<u>WATER QUALITY STUDY</u>: A COMPONENT OF THE WATERSHED MANAGEMENT PLAN FOR THE SULPHUR CREEK WATERSHED, NAPA COUNTY, CALIFORNIA

Prepared For

Stewardship Support and Watershed Assessment in the Napa River Watershed:

A CALFED project

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by

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1.0 Introduction

Water quality is a key factor affecting fish and other aquatic organisms within a stream ecosystem. This is especially true of salmonids including steelhead (anadromous rainbow trout, *Oncorhynchus mykiss*), which have narrow tolerances for a variety of water quality parameters. In reaches of Sulphur Creek that experience drastic seasonal recessions of surface flow during summer and fall, water quality plays a critical role in the quality of summer rearing habitat for juvenile steelhead. As stream flows diminish in late spring and early summer, steelhead and other resident fish are forced into isolated pools for the duration of the summer. During this time, water quality can quickly degrade without the flushing effects of continuous surface flow. Subsurface flow through the substrate is a vital source of new fresh water, but in the absence of agitation it contributes little or no dissolved oxygen.

Benthic macroinvertebrates are good indicators of water quality and overall stream function over time. Samples taken from several locations along the stream will reflect environmental conditions within the aquatic ecosystem. Certain organisms are highly intolerant to a variety of pollutants including sediment, nutrients, and temperature. Taxonomic analysis of such samples yields information on the benthic community which relates to water quality in the stream. Essentially the quality of the water can be determined based on what organisms are present within a given reach of stream.

2.0 Methods

Water quality was measured in Sulphur Creek to establish a limited baseline for current conditions within the stream. The objective of this study was to establish monitoring sites along the stream and to collect water quality data using field tests that can be conducted by volunteers. These tests include dissolved oxygen (D.O.), electrical conductivity, pH, water temperature, and air temperature. Additional information on physical habitat is also collected including water color, odor, weather, stream bed appearance, water depth, flow, and habitat change.

All water quality tests were done using the Napa County RCD stream monitoring protocol. One site (SUL-4) was selected in the middle of reach 2. and another in reach 3(SUL-5) to get a satisfactory geographic range along the stream. Additionally one site was selected in Heath Canyon Creek (HEA-1) near the confluence with Sulphur Creek. It was obvious at the onset of the site selection process that suitable monitoring sites would be limited by the presence of permanent water. Further, sites were selected based on their potential to support fish which eliminated the far lower sections and dry reaches of Sulphur Creek. Samples were collected on an approximately monthly basis at all three sites.

Dissolved oxygen, electrical conductivity (specific conductance), and water temperature were measured using a YSI-85 meter, which was calibrated prior to sampling. A hand held meter was used to measure pH, and it was also calibrated prior to sampling. Flow was estimated and categorized as brisk, moderate, low, or stagnant. Water depth at time of sampling was visually estimated. Air temperatures were taken in the shade.

3.0 Water Quality Monitoring Summarized Results

PARAMETER	SULPHUR SITE 1 (SUL-4)	SULPHUR SITE 2 (SUL-5)	HEATH CANYON SITE 1 (HEA-1)
Sample Dates	7/18/02, 8/2/02, 8/28/02, 9/12/02, 10/4/02, 12/6/02	7/18/02, 8/2/02, 8/15/02, 8/28/02, 9/12/02, 10/4/02, 12/6/02	7/18/02, 8/2/02, 8/15/02, 9/12/02, 10/4/02, 12/6/02
Water Temperature (°C)			
Range	11.5 - 20	10.4 - 17.7	10.1 - 18.7
Maximum	20 (8/28/02)	17.7 (8/15/02)	18.7 (8/15/02)
Minimum	11.5 (12/6/02)	10.4 (12/6/02)	10.1 (12/6/02)
Air Temperature (°C)			
Range	14 - 27	14 - 27	11 - 27
Maximum	27 (8/28/02)	27 (8/28/02)	27 (8/15/02)
Minimum	14 (12/6/02)	14 (12/6/02)	11 (12/6/02)
Dissolved Oxygen (mg/L)			
Range	6.16 - 9.83	4.47 - 9.23	4.33 - 9.34
Maximum	9.83 (12/6/02)	9.23 (12/6/02)	9.34 (12/6/02)
Minimum	6.16 (9/12/02)	4.47 (9/12/02)	4.33 (9/12/02)
Dissolved Oxygen (% Sat.)			
Range	62 - 94.4	44.4 - 86.7	45.1 - 93.3
Maximum	94.4 (8/28/02)	86.7 (7/18/02)	93.3 (7/18/02)
Minimum	62 (9/12/02)	44.4 (9/12/02)	45.1 (9/12/02)
pH (units)			
range	6.5 - 8.2	6.5 - 8.2	6.5 - 8
Maximum	8.2	8.2	8 (9/12/02)
Minimum	6.5 (7/18/02)	6.5 (7/18/02)	6.5 (7/18/02)
Electrical Conductivity (µS/cm)			
range	528 - 632	395 - 486	379 - 475
Maximum	632 (10/4/02)	486 (12/6/02)	475 (9/12/02)
Minimum	528 (8/2/02)	395 (7/18/02)	379 (7/18/02)
Flow category	Low throughout sampling period	Low through Aug. - no flow from Sept-Oct. Flow returned Dec.	Low through Aug. - no flow from Sept - Oct. Moderate flow returned in Dec.

TABLE 1. Water Quality Summary Table

Results from water quality monitoring provide limited baseline information on conditions within the stream environment during the late summer and fall. This is the period when cold water fish such as steelhead living in arid California streams experience the most stress from declining water quantity and quality. Water quality generally improves during winter as storms introduce fresh water. However, during winter a different set of water quality stressors can have an impact on both juvenile and adult fish. These are chiefly turbidity, extreme low temperatures, and the effects of urban and agricultural runoff. It is therefore important to conduct year-round water chemistry monitoring that is supplemented with macroinvertebrate samples throughout the stream.

Steelhead have a narrow tolerance range for DO and require generally well-saturated water to thrive. Temperature affects how much DO water can hold (Mitchell et al., 1995). As temperature rises, the amount of dissolved oxygen decreases and vice versa. When water holds all the dissolved oxygen it can hold at a given temperature, it is 100% saturated. Steelhead and other salmonids require high levels of DO saturation in order to thrive. Streams with DO levels above 90% saturation are considered best for maintaining healthy steelhead. There is a great deal of variation from one population to another in terms of how well the fish are adapted to tolerate reduced DO levels. Rainbow trout living in reservoirs for example often encounter water less than 90% saturation. Favorable levels of DO are 6 mg/L or greater. General guidelines suggest that stream dwelling rainbow trout (and steelhead) can tolerate DO levels as low as 4 mg/L before a metabolic compromise is initiated (Moyle, 2002).

The range of DO measured during this study remained above the critical 4 mg/L level at all sites (Table 1). Sulphur Creek had depressed DO levels at all sites during the late summer and early fall. Rainbow trout were observed at sampling site HEA-1 and SUL-5 throughout the study, suggesting that the fish were either able to tolerate low DO or had located a stratified area of the pool with higher levels than measured. These fish may have been able to survive the lower DO levels due to the relatively cold water temperatures at both sites, which would reduce metabolic rates during the warmest months.

The ranges of pH and electrical conductivity were within general guidelines for suitable steelhead rearing habitat. There was very little variation in pH at all sites (Table 1). Electrical conductivity was low throughout the study at all sites with little variation from one sample to the next.

3.1 Benthic Macroinvertebrate Sampling

Benthic Macroinvertebrate (BMI) sampling was conducted in the middle reach of Sulphur Creek by EcoTrust Environmental Inc in fall 1999. A sample in the lower middle reach of Sulphur Creek was also collected in spring 2000, and Heath Canyon in spring 2000. BMI samples were collected in 2001 and 2002, and the data from these samples is still being analyzed by the laboratory and will be available in April, 2003. Samples were collected using the CDFG Rapid Bioassessment protocol, which collects three replicate BMI samples per site in randomly selected riffles. The protocol is designed to eliminate, or greatly reduce, sampling bias within a sample reach. Sample reaches are defined as a series of five riffles, of which three are randomly selected. Three areas along a transect within the riffle are then agitated to dislodge BMI's within the substrate and wash them into a net. The contents of the net are then emptied into an alcohol-filled jar for analysis by a laboratory.

Table 2 summarizes the data from 1999 and 2000 using standardized macroinvertebrate classifications and metrics. The data from this sampling effort are being compared to a preliminary IBI (Index of Biological Integrity) for the Russian River Basin to indicate water quality. The IBI uses 5-6 key biological metrics calculated from a sample to rank the stream reach in terms of water quality. The following metrics were selected and integrated into a single scoring criteria: Taxa Richness, EPT Taxa, Modified EPT Index, Shannon Diversity, Tolerance Value and Percent Dominant Taxa. No IBI has been developed in Napa County, however efforts are being coordinated between CDFG and Friends of the Napa River to develop such a scoring system.

To calculate a ranking for any given site, the values for each metric (e.g. Taxa richness, EPT Taxa) is compared to the Visual Distribution Score ranges and given a score of 5, 3, or 1. A score is given for each of the six metrics. These scores are then added together to form a composite score (with a possible total of 30 points) that can be compared with other sites and rated using the scale below. In general, higher composite scores indicate better water quality.

Biological Metric	Visual Distribution Score		
	5	3	1
Taxa Richness	≥36	35-26	<26
% Dominant Taxa	≤14	15-39	>39
EPT Taxa	≥19	18-12	<12
Modified EPT	≥54	53-17	<17
Shannon Diversity	≥3.0	2.9-2.3	<2.3
Tolerance Value	≤3.0	3.1-4.6	>4.6

Using this preliminary IBI, a sample can be scored using the following scale:

Excellent	Good	Fair	Poor
30-24	23-18	15-11	11-6

The scale has been modified for Napa data, which does not include a modified EPT Index:

Excellent	Good	Fair	Poor
25-21	20-16	15-11	10-5

Using the modified Napa scoring criteria, the sample collected in middle reach Sulphur Creek (10/8/99) was given a score of 19. The BMI sample taken in the lower middle reach of Sulphur Creek (4/27/00) also received a score of 19. Both of these scores are at the upper end of the “Good” scale. The Heath Canyon sample collected on 4/30/00 was given a score of 23 which indicates excellent water quality. In order to draw conclusions based on any water quality data including BMI samples, a sufficiently large dataset must be analyzed. In light of the limited data currently available on BMI populations within Sulphur Creek, it is prudent to only discuss the immediate implications of this data. Sampling one reach does not allow for classification of the entire stream or even stream reach. The sample reflects conditions within a relatively narrow region of the stream and should be interpreted to reflect this limitation.

The samples taken from Sulphur Creek exhibited slight differences in composition and functional feeding group distribution. The spring 2000 sample contained a higher number of *Baetis tricaudatus* mayflies than the fall 1999 sample, which accounted for about 12% of the sample (Table 2). This abundance of Baetids may indicate higher levels of fine sediment at the second site. In general mayflies are highly intolerant to pollution, but this taxa thrives in streams with large amounts of fine sediment. Heath Canyon had several highly intolerant taxa that are known to be very sensitive to pollution.

A modified EPT index is used to remove tolerant taxa from the EPT Taxa metric in order to correct for their influence on the overall score. Specifically Baetid mayflies, and caddisflies in the family *Hydropsyche* are removed from the total count from their respective groups. Calculating a modified EPT index for samples from Sulphur and Heath Canyon would further refine the IBI score.

The feeding group distribution was relatively well balanced for the middle Sulphur Creek sample and the Heath Canyon sample. The high percentages of shredders and scrapers in both samples indicate favorable water quality conditions. The sample collected in spring 2000 had lower numbers of shredders and scrapers and a much higher percentage of collector/gatherers. This shift in the BMI community may be a function of higher nutrient and sediment levels in the lower reach or it may be purely a variation among samples. Without long term data and an adequate number of samples, it is not clear whether water quality is significantly better or worse in the lower reach. A modified EPT index would also help to refine this distinction along the stream.

4.0 Conclusions:

The limited data for water quality on Sulphur and Heath Canyon Creek are consistent with observations made during habitat surveys. In general the lower reach had poor habitat scores while middle reaches provided more suitable habitat and Heath Canyon and upper Sulphur Creek provided the best rearing conditions. Year-round water chemistry monitoring and additional BMI data will yield a more detailed picture of the health of the aquatic environment.

Water quality appears to be generally good in Sulphur Creek and Heath Canyon Creek. Despite having DO levels below the optimal range, juvenile steelhead and resident rainbow trout were observed throughout the study in both streams. In lower Sulphur Creek, water quality may not be sufficient to support juvenile summer rearing steelhead due to DO depletion and elevated temperatures. Mid-day water temperatures were generally elevated (> 20° C) during habitat surveys, which combined with the absence of flow created pool conditions with extremely low levels of dissolved oxygen. Lack of surface flow may also limit the amount of food available as drift to rearing fish.

In all sample locations, low levels of DO were measured during the summer when flows tapered off. Fish were observed in the deeper parts of the sampling pool on Heath

Canyon and in the upper Sulphur site, where they may have been in a slowed metabolic state to conserve energy. The temperature was consistently low, which likely contributed to the fish's ability to survive periods of depressed DO.

Table 2. Benthic Macroinvertebrate Bioassessemt

Site	Heath Canyon	Sulphur Creek	Sulphur Creek
Date	April 30, 2000	October 8, 1999	April 27, 2000
Metrics used in a provisional Index of Biological Integrity (IBI) for the Russian River by CDFG			
Total taxa richness	64	59	74
% dominant taxa	10.07	33.81	22.36
EPT taxa richness	30	23	32
modified EPT Index			
Shannon Diversity (loge)	3.34	2.57	2.84
Tolerance Value (modified HBI)	3.52	4.32	4.48
Total Invertebrate abundance (m2)	2028	8884	2671
Number of distinct taxa by group			
Non-insect invertebrates	3	5	3
Odonata (dragon & damselflies)	2	2	2
Ephemeroptera (mayflies)	12	7	11
Plecoptera (stoneflies)	8	4	6
Hemiptera (true bugs)	0	0	0
Megaloptera (alderflies & hellgramites)	1	0	0
Trichoptera (caddisflies)	10	12	15
Lepidoptera (aquatic moths)	0	0	0
Coleoptera (aqutic beetles)	7	6	6
Misc. Diptera (true flies)	9	8	11
Chironomidae (midge flies)	12	15	20
% composition by group			
Non-insect invertebrates	1.55	3.39	1.05
Odonata (dragon & damselflies)	0.06	3.56	0.15
Ephemeroptera (mayflies)	32.05	9.79	21.43
Plecoptera (stoneflies)	18.39	1.89	19.19
Hemiptera (true bugs)	0	0	0
Megaloptera (alderflies & hellgramites)	0.06	0	0
Trichoptera (caddisflies)	9	46.87	5.6
Lepidoptera (aquatic moths)	0	0	0
Coleoptera (aqutic beetles)	16.43	9.71	3.39
Misc. Diptera (true flies)	12.94	21.27	33.14
Chironomidae (midge flies)	9.53	3.5	16.07
Functional feeding group % composition			
Predator	21.48	6.81	23.35
Parasite	0.49	2.92	1.03
Collector-gatherer	47.21	31.86	49.77
Collector-filterer	4.73	5.25	2.44
Macrophyte herbivore	0	0	0
Piercer herbivore	0.39	0	0
Scraper	16.51	15.01	4.07
Shredder	6.23	35.39	9.82
Xylophage (wood eater)	0	0	0
Omnivore	1.59	0.92	2.85
Unknown	1.38	1.82	6.69
Number of highly intolerant taxa	3	0	1
% highly intolerant taxa	1.24	0	0.28
Number of highly tolerant taxa	8	12	10
% highly tolerant taxa	15.88	35.35	26.28
% Baetis tricaudatus + Simulium	9.16	1.16	12.23
Long-lived taxa richness	8	8	9

5.0 References

Harrington, J., M. Born. 2000. *Measuring the Health of California Sreams and Rivers, 2nd edition.* Sustainable Land Stewardship International Institute.

Merrit, R. W., K. W. Cummins. 1996. *Aquatic Insects of North America, 3rd edition*. Kendall Hunt Publishing Co. 862pp.

Mitchell, M. K., W. B. Stapp. 1995. *Field Manual for Water Quality Monitoring.* Thomson-Shore Printers. 272 pp

Napa County RCD. 1998. *T-REX Volunteer Monitoring Program Final Report.*

Water Quality Results

Station HEA1 SampleDat 7/18/2002 SampleTim 11:30:00 AM Crew jk

Last Rain Last Rain 0 Comments first sample taken at this site- dry trib lb

Result Type	Matrix	Analyte	Units	Results	Comments
Field	Air	Weather	None	C	
Field	None	Habitat Change	None	N	
Field	Water	Depth	None	0.5-1	
Field	Water	Appearance	None	C	
Field	Water	Flow	None	1	
Field	Water	Stream Bed	None	N	
Field	Water	Odor	None	N	
Field	Water	Color	None	C	
Field Obs	Air	Temperature	°C	20	
Field Obs	Water	Temperature	°C	17.2	
Field Obs	Water	DO	%	93.3	
Field Obs	Water	pH	pH Units	6.5	
Field Obs	Water	Conductivity	µS/cm	379	
Field Obs	Water	DO	PPM	9.03	

Station HEA1 SampleDat 8/2/2002 SampleTim 12:30:00 PM Crew jk

Last Rain Last Rain 0 Comments slight flow many sh yoy, 1+, 2+ in pool

Result Type	Matrix	Analyte	Units	Results	Comments
Field	Air	Weather	None	C	
Field	None	Habitat Change	None	N	
Field	Water	Depth	None	1-2	
Field	Water	Appearance	None	C	
Field	Water	Color	None	C	
Field	Water	Flow	None	1	
Field	Water	Odor	None	N	
Field	Water	Stream Bed	None	B	
Field Obs	Air	Temperature	°C	23	
Field Obs	Water	Conductivity	µS/cm	395	
Field Obs	Water	DO	%	67	
Field Obs	Water	Temperature	°C	18.3	
Field Obs	Water	DO	PPM	6.3	
Field Obs	Water	pH	pH Units	7.9	

Station HEA1 SampleDat 8/15/2002 SampleTim 1:30:00 PM Crew jk

Last Rain Last Rain 0 Comments substaintial decrease in water level - water

Result Type	Matrix	Analyte	Units	Results	Comments
Field	Air	Weather	None	C	
Field	Water	Odor	None	N	
Field	Water	Depth	None	3+	
Field	Water	Appearance	None	MD	

Field	Water	Flow	None	1
Field	Water	Stream Bed	None	B
Field	Water	Color	None	W
Field Obs	Air	Temperature	°C	27
Field Obs	Water	Temperature	°C	18.7
Field Obs	Water	pH	pH Units	7.8
Field Obs	Water	DO	PPM	5.01
Field Obs	Water	Conductivity	µS/cm	440.3
Field Obs	Water	DO	%	53.8

Station HEA1 SampleDat 9/12/2002 SampleTim 12:30:00 PM Crew jk

Last Rain Last Rain 0 Comments water level dropped since last time many

Result Type	Matrix	Analyte	Units	Results	Comments
Field	Air	Weather	None	C	
Field	None	Habitat Change	None	N	
Field	Water	Color	None	C	
Field	Water	Appearance	None	OS	
Field	Water	Depth	None	3+	
Field	Water	Stream Bed	None	G	
Field	Water	Flow	None	0	
Field Obs	Air	Temperature	°C	23.5	
Field Obs	Water	Conductivity	µS/cm	475.7	
Field Obs	Water	Temperature	°C	16.8	
Field Obs	Water	pH	pH Units	8	
Field Obs	Water	DO	PPM	4.33	
Field Obs	Water	DO	%	45.1	

Station HEA1 SampleDat 10/4/2002 SampleTim 9:15:00 AM Crew jk

Last Rain Last Rain 0 Comments several 2+ sh in lower pool strata. Water has

Result Type	Matrix	Analyte	Units	Results	Comments
Field	Air	Weather	None	C	
Field	None	Habitat Change	None	O	water clear
Field	Water	Flow	None	0	
Field	Water	Color	None	C	
Field	Water	Odor	None	E	
Field	Water	Depth	None	3+	
Field	Water	Appearance	None	C	
Field	Water	Stream Bed	None	N	
Field Obs	Air	Temperature	°C	15	
Field Obs	Water	DO	PPM	6.52	
Field Obs	Water	DO	%	62.2	
Field Obs	Water	pH	pH Units	7.9	
Field Obs	Water	Temperature	°C	13.2	
Field Obs	Water	Conductivity	µS/cm	415.6	

Station HEA1 SampleDat 12/6/2002 SampleTim 12:00:00 PM Crew jk

Last Rain Last Rain 0 Comments

Result Type	Matrix	Analyte	Units	Results	Comments
Field	Air	Weather	None	SO	
Field	None	Habitat Change	None	N	
Field	Water	Color	None	C	
Field	Water	Stream Bed	None	N	
Field	Water	Flow	None	2	
Field	Water	Odor	None	N	
Field	Water	Depth	None	3+	
Field	Water	Appearance	None	C	
Field Obs	Air	Temperature	°C	11	
Field Obs	Water	pH	pH Units	7.4	
Field Obs	Water	DO	PPM	9.34	
Field Obs	Water	Temperature	°C	10.1	
Field Obs	Water	Conductivity	µS/cm	382.8	
Field Obs	Water	DO	%	83.1	

Station SUL4 SampleDat 7/18/2002 SampleTim 11:50:00 AM Crew jk

Last Rain Last Rain 0 Comments first time sampled

Result Type	Matrix	Analyte	Units	Results	Comments
Field	Air	Weather	None	C	
Field	None	Habitat Change	None	N	
Field	Water	Flow	None	1	
Field	Water	Odor	None	N	
Field	Water	Stream Bed	None	N	
Field	Water	Depth	None	0.5-1	
Field	Water	Appearance	None	C	
Field	Water	Color	None	C	
Field Obs	Air	Temperature	°C	22	
Field Obs	Water	DO	PPM	8.95	
Field Obs	Water	DO	%	93.1	
Field Obs	Water	Conductivity	µS/cm	544	
Field Obs	Water	Temperature	°C	17.5	
Field Obs	Water	pH	pH Units	6.5	

Station SUL4 SampleDat 8/2/2002 SampleTim 10:30:00 AM Crew jk

Last Rain Last Rain 0 Comments

Result Type	Matrix	Analyte	Units	Results	Comments
Field	Air	Weather	None	C	
Field	None	Habitat Change	None	N	
Field	Water	Flow	None	1	
Field	Water	Depth	None	0.5-1	
Field	Water	Stream Bed	None	N	
Field	Water	Odor	None	N	
Field	Water	Appearance	None	C	
Field	Water	Color	None	C	
Field Obs	Air	Temperature	°C	20.5	
Field Obs	Water	DO	PPM	7.04	
Field Obs	Water	DO	%	73.2	
Field Obs	Water	Temperature	°C	17.2	
Field Obs	Water	Conductivity	µS/cm	528	

Field Obs	Water	pH	pH Units	8.2	

Station SUL4 SampleDat 8/28/2002 SampleTim 2:30:00 PM Crew jk and mc

Last Rain Last Rain 0 Comments

Result Type	Matrix	Analyte	Units	Results	Comments
Field	Air	Weather	None	C	
Field	Water	Stream Bed	None		
Field	Water	Color	None	C	
Field	Water	Flow	None	1	
Field	Water	Depth	None	1-2	
Field	Water	Appearance	None	C	
Field Obs	Air	Temperature	°C	27	
Field Obs	Water	pH	pH Units	8.2	
Field Obs	Water	Temperature	°C	20	
Field Obs	Water	Conductivity	µS/cm	612	
Field Obs	Water	DO	PPM	8.59	
Field Obs	Water	DO	%	94.4	

Station SUL4 SampleDat 9/12/2002 SampleTim 11:45:00 AM Crew jk

Last Rain Last Rain 0 Comments flow is reduced from last sample

Result Type	Matrix	Analyte	Units	Results	Comments
Field	Air	Weather	None	C	
Field	None	Habitat Change	None	N	
Field	Water	Odor	None	N	
Field	Water	Flow	None	1	
Field	Water	Color	None	C	
Field	Water	Stream Bed	None	N	
Field	Water	Appearance	None	C	
Field	Water	Depth	None	0.5-1	
Field Obs	Air	Temperature	°C	20.5	
Field Obs	Water	Temperature	°C	15.5	
Field Obs	Water	DO	%	62	
Field Obs	Water	Conductivity	µS/cm	613	
Field Obs	Water	pH	pH Units	8.2	
Field Obs	Water	DO	PPM	6.16	

Station SUL4 SampleDat 10/4/2002 SampleTim 9:40:00 AM Crew jk

Last Rain Last Rain 0 Comments alder leaves starting to fall

Result Type	Matrix	Analyte	Units	Results	Comments
Field	Air	Weather	None	C	
Field	None	Habitat Change	None	N	
Field	Water	Appearance	None	C	
Field	Water	Depth	None	1-2	
Field	Water	Color	None	C	
Field	Water	Flow	None	1	
Field	Water	Stream Bed	None	N	
Field	Water	Odor	None	N	
Field Obs	Air	Temperature	°C	20	

Field Obs	Water	DO	PPM	8.85
Field Obs	Water	Temperature	°C	11.7
Field Obs	Water	DO	%	81.7
Field Obs	Water	pH	pH Units	8.2
Field Obs	Water	Conductivity	µS/cm	632

Station SUL4 SampleDat 12/6/2002 SampleTim 1:10:00 PM Crew JK

Last Rain Last Rain 0 Comments

Result Type	Matrix	Analyte	Units	Results	Comments
Field	Air	Weather	None	SO	
Field	None	Habitat Change	None	N	
Field	Water	Flow	None	1	
Field	Water	Color	None	C	
Field	Water	Depth	None	1-2	
Field	Water	Stream Bed	None	N	
Field	Water	Odor	None	N	
Field	Water	Appearance	None	C	
Field Obs	Air	Temperature	°C	14	
Field Obs	Water	pH	pH Units	8	
Field Obs	Water	Temperature	°C	11.5	
Field Obs	Water	DO	PPM	9.83	
Field Obs	Water	Conductivity	µS/cm	604	
Field Obs	Water	DO	%	90.4	

Station SUL5 SampleDat 7/18/2002 SampleTim 12:45:00 PM Crew jk

Last Rain Last Rain 0 Comments first time this site sampled- difficult access

Result Type	Matrix	Analyte	Units	Results	Comments
Field	Air	Weather	None	C	
Field	None	Habitat Change	None	N	
Field	Water	Appearance	None	C	
Field	Water	Depth	None	1-2	
Field	Water	Flow	None	1	
Field	Water	Odor	None	N	
Field	Water	Color	None	C	
Field	Water	Stream Bed	None	N	
Field Obs	Air	Temperature	°C	23	
Field Obs	Water	pH	pH Units	6.5	
Field Obs	Water	DO	PPM	8.5	
Field Obs	Water	Conductivity	µS/cm	395	
Field Obs	Water	DO	%	86.7	
Field Obs	Water	Temperature	°C	16.3	

Station SUL5 SampleDat 8/2/2002 SampleTim 11:20:00 AM Crew jk

Last Rain Last Rain 0 Comments

Result Type	Matrix	Analyte	Units	Results	Comments
Field	Air	Weather	None	C	
Field	None	Habitat Change	None	N	
Field	Water	Color	None	C	

Field	Water	Appearance	None	C
Field	Water	Flow	None	1
Field	Water	Stream Bed	None	N
Field	Water	Odor	None	N
Field	Water	Depth	None	1-2
Field Obs	Air	Temperature	°C	21.5
Field Obs	Water	Conductivity	µS/cm	410
Field Obs	Water	DO	%	72.6
Field Obs	Water	DO	PPM	7.06
Field Obs	Water	pH	pH Units	8.2
Field Obs	Water	Temperature	°C	16.3

Station SUL5 SampleDat 8/15/2002 SampleTim 2:10:00 PM Crew jk

Last Rain Last Rain 0 Comments very little flow

Result Type	Matrix	Analyte	Units	Results	Comments
Field	Air	Weather	None	C	
Field	None	Habitat Change	None	N	
Field	Water	Odor	None	N	
Field	Water	Stream Bed	None	N	
Field	Water	Color	None	C	
Field	Water	Appearance	None	C	
Field	Water	Depth	None	0.5-1	
Field	Water	Flow	None	1	
Field Obs	Air	Temperature	°C	26	
Field Obs	Water	Conductivity	µS/cm	420	
Field Obs	Water	DO	%	59.4	
Field Obs	Water	DO	PPM	5.65	
Field Obs	Water	pH	pH Units	8	
Field Obs	Water	Temperature	°C	17.7	

Station SUL5 SampleDat 8/28/2002 SampleTim 2:55:00 PM Crew jk mc

Last Rain Last Rain 0 Comments recent water level drop- isolated pool

Result Type	Matrix	Analyte	Units	Results	Comments
Field	Air	Weather	None	C	
Field	None	Habitat Change	None	O	no flow
Field	Water	Stream Bed	None	N	
Field	Water	Depth	None	0.5-1	
Field	Water	Color	None	C	
Field	Water	Odor	None	N	
Field	Water	Appearance	None	C	
Field	Water	Flow	None	0	
Field Obs	Air	Temperature	°C	27	
Field Obs	Water	DO	PPM	6.95	
Field Obs	Water	Temperature	°C	17.6	
Field Obs	Water	Conductivity	µS/cm	409	
Field Obs	Water	DO	%	72.8	
Field Obs	Water	pH	pH Units	7.9	

Station SUL5 SampleDat 9/12/2002 SampleTim 12:10:00 PM Crew jk

Last Rain Last Rain 0 Comments

Result Type	Matrix	Analyte	Units	Results	Comments
Field	Air	Weather	None	C	
Field	Water	Appearance	None	C	
Field	Water	Stream Bed	None	N	
Field	Water	Color	None	C	
Field	Water	Depth	None	0.5-1	
Field	Water	Odor	None	N	
Field Obs	Air	Temperature	°C	19.5	
Field Obs	Water	pH	pH Units	8.2	
Field Obs	Water	Conductivity	µS/cm	420.7	
Field Obs	Water	DO	PPM	4.47	
Field Obs	Water	Temperature	°C	15	
Field Obs	Water	DO	%	44.4	

Station SUL5 SampleDat 10/4/2002 SampleTim 10:00:00 AM Crew jk

Last Rain Last Rain 0 Comments sculpin

Result Type	Matrix	Analyte	Units	Results	Comments
Field	Air	Weather	None	C	
Field	None	Habitat Change	None	N	
Field	Water	Stream Bed	None	N	
Field	Water	Odor	None	N	
Field	Water	Appearance	None	C	
Field	Water	Flow	None	0	
Field	Water	Color	None	C	
Field	Water	Depth	None	0.5-1	
Field Obs	Air	Temperature	°C	14	
Field Obs	Water	Conductivity	µS/cm	416.1	
Field Obs	Water	DO	PPM	7.14	
Field Obs	Water	pH	pH Units	8.2	
Field Obs	Water	DO	%	66.4	
Field Obs	Water	Temperature	°C	12	

Station SUL5 SampleDat 12/6/2002 SampleTim 12:45:00 PM Crew jk

Last Rain Last Rain 0 Comments

Result Type	Matrix	Analyte	Units	Results	Comments
Field	Air	Weather	None	SO	
Field	None	Habitat Change	None	N	
Field	Water	Odor	None	N	
Field	Water	Flow	None	1	
Field	Water	Color	None	C	
Field	Water	Appearance	None	C	
Field	Water	Stream Bed	None	N	
Field	Water	Depth	None	1-2	
Field Obs	Air	Temperature	°C	14	
Field Obs	Water	Temperature	°C	10.4	
Field Obs	Water	DO	PPM	9.23	
Field Obs	Water	Conductivity	µS/cm	486	

Field Obs	Water	pH	pH Units	7.6
Field Obs	Water	DO	%	82.7