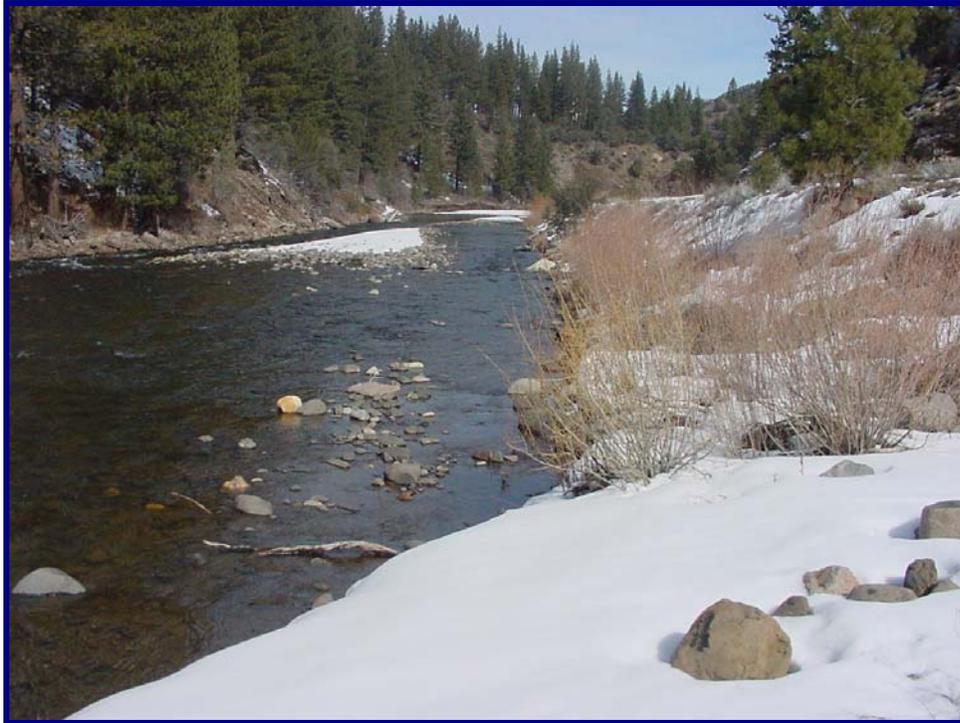


# Upper Carson River Watershed Water Quality Monitoring Program Final Report

June 2007



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**Prepared for:**  
California State Water Resources Control Board

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## EXECUTIVE SUMMARY

In May 2002, Alpine County in cooperation with the Carson Water Subconservancy District, Desert Research Institute (DRI), South Tahoe Public Utility District (STPUD) and the Alpine Watershed Group received funding from the State Water Resources Control Board to conduct a water quality monitoring program (program) in the Upper Carson River Watershed in Alpine County, California (watershed). The objective of the program is to begin to identify and quantify the various sources of contaminants, where possible, and to give public officials additional information to design proper remedial measures, including the development of total maximum daily loads (TMDL's). The overall goal of the program is to provide necessary data to guide restoration efforts aimed at improving water quality and biological resources in the watershed.

As part of this program, water quality data was collected over a two-year period from April 2004 through January 2006 from the Indian Creek, East Fork and West Fork drainages of the watershed. Sierra Environmental Monitoring analyzed samples for total nitrogen, total phosphorus (TP), ortho-phosphate, total suspended solids, turbidity, conductivity, sodium adsorption ratio, E. coli, and total coliform. Field measurements included ambient and water temperature, dissolved oxygen, conductivity, pH and streamflow (at selected sites). All sampling efforts were conducted under the guidance of an approved quality assurance project plan. Sampling that is routinely conducted by STPUD was also utilized for this program. The collected data was then compiled and analyzed by the DRI. Historical data obtained from the STORET database system and the Nevada Division of Environmental Protection (NDEP) was also included in the compilation in order provide a comprehensive database that can be used to guide future projects and studies. Data exploration focused on four areas: summary of all data, seasonal comparison, trends, and spatial comparison.

Both the West Fork Carson River and Indian Creek, a tributary to the East Fork Carson River, are listed as impaired under California's Section 303(d) of the federal Clean Water Act. The West Fork is listed for TP, percent sodium, nitrogen, and pathogens. Indian Creek is listed for pathogens. Although these streams are listed there is very little information available to identify where and what is causing the impairment and whether some of the impairment could be naturally occurring. In July 2003, a TMDL for Indian Creek Reservoir (ICR) for TP was approved by the U.S. Environmental Protection Agency. The long-term, primary numeric target for the TMDL is an annual mean concentration in the water column of 0.02 mg/L TP. This target is projected for attainment by 2024. An interim TP target of 0.04 mg/L was implemented and is projected for attainment by 2013. If water quality monitoring demonstrates that the beneficial uses are supported at higher TP concentrations, the TMDL may be revised. One of the goals of this program is to provide information on the water quality of the Indian Creek watershed and for the external sources of water going into ICR, which includes the West Fork Carson River.

## **Significant Findings**

- The median TP concentration is more than twice as high in the Indian Creek basin than the median for the East or West Forks basins. Median values for TP at East Fork sites are 0.04 mg/L, 0.03 mg/L for West Fork sites, and 0.09 mg/L for Indian Creek sites.
- During high water events TP and other constituents tend to increase significantly. The storm event of May 2005 revealed TP levels on the East Fork ranging from 0.8 mg/L at EF4-WQ1 to 0.88 mg/L at EF7-WQ1 and on the West Fork from 0.06 mg/L at WF7-WQ1 to 0.07 mg/L at WF8-WQ1.
- Sampling of the West Fork in June 2005 showed TP concentrations up to 0.12 mg/L. Since West Fork water is potentially diverted to Indian Creek Reservoir during this time of year, this level of TP is of concern considering that the interim target for ICR is 0.04 mg/L.
- Maximum values for total and fecal coliform for West Fork and Indian Creek sites exceeded 24,000 counts.
- Median value for total coliform for East Fork sites is 410, 230 for West Fork sites, and 150 for Indian Creek sites. In general, Wolf, Millberry, Markleeville and Bryant Creeks show higher median values for total coliform.
- Range of values for nitrates are significantly higher in the West Fork and Indian Creek basins than the East Fork basin.
- Median values in the West Fork basin for ortho-phosphate concentrations were lower than East Fork or Indian Creek basins.
- All of the high sodium adsorption ratio values and sodium values are found in the Indian Creek basin.

## **Recommendations**

- Additional monitoring for TP should be conducted to better identify the source(s) of TP and if it is natural or man-induced.
- Continued monitoring of Millberry, Markleeville and Wolf Creeks for total coliforms should be conducted in order to isolate the source(s) of contamination.
- Sources of funding should be secured in order to continue the monitoring effort developed for this program to ensure a large dataset.
- Sites should be monitored on a monthly basis to ensure a large dataset at the same frequency as the STPUD monitoring program and satisfy regulatory requirements for the computation of the mean of the monthly means

## ABBREVIATIONS

AWG	Alpine Watershed Group
CWA	Clean Water Act
CWSD	Carson Water Subconservancy District
DRI	Desert Research Institute
EDA	Exploratory Data Analysis
EF	East Fork Carson River
EPA	U. S. Environmental Protection Agency
HPR	Harvey Place Reservoir
ICR	Indian Creek Reservoir
IQR	Interquartile range
LRWQCB	Lahontan Regional Water Quality Control Board
NDEP	Nevada Division of Environmental Protection
QAPP	Quality Assurance Project Plan
QPR	Quarterly Progress Report
SAR	Sodium Adsorption Ratio
SEM	Sierra Environmental Monitoring
SOW	Scope of Work
STPUD	South Tahoe Public Utility District
SWRCB	State (California) Water Resources Control Board
TAC	Technical Advisory Committee
TMDL	Total maximum daily load
TP	Total Phosphorus
TSS	Total suspended solids
USFS	U.S. Forest Service
USGS	U.S. Geological Survey
WF	West Fork Carson River

## 1.0 Introduction

### 1.1 Project Background

In May 2002 Alpine County in cooperation with the Carson Water Subconservancy District (CWSD), Desert Research Institute (DRI), South Tahoe Public Utility District (STPUD) and the Alpine Watershed Group (AWG) received funding from the State Water Resources Control Board (SWRCB) to conduct a water quality monitoring program (program) in the Upper Carson River Watershed in Alpine County, California (watershed). The objective of the program is to begin to identify and quantify the various sources of contaminants, where possible, and to give public officials the necessary information to design proper remedial measures, including the development of total daily maximum daily loads (TMDL's). The overall goal of the program is to provide the necessary data to guide restoration efforts aimed at improving water quality and biological resources in the Upper Carson River Watershed.

Alpine County encompasses the headwaters of both the East and West Forks of the Carson River and associated tributaries. These streams support a variety of land use activities or beneficial uses including agriculture and outdoor recreational activities. Naturally occurring and human induced activities may have impacted the natural resources of the streams. The Carson River is the principal source of water supply for irrigation in Alpine County, California and Douglas, Carson City, Lyon and Churchill Counties located in Nevada. Federal and state agencies, local municipalities, and water purveyors are concerned about potential degradation of the Carson River water quality from contaminants entering the river. Many potential sources exist for stream impairment including natural variability, atmospheric deposition, agriculture, and grazing and urban impacts.



**West Fork Carson River in Hope Valley**  
(May 2004 – Sampling Site WF8-WO1)

Currently, both the West Fork Carson River and Indian Creek, a tributary to the East Fork of the Carson River, are listed as impaired under California's Section 303(d) of the federal Clean Water Act (CWA). The West Fork is listed for phosphorus, percent sodium, nitrogen, and pathogens. Indian Creek is listed for pathogens. Although these streams are listed as impaired there is very little information available to identify where and what is causing the impairment and/or whether some of the

impairment could be naturally occurring. The East Fork of the Carson River is not currently listed on the California 303(d) list but is lacking in water quality data needed to assess if water quality objectives are being met. In July 2003 the U.S. Environmental Protection

Agency (EPA) approved a TMDL for Indian Creek Reservoir (ICR) for total phosphorus (TP) due to the frequent violations of water quality objectives and because of TP as a factor in reservoir eutrophication. Since most of the water supplied to ICR comes from the West Fork, understanding the water quality in the West Fork is important for meeting the ICR TMDL. The Carson River is also listed on the Nevada 303(d) list for TP, total suspended solids (TSS) and turbidity. In 2005, EPA approved the TMDL for TP. The TMDL for TSS and Turbidity is currently in draft form.

The program utilized and incorporated information from other projects conducted within the upper watershed. In 2002 the Sierra Nevada Alliance and the AWG obtained funding from a Proposition 13 grant to conduct a Stream Corridor Condition Assessment of the watershed. As part of this project a comprehensive database was developed. Data collected from this program has been incorporated into this database. Also, a “windshield survey” of specific sites where sampling would yield useful data along the East and West Forks of the Carson River as well as the Wolf Creek and Markleeville/Hot Springs Creeks (tributaries of the East Fork Carson River) was conducted as part of the assessment. The sites identified by the survey were used to direct the sampling activities under this program.



**East Fork Carson River by Hangsman Bridge**  
(May 2004 – Sampling Site EF4-WQ1)

As part of this program water quality data was collected over a two-year period from April 2004 through January 2006. Samples were analyzed for total Nitrogen, total phosphorus, orthophosphate, total suspended solids, turbidity, conductivity, sodium adsorption ratio, E. coli, and total coliform. Field measurements included ambient and water temperature, dissolved oxygen, conductivity, pH and streamflow (at selected sites).

All sampling efforts were conducted under the guidance of an approved Quality

Assurance Project Plan (QAPP) (Appendix A). Sampling that is routinely conducted by STPUD was also utilized for this program. The data was then compiled by DRI with historical data (ranging from 1956 to 2006) obtained from the STORET database and the Nevada Division of Environmental Protection (NDEP) to provide a comprehensive database that can be used to guide future projects and studies. This data will be submitted to the EPA STORET database. Information from this program is available upon request from Alpine County or the CWSD.

## 1.2 Project Area Description

The entire Carson River Watershed covers an approximate area of 3,965 square miles and includes portions of six counties and two states. These are Alpine County, California and Douglas, Lyon, Storey, Carson City and Churchill Counties in Nevada. Approximately 606 square miles of the watershed is located in Alpine County and is the main focus of this study (Figure 1.2-1). Four sub-watersheds are located with Alpine County (MACTEC 2004):

1. Wolf Creek
2. East Fork Carson River
3. Markleeville Creek
4. West Fork Carson River

Major valleys within these sub-watersheds include the following: Charity Valley, Pleasant Valley, Hope Valley, Diamond Valley, Wolf Creek Meadow, and Faith Valley.

The upper watershed was shaped by Pleistocene glaciation. An ancient fault line in the Sierra Nevada was expanded and filled by glaciers and glacial melt, forming Lake Tahoe and the Carson Range 1,800,000 to 500,000 years ago (Horton 1997). Only a few glacial moraines still exist and none are very extensive. Cenozoic (the most recent era of geologic time) faults are predominant in the upper watershed and metamorphic rocks are widely distributed. Fossil evidence indicates that metamorphic rocks are predominately Late Triassic and Early Jurassic (230 to 187 million years old) in age. Siltstone, shale, sandstone, and greywacke are common and contain volcanic materials. Limestone and gypsum are also common. The Sierra Nevada is composed mainly of intrusive granitic rocks. A relatively large number of thermal springs are present within the upper watershed.

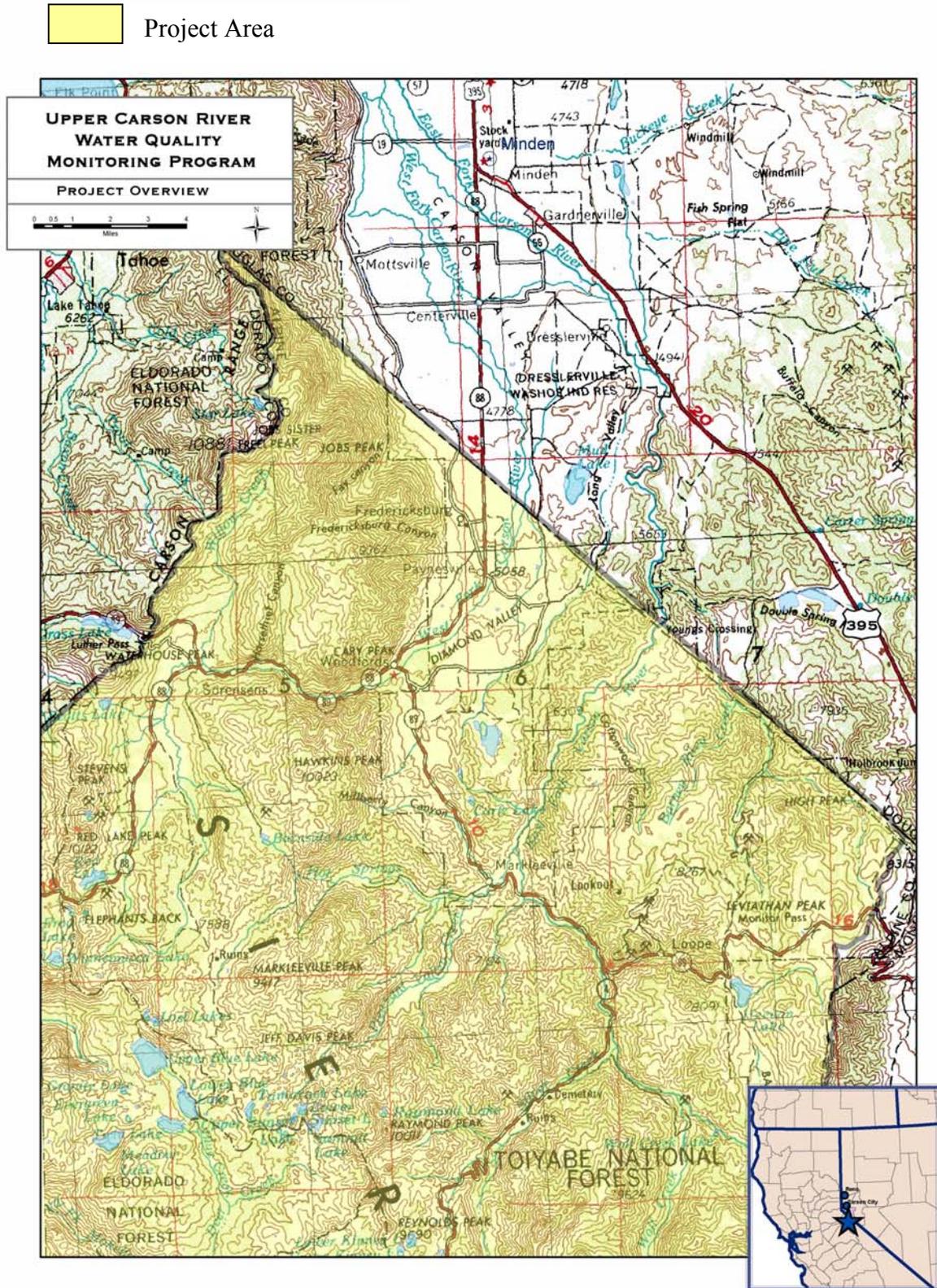


**West Fork Carson River Winter Conditions**  
October 2004

The East Fork drainage is characterized by extremely steep slopes and channels that are strongly incised into volcanic material. This volcanic material creates a highly erosive terrain in the East Fork drainage. The West Fork has a similar terrain but the volcanic materials are found more in the upper portions of the watershed. Granitic rock is predominant throughout the West Fork drainage and also tends to be highly erosive.

The climate of the upper watershed is characterized by long, very cold winters and short, moderate to warm summers. Areas in the Sierra Nevada above 9,000 feet typically receive more than 40 inches of precipitation per year, usually as snowfall. The average annual precipitation at elevations of 4,500 to 9,000 feet is about eight to twenty inches.

Figure 1.2-1: Project Area



Temperatures vary depending upon the season. In the upper watershed the average annual temperature ranges from 45°F in valley regions to 33°F in the mountain ranges.

The Carson River system rises in the Sierra Nevada and is fed by waters from melting snow and springs. The river begins as two separate tributaries, the East and West Forks. The East Fork originates south of Ebbetts Pass in part of the Carson-Iceberg Wilderness at an elevation of about 11,460 feet. The West Fork begins near Lost Lakes at about 9,000 feet in elevation. The East and West Forks merge to form the mainstem Carson River just south of Genoa, Nevada in Carson Valley. Tributaries to the East and West Forks include the following:

**East Fork Drainage**

Bryant Creek	Markleeville Creek
Leviathan Creek	Hot Springs Creek
Mountaineer Creek	Charity Valley Creek
Poison Creek	Spratt Creek
Wolf Creek	Pleasant Valley Creek
Dixon Creek	Raymond Canyon Creek
Elder Creek	Hodge Creek
Bull Canyon Creek	Jeff Davis Creek
Indian Creek	Golden Canyon Creek
Poison Creek	Murray Canyon Creek
Poison Flat Creek	
Silver Creek	
Noble Creek	
Raymond Meadows Creek	
Eagle Creek	

**West Fork Drainage**

Horsethief Creek	Forestdale Creek
Willow Creek	Red Lake Creek
Hawkins Creek	Crater Lake Creek

Flows in the Carson River system vary from year to year. Major factors influencing the flow regime are annual and monthly precipitation rates and temperatures, accumulated snowpack and runoff characteristics in the headwaters and tributaries. Flooding occurs on a regular basis with the most recent event occurring New Years 2006. These events often result in landslides, high rates of erosion, debris flows and streambank destabilization. On the East Fork, just downstream of the confluence with Wolf Creek there is a massive active landslide that dates back to the 1960's (MACTEC 2004). Evidence of debris flows are found throughout the East Fork drainage and also occur in the upper portion of the West Fork drainage, particularly in association with volcanic geology (MACTEC 2004).

Numerous small alpine reservoirs and lakes are located within the upper watershed but provide very limited storage capacity. The reservoirs were originally constructed to serve agricultural needs, or were originally small lakes whose capacity was increased by dam construction. Two upper watershed reservoirs, Indian Creek and Harvey Place Reservoirs, were constructed specifically for storage of treated wastewater from the Lake Tahoe Basin.

Indian Creek Reservoir was constructed in 1969-1970 on an ephemeral tributary of Indian Creek, a tributary to the East Fork Carson River to store the tertiary wastewater effluent. The reservoir became eutrophic during the 1970's and was placed on the California's Section 303(d) list in the 1980's. STPUD discontinued wastewater disposal to the reservoir in 1989 and acquired water rights to maintain a minimum reservoir level to support recreation uses. Today, Indian Creek Reservoir is a very popular fishing and camping area. Harvey Place Reservoir was constructed in 1989 for the purpose of storing the effluent. Reuse facilities are located on various ranches in Diamond Valley, Wade Valley, Carson Valley and Fredricksburg for crop irrigation.

Over 84% of the land in the upper watershed is public land, predominately U.S. Forest Service land. Land uses throughout the upper watershed include irrigated pasturelands, logging, road construction and recreation. Recreational use includes fishing, camping and winter activities such as cross county skiing and off road vehicle use. Historic land use activities include the clear-cutting of the forests and massive log floats down the river during the Comstock mining era. Leviathan Mine is also located within the East Fork drainage and severely degraded local streams including Bryant Creek, a tributary to the East Fork.

### **1.3 Key Project Roles and Responsibilities**

#### **Contract Manager**

The Contract Manager, provided by SWRCB, served as the day to day representative for administration of the project and acted on behalf of the SWRCB with respect to this project. Ling Tseng served in this position for the first two years of the project. Joanna Jensen of the SWRCB later assumed the position. The Contract Manager role included the approval of technical design and conduct, review of all reports, to include quarterly progress reports (QPRs) and draft final report.

#### **Project Director**

The Project Director is Judy Molnar of Alpine County. The Project Directors role includes the oversight of the project including the administration of the grant funds, development of contracts, and review of all work products prior to submittal to Contract Manager.

#### **Project Administrator**

The Project Administrator is Edwin James of the CWSD. The Project Administrator role includes the oversight of all technical and administrative tasks associated with performing and completing the work for this project. The Project Administrator provides guidance to other key personnel and direct the efforts to organize, describe, and interpret the results of the monitoring effort; review all work products, including reports and invoices prior to submittal to Project Director; and will ensure that all project deliverables are in accordance with the schedule set forth in the Scope of Work (SOW).

### **Project Coordinator**

The Project Coordinator is Genie Azad of the CWSD. The Project Coordinator is responsible for the day-to-day communication and coordination of the work performed for this project. The Project Coordinator prepares the QPRs and invoices, coordinates the efforts of the technical advisory committee (TAC) and subcontractors, and is a primary writer of the final project report. Project Coordinator schedules and assists in the facilitation of public meetings, and prepares all agendas and meeting notes. The Project Coordinator also served as a field monitor, procured any necessary equipment and input field and streamflow data into spreadsheets.

### **Data Manager**

The Data Manager is David McGraw of the DRI. The role of the Data Manager includes the compilation and interpretation of all data collected during this study plus historical data search and compilation. The Data Manager is a primary writer of the final project report.

### **Laboratory Analysis and Quality Control Advisors**

The laboratory and quality control advisors are John Kobza of SEM and Terry Powers of STPUD. The Advisors ensure the completion of laboratory analyses on a timely basis and returns analytical results to the Data Manager and Project Coordinator. Advisors also provide assistance with information concerning analytical techniques for constituents and adherence to data quality objectives. Advisor ensure that the project adheres to the guidelines outlined in the SEM Quality Assurance Manual, the STPUD Laboratory Assurance Plan laboratory's and the QAPP prepared for this project.

### **Field Monitors**

The field monitors for CWSD are Genie Azad and Margie Evans. The monitors perform all field activities of the project, including collecting water samples in accordance with the field quality assurance data collection outlined in the QAPP. Field monitors for samples analyzed by STPUD were provided by STPUD.

### **GIS Database Manager**

GIS Database Manager is Clint Celio of Celio and Sons, Inc. The database manager is responsible for the integration of the data collected from this project into the GIS data framework created for the Proposition 13 Stream Corridor Condition Survey. The GIS Manager also provides guidance to Data Manager and Project Coordinator regarding sampling location coding and storage, updating, retrieval and visual presentation of data.

## **1.4 Technical Advisory Committee**

The members of the Technical Advisory Committee (TAC) consisted of Jason Churchill (LRWQCB), Randy Pahl [Nevada Division of Environmental Protection (NDEP)], Jeanmarie Stone (NDEP), Terry Powers (STPUD), Dan Kaffer (Western Nevada RC&D), Paul Pugsley (Carson Valley Conservation District), Dick McCleery (Central Sierra RC&D), Mark DeMaio (Alpine County Department of Public Works), Sally Champion (U.S. Forest Service), Hal Bird (STPUD), Mary Bennington/Marie Barry (Washoe Tribe of California and Nevada), and Laura Leuders/Hanna Schembri (Alpine Watershed Group).

The TAC met on four occasions during the project to review procedures, data results and project progress. All TAC meetings were facilitated by the project coordinator and were attended by members of the project team. The TAC meeting notes are available from the CWSD.

### **1.5 Public Participation**

In order to answer questions and address any concerns from community members about the project a public meeting was held in the Alpine County Administration Building in Markleeville, California on Thursday, March 25, 2004. The meeting was posted in the Record-Courier on March 19, 2004. A presentation about the program was provided by the CWSD and project team members were available for questions. There were no concerns raised by community members at the meeting. Relatively few questions were received. The questions that were asked were focused on sampling site locations and parameters that the samples would be analyzed for. These questions were properly addressed at the meeting to the satisfaction of the community members. Displays and other materials about the program were available for distribution to the community.

In addition to public meetings, articles about the program were published in the local newspaper and in the watershed newsletter "The Flow". The CWSD website also had information regarding the program available on their website at [www.cwsd.org](http://www.cwsd.org). Updates regarding project progress were provided to the Alpine Watershed Group, CWSD Board of Directors, Alpine County, and the Carson River Coalition numerous times during project implementation.

Due to scheduling conflicts the final public meetings will be held on July 18, 2007. Two meetings will be held, one at the Alpine County Board of Supervisors and another at the CWSD Board of Directors meeting. Both meetings are posted, open meetings. The CWSD will provide SWRCB with documentation about the meetings as an attachment to this report by July 31, 2007.

Presentations about the project will be held during the summer of 2007. Identified groups include:

- Lahontan Regional Water Quality Control Board
- Carson River Coalition
- Alpine Watershed Group

## 2.0 Monitoring Plan and Methods

### 2.1 Selection of Monitoring Locations

Water quality sampling was conducted specifically for this program by CWSD and STPUD at eight sites within the West Fork drainage and fifteen sites within the East Fork drainage. Figure 2.1-1 shows the location of CWSD and STPUD monitoring sites and Table 2.1-1 provides information about each site. In addition STPUD also conducted sampling at Red and Summit Lakes on an annual basis.

The analysis for this program also incorporated data obtained from NDEP and the STORET database. Appendix C provides a list of these sites and Figure 2.1-2 provides the monitoring site locations for the sites.

Factors used in determining monitoring locations include safe and legal access, recommendations from the windshield survey conducted by the assessment team plus the proximity to USGS gauges. Sampling locations were recorded with GPS receivers and described in field data sheets.

**Table 2.1-1: Monitoring Site Locations**

Site Identification Number	Site Description	Sample Collector	Laboratory
<b>West Fork Carson River Drainage</b>			
WF1-WQ1/SW-06	West Fork at California/Nevada Stateline at Brooke Residence	STPUD	STPUD
WF5-WQ1/SW-01	West Fork at Crystal Springs Road upstream of USGS Gauging Station	STPUD	STPUD
WF2-WQ1/SW-05	West Fork below Fredericksburg diversion ditch off of Diamond Valley Road	STPUD	STPUD
WF7-WQ1	West Fork in Hope Valley just below confluence with Willow Creek	CWSD	SEM
RC1-WQ1	Alhambra Mine Creek before confluence with West Fork and after confluence with Red Lake Creek	CWSD	SEM
WF10-WQ1	West Fork above confluence with Alhambra Mine Creek	CWSD	SEM
HC1-WQ1	Hawkins Creek just before confluence with West Fork	CWSD	SEM
WF8-WQ1*	West Fork just upstream of Highway 89 Bridge before Blue Lakes Road.	CWSD	SEM
<b>East Fork Carson River Drainage</b>			
EF0-WQ1	East Fork upstream of Washoe Dam	CWSD	SEM
EF4-WQ1	East Fork at Hangman's Bridge	CWSD	SEM
MC1-WQ1	Monitor Creek just before confluence with East Fork	CWSD	SEM
EF7-WQ1	East Fork just below confluence of Silver and Wolf Creeks	CWSD	SEM
WC1-WQ1	Wolf Creek at upper most campground area	CWSD	SEM
MKC2-WQ1	Markleeville Creek at campground just outside of Town of Markleeville	CWSD	SEM
MKC3-WQ1	Markleeville Creek at bridge below Grover Hot	CWSD	SEM

Site Identification Number	Site Description	Sample Collector	Laboratory
	Springs		
MBC1-WQ1	Millberry Creek at the USFS Guard Station in the Town of Markleeville just before confluence with Markleeville Creek	CWSD	SEM
MBC2-WQ1	Millberry Creek along east side of Highway 89 approximately ½ mile outside of Markleeville	CWSD	SEM
MBC3-WQ1**	Millberry Creek downstream of Turtle Rock Park by old treatment ponds	CWSD	SEM
MBC4-WQ1**	Millberry Creek in Turtle Rock Park upstream of bridge in campground	CWSD	SEM
MBC5-WQ1***	Millberry Creek along Highway 89 by PC transformer	CWSD	SEM
MBC6-WQ1***	Millberry Creek along Highway 89 in front of Red House	CWSD	SEM
SW-02	Indian Creek above Indian Creek Reservoir at diversion of Harvey Channel, approximately 0.65 miles downstream of Highway 89	STPUD	STPUD
SW-03	Indian Creek below Indian Creek Reservoir approximately 10' downstream of first bidge on Diamond Valley Road at the Snowshoe Thompson marker	STPUD	STPUD
<b>Lake Sampling Sites</b>			
RL-WQ1	Red Lake	STPUD	STPUD
SL-WQ1	Summit Lake	STPUD	STPUD

**Notes:**

\* This is a winter site and was used when access to RC1-WQ1 and WF10-WQ1 was not available due to snow conditions.

\*\*This site was added on in response to high t. coliform levels in Millberry Creek. Only two samples were taken at this site and were analyzed for T. Coliform only.

\*\*\* This site was added on in response to high t. coliform levels in Millberry Creek. Only one sample was taken at this site and were analyzed for T. coliform only.

## 2.2 Field Measurement and Sample Collection

A total of 12 scheduled sampling events were conducted within the West and East Fork drainage by the CWSD. Each event consisted of two field days. In addition, two storm events were sampled. Monitoring locations sampled by STPUD occurred on a monthly basis with exception of lake sampling events that were conducted annually. The frequency of CWSD monitoring events are shown in Table 2.2-1.

**Table 2.2-1: Frequency of CWSD Monitoring Events**

Date of Monitoring	Type of Sampling Event
April 29, 2004	Regular, scheduled event
April 30, 2004	Regular, scheduled event
May 27, 2004	Regular, scheduled event
May 28, 2004	Regular, scheduled event
June 24, 2004	Regular, scheduled event
June 25, 2004	Regular, scheduled event
July 22, 2004	Regular, scheduled event
July 23, 2004	Regular, scheduled event
October 25, 2004	Regular, scheduled event
October 26, 2004	Blizzard conditions. No access to West Fork or Upper East

Date of Monitoring	Type of Sampling Event
	Fork sites.
November 4, 2004	Sampling conducted for sites inaccessible on October 26, 2004
January 26, 2005	Regular, scheduled event. Snow 3-4' deep, snow shoes were used to access sites. No access to three of the West Fork sites (RC1-WQ1; WF10-WQ1; HC1-WQ1).
January 27, 2005	Regular, scheduled event
April 18, 2005	Regular, scheduled event
April 19, 2005	Regular, scheduled event
May 16, 2005	<u>Storm Event</u> . This was a scheduled event but there were heavy rains within past 24 hours with river at flood stage. All scheduled sites sampled.
May 17, 2005	Regular, scheduled event.
June 20, 2005	Regular, scheduled event.
June 21, 2005	Regular, scheduled event.
July 18, 2005	Regular, scheduled event.
July 19, 2005	Regular, scheduled event.
October 11, 2005	Regular, scheduled event.
October 12, 2005	Regular, scheduled event. Hawkins Creek dry.
December 13, 2005	<u>Storm Event</u> . Sampled collected by Alpine Watershed Group Watershed Coordinator on behalf of CWSD and then transferred to CWSD staff for transport to laboratory. Sites limited to MKC2-WQ1, EF4, WQ1 and WF8-WQ1.
January 25, 2006	Regular, scheduled event.
January 26, 2006	Regular, scheduled event. No access to three of the West Fork sites (RC1-WQ1; WF10-WQ1; HC1-WQ1).

The field measurements, sample collection and sample transport were conducted in accordance with the QAPP. Grab samples were immediately placed in an ice-filled cooler and kept at 4 degrees Celsius for transfer to the appropriate laboratory. A signed chain-of-custody form accompanied each cooler.

Field measurements were conducted for ambient temperature, water temperature, pH and conductivity. In addition, streamflow measurements were taken at select locations to provide supplemental data regarding stream flow conditions during sampling events. Streamflow and field data is provided in Appendix B.

### 2.3 Water Quality Parameters

Table 2.3-1 summarizes the parameters that were measured during the program and whether the samples were analyzed in the field or by a professional laboratory. Data quality objectives are provided in Table 2.3-2 and can also be found in Section 7.0 of the QAPP located in Appendix A.

**Table 2.3-1: Summary of Monitoring Design**

Parameter	Type of Monitoring
Stream Flow	F
Temperature	F
Dissolved Oxygen	F
pH	F
Conductivity	F, L
Turbidity	L
Total Nitrogen 4 (Sum of TKN, nitrate as N and nitrite as N)	L
Ortho-Phosphate	L
Total Phosphorous	L
Sodium Adsorption Ratio (SAR)	L
Quanti-Tray (E. coli Colilert Quanti-Tray, Total Coliform Quanti-Tray)	L
Suspended Solids	L
Stream Habitat Observations	F

Codes for Table 2.4-1: Type: F: field analysis, L: in-house lab analysis

**Table 2.3-2: Data Quality Objectives for Conventional Water Quality Parameters**

Parameter	Method/ range	Units	Reporting Limit	Sensitivity	Precision	Accuracy	Completeness
Temperature	Thermometer or meter (-5 to 50)	° C	-5	0.5 ° C	± 0.5 ° C	± 0.5 ° C	80%
Dissolved oxygen	DO Meter	mg/L	0.1 mg/L	0.1 mg/L	± 10%	± 10%	80%
pH	pH meter	pH units	2.0	0.1 unit	± 0.2 units	± 0.2 units	80%
Conductivity	conductivity meter	µS/cm	10	10 µS/cm	± 10%	± 10%	80%
Suspended Solids <sup>†</sup>	Gravimetric	mg/L	1*	0.05	± 10%	± 10%	80%
Turbidity <sup>†</sup>	Nephelometer	NTUs	0.1*	0.1	± 10%	± 10%	80%

<sup>†</sup> Note: Performed in the SEM and STPUD Laboratories..

\* These values represent detection limits

**Table 2.3-3. Data Quality Objectives for Nutrients Analyzed Using Ion chromatography or Spectrophotometers**

Parameter	Method	Units	Reporting Limit	Sensitivity	Precision	Accuracy	Completeness
TKN	Semi-automated Colorimetry	mg/L	0.05	0.02	±0.2 (<2.0) ±10% (≥2)	±0.2 (<2.0) ±10% (≥2)	80%
Nitrate Nitrogen	Ion Chromatography Automated Colorimetry	mg/L mg/L	0.05 0.005	0.05 0.005	±0.2 (<2.0) ±10% (≥2))	±0.2 (<2.0) ±10% (≥2)	80% 80%
Nitrite Nitrogen	Ion Chromatography Automated Colorimetry	mg/L mg/L	0.05 0.005	0.05 0.005	±0.2 (<2.0) ±10% (≥2))	±0.2 (<2.0) ±10% (≥2)	80% 80%
Ortho-Phosphate-P	Automated Colorimetry	mg/L	0.01	0.01	±10% (≥2)	±10% (≥2)	80%
Total Phosphorous	Automated Colorimetry	mg/L	0.01	0.01	±0.2 (<2.0) ±10% (≥2)	±0.2 (<2.0) ±10% (≥2)	80%

**Table 2.3-4: Data Quality Objectives for Metals Using ICP-OES**

Parameter	Method/range	Units	Reporting Limit	Sensitivity	Precision	Accuracy	Completeness
Calcium	EPA 200.7	mg/L	0.2	0.2	±0.2 (<2.0) ±10% (≥2)	±0.2 (<2.0) ±10% (≥2)	80%
Magnesium	EPA 200.7	mg/L	0.2	0.2	±0.2 (<2.0) ±10% (≥2)	±0.2 (<2.0) ±10% (≥2)	80%
Potassium	EPA 200.7	mg/L	0.5	0.5	±0.2 (<2.0) ±10% (≥2)	±0.2 (<2.0) ±10% (≥2)	80%
Sodium	EPA 200.7	mg/L	0.2	0.2	±0.2 (<2.0) ±10% (≥2)	±0.2 (<2.0) ±10% (≥2)	80%

**Table 2.3-5: Data Quality Objectives for Biological Parameters**

Parameter	Method/ range	Units	Detection Limit	Sensitivity	Precision	Accuracy	Complete-ness
Total Coliform Bacteria	Multiple Tube Fermentation	MPN/100ml	1	see Standard Meth, 18 <sup>th</sup> ed. Section 9223 B	see Standard Meth, 18 <sup>th</sup> ed. section 9223 B	N/A	80%
E. coli Bacteria	Multiple Tube Fermentation	MPN/100ml	1	see Standard Meth, 18 <sup>th</sup> ed. Section 9223 B	see Standard Meth, 18 <sup>th</sup> ed. section 9223 B	N/A	80%

## 2.4 Field and Laboratory Quality Control

All quality control procedures followed guidelines and requirements set forth in the projects Quality Assurance Project Plan (QAPP, Appendix A). The QAPP was written by project personnel with guidance and review provided by the TAC. The QAPP was approved by the SWRCB prior to conducting any sampling activities.

### Field Quality Control

Field meters were calibrated the day before a sampling event. Before leaving the sampling site all recorded values were checked and recorded. Parameters with questionable values were re-measured for confirmation. All grab samples were collected in clean vessels that were rinsed three times with water from the site. Sample collection bottles that were provided by the laboratory were labeled with site identification numbers, site name, date and time of sample collection and placed in ice-filled coolers. Chain of custody forms accompanied all coolers to the appropriate laboratory. For quality control purposes field blanks were collected every sampling event from both the East Fork and the West Fork drainages. Distilled water was taken into the field and was poured into sample collection bottles and sent to the laboratory for analysis. Twice a year split samples were obtained and were sent to the laboratory for analysis. All field blanks and split samples were coded so that laboratory staff could not distinguish these quality control samples from other samples.

### Laboratory Quality Control

Laboratory quality control procedures are outlined in the SEM and STPUD quality assurance manuals. For bacteria samples, split field samples or split positive controls were analyzed by SEM laboratory twice annually. A maintenance log is kept by the laboratory staff that detail the dates of instrument inspection, calibrations, dates for reagents and standards, and any problems noted with the instruments, samplers, or reagents. Instrument calibration/standardization and frequency is provided in Section 16 of the QAPP located in Appendix A.

Figure 2.1-1: Water Quality Monitoring Site Locations - CWSD & STPUD

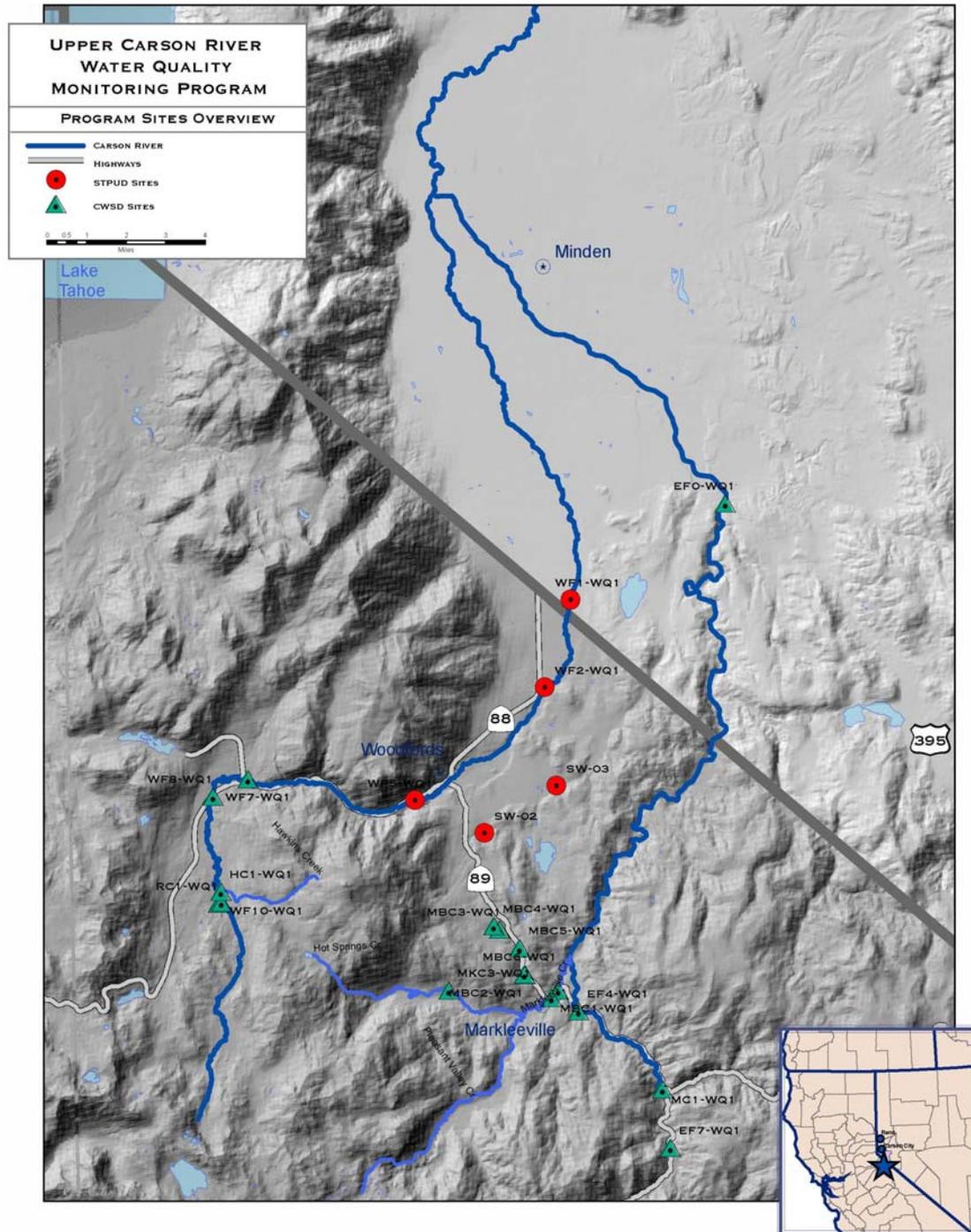
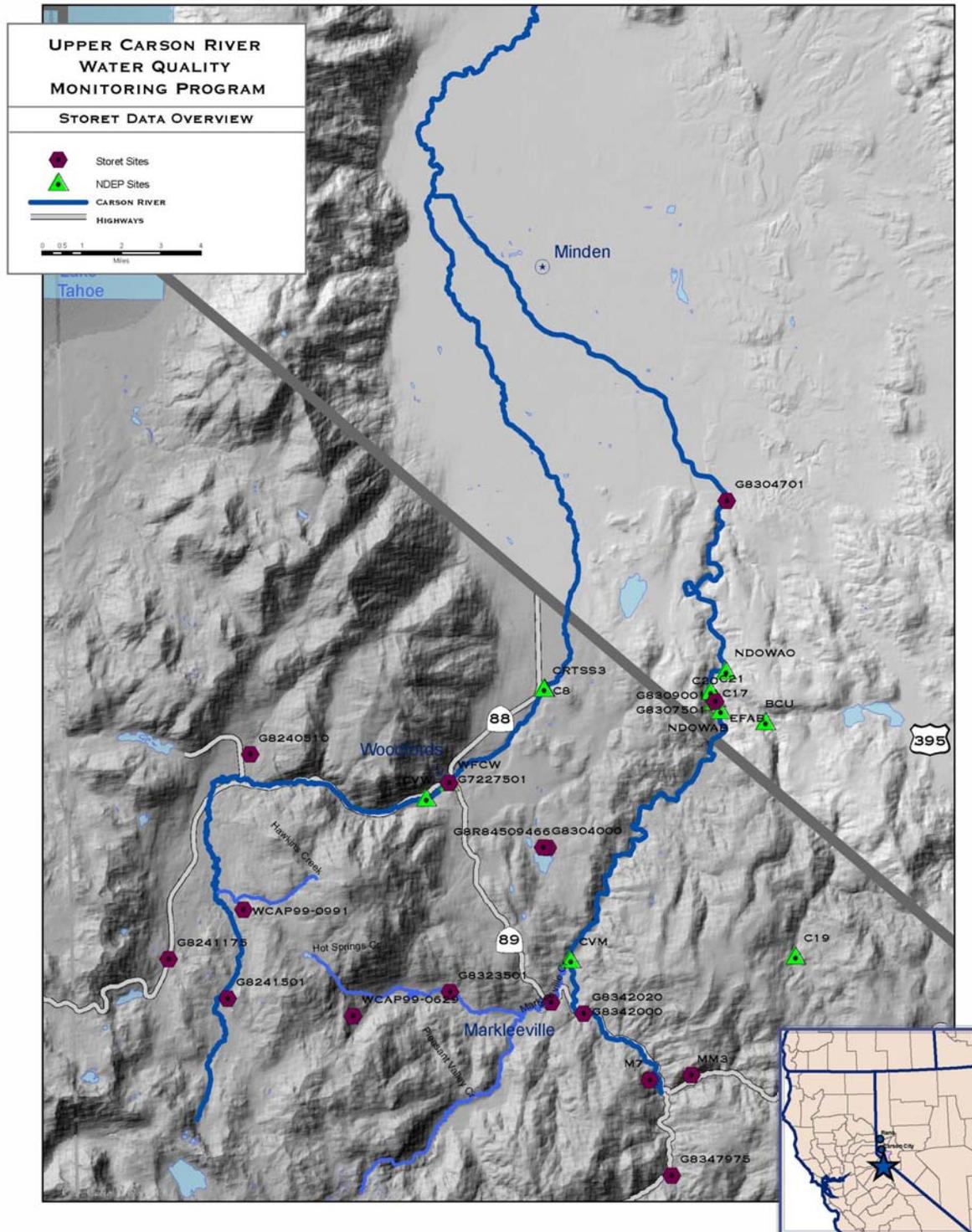


Figure 2.1-2: Water Quality Monitoring Site Locations - STORET & NDEP



## 3.0 Data Results and Discussion

### 3.1 Introduction

This section provides a summary and exploratory data analysis of all historic and current surface water data in the basin. The primary purpose of this detailed analysis is to identify potential problem areas with greater precision.

Data exist for 23 parameters. But because TMDLs are a primary concern, this study focuses on those listed on California's 303(d) list, specifically: Nitrogen species (Total Nitrogen and Nitrate), Phosphorus species (Ortho-phosphate and Total Phosphorus), Coliforms (Total and Fecal), Sodium Adsorption Ratio, and Sodium. Laboratory data results from SEM are provided in Appendix D. Data from the STORET and NDEP are provided on the enclosed CD.

### 3.2 Exploratory Data Analysis

The method used in this study to analyze the data will begin with exploratory data analysis (EDA). From the Engineering Statistics Handbook ( *NIST/SEMATECH e-Handbook of Statistical Methods*, <http://www.itl.nist.gov/div898/handbook/>), "EDA is an approach to data analysis that postpones the usual assumptions about what kind of model the data follow with the more direct approach of allowing the data itself to reveal its underlying structure and model." EDA relies heavily on graphical techniques. From the Engineering Statistics Handbook, the purpose of EDA is to:

1. Maximize insight into a data set;
2. Uncover underlying structure;
3. Extract important variables;
4. Detect outliers and anomalies;
5. Test underlying assumptions;
6. Develop parsimonious models; and
7. Determine optimal factor settings.

The exploration of the data for this study focuses on four areas: Summary of all data; Seasonal Comparison; Trends; and Spatial Comparison. With these four analyses it will be possible to obtain an accurate idea of the water quality in the Upper Carson River Basin and isolate potential sources of poor quality. The following are the expected results from each of the four analyses:

Data Summary: This analysis will provide an overview of the all the data for the Carson basin as a whole. Then, comparisons will be made between the West Fork, East Fork, Main Stem, and Indian Creek subbasins. The results from this analysis will be an expected value and expected range. The expected value is simply a measure of the central location of the data. Typically the mean/average is used. However, because much of the data is reported as 'less-than' a value, in addition to the data being heavily-skewed, the median is a more appropriate measure. The expected range will be an assessment of how much variation one can expect in

the data. Typically the variance or standard deviation is used; however, for the same reasons listed above, the interquartile range (IQR) will be used. The IQR is the range of values containing 50% of the data.

Seasonal Summary: The seasonal summary is an evaluation of the differences in water quality among the seasons.

Trend Summary: A visual and statistical evaluation of the change in water quality over time.

Spatial Summary: The results of the spatial analysis will isolate differences in water quality in various tributaries and reaches of the stream.

This study makes extensive use of boxplots. Boxplots are useful plots for comparing populations and provide an easy graphical representation of the median, upper and lower quartiles, and outliers. However, as described above, many data points are censored, or reported as a 'less-than' value. These censored data are impossible to represent accurately in a boxplot. For this study, these data are represented by their censoring limit, usually the detection limit. For example, a data point of  $<0.05$  would be plotted as 0.05. The effect of this modification is to skew the boxplot slightly toward higher values. For this reason it should be stressed that boxplots are considered approximations of the data set and should only be used for visual comparison. The un-modified data are provided with this study and should be used for any further analysis. Any statistical analysis presented in this study was performed on the actual data, not the data used to construct the boxplots.

Evaluation of differences in populations (for example, the difference between nitrate values at sites A and B) were performed using non-parametric analysis of variance (ANOVA). The Peto-Peto modification of the Wilcoxon test (Wilcoxon 1945; Miller, et. Al 1990) was used in this study to determine if populations are different at 95 percent confidence level. The Wilcoxon test is similar to the two-sample t-test except the Wilcoxon test is performed on the ranks of the data, rather than the data itself. Non-parametric methods like the Wilcoxon test have been shown to be more appropriate for datasets with censored (less-than) values than equivalent parametric methods (Helsel 2004).

### **3.3 Data Sources**

The data used for this study come from three primary sources: 1) STORET, which is a data repository for water quality, biological, and physical data. Data found in STORET relevant to this study come from the USGS, the SWRCB, and EPA; 2) USGS, for flow and water quality data; and 3) the CWSD for two years of monitoring of the flow and water quality in the upper reaches of the basin; and 4) the NDEP.

There are 81 sites with samples taken between 1956 and 2006. Sampling site locations are provided in Figures 2.1-1 and 2.1-2. Appendix C contains information on all sites, current and historic, along with periods of records. Though the additional data collected for this study were located in the upper reaches of the watershed, the purpose of this study is to

present all of the surface water data collected in the basin. These data include some sites in Nevada as well as reservoirs, tributaries and ditches.

### 3.4 Data Summary

The following is a summary and comments for each parameter. The purpose of this data summary is simply to provide a general idea of what values to expect and to identify locations of outliers. As noted above, the median and IQR are the non-parametric measures of central location and variance used in this analysis.

#### 3.4-1 Overview of Data Summary

The following tables provide data summaries by parameter and by drainage along with any special notations regarding the data.

##### 3.4.1.1 Data Summary By Parameter

#### Nitrate

<i>Number of samples</i>	<i>Period of Record</i>	<i>min</i>	<i>max</i>	<i>median</i>	<i>IQR</i>
3684	1963-2006	0.0	15.2	<b>0.04</b>	<b>0.01-0.20</b>

#### Total Nitrogen

<i>Number of samples</i>	<i>Period of Record</i>	<i>min</i>	<i>max</i>	<i>median</i>	<i>IQR</i>
511	1978-2006	0.0	7.8	<b>0.26</b>	<b>0.18-0.39</b>

#### Ortho-phosphate

<i>Number of samples</i>	<i>Period of Record</i>	<i>min</i>	<i>max</i>	<i>median</i>	<i>IQR</i>
2918	1966-2006	0.0	4.94	<b>0.014</b>	<b>0.01-0.04</b>

#### Total Phosphorus

<i>Number of samples</i>	<i>Period of Record</i>	<i>min</i>	<i>max</i>	<i>median</i>	<i>IQR</i>
38158	1967-2006	0.0	21.0	<b>0.05</b>	<b>0.02-0.11</b>

#### Total Coliform

<i>Number of samples</i>	<i>Period of Record</i>	<i>min</i>	<i>max</i>	<i>median</i>	<i>IQR</i>
2564	1980-2006	0	24,000	<b>230</b>	<b>40-930</b>

**Fecal Coliform**

<i>Number of samples</i>	<i>Period of Record</i>	<i>min</i>	<i>max</i>	<i>median</i>	<i>IQR</i>
2413	1980-2006	0	24,000	<b>30</b>	<b>23-230</b>

**Sodium**

<i>Number of samples</i>	<i>Period of Record</i>	<i>min</i>	<i>max</i>	<i>median</i>	<i>IQR</i>
2608	1956-2006	0	150	<b>6.2</b>	<b>4.14-10.00</b>

**Sodium Adsorption Ratio**

<i>Number of samples</i>	<i>Period of Record</i>	<i>min</i>	<i>max</i>	<i>median</i>	<i>IQR</i>
2414	1960-2006	0	7.63	<b>0.44</b>	<b>0.34-0.65</b>

**3.4.1.2 Data Summary By Drainage**

The following tables provide data summaries for the East Fork, West Fork and Indian Creek sites.

**Table 3.4.1.2-1 Data Summary for East Fork Carson River Sites**

<b>Parameter</b>	<b>Number of samples</b>	<b>Period of Record</b>	<b>Min</b>	<b>Max</b>	<b>Median</b>	<b>IQR</b>
NO3-N	149	1966-2006	0.0	0.63	<b>0.02</b>	<b>0.01-0.09</b>
Total N	177	1978-2006	0.0	2.9	<b>0.25</b>	<b>0.16-0.42</b>
Ortho Phosphate	207	1966-2006	0.0	0.19	<b>0.02</b>	<b>0.01-0.02</b>
Total P	220	1969-2006	0.0	21	<b>0.04</b>	<b>0.02-0.06</b>
Total Coliform	113	1985-2006	0.0	3,076	<b>410</b>	<b>179-1,120</b>
Fecal Coliform	13	1985-2005	1.0	457	<b>9</b>	<b>3-32</b>
Sodium	191	1956-2004	2.0	89.8	<b>8.3</b>	<b>5.65-11.0</b>
Sodium Adsorption Ratio	68	1965-2004	0.26	1.0	<b>0.4</b>	<b>0.4-0.5</b>

**Table 3.4.1.2-2 Data Summary for West Fork Carson River Sites**

Parameter	Number of samples	Period of Record	Min	Max	Median	IQR
NO3-N	1,297	1963-2006	0.0	5.32	<b>0.04</b>	<b>0.01-0.10</b>
Total N	334	1978-2006	0.0	7.8	<b>0.27</b>	<b>0.19-0.37</b>
Ortho Phosphate	1,046	1966-2006	0	2.74	<b>0.01</b>	<b>0.01-0.01</b>
Total P	1,343	1968-2006	0	2.94	<b>0.03</b>	<b>0.02-0.05</b>
Total Coliform	907	1980-2006	0	24,000	<b>230</b>	<b>43-930</b>
Fecal Coliform	846	1980-2006	0	24,000	<b>40</b>	<b>30-230</b>
Sodium	985	1956-2006	0	91	<b>4.31</b>	<b>3.10-6.41</b>
Sodium Adsorption Ratio	919	1960-2006	0	1.57	<b>0.35</b>	<b>0.28-0.46</b>

**Table 3.4.1.2-3 Data Summary for Indian Creek Basin Sites\***

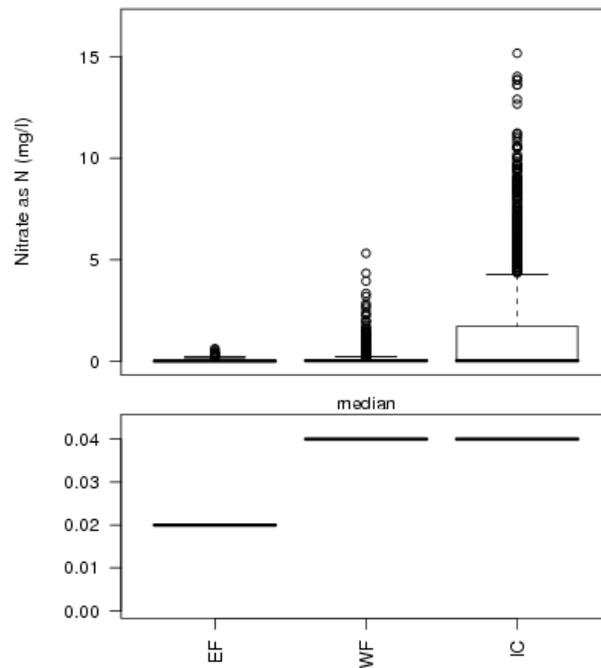
Parameter	Number of samples	Period of Record	Min	Max	Median	IQR
NO3-N	1,723	1979-2006	0.01	15.16	<b>0.04</b>	<b>0.01-1.73</b>
Ortho Phosphate	1,306	1979-2006	0.01	4.94	<b>0.03</b>	<b>0.01-0.22</b>
Total P	1,718	1971-2006	0.01	5.86	<b>0.09</b>	<b>0.05-0.20</b>
Total Coliform	1,172	1980-2006	2	24,000	<b>150</b>	<b>30-930</b>
Fecal Coliform	1,174	1980-2006	2	24,000	<b>30</b>	<b>2-90</b>
Sodium	1,099	1971-2006	0	150	<b>8.74</b>	<b>6.2-39.6</b>
Sodium Adsorption Ratio	1,096	1980-2006	0	7.631	<b>0.573</b>	<b>0.44-1.70</b>

\* Includes Indian Creek Reservoir and Harvey Place both of which are reclaimed water reservoirs.

### 3.5 Comparison Among Basins

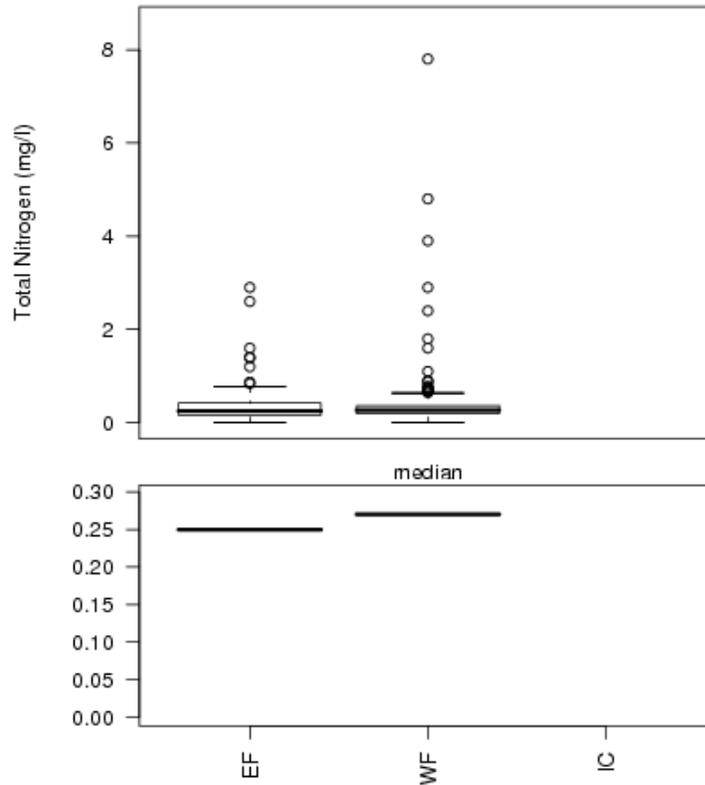
This analysis will suggest differences among the three primary basins: East Fork Carson River (EF), West Fork Carson River (WF) and Indian Creek (IC). Though all basins have similar geology and climate, land uses differ among them. The graphs and summary below will provide a general idea of the differences among the basins. A more detailed analysis is presented below in the 'Spatial Differences' section.

#### Nitrate



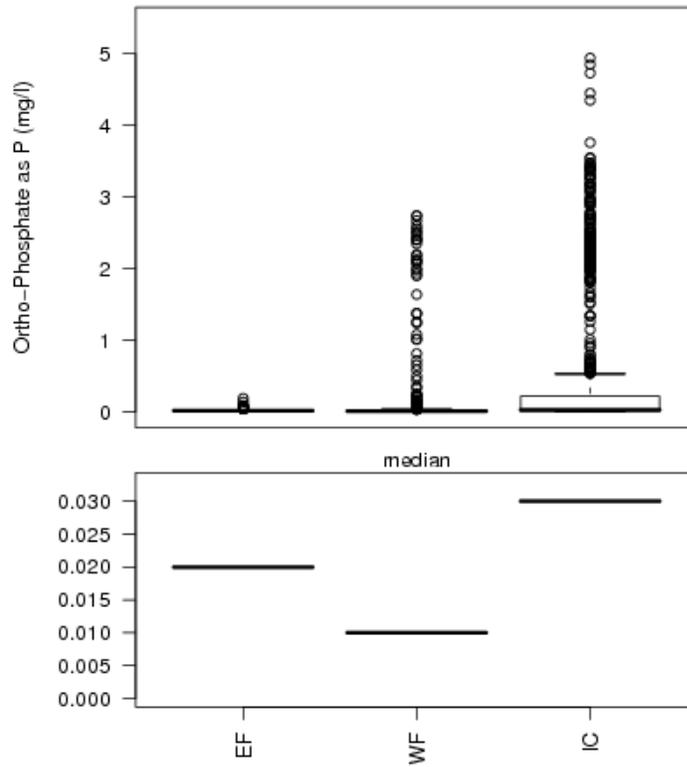
East Fork nitrate values are significantly lower than the West Fork or Indian Creek values. Also, the range of values is significantly higher in the West Fork and Indian Creek.

### Total Nitrogen



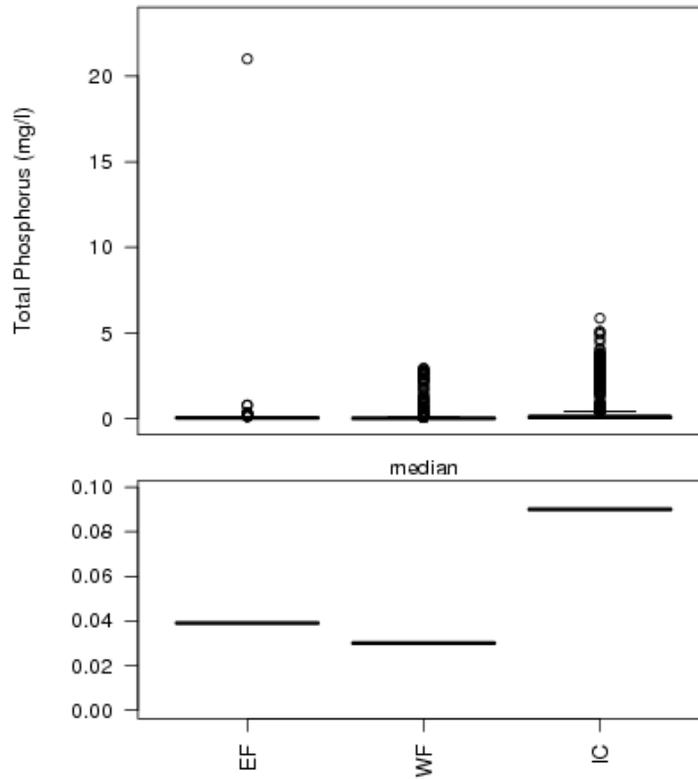
There is no significant difference in total nitrogen concentrations between the East and West Forks.

### Ortho-Phosphate



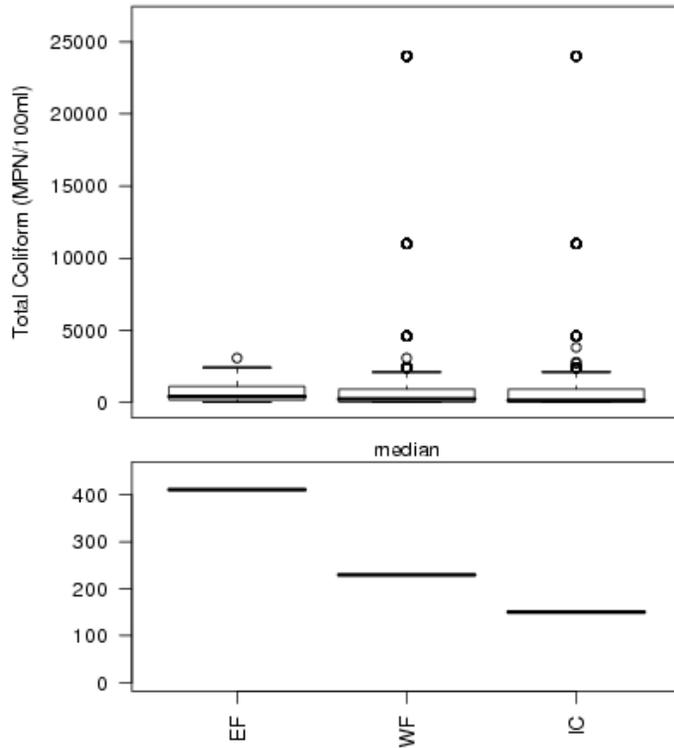
The West Fork Carson River has significantly lower ortho-phosphate concentrations than the East Fork or Indian Creek.

### Total Phosphorus



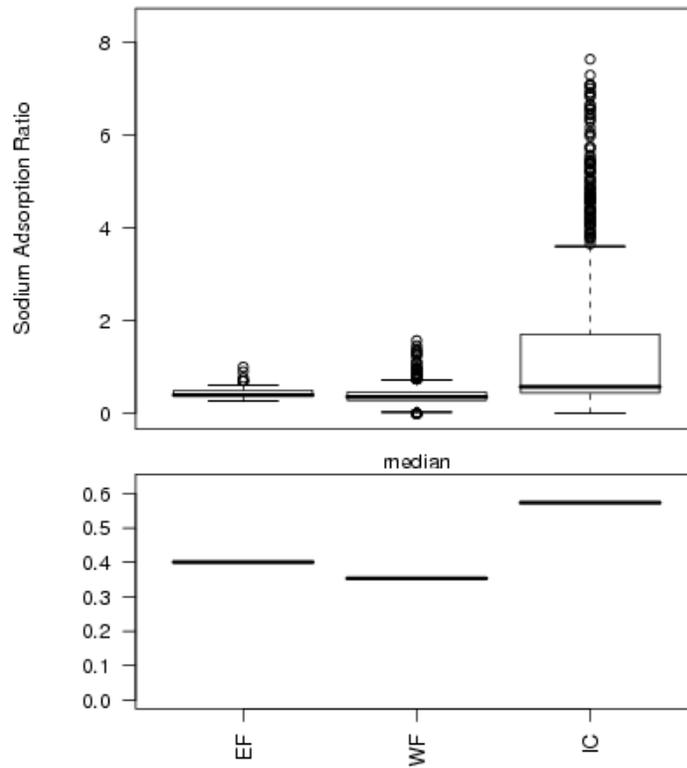
The median Indian Creek total phosphorus concentration is more than twice as high as the median for the East or West Forks.

### Total Coliform



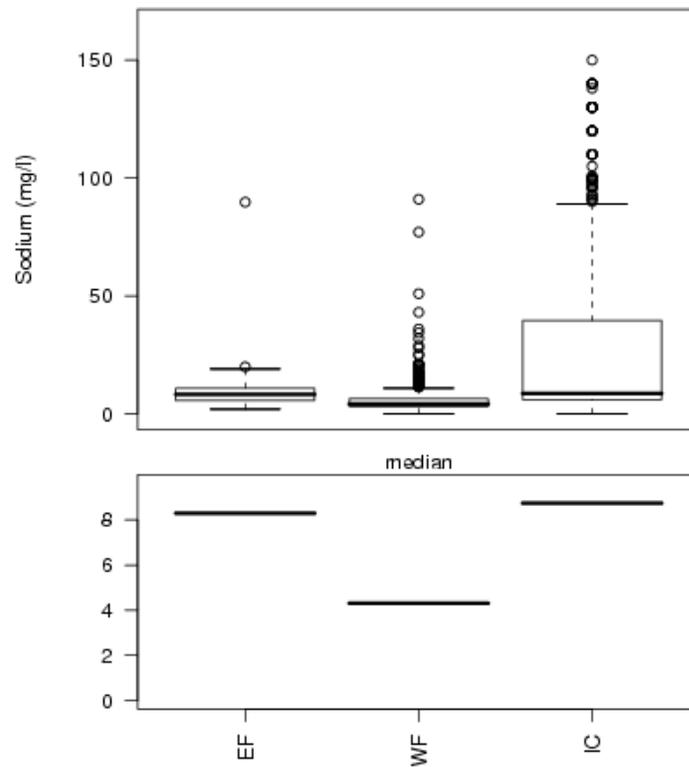
Though high values (> 1000 MPN/100ml) are found in all basins, the East Fork has a significantly higher median. Extremely high values are found in both the West Fork and Indian Creek.

### Sodium Adsorption Ratio (SAR)



All of the high sodium adsorption ratio values are found in the Indian Creek basin, specifically Indian Creek Reservoir and Harvey Place Reservoir.

## Sodium

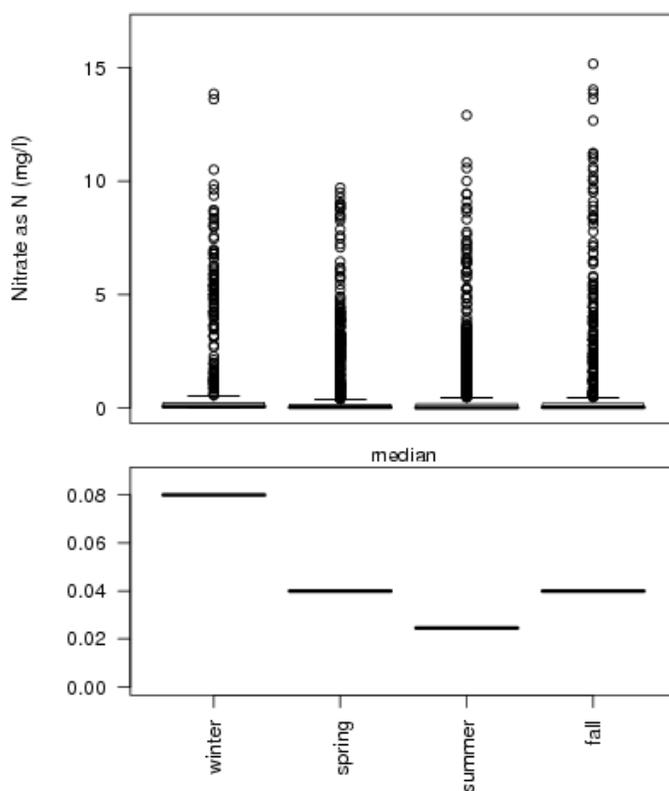


Most of the high sodium values are found in the Indian Creek basin, specifically Indian Creek Reservoir and Harvey Place Reservoir.

### 3.6 Seasonal Comparison

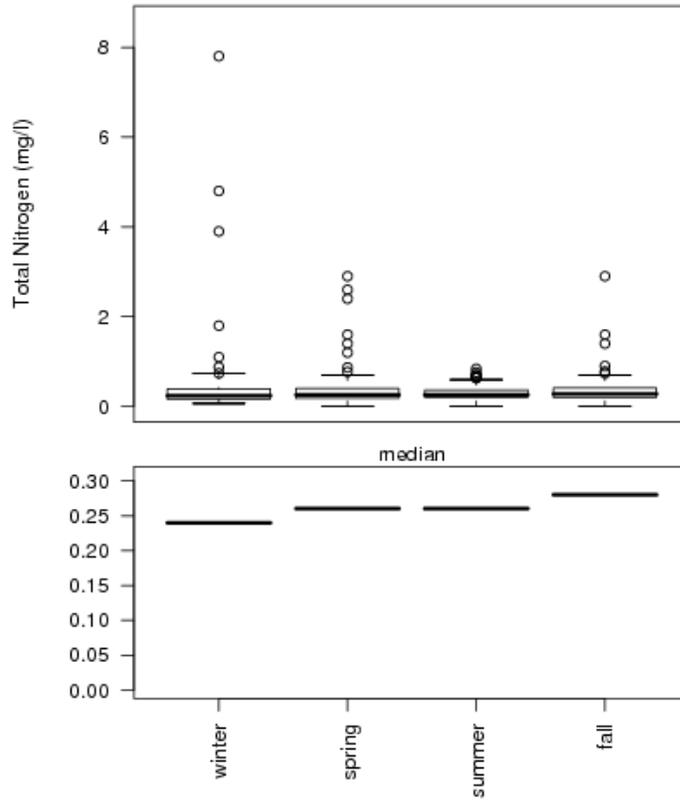
The purpose of this analysis is to determine if water quality changes by season. For this study, winter is December, January and February, spring is March, April and May, summer is June, July and August, and fall is September, October and November. Results from this analysis will be useful for the design of future monitoring programs.

#### Nitrate



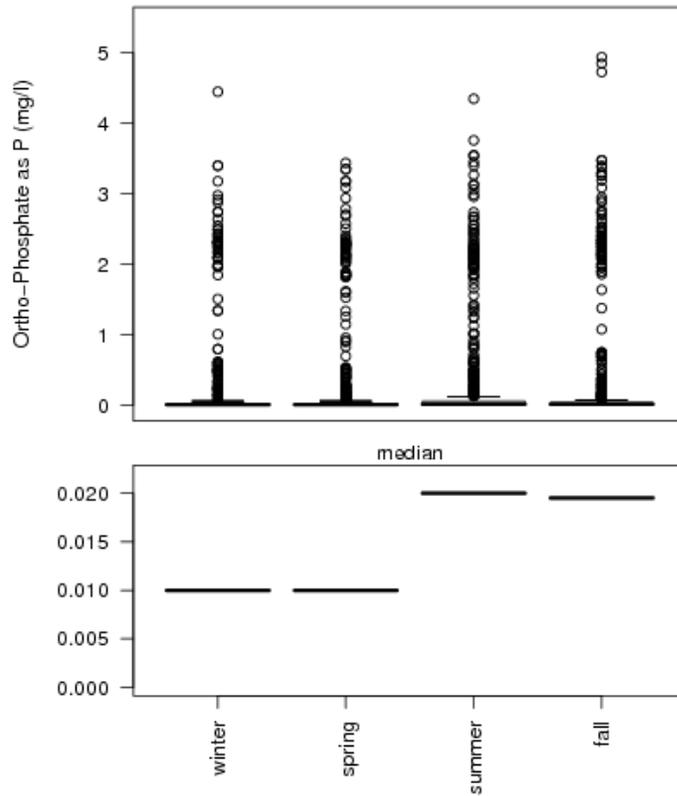
Median concentrations for all seasons are between 0.02 mg/L and 0.08 mg/L. The median concentration is significantly lower in the summer (0.02 mg/L) than in the winter (0.08 mg/L).

### Total Nitrogen



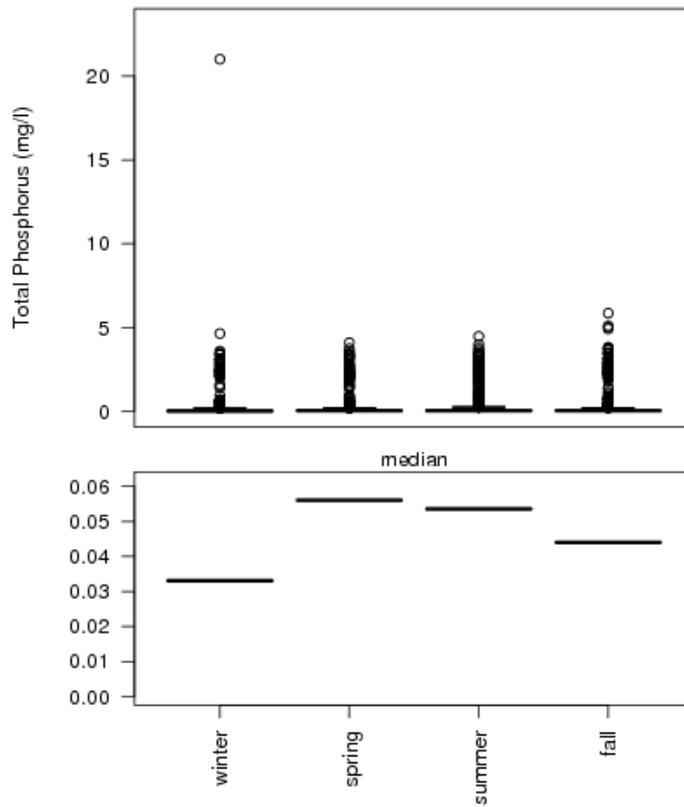
There is no significant seasonal difference in total nitrogen.

### Ortho-Phosphate



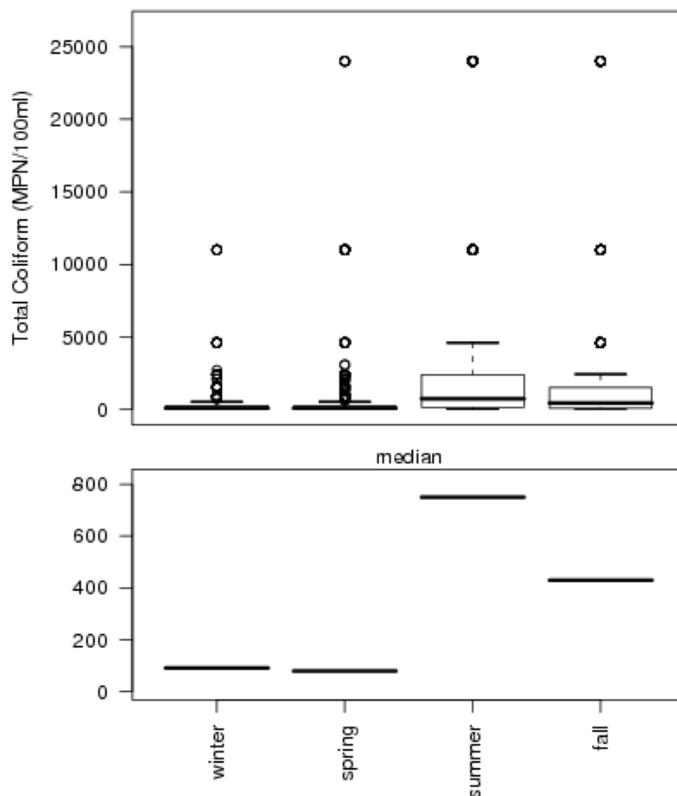
Median values are between 0.01 and 0.02 mg/L as P with slightly higher median values in summer and fall.

### Total Phosphorus



All total phosphorus medians lie between 0.03 and 0.06 mg/L with the lowest median value in the winter.

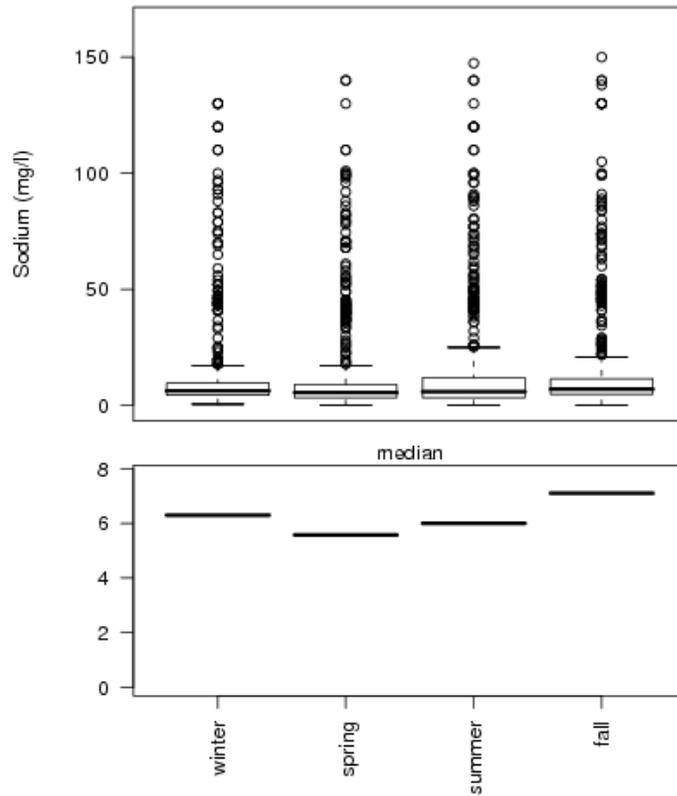
### Total Coliform



Median total coliform counts range from 100 to 800, with higher medians in the summer and fall, though high values can be found in all seasons. Values greater than 20000 are from sites: SW-03 (Indian Creek), SW-04 (Indian Creek), WF2-WQ1 (Carson River at Paynesville), WF1-WQ1 (Carson River at Stateline), SW-07 (Fredericksburg Ditch), and SW-08 (Irrigation Ditch).

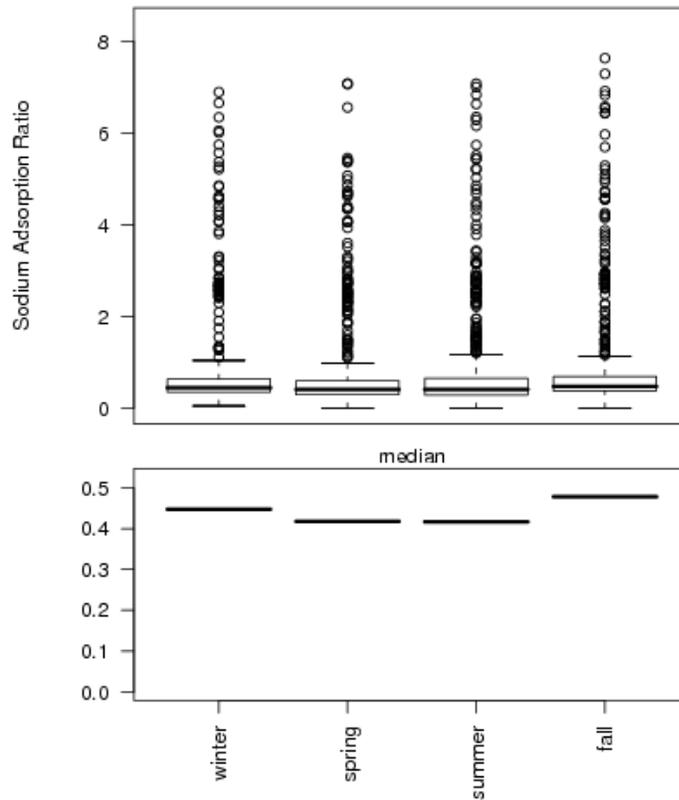


## Sodium



There is no significant seasonal difference in sodium concentration.

### Sodium Adsorption Ratio

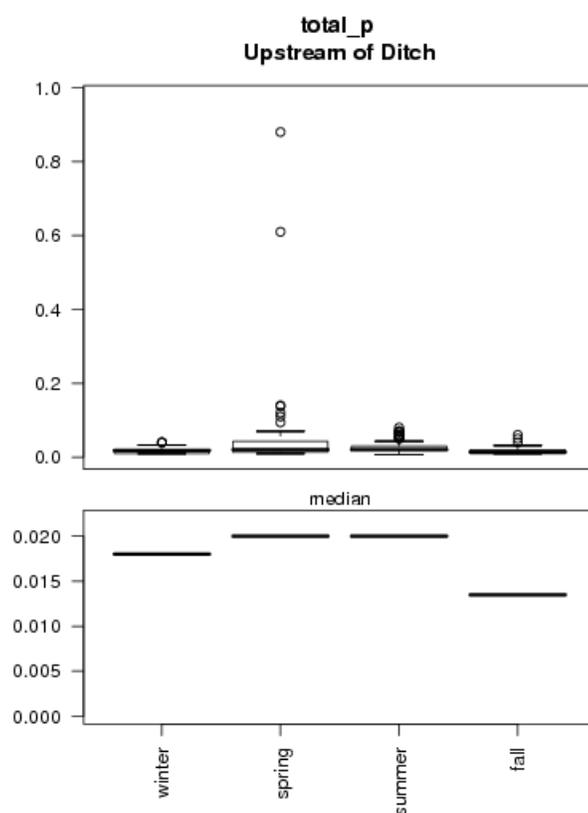


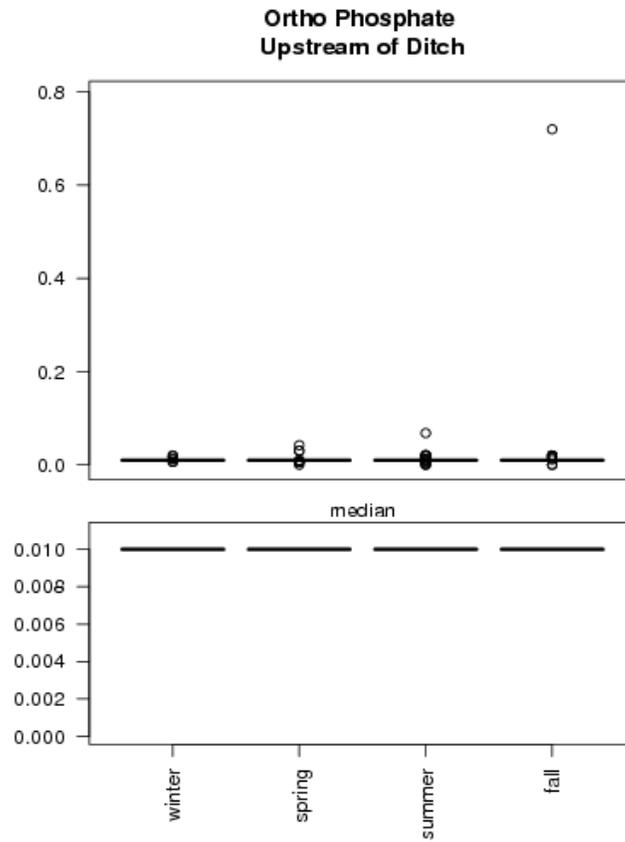
There is no significant seasonal difference in sodium adsorption ratio.

### 3.7 West Fork Carson River and Indian Creek Reservoir

Indian Creek Reservoir receives water each spring from a diversion of the West Fork Carson River at Woodfords. Because of Indian Creek Reservoir's inclusion on the State of California's 303(d) list of impaired waters for phosphorus, an additional seasonal summary is presented here.

The water diverted to Indian Creek Reservoir is represented by all the West Fork sites upstream of, and including, the Woodfords gage. The two plots below for total phosphorus and ortho-phosphate give an overview of the external phosphorus loading to Indian Creek Reservoir.





West Fork diversions to Indian Creek Reservoir occur only in the spring, with a median total phosphorus concentration of 0.02 mg/L and a median ortho-phosphate concentration of < 0.01 mg/L.

### 3.8 Spatial Differences

New sampling sites in the upper reaches of the basin were chosen to isolate potential problem areas. Current water quality standards are in place for few sites and, as such, the standards apply to all reaches upstream. These standards may be inappropriate for such large areas. The collection of data at these new sites will provide the foundation for future monitoring throughout the basin.

Each plot in this analysis consists of two stacked plots. The upper plot is a typical boxplot with the number of samples presented near the top of the plot. The lower plot is the median value for each site. The data are presented in this way because for most of the boxplots it is difficult to distinguish populations due to the large range of values and outliers.

The following is a comparison of water quality along each reach.

#### 3.8.1 West Fork Carson River

Figure 3.8.1-1 shows the location for many of the sites on the West Fork of the Carson River. Several tributaries enter this reach and the choice of sample locations can identify their contribution to the water quality of the West Fork Carson River. The most significant tributaries include Red Lake Creek, Hawkins Creek, and Willow Creek.

The following graphs show sites in the West Fork Carson River Basin. They are listed left to right in approximate upstream to downstream order. Tributaries are inserted where appropriate. The boxplots represent all the data for each site/parameter combination, while the median plot below gives a simpler overview of the changes in median water quality along the stream.

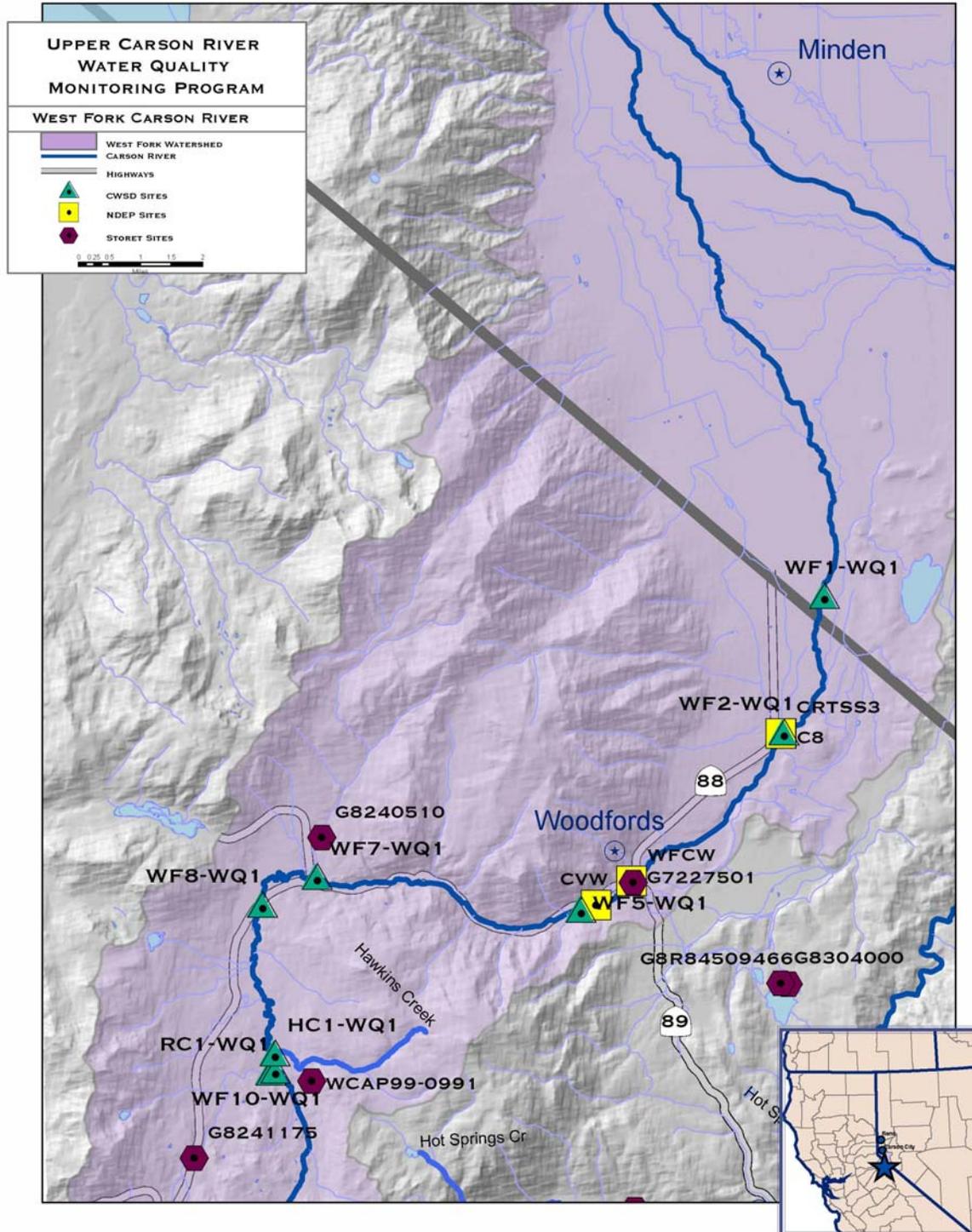


**Red Lake Creek – looking downstream**  
**Tributary to the West Fork Carson River**  
Sampling Site #RC1-WQ1, May 2004



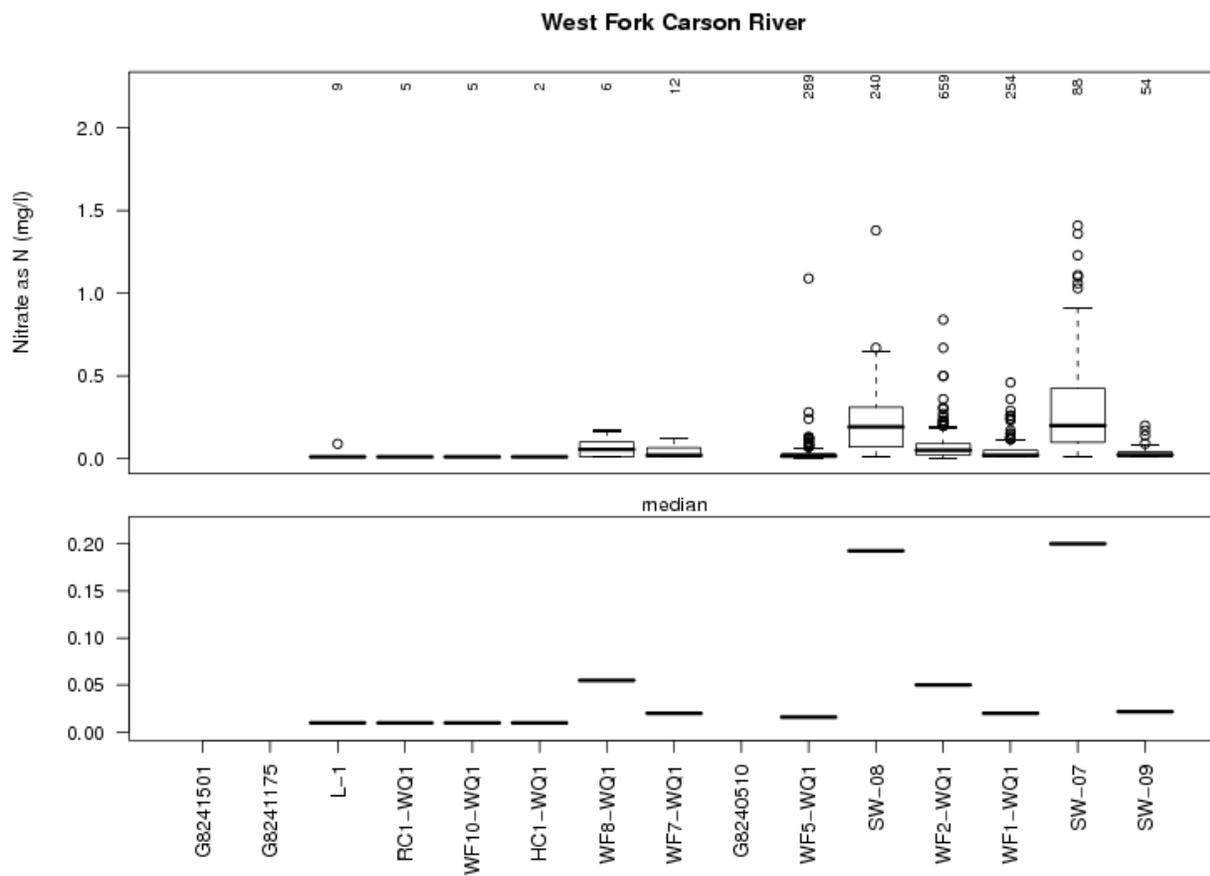
**Hawkins Creek**  
**Tributary to the West Fork Carson River**  
Sampling Site #HC1-WQ1, April 2004

Figure 3.8.1-1: West Fork Drainage Water Quality Monitoring Sites



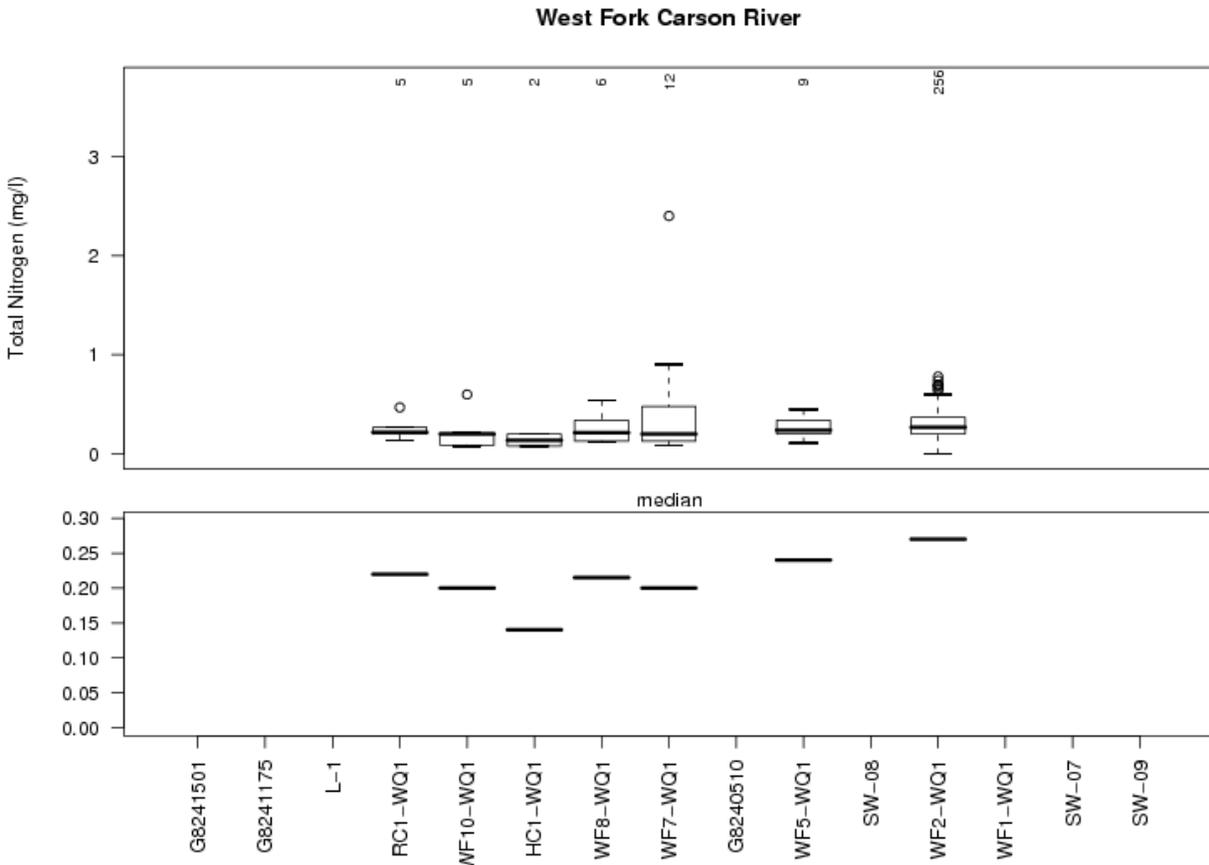
## Nitrate

Concentrations for SW-07 (Fredricksburg Ditch at Stateline) and SW-08 (irrigation ditch along Carson River Road) are high, but they represent ditch samples in irrigated areas. Most median concentrations for sites on the main stem are below 0.05 mg/L, though there are several individual samples above 1.0 mg/L.



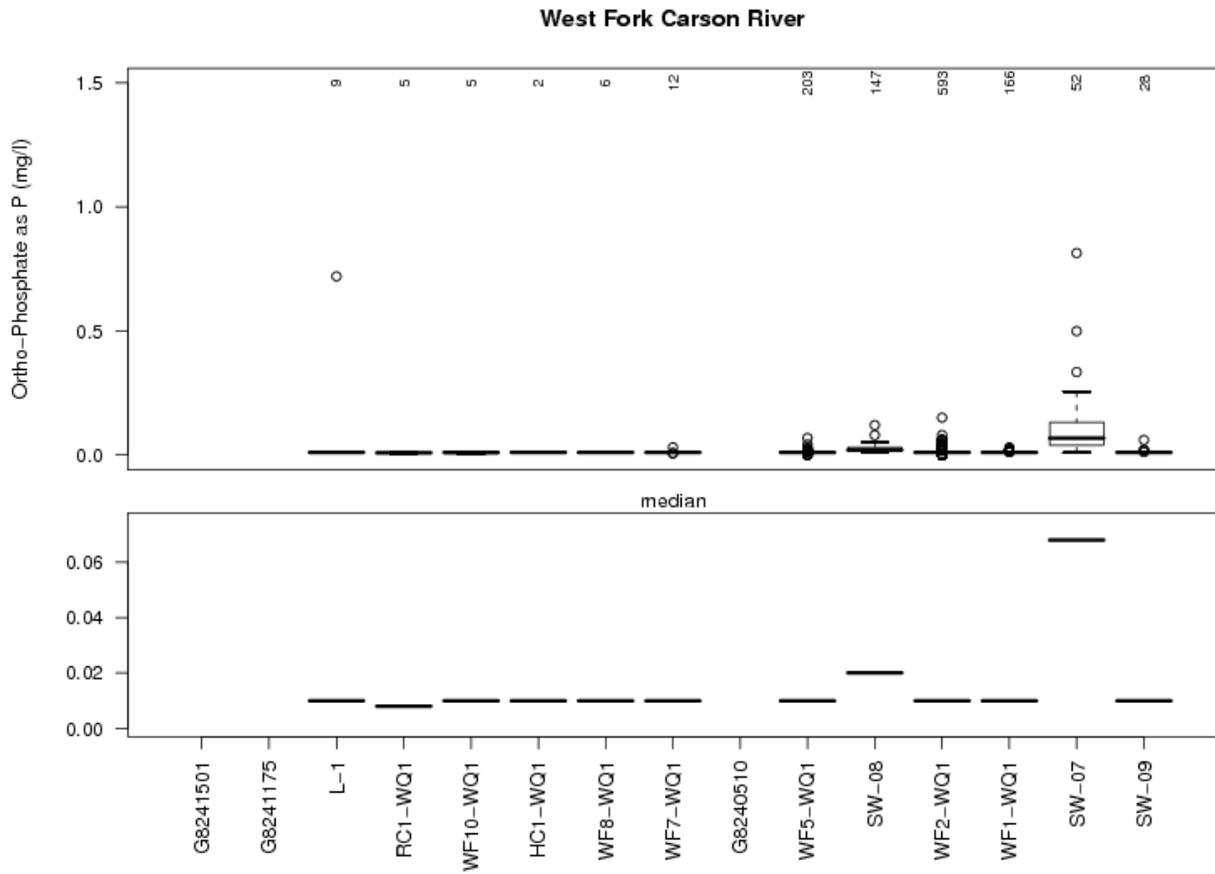
### Total Nitrogen

There is not enough data to draw any firm conclusions about spatial differences in total nitrogen, though the upper reaches have a typical value of around 0.2 mg/L and the most downstream median is 0.3 mg/L.



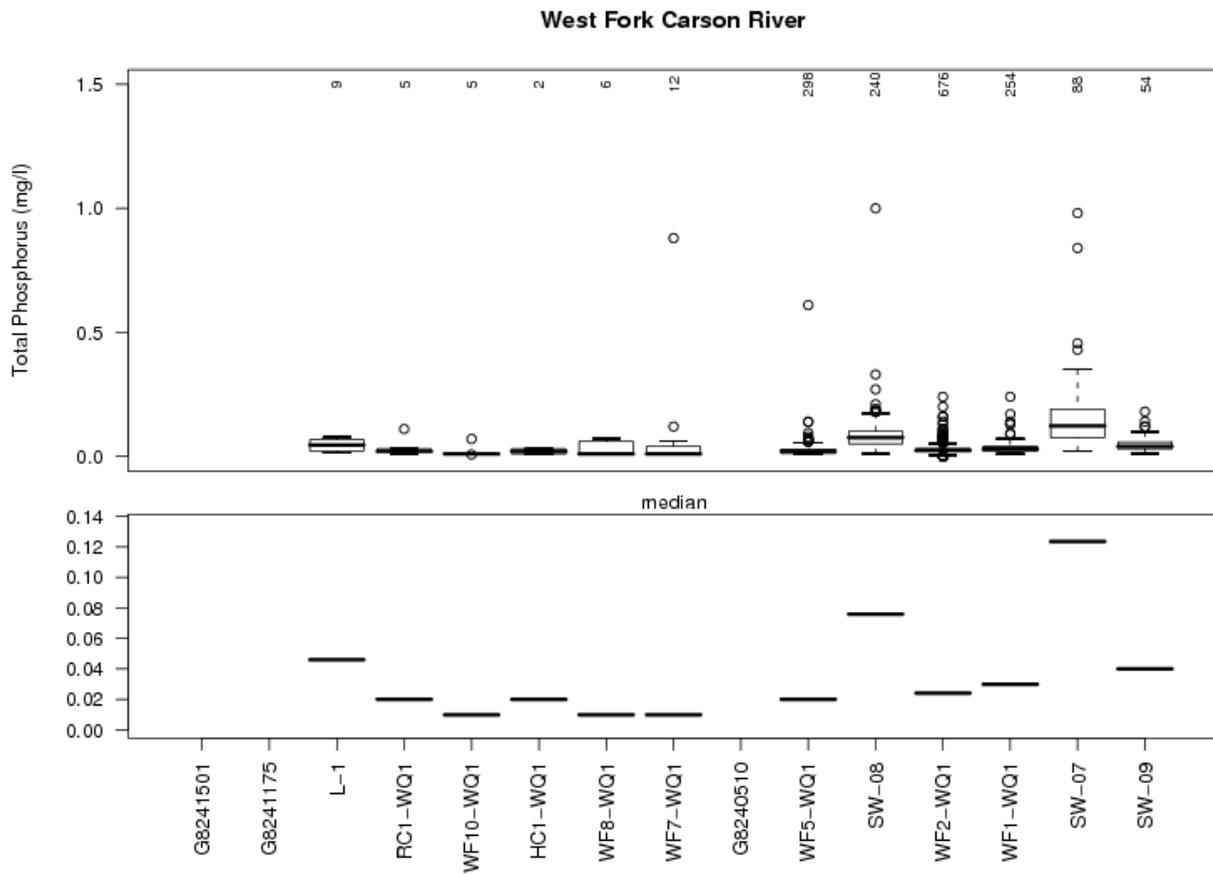
## Ortho-phosphate

Upstream median ortho-phosphate concentrations are around 0.01 mg/L, though the small number of observations should be noted. The ditch samples represented by site SW-07 are significantly higher than the rest of the samples in the basin.



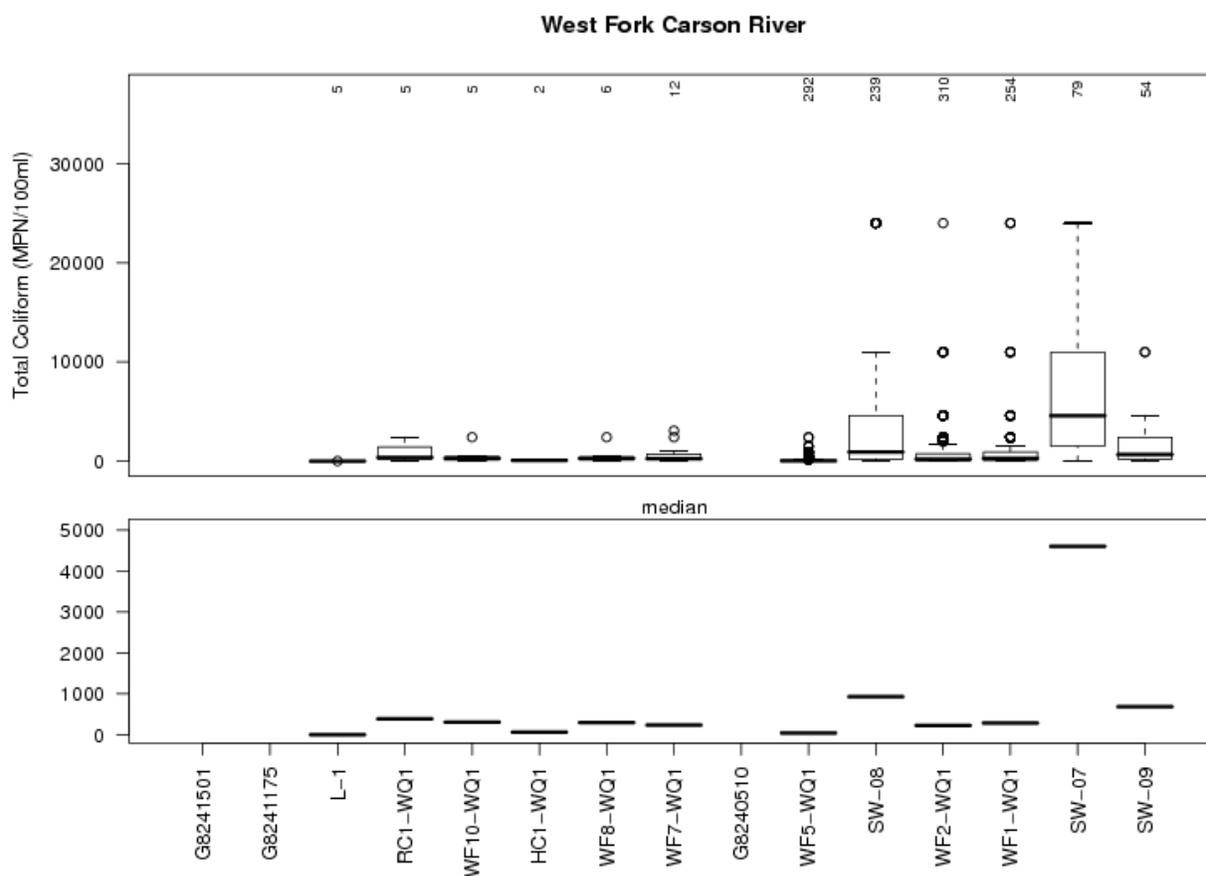
### Total Phosphorus

For total phosphorus, the ditches (SW-08 and SW-07) again show high medians and variances. All non-ditch sites have median values less than 0.05 mg/L.



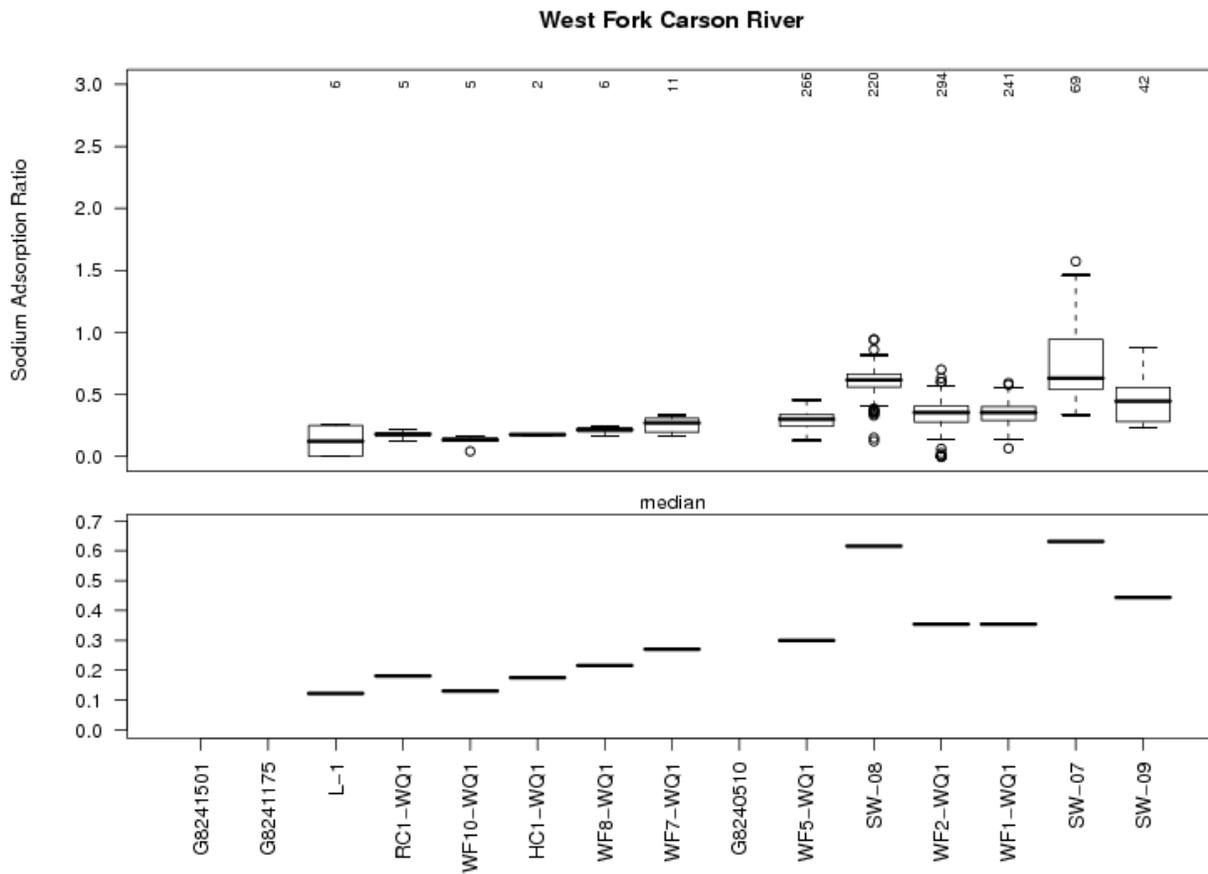
### Total Coliform

For those sites with more frequent sampling, SW-07 (Fredericksburg Ditch at State Line) and SW-08 (Irrigation Ditch along Carson River Road) have consistently high values. In the main stem of the West Fork, WF2 (below Fredericksburg Ditch) and WF1 (at the state line) show frequent high coliform counts, despite a relatively low median.



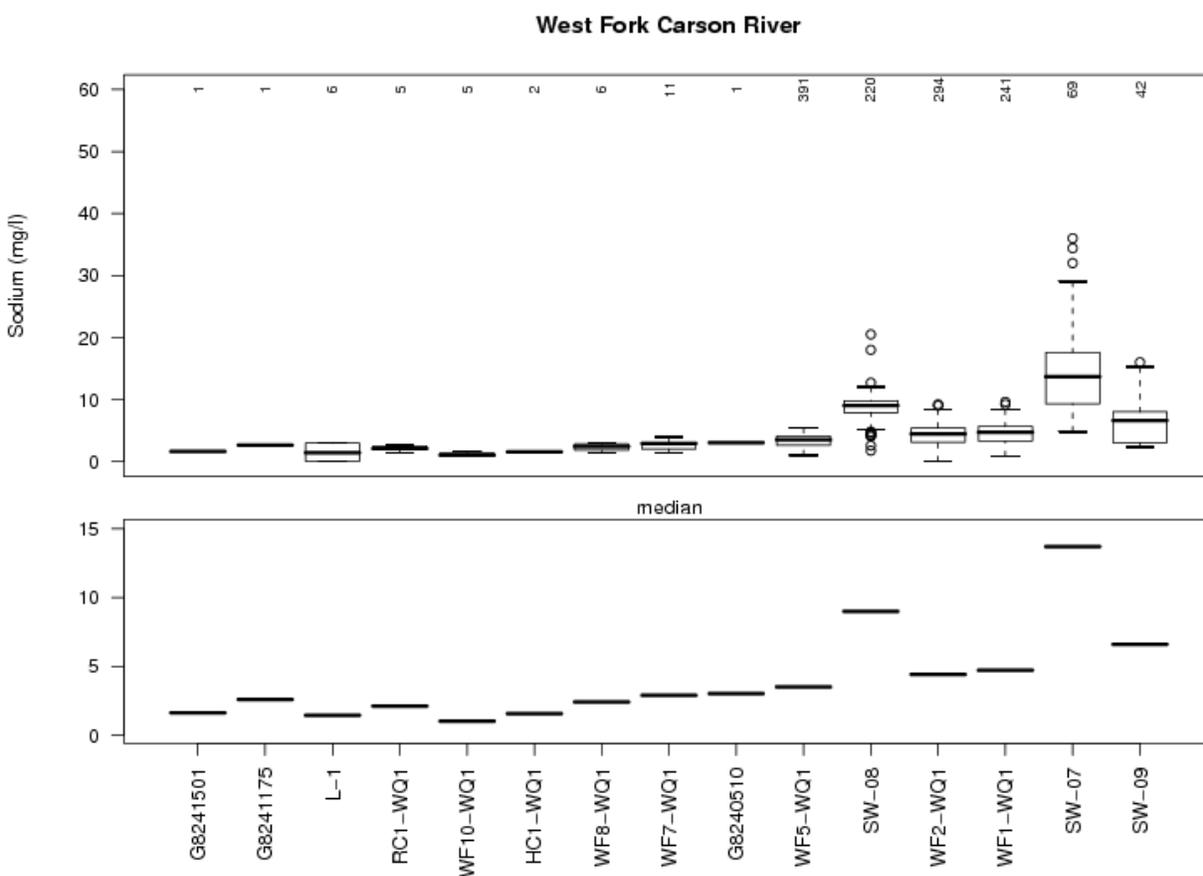
### Sodium Adsorption Ratio

There is a slow but steady increase in SAR from WF10-WQ1 (West Fork in Hope Valley) to Paynesville. SW-08 and SW-07 appear to be major contributors to SAR in the main stem.



## Sodium

There is a slow but steady increase in sodium (Na) in the upper reaches of the West Fork, from WF10-WQ1 (Hope Valley) to SW-09 (West Fork at Dressler Lane). SW-08 and SW-07 medians are significantly higher than those on the main stem.



### 3.8.1.1 Additional Conclusions

A more-detailed analysis of the difference among sites yielded the following conclusions:

- Nitrate increases significantly as the West Fork passes through Hope Valley. Concentrations decrease significantly after the confluence with Willow Creek.
- Total coliform is slightly higher in Red Lake Creek and has higher variation.
- Irrigation ditches, represented by sites SW-07 and SW-08 are significantly higher in nitrate, ortho-phosphate, total phosphorus, and sodium than the West Fork.

### 3.8.2 East Fork Carson River

Figure 3.8.2-1 shows the location for sites on the East Fork of the Carson River. Tributaries of interest include Wolf Creek, Silver Creek, Monitor Creek, Markleeville Creek, Hot Creek, Millberry Creek, and Bryant Creek. New sample sites were chosen to isolate the effects of these tributaries.

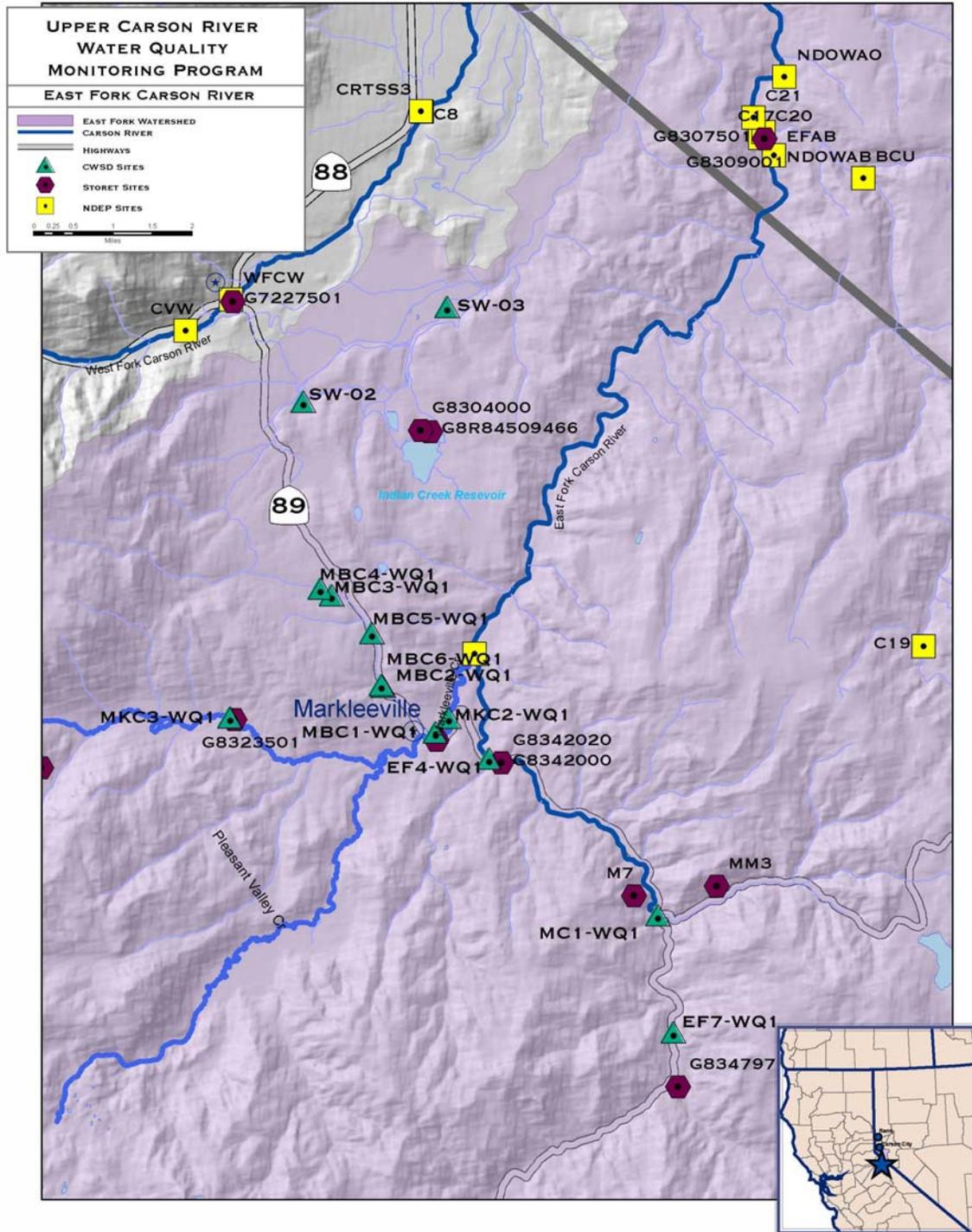


**Millberry Creek before confluence with East Fork**  
(May 2004 – Sampling Site MBC1-WQ1)



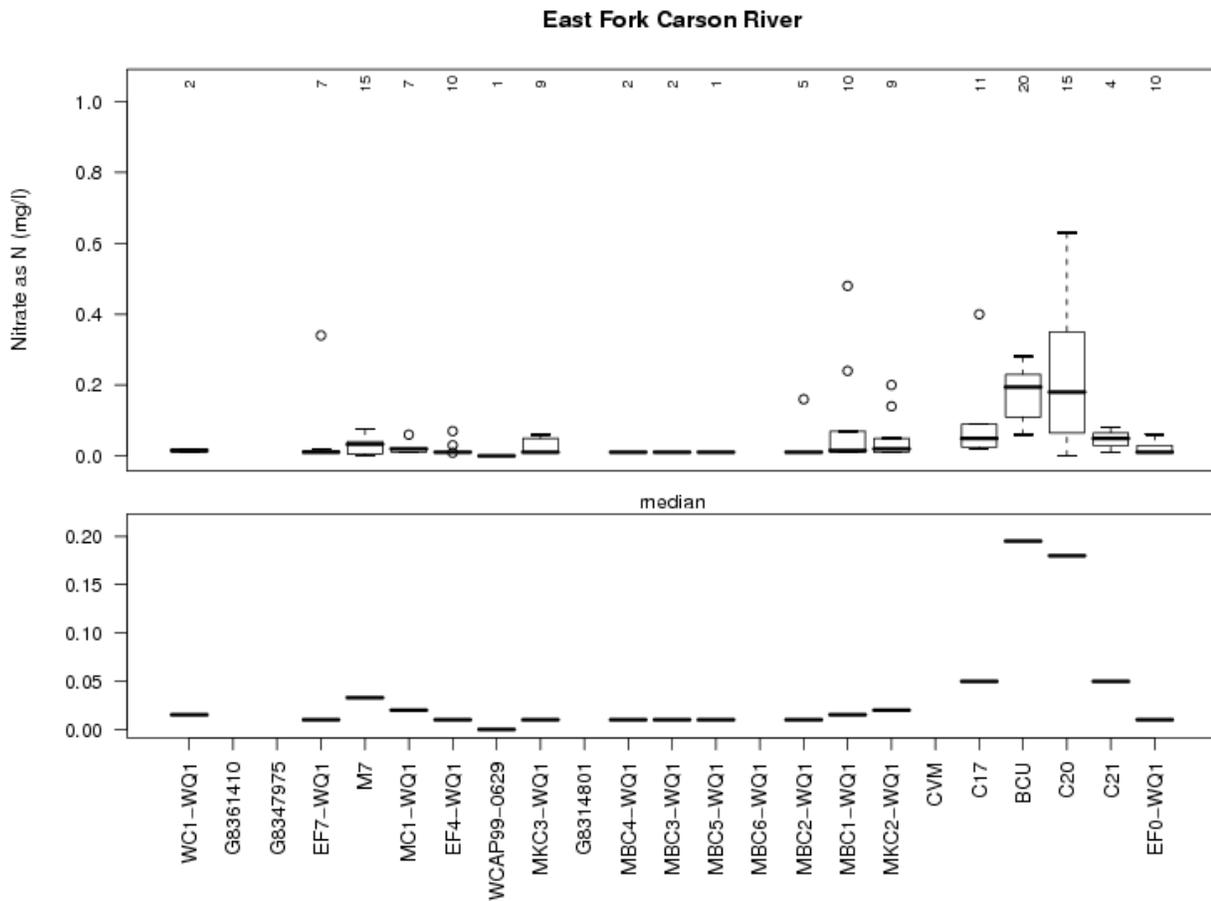
**Monitor Creek before confluence with East Fork**  
(May 2004 – Sampling Site MC1-WQ1)

Figure 3.8.2-1: East Fork Drainage Water Quality Monitoring Sites



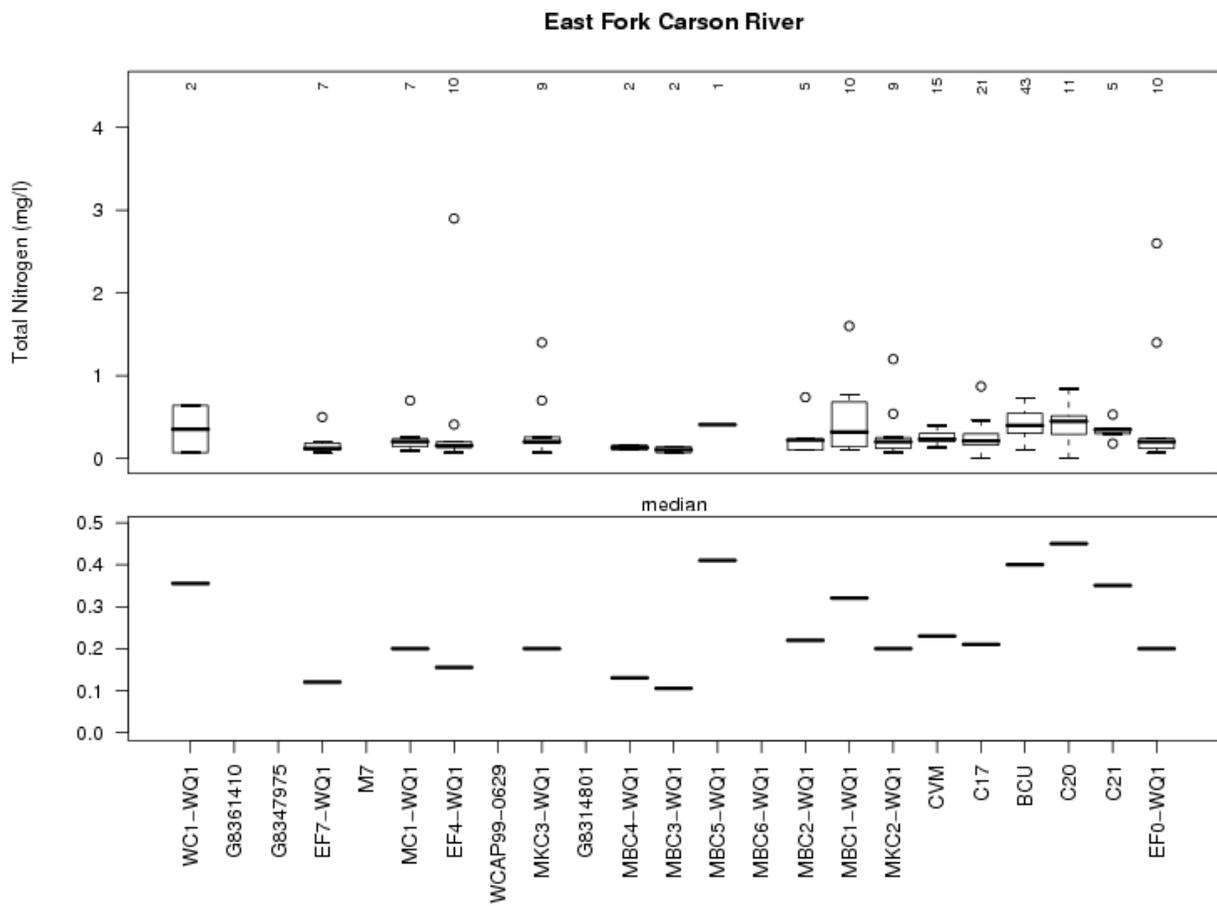
## Nitrate

From the headwaters to site C17 (East Fork above Bryant Creek), median nitrate concentrations remain below 0.05 mg/L. Sites BCU and C20 represent Bryant Creek and have significantly higher medians (around 0.20 mg/L). However, Bryant Creek appears to have little influence on concentrations in the East Fork, since downstream sites (C21 and EF0-WQ1) show medians at or below 0.05 mg/L.



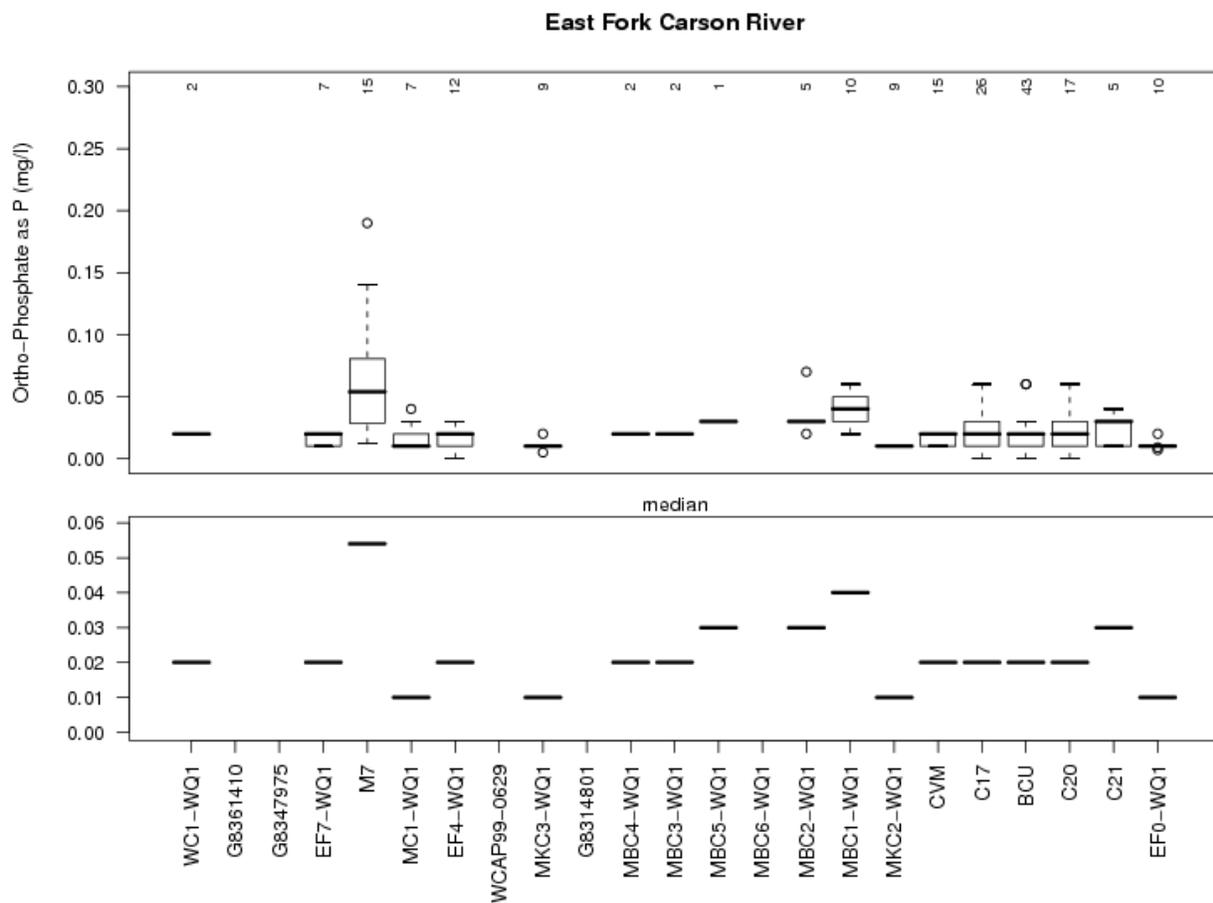
### Total Nitrogen

Median values of total nitrogen for most sites are based on relatively few values. Typical total nitrogen concentrations for most of the East Fork are between 0.1 and 0.5 mg/L. Values for Milberry Creek vary significantly, though with relatively high medians, further study may be warranted. Many of the medians computed for Milberry Creek were based on few samples. Bryant Creek (BCU and C20) has high concentrations but little effect on the East Fork.



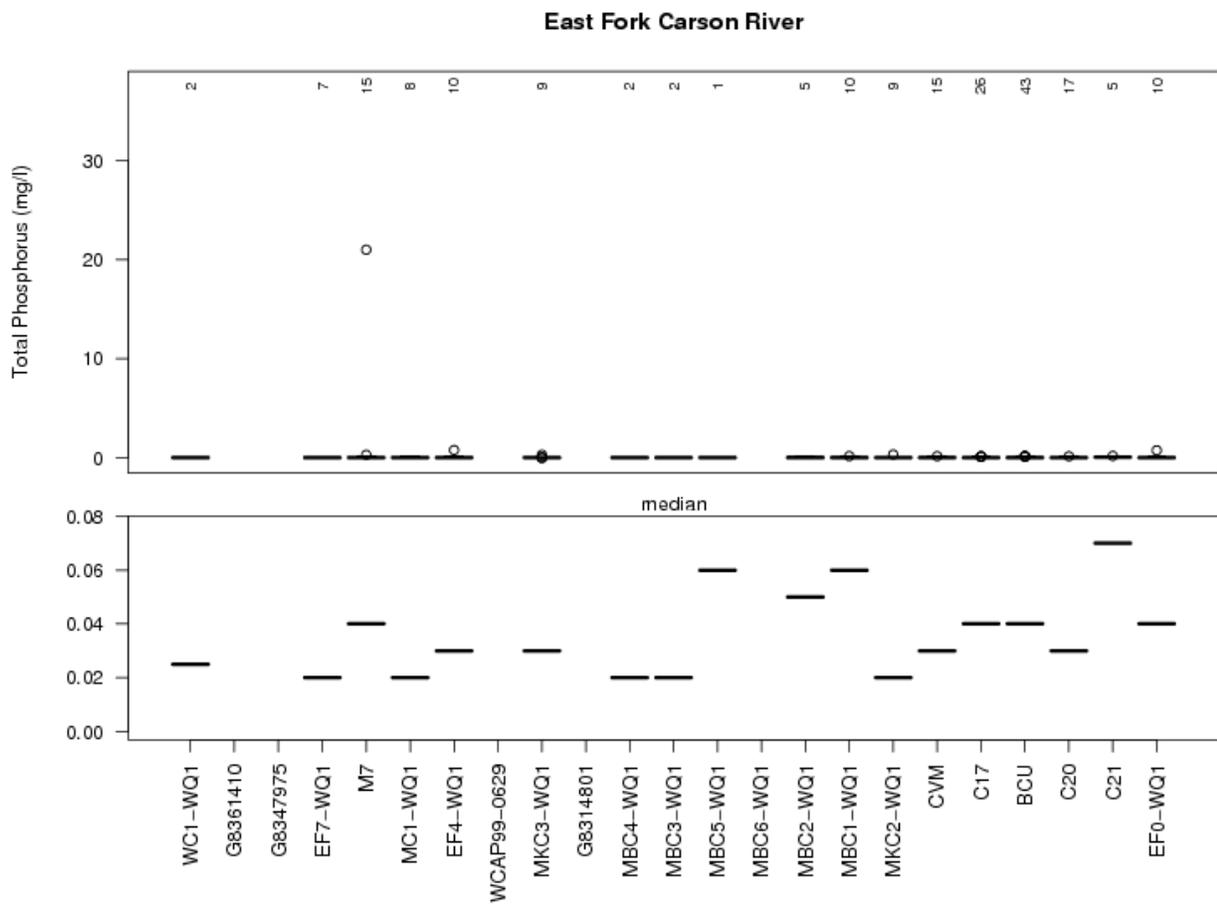
### Ortho-phosphate

Nearly all median values for ortho-phosphate in the East Fork are below 0.05 mg/L. Median values downstream of Markleeville are all around 0.02 mg/L.



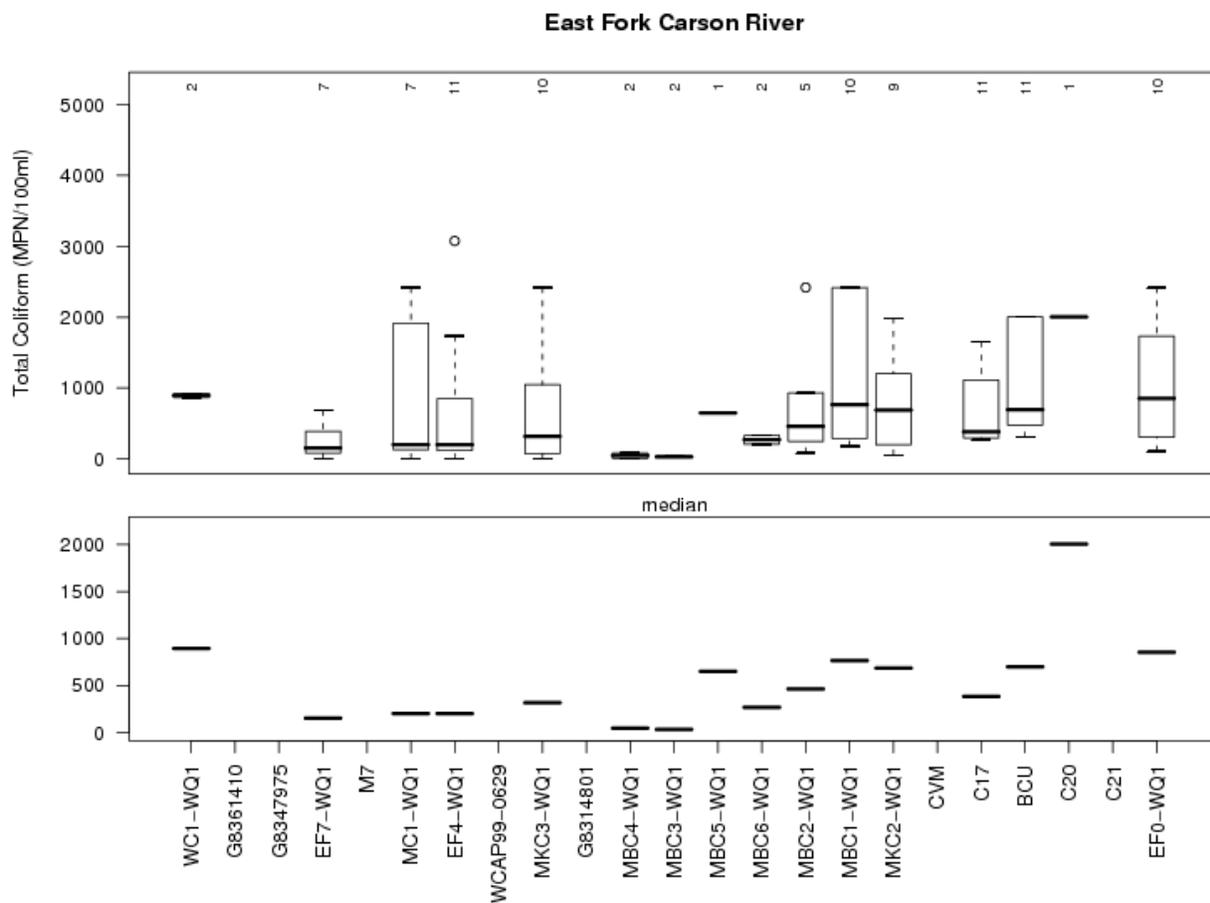
### Total Phosphorus

Most of the upper sites show a median total phosphorus concentration of less than 0.04 mg/L. Milberry Creek shows slightly higher values (sites beginning with MBC) with medians around 0.06 mg/L. Main stem sites downstream of the confluence with Milberry Creek remain around 0.04 mg/L. Site C21 (EF Carson Below Bryant Creek) appears significantly higher, but is only based on five samples.



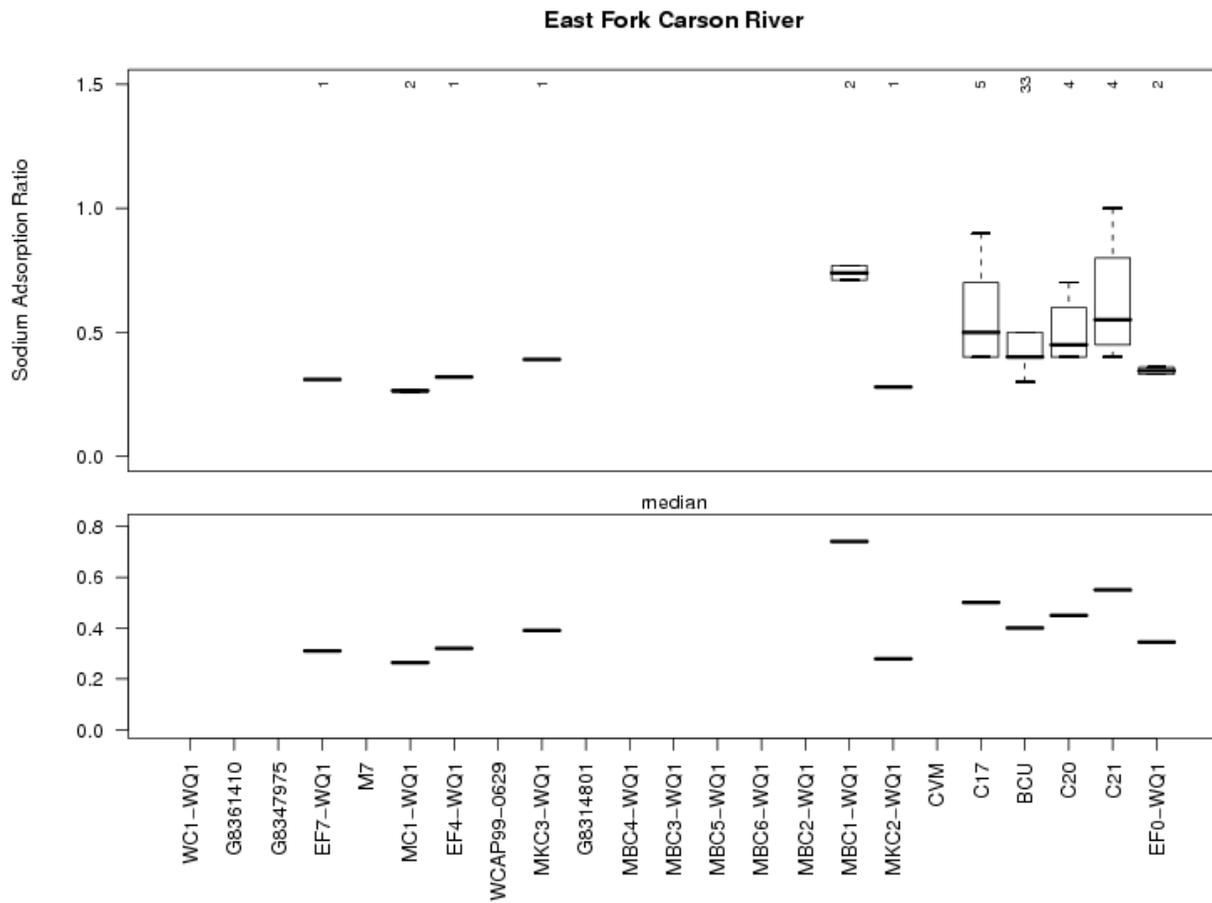
### Total Coliform

In general, Wolf Creek, Milberry Creek, Markleville Creek, and Bryant Creek show higher median values for Total Coliform.



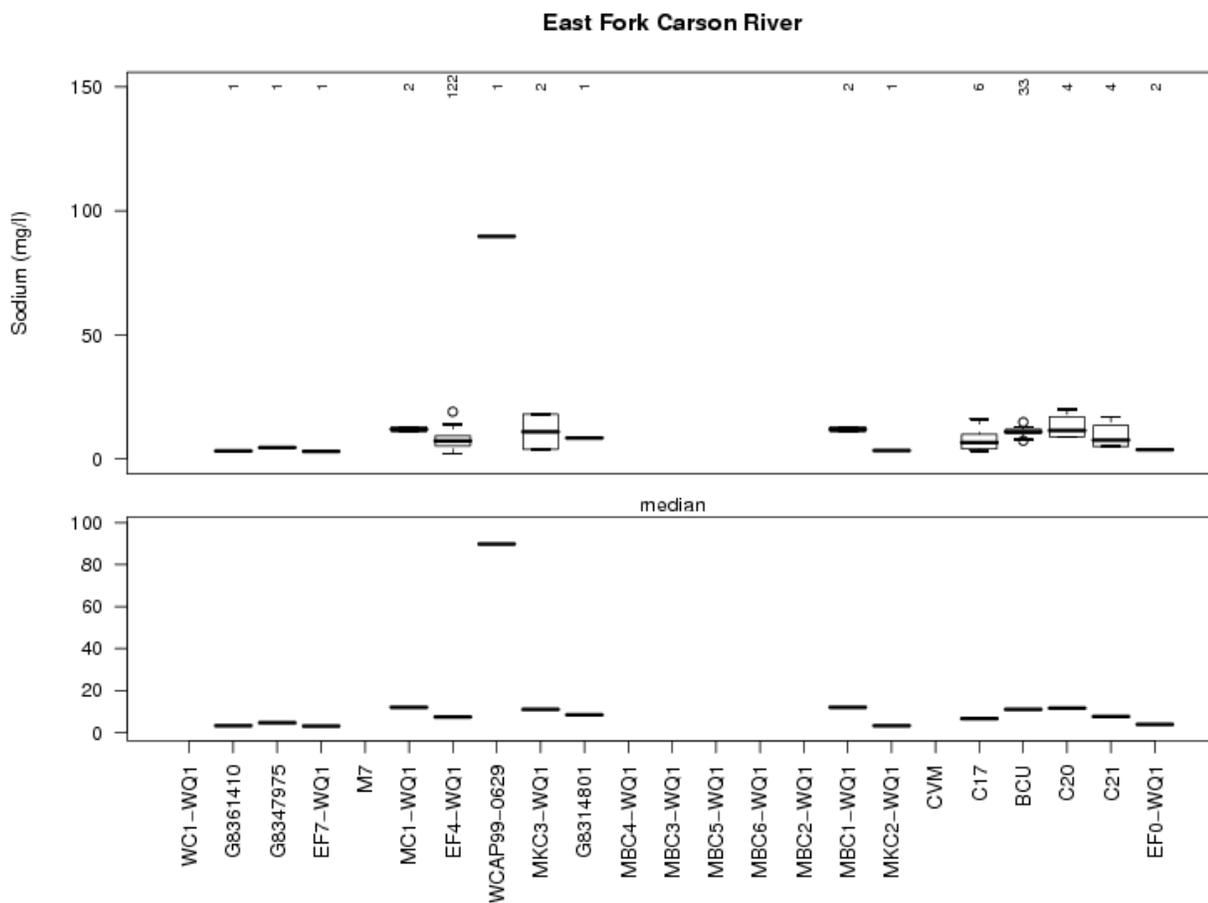
### Sodium Adsorption Ratio

SAR data is very sparse and few conclusions can be made. However, SAR appears to increase slightly with downstream sites. High median ratios are found in Milberry Creek (MBC1-WQ1).



## Sodium

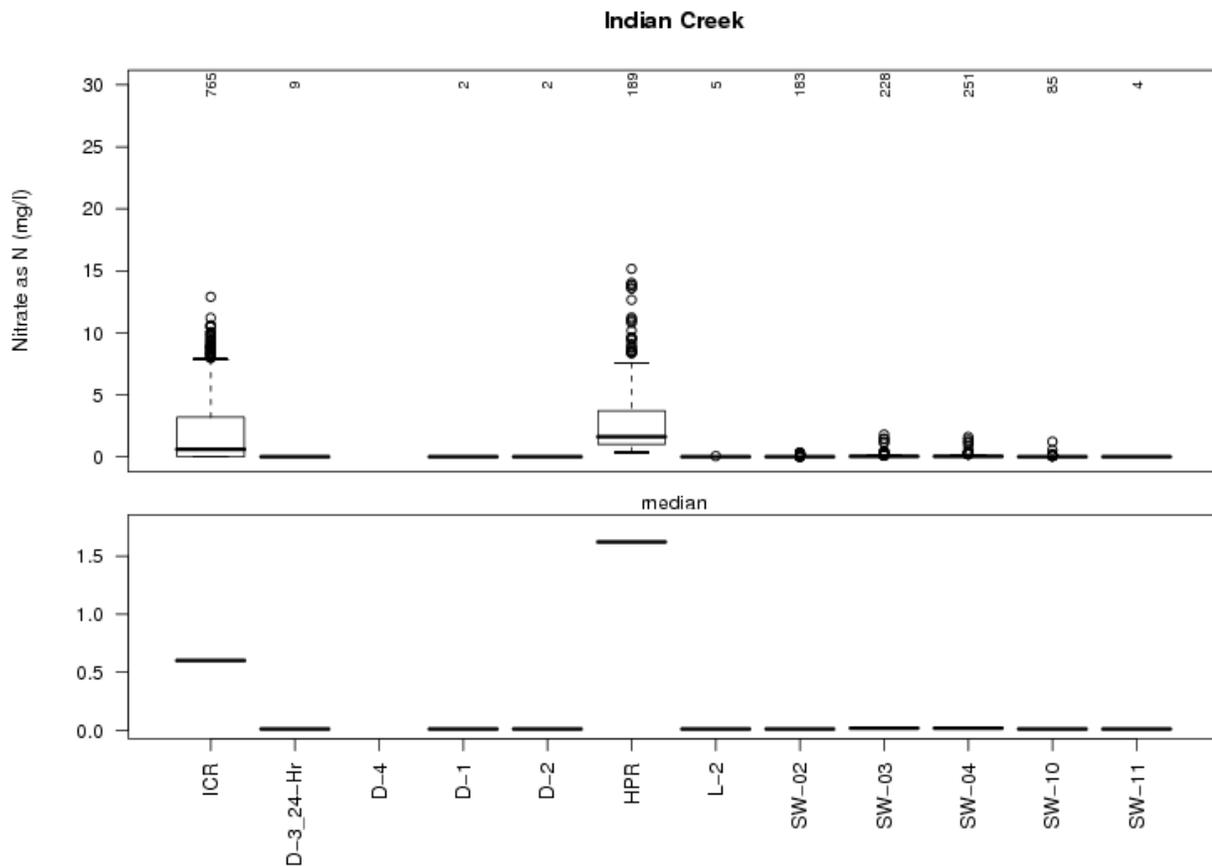
Nearly all values of sodium (Na) are below 20 meq/l, with most below 10 meq/l.



### 3.8.3 Indian Creek Sub-Watershed

#### Nitrate

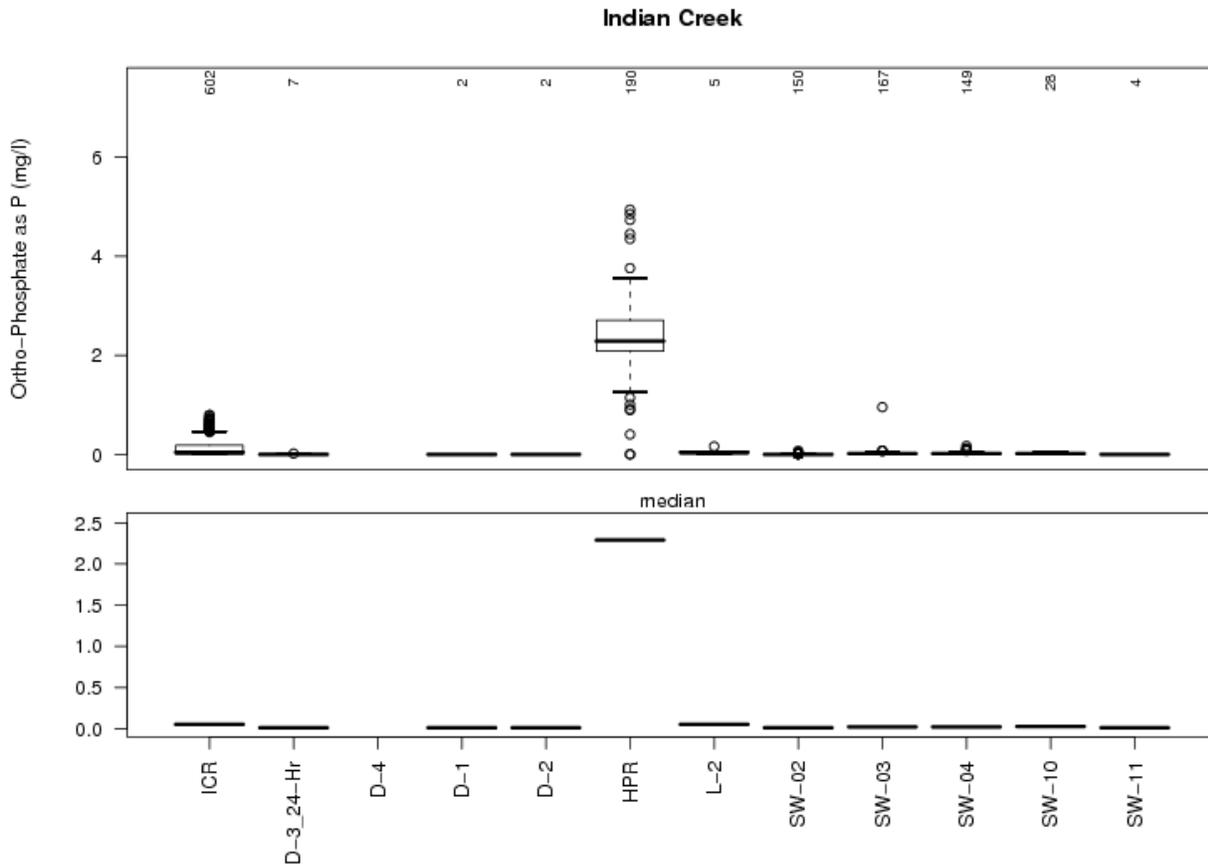
All median values of nitrate are below 0.05 mg/L, with the exception of Indian Creek Reservoir and Harvey Place Reservoir. A slight increase in variation can be found at sites SW-02, SW-04, and SW-10, though values never rise above 2 mg/L. Indian Creek and Harvey Place Reservoirs are significantly higher in both median concentration and maximum concentration. Values near or above the drinking water standard of 10 mg/L are not uncommon in the reservoirs.

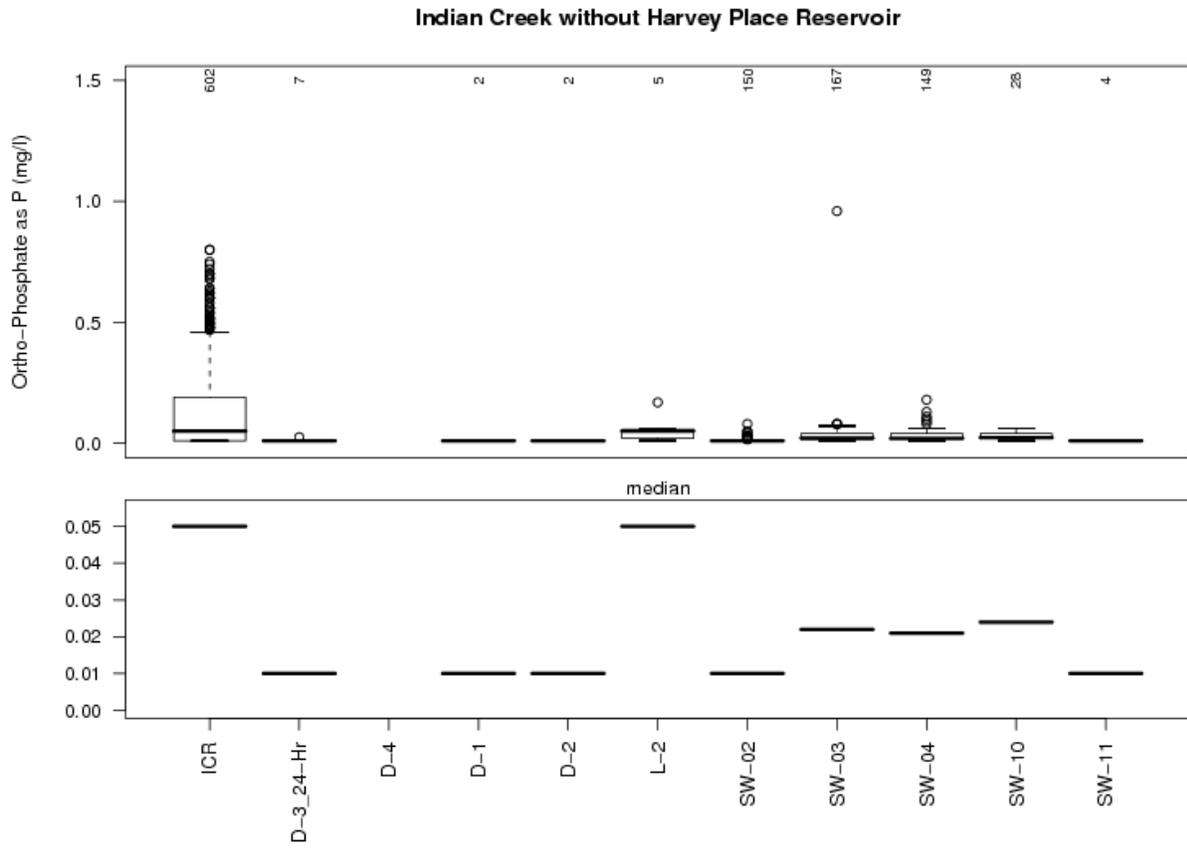


### Ortho-Phosphate

Because values for Harvey Place Reservoir are so much higher, differences in low concentrations are not as discernible. Therefore, a duplicate plot, with data from Harvey Place Reservoir removed, is provided below.

Typical values for ortho-phosphate in ditches and streams are around 0.02 mg/L, though values above 0.1 mg/L are sometimes found in sites SW-03 (ICR-middle) and SW-04 (ICR-lower). Indian Creek Reservoir (ICR) and Summit Lake (L-2) have median concentrations of 0.05 mg/L while Harvey Place Reservoir (HPR) has a median concentration of 2.3 mg/L. Twenty-five per cent of the samples taken in Indian Creek Reservoir have concentrations above 0.2 mg/L, while 95 percent of the samples in Harvey Place Reservoir are above 1.0 mg/L.



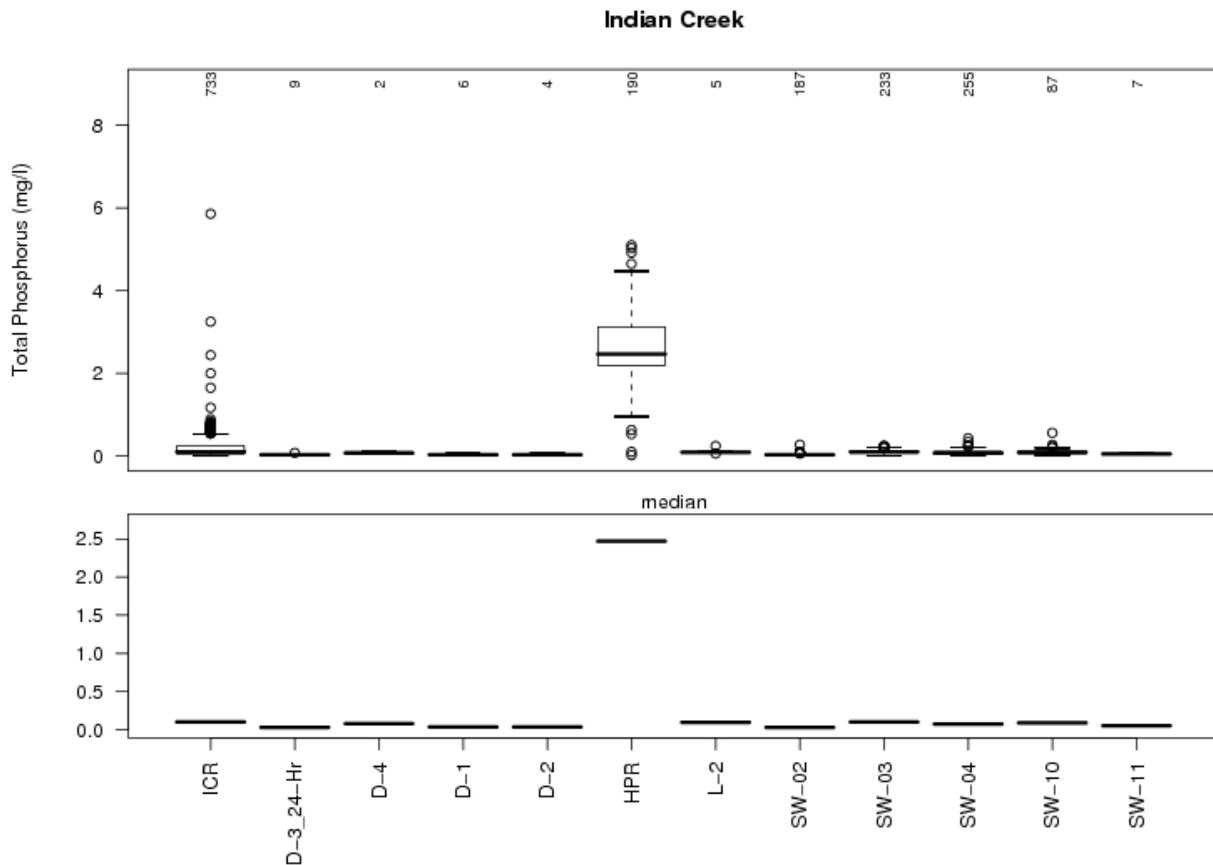


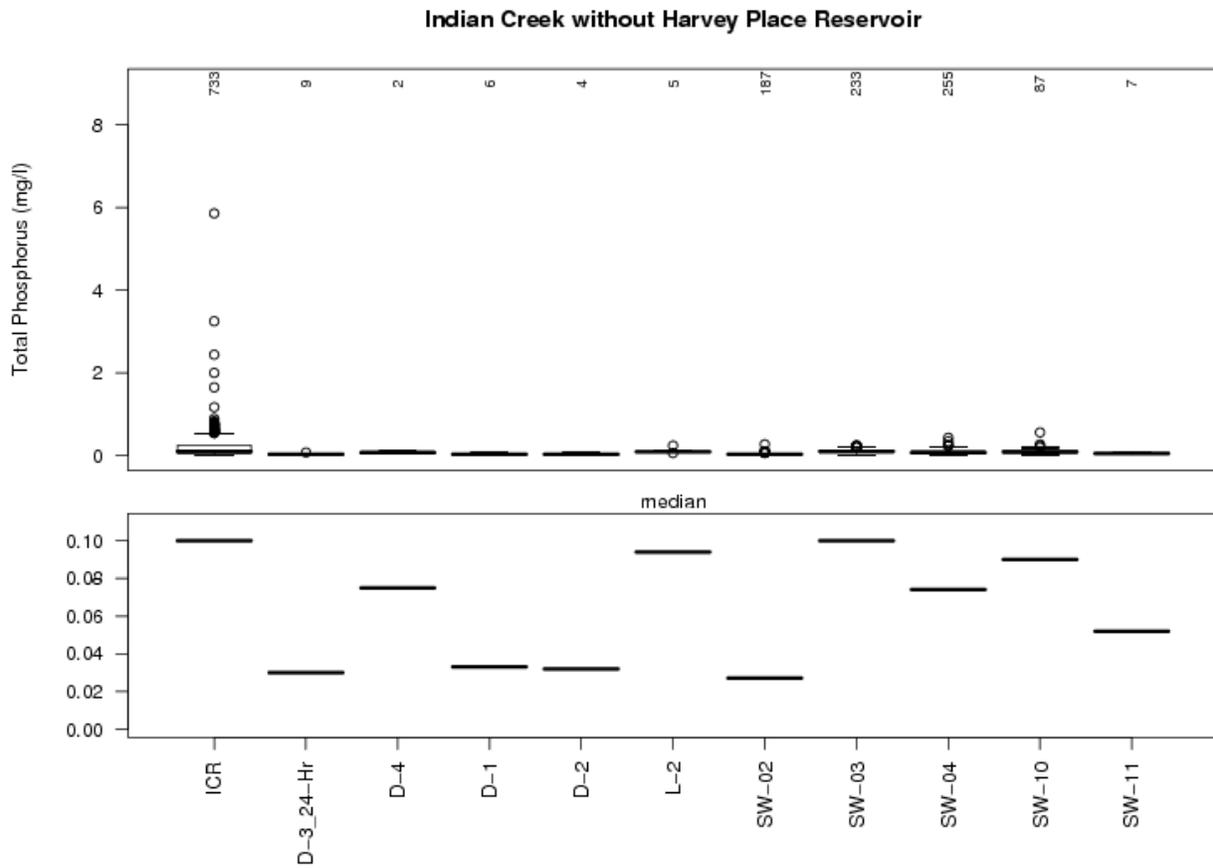
### Total Phosphorus

Approximately 95 per cent of the samples in Harvey Place Reservoir have a TP concentration above 1.0 mg/L. The median concentration in Harvey Place Reservoir is 2.5 mg/L, while the median in Indian Creek Reservoir is 0.1 mg/L. Both reservoirs experience a wide range of concentrations, with values as high as 5 mg/L in each.

Indian Creek shows the influence of Harvey Place Reservoir. The site upstream of the Reservoir (SW-02) has a median value of 0.03 mg/L, while downstream sites have higher medians that gradually decrease with distance from the Reservoir.

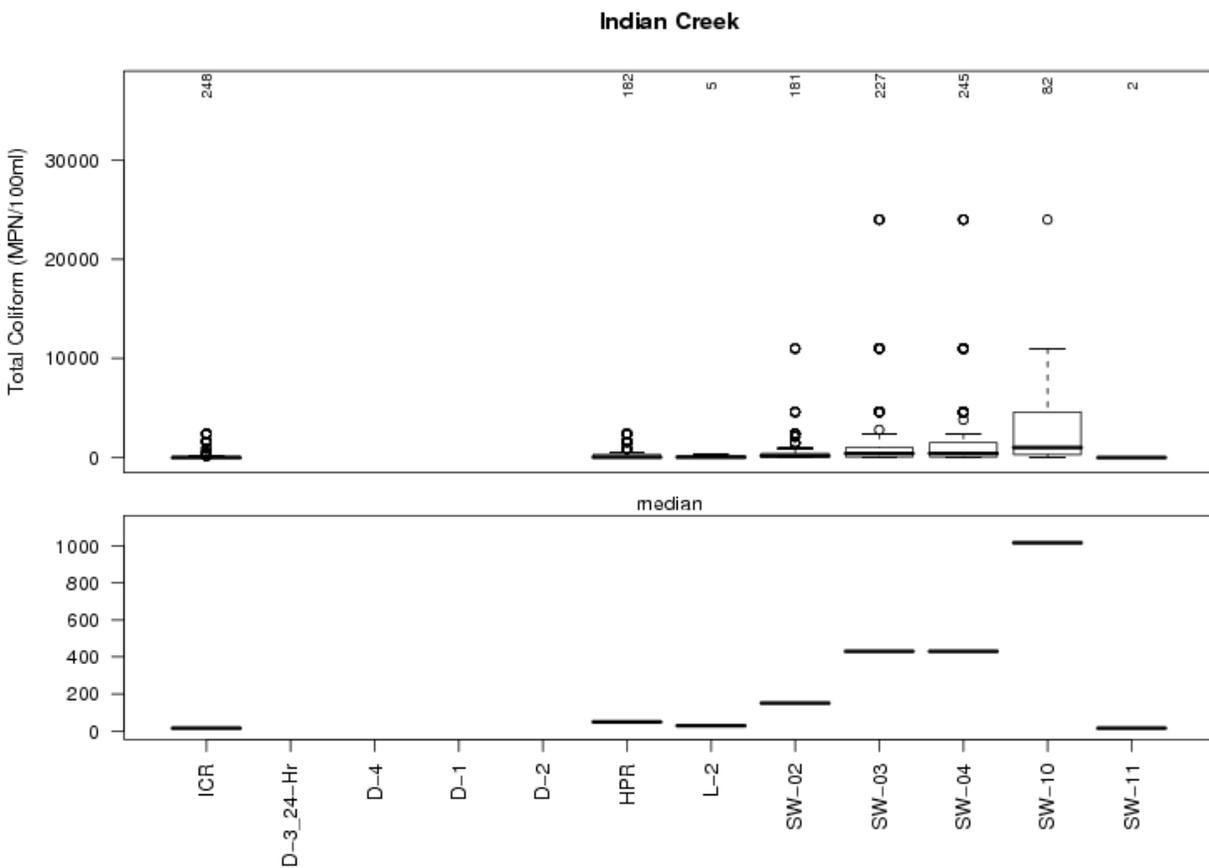
To help discern differences in low values, a second plot, with data from Harvey Place Reservoir removed, is provided below.





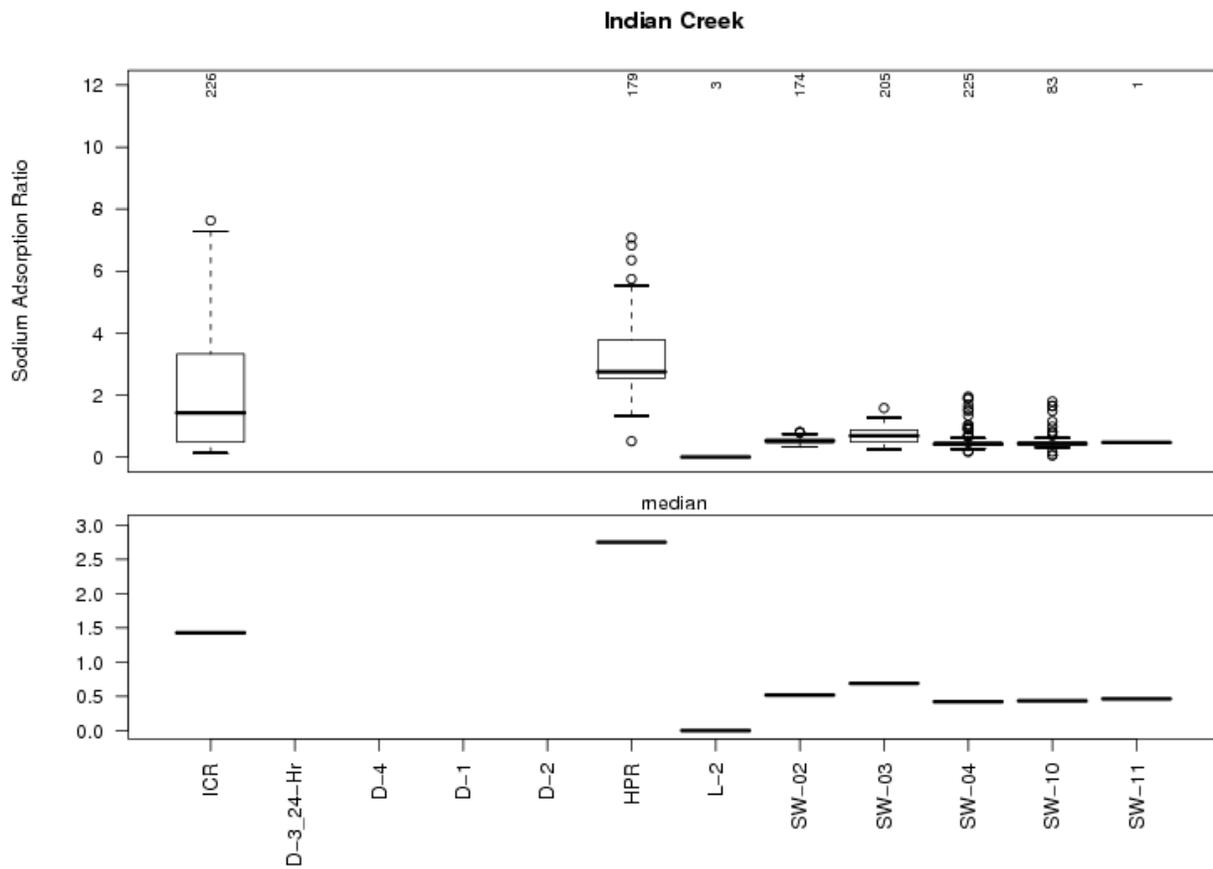
### Total Coliform

Median counts for Total Coliform, as well as the range of counts, appear to increase in Indian Creek (sites SW-02, SW-03, SW-04, and SW-10) as the stream travels through pastures irrigated for alfalfa and used for cattle grazing. Site SW-11 (Indian Creek Reservoir Effluent) shows low coliform counts.



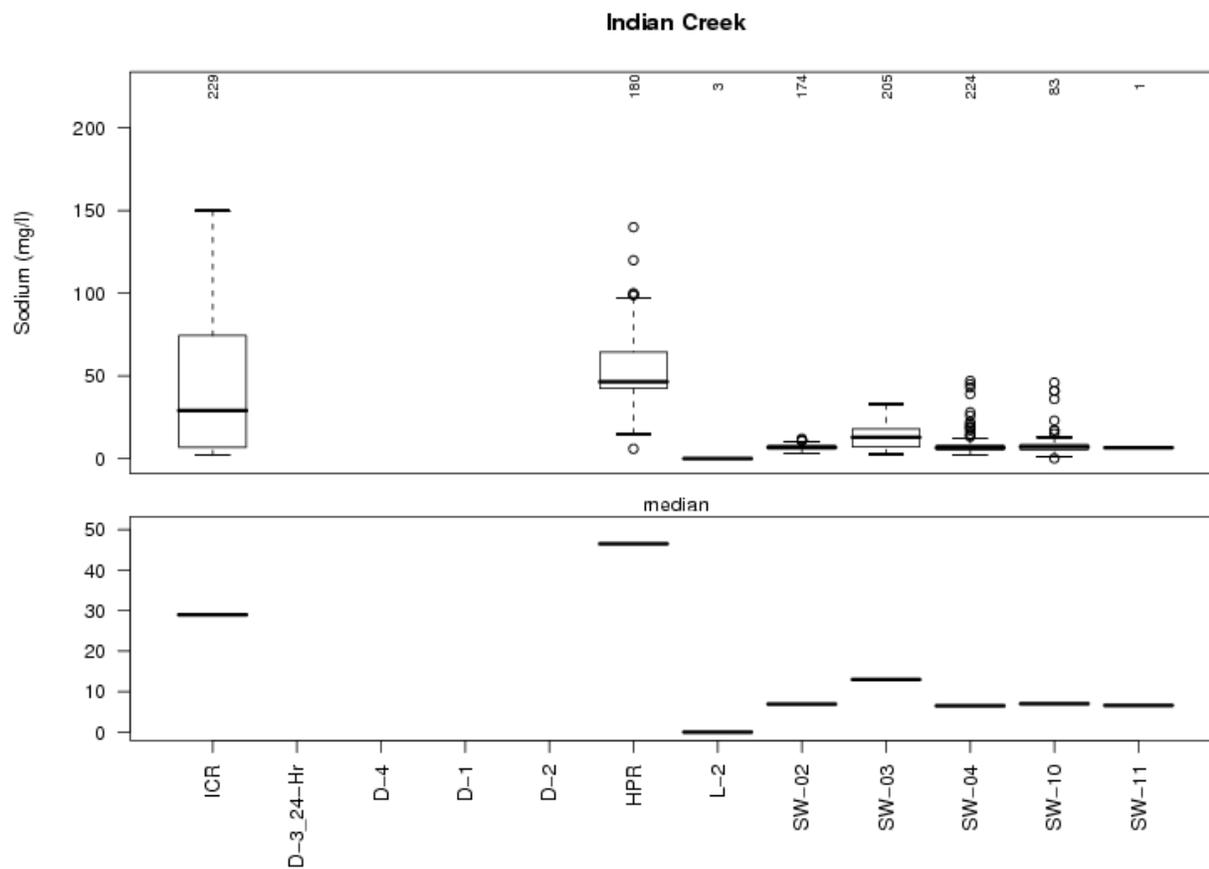
### Sodium Adsorption Ratio

In general, SAR are higher in the reservoirs, with median values of 1.5 in Indian Creek Reservoir and 2.8 in Harvey Place Reservoir, than they are in the streams and ditches where typical medians are below 1.0.



## Sodium

In general, sodium concentrations are higher in the reservoirs, with median values of 30 mg/L in Indian Creek Reservoir and 50 mg/L in Harvey Place Reservoir, than they are in the streams and ditches where typical medians are below 20 mg/L.



### 3.9 Long-Term Water Quality Trends – All Basins

A non-parametric Kendall-Tau test was performed to assess long-term changes in water quality for each parameter at each site. The table below summarizes the results of the test. Only site-parameter combinations with a significant result are presented. 'Significant' in this test means the p-value is less than the alpha chosen for the test; in this case alpha is 0.05. A p-value less than 0.05 means the trend is significant at the 95% confidence level. Graphs of the site-parameter combinations with significant trends are presented in Appendix E.

The presence of trends in some data sets complicate the previous analyses. Further studies should account for drastic changes in management that result in changes in water quality. For example, concentrations in Indian Creek Reservoir are orders of magnitude lower after 1995 than they are before 1995.

**Table 3.9-1: Long Term Water Quality Trends**

Site	Parameter	Tau	p	Trend
BCU (Bryant Creek)	Na	0.280	0.018	Increasing
BCU (Bryant Creek)	Total N	-0.394	0.000	Decreasing
HPR (Harvey Place Reservoir)	Na	-0.430	0.000	Decreasing
HPR (Harvey Place Reservoir)	NO <sub>3</sub> -N	-0.400	0.000	Decreasing
HPR (Harvey Place Reservoir)	SAR	-0.407	0.000	Decreasing
ICR (Indian Creek Reservoir)	Na	-0.521	0.000	Decreasing
ICR (Indian Creek Reservoir)	NO <sub>3</sub> -N	-0.533	0.000	Decreasing
ICR (Indian Creek Reservoir)	SAR	-0.511	0.000	Decreasing
ICR (Indian Creek Reservoir)	Total Coliform	-0.098	0.021	Decreasing
SW-03 (Indian Creek)	Na	-0.240	0.000	Decreasing
SW-04 (Indian Creek)	Na	-0.162	0.000	Decreasing
SW-08 (Ditch)	Na	0.250	0.000	Increasing
SW-10 (Indian Creek)	Na	-0.332	0.000	Decreasing
WF1-WQ1 (West Fork)	Fecal Coliform	-0.260	0.000	Decreasing
WF1-WQ1 (West Fork)	Total Coliform	-0.178	0.000	Decreasing
WF2-WQ1 (West Fork)	Fecal Coliform	-0.385	0.000	Decreasing
WF2-WQ1 (West Fork)	Total Coliform	-0.237	0.000	Decreasing
WF5-WQ1 (West Fork)	Total Coliform	-0.228	0.000	Decreasing

## 4.0 Summary and Recommendations

### 4.1 Comparison Among Basins

The East Fork basin show significantly lower levels of nitrates and total coliform than the West Fork or Indian Creek basins. The Indian Creek basin has higher concentrations of SAR and sodium and the median TP value is more than twice as high as the median for the West or East Fork Basins.

### 4.2 Seasonal Comparison

Few parameters show a significant difference among the seasons. The summer median nitrate value is lower than winter, spring or fall. The median summer and fall orthophosphate vales are higher than winter and spring. The lowest TP value occurs in winter. Coliform counts are more numerous in summer and fall, and sodium and sodium adsorption ratio are slightly lower in spring.

### 4.3 Spatial Differences

A summary for each parameter for the four major subbasins is provided above. In general the median values for each parameter stay low in the West and East Forks of the Carson until the most downstream sites, usually downstream of the state line, where a significant rise is found. Several sites or subbasins were found to be significant contributors to higher concentrations:

- On the West Fork of the Carson River, the ditches represented by sites SW-07 and SW-08 are significant contributors to lower water quality. Sites downstream of the state line show a gradual increase in concentration.
- On the East Fork, Bryant Creek is high in nitrate. Also, Milberry and Markleeville Creeks are higher than other nearby sites, and the presence of higher coliform counts is cause for concern.
- In the Indian Creek basin, Harvey Place and Indian Creek Reservoirs have much lower water quality than the surrounding streams, with the exception of coliform counts. The three lakes (two reservoirs plus Summit Lake) show higher orthophosphate values than the streams. Coliform counts increase in Indian Creek in the downstream direction.

### 4.3 Trends

There are 18 site-parameter combinations that show a significant temporal trend. Sites in the Indian Creek basin have significantly lower concentrations after 1995. Decisions regarding the management of the streams and reservoirs in the Indian Creek basin should account for this change.

### 4.4 Recommendations from Data Analysis

The additional monitoring stations selected for this study are critical to isolating areas of low water quality. It is therefore recommended that this monitoring effort be continued. Sources of funding should be secured in order to continue the monitoring effort.

If funding were available, monitoring along the main stems of the West and East Fork, and Indian Creek should be continued. On the West Fork, sampling should be continued at sites

WF10-WQ1, WF7-WQ1, WF8-WQ1, SW-08 (also called WF1-WQ1), and 310149. On the East Fork, sampling should continue at EF7-WQ1, MBC1-WQ1, MKC1-WQ1, C17 (E.Fk. Above Bryant Creek), and EF0-WQ1. In the Indian Creek basin, the sites monitored by STPUD should continue to be monitored. They are ICR, HPR, SW-02, SW-03, SW-04, SW-10, and SW-11.

Continued monitoring of Millberry Creek, Markleeville Creek and Wolf Creek for total coliforms should be conducted in order to isolate the source(s) of contamination.

All identified sites should be monitored on a monthly basis to ensure a large dataset at the same frequency as the STPUD monitoring program and satisfy regulatory requirements for the computation of mean of monthly means.

## 5.0 References

- Carson Water Subconservancy District (CWSD). 2004. *Upper Carson River Watershed Water Quality Monitoring Program-Quality Assurance Project Plan*. Prepared on behalf of Alpine County. Prepared for State Water Resources Control Board.
- Helsel, Dennis. 2004. *Nondetects and Data Analysis: Statistics for Censored Environmental Data*. John Wiley and Sons, New York. 268 pp. ISBN 0-471-6717308.
- Horton, G. 1997. *Carson River Chronology: A Chronology History of the Carson River and Related Water Issues*. Prepared for the Nevada Division of Water Resources.
- MACTEC, et al. 2004. *Upper Carson River Watershed Stream Corridor Condition Assessment*. Prepared for the Sierra Nevada Alliance and the Alpine Watershed Group.
- Miller, J., John E. Freun, Richard Johnson. 1990. *Probability and Statistics for Engineers*. 4<sup>th</sup> Edition. Prentice Hall, New Jersey. 612pp. ISBN 0-13-712761-8.
- Wilcoxon, F. 1945. *Individual Comparisons by Ranking Methods*. *Biometrics*, 1, 80-83.

# APPENDICES

Appendix A Upper Carson River Watershed Quality Assurance Project Plan

Appendix B Field Data

Appendix C Sampling Site Locations

Appendix D Sierra Environmental Monitoring Laboratory Data Results

Appendix E Plots of Significant Trends

# Appendix A

## Quality Assurance Project Plan

**UPPER CARSON RIVER WATERSHED  
WATER QUALITY MONITORING  
PROGRAM**

**QUALITY ASSURANCE PROJECT PLAN  
FINAL**

OUTLINE PREPARED BY:

First Edition: Gwen Starrett, SWRCB, 1998

Second Edition: Dominic Gregorio, SWRCB, 2001

COMPLETED PLAN PREPARED BY:

Carson Water Subconservancy District on behalf of Alpine County, CA

Refer correspondence to:

(Carson Water Subconservancy District, 777 E. Williams Street, Suite 110A, Carson  
City, NV 89701)

**Approvals:**

**Ling Tseng – Contract Manager  
State Water Resources Control Board**

**William Ray – QA Officer  
State Water Resources Control Board**

**Judy Molnar – Project Director  
Alpine County**

**2. Table of Contents**

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### **3. Distribution List**

All individuals and organizations listed in Section 4.2 and 4.3 will receive copies of this Quality Assurance Project Plan (QAPP), and any approved revisions of this QAPP. Once approved this QAPP will be available to any interested party by requesting a copy from Alpine County or the Carson Water Subconservancy District (CWSD).

### **4. Project Organization**

#### **4.1 Project Description**

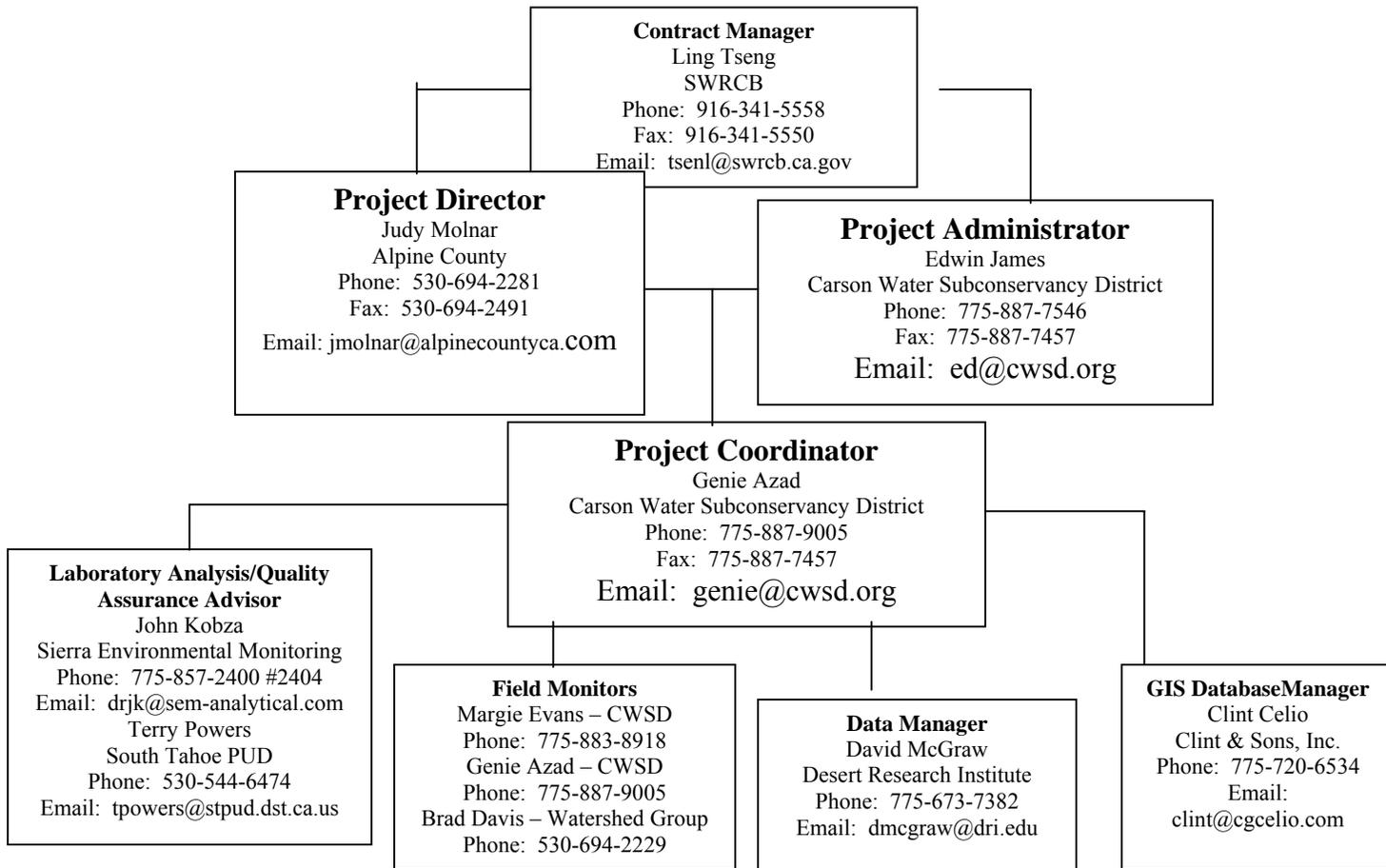
Alpine County in cooperation with the CWSD, South Tahoe Public Utility District (STPUD), Desert Research Institute (DRI) and the Alpine Watershed Group (Watershed Group) have received funding from the California State Water Resources Control Board (SWRCB) Clean Water Act Section 205(j) Grant Program. The funding will develop a comprehensive water quality monitoring program (project) for the Upper Carson River Watershed (Watershed) in Alpine County, California, specifically the West Fork and the East Fork of the Carson River plus Indian Creek, a tributary of the East Fork. The project will provide the data to guide prioritization for potential future projects and TMDL development in the Watershed. The project will also utilize and integrate with the stream corridor assessment that is being conducted by the Watershed Group through a Proposition 13 funding. The following subsections provide information on key individuals involved in the project.

## 4.2 Project Organization and Responsibilities

### 4.2.1 Organization Chart

The following organizational chart presents the key personnel and their role.

**Water Quality Monitoring Program Organization Chart**



### 4.2.2 Key Project Roles and Responsibilities

#### **Contract Manager**

The Contract Manager shall be the day to day representative for administration of this project, and except, as otherwise specifically provided, shall have full authority to act on behalf of the SWRCB with respect to this project. All communications with the SWRCB regarding this project shall be with the Contract Manager. Contract Manager will approve technical design, conduct, and data analysis. Contract Manager shall provide Project Coordinator the appropriate forms for data submittal to the STORET database and to the Information Center for the Environment Inventory Website; shall review all reports, to include quarterly progress reports (QPRs) and provide any comments and

changes to the Project Director. Contract Manager shall review and provide any final comments for the draft project report to the Project Director within four (4) weeks of receipt of the draft report. Contract Manager shall notify Project Director when the report has been approved and is considered final.

### **Project Director**

The Project Director shall oversee the project including the administration of the grant funds; shall promptly notify the Contract Manager of events or proposed changes that could affect the scope, budget, or schedule of work; and shall review all work products prior to submittal to Contract Manager.

### **Project Administrator**

The Project Administrator shall oversee all technical and administrative tasks associated with performing and completing the work for this project. These tasks include project management, budgeting, contract management and subcontract management. Project Administrator will provide guidance to other key personnel and direct the efforts to organize, describe, and interpret the results of the monitoring effort; review all work products, including reports and invoices prior to submittal to Project Director; and will ensure that all project deliverables are in accordance with the schedule set forth in the Scope of Work (SOW).

### **Project Coordinator**

The Project Coordinator shall be responsible for the day to day communication and coordination of the work performed for this project. Project Coordinator shall prepare the QPRs and invoices, assist in the preparation of the draft project report and incorporate any changes and additions to the final project report. Project Coordinator will coordinate the efforts of the TAC and subcontractors including the scheduling of meetings, meeting agendas and meetings minutes. Project Coordinator shall schedule, provide public notification of, and assist in the facilitation of the required public meetings. Project Coordinator will serve as a field monitor, procure any necessary equipment and assist in data management activities. Project Coordinator will provide information to the Contract Manager for data input in to the STORET database and Information Center for the Environment Inventory Website. Project Coordinator shall ensure that the project adheres to the guidelines outlined in this QAPP and the SOW.

### **Laboratory Analysis and Quality Control Advisors**

The Advisors shall ensure the completion of laboratory analyses on a timely basis and return analytical results to the Data Manager and Project Coordinator. Advisor shall also provide assistance with information concerning analytical techniques for constituents and adherence to data quality objectives. Advisor shall ensure that the project adheres to the guidelines outlined in this QAPP. Advisor shall assist in any training necessary for field monitors regarding sampling techniques, equipment useage and sampling protocols.

### **Field Monitors**

The field monitors shall perform all field activities of the project, including collecting water and soil samples (if deemed necessary) in accordance with the field quality

assurance data collection outlined in this QAPP, the USEPA Volunteer Stream Monitoring Methods Manual, the Sierra Environmental Monitoring Quality Assurance Manual and the South Tahoe Utility District Laboratory Assurance Plan.

### **Data Manager**

The Data Manager will perform the tasks outlined in Task 4 and 8 of the SOW. This includes historical data search and compilation plus the compilation and interpretation of all data collected during this study. The Data Manager will assist in the preparation of the draft project report.

### **GIS Database Manager**

GIS Database Manager shall integrate the data collected from this project into the GIS data framework created for the Proposition 13 Stream Corridor Condition Survey. GIS Manager will provide guidance to Data Manager and Project Coordinator regarding sampling location coding and storage, updating, retrieval and visual presentation of data.

### **4.3 Technical Advisors**

Jean Stone – Nevada Division of Environmental Protection, Bureau of Water Quality  
David McGraw – Desert Research Institute  
Jason Churchill – Lahontan Regional Water Quality Control Board  
Terry Powers – South Tahoe Public Utility District  
Randy Pahl – Nevada Division of Environmental Protection, Bureau of Water Quality  
Hal Bird – South Tahoe Public Utility District  
Mary Bennington – Washoe Tribe  
Paul Pugsley – Carson Valley Conservation District  
Sally Champion – U.S. Forest Service  
Dick McCleery – Central Sierra RC&D  
Dan Kaffer – Western Nevada RC&D/NRCS  
Mark DeMaio – Alpine County  
John Kobza – Sierra Environmental Monitoring

## **5. Problem Definition/Background**

### **5.1. Problem Statement**

Alpine County encompasses the headwaters of both the East and West Forks of the Carson River and Indian Creek. These streams support a variety of land use activities or beneficial uses including agriculture and outdoor recreational activities. Naturally occurring and human induced activities may have impacted the natural resources of the streams. Currently both Indian Creek and the West Fork of the Carson River do not meet water quality objectives and therefore have been listed under Section 303(d) of the Federal Clean Water Act. The East Fork has been delisted, however, due to a lack of data it is unknown if the stream is meeting water quality objectives. These streams are within the Upper Carson River Watershed which has been identified as a Category I Priority Watershed by the California Unified Watershed Assessment and a priority watershed by the Lahontan Watershed Initiative.

The West Fork of the Carson River is listed for phosphorus, sodium, nitrogen, and pathogens. Indian Creek is listed for pathogens. Although these streams are listed, there

is no information available to identify where and what is causing the impairment and/or whether the impairment is naturally occurring.

The East Fork of the Carson River has been delisted from the Section 303 (d) list for nutrients. However, due to a lack of water quality data it is unknown if the East Fork is meeting the water quality objectives. A phosphorus study was conducted by the USGS for the Nevada Division of Environmental Protection (NDEP) and the CWSD. Preliminary data from this study shows that in the spring the phosphorus concentration on the East Fork of the Carson River flowing into Nevada from California is as high as 0.3 mg/L. The water quality standard for phosphorus in Nevada and California is 0.1 mg/L and 0.03 mg/L respectively. In anticipation of future studies and projects on the East Fork, it is logical to include this reach in the monitoring program. Additionally, it is cost-effective to incorporate monitoring activities for several reaches into one monitoring program.

### **5.1.1. Project Mission and Goals**

#### **5.1.1.1. Mission**

The mission of the project is to provide data to guide prioritization for potential future projects and total maximum daily load (TMDL) development in the Watershed. The project will also utilize and integrate with the stream corridor assessment that is being conducted by the Watershed Group.

#### **5.1.1.2. Project Goals**

The goals of the project are:

- To identify and quantify the various sources of contaminants, where possible.
- Provide public officials the necessary information to design proper remedial measurements, including the establishment of TMDLs.
- Provide data that could be utilized by Alpine County, and other agencies, for future projects aimed at improving water quality and biological resources in the Watershed.

This project will supplement existing agency information by monitoring streams in the Watershed. The focus of the project is on habitat and chemical, physical and biological water quality measures that will identify the status of these aquatic resources. Information obtained will be provided to the regulatory agencies. It is the responsibility of the regulatory agencies to ensure that adequate and valid data are collected to meet their regulatory requirements.

### **5.2. Intended Usage of Data**

The data will be used by Alpine County, CWSD, Watershed Group and other agencies for future water quality improvement projects. The data will assist public officials with the design of proper remedial measurements, including the establishment of TMDLs. It will also be made available to the regulatory and resource management agencies to supplement their existing data collection efforts.

Data will be compiled by DRI and will be maintained at Alpine County and the CWSD. The information will be shared with the SWRCB, the Lahontan Regional Water Quality

Control Board (LRWQCB), and upon request to other state, federal, and local agencies and organizations.

## 6. Project/Task Description

### 6.1. General Overview of Monitoring

The water quality project will be conducted in the Watershed in Alpine County, California. Specific streams include the East and West Forks of the Carson River and Indian Creek, a tributary to the East Fork of the Carson River. Table 6.1-1 summarizes the monitoring design, including the physical, chemical and biological parameters to be measured, whether the samples will be analyzed in the field or by a professional lab, and the frequency of measurement.

Sampling that is routinely conducted by STPUD will be utilized by this study. For all other sampling events Sierra Environmental Monitoring will conduct any necessary laboratory analysis. Appendix 3 provides a list of the sampling sites, parameters that will be sampled for that specific site, and which laboratory will conduct the analysis.

**Table 6.1-1 Summary of Monitoring Design**

Parameter	Type of monitoring	Frequency of monitoring
Stream Flow	F	V
Temperature	F	V
Dissolved Oxygen	F	V
pH	F	V
Conductivity	F	V
Turbidity	L	V
Total Nitrogen 4 (Sum of TKN, nitrate as N and nitrite as N)	L	V
Ortho-Phosphate	L	V, X
Total Phosphorous	L	V, X
Sodium Absorption Ratio (SAR)	L	V
Percent Sodium	L	V
Quanti-Tray (E. coli Colilert Quanti-Tray, Total Coliform Quanti-Tray)	L	V
Suspended Solids	L	V
Stream Habitat Observations	F	V

Codes for Table 6.1.1: **Type:** F: field analysis, L: in-house lab analysis, **Frequency:** V: Variable, X: Storm Events

When possible, sampling during and/or following storm events will occur at various times throughout the project. If conditions allow samples will be taken during the peak of the hydrograph. Flow conditions and season will be documented on field sheets.

Chemistry and physical parameters will be monitored using protocols outlined in the USEPA Volunteer Stream Monitoring Methods Manual, Surface Water Ambient Monitoring Program (SWAMP), Sierra Environmental Monitoring Quality Assurance Plan and the STPUD Quality Assurance Plan. Stream habitat quality will be assessed using the U.S. Environmental Protection Agency (USEPA) Stream Habitat Assessment Form. Observational data includes weather conditions, physical and biological characterization (See Appendix 2).

**Table 6.1-2: Proposed Water Quality Sampling Events**

<b>Proposed Sampling Event*</b>	<b>Number of Samples/Site</b>
April/May 2004	2
June/July 2004	2
October 2004	1
January 2005	1
April/May 2005	2
June/July 2005	2
October 2005	1
January 2006	1
Estimated total # of Sampling Events	12

\*Sampling event schedule may vary depending upon flows. Sampling will be conducted during spring run-off when highest flows are expected and again during low flows. Water samples will also be collected during the same periods from irrigation return flow. Lakes will be sampled once a year.

## **6.2 Water Quality Control Plan for the Lahontan Region**

All of the water quality data will be compared to the Water Quality Control Plan for the Lahontan Region (Basin Plan). For results that are not comparable to the Basin Plan we will review those data with the TAC.

The Basin Plan Water Quality objectives for specific parameters for the East and West Forks of the Carson River are shown in Table 6.1-2.

**Table 6.2-1 Basin Plan Water Quality Objectives for Certain Parameters for East and West Forks of the Carson River**

Surface Water	Objective (mg/L)			
	Total Phosphorus (P)	Percent Sodium* (% Na)	Total Nitrogen N	Total Kjeldahl (TKN)
West Fork Carson River at Woodfords <sup>1</sup>	0.02	20	0.15	0.13
West Fork Carson River at Stateline <sup>1</sup>	0.03	20	0.25	0.22
East Fork Carson River <sup>2</sup>	<u>0.02</u> 0.03	<u>25</u> 30	<u>0.20</u> 0.30	-

**Notes:**

<sup>1</sup> Values shown are mean of monthly mean for the period of record.

<sup>2</sup> Annual average value/90<sup>th</sup> percentile value

\*  $\frac{(Na \times 100)}{Na + Ca + Mg + K} = \% Na$  Na, Ca, Mg and K expressed as millequivalents per liter (meq/L) concentrations.

Na + Ca + Mg + K

**6.2.1 Basin Plan General Water Quality Objectives**

The Basin Plan provides water quality objectives which apply to all surface waters in the Lahontan Region. Objectives that apply to this study include bacteria, dissolved oxygen, pH, sediment, temperature and turbidity. The following paragraphs state the Basin Plan objectives for these parameters.

Bacteria, Coliform: The Basin Plan states that the fecal coliform concentration, based on a minimum of not less than five samples for any 30 day period, shall not exceed a log mean of 20/100 ml, nor shall more than 10 percent of total samples during any 30-day period exceed 40/100 ml.

For the purposes of this study the TAC determined that the measuring of fecal coliform was not practical due to the limited holding time of 6 to 8 hours. The TAC determined that using the Quanti-Tray method would yield useful preliminary information by providing data for E. coli and total coliform and provide a 24 hour holding time. If the data suggests a potential bacteria problem, future studies or additional sampling under this study could be proposed focusing on bacteria possibly including measurements of fecal coliform.

Dissolved Oxygen: The Basin Plan states that dissolved oxygen concentration, as percent saturation, shall not be depressed by more than 10 percent, nor shall the minimum dissolved oxygen concentration be less than 80 percent of saturation.

The West and East Forks of the Carson River have beneficial use designations for cold water species and for species that have early life stages exposed directly to the water column (SPWN) so the Basin Plan's water quality criteria for ambient dissolved oxygen concentration is shown in the following table.

**Table 6.2.1-1 Water Quality Criteria for Ambient Dissolved Oxygen Concentrations <sup>1</sup> for the East and West Forks of the Carson River**

	Beneficial Use Class	
	COLD & SPWN (mg/L)	COLD (mg/L)
30 Day Mean	NA	6.5
7 Day Mean	9.5 (6.5) <sup>2</sup>	NA
7 Day Mean Minimum	NA	5.0
1 Day Minimum <sup>3,4</sup>	8.0 (5.0) <sup>2</sup>	4.0

Notes:

<sup>1</sup> From: USEPA. 1986. Ambient water quality criteria for DO

<sup>2</sup> Water column concentrations recommended to achieve the required intergravel DO concentrations. For SPWN the figures in parenthesis apply.

<sup>3</sup> For highly manipulatable discharges, further restrictions apply.

<sup>4</sup> All minima should be considered as instantaneous concentrations to be achieved at all times.  
SPWN For species that have early life stages exposed directly to the water column.

pH: The Basin Plan states that for fresh waters with designated beneficial uses for COLD, changes in normal ambient pH levels shall not exceed 0.5 pH units. For all other waters the pH shall not be depressed below 6.5 nor raised above 8.5.

Temperature: The Basin Plan states that the natural receiving water temperature shall not be altered unless it can be demonstrated to the satisfaction of the Regional Board that such an temperature alteration does not adversely affect the water for beneficial uses.

Turbidity: The Basin Plan states the waters shall be free of changes in turbidity that cause nuisance or adversely affect the water for beneficial uses. Increases in turbidity shall not exceed natural levels by more than 10 percent.

### 6.3 Project Timetable

Table 6.3.1 identifies the schedule of major activities associated with this project.

**Table 6.3-1: Project Timetable**

Task	Subtask	Deliverable	Completion Dates
<b>1.0</b>		<b>Project Management and Administration</b>	
	1.2	Quarterly Progress Reports (QPR)	Quarterly
	1.3	Subcontract Documentation	02/27/2004
	1.4	Water quality data submitted to USEPA STORET database	8/31/2006
<b>2.0</b>		<b>Public Participation</b>	
	2.1	Formation of TAC	02/27/2004
	2.2	Public Meetings	03/2004 11/2006
<b>3.0</b>		<b>Quality Assurance Plan</b>	
		Submittal of QAPP to Contract Manager	03/31/2004

<b>Task</b>	<b>Subtask</b>	<b>Deliverable</b>	<b>Completion Dates</b>
		Approval of QAPP by SWRCB	04/15/2004
<b>4.0</b>		<b>Literature Search and Historical Data Compilation</b>	
	4.1	Completion of literature search	06/30/2004
	4.2	Data compilation into database	08/31/2006
<b>5.0</b>		<b>GIS Database</b>	
		Framework of initial base data layers	03/31/2004
		Final GIS Framework/Database CD	12/29/2006
<b>6.0</b>		<b>Survey of Carson River</b>	
		Preliminary survey	2/27/2004
<b>7.0</b>		<b>Water Quality and Soil Sampling</b>	
	7.1	Water quality sampling events (Schedule provided in Section 6.2 of QAPP)	4/2004 – 5/2006
	7.2	Soil sampling	Summer 2005
<b>8.0</b>		<b>Data Compilation</b>	
	8.1	Compilation of data collected during study	7/2006
<b>9.0</b>		<b>Data Analysis, Draft and Final Reports</b>	
	9.1	Data Analysis	12/2006
	9.2	Draft Final Report	12/29/2006
	9.3	Final Report	03/31/2007
		Project Summary	03/31/2007
		Completed ICE Form	03/31/2007

## 7.0 Data Quality Objectives

This section identifies how accurate, precise, complete, comparable, sensitive and representative our measurements will be. These data quality objectives were derived by reviewing the Basin Plan, by considering the specifications of the instruments and methods which we will employ, and by considering the utility of the data. For purposes of this QAPP the data quality is considered adequate for the determination of general water quality conditions, with a potential application of the data to Section 305(b) reporting purposes. Data quality objectives are summarized in Tables 7.0-1 to 7.0-4.

**Table 7.0-1: Data Quality Objectives for Conventional Water Quality Parameters**

Parameter	Method/range	Units	Reporting Limit	Sensitivity	Precision	Accuracy	Completeness
Temperature	Thermometer or meter (-5 to 50)	°C	-5	0.5 °C	± 0.5 °C	± 0.5 °C	80%
Dissolved oxygen	DO Meter	mg/L	0.1 mg/L	0.1 mg/L	± 10%	± 10%	80%
pH	pH meter	pH units	2.0	0.1 unit	± 0.2 units	± 0.2 units	80%
Conductivity	conductivity meter	µS/cm	10	10 µS/cm	± 10%	± 10%	80%
Suspended Solids <sup>†</sup>	Gravimetric	mg/L	1*	0.05	± 10%	± 10%	80%
Turbidity <sup>†</sup>	Nephelometer	NTUs	0.1*	0.1	± 10%	± 10%	80%

<sup>†</sup> Note: Performed in the SEM and STPUD Laboratories..

\* These values represent detection limits

**Table 7.0-2. Data Quality Objectives for Nutrients Analyzed Using Ion chromatography or Spectrophotometers**

Parameter	Method	Units	Reporting Limit	Sensitivity	Precision	Accuracy	Completeness
TKN	Semi-automated Colorimetry	mg/L	0.05	0.02	±0.2 (<2.0) ±10% (≥2)	±0.2 (<2.0) ±10% (≥2)	80%
Nitrate Nitrogen	Ion Chromatography	mg/L	0.05	0.05	±0.2 (<2.0) ±10% (≥2)	±0.2 (<2.0) ±10% (≥2)	80%
	Automated Colorimetry	mg/L	0.005	0.005			80%
Nitrite Nitrogen	Ion Chromatography	mg/L	0.05	0.05	±0.2 (<2.0) ±10% (≥2)	±0.2 (<2.0) ±10% (≥2)	80%
	Automated Colorimetry	mg/L	0.005	0.005			80%
Ortho-Phosphate-P	Automated Colorimetry	mg/L	0.01	0.01	±10% (≥2)	±10% (≥2)	80%
Total Phosphorous	Automated Colorimetry	mg/L	0.01	0.01	±0.2 (<2.0) ±10% (≥2)	±0.2 (<2.0) ±10% (≥2)	80%

**Table 7.0-3: Data Quality Objectives for Metals Using ICP-OES**

Parameter	Method/range	Units	Reporting Limit	Sensitivity	Precision	Accuracy	Completeness
Calcium	EPA 200.7	mg/L	0.2	0.2	±0.2 (<2.0) ±10% (≥2)	±0.2 (<2.0) ±10% (≥2)	80%
Magnesium	EPA 200.7	mg/L	0.2	0.2	±0.2 (<2.0) ±10% (≥2)	±0.2 (<2.0) ±10% (≥2)	80%
Potassium	EPA 200.7	mg/L	0.5	0.5	±0.2 (<2.0) ±10% (≥2)	±0.2 (<2.0) ±10% (≥2)	80%
Sodium	EPA 200.7	mg/L	0.2	0.2	±0.2 (<2.0) ±10% (≥2)	±0.2 (<2.0) ±10% (≥2)	80%

**Table 7.0-4: Data Quality Objectives for Biological Parameters**

Parameter	Method/range	Units	Detection Limit	Sensitivity	Precision	Accuracy	Completeness
Total Coliform Bacteria	Multiple Tube Fermentation	MPN/100ml	1	see Standard Meth, 18 <sup>th</sup> ed. Section 9223 B	see Standard Meth, 18 <sup>th</sup> ed. section 9223 B	N/A	80%
E. coli Bacteria	Multiple Tube Fermentation	MPN/100ml	1	see Standard Meth, 18 <sup>th</sup> ed. Section 9223 B	see Standard Meth, 18 <sup>th</sup> ed. section 9223 B	N/A	80%

## 7.1. Accuracy

### 7.1.1. Chemical and Physical Parameters

Accuracy describes how close the measurement is to its true value. Accuracy is the measurement of a sample of known concentration and comparing the known value against the measured value. The accuracy of chemical measurements will be checked by performing analyses on standards of known concentration. These standards will be purchased from a supplier different than that used to obtain the calibration standards. The accuracy of field chemical measurements will be checked by performing tests on standards at the quality control sessions **held twice a year**. A standard is a known concentration of a certain solution. Standards can be purchased from chemical or scientific supply companies. Standards might also be prepared in-house from reagents. The concentration of the standards should be within the mid-range of the equipment.

### **7.1.2. Biological Parameters**

Accuracy for bacteria will be determined by analyzing a positive control sample twice annually. A positive control is similar to a standard, except that a specific discrete value is not assigned to the bacterial concentrations in the sample. This is due to the fact that bacteria are alive and capable of mortality and reproduction. Instead of a specific value, an approximate target value of the bacterial concentration is assigned to the sample by the laboratory preparing the positive control sample.

### **7.2. Comparability**

Comparability is the degree to which data can be compared directly to similar studies or the degree to which replicate analyses of the sample carried out over time compare to one another. The monitors will use the methods described in the following resource documents to ensure that their data can be compared to others:

- U.S. EPA's Volunteer Stream Monitoring: A Methods Manuals
- SWRCB Surface Water Ambient Monitoring Program (SWAMP)

Sierra Environmental Monitoring and South Tahoe PUD describe methods for ensuing comparability in their respective Quality Assurance Plans. Monitors will work closely with the quality assurance advisors for this project to ensure proper and consistent sampling and shipping procedures are followed.

### **7.3. Completeness**

Completeness is the fraction of planned data that must be collected in order to fulfill the statistical criteria of the project. There are no statistical criteria that require a certain percentage of data. However, it is expected that 80% of all measurements could be taken when anticipated. This accounts for adverse weather conditions, safety concerns, and equipment problems.

We will determine completeness by comparing the number of measurements we planned to collect compared to the number of measurements we actually collected that were also deemed valid. An invalid measurement would be one that does not meet the sampling methods requirements and the data quality objectives. Completeness results will be checked twice a year. This will allow us to identify and correct problems. The Data Quality Form: Completeness, found in Appendix 1, will be used to record completeness.

### **7.4. Precision**

#### **7.4.1. Chemical and Physical Parameters**

The precision objectives apply to duplicate and split samples taken as part of a QC session or as part of periodic in-field QC checks. Precision describes how well repeated measurements agree. The evaluation of precision described here relates to repeated measurements taken by either different monitors on the same sample or the same monitor analyzing replicate samples (in the field). Sampling variability will not be covered in this section. The Data Quality Form: Precision, found in Appendix 1, will be used to record precision.

#### 7.4.2. Biological Parameters

Precision for bacterial parameters will be determined by having the same analyst complete the procedure for laboratory duplicates of the same sample. At a minimum this should be done once per sampling event, or run duplicates on a minimum of 5% of the samples if there are over 20 samples run per day. The results of the duplicates should be within the confidence limits supplied by the manufacturer.

#### **7.5. Representativeness**

Representativeness describes how relevant the data are to the actual environmental condition. Problems can occur if:

Samples are taken in a stream reach that does not describe the area of interest (e.g. a headwaters sample should not be taken downstream of a point source),

Samples are taken in an unusual habitat type (e.g. a stagnant backwater instead of in the flowing portion of the creek),

Samples are not analyzed or processed appropriately, causing conditions in the sample to change (e.g. water chemistry measurements are not taken immediately).

Representativeness will be ensured by processing the samples in accordance with Section 10, 11 and 12, by following the established methods, and by obtaining approval of this document.

#### **7.6. Reporting Limit, Method Detection Limit and Sensitivity**

The Method Detection Limit is the lowest possible concentration the method can detect. This is important to record because we can never determine that a pollutant was not present, only that we could not detect it. Sensitivity is the ability of the instrument to detect one concentration from the next. Reporting Limits or Detection Limits and Sensitivities are noted in Tables 7.0-1. to 7.0-4. However, at very low concentrations the values are not very reliable. For this reason the lab usually has a minimum value for reporting that is always greater than detection limits. This reporting limit is the minimum value which with the lab has adequate confidence. For values less than the reporting limit the lab will report DNQ (detected, not quantified). For quantification purposes the lab will also report detection limit. For example, a value of nitrate nitrogen less than the detection limit will be reported as: DNQ, <0.005.

Because the water quality objectives provided by the State Board (see Table 6.2-1) are near the reporting limits listed in Tables 7.0-1 through 7.0-4 it is important to specify how to deal with low readings

#### **8. Training Requirements**

All field monitors listed in Section 4.2 will attend a one-day field session under the direction of STPUD personnel (trainers) and/or at the Citizen Monitoring training that will be provided to the Alpine Watershed Group under the direction of the South Yuba River Citizens League. These training days will include the opportunity for monitors to check the accuracy and precision of their equipment and techniques. Trainers will ensure that monitors are reading instruments and recording results correctly. Sampling and safety techniques will also be discussed as well as corrective actions.

## **9. Documentation and Records**

All field results will be recorded at the time of completion, using the field data sheets (see Appendix 2). Data sheets will be reviewed for outliers and omissions before leaving the sample site. Data sheets will be stored in hard copy form at the location specified in Section 5.2. Field data sheets are archived for three years from the time they were collected. If data entry is ever performed at another location, duplicate data sheets will be used, with the originals remaining at the headquarters site. Hard copies of all data as well as computer back-up disks are maintained at headquarters.

All voucher collections, completed data quality control forms and maintenance logs will also be kept at the headquarters location specified in Section 5.2. The maintenance log details the dates of equipment inspection, battery replacement and calibrations, as well as the dates reagents and standards are replaced.

## **10. Sampling Process Design**

### **10.1. Rationale for Selection of Sampling Sites**

Sampling sites are indicated on the maps in Appendix 4. The following criteria were evaluated when choosing sampling locations:

- access is safe,
- site is located on public access land,
- sample can be taken in main river current or where homogeneous mixing of water occurs,
- sample is representative of the part of the water body of interest,
- site was selected from “windshield survey” conducted during the Stream Corridor Assessment
- site is routinely sampled by STPUD.

Any reference sites are chosen upstream of any potential impact. A site chosen to reflect the impact of a particular discharge, tributary or land use is located downstream of the impact where the impact is completely integrated with the water, but upstream of any secondary discharge or disturbance.

### **10.2. Sample Design Logistics**

Safety measures will be discussed with all monitors. No in stream sampling will be conducted if there are small creek flood warnings or advisories. First aid kits should accompany monitors in the field.

### **Sampling Method Requirements**

The USEPA Volunteer Stream Monitoring Methods Manual and the SWAMP describes the appropriate sampling procedure for collecting samples for water chemistry. Water sampling apparatus will include Hanna Combo meter (pH, temperature and conductivity), SMART Dissolved Oxygen meter, extension pole type sampling devices, and hand held plastic containers. Sampling devices and sample bottles (that are not pre-sterilized and do not contain preservatives/fixing agents) will be rinsed three times with sample water prior to collecting each sample. For sterile bottles, whirl-paks, and sample bottles, which do contain preservatives/fixing agents (e.g., acids, etc.) never rinse with sample water prior to collecting the sample. Also, never use a sample bottle containing

preservatives/fixing agents for sampling; in these cases always use a sampling device to collect the sample prior to transferring the sample into the bottle.

Whenever possible, the monitor will sample from a bridge so that the water body is not disturbed from wading. Samples should be taken in the main part of the channel or thalweg, where possible. If it is necessary to wade into the water, the sample monitor stands downstream of the sample, taking a sample upstream. If the monitor disturbs sediment when wading, the monitor will wait until the effect of disturbance is no longer present before taking the sample.

Sediment samples will be collected in “depositional zones” that includes areas on the inside bend of the stream or areas downstream from obstacles such as boulders, islands, sand bars, or in shallow waters near the shore. Selected sample areas should represent upstream influences and various flow regimes. Samples will not be collected near or downstream of a bridge or debris. Samples will be collected with a scoop that can remove the fine surficial material deposited between rocks and debris in wadeable places. Shipping procedures and lab analysis will be conducted in accordance with SEM Quality Assurance protocols.

The following table describes the sampling equipment, sample holding container, sample preservation method and maximum holding time for each parameter.

**Table 11.1 Sampling Method Requirements**

Parameter	Sample Bottle	Preferred / Maximum Holding Times
<u>Conventional Parameters</u>		
Temperature	clear plastic bottle or sample directly	immediately
Dissolved oxygen	plastic bottle or sample directly	immediately
pH	plastic bottle or sample directly	immediately
Conductivity	plastic bottle or sample directly	immediately / refrigerate up to 28 days
Suspended solids	plastic bottle	immediately / refrigerate up to 7 days
Turbidity	plastic bottle	immediately / refrigerate in dark for up to 48 hr.
<u>Nutrients</u>		
TKN	plastic bottle	immediately / up to 28 days if the sample is acidified with H <sub>2</sub> SO <sub>4</sub> to pH ≤ 2
Nitrate N	plastic bottle	immediately / refrigerate in dark for up to 48 hours. Up to 28 days if the sample is acidified with H <sub>2</sub> SO <sub>4</sub> to pH ≤ 2
Nitrite-N	plastic bottle	immediately / refrigerate in dark for up to 48 hours.

Parameter	Sample Bottle	Preferred / Maximum Holding Times
Ortho-Phosphate-P	plastic bottle	immediately / refrigerate in dark for up to 48 hours
Total Phosphorous	plastic bottle	immediately / up to 28 days if the sample is acidified with H <sub>2</sub> SO <sub>4</sub> to pH ≤ 2
<u>Metals</u>		
Calcium	plastic bottle	Up to 6 months
Magnesium	plastic bottle	Up to 6 months
Sodium	plastic bottle	Up to 6 months
Potassium	Plastic bottle	Up to 6 months
<u>Biological Samples</u>		
Bacteria	Sterile plastic sampling bottle or whirl-pak	Refrigerate to 4 degrees C in the dark; 24 hour hold time

## 11. Sample Handling and Custody Procedures

### 12.1. Sample Handling

Identification information for each sample will be recorded on the field data sheets (see Appendix 2) when the sample is collected. Samples that are not processed immediately in the field will be labeled with the waterbody name, sample location, sample number, date and time of collection, sampler's name, and method used to preserve sample (if any).

### 12.2. Custody Procedures

In cases where the samples will be transferred from the monitor to SEM laboratory for analysis a Chain of Custody form will be used (See Appendix 5). This form identifies the waterbody name, sample location, sample number, date and time of collection, sampler's name, and method used to preserve sample (if any). It also indicates the date and time of transfer, and the name and signature of the sampler and the sample recipient.

In cases where the sample is taken by STPUD and remains in the custody of STPUD, then the field data sheet may be allowed to double as the chain of custody form.

### 12.3. Disposal

All analyzed samples or spent chemicals including used reagents, buffers or standards will be collected in a plastic bottle clearly marked "Waste" or "Poison". This waste material will be disposed of according to appropriate state and local regulations. This will usually mean disposal into a drain connected to a sewage treatment plant.

Whenever possible, if waste includes reagents from the detergent test, these wastes will be poured down a drain underneath a fume hood.

### **13. Analytical Methods Requirements**

Water chemistry is monitored using protocols outlined in the South Tahoe Public Utility District Laboratory Quality Assurance Plan for samples taken and analyzed by STPUD. Samples analyzed by SEM will utilize protocols outlined in that facility's Quality Assurance Plan and Standard Operating Procedures. The methods were chosen based on the following criteria:

- capability of sample collectors to use methods,
- provide data of known quality,
- ease of use,
- methods can be compared to professional methods in "Standard Methods" and "EPA' Methods for the Determination of Inorganic Substances in Environmental Samples".

If modifications of methods are needed, comparability will be determined by side-by-side comparisons with a US EPA or APHA Standard Method on no less than 50 samples. If the results meet the same precision and accuracy requirements as the approved method, the new method will be accepted.

Table 13.1 outlines the methods to be used, any modifications to those methods, and the appropriate reference to a standard method.

**Table 13.1 Analytical Methods for Water Quality Parameters**

<b>Parameter</b>	<b>Method</b>	<b>Modification</b>	<b>Reference (a)</b>
Temperature	Thermometer or Meter	None	SM 2550 B.
Dissolved Oxygen	Meter	None	ASTM D 888-87
pH	Meter	None	SM 4500-H B.
Conductivity	Meter	None	SM 2510 B.
Suspended Solids	Gravimetric	None	SM 2540 D
Turbidity	Nephelometric	None	SM 2130B
Total Kjeldahl Nitrogen	CuSO <sub>4</sub> /K <sub>2</sub> SO <sub>4</sub> Catalyzed Acid Digestion & Distillation	None	SM 4500 N(org)
Nitrate-N	Ion Chromatography	0.45 µm filtration	EPA 300
Nitrite-N	Ion Chromatography	0.45 µm filtration	EPA 300
Ortho-Phosphate-P	Ascorbic acid	0.45 µm filtration	EPA 365.3
Total Phosphorous	Persulfate digestion / Ascorbic Acid	None	EPA 365.3
Calcium	Inductively Coupled Plasma Optical Emmision Spectrometry	None	EPA 200.7
Magnesium	Inductively Coupled Plasma Optical Emmision Spectrometry	None	EPA 200.7
Potassium	Inductively Coupled Plasma Optical Emmision Spectrometry	None	EPA 200.7
Sodium	Inductively Coupled Plasma Optical Emmision Spectrometry	None	EPA 200.7
Total Coliform Bacteria	Chromogenic Fluorogenic Substrate Multiple Well	Sodium thiosulfate	SM 9223 B
<i>E. coli</i> Bacteria	Chromogenic Fluorogenic Substrate Multiple Well	Sodium thiosulfate	SM 9223 B

(a) All of the above method are described in “Standard Methods for the Examination of Water and Wastewater” 18<sup>th</sup> Edition. American Public Health Association et al, 1992 (SM) and “Methods for the Determination of Inorganic Substances in Environmental Samples”, U.S. Environmental Protection Agency, 1993 (EPA).

## **14. Quality Control Requirements**

Quality control samples will be taken to ensure valid data are collected. Depending on the parameter, quality control samples will consist of blanks, replicate samples, and split samples.

### **14.1. Cautions Regarding Test Procedures**

#### **14.1.1. Nutrients**

The Cadmium reduction nitrate test (EPA 353.2) measures nitrite as well as nitrate. Therefore the results for the nitrate test are actually mg/L (Nitrate + Nitrite)-Nitrogen. The STPUD laboratory subtracts Nitrite-N from the (Nitrate + Nitrite)-Nitrogen result. All nitrate-N reported results represent nitrate, only.

### **14.2. Blanks, Replicates, Split Samples, and Standardization**

Field/Laboratory Blanks: For all conventional water quality analyses, except temperature, dissolved oxygen, conductivity and pH, field and laboratory blanks will be analyzed once every sampling event.

Instructions for Field and Lab Blanks: Distilled water is taken into the field or used in the laboratory and handled just like a sample. It will be poured into the sample container and then analyzed. When reagents are used in a test method, then the reagents are added to the distilled water and these types of blanks are referred to as reagent blanks. Field blanks are recorded on the field data sheet.

Field Confirmations: When a second method for measuring temperature, dissolved oxygen, and pH is available in the field, then the monitors are encouraged to perform both measurements on a split sample at least once per sampling event. Examples of this sort of redundant measurement would be:

- for temperature, the use of an electronic thermometer (such as those that are built into dissolved oxygen meters) and an armored thermometer;
- for dissolved oxygen, the use of an oxygen meter and an indigo carmine colorimetric kit;
- for pH, a meter and a non-bleeding indicator strip.

This will serve to provide backup capability if the more sensitive electronic meters fail, and will provide additional confidence as to the quality of the data. The results of both measurements will be recorded along with the procedure used on the field data sheet. If both results are comparable then the result produced using the method of greater sensitivity will be the one entered in the final data set by the data manager in consultation with the monitor. If the two results are inconsistent, then the sample collector will note on the data sheet which of the results will be entered on the final data set by the data manager.

Replicate Samples: Replicate samples are two or more samples collected at the same time and place. When there are only two replicates then these are referred to as

duplicates. Duplicate samples will be collected as soon as possible after the initial sample has been collected, and will be subjected to identical handling and analysis. Labels for blank and replicates samples will be coded so that laboratory staff cannot distinguish the blanks and replicates from other samples. For bacterial analysis lab duplicates will be run at least once per sampling event, and when there are more than 20 samples run per day then there will be a minimum 5% of the samples analyzed in duplicate. Laboratory will run replicate samples according to that facility's Quality Assurance plan.

Split Samples: Twice a Year, split spiked samples (standards) will be analyzed. The split standard is one sample, containing a known concentration of an analyte that is divided equally into two or more sample containers. Split standards will be collected by the monitors, and sent to a professional laboratory (except for dissolved oxygen, temperature, conductivity and pH), before the maximum sample handling time is exceeded. Labels for blank and replicates samples will be coded so that laboratory staff cannot distinguish the blanks and replicates from other samples. Laboratory will perform duplicate analysis on blind samples. The professional laboratory will analyze the sample using the method referenced in Table 13.1

For turbidity using the dual tube (JTU) method, split field samples will be analyzed. The laboratory receiving the split sample will analyze it using the nephelometric method, even though these results are not strictly comparable to the visual JTU comparators. The results of turbidity using the two methods will be plotted to determine if there is a linear correlation. If this correlation is significant, then it will be used to estimate and compare results of the turbidity tubes with nephelometric results. The Technical Advisory Committee will use the product-moment correlation coefficient ( $r$ ) to determine the adequacy of the correlation

For bacteria, split field samples or split positive controls will be analyzed by the SEM laboratory twice annually.

Standardization of Instruments and Procedures: Temperature measurements will be standardized by comparing our thermometers to a NIST-certified or calibrated thermometer in ice water and ambient temperature water. All meters (pH, temperature, conductivity, DO) will be evaluated using standards provided with the assistance of a professional laboratory and/or the technical advisors.

Table 14.1 summarizes the quality control regimen.

**Table 14.1 Summary of Quality Control Requirements**

<b>Parameter</b>	<b>Blank</b>	<b>Duplicate Sample</b>	<b>Split Sample to lab</b>
Temperature	none	5% or a minimum of once a year	none
Dissolved oxygen	none	5% or a minimum of once a year	none
pH	none	5% or a minimum of once a year	none
Conductivity	none	5% or a minimum of once a year	none
Turbidity	daily	5% or a minimum of once a year	twice a year
Nitrate	daily	5% or a minimum of once a year	twice a year
Ortho-Phosphate	daily	5% or a minimum of once a year	twice a year
T Phosphorous	daily	5% or a minimum of once a year	twice a year
Calcium	daily	5% or a minimum of once a year	twice a year
Magnesium	daily	5% or a minimum of once a year	twice a year
Sodium	daily	5% or a minimum of once a year	twice a year
Total Coliform and E. Coli	daily	5% or a minimum of once per day	twice a year

## **15. Instrument/Equipment Testing, Inspection and Maintenance**

A maintenance log is kept by the sample monitor and by laboratory staff. These logs detail the dates of instrument and sampling gear inspection, calibrations performed in the laboratory, battery replacement, the dates reagents and standards are replaced, and any problems noted with instruments, samplers, or reagents.

### **15.1. Temperature**

Before each use, thermometers are checked for breaks in the column. If a break is observed, the alcohol thermometer will be placed in nearly boiling water so that the alcohol expands into the expansion chamber, and the alcohol forms a continuous column. Verify accuracy by comparing with a calibrated or certified thermometer.

### **15.2. Dissolved oxygen**

Before each use, DO meter is checked to see if it is clean and in good working order. Meter is calibrated before each use with zero oxygen solution.

### 15.3. Conductivity and pH

Before each use, conductivity and pH meters are checked to see if they are clean and in good working order. Conductivity and pH meters are calibrated before each use. Conductivity standards and pH buffers are replaced at least annually. Conductivity standards are stored with the cap firmly in place and in a dry place kept away from extreme heat. Do not re-use pH or conductivity standards.

### 15.4. Turbidity

Dual Tube Turbidity (JTU's): Before each use, turbidity tubes are checked to ensure that they are clean. The turbidity standard will be replaced annually.

Nephelometers: Meters and tubes should be checked for cleanliness and proper operation. The tubes should not be smudged or scratched.

### 15.5. Nutrients and Conventional Pollutants

Before each use, test kits are checked to ensure that droppers, sample containers, and color comparators are clean and in working condition. Colorimeter tubes should be checked to make sure they are clean and are not scratched. Reagents are replaced annually according to manufacturer's instructions.

## **16. Instrument Calibration / Standardization and Frequency**

Instruments will be calibrated and reagents checked against standards accordingly to the following schedule. Standards will be purchased from a chemical supply company or prepared by (or with the assistance of) a professional laboratory. Calibration records will be kept in the maintenance log at the headquarters location (described in Section 5.2.) where it can be easily accessed before and after equipment use. Calibrations that are performed by monitors in the field are recorded on the field data sheets, also archived at the headquarters. The frequency of calibration is described in Table 16-1.

**Table 16-1 Instrument Calibration and Frequency**

<b>Conventional Water Quality Parameters</b>		
<b>Equipment Type</b>	<b>Calibration Frequency</b>	<b>Standard or Calibration Instrument Used</b>
Temperature	Every sampling day	NIST calibrated or certified thermometer
pH	Every sampling day	pH 7.0 buffer and one other standard (4 or 10)
Conductivity	Every sampling day	Conductivity standard and distilled water
Dissolved Oxygen	Every sampling day	Zero oxygen solution
Dual Tube Turbidity	Every sampling day	Distilled water
Analytical balance	Every month	Class S weights
<b>Equipment type</b>	<b>Checked against Standard</b>	<b>Standard Used</b>
TKN	Every analysis batch	TKN standard
Nitrate-N	Every analysis batch	Nitrate-N standard
Nitrite-N	Every analysis batch	Nitrite-N standard
Ortho-Phosphate-P	Every analysis batch	ortho-Phosphate-P standard
Total Phosphorous	Every analysis batch	Total Phosphorous standard
<b>Equipment type</b>	<b>Checked against Standard</b>	<b>Standard Used</b>
Calcium	Every analysis batch	Calcium standard
Magnesium	Every analysis batch	Magnesium standard
Potassium	Every analysis batch	Potassium standard
Sodium	Every analysis batch	Sodium standard

**17. Inspection/Acceptance Requirements**

Upon receipt, buffer solutions, standards, and reagents used in the field will be inspected by the monitors for leaks or broken seals, and to compare the age of each reagent to the manufacturer’s recommended shelf-life. All other sampling equipment will be inspected for broken or missing parts, and will be tested to ensure proper operation.

Before usage, thermometers are inspected for breaks. Breaks can be eliminated by heating (see Section 15.1). If not, they will be returned to the manufacturer.

Reagents are replaced before they exceed manufacturer’s recommended shelf life. These shelf lives are typically one to two years. However, specific replacement dates can be determined by providing the reagent lot number to the manufacturer. Reagent replacement dates are noted in the maintenance log.

## **18. Data Acquisition Requirements**

### **18.1. Professional Analytical Data**

Only certified analytical laboratories or academic laboratories (with approval of State and/or Regional Board staff) will be used for quality assurance checks and analysis of field samples. The project team will review these laboratories' data. They may also review the lab's own quality control data to ensure data validity.

### **18.2. Geographical Information/ Mapping**

USGS maps will be used to verify watershed boundaries and river courses. Land use information will be obtained from local planning offices. When information is requested, the agency will be asked to provide appropriate metadata and any information on data limitations. This information will be maintained with the data files.

## **19. Data Management**

Field data sheets will be checked for completeness and signed in the field by the sample monitors. The monitors will identify any results where holding times have been exceeded, sample identification information is incorrect, samples were inappropriately handled, or calibration information is missing or inadequate. Such data will be marked as unacceptable and will not be entered into the electronic data base. Any equations needed to convert measurements will be noted on field sheets.

The laboratory will report their results to the data manager with a copy to the project coordinator. The data manager will verify sample identification information, review the chain-of-custody forms, and identify the data appropriately in the database. These data are also reviewed by the TAC twice annually.

The data manager will review the field sheets and enter the data deemed acceptable by the TAC. Upon entering the data the data manager will sign and archive the field data sheets. Data will be entered into a spreadsheet (MS Excel) or a database (MS Access) in a way that will be compatible with EPA's STORET and the Regional WQCB's database guidelines. Following initial data entry the data manager will review electronic data, compare to the original data sheets and correct entry errors. After performing data checks, and ensuring that data quality objectives have been met, data analysis will be performed.

A coding system for tracking and recording the data will be established that is consistent with the system used by the Stream Corridor Assessment team and with SWQCB. Codes will be developed for sample sites, water quality parameters and other information on field and lab sheets.

The project coordinator or data manager will provide the raw data to the State WQCB and Regional WQCB in electronic form at least once every two years so that it can be included in the 305(b) report. Appropriate quality assurance information may be provided upon request.

## **20. Assessment and Response Actions**

Review of all field and data activities is the responsibility of the project administrator with the assistance of the TAC. Within the first three sampling events, the State Water Board or Regional Board staff, or its designee, will evaluate field and laboratory performance and provide a report to the project director. All field and laboratory activities, and records may be reviewed by State and EPA quality assurance officers as requested.

## **21. Reports**

The TAC will review draft reports to ensure the accuracy of data analysis and data interpretation. Raw data will be made available to data users per their request. Every effort will be made to submit data and/or a report to the State and/or Regional Board staff in a fashion timely for their data uses, e.g. 305(b) reports.

## **22. Data Review, Validation and Verification**

Data sheets or data files are reviewed twice a year by the project administrator and data manager to determine if the data meet the QAPP objectives. Any outliers, spurious results or omissions will be reported to the project director. They will also evaluate compliance with the data quality objectives. They will suggest corrective action that will be implemented by the project coordinator. Problems with data quality and corrective action will be reported in final reports.

## **23. Validation and Verification Methods**

As part of standard field protocols, any sample readings out of the expected range will be reported to the project administrator. A second sample will be taken as soon as possible to verify the condition. If the data is invalid, then the data will be noted (flagged) on the data sheet. We will take further actions to trace the sources of error, and to correct those problems.

## **24. Reconciliation with DQOs**

The project administrator and data manager will review data twice annually to determine if the DQOs have been met. A quorum of 1/2+1 of the TAC will be required for committee decisions. If a quorum is not met at the meeting, work will still proceed. The work product (e.g., review and comments on data or reports) will then be sent out to the whole TAC for approval with a 30-day review period.

If data do not meet the project's specifications, the following actions will be taken. First, the project director, administrator, coordinator and data manager will review the errors and determine if the problem is equipment failure, calibration/maintenance techniques, or monitoring/sampling techniques. This will be reported to the TAC and they will suggest corrective action. If the problem cannot be corrected by training, revision of techniques, or replacement of supplies/equipment, then the project team and the TAC will review the DQOs and determine if the DQOs are feasible. If the specific DQOs are not achievable, they will determine whether the specific DQO can be relaxed, or if the parameter should be eliminated from the monitoring program. Any revisions to DQOs will be appended to this QAPP with the revision date and the reason for modification. The appended QAPP

will be sent to the quality assurance panel that approved and signed this plan. When the appended QAPP is approved, the monitoring team will work with the data manager to ensure that all data meeting the new DQOs are entered into the database. Archived data can also be entered.

## Appendix B

### Field Data Spreadsheets

# Field Data

## April 29, 2004

<u>Site Number</u>	<u>Water Body</u>	<u>WaterTemp (F)</u>	<u>pH</u>	<u>DO (ppm)</u>	<u>Time</u>
WQ-MBC-1	Millberry Creek	59.7	7.23	7.3	14:10
WQ-MKC-2	Markleeville Creek	46.1	7.17	na	15:30 Had trouble with DO meter
WQ-MKC-1	Markleeville Creek	42.7	7.01	8.4	12:20
EF4-WQ1	East Fork - Hangman's	42.7	7.36	4	11:34 Had trouble with DO meter
MC1-WQ1	Monitor Creek	44.5	7.75	7.1	10:40
EF7-WQ1	East Fork - below Wolf Creek	38.7	6.13		Had trouble with DO meter

## April 30, 2004

<u>Site Number</u>	<u>Water Body</u>	<u>WaterTemp (F)</u>	<u>pH</u>	<u>DO (ppm)</u>	<u>Time</u>
EF0-WQ1	East Fork-Washoe Bridge	42.7	7.01	8.5	9:46
RC1-WQ1	Alhambra Creek	44.2	7.07	7.2	12:04
WF10-WQ1	West Fork	43.5	6.7	8.2	12:54
HC1-WQ1	Hawkins Creek	45.7	6.96	7.6	13:58
WF7-WQ1	West Fork - below Willow Creek	40.4	6.74	7	11:14

## May 27, 2004

<u>Site Number</u>	<u>Water Body</u>	<u>WaterTemp (F)</u>	<u>pH</u>	<u>DO (ppm)</u>	<u>Time</u>	<u>Comments</u>
EF7-WQ1	East Fork	48	7.01	8.8	10:38	
MC1-WQ1	Monitor Creek	61.8	6.52	8.5	10:56	Algae present - see photo
EF4-WQ1	East Fork	63.8	6.21	9.1	12:02	
WQ-MKC-1	Markleeville Creek	54.8	7.34	9.4	13:09	
WQ-MBC-1	Millberry Creek	66.3	5.69	8.2	13:50	Heavy algae growth on substrate
WQ-MKC-2	Markleeville Creek	53.8	7.3	8.6	14:16	

**May 28, 2004****Storm event sampling**

<u>Site Number</u>	<u>Water Body</u>	<u>WaterTemp (F)</u>	<u>pH</u>	<u>DO (ppm)</u>	<u>Time</u>	<u>Comments</u>
EF0-WQ1	East Fork	58.6	6.56	9.6	9:36	Rain event night before
WF7-WQ1	West Fork	43.7	6.92	9.1	0:47	Water very turbid
RC1-WQ1	Alhambra Creek	46.8	7.44	9.7	11:13	Fast flows
WF10-WQ1	West Fork	41.7	7.11	10.1	12:07	
WF8-WQ1	West Fork - Hope Valley	44.1	7.04	8.7	12:38	

**June 3, 2004**

<u>Site Number</u>	<u>Water Body</u>	<u>WaterTemp (F)</u>	<u>pH</u>	<u>DO (ppm)</u>	<u>Time</u>	<u>Comments</u>
EF0-WQ1	East Fork	55	6.75	9.2	10:21	
WF7-WQ1	West Fork - Willow Creek	49.6	6.73	8.3	11:20	
RC1-WQ1	Alhambra Creek	55.6	7.15	10.4	12:10	
WF10-WQ1	West Fork	49.5	6.73	8	12:37	
HC1-WQ1	Hawkins Creek	51.1	6.83	8.6	12:56	

**June 24, 2004**

<u>Site Number</u>	<u>Water Body</u>	<u>WaterTemp (F)</u>	<u>pH</u>	<u>DO (ppm)</u>	<u>Time</u>	<u>Comments</u>
EF4-WQ1	EF-Hangmans	55.1	7.05		10:10	DO Meter not working.
EF7-WQ1	EF-Upper	54.9	6.89		10:50	Sunny, light breeze, apx. 76 degrees F Monitor Creek had very low flow and there was on
MC1-WQ1	Monitor Creek	56.1	7.68		11:34	oily fily on part of the backwater areas.
MKC2-WQ1	Campground	62.4	7.72		12:32	
MBC1-WQ1	Millberry Creek	60.5	7.71		12:49	MBC was milky colored. Flow was good.
MKC3-WQ1	Grover HS bridge	64.2	7.66		13:32	

**June 25, 2004**

<u>Site Number</u>	<u>Water Body</u>	<u>WaterTemp (F)</u>	<u>pH</u>	<u>DO (ppm)</u>	<u>Time</u>	<u>Comments</u>
EF0-WQ1	Ef - washoe Dam	62.7	7.6		10:02	DO Meter not working properly and pH meter would not calibrate properly but
WF7-WQ1	WF - Willow Creek	54.8	7.13		10:59	appeared to work fine. Added this site due to algae growth around bridge (apr. 200' upstream from bridge and 100" downstream from bridge there is algae growth.
WF0-WQ1	WF - bridge at 88 & 89	57.2	7.06		11:26	Weather- clear, light breeze, sunny apx.
RC1-WQ1	Alhambra Creek	57.7	7.21		12:05	76 degrees F
WF10-WF1	West Fork	55.7	6.87		12:54	
HC1-WQ1	Hawkins Creek	64.1	6.8		13:20	

**July 22, 2004**

<u>Site Number</u>	<u>Water Body</u>	<u>WaterTemp (C)</u>	<u>pH</u>	<u>DO (ppm)</u>	<u>Time</u>	<u>Comments</u>
EF7-WQ1	EF-Upper	17.1	7.63		11:40	Sunny and clear, no breeze
MC1-WQ1	Monitor Creek					No water present
EF4-WQ1	EF-Hangmans	19.9	7.83		12:36	
MKC2-WQ1	Campground	21	7.7		13:47	Overcast
MBC1-WQ1	Millberry Creek	17.4	6.98		14:20	
MKC3-WQ1	Grover HS bridge	20.3	7.82		14:56	

**July 23, 2004**

<u>Site Number</u>	<u>Water Body</u>	<u>WaterTemp (C)</u>	<u>pH</u>	<u>DO (ppm)</u>	<u>Time</u>	<u>Comments</u>
EF0-WQ1	Ef - washoe Dam		18.8	7.65	9:55	
WF7-WQ1	WF - Willow Creek		15.7	7.22	10:56	
RC1-WQ1	Alhambra Creek		17.8	7.18	12:20	
WF10-WF1	West Fork					No data recorded
HC1-WQ1	Hawkins Creek					No Flow

**October 25, 2004**

<u>Site Number</u>	<u>Water Body</u>	<u>WaterTemp (C)</u>	<u>pH</u>	<u>DO (ppm)</u>	<u>EC (umhos)</u>	<u>Air Temp ©</u>	<u>Time</u>	<u>Comments</u>
WC1-WQ1	Wolf Creek	3.3	8.1	7	70	7	10:42	New site added this sampling event located at upper
EF7-WQ1	East Fork	5	8.1	12	120	10	12:10	Day was overcast and breezy.
EF4-WQ1	East Fork	6.8	8.4	9	130	9.5	12:40	Stormy over the mountains.
MKC2-WQ1	Markleeville Creek	7.8	8.4	9	280	10	13:28	Leaves and twigs have created a natural dam apx. 6 feet downstream of sampling site.
MBC1-WQ1	Millberry Creek	6.8	7.8	8.5	310	11.5	14:00	
MKC3-WQ1	Markleeville Creek	7	8.4	8	360	9	14:30	

Special Note: We used CHEMets Kit for measuring DO and an EC meter for conductivity. These have not been used on previous sampling events . Also, used a new pH meter - Hanna HI 98127.

General note: We noticed much more sediment on river bottom at the lower watershed sites.

Apx. 40% of trees have lost leaves and flows were low at all sites. Special note - Millberry Creek was clear when it has been milky colored in the past.

**October 26, 2004**

<u>Site Number</u>	<u>Water Body</u>	<u>WaterTemp (C)</u>	<u>pH</u>	<u>DO (ppm)</u>	<u>EC (umhos)</u>	<u>Air Temp ©</u>	<u>Time</u>
EF0-WQ1	East Fork - Washoe Dam	4.8	7.8	5		2.5	10:20

No other sites sampled due to heavy snow fall starting previous evening and continuing throughout the day.

Road access to West Fork sites were closed and the Willow Creek site was determined to be unsafe for sampling activity due to lack of visibility.

**Comments**

Freezing drizzle, overcast

**November 4, 2004**

<u>Site Number</u>	<u>Water Body</u>	<u>WaterTemp (C)</u>	<u>pH</u>	<u>DO (ppm)</u>	<u>EC (umhos)</u>	<u>Air Temp @</u>	<u>Time</u>
WF7-WQ1	West Fork at confluence of Willow Creek	1.2	7.6	8	70	3.5	11:15
WF12-WQ1	Duplicate sample - same site as above						
WF8-WQ1	West Fork at bridge on Highway 89	3.4	7.6	7	80	5	11:40
WF9-WQ1	Field Blank						

Special Note: Lab reported an instrument failure while running the ion chromatography for nitrate and nitrite. Action taken - Data reported from run on Friday which had beginning QC which was good and the matrix spike data was good but the final QC was not. Data flagged as suspect due to instrument failure.

**Comments**

Snow with apx. 8" on the ground. Cloudy and looks like a storm is moving in.

Sunny, patchy clouds

**January 26, 2005**

<u>Site Number</u>	<u>Water Body</u>	<u>Time</u>	<u>H2O Temp</u> (degrees C)	<u>pH</u>	<u>EC</u> umhos	<u>DO</u> (mg/L)	<u>Temp (Air)</u> (degrees C)	<u>Comments</u>
EF7-WQ1	EF-Upper	11:30	3.2	8.1	120	7.5		Due to snow sampled just above the confluence
MC1-WQ1	Monitor Creek	12:25	4.1	8.3	640	8		8 of Monitor Creek
EF4-WQ1	EF-Hangmans	13:20	3.7	8.2	170	8.5		8 Milky sheen, good flow
MKC2-WQ1	Campground	Took on 1/27 due to conditions and time frame						
MBC1-WQ1	Millberry Creek	14:20	2.3	7.7	120	8.5		9 See note below
MKC3-WQ1	Grover HS bridge	14:40	4.1	8.1	180	8		6.5
MBC2-WQ1 **	Millberry Creek	15:15	3	7.7	100	7		6

Note - the EC was not calibrated prior to use as the wrong standard had been sent from supply facility but seemed to be working properly. Check against lab results.

MBC1 - Bob Williams of the Markleeville PUD approached us and stated that where we were sampling was in close proximity of where the main sewer line is (underground). He also said that the gas station in Markleeville, upstream from sampling site, had problems a couple of years ago regarding them accepting RV dump waste without a permit

\*\* New site added this sampling event. It is located upstream of other Millberry Creek site and is apx. 1/2 mile outside of town on the east side of the highway.

There has been major snowfall in the area over the last two weeks and there is between 3-4 feet of snow on ground.

We used snowshoes to get to sites.

There has been some meltoff but not significant.

**January 27, 2005**

<u>Site Number</u>	<u>Water Body</u>	<u>Time</u>	<u>H2O Temp</u>	<u>pH</u>	<u>EC</u>	<u>DO</u>	<u>Temp (Air)</u>	<u>Comments</u>
EF0-WQ1	Ef - washoe Dam	9:25	2.3	8.2	210	7		Sunny with apx. 3 ft. 7 snow on ground
EF12-WQ1	EF0 duplicate	9:45						
MKC2-WQ1	Campground	11:15	2.9	8.2	150	8	6.5	
WF7-WQ1	WF - Willow Creek	13:00	1.8	7.7	70	7	5.5	Overcast
WF12-WQ1	WF7 duplicate							
RC1-WQ1	Alhambra Creek	No sampling due to no access to area						
WF10-WF1	West Fork	No sampling due to no access to area						
HC1-WQ1	Hawkins Creek	No sampling due to no access to area						
WF8-WQ1	Bridge on Hwy 88	13:45	1.4	7.6	70	8	4	

**April 18, 2005**

<u>Site Number</u>	<u>Water Body</u>	<u>Time</u>	<u>H2O Temp</u> (degrees C)	<u>pH</u>	<u>EC</u> umhos	<u>DO</u> (mg/L)	<u>Temp (Air)</u> (degrees C)	<u>Comments</u>
EF7-WQ1	EF-Upper	10:30	3.7	7.9	90	10		Sunny, some snow in mtns, 10 no snow on ground
MC1-WQ1	Monitor Creek	11:15	4.9	8.2	290	11		6.5 Grayish sheen, most flow we've seen yet
EF4-WQ1	EF-Hangmans	11:37	5	8.1	110	10		8 A lot of organic debris in water
MKC2-WQ1	Campground	12:32	5.4	7.9	70	9	11.5	
MBC1-WQ1	Millberry Creek	13:07	10.9	7.6	140	7	15.5	Water clear
MKC3-WQ1	Grover HS bridge	14:00	6.6	7.7	50	9	15	
MBC2-WQ1	Millberry Creek	14:32	12.4	7.7	50	7		13 Milky colored water
MBC3-WQ1	Middle Millberry	14:55	9.8	7.3	60	8	12.5	Water clear

**April 19, 2005**

<u>Site Number</u>	<u>Water Body</u>	<u>Time</u>	<u>H2O Temp</u> (degrees C)	<u>pH</u>	<u>EC</u> umhos	<u>DO</u> (mg/L)	<u>Temp (Air)</u> (degrees C)	<u>Comments</u>
EF0-WQ1	Washoe Dam	9:50	5.7	7.7	110	7	4.8	Sunny with patches of clouds. Light now night before
WF7-WQ1	WF by willow creek	11:00	1.4	7.7	60	8	3.5	
WF8-WQ1	WF - upstream of bridge	11:30	2.5	7.6	60	8	7	
MBC4-WQ1	MCB above treatment pond	13:40	na	na	60	9	na	Had turned meters in already when decided to sample

## May 16, 2005

<u>Site Number</u>	<u>Water Body</u>	<u>Time</u>	<u>H2O Temp</u> (degrees C)	<u>pH</u>	<u>EC</u> umhos	<u>DO</u> (mg/L)	<u>Temp (Air)</u> (degrees C)	<u>Comments</u>
EF0-WQ1	EF Washoe Dam	10:00	5.7	7.3	60	8	8.5	Windy & overcast, high water, choc. colored with lots
EF4-WQ1	Hangmans	11:00	5.5	7.7	50	8	8.5	of debris (large root wads, etc.) the most turbid we have seen.
EF7-WQ1	Upper EF	11:50	5.4	7.7	40	8	8.5	
MC1-WQ1	Monitor Creek	12:20	10	8.3	290	8	8.5	
MKC2-WQ1	by campground	12:50	5.2	7.8	40	9	9	
MKC3-WQ1	by bridge	13:50	3.9	7.5	30	9	8.5	

Brad of Carson River Resort said that this is the highest he has seen the river since the 1997 flood. It rained heavy all night the night before. Kayakers reported that they were camped at Hangman's the water came way up over night. They were still able to make it to the take out.

## May 17, 2005

<u>Site Number</u>	<u>Water Body</u>	<u>Time</u>	<u>H2O Temp</u> (degrees C)	<u>pH</u>	<u>EC</u> umhos	<u>DO</u> (mg/L)	<u>Temp (Air)</u> (degrees C)	<u>Comments</u>
MBC1-WQ1	by guard station	10:25	9.8	7.5	180	9	12	Sunny, flow still high but has receded some
MBC2-WQ1	by red house	11:00	10.1	7.9	80	8	12	from yesterday.
MBC5-WQ1	by road	11:25	12.5	7.9	60	8	14.5	right next to it. Water clear in one portion and milky
MBC3-WQ1	Lower TRP	11:45	10	7.2	60	7	14	Mark DeMaio from AC present
MBC4-WQ1	Upper TRP	12:00	9.1	7.3	60	6	12.5	
MBC6-WQ1	Right by pond, coliform only	12:13						
WF7-WQ1	WF by willow creek	13:00	5.6	7.6	40	8	11	Still turbid but less than 5/16 see photos
WF8-WQ1	Upper by bridge	13:30	7.3	7.6	40	9	9	
WF9-WQ1	Blank	13:35						

**June 20, 2005**

<u>Site Number</u>	<u>Water Body</u>	<u>Time</u>	<u>H2O Temp</u> (degrees C)	<u>pH</u>	<u>EC</u> umhos	<u>DO</u> (mg/L)	<u>Temp (Air)</u> (degrees C)	<u>Comments</u>
WC1-WQ1	Wolf Creek	11:00	7.9	7.6	50	9	24	sunny, fast flow
EF7-WQ1	Upper most EF	11:35	10	7.6	50	7	25	
MC1-WQ1	Monitor Creek	11:55	12.6	8.4	560	8	21	Milky sheen Huge Ponderose pine across 25 river directly upstream up bridge
EF4-WQ1	Hangman's Bridge	12:15	9.5	7.8	50	8	25	river directly upstream up bridge
MKC2-WQ1	Markleeville at Campgd	13:05	11.5	7.8	60	7	23	
MBC1-WQ1	Millberry by guard station	13:30	13.6	7.3	150	8	25.5	Milky sheen
MKC3-WQ1	Markleeville at bridge	14:40	12.5	7.6	40	9	26	sunny, clear
MBC2-WQ1	Millberry outside of town	15:08	17	7.9	190	8	28	

**June 21, 2005**

<u>Site Number</u>	<u>Water Body</u>	<u>Time</u>	<u>H2O Temp</u> (degrees C)	<u>pH</u>	<u>EC</u> umhos	<u>DO</u> (mg/L)	<u>Temp (Air)</u> (degrees C)	<u>Comments</u>
EF0-WQ1	EF at Washoe Dam	10:12	10.8	7.9	50	9	24	sunny, breezy, flow high & clear
WF7-WQ1	WF at Willow Creek	11:10	9.1	7.6	40	9	20	
RC1-WQ1	Alambra Creek	11:30	11.5	7.9	60	7	19	Water very fast
WF10-WQ1	WF-Hope Valley	12:00	8	7.7	30	9	20.5	
HC1-WQ1	Hawkins Creek	12:35	9.8	7.5	30	9	20.5	

**July 18, 2005**

<u>Site Number</u>	<u>Water Body</u>	<u>Time</u>	<u>H2O Temp</u> (degrees C)	<u>pH</u>	<u>EC</u> umhos	<u>DO</u> (mg/L)	<u>Temp (Air)</u> (degrees C)	<u>Comments</u>
WC1-WQ1	Wolf Creek	10:50	12.7	7.3	50	8	25	Sunny, very warm, good flow
EF7-WQ1	Upper most EF	11:00	15.1	7.7	50	9	28	Fast, deep flow
MC1-WQ1	Monitor Creek	11:20	18.9	8.2	720	7	28	Visible flow but 1/2 of June's
EF4-WQ1	Hangman's Bridge	11:50	15.9	8.1	60	8	29	
MKC2-WQ1	Markleeville at Campgd	12:35	18.9	8.3	110	8	30	
EF12-WQ1	Duplicate Sample	12:35	18.9	8.3	110	8	30	Split with MKC2-WQ1
MBC1-WQ1	Millberry by guard station	13:05	17.6	7.5	180	7	28.5	Flow visible, but unable to take stream flow
MKC3-WQ1	Markleeville at bridge	13:37	20.2	8.2	80	7	30	
MBC2-WQ1	Millberry outside of town	14:18	21.1	8.1	230	7	30.5	

**July 19, 2005**

<u>Site Number</u>	<u>Water Body</u>	<u>Time</u>	<u>H2O Temp</u> (degrees C)	<u>pH</u>	<u>EC</u> umhos	<u>DO</u> (mg/L)	<u>Temp (Air)</u> (degrees C)	<u>Comments</u>
EF0-WQ1	EF at Washoe Dam	9:40	18.5	8.2	80	7	29	Sunny, clear, rained night before
WF7-WQ1	WF at Willow Creek	10:50	16.4	7.9	50	7	27.5	
RC1-WQ1	Alambra Creek	11:25	17.9	8.1	70	8	30.5	
WF10-WQ1	WF-Hope Valley	12:06	15.8	7.7	30	8	30	
HC1-WQ1	Hawkins Creek	12:40	20.7	7.7	40	8	27.5	
WF12-WQ1	Duplicate	12:16						Split w/WF10-WQ1
WF9-WQ1	Field Blank	13:07						

**October 11, 2005**

<u>Site Number</u>	<u>Water Body</u>	<u>Time</u>	<u>H2O Temp</u> (degrees C)	<u>pH</u>	<u>EC</u> umhos	<u>DO</u> (mg/L)	<u>Temp (Air)</u> (degrees C)	<u>Comments</u>
WC1-WQ1	Wolf Creek	10:40	7.1	7.6	110	7	21.5	38.5771852N / 119.6966287W
EF7-WQ1	Upper most EF	11:50	10	8.2	100	7	23.5	
MC1-WQ1	Monitor Creek	12:32	10.3	7.9	960	8		20 Flow to low to take stream flow Took GPS measurement with 20 County GPS
EF4-WQ1	Hangman's Bridge	12:45	10.3	8.4	110	9		
MBC1-WQ1	Millberry by guard station	13:25	10	8	260	9	21	
MBC2-WQ1	Millberry outside of town	13:50	13.2	8	220	8		22 Low flow, pools of water
MKC2-WQ1	Markleeville at Campgd	14:41	13.4	8.5	220	7		21.5 A lot of leaves in water

Sunny and clear. Slight breeze

**October 12, 2005**

<u>Site Number</u>	<u>Water Body</u>	<u>Time</u>	<u>H2O Temp</u> (degrees C)	<u>pH</u>	<u>EC</u> umhos	<u>DO</u> (mg/L)	<u>Temp (Air)</u> (degrees C)	<u>Comments</u>
EF0-WQ1	EF at Washoe Dam	10:00	9.2	8.6	210	9	15	Sunny and clear, slight breeze
WF7-WQ1	WF at Willow Creek	10:45	5.8	8.1	60	8	13.5	
RC1-WQ1	Alambra Creek	11:10	5	8.2	80	9	19.5	
WF10-WQ1	WF-Hope Valley	11:45	7.5	7.9	40	9	18	
HC1-WQ1	Hawkins Creek							No flow
MKC3-WQ1	MKC at bridge	13:50	9.2	8.6	390	8	23	
WF9-WQ1	Field Blank							

**January 25, 2006**

<u>Water Body</u>	<u>Time</u>	<u>H2O Temp</u> (degrees C)	<u>pH</u>	<u>EC</u> umhos	<u>DO</u> (mg/L)	<u>Temp (Air)</u> (degrees C)	<u>Comments</u>
Wolf Creek							Unaccessible - road closed
Upper most EF	10:15	0.8	7.9	130	9		5 Sunny. A lot of ice in river. Unsafe for stream flow
Monitor Creek	10:30	1.8	8.2	640	7		4.5
Hangman's Bridge	11:00	1	8.3	160	9		7
Markleeville at Campgd	12:00	3.4	8.3	130	9		11
Millberry by guard station	13:20	4.1	8.1	100	7		Severe undercutting and debris in channel suggests 12 heavy flow during flood
Markleeville at bridge	14:20	4.3	8.1	120	7		8
Millberry outside of town	15:00	4	7.9	80	7		Mud deposits on banks from flooding; some incision; 10 gravel deposits on south banks.

**January 26, 2006**

<u>Site Number</u>	<u>Water Body</u>	<u>Time</u>	<u>H2O Temp</u> (degrees C)	<u>pH</u>	<u>EC</u> umhos	<u>DO</u> (mg/L)	<u>Temp (Air)</u> (degrees C)	<u>Comments</u>
EF0-WQ1	EF at Washoe Dam	9:50	2.7	8.1	180	9		5.5 Very cold, breezy, some snow flurries
WF7-WQ1	WF at Willow Creek	11:05	1.6	8.2	70	8		1 Deep snow, difficult access, ice in river
RC1-WQ1	Alambra Creek							Unaccessible due to snow
WF8-WQ1	WF-Bridge, winter site	11:35	1.3	7.8	70	9		0 Ice in river, unsafe for stream flow
HC1-WQ1	Hawkins Creek							Unaccessible due to snow
EF12-WQ1	Duplicate	9:50						EF0-WQ1 site
WF12-WQ1	Duplicate	9:50						WF8-WQ1 site
WF9-WQ1	Field Blank							

# Streamflow Data

Site	Date	Time	Field(cfs)	Est. (cfs)	East Fork- Markleeville USGS gage (2hr dif)		Notes
					MKC2	MC1	
MBC1-WQ1	4/29/2004	14:01	0.87				
MKC3-WQ1	4/29/2004	15:00	109.06				
MKC2-WQ1	4/29/2004	12:37	316.72				
MC1-WQ1	4/29/2004	10:40	2.6				
EF7-WQ1	4/29/2004	10:03	N/A	465.68		785 316.72	2.6 Unsafe for streamflow
WF10-WQ1	4/30/2004	12:40	109.63				
HC1-WQ1	4/30/2004	13:45	11.02				
RC1-WQ1	4/30/2004	12:04	N/A				Unsafe for streamflow
MBC1-WQ1	5/27/2004	13:35	0.51				
MKC2-WQ1	5/27/2004	12:40	133.33				
MKC3-WQ1	5/27/2004	14:19	67.88				
MC1-WQ1	5/27/2004	11:20	2.6				
EF7-WQ1	5/27/2004	10:38	N/A	463.07		599 133.33	2.6 Unsafe for streamflow
WF10-WQ1	5/28/2004	11:30	223.45				Storm Event
HC1-WQ1	6/3/2004	12:56	7.66				
WF10-WQ1	6/3/2004	12:37	72.38				
RC1-WQ1	6/3/2004	12:10	21.46				
MBC1-WQ1	6/24/2004	12:50	0.8				
MKC3-WQ1	6/24/2004	13:32	23.69				
MKC2-WQ1	6/24/2004	12:32	45.63				
MC1-WQ1	6/24/2004	11:34	0.45				
EF7-WQ1	6/24/2004	10:50	N/A	222.92		269 45.63	0.45 Unsafe for streamflow
RC1-WQ1	6/25/2004	12:05	12.06				
HC1-WQ1	6/25/2004	13:20	2.72				
WF10-WQ1	6/25/2004	12:54	24.09				
MKC3-WQ1	7/22/2004	14:56	3.47				
MKC2-WQ1	7/22/2004	13:47	30.14				
EF7-WQ1	7/22/2004	11:25	152.9				

Site	Date	Time	Field(cfs)	Est. (cfs)	East Fork- Markleeville USGS gage (2hr dif)	MKC2	MC1	Notes
MBC1-WQ1	7/22/2004	14:20	N/A					To low to measure
MC1-WQ1	7/22/2004	12:09	N/A					No flow
HC1-WQ1	7/23/2004	13:35	N/A					No flow
RC1-WQ1	7/23/2004	12:20	9.28					
WF10-WQ1	7/23/2004	13:15	5.72					
MBC1-WQ1	10/25/2004	14:00	0.29					
MKC3-WQ1	10/25/2004	14:30	3.06					
MKC2-WQ1	10/25/2004	13:28	15.37					
MC1-WQ1	10/25/2004	12:25	N/A					No flow
EF7-WQ1	10/25/2004	12:10	78.61					
WC1-WQ1	1/25/2004	10:42	N/A					Unsafe access
RC1-WQ1	10/26/2004	N/A	N/A					Snow storm - no access
WF10-WQ1	10/26/2004	N/A	N/A					Snow storm - no access
HC1-WQ1	10/26/2004	N/A	N/A					Snow storm - no access
WC1-WQ1	1/26/2005	N/A	N/A					Road Closed - no access
MKC3-WQ1	1/26/2005	14:40	16.52					
MBC1-WQ1	1/26/2005	13:45	4.37					
MC1-WQ1	1/26/2005	12:15	4.75					
EF7-WQ1	1/26/2005	11:40	106.22					No access sampled just above confluence w/MC
WF8-WQ1	1/27/2005	13:45	41.55					Winter site
MKC2-WQ1	1/27/2005	11:00	47.97					
WC1-WQ1	4/18/2005	N/A	N/A					No access
MKC2-WQ1	4/18/2005	12:30	225.87					
MKC3-WQ1	4/18/2005	13:30	64.22					
MBC1-WQ1	4/18/2005	13:00	0.31					
MC1-WQ1	4/18/2005	11:00	19.48					
EF7-WQ1	4/18/2005	10:30	N/A	586.65		832	225.87	19.48 Unsafe access
WF8-WQ1	4/19/2005	11:30	N/A					Unsafe access
MC1-WQ1	5/16/2005	12:15	21.44					
WC1-WQ1	5/16/2005	N/A	N/A					No access

Site	Date	Time	Field(cfs)	Est. (cfs)	East Fork- Markleeville USGS gage (2hr dif)	MKC2	MC1	Notes
EF7-WQ1	5/16/2006	11:50	N/A	N/A		N/A		High & Fast flows - unsafe
MKC2-WQ1	5/16/2005	12:50	N/A					High & Fast flows - unsafe
MKC3-WQ1	5/16/2005	13:50	N/A					High & Fast flows - unsafe
MBC1-WQ1	5/17/2005	10:25	0.36					
WF8-WQ1	5/17/2005	13:30	N/A					High & Fast flows - unsafe
MKC3-WQ1	6/20/2005	14:26	78.66					
MC1-WQ1	6/20/2005	11:55	2.47					
MBC1-WQ1	6/20/2005	13:30	0.27					
MKC2-WQ1	6/20/2005	12:35	233.84					
WC1-WQ1	6/20/2005	11:00	N/A					Flows to fast & deep
EF7-WQ1	6/20/2005	11:35	N/A	793.69	1030	233.84	2.47	Flows to fast & deep
WF10-WQ1	6/21/2005	12:00	90.96					
HC1-WQ1	6/21/2005	12:45	8.69					
RC1-WQ1	6/21/2005	11:30	N/A					Flows to fast & deep
MBC1-WQ1	7/18/2005	13:05	N/A					Flow to low
WC1-WQ1	7/18/2005	10:50	N/A					Flows to fast & deep
EF7-WQ1	7/18/2005	10:39	N/A	467.18	536	68.82	0	Flows to fast & deep
MC1-WQ1	7/18/2005	11:20	N/A					Flow to low
MKC2-WQ1	7/18/2005	12:25	68.82					
MKC3-WQ1	7/18/2005	13:37	25.81					
HC1-WQ1	7/19/2005	12:40	1.42					
RC1-WQ1	7/19/2005	11:15	23.66					
WF10-WQ1	7/19/2005	11:52	31.94					
WC1-WQ1	10/11/2005	10:45	21.17					
MKC2-WQ1	10/11/2005	14:30	9.71					
EF7-WQ1	10/11/2005	11:50	78.19					
MC1-WQ1	10/11/2005	12:32	N/A					Flow to low
MBC1-WQ1	10/11/2005	13:25	N/A					Flow to low
MKC3-WQ1	10/12/2005	13:50	2.48					
HC1-WQ1	10/12/2005	11:55	N/A					No flow

<b>Site</b>	<b>Date</b>	<b>Time</b>	<b>Field(cfs)</b>	<b>Est. (cfs)</b>	<b>East Fork- Markleeville USGS gage (2hr dif)</b>	<b>MKC2 MC1</b>	<b>Notes</b>
RC1-WQ1	10/12/2005	11:20	4.71				
WF10-WQ1	10/12/2005	11:52	6.98				
WC1-WQ1	1/25/2006	N/A	N/A				No access
EF7-WQ1	1/25/2006	10:15	N/A	N/A			Ice - unsafe access
MKC2-WQ1	1/25/2006	12:00	111.43				
MKC3-WQ1	1/25/2006	14:20	31.52				
MBC1-WQ1	1/25/2006	13:20	3.68				
MC1-WQ1	1/25/2006	10:30	1.73				
WF8-WQ1	1/26/2006	11:35	N/A				Ice - unsafe access

## Appendix C

### Sampling Site Locations Table

### Sampling Sites with Period of Records

<i>Site</i>	<i>Site Name</i>	<i>Period of Record</i>
D-1	Carson R @ Diversion	2000-2000
D-2	SnowShoe @ Dressler	2000-2000
D-3_24-Hr	Dressler @ ICR Inlet	2000-2000
D-4	Millich @ Indian Cr	2000-2000
EF0-WQ1	East Fork before the Washoe Bridge	2004-2006
EF4-WQ1	East Fork at Hangman's Bridge	2004-2006
EF7-WQ1	East Fork below confluence with Silver and Wolf Creeks	2004-2006
G8230000	West Fork at Woodfords	1958-1987
G8240510	Willow Creek near mouth in Hope Valley	1956-1956
G8241175	Red Lake Creek at Highway 88	1956-1956
G8241501	West Fork below West Valley	1956-1956
G8307501	Mountaineer Creek below Poison Creek	1969-1969
G8309001	East Fork above Bryant Creek	1969-1969
G8314801	Markleeville Creek at Markleeville	1956-1956
G8342000	East Fork near Markleeville	1956-1988
G8342020	East Fork at Highway 4	1958-1984
G8347975	Silver Creek near the confluence with the East Fork	1956-1956
G8361410	Wolf Creek at Wolf Creek Meadows	1956-1956
HC1-WQ1	Hawkins Creek before confluence with West Fork	2004-2004
HPR	Harvey Place Reservoir	1989-2004
ICR	Indian Creek Reservoir at the outlet	1971-2004
L-1	Red Lake	2004-2006
L-2	Summit Lake	2004-2006
M7	Monitor Creek above mouth	1990-1991

<b>Site</b>	<b>Site Name</b>	<b>Period of Record</b>
MBC1-WQ1	MBC1-WQ1	2004-2006
MBC2-WQ1	MBC2-WQ1	2005-2006
MBC3-WQ1	MBC3-WQ1	2005-2005
MBC4-WQ1	MBC4-WQ1	2005-2005
MBC5-WQ1	MBC5-WQ1	2005-2005
MBC6-WQ1	MBC6-WQ1	2005-2006
MC1-WQ1	MC1-WQ1	2004-2006
MKC2-WQ1	MKC2-WQ1	2004-2006
MKC3-WQ1/ G8323501	Markleeville Creek at bridge below Hot Springs	1956-2006
MM3	Monitor Creek - 2196 meters above mouth	1990-1991
RC1-WQ1	Red Lake Creek before confluence with West Fork and before road culvert	2004-2006
Red Lake	Red Lake	2000-2002
SW-02	Indian Cr Upper	1980-2006
SW-03	Indian Cr Mid	1980-2006
SW-04	Indian Cr Lower	1980-2004
SW-07	Fredericksburg Ditch	1980-2004
SW-08	Irrigation Ditch	1981-2004
SW-09	Carson R Dressler Ln	1975-2004
SW-10	Indian Cr at Bruns	1985-2004
SW-11	ICR Effluent @ HPR box	2000-2003
SW-12	Bruns Diversion	2001-2003
SW-13	Fredericksburg Ditch	2001-2004
SW-14	Fredericksburg Ditch	2001-2002
SW-15	Celio Tailwater	2001-2004
SW-16	Drain Ditch @ Fairview Ln	2002-2004
WC1-WQ1	Wolf Creek in East Fork drainage at upper most campground area	2004-2006
WCAP03-R219	WCAP03-R219	2004-2004
WCAP03-R222	WCAP03-R222	2004-2004

<b>Site</b>	<b>Site Name</b>	<b>Period of Record</b>
WCAP99-0629	Hot Springs Creek	2002-2002
WCAP99-0991	Hawkins Creek	2002-2003
WF1-WQ1/SW-06	West Fork at Stateline	1980-2006
WF2-WQ1/SW-05	West Fork below Fredricksburg diversion ditch	1966-2006
WF10-WQ1	West Fork before confluence with Red Lake Creek	2004-2006
WF5-WQ1/SW-01	West Fork by gaging station by Crystal Springs Road	1980-2006
WF7-WQ1/HC1	West Fork in Hope Valley below confluence with Willow Creek	2004-2006
WF8-WQ1	West Fork upstream of bridge on Highway 89 before Blue Lakes Road	2004-2006
G8304000	Indian Creek Reservoir at outlet	1971-1973
G8R84509466	Indian Creek Reservoir near the dam	1977-1977
ICR-1	Indian Creek Reservoir	1998-2004
ICR-2	Indian Creek Reservoir	1998-1999
ICR-3	Indian Creek Reservoir	1998-1999
ICR-4	Indian Creek Reservoir	1998-1999
ICR-5	Indian Creek Reservoir	1998-1999
SD-1	Indian Creek Reservoir	2000-2000
SD-2	Indian Creek Reservoir	2000-2000
SD-3	Indian Creek Reservoir	2000-2000
BCU	Bryant Creek at Doud Springs	1997-2006
C17	East Fork just above Bryant Creek	1973-1986
C20	Bryant Creek above confluence with East Fork	1969-2004
C21	East Fork below confluence with Bryant Creek	1991-2002
C8	West Fork at Paynesville	1966-2006
CVM	East Fork below confluence of	2002-2004

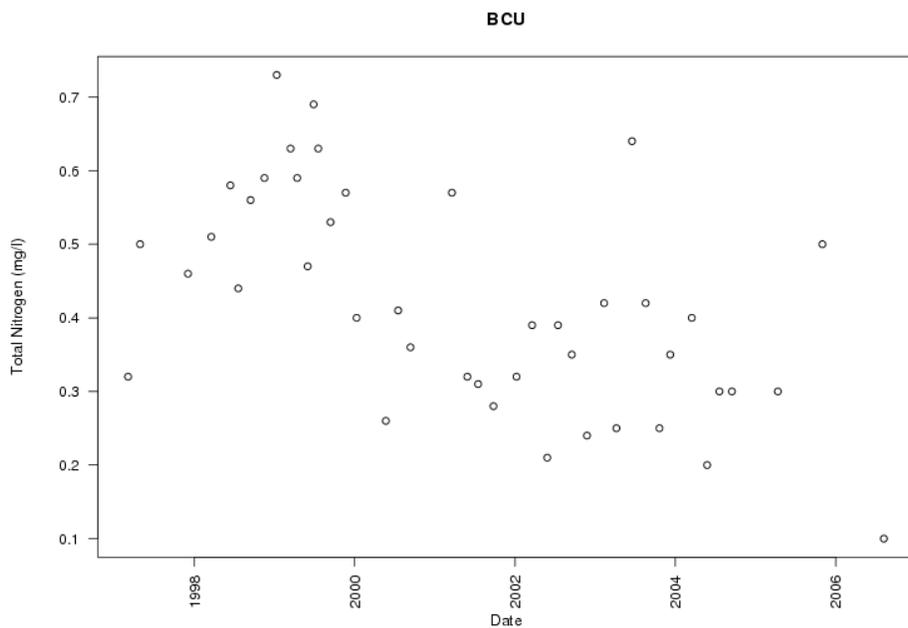
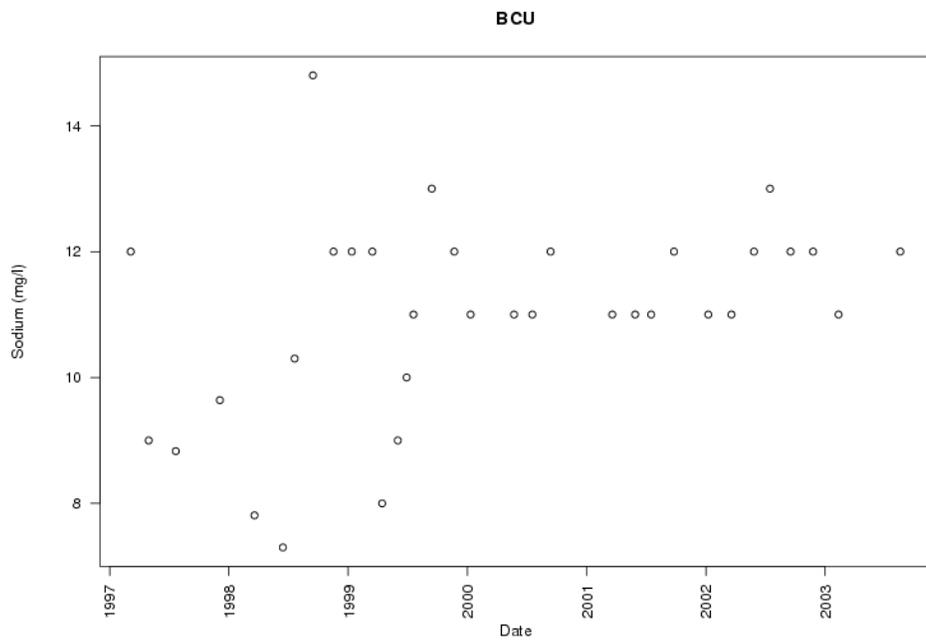
<b>Site</b>	<b>Site Name</b>	<b>Period of Record</b>
	Markleeville Creek	
CVW	West Fork at Woodfords gage	2002-2004
EFAB	East Fork above Bryant Creek	1999-2006
C19	Leviathan Mine	
CRTSS3	West Fork at Diamond Valley Bridge at Paynesville	
NDOWAB	East Fork above Bryant Creek	
NDOWAO	East Fork at Apple Orchard	
WFCW	West Fork at Woodfords	

Appendix D  
Sierra Environmental Monitoring  
Laboratory Data Results

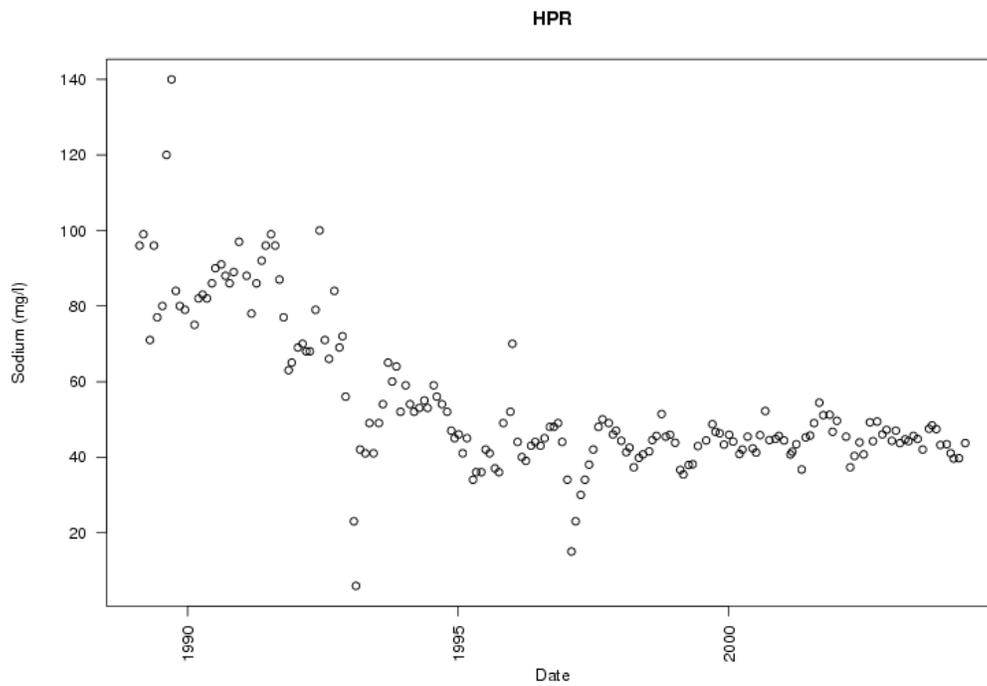
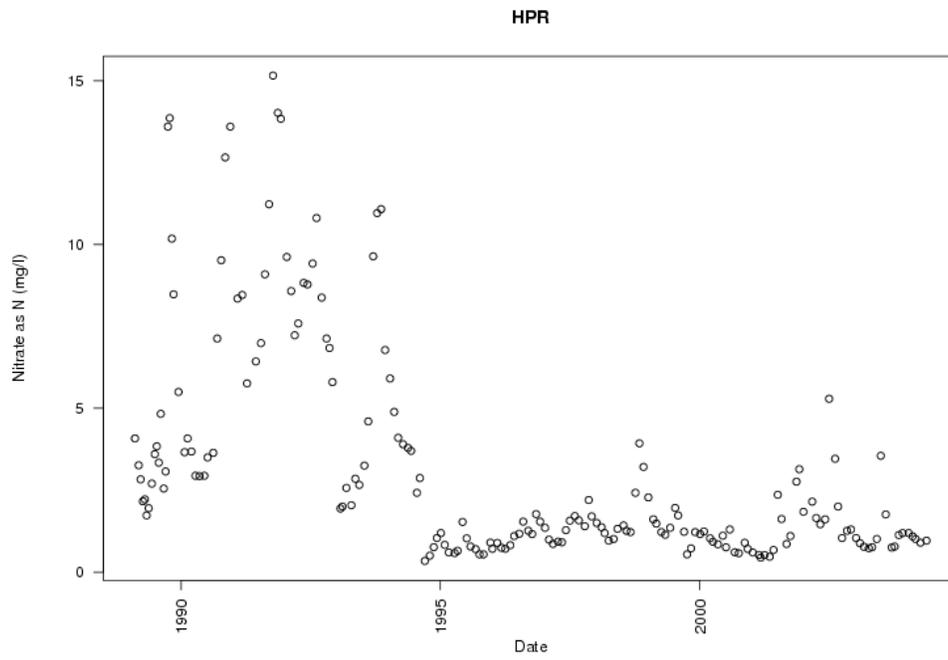
## Appendix E

### Plots of Significant Trends

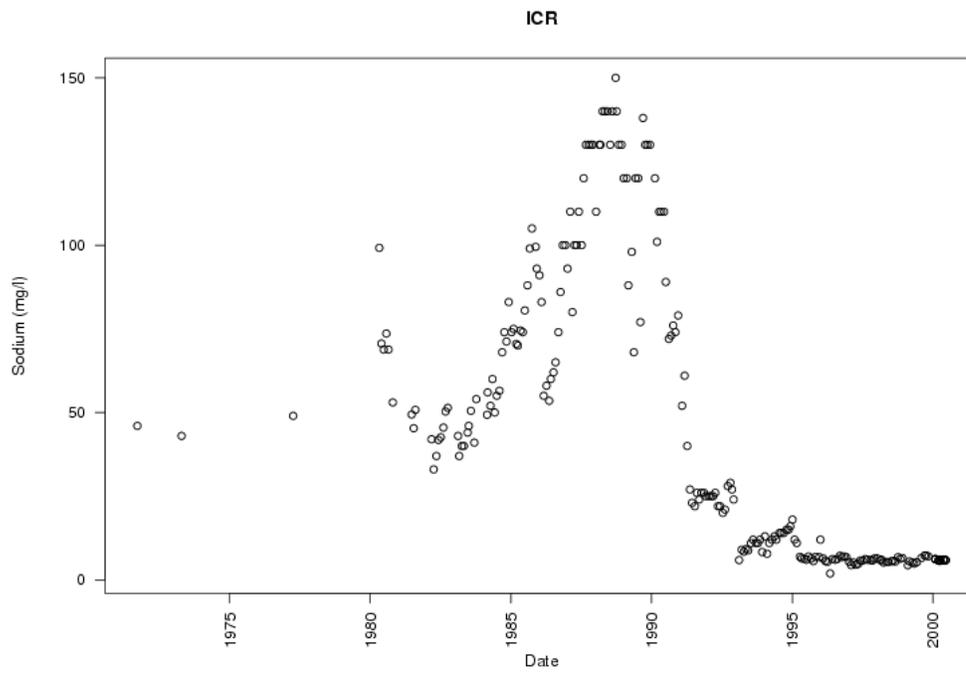
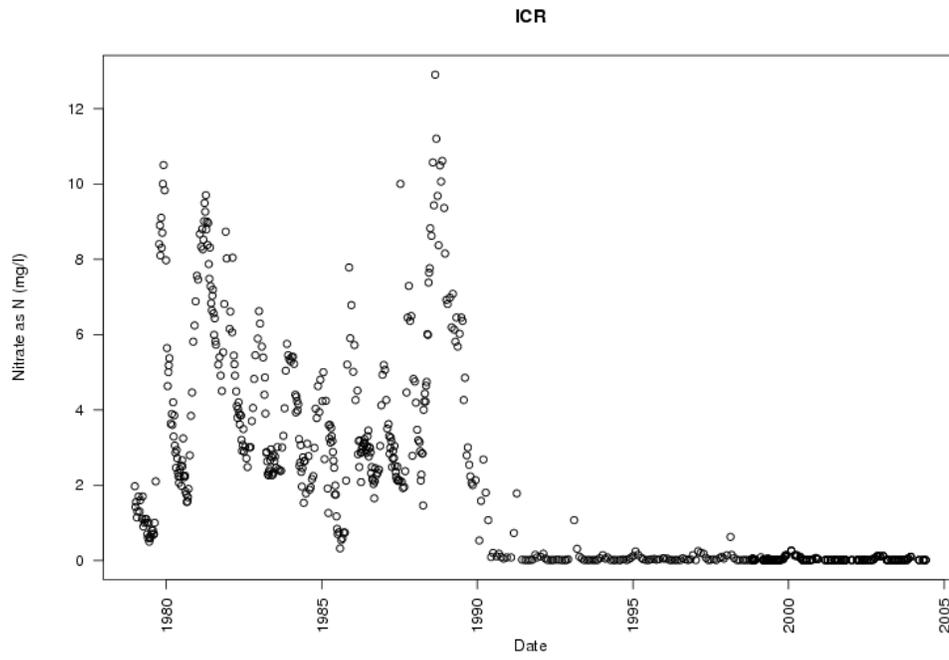
# Bryant Creek (BCU)



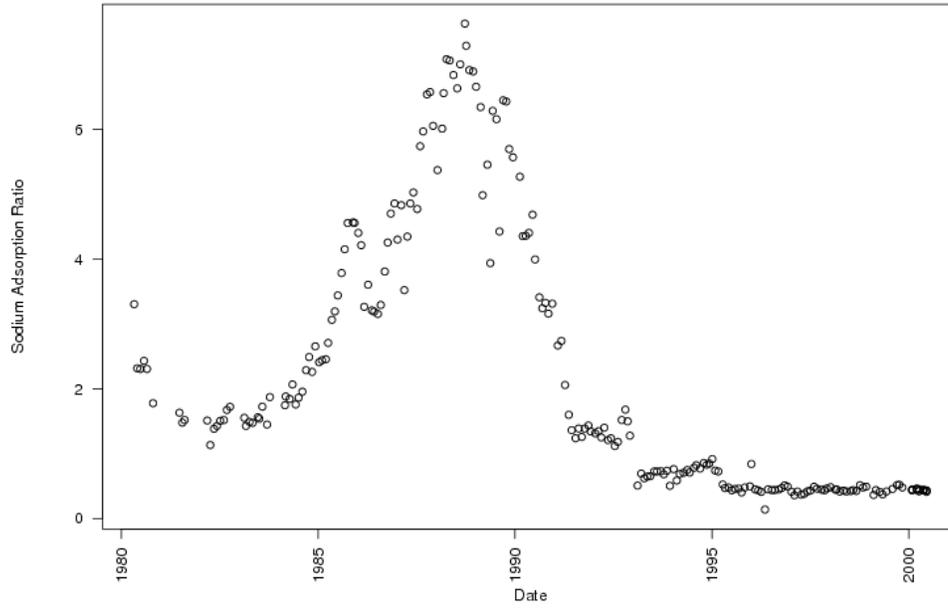
# Harvey Place Reservoir (HPR)



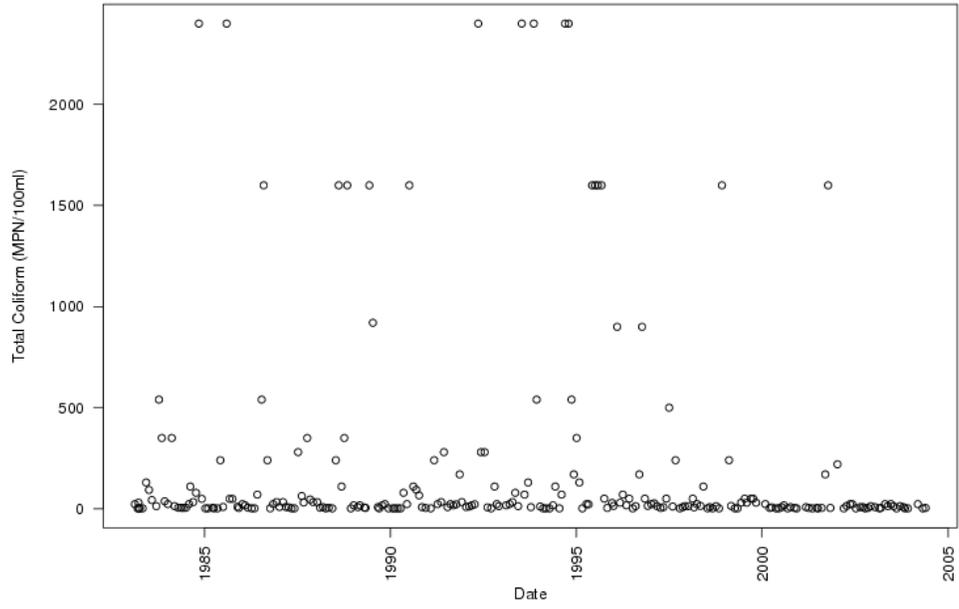
# Indian Creek Reservoir (ICR)



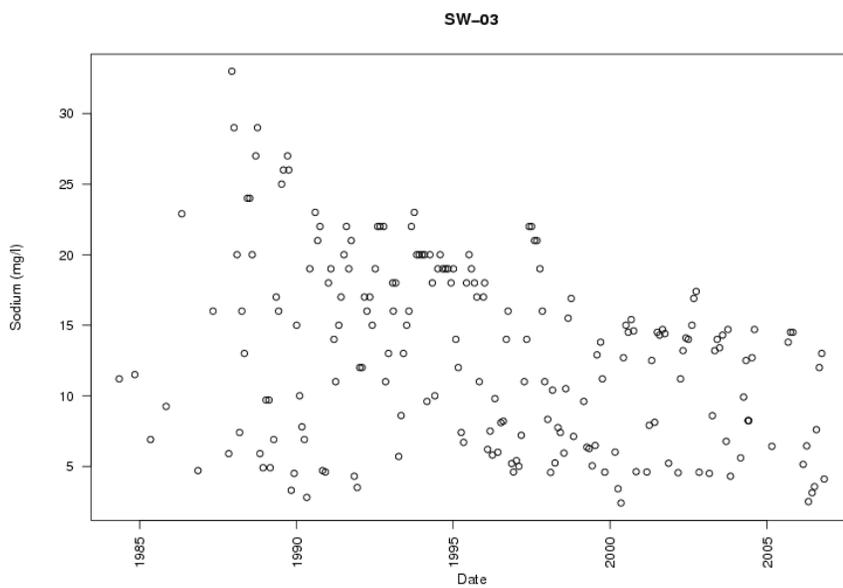
### ICR



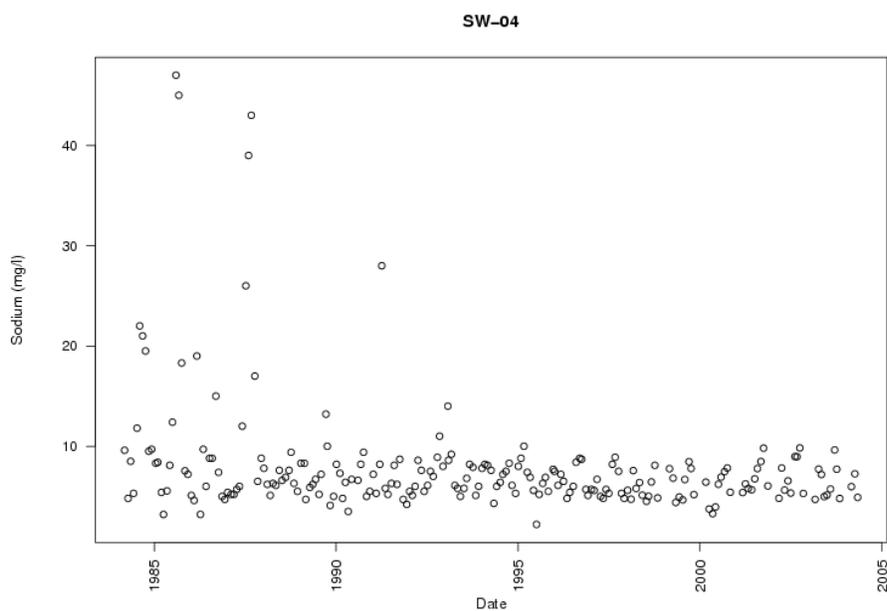
### ICR



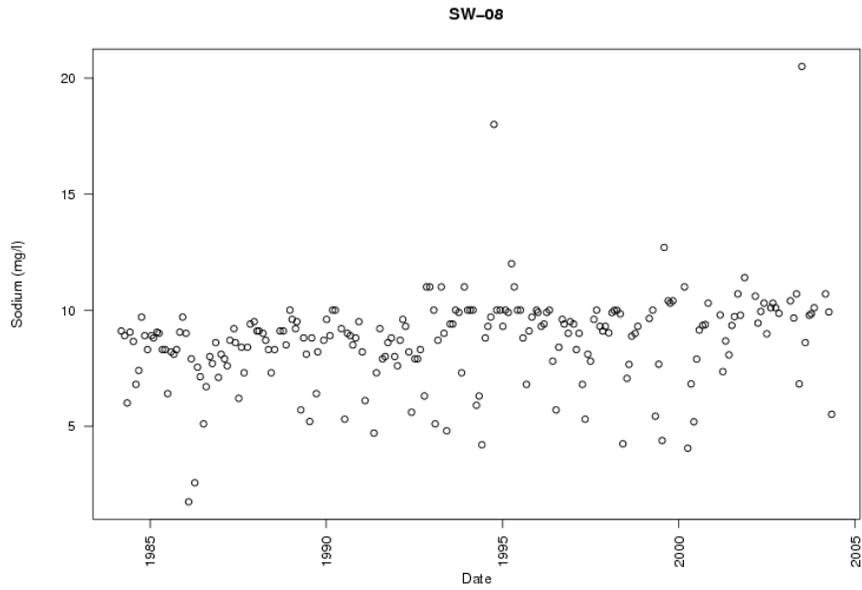
# Indian Creek Middle



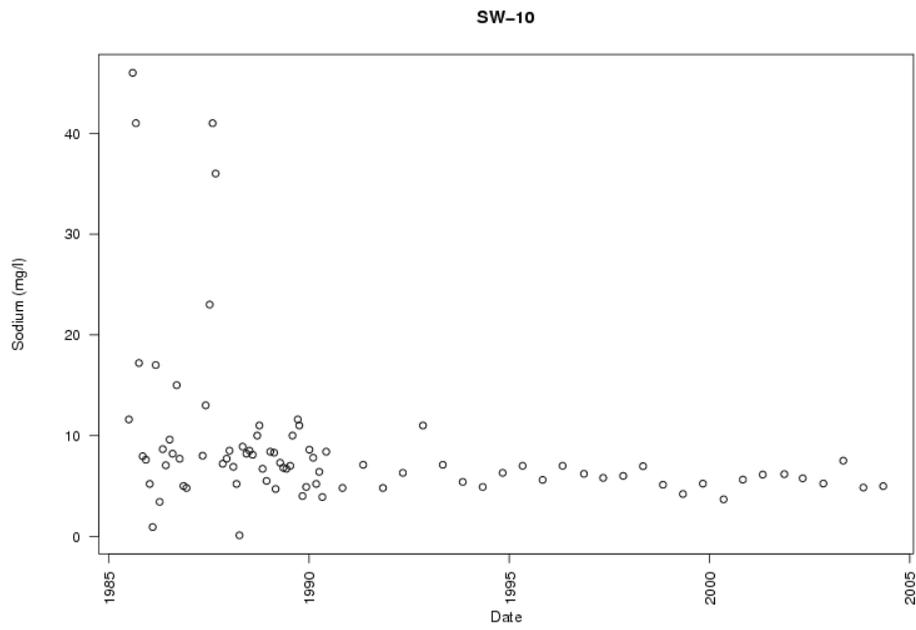
# Indian Creek Lower



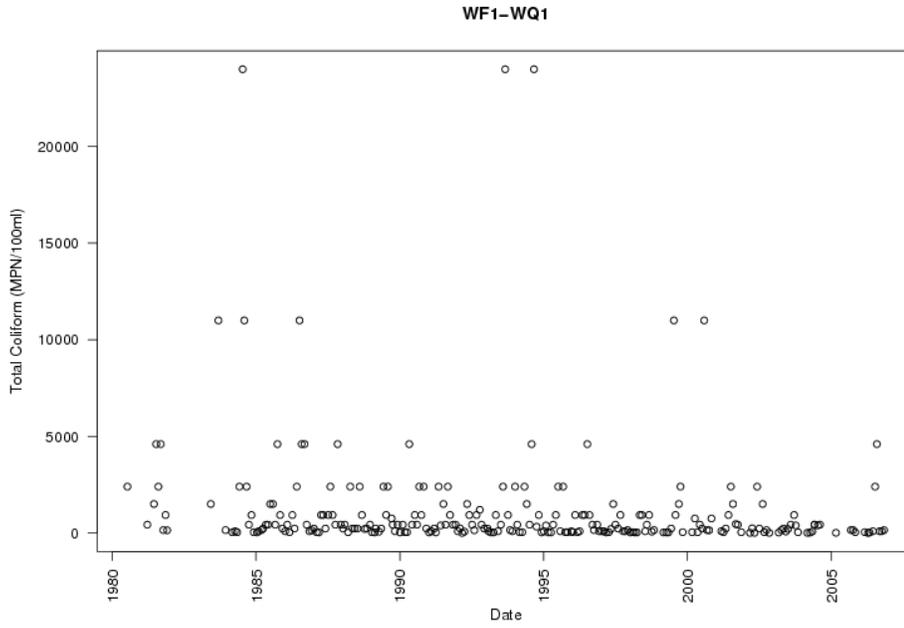
# Irrigation Ditch



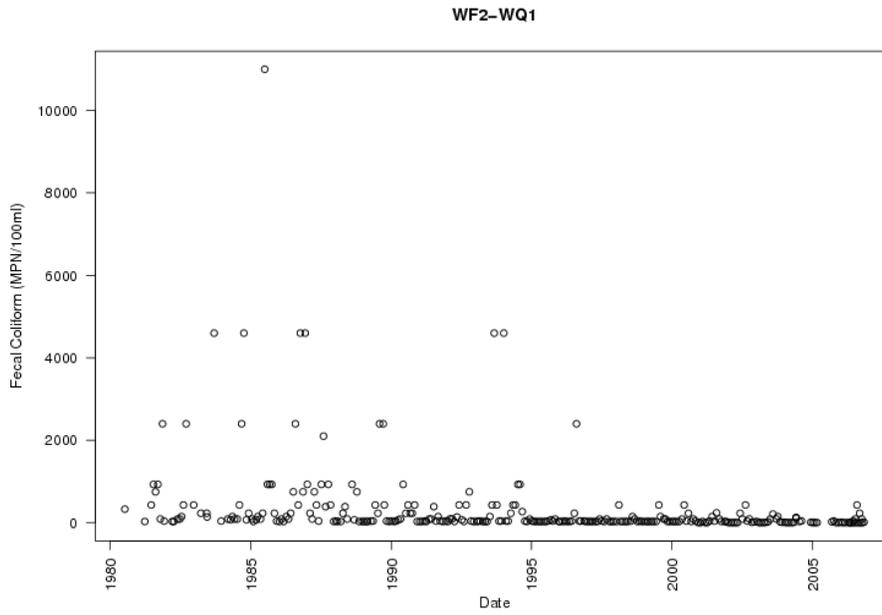
# Indian Creek at Bruns



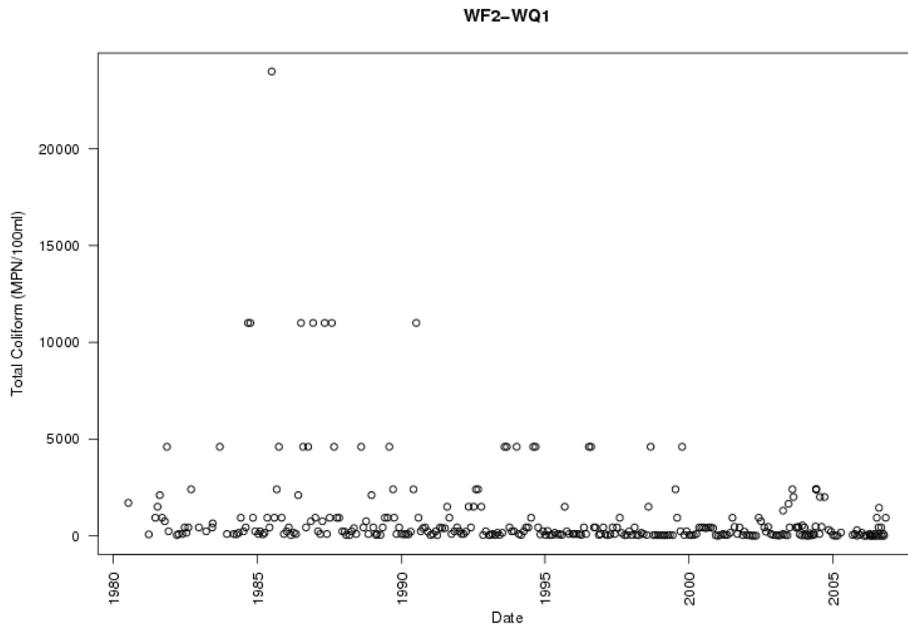
# West Fork Carson River at Stateline



# West Fork Carson River at Paynesville



# West Fork Carson River at Paynesville



# West Fork Carson River at Woodfords

