

Quartz Valley Indian Reservation

Water Quality Monitoring and Assessment Report 2017



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Cover photo: Kidder Creek

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1. Introduction

This document describes the water quality monitoring performed during 2017 by the Quartz Valley Indian Reservation (QVIR) Environmental Department. Our work is funded by Federal grants from the U.S. Environmental Protection Agency (USEPA), Bureau of Indian Affairs (BIA) and the Bureau of Reclamation (BOR) and is intended to help fulfill intentions of the Clean Water Act. Our efforts are designed to monitor the health of our local water bodies and to protect waters for a variety of beneficial uses.

The QVIR Environmental Department began the process of developing a Water Pollution Control Program in accordance with the Clean Water Act (CWA) in 2005. The Tribe set primary goals of ensuring salmonid spawning and rearing habitat, fishing, swimming, other wildlife habitat and cultural needs. The objective is to ensure these goals are met for the future protection and sustained use of valuable Reservation water resources, protection of public health and welfare, and the enhancement of water quality resources. The Tribe intends to protect and improve water resources through water quality monitoring, habitat evaluation, education and community outreach, planning and implementation.

A Quality Assurance Project Plan (QVIR 2006a) for water quality monitoring was developed by the Tribal Environmental Program and approved by U.S. Environmental Protection Agency (U.S. EPA) in 2006. The plan was updated and approved in 2016. Current water quality conditions are annually evaluated using the water quality objectives developed from various state, federal and tribal entities. The North Coast Regional Water Quality Control Board (NCRWQCB) Basin Plan water quality objectives are determined for the protection of beneficial uses (e.g., salmonids, agriculture, and recreation) established for the Scott River and its tributaries. U.S. EPA's (2000a) Ambient Water Quality Criteria Recommendations for Rivers and Streams in Nutrient Ecoregion II provides general guidance to analyze nutrient values but is not intended to be directly translated into standards. U.S. EPA 2007 Edition of the Drinking Water Standards and Health Advisories and the NCRWQCB Basin Plan were used to analyze groundwater results. For parameters without current water quality objectives established by either state or federal agencies, the QVIR Tribe has adopted their own objectives based on published research. Tables 1 and 2 lists the water quality standards used to assess surface water quality and ground water quality.

Table 1 Water quality standards used to assess surface water quality

Parameter monitored	Units	Water quality criteria		Source of standard
Temperature	°C	MWAT ¹ < 16.8°C < 19 °C		Welsh et al., 2001; Sullivan et al., 2000, U.S. EPA, 2003
pH	pH	Min	Max	North Coast Regional Water Quality Control Board (NCRWQCB). 2007 <i>Basin Plan</i> , Scott River Objective
		7	8.5	
Conductivity	mS/cm	50% Upper Limit	90% Upper Limit	North Coast Regional Water Quality Control Board (NCRWQCB). 2007 <i>Basin Plan</i> , Scott River Objective
		0.275	0.350	
Turbidity	NTU	< 5 above ambient turbidity levels		Berg, 1982; Lloyd, 1987
Dissolved Oxygen	mg/L	Min	50% Upper Limit	North Coast Regional Water Quality Control Board (NCRWQCB). 2007 <i>Basin Plan</i> , Scott River Objective
		7.0	9.0	
Total Phosphorus	mg/L	0.01		U.S. Environmental Protection Agency. 2000a. Ambient Water Quality Criteria Recommendations for Rivers and Streams in Nutrient Ecoregion II.
Total Nitrogen	mg/L	0.12		U.S. Environmental Protection Agency. 2000a. Ambient Water Quality Criteria Recommendations for Rivers and Streams in Nutrient Ecoregion II.

¹ MWAT: maximum weekly average temperature = highest 7-day, moving average temperature for a particular year.

Table 2 Drinking water standards used to assess groundwater quality.

Parameter	Units	Water Quality Objectives		Source
pH	pH units	Max	Min	North Coast Regional Water Quality Control Board (NCRWQCB). 2007 Basin Plan, Scott River Objective
		8	7	
Conductivity	mS/cm	90% Upper Limit	50% Upper Limit	North Coast Regional Water Quality Control Board (NCRWQCB). 2007 Basin Plan, Scott River Objective
		0.500	0.250	
<i>E. coli</i>	MPN/100 ml	1 MPN or Presence		US EPA 2006.

2. Methods

As mentioned above, we have developed a Quality Assurance Project Plan (QVIR 2016) that guides collection and analysis procedures, and this has been approved through a review by the U.S. EPA. We also have formal written Standard Operating Procedures (SOP's) that specifically outline collection, sampling handling, analysis, and equipment calibration and maintenance. Following these plans, data collection began during the late spring of 2007 and continues into 2017.

Our major collection effort in 2017 included surface water nutrient and bacteria grab samples collected at 2-week to 1-month intervals. Sampling locations were on Shackleford Creek, Sniktaw Creek, Mill Creek, and multiple locations on the Scott River mainstem and forks (Figure 1). The Scott River basin is a major tributary to the Klamath River and Quartz Valley is a major sub-basin of the Scott River, located in Siskiyou County, California.

The grab samples collected at these sites were analyzed for ten water quality parameters: total nitrogen, nitrate plus nitrite, total phosphorus, soluble reactive phosphorus, bacteria (*E. coli* and total coliform), pH, dissolved oxygen, and specific conductivity and stream discharge. Nitrogen and phosphorus are analyzed by Aquatic Research Inc., Seattle, WA. Bacteria analyses are completed at the QVIR Microbiology Lab. The Quartz Valley Indian Reservation operates its own bacteria lab, which is certified by the State of California through the Environmental Laboratory Accreditation Program (ELAP). The QVIR lab is also available to perform tests for the public on bacterial contamination of drinking water samples from wells or other sources. The remaining analyses were performed using a hand held YSI datasonde. Stream discharge measurements are performed using a Flow Tracker.

One site located at river mile 22 alongside the US Geological Survey discharge gage we deploy a YSI datasonde. Thirty-minute data collection occurs year-round for the following parameters: temperature, pH, dissolved oxygen, specific conductivity and turbidity.

In addition to the above water chemistry efforts, continuous temperature data was collected at a series of sites over the Scott River basin. Temperature was sampled at fourteen additional sites. The temperature monitoring locations consisted of two in the mainstem Scott River below Fort Jones, one on the East Fork, one on the South Fork, and seven in the tributaries near QVIR, two in the upper Scott River tributaries and one on a Scott tributary in the canyon. Temperature is measured and recorded at 30-minute intervals using HOBO continuous recording temperature devices (Onset Corp.). Additional details on the sampling methods and laboratory methods for each parameter are included in the QAPP (QVIR 2016).

The distribution of our surface water sampling array for both water quality and quantity is shown in Figure 1 and Table 3.

In addition to the surface water program, groundwater is also being monitored. We have performed monthly sampling of a set of drinking water wells and continuous monitoring occurs at a newly establish set of 13 static groundwater level monitoring wells. Bacteria sampling, static water level elevation, temperature and water chemistry is performed on the groundwater wells. The locations of the drinking water wells and the ground level monitoring wells are shown in Figure 2.

Table 3 Surface water sampling sites 2017

Site Code	Location	Type of sample	River mi ¹
DEEP	Deep Creek mouth	Temp	0.1
SRJB	Scott River at Jones Beach	Stream Discharge, Nutrient/Bacteria Grab	19
SRGA	Scott River at the USGS Gage	Datasonde, Nutrient/Bacteria Grab	22
SRES	Shackleford at Reservation	Temp, Stream Discharge, Nutrient/Bacteria Grab	2
MULE	Mule Creek	Temp	
SREF	Scott River East Fork	Temp, Stream Discharge, Nutrient/Bacteria Grab	0.5
SRSF	Scott River South Fork	Temp, Stream Discharge, Nutrient/Bacteria Grab	7
SHMI	Lower Shackleford - Mill	Temp, Nutrient/Bacteria Grab	2
SNCR	Sniktaw Creek	Temp, Nutrient/Bacteria Grab	2
SHFL	Shackleford at Falls	Temp, Nutrient/Bacteria Grab	4
MICR	Mill Creek at valley floor	Temp, Nutrient/Bacteria Grab	7
CAMO	Campbell Lake outlet	Temp	11
SUCC	Summit Lake outlet	Temp	11
KANG	Kangaroo Creek	Temp	1.5
GROU	Grouse Creek	Temp	1.5
UPSN	Upper Sniktaw Creek	Temp, Stream Discharge, Nutrients/Bacteria Grab	2.9

¹ Mainstem Scott: from Klamath River OR Tributaries: from confluence with Scott.

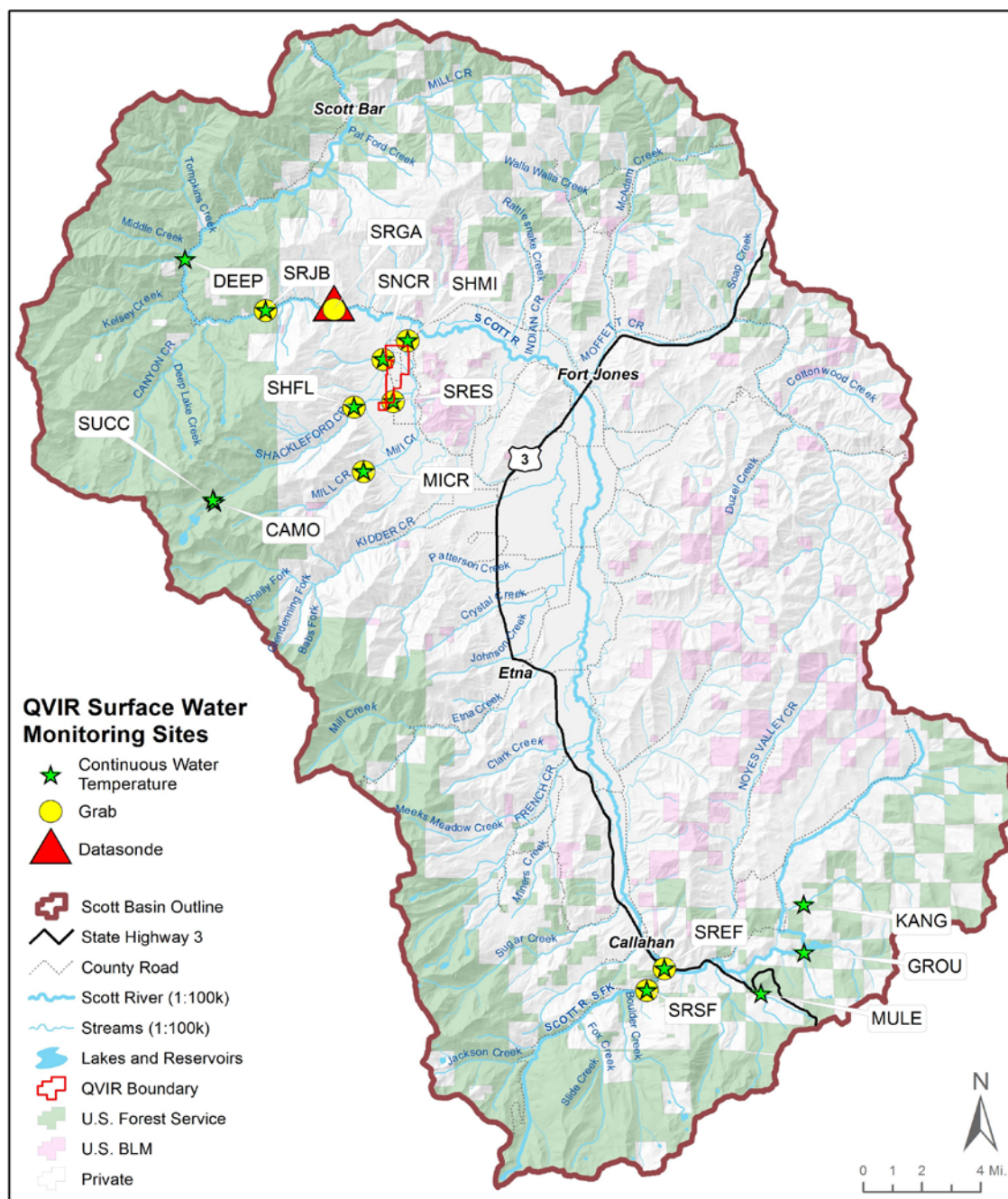


Figure 1 Surface water quality sampling locations 2017. Map created by Eli Asarian.

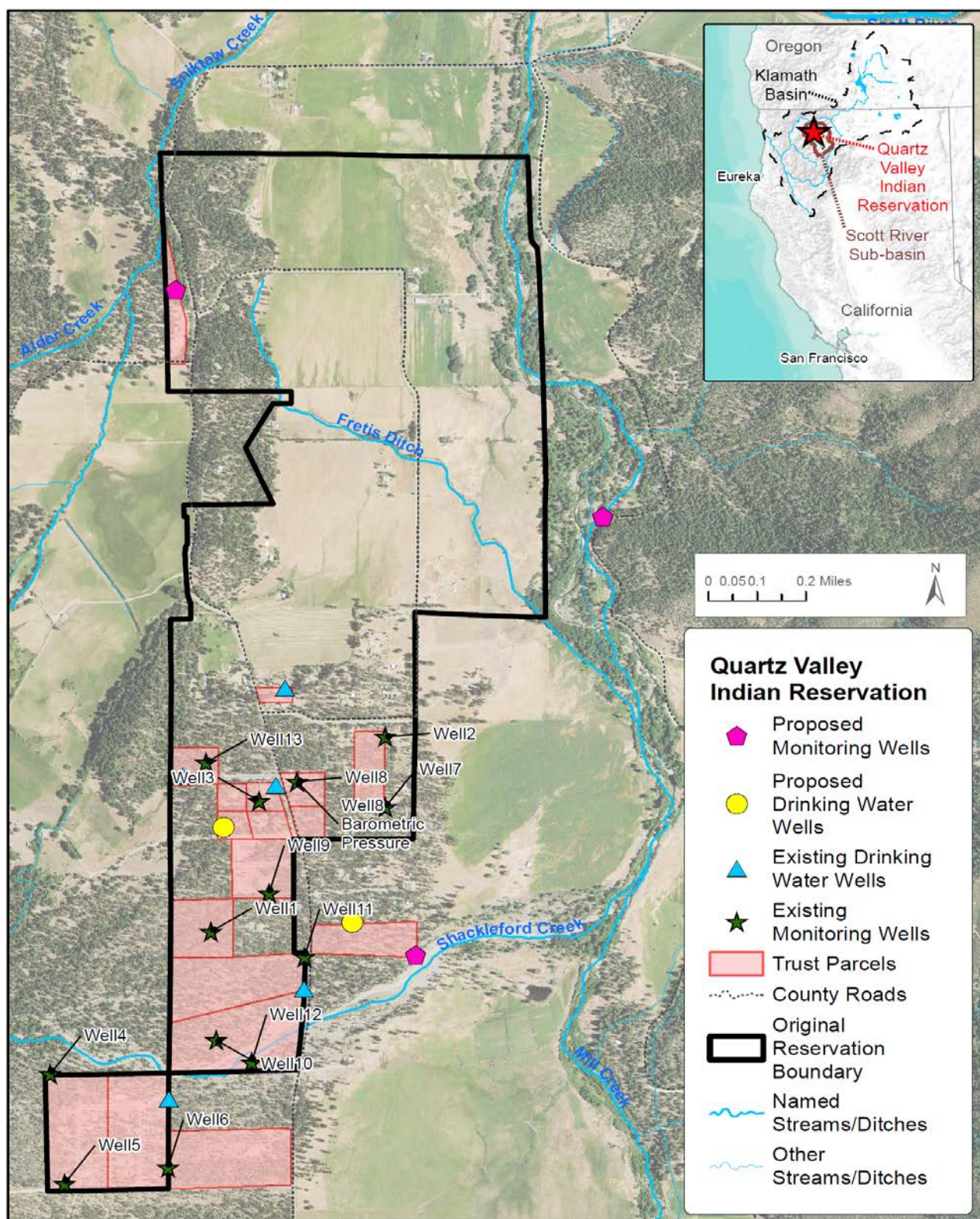


Figure 2 Locations of groundwater wells monitored in 2017. Map created by Eli Asarian.

3. Background on environmental conditions in the Scott River basin

Surface water chemistry and ground water elevation are functions of the overall hydrology of the basin, some discussion of climate and hydrology is presented here so to better evaluate surface and ground water quantity and chemistry patterns. From past sampling, we can see that stream discharge volume affects water quality. In general, as flow diminishes, the water temperatures tend to rise and we also see increased pollutant concentrations, as well as greater diurnal fluctuations, in chemical parameters such as dissolved oxygen and pH. The high elevation, mountainous climate of the valley typically has a daily range in air temperatures that is quite large, high day-time temperatures and substantial night-time cooling. Streamflow in the Scott River shows seasonal patterns based on snowmelt that diminishes by late June. These patterns are further modified by land use (e.g., roads, vegetation, forest harvests) and directly by water use and management (e.g., stream diversions and ground water pumping). Air temperatures clearly affect stream temperatures, low stream flows are more vulnerable to the fluctuating air temperature than higher flows, but we do not know the precise relationships in the Scott watershed.

There is also substantial groundwater seepage that occurs in the basin. Forward Looking Infrared Surveys from 2003 and 2006 identify many locations where there is regional cooling of water temperature due to these seeps (see Figure 3).

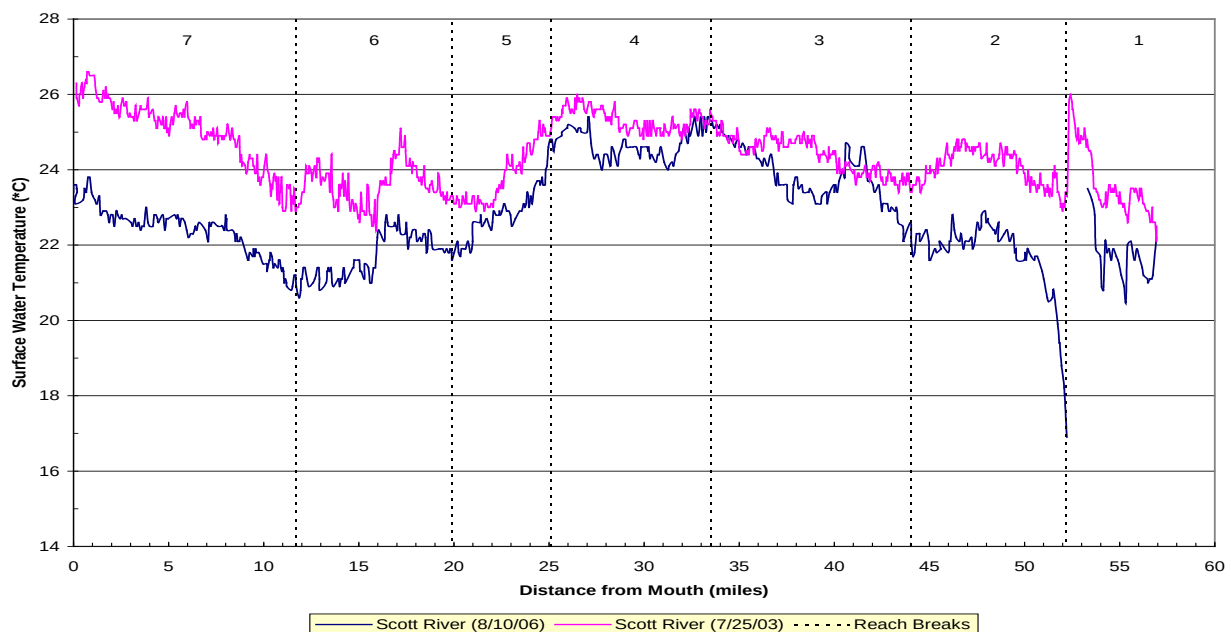


Figure 3 A comparison of median surface water temperature in the Scott River mainstem measured on 08/10/2006 and 07/25/2003 (Watershed Sciences, 2007)

The past year rainfall (WY 2017) from Quartz Hill summed to just over 32 inches (Figure 4). The months of February and March had the largest amounts of precipitation and these are evident in the peak flows shown in the Scott River hydrograph (Figure 8).

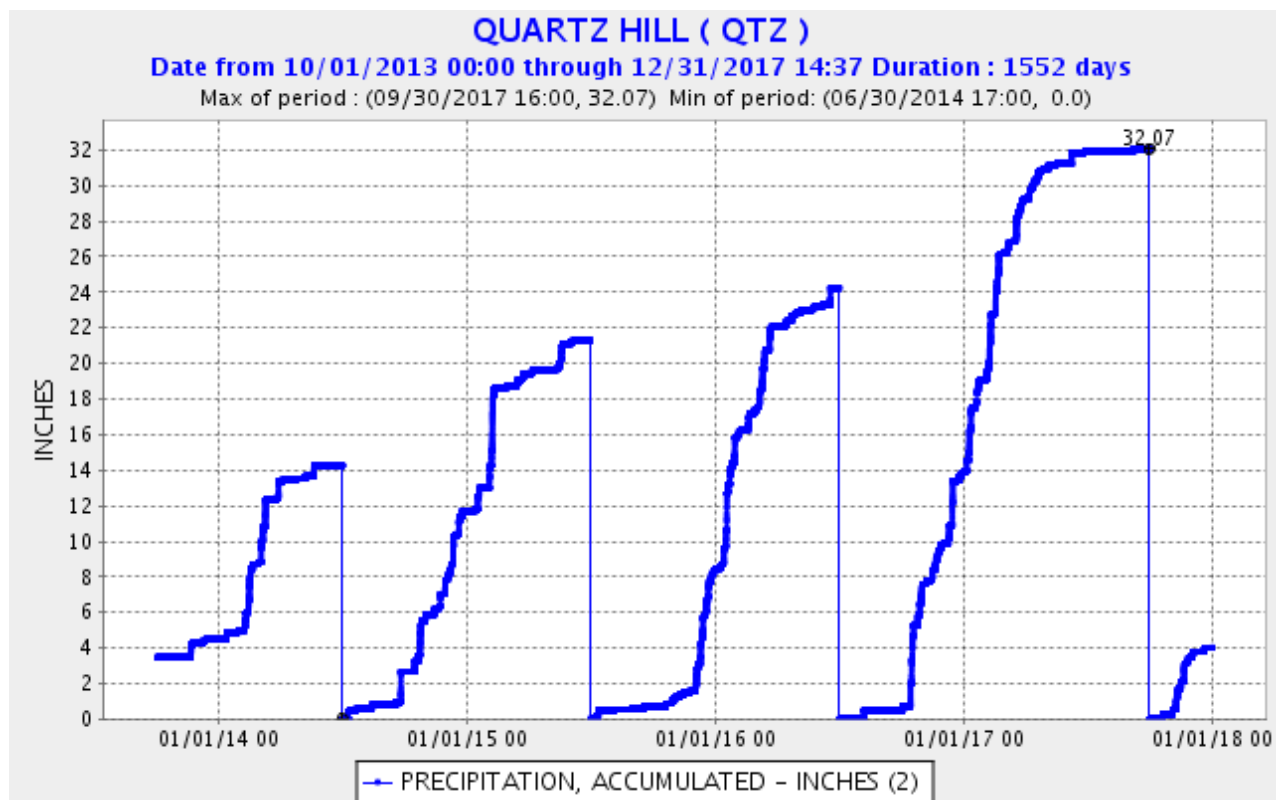


Figure 4 Precipitation at Quartz Hill for 2014-2017 WY.

Data available at:

http://cdec.water.ca.gov/histPlot/DataPlotter.jsp?staid=QTZ&sensor_no=2&duration=H&start=10%2F01%2F2013+00%3A00&end=09%2F30%2F2017+14%3A37&geom=Small

Snow pack is critical in the Scott basin since it will determine the duration of base flow conditions, conditions that prove to be stressful to aquatic life. Figure 5 depicts snow depths at the Scott mainstem headwater near Callahan (Middle Boulder) from WY 1945 to WY 2017.

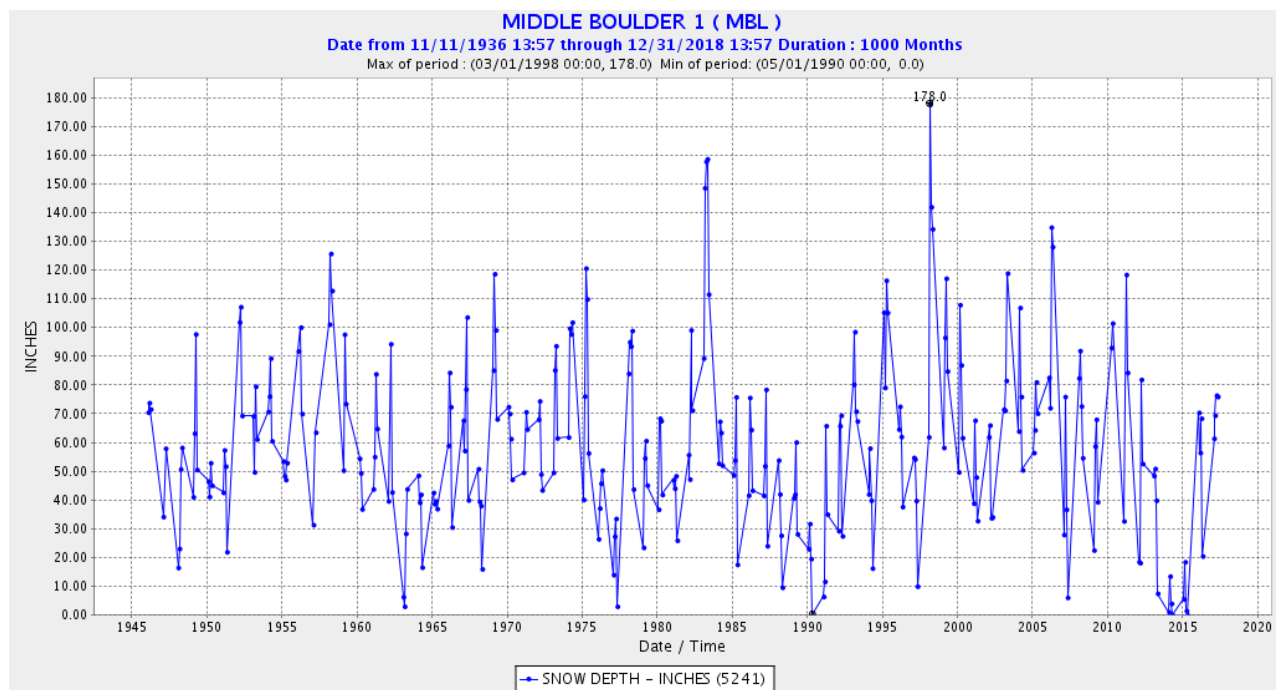


Figure 5 Snow Depths at the Scott Mainstem headwaters near Callahan (Middle Boulder) from WY 1945 to 2017.

Data available at the following link:

http://cdec.water.ca.gov/jspplot/jspPlotServlet.jsp?sensor_no=5241&end=09%2F30%2F2016+13%3A57&geom=huge&interval=30000&cookies=cdec01

The result of the climate on streamflow patterns is one of high winter flows and low summer flows as evident in the daily average flow (discharge) for the Scott River measured at the USGS gage since 1942 (Figure 6). This shows a consistent and unchanging pattern of typical peak flows of about 4,000 cfs with extremes over 20,000 cfs occurring nearly every 10 years. Also shown are low flows of about 40 cfs but with a trend of extreme low flows of less than 10 cfs starting about 1977. The increased frequency of these extremely low flows in recent years is of interest as lowered flows contribute to increased diurnal fluctuations in the stream chemistry as well as increased concentrations of pollutants. The increased frequency of low flows during summer since 1977 has been related to drought (Drake et al. 2000) but also to increased rates of agricultural groundwater pumping (Van Kirk and Naman 2008). Drake et al. (2000) and Van Kirk and Naman (2008) state there is evidence that April snow pack at higher elevations in the Marble Mountains has decreased in recent years. This supports the many climate models predicting that more precipitation may occur in the Pacific Northwest, but that it may not create greater snow pack except for at very high elevations (e.g., > 8,000 feet).

The last four water years at the Scott River gage show the details of the seasonal pattern (Figure 7). Generally high flows occur during winter with punctuated storm peaks, a steep decline during June and July to a low flow from August through October followed by increased flows in November.

In an early, but detailed, hydrologic study of the Scott Valley, Mack (1958) estimated 8-10 % (ca. 40,000 acre-feet) of the annual discharge of the Scott River was diverted from streams or pumped from ground water. He estimated that nearly all was used as irrigated agriculture; 55 % of the water was lost as evapotranspiration and 45 % percolated back to the aquifer. At that time, the

22,000 acre-feet lost was only 5 % of the total annual flow. However, since most of that 5% was used during the summer, the percent of irrigation water extracted from available flow would be larger, though he did not estimate this.

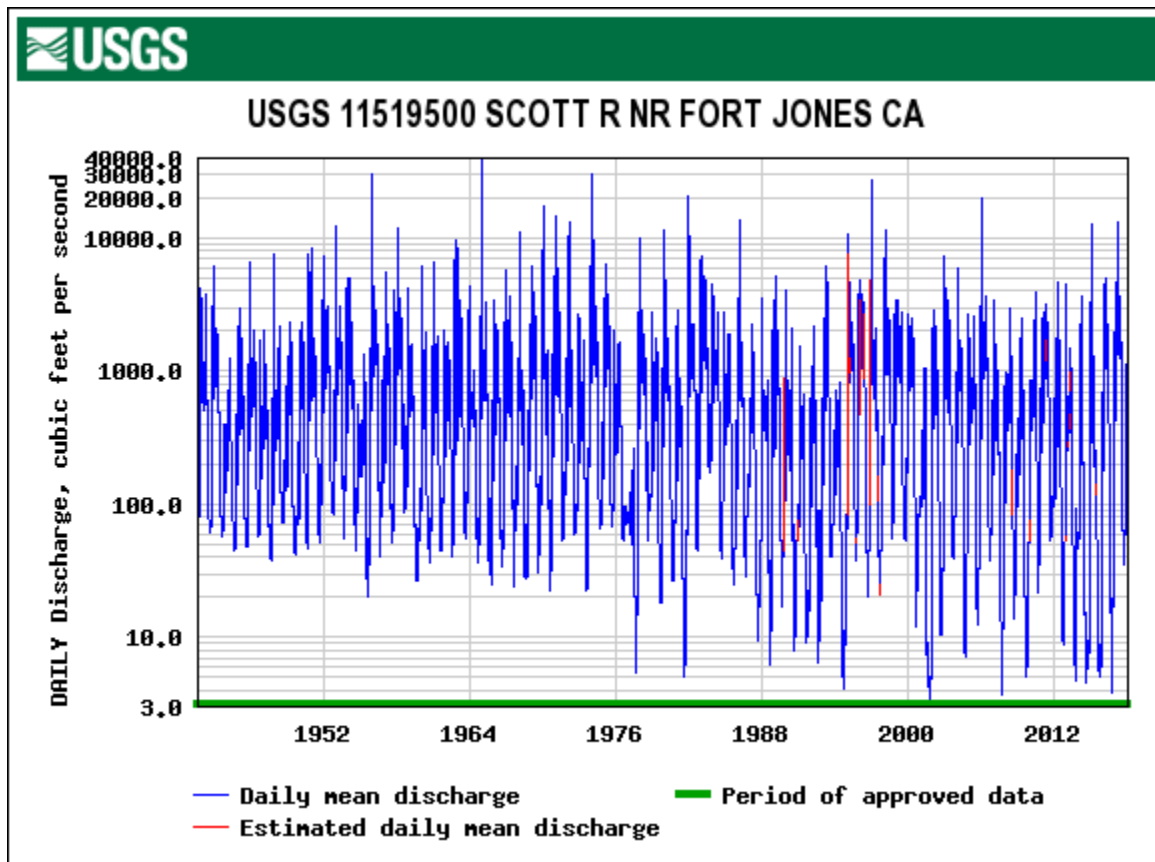


Figure 6 Scott River Discharge January 1988-January 2018 at the Scott River USGS Gaging Station.

The y-axis is a log-scale to show both the low and high flows. Highest flows (over 20,000 cfs) appear to occur periodically during the years 1996, and 2006. A shift appears to occur at 1977 when extremely low flows began to occur with greater frequency.

https://waterdata.usgs.gov/nwis/dv?cb_00060=on&format=gif_default&site_no=11519500&referred_module=sw&period=&begin_date=1941-10-01&end_date=2018-01-01

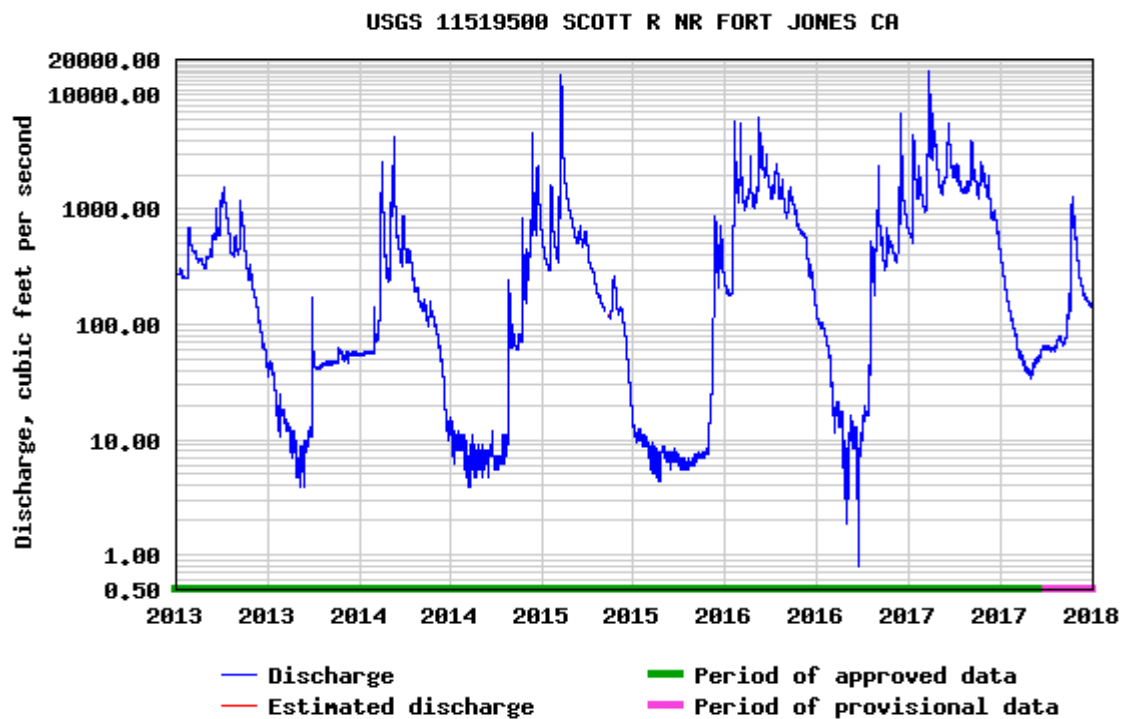


Figure 7 Scott River Discharge WY 2012-2017 at the Scott River USGS Gaging.
http://waterdata.usgs.gov/ca/nwis/uv?site_no=11519500

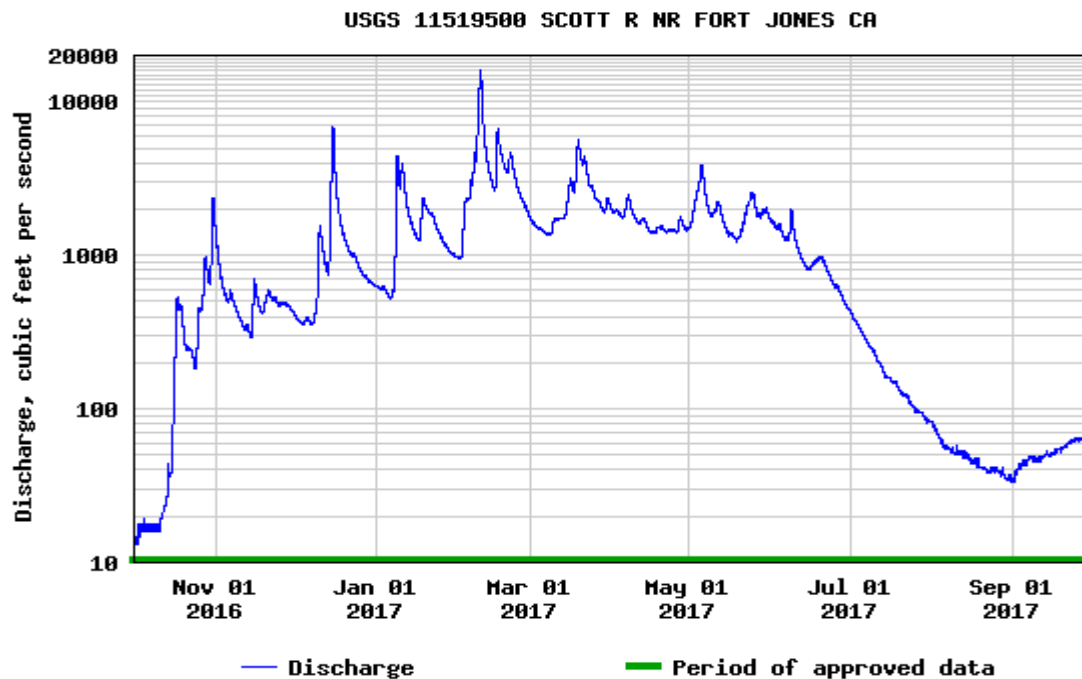


Figure 8 Scott River discharge WY2017 at the Scott River USGS Gaging Station

Data source:
http://nwis.waterdata.usgs.gov/nwisweb/graph?agency_cd=USGS&site_no=11519500&parm_cd=00060&begin_date=2013-10-01&end_date=2014-12-31

4. Results – Surface Water

Datasonde

Scott River continuous monitoring at USGS Gage

Continuous water quality monitoring occurs at the Scott River USGS gage near Fort Jones. Data collection began in 2007. Water quality is monitored by a YSI datasonde (YSI 6600 Series) with data recorded every 30 minutes year- round. Water quality parameters monitored by the datasonde are temperature, specific conductivity, dissolved oxygen, pH and turbidity. After downloading at the site, the data are finalized each year and the 2017 data is included in this report.

Figure 9 depicts the entire dataset allowing comparisons to be made between parameters. For instance, as flow and turbidity increase, conductivity decreases as well as the diurnal fluctuations in pH and dissolved oxygen which is a response to photorespiration. Trends observed in 2017 are similar to those collected since 2007.

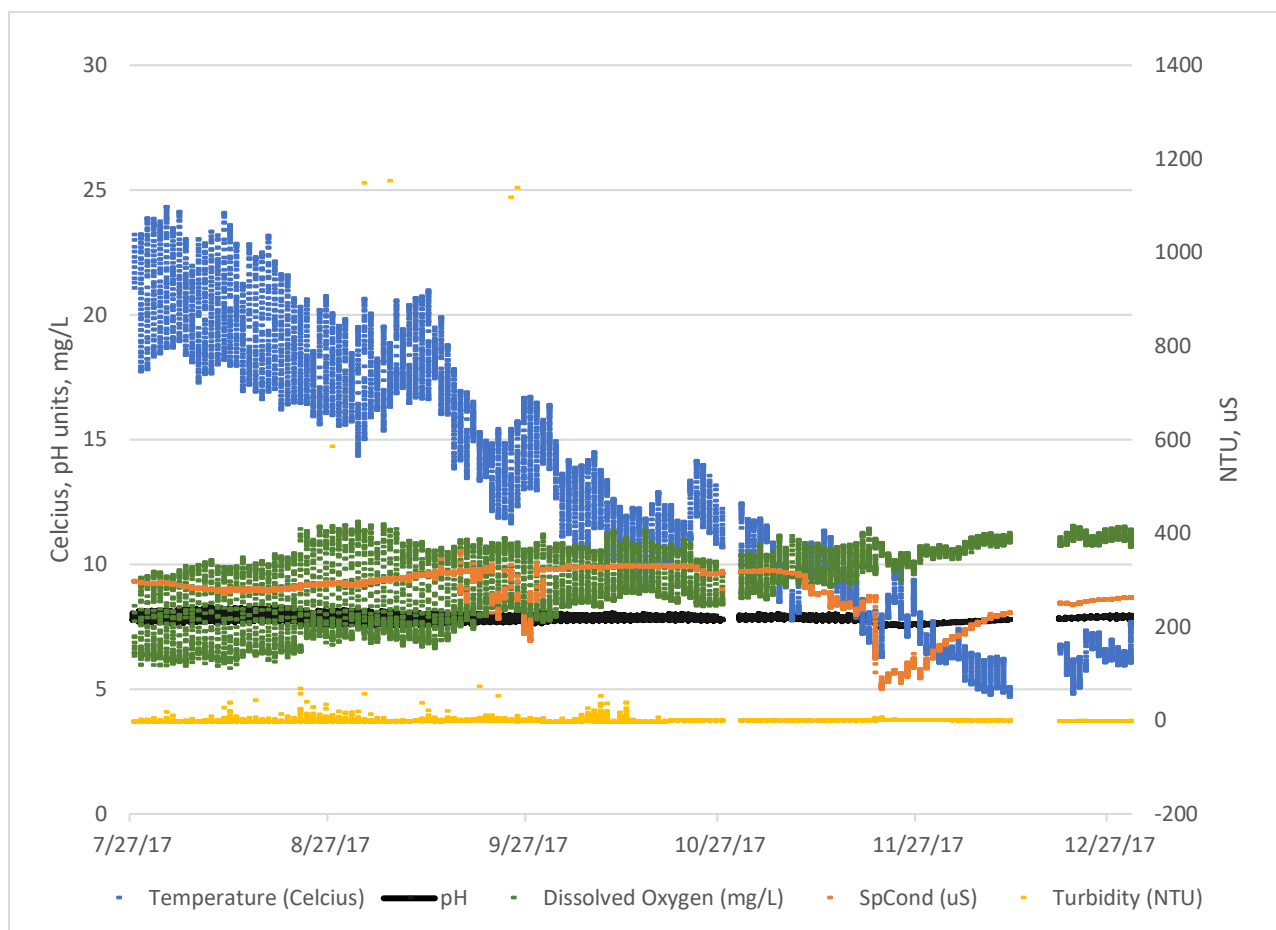


Figure 9 Continuous water quality data Scott River USGS Gaging Station 7/27/17 – 12/31/17.

Continuous Stream Temperature

The salmon risk assessment study approach used by (Sullivan et al. 2000) found that an MWAT of 19 ° C reduces growth of both coho and steelhead by 20 %. In addition, the MWAT causing death or elimination from an area can range from 21.0 - 25.0 ° C for coho and 21.0 - 26.0 ° C for steelhead. Elliot (1981) also found these MWAT values can block migration, inhibit smoltification and cause disease problems. Welsh et al. (2001) found a lower MWAT of 16.8 C as being a Coho suitability threshold (see also U.S. EPA, 2003).

The maximum weekly average temperatures for these sites are shown in Table 4. Typically, there is a pattern of stream warming as elevation drops, corresponding to the increasing air temperature as well as decreasing flows as elevation drops from the wilderness to the agriculturally dominated valley.

Tributary MWATs in 2017 are between 14 and 20°C showing the importance of the tributaries as summertime cool water sources to the mainstem. It is important to note that four tributaries are within the salmonid threshold of 16.8°C for all years sampled since 2007 (see Table 4 highlighted cells): Shackleford at the Trailhead, Kangaroo, Mill (Quartz Valley) and the South Fork Scott.

Surface water site	Elevation (ft)	MWAT (C)										
		2017	2016	2015	2014	2013	2012	2011	2010	2009	2008	2007
Summit Lake outlet	6,000		15.6	19.7	15.8	16.2	15.5			16.2	14.8	15.6
Campbell Lake outlet	5,000		18.2	19.3	18.5	18.3	18.3				17.7	
Shackleford Cr trailhead	4,600		14.2	15.1	15.1		14.3				13.5	16.4
Mule Creek	4,015	16.6	17.8	18.6	13.9		16.5				16.2	17.9
Kangaroo Cr	4,000	14.0		12.4		13.8	13.2			13.5	13.3	13
Grouse Cr	3,900	18.8	18.6	19.6	15	19.2	17.9				20.2	19
South Fork Scott R	3,750	15.1	15.0	15.9	13	15.5	15.9					
East Fork Scott R	3,160	21.9	22.4	22.9	17.8	22.9	21.6					
Upper Sniktaw	3,152	14.5	16.2	17.2								
Mill Cr	3,000	14.5	15.1	15.9	13.5	14.9	15.1				14.8	
Shackleford Falls	3,000	16.5	16.3	18.4	13.6	16.3					15.8	18.2
Shackleford at QVIR Bridge	2,850	18.2										
Lower Sniktaw Cr	2,750	17.1	18.8	18.6		16.3	17.4					
Scott River at Horn Lane	2,746						18.9					
Lower Shackleford/Mill Creek	2,723	16.7	16.4				16.1				15.7	17.1
Scott River at USGS Gage	2,631	21.2	22.1	23.1							20	21.8
Scott River at Jones Beach	2,484			25.4	23	25.1	20.2			24.7	21.1	
Deep Cr	2,200	20.1	19.4	20.8	23.4	18.5	17.9			19.5	17.7	

Table 4 Maximum weekly average temperature for surface waters in the Scott Basin 2007 – 2017. All highlighted values exceed the salmonid threshold of exhibiting an MWAT >16.8 C.

Nitrogen and phosphorus

Background: Nitrogen is an essential element for all living systems. Nitrogen (N) is generally not abundant in soils or surface waters as it is not normally a product of mineral weather of bedrock. Nitrogen enters ecosystems mainly by “fixation” from the atmosphere and once it is in the living systems, it is conserved relatively tightly via recycling mechanisms such as uptake by plants, fungi, or bacteria and is stored in organic tissues and soil organic matter. Presence of moderate to high concentrations in surface waters can be due to natural conditions (high amounts of nitrogen fixers or some marine sediments can contain nitrogen). High nitrogen in surface waters normally indicates a “leaky ecosystem” and may be due to ecosystem disturbance. Sources of nitrogen may

be forest fires, harvests, soil erosion. Presence of high nitrogen in surface water may also be due to pollution such as poorly designed domestic leach fields, runoff from farmyards, cattle accessing streams, excessive fertilizer use near stream courses, or industrial effluents discharging to streams. Total N measures all forms of nitrogen and normally is composed of mostly organic forms (various proteins or other organic compounds containing nitrogen), and lesser amounts of inorganic forms such as ammonium (NH_4^+), nitrate (NO_3^-) and nitrite (NO_2^-). Nitrate and nitrite are often included together or sometimes only reported as nitrate. Nitrite is an unstable form that is of low concentration and is normally quickly transformed to nitrate or ammonium. Both nitrate and nitrite are negatively charged forms of inorganic nitrogen and because of their negative charges, are not readily held by soils and are therefore soluble and leach easily to surface waters. They are readily taken back up by algae, plants, and bacteria and fungi and can increase plant and algae growth and turn streams and lakes green (eutrophication). Very high concentrations can result in fish kills. We have chosen 0.12 mg/L of total N as our threshold level for surface waters (Table 1). We also track the presence of nitrate and nitrite but do not have a threshold established, though it normally may be about 1/5 to 1/3 the amount of total N.

Phosphorus (P) is also an essential element for living systems; it is a product of mineral weathering and is found naturally in the soil, though at low levels. Higher levels of phosphorus indicate human activity. Crops and grazing land, soil bank erosion and sewage seepage are examples of activities leading to an increase in phosphorus. Total P includes all forms of dissolved phosphorus and includes organic and inorganic forms (PO_4^{2-}) which is the most readily used forms by plants and is what can also cause eutrophication. Our threshold for Total P is 0.12 mg/L, see Table 1.

Soluble reactive phosphorus (SRP) is the filterable orthophosphate fraction of the total phosphorus in the system. SRP is the form directly up taken by plant cells. Plants growing in the river channel (periphyton) or roots of riparian vegetation directly in the stream would benefit from this form of phosphorus. Excessive periphyton in the Scott River system can and has been shown to lead to poor water quality through the actions of photorespiration.

TN Results: Total Nitrogen sampled monthly in 2017 in conjunction with the collection of water chemistry using a hand-held datasonde (temperature, dissolved oxygen, pH, and specific conductivity). Samples were sent out to commercial labs for analysis of total nitrogen (TN). See results in Figure 10.

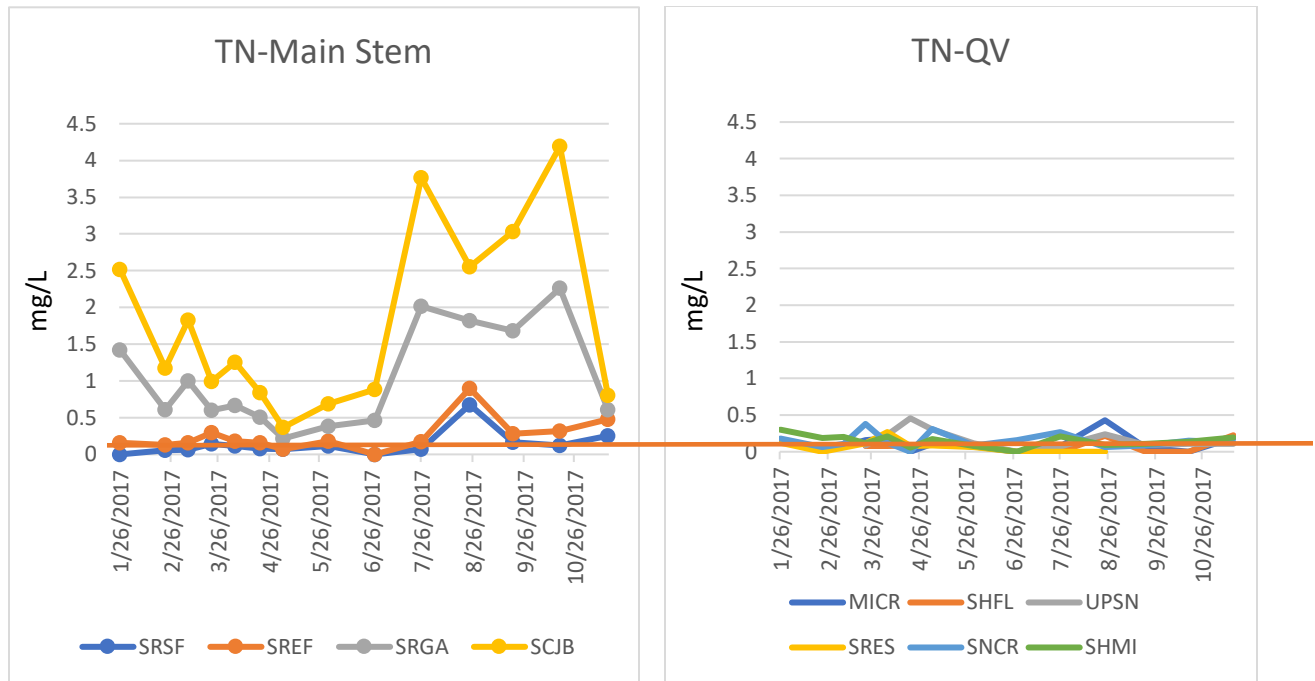


Figure 10 Total nitrogen concentrations Scott River mainstem and Quartz Valley 2017. Red line = USEPA water quality criteria $X < 0.12 \text{ mg/L}$

High total nitrogen concentrations are noted from June-October in 2017 for the mainstem Scott. The highest values all season are on the Scott River at the USGS Gaging Station (SRGA) and Jones Beach (SCJB), this is consistent with all previous sampling years. The majority of the sampling season and the majority of the mainstem sampling sites exceed our nutrient criteria during the sample season in 2017.

TN in the Quartz Valley tributaries follows a similar trend to that observed in previous years. USEPA criteria is exceeded at all sites for most of the sampling season.

Nitrate+Nitrite Results: Nitrate+Nitrite was sampled monthly in 2017 in conjunction with the collection of water chemistry using a hand-held datasonde (temperature, dissolved oxygen, pH, and specific conductivity). Samples were sent out to commercial labs for analysis of nitrate+nitrite (NO_2+NO_3). See results in Figure 11.

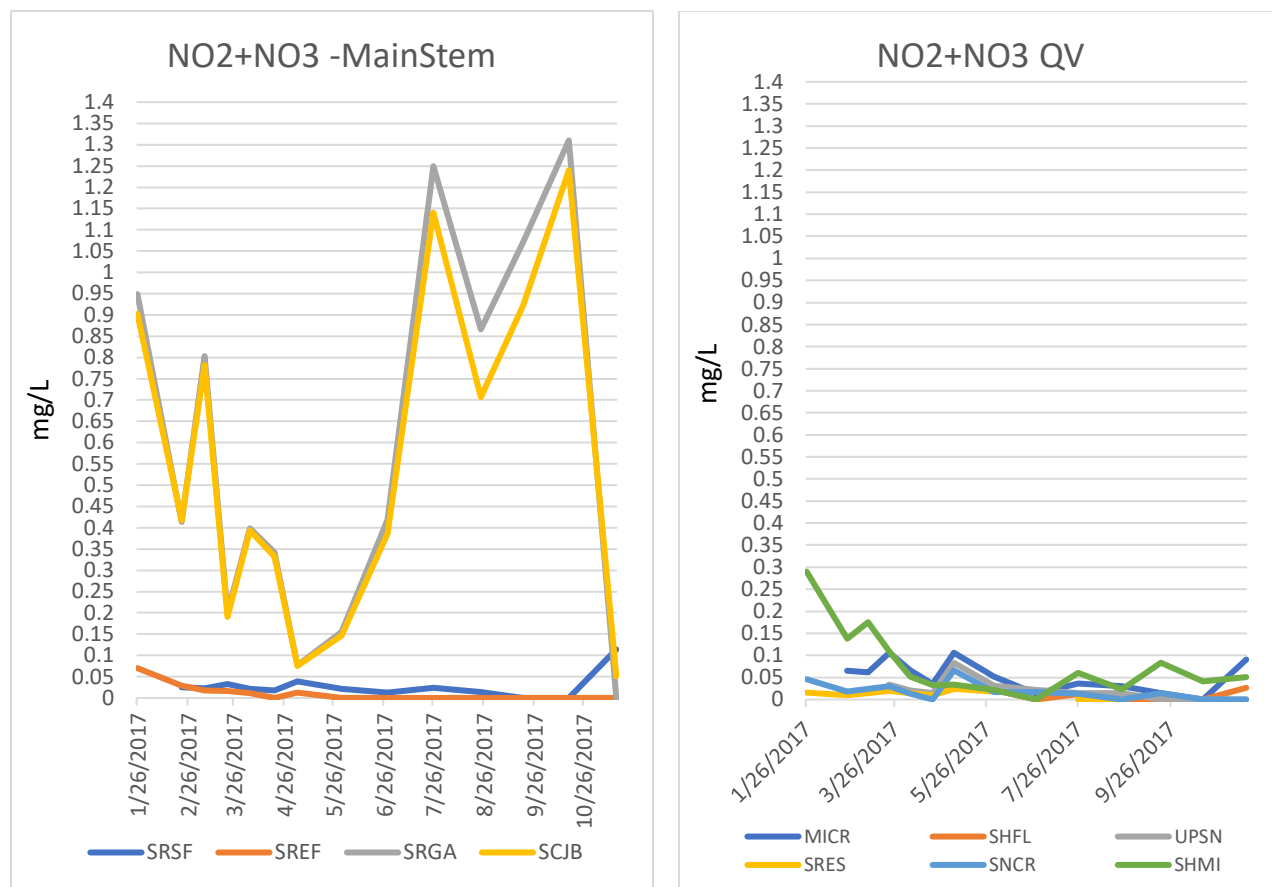


Figure 11 Nitrate+nitrite concentrations in the Scott River mainstem and Quartz Valley tributaries 2017.

Nitrate+Nitrite concentrations are much higher on the mainstem Scott River downstream of Callahan (SRGA and SRJB) than in the forks above the confluence (SREF and SRSF), see Figure 12. Levels begin high in January, drop through the spring and then begin to increase at the end of June peaking in September and then declining into the fall.

Quartz Valley tributaries nitrate+nitrite concentrations did not follow the same trend as the mainstem. Concentrations were much lower than the mainstem below Callahan but very similar to the concentrations observed in the east and south forks of the Scott.

TP Results: Total phosphorus was sampled monthly in 2017 in conjunction with the collection of water chemistry using a hand-held datasonde (temperature, dissolved oxygen, pH, and specific conductivity). Samples were sent out to commercial labs for analysis of nitrogen total phosphorus (TP). See results in Figure 12.

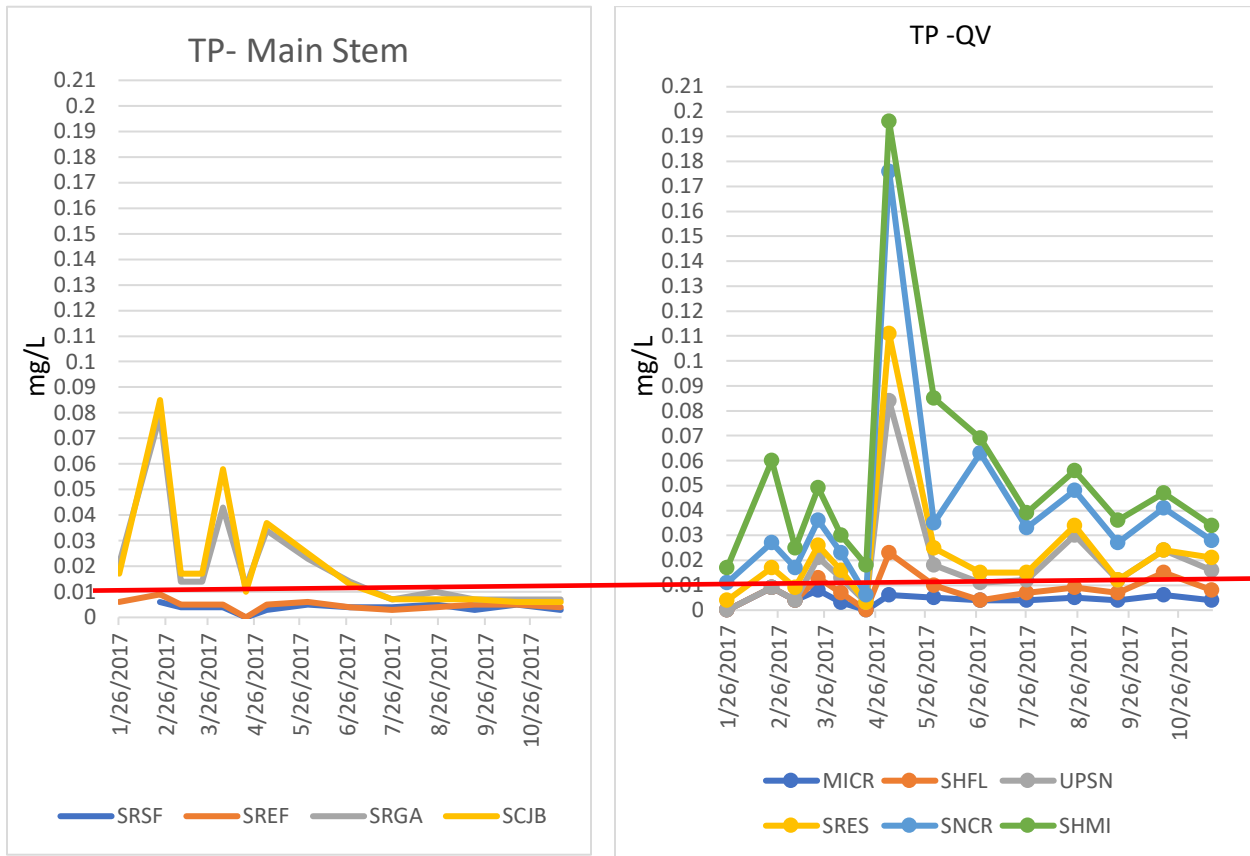


Figure 12 Total Phosphorus concentrations in the Scott River mainstem and Quartz Valley tributaries 2017. Red line = USEPA water quality criteria $X < 0.01 \text{ mg/L}$.

TP concentrations have been higher than all previous years sampled in both 2016 and again in 2017. The general trend of higher concentrations until June with declining concentrations the rest of the sampling period is consistent with previous years.

TP concentrations in the tributaries draining Quartz Valley are higher than previously observed. All sites with the exception of Mill Creek had exceedances in 2017.

SRP Results: Soluble reactive phosphorus was sampled monthly in 2017 in conjunction with the collection of water chemistry using a hand-held datasonde (temperature, dissolved oxygen, pH, and specific conductivity). Samples were sent out to commercial labs for analysis of soluble reactive phosphorus (SRP). See results in Figure 13.

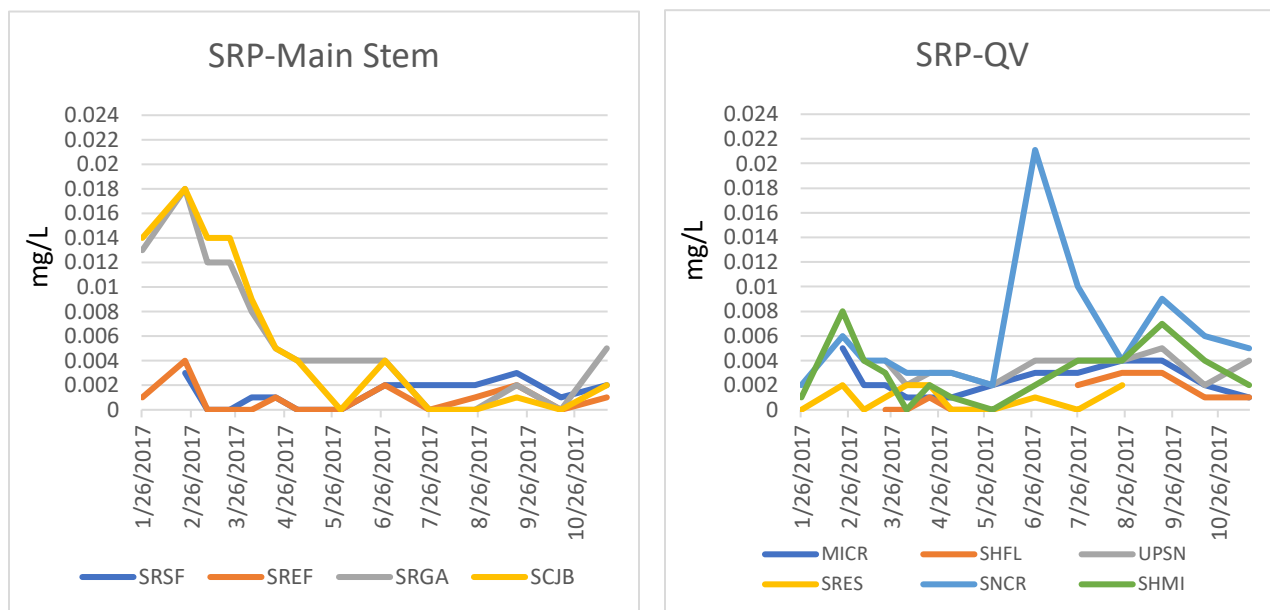


Figure 13 Soluble reactive phosphorus concentrations in the Scott River mainstem and Quartz Valley tributaries 2017.

SRP was much higher downstream of Callahan in the spring of 2017, after June all sites are within a similar range.

Quartz Valley tributaries did not show the same trend as the mainstem in 2017. Concentrations fluctuated all summer within a range of 0 – 0.008 mg/L, with the exception of a spike in early July on Sniktaw Creek.

Bacteria

Background: Bacteria samples were analyzed in QVIR labs for two types of bacteria—total coliform and *Escherichia coli* (*E. coli*). Total coliform are a general class of bacteria that occupy soils and waters and includes sources from both intestinal tracts of mammals or naturally free-living. *E. coli* are a species of coliform bacteria that are associated with mammal intestinal tracts (humans, cattle, or other warm-blooded animals) and are therefore ideal indicators for fecal contamination. Not all strains are pathogenic, but some are. Even if the *E. coli* detected in the sample is not pathogenic or disease causing, it is serious concern that other sorts of pathogens may also be present in the sample.

The North Coast Basin Plan objective for bacteria cites the California Public Health Department’s draft objective:

“In waters designated for contact recreation (REC-1) the median fecal coliform concentration based on a minimum of not less than 5 samples during a 30-day period, shall not exceed 50/100 ml.....”

These objectives are for fecal coliform, a subclass of coliform that includes *E. coli* and other pathogenic organisms. The QVIR lab tests for total coliforms would generally be expected to run higher than fecal coliform and *E. coli* would be expected to run lower. It has been stated that 60 to 90 % of total coliforms are often fecal and, 90 % of fecal coliforms are *Escherichia* and typically *E. coli* (APHA 1992). However, in our wilderness grazing studies we sample both fecal coliform and *E.coli* and have found *E.coli* to be approximately 50% of the fecal coliforms (Genzoli et al., 2015).

The US EPA in 2012, updated their 1987 criteria to be based on three bacteria concentration components: magnitude, duration and frequency.

*“The **magnitude** of the bacterial indicators are described by both a geometric mean (GM) and a statistical threshold value (STV) for the bacteria samples. The STV approximates the 90th percentile of the water quality distribution and is intended to be a value that should not be exceeded by more than 10 percent of the samples taken. The table summarizes the magnitude component of the recommendations. All three components are explained in more detail in the sections below.*

Criteria Elements	Recommendation 1 (estimated illness rate 36/1000)		Recommendation 2 (estimated illness rate 32/1000)	
Indicator	GM (cfu/100ml)	STV (cfu/100ml)	GM (cfu/100ml)	STV (cfu/100ml)
Enterococci (marine and fresh)	35	130	30	110
E.coli (fresh)	126	410	100	320

Duration and Frequency: *The waterbody GM should not be greater than the selected GM magnitude in any 30-day interval. There should not be greater than a ten percent excursion frequency of the selected STV magnitude in the same 30-day interval.”*

Comparison to these standards may be found in the recently published report by Genzoli et al., *Patterns in Fecal Indicator Bacteria in the Scott River Watershed, 2007-2014*. For this annual 2017 water quality report season we only graphed the data and trends reported in 2017.

Results: *E. coli* counts ranged from zero to over 1000 MPN/100 mL on the mainstem Scott and in the Quartz Valley tributaries. Sniktaw Creek had the highest concentrations, the mainstem Scott sites of the USGS Gaging Station (SRGA) and Jones Beach (SRJB) all had spikes over 100 MPN/100ml putting them at the second highest concentrations of 2017. See results in Figure 14.

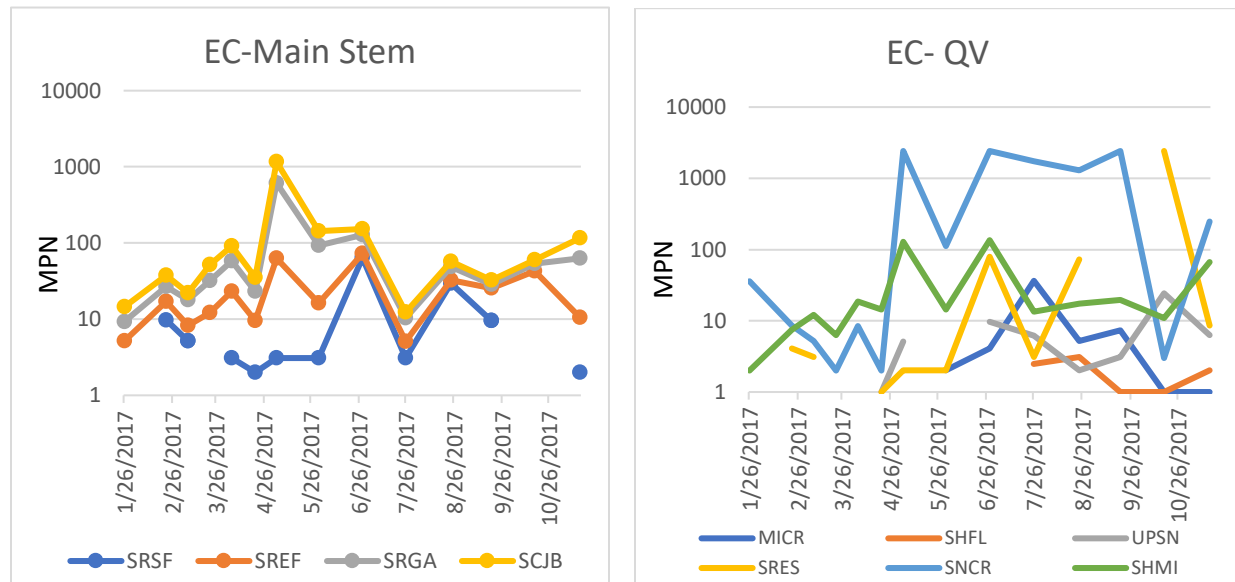


Figure 14 *E. coli* surface water concentrations in the Scott mainstem and Quartz Valley tributaries 2017. Note - this graph is on a logarithmic scale.

The peak for most mainstem sites was mid-April in 2017. The trend of highest concentrations corresponding with increased flows is apparent every year sampled. The South Fork Scott (SRSF) continues to annually be the site with the lowest concentrations on the mainstem Scott.

Concentrations in Quartz Valley depict an increasing trend from May to a peak in July. All sites were within a 100MPN from January to March, after March SNCR and SHMI increase in concentration while all other sites decreased. Sniktaw (SNCR) was nearly 100 times higher than all other sampled locations at the peak (SRES, MICR, SHMI, SHFL, UPSN). Sites SHMI and SNCR are locations at the most downstream location in the agricultural valley and MICR, SHFL, RES are all located upstream of the valley floor and generally have lower concentrations than those sites downstream.

5. Results – Groundwater Wells

Groundwater sampling was conducted approximately monthly on 20 drinking water wells. Collection of water chemistry was performed using the hand held YSI datasonde, and samples were collected and analyzed for total coliform and *E. coli*. The chemistry and bacterial samples were compared to the drinking water standards established by the NCRWQCB (2007) Basin Plan and USEPA (Table 2).

A set of 13 ground water monitoring wells were established in 2011 on the QVIR and were instrumented in 2012 with pressure transducers to provide continuous monitoring of static water level. An additional 3 wells were drilled in 2017.

Bacteria

E. coli was detected in three drinking water wells in 2017 (Table 5).

Approximately half the drinking water wells had detectable levels of total coliform bacteria (Table 6). The soils in the area are recent alluvial deposits and are therefore highly permeable. It is likely that the source of total coliform in the wells was subsurface flow from Shackleford Creek.

Table 5 E.coli results (MPN/100ml) in drinking water wells 2017. Positive wells are highlighted.

	2017											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
12808_Yamitch	0	0	0	0	0	0	0	0	0	0	0	
12817_Yamitch	0	0	0	0	0	0	0	0	0	0	0	
12839_Yamitch	0	0	0	0	0	0	0	0	0	0	0	
12912_Yamitch	0	0	0	0	0	0	0	0	0	0	0	
12920_Yamitch	0	0	0	0	0	0	0	0	0	0	0	
12837_Kuut	0	0	0	0	0	0	0	0	0	0	0	
12929_Kuut	0	P	0	0	0	0	0	0	0	0	0	
13422_Quartz Valley RD	0	0	0	0	0	0	0	0	0	0	0	
13601_QuartzValley RD	0	0	0	0	0	0	0	0	0	0	0	
13605_Quartz Valley RD	0	0	0	0	0	0	0	0	0	0	0	
13616_Quartz Valley RD	0	0	0	0	0	0	0	0	0	0	0	
13824_Quartz Valley RD	0	0	0	0	0	0	0	0	0	0	0	
9009_Big Meadows RD	0	0	0	0	0	0	0	0	P	0	0	
9013_BigMeadows RD	0	0	0	0	0	0	0	0	0	0	0	
9021_Sniktaw	0	0	0	0	0	0	0	0	0	0	0	
9024_Sniktaw	0	0	0	0	0	0	0	0	0	0	0	
9117_Sniktaw	0	0	0	0	0	0	0	0	0	0	0	
9031_Thaxtuuy	0	0	0	0	0	0	0	0	0	0	0	
Cram Gulch		0	0	0	P	0	0	P	0	0	0	
Gymnasium	0	0	0	0	0	0	0	0	0	0	0	

Table 6 Total coliform results (MPN/100ml) in drinking water wells. Wells with counts greater than zero or one are highlighted.

	2017											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
12808_Yamitch	0	0	0	P	0	0	0	0	0	0	0	P
12817_Yamitch	0	0	P	P	0	0	0	0	0	0	0	0
12839_Yamitch	0	0	0	0	0	0	0	0	0	0	0	0
12912_Yamitch	0	0	0	0	0	0	0	0	0	P	0	0
12920_Yamitch	0	0	0	0	0	0	0	0	0	P	0	0
12837_Kuut	P	0	0	0	0	0	0	0	P	0	0	0
12929_Kuut	0	P	P	0	0	0	0	0	0	0	0	0
13422_Quartz Valley RD	0	0	0	0	P	P	0	0	P	0	P	0
13601_Quartz Valley RD	0	0	0	0	0	0	0	0	0	0	0	0
13605_Quartz Valley RD	0	0	0	0	0	0	0	0	0	0	0	0
13616_Quartz Valley RD	0	0	0	0	0	0	0	0	0	0	0	0
13824_Quartz Valley RD	0	0	0	0	P	P	0	0	P	0	0	P
9009_Big Meadows RD	0	0	0	0	0	0	0	0	P	0	P	0
9013_BigMeadows RD	0	0	0	0	0	0	0	0	0	0	0	0
9021_Sniktaw	0	0	0	0	0	0	0	0	0	0	0	0
9024_Sniktaw	0	0	0	0	0	0	P	0	0	0	0	0
9117_Sniktaw	0	0	0	0	0	0	0	0	0	0	0	P
9031_Thaxtuuy	0	0	0	0	0	0	0	0	0	0	0	0
Cram Gulch	0	0	0	0	0	0	0	P	P	0	P	0
Gymnasium	0	0	0	0	0	0	0	0	0	0	0	0

Ground water chemistry

YSI data for groundwater chemistry indicates that all wells are annually consistent over time. A few wells annually indicate a much different pattern from the majority of wells.

pH

Drinking water pH ranged from 6 to 7.5 among most of the wells (Figure 15). The RWB Basin Plan thresholds for groundwater pH range from 7 to 8 (Table 2), therefore those below pH 7 are below the standard (see redline standard in Figure 15). It may be naturally occurring due to substrate type, however this has not been investigated. September was the lowest pH values, and significantly lower, on every well with the exception of 12817 Yamitch.

These patterns in groundwater pH are consistent with the past 10 years of monitoring.

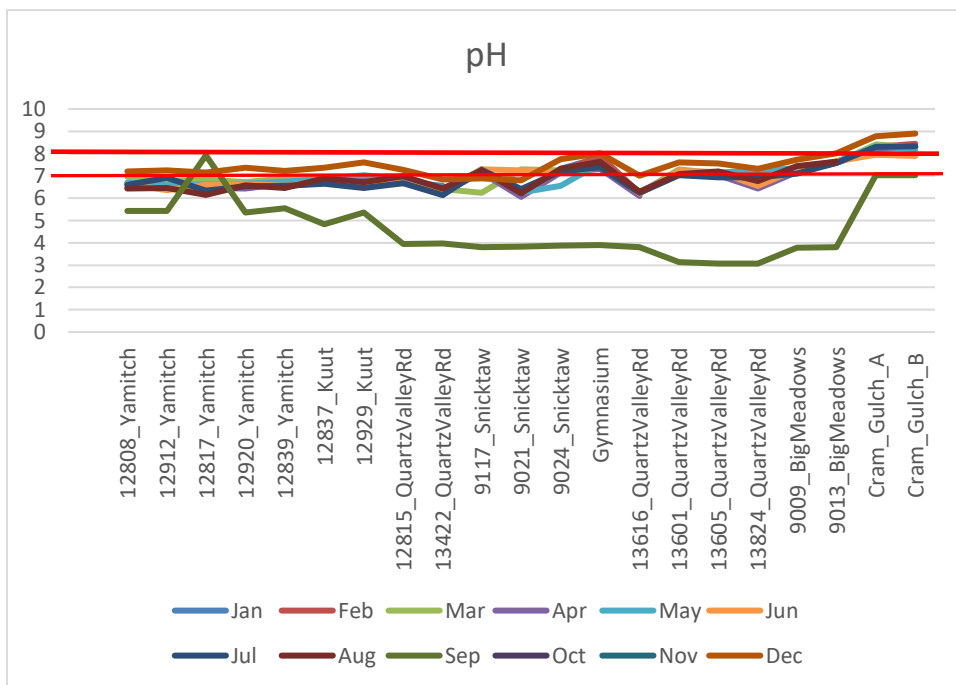


Figure 15 pH of drinking water wells 2017, Quartz Valley, CA

Temperature

Temperature of most well water was constant over time, from January through December, five wells began to fluctuate outside their normally consistent temperatures (Figure 16), this is consistent with previous years data and probably indicates these wells are more influenced by surface water and the temperature variations that occur seasonally in the nearby Shackleford and Sniktaw Creeks.

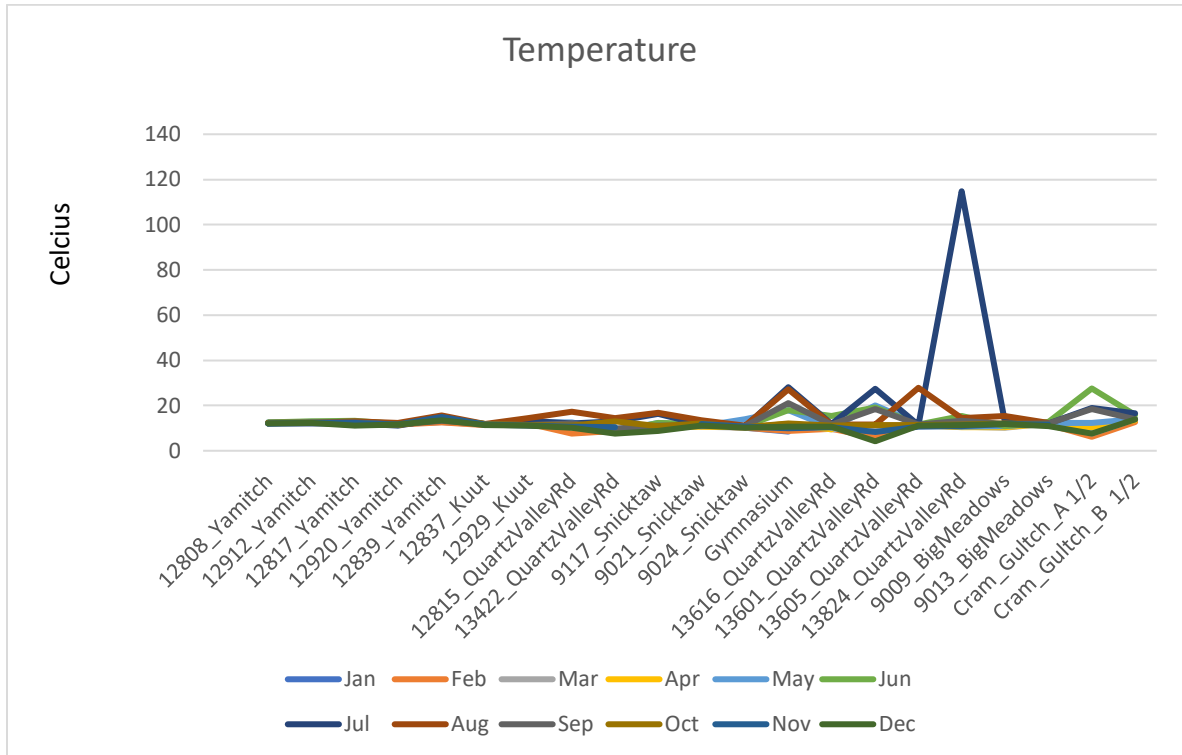


Figure 16 Temperature of drinking water wells 2017, Quartz Valley, CA.

Specific Conductivity

Specific conductivity in groundwater had little seasonal variation (Figure 17). Most wells ranged from 0.02 to 1.88 mS/cm most of the year. Fifteen out of 21 wells were below the threshold of < 50 % of samples falling below 0.25 mS/cm. Wells with higher conductivity suggest high dissolved solids may be present.

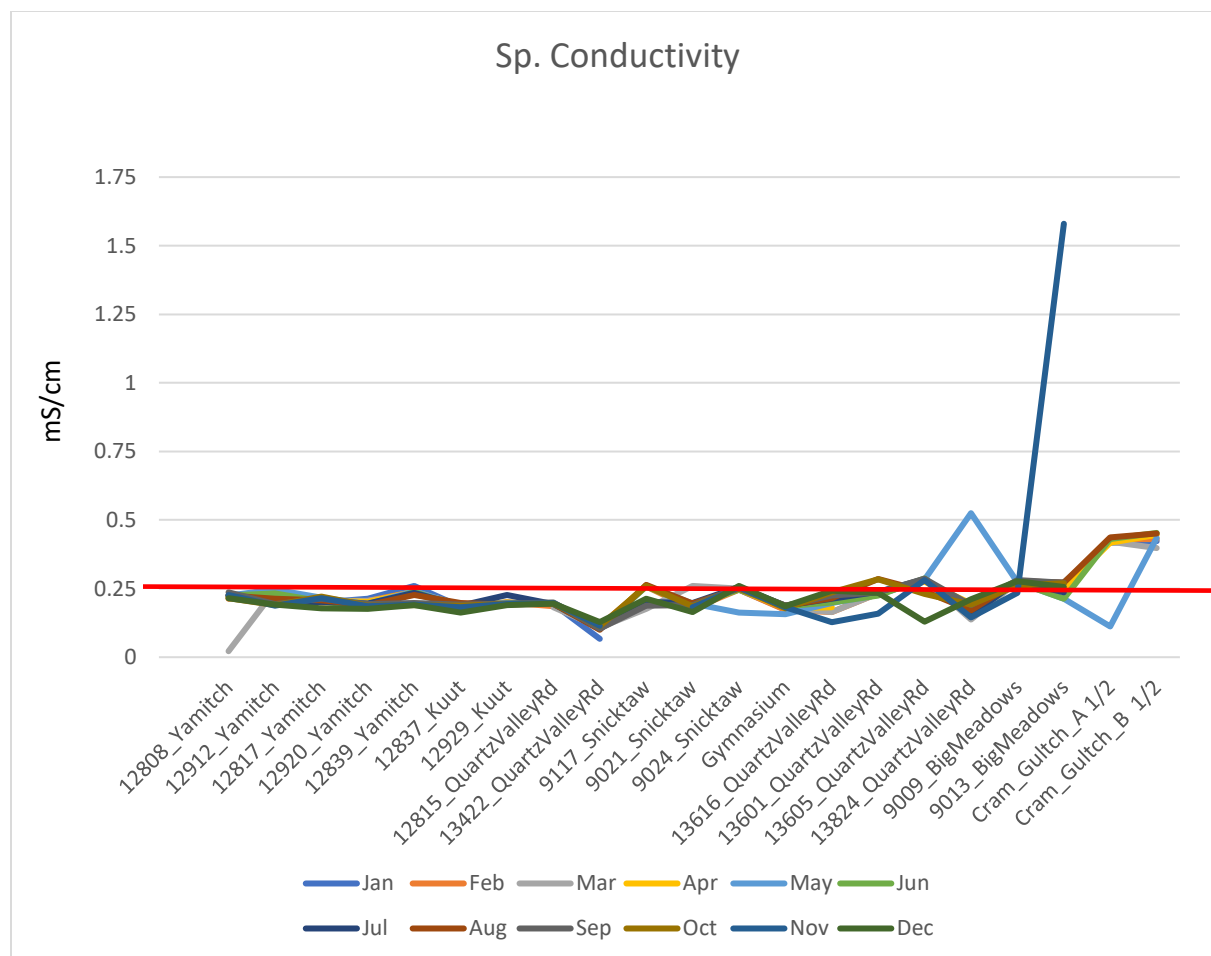


Figure 17 Specific conductivity in drinking water 2017 Quartz Valley, CA. Red line = RWQCB threshold for groundwater in the Scott River basin.

Dissolved Oxygen

Dissolved oxygen was generally above 4mg/L in most wells for most of the sampling season. The Gymnasium and Big Meadows Road wells have been observed at lower levels for the past five years. Cram Gulch is located in Shasta Valley and has a different geology than the Quartz Valley wells so the levels are expected to be different. More variability month to month appears to be occurring in the wells near creeks suggesting a groundwater surface water interaction. Yamitch wells are near Shackleford Creek and Quartz Valley Road and Big Meadows are near Sniktaw Creek, these wells have more variable dissolved oxygen levels than the Sniktaw Road wells which are further from the creek. See results in Figure 18.

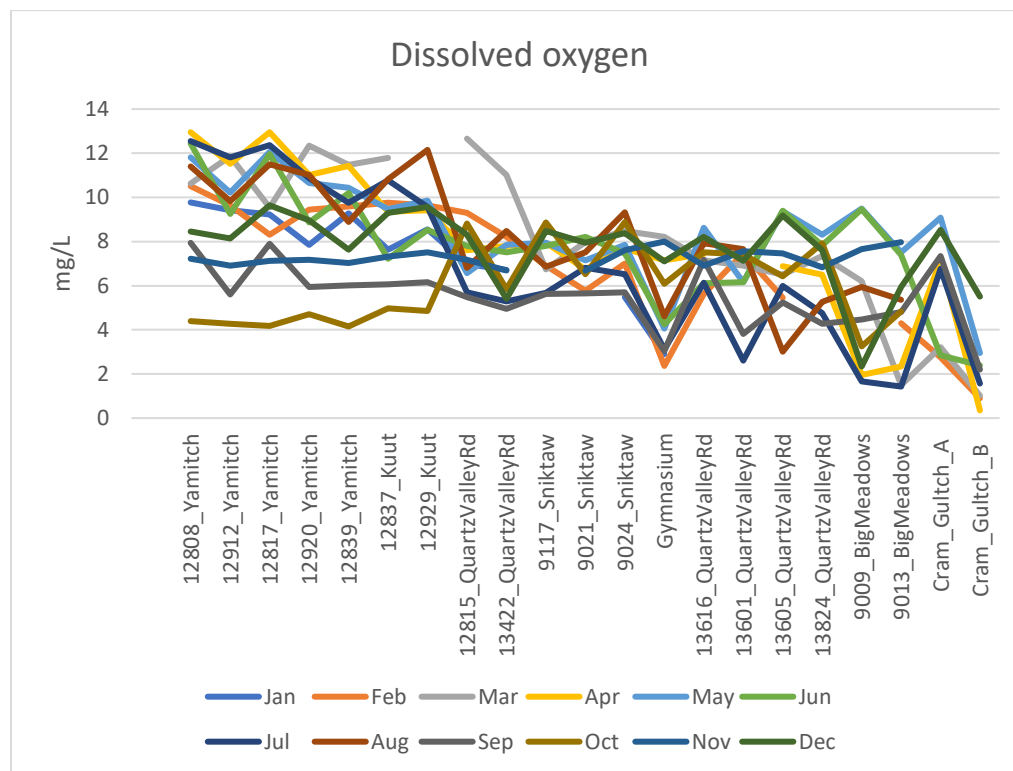
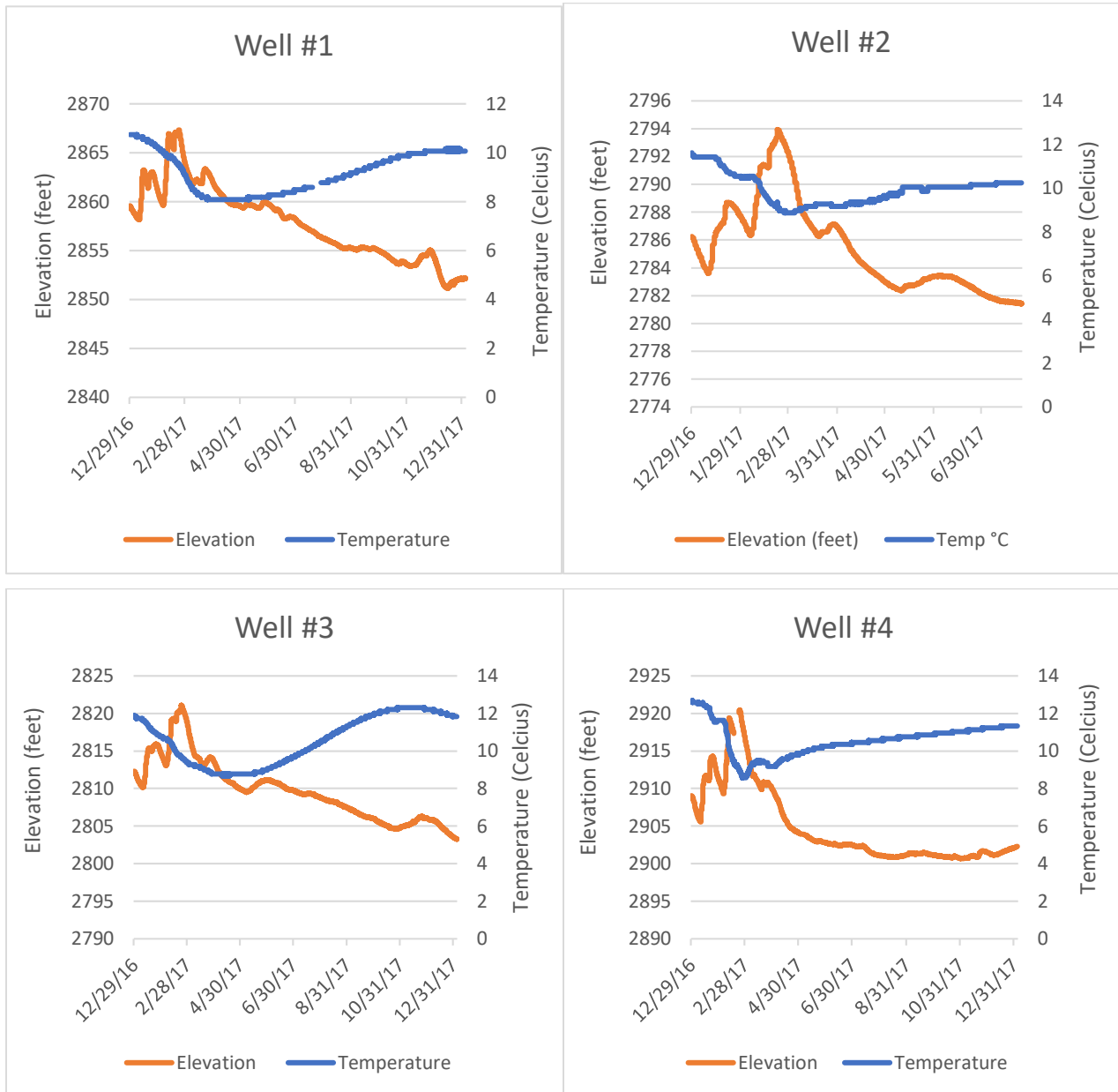


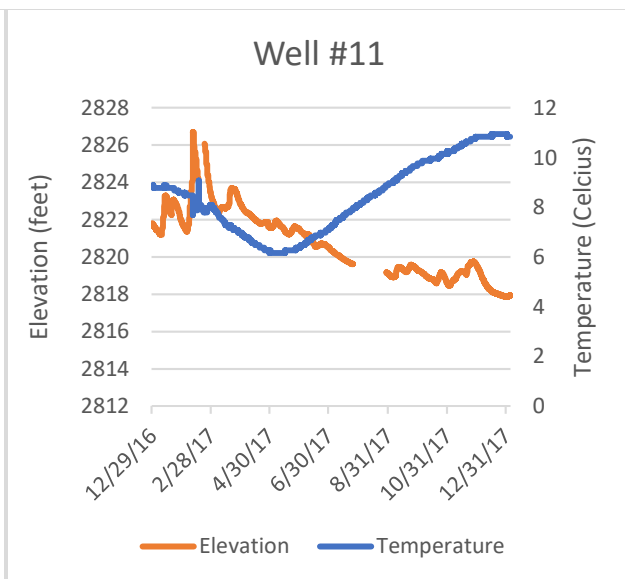
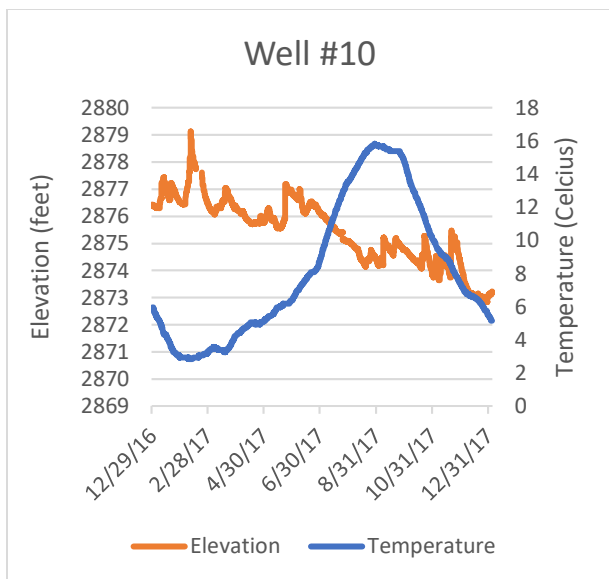
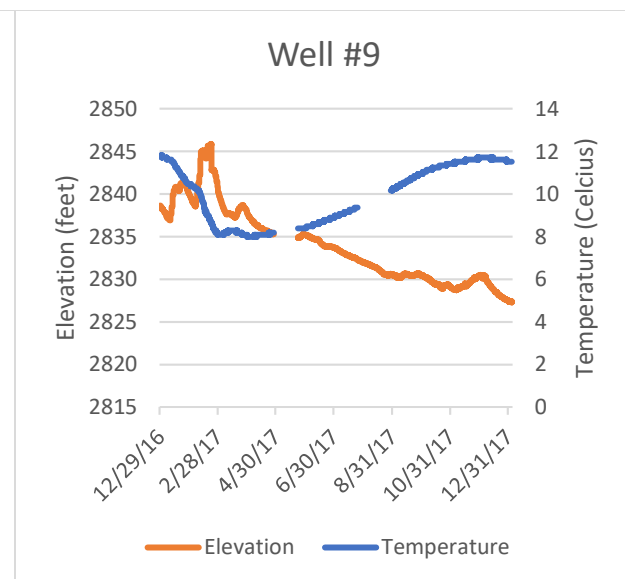
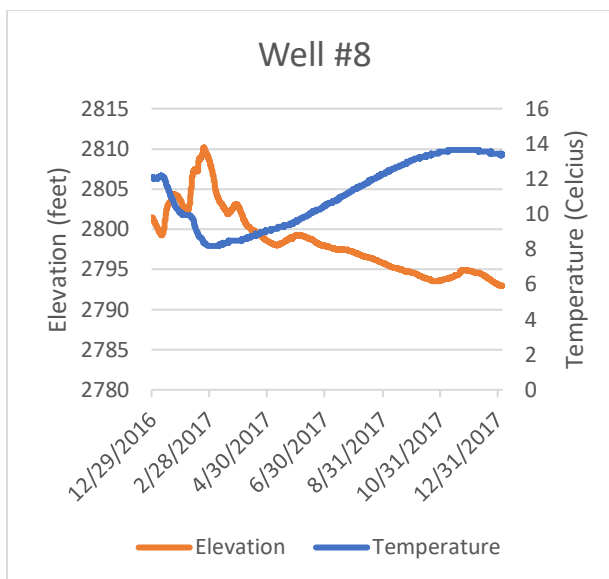
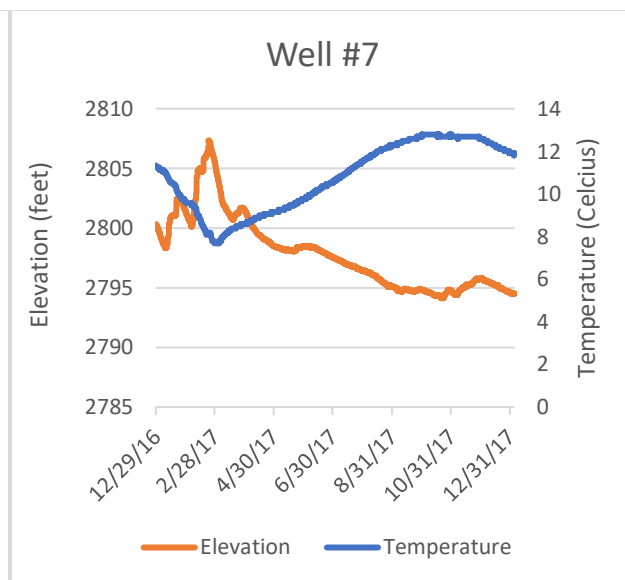
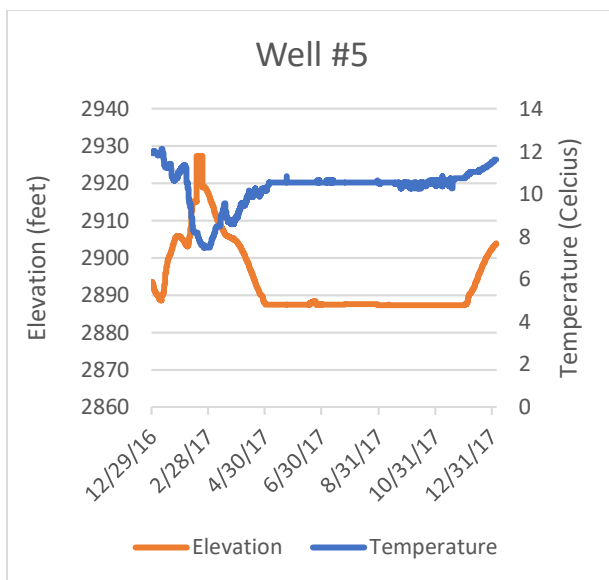
Figure 18 Percent Dissolved Oxygen in drinking water 2017 Quartz Valley, CA

Continuous Static Water Level

The following graphs depict the static groundwater level for the calendar year 2017. The wells vary topographically across the valley floor, the lowest elevation well is at 2795 ft and the highest is at 2927 ft above sea level, see Figure 2.

During the winter of 2016-2017, recharge varies according to the well's topographic elevation, as expected. Base flow groundwater elevations were higher during 2017 for all wells. The winter months experienced much more snow fall than the previous two drought years which increased the static water level and decreased the magnitude and duration of baseflow.





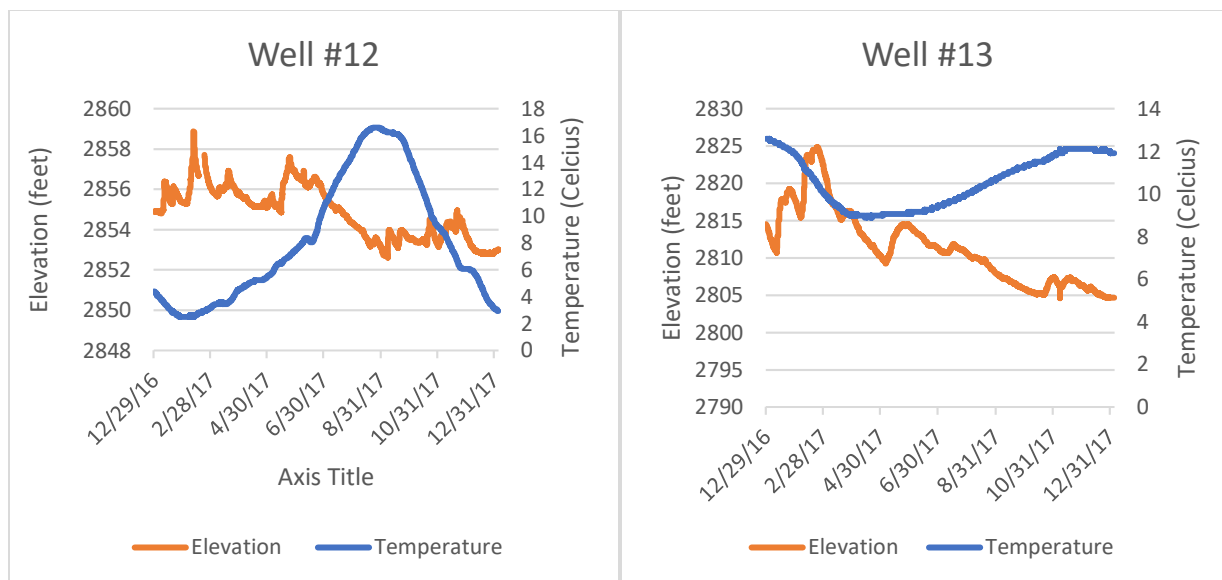


Figure 19 Static water elevation Quartz Valley, CA 2017.

6. Overall Integrated Summary

The nutrient water quality trends during 2017 were similar to those collected in previous years depicting the Quartz Valley tributaries sites as having a much lower concentration than the mainstem downstream of Callahan, with the exception of total phosphorus. Nutrient concentrations were a bit higher this year than 2016 with the peaks occurring earlier during baseflow, opposed to in the fall, as seen in 2016.

Bacteria was more variable in the tributaries than the mainstem in 2017, this trend is consistent across all sampling years. *E. coli* should continue to be closely monitored as it appears to pose seasonal public health threats for contact recreation at Sniktaw Creek and Jones Beach.

Groundwater quality was generally good with few outliers. *E.coli* was detected in three drinking water wells this year. Static groundwater elevations reached recharge levels in 2017 to conditions not seen since 2012.

Overall, water quality in the tributaries is much more suitable to salmonids than the mainstem. Tributaries are usually much cooler while the mainstem Scott River reaches summer time temperatures over 20 C. However, the tributaries along the west side of the valley disconnect from the mainstem as flow goes subsurface into the large alluvial deposits occurring at the tributaries confluence with the mainstem Scott, this can cause issues for adult and juvenile fish trying to access suitable habitats for spawning or rearing.

One of the greatest challenges to Shackleford Creek is that it does not maintain flow over the entire year. Observations for the past 10 years note the section at Quartz Valley Road at the Reservation has been going dry approximately the second to third week of July for three months or more (depending on fall rains). Coho and steelhead juveniles continue to be stranded in pools maintained by subsurface flow until those ultimately dry up as well. Flow typically remains constant through the baseflow season at the confluence with Mill Creek (~1 mile downstream of the Reservation). However, the confluence of Shackleford with the Scott River also goes subsurface year after year. We hypothesize this may be more a factor related to groundwater levels in the mainstem Scott

opposed to levels in Quartz Valley since Mill Creek does remain flowing through baseflow and groundwater pumping in Quartz Valley is relatively low.

Providing enough water for healthy fish production would be the most important management priority for the Reservation. Developing water management strategies to meet the needs of salmonids and farms is becoming more feasible with each year data is collected. Shackleford and Mill Creek surface flow data conducted by DWR from 2004 to present and the groundwater array the Tribe operates will serve as valuable information in the development of such a plan. Understanding water storage opportunities continues to be at the top of the list of recommended approaches to meeting the Tribal communities water needs.

7. Future Sampling

Surface water

Water chemistry will be monitored using the continuous recording datasonde at the gage site. Grab samples will also continue for chemistry and bacteria. The Hobo temperature array will be continued with minor modifications to sites selected.

Groundwater

Continuous groundwater probes will continue, and funding has been granted for three new locations: one on Sniktaw Creek another on Shackleford (this will contain real-time data acquisition) and another near lower Shackleford/Mill Creek, this will improve the spatial resolution of Quartz Valley's groundwater basin.

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