Root Creek Water District
Groundwater Sustainability Agency

Groundwater Sustainability Annual Report
(2015-2019)

April 2020

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Abbreviations

AF .... Acre-feet

DWR .... California Department of Water Resources

GIS .... Geographical Information Systems

GSP .... Groundwater Sustainability Plan

MID........ Madera Irrigation District

MSL........ Mean Sea Level

RCWD .... Root Creek Water District

RCWDGSA .... Root Creek Water District Groundwater Sustainability Agency

USBR........ United States Bureau of Reclamation

Executive Summary

Annual reports are a part of the Sustainable Management Groundwater Act legislation, intended to provide updated groundwater condition data to monitor the progress of a groundwater basin toward their sustainability goals set in a Groundwater Sustainability Plan (GSP). This specific report covers groundwater conditions within the boundaries of Root Creek Water District Groundwater Sustainability Agency (RCWDGSA). This is the first annual report and covers the period for 2015 through 2019. The RCWDGSA is located within the Madera Groundwater Subbasin in the southeastern corner along the banks of the San Joaquin River.

In size, the GSA accounts for less than 3 percent of the land area within the Madera Subbasin. Root Creek Water District (RCWD or District), which lies wholly within the GSA has recently contracted for surface water supplies from the Madera Irrigation District (MID) and the Wonderful Nut Orchards for up to 17,000 acre-feet (AF) of surface water in a given year. The District has also completed the first phase of an agricultural conveyance and distribution system that has the ability to deliver surface water to approximately 2,500 acres of farmland. To accomplish these achievements the district has invested more than 12 million dollars. The purchase and delivery of surface water supplies are crucial to the long-term groundwater sustainability of not only the District and the GSA but also the region and the subbasin.

Chapter 1 – Introduction

The purpose of this report is to fulfill the requirements of the California Code of Regulations Article 7 Section 356.2 by providing an annual update on the current conditions of groundwater sustainability within the RCWDGSA. This document provides a brief summary of background information for RCWDGSA, updated data for the latest water year including groundwater elevations, contours, and extraction, surface water use, and total water use by water use sector. Water supply and groundwater data from the latest water year will span from Spring 2015 to Fall 2019. Lastly, progress towards sustainability will be analyzed by taking into consideration the most recent water year data along with any planned or implemented projects or management actions.

RCWDGSA is located in the southeast corner of the Madera Groundwater Subbasin as defined by the California Department of Water Resources (DWR) Bulletin 118 as Subbasin No. 5-22.06. It is also located fully within the boundaries of Madera County as shown on **Figure 1**. The Madera Subbasin is the southernmost subbasin in the San Joaquin Valley Basin, just north of the San Joaquin River. The Sierra Nevada foothills and three groundwater subbasins border the Madera Subbasin north of the San Joaquin River, including the Merced, Chowchilla, and the Delta-Mendota Subbasins. The Kings Subbasin adjoins the Madera Subbasin south of the San Joaquin River.

RCWD covers almost 10,000 acres and is coterminous with RCWDGSA. Historically, RCWD has been almost exclusively agricultural land reliant on groundwater pumping. In 2014, an in-lieu pipeline was built to serve surface water, when available, to the north side of RCWD. In 2017, construction began on a 2,000-acre community development on the northeast side of the District called Riverstone. At build out, Riverstone is projected to have commercial and retail zones, parks, and approximately 6,578 housing units on approximately 2,000 acres. Riverstone projects building approximately 300 homes per year until build out. This changes the landscape of water use within RCWD from agricultural groundwater pumping to conjunctive programs to serve the variety of water use sectors. Beneficial users within the RCWDGSA include growers, commercial users or industry, domestic users, and groundwater dependent ecosystems.

The majority of surface water in the subbasin is supplied from the Fresno and San Joaquin Rivers. RCWD receives most of its surface water from the San Joaquin River via surface water contracts with MID, Wonderful, and the United States Bureau of Reclamation (USBR) Section 215 water, when available. Surface water, when available, is used for agricultural purposes. The remaining agricultural water demand and all municipal water demand is supplied by groundwater. RCWDGSA plans to minimize the impact to groundwater levels by implementing strategies such as percolating treated wastewater effluent, using stormwater detention basins for recharge, and water conservation techniques.

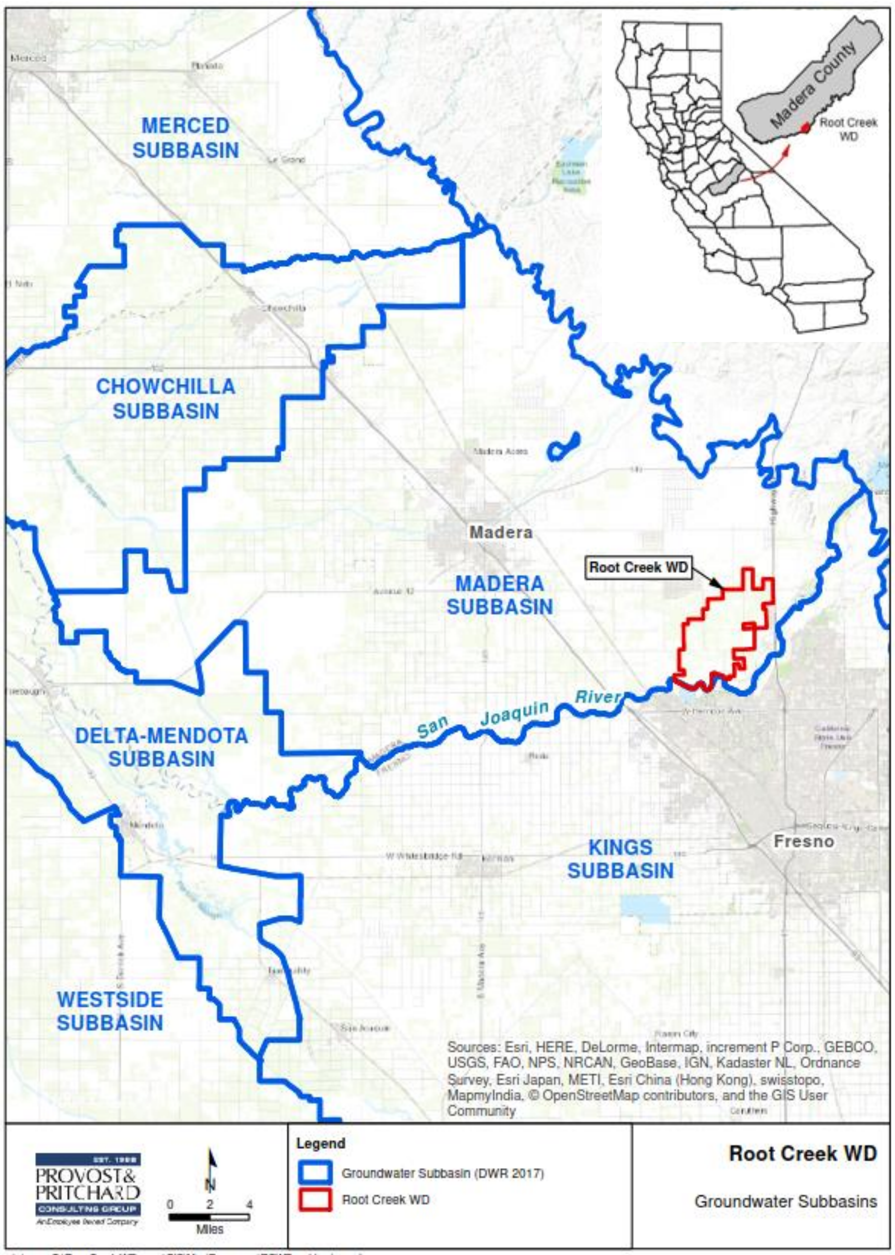


Figure 1. Root Creek Water District Location Map

Chapter 2 – Conditions of the Root Creek Water District GSA

This chapter details the current conditions of RCWDGSA including updated information on land use categories, the various water use sectors, total water use, surface water use, groundwater extraction, groundwater levels, and groundwater storage change. The volume of total water use is largely dependent upon the land use categories and water use sectors. Other factors influencing total water use include precipitation, evapotranspiration rates, and water conservation strategies. Groundwater extraction is dependent upon total water use and surface water supply available to fulfill demand. The change in groundwater storage is generally equal to the volume of groundwater extracted minus the volume of water that enters the groundwater system through recharge or subsurface flow and may be estimated using groundwater elevation.

Land Use Categories/Water Use Sectors

As mentioned, RCWDGSA is made up of agricultural, residential, and commercial land, the majority of which remains agricultural. According to a Geographic Information Systems (GIS) estimate, the RCWDGSA is approximately 9,674 acres after the annexation of about 360 acres in 2017. In 2014, approximately 8,474 acres of the District was covered by a crop as shown in **Table 1**. Since then, some land has been taken out of production and in 2017, construction on the Riverstone Development began. The first year residents began living in the Riverstone Development was 2017 and by the end of the year there were 100 homes connected to the water and sewer system. By the end of 2019, Riverstone Development has retired out a cumulative total of about 710 acres of farmland and completed the construction of 436 houses, growing the residential and commercial water use sectors.

The Madera County Agricultural Commissioner provides annual data for cropping within the County and was used for 2019 RCWD cropping patterns, presented in **Table 1** and shown on **Figure 2**. Agricultural land still makes up the majority of RCWDGSA reaching about 7,852 acres. Major crops include pistachios, almonds, and citrus.

Table 1. RCWD Cropping from 2014 - 2019

	2014	2015	2016	2017	2018*	2019	2015 to 2019 Change
Crop	Acreage						
Almond	1,740	2,133	2,143	2,134	2,395	2,334	201
Cherry	9	9	9	9	10	10	2
Citrus	2,959	2,959	2,960	2,959	2,938	2,887	-72
Date	1	1	1	1	1	1	0
Grape	384	262	262	220	218	220	-41
Nursery Plants	22	22	22	22	16	14	-9
Olive	214	93	93	93	70	57	-36
Persimmon	1	1	1	1	1	1	0
Pistachio	2,673	2,674	2,674	2,674	2,411	2,217	-457
Plum	5	5	8	7	8	4	-1
Pomegranate	7	7	7	7	7	7	0
Wheat	460	118	100	100	104	100	-18
Total Cropped Acreage	**8,474**	**8,283**	**8,278**	**8,226**	**8,179**	**7,852**	**-431**

*Approximately 300 acres annexed into the RCWD

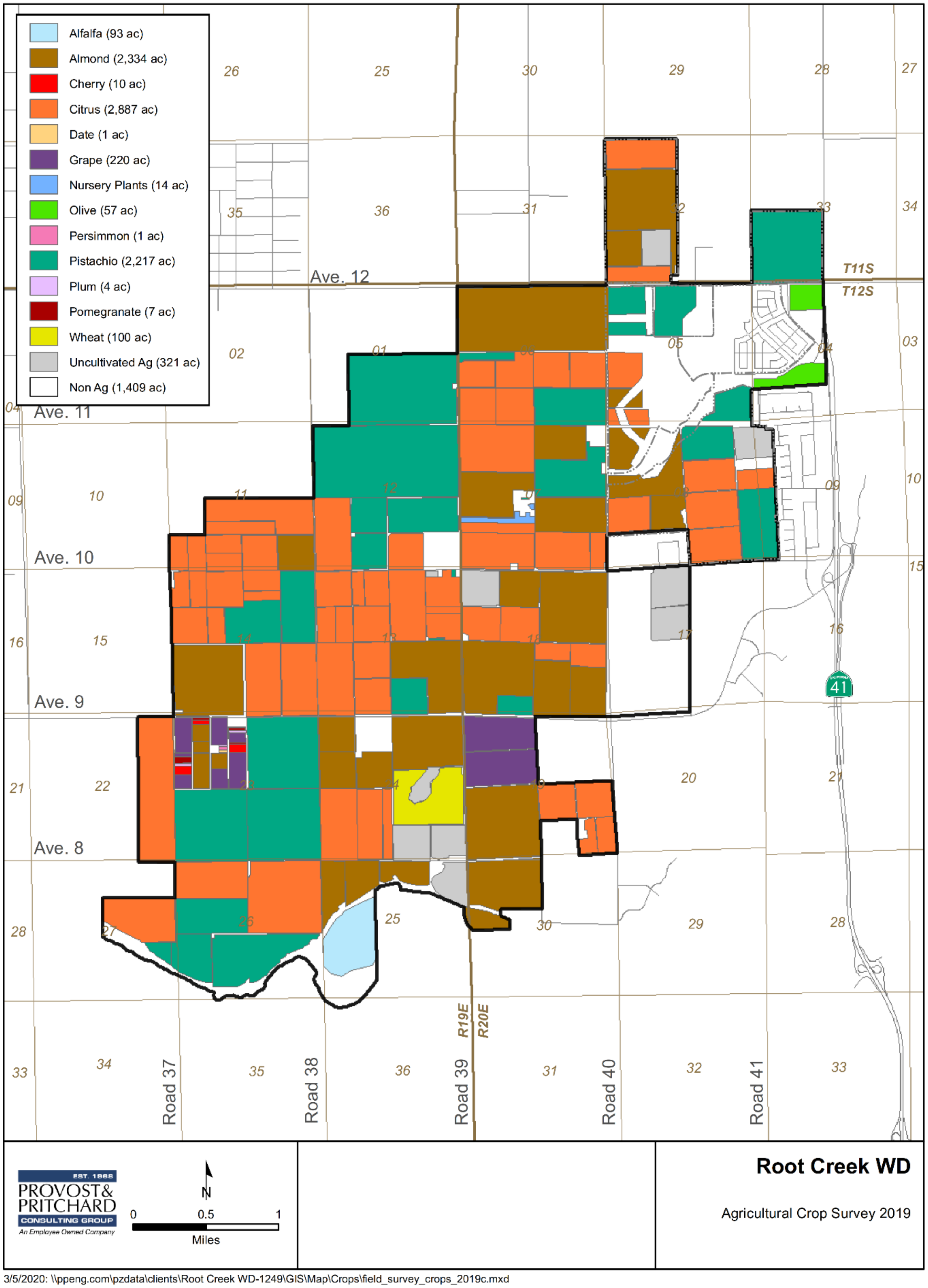


Figure 2. 2019 Agricultural Land Use in RCWD

Total Water Use

Total water use within the RCWDGSA is composed of municipal, agricultural, and rural residential demand; however rural residential is minimal and can be considered negligible. As more farmland is taken out of production for the Riverstone development, agricultural water use declines and municipal demand grows. Although, total water use within RCWDGSA is decreasing since the measured municipal demand is less than the water demand of the land that has been taken out of agricultural production, as shown by the data presented in this section.

Municipal

The municipal water demand in RCWDGSA is currently met solely by water produced with groundwater wells. Residential and commercial water use data was directly measured as the volume of water produced by the municipal wells. Since Riverstone is in the middle of development, new connections are being made monthly as homes, parks, and retail areas are being built. Construction water is also a fairly significant source of water consumption during the development process. A summary of the water system connections and water use data is presented in **Table 2**.

Table 2. Monthly Municipal Water Consumption by Water Use Category for Water Year 2019 (AF)

	2018			2019								
	October	**November**	**December**	**January**	**February**	**March**	**April**	**May**	**June**	**July**	**August**	**September**	**Total**
Connections:													
Residental	233	226	236	251	251	280	293	306	321	341	353	377	
Landscape Irrigation	0	19	19	19	25	26	26	26	26	26	26	27	
Commercial	3	3	3	3	3	3	3	3	3	3	3	3	
Water Deliveries (AF):													
Municipal	7.1	5.9	4.7	4.2	3.9	5.5	8.5	9.2	12.3	13.7	14.7	13.1	103
Landscape Irrigation	1.5	0.9	0.1	0.2	0.3	0.7	1.8	2.7	3.7	5.9	8.1	6.7	33
Commercial	0.6	0.3	0.2	0.2	0.2	0.4	0.4	0.5	0.5	0.8	0.9	0.6	6
Construction	0.5	0.4	0.1	0.0	0.0	0.6	2.4	2.8	11.9	13.6	11.4	3.7	48
Total:	9.7	7.6	5.2	4.7	4.4	7.2	13.1	15.2	28.4	34.1	35.2	24.1	189
Total Produced:	12.1	11.0	5.2	6.2	7.3	8.0	15.3	15.9	29.1	36.3	33.1	25.9	205

Agricultural

Agricultural water use is not directly measured in RCWDGSA, therefore, an alternate method for estimating total water use is applied. Cropping data, evapotranspiration (ET), and precipitation are used to determine the water use by crop type. The ET estimates developed by the Cal Poly Irrigation Training and Research Center (ITRC, see www.itrc.org) for “Irrigation District Water Balances” were used, which vary based on water year type (wet, typical, or dry) and irrigation method. An irrigation method was assumed for each crop type as shown in **Table 3**.

Table 3. Assumed Irrigation Methods for RCWDGSA

Crop	Presumed Irrigation Method
Almond	Drip/Micro
Cherry	Sprinkler
Citrus	Sprinkler
Date	Drip/Micro
Grape	Drip/Micro
Nursery Plants	Drip/Micro
Olive	Sprinkler
Persimmon	Sprinkler
Pistachio	Drip/Micro
Plum	Sprinkler
Pomegranate	Drip/Micro
Wheat	Surface

The ITRC classifies the ET data by irrigation method, as well as water year type (wet, typical or dry). DWR classifies and publishes a hydrologic classification index each year for the San Joaquin Valley water year based on measured unimpaired runoff from the tributaries feeding the San Joaquin River. The DWR classifications are used to estimate ET values for the year where above normal and below normal equate to a typical year.

After ET data was compiled for each crop and water year, effective precipitation should be accounted for. Effective precipitation was calculated for a typical hydrologically wet year, typical year, and dry year using the following set of equations:

Effective Precipitation
Nov – Feb = -0.54 + (0.94 x Gross Rainfall)
Mar = -1.07 + (0.837 x Gross Rainfall)
Oct = -0.06 + (0.635 x Gross Rainfall)

The calculated value of effective precipitation on an annual basis was taken off of the ET values for the respective water year type to obtain the crop water demands shown in **Table 4**.

Table 4. Crop Water Demands (ET_c) for Crops in RCWDGSA

Crop	Water Year Type		
	Wet (feet)	**Typical** (feet)	**Dry** (feet)
Almond	2.72	3.07	3.06
Cherry	2.73	3.00	3.03
Citrus	2.48	3.02	2.85
Date	2.65	2.89	2.92
Grape	2.01	2.10	2.11
Nursery Plants	2.65	2.89	2.92
Olive	2.80	3.03	3.00
Persimmon	2.73	3.00	3.03
Pistachio	2.69	2.77	2.75
Plum	2.73	3.00	3.03
Pomegranate	2.65	2.89	2.92
Wheat	0.85	1.35	1.07

Notes: No data in ITRC tables for "Typical year" for pistachios. However, for other crops, Typical is about 1% more than a Dry year.

Finally, the annual crop water demands, in feet, were multiplied by the acres of the respective crop type to estimate total water demand in acre-feet (AF), shown in **Table 5**. The total water demand for the agricultural sector in 2019 was approximately 20,257 AF for RCWDGSA.

Table 5. Total Crop Water Demand for the RCWDGSA from 2014 to 2019

	2014 (Critical year)			2015 (Critical year)			2016 (Dry year)			2017 (Wet year)			2018 (Below Normal year)			2019 (Wet year)		
Crop	Acres	ET (feet)	Estimated Demand (AF)	Acres	ET (feet)	Estimated Demand (AF)	Acres	ET (feet)	Estimated Demand (AF)	Acres	ET (feet)	Estimated Demand (AF)	Acres	ET (feet)	Estimated Demand (AF)	Acres	ET (feet)	Estimated Demand (AF)
Almond	1,740.2	3.06	5,325	2,133.2	3.06	6,528	2,143.2	3.06	6,558	2,133.7	2.72	5,804	2,394.9	3.07	7,352	2,334	2.72	6,349
Cherry	8.5	3.03	26	8.5	3.03	26	8.5	3.03	26	9.0	2.73	25	10.5	3.00	31	10	2.73	29
Citrus	2,959.1	2.85	8,433	2,959.1	2.85	8,433	2,959.5	2.85	8,435	2,959.1	2.48	7,339	2,938.4	3.02	8,874	2,887	2.48	7,160
Date	1.0	2.92	3	1.0	2.92	3	1.0	2.92	3	1.0	2.65	3	0.7	2.89	2	1	2.65	2
Grape	383.5	2.11	809	261.5	2.11	552	261.5	2.11	552	219.5	2.01	441	218.2	2.10	458	220	2.01	442
Nursery Plants	22.4	2.92	65	22.4	2.92	65	22.4	2.92	65	22.4	2.65	59	15.8	2.89	46	14	2.65	37
Olive	214.0	3.00	642	93.0	3.00	279	93.0	3.00	279	93.0	2.80	260	70.0	3.03	212	57	2.80	160
Persimmon	1.0	3.03	3	1.0	3.03	3	1.0	3.03	3	1.0	2.73	3	0.8	3.00	2	1	2.73	2
Pistachio	2,673.0	2.75	7,351	2,674.0	2.75	7,354	2,674.0	2.75	7,354	2,674.0	2.69	7,193	2,410.9	2.77	6,678	2,217	2.69	5,964
Plum	4.5	3.03	14	4.5	3.03	14	7.5	3.03	23	6.5	2.73	18	8.1	3.00	24	4	2.73	10
Pomegranate	6.5	2.92	19	6.5	2.92	19	6.5	2.92	19	7.0	2.65	19	6.9	2.89	20	7	2.65	18
Wheat	460.0	1.07	492	118.0	1.07	126	100.0	1.07	107	100.0	0.85	85	104.2	1.35	141	100	0.85	85
Totals	**8,473.7**		**23,182**	**8,282.7**		**23,401**	**8,278.1**		**23,423**	**8,226.2**		**21,248**	**8,179.2**		**23,841**	**7,852**		**20,257**

Surface Water

RCWD completed the construction of an in-lieu pipeline in 2014 to serve surface water to the Northern part of the district with a service area of approximately 2,500 acres. All surface water brought into RCWD is directed through the MID Lateral 6.2 which distributes water from the Madera Canal and ultimately the San Joaquin River. As mentioned, RCWD has surface water contracts with MID, Wonderful, and the USBR. The contract with MID allows RCWD to buy excess surface water at a contracted price, while the surface water from the contract with Wonderful is always available at a higher cost. The contract with USBR only allows RCWD to purchase section 215 flow which is classified as flood flow and only occurs once every few years on average. In the 2019 water year, RCWD purchased surface water from MID totaling approximately 8,200 AF. The majority of surface water was used in lieu of groundwater pumping for agricultural demand; however, approximately 600 AF was used for intentional recharge as shown in **Table 6**.

Table 6. Surface Water Supply for RCWD from 2015-2019

Year	Agricultural Use *(AF)*	Municipal Use *(AF)*	Intentional Recharge *(AF)*	Total *(AF)*
2014	502	-	-	502
2015	-	-	-	-
2016	-	-	-	-
2017	6,636	-	178	6,814
2018	1,361	-	-	1,361
2019	7,607	-	601	8,208

Change in Water Budget

Total water use in RCWDGSA is changing on an annual basis due to the land use conversion of farmland to residential development in the Riverstone Development area. As mentioned, at build-out Riverstone will consist of approximately 2,000 acres of residential space including houses, parks, and commercial zones. Municipal water use is generally lower than agricultural water use on a per acre basis. Furthermore, municipal water is treated and a portion of this water reenters the groundwater system through percolation ponds. **Table 7** documents the estimated change to the water budget for Riverstone based on actual municipal demand and estimated agricultural demand from fallowed land.

Table 7. Water Use Changes for Riverstone

	Reclaimed Water		Change in Land Use					Change in Water Budget
Year	**Ponds**	**Reuse**	**Irrigated Lands**	**Fallowed Land**	**Change in Irrigation Demand**	**Municipal Area**	**Municipal Demand**	*(AF)*
	(AF)	*(AF)*	*(acres)*	*(acres)*	*(AF)*	*(acres)*	*(AF)*	
2014	-	-	1,885	1	(27)	-	-	27
2015	-	-	1,798	92	(252)	-	-	252
2016	-	-	1,638	252	(562)	-	-	562
2017	1	-	1,538	352	(936)	30	70	1,045
2018	22	-	1,490	400	(1,115)	82	186	951
2019	46	-	1,176	710	(2,303)	120	205	2,745

Groundwater Extraction

Groundwater extraction for RCWDGSA is estimated by the total water demand minus the volume of water supplied by surface water sources. Water demand and surface water supply have been discussed separately in the preceding sections. **Table 8** presents water demand, surface water supply, and groundwater extraction by water use sector for the years 2015 to 2019. This table excludes the volume of surface water used for intentional recharge, which will be included in the discussion regarding groundwater storage change.

Table 8. Groundwater Extraction in RCWDGSA from 2015 to 2019

	Water Demand (AF)			Surface Water Use (AF)			Groundwater Extraction (AF)		
Water Year	*Crop Demand Estimate*	*Actual Municipal Demand*	*Total*	*Agricultural In-Lieu*	*Municipal*	*Total*	*Agricultural*	*Municipal*	*Total*
2015	23,401	0	23,401	0	0	0	23,401	0	23,401
2016	23,423	0	23,423	0	0	0	23,423	0	23,423
2017	21,248	70	21,318	6,636	0	6,636	14,612	70	14,682
2018	23,841	186	24,027	1,361	0	1,361	22,480	186	22,666
2019	20,257	205	20,462	7,607	0	7,607	12,650	205	**12,855**

Water demand for agricultural use was estimated based on ET, precipitation, and GIS estimated crop acreage and therefore has an approximate accuracy of about ±15%. Municipal water use was directly measured by electromagnetic flow meters at each of the wells and have an accuracy of about ±0.5%. Lastly, surface water deliveries were measured by propeller flow meter at the diversion point into RCWD and has an associated accuracy of about ±2%.

Chapter 3 – GSP Implementation Progress

Projects and Management Actions

Since the adoption of the RCWDGSA GSP, the RCWDGSA has continued to operate and implement the projects and management actions in the GSP. The in-lieu pipeline was built in 2014 to increase the ability of the RCWD to implement conjunctive use in wet years. Benefits of the pipeline have been seen in 2014, 2017, 2018, and 2019. Furthermore, the tiered pricing structure for groundwater pumping and surface water use will encourage growers to use surface water when available.

Sustainable Management Criteria

Groundwater Levels

Seasonal groundwater elevation contour maps for the 2019 water year are presented as **Figure 3** and **Figure 4** below. Historical groundwater contour maps for Spring 2015 – Spring 2018 are shown in **Appendix A**. Generally, groundwater flow continues to trend away from the San Joaquin River, flowing in the northerly direction with a slight westerly component. Groundwater elevations in the RCWDGSA range from 200 feet to 40 feet above mean sea level (msl) in the Spring and from 160 to 30 feet above msl in the Fall. The difference in groundwater elevations between the seasons is due to groundwater pumping during the summer months to irrigate crops.

The wells being monitored for sustainable management criteria have remained the same as in the RCWDGSA GSP. There are six wells total, located throughout the area as shown in **Figure 5**. The hydrographs associated with each of the representative monitoring wells are presented as **Figure 6** through **Figure 11**. The hydrographs include historical groundwater elevation trends along with recent data compared to the interim milestones, measurable objectives, and minimum thresholds set by RCWDGSA. The most recent groundwater elevation data for the representative monitoring wells is presented in **Table 9** next to the 2020 interim milestone objectives.

Table 9. 2019 Groundwater Surface Elevation Compared to 2020 Interim Milestones

	Well	Spring 2019 WSE	2020 Interim Milestone
Southern	83	190	170
	22	221	215
Central	85	61	85
	113	85	55
	65	102	70
North	130	58	57

A general downward trend has persisted over the last 40 years; however, in the last 5 years water levels seem to become more stable with the exception of the two wells; one on the westerly side of the central area and one in the north. Five of the six wells are at or above the projected measurable objective line, indicating that RCWDGSA is on track to meet interim milestones and sustainability goals. The one well below the measurable objective line is above the projected minimum threshold. This well is near the northern district boundary and is thought to be impacted by practices of the neighboring Groundwater Sustainability Agency. In general, water levels fell during the Fall of 2018 as expected, but rebounded well by the Spring of 2019. This is in part due to RCWDGSA's efforts to increase conjunctive use of surface water and groundwater and the availability of surface water. Water year type, presented in **Table 10**, can be related to groundwater elevation trends seen in the hydrographs.

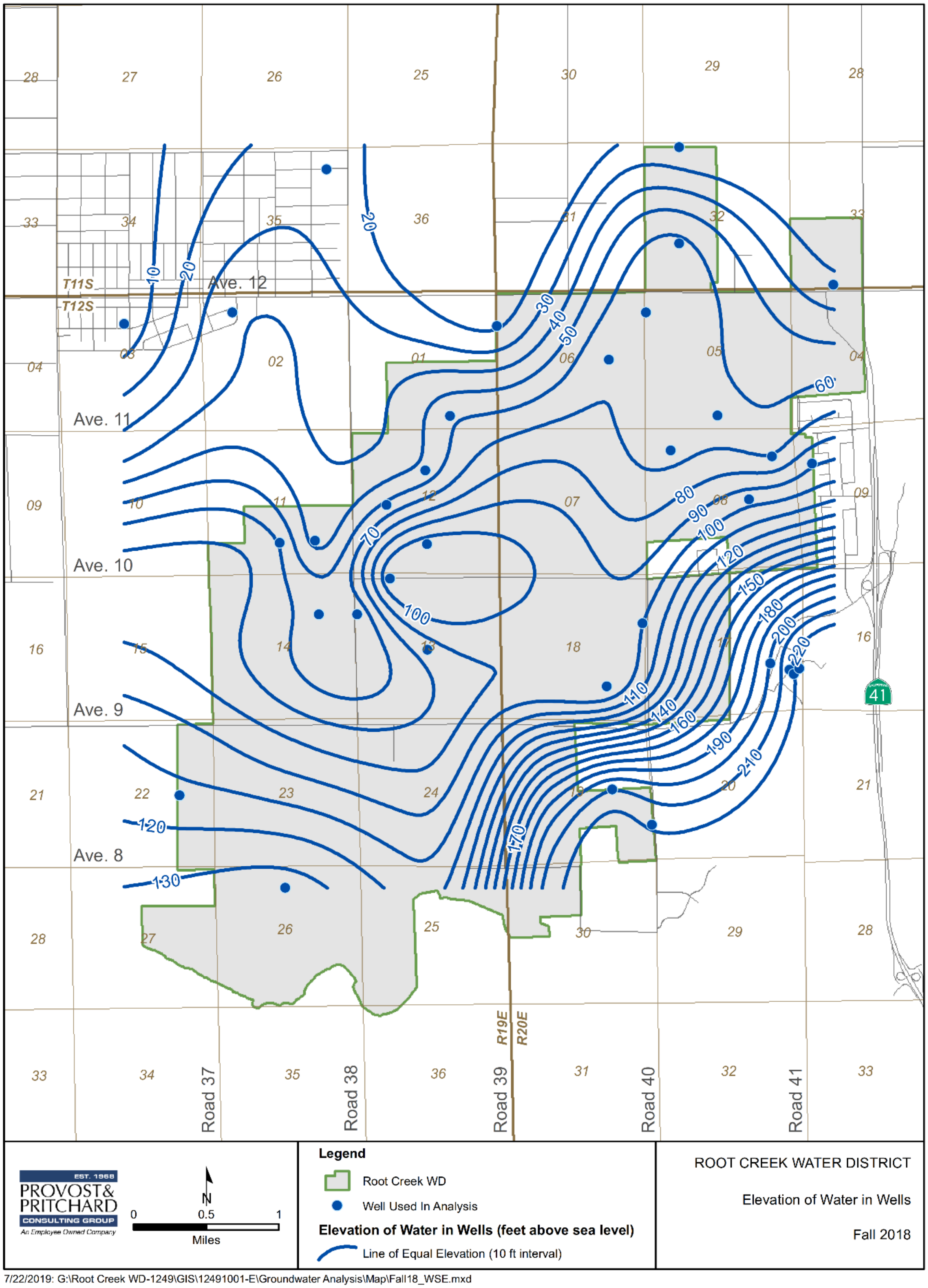


Figure 3. Groundwater Elevation Contours for RCWDGSA - Fall 2018

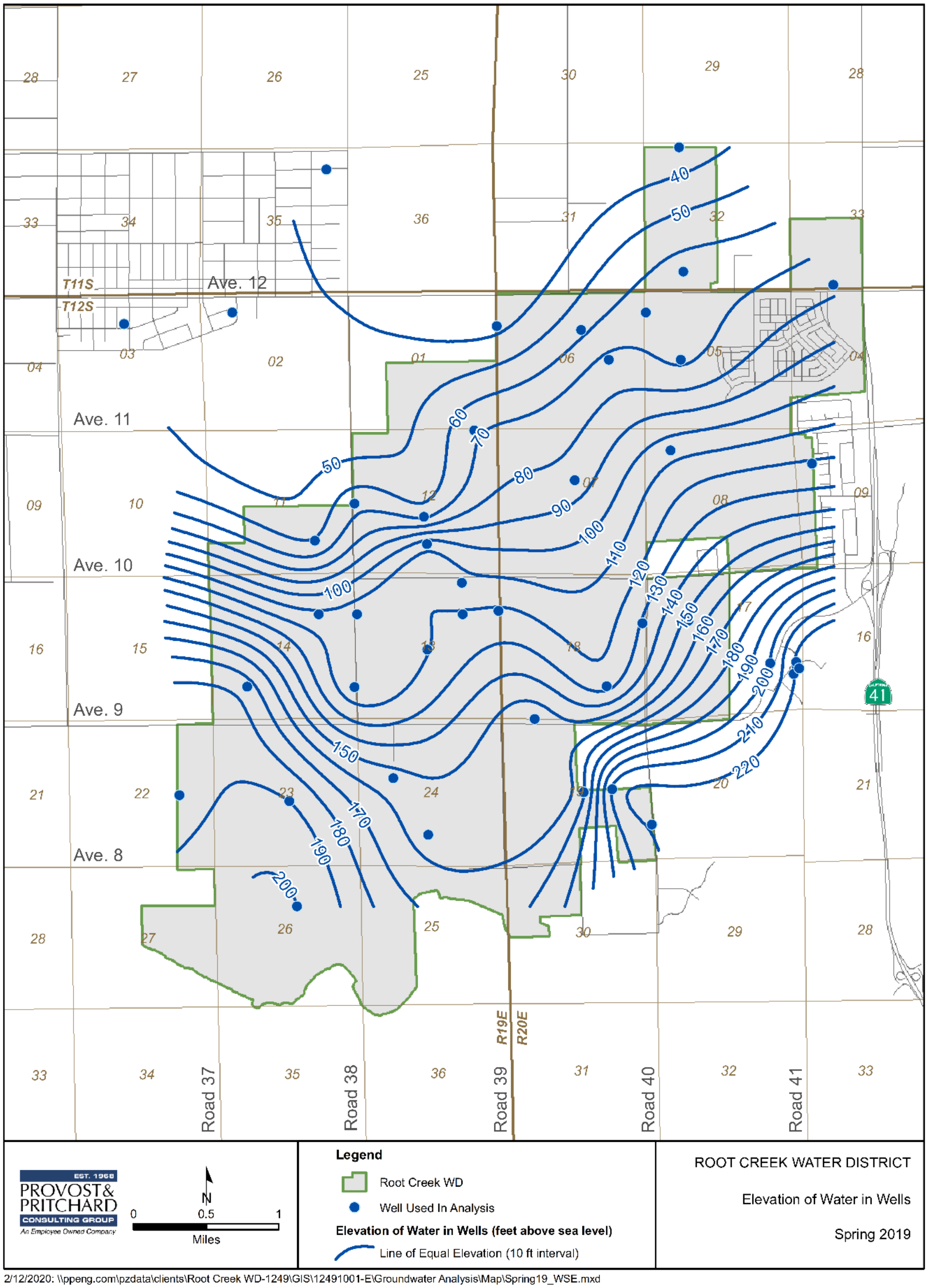


Figure 4. Groundwater Elevation Contours for RCWDGSA - Spring 2019

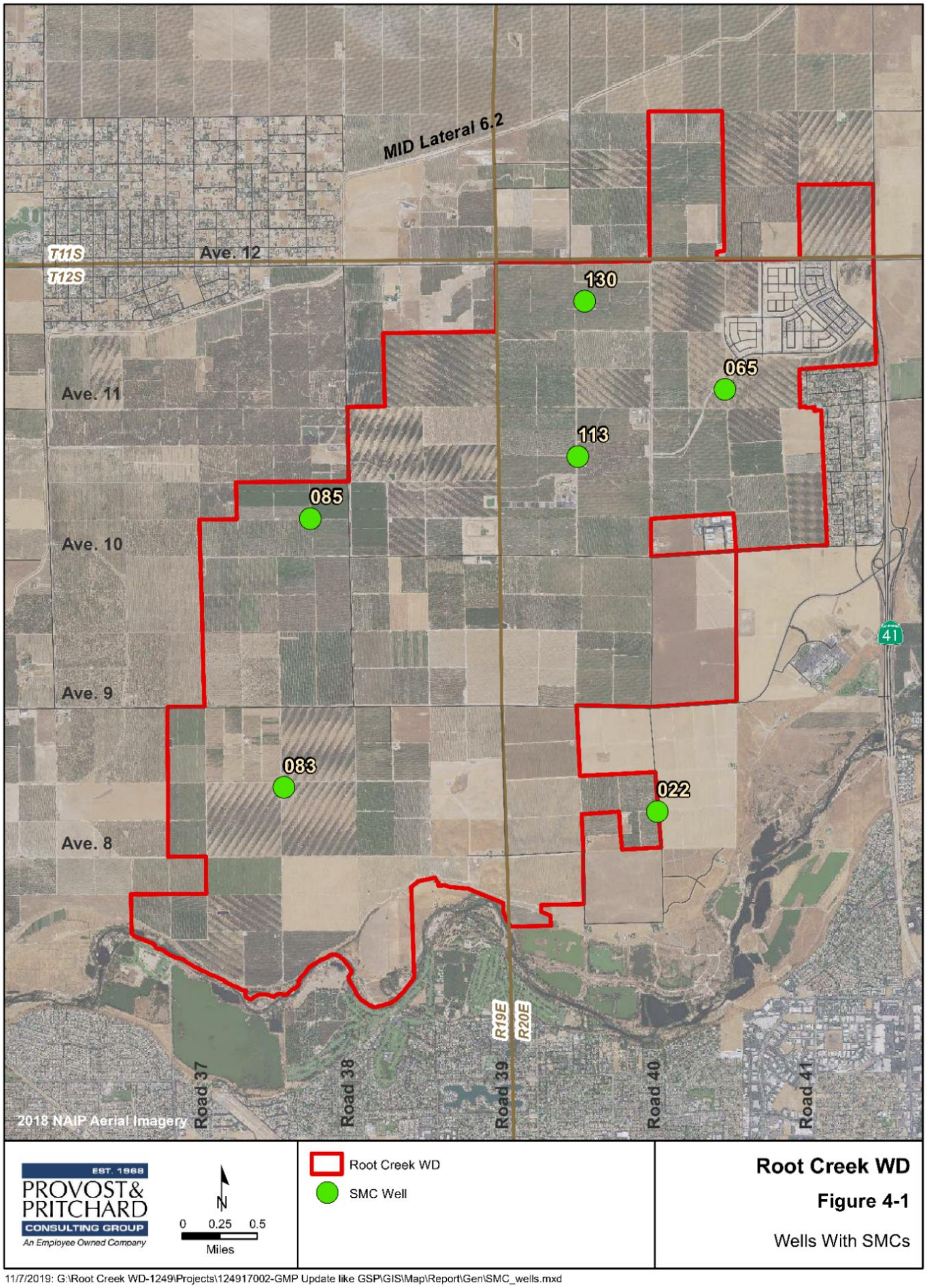


Figure 5. Location of SMC Wells in RCWDGSA

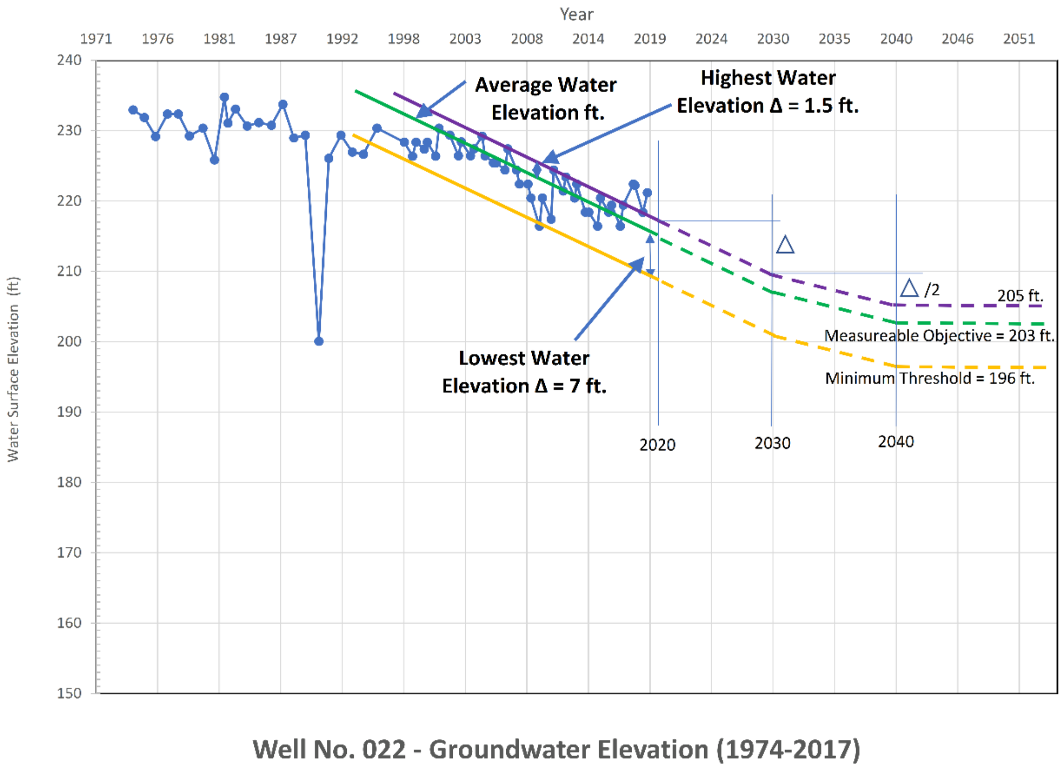


Figure 6. Well 22 Hydrograph(1974-2019)

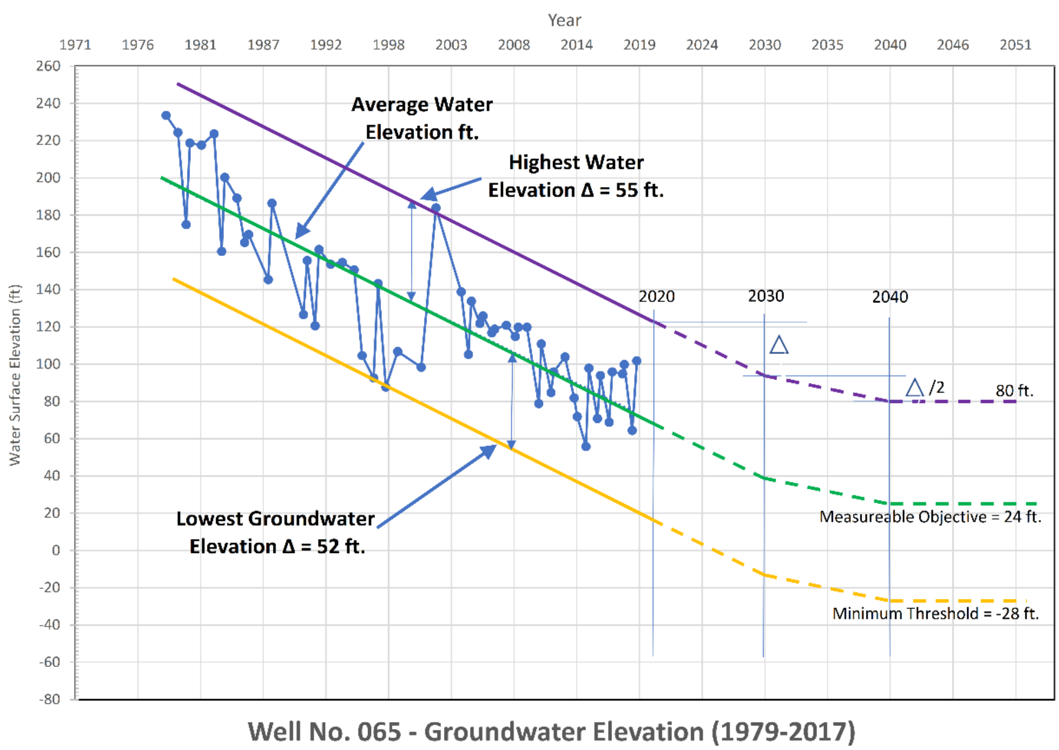


Figure 7. Well 65 Hydrograph (1979-2019)

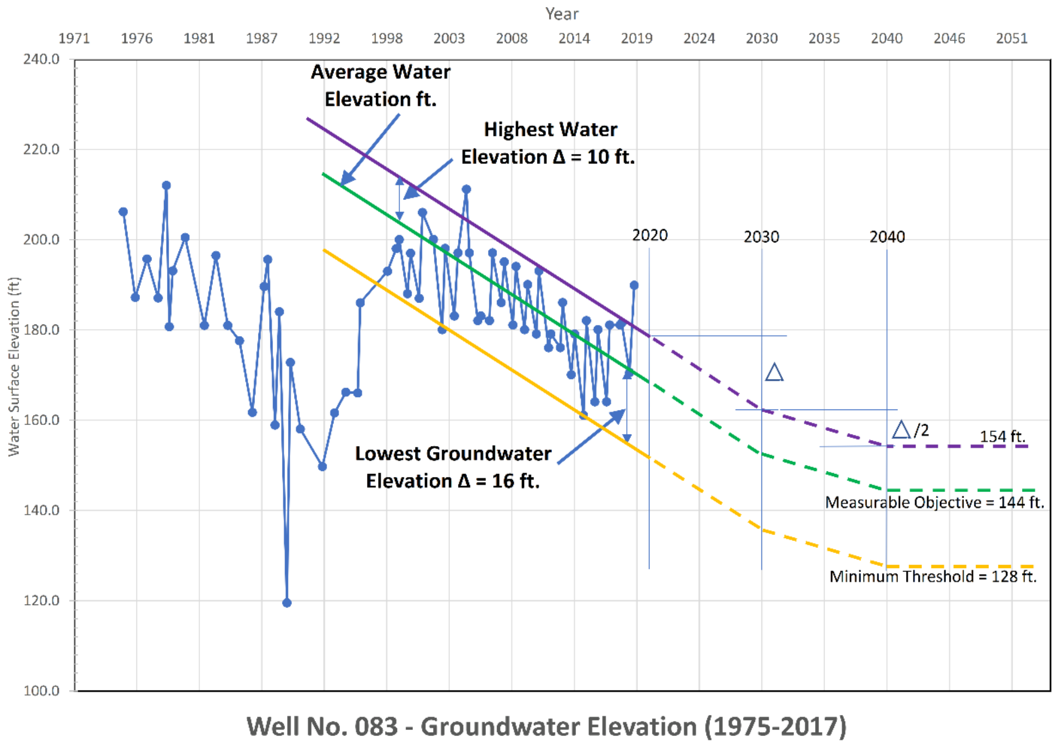


Figure 8. Well 83 Hydrograph (1975-2019)

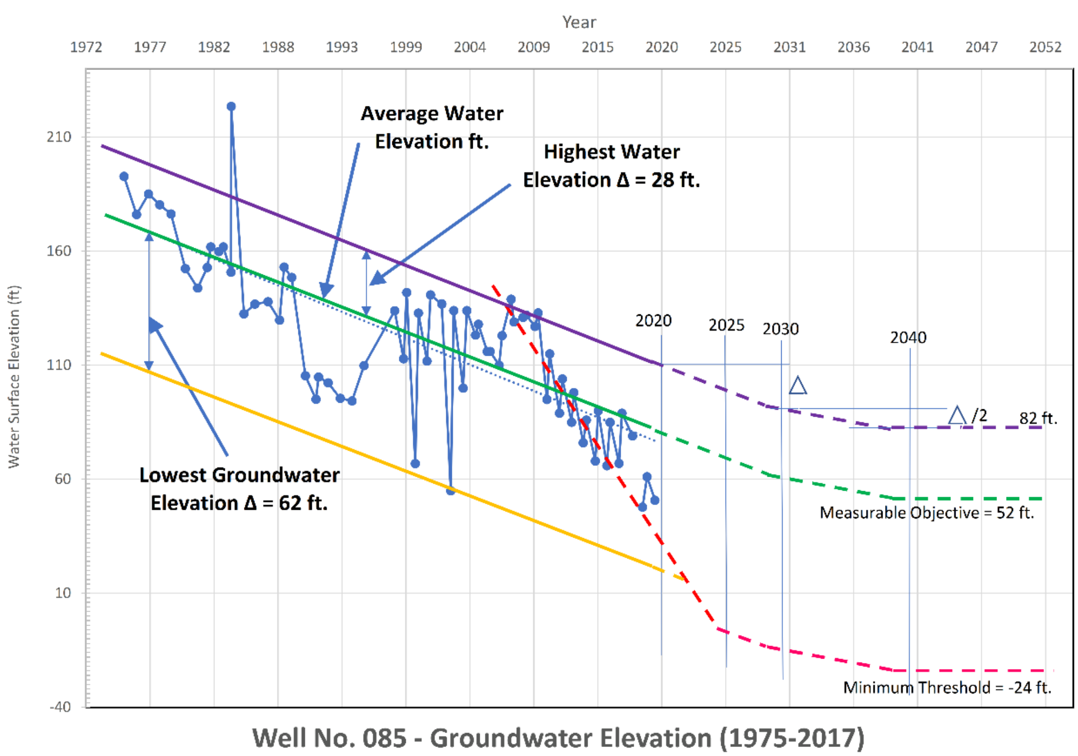


Figure 9. Well 85 Hydrograph (1975-2019)

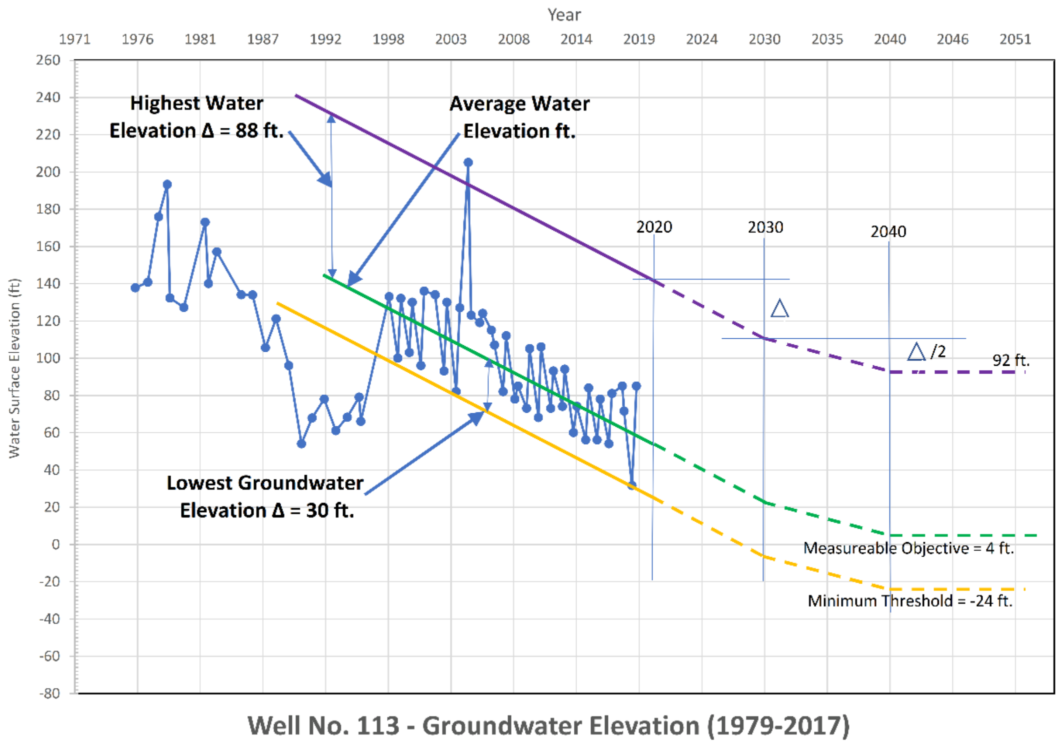


Figure 10. Well 113 Hydrograph (1976-2019)

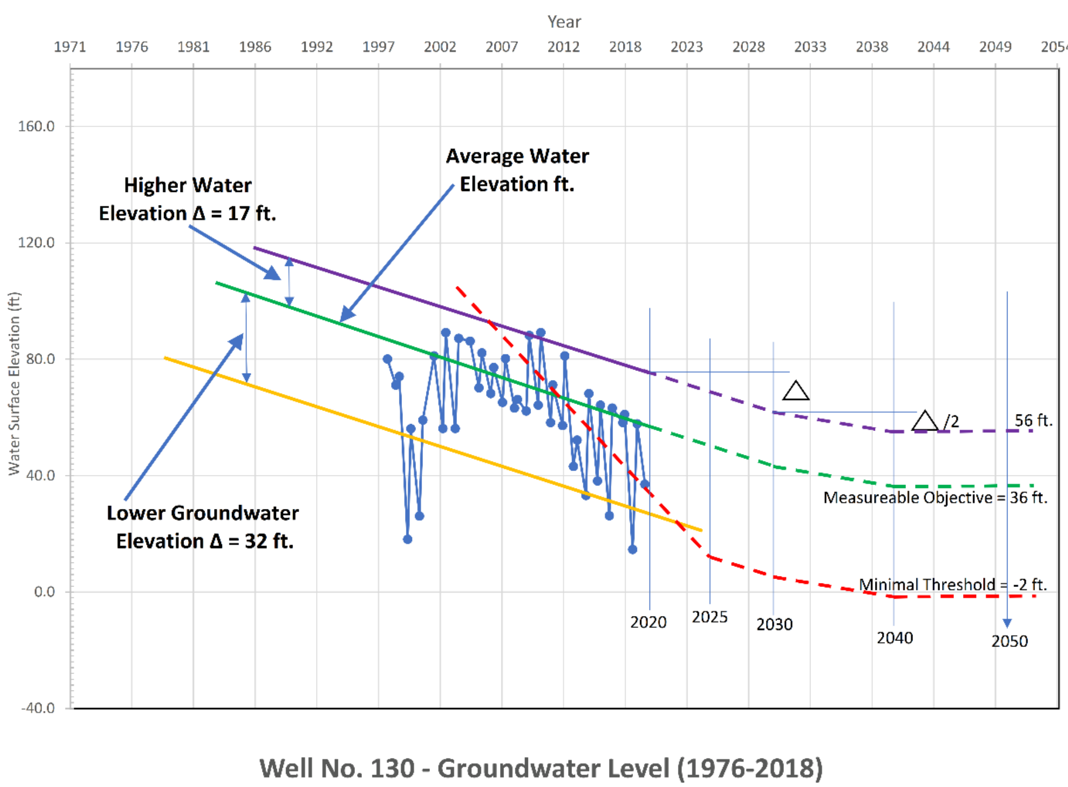


Figure 11. Well 130 Hydrograph (1998-2019)

Table 10. DWR Water Year Type Classification for San Joaquin Valley

Year	WY Type	Year	WY Type	Year	WY Type
1974	W	**1990**	C	**2005**	W
1975	W	**1991**	C	**2006**	W
1976	C	**1992**	C	**2007**	C
1977	C	**1993**	W	**2008**	C
1978	W	**1994**	C	**2009**	BN
1979	AN	**1995**	W	**2010**	AN
1980	W	**1996**	W	**2011**	W
1981	D	**1997**	W	**2012**	D
1982	W	**1998**	W	**2013**	C
1983	W	**1999**	AN	**2014**	C
1984	AN	**2000**	AN	**2015**	C
1985	D	**2001**	D	**2016**	D
1986	W	**2002**	D	**2017**	W
1987	C	**2003**	BN	**2018**	BN
1988	C	**2004**	D	**2019**	W
1989	C				

Note: C = critical, D = dry, BN = below normal, AN = above normal, w = wet

Groundwater Storage Change

Change in groundwater storage is caused by extracting more groundwater than is naturally or intentionally recharged or vice versa. RCWDGSA has two main sources of groundwater extraction as discussed in preceding sections: residential water use and agricultural irrigation. More recently, practices such as intentional recharge, stormwater detention, and treated wastewater effluent percolation have been implemented which help to balance the volume of groundwater extracted. Additionally, natural recharge occurs through seepage from the San Joaquin River. Due to the listed water management strategies by RCWDGSA and others discussed in the preceding sections, groundwater storage change over the last 5 years has been relatively balanced as shown in **Table 11**.

Based on groundwater elevation measurable objectives set by RCWDGSA, the objective for groundwater storage change is not to exceed a total depletion of approximately 55,000 AF by 2040, after which there should be no net storage change. The data presented below strongly indicates that RCWDGSA is on track to meeting its interim milestones and overall sustainability goal set in the GSP.

Table 11. Groundwater Storage Change from 2015-2019

Time Period	Average Change (ft)	Surface Area of Analysis (ac)	Assumed Specific Yield	Acre Feet Change
Spring 2014 - Spring 2015	7.8	7,596	0.12	7,110
Spring 2015 - Spring 2016	-4.8	7,596	0.12	-4,375
Spring 2016 - Spring 2017	-4.5	7,598	0.12	-4,103
Spring 2017 - Spring 2018	10.2	7,598	0.12	9,300
Spring 2018 – Spring 2019	-10	7,598	0.12	-9,117
Average	-0.26			-237
Fall 2014 – Fall 2015	10.5	7,596	0.12	9,537
Fall 2015 – Fall 2016	-13.2	7,601	0.12	-12,039
Fall 2016 – Fall 2017	18.8	7,601	0.12	17,147
Fall 2017 – Fall 2018	-25.0	7,598	0.12	-22,793
Fall 2018 – Fall 2019	10.9	7,598	0.12	9,938
Average	0.4			358

Figure 12 shows the annual change in groundwater storage next to groundwater use as a bar graph along with cumulative storage change within RCWDGSA boundaries since the 2015 water year. The corresponding water year type is shown below the year. **Figure 13** displays the groundwater storage change throughout the area between Spring 2018-2019.

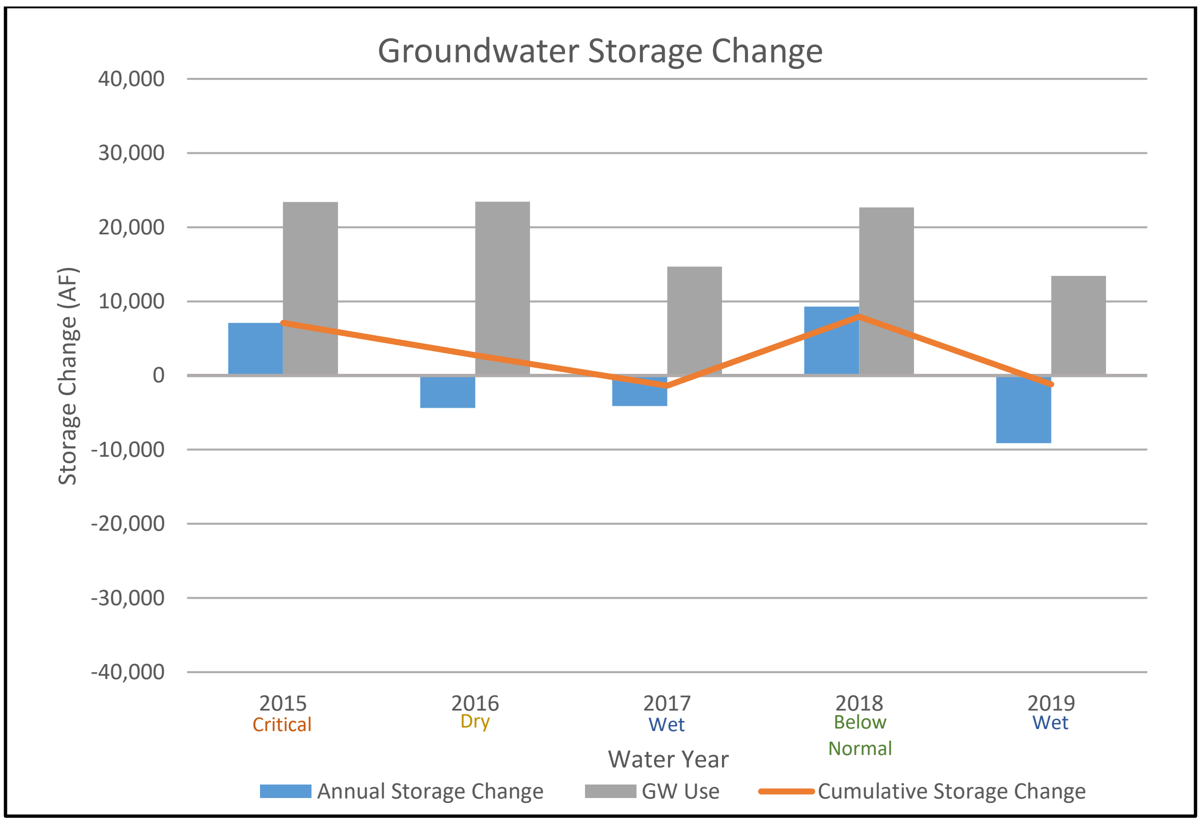


Figure 12. Groundwater Storage Change Between Fall Seasons 2015 to 2019

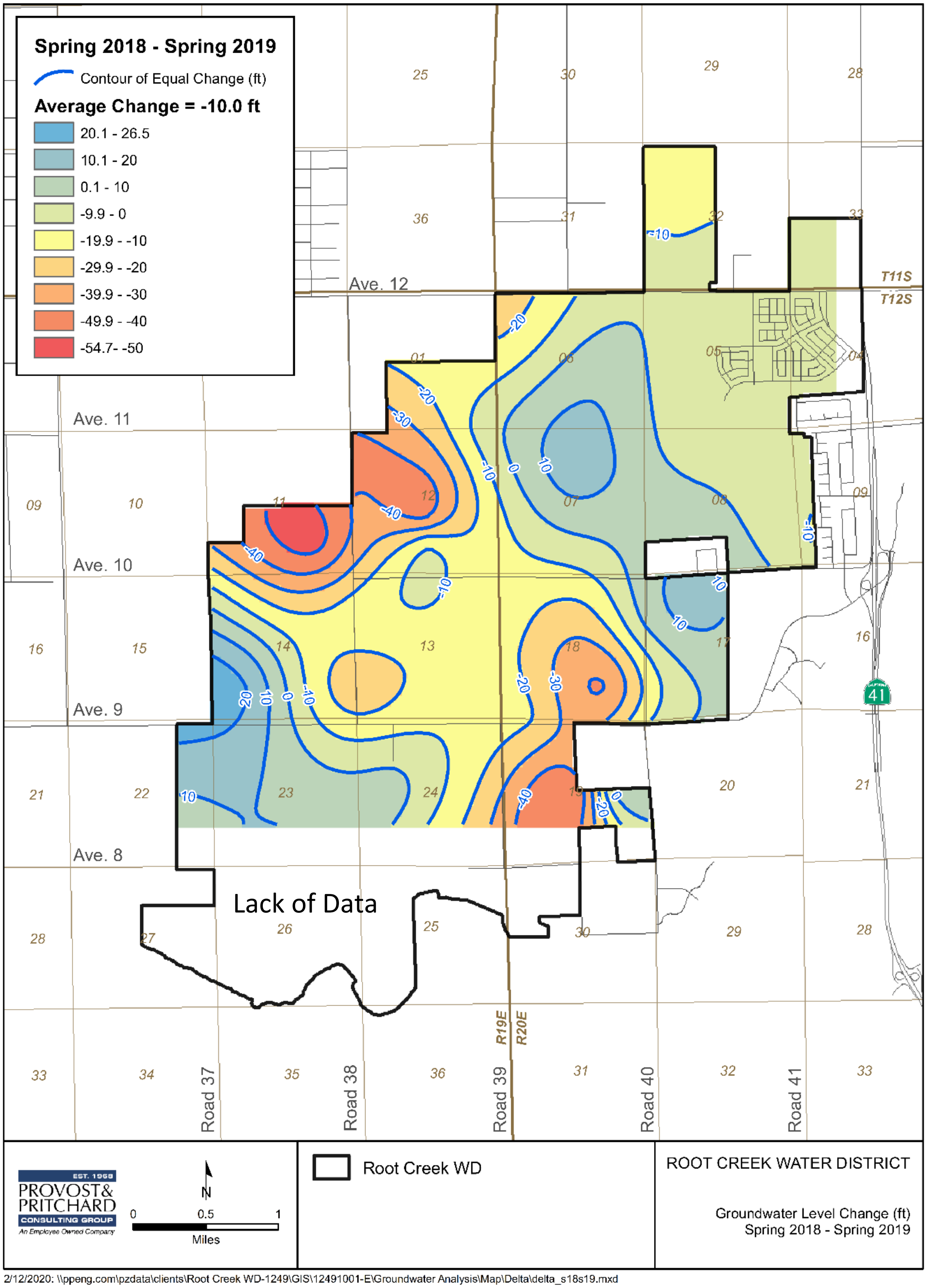
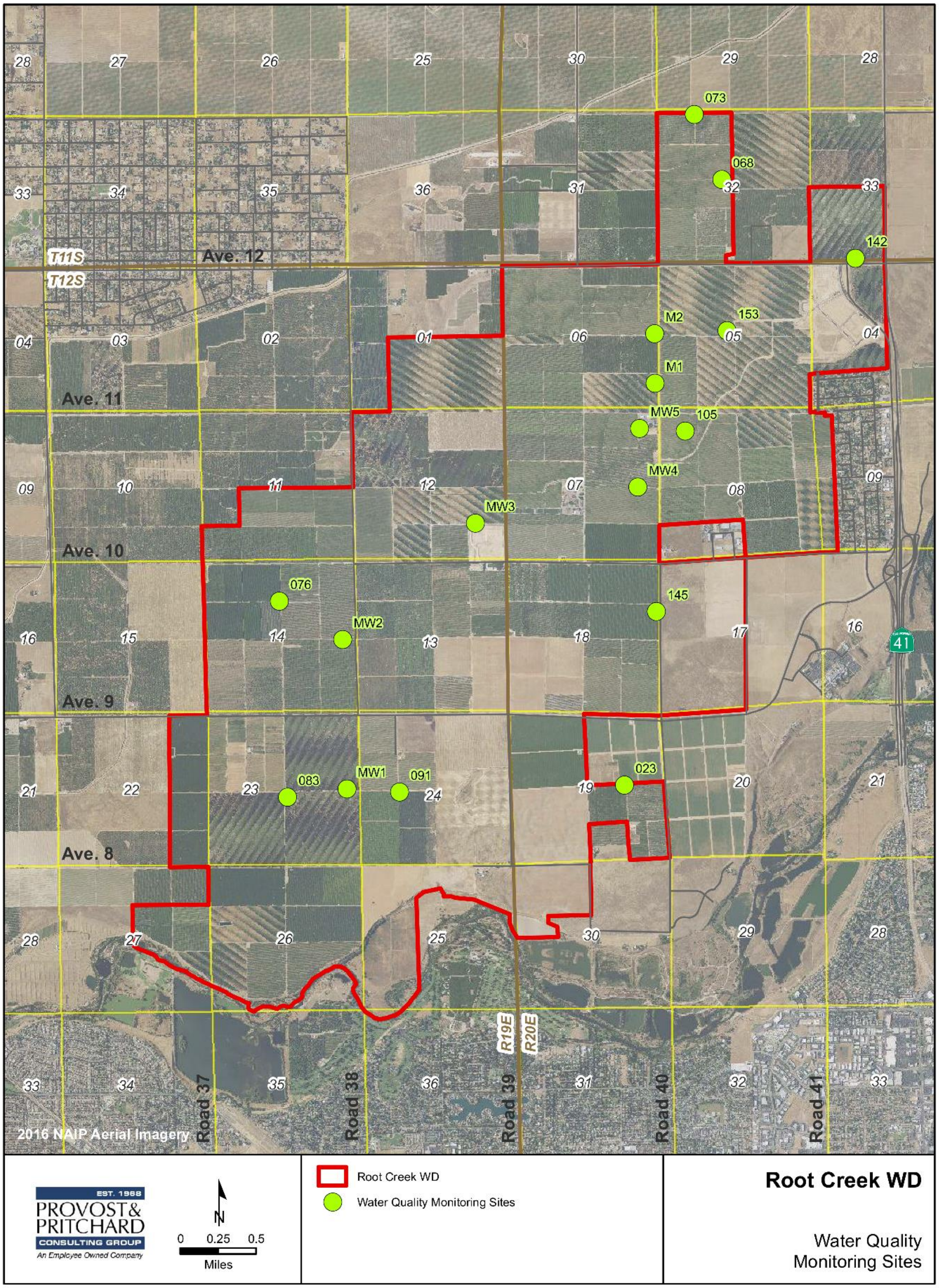


Figure 13. Change in Groundwater Storage in RCWDGSA - Spring 2018 to Spring 2019

Groundwater Quality

It is planned that groundwater quality will be monitored at the wells shown in **Figure 14**. As of now, the municipal wells (designated with an “M”) and the designated monitoring wells (designated with an “MW”) for the wastewater treatment plant have been monitored. Water quality data from 2018 and 2019 for the monitoring wells is presented in **Appendix B**. Since RCWDGSA created a goal to maintain water quality levels, the first few years of monitoring is setting a baseline for comparison. The first year of data shows relatively consistent values for constituents in the water.

Data gaps identified in the GSP include inconsistent frequency of monitoring water quality. It has also been noted that existing water quality data is minimal in irrigated rural areas. The monitoring network presented will fill the spatial data gap. The frequency at which the municipal and monitoring network wells will be monitored is at least semi-annual which will provide for consistent data.



8/6/2019: G:\Root Creek WD-1249\Projects\124917002-GMP Update like GSP\GIS\Map\Report\Monitoring\monitoring_waterqual.mxd

Figure 14. Water Quality Monitoring Wells in RCWDGSA

Land Subsidence

RCWDGSA has not historically experienced land subsidence as discussed in the GSP and thus, no sustainability management criteria have been established. As publicly available data is published, RCWDGSA will monitor the information for any changes. The USBR produces subsidence data through the San Joaquin River Restoration program and is shown on **Figure 15**. Between 2012 and 2019, RCWDGSA has seen minimal subsidence and therefore does not experience undesirable results.

Interconnected Surface Water and Groundwater

As mentioned in the GSP, there have been no sustainability criteria set for interconnected surface water. The most recent available monitoring data from the San Joaquin River Restoration Program is inconclusive and will continue to be monitored.

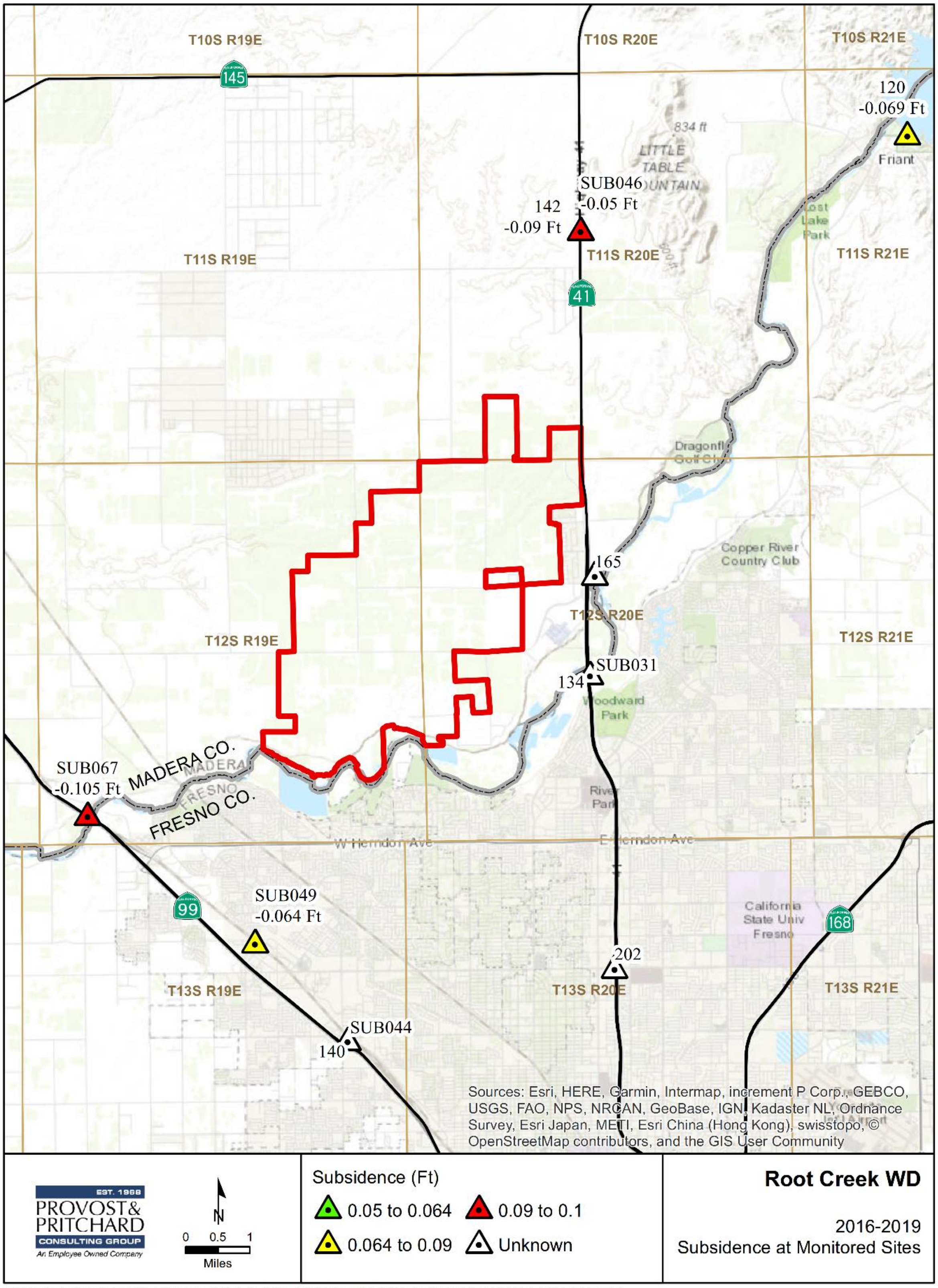
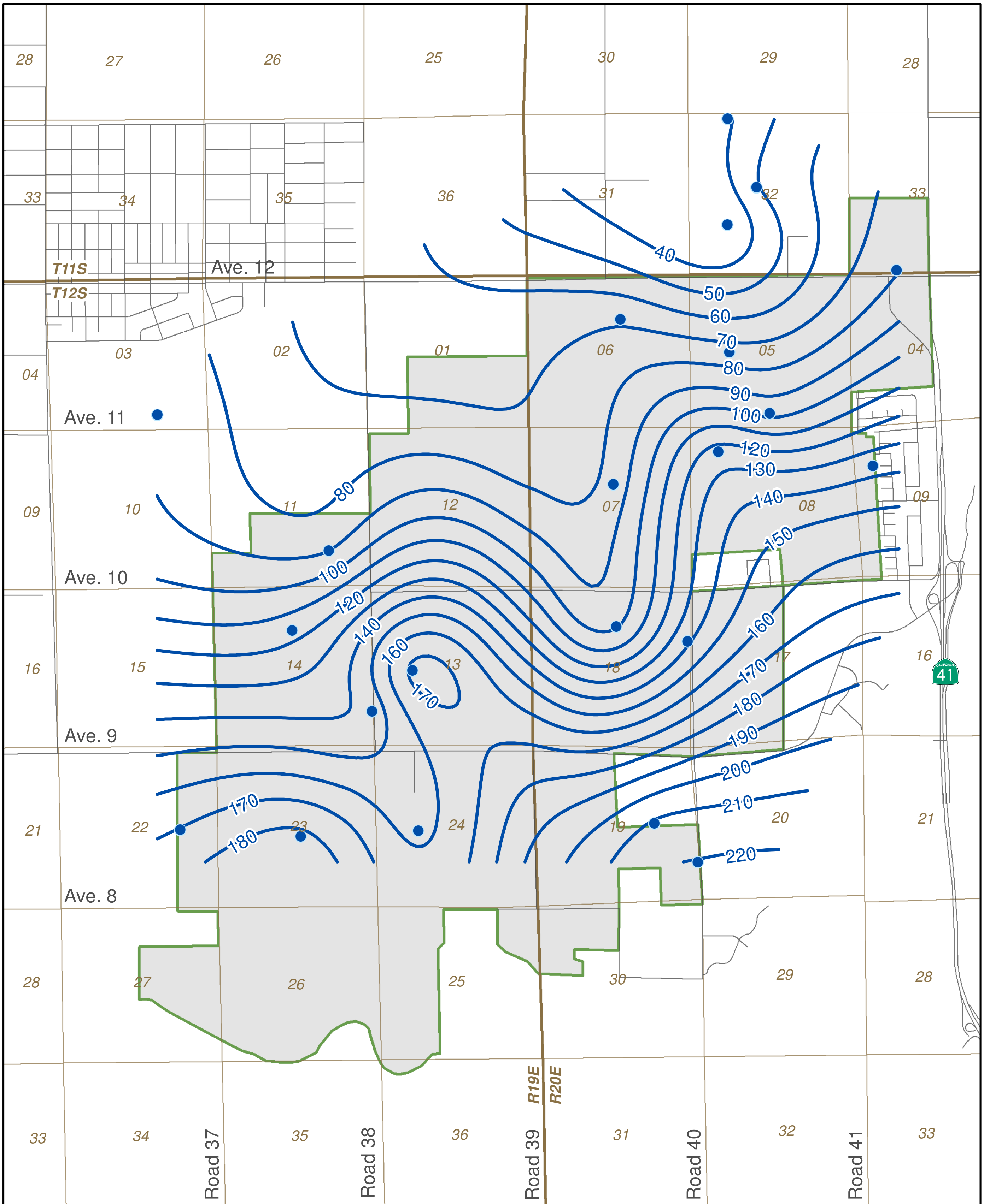


Figure 15. Land Subsidence 2016-2019

Appendix A
Groundwater Elevation Contours Spring 2015 – Spring 2018



0 0.5 1 Miles

N

EST. 1968
PROVOST & PRITCHARD
CONSULTING GROUP
An Employee Owned Company

286 W. Cromwell Ave.
Fresno, CA 93711-6162
(559) 449-2700

Legend

Well Used In Analysis

Elevation of Water in Wells (feet above sea level)

Line of Equal Elevation (10 ft interval)

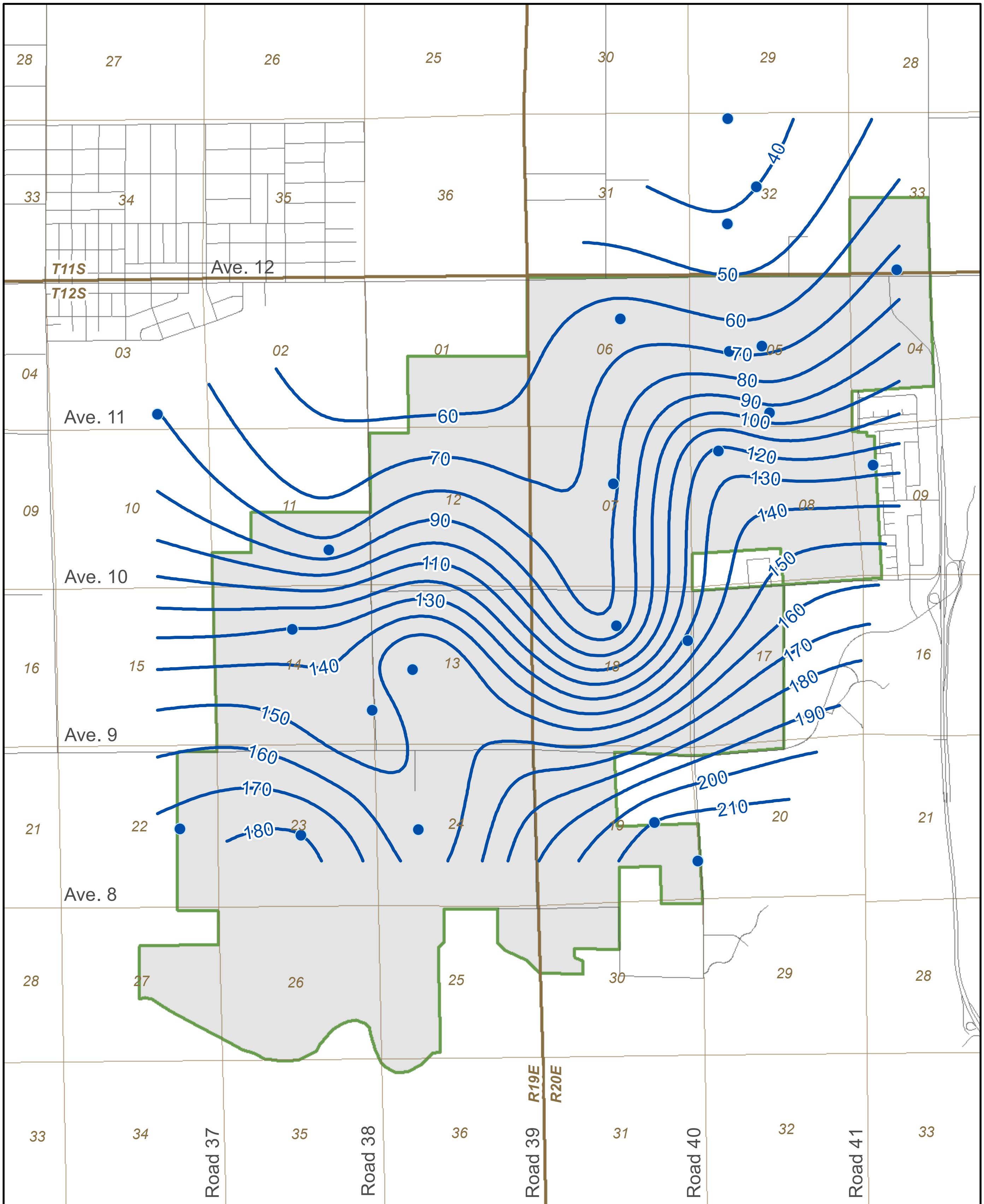
Root Creek WD

ROOT CREEK WATER DISTRICT

Elevation of Water in Wells

Spring 2015

9/9/2015: G:\Root Creek WD-1249\GIS\12491001-E\Groundwater Analysis\Map\Spring15_WSE.mxd



EST. 1968
PROVOST& PRITCHARD
CONSULTING GROUP
An Employee Owned Company

0 0.5 1
Miles

Legend

Well Used In Analysis

Elevation of Water in Wells (feet above sea level)

Line of Equal Elevation (10 ft interval)

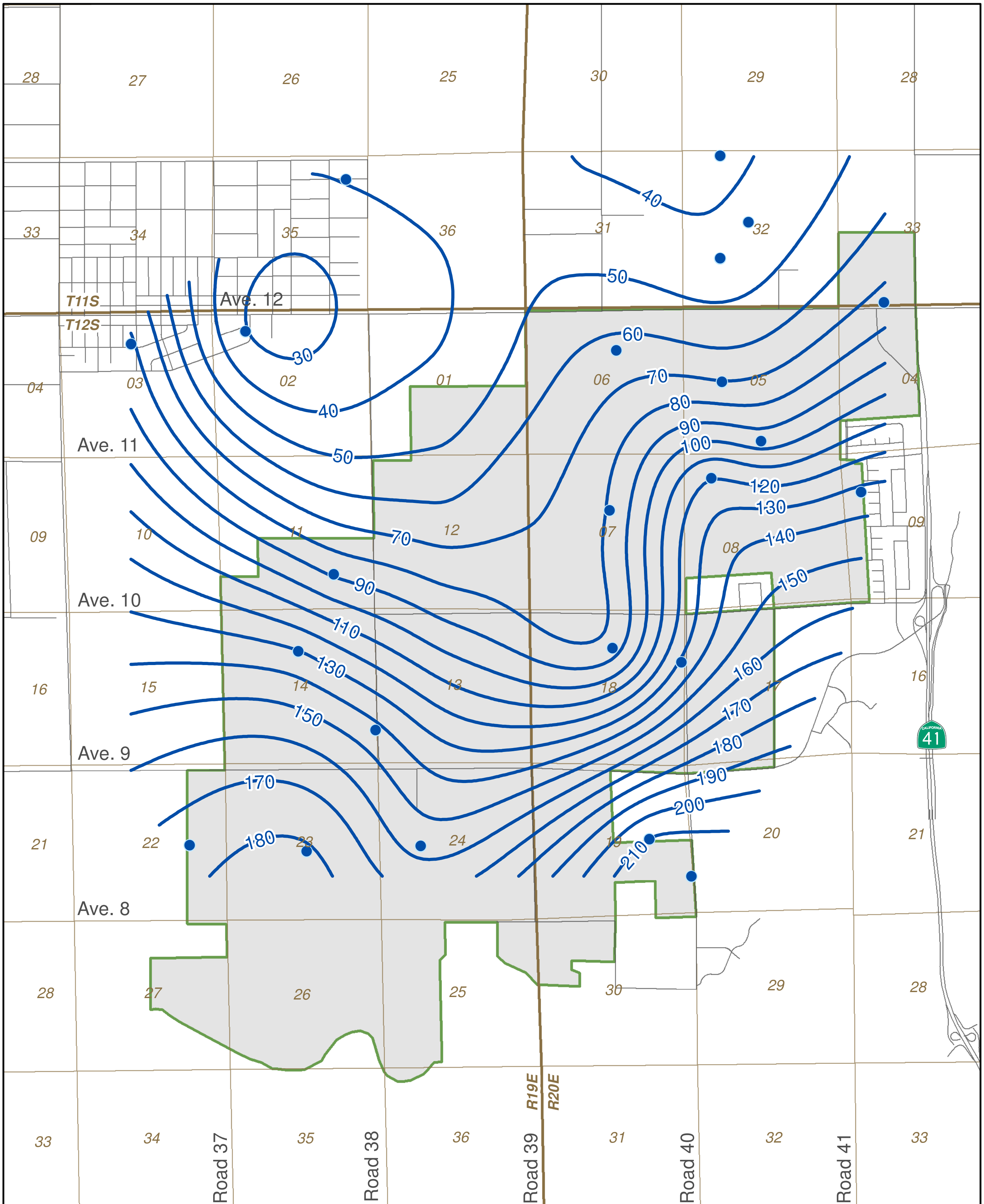
Root Creek WD

ROOT CREEK WATER DISTRICT

Elevation of Water in Wells

Spring 2016

7/20/2016: G:\Root Creek WD-1249\GIS\12491001-E\Groundwater Analysis\Map\Spring16_WSE.mxd



Legend

- Well Used In Analysis

Elevation of Water in Wells (feet above sea level)

- Line of Equal Elevation (10 ft interval)
- Root Creek WD

0 0.5 1
Miles

EST. 1968
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CONSULTING GROUP
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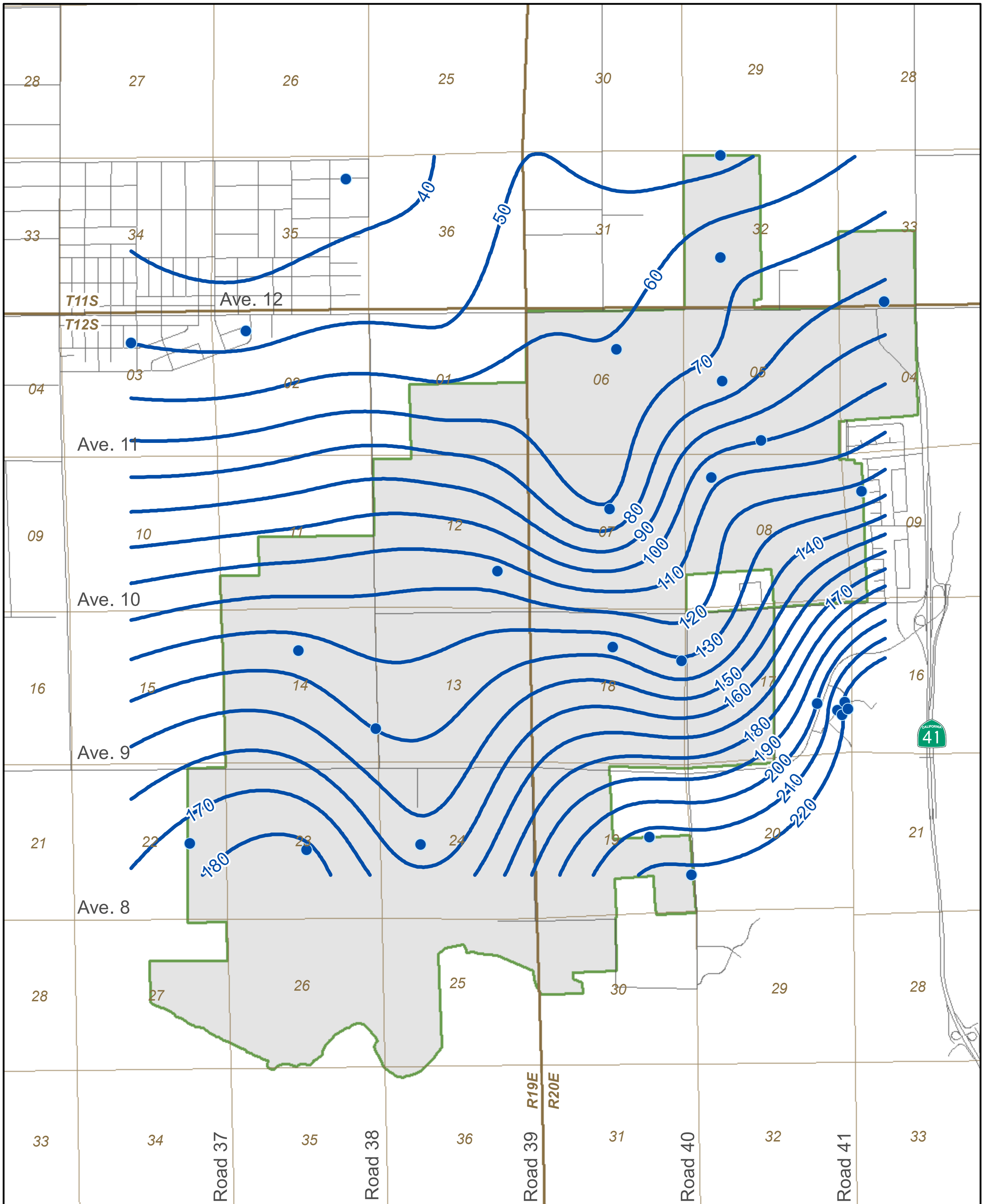
ROOT CREEK WATER DISTRICT

Elevation of Water in Wells

Spring 2017

6/28/2017: G:\Root Creek WD-1249\GIS\12491001-E\Groundwater Analysis\Map\Spring17_WSE.mxd



N

0 0.5 1

Miles

Legend

Root Creek WD

Well Used In Analysis

Elevation of Water in Wells (feet above sea level)

Line of Equal Elevation (10 ft interval)

ROOT CREEK WATER DISTRICT

Elevation of Water in Wells

Spring 2018

7/22/2019: G:\Root Creek WD-1249\GIS\12491001-E\Groundwater Analysis\Map\Spring18_WSE.mxd

Appendix B
Water Quality Data from 2018 and 2019

Appendix B

QUARTERLY MONITORING FOR THE FIRST YEAR THEN SEMI ANNUAL MONITORING

	4TH QTR 2017	1ST QTR 2018	2ND QTR 2018	3RD QTR 2018	4TH QTR 2018	2ND QTR 2019	4TH QTR 2019
Monitoring Well #1	12/28/2017	1/31/2018	4/19/2018	8/7/2018	10/24/2018	6/4/2019	
Depth-To-Water (0.01 feet)	136.44	136.04	135.00	139.37	140.04	138.9	
Groundwater Elev (feet)	201.23	201.93	202.97	198.6	197.93	199.07	
Temperature (©)	20.7	20	21.2	21.6	21.7	22.4	
pH (pH Units)	8.1	6.62	6.65	6.75	6.72	6.62	
Electrical Conductivity (umhos/cm)	273	331	288	264	274	186	

Monitoring Well #2	12/28/2017	1/31/2018	4/19/2018	8/7/2018	10/24/2018	6/4/2019	
Depth-To-Water (0.01 feet)	167.55	166.47	165.00	169.84	170.7	168.52	
Groundwater Elev (feet)	169.86	170.94	172.41	167.57	166.71	168.89	
Temperature (©)	19.0	19.6	22.5	23.5	2.5	22.4	
pH (pH Units)	8.31	6.55	6.06	5.94	6.13	6.22	
Electrical Conductivity (umhos/cm)	279	292	224	284	285	214	

Monitoring Well #3	12/28/2017	1/31/2018	4/19/2018	8/7/2018	10/24/2018	6/4/2019	
Depth-To-Water (0.01 feet)	218.42	241.97	217.00	220.07	220.32	231.71	
Groundwater Elev (feet)	137.32	113.77	138.74	135.67	135.42	124.03	
Temperature (©)	21.1	21.3	22.3	22.3	22.6	22	
pH (pH Units)	7.97	6.16	6.12	5.77	5.98	5.81	
Electrical Conductivity (umhos/cm)	442	478	493	358	296	336	

Monitoring Well #4	12/28/2017	1/31/2018	4/19/2018	8/7/2018	10/24/2018	6/4/2019	
Depth-To-Water (0.01 feet)	217.77	218.5	219.20	220.2	221.54	220.92	
Groundwater Elev (feet)	139.51	138.78	138.08	135.08	135.74	130.36	
Temperature (©)	22	21.7	22.1	23.4	23.0	24.1	
pH (pH Units)	8.02	6.24	5.77	5.54	5.86	5.71	
Electrical Conductivity (umhos/cm)	243	302	275	289	287	192	

Monitoring Well #5	12/28/2017	1/31/2018	4/19/2018	8/7/2018	10/24/2018	6/4/2019	
Depth-To-Water (0.01 feet)	220.36	219.36	219.00	222.37	223.13	222.47	
Groundwater Elev (feet)	141.05	142.05	142.41	139.04	138.28	138.94	
Temperature (©)	20.3	20.7	22.8	23.1	22.9	23.6	
pH (pH Units)	8.5	6.32	5.73	5.85	6.01	5.86	
Electrical Conductivity (umhos/cm)	239	245	187	187	185	140	

MONITORING AND REPORTING PROGRAM R5-2015-0018
ROOT CREEK WATER DISTRICT
RIVERSTONW WASTEWATER TREATMENT FACILITY
MADERA COUNTY

QUARTERLY MONITORING FOR THE FIRST YEAR THEN SEMI ANNUAL MONITORING

MONITORING WELL #1

	4TH QTR 2017	1ST QTR 2018	2ND QTR 2018	3RD QTR 2018	4TH QTR 2018	2ND QTR 2019	4TH QTR 2019
Alkalinity (mg/L)	100.0	110.0	110.0	110.0	96.0	89.0	
Bicarbonate (mg/L)	130.0	130.0	140.0	130.0	120.0	110.0	
Carbonate (mg/L)	ND	ND	ND	ND	ND	ND	
Boron (mg/L)	ND	ND	0.0	ND	ND	ND	
Calcium (mg/L)	25.0	23.0	24.0	23.0	24.0	20.0	
Chloride (mg/L)	11.0	11.0	12.0	9.3	12.0	9.1	
Hardness (mg. equiv)	110.0	98.0	100.0	95.0	99.0	84.0	
Iron (mg/L)	ND	ND	0.2	ND	ND	ND	
Magnesium (mg/L)	10.0	9.7	9.7	9.2	9.5	8.5	
Manganese (mg/L)	ND	ND	ND	ND	ND	ND	
Nitrate as N (mg/L)	3.7	3.6	4.1	2.9	3.6	2.7	
Potasium (mg/L)	4.4	4.4	4.2	3.8	4.0	3.9	
Sodium (mg/L)	20.0	20.0	20.0	18.0	20.0	18.0	
Sulfate (mg/L)	12.0	11.0	13.0	7.9	13.0	7.5	
Total Dissolved Solids (mg/L)	220.0	210.0	210.0	180.0	210.0	200.0	
Total Organic Carbon (mg/L)	0.25	0.27	ND	0.32	0.54	0.41	

QUARTERLY MONITORING FOR THE FIRST YEAR THEN SEMI ANNUAL MONITORING

MONITORING WELL #2

	4TH QTR 2017	1ST QTR 2018	2ND QTR 2018	3RD QTR 2018	4TH QTR 2018	2ND QTR 2019	4TH QTR 2019
Alkalinity (mg/L)	71.0	74.0	78.0	84.0	70.0	71.0	
Bicarbonate (mg/L)	87.0	91.0	95.0	100.0	86.0	87.0	
Carbonate (mg/L)	ND	ND	ND	ND	ND	ND	
Boron (mg/L)	ND	ND	0.02	ND	ND	ND	
Calcium (mg/L)	18.0	17.0	16.0	23.0	90.0	21.0	
Chloride (mg/L)	12.0	12.0	11.0	14.0	7.1	14.0	
Hardness (mg. equiv)	78.0	76.0	71.0	100.0	90.0	94.0	
Iron (mg/L)	0.2	ND	0.13	0.2	ND	0.1	
Magnesium (mg/L)	8.4	8.0	7.4	11.0	9.5	10.0	
Manganese (mg/L)	ND	ND	0.005	ND	ND	ND	
Nitrate as N (mg/L)	4.9	5.0	4.9	7.1	7.1	7.1	
Potasium (mg/L)	4.6	4.8	4.5	4.9	4.8	5.2	
Sodium (mg/L)	16.0	17.0	16.0	18.0	18.0	18.0	
Sulfate (mg/L)	7.8	8.0	7.2	12.0	11.0	11.0	
Total Dissolved Solids (mg/L)	210.0	210.0	200.0	250.0	260.0	280.0	
Total Organic Carbon (mg/L)	0.06	ND	ND	0.20	0.32	0.27	

QUARTERLY MONITORING FOR THE FIRST YEAR THEN SEMI ANNUAL MONITORING

MONITORING WELL #3

	4TH QTR 2017	1ST QTR 2018	2ND QTR 2018	3RD QTR 2018	4TH QTR 2018	2ND QTR 2019	4TH QTR 2019
Alkalinity (mg/L)	72.0	110.0	81.0	77.0	64.0	61.0	
Bicarbonate (mg/L)	88.0	130.0	99.0	94.0	77.0	75.0	
Carbonate (mg/L)	ND	ND	ND	ND	ND	ND	
Boron (mg/L)	ND	ND	0.02	ND	ND	ND	
Calcium (mg/L)	38.0	46.0	34.0	33.0	26.0	28.0	
Chloride (mg/L)	23.0	24.0	24.0	22.0	20.0	22.0	
Hardness (mg. equiv)	150.0	170.0	150.0	140.0	120.0	130.0	
Iron (mg/L)	0.6	ND	1.2	0.8	ND	0.5	
Magnesium (mg/L)	14.0	15.0	15.0	15.0	12.0	15.0	
Manganese (mg/L)	0.0	0.0	0.04	0.0	ND	0.0	
Nitrate as N (mg/L)	19.0	18.0	21.0	18.0	14.0	17.0	
Potasium (mg/L)	7.7	8.2	8.0	7.2	6.4	7.1	
Sodium (mg/L)	23.0	24.0	23.0	22.0	22.0	22.0	
Sulfate (mg/L)	22.0	22.0	23.0	19.0	16.0	19.0	
Total Dissolved Solids (mg/L)	330.0	370.0	340.0	320.0	290.0	330.0	
Total Organic Carbon (mg/L)	0.24	0.39	ND	0.28	0.63	0.80	

QUARTERLY MONITORING FOR THE FIRST YEAR THEN SEMI ANNUAL MONITORING

MONITORING WELL #4

	4TH QTR 2017	1ST QTR 2018	2ND QTR 2018	3RD QTR 2018	4TH QTR 2018	2ND QTR 2019	4TH QTR 2019
Alkalinity (mg/L)	45.0	170.0	54.0	52.0	49.0	47.0	
Bicarbonate (mg/L)	55.0	210.0	66.0	63.0	60.0	58.0	
Carbonate (mg/L)	ND	ND	ND	ND	ND	ND	
Boron (mg/L)	ND	ND	0.02	ND	ND	ND	
Calcium (mg/L)	22.0	19.0	21.0	21.0	21.0	21.0	
Chloride (mg/L)	18.0	20.0	20.0	19.0	28.0	23.0	
Hardness (mg. equiv)	110.0	82.0	88.0	89.0	85.0	88.0	
Iron (mg/L)	20.0	ND	4.8	1.6	0.3	1.1	
Magnesium (mg/L)	13.0	7.9	8.7	8.8	8.1	9.0	
Manganese (mg/L)	0.9	0.007	0.2	0.1	0.01	0.1	
Nitrate as N (mg/L)	11.0	12.0	12.0	11.0	12.0	12.0	
Potasium (mg/L)	10.0	6.8	7.4	6.6	6.1	6.8	
Sodium (mg/L)	17.0	18.0	18.0	19.0	19.0	19.0	
Sulfate (mg/L)	5.3	6.2	5.4	5.6	6.4	6.4	
Total Dissolved Solids (mg/L)	280.0	260.0	260.0	240.0	250.0	330.0	
Total Organic Carbon (mg/L)	1.20	0.11	ND	0.20	0.55	1.10	

QUARTERLY MONITORING FOR THE FIRST YEAR THEN SEMI ANNUAL MONITORING

MONITORING WELL #5

	4TH QTR 2017	1ST QTR 2018	2ND QTR 2018	3RD QTR 2018	4TH QTR 2018	2ND QTR 2019	4TH QTR 2019
Alkalinity (mg/L)	38.0	42.0	42.0	41.0	33.0	33.0	
Bicarbonate (mg/L)	46.0	51.0	51.0	50.0	40.0	41.0	
Carbonate (mg/L)	ND	ND	ND	NF	ND	ND	
Boron (mg/L)	ND	ND	0.02	NF	ND	ND	
Calcium (mg/L)	14.0	12.0	12.0	12.0	12.0	11.0	
Chloride (mg/L)	11.0	11.0	11.0	10.0	11.0	11.0	
Hardness (mg. equiv)	66.0	52.0	55.0	53.0	49.0	51.0	
Iron (mg/L)	8.0	ND	3.0	0.4	ND	0.9	
Magnesium (mg/L)	7.6	5.3	5.9	5.3	4.9	5.4	
Manganese (mg/L)	0.3	0.0	0.1	0.0	ND	0.0	
Nitrate as N (mg/L)	8.5	8.6	8.7	7.6	8.2	8.3	
Potasium (mg/L)	7.1	5.5	6.0	5.1	1.4	5.3	
Sodium (mg/L)	15.0	14.0	15.0	15.0	14.0	14.0	
Sulfate (mg/L)	3.2	3.1	2.2	2.7	2.6	2.7	
Total Dissolved Solids (mg/L)	210.0	210.0	200.0	200.0	180.0	190.0	
Total Organic Carbon (mg/L)	0.27	0.13	ND	ND	0.42	0.51	