YUROK TRIBE

Water Year 2002 (WY02) Report

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Yurok Tribe Environmental Program
PO Box 1027, Klamath, CA 95548

Kevin McKernan, Director
Lori McKinnon, Assistant Director
Ken Fetcho, Water Quality Coordinator
Eric Brunton, Hydrologist

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1 Introduction

This Water Year 2002 (WY02) Report is the first of a series of annual water reports documenting water quality and hydrologic data gathered by the Yurok Tribe Environmental Program (YTEP) data collection network in the Lower Klamath River watershed, specifically within and adjacent to the Yurok Indian Reservation (YIR). The long-term monitoring activities outlined in this report include water quality monitoring on the Klamath mainstem and within the tributaries, macroinvertabrate population sampling in selected tributaries, hydrologic monitoring performed on McGarvey and Blue Creeks, surface water herbicide monitoring and baseline rainfall information from the Notchko Weather Station.

2 Background

2.1 Klamath River

The health of the Klamath River and associated fisheries has been central to the life of the Yurok Tribe since time immemorial fulfilling subsistence, commercial, cultural, and ceremonial needs. Yurok oral tradition reflects this. The Yurok did not use terms for North or East, but rather spoke of direction in terms of the flow of water (Kroeber 14). The Yurok word for salmon, *nepuy* refers to “that which is eaten”. Likewise, the local waterways and watershed divides have traditionally defined Yurok aboriginal territories. Yurok ancestral land covers about 360,000 acres and is distinguished by the Klamath and Trinity Rivers, their surrounding lands, and the Pacific Coast extending from Little River to Damnation Creek.

The fisheries resource continues to be vital to the Yurok today. The September 2002 Klamath River fish kill, where a conservative estimate of 33,000 fish died in the Lower Klamath before reaching their natal streams to spawn, was a major tragedy for the Yurok people.

2.2 The Yurok Indian Reservation

The current (YIR) consists of a 56,000-acre corridor extending for one mile from each side of the Klamath River from the Trinity River confluence to the Pacific Ocean, including the channel (Figure 2-1). There are approximately two dozen major anadromous tributaries within that area. The mountains defining the river valley are typically 3,000 feet high. Along most of the river, the valley is quite narrow with rugged steep slopes. The vegetation is principally redwood and douglas fir forest with little area available for agricultural development. Historically prevalent, open prairies provided complex and diverse habitat.

At this time within the reservation 3,653 acres are held in trust status, 115 acres are Tribal Housing, 4,222 acres are Tribal fee lands and 3,499 acres are allotments (Yurok Tribal Planning Department). The majority of the remaining lands in the YIR are fee lands, (mostly owned by Simpson Resource Company), which are managed intensively for timber products. A small portion of the YIR consists of public lands managed by Redwood National/State Parks, the United States Forest Service (USFS) and a few private landholdings.

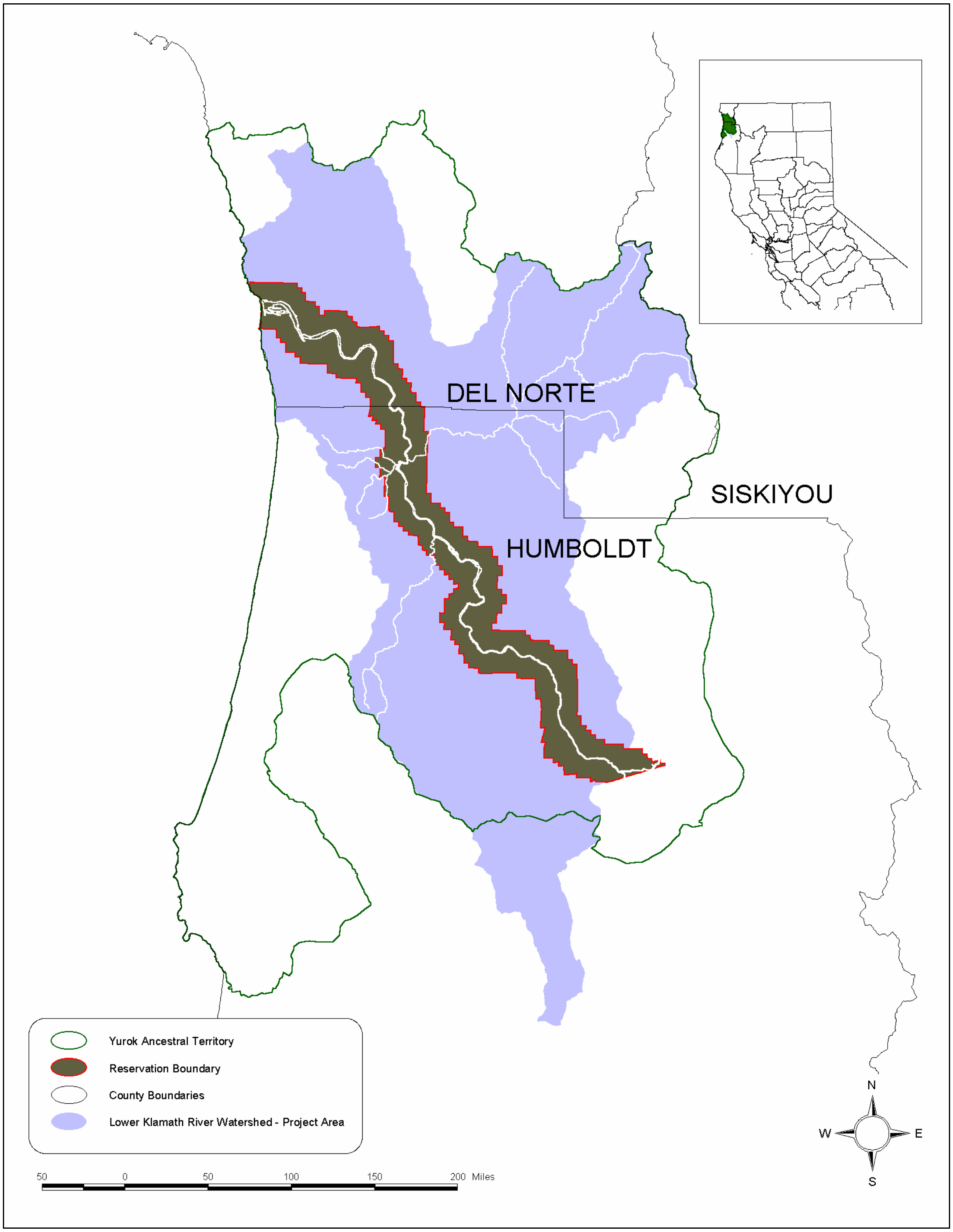

Figure 2-1 The Yurok Reservation exists one mile on each side of the Klamath River from Weitchpec at the confluence of the Trinity and the Klamath Rivers to the mouth at the Pacific Ocean

2.3 The Klamath River Watershed

The Klamath River system drains much of Northwestern California and South- Central Oregon (Figure 2-1). Thus, even activities taking place on land hundreds miles off the YIR can affect water conditions within the Reservation's boundaries. For example, upriver hydroelectric and diversion projects have altered natural flow conditions for decades. The majority of water flowing through the Reservation is derived from scheduled releases of impounded water from the Upper Klamath Basin that is often of poor quality with regards to human needs as well as the needs of fish and wildlife.

Some historically perennial streams now have ephemeral lower reaches and seasonal fish migration blockages because of inadequate dam releases from the Klamath and Trinity. The releases contribute to lower mainstem levels, excessive sedimentation which in turn causes subsurface flow and aggraded deltas. Additionally, the lower slough areas of some of the Lower Klamath tributaries that enter the estuary experience eutrophic conditions during periods of low flow. These can create water quality barriers to fish migration when dissolved oxygen levels are inadequate for migrating fish. The Klamath River is on California State Water Resource Control Board's 1998 303(d) List as impaired for temperature, dissolved oxygen, and nutrients.

The basin's fish habitat has also been greatly diminished in area and quality during the past century by accelerated sedimentation from mining, timber harvest practices, and road construction, as stated by Congress in the Klamath River Act of 1986. Management of private lands in the basin (including fee land within Reservation boundaries) has been, and continues to be, dominated by timber harvest for the last 100 years. Associated road building and slope destabilization have contributed to aggradations from increased sediment input into many of the tributaries to the Klamath River on the YIR. The steep terrain, granular soil matrix, and high precipitation have helped to produce erosive conditions throughout the area. Mass wasting is common. These conditions make road conditions difficult to stabilize and cause considerable siltation and turbidity problems in the Klamath River. The North Coast Region Quality Control Board (NCRQCB) suggests in their 303(d) Update List (2001) that sediment conditions within the channel and immoderate sediment loading have impaired beneficial uses within the Klamath watershed.

Nearly all of the Reservation streams that have perennial flow and no physical barriers to fish migration provide spawning, incubation, and rearing habitats for anadromous fish species. Perennial tributaries also provide important thermal refugia for fish of the Klamath River during periodic mainstem warm water episodes. Sufficient flows of clean water are essential to the long-term viability of a healthy fishery.

Water quality barriers, high sediment load, and herbicide spraying within anadromous and domestic watersheds all create the need for comprehensive, continuous water quality, hydrology and herbicide monitoring.

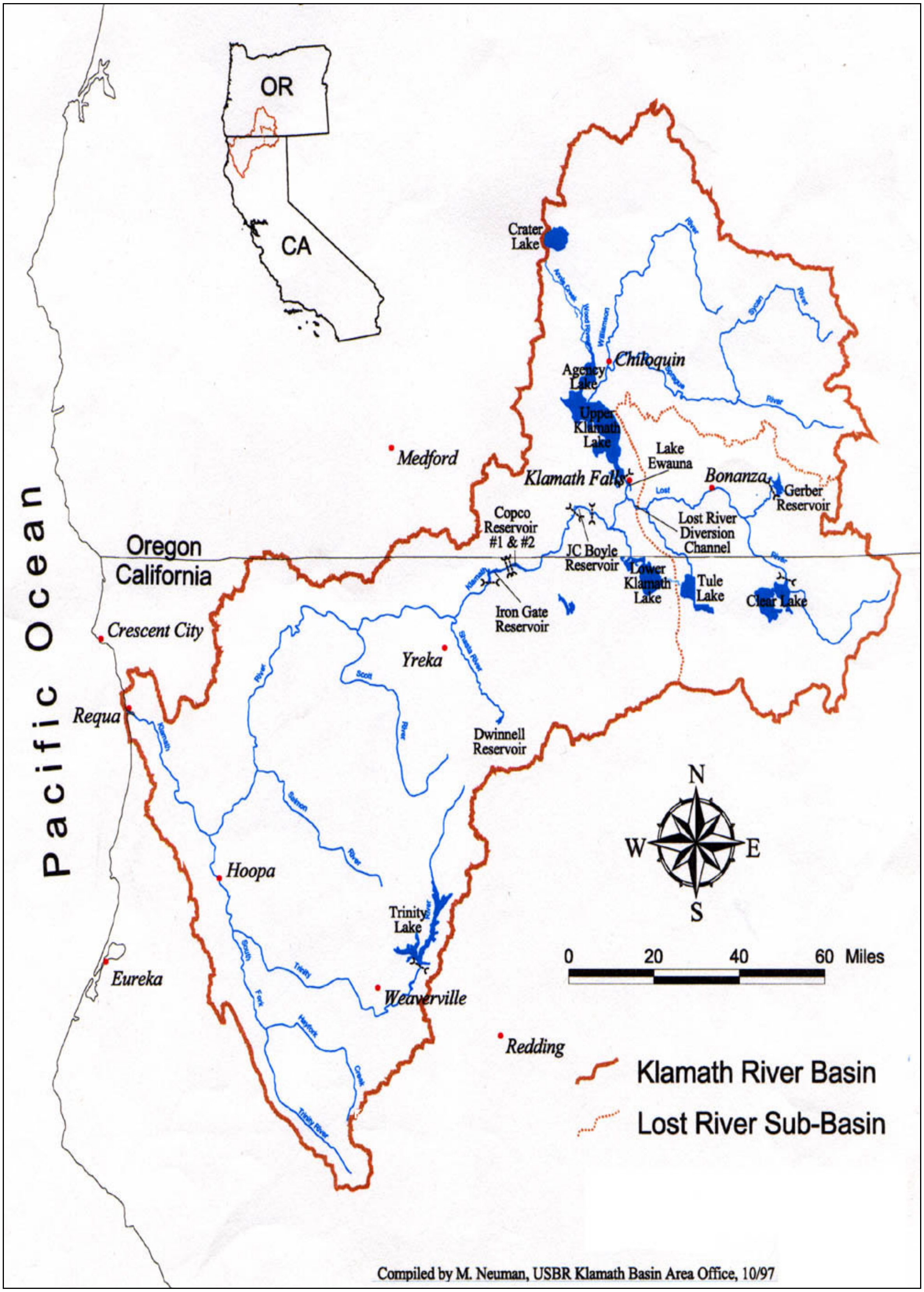

Figure 2-2 The Klamath River Basin

3 Yurok Tribe Water Monitoring Program

In 1998, the Yurok Tribe Environmental Program (YTEP) was created to protect and restore tribal natural resources through high quality scientific practices. YTEP is dedicated to improving and protecting the natural and cultural resources of the Yurok Tribe through collaboration and cooperation with local, private, state, tribal, and federal entities such as the Tribal Fisheries Department, US Fish and Wildlife Service (USFWS), and the U.S. Environmental Protection Agency (USEPA). An EPA General Assistance Program (GAP) Grant and funding allocated under the Clean Water Act Sections 104 and 106 both help to fund YTEP's water monitoring activities.

The hypothesis of the water-quality monitoring program is that the Lower Klamath River Basin has been impaired, physically, chemically, and biologically, by land uses within the respective watersheds. YTEP's professional staff utilizes appropriate protocols and quality control (QC) methods in the testing of this hypothesis.

YTEP entered into a contractual agreement to coordinate and conduct any herbicide monitoring activities during WY 2002. This was a continuation of the monitoring activities conducted during a three-year study which began in 1998 by the California Department of Pesticide Regulation (DPR) in coordination with the Yurok Tribe and USEPA, Region IX Office of Pesticide Programs. In response to community concerns the Yurok Environmental Monitoring Work Group (YEMWG) comprised of Yurok tribal members, YTEP staff, DPR staff, Simpson Resource Company staff, and other representatives formed in order to facilitate this study.

The purpose of this document is to present a synthesis of YTEP's hydrologic and water quality data collected in the Lower Klamath watershed for the WY02 and to produce recommendations. This report is part of YTEP's comprehensive program of monitoring and assessment of the chemical, physical, and biological integrity of the Klamath River and its tributaries in a scientific and defensible manner.

4 Quality Assurance

YTEP's staff undertook many measures to assure high quality hydrological, macroinvertabrate, herbicide, and water quality data during WY02. YTEP's staff consisted of the Water Quality Program Coordinator, Hydrologist, Pesticide Program Coordinator, Environmental Technician, and two Americorps volunteers. The staff reports to the Environmental Program Director, who is responsible for overseeing the Quality Assurance Program Plan (QAPP) for Water Quality Assessment and Monitoring.

The QAPP details the quality assurance (QA) and quality control (QC) procedures used to ensure and document that data is accurate, precise, complete, and representative of actual field conditions. The QAPP details the planning, implementation, and assessment criteria required for projects performed by YTEP for the generation, acquisition, and use of environmental water quality data. The QAPP is also applied for water quality monitoring and sampling activities undertaken by the Yurok Tribe outside of the YIR. Changes to the QAPP are approved by the Environmental Program Director.

In order to ensure comparability and accuracy of data, YTEP uses Standard Operating Procedures (SOPs). Where an SOP does not exist for a certain instrument or procedure, YTEP follows the manufacturer's suggested procedures. Detailed logs are kept in waterproof field notebooks, which also note any malfunctions, unusual circumstances, and/or variations.

A large portion of the data was collected at sites using continuous monitoring instruments such as the Hydrolab Datasonde 4A and H-350XL data logger. QC involves crosschecking the data from the field. For example, at the gaging stations the water level on a fixed, graduated staff plate was compared to the transducer/data collection platform reading. Equipment was also calibrated before deployment and post-calibrated after extraction. These procedures help ensure that the data is of the highest quality.

Data screening and validation are conducted on an ongoing basis. At no time is more than one month of data collected without that data being reviewed. The reviewer looks for missing data, large shifts in values, and applies common sense and her/his knowledge of the location. In addition, data validation includes checking information that has been transmitted from one form into another (e.g., field logbook to computer file) and making sure that there have been no errors in transmission. Daily averages, maximums, and minimums were all deleted when it resulted from less than a complete days worth of data.

5 Site Selection

The various sampling locations were chosen because the conditions at the site met the needs of the sampling project. Table 5.1.1-a shows the numerous sampling locations, their site Ids, name of the sub-watershed and measured parameters.

Table 5.1.1-a Sampling sites and their respective parameters in the Lower Klamath River Basin.

Sub-watershed	Site_id	Stage	Temp	Do	Turb	Specific conductivity	Ph	Macro	SSC	Long	Lat
McGarvey	Mc1	X	X	X	X	X	X	X	X	124 00 34	41 29 10
Terwer	Tu1							X		123 58 43	41 32 6
West Fork Blue	Wb1							X		123 53 46	41 28 4
West ForkPecwan	WP1							X		123 50 39	41 20 35
East Fork Pecwan	EP1							X		123 50 39	41 20 35
Lower Klamath	KJ1							X		123 52 35	41 21 5
Mettah	Me1							X		123 52 21	41 18 31
Tulley	Ty1							X		123 46 31	41 13 43
Johnsons	Jo1							X		123 52 4	41 20 38
Tectah	Te1							X		123 56 27	41 18 4
NF Tectah	Te2							X		123 57 49	41 15 48
SF Tectah	Te3							X		123 57 48	41 15 47
Roach	Ro1							X		123 51 2	41 16 31
Lower Blue	Lb1	X	X	X	X	X	X		X	123 54 4	41 26 55
Turwar	Tu2	X			X				X	123 58 6	41 32 47
Lower Klamath	TG		X	X	X	X	X			124 00 2	41 30 43
Middle Klamath	WE		X	X	X	X	X			123 42 11	41 11 10
Lower Trinity	TR		X	X	X	X	X			123 42 15	41 11 2
Lower Klamath	MF		X	X	X	X	X			123 45 19	41 12 27
Lower Blue	Lb2		X	X	X	X	X	X		123 54 30	41 26 34

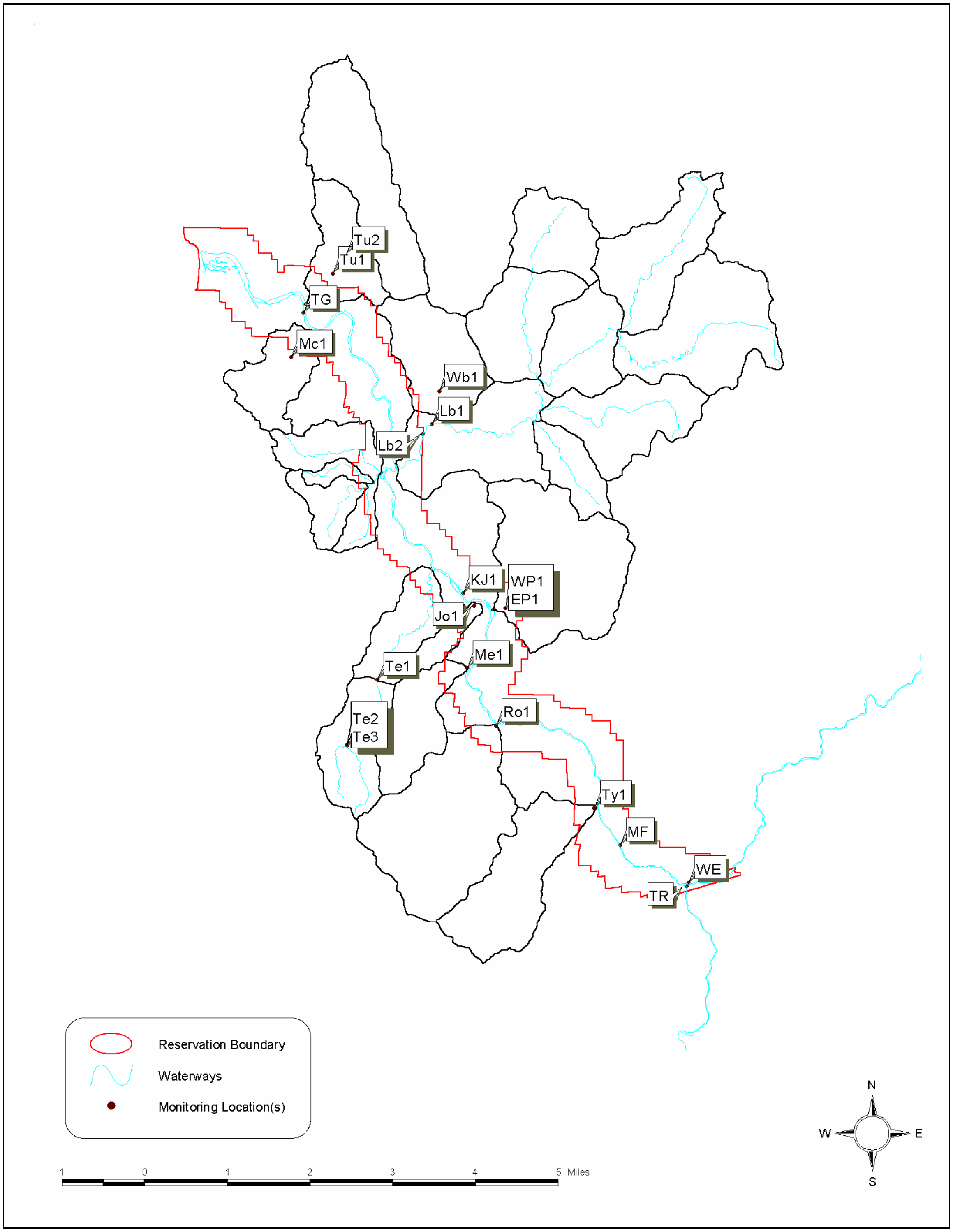

Figure 5-1 Lower Klamath Basin Monitoring Locations, Water Year 2002.

5.1 Water Quality

5.1.1 Mainstem

Site selection depended on the goals and objectives of the monitoring project. Accessibility and security also play a role in the decision making process. For example, sites for the USFWS water quality study on the Klamath River were chosen to develop a spatially distributed network on the river throughout the YIR. The Turwar monitoring site, (Figure 5-2) was chosen for its close proximity to the mouth of the river. The monitoring sites on the Klamath River at Martin's Ferry Bridge (Figure 5-3), in Weitchpec on the Klamath upstream of the Trinity River confluence (Figure 5-4), and in the Trinity upstream of the Klamath represent conditions before the two rivers merge and the conditions downstream after mixing has occurred.

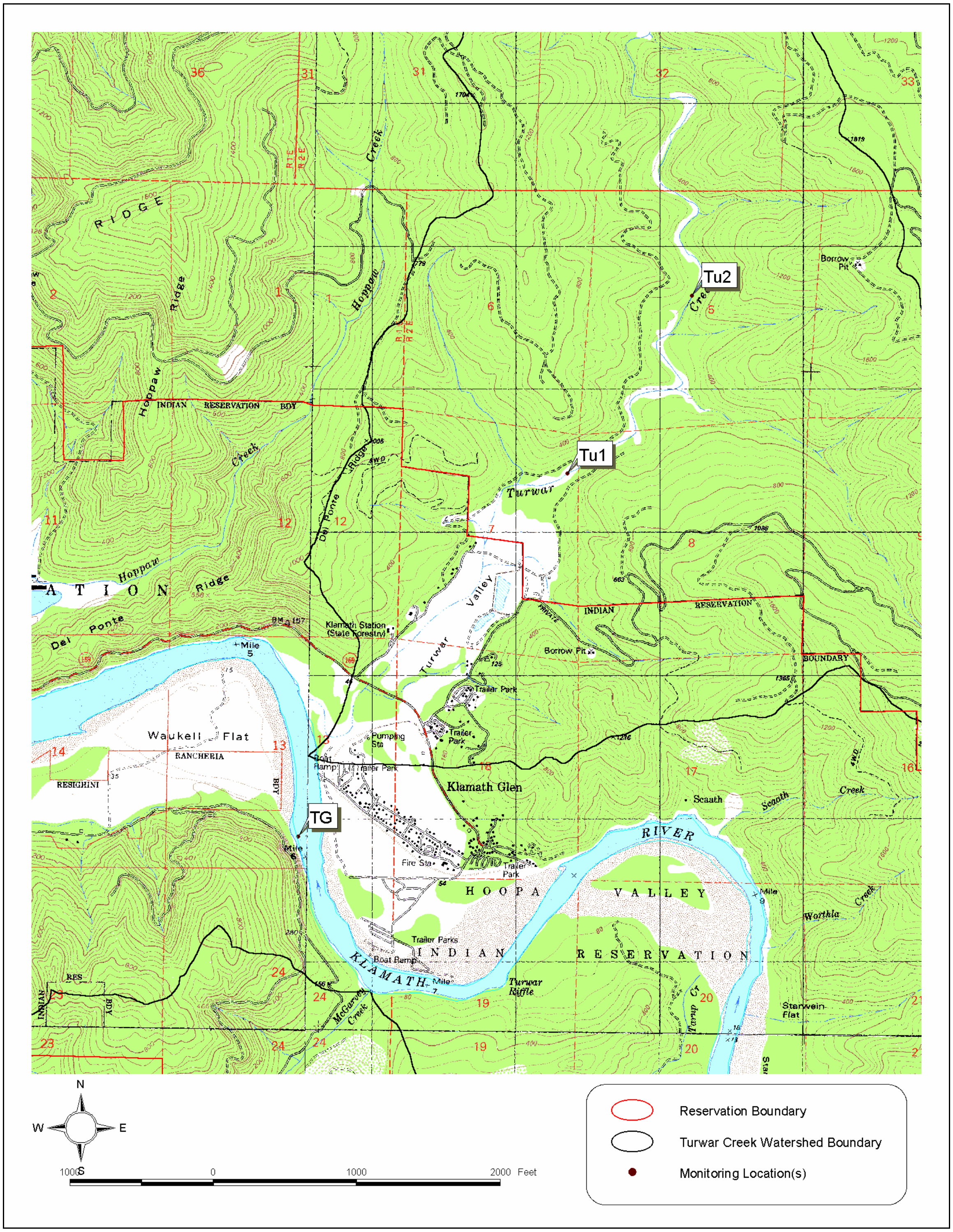

Figure 5-2 Turwar Creek and Mainstem Klamath River at USGS Turwar Gage Monitoring locations.

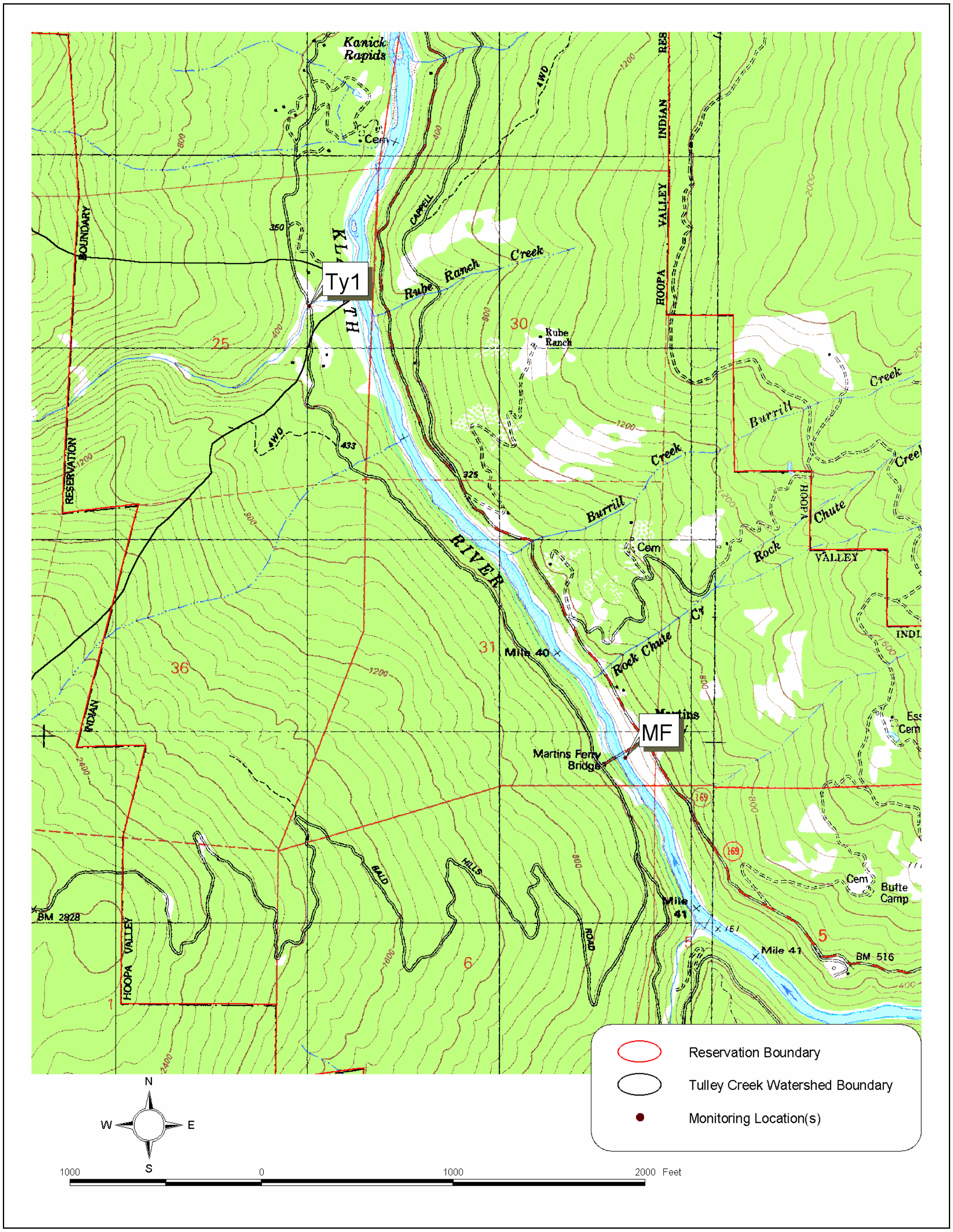

Figure 5-3 Tully Creek and Klamath River at Martins Ferry Monitoring Locations

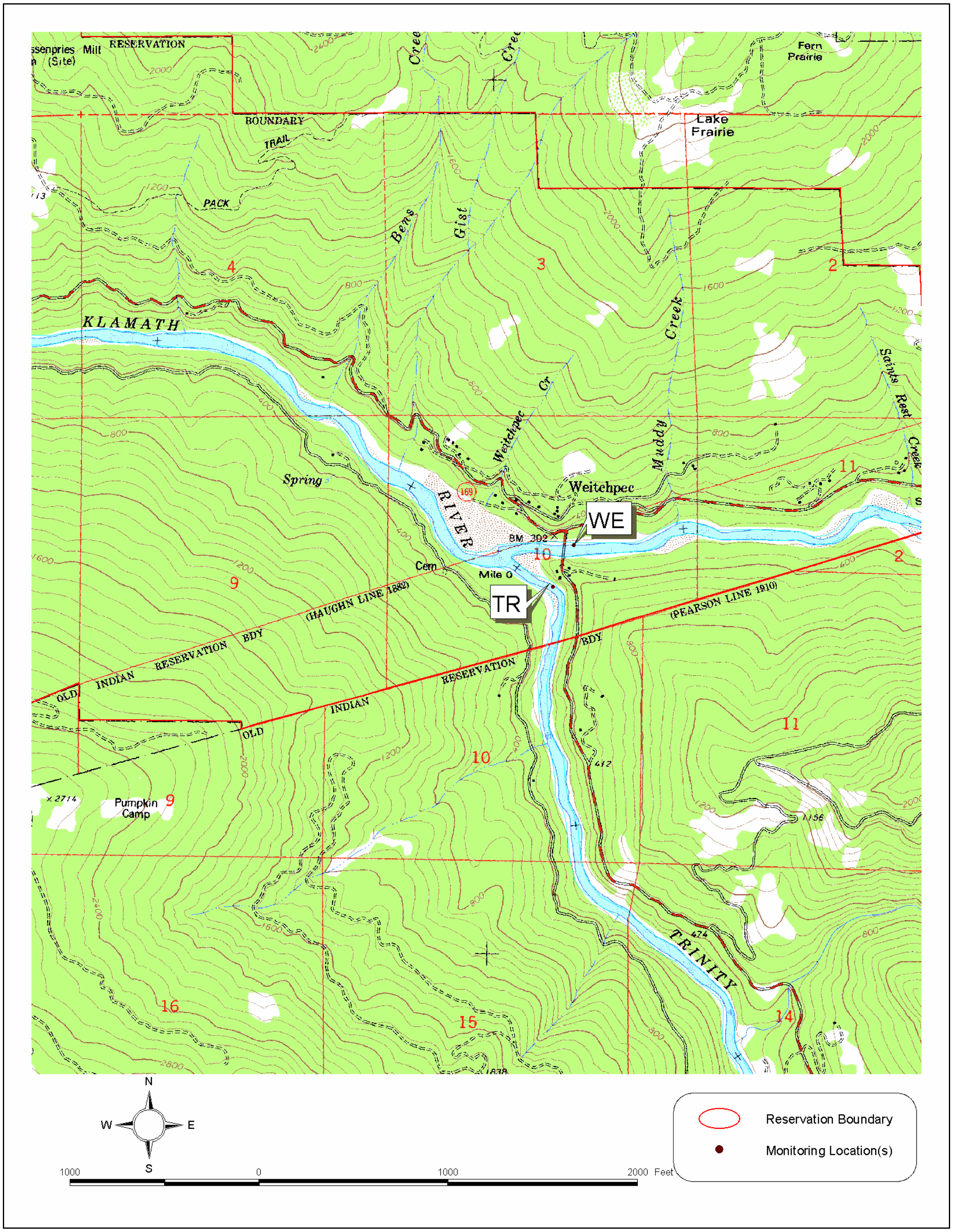

Figure 5-4 Klamath River at Weitchpec and Trinity River at Weitchpec monitoring locations.

5.1.2 Tributaries

The water quality monitoring sites were selected for their importance to fish habitat, potential for Tribal water sources, and current land management activities such as timber harvest and restoration projects. Water quality monitoring in the tributaries were located near the gaging stations so that water quality conditions can be linked to water levels. Other factors contributing to site selection include accessibility and relative safety from vandalism.

5.2 Macroinvertabrate Sampling

Site selection criteria for macroinvertabrate sampling include spatial distribution, herbicide application activity, watershed restoration activities, proposed future development, and other concurrent water quality monitoring activities. Sites were located in the lower reaches of watersheds that characterize the water quality and watershed health condition throughout the Lower Klamath (Table 5.1.2-a). YTEP is in the process of developing baseline conditions to document the magnitude and duration of water quality impacts. The following reasons were used as selection criteria for macroinvertabrate sampling:

1. *Spatial Distribution* - Sites located in the lower reaches of watersheds that characterize the water quality and watershed health condition throughout the Lower Klamath. Areas chosen to monitor baseline and long-term trends.

2. *Activity Specific* -Sites located above and/or below herbicide applications and other activities that may potentially impact water quality.

3. *Watershed Restoration Activities*- Sites located in watersheds and sub-watersheds that have active or proposed restoration activities. Sites are selected to monitor the long-term trends by tracking the watershed's recovery.

4. *Proposed Future Development*- Sites near locations of resource and proposed resource development.

5. *Klamath Mainstem Water Quality Characterization*- Sites located in the main stem Klamath River in order to compliment the on going water quality studies and characterization.

Table 5.1.2-a Selection criteria priority matrix for macroinvertabrate sampling.

Creek	Watershed	Sub-Watershed	Site ID	Primary Criteria	Secondary Criteria	Other
Lower Blue	Blue	Lower Blue	LB	1	3	2
West Fork Blue	Blue	West Fork Blue	Wb1	2	1	3
Johnsons	Johnsons	Johnsons	Jo	2	1	
Klamath	Klamath @ Johnsons	Lower Klamath	KJ1	5	1	
McGarvey	McGarvey	McGarvey	Mc1	3	1	
Mettah	Mettah	Mettah	Me1	3	1	
East Fork Pecwan	Pecwan	East Fork Pecwan	EP1	1	4	
West Fork Pecwan	Pecwan	West Fork Pecwan	WP1	1	4	
Tectah	Tectah	Techtah	Te1	3	1	
Tectah	Tectah	North Fork Tectah	Te2	3	1	
Tectah	Tectah	South Fork Tectah	Te3	3	1	
Tulley	Tulley	Tulley	Ty1	1	4	2
Terwer	Terwer	Terwer	Tu1	1	3	2
Roach	Roach	Roach	Ro1	1	3	

5.3 Hydrologic Monitoring

WaterLog Pressure Transducer/Data Collection Platforms, or gaging stations, on McGarvey (Figure 5-5) and Blue Creeks (Figure 5-6) monitor water levels and flow. Site locations were based on the presence of fish habitat and current land management activities, such as timber harvest and restoration projects. Sites were selected low enough in the watershed to document most of the water that drains from the watershed. The gaging stations also had to be in a location that did not become inundated during high flows, especially when the Klamath River backs up.

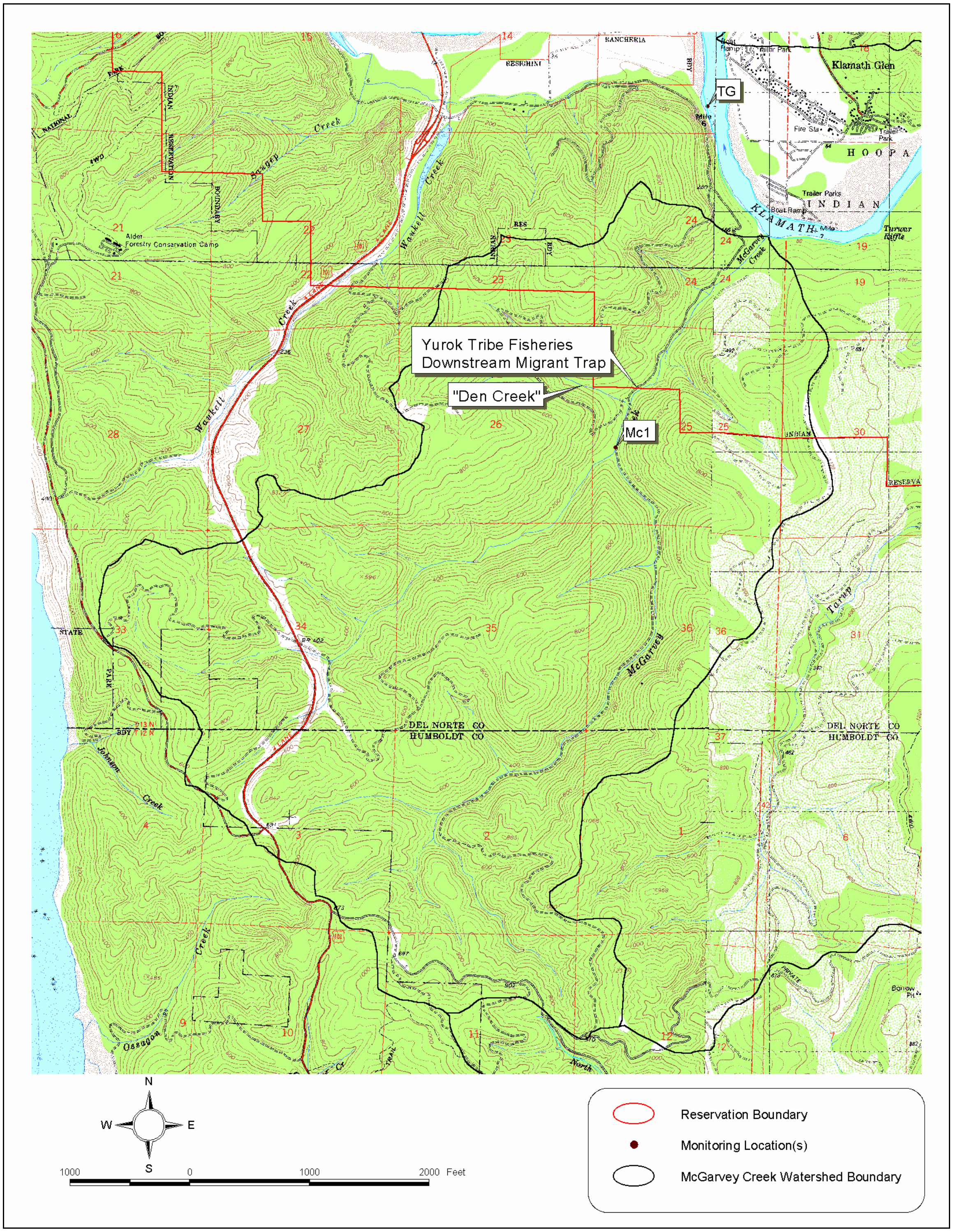

Figure 5-5 McGarvey Creek monitoring location.

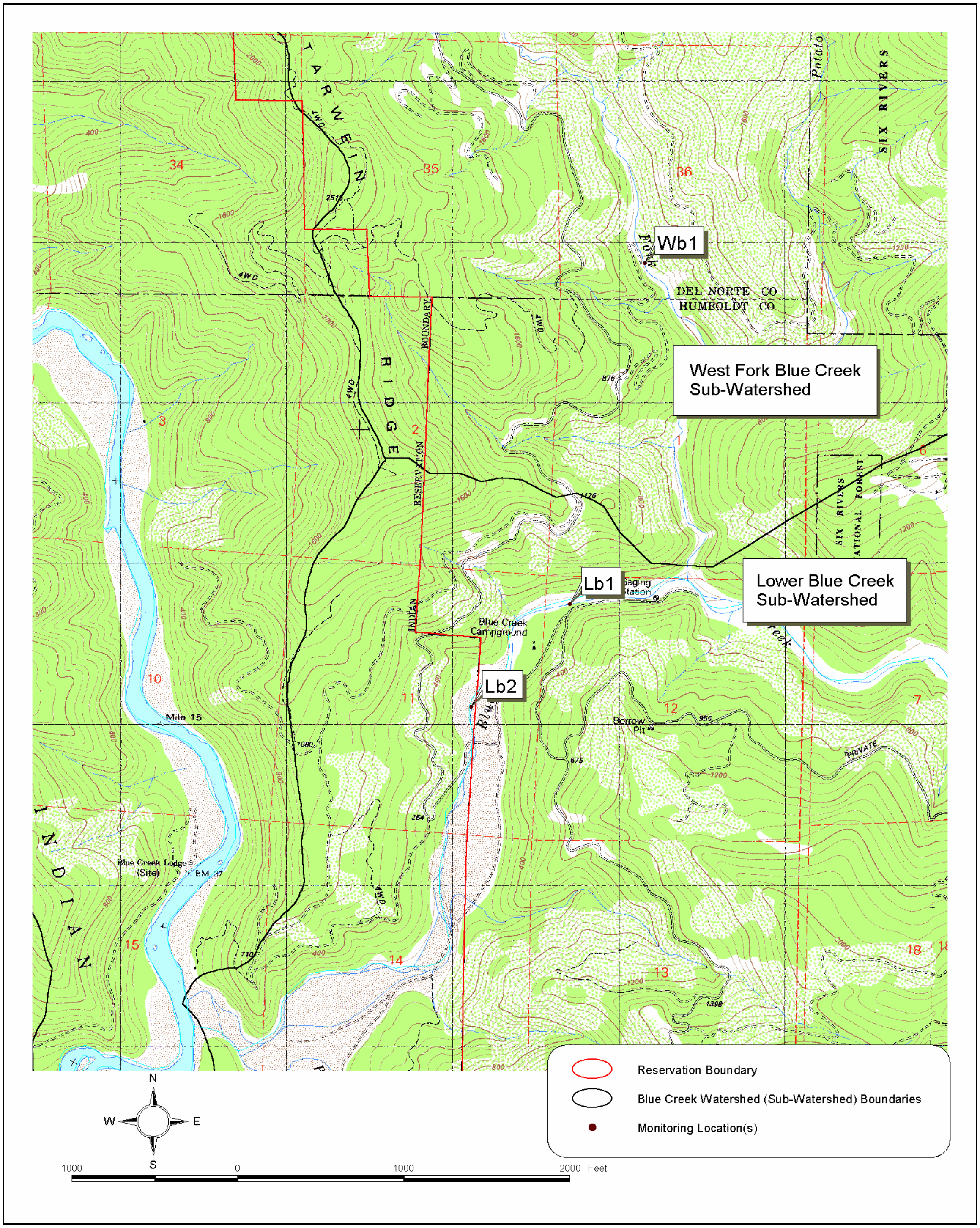

Figure 5-6 Blue Creek monitoring locations

5.4 Herbicide Monitoring

During the March 21, 2002 YEMWG meeting priorities were established for surface water monitoring based on proximity of Simpson's proposed spring spray units to surface water sources and herbicide(s) to be applied. Units sprayed with Oust (sulfometuron methyl) are not sampled due to lack of laboratory methodologies for analysis and cost. YTEP staff determined, based on priorities of the YEMWG, location of herbicide application units to surface water, accessibility, and herbicide(s) applied that there was only one feasible monitoring point in WY02. A surface water monitoring point was selected approximately 100 feet below Simpson spray unit 319, in a class III watercourse that flows into Mettah Creek (Figure 5-7). A contractor for Simpson completed spraying unit 319 with atrazine, by a ground broadcast method, on April 26, 2002.

5.5 Notchko Remote Automated Weather Station

Many sites for the meteorological station were ruled out due to steepness, vegetative cover, location in floodplains, lack of landowner permission and threat of vandalism. The Notchko site was selected because of its exposure to canyon winds, was not in the floodplain, and was more than 500 feet above the Klamath River (Figure 5-7).

Figure 5-7 Mettah Creek, Roach Creek, and the Notchko Weather Station monitoring locations

6 Methods

6.1 Water Quality Monitoring

6.1.1 Mainstem

In conjunction with the U.S. Fish and Wildlife Service (USFWS), the Yurok Tribe Environmental and Fisheries Programs participated in a water quality study on the mainstem Klamath River. The Tribe operated multi-probe water quality monitoring instruments. The instruments were deployed at four locations (Figure 5-1). The Yurok Tribe Fisheries Program collected the data at Martin's Ferry Bridge, Klamath River at Weitchpec and the Trinity River at Weitchpec. Although that data was not collected by YTEP, it will be included in this report to show a more comprehensive picture of water quality conditions on the Klamath River. YTEP operated the probe located at the Turwar gage.

The study was initiated in May, continued throughout the summer months and terminated in October. The parameters were measured at 30-minute intervals

Table 6.1.2-a. Grab samples, discreet surface water samples, were also collected at the four locations once every two weeks. However, this information has not yet been made available to the Tribe for reporting. The sample parameters are shown on Table 6.1.1-a

Table 6.1.1-a Parameters measured in the Klamath River Flow Study.

Analysis	Preservation Method
BOD / Biological Oxygen Demand	Ice
TSS / Total Suspended Solids	Ice
NO2 / Nitrite	Ice
NO3 / Nitrate	Ice
Alk / Akalinity	Ice
TDS / Total Dissolved Solids	Ice
TOC / Total Organic Carbon	Ice / sulfuric acid
Total-P / Total Phosphate Phosphorus	Ice / sulfuric acid
Ortho-P / Orthophosphate Phosphorus	Ice
Ca / Calcium	
Mg / Magnesium	
Org-P / Organic Phosphorus	
Condensed P / Condensed Phosphorus	
Chlorophyll-A	
Periphyton / ash free dry weight	
Ammonia and TKN / Total Kjeldahl Nitrogen	
Turbidity	

During this study, many QC measures were undertaken to ensure the data collected was of the highest quality. Hydrolab Datasondes were pre and post-calibrated once a week in order to avoid electronic drift and bio-fouling. When the Datasondes were deployed and extracted an audit was performed with a Hydrolab Quanta, a portable multi-probe instrument. The Quanta measurements were recorded at exactly the same time the Hydrolab was programmed to record a measurement. The parameters measured by the Quanta were, depth of the sample, dissolved oxygen in mg/l and % saturation, pH, specific conductivity and temperature.

In addition, a BOD 1L bottle was filled with water at the same time the Hydrolab Datasonde and measurements were recorded. Dissolved oxygen in mg/L was then determined by performing a Winkler titration using this sample of water. This data was recorded in the field notebook along with other pertinent information (crew, date, time, weather, unusual observations, etc).

6.1.2 Tributaries

YTEP also monitors water quality in the Lower Klamath tributaries. During the spring and summer months one Hydrolab is deployed at the Blue Creek gaging station (see Figure 5.1.2). The parameters were measured at 30-minute intervals. Parameters measured are shown in with their respective units of measurement
Table 6.1.2-a.

Table 6.1.2-a The parameters and respective units measured by the Hydrolab Datasondes are displayed in the table.

Parameter	Units
Dissolved Oxygen	% Saturation and mg/L
Specific Conducivity	microSiemens (uS)
Water Temperature	°C
pH	pH units
Turbidity	NTUs

During the fall and winter months Hydrolabs are deployed at the McGarvey and Blue Creek gaging stations (Figure 5-6, Figure 5-5). These instruments are programmed to measure turbidity, specific conductivity, and water temperature every 15 minutes. The Hydrolab Datasondes were pre and post-calibrated every two weeks in order to determine the quality of the data. As part of the QC procedure, Quanta measurements, with the exception of turbidity, were recorded simultaneously to a Datasonde measurement.

6.2 Macroinvertabrate Sampling

Evaluating the biological community of a stream or river through assessments of algae, macroinvertabrates and fish provides a sensitive and cost effective means of determining stream condition. Macroinvertabrates (invertebrates large enough to be seen with the naked eye) are fairly stationary, and are responsive to human disturbances. In addition, the relative sensitivity or tolerances of many macroinvertabrates to stream conditions is well known. Sampling of stream macroinvertabrates for biological assessments is an essential component of any comprehensive stream condition evaluation. The object of studying macroinvertabrates communities is to monitor the general health and water quality of the Klamath River and its Tributaries. According to the California Stream Bioassessment Procedure developed by the California Department of Fish and Game (DFG), benthic macroinvertabrate communities indicate physical and habitat characteristics that determine the stream integrity and ecological health.

During the spring 2002 YTEP sampled benthic macroinvertabrate populations in selected tributaries of the Lower Klamath River. Sampling was performed using the California Stream Bioassessment Procedure (May 1999) that the DFG has adapted from the U.S. Environmental Protection Agency's "Rapid Bioassessment Protocols of use in Streams and Rivers". YTEP staff, and one volunteer, collected specimens which were sent to a lab where a trained taxonomist identified and calculated the number of species.

A variety of QC measures were undertaken in the macroinvertabrate sampling. Sample labels were properly completed, including the sample identification code, date, stream name, sampling location, and collector's name and placed it into the sample container.

The outside of the container was labeled with the same information. Chain-of-custody forms, when needed, included the same information as the sample container labels.

After sampling had been completed at a given site, all nets, pans, etc. that had come in contact with the sample were rinsed thoroughly, examined carefully, and picked free of organisms or debris. The equipment was examined again prior to use at the next sampling site. Field replication is not a viable option as a QC method due to the disturbance that one sampling event creates.

Data generated in the field and laboratory is reviewed prior to being released internally or to an outside agent. The laboratory data is retained under the taxonomist's own SOP, which includes data validation and review. Laboratory processing is contracted to Jonathan Lee, a qualified local CSNP taxonomist and California Bioassessment Laboratories Network (CAMLnet) member. The CSBP has three levels of BMI identification. Level 3 is the professional level equivalent and requires identification of BMIs to a standard level of taxonomy, usually the genus and/or species (CSBP). If questionable macroinvertabrates are encountered The California Department of Fish and Game Aquatic Bioassessment Laboratory is used as a reference.

After processing the samples, the biological matrices are received from the taxonomist in an Excel spreadsheet format identifying the sample ID and the breakdown of BMI species into standard taxonomic levels. Following the CSBP, a table is generated showing sample values and means for the biological metrics listed.

6.3 Hydrologic Monitoring

The NCRWQCB includes the Lower Klamath River on the "impaired watch list" for excessive sediment loading. The NCRWQCB has suggests that more research is needed for the Lower Klamath to be officially listed as impaired. YTEP hydrologic monitoring and pre-TMDL research in selected tributaries is filling this data gap. The data will be used to help develop a sediment budget for the Lower Klamath River basin.

Physical variables such as flow and gage height were measured at computerized gaging stations with WaterLog Pressure Transducer/Data Collection Platforms (model H-350XL) at McGarvey and Blue Creeks. Stream levels were recorded every 15 minutes. This data was uploaded from the gaging station onto a portable laptop computer during site visits. The stage height was compared visually to staff plate readings and was adjusted accordingly when found to be +/- .05 feet off. Stream discharge was measured using a Price AA flow meter and an AquaCalc that were attached to a four-foot top set wading rod. Due to YTEP's limitations discharge measurements were restricted to wadable flows using USGS methods (USGS, 1999).

6.4 Herbicide Monitoring

YTEP staff conducted surface water sampling following DPR's protocol for *Study 172: Surface Water Monitoring for Forest Herbicides in the Yurok Aboriginal Territory*. According to DPR protocol, samples are to be taken not more than 30 days after the initial herbicide application, following a significant rain event that produces 0.5 inches of rain or more. Samples may be collected using a grab sample method or an automatic pump sampler method. All samples were collected in 1 liter amber glass bottles stored on ice and shipped to DPR within required holding times.

YTEP collected 4 (2 primary and 2 backup) surface water grab samples from the sample point on May 20, 2002. Samples were stored on ice during field transport, refrigerated at YTEP office overnight, and shipped on ice to DPR laboratories on 5-21-02. A chain of custody form was filled out for each sample requesting Atrazine analysis.

In anticipation of rain, an ISCO model number 6700 automatic pump sampler, programmed to start at 0.5 inches of rain fall, was deployed at the sample location on 5-24-02. The sampler was removed on on 5-30-02 due to insufficient rain. No samples were collected using the automatic pump sampler.

6.5 Notchko Remote Automated Weather Station (RAWS)

A Remote Automated Weather Station (RAWS) located across the Klamath River from Notchko Creek measures ambient weather conditions. The weather station is on loan from the Tribal Air Monitoring Support (TAMS) Center and the Institute for Tribal Environmental Professionals (ITEP). Certain procedures such as pesticide monitoring are dependant upon the amount of rainfall that has occurred. Meteorological data also water quality monitoring activities by giving real-time rainfall and other measurements. Meteorological data, specifically rainfall, provides information related to monitoring surface water for the presence of herbicides, and provides baseline information for hydrologic and water quality data studies.

The Notchko RAWS began operating on October 10, 2001. The station is located at 41º 17' 23" North latitude, 123º 51' 27" West longitude, approximately 495 feet above sea level. The following parameters were measured at the site on an hourly basis throughout the year: air temperature; rainfall; average and gust wind speed/direction; barometric pressure; relative humidity; solar radiation and fuel moisture/temperature. Historic data from this site can be retrieved on the internet at http://www.wrcc.dri.edu/cgi-bin/rawMAIN.pl?caCYUR. For the purposes of this report, only rainfall data is presented because of its relevance to the water quality and hydrology data presented.

7 Results

7.1 Water Quality (Mainstem)

7.1.1 Klamath River at Turwar

7.1.1.1 Temperature

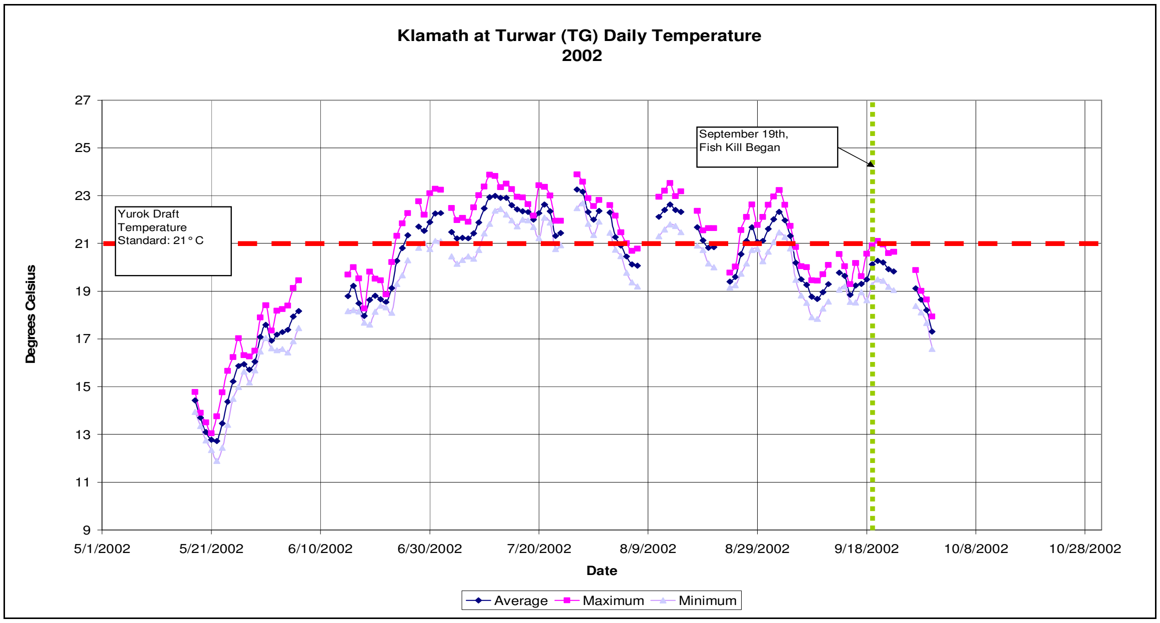

Figure 7-1 Annual Temperatures for the Klamath River at Turwar WY02.

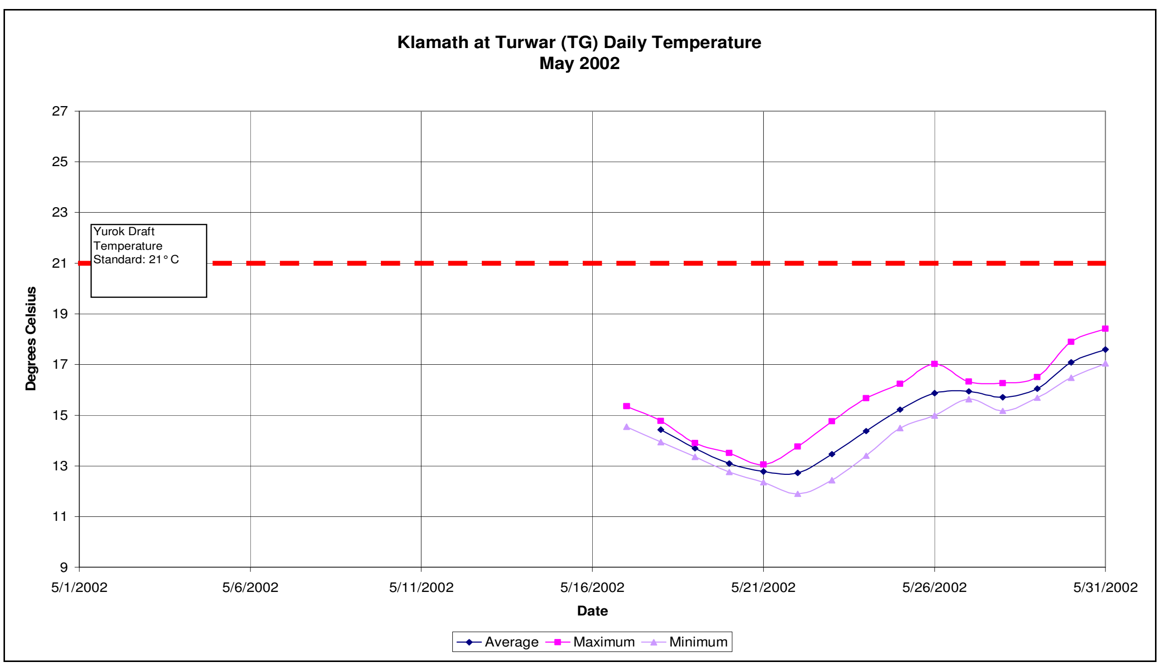

Figure 7-2 Daily Temperatures for the Klamath River at Turwar May 2002

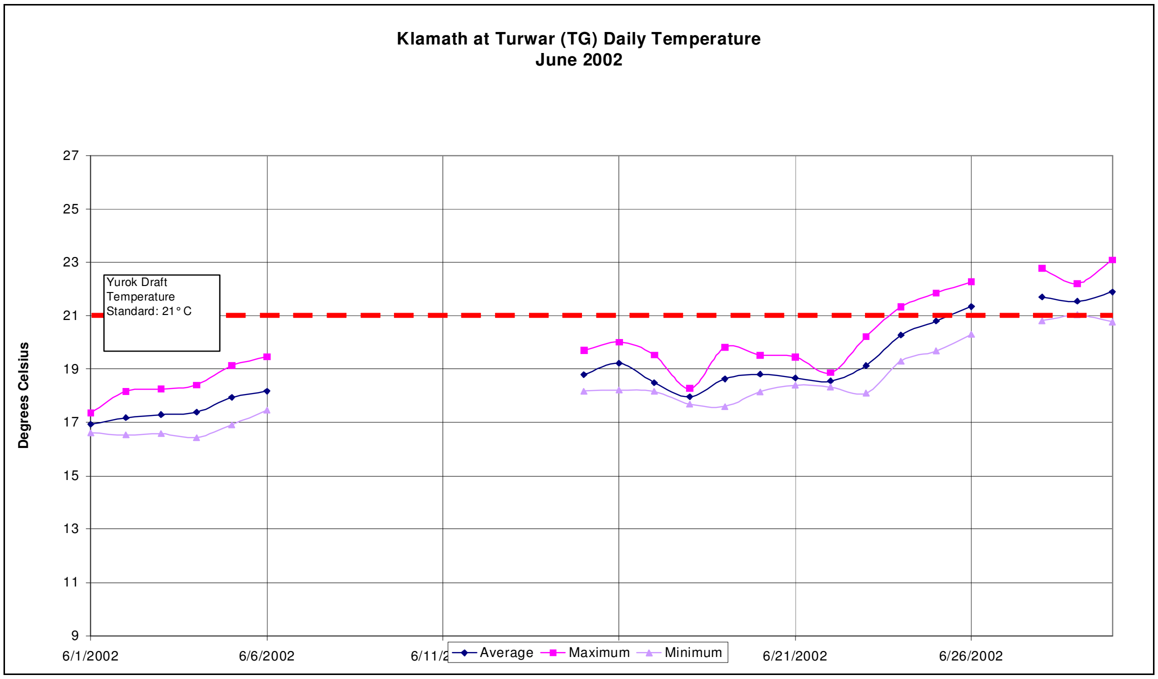

Figure 7-3 Daily Temperatures for the Klamath River at Turwar June 2002.

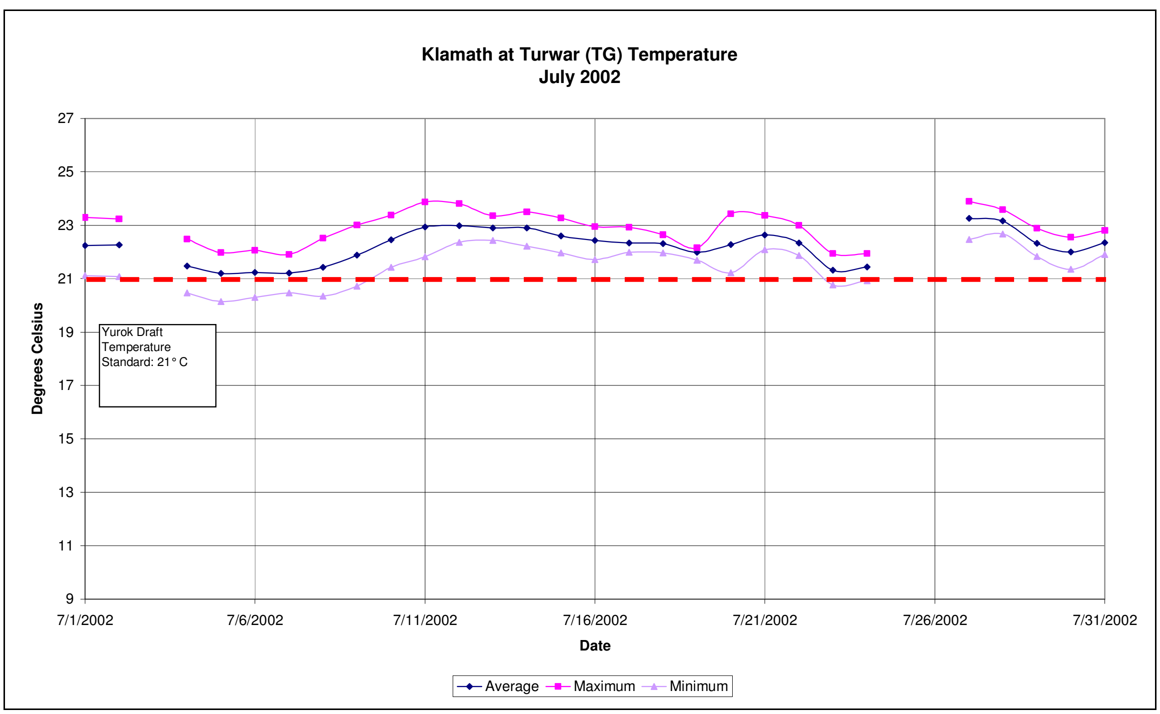

Figure 7-4 Daily Temperatures for the Klamath River at Turwar July 2002

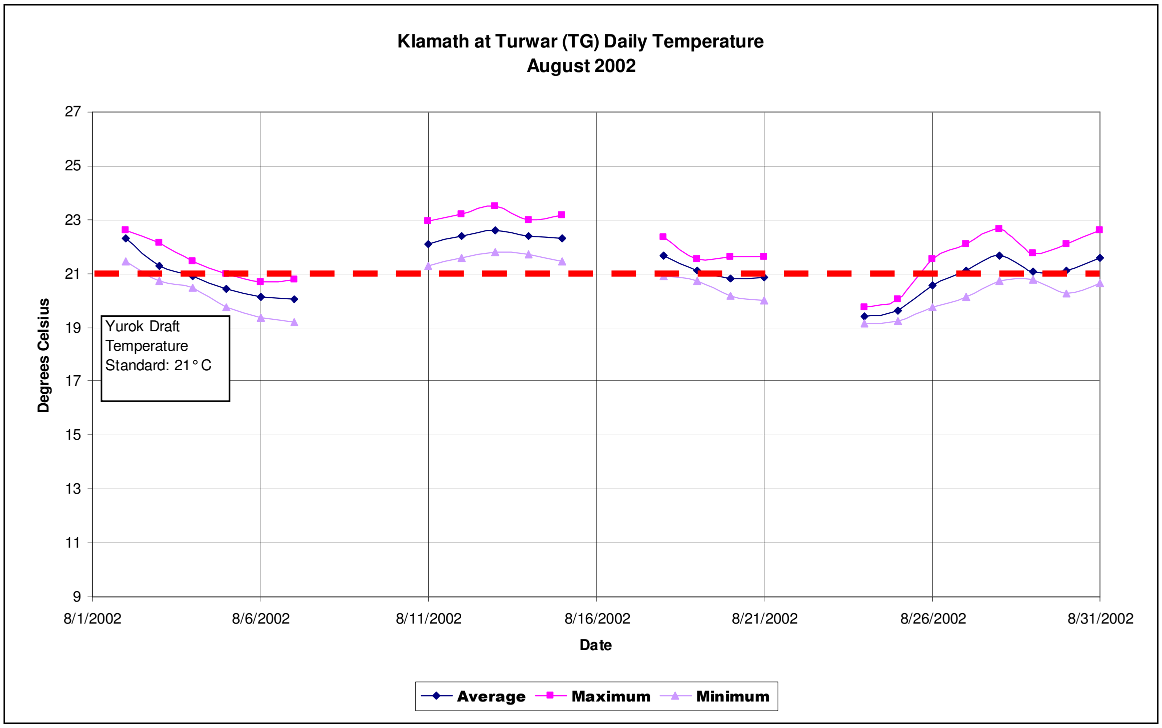

Figure 7-5 Daily Temperatures for the Klamath River at Turwar August 2002.

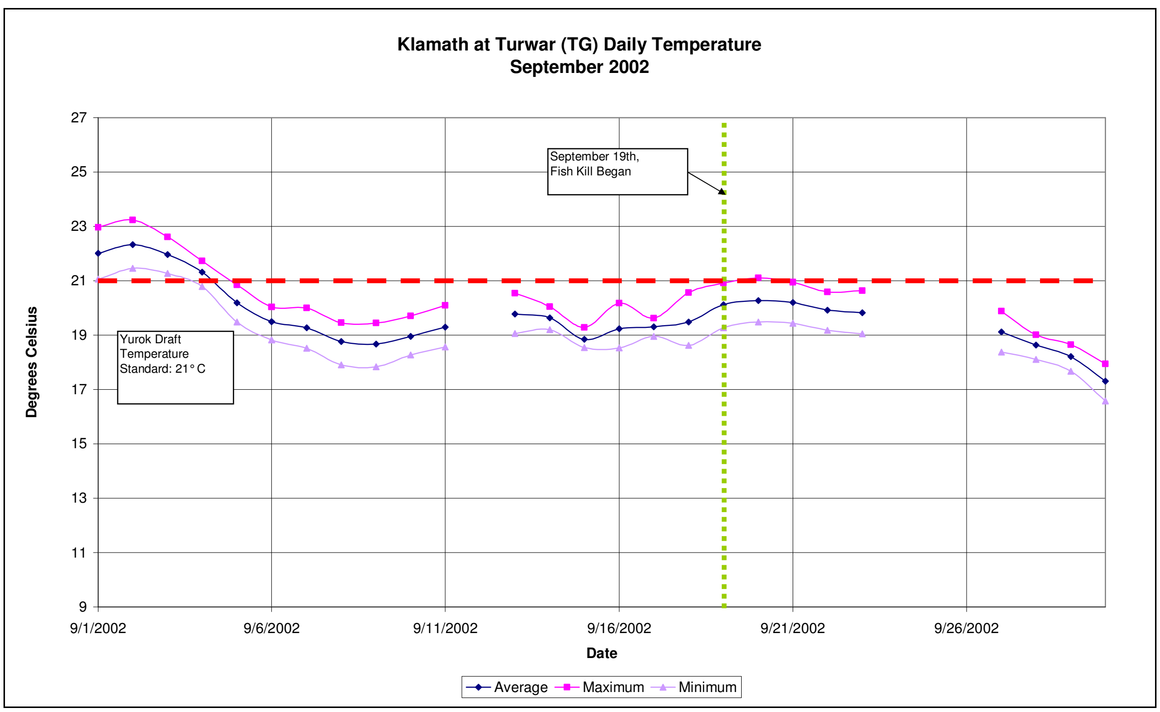

Figure 7-6 Daily Temperatures for the Klamath River at Turwar June 2002.

7.1.1.2 Dissolved Oxygen

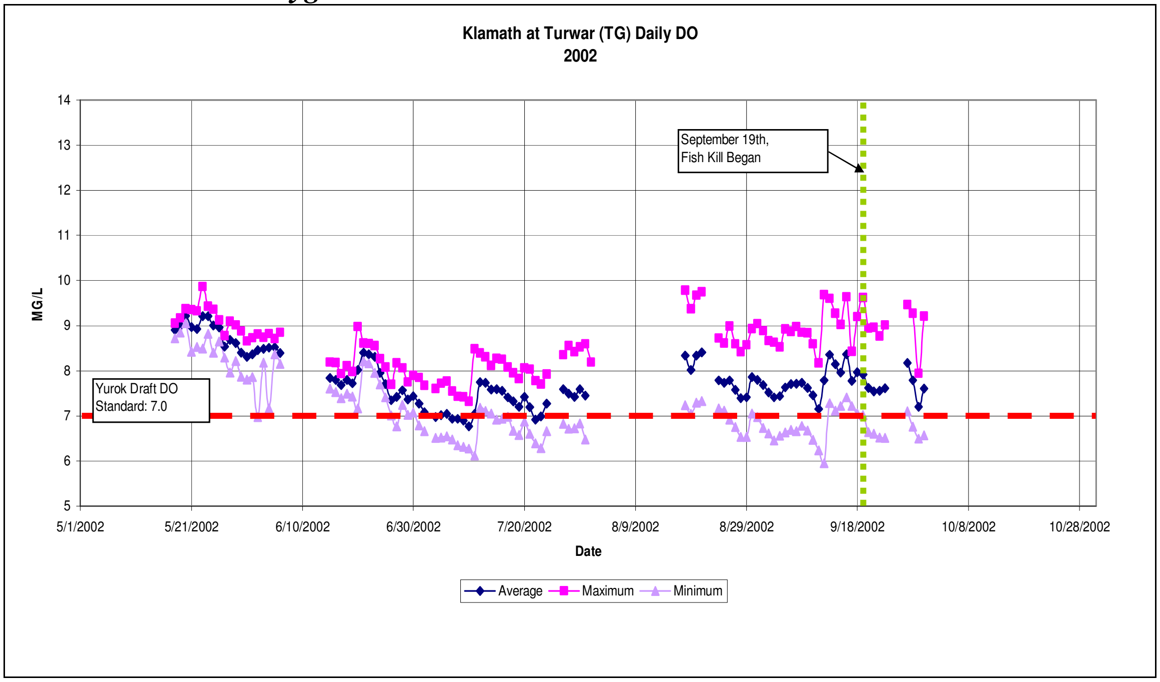

Figure 7-7 Daily DO values for the Klamath River at Turwar WY02.

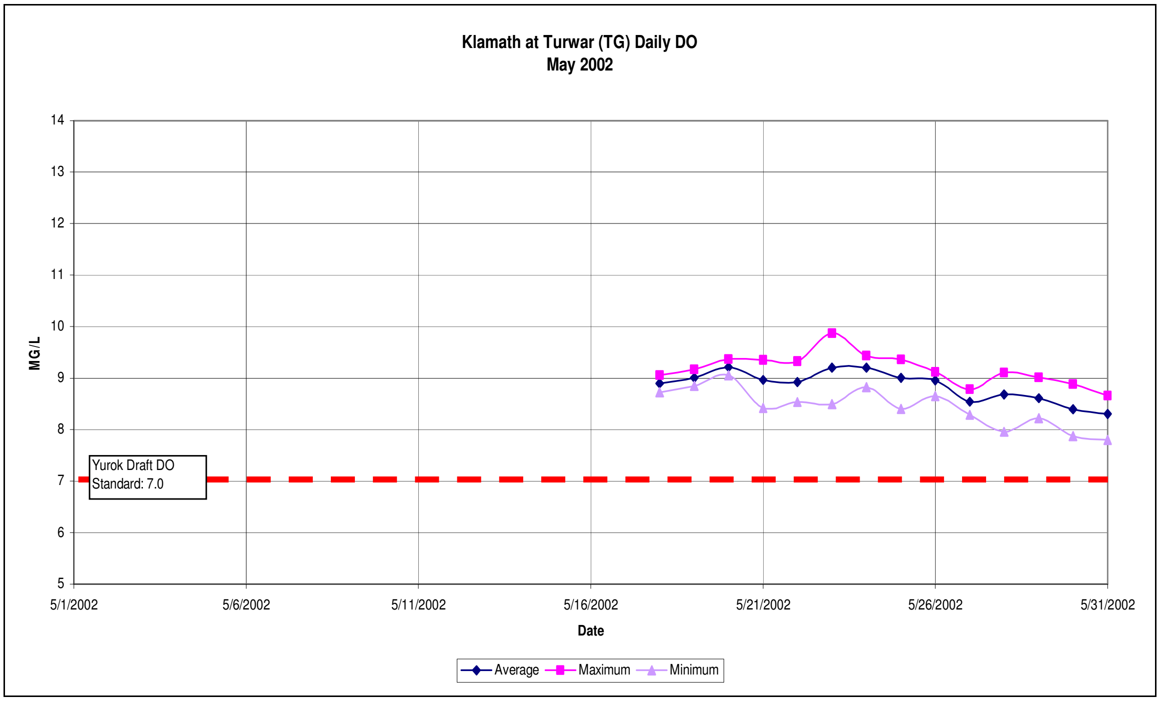

Figure 7-8 Daily DO values for the Klamath River at Turwar May 2002.

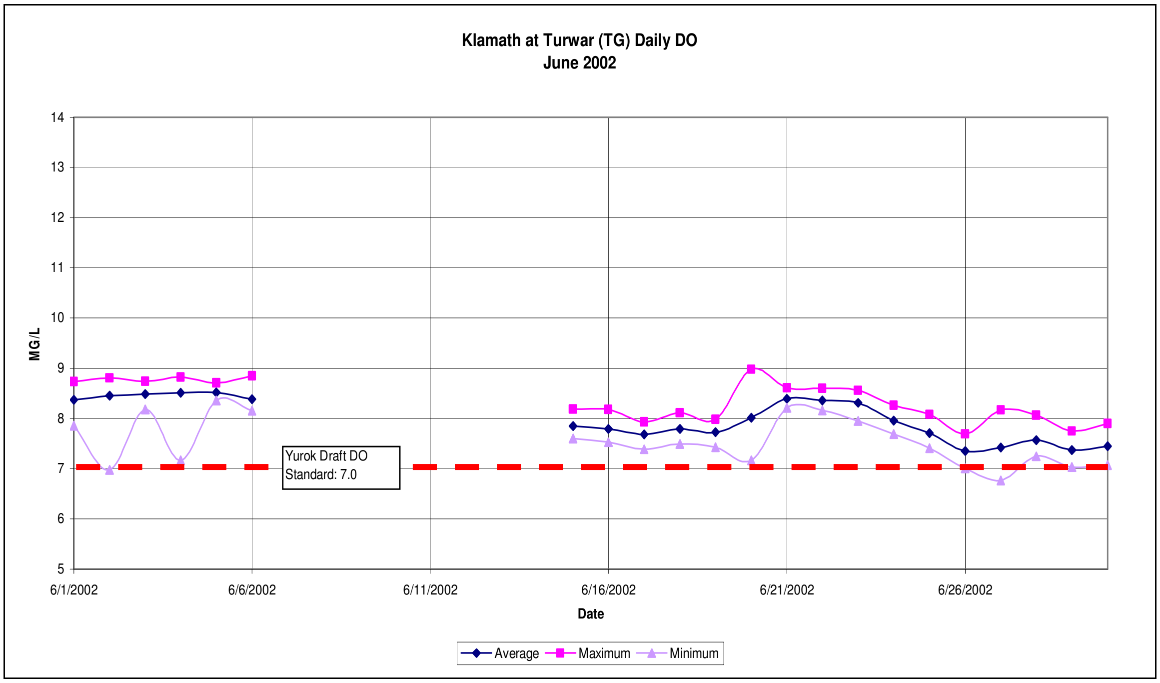

Figure 7-9 Daily DO values for the Klamath River at Turwar June 2002.

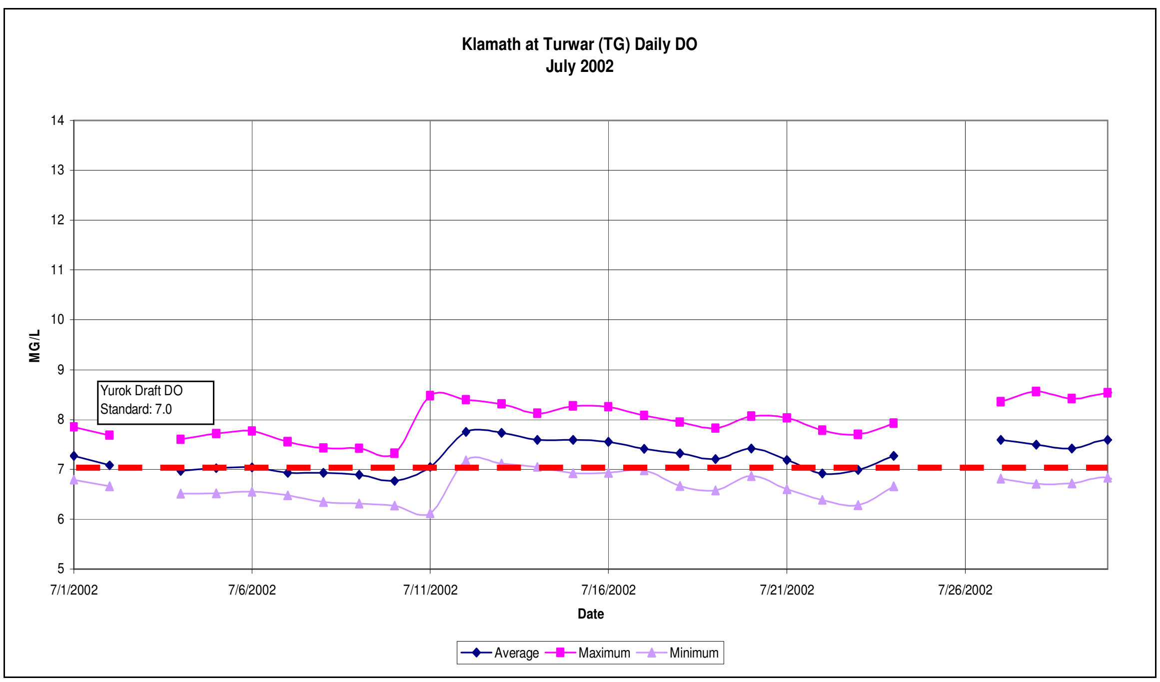

Figure 7-10 Daily DO values for the Klamath River at Turwar July 2002.

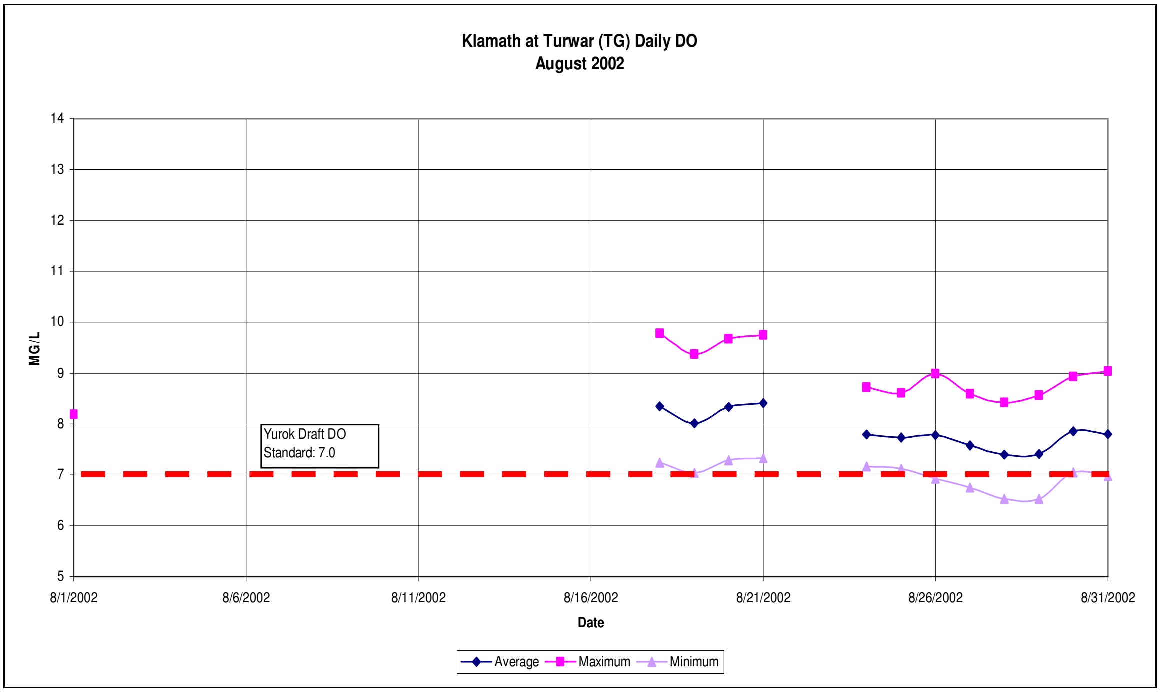

Figure 7-11 Daily DO values for the Klamath River at Turwar August 2002.

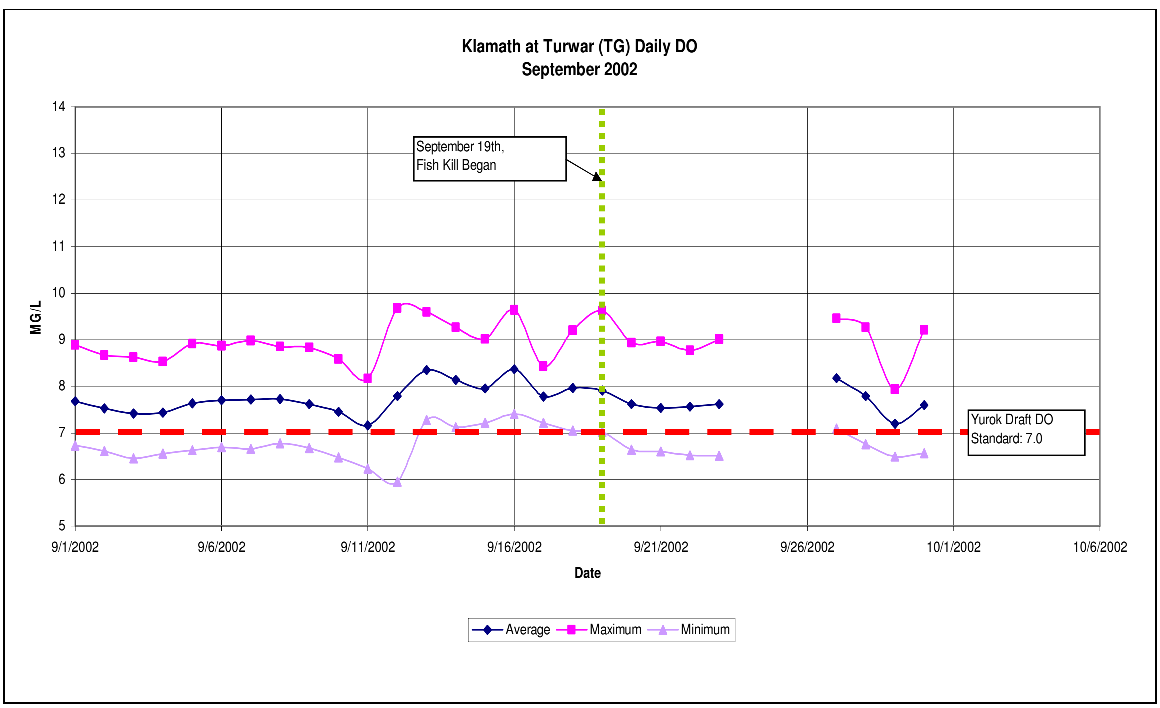

Figure 7-12 Daily DO values for the Klamath River at Turwar September 2002.

7.1.1.3 pH

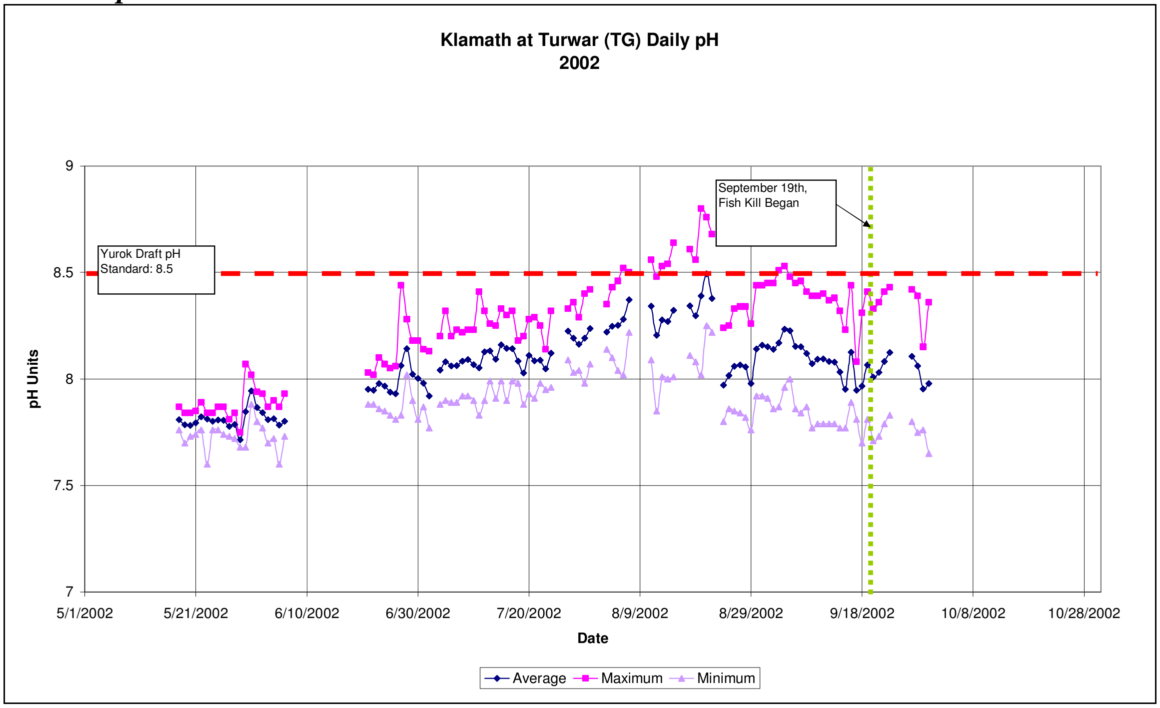

Figure 7-13 Daily pH values for the Klamath River at Turwar WY02.

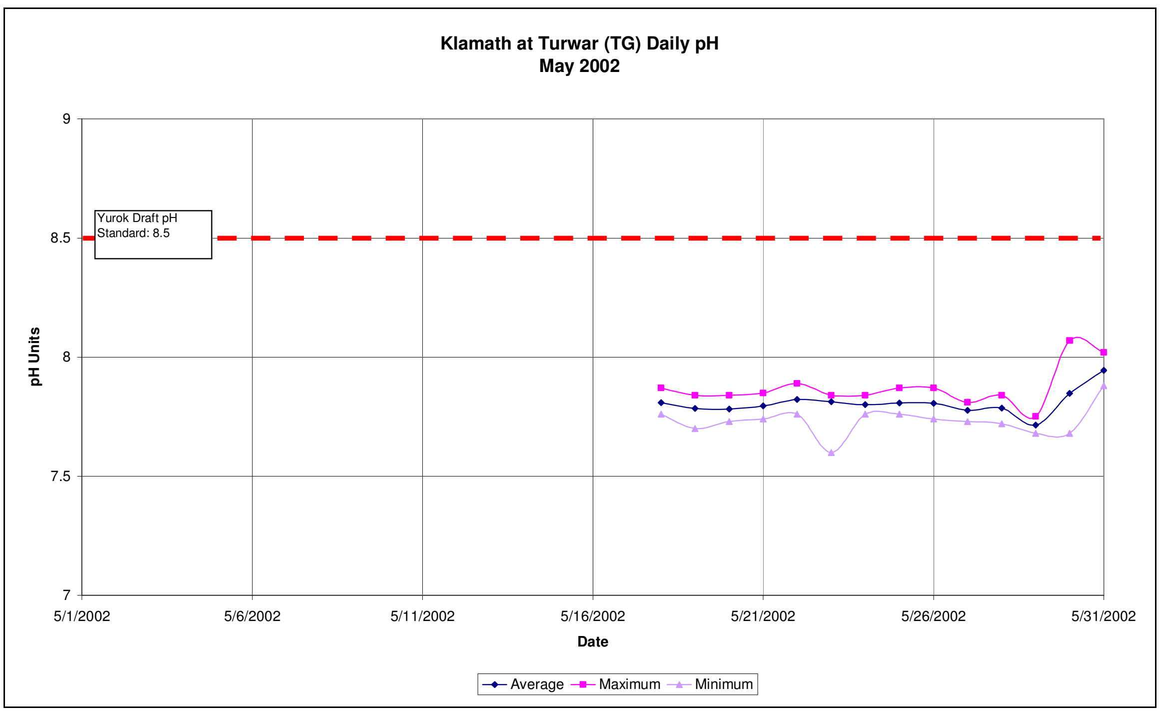

Figure 7-14 Daily pH values for the Klamath River at Turwar May 2002.

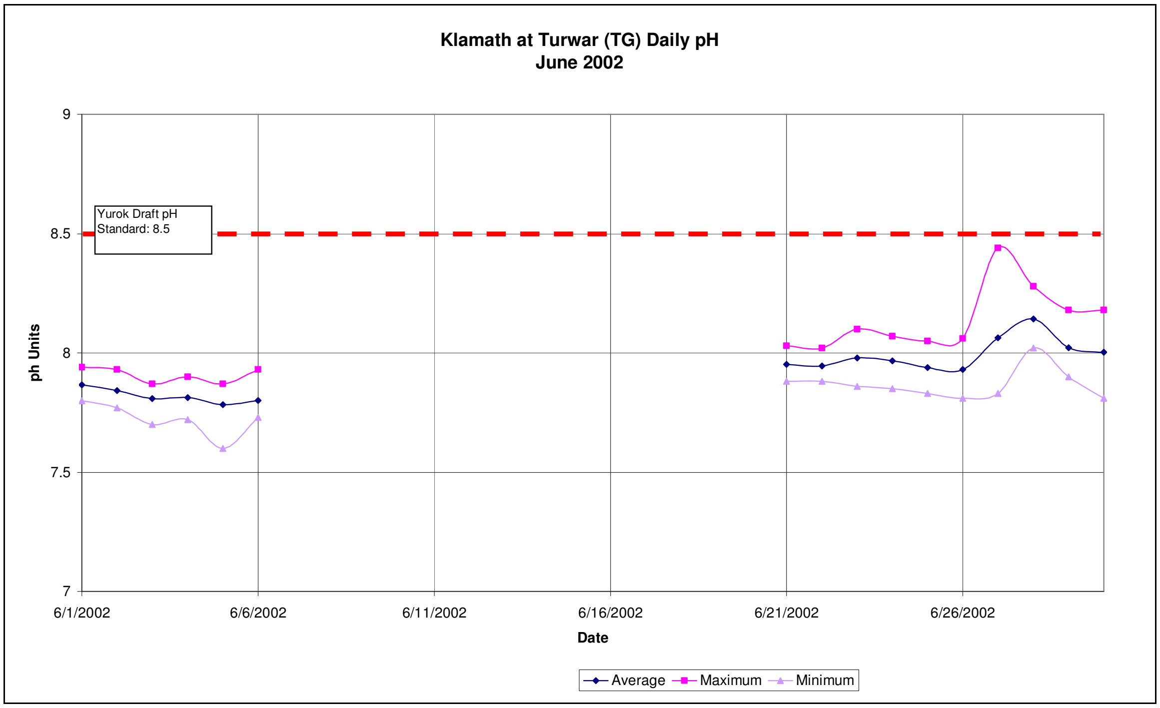

Figure 7-15 Daily pH values for the Klamath River at Turwar June 2002.

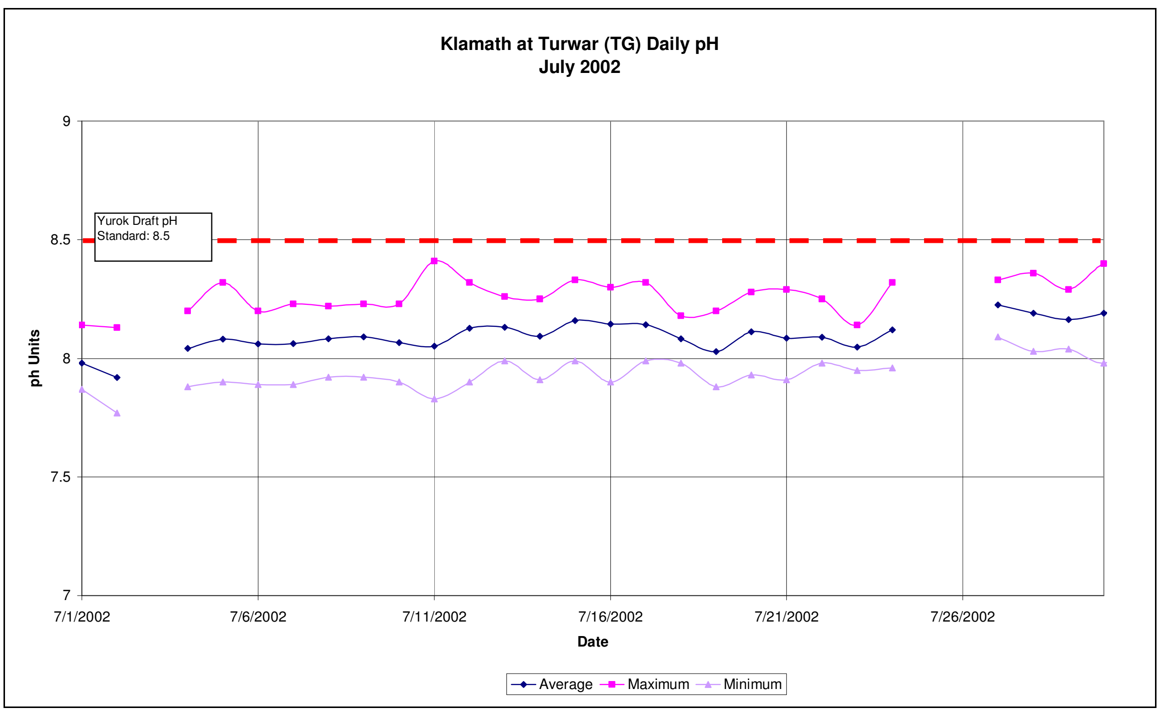

Figure 7-16 Daily pH values for the Klamath River at Turwar July 2002.

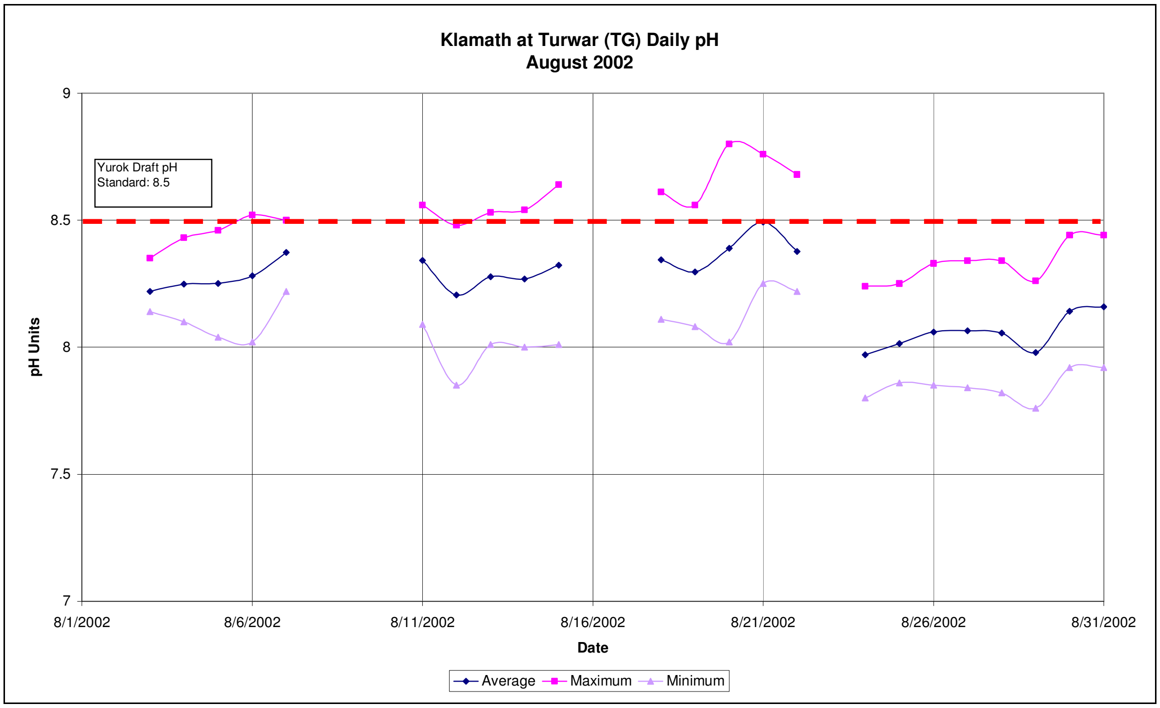

Figure 7-17 Daily pH values for the Klamath River at Turwar August 2002.

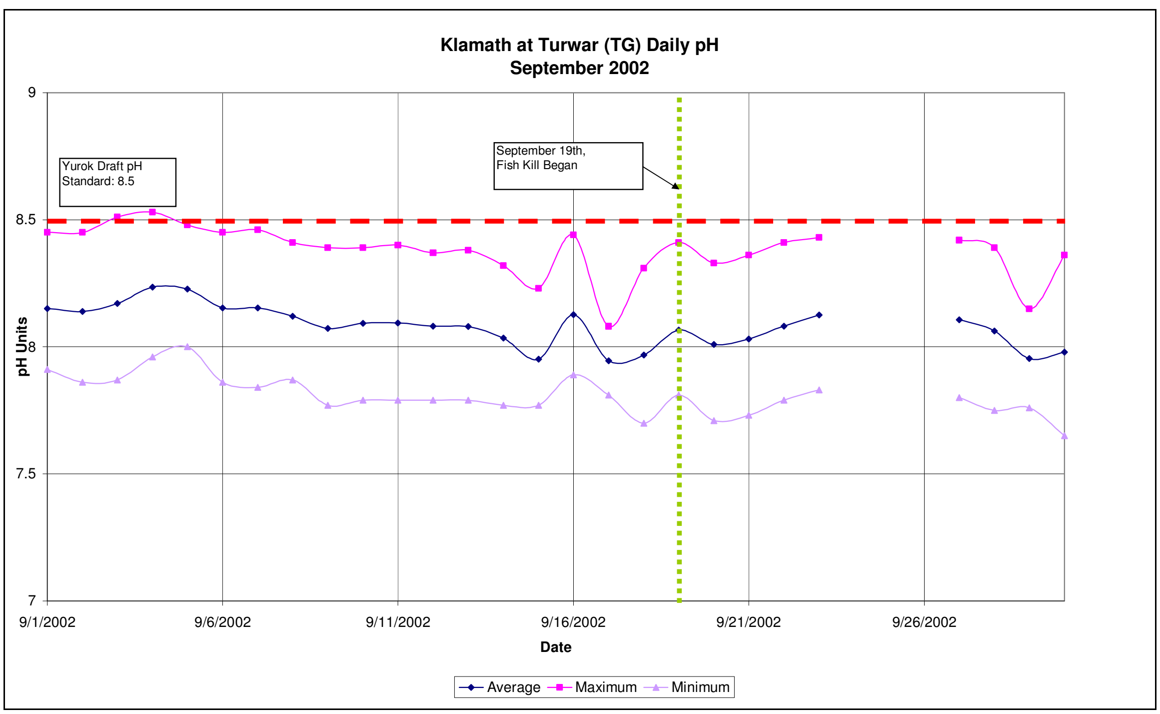

Figure 7-18 Daily pH values for the Klamath River at Turwar September 2002.

7.1.1.4 Specific Conductivity

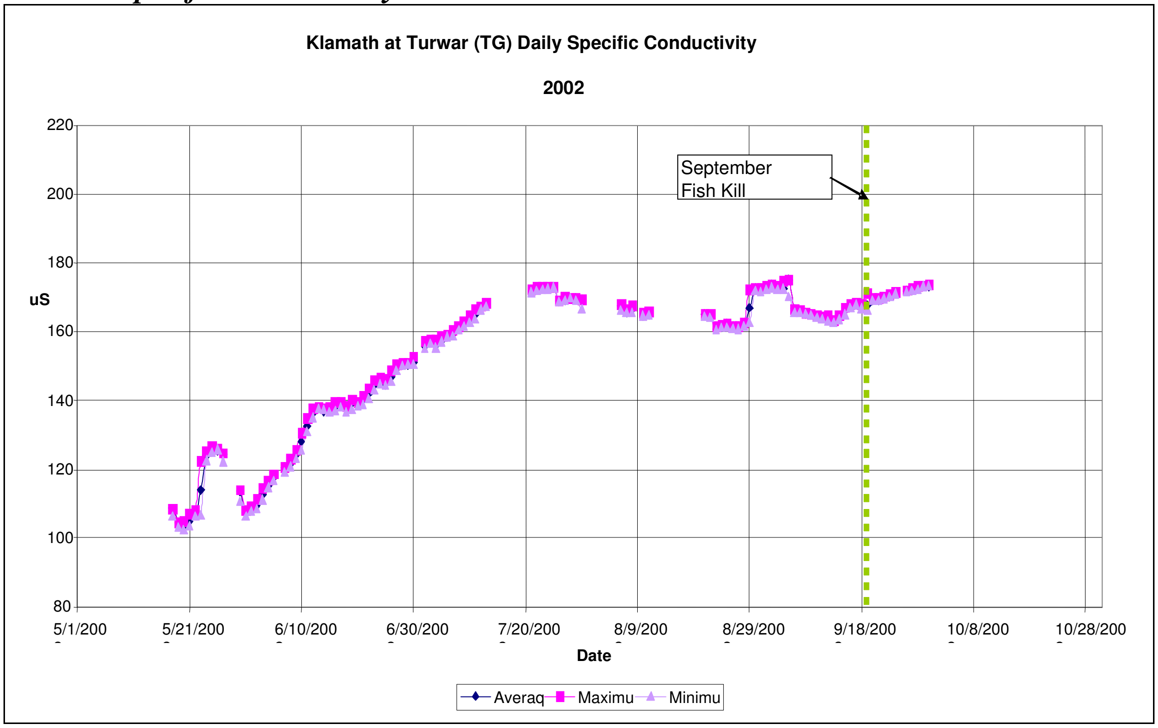

Figure 7-19 Daily Specific Conductivity values for the Klamath River at Turwar WY02.

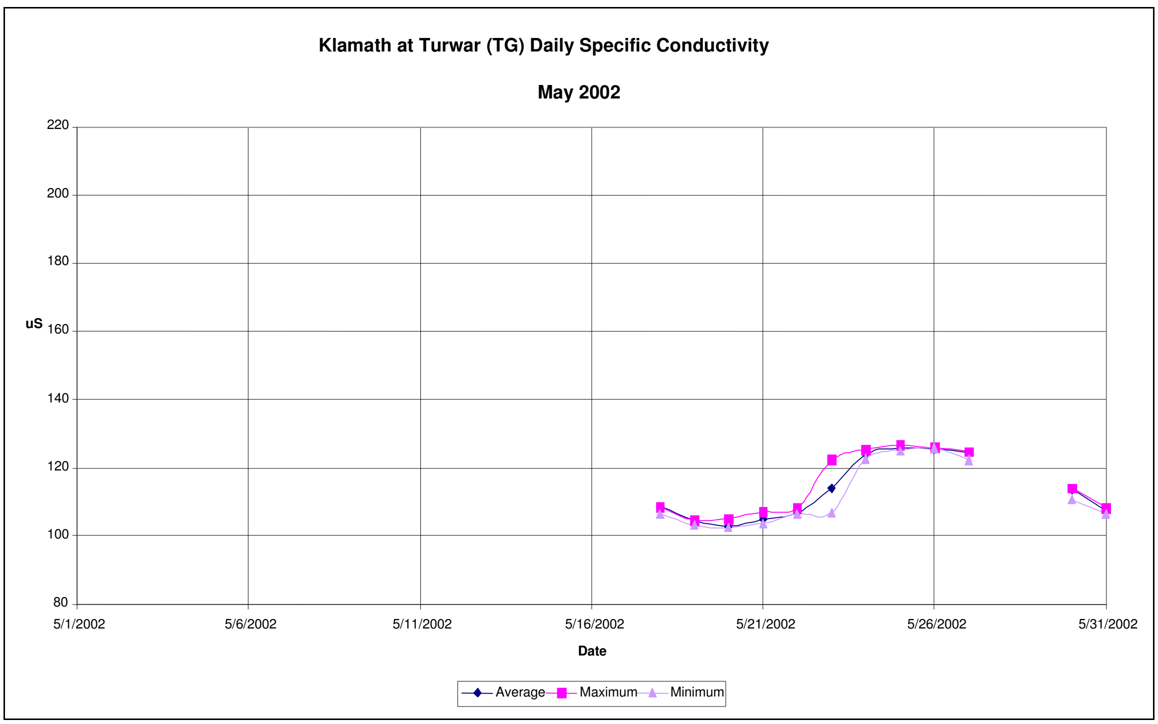

Figure 7-20 Daily Specific Conductivity values for the Klamath River at Turwar May 2002.

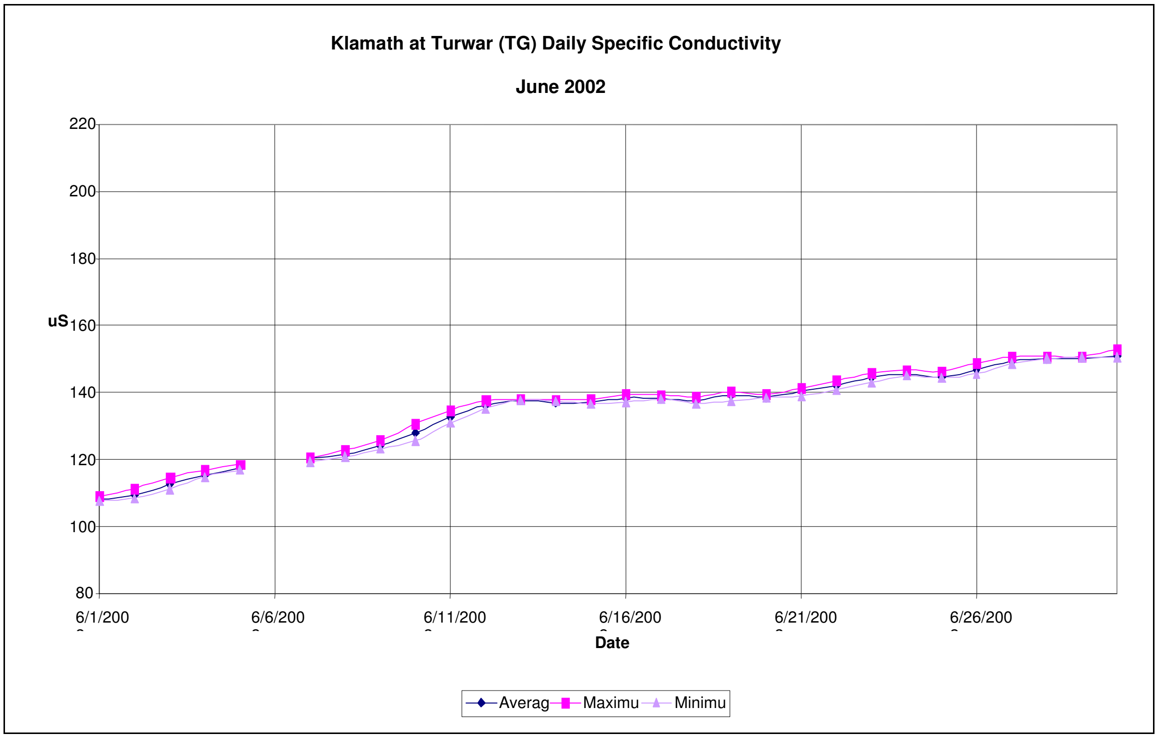

Figure 7-21 Daily Specific Conductivity values for the Klamath River at Turwar June 2002.

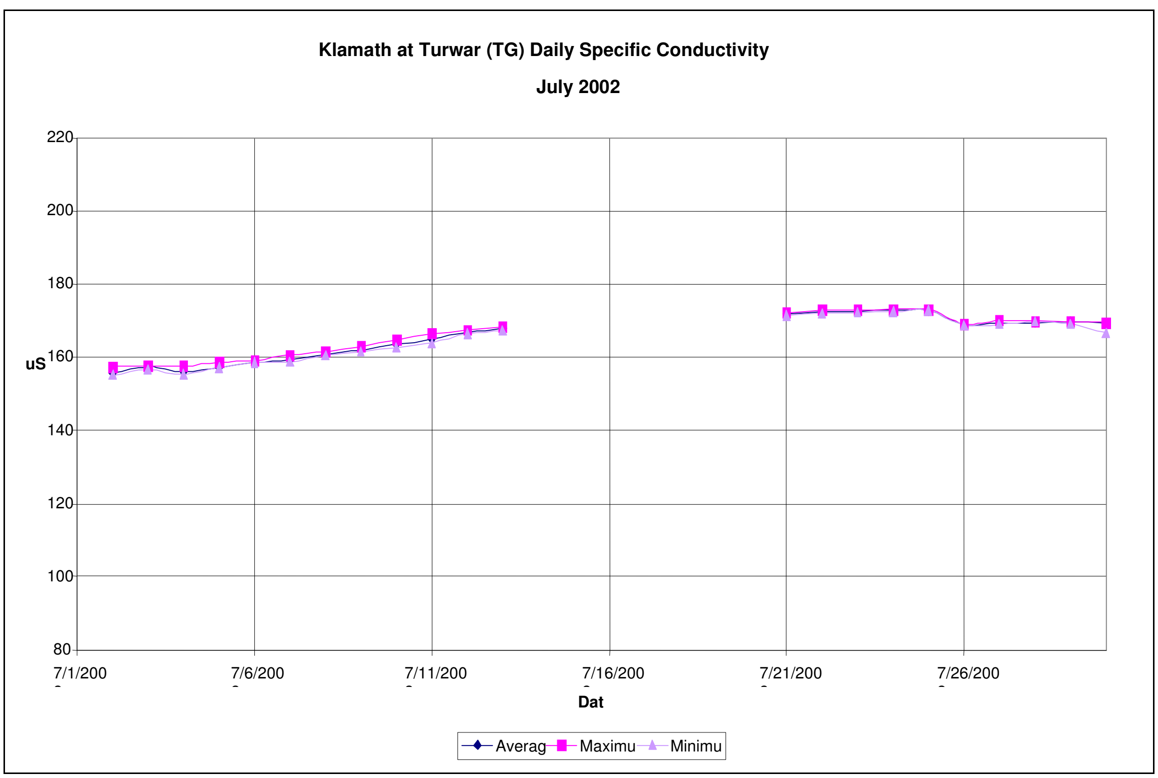

Figure 7-22 Daily Specific Conductivity values for the Klamath River at Turwar July 2002.

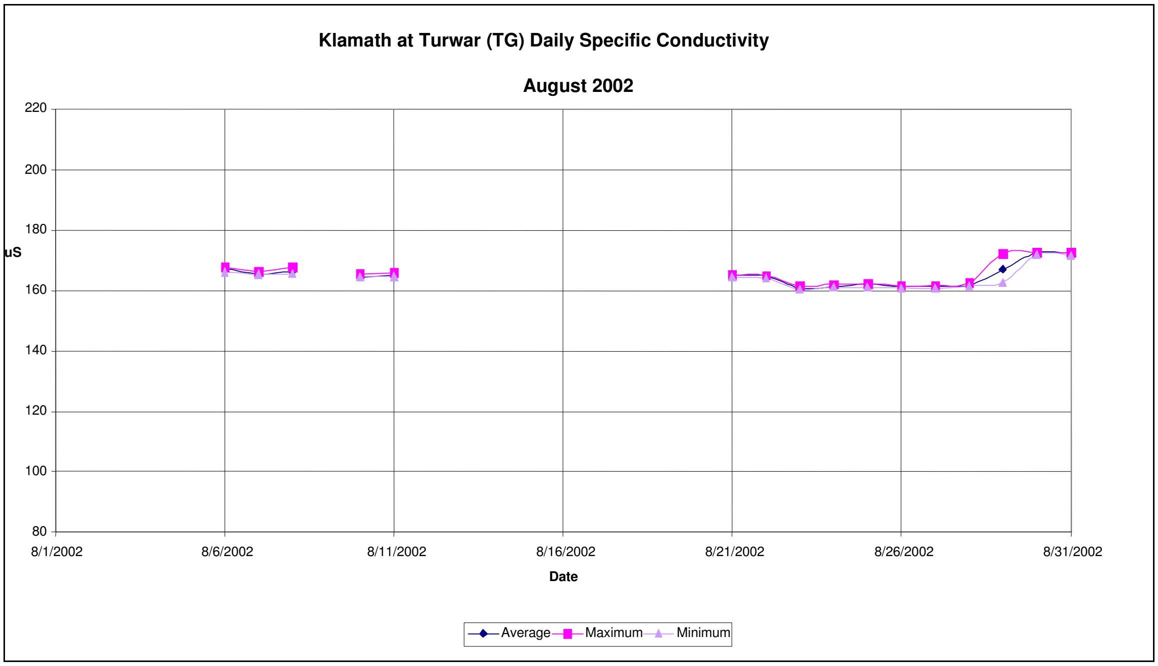

Figure 7-23 Daily Specific Conductivity values for the Klamath River at Turwar August 2002.

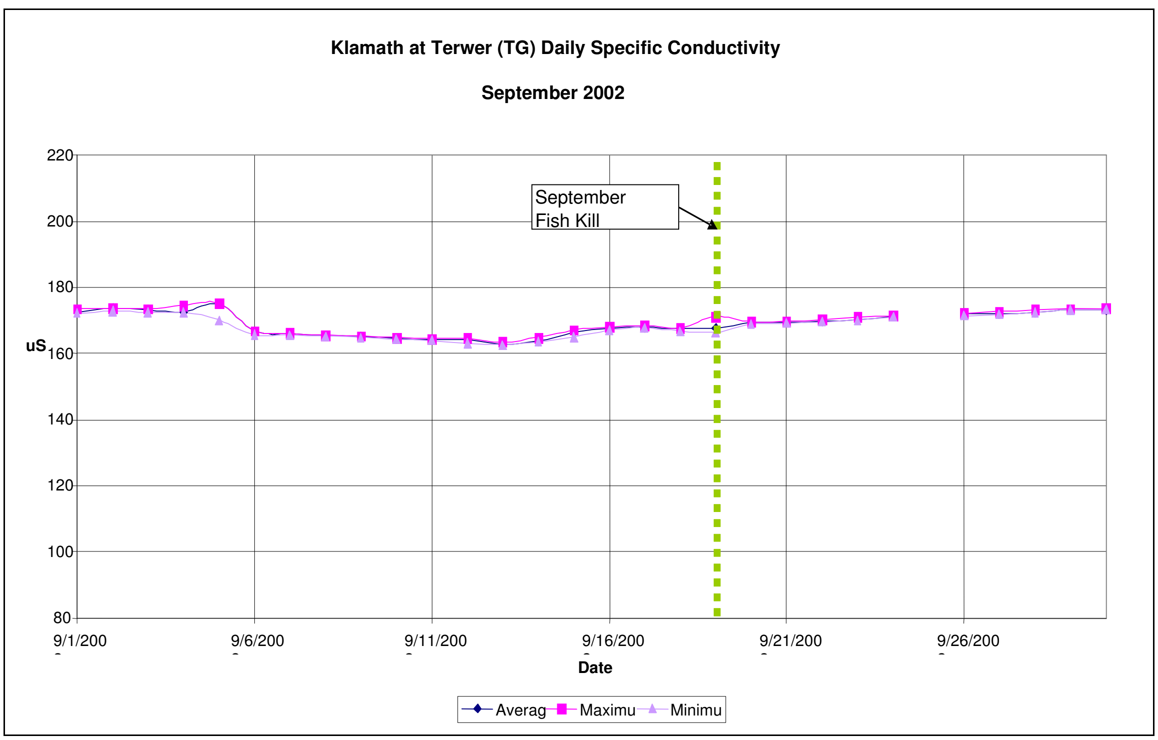

Figure 7-24 Daily Specific Conductivity values for the Klamath River at Turwar September 2002.

7.1.1.5 Air / Water Temperature and Flow

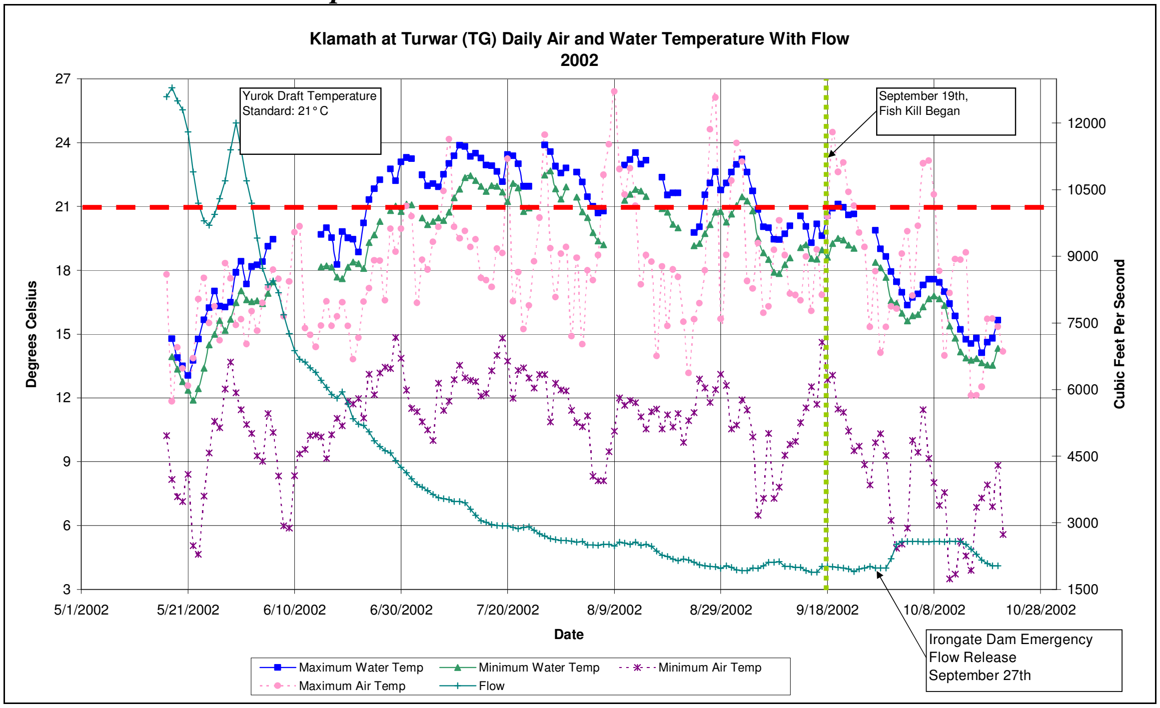

Figure 7-25 Daily Air / Water Temperature and Flow values for the Klamath River at Turwar WY02.

7.1.2 Klamath River at Martins Ferry

7.1.2.1 Temperature

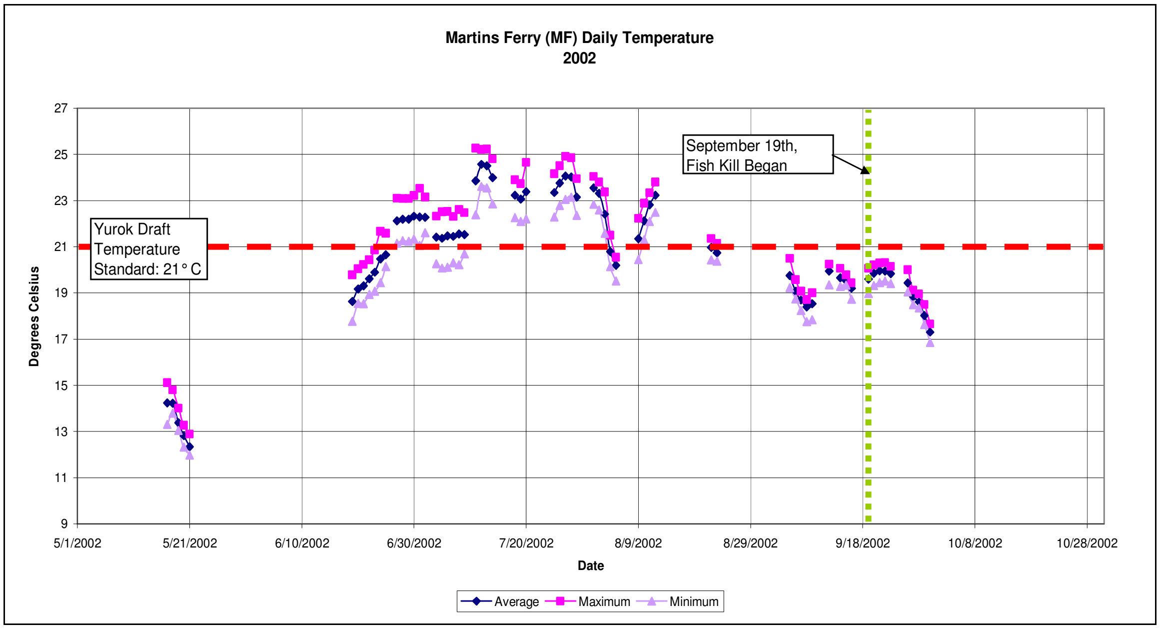

Figure 7-26 Daily Water Temperature values for the Klamath River at Martins Ferry WY02.

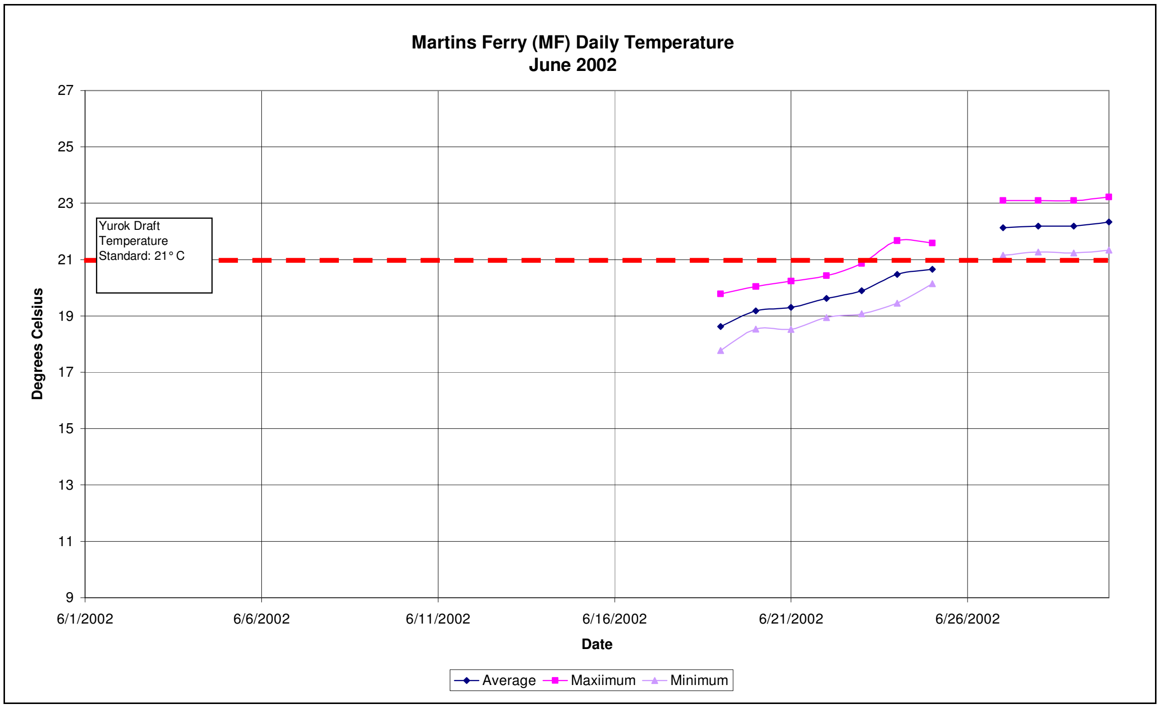

Figure 7-27 Daily Water Temperature values for the Klamath River at Martins Ferry June 2002.

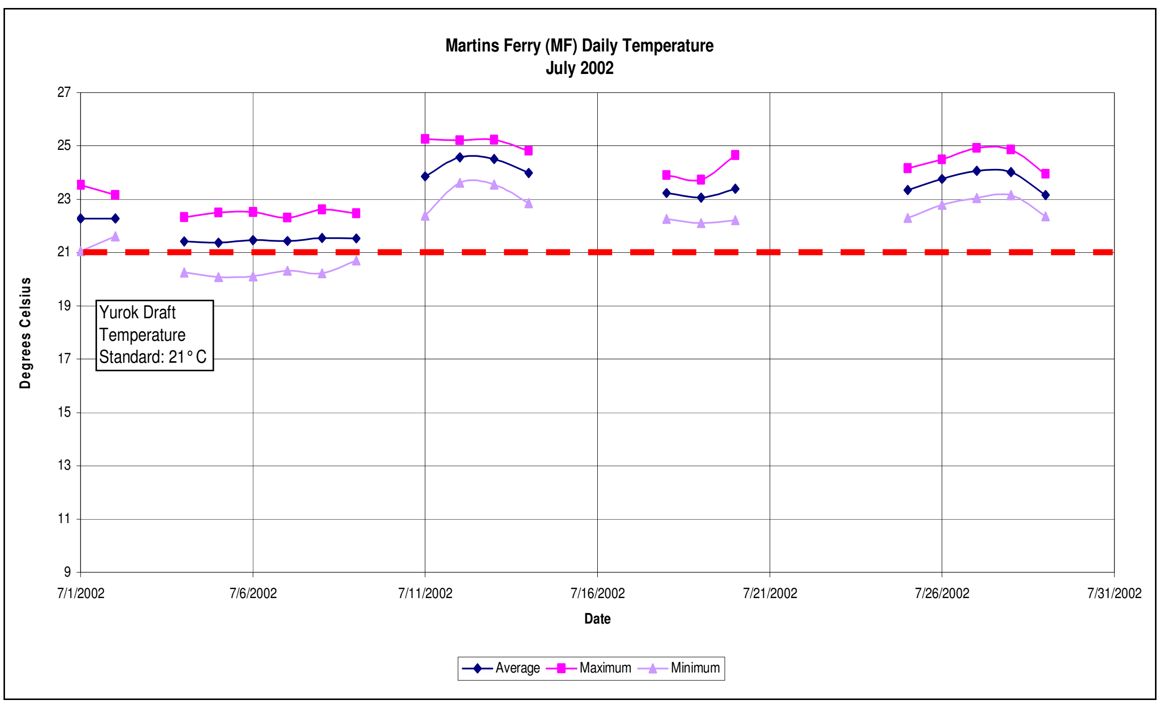

Figure 7-28 Daily Water Temperature values for the Klamath River at Martins Ferry July 2002.

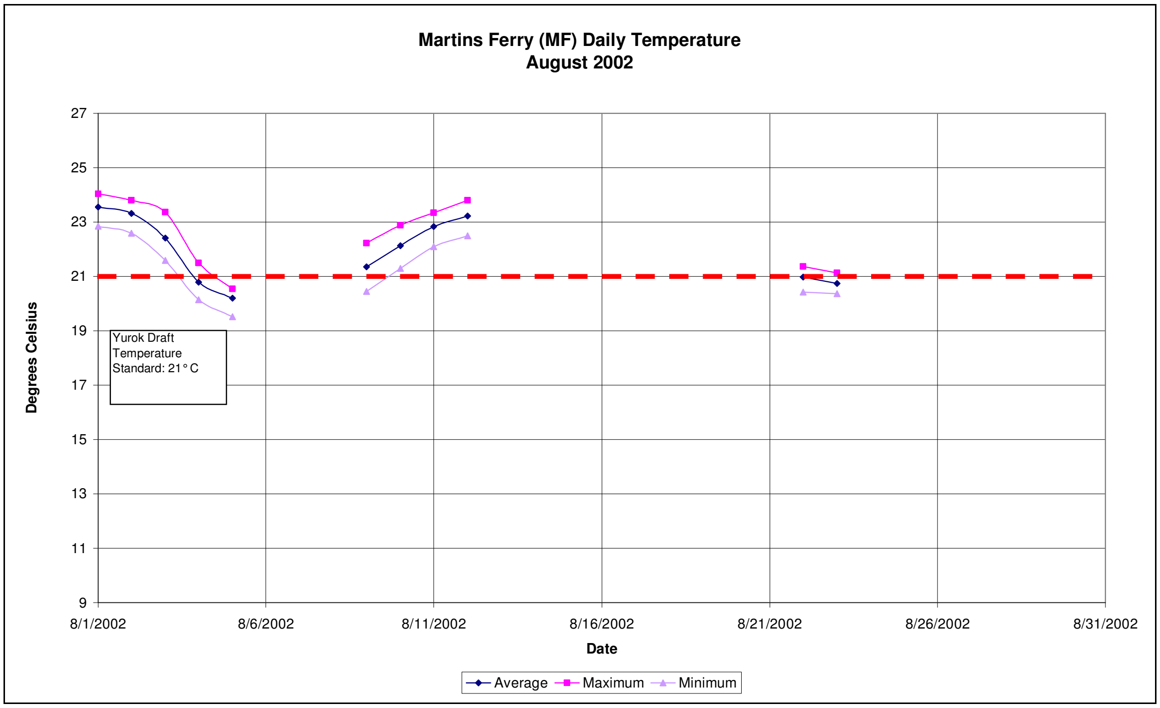

Figure 7-29 Daily Water Temperature values for the Klamath River at Martins Ferry August 2002

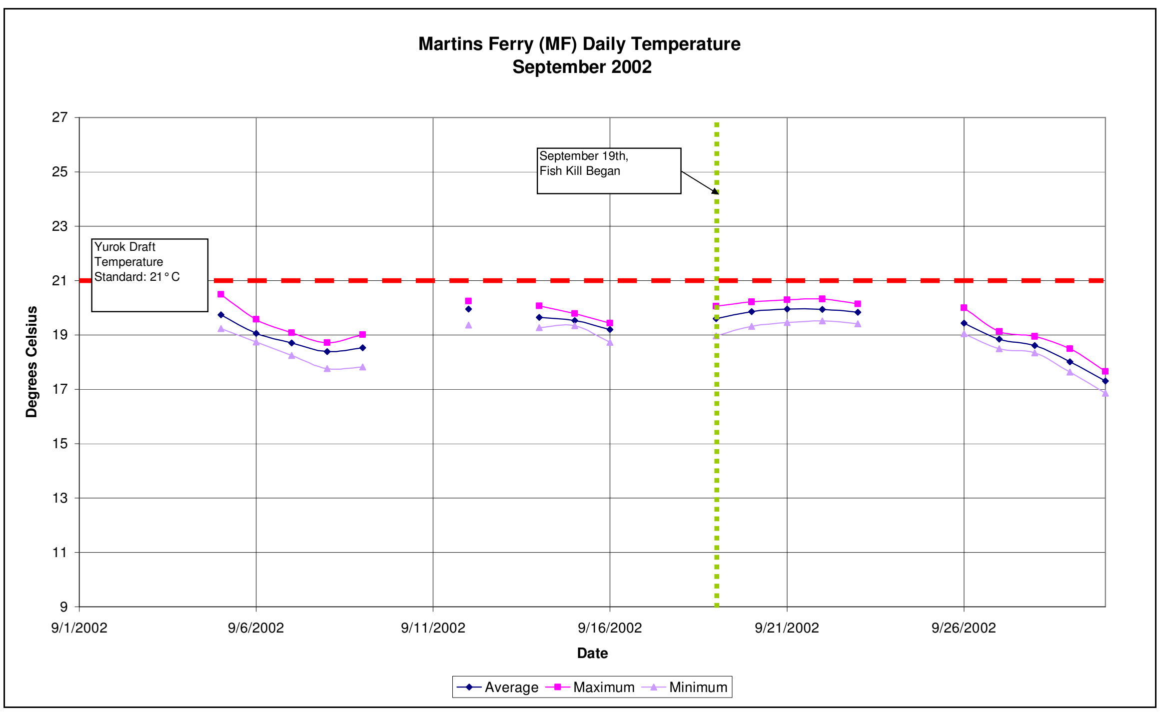

Figure 7-30 Daily Water Temperature values for the Klamath River at Martins Ferry September 2002

7.1.2.2 Dissolved Oxygen

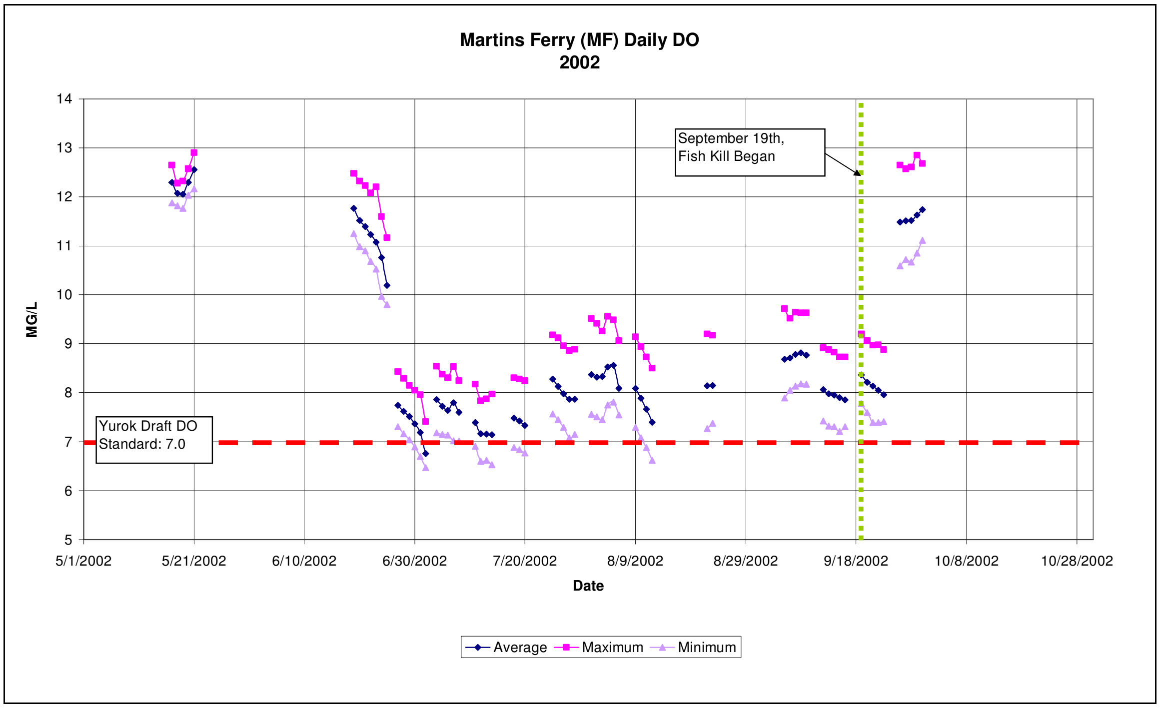

Figure 7-31 Daily Dissolved Oxygen values for the Klamath River at Martins Ferry WY02

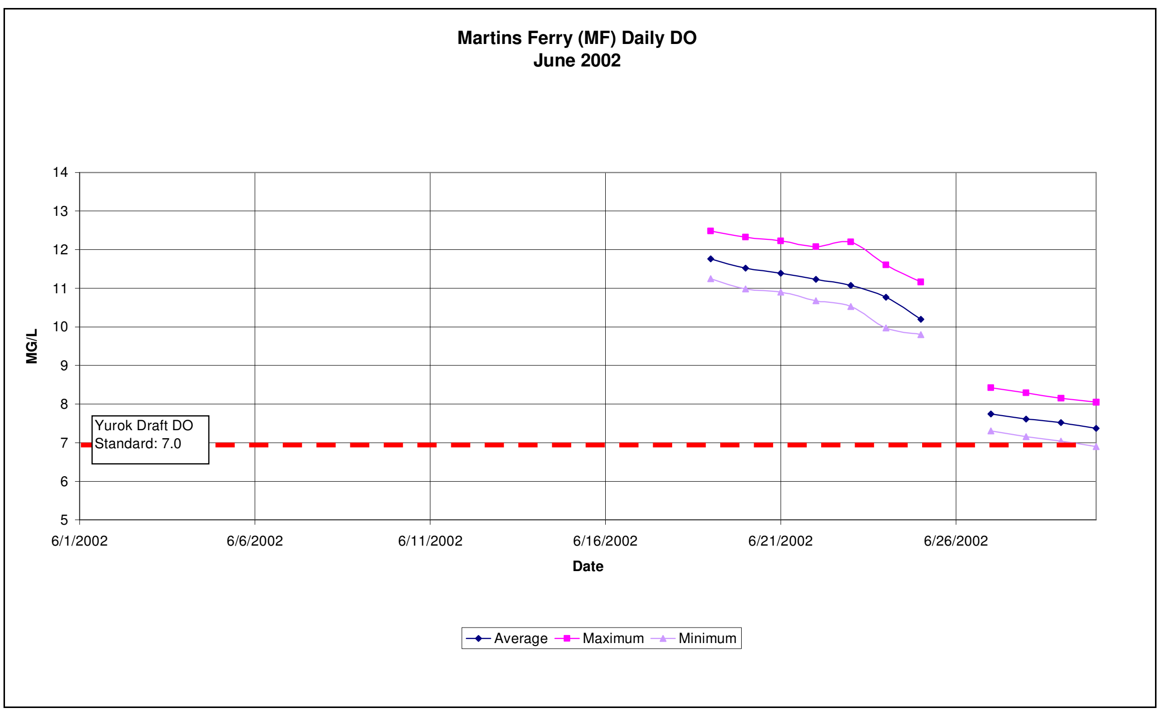

Figure 7-32 Daily Dissolved Oxygen values for the Klamath River at Martins Ferry June 2002

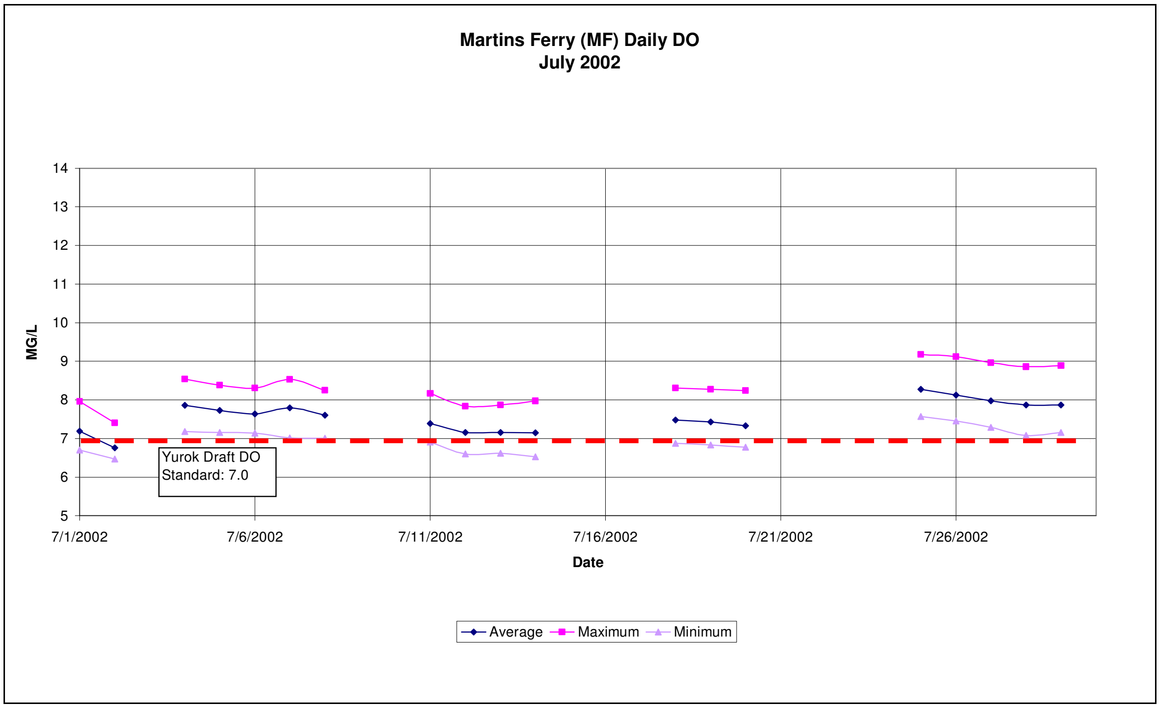

Figure 7-33 Daily Dissolved Oxygen values for the Klamath River at Martins Ferry July 2002

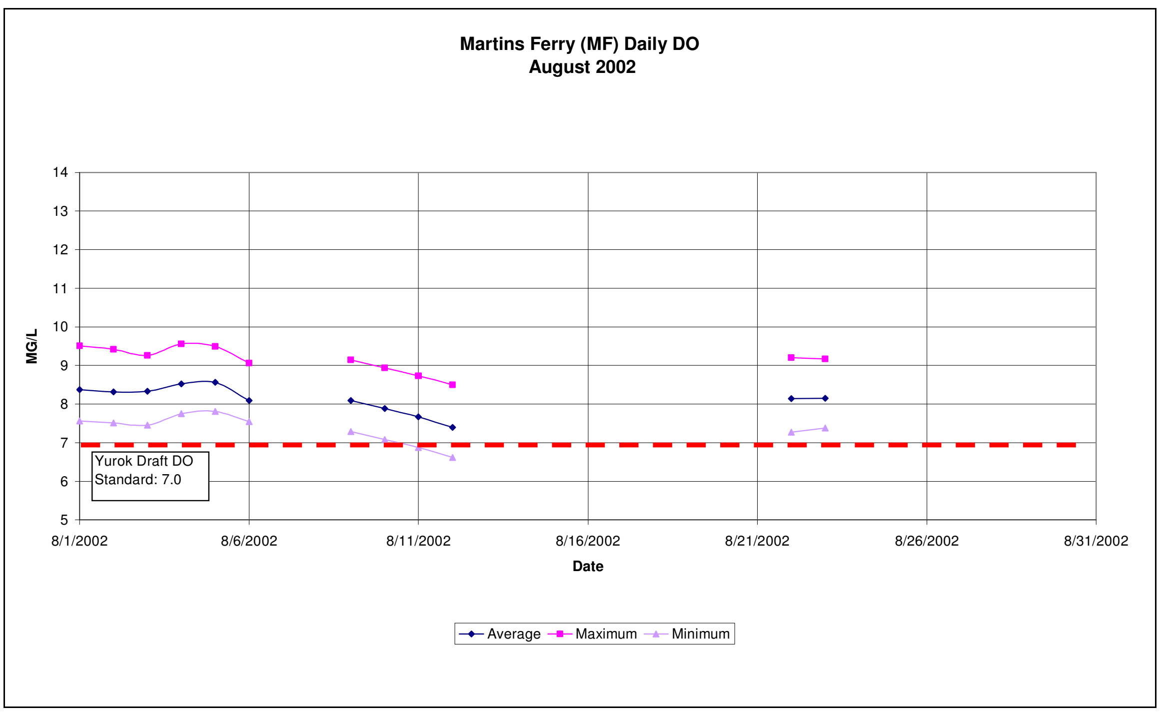

Figure 7-34 Daily Dissolved Oxygen values for the Klamath River at Martins Ferry August 2002

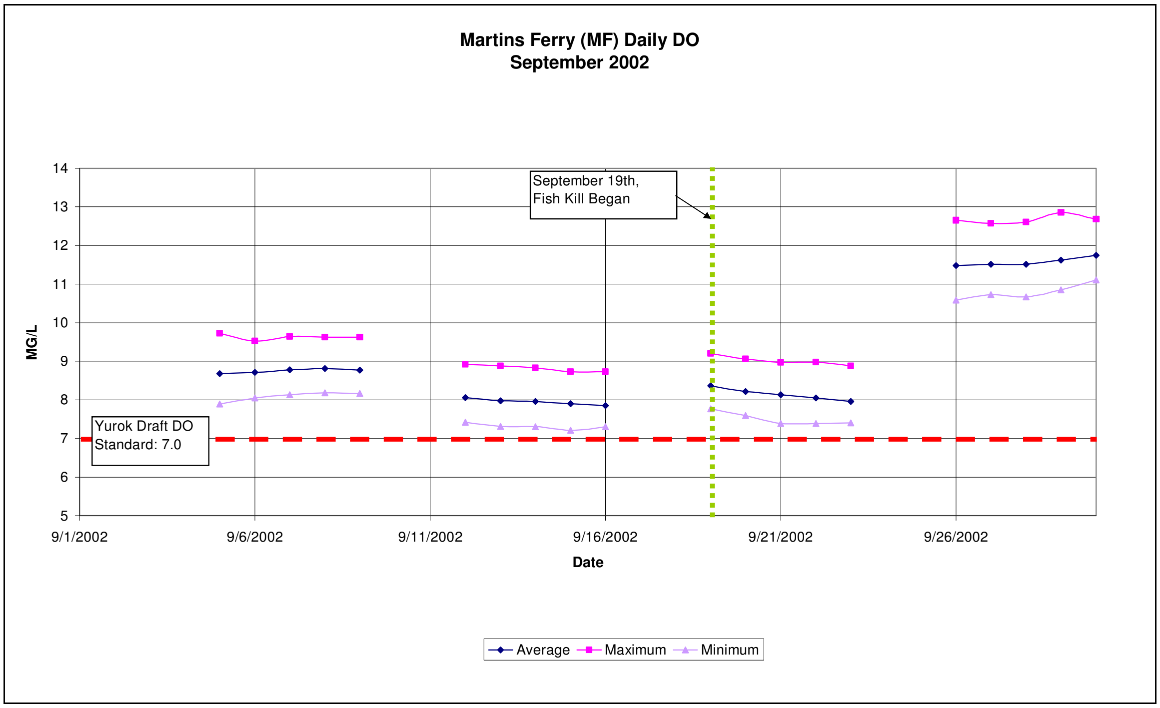

Figure 7-35 Daily Dissolved Oxygen values for the Klamath River at Martins Ferry September 2002

7.1.2.3 pH

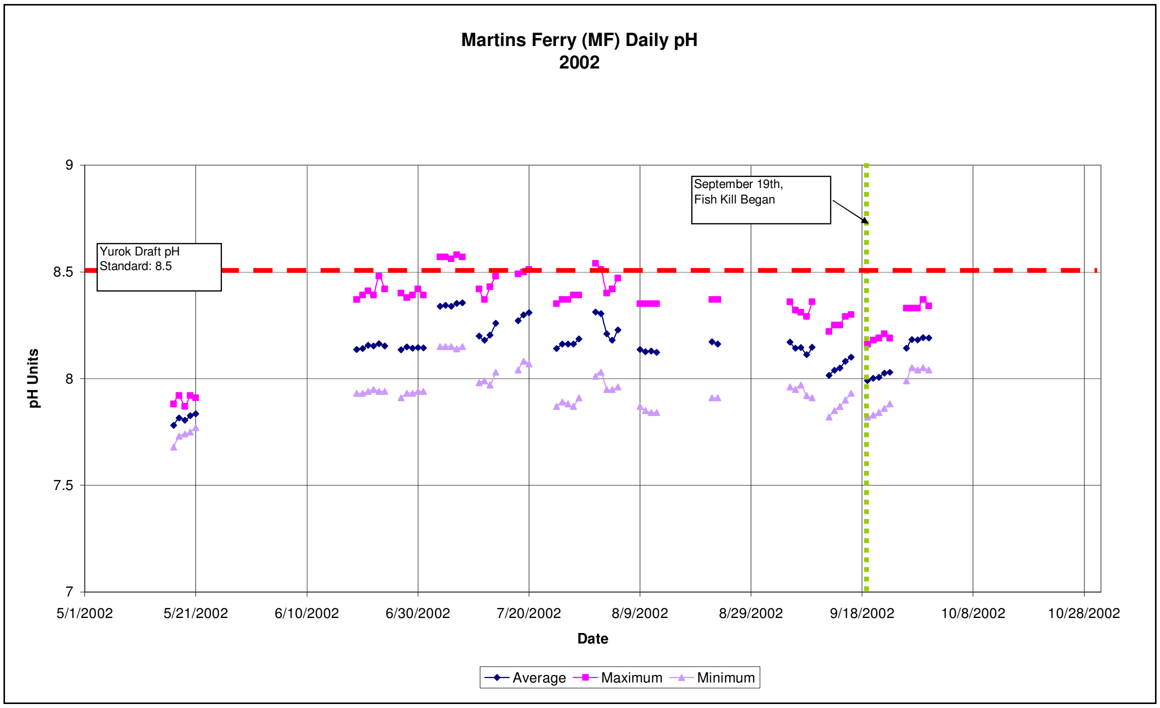

Figure 7-36 Daily pH values for the Klamath River at Martins Ferry WY02

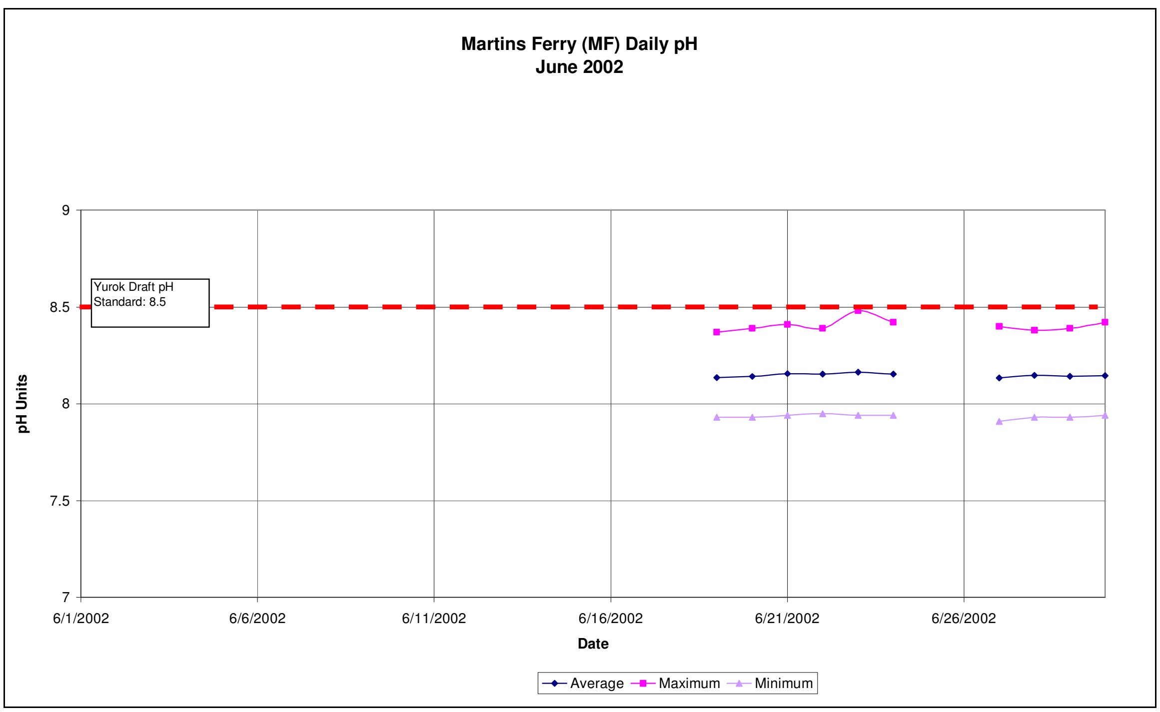

Figure 7-37 Daily pH values for the Klamath River at Martins Ferry June 2002

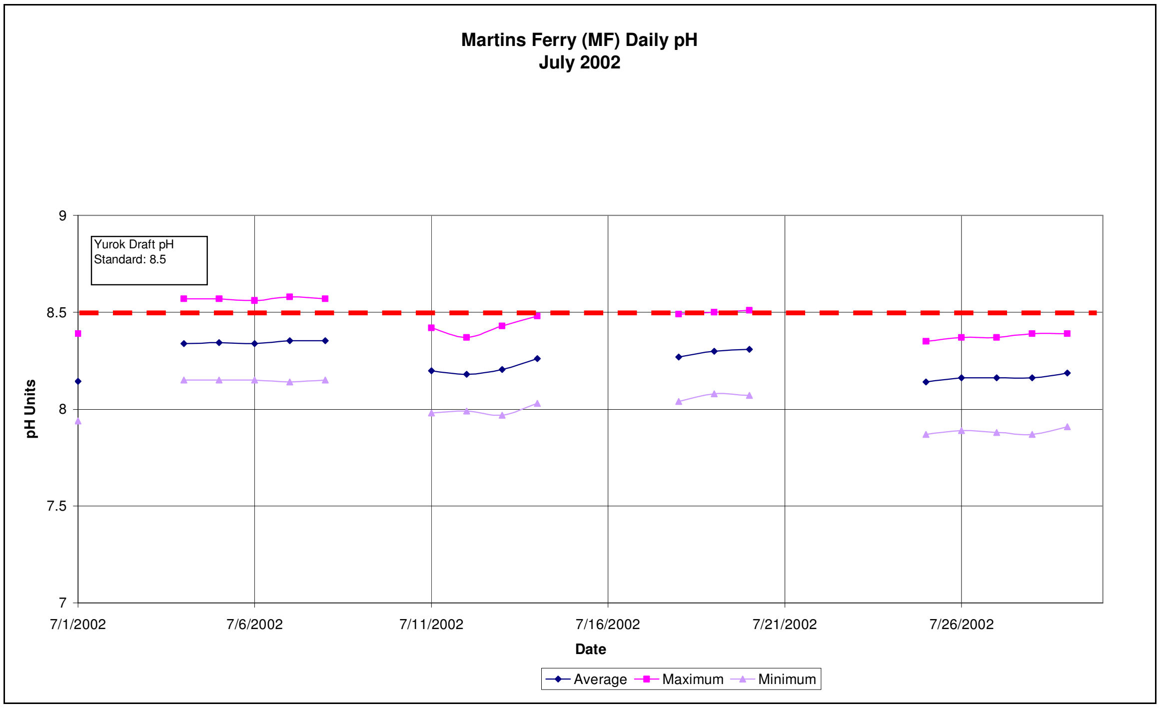

Figure 7-38 Daily pH values for the Klamath River at Martins Ferry July 2002

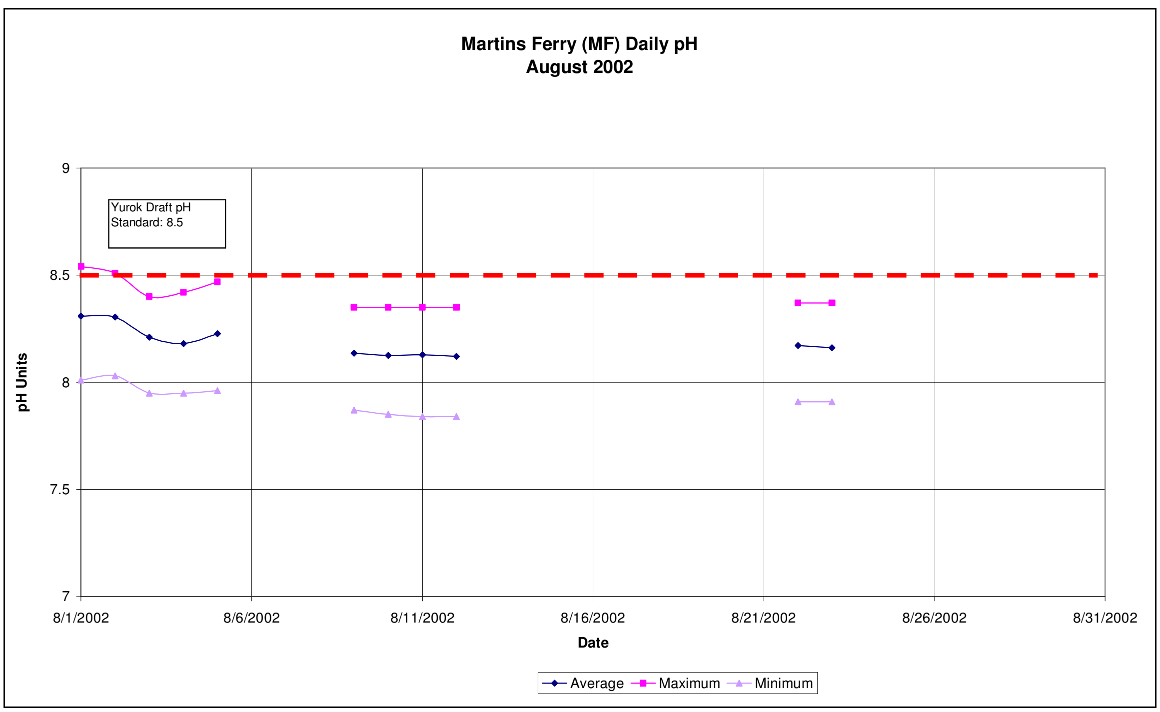

Figure 7-39 Daily pH values for the Klamath River at Martins Ferry August 2002

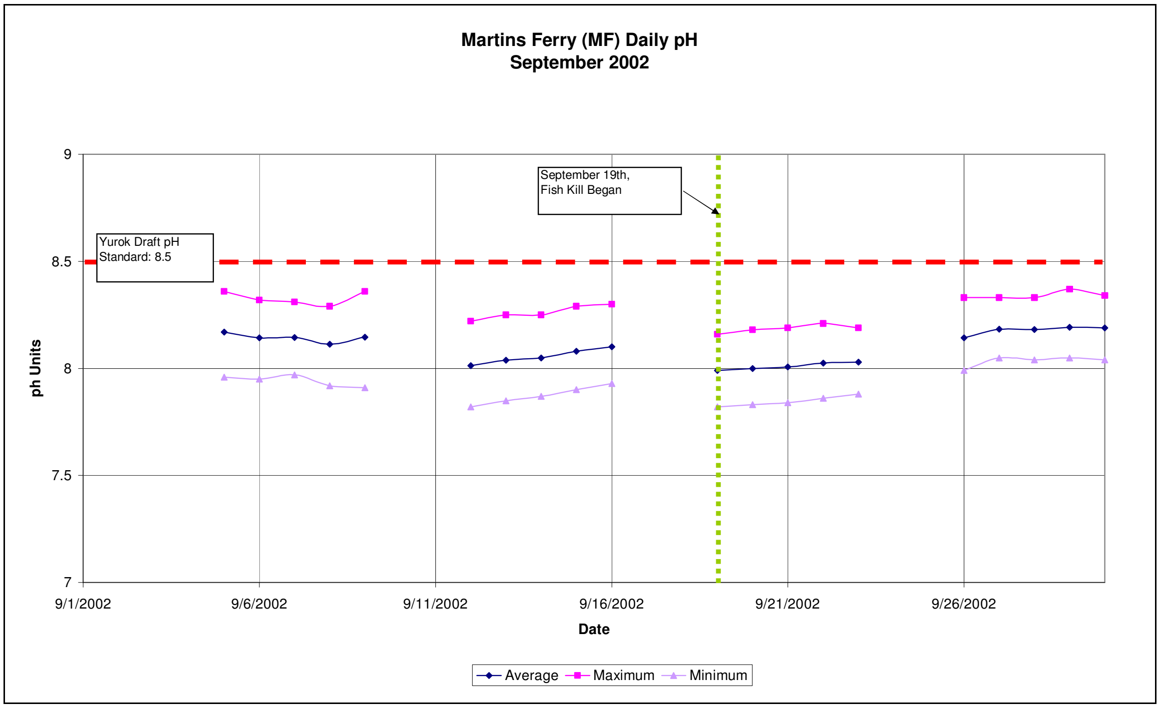

Figure 7-40 Daily pH values for the Klamath River at Martins Ferry September 2002

7.1.2.4 Specific Conductivity

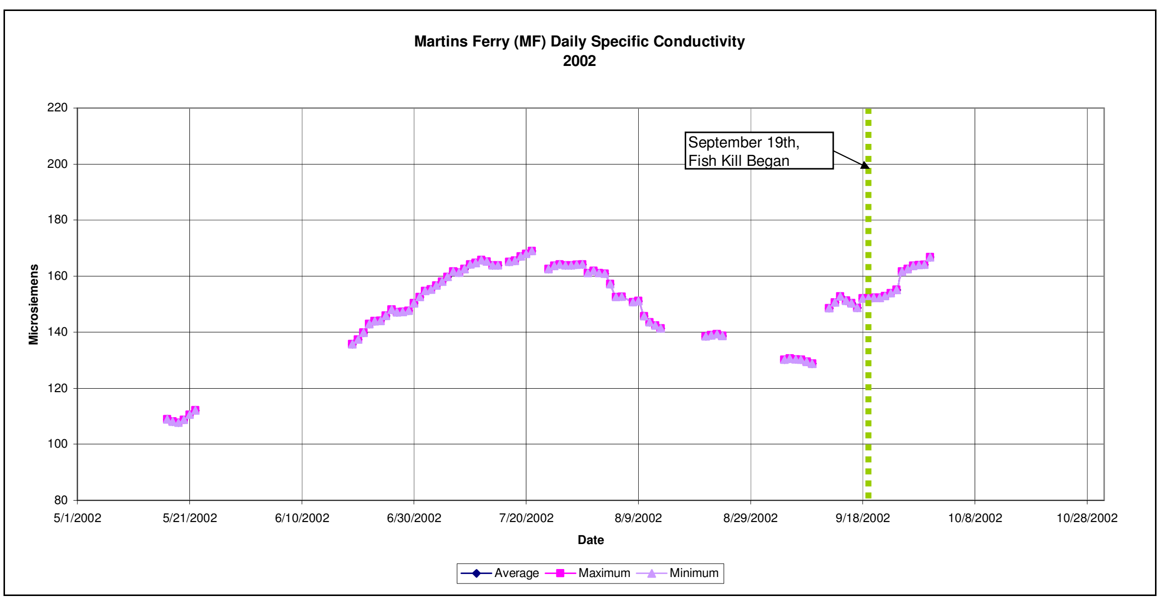

Figure 7-41 Daily Specific Conductivity values for the Klamath River at Martins Ferry WY02

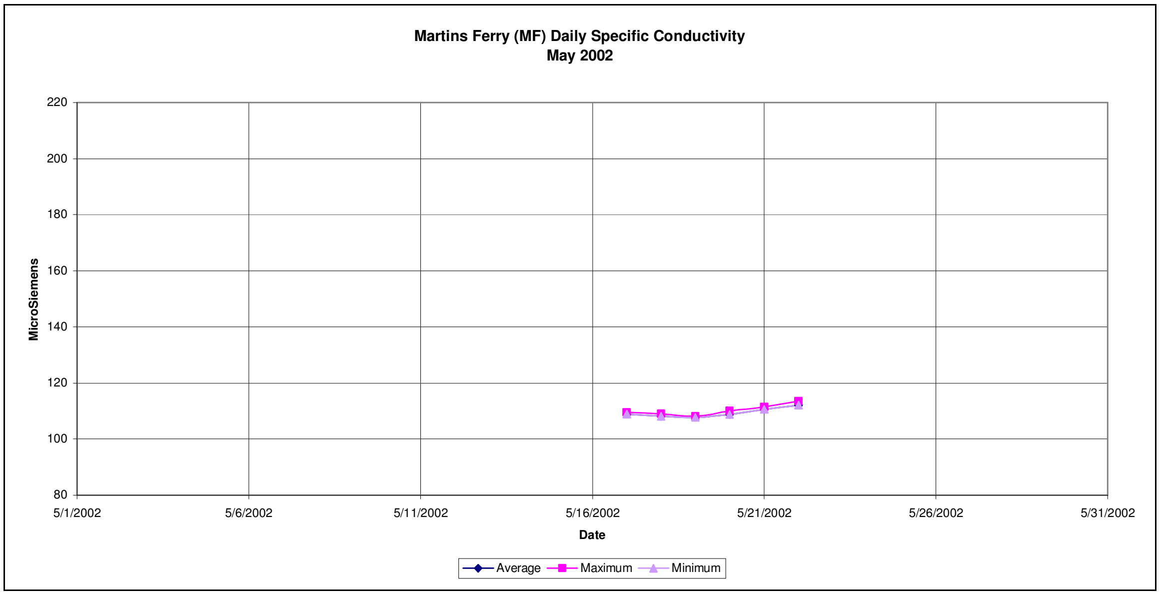

Figure 7-42 Daily Specific Conductivity values for the Klamath River at Martins Ferry May 2002

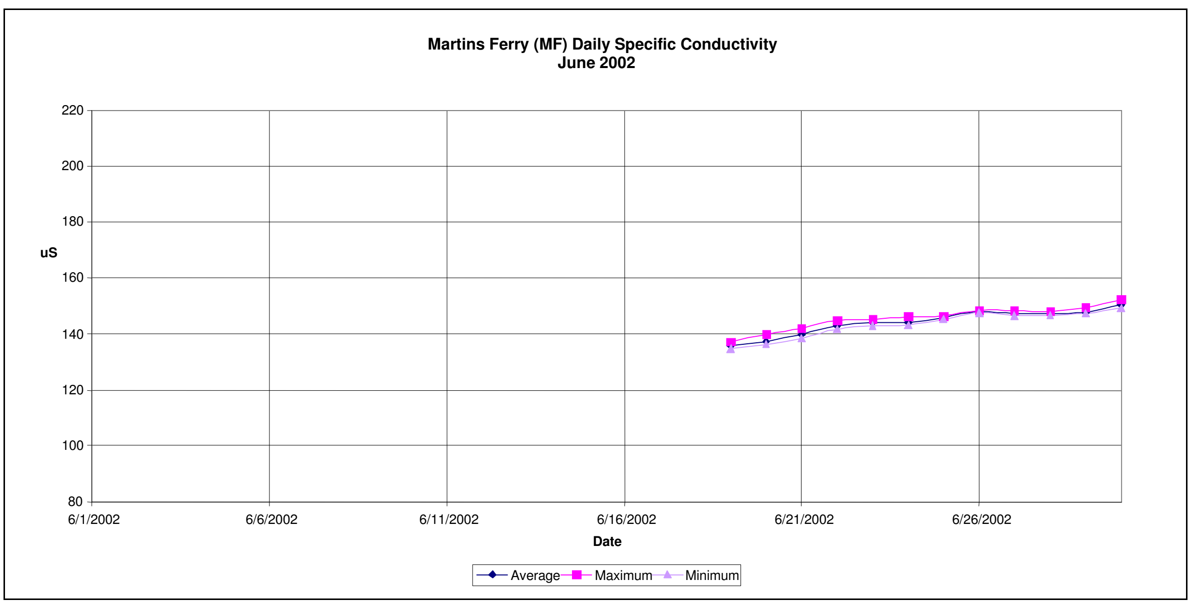

Figure 7-43 Daily Specific Conductivity values for the Klamath River at Martins Ferry June 2002

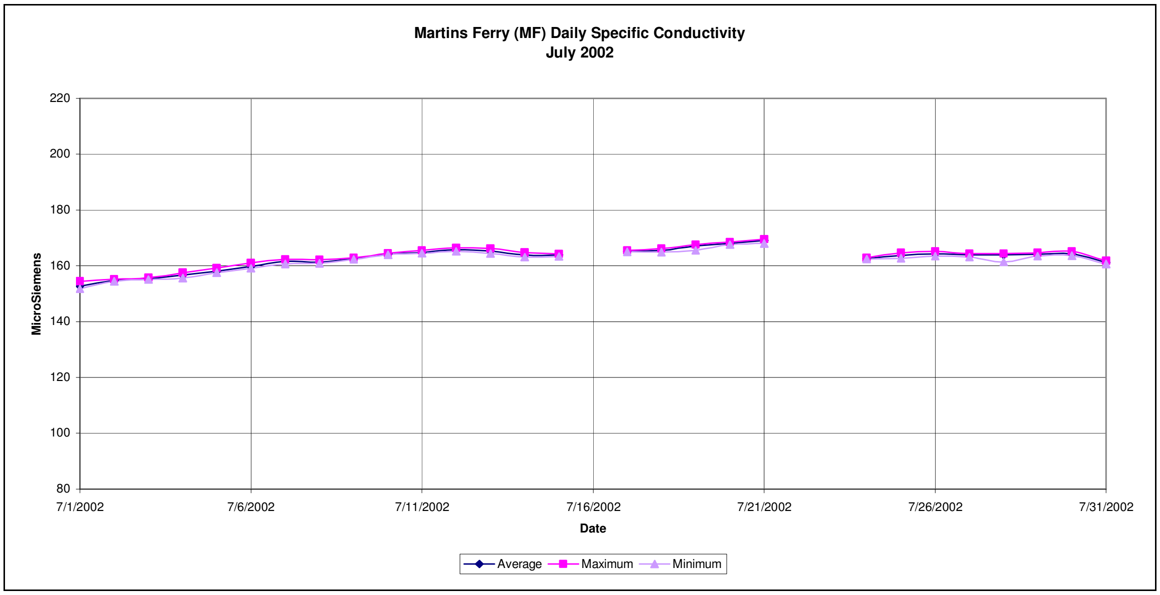

Figure 7-44 Daily Specific Conductivity values for the Klamath River at Martins Ferry July 2002

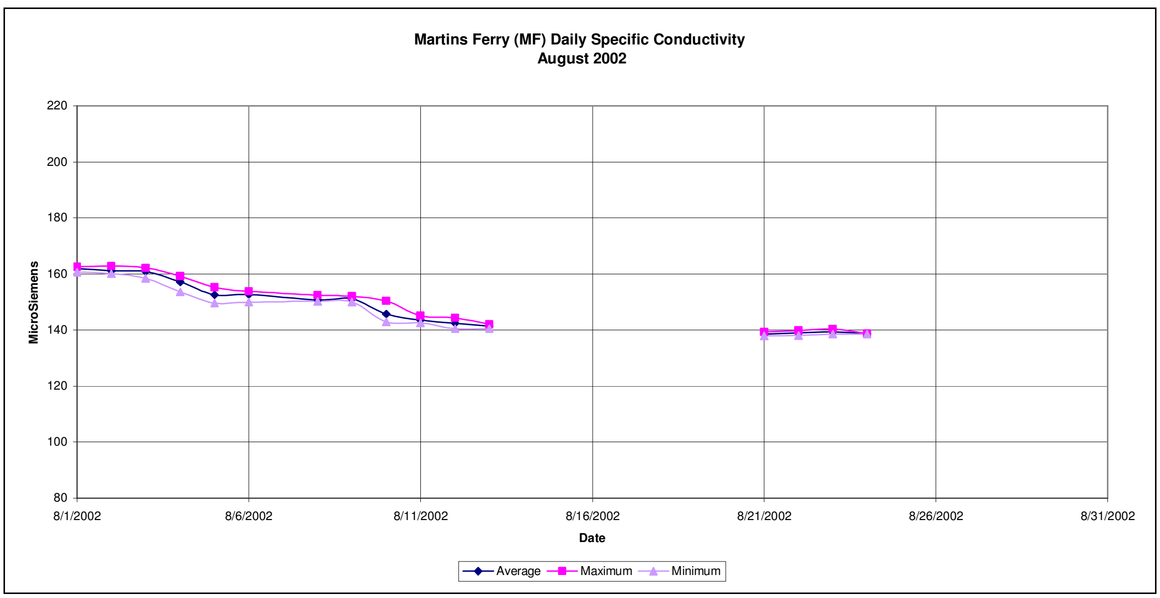

Figure 7-45 Daily Specific Conductivity values for the Klamath River at Martins Ferry August 2002

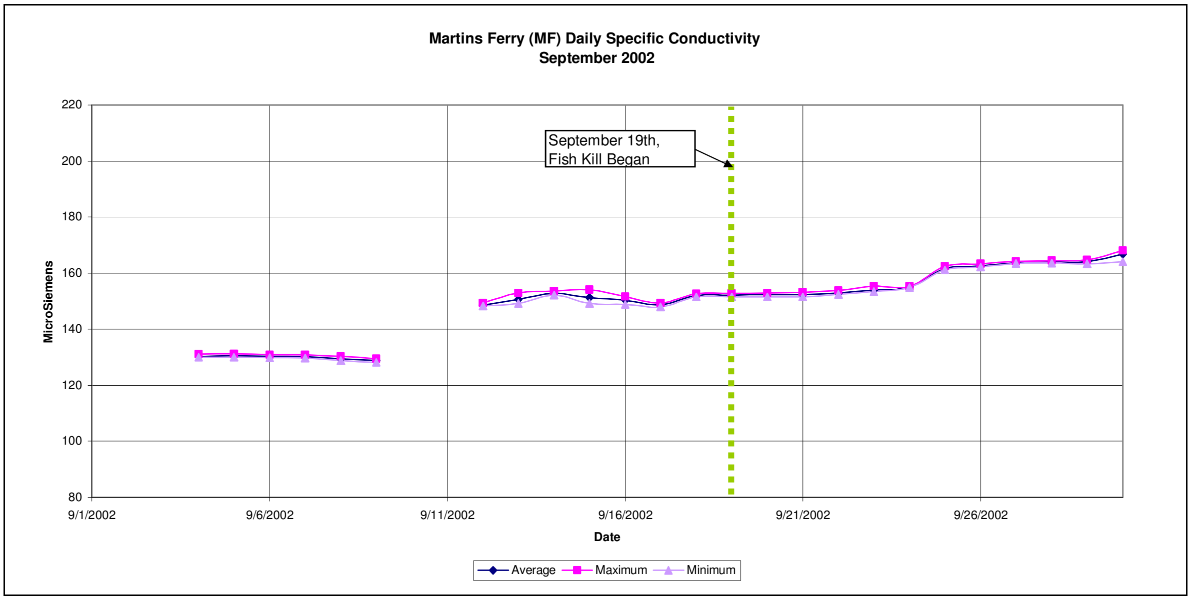

Figure 7-46 Daily Specific Conductivity values for the Klamath River at Martins Ferry September 2002

7.1.2.5 Water Temperature and Flow

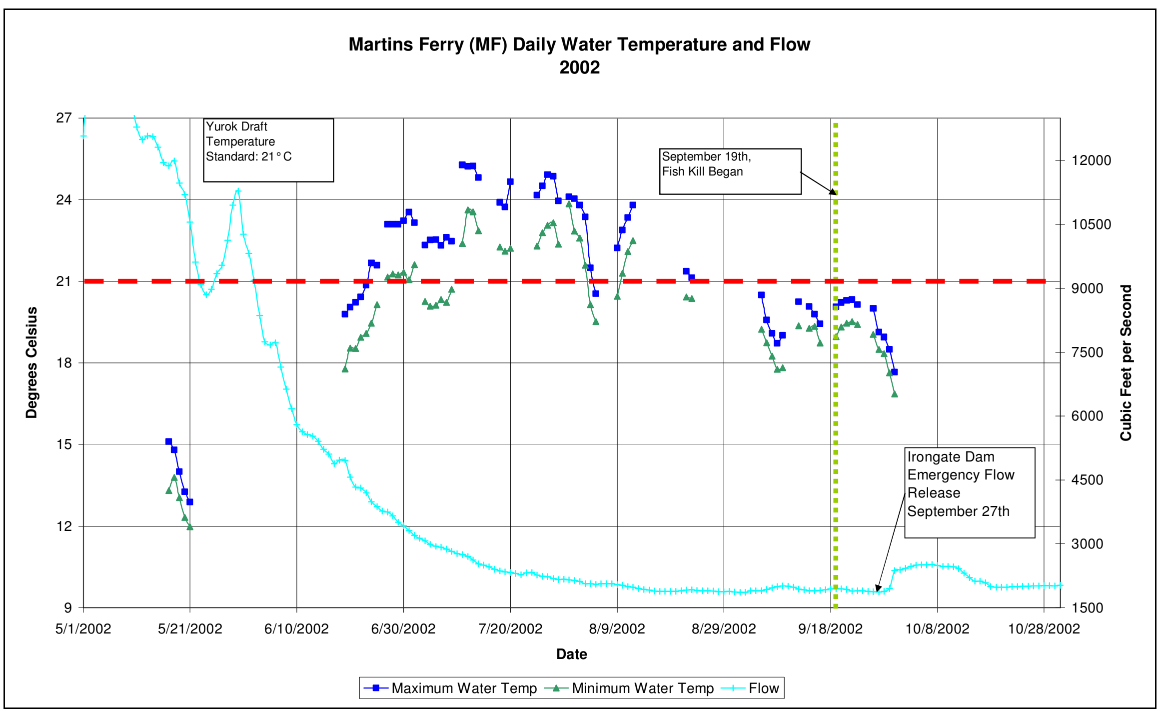

Figure 7-47 Daily Water Temperature and Flow values for the Klamath River at Martins Ferry June 2002

7.1.3 Klamath River at Weitchpec

7.1.3.1 Temperature

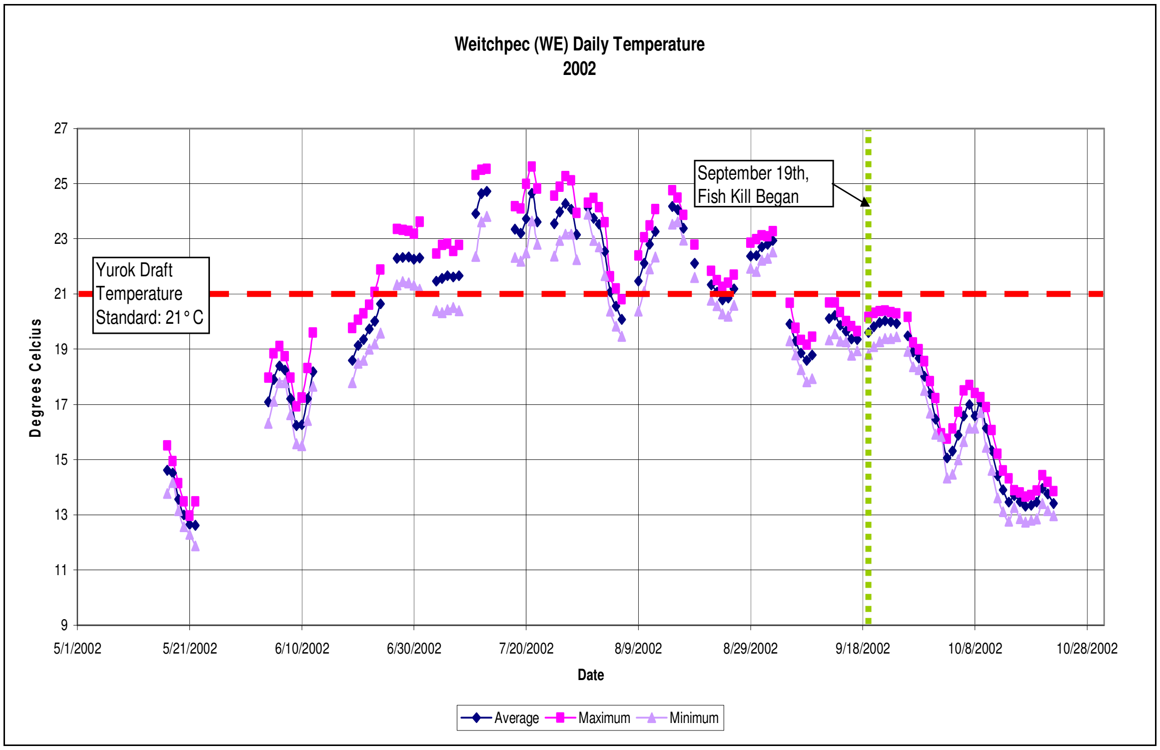

Figure 7-48 Water Temperature values for the Klamath River at Weitchpec WY02

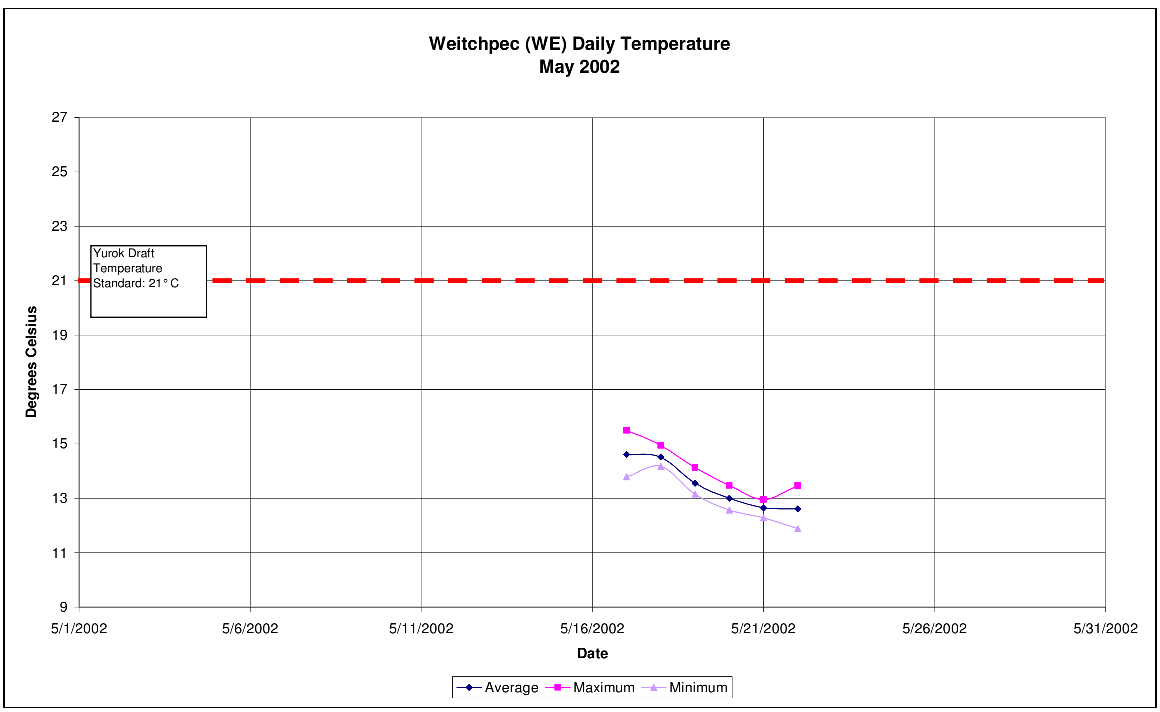

Figure 7-49 Water Temperature values for the Klamath River at Weitchpec May 2002

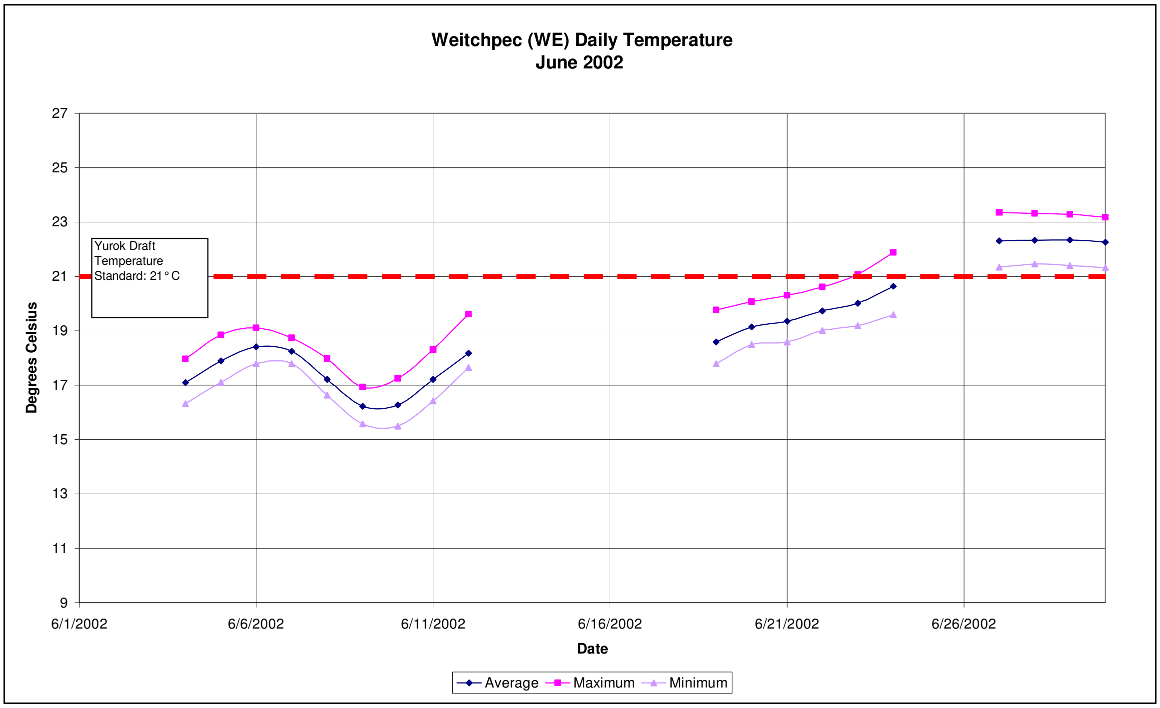

Figure 7-50 Water Temperature values for the Klamath River at Weitchpec June 2002

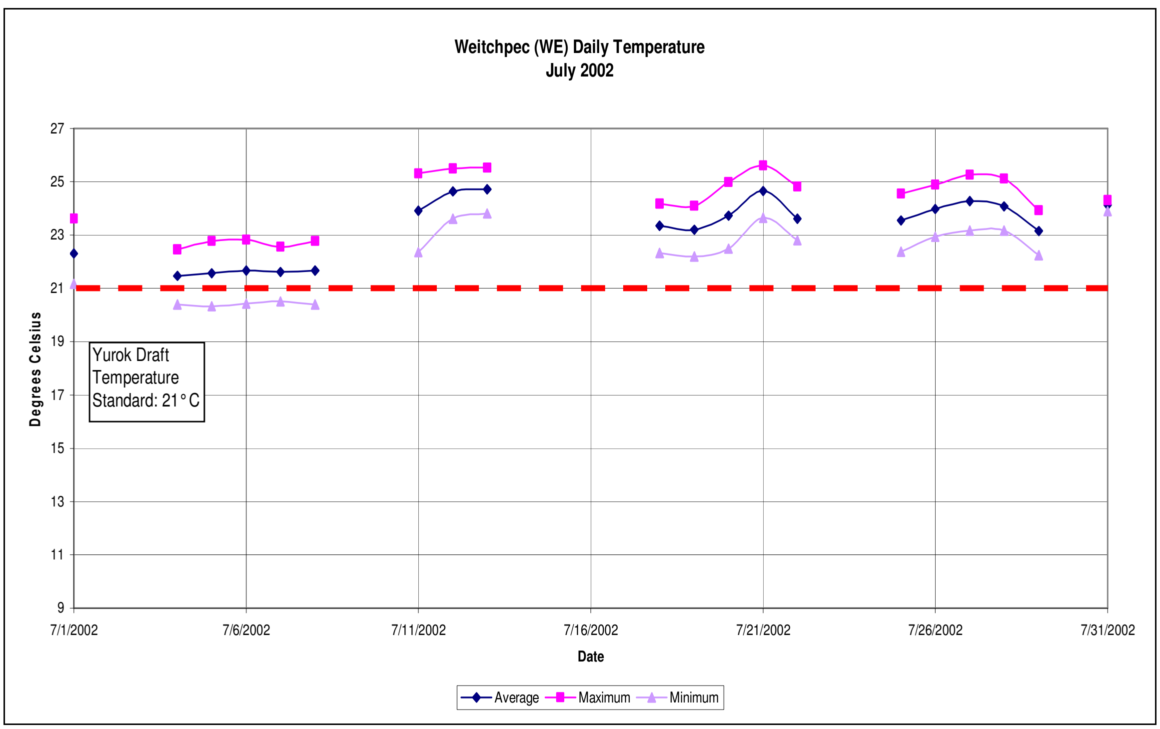

Figure 7-51 Water Temperature values for the Klamath River at Weitchpec July 2002

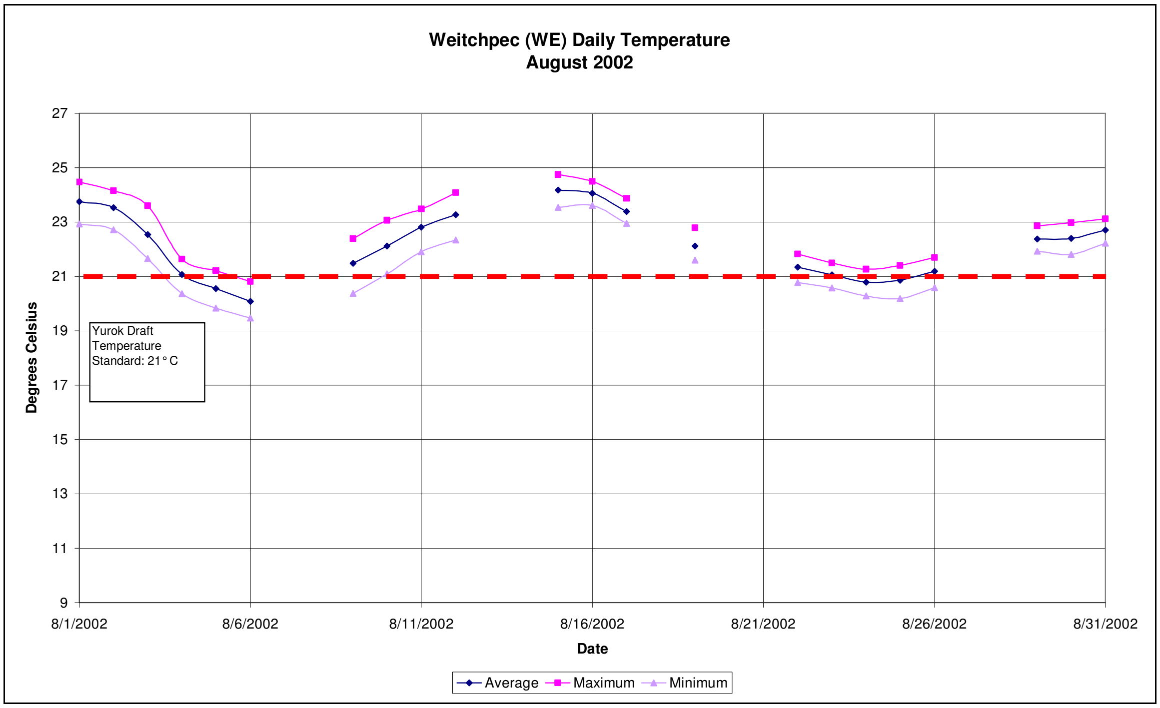

Figure 7-52 Water Temperature values for the Klamath River at Weitchpec August 2002

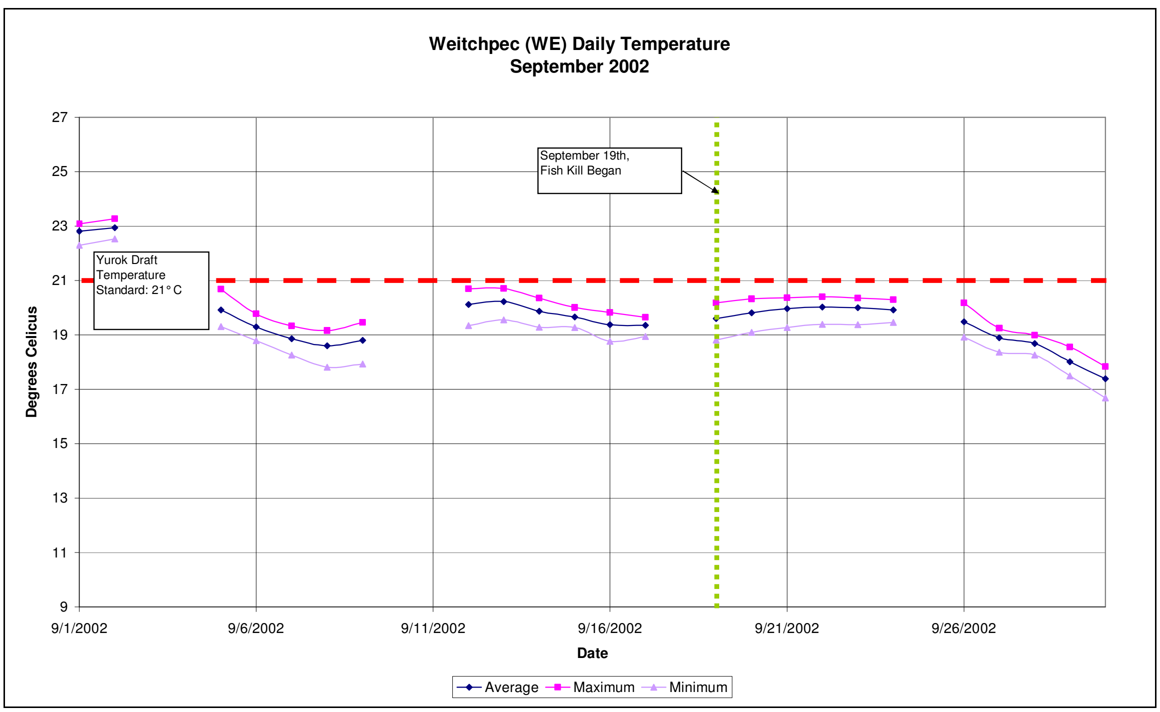

Figure 7-53 Water Temperature values for the Klamath River at Weitchpec September 2002

7.1.3.2 Dissolved Oxygen

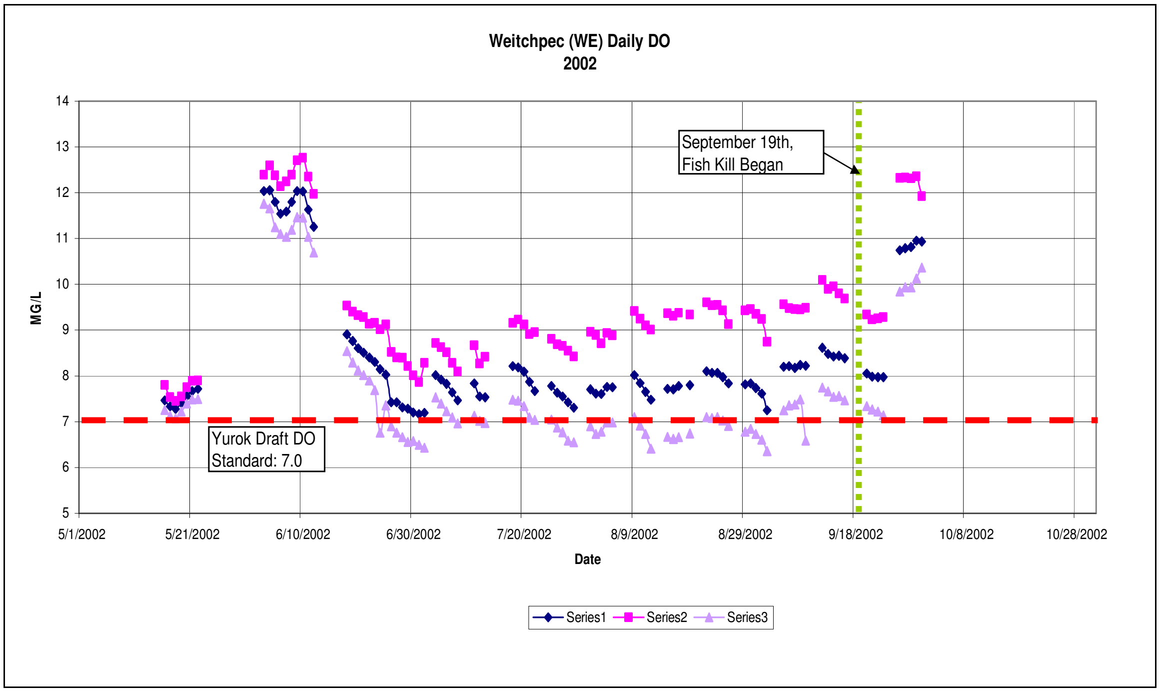

Figure 7-54 Dissolved Oxygen Values for the Klamath River at Weitchpec WY02

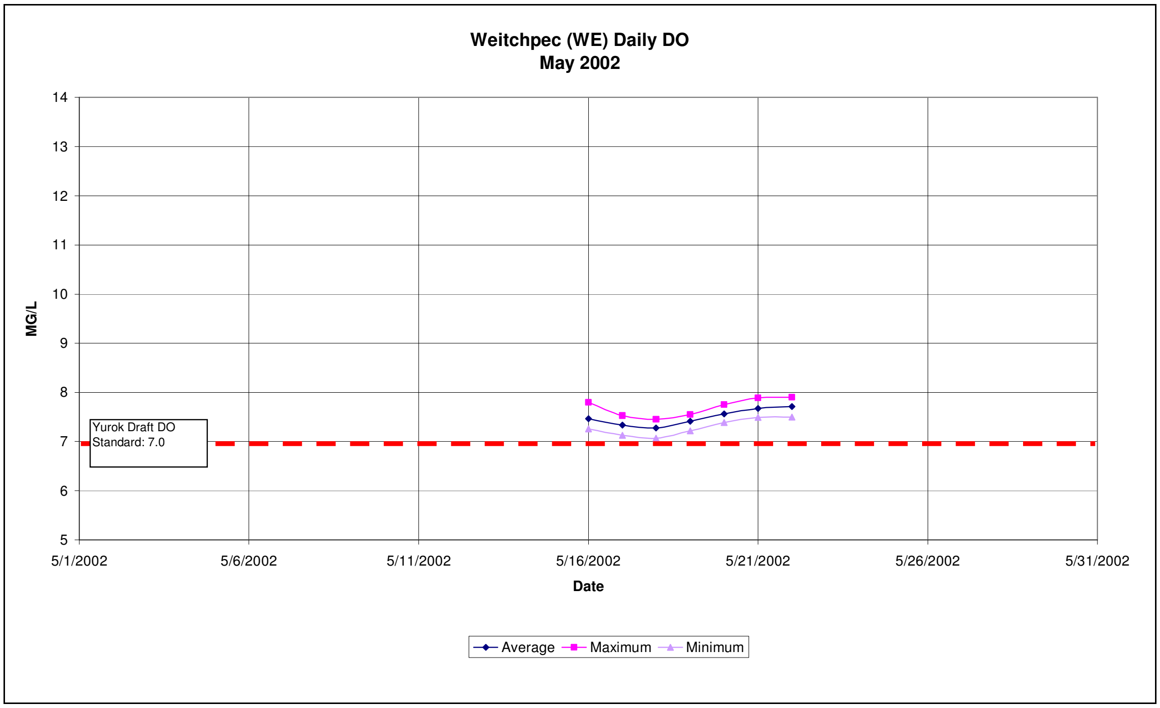

Figure 7-55 Dissolved Oxygen Values for the Klamath River at Weitchpec May 2002

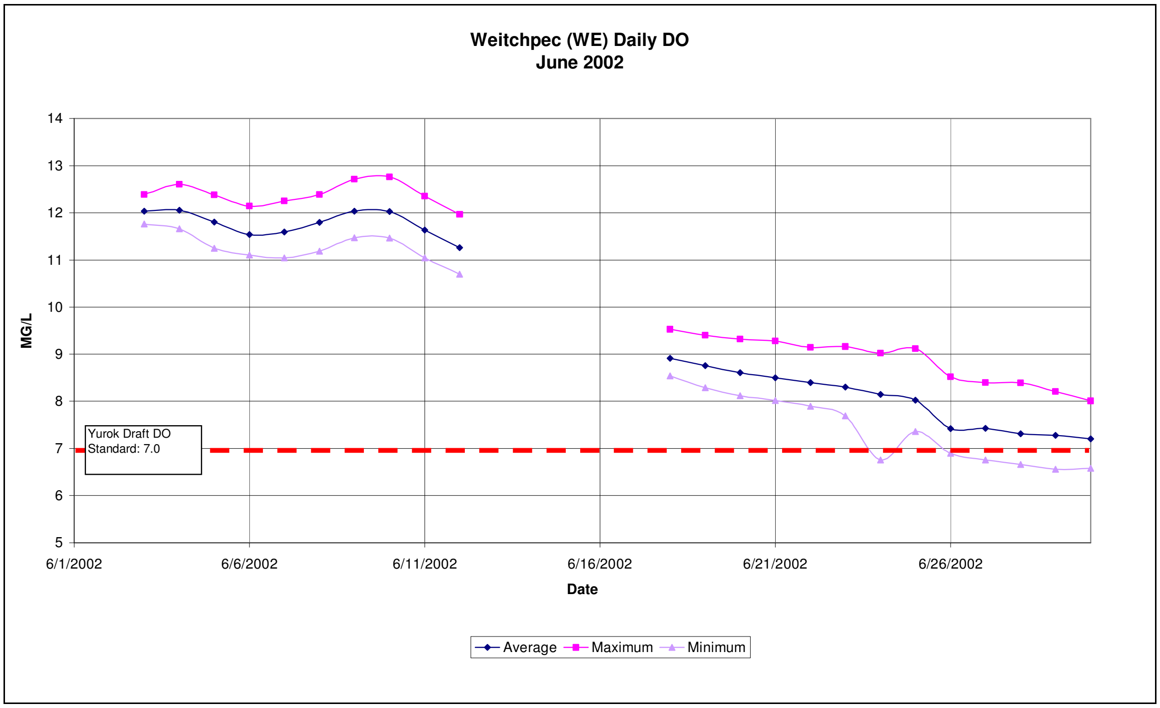

Figure 7-56 Dissolved Oxygen Values for the Klamath River at Weitchpec June 2002

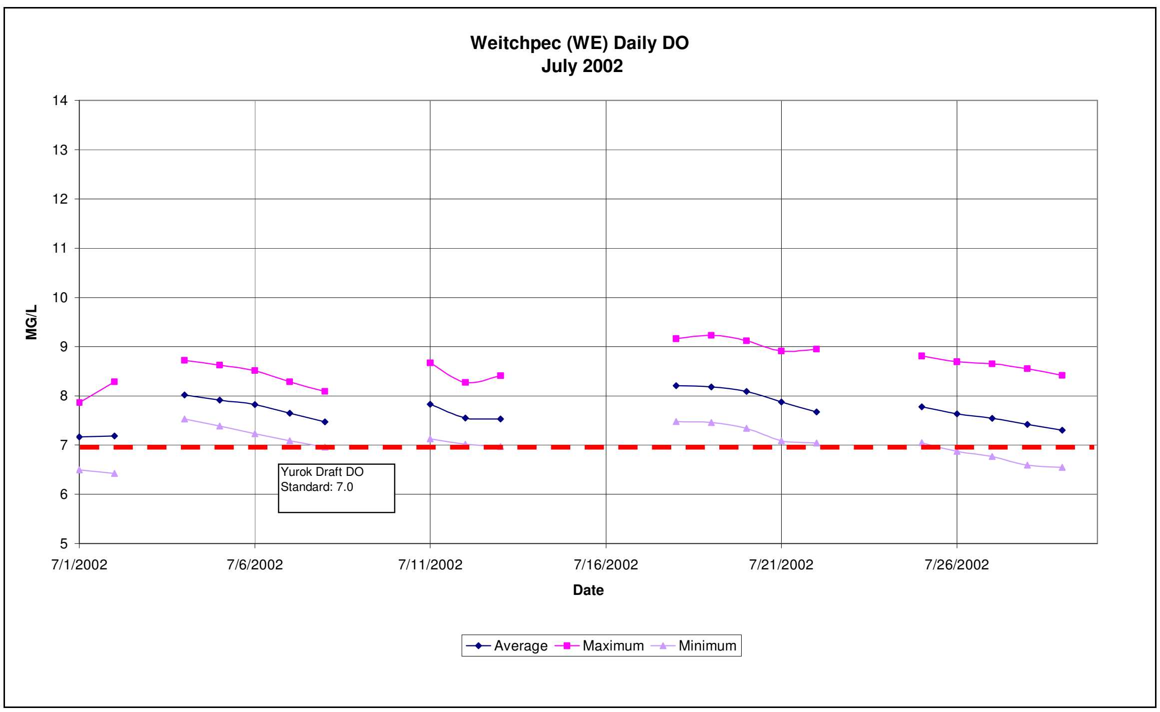

Figure 7-57 Dissolved Oxygen Values for the Klamath River at Weitchpec July 2002

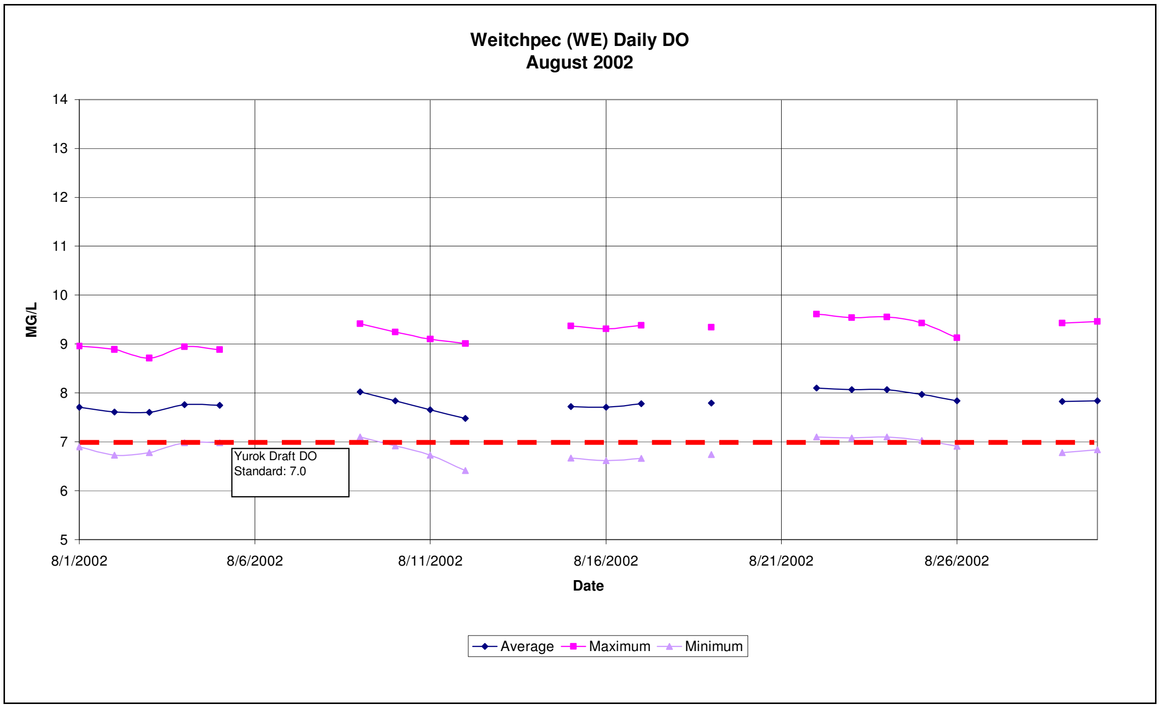

Figure 7-58 Dissolved Oxygen Values for the Klamath River at Weitchpec August 2002

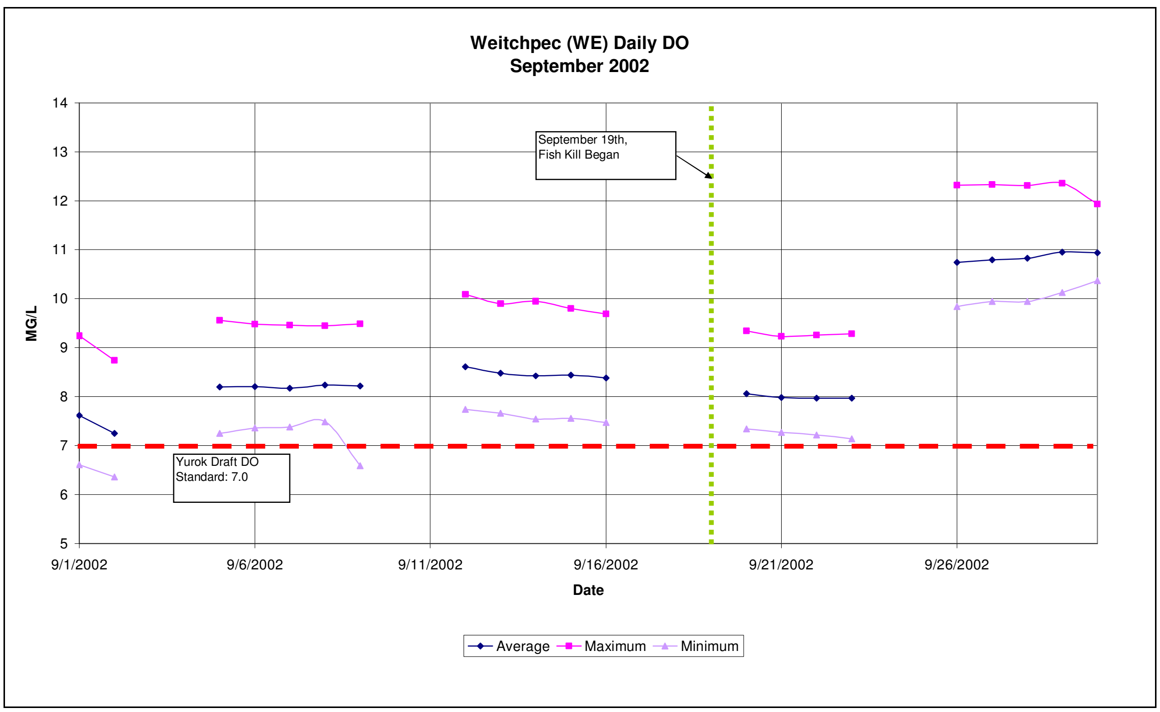

Figure 7-59 Dissolved Oxygen Values for the Klamath River at Weitchpec September 2002

7.1.3.3 pH

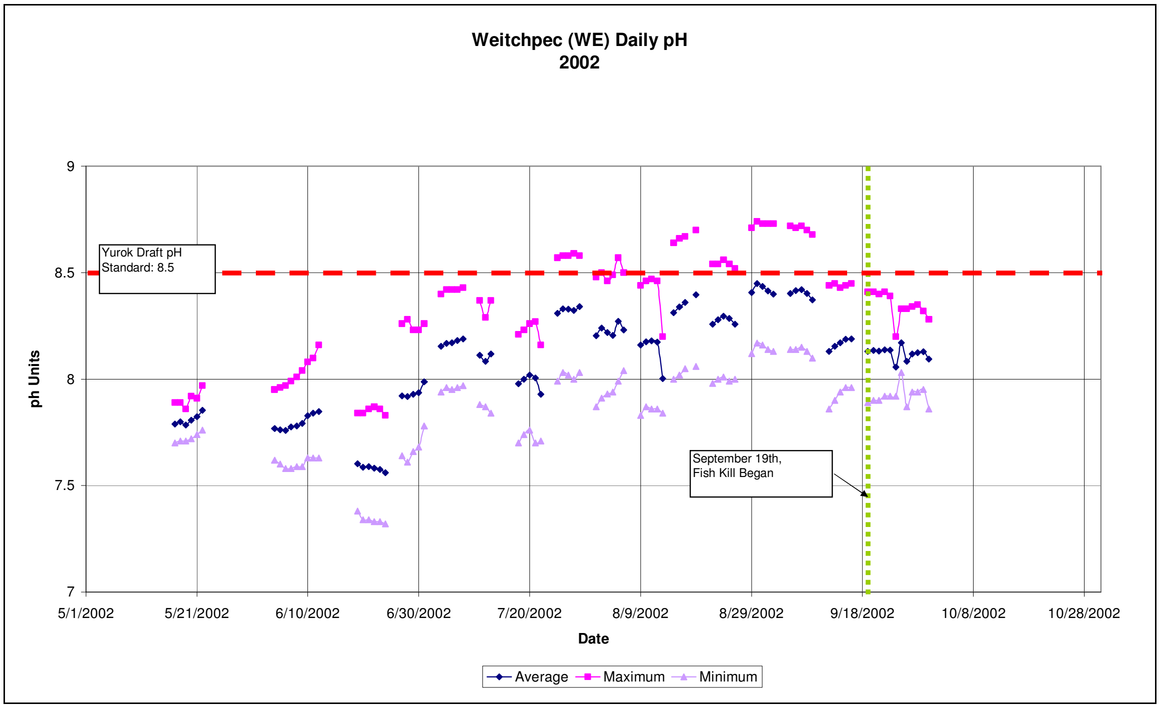

Figure 7-60 pH Values for the Klamath River at Weitchpec WY02

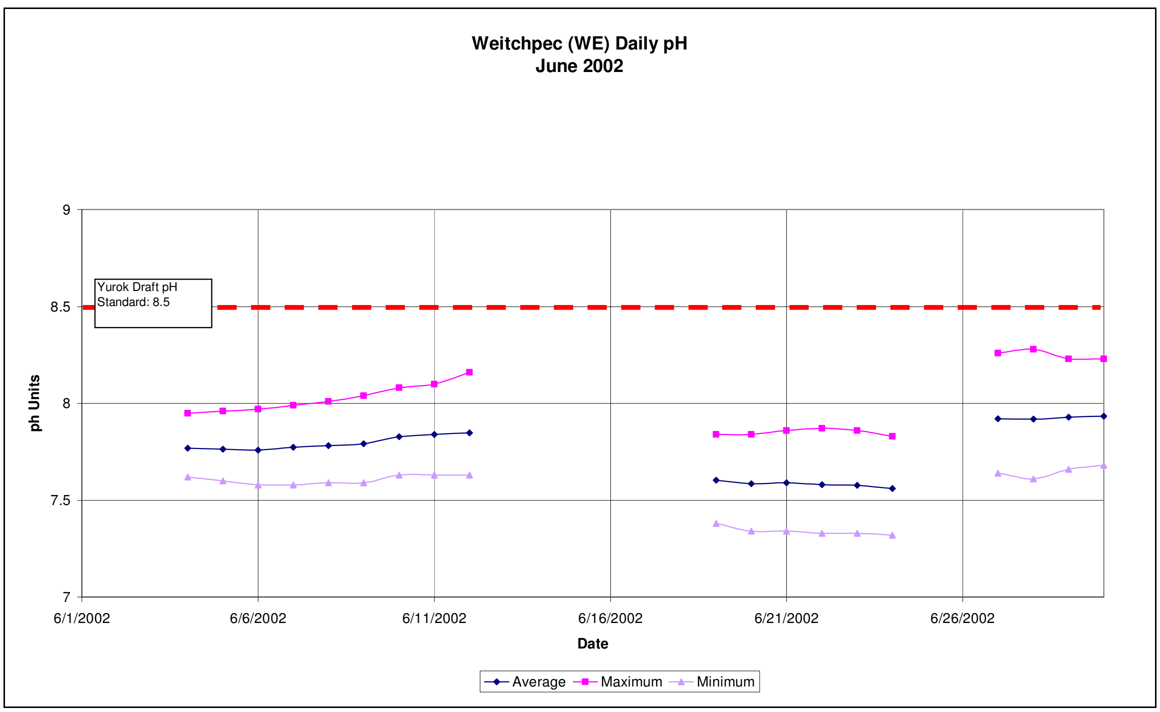

Figure 7-61 pH Values for the Klamath River at Weitchpec June 2002

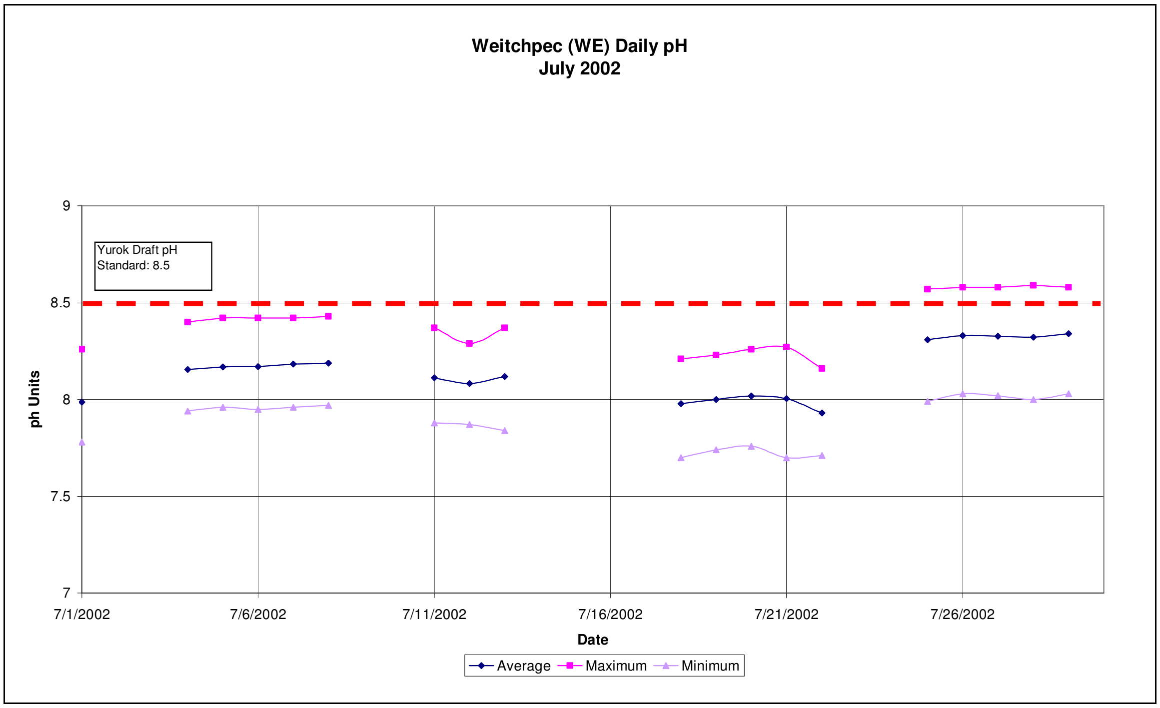

Figure 7-62 pH Values for the Klamath River at Weitchpec July 2002

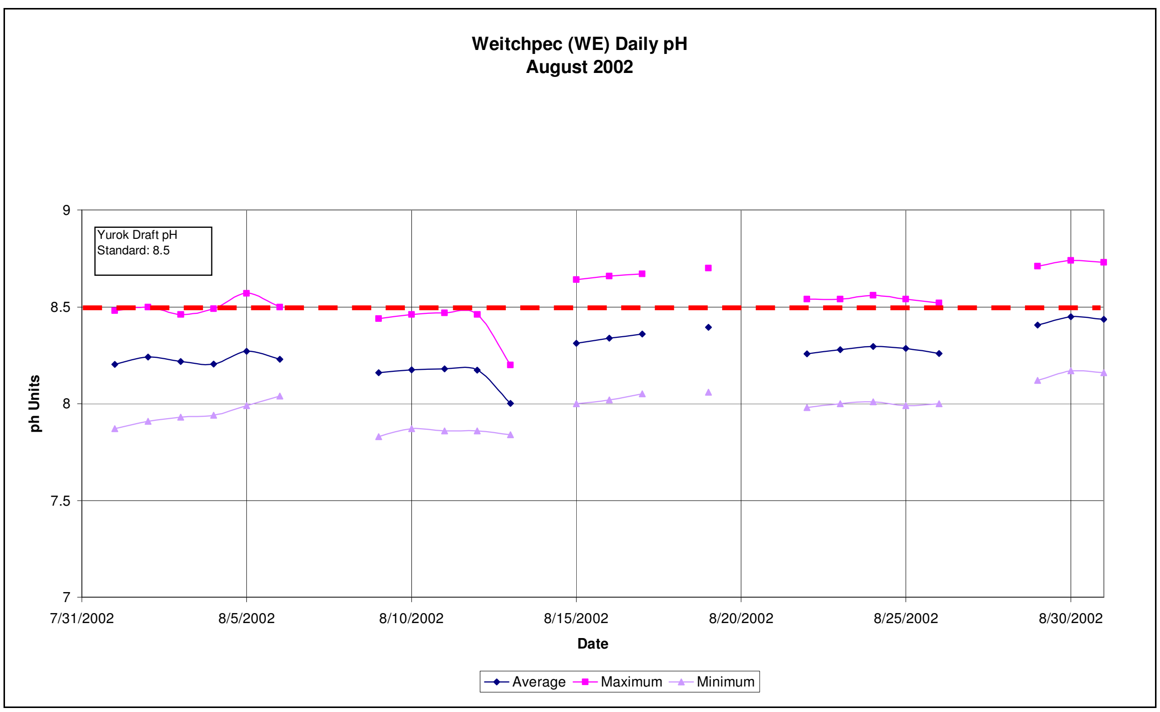

Figure 7-63 pH Values for the Klamath River at Weitchpec August 2002

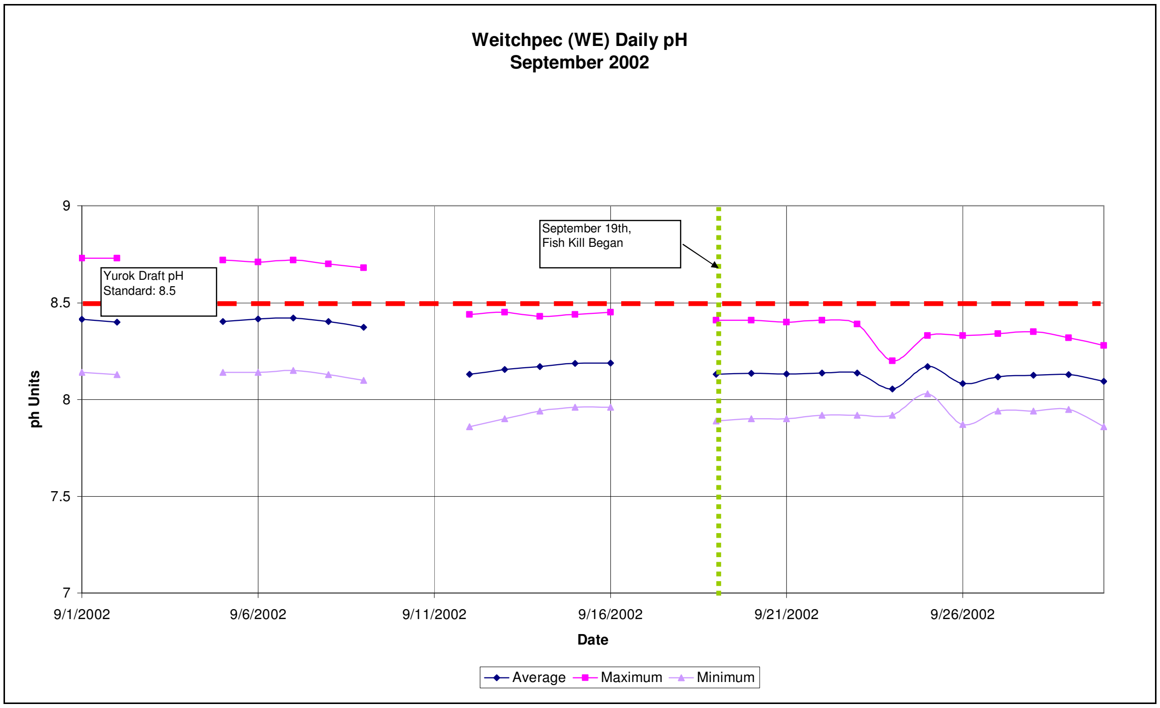

Figure 7-64 pH Values for the Klamath River at Weitchpec September 2002

7.1.3.4 Specific Conductivity

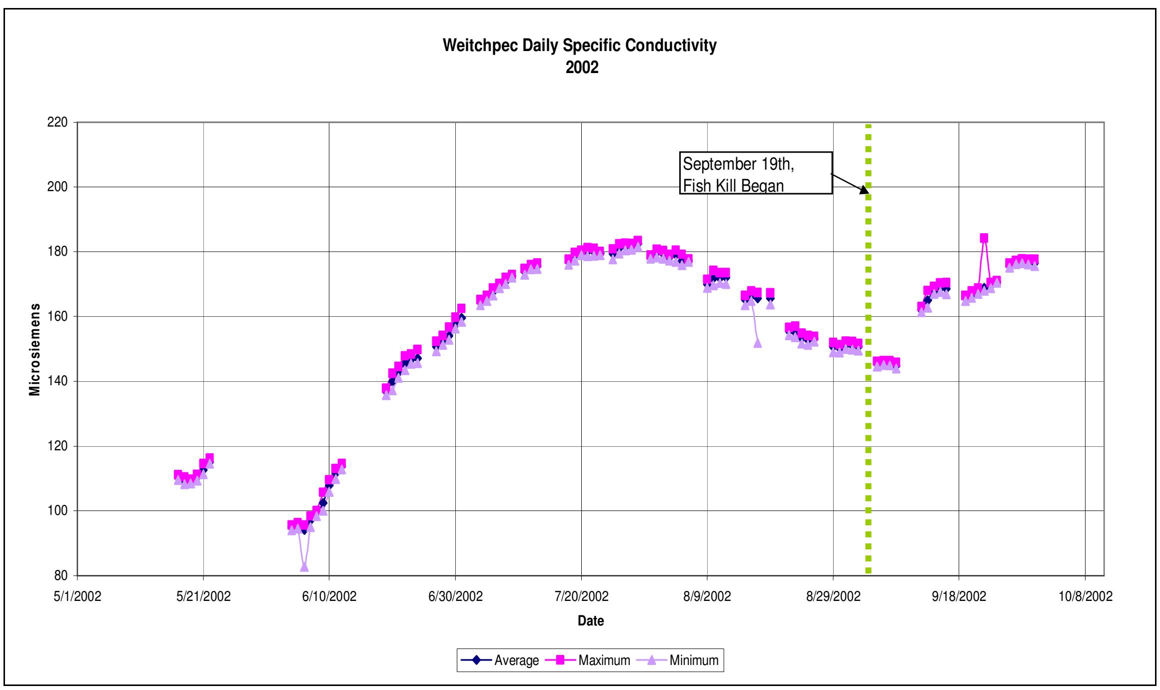

Figure 7-65 Specific Conductivity Values for the Klamath River at Weitchpec WY02

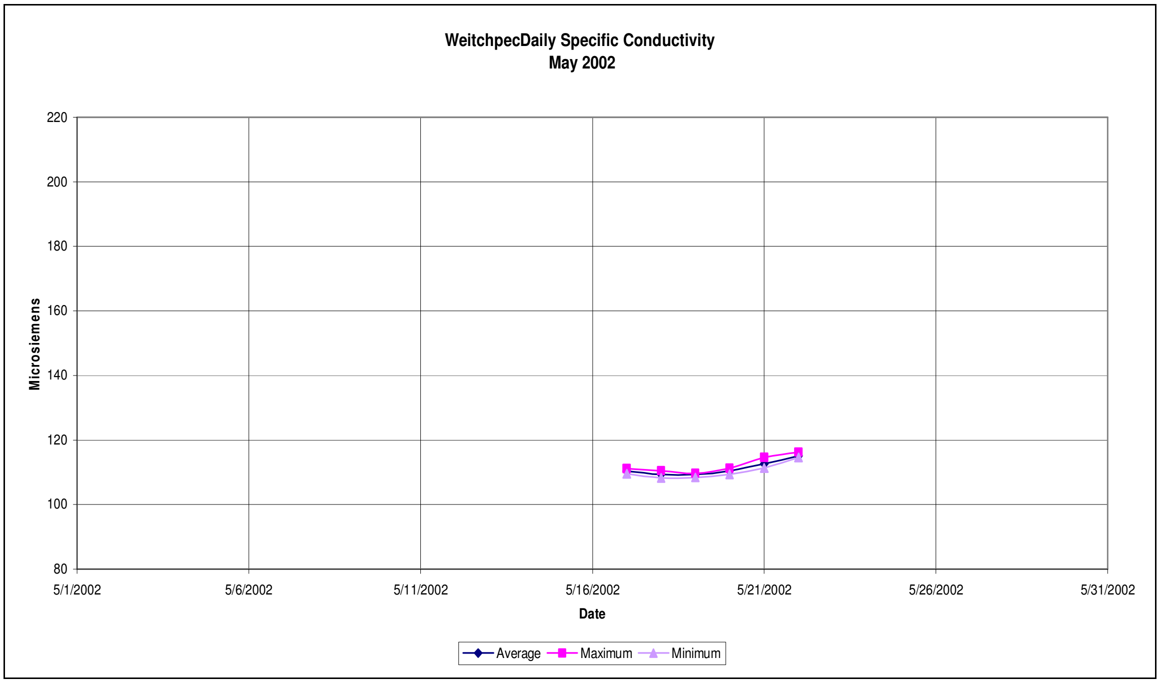

Figure 7-66 Specific Conductivity Values for the Klamath River at Weitchpec May 2002

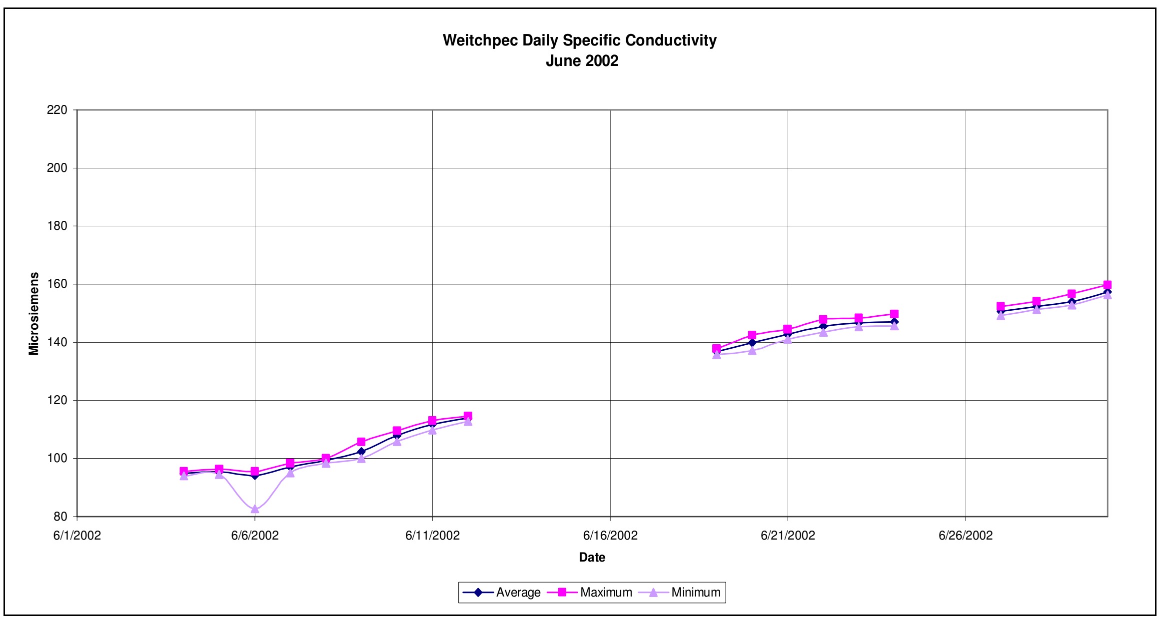

Figure 7-67 Specific Conductivity Values for the Klamath River at Weitchpec June 2002

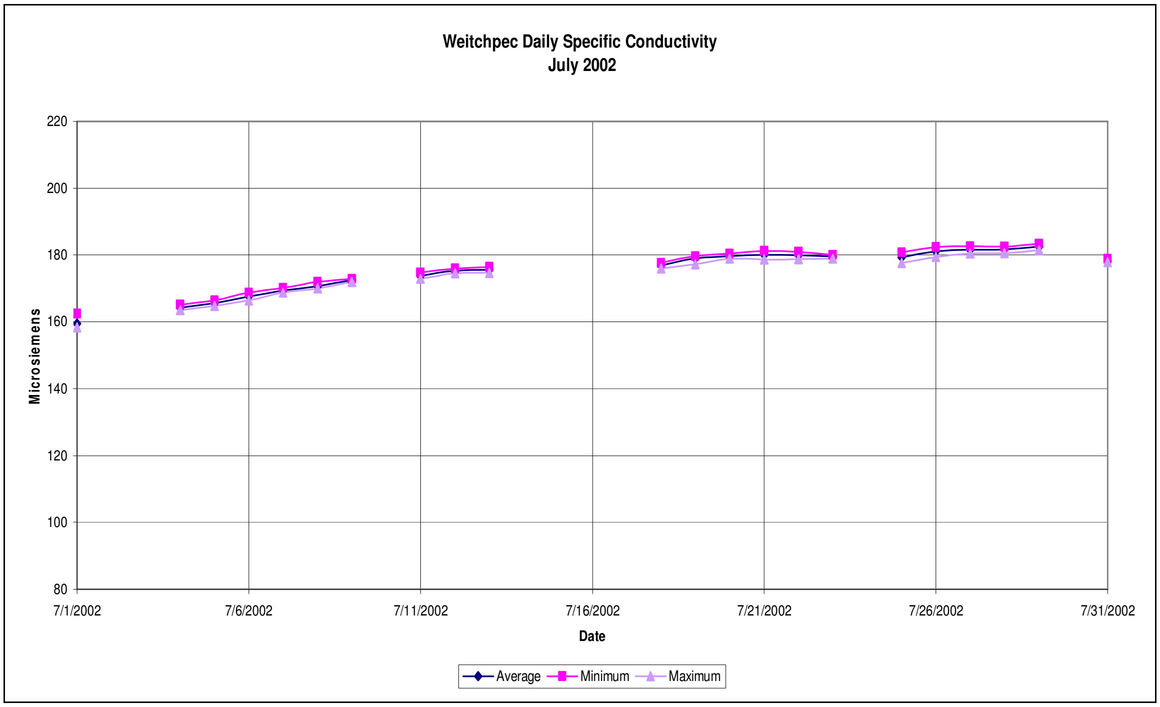

Figure 7-68 Specific Conductivity Values for the Klamath River at Weitchpec July 2002

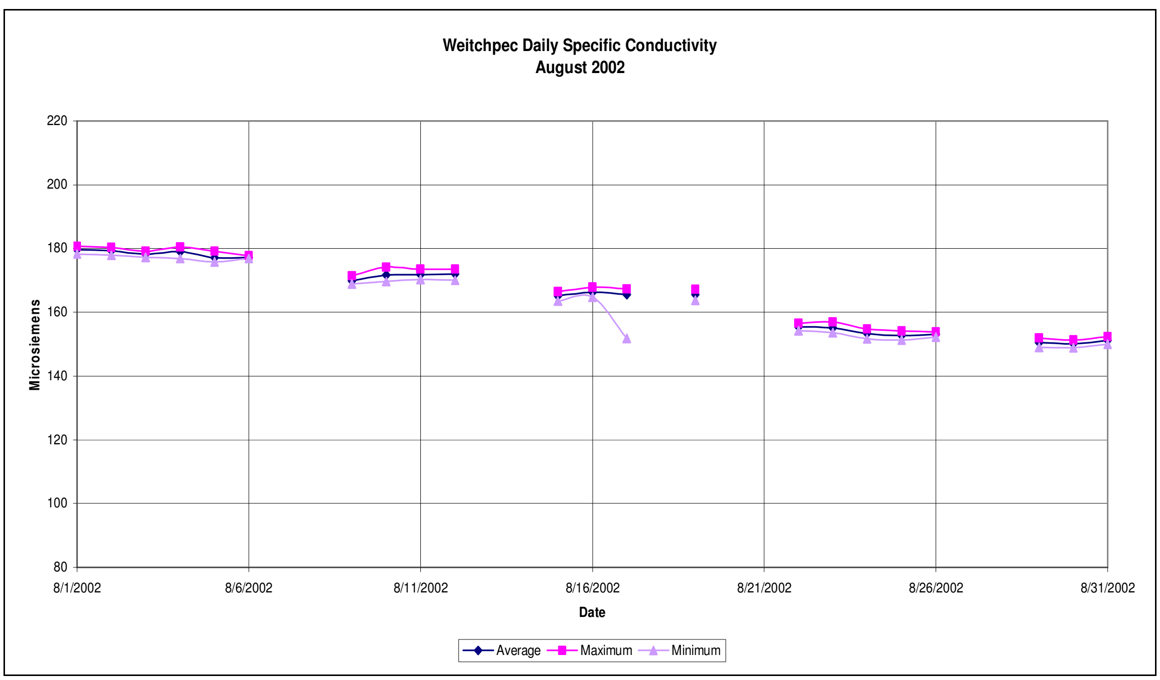

Figure 7-69 Specific Conductivity Values for the Klamath River at Weitchpec August 2002

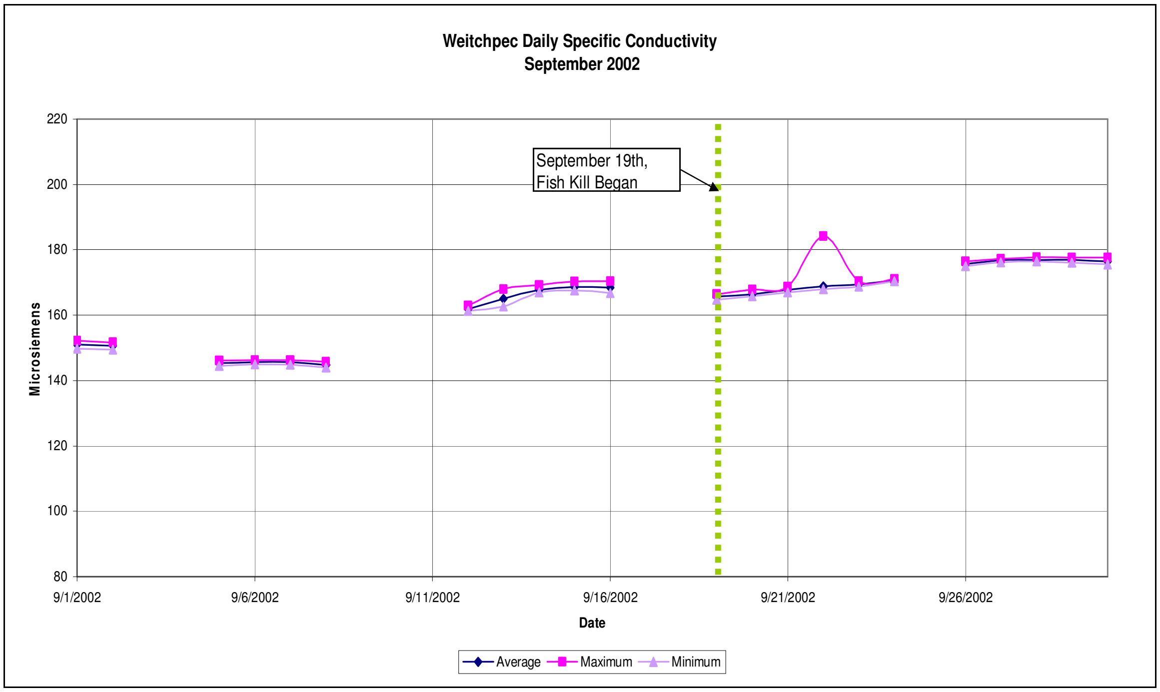

Figure 7-70 Specific Conductivity Values for the Klamath River at Weitchpec September 2002

7.1.3.5 Air / Water Temperature and Flow

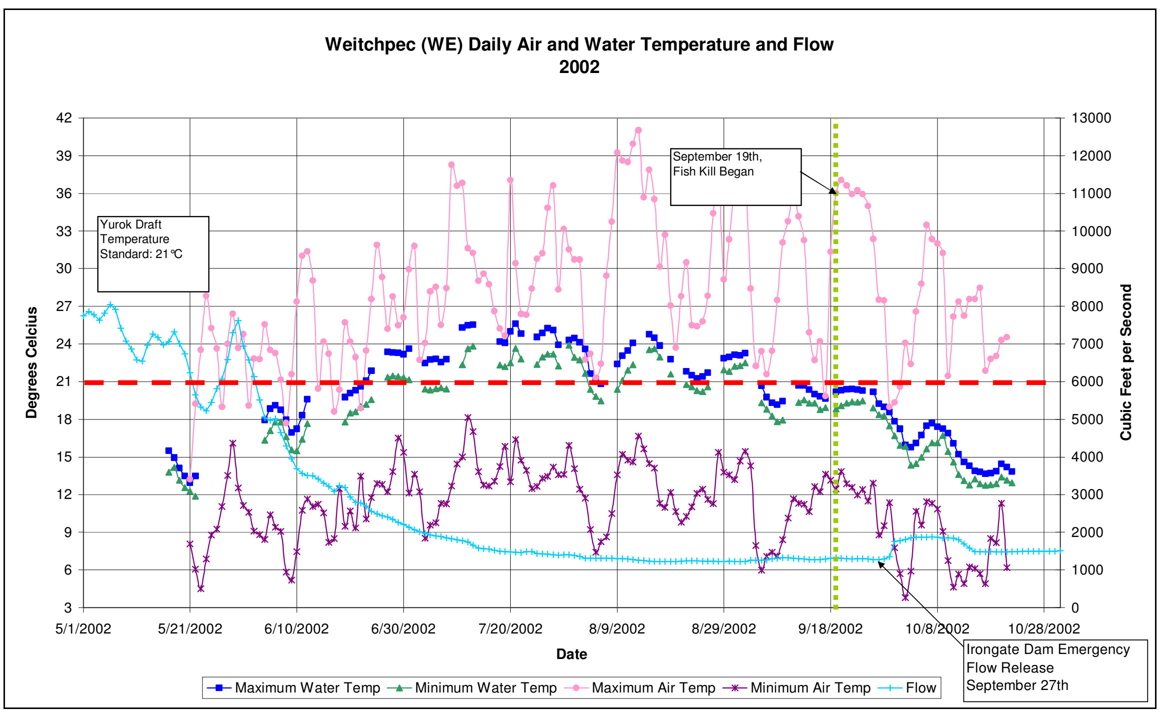

Figure 7-71 Water and Air Temperature and Flow Values for the Klamath River at Weitchpec WY02

7.1.4 Trinity River

7.1.4.1 Temperature

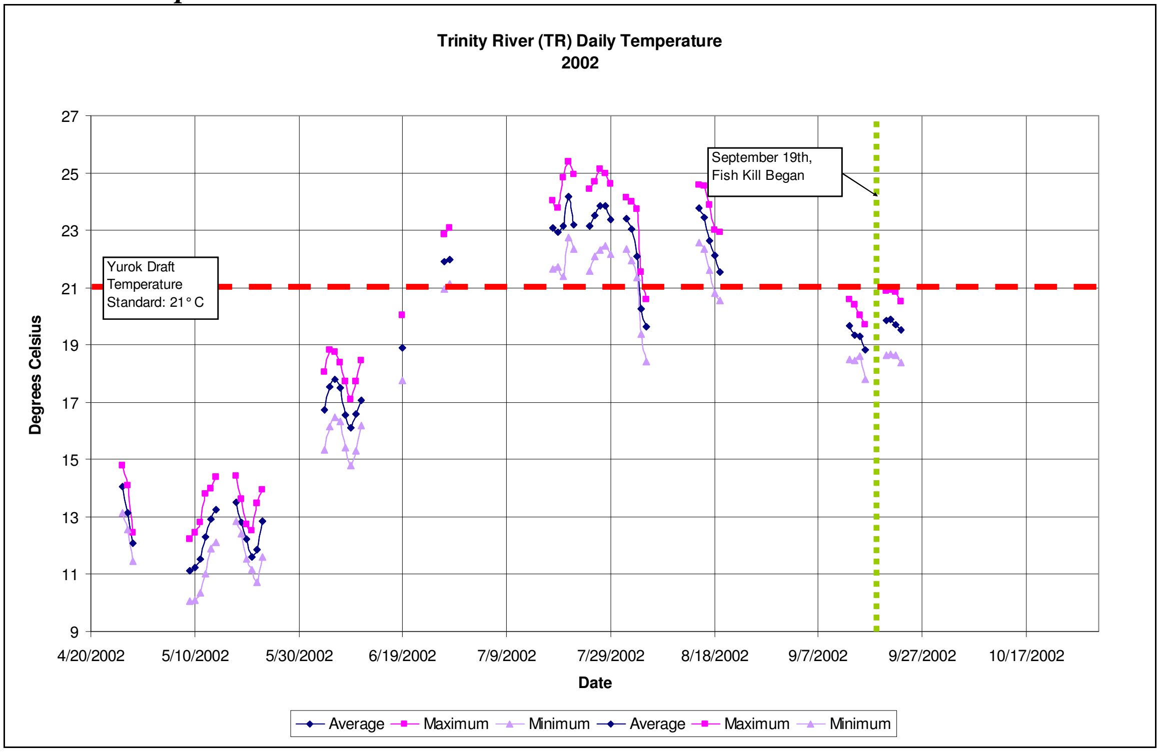

Figure 7-72 Water Temperature Values for the Trinity River Near the Confluence WY02

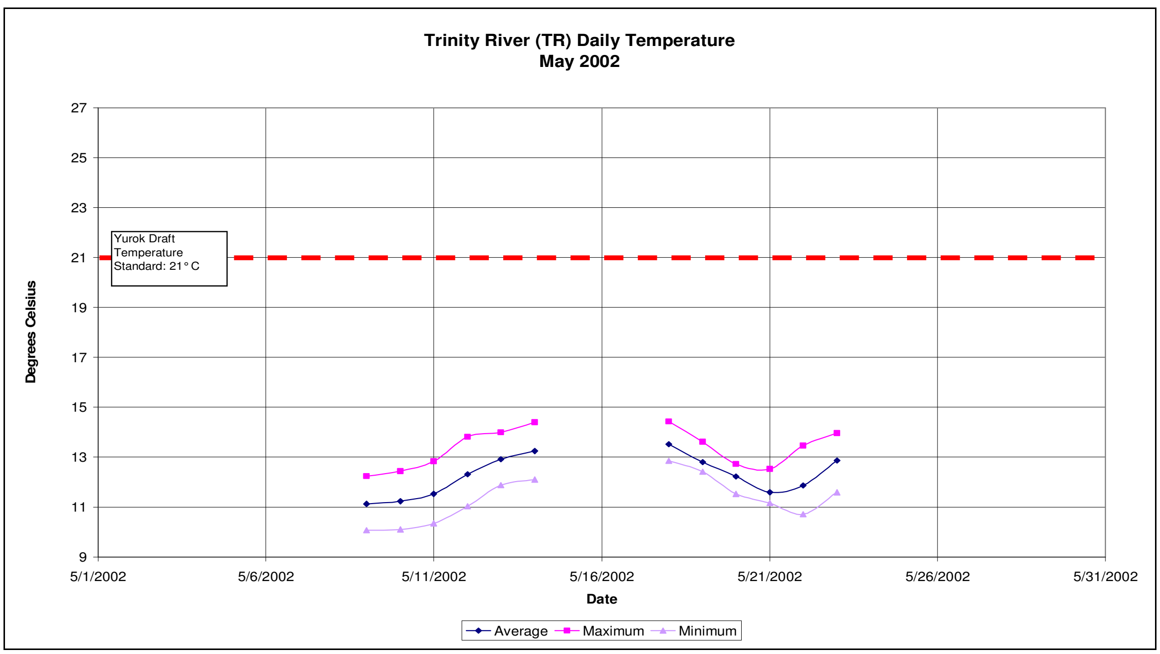

Figure 7-73 Water Temperature Values for the Trinity River Near the Confluence WY 2002

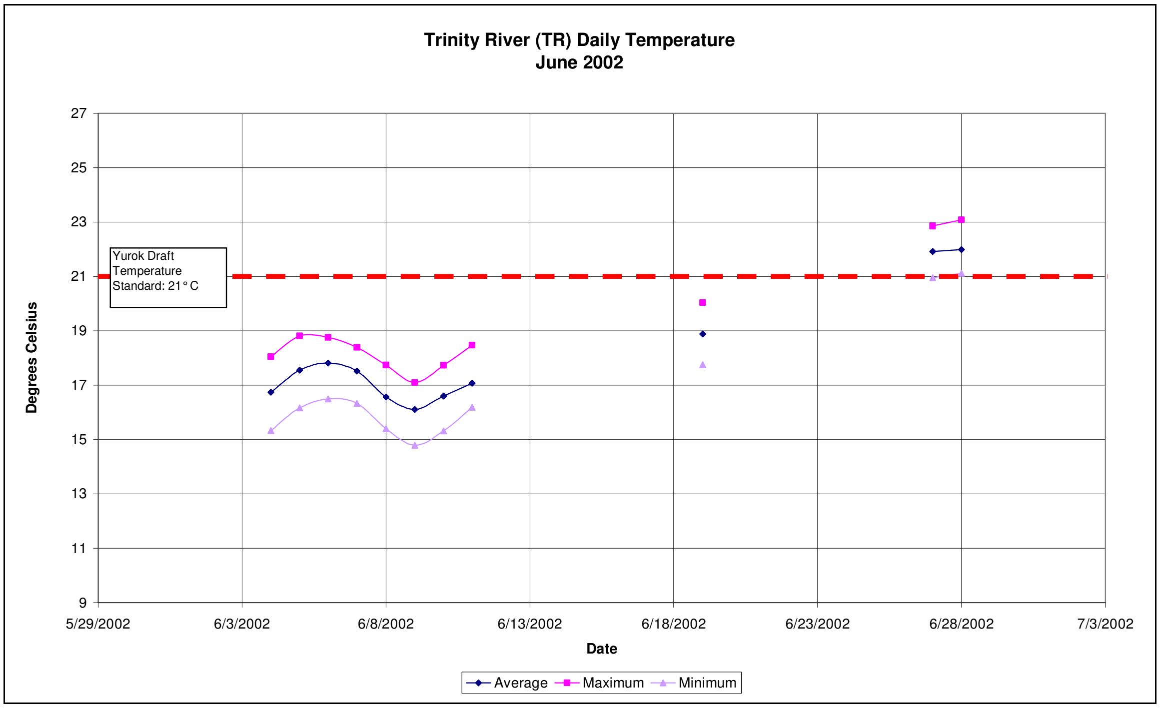

Figure 7-74 Water Temperature Values for the Trinity River Near the Confluence June 2002

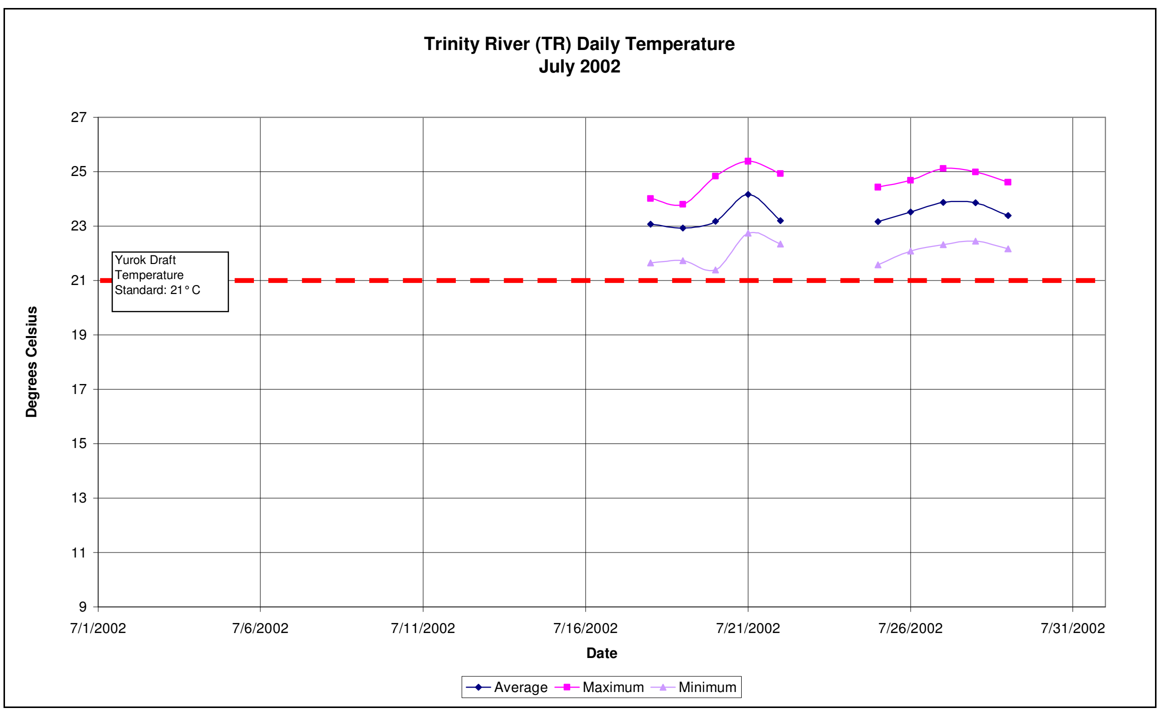

Figure 7-75 Water Temperature Values for the Trinity River Near the Confluence July 2002

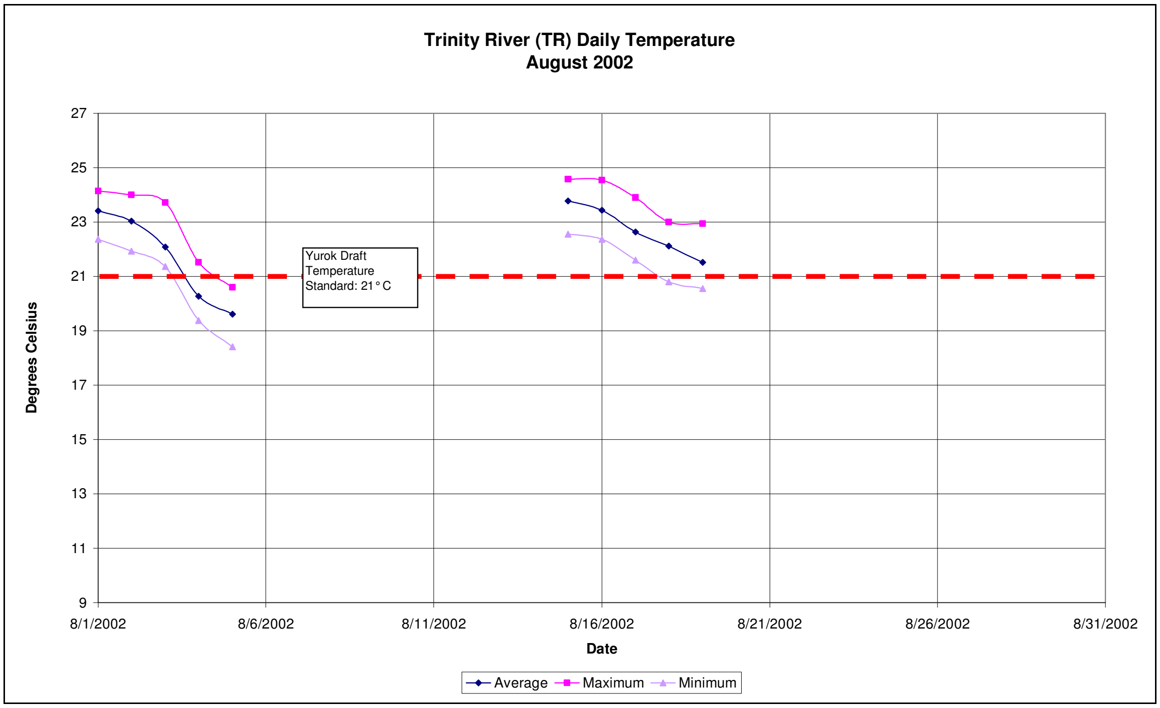

Figure 7-76 Water Temperature Values for the Trinity River Near the Confluence August 2002

7.1.4.2 Dissolved Oxygen

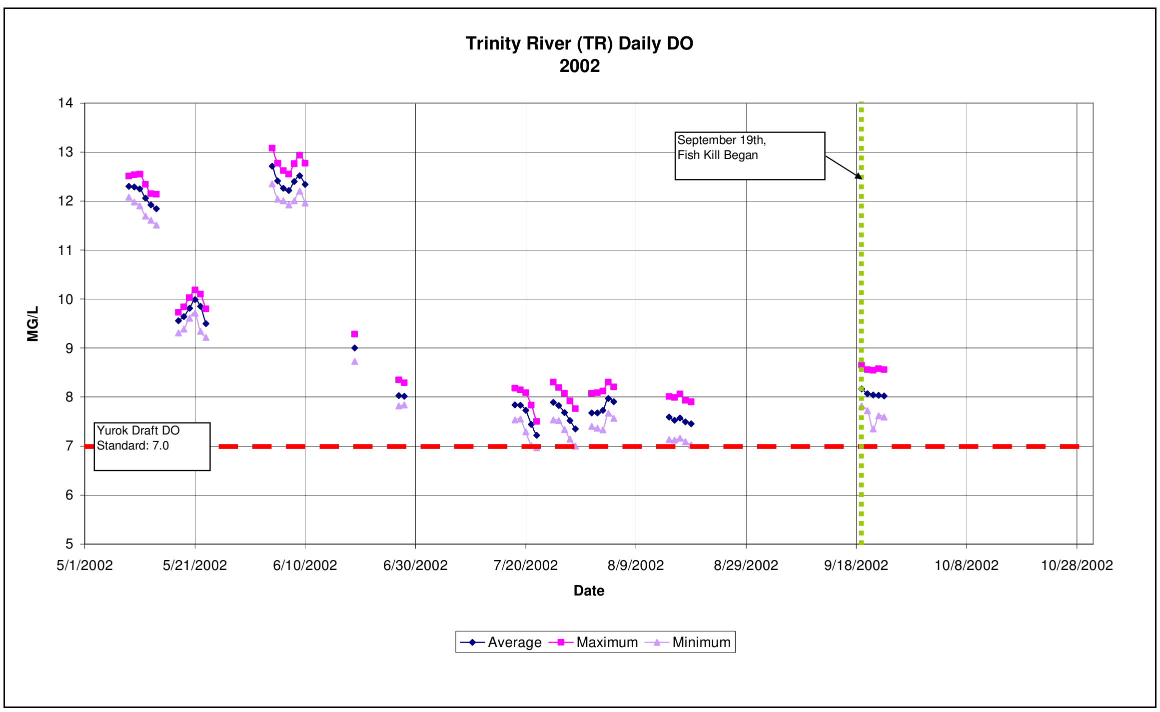

Figure 7-77 Dissolved Oxygen Values for the Trinity River Near the Confluence WY02

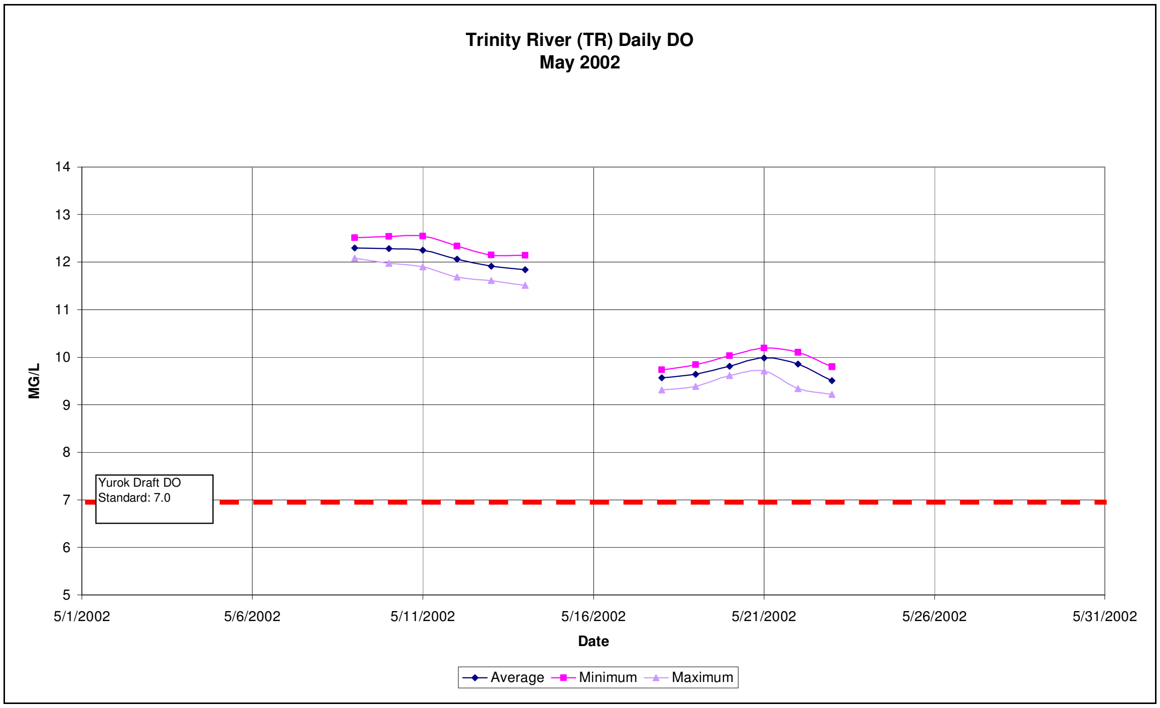

Figure 7-78 Dissolved Oxygen Values for the Trinity River Near the Confluence May 2002

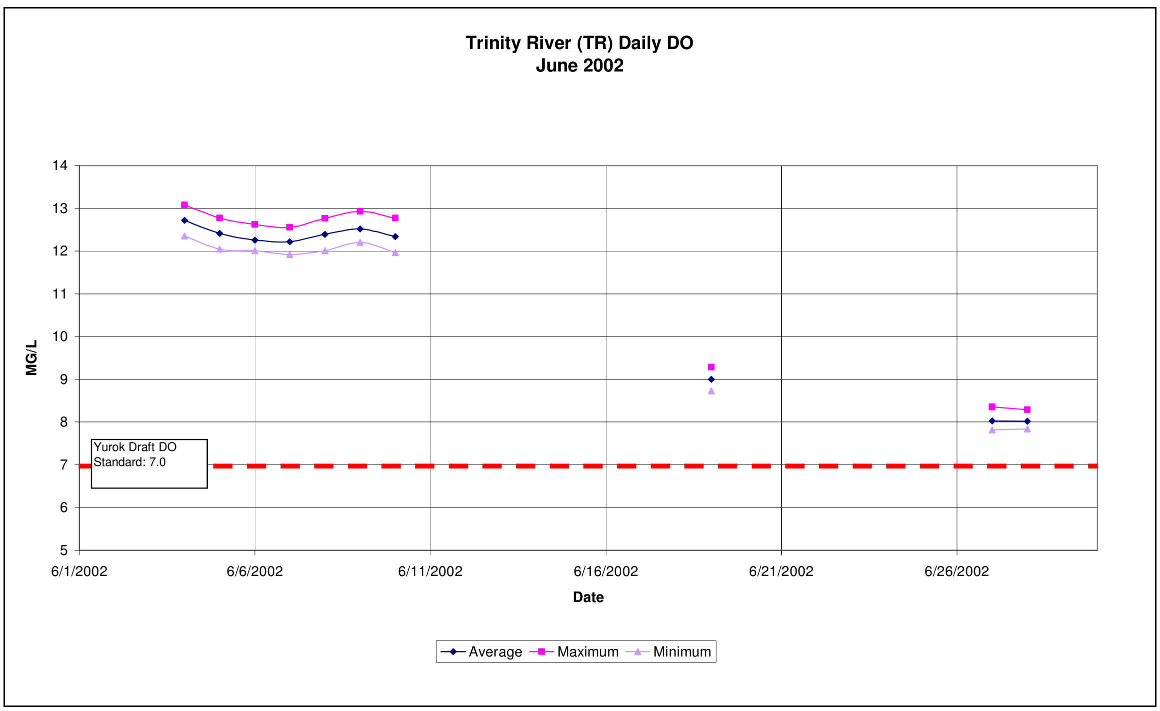

Figure 7-79 Dissolved Oxygen Values for the Trinity River Near the Confluence June 2002

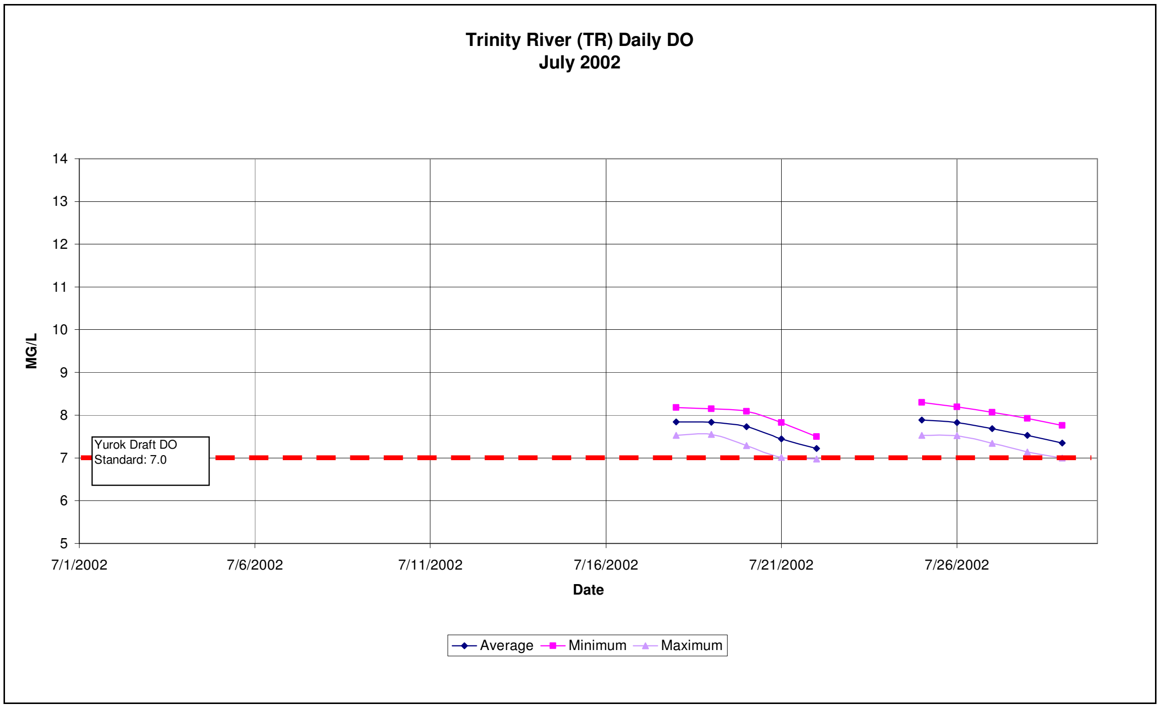

Figure 7-80 Dissolved Oxygen Values for the Trinity River Near the Confluence July 2002

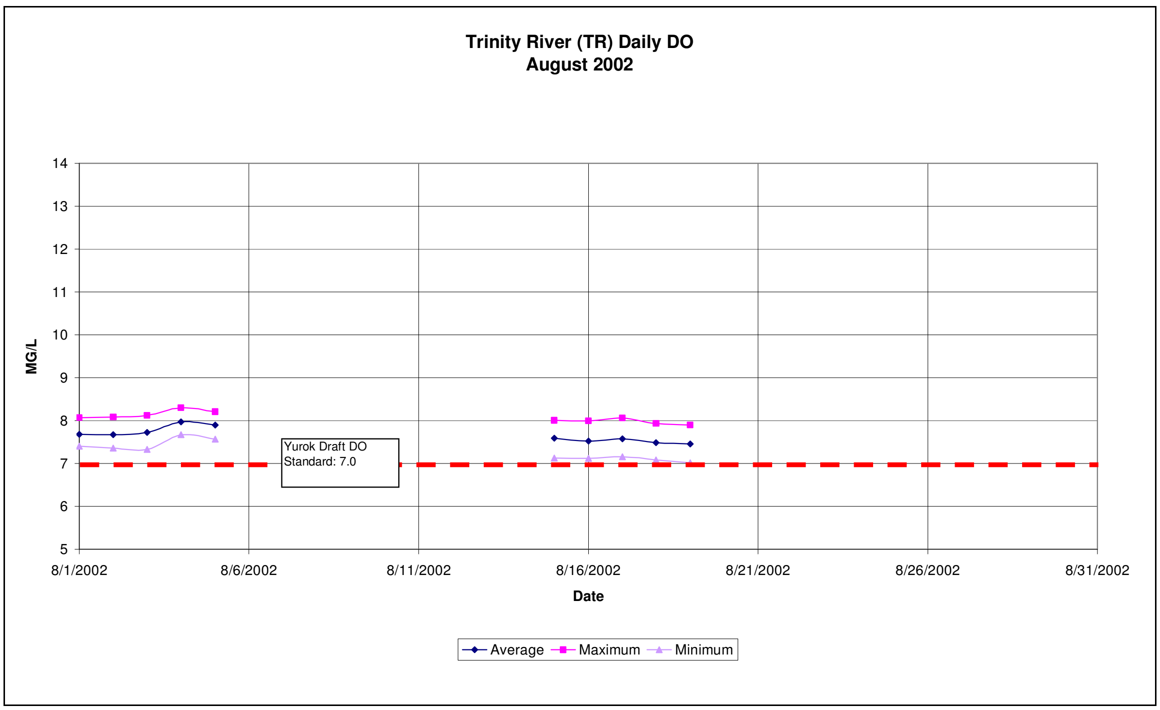

Figure 7-81 Dissolved Oxygen Values for the Trinity River Near the Confluence August 2002

7.1.4.3 pH

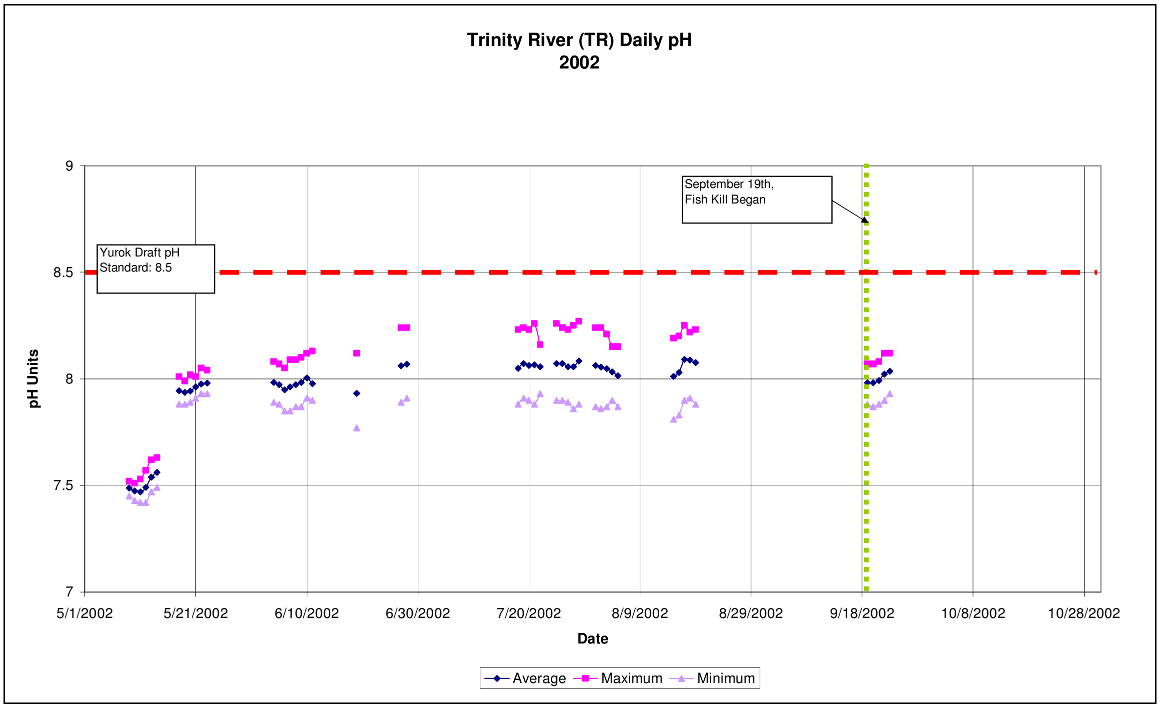

Figure 7-82 pH Values for the Trinity River Near the Confluence WY02

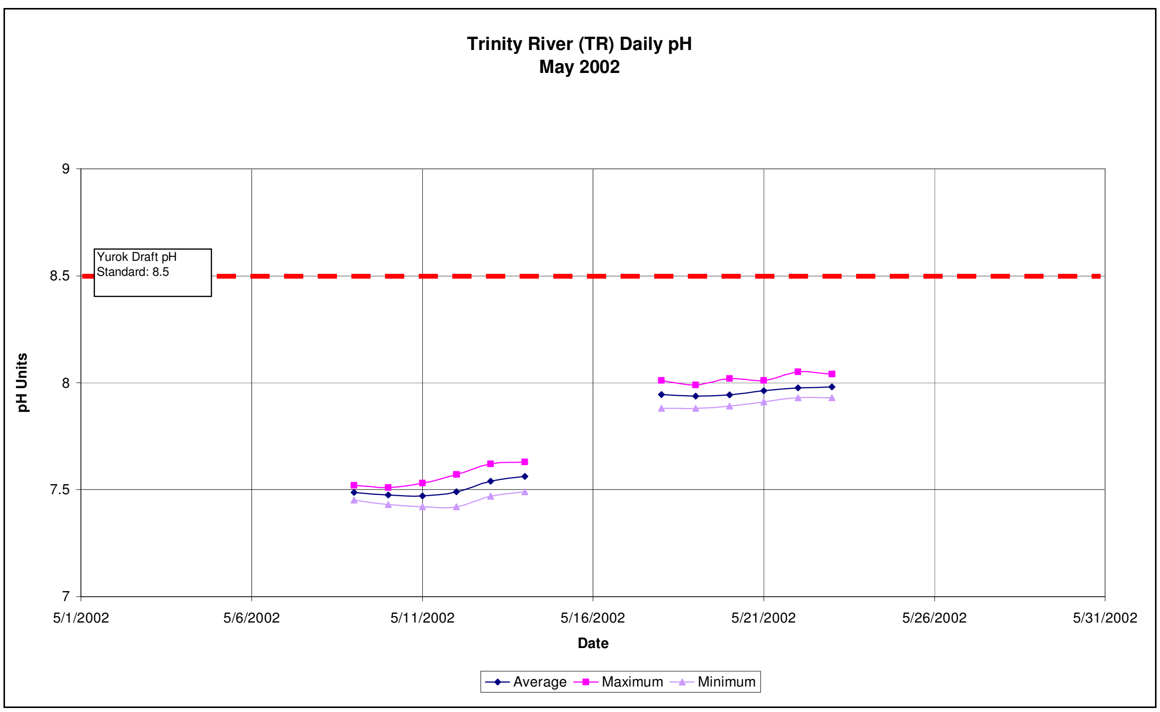

Figure 7-83 pH Values for the Trinity River Near the Confluence May 2002

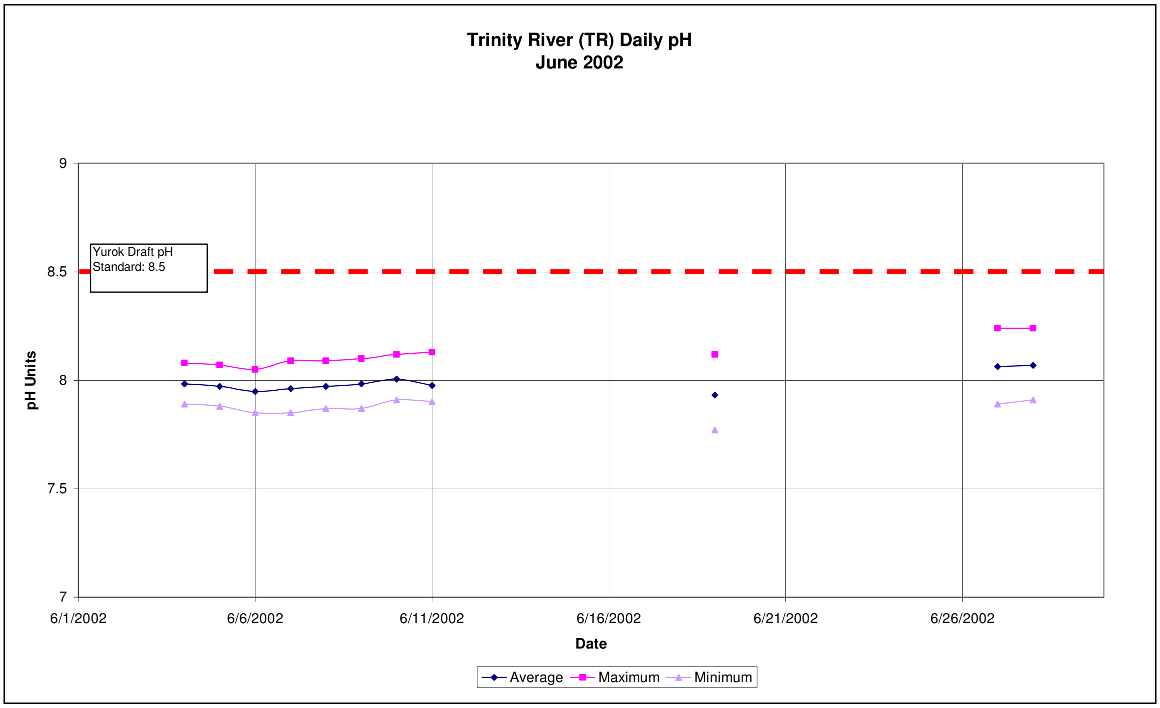

Figure 7-84 pH Values for the Trinity River Near the Confluence June 2002

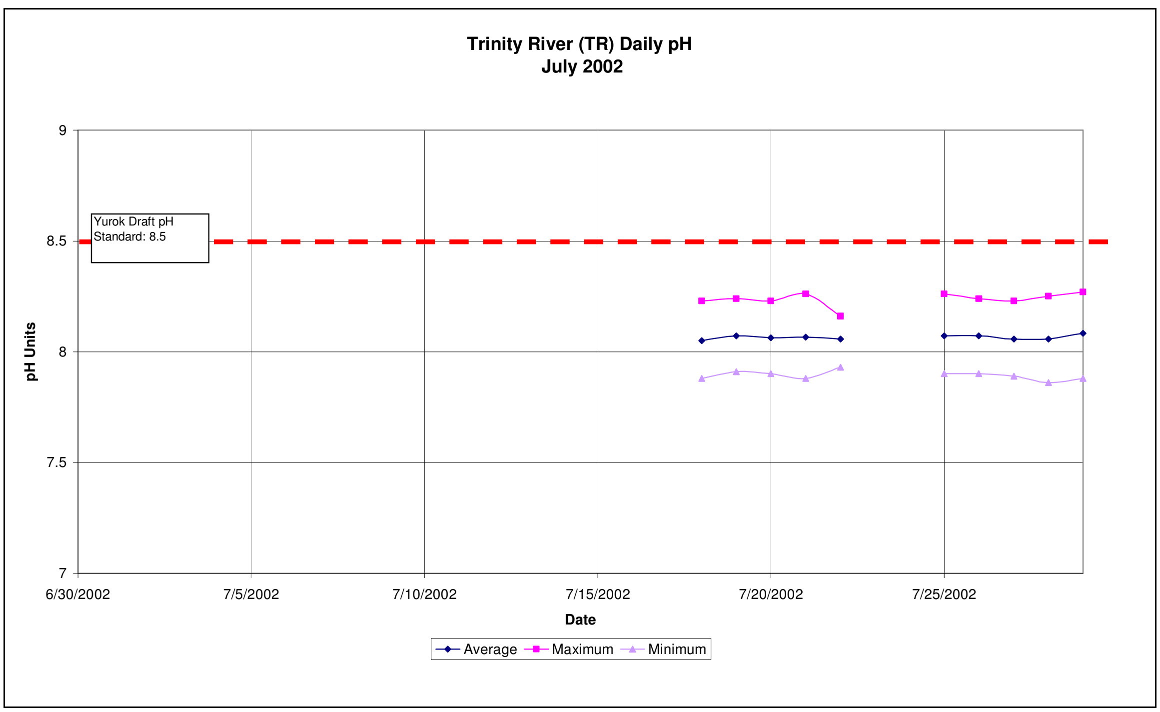

Figure 7-85 pH Values for the Trinity River Near the Confluence July 2002

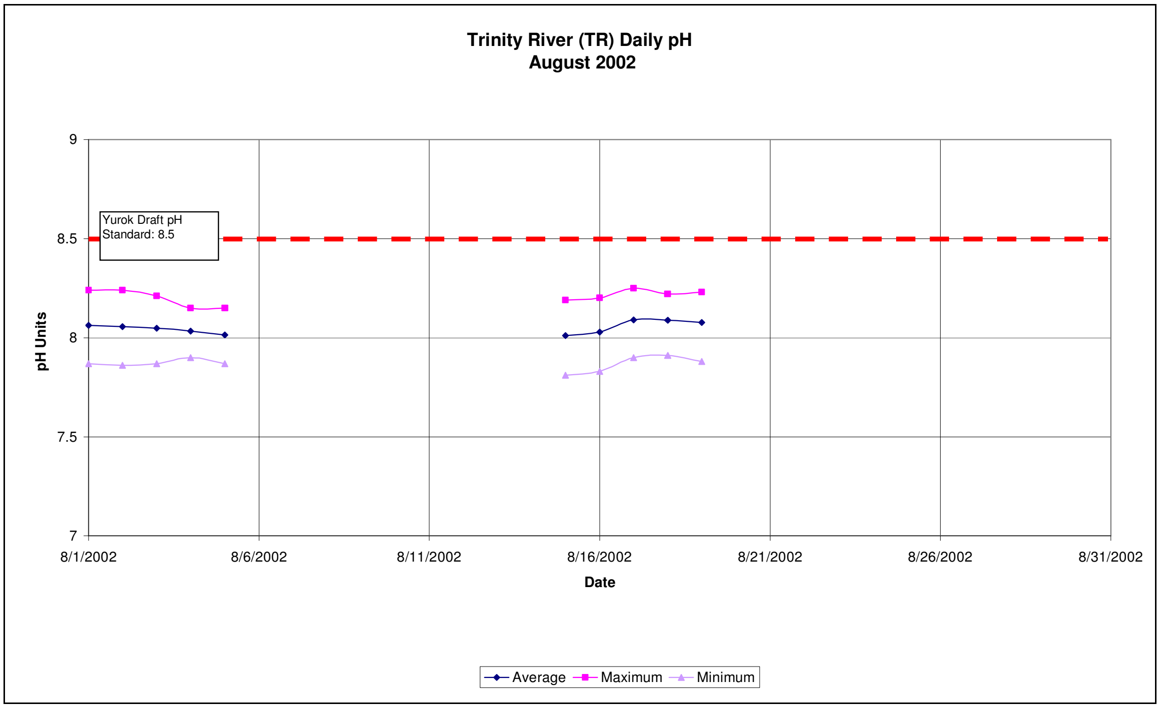

Figure 7-86 pH Values for the Trinity River Near the Confluence August 2002

7.1.4.4 Specific Conductivity

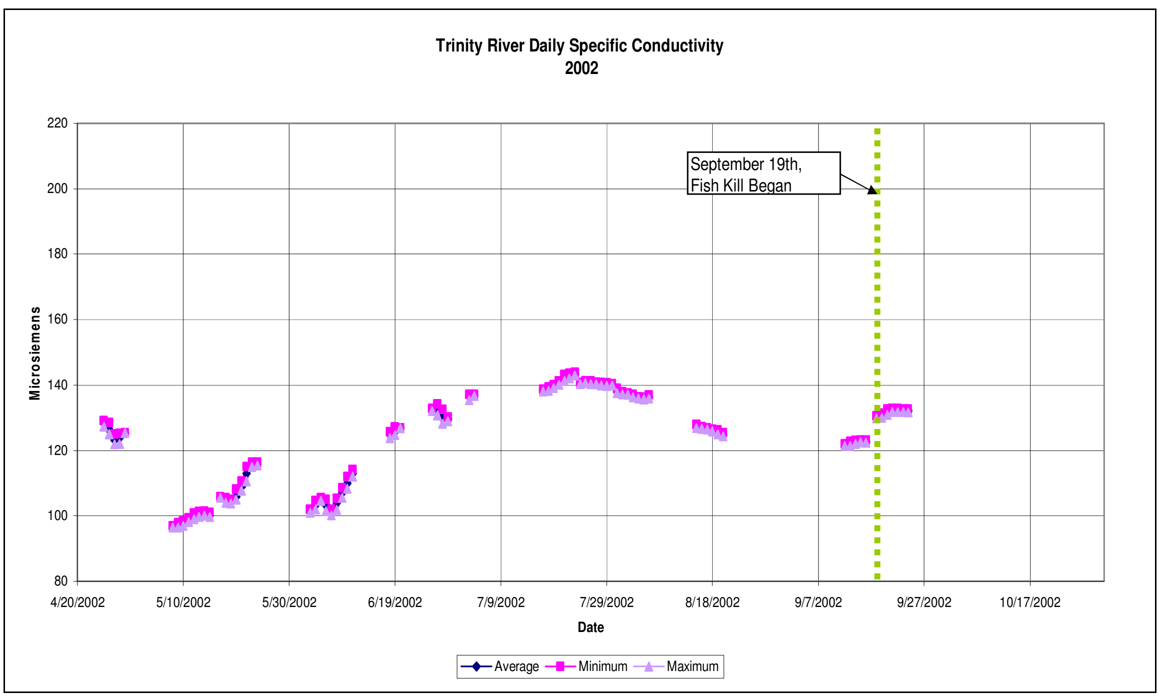

Figure 7-87 Specific Conductivity Values for the Trinity River Near the Confluence WY02

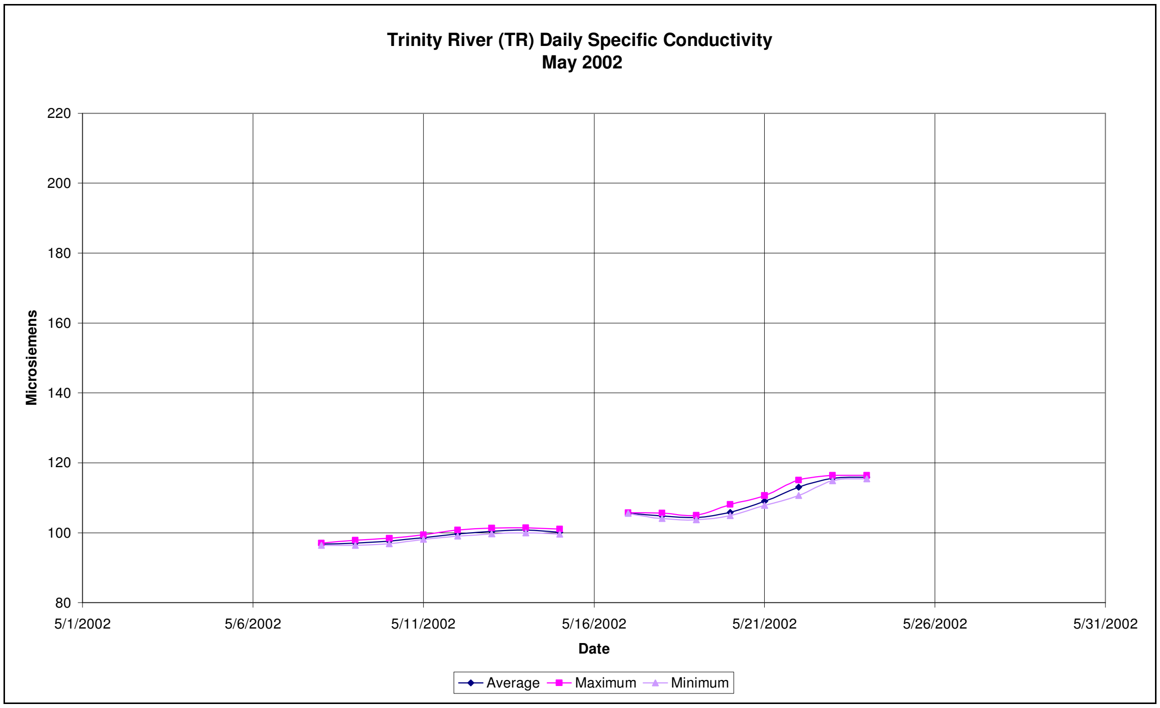

Figure 7-88 Specific Conductivity Values for the Trinity River Near the Confluence May 2002

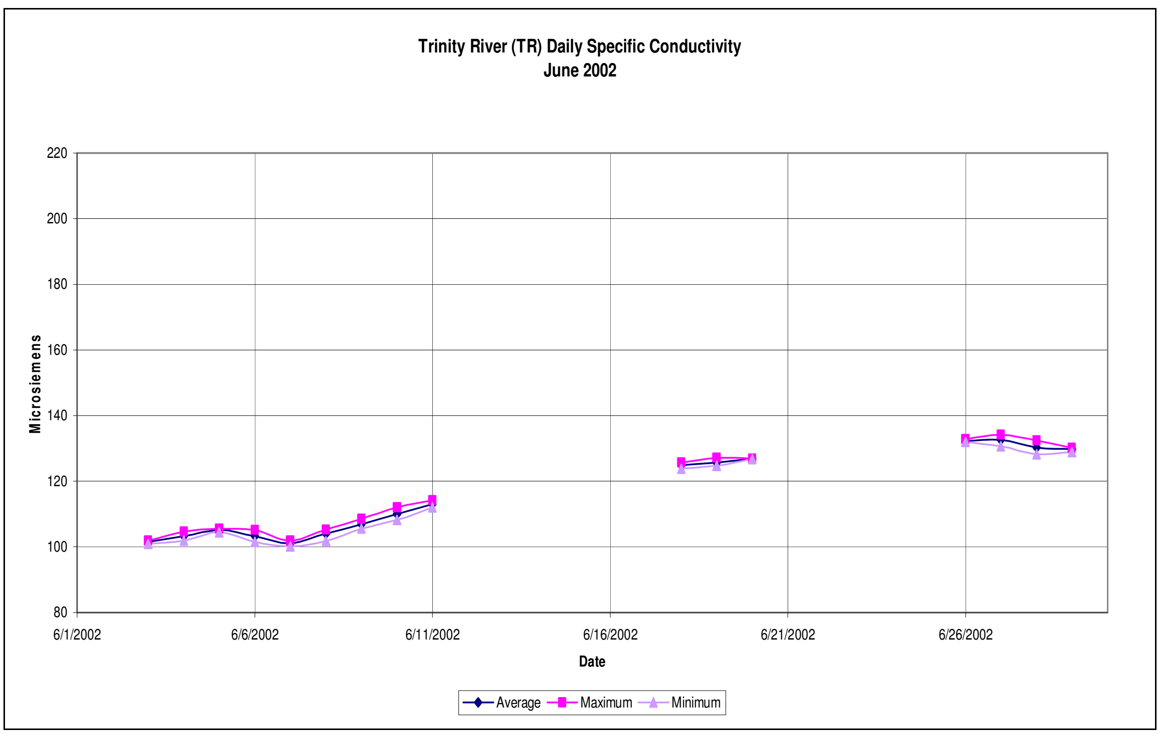

Figure 7-89 Specific Conductivity Values for the Trinity River Near the Confluence June 2002

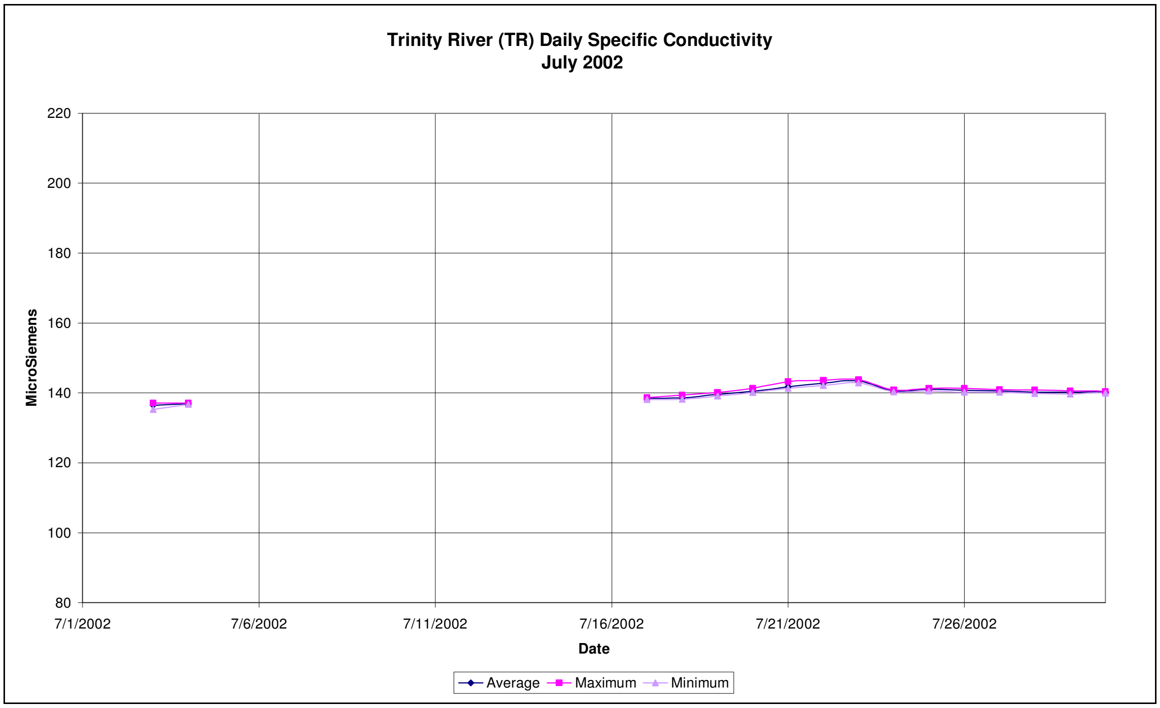

Figure 7-90 Specific Conductivity Values for the Trinity River Near the Confluence July 2002

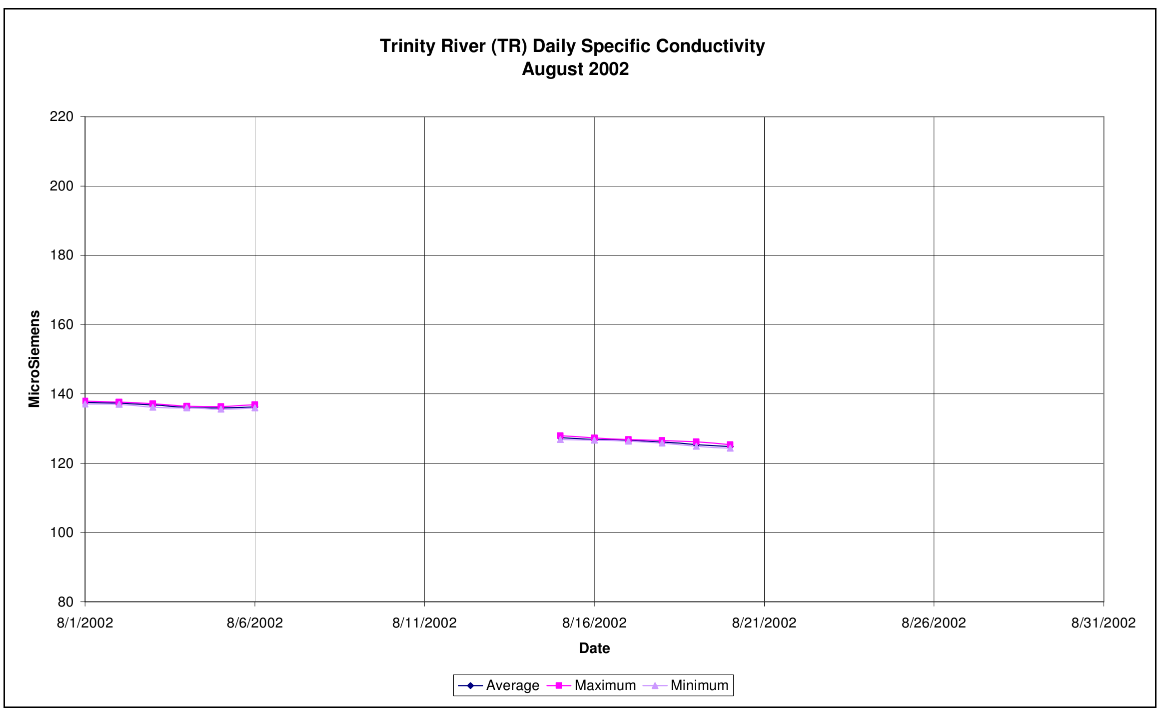

Figure 7-91 Specific Conductivity Values for the Trinity River Near the Confluence August 2002

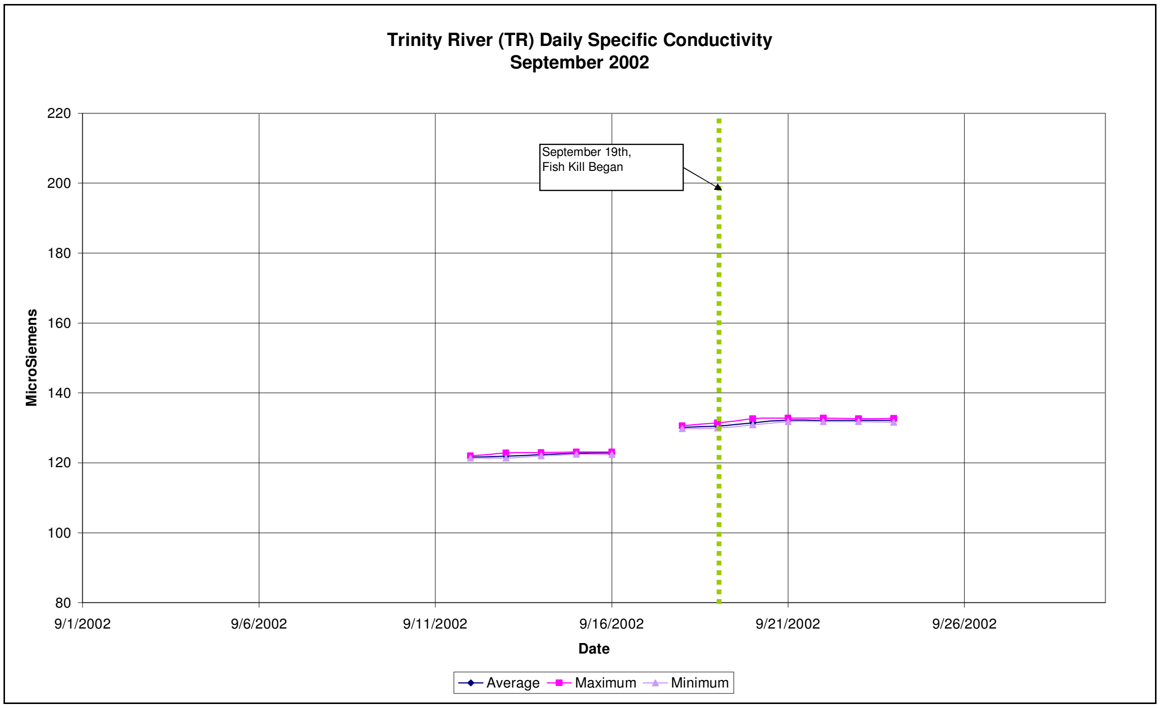

Figure 7-92 Specific Conductivity Values for the Trinity River Near the Confluence September 2002

7.1.4.5 Water Temperature and Flow

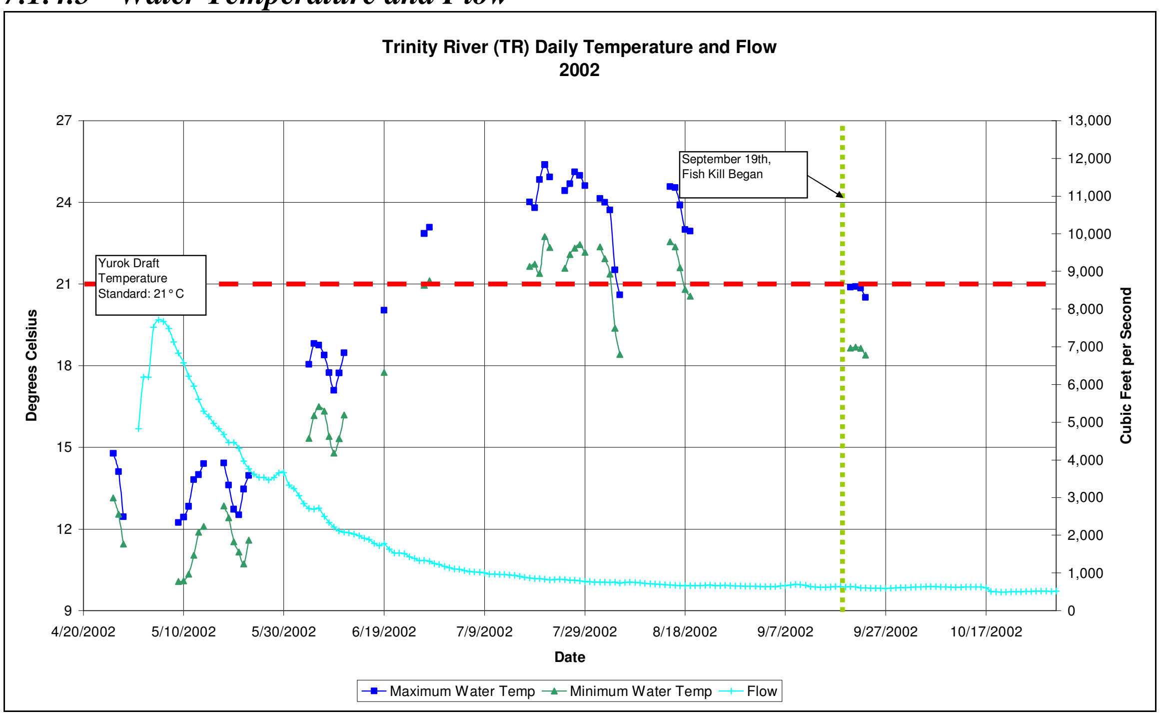

Figure 7-93 Water Temperature and Flow Values for the Trinity River Near the Confluence WY02

7.2 Water Quality (Tributaries)

7.2.1 Blue Creek

7.2.1.1 Temperature

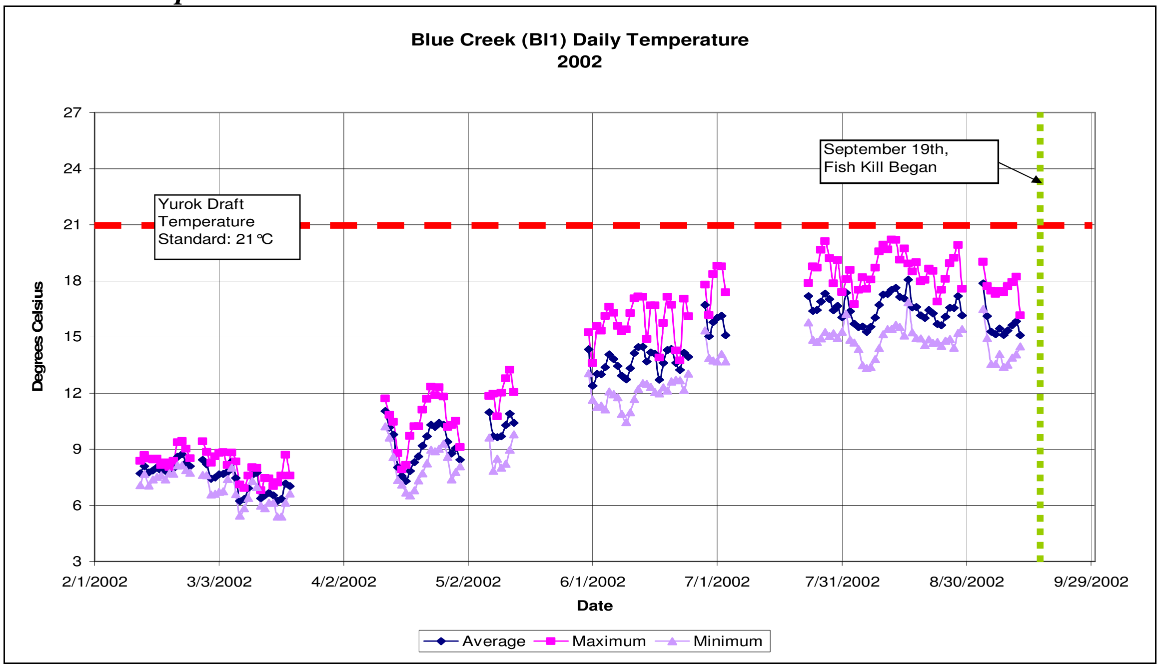

Figure 7-94 Water Temperature Values for Blue Creek WY02

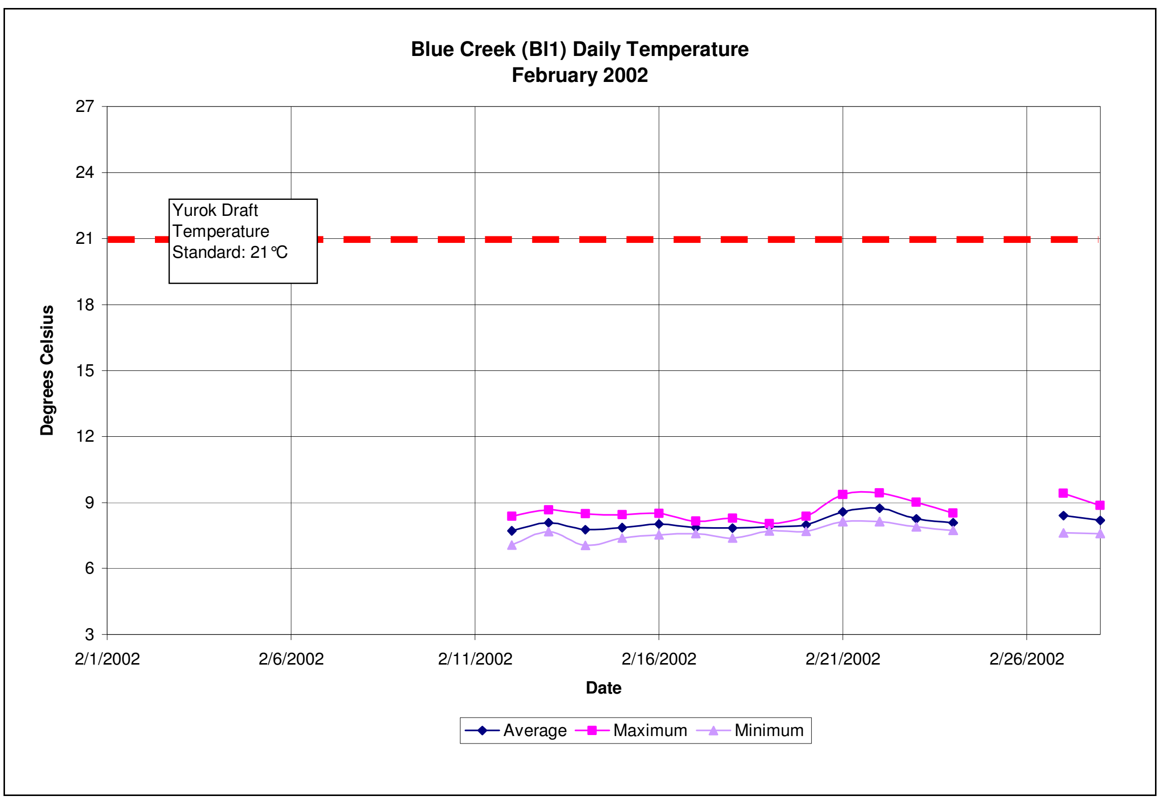

Figure 7-95 Water Temperature Values for Blue Creek February 2002

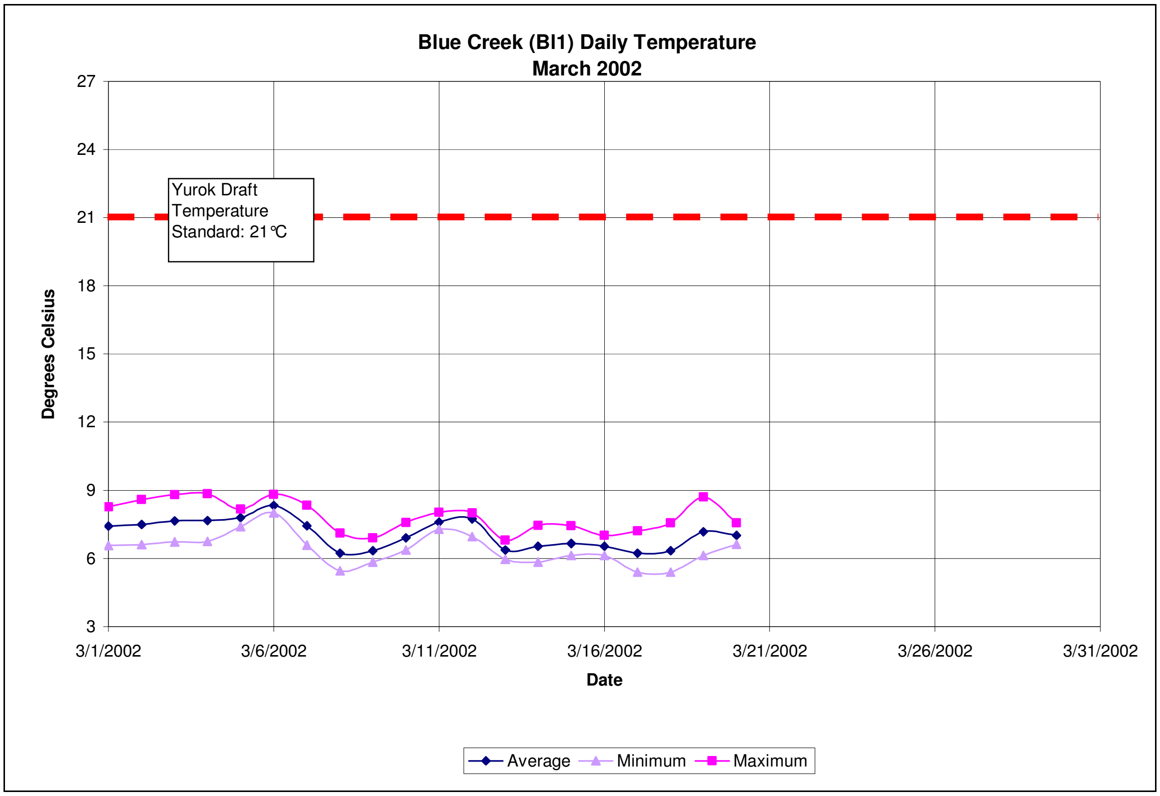

Figure 7-96 Water Temperature Values for Blue Creek March 2002

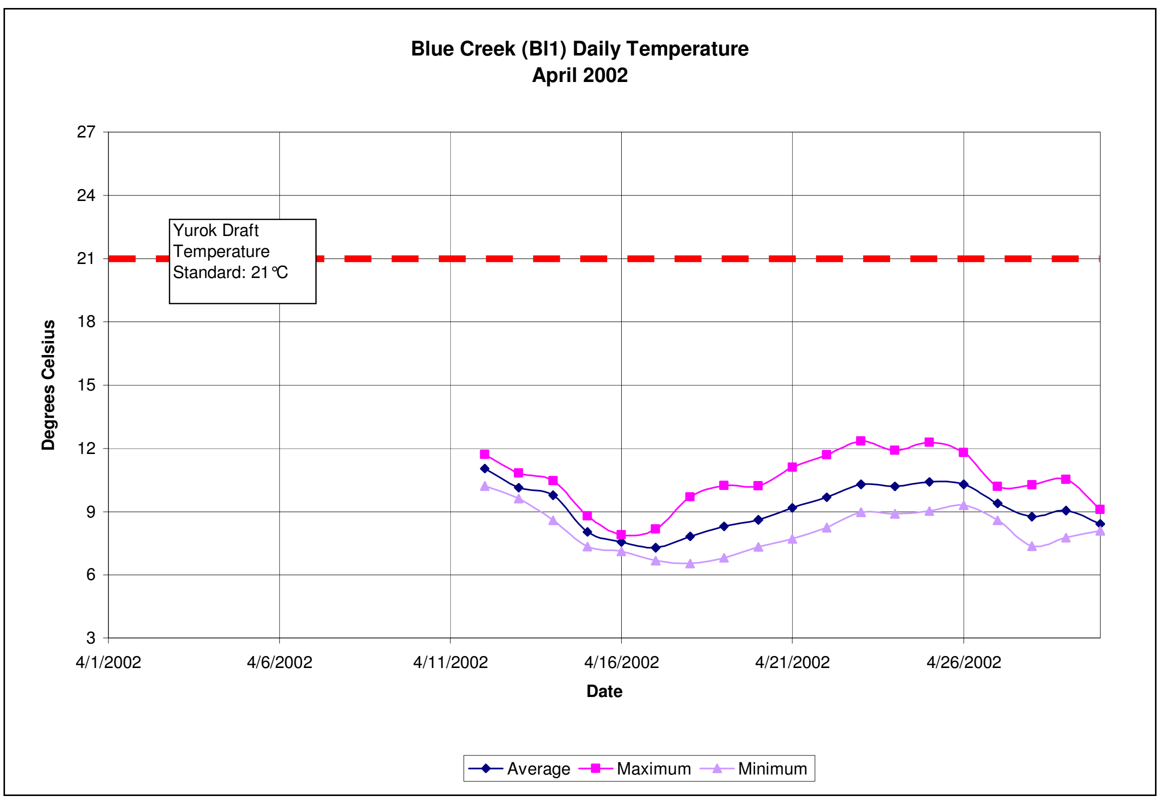

Figure 7-97 Water Temperature Values for Blue Creek April 2002

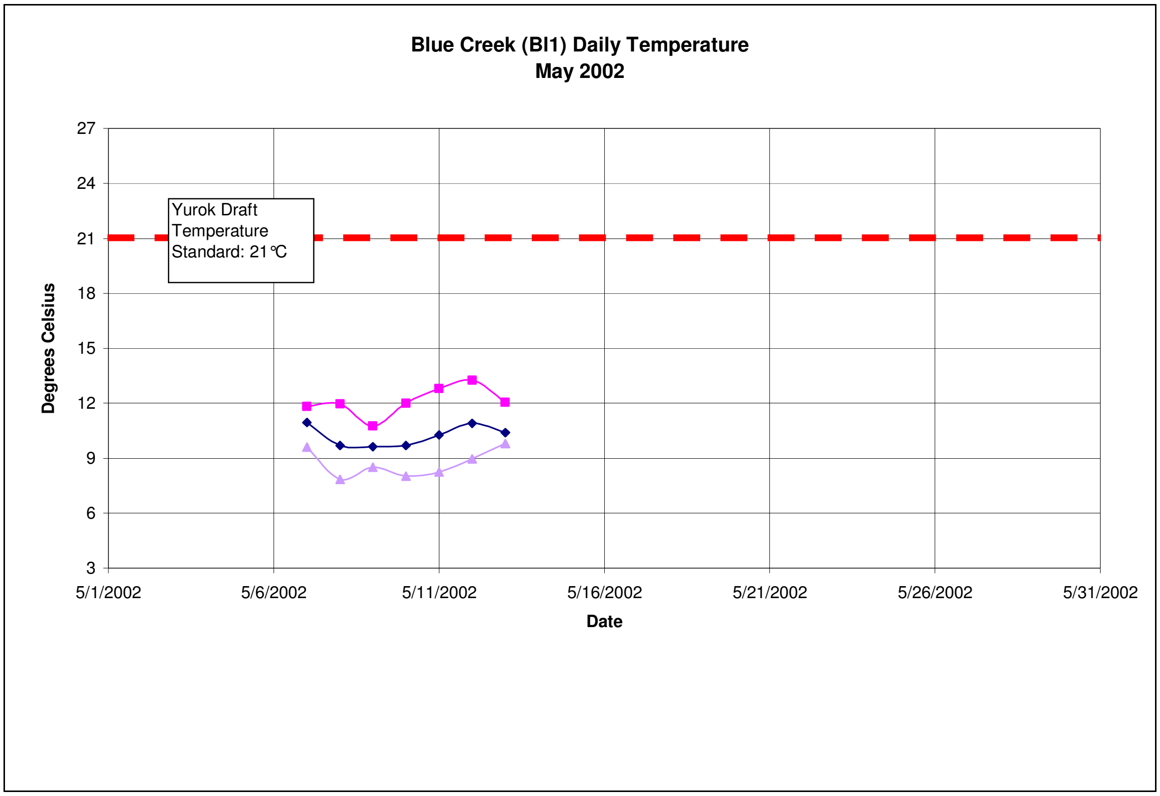

Figure 7-98 Water Temperature Values for Blue Creek May 2002

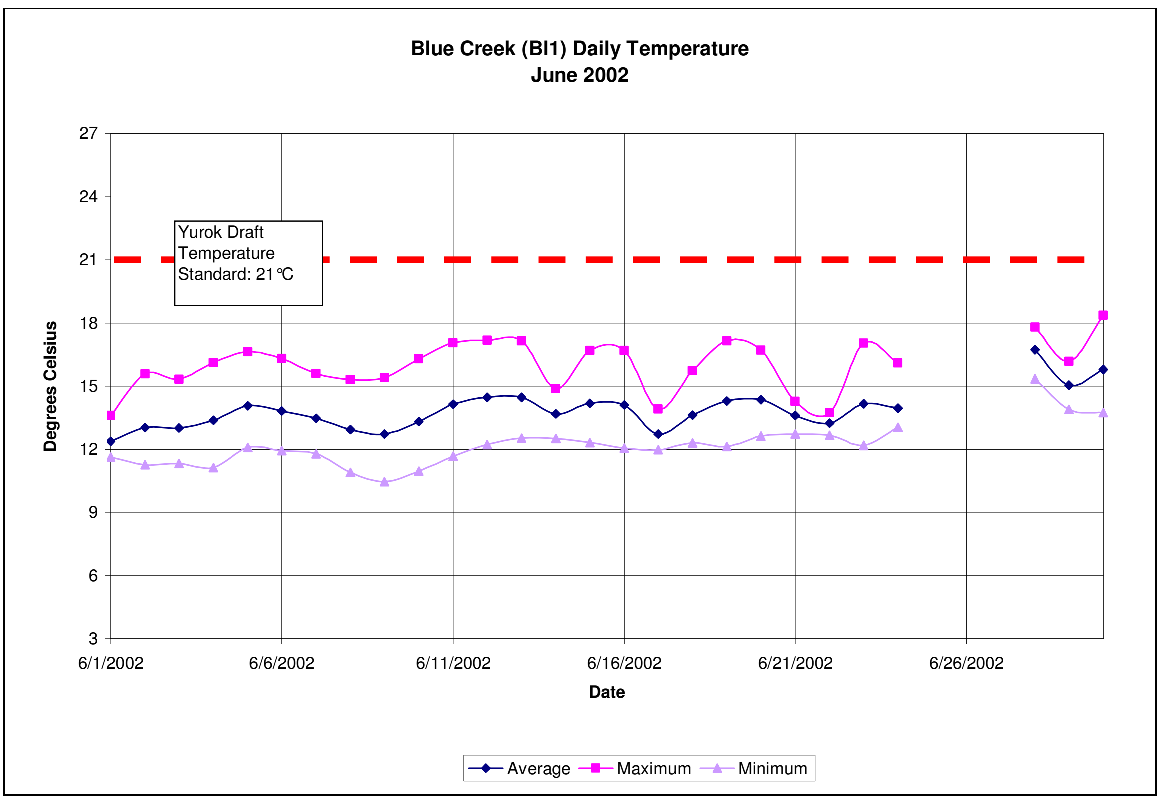

Figure 7-99 Water Temperature Values for Blue Creek June 2002

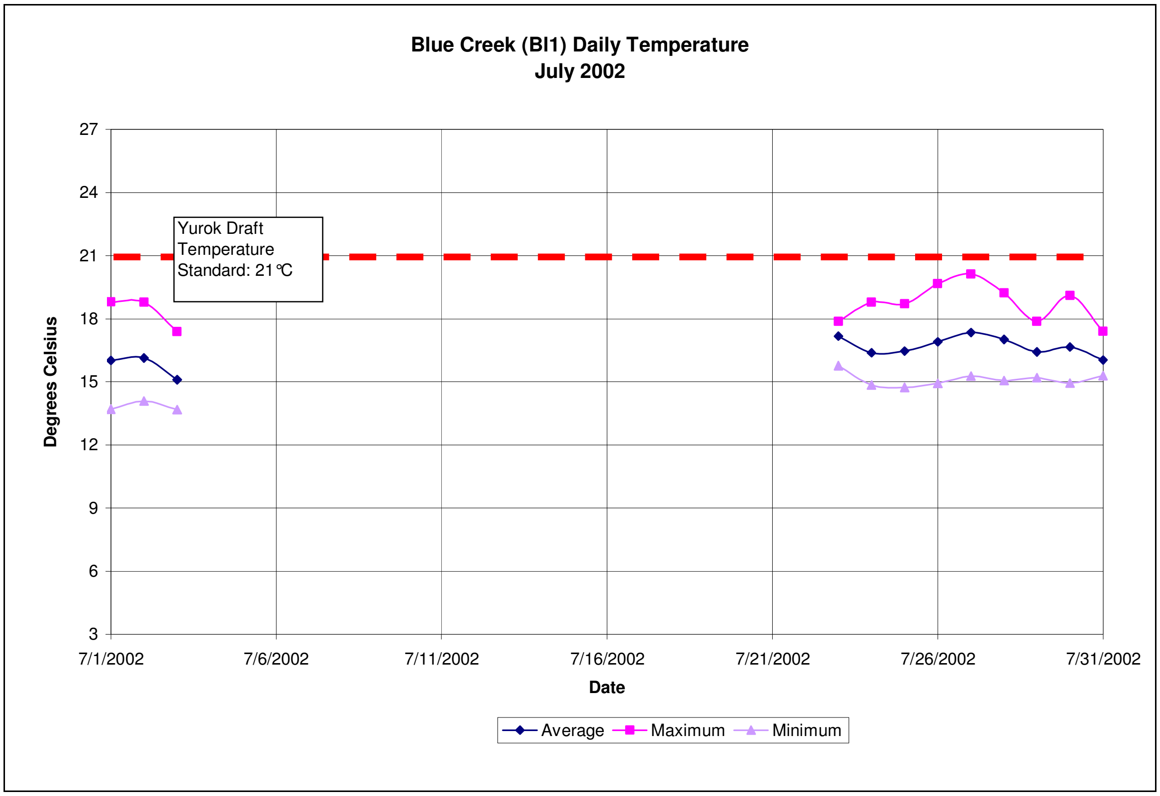

Figure 7-100 Water Temperature Values for Blue Creek July 2002

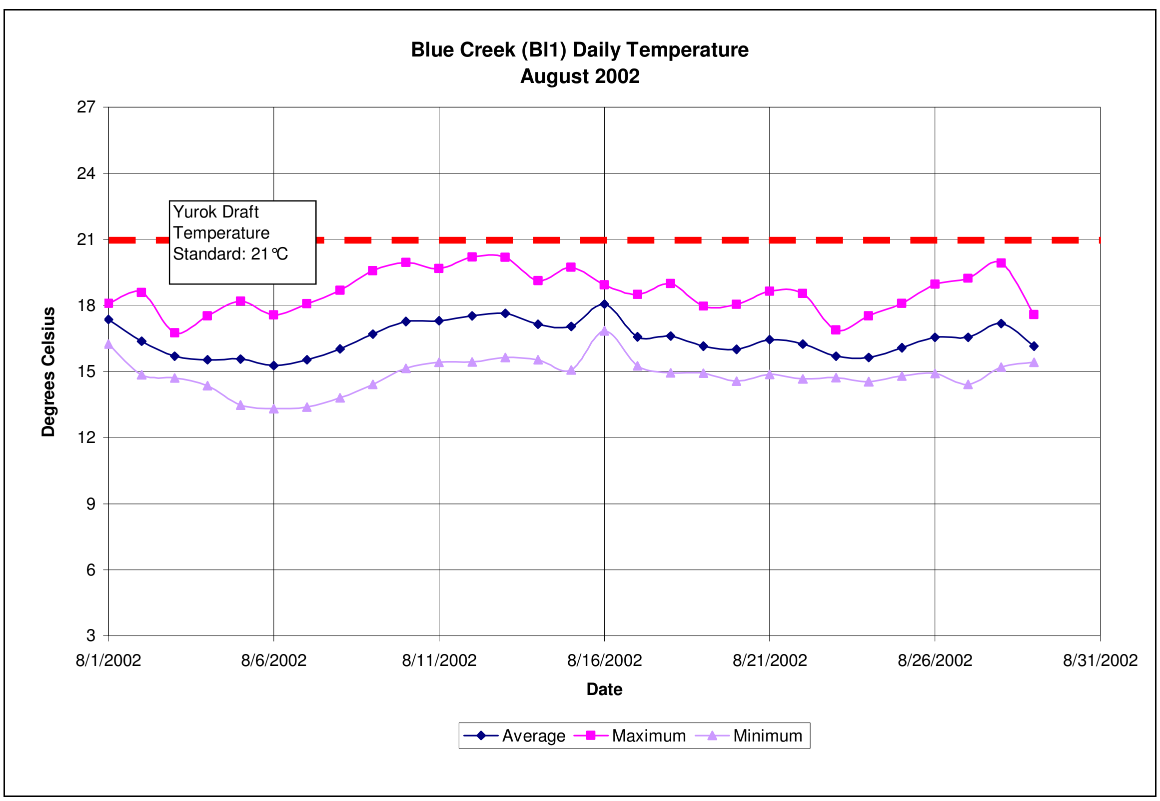

Figure 7-101 Water Temperature Values for Blue Creek August 2002

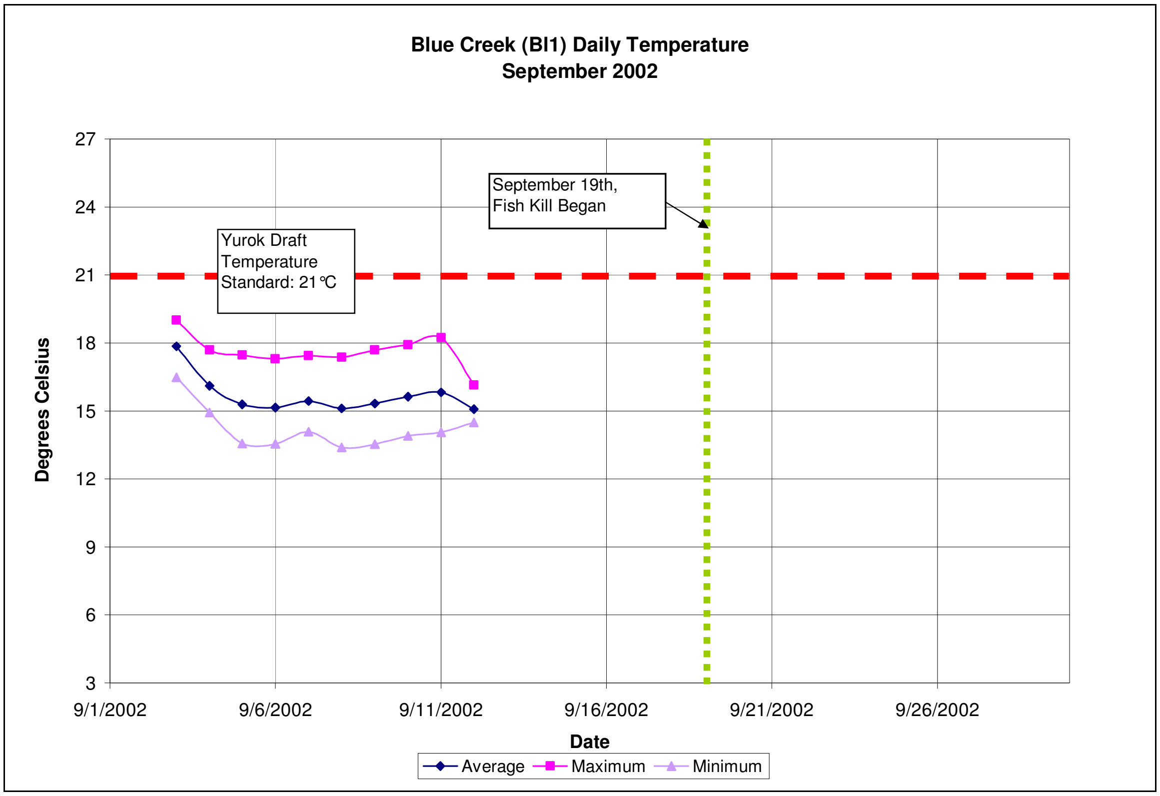

Figure 7-102 Water Temperature Values for Blue Creek September 2002

7.2.1.2 Dissolved Oxygen

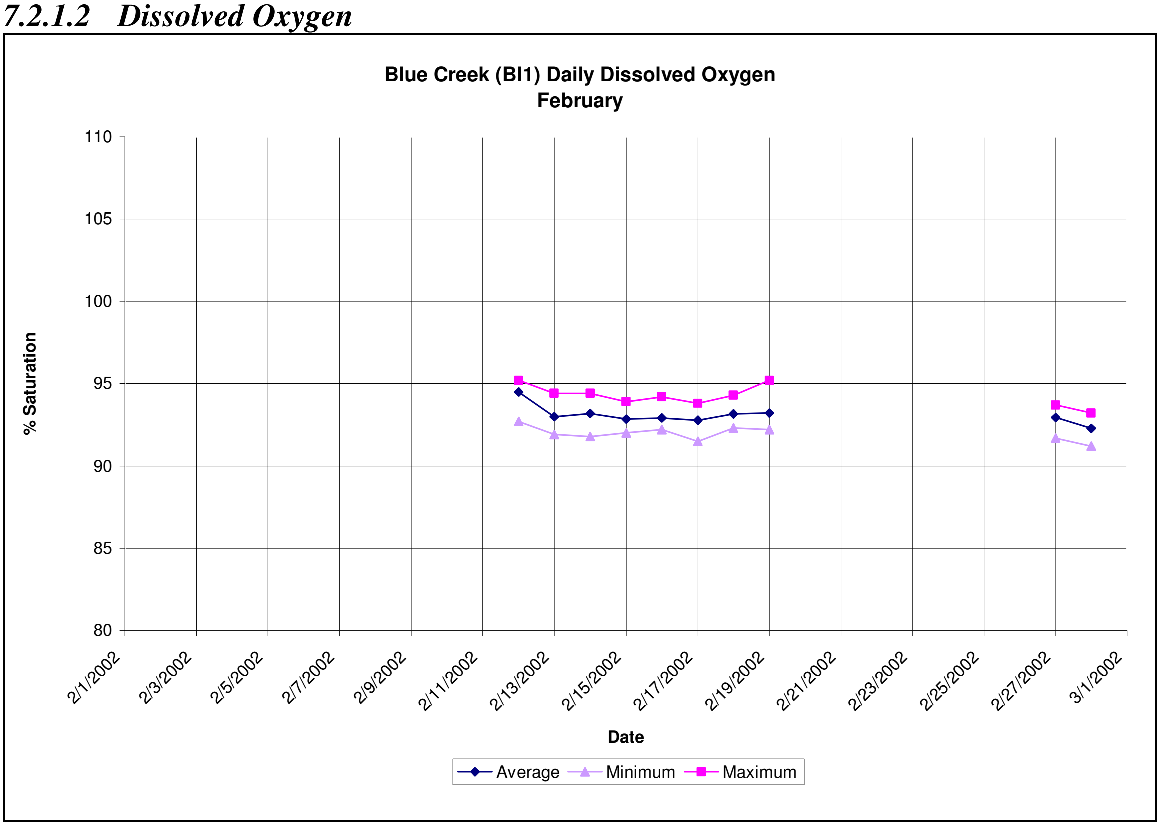

Figure 7-103 Dissolved Oxygen Values for Blue Creek February 2002

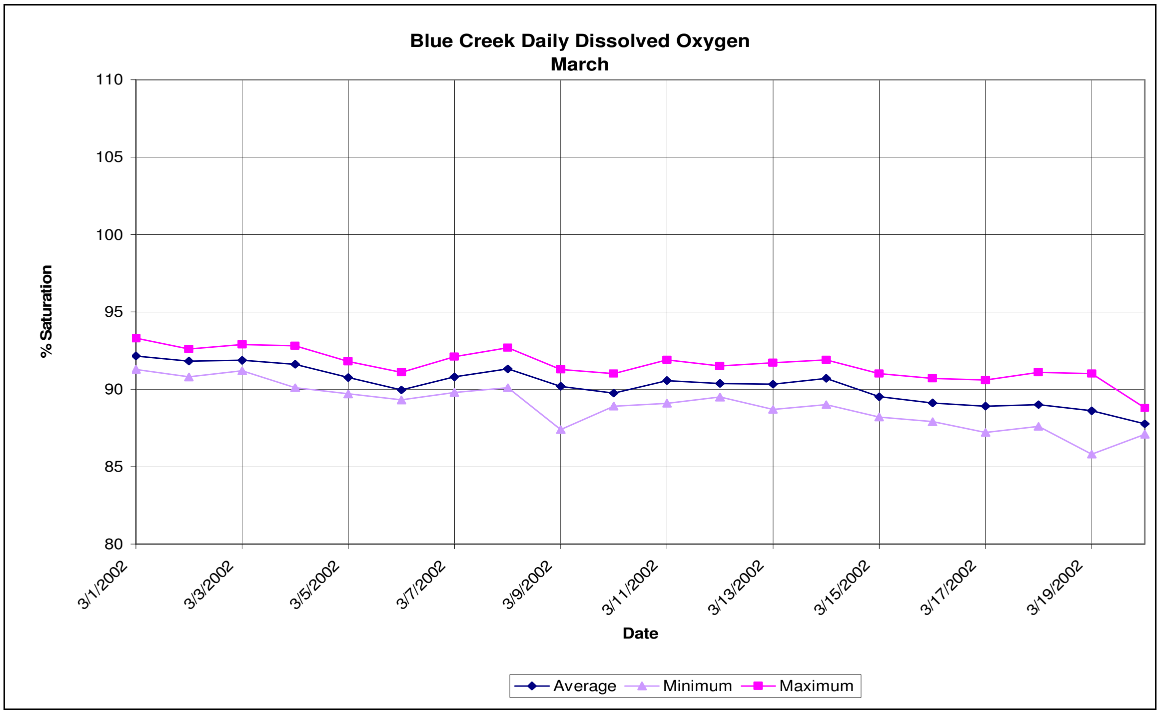

Figure 7-104 Dissolved Oxygen Values for Blue Creek March 2002

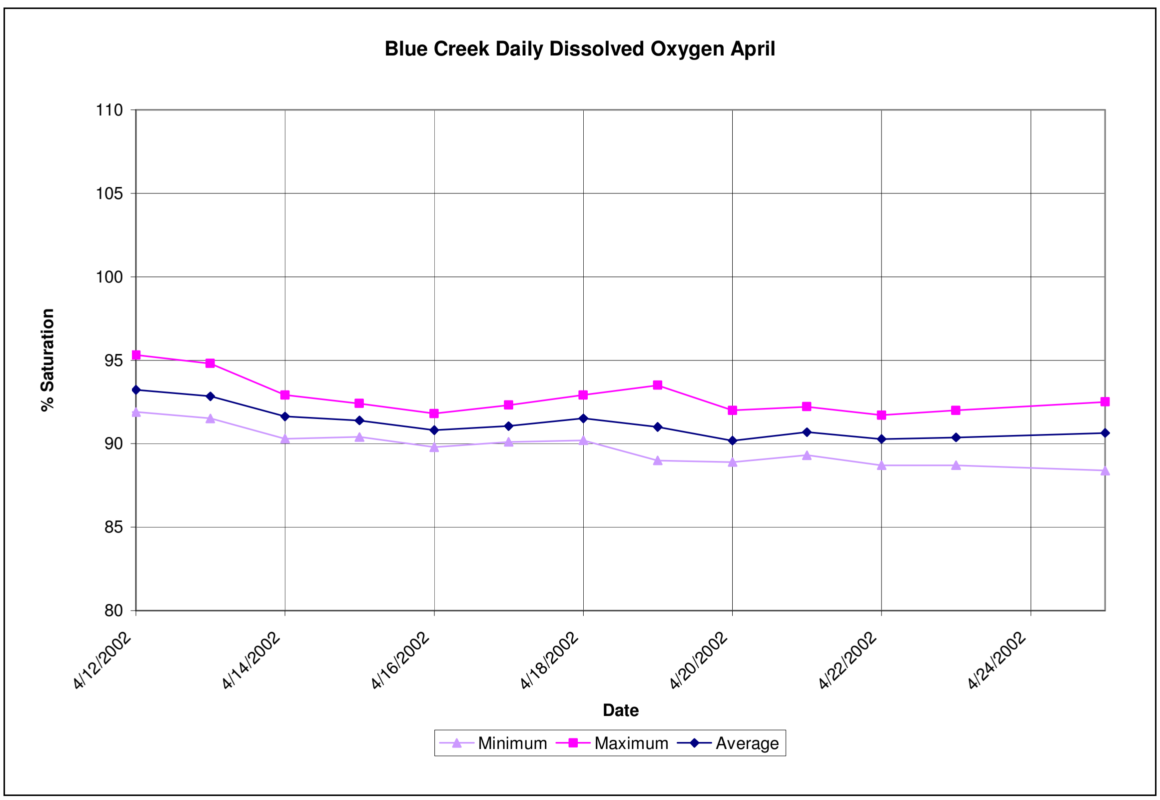

Figure 7-105 Dissolved Oxygen Values for Blue Creek April 2002

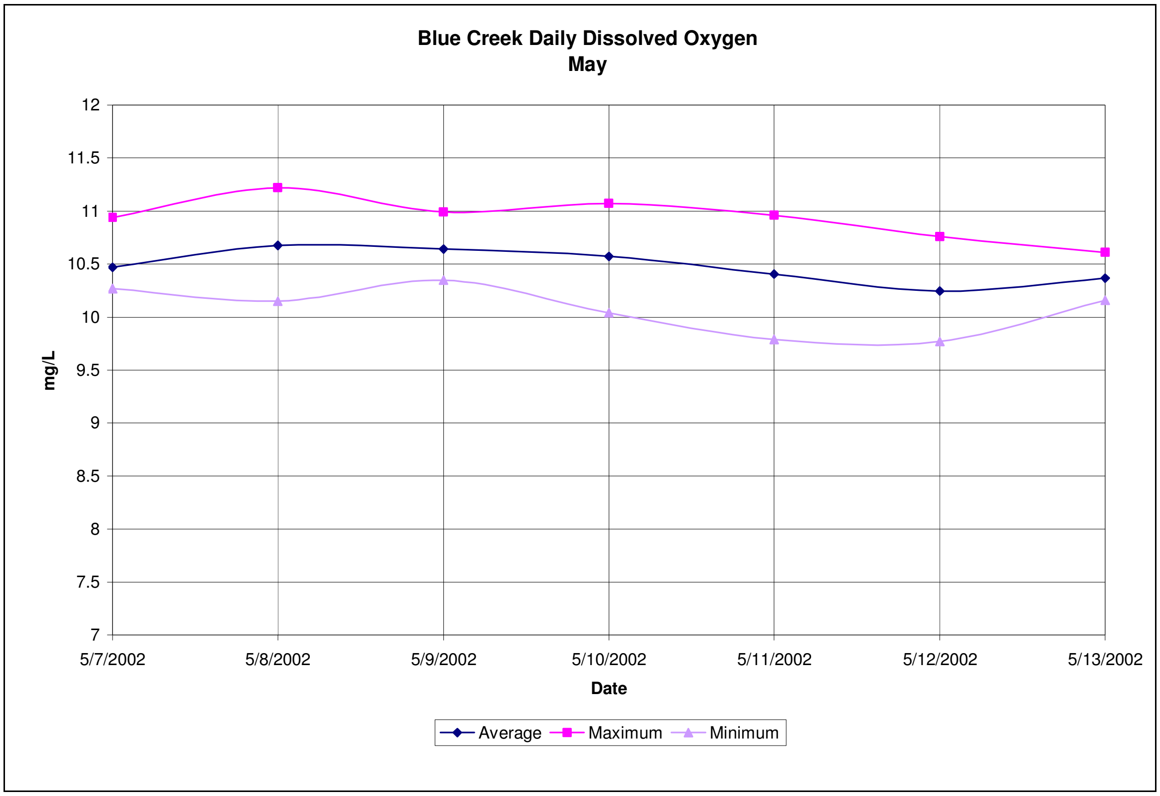

Figure 7-106 Dissolved Oxygen Values for Blue Creek May 2002

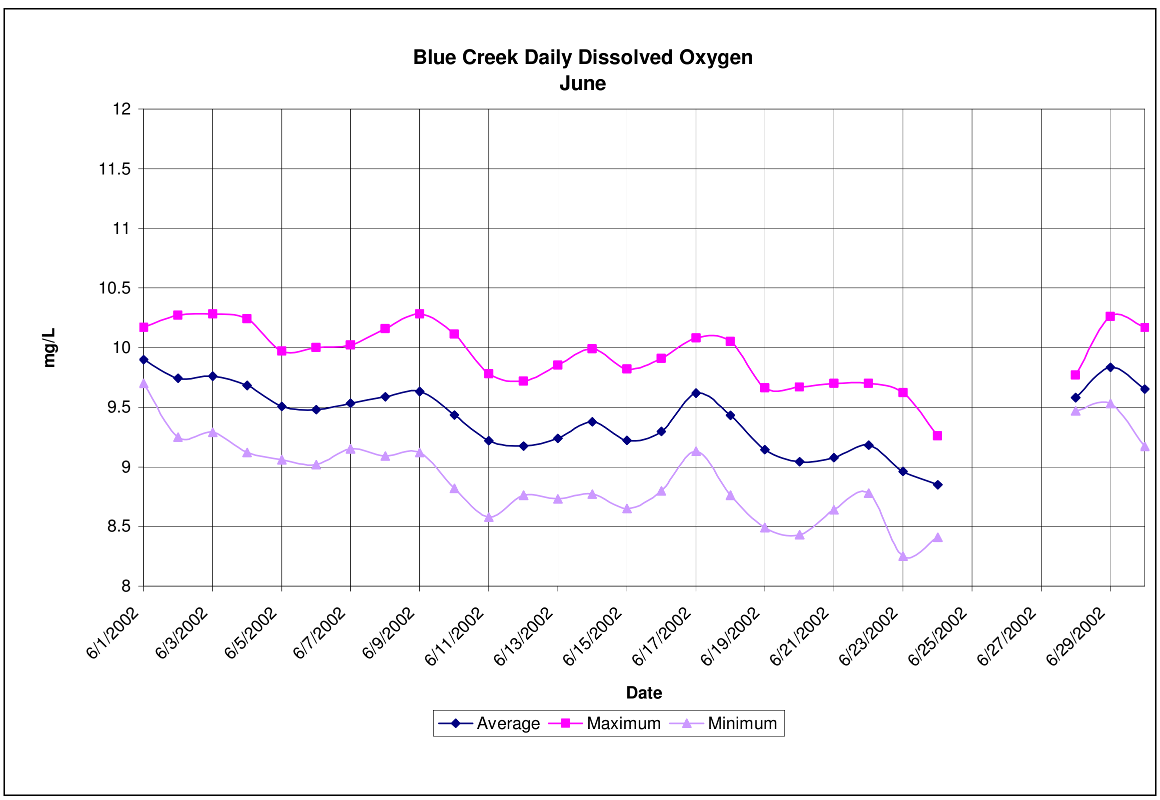

Figure 7-107 Dissolved Oxygen Values for Blue Creek June 2002

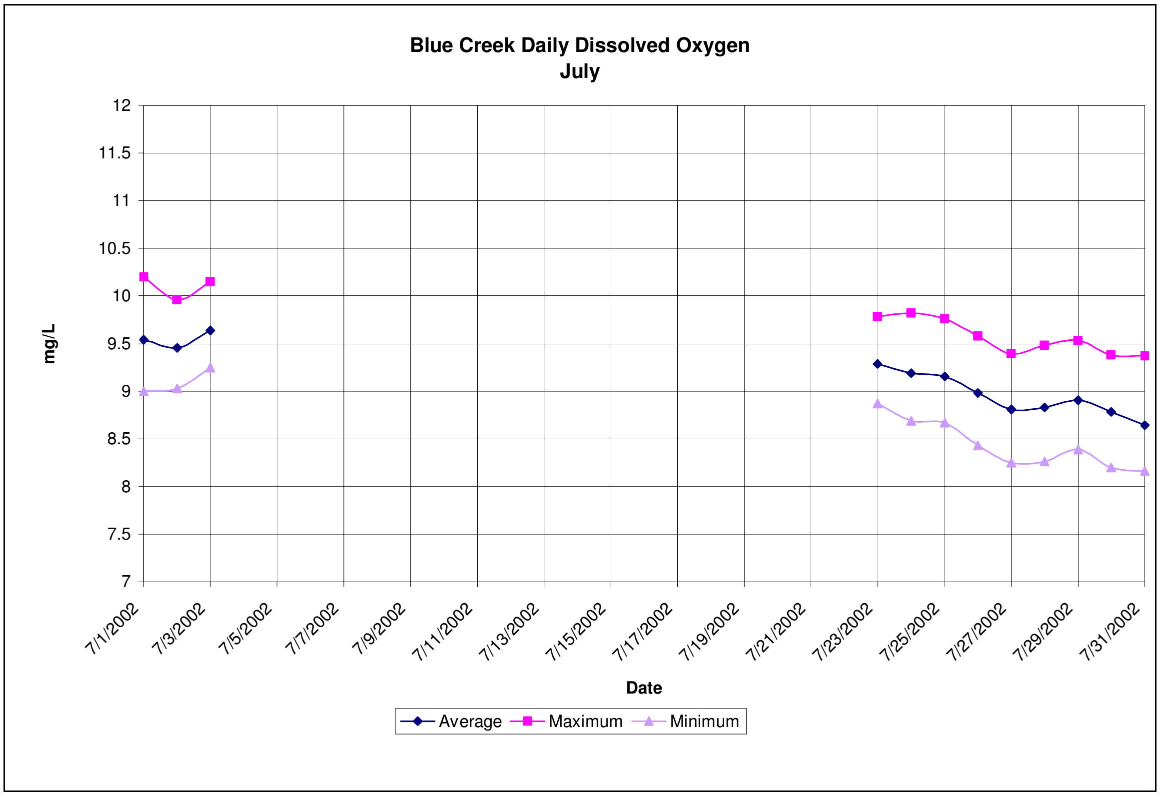

Figure 7-108 Dissolved Oxygen Values for Blue Creek July 2002

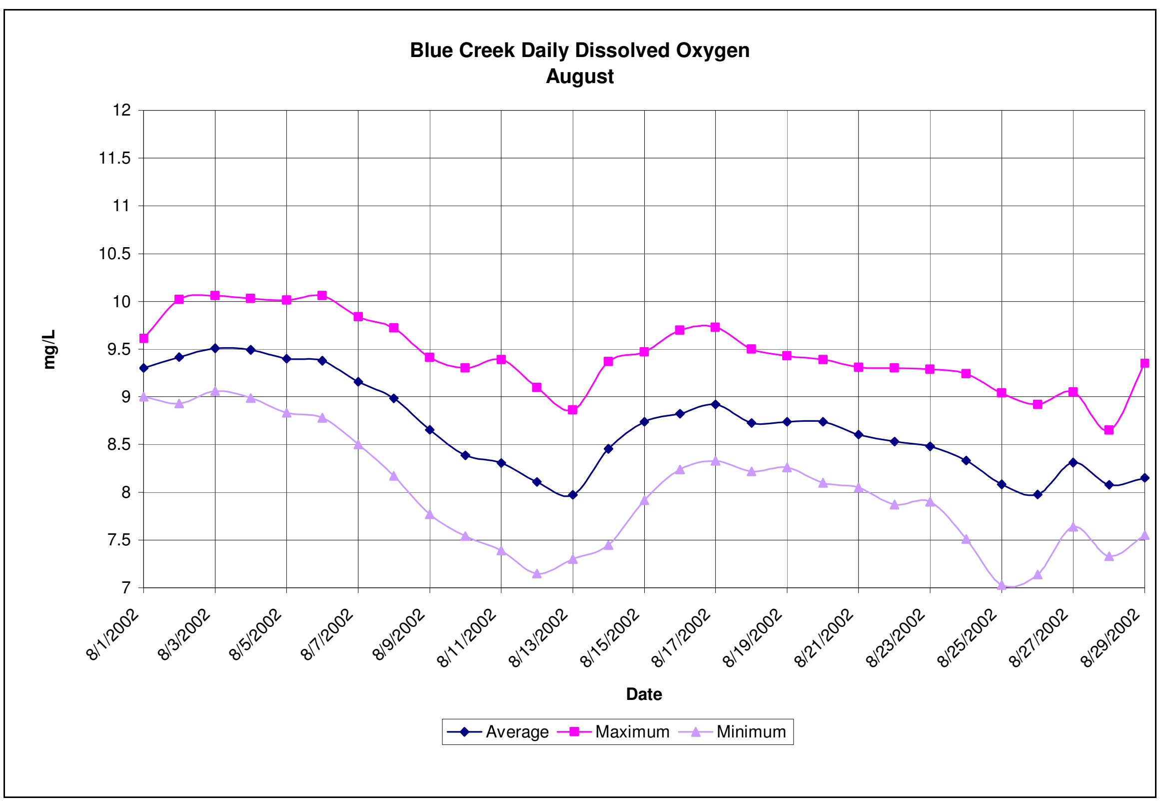

Figure 7-109 Dissolved Oxygen Values for Blue Creek August 2002

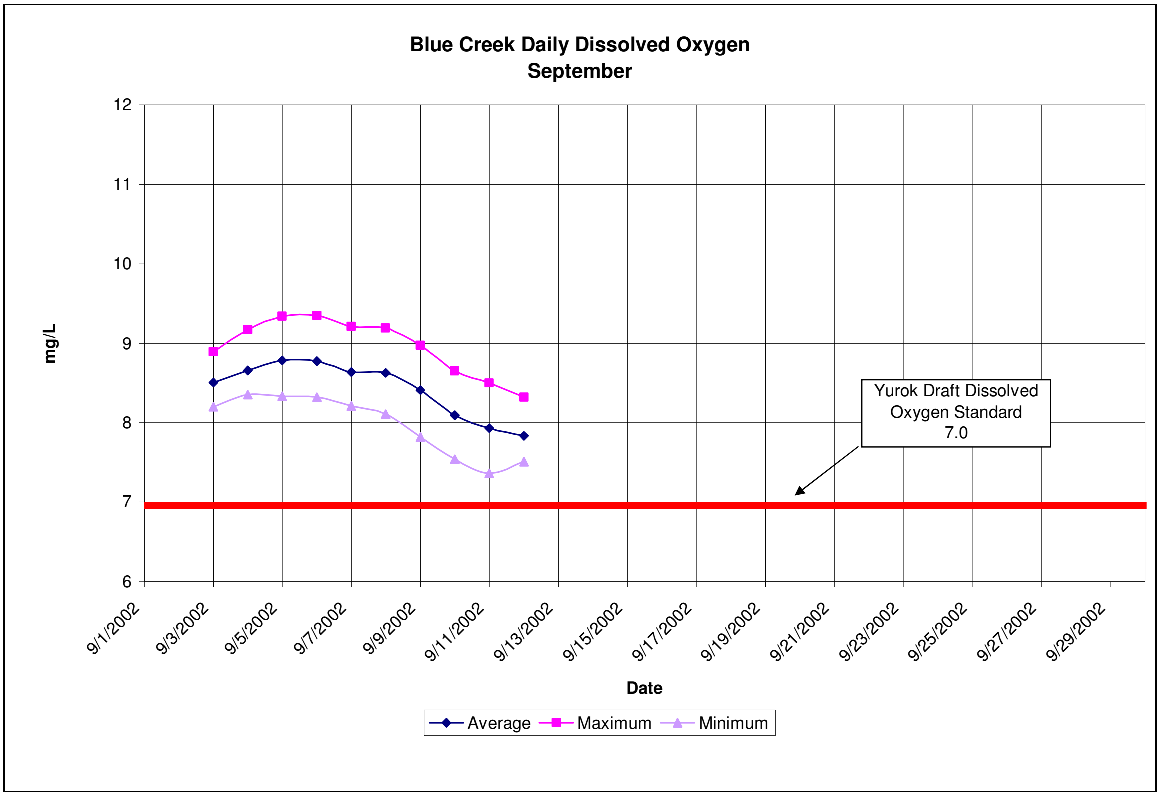

Figure 7-110 Dissolved Oxygen Values for Blue Creek September 2002

7.2.1.3 pH

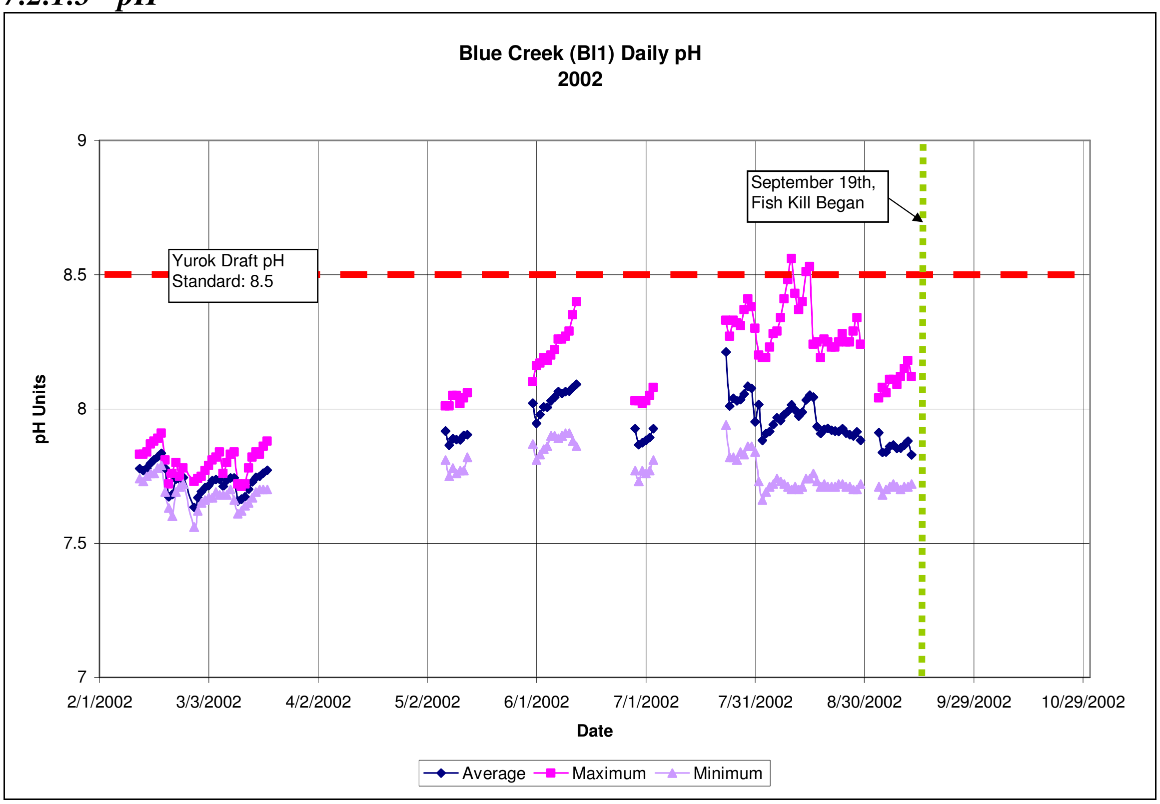

Figure 7-111 pH Values for Blue Creek WY02

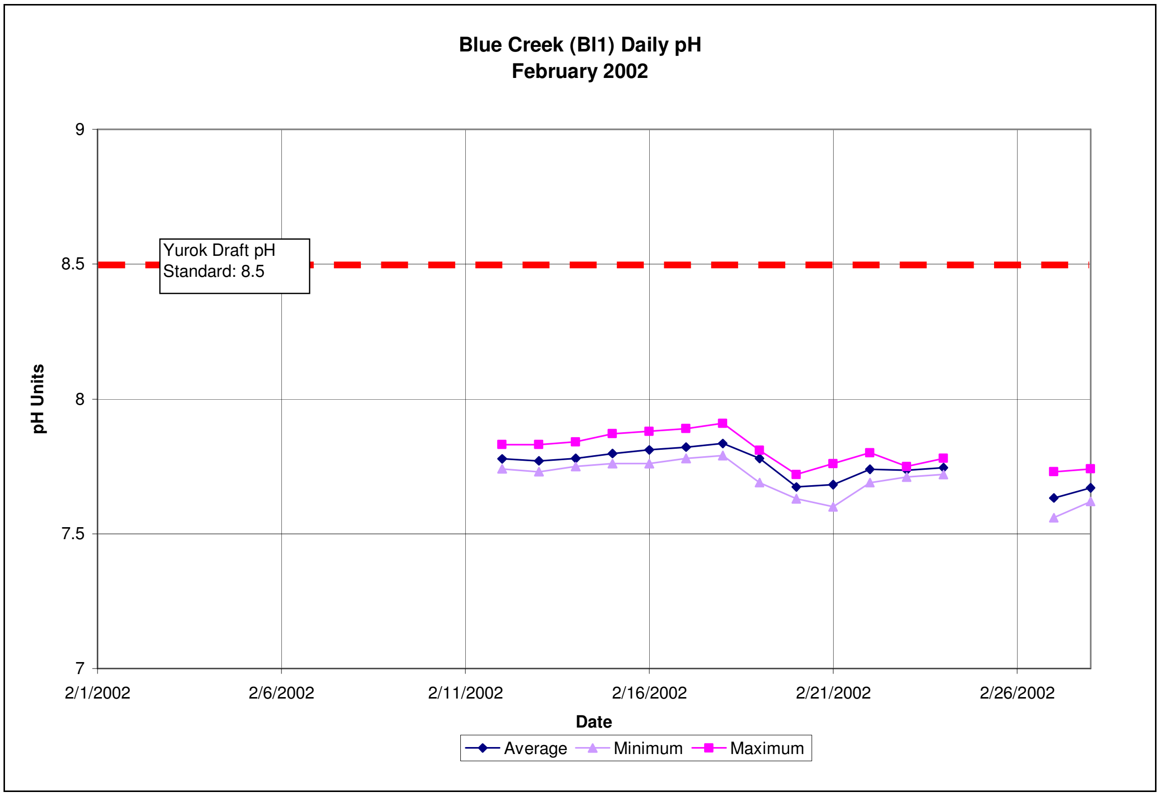

Figure 7-112 pH Values for Blue Creek February 2002

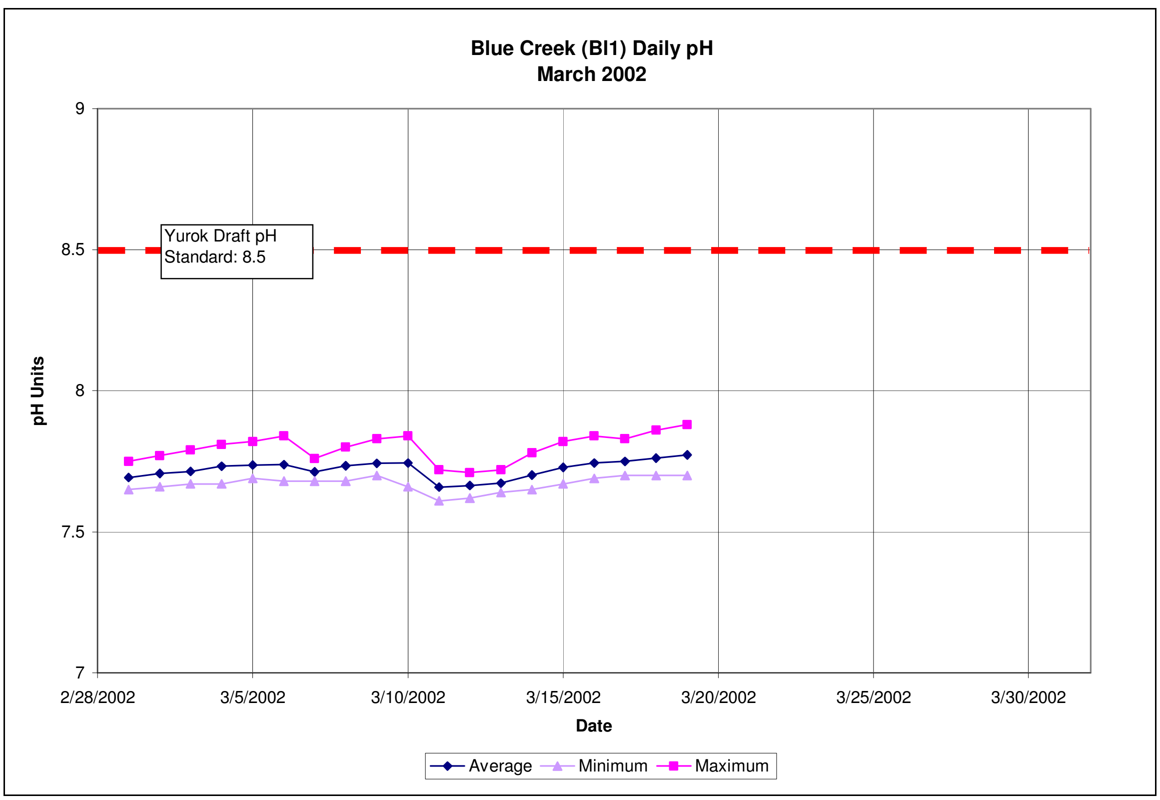

Figure 7-113 pH Values for Blue Creek March 2002

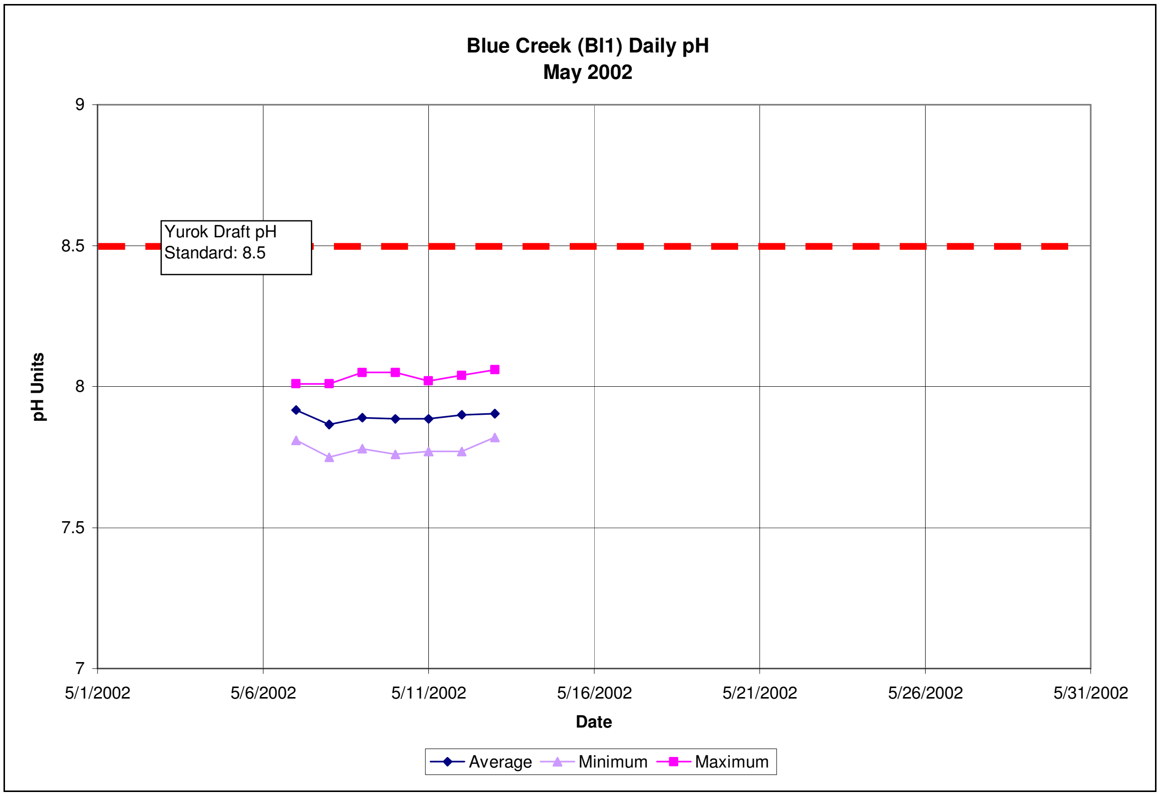

Figure 7-114 pH Values for Blue Creek May 2002

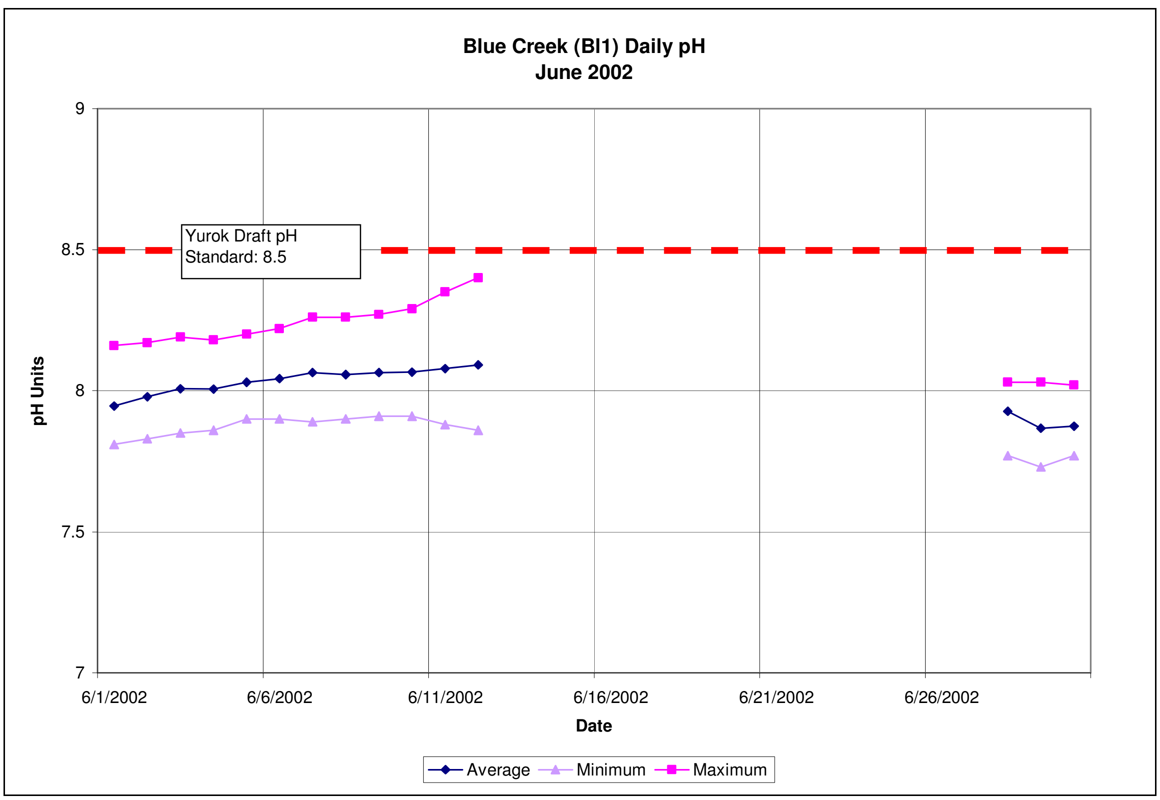

Figure 7-115 pH Values for Blue Creek June 2002

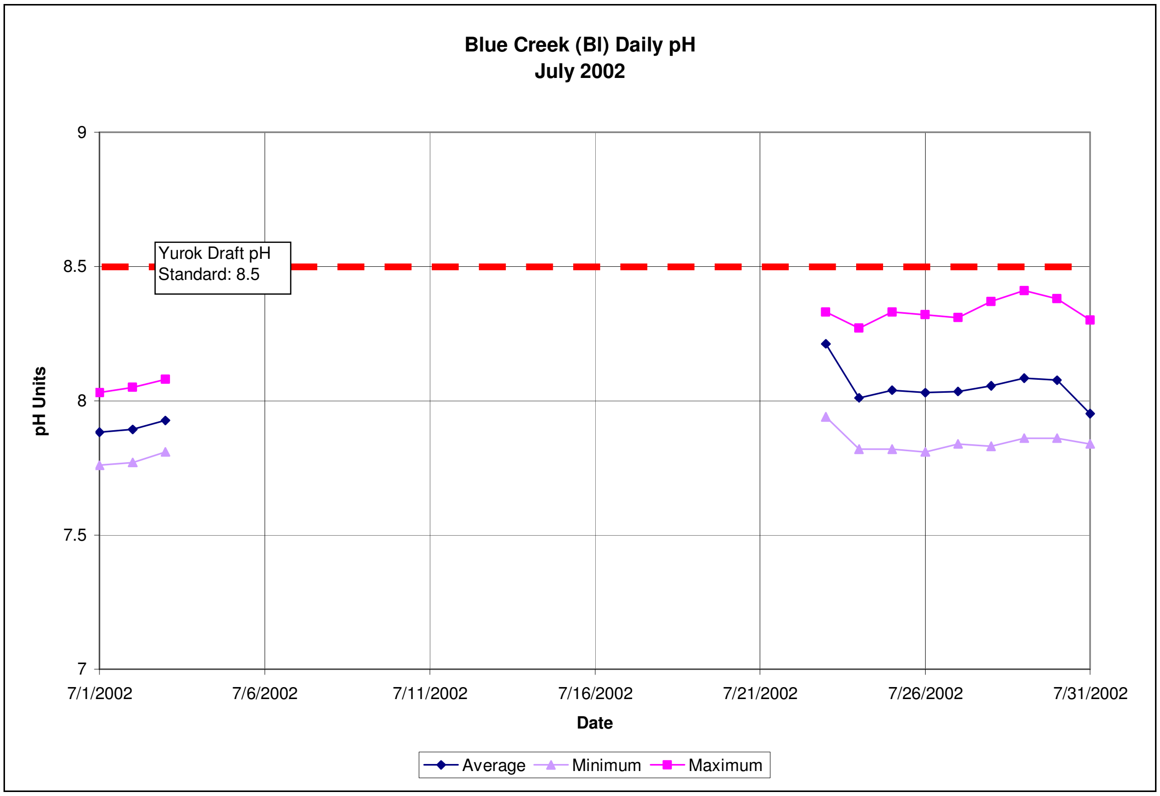

Figure 7-116 pH Values for Blue Creek July 2002

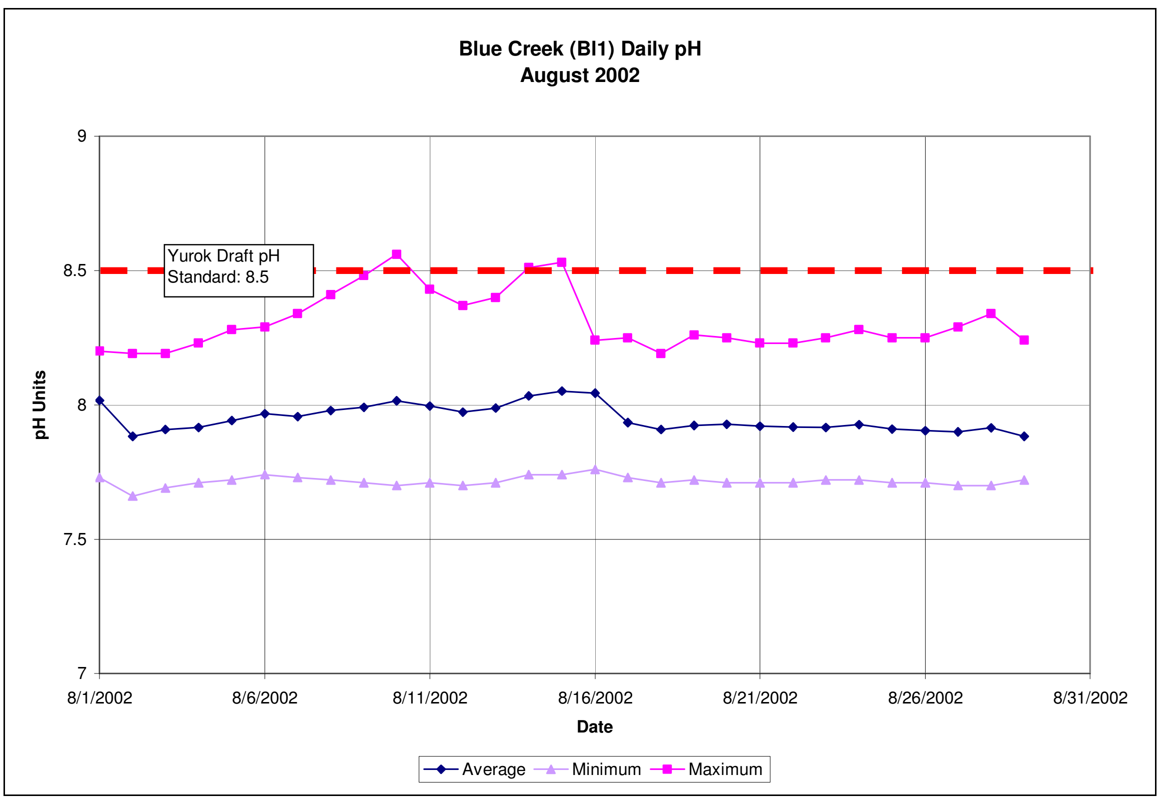

Figure 7-117 pH Values for Blue Creek August 2002

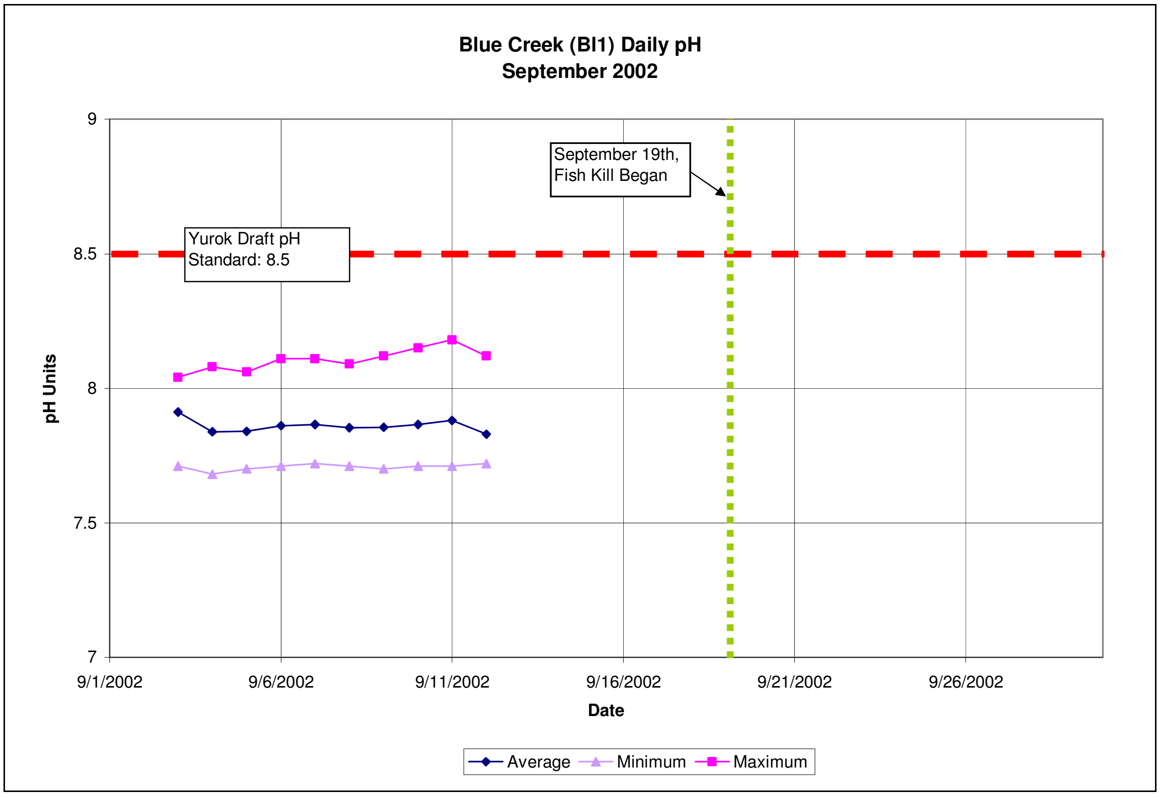

Figure 7-118 pH Values for Blue Creek September 2002

7.2.1.4 Specific Conductivity

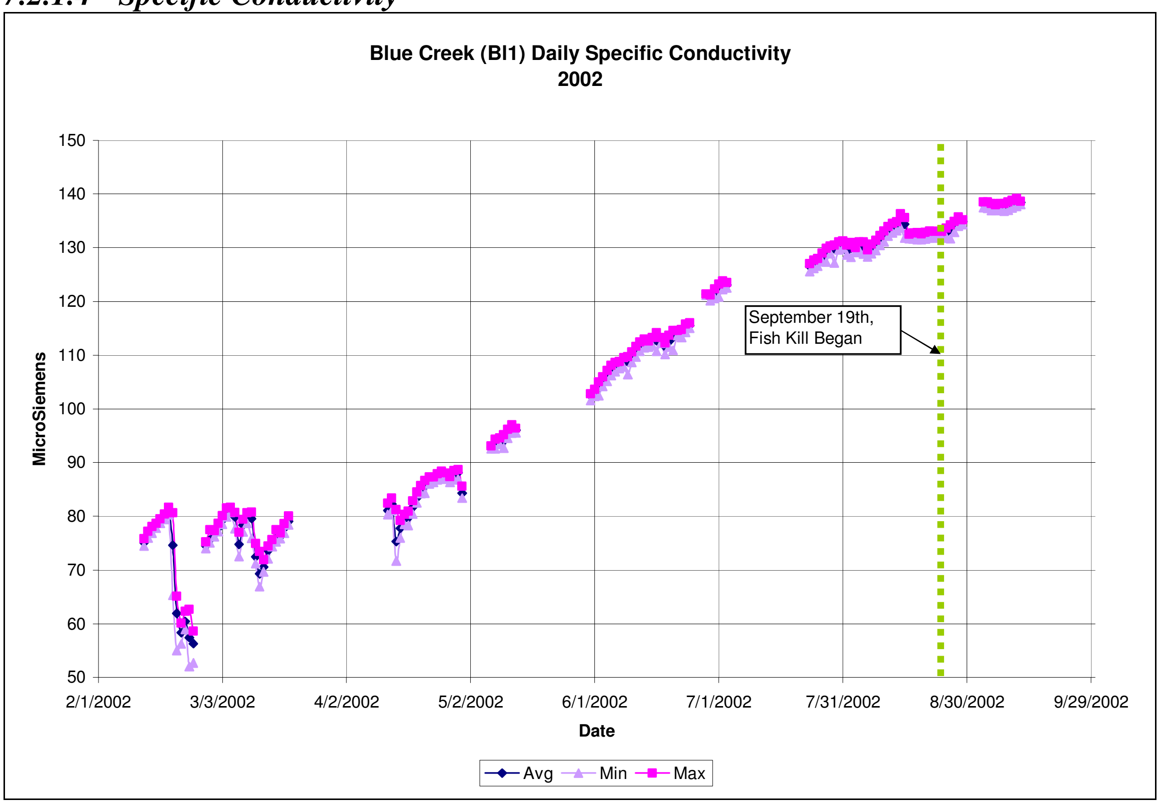

Figure 7-119 Specific Conductivity Values for Blue Creek WY02

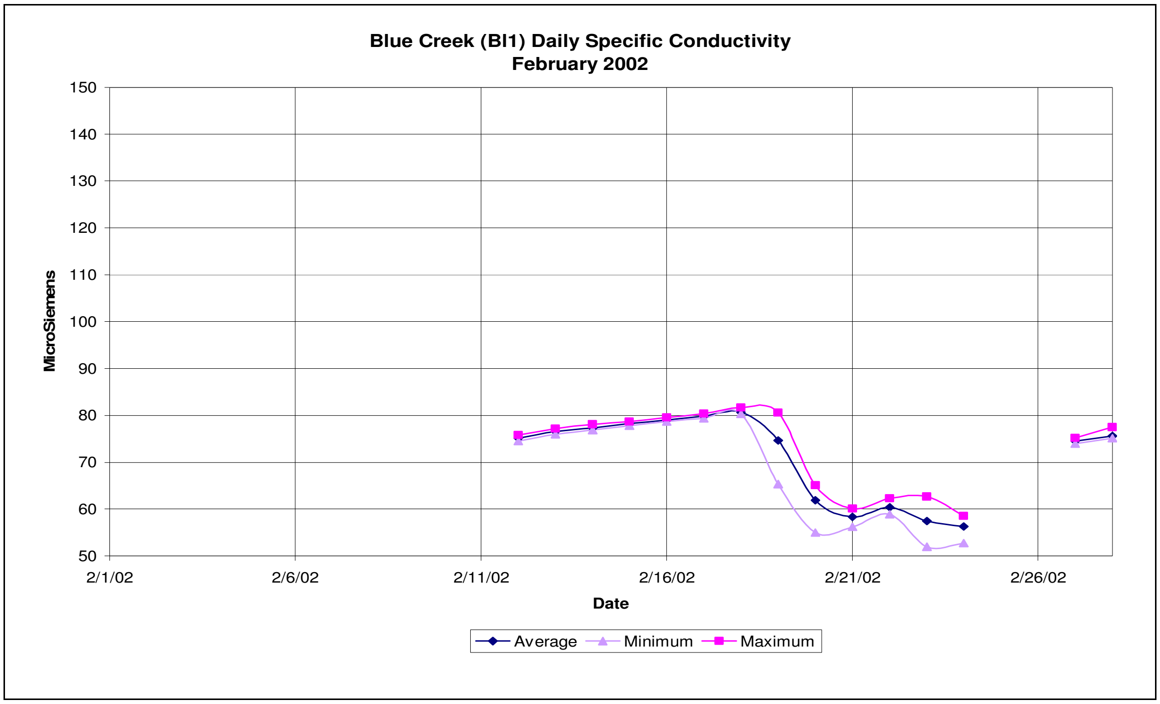

Figure 7-120 Specific Conductivity Values for Blue Creek February 2002

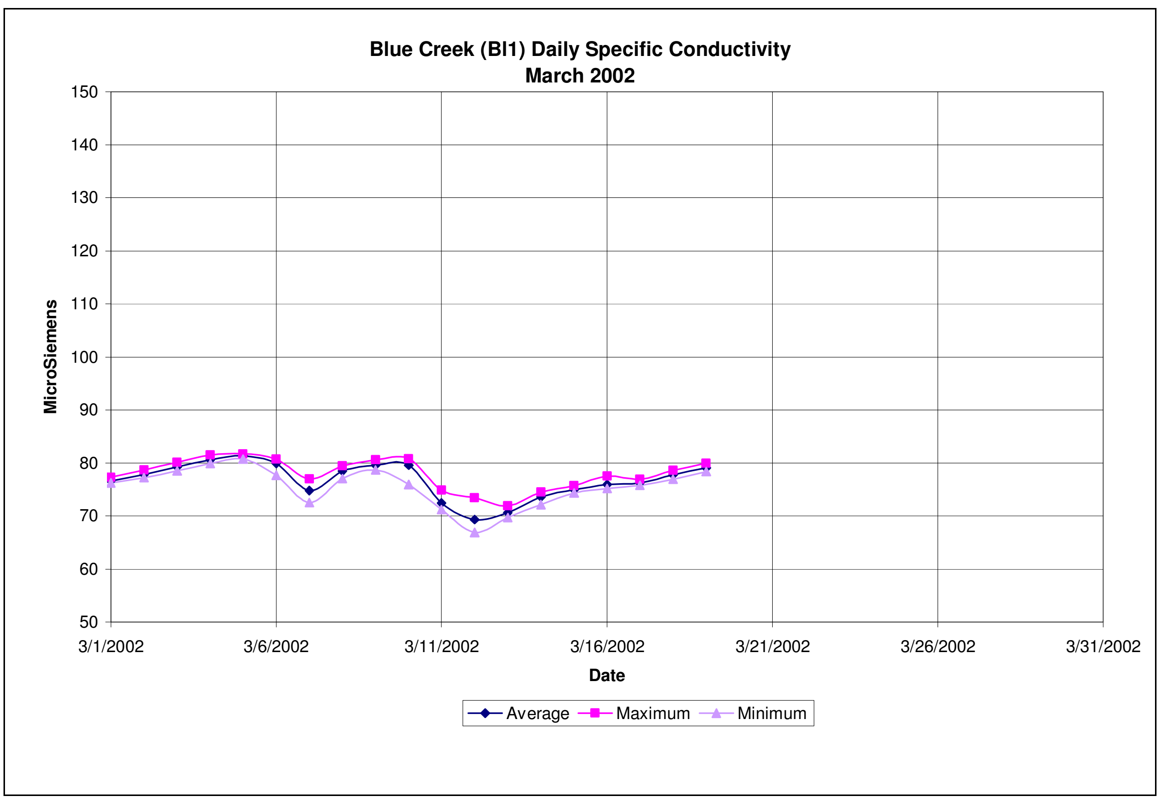

Figure 7-121 Specific Conductivity Values for Blue Creek March 2002

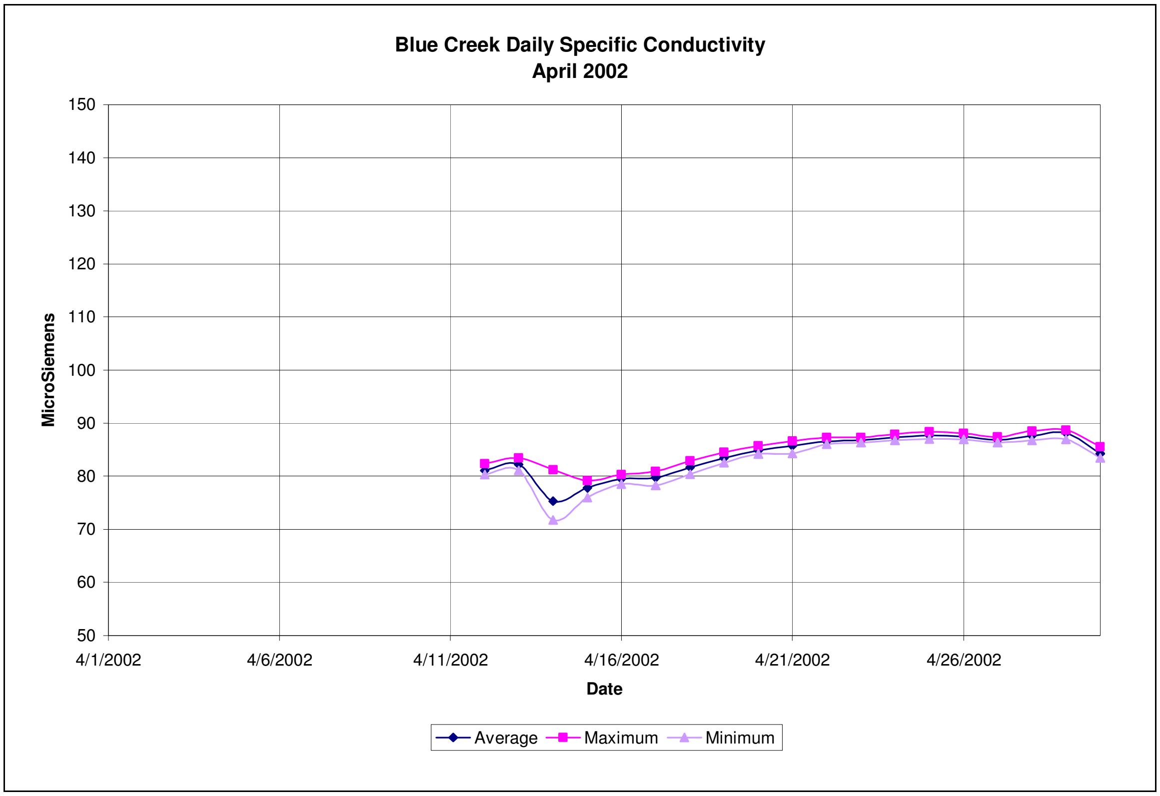

Figure 7-122 Specific Conductivity Values for Blue Creek April 2002

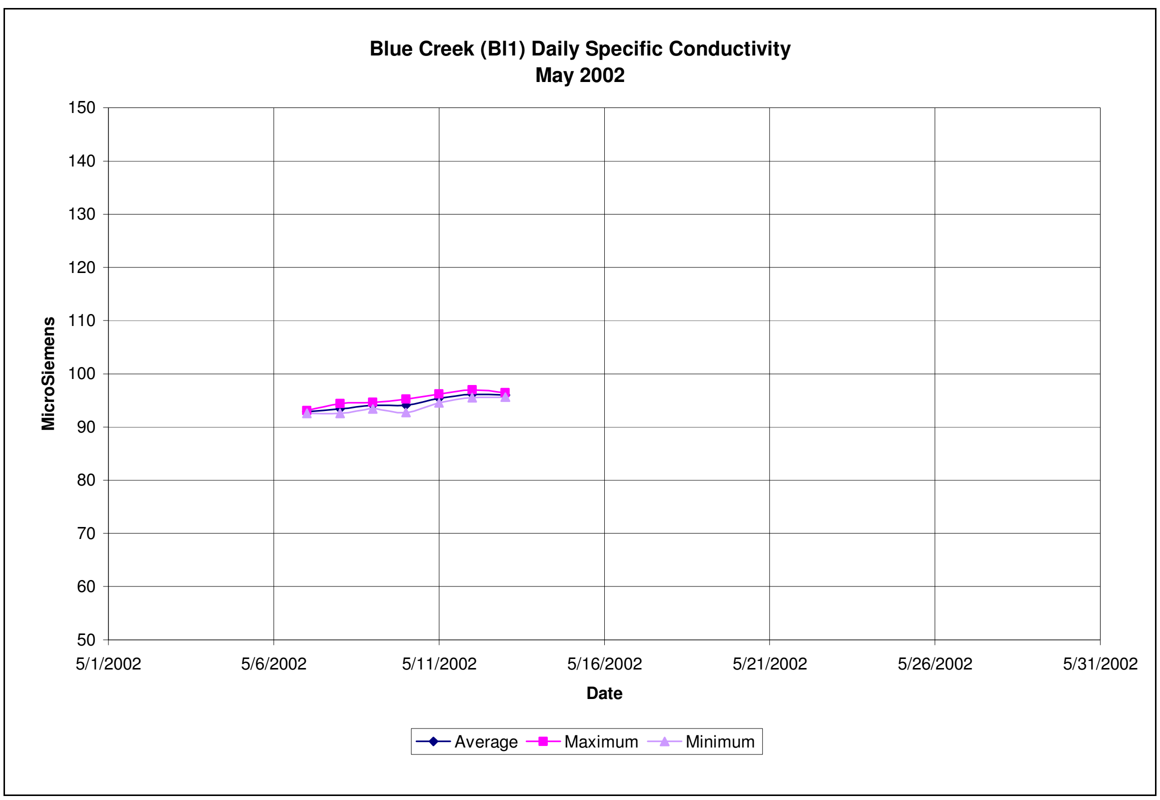

Figure 7-123 Specific Conductivity Values for Blue Creek May 2002

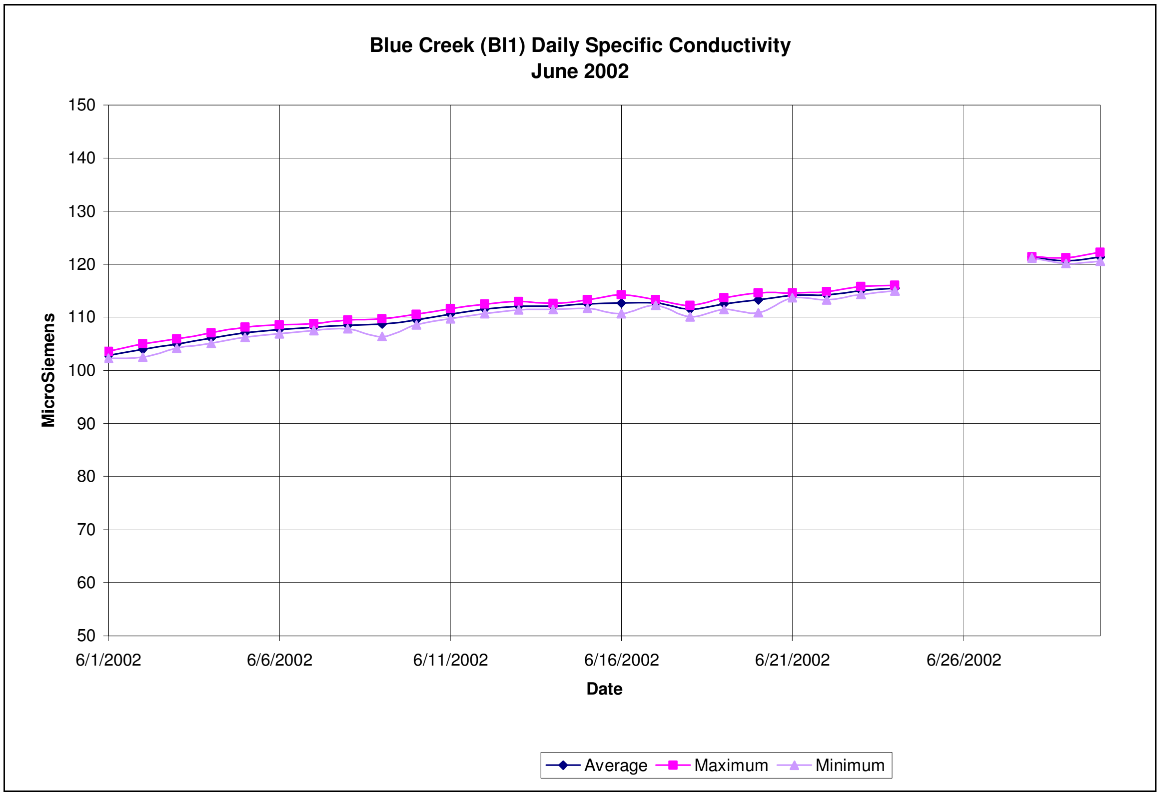

Figure 7-124 Specific Conductivity Values for Blue Creek June 2002

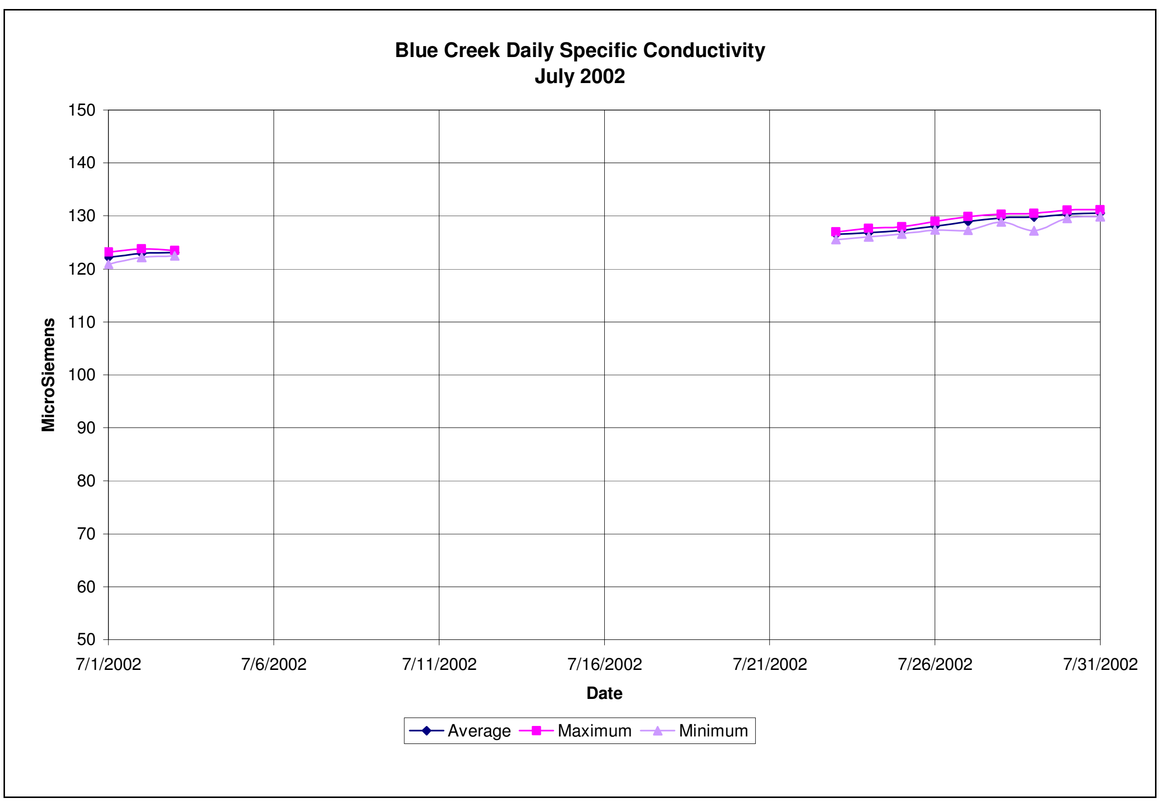

Figure 7-125 Specific Conductivity Values for Blue Creek July 2002

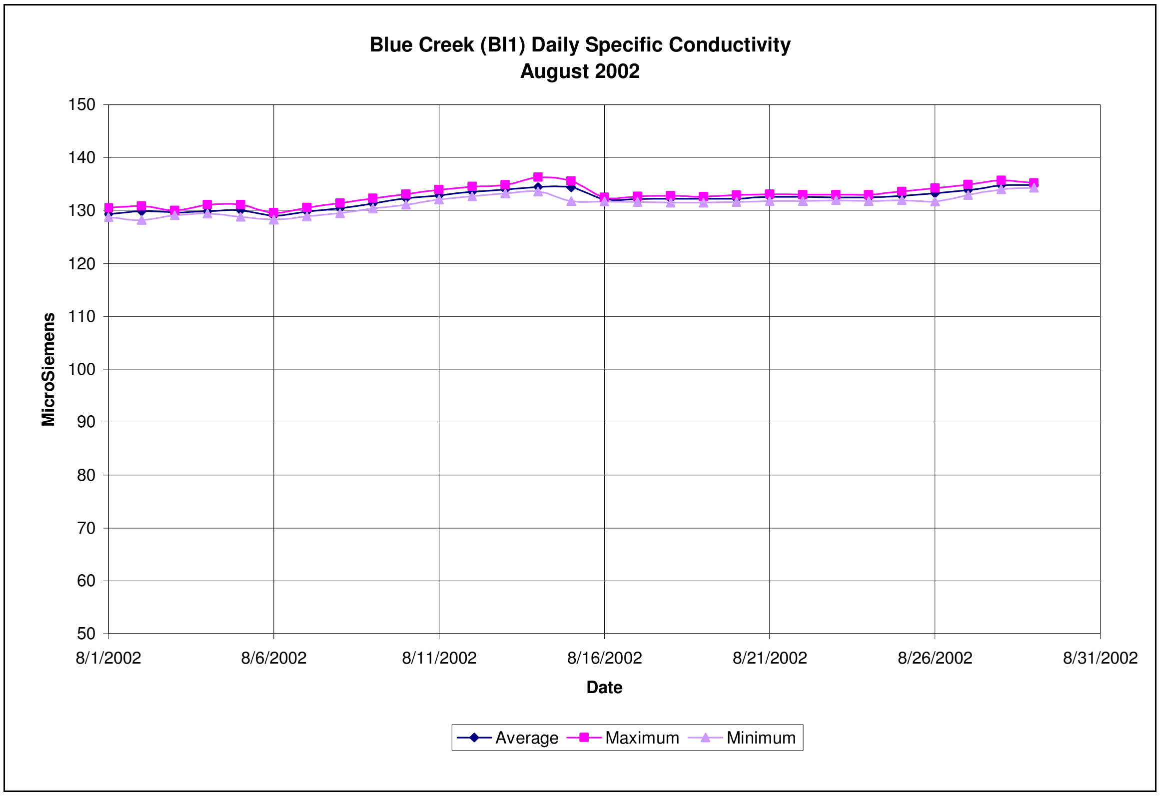

Figure 7-126 Specific Conductivity Values for Blue Creek August 2002

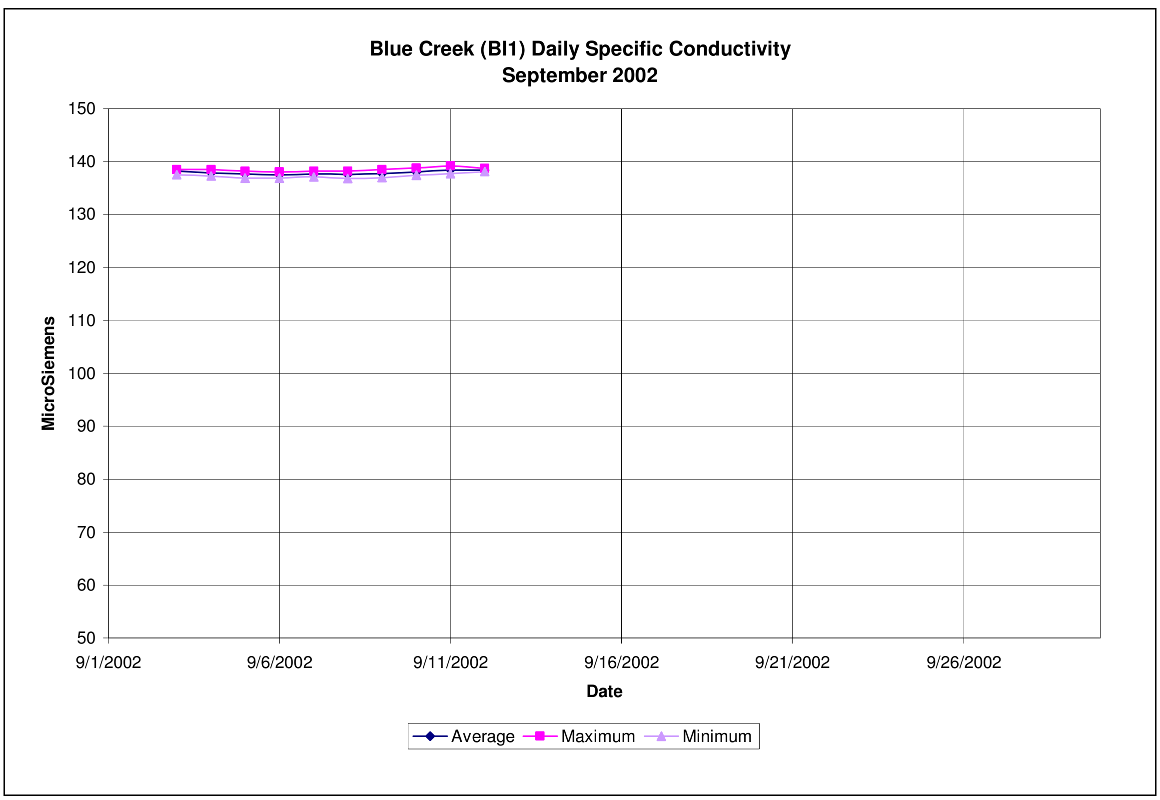

Figure 7-127 Specific Conductivity Values for Blue Creek September 2002

7.2.2 McGarvey Creek

7.2.2.1 Temperature

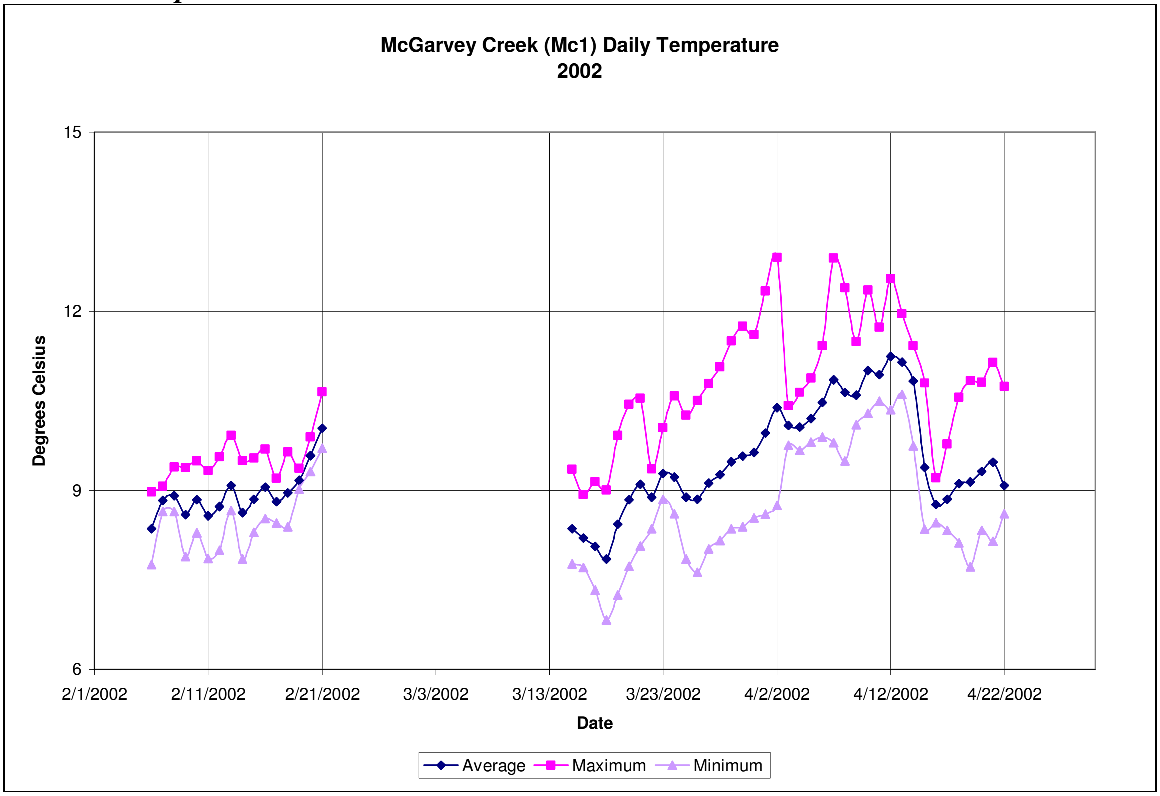

Figure 7-128 Temperature Values for McGarvey Creek WY02

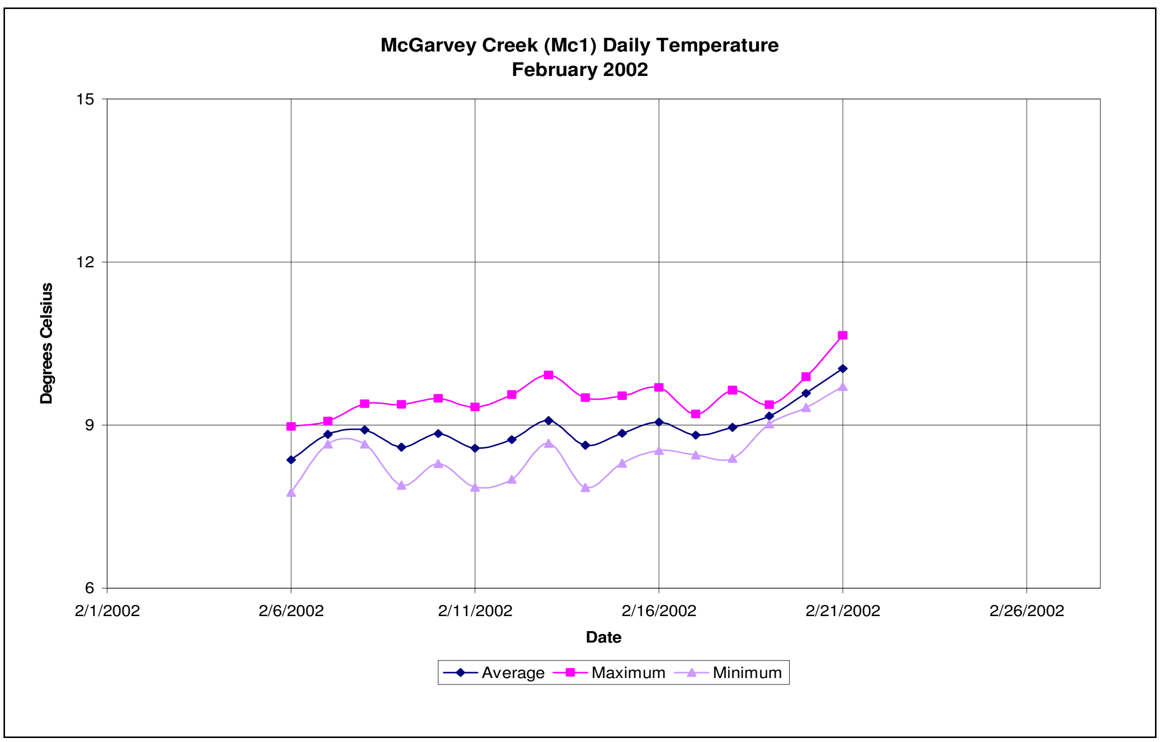

Figure 7-129 Temperature Values for McGarvey Creek February 2002

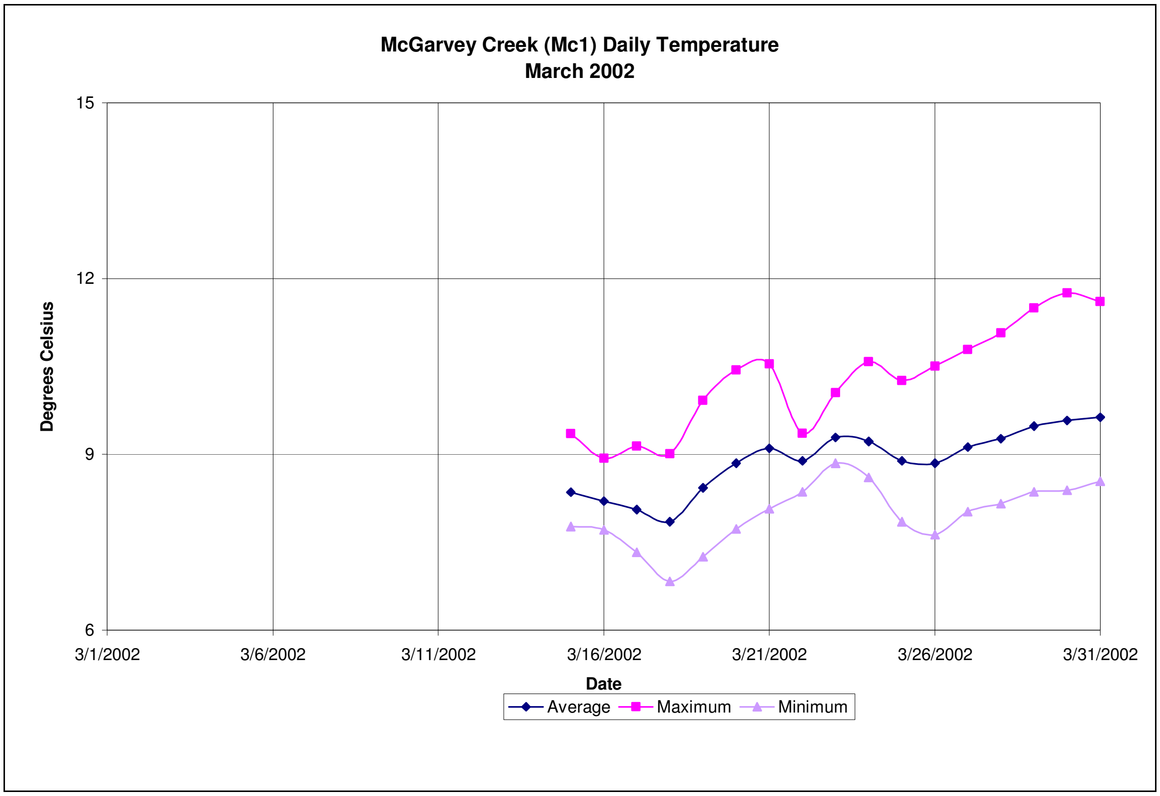

Figure 7-130 Temperature Values for McGarvey Creek March 2002

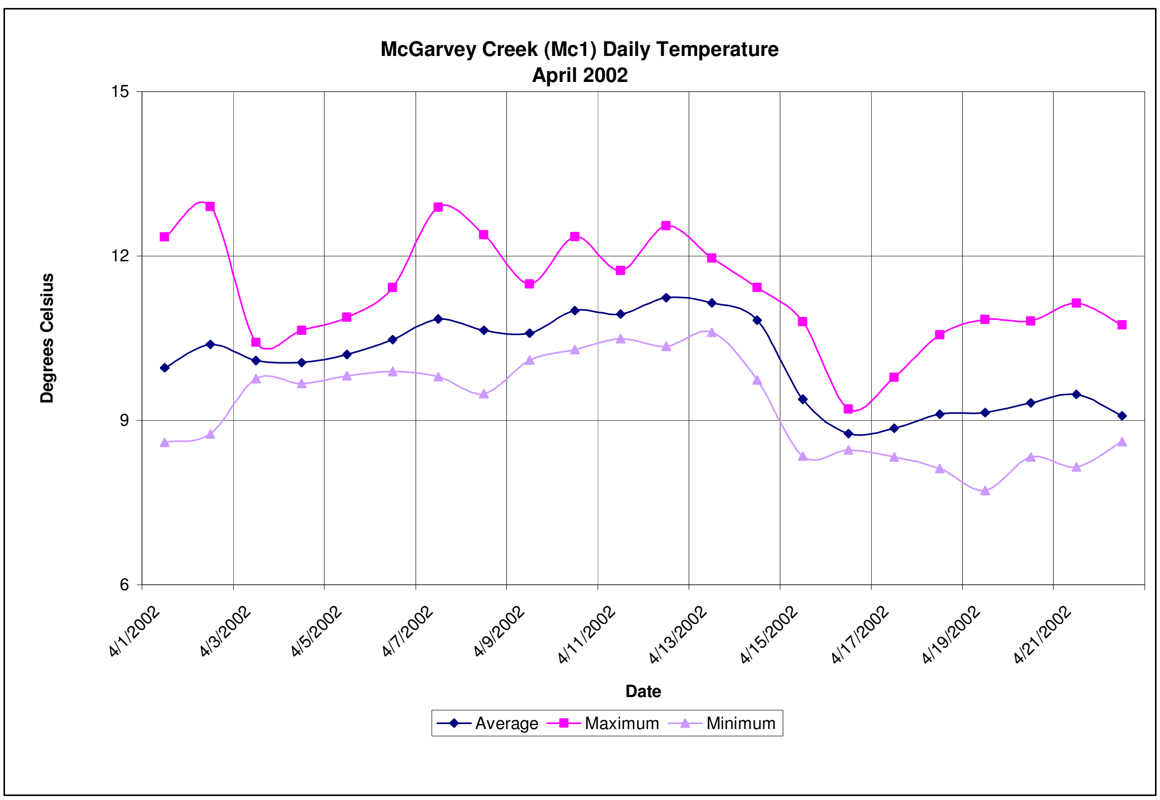

Figure 7-131 Temperature Values for McGarvey Creek April 2002

7.2.2.2 Dissolved Oxygen

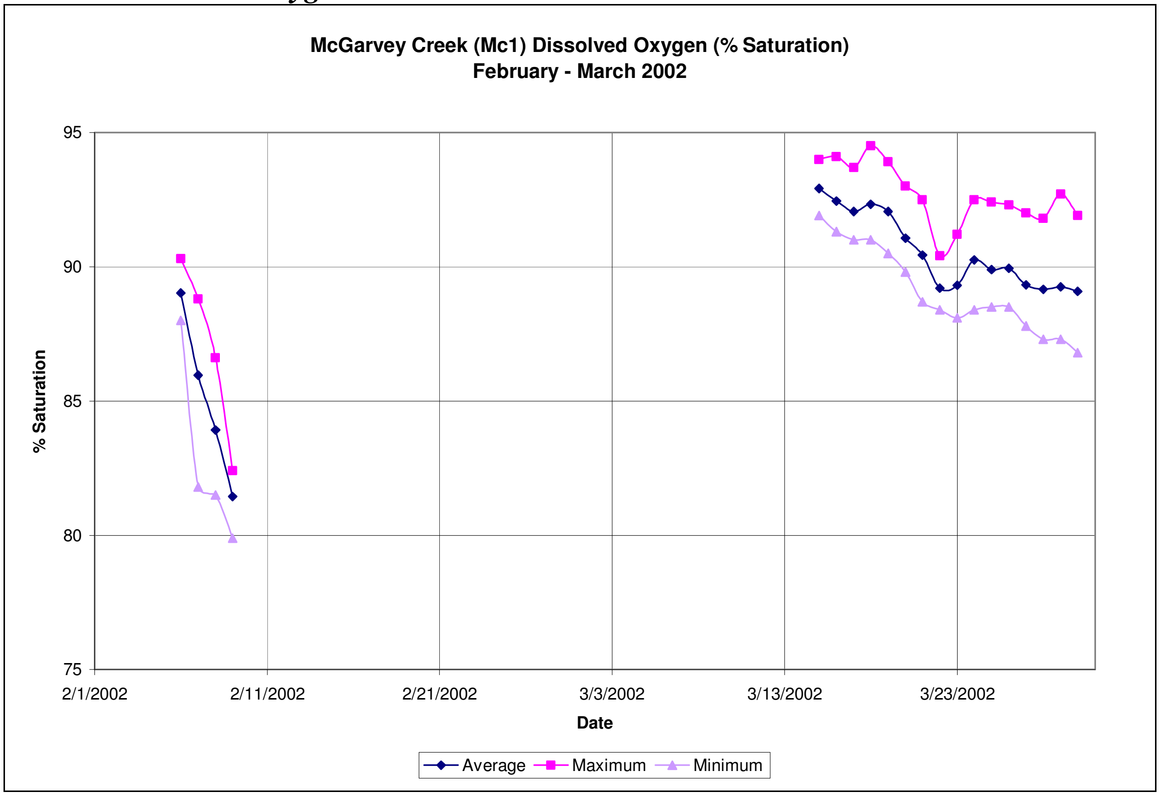

Figure 7-132 Dissolved Oxygen Values for McGarvey Creek February 2002

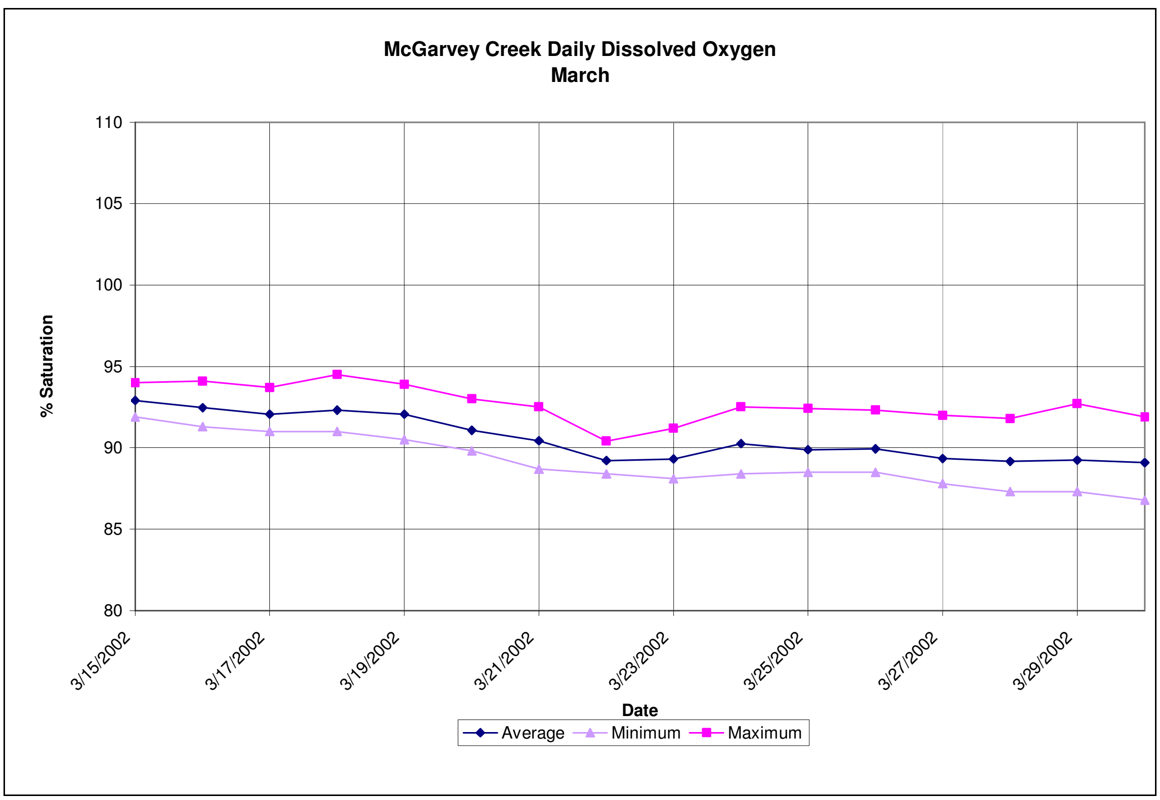

Figure 7-133 Dissolved Oxygen Values for McGarvey Creek March 2002

7.2.2.3 Specific Conductivity

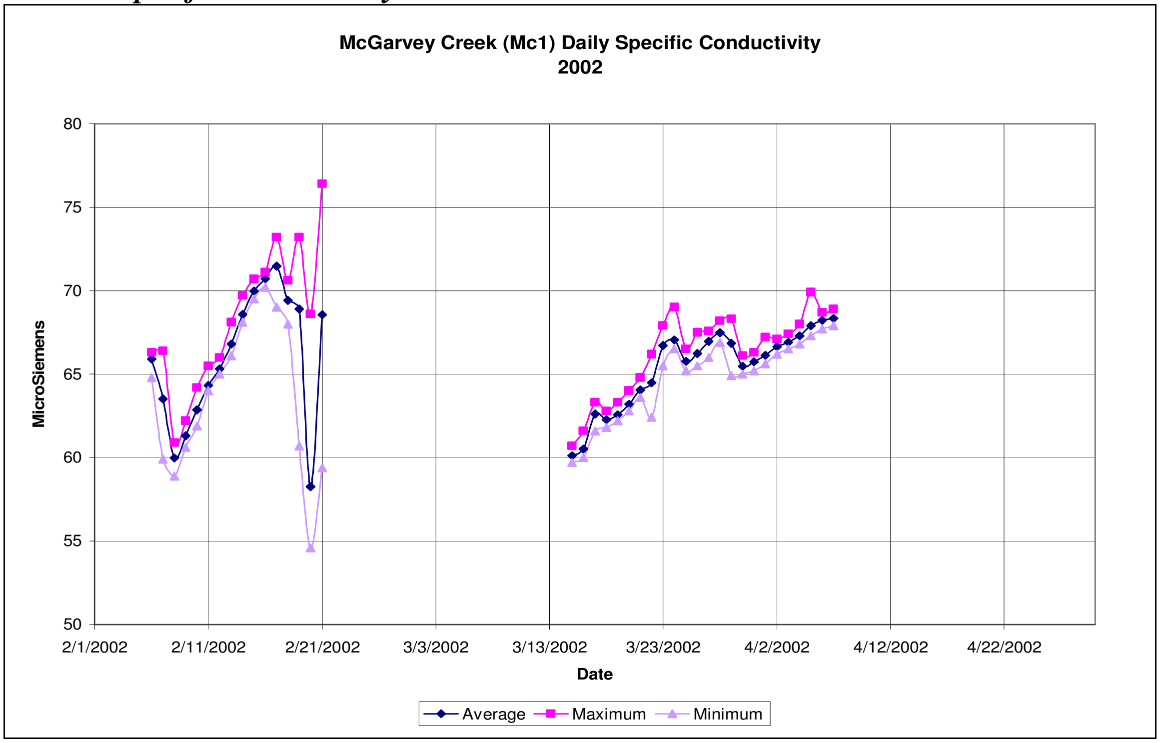

Figure 7-134 Specific Conductivity Values for McGarvey Creek WY02

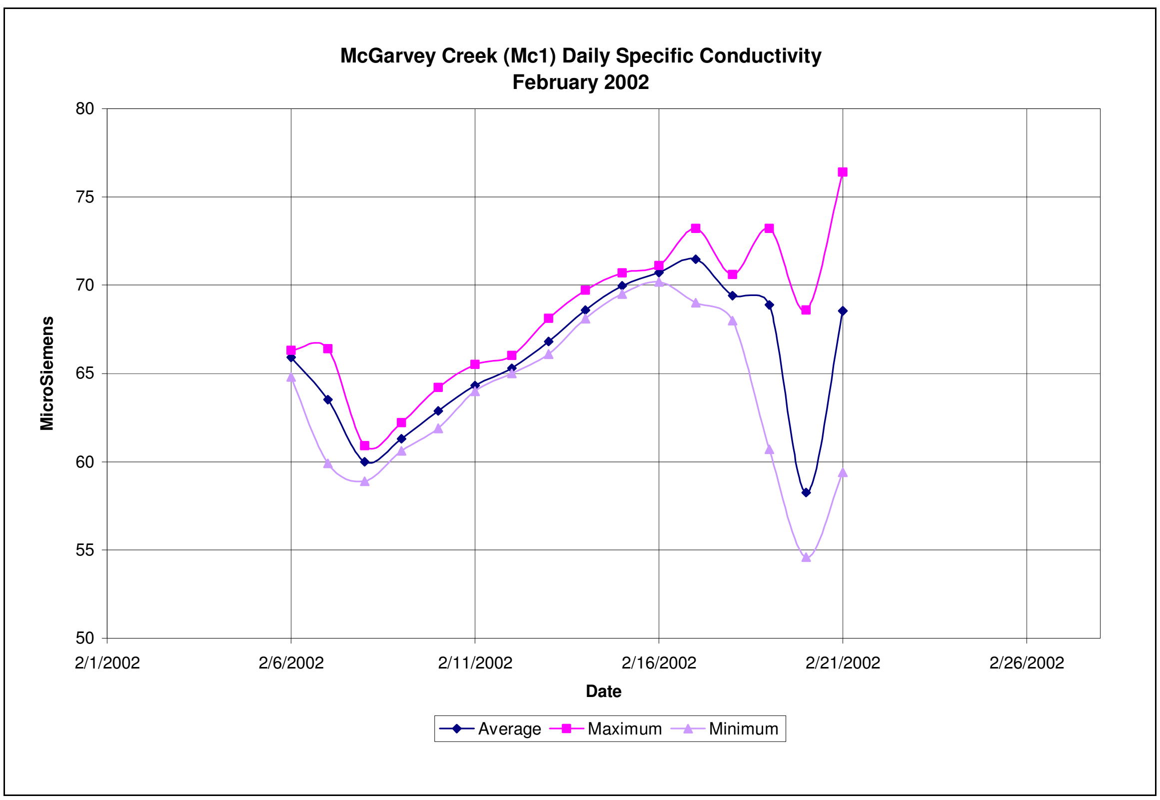

Figure 7-135 Specific Conductivity Values for McGarvey Creek February 2002

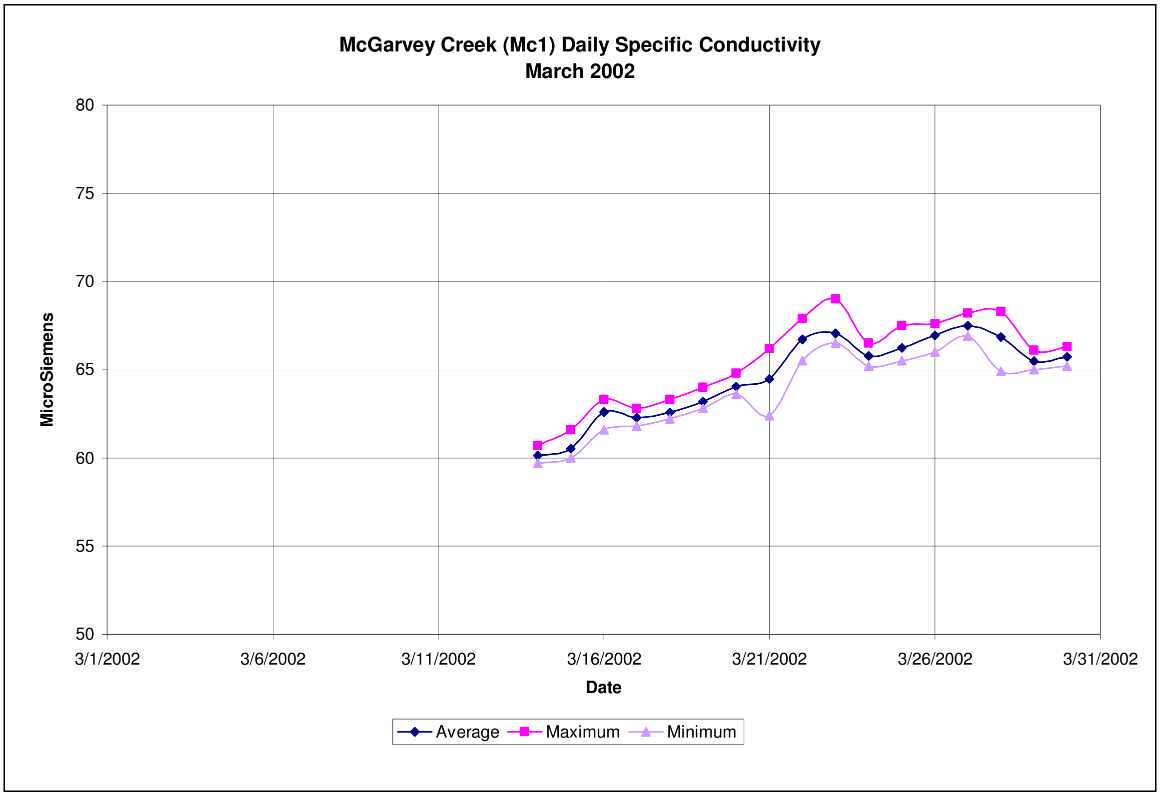

Figure 7-136 Specific Conductivity Values for McGarvey Creek March 2002

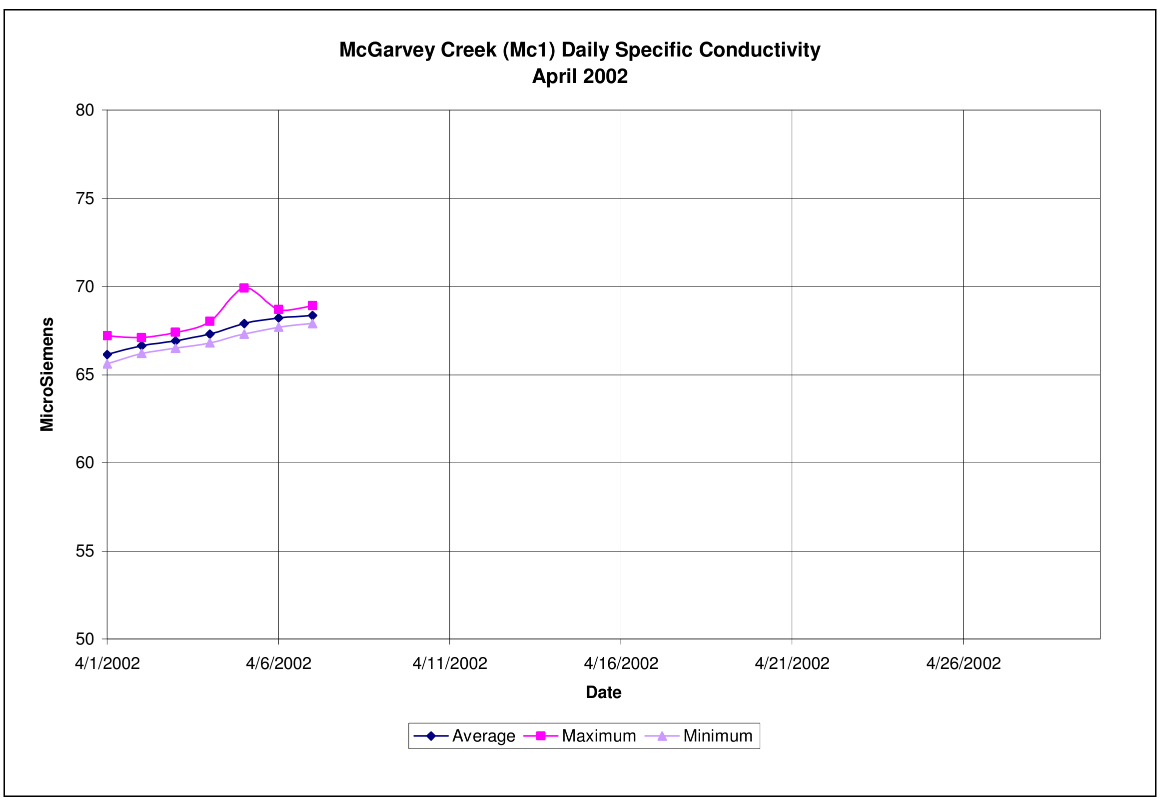

Figure 7-137 Specific Conductivity Values for McGarvey Creek April 2002

7.3 Macroinvertebrate Sampling

Table 7.2.2-a

		WY 2001			WY 2002		
Creek Name	Site ID	Date	Cumulative Visual Distribution Score	Russian River Index of Biological Integrity	Date	Cumulative Visual Distribution Score	Russian River Index of Biological Integrity
Tectah Mainstem	Te1	5/7/2001	18	good	Not sampled		
Tectah North Fork	Te2	5/7/2001	20	good	Not sampled		
Tectah South Fork	Te3	5/7/2001	18	good	Not sampled		
Roaches	Ro1	5/6/2001	14	fair	Not sampled		
Klamath at Wautec	Kj1	4/21/2001	18	good	Not sampled		
EF Pecwan	Ep1	4/21/2001	26	excellent	4/24/2002	22	good
Lower Blue	Bl2	Not sampled			5/7/2002	22	good
WF Blue	Wb1	4/15/2001	24	excellent	5/7/2002	20	good
McGarvey	Mc1	4/25/2001	18	good	Not sampled		
McGarvey	Mc1	4/15/2001	20	good	4/15/2002	16	fair
Metah	Me1	5/6/2001	14	fair	4/8/2002	20	good
Tulley Ck	Ty1	5/16/2001	10	poor	4/24/2002	18	good
Turwar	Tu1	4/25/2001	10	poor	Not sampled		
Turwar	Tu1	4/20/2001	12	fair	4/15/2002	14	fair
WF Pecwan	Wp1	4/21/2001	22	good	4/24/2002	24	excellent
Johnsons	Jo1	Not sampled			4/8/2002	22	good

7.4 Hydrologic Data

7.4.1 McGarvey Creek

The McGarvey gaging station began operating on December 1, 2001 at 12:00 AM. The station is located at 41° 29' 11.29" north latitude, 124° 00' 34.46" west longitude, upstream of the confluence of McGarvey and Den Creeks. The total drainage area of the watershed is 8.9 square miles. The following parameters are measured at the site on a fifteen-minute time step throughout the year: date, time, stage, air temperature (inside the gaging box), and battery voltage. Flow measurements are collected by YTEP at the gaging site periodically. The YTFD also monitors water temperature at various locations throughout McGarvey Creek including at the gaging station site. Those data are not shown in this report.

7.4.1.1 Discharge

Table 7.4.1-aDaily Minimum Discharge (cfs) Values for McGarvey Creek WY02.

Day	Octol	Nove	Decembe	January	February	March	April	May	June	July	August	Septemb
1				42.68	29.64	26.48	15.61	11.40	4.54	4.54	2.71	2.52
2				47.27	27.71	23.06	11.40	9.94	4.54	4.54	2.61	2.34
3				52.25	28.34	20.48	11.09	9.40	4.25	3.72	2.61	2.25
4				40.94	26.48	18.58	10.50	9.66	4.11	3.13	2.52	2.17
5				36.07	22.52	18.13	7.68	8.88	4.11	3.13	2.61	2.09
6				77.92	20.97	17.26	7.68	8.63	3.02	4.11	2.81	2.09
7				76.51	28.34	24.16	7.91	7.46	3.59	3.98	2.71	2.09
8				99.99	52.25	20.97	7.46	7.46	3.85	3.72	2.52	2.01
9				71.06	42.68	20.48	7.68	7.24	3.47	3.24	2.34	1.93
10				55.44	34.55	19.51	8.63	7.03	3.59	3.13	2.17	1.86
11				44.47	27.71	31.67	7.46	6.82	3.98	3.35	2.34	1.79
12				35.31	24.72	44.47	8.15	6.42	3.85	3.35	2.43	1.79
13				32.38	20.48	57.64	7.68	6.23	3.85	2.81	2.43	1.79
14				24.16	18.13	43.57	17.26	6.04	3.85	2.81	2.43	1.79
15				20.48	16.42	34.55	14.09	6.04	3.85	3.13	2.43	1.86
16				19.04	16.01	33.82	13.37	5.68	3.72	2.61	2.52	1.93
17				16.83	15.22	33.82	23.06	4.54	3.47	2.43	2.61	1.93
18				15.22	14.46	30.31	20.97	4.11	5.00	2.81	2.81	2.34
19				14.46	14.83	28.34	17.69	3.98	4.11	2.81	2.81	2.43
20				17.26	107.14	24.72	16.01	4.40	3.85	2.71	2.71	2.17
21				19.04	53.30	20.97	13.37	4.25	3.98	2.52	2.52	2.01
22				33.09	43.57	20.97	13.03	4.85	3.85	2.61	2.71	1.86
23				31.67	54.36	24.16	14.09	4.54	3.59	3.13	2.71	1.72
24				29.64	91.61	26.48	13.37	4.85	3.24	3.02	2.91	1.52
25				28.34	62.26	24.72	12.35	4.85	3.47	2.81	3.02	1.35
26				65.92	47.27	22.00	11.71	4.69	3.35	2.81	2.91	1.24
27				46.32	36.85	17.69	11.71	4.69	3.35	2.61	2.81	1.24
28				41.80	31.67	16.42	10.79	5.17	4.25	2.61	2.71	1.18
29				36.85		15.22	9.66	5.00	4.85	2.61	2.61	1.24
30				28.99		14.46	12.69	4.85	4.69	2.71	2.71	1.09
31				27.71		16.83		4.54		2.61	2.61	
	Monthly Statistics											
	Total			1229.13	1009.51	791.96	364.18	193.66	117.25	96.15	81.40	55.61
	Mean			39.65	36.05	25.55	12.14	6.25	3.91	3.10	2.63	1.85
	Max			99.99	107.14	57.64	23.06	11.40	5.00	4.54	3.02	2.52
	Min			14.46	14.46	14.46	7.46	3.98	3.02	2.43	2.17	1.09

Table 7.4.1-b Daily Maximum Discharge (cfs) Values for McGarvey Creek WY02.

Day	Octol	Nove	Decembe	January	February	March	April	May	June	July	August	September
1				58.77	36.85	31.67	23.60	14.83	6.04	5.33	3.02	2.71
2				96.57	30.98	26.48	22.52	12.35	5.86	5.17	3.13	2.61
3				63.46	33.82	26.48	18.13	11.71	5.00	5.17	3.02	2.52
4				53.30	28.34	20.48	13.03	11.40	5.00	5.00	3.02	2.43
5				76.51	27.71	19.51	11.71	11.09	4.85	5.00	2.91	2.25
6				118.60	28.34	29.64	11.71	10.79	5.00	4.85	3.24	2.25
7				103.52	94.89	54.36	15.61	10.22	4.69	4.54	3.13	2.25
8				185.72	79.36	24.16	13.73	9.40	5.00	4.54	3.02	2.17
9				99.99	55.44	23.06	16.42	8.38	4.69	4.40	4.11	2.09
10				76.51	43.57	35.31	11.40	8.63	4.85	4.25	2.61	2.09
11				55.44	34.55	50.21	14.09	7.91	5.00	4.40	2.71	2.01
12				45.39	27.71	98.27	11.71	7.91	4.54	4.40	2.61	1.93
13				38.45	24.72	103.52	16.83	8.15	4.69	4.69	2.61	1.93
14				33.82	20.97	76.51	76.51	7.68	4.85	4.54	2.61	2.01
15				24.72	18.58	62.26	20.48	7.68	4.54	4.69	2.71	2.01
16				21.48	17.26	49.22	32.38	7.68	4.54	4.11	2.81	2.09
17				19.99	17.26	46.32	30.98	6.82	5.86	3.85	2.81	2.43
18				17.69	15.61	41.80	26.48	6.42	8.63	4.69	3.13	3.02
19				21.48	101.74	37.64	21.48	6.04	5.17	3.47	3.13	2.71
20				19.99	288.05	31.67	18.58	6.04	5.17	3.59	3.47	2.43
21				44.47	188.58	25.89	16.42	6.42	5.00	3.24	2.91	2.25
22				45.39	58.77	34.55	17.26	6.42	4.40	3.35	2.91	2.01
23				41.80	194.40	37.64	16.01	5.68	4.25	3.47	3.02	1.93
24				36.07	158.98	33.09	16.01	5.68	4.40	3.47	3.24	1.72
25				86.85	91.61	29.64	14.46	5.68	4.11	3.35	3.24	1.59
26				98.27	64.68	27.71	13.73	5.50	3.98	3.24	3.24	1.40
27				71.06	58.77	25.89	13.37	6.42	4.40	3.24	3.13	1.40
28				49.22	38.45	19.99	12.03	6.62	6.04	3.02	2.91	1.35
29				45.39		22.00	19.51	6.23	6.23	3.02	2.81	1.40
30				37.64		22.00	22.00	5.68	5.68	3.24	3.02	1.29
31				30.98		26.48		5.50		3.02	2.91	
	Monthly Statistics											
	Total			1818.54	1880.01	1193.46	588.17	247.01	152.48	126.37	93.18	62.30
	Mean			58.66	67.14	38.50	19.61	7.97	5.08	4.08	3.01	2.08
	Max			185.72	288.05	103.52	76.51	14.83	8.63	5.33	4.11	3.02
	Min			17.69	15.61	19.51	11.40	5.50	3.98	3.02	2.61	1.29

Table 7.4.1-c Daily Average Discharge (cfs) Values for McGarvey Creek WY02.

Day	Octo	Nove	Dece	January	February	March	April	May	June	July	August	Septem
1	-	-	-	50.12	33.37	28.73	20.54	13.00	5.06	4.98	2.77	2.58
2	-	-	-	70.41	29.17	24.84	15.69	11.36	4.89	4.85	2.80	2.45
3	-	-	-	58.13	30.87	22.31	14.11	10.81	4.63	4.83	2.77	2.33
4	-	-	-	47.45	27.62	19.55	11.64	10.54	4.48	4.16	2.77	2.25
5	-	-	-	48.93	25.24	18.65	10.19	10.33	4.52	3.92	2.76	2.15
6	-	-	-	104.71	22.72	20.39	9.25	9.59	4.34	4.37	3.00	2.10
7	-	-	-	85.47	67.42	34.87	9.11	8.79	4.20	4.30	2.93	2.11
8	-	-	-	123.07	65.87	22.42	9.14	8.30	4.24	4.17	2.73	2.07
9	-	-	-	87.20	49.42	21.17	9.78	7.91	4.19	4.02	2.79	1.97
10	-	-	-	64.17	38.77	24.06	9.69	7.66	4.28	3.85	2.41	1.91
11	-	-	-	49.00	30.91	39.95	9.96	7.46	4.21	3.86	2.46	1.85
12	-	-	-	41.35	26.25	73.36	9.67	7.36	4.11	3.76	2.46	1.83
13	-	-	-	34.53	22.32	76.19	11.13	7.18	4.20	4.05	2.46	1.82
14	-	-	-	28.64	19.62	56.78	38.57	6.94	4.24	3.69	2.44	1.85
15	-	-	-	22.87	17.66	46.61	17.04	6.75	4.13	4.11	2.54	1.92
16	-	-	-	20.49	16.57	40.66	19.20	6.48	4.07	3.54	2.63	1.94
17	-	-	-	18.56	16.19	41.10	26.21	5.93	4.35	3.34	2.68	2.08
18	-	-	-	16.40	15.10	36.27	23.64	5.39	6.78	3.12	2.88	2.71
19	-	-	-	19.66	45.41	33.30	19.74	4.74	4.70	3.06	2.93	2.60
20	-	-	-	18.71	213.49	29.03	17.47	5.04	4.29	3.18	2.87	2.34
21	-	-	-	32.33	113.48	23.15	15.20	5.24	4.26	2.83	2.71	2.10
22	-	-	-	37.91	51.16	25.75	15.13	5.52	4.08	2.91	2.76	1.92
23	-	-	-	38.49	119.85	28.56	15.42	5.27	3.98	3.23	2.85	1.77
24	-	-	-	33.07	116.18	29.40	14.53	5.20	3.82	3.20	3.03	1.62
25	-	-	-	35.20	76.63	26.66	13.53	5.10	3.67	3.06	3.07	1.46
26	-	-	-	78.24	54.14	24.84	12.62	5.08	3.58	2.97	3.00	1.30
27	-	-	-	61.54	43.82	19.72	12.51	5.41	3.94	2.88	2.89	1.26
28	-	-	-	45.18	34.69	17.76	11.47	5.79	4.85	2.76	2.78	1.25
29	-	-	-	40.62		16.47	12.16	5.66	5.45	2.82	2.69	1.28
30	-	-	-	33.01		17.29	16.66	5.27	5.24	2.91	2.77	1.19
31	-	-	-	29.33		21.63		5.11		2.77	2.71	
	Monthly Statistics											
	Total			1474.75	1423.95	961.47	451.00	220.21	132.76	111.48	85.36	58.02
	Mean			47.57	50.86	31.02	15.03	7.10	4.43	3.60	2.75	1.93
	Max			123.07	213.49	76.19	38.57	13.00	6.78	4.98	3.07	2.71
	Min			16.40	15.10	16.47	9.11	4.74	3.58	2.76	2.41	1.19

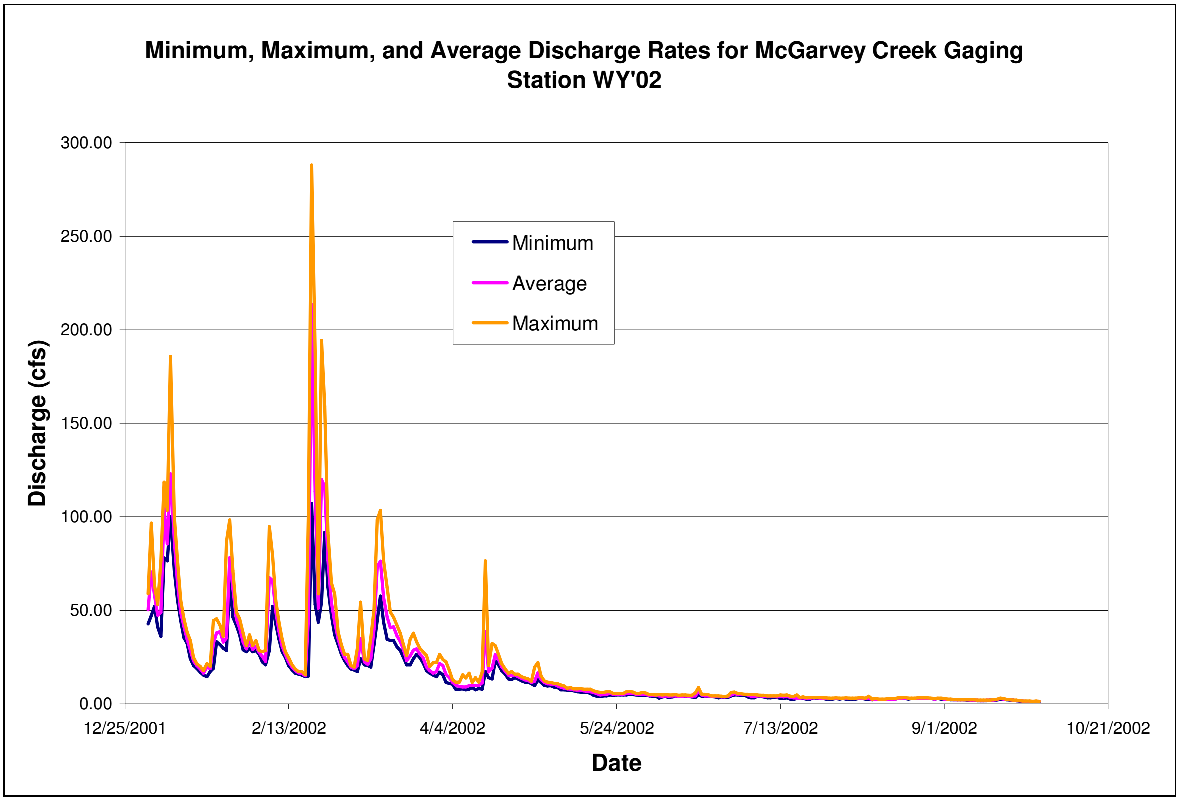

Figure 7-138 The mean, minimum, and maximum discharges estimated for McGarvey Creek gaging site from January 1, 2002 through September 30, 2002

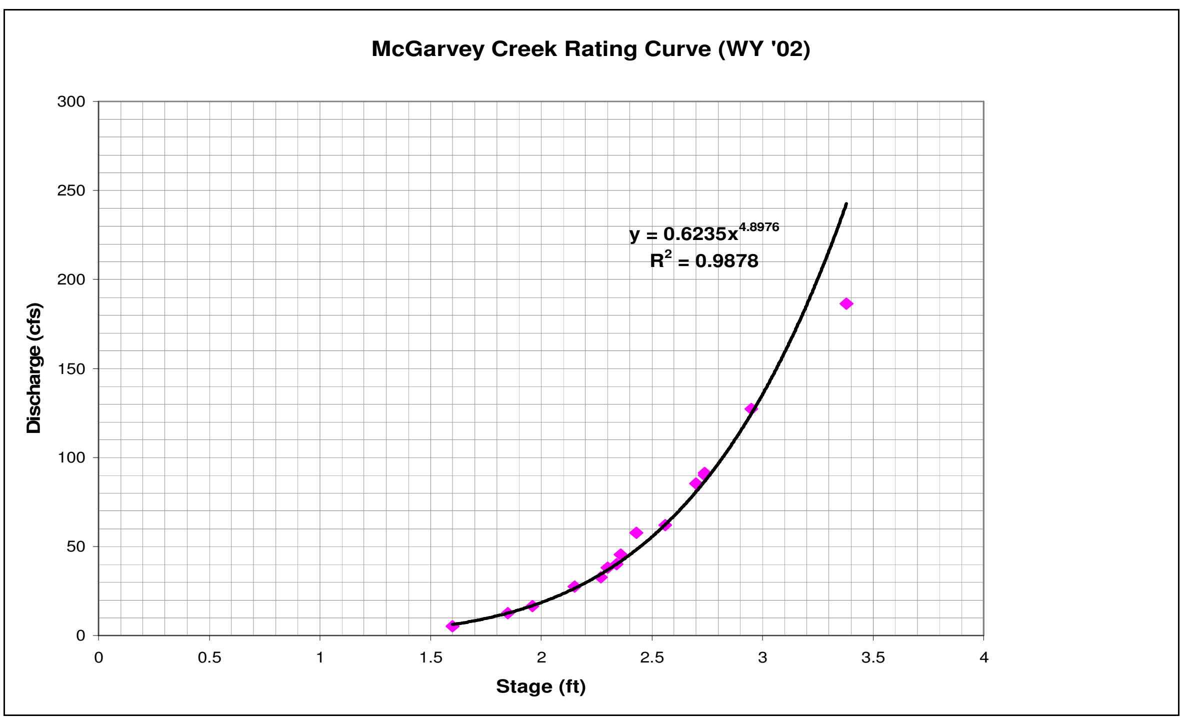

Figure 7-139 Discharge rating curve values for McGarvey Creek gaging station

7.4.1.2 Turbidity

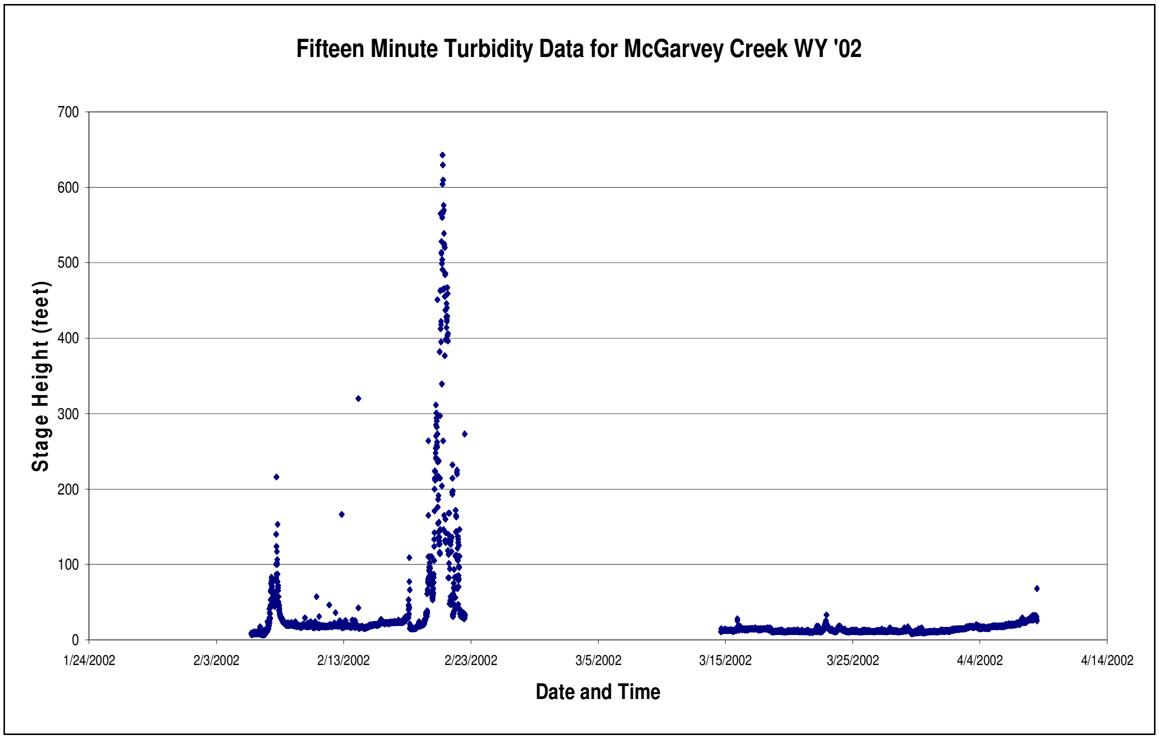

Figure 7-140 Fifteen minute turbidity data for McGarvey Creek WY 2002

7.4.2 Blue Creek

The Blue gaging station began operating on April 30th, 2002 at 1:45 PM. The station is located at 41° 27' 00" north latitude, 123° 53' 40" west longitude. The following parameters are measured at the site on a fifteen-minute time step throughout the year: date, time, stage, air temperature (inside the gaging box), and battery voltage. YTFD also monitors water temperature at various locations throughout Blue Creek including a site near the gaging station. Those data are not presented in this report.

7.4.2.1 Discharge

Table 7.4.2-a Daily Minimum Discharge (cfs) Values for Blue Creek WY02.

Day		Oct	Nov	Dec	Jan	Feb	Mar	Apri	May	June	July	Aug	Sept
1		-	-	-	-	-	-	-	391.33	207.37	120.78	79.30	56.64
2		-	-	-	-	-	-	-	383.29	195.92	118.60	79.30	55.17
3		-	-	-	-	-	-	-	371.39	195.92	118.60	79.30	55.17
4		-	-	-	-	-	-	-	355.83	187.56	116.44	79.30	55.17
5		-	-	-	-	-	-	-	344.39	184.81	114.30	79.30	55.17
6		-	-	-	-	-	-	-	333.14	179.38	112.18	77.55	56.64
7		-	-	-	-	-	-	-	322.08	176.70	110.08	75.82	56.64
8		-	-	-	-	-	-	-	307.64	171.40	108.00	74.11	56.64
9		-	-	-	-	-	-	-	300.55	166.18	105.95	72.42	55.17
10		-	-	-	-	-	-	-	290.08	163.60	101.89	70.75	55.17
11		-	-	-	-	-	-	-	279.80	161.05	101.89	70.75	53.72
12		-	-	-	-	-	-	-	276.41	156.00	101.89	69.10	52.30
13		-	-	-	-	-	-	-	276.41	153.50	99.90	67.47	52.30
14		-	-	-	-	-	-	-	266.39	153.50	97.92	67.47	52.30
15		-	-	-	-	-	-	-	259.81	151.03	97.92	65.86	53.72
16		-	-	-	-	-	-	-	253.32	148.58	95.97	65.86	53.72
17		-	-	-	-	-	-	-	250.11	146.15	94.03	65.86	53.72
18		-	-	-	-	-	-	-	246.92	161.05	94.03	64.28	65.86
19		-	-	-	-	-	-	-	243.75	148.58	94.03	64.28	58.13
20		-	-	-	-	-	-	-	259.81	143.74	92.12	65.86	55.17
21		-	-	-	-	-	-	-	250.11	143.74	90.23	65.86	52.30
22		-	-	-	-	-	-	-	234.37	141.35	90.23	64.28	52.30
23		-	-	-	-	-	-	-	225.18	136.63	90.23	64.28	50.89
24		-	-	-	-	-	-	-	222.16	136.63	90.23	64.28	50.89
25		-	-	-	-	-	-	-	216.18	132.00	88.36	64.28	49.50
26		-	-	-	-	-	-	-	213.22	129.72	86.50	64.28	48.13
27		-	-	-	-	-	-	-	213.22	129.72	84.67	61.16	48.13
28		-	-	-	-	-	-	-	240.60	127.45	82.86	59.63	49.50
29		-	-	-	-	-	-	-	240.60	127.45	82.86	59.63	49.50
30		-	-	-	-	-	-	-	225.18	125.21	82.86	59.63	49.50
31		-	-	-	-	-	-	-	213.22		81.07	58.13	
	Monthly Statistics												
	Total								8506.50	4681.94	3046.66	2119.38	1609.17
	Mean								274.40	156.06	98.28	68.37	53.64
	Max								391.33	207.37	120.78	79.30	65.86
	Min								213.22	125.21	81.07	58.13	48.13

Table 7.4.2-b Daily Maximum Discharge (cfs) Values for Blue Creek WY02.

Day		Octo	Nove	Dece	Janu	Febr	Mar	Apri	May	June	July	August	September
1		-	-	-	-	-	-	-	428.60	216.18	127.45	82.86	59.63
2		-	-	-	-	-	-	-	411.82	213.22	125.21	82.86	58.13
3		-	-	-	-	-	-	-	403.56	204.48	122.99	81.07	58.13
4		-	-	-	-	-	-	-	383.29	195.92	120.78	82.86	58.13
5		-	-	-	-	-	-	-	375.34	193.11	120.78	81.07	58.13
6		-	-	-	-	-	-	-	359.69	187.56	116.44	82.86	58.13
7		-	-	-	-	-	-	-	344.39	182.09	114.30	81.07	59.63
8		-	-	-	-	-	-	-	325.74	179.38	114.30	79.30	59.63
9		-	-	-	-	-	-	-	314.82	174.04	112.18	77.55	58.13
10		-	-	-	-	-	-	-	307.64	171.40	108.00	75.82	56.64
11		-	-	-	-	-	-	-	300.55	168.78	105.95	74.11	56.64
12		-	-	-	-	-	-	-	293.55	163.60	105.95	72.42	55.17
13		-	-	-	-	-	-	-	290.08	161.05	103.91	70.75	56.64
14		-	-	-	-	-	-	-	283.20	158.51	103.91	70.75	53.72
15		-	-	-	-	-	-	-	276.41	156.00	101.89	70.75	55.17
16		-	-	-	-	-	-	-	269.71	153.50	99.90	69.10	55.17
17		-	-	-	-	-	-	-	263.09	161.05	99.90	67.47	67.47
18		-	-	-	-	-	-	-	263.09	182.09	97.92	67.47	70.75
19		-	-	-	-	-	-	-	276.41	166.18	97.92	67.47	65.86
20		-	-	-	-	-	-	-	283.20	153.50	97.92	67.47	58.13
21		-	-	-	-	-	-	-	266.39	148.58	95.97	67.47	55.17
22		-	-	-	-	-	-	-	256.56	148.58	92.12	67.47	53.72
23		-	-	-	-	-	-	-	237.47	146.15	94.03	65.86	53.72
24		-	-	-	-	-	-	-	231.28	141.35	94.03	67.47	52.30
25		-	-	-	-	-	-	-	228.22	138.98	92.12	67.47	52.30
26		-	-	-	-	-	-	-	225.18	136.63	90.23	65.86	50.89
27		-	-	-	-	-	-	-	243.75	132.00	88.36	65.86	49.50
28		-	-	-	-	-	-	-	276.41	132.00	86.50	62.71	50.89
29		-	-	-	-	-	-	-	269.71	136.63	84.67	61.16	50.89
30		-	-	-	-	-	-	-	253.32	136.63	86.50	62.71	53.72
31		-	-	-	-	-	-	-	228.22		84.67	61.16	
	Monthly Statistics												
	Total								9170.70	4939.19	3186.83	2220.31	1702.12
	Mean								295.83	164.64	102.80	71.62	56.74
	Max								428.60	216.18	127.45	82.86	70.75
	Min								225.18	132.00	84.67	61.16	49.50

Table 7.4.2-c Daily Average Discharge (cfs) Values for Blue Creek WY02.

Day		Octo	Nove	Dece	Janu	Febr	Marc	Apri	May	June	July	August	September
1		-	-	-	-	-	-	-	409.10	213.78	126.45	81.98	58.16
2		-	-	-	-	-	-	-	400.98	207.08	123.25	81.41	57.20
3		-	-	-	-	-	-	-	387.61	199.89	120.83	80.26	56.84
4		-	-	-	-	-	-	-	369.27	193.53	119.60	80.26	56.62
5		-	-	-	-	-	-	-	358.07	189.78	117.75	80.20	56.78
6		-	-	-	-	-	-	-	347.53	185.45	114.95	80.11	57.27
7		-	-	-	-	-	-	-	334.33	180.51	112.91	79.06	58.02
8		-	-	-	-	-	-	-	318.87	175.26	111.26	77.06	57.96
9		-	-	-	-	-	-	-	309.44	171.54	109.18	75.16	57.26
10		-	-	-	-	-	-	-	302.11	168.87	106.32	73.37	56.26
11		-	-	-	-	-	-	-	291.28	165.27	104.44	72.13	55.33
12		-	-	-	-	-	-	-	285.46	161.51	103.18	71.08	54.19
13		-	-	-	-	-	-	-	284.47	158.54	102.00	69.79	53.32
14		-	-	-	-	-	-	-	276.99	156.37	100.67	68.71	53.25
15		-	-	-	-	-	-	-	269.90	154.73	99.41	68.32	54.15
16		-	-	-	-	-	-	-	262.97	151.78	98.15	67.29	54.21
17		-	-	-	-	-	-	-	257.82	151.71	97.11	66.60	58.53
18		-	-	-	-	-	-	-	255.83	172.22	96.66	66.30	68.79
19		-	-	-	-	-	-	-	255.33	156.65	96.38	65.78	61.78
20		-	-	-	-	-	-	-	271.80	148.89	95.79	66.37	56.86
21		-	-	-	-	-	-	-	256.41	145.92	92.84	66.67	54.57
22		-	-	-	-	-	-	-	246.00	144.44	91.37	66.30	53.11
23		-	-	-	-	-	-	-	233.32	142.20	92.54	65.83	51.99
24		-	-	-	-	-	-	-	226.87	139.31	91.75	65.88	51.48
25		-	-	-	-	-	-	-	223.90	136.35	90.11	65.65	50.64
26		-	-	-	-	-	-	-	219.79	133.47	88.57	65.15	49.65
27		-	-	-	-	-	-	-	222.01	131.29	86.91	63.95	49.47
28		-	-	-	-	-	-	-	257.23	130.12	84.50	62.10	49.60
29		-	-	-	-	-	-	-	255.72	132.16	83.65	57.74	50.07
30		-	-	-	-	-	-	-	240.59	131.44	83.99	60.86	51.21
31		-	-	-	-	-	-	-	223.62		82.70	60.14	
	Monthly Statistics												
	Total								8854.62	4830.07	3125.23	2171.53	1654.55
	Mean								285.63	161.00	100.81	70.05	55.15
	Max								409.10	213.78	126.45	81.98	68.79
	Min								219.79	130.12	82.70	57.74	49.47

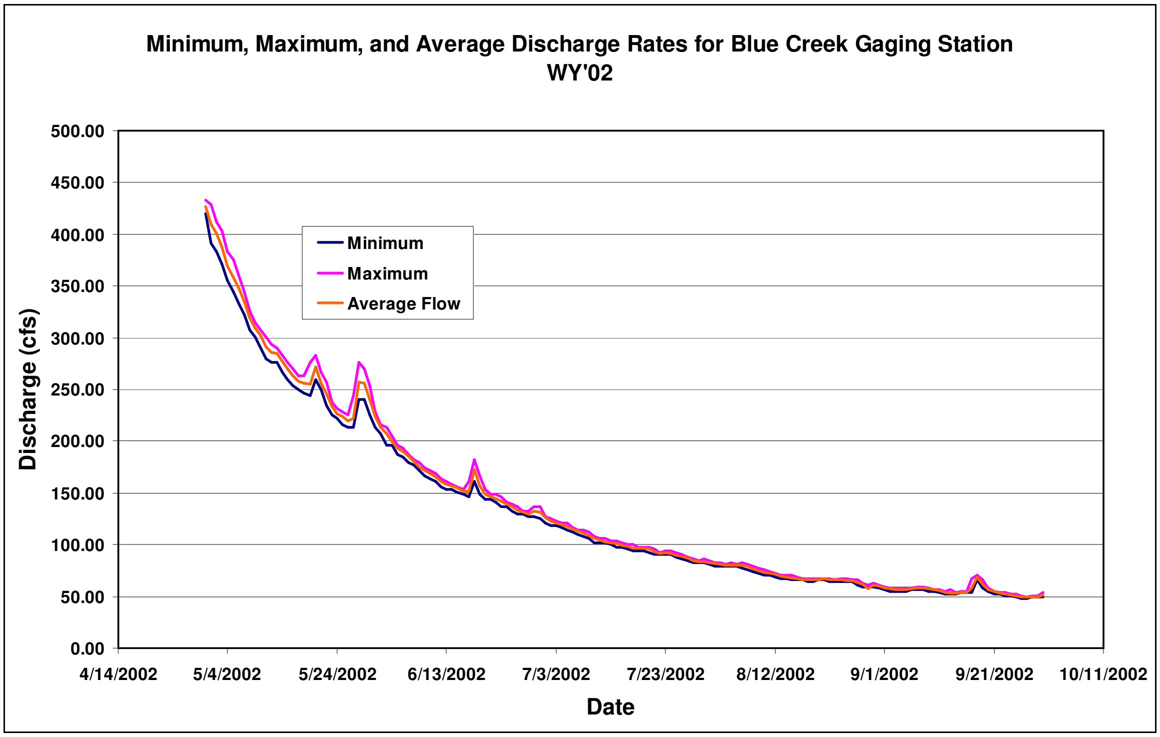

Figure 7-141 The mean, minimum, and maximum discharges recorded at Blue Creek gaging site from May 1, 2002 through September 30, 2002

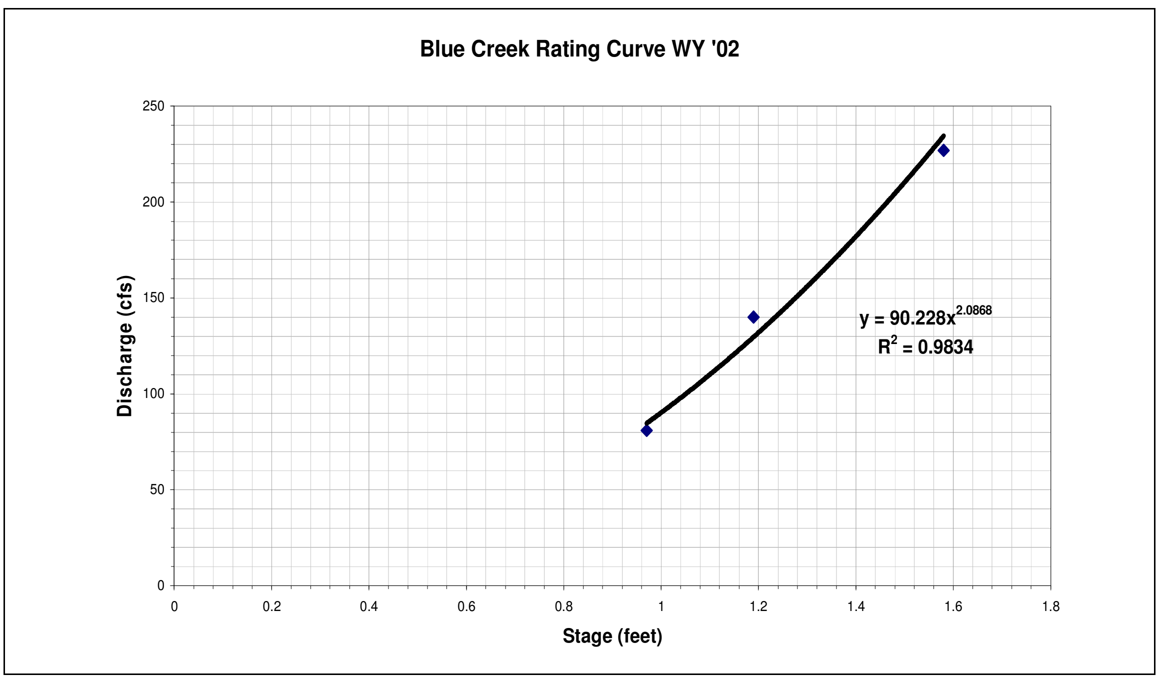

Figure 7-142 Discharge rating curve values for Blue Creek gaging station

7.4.2.2 Turbidity

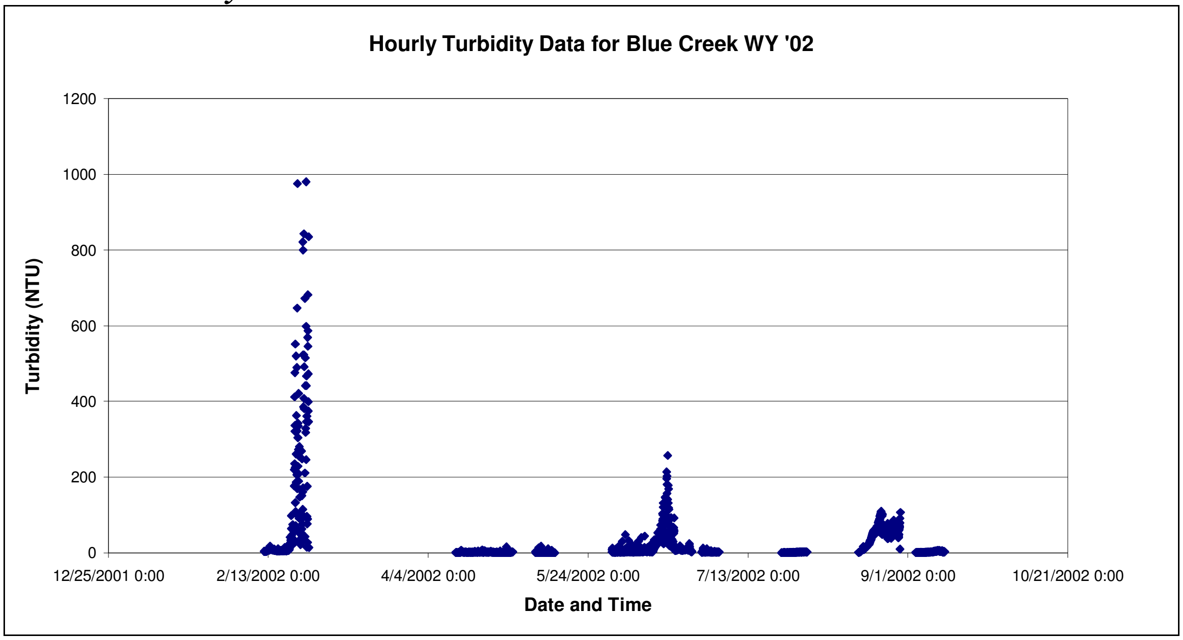

Figure 7-143 Hourly turbidity data for Blue Creek during WY02

7.5 Notchko RAWS Rainfall Data

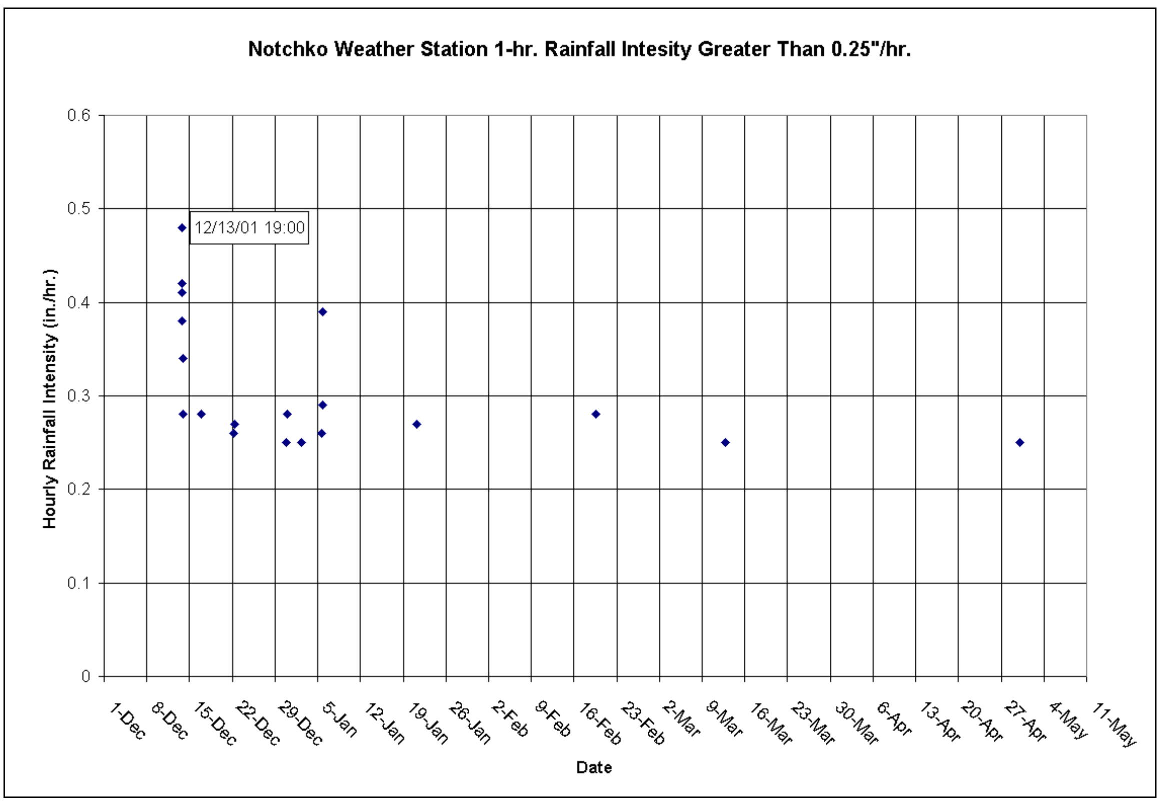

Figure 7-144 Notchko Weather Station One-Hour Rainfall Intensity Greater than .25''/hr

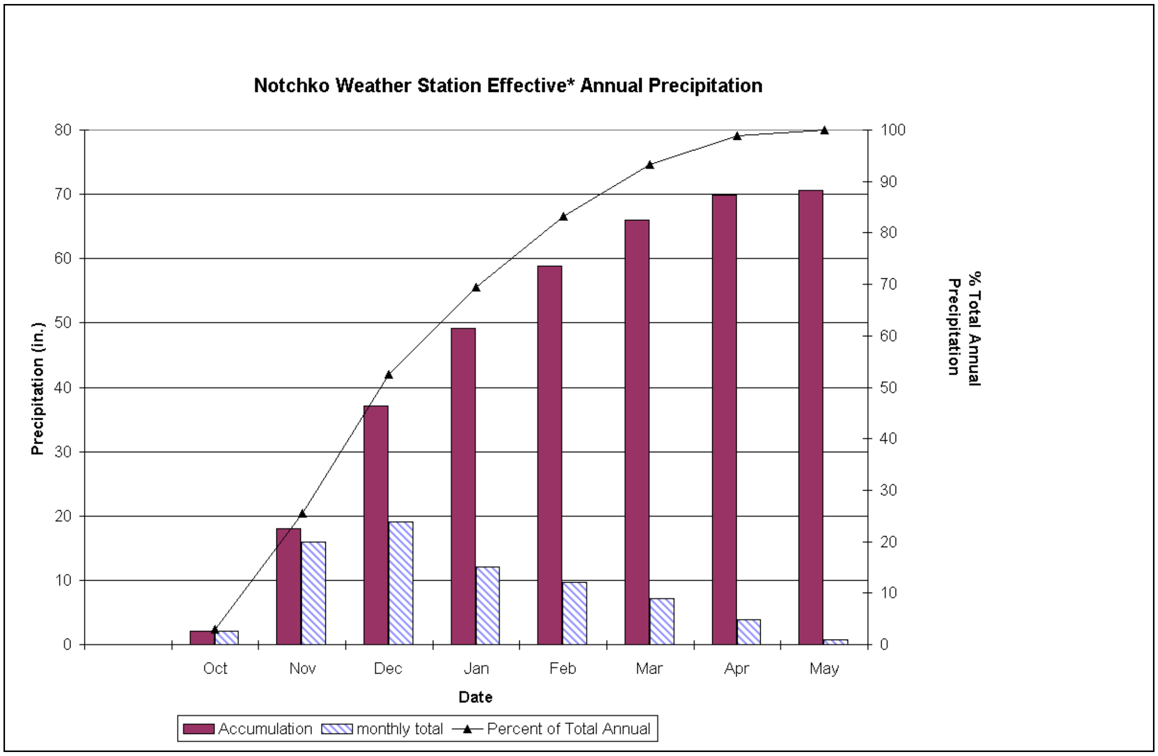

Figure 7-145 Notchko Weather Station Effective (represents 100% annual precipitation)

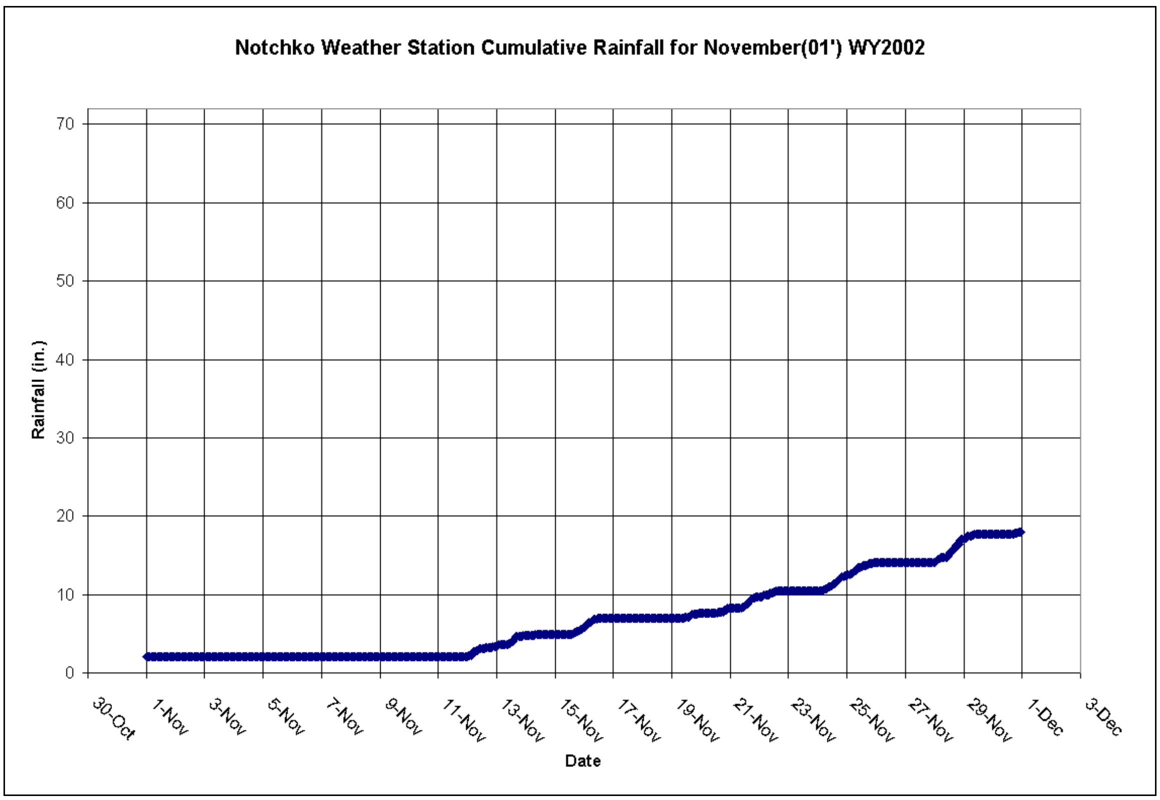

Figure 7-146 Notchko Weather Station Effective Annual Precipitation

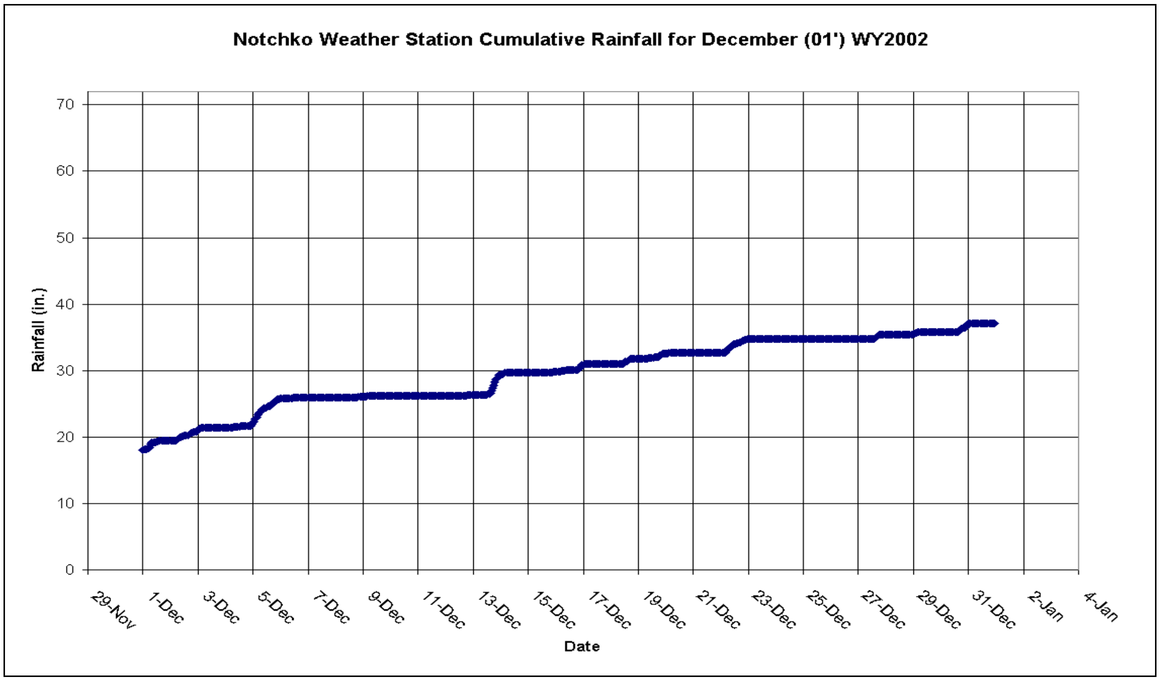

Figure 7-147 Notchko Weather Station Cumulative Rainfall for December 2001 WY02

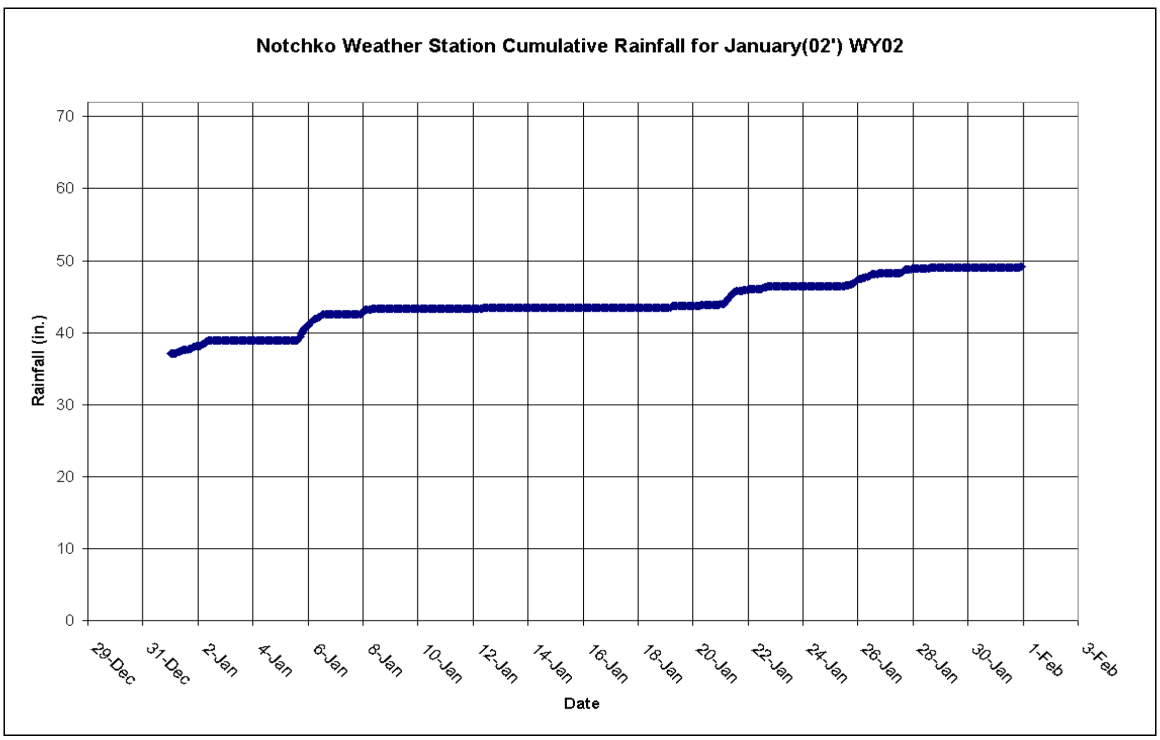

Figure 7-148 Notchko Weather Station Cumulative Rainfall for January 2002 WY02

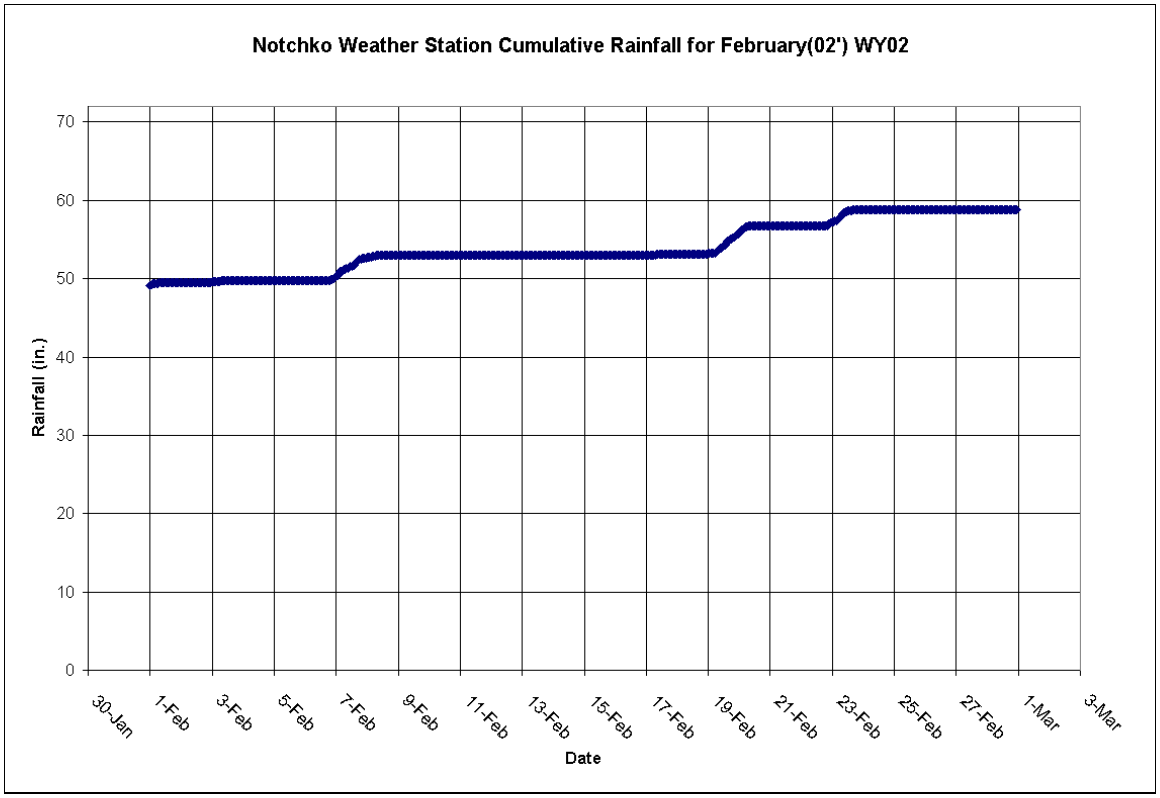

Figure 7-149 Notchko Weather Station Cumulative Rainfall for February 2002 WY02

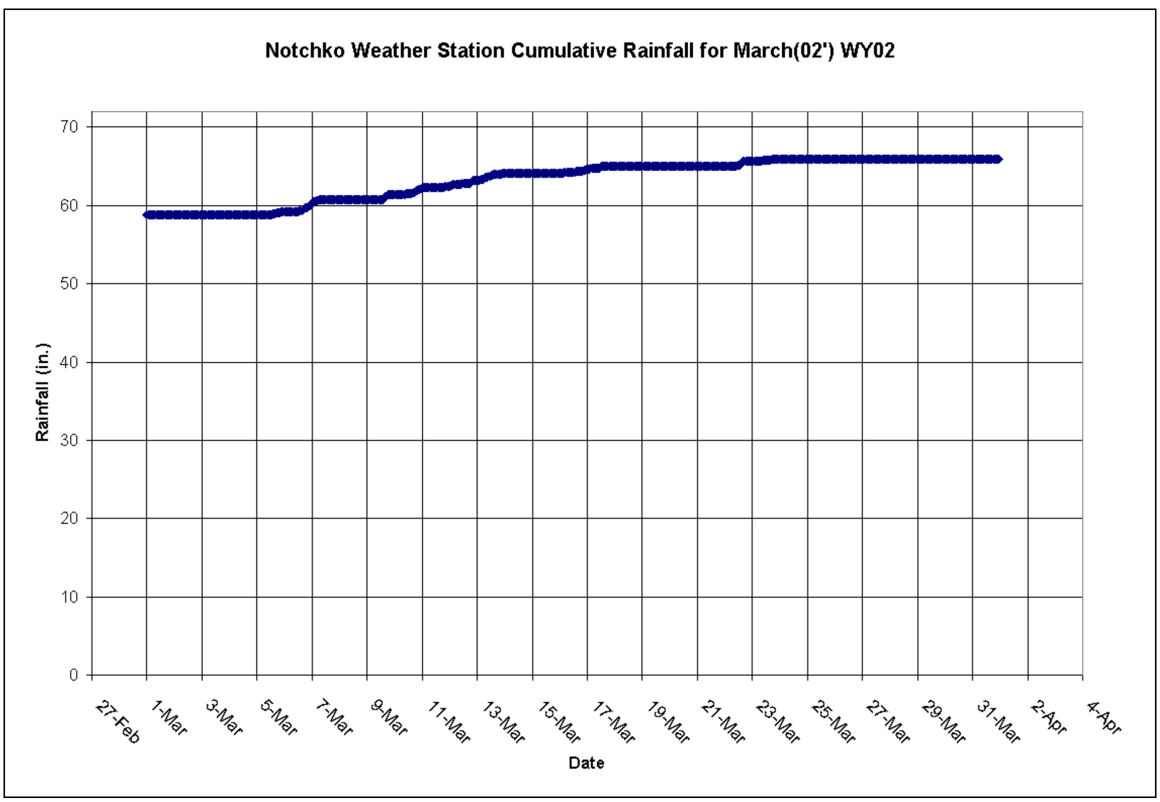

Figure 7-150 Notchko Weather Station Cumulative Rainfall for March 2002 WY02

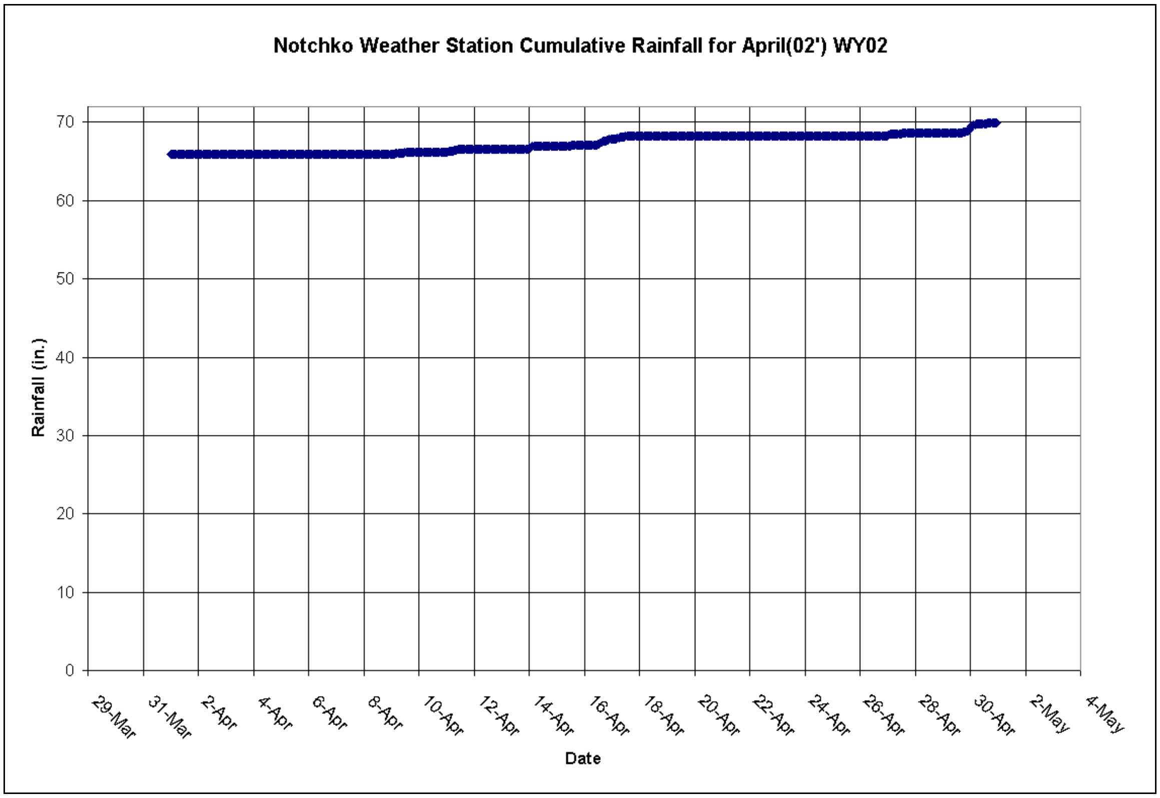

Figure 7-151 Notchko Weather Station Cumulative Rainfall for April 2002 WY02

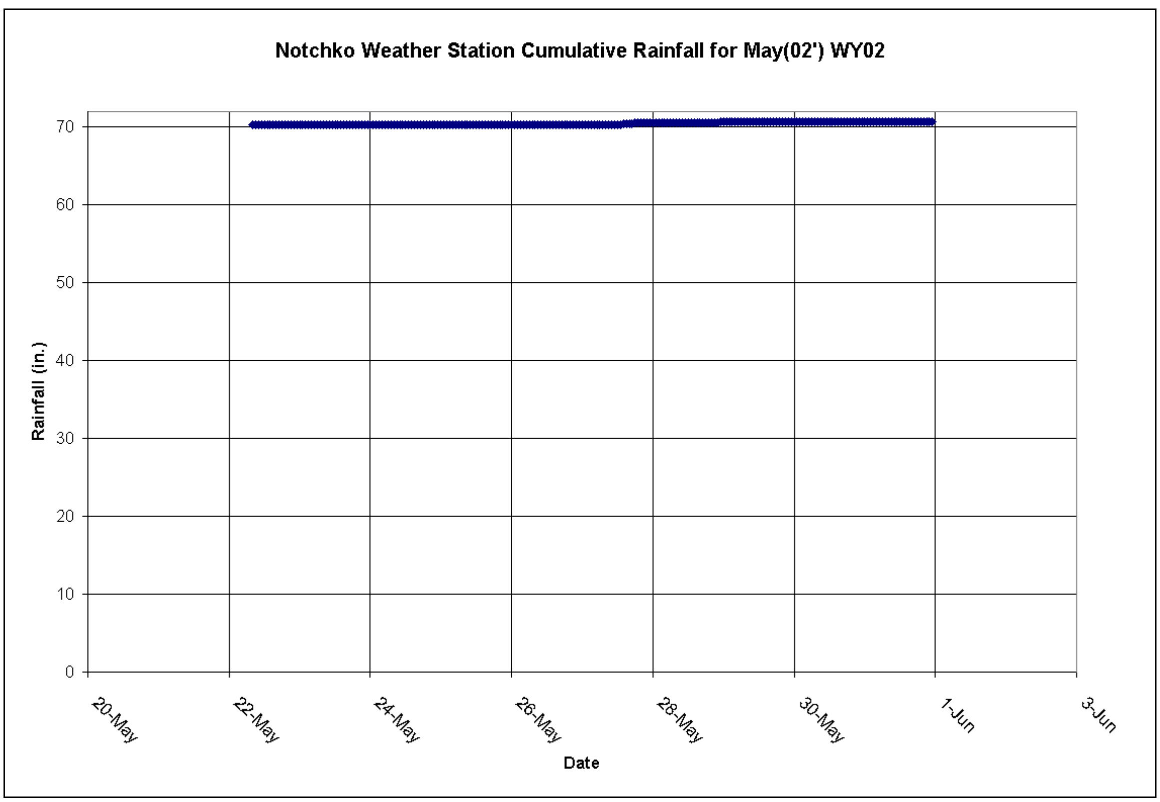

Figure 7-152 Notchko Weather Station Cumulative Rainfall for May 2002 WY02

7.6 Herbicide Monitoring

Table 7.4.2-a

Water Sampling Results at Mettah Creek May 20th, 2002

Sample #	Type	Time	Atrazine (ppb)	DEA (ppb)	ACET (ppb)	DACT (ppb)
1446	primary	11:40	ND	ND	ND	ND
1448	backup	11:40				
1453.	primary	12:10	ND	ND	ND	ND
1454	backup	12:10				
1447.	Field Blank	12:10	ND	ND	ND	ND

Minimum Detection Limit = 0.05, ND = non-detect at reporting limit

8 Results from Outside Agencies

The Yurok Tribe regularly coordinates its water quality monitoring activities with outside agencies. YTEP specifically coordinates with agencies conducting water quality and hydrologic monitoring on the YIR and Lower Klamath tributaries. Every effort is made to coordinate various sampling protocols, site location, data distribution and staffing. Those cooperating agencies are listed below:

North Coast Regional Water Quality Control Board
U.S. Geological Survey
California Department of Fish and Game
U.S. Fish and Wildlife Service

9 Discussion

9.1 Water Quality (Mainstem)

9.1.1 Klamath River at Turwar

9.1.1.1 Temperature

YTEP initiated water quality monitoring at the Turwar site on May 17th 2002 and ended on October 17th. The data set only reflects the data until the end of September due to the end of that water year. Water flows were considerably higher when monitoring began and as the water dropped the data sonde was moved to a location that had the best mixed flow and access for water quality personnel.

Water temperature is a measurement of the heat intensity per volume of water. Water temperature is one of the most important parameters and is essential to the measurement of dissolved oxygen, specific conductivity, pH, and almost every other water quality measurement.

Gaps in data occur due to problems with the instrumentation and battery failure. Minimum, average and maximum values were not generated on days with only partial data (less than 48 measurements taken at ½ hour intervals). Turwar was a challenging location to monitor in the later summer months due to the high level of boat traffic that occurs in the lower part of the Klamath River. On one occasion, it was documented that the hydrolab was washed onto the shore, most likely from the wave action generated from passing boats. This data was eliminated from the data set in order to maintain accuracy.

Water temperatures varied greatly over the sampling period, the lowest water temperature recorded was 11.9° on May 22nd and the highest water temperature recorded was 23.89℃ on July 27th. The maximum water temperature exceeded the Yurok Tribe's draft water temperature standard of 21° Celsius (69.8° Fahrenheit) for 58 days. Maximum water temperatures began exceeding 21° Celsius on June 24 and stayed above this temperature until September 5th, with the exception of a drop for a slight period at the end of August. The water temperature also rose above 21° in the middle of September.

It is interesting to note that water temperature conditions were below 21° before the fish kill occurred. However, the water temperatures were rising before and during the fish kill, contributing to additional stress. Temperatures in this range are stressful to coldwater fish species, and provide favorable conditions for certain fish pathogens such as *Ichthyopthirius multifilis* (ICH) and *Flavobacter columnare* (columnaris). During September 26 and 27 examinations of dead fish, DFG's Fish Health Laboratory found ICH and columnaris to be the principal disease present (Department of Fish and Game, 2003).

An additional figure was generated for this report that analyzed minimum and maximum water and air temperatures and flow. This was done to reflect the relief that the pulse flow provided after the fish kill. The pulse flow from Iron Gate Dam increased the flow at Turwar from 1980cfs to 2580cfs for two weeks. These flows were calculated from the stage height recorded at the USGS Turwar Gaging Station across the river from YTEP's monitoring site. Additionally, air temperatures dropped prior to the release of water from Iron Gate dam, likely causing a drop in the water temperature. It was documented that air temperatures were dropping throughout the basin. It is possible that this meteorological condition coupled with an increased volume of water caused a cooling effect on water temperatures documented at the Turwar site during the pulse flow.

With these two variables present it is difficult to determine if water temperatures would have dropped as low if the increased volume of water was not provided. However, it is evident that water and air temperatures did rise after the flow was reduced back to the flow conditions prior to the fish kill further reflecting the influence that volume and air temperature have on water temperature. Additional analysis is needed to determine if water temperatures will rise as high during warm meteorological conditions when there is a greater volume of water present in the lower river. It is possible that a higher volume of water may buffer warm air temperatures and reduces the level of increase in water temperatures during these periods.

9.1.1.2 Dissolved Oxygen

Dissolved oxygen refers to the amount of oxygen that is contained in an aqueous solution. Oxygen enters the water through several methods, which include diffusion from the surrounding air, by rapid movement or aeration and as a waste product of photosynthesis. There are three factors that determine the amount of oxygen that can be held in a water solution, water temperature, salinity and pressure. Gas solubility increases with temperature because colder water is able to hold more oxygen. Gas solubility increases with decreasing salinity because fresh water holds more oxygen than salt water. Finally, gas solubility decreases as pressure decreases. Prolonged exposure to low dissolved oxygen levels (<5 - 6 mg/l) may not directly kill an organism, but will increase its susceptibility to other environmental stresses (Gower, 1980).

Gaps in data occur due to problems with the instrumentation and battery failure. Minimum, average and maximum values were not generated on days with only partial data (less than 48 measurements taken at ½ hour intervals).

Dissolved oxygen (DO) levels varied over the sampling period, the lowest DO level recorded was 5.95 mg/L on September 12th and the highest DO level recorded was 9.87 mg/L on May 23rd. The minimum dissolved oxygen level fell below the Yurok Tribe's draft DO standard of 7 mg/L for 50 days. Minimum DO levels dropped below 7 mg/L starting on June 27th and stayed below 7 mg/L until the end of September, with the exception of a slight period in the middle of August and September.

It is important to note that DO is the most difficult parameter to monitor continuously. Electronic drift and biofouling contribute to lower DO readings. DO levels significantly rise when one data sonde in the river is removed and is replaced with one that is freshly calibrated. This was often done at the Turwar site. While this enabled for a continuous string of data it introduced another instrumental bias from a second unit. This trend can be observed throughout the entire data set and is problematic when analyzing the data. 2003 monitoring methods have been changed in order to correct the data for electronic and biofouling drift.

Oregon Department of Environmental Quality has referenced low DO levels as inhibiting salmonid migration. This may have played a role in inhibiting the salmon migration in the lower river prior to the fish kill. Further stringent review of DO levels at different flows and salmon run sizes in different years may help to further explain salmon migration behavior. Continuous DO monitoring will continue into the future in order to develop baseline conditions and track trends over time.

9.1.1.3 pH

pH is the measurement of the hydrogen-ion concentration in the water. pH is a major factor affecting the availability of nutrients to plants and animals. An increase in pH may cause heightened ammonia concentrations (EPA, 1986). At low pH, ammonia combines with water (H2O) to produce an ammonium ion (NH4+) and a hydroxide ion (OH-). The ammonium ion is non-toxic and not of concern to organisms. Above a pH of 9, ammonia (un-ionized) is the predominant species (Morgan et al., 1981). The un-ionized ammonia (NH3) is very toxic to organisms. Thus, organisms experience ammonia toxicity more readily at higher pH (NRC, 1979).

Gaps in data occur due to problems with the instrumentation and battery failure. Minimum, average and maximum values were not generated on days with only partial data (less than 48 measurements taken at ½ hour intervals).

pH levels varied over the sampling period, the lowest pH level recorded was 7.6 on May 24th and June 5th and the highest pH level recorded was 8.8 on August 20th. The maximum pH level exceeded the Yurok Draft pH standard of 8.5 for 9 days. Maximum pH levels began to exceed the standard on August 11th and dropped below the standard after August 22nd. This was a period of warm water temperatures and large daily variations in DO as well. Further indicating the inter-relationships these parameters have on each other. Otherwise, it appears that the pH levels are within the optimal range for freshwater streams.

9.1.1.4 Conductivity

Specific Conductivity is a measurement of how well a solution of water can pass an electric current, which increases with the amount of dissolved ionic substances, thus another method to determine the level of dissolved solids.

Gaps in data occur due to problems with the instrumentation and battery failure. Minimum, average and maximum values were not generated on days with only partial data (less than 48 measurements taken at ½ hour intervals).

Specific conductivity (Specific conductivity) levels varied over the sampling period. The lowest Specific conductivity level recorded at the Turwar site was 102.5 on May 20th and the highest Specific conductivity level recorded was 175.1 on September 5th. The Specific conductivity levels did not reach the Yurok Tribe's draft Specific conductivity standard which sates that levels shall have a 90% upper limit of 300 µmhos/cm @ 25° Celsius and a 50% upper limit of 200 µmhos/cm @ 25° Celsius. Percent upper limits means that 90% (or 50%) or more of the values must be less than or equal to an upper limit.

From May 22nd to May 27th a large shift in Specific conductivity was recorded at the Turwar site. After viewing rainfall data collected by the USGS at the Turwar Gaging Station it was determined to have been caused by an increase in rainfall that directly influenced the Specific conductivity of the Klamath River. This rain event most likely flushed dissolved solids into the river, increasing the ability of the water to carry an electric current.

9.1.2 Klamath River at Martins Ferry

9.1.2.1 Temperature

Refer to the discussion of temperature at Turwar that explains the gaps in data and a brief description of what water temperature is. Yurok Tribe Fisheries Program (YTFP) personnel from the Weitchpec office began operating a data sonde at Martins Ferry on May17th. YTEP is including the data in this report in order to show a more comprehensive view of the water quality in the mainstem Klamath River throughout the YIR during the spring, summer and fall months.

Water temperatures varied greatly over the sampling period at the Martins Ferry site. The lowest water temperature recorded was 11.97° Celsius on May 21st and the highest water temperature recorded was 25.27° Celsius on July 11th. The maximum water temperature exceeded the Yurok Tribe's draft water temperature standard of 21° Celsius (69.8° Fahrenheit) for 36 days. Maximum water temperatures began exceeding 21° Celsius on June 24th and stayed above this temperature until August 8th. The water temperature again rose above 21° Celsius on August 9th and was recorded above this level until August 12th. It is possible that if the data sonde was recording in the river for the entire summer a much higher number of days would have exceeded the Yurok Tribe's draft water temperature standard.

The water quality conditions in the Klamath River at Martin;s Ferry are a product of the Trinity River joining the Klamath River at Weitchpec, approximately 5 miles upstream (Figure 5-3). The Trinity River has, at times, a cooling effect on the Klamath River. Martins Ferry is far enough downstream that both rivers have enough time to thoroughly mix. An example of this can was seen on July 20th (Table 9.1.2-a) where the Trinity River has cooled the Klamath River at Martins Ferry average water temperature by 0.34 degrees Celsius. While the maximum water temperature in the Trinity River on July 20th reaches 24.83° Celsius (comparable to the Klamath River at Weitchpec at 24.99° Celsius) its minimum (21.39° Celsius) is lower than the Klamath River at Weitchpec (22.5° Celsius). This is important when considering the effect the Trinity River has on the Klamath River. The volume of water in both the Klamath River and Trinity River at Weitchpec is also important to consider when analyzing the effects the Trinity River has on the Klamath River. There are other variables that need to be considered, as well. Such variables include the water temperature and volume of water coming from Pine Creek (a tributary that flows into the Klamath River in between Weitchpec and Martins Ferry) and any subsurface flow that may also be cooling the river.

Table 9.1.2-a Min., max. and average water temperature values at three sites on July 20th 2002.

Temperature	Location		
	Klamath at Weitchpec	Trinity River at Weitchpec	Klamath River at Martins Ferry
Minimum	22.5	21.39	22.21
Average	23.73	23.17	23.39
Maximum	24.99	24.83	24.66

9.1.2.2 Dissolved Oxygen

Refer to the discussion of dissolved oxygen at Turwar that explains the gaps in data and a brief description of DO.

DO levels varied over the sampling period, the lowest DO level recorded was 6.47 mg/L on July 2nd and the highest DO level recorded was 12.9 mg/L on May 21st. The minimum DO level fell below the Yurok Tribe's draft DO standard of 7 mg/L for 12 days. Minimum DO levels dropped below 7 mg/L starting on June 30th and fluctuated above and below 7 mg/L until the middle of September. It is possible that if the data sonde was recording in the river for the entire summer a much higher number of days would have fell below the Yurok Tribe's draft DO standard.

9.1.2.3 pH

Refer to the discussion of pH at Turwar that explains the gaps in data and a brief description of what water pH is.

pH levels varied over the sampling period, the lowest pH level recorded was 7.68 on May 17th and the highest pH level recorded was 8.58 on July 7th. The maximum pH level exceeded the Yurok Tribe draft pH standard of 8.5 for 6 days. Maximum pH levels began to exceed the standard on August 11th and dropped below the standard after August 22nd. It is possible that if the data sonde was recording in the river for the entire summer a much higher number of days would have been above the Yurok Tribe's draft pH standard.

9.1.2.4 Conductivity

Refer to the discussion of Specific conductivity at Turwar that explains the gaps in data and a brief description of what Specific conductivity is.

Specific conductivity levels varied over the sampling period, the lowest Specific conductivity level recorded at the Martins Ferry site was 107.7 on May 19th and the highest Specific conductivity level recorded was 169.6 on July 21st. The Specific conductivity levels did not reach the Yurok Tribe's draft Specific conductivity standard which states that levels shall have a 90% upper limit of 300 µmhos/cm @ 25° Celsius and a 50% upper limit of 200 µmhos/cm @ 25° Celsius. % upper limits means that 90% (or 50%) or more of the values must be less than or equal to an upper limit.

Martins Ferry Specific conductivity seasonal variation is different than the seasonal variation at the Turwar site downriver. Martins Ferry rises and falls at a faster rate and then rises again later in season than the Turwar site. While Turwar gradually rises throughout the season and only slightly dips before rising again later in the season.

9.1.3 Klamath River at Weitchpec

9.1.3.1 Temperature

Refer to the discussion of temperature at Turwar that explains the gaps in data and a brief description of what water temperature is. YTFP personnel from the Weitchpec office began operating the data sonde at Weitchpec on May17th. YTEP is including the data in this report in order to show a more comprehensive view of the water quality in the mainstem Klamath River throughout the YIR during the spring, summer and fall months.

Water temperatures varied greatly over the sampling period at the Weitchpec site. The lowest water temperature recorded was 11.88° Celsius on May 22nd and the highest water temperature recorded was 25.61° Celsius on July 21st. The maximum water temperature exceeded the Yurok Tribe's draft water temperature standard of 21° Celsius (69.8° Fahrenheit) for 48 days. Maximum water temperatures began exceeding 21° Celsius on June 23rd and stayed above this temperature until September 2nd except for one day on

August 6th when it slightly dipped below 21°Celsius. It is possible that if the data sonde was recording in the river for the entire season a much higher number of days would have exceeded the Yurok Tribe's draft water temperature standard.

9.1.3.2 Dissolved Oxygen

Refer to the discussion of DO at Turwar that explains the gaps in data and a brief description of what DO is.

DO levels varied over the sampling period, the lowest DO level recorded was 6.36 mg/L on September 2nd and the highest DO level recorded was 12.76 mg/L on June 10th. The minimum DO level fell below the Yurok Tribe's draft DO standard of 7 mg/L for 34 days. Minimum DO levels dropped below 7 mg/L starting on June 24th and fluctuated above and below 7 mg/L until the September 9th. It is possible that if the data sonde was recording in the river for the entire season a much higher number of days would have fell below the Yurok Tribe's draft DO standard.

9.1.3.3 pH

Refer to the discussion of pH at Turwar that explains the gaps in data and a brief description of what water pH is.

pH levels varied over the sampling period, the lowest pH level recorded was 7.32 on June 24th and the highest pH level recorded was 8.74 on August 30th. The maximum pH level exceeded the Yurok Tribe's draft pH standard of 8.5 for 26 days. Maximum pH levels began to exceed the standard on July 25th and fluctuated around 8.5 until September 9th when they began to stay below 8.5 for the remainder of the season. It is possible that if the data sonde was recording in the river for the entire summer a much higher number of days would have been above the Yurok Tribe's draft pH standard.

9.1.3.4 Conductivity

Refer to the discussion of Specific conductivity at Turwar that explains the gaps in data and a brief description of what Specific conductivity is.

Specific conductivity levels varied over the sampling period, the lowest Specific conductivity level recorded at the Weitchpec site was 82.7 on June 6th and the highest Specific conductivity level recorded was 183.4 on July 29th. The Specific conductivity levels did not reach the Yurok Tribe's draft Specific conductivity standard which states that levels shall have a 90% upper limit of 300 µmhos/cm @ 25° Celsius and a 50% upper limit of 200 µmhos/cm @ 25° Celsius. % upper limits means that 90% (or 50%) or more of the values must be less than or equal to an upper limit.

9.1.4 Trinity River

9.1.4.1 Temperature

Refer to the discussion of temperature at Turwar that explains the gaps in data and a brief description of what water temperature is. YTFP personnel from the Weitchpec office began operating the data sonde at the Trinity River site on April 26th. YTEP is including the data in this report in order to show a more comprehensive view of the water quality in the mainstem Trinity River before it flows into the Klamath River during the spring, summer and fall months.

Water temperatures varied greatly over the sampling period at the Trinity River site. The lowest water temperature recorded was 10.07° Celsius on May 9th and the highest water temperature recorded was 25.38° Celsius on July 21st. The maximum water temperature exceeded the Yurok Tribe's draft water temperature standard of 21° Celsius (69.8° Fahrenheit) for 21 days. Maximum water temperatures began exceeding 21° Celsius on June 27th and stayed above this temperature until August 19th except for one day on August 5th when it slightly dipped below 21°Celsius. It is possible that if the data sonde was recording in the river for the entire summer a much higher number of days would have exceeded the Yurok Tribe's draft water temperature standard.

9.1.4.2 Dissolved Oxygen

Refer to the discussion of DO at Turwar that explains the gaps in data and a brief description of what DO is.

DO levels varied over the sampling period, the lowest DO level recorded was 6.97 mg/L on July 22nd and the highest DO level recorded was 13.08 mg/L on June 4th. The minimum DO level fell below the Yurok Tribe's draft DO standard of 7 mg/L for 3 days. It is possible that if the data sonde was recording in the river for the entire summer a much higher number of days would have fell below the Yurok Tribe's draft DO standard.

9.1.4.3 pH

Refer to the discussion of pH at Turwar that explains the gaps in data and a brief description of what water pH is.

pH levels varied over the sampling period, the lowest pH level recorded was 7.42 on May 11th and 12th and the highest pH level recorded was 8.27 on July 29th. The maximum pH levels did not exceed the Yurok Tribe's draft pH standard of 8.5.

9.1.4.4 Conductivity

Refer to the discussion of Specific conductivity at Turwar that explains the gaps in data and a brief description of what Specific conductivity is.

Specific conductivity levels varied over the sampling period, the lowest Specific conductivity level recorded at the Trinity River site was 96.4 on May 9th and the highest Specific conductivity level recorded was 143.8 on July 23rd. The Specific conductivity levels did not reach the Yurok Tribe's draft Specific conductivity standard which states that levels shall have a 90% upper limit of 300 µmhos/cm @ 25° Celsius and a 50% upper limit of 200 µmhos/cm @ 25° Celsius. % upper limits means that 90% (or 50%) or more of the values must be less than or equal to an upper limit.

9.2 Water Quality (Tributaries)

9.2.1 McGarvey Creek

9.2.1.1 Temperature

YTEP initiated water quality monitoring at the McGarvey Creek site on February 6th 2002 and ended on April 22nd. Gaps in data occur due to problems with the instrumentation and battery failure. Minimum, average and maximum values were not generated on days with only partial data (less than 48 measurements taken at ½ hour intervals, or less than 24 hour measurements taken at 1 hour intervals). The sampling objective for this time of the year in the tributaries is to develop a relationship of turbidity, flow and sediment concentration. Temperature is recorded to determine baseline conditions and track trends over time during the winter. YTFP has continuous temperature probes in many of the tributaries including McGarvey Creek that capture warmer temperatures experienced in the summer months.

Water temperatures varied over the sampling period. The lowest water temperature recorded was 6.83° Celsius on March 18th and the highest water temperature recorded was 12.9° Celsius on April 2nd.

9.2.1.2 Dissolved Oxygen

DO recordings at McGarvey Creek was only recorded in percent saturation. DO levels varied over the sampling period, the lowest DO level recorded was 79% on February 9th and the highest DO level recorded was 94.5% on March 18th.

It is important to note that DO is the most difficult parameter to monitor continuously. Electronic drift and biofouling contribute to lower DO readings. 2003 monitoring methods have been changed in order to correct the data for electronic and biofouling drift.

9.2.1.3 pH

The pH probe failed in McGarvey Creek and no data is available for review.

9.2.1.4 Conductivity

Specific conductivity levels varied over the sampling period, the lowest Specific conductivity level recorded at the McGarvey Creek site was 54.6 on February 20th and the highest Specific conductivity level recorded was 76.4 on February 21st. During storm events as stage height rose Specific conductivity levels dropped dramatically.

9.2.2 Blue Creek

9.2.2.1 Temperature

YTEP initiated water quality monitoring at the Blue Creek site on February 12th 2002 and ended on September 11th. Gaps in data occur due to problems with the instrumentation and battery failure. Minimum, average and maximum values were not generated on days with only partial data (less than 48 measurements taken at ½ hour intervals, or less than 24 hour measurements taken at 1 hour intervals). The sampling objective for the winter time is to develop a relationship of turbidity with flow, see the hydrological section for turbidity results. Other water quality parameters measured during the spring and summer months are recorded to determine baseline conditions and track trends over time. YTFP has continuous temperature probes in many of the tributaries including Blue Creek that capture the temperatures in different locations throughout the watershed.

Water temperatures varied over the sampling period. The lowest water temperature recorded was 5.4° Celsius on March 17th and 18th and the highest water temperature recorded was 20.19° Celsius on May 4th. The maximum water temperatures did not reach the Yurok Tribe's draft water temperature standard of 21° Celsius. However, it did come close to this temperature and stayed warm during late July and early August.

9.2.2.2 Dissolved Oxygen

DO was measured in mg/L beginning in May. DO levels varied over the sampling period, the lowest DO level recorded was 7.03 mg/L on August 25th and the highest DO level recorded was 11.22 mg/L May 8th.

It is important to note that DO is the most difficult parameter to monitor continuously. Electronic drift and biofouling contribute to lower DO readings. 2003 monitoring methods have been changed in order to correct the data for electronic and biofouling drift.

9.2.2.3 pH

pH levels varied over the sampling period, the lowest pH level recorded was 7.56 on February 27th and the highest pH level recorded was 8.56 on August 10th. The maximum pH levels exceeded the Yurok Tribe's draft pH standard of 8.5 for 2 days in the middle of August.

9.2.2.4 Conductivity

Specific conductivity levels varied over the sampling period, the lowest Specific conductivity level recorded at the Blue Creek site was 52 on February 23rd and the highest Specific conductivity level recorded was 138.5 on September 4th. During storm events as stage height rose Specific conductivity levels dropped dramatically. This can be seen during a storm event that occurred at the end of February.

9.3 Macroinvertabrate Sampling

Macroinvertabrate results are presented for both WY01 and WY02 in order to provide a broader sample size for this report. These data are presented as baseline data at this point. YTEP is not attempting to make conclusions at this early stage in this program, but expects to have the ability to do so once five years of data have been collected. The program recognizes the need to run more multi-variate analyses on the wide array of biological and physical metrics that are associated with macroinvertabrate sampling.

General observations of the data include: comparability in sample timing; changes by more than one category in the IBI (i.e. poor to good), physical stream conditions and site selection.

The Blue Creek and McGarvey Creek sites are located near continuous gaging stations and sites of data sonde deployment. Although water quality and hydrology data for WY01 is not available in this report for these sites, one may compare these data with future years in order to establish relationships in macroinvertabrate community health and stream conditions.

Since many of the sites are located at or near the mouths of the stream, YTEP notes that these sites represent a cumulative impact from the watershed and thus the lowest quality of water and habitat. However, it is important to note that the one sample taken in the mainstem Klamath demonstrates a higher quality than some of the tributaries. As explained above, these are only cursory baseline data and hypotheses and conclusions have yet to be developed.

In WY01, two samples were taken in the same location prior to and after the application of herbicides by helicopter (McGarvey and Turwar). This procedure was not duplicated in WY02 due to the fact that aerial herbicide application did not occur. Although the cumulative visual distribution score decreased in both instances following herbicide application, there is not enough evidence to make definitive conclusions about the effect of aerial herbicide application to the macroinvertabrate community due to confounding factors and small data set. These confounding factors include: the effect the first sampling event had on the site in terms of recolonization and distribution; lowering water levels between the two events; temperature conditions; and the fact that no herbicide concentrations were detected at detection limits in water samples.

One general trend that might be gleaned from the limited data set is that of timing on sample results. With the exception of Mc1 at 4/15/03 and Wp1, each site that was repeated in the two years showed a decline in cumulative visual distribution score the later it was sampled.

YTEP hopes with WY03 data further comparisons and analyses will serve as useful tools in the overall goal of assessing the physical, chemical and biological integrity of the Lower Klamath Basin.

9.4 Hydrologic Monitoring

9.4.1 McGarvey Creek

9.4.1.1 Discharge

Discharge values were calculated using the rating curve produced by flow measurements taken in the field. Statistical data is compiled from the discharge estimations and displayed in tabular form (Table 7.4.1-b and Table 7.4.1-c). McGarvey Creek experiences subsurface flows in the late summer, therefore no stage measurements or discharge estimations are calculated. The minimum estimated flow at McGarvey Creek was 1.09 cfs (prior to subsurface) occurring on September 30, 2002. The maximum estimated flow at McGarvey was 288 cfs on February 20, 2002.

9.4.1.2 Turbidity

Turbidity data was recorded periodically throughout WY02 at McGarvey Creek. Typically, turbidity is apparent during the winter months when storms produce large amounts of runoff creating higher flow events and higher velocities. The turbidity data show that the highest recorded value was approximately 650 NTUs. Turbidity levels approached near zero during the spring and summer.

9.4.2 Blue Creek

9.4.2.1 Discharge

Blue Creek flows continuously throughout the year at the gaging station site; however, only five months of data were recorded during WY’ 02 because the station was installed during April 2002. The estimated minimum daily flow was approximately 48.13 cfs. The highest estimated flow for the period of record was 225 cfs. These values do not represent a typical water year for Blue Creek because of the minimal amount of data available for the water-year. A typical water-year for Blue Creek may produce instantaneous flows near or over 11,000 cfs in the winter.

9.4.2.2 Turbidity

Hourly turbidity data was recorded periodically during WY02. Turbidity reached a maximum value near 1000 NTUs in late February 2002. Two other turbidity events are noticeable on Figure 7-143. These events may be storm related such as the September event, but the event in June 2002 represents some other source of turbidity such as a landslide, mass wasting, bank failure or other events occurring in the upper watershed.

9.5 NotchkoWeather Station

Since there was no observed rainfall from October 1st through October 10th, the cumulative rainfall total at this station for WY2002 is considered nearly complete with the exception of a freshet that occurred on September 17, 2002 that totaled approximately 0.25" at the USGS Turwar gaging station. The Notchko station, due to annual service and equipment upgrades, did not capture this event. The first rain event of the year occurred between 21:00 and 22:00 hours on October 10, shortly after the station was in operation. This event was minor, lasting only 12 hours with an accumulation of 0.13" Figure 7-146. In WY02, a total of 70.69 inches of rainfall were recorded at the Notchko RAWS. The highest monthly total and hourly intensity both occurred in December (Figure 7-147). The highest recorded hourly rainfall intensity occurred on December 13, 2001 between the hours of 18:00 and 19:00 at a rate of 0.48"/hr. In all, there were 11 occurrences of rainfall intensity of over 0.25"/hr. recorded in the month of December. Hourly rainfall intensities exceeding 0.25"/hr. are illustrated in Figure 7-144. A total of 19.07 inches of accumulated rainfall were recorded in December, making up approximately 27% of the total annual rainfall. As stated above, the majority of these events occurred in the month of December, while 5 more occurred in January making up a combined total of 16 or 84% of such events for the total water year.

9.6 Herbicide Monitoring

YTEP staff was not present during the application of atrazine on Simpson unit 319. YTEP did not verify through tank sampling or pesticide use reporting that atrazine was used on unit 319. According to Notchko Weather Station data 0.5 inches of rain did not fall in a significant amount of time. YTEP determined that there was not a significant amount of rainfall to initiate sampling. Based on laboratory results, and the above information, YTEP concludes that there was not a presence of atrazine above 0.05ppb in surface water at the monitoring point during May 20, 2002.

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Appendix A
Protocols

This Section includes:

1. **Protocol for operation of datasonde**
2. **Protocol for macroinvertabrate sampling- Rapid Bioassessment**

ARCATA FISH AND WILDLIFE SERVICE'S MULTI-PROBE MAINTENANCE AND DEPLOYMENT PROTOCOL

By

P. Zedonis, R. Turner, M. Cunanan,
K. Sirkin, and J. Ogawa

ARCATA FISH AND WILDLIFE OFFICE
U.S. Fish and Wildlife Service
1655 Heindon Rd
Arcata, California, 95521

February, 2003

PURPOSE STATEMENT

The challenge associated with water quality monitoring is to collect data that consistently represents the environmental conditions (Ministry 1999). To be able to best represent these conditions, it is important to develop a thorough protocol to obtain comparable data. To ensure the collection of good data, a quality assurance/quality control (QA/QC) program must be incorporated into the plans.

This document is the first of its kind for the USFWS in Arcata, California. It was largely put together to assure that persons involved with the Water Quality Monitoring Project are consistent in the protocols that they use. Specifically, this document covers protocols for the calibration and collection of continuous and spot data with multimeter probes (e.g. Hydrolab DataSondes and Quantas).

QUALITY ASSURANCE/QUALITY CONTROL

Two major components of QA/QC are accuracy and precision. Accuracy is how close the results are to a true or expected value. Instrument calibration is a necessary first step to assure accurate performance in the field. Precision, on the other hand, is the amount of agreement (or random error) among repeated independent measurements of the same parameter. The protocol identified herein, strives to obtain accurate and precise data.

DATASONDE AND QUANTA UTILIZATION

Step 1: Is your DataSonde/ Quanta ready to be used?

If you have not operated these instruments before, it is necessary that you spend a small amount of time reading the users guide, past reports, and practicing calibration of instrumentation. Demonstration of the instrumentation by veteran users is valuable and should be sought where available. As with any equipment, the more knowledgeable you are about the instrumentation, the better you will be able to collect good quality information. Attention to detail is required in order to obtain good quality and defensible results.

Upon receiving a DataSonde from the manufacturer or pulling one out of storage, there are many things to consider before the start of the field season. For example, how long since the pH reference solution was changed? If there is a low ionic strength reference probe, how old is it and should it be replaced? Is the gold cathode or the silver anode of the DO sensor discolored? These are but a few questions you must ask yourself before using the instrumentation. A thorough examination of the manufacturers recommended maintenance schedule will generally supply you with a list of things to consider. In some cases, previously collected data may provide some evidence as to where probes are starting to fail, allowing one to obtain a replacement probe early in the season. Making sure the instruments have met the maintenance schedules and are running correctly before the season starts serves as a first line of defense to help assure that data collection efforts are successful. Furthermore, doing so will limit instrumentation failures in the field and prevent excessive bias from being introduced into the data.

Step 2: Preparation of the Instrument for Deployment

Study Sites, Housing and Security
The monetary value of the instruments and the importance of the data collected require that water quality instruments be secure when in the field. Study locations are chosen at the discretion of the researchers and their objectives. In many cases, instrument placement includes considerations towards vandalism, ecological effects, access etc. An ideal site is one that is representative of the section of water being measured and has some object such as riparian trees, large boulders, bridge abutments or pilings that can provide a secure point of attachment for the equipment. The DataSonde is placed in a 4"-6" diameter perforated aluminum housing with a length of attached chain that is locked on site. Avoid sites that have lots of visitors and try and conceal the unit so it doesn't attract unnecessary attention.

Sampling Intervals
Water quality units should be deployed for one week or less at a time. This strict protocol helps prevent loss of data if the unit prematurely malfunctions and reduce the amount of error due to biofouling and electronic drift. Units may be left in the field longer because of unforeseen circumstances but this is not recommended.

Parameter Set-up
The DataSonde multiprobe is used in conjunction with a computer program called Hyperterminal. This program allows the user to set the DataSonde unit to record the desired parameters, calibrate the instrument and download the files onto the computer. When installed on a laptop, these tasks can be performed at the field site and result in more flexibility in performing field operations while maintaining consistent quality data. For specific methods on using the Hyperterminal program, refer to the Hydrolab Maintenance and Calibration Workshop Training Manual (EDS, 2001).

When first hooking up the DataSonde to the Hyperterminal program, the first item to set is the DataSonde date and time. This step is crucial to maintaining consistent data throughout the season. Using a calibrated clock, enter the time ten to fifteen seconds in the future and press enter on the computer when that time is reached. This calibrates the DataSonde clock with your own calibrated clock.

All parameters to be measured should be set up through the computer to record in the following sequence and units for consistency. Each of these parameters must be entered separately and in the order they are to be displayed on the screen (from left to right). Parameters include: Date, Time, Temp (^{o}C), Specific Conductivity (µS/cm), pH, Dissolved Oxygen (mg/L), Dissolved Oxygen (% Saturation) and I Batt (internal battery level).

File Creation
The creation of a file describes where an instrument will be placed, the time frame in which it will be deployed and extracted and its recording interval. To define the file name, a two-letter abbreviation of the site is used followed by the underline symbol and then the deployment date. An example would be TR_070302 for a unit that was deployed in the Trinity River on July 3rd, 2002. This pattern is important to allow accurate tracking and management of files. The instrument should be scheduled to start at a time prior to your arrival and deployment; this makes sure the deployment does not take place before the unit turns on. (Not doing so will invalidate any field audit performed at deployment). The stop date should be set for at least a week past the date you expect to extract the unit. This gives the user time to reschedule an extraction in case of unforeseen circumstances. Stop time should be set for sometime after dark so that an extraction audit is not missed in the middle of the last day of the file. Interval time should be set at 003000 which produces a recording every 30 minutes. Sensor and circulator warm up is set for 000200 to give the instruments two minutes to warm up before taking the recording. At this point, the file setup is complete.

Step 3: Calibration Procedures

The calibration process is the second line of defense for obtaining good water quality data. Consistently following the procedures outlined below will help ensure the data is of good quality. In addition, inconsistent application of a rigid protocol weakens the confidence of the data that in turn may inhibit our ability to draw any conclusions from the study.

Water Temperature
Before and after the field season, it is pertinent to verify that the thermisters of each instrument are recording to within the manufacturer's specifications. Although it is commonplace for manufacturers to mention that calibration is not required, it is necessary to verify that the instruments are performing as specified. Verification builds the researchers confidence that the data that has been or will be collected is of good quality; this may be especially true as the instruments age. The verification process takes place in a water bath and should span a temperature range that is representative of the field setting. This should be done both at the beginning and end of the field season; In multiyear studies this can be accomplished with one experiment. A verification study conducted by Zedonis and Cunanan (2001) on year-old instruments found all mulitprobes were within $\pm$ 0.2°C when compared to a NIST thermometer. It is not necessary to calibrate for temperature on a weekly basis. A check between the DataSonde and auditing Quanta will reveal differences that need further attention. Additionally, other calibrated temperature probes (e.g. Optic Stowaways) can be placed at sites to collect continuous temperature data throughout the season.

Specific Conductivity
Calibration for conductivity is performed in the laboratory with standards that have been allowed to equilibrate to ambient temperature. Because different temperatures affect

conductivity it is important that the standards be in equilibrium with the expected temperature of the water to be sampled.

Calibration should occur with a standard that brackets the range of conditions expected in the field. A two-point calibration of zero to 447µS/cm is appropriate for most northern California streams. In the Klamath River this range of standards is appropriate for most sites except the highly conductive Shasta River where a standard of 718µS/cm should be used.

Procedure:
Rinse the probes three times with DI water. Empty the calibration cup and dry the probe thoroughly. When the computer reads 0.0 for conductivity, enter that as the first calibration. Follow this by rinsing sparingly three times with the standard solution. When rinsing, be sure to swirl the solution adequately to remove or continually dilute any residual DI water remaining in the calibration cup. Discard standards after each use. Fill the calibration cup with enough standard to cover the probe and allow a few minutes for the readings to stabilize. After stabilization, use the labtop computer to enter the standard solution value as your final reading.

pH

Calibration for pH is also performed in the laboratory with buffers that have been allowed to reach room temperature. Again, use standards that bracket expected environmental conditions. For the Klamath River, pH standards of 7.0 and 10.0 are appropriate.

Procedure:
Rinse the calibration cup and associated probes three times with DI water. Rinse sparingly three times with pH 7.0 buffer. Again, be sure to swirl the solution adequately to remove or continually dilute any residual DI water in the calibration cup. Fill with pH 7.0 buffer and allow meter reading to stabilize for a few minutes. Record this as the initial value and then enter the buffer value of 7.0 into the laptop. This will be the final calibration value. Now pH 10.0 must be calibrated. Repeat the same process this time switching to pH 10.0 buffer.

Dissolved Oxygen

Dissolved oxygen instruments and sensors are sophisticated electronic equipment that requires frequent maintenance and delicate handling. Care should be taken so as to prevent the membrane from drying out, as well as protecting the instruments from sudden impacts, drastic temperature changes, and extremes of heat and cold.

Maintenance issues of the dissolved oxygen probe generally are associated with the membrane. This membrane is subject to biofouling and the electrolyte solution under the membrane slowly leaches into the environment. Exchanging the membrane and electrolyte solution regularly (i.e., every 6 or 7 days) should eliminate or limit any temporal bias due to any change in electrolyte concentration. Although dependent on the frequency of sampling and environmental conditions where the samples are being taken (e.g. eutrophic water), extended use of the instrument without consistently replacing the solution probably lessens the accuracy and precision of data. Calibration for dissolved oxygen percent saturation also effectively calibrates for dissolved oxygen in mg/L.

Procedure:
DO calibrations of the multiprobe instruments are performed at the laboratory or study site (preferred) with a 100-percent saturation method (EDS 2001). Following membrane replacement and overnight relaxation, fill the calibration cup with DI water until the water level is just below the DO membrane o-ring. All water must be removed from the DO membrane by gently dabbing the surface using a non-abrasive tissue such as a Kim-wipe. Use the corner of the Kim-wipe to absorb any water on the membrane that lies near the o-ring. To prevent airflow from interfering with the calibration, place the lid upside down over the calibration cup. Allow the readings to stabilize (about 5 minutes) and record the % saturation value as the initial reading. To calibrate, enter the site barometric pressure under BP: mmHg. Enter this final value on the datasheet.

Step 4: DataSonde Deployment

Upon arrival at each monitoring site, numerous tasks must be performed to successfully meet the QA/QC protocol and deploy the DataSonde (Table 1). Percent saturation must be calibrated with the above procedures for both the DataSonde and the auditing instrument (e.g. Quanta) using the average site barometric pressure (B.P.). after calibration, it is important to place both the DataSonde and Quanta in the water at least 5 minutes before the half hour to allow the instruments to stabilize. Care should be taken to avoid placement of the probe-end of the DataSonde or Quanta in areas with silt or algae. Likewise, wading upstream of a deployed DataSonde or Quanta should be avoided to prevent erroneous readings by dislodging sediments or algae.

Because the DataSondes and Quantas measure the same parameters, comparisons of their readings are used as part of the QA/QC analysis. In order to record similar environmental conditions, a watch synchronized to the computer and DataSonde is used to time the collection of audit information so that Quanta readings and Winkler samples are collected within five minutes of the time when the DataSonde will record river conditions. Upon review of the data, it was noticed that many audits were recorded outside of the five minute window. In order to retain the valuable information from these audits an exception was made to allow audits within twenty minutes of the DataSonde recording time. The Winkler test is used to represent an additional validation point for DO and will serve as the primary criteria for judgment of DataSonde data quality. It is imperative that all field personnel are certified in conducting titration tests for DO concentration (See instructions that follow). These procedures are performed at the time of both deployment and extraction.

Table 1. Schedule of events for a DataSonde deployment/ extraction event.

Duties	Arrival at the field site	On-site DO calibrations of Hydrolab and Quanta	Placement of newly calibrated DataSonde and Quanta	Record Quanta readings (collect DO Winkler sample)	Remove previous DataSonde and post-calibrate
Time	8:35	8:45	8:50	9:00	9:10

Though it is not necessary for quality control purposes, auditing the DataSondes performance between the time of deployment and extraction can help verify instrument readings. This is especially valuable at times of the day or season when water quality conditions are poor (e.g. low DO) and additional supporting information is needed to confirm conditions.

If additional DataSonde units are available, deploying a newly calibrated unit before extracting the previous one is recommended. Doing so allows for one set of audit information to validate the extraction of one datasonde and the deployment of another. Swapping the previous weeks' DataSonde with a newly calibrated DataSonde allows for collection of a continuous data string and reduces the number of visits necessary at each site. When not swapping, data is lost for the time needed for weekly membrane replacement and overnight relaxation between extraction and redeployment. Analysis using daily averages results in a loss of two days of data and may result in missing a poor water quality episode.

Winkler Titration Method

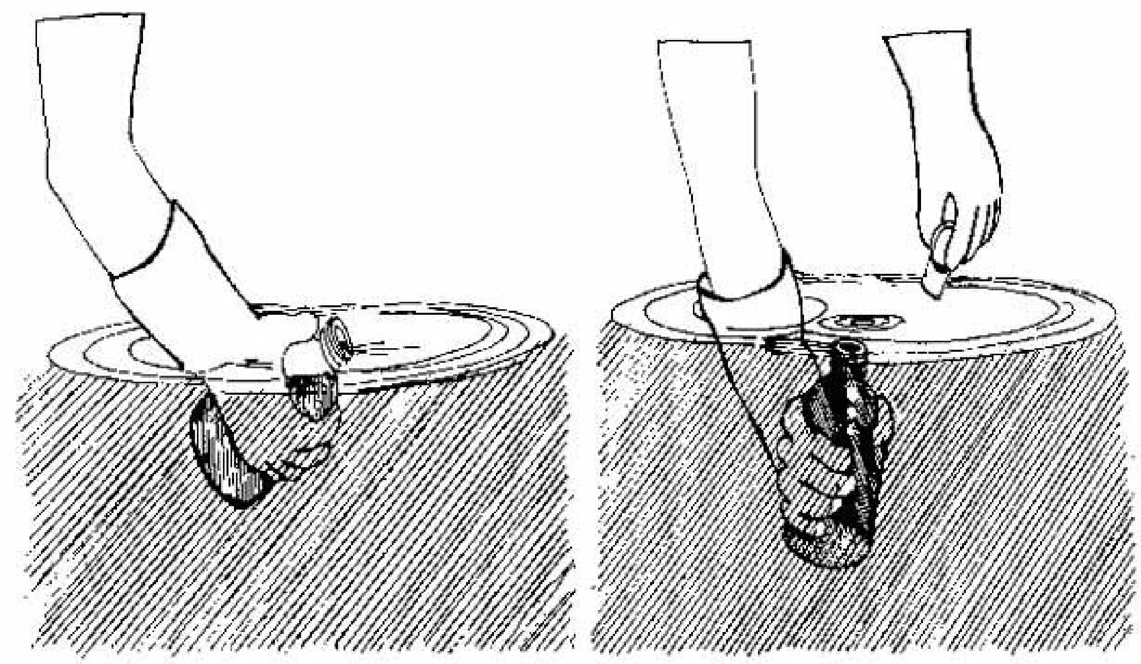
The Winkler titration method is a useful tool in obtaining spot checks or validation points. It is the most accurate chemical method for measuring the concentration of dissolved oxygen (Oregon 1999). The accuracy of this method depends on the experience and technique of the data collector. As stated earlier, each person performing this test is required to be certified through laboratory exercises. The Winkler Titration Method requires preventing exposure of the sample to atmospheric oxygen, which makes accurate and precise field determinations difficult (Wagner et al. 2000). The accuracy also depends on the quality of the kit used. For the quality of data collection used for water quality sampling it is important to use kits that produce similar results. The Hach Digital Titrator is an example of a test kit that AFWO uses to produce accurate and reproducible results.

The following procedure for collecting a sample for titration by the Winkler method should be applied (taken from the EPA's Volunteer Stream Monitoring: A methods manual):

1. Obtain a <u>clean</u> 300 mL glass BOD bottle (available with the Hach kit).
2. When selecting a site, the water must be deeper than the sample bottle. The water sample must be collected in a way that the bottle can be capped while it is submerged.
3. Wade into the stream and face either bank.
4. The sample is to be collected so that you are not standing upstream of the bottle. Slowly lower the bottle into the water, pointing it downstream, until the lower lip of the opening is just submerged. Allow the water to fill gradually, avoiding any

turbulence. When water level in the bottle has stabilized, slowly turn the bottle upright to fill it completely. Keep the bottle submerged and allow it to overflow for 2 or 3 minutes to ensure no air bubbles are trapped.

5. Cap the bottle while it is submerged. Lift the bottle and inspect for any bubbles. If there are any bubbles repeat the process.



6. Immediately fix the sample.

To fix the sample (taken from Hach Digital Titrator Methods 8215 and 8332):

1. To the bottle add the contents of one Manganous Sulfate Pillow and one Alkaline Iodide-Azide Reagent Pillow.
2. Immediately insert the stopper so that no air is trapped in the bottle. Invert several times to mix.
3. Wait till the floc settles then again invert several times to mix.
4. Remove the stopper and add the contents of one Sulfamic Acid Pillow. Replace the cap without trapping any bubbles and invert again to mix.
5. Insert a clean delivery tube into a titration cartridge and place it into the digital titrator.
6. Turn the digital titrator knob to eliminate any bubbles present within the delivery tube. Reset the digital titrator to zero and wipe the tip.
7. Measure out 100 mL using a graduated cylinder, and transfer the sample to the Erlenmeyer flask.
8. Place the delivery tube into the solution and swirl the flask while titrating with sodium thiosulfate till it reaches a pale yellow color.
9. Add two milliliters of Starch Indicator Solution and swirl to mix.
10. Continue the titration to a colorless end point. Record the number on the digital titrator.

11. Following the titration, rinse **ALL** equipment with deionized water, including the small delivery tube used to dispense the sodium thiosulfate. Cover glassware to prevent contamination. Clean laboratory equipment is essential.
12. Dispose of the Acid pillows properly.

Step 5: DataSonde Extraction

Extraction of DataSondes is similar to deployment in many ways. The procedure of the Quanta and Winkler tests to audit or verify environmental conditions are no different than during deployment. Calibrate the Quanta for dissolved oxygen and be sure to place the Quanta in the water for at least five minutes before recording to stabilize to ambient conditions. Record the Quanta information and collect a Winkler sample within five minutes (preferred) or twenty minutes (maximum) of the DataSonde extraction interval. Do not extract the DataSonde before it has recorded.

Step 6: Post Calibration

Post calibration of the instruments to a standard of known value is necessary to understand the amount of drift that occurred over the deployment period. This drift can be due to bio-fouling and/or electronic drift. Post calibration is an important part of the QA/QC process and provides a necessary evaluation of the instrumentation used in the previous deployment. Probes for specific conductance, pH and percent saturation are evaluated in the post calibration process within 24 hours of extraction. Temperature probes do not undergo a weekly post-calibration process. However, thermisters must be subjected to an annual performance test to verify accuracy.

Specific Conductivity

A temperature-equilibrated standard is used to post calibrate for specific conductivity. Rinse the cup probe three times with DI water and then three times with small amounts of the conductivity solution. Fill reservoir with standard and allow a few minutes for readings to stabilize. After stabilization, record the specific conductance reading. The difference of this value and the value of the known standard are then divided by the standard value and multiplied by 100 to determine the percent error or percent recovery of the instrument.

pH

At the end of the recording period, determine the probes precision for quality control purposes through a post calibration check of uncleaned probes (Radke 1998). Rinse the probe three times with DI water and then three times with small amounts of the pH buffer solution. Fill the cup with the pH solution, wait for the value to stabilize, then record the value. The recorded value is compared to the standard to obtain the post calibration difference.

Dissolved Oxygen
Post calibration of dissolved oxygen (mg/L) is not done directly but through the post calibration of percent saturation (see below). Winkler titrations performed in the field at the time of extraction represent a good method of determining bias of data collected by the instrument.

Percent Saturation
A post calibration is performed immediately after the extraction of the datasonde. The post-calibration process should be conducted on site. Fill the calibration cup of the uncleaned probe with DI water, carefully remove any water from the membrane, cover and allow the unit to stabilize. Input the correct barometric pressure, wait for the unit to stabilize, and record the reading displayed.

DATABASE DEVELOPMENT AND USE

Quality assurance and control does not just pertain to the time of data collection, but also extends to the processing of the recorded data. To process the large amount of data that is generated from water quality monitoring, a database is recommended. AFWO created a database in MS ACCESS to critique, summarize, manage, and store information collected during each deployment. As part of this process, the database offers the capability to provide graphics on water quality trends at any site, problems with instrumentation, calibration procedures or protocols.

Data processing begins with receipt of calibration records and DataSonde data files for each DataSonde deployment from cooperators and Service staff who participate in the monitoring program. This information is expected to be available to the database manager during the week the data has been extracted. Other necessary information required in the database includes:

1. Evaluation and correction of DataSonde file names
2. Importation of *.csv file into the database
3. Verification of data file content
4. Entry of ALL calibration/post-calibration/audit information into the database

REPORTING AND DATA QUALITY

It is recommended that continuous water quality records be characterized by the accuracy of the data collected. AFWO uses several comparisons in an attempt to describe the accuracy of each dataset of every DataSonde deployment.

Data Quality Ratings

As part of the quality assurance program of the AFWO, each dataset is evaluated and given a quality rating. This is done so as to provide some level of confidence that the measured and recorded data are accurately reflecting field conditions; in this case referring to the water quality of the mainstem Klamath River as well as some of its major tributaries. Quality assurance methods used to provide confidence levels of each DataSonde dataset include: 1) comparisons to field verification audits taken with an independent, calibrated instrument; and 2) evaluations of post-extraction comparisons to standards. In combination, these evaluations provide a means of identifying potential error of the instrumentation and thus each dataset. Quality ratings of each dataset are currently based upon the criteria shown in Table 2. Required information to establish a grade is provided in Table 3.

The methodology that is used to establish the final grading of each dataset incorporates error estimates from each applicable component of the quality control program. Grading for each parameter of a dataset is based upon different criteria (Table 2). For example, water temperature receives a grade better than a "D", only if there had been field audits at the time of deployment and extraction and the largest difference between audits and the DataSonde is less than 0.8 ^{o}C. In the absence of one or both field audits the dataset is graded "D". The importance of quality water temperature data cannot be overemphasized as this parameter has a significant influence on other parameter measurements.

Grading of specific conductivity, pH, and percent saturation (dissolved oxygen) data requires more information (Table 2). Here, the requirements include: 1) field audits using a calibrated multiprobe within 5 minutes of the DataSonde reading at the time of deployment and extraction; and 2) a post-extraction comparison to a standard (post calibration). In the absence of any one of these requirements, the data are graded "D". Post-calibration of the DataSondes is completed within 24 hours of extraction and are intended to account for differences (drift) between the time of deployment and extraction. For specific conductance and pH, standard solutions are used to check overall drift, where as the air-calibration method is used to determine drift for percent saturation readings.

Grading of dissolved oxygen concentration data, as opposed to the percent saturation, is also different from the other parameters (Table 2). Here, two types of field audits are used (Winkler titrations and Quanta measurements) to estimate the potential error of DataSonde information. When available, Winkler titrations are preferred over the Quanta readings in terms of determining a quality rating. Here again, the largest difference between the Winkler and DataSonde reading is used to establish the grade. In the absence of one or both Winklers, however, the grading of the data is based upon the largest difference with the two hand-held Quanta audits. In the absence of both the Winkler and multiprobe audit at either the time of deployment or extraction, the dataset is given a grade "D".

Table 2. Rating continuous records (adopted from USGS 2000)

Measured Physical Property	QUALITY RATING			
	A (Excellent)	B (Good)	C (Fair)	D (Poor or No QA/QC)
Water Temperature	≤ ± 0.2°C	> ± 0.2 to 0.5°C	> ± 0.5 to 0.8°C	> ± 0.8°C
Specific Conductance	≤ ± 3%	> ± 3 to 10 %	> ± 10 to 15%	> ± 15%
Dissolved Oxygen	≤ ± 0.3 mg/L	> ± 0.3 to 0.5 mg/L	> ± 0.5 to 0.8 mg/L	> ± 0.8 mg/L
pH	≤ ± 0.2 unit	> ± 0.2 to 0.5 unit	> ± 0.5 to 0.8 unit	> ± 0.8 unit
Percent Saturation [a]	≤ ± 3%	> ± 3% to 5%	> ± 5% to 8%	> ± 8%
Air Temperature [a]	≤ ± 0.2°C	> ± 0.2 to 0.5°C	> ± 0.5 to 0.8°C	> ± 0.8°C
Relative Humidity [a]	≤ ± 3%	> ± 3% to 5%	> ± 5% to 8%	> ± 8%

a – rating established by AFWO

Table 3. Required information used to estimate the quality rating of each dataset collected by DataSondes.

Parameter	Grading of DataSonde and Air Temperature/Relative Humidity Data				
	Field Audit: Multiprobe Instrument at Deployment	Field Audit: Multiprobe Instrument at Extraction	Post-Extraction Comparison of DataSonde to a Standard	Field Audit: Winkler Titration upon Deployment	Field Audit: Winkler Titration upon Extraction
Water Temperature	R [a]	R	NR [b]	NA [c]	NA
Specific Conductance	R	R	R	NA	NA
pH	R	R	R	NA	NA
Dissolved Oxygen (mg/L)	R [d]	R [d]	NR	R [e]	R [e]
% Saturation (Dissolved Oxygen)	R	R	R	NA	NA
Air Temperature	NR	NR	R	NA	NA
Relative Humidity	NR	NR	R	NA	NA

a - Required, b – Not Required, c – Not Applicable, d – Secondary audit data used to grade DO data, e – Primary audit data used to grade DO data

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