and soils that are similar to this Chanac soil but do not have a subsoil. Included areas make up about 15 percent of the total acreage. Permeability of this Chanac soil is moderately slow. Available water capacity is high. Runoff is medium, and the hazard of water erosion is moderate. Effective rooting depth is 60 inches or more. Most areas of this unit are used for irrigated crops, mainly almonds, lemons, oranges, and pistachios. Among the other crops grown are dryfarmed barley and wheat. Some areas are used for livestock grazing. This unit is suited to irrigated crops. It is limited by the strongly sloping and rolling slopes and the moderate hazard of erosion. Use of a cropping system that includes crop rotation or a cover crop, return of crop residue, and proper tillage improves soil tilth and increases fertility and the water intake rate. Leaving crop residue on or near the surface helps to conserve moisture, maintain tilth, and control erosion. Erosion can be reduced by planting a close growing cover crop. Diversions and grassed waterways may be needed. Because of the slope, sprinkler or drip irrigation is most suitable for orchard crops. Use of these methods permits the even, controlled application of water, reduces runoff, and minimizes the risk of erosion. Irrigation water needs to be applied at a rate that ensures optimum production without increasing deep percolation, runoff, and erosion. This unit is suited to dryfarmed grain. The main limitations are low rainfall and the moderate hazard of erosion. Because precipitation is not sufficient for annual cropping, a cropping system of grain, fallow, and then volunteer pasture is most suitable. All tillage should be done on the contour or across the slope to reduce the hazard of erosion. This unit is well suited to livestock grazing. If the range is overgrazed, the proportion of preferred

forage plants decreases and the proportion of less preferred forage plants increases; therefore, livestock grazing should be managed so that the desired balance of preferred species is maintained in the plant community. Proper grazing use increases the water intake rate, promotes plant growth early in the season, and protects the soil from erosion. Uniform distribution of grazing can be achieved by the proper placement of salt and livestock watering facilities. This map unit is in capability unit IVe-1 (17), irrigated and nonirrigated. Uniform distribution of grazing can be achieved by the proper placement of salt and livestock watering facilities.
This map unit is in capability units llle-1 (17), irrigated, and IVe-1, nonirrigated.

132-Chanac clay loam, 15 to 30 percent slopes. This deep, well drained soil is on alluvial fans and terraces. It formed in alluvium derived dominantly from granitic rock. The vegetation in areas not cultivated is mainly annual grasses and forbs. Elevation is 575 to 1,000 feet. The average annual precipitation is about 9 inches, the average annual temperature is about 64 degrees F, and the average frost-free season is 225 to 275 days. Typically, the surface layer is brown clay loam about 18 inches thick. The subsoil is brown sandy clay loam and sandy loam about 28 inches thick. The substratum to a depth of 60 inches or more is light brown sandy loam. In some areas the surface layer is loam or sandy loam. Included in this unit are small areas of Delano Variant clay loam, Cuyama loam, and soils that are similar to this Chanac soil but do not have a subsoil. Included areas make up about 15 percent of the total acreage. Permeability of this Chanac soil is moderately slow. Available water capacity is high. Runoff is rapid, and the hazard of water erosion is moderate. Effective rooting depth is 60 inches or more. Most areas of this unit are used for irrigated crops, mainly almonds, lemons, oranges, and pistachios. Among the other crops grown are dryfarmed barley and wheat. Some areas are used for livestock grazing. This unit is suited to irrigated crops. It is limited mainly by the moderately steep and hilly slopes and the moderate hazard of erosion. Use of a cropping system that includes crop rotation or a cover crop, return of crop residue, and proper tillage improves soil tilth and increases fertility and the water intake rate. Leaving crop residue on or near the surface helps to conserve moisture, maintain tilth, and control erosion. Erosion can be reduced by planting a close growing cover crop. Diversions and grassed waterways may be needed. Because of the slope, sprinkler or drip irrigation is most suitable for orchard crops. Use of these methods permits the even, controlled application of water, reduces runoff, and minimizes the risk of erosion. Irrigation water needs to be applied at a rate that ensures optimum production without increasing deep percolation, runoff, and erosion. If this unit is used for dryfarmed grain, the main limitations are low rainfall and the moderate hazard of erosion. Because precipitation is not sufficient for annual cropping, a cropping system of grain, fallow, and then volunteer pasture is most suitable. This unit is suited to livestock grazing. Steepness of slope limits access by livestock and promotes overgrazing of the less sloping areas. Cross-fencing and correctly placing livestock watering facilities help to distribute livestock grazing and to reduce overgrazing of the lower slopes. Grazing should be delayed until the soil is firm and the more desirable forage plants have achieved sufficient growth to withstand grazing pressure. If the plant cover is overgrazed, the soil becomes more susceptible to erosion. Proper grazing use improves water infiltration, promotes plant growth early in the season, and protects the soil from erosion. Livestock grazing should be managed to protect the soil from erosion. This map unit is in capability unit IVe-1 (17), irrigated and nonirrigated.

138-Delano sandy loam, 0 to 2 percent slopes. This deep, well drained soil is on alluvial plains and terraces. It formed in alluvium derived dominantly from granitic rock. The vegetation in areas not cultivated is mainly annual grasses and forbs. Elevation is 300 to 700 feet. The average annual precipitation is about 7 inches, the average annual temperature is about 64 degrees F, and the average frost-free period is 260 to 290 days. Typically, the surface layer is brown and pale brown sandy loam about 11 inches thick. The subsoil is light brown clay loam and sandy clay loam about 31 inches thick. The substratum to a depth of 60 inches or more is light yellowish brown sandy loam. In some areas the surface layer is loam. Included in this unit are small areas of Cuyama loam, Exeter sandy loam, Wasco sandy loam, Kimberlina fine sandy loam, and Zerker sandy clay loam. Included areas make up about 15 percent of the total acreage. Permeability of this Delano soil is moderately slow. Available water capacity is high. Runoff is slow, and the hazard of water erosion is slight. Effective rooting depth is 60 inches or more. This unit is used mainly for irrigated crops such as alfalfa, cotton, grapes, and oranges. It is also used for urban development. This unit is suited to irrigated row and orchard crops. It has few limitations. Use of a cropping system that includes crop rotation or a cover crop, return of crop residue, and proper tillage improves soil tilth and increases fertility and the water intake rate. Furrow, border, drip, and sprinkler irrigation systems are suited to this unit. The method used generally is governed by the crop grown. To avoid overirrigating and leaching of plant nutrients, applications of irrigation water should be adjusted to the available water capacity, the water intake rate, and the crop needs. For the efficient application and removal of irrigation water, leveling is needed in sloping areas. Leaving crop residue on or near the surface helps to conserve moisture, maintain tilth, and control erosion. If this unit is used for urban development, the main limitation is rare periods of flooding. Dikes and channels that have outlets for floodwater can be used to protect buildings and onsite sewage disposal systems from flooding. Septic tank absorption fields do not function properly during rainy periods because of wetness and the moderately slow permeability. The limitation of moderately slow permeability can be overcome by increasing the size of the absorption field. This map unit is in capability class I (17), irrigated, and capability subclass VIc, nonirrigated.

139-Delano sandy loam, 2 to 5 percent slopes. This deep, well drained soil is on alluvial plains and terraces. It formed in alluvium derived dominantly from granitic rock. The vegetation in areas not cultivated is mainly annual grasses and forbs. Elevation is 300 to 700 feet. The average annual precipitation is about 7 inches, the average annual temperature is about 64 degrees F, and the average frost-free season is 260 to 290 days. Typically, the surface layer is brown and pale brown sandy loam about 11 inches thick. The subsoil is light brown clay loam and sandy clay loam about 31 inches thick. The substratum to a depth of 60 inches or more is light yellowish brown sandy loam. In some areas the surface layer is loam. Included in this unit are small areas of Cuyama loam, Zerker loam, and Premier coarse sandy loam. Included areas make up about 10 percent of the total acreage. Permeability of this Delano soil is moderately slow. Available water capacity is moderate or high. Runoff is medium, and the hazard of water erosion is moderate. Effective rooting depth is 60 inches or more. This unit is used mainly for irrigated crops such as alfalfa, almonds, cotton, and oranges. Other crops grown are barley, olives, and pistachios. The unit is also used for urban development. This unit is suited to irrigated row and orchard crops. It has few limitations. Use of a cropping system that includes crop rotation or a cover crop, return of crop residue, and proper tillage improves soil tilth and increases fertility and the water intake rate. Leaving crop residue on or near the surface helps to conserve moisture, maintain tilth, and control erosion. For the efficient application and removal of irrigation water, leveling is needed in sloping areas. Furrow, border, drip, and sprinkler irrigation systems are suited to this unit. The method used generally is governed by the crop grown. If furrow irrigation systems are used, runs should be on the contour or across the slope. Irrigation water needs to be applied at a rate that ensures optimum production without increasing deep percolation, runoff, and erosion. If this unit is used for urban development, the main limitation is rare periods of flooding. Dikes and channels that have outlets for floodwater can be used to protect buildings and onsite sewage disposal systems from flooding. Septic tank absorption fields do not function properly during rainy periods because of wetness and the moderately slow permeability. The limitation of moderately slow permeability can be overcome by increasing the size of the absorption field. This map unit is in capability unit lle-1 (17), irrigated, and capability subclass VIe, nonirrigated.

140-Delano sandy loam, 5 to 9 percent slopes. This deep, well drained soil is on alluvial plains and terraces. It formed in alluvium derived dominantly from granitic rock. The vegetation in areas not cultivated is mainly annual grasses and forbs. Elevation is 300 to 700 feet. The average annual precipitation is about 7 inches, the average annual temperature is about 64 degrees F, and the average frost-free season is 260 to 290 days. Typically, the surface layer is brown and pale brown sandy loam about 11 inches thick. The subsoil is light brown clay loam and sandy clay loam about 31 inches thick. The substratum to a depth of 60 inches or more is light yellowish brown sandy loam. In some areas the surface layer is loam. Included in this unit are small areas of Cuyama loam, Zerker loam, and Premier coarse sandy loam. Included areas make up about 15 percent of the total acreage. Permeability of the Delano soil is moderately slow. Available water capacity is moderate or high. Runoff is medium, and the hazard of water erosion is moderate. Effective rooting depth is 60 inches or more. This unit is used mainly for irrigated crops such as alfalfa, almonds, cotton, and oranges. Other crops grown are barley, olives, and pistachios. This unit is suited to irrigated row and orchard crops. It is limited mainly by moderate slopes and the moderate hazard of erosion. Use of a cropping system that includes crop rotation or a cover crop, return of crop residue, and proper tillage improves soil tilth and increases fertility and the water intake rate. Leaving crop residue on or near the surface helps to conserve moisture, maintain tilth, and control erosion. Erosion can be reduced by planting a close growing cover crop. Because of the slope, sprinkler or drip irrigation is most suitable. Use of these methods permits the even, controlled application of water, reduces runoff, and minimizes the risk of erosion. Irrigation water needs to be applied at a rate that ensures optimum production without increasing deep percolation, runoff, and erosion. This map unit is in capability unit lle-1 (17), irrigated, and capability subclass VIe, nonirrigated.

145-DrIver coarse sandy loam, 0 to 2 percent slopes. This deep, well drained soil is on terraces. It formed in alluvium derived dominantly from granitic rock. The vegetation in areas not cultivated is mainly annual grasses and forbs. Elevation is 400 to 525 feet. The average annual precipitation is about 7 inches, the average annual temperature is about 64 degrees F, and the average frost-free season is 250 to 300 days. Typically, the surface layer is yellowish brown coarse sandy loam about 16 inches thick. The subsoil is yellowish brown loam about 11 inches thick. The upper 10 inches of the substratum is brown, weakly cemented coarse sandy loam, and the lower part to a depth of 65 inches is yellowish brown and pale brown, stratified loam and loamy coarse sand. In some areas the surface layer is sandy loam. Included in this unit are small areas of Lewkalb sandy loam and Wasco sandy loam. Also included are small areas of soils that have a strongly cemented pan below a depth of 20 inches or a brittle layer below a depth of 40 inches. Included areas make up about 15 percent of the total acreage. Permeability of the Driver soil is moderately slow in the subsoil and slow in the weakly cemented substratum. Available water capacity is moderate or high. Runoff is very slow, and the hazard of water erosion is slight. Effective rooting depth is 60 inches or more, but it is somewhat restricted by the weakly cemented substratum. This unit is used for irrigated crops, mainly cotton and alfalfa. This unit is suited to irrigated crops. Ripping and shattering the weakly cemented layer improves internal drainage and eases root penetration. Leaving crop residue on or near the surface helps to conserve moisture, maintain tilth, and control erosion. Using a cropping system that includes crop rotation or a cover crop, return of crop residue, and proper tillage improves soil tilth and increases fertility and the water intake rate. Furrow, border, and sprinkler irrigation systems are suited to this unit. The method used generally is governed by the crop grown. Irrigation water needs to be applied at a rate that ensures optimum production without increasing deep percolation, runoff, and erosion. This map unit is in capability unit lls-8 (17), irrigated, and capability subclass VIIs, nonirrigated.

146—Delano sandy loam, 1 to 5 percent slopes (CA668)

Map unit setting
General location: The east side of the southern part of the San Joaquin Valley
MLRA: 17—Sacramento and San Joaquin Valleys
Landscape: Valleys
Elevation: 495 to 695 feet (152 to 213 meters)
Mean annual precipitation: 7 to 9 inches (178 to 229 millimeters)
Mean annual air temperature: 64 to 66 degrees F (18 to 19 degrees C)
Frost-free period: 260 to 290 days

Map unit composition
Delano—80 percent
Minor components—20 percent

Characteristics of Delano and similar soils
Slope: 0 to 2 percent
Landform: Fan remnants
Parent material: Alluvium derived from granitoid rocks
Typical vegetation: Irrigated crops and, in a few nonirrigated areas, annual grasses, forbs, and shrubs
Percentage of the surface covered by rock fragments: 0 to 10 percent by coarse, subangular gravel
Restrictive feature: None noted
Available water capacity to a depth of 60 inches: About 7.9 inches (high)

Hydrologic properties
Present annual flooding: Rare Present annual ponding: None
Surface runoff class: Low Current water table: None noted
Natural drainage class: Well drained
Hydrologic soil group: B

Land capability classification
Irrigated areas: 2e-1
Nonirrigated areas: 6e

Typical profile
A—0 to 18 inches; sandy loam
Btk1—18 to 37 inches; sandy clay loam
Btk2—37 to 60 inches; sandy loam

Minor components

Hesperia and similar soils
Extent: About 7 percent of the map unit
Slope: 0 to 2 percent
Landform: Inset fans

Pleito and similar soils
Extent: About 5 percent of the map unit
Slope: 0 to 3 percent
Landform: Fan remnants

Arents, loamy, and similar soils Extent: About 3 percent of the map unit Slope: 1 to 3 percent
Landform: Alluvial fans

Calicreek and similar soils
Extent: About 2 percent of the map unit
Slope: 0 to 2 percent
Landform: Flood plains

Oil waste land
Extent: About 1 percent of the map unit
Slope: 1 to 3 percent
Landform: Alluvial fans and depressions

Riverwash
Extent: About 1 percent of the map unit
Slope: 0 to 1 percent
Landform: Drainageways

Urban land
Extent: About 1 percent of the map unit
Slope: 0 to 1 percent
Landform: Alluvial fans

146[ne]-Elkhills sandy loam, 9 to 50 percent slopes, eroded. This deep, well drained soil is primarily on uplifted, dissected old areas of valley fill. It formed in alluvium derived dominantly from sedimentary and granitic rock. The vegetation in areas not cultivated is mainly annual grasses, forbs, and scattered shrubs. Elevation is 600 to 1,800 feet. The average annual precipitation is about 7 inches, the average annual temperature is about 63 degrees F, and the average frost-free season is about 240 to 300 days. Typically, the surface layer is pale brown sandy loam about 7 inches thick. The subsurface layer is light yellowish brown fine sandy loam about 22 inches thick. The upper 20 inches of the underlying material is very pale brown coarse sandy loam, and the lower part to a depth of 65 inches or more is light gray, stratified gravelly coarse sand, sand, and loamy sand. In some areas the surface layer is loam or gravelly sandy loam. Included in this unit are small areas of Torriorthents; stratified, very sandy soils; and soils that have loam or clay loam in the underlying material. Included areas make up about 20 percent of the total acreage. Each included area is less than 15 percent of the total inclusions. Permeability of this Elkhills soil is moderately rapid. Available water capacity is moderate or high. Runoff is medium, and the hazard of water erosion is moderate. Effective rooting depth is 60 inches or more. Road building, petroleum construction activities, and past sheep grazing have disturbed the vegetation and surface layer in parts of this unit. These activities have exposed highly erodible soil material and increased the rate of erosion. Recently eroded soil material has accumulated in drainageways. In some areas erosion is more extensive on south-facing slopes. A few areas of this unit are used for livestock grazing. Oil wells are common on the unit. This unit is suited to livestock grazing. The production of forage is limited by low rainfall and steepness of slope. If the plant cover is overgrazed, the soil becomes more susceptible to soil erosion. Loss of the surface layer results in a severe decrease in productivity and in the potential of the soil to produce forage. Reestablishment of vegetation may be difficult if erosion has exposed material that is high in content of salt. Cross-fencing and correctly placing livestock watering facilities help to distribute livestock grazing and to reduce overgrazing of the lower slopes. This unit is limited for livestock watering ponds and other water impoundments because of the moderately rapid permeability of the soil. This map unit is in capability subclass *VIIe* (17), nonirrigated.

154-Exeter sandy loam, 0 to 2 percent slopes. This moderately deep, well drained soil is on alluvial terraces. It formed in alluvium derived dominantly from granitic rock. The vegetation in areas not cultivated is mainly annual grasses and forbs. Elevation is 300 to 600 feet. The average annual precipitation is about 8 inches, the average annual temperature is about 63 degrees F, and the average frost-free season is 250 to 300 days. Typically, the surface layer is pale brown sandy loam about 17 inches thick. The subsoil is brown loam about 7 inches thick. The next layer is a strongly lime- and silica-cemented layer about 14 inches thick. Stratified layers are below the pan. In some areas the surface layer is loam. Included in this unit are small areas of Delano sandy loam and Zerker loam. Included areas make up about 15 percent of the total acreage. Permeability of this Exeter soil is moderate. Available water capacity is very low to moderate. Runoff is slow, and the hazard of water erosion is slight. Effective rooting depth is 20 to 40 inches. Most areas of this unit are used for irrigated crops, mainly cotton, almonds, grapes, and oranges. Among the other crops grown are barley, alfalfa, and figs. This unit is suited to irrigated row and orchard crops. It is limited mainly by the moderate depth to the cemented layer. Use of a cropping system that includes crop rotation or a cover crop, return of crop residue, and proper tillage improves soil tilth and increases fertility and the water intake rate. Leaving crop residue on or near the surface helps to conserve moisture, maintain tilth, and control erosion. Ripping and shattering the cemented layer increases the effective rooting depth and improves internal drainage. Furrow, border, drip, and sprinkler irrigation systems are suited to this unit. The method used generally is governed by the crop grown. Irrigation water needs to be applied at a rate that ensures optimum production without increasing deep percolation, runoff, and erosion. This map unit is in capability units llls-8 (17), irrigated, and IVs-8, nonirrigated.

174-Kimberllna fine sandy loam, 0 to 2 percent slopes. This deep, well drained soil is on alluvial fans and plains. It formed in alluvium derived dominantly from granitic and sedimentary rock. The vegetation in areas not cultivated is mainly annual grasses and forbs with few scattered shrubs. Elevation is 250 to 1,000 feet. The average annual precipitation is about 6 inches, the average annual temperature is about 64 degrees F, and the average frost-free season is 250 to 300 days. Typically, the surface layer is brown fine sandy loam about 9 inches thick. The upper 36 inches of the underlying material is pale brown fine sandy loam, and the lower part to a depth of 71 inches is pale brown silt loam. In some areas the surface layer is sandy loam or coarse sandy loam. Included in this unit are small areas of Wasco sandy loam, Milham sandy loam, and Cajon loamy sand. Also included are small areas of soils that are similar to this Kimberlina soil but have a sandy clay loam surface layer. Included areas make up about 15 percent of the total acreage. Permeability of this Kimberlina soil is moderate. Available water capacity is high. Runoff is slow, and the hazard of water erosion is slight. Effective rooting depth is 60 inches or more. Most areas of this unit are used for irrigated crops, mainly almonds, alfalfa, cotton, and grapes. Among the other crops grown are potatoes, sugar beets, pistachios, and onions. Some areas are used for irrigated pasture, limited livestock grazing, and urban development. This unit is suited to irrigated crops. It has few limitations. Furrow, border, and sprinkler irrigation systems are suited to this unit. The method used generally is governed by the crop grown. To avoid overirrigating and leaching of plant nutrients, applications of irrigation water should be adjusted to the available water capacity, the water intake rate, and the crop needs. Use of a cropping system that includes crop rotation, growing a cover crop, return of crop residue, and proper tillage improves soil tilth and increases fertility and the water intake rate. Leaving crop residue on or near the surface helps to conserve moisture, maintain tilth, and control erosion. This unit is suited to hay and pasture. It has few limitations. Border and sprinkler irrigation systems are suited to this unit. To avoid overirrigating and leaching of plant nutrients, applications of irrigation water should be adjusted to the available water capacity, the water intake rate, and the crop needs. Proper stocking rates, pasture rotation, and restricted grazing during wet periods help to keep the pasture in good condition and to protect the soil from erosion. Periodic mowing and clipping help to maintain uniform growth, discourage selective grazing, and reduce clumpy growth. Proper grazing practices, weed control, and fertilizer are needed to ensure maximum quality of forage. If this unit is used for urban development, the main limitation is rare periods of flooding. If the density of housing is moderate to high, community sewage systems are needed to prevent contamination of water supplies as a result of seepage from onsite sewage disposal systems. Dikes and channels that have outlets for floodwater can be used to protect buildings and onsite sewage disposal systems from flooding.
This map unit is in capability class I (17), irrigated, and capability subclass VIIe, nonirrigated.

175-Kimberllna sandy loam, 2 to 5 percent slopes. This deep, well drained soil is on alluvial fans and plains. It formed in alluvium derived dominantly from granitic and sedimentary rock. The vegetation in most areas not cultivated is mainly annual grasses and forbs with scattered shrubs. Elevation is 250 to 1,000 feet. The average annual precipitation is about 6 inches, the average annual temperature is about 64 degrees F, and the average frost-free season is 250 to 300 days. Typically, the surface layer is brown sandy loam about 9 inches thick. The upper 36 inches of the underlying material is pale brown fine sandy loam, and the lower part to a depth of 71 inches is pale brown silt loam. In some areas the surface layer is fine sandy loam or coarse sandy loam. Included in this unit are small areas of Wasco sandy loam, Milham sandy loam, and Panache clay loam. Included areas make up about 15 percent of the total acreage.

Permeability of this Kimberlina soil is moderate. Available water capacity is high. Runoff is slow, and the hazard of water erosion is moderate. Effective rooting depth is 60 inches or more. This unit is used mainly for livestock grazing. It is also used for irrigated crops, urban development, and recreation. This unit is suited to irrigated crops. It has few limitations. Furrow, border, drip, and sprinkler irrigation systems are suited to this unit. The method used generally is governed by the crop grown. To avoid overirrigating and leaching of plant nutrients, applications of irrigation water should be adjusted to the available water capacity, the water intake rate, and the crop needs. For the efficient application and removal of irrigation water, leveling is needed in sloping areas. Salt tolerant crops should be grown while the soil is being reclaimed. Some areas are slightly saline-alkali in the native state. Use of a cropping system that includes crop rotation or a cover crop, return of crop residue, and proper tillage improves soil tilth and increases fertility and the water intake rate. Leaving crop residue on or near the surface helps to conserve moisture, maintain tilth, and control erosion. Erosion can be reduced by planting a close growing cover crop. This unit is suited to livestock grazing. The production of forage is limited by low rainfall. If the plant cover is overgrazed, the soil becomes more susceptible to erosion. Proper grazing use increases the water intake rate, promotes plant growth early in the season, and protects the soil from erosion. Uniform distribution of grazing can be achieved by the proper placement of salt and livestock watering facilities. Grazing should be delayed until the soil is firm and the more desirable forage plants have achieved sufficient growth to withstand grazing pressure. This unit is suited to recreation. It has few limitations for this use. Erosion and sedimentation can be controlled and the beauty of the area enhanced by maintaining adequate plant cover. Areas used for recreation can be protected from erosion by maintaining plant cover. If this unit is used for urban development, it has few limitations. If the density of housing is moderate to high, community sewage systems are needed to prevent contamination of water supplies as a result of seepage from onsite sewage disposal systems. This map unit is in capability unit IIe-1 (17), irrigated, and capability subclass VIIe, nonirrigated.

184-Lewkalb sandy loam, 0 to 2 percent slopes. This deep, well drained soil is on low terraces. It formed in alluvium derived dominantly from granitic rock. The native vegetation is mainly annual grasses and forbs. Elevation is 300 to 600 feet. The average annual precipitation is about 6 inches, the average annual temperature is about 64 degrees F, and the average frost-free season is 250 to 300 days.

Typically, the surface layer is light brownish gray and pale brown sandy loam about 23 inches thick. The upper 17 inches of the underlying material is weakly silica- cemented light gray sandy loam, and the lower part to a depth of 65 inches is light gray loamy sand. In some areas the surface layer is gravelly sandy loam or loam. Included in this unit are small areas of Wasco sandy loam and soils that have a weakly silica-cemented layer below a depth of 48 inches. Included areas make up about 15 percent of the total acreage. Permeability of this Lewkalb soil is moderately rapid in the surface layer and slow in the underlying cemented layer. Available water capacity is moderate. Runoff is very slow, and the hazard of water erosion is slight. Effective rooting depth is 60 inches or more but is somewhat limited by the weakly silica-cemented layer. This unit is used for irrigated crops, mainly cotton, potatoes, and alfalfa. This unit is suited to irrigated row crops. It is limited mainly by the weakly silica-cemented layer. Use of a cropping system that includes crop rotation or a cover crop, return of crop residue, and proper tillage improves soil tilth and increases fertility and the water intake rate. Ripping and shattering the weakly cemented layer improve drainage. Furrow, border, and sprinkler irrigation systems are suited to this unit. The method used generally is governed by the crop grown. Irrigation water needs to be applied at a rate that ensures optimum production without increasing deep percolation, runoff, and erosion. This map unit is in capability unit IIs-8 (17), irrigated, and capability subclass VIIs, nonirrigated.

192-McFarland loam. This deep, well drained soil is on alluvial fans and flood plains. It formed in alluvium derived dominantly from granitic rock. Slope is 0 to 2 percent. The vegetation in areas not cultivated is mainly annual grasses and forbs. Elevation is 285 to 400 feet. The average annual precipitation is about 6 inches, the average annual temperature is about 64 degrees F, and the average frost-free period is 250 to 275 days. Typically, the surface layer is grayish brown and brown loam about 24 inches thick. The upper 31 inches of the underlying material is pale brown and brown loam, and the lower part to a depth of 64 inches or more is light gray loam. In some areas the surface layer is clay loam and the lower part of the underlying material is fine sandy loam or sandy loam. Included in this unit are small areas of Wasco sandy loam, Kimberlina fine sandy loam, and Panoche clay loam. Included areas make up about 15 percent of the total acreage. Permeability of this McFarland soil is moderate. Available water capacity is high. Runoff is slow, and the hazard of water erosion is slight. Effective rooting depth is 60 inches or more. Most areas of this unit are used for irrigated crops, mainly alfalfa, cotton, and grapes. Among the other crops grown are milo, walnuts, and roses. Some areas are used for homesite developments. This unit is suited to irrigated crops. It has few limitations. Use of a cropping system that includes crop rotation or a cover crop, return of crop residue, and proper tillage improves soil tilth and increases fertility and the water intake rate. Maintaining crop residue on or near the surface reduces runoff and helps to maintain soil tilth and organic matter content. Furrow, border, and sprinkler irrigation systems are suited to this unit. The method used generally is governed by the crop grown. To avoid overirrigating and leaching of plant nutrients, applications of irrigation water should be adjusted to the available water capacity, the water intake rate, and the crop needs. If this unit is used for homesite development, the main limitation is rare periods of flooding. Dikes and channels that have outlets for floodwater can be used to protect buildings and onsite sewage disposal systems from flooding. Selection of adapted vegetation is critical for the establishment of lawns, shrubs, trees, and vegetable gardens. If the density of housing is moderate to high, community sewage systems are needed to prevent contamination of water supplies as a result of seepage from onsite sewage disposal systems. This map unit is in capability class I (17), irrigated, and capability subclass VIIe, nonirrigated.

200—Urban land-Delano complex, 0 to 2 percent slopes (CA668)

Map unit setting

General location: The east side of the southern part of the San Joaquin Valley
MLRA: 17—Sacramento and San Joaquin Valleys

Landscape: Valleys
Elevation: 495 to 695 feet (152 to 213 meters)
Mean annual precipitation: 7 to 9 inches (178 to 229 millimeters)
Mean annual air temperature: 64 to 66 degrees F (18 to 19 degrees C)
Frost-free period: 260 to 300 days

Map unit composition
Urban land—60 percent
Delano—25 percent
Minor components—15 percent

Characteristics of Urban land
Slope: 0 to 1 percent
Landform: Alluvial fans and fan remnants Typical vegetation: None assigned Hydrologic properties
Surface runoff class: Very high
Hydrologic soil group: D
Land capability classification
Nonirrigated areas: 8

Characteristics of Delano and similar soils
Slope: 0 to 2 percent
Landform: Fan remnants
Parent material: Alluvium derived from granitoid rocks
Typical vegetation: Irrigated crops and, in a few nonirrigated areas, annual grasses, forbs, and shrubs
Percentage of the surface covered by rock fragments: 0 to 10 percent by coarse, subangular gravel
Restrictive feature: None noted
Available

Hydrologic properties
Present annual flooding: Rare Present annual ponding: None
Surface runoff class: Low Current water table: None noted
Natural drainage class: Well drained
Hydrologic soil group: B

Land capability classification
Irrigated areas: 2e-1
Nonirrigated areas: 6e

Typical profile
A—0 to 18 inches; sandy loam
Btk1—18 to 37 inches; sandy clay loam
Btk2—37 to 60 inches; sandy loam

Minor components

Arents, loamy, and similar soils Extent: About 9 percent of the map unit Slope: 1 to 3 percent
Landform: Fan remnants

Hesperia and similar soils
Extent: About 5 percent of the map unit
Slope: 0 to 2 percent
Landform: Inset fans

Oil waste land
Extent: About 1 percent of the map unit
Slope: 1 to 3 percent
Landform: Fan remnants

200[ne]-MIIIsholm Variant-Montara complex, 15 to 30 percent slopes. This map unit is on hills and mountains. The present vegetation in most areas is mainly annual grasses, forbs, and shrubs. Elevation is 1,500 to 2,800 feet. The average annual precipitation is about 10 inches, the average annual air temperature is about 60 degrees F, and the average frost-free season is about 200 to 250 days. This unit is 45 percent Millsholm Variant sandy loam and 40 percent Montara clay loam. The components of this unit are so intricately intermingled that it was not practical to map them separately at the scale used. Included in this unit are small areas of Nacimiento silty clay loam and Ayar silty clay. Included areas make up about 15 percent of the total acreage. The Millsholm Variant soil is shallow and well drained. It formed in residuum derived dominantly from sandstone or shale. Typically, the surface layer is light brownish gray sandy loam about 5 inches thick. The subsoil is pale brown sandy loam about 6 inches thick. Fractured shale is at a depth of 11 inches. The soil is about 5 to 15 percent gravel. In some areas the surface layer is loam or clay loam. Permeability of the Millsholm Variant soil is moderate. Available water capacity is very low. Runoff is rapid, and the hazard of water erosion is moderate. Effective rooting depth is 10 to 20 inches. The Montara soil is shallow and well drained. It formed in residuum derived dominantly from serpentine. Typically, the soil is gray and grayish brown clay loam about 14 inches thick over serpentine. Permeability of the Montara soil is moderately slow. Available water capacity is very low or low. Runoff is rapid, and the hazard of water erosion is moderate. Effective rooting depth is 10 to 20 inches. This unit is used for livestock grazing. This unit is poorly suited to livestock grazing. The production of forage on the Millsholm Variant soil is limited by the very low available water capacity and shallow depth to bedrock. Production on the Montara soil is limited by a calcium to magnesium imbalance and the restricted available water capacity. This unit supports sparse stands of plants that are suitable for grazing. The herbaceous plant cover readily deteriorates if it is overgrazed. Proper grazing use increases the water intake rate, promotes plant growth early in the season, and protects the soil from erosion. Grazing should be delayed until the soil is firm and the more desirable forage plants have achieved sufficient growth to withstand grazing pressure. This map unit is in capability subclass VIIe (15), nonirrigated.

222-Premler coarse sandy loam, 2 to 5 percent slopes. This deep, well drained soil is on terraces. It formed in alluvium derived dominantly from granitic rock. The vegetation in areas not cultivated is mainly annual grasses and forbs. Elevation is 500 to 650 feet. The average annual precipitation is about 8 inches, the average annual temperature is about 63 degrees F, and the average frost-free season is 250 to 300 days. Typically, the surface layer is grayish brown and pale brown coarse sandy loam about 2 inches thick. The underlying material to a depth of 60 inches or more is light yellowish brown and brown coarse sandy loam. In some areas the surface layer is sandy loam or loam. Included in this unit are small areas of Delano sandy loam and Zerker loam. Included areas make up about 5 percent of the total acreage. Permeability of this Premier soil is moderately rapid. Available water capacity is moderate. Runoff is slow, and the hazard of water erosion is slight. Effective rooting depth is 60 inches or more. Most areas of this unit are used for livestock grazing. Oil wells are common on this unit. A few areas are used for irrigated crops such as citrus fruit, almonds, and cotton and for homesite development. This unit is suited to irrigated row and orchard crops. It is limited mainly by undulating slopes. Use of a cropping system that includes crop rotation or a cover crop, return of crop residue, and proper tillage improves soil tilth and increases the fertility and water intake rate. Growing a cover crop in nontilled areas increases the water intake rate and reduces runoff and erosion. Because of the slope, sprinkler or drip irrigation is best suited to this unit. Irrigation water needs to be applied at a rate that ensures optimum production without increasing deep percolation, runoff, and erosion. This unit is suited to livestock grazing. It has no major limitations. Proper grazing use increases the water intake rate, promotes plant growth early in the season, and protects the soil from erosion. Correct placement of salt and supplemental feed helps to distribute livestock grazing and prevent overgrazing. This unit is limited for livestock watering ponds and other water impoundments because of the moderately rapid permeability of the soil. If this unit is used for homesite development, it has few limitations. Preserving the existing plant cover during construction helps to control erosion. Plant cover can be established and maintained through proper fertilizing, seeding, mulching, and shaping of the slopes. In summer, irrigation is needed for lawn grasses, shrubs, vines, shade trees, and ornamental trees. This map unit is in capability units lie-(17), irrigated, and IVe-1, nonirrigated.

223-Premler coarse sandy loam, 5 to 9 percent slopes. This deep, well drained soil is on terraces. It formed in alluvium derived dominantly from granitic rock. The vegetation in areas not cultivated is mainly annual grasses and forbs. Elevation is 500 to 700 feet. The average annual precipitation is about 8 inches, the average annual temperature is about 63 degrees F, and the average frost-free season is 250 to 300 days. Typically, the surface layer is grayish brown and pale brown coarse sandy loam about 2 inches thick. The underlying material to a depth of 60 inches or more is light yellowish brown and brown coarse sandy loam. In some areas the surface layer is sandy loam or loam. Included in this unit are small areas of Delano sandy loam and Zerker loam. Included areas make up about 15 percent of the total acreage. Permeability of this Premier soil is moderately rapid. Available water capacity is moderate. Runoff is medium, and the hazard of water erosion is moderate. Effective rooting depth is 60 inches or more. Most areas of this unit are used for livestock grazing. A few areas are used for irrigated crops such as almonds or citrus fruit. Oil wells are common on this unit. This unit is suited to orchard crops. It is limited mainly by gently rolling slopes. Use of a cropping system that includes crop rotation or a cover crop, return of crop residue, and proper tillage improves soil tilth and increases the fertility and water intake rate. Growing a cover crop in nontilled areas increases water infiltration and reduces runoff and erosion. Because of the slope, sprinkler or drip irrigation is best suited to this unit. Irrigation water needs to be applied at a rate that ensures optimum production without increasing deep percolation, runoff, and erosion. This unit is suited to livestock grazing. It has no major limitations. Proper grazing use increases the water intake rate, promotes plant growth early in the season, and protects the soil from erosion. Correct placement of salt and supplemental feed helps to distribute livestock grazing and prevent overgrazing. This unit is limited for livestock watering ponds and other water impoundments because of the seepage potential. If this unit is used for homesite development, it has few limitations. Excavation for roads and buildings increases the hazard of erosion. Revegetating disturbed areas around construction sites as soon as possible helps to control erosion. In summer, irrigation is needed for lawn grasses, shrubs, vines, shade trees, and ornamental trees. The map unit is in capability units llle-1 (17), irrigated, and IVe-1, nonirrigated.

224-Premler coarse sandy loam, 9 to 15 percent slopes. This deep, well drained soil is on terraces. It formed in alluvium derived dominantly from granitic rock. The vegetation in areas not cultivated is mainly annual grasses and forbs. Elevation is 600 to 700 feet. The average annual precipitation is about 8 inches, the average annual temperature is about 62 degrees F, and the average frost-free season is 250 to 300 days. Typically, the surface layer is grayish brown and pale brown coarse sandy loam about 12 inches thick. The underlying material to a depth of 60 inches or more is light yellowish brown and brown coarse sandy loam. In some areas the surface layer is sandy loam or loam. Included in this unit are small areas of Delano sandy loam and Zerker loam. Included areas make up about 15 percent of the total acreage. Permeability of this Premier soil is moderately rapid. Available water capacity is moderate. Runoff is medium, and the hazard of water erosion is moderate. Effective rooting depth is 60 inches or more. Most areas of this unit are used for livestock grazing. A few areas are used for irrigated crops such as almonds or oranges. Oil wells are common on this unit. This unit is suited to irrigated orchard crops. It is limited mainly by rolling slopes. Use of a cropping system that includes growing a cover crop, return of crop residue, and proper tillage is needed to improve soil tilth and to increase fertility and the water intake rate. Growing a cover crop in nontilled areas increases water infiltration and reduces runoff and erosion. Leaving crop residue on or near the surface helps to conserve moisture, maintain tilth, and control erosion. Because of the slope, sprinkler or drip irrigation is best suited to this unit. Irrigation water needs to be applied at a rate that ensures optimum production without increasing deep percolation, runoff, and erosion. This unit is suited to livestock grazing. It has no major limitations. Proper grazing use increases the water intake rate, promotes plant growth early in the season, and protects the soil from erosion. Correct placement of salt and supplemental feed helps to distribute livestock grazing and prevent overgrazing. This unit is limited for livestock watering ponds and other impoundments because of the moderately rapid permeability of the soil. This map unit is in capability unit IVe-1 (17), irrigated, and IVe-1, nonirrigated.

225-Premler-Durorthlds association, 9 to 15 percent slopes. This map unit is on alluvial terraces. The vegetation in areas not cultivated is mainly annual grasses and forbs with scattered shrubs. Elevation is 500 to 800 feet. The average annual precipitation is about 8 inches, the average annual temperature is about 62 degrees F, and the average frost-free season is about 250 to 300 days. This unit is about 60 percent Premier coarse sandy loam and about 30 percent Durorthids. The Premier soils are on side slopes, and the Durorthids are on ridgetops. Included in this unit are small areas of Delano sandy loam and a soil that is similar to this Premier soil but has a cemented layer at a shallow depth. Included areas make up about 10 percent of the total acreage. The Premier soil is deep and well drained. It formed in alluvium derived dominantly from granitic rock. Typically, the surface layer is grayish brown and pale brown coarse sandy loam about 12 inches thick. The underlying material to a depth of 60 inches or more is light yellowish brown and brown coarse sandy loam. In some areas the surface layer is sandy loam or loam. Permeability of the Premier soil is moderately rapid. Available water capacity is moderate. Runoff is slow, and the hazard of water erosion is moderate. Effective rooting depth is 60 inches or more. The Durorthids are moderately deep and well drained. They formed in alluvium derived dominantly from granitic rock. The surface layer is coarse sandy loam, sandy loam, and loam about 20 to 40 inches thick. The next layer is a lime- and silica-cemented layer about 18 to 40 inches thick. Below this to a depth of 60 inches or more is sandy loam or fine sandy loam. Gravel content throughout the profile is 0 to 15 percent. Permeability of the Durorthids is moderately rapid. Available water capacity is low. Runoff is slow, and the hazard of water erosion is slight. Effective rooting depth is 20 to 40 inches. Most areas of this unit are used for livestock grazing. A few areas are used for irrigated almonds and oranges orchards. Oil wells are common on this unit. This unit is suited to irrigated orchard crops. The Premier soil is limited mainly by rolling slopes. The Durorthids are limited mainly by shallow depth to a cemented layer, rolling slopes, and low available water capacity. Use of a cropping system that includes growing a cover crop, return of crop residue, and proper tillage is needed to improve soil tilth and to increase the fertility and water intake rate. Growing a cover crop in nontilled areas increases water infiltration and reduces runoff and erosion. Leaving crop residue on or near the surface helps to conserve moisture, maintain tilth, and control erosion. Ripping and shattering the cemented layer in the Durorthids increases the effective rooting depth and improves internal drainage. Because of the slope, sprinkler or drip irrigation is best suited to this unit. Irrigation water needs to be applied at a rate that ensures optimum production without increasing deep percolation, runoff, and erosion. This unit is suited to livestock grazing. It has no major limitations. If the plant cover is overgrazed, the unit becomes more susceptible to erosion. Proper grazing use increases the water intake rate, promotes plant growth early in the season, and protects the soil from erosion. Grazing should be delayed until the soil is firm and the more desirable forage plants have achieved sufficient growth to withstand grazing pressure. This unit is limited for livestock watering ponds and other water impoundments because of the moderately rapid permeability of the soil. The Premier soil is in capability unit IVe-1 (17), irrigated, and IVe-1, nonirrigated. The Durorthids are in capability unit IVe-8 (17), irrigated, and IVe-8, nonirrigated.

229-Riverwash. Riverwash consists of areas of sand and gravel that are adjacent to or occur as islands within the Kern River and small intermittent streams. During periods when the water level is normal, parts of these areas are inundated. Under flood conditions, nearly all of these areas are flooded. At present, however, floods on the Kern River generally are controlled by a large dam. Riverwash supports little if any vegetation, but in places there are a few scattered annual grasses, forbs, and willows and some brushy plants. This unit has limited value for livestock grazing and has no value for farming. The unit has its greatest value as recreational sites and as a source of aggregate material for roadbuilding or general construction. This map unit is in capability subclass Vlllw (17).

243-Wasco sandy loam. This deep, well drained soil is on recent alluvial fans and flood plains. It formed in alluvium derived dominantly from granitic rock. Slope is 0 to 2 percent. Before this unit was cultivated, the vegetation was annual grasses, forbs, and scattered shrubs. Elevation is 250 to 500 feet. The average annual precipitation is about 6 inches, the average annual temperature is about 64 degrees F, and the average frost-free season is 250 to 300 days. Typically, the surface layer is brown and yellowish brown sandy loam about 15 inches thick. The underlying material to a depth of 60 inches or more is brown and pale brown sandy loam. In some areas the surface layer is fine sandy loam. Included in this unit are small areas of Kimberlina fine sandy loam, Milham sandy loam, Panache clay loam, and Lewkalb sandy loam. Included areas make up about 20 percent of the total acreage. Permeability of this Wasco soil is moderately rapid. Available water capacity is moderate. Runoff is slow, and the hazard of water erosion is slight. Effective rooting depth is 60 inches or more. Most areas of this unit are used for a wide variety of irrigated crops, mainly cotton, alfalfa, grapes, potatoes, onions, almonds, pistachios, sugar beets, walnuts, and blackeye beans. Some areas are used for specialty crops, ornamentals, and homesite development. This unit is suited to irrigated crops. It has few limitations. A cropping system that includes crop rotation or a cover crop, return of crop residue, and proper tillage improves soil tilth and increases the fertility and water intake rate. Maintaining crop residue on or near the surface reduces runoff and helps to maintain soil tilth and organic matter content. Furrow, border, and sprinkler irrigation systems are suited to this unit. The method used generally is governed by the crop grown. To avoid overirrigating and leaching of plant nutrients, applications of irrigation water should be adjusted to the available water capacity, the water intake rate, and the crop needs. If this unit Wasco soil is used for homesite development, the main limitation is rare periods of flooding. Flooding can be controlled only by use of major flood control structures. If the density of housing is moderate to high, community sewage systems are needed to prevent contamination of water supplies as a result of seepage from onsite sewage disposal systems. This map unit is in capability unit lls-4 (17), irrigated, and capability subclass VIIs, nonirrigated.

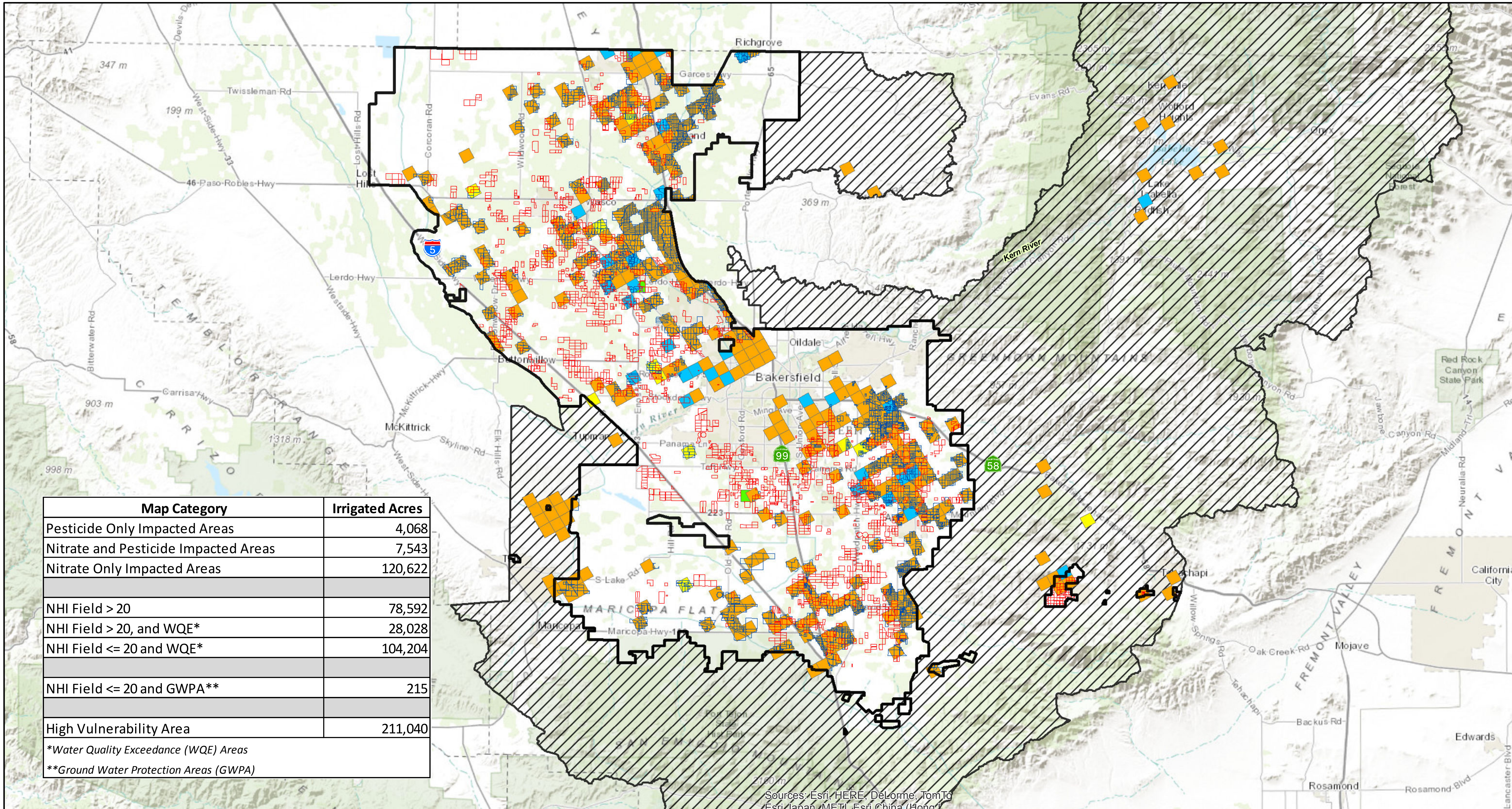
254-Zerker loam, 2 to 5 percent slopes. This deep, well drained soil is on terraces and alluvial fans. It formed in alluvium derived dominantly from granitic rock. The vegetation in areas not cultivated is mainly annual grasses, forbs, and scattered shrubs. Elevation is 475 to 550 feet. The average annual precipitation is about 8 inches, the average annual temperature is about 62 degrees F, and the average frost-free season is 250 to 300 days. Typically, the surface layer is dark yellowish brown and brown loam about 17 inches thick. The upper 11 inches of the underlying material is brownish yellow clay loam, and the lower part to a depth of 62 inches is yellowish brown and light yellowish brown sandy clay loam. In some areas the surface layer is sandy loam or sandy clay loam. Included in this unit are small areas of Delano sandy loam, Premier coarse sandy loam, and Lewkalb sandy loam. Included areas make up about 10 percent of the total acreage. Permeability of this Zerker soil is moderately slow. Available water capacity is high. Runoff is slow, and the hazard of water erosion is slight. Effective rooting depth is 60 inches or more. This unit is used mainly for irrigated orchard crops such as almonds and oranges. It is also used for dryfarmed grain. This unit is suited to irrigated crops. It has few limitations. A cropping system that includes crop rotation or a cover crop, return of crop residue, and proper tillage improves soil tilth and increases the fertility and water intake rate. Maintaining crop residue on or near the surface reduces runoff and helps to maintain soil tilth and organic matter content. Furrow, border, and sprinkler irrigation systems are suited to this unit. The method used generally is governed by the crop grown. To avoid overirrigating and leaching of plant nutrients, applications of irrigation water should be adjusted to the available water capacity, the water intake rate, and the crop needs. This map unit is in capability unit lle-1 (17), irrigated, and capability subclass VIe, nonirrigated.

255-Zerker loam, 5 to 9 percent slopes. This deep, well drained soil is on terraces and alluvial fans. It formed in alluvium derived dominantly from granitic rock. The vegetation in areas not cultivated is mainly annual grasses, forbs, and scattered shrubs. Elevation is 450 to 800feet. The average annual precipitation is about 8 inches, the average annual temperature is about 62 degrees F, and the average frost-free season is 250 to 300 days. Typically, the surface layer is dark yellowish brown and brown loam about 17 inches thick. The upper 11 inches of the underlying material is brownish yellow clay loam, and the lower part to a depth of 62 inches is yellowish brown and light yellowish brown sandy clay loam. In some areas the surface layer is sandy loam or sandy clay loam. Included in this unit are small areas of Delano sandy loam, Premier coarse sandy loam, and Lewkalb sandy loam. Also included are small areas of a soil that is similar to this Zerker soil but has a subsoil below a depth of 60 inches. Included areas make up about 15 percent of the total acreage. Permeability of this Zerker soil is moderately slow. Available water capacity is high. Runoff is medium, and the hazard of water erosion is moderate. Effective rooting depth is 60 inches or more. This unit is used mainly for irrigated orchard crops such as almonds and oranges. This unit is suited to irrigated crops. It is limited mainly by the steepness of slope. Use of a cropping system that includes growing a cover crop, return of crop residue, and proper tillage improves soil tilth and increases the fertility and water intake rate. Leaving crop residue on or near the surface helps to conserve moisture, maintain tilth, and control erosion. Because of the slope, sprinkler or drip irrigation is most suitable. Irrigation water needs to be applied at a rate that ensures optimum production without increasing deep percolation, runoff, and erosion. The map unit is in capability unit llle-1 (17), irrigated, and capability subclass VIe, nonirrigated.

256-Zerker sandy clay loam, 0 to 2 percent slopes. This deep, well drained soil is on terraces and alluvial fans. It formed in alluvium derived dominantly from granitic rock. The vegetation in areas not cultivated is mainly annual grasses, forbs, and scattered shrubs. Elevation is 475 to 550 feet. The average annual precipitation is about 8 inches, the average annual temperature is about 62 degrees F, and the average frost-free season is 250 to 300 days. Typically, the surface layer is dark yellowish brown and brown sandy clay loam about 17 inches thick. The upper 11 inches of the underlying material is brownish yellow clay loam, and the lower part to a depth of 62 inches is yellowish brown and light yellowish brown sandy clay loam. In some areas the surface layer is sandy loam or loam. Included in this unit are small areas of Delano sandy loam and Premier coarse sandy loam. Included areas make up about 15 percent of the total acreage. Permeability of this Zerker soil is moderately slow. Available water capacity is high. Runoff is slow, and the hazard of water erosion is slight. Effective rooting depth is 60 inches or more. This unit is used for irrigated crops such as alfalfa, cotton, almonds, and oranges. This unit is suited to irrigated crops. It has few limitations. Use of a cropping system that includes crop rotation or a cover crop, return of crop residue, and proper tillage is needed to improve soil tilth and to increase the fertility and water intake rate. Furrow, border, and sprinkler irrigation systems are suited to this unit. The method used generally is governed by the crop grown. To avoid overirrigating and leaching of plant nutrients, applications of irrigation water should be adjusted to the available water capacity, the water intake rate, and the crop needs. This map unit is in capability class **I** (17), irrigated, and capability subclass VIc, nonirrigated.

ATTACHMENT 2

KRWCA High Vulnerability Areas Map



Map Category	Irrigated Acres
Pesticide Only Impacted Areas	4,068
Nitrate and Pesticide Impacted Areas	7,543
Nitrate Only Impacted Areas	120,622
NHI Field > 20	78,592
NHI Field > 20, and WQE*	28,028
NHI Field <= 20 and WQE*	104,204
NHI Field <= 20 and GWPA**	215
High Vulnerability Area	211,040

**Water Quality Exceedance (WQE) Areas*

***Ground Water Protection Areas (GWPA)*

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Legend

- Kern River Watershed Coalition Authority (Primary)
- Kern River Watershed Coalition Authority (Secondary)
- NHI Field > 20
- NHI Field <= 20, Majority of Field Intersects WQE Nitrates and Pesticides
- NHI Field <=20, Majority of Field Intersects GWPA
- Pesticide Impacted Area
- Nitrate and Pesticide Impacted Area
- Nitrate Impacted Area
- Ground Water Protection Areas (Leaching)**

***Ground Water Protection Areas from CA Dept. of Pesticide Regulation*

Note: As submitted to the Central Valley Regional Water Quality Control Board on February 4, 2015.

Kern River Watershed Coalition Authority

High Vulnerability Areas