Total Maximum Daily Load (TMDL)
For Total Phosphorus

Final Report
August 2003
(Approved January 2004)

Roberson (Robeson) Creek
Subbasin 03-06-04
Cape Fear River Basin
North Carolina

Prepared by:
NC Department of Environment and Natural Resources
Division of Water Quality
Water Quality Section
1617 Mail Service Center
Raleigh, NC 27699-1617
(919) 733-5083

INDEX OF TMDL SUBMITTAL

1. 303(d) List Information

State	North Carolina
County	Chatham
Basin	Cape Fear River Basin

303(d) Listed Waters

Name of Stream	Description	Class	Index #	Subbasin	Miles
Roberson Creek	From a point 0.3 miles upstream of mouth to B. Everett Jordan Lake, Haw River	WS-IV, NSW, C	16-38-(5)	30604	0.6

14 digit HUC or Cataloging Unit(s)	03030002060030
Area of Impairment	0.6 miles
WQS Violated	Chlorophyll *a*
Pollutant of Concern	Total Phosphorus
Sources of Impairment	Point and nonpoint sources from entire watershed

2. Public Notice Information

A draft of the Roberson Creek TMDL was publicly noticed through various means, including notification in the local newspaper, *The Chatham Record*, on June 19, 2003. DWQ electronically distributed the draft TMDL and public comment information to known interested parties. The TMDL was also available from the Division of Water Quality's website at http://h2o.enr.state.nc.us/tmdl/draft_TMDLs.htm during the comment period beginning June 19 and ending July 21. A public meeting was held on July 15 at the Chatham County Agricultural Center Auditorium in Pittsboro. At this meeting, staff presented the TMDL and answered questions. In addition to DWQ staff, 14 people attended the meeting.

Did notification contain specific mention of TMDL proposal? Yes
Were comments received from the public? Yes
Was a responsiveness summary prepared? Yes. A responsiveness summary is found in Chapter 10 of the TMDL report.

3. TMDL Information

Critical condition: Dry hydrologic conditions; summer algal growing season

Seasonality: TMDL is based on meeting the target standard during the critical summer growing season. The TMDL is applied to the period, April through October. Weather related variability during the model period is incorporated. Basing the TMDL on this warm weather period will also protect Roberson Creek during the cold weather period (November – March).

Development tools: FLUX, BATHTUB, SWAT

Supporting documents: Total Maximum Daily Load (TMDL) For Total Phosphorus, NC Division of Water Quality (2003)

TMDL

Total mass daily load allocation of total phosphorus in kilograms (kg).

Source Types	TMDL for Summer (April-October)	% Reduction
1. Non-point source		
Urban	44	71
Forest	--	0
Pasture/Hay lands	--	0
2. Point source WWTP	146	71
Total	190	71

Load allocation at critical condition: 190 kg TP/ summer (0.89 kg TP/day/summer)

Waste load allocation (WLA): 146 kg TP/summer (0.68 kg TP/day/summer)

Load allocation (LA): 44 kg TP/summer (0.21 kg TP/day/summer)

Margin of Safety (applied to the water quality criteria): An explicit margin of safety of 7.9 µg/L chlorophyll *a* based on meeting the lower 80% confidence interval of receiving water model predictions.

TABLE OF CONTENTS

TABLES

FIGURES

1 Introduction

Roberson (Robeson) Creek [1] is currently on North Carolina's 303(d) list of impaired waters for chlorophyll *a* (chl *a*) violations in 0.6 miles of the lower reach near its confluence with the Haw River arm of Jordan Lake. The main stem of Roberson Creek is also on the 303(d) list for biological impairment from a point 0.7 miles downstream of SR 2159 to upstream of the mouth. In addition, Pittsboro Lake, located on the upper portion of Roberson Creek in the Town of Pittsboro, is on the 303(d) list due to aquatic weeds. This report focuses on impairment related to chl *a* in the most downstream portion of Roberson Creek, referred to hereafter as the *Roberson Creek Cove*. The report determines sources and allowable loads of total phosphorus, which has been identified as the factor most limiting the growth of algae as measured by chl *a*.

Section 303(d) of the Clean Water Act (CWA) requires states to develop a list of waters not meeting water quality standards or which have impaired uses. This list, referred to as the 303(d) list, is submitted biennially to the U.S. Environmental Protection Agency (EPA) for review.

The 303(d) process requires that a Total Maximum Daily Load (TMDL) be developed for each of the waters appearing on Part I of the 303(d) list. The objective of a TMDL is to estimate allowable pollutant loads and allocate to known sources so that actions may be taken to restore the water to its intended uses (USEPA, 1991). Generally, the primary components of a TMDL, as identified by EPA (1991, 2000a) and the Federal Advisory Committee (FACA, 1998) are as follows:

Target identification or selection of pollutant(s) and end-point(s) for consideration. The pollutant and end-point are generally associated with measurable water quality related characteristics that indicate compliance with water quality standards. North Carolina indicates known pollutants on the 303(d) list.

---

[1] There are several spellings of this waterbody. A 1930's USDA SCS soil map refers to the creek as *Robeson* Creek as do the NC Department of Transportation road signs marking access points to the creek. However, USGS and DWQ have spelled the creek as *Roberson* Creek. The spelling used by USGS will be used in the main body of the report.

Source assessment. All sources that contribute to the impairment should be identified and loads quantified, where sufficient data exist.

Reduction target. Estimation or level of pollutant reduction needed to achieve water quality goal. The level of pollution should be characterized for the waterbody, highlighting how current conditions deviate from the target end-point. Generally, this component is identified through water quality modeling.

Allocation of pollutant loads. Allocating pollutant control responsibility to the sources of impairment. The wasteload allocation portion of the TMDL accounts for the loads associated with existing and future point sources. Similarly, the load allocation portion of the TMDL accounts for the loads associated with existing and future non-point sources, stormwater, and natural background.

Margin of Safety. The margin of safety addresses uncertainties associated with pollutant loads, modeling techniques, and data collection. Per EPA (2000a), the margin of safety may be expressed explicitly as unallocated assimilative capacity or implicitly due to conservative assumptions.

Seasonal variation. The TMDL should consider seasonal variation in the pollutant loads and end-point. Variability can arise due to stream flows, temperatures, and exceptional events (e.g., droughts, hurricanes).

Critical Conditions. Critical conditions indicate the combination of environmental factors that result in just meeting the water quality criterion and have an acceptably low frequency of occurrence.

Section 303(d) of the CWA and the Water Quality Planning and Management regulation (USEPA, 2000a) require EPA to review all TMDLs for approval or disapproval. Once EPA approves a TMDL, then the waterbody may be moved to Category 4a of the Integrated Report. Waterbodies remain in Category 4a until compliance with water quality standards is achieved. Where conditions are not appropriate for the development of a TMDL, management strategies may still result in the restoration of water quality.

The goal of the TMDL program is to restore designated uses to water bodies. Thus, the implementation of nutrient controls throughout the watershed will be necessary to restore uses in the Roberson Creek Cove. Although an implementation plan is not included as part of this TMDL, reduction strategies for point and nonpoint sources will be needed. The involvement of local governments and agencies will be critical in order to develop implementation plans and reduction strategies. Development of an implementation plan will begin during public review of the TMDL. The NCSU Water Quality Group will be developing general and site-specific implementation plans.

1.1 Watershed Description

Roberson Creek flows in an easterly direction 10.9 miles from its origins southwest of the Town of Pittsboro to its mouth at the Haw River arm of Jordan Lake (Figure 1.1). Located entirely within the Pittsboro town limits and its extra-territorial jurisdiction, the 28.6-mi ^{2}, piedmont watershed is approximately 73% forested, 9% agricultural, and 16% urban (NCSU Water Quality Group 2002; Figure 1.2). Part of the upper watershed consists of residential, commercial, and industrial development surrounding the Town of Pittsboro. The area outside of the corporate limits of Pittsboro consists primarily of low density residential development, agriculture, and forestland. The Pittsboro wastewater treatment plant (WWTP; NPDES permit #NC0020354) discharges into Roberson Creek 7.0 miles upstream from Jordan Lake. The lower watershed, from the Pittsboro WWTP to Jordan Lake consists mostly of undeveloped forestland, low density residential development, pasture and hayfields.

The Roberson Creek watershed is located within the Carolina Slate Belt, which consists of predominately metavolcanic and metigneous rocks. This geology typically yields low base flows compared to other hydrologic areas (Giese and Mason 1993). Roberson Creek descends approximately 230 feet from its headwaters to Jordan Lake (10.9 miles), with approximately 100 feet of descent in the last three miles. This gradient is typical of streams in the Haw River basin.

Surface water classifications are designations applied to surface water bodies that define the best uses to be protected within these waters (for example swimming, fishing, drinking water supply) and carry with them an associated set of water quality standards to protect those uses. Roberson

Creek is classified as a water supply watershed (WS-IV), nutrient sensitive (NSW), and a class C waterbody. The waters are protected for drinking water supply, secondary recreation, fishing, wildlife, fish and aquatic life propagation and survival, agriculture and other uses suitable for Class C. Secondary recreation includes wading, boating, and other uses involving human body contact with water where such activities take place in an infrequent, unorganized, or incidental manner.

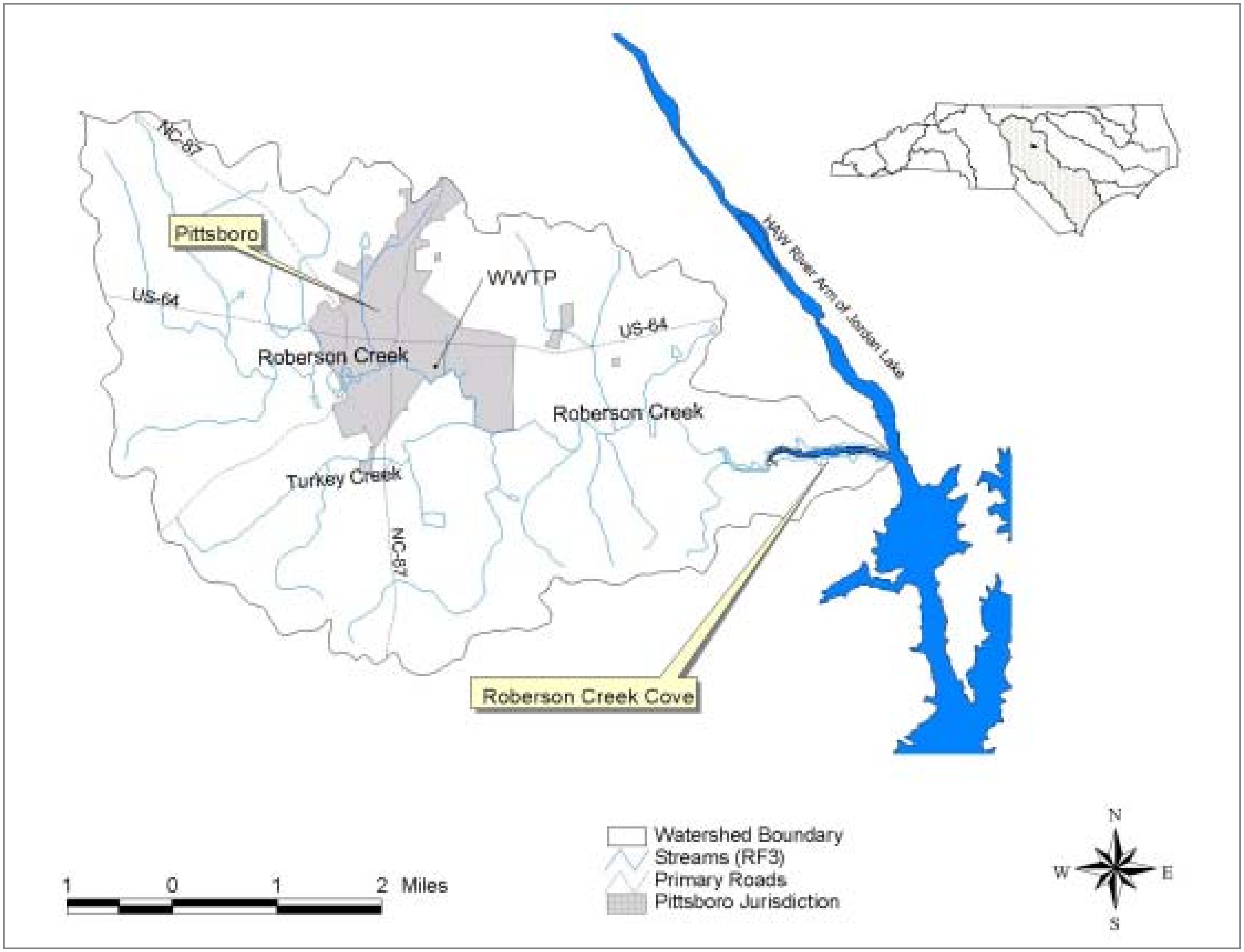

Figure 1.1. Map of Roberson Creek watershed (DWQ subbasin 030604; 14 digit HUC 03030002060030).

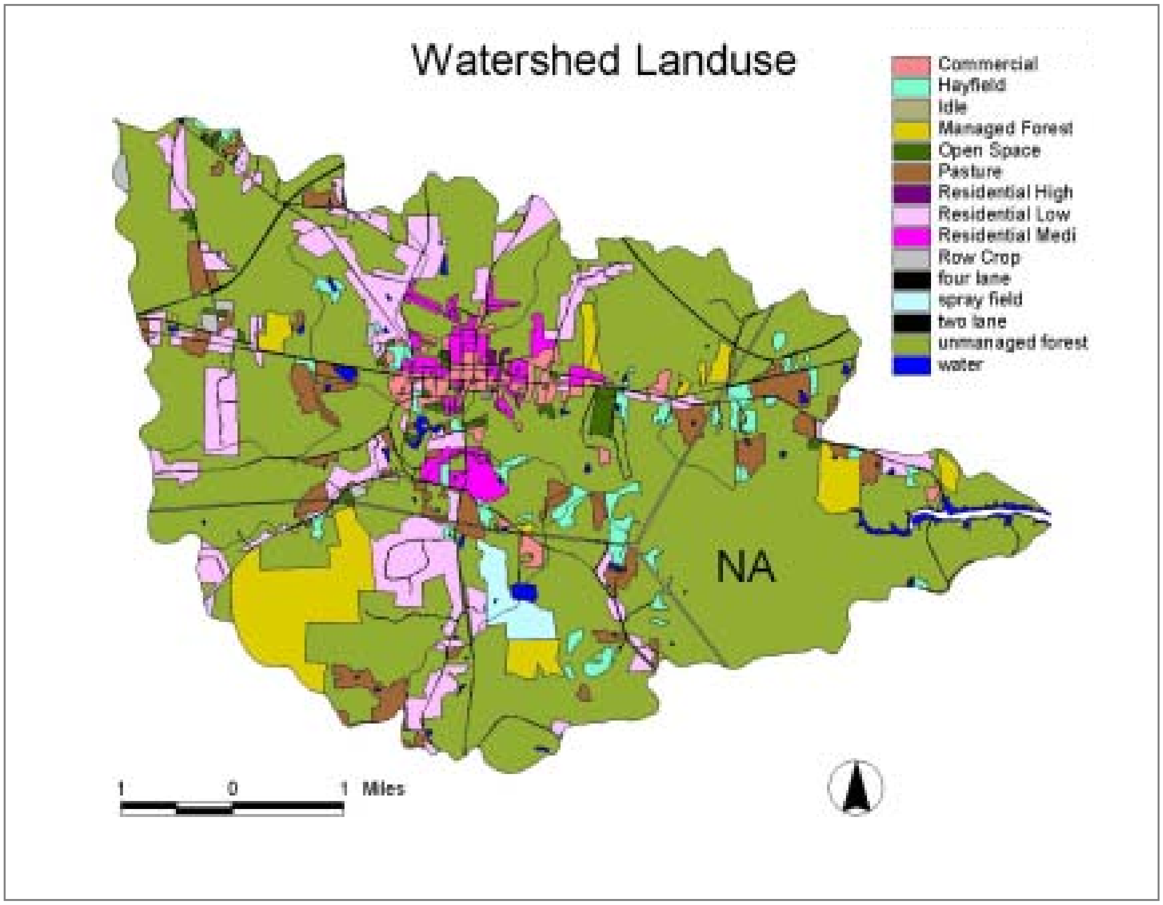

Figure 1.2. Land use map of the Roberson Creek watershed (2002; provided by Angela Moreland of the NCSU Water Quality Group). Landuse digitized by orthoquad and field verification of landuse using orthophotos. Categories are based on Anderson landuse classifications.

1.2 Water Quality Target

Roberson Creek appears on North Carolina's 303 (d) list for chl *a*. This downstream portion of Roberson Creek is partially lentic in nature and can be considered a small cove on the Haw River arm of Jordan Lake (Figure 1.3). Chlorophyll *a*, the dominant pigment in algal cells, is a useful surrogate for algal biomass.

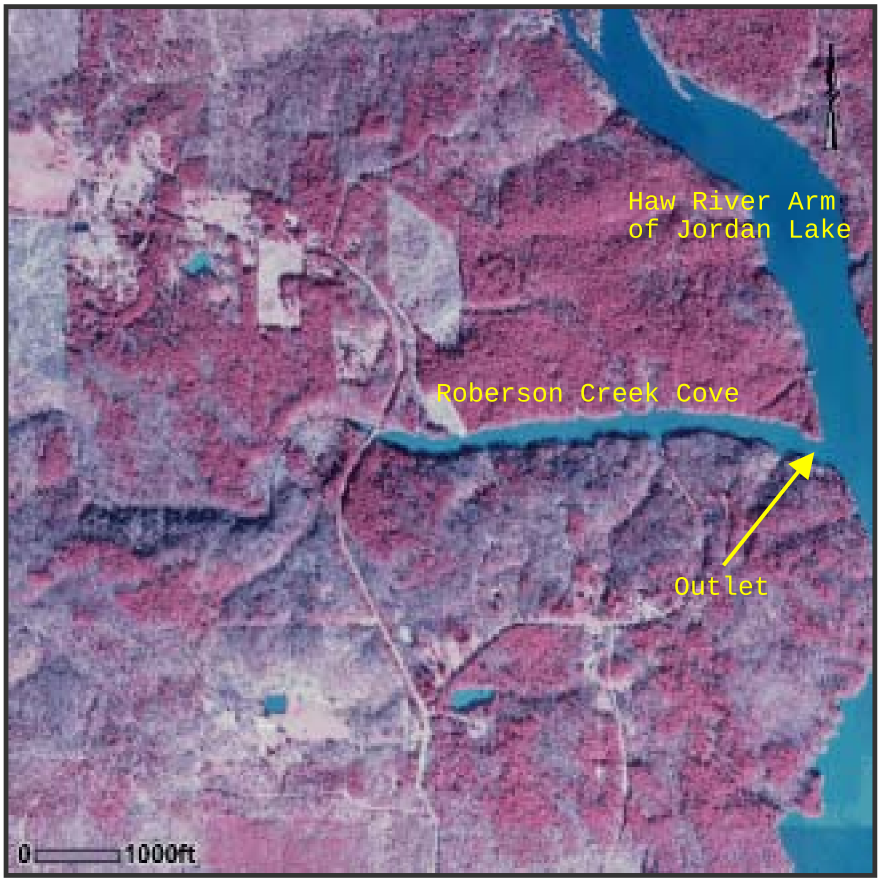

Figure 1.3. Color infrared photography (1998 DOQQ) of the Roberson Creek cove.

The following North Carolina standard (15A NCAC 02B.0211) applies to all freshwater surface waters:

> *Chlorophyll a (corrected): not greater than 40 µg/l for lakes, reservoirs, and other waters subject to growths of macroscopic or microscopic vegetation not designated as trout waters, and not greater than 15 µg/l for lakes, reservoirs, and other waters subject to growths of macroscopic or microscopic vegetation designated as trout waters (not applicable to lakes and reservoirs less than 10 acres in surface area); the Commission or its designee may prohibit or limit any discharge of waste into surface waters if, in the opinion of the Director, the surface waters experience or the discharge would result in growths of microscopic or macroscopic vegetation such that the standards established*

pursuant to this Rule would be violated or the intended best usage of the waters would be impaired.

The TMDL target is based on the frequency of algal blooms: no more than 10% of samples collected in a specified area and time should be above 40 µg/L chl *a*. This target, based on USEPA guidance for use support determination, was also selected for NC's Neuse River Estuary TMDL for Total Nitrogen approved by EPA in 2002 (Office of Water 1997).

Algal growth is affected by numerous biotic and abiotic factors including light availability, flow and water velocity, nutrients (particularly nitrogen (N) and phosphorus (P)), grazing, and other influences. Nutrient controls are the most common focus of management schemes for reducing excessive algal growth. While the chemical factors that determine algal biomass can vary by waterbody and season, P is often cited as a limiting factor in many lakes and reservoirs (Wetzel 2001). When P is limiting, reductions in P will decrease algal productivity because the species is the nutrient in greatest demand in relation to supply.

Phytoplankton communities exhibit varying nutrient requirements but on a whole require N and P in amounts approximately equal to Redfield's (1958) molar ratio of 16N:1P (7.2N:1P by mass). Deviations from this ratio have been used to infer nutrient limitation without the benefit of nutrient bioassay experiments or algal growth potential tests. Ratios less than the Redfield ratio generally suggest P limitation. In Roberson Creek, N:P ratios suggest a stronger P limitation than N. During the period 1997 - 2002, most values (interquartile range) of the TN:TP ratio by mass fell between 7 and 14 (Figure 1.4). This ratio was higher during the latter part of that period.

This TMDL will assess the amount of total P (TP) reduction necessary to comply with the chl *a* target. The focus on P is based on the assumption that P will ultimately control growth. In addition, P is typically more cost-effective to remove from point sources and reductions will drive the cove to an increasingly P limited state (Thomann and Mueller 1987, Wetzel 2001).

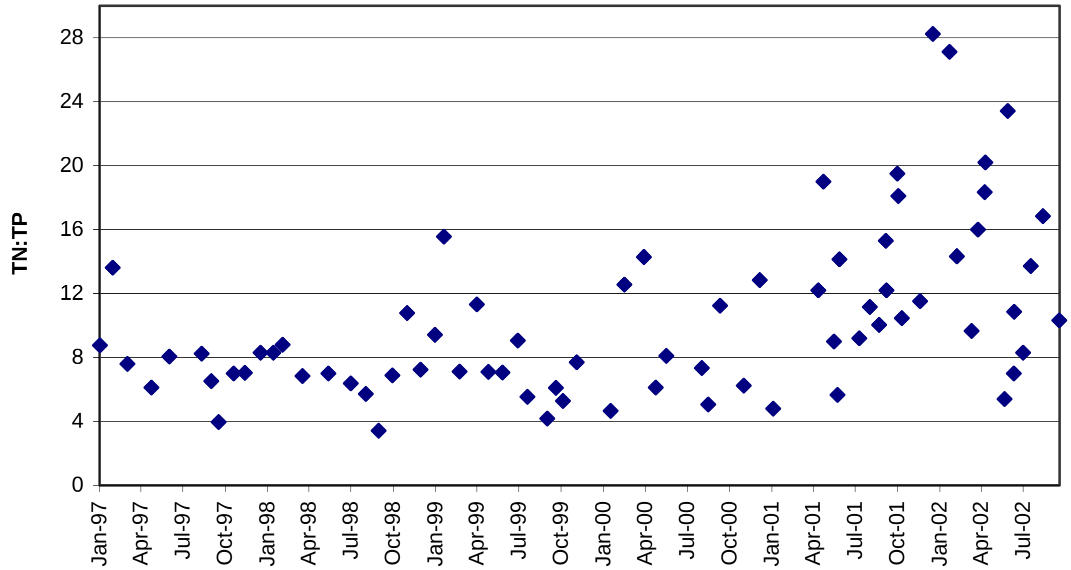

Figure 1.4. Total nitrogen to total phosphorus ratios (TN:TP) by mass for the ambient station (RC10) on Roberson Creek. For reference, the Redfield ratio is 7.2 (by mass).

1.3 Water Quality Assessment

Historical data from the DWQ ambient monitoring station (B2450000), located in the Roberson Creek Cove (Figure 1.5), indicates elevated nutrient levels, high algal productivity and frequent nuisance algal blooms. From 1997 to 2002, mean total phosphorus concentrations ranged from 0.11 to 0.16 mg/L (Table 1.1). The cove can be considered eutrophic for TP and eutrophic/mesotrophic for TN, based on its ranking among findings of the OECD eutrophication program (USEPA 2000). Likewise, trophic state indices (Carlson 1977) calculated for 2001 and 2002 suggest the waterbody is also in a eutrophic state with Trophic State Index (TSI) values between 50 and 70.

Table 1.1. Summary statistics (mean, median, standard error, and number of samples N) for nutrients and chlorophyll *a* samples collected at the Roberson Creek ambient station year round.

		1997	1998	1999	2000	2001	2002 [1]
TP (mg/L)	Mean	.163	.121	.133	.116	.126	.105
	Median	.150	.115	.140	.09	.100	.100
	SE	.02	.019	.009	.015	.024	.014
	N	10	12	12	9	18	15
TN (mg/L)	Mean	1.18	.928	1.00	.867	1.50	1.50
	Median	1.14	.755	1.08	.880	1.29	1.24
	SE	.12	.145	.074	.072	.127	.263
	N	10	12	12	9	18	15
Chl a (µg/L) [2]	Mean	--	29.7	48.8	61.8	38.7	31.7
	Median	--	26.0	45.0	44.0	31.0	30.0
	SE	--	7.6	18.9	28.0	5.9	6.8
	N	--	7	4	4	13	15
Hydrologic Condition		Average	Dry	Wet	Dry	Dry	Dry
Flow (% of Long Term Mean) [3]		82%	140%	83%	48%	26%	26%

1 Summary statistics for 2002 are for Jan – Oct.
2 Chlorophyll *a* data for 1998-2000 are reported as uncorrected for pheophytin, which may overestimate the actual corrected value.
3 Based on 43 year record at the Tick Creek gage.

When indicators of dissolved oxygen (DO) and pH at the ambient station suggest potential blooms conditions, phytoplankton samples are collected by DWQ for biovolume and community analysis. Of the 31 phytoplankton samples collected between 1987 and 2002, 97% were considered blooms (NCDWQ 2002). The magnitude ranged from mild (10,000-20,000 units/ml) to severe (>30,000 units/ml). Algal densities ranged from 12,000 to 244,400 units/ml.

A special study was conducted from December 2000 through August 2002 in support of TMDL development (NCDWQ 2002). There were two stations located in the cove (RC10 and RC11) and 12 stations located upstream throughout the watershed (Figure 1.5). Sample parameters for the study consisted of nutrients (except for orthophosphate), biochemical oxygen demand, DO, pH, temperature, and conductivity. Flow measurements were taken where possible during each sampling event and a stage-flow relationship was developed at RC8 in the lower study area. At two of the sites (RC10 and RC11) located in the cove, additional parameters or analyses included algal community analysis and depth integrated physical profiles.

Warm weather period data did not reveal strong vertical temperature stratification or frequent anoxic bottom waters in the cove. Average pH and DO concentrations reveal elevated algal productivity levels (Table 1.2). Secchi depth, a measure of water column transparency, ranged from 0.35 to 0.53 m, averaging 0.40 m and 0.37 m, respectively during 2001 and 2002.

Table 1.2. Summary statistics for physicochemical properties of the Roberson Creek Cove (2001-2002) based on pooled surface samples from RC10 and RC11 collected during the period, April - October. N = # of samples.

		Temp. (^oC)	DO (mg/L)	pH (std. units)	Conductivity (umhos)	Secchi Depth (m)
2001	Mean	24.5	10.8	8.78	221.7	0.40
	Median	26.0	11.0	8.80	220.0	--
	SE	1.5	0.74	0.35	6.96	0.05
	N	15	15	15	11	2
2002	Mean	26.3	9.78	8.42	289.3	0.37
	Median	27.6	10.6	8.80	305.5	0.34
	SE	1.41	0.86	1.41	50.7	0.04
	N	12	12	14	8	6

Nutrient concentrations (TP and TN) for RC8, the most downstream tributary station, and RC10, the ambient station in the cove are shown in Figure 1.6. Concentrations in the cove were generally lower than the those at RC8. This may be attributable to factors such as sedimentation, algal uptake and dilution.

Time series data for chl *a* (modified non-acidification method) in Figure 1.7 indicates frequent exceedences of 40 µg/L during both years, primarily during summer and fall. Most values exceed 20 µg/L. Chlorophyll *a* concentrations in the cove averaged 32.9 µg/L and 39.1 µg/L (medians were 25.8 µg/L and 33.8 µg/L) during the period April through October of 2001 and 2002, respectively. Data collected during 2001 and 2002 (primarily 2001) are used for modeling and establishing the TMDL.

RC4 Roberson Creek at 15/501 Pittsboro
RC5ups Roberson Creek WWTP upstream monitoring site
RC5eff Roberson Creek WWTP effluent outfall site (#NC0020354)
RC5dns Roberson Creek WWTP downstream monitoring site
TC1 Turkey Creek at Hwy 15/501 (upstream from Townsend Foods
TC2 Turkey Creek at SR1012 (downstream from Townsend Foods)
TC3 Turkey Creek 100 feet upstream Roberson/Turkey confluence
CC2lft Camp Creek upstream of tributary draining Townsend Foods
CC2rt Un-named tributary draining Townsend Foods property
CC bdg Camp Creek at SR1012 (downstream from Townsend Foods)
CC3 Camp Creek 100 feet upstream from Roberson/Camp confluen
RC8 Roberson Creek at flow rating site near Lucian Bland Rd.
RC10 Roberson Creek arm at boat ramp (ambient site #B2450000)
RC11 Roberson Creek arm at 0.5 mi downstream from RC10

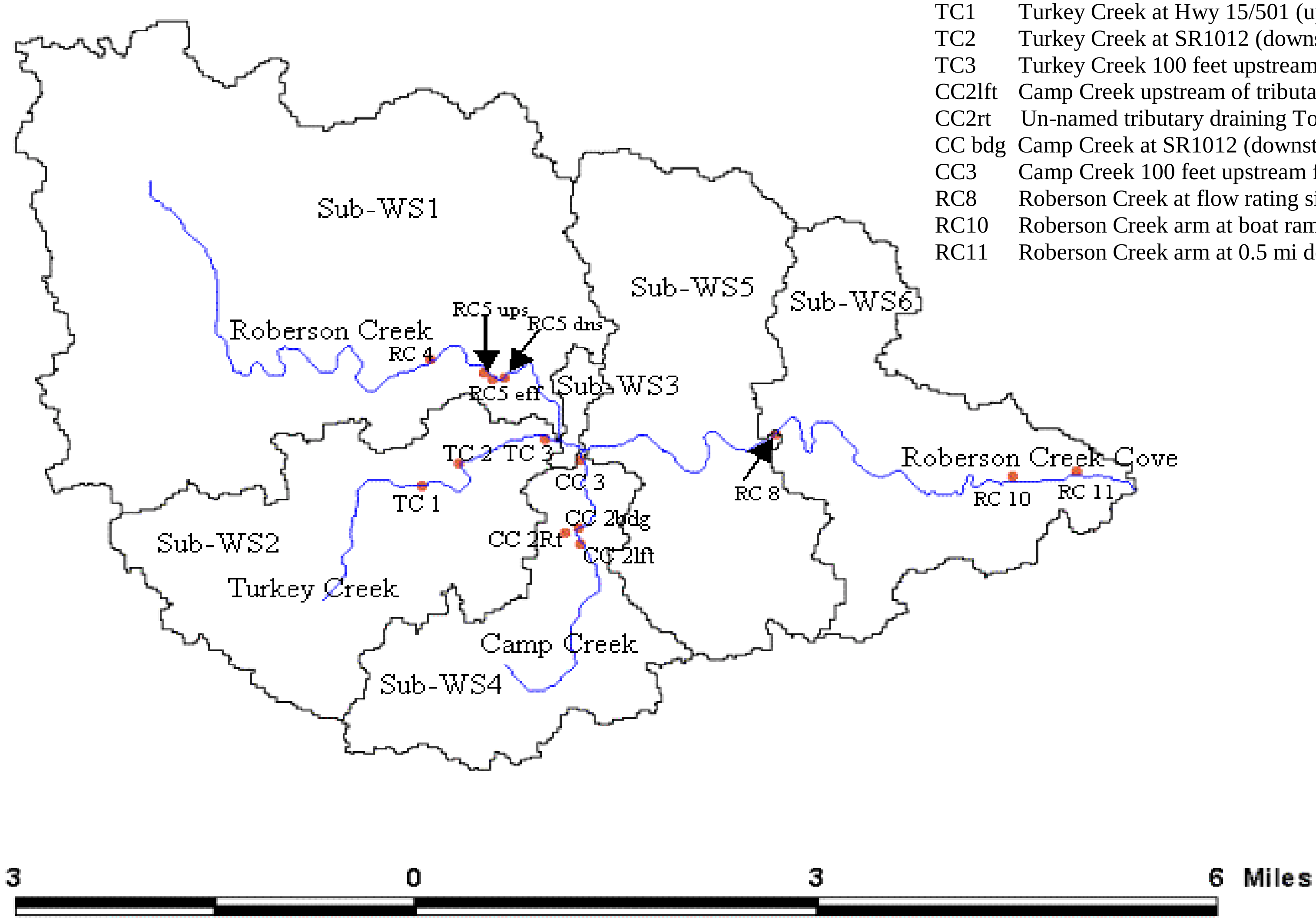

Figure 1.5. Location of sampling stations and subwatersheds in the Roberson Creek watershed during the TMDL study.

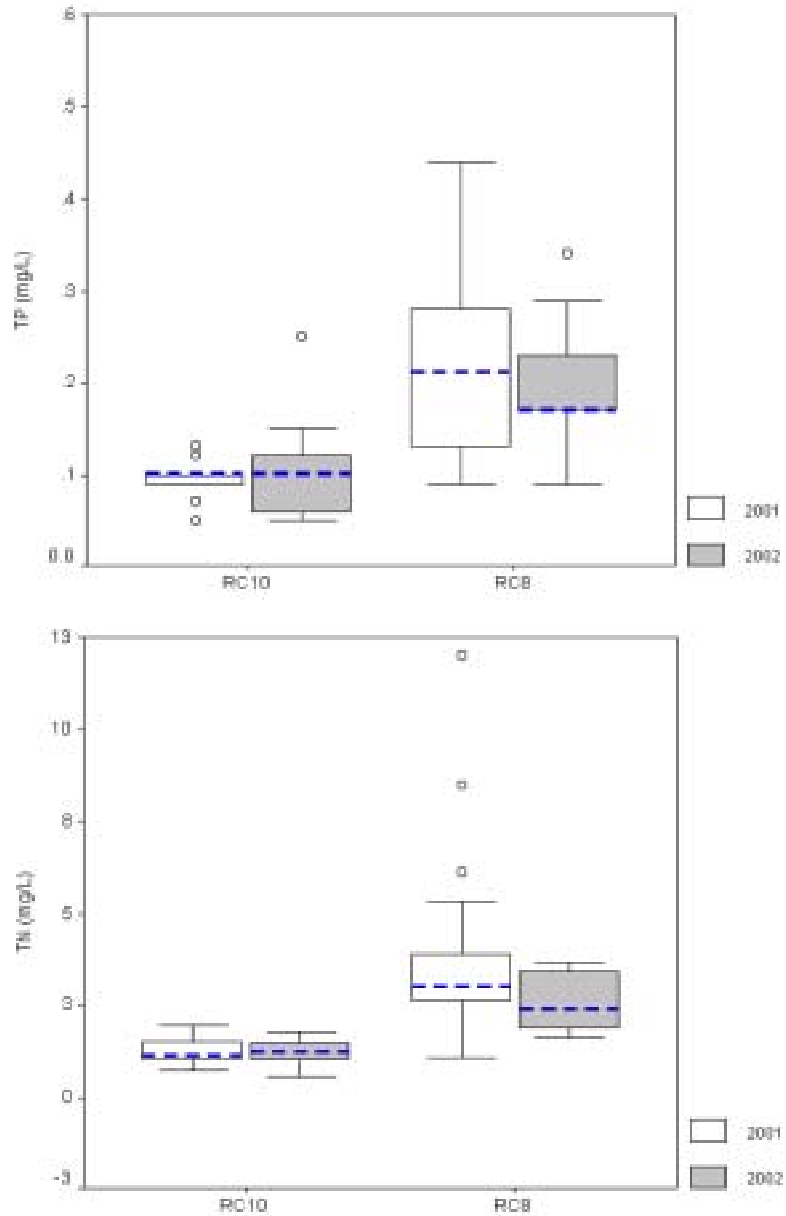

Figure 1.6. Boxplots of nutrient concentrations (total phosphorus-top; total nitrogen-bottom) for stations RC8 and RC10 during the April - October periods of 2001 and 2002. The boxes represent the median (dashed line), quartiles and outliers. One TP value (0.84 mg/L) from 5/30/2001 at RC8 is not shown on the graph.

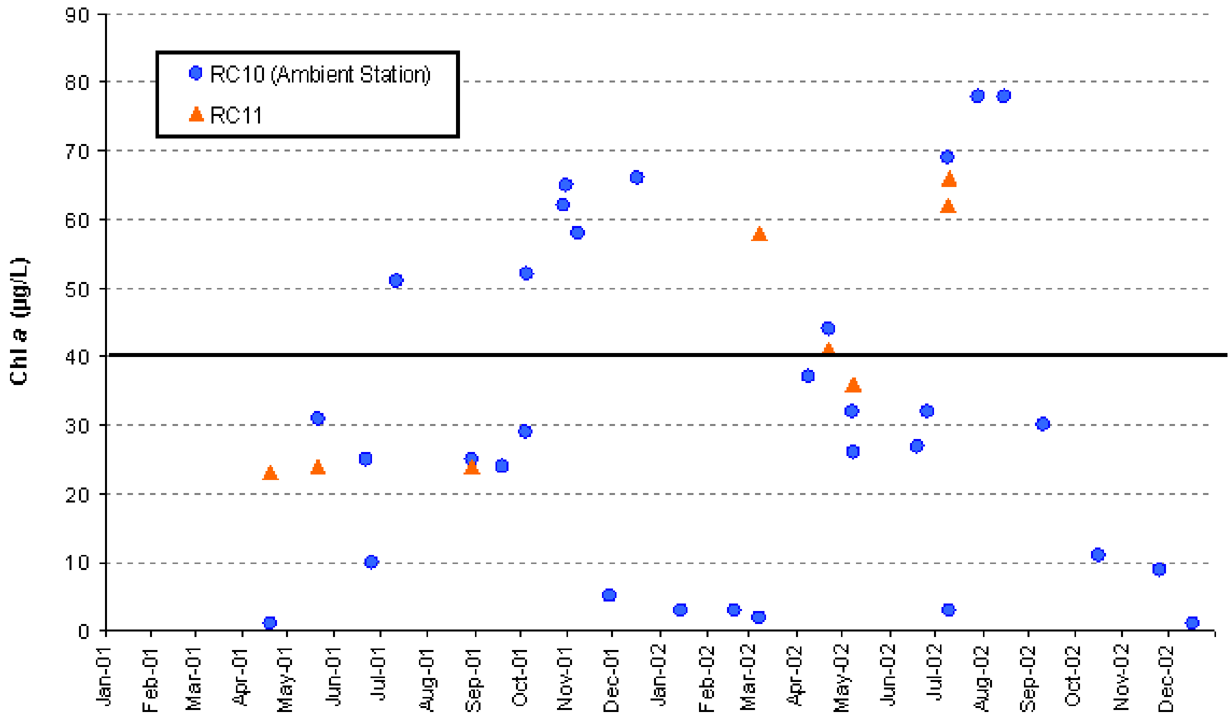

Figure 1.7. Chlorophyll *a* concentrations at RC10 and RC11 for the period 2001 through 2002.

2 Source Assessment

Nutrients are transported from throughout the watershed to Roberson Creek in two primary ways: runoff and direct point source. Runoff from various land uses contributes nutrients to the impaired waterbody primarily during storm events. The other major source of nutrients is the Town of Pittsboro Wastewater Treatment Plant.

The DWQ monitors a suite of water quality parameters, including nutrients, at an ambient station on Roberson Creek Cove on a monthly basis (RC10). During the special TMDL study for the Roberson Creek watershed, there were five stations on the creek and seven stations on the tributaries of the creek (Figure 1.5). The station, RC8, was responsible for delivering the majority TP from the Roberson Creek watershed down to the cove. The longitudinal distribution of TP from near downtown Pittsboro to the watershed outlet (RC8) is given in Figure 2.1. The data collected for the study is presented in Appendix 1.

2.1 Point Source Assessment

Point sources are typically those regulated under National Pollutant Discharge Elimination System (NPDES) programs. Permitted discharge facilities measure nutrient levels in their effluent at a frequency based on facility class and waste type. Currently, there is one NPDES permitted point source, the Pittsboro Waste Water Treatment Plant (WWTP), in the Roberson Creek watershed. The plant discharges domestic waste in the watershed, five miles upstream from RC8. The plant is permitted to discharge 0.75 MGD (monthly average) of effluent water with TP concentration of 2.0 mg/liter (quarterly average). There are no regulated MS4 areas within the watershed.

In 2001, the annual average concentration of TP before reaching the WWTP site (S2_RC5eff) was 0.07 mg/l (Figure 2.1) RC5_eff is the site at the outlet of the effluent plant. TP measured at the site is the concentration of the effluent, not the concentration of the water of the creek. The average concentration peaked to 2.5 mg/l at the WWTP site, which was higher than the permitted concentration 2 mg/l. As the water routed to downstream, the concentration gradually reduced to 0.92 mg/l at the station S3_RC 5dns. The concentration of TP at the WWTP site ranged from 0.2 mg/l to 9.0 mg/l. Out of 16 samples collected in 2001, 8 samples indicated TP concentration below 1.9 mg/l and four indicated above 3.2 mg/l.

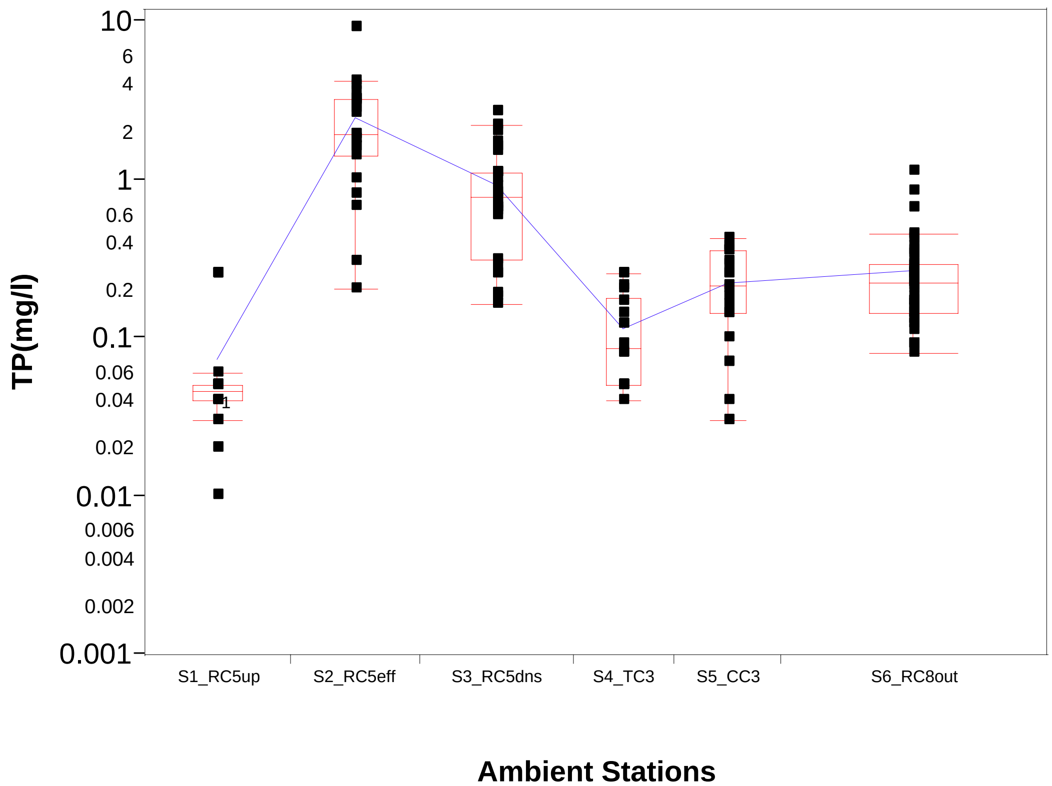

Figure 2.1. Box plot showing total phosphorus concentration at the stations in Roberson Creek Watershed. The stations are arranged from upstream to downstream. The prefix S stands for station; RC for Roberson Creek; CC for Camp Creek; and TC for Turkey Creek. The line connects the means at each station.

2.2 Non-Point Source Assessment

Non-point sources are diffuse sources that typically cannot be identified as entering a water body at a single location. Agriculture and urban lands were the two major non-point sources of TP in the watershed (Figure 1.2). Agriculture land sources included cropland, pasture/hay land, and forested land. Urban land sources were streets, lawns, roofs, driveways, parking lots, and sewer.

2.2.1 Agricultural Lands

Sources of TP in agriculture lands are chemical fertilizer, wastewater, and litter fall. In the watershed, a majority of farmers practiced animal grazing and hay cultivation during 2001. They applied nitrogen fertilizer, 33-0-0, twice in a year at a rate of 168 kg/ha (source: Mr. Henry Outz, Chatham Soil and Water Conservation District). The first application began in the second week of March and the second application in the second week of September. Hay was harvested in May.

Townsend Foods, Inc. owns about 600 acres of land and manages a 16-acre lagoon. Most of the land is used to graze a modest herd of cattle except in the waste lagoon spray fields The company has acquired a DWQ permit (WQ0001755) and is allowed to operate the spray fields (130 acres) with no discharge to surface waters.

Townsend Foods irrigated the spray fields three to four times a month during 2001 (Source: DWQ Permit #WQ0001755). The amount of irrigation was estimated to be 2.6 mm per month. The concentration of TP in the irrigated lagoon wastewater was estimated to be 11 mg/l (3 kg/ha) (Table 2.1). Phosphorus from the irrigated wastewater, transported via surface and sub-surface runoff, appears to have moved into Turkey Creek and Camp Creek (Figure 2.1). These results suggest that the spray fields owned by Townsend Foods Inc. may have delivered considerable amounts of P to Roberson Creek during storm events in 2001.

Table 2.1. Average concentration of total phosphorus (mg/l) in Townsend irrigation wastewater in 2001.

Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec
NA	NA	NA	9	NA	NA	NA	9.5	13.7	12.9	8	15.1

Litter fall accumulation in forested lands seems to have also delivered organic P in Roberson Creek. Osborne and Kovacic (1993) reported that during the winter dormant season, due to continuous deposition of leaves, the level of P reaches saturation stage in forested land and eventually leaks P. A separate field measurement of P concentration with regard to litter fall accumulation in Roberson Creek watershed was not conducted in this study. However, an assessment of P in this regard was undertaken by using a watershed model, Soil and Water Assessment Tool, Version 2000. The results of the model are explained in the following sections.

2.2.2 Urban lands

Human activities in urban areas seem to be a major source of TP to Roberson Creek. Frequent dish and car washing soaps and detergents that contain P could be a source of TP to the creek, possibly via runoff and/or sewer leakage. The statewide phosphate detergent ban in 1988 may have minimized some (but not all) of these sources. In North America and Europe, domestic sewage produced by 1 person each year contains about 0.8 kg of P (http://www.glencoe.com/sec/science/biology/ bacc / teacher_resources/pdfs/ext-inq.pdf).

Fertilizer applications to lawns are also a major source of TP in Roberson Creek. In 2001, fertilizers used for lawns were 18-24-10 (N-P-K) and 10-10-10. The fertilizers were applied four times in a year - two applications in March/April and remaining two in September/October. The fertilizers were applied to lawns at the rate of 50 lbs. per 12,000 square feet. In a study conducted in Lake Wingra and Lake Mendota, Madison, Wisconsin, the combined contribution of P within the basins from lawns and streets was estimated to be 80%, with lawns contributing more than the street (Waschbusch et al. 1995).

Overall, the combined effects of above point sources and non-point sources are estimated to be 0.26 mg/l of TP in a year-round average at the ambient station, RC8 (Figure 2.1). The station is located about 1.8 mile upstream from the cove.

3 Modeling Approach

3.1 Receiving Water Model

3.1.1 Model Framework

The empirical eutrophication modeling package, BATHTUB v. 5.4, was employed to model the effect of nutrient loading on water quality in the Roberson Creek Cove. An estimation of tributary loadings for input into BATHTUB was determined using an associated model, FLUX v. 5.1.

BATHTUB applies nutrient balance and eutrophication response models to lakes and reservoirs (including partial reservoirs and embayments) (Walker 1996). The program performs steady-state water and nutrient balance calculations accounting for advective and diffusive transport and nutrient sedimentation. Eutrophication related state variables are predicted from empirical relationships developed and tested from assessment of US Army Corps of Engineers' reservoir data (Walker 1983). Inputs and outputs are expressed in probabilistic terms (mean and CV or coefficient of variation) to account for limitations in data and model errors. Output CVs are based on first-order error analysis.

Mass balances are computed at steady state over an appropriate averaging period. The averaging period is typically 1 year for reservoirs with long residence times or seasonal (e.g. May-September) for reservoirs with relatively short residence times. Day-to-day changes in load or eutrophication parameters cannot be represented in the model. Therefore, short-term responses and effects cannot be explicitly evaluated.

Several options are available within BATHTUB for modeling nutrient sedimentation, chl *a*, and transparency. They include first and second order models of N and P sedimentation. Also, there are 5 chl *a* models to choose from with variables including N, P, turbidity and flushing rate.

The model has been successfully applied in several management efforts in N.C. (Butcher et al. 1995, NCDEHNR 1992; Research Triangle Institute 1998) and throughout the U.S. (Kennedy 1995, Illinois Environmental Protection Agency 2002). BATHTUB has been cited as an effective tool for water quality assessment, particularly where data are limited (Ernst et al. 1994).

FLUX is used to estimate tributary nutrient loading for input into BATHTUB from grab sample concentrations and continuous flow data. The program derives flow weighted nutrient concentrations from tributary sample data and continuous flow data over a specified averaging period. Flow-weighted concentration is a ratio of the constituent load to the mean discharge. Available loading calculations methods include direct load averaging, ratio estimates, and regression methods.

Data for the period April 1 to October 31, 2001, an extended algal growing season, was used to calibrate the BATHTUB model. A verification exercise was carried out using data from 2002 to evaluate model performance.

3.1.2 Model Setup

3.1.2.1 Segment Morphometry

The Roberson Creek Cove was modeled in BATHTUB as a single reservoir embayment (spatially averaged). Based on a comparison of data from RC10 and RC11, the two cove sites, this configuration is appropriate because spatial variations in nutrients and chl *a* are relatively unimportant. Longitudinal dispersion is not considered with this configuration. The cove length (~1.75 km) and surface area (~0.13 km^2) were approximated using georeferenced color infrared photography (DOQQ; Figure 1.3) and standard GIS spatial measurement tools (ArcView 3.3). The mean depth was 4.5 m and 3.2 m during 2001 and 2002, respectively. Mean depth of the mixed layer was estimated using a multivariate regression equation provided by Walker (1996).

The major external inflow to the cove is Roberson Creek. Smaller inflows downstream of RC8 on Roberson Creek are not monitored (or gaged) and must be accounted for indirectly by adjusting loads and flows at RC8 upwards. The drainage divide at RC8 was manually delineated using Arcview Spatial Analyst with the aid of a USGS topographic map.

The confluence of the Roberson Creek and the Haw River Arm of Jordan Lake is modeled as a simple outflow boundary with no diffusive exchange. Outflow is predicted using water balance calculations. The outflow assumption is based primarily on two factors: (1) the lack of hydraulic flow data for diffusive exchange with the Haw River and (2) the lake elevations (and therefore volume) at the Jordan Dam during 2001 decreased steadily between April and October supporting the notion that flows did not back up into the cove. During 2002, the elevation at the Jordan Dam decreased until September when it increased by about 2 meters from September through the end of October. However, a hydrodynamic model of Jordan Lake indicated that net water movement in the Haw River arm occurs overwhelmingly in the southward direction (Tetra Tech 2002). Therefore, if any exchange does occur, it is likely limited to infrequent, isolated occurrences and considered insignificant to the overall eutrophication response of the Roberson Creek Cove.

3.1.2.2 Climate Input and Atmospheric Loads

Precipitation data (2001 – 2002) from the Siler City Airport in Chatham County was supplied by the State Climate Office of North Carolina. Located to the west of the cove, the Siler City station was chosen due to its proximity to the Tick Creek stream over a station at Chapel Hill to the north.

Pan evaporation data from Chapel Hill (Chapel Hill 2W) was provided by the National Climatic Data Center in Asheville, NC. A pan coefficient of 0.71 was applied to calculate evaporation in the cove (Yonts et. al 1973).

BATHTUB also requires atmospheric loading of nutrients. Data for wet and dry deposition of TN was taken from U.S. EPA (2001; Candor station-CND125). Since data for 2002 was not available, values from 2001 were also used in the 2002 verification exercise. Deposition of TP was taken from Dodds et al. (1992).

3.1.2.3 In-Lake Concentrations

Monitoring data from the ambient station in the Roberson Creek Cove and data collected during the TMDL study were summarized for input into BATHTUB. The model requires inputs of growing season mean and CV_{mean} for TN, TP, organic N, secchi depth, and chl *a*. Orthophosphorus data were not available. For summary purposes, data below detection limit was converted to one half of the limit value. Data from RC10 and RC11 were pooled (averaged across stations on a given date). All values are based on surface grab samples since water column profile data were not available for nutrients and chl *a*.

3.1.2.4 Tributary Loading Estimates

Daily Flow Estimates

FLUX requires daily mean flows for the selected period of interest. Roberson Creek is not gaged, therefore flow data from a nearby station with a continuous flow record was adapted for use. In selecting an appropriate gage, factors of proximity, drainage area characteristics, and location within the same hydrologic area are important. Daily mean flow for Roberson Creek is estimated based on constant runoff per square mile of the selected gage, adjusted for water withdrawals and discharges.

Two candidate gages were considered: Rocky River at SR1300 (USGS 0210166029) and Tick Creek (USGS 02101800). The drainage areas for the Rocky River and Tick Creek gages are 7.4 and 15.5 square miles, respectively. Both Chatham County sites are located in the same low flow hydrologic area (HA7) as the Roberson Creek watershed (Giese and Mason 1993). Low flow hydrologic areas are regions with relatively uniform low-flow characteristics. In the Piedmont, underlying rock type is the most important factor influencing the delineations. The watersheds of the Rocky River and Tick Creek gages are similar to Roberson Creek: heavily forested with relatively small percentages of urban development.

Daily flows for Roberson Creek were estimated by multiplying flow at the candidate gage by the ratio of the drainage areas (e.g., RC8 drainage area divided by Tick Creek drainage area). The resulting flow was further adjusted for Pittsboro's wastewater treatment plant discharge by adding the flow to the estimated Roberson Creek flow (at RC8). A comparison of 2001 flow (April – October) for the two gages with instantaneous flow from Roberson Creek site RC8 is shown in Figure 3.1.

The daily flows estimated from the Tick Creek gage were chosen for further use in modeling. It captured the storm flows better than the Rocky River gage and tracks the pattern of instantaneous flow measurements reasonably well. Note that flow is underestimated in part of late summer and fall. However, most of these flows are below 5 cfs so the difference is not expected to have a large effect on loading estimates.

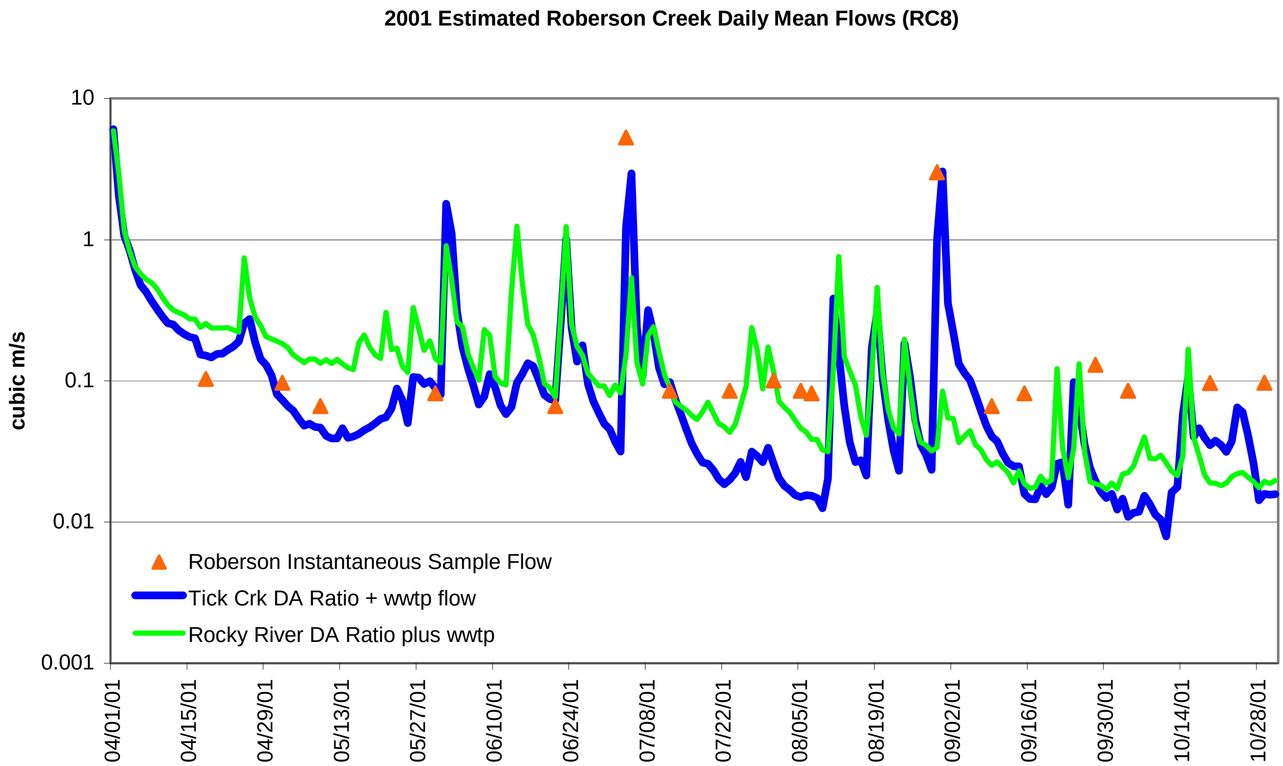

Figure 3.1. Comparison of estimated Roberson Creek stream flow at RC8 using Tick Creek and Rocky River gages (adjusted for wastewater treatment plant flow) with instantaneous flow data collected at RC8.

Selection of Loading Calculation Method

There are many different approaches that can be used to estimate nutrient loads from observed concentration and flow data. The true value of load can only be determined with continuous flow and concentration records. Several choices are available within FLUX for load calculations including direct load averaging (Method 1), ratio estimates (Methods 2 and 3), and regression methods (Methods 4-6). Loading estimates are generally chosen based upon minimum bias and minimum variance. Unrepresentative sampling or use of an inappropriate calculation method contributes to bias, representing the difference between the estimate and the true value. Method selection is often based primarily upon minimum variance given representative sampling and reasonably independent residuals (flow, date, and autocorrelation). Optional stratification of the data into subgroups based on flow, date, and/or season may increase accuracy and precision of loading estimates in some cases.

Load Determination for 2001

In smaller, flashy streams like Roberson Creek, variance and extremes of instantaneous sample flows will be higher than those of daily mean flows. In order to reduce bias, daily mean flows were substituted for instantaneous sample flows (Walker 1996).

The data were stratified into two subgroups based on flow. Although the averaging period was generally dry, there were a small number of samples collected following storms (Figure 3.2). Data limitations allowed only 3 samples (model minimum) in the highest flow strata. Following data stratification, loading estimates using methods 1 through 4 tended to converge and the CV values were reduced. This limited variation among calculation methods is desirable and indicates robustness. Estimated mass loading to this site among all six calculation methods ranged from 489 to 618 kg of P. Selection was based on the lowest CV value and the lack of slope significance for residuals graphed versus date and flow. Method 3 was chosen in all cases.

Method 3 in the FLUX model is a modified ratio estimator based on Beale (1962), which calculates load as the flow-weighted average concentration times the mean flow over the average period with a statistical correction for bias (Table 3.1). This ratio method performs best when flow and concentration are weakly related, although it adjusts for potential bias when there is a stronger relationship. A plot of TP concentrations with flow generally confirms this type of relationship (Figure 3.3). At the highest flows, concentration decreased during the period of interest. The pattern was similar for TN and inorganic N. Ratio methods, in general, tend to be more robust than other approaches with respect to bias from constituent characteristics (Preston et al. 1989).

Table 3.1 FLUX equations used for calculation of tributary loads to Roberson Creek (from Walker 1996).

Method 2 - Flow-Weighted Concentration (Ratio Estimate)

$$W_2 = W_1 \text{ Mean}(Q)/\text{Mean}(q)$$

Method 3 - Modified Ratio Estimate (Bodo and Unny 1983)

$$W_3 = W_2(1 + F_{wq}/n)/(1 + F_q/n)$$

where

c_i	=	measured concentration in sample i (mg/m^3)
q_i	=	measured flow during sample i (hm^3/year)
b	=	slope of ln(c) versus ln(q) regression
a	=	intercept of ln(c) versus ln(q) regression
w_i	=	measured flux during sample i = q_i c_i (kg/year)
F_{wq}	=	Cov(w,q) / [Mean(w) Mean(q)]
F_q	=	Var(q) / [Mean(q) Mean(q)]
F_Q	=	Var(Q) / [Mean(Q) Mean(Q)]
Q_j	=	mean flow on day j (hm^3/year)
n	=	number of samples (i)
N	=	number of daily flows (j)
W_m	=	estimated mean flux over N days, method m (kg/year)
V_m	=	variance of estimated mean flux, method m (kg/year)^2
r	=	0.5 b (b + 1)
$\sum_j$	=	sum over N dates in daily flow record
SE	=	standard error of estimate for ln(c) versus ln(q) regression
Mean(x)	=	mean of vector x
Var(x)	=	variance of vector x
Cov(x,y)	=	covariance of vectors x and y

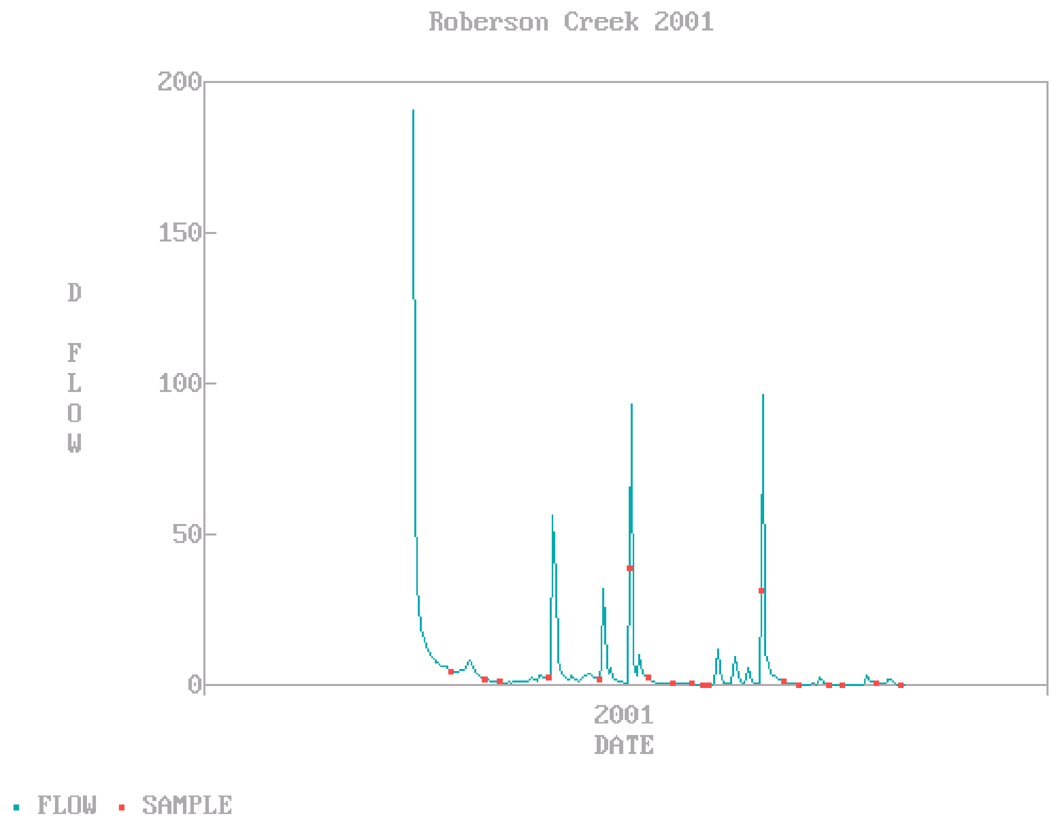

Figure 3.2. Plot of daily flow record (April – October 2001) and dates of sample collection (red squares) for RC8 on Roberson Creek. The symbols indicate the daily flows on the dates of sample collection. Flow units are hm^3/yr (= cfs * 0.893).

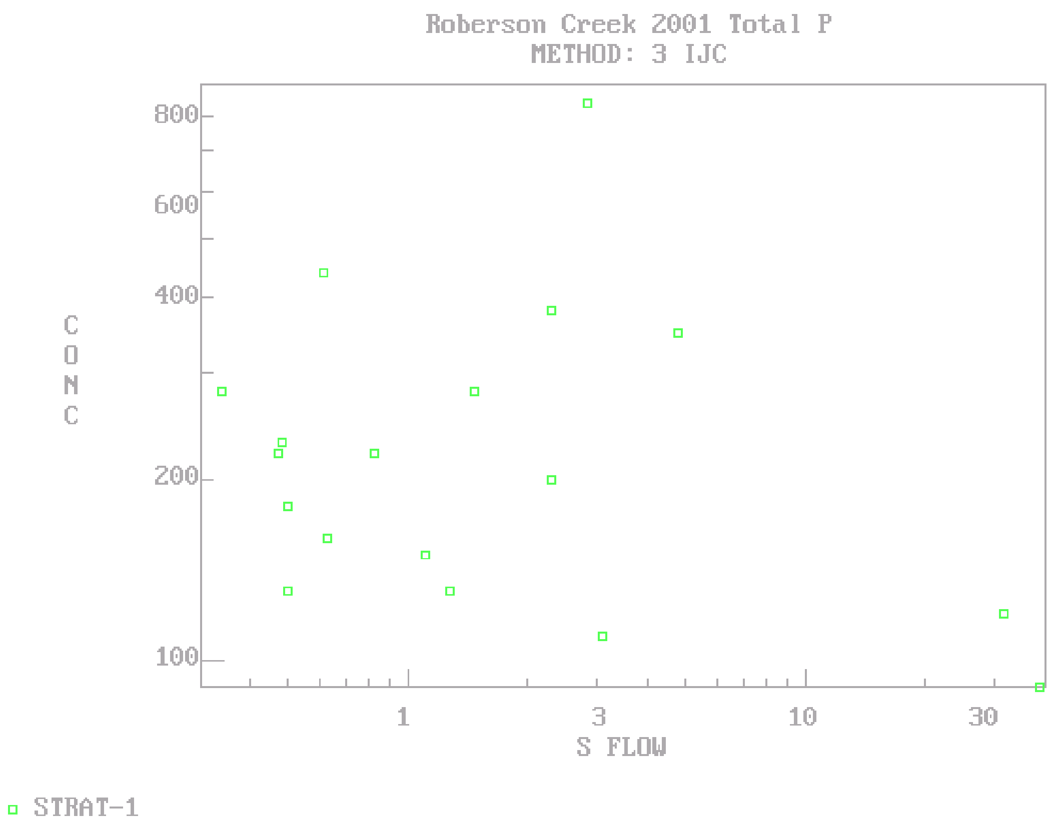

Figure 3.3. Plot of sample flow (hm^3/yr) versus total phosphorus concentration (mg/m^3) during the period April through October, 2001 at RC8.

Load Determination for 2002

For summer 2002, the data were limited (8 sampling dates, April – August) and storm flows, primarily during October, were not sampled (Figure 3.4). Therefore, a low percentage of the flow volume was sampled. Walker (1996) recommends using calculation method 2 or 3 when load estimates must be generated from limited data and weakly representative sampling. The data were not stratified into subgroups and flow substitution was not used. The choice between method 2 or 3 was decided based upon the lowest CV value. Method 2 was chosen in all cases. This method is similar to method 3 used for 2001 and can be considered a ratio estimate (Table 3.1).

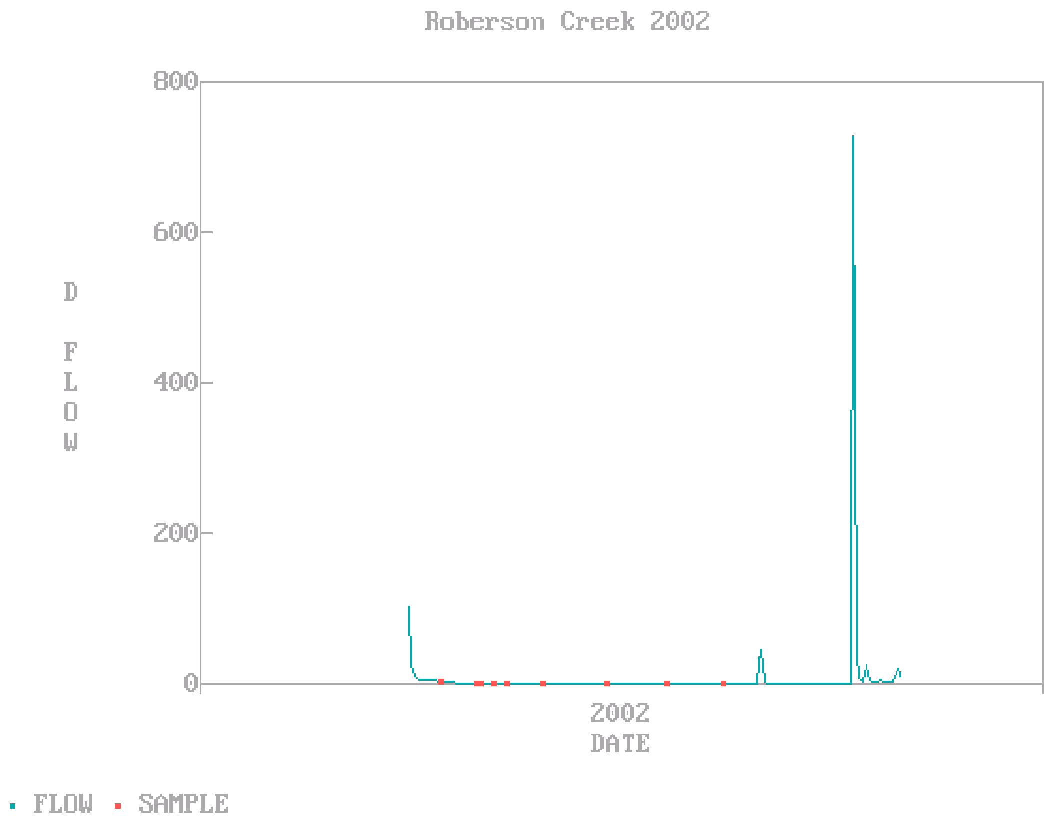

Figure 3.4. Plot of daily flow record (April – October 2002) and dates of sample collection (red squares). The symbols indicate the daily flows on the dates of sample collection. Flow units are hm^3/yr.

Loading Results

Data collected at the most downstream tributary station, RC8, was used to calculate loads and flow-weighted concentrations using FLUX. The watershed area above RC8 is approximately 24.6 square miles (~86% of the Roberson Creek watershed). Loading estimates generated with FLUX were adjusted upward slightly to account for the additional drainage area downstream of RC8 assuming a constant load per unit area. Accordingly, the summer loading estimate to the cove for TP loading in 2001 was 597 kg with a standard error of 101 kg. This load is computed by multiplying the adjusted flow volume during the period (6.9 hm^3/yr*0.586) by the flow-weighted concentration derived using method 3. Table 3.2 presents flow-weighted concentrations for TP, TN and inorganic N required for input into BATHTUB.

Since orthophosphorus data were not available, input for BATHTUB was assumed to be 70% of TP. Although higher than the proportion used for the Jordan Lake Nutrient Response Model (55%; Tetra Tech 2002), this conservative approach is supported by the dominant role of the Pittsboro wastewater treatment plant. Phosphorus in wastewater (raw to treated) is 60 to 70% inorganic on average (Thomann and Mueller 1987).

Table 3.2. Estimated summer flow-weighted concentrations for the Roberson Creek Cove using adjusted FLUX results (April through October).

2001		
	Concentration (mg/L)	CV_{mean}*
Total Phosphorus	0.148	0.170
Total Nitrogen	1.950	0.153
Inorganic Nitrogen	1.426	0.226

2002		
	Concentration (mg/L)	CV_{mean}
Total Phosphorus	0.166	0.165
Total Nitrogen	2.369	0.147
Inorganic Nitrogen	1.915	0.182

* CV_{mean} = standard error of the mean divided by the mean.

3.1.3 BATHTUB Calibration

Data for the period April 1 to October 31, 2001 (a dry year) was used to calibrate the BATHTUB model. Following specification of data inputs, water balances were checked for conservation of mass. Calculated nutrient turnover ratios (length of averaging period/mass residence time) that exceed 2.0 support the use of a seasonal averaging period, the period over which water and mass balance calculations are performed. For 2001, turnover ratios for the uncalibrated model were 11.0 and 10.3 for TP and TN, respectively. Hydraulic residence time was approximately 31 days during 2001.

Application of BATHTUB proceeds with selection and calibration of submodels for nutrient sedimentation (N and P) and empirical eutrophication response for chl *a*. Selection of a submodel for diffusion was not necessary for this application since the cove is considered as a single segment.

Several t-statistics calculated from observed and estimated data are used to select and calibrate submodels. Two statistics supplied by the model, T2 and T3, aid in testing model applicability. T2 is based on error typical of model development data set. T3 is based on observed and predicted error, taking into consideration model inputs and inherent model error. The statistics indicate whether the means differ significantly at the 95% confidence level. If their absolute values exceed 2, the model may not be appropriate. The T1 statistic can be used to determine whether additional calibration is desirable. In cases where predicted and observed values differ significantly, calibration coefficients can be applied to account for the site-specific application of the model. Calibration to account for model error is often appropriate. However, Walker (1996) recommends a conservative approach to calibration since differences can result from factors such as measurement error and random data input errors.

For P and N sedimentation, the initial test of model applicability excluded first order models. In the case of P, a second order decay rate function (model 2) was chosen for its superior fit using T2 and T3 error statistics. The Bachman (1980) model based on volumetric load was selected for N sedimentation. T1 values for both models indicated that additional calibration was not necessary.

Chlorophyll model selection and calibration proceeds similar to nutrients described above. The available chl *a* models in generalized form are shown in Table 3.3. Following exclusion of models 1, 2 and 5 based on T2 and T3 error statistics, model 3 and 4 were evaluated further. Secchi depth in the cove indicates that irradiance (light) is not an insignificant control on algal productivity. Since a term for light is not included in the two candidate models, predicted chl *a* may be overestimated. Model 4 underestimated chl *a* concentrations, which appeared counterintuitive. Therefore, Model 3 was selected (Equation 3.1).

$$\text{chl } a = CB*0.2*(X_{pn}^{\ 1.25})\text{-----------------------------}(3.1)$$
$$X_{pn} = [P^{-2} + ((N\text{-}1\ 50)/12)^{\ -2}]^{\ -0.5}$$

Chlorophyll *a* concentration is in units of mg/m^3 (or µg/L) and the composite nutrient (P and N) concentration in mg/m^3 (X_{pn}) is based on TN and TP (see Walker 1996). A calibration factor (CB) of 0.83 was applied to the model to account for a minor overestimation. The empirical models available within BATHTUB are generalizations about reservoir response. Unique features of a particular reservoir often requires calibration in this fashion to match observed reservoir conditions. Such an adjustment is necessary and appropriate if done in a conservative manner as recommended by Walker (1996).

To some extent, the calibration factor incorporates the depressive effects of light limitation on algal growth. The utility of this factor is limited, however, because the model is not linear. Finally, since organic N is calculated using chl *a*, a calibration factor of 0.83 was applied to this constituent as well. Final results of the calibrated model are presented in Figure 3.5.

Table 3.3. Chlorophyll *a* models within BATHTUB described according to limiting factors.

Model	Limiting Factors
1	P, N. light, flushing
2	P, light, flushing
3	P, N
4	P (linear)
5	P (exponential)

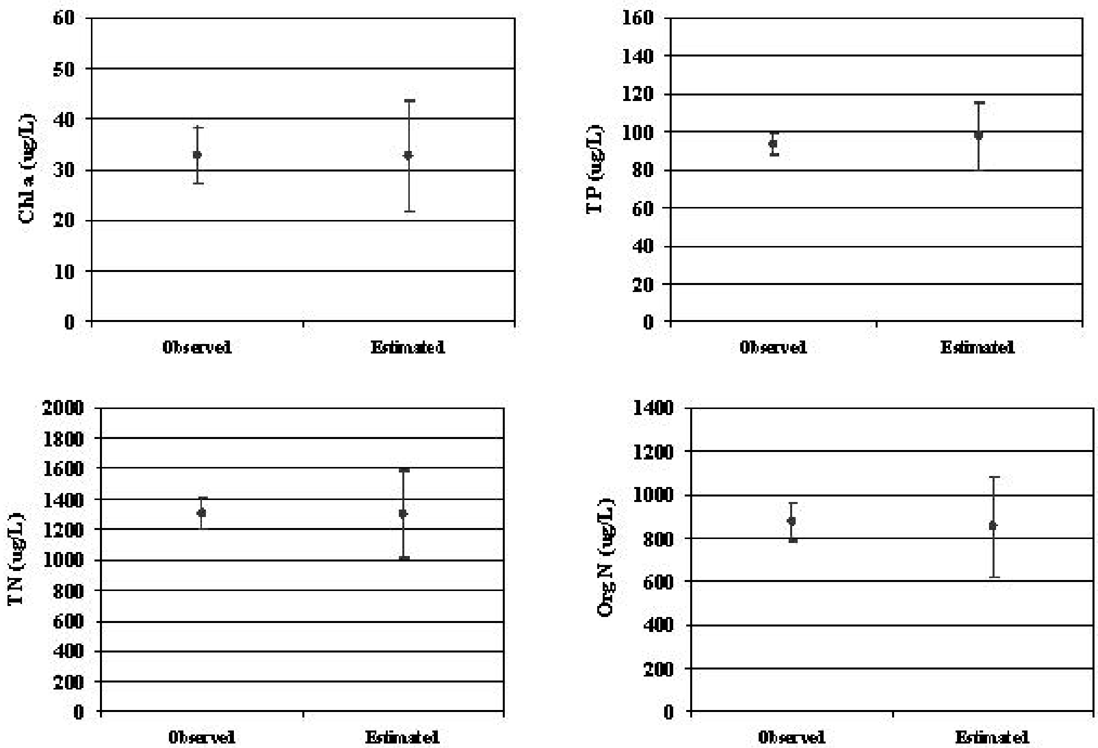

Figure 3.5. BATHTUB calibration for Roberson Creek Cove (April – October 2001). Values plotted are observed and estimated means +/- one standard error.

3.1.4 BATHTUB Verification

Data from 2002 were used to test the accuracy and predictive capability of the calibrated model. The model was run using 2002 input (climate, lake concentrations, and tributary loading) with the same submodels and calibration coefficients derived during the calibration process.

Results for the period April through October indicate over-prediction of nutrients, particularly nitrogen (Figure 3.6). Since nutrient samples were not collected during October 2002, a potential for bias in the loading estimate was suspected. The area experienced a drought during the summer of 2002 and the majority of precipitation occurred during October. The calculated mean flow for 2001 and 2002 (April – October) was 0.17 cms (CV_{mean} =.20) and 0.18 cms (CV_{mean} =.56), respectively.

Since nutrient samples to calculate loads were not collected during October, a potential for bias in the loading estimate was suspected so the model was run without October input. Results indicate improved performance for nutrients (Figure 3.7).

The growing season average for chl *a* predicted by the model is underestimated but within reasonable performance ranges (using t statistics; Figure 3.7). A reduction in abiotic turbidity during the low flow drought period could have contributed to an underestimation of chl *a*. Although a factor was applied to the calibrated model to partially account for the effects of light limitation, the model is limited when there are large deviations from the non-algal turbidity conditions experienced during the calibration period. Based on these results, the verification indicates the model adequately describes the observed behavior and demonstrates acceptable predictive capacity for below average hydrologic conditions.

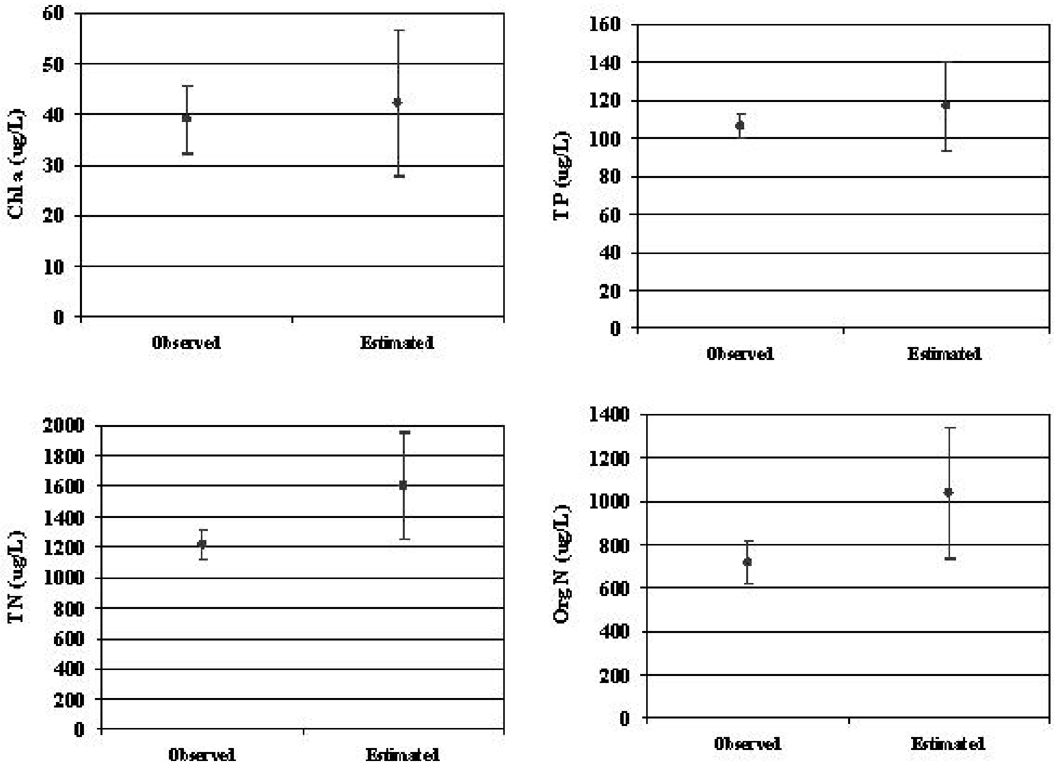

Figure 3.6. BATHTUB verification for Roberson Creek Cove using data inputs from April – October 2002. Values plotted are observed and estimated means +/- one standard error.

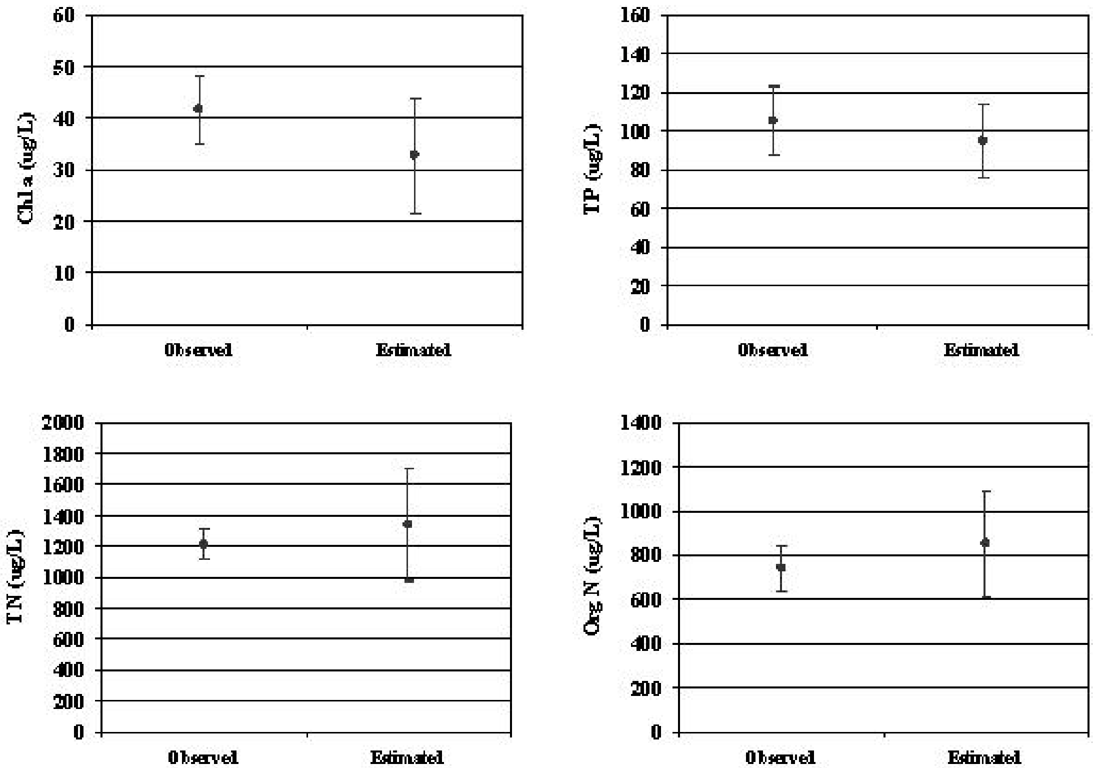

Figure 3.7. BATHTUB verification for Roberson Creek Cove using data inputs from April – September 2002. Values plotted are observed and estimated means +/- one standard error.

3.2 Watershed Loading Model

A physically-based watershed model, the Soil and Water Assessment Tool (SWAT), Version 2000, was used to assess the impact of point source and non-point source on TP in Roberson Creek watershed with varying land use and management conditions for 2001. The model was developed by Dr. Jeff Arnold for the USDA Agriculture Research Service. It is a continuous time model and enables the user to study long term impacts of nutrients. The model has been interfaced with ArcView GIS in a software package known as AVSWAT-2000 (Luzio, et al. 2002). In this study, the software was used for watershed delineation, hydrological and agriculture management inputs, and model calibration.

The watershed model computes surface runoff volume using a modification of the SCS curve number method and peak runoff rate predictions using a modification of the rational method. The model routes flow through the channel using a variable storage coefficient method.

The watershed model monitors six different pools of P in soils. Three pools are inorganic forms of P while the other three pools are organic forms of P. Fresh organic P is associated with crop residue and microbial bio-mass while the active and stable organic P pools are associated with soil humus. Soil inorganic P is divided into solution, active, and stable pools. Total phosphorus (TP) is the sum of organic P and inorganic P.

The model allows nutrient levels to be input as concentrations. However, it performs all calculations on a mass basis. To convert a concentration to a mass, the concentration is multiplied by a bulk density and the depth of the layer and divided by 100.

Nutrient transformations in the stream are controlled by the in-stream water quality component of the model. The in-stream kinetics used in SWAT for nutrient routing are adapted from the QUAL2E model. The model tracks nutrients dissolved in the stream and nutrients adsorbed to the sediment. Dissolved nutrients are transported with the water while those sorbed to sediments are allowed to be deposited with the sediment on the bed of the channel. A detailed process of P is posted at http://ftp.brc.tamus.edu/pubs/swat/doc/ swat2000theory.pdf.

3.2.1 Model Setup

Roberson Creek watershed was delineated by using the ArcView interface SWAT model, AVSWAT. The model utilizes the Reach file 3(RF3) stream coverage and Digital Elevation Model (DEM) data to delineate the watershed. The model assigns a hydrologic unit code to each land use type in each sub-watershed to estimate hydrologic responses and nutrient pools. The estimated hydrologic responses and nutrients pools are then routed towards watershed outlets.

A total of six sub-watersheds were delineated for this study (Figure 1.5). Sub-watershed 1 consisted of the urban area of Pittsboro and the Pittsboro WWTP. Sub-watersheds 2 and 4, respectively, represented Turkey Creek and Camp Creek. Both creeks collected nutrients from wastewater spray fields. The nutrient loads collected from the sub-watersheds 1, 2 and 4 were routed through the sub-watersheds 3, 5, and 6. Sub-watershed 6 contains the Roberson Creek cove off Jordan Lake.

Since the watershed model is not designed for cove conditions, the application of the model was limited up to the sub-watershed 5. The ambient station, RC8, was located at the mouth of sub-watershed 5 and therefore, is considered for the model calibration as well as for TMDL allocation.

3.2.1.1 Model Inputs

The model, SWAT-2000, was set up with major input parameters: weather, agriculture management, and point source discharge. The weather data collected by the nearby weather station located at the Siler City Airport was acquired through the State Climate Office of North Carolina. Rainfall and temperature data for the study year 2001 are presented in the Appendix. The total rainfall during 2001 was 754 mm. The amount of rainfall was considerably less than the long term mean annual rainfall, 1205 mm (Source: The State Climate Office of North Carolina). Therefore, the study year 2001 was a dry year.

Soil parameters including bulk density, soil layer, available water, hydraulic conductivity, and texture type were acquired by the U.S. STATSGO database for this study. There were three types of soils in the watershed: Herndon (NC061), Goldston (NC064), and Wedowee (NC068).

Cultivation of hay was the major agricultural practice in the watershed. The common cultural practices that were input into the model are explained in §2.2 above.

Pittsboro WWTP was the only point source that discharged effluent water to Roberson Creek. The discharge rate and the concentration of TP are presented in Appendix XIII. The summarization of the data is explained in §2.1 above.

3.2.2 Model Calibration

Flow and nutrient data measured at station RC 8 during 2001 was utilized to calibrate the model. Because ground cover and infiltrability of land changes with season, the model was calibrated for summer season (April-October) and winter season (November-March). The adjusted parameters to calibrate the model with regards to the two seasons are presented in Table 3.4. The model calibration results follow.

3.2.2.1 Flow

Calibration of the model with regards to flow is essential, because the flow is the main carrier of TP. Time series of the simulated and observed flow for the year 2001 are presented in Figure 3.8. On average, the model predicted a flow rate slightly less than the observed flow rate (Table 3.5). However the difference between the estimated and observed flow rate was not significantly different ($P > 0.05$). Also, the correlation coefficient between the observed and the simulated flow rate was 0.92. The strong correlation suggests that the model simulated the flow rates closely with the observed rates.

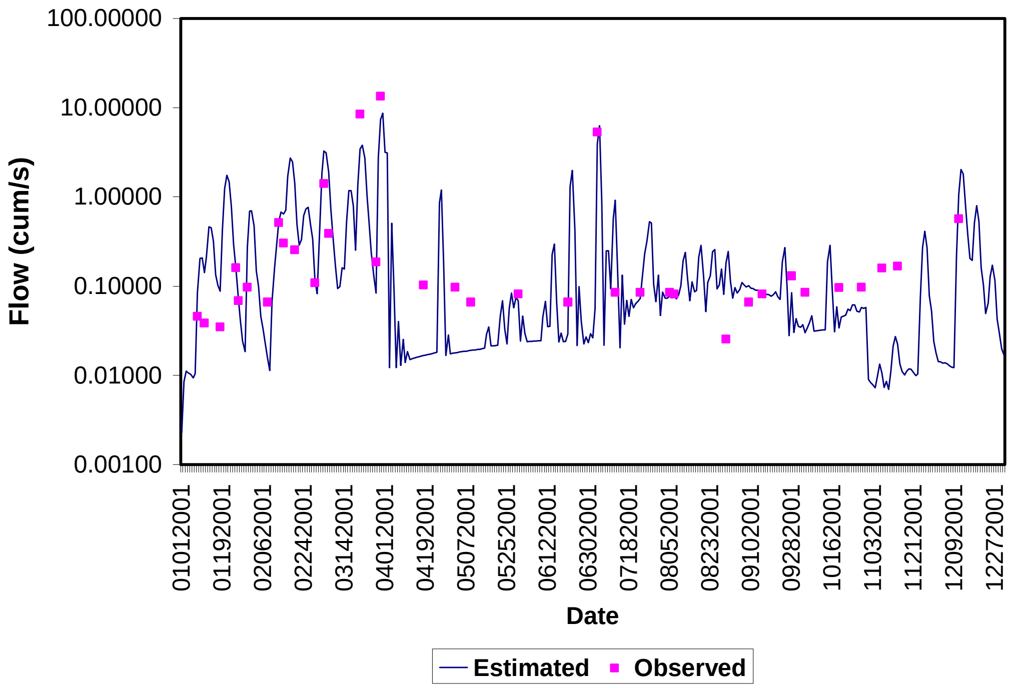

Figure 3.8. Comparison of observed flow and simulated flow at the ambient station RC 8 for 2001.

Table 3.4. Adjusted parameters for the model calibration.

Season/Land Types	Channel Hydraulic Conductivity (k in mm/hr)	Manning's n	Curve Number (CN)	Support Practice Factor (USLE-P)
1. Summer	20.00	0.014		
Urban			82	1.00
Forest			55	0.60
Pasture/Hay Land (WS 1,3,5,6)			61	0.60
Pasture/Hay Land (WS 2,4)			74	0.80
2. Winter	0.00	0.10		
Urban			82	0.10
Forest			60	0.35
Pasture/Hay Land (WS 1,3,5,6)			69	0.15
Pasture/Hay Land (WS 2,4)			79	0.15

Table 3.5. Estimation of mean and standard error for the flow rates.

Seasons	Observed (cum/s)	Estimated (cum/s)
Summer	0.40± 0.30	0.34 ± 0.23
Winter	1.40 ± 0.80	1.10 ± 0.42

3.2.2.2 Total Phosphorus

Flow measurement at the ambient station, RC8, was not continuous; the measurement was taken only 2-4 times in a month. The gap between the measurements can potentially result in high variance when estimating daily average TP loads (Preston et al. 1989; Hodgkins 2001). Daily load was estimated by multiplying TP concentration with respective flow and conversion factor (Equation 3.2) in this study.

$$\text{Load (kg/day)} = \text{flow (cum/s)} * \text{concentration (mg/l)} * 86.4 \text{ --------------------(3.2)}$$

In order to reduce the variance, daily mean flow and daily TP measurement are required. There are many different approaches that can be used to estimate daily TP loads from non-continuous flow data. Some of the approaches are explained above (§3.1.2.4). For the watershed model, a regression method based on load and flow was used. The procedure adopted is as follows: The measured TP concentration was first converted to TP load by using the above equation 3.2. The estimated load was then correlated with measured flow. The correlation is expressed by the following regression equations 3.3 and 3.4

Summer:

TP (kg) = 1.79 + 7.45 * Flow (cum/s) -------------------------(3.3)

R-Square = 0.96

Winter:

TP (kg) = 0.28 + 20.83 * Flow (cum/s)--------------------------(3.4)

R-Square = 0.90

Because the daily mean flow as estimated by the watershed model closely followed with the measured flows (Table 3.3 and Figure 3.8), the estimated daily mean flow was utilized to estimate daily mean TP load by using the above equations 3.2 and 3.3 for summer and winter seasons respectively. The estimated TP loads using the regressing equations were then compared with the estimated load using the watershed model. The difference between the two estimations was not significant when they were compared with respect to estimated mean load and total load for the both seasons (Table 3.6 and Figure 3.9). Also the daily summer load of TP as estimated by the SWAT model was within 1 standard error of the estimation by the FLUX model (Table 3.6).

Table 3.6. Estimation of mean and standard error for TP (kg/day) at the station RC 8.

Seasons	Load Regression Method	SWAT Model	FLUX Ratio Method
Summer	3.19 ± 0.31	3.05 ± 0.4	2.40 ± 0.41
Winter	12.3 ± 1.97	11.97 ± 3.15	--

3.2.3 Model Output

The watershed model indicated that the discharge rate of water at the ambient station, RC8, was substantially higher during winter than summer (Figure 3.9). In total, winter TP load was 63% more than the summer TP load.

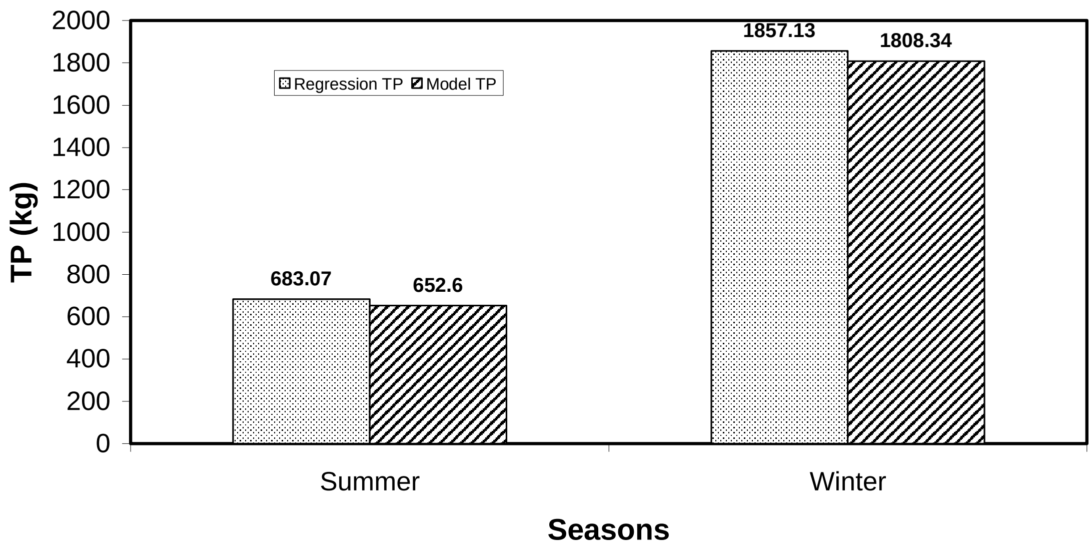

Figure 3.9. Total load of total phosphorus as estimated by the load regression method and the SWAT model for the study year 2001.

Non-point sources were greater contributors of TP during the winter season (Table 3.7). Urban areas contributed an estimated 814 kg (45%) of TP in 2001. Also, it appears that litter fall in the forested land contributed about 344 kg of TP (19%) and pasture/hay lands contributed about 253 kg (14%). Twenty one percent (21%) of the pasture/hay lands contribution was derived from subwatersheds 2 and 4, where the wastewater spray fields were located.

Contributions from forested lands and pasture lands were almost negligible during summer 2001 (Table 3.7). It could be due to low flow, less litter fall, and high infiltration rates. During summer, infiltrability of lands remains high due to low soil moisture condition. The soluble P would then most likely to be leached down to ground water. Recharge of P from ground water to the creek is assumed to be negligible in this study.

Pittsboro WWTP and wet-weather load from urban lands were the two major sources of TP during summer, with the WWTP being the largest source of TP (77%). The WWTP contributed about 503 kg and 398 kg of TP during summer and winter respectively. The plant contribution was about 26% more during summer. In a contrast, the urban contribution was about 80% less during summer. Urban sources may include stormwater runoff and leaking sewer lines.

Table 3.7. Total phosphorus loads (kg) delivered to station RC 8 during 2001.

Source Types	Summer	%	Winter	%
1. Non-point source				
Urban	150	23	814	45
Forest	_		344	19
Pasture/Hay Land	_		253	14
2. Point source				
WWTP	503	77	398	22
Total	653	100	1808	100

4 Allocation

4.1 Total Maximum Daily Load (TMDL)

A Total Maximum Daily Load is the maximum amount of a pollutant that a water body can receive and still meet water quality standards, partitioned among point and nonpoint sources. A TMDL is comprised of the sum of wasteload allocations (WLA) for point sources, load allocations (LA) for nonpoint sources, and a margin of safety, expressed by the equation:

$$\text{TMDL} = \Sigma \text{ WLA} + \Sigma \text{ LA} + \text{MOS}$$

The objectives of the TMDL are to estimate allowable pollutant loads, and to allocate them among the general pollutant sources in the watershed. 40 CFR §130.2 (i) states that TMDLs can be expressed in terms of mass per time (e.g. pounds per day), toxicity, or other appropriate measures. This TMDL will be expressed in terms of % TP load reduction and allowable load in kilograms, representing the maximum load the water body can assimilate and maintain the water quality criterion for chl *a*.

The calibrated model was applied to predict the impacts of alternative P loading scenarios. The target is to have no more than 10% of the samples exceed a chl *a* concentration of 40 µg/L. Model results indicate that a 50% reduction in TP load based on 2001 conditions is needed to meet the chl *a* standard *without* an added margin of safety (Figure 14). However, due to uncertainty in data and the model, a margin of safety based in probabilities was incorporated into the TMDL.

The model predicts a mean growing season chl *a* of 21.9 µg/L when the frequency of concentrations above 40 µg/L is 10% (Figure 4.1). The associated 80% confidence interval around the mean, 14.0 µg/L to 34.3 µg/L, was calculated according to Walker (1996) using the calibrated model's value of CV_{mean} (0.33) for chl *a*. Critical values of the t distribution were obtained from statistical tables in Zar (1999). The measure of model uncertainty, CV_{mean}, incorporates model error based on seasonal variability and inherent model error.

The margin of safety for this TMDL is based on meeting the lower 80% confidence limit (14 µg/L). Accordingly, <u>a reduction in TP load of 71%</u> would be needed to provide "certainty" at the 80% confidence level, that the water quality standard will be met. This reduction scenario would allow less than 3% exceedence of the 40 µg/L chl *a* standard based on model results.

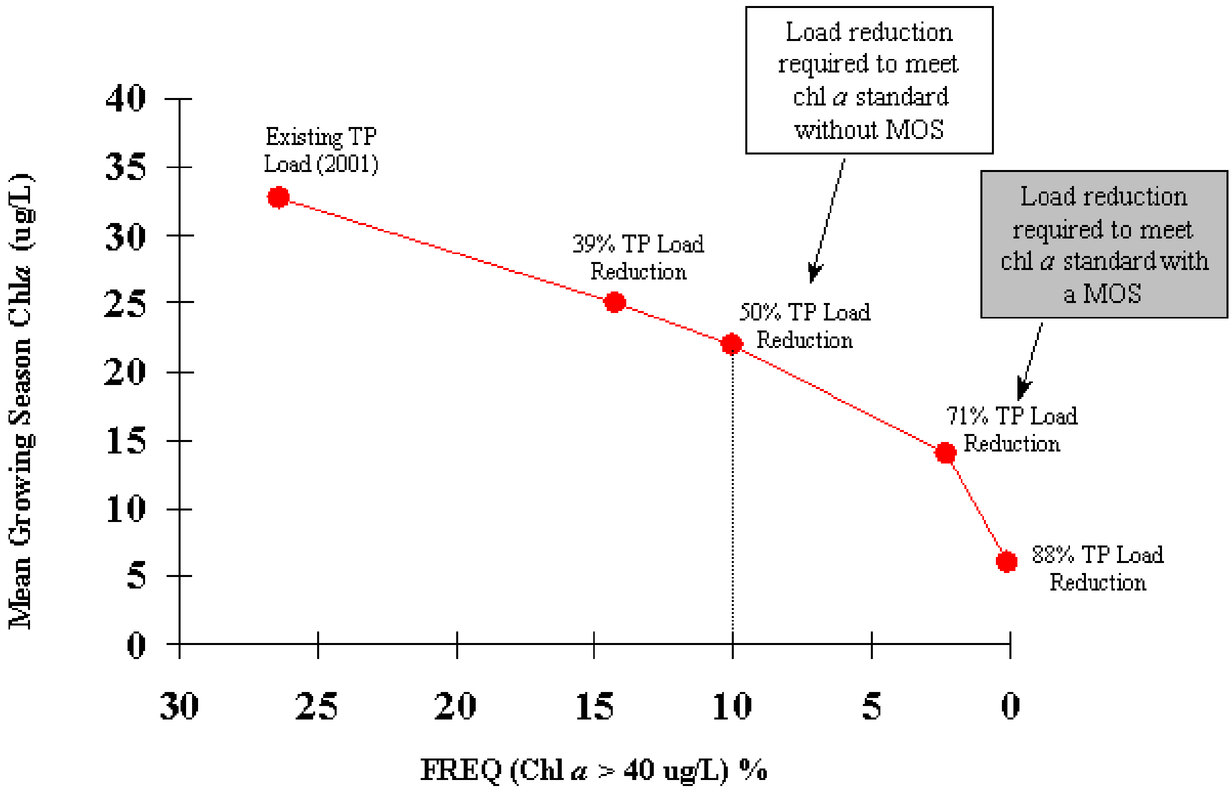

Figure 4.1. Load reduction scenarios for total phosphorus (TP) in the Roberson Creek Cove. TMDL target standard is to have less than or equal to 10% of the samples above the chlorophyll a standard of 40 µg/L. The margin of safety (MOS) is based on an 80% confidence limit of model predictions.

4.2 Critical Conditions

The allowable TP load to the Roberson Creek Cove is based on an identified critical condition: a dry hydrologic period during the algal growing season. During the averaging period of 2001 (April – October), the average mean daily flow was 41% of the historical 43-year average based on flow at the Tick Creek USGS gage. This dry year is considered to be the critical hydrologic condition for nutrient enrichment since residence time and nutrient retention is maximized. With particularly severe drought conditions during April through September, 2002 was also a dry year. However, sufficient data was not available to use 2002 for the reduction target. In addition, a drought of such severity represents an extreme condition.

Nutrient loading will vary year-to-year based on changes in flow regime. Nutrient loading data from wet years was not available for this modeling effort. However, nutrient loads associated with higher flow years will be flushed through the cove more rapidly resulting in a shorter residence time. The higher flows will also be accompanied by an increase in algal light limitation due to abiotic turbidity (Reynolds 1984).

4.3 Seasonal Variation

Chlorophyll *a* concentrations in the Roberson Creek cove tend to be highest during the summer growing season. Blooms can occur during other times of the year to a much lesser extent (Figure 1.6). Conditions of lower water temperature, lower irradiance, and higher flow generally suppress algal growth during winter and early spring. Higher nutrient loads during the colder weather months tend to be flushed through the system rapidly, making nutrients unavailable for algal uptake. Moreover, lower solar radiation and a more turbid water column during these periods will also suppress algal productivity. Thus, this TMDL focuses on nutrient loading and algal response during an extended growing season of April through October only. Basing the TMDL on this warm weather period will protect Roberson Creek during the cold weather period (November – March).

Seasonal variation during the averaging period in nutrient load and response is captured within the models used for this TMDL. In BATHTUB, it is incorporated in terms of seasonal averages for summer and associated error terms. For SWAT, summer and winter conditions during 2001 are modeled to understand nutrient loading over an annual period.

4.4 Model Uncertainty and Margin of Safety

The margin of safety is an additional factor of the TMDL that accounts for uncertainty in the relationship between pollutant loads and receiving water quality. This margin of safety can be provided implicitly through conservative analytical assumptions and/or explicitly by reserving a portion of the load capacity.

For Roberson Creek, an explicit margin of safety has been applied to the water quality criterion. It is based on meeting the lower 80% confidence limit of the predicted mean chl *a* concentration at the 10% exceedence level. The BATHTUB model calculates a measure of error based on seasonal variability and inherent model error (CV_{mean}). The confidence intervals were calculated using values of CV_{mean} for chl *a* according to Walker (1996; p.1-9) using statistical tables in Zar (1999).

In the receiving water model, uncertainty in loads is incorporated into the analyses by including a CV in the model input. The loading values and error are calculated within FLUX. The lack of agreement between modeled, both FLUX and SWAT, and estimated P concentrations could be due in part to the uncertainty associated with calculating loads from non-continuous data (Preston et al. 1989). In addition, FLUX uses statistical techniques to estimate loadings rather than process-based formulations used in SWAT.

The inability to accurately predict specific observed P loading within SWAT can be attributed to model error, lack of sufficient information in source assessment, gaps in our scientific knowledge, natural variability in P concentrations, field and laboratory measurement error, and lack of current site specific model input parameters. The watershed model, SWAT, selected to guide initial decision making, is not adept at characterizing prediction uncertainty. Because of the lack of certain site specific information, professional best judgment and literature values were used to calculate the P loading from the various land uses. Therefore, the model results should be interpreted in light of the model limitations and prediction uncertainty.

4.5 Waste Load Allocation

Pittsboro WWTP was the only point source in Roberson Creek watershed during the study period. The plant contributed about 503 kg of TP during summer (Table 3.6). As per the discussion in § 4.1 above, reduction of TP required to meet the chl *a* standard at the Roberson Creek Cove with a margin of safety is 71%. Therefore, reductions of TP required from the WWTP were estimated to be 357 kg for summer.

4.6 Load Allocation

Non-point sources that contributed TP in the Roberson Creek watershed were urban lands, forested lands, and pasture/hay lands on an annual basis. There are no permitted stormwater sources (MS4) in this watershed. Urban lands were the only non-point sources that contributed 153 kg of TP during summer season (Table 3.7). Reduction required from the urban lands to meet the chl *a* in the cove was, therefore, 106 kg. Overall, the reduction of TP required to meet the chl *a* standard at the Roberson Creek cove was 464 kg during the summer season (April – October).

Table 4.1. Total mass daily load allocation of total phosphorus in kilograms (kg).

Source Types	TMDL for Summer (April - October)	% Reduction
1. Non-point source		
Urban	44	71
Forest	--	0
Pasture/Hay lands	--	0
2. Point source		
WWTP	146	71
Total	190	71

5 Implementation Plan

The TMDL analysis was performed using the best data available to specify the nutrient reductions necessary to achieve water quality criteria: the chl *a* target in this lower portion of Roberson Creek. The intent of meeting the criteria is to support the designated use classifications in the watershed. The decision to focus on P was based on the assumption that P will ultimately control growth in the cove and reductions in P will drive the cove to an increasingly P limited state (by increasing the N:P ratio). As a practical matter, some reductions of N will likely accompany P reductions. This is desirable because although N is not the *primary* limiting nutrient during most of time, loading of N does contribute to algal growth in the cove. Furthermore, downstream waters such as Jordan Lake may be affected by N contribution from this watershed. Therefore, an increase in N loading is not be recommended.

The TMDL requires reductions from urban sources of P and Pittsboro's wastewater treatment plant. In addition to reductions form existing urban sources, future growth in urban land uses within the watershed should be accompanied by nutrient control measures.

This TMDL targets an algal growing season due to timing of algal blooms and residence time in the cove. The reductions will protect Roberson Creek and its intended uses during all times of the year. Nonetheless, nutrient controls during winter are suggested for two reasons. First, downstream waters (Jordan Lake) are affected by nutrients transported from this watershed. Second, there may be some stored P within the watershed derived from the winter that may be transported to the cove during summer.

A detailed implementation plan is not included in this TMDL. The involvement of local governments and agencies will be needed in order to develop the implementation plan. During 2002, the NCSU Water Quality Group received a EPA Section 319 grant to perform a watershed assessment of the Roberson Creek watershed. Part of the project will involve identification of areas for targeting of best management practices (BMP) within the watershed. The Water Quality Group will be developing general and site-specific implementation plans for Roberson Creek.

6 Stream Monitoring

Monitoring will continue on a monthly interval at the ambient monitoring site in the Roberson Creek Cove. The continued monitoring of nutrient and chl *a* concentrations will allow for the evaluation of progress towards the goal of achieving water quality standards and intended best uses.

7 Future Efforts

Overall, the reduction of TP required to meet the chl *a* standard at the Roberson Creek cove was 464 kg during the summer season. Nutrient loading will vary year-to-year based on changes in flow regime. The allowable TP load to the Roberson Creek Cove is based on an identified critical condition for nutrient enrichment: a dry algal growing season. Dry hydrologic conditions in Roberson Creek Cove would be expected to maximize residence time and nutrient retention, thereby promoting algal growth (Wetzel 2001). Further monitoring and modeling may be desirable in the future to confirm these assumptions. Future work may include an enhanced characterization of the relationship between flow and nutrient concentrations across a range of hydrologic conditions. Likewise, an analysis of eutrophication response during wetter years may be useful.

8 Public Participation

A draft of the Roberson Creek TMDL was publicly noticed through various means, including notification in the local newspaper, *The Chatham Record*, on June 19, 2003. DWQ electronically distributed the draft TMDL and public comment information to known interested parties. The TMDL was also available from the Division of Water Quality's website at http://h2o.enr.state.nc.us/tmdl/draft_TMDLs.htm during the comment period beginning June 19 and ending July 21.

A public meeting was held on July 15 at the Chatham County Agricultural Center Auditorium in Pittsboro. At this meeting, staff presented the TMDL and answered questions. In addition to

DWQ staff, 14 people attended the meeting. Person attending represented environmental advocacy groups (3), local government agencies (6), research univeristies (3), and private landowners (2).

9 Further Information

Further information concerning North Carolina's TMDL program can be found on the Internet at the Division of Water Quality website**:** http://h2o.enr.state.nc.us/tmdl/.

Technical questions regarding this TMDL should be directed to the following members of the DWQ Modeling/TMDL Unit: J. Todd Kennedy, Modeler (todd.kennedy@ncmail.net), Narayan Rajbhandari, Modeler (narayan.rajbhandari@ncmail.net), and Michelle Woolfolk, Supervisor (michelle.woolfolk@ncmail.net).

10 Responsiveness Summary

A draft of the Roberson Creek TMDL was publicly noticed through various means, including notification in the local newspaper, *The Chatham Record*, on June 19, 2003. DWQ electronically distributed the draft TMDL and public comment information to known interested parties. The TMDL was also available from the Division of Water Quality's website at http://h2o.enr.state.nc.us/tmdl/draft_TMDLs.htm during the comment period beginning June 19 and ending July 21.

A public meeting was held on July 15 at the Chatham County Agricultural Center Auditorium in Pittsboro. At this meeting, staff presented the TMDL and answered questions.

Four people submitted written comments concerning the proposed TMDL:

1. Keith Megginson
Chatham County Planning Director
June 12, 2003

2. Elaine Chiosso and Catherine Deininger
Haw River Assembly
July 21, 2003

3. David B. Hughes
Town Manager, Town of Pittsboro
July 23, 2003

4. Robert W. Slocum, Jr.
Executive Vice President, NC Forestry Association
July 25, 2003

Although comments from Mr. Hughes and Mr. Slocum were received after the official comment period ended, responses have been provided.

1. Comments from Keith Megginson

Comment:

My comment is about page 18, section 2.2.2. In said section it gives P loadings for domestic sewage and addresses dish washing as possibly increasing the level of P. I did not find that the document addresses how this relates to P loadings in Roberson Creek, whether by failing septic systems in the rural areas or increased loadings to Pittsboro WWTP.

Response:

The commenter is correct: this is an indirect load of P to the system. As a result of dish washing, the P in some detergents may be transported to septic systems and/or the wastewater treatment plant. Despite the intermediate fate (septic tank or WWTP), the P may ultimately be transported from the watershed to the Roberson Creek Cove.

2. Comments from Haw River Assembly

Comment:

Any TMDL for Robeson Creek needs to account for additional future sources of non-point source pollution due to growth. Pittsboro is on the brink of a significant amount of growth. If this TMDL doesn't include an allocation for growth, any development in Pittsboro could quickly overwhelm the pollutant cap and prevent achievement for water quality standards for Robeson Creek. Failure to meet water quality standards, technically, could cause a prohibition of all future pollutant loads. Therefore, it is in the best interest of the state and local government to account for anticipated growth.

Response:

The margin of safety within the TMDL acts to preserve a portion of the assimilative capacity. In addition, the TMDL contains an implicit factor for growth as it pertains to the wasteload allocation. Any future growth in waste flows to the plant will be limited by the summer wasteload allocation. Nonpoint source controls should be implemented concomitant with future growth of the town to prevent net increases in urban sources of P. Monitoring will continue in the Roberson Creek Cove as this TMDL is implemented. If necessary, the TMDL will be revisited if the waterbody does not attain its intended uses in the future as expected.

Comment:
On the current cover page for the draft public review "Now Available upon Request," the short summary needs to include a statement of how phosphorus is related to chlorophyll-*a*. For instance, you could add to the last sentence of the summary so that it reads, "The study identifies the sources of pollution, determines allowable loads to the surface waters, and suggest allocations for total phosphorus *which is limiting factor in the growth of algae as measured by chlorophyll-a*." Otherwise, someone who is not as familiar with the background of the Robeson Creek TMDL study might not make the connection between chlorophyll-*a* and phosphorus, since the connection is not explained until page 7 of the report.

Response:
The referenced cover page is not included in the final TMDL. However, the document has been revised to reflect this recommendation by adding language to the introduction chapter.

Comment:
We are concerned that extreme conditions for drought period (April – October) of 2002 were not used in calculating the allowable Total Phosphorus load for the Robeson Creek cove. Streams are most vulnerable to pollution problems during worst-case flows due to high or low water flows during wet or dry weather conditions. Stream flow is an important part of this TMDL and to protect Robeson Creek, it is critical that the worst-case flow is used.

Response:
Data was not available for September and October of 2002. Therefore while some of the data from 2002 was used to test the model, the data were insufficient to calibrate the model and accordingly derive the TMDL.

In addition, the allowable TP load to Roberson Creek Cove is based on critical conditions of a dry summer. During 2001 (Apr – Oct), the average mean daily flow was 41% of the historical 43-year average based on flow measured at the Tick Creek gage. During the same period of 2002, flow was 44% of the historical average. However, based on the months April through September, the percent of historic averages was 46% (2001) and 14% (2002). Clearly this period of 2002 was extremely dry. Most of the flow occurred during October of that year. In fact during the period of June – July, flow during 2002 was 3% of the historical average. DWQ believes that the Roberson Creek TMDL should not be based on such extreme hydrologic conditions.

Comment:
We believe it will be necessary to continue to monitor Turkey Creek and Camp Creek during storm events due to run-off from Townsend Foods spray fields. Page 17 of the draft reports states "Phosphorus from the irrigated wastewater transported via surface and subsurface runoff, appears to have moved into Turkey Creek and Camp Creek. The results suggest that the pasturelands owned by Townsend Food Inc. may have discharged considerable amount of P to Roberson Creek during storm events in 2001." Although much of the runoff may occur normally in the winter months, an unusually wet summer such as we are experiencing in 2003 could result in more phosphorus loading from this source than anticipated.

Response:
The allowable TP load to Roberson Creek Cove is based on critical conditions of a dry summer period. Dry hydrologic conditions in Roberson Creek Cove would tend to maximize residence time and nutrient retention, thereby promoting algal growth. The average residence time during 2001 was 31 days. During wetter years, DWQ expects the residence time to decrease and flushing to increase in the cove, lessening the potential for algal blooms. The TMDL established during the critical condition will also protect water quality during other periods in terms of season and hydrologic years.

Comment:
To insure timeliness in the implementation of this TMDL, a schedule of milestones for meeting the TMDL needs to be included in the final draft. Even if the development of milestones for non-point source pollution is part of the implementation plan that NCSU Water Quality Group is working on, a schedule of milestones for the point source pollution should be included in the TMDL report.

Response:

Comment refers to implementation. An implementation plan is not included in the TMDL submittal for EPA approval. Monitoring will continue on a monthly interval at the ambient monitoring site in the Roberson Creek Cove. The continued monitoring of nutrient and chl *a* concentrations will allow for the evaluation of progress towards the goal of achieving water quality standards and intended best uses.

3. Comments from David B. Hughes

Comment:
If the criteria for P is based on 10% exceedences for a typical year and the model is based on a dry year (non-typical), it would seem that the criteria would be overly conservative. It would also seem that an added margin of safety is even more conservative.

Response:
The TMDL target is based on the chlorophyll *a* criteria combined with current use assessment methodology. Combining the two, no more than 10% of samples collected in a specified area and time should be above 40 µg/L chl *a*. The TMDL is established for P because DWQ believes it is the primary limiting nutrient in the cove. The allowable TP load to Roberson Creek Cove is based on critical conditions of a dry summer period. Sufficient data for use as a basis for this TMDL was only available for 2001. The chl *a* standard and intended uses in the cove should be met during dry years and wet years. A margin of safety is a required component of TMDLs that accounts for uncertainty.

Comment:
If flow data was underestimated, how would that affect the results?

Response:
The daily flows from the Tick Creek gage were adapted for use in the modeling of loads to the Roberson Creek cove. Based on comparison with instantaneous flow data collected on Roberson Creek, the adapted Tick Creek flow underestimated flow in Roberson Creek in part of late summer and fall. However, most of these flows were below 5 cfs and the difference is not expected to have a significant effect on loading estimates.

Comment:

The last paragraph on page 31 states that “since a term for light is not included in the candidate models, predicted chl a may be overestimated.” What is the overestimation and how did the calibration factor accurately account for this?

Response:

The chl *a* model is based on an empirical relationship between chl *a* and nutrients. An adjustment is made to the model to account for site-specific conditions in Roberson Creek: the calibration factor. The calibration factor (0.83) reduces the apparent chl a predicted by the model to more closely match observed conditions: a typical calibration procedure in the modeling process. The need for the calibration could have been due to the inhibitory influence of a diminished light field within the water column.

Comment:

What does paragraph 3 and 4 of section 4.4, page 48, mean and what is the lack of agreement between the models?

Response:

Models are merely tools used for system description and prediction. Uncertainty is always present in model results. Decisions made based on model results should be made in light of model limitations and uncertainty.

The SWAT model and the FLUX model produced different estimates of P load, however, the estimates were within one standard error of each other. The SWAT model is a process model that describes P transport in a mechanistic fashion. The model was calibrated to a P load derived from regression using P load and flow. The FLUX model uses a statistical approach (modified ratio estimator) to calculate load from daily flow values and biweekly P concentrations.

Comment:

The footnote below the chart on page 9 mentioned data is uncorrected for pheophytin, which may overestimate the actual corrected value. What are the ramification for this?

Response:

Pheophytin is a component of algae representing dead cells. Due to problems with lab data, the data from 1998-2000 are uncorrected for this component. There are no ramifications for the TMDL because only data from 2001, which were corrected chl *a* concentrations, were used.

Comment:
Why was the BATHTUB model used in this study versus the WASP/EUTRO5 model used for the Jordan Lake Nutrient Response study done by Tetra Tech, Inc.?

Response:
The Jordan Lake Nutrient Response model did contain sufficient spatial resolution to model the Roberson Creek Cove. Further, the Jordan model development was not complete when development of the Roberson Creek TMDL began.

Comment:
What other WWTP's have had TMDL's for either P or N applied to them? What limits were applied to them? Were any of the plants comparable in size to Pittsboro's plant? What were the phase-in periods for compliance to the new limits?

Response:
Comments refer to implementation. An implementation plan is not included in the TMDL submittal for EPA approval. DWQ's NPDES permitting unit will provide the Town of Pittsboro will information relating to these issues during the implementation phase.

Comment:
The implementation schedule must recognize the Town's limited financial capabilities, and must allow sufficient time for the Town to obtain funding necessary to upgrade the plant to achieve the proposed P limitations. The town should be given an implementation time period that is at least as long as the one provided to the dischargers in the Neuse Basin when the TN limit was imposed there.

Response:
Comment refers to implementation. An implementation plan is not included in the TMDL submittal for EPA approval.

Comment:

In the public meeting it was discussed that the Division is proposing the mass-based TP standards from the TMDL model be implemented form April 1 – October 31, and that the existing 2.0 mg/L quarterly average remain in place for the remaining months. The Town supports this proposal.

Response:

Comment refers to implementation. An implementation plan is not included in the TMDL submittal for EPA approval.

4. Comments from Robert W. Slocum, Jr.

Comment:

We have reviewed the proposed TMDL for Roberson Creek in Chatham County and are pleased that any contributions of phosphorus form forestry activities are considered as part of background discharges. This is consistent with numerous scientific studies and recognizes that land disturbing forestry activities in NC are regulated under the Sedimentation Pollution Control Act. As you finalized this TMDL and develop others, we urge the agency to continue this approach to forestry activities.

Response:

The TMDL identified forest lands as part of the background source of P in the watershed and did not refer to any forestry activities specifically. The watershed model did not predict loading of P to the cove from forest lands during the summer period of 2001.

The Chatham News

NORTH CAROLINA

CHATHAM COUNTY

AFFIDAVIT OF PUBLICATION

Before the undersigned, a Notary Public of said County and State, duly commissioned, qualified, and authorized by law to administer oaths, personally appeared

Florence Turner who being first duly sworn, deposes and says: that he (she) is

Accounts Receivable Clerk

(Owner, partner, publisher, or other officer or employee authorized to make this affidavit)

of The Chatham News Publishing Co., Inc., engaged in the publication of a newspaper known as, The Chatham News, published, issued, and entered as second class mail in the Town of Siler City, in said County and State; that he (she) is authorized to make this affidavit and sworn statement; that the notice or legal advertisement, a true copy of which is attached hereto, was published in The Chatham News on the following dates:

June 19 2003

and that the said newspaper in which such notice, paper, document, or legal advertisement was published was, at the time of each and every such publication, a newspaper meeting all of the requirements and qualifications of Section 1-597 of the General Statutes of North Carolina and was a qualified newspaper within the meaning of Section 1-597 of the General Statues of North Carolina.

This 19th day of June, 2003

Florence E. Turner

(Signature of person making affidavit)

Sworn to and subscribed before me, this 19th

day of June, 2003

Notary Public

My Commission expires: 11-07-2005

Public Notice
State of North Carolina
Division of Water Quality

Availability of the Total Phosphorus Total Maximum Daily Load (TMDL) for Roberson Creek

Copies of the TMDL may be obtained by calling J. Todd Kennedy at (919) 733-5083 ext. 514 or on the internet at http://h2o.enr.state.nc.us/tmdl. A public meeting to discuss the TMDL will be held on July 15 at 10 AM at the following address: Chatham County Agricultural Center Auditorium, 45 South Street, Pittsboro. Written comments regarding this TMDL will be accepted until July 21, 2003. Please mail comments to: NCDWQ Planning Branch, attn: J. Todd Kennedy, 1617 Mail Service Center, Raleigh, NC 27699.

Jn19-1tc

11 References

Bachman, R.W. 1980. Prediction of total nitrogen in lakes and reservoirs. In Restoration of lakes and inland waters; Proceedings of an international symposium on inland waters and lake restoration. Portland, Maine. U.S. Environmental Protection Agency, Office of Water Regulations and Standards, EPA-440-581-010, Washington, D.C.

Beale, E.M.L. 1962. Some uses of computers in operational research. *Industrielle Organisation* 31:51-52.

Butcher, J., T. Clements, A. Beach, K. Brewer, D. Korn, N. Archambault, and P. Kellar. 1995. Falls Lake Watershed Study-Final Report. Prepared for the NC Department of Environment, Health and Natural Resources. The Cadmus Group, Durham, NC.

Carlson, R.E. 1977. A trophic state index for lakes. *Limnology and Oceanography* 22:361-369.

Dodd, R.C., G. McMahon, and S. Stichter. 1992. Watershed planning in the Albemarle-Pamlico Estaurine System. Report I – Annual Average Nutrient Budgets. Report No. 92-10. Albemarle-Pamilco Estuarine Study. NC DEHNR. Raleigh, NC.

Ernst, M.R., W. Frossard, and J.L. Mancini. 1994. Two eutrophication models make the grade. *Water Environment and Technology*. November, 15-16.

Giese, G.L. and R.R. Mason, Jr. 1993. Low-flow characteristics of streams in North Carolina. U.S. Geological Survey water-supply paper 2403.

Hodgkins, Genn A. 2001. Total Phosphorus Loads for Selected Tributaries to Sebago Lake, Maine. Water Resources Investigations Report 01-4003. U. S. Department of the Interior, USGS, Augusta, Maine.

Illinois Environmental Protection Agency. 2002. Governor Bond Lake TMDL Report.

Kennedy, R.H. 1995. Application of the BATHTUB model to selected southeastern reservoirs. Technical Report EL-94-14, U.S. Army Engineer Waterways Experiment Station, Vicksburg, MS.

Luzio M. D., R Srinivasan, J. G. Arnold, and S. L. Neitsch. 2002. ArcView Interface For SWAT2000, User's Guide. Blackland Research and Extension Center. Texas Agricultural Experimental Station. 720 East Blackland Road, Temple, Texas, 76502.

NCSU Water Quality Group. 2002. Roberson Creek Watershed Landuse Classification. Raleigh, NC.

NC Department of Environment, Health and Natural Resources (DEHNR) and SC Department of Health and Environmental Control. 1992. Water Quality Investigation of Lake Wylie. Report No. 92-04.

NC Division of Water Quality. 2002. Roberson Creek TMDL Study Final Report Memorandum.

Office of Water. 1997. Guidelines for preparation of the comprehensive state water quality assessments. EPA-841-B-97-00. U.S. Environmental Protection Agency, Washington D.C.

Osborne, L. L. and D. A. Kovacic. 1993. Riparian Vegetated Buffer Strips in Water Quality Restoration and Stream Management. Fresh Water Biology, 29:243-258.

Preston, S.D., V.J. Bierman, and S.E. Silliman. 1989. An evaluation of methods for the estimation of tributary mass loads. *Water Resources Research* 25(6): 1379-1389.

Redfield, A. 1958. The biological control of chemical factors in the environment. *Am. Sci*. 45:205-221.

Research Triangle Institute. 1998. Eutrophication Modeling for the Randleman Lake Project. Final Report submitted to the NC Department of Environment and Natural Resources, Division of Water Quality. RTI, Research Triangle Park, NC. September 1998.

Reynolds, C.S. 1984. *The Ecology of Freshwater Phytoplankton*. Cambridge University Press, Cambridge.

Tetra Tech. 2002. Jordan Lake Nutrient Response Model. Prepared for The Jordan Lake Project Partners. Tetra Tech, Inc., Research Triangle Park, NC. November 2002.

Thomann, R.V. and Mueller, J.A. 1987. *Principles of Surface Water Quality Modeling and Control*. Harper and Row, New York, NY.

U.S. Environmental Protection Agency (USEPA). 1991. Guidance for Water Quality-Based Decisions: The TMDL Process. Assessment and Watershed Protection Division, Washington, DC.

U.S. Environmental Protection Agency, Federal Advisory Committee (FACA). Draft final TMDL Federal Advisory Committee Report. 4/28/98.

U. S. Environmental Protection Agency. 1999 Protocol for Developing Nutrient TMDLs.1st Edition. Office of Water, Washington DC. EPA-841-B-88-007.

U.S. Environmental Protection Agency (USEPA) 2000a. Revisions to the Water Quality Planning and Management Regulation and Revisions to the National Pollutant Discharge Elimination System Program in Support of Revisions to the Water Quality Planning and management Regulation; Final Rule. Fed. Reg. 65:43586-43670 (July 13, 2000).

U. S. Environmental Protection Agency. 2000b. Nutrient Criteria Technical Guidance Manual: Lakes and Reservoirs. 1st Edition. Office of Water, Washington DC. EPA-822-B00-001.

U.S. Environmental Protection Agency (USEPA). 2001. Clean Air Status and Trends Network (CASTNet) Annual Report. Prepared by Harding ESE, Inc. November 2002.

Walker,W.W. 1983. Empirical methods for predicting eutrophication in impoundments. Report 2, Phase II: Model Testing. Technical Report E-81-9. U. S. Army Engineer Waterways Experiment Station, Vicksburg, MS.

Walker, W.W. 1996. Simplified procedures for eutrophication assessment and prediction: User manual. Instruction Report W-96-2, U. S. Army Engineer Waterways Experiment Station, Vicksburg, MS.

Waschbusch, R. J., W. R. Selbig, and R. T. Bannerman. 1994-95. Sources of Phosphorus in Storm water and Street Dirt from Two Urban Residential Basins in Madison, Wisconsin. USGS. Water-Resources Investigation Report. 99-4021.

Wetzel, R.G. 2001. *Limnology: Lake and River Ecosystems*, 3rd Edition. Academic Press, San Diego.

Yonts, W.L., Giese, G.L., and Hubbard, E.F. 1973. Evaporation from Lake Michie, North Carolina, 1961-1971. U.S. Geological Survey Water Resources Investigations Report 38-73. 27 p.

Zar, J.H. 1999. Biostatistical Analysis. Fourth Edition. Prentice Hall, New Jersey.

Appendix I. Water quality data collected during the Roberson Creek TMDL Study (2000-2002).

Roberson Creek Physical/Chemical and Flow
See accompanying Qualifier Codes list

Station # & Location	Sample Date	Time	NH3	TKN	NOX	TP	TN	BOD5	Na	DO	pH	Temp	Cond	Stage feet	Flow	fecal MF	Chl a
	yy/mm/dd		mg/L	mg/L	mg/L	mg/L	mg/l	mg/L	mg/L	mg/L	units	C	umhos	(RC8 only)	cfs	/100 ml	ug/L
RC4 Hwy 15/501	00/12/14	1040	ns	ns	ns	ns		ns	ns	10.3	7.2	5.6	127		ns	ns	
Roberson Cr	00/12/21	0915	0.12	0.4	0.24	0.04	0.64	2.2	6.4	11.8	6.9	3.3	109		ns	160	
Lat 35° 42' 57"																	
Long 79° 10' 44"																	
RC5 ups	00/12/14	1050	0.02	0.4	0.13	0.04	0.53	ns	ns	9.3	7.4	5.8	131		ns	ns	
Roberson Cr	00/12/21	1120	ns	ns	ns	ns		ns	6.4	10.8	7.2	3.2	129		ns	160	
upstream WWTP	01/01/08	1045	0.02	0.4	0.37	0.04	0.77	1.1	7	11.5	6.8	2.4	141		0.71	27	
Lat 35° 42' 52"	01/01/18	1030	0.06	0.6	0.34	0.03	0.94	1.7	7.5	10.0	7.9	6.4	146		0.42	45	
Long 79° 10' 18"	01/01/25	1200	0.05	0.5	0.14	0.01	0.64	0.9	5.8	12.0	7.3	5.9	117		1.66	260	
	01/02/08	1115	Lab	Lab	<1.0	Lab		7.1	7.2	10.3	7.3	7.5	137		1.49	<10	
	01/02/13	1100	Lab	Lab	Lab	<0.5		2.3	5.8	10.9	7.0	5.1	80		3.85	380	
	01/02/20	1150	Lab	Lab	Lab	<0.5		3.5	6.6	10.7	7.2	8.6	110		3.68	2500	
	01/03/01	1100	<0.5	<1.0	<0.5	<0.5		<2	7.1	7.7	7.4	10.3	121		1.21	73	
	01/03/07	1045	0.55	<1.0	<0.5	<0.5		2.6	5.5	10.9	7.1	7.5	91		6.03	310	
	01/03/28	1240	<0.20	<0.6	0.3	<0.10		<2	5.5	10.7	7.9	10.8	94		2.78	22	
	01/04/18	1120	<0.20	0.8	0.29	<0.10	1.09	<2	6.2	9.3	8.1	11.9	109		1.69	220	
	01/05/02	1115	<0.20	<0.6	0.28	<0.10		1.2	7.1	6.3	7.4	19.9	122		0.89	110	
	01/05/09	1110	<0.20	<0.6	0.36	<0.10		1.3	8.6	11.5	8.1	19.1	270		0.62	57Q	
	01/05/30	1030	<0.20	<0.6	0.15	<0.10		3.0	6.9	4.2	7.1	19.4	106		0.91	520	
	01/06/21	1050	0.11	0.5	0.29	0.03	0.76	1.6	6	5.6	7.1	24.3	100		0.16	470	
	01/08/07	1115	0.09	0.5	0.38	0.04	0.85	7.2	6.5	3.8	7.0	23.8	115		0.45	520	
	01/08/30	1040	0.04	0.7	0.16	0.06	0.86	2.1	5.2	5.0	7.2	25.3	104		1.98	430	
	01/10/04	1050	0.04	0.4	0.33	0.04	0.72	ns	6.1	9.0	6.8	16.6	125		0.49	250	
	01/11/07	1130	0.02	0.2	0.21	0.02	0.45	1.0	6.7	7.8	7.3	10.3	138		0.35	54 B1	

	01/11/14	1120	0.05	0.3	0.26	0.02	0.57	1.3	6.5	8.9	6.8	4.4	137		0.90	73 Q	
	01/12/11	1100	0.18	0.4	0.1	0.05	0.51	2.6	ns	12.3	7.2	6.3	103		1.10	2200	
	02/01/10	1125	0.06	0.4	0.37	0.05	0.76	1.3 G5	ns	14.7	6.9	1.9	177		2.78	1800 B1	
	02/02/05	1135	0.05	0.3	0.38	0.04	0.72	1.9 G5G1	ns	9.6	7.2	6.1	108		2.75	46 Q1	
	02/03/08	1215	0.14	0.4	0.25	0.04	0.63	1.6	ns	11.2	7.0	6.7	114		0.62	49	
	02/04/15	1110	0.08	0.4	0.28	0.05	0.67	1.5	ns	8.4	7.0	20.3	61		0.52	190	
	02/05/01	1040	0.08	0.5	0.35	0.04	0.80	1.6	ns	5.3	7.1	17.4	164		no flow	120	
	02/06/26	1010	0.09	0.5	0.38	0.04	0.86	1.6	ns	3.4	7.1	23.8	355		no flow	340 B4	
RC5 eff	00/12/21	1110	0.22	1.1	16	0.67	17.10	ns	55	10.0	6.8	11.0	487			<10	
WWTP effluent	01/01/08	1000	0.48	5.5	16	1.80	21.50	1.2	58	9.4	7.2	11.1	480			<10	
Lat 35° 42' 49"	01/01/18	1020	0.04	1.6	31	3.20	32.60	1.8	64	9.9	7.8	12.4	543			<10	
Long 79° 10' 14"	01/01/25	1145	ns	ns	ns	ns		ns	ns	8.5	7.2	11.4	460				
	01/02/08	1145	Lab	1.1	Lab	3.20		6.3	50	7.2	6.4	13.0	491			10k	
	01/02/13	1130	Lab	Lab	Lab	Lab		3.8	48	10.2	7.1	12.0	306			10k	
	01/02/20	1130	Lab	Lab	Lab	Lab		4.2	56	9.7	7.0	12.5	389			160	
	01/03/01	1040	ns	ns	ns	ns		ns	ns	9.2	ns	13.6	694				
	01/03/07	1100	0.80	3.0	26	1.00	29.00	6.6	55	9.8	7.1	11.8	507			100	
	01/03/28	1250	0.28	3.2	42	3.60	45.20	6.6	110	9.9	7.3	14.0	643			250	
	01/04/18	1100	0.79	8.9	53	9.00	61.90	2.1	190	8.8	6.4	16.3	995			2700	
	01/05/02	1100	0.37	4.5	48	2.80	52.50	10.4	180	9.2	7.0	17.8	990			430	
	01/05/09	1100	<0.20	3.3	43	3.10	46.30	3.6	210	8.3	7.1	19.9	1122			Lab	
	01/05/30	1000	<0.20	1.7	41	3.00	42.70	ns	160	5.8	7.0	21.5	927			4	
	01/06/21	1025	0.12	1.2	23	1.90	24.20	1.0	120	7.2	7.6	23.6	676			12	
	01/08/07	1045	0.05	2.0	19	2.60	21.00	2 U	81	7.3	7.6	25.6	440			17	
	01/08/30	1015	0.02	0.2	15	0.80	15.20	1.0	52	7.5	7.0	24.0	442			4	
	01/10/04	1025	0.01 U	0.20 U	22	1.80		ns	77	8.0	7.2	21.2	599			22	
	01/11/07	1045	0.03	0.20 U	24	1.60		0	J2	10.3	6.8	17.7	661			1	
	01/11/14	1055	0.01	0.20 U	18	1.40		1	170	12.2	6.6	16.2	728				
	02/02/05	1115	0.06	0.3	32	3.20	32.28	3.7J2G1G5	ns	7.9	ns	12.9	886			5Q1	
	02/01/10	1100	0.04	6.6	25	1.60	31.60	0.4 G5	ns	11.0	7.1	7.6	737			2	
	02/03/08	1100	0.12	0.4	2.4	0.20	2.79	1.6	ns	8.7	7.2	13.6	718			44	
	02/04/15	1050	0.07	0.4	2.3	0.30	2.73	1.2	ns	10.1	7.1	17.9	666			3	

	02/05/01	1010	0.42	.20 U	20	1.90		1,7	ns	8.3	7.1	19.4	784			1 B2	
	02/06/26	1000	0.03	0.4	26	3.90	26.41	1.3	ns	4.3	6.6	25.2	838			9	
	02/08/15	1000	0.02	0.8	30	4.20	30.84	ns	ns								
RC5 dns	00/12/14	1100	0.02	0.9	8.8	0.66	9.70	1.5	ns	8.0	7.1	5.6	256		ns		
Roberson Cr	00/12/21	1055	0.05	0.6	4	0.18	4.60	ns	15	10.7	7.1	4.6	210		1.69	200	
downstream WWTP	01/01/08	1015	0.80	1.1	7	0.67	8.10	1.3	30	10.1	7.0	5.6	280		1.00	82	
Lat 35^{o} 42’50"	01/01/18	1015	0.31	1.0	9	1.00	10.00	1.7	31	9.5	7.6	8.7	318		1.07	64	
Long 79^{o} 10’08"	01/01/25	1125	0.05	0.6	3.6	0.31	4.20	0.8	12	12.0	7.0	6.1	178		2.66	140	
	01/01/30	1300	<0.01	0.8	7.1	0.76	7.90	0.7	19	10.6	7.1	9.9	252		2.27	27	
	01/02/08	1135	Lab	<1.0	Lab	Lab		6.9	21	10.1	7.0	9.0	277		1.37	27	
	01/02/13	1115	Lab	Lab	Lab	<0.5		2.5	13	12.3	7.4	6.5	115		4.89	340	
	01/02/20	1115	ns	ns	ns	ns		ns	ns	10.4	7.6	8.9	177		4.63	ns	
	01/03/01	1030	0.95	2.3	8.8	0.90	11.10	2.3	25	10.2	7.5	9.0	237		2.22	73	
	01/03/07	1100	<0.5	<1.0	3.2	<0.5		3.0	14	10.3	7.4	8.8	132		7.55	480	
	01/03/28	1350	<0.20	1.0	9.1	0.69	10.10	2.1	25	10.3	7.8	11.5	232		3.92	40	
	01/04/18	1110	0.36	3.4	11	2.20	14.40	6.7	44	8.4	7.0	12.4	321		2.23	3000	
	01/05/02	1040	0.20	2.0	20	1.10	22.00	5.2	83	7.4	7.8	18.0	604		1.56	250	
	01/05/09	1045	<0.20	2.3	24	1.60	26.30	2.2	120	6.9	7.3	18.1	448		0.90	48Q	
	01/05/30	1020	<0.20	1.3	17	1.10	18.30	2.3	56	4.4	7.0	19.6	376		1.46	360	
	01/06/21	1015	0.08	0.7	9.6Q	0.78		1.2	52	5.3	7.3	21.0	343		0.33	420	
	01/08/07	1035	0.15	0.6	8.9	1.10	9.52	2 U	28	3.3	7.2	23.8	272		0.74	320	
	01/08/30	1020	0.03	0.6	3.2	0.19	3.82	1.0	15	5.3	7.0	25.0	171		2.49	460	
	01/10/04	1030	0.03	0.22 U	9	0.66		ns	34	7.7	6.7	18.1	320		0.77	250	
	01/11/07	1100	0.04	0.20 U	13	0.83		0.7	63	8.2	7.1	13.5	409		0.63	28	
	01/11/14	1105	ns	ns	ns	ns		ns	ns	9.3	6.5	7.6	417		2.21	ns	
	01/12/11	1045	0.08	0.5	1.8	0.16	2.25	2.2	ns	10.3	7.0	6.5	165		2.40	3100	
	02/01/10	1105	0.34	1.5	4.1	0.29	5.60	1.9 G5	ns	14.8	7.0	2.1	272		3.92	730	
	02/02/05	1120	0.05	0.4	6.7	0.63	7.11	2.1	ns	6.4	7.2	7.1	262		3.78	68 B4Q1	
	02/03/08	1120	0.08	.20 U	18	1.50		1.2	ns	11.4	7.1	9.2	198		2.20	16	
	02/04/15	1030	0.05	.20 U	14	1.70		1.4	ns	7.3	7.0	20.0	214		1.92	65 B4 Q1	
	02/05/01	1000	0.06	0.4	7.3	0.59	7.70	ns	ns	6.1	7.0	18.2	306		0.98	97	

	02/06/26	0950	0.06	.20 U	14	2.00		1.6	ns	5.2	7.0	23.0	586		0.42	310 B4	
	02/08/15	1015	0.03	0.8	20	2.70	20.75	ns	ns								
TC1	00/12/14	1010	0.04	0.3	0.05	0.04	0.35	1.2	ns	10.0	7.3	5.0	118		ns	ns	
Turkey Cr at	00/12/21	0930	0.04	0.6	0.01	0.03	0.61	ns	5.4	12.9	7.0	0.9	ns		0.56	210	
Hwy 15/501	00/12/28	1040	0.10	0.5	0.21	0.04	0.71	1.2	ns	12.0	7.2	2.2	102		ns	38	
Lat 35° 42' 06"	01/01/08	0900	0.02	0.3	0.2	0.03	0.50	1.0	6.8	11.9	7.3	1.7	111		0.06	130	
Long 79° 10' 48"	01/01/18	0910	0.05	0.4	0.11	0.02	0.51	1.1	6.2	11.1	7.6	5.7	96		0.05	27	
	01/01/25	1015	0.05	0.4	0.15	0.01	0.55	0.5	6.9	13.2	7.1	2.2	97		0.20	71	
	01/01/30	1015	0.01	0.5	0.17	0.04	0.67	0.7	6.7	10.6	7.2	8.0	103		0.18	64	
	01/02/08	1000	0.00	<1.0	<0.5	<0.5		6.9	7.7	11.5	6.8	5.2	107		0.15	14	
	01/02/13	1030	Lab	Lab	Lab	<0.5		2.8	7.8	11.8	7.0	5.2	61		4.15	380	
	01/02/20	0830	Lab	Lab	Lab	<0.5		1.2	6.5	11.9	7.0	5.2	83		0.52	160	
	01/03/01	0830	<0.5	<1.0	<0.5	<0.5		<2	8.2	10.2	7.1	8.0	97		0.42	260	
	01/03/07	0930	0.80	1.3	<0.5	<0.5		<2.0	6	12.3	7.9	4.4	77		1.56	220	
	01/03/28	0830	<0.20	<0.6	0.15	<0.10		<2.0	6.5	12.4	7.2	6.0	89		0.55	74	
	01/04/18	0845	0.20 U	0.60 U	0.15	0.10 U		2.1	7.4	10.2	7.5	9.0	100		0.19	150	
	01/05/02	0830	<0.20	<0.6	<0.15	<0.10		1.0	8.2	6.8	7.1	15.7	110		0.16	150	
	01/05/09	0845	<0.20	<0.6	<0.15	<0.10		1.1	8.5	6.7	7.5	15.3	114		0.04	200Q	
	01/05/30	0840	<0.20	<0.6	0.17	<0.10		ns	7.7	5.4	7.5	17.6	106		0.09	1900 B1	
	01/06/21	0830	0.06	0.4	0.19	0.03	0.59	1.0	6.5	5.0	7.0	21.7	105		0.09	240	
	01/08/07	0857	0.32	0.6	0.11	0.06	0.69	0.7	6.5	4.2	6.9	23.0	45		0.05	57 J2	
	01/08/30	0900	0.03	0.3	0.19	0.05	0.51	0.4	5.6	5.3	7.1	22.8	87		0.31	240	
	01/10/04	0900	0.01 U	0.3	0.14	0.03	0.42	ns	5.9	6.9	7.3	14.7	180		0.11	240 Q	
	01/11/07	0915	0.14 J3	0.3	0.02	0.02	0.32	0.9 J2	7.2	8.5	7.1	7.2	123		0.05	9 Q	
	01/12/11	0900	ns	ns	ns	ns		ns	ns	10.9	7.2	4.3	115		no flow		
	02/01/10	0910	0.07	0.8	0.24	0.05	1.05	1.1 G5	ns	16.6	7.1	2.3	98		0.45	770 B4	
	02/02/05	0940	0.03	0.2	0.29	0.03	0.49	1.1J2G1	ns	12.6	7.1	3.0	93		0.51	33Q1	
	02/03/08	0910	0.20	0.4	0.12	0.03	0.47	1.1	ns	13.2	7.1	6.0	102		no flow	110 Q2 B4	
	02/04/15	0840	0.26	0.3	0.12	0.04	0.41	1.4	ns	8.5	7.4	17.0	106		no flow	67 Q2	
	02/05/01	0830	0.06	0.3	0.22	0.03	0.54	ns	ns	7.2	7.2	16.4	120		0.06	120	
TC2	00/12/14	0945	6.90	7.9	1.9	1.40	9.80	34.4	ns	6.8	7.1	5.2	1425		ns	ns	

Turkey Cr at	00/12/21	1015	1.20	3.2	1.1	0.47	4.30	ns	22	12.9	7.2	1.2	ns		0.62	620	
SR 1012	00/12/28	1010	10.00	14.0	2.3	4.20	16.30	59.0	87	11.2	7.2	2.0	761		ns	5300	
Lat 35° 42’15"	01/01/08	0945	0.97	1.2	1.3	0.42	2.50	6.6	38	10.8	7.2	2.8	370		0.16	410	
Long 79° 10’30"	01/01/18	0920	0.80	1.3	1.2	0.33	2.50	4.2	49	9.4	7.9	6.1	397		0.14	82	
	01/01/25	1030	1.00	2.0	1.6	0.47	3.60	6.6	38	13.2	7.2	3.2	348		0.31	140	
	01/01/30	1030	11.00	13.0	2.9	3.90	15.90	25.0	85	8.3	7.6	8.5	860		1.44	140	
	01/01/30	1250	8.50	11.0	3	2.80	14.00	24.0	81	10.4	7.3	10.1	760		ns	2400	
	01/02/08	1020	<0.5	Lab	<0.5	<0.5		7.3	30	11.9	7.2	6.1	317		0.22	64	
	01/02/13	0930	Lab	Lab	Lab	<0.5		3.7	14	12.7	7.6	5.7	164		3.67	740	
	01/02/20	0900	Lab	Lab	Lab	<0.5		0.9	12	12.3	7.3	5.2	142		0.87	320	
	01/03/01	1000	1.50	2.0	0.95	<0.5	2.95	4.6	15	9.6	7.8	9.2	187		0.50	590	
	01/03/07	1215	Lab	1.8	0.66	<0.5	2.46	2.6	9.9	11.6	8.1	7.1	126		1.58	270	
	01/03/28	1100	0.29	<0.6	0.76	<0.1		2.4	9.6	10.8	7.6	9.4	129		0.56	360	
	01/04/18	1030	3.50	3.9	1.8	<0.10	5.70	5.8	14	9.8	7.9	10.5	197		0.54	230	
	01/05/02	1010	3.50	3.9	3.6	<0.10	7.50	4.3	14	5.4	7.9	16.3	209		0.09	210	
	01/05/09	1030	4.70	5.7	2.4	0.23	8.10	9.6	22	4.0	7.0	15.6	271		0.10	Lab	
	01/05/30	0945	6.00	6.5	1.6	0.29	8.10	22.0	17	3.7	7.0	17.0	242		0.14	360	
	01/06/21	0950	12.00	Lab	3.2	0.26		12.0	17	3.3	7.1	22.2	267		0.14	3000	
	01/08/07	1020	0.09	0.5	1.1	0.12	1.55	2.4	18	5.4	7.3	23.4	209		0.14	120 B1	
	01/08/30	1000	0.14	1.3	1	0.30	2.30	1.1	17	5.7	7.1	23.3	175		0.28	190 B1	
	01/10/04	1000	0.21	1.0	0.77	0.16	1.77	ns	13	6.8	6.8	15.2	193		0.14	190 QB4	
	01/11/07	1040	0.11	0.3	0.43	0.08	0.76	0.8	36	7.1	7.1	8.6	315		0.08	34	
	01/11/14	1040	2.80	6.1	0.95	0.49	7.05	3.1	79	8.0	6.9	4.2	485		0.09	460 Q	
	01/12/11	1020	0.42	2.1	1.8	1.00	3.90	8.4	ns	11.2	6.9	4.8	440		0.54	10000 B3	
	02/01/10	1040	1.40	1.8	0.42	0.08	2.22	1.2 G5	ns	15.8	7.2	1.5	154		0.56	420	
	02/02/05	1055	0.66J3	0.8	0.52	0.05	1.36	1.2	ns	12.7	7.2	3.7	136		0.54	130 B4G1	
	02/03/08	1045	0.62	1.0	0.34	0.06	1.34	1.6	ns	11.6	7.0	8.9	167		no flow	80 B4	
	02/04/15	1015	0.17	0.7	0.67	0.08	1.32	2.2	ns	10.1	7.0	19.1	165		no flow	630 B4	
	02/05/01	0935							ns	5.2	7.2	16.6	315		no flow	170	
	02/06/26	0930	0.02	0.4	0.85	0.09	1.23	0.8							no flow	13	
TC3	01/02/20	1000	Lab	Lab	0.56	<0.5		2.0	11	12.3	7.0	6.6	127		1.10	1200	
Turkey Cr at mouth	01/03/01	0945	Lab	Lab	Lab	Lab		2.7	13	9.8	8.0	8.4	188		0.58	6300	
Lat 35° 42’25"	01/03/07	1015	0.64	1.1	0.83	<0.5	1.93	2.5	9.2	12.4	7.3	5.8	116		2.22	180	

Long 79° 09' 49"	01/03/28	1010	4.30	4.5	2.7	<0.10	7.20	<2	9.8	11.2	7.4	8.3	160		0.72	58	
	01/04/18	1000	0.55	1.3	2.2	0.10 U	3.50	<2	9.9	11.5	7.3	10.6	139		0.58	52	
	01/05/02	0945	<0.2	<0.6	1.6	<0.10		1.1	11	9.6	7.2	15.3	140		0.25	43	
	01/05/09	1000	<0.2	<0.6	0.67	<0.10		0.8	13	8.2	7.2	15.4	162		0.15	240 Q	
	01/05/30	0930	0.43	1.1	2.9	<0.10	4.00	2.2	17	6.6	7.5	16.8	212		0.26	140B1	
	01/06/21	0930	0.14	0.6	0.59	0.12	1.16	0.7	10	7.9	7.2	21.2	139		0.25	2600	
	01/08/07	0847	0.04	0.3	0.39	0.09	0.70	2 U	11	5.2	7.2	22.1	109		0.13	310	
	01/08/30	0940	0.03	0.4	0.5	0.08	0.87	1.0	8.4	6.8	6.9	22.5	117		0.45	360	
	01/10/04	0945	0.01 U	0.6	1	0.21	1.59	2.3	24	7.3	7.2	14.2	260		0.17	980 B4	
	01/11/07	1010	0.02	0.4	0.15	0.08	0.51	1.0	16	12.5	7.1	7.0	203		0.13	ns	
	01/11/14	1020	0.01 UJ3	0.20 U	0.16	0.04		0.7	17	11.9	7.1	7.2	211		0.59	34 Q	
	01/12/11	1000	0.25 J3	0.9	0.76 J3	0.20		3.3	ns	10.9	7.2	4.7	200		0.60	4100	
	02/01/10	1015	11.00	12.0	0.48	0.17	12.48	0.2 G5	ns	15.3	7.2	1.2	475		0.72	5	
	02/02/05	1035	18.00	56.0	0.6	0.14	56.60	2.2 G5G1	ns	11.6	7.2	4.3	637		0.59	660 B4 Q1	
	02/03/08	1045	0.20	0.6	0.63	0.05	1.23	1.5	ns	11.6	7.0	8.9	157		0.12	230	
	02/04/15	1000						1.2	ns	11.6	7.0	18.9	130		no flow	56	
	02/05/01	0920						ns	ns	8.3	7.5	16.9	160		0.17	60	
	02/06/26	0910	2.10	2.7	1.2	0.12	3.90	6.6	ns						no flow	51	
CC2 left	00/12/28	1035	0.18	0.4	0.56	0.07	0.96	ns	ns	14.0	7.6	1.5	230		ns	ns	
Camp Cr. upstream	01/01/08	0915	0.02	0.3	0.06	0.04	0.36	0.6	20	12.9	7.3	1.4	187		0.07	36	
from UT that drains	01/01/18	0940	0.13	0.4	0.05	0.02	0.45	0.5	15	9.4	7.9	5.6	152		0.10	27	
Townsend property	01/01/25	1100	<0.01	0.5	0.19	0.02	0.69	0.2	19	14.4	7.1	3.0	197		0.11	100	
Lat 35° 41' 42"	01/01/30	1115	0.06	0.6	1.1	0.06	1.70	0.1	22	11.8	7.1	8.8	200		0.17	73	
Long 79° 09' 32"	01/01/30	1230	0.01	0.9	1	0.04	1.90	0.3	22	13.0	7.2	10.0	213		ns	500	
	01/02/08	1040	<0.5	<1.0	0.74	<0.5		7.4	18	13.4	7.4	5.5	195		0.13	10k	
	01/02/13	1000	Lab	Lab	Lab	<0.5		2.2	14	13.0	7.1	5.1	140		3.89	850	
	01/02/20	0915	Lab	Lab	<0.5	<0.5		0.5	10	12.4	7.5	5.3	114		0.63	180	
	01/03/01	0900	<0.5	<1.0	<0.5	<0.5		<2	13	11.5	8.0	7.4	136		0.32	45	
	01/03/07	0900	<0.5	<1.0	<0.5	<0.5		<2.0	8.6	12.8	7.2	4.5	97		1.32	120	
	01/03/28	0900	<0.20	<0.6	<0.15	<0.10		<2.0	7.3	12.8	7.3	5.0	91		0.43	10	
	01/04/18	0900	<0.20	<0.6	<0.15	<0.10		<2	7.2	11.0	6.6	8.0	92		0.14	86	
	01/05/02	0900	<0.20	<0.6	<0.15	<0.10		0.7	8.2	8.8	7.3	14.2	99		0.07	95	
	01/05/09	0910	<0.20	<0.6	<0.15	<0.10		0.4	8.7	7.6	6.9	14.0	101		0.04	260Q	
	01/05/30	0840	<0.20	<0.6	0.27	<0.10		ns	8.7	8.4	7.5	15.9	101		0.20	91 B4	

	01/06/21	0900	0.04	0.4	0.22	0.04	0.58	0.5	7.7	7.9	7.3	20.5	95		0.13	39	
	01/11/07	0940	0.04	0.6	0.09	0.66	0.68	0.8	70	12.2	7.0	7.0	170		0.06	370	
	01/11/14	0930	0.04	0.6	0.15	0.09	0.78	3.8	ns	14.0	7.2	2.4	145		0.08	10000 B3	
	01/12/11	0915							ns	13.4	7.2	4.3	115		0.11	ns	
	02/01/10	0940	0.02	0.3	0.7	0.04	1.03	0.8 G5	ns	16.5	7.0	1.4	129		0.43	560	
	02/02/05	1000							ns	12.6	7.2	12.6	95		0.43	ns	
	02/03/08	0955	0.01	.20 U	.01 U	0.02		1.1	ns	11.8	7.0	15.3	100		0.10	49 Q2	
	02/04/15	0855	0.08	0.5	0.06	0.03	0.52	0.7	ns	9.8	7.1	17.4	106		no flow	15 Q2	
	02/05/01	0900	0.03	0.3	0.28	0.03	0.56	ns	ns	8.1	7.0	15.6	107		0.08	8	
CC2right	00/12/28	1030	15.00	31.0	4.1	5.40	35.10	ns	ns	11.8	7.3	1.7	956		ns	ns	
Ut that drains	01/01/08	0915	2.70	4.5	4.2	1.30	8.70	1.6	65	9.7	7.4	1.6	763		0.06	130	
Townsend property	01/01/30	1100	11.00	13.0	4.7	3.50	17.70	23.0	90	10.2	7.4	9.2	880		1.19	1000	
Lat 35° 41' 47"	01/01/30	1215	9.70	12.0	5.2	3.50	17.20	16.0	93	9.3	7.3	10.4	860		ns	730	
Long 79° 09' 39"	01/02/08	1045	<0.5	1.0	1.2	1.30	2.20	7.5	69	10.9	7.5	5.4	771		ns	18	
	01/02/13	1000	Lab	Lab	Lab	0.90		4.3	56	13.1	7.4	5.1	550		0.50	260	
	01/02/20	0915	Lab	Lab	1.6	0.65		0.5	49	11.9	7.2	4.5	548		0.11	290	
	01/03/01	0915	<0.5	Lab	0.63	0.87		<2	57	11.1	8.2	6.6	607		0.07	590	
	01/03/07	0905	<0.5	<1.0	<0.5	<0.5		<2.0	9.1	12.4	7.7	3.8	442		0.10	10K	
	01/03/28	0915	ns	ns	ns	ns		ns	ns	12.6	7.4	3.6	432		0.02	ns	
	01/04/18	0910	<0.20	0.8	<0.15	0.81		<2	32	10.3	7.4	8.0	357		ns	51	
	01/11/07	0925	0.04	0.3	0.01 U	0.02		0.4	12	9.0	7.3	7.4	600		ns	150	
	01/11/14	0945	0.05	2.3	2.3	1.4 J3	4.60	6.3	ns	8.2	6.8	2.9	621		ns	6800 **3**	
	01/12/11	0920	0.05	2.3	2.3	1.4 J3	4.60	6.3	ns	12.1	6.8	4.6	665		ns	6800 B3	
	02/01/10	0930	0.02	1.1	1	0.44	2.10	0.9G5	ns	15.5	6.9	1.2	480		0.37	350	
	02/02/05	1010	0.02	0.20 U	0.02	0.22		0.7 G5G1	ns	12.8	7.2	2.1	403		0.30	140 B4 Q1	
	02/03/08	0930	.01 U	0.2	.01 U	0.15		0.7	ns	12.6	7.0	5.3	560		ns	920 B4 Q2	
	02/04/15	0905	0.04	0.4	0.18	0.31	0.58	0.1	ns	8.5	7.3	17.0	419		ns	250 B4	
CC2 bridge	00/12/14	1000	0.83	1.9	3.5	1.00	5.40	6.50	ns	10.1	7.4	4.8	559		ns	ns	
Camp Cr at SR 1012	00/12/21	1000	1.60	3.6	1.9	0.80	5.50	ns	40	13.2	7.0	0.6	ns		0.43	590	
downstream UT	00/12/28	0950	ns	ns	ns	ns		ns	ns	11.8	7.3	1.7	956		ns	ns	

that																	
drains Townsend	01/01/18	0950	1.40	4.3	6	1.60	10.30	10.0	68	10.7	8.1	5.8	584		0.23	780	
property	01/01/25	1115	0.87	1.5	2	0.47	3.50	0.1	40	13.1	7.2	2.7	440		ns	130	
Lat 35° 41' 49"	01/01/30	1130	8.70	11.0	4.3	2.90	15.30	15.0	80	10.4	7.2	9.6	740		1.36	780	
Long 79° 09' 33"	01/02/08	1100	Lab	<1.0	Lab	<0.5		7.5	34	12.5	7.5	5.8	346		0.14	10k	
	01/02/13	1015	Lab	Lab	Lab	<0.5		1.9	19	12.0	7.3	5.9	340		ns	790	
	01/02/20	0930	Lab	Lab	<0.5	<0.5		0.6	14	12.9	7.2	5.4	178		ns	250	
	01/03/01	0920	<0.5	Lab	<0.5	<0.5		<2	18	11.4	8.1	7.3	209		ns	350	
	01/03/07	0925	<0.5	<1.0	<0.5	<0.5		<2.0	11	11.2	7.7	7.5	240		ns	170	
	01/03/28	0925	0.20	1.4	<0.15	<0.10		<2	8.9	12.5	7.4	5.0	119		ns	80	
	01/04/18	0920	<0.20	<0.6	<0.15	0.10		<2	9	ns	ns	ns	ns		ns	ns	
CC3	01/02/20	1010	Lab	Lab	0.25	<0.5		0.7	14	12.9	7.6	6.4	166		0.92	280	
Camp Cr at mouth	01/03/01	1000	<0.20	<0.6	<0.15	0.14		<2	9.4	12.2	7.4	7.7	198		0.46	500	
Lat 35° 42' 16"	01/03/07	1000	<0.5	<1.0	<0.5	<0.5		<2.0	11	12.3	7.1	4.9	140		1.81	220	
Long 79° 09' 32"	01/03/28	1000	ns	ns	ns	ns		ns	ns	13.1	7.7	6.1	121		0.59	ns	
	01/04/18	0930	<0.20	<0.6	<0.15	0.21		<2	9.4	12.0	7.5	8.2	109		0.30	50	
	01/05/02	0930	<0.20	0.6	<0.15	0.30		1.1	9	8.6	7.5	15.0	122		0.15	200	
	01/05/09	0940	<0.20	<0.6	0.24	0.42		0.9	8.6	7.2	6.9	15.0	126		0.08	99 B4,Q	
	01/05/30	0915	<0.20	<0.6	0.29	0.38		ns	12	8.2	7.3	16.5	143		0.22	680 B4	
	01/06/21	0910	0.03	0.4	0.23	0.35	0.60	0.5	9.6	7.3	7.3	20.8	96		0.20	320	
	01/08/07	0920	0.08	0.4	0.23	0.35	0.65	2 U	9	6.0	7.1	21.8	121		0.03	91 B4	
	01/08/30	0925	0.02	0.4	0.18	0.20	0.55	0.2	9.3	7.3	7.0	22.0	119		0.30	580	
	01/10/04	0930	0.03	0.3	0.31	0.29	0.61	2.8	12	6.7	7.1	14.0	156		0.06	5700	
	01/11/07	1005	0.30	0.8	0.04	0.18	0.82	0.6	18	10.4	7.2	8.0	200		0.11	1400 B1	
	01/11/14	1000	0.01	1.0	0.05	0.16	1.05	2.0	24	13.1	6.9	2.7	253		0.15	4900 Q	
	01/12/11	0940	0.03	0.8	0.47 J3	0.37		2.9	ns	12.4	7.2	4.6	212		0.51	7600 B3	
	02/01/10	1000	0.04	1.0	0.75	0.10	1.75	1.1 G5	ns	16.4	7.1	1.4	189		0.53	450	
	02/02/05	1020	0.12	0.3	0.09	0.04	0.34	0.8 G5G1	ns	12.8	7.2	2.8	120		0.55	440 Q1	
	02/03/08	1000	0.02	.20 U	0.01	0.03		0.9	ns	13.3	7.0	6.1	125		no flow	79 B4 Q2	
	02/04/15	0930	0.03	0.3	0.1	0.07	0.42	1.2	ns	17.5	10.8	7.1	121		no flow	2600 B3	
	02/05/01	0910	0.04	0.3	0.28	0.14	0.55	ns	ns	7.8	7.1	15.9	132		no flow	870	
RC8 staff	00/12/14	1130	0.39	1.0	5.1	0.33	6.10	ns	ns	12.9	7.5	5.4	344	ns	ns	ns	

Roberson Cr near	00/12/21	0850	0.72	1.4	1.6	0.29	3.00	ns	21	12.8	7.2	1.0	ns	ns	ns	530	
Lucian Bland Rd	00/12/28	0915	ns	ns	ns	ns		ns	ns	13.8	7.4	1.4	ns	1.58	3.41	ns	
Lat 35^{o} 42’05"	01/01/08	0830	0.52	1.0	4.3	0.42	5.30	1.2	24	11.1	7.1	2.0	302	1.46	1.62	45	
Long 79^{o} 07’49"	01/01/11	1030	ns	ns	ns	ns		ns	ns	10.9	7.2	3.4	384	1.44	1.36	ns	
	01/01/18	0935	0.02	0.9	4.3	0.45	5.20	1.2	27	10.8	7.9	5.4	288	1.47	1.23	18	
	01/01/25	0940	0.16	0.8	2.2	0.26	3.00	0.5	16	13.5	6.8	3.1	170	1.71	5.65	100	
	01/01/26	1000	ns	ns	ns	ns		ns	ns	14.3	7.2	1.7	264	1.51	2.43	ns	
	01/01/30	0930	1.40	5.3	3.6	0.66	8.90	4.0	27	12.0	7.1	6.9	318	1.58	3.42	82	
	01/02/08	0930	Lab	<1.0	Lab	<0.5		7.5	16	13.0	7.2	4.9	220	2.34	2.34	10k	
	01/02/13	0840	Lab	Lab	Lab	<0.5		9.2	20	11.2	7.3	5.5	231	2.04	18.17	420	
	01/02/15	0930	ns	ns	ns	ns		ns	ns	ns	ns	ns	ns	1.86	10.68	ns	
	01/02/20	1230	Lab	Lab	Lab	<0.5		1.2	11	11.6	7.3	9.5	136	1.82	9.00	390	
	01/03/01	1300	<0.5	<1.0	2.5	<0.5		<2	15	10.8	7.7	11.5	195	1.64	3.83	100	
	01/03/05	1330	ns	ns	ns	ns		ns	ns	ns	ns	ns	ns	2.64	49.75	ns	
	01/03/07	1315	<0.5	<1.0	1.3	<0.5		<2	9	11.8	7.0	9.2	128	1.98	13.75	360	
	01/03/21	0800	ns	ns	ns	ns		ns	ns	ns	ns	ns	ns	5.2	448.17	ns	
	01/03/21	0940	ns	ns	ns	ns		ns	ns	ns	ns	ns	ns	4.45	297.49	ns	
	01/03/21	1145	ns	ns	ns	ns		ns	ns	ns	ns	ns	ns	3.75	203.46	ns	
	01/03/28	1330	<0.20	0.6	4	0.21	4.60	<2	14	12.1	7.2	11.9	136	1.75	6.58	28	
	01/03/30	0845	ns	ns	ns	ns		ns	ns	ns	ns	ns	ns	5.95	547.31	ns	
	01/03/30	1005	ns	ns	ns	ns		ns	ns	ns	ns	ns	ns	5.31	474.36	ns	
	01/04/18	1245	<0.20	<0.6	5.8	0.35		<2	16	12.6	8.1	12.9	185	1.62	3.65	ns	
	01/05/02	1300	<0.20	0.8	7.7	0.38	8.50	1.5	40	12.6	8.1	19.3	314	1.58	3.42	15	
	01/05/09	1300	<0.20	0.7	4.6	0.28	5.30	1.3	40	11.5	8.1	19.1	270	1.52	2.34	58	
	01/05/30	1130	<0.20	1.0	11	0.84	12.00	ns	44	7.1	7.1	20.2	305	1.54	2.88	ns	
	01/06/21	1230	0.33	0.9	1.7	0.20	2.59	<2.0	18	8.1	7.3	25.2	160	1.52	2.34	140B1	
	01/07/04	1530	0.03	0.7	0.4	0.09	1.06	ns	ns	9.5	7.1	25.8	230	3.7	187.00	ns	
	01/07/23	1730	0.06	0.6	2.5	0.16	3.05	ns	ns	8.9	7.0	26.2	281	1.56	3.00	ns	
	01/07/12	1830	0.29	0.5	1.3	0.11	1.78	ns	ns	10.2	7.4	26.0	260	1.56	3.00	ns	
	01/07/31	1830	0.13	0.5	2.2	0.22	2.74	ns	ns	9.1	7.2	26.2	234	1.60	3.56	ns	
	01/08/05	1415	0.04	0.6	2.3	0.22	2.87	ns	ns	8.0	7.1	28.0	209	1.56	3.00	ns	
	01/08/07	1235	0.06	0.4	1.9	0.23	2.34	2 U	16	8.2	7.0	28.5	345	1.54	2.88	80 B4	
	01/08/30	1115	0.02	0.4	0.7	0.12	1.09	1.0	8.4	7.8	7.0	24.4	116	3	106.00	110	
	01/09/09	1330	0.01 U	0.3	2.7	0.13	3.04	ns	ns	8.1	7.1	24.8	213	1.52	2.34	ns	
	01/09/15	1845	0.01	0.2	2.6	0.13	2.83	ns	ns	7.6	7.2	24.0	242	1.54	2.88	ns	
	01/09/28	1730	0.22	0.8	2.6	0.44	3.37	ns	ns	7.7	7.0	18.0	211	1.68	4.60	ns	
	01/10/04	1310	0.01 U	0.3	2.6	0.28	2.93	27 G4	17	8.3	7.0	16.2	189	1.56	3.00	49	
	01/10/19	1900	0.20	1.6	2.3	0.15	3.90	ns	ns	7.7	7.3	13.3	197	1.58	3.41	ns	

	01/10/29	1230	0.09	0.7	3.1	0.18	3.84	ns	ns	10.1	7.2	10.1	277	1.58	3.42	ns	
	01/11/07	1230	0.01	0.6	3.8	0.16	4.35	0.8	ns	12.3	7.1	5.5	285	1.7	5.60	33	
	01/11/14	1145	0.07	0.4	3.2	0.12	3.63	0.2	57	9.4	7.0	5.3	289	1.72	5.90	46 Q	
	01/12/11	1235	0.02	0.5	4.2	0.26	4.71	2	ns	11.5	7.2	5.8	340	2.14	20.00	2800	
	02/01/24	1630	0.33	0.8	1.7	0.14	2.49	ns	ns	12.4	7.1	5.9	267	1.63	3.81	ns	
	02/01/31	0930	0.06	0.3	1.4	0.09	1.70	ns	ns	12.2	7.0	5.9	199	1.76	6.90	ns	
	02/02/05	1245	1.0 J3	1.1	2.2	0.14	3.30	1.7G5G1	ns	10.4	7.2	6.4	193	1.76	6.90	60 Q1	
	02/01/10	1240	0.32	0.7	1.6	0.13	2.26	1.4 G5	ns	16.0	7.0	2.0	201	1.74	6.58	420	
	02/03/08	1320	.01 U	.2 U	0.76	0.08		1 U	ns	12.5	7.1	10.8	137	1.78	7.20	34	
	02/04/15	1140	0.04	0.4	1.2	0.09	1.62	1	ns	12.6	7.6	19.1	162	1.72	5.90	30	
	02/05/01	1030	0.04	0.6	2	0.14	2.56	ns	ns	7.7	7.2	18.0	208	1.64	3.83	240 B4	
	02/05/02	1830	0.06	0.5	3.2	0.23	3.65	ns	ns	7.8	7.2	17.9	217	1.64	3.83	ns	
	02/05/08	1430	0.04	0.4	1.6	0.17	1.98	ns	ns	6.4	7.1	18.2	229	1.58	3.42	ns	
	02/05/14	0700	0.05	0.3	2.1	0.17	2.36	ns	ns	ns	ns	ns	ns	1.46	1.62	ns	
	02/05/29	1830	0.03	0.6	3	0.17	3.58	ns	ns	ns	ns	ns	ns	1.46	1.62	ns	
	02/06/26	1045	.01 U	0.7	1.2	0.29	1.85	4	ns	6.9	7.7	24.4	408	1.36	0.32	19	
	02/07/22	1330	0.02	0.9	2.5	0.34	3.42	ns	ns	12.2	8.2	26.5	282	1.36	0.32	ns	
	02/08/15	1040	.02 U	0.7	1.1	0.22	1.80	ns	ns	ns	ns	ns	ns	1.60	3.54	ns	
RC10	01/05/10	1105	<0.20	<0.6	0.92	0.10		ns	Lab	13.7	10.4	27.0	235			ns	
Roberson Cr near	01/06/13	1045	0.05	1.0	0.09	0.12	1.08	ns	48	15.2	11.8	30.0	263			1B1,Q	ns
Seaforth ramp	01/06/21	1255	0.03	0.7	<0.01	0.13		1.1	32	14.4	10.1	31.2	222			2	25
(#B2450000)	01/07/11	1330	0.76	1.5	0.02	0.05	1.52	ns	ns	6.0	7.0	26.0	210			73	51
Lat 35^o 42' 10"	01/08/07	1110	0.02	1.1	0.01 U	0.12		4.0	43	11.1	9.3	30.5	198			6	ns
Long 79^o 06' 05"	01/08/30	1155	0.02	1.0	0.01 U	0.09		0.5 J2	33	11.1	9.3	30.5	198			1	25
	01/09/19	1135	0.01 U	1.0	0.01 U	0.10		5.5 J2	46	12.9	9.2	25.5	211			3 Q	24
	01/10/05	0920	0.26	1.1	0.12	0.10	1.22	ns	ns	10.1	8.9	21.3	228			27	52
	01/10/04	1120	0.01 U	1.0	0.07	0.07	1.07	ns	64	10.3	8.7	22.0	230			6	29
	01/10/29	1310	0.06	1.3	0.65	0.10	1.95	ns	39	11.0	8.8	21.4	271			na	62
	01/10/31	0950	0.22	1.5	0.31	0.10	1.81	ns	ns	12.7	8.8	15.8	258			1 B2 Q	65
	01/11/08	1120	0.01	1.3	0.06	0.13	1.36	7.7	99	12.8	8.6	15.1	255			1 B2 Q	58
	01/12/17	1320	0.20	1.5	0.92	0.21	2.42	ns	ns	11.7	8.0	7.1	280			ns	66
	02/04/08	1325	0.01	0.7	0.49	0.12	1.16	ns	ns	10.7	8.3	16.9	150			41	37
	02/04/15	1210						ns	ns	9.3	8.8	22.9	107			ns	ns
	02/04/22	1425	0.03	0.9	0.43	0.08	1.28	ns	ns	6.1	9.0	25.0	193			4 Q1	44
	02/05/07	1755	0.08	0.6	0.55	0.06	1.10	ns	ns	12.8	8.8	22.8	246			ns	32

	02/05/08	1410	.01 U	0.6	0.43	0.05	1.01	4.8	ns	11.7	9.2	28.0	258			ns	26
	02/06/19	1605	0.02	0.4	0.18	0.10	0.54	ns	ns	10.9	8.8	27.6	216			ns	27
	02/06/26	1225	0.04	1.4	.01 U	0.06		4.9	ns	5.5	7.6	29.8	360			2	32
	02/07/09	1430	0.04	0.6	1.2	0.25	1.75	ns	ns	13.1	9.1	30.1	260			ns	69
	02/07/29	1415	0.03	0.8	0.02	0.10	0.83	8.7	ns	14.2	9.5	32.4	468			4	78
	02/08/15	1215	.02 U	1.5	.02 U	0.11		ns	ns	8.1	8.0	31.2	411			ns	78
	02/08/28	0950							ns	2.2	7.0	25.8	433				
RC11	01/06/13	1035	0.12	1.0	0.16	0.11	1.11	ns	23	15.3	11.7	30.4	243		ns	B1,Q	23
Roberson Cr o.5 mi	01/06/21	1245	0.06	1.3 Q	0.01 U	0.08		1.3	32	14.9	10.1	31.6	230			1	24
from Seaforth ramp	01/08/07	1100	0.03	1.2	0.01 U	0.10		2.1	21	13.1	9.5	30.7	202			1	
Lat 35° 42’12"	01/08/30	1145	0.03	1.0	0.01 U	0.12		1.1	26	13.1	9.5	30.7	202			2	
Long 79° 05’35"	01/09/19	1145	0.01 U	1.0	0.01 U	0.09		5.6	23	11.3	8.8	25.2	197			9 Q	
	01/10/04	1110	0.01 U	0.8	0.15	0.06	0.99	ns	64	10.3	8.7	22.0	230			1	24
	01/10/29	1320	0.05	1.4	0.72	0.11	2.12	ns	36 A	11.0	8.8	21.4	270			na	
	01/11/08	1115	0.07	1.4	0.01	0.12	1.41	7.4	91	12.2	8.5	16.0	232			1 Q	
	02/04/15	1220							ns	9.5	8.7	22.9	107				
	02/04/22	1415	0.01	0.8	0.41	0.04	1.18	ns	ns	5.9	9.3	25.3	208			2 Q1	58
	02/05/08	1400	.01 U	0.5	0.53	0.06	1.05	6.6	ns	13.7	9.4	27.0	286			ns	41
	02/06/26	1235	.01 U	1.1	.01 U	0.05		4.1	ns	7.4	8.6	29.9	318			3	36
	02/07/29	1400	.02 U	0.9	0.5	0.15	1.39	6.0	ns	13.0	9.1	32.3	497			10	62
	02/08/15	1200	.02 U	1.6	.02 U	0.14		ns	ns	8.1	8.0	32.0	410			ns	66
	02/08/28	1000							ns	0.2	6.8	26.9	437				

Qualifier Codes:

SYMBOL

DEFINITION

A

Value reported is the mean (average) of two or more determinations. This code is to be used if the results of two or more discrete and separate samples are averaged. These samples shall have been processed and analyzed independently (e.g. field duplicates, different dilutions of the same sample).

B

Results based upon colony counts outside the acceptable range and should be used with caution. This code applies to microbiological tests and specifically to membrane filter (MF) colony counts. It is to be used if less than 100% sample was analyzed and the colony count is generated from a plate in which the number of coliform colonies exceeds the ideal ranges indicated by the method. These ideal ranges are defined in the method as:

Fecal coliform bacteria: 20-60 colonies Total coliform bacteria: 20-80 colonies

1. Countable membranes with less than 20 colonies. Reported value is estimated or is a total of the counts on all filters reported per 100 ml.
2. Counts from all filters were zero. The value reported is based on the number of colonies per 100 ml that would have been reported if there had been one colony on the filter representing the largest filtration volume (reported as a less than "<" value).
3. Countable membranes with more than 60 or 80 colonies. The value reported is calculated using the count from the smallest volume filtered and reported as a greater than ">" value.
4. Filters have counts of both >60 or 80 and <20. Reported value is a total of the counts from all countable filters reported per 100 ml.
5. Too many colonies were present; too numerous to count (TNTC), the numeric value represents the maximum number of counts typically accepted on a filter membrane (60 for fecal and 80 for total), multiplied by 100 and then divided by the smallest filtration volume analyzed. This number is reported as a greater than value.
6. Estimated Value. Blank contamination evident.

Note: A "B" value shall be accompanied by justification for its use denoted by the numbers listed above (ex. B1, B2, etc.)

C

Total residual chlorine was present in sample upon receipt in the laboratory; value not accurate (cyanide, phenol, NH3, TKN, coliform, organics)

G

A single quality control failure occurred during biochemical oxygen demand (BOD) analysis. The sample results should be used with caution.

1. The dissolved oxygen (DO) depletion of the dilution water blank exceeded 0.2 mg/L.
2. The bacterial seed controls did not meet the requirement of a DO depletion of at least 2.0 mg/L and/or a DO residual of at least 1.0 mg/L.
3. No sample dilution met the requirement of a DO depletion of at least 2.0 mg/L and/or a DO residual of at least 1.0 mg/L.
4. Evidence of toxicity was present. This is generally characterized by a significant increase in the BOD value as the sample concentration decreases.
5. The glucose/glutamic acid standard exceeded the range of 198 ± 30.5 mg/L.
6. The calculated seed correction exceeded the range of 0.6 to 1.0 mg/L.
7. Less than 1 mg/L DO remained for all dilutions set. The reported value is an estimated greater than value and is calculated for the dilution using the least amount of sample.
8. Oxygen usage is less than 2 mg/L for all dilutions set. The reported value is an estimated less than value and is calculated

for the dilution using the most amount of sample.
9.The DO depletion of the dilution water blank produced a negative value.

Note: A "G" value shall be accompanied by justification for its use denoted by the numbers listed above (ex. G1, G2, etc.)

J

Estimated value; value may not be accurate. This code is to be used in the following instances:

1.surrogate recovery limits have been exceeded;
2.the reported value failed to meet the established quality control criteria for either precision or accuracy;
3.the sample matrix interfered with the ability to make any accurate determination; or
4.the data is questionable because of improper laboratory or field protocols (e.g. composite sample was collected instead of grab, plastic instead of glass container, etc.).
5.temperature limits exceeded (samples frozen or >6° C) during transport, non-reportable for NPDES compliance monitoring.
6.the laboratory analysis was from an unpreserved or improperly chemically preserved sample. The data may not be accurate.
7.This qualifier is used to identify analyte concentration exceeding the upper calibration range of the analytical instrument/method. The reported value should be considered estimated.

Note: A "J" value shall be accompanied by justification for its use denoted by the numbers listed above (ex. J1, J2, etc.). A "J" value shall not be used if another code applies (ex. N, V, M).

M

Sample and duplicate results are "out of control". The sample is non-homogenous (e.g. VOA soil). The reported value is the lower value of duplicate analyses of a sample.

N

Presumptive evidence of presence of material; estimated value. This code is to be used if:

1.The component has been tentatively identified based on mass spectral library search;
2.There is an indication that the analyte is present, but quality control requirements for confirmation were not met (i.e., presence of analyte was not confirmed by alternate procedures).
3.This code shall be used if the level is too low to permit accurate quantification, but the estimated concentration is less than the laboratory practical quantitation limit and greater than the laboratory method detection limit. This code is not routinely used for most analyses.

Q

Holding time exceeded. These codes shall be used if the value is derived from a sample that was received, prepared and/or analyzed after the approved holding time restrictions for sample preparation and analysis.

1.Holding time exceeded prior to receipt by lab

	2.Holding time exceeded following receipt by lab
S	Not enough sample provided to prepare and/or analyze a method-required matrix spike (MS) and/or duplicate (MSD).
U	Indicates that the analyte was analyzed for but not detected above the reported practical quantitation limit*. The number value reported with the "U" qualifier is equal to the laboratory's practical quantitation limit*.
X	Sample not analyzed for this constituent
	1.Sample not screened for this compound. 2.Sampled, but analysis lost or not performed-field error 3.Sampled, but analysis lost or not performed-lab error
	Note: an "X" value shall be accompanied by justification for its use by the numbers listed.
V	Indicates the analyte was detected in both the sample and the associated method blank. Note: The value in the blank shall not be subtracted from the associated samples.
Z	The sample results are rejected due to serious deficiencies in the ability to analyze the sample and meet quality control criteria. The presence or absence of the analyte cannot be verified.
P	Elevated PQL* due to matrix interference and/or sample dilution.
Y	Elevated PQL* due to insufficient sample size
*PQL	The Practical Quantitation Limit (PQL) is defined and proposed as "the lowest level achievable among laboratories within specified limits during routine laboratory operation". The PQL is about three to five times the calculated Method Detection Limit (MDL) and represents a practical and routinely achievable detection limit with a relatively good certainty that any reported value is reliable"

Appendix II. DWQ ambient data collected at RC10.

	TKN (mg/L)	NOx (mg/L)	TP (mg/L)	Chl a (ug/L)	TN (mg/L)
1/30/97	0.400	0.740	0.130		1.140
2/27/97	0.400	1.100	0.110		1.500
3/31/97	0.200	0.560	0.100		0.760
5/22/97	0.400	0.580	0.160		0.980
6/30/97	1.000	0.130	0.140		1.130
9/8/97	0.500	0.160	0.080		0.660
9/29/97	0.600	0.770	0.210		1.370
10/15/97	0.600	0.310	0.230		0.910
11/17/97	0.300	1.100	0.200		1.400
12/11/97	0.400	1.500	0.270		1.900
1/14/98	0.500	0.580	0.130		1.080
2/11/98	0.600	0.730	0.160		1.330
3/3/98	0.300	0.580	0.100		0.880
4/15/98	0.400	0.490	0.130		0.890
5/27/98	0.200	0.420	0.020	40	0.620
6/11/98	0.300	0.260	0.080	18	0.560
7/29/98	0.500	0.010	0.080	26	0.510
8/31/98	0.600	0.030	0.110	58	0.630
9/28/98	0.400	0.010	0.120		0.410
10/28/98	0.500	0.120	0.090	50	0.620
11/29/98	0.600	0.910	0.140	11	1.510
12/28/98	1.000	1.100	0.290	5	2.100
1/28/99	0.600	0.530	0.120		1.130
2/17/99	0.400	1.000	0.090	7	1.400
3/23/99	0.400	0.670	0.150		1.070
4/29/99	0.400	0.620	0.090		1.020
5/24/99	0.400	0.310	0.100	51	0.710
6/24/99	0.900	0.300	0.170		1.200
7/27/99	1.100	0.170	0.140	98	1.270

8/17/99	0.600	0.010	0.110	39	0.610
9/29/99	0.400	0.270	0.160		0.670
10/18/99	0.600	0.500	0.180		1.100
11/2/99	0.500	0.240	0.140		0.740
12/2/99	0.400	0.680	0.140		1.080
2/14/00	0.400	0.440	0.180		0.840
3/15/00	0.400	0.480	0.070		0.880
4/26/00	0.500	0.500	0.070		1.000
5/22/00	0.400	0.090	0.080	19	0.490
6/14/00	0.700	0.030	0.090		0.730
8/30/00	0.700	0.550	0.170	64	1.250
9/13/00	0.600	0.110	0.140	140	0.710
10/9/00	0.600	0.300	0.080	24	0.900
11/29/00	0.700	0.300	0.160		1.000
1/3/01	0.500	1.300	0.140		1.800
2/1/01	1.000	1.400	0.500		2.400
5/21/01	0.600	1.300	0.100	31	1.900
6/25/01	0.980	0.010	0.070	10	0.990
7/11/01	1.500	0.020	0.050	51	1.520
10/5/01	1.100	0.120	0.100	52	1.220
10/31/01	1.500	0.310	0.100	65	1.810
11/29/01	0.550	1.800	0.040	5	2.350
12/17/01	1.500	0.920	0.210	66	2.420
1/14/02	3.600	1.200	0.170	3	4.800
2/19/02	0.940	1.500	0.090	3	2.440
3/7/02	0.290	0.570	0.060	2	0.860
4/8/02	0.670	0.490	0.120	37	1.160
5/7/02	0.550	0.550	0.060	32	1.100
6/19/02	0.360	0.180	0.100	27	0.540
7/10/02	0.640	0.990	0.150	3	1.630
9/10/02	0.660	0.350	0.060	30	1.010

Appendix III. Water column profile data for the Roberson Creek Cove.

Station # & Location	Sample Date	Time	Depth (meters)	DO	pH	Temp	Cond	Secchi	Chlorophyll a
	yy/mm/dd			mg/L	units	C	umhos	meters	ug/L
Roberson Cr near	01/06/13	1045	0.1	15.2	11.8	30.0	263		ns
Seaforth ramp	01/06/21	1255	0.1	14.4	10.1	31.2	222		25
(#B2450000)	01/07/11	1330	0.1	6.0	7.0	26.0	210		51
Lat 35^{o} 42' 10"	01/08/07	1110	0.1	11.1	9.3	30.5	198		ns
Long 79^{o} 06' 05"	01/08/30	1155	0.1	11.1	9.3	30.5	198		25
	01/09/19	1135	0.1	12.9	9.2	25.5	211	0.35	24
	01/09/19	1135	1	12.6	9.1	24.8	212		
	01/09/19	1135	2	10.7	7.7	24.2	217		
	01/09/19	1135	3	8.7	8.0	22.6	210		
	01/09/19	1135	3.5	8.7	8.0	22.6	210		
	01/10/05	0920	0.1	10.1	8.9	21.3	228		52
	01/10/04	1120	0.1	10.3	8.7	22.0	230		29
	01/10/29	1310	0.1	11.0	8.8	21.4	271		62
	01/10/31	0950	0.1	12.7	8.8	15.8	258		65
	01/11/08	1120	0.1	12.8	8.6	15.1	255	0.50	58
	01/11/08	1120	1	11.3	8.3	13.3	253		
	01/11/08	1120	2	9.7	7.5	12.2	255		
	01/11/08	1120	2.5	9.7	7.4	11.1	265		
	01/12/17	1320	0.1	11.7	8.0	7.1	280		66
	01/04/08	1325	0.1	10.7	8.3	16.9	150	0.35	37
	02/04/15	1210	0.1	9.3	8.8	22.9	107		ns
	02/04/15	1210	1	9.1	8.6	22.8	106		
	02/04/15	1210	2	8.8	8.0	22.0	106		
	02/04/15	1210	3	7.6	7.9	21.2	107		
	02/04/15	1210	3.3	7.1	7.8	18.6	111		
	02/04/22	1425	0.1	6.1	9.0	25.0	193	0.30	44
	02/04/22	1425	1	6.0	8.2	24.5	194		
	02/04/22	1425	2	5.6	7.8	24.0	193		

	02/04/22	1425	3	5.5	7.7	22.8	193		
	02/04/22	1425	3.5	5.2	7.4	21.3	196		
	02/05/07	1755	0.1	12.8	8.8	22.8	246		32
	02/05/08	1410	0.1	11.7	9.2	28.0	258	0.30	26
	02/05/08	1410	1	12.0	9.0	24.5	255		
	02/05/08	1410	2	11.4	8.8	23.5	256		
	02/05/08	1410	2.5	8.4	7.5	22.6	255		
	02/06/19	1605	0.1	10.9	8.8	27.6	216		27
	02/06/26	1225	0.1	5.5	7.6	29.8	360		32
	02/07/09	1430	0.1	13.1	9.1	30.1	260		69
	02/07/29	1415	0.1	14.2	9.5	32.4	468	0.30	78
	02/07/29	1415	1	6.5	8.6	29.3	470		
	02/07/29	1415	2	6.1	8.7	28.4	474		
	02/08/15	1215	0.1	8.1	8.0	31.2	411		78
	02/08/28	0950	0.1	2.2	7.0	25.8	433	0.45	
	02/08/28	0950	1	2.2	6.8	25.6	426		
	02/08/28	0950	1.4	1.6	6.8	25.1	417		
RC11	01/06/13	1035	0.1	15.3	11.7	30.4	243		23
Roberson Cr o.5 mi	01/06/21	1245	0.1	14.9	10.1	31.6	230		24
from Seaforth ramp	01/08/07	1100	0.1	13.1	9.5	30.7	202		
Lat 35^{o} 42’ 12"	01/08/30	1145	0.1	13.1	9.5	30.7	202		
Long 79^{o} 05’ 35"	01/09/19	1145	0.1	11.3	8.8	25.2	197	0.45	
	01/09/19	1145	1	10.1	8.7	24.9	198		
	01/09/19	1145	2	9.1	8.4	24.5	197		
	01/09/19	1145	3	8.9	8.3	24.5	198		
	01/09/19	1145	4	8.5	7.9	24.2	212		
	01/09/19	1145	5	6.8	7.4	23.8	218		
	01/09/19	1145	6	3.8	7.0	23.0	226		

	01/10/04	1110	0.1	10.3	8.7	22.0	230		24
	01/10/29	1320	0.1	11.0	8.8	21.4	270		
	01/11/08	1115	0.1	12.2	8.5	16.0	232	0.50	
	01/11/08	1115	1	11.4	8.4	15.1	237		
	01/11/08	1115	2	10.8	8.2	14.9	236		
	01/11/08	1115	3	10.1	7.8	14.6	251		
	01/11/08	1115	4	9.7	7.6	14.2	254		
	01/11/08	1115	5	9.1	7.3	13.5	255		
	01/11/08	1115	6	7.3	7.0	13.2	322		
	02/04/15	1220	0.1	9.5	8.7	22.9	107	0.40	
	02/04/15	1220	1	9.1	8.6	22.6	107		
	02/04/15	1220	2	8.7	8.0	22.1	107		
	02/04/15	1220	3	8.2	8.0	21.3	106		
	02/04/15	1220	5	6.5	7.2	19.9	107		
	02/04/15	1220	5	6.5	7.2	19.8	110		
	02/04/22	1415	0.1	5.9	9.3	25.3	208	0.30	58
	02/04/22	1415	1	5.7	8.8	25.2	207		
	02/04/22	1415	2	5.3	8.6	24.9	208		
	02/04/22	1415	3	5.3	8.0	24.0	207		
	02/04/22	1415	4	5.0	7.5	23.5	207		
	02/04/22	1415	4.6	5.0	7.5	23.5	209		
	02/05/08	1400	0.1	13.7	9.4	27.0	286	0.30	41
	02/05/08	1400	1	13.3	9.2	23.9	259		
	02/05/08	1400	2	10.1	8.0	22.5	262		
	02/05/08	1400	3	7.3	7.3	21.3	265		
	02/06/26	1235	0.1	7.4	8.6	29.9	318		36
	02/07/29	1400	0.1	13.0	9.1	32.3	497	0.35	62
	02/07/29	1400	1	6.7	8.5	30.2	549		
	02/07/29	1400	2	5.0	8.3	29.0	594		
	02/08/15	1200	0.1	8.1	8.0	32.0	410		66
	02/08/28	1000	0.1	0.2	6.8	26.9	437		
	02/08/28	1000	1	0.2	6.8	26.9	436	0.60	

	02/08/28	1000	2	0.15	6.8	26.9	436		
	02/08/28	1000	3	0.14	6.8	26.6	530		
	02/08/28	1000	4	1.14	7	26.2	641		
	02/08/28	1000	4.5	2.73	6.9	26.1	674		

Appendix IV. Stream flow inputs for FLUX.

	Flows in cfs		Estimated Roberson Creek Flow at RC8 using DA ratio			Estimated Roberson Ck. (RC8) plus WWTP Flow	
DATE	Rocky River Flow	Tick Creek Flow	--using Tick Creek	--using Rocky River	Pittsboro wwtp flow	--using Tick Creek	--using Rocky River
04/01/01	62	133	211.47	205.84	2.0336	213.5036	207.8736
04/02/01	31	45	71.55	102.92	1.2927	72.8427	104.2127
04/03/01	12	23	36.57	39.84	1.10515	37.67515	40.94515
04/04/01	8.5	18	28.62	28.22	0.9641	29.5841	29.1841
04/05/01	6.6	13	20.67	21.912	0.9734	21.6434	22.8854
04/06/01	5.8	10	15.9	19.256	0.97495	16.87495	20.23095
04/07/01	5.3	8.9	14.151	17.596	0.95635	15.10735	18.55235
04/08/01	5	7.6	12.084	16.6	0.96565	13.04965	17.56565
04/09/01	4.5	6.6	10.494	14.94	0.94395	11.43795	15.88395
04/10/01	3.9	5.8	9.222	12.948	0.9083	10.1303	13.8563
04/11/01	3.4	5.1	8.109	11.288	0.92845	9.03745	12.21645
04/12/01	3.1	5	7.95	10.292	0.93	8.88	11.222
04/13/01	3	4.6	7.314	9.96	0.775	8.089	10.735
04/14/01	2.9	4.3	6.837	9.628	0.7564	7.5934	10.3844
04/15/01	2.7	4.1	6.519	8.964	0.7099	7.2289	9.6739
04/16/01	2.7	4	6.36	8.964	0.7037	7.0637	9.6677
04/17/01	2.4	3.1	4.929	7.968	0.4867	5.4157	8.4547
04/18/01	2.5	2.9	4.611	8.3	0.73005	5.34105	9.03005
04/19/01	2.3	2.8	4.452	7.636	0.73315	5.18515	8.36915
04/20/01	2.3	3	4.77	7.636	0.71455	5.48455	8.35055
04/21/01	2.3	3	4.77	7.636	0.73935	5.50935	8.37535
04/22/01	2.3	3.2	5.088	7.636	0.7657	5.8537	8.4017
04/23/01	2.2	3.4	5.406	7.304	0.78895	6.19495	8.09295
04/24/01	2.1	3.7	5.883	6.972	0.84785	6.73085	7.81985
04/25/01	7.7	5.2	8.268	25.564	0.7967	9.0647	26.3607
04/26/01	3.9	5.6	8.904	12.948	0.76415	9.66815	13.71215
04/27/01	2.8	3.7	5.883	9.296	0.7285	6.6115	10.0245
04/28/01	2.4	2.7	4.293	7.968	0.7595	5.0525	8.7275

04/29/01	2	2.5	3.975	6.64	0.62	4.595	7.26
04/30/01	1.9	2	3.18	6.308	0.69595	3.87595	7.00395
05/01/01	1.8	1.3	2.067	5.976	0.7688	2.8358	6.7448
05/02/01	1.8	1.3	2.067	5.976	0.51925	2.58625	6.49525
05/03/01	1.7	1.2	1.908	5.644	0.43555	2.34355	6.07955
05/04/01	1.5	1.1	1.749	4.98	0.42935	2.17835	5.40935
05/05/01	1.4	0.94	1.4946	4.648	0.4154	1.91	5.0634
05/06/01	1.3	0.78	1.2402	4.316	0.4557	1.6959	4.7717
05/07/01	1.3	0.64	1.0176	4.316	0.73315	1.75075	5.04915
05/08/01	1.3	0.59	0.9381	4.316	0.72695	1.66505	5.04295
05/09/01	1.2	0.58	0.9222	3.984	0.72695	1.64915	4.71095
05/10/01	1.3	0.48	0.7632	4.316	0.6758	1.439	4.9918
05/11/01	1.2	0.43	0.6837	3.984	0.69285	1.37655	4.67685
05/12/01	1.3	0.43	0.6837	4.316	0.6944	1.3781	5.0104
05/13/01	1.2	0.6	0.954	3.984	0.6758	1.6298	4.6598
05/14/01	1.1	0.42	0.6678	3.652	0.7285	1.3963	4.3805
05/15/01	1	0.31	0.4929	3.32	0.93	1.4229	4.25
05/16/01	1.7	0.34	0.5406	5.644	0.94395	1.48455	6.58795
05/17/01	2	0.48	0.7632	6.64	0.8153	1.5785	7.4553
05/18/01	1.6	0.54	0.8586	5.312	0.80135	1.65995	6.11335
05/19/01	1.4	0.63	1.0017	4.648	0.7595	1.7612	5.4075
05/20/01	1.3	0.7	1.113	4.316	0.77965	1.89265	5.09565
05/21/01	3	0.7	1.113	9.96	0.82925	1.94225	10.78925
05/22/01	1.5	0.86	1.3674	4.98	0.87265	2.24005	5.85265
05/23/01	1.6	1.5	2.385	5.312	0.72385	3.10885	6.03585
05/24/01	1.1	1.1	1.749	3.652	0.837	2.586	4.489
05/25/01	0.98	0.62	0.9858	3.2536	0.7905	1.7763	4.0441
05/26/01	3.3	1.9	3.021	10.956	0.73315	3.75415	11.68915
05/27/01	2.3	1.9	3.021	7.636	0.7006	3.7216	8.3366
05/28/01	1.5	1.6	2.544	4.98	0.81685	3.36085	5.79685
05/29/01	1.8	1.7	2.703	5.976	0.81995	3.52295	6.79595
05/30/01	1.3	1.5	2.385	4.316	0.7688	3.1538	5.0848

05/31/01	1.2	1.3	2.067	3.984	0.7533	2.8203	4.7373
06/01/01	9.2	39	62.01	30.544	1.47095	63.48095	32.01495
06/02/01	5.2	24	38.16	17.264	1.10515	39.26515	18.36915
06/03/01	2.6	6.5	10.335	8.632	0.61845	10.95345	9.25045
06/04/01	2.4	3.5	5.565	7.968	0.5983	6.1633	8.5663
06/05/01	1.5	2.4	3.816	4.98	0.5425	4.3585	5.5225
06/06/01	1.1	1.6	2.544	3.652	0.7316	3.2756	4.3836
06/07/01	0.93	1.2	1.908	3.0876	0.4898	2.3978	3.5774
06/08/01	2.3	1.4	2.226	7.636	0.50685	2.73285	8.14285
06/09/01	2.1	2.2	3.498	6.972	0.44795	3.94595	7.41995
06/10/01	1	1.7	2.703	3.32	0.46345	3.16645	3.78345
06/11/01	0.89	1.2	1.908	2.9548	0.45415	2.36215	3.40895
06/12/01	0.84	0.97	1.5423	2.7888	0.51305	2.05535	3.30185
06/13/01	4.3	0.91	1.4469	14.276	0.8525	2.2994	15.1285
06/14/01	13	1.6	2.544	43.16	0.88195	3.42595	44.04195
06/15/01	5.1	2.1	3.339	16.932	0.59985	3.93885	17.53185
06/16/01	2.5	2.6	4.134	8.3	0.5859	4.7199	8.8859
06/17/01	2.1	2.5	3.975	6.972	0.527	4.502	7.499
06/18/01	1.4	1.9	3.021	4.648	0.52545	3.54645	5.17345
06/19/01	0.89	1.5	2.385	2.9548	0.42315	2.80815	3.37795
06/20/01	0.78	1.3	2.067	2.5896	0.55335	2.62035	3.14295
06/21/01	0.66	1.3	2.067	2.1912	0.50065	2.56765	2.69185
06/22/01	2.7	4.9	7.791	8.964	1.3485	9.1395	10.3125
06/23/01	13	22	34.98	43.16	0.75175	35.73175	43.91175
06/24/01	2.4	4.7	7.473	7.968	0.8866	8.3596	8.8546
06/25/01	1.6	2.5	3.975	5.312	0.86335	4.83835	6.17535
06/26/01	1.4	3.5	5.565	4.648	0.73315	6.29815	5.38115
06/27/01	1	1.7	2.703	3.32	0.65875	3.36175	3.97875
06/28/01	0.9	1.2	1.908	2.988	0.6231	2.5311	3.6111
06/29/01	0.8	0.94	1.4946	2.656	0.6014	2.096	3.2574
06/30/01	0.81	0.75	1.1925	2.6892	0.5642	1.7567	3.2534
07/01/01	0.65	0.62	0.9858	2.158	0.6169	1.6027	2.7749

07/02/01	0.83	0.48	0.7632	2.7556	0.5487	1.3119	3.3043
07/03/01	0.72	0.38	0.6042	2.3904	0.5115	1.1157	2.9019
07/04/01	1	26	41.34	3.32	2.1173	43.4573	5.4373
07/05/01	5.4	65	103.35	17.928	1.085	104.435	19.013
07/06/01	1.2	4.8	7.632	3.984	0.7657	8.3977	4.7497
07/07/01	0.81	2	3.18	2.6892	0.66495	3.84495	3.35415
07/08/01	2	6.6	10.494	6.64	0.74555	11.23955	7.38555
07/09/01	2.3	4.3	6.837	7.636	0.89745	7.73445	8.53345
07/10/01	1.5	2.3	3.657	4.98	0.7161	4.3731	5.6961
07/11/01	0.99	1.7	2.703	3.2868	0.63395	3.33695	3.92075
07/12/01	0.77	1.8	2.862	2.5564	0.60295	3.46495	3.15935
07/13/01	0.59	1.3	2.067	1.9588	0.5425	2.6095	2.5013
07/14/01	0.55	0.98	1.5582	1.826	0.50685	2.06505	2.33285
07/15/01	0.51	0.7	1.113	1.6932	0.4991	1.6121	2.1923
07/16/01	0.46	0.5	0.795	1.5272	0.48205	1.27705	2.00925
07/17/01	0.42	0.37	0.5883	1.3944	0.48515	1.07345	1.87955
07/18/01	0.5	0.29	0.4611	1.66	0.4712	0.9323	2.1312
07/19/01	0.61	0.28	0.4452	2.0252	0.46965	0.91485	2.49485
07/20/01	0.5	0.25	0.3975	1.66	0.42315	0.82065	2.08315
07/21/01	0.41	0.2	0.318	1.3612	0.3937	0.7117	1.7549
07/22/01	0.38	0.15	0.2385	1.2616	0.41385	0.65235	1.67545
07/23/01	0.31	0.13	0.2067	1.0292	0.49445	0.70115	1.52365
07/24/01	0.34	0.12	0.1908	1.1288	0.59365	0.78445	1.72245
07/25/01	0.48	0.12	0.1908	1.5936	0.75175	0.94255	2.34535
07/26/01	0.82	0.15	0.2385	2.7224	0.496	0.7345	3.2184
07/27/01	2.3	0.21	0.3339	7.636	0.7781	1.112	8.4141
07/28/01	1.6	0.32	0.5088	5.312	0.527	1.0358	5.839
07/29/01	0.78	0.27	0.4293	2.5896	0.50685	0.93615	3.09645
07/30/01	1.7	0.43	0.6837	5.644	0.50375	1.18745	6.14775
07/31/01	1.1	0.27	0.4293	3.652	0.4898	0.9191	4.1418
08/01/01	0.62	0.16	0.2544	2.0584	0.465	0.7194	2.5234
08/02/01	0.55	0.11	0.1749	1.826	0.46035	0.63525	2.28635

08/03/01	0.5	0.09	0.1431	1.66	0.45105	0.59415	2.11105
08/04/01	0.43	0.08	0.1272	1.4276	0.42005	0.54725	1.84765
08/05/01	0.36	0.06	0.0954	1.1952	0.43555	0.53095	1.63075
08/06/01	0.32	0.05	0.0795	1.0624	0.4681	0.5476	1.5305
08/07/01	0.27	0.05	0.0795	0.8964	0.4619	0.5414	1.3583
08/08/01	0.27	0.04	0.0636	0.8964	0.4588	0.5224	1.3552
08/09/01	0.23	0.04	0.0636	0.7636	0.3782	0.4418	1.1418
08/10/01	0.22	0.21	0.3339	0.7304	0.37975	0.71365	1.11015
08/11/01	0.84	7.6	12.084	2.7888	1.4353	13.5193	4.2241
08/12/01	7.5	2.2	3.498	24.9	1.91425	5.41225	26.81425
08/13/01	1.3	0.91	1.4469	4.316	0.9114	2.3583	5.2274
08/14/01	1.1	0.5	0.795	3.652	0.50685	1.30185	4.15885
08/15/01	0.87	0.34	0.5406	2.8884	0.39525	0.93585	3.28365
08/16/01	0.47	0.36	0.5724	1.5604	0.3937	0.9661	1.9541
08/17/01	0.33	0.25	0.3975	1.0956	0.3565	0.754	1.4521
08/18/01	1.1	3.6	5.724	3.652	0.3441	6.0681	3.9961
08/19/01	4.8	6.6	10.494	15.936	0.36115	10.85515	16.29715
08/20/01	1.1	2.1	3.339	3.652	0.33325	3.67225	3.98525
08/21/01	0.58	0.99	1.5741	1.9256	0.30845	1.88255	2.23405
08/22/01	0.4	0.52	0.8268	1.328	0.31	1.1368	1.638
08/23/01	0.35	0.31	0.4929	1.162	0.3193	0.8122	1.4813
08/24/01	2	3.9	6.201	6.64	0.3255	6.5265	6.9655
08/25/01	0.89	2.2	3.498	2.9548	0.32395	3.82195	3.27875
08/26/01	0.42	0.97	1.5423	1.3944	0.3317	1.874	1.7261
08/27/01	0.28	0.55	0.8745	0.9296	0.3689	1.2434	1.2985
08/28/01	0.24	0.39	0.6201	0.7968	0.4309	1.051	1.2277
08/29/01	0.22	0.27	0.4293	0.7304	0.39525	0.82455	1.12565
08/30/01	0.25	22	34.98	0.83	0.3596	35.3396	1.1896
08/31/01	0.48	67	106.53	1.5936	1.39655	107.92655	2.99015
09/01/01	0.3	7.3	11.607	0.996	0.93	12.537	1.926
09/02/01	0.35	4.4	6.996	1.162	0.7471	7.7431	1.9091
09/03/01	0.28	2.7	4.293	0.9296	0.35805	4.65105	1.28765

09/04/01	0.33	2.3	3.657	1.0956	0.34565	4.00265	1.44125
09/05/01	0.35	2	3.18	1.162	0.39835	3.57835	1.56035
09/06/01	0.25	1.5	2.385	0.83	0.4154	2.8004	1.2454
09/07/01	0.22	1.1	1.749	0.7304	0.42005	2.16905	1.15045
09/08/01	0.19	0.85	1.3515	0.6308	0.3472	1.6987	0.978
09/09/01	0.16	0.67	1.0653	0.5312	0.3596	1.4249	0.8908
09/10/01	0.16	0.57	0.9063	0.5312	0.41075	1.31705	0.94195
09/11/01	0.16	0.47	0.7473	0.5312	0.33015	1.07745	0.86135
09/12/01	0.13	0.36	0.5724	0.4316	0.35495	0.92735	0.78655
09/13/01	0.11	0.36	0.5724	0.3652	0.3007	0.8731	0.6659
09/14/01	0.12	0.29	0.4611	0.3984	0.41385	0.87495	0.81225
09/15/01	0.13	0.21	0.3339	0.4316	0.2232	0.5571	0.6548
09/16/01	0.12	0.19	0.3021	0.3984	0.21235	0.51445	0.61075
09/17/01	0.12	0.18	0.2862	0.3984	0.22475	0.51095	0.62315
09/18/01	0.11	0.16	0.2544	0.3652	0.37975	0.63415	0.74495
09/19/01	0.1	0.14	0.2226	0.332	0.3317	0.5543	0.6637
09/20/01	0.11	0.18	0.2862	0.3652	0.33325	0.61945	0.69845
09/21/01	1.2	0.37	0.5883	3.984	0.32395	0.91225	4.30795
09/22/01	0.3	0.46	0.7314	0.996	0.20615	0.93755	1.20215
09/23/01	0.14	0.13	0.2067	0.4648	0.2604	0.4671	0.7252
09/24/01	0.17	1.8	2.862	0.5644	0.60295	3.46495	1.16735
09/25/01	1.3	1.2	1.908	4.316	0.3565	2.2645	4.6725
09/26/01	0.26	0.63	1.0017	0.8632	0.24955	1.25125	1.11275
09/27/01	0.13	0.38	0.6042	0.4316	0.248	0.8522	0.6796
09/28/01	0.13	0.29	0.4611	0.4316	0.2263	0.6874	0.6579
09/29/01	0.12	0.21	0.3339	0.3984	0.2449	0.5788	0.6433
09/30/01	0.1	0.16	0.2544	0.332	0.2666	0.521	0.5986
10/01/01	0.1	0.14	0.2226	0.332	0.3348	0.5574	0.6668
10/02/01	0.11	0.12	0.1908	0.3652	0.2418	0.4326	0.607
10/03/01	0.13	0.11	0.1749	0.4316	0.341	0.5159	0.7726
10/04/01	0.17	0.1	0.159	0.5644	0.2232	0.3822	0.7876
10/05/01	0.18	0.08	0.1272	0.5976	0.2821	0.4093	0.8797

10/06/01	0.26	0.1	0.159	0.8632	0.2573	0.4163	1.1205
10/07/01	0.33	0.14	0.2226	1.0956	0.3193	0.5419	1.4149
10/08/01	0.22	0.13	0.2067	0.7304	0.26505	0.47175	0.99545
10/09/01	0.22	0.09	0.1431	0.7304	0.2542	0.3973	0.9846
10/10/01	0.23	0.05	0.0795	0.7636	0.2883	0.3678	1.0519
10/11/01	0.22	0.05	0.0795	0.7304	0.1984	0.2779	0.9288
10/12/01	0.1	0.06	0.0954	0.332	0.4774	0.5728	0.8094
10/13/01	0.12	0.17	0.2703	0.3984	0.35185	0.62215	0.75025
10/14/01	0.22	1.1	1.749	0.7304	0.29605	2.04505	1.02645
10/15/01	1.7	2.2	3.498	5.644	0.279	3.777	5.923
10/16/01	0.33	0.7	1.113	1.0956	0.30225	1.41525	1.39785
10/17/01	0.22	0.83	1.3197	0.7304	0.30845	1.62815	1.03885
10/18/01	0.13	0.67	1.0653	0.4316	0.3286	1.3939	0.7602
10/19/01	0.11	0.59	0.9381	0.3652	0.3007	1.2388	0.6659
10/20/01	0.12	0.67	1.0653	0.3984	0.26505	1.33035	0.66345
10/21/01	0.12	0.63	1.0017	0.3984	0.2418	1.2435	0.6402
10/22/01	0.12	0.53	0.8427	0.3984	0.26505	1.10775	0.66345
10/23/01	0.12	0.61	0.9699	0.3984	0.34255	1.31245	0.74095
10/24/01	0.12	1.2	1.908	0.3984	0.37665	2.28465	0.77505
10/25/01	0.13	1.1	1.749	0.4316	0.3627	2.1117	0.7943
10/26/01	0.12	0.7	1.113	0.3984	0.3348	1.4478	0.7332
10/27/01	0.13	0.42	0.6678	0.4316	0.248	0.9158	0.6796
10/28/01	0.13	0.2	0.318	0.4316	0.186	0.504	0.6176
10/29/01	0.12	0.17	0.2703	0.3984	0.28675	0.55705	0.68515
10/30/01	0.11	0.16	0.2544	0.3652	0.29605	0.55045	0.66125
10/31/01	0.11	0.14	0.2226	0.3652	0.3317	0.5543	0.6969
04/01/02	11	73	116.07	36.52	0.9951	117.0651	37.5151
04/02/02	4.7	18	28.62	15.604	0.682	29.302	16.286
04/03/02	3.1	11	17.49	10.292	0.6107	18.1007	10.9027
04/04/02	2.5	7.2	11.448	8.3	0.55025	11.99825	8.85025
04/05/02	2	5.6	8.904	6.64	0.52855	9.43255	7.16855

04/06/02	1.9	4.8	7.632	6.308	0.5115	8.1435	6.8195
04/07/02	1.8	4.1	6.519	5.976	0.48515	7.00415	6.46115
04/08/02	1.9	3.6	5.724	6.308	0.50685	6.23085	6.81485
04/09/02	1.9	3.7	5.883	6.308	0.54405	6.42705	6.85205
04/10/02	3.9	4.4	6.996	12.948	0.58435	7.58035	13.53235
04/11/02	1.8	3.9	6.201	5.976	0.51305	6.71405	6.48905
04/12/02	1.5	3.4	5.406	4.98	0.5115	5.9175	5.4915
04/13/02	1.7	4.1	6.519	5.644	0.65255	7.17155	6.29655
04/14/02	1.4	3.1	4.929	4.648	0.62775	5.55675	5.27575
04/15/02	1.3	2.8	4.452	4.316	0.5394	4.9914	4.8554
04/16/02	1.2	2.3	3.657	3.984	0.6758	4.3328	4.6598
04/17/02	1.1	2.1	3.339	3.652	0.4557	3.7947	4.1077
04/18/02	0.99	1.9	3.021	3.2868	0.38905	3.41005	3.67585
04/19/02	0.92	1.7	2.703	3.0544	0.54405	3.24705	3.59845
04/20/02	0.9	1.6	2.544	2.988	0.4216	2.9656	3.4096
04/21/02	0.86	1.5	2.385	2.8552	0.43865	2.82365	3.29385
04/22/02	0.85	1.3	2.067	2.822	0.47585	2.54285	3.29785
04/23/02	0.66	1.1	1.749	2.1912	0.46345	2.21245	2.65465
04/24/02	0.6	1	1.59	1.992	0.45725	2.04725	2.44925
04/25/02	0.7	0.94	1.4946	2.324	0.465	1.9596	2.789
04/26/02	0.64	1	1.59	2.1248	0.46035	2.05035	2.58515
04/27/02	0.55	0.9	1.431	1.826	0.51305	1.94405	2.33905
04/28/02	0.6	0.84	1.3356	1.992	0.31	1.6456	2.302
04/29/02	0.57	1.2	1.908	1.8924	0.44795	2.35595	2.34035
04/30/02	0.53	1.2	1.908	1.7596	0.4371	2.3451	2.1967
05/01/02	0.53	1.1	1.749	1.7596	0.4371	2.1861	2.1967
05/02/02	0.66	0.72	1.1448	2.1912	0.45105	1.59585	2.64225
05/03/02	0.67	0.92	1.4628	2.2244	0.4123	1.8751	2.6367
05/04/02	1	1.1	1.749	3.32	0.43555	2.18455	3.75555
05/05/02	1.4	1.2	1.908	4.648	0.4216	2.3296	5.0696
05/06/02	0.81	1.2	1.908	2.6892	0.4278	2.3358	3.117
05/07/02	0.66	0.74	1.1766	2.1912	0.4278	1.6044	2.619

05/08/02	0.53	0.51	0.8109	1.7596	0.45725	1.26815	2.21685
05/09/02	0.54	0.38	0.6042	1.7928	0.3968	1.001	2.1896
05/10/02	0.46	0.28	0.4452	1.5272	0.3906	0.8358	1.9178
05/11/02	0.41	0.19	0.3021	1.3612	0.3689	0.671	1.7301
05/12/02	0.37	0.17	0.2703	1.2284	0.3286	0.5989	1.557
05/13/02	0.42	0.18	0.2862	1.3944	0.3286	0.6148	1.723
05/14/02	0.64	0.24	0.3816	2.1248	0.40455	0.78615	2.52935
05/15/02	0.67	0.22	0.3498	2.2244	0.30535	0.65515	2.52975
05/16/02	0.53	0.27	0.4293	1.7596	0.31155	0.74085	2.07115
05/17/02	0.44	0.3	0.477	1.4608	0.30845	0.78545	1.76925
05/18/02	0.83	0.17	0.2703	2.7556	0.2387	0.509	2.9943
05/19/02	1.1	0.16	0.2544	3.652	0.51305	0.76745	4.16505
05/20/02	0.57	0.16	0.2544	1.8924	0.32705	0.58145	2.21945
05/21/02	0.41	0.14	0.2226	1.3612	0.3937	0.6163	1.7549
05/22/02	0.33	0.06	0.0954	1.0956	0.3937	0.4891	1.4893
05/23/02	0.36	0.05	0.0795	1.1952	0.37045	0.44995	1.56565
05/24/02	0.27	0.05	0.0795	0.8964	0.35805	0.43755	1.25445
05/25/02	0.22	0.05	0.0795	0.7304	0.34565	0.42515	1.07605
05/26/02	0.21	0.04	0.0636	0.6972	0.2976	0.3612	0.9948
05/27/02	0.17	0.03	0.0477	0.5644	0.27745	0.32515	0.84185
05/28/02	0.2	0.03	0.0477	0.664	0.30535	0.35305	0.96935
05/29/02	0.14	0.04	0.0636	0.4648	0.3348	0.3984	0.7996
05/30/02	0.22	0.03	0.0477	0.7304	0.372	0.4197	1.1024
05/31/02	0.34	0.03	0.0477	1.1288	0.40455	0.45225	1.53335
06/01/02	0.32	0.03	0.0477	1.0624	0.3348	0.3825	1.3972
06/02/02	0.2	0.03	0.0477	0.664	0.31465	0.36235	0.97865
06/03/02	0.21	0.04	0.0636	0.6972	0.3317	0.3953	1.0289
06/04/02	0.12	0.03	0.0477	0.3984	0.33945	0.38715	0.73785
06/05/02	0.13	0.02	0.0318	0.4316	0.34565	0.37745	0.77725
06/06/02	0.12	0.02	0.0318	0.3984	0.5177	0.5495	0.9161
06/07/02	0.1	0.04	0.0636	0.332	0.50065	0.56425	0.83265
06/08/02	0.16	0.03	0.0477	0.5312	0.35185	0.39955	0.88305

06/09/02	0.12	0.02	0.0318	0.3984	0.2976	0.3294	0.696
06/10/02	0.13	0.02	0.0318	0.4316	0.33325	0.36505	0.76485
06/11/02	0.08	0.01	0.0159	0.2656	0.32705	0.34295	0.59265
06/12/02	0.08	0.01	0.0159	0.2656	0.32705	0.34295	0.59265
06/13/02	0.08	0.01	0.0159	0.2656	0.32705	0.34295	0.59265
06/14/02	0.06	0.01	0.0159	0.1992	0.34255	0.35845	0.54175
06/15/02	0.1	0	0	0.332	0.31155	0.31155	0.64355
06/16/02	0.07	0	0	0.2324	0.28675	0.28675	0.51915
06/17/02	0.04	0	0	0.1328	0.32705	0.32705	0.45985
06/18/02	0.03	0	0	0.0996	0.3379	0.3379	0.4375
06/19/02	0.04	0	0	0.1328	0.3286	0.3286	0.4614
06/20/02	0.06	0	0	0.1992	0.3565	0.3565	0.5557
06/21/02	0.03	0	0	0.0996	0.32705	0.32705	0.42665
06/22/02	0.02	0	0	0.0664	0.2976	0.2976	0.364
06/23/02	0.02	0	0	0.0664	0.2728	0.2728	0.3392
06/24/02	0.03	0	0	0.0996	0.3255	0.3255	0.4251
06/25/02		0	0	0	0.30845	0.30845	0.30845
06/26/02	0.04	0	0	0.1328	0.372	0.372	0.5048
06/27/02	1.7	0.01	0.0159	5.644	0.37665	0.39255	6.02065
06/28/02	6.3	0.02	0.0318	20.916	0	0.0318	20.916
06/29/02	0.4	0.02	0.0318	1.328	0	0.0318	1.328
06/30/02	0.13	0.02	0.0318	0.4316	0	0.0318	0.4316
07/01/02	0.11	0.01	0.0159	0.3652	0.31465	0.33055	0.67985
07/02/02	0.09	0.01	0.0159	0.2988	0.32085	0.33675	0.61965
07/03/02	0.05	0	0	0.166	0.35185	0.35185	0.51785
07/04/02	0.04	0	0	0.1328	0.31775	0.31775	0.45055
07/05/02	0.04	0	0	0.1328	0.3131	0.3131	0.4459
07/06/02	0.03	0	0	0.0996	0.30225	0.30225	0.40185
07/07/02	0.04	0	0	0.1328	0.2821	0.2821	0.4149
07/08/02	0.03	0	0	0.0996	0.32395	0.32395	0.42355
07/09/02	0.03	0	0	0.0996	0.3224	0.3224	0.422
07/10/02	0.03	0	0	0.0996	0.36115	0.36115	0.46075

07/11/02	0.05	0	0	0.166	0.4092	0.4092	0.5752
07/12/02	0.03	0	0	0.0996	0.34875	0.34875	0.44835
07/13/02	0.04	0	0	0.1328	0.30535	0.30535	0.43815
07/14/02	0.03	0	0	0.0996	0.31775	0.31775	0.41735
07/15/02	0.02	0	0	0.0664	0.33635	0.33635	0.40275
07/16/02	0.01	0	0	0.0332	0.31465	0.31465	0.34785
07/17/02	0	0	0	0	0.31775	0.31775	0.31775
07/18/02	0	0	0	0	0.3069	0.3069	0.3069
07/19/02	0	0	0	0	0.3069	0.3069	0.3069
07/20/02	0	0	0	0	0.31155	0.31155	0.31155
07/21/02	0	0	0	0	0.2759	0.2759	0.2759
07/22/02	0	0	0	0	0.3999	0.3999	0.3999
07/23/02	0	0	0	0	0.403	0.403	0.403
07/24/02	1.3	0.23	0.3657	4.316	0.33015	0.69585	4.64615
07/25/02	0.72	0.07	0.1113	2.3904	0.3348	0.4461	2.7252
07/26/02	0.13	0.04	0.0636	0.4316	0.4185	0.4821	0.8501
07/27/02	0.08	0.02	0.0318	0.2656	0.49135	0.52315	0.75695
07/28/02	0.05	0.02	0.0318	0.166	0.33945	0.37125	0.50545
07/29/02	0.03	0.01	0.0159	0.0996	0.33325	0.34915	0.43285
07/30/02	0	0	0	0	0.33015	0.33015	0.33015
07/31/02	0	0	0	0	0.32395	0.32395	0.32395
08/01/02	0	0	0	0	0.3317	0.3317	0.3317
08/02/02	0	0	0	0	0.33325	0.33325	0.33325
08/03/02	0	0	0	0	0.3038	0.3038	0.3038
08/04/02	0	0	0	0	0.28675	0.28675	0.28675
08/05/02	0	0	0	0	0.2976	0.2976	0.2976
08/06/02	0	0	0	0	0.3286	0.3286	0.3286
08/07/02	0	0	0	0	0.3224	0.3224	0.3224
08/08/02	0	0	0	0	0.3472	0.3472	0.3472
08/09/02	0	0	0	0	0.3689	0.3689	0.3689
08/10/02	0	0	0	0	0.27745	0.27745	0.27745
08/11/02	0	0	0	0	0.27125	0.27125	0.27125

08/12/02	0		0	0	0.3379	0.3379	0.3379
08/13/02	0	0	0	0	0.3193	0.3193	0.3193
08/14/02	0.01	0	0	0.0332	0.3348	0.3348	0.368
08/15/02	0.03	0	0	0.0996	0.3906	0.3906	0.4902
08/16/02	0.09	0	0	0.2988	0.35805	0.35805	0.65685
08/17/02	0.22	0	0	0.7304	0.3348	0.3348	1.0652
08/18/02	0.14	0	0	0.4648	0.2976	0.2976	0.7624
08/19/02	0.28	0	0	0.9296	0.3534	0.3534	1.283
08/20/02	0.45	0	0	1.494	0.341	0.341	1.835
08/21/02	0.26	0	0	0.8632	0.33635	0.33635	1.19955
08/22/02		0	0	0	0.3317	0.3317	0.3317
08/23/02	0.07	0	0	0.2324	0.3348	0.3348	0.5672
08/24/02	0.03	0	0	0.0996	0.3379	0.3379	0.4375
08/25/02	0.37	0	0	1.2284	0.2821	0.2821	1.5105
08/26/02	0.61	0	0	2.0252	0.36115	0.36115	2.38635
08/27/02	1.6	0	0	5.312	0.3968	0.3968	5.7088
08/28/02	2.7	0	0	8.964	0.37665	0.37665	9.34065
08/29/02	1.7	0	0	5.644	0.372	0.372	6.016
08/30/02	3.5	0	0	11.62	0.589	0.589	12.209
08/31/02	80	20	31.8	265.6	1.5655	33.3655	267.1655
09/01/02	62	32	50.88	205.84	0.94705	51.82705	206.78705
09/02/02	5.9	2.4	3.816	19.588	0.47895	4.29495	20.06695
09/03/02	3.2	0.83	1.3197	10.624	0.43555	1.75525	11.05955
09/04/02	1.6	0.33	0.5247	5.312	0.4123	0.937	5.7243
09/05/02		0.15	0.2385	0	0.3937	0.6322	0.3937
09/06/02	0.34	0.07	0.1113	1.1288	0.37355	0.48485	1.50235
09/07/02	0.22	0.03	0.0477	0.7304	0.3348	0.3825	1.0652
09/08/02	0.19	0.02	0.0318	0.6308	0.3131	0.3449	0.9439
09/09/02	0.17	0.01	0.0159	0.5644	0.3534	0.3693	0.9178
09/10/02	0.14	0	0	0.4648	0.341	0.341	0.8058
09/11/02	0.13	0	0	0.4316	0.33325	0.33325	0.76485
09/12/02	0.1	0	0	0.332	0.33325	0.33325	0.66525

09/13/02	0.09	0	0	0.2988	0.341	0.341	0.6398
09/14/02	0.1	0	0	0.332	0.5022	0.5022	0.8342
09/15/02	0.69	0	0	2.2908	0.7874	0.7874	3.0782
09/16/02	0.76	0.02	0.0318	2.5232	0.99045	1.02225	3.51365
09/17/02	0.34	0.03	0.0477	1.1288	0.52855	0.57625	1.65735
09/18/02	0.6	0.03	0.0477	1.992	0.4805	0.5282	2.4725
09/19/02	1.2	0.06	0.0954	3.984	0.4619	0.5573	4.4459
09/20/02	0.41	0.09	0.1431	1.3612	0.4712	0.6143	1.8324
09/21/02	0.26	0.05	0.0795	0.8632	0.38905	0.46855	1.25225
09/22/02	0.18	0.03	0.0477	0.5976	0.3627	0.4104	0.9603
09/23/02	0.17	0.02	0.0318	0.5644	0.4185	0.4503	0.9829
09/24/02	0.14	0.01	0.0159	0.4648	0.40765	0.42355	0.87245
09/25/02	0.12	0	0	0.3984	0.41075	0.41075	0.80915
09/26/02	0.13	0	0	0.4316	0.4309	0.4309	0.8625
09/27/02	0.9	0	0	2.988	0.41385	0.41385	3.40185
09/28/02	0.97	0	0	3.2204	0.37665	0.37665	3.59705
09/29/02	0.29	0	0	0.9628	0.33015	0.33015	1.29295
09/30/02	0.18	0	0	0.5976	0.38285	0.38285	0.98045
10/1/02		0	0	0	0.3875	0.3875	0.3875
10/2/02		0	0	0	0.37355	0.37355	0.37355
10/3/02		0	0	0	0.37975	0.37975	0.37975
10/4/02		0	0	0	0.38905	0.38905	0.38905
10/5/02		0	0	0	0.3472	0.3472	0.3472
10/6/02		0	0	0	0.3348	0.3348	0.3348
10/7/02		0	0	0	0.3906	0.3906	0.3906
10/8/02		0	0	0	0.39525	0.39525	0.39525
10/9/02		0	0	0	0.38905	0.38905	0.38905
10/10/02		0	0	0	0.58125	0.58125	0.58125
10/11/02		512	814.08	0	2.1948	816.2748	2.1948
10/12/02		29	46.11	0	0.9424	47.0524	0.9424
10/13/02		6	9.54	0	0.62775	10.16775	0.62775
10/14/02		3.2	5.088	0	0.56575	5.65375	0.56575

10/15/02		1.9	3.021	0	0.62	3.641	0.62
10/16/02		18	28.62	0	1.21985	29.83985	1.21985
10/17/02		7.8	12.402	0	0.7378	13.1398	0.7378
10/18/02		3.6	5.724	0	0.59675	6.32075	0.59675
10/19/02		2.4	3.816	0	0.52235	4.33835	0.52235
10/20/02		1.8	2.862	0	0.48205	3.34405	0.48205
10/21/02		1.5	2.385	0	0.52545	2.91045	0.52545
10/22/02		4.5	7.155	0	0.6293	7.7843	0.6293
10/23/02		3.5	5.565	0	0.5425	6.1075	0.5425
10/24/02		2.3	3.657	0	0.5332	4.1902	0.5332
10/25/02		1.9	3.021	0	0.5394	3.5604	0.5394
10/26/02		1.6	2.544	0	0.4898	3.0338	0.4898
10/27/02		1.6	2.544	0	0.465	3.009	0.465
10/28/02		1.9	3.021	0	0.64015	3.66115	0.64015
10/29/02		11	17.49	0	0.8463	18.3363	0.8463
10/30/02		14	22.26	0	1.0168	23.2768	1.0168
10/31/02		6.9	10.971	0	0.74555	11.71655	0.74555

Appendix V. FLUX water quality sample input files.

RC 8 inflow, flows in cfs, samples in ug/L								
DATE	flow	ammon	tkn	nox	total p	total n	inorg n	org n
04/18/01	3.65	0.10	0.3	5.8	0.35	6.10	5.90	0.20
05/02/01	3.42	0.10	0.8	7.7	0.38	8.50	7.80	0.70
05/09/01	2.34	0.10	0.7	4.6	0.28	5.30	4.70	0.60
05/30/01	2.88	0.10	1.0	11	0.84	12.00	11.10	0.90
06/21/01	2.34	0.33	0.9	1.7	0.20	2.59	2.03	0.56
07/04/01	187.00	0.03	0.7	0.4	0.09	1.06	0.43	0.63
07/23/01	3.00	0.06	0.6	2.5	0.16	3.05	2.56	0.49
07/12/01	3.00	0.29	0.5	1.3	0.11	1.78	1.59	0.19
07/31/01	3.56	0.13	0.5	2.2	0.22	2.74	2.33	0.41
08/05/01	3.00	0.04	0.6	2.3	0.22	2.87	2.34	0.53
08/07/01	2.88	0.06	0.4	1.9	0.23	2.34	1.96	0.38
08/30/01	106.00	0.02	0.4	0.7	0.12	1.09	0.72	0.37
09/09/01	2.34	0.01	0.3	2.7	0.13	3.04	2.71	0.34
09/15/01	2.88	0.01	0.2	2.6	0.13	2.83	2.61	0.22
09/28/01	4.60	0.22	0.8	2.6	0.44	3.37	2.82	0.55
10/04/01	3.00	0.01	0.3	2.6	0.28	2.93	2.61	0.33
10/19/01	3.41	0.20	1.6	2.3	0.15	3.90	2.50	1.40
10/29/01	3.42	0.09	0.7	3.1	0.18	3.84	3.19	0.65

RC 8 inflow, flows in cfs, samples in ug/L								
DATE	flow	ammon	tkn	nox	total p	total n	inorg n	org n
04/15/02	5.90	0.04	0.4	1.2	0.09	1.62	1.24	0.38
05/01/02	3.83	0.04	0.6	2	0.14	2.56	2.04	0.52
05/02/02	3.83	0.06	0.5	3.2	0.23	3.65	3.26	0.39
05/08/02	3.42	0.04	0.4	1.6	0.17	1.98	1.64	0.34
05/14/02	1.62	0.05	0.3	2.1	0.17	2.36	2.15	0.21
05/29/02	1.62	0.03	0.6	3	0.17	3.58	3.03	0.55
06/26/02	0.32	0.01	0.7	1.2	0.29	1.85	1.21	0.65
07/22/02	0.32	0.02	0.9	2.5	0.34	3.42	2.52	0.90
08/15/02	3.54	0.01	0.7	1.1	0.22	1.80	1.11	0.69

Appendix VI. FLUX output files – 2001.

```
 Total P Load with stratification and flow substitution:

Roberson Creek 2001               VAR=total p   METHOD= 3 IJC

 STRATIFICATION SCHEME:
        ---- DATE ----   -- SEASON --  -------- FLOW --------
 STR    >=MIN    < MAX  >=MIN  < MAX       >=MIN       < MAX
   1                        0      0         .00        4.00
   2                        0      0        4.00      209.89

 STR   SAMPLES    EVENTS     FLOWS  VOLUME %
   1        15        15       159     18.60
   2         3         3        55     81.40
 EXCLUDED    0         0         0       .00
    TOTAL   18        18       214    100.00


 Roberson Creek 2001               VAR=total p   METHOD= 3 IJC
 COMPARISON OF SAMPLED AND TOTAL FLOW DISTRIBUTIONS
 STR       NQ  NC  NE  VOL%   TOTAL FLOW SAMPLED FLOW   C/Q SLOPE SIGNIF
  1       159  15  15  18.6        1.477        1.249        .124   .547
  2        55   3   3  81.4       18.682       25.065       -.616   .073
***       214  18  18 100.0        5.899        5.218

 FLOW STATISTICS
 FLOW DURATION =     214.0 DAYS  =   .586 YEARS
 MEAN FLOW RATE =     5.899 HM3/YR
 TOTAL FLOW VOLUME =       3.46 HM3
 FLOW DATE RANGE   = 20010401 TO 20011031
 SAMPLE DATE RANGE = 20010418 TO 20011029

 METHOD         MASS (KG)   FLUX (KG/YR)  FLUX VARIANCE CONC (PPB)      CV
 1 AV LOAD          618.1         1054.9      .4175E+05     178.84    .194
 2 Q WTD C          534.3          911.9      .2998E+05     154.60    .190
 3 IJC              512.8          875.2      .2222E+05     148.38    .170
 4 REG-1            604.9         1032.5      .1453E+06     175.04    .369
 5 REG-2            489.0          834.7      .1116E+07     141.51   1.265
 6 REG-3            613.2         1046.6      .4681E+06     177.43    .654

 Roberson Creek 2001               VAR=total p   METHOD= 3 IJC
 X =S FLOW  , Y =CONC

 BIVARIATE REGRESSION:  Y VS. X
  INTERCEPT          =      2.3472  SLOPE                =      -.1070
  R-SQUARED          =       .0675  MEAN SQUARED ERROR =       .0591
  STD ERROR OF SLOPE =       .0994  DEGREES OF FREEDOM =          16
  T STATISTIC        =     -1.0765  PROBABILITY(>|T|)  =       .2980
  Y MEAN             =      2.3262  Y STD DEVIATION    =       .2443
  X MEAN             =       .1966  X STD DEVIATION    =       .5933
 RESIDUALS ANALYSIS:
  RUNS TEST Z        =     -2.4794  PROBABILITY (>|Z|) =       .0066
  LAG-1 AUTOCORREL.  =       .3340  PROBABILITY (>|R|) =       .0782
```

EFFECTIVE SAMPLES = 9 SLOPE SIGNIFICANCE = .4764

Total N Load with stratification and flow substitution:

Roberson Creek 2001 Total N VAR=total n METHOD= 3 IJC

STRATIFICATION SCHEME:

	---- DATE ----		-- SEASON --		-------- FLOW --------	
STR	>=MIN	< MAX	>=MIN	< MAX	>=MIN	< MAX
1			0	0	.00	4.00
2			0	0	4.00	209.89

STR	SAMPLES	EVENTS	FLOWS	VOLUME %
1	15	15	159	18.60
2	3	3	55	81.40
EXCLUDED	0	0	0	.00
TOTAL	18	18	214	100.00

Roberson Creek 2001 Total N VAR=total n METHOD= 3 IJC
X =S FLOW , Y =CONC

BIVARIATE REGRESSION: Y VS. X

INTERCEPT =	3.5353	SLOPE =	-.1518
R-SQUARED =	.1146	MEAN SQUARED ERROR =	.0666
STD ERROR OF SLOPE =	.1055	DEGREES OF FREEDOM =	16
T STATISTIC =	-1.4393	PROBABILITY(>|T|) =	.1665
Y MEAN =	3.5055	Y STD DEVIATION =	.2660
X MEAN =	.1966	X STD DEVIATION =	.5933

RESIDUALS ANALYSIS:

RUNS TEST Z =	-3.0304	PROBABILITY (>|Z|) =	.0012
LAG-1 AUTOCORREL. =	.5274	PROBABILITY (>|R|) =	.0126
EFFECTIVE SAMPLES =	6	SLOPE SIGNIFICANCE =	.4562

Roberson Creek 2001 Total N VAR=total n METHOD= 3 IJC
COMPARISON OF SAMPLED AND TOTAL FLOW DISTRIBUTIONS

STR	NQ	NC	NE	VOL%	TOTAL FLOW	SAMPLED FLOW	C/Q SLOPE	SIGNIF
1	159	15	15	18.6	1.477	1.249	.261	.148
2	55	3	3	81.4	18.682	25.065	-.865	.047
***	214	18	18	100.0	5.899	5.218		

FLOW STATISTICS
FLOW DURATION = 214.0 DAYS = .586 YEARS
MEAN FLOW RATE = 5.899 HM3/YR
TOTAL FLOW VOLUME = 3.46 HM3
FLOW DATE RANGE = 20010401 TO 20011031
SAMPLE DATE RANGE = 20010418 TO 20011029

METHOD	MASS (KG)	FLUX (KG/YR)	FLUX VARIANCE	CONC (PPB)	CV
1 AV LOAD	7983.0	13625.2	.3759E+07	2309.91	.142
2 Q WTD C	7141.8	12189.5	.6553E+07	2066.51	.210
3 IJC	6738.2	11500.7	.3106E+07	1949.73	.153
4 REG-1	8420.1	14371.2	.8199E+07	2436.38	.199
5 REG-2	7667.3	13086.3	.7740E+07	2218.55	.213
6 REG-3	8707.0	14861.0	.1061E+08	2519.41	.219

```
Roberson Creek 2001 Total N       VAR=total n   METHOD= 3 IJC
X =S FLOW  , Y =CONC

BIVARIATE REGRESSION:  Y VS. X
 INTERCEPT          =      3.5353  SLOPE                =      -.1518
 R-SQUARED          =       .1146  MEAN SQUARED ERROR =       .0666
 STD ERROR OF SLOPE =       .1055  DEGREES OF FREEDOM =          16
 T STATISTIC        =     -1.4393  PROBABILITY(>|T|)  =       .1665
 Y MEAN             =      3.5055  Y STD DEVIATION    =       .2660
 X MEAN             =       .1966  X STD DEVIATION    =       .5933
RESIDUALS ANALYSIS:
 RUNS TEST Z        =     -3.0304  PROBABILITY (>|Z|) =       .0012
 LAG-1 AUTOCORREL.  =       .5274  PROBABILITY (>|R|) =       .0126
 EFFECTIVE SAMPLES  =           6  SLOPE SIGNIFICANCE =       .4562

Roberson Creek 2001 Total N       VAR=total n   METHOD= 3 IJC
X =S FLOW  , Y =RESIDUAL

BIVARIATE REGRESSION:  Y VS. X
 INTERCEPT          =      -.1322  SLOPE                =       .1743
 R-SQUARED          =       .1372  MEAN SQUARED ERROR =       .0715
 STD ERROR OF SLOPE =       .1093  DEGREES OF FREEDOM =          16
 T STATISTIC        =      1.5950  PROBABILITY(>|T|)  =       .1271
 Y MEAN             =      -.0979  Y STD DEVIATION    =       .2792
 X MEAN             =       .1966  X STD DEVIATION    =       .5933
RESIDUALS ANALYSIS:
 RUNS TEST Z        =     -3.0304  PROBABILITY (>|Z|) =       .0012
 LAG-1 AUTOCORREL.  =       .3787  PROBABILITY (>|R|) =       .0540
 EFFECTIVE SAMPLES  =           8  SLOPE SIGNIFICANCE =       .3297

Roberson Creek 2001 Total N       VAR=total n   METHOD= 3 IJC
X =DATE    , Y =RESIDUAL

BIVARIATE REGRESSION:  Y VS. X
 INTERCEPT          =   2046.2870  SLOPE                =     -1.0224
 R-SQUARED          =       .3511  MEAN SQUARED ERROR =       .0537
 STD ERROR OF SLOPE =       .3475  DEGREES OF FREEDOM =          16
 T STATISTIC        =     -2.9422  PROBABILITY(>|T|)  =       .0093
 Y MEAN             =      -.0979  Y STD DEVIATION    =       .2792
 X MEAN             =   2001.5778  X STD DEVIATION    =       .1618
RESIDUALS ANALYSIS:
 RUNS TEST Z        =     -1.1762  PROBABILITY (>|Z|) =       .1197
 LAG-1 AUTOCORREL.  =       .1124  PROBABILITY (>|R|) =       .3166
 EFFECTIVE SAMPLES  =          14  SLOPE SIGNIFICANCE =       .0224


Roberson Creek 2001 Total N       VAR=total n   METHOD= 1 AV LOAD
X =S FLOW  , Y =RESIDUAL

BIVARIATE REGRESSION:  Y VS. X
 INTERCEPT          =      -.3080  SLOPE                =       .4521
 R-SQUARED          =       .4054  MEAN SQUARED ERROR =       .1122
 STD ERROR OF SLOPE =       .1369  DEGREES OF FREEDOM =          16
 T STATISTIC        =      3.3025  PROBABILITY(>|T|)  =       .0047
 Y MEAN             =      -.2191  Y STD DEVIATION    =       .4214
```

```
 X MEAN             =       .1966  X STD DEVIATION    =       .5933
RESIDUALS ANALYSIS:
 RUNS TEST Z        =     -.5413  PROBABILITY (>|Z|) =       .2941
 LAG-1 AUTOCORREL.  =      .3605  PROBABILITY (>|R|) =       .0631
 EFFECTIVE SAMPLES  =          8  SLOPE SIGNIFICANCE =       .0685

Roberson Creek 2001 Total N       VAR=total n   METHOD= 1 AV LOAD
X =DATE    , Y =RESIDUAL

BIVARIATE REGRESSION:  Y VS. X
 INTERCEPT          =   3381.4190  SLOPE              =     -1.6895
 R-SQUARED          =       .4209  MEAN SQUARED ERROR =       .1093
 STD ERROR OF SLOPE =       .4955  DEGREES OF FREEDOM =          16
 T STATISTIC        =     -3.4099  PROBABILITY(>|T|)  =       .0038
 Y MEAN             =      -.2191  Y STD DEVIATION    =       .4214
 X MEAN             =   2001.5778  X STD DEVIATION    =       .1618
RESIDUALS ANALYSIS:
 RUNS TEST Z        =      -.1915  PROBABILITY (>|Z|) =       .4240
 LAG-1 AUTOCORREL.  =      -.0079  PROBABILITY (>|R|) =       .4867
 EFFECTIVE SAMPLES  =          18  SLOPE SIGNIFICANCE =       .0038


Roberson Creek 2001 Total N       VAR=total n   METHOD= 1 AV LOAD
X =S FLOW  , Y =CONC

BIVARIATE REGRESSION:  Y VS. X
 INTERCEPT          =      3.5353  SLOPE              =      -.1518
 R-SQUARED          =       .1146  MEAN SQUARED ERROR =       .0666
 STD ERROR OF SLOPE =       .1055  DEGREES OF FREEDOM =          16
 T STATISTIC        =     -1.4393  PROBABILITY(>|T|)  =       .1665
 Y MEAN             =      3.5055  Y STD DEVIATION    =       .2660
 X MEAN             =       .1966  X STD DEVIATION    =       .5933
RESIDUALS ANALYSIS:
 RUNS TEST Z        =     -3.0304  PROBABILITY (>|Z|) =       .0012
 LAG-1 AUTOCORREL.  =       .5274  PROBABILITY (>|R|) =       .0126
 EFFECTIVE SAMPLES  =           6  SLOPE SIGNIFICANCE =       .4562


Inorganic N Load with stratification and with flow substitution:

 Roberson Creek 2001              VAR=inorg n   METHOD= 3 IJC

STRATIFICATION SCHEME:
       ---- DATE ----   -- SEASON --  -------- FLOW --------
STR    >=MIN    < MAX  >=MIN  < MAX       >=MIN       < MAX
  1                        0      0         .00        4.00
  2                        0      0        4.00      209.89

STR   SAMPLES    EVENTS     FLOWS  VOLUME %
  1        15        15       159     18.60
  2         3         3        55     81.40
EXCLUDED    0         0         0       .00
   TOTAL   18        18       214    100.00
```

```
 Roberson Creek 2001               VAR=inorg n   METHOD= 3 IJC
 COMPARISON OF SAMPLED AND TOTAL FLOW DISTRIBUTIONS
 STR       NQ  NC  NE  VOL%   TOTAL FLOW SAMPLED FLOW   C/Q SLOPE SIGNIF
  1       159  15  15  18.6        1.477        1.249        .275   .149
  2        55   3   3  81.4       18.682       25.065      -1.195   .062
***       214  18  18 100.0        5.899        5.218

 FLOW STATISTICS
 FLOW DURATION =     214.0 DAYS  =   .586 YEARS
 MEAN FLOW RATE =     5.899 HM3/YR
 TOTAL FLOW VOLUME =       3.46 HM3
 FLOW DATE RANGE   = 20010401 TO 20011031
 SAMPLE DATE RANGE = 20010418 TO 20011029

 METHOD         MASS (KG)   FLUX (KG/YR)  FLUX VARIANCE CONC (PPB)      CV
 1 AV LOAD         5805.5         9908.8      .3282E+07    1679.85    .183
 2 Q WTD C         5381.2         9184.6      .7814E+07    1557.08    .304
 3 IJC             4929.7         8414.0      .3629E+07    1426.44    .226
 4 REG-1           6579.9        11230.4      .2452E+08    1903.91    .441
 5 REG-2           7408.4        12644.4      .2191E+10    2143.63   3.702
 6 REG-3           6916.4        11804.7      .9750E+09    2001.27   2.645

 Roberson Creek 2001               VAR=inorg n   METHOD= 1 AV LOAD
 X =S FLOW  , Y =RESIDUAL

 BIVARIATE REGRESSION:  Y VS. X
  INTERCEPT          =     -.4624  SLOPE                =       .7581
  R-SQUARED          =      .6998  MEAN SQUARED ERROR =       .0922
  STD ERROR OF SLOPE =      .1241  DEGREES OF FREEDOM =          16
  T STATISTIC        =     6.1072  PROBABILITY(>|T|)  =       .0001
  Y MEAN             =     -.3133  Y STD DEVIATION    =       .5377
  X MEAN             =      .1966  X STD DEVIATION    =       .5933
 RESIDUALS ANALYSIS:
  RUNS TEST Z        =    -3.4156  PROBABILITY (>|Z|) =       .0003
  LAG-1 AUTOCORREL.  =      .5228  PROBABILITY (>|R|) =       .0133
  EFFECTIVE SAMPLES  =          6  SLOPE SIGNIFICANCE =       .0251

 Roberson Creek 2001               VAR=inorg n   METHOD= 1 AV LOAD
 X =DATE    , Y =RESIDUAL

 BIVARIATE REGRESSION:  Y VS. X
  INTERCEPT          =  4464.9610  SLOPE                =     -2.2309
  R-SQUARED          =      .4506  MEAN SQUARED ERROR =       .1688
  STD ERROR OF SLOPE =      .6158  DEGREES OF FREEDOM =          16
  T STATISTIC        =    -3.6229  PROBABILITY(>|T|)  =       .0026
  Y MEAN             =     -.3133  Y STD DEVIATION    =       .5377
  X MEAN             =  2001.5778  X STD DEVIATION    =       .1618
 RESIDUALS ANALYSIS:
  RUNS TEST Z        =     -.1915  PROBABILITY (>|Z|) =       .4240
  LAG-1 AUTOCORREL.  =     -.0546  PROBABILITY (>|R|) =       .4084
  EFFECTIVE SAMPLES  =         18  SLOPE SIGNIFICANCE =       .0026


 Roberson Creek 2001               VAR=inorg n   METHOD= 3 IJC
 X =S FLOW  , Y =RESIDUAL
```

```
BIVARIATE REGRESSION:  Y VS. X
 INTERCEPT          =       .3236  SLOPE               =      -.2419
 R-SQUARED          =       .1918  MEAN SQUARED ERROR =       .0922
 STD ERROR OF SLOPE =       .1241  DEGREES OF FREEDOM =          16
 T STATISTIC        =     -1.9489  PROBABILITY(>|T|)  =       .0663
 Y MEAN             =       .2760  Y STD DEVIATION    =       .3277
 X MEAN             =       .1966  X STD DEVIATION    =       .5933
RESIDUALS ANALYSIS:
 RUNS TEST Z        =     -3.4156  PROBABILITY (>|Z|) =       .0003
 LAG-1 AUTOCORREL.  =       .5228  PROBABILITY (>|R|) =       .0133
 EFFECTIVE SAMPLES  =           6  SLOPE SIGNIFICANCE =       .3243

 Roberson Creek 2001               VAR=inorg n   METHOD= 3 IJC
X =DATE    , Y =RESIDUAL

BIVARIATE REGRESSION:  Y VS. X
 INTERCEPT          =   1468.6420  SLOPE               =      -.7336
 R-SQUARED          =       .1312  MEAN SQUARED ERROR =       .0991
 STD ERROR OF SLOPE =       .4720  DEGREES OF FREEDOM =          16
 T STATISTIC        =     -1.5543  PROBABILITY(>|T|)  =       .1366
 Y MEAN             =       .2760  Y STD DEVIATION    =       .3277
 X MEAN             =   2001.5778  X STD DEVIATION    =       .1618
RESIDUALS ANALYSIS:
 RUNS TEST Z        =     -3.1457  PROBABILITY (>|Z|) =       .0008
 LAG-1 AUTOCORREL.  =       .3192  PROBABILITY (>|R|) =       .0878
 EFFECTIVE SAMPLES  =           9  SLOPE SIGNIFICANCE =       .3088
```

Appendix VII . FLUX output files – 2002

```
 Roberson Creek 2002 Total P       VAR=total p   METHOD= 1 AV LOAD
 Comparison of Sampled & Total Flow Distributions
        ------ SAMPLED -----     ------- TOTAL ------
 STRAT   N     MEAN  STD DEV      N     MEAN  STD DEV     DIFF    T PROB(>T)
  1      9     2.42     1.66    214     6.21    50.50    -3.79   1.08   .280
***      9     2.42     1.66    214     6.21    50.50    -3.79   1.08   .280

 Average Sample Interval =  13.6 Days, Date Range = 20020415 to 20020815
 Maximum Sample Interval =    27 Days, Date Range = 20020529 to 20020626
 Percent of Total Flow Volume Occuring In This Interval =    .7%

 Total Flow Volume on Sampled Days =         11.1 hm3
 Total Flow Volume on All Days     =       1328.9 hm3
 Percent of Total Flow Volume Sampled =      .8%

 Maximum Sampled Flow Rate =        5.27 hm3/yr
 Maximum Total Flow Rate   =      729.50 hm3/yr
 Number of Days when Flow Exceeded Maximum Sampled Flow = 26 out of  214
 Percent of Total Flow Volume Occurring at Flow Rates Exceeding the
       Maximum Sampled Flow Rate =    88.5%

 Roberson Creek 2002 Total P       VAR=total p   METHOD= 1 AV LOAD
 Comparison of Sampled & Total Flow Distributions
        ------ SAMPLED -----     ------- TOTAL ------
 STRAT   N     MEAN  STD DEV      N     MEAN  STD DEV     DIFF    T PROB(>T)
  1      9     1.23     1.34    214     6.21    50.50    -4.98   1.43   .150
***      9     1.23     1.34    214     6.21    50.50    -4.98   1.43   .150

 Average Sample Interval =  13.6 Days, Date Range = 20020415 to 20020815
 Maximum Sample Interval =    27 Days, Date Range = 20020529 to 20020626
 Percent of Total Flow Volume Occuring In This Interval =    .7%

 Total Flow Volume on Sampled Days =         11.1 hm3
 Total Flow Volume on All Days     =       1328.9 hm3
 Percent of Total Flow Volume Sampled =      .8%

 Maximum Sampled Flow Rate =        4.46 hm3/yr
 Maximum Total Flow Rate   =      729.50 hm3/yr
 Number of Days when Flow Exceeded Maximum Sampled Flow = 28 out of  214
 Percent of Total Flow Volume Occurring at Flow Rates Exceeding the
       Maximum Sampled Flow Rate =    89.3%

 Roberson Creek 2002 Total P       VAR=total p   METHOD= 1 AV LOAD
 COMPARISON OF SAMPLED AND TOTAL FLOW DISTRIBUTIONS
 STR       NQ  NC  NE  VOL%   TOTAL FLOW SAMPLED FLOW   C/Q SLOPE SIGNIF
  1       214   9   9 100.0        6.210        2.423       -.283   .015
***       214   9   9 100.0        6.210        2.423

 FLOW STATISTICS
 FLOW DURATION =     214.0 DAYS  =   .586 YEARS
 MEAN FLOW RATE =     6.210 HM3/YR
 TOTAL FLOW VOLUME =       3.64 HM3
```

FLOW DATE RANGE   = 20020401 TO 20021031
SAMPLE DATE RANGE = 20020415 TO 20020815

METHOD	MASS (KG)	FLUX (KG/YR)	FLUX VARIANCE	CONC (PPB)	CV
1 AV LOAD	236.3	403.2	.6989E+04	64.94	.207
2 Q WTD C	605.5	1033.4	.2908E+05	166.42	.165
3 IJC	596.6	1018.3	.3363E+05	163.99	.180
4 REG-1	486.0	829.5	.3077E+05	133.58	.211
6 REG-3	546.7	933.0	.2169E+05	150.25	.158

```
Roberson Creek 2002 Total P       VAR=total p   METHOD= 2 Q WTD C
X =S FLOW  , Y =RESIDUAL

BIVARIATE REGRESSION:  Y VS. X
 INTERCEPT         =       .1186  SLOPE               =      -.2827
 R-SQUARED         =       .5941  MEAN SQUARED ERROR =       .0138
 STD ERROR OF SLOPE =      .0883  DEGREES OF FREEDOM =           7
 T STATISTIC       =     -3.2009  PROBABILITY(>|T|)  =       .0148
 Y MEAN            =       .0554  Y STD DEVIATION    =       .1726
 X MEAN            =       .2234  X STD DEVIATION    =       .4706
RESIDUALS ANALYSIS:
 RUNS TEST Z       =     -1.4056  PROBABILITY (>|Z|) =       .0799
 LAG-1 AUTOCORREL.  =      .1422  PROBABILITY (>|R|) =       .3348
 EFFECTIVE SAMPLES  =          6  SLOPE SIGNIFICANCE =       .0592

Roberson Creek 2002 Total P       VAR=total p   METHOD= 2 Q WTD C
X =DATE    , Y =RESIDUAL

BIVARIATE REGRESSION:  Y VS. X
 INTERCEPT         =  -2182.1680  SLOPE               =      1.0898
 R-SQUARED         =       .5174  MEAN SQUARED ERROR =       .0164
 STD ERROR OF SLOPE =      .3978  DEGREES OF FREEDOM =           7
 T STATISTIC       =      2.7392  PROBABILITY(>|T|)  =       .0281
 Y MEAN            =       .0554  Y STD DEVIATION    =       .1726
 X MEAN            =   2002.4145  X STD DEVIATION    =       .1139
RESIDUALS ANALYSIS:
 RUNS TEST Z       =      -.6827  PROBABILITY (>|Z|) =       .2474
 LAG-1 AUTOCORREL.  =     -.0397  PROBABILITY (>|R|) =       .4526
 EFFECTIVE SAMPLES  =          9  SLOPE SIGNIFICANCE =       .0281

Roberson Creek 2002 Total P       VAR=total p   METHOD= 3 IJC
X =S FLOW  , Y =RESIDUAL

BIVARIATE REGRESSION:  Y VS. X
 INTERCEPT         =       .1250  SLOPE               =      -.2827
 R-SQUARED         =       .5941  MEAN SQUARED ERROR =       .0138
 STD ERROR OF SLOPE =      .0883  DEGREES OF FREEDOM =           7
 T STATISTIC       =     -3.2009  PROBABILITY(>|T|)  =       .0148
 Y MEAN            =       .0618  Y STD DEVIATION    =       .1726
 X MEAN            =       .2234  X STD DEVIATION    =       .4706
RESIDUALS ANALYSIS:
 RUNS TEST Z       =     -1.4056  PROBABILITY (>|Z|) =       .0799
 LAG-1 AUTOCORREL.  =      .1422  PROBABILITY (>|R|) =       .3348
 EFFECTIVE SAMPLES  =          6  SLOPE SIGNIFICANCE =       .0592

Roberson Creek 2002 Total P       VAR=total p   METHOD= 3 IJC
```

```
 X =DATE    , Y =RESIDUAL

 BIVARIATE REGRESSION:  Y VS. X
  INTERCEPT          =  -2182.1620  SLOPE                =      1.0898
  R-SQUARED          =       .5174  MEAN SQUARED ERROR =       .0164
  STD ERROR OF SLOPE =       .3978  DEGREES OF FREEDOM =           7
  T STATISTIC        =      2.7392  PROBABILITY(>|T|)  =       .0281
  Y MEAN             =       .0618  Y STD DEVIATION    =       .1726
  X MEAN             =   2002.4145  X STD DEVIATION    =       .1139
 RESIDUALS ANALYSIS:
  RUNS TEST Z        =      -.6827  PROBABILITY (>|Z|) =       .2474
  LAG-1 AUTOCORREL.  =      -.0396  PROBABILITY (>|R|) =       .4527
  EFFECTIVE SAMPLES  =           9  SLOPE SIGNIFICANCE =       .0281


 Roberson Creek 2002 Total N       VAR=total n   METHOD= 3 IJC
 COMPARISON OF SAMPLED AND TOTAL FLOW DISTRIBUTIONS
 STR       NQ  NC  NE  VOL%   TOTAL FLOW SAMPLED FLOW   C/Q SLOPE SIGNIF
  1       214   9   9 100.0        6.210        2.423       -.067   .562
***       214   9   9 100.0        6.210        2.423

 FLOW STATISTICS
 FLOW DURATION =     214.0 DAYS  =   .586 YEARS
 MEAN FLOW RATE =     6.210 HM3/YR
 TOTAL FLOW VOLUME =       3.64 HM3
 FLOW DATE RANGE   = 20020401 TO 20021031
 SAMPLE DATE RANGE = 20020415 TO 20020815

 METHOD         MASS (KG)   FLUX (KG/YR)  FLUX VARIANCE CONC (PPB)      CV
 1 AV LOAD         3362.5         5739.1      .1642E+07     924.21    .223
 2 Q WTD C         8617.8        14708.6      .4664E+07    2368.65    .147
 3 IJC             8533.4        14564.5      .5051E+07    2345.45    .154
 4 REG-1           8183.1        13966.7      .9254E+07    2249.17    .218
 6 REG-3           8721.9        14886.4      .6654E+07    2397.29    .173

 Roberson Creek 2002 Total N       VAR=total n   METHOD= 2 Q WTD C
 X =S FLOW  , Y =RESIDUAL

 BIVARIATE REGRESSION:  Y VS. X
  INTERCEPT          =       .0248  SLOPE                =      -.0666
  R-SQUARED          =       .0516  MEAN SQUARED ERROR =       .0206
  STD ERROR OF SLOPE =       .1079  DEGREES OF FREEDOM =           7
  T STATISTIC        =      -.6171  PROBABILITY(>|T|)  =       .5616
  Y MEAN             =       .0099  Y STD DEVIATION    =       .1379
  X MEAN             =       .2234  X STD DEVIATION    =       .4706
 RESIDUALS ANALYSIS:
  RUNS TEST Z        =       .7631  PROBABILITY (>|Z|) =       .2227
  LAG-1 AUTOCORREL.  =      -.4729  PROBABILITY (>|R|) =       .0780
  EFFECTIVE SAMPLES  =           9  SLOPE SIGNIFICANCE =       .5616

 Roberson Creek 2002 Total N       VAR=total n   METHOD= 2 Q WTD C
 X =DATE    , Y =RESIDUAL

 BIVARIATE REGRESSION:  Y VS. X
  INTERCEPT          =     54.6564  SLOPE                =      -.0273
  R-SQUARED          =       .0005  MEAN SQUARED ERROR =       .0217
```

```
  STD ERROR OF SLOPE =       .4574  DEGREES OF FREEDOM =           7
  T STATISTIC        =      -.0597  PROBABILITY(>|T|)  =       .9529
  Y MEAN             =       .0099  Y STD DEVIATION    =       .1379
  X MEAN             =   2002.4145  X STD DEVIATION    =       .1139
 RESIDUALS ANALYSIS:
  RUNS TEST Z        =       .7631  PROBABILITY (>|Z|) =       .2227
  LAG-1 AUTOCORREL.  =      -.4800  PROBABILITY (>|R|) =       .0749
  EFFECTIVE SAMPLES  =           9  SLOPE SIGNIFICANCE =       .9529

 Roberson Creek 2002 Inorganic N   VAR=inorg n   METHOD= 2 Q WTD C
 COMPARISON OF SAMPLED AND TOTAL FLOW DISTRIBUTIONS
 STR       NQ  NC  NE  VOL%   TOTAL FLOW SAMPLED FLOW   C/Q SLOPE SIGNIF
  1       214   9   9 100.0        6.210        2.423       -.028   .841
***       214   9   9 100.0        6.210        2.423

 FLOW STATISTICS
 FLOW DURATION =     214.0 DAYS  =   .586 YEARS
 MEAN FLOW RATE =     6.210 HM3/YR
 TOTAL FLOW VOLUME =       3.64 HM3
 FLOW DATE RANGE   = 20020401 TO 20021031
 SAMPLE DATE RANGE = 20020415 TO 20020815

 METHOD         MASS (KG)   FLUX (KG/YR)  FLUX VARIANCE CONC (PPB)      CV
 1 AV LOAD         2719.1         4641.0      .1239E+07     747.38    .240
 2 Q WTD C         6968.9        11894.3      .4694E+07    1915.44    .182
 3 IJC             6892.1        11763.3      .4990E+07    1894.35    .190
 4 REG-1           6818.5        11637.7      .1032E+08    1874.12    .276
 6 REG-3           7310.4        12477.1      .7851E+07    2009.30    .225

 Roberson Creek 2002 Inorganic N   VAR=inorg n   METHOD= 2 Q WTD C
 X =S FLOW  , Y =RESIDUAL

 BIVARIATE REGRESSION:  Y VS. X
  INTERCEPT          =      -.0013  SLOPE              =      -.0280
  R-SQUARED          =       .0056  MEAN SQUARED ERROR =       .0351
  STD ERROR OF SLOPE =       .1407  DEGREES OF FREEDOM =           7
  T STATISTIC        =      -.1994  PROBABILITY(>|T|)  =       .8412
  Y MEAN             =      -.0075  Y STD DEVIATION    =       .1756
  X MEAN             =       .2234  X STD DEVIATION    =       .4706
 RESIDUALS ANALYSIS:
  RUNS TEST Z        =       .7631  PROBABILITY (>|Z|) =       .2227
  LAG-1 AUTOCORREL.  =      -.3710  PROBABILITY (>|R|) =       .1329
  EFFECTIVE SAMPLES  =           9  SLOPE SIGNIFICANCE =       .8412

 Roberson Creek 2002 Inorganic N   VAR=inorg n   METHOD= 2 Q WTD C
 X =DATE    , Y =RESIDUAL

 BIVARIATE REGRESSION:  Y VS. X
  INTERCEPT          =    820.1454  SLOPE              =      -.4096
  R-SQUARED          =       .0706  MEAN SQUARED ERROR =       .0328
  STD ERROR OF SLOPE =       .5618  DEGREES OF FREEDOM =           7
  T STATISTIC        =      -.7291  PROBABILITY(>|T|)  =       .4947
  Y MEAN             =      -.0075  Y STD DEVIATION    =       .1756
  X MEAN             =   2002.4145  X STD DEVIATION    =       .1139
 RESIDUALS ANALYSIS:
  RUNS TEST Z        =       .7631  PROBABILITY (>|Z|) =       .2227
```

```
  LAG-1 AUTOCORREL.  =      -.4542  PROBABILITY (>|R|) =       .0865
  EFFECTIVE SAMPLES  =           9  SLOPE SIGNIFICANCE =       .4947

 Roberson Creek 2002 Inorganic N   VAR=inorg n   METHOD= 2 Q WTD C
 X =S FLOW  , Y =CONC

 BIVARIATE REGRESSION:  Y VS. X
  INTERCEPT          =      3.2810  SLOPE              =      -.0280
  R-SQUARED          =       .0056  MEAN SQUARED ERROR =       .0351
  STD ERROR OF SLOPE =       .1407  DEGREES OF FREEDOM =           7
  T STATISTIC        =      -.1994  PROBABILITY(>|T|)  =       .8412
  Y MEAN             =      3.2747  Y STD DEVIATION    =       .1756
  X MEAN             =       .2234  X STD DEVIATION    =       .4706
 RESIDUALS ANALYSIS:
  RUNS TEST Z        =       .7631  PROBABILITY (>|Z|) =       .2227
  LAG-1 AUTOCORREL.  =      -.3710  PROBABILITY (>|R|) =       .1329
  EFFECTIVE SAMPLES  =           9  SLOPE SIGNIFICANCE =       .8412


Verification Loads: Apr-Sep 2002

 Roberson Verification             VAR=total p   METHOD= 2 Q WTD C
 Comparison of Sampled & Total Flow Distributions
        ------ SAMPLED -----     ------- TOTAL ------
 STRAT   N     MEAN  STD DEV      N     MEAN  STD DEV     DIFF    T PROB(>T)
  1      9     2.42     1.66    183     2.23     8.99      .20   -.23   .815
***      9     2.42     1.66    183     2.23     8.99      .20   -.23   .815

 Average Sample Interval =  13.6 Days, Date Range = 20020415 to 20020815
 Maximum Sample Interval =    27 Days, Date Range = 20020529 to 20020626
 Percent of Total Flow Volume Occuring In This Interval =   2.2%

 Total Flow Volume on Sampled Days =         11.1 hm3
 Total Flow Volume on All Days     =        407.2 hm3
 Percent of Total Flow Volume Sampled =     2.7%

 Maximum Sampled Flow Rate =        5.27 hm3/yr
 Maximum Total Flow Rate   =      104.62 hm3/yr
 Number of Days when Flow Exceeded Maximum Sampled Flow = 15 out of  183
 Percent of Total Flow Volume Occurring at Flow Rates Exceeding the
       Maximum Sampled Flow Rate =    71.6%

 Roberson Verification             VAR=total p   METHOD= 2 Q WTD C
 COMPARISON OF SAMPLED AND TOTAL FLOW DISTRIBUTIONS
 STR       NQ  NC  NE  VOL%   TOTAL FLOW SAMPLED FLOW   C/Q SLOPE SIGNIF
  1       183   9   9 100.0        2.225        2.423       -.283   .015
***       183   9   9 100.0        2.225        2.423

 FLOW STATISTICS
 FLOW DURATION =     183.0 DAYS  =   .501 YEARS
 MEAN FLOW RATE =     2.225 HM3/YR
 TOTAL FLOW VOLUME =       1.11 HM3
 FLOW DATE RANGE   = 20020401 TO 20020930
 SAMPLE DATE RANGE = 20020415 TO 20020815

 METHOD         MASS (KG)   FLUX (KG/YR)  FLUX VARIANCE CONC (PPB)      CV
```

```
1 AV LOAD          202.0          403.2      .6989E+04     181.23    .207
2 Q WTD C          185.5          370.3      .3733E+04     166.42    .165
3 IJC              182.8          364.9      .4318E+04     163.99    .180
4 REG-1            190.0          379.3      .2914E+04     170.48    .142
6 REG-3            185.6          370.5      .2136E+04     166.51    .125

Roberson Verification            VAR=total p   METHOD= 2 Q WTD C
X =S FLOW  , Y =RESIDUAL

BIVARIATE REGRESSION:  Y VS. X
 INTERCEPT          =       .1186  SLOPE                =      -.2827
 R-SQUARED          =       .5941  MEAN SQUARED ERROR =       .0138
 STD ERROR OF SLOPE =       .0883  DEGREES OF FREEDOM =           7
 T STATISTIC        =     -3.2009  PROBABILITY(>|T|)  =       .0148
 Y MEAN             =       .0554  Y STD DEVIATION    =       .1726
 X MEAN             =       .2234  X STD DEVIATION    =       .4706
RESIDUALS ANALYSIS:
 RUNS TEST Z        =     -1.4056  PROBABILITY (>|Z|) =       .0799
 LAG-1 AUTOCORREL.  =       .1422  PROBABILITY (>|R|) =       .3348
 EFFECTIVE SAMPLES  =           6  SLOPE SIGNIFICANCE =       .0592


Roberson Verification            VAR=total p   METHOD= 2 Q WTD C
X =DATE    , Y =RESIDUAL

BIVARIATE REGRESSION:  Y VS. X
 INTERCEPT          =  -2182.1680  SLOPE                =      1.0898
 R-SQUARED          =       .5174  MEAN SQUARED ERROR =       .0164
 STD ERROR OF SLOPE =       .3978  DEGREES OF FREEDOM =           7
 T STATISTIC        =      2.7392  PROBABILITY(>|T|)  =       .0281
 Y MEAN             =       .0554  Y STD DEVIATION    =       .1726
 X MEAN             =   2002.4145  X STD DEVIATION    =       .1139
RESIDUALS ANALYSIS:
 RUNS TEST Z        =      -.6827  PROBABILITY (>|Z|) =       .2474
 LAG-1 AUTOCORREL.  =      -.0397  PROBABILITY (>|R|) =       .4526
 EFFECTIVE SAMPLES  =           9  SLOPE SIGNIFICANCE =       .0281
```

Appendix VIII. BATHTUB calibration input files and output.

Uncalibrated Model:

```
 Roberson Creek Cove 2001

 MODEL OPTIONS:
  1 CONSERVATIVE SUBSTANCE            0 NOT COMPUTED
  2 PHOSPHORUS BALANCE                2 2ND ORDER, DECAY
  3 NITROGEN BALANCE                  4 BACHMAN VOL. LOAD
  4 CHLOROPHYLL-A                     3 P, N, LOW-TURBIDITY
  5 SECCHI DEPTH                      1 VS. CHLA & TURBIDITY
  6 DISPERSION                        1 FISCHER-NUMERIC
  7 PHOSPHORUS CALIBRATION            1 DECAY RATES
  8 NITROGEN CALIBRATION              1 DECAY RATES
  9 ERROR ANALYSIS                    1 MODEL & DATA
 10 AVAILABILITY FACTORS              1 USE FOR MODEL 1 ONLY
 11 MASS-BALANCE TABLES               1 USE ESTIMATED CONCS

 ATMOSPHERIC LOADS & AVAILABILITY FACTORS:
             ATMOSPHERIC-LOADS   AVAILABILITY
 VARIABLE     KG/KM2-YR      CV      FACTOR
  1 CONSERV         .00     .00         .00
  2 TOTAL P       65.00     .50        1.33
  3 TOTAL N      536.00     .50         .59
  4 ORTHO P       32.50     .50         .33
  5 INORG N      359.00     .50         .79

 GLOBAL INPUT VALUES:
 PARAMETER                         MEAN     CV
 PERIOD LENGTH     YRS             .586   .000
 PRECIPITATION M                   .532   .200
 EVAPORATION   M                   .690   .300
 INCREASE IN STORAGE M             .000   .000

 TRIBUTARY DRAINAGE AREAS AND FLOWS:
 ID TYPE SEG NAME              DRAINAGE AREA    MEAN FLOW  CV OF MEAN FLOW
                                         KM2       HM3/YR
  1   1    1 Roberson RC8             74.240        6.860        .201

 TRIBUTARY CONCENTRATIONS (PPB): MEAN/CV
 ID        CONSERV       TOTAL P      TOTAL N       ORTHO P       INORG N
  1       .0/ .00   148.4/ .17  1949.7/ .15   103.9/ .17  1426.4/ .23

 MODEL SEGMENTS & CALIBRATION FACTORS:
                                 ----------- CALIBRATION FACTORS -----------
 SEG OUTFLOW GROUP SEGMENT NAME      P SED  N SED  CHL-A SECCHI    HOD      DISP
  1       0     1  Roberson           1.00   1.00   1.00   1.00   1.00     1.000
                              CV:    .000   .000   .000   .000   .000      .000

 SEGMENT MORPHOMETRY: MEAN/CV
                    LENGTH      AREA  ZMEAN      ZMIX       ZHYP
 ID LABEL               KM       KM2      M         M          M
  1 Roberson          1.75     .1300   4.50   4.24/ .00    .00/ .00
```

```
SEGMENT OBSERVED WATER QUALITY:
SEG     TURBID CONSER TOTALP TOTALN  CHL-A SECCHI  ORG-N  TP-OP   HODV   MODV
           1/M    ---   MG/M3  MG/M3  MG/M3      M  MG/M3  MG/M3 MG/M3-D MG/M3-D
 1 MN:     .00     .0    93.8 1308.1   32.9     .4  876.2     .0     .0     .0
   CV:     .00    .00     .06    .08    .17    .13    .10    .00    .00    .00

MODEL COEFFICIENTS:
COEFFICIENT          MEAN      CV
DISPERSION FACTO    1.000     .70
P DECAY RATE        1.000     .45
N DECAY RATE        1.000     .55
CHL-A MODEL         1.000     .26
SECCHI MODEL        1.000     .10
ORGANIC N MODEL     1.000     .12
TP-OP MODEL         1.000     .15
HODV MODEL          1.000     .15
MODV MODEL          1.000     .22
BETA  M2/MG          .025     .00
MINIMUM QS          4.000     .00
FLUSHING EFFECT     1.000     .00
CHLOROPHYLL-A CV     .620     .00

CASE NOTES:
single reservoir

spatially averaged
```

Water Balance:

```
CASE: Roberson Creek Cove 2001
HYDRAULIC AND DISPERSION PARAMETERS:
              NET RESIDENCE  OVERFLOW      MEAN ----DISPERSION-----  EXCHANGE
           INFLOW      TIME      RATE  VELOCITY ESTIMATED   NUMERIC      RATE
SEG OUT    HM3/YR       YRS      M/YR     KM/YR    KM2/YR    KM2/YR    HM3/YR
  1   0      6.82    .08571      52.5      20.4        3.       18.        0.
CASE: Roberson Creek Cove 2001
GROSS WATER BALANCE:
                      DRAINAGE AREA      ---- FLOW (HM3/YR) ----      RUNOFF
ID  T LOCATION                  KM2         MEAN  VARIANCE    CV        M/YR
----------------------------------------------------------------------------
 1  1 Roberson RC8           74.240        6.860  .190E+01  .201        .092
----------------------------------------------------------------------------
PRECIPITATION                  .130         .118  .557E-03  .200        .908
TRIBUTARY INFLOW             74.240        6.860  .190E+01  .201        .092
***TOTAL INFLOW              74.370        6.978  .190E+01  .198        .094
ADVECTIVE OUTFLOW            74.370        6.825  .190E+01  .202        .092
***TOTAL OUTFLOW             74.370        6.825  .190E+01  .202        .092
***EVAPORATION                 .000         .153  .211E-02  .300        .000
----------------------------------------------------------------------------

GROSS MASS BALANCE BASED UPON ESTIMATED CONCENTRATIONS
COMPONENT: TOTAL P
                      ----- LOADING ---- --- VARIANCE ---          CONC  EXPORT
```

ID T LOCATION	KG/YR	%(I)	KG/YR**2	%(I)	CV	MG/M3	KG/KM2
1 1 Roberson RC8	1017.9	99.2	.718E+05	100.0	.263	148.4	13.7
PRECIPITATION	8.4	.8	.179E+02	.0	.500	71.6	65.0
TRIBUTARY INFLOW	1017.9	99.2	.718E+05	100.0	.263	148.4	13.7
***TOTAL INFLOW	1026.3	100.0	.718E+05	100.0	.261	147.1	13.8
ADVECTIVE OUTFLOW	668.4	65.1	.407E+05	56.7	.302	97.9	9.0
***TOTAL OUTFLOW	668.4	65.1	.407E+05	56.7	.302	97.9	9.0
***RETENTION	358.0	34.9	.175E+05	24.3	.369	.0	.0

	HYDRAULIC	-------------- TOTAL P	--------------		
OVERFLOW RATE M/YR	RESIDENCE TIME YRS	POOL CONC MG/M3	RESIDENCE TIME YRS	TURNOVER RATIO -	RETENTION COEF -
52.50	.0857	93.8	.0535	10.9605	.3488

GROSS MASS BALANCE BASED UPON ESTIMATED CONCENTRATIONS
COMPONENT: TOTAL N

	----- LOADING	----	--- VARIANCE	---		CONC	EXPORT
ID T LOCATION	KG/YR	%(I)	KG/YR**2	%(I)	CV	MG/M3	KG/KM2
1 1 Roberson RC8	13375.1	99.5	.114E+08	100.0	.253	1949.7	180.2
PRECIPITATION	69.7	.5	.121E+04	.0	.500	590.4	536.0
TRIBUTARY INFLOW	13375.1	99.5	.114E+08	100.0	.253	1949.7	180.2
***TOTAL INFLOW	13444.8	100.0	.114E+08	100.0	.251	1926.7	180.8
ADVECTIVE OUTFLOW	8903.1	66.2	.800E+07	70.0	.318	1304.5	119.7
***TOTAL OUTFLOW	8903.1	66.2	.800E+07	70.0	.318	1304.5	119.7
***RETENTION	4541.7	33.8	.404E+07	35.4	.443	.0	.0

	HYDRAULIC	-------------- TOTAL N	--------------		
OVERFLOW RATE M/YR	RESIDENCE TIME YRS	POOL CONC MG/M3	RESIDENCE TIME YRS	TURNOVER RATIO -	RETENTION COEF -
52.50	.0857	1308.1	.0569	10.2957	.3378

CASE: Roberson Creek Cove 2001

WATER BALANCE TERMS (HM3/YR):

	-------- INFLOWS	--------		STORAGE	--- OUTFLOWS ---		DOWNSTR	
SEG	EXTERNAL	PRECIP	ADVECT	INCREASE	ADVECT	DISCH	EXCHANGE	EVAP
1	.686E+01	.118E+00	.000E+00	.000E+00	.682E+01	.000E+00	.000E+00	.153E+00
NET	.686E+01	.118E+00	.000E+00	.000E+00	.682E+01	.000E+00	.000E+00	.153E+00

MASS BALANCE TERMS (KG/YR) FOR: TOTAL P BASED UPON ESTIMATED CONCS:

	--------- INFLOWS	--------		STORAGE	---- OUTFLOWS----		NET	NET
SEG	EXTERNAL	ATMOSP	ADVECT	INCREASE	ADVECT	DISCH	EXCHANGE	RETENT

1	.102E+04	.845E+01	.000E+00	.000E+00	.668E+03	.000E+00	.000E+00	.358E+03
NET	.102E+04	.845E+01	.000E+00	.000E+00	.668E+03	.000E+00	.000E+00	.358E+03

MASS BALANCE TERMS (KG/YR) FOR: TOTAL N BASED UPON ESTIMATED CONCS:

	INFLOWS			STORAGE	OUTFLOWS		NET	NET
SEG	EXTERNAL	ATMOSP	ADVECT	INCREASE	ADVECT	DISCH	EXCHANGE	RETENT
1	.134E+05	.697E+02	.000E+00	.000E+00	.890E+04	.000E+00	.000E+00	.454E+04
NET	.134E+05	.697E+02	.000E+00	.000E+00	.890E+04	.000E+00	.000E+00	.454E+04

Nutrient Balance Model Selection:

CASE: Roberson Creek Cove 2001

T STATISTICS COMPARE OBSERVED AND PREDICTED MEANS
USING THE FOLLOWING ERROR TERMS:
1 = OBSERVED WATER QUALITY ERROR ONLY
2 = ERROR TYPICAL OF MODEL DEVELOPMENT DATA SET
3 = OBSERVED AND PREDICTED ERROR

SEGMENT: 1 Roberson

		OBSERVED		ESTIMATED			T STATISTICS		
VARIABLE		MEAN	CV	MEAN	CV	RATIO	1	2	3
TOTAL P	MG/M3	93.8	.06	105.4	.20	.89	-1.95	-.43	-.56
TOTAL N	MG/M3	1308.1	.08	1518.4	.20	.86	-1.86	-.68	-.69
C.NUTRIENT	MG/M3	67.3	.07	77.4	.15	.87	-2.01	-.70	-.84
CHL-A	MG/M3	32.9	.17	45.9	.32	.72	-1.96	-.96	-.91
SECCHI	M	.4	.13	.4	.20	1.13	.98	.44	.51
ORGANIC N	MG/M3	876.2	.10	1330.4	.28	.66	-4.26	-1.67	-1.40
TP-ORTHO-P	MG/M3	.0	.00	117.4	.28	.00	.00	.00	.00

CASE: Roberson Creek Cove 2001

T STATISTICS COMPARE OBSERVED AND PREDICTED MEANS
USING THE FOLLOWING ERROR TERMS:
1 = OBSERVED WATER QUALITY ERROR ONLY
2 = ERROR TYPICAL OF MODEL DEVELOPMENT DATA SET
3 = OBSERVED AND PREDICTED ERROR

SEGMENT: 1 Roberson

		OBSERVED		ESTIMATED			T STATISTICS		
VARIABLE		MEAN	CV	MEAN	CV	RATIO	1	2	3
TOTAL P	MG/M3	93.8	.06	97.9	.18	.96	-.72	-.16	-.22
TOTAL N	MG/M3	1308.1	.08	1421.6	.17	.92	-1.04	-.38	-.43
C.NUTRIENT	MG/M3	67.3	.07	71.9	.14	.94	-.96	-.33	-.44

CHL-A	MG/M3	32.9	.17	41.9	.31	.79	-1.42	-.70	-.68
SECCHI	M	.4	.13	.4	.20	1.09	.69	.31	.37
ORGANIC N	MG/M3	876.2	.10	1238.3	.27	.71	-3.53	-1.38	-1.21
TP-ORTHO-P	MG/M3	.0	.00	110.2	.27	.00	.00	.00	.00

CASE: Roberson Creek Cove 2001

T STATISTICS COMPARE OBSERVED AND PREDICTED MEANS
USING THE FOLLOWING ERROR TERMS:
1 = OBSERVED WATER QUALITY ERROR ONLY
2 = ERROR TYPICAL OF MODEL DEVELOPMENT DATA SET
3 = OBSERVED AND PREDICTED ERROR

SEGMENT: 1 Roberson

VARIABLE		OBSERVED MEAN	CV	ESTIMATED MEAN	CV	RATIO	T STATISTICS 1	2	3
TOTAL P	MG/M3	93.8	.06	86.4	.19	1.09	1.37	.31	.42
TOTAL N	MG/M3	1308.1	.08	1423.1	.17	.92	-1.05	-.38	-.44
C.NUTRIENT	MG/M3	67.3	.07	67.0	.14	1.00	.06	.02	.03
CHL-A	MG/M3	32.9	.17	38.3	.31	.86	-.90	-.44	-.43
SECCHI	M	.4	.13	.4	.20	1.05	.42	.19	.23
ORGANIC N	MG/M3	876.2	.10	1157.3	.27	.76	-2.84	-1.11	-.98
TP-ORTHO-P	MG/M3	.0	.00	103.9	.27	.00	.00	.00	.00

CASE: Roberson Creek Cove 2001

T STATISTICS COMPARE OBSERVED AND PREDICTED MEANS
USING THE FOLLOWING ERROR TERMS:
1 = OBSERVED WATER QUALITY ERROR ONLY
2 = ERROR TYPICAL OF MODEL DEVELOPMENT DATA SET
3 = OBSERVED AND PREDICTED ERROR

SEGMENT: 1 Roberson

VARIABLE		OBSERVED MEAN	CV	ESTIMATED MEAN	CV	RATIO	T STATISTICS 1	2	3
TOTAL P	MG/M3	93.8	.06	84.8	.23	1.11	1.68	.38	.42
TOTAL N	MG/M3	1308.1	.08	1304.5	.22	1.00	.03	.01	.01
C.NUTRIENT	MG/M3	67.3	.07	63.6	.17	1.06	.80	.28	.30
CHL-A	MG/M3	32.9	.17	35.9	.34	.92	-.51	-.25	-.23
SECCHI	M	.4	.13	.4	.20	1.03	.24	.11	.12
ORGANIC N	MG/M3	876.2	.10	1102.5	.28	.79	-2.34	-.92	-.78
TP-ORTHO-P	MG/M3	.0	.00	99.6	.28	.00	.00	.00	.00

CASE: Roberson Creek Cove 2001

T STATISTICS COMPARE OBSERVED AND PREDICTED MEANS
USING THE FOLLOWING ERROR TERMS:
1 = OBSERVED WATER QUALITY ERROR ONLY
2 = ERROR TYPICAL OF MODEL DEVELOPMENT DATA SET
3 = OBSERVED AND PREDICTED ERROR

SEGMENT: 1 Roberson

VARIABLE		OBSERVED MEAN	CV	ESTIMATED MEAN	CV	RATIO	T STATISTICS 1	2	3

TOTAL P	MG/M3	93.8	.06	116.3	.20	.81	-3.59	-.80	-1.04
TOTAL N	MG/M3	1308.1	.08	1602.4	.18	.82	-2.54	-.92	-1.01
C.NUTRIENT	MG/M3	67.3	.07	83.9	.14	.80	-3.16	-1.10	-1.41
CHL-A	MG/M3	32.9	.17	50.8	.31	.65	-2.55	-1.25	-1.21
SECCHI	M	.4	.13	.3	.20	1.18	1.31	.59	.69
ORGANIC N	MG/M3	876.2	.10	1440.6	.28	.61	-5.07	-1.99	-1.68
TP-ORTHO-P	MG/M3	.0	.00	126.0	.28	.00	.00	.00	.00

CASE: Roberson Creek Cove 2001

T STATISTICS COMPARE OBSERVED AND PREDICTED MEANS
USING THE FOLLOWING ERROR TERMS:
1 = OBSERVED WATER QUALITY ERROR ONLY
2 = ERROR TYPICAL OF MODEL DEVELOPMENT DATA SET
3 = OBSERVED AND PREDICTED ERROR

SEGMENT: 1 Roberson

VARIABLE		OBSERVED MEAN	CV	ESTIMATED MEAN	CV	RATIO	T STATISTICS 1	2	3
TOTAL P	MG/M3	93.8	.06	138.5	.17	.68	-6.50	-1.45	-2.13
TOTAL N	MG/M3	1308.1	.08	1814.4	.16	.72	-4.09	-1.49	-1.84
C.NUTRIENT	MG/M3	67.3	.07	98.0	.12	.69	-5.39	-1.87	-2.71
CHL-A	MG/M3	32.9	.17	61.7	.30	.53	-3.69	-1.81	-1.82
SECCHI	M	.4	.13	.3	.20	1.29	2.02	.90	1.06
ORGANIC N	MG/M3	876.2	.10	1689.5	.28	.52	-6.70	-2.63	-2.23
TP-ORTHO-P	MG/M3	.0	.00	145.4	.28	.00	.00	.00	.00

CASE: Roberson Creek Cove 2001

T STATISTICS COMPARE OBSERVED AND PREDICTED MEANS
USING THE FOLLOWING ERROR TERMS:
1 = OBSERVED WATER QUALITY ERROR ONLY
2 = ERROR TYPICAL OF MODEL DEVELOPMENT DATA SET
3 = OBSERVED AND PREDICTED ERROR

SEGMENT: 1 Roberson

VARIABLE		OBSERVED MEAN	CV	ESTIMATED MEAN	CV	RATIO	T STATISTICS 1	2	3
TOTAL P	MG/M3	93.8	.06	147.6	.17	.64	-7.55	-1.68	-2.53
TOTAL N	MG/M3	1308.1	.08	1933.1	.15	.68	-4.88	-1.78	-2.26
C.NUTRIENT	MG/M3	67.3	.07	104.7	.12	.64	-6.34	-2.20	-3.27
CHL-A	MG/M3	32.9	.17	67.0	.30	.49	-4.18	-2.05	-2.07
SECCHI	M	.4	.13	.3	.20	1.34	2.35	1.05	1.22
ORGANIC N	MG/M3	876.2	.10	1810.6	.28	.48	-7.41	-2.90	-2.46
TP-ORTHO-P	MG/M3	.0	.00	154.9	.28	.00	.00	.00	.00

Chlorophyll a Model Selection:

CASE: Roberson Creek Cove 2001

T STATISTICS COMPARE OBSERVED AND PREDICTED MEANS
USING THE FOLLOWING ERROR TERMS:
1 = OBSERVED WATER QUALITY ERROR ONLY
2 = ERROR TYPICAL OF MODEL DEVELOPMENT DATA SET
3 = OBSERVED AND PREDICTED ERROR

SEGMENT: 1 Roberson

VARIABLE		OBSERVED MEAN	CV	ESTIMATED MEAN	CV	RATIO	T STATISTICS 1	2	3
TOTAL P	MG/M3	93.8	.06	97.9	.18	.96	-.72	-.16	-.22
TOTAL N	MG/M3	1308.1	.08	1304.5	.22	1.00	.03	.01	.01
C.NUTRIENT	MG/M3	67.3	.07	68.6	.16	.98	-.29	-.10	-.12
CHL-A	MG/M3	32.9	.17	12.3	.30	2.69	5.81	2.86	2.86
SECCHI	M	.4	.13	.5	.19	.79	-1.85	-.83	-1.03
ORGANIC N	MG/M3	876.2	.10	562.7	.18	1.56	4.52	1.77	2.13
TP-ORTHO-P	MG/M3	.0	.00	57.5	.21	.00	.00	.00	.00

CASE: Roberson Creek Cove 2001

T STATISTICS COMPARE OBSERVED AND PREDICTED MEANS
USING THE FOLLOWING ERROR TERMS:
1 = OBSERVED WATER QUALITY ERROR ONLY
2 = ERROR TYPICAL OF MODEL DEVELOPMENT DATA SET
3 = OBSERVED AND PREDICTED ERROR

SEGMENT: 1 Roberson

VARIABLE		OBSERVED MEAN	CV	ESTIMATED MEAN	CV	RATIO	T STATISTICS 1	2	3
TOTAL P	MG/M3	93.8	.06	97.9	.18	.96	-.72	-.16	-.22
TOTAL N	MG/M3	1308.1	.08	1304.5	.22	1.00	.03	.01	.01
C.NUTRIENT	MG/M3	67.3	.07	68.6	.16	.98	-.29	-.10	-.12
CHL-A	MG/M3	32.9	.17	10.8	.30	3.06	6.58	3.23	3.25
SECCHI	M	.4	.13	.5	.19	.78	-2.00	-.89	-1.11
ORGANIC N	MG/M3	876.2	.10	528.5	.17	1.66	5.16	2.02	2.53
TP-ORTHO-P	MG/M3	.0	.00	54.8	.21	.00	.00	.00	.00

CASE: Roberson Creek Cove 2001

T STATISTICS COMPARE OBSERVED AND PREDICTED MEANS
USING THE FOLLOWING ERROR TERMS:
1 = OBSERVED WATER QUALITY ERROR ONLY
2 = ERROR TYPICAL OF MODEL DEVELOPMENT DATA SET
3 = OBSERVED AND PREDICTED ERROR

SEGMENT: 1 Roberson

VARIABLE		OBSERVED MEAN	CV	ESTIMATED MEAN	CV	RATIO	T STATISTICS 1	2	3
TOTAL P	MG/M3	93.8	.06	97.9	.18	.96	-.72	-.16	-.22
TOTAL N	MG/M3	1308.1	.08	1304.5	.22	1.00	.03	.01	.01
C.NUTRIENT	MG/M3	67.3	.07	68.6	.16	.98	-.29	-.10	-.12
CHL-A	MG/M3	32.9	.17	39.5	.33	.83	-1.07	-.53	-.50
SECCHI	M	.4	.13	.4	.20	1.07	.51	.23	.27
ORGANIC N	MG/M3	876.2	.10	1184.0	.28	.74	-3.07	-1.20	-1.03

TP-ORTHO-P	MG/M3	.0	.00	106.0	.27	.00	.00	.00	.00

CASE: Roberson Creek Cove 2001

T STATISTICS COMPARE OBSERVED AND PREDICTED MEANS
USING THE FOLLOWING ERROR TERMS:
1 = OBSERVED WATER QUALITY ERROR ONLY
2 = ERROR TYPICAL OF MODEL DEVELOPMENT DATA SET
3 = OBSERVED AND PREDICTED ERROR

SEGMENT: 1 Roberson

VARIABLE		OBSERVED MEAN	OBSERVED CV	ESTIMATED MEAN	ESTIMATED CV	RATIO	T STATISTICS 1	T STATISTICS 2	T STATISTICS 3
TOTAL P	MG/M3	93.8	.06	97.9	.18	.96	-.72	-.16	-.22
TOTAL N	MG/M3	1308.1	.08	1304.5	.22	1.00	.03	.01	.01
C.NUTRIENT	MG/M3	67.3	.07	68.6	.16	.98	-.29	-.10	-.12
CHL-A	MG/M3	32.9	.17	27.4	.32	1.20	1.08	.53	.51
SECCHI	M	.4	.13	.4	.20	.95	-.45	-.20	-.24
ORGANIC N	MG/M3	876.2	.10	908.5	.25	.96	-.37	-.14	-.13
TP-ORTHO-P	MG/M3	.0	.00	84.5	.26	.00	.00	.00	.00

CASE: Roberson Creek Cove 2001

T STATISTICS COMPARE OBSERVED AND PREDICTED MEANS
USING THE FOLLOWING ERROR TERMS:
1 = OBSERVED WATER QUALITY ERROR ONLY
2 = ERROR TYPICAL OF MODEL DEVELOPMENT DATA SET
3 = OBSERVED AND PREDICTED ERROR

SEGMENT: 1 Roberson

VARIABLE		OBSERVED MEAN	OBSERVED CV	ESTIMATED MEAN	ESTIMATED CV	RATIO	T STATISTICS 1	T STATISTICS 2	T STATISTICS 3
TOTAL P	MG/M3	93.8	.06	97.9	.18	.96	-.72	-.16	-.22
TOTAL N	MG/M3	1308.1	.08	1304.5	.22	1.00	.03	.01	.01
C.NUTRIENT	MG/M3	67.3	.07	68.6	.16	.98	-.29	-.10	-.12
CHL-A	MG/M3	32.9	.17	65.3	.37	.50	-4.03	-1.98	-1.67
SECCHI	M	.4	.13	.3	.23	1.32	2.25	1.00	1.07
ORGANIC N	MG/M3	876.2	.10	1773.1	.34	.49	-7.19	-2.82	-2.01
TP-ORTHO-P	MG/M3	.0	.00	152.0	.33	.00	.00	.00	.00

Calibrated Model:

Roberson Creek Cove 2001

MODEL OPTIONS:

1 CONSERVATIVE SUBSTANCE	0 NOT COMPUTED
2 PHOSPHORUS BALANCE	2 2ND ORDER, DECAY
3 NITROGEN BALANCE	4 BACHMAN VOL. LOAD
4 CHLOROPHYLL-A	3 P, N, LOW-TURBIDITY
5 SECCHI DEPTH	1 VS. CHLA & TURBIDITY
6 DISPERSION	1 FISCHER-NUMERIC
7 PHOSPHORUS CALIBRATION	1 DECAY RATES

8	NITROGEN CALIBRATION	1 DECAY RATES
9	ERROR ANALYSIS	1 MODEL & DATA
10	AVAILABILITY FACTORS	1 USE FOR MODEL 1 ONLY
11	MASS-BALANCE TABLES	1 USE ESTIMATED CONCS

ATMOSPHERIC LOADS & AVAILABILITY FACTORS:

VARIABLE	ATMOSPHERIC-LOADS KG/KM2-YR	CV	AVAILABILITY FACTOR
1 CONSERV	.00	.00	.00
2 TOTAL P	65.00	.50	1.33
3 TOTAL N	536.00	.50	.59
4 ORTHO P	32.50	.50	.33
5 INORG N	359.00	.50	.79

GLOBAL INPUT VALUES:

PARAMETER		MEAN	CV
PERIOD LENGTH	YRS	.586	.000
PRECIPITATION	M	.532	.200
EVAPORATION	M	.690	.300
INCREASE IN STORAGE	M	.000	.000

TRIBUTARY DRAINAGE AREAS AND FLOWS:

ID	TYPE	SEG	NAME	DRAINAGE AREA KM2	MEAN FLOW HM3/YR	CV OF MEAN FLOW
1	1	1	Roberson RC8	74.240	6.860	.201

TRIBUTARY CONCENTRATIONS (PPB): MEAN/CV

ID	CONSERV	TOTAL P	TOTAL N	ORTHO P	INORG N
1	.0/ .00	148.4/ .17	1949.7/ .15	103.9/ .17	1426.4/ .23

MODEL SEGMENTS & CALIBRATION FACTORS:

					-----------	CALIBRATION	FACTORS	-----------		
SEG	OUTFLOW	GROUP	SEGMENT NAME		P SED	N SED	CHL-A	SECCHI	HOD	DISP
1	0	1	Roberson		1.00	1.00	1.00	1.00	1.00	1.000
				CV:	.000	.000	.000	.000	.000	.000

SEGMENT MORPHOMETRY: MEAN/CV

ID	LABEL	LENGTH KM	AREA KM2	ZMEAN M	ZMIX M	ZHYP M
1	Roberson	1.75	.1300	4.50	4.24/ .00	.00/ .00

SEGMENT OBSERVED WATER QUALITY:

SEG		TURBID 1/M	CONSER ---	TOTALP MG/M3	TOTALN MG/M3	CHL-A MG/M3	SECCHI M	ORG-N MG/M3	TP-OP MG/M3	HODV MG/M3-D	MODV MG/M3-D
1	MN:	.00	.0	93.8	1308.1	32.9	.4	876.2	.0	.0	.0
	CV:	.00	.00	.06	.08	.17	.13	.10	.00	.00	.00

MODEL COEFFICIENTS:

COEFFICIENT	MEAN	CV
DISPERSION FACTO	1.000	.70
P DECAY RATE	1.000	.45
N DECAY RATE	1.000	.55
CHL-A MODEL	.830	.26
SECCHI MODEL	1.000	.10
ORGANIC N MODEL	.830	.12
TP-OP MODEL	1.000	.15

HODV MODEL	1.000	.15
MODV MODEL	1.000	.22
BETA M2/MG	.025	.00
MINIMUM QS	4.000	.00
FLUSHING EFFECT	1.000	.00
CHLOROPHYLL-A CV	.620	.00

CASE NOTES:
single reservoir

spatially averaged

Calibrated Model Results:

CASE: Roberson Creek Cove 2001

T STATISTICS COMPARE OBSERVED AND PREDICTED MEANS
USING THE FOLLOWING ERROR TERMS:
1 = OBSERVED WATER QUALITY ERROR ONLY
2 = ERROR TYPICAL OF MODEL DEVELOPMENT DATA SET
3 = OBSERVED AND PREDICTED ERROR

SEGMENT: 1 Roberson

VARIABLE		OBSERVED MEAN	OBSERVED CV	ESTIMATED MEAN	ESTIMATED CV	RATIO	T STATISTICS 1	2	3
TOTAL P	MG/M3	93.8	.06	97.9	.18	.96	-.72	-.16	-.22
TOTAL N	MG/M3	1308.1	.08	1304.5	.22	1.00	.03	.01	.01
C.NUTRIENT	MG/M3	67.3	.07	68.6	.16	.98	-.29	-.10	-.12
CHL-A	MG/M3	32.9	.17	32.8	.33	1.00	.02	.01	.01
SECCHI	M	.4	.13	.4	.20	1.00	-.01	.00	-.01
ORGANIC N	MG/M3	876.2	.10	855.6	.27	1.02	.24	.09	.08
TP-ORTHO-P	MG/M3	.0	.00	94.0	.27	.00	.00	.00	.00

CASE: Roberson Creek Cove 2001

OBSERVED AND PREDICTED DIAGNOSTIC VARIABLES
RANKED AGAINST CE MODEL DEVELOPMENT DATA SET

SEGMENT: 1 Roberson

VARIABLE		VALUES OBSERVED	VALUES ESTIMATED	RANKS (%) OBSERVED	RANKS (%) ESTIMATED
TOTAL P	MG/M3	93.80	97.93	77.2	78.7
TOTAL N	MG/M3	1308.10	1304.49	66.2	66.0
C.NUTRIENT	MG/M3	67.26	68.63	78.6	79.3
CHL-A	MG/M3	32.92	32.79	94.8	94.8
SECCHI	M	.40	.40	9.6	9.6
ORGANIC N	MG/M3	876.20	855.65	88.6	87.7
TP-ORTHO-P	MG/M3	.00	94.01	.0	88.5
ANTILOG PC-1		1416.73	1417.30	91.0	91.0
ANTILOG PC-2		7.56	7.49	62.1	61.4
(N - 150) / P		12.35	11.79	31.9	29.5

INORGANIC N / P	.00	114.59	.0	91.3
TURBIDITY 1/M	1.68	1.68	87.5	87.5
ZMIX * TURBIDITY	7.11	7.11	85.3	85.3
ZMIX / SECCHI	10.59	10.58	91.5	91.4
CHL-A * SECCHI	13.17	13.13	64.1	63.9
CHL-A / TOTAL P	.35	.33	82.0	80.0
FREQ(CHL-a>10) %	94.65	94.58	.0	.0
FREQ(CHL-a>20) %	68.93	68.71	.0	.0
FREQ(CHL-a>30) %	43.63	43.38	.0	.0
FREQ(CHL-a>40) %	26.62	26.41	.0	.0
FREQ(CHL-a>50) %	16.25	16.09	.0	.0
FREQ(CHL-a>60) %	10.06	9.95	.0	.0
CARLSON TSI-P	69.63	70.25	.0	.0
CARLSON TSI-CHLA	64.88	64.84	.0	.0
CARLSON TSI-SEC	73.20	73.19	.0	.0

Appendix IX. BATHTUB verification files.

```
Verification - Apr-Oct

Roberson Creek Cove 2002

 MODEL OPTIONS:
  1 CONSERVATIVE SUBSTANCE            0 NOT COMPUTED
  2 PHOSPHORUS BALANCE                2 2ND ORDER, DECAY
  3 NITROGEN BALANCE                  4 BACHMAN VOL. LOAD
  4 CHLOROPHYLL-A                     3 P, N, LOW-TURBIDITY
  5 SECCHI DEPTH                      1 VS. CHLA & TURBIDITY
  6 DISPERSION                        1 FISCHER-NUMERIC
  7 PHOSPHORUS CALIBRATION            1 DECAY RATES
  8 NITROGEN CALIBRATION              1 DECAY RATES
  9 ERROR ANALYSIS                    1 MODEL & DATA
 10 AVAILABILITY FACTORS              1 USE FOR MODEL 1 ONLY
 11 MASS-BALANCE TABLES               1 USE ESTIMATED CONCS

 ATMOSPHERIC LOADS & AVAILABILITY FACTORS:
             ATMOSPHERIC-LOADS   AVAILABILITY
 VARIABLE     KG/KM2-YR      CV      FACTOR
  1 CONSERV         .00     .00         .00
  2 TOTAL P       65.00     .50        1.33
  3 TOTAL N      536.00     .50         .59
  4 ORTHO P       32.50     .50         .33
  5 INORG N      359.00     .50         .79

 GLOBAL INPUT VALUES:
 PARAMETER                          MEAN     CV
 PERIOD LENGTH     YRS              .586   .000
 PRECIPITATION M                    .607   .200
 EVAPORATION   M                    .683   .300
 INCREASE IN STORAGE M              .000   .000

 TRIBUTARY DRAINAGE AREAS AND FLOWS:
 ID TYPE SEG NAME            DRAINAGE AREA    MEAN FLOW  CV OF MEAN FLOW
                                       KM2       HM3/YR
  1   1    1 Roberson               74.240        7.220        .560

 TRIBUTARY CONCENTRATIONS (PPB): MEAN/CV
 ID       CONSERV      TOTAL P      TOTAL N      ORTHO P      INORG N
  1      .0/ .00   166.4/ .17  2368.6/ .15   116.5/ .17  1915.4/ .18

 MODEL SEGMENTS & CALIBRATION FACTORS:
                                  ----------- CALIBRATION FACTORS -----------
 SEG OUTFLOW GROUP SEGMENT NAME      P SED  N SED  CHL-A SECCHI    HOD      DISP
  1       0     1  Roberson           1.00   1.00   1.00   1.00   1.00     1.000
                              CV:     .000   .000   .000   .000   .000      .000

 SEGMENT MORPHOMETRY: MEAN/CV
                     LENGTH      AREA  ZMEAN      ZMIX       ZHYP
 ID LABEL                KM       KM2      M         M          M
  1 Roberson           1.75     .1300   3.20   3.20/ .00    .00/ .00
```

SEGMENT OBSERVED WATER QUALITY:

SEG	TURBID	CONSER	TOTALP	TOTALN	CHL-A	SECCHI	ORG-N	TP-OP	HODV	MODV
	1/M	---	MG/M3	MG/M3	MG/M3	M	MG/M3	MG/M3	MG/M3-D	MG/M3-D
1 MN:	.00	.0	106.7	1217.9	39.1	.4	720.2	.0	.0	.0
CV:	.00	.00	.06	.08	.17	.10	.14	.00	.00	.00

MODEL COEFFICIENTS:

COEFFICIENT	MEAN	CV
DISPERSION FACTO	1.000	.70
P DECAY RATE	1.000	.45
N DECAY RATE	1.000	.55
CHL-A MODEL	.830	.26
SECCHI MODEL	1.000	.10
ORGANIC N MODEL	.830	.12
TP-OP MODEL	1.000	.15
HODV MODEL	1.000	.15
MODV MODEL	1.000	.22
BETA M2/MG	.025	.00
MINIMUM QS	4.000	.00
FLUSHING EFFECT	1.000	.00
CHLOROPHYLL-A CV	.620	.00

CASE NOTES:
single reservoir

spatially averaged

CASE: Roberson Creek Cove 2002

T STATISTICS COMPARE OBSERVED AND PREDICTED MEANS
USING THE FOLLOWING ERROR TERMS:
1 = OBSERVED WATER QUALITY ERROR ONLY
2 = ERROR TYPICAL OF MODEL DEVELOPMENT DATA SET
3 = OBSERVED AND PREDICTED ERROR

SEGMENT: 1 Roberson

VARIABLE		OBSERVED MEAN	CV	ESTIMATED MEAN	CV	RATIO	T STATISTICS 1	2	3
TOTAL P	MG/M3	106.7	.06	117.0	.20	.91	-1.62	-.34	-.45
TOTAL N	MG/M3	1217.9	.08	1604.7	.22	.76	-3.63	-1.25	-1.16
C.NUTRIENT	MG/M3	68.3	.07	84.2	.17	.81	-3.09	-1.04	-1.14
CHL-A	MG/M3	39.1	.17	42.3	.34	.92	-.46	-.23	-.21
SECCHI	M	.4	.10	.4	.20	1.03	.29	.10	.13
ORGANIC N	MG/M3	720.2	.14	1040.5	.29	.69	-2.67	-1.47	-1.16
TP-ORTHO-P	MG/M3	.0	.00	112.6	.28	.00	.00	.00	.00

```
Verification - Apr-Sept

Roberson Creek Cove 2002

 MODEL OPTIONS:
  1 CONSERVATIVE SUBSTANCE            0 NOT COMPUTED
  2 PHOSPHORUS BALANCE                2 2ND ORDER, DECAY
  3 NITROGEN BALANCE                  4 BACHMAN VOL. LOAD
  4 CHLOROPHYLL-A                     3 P, N, LOW-TURBIDITY
  5 SECCHI DEPTH                      1 VS. CHLA & TURBIDITY
  6 DISPERSION                        1 FISCHER-NUMERIC
  7 PHOSPHORUS CALIBRATION            1 DECAY RATES
  8 NITROGEN CALIBRATION              1 DECAY RATES
  9 ERROR ANALYSIS                    1 MODEL & DATA
 10 AVAILABILITY FACTORS              1 USE FOR MODEL 1 ONLY
 11 MASS-BALANCE TABLES               1 USE ESTIMATED CONCS

 ATMOSPHERIC LOADS & AVAILABILITY FACTORS:
             ATMOSPHERIC-LOADS   AVAILABILITY
 VARIABLE     KG/KM2-YR      CV      FACTOR
  1 CONSERV         .00     .00         .00
  2 TOTAL P       65.00     .50        1.33
  3 TOTAL N      536.00     .50         .59
  4 ORTHO P       32.50     .50         .33
  5 INORG N      359.00     .50         .79

 GLOBAL INPUT VALUES:
 PARAMETER                      MEAN     CV
 PERIOD LENGTH     YRS          .501   .000
 PRECIPITATION M                .480   .200
 EVAPORATION   M                .501   .300
 INCREASE IN STORAGE M          .000   .000

 TRIBUTARY DRAINAGE AREAS AND FLOWS:
 ID TYPE SEG NAME            DRAINAGE AREA    MEAN FLOW  CV OF MEAN FLOW
                                       KM2       HM3/YR
  1   1    1 Roberson               74.240        2.225         .300

 TRIBUTARY CONCENTRATIONS (PPB): MEAN/CV
 ID       CONSERV      TOTAL P      TOTAL N      ORTHO P      INORG N
  1      .0/ .00   166.4/ .17  2368.6/ .15   116.5/ .17  1915.4/ .18

 MODEL SEGMENTS & CALIBRATION FACTORS:
                                  ----------- CALIBRATION FACTORS -----------
 SEG OUTFLOW GROUP SEGMENT NAME      P SED  N SED  CHL-A SECCHI    HOD      DISP
  1       0     1  Roberson          1.00   1.00   1.00   1.00   1.00     1.000
                              CV:    .000   .000   .000   .000   .000      .000

 SEGMENT MORPHOMETRY: MEAN/CV
                    LENGTH      AREA  ZMEAN       ZMIX       ZHYP
 ID LABEL               KM       KM2      M          M          M
  1 Roberson          1.75     .1300   3.20   3.20/ .00    .00/ .00

 SEGMENT OBSERVED WATER QUALITY:
```

SEG	TURBID	CONSER	TOTALP	TOTALN	CHL-A	SECCHI	ORG-N	TP-OP	HODV	MODV
	1/M	---	MG/M3	MG/M3	MG/M3	M	MG/M3	MG/M3	MG/M3-D	MG/M3-D
1 MN:	.00	.0	105.5	1215.9	41.7	.4	743.0	.0	.0	.0
CV:	.00	.00	.17	.08	.16	.10	.14	.00	.00	.00

MODEL COEFFICIENTS:

COEFFICIENT	MEAN	CV
DISPERSION FACTO	1.000	.70
P DECAY RATE	1.000	.45
N DECAY RATE	1.000	.55
CHL-A MODEL	.830	.26
SECCHI MODEL	1.000	.10
ORGANIC N MODEL	.830	.12
TP-OP MODEL	1.000	.15
HODV MODEL	1.000	.15
MODV MODEL	1.000	.22
BETA M2/MG	.025	.00
MINIMUM QS	4.000	.00
FLUSHING EFFECT	1.000	.00
CHLOROPHYLL-A CV	.620	.00

CASE NOTES:
single reservoir

spatially averaged

CASE: Roberson Creek Cove 2002

T STATISTICS COMPARE OBSERVED AND PREDICTED MEANS
USING THE FOLLOWING ERROR TERMS:
1 = OBSERVED WATER QUALITY ERROR ONLY
2 = ERROR TYPICAL OF MODEL DEVELOPMENT DATA SET
3 = OBSERVED AND PREDICTED ERROR

SEGMENT: 1 Roberson

		OBSERVED		ESTIMATED			T STATISTICS		
VARIABLE		MEAN	CV	MEAN	CV	RATIO	1	2	3
TOTAL P	MG/M3	105.5	.17	94.8	.20	1.11	.63	.40	.41
TOTAL N	MG/M3	1215.9	.08	1343.3	.27	.91	-1.25	-.45	-.36
C.NUTRIENT	MG/M3	67.9	.12	68.6	.18	.99	-.08	-.05	-.05
CHL-A	MG/M3	41.7	.16	32.8	.34	1.27	1.54	.69	.63
SECCHI	M	.4	.10	.4	.20	.92	-.86	-.31	-.39
ORGANIC N	MG/M3	743.0	.14	854.6	.28	.87	-1.00	-.56	-.45
TP-ORTHO-P	MG/M3	.0	.00	93.6	.27	.00	.00	.00	.00

CASE: Roberson Creek Cove 2002

OBSERVED AND PREDICTED DIAGNOSTIC VARIABLES
RANKED AGAINST CE MODEL DEVELOPMENT DATA SET

SEGMENT: 1 Roberson
----- VALUES ----- --- RANKS (%) ----

VARIABLE		OBSERVED	ESTIMATED	OBSERVED	ESTIMATED
TOTAL P	MG/M3	105.50	94.84	81.0	77.6
TOTAL N	MG/M3	1215.90	1343.26	61.9	67.7
C.NUTRIENT	MG/M3	67.95	68.63	78.9	79.3
CHL-A	MG/M3	41.68	32.79	97.4	94.8
SECCHI	M	.37	.40	7.9	9.7
ORGANIC N	MG/M3	743.00	854.62	81.1	87.6
TP-ORTHO-P	MG/M3	.00	93.62	.0	88.5
ANTILOG PC-1		1588.40	1412.26	92.3	90.9
ANTILOG PC-2		8.20	7.52	67.8	61.7
(N - 150) / P		10.10	12.58	22.2	32.9
INORGANIC N / P		.00	403.43	.0	99.6
TURBIDITY	1/M	1.66	1.66	87.3	87.3
ZMIX * TURBIDITY		5.31	5.31	75.0	75.0
ZMIX / SECCHI		8.65	7.94	84.7	80.9
CHL-A * SECCHI		15.42	13.22	72.0	64.3
CHL-A / TOTAL P		.40	.35	86.5	81.4
FREQ(CHL-a>10) %		97.68	94.58	.0	.0
FREQ(CHL-a>20) %		80.91	68.71	.0	.0
FREQ(CHL-a>30) %		58.73	43.38	.0	.0
FREQ(CHL-a>40) %		40.37	26.41	.0	.0
FREQ(CHL-a>50) %		27.30	16.09	.0	.0
FREQ(CHL-a>60) %		18.47	9.94	.0	.0
CARLSON TSI-P		71.33	69.79	.0	.0
CARLSON TSI-CHLA		67.19	64.84	.0	.0
CARLSON TSI-SEC		74.33	73.09	.0	.0

Appendix X. BATHTUB phosphorus loading scenarios.

Roberson Creek Cove 2001

MODEL OPTIONS:

1	CONSERVATIVE SUBSTANCE	0 NOT COMPUTED
2	PHOSPHORUS BALANCE	2 2ND ORDER, DECAY
3	NITROGEN BALANCE	4 BACHMAN VOL. LOAD
4	CHLOROPHYLL-A	3 P, N, LOW-TURBIDITY
5	SECCHI DEPTH	1 VS. CHLA & TURBIDITY
6	DISPERSION	1 FISCHER-NUMERIC
7	PHOSPHORUS CALIBRATION	1 DECAY RATES
8	NITROGEN CALIBRATION	1 DECAY RATES
9	ERROR ANALYSIS	0 NOT COMPUTED
10	AVAILABILITY FACTORS	1 USE FOR MODEL 1 ONLY
11	MASS-BALANCE TABLES	1 USE ESTIMATED CONCS

ATMOSPHERIC LOADS & AVAILABILITY FACTORS:

VARIABLE	ATMOSPHERIC-LOADS KG/KM2-YR	CV	AVAILABILITY FACTOR
1 CONSERV	.00	.00	.00
2 TOTAL P	65.00	.50	1.33
3 TOTAL N	536.00	.50	.59
4 ORTHO P	32.50	.50	.33
5 INORG N	359.00	.50	.79

GLOBAL INPUT VALUES:

PARAMETER		MEAN	CV
PERIOD LENGTH	YRS	.586	.000
PRECIPITATION	M	.532	.200
EVAPORATION	M	.690	.300
INCREASE IN STORAGE	M	.000	.000

TRIBUTARY DRAINAGE AREAS AND FLOWS:

ID	TYPE	SEG	NAME	DRAINAGE AREA KM2	MEAN FLOW HM3/YR	CV OF MEAN FLOW
1	1	1	-70.7%	74.240	6.860	.201
2	1	2	-49.6%	74.240	6.860	.201
3	1	3	-87.5%	74.240	6.860	.201
4	1	4	-25%	74.240	6.860	.201
5	1	5	-39%	74.240	6.860	.201
6	1	6	-0%	74.240	6.860	.201

TRIBUTARY CONCENTRATIONS (PPB): MEAN/CV

ID	CONSERV	TOTAL P	TOTAL N	ORTHO P	INORG N
1	.0/ .00	43.5/ .00	1949.7/ .00	30.4/ .00	1426.4/ .00
2	.0/ .00	74.8/ .00	1949.7/ .00	52.4/ .00	1426.4/ .00
3	.0/ .00	18.6/ .00	1949.7/ .00	13.0/ .00	1426.4/ .00
4	.0/ .00	111.3/ .00	1949.7/ .00	77.9/ .00	1426.4/ .00
5	.0/ .00	90.5/ .00	1949.7/ .00	63.4/ .00	1426.4/ .00
6	.0/ .00	148.4/ .00	1949.7/ .00	103.9/ .00	1426.4/ .00

MODEL SEGMENTS & CALIBRATION FACTORS:

SEG	OUTFLOW	GROUP	SEGMENT NAME	----------- CALIBRATION FACTORS ----------- P SED	N SED	CHL-A	SECCHI	HOD	DISP

1	0	1	TP -70.7%		1.00	1.00	1.00	1.00	1.00	1.000
				CV:	.000	.000	.000	.000	.000	.000
2	0	1	TP -49.6%		1.00	1.00	1.00	1.00	1.00	1.000
				CV:	.000	.000	.000	.000	.000	.000
3	0	1	TP -87.5%		1.00	1.00	1.00	1.00	1.00	1.000
				CV:	.000	.000	.000	.000	.000	.000
4	0	1	TP -25%		1.00	1.00	1.00	1.00	1.00	1.000
				CV:	.000	.000	.000	.000	.000	.000
5	0	1	TP -39%		1.00	1.00	1.00	1.00	1.00	1.000
				CV:	.000	.000	.000	.000	.000	.000
6	0	1	2001 Condition		1.00	1.00	1.00	1.00	1.00	1.000
				CV:	.000	.000	.000	.000	.000	.000

SEGMENT MORPHOMETRY: MEAN/CV

ID	LABEL	LENGTH KM	AREA KM2	ZMEAN M	ZMIX M	ZHYP M
1	TP -70.7%	1.75	.1300	4.50	4.20/ .00	.00/ .00
2	TP -49.6%	1.75	.1300	4.50	4.20/ .00	.00/ .00
3	TP -87.5%	1.75	.1300	4.50	4.20/ .00	.00/ .00
4	TP -25%	1.75	.1300	4.50	4.20/ .00	.00/ .00
5	TP -39%	1.75	.1300	4.50	4.20/ .00	.00/ .00
6	2001 Condition	1.75	.1300	4.50	4.20/ .00	.00/ .00

SEGMENT OBSERVED WATER QUALITY:

SEG		TURBID 1/M	CONSER ---	TOTALP MG/M3	TOTALN MG/M3	CHL-A MG/M3	SECCHI M	ORG-N MG/M3	TP-OP MG/M3	HODV MG/M3-D	MODV MG/M3-D
1	MN:	.00	.0	.0	.0	.0	.0	.0	.0	.0	.0
	CV:	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
2	MN:	.00	.0	.0	.0	.0	.0	.0	.0	.0	.0
	CV:	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
3	MN:	.00	.0	.0	.0	.0	.0	.0	.0	.0	.0
	CV:	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
4	MN:	.00	.0	.0	.0	.0	.0	.0	.0	.0	.0
	CV:	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
5	MN:	.00	.0	.0	.0	.0	.0	.0	.0	.0	.0
	CV:	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
6	MN:	.00	.0	.0	.0	.0	.0	.0	.0	.0	.0
	CV:	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00

MODEL COEFFICIENTS:

COEFFICIENT	MEAN	CV
DISPERSION FACTO	1.000	.70
P DECAY RATE	1.000	.45
N DECAY RATE	1.000	.55
CHL-A MODEL	.830	.26
SECCHI MODEL	1.000	.10
ORGANIC N MODEL	.830	.12
TP-OP MODEL	1.000	.15
HODV MODEL	1.000	.15
MODV MODEL	1.000	.22
BETA M2/MG	.025	.00
MINIMUM QS	4.000	.00
FLUSHING EFFECT	1.000	.00
CHLOROPHYLL-A CV	.620	.00

```
CASE: Roberson Creek Cove 2001

T STATISTICS COMPARE OBSERVED AND PREDICTED MEANS
USING THE FOLLOWING ERROR TERMS:
 1 = OBSERVED WATER QUALITY ERROR ONLY
 2 = ERROR TYPICAL OF MODEL DEVELOPMENT DATA SET
 3 = OBSERVED AND PREDICTED ERROR

SEGMENT:  1 TP -70.7%
                      OBSERVED     ESTIMATED              T STATISTICS
VARIABLE            MEAN    CV    MEAN    CV   RATIO      1       2       3
-------------------------------------------------------------------------
TOTAL P    MG/M3      .0   .00    37.3   .07     .00    .00     .00     .00
TOTAL N    MG/M3      .0   .00  1304.5   .19     .00    .00     .00     .00
C.NUTRIENT MG/M3      .0   .00    34.8   .07     .00    .00     .00     .00
CHL-A      MG/M3      .0   .00    14.0   .27     .00    .00     .00     .00
-------------------------------------------------------------------------

SEGMENT:  2 TP -49.6%
                      OBSERVED     ESTIMATED              T STATISTICS
VARIABLE            MEAN    CV    MEAN    CV   RATIO      1       2       3
-------------------------------------------------------------------------
TOTAL P    MG/M3      .0   .00    58.0   .09     .00    .00     .00     .00
TOTAL N    MG/M3      .0   .00  1304.5   .19     .00    .00     .00     .00
C.NUTRIENT MG/M3      .0   .00    49.7   .10     .00    .00     .00     .00
CHL-A      MG/M3      .0   .00    21.9   .29     .00    .00     .00     .00
-------------------------------------------------------------------------

SEGMENT:  3 TP -87.5%
                      OBSERVED     ESTIMATED              T STATISTICS
VARIABLE            MEAN    CV    MEAN    CV   RATIO      1       2       3
-------------------------------------------------------------------------
TOTAL P    MG/M3      .0   .00    18.1   .05     .00    .00     .00     .00
TOTAL N    MG/M3      .0   .00  1304.5   .19     .00    .00     .00     .00
C.NUTRIENT MG/M3      .0   .00    17.8   .05     .00    .00     .00     .00
CHL-A      MG/M3      .0   .00     6.1   .27     .00    .00     .00     .00
-------------------------------------------------------------------------

SEGMENT:  4 TP -25%
                      OBSERVED     ESTIMATED              T STATISTICS
VARIABLE            MEAN    CV    MEAN    CV   RATIO      1       2       3
-------------------------------------------------------------------------
TOTAL P    MG/M3      .0   .00    79.0   .11     .00    .00     .00     .00
TOTAL N    MG/M3      .0   .00  1304.5   .19     .00    .00     .00     .00
C.NUTRIENT MG/M3      .0   .00    61.0   .12     .00    .00     .00     .00
CHL-A      MG/M3      .0   .00    28.3   .30     .00    .00     .00     .00
-------------------------------------------------------------------------

SEGMENT:  5 TP -39%
                      OBSERVED     ESTIMATED              T STATISTICS
VARIABLE            MEAN    CV    MEAN    CV   RATIO      1       2       3
-------------------------------------------------------------------------
TOTAL P    MG/M3      .0   .00    67.4   .10     .00    .00     .00     .00
TOTAL N    MG/M3      .0   .00  1304.5   .19     .00    .00     .00     .00
C.NUTRIENT MG/M3      .0   .00    55.2   .11     .00    .00     .00     .00
CHL-A      MG/M3      .0   .00    25.0   .29     .00    .00     .00     .00
```

SEGMENT: 6 2001 Condition

VARIABLE		OBSERVED MEAN	OBSERVED CV	ESTIMATED MEAN	ESTIMATED CV	RATIO	T STATISTICS 1	T STATISTICS 2	T STATISTICS 3
TOTAL P	MG/M3	.0	.00	97.9	.12	.00	.00	.00	.00
TOTAL N	MG/M3	.0	.00	1304.5	.19	.00	.00	.00	.00
C.NUTRIENT	MG/M3	.0	.00	68.6	.13	.00	.00	.00	.00
CHL-A	MG/M3	.0	.00	32.8	.31	.00	.00	.00	.00

SEGMENT: 7 AREA-WTD MEAN

VARIABLE		OBSERVED MEAN	OBSERVED CV	ESTIMATED MEAN	ESTIMATED CV	RATIO	T STATISTICS 1	T STATISTICS 2	T STATISTICS 3
TOTAL P	MG/M3	.0	.00	59.6	.10	.00	.00	.00	.00
TOTAL N	MG/M3	.0	.00	1304.5	.18	.00	.00	.00	.00
C.NUTRIENT	MG/M3	.0	.00	47.9	.09	.00	.00	.00	.00
CHL-A	MG/M3	.0	.00	21.3	.29	.00	.00	.00	.00

CASE: Roberson Creek Cove 2001

OBSERVED AND PREDICTED DIAGNOSTIC VARIABLES
RANKED AGAINST CE MODEL DEVELOPMENT DATA SET

SEGMENT: 1 TP -70.7%

VARIABLE	VALUES OBSERVED	VALUES ESTIMATED	RANKS (%) OBSERVED	RANKS (%) ESTIMATED
TOTAL P MG/M3	.00	37.34	.0	39.1
TOTAL N MG/M3	.00	1304.50	.0	66.0
C.NUTRIENT MG/M3	.00	34.81	.0	48.7
CHL-A MG/M3	.00	14.03	.0	69.9
(N - 150) / P	.00	30.92	.0	81.0
CHL-A / TOTAL P	.00	.38	.0	84.7
FREQ(CHL-a>10) %	.00	59.36	.0	.0
FREQ(CHL-a>20) %	.00	18.90	.0	.0
FREQ(CHL-a>30) %	.00	6.23	.0	.0
FREQ(CHL-a>40) %	.00	2.28	.0	.0
FREQ(CHL-a>50) %	.00	.92	.0	.0
FREQ(CHL-a>60) %	.00	.40	.0	.0
CARLSON TSI-P	.00	56.35	.0	.0
CARLSON TSI-CHLA	.00	56.51	.0	.0

SEGMENT: 2 TP -49.6%

VARIABLE	VALUES OBSERVED	VALUES ESTIMATED	RANKS (%) OBSERVED	RANKS (%) ESTIMATED
TOTAL P MG/M3	.00	58.01	.0	58.4
TOTAL N MG/M3	.00	1304.48	.0	66.0
C.NUTRIENT MG/M3	.00	49.68	.0	66.0
CHL-A MG/M3	.00	21.89	.0	86.4
(N - 150) / P	.00	19.90	.0	59.2

CHL-A / TOTAL P	.00	.38	.0	84.9
FREQ(CHL-a>10) %	.00	83.00	.0	.0
FREQ(CHL-a>20) %	.00	43.48	.0	.0
FREQ(CHL-a>30) %	.00	20.66	.0	.0
FREQ(CHL-a>40) %	.00	9.99	.0	.0
FREQ(CHL-a>50) %	.00	5.03	.0	.0
FREQ(CHL-a>60) %	.00	2.64	.0	.0
CARLSON TSI-P	.00	62.70	.0	.0
CARLSON TSI-CHLA	.00	60.88	.0	.0

SEGMENT: 3 TP -87.5%

	----- VALUES -----		--- RANKS (%) ----	
VARIABLE	OBSERVED	ESTIMATED	OBSERVED	ESTIMATED
TOTAL P MG/M3	.00	18.13	.0	14.0
TOTAL N MG/M3	.00	1304.48	.0	66.0
C.NUTRIENT MG/M3	.00	17.82	.0	19.3
CHL-A MG/M3	.00	6.08	.0	28.6
(N - 150) / P	.00	63.66	.0	97.4
CHL-A / TOTAL P	.00	.34	.0	80.1
FREQ(CHL-a>10) %	.00	13.28	.0	.0
FREQ(CHL-a>20) %	.00	1.28	.0	.0
FREQ(CHL-a>30) %	.00	.20	.0	.0
FREQ(CHL-a>40) %	.00	.04	.0	.0
FREQ(CHL-a>50) %	.00	.01	.0	.0
FREQ(CHL-a>60) %	.00	.00	.0	.0
CARLSON TSI-P	.00	45.94	.0	.0
CARLSON TSI-CHLA	.00	48.30	.0	.0

SEGMENT: 4 TP -25%

	----- VALUES -----		--- RANKS (%) ----	
VARIABLE	OBSERVED	ESTIMATED	OBSERVED	ESTIMATED
TOTAL P MG/M3	.00	78.98	.0	71.1
TOTAL N MG/M3	.00	1304.48	.0	66.0
C.NUTRIENT MG/M3	.00	61.05	.0	74.9
CHL-A MG/M3	.00	28.33	.0	92.4
(N - 150) / P	.00	14.62	.0	41.2
CHL-A / TOTAL P	.00	.36	.0	82.9
FREQ(CHL-a>10) %	.00	91.46	.0	.0
FREQ(CHL-a>20) %	.00	59.93	.0	.0
FREQ(CHL-a>30) %	.00	34.36	.0	.0
FREQ(CHL-a>40) %	.00	19.30	.0	.0
FREQ(CHL-a>50) %	.00	11.00	.0	.0
FREQ(CHL-a>60) %	.00	6.42	.0	.0
CARLSON TSI-P	.00	67.15	.0	.0
CARLSON TSI-CHLA	.00	63.40	.0	.0

SEGMENT: 5 TP -39%

	----- VALUES -----		--- RANKS (%) ----	
VARIABLE	OBSERVED	ESTIMATED	OBSERVED	ESTIMATED
TOTAL P MG/M3	.00	67.37	.0	64.8

TOTAL N MG/M3	.00	1304.48	.0	66.0
C.NUTRIENT MG/M3	.00	55.19	.0	70.7
CHL-A MG/M3	.00	24.97	.0	89.8
(N - 150) / P	.00	17.14	.0	50.5
CHL-A / TOTAL P	.00	.37	.0	84.2
FREQ(CHL-a>10) %	.00	87.82	.0	.0
FREQ(CHL-a>20) %	.00	51.92	.0	.0
FREQ(CHL-a>30) %	.00	27.22	.0	.0
FREQ(CHL-a>40) %	.00	14.23	.0	.0
FREQ(CHL-a>50) %	.00	7.63	.0	.0
FREQ(CHL-a>60) %	.00	4.23	.0	.0
CARLSON TSI-P	.00	64.86	.0	.0
CARLSON TSI-CHLA	.00	62.16	.0	.0

SEGMENT: 6 2001 Condition

	----- VALUES -----		--- RANKS (%) ----	
VARIABLE	OBSERVED	ESTIMATED	OBSERVED	ESTIMATED
TOTAL P MG/M3	.00	97.93	.0	78.7
TOTAL N MG/M3	.00	1304.48	.0	66.0
C.NUTRIENT MG/M3	.00	68.63	.0	79.3
CHL-A MG/M3	.00	32.79	.0	94.8
(N - 150) / P	.00	11.79	.0	29.5
CHL-A / TOTAL P	.00	.33	.0	80.0
FREQ(CHL-a>10) %	.00	94.58	.0	.0
FREQ(CHL-a>20) %	.00	68.71	.0	.0
FREQ(CHL-a>30) %	.00	43.38	.0	.0
FREQ(CHL-a>40) %	.00	26.41	.0	.0
FREQ(CHL-a>50) %	.00	16.09	.0	.0
FREQ(CHL-a>60) %	.00	9.95	.0	.0
CARLSON TSI-P	.00	70.26	.0	.0
CARLSON TSI-CHLA	.00	64.84	.0	.0

Appendix XI. Monthly average depth of irrigated water on the wastewater spray fields of Townsend Foods Inc.

Month	B1	B2	B3	B4	B5	R1	R2	R3	R4	R5
	(in)	(in)	(in)	(in)	(in)	(in)	(in)	(in)	(in)	(in)
Jan	0.83	0.00	0.00	0.00	0.00	0.80	0.67	0.86	0.82	0.82
Feb	0.59	0.59	0.56	0.32	0.55	0.62	0.64	0.73	0.62	0.49
Mar	0.50	0.49	0.47	0.59	0.56	0.52	0.77	0.77	0.53	0.90
Apr	1.36	1.29	1.35	1.14	1.12	1.50	1.60	1.84	1.59	1.76
May	1.02	1.10	1.22	1.07	1.11	0.79	0.76	0.85	0.78	0.73
Jun	1.47	1.36	1.44	1.64	1.72	1.24	1.31	1.41	1.19	1.50
Jul	1.43	1.40	1.45	1.16	1.05	1.47	1.70	1.75	1.87	1.68
Aug	1.08	1.10	1.02	1.16	1.30	1.19	1.18	1.14	1.18	1.36
Sep	1.65	1.64	2.05	1.39	1.55	1.62	1.72	1.66	1.59	1.85
Oct	0.90	0.98	0.79	0.99	0.95	0.82	0.66	0.94	0.86	0.85
Nov	0.78	0.89	0.87	0.94	0.93	1.00	1.09	1.22	0.90	1.08
Dec	0.51	0.62	0.42	0.43	0.61	0.72	0.42	0.72	0.75	0.67

Appendix XII. Daily average temperature and precipitation recorded in the Siler City Airport.

	SilerCity	SilerCity	SilerCity	SilerCity
Date-Time	AirTempMax C	AirTempMin C	DailyPrecip in	DailyPrecip mm
1/1/01 23:59	5.03	-7.80	0.00	0.00
1/2/01 23:59	3.42	-7.26	0.00	0.00
1/3/01 23:59	4.15	-13.62	0.00	0.00
1/4/01 23:59	6.92	-11.80	0.00	0.00
1/5/01 23:59	10.98	-9.02	0.00	0.00
1/6/01 23:59	10.03	-5.64	0.00	0.00
1/7/01 23:59	13.61	-4.22	0.00	0.00
1/8/01 23:59	7.54	0.98	0.11	2.79
1/9/01 23:59	4.22	-3.54	0.00	0.00
1/10/01 23:59	12.73	-6.38	0.00	0.00
1/11/01 23:59	16.64	-5.84	0.00	0.00
1/12/01 23:59	8.55	1.72	0.19	4.83
1/13/01 23:59	12.93	0.11	0.00	0.00
1/14/01 23:59	9.63	4.83	0.00	0.00
1/15/01 23:59	17.79	3.01	0.04	1.02
1/16/01 23:59	14.56	0.85	0.00	0.00
1/17/01 23:59	9.76	-2.20	0.00	0.00
1/18/01 23:59	6.72	4.22	0.06	1.52
1/19/01 23:59	21.50	5.64	0.31	7.87
1/20/01 23:59	16.30	-0.30	0.31	7.87
1/21/01 23:59	6.65	-6.18	0.00	0.00
1/22/01 23:59	8.41	-6.99	0.00	0.00
1/23/01 23:59	10.64	-4.83	0.00	0.00
1/24/01 23:59	13.95	-3.41	0.00	0.00
1/25/01 23:59	5.98	-2.66	0.00	0.00
1/26/01 23:59	8.61	-8.95	0.00	0.00
1/27/01 23:59	15.16	-0.98	0.00	0.00
1/28/01 23:59	13.13	-6.25	0.00	0.00
1/29/01 23:59	16.71	-2.66	0.00	0.00
1/30/01 23:59	18.67	10.84	0.30	7.62
1/31/01 23:59	19.54	7.40	0.00	0.00
2/1/01 23:59	10.37	1.25	0.00	0.00
2/2/01 23:59	11.99	0.45	0.00	0.00
2/3/01 23:59	8.81	-4.69	0.00	0.00
2/4/01 23:59	6.86	-2.32	0.04	1.02
2/5/01 23:59	14.35	-1.78	0.01	0.25
2/6/01 23:59	14.62	-5.43	0.00	0.00
2/7/01 23:59	20.88	-3.07	0.00	0.00
2/8/01 23:59	20.62	-0.37	0.00	0.00
2/9/01 23:59	21.70	6.80	0.00	0.00
2/10/01 23:59	17.79	2.34	0.10	2.54
2/11/01 23:59	10.03	-0.70	0.00	0.00
2/12/01 23:59	4.36	-1.11	0.14	3.56
2/13/01 23:59	13.87	0.31	0.14	3.56

2/14/01 23:59	15.29	8.75	0.07	1.78
2/15/01 23:59	21.16	15.08	0.00	0.00
2/16/01 23:59	24.47	11.23	0.34	8.64
2/17/01 23:59	11.78	-0.10	0.56	14.22
2/18/01 23:59	6.12	-4.96	0.00	0.00
2/19/01 23:59	12.73	-5.30	0.00	0.00
2/20/01 23:59	20.41	0.72	0.00	0.00
2/21/01 23:59	17.52	5.03	0.00	0.00
2/22/01 23:59	7.74	-3.95	0.00	0.00
2/23/01 23:59	11.38	-6.98	0.25	6.35
2/24/01 23:59	15.57	-2.19	0.00	0.00
2/25/01 23:59	19.61	8.68	0.17	4.32
2/26/01 23:59	20.82	6.25	0.00	0.00
2/27/01 23:59	18.20	-0.50	0.00	0.00
2/28/01 23:59	13.67	6.04	0.00	0.00
3/1/01 23:59	16.10	0.64	0.00	0.00
3/2/01 23:59	22.23	2.14	0.00	0.00
3/3/01 23:59	12.06	8.14	0.42	10.67
3/4/01 23:59	9.29	7.74	0.62	15.75
3/5/01 23:59	11.79	0.71	0.11	2.79
3/6/01 23:59	4.49	-2.66	0.00	0.00
3/7/01 23:59	8.82	-1.85	0.00	0.00
3/8/01 23:59	14.48	-5.70	0.00	0.00
3/9/01 23:59	14.68	-0.30	0.00	0.00
3/10/01 23:59	13.00	-6.85	0.00	0.00
3/11/01 23:59	18.87	-2.05	0.00	0.00
3/12/01 23:59	19.61	2.54	0.10	2.54
3/13/01 23:59	23.31	13.14	0.00	0.00
3/14/01 23:59	20.88	5.72	0.00	0.00
3/15/01 23:59	12.01	7.19	0.46	11.68
3/16/01 23:59	10.64	5.70	0.00	0.00
3/17/01 23:59	17.65	3.61	0.01	0.25
3/18/01 23:59	13.67	0.44	0.00	0.00
3/19/01 23:59	13.74	-1.37	0.00	0.00
3/20/01 23:59	7.60	3.62	1.01	25.65
3/21/01 23:59	10.17	6.79	0.18	4.57
3/22/01 23:59	17.59	4.09	0.01	0.25
3/23/01 23:59	19.53	-2.33	0.00	0.00
3/24/01 23:59	23.38	-0.51	0.00	0.00
3/25/01 23:59	13.53	3.41	0.00	0.00
3/26/01 23:59	9.82	-0.57	0.00	0.00
3/27/01 23:59	9.28	-4.35	0.00	0.00
3/28/01 23:59	13.60	-6.25	0.00	0.00
3/29/01 23:59	8.69	3.34	1.80	45.72
3/30/01 23:59	21.02	5.84	0.21	5.33
3/31/01 23:59	20.62	5.78	0.49	12.45
4/1/01 23:59	14.08	4.30	0.17	4.32
4/2/01 23:59	17.58	-0.44	0.00	0.00
4/3/01 23:59	15.77	7.33	0.11	2.79

4/4/01 23:59	13.34	3.22	0.00	0.00
4/5/01 23:59	19.46	0.44	0.00	0.00
4/6/01 23:59	26.00	6.92	0.00	0.00
4/7/01 23:59	30.99	14.89	0.00	0.00
4/8/01 23:59	32.07	18.06	0.00	0.00
4/9/01 23:59	32.95	14.75	0.00	0.00
4/10/01 23:59	33.01	13.88	0.00	0.00
4/11/01 23:59	27.61	16.17	0.00	0.00
4/12/01 23:59	30.24	17.72	0.00	0.00
4/13/01 23:59	25.80	12.60	0.02	0.51
4/14/01 23:59	25.94	8.28	0.00	0.00
4/15/01 23:59	23.65	9.16	0.01	0.25
4/16/01 23:59	20.68	6.92	0.00	0.00
4/17/01 23:59	12.35	1.53	0.04	1.02
4/18/01 23:59	12.73	-2.59	0.00	0.00
4/19/01 23:59	18.32	-3.47	0.00	0.00
4/20/01 23:59	22.37	1.73	0.00	0.00
4/21/01 23:59	26.07	11.39	0.00	0.00
4/22/01 23:59	27.75	10.37	0.00	0.00
4/23/01 23:59	28.16	11.38	0.00	0.00
4/24/01 23:59	29.50	13.88	0.00	0.00
4/25/01 23:59	14.21	2.34	0.63	16.00
4/26/01 23:59	19.54	1.53	0.01	0.25
4/27/01 23:59	26.00	0.92	0.00	0.00
4/28/01 23:59	27.62	7.07	0.00	0.00
4/29/01 23:59	20.00	9.97	0.00	0.00
4/30/01 23:59	25.66	3.62	0.00	0.00
5/1/01 23:59	27.14	9.77	0.00	0.00
5/2/01 23:59	27.82	10.51	0.00	0.00
5/3/01 23:59	29.09	9.70	0.00	0.00
5/4/01 23:59	30.38	9.50	0.00	0.00
5/5/01 23:59	31.60	11.99	0.00	0.00
5/6/01 23:59	21.35	12.59	0.00	0.00
5/7/01 23:59	22.43	8.48	0.00	0.00
5/8/01 23:59	24.60	7.54	0.00	0.00
5/9/01 23:59	27.08	10.24	0.00	0.00
5/10/01 23:59	27.88	10.64	0.00	0.00
5/11/01 23:59	30.85	12.33	0.00	0.00
5/12/01 23:59	30.17	13.61	0.06	1.52
5/13/01 23:59	23.65	7.53	0.01	0.25
5/14/01 23:59	24.59	3.70	0.00	0.00
5/15/01 23:59	24.05	8.41	0.14	3.56
5/16/01 23:59	18.60	12.19	0.24	6.10
5/17/01 23:59	14.75	11.78	0.05	1.27
5/18/01 23:59	30.38	13.47	0.00	0.00
5/19/01 23:59	33.14	14.35	0.01	0.25
5/20/01 23:59	27.87	17.25	0.00	0.00
5/21/01 23:59	27.42	18.60	0.00	0.00
5/22/01 23:59	30.45	17.11	0.32	8.13

5/23/01 23:59	25.93	9.97	0.01	0.25
5/24/01 23:59	29.51	7.13	0.00	0.00
5/25/01 23:59	27.83	16.65	0.02	0.51
5/26/01 23:59	25.20	11.38	0.32	8.13
5/27/01 23:59	28.56	8.01	0.00	0.00
5/28/01 23:59	21.36	11.32	0.30	7.62
5/29/01 23:59	26.54	12.53	0.08	2.03
5/30/01 23:59	28.36	10.04	0.00	0.00
	-99.00	-99.00	-99.00	-99.00
	-99.00	-99.00	-99.00	-99.00
	-99.00	-99.00	-99.00	-99.00
	-99.00	-99.00	-99.00	-99.00
	-99.00	-99.00	-99.00	-99.00
	-99.00	-99.00	-99.00	-99.00
	-99.00	-99.00	-99.00	-99.00
	-99.00	-99.00	-99.00	-99.00
	-99.00	-99.00	-99.00	-99.00
	-99.00	-99.00	-99.00	-99.00
	-99.00	-99.00	-99.00	-99.00
	-99.00	-99.00	-99.00	-99.00
	-99.00	-99.00	-99.00	-99.00
	-99.00	-99.00	-99.00	-99.00
6/14/01 23:59	29.11	20.75	0.37	9.40
6/15/01 23:59	31.26	19.61	0.00	0.00
6/16/01 23:59	32.68	17.79	0.06	1.52
6/17/01 23:59	32.74	17.26	0.00	0.00
6/18/01 23:59	31.12	13.61	0.00	0.00
6/19/01 23:59	31.05	16.85	0.00	0.00
6/20/01 23:59	32.00	15.84	0.00	0.00
6/21/01 23:59	32.81	18.74	0.00	0.00
6/22/01 23:59	32.48	18.40	2.07	52.58
6/23/01 23:59	28.22	18.81	0.08	2.03
6/24/01 23:59	27.76	18.47	0.00	0.00
6/25/01 23:59	27.29	18.46	0.18	4.57
6/26/01 23:59	30.72	19.34	0.00	0.00
6/27/01 23:59	32.61	17.73	0.00	0.00
6/28/01 23:59	32.81	18.20	0.00	0.00
6/29/01 23:59	32.48	17.72	0.00	0.00
6/30/01 23:59	32.27	18.88	0.00	0.00
7/1/01 23:59	31.46	20.15	0.10	2.54
7/2/01 23:59	28.82	18.47	0.02	0.51
7/3/01 23:59	28.30	18.54	0.00	0.00
7/4/01 23:59	31.60	19.61	2.46	62.48
7/5/01 23:59	30.31	19.47	0.00	0.00
7/6/01 23:59	28.90	15.97	0.00	0.00
7/7/01 23:59	29.36	14.35	0.00	0.00
7/8/01 23:59	27.36	19.21	0.30	7.62
7/9/01 23:59	32.00	19.47	0.00	0.00
7/10/01 23:59	33.68	19.61	0.00	0.00

7/11/01 23:59	33.48	19.68	0.60	15.24
7/12/01 23:59	30.85	18.20	0.00	0.00
7/13/01 23:59	25.93	15.16	0.00	0.00
7/14/01 23:59	29.10	12.26	0.00	0.00
7/15/01 23:59	30.51	11.93	0.00	0.00
7/16/01 23:59	31.66	13.27	0.00	0.00
7/17/01 23:59	31.32	16.38	0.00	0.00
7/18/01 23:59	31.26	19.35	0.11	2.79
7/19/01 23:59	29.23	20.08	0.01	0.25
7/20/01 23:59	28.10	16.04	0.00	0.00
7/21/01 23:59	28.96	13.75	0.00	0.00
7/22/01 23:59	30.11	13.28	0.00	0.00
7/23/01 23:59	31.66	17.59	0.00	0.00
7/24/01 23:59	29.65	22.84	0.63	16.00
7/25/01 23:59	31.05	20.76	0.12	3.05
7/26/01 23:59	29.52	20.69	0.25	6.35
7/27/01 23:59	25.01	19.47	0.37	9.40
7/28/01 23:59	23.04	17.99	0.00	0.00
7/29/01 23:59	26.15	17.93	0.03	0.76
7/30/01 23:59	25.94	16.58	0.10	2.54
7/31/01 23:59	29.03	14.89	0.00	0.00
8/1/01 23:59	26.54	15.16	0.00	0.00
8/2/01 23:59	29.10	12.47	0.00	0.00
8/3/01 23:59	31.19	13.08	0.00	0.00
8/4/01 23:59	31.19	18.94	0.00	0.00
8/5/01 23:59	32.14	15.97	0.00	0.00
8/6/01 23:59	33.29	16.85	0.00	0.00
8/7/01 23:59	35.77	21.23	0.00	0.00
8/8/01 23:59	36.04	22.04	0.00	0.00
8/9/01 23:59	37.25	19.75	0.20	5.08
8/10/01 23:59	35.44	20.76	0.03	0.76
8/11/01 23:59	34.57	20.83	0.73	18.54
8/12/01 23:59	33.08	20.83	0.00	0.00
8/13/01 23:59	29.52	22.18	0.04	1.02
8/14/01 23:59	30.92	19.28	0.00	0.00
8/15/01 23:59	31.60	18.27	0.00	0.00
8/16/01 23:59	32.00	17.46	0.00	0.00
8/17/01 23:59	32.95	23.99	0.02	0.51
8/18/01 23:59	29.32	20.29	1.09	27.69
8/19/01 23:59	30.24	21.36	0.02	0.51
8/20/01 23:59	31.48	20.42	0.00	0.00
8/21/01 23:59	29.85	15.17	0.00	0.00
8/22/01 23:59	31.05	13.41	0.00	0.00
8/23/01 23:59	32.34	14.29	0.47	11.94
8/24/01 23:59	28.37	18.13	0.88	22.35
8/25/01 23:59	29.85	15.44	0.00	0.00
8/26/01 23:59	30.38	14.29	0.00	0.00
8/27/01 23:59	33.35	18.20	0.34	8.64
8/28/01 23:59	31.66	18.27	0.01	0.25

8/29/01 23:59	32.75	21.50	0.00	0.00
8/30/01 23:59	29.33	20.02	0.53	13.46
8/31/01 23:59	30.05	21.24	0.12	3.05
9/1/01 23:59	25.14	20.15	0.10	2.54
9/2/01 23:59	27.56	18.81	0.00	0.00
9/3/01 23:59	23.59	19.35	0.00	0.00
9/4/01 23:59	25.14	17.67	0.19	4.83
9/5/01 23:59	30.12	16.31	0.00	0.00
9/6/01 23:59	29.11	15.84	0.00	0.00
9/7/01 23:59	28.98	13.41	0.00	0.00
9/8/01 23:59	29.71	12.94	0.00	0.00
9/9/01 23:59	29.99	14.76	0.00	0.00
9/10/01 23:59	31.05	21.23	0.01	0.25
9/11/01 23:59	28.03	13.62	0.00	0.00
9/12/01 23:59	28.71	10.79	0.00	0.00
9/13/01 23:59	27.63	10.72	0.00	0.00
9/14/01 23:59	26.36	10.85	0.00	0.00
9/15/01 23:59	22.11	9.91	0.00	0.00
9/16/01 23:59	24.33	7.61	0.00	0.00
9/17/01 23:59	26.56	4.51	0.00	0.00
9/18/01 23:59	28.78	6.94	0.00	0.00
9/19/01 23:59	28.78	9.50	0.00	0.00
9/20/01 23:59	27.44	16.78	0.39	9.91
9/21/01 23:59	29.25	14.90	0.01	0.25
9/22/01 23:59	30.80	13.28	0.00	0.00
9/23/01 23:59	31.60	16.45	0.00	0.00
9/24/01 23:59	23.73	18.40	1.07	27.18
9/25/01 23:59	20.96	6.73	0.01	0.25
9/26/01 23:59	20.96	2.68	0.00	0.00
9/27/01 23:59	25.08	4.31	0.00	0.00
9/28/01 23:59	21.64	6.87	0.00	0.00
9/29/01 23:59	20.69	5.04	0.00	0.00
9/30/01 23:59	19.61	3.49	0.00	0.00
10/1/01 23:59	23.46	0.25	0.00	0.00
10/2/01 23:59	26.95	4.17	0.00	0.00
10/3/01 23:59	28.98	7.07	0.00	0.00
10/4/01 23:59	28.98	8.08	0.00	0.00
10/5/01 23:59	28.57	9.57	0.00	0.00
10/6/01 23:59	20.90	4.03	0.33	8.38
10/7/01 23:59	18.67	-0.22	0.00	0.00
10/8/01 23:59	17.05	-0.29	0.00	0.00
10/9/01 23:59	18.40	-1.57	0.00	0.00
10/10/01 23:59	24.60	2.41	0.00	0.00
10/11/01 23:59	26.08	7.54	0.00	0.00
10/12/01 23:59	25.21	8.48	0.00	0.00
10/13/01 23:59	26.81	8.82	0.00	0.00
10/14/01 23:59	24.20	14.29	0.84	21.34
10/15/01 23:59	22.91	6.13	0.00	0.00
10/16/01 23:59	24.60	3.90	0.00	0.00

10/17/01 23:59	17.73	-0.36	0.00	0.00
10/18/01 23:59	17.86	-1.91	0.00	0.00
10/19/01 23:59	23.18	-1.84	0.00	0.00
10/20/01 23:59	25.67	4.57	0.00	0.00
10/21/01 23:59	27.90	4.78	0.00	0.00
10/22/01 23:59	29.45	11.18	0.00	0.00
10/23/01 23:59	29.66	10.18	0.00	0.00
10/24/01 23:59	30.46	12.74	0.00	0.00
10/25/01 23:59	25.68	6.73	0.12	3.05
10/26/01 23:59	18.61	1.53	0.00	0.00
10/27/01 23:59	10.31	-3.13	0.00	0.00
10/28/01 23:59	13.20	-2.93	0.00	0.00
10/29/01 23:59	18.20	-5.09	0.00	0.00
10/30/01 23:59	23.59	-2.66	0.00	0.00
10/31/01 23:59	22.23	0.64	0.00	0.00
11/1/01 23:59	25.28	2.75	0.00	0.00
11/2/01 23:59	26.50	13.01	0.00	0.00
11/3/01 23:59	28.64	10.71	0.00	0.00
11/4/01 23:59	21.76	1.94	0.00	0.00
11/5/01 23:59	18.81	0.12	0.00	0.00
	-99.00	-99.00	-99.00	-99.00
11/7/01 23:59	24.67	-2.72	0.00	0.00
11/8/01 23:59	25.96	-1.30	0.00	0.00
11/9/01 23:59	20.69	-1.10	0.00	0.00
	-99.00	-99.00	-99.00	-99.00
	-99.00	-99.00	-99.00	-99.00
11/12/01 23:59	15.63	-2.66	0.00	0.00
11/13/01 23:59	16.51	-4.69	0.00	0.00
11/14/01 23:59	20.43	-1.44	0.00	0.00
11/15/01 23:59	21.71	1.13	0.00	0.00
11/16/01 23:59	24.74	-0.22	0.00	0.00
11/17/01 23:59	22.43	4.17	0.00	0.00
11/18/01 23:59	19.47	0.92	0.00	0.00
11/19/01 23:59	21.78	3.16	0.00	0.00
11/20/01 23:59	15.03	2.15	0.00	0.00
11/21/01 23:59	12.94	-4.82	0.00	0.00
11/22/01 23:59	18.07	-5.90	0.00	0.00
11/23/01 23:59	19.62	-2.93	0.01	0.25
11/24/01 23:59	20.83	10.64	0.35	8.89
11/25/01 23:59	22.86	17.06	0.01	0.25
11/26/01 23:59	24.06	9.30	0.00	0.00
11/27/01 23:59	25.62	8.35	0.00	0.00
11/28/01 23:59	26.69	10.38	0.00	0.00
11/29/01 23:59	24.33	11.40	0.01	0.25
11/30/01 23:59	20.56	14.35	0.00	0.00
12/1/01 23:59	22.31	4.98	0.01	0.25
12/2/01 23:59	17.53	3.16	0.00	0.00
12/3/01 23:59	17.19	-1.98	0.00	0.00
12/4/01 23:59	23.33	-3.40	0.00	0.00

12/5/01 23:59	25.48	-1.03	0.00	0.00
12/6/01 23:59	24.33	4.24	0.00	0.00
12/7/01 23:59	24.94	8.62	0.00	0.00
12/8/01 23:59	23.72	9.09	0.00	0.00
12/9/01 23:59	16.38	7.06	0.00	0.00
12/10/01 23:59	7.35	5.18	1.05	26.67
12/11/01 23:59	9.43	4.77	0.39	9.91
12/12/01 23:59	11.12	8.62	0.01	0.25
12/13/01 23:59	14.15	9.91	0.04	1.02
12/14/01 23:59	20.90	12.94	0.01	0.25
12/15/01 23:59	16.78	0.66	0.00	0.00
12/16/01 23:59	14.90	-1.64	0.00	0.00
12/17/01 23:59	20.83	2.14	0.43	10.92
12/18/01 23:59	17.46	-0.90	0.01	0.25
12/19/01 23:59	17.67	-2.99	0.00	0.00
12/20/01 23:59	10.38	-4.28	0.00	0.00
12/21/01 23:59	11.99	-6.10	0.00	0.00
12/22/01 23:59	11.52	-7.66	0.00	0.00
12/23/01 23:59	15.98	-3.60	0.03	0.76
12/24/01 23:59	14.69	-3.06	0.10	2.54
12/25/01 23:59	8.14	-6.92	0.00	0.00
12/26/01 23:59	8.28	-5.90	0.00	0.00
12/27/01 23:59	7.20	-8.74	0.00	0.00
12/28/01 23:59	13.08	-6.85	0.00	0.00
12/29/01 23:59	16.25	-1.24	0.00	0.00
12/30/01 23:59	6.93	-5.22	0.00	0.00
12/31/01 23:59	5.11	-6.44	0.00	0.00

Appendix XIII. Daily average flow and concentration of total Phosphorus discharged from the Pittsboro WWTP to Roberson Creek during 2001.

Date	Flow	P	Date	Flow	P	Date	Flow	P
	mgd	mg/l		mgd	mg/l		mgd	mg/l
2001/01/01	0.239	1.4	2001/05/01	0.496	3.57	2001/09/01	0.6	
2001/01/02	0.247		2001/05/02	0.335		2001/09/02	0.482	
2001/01/03	0.223		2001/05/03	0.281		2001/09/03	0.231	0.59
2001/01/04	0.279		2001/05/04	0.277		2001/09/04	0.223	
2001/01/05	0.227	1.4	2001/05/05	0.268		2001/09/05	0.257	0.59
2001/01/06	0.218		2001/05/06	0.294		2001/09/06	0.268	
2001/01/07	0.244		2001/05/07	0.473		2001/09/07	0.271	
2001/01/08	0.259		2001/05/08	0.469		2001/09/08	0.224	
2001/01/09	0.249		2001/05/09	0.469	2.71	2001/09/09	0.232	
2001/01/10	0.257	2.05	2001/05/10	0.436		2001/09/10	0.265	0.8
2001/01/11	0.254		2001/05/11	0.447		2001/09/11	0.213	
2001/01/12	0.257		2001/05/12	0.448		2001/09/12	0.229	
2001/01/13	0.251		2001/05/13	0.436		2001/09/13	0.194	
2001/01/14	0.254		2001/05/14	0.47		2001/09/14	0.267	
2001/01/15	0.246	2.54	2001/05/15	0.6		2001/09/15	0.144	
2001/01/16	0.254		2001/05/16	0.609	2.96	2001/09/16	0.137	
2001/01/17	0.261		2001/05/17	0.526		2001/09/17	0.145	
2001/01/18	0.28	2.54	2001/05/18	0.517		2001/09/18	0.245	
2001/01/19	0.41		2001/05/19	0.49		2001/09/19	0.214	1.28
2001/01/20	0.375		2001/05/20	0.503		2001/09/20	0.215	
2001/01/21	0.282		2001/05/21	0.535		2001/09/21	0.209	
2001/01/22	0.306	1.73	2001/05/22	0.563		2001/09/22	0.133	
2001/01/23	0.293		2001/05/23	0.467	3.31	2001/09/23	0.168	
2001/01/24	0.281		2001/05/24	0.54		2001/09/24	0.389	0.89
2001/01/25	0.256		2001/05/25	0.51		2001/09/25	0.23	
2001/01/26	0.239		2001/05/26	0.473		2001/09/26	0.161	
2001/01/27	0.241		2001/05/27	0.452		2001/09/27	0.16	
2001/01/28	0.244		2001/05/28	0.527	1.06	2001/09/28	0.146	
2001/01/29	0.29		2001/05/29	0.529		2001/09/29	0.158	
2001/01/30	0.313		2001/05/30	0.496		2001/09/30	0.172	
2001/01/31	0.261	1.43	2001/05/31	0.486	1.06	2001/10/01	0.216	
2001/02/01	0.269		2001/06/01	0.949		2001/10/02	0.156	1.42
2001/02/02	0.258		2001/06/02	0.713		2001/10/03	0.22	
2001/02/03	0.229		2001/06/03	0.399		2001/10/04	0.144	
2001/02/04	0.288		2001/06/04	0.386		2001/10/05	0.182	
2001/02/05	0.271		2001/06/05	0.35		2001/10/06	0.166	
2001/02/06	0.284		2001/06/06	0.472		2001/10/07	0.206	
2001/02/07	0.255	2.2	2001/06/07	0.316	0.72	2001/10/08	0.171	
2001/02/08	0.255		2001/06/08	0.327	0.69	2001/10/09	0.164	1.12
2001/02/09	0.255		2001/06/09	0.289		2001/10/10	0.186	
2001/02/10	0.249		2001/06/10	0.299		2001/10/11	0.128	
2001/02/11	0.276		2001/06/11	0.293		2001/10/12	0.308	

2001/02/12	0.432		2001/06/12	0.331	0.58	2001/10/13	0.227	
2001/02/13	0.371		2001/06/13	0.55	0.8	2001/10/14	0.191	
2001/02/14	0.34		2001/06/14	0.569		2001/10/15	0.18	
2001/02/15	0.38	1.99	2001/06/15	0.387		2001/10/16	0.195	
2001/02/16	0.674		2001/06/16	0.378		2001/10/17	0.199	0.7
2001/02/17	0.571		2001/06/17	0.34		2001/10/18	0.212	
2001/02/18	0.44		2001/06/18	0.339		2001/10/19	0.194	
2001/02/19	0.458		2001/06/19	0.273		2001/10/20	0.171	
2001/02/20	0.425		2001/06/20	0.357	1.79	2001/10/21	0.156	
2001/02/21	0.391		2001/06/21	0.323		2001/10/22	0.171	
2001/02/22	0.446	1.97	2001/06/22	0.87		2001/10/23	0.221	
2001/02/23	0.443		2001/06/23	0.485		2001/10/24	0.243	1.93
2001/02/24	0.406		2001/06/24	0.572		2001/10/25	0.234	
2001/02/25	0.439		2001/06/25	0.557		2001/10/26	0.216	
2001/02/26	0.427		2001/06/26	0.473		2001/10/27	0.16	
2001/02/27	0.413		2001/06/27	0.425		2001/10/28	0.12	
2001/02/28	0.423	1.63	2001/06/28	0.402	1.19	2001/10/29	0.185	
2001/03/01	0.401		2001/06/29	0.388		2001/10/30	0.191	1.12
2001/03/02	0.417		2001/06/30	0.364		2001/10/31	0.214	
2001/03/03	0.972		2001/07/01	0.398		2001/11/01	0.2	
2001/03/04	0.718		2001/07/02	0.354		2001/11/02	0.2	
2001/03/05	0.619		2001/07/03	0.33		2001/11/03	0.188	
2001/03/06	0.538	1.34	2001/07/04	1.366		2001/11/04	0.16	
2001/03/07	0.479		2001/07/05	0.7		2001/11/05	0.171	
2001/03/08	0.452		2001/07/06	0.494	0.84	2001/11/06	0.387	1.52
2001/03/09	0.438		2001/07/07	0.429		2001/11/07	0.182	
2001/03/10	0.415		2001/07/08	0.481		2001/11/08	0.189	
2001/03/11	0.416		2001/07/09	0.579	0.81	2001/11/09	0.192	
2001/03/12	0.451	1.62	2001/07/10	0.462		2001/11/10	0.16	
2001/03/13	0.433		2001/07/11	0.409		2001/11/11	0.167	
2001/03/14	0.45		2001/07/12	0.389		2001/11/12	0.187	
2001/03/15	0.587		2001/07/13	0.35		2001/11/13	0.187	1.01
2001/03/16	0.497		2001/07/14	0.327		2001/11/14	0.256	
2001/03/17	0.443		2001/07/15	0.322		2001/11/15	0.251	
2001/03/18	0.443		2001/07/16	0.311	5.77	2001/11/16	0.233	
2001/03/19	0.332		2001/07/17	0.313		2001/11/17	0.232	
2001/03/20	1.136		2001/07/18	0.304		2001/11/18	0.249	
2001/03/21	0.92		2001/07/19	0.303		2001/11/19	0.268	
2001/03/22	0.672		2001/07/20	0.273		2001/11/20	0.262	0.87
2001/03/23	0.593	2.33	2001/07/21	0.254		2001/11/21	0.248	
2001/03/24	0.517		2001/07/22	0.267		2001/11/22	0.212	
2001/03/25	0.519		2001/07/23	0.319	2.04	2001/11/23	0.241	
2001/03/26	0.499	2.74	2001/07/24	0.383		2001/11/24	0.234	
2001/03/27	0.465		2001/07/25	0.485		2001/11/25	0.251	
2001/03/28	0.571		2001/07/26	0.32		2001/11/26	0.267	
2001/03/29	1.82		2001/07/27	0.502		2001/11/27	0.267	0.69
2001/03/30	1.062		2001/07/28	0.34		2001/11/28	0.256	
2001/03/31	1.084		2001/07/29	0.327		2001/11/29	0.266	
2001/04/01	1.312		2001/07/30	0.325	1.76	2001/11/30	0.255	

2001/04/02	0.834		2001/07/31	0.316		2001/12/01	0.242	
2001/04/03	0.713		2001/08/01	0.3		2001/12/02	0.254	
2001/04/04	0.622		2001/08/02	0.297		2001/12/03	0.297	
2001/04/05	0.628		2001/08/03	0.291		2001/12/04	0.3	1.09
2001/04/06	0.629	2.18	2001/08/04	0.271		2001/12/05	0.313	
2001/04/07	0.617		2001/08/05	0.281		2001/12/06	0.311	
2001/04/08	0.623		2001/08/06	0.302		2001/12/07	0.289	
2001/04/09	0.609		2001/08/07	0.298	2.41	2001/12/08	0.287	
2001/04/10	0.586		2001/08/08	0.296		2001/12/09	0.276	
2001/04/11	0.599	3.4	2001/08/09	0.244		2001/12/10	0.29	
2001/04/12	0.6		2001/08/10	0.245		2001/12/11	0.359	
2001/04/13	0.5		2001/08/11	0.926		2001/12/12	0.385	
2001/04/14	0.488		2001/08/12	1.235		2001/12/13	0.354	
2001/04/15	0.458		2001/08/13	0.588		2001/12/14	0.352	
2001/04/16	0.454	3.71	2001/08/14	0.327		2001/12/15	0.356	
2001/04/17	0.314		2001/08/15	0.255		2001/12/16	0.319	
2001/04/18	0.471		2001/08/16	0.254	1.24	2001/12/17	0.327	
2001/04/19	0.473		2001/08/17	0.23		2001/12/18	0.405	1.63
2001/04/20	0.461	3.71	2001/08/18	0.222		2001/12/19	0.399	
2001/04/21	0.477		2001/08/19	0.233		2001/12/20	0.348	
2001/04/22	0.494		2001/08/20	0.215		2001/12/21	0.352	
2001/04/23	0.509		2001/08/21	0.199	1.73	2001/12/22	0.34	
2001/04/24	0.547		2001/08/22	0.2		2001/12/23	0.319	
2001/04/25	0.514		2001/08/23	0.206		2001/12/24	0.477	1.63
2001/04/26	0.493	2.77	2001/08/24	0.21		2001/12/25	0.312	1.63
2001/04/27	0.47		2001/08/25	0.209		2001/12/26	0.341	2.47
2001/04/28	0.49		2001/08/26	0.214		2001/12/27	0.36	2.47
2001/04/29	0.4		2001/08/27	0.238		2001/12/28	0.345	
2001/04/30	0.449		2001/08/28	0.278	1.08	2001/12/29	0.323	
			2001/08/29	0.255		2001/12/30	0.342	
			2001/08/30	0.232		2001/12/31	0.317	
			2001/08/31	0.901				