Quartz Valley Indian Reservation
Water Quality Monitoring and Assessment
Report 2007

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- **Quartz Valley, CA landowner participants**
- **Peer Review Team**
- **Klamath Basin Tribal Water Quality Workgroup**

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I. Background

The Quart Valley Indian Reservation (QVIR) Environmental Protection Department (EPD) 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 Tribe and approved by EPA in 2006. Current water quality conditions were evaluated in 2007 using the water quality objectives developed from various state, federal and Tribal entities. The NCRWQCB Basin Plan water quality objectives are determined for the protection of beneficial uses (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* was used to analyze groundwater results. For parameters with out current water quality objectives established by either state or federal agencies, the QVIR Tribe has adopted an objective based on published salmonid research. Table 1 in Section I lists each water quality parameter monitored in 2007, the water quality objective used for comparison and their sources. Table 7 in Section IV lists the water quality objectives used for comparison of groundwater results and their sources.

Table 1: Water quality objectives used to analyze results.

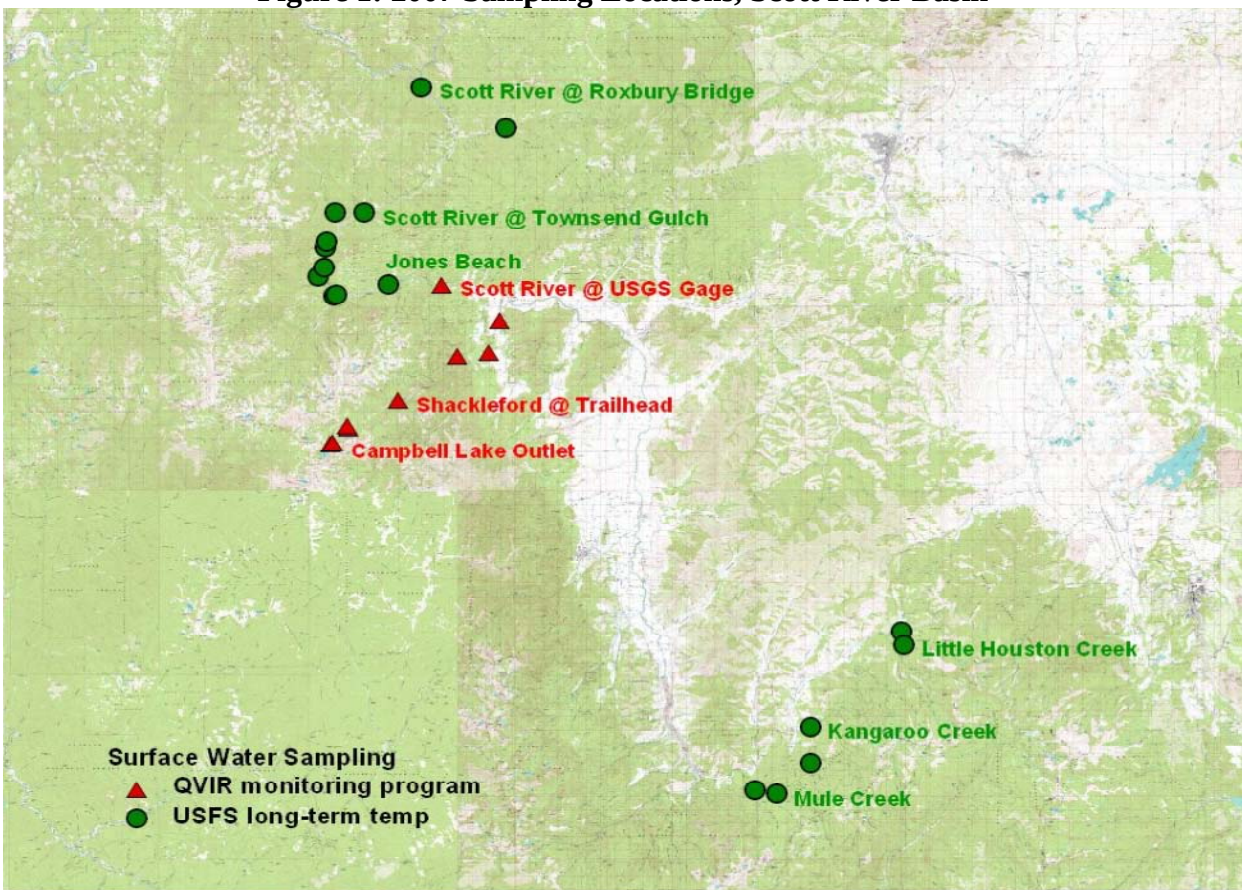
Parameter	Units	Water Quality Objectives			Source
Temperature	^{o}C	MWAT		< 16.8^{o} C	Sullivan et al., 2000; Welsh et al., 2001; U.S. EPA, 2003
pH	pH	Max		Min	North Coast Regional Water Quality Control Board (NCRWQCB). 2007 *Basin Plan*, Scott River Objective
		8.5		7	
Conductivity	µS/cm	90% Upper Limit		50% Upper Limit	North Coast Regional Water Quality Control Board (NCRWQCB). 2007 *Basin Plan*, Scott River Objective
		0.350		0.275	
Turbidity	NTU	< 5 above ambient turbidity levels			Berg, 1982; Lloyd, 1987
Dissolved Oxygen	mg/L	Min	90% Upper Limit	50% Upper Limit	North Coast Regional Water Quality Control Board (NCRWQCB). 2007 *Basin Plan*, Scott River Objective
		7.0		9.0	
Total Phosphorus	µg/L	10.00			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.
Escherichia coli	MPN	a. Single sample >235 b. Five equally spaced samples over 30 days >50			a. US EPA 1986. Ambient Water Quality Criteria for Bacteria. b. North Coast Regional Water Quality Control Board (NCRWQCB). 2007 *Basin Plan*
Chlorophyll a	ug/l	10			Tetra Tech, Inc. 2006. Technical Approach to Develop Nutrient Numeric Endpoints for California. Prepared for U.S. EPA Region IX.

II. Methods

In accordance with the approved QAPP, data collection began in 2007. Seven sites were selected on Shackleford Creek within each land use zone identified in the QVIR QAPP (QVIR 2006a). Grab samples were collected and analyzed for five water quality parameters: nutrients, pH, dissolved oxygen, turbidity and discharge. Continuous temperature monitoring occurred at each site. Macroinvertebrates were collected at two sites, Shackleford Creek near the mouth and Shackleford Creek at the wilderness trailhead. In addition to Shackleford Creek sites, the QVIC also maintained a multi-channel data recorder (datasonde) on the mainstem Scott River at the U.S. Geologic Survey (USGS) flow gage below Fort Jones. Automated temperature sensors were also deployed in the main stem, below the valley, and in Scott River tributaries, both above and below the valley (USFS long-term temperature locations).

Figure 1 depicts the 2007 locations of the long-term temperature sites and the Tribal water quality monitoring program (bacteria, nutrients and sonde). Figure 2 depicts the QVIR nutrient, bacteria and sonde sampling locations in 2007 identifying land ownership. Appendix E contains a spreadsheet of all sites, GPS location and parameters collected for both groundwater and surface water.

Figure 1: 2007 Sampling Locations, Scott River Basin



(Map created by M.Horney, NRCS-USDA)

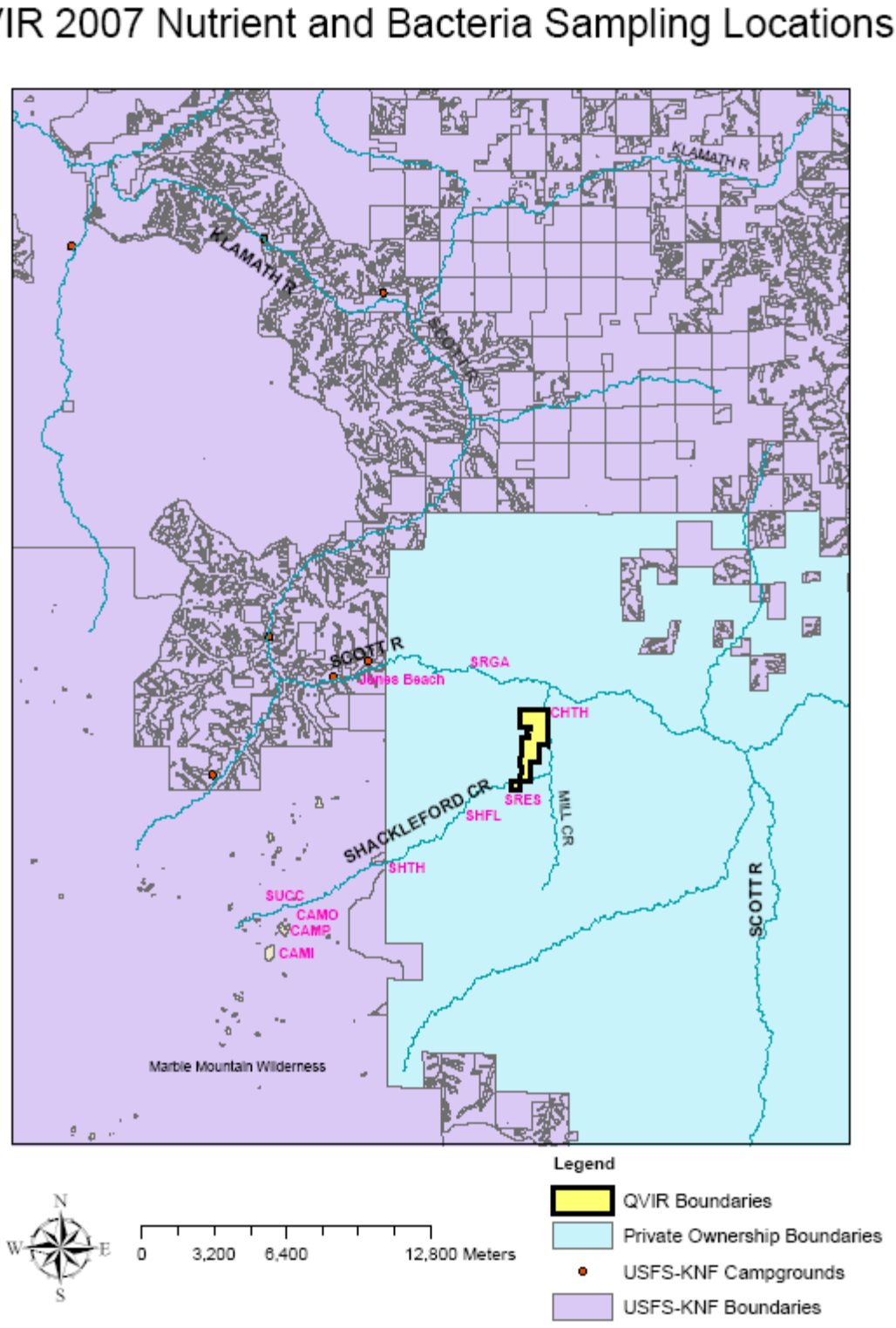


Figure 2: QVIR 2007 nutrient and bacteria sampling locations. Site code 'SRGA' is the location of the continuous, real-time datasonde.

Three laboratories were used to analyze nutrient, bacteria and macroinvertebrate samples in 2007. The Quartz Valley Indian Reservation operates its own bacteria lab, which is certified through the State of California, and analyzed all bacteria samples according to CA state lab certification specifications. Nutrient and chlorophyll samples were analyzed by Aquatic Research Inc. in Seattle, WA. Jon Lee Consulting in Eureka, CA performed the analyses on macroinvertebrate samples.

Specific sampling methods and laboratory methods for each parameter are included in the *Quartz Valley Indian Reservation's Quality Assurance Project Plan for Water Quality Sampling and Analysis* (QVIR 2006a). Standardized Operating Procedures (SOP's) for surface water nutrient and bacteria sampling are included in Appendix A. Information on additional protocols or quality assurance procedures (i.e. calibration) is available upon request.

Table 2 lists the field calibration, maintenance, testing and inspection for equipment used to monitor temperature, pH, dissolved oxygen, turbidity and conductivity. Table 3 lists the required sample containers, volumes, preservation methods, analysis method and holding times for water samples requiring laboratory analysis.

Table 2: Quality Control Requirements for Surface Water Field Measurements

Field Parameters: Temperature, pH, Dissolved Oxygen, Turbidity, Conductivity					
QC Sample	**Data Quality Indicator (DQI)[2]**	**Frequency/ Number**	**Methods/ SOP QC Acceptance Limits[3]**	**Acceptance Criteria/ Measurement performance criteria[4]**	**Corrective Action**
Temperature YSI 556 & 6600 MPS Multi Probe System: YSI Precision™ Thermistor					
Field Duplicate	Precision (S & A)	1/5 field samples	N/A	± 0.15°C	Collect & analyze 3rd sample. Qualify data if still exceeding criteria.
QC Check Sample[5]	Accuracy	N/A	N/A	N/A	None. Sensor not used if it did not meet annual calibration criteria.
Temperature- Onset HOBO Water Temp Pro Loggers					
Field Duplicate	Precision (S & A)	1/5 field samples	N/A	± 0.2°C	Collect & analyze 3rd sample. Qualify data if still exceeding criteria.
QC Check Sample[6]	Accuracy	N/A	N/A	N/A	None. Sensor not used if it didn't meet annual calibration criteria.
pH- YSI 556 & 6600 MPS Multi Probe System: YSI Glass Combination electrode					
Field Duplicate	Precision (S & A)	1/5 field samples	N/A	± 0.2 units	Collect & analyze 3rd sample. Qualify data if still exceeding criteria.
QC Check Sample[6]	Accuracy	1/ batch each day	± 0.5 units of true value for both calibration check standards	± 0.5 units of true value	Qualify associated field data
Dissolved Oxygen- YSI 556 & 6600 MPS Multi Probe System Steady state polarographic					
Field Duplicate	Precision (S & A)	1/5 field samples	N/A	± 20%RPD	Collect & analyze 3rd sample. Qualify data if still exceeding criteria.
QC Check Sample[6]	Accuracy	1/ batch each day	± 0.5 mg/L of true value of full saturation standard	± 0.5 mg/L of true value	Qualify associated field data
Conductivity- YSI 556 & 6600 MPS Multi Probe System: YSI 4-electrode cell with autoranging					
Field Duplicate	Precision (S & A)	1/5 field samples	N/A	± 20%RPD	Collect & analyze 3rd sample.
QC Check Sample[6]	Accuracy	1/ batch each day	± 10% of true value or ±20 µS/cm (whichever is greater) for both calibration check standards	± 0.5% of true value	Qualify associated field data
Turbidity- YSI 660 MPS Multi Probe System					
Field Duplicate	Precision (S & A)	1/5 field samples	N/A	± 20%RPD	Collect & analyze 3rd sample. Qualify data if still exceeding criteria.

Table 1 (cont.) QC Sample	Data Quality Indicator (DQI)[2]	Frequency / Number	Methods/ SOP QC Acceptance Limits[3]	Acceptance Criteria/ Measurement performance criteria[4]	Corrective Action
QC Check Sample[6]	Accuracy	1/ batch each day	± 20% or ±2 NTU of 20 NTU standard (whichever is greater) and ±1 NTU for 0 NTU standard	± 20% of true value	Qualify associated field data
Turbidity- Model WQ770 Turbidity Meter					
Field Duplicate	Precision (S & A)	1/5 field samples	N/A	± 20%RPD	Collect & analyze 3rd sample. Qualify data if still exceeding criteria.
QC Check Sample[6]	Accuracy	1/ batch each day	± 20% or ±2 NTU of 20 NTU standard (whichever is greater) and ±1 NTU for 0 NTU standard	± 20% of true value	Qualify associated field data

[2] Data Quality Indicators may be related to sampling (S) and/or analysis (A) activities.
[3] For field duplicate samples, there are no method-specific QC acceptance limits. (NA - Not applicable.)
[4] The information in this column supports acceptance criteria/measurement performance criteria introduced in Section 1.7 For this study, the field measurement's QC acceptance limits (as determined from a calibration check sample analyzed half-way through the field day) were reviewed and found acceptable to meet the current data quality needs. As such, the field measurement's QC acceptance limits and the project's measurement performance criteria are equivalent.
[5] Accuracy is not ensured through the analysis of a QC check. If the temperature sensor meets the annual calibration procedures and criteria presented in Table 2.7.1, the measurements are considered accurate enough to meet the needs of the current project.
[6] Accuracy is ensured through the calibration and calibration check process presented in Table 2.7.1. The post calibration check sample(s) will be considered as QC check samples for the field measurements.

ALL SAMPLES ARE SURFACE WATER MATRIX. ALL SAMPLES ARE COLLECTED BY THE SAME PROCEDURE. NO ADDITIONAL QC CHECKS ARE PLANNED BEYOND THOSE IDENTIFIED ABOVE FOR ACCURACY AND PRECISION.

Table 3: Required sample containers, volumes, preservation methods, analysis method and holding times for water samples requiring laboratory analysis.

Analysis	Container Type	Sample Volume	Preservation Method	Maximum Holding Time	Laboratory Detection Limit	Analysis Method	Inorganic[5] No. of:[1]	
							Dup	MS
Macro-invertebrates	HD Polyethylene	500 ml	95% denatured CH_3CH_2OH (ethanol)	15 days	N/A	Level 1 CSBP[2]	N/A	
Total Phosphorous (TPO_4)	HD Polyethylene	1000 ml	H_2SO_4	28 DAYS	0.050 ppm	EPA 365.2	1 Dup and MS per analytical batch 500 ml	
Dissolved Phosphorus	Same Bottle As T-P	250 ml	H_2SO_4	28 DAYS	0.050 ppm	EPA 365.2	Same as bottle as T-P Dup and MS	
Total Nitrogen	HD Polyethylene	1000 ml	None	28 DAYS	0.40 ppm	EPA 351.3	N/A	
Ammonium Nitrogen	HD Polyethylene	500 ml	H_2SO_4	28 Days	.10 ppm	EPA 350.2	1 Dup and MS per analytical batch 1liter	
Nitrate + Nitrite	Same Bottle As T-P	125 ml	4 DEG C,	48 HRS	400 ppb	EPA 300.0	1 Dup and MS per analytical batch	
Phytoplankton	HD Polyethylene	250 ml	1% Lugol solution	1 year or more	0.45 micrometer membrane filter	Standard Methods, 1992,10200.F .2.c	10% of samples for duplication	
Chlorophyll a	Amber Glass	1 liter	None	24 Hrs To Filtration	2 ppb	SM10200H2 B	1 Dup and MS per analytical batch 2 liters	
Pesticides-Trifluralin	Amber Glass	1 liter	None	7 days	1.0 ug/l	EPA 8141A	Extra Liter for Duplicate	
Pesticides-Diuron	Amber Glass	1 liter	None	7 days	1.0 ug/l	EPA 632	Extra Liter for Duplicate	
Total Coliform and *E.coli*	Polystyrene	100 ml	None	8 hours	1 MPN	Standard Method 9223B	1 Dup per every 10 samples	

[1] Include number of associated analytical QC samples if collection of additional sample volume and/or bottles is necessary. If the QC samples listed are part of the analysis but no additional sample volume and/or bottles are needed, include "NAS" (for "no additional sample") in the column. (Note: MS=matrix spike, MSD=matrix spike duplicate, dup=laboratory duplicate/replicate.)

III. Surface Water Results and Assessment Methodology

A. Scott River Water Quality Monitoring at USGS Gage

The Scott River USGS gage near Fort Jones (SFJ) was upgraded to include QVIR Environmental Program Department (EPD)'s YSI datasonde in 2007. Data were recorded every 30 minutes from June 28 to September 30th, 2007. Attempts are being made to keep the probe in year-round, however analysis for this report only includes data downloaded until 9/30/07 to correspond with the end of our federal funding cycle. Preliminary data are available online at http://cdec.water.ca.gov/cgi-progs/queryF?sfj. Data is finalized each year in the Tribe's water quality report to EPA.

Water quality parameters monitored using the YSI datasonde include: temperature, specific conductivity, dissolved oxygen concentration, dissolved oxygen charges, pH and turbidity. Each parameter was compared to state, federal or Tribal water quality objectives based on the specific life stage needs of salmonids. Data have not been corrected to account for bio-fouling that may have occurred. However, an initial comparison of pre and post calibration documentation revealed little bio-fouling was occurring at this site in 2007. Appendix E is a sample calibration data sheet, the calibration was performed on August 2, 2007.

1. Temperature

The datasonde placed at the Scott River USGS gaging station (SRGA) recorded temperature data every 30 minutes. For analysis, the maximum weekly average temperature (MWAT) was determined for this location and compared to reference values for lethal and sub-lethal MWAT values affecting salmonids of different life stages. A salmon risk assessment study approach used by Sullivan *et al.* (2000) found that an MWAT of 19ºC 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 - 25.0º C for coho and 21.0 - 26.0ºC for steelhead. Elliot (1981) also found these MWAT values can block migration, inhibit smoltification and cause disease problems. (Sullivan et al., 2000; Welsh et al., 2001; U.S. EPA, 2003).

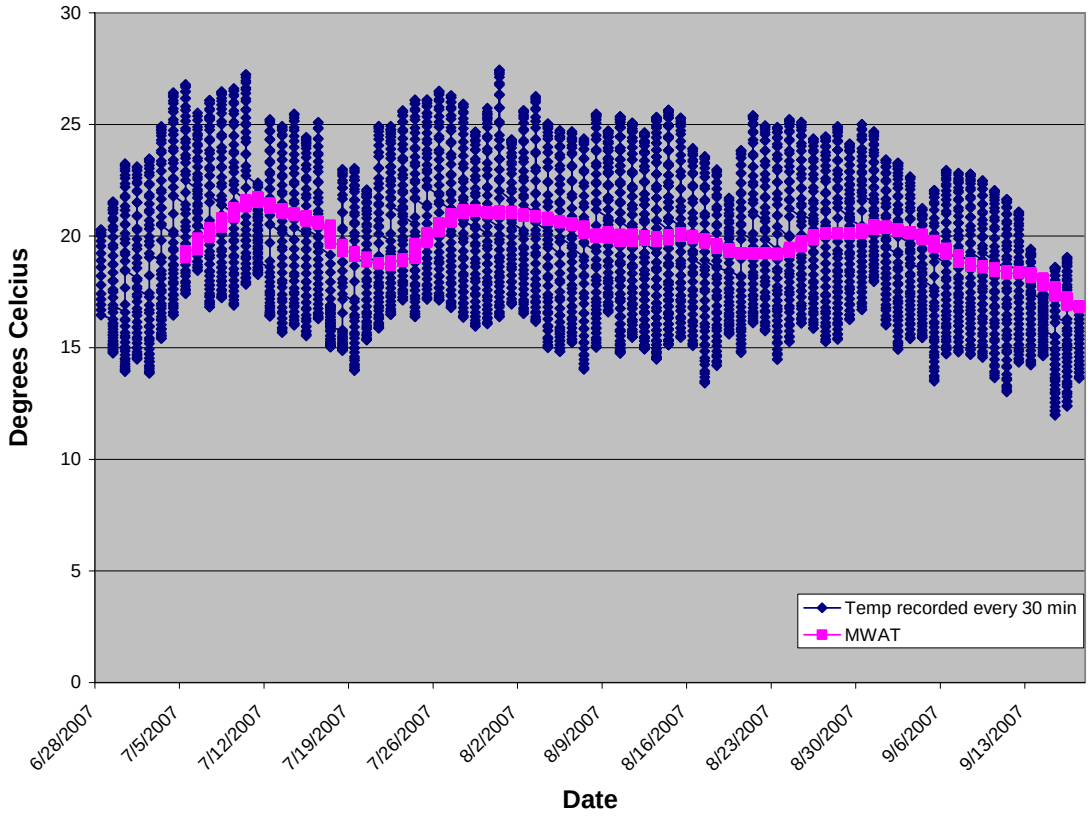


Figure 3 Temperature at the Scott River USGS Gaging Station 2007.

2. Specific Conductivity

The datasonde placed at the at the Scott River USGS gaging station (SRGA) recorded specific conductivity every 30 minutes. *Basin Plan* (NCRWQCB 2007) water quality objectives for the Scott River are 0.35 and 0.25 mS/cm (90% upper limit and 50% lower limit, respectively) and these values were used as a reference in analysis. The calculated median was 0.205 mS/cm. The median value is less than 0.25 mS/cm meeting the water quality objective for specific conductivity in 2007.

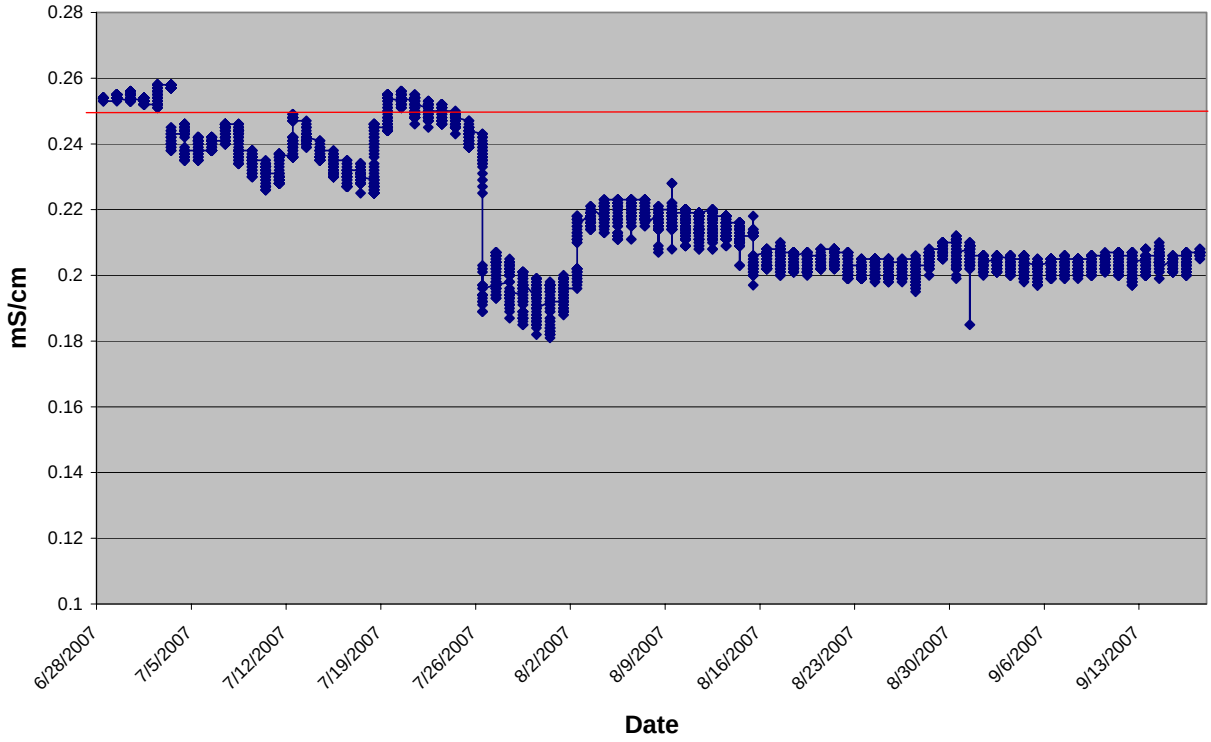


Figure 4 Specific conductivity at the Scott River USGS Gaging Station 2007. Fifty percent of the values must be less than 0.25 mS/cm (red line).The red line is the (NCRWQCB 2007) *Basin Plan* water quality objective used here for analysis.

3. Dissolved Oxygen

The datasonde placed at the at the Scott River USGS gaging station (SRGA) recorded dissolved oxygen (D.O.) every 30 minutes. The *Basin Plan* (NCRWQCB, 2007) Scott River objectives were again used for comparison, a minimum of 7mg/l and a 50% lower limit of 9mg/l. The minimum value, 7 mg/l, was not met in 2007 from July 3rd - July 17th, July 26th – September 1st (except for July 30th) and September 6th-10th and 13th. The calculated median for 2007 data was 8.83 mg/l, this does not meet the 50% lower limit of 9mg/l.

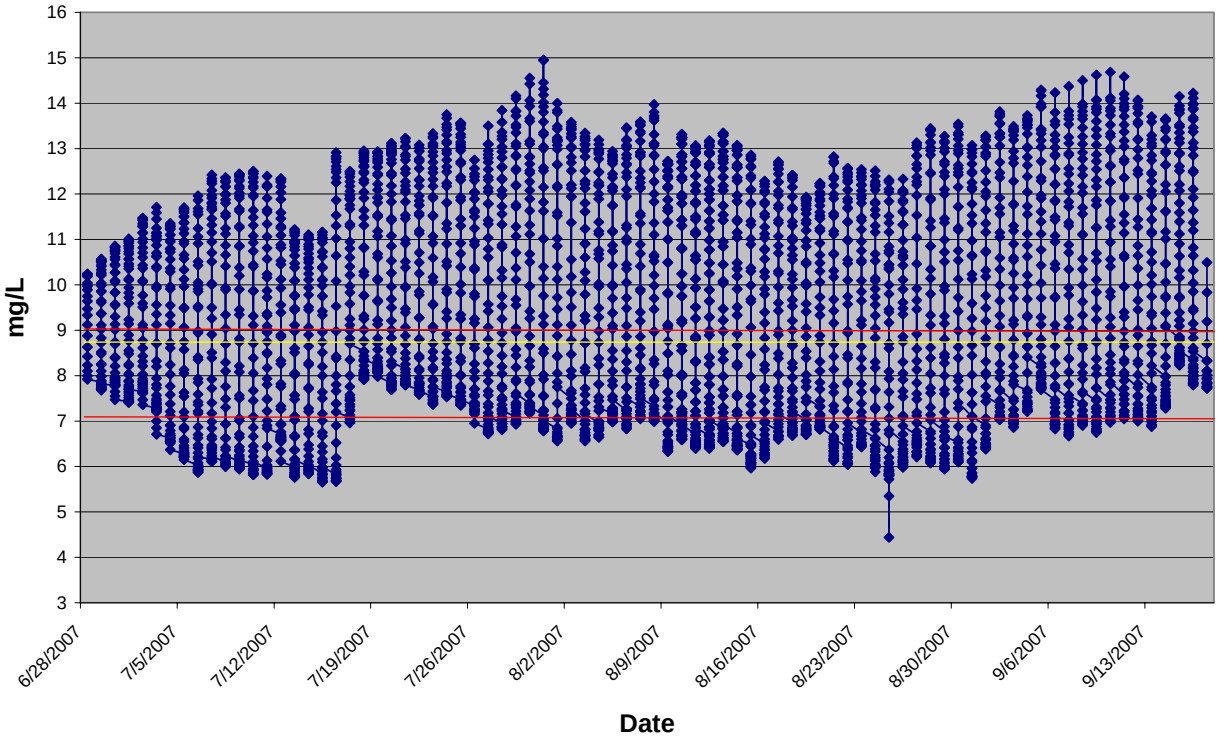


Figure 5 Dissolved Oxygen at the Scott River USGS Gaging Station 2007. The red lines are the minimum value and 50% lower limit, 7mg/l and 9mg/l respectively (NCRWQCB 2007). The yellow line is the calculated median value to compare to the 50% lower limit (9mg/l).

4. pH

The datasonde placed at the Scott River USGS gaging station (SRGA) recorded the pH every 30 minutes. The *Basin Plan* (NCRWQCB, 2007) Scott River water quality objectives for pH are greater than 7 and less than 8.5. The *Basin Plan* maximum value of 8.5 was exceeded in 2007 on June 29th, July 8th-16th, and July 28th – September 16th (end of analysis).

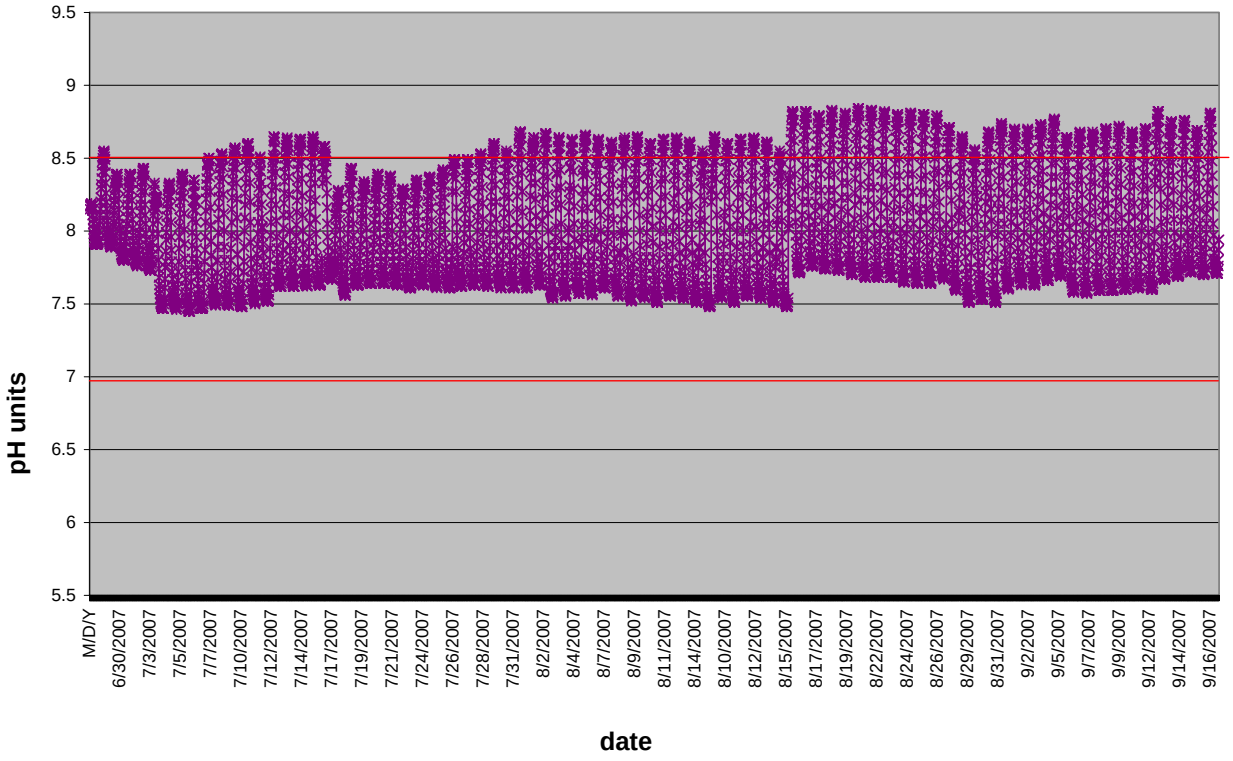


Figure 6 Data for pH at the Scott River USGS Gaging Station 2007. The red lines are indicating the NCRWQCB 2007 *Basin Plan* water quality objectives: minimum (pH 7) and maximum (pH 8.5).

5. Turbidity

Turbidity was collected each half hour at the USGS gaging station from 7/28/07 to 9/17/07. The Tribe adopted an action level of 5 NTU above the natural level. The action level was determined using coho salmon research results from Berg (1982) and Lloyd (1987). The action level is a water quality objective set by the Tribe, see QVIR QAPP. There is not a water quality objective for turbidity established by either, EPA or NCRWQCB.

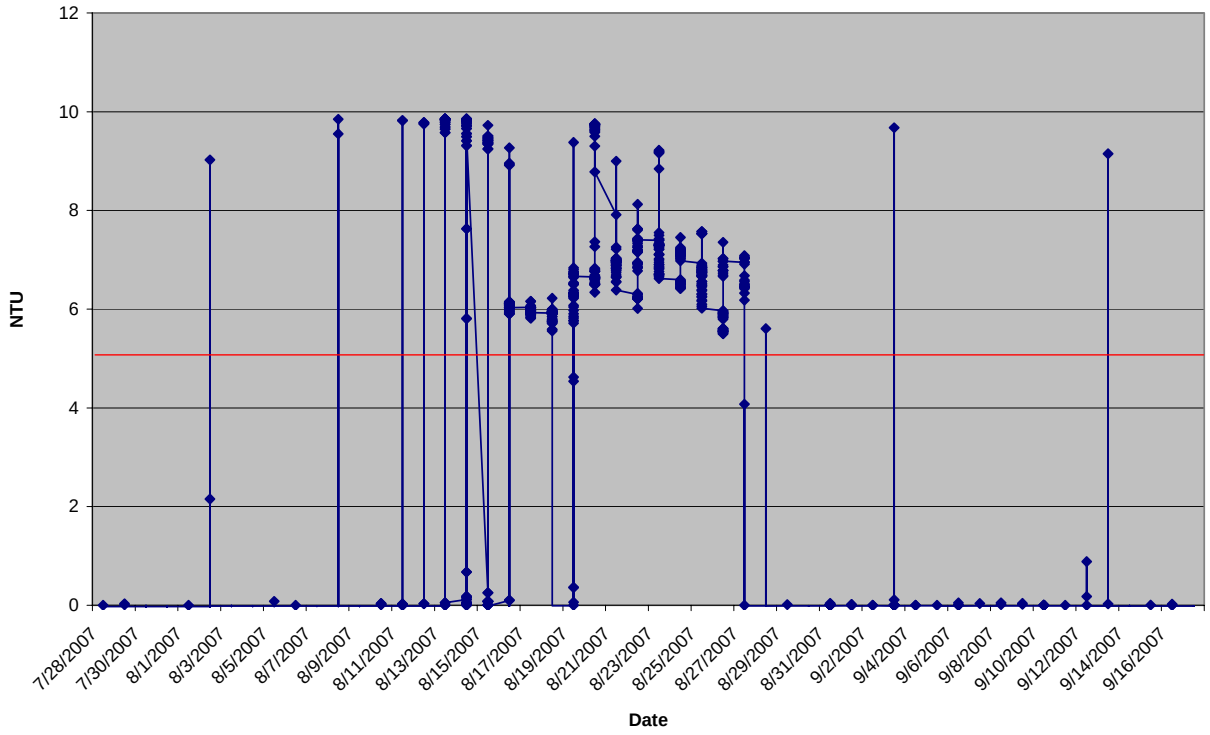


Figure 7. Turbidity at the Scott River USGS Gaging Station 2007. The red line indicates the Tribal water quality objective of 5 NTU used for analysis.

6. Nutrients

Figure 8 shows the concentrations of total nitrogen (TN), total phosphorus (TP), chlorophyll-*a* (Chloro a), and phaeophytin-*a* (PHAEO a) at the Scott River gaging station. U.S. EPA (2000a) upper limit recommendations for nutrients are 0.12 mg/L for TN, 10 µg/L for TP, 10 µg/L for chlorophyll-*a* and 15 ug/l for PHAEO a were used as reference values to compare with the Scott River data. There are no water quality objectives in the *Basin Plan* for these parameters. Both TP and TN were above EPA recommendations in 2007.

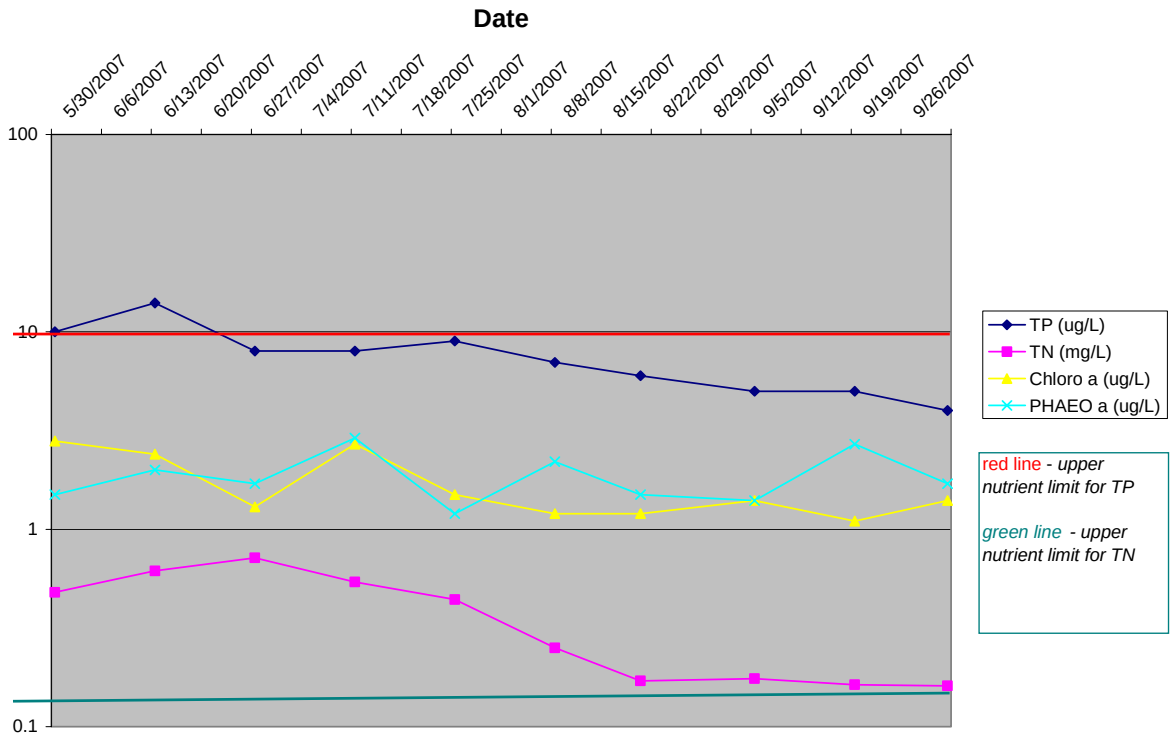


Figure 8 Nutrients at the Scott River USGS Gaging Station 2007 versus EPA water quality recommendations for TP (red line) and TN (green line).

B. Scott River Mainstem and Tributary Temperature Monitoring

Temperature loggers were deployed in both the mainstem and tributaries throughout the Scott River basin. Site locations were selected by the USFS for long-term temperature monitoring in the basin. The USFS did not have funding to continue this effort in 2007, but the QVIR EPD felt it imperative that these data were collected to supplement the ground water modeling efforts related to the TMDL implementation plan. The NCRWQCB agreed and supplied QVIR calibrated water and air temperature loggers. Table 4 contains results for mainstem and tributary sites, including the seven longitudinally in the Shackleford Creek watershed.

MWATs, 7-Day running averages and daily temperatures were graphed for all sites and are included on the data CD. Literature on the effects of temperature on Pacific salmon (Sullivan et al., 2000; Welsh et al., 2001; U.S. EPA, 2003) were used to analyze the Scott River and tributary temperature results.

Table 4. Maximum Weekly Average Temperature (MWAT) for Scott River Tributaries and mainstem 2007 locations. Coho suitability is based on 16.8ºC MWAT (Welsh et al., 2001).

Coho Suitable	MWAT - ºC	Site	Date
Y	15.4	Crater Creek	11-Jul
N	17	Houston Creek	11-Jul
Y	13.3	Kangaroo Creek	2-Aug
N	19	Grouse Creek	11-Jul
N	17.9	Mule Creek	11-Jul
N	18.2	Big Mill Creek	11-Jul
N	18.3	CAMI (*Campbell Lake Inlet)*	12-Jul
Y	15.6	SUCC (*Shackleford Upstream Campbell Lake Outlet*)	3-Aug
Y	16.4	SHTH (*Shackelford at Trailhead*)	26-Jul
N	18.2	SHFL (*Shackleford at Falls)*	27-Jul
Y	14.8	SRES (*Shackleford at Reservation)*	22-Jun
N	17.1	CHTH (*Lower Shackleford)*	1-Aug
Y	15.6	Canyon Creek	3-Aug
N	17.6	Kelsey Creek	12-Jul
N	17.3	Middle Creek	12-Jul
Y	16.6	Tompkins Creek	2-Aug
Y	16.4	Scott Bar Mill Creek	12-Jul
Mainstem Scott River MWAT			
N	21.8	Scott River @ USGS Gage	11-Jul
N	23.3	Scott River Above Canyon Creek	11-Jul
N	21.3	Scott River @ Bridge Flat	29-Jul
N	22.3	Scott River @ Townsend Gulch	1-Aug
N	24.3	Scott River @ Roxbury Bridge	11-Jul

C. Shackleford Creek Water Quality and Flow Monitoring

1. Nutrient Grab Samples

Nutrient grab samples from sites in the Shackleford Creek watershed were analyzed for total nitrogen, total phosphorous, chlorophyll-*a*, and phaeophytin-*a*. Table 5 is a list of each site by code and the approximate location, see Figure 2 and Appendix B for a map of the nine monitoring site locations.

Table 5: Sampling site codes for 2007, description of location and property status

Site Code	Location Description	Property Status
CAMI	Inlet to Campbell Lake Outlet of Cliff Lake	Wilderness - USFS
CAMP-1 & 6	Sample depth 1 meter on Campbell Lake – CAMP-1 Sample depth 6 meters on Campbell Lake – CAMP-6	Wilderness - USFS
CAMO	Outlet of Campbell Lake	Wilderness - USFS
SUCC	Outlet of Summit Lake	Wilderness - USFS
SHTH	Shackleford at wilderness trailhead	Wilderness - USFS
SHFL	Shackleford at Falls	Private
SRES	Shackleford at Quartz Valley Indian Reservation	US Bureau of Indian Affairs
CHTH	Shackelford at Tribal Trust parcel near mouth	US Bureau of Indian Affairs
SRGA	Scott River at the USGS Gaging Station near Fort Jones	Private

a. Total Nitrogen (TN)

Total nitrogen concentrations for water samples collected in Shackleford Creek watershed in 2007 are displayed as Figure 9.

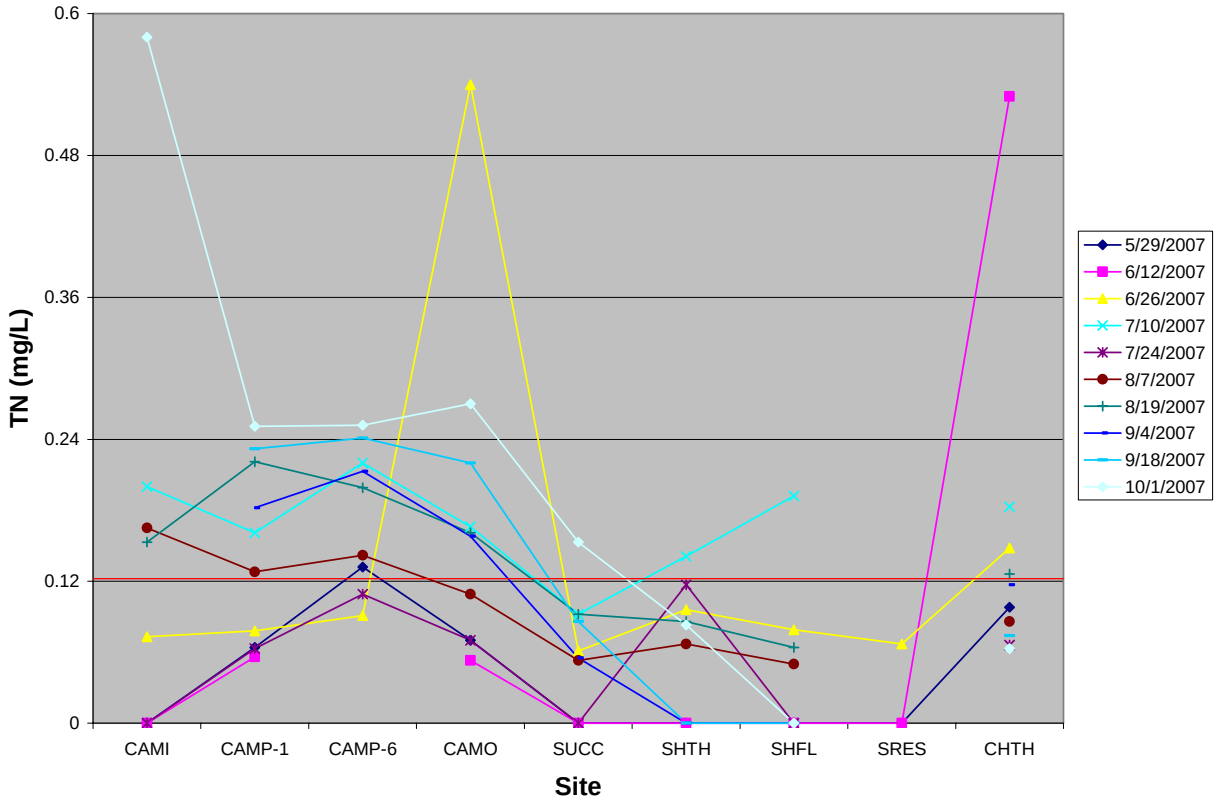


Figure 9 Total Nitrogen at nine Shackleford Creek locations sampled biweekly, from May to October 2007. The red line, 0.12 mg/l, is the upper nutrient limit recommendation used for analysis provided by EPA (Table 1).

b. Total Phosphorus (TP)

Total phosphorus concentrations in water samples collected in the Shackleford Creek watershed in 2007 are displayed as Figure 10.

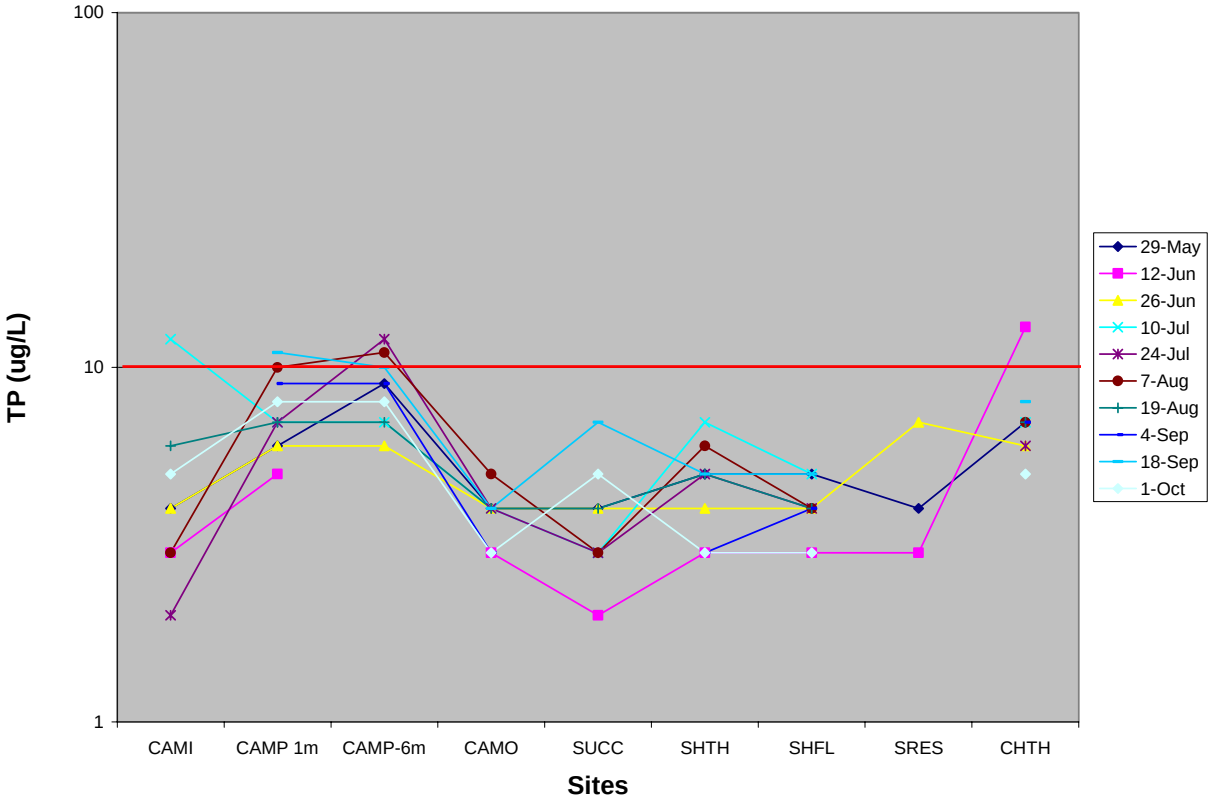


Figure 10 Total Phosphorus at nine Shackleford Creek locations biweekly from May to October 2007. Sampling in 2007 for TP revealed exceedance of the 10.0 µg/l limit, red line, recommended by the U.S. EPA (2000).

c. Chlorophyll a

Chlorophyll *a* concentrations in water samples collected in the Shackleford Creek watershed in 2007 are displayed as Figure 11.

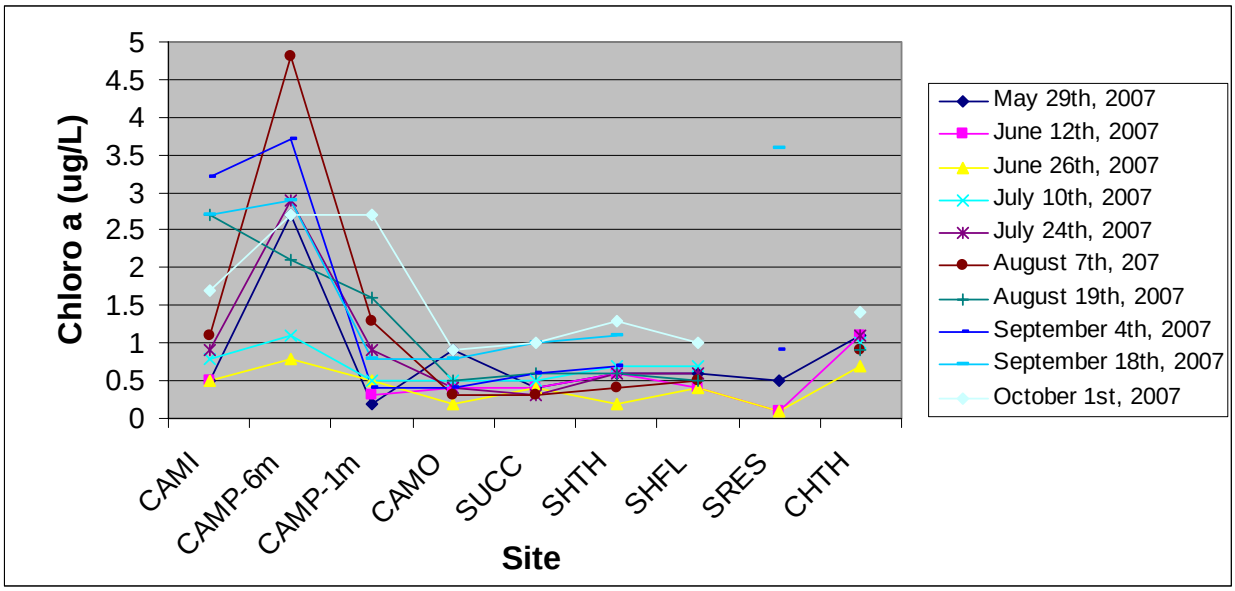


Figure 11 Chlorophyll *a* at nine Shackleford Creek locations sampled biweekly from May to October 2007. Chlorophyll-*a* values were all less than the 10 µg/L, which is recommended by TetraTech (2006) as a Nutrient Numeric Endpoint (NNE) to protect the COLD (coldwater fisheries) in lakes in the state of California.

d. Phaeophytin a (PHAEO a)

Phaeophytin a concentrations for water samples collected in Shackelford Creek watershed in 2007 are displayed as Figure 12.

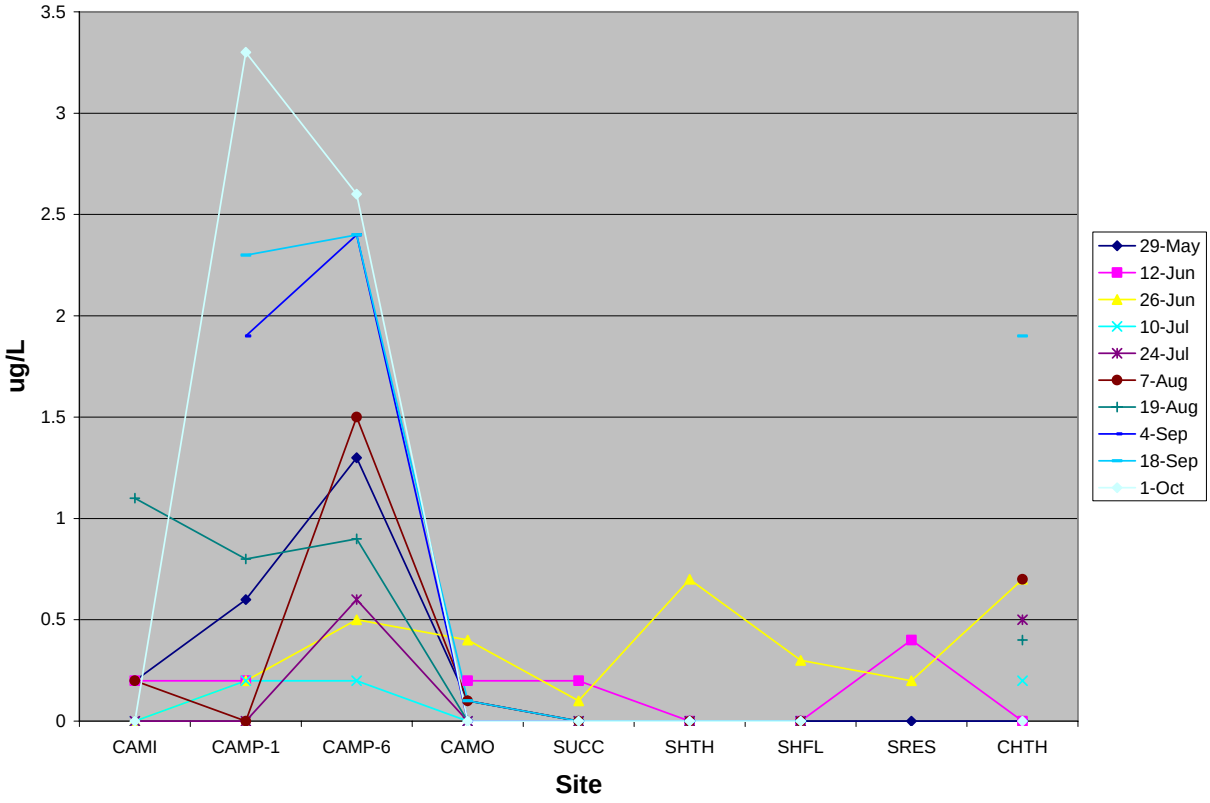


Figure 12. Phaeophytin *a* at nine Shackleford Creek locations sampled biweekly from May to October 2007.

2. Discharge Monitoring

Surface flows were calculated at each site for three reasons: to calculate loading of nutrients and bacteria, to observe the natural discharge conditions above all diversions, and to determine the amount of habitat supporting aquatic life and recreation on Shackleford Creek.

Discharge measurements occurred every two weeks from May 29th, 2007 to October 1st, 2007. An AquaCalc flow meter was used following the USDA (Harrelson et al., 1999) *Stream Channel Reference Site* protocol.

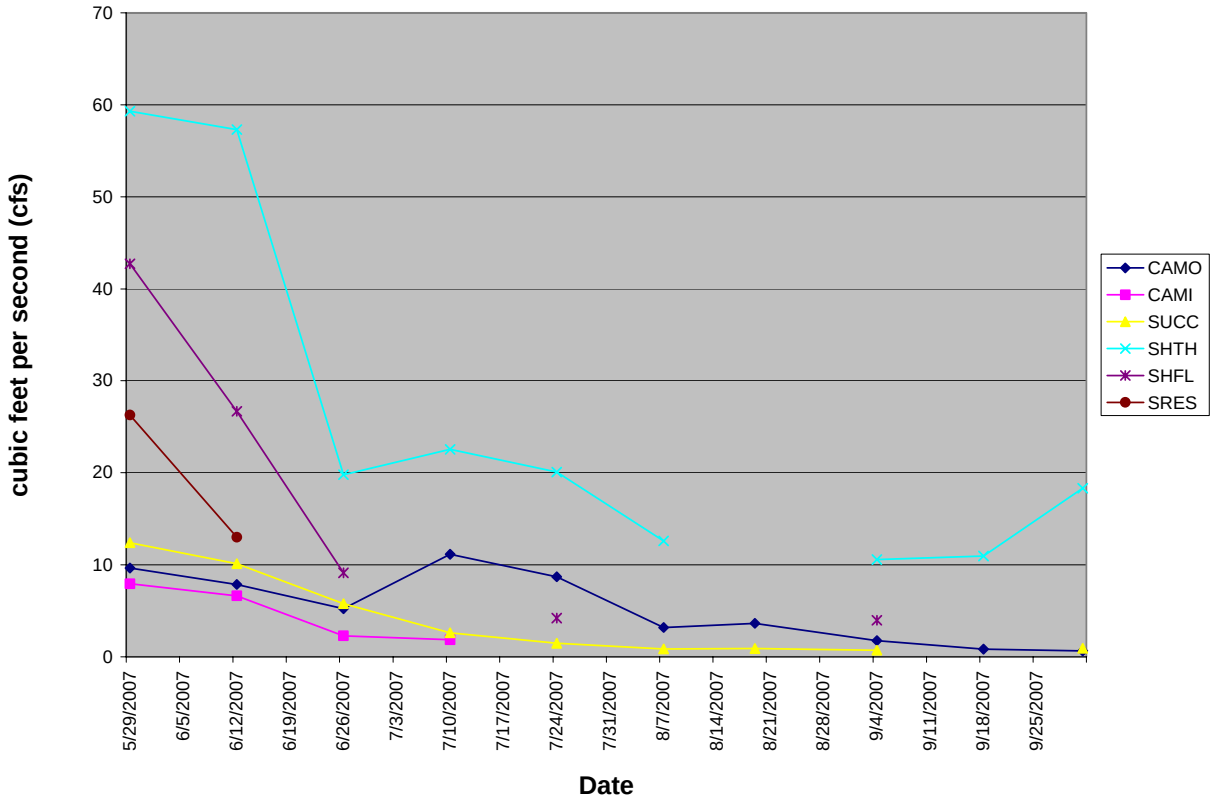


Figure 13. Discharge measurements at six Shackleford Creek locations measured bi-weekly from May to October 2007. The Campbell Lake inlet (CAMI) site was dry from the 7/17/07 sample date to the end of sampling. Shackleford at the Reservation (SRES) was dry from the 06/19/07 sample date to the end of sampling. Shackleford above the confluence with Campbell Lake outflow was too low to get an accurate measurement from the 9/11/07 sample date through the end of sampling.

3. YSI Parameters

a. Dissolved Oxygen

Figure 14 graphs all dissolved oxygen measurements taken at the time of nutrient and bacteria sampling.

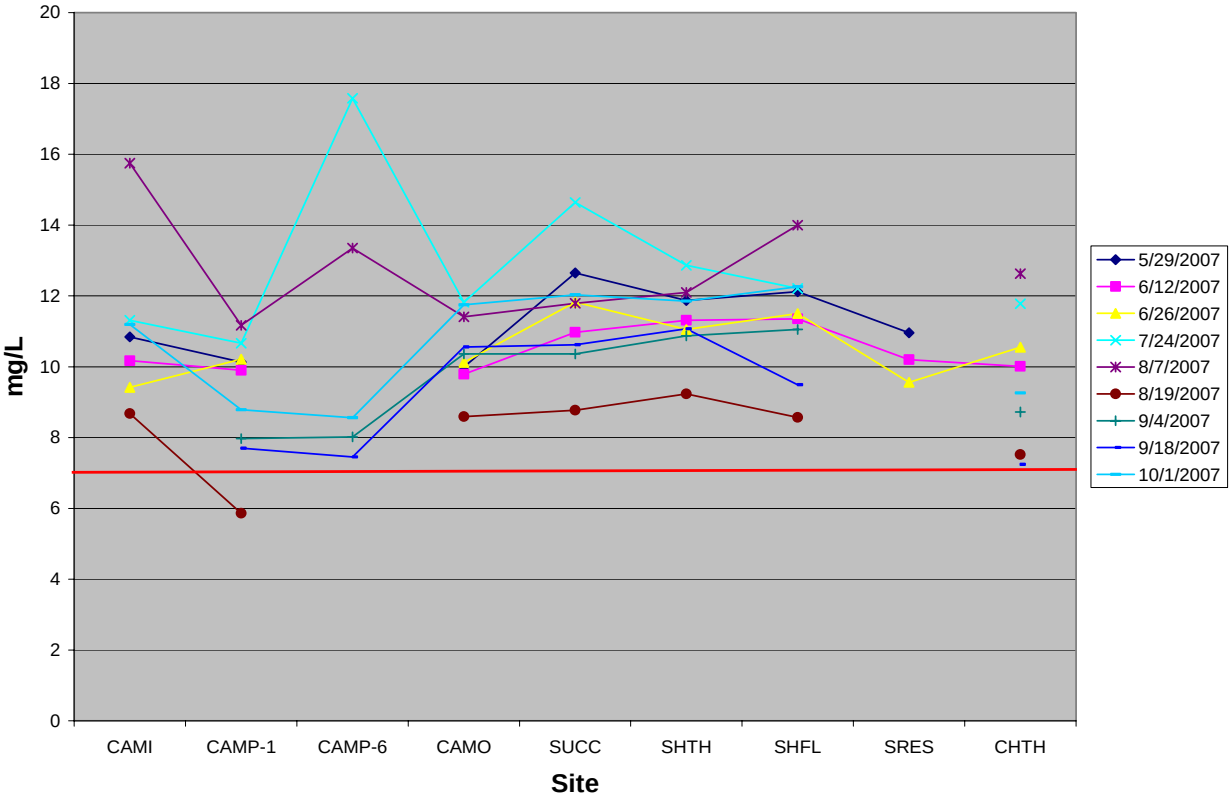


Figure 14. YSI probe results for D.O. at nine Shackleford Creek locations from bi-weekly spot samples in 2007. The red represents the *Basin Plan* (NCRWQCB 2007) water quality objective of 7mg/l minimum. Only one sample in 2007 was below 7 mg/l.

b. pH

Figure 15 graphs all pH measurements taken at the time of nutrient and bacteria sampling.

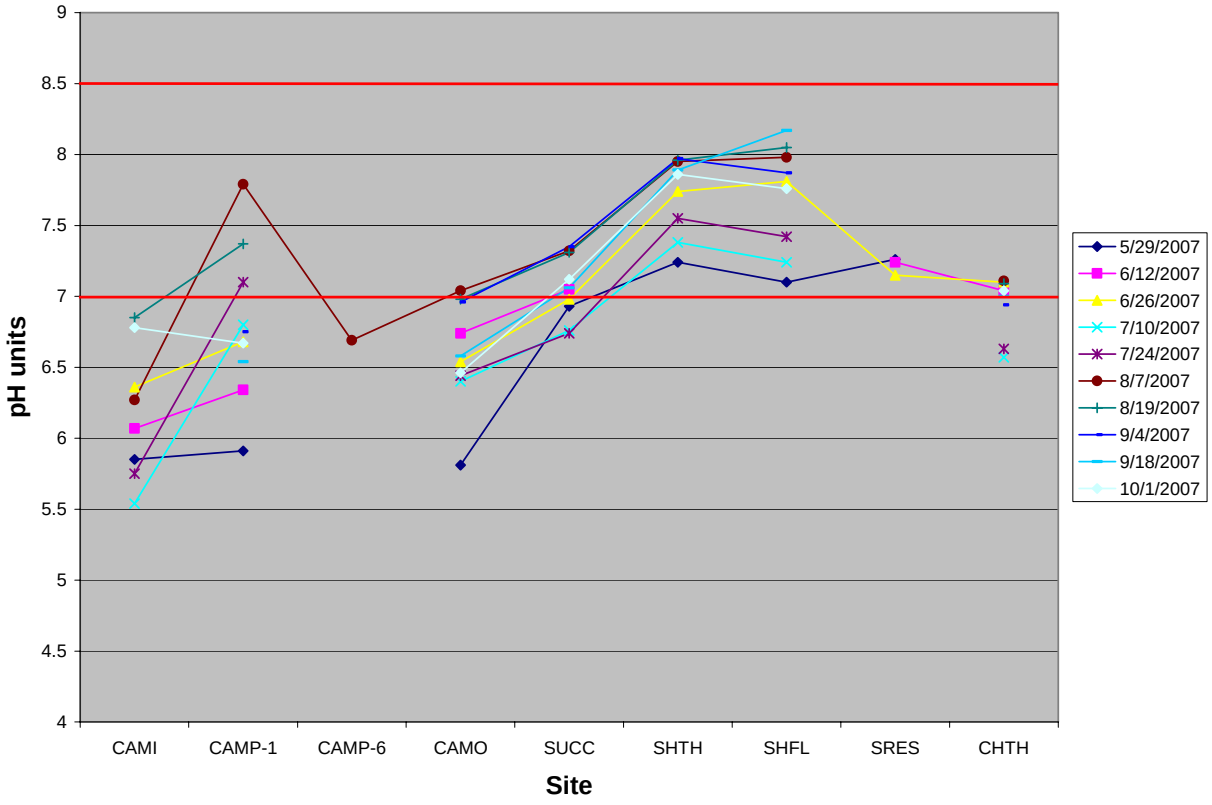


Figure 15. YSI probe results for pH at nine Shackleford Creek locations from bi-weekly spot samples from May-October 2007. The red lines represent the upper (8.5 pH units) and lower (7 pH units) water quality objectives from the NCRWQCB *Basin Plan* (2007). Violations of the minimum pH criteria, 7 pH units, occurred on Shackleford Creek in the wilderness and lower Shackleford near the mouth.

c. Specific Conductivity

Figure 16 graphs all specific conductivity measurements taken at the time of nutrient and bacteria sampling.

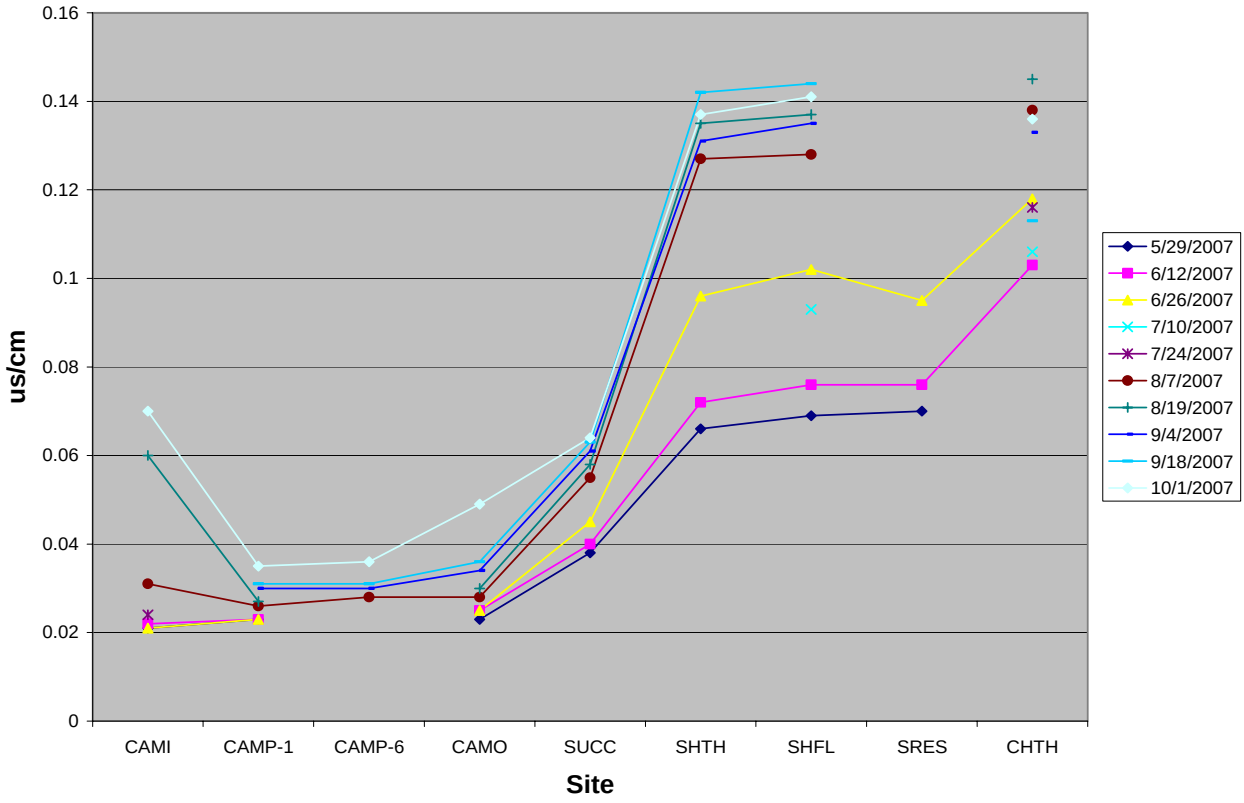


Figure 16. YSI probe results for specific conductance at nine Shackleford Creek locations from bi-weekly spot samples in 2007. All values were less than the water quality objective in the NCWQCB *Basin Plan* 2007.

D. Aquatic Macroinvertebrate Samples of Upper and Lower Shackleford Creek

Aquatic macroinvertebrate communities can be useful indicators of the health of aquatic ecosystems and are widely used as an index of water quality (Plafkin et al., 1989; Barbour, 1999). Sampling was carried out using the California Rapid Bioassessment Protocols (Harrington, 1999; Ode, 2007). The two sampling stations reported here were Shackleford Creek at the Marble Mountain Wilderness boundary (SHTH) and in lower Shackleford Creek below its convergence with Mill Creek (CHTH), a reach impacted by agricultural water extraction. Sampling took place in August 2007.

The aquatic macroinvertebrate indices discussed here are the EPT Index, Richness Index, Percent Dominant Taxa and the Benthic Index of Biotic Integrity (B-IBI). Table 6 shows reference values for four macroinvertebrate indices and results from upper and lower Shackleford Creek sites. Indices are as follows with literature citations for reference value derivation:

- EPT Index: The number of taxa (species) present in the sample from the orders Ephemeroptera (mayflies), Plecoptera (stoneflies) and Trichoptera (caddisflies), which all have very low tolerance to pollution. Harrington (1999) and Lee (1998).
- Richness: The Richness Index is the total number of taxa found in a sample (Plafkin et al., 1989; Barbour et al., 1999).
- Percent Dominance: The Percent Dominant Taxa Index is calculated by dividing the number of animals in the most abundant taxa by the total number of organisms in the entire sample.
- Benthic Index of Biotic Integrity (B-IBI): Composite index of macroinvertebrate community comprised of several other indices (Rehn and Ode, In Review). The Northeastern California B-IBI is still preliminary, and thus should be considered provisional in its application here.

Table 6. Stream condition indices using Richness, EPT and Percent Dominance as advanced by Lee (1998), and B-IBI from Rehn and Ode (In Review).

Index	Low Impact	Moderate Impact	High Impact	**SHTH**	**CHTH**
Richness	> or = 40	25-39	<25	**36**	**34**
EPT Taxa	> or = 25	15-24	<15	**25**	**20**
% Dominance	<20%	20-39%	>40%	**32**	**52**
B-IBI	>80	40-80	<40	**80**	**60**

E. Scott River and Shackleford Creek Bacteria Sampling

Bacteria sampling occurred bi-weekly and was collected at the same time as nutrients, discharge and YSI handheld spot samples. The Most Probable Number (MPN) or colony forming units (cfu)/100 ml of *Escherichia coli* (*E. coli*) and total coliform were determined for each sample date. Reconnaissance occurred during 2007 to isolate when, where and the frequency at which exceedances might be occurring.

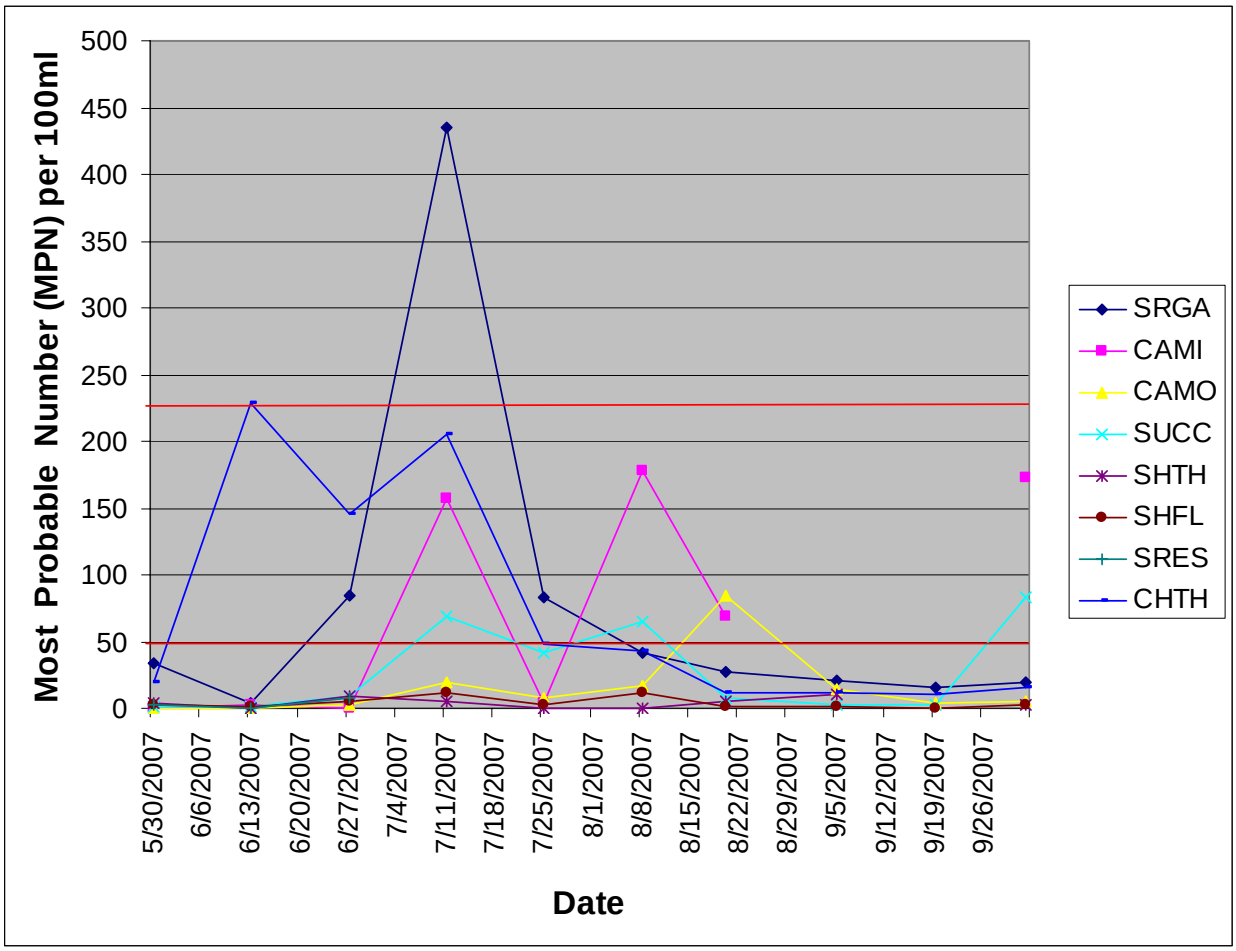


Figure 17 *E.coli* results for Shackleford Creek and the Scott River in 2007. A federal (U.S. EPA 1986) exceedance occurs if any single sample exceeds 235 MPN (top red line). The NCRWQCB (2007) *Basin Plan* objective is more stringent, with a limit of 50 MPN (bottom red line) based in 5 sampling events within 30 days.

IV. Groundwater Sampling Results and Assessment Methodology

The QVIR EPD is in the process of amending the QAPP to include parameters and protocols for groundwater sampling. In 2007, we used funding from the BIA Baseline Watershed Assessment program to cover this cost. However, we wanted to include the following groundwater information to U.S. EPA for their analysis. Future annual reports to EPA will include groundwater data collected in accordance with the Tribe's revised QAPP. Standard Operating Procedures (SOP) and protocols were developed for data collection based on EPA approved procedures from the 29 Palms Tribe. SOP's for the collection of bacteria (total coliform and *E. coli*) and YSI parameters (DO, pH, temp and conductivity) are available upon request. The static water level protocol was developed by the Scott River Watershed Council Community Groundwater Measuring Program (Scott River Watershed Program. 2006.). Well level measurements were taken using a Keck Water Level Meter. *E. coli* samples were processed and analyzed at the Quartz Valley Indian Reservation bacteria lab, which is certified through the State of California.

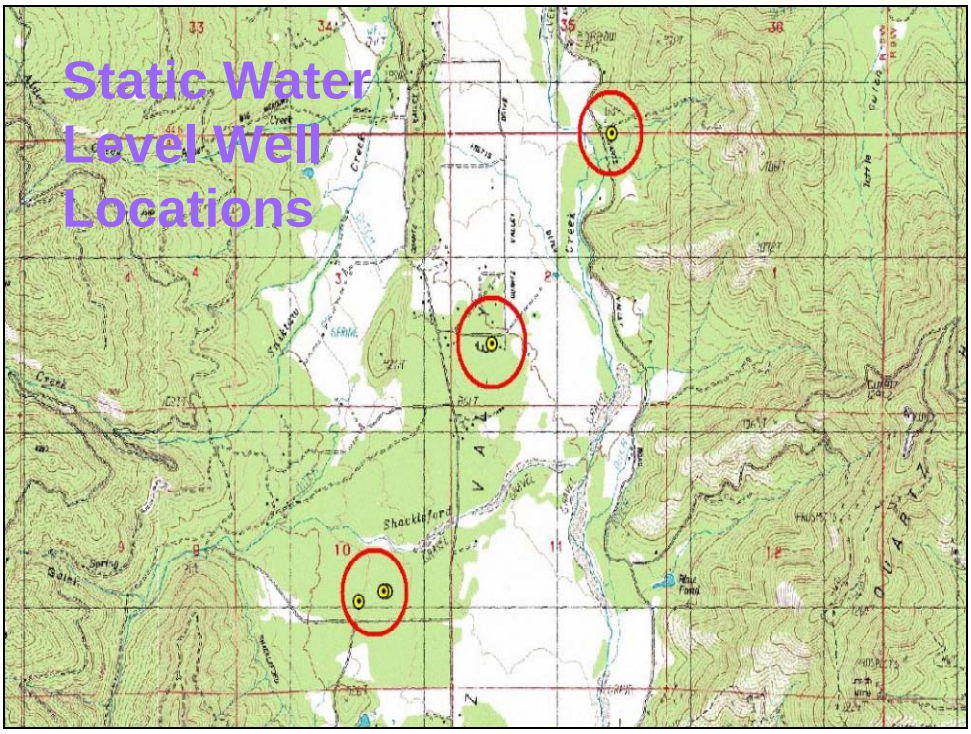
Samples were collected the first week of each month. This corresponds with well depth data being collected throughout the Scott River basin for the current groundwater study. The NCRWQCB (2007) *Basin Plan* has set water quality objectives for certain groundwater water quality parameters in the Scott Valley. U.S. EPA has set water quality objectives for drinking water. All data results were compared to either state or federal standards. Table 7 lists each groundwater parameter, the water quality objective and its source.

Table 7: Drinking Water Standards from US EPA (2006) and groundwater quality objectives from the NCRWQCB (2007) *Basin Plan*.

Parameter	**Units**	**Water Quality Objectives**		**Source**
pH	pH	Max	Min	North Coast Regional Water Quality Control Board (NCRWQCB). 2007 Basin Plan, Scott River Objective
		8	7	
Conductivity	µS/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	
Escherichia coli	MPN	Presence		US EPA 2006.

A. Static Water Level

We were able to obtain static water level on five wells throughout the sampling period, but were unable to collect data at other sites for reasons currently being investigated.



(Map created by M.Horney, NRCS-USDA)

Figure 18 2007 static water level QVIR well locations.

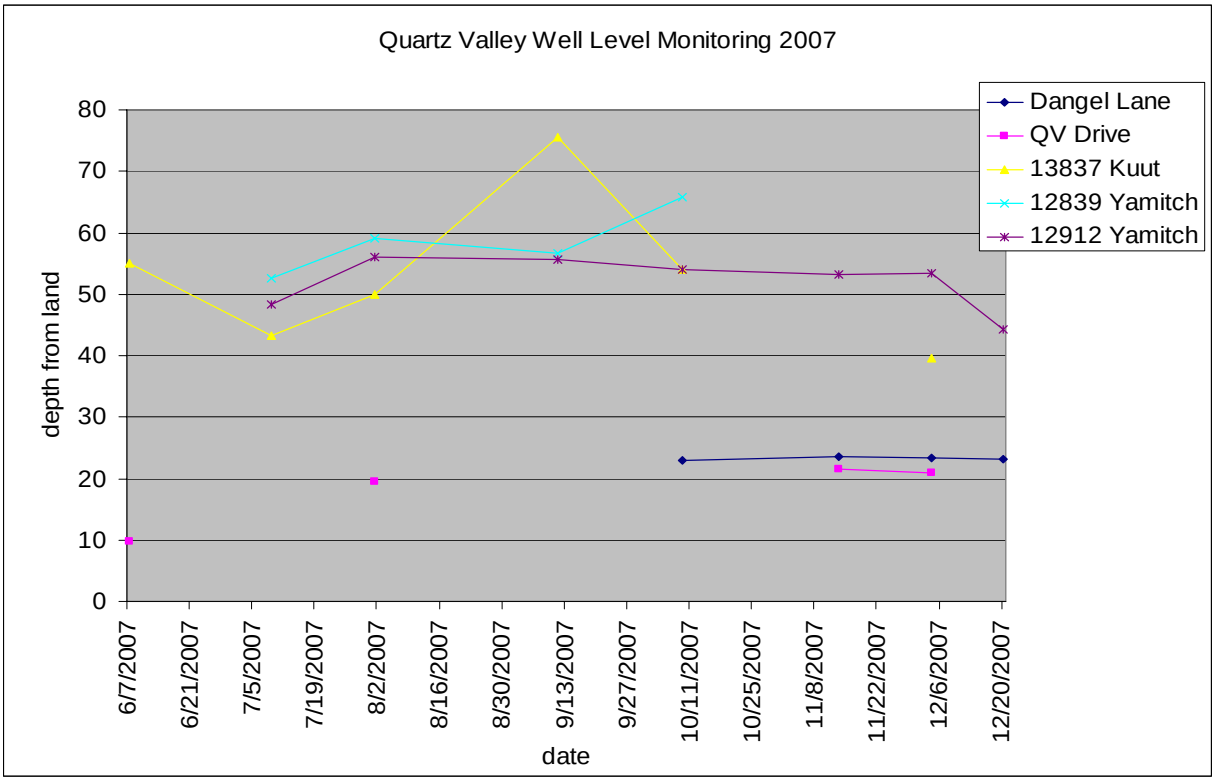


Figure 19 Static well level data in Quartz Valley from June through December 2007.

B. Water Quality – dissolved oxygen, pH, temperature, specific conductivity
Water quality data were collected from drinking wells at the same time as the *E. coli* and static water level. The same parameters were collected in Shackleford Creek, directly adjacent to the wells, at the time of groundwater sampling. Temperature, dissolved oxygen and specific conductivity were all collected and within standards. Violations to groundwater Scott River objectives in the NCRWQCB (2007) *Basin Plan* for pH was noted on 11 of 14 wells sampled and also in Shackleford Creek at the time of sampling. Groundwater values range from 5.08 – 7.85 pH units. Surface water values range from 6.4 – 7.44 pH units.

C. Total Coliform and *E. coli*
In 2007, June-December, monthly well water samples were collected and analyzed for total coliform and *E. coli. E. coli* was not detected in any wells during this sampling set. Coliform was detected in 10/14 drinking wells. Levels range from 1 - 48 MPN/100ml sample. All five wells on Yamitch in December had low levels of total coliform. #12837 Kuut and #9009 Big Meadows had low levels recorded only in June. Wells #13605 (Ish Pish), #9021 (Sniktaw) and #12929 (Kuut) had no coliform from June – December 2007. In response to positive *E.coli* results during the winter of 2006, bacteria sampling increased to bi-monthly in December and will continue at this frequency through snowmelt.

V. Discussion

A. Scott River Water Quality

Data were most intensively collected at the USGS gage site below Ft. Jones (site SRGA), but automated temperature probes were deployed at a number of locations as well. Additionally, nutrient grab samples were collected at SRGA.

The datasonde located at SRGA, revealed significant violations to the NCRWQCB (2007) *Basin Plan* and U.S. EPA (2000) water quality recommendations. During the entire 2007 sampling period on the Scott River, at SRGA, the water quality was unsuitable salmonid habitat due to violations of pH, dissolved oxygen, temperature, nitrogen and phosphorus. During a portion of the time, it was also unsuitable for human recreation due to high *E. coli* counts. It is important to note that the water quality at this location on the Scott River is at the base of the valley, prior to entering US Forest Service lands that are extensively used for recreation. Nocturnal and diurnal fluctuations in dissolved oxygen and pH indicate high rates of algal respiration and photosynthesis. Nutrient enriched conditions that foster these algae blooms may be partially caused by flow depletion and stagnation. High day time temperatures and pH coupled with nighttime dissolved oxygen sags create chronically unsuitable habitat for salmonids.

Temperature: The datasonde results from SRGA shows the greatest MWAT recorded was 21.76 during the week of July 11th, 2007 and daily maximum temperatures exceeded lethal for coho and steelhead many days from July through late August. Other automated temperature probe data from the mainstem Scott River show MWATs ranging from 21.3 to 24.3º C, all well into the range of critical stress for salmonids identified by U.S. EPA (2003).

Dissolved Oxygen: The wide range of daily dissolved oxygen in the Scott River suggests eutrophication likely due to agricultural pollution, waste water treatment plant (Fort Jones) and/or flow depletion/stagnation.

pH: The NCRWQCB (2007) *Basin Plan* maximum value of 8.5 was exceeded in 2007 on June 29th, July 8th-16th, and July 28th – September 16th (end of sampling). Algal photosynthesis is the likely cause of these elevated pH values. High nutrient concentrations from agricultural return water in combination with depleted low flows provide ideal conditions for algae blooms. High pH is a substantial concern for salmonid health because pH over 8.5 at temperatures over 25º C converts ammonium ions to highly lethal dissolved ammonia (Goldman and Horn, 1983).

Nutrients: Nutrients do not directly affect salmonids, but can impact them indirectly by stimulating the growth of algae and aquatic macrophytes to nuisance levels that can adversely impact water quality (dissolved oxygen and pH). The concentration of nutrients required to cause nuisance levels of periphyton varies widely from one stream to another (U.S. EPA, 2000b; Tetra Tech, 2004, 2006), and detailed data analyses are required to determine relationships. In the absence of such analyses for Shackleford Creek and the Scott River, we use the U.S. EPA's (2000a) *Ambient Water Quality Criteria Recommendations for Rivers and Streams in Nutrient Ecoregion II*. U.S. EPA provided the document as general guidance, but did not intend for these values to be directly translated into standards. We use U.S. EPA's recommendations of 0.12 mg/L total nitrogen (TN) and 10 µg/L total phosphorus (TP) as preliminary reference values to compare our data with, understanding that these values are subject to uncertainty.

Total nitrogen samples at SRGA in 2007 were above U.S. EPA's (2000a) 0.12 mg/L recommendation in every sample. The highest sample recorded, 0.718 mg/L, was on June 27th, 2007. Total phosphorus (TP) concentrations were above the recommended level of 10.0 ug/l set by the U.S. EPA (2000a) on May 30th and June 13th, 2007. Phosphorus levels were generally low and thus could potentially be more limiting to algal growth than nitrogen is, but more data collection and analysis are needed to make that determination.

Chlorophyll *a* levels in water column samples were low, suggesting that the free-floating phytoplankton are not driving these diurnal cycles. This is consistent with many other studies suggesting that algal communities in flowing rivers and streams are typically dominated by benthic algae, whereas phytoplankton are more abundant in still waters such as lakes and reservoirs (Tetra Tech, 2006).

Specific Conductivity: Although NCRWQCB (2007) *Basin Plan* standards were not exceeded for specific conductance or conductivity, fluctuations in conductivity are likely related to varying quantities of agricultural return water with changing diversion and return flow patterns through summer.

Bacteria (*E. coli*): On July 10th, 2007 *E. coli* samples on the Scott River, at SRGA, hit 435.2 MPN colonies/100ml, this is almost twice the numeric criteria set forth in U.S. EPA (1986) *Ambient Water Quality Criteria for Bacteria* (235 MPN). This value far exceeds the NCRWQCB (2007) *Basin Plan* standard of 50 MPN, but five samples over 30 days would be required to test for a violation.

Jones Beach, a popular summer swimming spot, is located approximately 2 miles downstream of SRGA; no significant tributary dilution occurs prior to the beach. This poses a public health threat and will be monitored more intensely in 2008 for the protection of recreating people on the Scott River. Probable sources of *E. coli* contamination in Scott Valley include livestock, wildlife and septic systems. DNA sampling of *E. coli* in 2008 will be aimed at determining which species are having the greatest effect.

Turbidity: The turbidity level observed in the Scott River for the period of 07/28/07-09/17/07 was generally 0 NTU with occasional spikes between 1 NTU and 10 NTU, suggesting little or no impairment relative to salmonid needs (Berg, 1982; Lloyd, 1987) during low flow periods.

B. Scott River Tributary Water Temperatures

Results from Table 5 show that there are several Scott River tributaries that maintain optimal temperatures for salmonids (Sullivan et al., 2000; U.S. EPA, 2003) and suitability for coho salmon. Those with optimal temperatures include Crater, Canyon, Tompkins, Mill (Scott Bar), and Kangaroo Creek. Some tributaries to the Scott River Canyon such as Kelsey Creek and Middle Creek may have elevated temperatures as a result of lingering cumulative effects damage from the January 1997 storm (QVIC, 2006c).

Shackelford Creek has optimal water temperatures upstream of agricultural diversion, but temperatures warm to levels stressful or lethal to salmonids in lower reaches, and often lose surface flows altogether (see section below for more in-depth discussion of Shackleford Creek temperatures).

C. Shackleford Creek Water Quality

Shackleford Creek sampling in 2007 revealed *Basin Plan* (NCRWQCB, 2007) violations for the following parameters: pH and *E. coli*. Total nitrogen and total phosphorus exceeded EPA recommendations. Temperature data showed that temperatures are unsuitable for the needs of salmonids. Macroinvertebrate samples from upper and lower Shackleford Creek suggest that the lower reaches are compromised.

Nutrients: Total nitrogen sampling in 2007 revealed exceedances of U.S. EPA's (2002) recommended TN limit of 0.12 mg/L at all sampling locations on Shackleford Creek. Sampling occurred bi-monthly from June through October 1st, 2007. This level was exceeded every sampling week at some location on Shackleford in 2007. The lowest levels were observed between the wilderness trailhead and the QVIC Reservation, the highest values were observed at the wilderness lakes and lower Shackleford Creek. Sampling in 2007 for total phosphorus also revealed exceedance of the 10.0 µg/l limit recommended by the U.S. EPA (2000). Exceedances occurred at CAMI (inlet to Campbell Lake), CAMP- 1,6 meter depth (Campbell Lake) and CHTH (lower Shackleford).

Chlorophyll-*a* values were all less than the 10 µg/L, which is recommended by TetraTech (2006) as a Nutrient Numeric Endpoint (NNE) to protect the COLD (coldwater fisheries) in lakes in the state of California. The highest values were observed in the wilderness lakes, but were still lower than the NNE. Phaeophytin is the breakdown product of chlorophyll and high concentrations of phaeophytin can indicate a seasonal crash of algae blooms. As expected based on low chlorophyll a concentrations, phaeophytin concentrations were also low in the Shackleford Creek water samples.

Dissolved oxygen: Only one D.O. measurement in 2007 on Shackleford Creek was below the *Basin Plan* (NCRWQCB, 2007) standard for dissolved oxygen. Campbell Lake was below 7mg/L on August 19th, at the 1 meter depth. It is important to note that the values represent the time of day the grab samples were taken, values may vary at different times of day.

Temperature: A significant finding from a longitudinal comparison was that the outflows from Campbell Lake were on average ~4º C warmer in comparison to Cliff Lake outflow and ~6.5º C warmer than the outflow of Summit Lake. The lake's dam is constructed so that the water flowing out of Campbell Lake is released from the surface. The outflow dam could potentially be altered to release water from a lower point thereby, decreasing water temperatures on Shackleford Creek and the Scott River. A USFS inventory of wilderness lakes with dam construction would also be useful to investigate how many high mountain lakes have this type of construction. Alterations to release water from a lower lake depth could aid greatly in attaining lower summer water temperatures, an objective of the Scott River TMDL. However, this would be contingent on the water of Shackleford Creek reaching the mainstem Scott. More analysis would need to be performed in order to determine if this would be feasible.

pH: pH measurements that fell below 7.0 pH units (lower limit water quality objectives NCRWQCB Basin Plan 2007) were observed on Shackleford Creek in the wilderness and lower Shackleford near the mouth (Figure 15). The wilderness exceedances occurred throughout the entire sampling period and the lower Shackleford site occurred on July 10th and 24th, 2007. The maximum pH criterion (8.5) was not exceeded at any of the sites monitored in the Shackleford Creek watershed. The majority of groundwater pH samples also came in below the *Basin Plan*

objectives. It will be useful to investigate the extent to which this in due to natural sources (such as geology) or to anthropogenic causes, such as materials brought into the system for, or exposed in an accelerated way by mining which took place in the Shackleford drainage in the 1800's-1900's.

Specific Conductance: NCRWQCB (2007) *Basin Plan* objectives for streams (excluding Scott River) in the Scott River watershed are 0.400 and 0.275 mS/cm, (90% upper limit and 50% lower limit, respectively). No violations to specific conductivity water quality targets occurred on Shackleford Creek in 2007.

E. Coli: Samples for *E. coli* in 2007 on Shackleford Creek exceeded 50 MPN in four locations, the outflow of Cliff Lake (CAMI), Campbell Lake (CAMO), Summit Lake (SUCC) and lower Shackleford (CHTH) near the mouth. These were single samples only and never exceeded the single sample 235 MPN set forth by U.S. EPA (1986). Five samples equally spaced over a 30-day period greater than 50 MPN would be a violation to the NCWQCB *Basin Plan* (2007). Data collected in 2007 highlights the time of year when this type of violation may be occurring to allow us to better focus our efforts in 2008. A longitudinal comparison by site revealed that higher levels are occurring in the wilderness, becoming lower beginning at the trailhead site through Shackleford falls and the Reservation but then increasing dramatically at the lowest site near the mouth of Shackleford. The highest values were observed the beginning of June through the end of August in 2007.

Macroinvertebrates: Results of the EPT Index for the upper and lower Shackleford Creek sites (or reaches) show a high score at the Marble Mountain Wilderness trailhead of 25 species present, which indicates a high level of aquatic health. The EPT Index score for lower Shackleford Creek is 20, which indicates moderate health. The lower reach is perturbed by flow fluctuations related to agricultural water withdrawals. However, the lower sampling site is about 1 miles downstream of the confluence with Mill Creek that exhibits steady surface flows and moderate aquatic health. It is possible that drift of insects downstream from Mill Creek is partially responsible for the moderate health score at the lower Shackleford site.

The control site at the Wilderness boundary had 36 species, which is equivalent to its Richness score and indicative of good health range, but the lower site had a very similar score (34). As with the EPT Index, the richness score at the lower Shackleford site could be inflated due to drift of aquatic macroinvertebrates from Mill Creek.

Results between the two locations are dramatically different for the Percent Dominance Index, but array as expected. The Percent Dominance score at the Wilderness boundary only reflects moderate aquatic health, which was lower than we expected. However, sampling occurred in August, well after spring immergence of many species. Sampling earlier in the year, when macroinvertebrates are easier to collect, may have resulted in a higher rating for aquatic health at the Wilderness boundary. The Percent Dominance score for the lower sampling site was 52%, which indicates poor or moderate aquatic health. This relatively low health rating likely reflects flow fluctuations and poor water quality, which are known to alter macro invertebrate community structure.

The IBI score at the upper Shackleford Creek monitoring station at the Wilderness trailhead had a score of 81 or a designation of Very Good (Table 6), which would be expected given the undisturbed watershed conditions upstream. The lower reach of Shackleford Creek impacted by

flow diversion has a score on the cusp of Good and Fair (60), possibly benefiting from macroinvertebrates drifting to the site from Mill Creek.

Groundwater: Temperature, dissolved oxygen and specific conductivity were all collected and within NCRWQCB *Basin Plan* (2007) water quality objectives. Eleven of the 14 wells had pH values below *Basin Plan* objectives (7 pH units), ranging from 5.08-7.85 pH units. *E.coli* was not detected in any wells during this sampling period. Total coliform was detected in 10 of the 14 wells, with levels ranging from 1-48 MPN/100ml sample.

Summary: Water quality on Shackleford Creek in 2007 was relatively good from the wilderness trailhead to the Reservation. However, *E.coli* reconnaissance samples revealed that violations are probably occurring in the wilderness as well as lower Shackleford. Low pH values observed in the lake and groundwater will be investigated further. High TN levels were observed throughout the entire watershed.

Shackleford falls, located approximately one mile upstream of the reservation, creates a natural barrier to anadromous fish. However, trout are present throughout all of Shackleford Creek, except lower sections of the creek where it ceases to flow during summer months. Flow monitoring data showed that after July 16th, 2007 the creek no longer has water to support this ecology and the habitat is dry downstream of the falls (exact point varies).

Shackleford joins Mill Creek, which retains surface flow, approximately ½ mile downstream of the reservation. The water quality in lower Shackleford revealed high TN, TP, *E.coli* and stream temp (MWAT). There may also be diurnal swings in dissolved oxygen and/or pH that were not captured during the time of day that nutrient and bacteria was being collected. This location is habitat for over-summering coho.

Airborne thermal infrared radar (TIR) data collected in 2006 (Watershed Sciences Inc., 2007) and water quality information from 2007 were used to assess the approximate amount of suitable habitat in Shackelford creek, for people and fish (Table 8).

Table 8. Supporting Beneficial Uses for Shackleford Creek 2007

Beneficial Use	Fully supporting	Supporting but threatened	Partially supporting	Not supporting	Not attainable	Unassessed
Municipal Supply		10 miles				
Agricultural Supply	X					Groundwater pumping
Groundwater Recharge						10 miles
Water Contact Recreation	5.0 miles		1 mile	3 miles		1 mile
Commercial and Sport Fishing	6.5 miles		1 mile	1.5 miles - dry		1 mile
Rare, Threatened, or Endangered Species	0.5 miles – upstream of valley		1 mile	1.5 miles - dry	6 miles	1 mile
Spawning, Reproduction, and /or Early Development	0.5 miles – upstream of valley		1 mile	1.5 miles - dry	6 miles	1 mile
Cultural/ ceremonial	6.5 miles – upstream of valley	1 mile		1.5 miles - dry		1 mile

D. Future Sampling

Based on our 2007 water quality data, we will continue monitoring to capture data from a variety of water year types. In 2008, will refine our water quality monitoring program at several sites, for various parameters:

Shackleford Creek:
TN will be sampled beyond October, because the October 2007 sample was the highest TN level recorded in the Creek.

Dissolved oxygen and pH sampling will continue approximately 2-4 weeks after pH and dissolved oxygen are within state water quality objectives.

Macroinvertebrate sampling will occur in the spring (April/May) to capture maximum diversity and later in the fall (mid-September/early October) to better understand natural seasonal variation. One to two sampling sites will be added on Mill Creek to help inform our analysis at CHTH. The wilderness lakes will only be sampled 1-2 times during the summer season.

A continuously recording datasonde will be deployed at the reservation until flows cease, it will then be moved to the lower Shackleford site to assess if diurnal swings in pH and D.O could be occurring.

Scott River:

Benthic algae will be collected during summer low-flow conditions at the Scott River Gage. As noted, pH and D.O. and chlorophyll *a* levels in the Scott River indicate high levels of benthic algae are probably present at the Scott River gage and/or in areas upstream. Sampling and analyzing benthic alga levels will help identify factors that contribute to increased algal growth, so that potential restoration efforts can be targeted. Algae sampling protocols include scraping of algae from a fixed area (e.g. 1 x 3 inches) of stream substrate (U.S. EPA, 2002; Eilers, 2005). Samples should be analyzed for algal species composition and biomass (benthic chlorophyll *a* concentrations in units of mass per area of streambed, not to be confused with water column chlorophyll *a* concentrations in units of mass per water volume). 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.

E. coli sampling should occur at Jones Beach, for the protection of people recreating. Secondly, sampling in various locations of the Scott mainstem will allow us to prioritize restoration efforts to minimize bacterial pollution to the river. Specific sampling, 5 samples over a 30 day period, will occur at the wilderness and lower Shackleford to monitor the extent of bacterial pollution.

Groundwater:

Groundwater sampling in 2008 will include collection of nutrients, four times a year to represent each season. This will expand the protection of our drinking water program.

In order to examine the level of connectivity of the surface and groundwater, continuous temperature probes will be added at selected wells near Shackleford and Sniktaw. One well near Shackleford will be equipped with a continuous water level probe to determine the groundwater level at which Shackleford dries up and regains flow.

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VII. Appendix

A. Standard Operation Procedures for Surface Water Sampling

B. Sampling Locations 2007: Shackleford and Scott @ USGS Gaging Station

C. 2007 Temperature Monitoring Locations: Scott River East Fork Tributaries

D. 2007 Temperature Monitoring Locations: Scott River canyon and Tributaries

E. Sample Datasonde Calibration datasheet

F. 2007 Sampling Locations and Parameters collected

DOCUMENT TYPE: Standard Operating Procedure

TITLE: Surface Water Sampling

PREPARED BY: Crystal Bowman, QVIR Environmental Director _____

APPROVED BY: Janis Gomes, USEPA Project Officer _____

IMPLEMENTED BY: Tami Clayton, QVIR Water Quality Coordinator _____

Scope and Application

1.1 This standard operating procedure must be followed when collecting and storing surface water samples for laboratory analysis.
1.2 Samples must be collected in such a way that no foreign material is introduced into the sample and no material of interest escapes from the sample prior to analysis.

2.0 Personnel Qualifications

2.1 All field samplers will be pre-trained in all sampling and equipment procedures by an experienced sampler before beginning the sampling procedure.

2.2 All personnel will be responsible for complying will all quality assurance/quality control requirements as outlined in the QVIR QAPP.

3.0 Summary of Sample Collection Procedure

3.1 Acquire certified sample containers from Laboratory.
3.1.1 Order 100 ml bottles from IDEXX and perform quality control (see QVIR Lab Manual)
3.1.2 Call lab and order sample bottles
3.2 Do all necessary preparation prior to sampling.
3.3 Assemble all equipment (See 6. Equipment and Supplies Checklist).
3.4 Collect all QA samples.
3.5 Perform field analyses.
3.6 Obtain samples using dip sampler if necessary and certified clean collection bottle.
3.7 Store nutrient samples at 4ºC and bacteria samples at 10ºC
3.8 Submit samples to laboratory (Refer to Sample Submission SOP).

4.0 Grab Sampling Procedure – Nutrients, Chlorophyll a and Phaeophytin a

4.1 Streams are always sampled upstream from any manmade structure such as a bridge.

4.2 Lakes are sampled at their outlet.

4.3 Collect from the same sampling site each time.

4.4 Check last year's field notes or GPS log for exact sampling location.

4.5 Immerse the thermometer or YSI handheld in the water and leave immersed five minutes before reading temperature. Avoid disturbing the bottom with the thermometer at the sample site.

4.6 Label bottle with a unique site code (geographic area name and stream or lake name), date, time, water temperature and sampler's initials. Include whether it is a grab or composite sample. Label bottle before immersion using a black permanent marker or pre-printed labels. If using pre-printed labels affix with clear plastic packaging tape to avoid them getting wet. Aquatic Research Inc., contracted lab, provides only certified clean containers.

4.7 Use latex gloves when handling bottles during sampling. Fingers contain contaminants such as nitrates. Bug repellents or sunscreen is particularly troublesome as contaminants. Once the gloves are on, be careful not to touch your face, the ground, or anything but the bottles.

4.8 The sample should be taken from flowing, not stagnant water, facing upstream positioned in the thalwag.

4.9 Be sure to immerse the bottle completely, 10 cm (4 inches) deep, with mouth of bottle pointing upstream, so no water flows over your hand into the bottle. Remove the cap under water. Be sure the bottle does not get near the bottom of the stream where sediments can be disturbed. Water samples should be collected 6-12 inches below the water surface. Fill bottle at least half full, replace cap loosely, remove from water and shake. Pour out rinse water downstream of sample point. Pour some rinse water over inside of cap. Do not touch bottle mouth or inside of cap. Partially fill the bottle, cap, shake, and rinse three times.

4.10 Collect the sample on the fourth immersion. Use the same procedure as before but fill bottle completely. Be careful not to contaminate the sample with surface film, contact with human skin, breathing in/on the bottle or cap, etc. If necessary, squeeze the bottle slightly as the cap is tightened so no air remains in bottle. If stream is too shallow to immerse bottle fully, collect as much as possible, being very careful not to touch the bottom. Note depth on field notes.

4.11 Collect one "duplicate" sample every two weeks (sampling frequency). Sample sites chosen for duplicate sampling are selected at random among sites sampled. When a duplicate sample is selected for the site, repeat procedures as with normal stream samples. The duplicate is the second sample when two samples are collected. Duplicates document repeatability of individual sample collections and reproducibility of laboratory results.

4.12 Place sample immediately in a Ziplock bag in the cooler after collection. Do not expose sample bottles to the sun. Fill out the field data sheet, noting any unusual conditions such as wind or rain. Measure air temperature (shaded) and record. Dispose of latex gloves.

4.13 Samples are analyzed in the lab. Keep samples cool while transporting. Ziplock bags (double bagged) filled with snow work well if frozen icepacks are unavailable for transport from the field. Store at 4 ºC but do not freeze. Include a separate Ziploc bag containing the completed Chain of Custody form. Ship to the lab in a picnic cooler with frozen icepacks via FedEx or UPS overnight. Do not ship so the sample

arrives on a weekend. If necessary, keep samples refrigerated for arrival weekdays. Hand delivery to the lab is preferred; or arrange for a contact to pick up the samples.

5.0 Grab Sampling Procedure – Total Coliforms and *E. coli*

4.1 Streams are always sampled upstream from any manmade structure such as a bridge.

4.2 Lakes are sampled at their outlet.

4.3 Collect from the same sampling site each time.

4.4 Check last year's field notes or GPS log for exact sampling location.

4.5 Immerse the thermometer or YSI handheld in the water and leave immersed five minutes before reading temperature. Avoid disturbing the bottom with the thermometer at the sample site.

4.6 Label bottle with location (geographic area name and stream or lake name), date, time, water temperature and sampler's initials. Label bottle before immersion using a black permanent marker or pre-printed labels. QVIR Bacteria Lab, State Certified Lab, purchases only certified sterile, 100 ml, sealed containers from IDEXX.

4.7 Use latex gloves when handling bottles during sampling. Fingers contain contaminants such as nitrates. Bug repellents or sunscreen are particularly troublesome as contaminants. Once the gloves are on, be careful not to touch your face, the ground, or anything but the bottles.

4.8 The sample should be taken from flowing, not stagnant water, facing upstream positioned in the thalwag.

4.9 Be sure to immerse the bottle completely, 10 cm (4 inches) deep, with mouth of bottle pointing upstream, so no water flows over your hand into the bottle. Be sure the bottle does not get near the bottom of the stream where sediments can be disturbed. Water samples should be collected 6-12 inches below the water surface. Fill bottle, to the 100ml line indicated, on **first immersion,** pour off the excess and cap. Do not under fill or over fill, do not redunk. If too much water is poured off, redo sample with new 100 ml container.

4.10 Do not touch bottle mouth or inside of cap. Be careful not to contaminate the sample with surface film, contact with human skin, breathing in/on the bottle or cap, etc. If stream is too shallow to immerse bottle fully, collect as much as possible, being very careful not to touch the bottom. Note depth on field notes.

4.11 Collect one "duplicate" sample every two weeks (sampling frequency). Sample sites chosen for duplicate sampling are selected at random among sites sampled.

When a duplicate sample is selected for the site, repeat procedures as with normal stream samples. The duplicate is the second sample when two samples are collected. Duplicates document repeatability of individual sample collections and reproducibility of laboratory results.

4.12 Samples are analyzed in the QVIR Bacteria lab. Keep samples cool while transporting. Store at 10 ºC but do not freeze. Hand deliver to the lab. See Lab SOP.

6. Equipment/Supplies

Equipment that is necessary for the collection of surface water samples includes:

6.1 Wilderness First Aid Pack
6.2 Water Filter
6.3 Camel Packs
6.4 Ice Packs
6.5 Coolers
6.6 Sample Bottles
6.7 Sun Block
6.8 Leatherman
6.9 Waders & Boots
6.10 Camera
6.11 Note Pad & Pencil
6.12 Calculator
6.13 Data Sheets
6.14 Meter Measuring Tape/ 4 Utility Clamps
6.15 YSI Handheld
6.16 Aqua Calc & Rod
6.17 Turbidity Meter
6.18 Tape measure (25 ft.)
6.19 Latex gloves
6.20 Ziploc bags
6.21 GPS Unit
6.22 Field Notebook
6.23 2 Waterproof (Sharpie) pens and 2 black ink-writing pens
6.24 Water or Gatorade
6.25 Air temperature thermometer
6.26 Trash bag

7. Procedure for Nutrients, Chlorophyll a and Phaeophytin a

7.1 Two weeks prior to sampling – order bottles from Aquatic Research Inc. for sampling.
7.2 Create sampling bottle labels, label sample bottles, place in cooler.
7.3 Fill out mailing label.
7.4 Be sure Blue Ice packs are freezing.
7.5 Calibrate YSI handheld according to protocol.
7.6 Fill tatum: write-in-the-rain data sheets (Flow & Surface Water per site), pencils, calculator, field notebook, thermometer (NIST),
7.7 Pack truck, complete gear checklist (See Section 5)

7.8 Arrive at first sampling site, make sure all instrumentation is in shade.
7.9 Collect flow according to USDA protocol, record on flow datasheet.
7.10 Just upstream of flow site, place YSI probe in water to stabilize in the thalwag, where the water samples will be taken (see discharge data sheet to locate thalwag). The probes should be ~ 6-12 inches below water surface. Record results on surface water datasheet.
7.11 Collect nutrient samples according to protocol (Section 4). Place samples in a Ziploc bag in cooler. Record sample collected and time of collection.
7.12 Collect Total Coliforms and *E.coli* samples according to protocol (Section 5). Place samples in cooler. Record sample collected and time of collection.
7.13 Take air temperature inside riparian canopy (if possible), record.
7.14 Wilderness samples will be packed into a Ziploc bag and placed inside another Ziploc filled with Blue Ice. Upon reaching the car, at the trailhead, samples will be placed inside the cooler w/fresh Blue Ice prior to collecting samples at the trailhead.
7.15 Once all samples are collected, return to office, open cooler and replace all ice packs with fresh Blue Ice from office freezer. Put used Blue Ice from sampling day in freezer, to re-freeze. The samples sit overnight in the cooler.
7.16 Arrive to office the next day, replace Blue Ice with fresh from freezer.
7.17 Complete Chain of Custody (COC) Forms as each sites samples are packed into the cooler. Copy COC from, file at QVIR, send original COC in a Ziploc bag in the cooler with the samples.
7.18 Using packing tape secure lid on cooler, place FedEx label on the handle (luggage tag style labels). Drop off at Yreka Mail Box and Package Service in Yreka by 1:30 pm.

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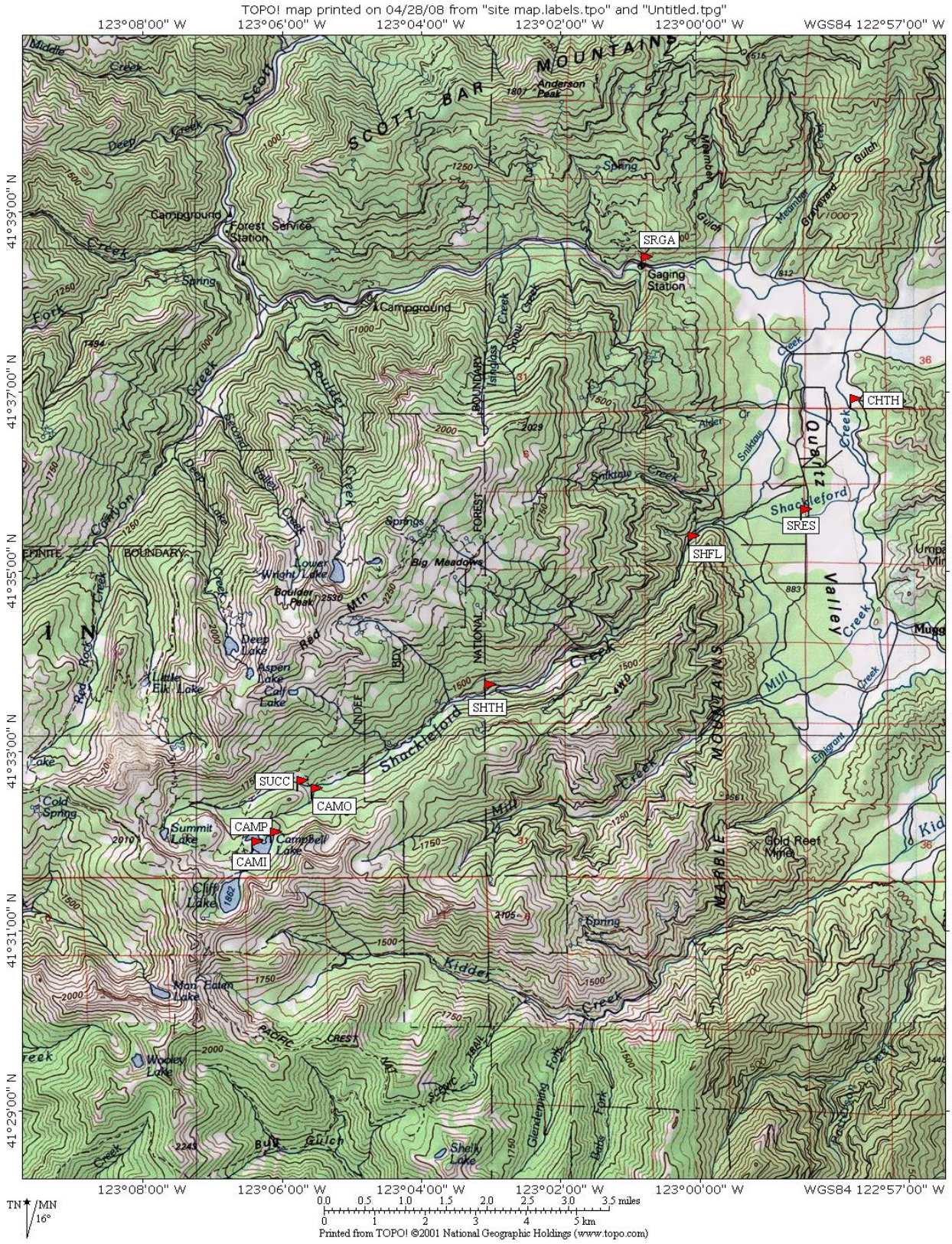
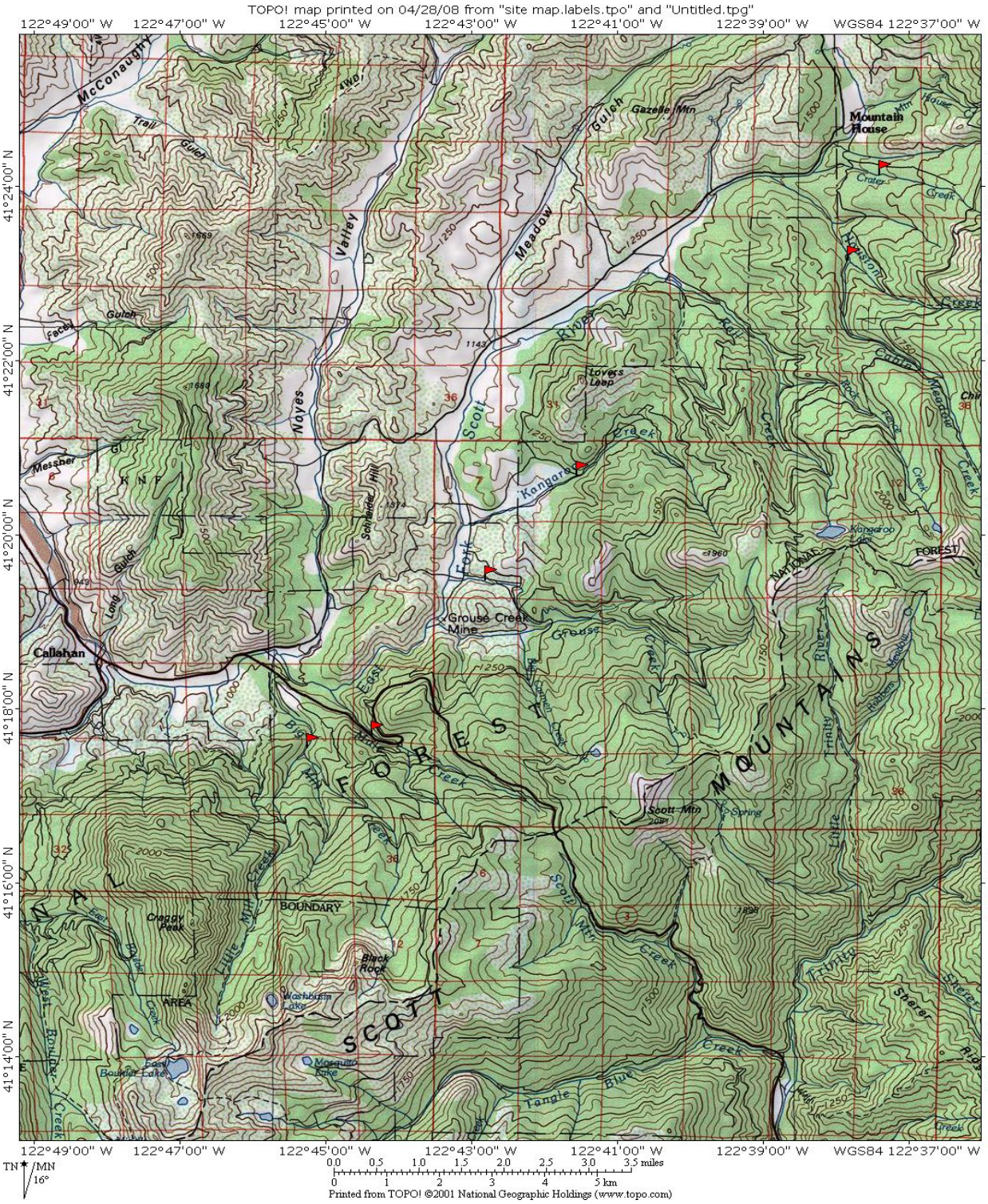
Comments:

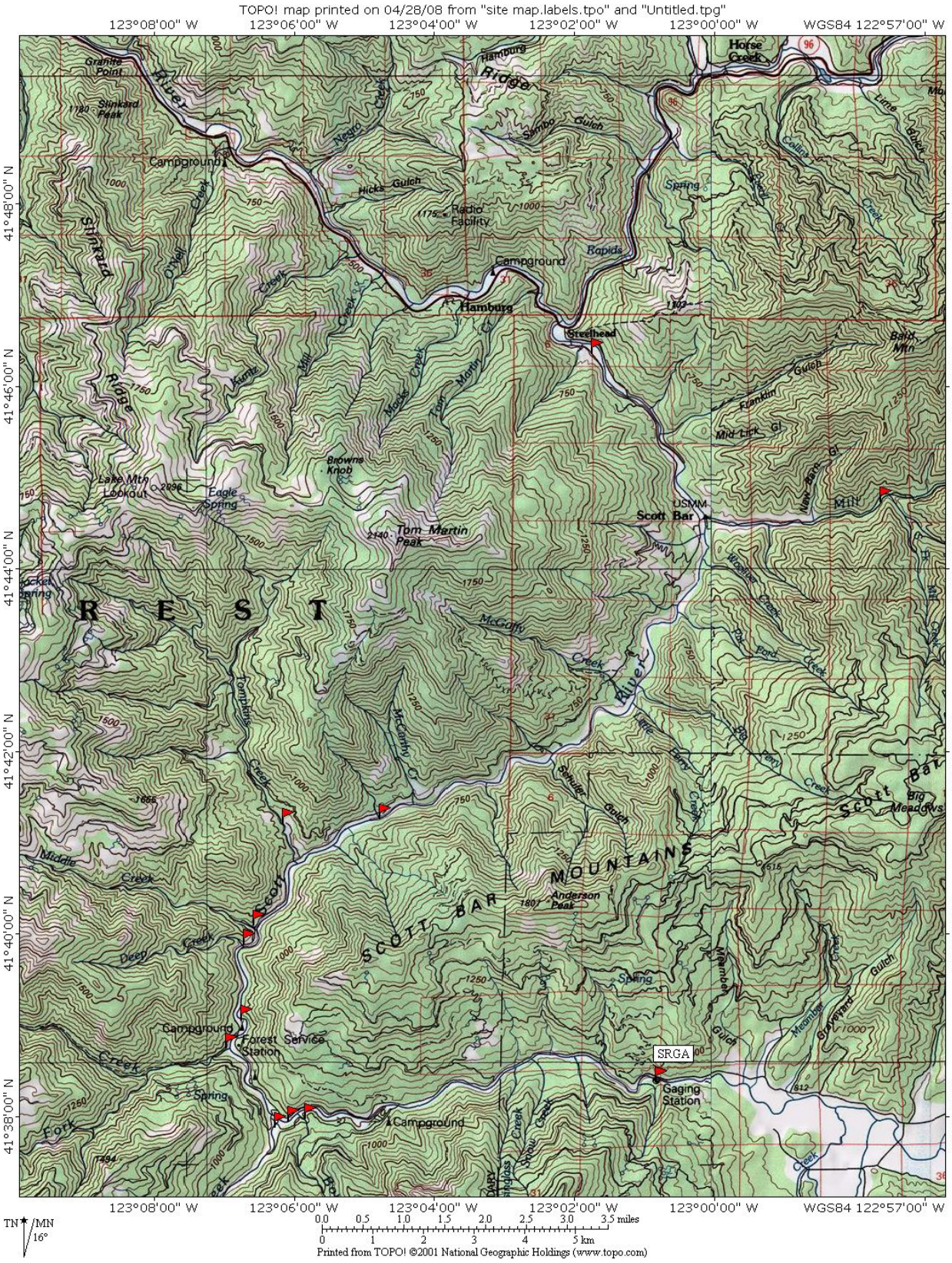
- If there is no current, create a current artificially by pushing the bottle forward horizontally.
- For shallow waters such as streams springs, seeps or other types of discharges, attempt to sample the water without touching any solids.
- if flows are too deep, wide or fast samples may be taken from a well-mixed area at the water's edge.



B: Sampling Locations 2007 Shackleford and Scott @ USGS Gaging Station



C. 2007 Temperature Monitoring Locations: Scott River East Fork Tributaries



D. 2007 Temperature Monitoring Locations: Scott River canyon and Tributaries

QUARTZ VALLEY INDIAN RESERVATION
DATASONDE AUDIT/CALIBRATION DATASHEET

Site: SRGA
Date: 8-2-07
Collectors: TL, TC

BP (mmHg) 767.1
Datasonde SN# 06K1141
Audit sonde SN # 556

Extraction (Audit Sonde)

Time	Temp (°C)	Sp. Cond.	DO (%sat)	DO (mg/L)	pH	Turbidity
930	17.01	0.218	95.3	9.21	7.83	—

Pre and Post Cleaning Readings

Status	Instrument	Time	Temp (°C)	Sp. Cond.	DO (mg/L)	pH	Turbidity
Pre-Clean	Site Sonde	0945	14.35	0.260	8.62	7.93	-2.2
Audit Sonde		0945	14.69	0.257	7.79	7.53	—
Post-Clean	Site Sonde	0958	15.68	0.260	9.27	7.48	-1.9
Audit Sonde		0950	14.71	0.258	7.99	7.52	—

Calibration

	Old -DO (mg/L)	New -DO (mg/L)	Sp. Cond.	pH 7	pH 10	Turbidity	Turbidity
Temp of Standard	24.56	23.63	24.27	25.63	25.14	21.07	24.15
Value of Standard	XXXX	XXXX	1.000	7.00	10.00	0	123
Initial Reading	8.88	98.2	1.002	7.06	10.00	-0.7	126.9
Calibrated to:	8.35	100.9	1.000	6.99	10.00	0.0	123.0

File Information

Downloaded File Name: SR072607
New File Name: S080207
Start Date and Time: 8/2/07 1130

Old DO probe SN# 06K1184
New DO probe SN# 07J10063
Battery Voltage: 12.1

Deployment (Audit Sonde)

Time	Temp (°C)	Sp. Cond.	DO (%sat)	DO (mg/L)	pH	Turbidity
1125	19.27	0.217	117.9	10.88	8.18	—

2nd Day DO Cal. --- Temp_____ Initial Reading_____ Calibrated to_____

Notes:

10	7.06	10.15
15	7.04	10.10
20	7.02	10.05
25	7.00	10.00
30	6.99	9.96

E: Sample datasonde calibration datasheet

Appendix F: Sampling Locations and Parameters collected 2007			Temp	Nutrients				Macros	YSI handheld				e. Coli	YSI Sonde					Discharge	Static Groundwater Level
Lat (N)	Long (W)	Site Location		TP	TN	Chloro a	Phaeo		pH	temp	DO	sp. Cond		pH	temp	DO	turbidity	Sp Cond		
SURFACE WATER																				
41º31'52"	123º06'27"	Cliff Lake Outlet	X	X	X	X	X		X	X	X	X	X						X	
41º31'56"	123º06'21"	Campbell Lake - surface		X	X	X	X		X	X	X	X	X							
41º31'56"	123º06'21"	Campbell Lake - bottom		X	X	X	X		X	X	X	X	X							
41º32'32"	123º05'33"	Campbell Lake Outlet	X	X	X	X	X		X	X	X	X	X						X	
41º32'37"	123º05'37"	Summit Lake Outlet	X	X	X	X	X		X	X	X	X	X						X	
41º33'39"	123º03'03"	Shackleford @ Trailhead	X	X	X	X	X	X	X	X	X	X	X						X	
41º35'26"	123º00'03"	Shackleford @ Falls	X	X	X	X	X		X	X	X	X	X						X	
41º35'36"	122º58'30"	Shackleford @ QVIR	X	X	X	X	X		X	X	X	X	X						X	
41º36'55"	122º57'56"	Shackleford near mouth	X	X	X	X	X	X	X	X	X	X	X						X	
41º17'45"	122º45'06"	Big Mill Creek	X																	

			Temp	Nutrients				Macros	YSI handheld				e. Coli	YSI Sonde					Discharge	Static Groundwater Level
Lat (N)	Long (W)	Site Location		TP	TN	Chloro a	Phaeo		pH	temp	DO	sp. Cond		pH	temp	DO	turbidity	Sp Cond		
41º18'52"	122º42'21"	Grouse Creek	X																	
41º20'19"	122º42'21"	Kangaroo Creek	X																	
41º24'12"	122º37'46"	Crater Creek	X																	
41º23'39"	122º37'37"	Little Houston Creek	X																	
41º38'24"	123º00'50"	Scott River @ USGS Gage	X	X	X	X	X		X	X	X	X	X	X	X	X	X	X		
41º37'56"	123º06'18"	Canyon Creek	X																	
41º39'54"	123º06'44"	Deep Creek	X																	
41º38'41"	123º07'06"	Kelsey Creek	X																	
41º40'06"	123º06'38"	Middle Creek	X																	
41º44'46"	122º57'38"	Scott Bar Mill Creek	X																	
41º46'24"	123º01'54"	Scott River @ Roxbury Bridge	X																	

			Temp	Nutrients				Macros	YSI handheld				e. Coli	YSI Sonde					Discharge	Static Groundwater Level
Lat (N)	Long (W)	Site Location		TP	TN	Chloro a	Phaeo		pH	temp	DO	sp. Cond		pH	temp	DO	turbidity	Sp Cond		
41º41'18"	123º04'45"	Scott River @ Townsend Gulch	X																	
41º39'04"	123º06'46"	Scott River @ Bridge Flat	X																	
41º38'22"	123º03'33"	Jones Beach	X																	
41º41'19"	123º06'13"	Tompkins Creek	X																	
Groundwater																				
41º35'25"	122º58'50"	#12912 Yamitch							X	X	X	X	X							X
		#12920 Yamitch							X	X	X	X	X							
		#12817 Yamitch							X	X	X	X	X							
		#12808 Yamitch							X	X	X	X	X							
41º35'25"	122º58'51"	#12839 Yamitch							X	X	X	X	X							X
			Temp	Nutrients				Macros	YSI handheld				e. Coli	YSI Sonde					Discharge	Groundwater

Lat (N)	Long (W)	Site Location		TP	TN	Chloro a	Phaeo		pH	temp	DO	sp. Cond		pH	temp	DO	turbidity	Sp Cond		
41º35'23"	122º58'59"	#12837 Kuut							X	X	X	X	X							X
		#12929 Kuut							X	X	X	X	X							
		#9009 Big Meadows							X	X	X	X	X							
		#13605 Ish Pish							X	X	X	X	X							
		#13624 Keet							X	X	X	X	X							
		#10503 Cram Gulch							X	X	X	X	X							
		#9117 Sniktaw							X	X	X	X	X							
41º36'50"	122º57'37"	#14208 Dangel Lane							X	X	X	X	X							X
41º36'11"	122º58'16"	#100 Quartz Valley Drive							X	X	X	X	X							X

F. 2007 Sampling Locations and Parameters Collected