Quartz Valley Indian Reservation

Water Quality Monitoring and Assessment Report 2013

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- US Environmental Protection Agency (US EPA)
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- Klamath Basin Tribal Water Quality Workgroup

Cover photo: Shackleford Creek entering the Scott River Mainstem

Table of Contents

List of Tables

List of Figures

1. Introduction

This document describes the water quality monitoring performed during 2013 by the Quartz Valley Indian Reservation (QVIR) Environmental Department. Our work is funded by Federal grants from the U.S. Environmental Protection Agency (USEPA) 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 help 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 will be updated in 2014. 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 *Basin Plan*, Scott River Objective
		7	8.5	
Conductivity	mS/cm	50% Upper Limit	90% Upper Limit	North Coast Regional Water Quality Control Board (NCRWQCB). 2007 *Basin Plan*, 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 *Basin Plan*, 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	
E. coli	MPN/ 100 ml	1 MPN or Presence		US EPA 2006.

2. Methods

As mentioned above, we have developed a Quality Assurance Project Plan (QVIR 2006a) 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 2013.

Our major collection effort in 2013 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 the 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 eight water quality parameters: total nitrogen, nitrate plus nitrite, total phosphorus, bacteria (*E. coli* and total coliform), pH, dissolved oxygen, and specific conductivity. 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 certified and 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.

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 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 2006a).

The distribution of our surface water sampling array for both water chemistry and temperature 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 ground water static 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.

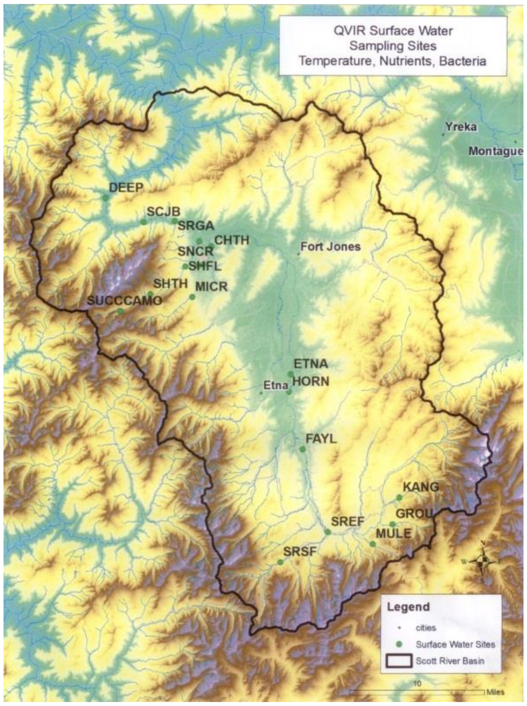


Figure 1 Surface water quality sampling locations 2013

Table 3 Surface water sampling sites 2013

Site Code	Location	Type of sample	River mi [1]
DEEP	Deep Creek mouth	Temp	0.1
SRJB	Scott River at Jones Beach	Temp, Grab	19
SRGA	Scott River at the USGS Gage	Temp, Datasonde, Grab	22
ELLER	Scott River at Eller Lane	Grab	38
HORN	Scott River at Horn Lane	Grab	42
SREF	Scott River East Fork	Temp, Grab	0.5
SRSF	Scott River South Fork	Temp, Grab	7
SHML	Lower Shackleford - Mill	Temp, Grab	2
SNCR	Sniktaw Creek	Temp, Grab	2
SHFL	Shackleford at Falls	Temp, Grab	4
MICR	Mill Creek at valley floor	Temp, Grab	7
SHTH	Shackleford at trailhead	Temp	9
CAMO	Campbell Lake outlet	Temp	11
SUCC	Summit Lake outlet	Temp	11
KANG	Kangaroo Creek	Temp	1.5
GROU	Grouse Creek	Temp	1.5

[1] from Klamath River or confluence with Scott for tributaries.

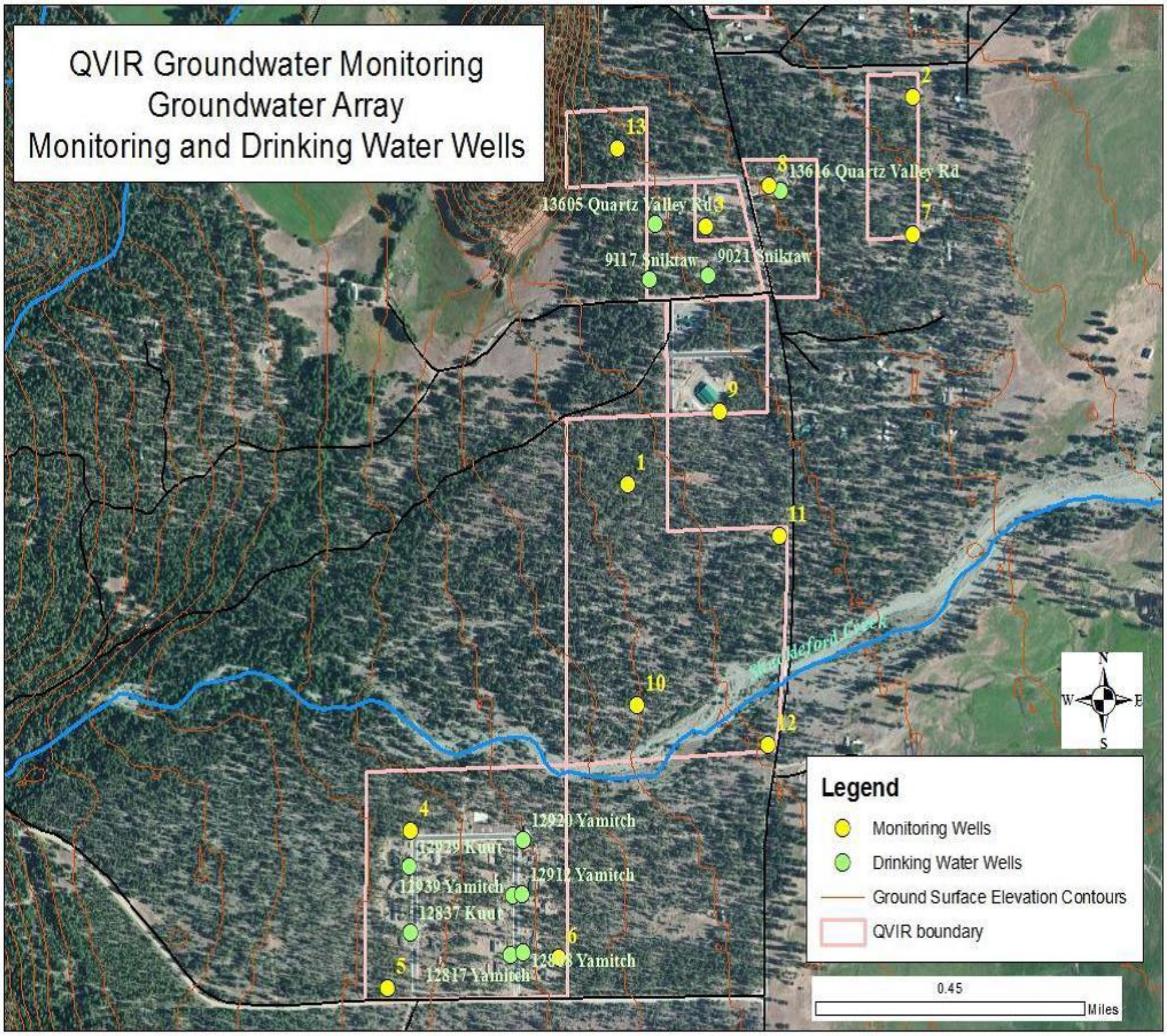


Figure 2 Locations of groundwater wells monitored in 2013

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 landuse (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. Included here for reference is the daily air temperatures recorded at the Montague airport, Figure 3.

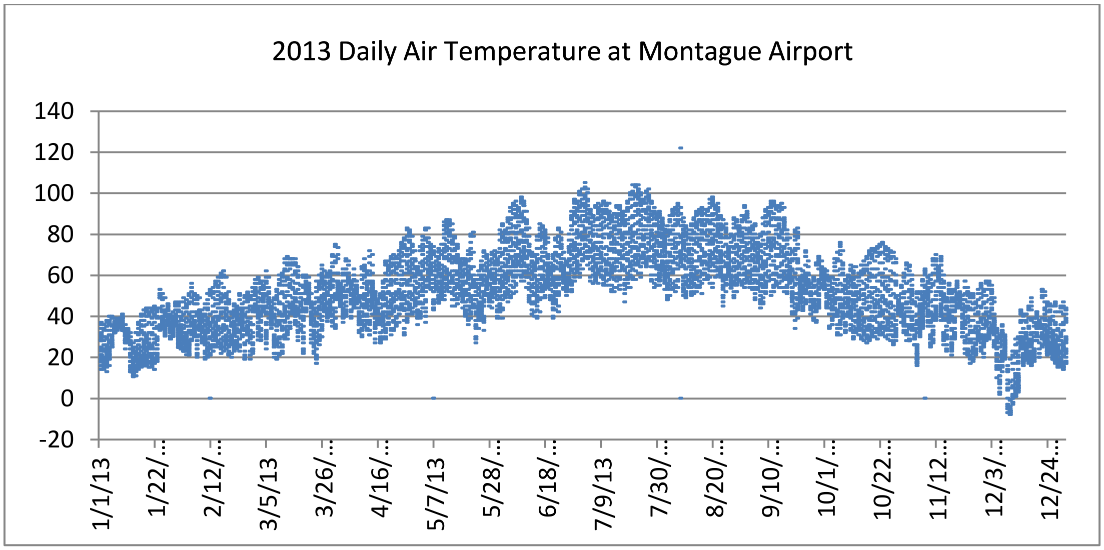


Figure 3 Hourly air temperatures for 2013 from the Montague Airport, CA

There is also substantial groundwater seepage that occurs in the basin. Forward Looking Infrared Surveys from 2003 and 2006 identify many locations were there is regional cooling of water temperature due to these seeps (see Figure 4).

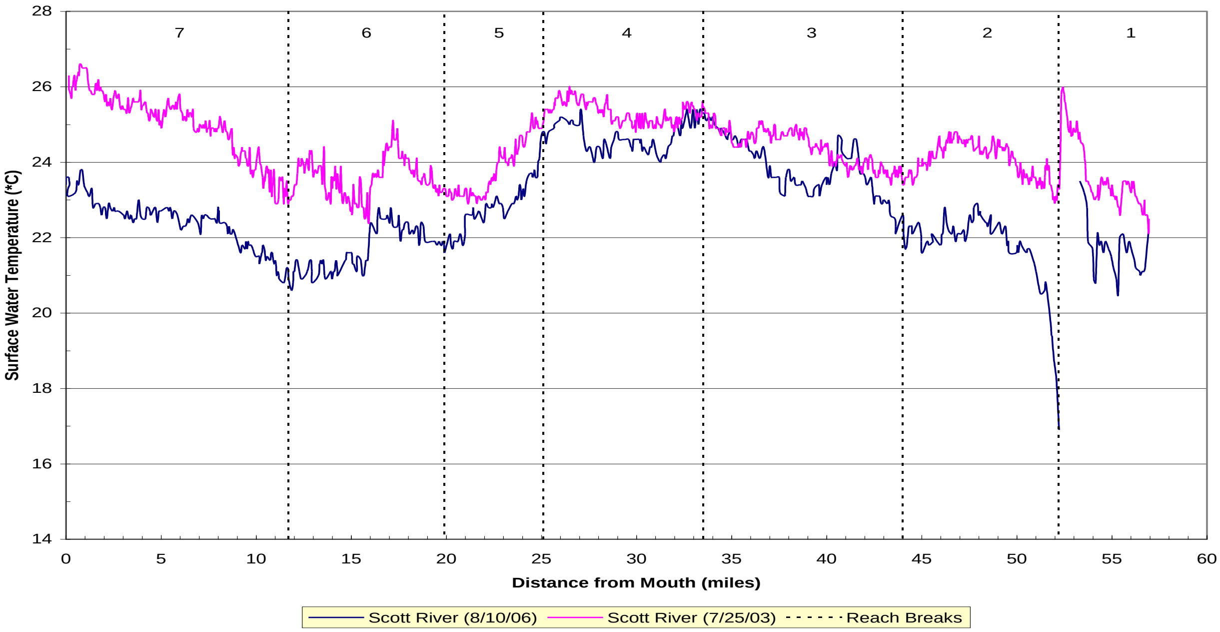


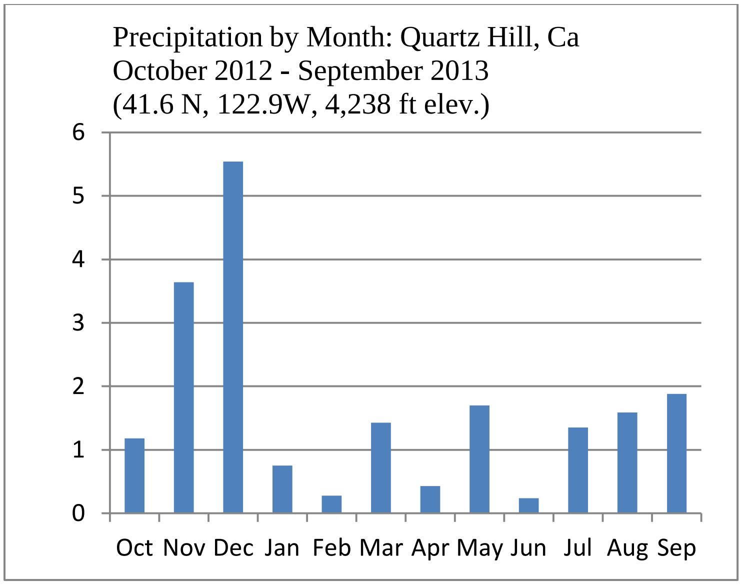
Figure 4 A comparison of median surface water temperature in the Scott River mainstem measured on 08/10/2006 and 07/25/2003 (Watershed Sciences, 2007)

The past year rainfall (2013) from Quartz Hill summed to just over 20 inches (Figure 5). The months of November and December had the largest amounts of precipitation and these are evident in the peak flows shown on the hydrograph on the Scott River (Figure 8).

Figure 5 Precipitation at Quartz Hill for 2013 water year (October 2012 to September 2013) was low, summing to just over 20 inches.

Data available at:

http://cdec.water.ca.gov/histPlot/DataPlotter.jsp?staid=QTZ&sensor_no=2&duration=H&start=10/20/2012+00:00&end=11/20/2012+14:37&geom=small



Snow fall in 2013 was drastically lower than previous years, measuring only a few inches, see Figure 6. A steady decline is also noted over the past 5 years and the lack of snowpack has a significant negative effect on late summer and fall baseflows.

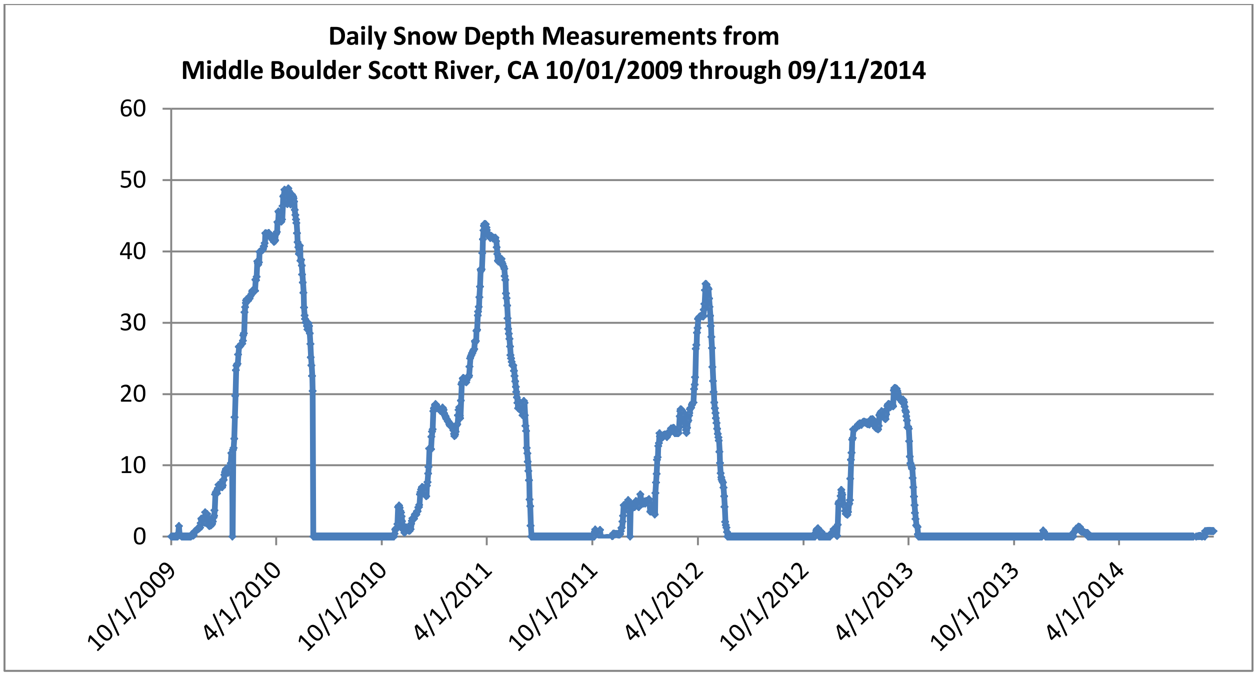


Figure 6 A comparison of snow depths at the Scott mainstem headwater near Callahan from WY 2009 to WY 2014.

Data available at the following link:

http://cdec.water.ca.gov/cgi-progs/snow/PAGE6

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 7). This shows a fairly 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 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 8). 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. The last four years of stream discharge show the same downward trend in peak and low flows as expected based on the snow pack data (Figure 6).

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.

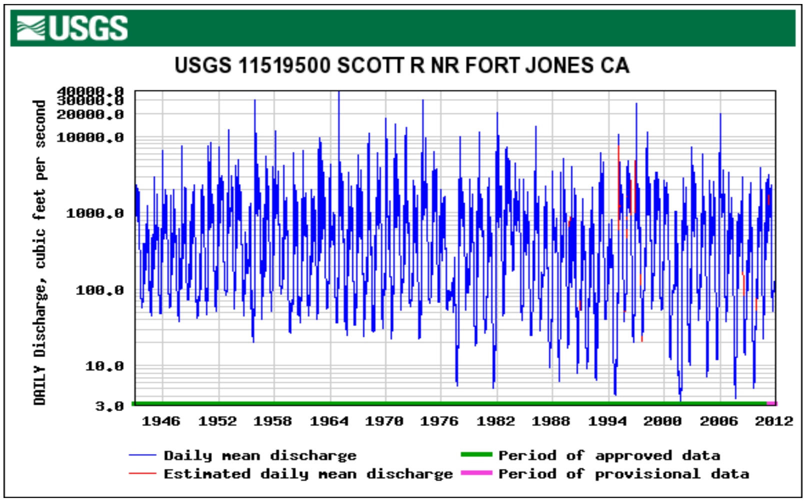


Figure 7 Scott River Discharge since 1942 at the Scott River USGS Gaging Station

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 1955, 1964, 1978, 1982, 1996, and 2006. A shift appears to occur at 1977 when extremely low flows began to occur with greater frequency.

http://waterdata.usgs.gov/ca/nwis/uv?site_no=11519500

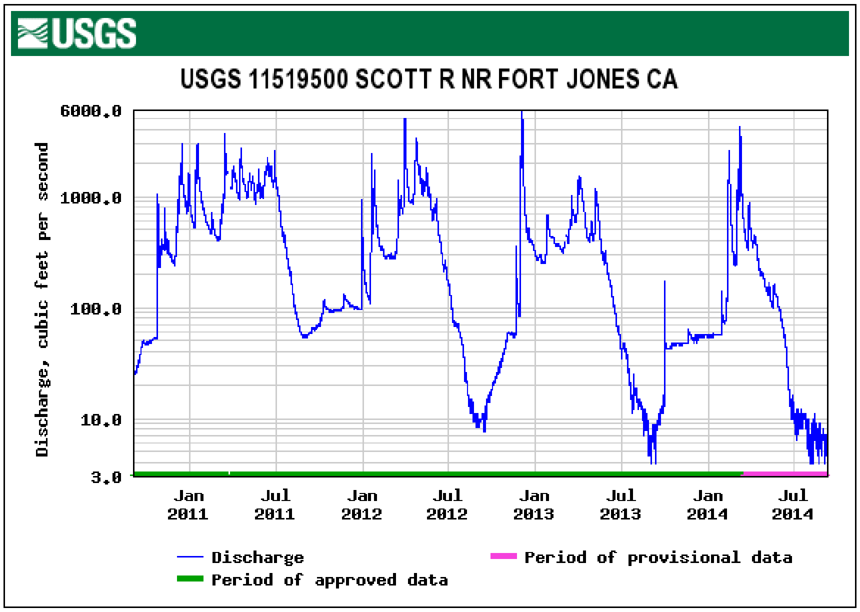


Figure 8 Scott River Discharge WY 2010-2013 at the Scott River USGS Gaging Station

These four water years depict the typical annual variation in low flow in summer-time. Fall of 2011 had a low base flow of 50 cfs, the fall of 2012 was around 9 cfs and 2013 was around 4 cfs.

http://waterdata.usgs.gov/ca/nwis/uv?site_no=11519500

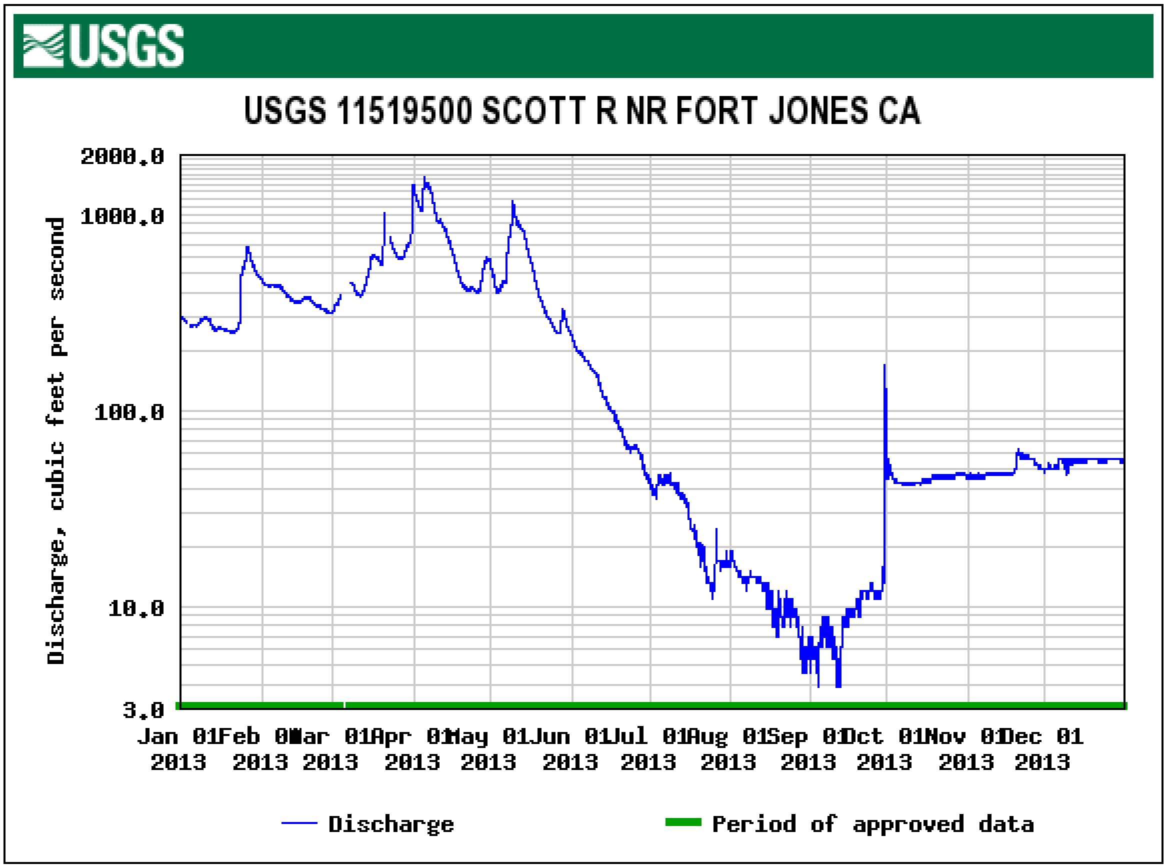


Figure 9 Scott River streamflow for 2013 depicts winter storm discharge increases throughout January and March, flows peaking at 1500 cfs in April during spring runoff from snowmelt, and a declining trend through base flow with the lowest flows at 4 cfs in October. http://waterdata.usgs.gov/ca/nwis/uv?site_no=11519500

4. Results – Surface Water

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 and depict a pattern of stream warming as elevation drops, this directly corresponds to the increasing air temperature as well as decreasing flows as elevation drops from the wilderness to the agriculturally dominated valley.

Tributaries above 3,000 feet were generally around 16° C. Exceptions were the outlet of Campbell Lake in the Wilderness. This lake is located directly downsteam of Cliff Lake, likely reasoning would be a "double warming" effect of those waters being stagnant twice before discharging into Shackleford. Other exceptions include the East Fork of the Scott River and Grouse Creek with MWAT's of 22.9 and 19.2 respectively.

Tributaries below 3,000 feet had MWATs between 15 and 18 C showing the importance of the tributaries as summertime cool water sources to the mainstem Scott River.

The MWATs were up very similar to those of 2012. Because of the large number of graphs, the continuous stream temperature monitoring data are available upon request.

Table 4Maximum weekly average temperature for surface waters in the Scott Basin 2013

Surface water site	MWAT (C)	Elevation (ft)
Summit Lake outlet	16.2	6,000
Campbell Lake outlet	18.3	5,000
Shackleford Cr trailhead	15.1	4,600
Mill Cr	14.9	3,000
Shackleford Falls	16.3	3,000
Sniktaw Cr	16.3	2,750
South Fork Scott R	15.5	3,750
Kangaroo Cr	13.8	4,000
Grouse Cr	19.2	3,900
East Fork Scott R	22.9	3,160
Deep Cr	18.5	2,200

Nitrogen and phosphorus

Background: Nitrogen is an important 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 leachfields, 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 sometime 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 considered to be about 1/5 to 1/3 the amount of total N.

Phosphorus (P) is also an important element for living systems; it is a product of mineral weathering and is found naturally in the soil, though at somewhat low levels. Total P includes all forms of dissolved phosphorus and includes organic and also 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.

Results: Nutrients were sampled bi-monthly during the growing season of 2013 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 N and NO_3+NO_2) and phosphorus (Total P). The Total N (TN) results of our summer grab samples in streams indicated that the tributaries are generally low in nitrogen, Sniktaw Creek being the exception; however, the locations in the Scott River below Callahan have elevated nitrogen (Figures 10 and 11). The tributaries are also generally low in Total P (TP) except for Sniktaw Creek (Figure 13) and, as with nitrogen, the mainstem locations downstream of Callahan (Figures 14 and 15). Trend analysis by site is described following each graph (Figures 10-15).

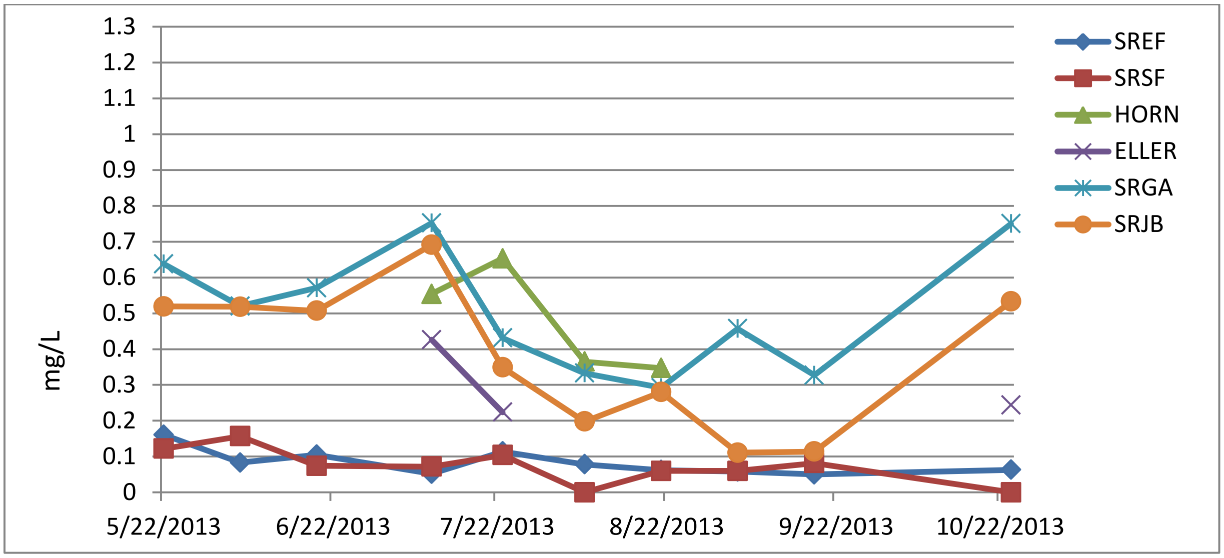


Figure 10 Total Nitrogen concentrations in surface waters of the Scott mainstem 2013

The south fork (SRSF) and east fork (SREF) Scott TN shows a stable trend of higher concentrations in the spring gradually declining as the season progresses. The highest values all season are at the Scott River Gage (SRGA) with the exception of three samples (July through beginning of August) from the mainstem at Horn Lane (HORN). HORN was only sampled four times in the season and three of the four were the highest concentrations collected on the mainstem Scott that particular sampling day. Mainstem concentration trends begin high in May, gradually rise in late June, and in general decline until a spike on the last sample event in October. SRSF and SREF are the only sites within our standard.

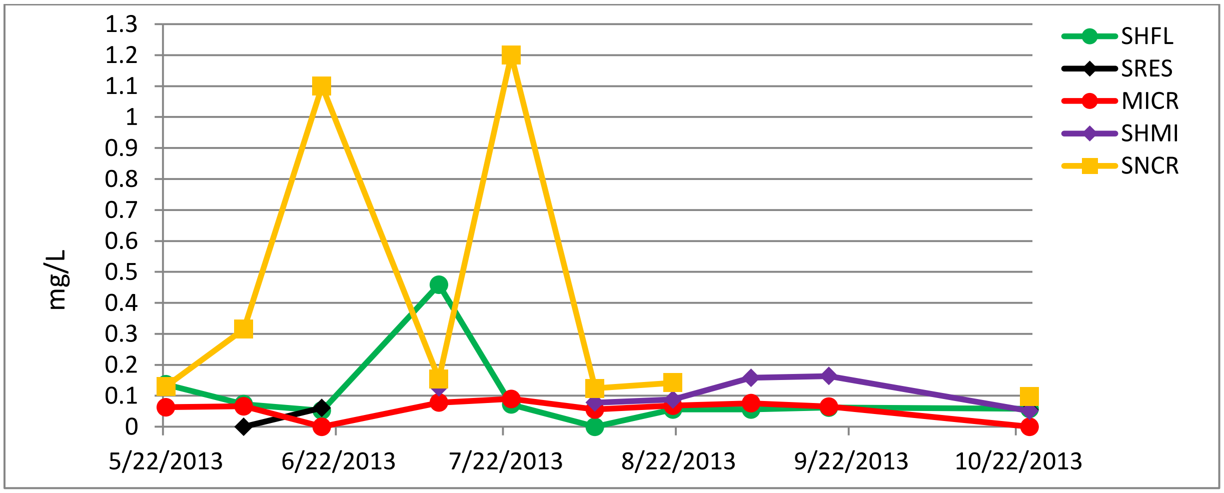


Figure 11 Total Nitrogen in surface waters of Quartz Valley tributaries 2013

TN in the Quartz Valley tributaries tends to be right around our water quality standard of 0.12ug/L, with the exception of Sniktaw Creek (SNCR), (ten times the standard) and one sampling event at Shackelford Falls (SHFL). Shackleford downstream of Mill Creek (SHMI) also had a few sample events exceeding this standard in late August and early September.

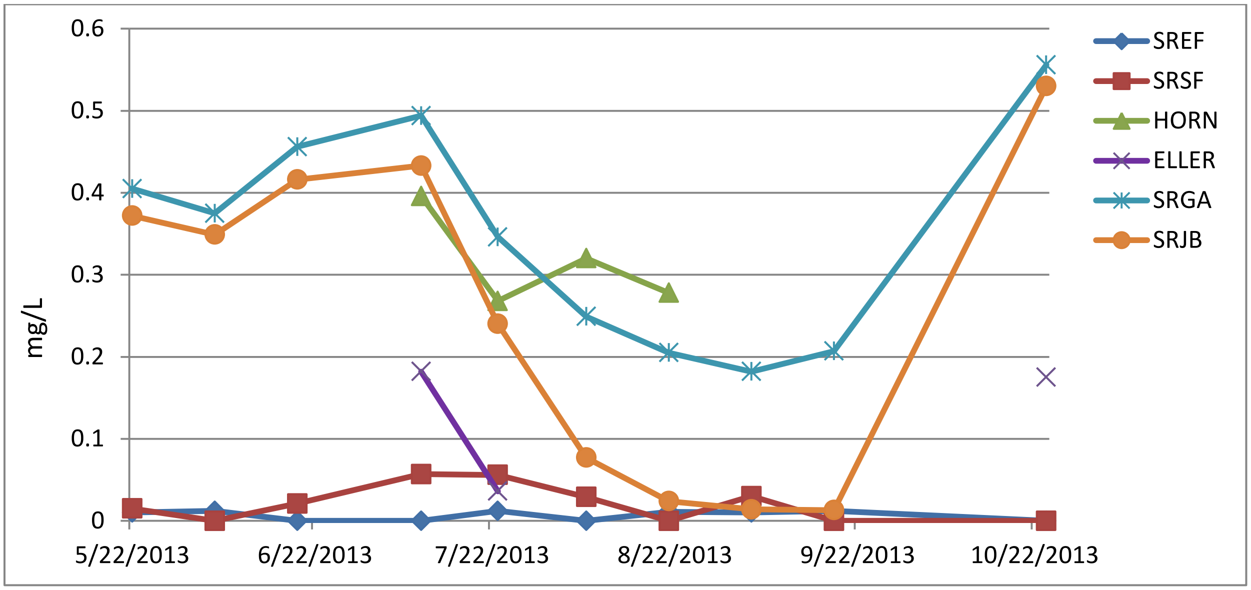


Figure 12 Nitrate + Nitrite concentrations in surface waters of the Scott mainstem 2013

Nitrate+Nitrite concentrations, as expected, follow a similar trend to TN. Concentrations are much higher on the mainstem below Callahan (HORN, ELLR and SRGA and SRJB) than in the forks above the confluence (SREF and SRSF). Levels begin high in May, peak at the end of June and gradually decline until our last sample event in October when levels spike to the highest concentration observed all sampling season.

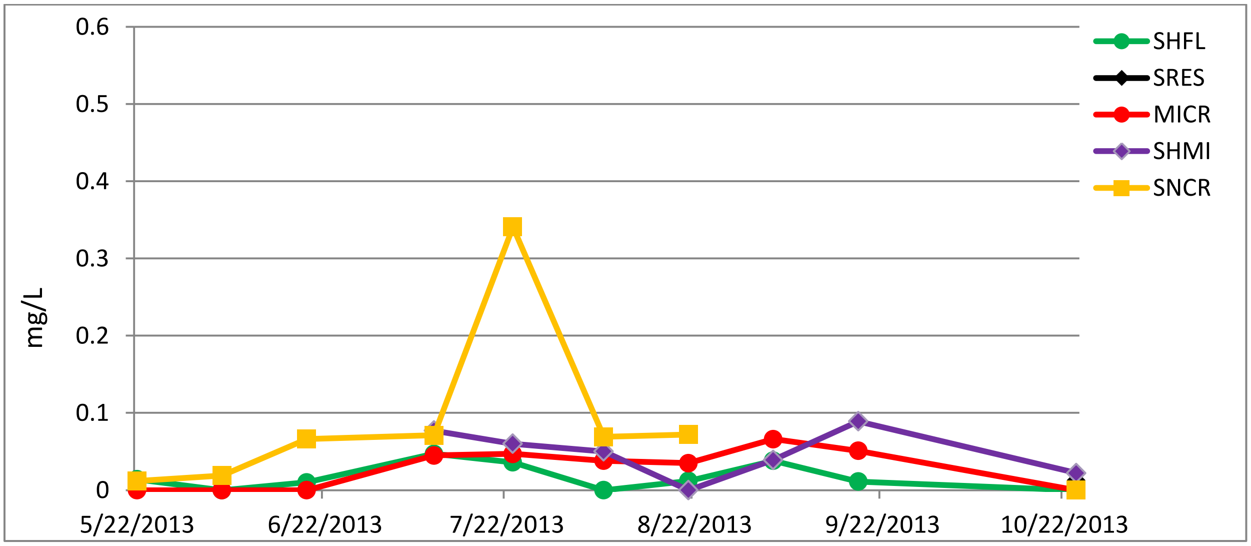


Figure 13 Nitrate + Nitrite concentrations in surface waters of Quartz Valley tributaries 2013

Nitrate+Nitrite concentrations also follow a similar trend to TN in Quartz Valley tributaries. The highest concentration was observed at Sniktaw Creek (SNCR) in July, three times higher than all other sampling site events, a concentration more similar to the mainstem Scott than other tributaries in Quartz Valley.

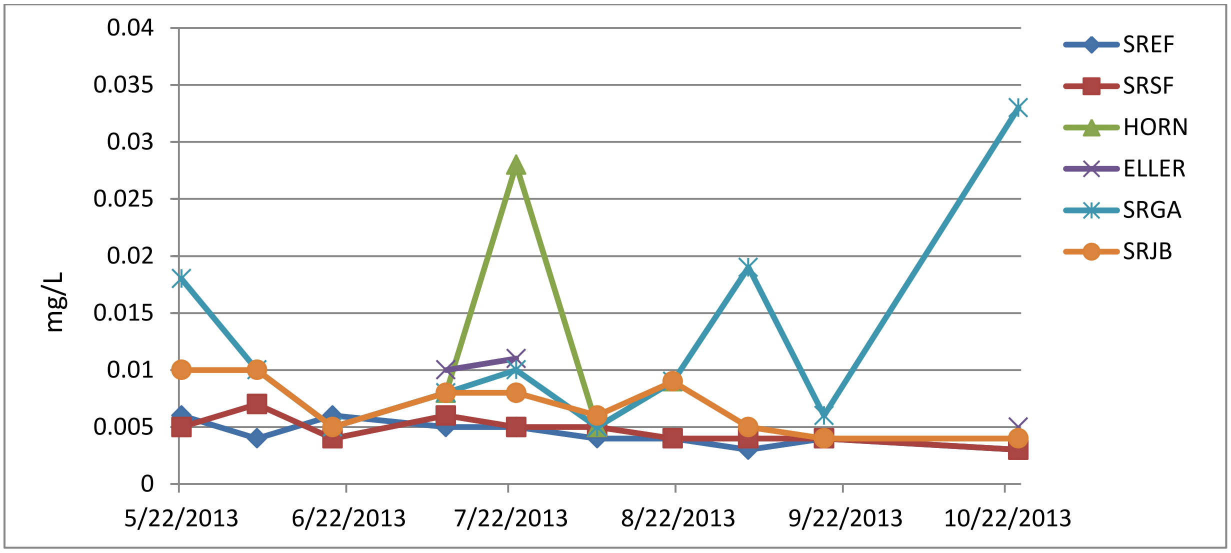


Figure 14 Total Phosphorus concentrations in surface waters of the Scott mainstem 2013

TP concentrations in the mainstem Scott remain relatively steady upstream of the valley floor in the east (SREF) and south fork (SRSF) locations. Three sites in 2013 exceeded our standard of 0.01 mg/L: ELLER, HORN and SRGA. Upstream of Callahan on the east and south fork concentrations were within the standard, as well as at Jones Beach (SRJB).

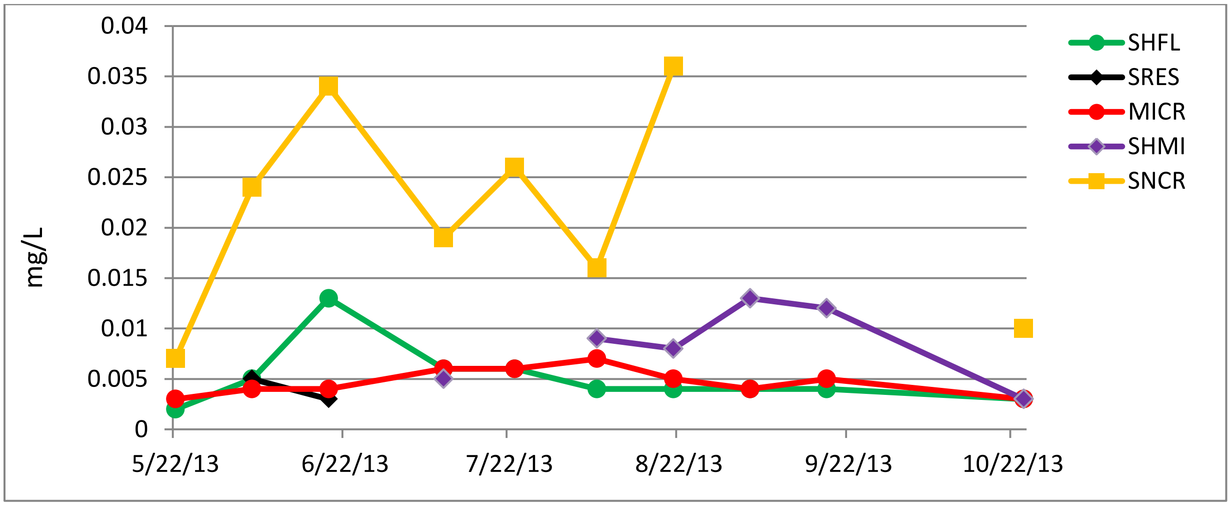


Figure 15 Total Phosphorus concentrations in surface waters of the Quartz Valley tributaries 2013

TP concentrations in the tributaries draining Quartz Valley depict a trend of the highest concentrations at the downstream end of the valley prior to entering the Scott River (site codes: SNCR and SHMI) and lowest concentrations at the most upstream sampling points prior to entering the agricultural fields (site codes SHFL, MICR and SRES). SNCR, SHMI and SHFL all exceeded our standard at least once during the 2013 sampling season.

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 samples, total coliforms were commonly 1,000 MPN/100 ml whereas E. coli were typically 100 MPN/100 ml.

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."*

During the 2013 season we did not sample at the frequency needed to compare to these standards, the data is only graphed and trends reported.

Results: *E. coli* counts ranged from zero to over 328 MPN/100 mL on the mainstem Scott (Figure 16) and zero to 2,500 in the Quartz Valley tributaries (Figure 17). Sniktaw Creek had the highest concentrations, the mainstem Scott sites of south fork, east fork, Horn and Eller lane all had spikes over 100 MPN/100ml putting them at the second highest concentrations of 2013. Tributary concentrations, per site, are much more stable over time than the mainstem Scott.

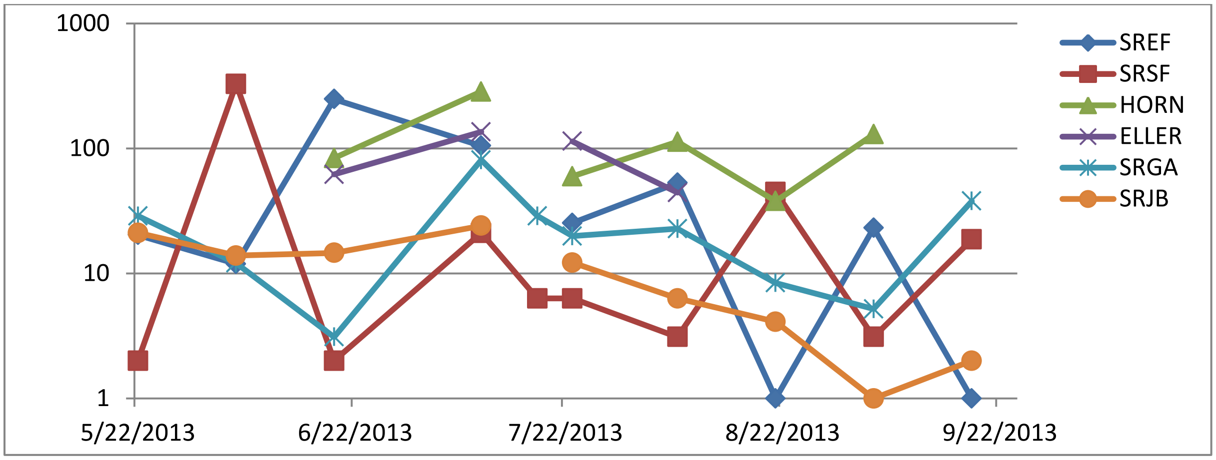


Figure 16 E.coli surface water concentrations in the Scott mainstem 2013

Most sites peaked at the beginning of July (HORN, ELLER, SRGA, SRJB) with the exception of the east and south fork (SREF, SRSF). Peak concentrations on the forks were seen in late-May and early-June.

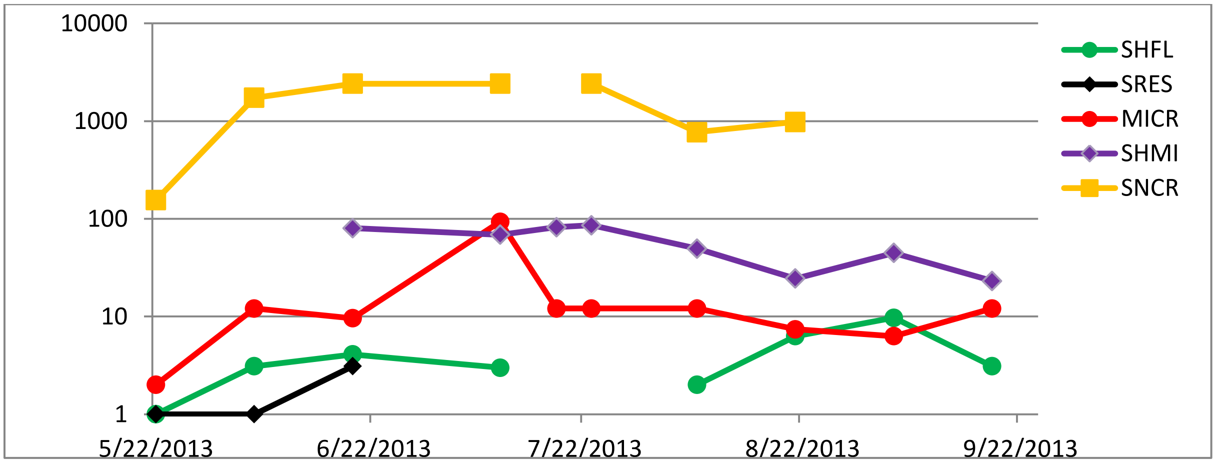


Figure 17 E.coli surface water concentrations of Quartz Valley tributaries 2013

Concentrations in Quartz Valley do not depict any clear peak's in concentration with the exception of Mill Creek (MICR). Sniktaw (SNCR) was 100 times higher than all other sampled locations (SRES, MICR, SHMI, SHFL). 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. 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. This will allow us to produce 2-dimensional graphs of water levels, see example from April 4, 2012 (Figure 18).

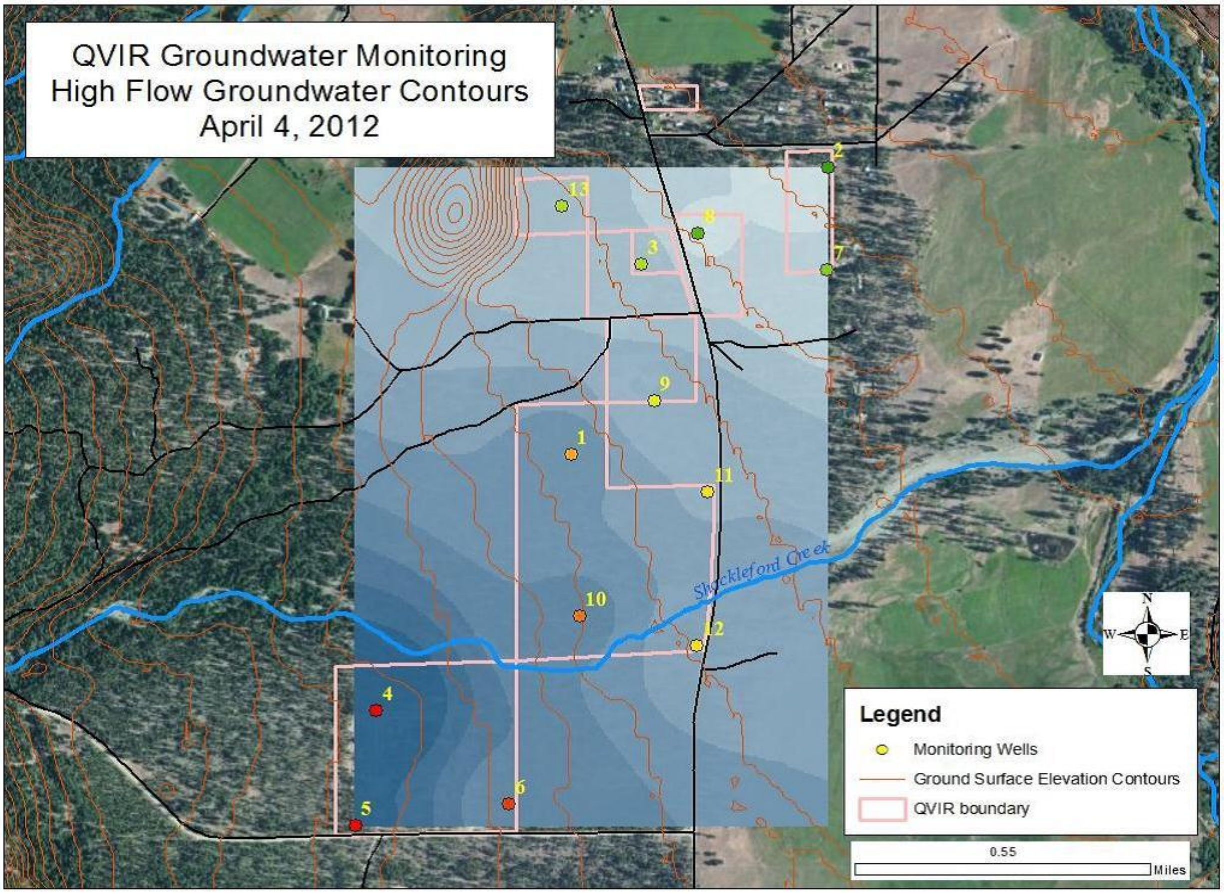


Figure 18 Groundwater elevation contours from the continuous well array. Groundwater elevation increases with darker color; surface elevations are shown in red lines.

Bacteria

All drinking water wells were free of *E. coli* in 2013 (Table 4).

About one-half the drinking water wells had detectable levels of total coliform bacteria (Table 5). 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 2013. No wells had detections of *E. coli* this year.

	2012		2013										
	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Aug	Sep	Oct	Nov	Dec
12808_Yamitch		0	0	0					0	0	0	0	0
12817_Yamitch		0	0	0					0	0	0	0	0
12839_Yamitch		0	0	0	0				0	0	0	0	0
12912_Yamitch	0		0	0	0	0	0	0	0	0	0	0	0
12920_Yamitch	0	0		0	0	0	0	0	0	0	0	0	0
12837_Kuut		0	0	0					0	0	0	0	0
12929_Kuut	0			0	0	0	0	0	0	0	0	0	0
13601_QuartzValley RD	0			0	0	0	0	0		0		0	0
13605_Quartz Valley RD		0		0		0			0	0		0	0
13616_Quartz Valley RD		0	0	0		0			0	0		0	0
13824_Quartz Valley RD			0	0	0	0	0	0	0	0		0	0
14208_Dangle	0	0				0			0				
9009_Big Meadows RD		0		0	0	0			0	0		0	0
9013_BigMeadows RD													0
9021_Sniktaw	0	0	0	0	0	0	0	0	0	0		0	0
9024_Sniktaw				0		0			0	0		0	0
9117_Sniktaw		0	0	0					0	0		0	0
9031_Thaxtuuy	0				0	0		0	0	0	0	0	0
Cram_Gulch								0					
Gymnasium			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.

	2012		2013										
	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Aug	Sep	Oct	Nov	Dec
12808_Yamitch		0	0	0					8.6	0	0	0	4
12817_Yamitch		0	0	0					0	0	0	0	1
12839_Yamitch		0	0	0	0				0	0	0	0	0
12912_Yamitch	0		0	0	2	0	0	0	0	0	0	0	0
12920_Yamitch	0	0		0	0	0	0	0	2	0	0	0	0
12837_Kuut		0	0	0					0	0	0	0	2
12929_Kuut	0			0	0	0	0	0	0	0	0	0	0
13601_QuartzValley RD	0			0	0	0	0	0		0		0	0
13605_Quartz Valley RD		0		0		0			0	0		0	1
13616_Quartz Valley RD		0	0	0		0			0	0		0	2
13824_Quartz Valley RD			0	0	0	0	0	0	0	0		0	0
14208_Dangle	0	1				0			2				
9009_Big Meadows RD		0		0	0	0			1	0		0	2
9013_BigMeadows RD													0
9021_Sniktaw	0	0	0	0	0	0	0	0	0	0		0	2
9024_Sniktaw				0		0			5.2	0		0	0
9117_Sniktaw		0	0	0					0	0		0	0
9031_Thaxtuuy	0				0	0		0	0	0	0	0	0
Cram_Gulch								0					
Gymnasium			0	0	0		0	0	0	0		0	0

Ground water chemistry

YSI data indicates that wells were quite consistent over time with respect to chemistry, though individual wells showed differences relative to each other.

Drinking water pH ranged from 6 to 7.5 among most of the wells (Figure 19). The thresholds for groundwater pH range from 7 to 8 (Table 2), therefore those below pH 7 are below the standard. It may be naturally occurring due to substrate type, however this has not been investigated. The lowest consistent pH was 9021 Sniktaw, this has been noted every year sampling has occurred, since 2007. The gymnasium has the highest pH consistently; these two wells are across the street from one another.

These patterns in groundwater pH are consistent with the past 6 years of monitoring. The noticeable drop in pH occurred in mid-April, consistent with sampling years 2011 and 2012.

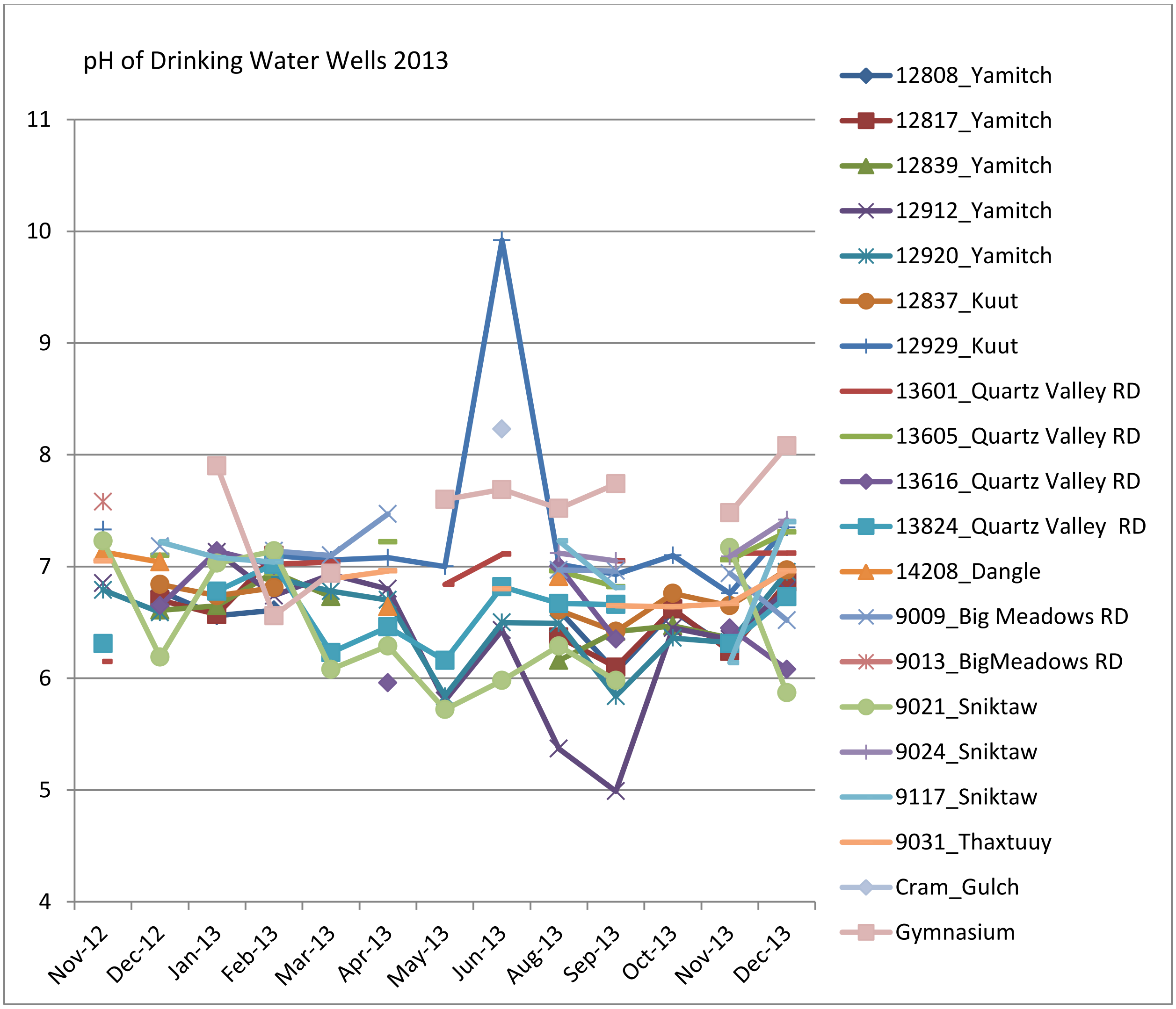


Figure 19 pH of drinking water wells 2013, Quartz Valley, Ca

Temperature of well water was constant over time, but individual wells showed differences among themselves (Figure 20). Temperatures were within 10 to 13 C, consistent with the last 6 years of sampling.

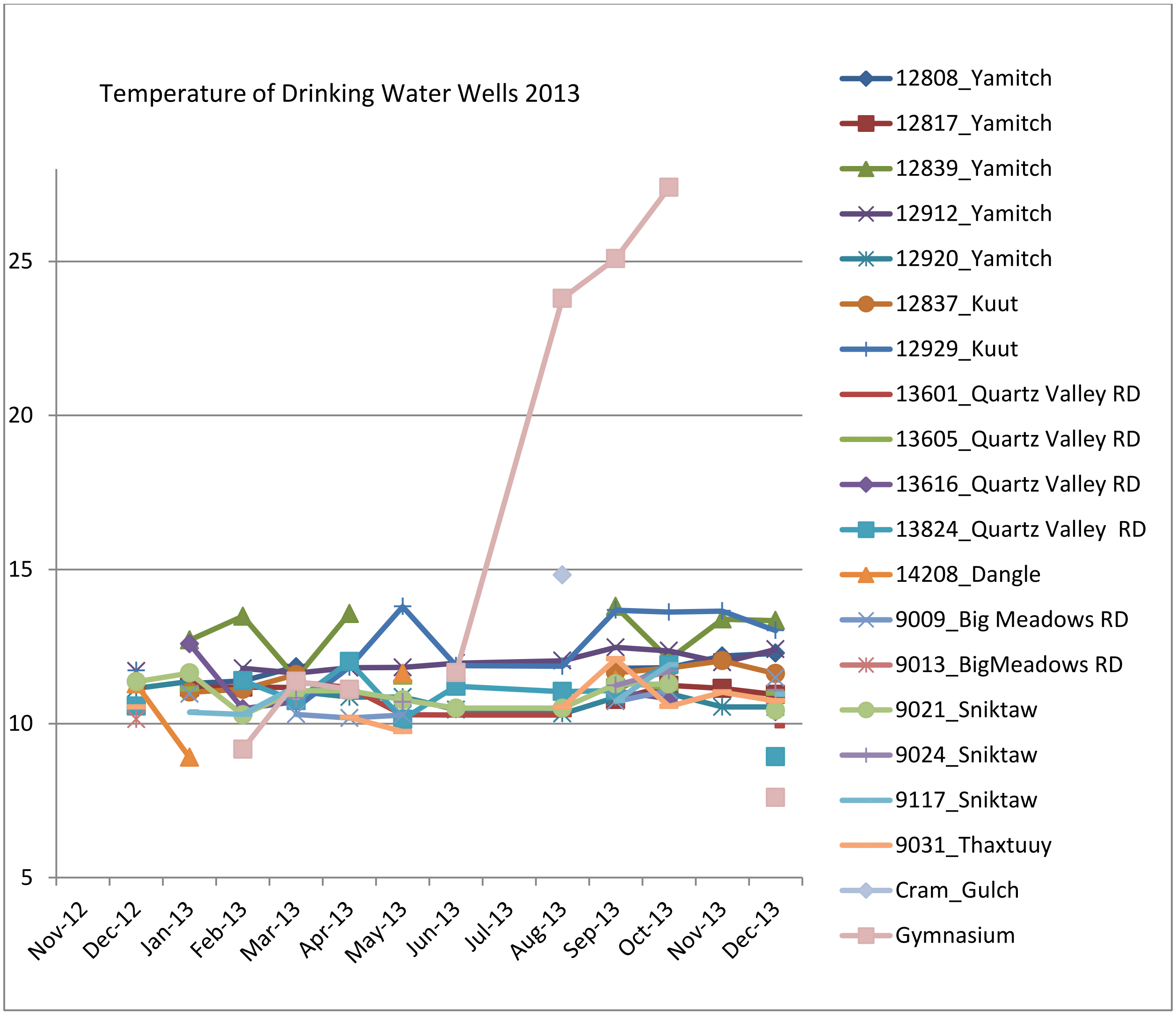


Figure 20 Temperature of drinking water 2013, Quartz Valley, Ca

Specific conductivity in groundwater had little seasonal variation (Figure 21). Most wells ranged from 0.17 to 0.25 mS/cm most of the year with a notable increase to 0.45 mS/cm mid-April which corresponds to the pH drop. Big Meadows 9009 and Dangle Lane were above the threshold for < 50 % of samples falling below 0.25 mS/cm. These wells with higher conductivity suggest high dissolved solids may be present.

The patterns were similar to those of 2011 and 2012.

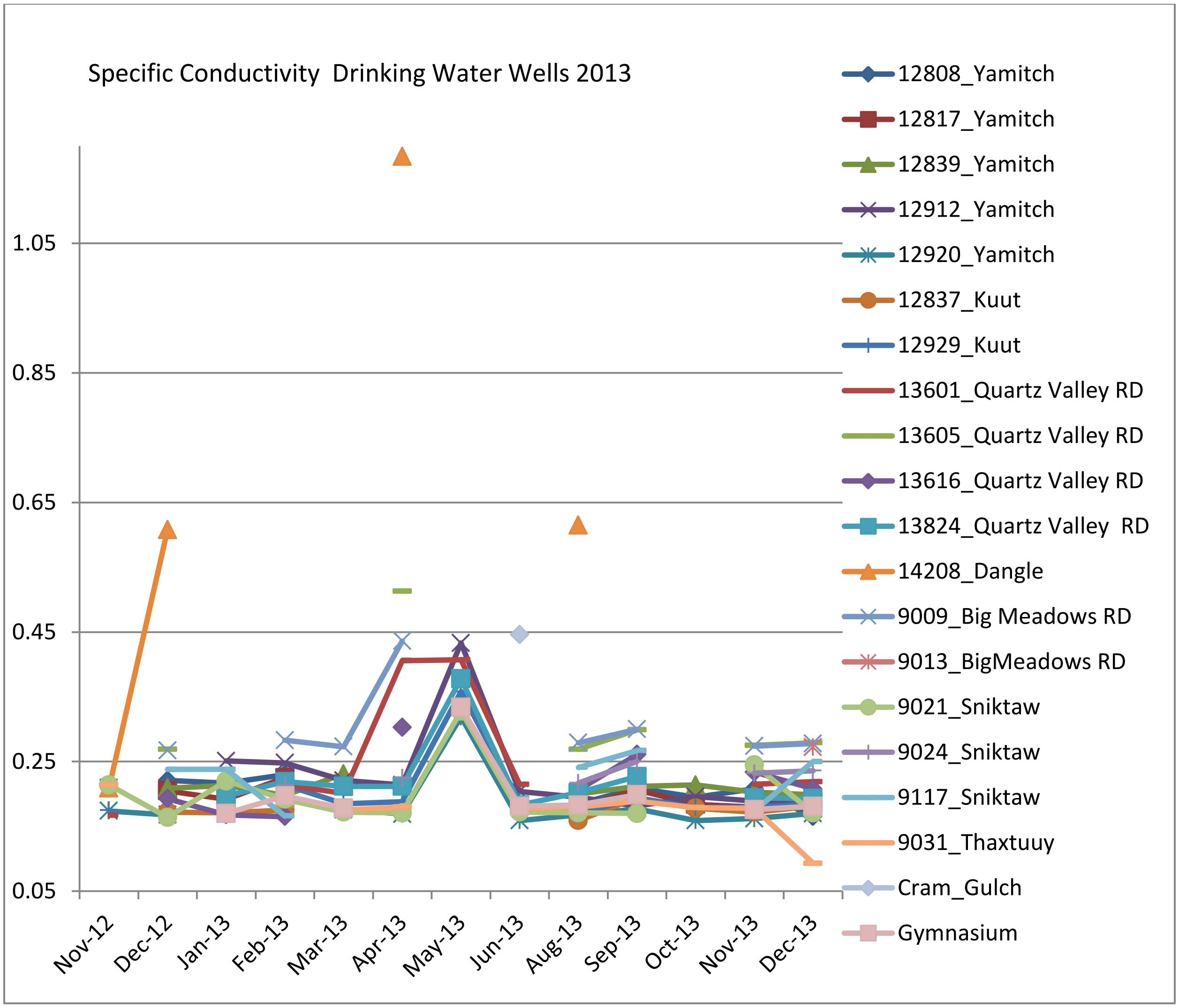


Figure 21 Specific conductivity in drinking water 2013, Quartz Valley, Ca

Dissolved oxygen was generally above 6 mg/L in most wells except for Big Meadows, Dangle Lane and the Gymnasium which were substantially lower (Figure 22). Low oxygen suggests reducing conditions and perhaps a slower turnover of the water in that aquifer. It is generally presumed that the soil reactions will consume oxygen and deeper wells are expected to have lower oxygen. The two shallow wells having the lowest oxygen may suggest that oxidizing reactions are occurring there.

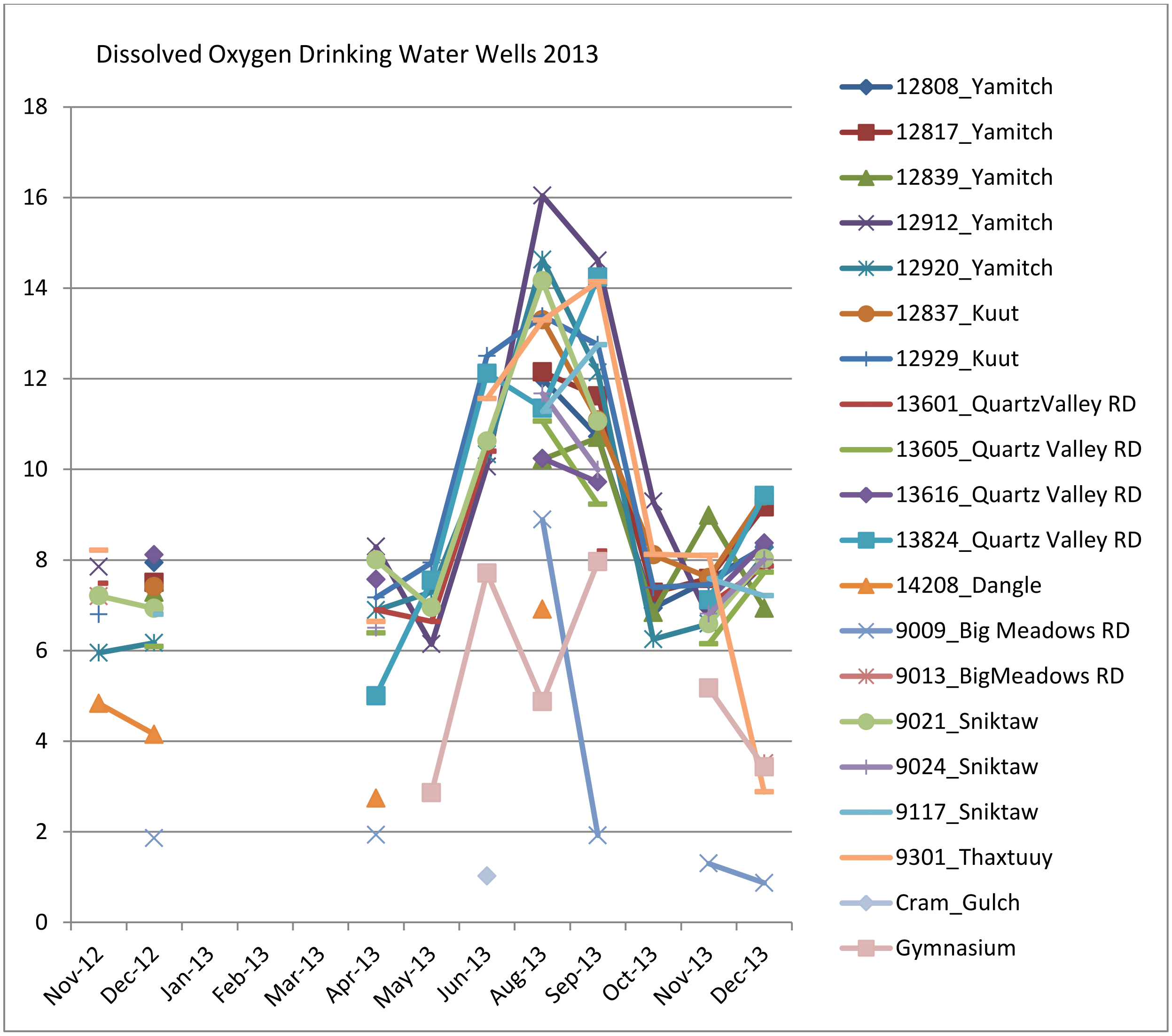


Figure 22 Dissolved oxygen in drinking water 2013, Quartz Valley, Ca

Continuous Static Water Level

The following graphs are the results since the probes were deployed in March of 2012. This data has not been analyzed and reported previously, so it is included herein. Results vary by well, during the 2012-2013 water year the procedures for deployment and downloading were new to the program and crews and therefore less formalized as they are today. Most wells depict two baseline periods, the summer of 2012 and 2013. 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 35.

During the winter of 2012 – 2013, recharge varies according to the well's topographic elevation. The well at a higher topographic elevation did not reach recharge levels of the spring of 2012 during the winter months, see Figures 27 and 28. Full winter recharge occurred on all the remaining wells during the winter months.

Base flow groundwater elevations were the same in 2013 as in 2012 for the four wells at the lowest topographic elevation on the valley floor, see Figures 25, 29, 30, and 34. Three wells (#1, #11 and #12) were approximately one foot lower in 2013 than 2012, See Figures 23, 32 and 33. Wells #4 and #10 showed the biggest drop from 2013 than 2012 with differences of approximately four feet lower, see Figures 26 and 31, these two wells are on each side of Shackleford Creek were it runs through the Reservation. Two wells at the highest topographic elevation off the valley floor (#5 and #6) were dry during base flow so we are unable to compare 2012 to 2013 static water level, see Figures 27 and 28. As expected, with increasing topographic elevation, the static water level was lower in 2013 than in 2012.

Figure 35 depicts the groundwater monitoring wells on a topographic map. The three general trends observed when comparing 2012 and 2013 base flow groundwater elevation (-0ft, -1ft and -4ft) are indicated by drawing an ellipse around the wells with a similar trend. The black ellipse is 0ft difference, the yellow ellipse is a one foot difference and the red ellipse is a four foot difference.

Comparisons of groundwater temperature reveal three wells, #10, #11 and #12, being influenced by the surface water of Shackleford Creek. Temperatures in these three wells were more erratic than all other wells sampled, while wells further from the creek had the more stable groundwater temperatures both daily and annually. Temperature on the three wells close to Shackleford depict an annual variation of approximately 8-12C, while the wells further from Shackleford only varied about 2C all year.

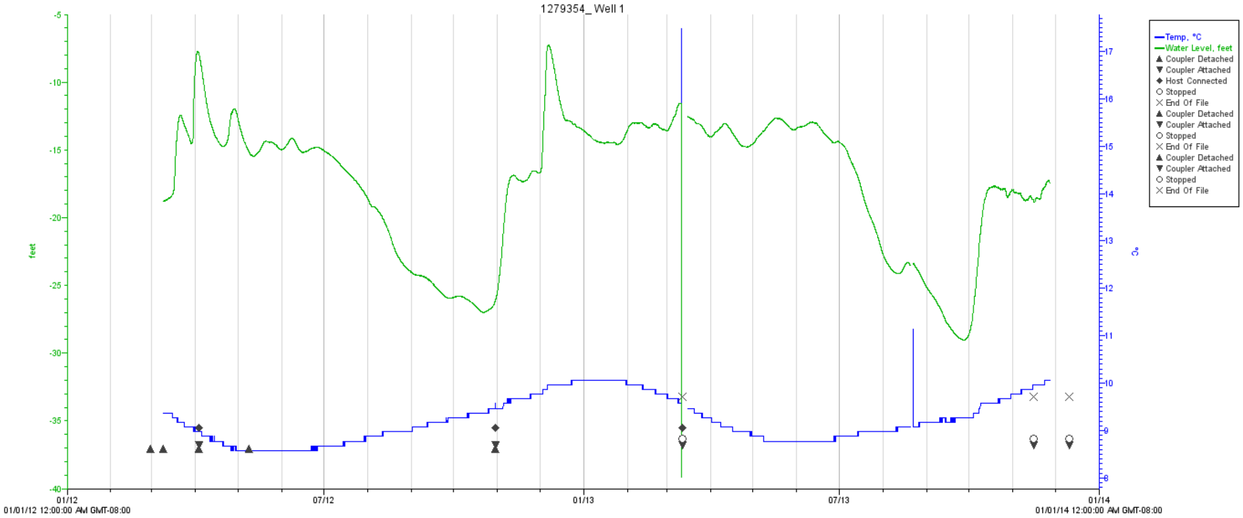


Figure 23 Well #1 Static water level and groundwater temperature 03/09/12 through 01/27/13

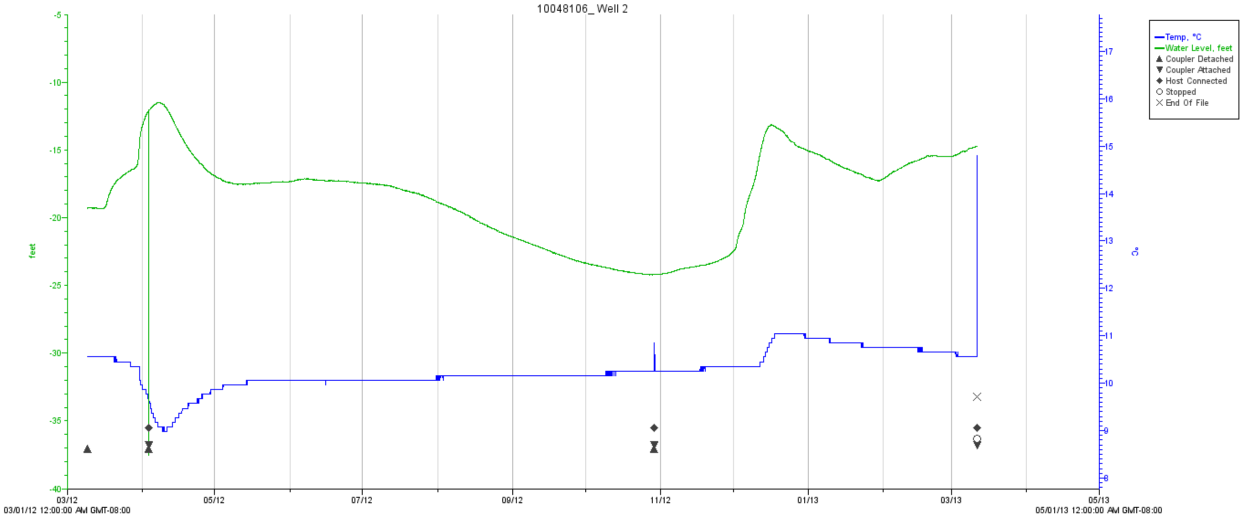


Figure 24 Well #2 Static water level and groundwater temperature 03/09/12 through 03/15/13

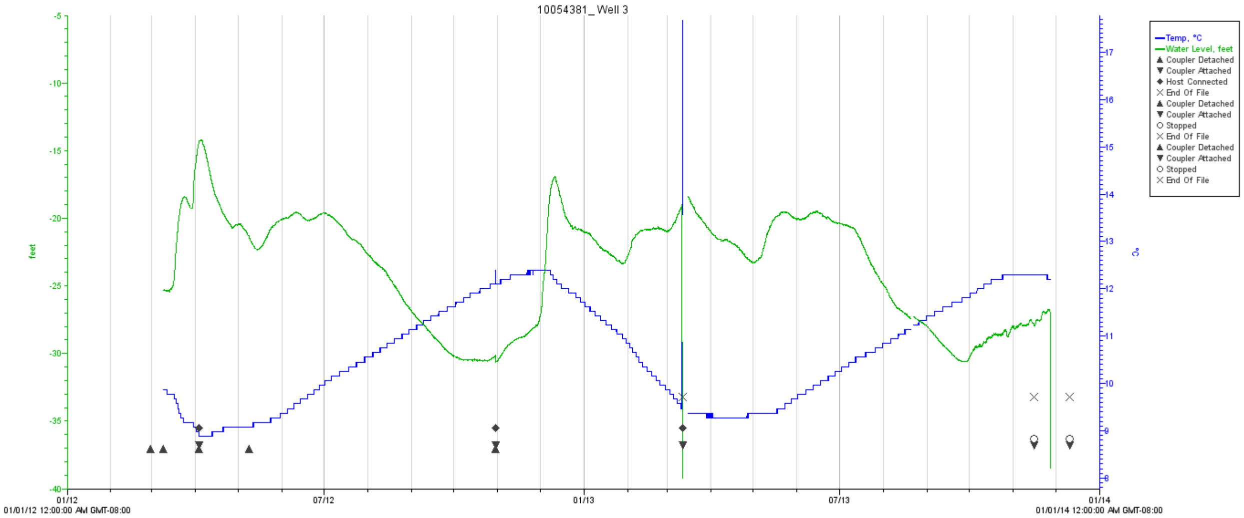


Figure 25 Well #3 Static water level and groundwater temperature 03/09/12 through 11/27/13

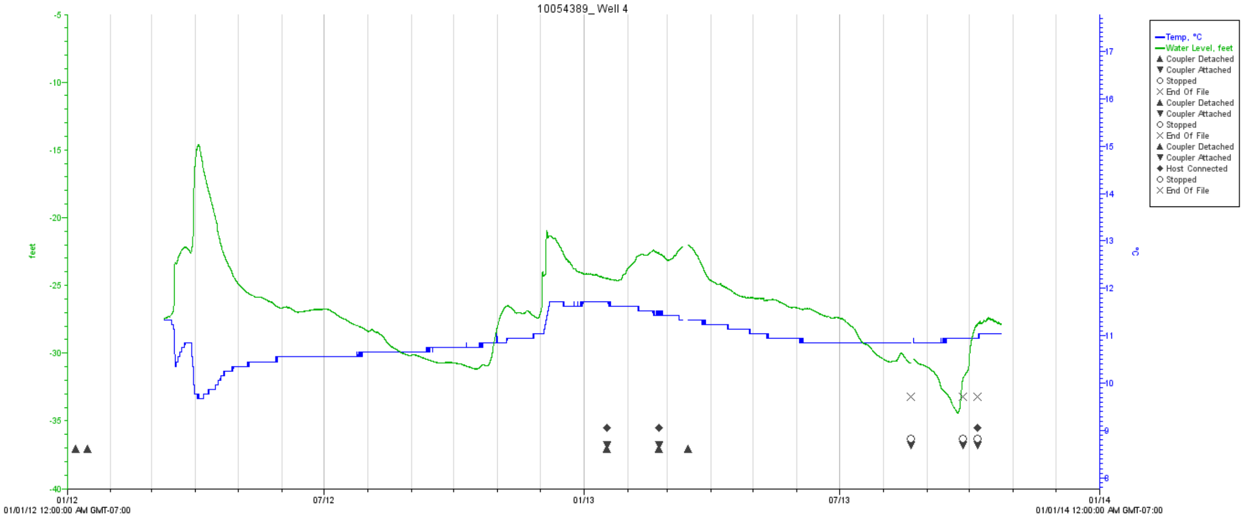


Figure 26 Well #4 Static water level and groundwater temperature 03/09/12 through 10/23/13

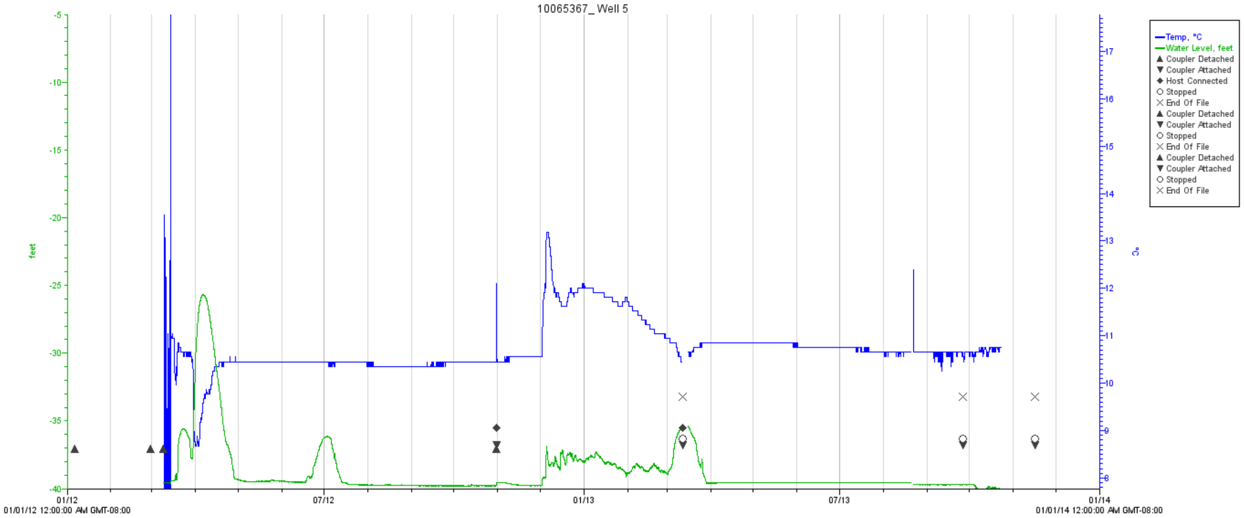


Figure 27 Well #5 Static water level and groundwater temperature 03/09/12 through 10/23/13

***This well has been dry for most of the monitoring period graphed.**

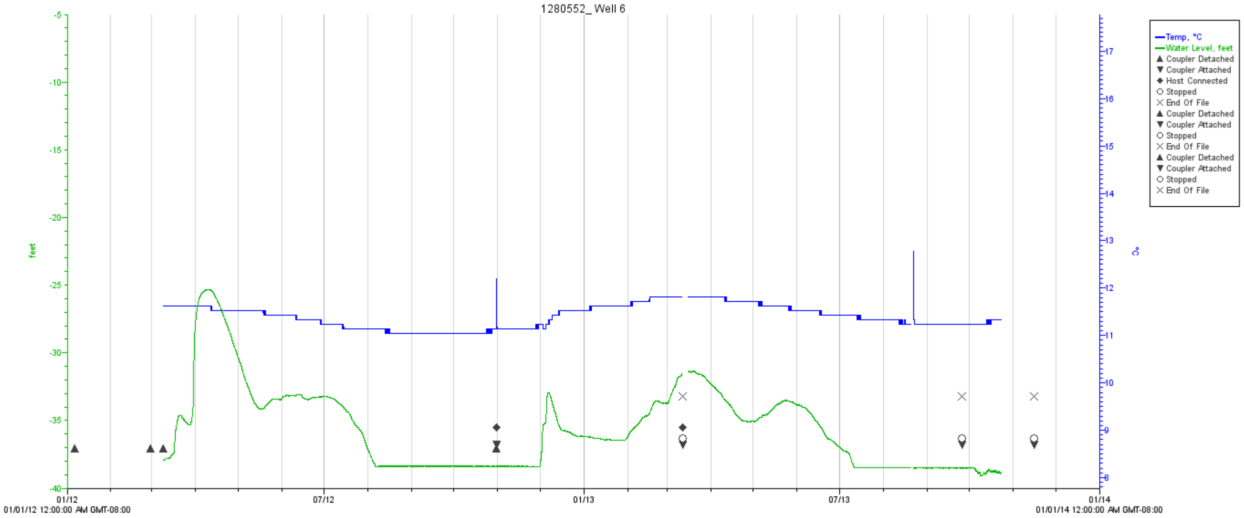


Figure 28 Well #6 Static water level and groundwater temperature 03/09/12 through 10/23/13

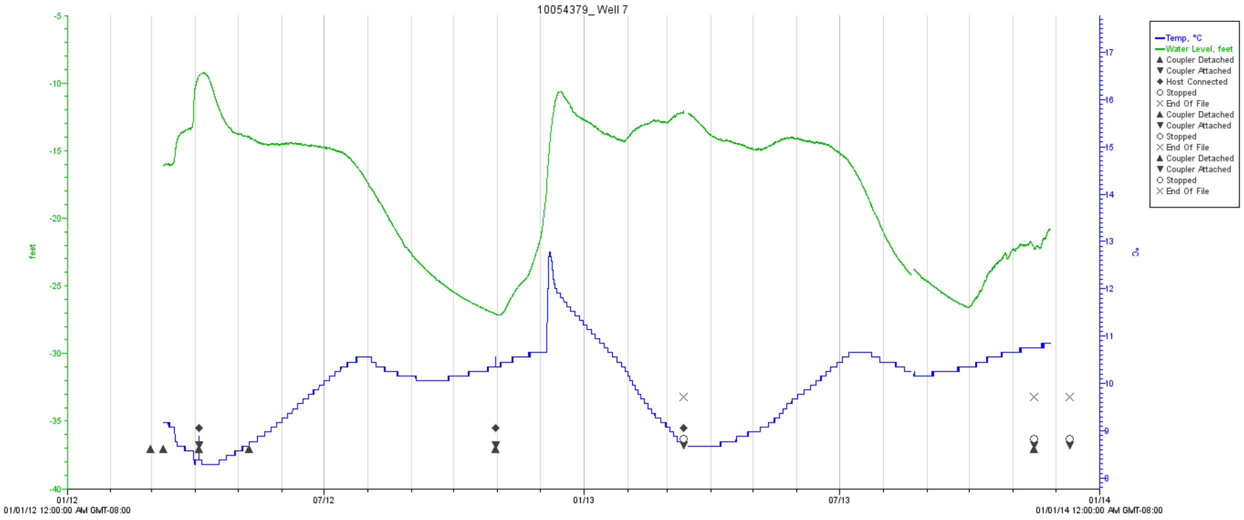


Figure 29 Well #7 Static water level and groundwater temperature 03/09/12 through 11/27/13

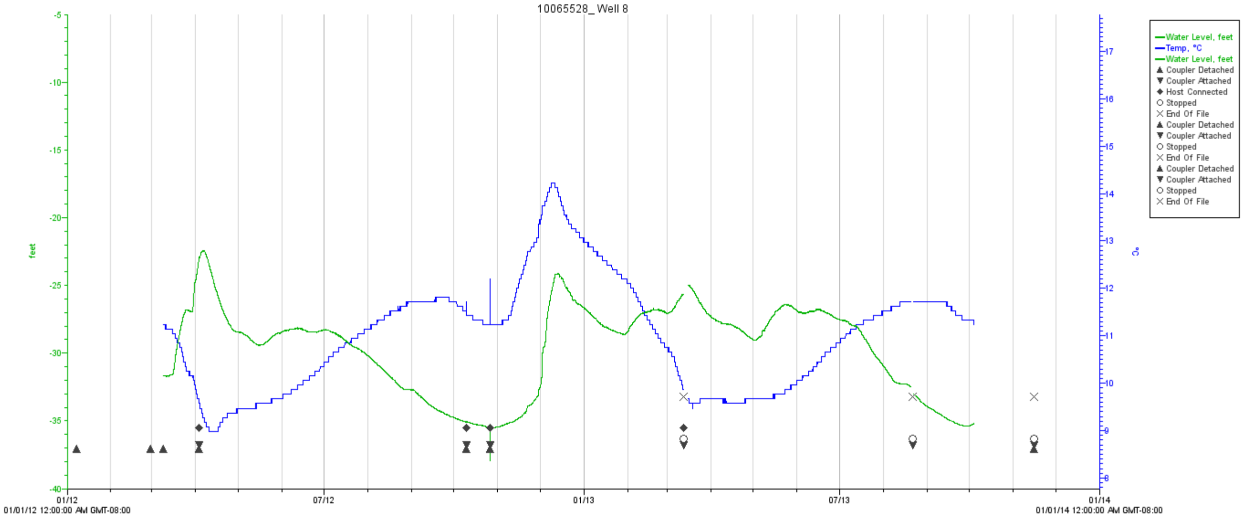


Figure 30 Well # 8 Static water level and groundwater temperature 03/09/12 through 10/01/13

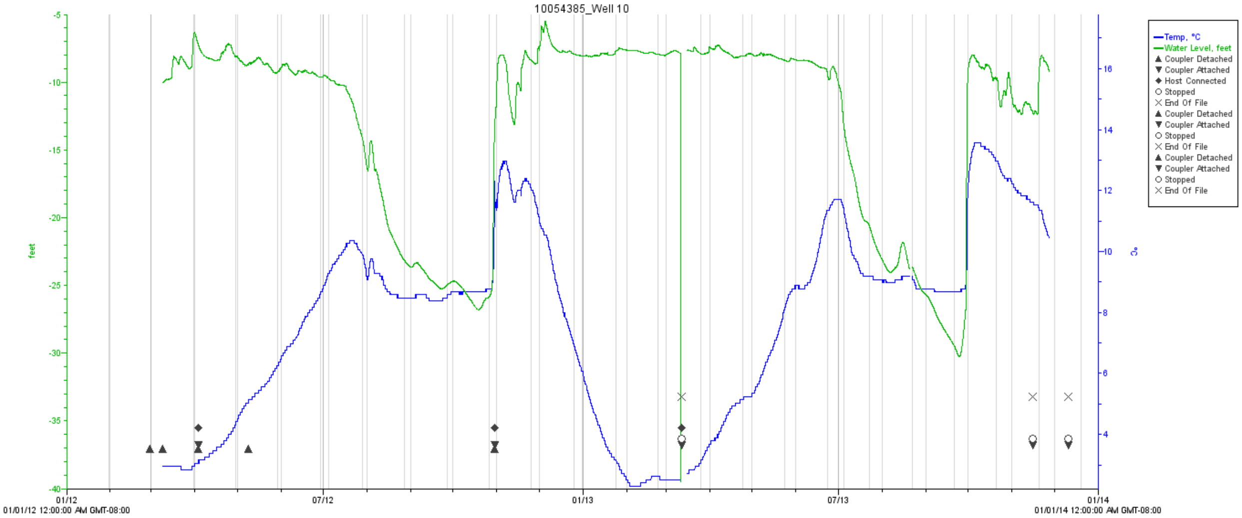


Figure 31 Well #10 Static water level and groundwater temperature 03/09/12 through 11/27/13

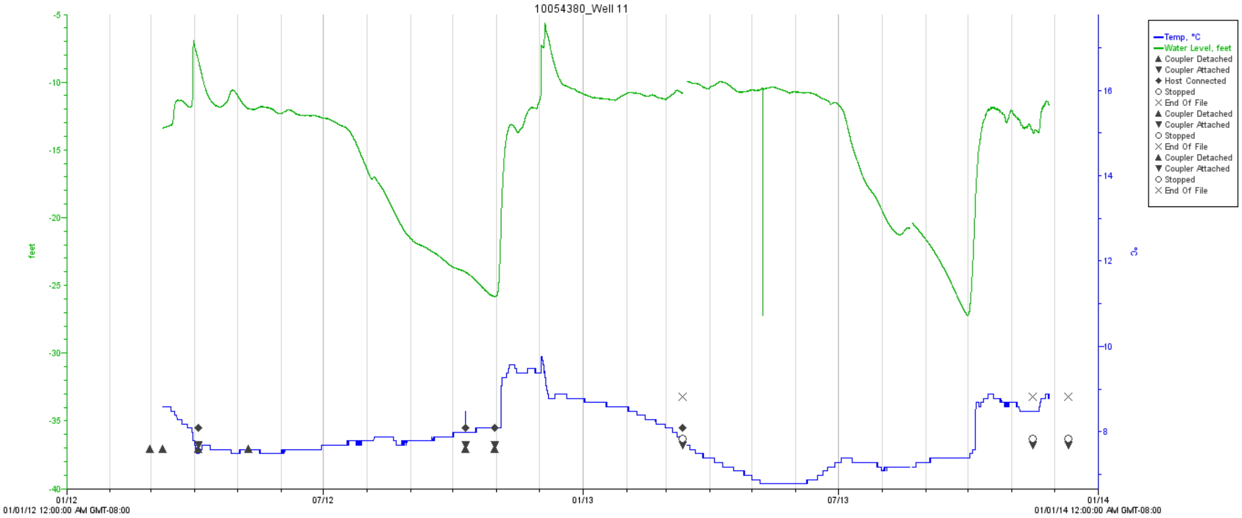


Figure 32 Well #11 Static water level and groundwater temperature 03/09/12 through 11/27/13

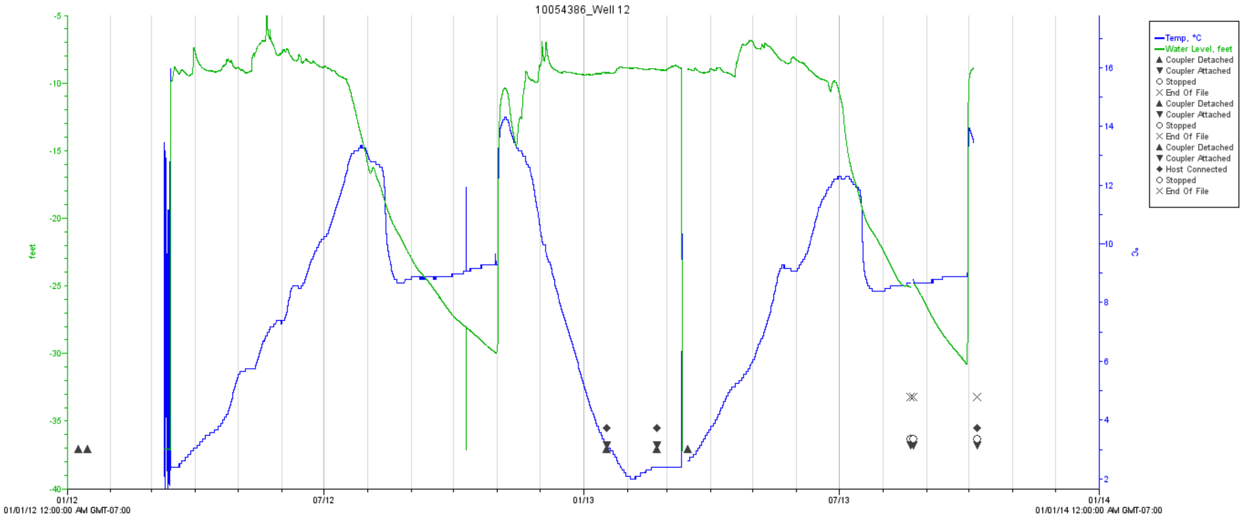


Figure 33 Well #12 Static water level and groundwater temperature 03/09/12 through 10/04/13

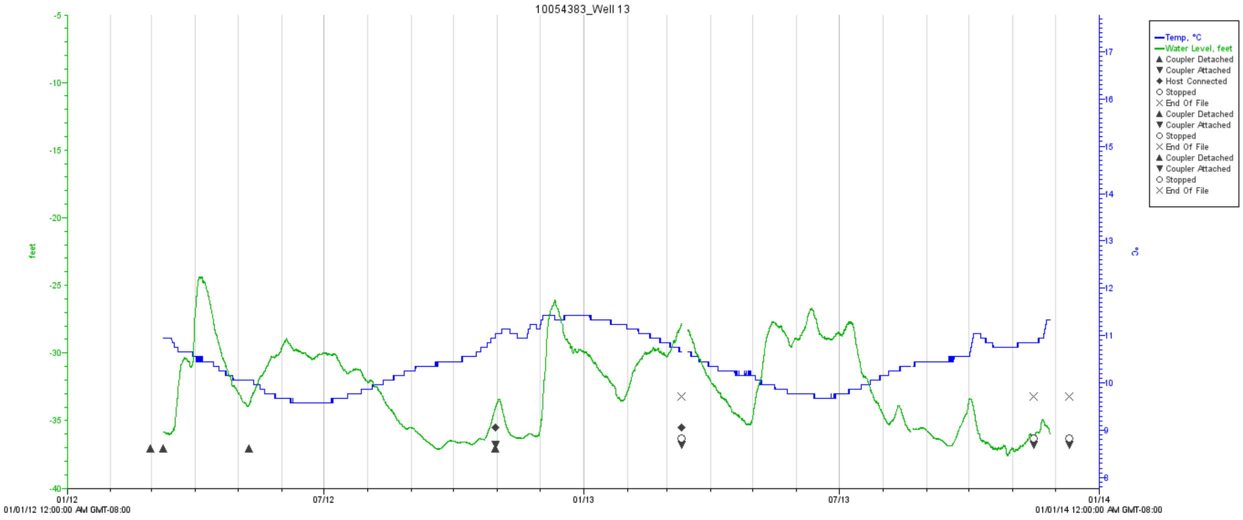


Figure 34 Well #13 Static water level and groundwater temperature 03/09/12 through 11/27/13

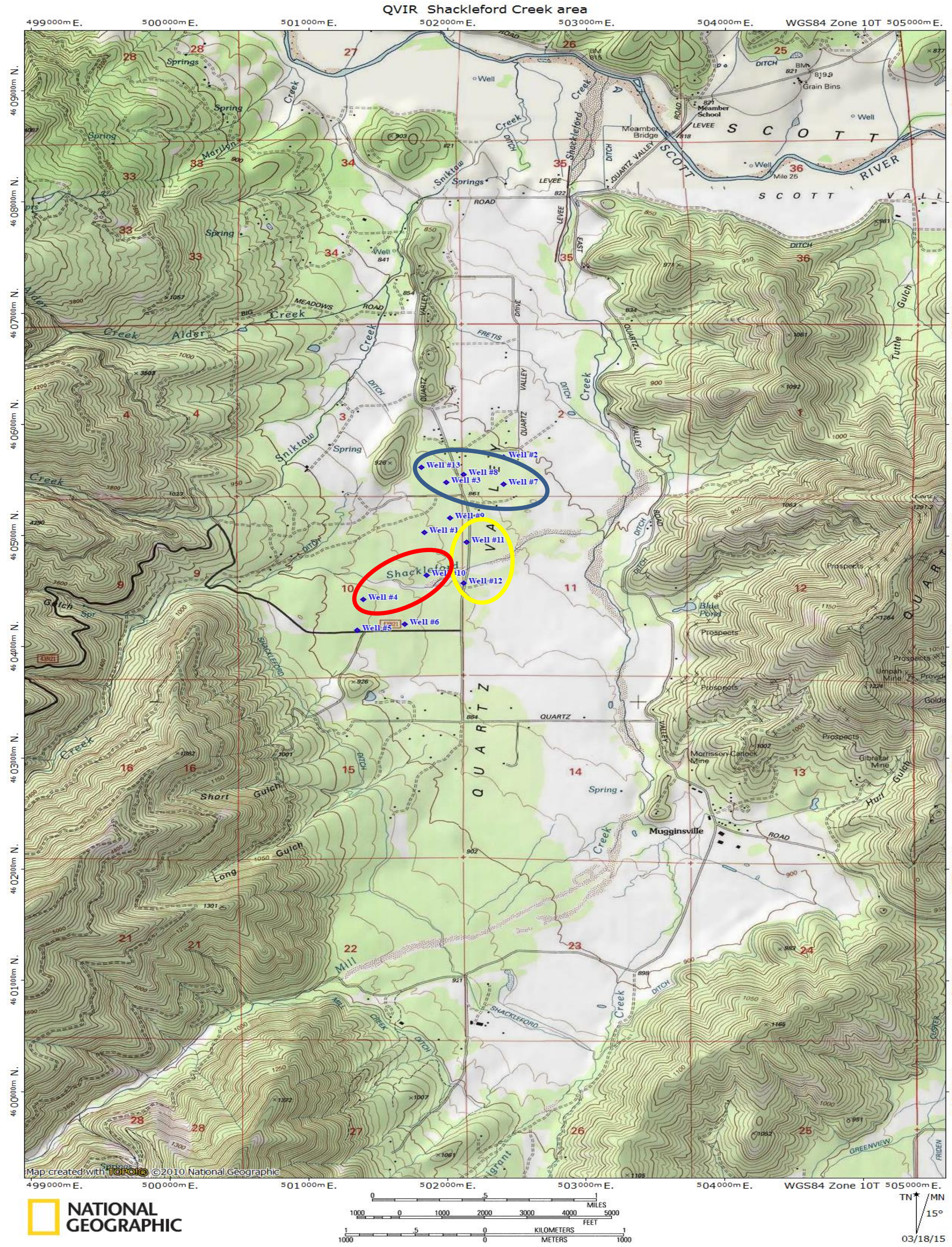


Figure 35 Map of Quartz Valley continuous groundwater monitoring array. The ellipses indicate net change in static water level between 2012 and 2013: black = 0ft, yellow = 1ft and red = 4ft.

6. Overall Integrated Summary

Quartz Valley tributary water quality, nitrogen and phosphorus, in 2013 was relatively good for fish in the upper basin and in the lower sections that are able to retain surface flows, with the exception of Sniktaw Creek. Nitrogen and phosphorus continued to be high in the mainstem Scott, downstream of Callahan, this trend is consistent with all years sampled since 2007.

Bacteria is more variable on the mainstem Scott than is observed in tributaries and levels in 2013 were much like levels seen in previous years on both the tributaries and the mainstem. *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 not detected in drinking waters this year and water quality was very consistent with previous years samples. Static groundwater levels appear to be lower in 2013 than in 2012 at wells located at higher elevation, as expected giver than much lower snowpack and precipitation observed in 2013.

Overall, water quality in the tributaries is much more suitable to salmonids than the mainstem. Tributaries are much cooler while the mainstem Scott River reaches summer time temperatures over 20 C. The main problem is that many of 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.

The greatest challenge 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.

Resolving the issue of drying stream channels 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 of data 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 our list of recommended approaches to meeting our communities water needs.

7. Future Sampling

Surface water

Water chemistry will be monitored using the continuous recording datasonde at the gage site, 2013 technical issues occurred and this data was not presented herein following quality assurance procedures. Grab samples will also continue for chemistry and bacteria. The Hobo temperature array will be continued with minor modifications to sites selected.

Real-time datasonde and flow gages stations are being implemented on Shackleford at the wilderness boundary and on BLM land in the Mill Creek drainage.

Periphyton (benthic algae) sampling will be started in 2015. As noted in previous water quality reports, pH and D.O. levels in the Scott River indicate high levels of periphyton are probably present at the Scott River gage and/or in areas upstream. Sampling and analyzing benthic algal levels will help identify factors that contribute to increased algal growth, so that potential restoration efforts can be targeted. Algae sampling protocols from the state SWAMP program will be utilized. Samples should be analyzed for algal species composition and biomass. If collected at multiple dates through the low-flow summer season, the data will provide information on the timing and magnitude of peak algal biomass.

Groundwater

Groundwater sampling will continue and funds are being pursued to include heavy metal and/or pesticide herbicide sampling to understand baseline levels of those pollutants. Continuous groundwater probes will continue and funding is being sought for two new locations, one on Sniktaw Creek and another near Mill Creek, this will improve the spatial resolution of Quartz Valley's groundwater basin.

References

American Public Health Association (APHA). 1992. Standard methods for the examination of wastes and wastewater, 18th ed. Table 9225:I. p. 9-66. Cited from http://www.cnawater.com/WhatAreColiformsEColi.html

Berg, L. 1982. The effect of short term pulses of suspended sediment on the behavior of juvenile salmonids. Pages 177-196 in G.F. Hartman et al. editors. Proceedings of the Carnation Creek Workshop: a ten-year review. Department of Fisheries and Oceans, Nanaimo, B.C.

Drake, D.J., K.W. Tate, and H. Carlton. 2000. Analysis shows climate-caused decreases in Scott River falls flows. California Agriculture 54:46-49. http://californiarangeland.ucdavis.edu/Publications%20pdf/scott.river.flows.pdf

Elliot, J 1981. Some aspects of thermal stress on freshwater teleosts. In Pickering, A.D. ed., Stress and Fish: Academic Press, London.

Goldman, C.R. and A.J. Horne. 1983. Limnology. McGraw-Hill, Inc. New York . 464 pp.

Lloyd, D.S. 1987. Turbidity as a water quality standard for salmonid habitats in Alaska. North American Journal of Fisheries Management. 7:34–45.

Mack, S. 1958. Geology and ground-water features of Scott Valley Siskiyou County, California. Geological Survey Water-Supply Paper 1462. Prepared in cooperation with the California Dept. of Water Resources. Washington Government Printing Office Washington DC. http://www.scottriver.org/wp-content/uploads/2011/10/Mack1958.pdf

North Coast Regional Water Quality Control Board (NCRWQCB). 2007. Water Quality Control Plan for the North Coast Region (Basin Plan). NCRWQCB, Santa Rosa, CA.

Quartz Valley Indian Reservation (QVIR) 2006a. Quality Assurance Project Plan for Water Quality Sampling and Analysis, CWA 106 grant identification # I-96927206-0. Prepared by Quartz Valley Indian Reservation with technical assistance from Kier Associates and Rebekah Sluss.

QVIC Monitoring Plan. 2006b. Quartz Valley Indian Reservation Water Quality Monitoring Plan. Prepared by Kier Associates for Quartz Valley Indian Reservation, Fort Jones, CA.

Quartz Valley Indian Community. 2006c. Review of public draft Shasta River Temperature and Dissolved Oxygen TMDLs. Quartz Valley Indian Reservation, Ft. Jones, CA.

Quartz Valley Indian Community. 2008. Water Quality Assessment Report. Prepared by Crystal Bowman on behalf of the Quartz Valley Indian Reservation, Ft. Jones, CA.

Sullivan, K., D. J. Martin, R. D. Cardwell, J. E. Toll, and S. Duke. 2000. An analysis of the effects of temperature on salmonids of the Pacific Northwest with implications for selecting temperature criteria. Sustainable Ecosystems Institute. Portland, OR. 192 pp.

Tetra Tech, Inc. 2004. Progress Report Development of Nutrient Criteria in California: 2003-2004. Prepared for US EPA Region IX. Tetra Tech, Lafayette, CA.

Tetra Tech, Inc. 2006. Technical Approach to Develop Nutrient Numeric Endpoints for California. Prepared for U.S. EPA Region IX. Tetra Tech, Inc. Lafayette, CA.

U.S. Environmental Protection Agency. 1986. Ambient Water Quality Criteria for Bacteria. Office of Water, Washington D.C. EPA-822-R-99-014.

U.S. Environmental Protection Agency. 1986. Ambient Water Quality Criteria for Dissolved Oxygen. Office of Water, Washington D.C. EPA-440/5-86-001.

U.S. Environmental Protection Agency. 1999b. 1999 Update of Ambient Water Quality Criteria for Ammonia. Office of Water, Washington D.C. EPA

U.S. Environmental Protection Agency. 2000a. Ambient Water Quality Criteria Recommendations for Rivers and Streams in Nutrient Ecoregion II. Office of Water, Washington D.C. EPA 822-B-00-015. 120 p.

U.S. Environmental Protection Agency. 2000b. Nutrient Criteria Technical Guidance Manual: Rivers and Streams. Office of Water and Office of Science and Technology , Washington D.C. EPA-822-B-00-002.

U.S. Environmental Protection Agency (USEPA). 2002. Surface Waters Western Pilot Study: Field Operations Manual for Non-Wadeable Rivers and Streams (Draft). Environmental Monitoring and Assessment Program, Office of Research and Development, U.S. EPA, Washington D.C. 227 p.

U.S. Environmental Protection Agency. 2003. EPA Region 10 Guidance for Pacific Northwest State and Tribal Temperature Water Quality Standards. EPA Project # 910-B-03-002. Region 10 U.S. EPA, Seattle WA. 57 p.

U.S. Environmental Protection Agency. 2006. Edition of the Drinking Water Standards and Health Advisories. Office of Water. 11p.

Van Kirk, R.W. and S.W. Naman. 2008. Relative effects of climate and water use on base-flow trends in the lower Klamath basin. Journal of the America Water Resources Association. 44:1035-1052. http://www.fws.gov/arcata/fisheries/reports/technical/Van%20Kirk%20and%20Namen%20Base%20flow%20Trends%20JAWRA.pdf

Watershed Sciences. 2007. Airborne Thermal Infrared Remote Sensing**,** Scott River Basin, CA. Prepared on behalf of the Quartz Valley Indian Reservation.

Welsh, H.H., G.R. Hodgson, M.F. Roche, B.C. Harvey. 2001. Distribution of Juvenile Coho Salmon (Oncorhynchus kisutch) in Relation to Water Temperature in Tributaries of a Northern California Watershed Determining Management Thresholds for an Impaired Cold-water Adapted Fauna. In review for publication in the North American Journal of Fisheries Management. 21:464-470, 2001.