



Consulting  
Engineers and  
Scientists

## Annual Report for the Martis Valley Groundwater Basin

### Water Years 2018 and 2019

---

January 22, 2021

---





Consulting  
Engineers and  
Scientists

# **Martis Valley Groundwater Basin Annual Report Water Years 2018 and 2019**

Prepared for:

Truckee Donner Public Utility District (TDPUD)

On behalf of Truckee Donner Public Utility District (TDPUD), Northstar Community Service District (NCSD), and Placer County Water Agency (PCWA) collectively referred to as the MVGB Agencies.

Prepared by:

GEI Consultants  
2868 Prospect Park Drive, Suite 400  
Sacramento, CA 95670

January 22, 2021

---

TRUCKEE DONNER PUBLIC UTILITY DISTRICT  
MARTIS VALLEY GROUNDWATER BASIN ANNUAL REPORT

WATER YEARS 2018 AND 2019

Certifications and Seals

*This report and analysis was prepared by the following GEI Consultants Inc. professional geologists.  
Report sections contained herein based on available data and were prepared by:*



Date: January 22, 2021

---

Sean Storey  
Geologist-In-Training No. 812



Date: January 22, 2021

---

Richard W. Shatz  
Principal Hydrogeologist  
California Certified Hydrogeologist  
C.H.G. No. 84

# Table of Contents

---

Table of Contents .....	ii
Executive Summary.....	4
1. Introduction.....	5
1.1 Martis Valley Groundwater Basin .....	5
1.2 Climatic Conditions .....	6
1.3 Surface Water Conditions.....	6
2. Groundwater Conditions .....	7
2.1 Groundwater Levels .....	7
2.2 Groundwater Flow .....	8
3. Groundwater Extraction.....	9
4. Surface Water Diversions .....	12
5. Groundwater Recharge.....	14
6. Total Water Use .....	15
7. Change in Groundwater Storage .....	16
8. Groundwater Management Activities .....	18
9. Conclusions and Recommendations .....	19
10. References .....	20

## Figures

### Attachment A. Monitoring Well Hydrographs

### Attachment B. Piezometer Hydrographs

## Figures

Figure 1	Martis Valley Groundwater Basin Location
Figure 2	Annual Precipitation Deviation from Mean: Truckee Ranger Station No. 049343
Figure 3	Martis Valley Groundwater Basin Monitoring Well Locations
Figure 4	Martis Valley Groundwater Basin Historic Groundwater Level Elevations, Water Years 1989-2019
Figure 5	Martis Valley Groundwater Basin Historic Groundwater Level Elevations, Water Years 2018-2019
Figure 6	Martis Valley Groundwater Basin Spring 2018 Groundwater Elevation Contours
Figure 7	Martis Valley Groundwater Basin Fall 2018 Groundwater Elevation Contours
Figure 8	Martis Valley Groundwater Basin Spring 2019 Groundwater Elevation Contours
Figure 9	Martis Valley Groundwater Basin Fall 2019 Groundwater Elevation Contours
Figure 10	Martis Valley Groundwater Basin Monthly Pumping Totals
Figure 11	Martis Valley Groundwater Basin Locations of Groundwater Extractions
Figure 12	Martis Valley Groundwater Basin Change in Groundwater Elevation, Spring 2017-Spring 2018
Figure 13	Martis Valley Groundwater Basin Change in Groundwater Elevation, Spring 2018-Spring 2019
Figure 14	Change in Storage and Groundwater Use

## **Tables**

Table 1	Groundwater Extractions for Water Year 2017-2018
Table 2	Groundwater Extractions for Water Year 2018-2019
Table 3	Surface Water Usage Reported for Water Year 2017-2018
Table 4	Surface Water Usage Reported for Water Year 2018-2019
Table 5	Estimated Groundwater Recharge from T-TSA for Water Years 2017-2018
Table 6	Estimated Groundwater Recharge from T-TSA for Water Years 2018-2019
Table 7	Total Water Use for Water Years 2018-2019
Table 8	Estimated Change in Storage

# Executive Summary

---

This report provides annual monitoring data and an assessment of groundwater conditions in the Martis Valley Groundwater Basin (MVGB or Basin) for water years 2018 and 2019. A water year is defined as October through September of any year.

The MVGB does not have to comply with the Sustainable Groundwater Management Act (SGMA), as the basin was re-classified in 2018 as a very low priority basin. However, the MVGB Agencies recognize the importance of groundwater management and are continuing to implement their 2013 Groundwater Management Plan.

Groundwater levels, groundwater extractions, surface water conditions, groundwater recharge from imported wastewater, measured and estimated total water use and groundwater storage change estimates were compiled and analyzed. All wells remained above their historical low levels in water year 2018 and 2019, except at one well for one month. Groundwater level elevations for the monitoring well network exhibited slight decreases in the below normal precipitation and increased pumping in water year 2018. Groundwater conditions improved in 2019 due to above normal precipitation and reduced groundwater pumping. Change in groundwater storage values reflected these conditions, and overall groundwater in storage increased by about 700 acre-feet over the last two water years. The basin storage has been conservatively estimated to be about 484,000 acre-feet so the overall annual change is small (less than 1% annually) in comparison to the total water stored in the basin.

# 1. Introduction

---

The Martis Valley Groundwater Basin (MVGB or Basin) groundwater resources have been evaluated for many years starting in the 1990s. In 2013, a Groundwater Management Plan (GMP) was developed for the basin. In 2014, the Sustainable Groundwater Management Act (SGMA) classified the MVGB as medium priority basin and was required to comply with the SGMA. In December 2016, an Alternative Submittal to a Groundwater Sustainability Plan was submitted to the California Department of Water Resources (DWR) by the Truckee Donner Public Utility District (TDPUD) on behalf its local MVGB SGMA Agencies (MVGB SGMA Local Agencies), including: TDPUD, Northstar Community Services District (NCS), Placer County Water Agency (PCWA), the Town of Truckee, Nevada County, and Placer County. As referenced in the MVGB Alternative Submittal, scientific analyses showed the basin has at least a 25-year history of sustainable groundwater operations and conditions, despite several periods of drought. In compliance with SGMA requirements an Annual Report for water years (WYs) 2016 and 2017 were developed and submitted to DWR.

Prior to DWR completing its review of the Alternative and Annual Reports, DWR was required to review basin prioritizations as part of implementation of SGMA. The MVGB SGMA Local Agencies reviewed DWR's initial prioritization of the basin and worked extensively with DWR staff to ensure accurate information was being used. In 2018, DWR re-evaluated the basin and changed its priority to Very Low Priority, thus the basin was no longer required to comply with SGMA. The MVGB Agencies recognize the importance of groundwater management and continue to implement the 2013 GMP. As part of this plan, Best Management Objective #1, is to compile an annual report to summarize groundwater conditions and to share the information with interested stakeholders. This document provides a summary and interpretation of groundwater conditions for WY's 2018 and 2019. The report provides historic data for reference along with more detailed assessment of the conditions since implementation of the GMP.

## 1.1 Martis Valley Groundwater Basin

The MVGB, Basin No. 6-67, as defined by DWR in Bulletin 118 Interim Update (2016), is a 35,600 acre (57 square mile) intermontane, fault-bounded basin east of the Sierra Nevada crest. **Figure 1** shows the location of the MVGB and pertinent geographic features.

The MVGB uses groundwater almost exclusively for water demands, although several major surface water bodies are present within the basin. The Truckee River traverses the Basin from the southwest to the northeast in a shallow, incised channel. Principal tributaries to the Truckee River within the MVGB are Donner Creek, Martis Creek, and Prosser Creek; as well as discharge from Boca Reservoir slightly before the Truckee River leaves the Basin. Surface water storage reservoirs inside MVGB include Martis Lake and Prosser Reservoir. Donner Lake and Boca Reservoir lie just outside the MVGB boundaries, but release surface water into the MVGB. Although surface water released from reservoirs is not used to satisfy local demands, it is a major, and highly regulated, component of the Basin's hydrologic system. Surface water within the MVGB is under the purview of the Truckee River

Operating Agreement (TROA), a Bi-State, multi-party Federal Agreement enacted by the US Congress which sets limits on the consumptive use of both groundwater and surface water in the Basin.

Wastewater is generated within the MVGB, within the Truckee River watershed, and outside the watershed (Lake Tahoe area) and sent to a treatment facility operated by the Tahoe-Truckee Sanitary Agency (T-TSA). The treated water is recharged into the groundwater system via two leach fields (**Figure 1**), increasing the groundwater contribution to downstream Truckee River flows.

## 1.2 Climatic Conditions

Water year types were developed for the MVGB using local precipitation data from Truckee Ranger Station No. 049043. Its location is shown on **Figure 1**. The deviation of annual WY precipitation from the mean is shown on **Figure 2**. Wet conditions were set at more than one standard deviation above the mean annual WY precipitation total. Above normal conditions were defined as annual precipitation between the mean value and one standard deviation above it. Likewise, below normal conditions were defined as an annual precipitation between the mean value and one standard deviation below it. Dry conditions were defined as an annual precipitation total more than one standard deviation below the mean. Water years 2018 and 2019 are classified as below normal and above normal water years, respectively. This corresponds with increases and decreases observed in both groundwater elevations over the same period.

## 1.3 Surface Water Conditions

The Truckee River is the dominant hydrologic feature in the MVGB. It conveys hundreds of thousands of acre-feet (AF) of surface water through the Basin and flows along the lowest portions of the valley floor. Outflow from the basin in the Truckee River in water year 2018 was about 570,000 acre-feet. Flows through the gage in 2019 were not fully documented.

For the most part, groundwater consistently discharges to the river throughout the Basin as was evidenced during the last drought when in 2016 levels prevented releases of water from Lake Tahoe. Although at very low levels water was still present in portions of the river due to groundwater discharges. Therefore, maintaining groundwater levels at or above the 2016 levels ensures groundwater will continue to discharge to the river.



## 2. Groundwater Conditions

---

Wells used for groundwater level monitoring in the MVGB are shown on **Figure 3**. Water levels at these wells are monitored by the MVGB Agencies and DWR and are reported to the California Statewide Groundwater Elevation Monitoring (CASGEM) program. These wells are used to help assess the sustainability of the MVGB. Data from the wells were used to generate hydrographs to show groundwater level elevation trends over time at each monitoring location. Groundwater levels in the Basin range from within a few feet of ground surface to as much as 100 feet below ground surface and have consistently remained within this range.

Three of the CASGEM monitoring wells (TH-Fibreboard, TH-Prosser Village and TH-Martis Valley) are located near municipal supply wells that at times affect their measurements. Historically, it was not documented whether the nearby municipal wells were pumping or recently shut off when the measurements were taken. This has been corrected in recent years. In addition to the CASGEM wells, six piezometers were constructed near Martis Creek for a restoration project and provide some additional information about the groundwater conditions in the Basin.

### 2.1 Groundwater Levels

Long-term hydrographs, from 1989 through 2019 for the monitoring wells are presented on **Figure 4** along with the water year types. Water year 2018 and 2019 groundwater levels are all within their historic ranges except for one well and only for one month.

Beginning in Spring 2017, as a management action, the MVGB Agencies began monthly monitoring of accessible monitoring wells to track groundwater levels during the summer months when groundwater use typically increases and groundwater levels would be lower. **Figure 5** provides shorter time period than **Figure 4** to further assess these seasonal variations in groundwater levels. As shown, groundwater elevations, depending on the location in the Basin, have either increased by a fairly significant amount (greater than 10 feet), decreased slightly (less than 10 feet) or remained stable during the last two years. This is common in a groundwater basin due to annual differences in precipitation, droughts, and where wells pump groundwater. Seasonal fluctuations due to climate and pumping patterns are apparent. In general, Spring groundwater levels decreased from 2017 to 2018 and increased from 2018 to 2019 in response to a below normal precipitation in water year 2018 and above normal precipitation in water year 2019.

Hydrographs for each individual monitoring well are presented in **Attachment A**. These hydrographs contain the full historical record of measurements extending to the end of water year 2019, along with historical low groundwater levels. Groundwater elevations in the Basin's monitoring wells remained above historical low levels throughout water years 2018 and 2019 even with monthly monitoring through the summer months except at well 17N16E17F002M where for one month groundwater levels appear to have fallen below historic lows by about 5 feet. However, given that quarterly monitoring had not previously detected this potential pumping influence on groundwater levels at this well, it is not conclusive that the well level was actually below the historic level for this particular month of the year. The following month the level was above the historic low suggesting this well may be influenced by pumping at nearby wells. All wells except this well remained above 2016 drought levels.

Groundwater levels have been measured since 2012 in six shallow piezometers (small diameter monitoring wells) to characterize the shallow groundwater, less than 20 feet below ground surface, as part of the Middle Martis Creek wetland restoration project (Balance Hydrologics, 2020). **Attachment B** contains a copy of the report and hydrographs at each of the piezometers. Figure 6 shows their locations. Groundwater levels in this shallow aquifer may or may not be characteristic of the deeper groundwater aquifer, monitored by well 17N17E29B001M. Static groundwater levels are about 20 feet deeper in 17N17E29B001M than in the piezometer-1, suggesting there may be two separate aquifers at this location. Groundwater levels in the piezometers fluctuate seasonally with periods when groundwater levels decline by more than 3.5 feet, typically in the summer months. Groundwater levels during WY 2018 and 2019 remained within their historic levels and durations of shallow levels.

## 2.2 Groundwater Flow

Seasonal groundwater level elevation contours for Spring and Fall 2018 through 2019 are shown on **Figures 6 through 9**. These contours reflect pumping, recharge, geologic conditions, and discharges to surface water. Monitoring well groundwater levels and bed elevations of gaining surface water reaches were used to develop the groundwater elevation contour maps. Groundwater levels at 17N16E13K003M were used for contouring. Groundwater flow patterns remained the same during both water years, with flow from the perimeter of the MVGB towards the Truckee River, consistent with previous years. The groundwater contours show the pumping has changed this regional pattern near the airport, but this is not a new development as the historic contours have also reflected this pumping depression. The pumping depression appears to be being caused by the Martis Valley municipal well. The extent and depth has not changed significantly over time. Fall season contours exhibit lower groundwater level elevations in the central portions of the Basin, relative to Spring conditions, due to increased pumping and less natural recharge. Spring contours for both years are similar, although at slightly different elevations, indicating recharge is reaching and refilling the aquifers.

### 3. Groundwater Extraction

---

Groundwater extractions for various water use sectors are presented in **Tables 1 and 2** for water years 2018 and 2019, respectively. The general locations of the community water service areas, non-community water purveyors along with the location of golf courses are shown on **Figure 10**. The methods used to measure extraction data are noted along with water use sector totals. The total water use is based on metered and estimated pumping. Total groundwater extraction in the MVGB was about 7,070 and 6,566 acre-feet (AF) for WYs 2018 and 2019, respectively.

Municipal groundwater extractions by TDPUD and NCSD, which are metered, account for about 75% of the total extractions; therefore, total groundwater extraction is well qualified. Groundwater extraction estimates for non-community uses and golf course irrigation were developed by others and are reported annually to the DWR State Board and TROA program. These estimates are developed on a calendar year basis not by water years. The calendar year extraction data is approximately equal to water year estimates due to the annual cycle of climatic conditions, including freezing temperatures and significant amounts of snow and other precipitation, which limit the need to pump groundwater in the spring and summer months of each water year. These estimated values are used in **Tables 1 and 2**. A full reporting of annual 2019 estimates will be available in 2021, in the TROA annual report.

The locations of wells for the public and community water systems, and general locations of golf courses and non-community entities that also use groundwater in the MVGB, are shown on **Figure 10**. The distribution of groundwater extractions for the wells are illustrated by the size of the symbol (magnitude) and color (pumping entity). The largest volume of water extracted at any location in the MVGB is from the Martis Valley well, located near the airport, and has altered the regional groundwater flow direction. Three other wells north of the Truckee River and west of Truckee are the next largest producers in the valley, but do not appear to change the overall regional groundwater flow direction. This figure is useful for comparison with the groundwater contours (presented in Section 2).

A graphical representation of monthly and annual pumping for TDPUD and NCSD wells are presented on **Figure 11**. Seasonally groundwater demand peaks in the summer and declines to approximately one-third to one-quarter of that amount during the winter and spring. This distribution suggests that calendar (for non-community users and golf course irrigation) and water year pumping estimates are typically similar in magnitude for this basin, hence the tabulated totals in **Tables 1 and 2** with calendar year pumping estimates are defensible surrogates to approximate water year pumping estimates. **Figure 11** also shows that the overall pumping volume fluctuates from year to year but overall remains fairly consistent, varying only by about 400 AF over the last four years. Groundwater use was higher in water year 2018 than in 2019, consistent with the below and above normal precipitation and corresponding groundwater levels.

**Table 1 Groundwater Pumping for Water Year 2017-2018 (values in acre-feet)**

Agency	Metered/ Estimated	2017			2018									Annual		
		Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Total	Percent	
<b>Public Utility Water Purveyors<sup>1</sup></b>																
<b>Truckee-Donner PUD</b>																
Potable																
	1. Airport Well	Metered	8	7	8	7	5	37	10	24	39	53	39	97	Water Year 335	
	2. Martis Valley Well	Metered	185	165	179	179	170	123	150	109	171	215	213	204	2,063	
	3. South Side Well	Metered	0	0	0	0	0	0	0	0	0	0	0	0	0	
	4. Glenshire Dr Well	Metered	0	0	0	0	0	0	0	9	40	68	47	5	168	
	5. Hirschdale Well	Metered	0	0	0	0	0	0	0	1	1	1	1	1	7	
	6. Prosser Annex Well	Metered	11	0	0	0	0	0	0	10	20	27	24	20	111	
	7. Prosser Heights Well	Metered	9	0	0	0	0	0	0	6	15	19	18	12	79	
	8. Sanders Well	Metered	0	0	0	0	0	0	0	36	39	41	40	36	192	
	9. Prosser Village Well	Metered	53	16	26	26	20	37	23	72	87	98	97	79	632	
	10. Northside Well	Metered	0	0	0	0	0	0	0	18	22	20	16	76		
	11. Old Greenwood Well	Metered	18	16	27	22	21	37	22	36	53	75	78	0	407	
	12. Well 20	Metered	2	0	0	0	0	0	0	4	15	19	17	14	70	
	13. "A" Well	Metered	0	0	0	0	0	0	0	0	5	0	0	0	5	
Non Potable																
	14. Fibreboard Well	Metered	25	0	0	0	0	0	16	40	97	105	94	81	459	
	15. Donner Creek Well	Metered	6	0	0	0	0	0	1	14	49	62	47	35	213	
	16. Southside well #1	Metered	2	0	0	0	0	0	0	0	1	1	2	1	8	
	<b>Subtotal</b>		<b>319</b>	<b>206</b>	<b>241</b>	<b>236</b>	<b>217</b>	<b>234</b>	<b>221</b>	<b>360</b>	<b>649</b>	<b>805</b>	<b>736</b>	<b>601</b>	<b>4,824</b>	<b>68%</b>
<b>Community Water Purveyors<sup>2</sup></b>																
<b>Northstar C.S.D.</b>																
	TH-1	Metered	7	1	0	0	1	1	2	8	19	29	15	5	Water Year 86	
	TH-2	Metered	6	0	0	0	0	0	2	6	23	30	24	28	122	
	Well 1	Metered	13	3	4	3	3	5	7	30	46	59	36	32	242	
	Well 2	Metered	18	7	5	4	4	1	0	0	0	5	29	31	104	
	Well 3	Metered	3	1	2	1	1	1	1	2	3	4	3	3	25	
	<b>Subtotal</b>		<b>47</b>	<b>12</b>	<b>11</b>	<b>10</b>	<b>9</b>	<b>8</b>	<b>12</b>	<b>46</b>	<b>91</b>	<b>127</b>	<b>108</b>	<b>99</b>	<b>579</b>	<b>8%</b>
<b>Non-Community Water Purveyors<sup>3,2</sup> (Estimated using 2018 calendar year values.)</b>																
Calendar Year																
	Hobart Work Center	Estimated													3	
	Aggregates Martis Valley	Estimated													374	
	<b>Subtotal</b>														<b>376</b>	<b>5%</b>
<b>Golf Courses<sup>3,2</sup> (Estimated using 2018 calendar year values.)</b>																
Calendar Year																
	Gray's Crossing <sup>4</sup>	Estimated	(Served by TDPUD and included in their reported pumping)											0		
	Old Greenwood <sup>4</sup>	Estimated	(Served by TDPUD and included in their reported pumping)											0		
	Ponderosa (9-hole Course)	Estimated												4		
	Coyote Moon <sup>4</sup>	Estimated	(Served by TDPUD and included in their reported pumping)											0		
	Schaffer's Mill	Estimated												237		
	Lahontan	Estimated												311		
	Northstar	Estimated												170		
	Martis Camp	Estimated												315		
	Tahoe Donner	Estimated	(component of demand provided by TDPUD from wells in basin)											253		
	<b>Subtotal</b>														<b>1,291</b>	<b>18%</b>
													<b>Total</b>	<b>7,070</b>		

<sup>1</sup>Values reported in gallons and converted to acre-feet

<sup>2</sup>Values reported in million gallons and converted to acre-feet

<sup>3</sup>Estimated and obtained from Annual Inventory of Water Use Lake Tahoe & Truckee River Basins Calendar Year 2018

<sup>4</sup>Groundwater use already accounted for in TDPUD reported pumping and not included in golf course demand subtotal

**Table 2 Groundwater Pumping for Water Year 2018-2019 (values in acre-feet)**

Agency	Metered/ Estimated	2018			2019									Annual		
		Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Total	Percent	
<b>Public Utility Water Purveyors<sup>1</sup></b>																
<b>Truckee-Donner PUD</b>																
Potable																
															<b>Water Year</b>	
1. Airport Well	Metered	21	10	21	12	11	10	16	9	5	20	21	10	166		
2. Martis Valley Well	Metered	175	161	175	184	161	178	161	169	191	210	206	193	2,163		
3. South Side Well	Metered	0	0	0	0	0	0	0	0	0	0	0	0	0		
4. Glenshire Dr Well	Metered	5	3	0	0	0	0	0	3	26	69	62	33	201		
5. Hirschdale Well	Metered	1	0	0	1	1	1	1	1	1	1	1	1	9		
6. Prosser Annex Well	Metered	13	0	0	0	0	0	0	10	22	25	30	27	127		
7. Prosser Heights Well	Metered	10	0	0	0	0	0	0	10	10	15	9	6	60		
8. Sanders Well	Metered	31	15	0	0	0	0	7	37	37	41	40	25	232		
9. Prosser Village Well	Metered	34	20	40	37	33	37	36	31	78	103	97	77	624		
10. Northside Well	Metered	0	0	0	0	0	0	0	14	20	20	8		63		
11. Old Greenwood Well	Metered	0	0	0	0	0	0	0	1	40	91	87	48	267		
12. Well 20	Metered	8	0	0	0	0	0	0	6	15	19	19	13	80		
13. "A" Well	Metered	0	0	0	0	0	0	0	0	0	0	0	0	0		
Non Potable																
14. Fibreboard Well	Metered	20	0	0	0	0	0	7	47	81	113	102	54	424		
15. Donner Creek Well	Metered	3	0	0	0	0	0	0	3	38	54	49	22	168		
16. Southside well #1	Metered	0	0	0	0	0	0	0	0	2	0	1	1	4		
	<b>Subtotal</b>	<b>320</b>	<b>210</b>	<b>235</b>	<b>235</b>	<b>206</b>	<b>226</b>	<b>228</b>	<b>326</b>	<b>559</b>	<b>781</b>	<b>746</b>	<b>517</b>	<b>4,588</b>	<b>70%</b>	
<b>Community Water Purveyors<sup>2</sup></b>																
<b>Northstar C.S.D.</b>																
															<b>Water Year</b>	
TH-1	Metered	0	1	1	0	1	0	2	2	18	17	1	2	46		
TH-2	Metered	6	2	0	0	1	1	0	0	0	10	27	15	61		
Well 1	Metered	16	5	5	3	0	0	1	0	30	41	64	44	211		
Well 2	Metered	21	4	5	5	5	8	3	27	19	34	0	13	144		
Well 3	Metered	3	2	2	3	3	2	1	2	3	5	5	5	37		
	<b>Subtotal</b>	<b>46</b>	<b>15</b>	<b>12</b>	<b>12</b>	<b>9</b>	<b>10</b>	<b>8</b>	<b>31</b>	<b>70</b>	<b>108</b>	<b>97</b>	<b>78</b>	<b>497</b>	<b>8%</b>	
<b>Non-Community Water Purveyors<sup>3,2</sup> (Estimated using 2019 calendar year values.)</b>																
Calendar Year																
Hobart Work Center <sup>5</sup>	Estimated														3	
Aggregates Martis Valley <sup>5</sup>	Estimated														374	
	<b>Subtotal</b>														<b>376</b>	<b>6%</b>
<b>Golf Courses<sup>3,2</sup> (Estimated using 2019 calendar year values.)</b>																
Calendar Year																
Gray's Crossing <sup>4</sup>	Estimated	(Served by TDPUD and included in their reported pumping)													0	
Old Greenwood <sup>4</sup>	Estimated	(Served by TDPUD and included in their reported pumping)													0	
Ponderosa (9-hole Course)	Estimated	(Private wells not operated by TDPUD, monthly pumping not available)													33	
Coyote Moon <sup>4</sup>	Estimated	(Served by TDPUD and included in their reported pumping)													0	
Schaffer's Mill <sup>5</sup>	Estimated														237	
Lahontan <sup>5</sup>	Estimated														311	
Northstar <sup>5</sup>	Estimated														170	
Martis Camp <sup>5</sup>	Estimated														315	
Tahoe Donner	Estimated	(component of demand provided by TDPUD from wells in basin)													38	
	<b>Subtotal</b>														<b>1,105</b>	<b>17%</b>
															<b>Total</b>	<b>6,566</b>

<sup>1</sup>Values reported in gallons and converted to acre-feet

<sup>2</sup>Values reported in million gallons and converted to acre-feet

<sup>3</sup>Estimated and obtained from Annual Inventory of Water Use Lake Tahoe & Truckee River Basins Calendar Year 2018

<sup>4</sup>Groundwater use already accounted for in TDPUD reported pumping and not included in golf course demand subtotal

<sup>5</sup>Groundwater use not currently available, used 2018 values as surrogate.

## 4. Surface Water Diversions

Although the Truckee River and multiple tributaries course throughout the MVGB, surface water constitutes less than one percent of Basin water supply. The total surface water diverted for use is 261 AF in 2018 but not all was diverted within the MVGB. Estimated surface water diversions are listed in **Tables 3 and 4** for water years 2018 and 2019, respectively. Water diversions for 2019 will be updated when the 2019 TROA annual report is released in 2021.

NCSD has water rights to use water from Big Springs, which is located outside the Basin but within the watershed as shown on **Figure 11**. Northstar Resort uses water from the spring, primarily for snowmaking. A portion of this water supplies recharge to the Basin aquifer by storing water as snow, which later melts, becomes runoff, and infiltrates into the Basin. Water from the spring is also used in the Basin, at the Northstar golf course, along with other commercial and domestic uses. The amount of groundwater recharge attributable to surface water from Big Springs cannot be quantified at this time.

A second surface water source, from within the MVGB, is used for irrigation at the Ponderosa Golf Course, but its diversion point is unidentified. Some deep percolation from turf irrigation also provides some groundwater recharge within the MVGB.

Agency	Actual/ Estimated	2017			2018									Annual
		Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Total
<b>Public Utility Water Purveyors</b>														
Truckee-Donner PUD <sup>1</sup>	Actual	0	0	0	0	0	0	0	0	0	0	0	0	0
	<b>Subtotal</b>													<b>0</b>
<b>Community Water Purveyors (2018 calendar year values)</b>														
Northstar C.S.D. <sup>2</sup>	Estimated (From Big Springs)													74
	<b>Subtotal</b>													<b>74</b>
<b>Non-Community Water Purveyors (2018 calendar year values)</b>														
Hobart Work Center	n/a	0	0	0	0	0	0	0	0	0	0	0	0	0
Aggregates Martis Valley	n/a	0	0	0	0	0	0	0	0	0	0	0	0	0
	<b>Subtotal</b>													<b>0</b>
<b>Golf Courses (2018 calendar year values from Annual Water Use report 2018.)</b>														
Ponderosa Golf Course	Estimated													77
Northstar Golf Course <sup>2</sup>	Estimated (From Big Springs)													111
	<b>Subtotal</b>													<b>187</b>
													<b>Total</b>	<b>261</b>

n/a = Not Applicable

<sup>1</sup> TDPUD has an allocation of Truckee River flows but does not use it, has no infrastructure to access it, and has no plans to use it.

<sup>2</sup> NCSD holds riparian water rights for use of Big Springs, which is outside of the MVGB. A portion of this water is used for limited industrial use within the MVGB and Northstar Golf Course.

**Table 4 Surface Water Usage Reported for Water Year 2018-2019 (values in acre-feet)**

Agency	Actual/ Estimated	2018			2019									Annual
		Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Total
<b>Public Utility Water Purveyors</b>														
Truckee-Donner PUD <sup>1</sup>	Actual	0	0	0	0	0	0	0	0	0	0	0	0	0
<b>Subtotal</b>														<b>0</b>
<b>Community Water Purveyors (2019 calendar year values)</b>														
Northstar C.S.D. <sup>2,3</sup> (M&I)	Estimated (From Big Springs)													
<b>Subtotal</b>														<b>0</b>
<b>Non-Community Water Purveyors (2019 estimated pumping not currently available, 2018 values used as surrogate)</b>														
Hobart Work Center	n/a	0	0	0	0	0	0	0	0	0	0	0	0	0
Aggregates Martis Valley	n/a	0	0	0	0	0	0	0	0	0	0	0	0	0
<b>Subtotal</b>														<b>0</b>
<b>Golf Courses (2019 estimated pumping not currently available, 2018 values used as surrogate)</b>														
Ponderosa Golf Course	Estimated (Source unknown)													77
Northstar Golf Course <sup>2,3</sup>	Estimated (From Big Springs)													111
<b>Subtotal</b>														<b>187</b>
													<b>Total</b>	<b>187</b>

n/a = Not Applicable

<sup>1</sup> TDPUD has an allocation of Truckee River flows but does not use it, has no infrastructure to access it, and has no plans to use it.

<sup>2</sup> NCSD holds riparian water rights for use of Big Springs, which is outside of the MVGB. A portion of this water is used for limited M&I use within the MVGB and Northstar Golf Course.

<sup>3</sup> 2019 values not reported at this time.

# 5. Groundwater Recharge

Wastewater is exported from the North Lake Tahoe area and is sent to the Tahoe-Truckee Sanitary Agency (T-TSA) water treatment plant, located in the MVGB. Total estimated monthly wastewater imports to the MVGB from areas outside the Basin for the past two water years, as well as wastewater derived from within the MVGB, from the Truckee Sanitary District (TSD), were provided by T-TSA and are listed in **Tables 5 and 6** for water years 2018 and 2019, respectively. About 2,000 AF and 2,250 AF of wastewater was imported into the MVGB in water years 2018 and 2019, respectively.

The treated water from the T-TSA is recharged into the MVGB groundwater system through subsurface leach fields (pipes with holes surrounded by gravel) under permit with the Lahontan RWQCB. The locations of the leach fields are shown on **Figure 1**. About 4,500 to 4,800 AF of treated water was recharged into the MVGB in water years 2018 and 2019, respectively. Wastewater from TSD is partially derived from groundwater pumping within the MVGB and partially offset impacts of local pumping near the Truckee River.

**Table 5 Estimated Groundwater Recharge from T-TSA for Water Year 2017-2018 (acre-feet)**

Tahoe-Truckee Sanitary Agency (T-TSA) Sources of Inflows <sup>1</sup>	Actual/ Estimated	2017			2018							Annual WY Total		
		Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul		Aug	Sep
Lake Tahoe Area (Imported water)	Estimated	121	140	156	159	138	200	235	169	162	207	174	138	<b>2,000</b>
Truckee Sanitary District (TSD)	Actual	182	199	220	220	190	249	266	213	211	242	209	183	<b>2,585</b>
<b>Total</b>													<b>4,584</b>	

<sup>1</sup> Deliveries to treatment facility from outside the MVGB provided by T-TSA and are converted from million gallons to acre-feet

<sup>2</sup> Metered readings from Granite Flats used to calculate imported wastewater from Lake Tahoe area

**Table 6 Estimated Groundwater Recharge from T-TSA for Water Year 2018-2019 (acre-feet)**

Tahoe-Truckee Sanitary Agency (T-TSA) Sources of Inflows <sup>1</sup>	Actual/ Estimated	2018			2019							Annual WY Total		
		Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul		Aug	Sep
Lake Tahoe Area (Imported water)	Estimated	112	115	148	173	188	251	309	246	196	219	184	113	<b>2,253</b>
Truckee Sanitary District (TSD)	Actual	181	166	201	216	216	275	301	237	202	216	193	194	<b>2,599</b>
<b>Total</b>													<b>4,852</b>	

<sup>1</sup> Deliveries to treatment facility from outside the MVGB provided by T-TSA and are converted from million gallons to acre-feet

<sup>2</sup> Metered readings from Granite Flats used to calculate imported wastewater from Lake Tahoe area



## 6. Total Water Use

The total estimated groundwater and surface water use in the MVGB by sector is summarized in **Table 7**. Almost all of the water use is provided from groundwater. About one-third of the groundwater pumped was returned to the Basin after being treated by T-TSA.

<u>Water Use Sector</u>	<b>2018</b>	<b>2019</b>
<b>Municipal and Industrial (M&amp;I)</b>	<b>5,779</b>	<b>5,462</b>
Groundwater Metered	5,403	5,085
Groundwater Estimated	376	376
<b>Golf Courses</b>	<b>1,367</b>	<b>1,181</b>
Groundwater Estimated	1,291	1,105
Surface Water Estimated <sup>1</sup>	77	77
<b>Total</b>	<b>7,146</b>	<b>6,643</b>

<sup>1</sup> Only includes water sources in MVGB, see Tables 3 and 4.

# 7. Change in Groundwater Storage

An empirical approach was used to calculate change in storage using spring groundwater elevation contours for 2017, 2018 and 2019. The spring contour surfaces were then subtracted to produce water level change distributions for the two previous water years. The use of spring to spring water level differences was deemed to be the most appropriate when assessing ambient groundwater conditions, because it has less influence of temporal, localized changes due to pumping adjacent to monitoring wells.

**Figure 12** and **Figure 13** spatially show the estimated groundwater elevation changes (current year elevations subtracted from previous year elevations). Portions of the Basin with no data on the groundwater or water table surface were not contoured. It is apparent that most changes in groundwater storage are near the highest density of pumping, shown on **Figure 11**.

Actual storage change estimates are dependent upon the assumed specific yield (the percent of sediments with pore space that contains water that can be drained by gravity) or storage coefficient (similar to specific yield but used when aquifers are more confined as is typical with depth) of the aquifer formation. Given the complex and often interbedded nature of the MVGB aquifer system, an average of depth storage coefficients (ranging from 0.1 to 0.5) were used for the analysis. The results and input values are presented in **Table 8**. Groundwater in storage in the MVGB decreased in 2018 due to the 2017 having abundant precipitation (a Wet year) followed by a Below Normal precipitation and increased pumping in 2018. During water year 2019, the groundwater storage rose due to Above Normal precipitation and lower pumping, leading to an increase in groundwater levels.

<b>Table 8</b>		<b>Estimated Change in Storage</b>		
<b>Time Periods for Groundwater Level Elevation Comparisons</b>	<b>Basin Area Used in Analysis<sup>1</sup> (acres)</b>	<b>Average Groundwater Level Change (feet)</b>	<b>Average Storage Coefficients</b>	<b>Estimated Change in Storage (AF)</b>
Spring 2017 - Spring 2018	24,500	-2.16	0.075	-3,977
Spring 2018 - Spring 2019	24,500	2.54	0.075	4,664
Total Change 2018 and 2019 Wys				688

<sup>1</sup> Basin Area limited to extent of MVGB with groundwater elevation data to limit interpolation error

Historic trends in the estimated annual and cumulative change of groundwater in storage, along with water year type and annual groundwater use are shown on **Figure 14**. Storage change and groundwater

use estimates prior to water year 2017 were derived from previous analyses. Over the last two water years, groundwater in storage, increased by about 700 AF, indicating the basin is healthy and probably in balance. For perspective, the basin has about 484,000 acre-feet in storage, so the overall annual change is small (less than 1% over the two-year period) in comparison to the total water stored in the basin.

## 8. Groundwater Management Activities

---

The MVGB Agencies continue to invest in the stewardship of the Basin and practicing of adaptive management to proactively ensure that the Basin operates within its sustainable yield. This includes more frequent monitoring of key data points and interactions with local stakeholders' meetings.

The most significant management action has been the voluntary implementation of monthly monitoring of groundwater levels for all wells in the CASGEM program. This proactive move to monthly monitoring over three years ago and well before the mandate was, in part, to investigate and address uncertainties in seasonal variations. The results and trends from this improved monitoring program are presented in this report, and both TDPUD and NCSD, who are responsible for the monitoring, intend to continue this monthly monitoring going forward as an MVGB adaptive management strategy.

The MVGB Agencies continue to interact with local environmental interests and MVGB stakeholders to provide information and hear concerns. Primarily, this has been done by the participation in the Truckee River Basin Working Group (TRBWG). The TRBWG was formed with the passage of the Truckee River Operating Agreement (TROA) twenty years ago and has been strengthened with the support of the newly formed DWR-TROA division. The TRBWG is comprised of the California stakeholders in the river watershed including water purveyors, local governments, environmental interests, recreational interests, DWR, California Department of Fish and Wildlife, United States Forest Service, and others.

## 9. Conclusions

---

Groundwater levels have remained stable in the MVGB through WY 2019. All groundwater levels have remained above their respective historic low levels and above 2016 levels in all but one well which detected this seasonal variation by more frequent monthly monitoring. Because groundwater levels remained higher than in 2016, when groundwater discharges provided some flow to the Truckee River, groundwater continued to discharge to the river through WY 2018 and WY 2019.

Below normal precipitation and higher groundwater use in WY 2018 resulted in a temporary decrease in groundwater storage. In 2019, groundwater levels recovered due to a decrease in pumping and above normal precipitation. During the two-year period, groundwater in storage increased by about 700 AF.

# 10. References

---

Balance Hydrologics, 2020. Pre- and Post-Restoration Hydrologic Monitoring Results, WY2013-WY2019, Middle Martis Creek Wetland Restoration Project, Placer County, California.

Brown and Caldwell, 2013. Martis Valley Groundwater Management Plan (GMP).

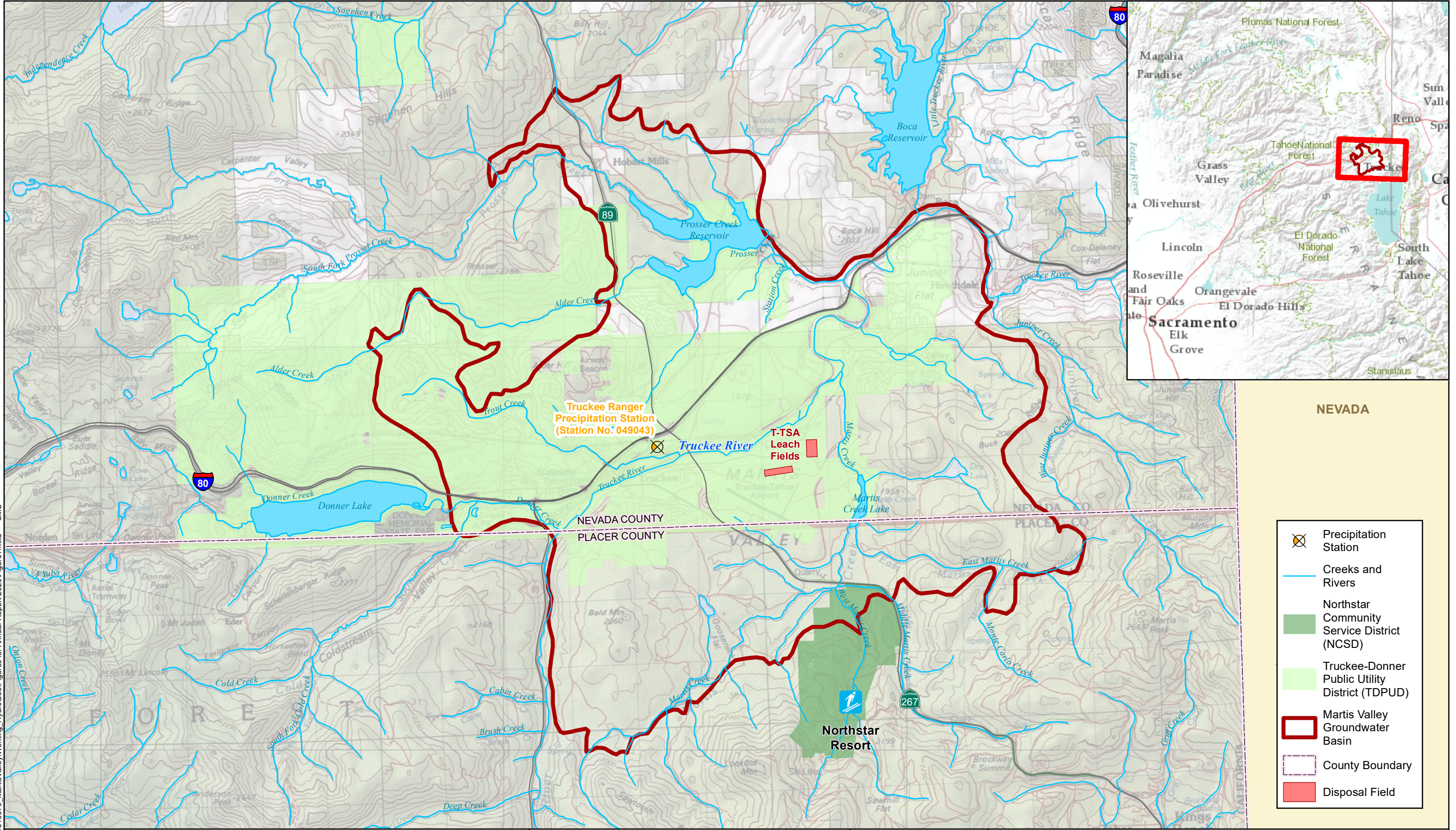
California Department of Water Resources (DWR), 2019. Annual Inventory of Water Use, Lake Tahoe and Truckee River Basins, Calendar Year 2018.

Truckee Donner Public Utility District (TDPUD), December 2016. Martis Valley Groundwater Basin Sustainable Groundwater Management Act Alternative Submittal.

Truckee Donner Public Utility District (TDPUD), March 2018. Annual Report for the Martis Valley Groundwater Basin, Sustainable Groundwater Management Act Alternative Submittal, Water Years 2016 and 2017.

# Figures

---



22Aug2020 Z:\Projects\1610379\_MartisValley\Working\_HydroGeo\Figures for Annual Report 2020\Figure1.mxd SMS



Martis Valley Annual Report  
Water Year 2018 and 2019  
Nevada and Placer Counties, California

Truckee-Donner Public Utility District



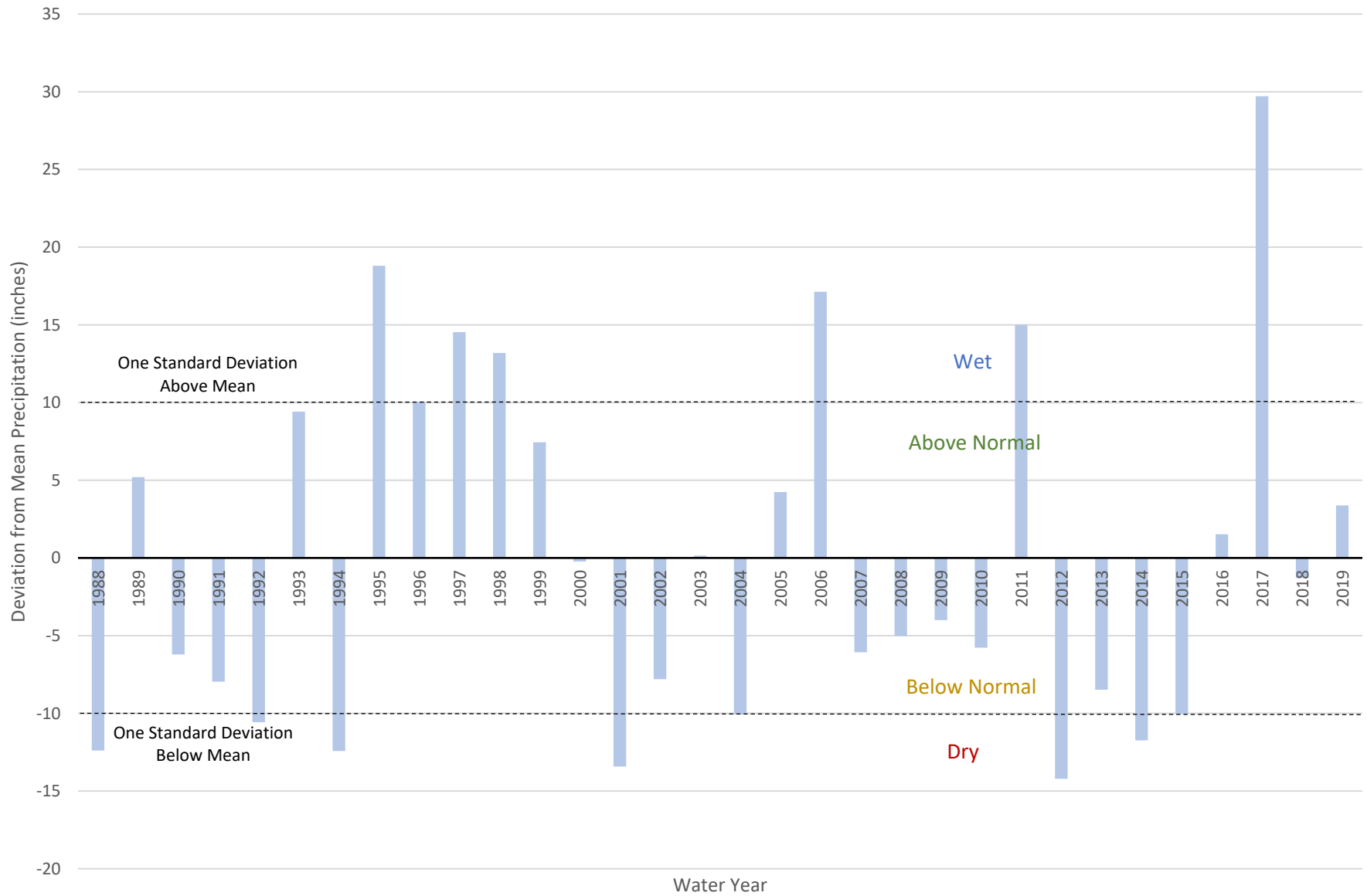
MARTIS VALLEY GROUNDWATER BASIN  
LOCATION

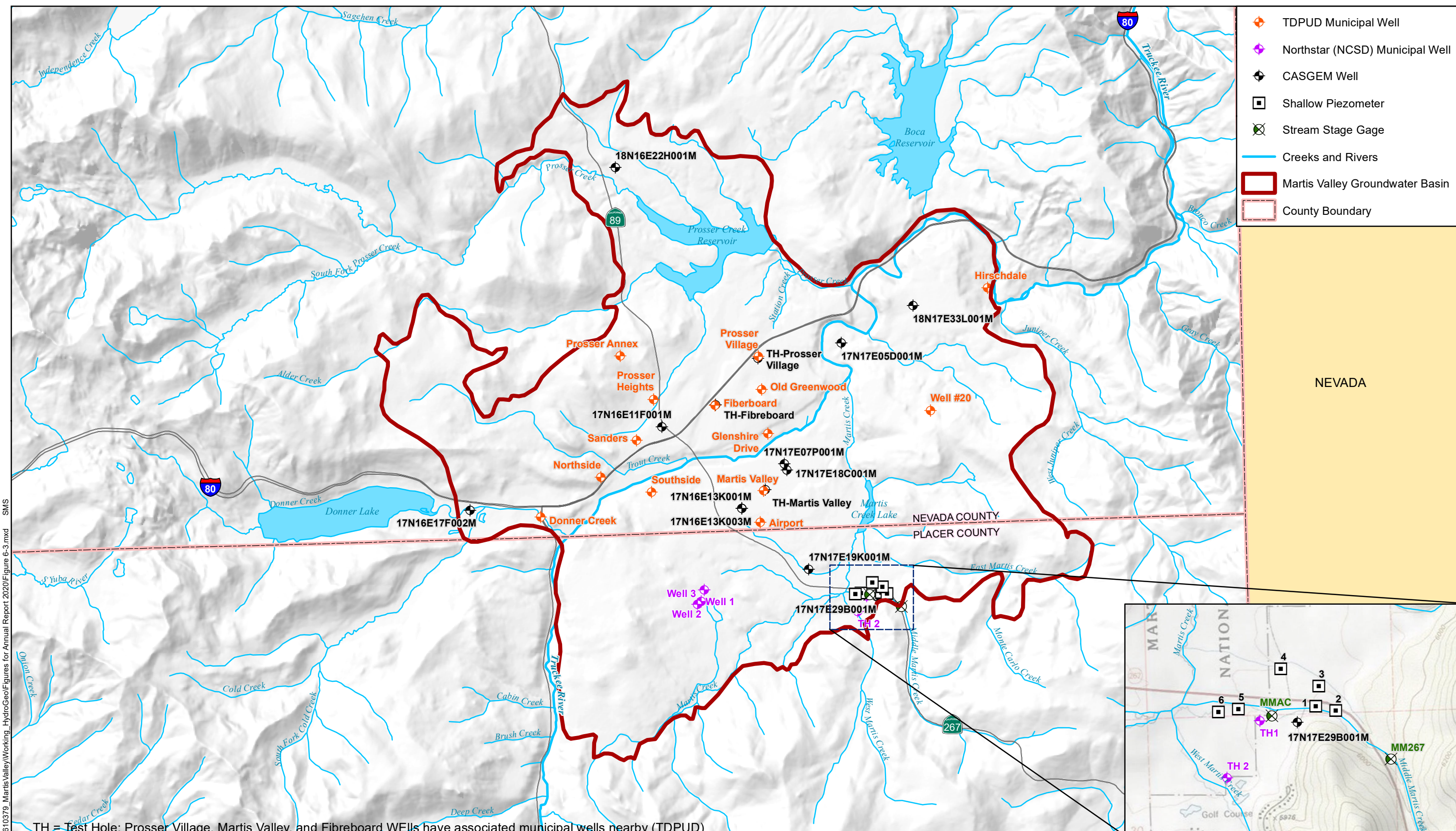
DECEMBER 2020

FIGURE 1



Figure 2  
Annual Precipitation Deviation from Mean: Truckee Ranger Station No. 049043





22Aug2020 Z:\Projects\1610379\_Martis Valley\Working\_HydroGeo\Figures for Annual Report 2020\Figure 6-3.mxd SMS



Martis Valley Annual Report  
 Water Year 2018 and 2019  
 Nevada and Placer Counties, California

Truckee-Donner Public Utility District



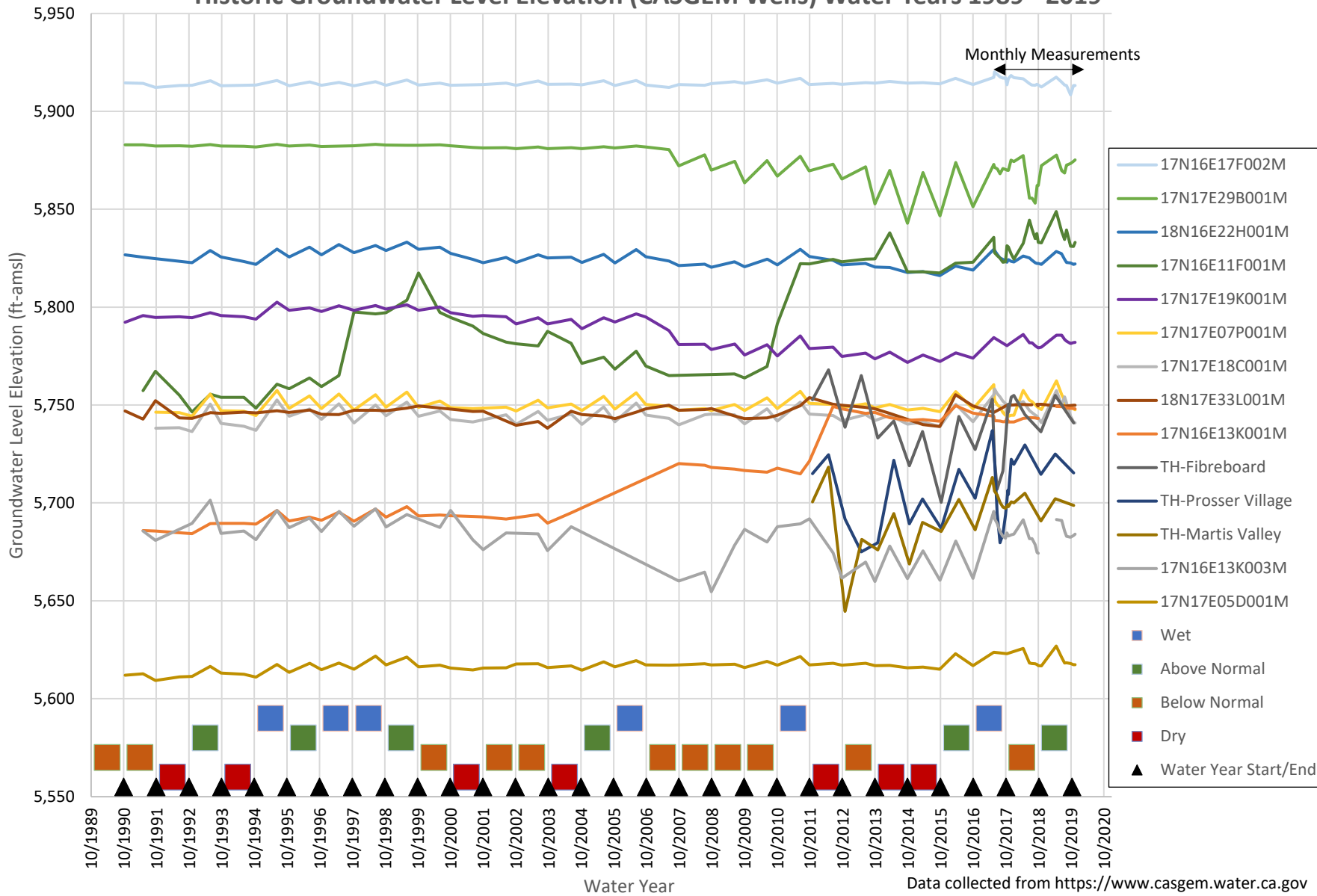
**MARTIS VALLEY GROUNDWATER BASIN  
 MONITORING WELL LOCATIONS**

DECEMBER 2020

FIGURE 3

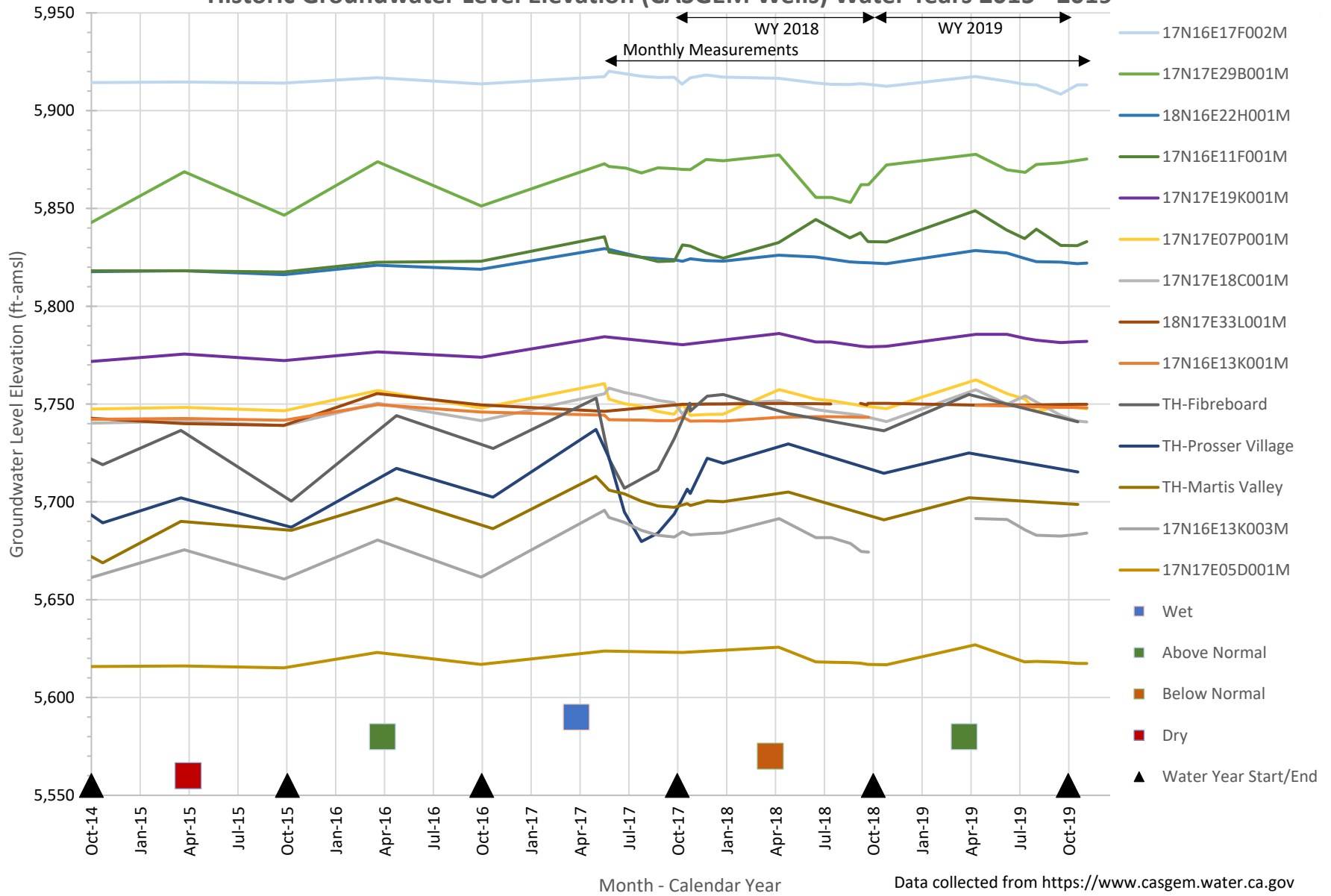
TH = Test Hole; Prosser Village, Martis Valley, and Fibreboard WElls have associated municipal wells nearby (TDPUD)

**Figure 4: Martis Valley Groundwater Basin**  
**Historic Groundwater Level Elevation (CASGEM Wells) Water Years 1989 - 2019**

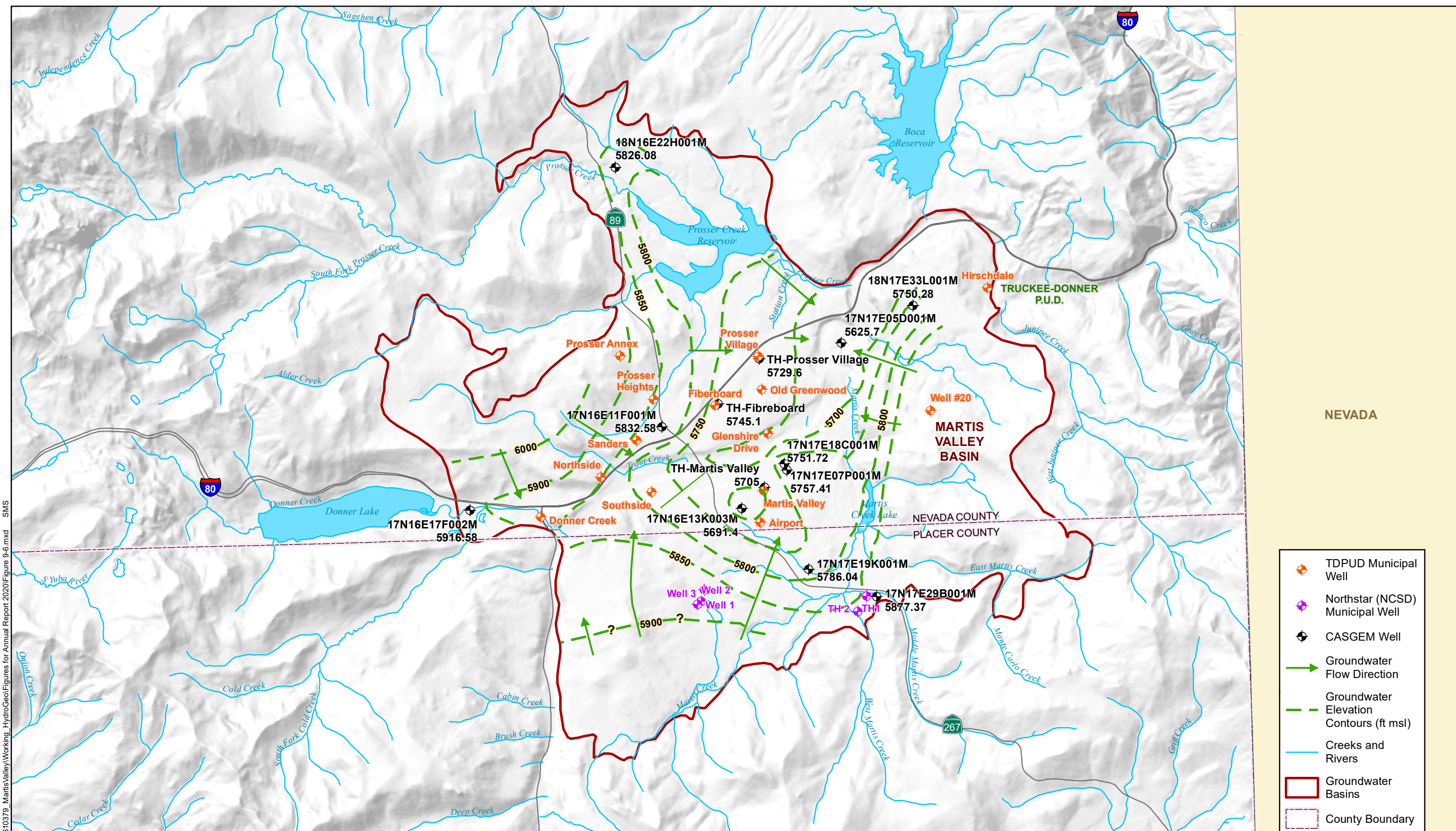


Data collected from <https://www.casgem.water.ca.gov>

**Figure 5: Martis Valley Groundwater Basin**  
**Historic Groundwater Level Elevation (CASGEM Wells) Water Years 2015 - 2019**

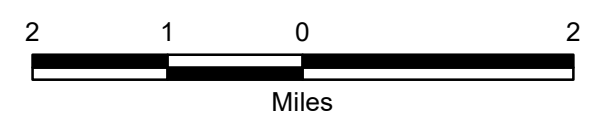


Data collected from <https://www.casgem.water.ca.gov>



- TDPUD Municipal Well
- Northstar (NCSD) Municipal Well
- CAGSEM Well
- Groundwater Flow Direction
- Groundwater Elevation Contours (ft msl)
- Creeks and Rivers
- Groundwater Basins
- County Boundary

07Oct2020 Z:\Projects\1610379\_MartisValley\Working\_HydroGeo\Figures for Annual Report 2020\Figure 9-6.mxd SMS



Martis Valley Annual Report  
 Water Year 2018 and 2019  
 Nevada and Placer Counties, California

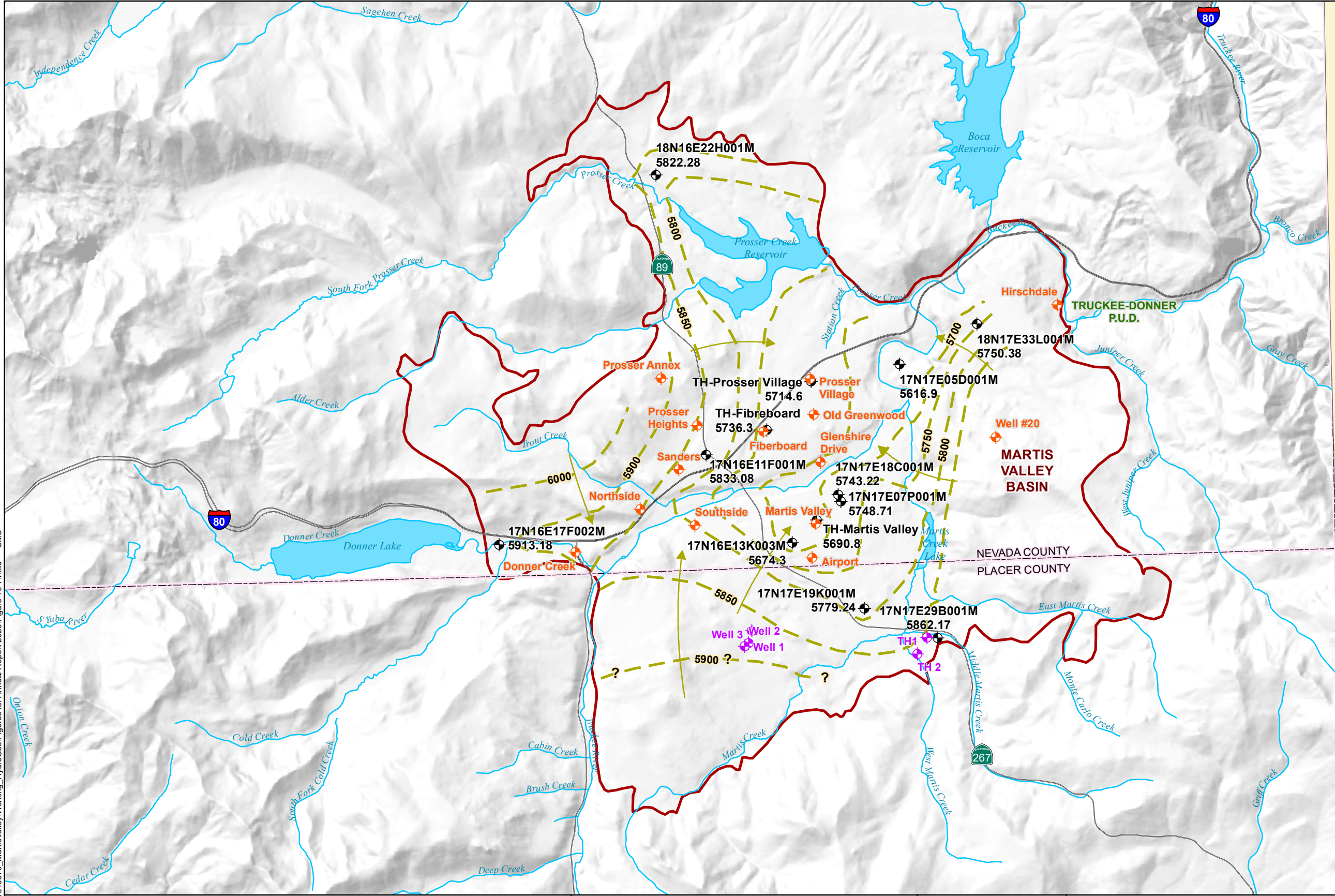
Truckee-Donner Public Utility District



**MARTIS VALLEY GROUNDWATER BASIN  
 GROUNDWATER ELEVATION CONTOURS  
 SPRING 2018**

DECEMBER 2020

FIGURE 6



- TDPUD Municipal Well
- Northstar (NCSD) Municipal Well
- Monitoring Wells
- Groundwater Flow Direction
- Groundwater Elevation Contours (ft msl)
- Creeks and Rivers
- Groundwater Basins
- County Boundary

NEVADA

NEVADA COUNTY  
PLACER COUNTY



Martis Valley Annual Report  
Water Year 2018 and 2019  
Nevada and Placer Counties, California

Truckee Donner Public Utility District

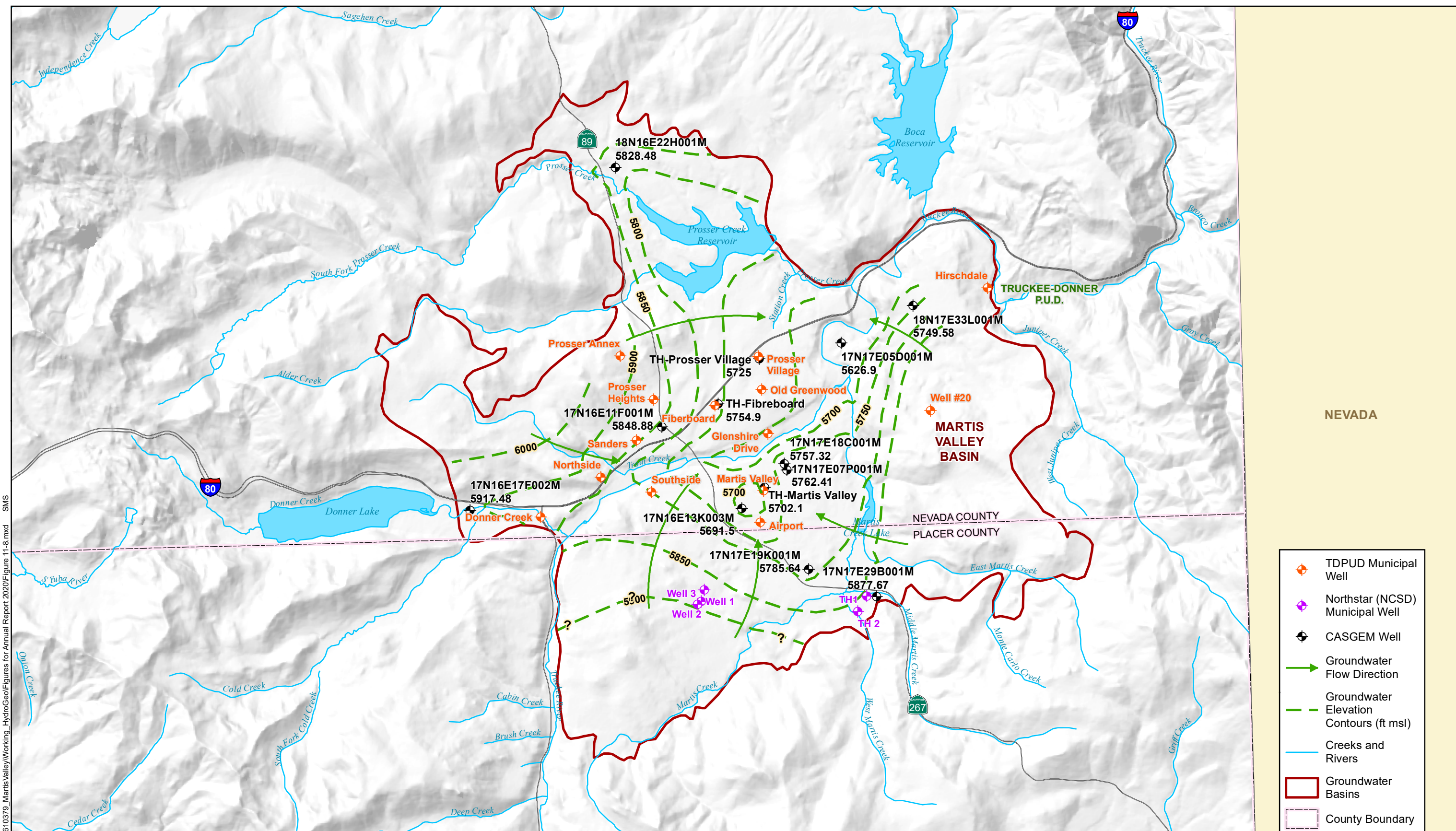


MARTIS VALLEY GROUNDWATER BASIN  
GROUNDWATER ELEVATION CONTOURS  
FALL 2018

DECEMBER 2020

FIGURE 7

07Oct2020 Z:\Projects\1610379\_MartisValley\Working\_HydroGeo\Figures for Annual Report 2020\Figure 10-7.mxd SMS



22Aug2020 Z:\Projects\1610379\_Martis Valley\Working\_HydroGeo\Figures for Annual Report 2020\Figure 11-8.mxd SMS



Martis Valley Annual Report  
 Water Year 2018 and 2019  
 Nevada and Placer Counties, California

Truckee Donner Public Utility District



**MARTIS VALLEY GROUNDWATER BASIN**  
**GROUNDWATER ELEVATION CONTOURS**  
**SPRING 2019**

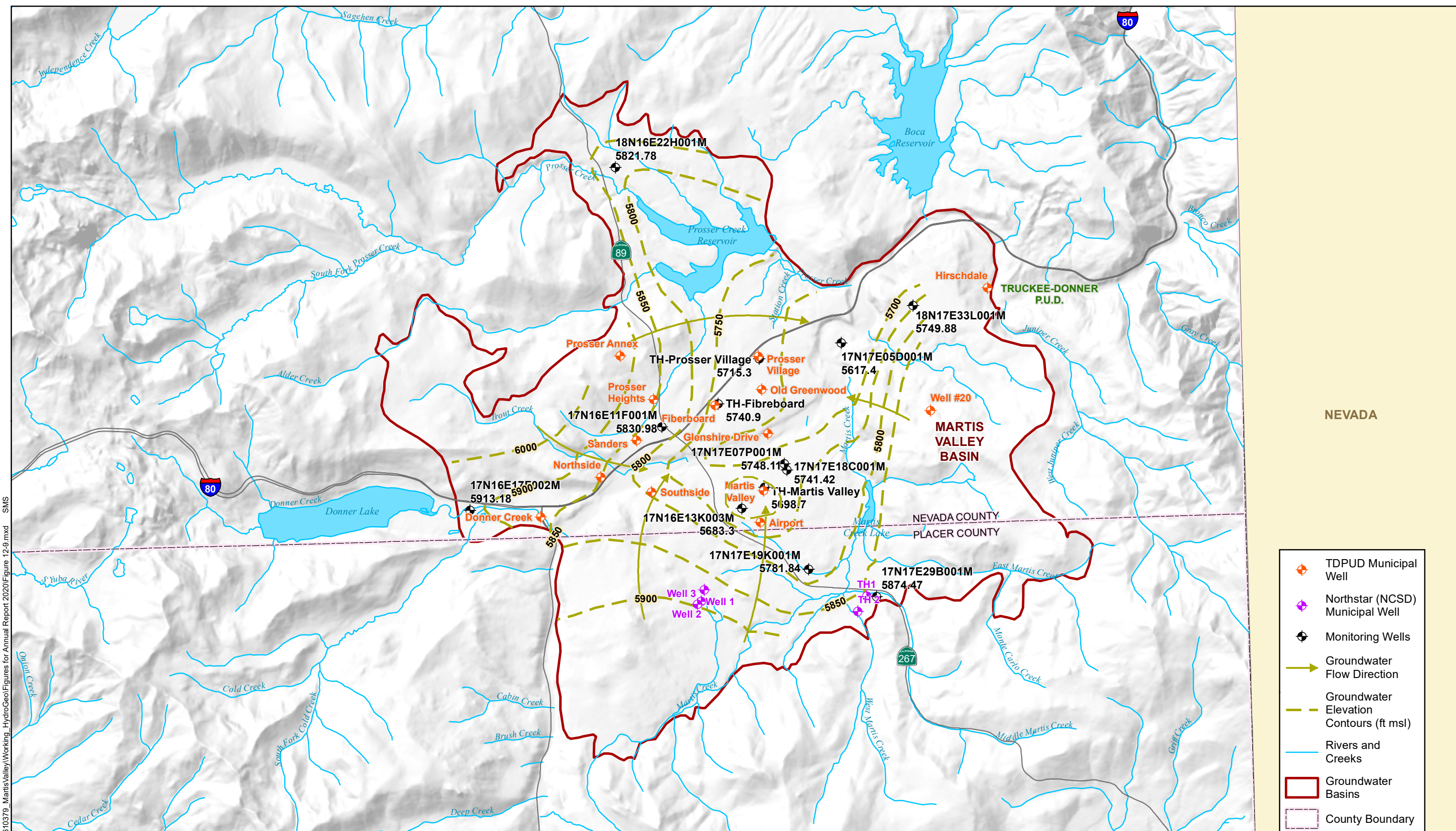
DECEMBER 2020

FIGURE 8

- TDPUD Municipal Well
- Northstar (NCSD) Municipal Well
- CAGSEM Well
- Groundwater Flow Direction
- Groundwater Elevation Contours (ft msl)
- Creeks and Rivers
- Groundwater Basins
- County Boundary

NEVADA

NEVADA COUNTY  
PLACER COUNTY



07Oct2020 Z:\Projects\1610379\_MartisValley\Working\_HydroGeo\Figures for Annual Report 2020\Figure 12-9.mxd SMS



Martis Valley Annual Report  
 Water Year 2018 and 2019  
 Nevada and Placer Counties, California

Truckee Donner Public Utility District



MARTIS VALLEY GROUNDWATER BASIN  
 GROUNDWATER ELEVATION CONTOURS  
 FALL 2019

DECEMBER 2020

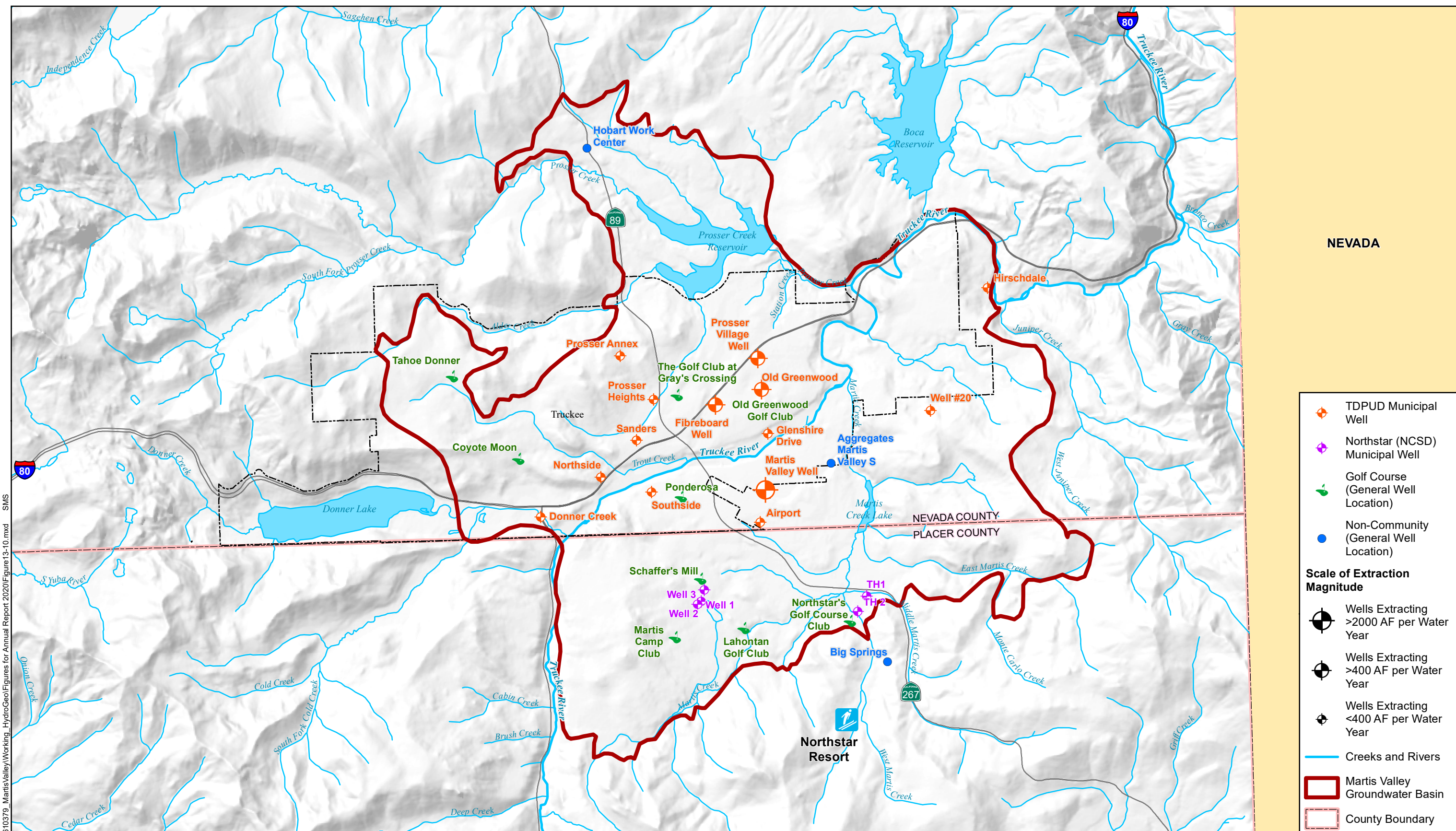
FIGURE 9

- TDPUD Municipal Well
- Northstar (NCSD) Municipal Well
- Monitoring Wells
- Groundwater Flow Direction
- Groundwater Elevation Contours (ft msl)
- Rivers and Creeks
- Groundwater Basins
- County Boundary

NEVADA

NEVADA COUNTY  
 PLACER COUNTY





07Oct2020 Z:\Projects\1610379\_MartisValley\Working\_HydroGeo\Figures for Annual Report 2020\Figure13-10.mxd SMS



Martis Valley Annual Report  
 Water Year 2018 and 2019  
 Nevada and Placer Counties, California

Truckee-Donner Public Utility District



**MARTIS VALLEY GROUNDWATER BASIN  
 LOCATIONS OF GROUNDWATER EXTRACTIONS**

DECEMBER 2020

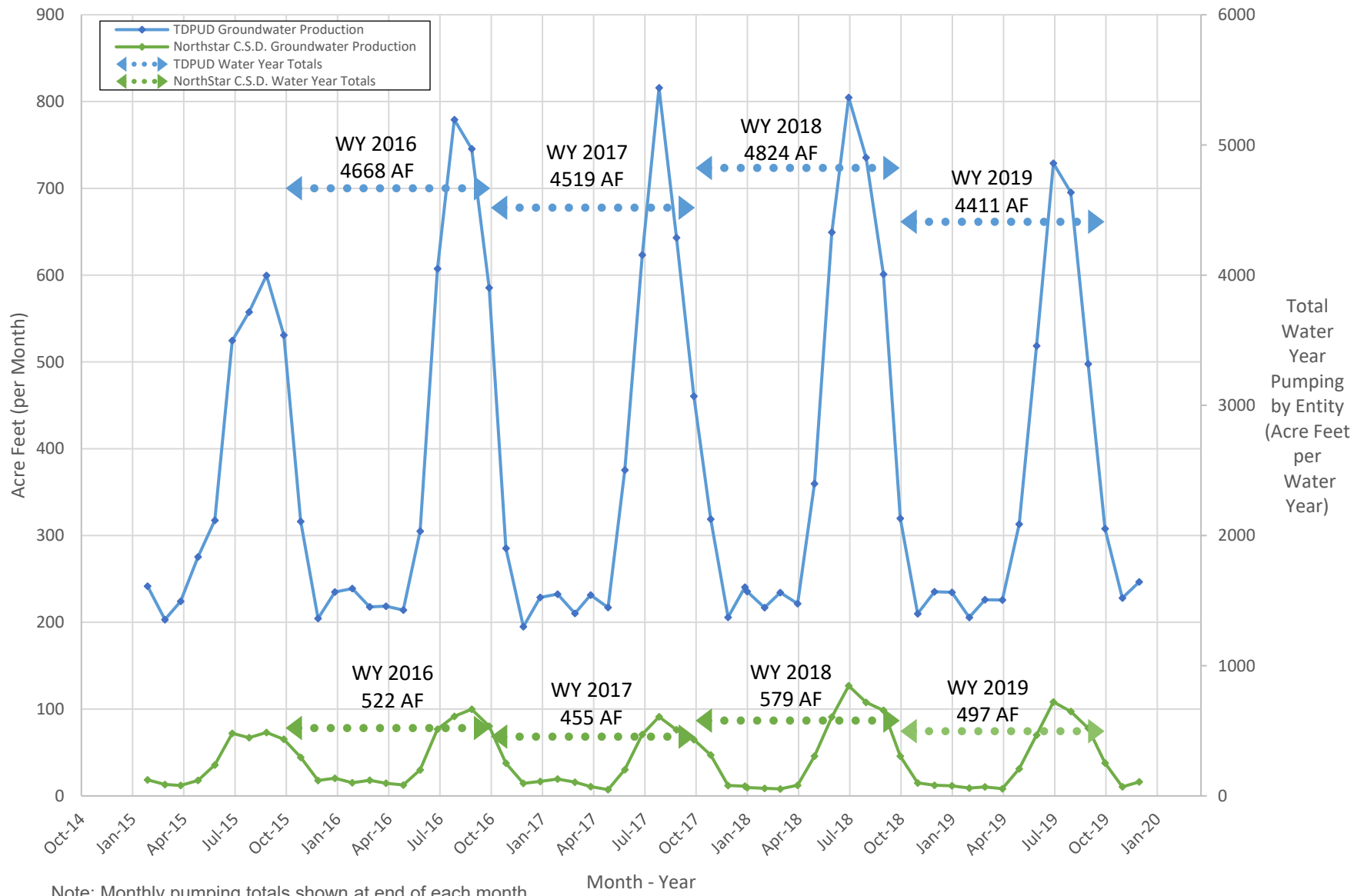
FIGURE 10

- TDPUD Municipal Well
  - Northstar (NCSD) Municipal Well
  - Golf Course (General Well Location)
  - Non-Community (General Well Location)
- Scale of Extraction Magnitude**
- Wells Extracting >2000 AF per Water Year
  - Wells Extracting >400 AF per Water Year
  - Wells Extracting <400 AF per Water Year
- Creeks and Rivers
  - Martis Valley Groundwater Basin
  - County Boundary

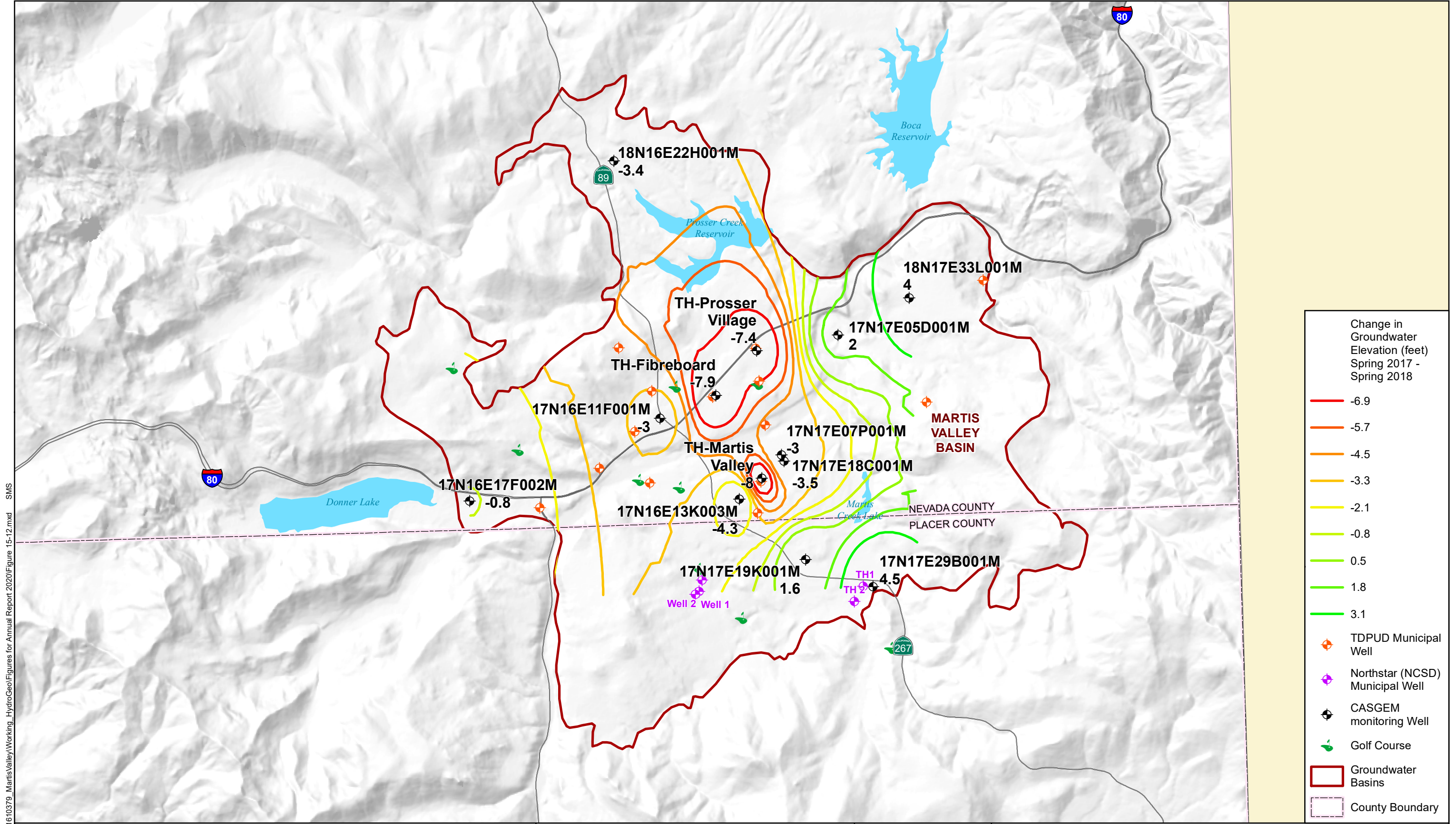
NEVADA

NEVADA COUNTY  
 PLACER COUNTY

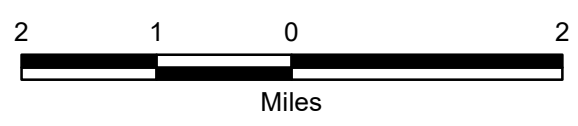
Figure 11  
Martis Valley Groundwater Basin Monthly Pump Totals



Note: Monthly pumping totals shown at end of each month.



07Oct2020 Z:\Projects\1610379\_MartisValley\Working\_HydroGeo\Figures for Annual Report 2020\Figure 15-12.mxd SMS



Martis Valley Annual Report  
Water Year 2018 and 2019  
Nevada and Placer Counties, California

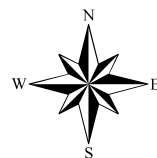
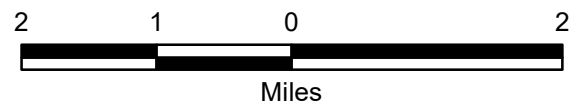
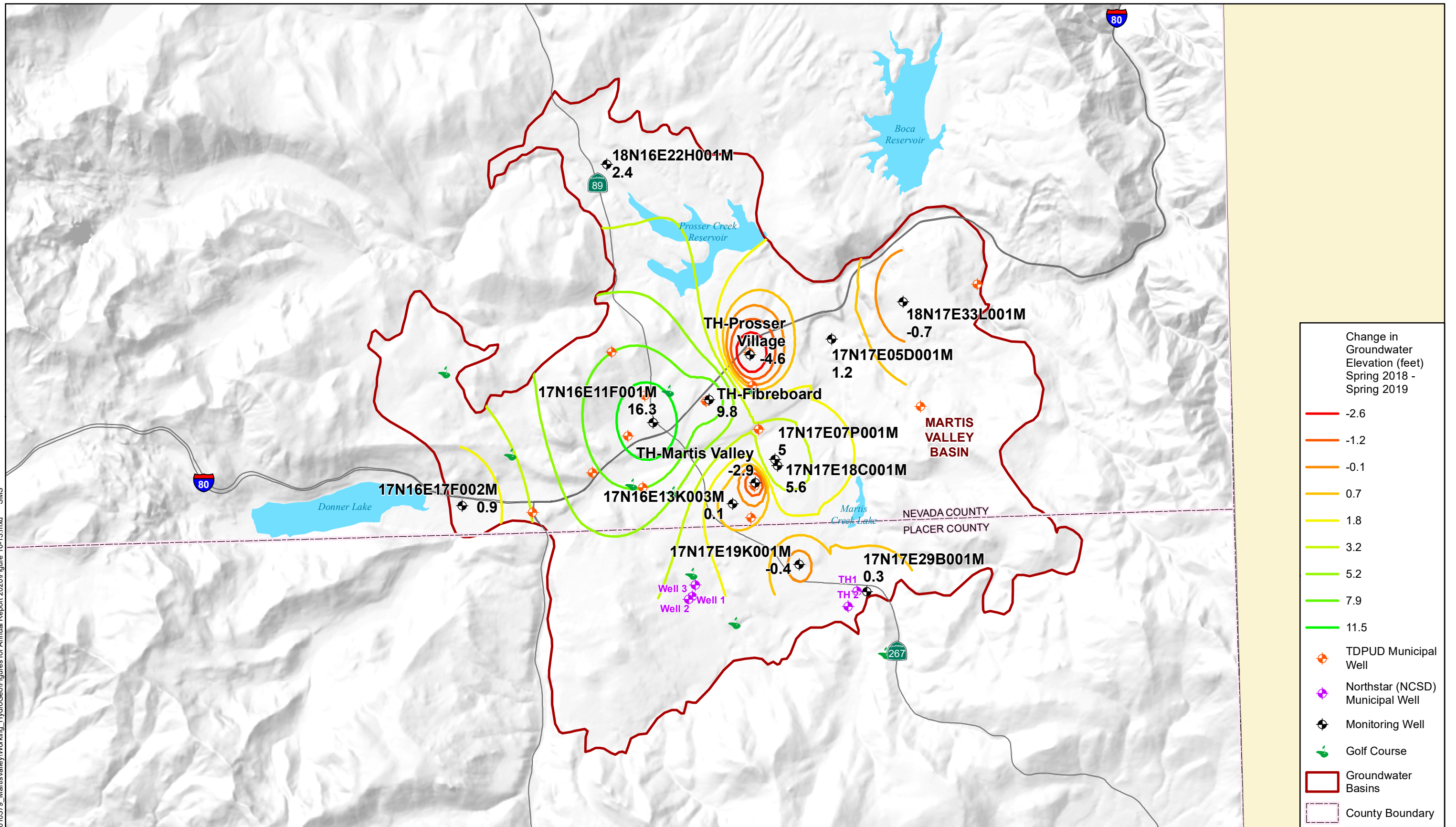
Truckee-Donner Public Utility District



**MARTIS VALLEY GROUNDWATER BASIN  
CHANGE IN GROUNDWATER ELEVATION  
SPRING 2017 TO SPRING 2018**

DECEMBER 2020

FIGURE 12



Martis Valley Annual Report  
Water Year 2018 and 2019  
Nevada and Placer Counties, California

Truckee Donner Public Utility District

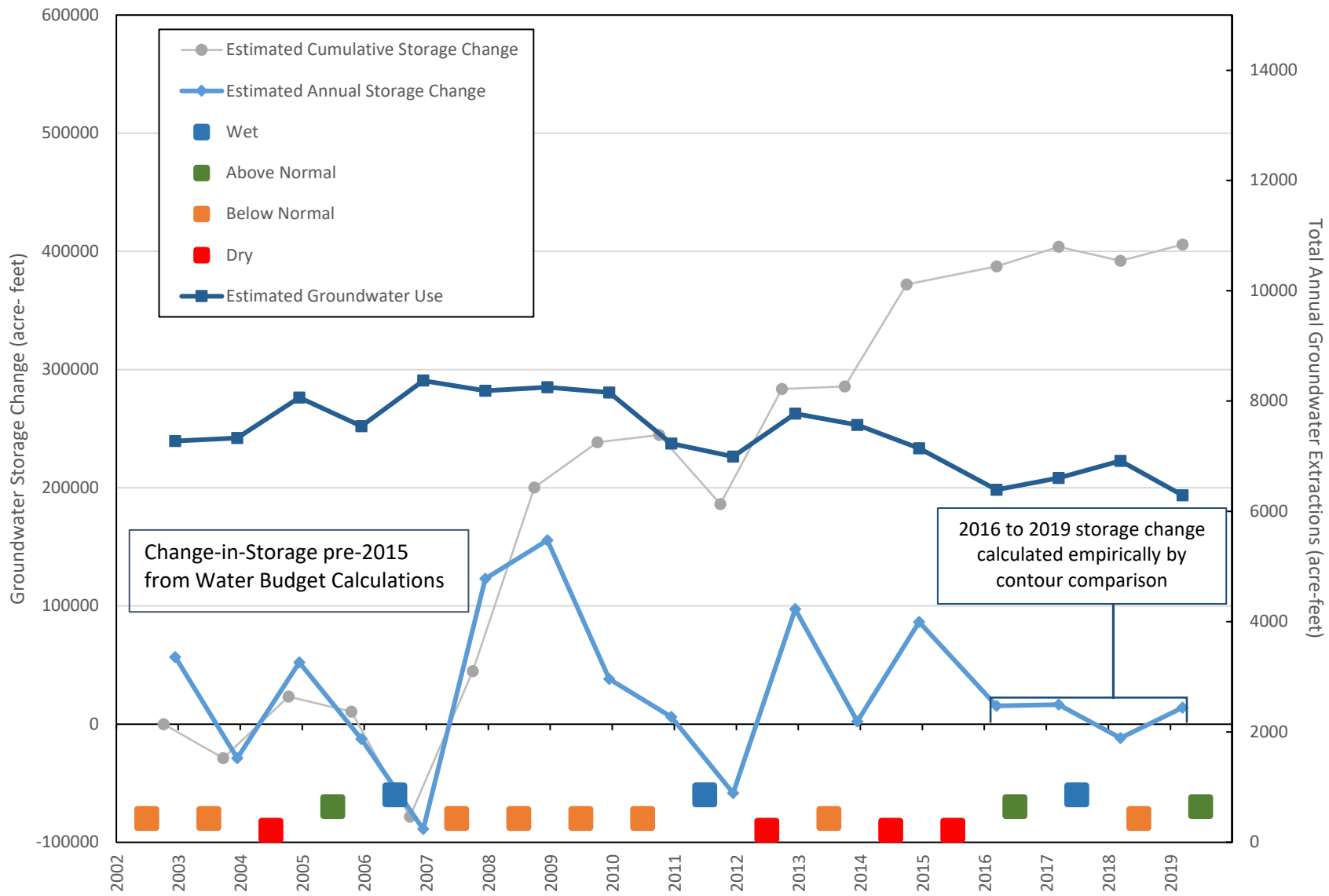


**MARTIS VALLEY GROUNDWATER BASIN  
CHANGE IN GROUNDWATER ELEVATION  
SPRING 2018 TO SPRING 2019**

DECEMBER 2020

FIGURE 13

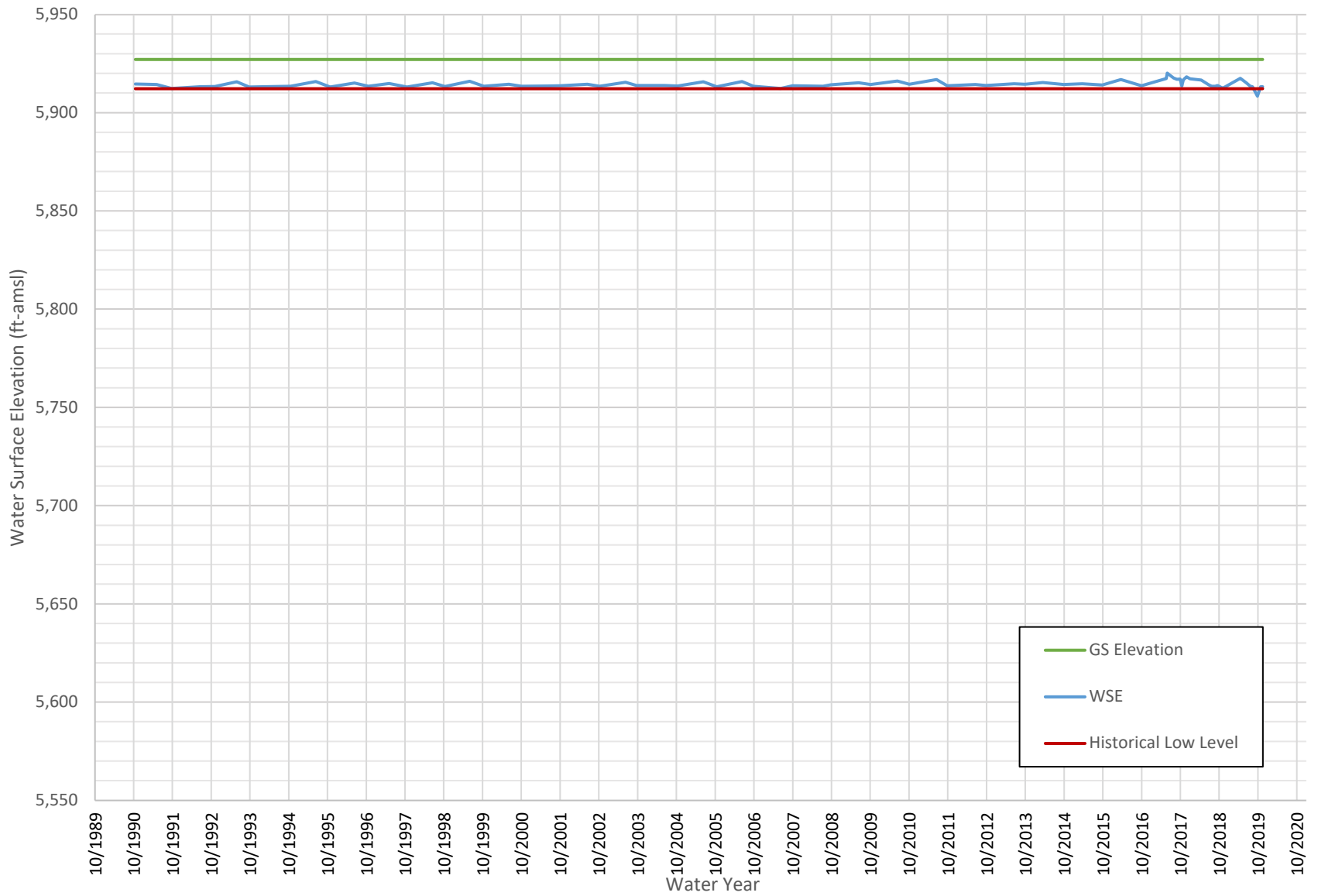
Figure 14  
Change in Storage and Groundwater Use



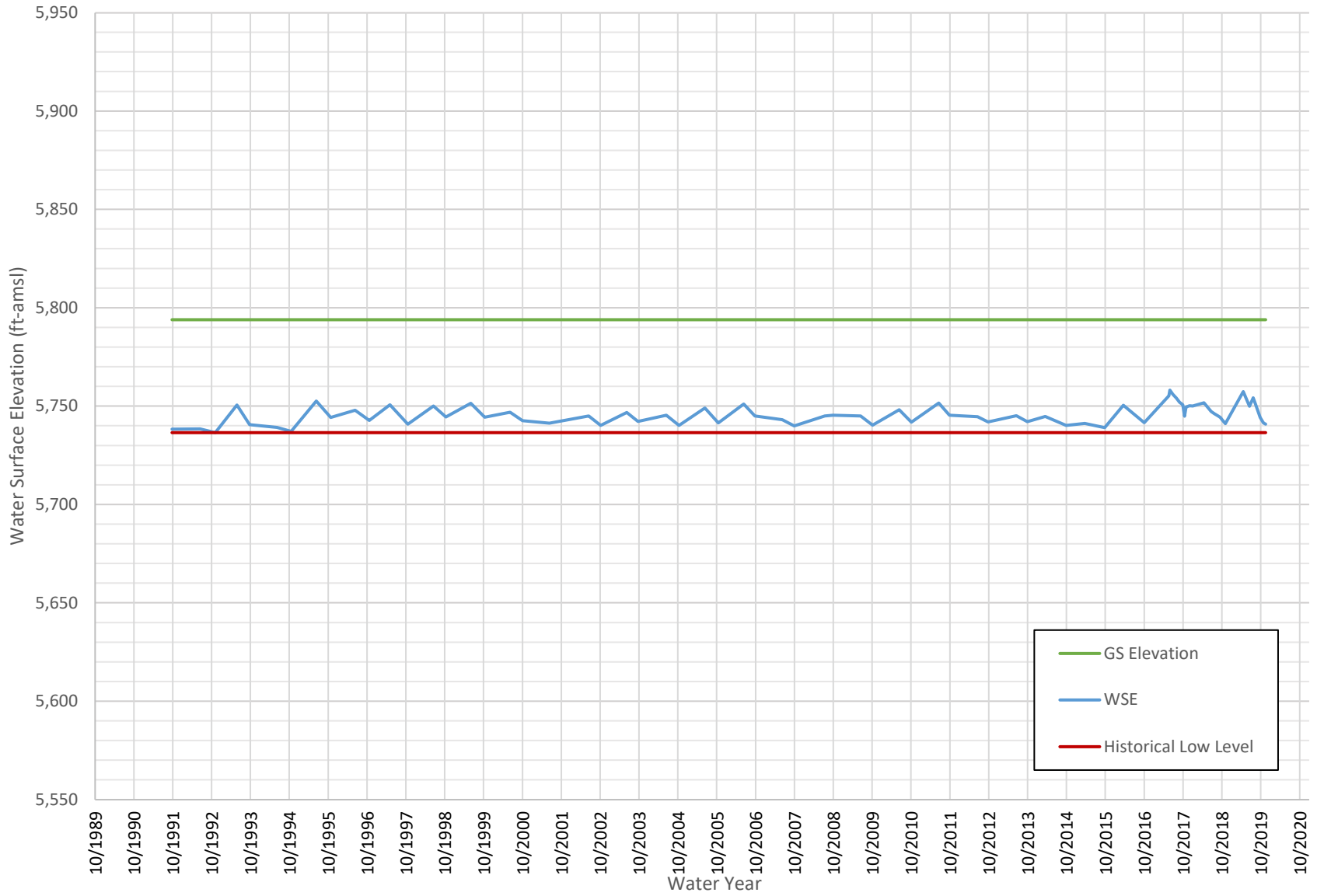
# **Attachment A. Monitoring Well Hydrographs**

---

# 17N16E17F002M

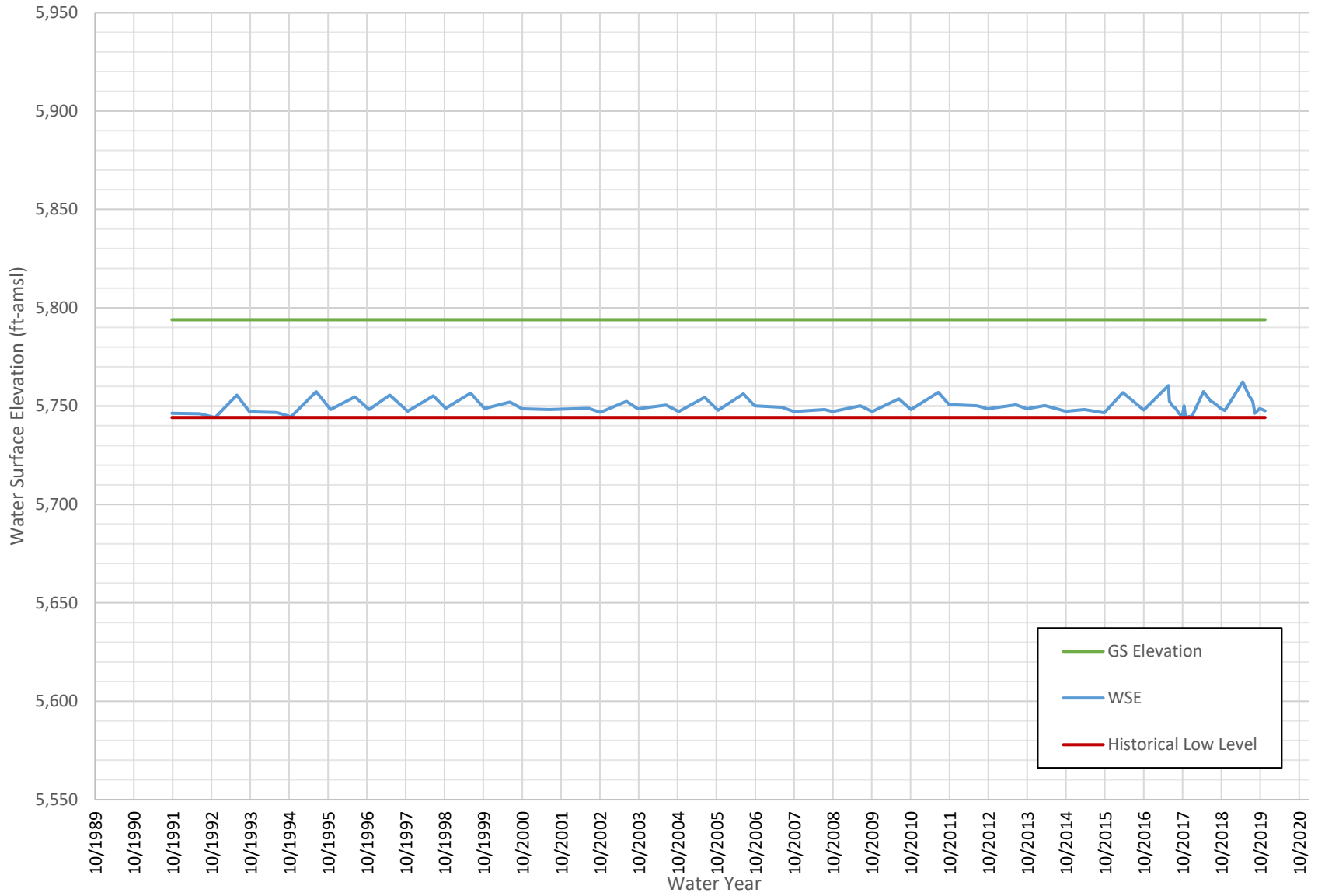


# 17N17E18C001M

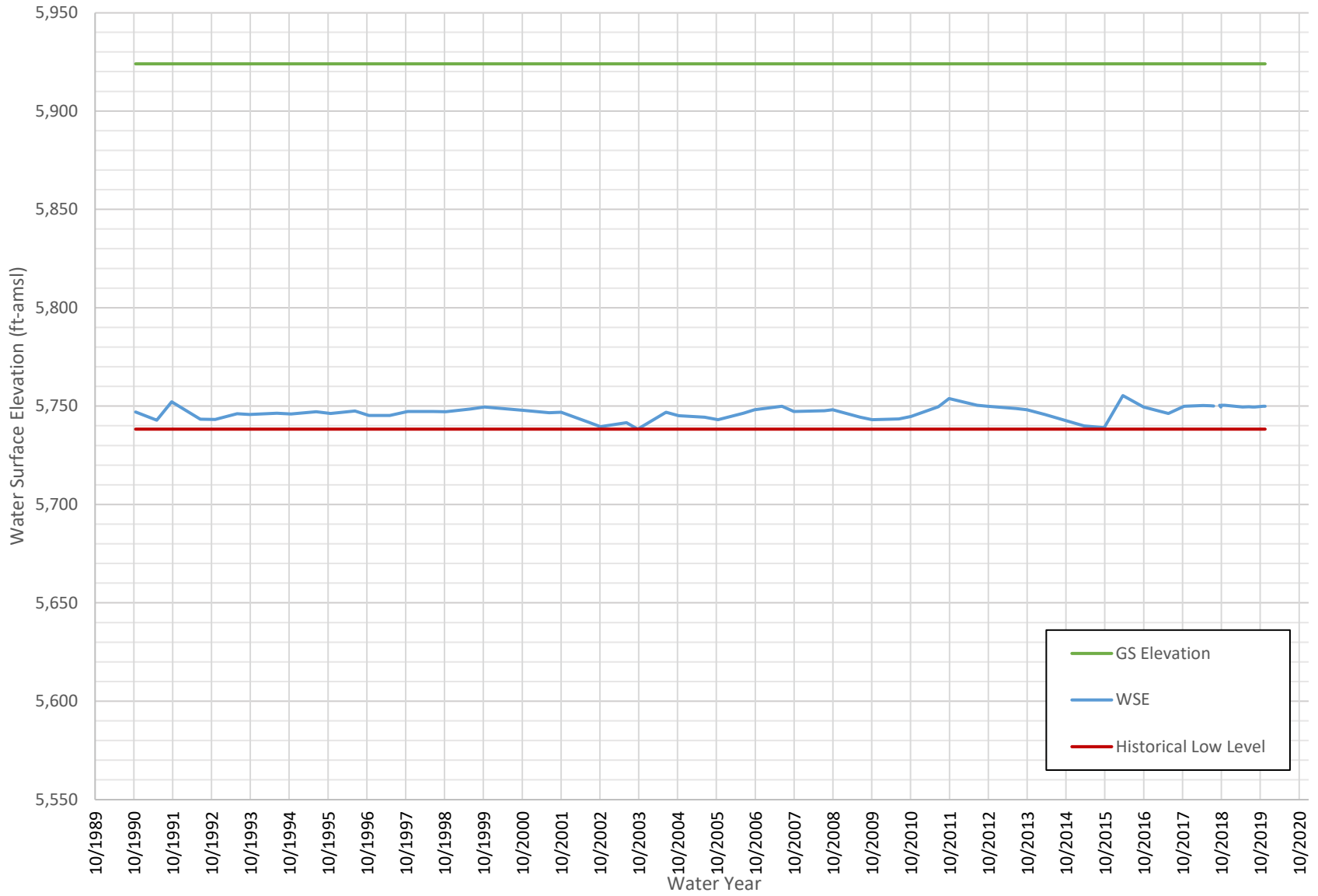




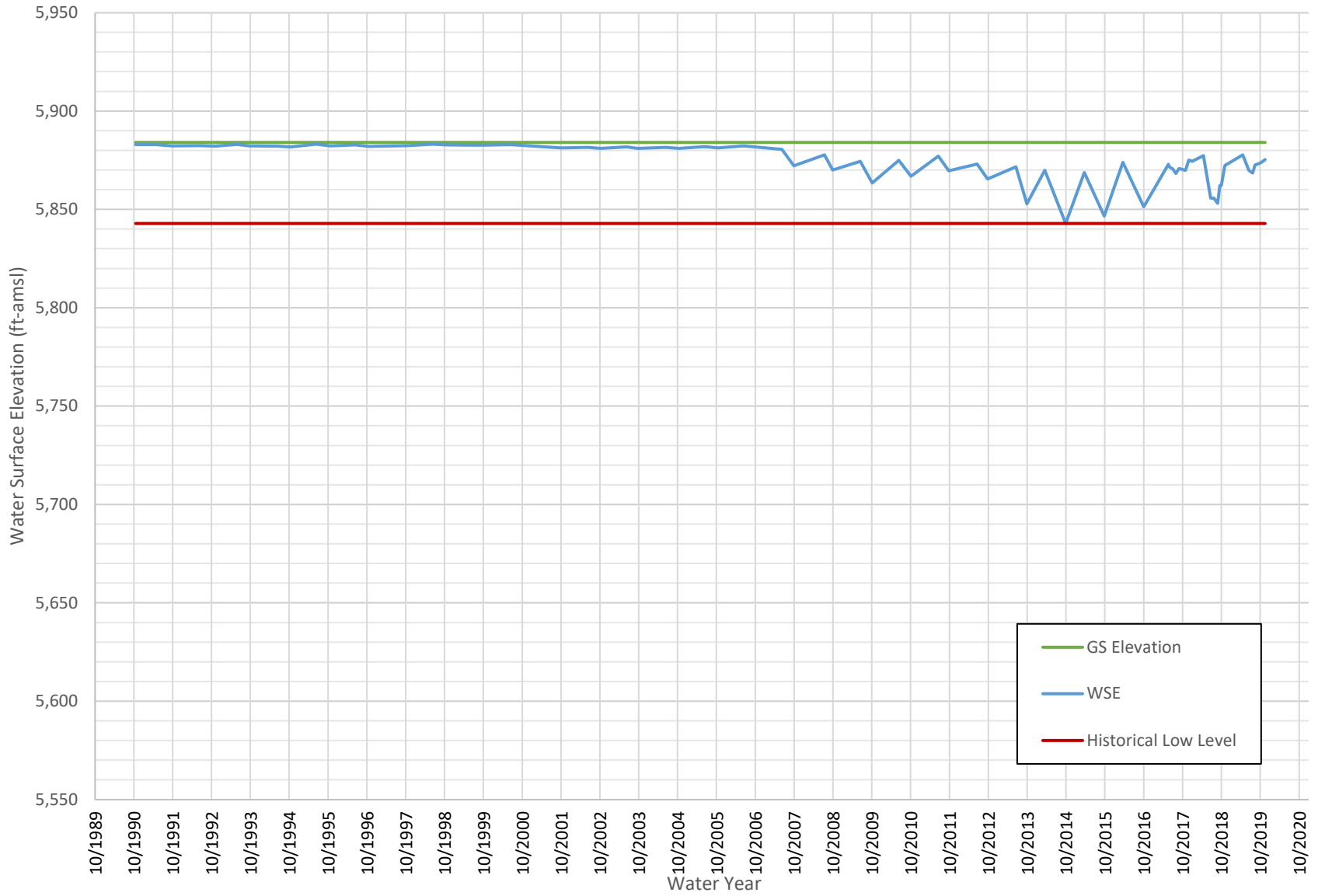
# 17N17E07P001M



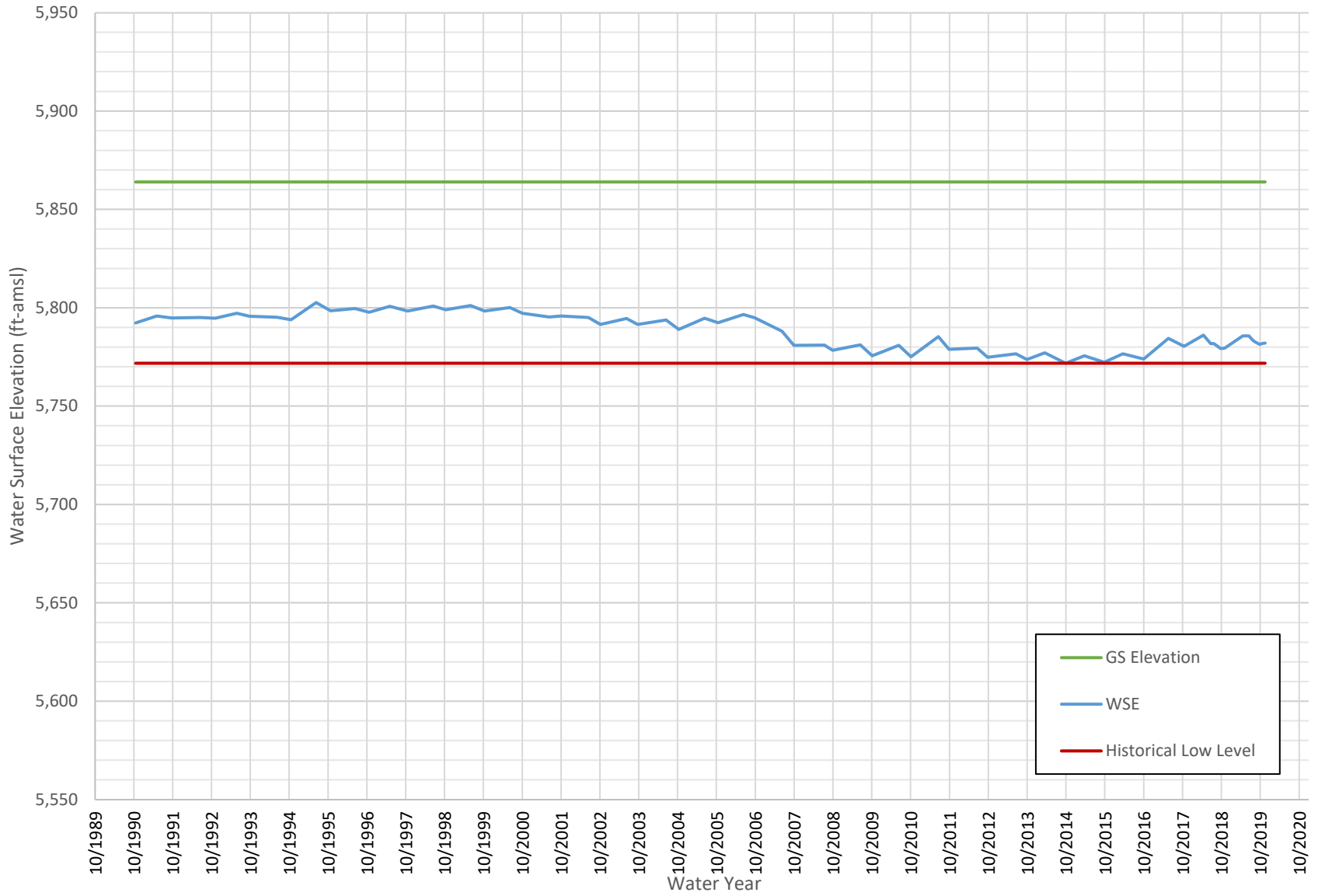
# 18N17E33L001M



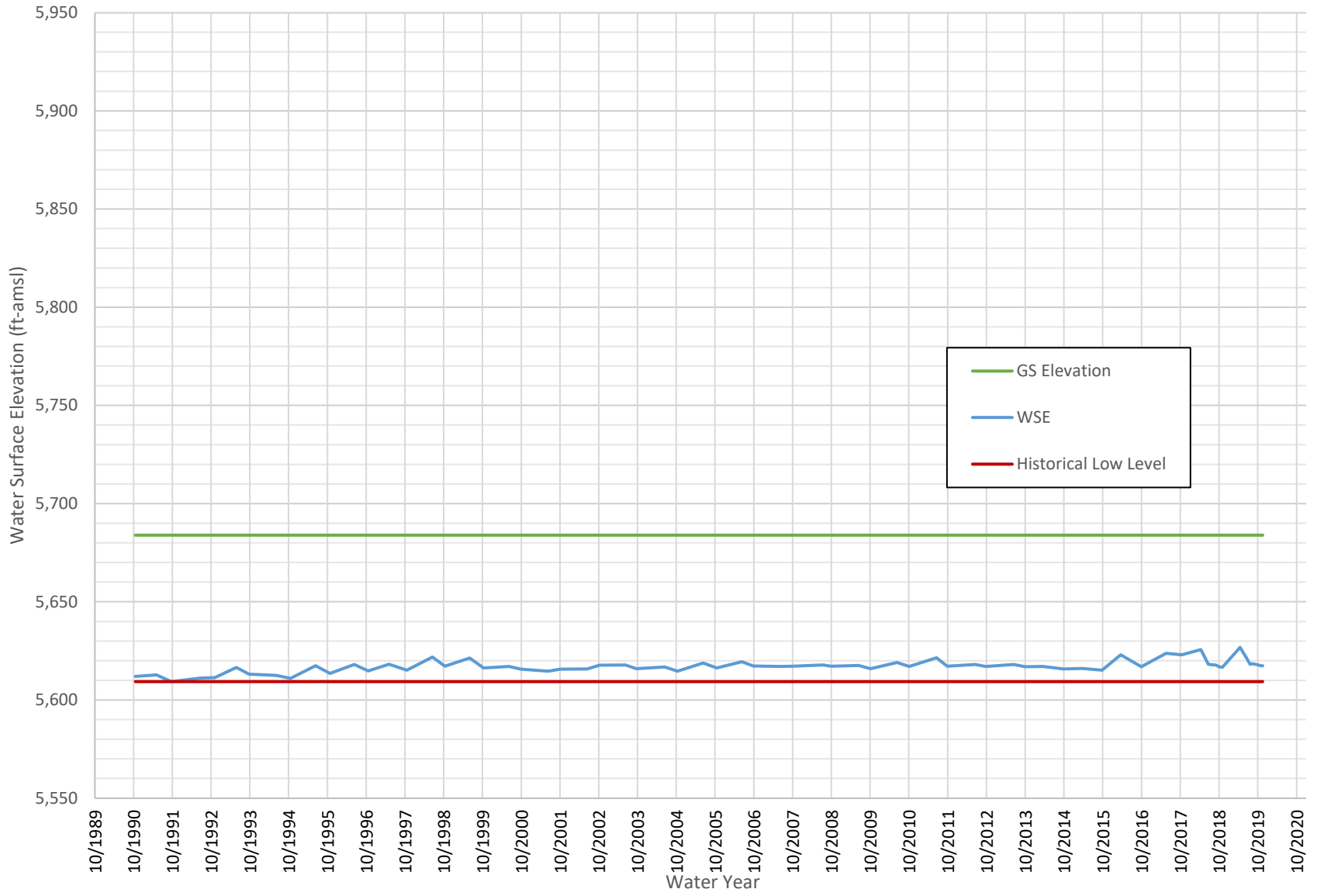
# 17N17E29B001M



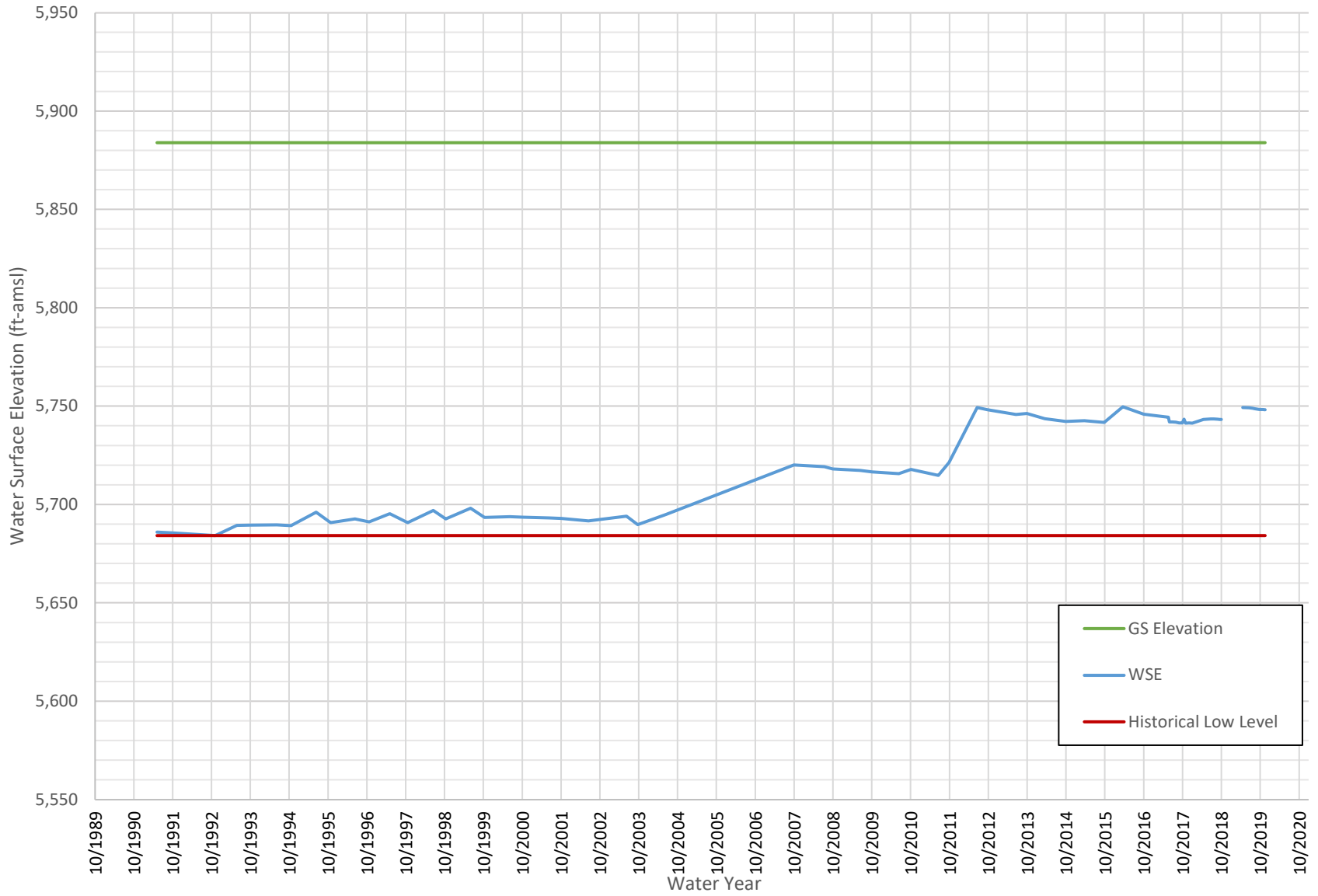
# 17N17E19K001M



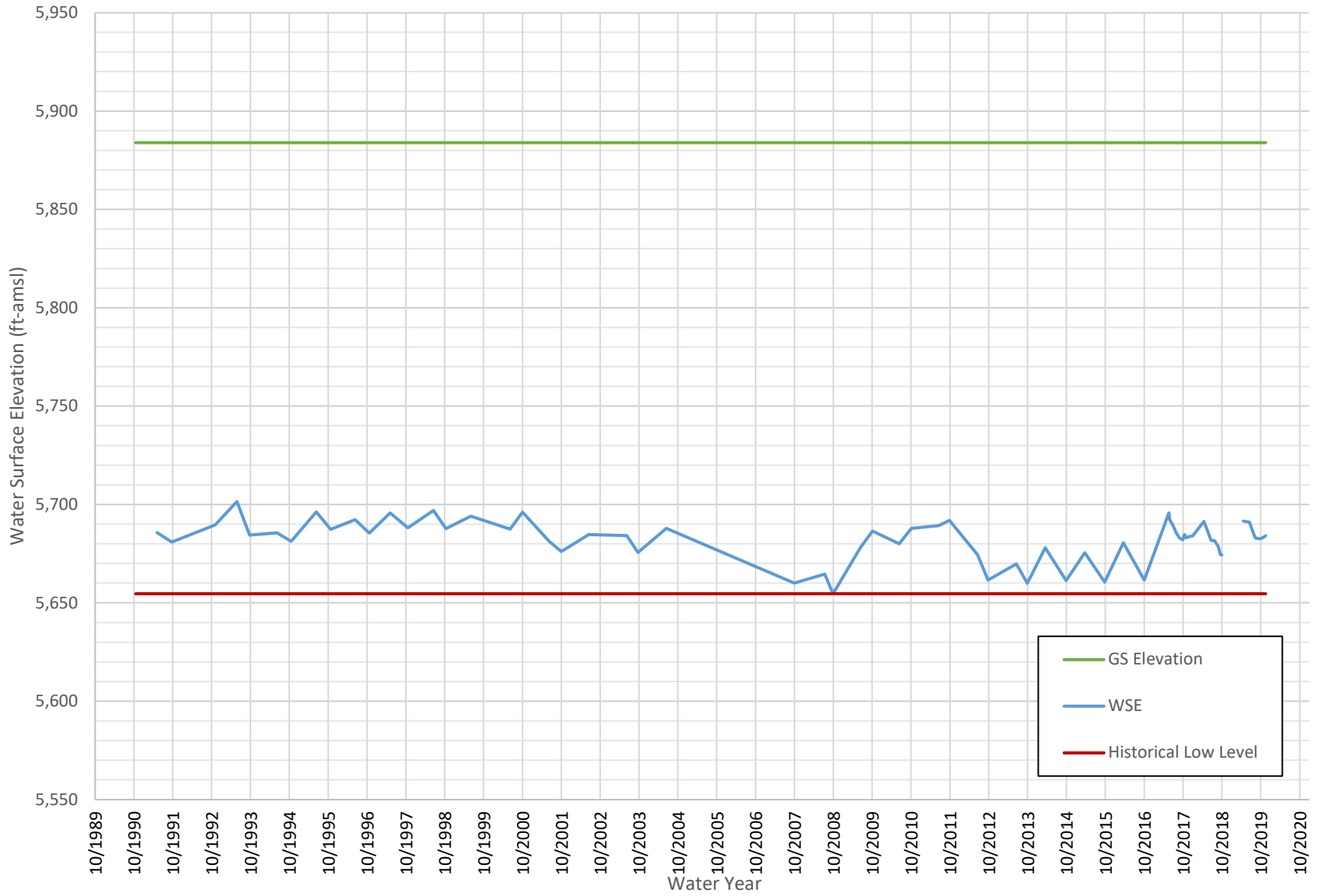
# 17N17E05D001M



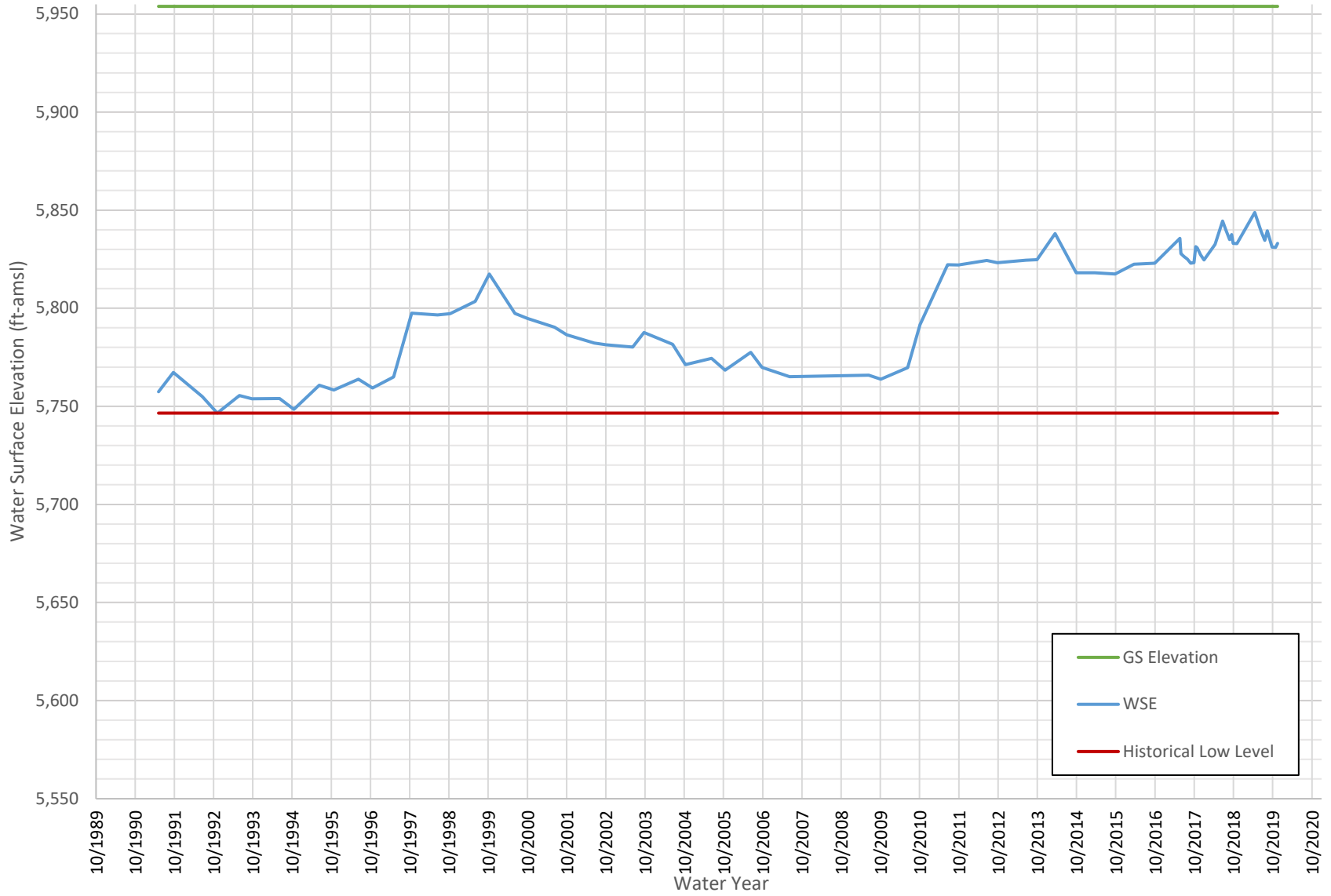
# 17N16E13K001M



# 17N16E13K003M



# 17N16E11F001M

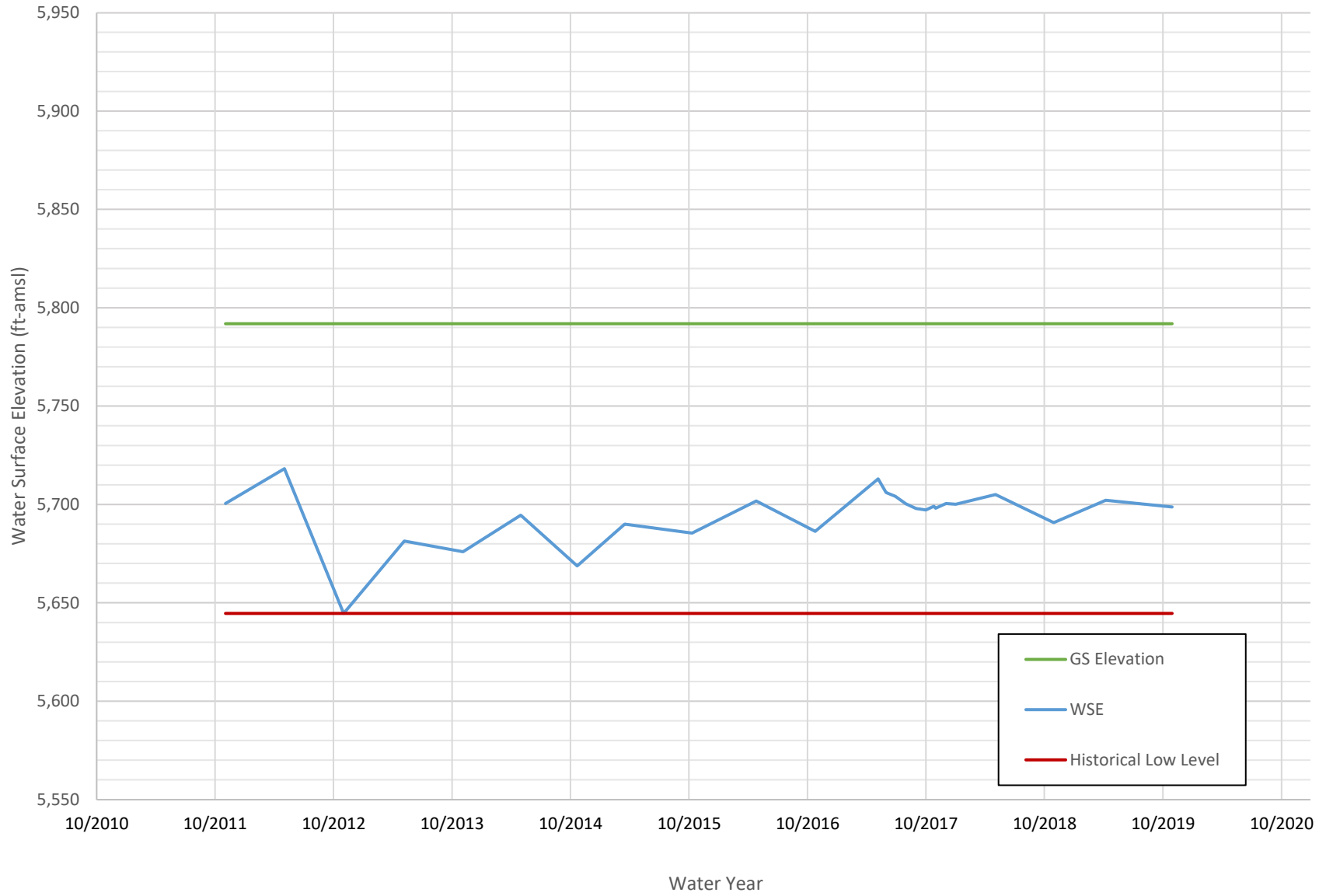




# 18N16E22H001M



# Martis Valley



# Prosser Village



# Fibreboard



# Attachment B. Piezometer Hydrographs

---

**Memo**

To: Beth Christman, Truckee River Watershed Council

From: Brian Hastings, P.G.

Date: January 6, 2020

**Subject: Pre- and Post-Restoration Hydrologic Monitoring Results, WY2013-WY2019,  
Middle Martis Creek Wetland Restoration Project,  
Placer County, California**

---

***Introduction and Background***

Middle Martis Creek emerges from a canyon and spills into Martis Valley over an alluvial fan. An alluvial fan is a landform located at a slope transition and dominated by active and dynamic depositional processes, such that the active channel can change or inundate large areas of the alluvial fan. These processes were impaired when road improvements to SR267 confined flow to the south side of the road, depriving the rest of the alluvial fan and meadow of flooding. Focusing flows to the south side of the road caused erosion of the meadow and impacted water quality, groundwater, vegetation, and habitat (Shaw and others, 2012). Recent and on-going monitoring under the Truckee River Water Quality Improvement Program (CDM, 2019) also has identified Middle Martis Creek as a dominant suspended sediment source to Martis Reservoir, due to road sanding operations and runoff from SR267.

The Middle Martis Creek Wetland Restoration Project (Project) was designed in 2012 with the goal to restore alluvial fan processes, augment hydrologic support for montane meadow habitat and encourage sediment deposition and storage (Shaw and others, 2012). The Project was implemented in the summer of 2016. This memo provides a data summary of surface water and groundwater data for the Project with 3+ years of pre-Project monitoring data and 3 years of post-Project monitoring data. These data provide for an evaluation of how the Project has influenced streamflow and groundwater conditions, project effectiveness, and can be used to guide adaptive management in future years.

The Project design was based on evidence that historical stream flow paths once occupied the north side of SR267, whereas the main or existing channel runs along the south side of SR267 (Shaw and others, 2012a, Shaw and others, 2012b). The Project design goals were to:

- Restore hydrologic and sediment transport continuity to the former channel and meadow north of SR267;
- Restore wet meadow conditions on the Middle Martis Creek Alluvial Fan;

- Reduce flooding of SR267.

To achieve these goals, the design included elements that: 1) divert high flows to the north side of the Middle Martis alluvial fan while maintaining baseflow to the south side of the alluvial fan to sustain existing riparian and wetland communities; 2) modify historical features or watershed disturbances that had re-routed dominant streamflow patterns; and 3) modify surface water and shallow groundwater drainage to prevent overflow and seepage onto SR267.

Balance maintains two streamflow gaging stations as part of this monitoring program: 1) Middle Martis Creek upstream of the Project, and 2) Middle Martis Creek downstream of the Project in the main channel. Stream stage, specific conductance and water temperature are recorded continuously (every 15 minutes) at both stations. Manual streamflow measurements are conducted periodically to maintain stage to streamflow rating curves, which are used to convert the record of stage to streamflow. The two gages provide records of streamflow upstream and downstream of the diversion which can be used to calculate streamflow to the historical channels and meadow north of SR267. In addition, Balance maintains 6 shallow groundwater monitoring wells located across the alluvial fan. Groundwater data are recorded hourly. Groundwater data are used to evaluate the effect of the streamflow diversion on groundwater recharge. Streamflow gaging stations and groundwater monitoring wells are shown in **Figure 1**.

### ***Hydrologic Monitoring Results and Discussion***

#### *WY2013-WY2019 Precipitation Summary*

Project monitoring data was measured or recorded for a 6+ year period: 3+ years pre-project, 3 years post-project. We reviewed precipitation data for a climate station<sup>1</sup> located approximately 3.5 miles southwest of the Project at similar elevation (6,500 feet) to the Middle Martis Creek watershed. Cumulative daily precipitation for WY2013 through WY2019 is illustrated in **Figure 2** and compared with the 30-year, long-term average of 34.3 inches over the period from 1981 to 2010).

Over this time period, the Truckee-Tahoe area transitioned from drought into a wetter period. The drought was characterized with below average annual precipitation for 4 consecutive years from WY2012 to WY2015. After the Project was implemented in late 2016, the area received more than twice the average annual precipitation in WY2017. Regional groundwater storage increased and groundwater use in the Martis Basin decreased (GEI, 2018). WY2017 was followed by a near average precipitation year in WY2018, and an above average year in WY2019. The very dry conditions during the pre-project monitoring period and the relatively wet conditions after restoration implementation confound comparisons between pre- and post-Project conditions.

---

<sup>1</sup> Station ID 834, near Truckee, CA, operated by the Natural Resource and Conservation Service.

Middle Martis Creek Hydrology upstream of the Project

The upstream streamflow gaging station was installed on Middle Martis Creek in March 2013 (WY2013) approximately 1,300 feet upstream of the Project to evaluate inflows to the project reach over time. An observer log describing our observations and data collected at this station across all monitoring years is shown in **Appendix A**. Daily mean streamflow for Middle Martis Creek upstream of the Project across all monitored years is provided in **Figure 3**, while annual hydrologic metrics across all monitoring years is provided in **Table 1**.

We characterize hydrology for the period of record to illustrate differences in streamflow as they relate to year type (i.e., dry, average, wet). We note that this streamflow gage is subject to freezing therefore, winter baseflow is sometimes estimated. In addition, our ability to measure streamflow less than 0.1 cfs is limited at this station. Low flows less than 0.1 cfs typically infiltrate the channel bed a short distance downstream of the gaging station and upstream of the restoration project.

In WY2013, peak snowmelt-runoff of 4.4 cfs occurred on March 14, 2013. Based on other nearby gages, annual peak flow was likely much higher and occurred on December 2, 2012, before the gaging station was installed. Subsequently, in late July and early August 2013, streamflow receded to roughly 0.02 cfs or less. Summer low flows infiltrated the streambed a short distance downstream of the gage, such that the channel was dry in the vicinity of the Project area. Partial annual runoff volume in WY2013 was estimated to be 359 acre-feet.

In WY2014, a rain-on-snow event on February 8-9, 2014 generated the annual peak flow of 16.9 cfs. Peak snowmelt of 2.3 cfs occurred in late March 2014, significantly earlier than in most years. Daily baseflow levels below 0.1 cfs began in late June and persisted through the rest of the water year with some higher daily flows coinciding with some summer precipitation. Similar to WY2013, the streambed was dry a short distance downstream of the gage beginning in late July 2014. Annual runoff volume in WY2014 was estimated to be 676 acre-feet.

In WY2015, the annual peak flow of 19.4 cfs was recorded on February 8, 2015, during a rain-on-snow event. Peak daily flow from snowmelt of 1.5 cfs occurred on March 11, 2015. From mid-July through most of September daily flows were estimated to be 0.1 cfs or less. Again, the streambed was dry a short distance downstream of the gage during the summer baseflow period. Annual runoff volume in WY2015 was estimated to be 572 acre-feet.

In WY2016, the annual peak flow of 30 cfs occurred on January 30, 2016 during a rain on snow event. An estimated peak snowmelt flow of 17 cfs occurred on April 9, 2016. Snowmelt runoff receded to baseflow conditions of less than 0.1 cfs by the end of June. Daily mean flows remained below 0.1 cfs for the rest of the water year (through September) due to a drier than average summer with no additional precipitation. Baseflow persisted further downstream in WY2016, but continuous flow downstream to the Project reach was not recorded even with near average annual precipitation. Annual runoff volume in WY2016 was calculated to be 1,416 acre-feet.



In WY2017, early autumn rain caused streamflow to increase in Middle Martis Creek during completion of the restoration project. Rain-on-snow events in December, January, February and March generated multiple peak flows that exceeded 50 cfs. The estimated annual peak flow of 84 cfs was recorded on February 9, 2017, also estimated to be the peak flow of record. The above-average snowpack resulted in a prolonged snowmelt runoff period with peak snowmelt runoff of approximately 40 cfs occurring on May 5, 2017. The snowmelt runoff receded into the summer months, but summer baseflow remained above 0.2 cfs for the first time during the period of record. Annual runoff volume in WY2017 was estimated to be 5,851 acre-feet.

In early WY2018, baseflow and runoff response was higher than in previous years due to the previous very wet year; autumn rain generated two peak flows greater than 10 cfs in November. Rain-on-snow events in January, March and April generated multiple additional peak flows. The annual peak flow of 54 cfs was measured on April 7, 2018. Near-record monthly snowfall in March 2018 allowed for snowmelt runoff to persist into the late spring, and baseflow receded into the summer months with flows receding to below 0.1 cfs in mid-July and dry conditions at our gage observed in August, likely the result of several months absent of precipitation. Baseflow increased in late August and September as a result of lower temperatures and reduced evapo-transpiration. Annual runoff volume in WY2018 was estimated to be 1,368 acre-feet; similar to WY2016.

In WY2019, after a brief period of low flow, baseflows increased in the fall and winter with the onset of precipitation. Streamflow gradually rose through the winter into the spring with only a couple of rain-on-snow events. The annual peak flow of 41.5 cfs occurred on April 9 after a moderate rain-on-snow event. Peak snowmelt runoff of 37 cfs occurred on April 25, 2019. Well above average snowpack and cool spring temperatures prolonged the snowmelt runoff period well into July. The remainder of the water year was dry; however, baseflow remained above 0.15 cfs. Annual runoff volume in WY2019 was estimated to be 2,809 acre-feet.

#### Middle Martis Creek Restored Meadow Hydrology

For the purposes of comparing pre- and post-project monitoring, an additional gaging station was installed in the main channel (south side of SR267) downstream of the diversion in October 2016<sup>2</sup>. A station observer log across all post-project monitoring years is shown in **Appendix B**. In **Figure 4**, daily mean streamflow for Middle Martis Creek at this station is compared with daily mean streamflow at the upstream station. The difference between streamflow measured at these two stations is calculated to be streamflow diverted to the restored reach of Middle Martis Creek and is shown as a dashed red line in Figure 4. Based on comparison of data at the upstream and downstream stations and our observations, streamflows less than or equal to roughly 1.0 cfs at the upstream station flow to the main channel, with minimal or no bypass to the restored reach. These flows are designed to maintain the existing riparian community.

---

<sup>2</sup> The Project construction diversion pipe remained in the main channel through December 19, 2017 and may have affected our ability to accurately measure streamflow at this station up until that date.

Between October 16, 2016 and October 27, 2016, all streamflow was temporarily diverted into the restored reach of Middle Martis Creek to accommodate construction of a new headwall and culvert inlet to the main channel. After October 27, 2016, the Project began functioning as designed with streamflow split between the main and restored channels.

Multiple large flood events occurred in WY2017; imagery for these higher flows provide an infrequent illustration of restored alluvial fan flooding (**Figures 5, 6, and 7**). For the post-project period-of-record, peak streamflow to the restored meadow occurred on February 9, 2017 and was calculated to be roughly 80 cfs with about 5.5 cfs in the main channel. Streamflow was primarily sustained to the restored meadow through June in WY2017. In WY2018, streamflow was intermittent to the restored meadow between October and June but was sustained continuously between late March through early June with peak flows roughly 50 cfs. In WY2019, streamflow to the restored meadow was initiated in January with intermittent flow until early March when flow was sustained through late June. Peak flows exceeded 20 cfs.

In all, Middle Martis Creek runoff was roughly 10,600 acre-feet for the post-project period (WY2017-WY2019). Of this total, 74 percent or roughly 7,800 acre-feet was provided to support wet meadow restoration north of SR267. The remaining 26 percent, or 2,700 acre-feet, was maintained in the main channel to support existing riparian communities and recharge local groundwater.

Returning peak flows and associated runoff volumes to the north side of SR 267 has reduced, and possibly, eliminated flooding that historically used to occur along the southside of the highway and near the main channel. In fact, higher peak flows were measured post-project when compared to pre-project and flooding was not observed on SR 267.

### Groundwater Monitoring

California Department of Water Resources (DWR) conducts bi-annual monitoring of deeper groundwater conditions from two deep wells in Martis Valley. For context of regional climate conditions and changes through the monitoring period, we show data for the period of record for these wells in **Figure 8**. From **Figure 8**, conditions between 2007 and 2015 reflect a net decline in deeper groundwater levels in the Martis Groundwater Basin with a maximum depth to groundwater recorded in October 2014. From 2016 to 2019, four consecutive years of average or above average precipitation and runoff have resulted in increases to deeper groundwater elevations, but they continue to be below the historical long-term condition (pre-2007, see **Figure 8**).

As part of this monitoring program, we measured groundwater conditions at 6 shallow piezometers across the Project area. While increasing groundwater elevations was not a goal in the design, groundwater conditions in the 6 piezometers characterize the shallow groundwater less than 20 feet below ground surface and are related to habitat and wetland conditions. These shallow conditions may or may not be characteristic of the deeper groundwater aquifer described in the preceding paragraph. An observer log of groundwater observations and measurements at all piezometers and across all years is provided in **Appendix C**. To evaluate

efficacy of the Project, we focus on groundwater conditions at 2 piezometers in the restored alluvial fan reach (Piezometers 13-03 and 13-04) and compared between pre-project conditions in WY2016 and post-project conditions in WY2018. These years were characterized with similar annual precipitation and runoff volumes. We also evaluate how the project maintains shallow groundwater conditions in riparian and meadow areas along the former or main channel, south of SR267, using 4 piezometers (Piezometers 13-01, 13-02, 13-05 and 13-06).

We note that data are absent for part of the entirety of WY2019 for Piezometers 13-01 and 13-05 due to battery failures.

#### Maintaining Shallow Groundwater South of SR 267

Piezometers 13-01, 13-02, 13-05, and 13-06 are all located south of SR 267. While high flows were restored to the north side of SR 267 by design, baseflow and all flows less than roughly 1.0 cfs were maintained in the main channel to support existing riparian communities and instream habitat. **Figures 9, 10, 11, and 12** show groundwater elevations for these piezometers, respectively with associated streamflow in the main channel. We note that after October 2016 (post-project), streamflow in the main channel was reduced to a maximum of roughly 6 cfs by design.

Groundwater in Piezometer 13-01 (**Figure 9**) shows fluctuations of more than 3.5 feet from year to year and typically rises to within 12-inches of the ground surface for only very short period of times, likely associated with overbank flooding in the main channel. Post-project, even during periods absent of high-flows, groundwater elevations were sustained at elevations and durations similar to pre-Project groundwater elevations. Even after the project reduced streamflow in the main channel to a maximum of 6 cfs, groundwater elevations were maintained at elevations similar to pre-project conditions. Battery failure prevented data collection in WY2019 in this piezometer. Piezometer 13-02 (**Figure 10**) is located south of SR 267 and on the apex of the alluvial fan. Groundwater elevations have fluctuated more than 7 feet seasonally, but rarely have risen to within 2 feet of the ground surface. Groundwater elevations in this location are sensitive to increases in flow in Middle Martis Creek (main channel) as shown by the rapid rises and falls. Groundwater elevations and durations of higher groundwater are sustained under post-project conditions. Even after the project reduced streamflow in the main channel to a maximum of 6 cfs, groundwater elevations were maintained at elevations similar to pre-project conditions.

Piezometer 13-05 (**Figure 11**) and Piezometer 13-06 (**Figure 12**) are located further downgradient on the alluvial fan and may be influenced by surface waters from both West Martis Creek and the main channel of Middle Martis Creek. In Piezometer 13-05, groundwater elevations fluctuate more than 4.5 feet within a year and typically rise to within 12-inches of the ground surface in each year. Post-project conditions show these groundwater elevations were maintained. In fact, groundwater elevations were sustained within 2 feet of the ground surface in the first 2 years post-project, likely due to the wetter than average conditions and late season elevated baseflow observed in WY2017. Even after the project reduced streamflow in the main channel to a maximum of 6 cfs, groundwater elevations were maintained at

elevations similar to pre-project conditions. Battery failure prevented data collection in WY2019 in Piezometer 13-05; however, several manual measurements of groundwater elevations were recorded.

Groundwater can fluctuate by more than 5 feet seasonally in Piezometer 13-06 and typically rises to within 12-inches of the ground surface in most years, regardless of year type. Under post-project conditions, groundwater elevations were sustained near the surface for longer durations; but these results may be indicative of wetter conditions.

#### Groundwater Conditions in the Restored Meadow

Piezometers 13-03 and 13-04 are located north of SR 267 and illustrate the results of restored surface flows to the northern side of the alluvial fan. Piezometer 13-03 (**Figure 13**) exhibits seasonal artesian conditions both pre- and post-project; but groundwater elevations can fluctuate over 11.5 feet within a single year. Post project, seasonal groundwater elevation fluctuations were minimized to between approximately 5.5- and 9.0-feet post-project; likely as a result of streamflow restored to this portion of the alluvial fan.

Groundwater elevations measured in Piezometer 13-04 (**Figure 14**) historically fluctuated 10 to 11 feet on a seasonal basis and have risen to within 12-inches of the surface year after year, regardless of year type. Post-project conditions show that seasonal groundwater elevation fluctuations were minimized to between 8 and 10 feet and sustained elevations near the ground surface; Post-project seasonal groundwater lows at this location were very similar to pre-project lows after comparable near-average precipitation years in WY2016 and WY2018.

Using the data for the same two piezometers (13-03 and 13-04) daily depth to water are regressed with streamflow values measured at the gage upstream of the project for pre-project (WY2016) and post-project (WY2018), years that had similar precipitation and runoff characteristics (**Figures 15 and 16**). While variations in the data are apparent and likely related to initial storm response at the beginning of the wet season (WY2018), there are some stronger relationships that illustrate that when comparing conditions under similar hydrologic year types, groundwater is maintained near or above the surface for longer post-project when streamflow recedes below 3 cfs (as measured upstream).

#### **Conclusions**

Post-project monitoring in years WY2017 through WY2019 occurred during wetter conditions when compared with pre-project monitoring years WY2013 through WY2015 (characterized as below average or dry years); WY2016 was the only year with near average precipitation. These conditions confound our comparison of pre- and post-conditions; however, monitoring results suggest that the goals established as part of the design basis (Shaw and others, 2012b) were achieved:

*Goal #1: Restore hydrologic and sediment transport continuity*

Result: Monitoring qualitative and quantitative results for this program show that significant runoff volume and sediment has been returned to the areas of the Middle Martis alluvial fan, north of SR 267. The project returned more than 7,000 acre-feet of runoff to the wet meadow on the north side of SR 267 over a 3-year period. Under average precipitation years, we anticipate similar or slightly less runoff volume over the next 3-years.

*Goal #2: Restore wet meadow condition on the Middle Martis alluvial fan*

Result: While soil saturation or vegetation monitoring was not a component of this monitoring program, we show that in at least one well on the north side of SR 267, shallow groundwater conditions near the surface (within 12-inches) may be extended by over 20 days in an average hydrologic year.

*Goal #3: Reduce flooding of SR 267*

Result: Returning peak flows and associated runoff volumes to the north side of SR 267 has reduced, and possibly, eliminated flooding that historically used to occur along the southside of the highway and near the main channel.

In addition, we measured no impact to shallow groundwater adjacent to the main channel, where flows were reduced to less than 6 cfs, but baseflow is maintained. In fact, we measure similar responses in shallow groundwater post-project as compared to pre-project conditions.

***Suggestions***

This monitoring program occurred coincident with a transition in climate patterns. Pre-project conditions were characterized by below average annual precipitation while post-project conditions were characterized by above average annual precipitation. As such, climate patterns confounded differences that might be clearly detected from monitoring before and after implementation of the Project. Additional low-cost monitoring measures can be conducted to augment the results in this report. These include before and after comparisons of normalized difference vegetation index (NDVI) derived from historical imagery and future imagery as they become available. This index is a simple graphical indicator that can be used to analyze remote sensing measurements and assess whether the target being observed contains live green vegetation or not. The assumption is that the Project will have a net increase in the NDVI values over time.

***References***

CDM Smith and Balance Hydrologics 2019, Draft annual monitoring report for: Implementation of the Truckee River Water Quality Monitoring Plan, Water year 2019, report prepared for Placer County, 171 p. + appendices.

GEI Consultants, 2018, Annual report for the Martis Valley Groundwater Basin Sustainable Management Act alternative submittal, water years 2016 and 2017, consulting report prepared for Truckee Donner Public Utility District (TDPUD), 58 p.

Natural Resources Conservation Service (NRCS), 2017, Annual precipitation statistics, Truckee #2 Snow Telemetry (SNOTEL), site number 834, near Truckee, California,  
<https://wcc.sc.egov.usda.gov/nwcc/site?sitenum=834&state=ca>

Shaw, D., Chartrand, S., and Haraden, C., 2012a, Messy creeks: Restoring floods and sediment production and storage on alluvial fans, California Society for Ecological Restoration Quarterly Newsletter, v. 22, issue 4, pp. 1-6.

Shaw, D., Hastings, B., and Riedner, R., 2012b, Feasibility assessment and limited design basis for restoration and drainage enhancement alternatives on Middle Martis Creek at State Road 267, Placer County, California, Balance Hydrologics consulting report prepared for the Truckee River Watershed Council, 23 p.

Attached:

Table 1

Figures 1-16

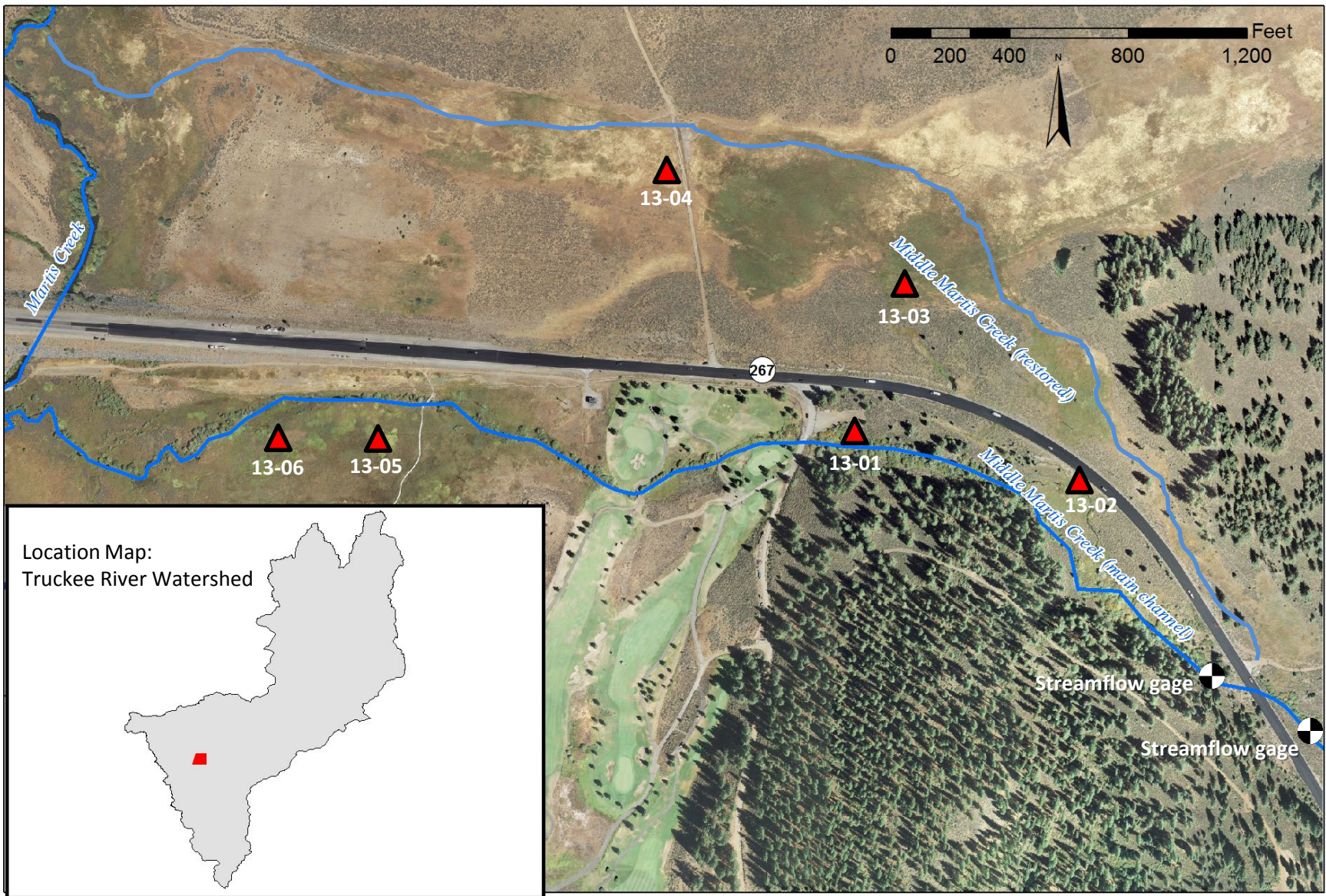
Appendices A, B and C

**Table 1. Streamflow metrics for Middle Martis Creek upstream of the Project, WY2013 - WY2019.**

<b>Water Year</b>	<b>Mean Annual Flow</b>	<b>Minimum Daily Flow</b>	<b>Max Instantaneous Flow</b>	<b>Runoff Volume</b>	<b>Year Type</b>	<b>Remarks</b>
	<i>(cfs)</i>	<i>(cfs)</i>	<i>(cfs)</i>	<i>(acre-feet)</i>		
<b>Pre-Project Monitoring</b>						
WY2013	n/a	n/a	n/a	359	Dry	Incomplete water year; peak snowmelt runoff 4.4 cfs
WY2014	0.94	<0.01	16.9	676	Dry	Well below average precipitation
WY2015	0.8	<0.01	19.4	572	Dry	Well below average precipitation
WY2016	2.0	0.02	30	1,416	Average	
<b>Post-Project Monitoring</b>						
WY2017	8.3	0.05	84	5,851	Wet	Project construction completed in October 2016
WY2018	1.9	0.00	54	1,368	Average	Extended dry period between June and September
WY2019	4.0	0.13	41	2,810	Wet	Limited rain-on-snow events; extended dry summer

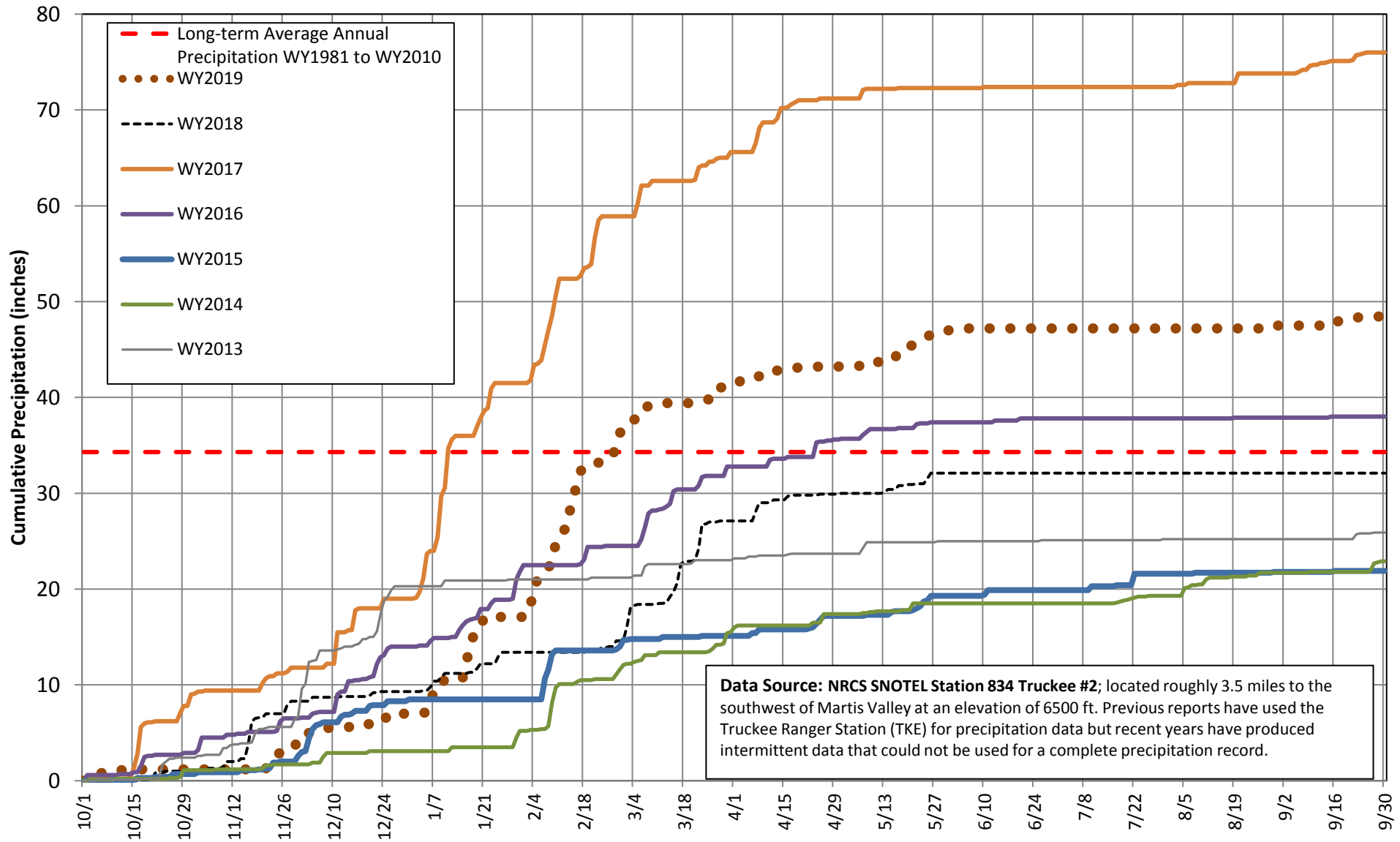
**Notes:**

Year types are relative to the long-term average annual precipitation (34.3 inches, Truckee #2, WY1981-WY2000)

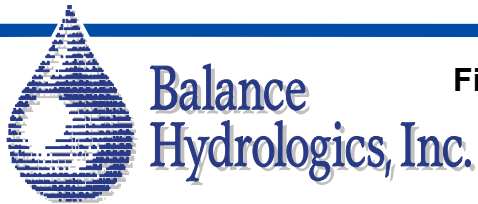


**Figure 1. Middle Martis Creek Wetland Restoration, Surface and Groundwater Monitoring Locations, Placer County, California. August 2017 aerial photograph (Post-Restoration)** Streamflow was restored to the historical channel in October 2016; baseflow is designed to continue down the main channel.

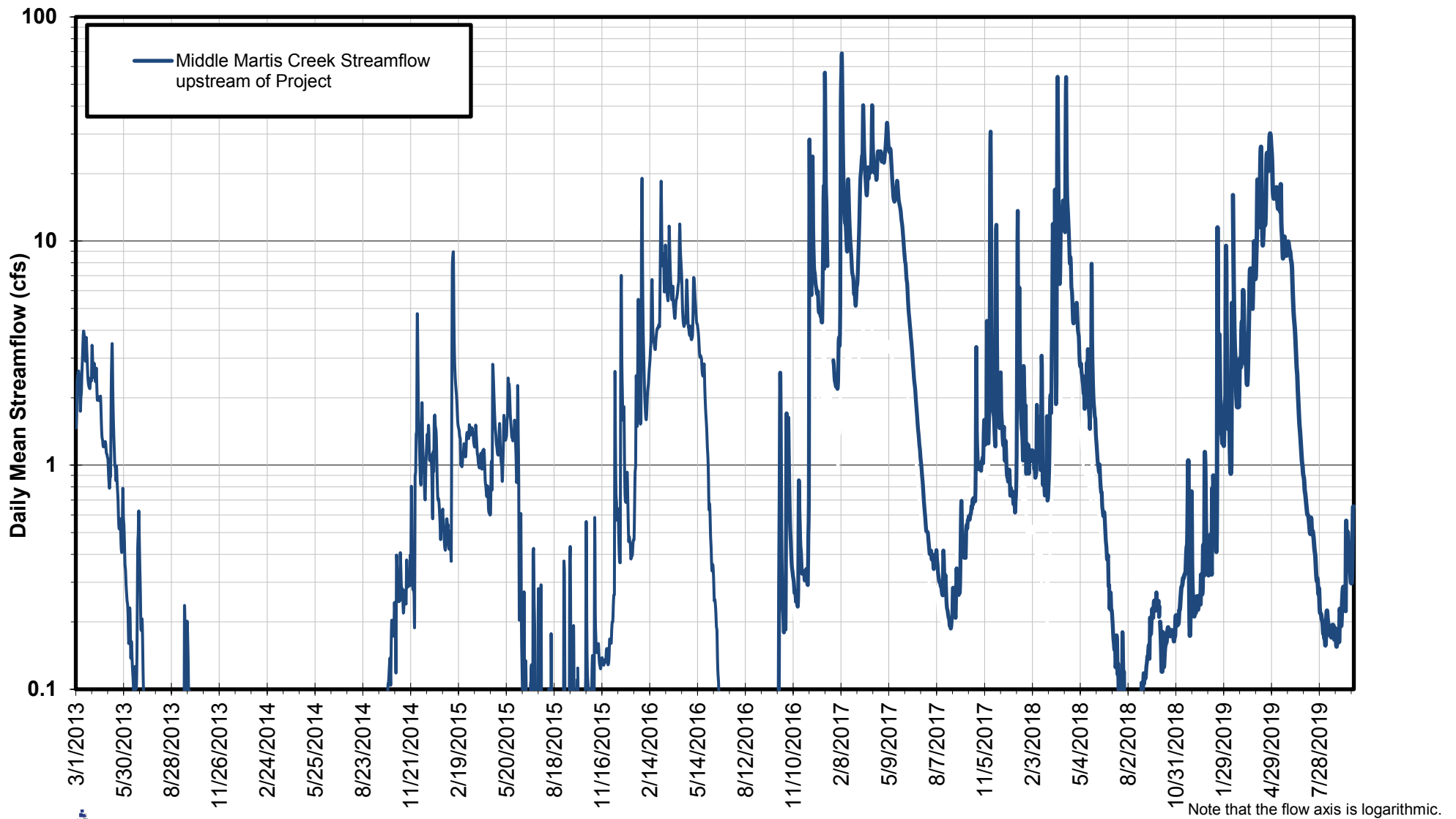




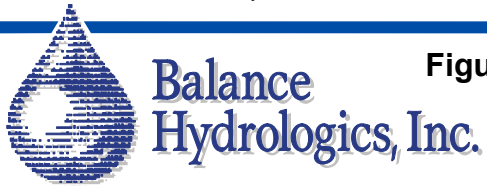
**Data Source:** NRCS SNOTEL Station 834 Truckee #2; located roughly 3.5 miles to the southwest of Martis Valley at an elevation of 6500 ft. Previous reports have used the Truckee Ranger Station (TKE) for precipitation data but recent years have produced intermittent data that could not be used for a complete precipitation record.

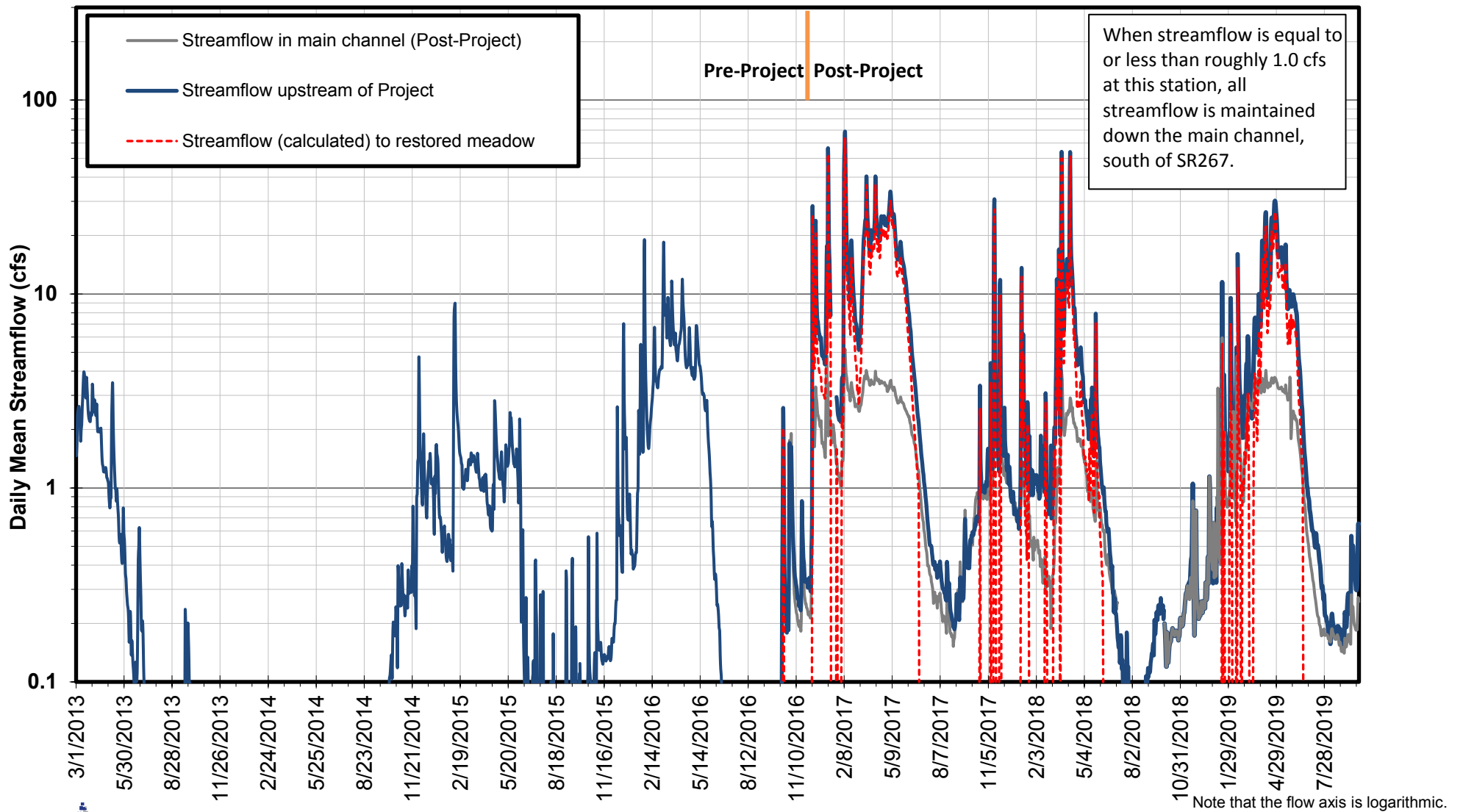


**Figure 2. Cumulative Daily Precipitation, Truckee, California, Water Years 2013-2019.** WY2019 annual precipitation was 48.7 inches, above the long-term (1980-2010) average annual precipitation of 34.3 inches.



**Figure 3. Daily Mean Streamflow, Middle Martis Creek upstream of the Middle Martis Wetland Restoration Project, Placer County, California, WY2013 (partial) through WY2019.**





**Figure 4. Daily Mean Streamflow and Calculated Streamflow to Restored Reach and Meadow, Middle Martis Wetland Restoration Project, Placer County, California, WY2013 (partial) through WY2019.**

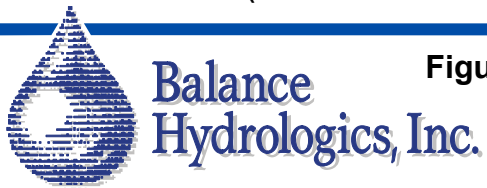




Photo credit: Brian Hastings



**Balance  
Hydrologics, Inc.**

212036 Photos.ppt

**Figure 5. Restored alluvial fan flooding, Middle Martis Restoration Project, Placer County, California.** December 10, 2016; flow in photo is calculated to be 40 cfs based on gaging records.

© 2020 Balance Hydrologics, Inc.



Photo credit: Brian Hastings



**Balance  
Hydrologics, Inc.**

212036 Photos.ppt

**Figure 6. Restored alluvial fan flooding, Middle Martis Wetland Restoration Project, Placer County, California.** Looking downstream; main channel identified on the left; restored channel and alluvial fan flooding center; near peak snowmelt runoff, April 17, 2017; flow to restored channel/meadow is calculated to be 25 cfs based on gaging records.

© 2020 Balance Hydrologics, Inc.

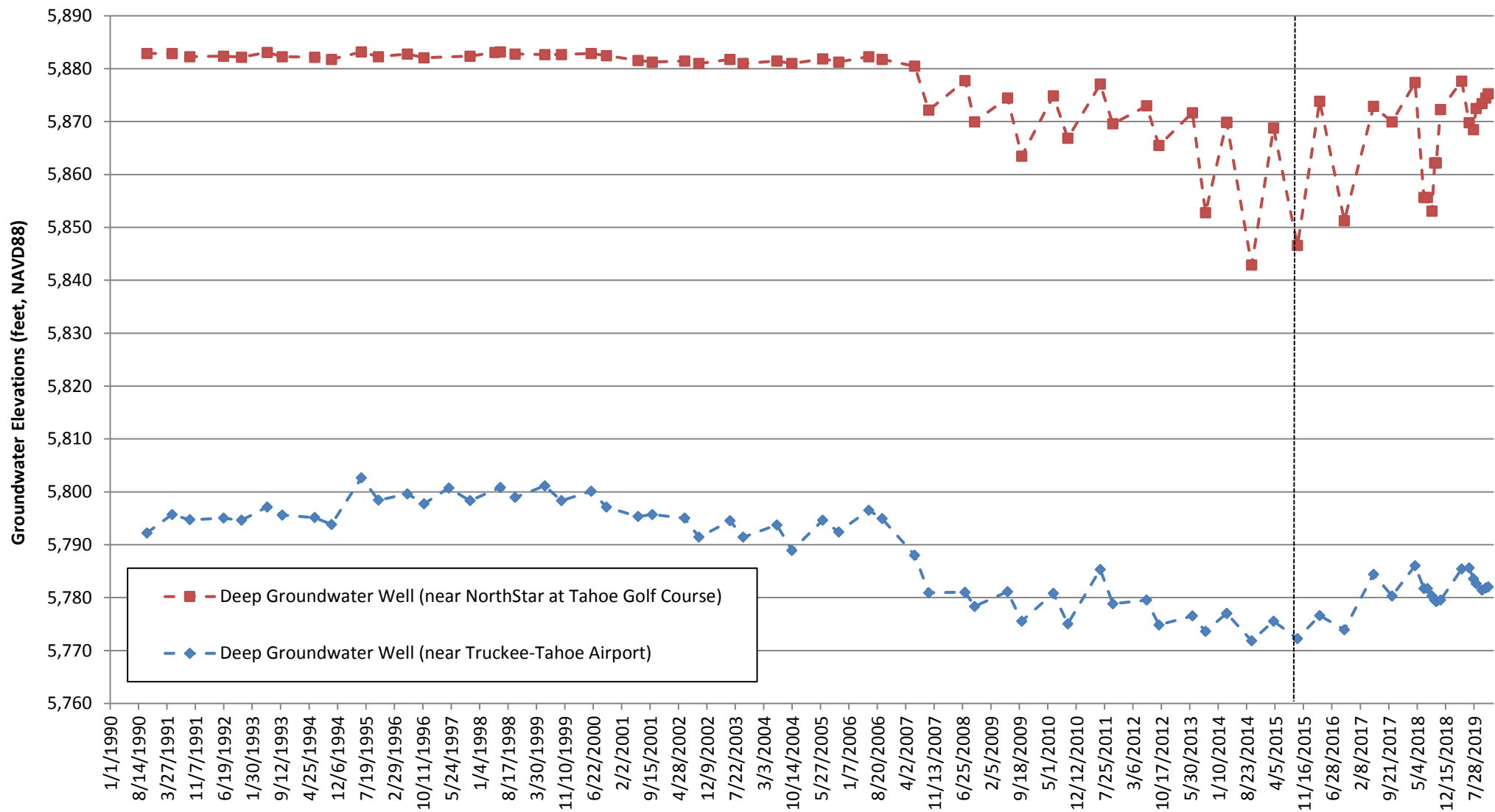


**Balance  
Hydrologics, Inc.**

212036 Photos.ppt

**Figure 7. Restored alluvial fan flooding, Middle Martis Wetland Restoration Project, Placer County, California.** Looking upstream toward SR 267; near peak-snowmelt runoff, April 17, 2017; flow in photo is calculated to be 25 cfs based on gaging records.

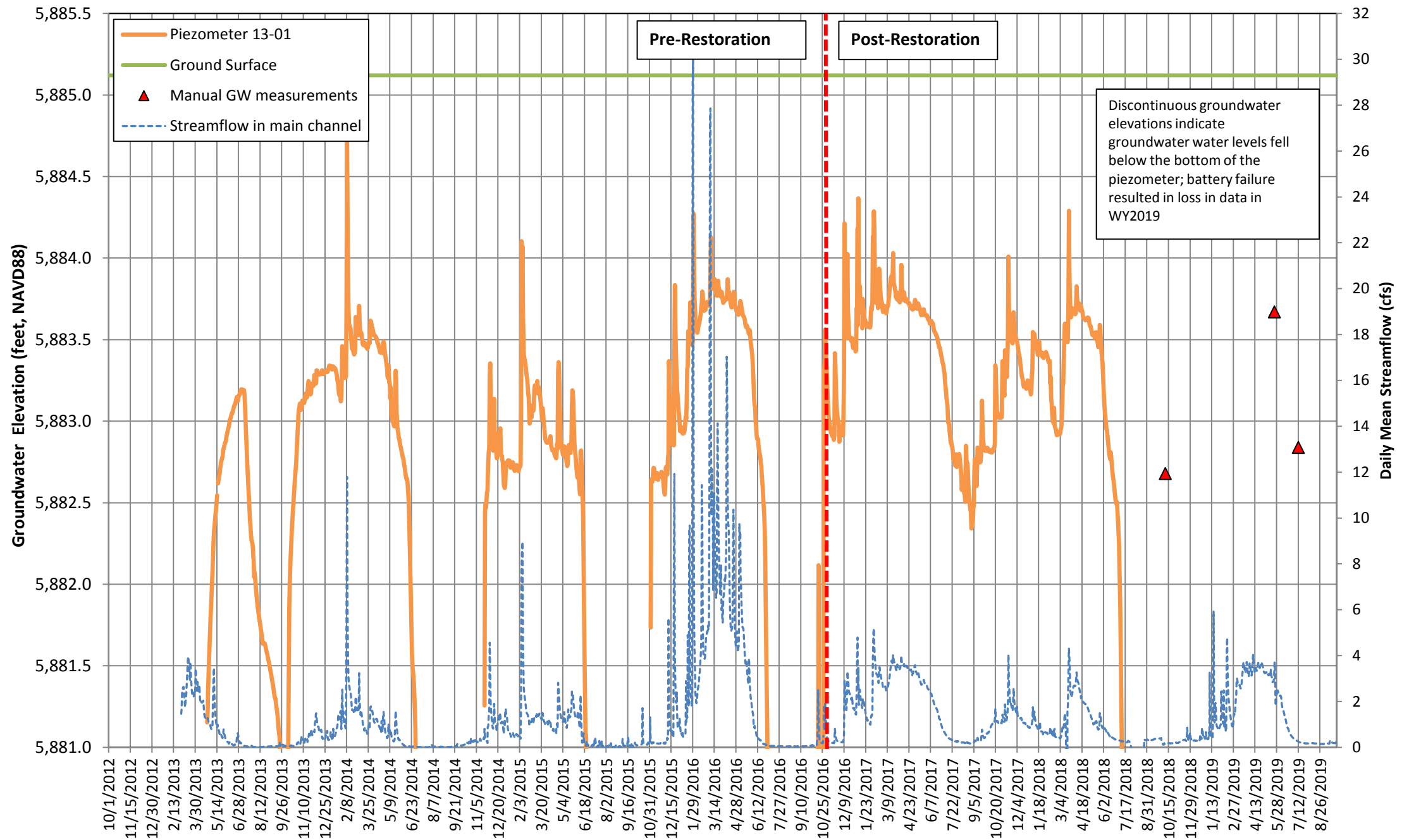
© 2020 Balance Hydrologics, Inc.



Data source: California Department of Water Resources



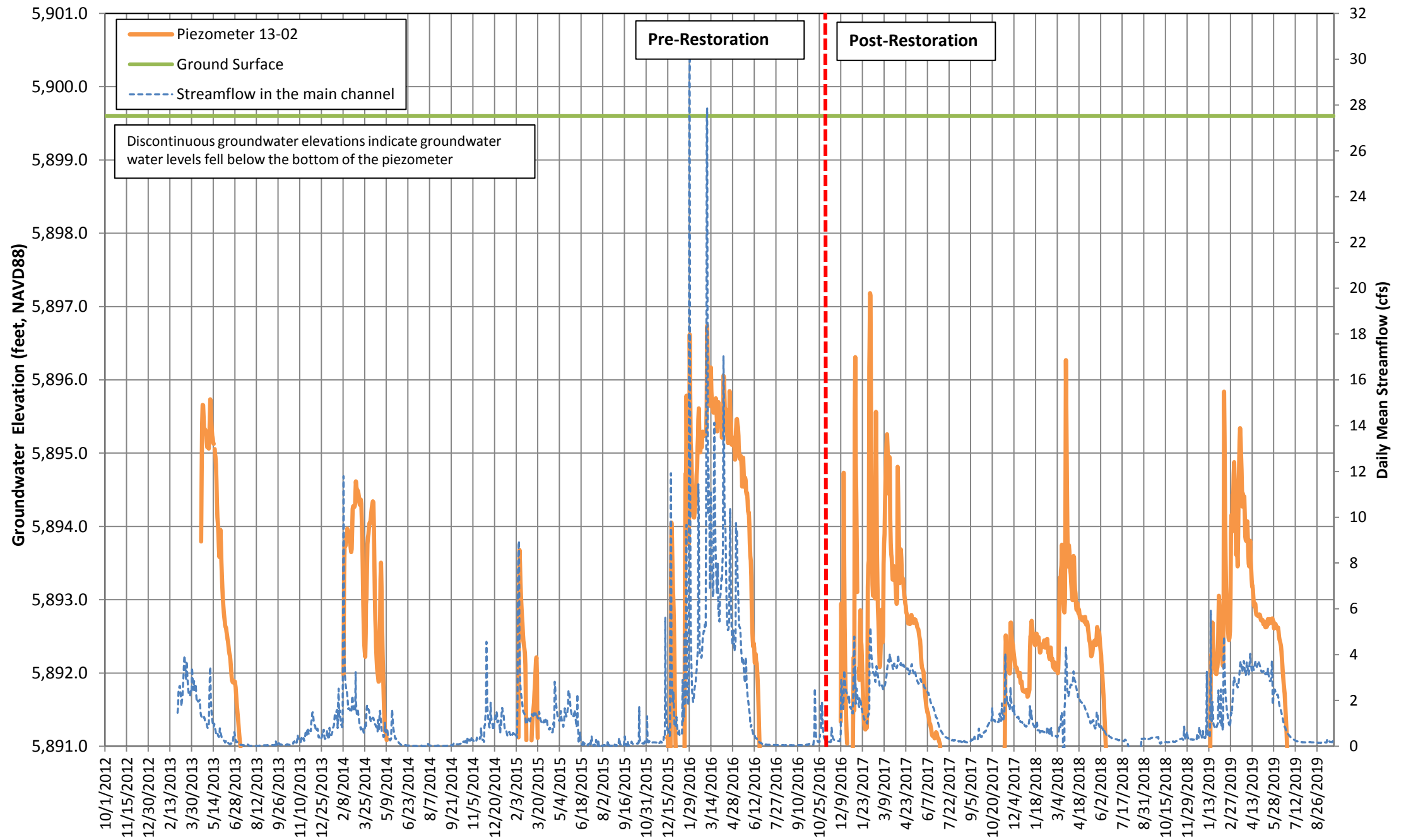
**Figure 8. Semi-annual deep groundwater elevations, Martis Valley, Placer County, California, January 1980 through November 2019.** Middle Martis Wetland Restoratoin Project was completed early November 2016 (vertical dashed line).



**Balance  
Hydrologics, Inc.**

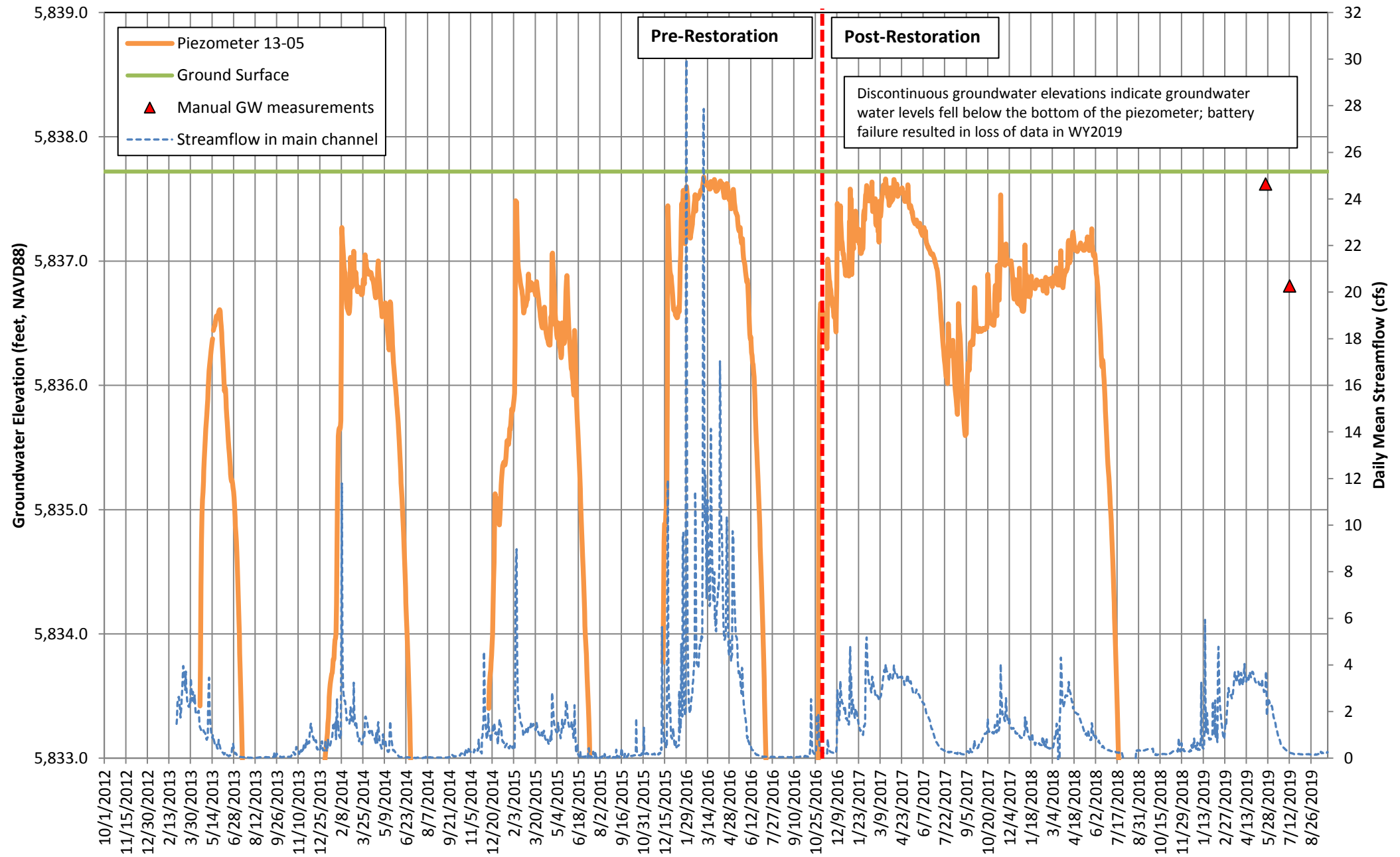
**Figure 9. Daily Shallow Groundwater Elevations in Piezometers 13-01, Middle Martis Wetland Restoration Project, Placer County, California, partial WY2013 through WY2019.** (see Figure 1 for piezometer locations)





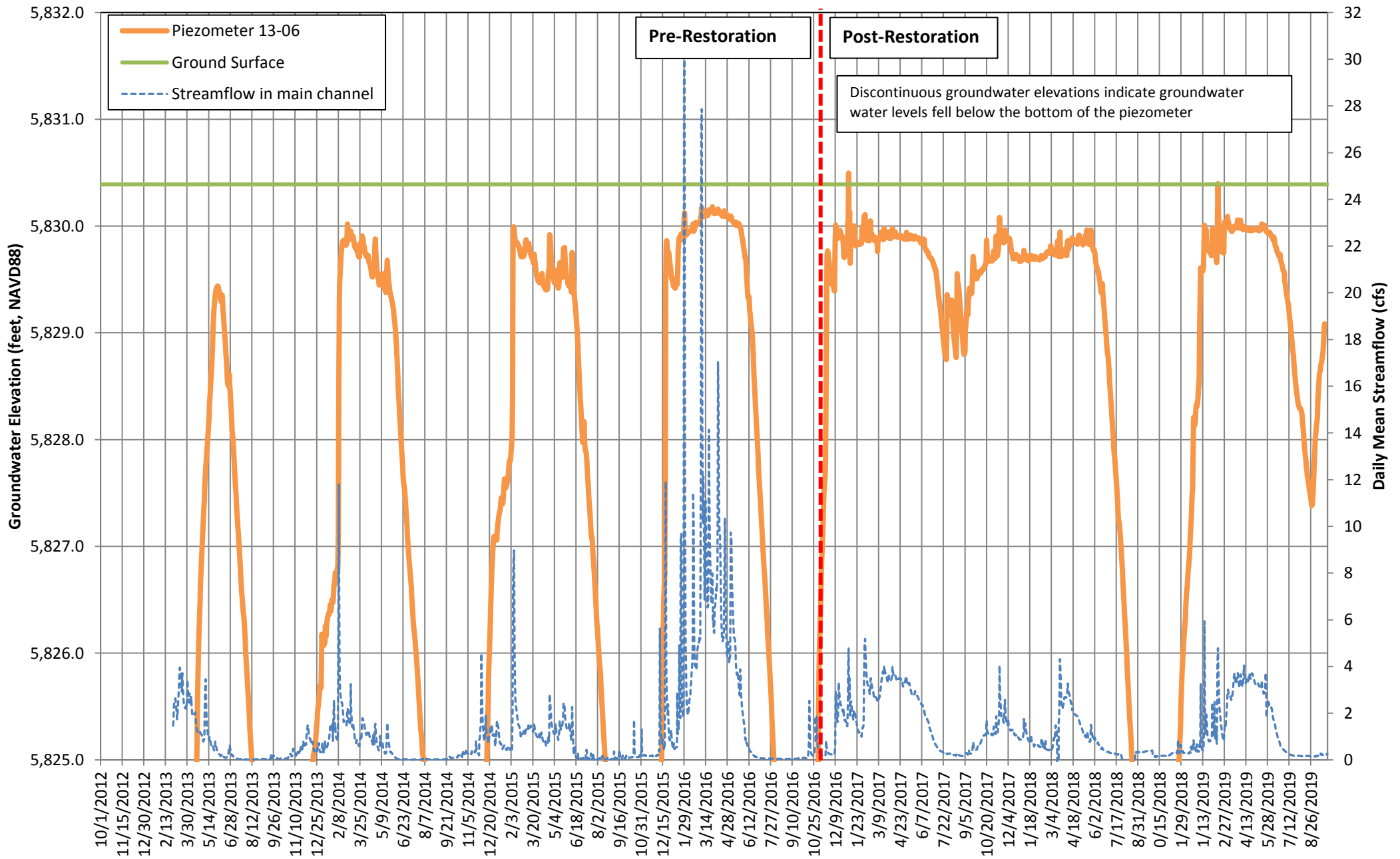
**Balance  
Hydrologics, Inc.**

**Figure 10. Daily Shallow Groundwater Elevations in Piezometers 13-02, Middle Martis Wetland Restoration Project, Placer County, California, partial WY2013 through WY2019.** (see Figure 1 for piezometer locations)



**Balance  
Hydrologics, Inc.**

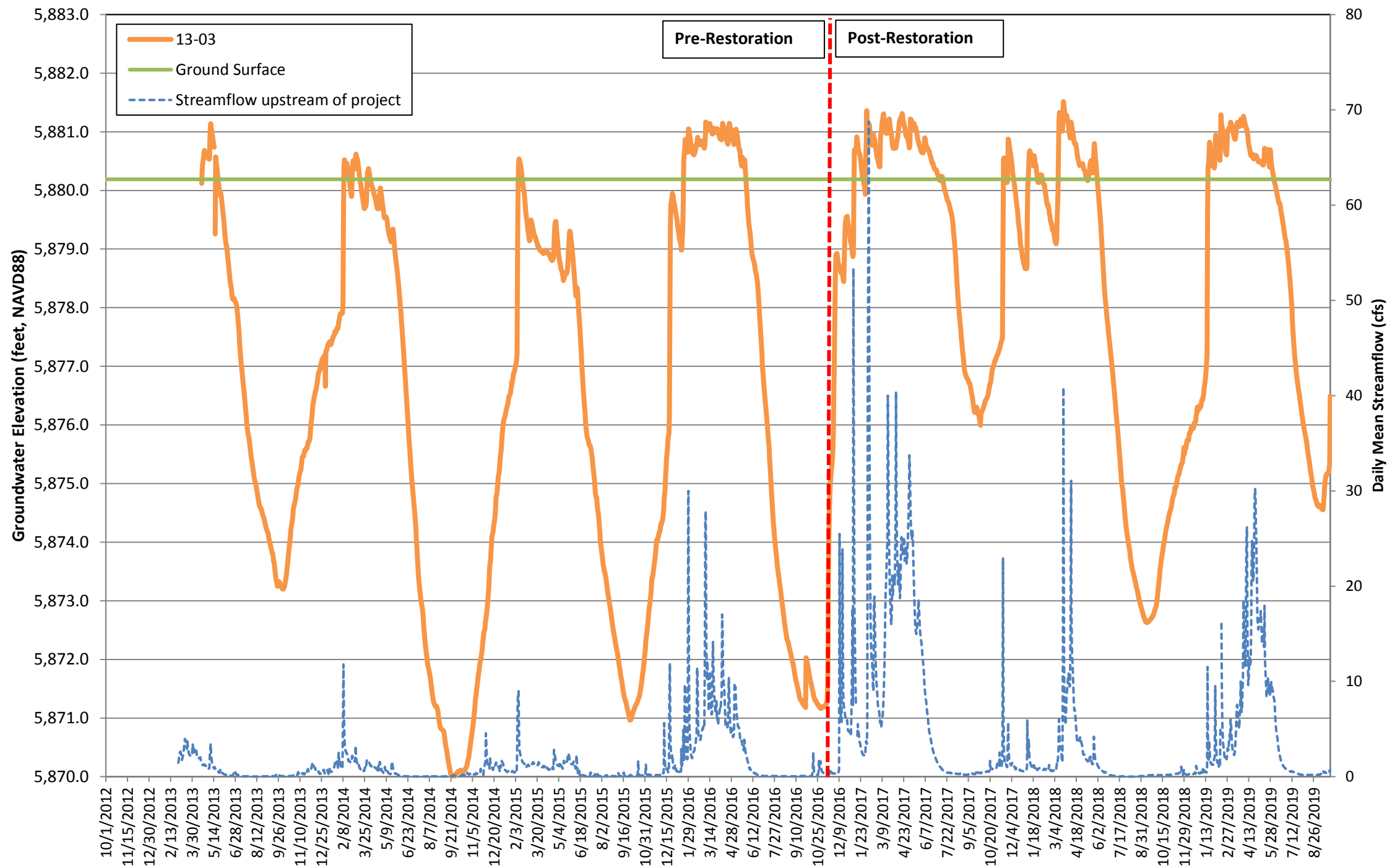
**Figure 11. Daily Shallow Groundwater Elevations, in Piezometer 13-05, Middle Martis Wetland Restoration Project, Placer County, California, partial WY2013 through WY2019. (see Figure 1 for piezometer locations).**



**Balance  
Hydrologics, Inc.**

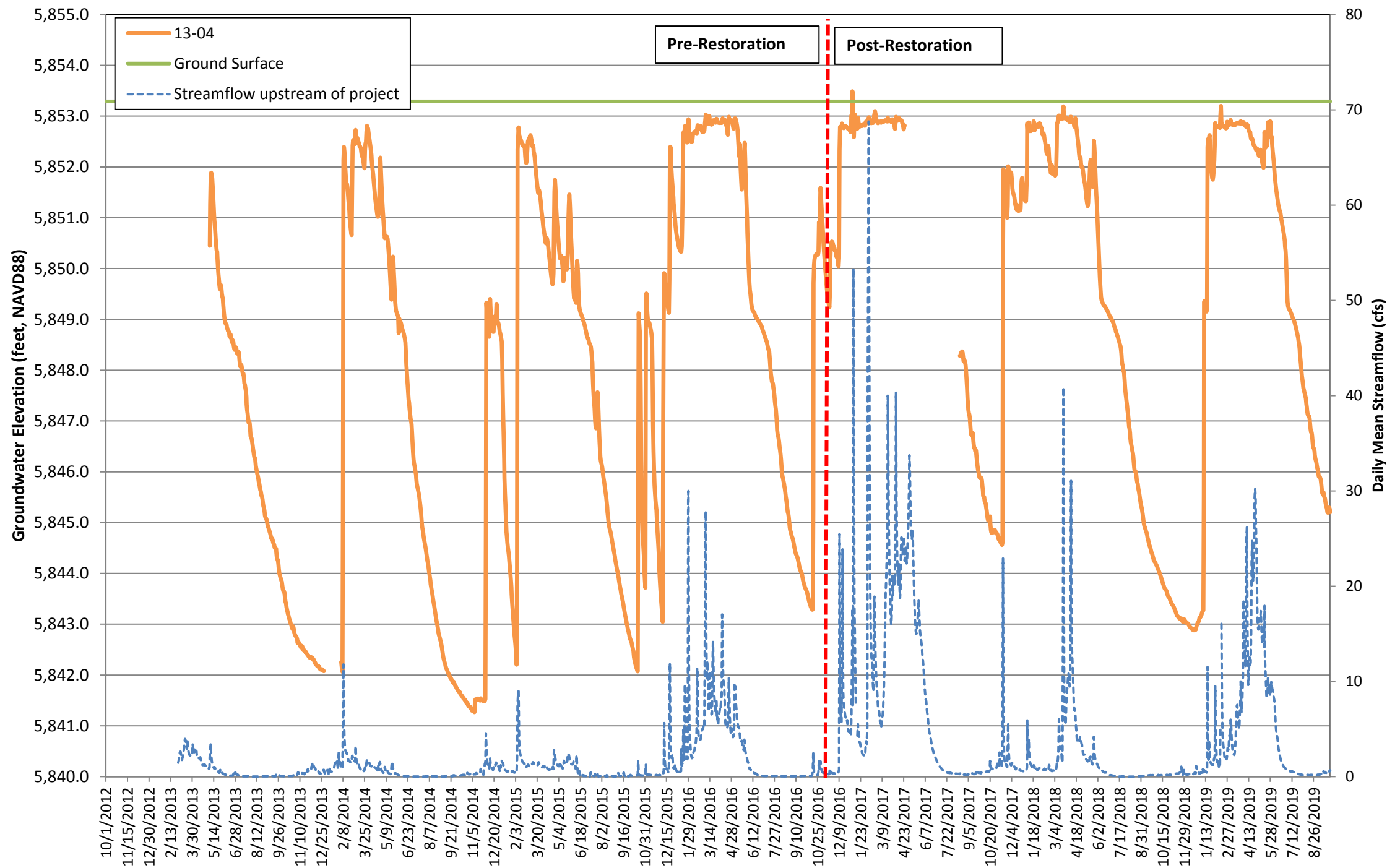
**Figure 12.**

**Daily Shallow Groundwater Elevations, in Piezometer 13-06, Middle Martis Wetland Restoration Project, Placer County, California, partial WY2013 through WY2018.** (see Figure 1 for piezometer locations).



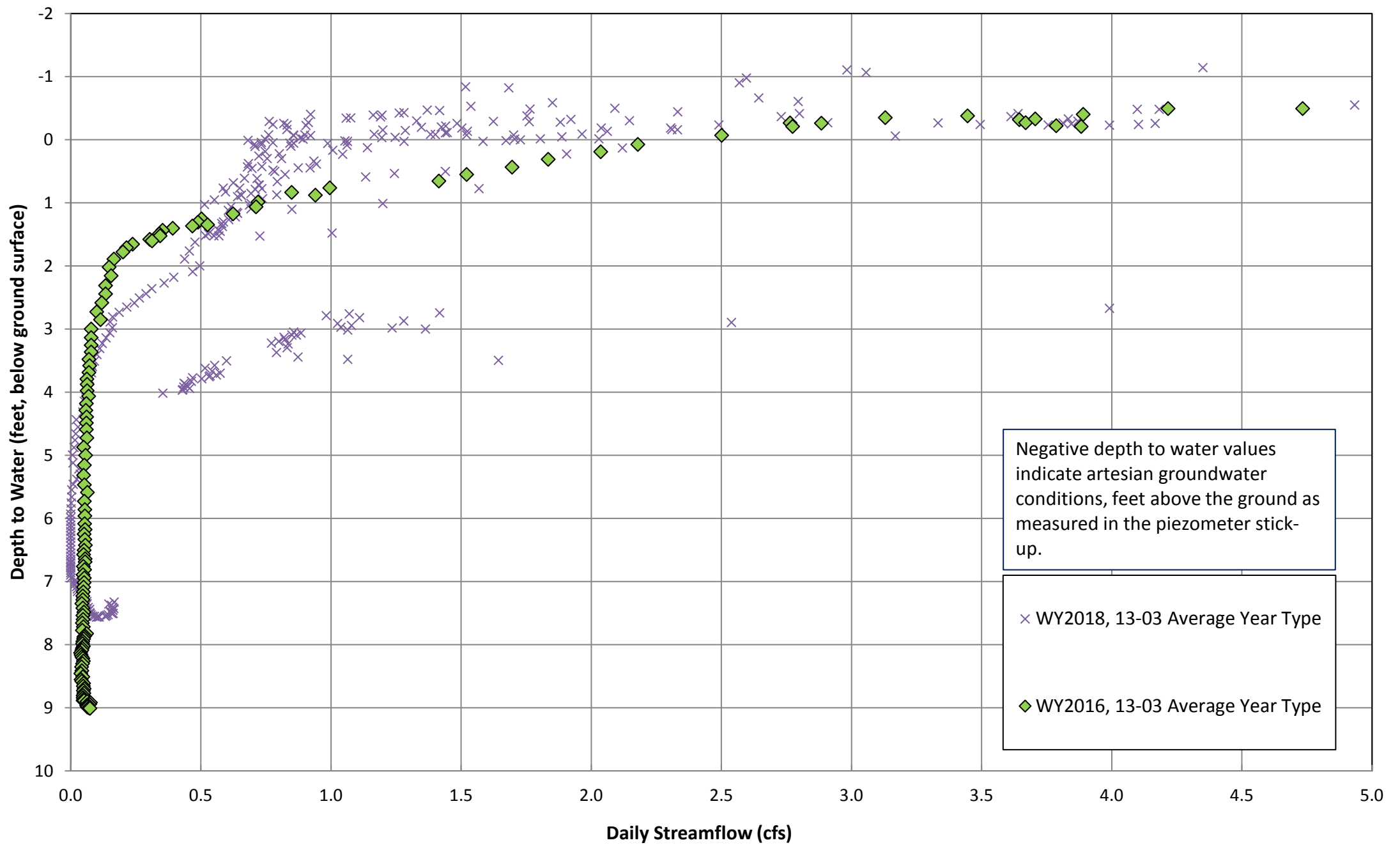
**Balance  
Hydrologics, Inc.**

**Figure 13. Daily Shallow Groundwater Elevations, Piezometer 13-03, Middle Martis Wetland Restoration Project, Placer County, California, Partial WY2013 through WY2019. (see Figure 1 for Piezometer locations)**

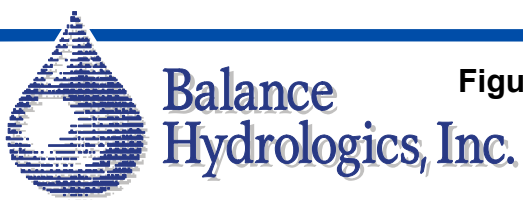


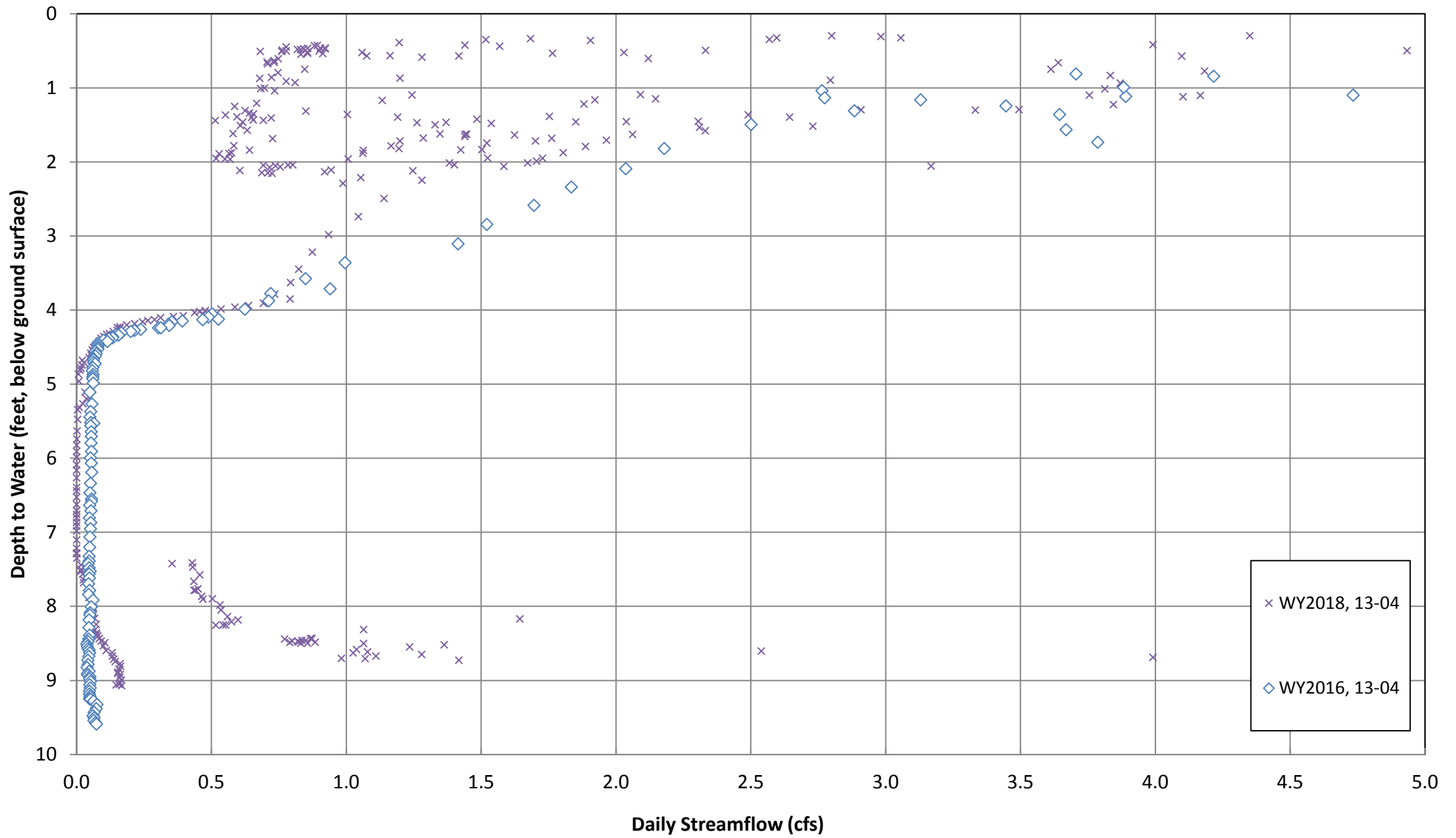
**Balance  
Hydrologics, Inc.**

**Figure 14. Daily Shallow Groundwater Elevations, Piezometer 13-04, Middle Martis Wetland Restoration Project, Placer County, California, Partial WY2013 through WY2019. (see Figure 1 for Piezometer locations)**

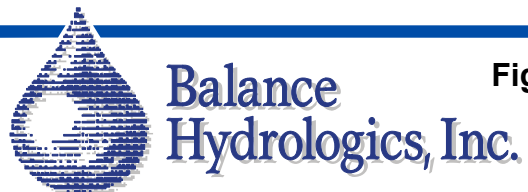


**Figure 15. Groundwater response to streamflow in the restored meadow (Piezo 13-03), Middle Martis Wetland Restoration Project, Placer County, California, WY2016 v. WY2018**  
 Post-restoration groundwater data suggests groundwater levels remained higher at lower flows when compared to pre-restoration data.





**Figure 16. Groundwater response to streamflow in a restored meadow (Piezo 13-04), Middle Martis Wetland Restoration Project, Placer County, California, WY2016 v. WY2018**



**Appendix A1 Station Observer Log:  
Middle Martis Creek at State Route 267 (MM267), partial water year 2013**

Site Conditions				Streamflow			Water Quality Observations			Remarks
Date/Time (observer time)	Observer	Stage (feet)	Hydrograph (R/F/S/B)	Measured Discharge (cfs)	Instrument Used (AA/PY)	Estimated Accuracy (e/g/f/p)	Water Temperature (oC)	Field Specific Conductance (umhos/cm)	Adjusted Specific Conductance (at 25 oC)	
3/1/2013 14:30	cs, bkh	4.855	S/R	1.02	PY	f	1.8	168	301	Gage installed, 2 levelloggers, staff plate; Sunny, warm 55 deg. C, water clear, gravels, cobbles covered in fines and road sand. Gaging station location is 1,500 feet upstream of culvert under HWY 267; at least two stormdrain outfalls (draining HWY267) enter channel downstream, but no major tributaries. Total watershed area: 4.4 sq. miles
3/14/2013 16:45	bkh	5.175	R	3.75	PY	g	3.2	152	262	Sunny, warm with above freezing temps at night; highest flows of year so far; water turbid, downloaded levelloggers to confirm data collection
3/20/2013 10:05	bkh	5.175	Peak	3.87	PY	g	1.2	158	288	Rain overnight; rain/snow mix with some clearing. No significant road roadoff, but peak flow may have occurred during the night; water turbid,
4/14/2013 15:30	ds	4.94	B	1.62	PY	e	--	--		Water slightly cloudy, dirunal snowmelt, warm 60 deg.
4/24/2013 16:00	bkh, jo	4.84	B	0.87	PY	g	10.9	144	202	Sunny, warm 55 deg; most snowmelt in watershed has passed; water slightly cloudy, sig. road sand in gaging pool, 6-in fish in pools
5/29/2013 14:15	bkh	4.76	S/F	0.31	PY	f	15.4	207	257	Rain last night; sunny, warming into 80s this week; willow leafing out, grasses and algae in channel, water clear but abundant fines on bed and sand in gage pool; replaced levelloggers on this day (SC/T, LL), new calibration required
6/26/2013 11:15	bkh	4.705	B	--	--	--	9.5	199	290	Some rain over last 2 days, water clear; download, no flow measured.
7/31/2013 10:30	bkh	4.56	B	0.02	est.	p	9.2	183	268	Flow is too little to measure accurately with pygmy; estimated over riffle; water clear; abundant road sand in gaging pool, streamflow infiltrates in bed at culvert downstream; hot July with some thunderstorms
10/1/2013 9:45	bkh	4.65	B	0.08	PY	f	2.9	171	298	Water clear, all flow originating from Elizabethtown springs, flows ceases somewhere near HWY 267 crossing, willows going dormant

Observer Key: (ds) is David Shaw, (bkh) is Brian Hastings, (cs) is Collin Strassenburgh, (jo) is Jon Owen;

Stage: observed on staff plate, arbitrary datum

Hydrograph: Describes stream stage as rising (R), falling (F), steady (S), or baseflow (B)

Instrument used: PY: pygmy, AA: standard meter

Estimated measurement accuracy: Excellent (E) = +/-2%, Good (G) = +/-5%, Fair (F) = +/-8%, Poor (P) = estimated percent accuracy given

Specific conductance: Measured in micromhos/cm in field; then adjusted to 25degC by equation  $(1.8813774452 - [0.050433063928 * \text{field temp}] + [0.00058561144042 * \text{field temp}^2]) * \text{Field specific conductance}$



**Appendix A2. Station Observer Log:**  
**Middle Martis Creek above Highway 267 (MM267), water year 2014**

Site Conditions		Streamflow			Water Quality Observations				Remarks	
Date/Time (observer time)	Observer	Stage (feet)	Hydrograph (R/F/S/B)	Measured Discharge (cfs)	Instrument Used (AA/PY/MM)	Estimated Accuracy (e/g/l/p)	Water Temperature (oC)	Field Specific Conductance (µmhos/cm)		Adjusted Specific Conductance (at 25 oC)
10/1/2013 10:15	bkh	4.65	B	0.08	PY	f	2.9	171	298	Water clear, all flow originating from Elizabethtown springs, flows ceases somewhere near HWY 267 crossing, willows going dormant, likely resulting in higher flows in creek,
11/5/2013 10:30	bkh	4.72	B	0.18	PY	g	1.3	143	260	Ice covering gage, all leaves off trees, 6 inches of snow last weekend, mostly melted now.
1/2/2014 12:00	bkh	4.78	B	0.22	PY	f	1.3	217	394	Extended dry period; sunny, 40 degrees; ice covering gaging pool, broke through 2-3 inches of ice to get stage reading--possible ice affected. Removed ice downstream to measure flow, 6-inch fish
2/8/2014 14:45	ds, cs	5.42	R	3.73	PY	f	--	--	--	Steady rain, some ice in channel, significant runoff from HWY 267, storm expected to continue for 2 days.
2/9/2014 13:15	ds, cs	5.87	F	12.62	PY	g	--	--	--	Heavy rain overnight, no snow or ice in channel, close to peak flow, no highway runoff
2/11/2014 15:15	bkh	5.15	F	--	--	--	--	--	--	Download, no ice/snow in channel, gage in good condition after event, water slightly turbid, water still high from last weekend rains.
2/20/2014 12:40	bkh	4.94	F	--	--	--	-0.4	189	359	Troubleshooting LL download; successful, water clear, significant road sand in gage pool, 4-inch fish
3/18/2014 14:00	bkh, pk	4.87	B	0.54	PY	g	1.3	184	334	Sunny, clear, warm days cold nights; water clear, willows still dormant, snowmelt could begin next week
4/9/2014 13:30	bkh	4.87	B	0.66	PY	g	6.4	216	342	Sunny, warm, possible peak snowmelt runoff expected this week or next for this station; extremely low flow for this time of year; water clear, lots of road sand in pool, willow beginning to bud.
6/25/2014 12:30	bkh	4.55	B	0.03	visual	p	11.6	195	268	Sunny, dry, extremely low flows for time of year; Middle Martis is dry south of HWY 267. Pools are accumulating fine sediment and algae.
7/24/2014 10:15	bkh	4.55	B	0.05	MM	f	10.7	183	258	Recent rains; otherwise extremely dry; measured flow and water quality at all Martis Valley tributaries;
8/13/2014 10:30	bkh	4.56	B	0.05	visual	p	9.1	141	207	Recent rains have elevated flows in creek; water clear; download. HWM: 4.77 (recent)
10/1/2014 0:00	bkh	4.64	B	0.07	PY	f	2.1	198	352	Sunny, cool morning; willows beginning to drop leaves; aspen still green, abundant needles/leaves in pool, possible stage shift; recent rains have elevated flows, peak likely occurred 9/27

Observer Key: (ds) is David Shaw, (bkh) is Brian Hastings, (cs) is Collin Strassenburgh, (pk) is Peter Kulchawik

Stage: Water level observed at outside staff plate (arbitrary datum)

Instruments used to measure velocity: AA: Standard meter; PY: Pygmy meter; MM: Marsh McBurney

Hydrograph: Describes stream stage as rising (R), falling (F), steady (S), baseflow (B) or uncertain (U)

Specific conductance: Measured in micromhos/cm in field; then adjusted to 25degC by equation  $(1.8813774452 - 0.050433063928 * \text{field temp}) + [0.00058561144042 * \text{field temp}^2]$  \* Field specific conductance

Additional Sampling: Qss = Suspended sediment

**Appendix A3. Station Observer Log:  
Middle Martis Creek above Highway 267 (MM267), water year 2015**

Site Conditions				Streamflow			Water Quality Observations				Remarks
Date/Time (observer time)	Observer	Stage (feet)	Hydrograph (R/F/S/B)	Measured Discharge (cfs)	Instrument Used (AA/PY/MM)	Estimated Accuracy (e/g/t/p)	Water Temperature (oC)	Field Specific Conductance (umhos/cm)	Adjusted Specific Conductance (at 25 oC)	Water Quality Collected? (NTU, Qss?)	
10/1/2014 11:15	bkh	4.64	B	0.07	PY	f	2.1	198	352	--	Willows dropping leaves; aspen still green; possible stage shifts from needles in pool; rain/snow previous 7 days
12/3/2014 13:15	CDM	5.39	u	--	--	--	--	--	--	Qss	
1/9/2015 10:30	bkh, kb	--	ice	ice	--	--	--	--	--	--	Cloudy, 40 deg F; stream frozen with minimal flow under ice; these conditions likely persist through last couple weeks of December and into mid-January due to below-average temps. Levelloggers frozen in stilling well; no snow on banks;
2/7/2015 8:25	CDM	5.60	u	--	--	--	--	--	--	Qss	
2/7/2015 10:15	ds	5.51	F	5.98	PY	f	1.2	164.0	299	--	Significant rainfall; snow levels above 8500+ ft; major road runoff overnight with overbank flows in channel;
2/8/2015 15:00	pk	5.78	R	11.50	MM	g	--	--	--	--	Stage rising since noon today after rain; turbid flow; overbank flow observed
2/8/2015 16:35	CDM	5.93	u	--	--	--	--	--	--	Qss	
2/27/2015 10:15	bkh	4.84	S	--	--	--	--	--	--	--	Water mostly clear; no snow or ice in channel; installed turbidity probe as part of Placer County monitoring project;
3/6/2015 13:15	bkh, CDM	4.90	S	--	--	--	--	--	--	1.2 NTU	downloaded streamgage levellogger; water clear with some ice on surface
3/6/2015 14:00	CDM	4.88	u	--	--	--	--	--	--	Qss	
3/27/2015 13:45	bkh	4.82	B	--	--	--	--	--	--	--	Water clear; sunny warm; 10" trout in gage pool; no spring snowmelt runoff expected
4/21/2015 16:50	CDM	4.94	u	--	--	--	--	--	--	Qss	
4/24/2015 8:25	CDM	5.03	u	--	--	--	--	--	--	Qss	
5/14/2015 14:00	bkh	4.78	B	--	--	--	--	--	--	--	
6/10/2015 10:37	CDM	5.05	u	--	--	--	--	--	--	Qss	
6/23/2015 9:15	bkh, bt	4.63	B	--	--	--	8.6	184	274	0.9 NTU	CDM reinstalled turbidity probe on in early June; data downloaded; very low flow, estimated flow 0.02 cfs, water clear, benchtop NTU meter reads 0.9 NTU; warm days, getting warmer this week (90 degrees F).
7/8/2015 9:10	bkh, bt	4.61	B	0.08	PY	p	12.0	200	272	0.6 NTU	Recent warm temperatures; recent t-storms; flows still low and unresponsive to rains; desktop turbidity: 0.62 NTU
7/21/2015 10:00	bt	4.60	B	0.1	PY	p	--	--	--	--	Flow measurement collected with only one velocity vertical; extreme low flow
8/27/2015 10:15	bt	4.61	B	--	--	--	--	--	--	--	Extreme low stage/flow; flow too low to accurately measure; estimated <0.1 cfs
9/10/2015 9:30	bt	4.63	B	--	--	--	--	--	--	--	leaf fall in creek; flow is trickle
10/7/2015 9:15	bt	4.67	B	--	--	--	7.2	229	355	--	Final download for WY2015; weather clear, recent rains >1.0 inch, baseflow slightly elevated.
10/17/2015 10:34	bt	4.96	R	--	--	--	--	--	--	--	Stage rising and samples taken at 10:50 with 4.98 stage(Peak) water was about knoeep deep estimates about 2.5 cfs
10/28/2015 12:07	bt	4.73	B	--	--	--	--	--	--	--	Low flow; good size fish in pool where staff plate is (6")
11/13/2015 9:02	bt	4.83	B	--	--	--	--	--	--	--	Stream frozen

Observer Key: (ds) is David Shaw, (bkh) is Brian Hastings, (kb) is Kerensa Brooks, (bt) is Ben Trustman, (pk) is Peter Kulchawik, CDM is staff from CDM Truckee office, who maintain a near continuous turbidity station at this location, as funded by Placer County's Truckee River Water Quality Monitoring Program.

Stage: Water level observed at outside staff plate (arbitrary datum)

Instruments used to measure velocity: AA: Standard meter; PY: Pygmy meter; MM: Marsh McBurney

Hydrograph: Describes stream stage as rising (R), falling (F), steady (S), baseflow (B) or uncertain (U)

Specific conductance: Measured in micromhos/cm in field; then adjusted to 25degC by equation  $(1.8813774452 - [0.050433063928 * \text{field temp}] + [0.00058561144042 * \text{field temp}^2]) * \text{Field specific conductance}$

Additional Sampling: Qss = Suspended sediment concentration, funded, monitored and reported as part of Placer County's Water Quality Monitoring Program.

**Appendix A4. Station Observer Log:  
Middle Martis Creek above Highway 267 (MM267), water year 2016**

Site Conditions				Streamflow			Water Quality Observations				Remarks
Date/Time (observer time)	Observer	Stage	Hydrograph	Measured Discharge	Instrument Used	Estimated Accuracy	Water Temperature	Field Specific Conductance	Adjusted Specific Conductance	Water Quality Collected?	
		(feet)	(R/F/S/B)	(cfs)	(AA/PY/MM)	(e/g/f/b)	(oC)	(µS)	(at 25 oC)	(NTU, Qss?)	
10/1/2015 9:00	ds, pk	4.715	F	0.08	PY	f	--	--	--	Qss	Rain, water mostly clear; first rain in weeks
10/7/2015 9:15	bt	4.67	B	--	--	--	7.2	229	355	0.6 NTU	Final download for WY2015; weather clear, recent rains >1.0 inch, baseflow slightly elevated.
10/17/2015 10:34	bt	4.96	R	--	--	--	--	--	--	--	Stage rising and samples taken at 10:50 with 4.98 stage(Peak) water was about knee deep estimates about 2.5 cfs
10/28/2015 12:07	bt	4.73	B	--	--	--	--	--	--	--	Low flow; good size fish in pool where staff plate is (6") downloaded Turbidity and changed batteries (levels reading 10.46)
11/2/2015 9:00	ds, pk	5.03	S	0.55	PY	g	--	--	--	Qss	Rain started at 10am yesterday; turned to snow overnight; 2-3" of snow on ground, water mostly clear, measured discharge may be slightly higher due to flow over grasses on left bank.
11/13/2015 9:02	bt	4.83	B	--	--	--	--	--	--	--	Stream frozen; turbidity meter stuck in ice and needed some work to get out; some snow on ground and soil frozen; installed a cord to help get probe out of tube; changed batteries
12/2/2015 9:48	bt	5.1 (frozen)	--	--	--	--	--	--	--	--	Stream completely frozen-thick enough to stand on; turbidity meter frozen in place
12/21/2015 14:45	bt	5.48	R	3.81	py	g	0.1	230	--	--	Turbidity sample collected; changed batteries in Manta; stage below floodplain elevation; about 1.5-2.0' of snow next to stream
12/22/2015 9:00	bt,bkh	5.81	F	5.76	MM	g	1.3	197	--	--	Rain ending; 3.61 @ Donner lake; rain on snow-snow levels started @ 6200' and rose to 7000' overnight; Donner Ck 2 89 is at 90 cfs 8:45am; Truckee River @ Truckee 300 cfs; significant road runoff and snowmelt; less turbid than day before
1/8/2016 10:20	bt	--	--	--	--	--	--	--	--	--	Creek frozen with 3' of snow on top and all instruments frozen in place.
1/18/2016 11:13	bt	5.05	U	0.87	py	g	1.3	281	--	--	Rained over weekend to 7000'; U/S of staff plate still covered with snow and ice; levelogger frozen in place and not able to download; changed Manta batteries
1/29/2016 12:02	bt	5.30	R	3.44	MM	g/f	2.8	306	533	Qss	Water turbid; rain started early Friday morning; light rain when arrived but increased during sample; snowpack reduced by at least 1-1.5' around the stream since last visit; stage at 5.34 at 12:31
2/5/2016 11:10	bt	5.16	S	1.69	py	g	0.4	226	--	--	Water flowing and clear; some ice around edges and u/s; still 1-2' of snow on ground on west side; 6" of snow on ground on east side with bare ground exposed under canopy; lots of surface measurements during flow measurements due to grass in channel
2/25/2016 14:15	bkh, pk	5.32	S	3.18	py	g	--	--	--	5.42 NTU	Warm dry period, elevated stage with snowmelt runoff, 25% snow still remaining on banks, less than 1' deep, water mostly clear; removed turbidity probe--unable to download or replace batteries.
2/26/2016 11:38	bt	5.34	S	--	--	--	--	--	--	--	Changed batteries and downloaded turbidity meter in office; replaced in stream at 11:39
3/5/2016 9:15	bkh, bt	5.57	F	7.60	MM	g	3.3	156	267	Qss	1.5" rain overnight; roads washed of road sand, water is milky, but bed is visible; stormwater outfalls were active during storm; abundant road sediment on floodplain; runoff from roadside ditch still slightly active. Qss at 9:00
3/10/2016 13:36	bt	5.62	S	9.32	MM	e	5.6	153	242	--	Water slightly milky; flow is steady at higher level much like storm on 3/5/16; flow from snowmelt
3/25/2016 11:45	bt	5.48	S	--	--	--	4.7	147	240	--	Water slightly turbid and milky; turbidity meter had logging turned off--turned back on and changed batteries
4/7/2016 14:30	bkh	5.47	R	5.16	MM	g	8.9	131	190	Qss; 6.8 NTU	Sunny, warm, peak snowmelt likely occurred a couple weeks earlier or occurred as a rain-on-snow. Water slightly milky, measured turbidity manual for calibration, collected Qss sample at 14:40, willows/alder still dormant; download
4/26/2016 10:38	bt	5.40	F	4.18	py	g	4.2	157	260	--	Downloaded turbidity meter and changed batteries; water clear or slightly milky; grass very green but little growth on willows
5/11/2016 14:45	bt	5.40	S	--	--	--	12.3	140	184	Qss; 7.1 NTU	Meet Neil B. from CDM to troubleshoot turbidity probe; changed batteries; water slightly milky;
6/3/2016 14:30	bt	5.03	U	0.71	py	f	15.1	182	225	3.2 NTU	Sunny, hot, low-flows, difficult to measure.
6/10/2016 9:30	bkh, bt	4.95	B	0.35	py	g	9.7	180	252	--	Sunny, warm period; abundant streamside vegetation; water clear, improved measurement from 6/3/16
6/30/2016 12:43	bt	4.68	B	--	--	--	--	--	--	--	Downloaded turbidity meter and changed batteries; water clear; est. 0.2 cfs-very low flow; channel at crossing is <0.3 ft deep but gets deeper as it goes upstream; 3.5 in fish observed in u/s pool
7/25/2016 14:03	bt	4.56	B	--	MM	f	16.5	205	244	--	Downloaded Manta probe and changed batteries; very low flow; grasses tall in the channel at crossing; 3 inch fish in the stream by crossing; extremely hard to measure flow; very low velocity as evidence of turbidity persisting after walking in channel
8/15/2016 10:28	bt	4.60	B	--	--	--	11.3	240	326	--	Downloaded turbidity meter and changed batteries; channel over grown with grasses; est flow <0.007; pool at gage <1 ft deep; veg very green and healthy
9/8/2016 10:30	bkh	4.61	B	--	--	--	7.1	165	250	--	Water clear, trickle of flow at gage, nighttime temperatures near or below freezing.
9/9/2016 13:15	bt	4.58	B	--	--	--	10.1	176	246	--	Water clear, 6+" fish in gage pool, downloaded NTU datalogger; changed batteries
10/4/2016 12:15	bt	4.74	B	0.07	MM	g	4.5	219	356	--	End of water year inspection and download. Water clear, willows dormant, increased flow

Observer Key: (ds) is David Shaw, (bkh) is Brian Hastings, (bt) is Ben Trustman, (pk) is Peter Kulchawik  
 Stage: Water level observed at outside staff plate (arbitrary datum)  
 Instruments used to measure velocity: AA: Standard meter, PY: Pygmy meter, MM: Marsh McBurne  
 Hydrograph: Describes stream stage as rising (R), falling (F), steady (S), baseflow (B) or uncertain (U)  
 Specific conductance: Measured in micromhos/cm in field; then adjusted to 25degC by equation  $(1.8813774452 - [0.050433063928 * \text{field temp}] + [0.00058561144042 * \text{field temp}^2]) * \text{Field specific conductance}$   
 Additional Sampling: Qss = Suspended sediment concentration

**Appendix A5. Station Observer Log:  
Middle Martis Creek upstream of the Project, water year 2017**

Site Conditions			Discharge			Water Quality Observations					Remarks
Date/Time (observer time)	Observer	Stage	Hydrograph	Measured Streamflow	Instrument Used	Estimated Accuracy	Water Temperature	Field Specific Conductance	Adjusted Specific Conductance	Water Quality Collected?	
		(feet)	(R/F/S/B)	(cfs)	(AA/PY/MM)	(e/g/f/p)	(oC)	(µmhos/cm)	(at 25 oC)	(NTU, Qss?)	
10/4/2016 12:15	bt	4.74	B	0.07	MM	g	4.5	219	356	--	End of water year inspection and download. Water clear, willows dormant, water clear
10/14/2016 16:20	ds	4.96	--	--	--	--	--	--	--	--	Low flow, abundant grasses in channel; stage observation only
10/16/2016 13:15	ds	5.46	R	1.57	PY	f	--	--	--	--	Heavy rain; 2.5"
10/17/2016 14:30	pk	5.28	F	1.02	PY	g	7.6	342	510	Qss	Weather clearing; 3-day AR event ~6" of precip (rain); water mostly clear
10/28/2016 11:30	bt	5.535	R	2.37	PY	g/f	7.8	203	302	--	Water slightly milky in color
10/31/2016 12:00	bt	5.35	U	1.45	MM	e/g	5.6	185	294	--	Post storm, 1" of snow on ground, icy, water milky
11/29/2016 10:43	bt	5.00	S	0.37	MM	g	0.6	190	356	0.82 NTU	Iced over but able to break through at staff plate; Turb measured at beginning of pool where gage is in shallow area (no ice); cleared ice for flow d/s; water clear; some grasses on right edge of channel
12/10/2016 9:15	bkh	6.90	R	39.4	AA	f	--	--	--	Qss (2), 108.5 NTU	Major AR event; rain-on-snow/ rain on bare ground. Stage difficult to read (+/- 0.1 ft); water very turbid
12/10/2016 13:15	bkh, ds	6.95	R	46.4	AA	f/g	2.4	91	161	Qss (1), 69.5 NTU	Steady rain, WSE is 0.5' below top of bank;
12/16/2016 12:15	pk	6.24	F	20.1	MM	e	--	--	--	Qss (2)	Qss collected at 11:25; 2" of rainfall overnight, mostly rain on bare ground, rain on snow up high
12/20/2016 14:12	bt	5.50	S	--	--	--	3.0	126	217	--	Downloaded turbidity probe and stream gage; water turbid at gage and could not see bottom; water milky where channel is shallow
1/16/2017 14:00	bkh, bt	5.58	S	5.59	MM	e	2.3	99	175	--	Post storm (1/8/17), major AR rain-on-snow event, followed by 2-3 feet of snow. No ice. Banks show erosion, abundant fine and coarse sediment in channel; likely stage shift; banks 2 feet+ of snow, many trees fallen or leaning into channel from heavy snow; downloaded gage and turbidity probe (removed probe for repair).
1/28/2017 15:00	bkh	5.35	U	--	--	--	--	--	--	--	Visited gage to re-install turbidity probe. Probe was installed without PVC protector to avoid sedimentation. Unit secured to stilling well using 2 hose clamps; water mostly clear, NTU < 10 (visual); flow elevated for this time of year; 3-4 ft of snow on banks
2/7/2017 14:15	bt, pk	7.17	R	54.8	MM	f/g	0.2	112	212	Qss, NTU	Water over bank and flowing behind the gage; highest measured flow at site; water turbid and brown; left side high flow channel est 0.25-0.5 cfs; stage may be slightly affected by willow branches leaning in water; rain has been steady for 18 hrs and just tapering off; NTU 29.9
3/3/2017 13:15	bkh, bt	5.63	S	6.71	MM	e	3.1	143	246	--	Dry period; freezing nights, 40 deg days; water mostly clear, lots of road runoff entering channel (snowmelt); channel bank erosion prominent and gaging pool grade-control has moved; likely new rating curve needed or large stage shift. NTU probe is having issues downloading or saving data; abundant road sand in channel
3/29/2017 11:45	bt	6.01	S	15.06	MM	e	5.5	82	131	7.9 NTU	Sunny, 58 degrees; water slightly turbid; flow slightly overbank downstream of gage
4/25/2017 11:15	bt	6.61	S	22.18	MM	f	5.4	66	105	8.1 NTU	Overcast, cool, water turbid; flow still flowing overbank slightly; stage fluctuating by as much as 0.06' turbulence
5/2/2017 13:17	bt	6.30	R	--	--	--	--	--	--	Qss, 17.1 NTU	Sample collected and Turb measured from sample bottle.
5/18/2017 13:30	bt	6.01	R	--	--	--	9.1	56	80	7.8 NTU	Downloaded turbidity files; changed batteries; water milky; unable to see bottom of pool at gage
5/26/2017 15:15	bt	6.10	R	15.72	--	--	9.8	50	70	Qss, 10 NTU	Partly cloudy; post-peak snowmelt runoff, but still high. Water turbid; collected sample
6/2/2017 13:00	bkh	5.95	U	--	--	--	11.1	54	73	Qss, 10.4 NTU	Sunny, warm; >50% of snowpack melted in watershed; water turbid, elevated flow; gage intact, but sediment filling stilling well; likely PT calibration shift upon return after download; Collected sample
6/21/2017 9:21	bt	5.55	U	--	--	--	11.0	80	109	Qss, 6.6 NTU	Stream flow still elevated-much higher than baseflow; lots of grasses and veg;
7/18/2017 10:00	bt	5.27	S	0.59	MM	e	11.0	124	169	--	Water clear; sunny, warm period; still elevated flow relative to years past
8/18/2017 9:30	bt	5.15	B	--	--	--	12.1	151	200	3.2	Installed new PVC for Manta probe; downloaded and checked data from SC logger
9/18/2017 13:30	bt, jj	5.12	B	0.28	MM	g	10.1	146	205	--	Water clear; baseflow-low flow late season; lots of grass in channel at measurement site; grass still green; leaves green on willows
10/5/2017 16:07	bt	5.20	B	--	--	--	6.6	127	196	1.9	Downloaded Manta probe; water clear; leaves falling off willows; very low velocity in channel; logger S/N 2046793 in slate mode, restarted at 16:30

Observer Key: (ds) is David Shaw, (bkh) is Brian Hastings, (bt) is Ben Trustman, (pk) is Peter Kulchawik, (jj) is Jack Jacquet

Stage: Water level observed at outside staff plate (arbitrary datum)

Instruments used to measure velocity: AA: Standard meter; PY: Pygmy meter; MM: Marsh McBurney

Hydrograph: Describes stream stage as rising (R), falling (F), steady (S), baseflow (B) or uncertain (U)

Specific conductance: Measured in micromhos/cm in field; then adjusted to 25degC by equation (1.8813774452 - [0.050433063928 \* field temp] + [0.00058561144042 \* field temp^2]) \* Field specific conductance

Additional Sampling: Qss = Suspended sediment concentration

**Appendix A6. Station Observer Log:  
Middle Martis Creek upstream of the Project, Water Year 2018**

Site Conditions		Discharge			Water Quality Observations							Remarks
Date/Time (observer time)	Observer	Stage	Hydrograph	Measured Discharge	Instrument Used	Estimated Accuracy	Water Temperature	Field Specific Conductance	Adjusted Specific Conductance	Water Quality Collected?	NTU	
		(feet)	(R/F/S/B)	(cfs)	(AA/PY/MM)	(e/g/f/p)	(oC)	(µmhos/cm)	(at 25 oC)	Qss?		
10/5/2017 16:07	bt	5.20	B	--	--	--	6.6	127	196	--	1.9	Downloaded turbidity probe; water clear; leaves falling from willows; very low velocity in channel; logger S/N 2046793 in slate mode, restarted at 16:30
12/1/2017 14:19	bt	5.37	B	--	--	--	3.6	123	208	--	2.6	Downloaded turbidity probe and changed batteries; all leaves off willows; stream slightly milky
12/13/2017 11:30	bkh	5.47	Ice	0.8	MM	f/p	0.7	111	206	--	1.5	Sunny, cool; last several weeks overnight temps in single digits or teens; gaging pool frozen with underflow; loggers frozen in well; broke ice 75 ft downstream to measure flow;
1/8/2018 9:30	bt	5.41	S	--	--	--	--	--	--	--	--	Slight rain; water is milky; downloaded turbidity probe and changed batteries
1/8/2018 13:00	bkh, tg	5.44	S	1.61	MM	g	2.7	130	228	Yes	--	Warm winter storm, only upper reaches of watershed snow covered; currently raining with rain/snow levels above 8,000 ft; 1.0" of rain 2 days prior; additional 0.5"-1.0" expected over next 36 hours; water milky, evidence of recent stormwater runoff from road. (did not visit downstream gage)
1/17/2018 13:15	bkh	5.325	S	--	--	--	--	--	--	--	--	Continued high winter baseflow; cloudy warm period, rain and snow expect this week; downloads
2/2/2018 11:05	bt	5.33	B	0.93	MM	g	1.8	149	267	--	0.9	Water clear; evidence of overbank flow since last measurement; unable to identify HWM; some snow on the ground 1-2 inches
3/9/2018 10:14	bt	5.38	B	--	--	--	0.9	218	404	--	--	Water clear; 1-2 feet of snow around stream banks; downloaded turbidity probe and changed batteries
3/13/2018 13:45	bt	5.79	R	6.62	MM	f	1.0	180	333	Yes	64	Raining for last couple of hours; rain increased while measuring flow; water is brown and turbid; water starting to go overbank; snow around stream patchy with 1-6 inches in spots
3/21/2018 14:32	bt, jj	6.18	R	16.9	MM	g/f	0.2	179	341	Yes	65	Rain on snow; light to moderate rain for last 18 hrs; snow depth around gage is 1-2 ft; water is turbid; no debris; sample collected at 14:55
3/22/2018 13:45	bt, bkh	6.80	R	47.3	MM	g	0.2	95	179	Yes	63	Rain-on-snow event; stream overbank; water very turbid; rain for last 36 hours; dug through snow to measure bank to bank flow; sample collected at 13:32
3/30/2018 14:30	bkh	5.81	R	8.36	MM	g	--	--	--	No	--	Sunny, warm, snowmelt runoff; slightly turbid; download; abundant road sand in channel and on floodplain.
4/6/2018 14:25	bkh	6.28	R	--	--	--	4.8	113	186	Yes	--	Light to moderate rain; 0.20" in last 12 hours; more expected over next 24 hrs; rain-on-snow, lower watershed is melted out; road runoff discharging to creek; water turbid.
4/7/2018 8:10	tg	6.81	R	--	--	--	--	--	--	Yes	--	Rain on snow event; possible annual peak flow; completed float tests; sample collected at 07:50
4/12/2018 10:30	bt	5.90	U	8.55	MM	f	3.4	149.0	253.8	no	14.2	Water is cloudy; some grasses on right edge of water; secondary channel on left bank is flowing ≈0.015 cfs; downloaded turbidity probe and changed batteries; also created new file MM041218
5/25/2018 8:32	bt	5.80	U	--	--	--	8.2	139	205	Yes	49	Intermittent rain for last week and persistent rain since early am hours-just subsided; water is turbid and brown; cannot see bottom of creek; downloaded turbidity probe and changed batteries; Qss sample collected at 8:42
6/1/2018 13:00	bkh	5.345	R	1.23	PY	g	8.9	151	213	No	2.8	Water clear; sunny, warm; snow completely melted in watershed; abundant sand/silts covering bed
7/2/2018 10:58	bt	5.14	B	--	--	--	12.5	192	250	no	0.9	Water clear; lots of grasses in channel downstream of gage; downloaded turbidity probe and changed batteries
7/13/2018 10:05	bt	5.10	B	0.11	MMB	g	14.5	200	251	no	--	Abundant grasses downstream of flow measurement; water clear; 4.5 inch fish in channel.
8/9/2018 11:45	bkh	5.08	No Flow	--	--	--	--	--	--	--	--	No flow downstream of gage; pooled at gage
9/19/2018 9:48	bt, jj	5.13	B	--	--	--	5.2	171	275	no	0.6	Flow very low; no velocity in open channel; grasses are abundant in the channel; some velocity in downstream grasses estimated 0.13 cfs
10/8/2018 12:38	bt	5.17	B	--	--	--	6.6	213	329	no	--	Low flow; estimated flow ≈0.13 cfs; water clear; leaves on willows falling; second logger in slate mode memory used/free 35314/4686; relaunched logger 10/8/18 13:15

Observer Key: (ds) is David Shaw, (bkh) is Brian Hastings, (bt) is Ben Trustman, (pk) is Peter Kulchawik, (jj) is Jack Jacquet, (tg) is Teresa Garrison

Stage: Water level observed at outside staff plate (arbitrary datum)

Instruments used to measure velocity: AA: Standard meter, PY: Pygmy meter, MM: Marsh McBurney

Hydrograph: Describes stream stage as rising (R), falling (F), steady (S), baseflow (B) or uncertain (U)

Specific conductance: Measured in micromhos/cm in field; then adjusted to 25degC by equation  $(1.8813774452 - [0.050433063928 * \text{field temp}] + [0.00058561144042 * \text{field temp}^2]) * \text{Field specific conductance}$

Additional Sampling: Qss = Suspended sediment concentration

**Appendix A7. Station Observer Log:  
Middle Martis Creek upstream of the Project, Water Year 2019**

Site Conditions				Discharge			Water Quality Observations					Remarks
Date/Time (observer time)	Observer	Stage	Hydrograph	Measured Discharge	Instrument Used	Estimated Accuracy	Water Temperature	Field Specific Conductance	Adjusted Specific Conductance	Water Quality Collected?	NTU	
		(feet)	(R/F/S/B)	(cfs)	(AA/PY/MM)	(e/g/f/p)	(oC)	(µmhos/cm)	(at 25 oC)	Qss?	NTU	
10/8/2018 12:38	bt	5.17	B	--	--	--	6.6	213	329	no	--	Low flow; estimated flow ≈0.13 cfs; water clear; leaves on willows falling; second logger in slate mode memory used/free 35314/4686; relaunched logger 10/8/18 13:15
11/3/2018 0:00	bt	--	--	--	--	--	--	--	--	--	--	Reinstalled NTU probe (logger out for repair since July)
11/23/2018 14:45	bkh	5.64	R	1.05	MM	f	2.2	613	1086	yes	--	Rain, 38 deg F, possible ice-affected flows, water dark and turbid, rain mixing with snow. Collected a sample at 15:03
12/21/2018 9:20	bt	5.43	S	0.38	MM	g	2.3	279	493	no	2.2	Light to moderate overnight rain; streamflow is not visibly elevated; water clear; no turbidity; laminar flow with low velocity; 3-5 inches of snow on banks; no flow in three culverts downstream; all water into diversion
1/10/2019 12:45	bkh	ice affected	S	0.55	PY	p	--	--	--	--	--	Gaging pool frozen; removed snow from channel to measure flow; sunny,
1/17/2019 9:15	ds	6.04	U	4.46	AA	f	--	--	--	yes	--	Storm, heavy wet snow, heavy rain previous evening, lots of snow and ice in channel; ice affected flow, water slightly turbid. Collected sample at 9:50
1/29/2019 13:30	bkh	5.46	S	1.06	MM	g	2.8	241	417	no	--	Cloudy, warm, elevated stage, channel mostly melted out with 12-18" of snow on banks; abundant road sand in channel, rain expected 2/2/19. downloaded.
2/1/2019 9:10	bt	5.52	--	--	--	--	2.3	242	428	no	--	Download NTU unit and replace batteries; water clear; 2+ feet of snow on banks,
2/2/2019 11:25	pk/ds	6.16	F	9.32	AA	f		173	332	yes	--	Heavy rain overnight; currently snowing, 30 deg F; water turbid. Collected sample at 11:25
3/4/2019 13:45	bkh	5.74	S	4.17	MM	g	--	--	--	--	--	Partly sunny, 40 deg F; no ice or flow in channel, 3-5 ft of snow on banks
4/2/2019 13:35	bt	6.29	R	--	--	--	2.9	155	269	yes	20.5	Sample collected at 13:45; downloaded Manta probe and changed batteries (did not connect easily); raining in pulses, steady at times for last 18hrs; water level high and increased flow; water is moderately turbid; most snow is melted near gage and around stream at gaging site; floodplain is melted out; flow steady through culvert downstream and flowing onto fan
4/9/2019 10:45	bkh	6.6	F	24.7	AA	f	--	--	--	yes	15.0	1 inch of rain overnight; rain on snow; melted most of the snow along banks; slightly turbid; road runoff entering downstream of gage
4/19/2019 14:54	pk,jj	6.4	R	23.9	MM	e	8.2	75	111	no	12.5	Significant snowmelt occurring; water turbid; unable to see channel bottom at depth greater than 2 feet; snow cover gone from overbank areas; snow patches in the trees; side channel just upstream of the gage is active with est. 20 gpm
5/16/2019 8:40	bt	6.35	F	20.3	MM	g/f	4.6	52	85	yes	15.9	Rained overnight turning to snow in the am; gages in Squaw and Ward peaked and are falling; water is brown and channel is wide; downloaded Manta Turbidity probe and replaced batteries; Qss sample collected at 8:43
5/29/2019 10:13	bt	5.98	S	--	--	--	6.4	62	96	no	6.7	Downloaded data logger SN 2046793; datalogger SN 1068702 would not connect and is dead; all trees and willows have leaves and grasses are greening up
7/23/2019 11:15	bkh	5.32	B	0.47	MM	f	15.5	146	188	no	0.86	Last rain 40+ days; abundant/verdant veg along banks; water clear; some algae; download
8/20/2019 11:17	bt	5.28	B	0.26	MM	g/f	13.3	179	231	no	--	Baseflow; lots of grasses in channel; water clear; large rock on bank by gage has fallen into water from erosion underneath; Manta probe experiencing malfunctions--dropped off at CDM after troubleshooting
9/27/2019 9:18	bt	5.28	B	0.37	MM	g/f	9.2	177.0	253.0	no	--	Re-installed Manta Probe at 9:18; leaves are falling off of trees; lots of grasses in channel; baseflow; no flow in downstream culvert

Observer Key: (ds) is David Shaw, (bkh) is Brian Hastings, (bt) is Ben Trustman, (pk) is Peter Kulchawik, (jj) is Jack Jacquet

Stage: Water level observed at outside staff plate (arbitrary datum)

Instruments used to measure velocity: AA: Standard meter; PY: Pygmy meter; MM: Marsh McBurney

Hydrograph: Describes stream stage as rising (R), falling (F), steady (S), baseflow (B) or uncertain (U)

Specific conductance: Measured in micromhos/cm in field; then adjusted to 25degC by equation  $(1.8813774452 - [0.050433063928 * \text{field temp}] + [0.00058561144042 * \text{field temp}^2]) * \text{Field specific conductance}$

Additional Sampling: Qss = Suspended sediment concentration

**Appendix B1. Station Observer Log:  
Middle Martis Creek downstream (main channel), water year 2018**

Site Conditions		Streamflow			Water Quality Observations			Remarks		
Date/Time (observer time)	Observer	Stage	Hydrograph	Measured Discharge	Instrument Used	Estimated Accuracy	Water Temperature	Field Specific Conductance	Adjusted Specific Conductance	
		(feet)	(R/F/S/B)	(cfs)	(AA/PY/MM)	(e/g/f/p)	(oC)	(µmhos/cm)	(at 25 oC)	
10/5/2017 14:58	bt	7.61	B	--	--	--	6.4	128	199	Flow increased since last visit; all aspen trees have changed color; grasses still green around channel; S/N 2060041 in slate mode-restarted at 15:30
12/13/2017 11:45	bkh	ice-affected	B	0.50	MM	g	--	--	--	Sunny, cool, gaging pool is frozen with ice mounding at staff plate (see photo); underflow. Broke ice to measure flow roughly 30 ft upstream of gage; 100% of streamflow is flowing down main channel.
1/17/2018 14:00	bkh	7.64	B	0.76	MM	g	--	--	--	Download; water clear, high baseflow, last rain 1/6/18? Channel is dynamic at gage and existing d/s pool control is soft; stage shift possible; road sands accumulated in reach. Roughly 10% of flow is flowing down restored channel.
2/2/2018 12:02	bt	7.62	B	0.73	MM	f	2.5	150	265	Lots of sediment in gage pool; water clear; some snow on the ground; orifice 3/4 full across street
3/22/2018 14:15	bkh, bt	8.05	S	4.36	MM	e	0.2	89	168	Rain for last 36 hours; turbid flow; secondary channel active with road stormwater runoff upstream of gage.
3/30/2018 15:15	bkh	7.89	R	2.45	MM	g	--	--	--	Sunny, warm, patchy snow cover on ground, but snowmelt signal noted over last few days; coarse sand in channel, sediment is at 7.25 feet on staff plate; no woody obstructions in gage reach
6/1/2018 13:00	bkh	7.59	S	0.92	PY	g	8.9	151	213	Sunny warm, minor flow down restored channel; most baseflow in former channel; abundant sediment deposition at gage; likely stage shift in March and April
10/8/2018 13:34	bt	7.42	B	--	--	--	8.2	217	320	Very low flow; estimated =0.12 cfs; SCT logger stuck in sediment and might need adjustment upon next download; SCT logger was in slate mode with memory full at 9/13/18 07:30; relaunched in continuous mode 10/8/18 14:00; second levelogger also in slate mode; memory used/free 35322/4678; relaunched logger to reset memory 10/8/18 14:00

Observer Key: (bkh) is Brian Hastings, (bt) is Ben Trustman

Stage: Water level observed at outside staff plate (arbitrary datum)

Instruments used to measure velocity: AA: Standard meter; PY: Pygmy meter; MM: Marsh McBurney

Hydrograph: Describes stream stage as rising (R), falling (F), steady (S), baseflow (B) or uncertain (U)

Specific conductance: Measured in micromhos/cm in field; then adjusted to 25degC by equation  $(1.8813774452 - [0.050433063928 * \text{field temp}] + [0.00058561144042 * \text{field temp}^2]) * \text{Field specific conductance}$

Additional Sampling: Qss = Suspended sediment concentration

**Appendix B2. Station Observer Log:  
Middle Martis Creek downstream (main channel), water year 2019**

Site Conditions		Streamflow			Water Quality Observations			Remarks		
Date/Time (observer time)	Observer	Stage (feet)	Hydrograph (R/F/S/B)	Measured Discharge (cfs)	Instrument Used (AA/PY/MM)	Estimated Accuracy (e/g/f/p)	Water Temperature (oC)	Field Specific Conductance (µmhos/cm)	Adjusted Specific Conductance (at 25 oC)	Remarks
10/8/2018 13:34	bt	7.42	B	--	--	--	8.2	217	320	Very low flow; estimated ≈0.12 cfs; SCT logger stuck in sediment and might need adjustment upon next download; SCT logger was in slate mode with memory full at 9/13/18 07:30; relaunched in continuous mode 10/8/18 14:00; second levellogger also in slate mode; memory used/free 35322/4678; relaunched logger to reset memory 10/8/18 14:00
12/24/2018 12:10	bkh, pk	7.55	R	0.41	MM	g	--	--	--	Storm, rain started mid-morning, turned to snow quickly; water clear, no sample collected; 6" of snow on banks; snow mixing with rain.
1/17/2019 8:35	ds	8.50	R	2.2	AA	g				Heavy rain previous night; now snowing, channel mostly clean of snow nad ice; ice affected flow
1/29/2019 14:30	bkh	7.64	S	0.73	MM	e	2.7	223	417	Cloudy, warm, channel mostly clear of snow and ice; snow along banks, no ice affecting flow. Downloaded.
2/2/2019 12:00	ds/pk	7.94	S/R	3.33	AA	g	--	171	331	Heavy rain previous night; now snowing, snow in channel at culverts may be directing flow towards restored channel; water turbid;
3/4/2019 14:30	bkh	7.80	S	1.91	MM	g	--	--	--	Cloudy, channel free of ice and snow; 2-3 ft of snow on banks; flow split, about equal amount down restored channel
4/18/2019 15:00	bkh	7.89	R	3.48	py	g	--	--	--	Warmer temps; lots of snowmelt runoff; Middle martis might peak in a couple weeks
5/29/2019 10:48	bt, jj	7.81	S	2.69	MM	g	6.8	64	98	Inlet to culvert completely under water; 6 inches of metal cage exposed; no additional run off flowing into creek from HWY 267; water clear; gaging pool has lots of sediment on stream bed; data loggers had some resistance when removing; removed the stilling well to clean out sediment at 11:34 gage height 7.81 and re-installed at 11:39 gage height 7.81; Turbidity 5.71 NTU
6/30/2019 16:30	bkh	--	--	--	--	--	--	--	--	Very little flow to the new channel; most baseflow in the old Middle Martis Creek
7/23/2019 12:00	bkh	7.43	B	0.30	MM	f	15.5	146	188	All flow is to the old channel; some ponded water in new channel; download
8/20/2019 12:17	bt	7.40	B	0.17	MM	g/f	15.1	184	227	Baseflow; bed at gage has lots of fine sediment; water clear
9/9/2019 9:45	bkh	7.40	B	--	--	--	--	--	--	Stage observation for downstream construction purposes. New channel (north of HWY267 is wet but not flow)
10/25/2019 9:10	bt	7.44	B	0.22	MM	g/f	2.2	116	204	Grasses dry; no flow in overflow culvert across the street

Observer Key: (bkh) is Brian Hastings, (bt) is Ben Trustman, (ds) is David Shaw, (pk) is Peter Kulchawik, (jj) is Jack Jacquet

Stage: Water level observed at outside staff plate (arbitrary datum)

Instruments used to measure velocity: AA: Standard meter; PY: Pygmy meter; MM: Marsh McBurney

Hydrograph: Describes stream stage as rising (R), falling (F), steady (S), baseflow (B) or uncertain (U)

Specific conductance: Measured in micromhos/cm in field; then adjusted to 25degC by equation  $(1.8813774452 - [0.050433063928 * \text{field temp}] + [0.00058561144042 * \text{field temp}^2]) * \text{Field specific conductance}$

Additional Sampling: Qss = Suspended sediment concentration



**Appendix C. Groundwater monitoring observations, Middle Martis Creek alluvial fan  
Placer County, California, Water Years 2013-2019**

Site Conditions			Water Quality Observations					Remarks		
Date/Time	Observer	Top-of-casing to water (ft)	Depth to water (ft, bgs)	Water Surface Elevation (NGVD/NAVD)	Temperature (°C)	Specific Conductance (at field temp.) (µS/cm)	Specific Conductance (at 25 °C) (µS/cm)	Bailed?	Remarks	
<b>Piezometer 13-01</b> <b>Depth to bottom =</b> 5.10 ft btoc <b>Total Stickup =</b> 0.43 ft above gs <b>Elevation (TOC) =</b> 5885.55 ft								<b>Location: Northstar, south of HWY 267, adjacent to Middle Martis Creek</b> Installed on 4/17/13		
4/19/13 13:00	bkh	dry			--	--	--	n	20 feet north of Creek; est. flow 2 cfs, SC/T 224 uS at 25 deg C.	
4/25/2013 11:00	bkh, jo	4.34	3.91	5881.21	5.5	253	410	n	Sunny, very dry period, peak snowmelt occurred several weeks earlier	
5/17/2013 9:25	bkh	2.94	2.51	5882.61	7.2	291	451	n	Sunny, windy, meadow is verdant, willows leafing out, download, est flow in MM Creek, 1.5 cfs, SC/T = 255 @ 25 deg C, rain yesterday (0.2 inches?)	
6/26/2013 9:30	bkh	2.41	1.98	5883.14	9.0	435	642	n	Rain last two days; beaver dams are promoting pond along Middle Martis Ck adjacent to well, may influence local gw levels; Flow in creek is less than 1 cfs, SC/T = 277 @ 25 deg C; well stratified, surface SC/T = 440 @ 25 deg C.	
7/31/2013 9:00	bkh	3.42	2.99	5882.13	10.7	502	707	n	No active flow in M. Martis Creek adjacent to well; but ponded behind beaver dam; water stratified in well, 490 @ 25 deg C at surface	
10/1/2013 10:30	bkh	4.94	4.51	5880.61	9.7	514	744	n	M. Martis Creek adjacent is dry, water is at very bottom of well	
11/5/2013 11:10	bkh, pk	2.46	2.03	5883.09	5.7	395	637	n	Recent snow melt; flow re-emerged in Middle Martis Creek, beaver dam elevating water levels locally	
1/2/2014 12:15	bkh	2.25	1.82	5883.30	5.3	420	685	n	2-3 inches of snow around well; extremely cold nights; beaver dam impounding water, currently frozen.	
2/20/2014 11:00	bkh	2.06	1.63	5883.49	1.2	420	765	n	Bare ground, no snow; recent rains raised streamflows and likely elevated gw levels; water levels still affected by beaver dam	
4/9/2014 11:30	bkh	2.04	1.61	5883.51	2.9	415	722	n	Sunny, warm, no snow in meadow; anticipate peak snowmelt this week or next; beaver dam affecting water levels	
6/4/2014 11:00	bkh	2.73	2.30	5882.82	5.7	423	682	n	Very dry period; no snow remaining; beaver dam still in place; flows in MM creek are low	
8/13/2014 10:55	bkh	dry						n	MM Creek adjacent is dry; but flowing upstream of crossing; recent t-storms	
10/1/2014 12:40	bkh	dry						n	Mud in bottom of piezo; recent rains; but not enough to see surface flows extended downstream of SR267 crossing	
1/9/2015 11:38	bkh, kb	2.79	2.36	5882.76	5.8	474	762	n	Water could be elevated by beaver dam; no snow in meadow, cold dry period	
4/21/15 9:45	bkh	2.80	2.37	5882.75	6.9	306	478	n	Beaver dam actively returning water; evidence of crossbank/floodplain flow 2/8??; no snowmelt runoff; willows leafing out; reset logger because date was reading 2016	
7/2/15 9:06	bkh, bt	5.05	4.62	5880.50	--	--	--	n	Level logger dry; may be standing water; YSI not registering--GW probably below piezo; MM dry w/no ponding water at 3' deep; veg verdant but no indication of GW	
9/10/15 10:24	bt	5.05	4.62	5880.50	14.0	--	--	n	Very dry; grasses dry; well dry with little mud at bottom; logger dry	
10/7/15 10:12	bt	5.11	4.68	5880.44	12.6	--	--	n	logger moist with condensation but dry	
3/25/16 12:04	bt	1.74	1.31	5883.81	5.9	160	257	n	Multiple channels flowing; all snow melted; not stratified	
6/10/16 9:40	bkh/bt	2.64	2.21	5882.91	11.3	205	284	n	Warm and windy; beaver dam still in place, not active, but still has affect on surface water elevations	
10/4/16 13:08	bt	5.05	4.62	5880.50	--	--	--	n	Level logger dry when removed; well is essentially dry with a layer of standing water at the bottom; not enough water for SC reading; grasses dry	
11/29/16 11:51	bt	2.59	2.16	5882.96	6.7	356	547	n	About 6 inches of snow on the ground, any more and the well will be covered; stratified at depth C371.7 @ 7.5 degC, SC 558 @ 25 degC	
4/25/17 12:21	bt	1.86	1.43	5883.69	8.5	157	230	n	Stream flowing; milky; overbank below well and running in multiple channels; well clear of snow; Stratified at depth Temp 6.4 deg C, C 227.2 @ 6.4 degC, 348.8 @ 25 degC; date/time displaying wrong on Solinst software	
8/8/17 9:45	bt	2.73	2.30	5882.82	14.8	267	333	n	No stratification; grasses green with some drying underneath; creek still flowing; lots of wildflowers; date on logger is not correct	
10/5/17 14:29	bt	2.73	2.30	5882.82	12.7	253	332	n	Ground dry; grasses dry; stream still flowing; date off on logger but data ok	
1/23/18 12:13	bt	2.13	1.70	5883.42	5.0	207	335	n	Channel full and flowing; soil wet with some small snow patches; restarted logger at 13:00 to fix time date problem	
4/30/18 10:33	bt	1.92	1.49	5883.63	7.9	212	317	n	Stream flowing ≈ 1-2cfs; stream slightly overbank in floodplain near well with some inundation	
10/8/18 13:07	bt	2.87	2.44	5882.68	12.6	372	486	n	No Stratification; grass and vegetation dry; no streamflow	
5/23/19 8:55	bt	1.88	1.45	5883.67	9.5	230	328	n	No Stratification; data logger would not connect; battery is dead; data logger string broke when removing the logger; replaced string and left logger cap attached	
7/12/19 8:46	bt	2.71	2.28	5882.84	11.8	226	302	n	Logger would not launch--resend back to Solinst	
10/29/19 10:40	bt	2.90	2.47	5882.65	9.6	218	309	n	No logger in the well; no stratification; logger needed new battery and we decided not to replace per TRWC	

Site Conditions			Water Quality Observations					Remarks	
Date/Time	Observer	Top-of-casing to water (ft)	Depth to water (ft, bgs)	Water Surface Elevation (NGVD/NAVD)	Temperature (°C)	Specific Conductance (at field temp.) (µS/cm)	Specific Conductance (at 25 °C)	Bailed?	
<b>Piezometer 13-02</b>								<b>Location: Northstar, south of HWY 267, adjacent to HWY</b>	
<b>Depth to bottom =</b>		10.20 ft btoc			Installed on 4/17/13				
<b>Total Stickup =</b>		1.33 ft above gs							
<b>Elevation (TOC)=</b>		5900.93							
4/19/13 14:15	bkh	6.78	5.45	5894.15	--	--	--	y	Measured DTW before bailing; bailed until dry; slow to fill; no measurements collected after
4/25/2013 11:45	bkh, jo	5.69	4.36	5895.24	3.6	740	1263	n	Stratified, surface water in well: 1,000 uS at 25 deg. C.
5/17/2013 9:40	bkh	5.75	4.42	5895.18	4.4	869	1452	n	Stratified at surface: 689 @ 4.8 deg C
6/26/2013 9:45	bkh	9.07	7.74	5891.86	6.4	816	1291	n	SC suggests waters are relatively older than wells adjacent to creek, gw levels dropped precipitously here probably due to the location on the apex of the fan
7/31/2013 9:10	bkh	--	--	--	--	--	--	n	GW level near bottom of well; LL is not registering SC/T likely due to the sensor located above any water in well; lower SC/T manual readings may be associated with mud at bottom of well
10/1/2013 10:41	bkh	--	--	--	--	--	--	n	Well is dry, stagnant water/mud in bottom of well cap,
11/5/2013 11:30	bkh, pk	--	--	--	--	--	--	n	This well has been dry since July, no snow in meadow or significant flow in creek to support increased water levels here
1/2/2014 12:45	bkh	--	--	--	--	--	--	n	Dry, no snow around wellhead; cold dry period
2/20/2014 11:15	bkh	6.99	5.66	5893.94	3.8	653	1109	n	Secondary channel 40 ft to the south is flowing (0.1 cfs, estimate), no snow on ground
4/9/2014 11:45	bkh	6.70	5.37	5894.23	3.2	460	794	n	Ground is very dry; adjacent channel is flowing at about 0.2 cfs;
6/4/2014 11:30	bkh	10.10	8.77	5890.83	5.3	503	820	n	Dry, some moisture on levellogger; depth of water could be water sitting at bottom of piezo
8/13/2014 11:15	bkh	dry	--	--	--	--	--	n	some water in bottom of piezo, but likely stagnant waters in well
10/1/2014 12:50	bkh	10.10	8.77	5890.83	7.6	268	411	n	Dry?, water likely in cap at bottom of piezo;
1/9/2015 12:15	bkh, kb	10.15	8.82	5890.78	--	--	--	n	Dry?, water likely in cap at bottom of piezo;
4/21/2015 10:00	bkh	10.17	8.84	5890.76	7.5	600	922	n	Adjacent swale dry but evidence of flow-Feb?; possible stagnant water in well; restart logger because date reading 2016
7/2/15 9:24	bkh, bt	10.15	8.82	5890.78	11.6	465	639	n	No sign of precip in last week; very little water in piezo; might be standing; horse tail still evident
9/10/15 10:05	bt	10.21	8.88	5890.72	13.3	--	--	n	logger damp from condensation but well dry with mud at bottom; grasses dry
10/7/15 10:25	bt	10.22	8.89	5890.71	12.3	--	--	n	logger dry; slightly green grass from precip 4 days prior; willows 85% bare
2/26/16 11:51	bt	5.67	4.34	5895.26	4.5	180	300	n	Multiple channels flowing; still 1-2 ft deep patches of snow in the area
3/25/16 12:20	bt	5.29	3.96	5895.64	4.5	188	313	n	secondary channel that is closer to well is flowing (sandbag diverted); stratified C 214.7 @ 4.0 degC SC 358.2
6/10/16 11:00	bkh/bt	8.54	7.21	5892.39	7.8	192	293	n	Dry and warm conditions; flows in creek are falling quickly
10/4/16 13:19	bt	10.20	8.87	5890.73	--	--	--	n	Dry with small layer of wetness at bottom; logger only wet on the tip; no SC; road was cut right next to well
11/29/16 12:06	bt	10.16	8.83	5890.77	--	--	--	n	Just tip of logger wet; not enough water to submerge the new SC meter
4/25/17 12:36	bt	8.12	6.79	5892.81	6.8	109	168	n	Ground mostly dry soil but wet if srape off top layer; Stratified at depth Temp 5.5 deg C, C 232.5@ 5.5 degC, SC 369.2 @25 DegC
8/8/17 10:15	bt	10.19	8.86	5890.74	--	--	--	n	Only tip of logger was wet with little mud; not enough water for SC measurement; date on logger was off with last reading as 12/18/2018; restarted the logger after download to see if date will fix
10/5/17 14:45	bt	10.16	8.83	5890.77	--	--	--	n	Only 1.5 inches of logger tip wet; not enough water in well for SC measurement; logger date and time fixed
1/23/18 12:29	bt	8.49	7.16	5892.44	6.6	384	591	n	Some snow on ground; soil wet
4/30/18 10:53	bt	8.18	6.85	5892.75	7.3	54	82	n	Stratified at depth T 5.8°C, C 298.7, SC 472; soil dry; no visible flow in channels near well
10/8/18 13:18	bt	10.15	8.82	5890.78	--	--	--	n	Well dry except for a little water at bottom; no SC measurement ; soil dry; vegetation dry
5/23/19 9:15	bt	--	--	--	--	--	--	n	String is broken; need to bring pole for logger recovery
5/29/19 11:49	bt	8.24	6.91	5892.69	9.1	180	258	n	Stratified at depth: T 7.7°C, C 262.2, SC 391.5; recovered data logger; replaced string; soil slightly damp; grasses greening up
10/29/19 10:46	bt	10.02	8.69	5890.91	--	--	--	n	Water in well not deep enough for SCT reading; downloaded logger and removed from well; dates on data were adjusted due to software--see notes for correction; soil and grasses are dry

Site Conditions			Water Quality Observations					Remarks	
Date/Time	Observer	Top-of-casing to water (ft)	Depth to water (ft, bgs)	Water Surface Elevation (NGVD/NAVD)	Temperature (°C)	Specific Conductance (at field temp.) (µS/cm)	Specific Conductance (at 25 °C)	Bailed?	
<b>Piezometer 13-03</b>								<b>Location: Airport, East of Waddle Ranch access road</b>	
<b>Depth to bottom =</b>		18.20 ft btoc			Installed 4/18/13				
<b>Total Stickup =</b>		1.75 ft above gs							
<b>Ground Elevation =</b>		5881.93							
4/19/13 14:35		2.45	0.70	5879.48	6.9	217	339	y	Removed 45 bailors full; water slow to rise, still rising upon measurement; adjacent drainage (next to RR grade) wet, SC/T: 380 uS at 25 C
4/25/2013 10:00	bkh, jo	1.23	-0.52	5880.70	4.4	300	501	n	Artesian, no stratification
5/17/2013 9:55	bkh	1.23	-0.52	5880.70	4.8	152	251	n	artesian, slightly stratified, at surface 218 @16.9 dg C
6/26/2013 10:00	bkh	3.77	2.02	5878.16	5.7	152	245	n	SC suggests fresher waters relative to the south side of HWY267 (piezo 13-02); meadow in this portion of the fan is still verdant
7/31/2013 9:20	bkh	6.38	4.63	5875.55	6.3	154	244	n	Meadow mostly brown with isolated green patches, no stratification in well, very fresh water when compared to gw south of HWY 267 (13-02)
10/1/2013 10:54	bkh	8.66	6.91	5873.27	6.6	176	277	n	No stratification in well, meadow very dry, some rain recently
11/5/2013 11:40	bkh, pk	6.98	5.23	5874.95	5.9	161	258	n	No stratification in well, no snow in meadow
1/2/2014 12:55	bkh	18.25	16.50	5863.68	--	--	--	n	Dry cold conditions; very little snow in meadow; dtw is suspect
2/20/2014 11:30	bkh	1.60	-0.15	5880.33	3.1	150	260	n	Ice buildup in well (above ground) may affect pressure; head falling once ice removed
4/9/2014 12:00	bkh	1.87	0.12	5880.06	3.5	144	247	n	Meadow is dry; swale along RR grade is wet but no flowing water;
6/4/2014 11:45	bkh	3.57	1.82	5878.36	3.5	146	250	n	meadow is verdant, no flow in meadow swales; no snow remaining in watershed
8/13/2014 11:15	bkh	10.31	8.56	5871.62	4.3	204	342	n	stratified at very bottom
10/1/2014 13:05	bkh	11.90	10.15	5870.03	4.9	175	288	n	
1/9/2015 12:35	bkh, kb	5.84	4.09	5876.09	8.0	165	250	n	dry period; no snow in meadow
4/21/2015 10:25	bkh	3.16	1.41	5878.77	6.6	154	239	n	restarted logger @ 11 date reading 2016?
7/2/2015 9:35	bkh, bt	6.12	4.37	5875.81	9.1	182	260	n	Field still very green
9/10/2015 10:42	bt	10.21	8.46	5871.72	10.3	194	276	n	field dry; grasses very dry
10/7/2015 10:39	bt	10.82	9.07	5871.11	10.2	188	269	n	grass dry and brown; soil slightly moist from precip 4 days prior
1/8/16 10:49	bt	2.57	0.82	5879.36	6.8	161	252	n	1.5-2' of snow in meadow
2/5/16 14:05	bt	1.20	-0.55	5880.73	5.6	156	252	n	8" of ice in well-was able to remove to access logger; 6+" of snow in meadow; lots of channels active and wet some fully exposed; Stratified SC at top - C 144.7@4.6C and SC 236.8@25
3/25/16 12:31	bt	0.89	-0.86	5881.04	5.4	83	134	n	meadow is saturated; channel flowing 10 ft east of well; small amount of ice at top of water; stratified C 144.0@5.6 degC SC 228.9
6/10/16 9:40	bkh/bt	2.97	1.22	5878.96	12.2	179	242	n	Meadow is still wet and very verdant
10/4/16 13:31	bt	10.76	9.01	5871.17	10.4	168	234	n	grasses are brown and very dry
11/29/16 15:22	bt	2.58	0.83	5879.35	6.8	158	242	n	About 4 inches of snow at well and meadow covered
4/25/17 12:50	bt	1.15	-0.60	5880.78	8.6	46	67	n	soil wet; channel flowing into meadow 40 ft to east; Stratified at depth Temp 6.4 degC, C 137.6 @6.4 degC, SC 213.3@ 25 degC
8/8/17 10:33	bt	5.21	3.46	5876.72	13.8	105	134	n	Stratification at depth- T 10.0°C C 144.6 SC 200.0; grasses very green and lush; date on logger is off
10/5/17 15:30	bt	5.67	3.92	5876.26	11.0	152	208	n	Date off on logger but data ok; restarted logger after download at 16:00; grasses dry; meadow dry
1/23/18 12:40	bt	--	--	--	--	--	--	n	Unable to measure depth to water due to ice in well; some patchy snow and soil id damp
4/30/18 11:22	bt	1.52	-0.23	5880.41	8.7	27	40	n	Stratified at depth T 6.27°C, C 139.4, SC 215.3; soils damp; some ponding in the meadow; grasses starting to grow
10/8/18 14:07	bt	8.57	6.82	5873.36	11.0	169	229	n	Grass dry; soil dry
5/23/19 9:26	bt	1.14	-0.61	5880.79	7.6	131	195	n	Stratified at depth : T 7.0°C, C 150.2, SC 228.7; ground wet from rain but not saturated; some small inundated spots in meadow
10/29/19 11:01	bt	5.76	4.01	5876.17	9.8	165	232	n	No stratification; downloaded and removed loggers; check dates on download-see notes; grasses and soil dry

Site Conditions			Water Quality Observations					Remarks	
Date/Time	Observer	Top-of-casing to water (ft)	Depth to water (ft, bgs)	Water Surface Elevation (NGVD/NAVD)	Temperature (°C)	Specific Conductance (at field temp.) (µS/cm)	Specific Conductance (at 25 °C)	Bailed?	
<b>Piezometer 13-04</b>								<b>Location: Airport, west of Waddle Ranch access road</b>	
<b>Depth to bottom</b>		13.20 ft btoc			Installed 4/18/13				
<b>Total stickup</b>		1.40 ft above gs							
<b>Elevation (TOC):</b>		5854.74 ft							
4/19/13 14:45	bkh	3.16	1.76	5851.58	6.4	584	924	y	Measurement before bailing; water slow to rise after bailing 11 bailors
4/25/2013 10:00	bkh, jo	3.77	2.37	5850.97	5.2	586	958	n	Ponded area across road is quickly drying; meadow wet
5/17/2013 10:10	bkh	3.98	2.58	5850.76	5.7	235	379	n	Meadow wet, but drainage is mostly dry on east side of road
6/26/2013 10:20	bkh	6.34	4.94	5848.40	6.9	238	372	n	Meadow west of the Waddle access road beginning to dessicate
7/31/2013 9:40	bkh	8.08	6.68	5846.66	7.8	310	472	n	Slightly stratified, 375@ 25 deg C at surface. Very dry around well, but some verdant patches of meadow east of Waddle Ranch access road
10/1/2013 11:07	bkh	10.88	9.48	5843.86	8.5	304	454	n	No measurable stratification in well
11/5/2013 12:00	bkh, pk	12.08	10.68	5842.66	8.0	320	485	n	Silty and muddy at bottom of well; no stratification
1/2/2014 13:30	bkh	5.94	4.54	5848.80	--	--	200	n	SC is reading mucy lower than historical conditions; recent snowmelt?
2/20/2014 11:50	bkh	3.55	2.15	5851.19	4.0	170	287	n	Levellogger sitting in mud at bottom of peizo; SC = 200 at 25 deg C at surface, meadow free of snow; soils moist; no standing water upstream of Waddle Ranch Road
4/9/2014 12:20	bkh	2.58	1.18	5852.16	4.3	248	415	n	Meadow is wet but no ponding or flow in swale
6/4/2014 11:55	bkh	5.72	4.32	5849.02	5.4	325	528	n	Meadow surface is dry
8/13/2014 11:20	bkh	11.14	9.74	5843.60	6.2	363	578	n	Mud on Levellogger; SC slightly lower in water above LL.
10/1/2014 13:20	bkh	12.96	11.56	5841.78	--	--	--	n	Muddy at bottom; uncertain if actual gw level measured, evaluate record over time
1/9/2015 13:00	bkh, kb	8.06	6.66	5846.68	8.7	142	211	n	Meadow dry;
4/21/2015 10:30	bkh	5.06	3.66	5849.68	8.1	253	382	n	rebooted logger @ 11am reading 2016?
7/2/15 10:15	bkh, bt	6.05	4.65	5848.69	11.6	253	348	n	Flowers still in field
9/10/15 10:58	bt	11.08	9.68	5843.66	11.3	338	469	n	field very dry; mud on tip of logger
10/7/15 11:04	bt	12.30	10.90	5842.44	12.6	365	489	n	logger wet with muddy tip; grass very dry
1/8/16 11:14	bt	4.22	2.82	5850.52	7.1	210	326	n	LL frozen in and would not dislodge with moderate force-did not force too hard because did not want to break string
2/5/16 15:14	bt	2.26	0.86	5852.48	4.9	211	348	n	Stratified with top at C 141 @4.0C and SC 234@25
3/25/16 12:46	bt	1.86	0.46	5852.88	6.1	183	292	n	meadow saturated with some ponding; stratified C 201.6 @ 6.1 SC 315.6
6/10/16 10:00	bkh/bt	5.51	4.11	5849.23	11.5	230	317	n	No ponding upstream of road; meadow is still wet but flows have decreased significantly
10/4/16 13:45	bt	11.16	9.76	5843.58	12.2	256	333	n	Grasses dry and brown
11/29/16 15:04	bt	4.35	2.95	5850.39	9.1	240	345	n	3 inches of snow at well meadow covered
4/25/17 13:06	bt	1.95	0.55	5852.79	8.0	20	27	n	Soil wet and soft; some inundation in meadow between 13-03 and 13-04; very squishy; Stratified at depth Temp 7.1 degC, C 173.7 @7.1 degC, SC 262.9 @25 degC; no sound from sounder possibly due to low SC at top of water column was able to identify depth to water with sounder tape visually
8/8/17 10:49	bt	6.06	4.66	5848.68	14.8	86	107	n	Stratification at depth- T11.9°C C 202.7 SC 270.4; logger would not connect to computer; tried several different ways to solve problem to no avail; all other downloads have worked earlier in day;will bring extra logger next visit to exchange
8/18/17 11:26	bt	6.45	5.05	5848.29	15.3	69	85	n	logger not connecting; installed new logger SN2060039 until SC logger is fixed; logger set to start 8_18_17 12:00 measuring hourly
10/5/17 15:48	bt	9.10	7.70	5845.64	13.4	74	95	n	grasses dry; soil dry and meadow dry; drop in SC looking at previous years
12/13/17 12:15	bkh	3.56	2.16	5851.18	8.4	177	260	n	Downloaded temporary logger and replaced with SC logger with new battery
1/23/18 12:48	bt	1.94	0.54	5852.80	5.9	227	357	n	Soil damp; some ponding next to the Arizona crossing to the east
4/30/18 11:37	bt	2.76	1.36	5851.98	9.1	120	173	n	Stratified at depth T 7.3°C, C 218.0, SC 330.3; soil slightly damp; some ponding and low flow at the Arizona crossing ; grasses more abundant in this part of meadow
10/8/18 14:20	bt	10.74	9.34	5844.00	12.5	272	357	n	Grass dry; soil dry; restarted logger at 15:00 to put it in continuous mode
5/23/19 9:39	bt	1.94	0.54	5852.80	9.8	167	235	n	Stratified at depth: T 9.9°C, C 215.3, SC 303.5; ground wet from rain; no standing water or inundation; water flowing over Arizona crossing ; logger had mud on bottom 2 inches and caked in SC slot; rinsed in well water to get mud out
10/29/19 11:15	bt	10.36	8.96	5844.38	11.4	215	291	n	Soil and grasses are dry; downloaded and removed the logger

Site Conditions			Water Quality Observations					Remarks	
Date/Time	Observer	Top-of-casing to water (ft)	Depth to water (ft, bgs)	Water Surface Elevation (NGVD/NAVD)	Temperature (°C)	Specific Conductance (at field temp.) (µS/cm)	Specific Conductance (at 25 °C)	Bailed?	
<b>Piezometer 13-05</b>								<b>Location: ACOE, south of HWY 267, near boardwalk</b>	
<b>Depth to bottom</b>		6.00 ft btoc			Installed 4/18/13				
<b>Total stick up</b>		0.68 ft above gs							
<b>Elevation (TOC)</b>		5838.39							
4/19/13 15:30	bkh	4.95	4.27	5833.44	2.6	203	356	y	Measurement before bailing; water slow to rise, surface water in adjacent swale--perched gw?
4/25/2013 12:30	bkh, jo	3.29	2.61	5835.10	1.7	196	352	n	Meadow is wet with runoff in swales (10 gpm)
5/17/2013 10:30	bkh	1.95	1.27	5836.44	3.0	216	375	n	Generally dry around piezo, but meadow is mostly wet
6/26/2013 10:30	bkh	3.18	2.50	5835.21	5.2	258	422	n	Meadow is verdant, grasses growing taller, slight stratification in well (SC/T at surface, 365 @ 25 deg C)
7/31/2013 10:00	bkh	5.86	5.18	5832.53	7.0	285	444	n	Middle Martis Creek in meadow is dry, willow mortality along creek, meadow is mostly dry,
10/1/2013 11:20	bkh	5.93	5.25	5832.46	6.3	129	205	n	Likely well is dry and some stagnant water/mud in well cap
11/5/2013 13:15	bkh, pk	--	--	--	--	--	--	n	Meadow dry, flow in Middle Martis Creek
1/2/2014 13:40	bkh	--	--	--	--	--	--	n	Dry conditions
2/20/2014 12:08	bkh	1.70	1.02	5836.69	-0.30	170	322	n	meadow free of snow; soils moist to wet; flow in meadow swales; flow in Middle Martis Creek
4/9/2014 12:40	bkh	1.45	0.77	5836.94	0.10	148	278	n	Meadow is dry; some water in adjacent swales
6/4/2014 12:15	bkh	2.56	1.88	5835.83	2.00	209	373	n	Meadow dry; no surface flow in adjacent swales; MM creek is a trickle at Franks Bridge
8/13/2014 11:30	bkh	dry							Meadow still green but browning; recent rains
10/1/2014 13:35	bkh	dry							Meadow dry and brown
1/9/2015 14:15	bkh, kb	3.15	2.47	5835.24	4.50	245	408	n	Meadow dry and cold;
4/21/2015 10:53	bkh	2.10	1.42	5836.29	4.50	255	425	n	Likely to see SCT increase over time due to no new GW pushing old?; reset logger 2016 reading
7/2/15 10:29	bkh,bt	4.30	3.62	5834.09	8.2	263	396	n	Meadow is dry but still verdant;MM is super dry estimated 0.01 cfs @gage upstream
9/10/15 11:18	bt	5.94	5.26	5832.45	10.9	147	206	n	logger dry;grass slightly greener than other side of the highway but still pretty dry
10/7/15 12:10	bt	5.93	5.25	5832.46	11.3	128	177	n	logger had condensation but dry; sc meter had 2" of wetness with mud on end; dry with closeby willows 60% bare
2/5/16 12:09	bt	1.10	0.42	5837.29	0.7	162	--	n	4-6" of snow in meadow around well; all channels wet and exposed; Stratified SC at top C122@1.7 SC too cold for reading
3/25/16 13:02	bt	0.80	0.12	5837.59	7.2	167	258	n	meadow saturated with ponding at well; channel flowing 30 ft due east; slightly stratified C157.4 @ 5.1 deg C SC 253.6
6/10/16 11:45	bkh/bt	1.98	1.30	5836.41	13.3	194	255	n	Still flow south of HWY 267; estimated to be 10-15 gpm; meadow wet and verdant
10/4/16 14:02	bt	5.90	5.22	5832.49	11.5	119	160	n	All grass in meadow dry and brown
11/29/16 14:26	bt	1.78	1.10	5836.61	5.2	178	286	n	Meadow covered with 4-6+ inches of snow; no inundation
4/25/17 13:26	bt	0.85	0.17	5837.54	8.9	95	137	n	Meadow inundated with 1" of water; soggy but not squishy; stratified at depth Temp 7.7 degC, C 113.3 @7.7 degC, SC 168.3 @25 degC
8/8/17 11:17	bt	1.96	1.28	5836.43	15.3	59	72	n	Stratification at depth- T11.3°C C 121.7 SC 163.8; meadow very green; soil is moist and squishy in some places; date on logger is off
10/5/17 13:22	bt	1.92	1.24	5836.47	12.0	129	172	n	Date and time off on logger but data ok; grasses drying around well
1/23/18 13:05	bt	1.61	0.93	5836.78	4.3	124	206	n	No snow; soil damp; time and date off on logger; restarted logger to fix date and time at 14:00
4/30/18 12:58	bt	1.27	0.59	5837.12	6.1	143	224	n	Soil damp; grasses just beginning to grow
10/8/18 14:38	bt	--	--	--	--	--	--	n	Logger dry
5/23/19 10:07	bt	0.77	0.09	5837.62	7.3	88	133	n	Water just below ground surface; no stratification; ground wet from rain but no saturation or inundation ; logger unable to connect needs battery
7/12/19 9:06	bt	1.59	0.91	5836.80	12.0	92	122	n	Replaced logger in well
10/29/19 11:35	bt	2.02	1.34	5836.37	8.4	139	204	n	Grasses are dry; downloaded and removed logger

Site Conditions			Water Quality Observations					Remarks	
Date/Time	Observer	Top-of-casing to water (ft)	Depth to water (ft, bgs)	Water Surface Elevation (NGVD/NAVD)	Temperature (°C)	Specific Conductance (at field temp.) (µS/cm)	Specific Conductance (at 25 °C)	Bailed?	
<b>Piezometer 13-06</b>								<b>Location: ACOE, south of HWY 267, west of 13-05</b>	
<b>Depth to bottom</b>		6.88 ft btoc			Installed 4/18/13				
<b>Total stick up</b>		0.95 ft above gs							
<b>Elevation (TOC)</b>		5831.33 ft							
4/19/13 15:52	bkh	6.02	5.07	5825.31	--	--	--	y	Measurement before bailing; water slow to rise, surface water in adjacent swale--perched gw?
4/25/2013 13:30	bkh, jo	5.12	4.17	5826.21	1.5	218	394	n	Meadow is wet, water is ponded in adjacent swales
5/17/2013 10:45	bkh	2.96	2.01	5828.37	2.0	248	442	n	Meadow is wet, swale south of piezo flowing, SC/T 260 @ 25 deg C,
6/26/2013 10:40	bkh	2.70	1.75	5828.63	3.5	305	522	n	Adjacent swales are dry, meadow is verdant
7/31/2013 10:15	bkh	5.37	4.42	5825.96	4.9	268	442	n	Grasses browning around well, adjacent swales dry
10/1/2013 11:30	bkh	--	--	--	--	--	--	n	Well dry, removed LL to troubleshoot download
11/5/2013 13:00	bkh, pk	--	--	--	--	--	--	n	Meadow dry, flow in Middle Martis Creek
1/2/2014 13:45	bkh	5.58	4.63	5825.75	--	--	325	n	Dry conditions prevail; but recent snowmelt and streamflow in Middle Martis has increases water levels in this well.
2/20/2014 12:15	bkh	1.47	0.52	5829.86	-0.70	182	349	n	Ice in piezo above ground; water level falling after ice removed;
4/9/2014 12:45	bkh	1.59	0.64	5829.74	0.40	210	391	n	Meadow here is wet, ponding in adjacent swale (SC = 195 at 3.5 deg C)
6/4/2014 12:20	bkh	2.17	1.22	5829.16	2.40	200	353	n	Adjacent swale is wet, but no flow
8/13/2014 11:45	bkh	6.68	5.73	5824.65	3.70	436	742	n	Only minor water in piezo; SC values appear high relative to historical measurements
10/1/2014 13:40	bkh	dry						n	Meadow dry and brown
1/9/2015 14:28	bkh, kb	4.04	3.09	5827.29	3.3	202	348	n	Meadow dry
4/21/2015 11:11	bkh	1.90	0.95	5829.43	3.5	237	406	n	Meadow moist @piezo
7/2/15 10:37	bkh,bt	3.37	2.42	5827.96	6.9	282	440	n	hydraulic floor upwelling?; sync time and restrtd logger at 11am
9/10/15 11:47	bt	6.81	5.86	5824.52	11.2	--	--	n	dry with little mud at bottom
10/7/15 12:23	bt	6.85	5.90	5824.48	10.0	--	--	n	dry; installed new logger S/N 2046787 runs on Solinst Levellogger 4.1.1
2/5/16 12:26	bt	1.40	0.45	5829.93	3.1	274	474	n	Measured at short end of sounder and cannot distiguish hundreths; Stratified SC at top C 229@0.6C and SC too cold
3/25/16 13:11	bt	1.21	0.26	5830.12	4.4	256	428	n	reset logger to measure on the hour was measuring every 5 min-started at 14:00; near peak snowmelt runoff
6/10/16 11:55	bkh, bt	2.01	1.06	5829.32	11.9	306	417	n	Meadow wet, but no active flow in swales, Middle Martis Ck is drying quickly.
10/4/16 14:12	bt	6.86	5.91	5824.47	--	--	--	n	Water depth in piezo is insufficient SC; grasses brown and dry
11/29/16 14:43	bt	1.83	0.88	5829.50	4.3	261	431	n	4-6+ inches of snow in meadow; no inundation
4/25/17 13:38	bt	1.45	0.50	5829.88	6.7	12	19	n	Meadow inundated with 1" of water; soggy not squishy; no sound from depth sounder possibly due to low SC at top of water column bu was able to visually measure death to water with sounder tape; stratified at depth Temp 5.5 degC, C 134.2 @5.5 degC, SC 214.0 @ 25 degC
8/8/17 11:50	bt	1.98	1.03	5829.35	13.6	36	46	n	Stratification at depth- T9.7°C C 144.9 SC 203.7; Grasses are green and tall; soil is moist and pokets of inundation in meadow surrounding the well; water is persistant after wet year
10/5/17 14:07	bt	1.73	0.78	5829.60	10.6	104	144	n	Some standing water in the meadow surrounding well but not as far east as 13-05
1/23/18 18:18	bt	--	--	--	--	--	--	n	Unable to measure due to ice; well is located est. 120 steps west of 13-05
4/30/18 13:11	bt	1.48	0.53	5829.85	2.1	15	26	n	Stratified at depth: T 1.6°C, C 126.3, SC 227.3; some relict channels are ponded with water; soil wet; grasses are not goring yet
10/8/18 14:53	bt	6.78	5.83	5824.55	--	--	--	n	Well is almost dry; little mud on tip of logger; not enough water for SC measurement; grass dry and soil slightly damp
5/23/19 10:19	bt	1.34	0.39	5829.99	5.5	78	124	n	Stratification at depth: T5.0°C, C 185.9, SC 299.4; ground wet from rain and soft with puddling water when stepped on
10/29/19 11:46	bt	1.83	0.88	5829.50	6.5	132	204	n	Downloaded and removed logger

Notes:

- 1) (bkh) = Brian Hastings, (jo) = Jon Owens, (pk) = Peter Kulchawik, (kb) = Kerensa Brooks, (bt)=Benjamin Trustman
- 2) Water surface elevations are based on ground surface elevations surveyed into a USACE benchmark
- 3) btoc=below top of casing; bgs=below ground surface
- 4) Specific conductance: Measured in micromhos/cm in field using a YSI30 hand-held meter; then adjusted to 25degC by equation  $(1.8813774452 - [0.050433063928 * \text{field temp}] + [0.00058561144042 * \text{field temp}^2]) * \text{Field specific conductance}$