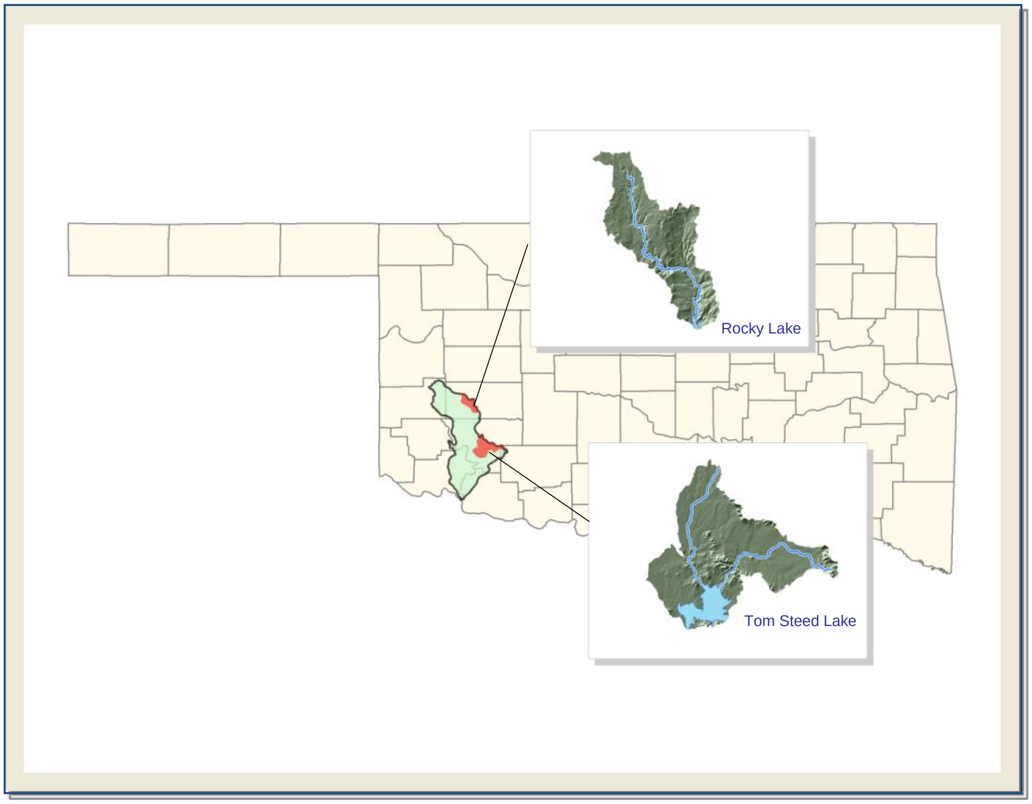
FINAL

CHLOROPHYLL-*a* TOTAL MAXIMUM DAILY LOADS FOR ROCKY LAKE (OK311500030060_00) AND TOM STEED LAKE (OK311500020060_00)



Prepared for:

OKLAHOMA DEPARTMENT OF ENVIRONMENTAL QUALITY

Prepared by:

PARSONS

SEPTEMBER 2011

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ACRONYMS AND ABBREVIATIONS

BUMP	Beneficial Use Monitoring Program
CAFO	Concentrated Animal Feeding Operation
CFR	Code of Federal Regulations
CV	Coefficient of Variation
CWA	Clean Water Act
DMR	Discharge monitoring report
HUC	Hydrologic unit code
kg	Kilograms
LA	Load allocation
mg/L	Milligram per liter
MOS	Margin of safety
NPDES	National Pollutant Discharge Elimination System
NSE	Nash-Sutcliffe Efficiency
NLW	Nutrient limited watershed
NPS	Nonpoint source
O.S.	Oklahoma statutes
ODEQ	Oklahoma Department of Environmental Quality
OSWD	Onsite wastewater disposal
OWRB	Oklahoma Water Resources Board
SWAT	Soil and Water Assessment Tool
SWS	Sensitive public and private water supply
TMDL	Total maximum daily load
TSI	Trophic state index
USBOR	United States Bureau of Reclamation
USDA	United States Department of Agriculture
USEPA	United States Environmental Protection Agency
USGS	United States Geological Survey
µg/L	Microgram per liter
WLA	Wasteload allocation
WQM	Water quality monitoring
WQMP	Water quality management plan
WQS	Water quality standard
WWTP	Wastewater treatment plant

Executive Summary

This report documents the data and assessment methods used to establish total maximum daily loads (TMDLs) for Rocky Lake (OK311500030060_00), and Tom Steed Lake (OK311500020060_00). The Oklahoma Department of Environmental Quality (ODEQ) placed these waterbodies in Category 5 of the Water Quality in Oklahoma (2008 Integrated Report) for nonsupport of the public and private water supply designated use because of elevated levels of chlorophyll-*a*.

Both of these lakes are in the Lower North Fork of the Red River basin, in southwest Oklahoma. Rocky Lake, also known as Hobart Lake, is a 347 acre lake in Washita County with a conservation pool storage of 4,210 acre-feet. It was impounded in 1933, and serves as a recreational lake and also the supplemental municipal water supply for the city of Hobart (OWRB 2009). Tom Steed Lake is a 6,400 acre lake in Kiowa County with a conservation pool storage of 88,970 acre-feet. It was first impounded in 1975 by the construction of Mountain Park Dam on West Otter Creek by the U.S. Bureau of Reclamation. It functions as a flood control lake and is also used as a supplemental water supply, recreation, and fish and wildlife propagation (OWRB 2009).

The watersheds of both lakes are sparsely populated, with developed land accounting for less than 2 percent of the watershed area. The most dominant land use category throughout both watersheds is cultivated cropland. Both watersheds also have a significant percentage of land classified as scrub and shrubland.

Data assessment and TMDL calculations are conducted in accordance with requirements of Section 303(d) of the federal Clean Water Act (CWA), Water Quality Planning and Management Regulations (40 CFR Part 130), United States Environmental Protection Agency (USEPA) guidance, and ODEQ guidance and procedures. ODEQ is required to submit all TMDLs to USEPA for review and approval. Once the USEPA approves a TMDL, then the waterbody may be moved to Category 4a of a State's Integrated Water Quality Monitoring and Assessment Report, where it remains until compliance with water quality standards (WQS) is achieved (USEPA 2003).

The purpose of this TMDL report is to establish nutrient load allocations necessary for reducing chlorophyll-*a* levels in the lakes, which is the first step toward restoring water quality and protecting public health. TMDLs determine the pollutant loading a waterbody can assimilate without exceeding applicable WQS. TMDLs also establish the pollutant load allocation necessary to meet the WQS established for a waterbody based on the relationship between pollutant sources and water quality conditions in the waterbody. A TMDL consists of a wasteload allocation (WLA), load allocation (LA), and a margin of safety (MOS). The WLA is the fraction of the total pollutant load apportioned to point sources, and includes stormwater discharges regulated under the National Pollutant Discharge Elimination System (NPDES) as point sources. The LA is the fraction of the total pollutant load apportioned to nonpoint sources. The MOS is a percentage of the TMDL set aside to account for the lack of knowledge associated with natural process in aquatic systems, model assumptions, and data limitations.

This report does not stipulate specific control actions (regulatory controls) or management measures (voluntary best management practices) necessary to reduce nutrients within each watershed. Watershed-specific control actions and management measures will be identified, selected, and implemented under a separate process involving stakeholders who live and work in the watersheds, along with tribes, and local, state, and federal government agencies.

E.1 Problem Identification and Water Quality Target

Elevated levels of chlorophyll-*a* in lakes reflect excessive algae growth, which can have deleterious effects on the quality and treatment costs of drinking water. Excessive algae growth can also negatively impact the aquatic biological communities of lakes. Elevated chlorophyll-*a* levels typically indicate excessive loading of the primary growth-limiting algal nutrients nitrogen and phosphorus to the waterbody, a process known as eutrophication.

The following excerpt from the Oklahoma WQS (Oklahoma Administrative Code [OAC] Chapter 45: 785:45-5-10) stipulates the numeric criterion that has been set for sensitive public and private water supply (SWS) lakes including Rocky Lake and Tom Steed Lake (OWRB 2008).

> *785:45-5-10. Public and private water supplies*
> *The following criteria apply to surface waters of the state having the designated beneficial use of Public and Private Water Supplies:*
>
> *(7) Chlorophyll-a numerical criterion for certain waters. The long term average concentration of chlorophyll-a at a depth of 0.5 meters below the surface shall not exceed 0.010 milligrams per liter in Wister Lake, Tenkiller Ferry Reservoir, nor any waterbody designated SWS in Appendix A of this Chapter. Wherever such criterion is exceeded, numerical phosphorus or nitrogen criteria or both may be promulgated.*

Rocky Lake is also assigned the designation of "nutrient limited watershed" (NLW) in OAC Chapter 45: 785:45-5-29. A NLW means a watershed of a waterbody with a designated beneficial use which is adversely affected by excess nutrients as determined by Carlson's Trophic State Index (using chlorophyll-*a*) of 62 or greater, or is otherwise listed as "NLW" in Appendix A of Chapter 45 (OWRB 2010). In the case of Rocky Lake the NLW designation applies to its entire watershed and drainage area, including all direct and indirect tributaries (OWRB 2010).

In Rocky Lake, chlorophyll-*a* levels averaged 43.0 µg/L from 2003 to 2009, which is equivalent to a Carlson's Trophic State Index (TSI) of 67 (Carlson 1977). These data were used in the Beneficial Use Monitoring Program to support the decision to place the lake on the ODEQ 2008 §303(d) list (ODEQ 2008) for non-support of the Public and Private Water Supply Use.

Pooling data from all sites in Tom Steed Lake, chlorophyll-*a* levels averaged 23.1 µg/L (TSI = 61), significantly lower than in Rocky Lake but still elevated relative to the long-term average SWS criterion of 10 µg/L. Data available for the period of record were used in the Beneficial Use Monitoring Program to support the decision to place Tom Steed Lake on the ODEQ 2008 §303(d) list (ODEQ 2008) for non-support of the Public and Private Water Supply Use.

During the years 1998 to 2009, total nitrogen levels in Rocky Lake averaged approximately 1.5 mg/L, and total phosphorus levels averaged 0.13 mg/L. Total nitrogen is calculated as the sum of Kjeldahl nitrogen and two inorganic forms in different oxidation states: nitrate and nitrite nitrogen. Kjeldahl nitrogen is the sum of organic nitrogen and ammonia nitrogen. Total phosphorus is comprised of organic phosphorus, inorganic orthophosphorus, and inorganic polyphosphates. Thermal stratification was not observed during the 2006-2007 assessment period, likely due to the shallow nature of the lake (OWRB 2007). Thus, nutrient fluxes from sediments were available year-round in the photic zone where light permits algal photosynthesis.

Total nitrogen levels in Tom Steed Lake averaged approximately 0.70 mg/L, and total phosphorus levels averaged 0.073 mg/L. As in Rocky Lake, thermal stratification was not observed during 2006-2007 in Tom Steed Lake (OWRB 2007).

The Code of Federal Regulations (40 CFR §130.7(c)(1)) states that "TMDLs shall be established at levels necessary to attain and maintain the applicable narrative and numerical water quality standards." The water quality target established for each lake must demonstrate compliance with the numeric criterion prescribed for SWS lakes in the Oklahoma WQS (OWRB 2008). Therefore the water quality target established for Rocky Lake and Tom Steed Lake is to achieve a long-term average in-lake concentration of 10 µg/L for chlorophyll-*a*. Rocky Lake is also included in the 303(d) list for turbidity and color impairments, while Tom Steed Lake is listed for turbidity exceedances. The implementation of this TMDL will at least partially address the impairment resulting from turbidity levels and color in the lakes. However, these water quality issues will be addressed specifically on a future date.

E.2 Pollutant Source Assessment

This section includes an assessment of the known and suspected sources of nutrients contributing to the eutrophication of Rocky Lake and Tom Steed Lake. Nutrient sources identified are categorized and quantified to the extent that reliable information is available. Generally, nutrient loadings causing eutrophication of lakes originate from point or nonpoint sources of pollution. Point sources are permitted through the NPDES program. Nonpoint sources are diffuse sources that typically cannot be identified as entering a waterbody through a discrete conveyance at a single location. Nonpoint sources may emanate from land activities that contribute nutrient loads to surface water as a result of rainfall runoff. For the TMDLs in this report, all sources of pollutant loading not regulated by NPDES are considered nonpoint sources.

Under 40 CFR, §122.2, a point source is described as a discernable, confined, and discrete conveyance from which pollutants are or may be discharged to surface waters. NPDES-permitted facilities classified as point sources that may contribute nutrient loading include:

- NPDES municipal wastewater treatment plant (WWTP) discharges;
- NPDES industrial WWTP discharges;
- NPDES municipal no-discharge WWTPs;
- NPDES concentrated animal feeding operations (CAFOs);
- NPDES municipal separate storm sewer system discharges;

Of these five types of facilities only one type occurs within Rocky Lake and Tom Steed watersheds – municipal no-discharge WWTPs. Therefore there are no point sources discharging to the lakes or the tributaries of each lake within the Study Area. For the purposes of these TMDLs, no-discharge facilities are not considered a source of nutrient loading. It is possible that the wastewater collection system associated with no-discharge facilities could be a source of nutrient loading, or that discharges from the wastewater plant may occur during large rainfall events that exceed the systems' storage capacities. These types of unauthorized discharges are typically reported as sanitary sewer overflows. However, the facilities in Table 3-1 have not reported a sanitary sewer overflow since 2000. Furthermore, given the small size of the wastewater collection systems of these no-discharge facilities the contributions of nutrient loads would be negligible.

As there are no point source discharges in the Study Area, the external nutrient loading to each lake originates from nonpoint sources. Nonpoint sources include those sources that cannot be identified as entering the waterbody at a specific location. The relatively homogeneous land use/land cover categories throughout the Study Area associated with agricultural and forest and range management activities have a strong influence on the origin and pathways of nutrient sources to surface water. Nutrient sources in rural watersheds originate from soil erosion, agricultural fertilization, residues from mowing and harvesting, atmospheric deposition of nutrients, failing onsite wastewater disposal (OSWD) systems, and fecal waste deposited in the watershed by wildlife, livestock, and pets. Causes of soil erosion can include natural causes such as flooding and winds, construction activities, vehicular traffic, and agricultural activates.

Given a lack of instream water quality data and pollutant source data available to quantify nutrient and sediment loading directly from the tributaries of Rocky Lake and Tom Steed Lake, a watershed loading model – the Soil and Water Assessment Tool (SWAT) – was used to develop nonpoint source loading estimates. These estimates from SWAT were used to quantify the nutrient contributions to each lake. SWAT is a basin-scale watershed model that can be operated on a daily time step (Neitsch et al. 2007). SWAT is designed to predict the impact of management strategies on water, nutrient, sediment, and agricultural chemical yields. The model is physically (and empirically) based, computationally efficient, and capable of continuous simulation over long time periods. The major components of the model include weather, hydrology, soil temperature and properties, plant growth, nutrients, and land management. The development and calibration of the SWAT model is described in detail in the report *Technical Methods Summary for Watershed and Water Quality Modeling of Sensitive Water Supply Lakes in Oklahoma* (Parsons 2010).

There are no stream flow or water quality monitoring stations in the tributaries to Rocky Lake or Tom Steed Lake. In order to calibrate the SWAT model it was necessary to extend the modeled area to encompass watersheds with stream flow gages and nutrient concentration measurements. Thus, the SWAT model simulated the entire United States Geologic Survey (USGS) hydrologic unit 11120303 (Lower North Fork of the Red River Basin), a 1,390 square mile area that includes the contributing watersheds of both Rocky Lake and Tom Steed Lake.

A fifteen year period (1994 - 2008) was simulated in the SWAT model. However, the first four years were considered a "spin-up" period for stabilizing model initial conditions, and the model output consisted of only the latter 11 years (1998 - 2008). The variables simulated in SWAT included flow, organic phosphorus, mineral ortho-phosphorus, organic nitrogen, ammonia nitrogen, nitrate nitrogen, nitrite nitrogen, and total suspended solids.

The SWAT hydrologic calibration was primarily performed based on flow data available at the USGS gages located on the North Fork Red River near Tipton (0730728) and Otter Creek near Snyder (07307010). The primary calibration targets included annual water balances, but modeled monthly flows and the resulting flow duration curves were also compared to measured values. Overall, the model reproduces the annual flows within 15 percent in most years, with overall errors for the calibration and validation periods well below the target (-5% for North Fork Red River and <1% for Otter Creek). Resulting Nash-Sutcliffe Efficiency (NSE) Coefficients and correlation coefficient values were 0.860 and 0.861 for North Fork Red River and 0.939 and 0.943 for Otter Creek. Both of those two coefficients meet the targets of 0.5 for NSE and 0.6 for r^2, indicating very good model performance.

After hydrologic calibration, the SWAT-predicted nutrient concentrations were compared to measured nutrient concentrations at the two water quality stations where they were available: Elk Creek near Hobart (OK311500030010-001AT) and the North Fork Red River near Headrick (OK311500010020-001AT). In most cases, the SWAT model reproduced the average nutrient concentrations within 20 percent of the averages calculated using measured concentrations. In some instances, the model does not replicate observed nutrient speciation for a given period, but nevertheless the total phosphorus and nitrogen predicted averages are within target for both the calibration and verification periods. Overall, the model reproduces the average concentrations of all nutrients within 20 percent of the observed averages.

Based on the calibrated SWAT model, average loads of nutrients from each of the individual subwatersheds were estimated for the period 1998 to 2008. The average daily flows and loads into Rocky Lake and Tom Steed Lake are displayed in Table ES-1. Under current conditions, Rocky Lake is estimated to receive a total annual load of 38,000 kg of phosphorus and 62,000 kg of nitrogen, on average, from nonpoint sources in its watershed. Tom Steed Lake is estimated to receive a total annual load of 68,600 kg of phosphorus and 116,400 kg of nitrogen, on average, from nonpoint sources in its watershed.

Table ES-1 Average Daily Flows and Nutrient Loads Discharging to Rocky Lake and Tom Steed Lake

Parameter	Rocky Lake[a]	Tom Steed Lake[b]
Watershed Size (square miles)	55	119
Flow (m^3/day)	3.97×10^4	1.20×10^5
Organic Phosphorus (kg/year)	14,600	14,600
Mineral Ortho-Phosphorus (kg/year)	23,400	54,000
Total Phosphorus (kg/year)	**38,000**	**68,600**
Organic Nitrogen (kg/year)	24,500	50,000
Ammonia Nitrogen (kg/year)	10,200	33,200
Nitrite Nitrogen (kg/year)	700	5,100
Nitrate Nitrogen (kg/year)	26,600	28,100
Total Nitrogen (kg/year)	**62,000**	**116,400**

E.3 Technical Approach and Methods

The objective of a TMDL is to estimate allowable pollutant loads and to allocate these loads to the known pollutant sources in the watershed so appropriate control measures can be implemented and the WQS achieved. In order to ascertain the effect of management measures on in-lake water quality, it is necessary to establish a linkage between the external loading of nutrients and the waterbody response in terms of lake water quality conditions, as evaluated by chlorophyll-*a* concentrations. This section describes the water quality analysis of the linkage between chlorophyll-*a* levels in Rocky Lake and Tom Steed Lake and the nutrient loadings from their watersheds.

The water quality linkage analysis was performed using the BATHTUB model (Walker 1986). BATHTUB is a U.S. Army Corps of Engineers model designed to simulate eutrophication in reservoirs and lakes. BATHTUB has been cited as an effective tool for reservoir and lake water quality assessment and management, particularly where data are limited. The model incorporates several empirical equations of nutrient settling and algal growth to predict steady-state water column nutrient and chlorophyll-*a* concentrations based on water body characteristics, hydraulic characteristics, and external nutrient loadings.

The model was run under existing average, steady-state conditions. An averaging period of one year was used to depict the duration of mass-balance calculations for both lakes. A single, well-mixed lake was assumed for both reservoirs. Key water quality parameters for BATHTUB input include total phosphorus, inorganic ortho-phosphorus, total nitrogen, and inorganic nitrogen. Output from the SWAT model was the primary source of data inputs to the BATHTUB model. Although SWAT can provide daily output, BATHTUB is a steady-state model and not appropriate for interpreting short-term responses of lakes to nutrients. Therefore, the long-term average annual loads from the SWAT modeled period were applied as inputs to BATHTUB.

The BATHTUB models were calibrated to measured in-lake water quality conditions (based on 2002-2008 data) using phosphorus and nitrogen calibration factors. The model-predicted concentrations of total nitrogen, total phosphorus, chlorophyll-*a*, and Secchi depth under existing average conditions are compared to average measured concentrations from each lake in Table ES-2.

Table ES-2 Model Predicted and Measured Water Quality Parameter Concentrations

Water Quality Parameter	Rocky Lake		Tom Steed Lake	
	Modeled	Measured	Modeled	Measured
Total Phosphorus (mg/L)	0.130	0.133	0.070	0.073
Total Nitrogen (mg/L)	1.45	1.51	0.740	0.703
Chlorophyll-*a* (µg/L)	44.9	43.0	16.6	23.1
Secchi depth (meters)	0.30	0.29	0.40	0.38

Simulations were performed using the BATHTUB model to evaluate the effect of loading reductions on chlorophyll-*a* levels. The simulations indicated that the water quality target of 10 µg/L chlorophyll-*a* as a long-term average concentration could be achieved if the total phosphorus and nitrogen loads to Rocky Lake were reduced by 87% from the existing load (Table ES-3). In Tom Steed Lake, the water quality target of 10 µg/L chlorophyll-*a* could be achieved if the total phosphorus and nitrogen loads were reduced by 65% from the existing load. These maximum daily loads include a 10% explicit margin of safety.

Table ES-3 Total Phosphorus and Nitrogen Load Reductions to Meet a 10 µg/L Chlorophyll-*a* Water Quality Target

	Rocky Lake	Tom Steed Lake
Maximum Allowable Load of Total Phosphorus (kg/year)	5,000	24,000
Maximum Allowable Load of Total Nitrogen (kg/year)	8,000	41,000
% Reduction	87%	65%

E.4 TMDLs and Load Allocations

The TMDLs for the §303(d)-listed waterbodies covered in this report were derived using the outputs from the BATHTUB model. A TMDL is expressed as the sum of all WLAs (point source loads), LAs (nonpoint source loads), and an appropriate margin of safety (MOS), which attempts to account for the lack of knowledge concerning the relationship between loading limitations and water quality. This definition can be expressed by the following equation:

$$TMDL = \Sigma\, WLA + \Sigma\, LA + MOS$$

There are no point sources of wastewater discharging to Rocky Lake or Tom Steed Lake or their tributaries. Furthermore, Oklahoma's implementation of WQS (OAC 785:46-13-4) prohibits new point source discharges to these lakes, excepting stormwater with approval from ODEQ. Thus, the wasteload allocations for the two waterbodies are zero.

The load allocation for all nonpoint sources to Rocky Lake was conservatively estimated at 5,000 kg/yr of phosphorus and 8,000 kg/year of total nitrogen, an 87% reduction from existing loads. Similarly, the load allocation for all nonpoint sources to Tom Steed Lake was conservatively estimated at 24,000 kg/yr of total phosphorus and 41,000 kg/year of total nitrogen, a 65% reduction from existing loads.

USEPA guidance allows for use of implicit or explicit expressions of the MOS, or both. When conservative assumptions are used in development of the TMDL, or conservative factors are used in the calculations, the MOS is implicit. When a specific percentage of the TMDL is set aside to account for the lack of knowledge, then the MOS is considered explicit. In these TMDLs, the MOS has both an explicit component, 10%, and an implicit component that is incorporated by the application of load reductions for both nitrogen and phosphorus. Seasonal variation was accounted for in these TMDLs by using more than 5 years of water quality data collected in each of the four seasons.

Load reduction scenario simulations were run using the BATHTUB model to calculate and express the TMDL as annual average phosphorus and nitrogen loads (in kg/yr) that, if achieved, should decrease chlorophyll-*a* concentrations to meet the water quality target. However, a recent court decision (*Friends of the Earth, Inc. v. EPA, et al.*, often referred to as the Anacostia decision) states that TMDLs must include a daily load expression. It is important to recognize that the chlorophyll-*a* response to nutrient loading in both Rocky Lake and Tom Steed Lake is affected by many factors such as: internal lake nutrient loading, water residence time, wind action and the interaction between light penetration, nutrients, sediment load and algal response. As such it is important to note that expressing this TMDL in daily time steps does not imply a daily response to a daily load is practical from an implementation perspective.

The USEPA's *Technical Support Document for Water Quality-Based Toxics Control* (USEPA 1991b) provides a statistical method for identifying a statistical maximum daily limit that is based on a long-term average and considering variation in a dataset. The method is represented by the following equation:

where MDL = maximum daily load
LTA = long-term average load
z = z statistic of the probability of occurrence (0.95 is assumed for this value)
$\sigma^2 = \ln(CV^2+1)$
CV = coefficient of variation

The coefficient of variation of daily nitrogen and phosphorus nonpoint source (NPS) loads were calculated from SWAT model output and ranged from 8.2 to 11 for phosphorus and from 5.7 to 7.9 for nitrogen. Assuming a probability of occurrence of 95 percent, the maximum daily load corresponding to the allowable average load of 5,000 kg of phosphorus and 8,000 kg of nitrogen per year to Rocky Lake is translated to a daily maximum load of 13.7 kg/day of phosphorus and 21.9 kg/day of nitrogen. For Tom Steed Reservoir, the allowable average load of 24,000 kg of phosphorus and 41,000 kg of nitrogen per year is translated to a daily maximum load of 65 kg/day of phosphorus and 112.3 kg/day of nitrogen. Reduction of total phosphorus and total nitrogen loads to these levels is expected to result in achievement of WQS for chlorophyll-*a* in each lake.

Table ES-4 TMDLs for Chlorophyll-*a* Expressed in Kilograms of Total Phosphorus and Nitrogen Per Day

Waterbody Name	Waterbody ID	Nutrient	TMDL	WLA	LA	MOS
Rocky Lake	OK311500030060_00	Total Phosphorus	13.7 kg/day	0	12.3 kg/day	1.4 kg/day
		Total Nitrogen	21.9 kg/day	0	19.7 kg/day	2.2 kg/day
Tom Steed Lake	OK311500020060_00	Total Phosphorus	65 kg/day	0	58.5 kg/day	6.5 kg/day
		Total Nitrogen	112.3 kg/day	0	101.1 kg/day	11.2 kg/day

E.5 Public Participation

The public had the opportunity to review the Chlorophyll-*a* TMDL Report for Rocky and Tom Steed Lakes, submit comments to DEQ, and/or request a public meeting. The public comment period lasted 45 days. DEQ received one comment during the public comment period which became a part of the record of this TMDL report. The response to this comment can be found in Appendix C. No changes were made to the Chlorophyll-*a* TMDL Report for Rocky and Tom Steed Lakes as a result of this comment. There were no requests for a public meeting.

SECTION 1
INTRODUCTION

1.1 TMDL Program Background

Section 303(d) of the federal Clean Water Act (CWA) and U.S. Environmental Protection Agency (USEPA) Water Quality Planning and Management Regulations (40 Code of Federal Regulations [CFR] Part 130) require states to develop total maximum daily loads (TMDLs) for waterbodies not meeting designated uses where technology-based controls are in place. TMDLs establish the allowable loadings of pollutants or other quantifiable parameters for a waterbody based on the relationship between pollution sources and instream water quality conditions, so States can implement water quality-based controls to reduce pollution from point and nonpoint sources and restore and maintain water quality (USEPA 1991a).

This report documents the data and assessment used to establish TMDLs for chlorophyll-*a* for two lakes (reservoirs) in the Lower North Fork of the Red River (hydrologic unit code [HUC] 11120303) basin. Elevated levels of chlorophyll-*a* in lakes reflect excessive algae growth, which can have deleterious effects on the quality and treatment costs of drinking water. Excessive algae growth can also negatively impact the aquatic biological communities of lakes. Elevated chlorophyll-*a* levels typically indicate excessive loading of the primary growth-limiting algal nutrients nitrogen and phosphorus to the waterbody, a process known as eutrophication. Data assessment and TMDL calculations are conducted in accordance with requirements of Section 303(d) of the CWA, Water Quality Planning and Management Regulations (40 CFR Part 130), USEPA guidance, and Oklahoma Department of Environmental Quality (ODEQ) guidance and procedures. ODEQ is required to submit all TMDLs to USEPA for review and approval. Once the USEPA approves a TMDL, then the waterbody may be moved to Category 4a of a State’s Integrated Water Quality Monitoring and Assessment Report, where it remains until compliance with water quality standards (WQS) is achieved (USEPA 2003). The purpose of this TMDL report is to establish nutrient load allocations necessary for reducing chlorophyll-*a* levels in the lakes, which is the first step toward restoring water quality and protecting public health. TMDLs determine the pollutant loading a waterbody can assimilate without exceeding applicable WQS. TMDLs also establish the pollutant load allocation necessary to meet the WQS established for a waterbody based on the relationship between pollutant sources and water quality conditions in the waterbody. A TMDL consists of a wasteload allocation (WLA), load allocation (LA), and a margin of safety (MOS). The WLA is the fraction of the total pollutant load apportioned to point sources, and includes stormwater discharges regulated under the National Pollutant Discharge Elimination System (NPDES) as point sources. The LA is the fraction of the total pollutant load apportioned to nonpoint sources. The MOS is a percentage of the TMDL set aside to account for the lack of knowledge associated with natural process in aquatic systems, model assumptions, and data limitations.

This report does not stipulate specific control actions (regulatory controls) or management measures (voluntary best management practices) necessary to reduce nutrients within each watershed. Watershed-specific control actions and management measures will be identified, selected, and implemented under a separate process involving stakeholders who live and work in the watersheds, along with tribes, and local, state, and federal government agencies.

This TMDL report focuses on waterbodies that ODEQ placed in Category 5 [303(d) list] of the *Water Quality in Oklahoma, 2008 Integrated Report* (2008 Integrated Report) for non-support of the public and private water supply use. The waterbodies addressed in this report include:

- Rocky Lake (OK311500030060_00), and
- Tom Steed Lake (OK311500020060_00).

Figures 1-1 and 1-2 are location maps showing these Oklahoma waterbodies and their contributing watersheds. These maps also display locations of the water quality monitoring (WQM) stations used as the basis for placement of these waterbodies on the Oklahoma §303(d) list. These waterbodies and their surrounding watersheds are hereinafter referred to as the Study Area.

1.2 Watershed and Lake Description

Lake Characteristics. Rocky Lake, also known as Hobart Lake, is a 347 acre lake in Washita County with a conservation pool storage of 4,210 acre-feet. It was impounded in 1933, and serves as a recreational lake and also the supplemental municipal water supply for the city of Hobart (OWRB 2009). Little Elk Creek, which is 15 miles long, is the primary tributary flowing to Rocky Lake. Based on the Beneficial Use Monitoring Program (BUMP) sample period of October 2008 through August 2009, the average secchi disk depth in Rocky Lake was only 20 centimeters (OWRB 2009).

Tom Steed Lake is a 6,400 acre lake in Kiowa County with a conservation pool storage of 88,970 acre-feet. It was first impounded in 1975 by the construction of Mountain Park Dam on West Otter Creek by the United States Bureau of Reclamation (USBOR) (OWRB 2009). It functions as a flood control lake and is also used for supplemental water supply, recreation, and fish and wildlife propagation (OWRB 2009). An aqueduct system constructed by the USBOR is designed to convey water from Tom Steed Lake to the cities of Altus, Snyder, Frederick, and the Hackberry Flat Wildlife Management Area for municipal use (USBOR 2010). Great Plains State Park borders the eastern and southern shores of Tom Steed Lake. The 5,000 acre Mountain Park Wildlife Management Area is located along the northern shores of Tom Steed Lake. West Otter Creek and Glenn Creek, which are both approximately 14 miles long, are the two main tributaries that flow into Tom Steed Lake. The Bretch Diversion Dam and Canal also diverts streamflow from Elk Creek into the watershed of Tom Steed Lake. Based on the BUMP sample period of November 2006 through July 2007, the average secchi disk depth in Tom Steed Lake was 57 centimeters (OWRB 2009).

There is very little developed land bordering the shoreline of either lake. Both lakes are popular fishing and boating recreation destinations. Table 1-1 provides general characteristics of each lake.

Table 1-1 General Lake Characteristics

Waterbody Name and WBID	Surface Area (Acres)	Conservation Pool Storage (Acre- Feet)	Normal Elevation (Feet MSL)	Average Depth (Feet)	Shoreline (Miles)	Management Agency
Rocky (Hobart) Lake OK311500030060_00	347	4,210	1,634	11.64	8	City of Hobart
Tom Steed Lake OK311500020060_00	6,400	88,970	1,411	15.08	31	USBOR

MSL = Mean Sea Level

Figure 1-1 Rocky Lake

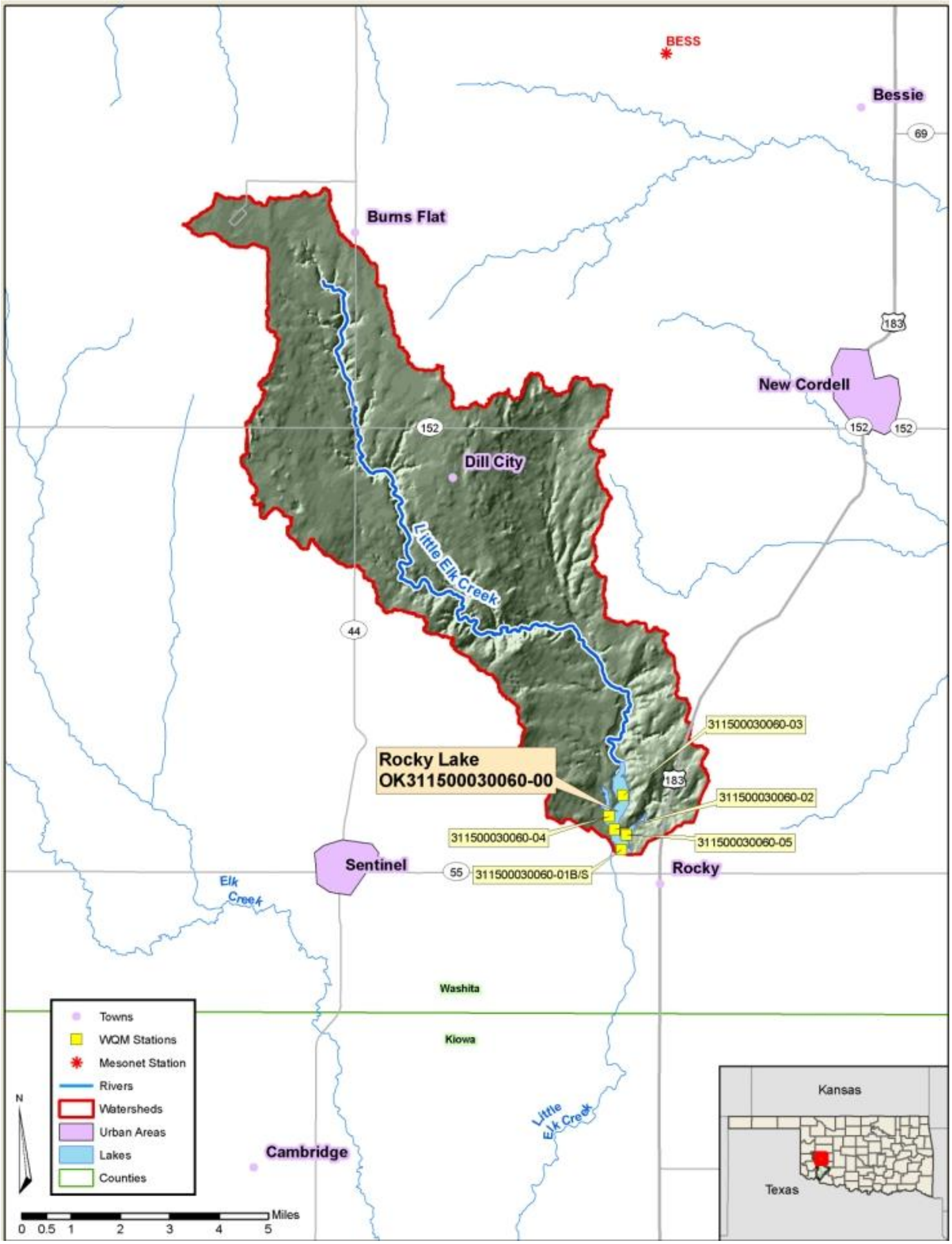
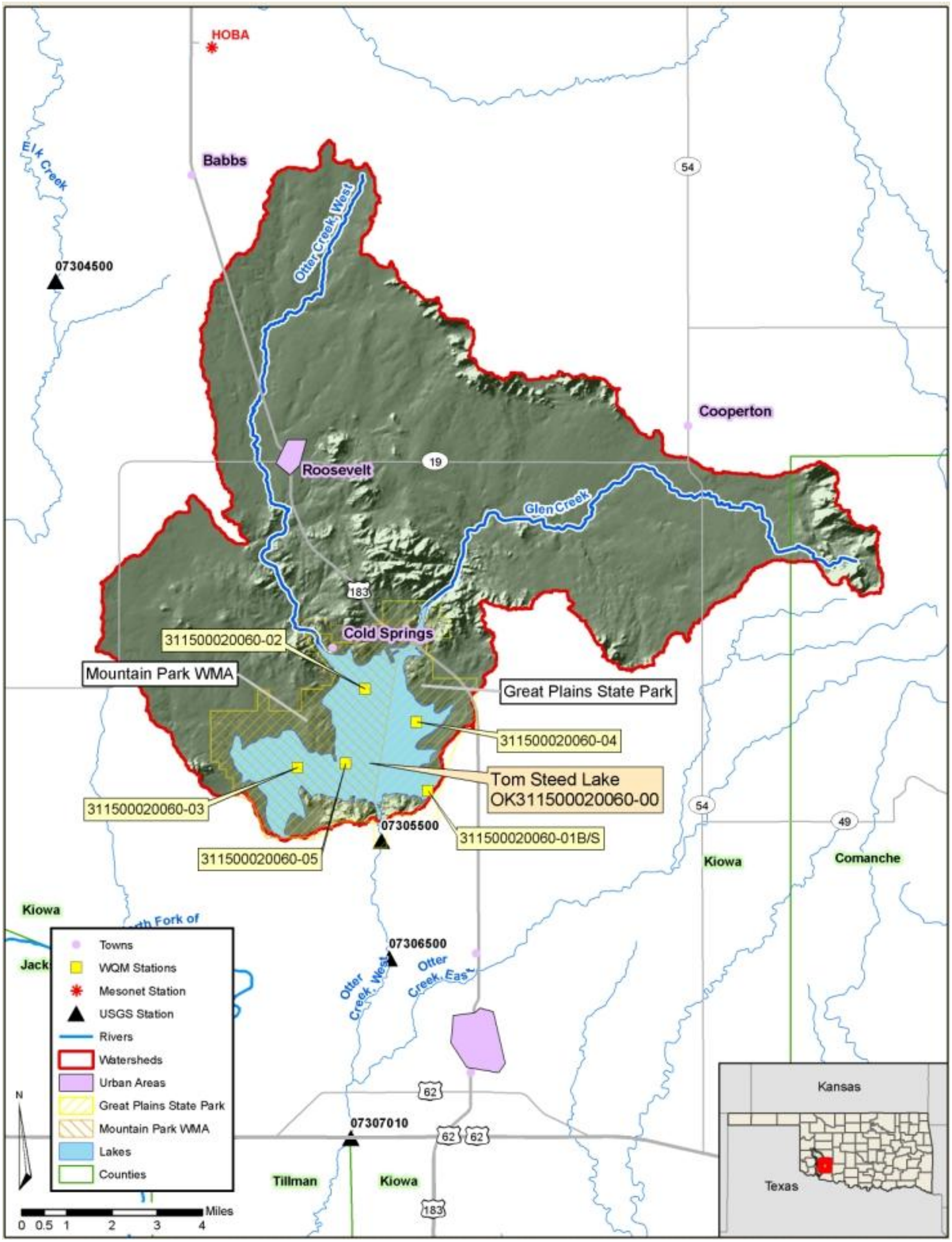


Figure 1-2 Tom Steed Lake



General. Both lakes are within the larger Lower North Fork of the Red River basin which is located in the southwestern portion of Oklahoma. Rocky Lake's contributing watershed is located entirely in Washita County. The majority of the watershed of Tom Steed Lake is located in Kiowa County, but a small portion lies in Comanche County. These counties are part of the Central Great Plains Level III ecoregions (Woods et al 2005). Once dominated by grassland, with scattered low trees and shrubs in the south, much of this ecological region is now cropland. The eastern boundary of the region marks the eastern limits of the major winter wheat growing area of the United States (Woods et al 2005). The Rocky Lake watershed is located in the Anadarko Basin geological province and the Tom Steed Lake watershed is located in the Wichita Mountain Uplift Basin geological province. Table 1-2, derived from the 2010 U.S. Census, demonstrates that the counties in which these watersheds are located are sparsely populated (U.S. Census Bureau 2010). The town of Dill City is located in the Rocky Lake watershed and the towns of Roosevelt and Cold Springs are in the Tom Steed Lake watershed.

Table 1-2 County Population and Density

County Name	Population (2010 Census)	Population Density (per square mile)
Washita	11,269	11.1
Kiowa	9,446	9.1
Comanche	124,098	114

Climate. Table 1-3 summarizes the average annual precipitation for Rocky Lake (OK311500030060_00) and Tom Steed Lake (OK311500020060_00). Average annual precipitation values were derived from the Oklahoma Mesonet Dataset (http://www.mesonet.org) based on a period of record of 1994 to 2009.

Table 1-3 Average Annual Precipitation by Watershed 1994-2009

Waterbody Name	Waterbody ID	Average Annual Precipitation (inches)
Rocky Lake	OK311500030060_00	29.8[1]
Tom Steed Lake	OK311500020060_00	29.6[2]

[1] *at Bessie Mesonet station*
[2] *at Hobart Mesonet station*

Land Use. The contributing drainage areas of the Rocky Lake and Tom Steed Lake watersheds are approximately 55 and 119 square miles, respectively. Table 1-4 summarizes the percentages and acreages of the land use categories for the contributing watersheds. The land use/land cover data were derived from the United States Geological Survey (USGS) 2001 National Land Cover Dataset (USGS 2007). Land use in the watersheds of Rocky Lake and Tom Steed Lake is displayed in Figures 1-3 and 1-4, respectively. The most dominant land use category throughout the Study Area is cultivated cropland. Both watersheds in the Study Area also have a significant fraction of land classified as scrub and shrubland. The aggregated total of low, medium, and high intensity developed land accounts for less than 2 percent of the land use in each watershed.

Table 1-4 Land Use Summary by Watershed

NLCD2001 Code	Description	Tom Steed Lake		Rocky Lake	
		Acres	Percent	Acres	Percent
11	Open Water	6,195	8.2	366	1.0
21	Developed, Open Space	2,462	3.2	2,185	6.2
22	Developed, Low Intensity	94	0.1	281	0.8
23	Developed, medium Intensity	21	0.0	144	0.4
24	Developed, High Intensity	0	0.0	144	0.4
31	Barren Land	1	0.0	2	0.0
41	Deciduous Forest	247	0.3	0	0.0
42	Evergreen Forest	182	0.2	0	0.0
43	Mixed Forest	2,684	3.5	792	2.2
52	Scrub/Shrub	26,988	35.5	5,661	16.0
71	Grassland/Herbaceous	5,170	6.8	2,274	6.4
82	Cultivated Crops	31,657	41.7	23,463	66.3
90	Palustrine Forested Wetland	275	0.4	50	0.1
95	Emergent Herbaceous Wetland	5	0.0	0	0.0
	Total Drainage Area	**75,982**		**35,363**	

Figure 1-3 Rocky Lake Watershed Land Use

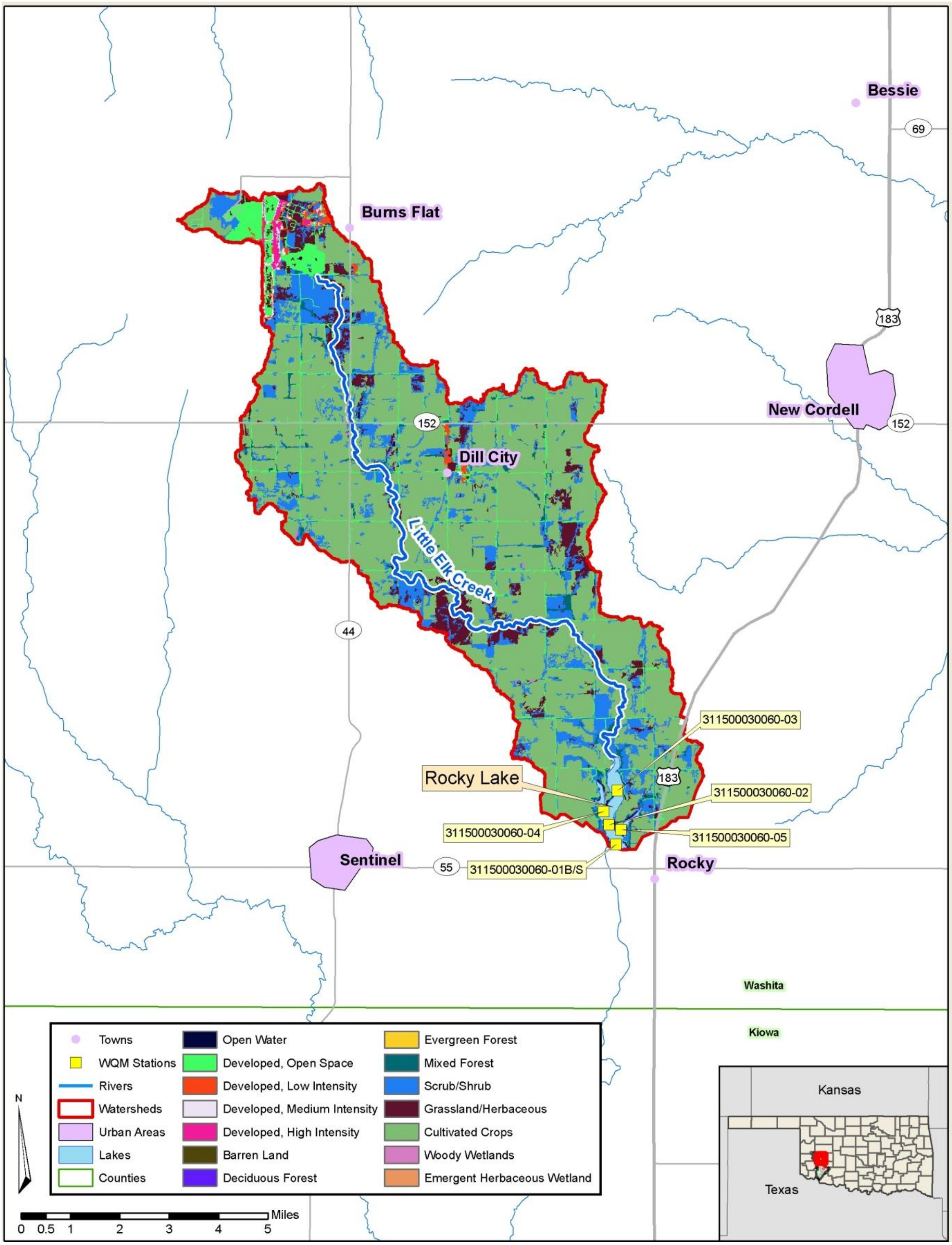
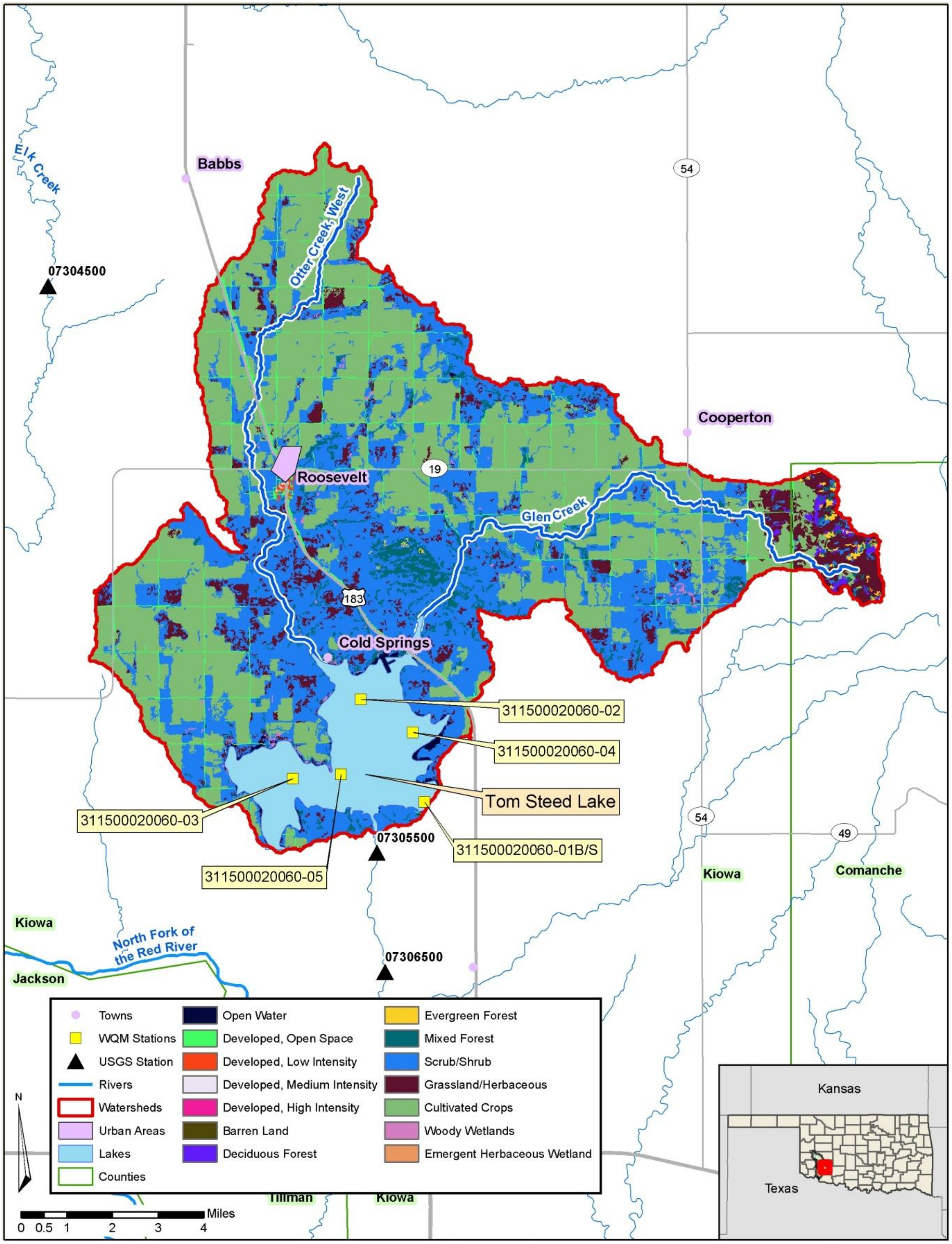


Figure 1-4 Tom Steed Lake Watershed Land Use



1.3 Flow Characteristics

Stream flow characteristics and data are key information when conducting water quality assessments such as TMDLs. However, there are no flow gages located on any of the tributaries to Rocky Lake and Tom Steed Lake. Given the lack of historical or instantaneous stream flow data, flow estimates for these tributaries, based on flow data derived from USGS gage stations on tributaries in adjacent watersheds, were developed using watershed modeling discussed in further detail in Section 3. There is no USGS stage gage station below Rocky Lake and therefore there is no historical flow release or lake stage volume data available. From October 1972 to June 2003, the USGS measured streamflow in West Otter Creek just downstream of the Tom Steed Lake dam on West Otter Creek at gage station 070305500. Since July 2000, the USGS has measured streamflow at gage station 07307010, downstream on Otter Creek near Snyder, Oklahoma.

SECTION 2
PROBLEM IDENTIFICATION AND WATER QUALITY TARGET

2.1 Oklahoma Water Quality Standards

Chapters 45 and 46 of Title 785 of the Oklahoma Administrative Code (OAC) contain Oklahoma's WQS and implementation procedures (OWRB 2008), respectively. The Oklahoma Water Resources Board (OWRB) has statutory authority and responsibility concerning establishment of state water quality standards, as provided under 82 Oklahoma Statute [O.S.], §1085.30. This statute authorizes the OWRB to promulgate rules *…which establish classifications of uses of waters of the state, criteria to maintain and protect such classifications, and other standards or policies pertaining to the quality of such waters.* [O.S. 82:1085:30(A)]. Beneficial uses are designated for all waters of the state. Such uses are protected through restrictions imposed by the antidegradation policy statement, narrative water quality criteria, and numerical criteria (OWRB 2008). An excerpt of the Oklahoma WQS (Chapter 45,Title 785) summarizing the State of Oklahoma Antidegradation Policy is provided in Appendix A. The beneficial uses designated for Rocky Lake and Tom Steed Lake include primary body contact recreation, the warm water aquatic community subcategory of the fish and wildlife propagation, irrigation agricultural water supply, public and private water supply, and aesthetics. The entire watershed of Rocky Lake is designated as a "nutrient-limited watershed" in §785:45-5-29 (OWRB 2008). Table 2-1, an excerpt from the 2008 Integrated Report (ODEQ 2008), summarizes the public/private water supply use attainment status and the waterbody/pollutant combinations that require TMDLs for the two waterbodies. The TMDL priority shown in Table 2-1 is directly related to the TMDL target date. The TMDLs established in this report, which are a necessary step in the process of restoring water quality, only address the nonattainment of the public and private water supply use.

Table 2-1 Excerpt from the 2008 Integrated Report – Oklahoma §303(d) List of Impaired Waters (Category 5a)

Waterbody Name and WBID	Waterbody Size (Acres)	TMDL Date	TMDL Priority	Causes of Impairment	Designated Use Not Supported
Rocky (Hobart) Lake OK311500030060_00	347	2016	3	▪ Chlorophyll-*a* ▪ Turbidity ▪ Color	▪ Public and Private Water Supply ▪ Warm Water Aquatic Community ▪ Aesthetic
Tom Steed Lake OK311500020060_00	6,400	2010	1	▪ Chlorophyll-*a* ▪ Turbidity	▪ Public and Private Water Supply ▪ Warm Water Aquatic Community

Source: 2008 Integrated Report, ODEQ 2008.

The definition of SWS is summarized by the following excerpt from OAC 785:45-5-25 of the Oklahoma WQS (OWRB 2008).

> ***Sensitive Public and Private Water Supplies (SWS).***
> *(A) Waters designated "SWS" are those waters of the state which constitute sensitive public and private water supplies as a result of their unique physical conditions and are listed in Appendix A of this Chapter as "SWS" waters. These are waters (a) currently used as water supply lakes, (b) that generally possess a watershed of less than approximately 100 square miles or (c) as otherwise designated by the Board.*
> *(B) New point source discharges of any pollutant after June 11, 1989, and increased load of any specified pollutant from any point source discharge existing as of June 11, 1989, shall be prohibited in any waterbody or watershed designated in Appendix A of this Chapter with the limitation "SWS". Any discharge of any pollutant to a waterbody designated "SWS" which would, if it occurred, lower existing water quality shall be prohibited, provided however that new point source discharge(s) or increased load of specified pollutants described in 785:45-5-25(b) may be approved by the permitting authority in those circumstances where the discharger demonstrates to the satisfaction of the permitting authority that a new point source discharge or increased load from an existing point source discharge will result in maintaining or improving the water quality of both the direct receiving water and any downstream waterbodies designated SWS.*

The following excerpt from the Oklahoma WQS (OAC 785:45-5-10) stipulates the numeric criterion that has been set for SWS lakes including Rocky Lake and Tom Steed Lake (OWRB 2008).

> *785:45-5-10. Public and private water supplies*
> *The following criteria apply to surface waters of the state having the designated beneficial use of Public and Private Water Supplies:*
>
> *(7) Chlorophyll-a numerical criterion for certain waters. The long term average concentration of chlorophyll-a at a depth of 0.5 meters below the surface shall not exceed 0.010 milligrams per liter in Wister Lake, Tenkiller Ferry Reservoir, nor any waterbody designated SWS in Appendix A of this Chapter. Wherever such criterion is exceeded, numerical phosphorus or nitrogen criteria or both may be promulgated.*

Rocky Lake is also assigned the designation of “nutrient limited watershed” (NLW) in OAC 785:45-5-29. A NLW means a watershed of a waterbody with a designated beneficial use which is adversely affected by excess nutrients as determined by Carlson's Trophic State Index (TSI) (using chlorophyll-*a*) of 62 or greater, or is otherwise listed as "NLW" in Appendix A of Chapter 45 (OWRB 2010). In the case of Rocky Lake the NLW designation applies to its entire watershed and drainage area, including all direct and indirect tributaries (OWRB 2010).

Due to the location of the Mountain Park Wildlife Management Area within its watershed, the OWRB placed Tom Steed Lake on Table 1, Appendix B of Chapter 45 as an area with waters of recreational and/or ecological significance. New discharges or increased loading from existing discharges to Appendix B waters may be allowed under such conditions that ensure that the recreational and ecological significance of these waters will be maintained (OWRB 2010).

2.2 Problem Identification

In this subsection water quality data summarizing waterbody impairment caused by elevated levels of chlorophyll-*a* are summarized. Water quality data available for other nutrient parameters is also summarized. Table 2-2 provides the latitude and longitude locations of WQM stations associated with each lake. All of these WQM stations are part of the Oklahoma Beneficial Use Monitoring Program network (OWRB 2007). Table 2-2 also provides a hyperlink to the OWRB Data Viewer (http://maps.owrb.state.ok.us/ms/ws/wqbycounty.php) from which lake water quality data were obtained. The location of the WQM stations are illustrated in Figure 1-1 (Rocky Lake) and Figure 1-2 (Tom Steed Lake).

Table 2-2 Water Quality Monitoring Stations used for 2008 §303(d) Listing Decision

Water Body ID	Station ID*	Latitude	Longitude	Site Description
Rocky Lake				
311500030060_00	311500030060-01B	35.167161	-99.074258	Bottom
311500030060_00	311500030060-01S	35.167161	-99.074258	Near Surface
311500030060_00	311500030060-02	35.173031	-99.076792	Near Surface
311500030060_00	311500030060-03	35.183122	-99.073808	Near Surface
311500030060_00	311500030060-04	35.176941	-99.078844	Near Surface
311500030060_00	311500030060-05	35.171582	-99.072444	Near Surface
Tom Steed Lake				
311500020060_00	311500020060-01B	34.749953	-98.968383	Bottom
311500020060_00	311500020060-01S	34.749953	-98.968383	Near Surface
311500020060_00	311500020060-02	34.782683	-98.992947	Near Surface
311500020060_00	311500020060-03	34.757406	-99.019192	Near Surface
311500020060_00	311500020060-04	34.772099	-98.972794	Near Surface
311500020060_00	311500020060-05	34.758736	-99.000557	Near Surface

* Hyper links are workable in the electronic version of this document.

2.2.1 Chlorophyll-*a* Data Summary

Table 2-3 summarizes chlorophyll-*a* data collected from Rocky Lake WQM stations since 2002. The data summary in Table 2-3 provides a general understanding of the amount of water quality data available and the severity of exceedances over the water quality criterion of 10 µg/L chlorophyll-*a*, as a long-term average at a depth of one-half meter. Chlorophyll-*a* levels averaged 43.0 µg/L which is equivalent to a Carlson's TSI of 67 (Carlson 1977). Data from 2003 to 2007 were used in the Beneficial Use Monitoring Program to support the decision to place the lake on the ODEQ 2008 §303(d) list (ODEQ 2008) for non-support of the Public and Private Water Supply Use. For this TMDL development, when possible, available data from the most recent 10 years (2000-2009) were used (OAC 785:46-15-3(c)(3)). The water quality data are provided in Appendix B.

Table 2-3 Summary of Chlorophyll-*a* Measurements in Rocky Lake 2003-2009 (all values in µg/L)

Station ID	Number of Samples	Minimum	Maximum	Average	Median
311500030060-01B†	7	26.2	76.7	44.2	40.9
311500030060-01S	16	13.8	67.8	33.3	26.9
311500030060-02	11	26.1	92.3	51.1	40.7
311500030060-03	9	20.7	88.4	52.7	52.7
311500030060-04	9	25.3	80.8	47.4	44.5
311500030060-05	8	22.3	47.9	35.3	36.2
All*	53	26.1	47.9	43.0	38.8

†note that data from this deep station cannot be compared to the water quality criterion, which applies to samples collected at a depth of 0.5 meter. It is included for informational purposes only.
** Bottom data was excluded*

Table 2-4 summarizes chlorophyll-*a* measurements collected from Tom Steed Lake from 2002 through 2007. Pooling data from all sites, chlorophyll-*a* levels averaged 23.1 µg/L (TSI = 61), significantly lower than in Rocky Lake but still elevated relative to the long-term average SWS criterion of 10 µg/L. Data from 2002 to 2007 were used in the Beneficial Use Monitoring Program to support the decision to place the lake on the ODEQ 2008 §303(d) list (ODEQ 2008) for non-support of the Public and Private Water Supply Use. The water quality data are provided in Appendix B.

Table 2-4 Summary of Chlorophyll-*a* Measurements in Tom Steed Lake 2002-2007 (all values in µg/L)

Station ID	Number of Samples	Minimum	Maximum	Average	Median
311500020060-01B†	8	3.4	99	20.7	9.5
311500020060-01S	22	2.2	96	11.2	5.8
311500020060-02	12	3.1	302	34.2	10.0
311500020060-03	12	2.8	222	29.4	9.7
311500020060-04	12	2.2	232	26.5	6.9
311500020060-05	11	2.1	174	24.3	7.4
All*	69	2.1	302.0	23.1	7.65

†note that data from this deep station cannot be compared to the water quality criterion, which applies to samples collected at a depth of 0.5 meter. It is included for informational purposes only.

** Bottom data was excluded*

2.2.2 Nutrient Data Summary

During the years 1998 to 2009, total nitrogen levels in Rocky Lake averaged approximately 1.5 mg/L, and total phosphorus levels averaged 0.13 mg/L (Table 2-5). Total nitrogen is calculated as the sum of Kjeldahl nitrogen and two inorganic forms in different oxidation states: nitrate and nitrite nitrogen. Kjeldahl nitrogen is the sum of organic nitrogen and ammonia nitrogen. Total phosphorus is comprised of organic phosphorus, inorganic orthophosphorus, and inorganic polyphosphates. Thermal stratification was not observed during the 2006-2007 assessment period, likely due to the shallow nature of the lake (OWRB 2007). Thus, nutrient fluxes from sediments were available year-round in the photic zone where light permits algal photosynthesis.

Table 2-5 Summary of Average Nutrient Measurements in Rocky Lake 1998-2009 (all values in mg/L)‡

Station ID	Nitrogen, Ammonia	Nitrogen, Kjeldahl	Nitrogen, Nitrate+Nitrite	Phosphorus, Ortho	Phosphorus, Total
311500020060-01B	0.340	1.385	0.140	0.104	0.210
311500020060-01S	0.095	1.281	0.222	0.052	0.132
311500020060-02	0.089	1.297	0.188	0.037	0.127
311500020060-03	0.085	1.362	0.259	0.038	0.141
311500020060-04	0.034	1.318	0.124	0.030	0.123
311500020060-05	0.034	1.301	0.145	0.035	0.125
All	0.091	1.316	0.194	0.041	0.133

‡ *Non-detects were averaged at the detection limit*

Total nitrogen levels in Tom Steed Lake averaged approximately 0.70 mg/L, and total phosphorus levels averaged 0.073 mg/L (Table 2-6). As in Rocky Lake, thermal stratification was not observed during 2006-2007 in Tom Steed Lake (OWRB 2007).

Water quality data for nutrient parameters in both lakes are provided in Appendix B.

2.3 Water Quality Target

The Code of Federal Regulations (40 CFR §130.7(c)(1)) states that, "TMDLs shall be established at levels necessary to attain and maintain the applicable narrative and numerical water quality standards." The water quality target established for each lake must demonstrate compliance with the numeric criterion prescribed for SWS lakes in the Oklahoma WQS (OWRB 2008). Therefore the water quality target established for Rocky Lake and Tom Steed Lake is to achieve a long-term average in-lake concentration of 10 µg/L for chlorophyll-*a*. Rocky Lake is also included in the 303(d) list for turbidity and color, while Tom Steed Lake is listed for turbidity exceedances. The implementation of this TMDL will at least partially address the impairment resulting from turbidity levels and color in the lakes. However, these water quality issues will be addressed specifically on a future date.

Table 2-6 Summary of Average Nutrient Measurements in Tom Steed Lake 2002-2007 (all values in mg/L)‡

Station ID	Nitrogen, Ammonia	Nitrogen, Kjeldahl	Nitrogen, Nitrate+Nitrite	Phosphorus, Ortho	Phosphorus, Total
311500020060-01B	0.025	0.547	0.084	0.035	0.067
311500020060-01S	0.039	0.630	0.088	0.048	0.071
311500020060-02	0.028	0.617	0.072	0.044	0.075
311500020060-03	0.039	0.619	0.070	0.041	0.073
311500020060-04	0.031	0.641	0.091	0.053	0.076
311500020060-05	0.031	0.663	0.083	0.050	0.073
All	0.033	0.624	0.078	0.046	0.073

‡ *Non-detects were averaged at the detection limit*

SECTION 3
POLLUTANT SOURCE ASSESSMENT

This section includes an assessment of the known and suspected sources of nutrients contributing to the eutrophication of Rocky Lake and Tom Steed Lake. Nutrient sources identified are categorized and quantified to the extent that reliable information is available. Generally, nutrient loadings causing eutrophication of lakes originate from point or nonpoint sources of pollution. Point sources are permitted through the NPDES program. Nonpoint sources are diffuse sources that typically cannot be identified as entering a waterbody through a discrete conveyance at a single location. Nonpoint sources may emanate from land activities that contribute nutrient loads to surface water as a result of rainfall runoff. For the TMDLs in this report, all sources of pollutant loading not regulated by NPDES are considered nonpoint sources. The following discussion provides a general summary of the point and nonpoint sources of nutrients emanating from the contributing watersheds of each lake.

3.1 Assessment of Point Sources

Under 40 CFR §122.2, a point source is described as a discernable, confined, and discrete conveyance from which pollutants are or may be discharged to surface waters. NPDES-permitted facilities classified as point sources that may contribute nutrient loading include:

- NPDES municipal wastewater treatment plant (WWTP) discharges;
- NPDES industrial WWTP discharges;
- NPDES municipal no-discharge WWTPs;
- NPDES concentrated animal feeding operations (CAFOs);
- NPDES municipal separate storm sewer system discharges;

Of these five types of facilities only one type occurs within Rocky Lake and Tom Steed watersheds – municipal no-discharge WWTPs. Therefore there are no point sources discharging to the lakes or the tributaries of each lake within the Study Area. The no-discharge facilities permitted within each watershed are listed in Table 3-1 and their location is shown in Figures 3-1 and 3-2. For the purposes of these TMDLs, no-discharge facilities are not considered a source of nutrient loading. It is possible that the wastewater collection system associated with no-discharge facilities could be a source of nutrient loading, or that discharges from the wastewater plant may occur during large rainfall events that exceed the systems' storage capacities. These types of unauthorized discharges are typically reported as sanitary sewer overflows. However, the facilities in Table 3-1 have not reported a sanitary sewer overflow since 2000. Furthermore, given the small size of the wastewater collection systems of these no-discharge facilities the contributions of nutrient loads would be negligible.

Table 3-1 NPDES No-Discharge Facilities in the Study Area

Facility	Facility ID	County	Facility Type	Type	Waterbody ID and Name
Burns Flat-North Lagoon	10809	Washita	Lagoon Total Retention	Municipal	Rocky (Hobart) Lake OK311500030060_00
Clinton-Sherman Industrial Airpark	11506†	Washita	Lagoon Total Retention	Municipal	Rocky (Hobart) Lake OK311500030060_00
Dill City WWTF	11507	Washita	Lagoon Total Retention	Municipal	Rocky (Hobart) Lake OK311500030060_00
Roosevelt WWTF	11511	Kiowa	Lagoon Total Retention	Municipal	Tom Steed Lake OK311500020060_00

† Until 2002, this facility discharged wastewater under NPDES permit OK0027031

3.2 Assessment of Nonpoint Sources

As previously stated, there are no point source discharges in the Study Area; therefore all of the nutrient loading to each lake originates from nonpoint sources. Nonpoint sources include those sources that cannot be identified as entering the waterbody at a specific location. The relatively homogeneous land use/land cover categories throughout the Study Area associated with agricultural and forest and range management activities have a strong influence on the origin and pathways of nutrient sources to surface water. Nutrient sources in rural watersheds originate from soil erosion, agricultural fertilization, residues from mowing and harvesting, and fecal waste deposited in the watershed by livestock. Causes of soil erosion can include natural causes such as flooding and winds, construction activities, vehicular traffic, and agricultural activities. Other sources of nutrient loading in a watershed include atmospheric deposition, failing onsite wastewater disposal (OSWD) systems, and fecal waste deposited in the watershed by wildlife and pets. The following sections provide general information on nonpoint sources contributing nutrient loading within the Study Area.

3.2.1 SWAT Model Development for Nonpoint Sources Loadings

Given the lack of instream water quality data and pollutant source data available to quantify nutrient and sediment loading directly from the tributaries of Rocky Lake and Tom Steed Lake, a watershed loading model – the Soil and Water Assessment Tool (SWAT) – was used to develop nonpoint source loading estimates. These estimates from SWAT were used to quantify the nutrient contributions to each lake. SWAT is a basin-scale watershed model that can be operated on a daily time step (Neitsch et al. 2005). SWAT is designed to predict the impact of management strategies on water, nutrient, sediment, and agricultural chemical yields. The model is physically (and empirically) based, computationally efficient, and capable of continuous simulation over long time periods. The major components of the model include weather, hydrology, soil temperature and properties, plant growth, nutrients, and land management. The development and calibration of the SWAT model is described in detail in the report *Technical Methods Summary for Watershed and Water Quality Modeling of Sensitive Water Supply Lakes in Oklahoma* (Parsons 2010). A summary of the SWAT modeling of nonpoint sources is provided below.

Figure 3-1 NPDES No-Discharge Facilities in Rocky Lake Watershed

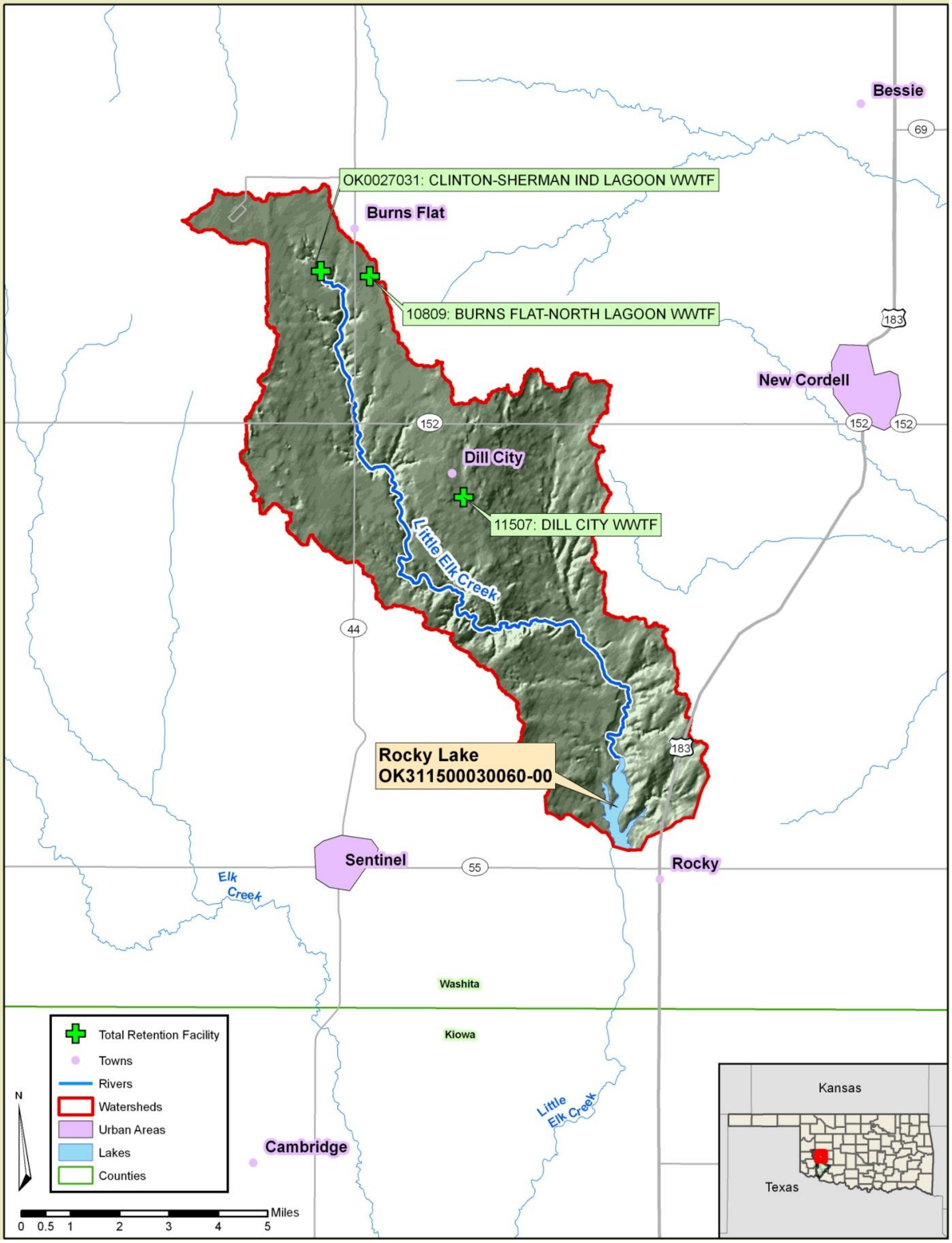
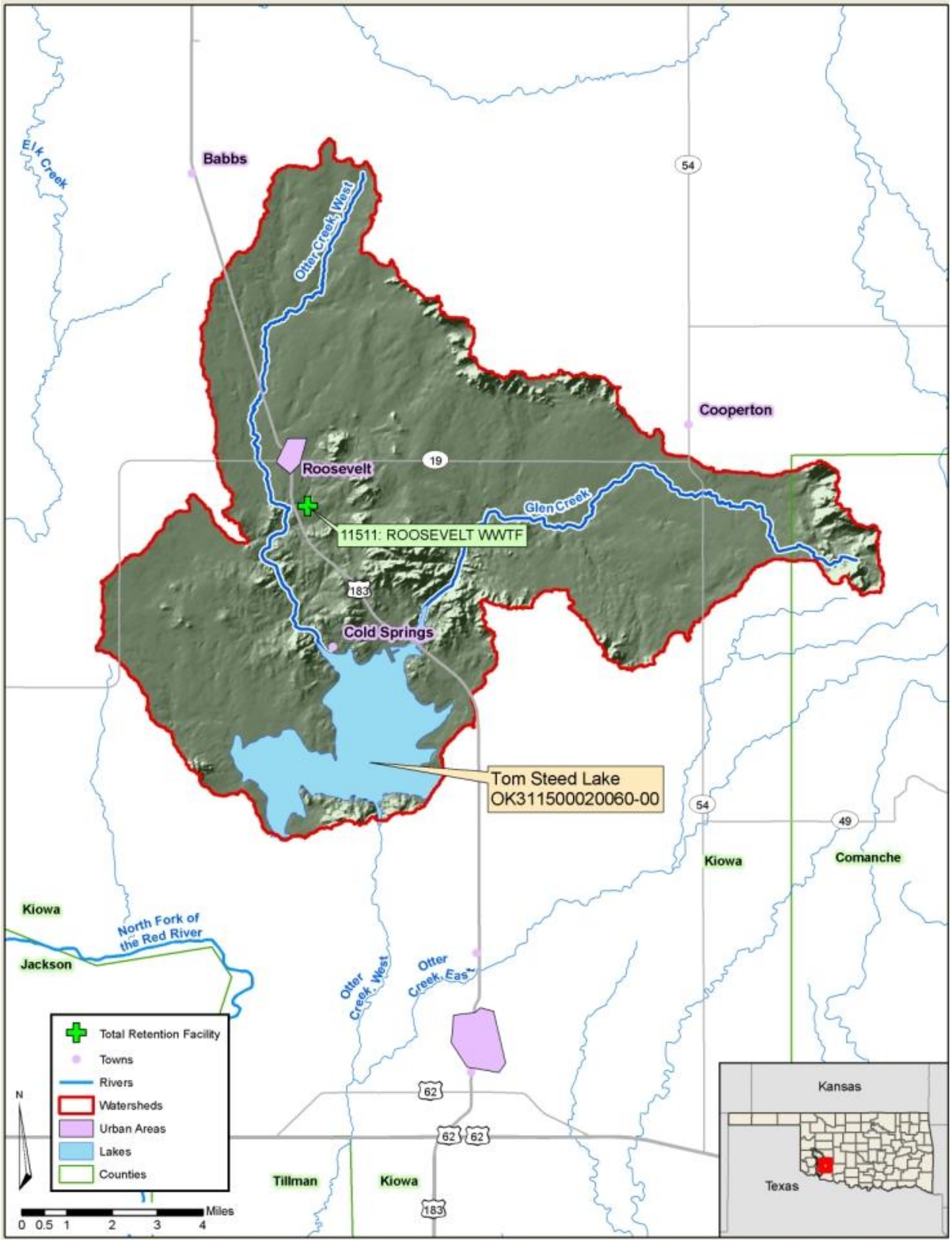


Figure 3-2 NPDES No-Discharge Facilities in Tom Steed Lake Watershed

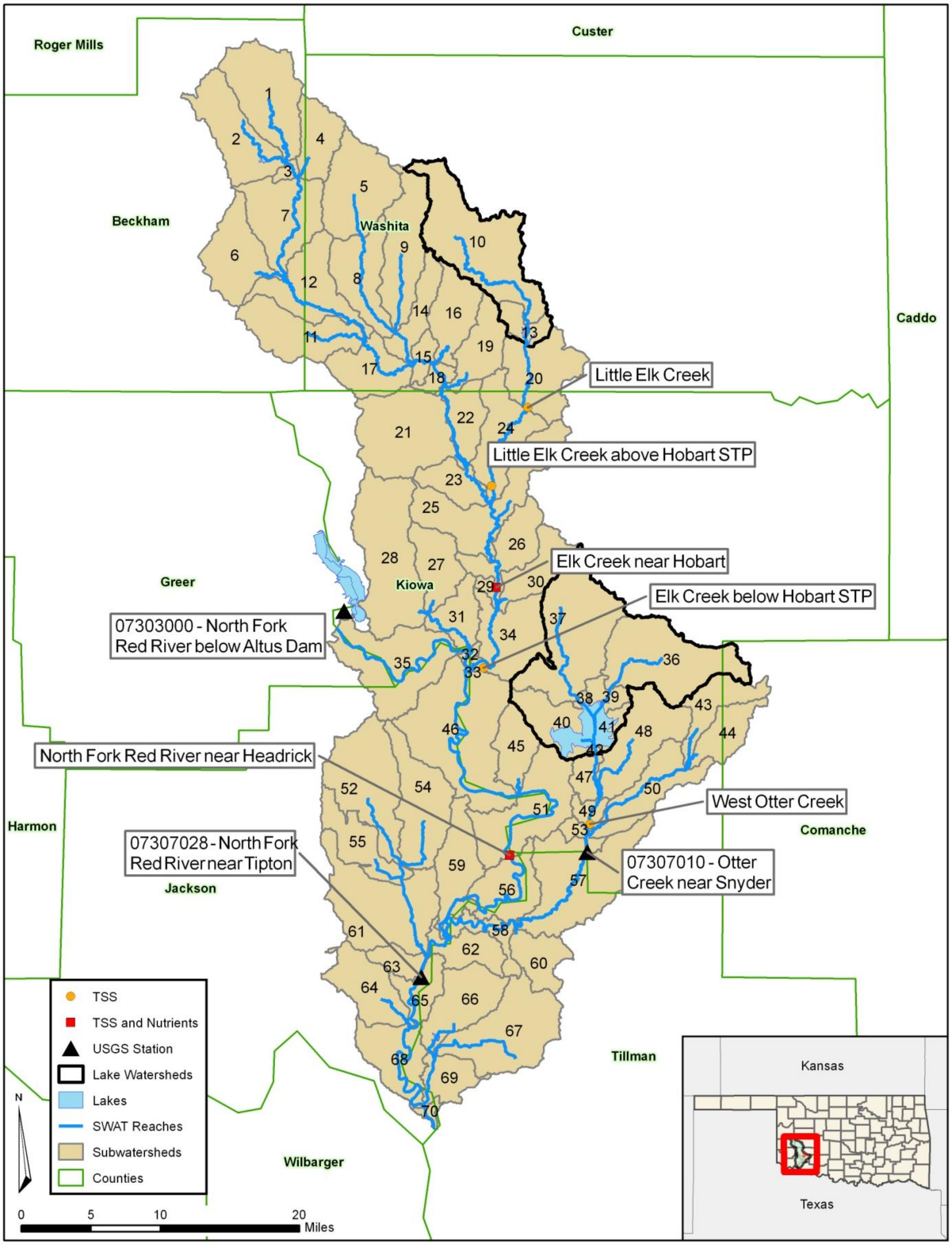


There are no stream flow or water quality monitoring stations in the tributaries to Rocky Lake or Tom Steed Lake. In order to calibrate the SWAT model it was necessary to extend the modeled area to encompass watersheds with stream flow gages and nutrient concentration measurements. Thus, the SWAT model simulated an entire USGS hydrologic unit 11120303 (Lower North Fork of the Red River Basin), a 1,390 square mile area that includes the contributing watersheds of both Rocky Lake and Tom Steed Lake (Figure 3-3). The main streams located in the model domain are the North Fork of the Red River, Elk Creek, Otter Creek, Stinking Creek, Little Elk Creek (the main tributary to Rocky Lake), and West Otter Creek (the main tributary to Tom Steed Lake). The watershed is predominantly rural and agricultural with a few urban centers including Altus, Elk City, Hobart, and Snyder. The modeled area was split into 70 sub-watersheds (Figure 3-3) based on the National Elevation Dataset (http://ned.usgs.gov) and the National Hydrography Dataset (http://nhd.usgs.gov) of the USGS. The watersheds of Rocky Lake and Tom Steed Lake were two of the subwatersheds simulated in SWAT, and are outlined in black in Figure 3-3. This figure also shows the locations of USGS gages and water quality monitoring stations at which the SWAT model was calibrated.

Soil data were derived from the STATSGO State Soil Geographic Database of the United States Department of Agriculture (USDA) Natural Resource Conservation Service (http://soils.usda.gov/survey/geography/statsgo/). Land use and land cover data were derived from the 2001 National Land Cover Dataset (http://www.mrlc.gov/nlcd.php) (USGS 2007). Data on the acreage of crops harvested at a county level were obtained from the 2007 Census of Agriculture (http://www.nass.usda.gov/ Statistics_by_State/ Oklahoma/index.asp). County-level summaries of annual cattle population estimates from the National Agricultural Statistics Service were evenly distributed across pasture land. Soil phosphorus concentrations were the county averages for the period 1994 to 2001 from the Oklahoma State University Department of Plant and Soil Science (Storm et al, 2000).

Point source discharges of pollutants in the modeled HUC 11120303 watershed were included in the SWAT model, using discharge monitoring reports (DMR) to indicate flows and loads. CAFOs were not included in the SWAT model, given the insignificant contributions from the two no-discharge concentrated animal feeding operation (CAFO) facilities located in the modeled hydrologic unit. OSWD systems (septic systems) were also not included in the SWAT model. Using data from the 1990 census to estimate a density of household with OSWDs, there were 2,662 OSWD systems within the simulated watershed. Of these, approximately 107 OSWDs were estimated to lie within the Rocky Creek watershed, and 146 within the watershed of Tom Steed Lake. More recent OSWD data are not available. Because the areas with the highest density of septic systems are close to urban developments that currently have a permitted WWTP (e.g. City of Ada and City of Elk City), it was assumed that about half of the properties that utilized OSWDs for wastewater disposal in 1990 have since connected to municipal sewer collection systems. Using an 8% rate of OSWD systems malfunctioning derived from a 2001 study by Reed, Stowe & Yanke, LLC done in the Texas panhandle, a total of 106 systems are assumed to be malfunctioning and leaking wastewater to the modeled watershed (Reed, Stowe & Yanke LLC 2001). Using the same calculations, only 4 of those malfunctioning OSWD systems would be present in the Rocky Lake watershed, and 6 in the watershed of Tom Steed Lake. Because the estimated number of malfunctioning OSWD systems is insignificant, nutrient loadings from these systems were not included in the SWAT model.

Figure 3-3 Subwatersheds Simulated in the SWAT Watershed Model



A fifteen year period (1994 - 2008) was simulated in the SWAT model. However, the first four years were considered a "spin-up" period for stabilizing model initial conditions, and the model output consisted of only the latter 11 years (1998 - 2008). The variables simulated in SWAT included flow, organic phosphorus, mineral ortho-phosphorus, organic nitrogen, ammonia nitrogen, nitrate nitrogen, nitrite nitrogen, and total suspended solids.

The SWAT hydrologic calibration was primarily performed based on flow data available at the USGS gages (Figure 3-3) located on the North Fork Red River near Tipton (0730728) and Otter Creek near Snyder (07307010). The primary calibration targets included annual water balances, but modeled monthly flows (Figure 3-4) and the resulting flow duration curves were also compared to measured values. Overall, the model reproduces the annual flows within the 15 percent target for most years, with overall errors for the calibration and validation periods well below the target (-5% for North Fork Red River and <1% for Otter Creek). Resulting Nash-Sutcliffe Efficiency coefficients (NSE) and correlation coefficient (r^2) values were 0.860 and 0.861 for North Fork Red River and 0.939 and 0.943 for Otter Creek. Both of those two coefficients are above the minimum targets of 0.5 for NSE and 0.6 for r^2, indicating very good model performance.

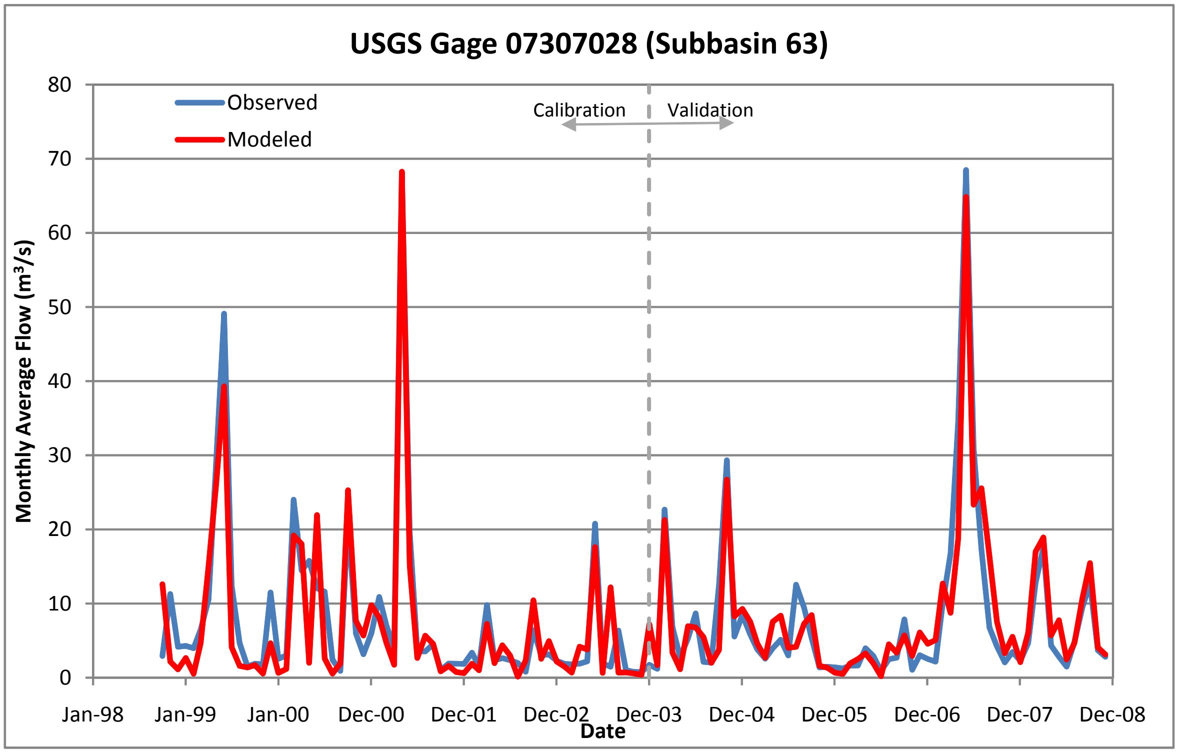
After hydrologic calibration, the SWAT-predicted nutrient concentrations were compared to the average measured nutrient concentrations at the two water quality stations where they were available (Figure 3-3): Elk Creek near Hobart (OK311500030010-001AT) and the North Fork Red River near Headrick (OK311500010020-001AT). In most cases, the SWAT model reproduced the average nutrient concentrations within 20 percent of the measured averages (Figure 3-5). In some instances, the model does not replicate speciation for a given period, but nevertheless the total phosphorus and nitrogen predicted averages are within target for both the calibration and verification periods. Overall (calibration+validation), the model reproduces the average concentrations of all nutrients within 20 percent of the observed averages. However, it is noted that the monitoring data available for calibration are from low to moderate flow conditions. As a result, there is more uncertainty on high flow loading values.

3.2.2 Estimated Nutrient Loading from Nonpoint Sources

The SWAT modeling was used to estimate nutrient loads from land management activities such as soil erosion, agricultural fertilization, residues from mowing and harvesting, and fecal waste deposited in the field by livestock. Nutrient loading associated with atmospheric deposition is incorporated into the lake model BATHTUB (see Section 4). Fecal waste deposited in the watershed by wildlife and pets is not considered to be a significant source of nutrient loading in either watershed so it was not quantified as model input.

Based on the calibrated SWAT model, average loads of nutrients from each of the individual subwatersheds were estimated for the period 1998 to 2008. For comparative purposes, the phosphorus and nitrogen loads are expressed on an areal basis in kilograms per hectare per year (kg/ha/yr) in Figures 3-6 and 3-7. Results for other nutrients are provided in *Technical Methods Summary for Watershed and Water Quality Modeling of Sensitive Water Supply Lakes in Oklahoma* (Parsons 2010). The average daily flows and loads into Rocky Lake and Tom Steed Lake are displayed in Table 3-2. Under current conditions, Rocky Lake is estimated to receive a total annual load of 38,000 kg of phosphorus and 62,000 kg of nitrogen, on average, from nonpoint sources in its watershed. Tom Steed Lake is estimated to receive a total annual load of 68,600 kg of phosphorus and 116,400 kg of nitrogen, on average, from nonpoint sources in its watershed.

Figure 3-4 Observed and SWAT Modeled Average Monthly Flows



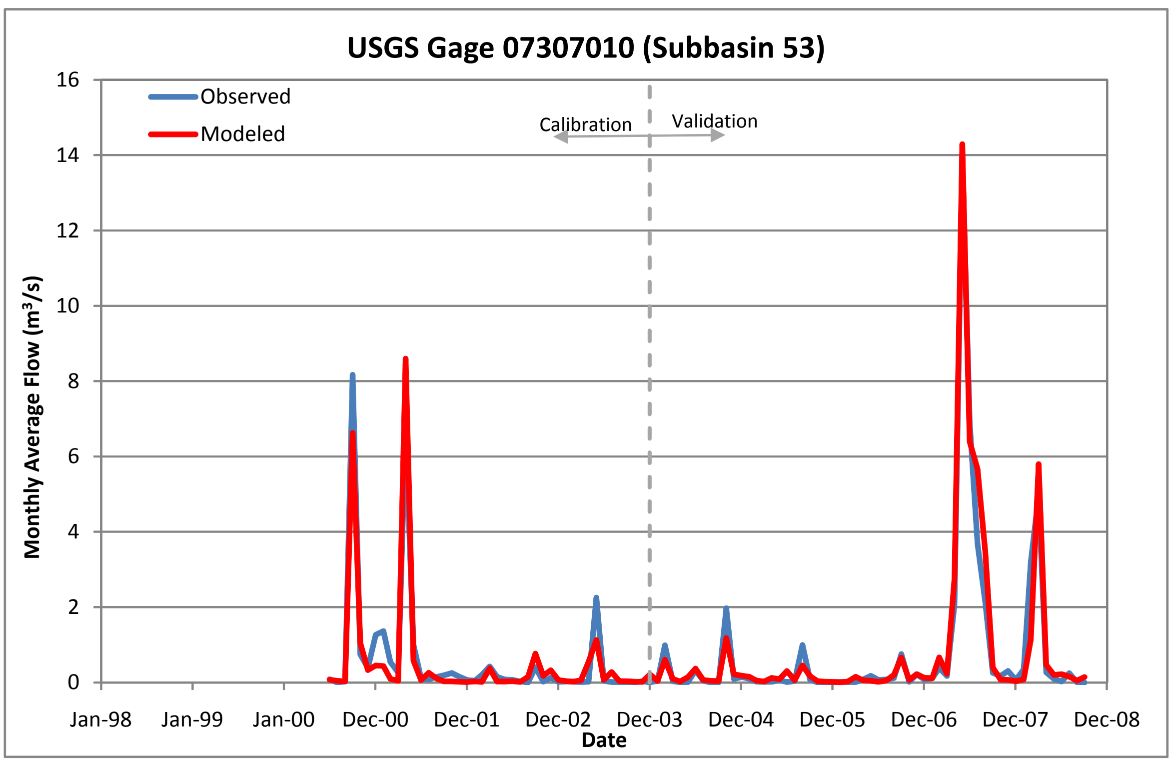
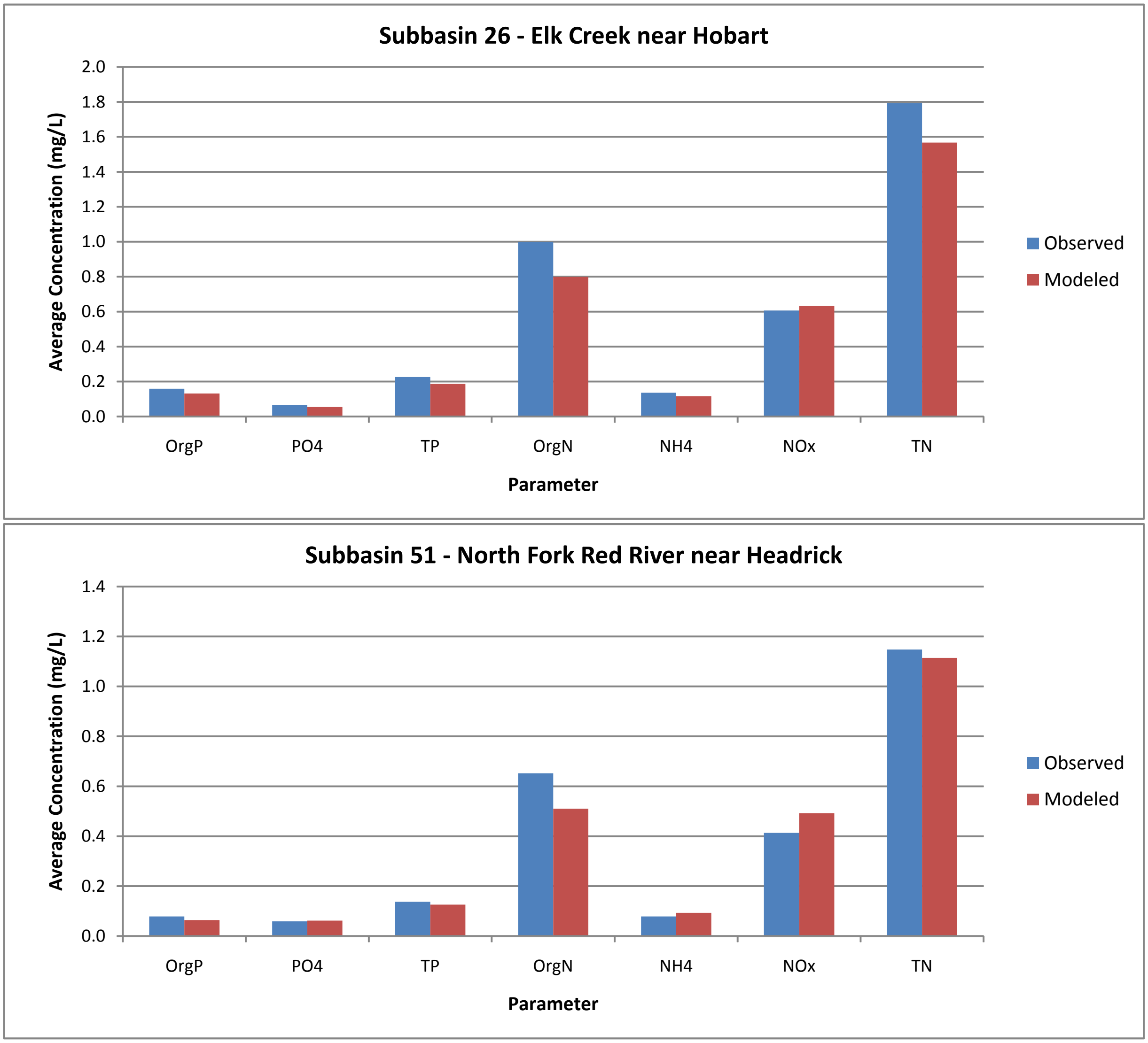


Figure 3-5 Observed and SWAT Modeled Nutrient Concentrations



OrgP = organic phosphorus; PO4 = mineral phosphate phosphorus; TP = total phosphorus; OrgN = organic nitrogen; NH4 = ammonia nitrogen; NOx = nitrate+nitrite nitrogen

Table 3-2 Average Flows and Nutrient Loads Discharging to Rocky Lake and Tom Steed Lake

Parameter	Rocky Lake	Tom Steed Lake
Watershed Size (square miles)	55	119
Flow (m^3/day)	3.97×10^4	1.20×10^5
Organic Phosphorus (kg/year)	14,600	14,600
Mineral Ortho-Phosphorus (kg/year)	23,400	54,000
Total Phosphorus (kg/year)	**38,000**	**68,600**
Organic Nitrogen (kg/year)	24,500	50,000
Ammonia Nitrogen (kg/year)	10,200	33,200
Nitrite Nitrogen (kg/year)	700	5,100
Nitrate Nitrogen (kg/year)	26,600	28,100
Total Nitrogen (kg/year)	**62,000**	**116,400**

Figure 3-6 Average Total Phosphorus Loading from SWAT Subwatersheds

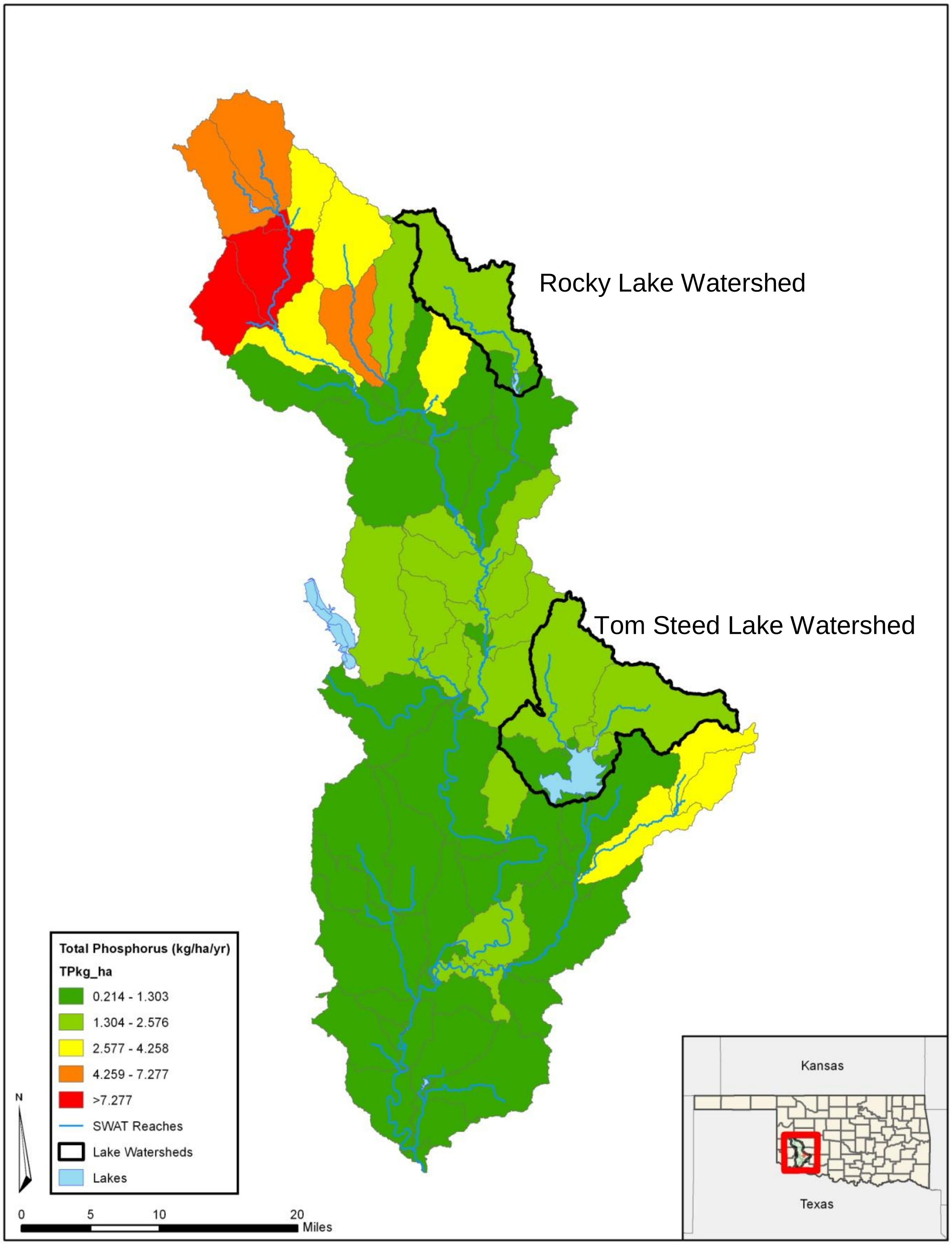
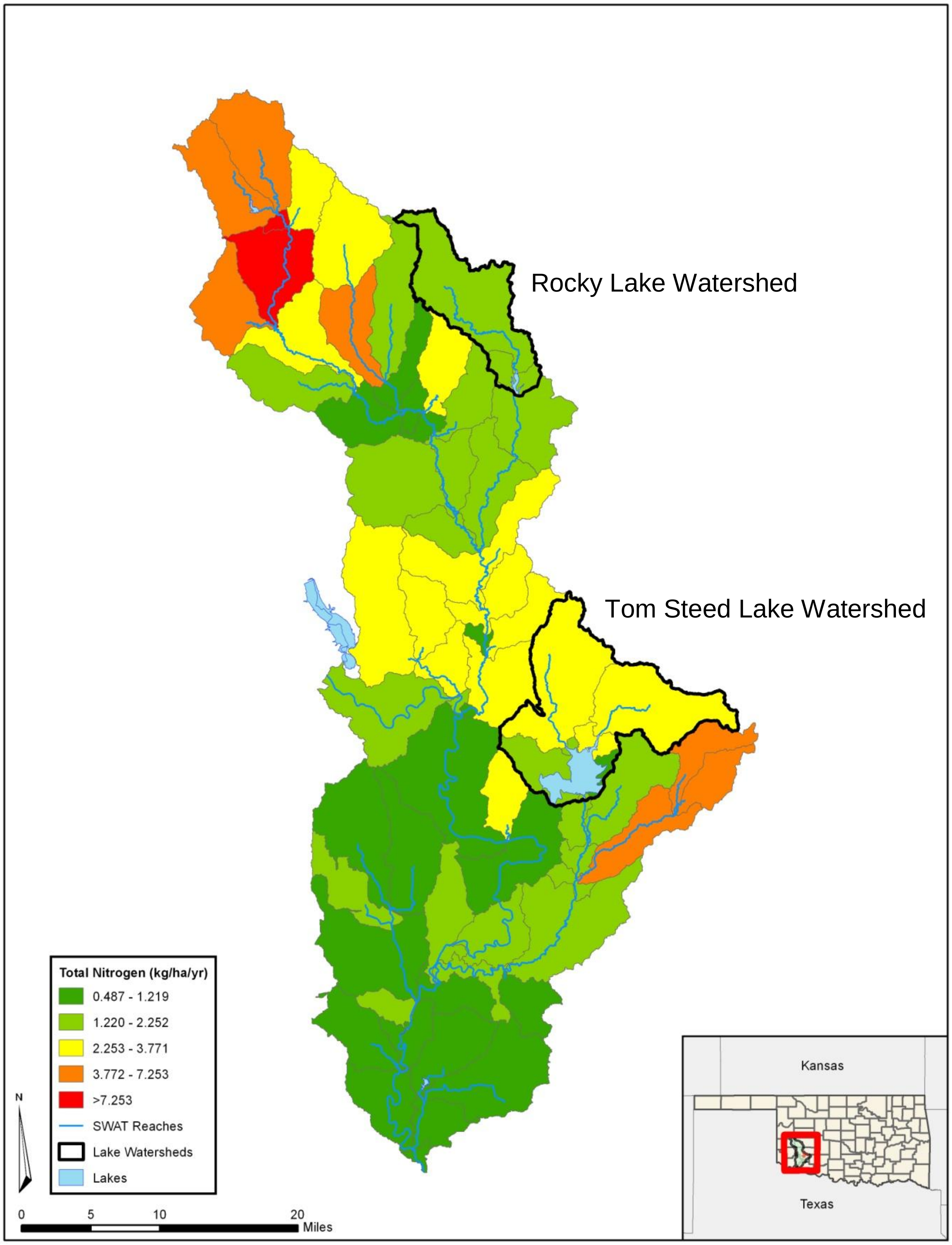


Figure 3-7 Average Total Nitrogen Loading from SWAT Subwatersheds



SECTION 4
TECHNICAL APPROACH AND METHODS

The objective of a TMDL is to estimate allowable pollutant loads and to allocate these loads to the known pollutant sources in the watershed so appropriate control measures can be implemented and the WQS achieved. In order to ascertain the effect of management measures on in-lake water quality, it is necessary to establish a linkage between the external loading of nutrients and the waterbody response in terms of lake water quality conditions, as evaluated by chlorophyll-*a* concentrations. This section describes the water quality analysis of the linkage between chlorophyll-*a* levels in Rocky Lake and Tom Steed Lake and the nutrient loadings from their watersheds.

The report *Technical Methods Summary for Watershed and Water Quality Modeling of Sensitive Water Supply Lakes in Oklahoma* (Parsons 2010) provides a thorough description of the water quality modeling analysis. The sections below summarize the inputs and results of that modeling.

4.1 BATHTUB Model Description

The water quality linkage analysis was performed using the BATHTUB model (Walker 1986). BATHTUB is a U.S. Army Corps of Engineers model designed to simulate eutrophication in reservoirs and lakes. BATHTUB has been cited as an effective tool for reservoir and lake water quality assessment and management, particularly where data are limited. The model incorporates several empirical equations of nutrient settling and algal growth to predict steady-state water column nutrient and chlorophyll-*a* concentrations based on water body characteristics, hydraulic characteristics, and external nutrient loadings.

BATHTUB predicts steady-state concentrations of chlorophyll-*a*, total phosphorus, total nitrogen, water transparency, and a conservative substance (e.g., chloride or a dye tracer) in a water body under various hydrologic and loading conditions. To do this, the model requires inputs that describe the physical characteristics of each lake (e.g., depth, surface area), tributary flow rates and loadings (which can be estimated by BATHTUB or input from another model), and observed water quality concentrations to use as calibration targets.

4.2 BATHTUB Model Setup and Input Data

The model was run under average, steady-state conditions.

Lake Morphometry. BATHTUB allows the user to segment a lake into a hydraulic network. However, significant lake morphometry data is required to justify the complex assumptions inherent in partitioning a reservoir into multiple hydraulically linked segments. A single segment was deemed applicable for both reservoirs which are considered relatively well-mixed horizontally. Bathymetric data for Tom Steed Lake was available through the U.S. Bureau of Reclamation; however no morphometric data is available for Rocky Lake. Therefore, for the purposes of this study and given the narrow, shallow characteristics of Rocky Lake, a well-mixed lake of oblong shape was assumed. Based on availability of both flow and water quality data, for the purposes of TMDL development, a single segment was determined as sufficient for both lakes. In addition, an averaging period of one year was used to depict the duration of mass-balance calculations (e.g., a single filling and emptying event in a year) for both lakes. Lake characteristics are provided in Table 4-1, based on the lake's size when the conservation pool is full.

Table 4-1 Lake Morphometric Characteristics

Lake	Lake Volume (m^3)	Surface Area (km^2)	Mean Depth (m)
Tom Steed Lake	120,000,000	25.9	4.63
Rocky Lake	3,784,000	1.376	2.75

Meteorology. The BATHTUB model requires both precipitation and evaporation data. Precipitation data are available from the Oklahoma MESONET system and were provided in Section 1.2. Water surface evaporation rates in Oklahoma have been reported by the Oklahoma Water Resources Board to vary from 48 inches per year in the eastern part of the state to 65 inches per year in the southwest (http://www.owrb.ok.gov/util/waterfact.php). A rate of 65 inches per year was applied for both Tom Steed Lake and Rocky Lakes due to their location in the southwest corner of the state.

Inflows and Loads. Key water quality parameters for BATHTUB input include total phosphorus, inorganic ortho-phosphorus, total nitrogen, and inorganic nitrogen. Output from the SWAT model, described in Section 3.2, was the primary source of data inputs to the BATHTUB model. Although SWAT can provide daily output, BATHTUB is a steady-state model and not appropriate for interpreting short-term responses of lakes to nutrients. Therefore, the long-term average annual loads from the SWAT modeled period were applied as inputs to BATHTUB.

BATHTUB also requires an estimate of atmospheric deposition of total and inorganic nitrogen and phosphorus. Atmospheric deposition can contribute a significant amount of phosphorus and nitrogen directly to a lake surface when the ratio of watershed area to lake surface area is low. Atmospheric deposition measurements from site OK17 (Kessler Farm Field Laboratory, in McClain County) of the National Atmospheric Deposition Program (http://nadp.sws.uiuc.edu/) were used. Table 4-2 summarizes the estimate of atmospheric loads based on the data compiled from site OK17 for the period 1983-2010. These loads are insignificant when compared to the loads from the watersheds.

Table 4-2 Estimate of Atmospheric Loads

Atmospheric Loads	Areal Mean (mg/m^2-yr)	Estimated Load to Rocky Lake (kg/year)	Estimated Load to Tom Steed Lake (kg/year)	CV
Total Nitrogen	1127	1.55	29.2	0.2
Inorganic Nitrogen	200	0.28	5.2	0.5

Empirical equations. BATHTUB consists of a series of empirical equations that have been calibrated and tested for lake application. These empirical relationships are used to calculate steady-state concentrations of total phosphorus, total nitrogen, chlorophyll-*a*, and transparency based on the inputs and forcing functions. To predict each output (e.g., total phosphorus concentration), one of several built-in empirical equations must be selected. The BATHTUB model was run using the following options:

- Phosphorus and Nitrogen balance: second-order decay rate function
- Chlorophyll-*a*: phosphorus, nitrogen, light, flushing
- Water transparency: Secchi vs. chlorophyll-*a* and turbidity

4.3 BATHTUB Model Calibrations and Output

The model was run under average existing conditions, and calibrated to measured in-lake water quality conditions for the period of record of the available sampling data using phosphorus and nitrogen calibration factors. Table 4-3 includes the calibration factors used for both lakes.

Table 4-3 Calibration Factors Used for Lakes

Calibration Factor	Rocky Lake	Tom Steed Lake
Total Phosphorus	0.95	3.6
Total Nitrogen	2.07	20
Chlorophyll-*a*	1.95	1.65
Secchi Disk	1	1

The model-predicted concentrations of total nitrogen, total phosphorus, chlorophyll-*a*, and Secchi depth under existing average conditions are compared to average measured concentrations from each lake in Table 4-4. The measured average values are derived from the available water quality data set provided in Appendix B.

Table 4-4 Model Predicted and Measured Water Quality Parameter Concentrations

Water Quality Parameter	Rocky Lake		Tom Steed Lake	
	Modeled	Measured (average)	Modeled	Measured (average)
Total Phosphorus (mg/L)	0.130	0.133	0.070	0.073
Total Nitrogen (mg/L)	1.45	1.51	0.740	0.703
Chlorophyll-*a* (µg/L)	44.9	43.0	16.6	23.1
Secchi depth (meters)	0.30	0.29	0.40	0.38

4.4 Modeled Load Reduction Scenarios

Simulations were performed using the BATHTUB model to evaluate the effect of loading reductions on chlorophyll-*a* levels. The simulations indicated that the water quality target of 10 µg/L chlorophyll-*a* as a long-term average concentration could be achieved if the total nitrogen and phosphorus loads to Rocky Lake were reduced by 87% from the existing loads, to 8,000 kg/year of total nitrogen and 5,000 kg/year of total phosphorus. In Tom Steed Lake, the water quality target of 10 µg/L chlorophyll-*a* could be achieved if the total nitrogen and phosphorus loads were reduced by 65% from existing loading, to 41,000 kg/year of total nitrogen and

24,000 kg/year of total phosphorus. Table 4-5 summarizes the percent reduction goals for nutrient loading established for each lake. In addition to these maximum allowable loads, an explicit margin of safety of 10 percent places further limits on loading of both nitrogen and phosphorus.

Table 4-5 Total Phosphorus and Nitrogen Load Reductions to Meet a 10 µg/L Chlorophyll-*a* In-lake Water Quality Target

	Rocky Lake	Tom Steed Lake
Maximum Allowable Load of Total Phosphorus (kg/year)	5,000	24,000
Maximum Allowable Load of Total Nitrogen (kg/year)	8,000	41,000
% Reduction	**87%**	**65%**

Eutrophication is one of the leading causes of pollution in lakes and reservoirs throughout the world (Smith 2003). Therefore, determining which nutrients limit phytoplankton growth is an important step in the development of effective lake and watershed management strategies (Dodds and Priscu 1990; Elser *et al.* 1990; Smith *et al.* 2002). It is often assumed that algal productivity of most freshwater lakes and reservoirs is primarily limited by the availability of the nutrient phosphorus. Therefore, limits on phosphorus loading to lakes are sometimes considered a necessary, and typically sufficient, mechanism to reduce eutrophication. However, more recent studies in reservoirs indicate that both nitrogen and phosphorus play key roles, along with light, mixing conditions, predation by zooplankton, and residence time, in limiting algal growth (Kimmel et al., 1990). In a study of 19 Kansas reservoirs, Dzialowski et al. (2005) utilized bioassays to measure algal growth limitation, and found that phytoplankton growth substantially increased with phosphorus addition (implying that phosphorus alone limited growth) in only 8% of the bioassays. Nitrogen was the sole limiting nutrient in 16% of the bioassays. In 67% of the bioassays, significant algal growth did not occur upon addition of nitrogen or phosphorus singly, but did grow in response to addition of both nitrogen and phosphorus. In these systems, algal growth was considered to be co-limited by availability of phosphorus and nitrogen. Co-limitation by nitrogen and phosphorus was also reported to be the most common condition for two lakes in north Texas (Chrzanowski and Grover 2001). In some cases, growth limitation by phosphorus has been observed to be more common in the spring, followed by a shift to nitrogen limitation in the summer and fall.

Figures 4-1 and 4-2 display summary plots of multiple combinations of N and P concentrations and percent reductions that result in 10 µg/L chlorophyll-*a* estimated by BATHTUB. While the relative importance of nitrogen and phosphorus in limiting algal productivity in Tom Steed and Rocky Lakes has not been established, this TMDL calculates load allocations for both nitrogen and phosphorus as a conservative approach to ensure that water quality targets are met. While the BATHTUB model is capable of simulating chlorophyll-*a* concentrations from both P and N concentrations, it is an empirically derived statistical algorithm that does not include the concept of a limiting nutrient. In other words, chlorophyll-*a* concentrations are a continuous function of both N and P contributions which can vary from season to season. Since there are infinite combinations of N and P concentrations that could result in the desired chlorophyll-*a* concentration and BATHTUB is not capable of discerning between them, reductions were assumed to be the same for both nutrient parameters. The red lines in Figures 4-1 and 4-2 show portray equal percent reductions of both nutrients for the two lakes, which can serve as a starting point for an implementation strategy for achieving the chlorophyll-*a* water quality target in the lakes. Depending on the local environmental and socio-economical conditions, different percent reductions for the two nutrients may be used based on the curves in Figures 4-1 and 4-2 to achieve the target chlorophyll-*a* level in the lakes.

Figure 4-1 Total N and Total P Combinations Resulting in 10 µg/L Chlorophyll-*a* - Rocky Lake

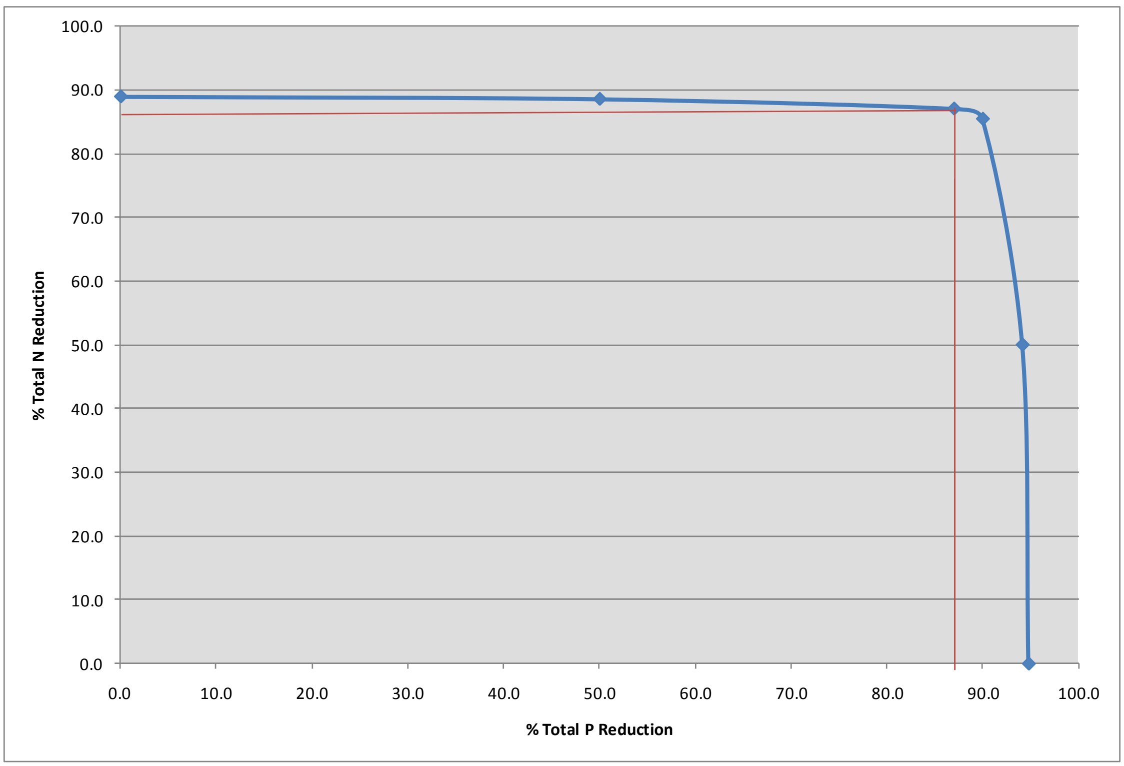
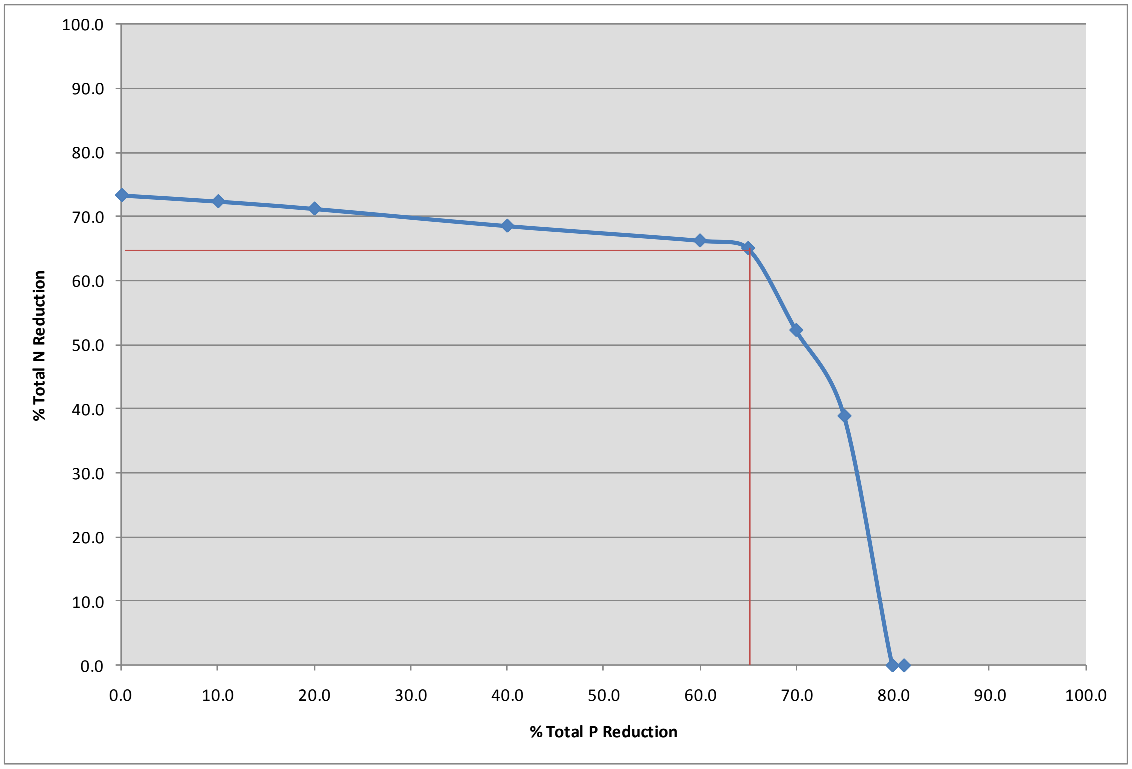


Figure 4-2 Total N and Total P Reduction Combinations Resulting in 10 µg/L Chlorophyll-*a* - Tom Steed Lake



SECTION 5
TMDLS AND LOAD ALLOCATIONS

Models were used to calculate and express TMDLs for each lake as annual average phosphorus and nitrogen loads (kg/yr) that, if achieved, should meet the water quality target established for chlorophyll-*a*.

5.1 Wasteload Allocation

There are no point sources of wastewater discharging to Rocky Lake or Tom Steed Lake or their tributaries. Furthermore, Oklahoma's implementation of WQS (OAC 785:46-13-4) prohibits new point source discharges to these lakes, excepting stormwater with approval from ODEQ. "*New point source discharges of any pollutant after June 11, 1989, and increased load of any specified pollutant from any point source discharge existing as of June 11, 1989, shall be prohibited in any waterbody or watershed designated in Appendix A of OAC 785:45 with the limitation "SWS".* Thus, the wasteload allocations for the two waterbodies are zero.

5.2 Load Allocation

The load allocation for all nonpoint sources to Rocky Lake was conservatively estimated as 5,000 kg/yr of total phosphorus and 8,000 kg/yr of total nitrogen, representing an 87% reduction from existing loading. Similarly, the load allocation for all nonpoint sources to Tom Steed Lake was conservatively estimated based on modeling analysis as 24,000 kg/yr of total phosphorus and 41,000 kg/yr of total nitrogen, representing a 65% reduction from existing loading.

5.3 Seasonal Variability

Federal regulations (40 CFR §130.7(c)(1)) require that TMDLs account for seasonal variation in watershed conditions and pollutant loading. The WQS for chlorophyll-*a* specifically apply as a long-term average concentration (OAC 785:45-5-10(7)). Oklahoma procedures to implement WQS (OAC 785:46-7-2) specify that the mean annual average outflow represents the long term average flow in lakes. Seasonal variation was accounted for in these TMDLs by using more than 5 years of water quality data collected in each of the four seasons.

5.4 Margin of Safety

Federal regulations (40 CFR §130.7(c)(1)) require that TMDLs include a MOS. The MOS is a conservative measure incorporated into the TMDL equation that accounts for the lack of knowledge associated with calculating the allowable pollutant loading to ensure WQSs are attained. USEPA guidance allows for use of implicit or explicit expressions of the MOS, or both. When conservative assumptions are used in development of the TMDL, or conservative factors are used in the calculations, the MOS is implicit. When a specific percentage of the TMDL is set aside to account for the lack of knowledge, then the MOS is considered explicit.

These TMDLs include both an explicit and implicit MOS. The explicit MOS is 10%. The implicit MOS is incorporated by the application of load reductions for both nitrogen and phosphorus.

At the outset of developing these TMDLs a method was developed to use Monte Carlo analysis to investigate the uncertainty as an effective means to quantify an explicit MOS. This approach works well and, toward that end, a Monte Carlo version of BATHTUB was refined and applied (Parsons 2010). Although the BATHTUB model is available in the public domain, the source code is not. As part of this TMDL development effort, to develop the Monte Carlo version of BATHTUB, a separate code was created that encompasses the state equations described in the BATHTUB documentation. During testing of the method, it was discovered that, under certain circumstances, the Monte Carlo code and BATHTUB version 6.1 produce different answers. DEQ will conduct further investigation with the U.S. Army Corps of Engineers to try to determine the source of the differences. Until the computational differences are reconciled within the BATHTUB model, DEQ will rely on an explicit MOS of 10% for both lakes in addition to the implicit MOS derived from establishing TMDLs for both nitrogen and phosphorus for each lake.

5.5 TMDL Calculations

A TMDL is expressed as the sum of all WLAs (point source loads), LAs (nonpoint source loads), and an appropriate MOS, which attempts to account for the lack of knowledge concerning the relationship between loading limitations and water quality. This definition can be expressed by the following equation:

$$TMDL = \Sigma\, WLA + \Sigma\, LA + MOS$$

Load reduction scenario simulations were run using the BATHTUB model to calculate and express the TMDL as annual average phosphorus and nitrogen loads (in kg/yr) that, if achieved, should decrease chlorophyll-*a* concentrations to meet the water quality target. Given that transport, assimilation, and dynamics of nutrients vary both temporally and spatially, nutrient loading to both lakes from a practical perspective must be managed on a long-term basis typically as pounds or kilograms per year. However, a recent court decision (*Friends of the Earth, Inc. v. EPA, et al.,* often referred to as the Anacostia decision) states that TMDLs must include a daily load expression. It is important to recognize that the chlorophyll-*a* response to nutrient loading in both Rocky Lake and Tom Steed Lake is affected by many factors such as: internal lake nutrient loading, water residence time, wind action and the interaction between light penetration, nutrients, sediment load and algal response. As such it is important to note that expressing this TMDL in daily time steps does not imply a daily response to a daily load is practical from an implementation perspective.

The USEPA's *Technical Support Document for Water Quality-Based Toxics Control* (USEPA 1991b) provides a statistical method for identifying a statistical maximum daily limit that is based on a long-term average and considering variation in a dataset. The method is represented by the following equation:

where *MDL* = maximum daily load
LTA = long-term average load
z = z statistic of the probability of occurrence (0.95 is used for this value)
$\sigma^2 = \ln(CV^2+1)$
CV = coefficient of variation

The coefficient of variation of daily nitrogen and phosphorus NPS loads were calculated from SWAT model output and ranged from 8.2 to 11 for phosphorus and from 5.7 to 7.9 for nitrogen. As illustrated in Figures 4-1 and 4-2, there are infinite combinations of N and P reductions, as calculated by BATHTUB, that will achieve the 10 µg/L chlorophyll-*a* criterion. Here, we employ an equal reduction between N and P as a starting point for the TMDL. During implementation, it may become evident that some other combination of N and P reductions is more cost effective.

Using the equal reductions (65% for Tom Steed and 87% for Rocky), the maximum load corresponding to the allowable average load of 5,000 kg of phosphorus and 8,000 kg of nitrogen per year to Rocky Lake is translated to a daily maximum load of 13.7 kg/day of phosphorus and 21.9 kg/day of nitrogen. For Tom Steed Reservoir, the allowable average load of 24,000 kg of phosphorus and 41,000 kg of nitrogen per year is translated to a daily maximum load of 65 kg/day of phosphorus and 112.3 kg/day of nitrogen. Reduction of total phosphorus and total nitrogen loads to these levels is expected to result in achievement of WQS for chlorophyll-*a* in each lake.

Table 5-1 TMDLs for Chlorophyll-*a* Expressed in Kilograms of Total Phosphorus and Nitrogen Per Day

Waterbody Name	Waterbody ID	Nutrient	TMDL	WLA	LA	MOS
Rocky Lake	OK311500030060_00	Total Phosphorus	13.7 kg/day	0	12.3 kg/day	1.4 kg/day
		Total Nitrogen	21.9 kg/day	0	19.7 kg/day	2.2 kg/day
Tom Steed Lake	OK311500020060_00	Total Phosphorus	65 kg/day	0	58.5 kg/day	6.5 kg/day
		Total Nitrogen	112.3 kg/day	0	101.1 kg/day	11.2 kg/day

SECTION 6
PUBLIC PARTICIPATION

The Chlorophyll-*a* TMDL Report for Rocky and Tom Steed Lakes was sent to other related governmental agencies for peer review and then submitted to EPA to be Preliminarily Reviewed on June 16, 2011. EPA completed their review on July 7, 2011. On July 26, 2011 a public notice about the Chlorophyll-*a* TMDL Report for Rocky and Tom Steed Lakes was sent to all persons on the DEQ contact list either who have requested all notices or who live in the watershed of interest. In addition, the public notice was posted on the DEQ webpage at http://www.deq.state.ok.us/wqdnew/index.htm and sent to local newspapers and/or other publications in the watershed area affected by this TMDL.

The public was given a 45-day opportunity to review the Chlorophyll-*a* TMDL Report for Rocky and Tom Steed Lakes, submit comments to DEQ, and/or request a public meeting. The public comment period ended on September 9, 2011. DEQ received one comment during the public comment period. This written comment became a part of the record of this TMDL report. The response to this comment can be found in Appendix C. No changes were made to the Chlorophyll-*a* TMDL Report for Rocky and Tom Steed Lakes as a result of this comment.

There were no requests for a public meeting.

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APPENDIX A

STATE OF OKLAHOMA ANTIDEGRADATION POLICY

Appendix A
State of Oklahoma Antidegradation Policy

785:45-3-1. Purpose; Antidegradation policy statement

(a) Waters of the state constitute a valuable resource and shall be protected, maintained and improved for the benefit of all the citizens.

(b) It is the policy of the State of Oklahoma to protect all waters of the state from degradation of water quality, as provided in OAC 785:45-3-2 and Subchapter 13 of OAC 785:46.

785:45-3-2. Applications of antidegradation policy

(a) Application to outstanding resource waters (ORW). Certain waters of the state constitute an outstanding resource or have exceptional recreational and/or ecological significance. These waters include streams designated "Scenic River" or "ORW" in Appendix A of this Chapter, and waters of the State located within watersheds of Scenic Rivers. Additionally, these may include waters located within National and State parks, forests, wilderness areas, wildlife management areas, and wildlife refuges, and waters which contain species listed pursuant to the federal Endangered Species Act as described in 785:45-5-25(c)(2)(A) and 785:46-13-6(c). No degradation of water quality shall be allowed in these waters.

(b) Application to high quality waters (HQW). It is recognized that certain waters of the state possess existing water quality which exceeds those levels necessary to support propagation of fishes, shellfishes, wildlife, and recreation in and on the water. These high quality waters shall be maintained and protected.

(c) Application to Sensitive Public and Private Water Supplies (SWS). It is recognized that certain public and private water supplies possess conditions that make them more susceptible to pollution events and require additional protection. These sensitive water supplies shall be maintained and protected.

(d) Application to beneficial uses. No water quality degradation which will interfere with the attainment or maintenance of an existing or designated beneficial use shall be allowed.

(e) Application to improved waters. As the quality of any waters of the state improve, no degradation of such improved waters shall be allowed.

785:46-13-1. Applicability and scope

(a) The rules in this Subchapter provide a framework for implementing the antidegradation policy stated in OAC 785:45-3-2 for all waters of the state. This policy and framework includes three tiers, or levels, of protection.

(b) The three tiers of protection are as follows:

(1) Tier 1. Attainment or maintenance of an existing or designated beneficial use.

(2) Tier 2. Maintenance or protection of High Quality Waters and Sensitive Public and Private Water Supply waters.

(3) Tier 3. No degradation of water quality allowed in Outstanding Resource Waters.

(c) In addition to the three tiers of protection, this Subchapter provides rules to implement the protection of waters in areas listed in Appendix B of OAC 785:45. Although Appendix B areas are not mentioned in OAC 785:45-3-2, the framework for protection of Appendix B areas is similar to the implementation framework for the antidegradation policy.

(d) In circumstances where more than one beneficial use limitation exists for a waterbody, the most protective limitation shall apply. For example, all antidegradation policy implementation rules applicable to Tier 1 waterbodies shall be applicable also to Tier 2 and Tier 3 waterbodies or areas, and implementation rules applicable to Tier 2 waterbodies shall be applicable also to Tier 3 waterbodies.

(e) Publicly owned treatment works may use design flow, mass loadings or concentration, as appropriate, to calculate compliance with the increased loading requirements of this section if those flows, loadings or concentrations were approved by the Oklahoma Department of Environmental Quality as a portion of Oklahoma's Water Quality Management Plan prior to the application of the ORW, HQW or SWS limitation.

785:46-13-2. Definitions

The following words and terms, when used in this Subchapter, shall have the following meaning, unless the context clearly indicates otherwise:

"Specified pollutants" means

(A) Oxygen demanding substances, measured as Carbonaceous Biochemical Oxygen Demand (CBOD) and/or Biochemical Oxygen Demand (BOD);

(B) Ammonia Nitrogen and/or Total Organic Nitrogen;

(C) Phosphorus;

(D) Total Suspended Solids (TSS); and

(E) Such other substances as may be determined by the Oklahoma Water Resources Board or the permitting authority.

785:46-13-3. Tier 1 protection; attainment or maintenance of an existing or designated beneficial use

(a) General.

(1) Beneficial uses which are existing or designated shall be maintained and protected.

(2) The process of issuing permits for discharges to waters of the state is one of several means employed by governmental agencies and affected persons which are designed to attain or maintain beneficial uses which have been designated for those waters. For example, Subchapters 3, 5, 7, 9 and 11 of this Chapter are rules for the permitting process. As such, the latter Subchapters not only implement numerical and narrative criteria, but also implement Tier 1 of the antidegradation policy.

(b) Thermal pollution. Thermal pollution shall be prohibited in all waters of the state. Temperatures greater than 52 degrees Centigrade shall constitute thermal pollution and shall be prohibited in all waters of the state.

(c) Prohibition against degradation of improved waters. As the quality of any waters of the state improves, no degradation of such improved waters shall be allowed.

785:46-13-4. Tier 2 protection; maintenance and protection of High Quality Waters and Sensitive Water Supplies

(a) General rules for High Quality Waters. New point source discharges of any pollutant after June 11, 1989, and increased load or concentration of any specified pollutant from any point source discharge existing as of June 11, 1989, shall be prohibited in any waterbody or watershed designated in Appendix A of OAC 785:45 with the limitation "HQW". Any discharge of any pollutant to a waterbody designated "HQW" which would, if it occurred, lower existing water quality shall be prohibited. Provided however, new point source discharges or increased load or concentration of any specified pollutant from a discharge existing as of June 11, 1989, may be approved by the permitting authority in circumstances where the discharger demonstrates to the satisfaction of the permitting authority that such new discharge or increased load or concentration would result in maintaining or improving the level of water quality which exceeds that necessary to support recreation and propagation of fishes, shellfishes, and wildlife in the receiving water.

(b) General rules for Sensitive Public and Private Water Supplies. New point source discharges of any pollutant after June 11, 1989, and increased load of any specified pollutant from any point source discharge existing as of June 11, 1989, shall be prohibited in any waterbody or watershed designated in Appendix A of OAC 785:45 with the limitation "SWS". Any discharge of any pollutant to a waterbody designated "SWS" which would, if it occurred, lower existing water quality shall be prohibited. Provided however, new point source discharges or increased load of any specified pollutant from a discharge existing as of June 11, 1989, may be approved by the permitting authority in circumstances where the discharger demonstrates to the satisfaction of the permitting authority that such new discharge or increased load will result in maintaining or improving the water quality in both the direct receiving water, if designated SWS, and any downstream waterbodies designated SWS.

(c) Stormwater discharges. Regardless of subsections (a) and (b) of this Section, point source discharges of stormwater to waterbodies and watersheds designated "HQW" and "SWS" may be approved by the permitting authority.

(d) Nonpoint source discharges or runoff. Best management practices for control of nonpoint source discharges or runoff should be implemented in watersheds of waterbodies designated "HQW" or "SWS" in Appendix A of OAC 785:45.

785:46-13-5. Tier 3 protection; prohibition against degradation of water quality in outstanding resource waters

(a) General. New point source discharges of any pollutant after June 11, 1989, and increased load of any pollutant from any point source discharge existing as of June 11, 1989, shall be prohibited in any waterbody or watershed designated in Appendix A of

OAC 785:45 with the limitation "ORW" and/or "Scenic River", and in any waterbody located within the watershed of any waterbody designated with the limitation "Scenic River". Any discharge of any pollutant to a waterbody designated "ORW" or "Scenic River" which would, if it occurred, lower existing water quality shall be prohibited.

(b) Stormwater discharges. Regardless of 785:46-13-5(a), point source discharges of stormwater from temporary construction activities to waterbodies and watersheds designated "ORW" and/or "Scenic River" may be permitted by the permitting authority. Regardless of 785:46-13-5(a), discharges of stormwater to waterbodies and watersheds designated "ORW" and/or "Scenic River" from point sources existing as of June 25, 1992, whether or not such stormwater discharges were permitted as point sources prior to June 25, 1992, may be permitted by the permitting authority; provided, however, increased load of any pollutant from such stormwater discharge shall be prohibited.

(c) Nonpoint source discharges or runoff. Best management practices for control of nonpoint source discharges or runoff should be implemented in watersheds of waterbodies designated "ORW" in Appendix A of OAC 785:45, provided, however, that development of conservation plans shall be required in sub-watersheds where discharges or runoff from nonpoint sources are identified as causing or significantly contributing to degradation in a waterbody designated "ORW".

(d) LMFO's. No licensed managed feeding operation (LMFO) established after June 10, 1998 which applies for a new or expanding license from the State Department of Agriculture after March 9, 1998 shall be located...[w]ithin three (3) miles of any designated scenic river area as specified by the Scenic Rivers Act in 82 O.S. Section 1451 and following, or [w]ithin one (1) mile of a waterbody [2:9-210.3(D)] designated in Appendix A of OAC 785:45 as "ORW".

785:46-13-6. Protection for Appendix B areas

(a) General. Appendix B of OAC 785:45 identifies areas in Oklahoma with waters of recreational and/or ecological significance. These areas are divided into Table 1, which includes national and state parks, national forests, wildlife areas, wildlife management areas and wildlife refuges; and Table 2, which includes areas which contain threatened or endangered species listed as such by the federal government pursuant to the federal Endangered Species Act as amended.

(b) Protection for Table 1 areas. New discharges of pollutants after June 11, 1989, or increased loading of pollutants from discharges existing as of June 11, 1989, to waters within the boundaries of areas listed in Table 1 of Appendix B of OAC 785:45 may be approved by the permitting authority under such conditions as ensure that the recreational and ecological significance of these waters will be maintained.

(c) Protection for Table 2 areas. Discharges or other activities associated with those waters within the boundaries listed in Table 2 of Appendix B of OAC 785:45 may be restricted through agreements between appropriate regulatory agencies and the United States Fish and Wildlife Service. Discharges or other activities in such areas shall not substantially disrupt the threatened or endangered species inhabiting the receiving water.

(d) Nonpoint source discharges or runoff. Best management practices for control of nonpoint source discharges or runoff should be implemented in watersheds located within areas listed in Appendix B of OAC 785:45.

APPENDIX B

AMBIENT WATER QUALITY DATA

CHLOROPHYLL-A DATA — 2002 TO 2009

PHOSPHORUS AND NITROGEN DATA – 1998 TO 2009

SECHI DEPTH AND TURBIDITY DATA – 2001 TO 2010

TOTAL SUSPENDED SOLIDS DATA — 1998 TO 2000

Ambient Water Quality Data for Tom Steed Lake, 1999-2010

WQM Station	Date	Parameter	Value	Units
311500020060-01B	9/7/2004	Corrected Chlorophyl A	5.9	mg/m3
311500020060-01B	12/7/2004	Corrected Chlorophyl A	98.8	mg/m3
311500020060-01B	3/8/2005	Corrected Chlorophyl A	7.74	mg/m3
311500020060-01B	6/7/2005	Corrected Chlorophyl A	3.38	mg/m3
311500020060-01B	11/1/2006	Corrected Chlorophyl A	19.9	mg/m3
311500020060-01B	3/19/2007	Corrected Chlorophyl A	12.3	mg/m3
311500020060-01B	5/2/2007	Corrected Chlorophyl A	11.2	mg/m3
311500020060-01B	7/30/2007	Corrected Chlorophyl A	6.6	mg/m3
311500020060-01S	12/31/2002	Corrected Chlorophyl A	2.8	mg/m3
311500020060-01S	12/31/2002	Corrected Chlorophyl A	2.9	mg/m3
311500020060-01S	6/25/2003	Corrected Chlorophyl A	4.2	mg/m3
311500020060-01S	6/25/2003	Corrected Chlorophyl A	3.5	mg/m3
311500020060-01S	6/30/2003	Corrected Chlorophyl A	4.1	mg/m3
311500020060-01S	7/1/2003	Corrected Chlorophyl A	2.4	mg/m3
311500020060-01S	7/1/2003	Corrected Chlorophyl A	2.2	mg/m3
311500020060-01S	9/7/2004	Corrected Chlorophyl A	5.6	mg/m3
311500020060-01S	9/7/2004	Corrected Chlorophyl A	3.2	mg/m3
311500020060-01S	12/7/2004	Corrected Chlorophyl A	2.39	mg/m3
311500020060-01S	12/7/2004	Corrected Chlorophyl A	96.1	mg/m3
311500020060-01S	3/8/2005	Corrected Chlorophyl A	8.66	mg/m3
311500020060-01S	3/8/2005	Corrected Chlorophyl A	6.43	mg/m3
311500020060-01S	6/7/2005	Corrected Chlorophyl A	5.66	mg/m3
311500020060-01S	6/7/2005	Corrected Chlorophyl A	9.67	mg/m3
311500020060-01S	11/1/2006	Corrected Chlorophyl A	20.2	mg/m3
311500020060-01S	11/1/2006	Corrected Chlorophyl A	20.9	mg/m3
311500020060-01S	3/19/2007	Corrected Chlorophyl A	12.5	mg/m3
311500020060-01S	5/2/2007	Corrected Chlorophyl A	11.5	mg/m3
311500020060-01S	5/2/2007	Corrected Chlorophyl A	9.52	mg/m3
311500020060-01S	7/30/2007	Corrected Chlorophyl A	6.52	mg/m3
311500020060-01S	7/30/2007	Corrected Chlorophyl A	6	mg/m3
311500020060-02	12/31/2002	Corrected Chlorophyl A	3.1	mg/m3
311500020060-02	6/25/2003	Corrected Chlorophyl A	4.8	mg/m3
311500020060-02	6/30/2003	Corrected Chlorophyl A	15.4	mg/m3
311500020060-02	7/1/2003	Corrected Chlorophyl A	10.3	mg/m3
311500020060-02	9/7/2004	Corrected Chlorophyl A	5.8	mg/m3
311500020060-02	12/7/2004	Corrected Chlorophyl A	302	mg/m3
311500020060-02	3/8/2005	Corrected Chlorophyl A	7.65	mg/m3
311500020060-02	6/7/2005	Corrected Chlorophyl A	14	mg/m3
311500020060-02	11/1/2006	Corrected Chlorophyl A	18.8	mg/m3
311500020060-02	3/19/2007	Corrected Chlorophyl A	11.7	mg/m3
311500020060-02	5/2/2007	Corrected Chlorophyl A	6.72	mg/m3
311500020060-02	7/30/2007	Corrected Chlorophyl A	9.69	mg/m3
311500020060-03	12/31/2002	Corrected Chlorophyl A	2.8	mg/m3
311500020060-03	6/25/2003	Corrected Chlorophyl A	13.6	mg/m3
311500020060-03	6/30/2003	Corrected Chlorophyl A	9.3	mg/m3
311500020060-03	7/1/2003	Corrected Chlorophyl A	5.9	mg/m3
311500020060-03	9/7/2004	Corrected Chlorophyl A	9.4	mg/m3
311500020060-03	12/7/2004	Corrected Chlorophyl A	222	mg/m3
311500020060-03	3/8/2005	Corrected Chlorophyl A	12.7	mg/m3
311500020060-03	6/7/2005	Corrected Chlorophyl A	15.8	mg/m3
311500020060-03	11/1/2006	Corrected Chlorophyl A	35.1	mg/m3

WQM Station	Date	Parameter	Value	Units
311500020060-03	3/19/2007	Corrected Chlorophyl A	8.84	mg/m3
311500020060-03	5/2/2007	Corrected Chlorophyl A	7.41	mg/m3
311500020060-03	7/30/2007	Corrected Chlorophyl A	10.03	mg/m3
311500020060-04	12/31/2002	Corrected Chlorophyl A	2.2	mg/m3
311500020060-04	6/25/2003	Corrected Chlorophyl A	4	mg/m3
311500020060-04	6/30/2003	Corrected Chlorophyl A	9.7	mg/m3
311500020060-04	7/1/2003	Corrected Chlorophyl A	6.9	mg/m3
311500020060-04	9/7/2004	Corrected Chlorophyl A	6.9	mg/m3
311500020060-04	12/7/2004	Corrected Chlorophyl A	232	mg/m3
311500020060-04	3/8/2005	Corrected Chlorophyl A	5.28	mg/m3
311500020060-04	6/7/2005	Corrected Chlorophyl A	8.56	mg/m3
311500020060-04	11/1/2006	Corrected Chlorophyl A	18.4	mg/m3
311500020060-04	3/19/2007	Corrected Chlorophyl A	11.8	mg/m3
311500020060-04	5/2/2007	Corrected Chlorophyl A	5.64	mg/m3
311500020060-04	7/30/2007	Corrected Chlorophyl A	6.71	mg/m3
311500020060-05	12/31/2002	Corrected Chlorophyl A	2.1	mg/m3
311500020060-05	6/25/2003	Corrected Chlorophyl A	5	mg/m3
311500020060-05	6/30/2003	Corrected Chlorophyl A	12.9	mg/m3
311500020060-05	7/1/2003	Corrected Chlorophyl A	7.4	mg/m3
311500020060-05	9/7/2004	Corrected Chlorophyl A	6.4	mg/m3
311500020060-05	12/7/2004	Corrected Chlorophyl A	174	mg/m3
311500020060-05	3/8/2005	Corrected Chlorophyl A	7.03	mg/m3
311500020060-05	6/7/2005	Corrected Chlorophyl A	16.8	mg/m3
311500020060-05	11/1/2006	Corrected Chlorophyl A	17.7	mg/m3
311500020060-05	5/2/2007	Corrected Chlorophyl A	6.28	mg/m3
311500020060-05	7/30/2007	Corrected Chlorophyl A	11.79	mg/m3
311500020060-01B	10/13/1999	Nitrogen, Ammonia	<0.05	mg/L
311500020060-01B	4/26/2000	Nitrogen, Ammonia	<0.05	mg/L
311500020060-01B	7/19/2000	Nitrogen, Ammonia	<0.05	mg/L
311500020060-01B	10/1/2002	Nitrogen, Ammonia	<0.05	mg/L
311500020060-01B	12/30/2002	Nitrogen, Ammonia	<0.05	mg/L
311500020060-01B	4/1/2003	Nitrogen, Ammonia	<0.05	mg/L
311500020060-01B	7/1/2003	Nitrogen, Ammonia	<0.05	mg/L
311500020060-01S	10/13/1999	Nitrogen, Ammonia	<0.05	mg/L
311500020060-01S	1/11/2000	Nitrogen, Ammonia	0.1	mg/L
311500020060-01S	4/26/2000	Nitrogen, Ammonia	<0.05	mg/L
311500020060-01S	7/19/2000	Nitrogen, Ammonia	0.05	mg/L
311500020060-01S	10/1/2002	Nitrogen, Ammonia	<0.05	mg/L
311500020060-01S	12/30/2002	Nitrogen, Ammonia	<0.05	mg/L
311500020060-01S	4/1/2003	Nitrogen, Ammonia	<0.05	mg/L
311500020060-01S	7/1/2003	Nitrogen, Ammonia	<0.05	mg/L
311500020060-01S	9/8/2004	Nitrogen, Ammonia	0.07	mg/L
311500020060-01S	12/7/2004	Nitrogen, Ammonia	0.05	mg/L
311500020060-01S	3/8/2005	Nitrogen, Ammonia	<0.05	mg/L
311500020060-01S	6/7/2005	Nitrogen, Ammonia	<0.05	mg/L
311500020060-02	10/13/1999	Nitrogen, Ammonia	<0.05	mg/L
311500020060-02	1/11/2000	Nitrogen, Ammonia	<0.05	mg/L
311500020060-02	4/26/2000	Nitrogen, Ammonia	<0.05	mg/L
311500020060-02	7/19/2000	Nitrogen, Ammonia	<0.05	mg/L
311500020060-02	10/1/2002	Nitrogen, Ammonia	<0.05	mg/L
311500020060-02	12/30/2002	Nitrogen, Ammonia	<0.05	mg/L
311500020060-02	4/1/2003	Nitrogen, Ammonia	<0.05	mg/L

WQM Station	Date	Parameter	Value	Units
311500020060-02	7/1/2003	Nitrogen, Ammonia	<0.05	mg/L
311500020060-02	9/8/2004	Nitrogen, Ammonia	0.06	mg/L
311500020060-02	12/7/2004	Nitrogen, Ammonia	<0.05	mg/L
311500020060-02	3/8/2005	Nitrogen, Ammonia	<0.05	mg/L
311500020060-02	6/7/2005	Nitrogen, Ammonia	<0.05	mg/L
311500020060-03	10/13/1999	Nitrogen, Ammonia	<0.05	mg/L
311500020060-03	1/11/2000	Nitrogen, Ammonia	0.11	mg/L
311500020060-03	4/26/2000	Nitrogen, Ammonia	<0.05	mg/L
311500020060-03	7/19/2000	Nitrogen, Ammonia	0.08	mg/L
311500020060-03	10/1/2002	Nitrogen, Ammonia	<0.05	mg/L
311500020060-03	12/30/2002	Nitrogen, Ammonia	<0.05	mg/L
311500020060-03	4/1/2003	Nitrogen, Ammonia	<0.05	mg/L
311500020060-03	7/1/2003	Nitrogen, Ammonia	<0.05	mg/L
311500020060-03	9/8/2004	Nitrogen, Ammonia	0.05	mg/L
311500020060-03	12/7/2004	Nitrogen, Ammonia	<0.05	mg/L
311500020060-03	3/8/2005	Nitrogen, Ammonia	<0.05	mg/L
311500020060-03	6/7/2005	Nitrogen, Ammonia	<0.05	mg/L
311500020060-04	10/1/2002	Nitrogen, Ammonia	<0.05	mg/L
311500020060-04	12/30/2002	Nitrogen, Ammonia	<0.05	mg/L
311500020060-04	4/1/2003	Nitrogen, Ammonia	<0.05	mg/L
311500020060-04	7/1/2003	Nitrogen, Ammonia	<0.05	mg/L
311500020060-04	9/8/2004	Nitrogen, Ammonia	0.07	mg/L
311500020060-04	12/7/2004	Nitrogen, Ammonia	<0.05	mg/L
311500020060-04	3/8/2005	Nitrogen, Ammonia	<0.05	mg/L
311500020060-04	6/7/2005	Nitrogen, Ammonia	<0.05	mg/L
311500020060-05	10/1/2002	Nitrogen, Ammonia	<0.05	mg/L
311500020060-05	12/30/2002	Nitrogen, Ammonia	<0.05	mg/L
311500020060-05	4/1/2003	Nitrogen, Ammonia	<0.05	mg/L
311500020060-05	7/1/2003	Nitrogen, Ammonia	<0.05	mg/L
311500020060-05	9/8/2004	Nitrogen, Ammonia	0.07	mg/L
311500020060-05	12/7/2004	Nitrogen, Ammonia	<0.05	mg/L
311500020060-05	3/8/2005	Nitrogen, Ammonia	<0.05	mg/L
311500020060-05	6/7/2005	Nitrogen, Ammonia	<0.05	mg/L
311500020060-01B	10/13/1999	Nitrogen, Kjeldahl	0.41	mg/L
311500020060-01B	4/26/2000	Nitrogen, Kjeldahl	0.69	mg/L
311500020060-01B	7/19/2000	Nitrogen, Kjeldahl	0.45	mg/L
311500020060-01B	10/1/2002	Nitrogen, Kjeldahl	0.64	mg/L
311500020060-01B	12/30/2002	Nitrogen, Kjeldahl	0.46	mg/L
311500020060-01B	4/1/2003	Nitrogen, Kjeldahl	0.5	mg/L
311500020060-01B	7/1/2003	Nitrogen, Kjeldahl	0.68	mg/L
311500020060-01S	10/13/1999	Nitrogen, Kjeldahl	0.48	mg/L
311500020060-01S	1/11/2000	Nitrogen, Kjeldahl	0.33	mg/L
311500020060-01S	4/26/2000	Nitrogen, Kjeldahl	0.99	mg/L
311500020060-01S	7/19/2000	Nitrogen, Kjeldahl	0.54	mg/L
311500020060-01S	10/1/2002	Nitrogen, Kjeldahl	0.78	mg/L
311500020060-01S	12/30/2002	Nitrogen, Kjeldahl	0.49	mg/L
311500020060-01S	4/1/2003	Nitrogen, Kjeldahl	0.48	mg/L
311500020060-01S	7/1/2003	Nitrogen, Kjeldahl	0.76	mg/L
311500020060-01S	9/8/2004	Nitrogen, Kjeldahl	0.75	mg/L
311500020060-01S	12/7/2004	Nitrogen, Kjeldahl	0.59	mg/L
311500020060-01S	3/8/2005	Nitrogen, Kjeldahl	0.52	mg/L
311500020060-01S	6/7/2005	Nitrogen, Kjeldahl	0.43	mg/L

WQM Station	Date	Parameter	Value	Units
311500020060-01S	11/1/2006	Nitrogen, Kjeldahl	0.93	mg/L
311500020060-01S	5/2/2007	Nitrogen, Kjeldahl	0.69	mg/L
311500020060-01S	7/30/2007	Nitrogen, Kjeldahl	0.69	mg/L
311500020060-02	10/13/1999	Nitrogen, Kjeldahl	0.34	mg/L
311500020060-02	1/11/2000	Nitrogen, Kjeldahl	0.36	mg/L
311500020060-02	4/26/2000	Nitrogen, Kjeldahl	0.59	mg/L
311500020060-02	7/19/2000	Nitrogen, Kjeldahl	0.41	mg/L
311500020060-02	10/1/2002	Nitrogen, Kjeldahl	0.62	mg/L
311500020060-02	12/30/2002	Nitrogen, Kjeldahl	0.51	mg/L
311500020060-02	4/1/2003	Nitrogen, Kjeldahl	0.46	mg/L
311500020060-02	7/1/2003	Nitrogen, Kjeldahl	1.02	mg/L
311500020060-02	9/8/2004	Nitrogen, Kjeldahl	0.75	mg/L
311500020060-02	12/7/2004	Nitrogen, Kjeldahl	0.63	mg/L
311500020060-02	3/8/2005	Nitrogen, Kjeldahl	0.56	mg/L
311500020060-02	6/7/2005	Nitrogen, Kjeldahl	0.62	mg/L
311500020060-02	11/1/2006	Nitrogen, Kjeldahl	0.79	mg/L
311500020060-02	3/19/2007	Nitrogen, Kjeldahl	0.92	mg/L
311500020060-02	5/2/2007	Nitrogen, Kjeldahl	0.61	mg/L
311500020060-02	7/30/2007	Nitrogen, Kjeldahl	0.61	mg/L
311500020060-02	11/17/2009	Nitrogen, Kjeldahl	0.69	mg/L
311500020060-03	10/13/1999	Nitrogen, Kjeldahl	0.31	mg/L
311500020060-03	1/11/2000	Nitrogen, Kjeldahl	0.46	mg/L
311500020060-03	4/26/2000	Nitrogen, Kjeldahl	0.53	mg/L
311500020060-03	7/19/2000	Nitrogen, Kjeldahl	0.45	mg/L
311500020060-03	10/1/2002	Nitrogen, Kjeldahl	0.64	mg/L
311500020060-03	12/30/2002	Nitrogen, Kjeldahl	0.46	mg/L
311500020060-03	4/1/2003	Nitrogen, Kjeldahl	0.46	mg/L
311500020060-03	7/1/2003	Nitrogen, Kjeldahl	0.78	mg/L
311500020060-03	9/8/2004	Nitrogen, Kjeldahl	0.77	mg/L
311500020060-03	12/7/2004	Nitrogen, Kjeldahl	0.62	mg/L
311500020060-03	3/8/2005	Nitrogen, Kjeldahl	0.46	mg/L
311500020060-03	6/7/2005	Nitrogen, Kjeldahl	0.64	mg/L
311500020060-03	11/1/2006	Nitrogen, Kjeldahl	0.85	mg/L
311500020060-03	3/19/2007	Nitrogen, Kjeldahl	1.04	mg/L
311500020060-03	5/2/2007	Nitrogen, Kjeldahl	0.7	mg/L
311500020060-03	7/30/2007	Nitrogen, Kjeldahl	0.62	mg/L
311500020060-03	11/17/2009	Nitrogen, Kjeldahl	0.74	mg/L
311500020060-04	10/1/2002	Nitrogen, Kjeldahl	0.64	mg/L
311500020060-04	12/30/2002	Nitrogen, Kjeldahl	0.44	mg/L
311500020060-04	4/1/2003	Nitrogen, Kjeldahl	0.45	mg/L
311500020060-04	7/1/2003	Nitrogen, Kjeldahl	0.67	mg/L
311500020060-04	9/8/2004	Nitrogen, Kjeldahl	0.69	mg/L
311500020060-04	12/7/2004	Nitrogen, Kjeldahl	0.68	mg/L
311500020060-04	3/8/2005	Nitrogen, Kjeldahl	0.47	mg/L
311500020060-04	6/7/2005	Nitrogen, Kjeldahl	0.58	mg/L
311500020060-04	11/1/2006	Nitrogen, Kjeldahl	0.78	mg/L
311500020060-04	3/19/2007	Nitrogen, Kjeldahl	0.94	mg/L
311500020060-04	5/2/2007	Nitrogen, Kjeldahl	0.76	mg/L
311500020060-04	7/30/2007	Nitrogen, Kjeldahl	0.59	mg/L
311500020060-05	10/1/2002	Nitrogen, Kjeldahl	0.94	mg/L
311500020060-05	12/30/2002	Nitrogen, Kjeldahl	0.54	mg/L
311500020060-05	4/1/2003	Nitrogen, Kjeldahl	0.42	mg/L

WQM Station	Date	Parameter	Value	Units
311500020060-05	7/1/2003	Nitrogen, Kjeldahl	0.72	mg/L
311500020060-05	9/8/2004	Nitrogen, Kjeldahl	0.74	mg/L
311500020060-05	12/7/2004	Nitrogen, Kjeldahl	0.58	mg/L
311500020060-05	3/8/2005	Nitrogen, Kjeldahl	0.37	mg/L
311500020060-05	6/7/2005	Nitrogen, Kjeldahl	0.58	mg/L
311500020060-05	11/1/2006	Nitrogen, Kjeldahl	0.87	mg/L
311500020060-05	3/19/2007	Nitrogen, Kjeldahl	0.92	mg/L
311500020060-05	5/2/2007	Nitrogen, Kjeldahl	0.66	mg/L
311500020060-05	7/30/2007	Nitrogen, Kjeldahl	0.62	mg/L
311500020060-01B	10/13/1999	Nitrogen, Nitrate as N	<0.05	mg/L
311500020060-01B	4/26/2000	Nitrogen, Nitrate as N	0.09	mg/L
311500020060-01B	7/19/2000	Nitrogen, Nitrate as N	<0.05	mg/L
311500020060-01B	10/1/2002	Nitrogen, Nitrate as N	<0.01	mg/L
311500020060-01B	12/30/2002	Nitrogen, Nitrate as N	0.11	mg/L
311500020060-01B	4/1/2003	Nitrogen, Nitrate as N	<0.05	mg/L
311500020060-01B	7/1/2003	Nitrogen, Nitrate as N	0.07	mg/L
311500020060-01S	10/13/1999	Nitrogen, Nitrate as N	<0.05	mg/L
311500020060-01S	1/11/2000	Nitrogen, Nitrate as N	0.09	mg/L
311500020060-01S	4/26/2000	Nitrogen, Nitrate as N	0.08	mg/L
311500020060-01S	7/19/2000	Nitrogen, Nitrate as N	<0.05	mg/L
311500020060-01S	10/1/2002	Nitrogen, Nitrate as N	<0.05	mg/L
311500020060-01S	12/30/2002	Nitrogen, Nitrate as N	0.08	mg/L
311500020060-01S	4/1/2003	Nitrogen, Nitrate as N	<0.05	mg/L
311500020060-01S	7/1/2003	Nitrogen, Nitrate as N	0.07	mg/L
311500020060-01S	9/8/2004	Nitrogen, Nitrate as N	<0.05	mg/L
311500020060-01S	12/7/2004	Nitrogen, Nitrate as N	0.29	mg/L
311500020060-02	10/13/1999	Nitrogen, Nitrate as N	<0.05	mg/L
311500020060-02	1/11/2000	Nitrogen, Nitrate as N	0.07	mg/L
311500020060-02	4/26/2000	Nitrogen, Nitrate as N	0.07	mg/L
311500020060-02	7/19/2000	Nitrogen, Nitrate as N	<0.05	mg/L
311500020060-02	10/1/2002	Nitrogen, Nitrate as N	<0.05	mg/L
311500020060-02	12/30/2002	Nitrogen, Nitrate as N	0.1	mg/L
311500020060-02	4/1/2003	Nitrogen, Nitrate as N	<0.05	mg/L
311500020060-02	7/1/2003	Nitrogen, Nitrate as N	<0.05	mg/L
311500020060-02	9/8/2004	Nitrogen, Nitrate as N	<0.05	mg/L
311500020060-02	12/7/2004	Nitrogen, Nitrate as N	0.28	mg/L
311500020060-03	10/13/1999	Nitrogen, Nitrate as N	0.06	mg/L
311500020060-03	1/11/2000	Nitrogen, Nitrate as N	<0.05	mg/L
311500020060-03	4/26/2000	Nitrogen, Nitrate as N	0.06	mg/L
311500020060-03	7/19/2000	Nitrogen, Nitrate as N	<0.05	mg/L
311500020060-03	10/1/2002	Nitrogen, Nitrate as N	0.05	mg/L
311500020060-03	12/30/2002	Nitrogen, Nitrate as N	0.1	mg/L
311500020060-03	4/1/2003	Nitrogen, Nitrate as N	<0.05	mg/L
311500020060-03	7/1/2003	Nitrogen, Nitrate as N	<0.05	mg/L
311500020060-03	9/8/2004	Nitrogen, Nitrate as N	<0.05	mg/L
311500020060-03	12/7/2004	Nitrogen, Nitrate as N	0.27	mg/L
311500020060-04	10/1/2002	Nitrogen, Nitrate as N	<0.05	mg/L
311500020060-04	12/30/2002	Nitrogen, Nitrate as N	0.09	mg/L
311500020060-04	4/1/2003	Nitrogen, Nitrate as N	<0.05	mg/L
311500020060-04	7/1/2003	Nitrogen, Nitrate as N	<0.05	mg/L
311500020060-04	9/8/2004	Nitrogen, Nitrate as N	<0.05	mg/L
311500020060-04	12/7/2004	Nitrogen, Nitrate as N	0.29	mg/L

WQM Station	Date	Parameter	Value	Units
311500020060-05	10/1/2002	Nitrogen, Nitrate as N	<0.05	mg/L
311500020060-05	12/30/2002	Nitrogen, Nitrate as N	0.09	mg/L
311500020060-05	4/1/2003	Nitrogen, Nitrate as N	<0.05	mg/L
311500020060-05	7/1/2003	Nitrogen, Nitrate as N	0.05	mg/L
311500020060-05	9/8/2004	Nitrogen, Nitrate as N	<0.05	mg/L
311500020060-05	12/7/2004	Nitrogen, Nitrate as N	0.26	mg/L
311500020060-01S	3/8/2005	Nitrogen, Nitrate/Nitrite as N	0.21	mg/L
311500020060-01S	6/7/2005	Nitrogen, Nitrate/Nitrite as N	0.05	mg/L
311500020060-01S	11/1/2006	Nitrogen, Nitrate/Nitrite as N	<0.05	mg/L
311500020060-01S	5/2/2007	Nitrogen, Nitrate/Nitrite as N	<0.05	mg/L
311500020060-01S	7/30/2007	Nitrogen, Nitrate/Nitrite as N	<0.05	mg/L
311500020060-02	3/8/2005	Nitrogen, Nitrate/Nitrite as N	0.21	mg/L
311500020060-02	6/7/2005	Nitrogen, Nitrate/Nitrite as N	<0.05	mg/L
311500020060-02	11/1/2006	Nitrogen, Nitrate/Nitrite as N	<0.05	mg/L
311500020060-02	3/19/2007	Nitrogen, Nitrate/Nitrite as N	<0.05	mg/L
311500020060-02	5/2/2007	Nitrogen, Nitrate/Nitrite as N	<0.05	mg/L
311500020060-02	7/30/2007	Nitrogen, Nitrate/Nitrite as N	<0.05	mg/L
311500020060-02	11/17/2009	Nitrogen, Nitrate/Nitrite as N	<0.05	mg/L
311500020060-03	3/8/2005	Nitrogen, Nitrate/Nitrite as N	0.15	mg/L
311500020060-03	6/7/2005	Nitrogen, Nitrate/Nitrite as N	0.06	mg/L
311500020060-03	11/1/2006	Nitrogen, Nitrate/Nitrite as N	<0.05	mg/L
311500020060-03	3/19/2007	Nitrogen, Nitrate/Nitrite as N	<0.05	mg/L
311500020060-03	5/2/2007	Nitrogen, Nitrate/Nitrite as N	<0.05	mg/L
311500020060-03	7/30/2007	Nitrogen, Nitrate/Nitrite as N	<0.05	mg/L
311500020060-03	11/17/2009	Nitrogen, Nitrate/Nitrite as N	<0.05	mg/L
311500020060-04	3/8/2005	Nitrogen, Nitrate/Nitrite as N	0.23	mg/L
311500020060-04	6/7/2005	Nitrogen, Nitrate/Nitrite as N	0.07	mg/L
311500020060-04	11/1/2006	Nitrogen, Nitrate/Nitrite as N	<0.05	mg/L
311500020060-04	3/19/2007	Nitrogen, Nitrate/Nitrite as N	<0.05	mg/L
311500020060-04	5/2/2007	Nitrogen, Nitrate/Nitrite as N	0.05	mg/L
311500020060-04	7/30/2007	Nitrogen, Nitrate/Nitrite as N	<0.05	mg/L
311500020060-05	3/8/2005	Nitrogen, Nitrate/Nitrite as N	0.2	mg/L
311500020060-05	6/7/2005	Nitrogen, Nitrate/Nitrite as N	0.07	mg/L
311500020060-05	11/1/2006	Nitrogen, Nitrate/Nitrite as N	<0.05	mg/L
311500020060-05	3/19/2007	Nitrogen, Nitrate/Nitrite as N	<0.05	mg/L
311500020060-05	5/2/2007	Nitrogen, Nitrate/Nitrite as N	<0.05	mg/L
311500020060-05	7/30/2007	Nitrogen, Nitrate/Nitrite as N	<0.05	mg/L
311500020060-01B	10/13/1999	Nitrogen, Nitrite as N	<0.05	mg/L
311500020060-01B	4/26/2000	Nitrogen, Nitrite as N	<0.05	mg/L
311500020060-01B	7/19/2000	Nitrogen, Nitrite as N	<0.05	mg/L
311500020060-01B	10/1/2002	Nitrogen, Nitrite as N	<0.05	mg/L
311500020060-01B	12/30/2002	Nitrogen, Nitrite as N	<0.05	mg/L
311500020060-01B	4/1/2003	Nitrogen, Nitrite as N	<0.05	mg/L
311500020060-01B	7/1/2003	Nitrogen, Nitrite as N	0.09	mg/L
311500020060-01S	10/13/1999	Nitrogen, Nitrite as N	0.06	mg/L
311500020060-01S	1/11/2000	Nitrogen, Nitrite as N	<0.05	mg/L
311500020060-01S	4/26/2000	Nitrogen, Nitrite as N	<0.05	mg/L
311500020060-01S	7/19/2000	Nitrogen, Nitrite as N	<0.05	mg/L
311500020060-01S	10/1/2002	Nitrogen, Nitrite as N	<0.05	mg/L
311500020060-01S	12/30/2002	Nitrogen, Nitrite as N	<0.05	mg/L
311500020060-01S	4/1/2003	Nitrogen, Nitrite as N	<0.05	mg/L
311500020060-01S	7/1/2003	Nitrogen, Nitrite as N	0.09	mg/L

WQM Station	Date	Parameter	Value	Units
311500020060-01S	9/8/2004	Nitrogen, Nitrite as N	<0.05	mg/L
311500020060-01S	12/7/2004	Nitrogen, Nitrite as N	<0.05	mg/L
311500020060-02	10/13/1999	Nitrogen, Nitrite as N	<0.05	mg/L
311500020060-02	1/11/2000	Nitrogen, Nitrite as N	<0.05	mg/L
311500020060-02	4/26/2000	Nitrogen, Nitrite as N	<0.05	mg/L
311500020060-02	7/19/2000	Nitrogen, Nitrite as N	<0.05	mg/L
311500020060-02	10/1/2002	Nitrogen, Nitrite as N	<0.05	mg/L
311500020060-02	12/30/2002	Nitrogen, Nitrite as N	<0.05	mg/L
311500020060-02	4/1/2003	Nitrogen, Nitrite as N	<0.05	mg/L
311500020060-02	7/1/2003	Nitrogen, Nitrite as N	<0.05	mg/L
311500020060-02	9/8/2004	Nitrogen, Nitrite as N	<0.05	mg/L
311500020060-02	12/7/2004	Nitrogen, Nitrite as N	<0.05	mg/L
311500020060-03	10/13/1999	Nitrogen, Nitrite as N	<0.05	mg/L
311500020060-03	1/11/2000	Nitrogen, Nitrite as N	<0.05	mg/L
311500020060-03	4/26/2000	Nitrogen, Nitrite as N	<0.05	mg/L
311500020060-03	7/19/2000	Nitrogen, Nitrite as N	<0.05	mg/L
311500020060-03	10/1/2002	Nitrogen, Nitrite as N	<0.05	mg/L
311500020060-03	12/30/2002	Nitrogen, Nitrite as N	<0.05	mg/L
311500020060-03	4/1/2003	Nitrogen, Nitrite as N	<0.05	mg/L
311500020060-03	7/1/2003	Nitrogen, Nitrite as N	<0.05	mg/L
311500020060-03	9/8/2004	Nitrogen, Nitrite as N	<0.05	mg/L
311500020060-03	12/7/2004	Nitrogen, Nitrite as N	<0.05	mg/L
311500020060-04	10/1/2002	Nitrogen, Nitrite as N	<0.05	mg/L
311500020060-04	12/30/2002	Nitrogen, Nitrite as N	<0.05	mg/L
311500020060-04	4/1/2003	Nitrogen, Nitrite as N	<0.05	mg/L
311500020060-04	7/1/2003	Nitrogen, Nitrite as N	0.06	mg/L
311500020060-04	9/8/2004	Nitrogen, Nitrite as N	<0.05	mg/L
311500020060-04	12/7/2004	Nitrogen, Nitrite as N	<0.05	mg/L
311500020060-05	10/1/2002	Nitrogen, Nitrite as N	<0.05	mg/L
311500020060-05	12/30/2002	Nitrogen, Nitrite as N	<0.05	mg/L
311500020060-05	4/1/2003	Nitrogen, Nitrite as N	<0.05	mg/L
311500020060-05	7/1/2003	Nitrogen, Nitrite as N	<0.05	mg/L
311500020060-05	9/8/2004	Nitrogen, Nitrite as N	<0.05	mg/L
311500020060-05	12/7/2004	Nitrogen, Nitrite as N	<0.05	mg/L
311500020060-01B	10/13/1999	Nitrogen, Organic	0.41	mg/L
311500020060-01S	10/13/1999	Nitrogen, Organic	0.48	mg/L
311500020060-01S	1/11/2000	Nitrogen, Organic	0.23	mg/L
311500020060-02	10/13/1999	Nitrogen, Organic	0.34	mg/L
311500020060-02	1/11/2000	Nitrogen, Organic	0.36	mg/L
311500020060-03	10/13/1999	Nitrogen, Organic	0.31	mg/L
311500020060-03	1/11/2000	Nitrogen, Organic	0.35	mg/L
311500020060-01B	10/13/1999	Nitrogen, Total	0.41	mg/L
311500020060-01S	10/13/1999	Nitrogen, Total	0.54	mg/L
311500020060-01S	1/11/2000	Nitrogen, Total	0.42	mg/L
311500020060-02	10/13/1999	Nitrogen, Total	0.34	mg/L
311500020060-02	1/11/2000	Nitrogen, Total	0.43	mg/L
311500020060-03	10/13/1999	Nitrogen, Total	0.37	mg/L
311500020060-03	1/11/2000	Nitrogen, Total	0.46	mg/L
311500020060-01B	10/13/1999	Phosphorous, Ortho	0.039	mg/L
311500020060-01B	4/26/2000	Phosphorous, Ortho	0.022	mg/L
311500020060-01B	7/19/2000	Phosphorous, Ortho	0.04	mg/L
311500020060-01B	10/1/2002	Phosphorous, Ortho	0.023	mg/L

WQM Station	Date	Parameter	Value	Units
311500020060-01B	12/30/2002	Phosphorous, Ortho	0.036	mg/L
311500020060-01B	4/1/2003	Phosphorous, Ortho	0.036	mg/L
311500020060-01B	7/1/2003	Phosphorous, Ortho	0.049	mg/L
311500020060-01S	10/13/1999	Phosphorous, Ortho	0.036	mg/L
311500020060-01S	1/11/2000	Phosphorous, Ortho	0.035	mg/L
311500020060-01S	4/26/2000	Phosphorous, Ortho	0.02	mg/L
311500020060-01S	7/19/2000	Phosphorous, Ortho	0.022	mg/L
311500020060-01S	10/1/2002	Phosphorous, Ortho	0.019	mg/L
311500020060-01S	12/30/2002	Phosphorous, Ortho	0.035	mg/L
311500020060-01S	4/1/2003	Phosphorous, Ortho	0.035	mg/L
311500020060-01S	7/1/2003	Phosphorous, Ortho	0.049	mg/L
311500020060-01S	9/8/2004	Phosphorous, Ortho	0.074	mg/L
311500020060-01S	12/7/2004	Phosphorous, Ortho	0.132	mg/L
311500020060-01S	3/8/2005	Phosphorous, Ortho	0.091	mg/L
311500020060-01S	6/7/2005	Phosphorous, Ortho	0.041	mg/L
311500020060-01S	11/1/2006	Phosphorous, Ortho	0.06	mg/L
311500020060-01S	5/2/2007	Phosphorous, Ortho	0.034	mg/L
311500020060-01S	7/30/2007	Phosphorous, Ortho	0.035	mg/L
311500020060-02	10/13/1999	Phosphorous, Ortho	0.011	mg/L
311500020060-02	1/11/2000	Phosphorous, Ortho	0.037	mg/L
311500020060-02	4/26/2000	Phosphorous, Ortho	0.016	mg/L
311500020060-02	7/19/2000	Phosphorous, Ortho	0.018	mg/L
311500020060-02	10/1/2002	Phosphorous, Ortho	0.021	mg/L
311500020060-02	12/30/2002	Phosphorous, Ortho	0.038	mg/L
311500020060-02	4/1/2003	Phosphorous, Ortho	0.059	mg/L
311500020060-02	7/1/2003	Phosphorous, Ortho	0.036	mg/L
311500020060-02	9/8/2004	Phosphorous, Ortho	0.068	mg/L
311500020060-02	12/7/2004	Phosphorous, Ortho	0.133	mg/L
311500020060-02	3/8/2005	Phosphorous, Ortho	0.094	mg/L
311500020060-02	6/7/2005	Phosphorous, Ortho	0.026	mg/L
311500020060-02	11/1/2006	Phosphorous, Ortho	0.061	mg/L
311500020060-02	3/19/2007	Phosphorous, Ortho	0.043	mg/L
311500020060-02	5/2/2007	Phosphorous, Ortho	0.037	mg/L
311500020060-02	7/30/2007	Phosphorous, Ortho	0.012	mg/L
311500020060-03	10/13/1999	Phosphorous, Ortho	0.011	mg/L
311500020060-03	1/11/2000	Phosphorous, Ortho	0.025	mg/L
311500020060-03	4/26/2000	Phosphorous, Ortho	0.014	mg/L
311500020060-03	7/19/2000	Phosphorous, Ortho	0.022	mg/L
311500020060-03	10/1/2002	Phosphorous, Ortho	0.017	mg/L
311500020060-03	12/30/2002	Phosphorous, Ortho	0.032	mg/L
311500020060-03	4/1/2003	Phosphorous, Ortho	0.049	mg/L
311500020060-03	7/1/2003	Phosphorous, Ortho	0.036	mg/L
311500020060-03	9/8/2004	Phosphorous, Ortho	0.062	mg/L
311500020060-03	12/7/2004	Phosphorous, Ortho	0.128	mg/L
311500020060-03	3/8/2005	Phosphorous, Ortho	0.081	mg/L
311500020060-03	6/7/2005	Phosphorous, Ortho	0.031	mg/L
311500020060-03	11/1/2006	Phosphorous, Ortho	0.063	mg/L
311500020060-03	3/19/2007	Phosphorous, Ortho	0.039	mg/L
311500020060-03	5/2/2007	Phosphorous, Ortho	0.032	mg/L
311500020060-03	7/30/2007	Phosphorous, Ortho	0.015	mg/L
311500020060-04	10/1/2002	Phosphorous, Ortho	0.018	mg/L
311500020060-04	12/30/2002	Phosphorous, Ortho	0.034	mg/L

WQM Station	Date	Parameter	Value	Units
311500020060-04	4/1/2003	Phosphorous, Ortho	0.035	mg/L
311500020060-04	7/1/2003	Phosphorous, Ortho	0.039	mg/L
311500020060-04	9/8/2004	Phosphorous, Ortho	0.058	mg/L
311500020060-04	12/7/2004	Phosphorous, Ortho	0.135	mg/L
311500020060-04	3/8/2005	Phosphorous, Ortho	0.094	mg/L
311500020060-04	6/7/2005	Phosphorous, Ortho	0.033	mg/L
311500020060-04	11/1/2006	Phosphorous, Ortho	0.062	mg/L
311500020060-04	3/19/2007	Phosphorous, Ortho	0.069	mg/L
311500020060-04	5/2/2007	Phosphorous, Ortho	0.039	mg/L
311500020060-04	7/30/2007	Phosphorous, Ortho	0.023	mg/L
311500020060-05	10/1/2002	Phosphorous, Ortho	0.021	mg/L
311500020060-05	12/30/2002	Phosphorous, Ortho	0.022	mg/L
311500020060-05	4/1/2003	Phosphorous, Ortho	0.038	mg/L
311500020060-05	7/1/2003	Phosphorous, Ortho	0.043	mg/L
311500020060-05	9/8/2004	Phosphorous, Ortho	0.066	mg/L
311500020060-05	12/7/2004	Phosphorous, Ortho	0.126	mg/L
311500020060-05	3/8/2005	Phosphorous, Ortho	0.093	mg/L
311500020060-05	6/7/2005	Phosphorous, Ortho	0.034	mg/L
311500020060-05	11/1/2006	Phosphorous, Ortho	0.065	mg/L
311500020060-05	3/19/2007	Phosphorous, Ortho	0.044	mg/L
311500020060-05	5/2/2007	Phosphorous, Ortho	0.032	mg/L
311500020060-05	7/30/2007	Phosphorous, Ortho	0.012	mg/L
311500020060-01B	10/13/1999	Phosphorous, Total	0.119	mg/L
311500020060-01B	4/26/2000	Phosphorous, Total	0.067	mg/L
311500020060-01B	7/19/2000	Phosphorous, Total	0.053	mg/L
311500020060-01B	10/1/2002	Phosphorous, Total	0.05	mg/L
311500020060-01B	12/30/2002	Phosphorous, Total	0.046	mg/L
311500020060-01B	4/1/2003	Phosphorous, Total	0.055	mg/L
311500020060-01B	7/1/2003	Phosphorous, Total	0.078	mg/L
311500020060-01S	10/13/1999	Phosphorous, Total	0.045	mg/L
311500020060-01S	1/11/2000	Phosphorous, Total	0.056	mg/L
311500020060-01S	4/26/2000	Phosphorous, Total	0.059	mg/L
311500020060-01S	7/19/2000	Phosphorous, Total	0.068	mg/L
311500020060-01S	10/1/2002	Phosphorous, Total	0.048	mg/L
311500020060-01S	12/30/2002	Phosphorous, Total	0.047	mg/L
311500020060-01S	4/1/2003	Phosphorous, Total	0.051	mg/L
311500020060-01S	7/1/2003	Phosphorous, Total	0.071	mg/L
311500020060-01S	9/8/2004	Phosphorous, Total	0.09	mg/L
311500020060-01S	12/7/2004	Phosphorous, Total	0.137	mg/L
311500020060-01S	3/8/2005	Phosphorous, Total	0.115	mg/L
311500020060-01S	6/7/2005	Phosphorous, Total	0.065	mg/L
311500020060-01S	11/1/2006	Phosphorous, Total	0.101	mg/L
311500020060-01S	5/2/2007	Phosphorous, Total	0.044	mg/L
311500020060-01S	7/30/2007	Phosphorous, Total	0.07	mg/L
311500020060-02	10/13/1999	Phosphorous, Total	0.031	mg/L
311500020060-02	1/11/2000	Phosphorous, Total	0.061	mg/L
311500020060-02	4/26/2000	Phosphorous, Total	0.067	mg/L
311500020060-02	7/19/2000	Phosphorous, Total	0.047	mg/L
311500020060-02	10/1/2002	Phosphorous, Total	0.062	mg/L
311500020060-02	12/30/2002	Phosphorous, Total	0.054	mg/L
311500020060-02	4/1/2003	Phosphorous, Total	0.082	mg/L
311500020060-02	7/1/2003	Phosphorous, Total	0.085	mg/L

WQM Station	Date	Parameter	Value	Units
311500020060-02	9/8/2004	Phosphorous, Total	0.1	mg/L
311500020060-02	12/7/2004	Phosphorous, Total	0.139	mg/L
311500020060-02	3/8/2005	Phosphorous, Total	0.116	mg/L
311500020060-02	6/7/2005	Phosphorous, Total	0.065	mg/L
311500020060-02	11/1/2006	Phosphorous, Total	0.1	mg/L
311500020060-02	3/19/2007	Phosphorous, Total	0.061	mg/L
311500020060-02	5/2/2007	Phosphorous, Total	0.043	mg/L
311500020060-02	7/30/2007	Phosphorous, Total	0.056	mg/L
311500020060-02	11/17/2009	Phosphorous, Total	0.107	mg/L
311500020060-03	10/13/1999	Phosphorous, Total	0.042	mg/L
311500020060-03	1/11/2000	Phosphorous, Total	0.067	mg/L
311500020060-03	4/26/2000	Phosphorous, Total	0.071	mg/L
311500020060-03	7/19/2000	Phosphorous, Total	0.067	mg/L
311500020060-03	10/1/2002	Phosphorous, Total	0.056	mg/L
311500020060-03	12/30/2002	Phosphorous, Total	0.043	mg/L
311500020060-03	4/1/2003	Phosphorous, Total	0.054	mg/L
311500020060-03	7/1/2003	Phosphorous, Total	0.072	mg/L
311500020060-03	9/8/2004	Phosphorous, Total	0.086	mg/L
311500020060-03	12/7/2004	Phosphorous, Total	0.133	mg/L
311500020060-03	3/8/2005	Phosphorous, Total	0.108	mg/L
311500020060-03	6/7/2005	Phosphorous, Total	0.071	mg/L
311500020060-03	11/1/2006	Phosphorous, Total	0.108	mg/L
311500020060-03	3/19/2007	Phosphorous, Total	0.059	mg/L
311500020060-03	5/2/2007	Phosphorous, Total	0.038	mg/L
311500020060-03	7/30/2007	Phosphorous, Total	0.055	mg/L
311500020060-03	11/17/2009	Phosphorous, Total	0.111	mg/L
311500020060-04	10/1/2002	Phosphorous, Total	0.05	mg/L
311500020060-04	12/30/2002	Phosphorous, Total	0.046	mg/L
311500020060-04	4/1/2003	Phosphorous, Total	0.055	mg/L
311500020060-04	7/1/2003	Phosphorous, Total	0.076	mg/L
311500020060-04	9/8/2004	Phosphorous, Total	0.089	mg/L
311500020060-04	12/7/2004	Phosphorous, Total	0.141	mg/L
311500020060-04	3/8/2005	Phosphorous, Total	0.114	mg/L
311500020060-04	6/7/2005	Phosphorous, Total	0.064	mg/L
311500020060-04	11/1/2006	Phosphorous, Total	0.105	mg/L
311500020060-04	3/19/2007	Phosphorous, Total	0.069	mg/L
311500020060-04	5/2/2007	Phosphorous, Total	0.045	mg/L
311500020060-04	7/30/2007	Phosphorous, Total	0.061	mg/L
311500020060-05	10/1/2002	Phosphorous, Total	0.048	mg/L
311500020060-05	12/30/2002	Phosphorous, Total	0.045	mg/L
311500020060-05	4/1/2003	Phosphorous, Total	0.053	mg/L
311500020060-05	7/1/2003	Phosphorous, Total	0.077	mg/L
311500020060-05	9/8/2004	Phosphorous, Total	0.09	mg/L
311500020060-05	12/7/2004	Phosphorous, Total	0.13	mg/L
311500020060-05	3/8/2005	Phosphorous, Total	0.114	mg/L
311500020060-05	6/7/2005	Phosphorous, Total	0.068	mg/L
311500020060-05	11/1/2006	Phosphorous, Total	0.102	mg/L
311500020060-05	3/19/2007	Phosphorous, Total	0.048	mg/L
311500020060-05	5/2/2007	Phosphorous, Total	0.041	mg/L
311500020060-05	7/30/2007	Phosphorous, Total	0.056	mg/L
311500020060-02	9/8/2004	Secchi Depth	34	cm
311500020060-02	12/7/2004	Secchi Depth	25	cm

WQM Station	Date	Parameter	Value	Units
311500020060-02	3/8/2005	Secchi Depth	35	cm
311500020060-02	6/7/2005	Secchi Depth	60	cm
311500020060-02	11/17/2009	Secchi Depth	30	cm
311500020060-02	2/9/2010	Secchi Depth	38	cm
311500020060-05	9/8/2004	Secchi Depth	25	cm
311500020060-05	12/7/2004	Secchi Depth	29	cm
311500020060-05	3/8/2005	Secchi Depth	35	cm
311500020060-05	6/7/2005	Secchi Depth	70	cm
311500020060-02	9/8/2004	Turbidity, Field	33	NTU
311500020060-02	12/7/2004	Turbidity, Field	37	NTU
311500020060-02	3/8/2005	Turbidity, Field	29	NTU
311500020060-02	6/7/2005	Turbidity, Field	50	NTU
311500020060-02	11/1/2006	Turbidity, Field	35	NTU
311500020060-02	3/19/2007	Turbidity, Field	62	NTU
311500020060-02	5/2/2007	Turbidity, Field	22	NTU
311500020060-02	7/30/2007	Turbidity, Field	7	NTU
311500020060-02	11/17/2009	Turbidity, Field	37	NTU
311500020060-02	2/9/2010	Turbidity, Field	22	NTU
311500020060-05	9/8/2004	Turbidity, Field	28	NTU
311500020060-05	12/7/2004	Turbidity, Field	44	NTU
311500020060-05	3/8/2005	Turbidity, Field	30	NTU
311500020060-05	6/7/2005	Turbidity, Field	59	NTU
311500020060-05	11/1/2006	Turbidity, Field	37	NTU
311500020060-05	3/19/2007	Turbidity, Field	49	NTU
311500020060-05	5/2/2007	Turbidity, Field	20	NTU
311500020060-05	7/30/2007	Turbidity, Field	6	NTU
311500020060-01B	10/13/1999	Solids, Suspended	80	mg/L
311500020060-01B	4/26/2000	Solids, Suspended	19	mg/L
311500020060-01B	7/19/2000	Solids, Suspended	8	mg/L
311500020060-01S	10/13/1999	Solids, Suspended	6	mg/L
311500020060-01S	1/11/2000	Solids, Suspended	21	mg/L
311500020060-01S	4/26/2000	Solids, Suspended	15	mg/L
311500020060-01S	7/19/2000	Solids, Suspended	8	mg/L
311500020060-02	7/19/2000	Solids, Suspended	6	mg/L
311500020060-02	1/11/2000	Solids, Suspended	20	mg/L
311500020060-02	4/26/2000	Solids, Suspended	14	mg/L
311500020060-02	10/13/1999	Solids, Suspended	2	mg/L
311500020060-03	10/13/1999	Solids, Suspended	18	mg/L
311500020060-03	1/11/2000	Solids, Suspended	20	mg/L
311500020060-03	4/26/2000	Solids, Suspended	17	mg/L
311500020060-03	7/19/2000	Solids, Suspended	6	mg/L

Ambient Water Quality Data for Rocky Lake, 1998-2009

WQM Station	Date	Parameter	Value	Units
311500030060-01B	11/13/2003	Corrected Chlorophyl A	51.3	mg/m3
311500030060-01B	4/28/2004	Corrected Chlorophyl A	26.4	mg/m3
311500030060-01B	7/28/2004	Corrected Chlorophyl A	40.9	mg/m3
311500030060-01B	11/8/2006	Corrected Chlorophyl A	28.2	mg/m3
311500030060-01B	5/1/2007	Corrected Chlorophyl A	59.7	mg/m3
311500030060-01B	7/30/2007	Corrected Chlorophyl A	26.17	mg/m3
311500030060-01B	10/28/2008	Corrected Chlorophyl A	76.7	mg/m3
311500030060-01S	11/13/2003	Corrected Chlorophyl A	54.3	mg/m3
311500030060-01S	11/13/2003	Corrected Chlorophyl A	38.8	mg/m3
311500030060-01S	1/28/2004	Corrected Chlorophyl A	32.1	mg/m3
311500030060-01S	1/28/2004	Corrected Chlorophyl A	13.8	mg/m3
311500030060-01S	1/28/2004	Corrected Chlorophyl A	23.7	mg/m3
311500030060-01S	4/28/2004	Corrected Chlorophyl A	26.4	mg/m3
311500030060-01S	4/28/2004	Corrected Chlorophyl A	19	mg/m3
311500030060-01S	7/28/2004	Corrected Chlorophyl A	37.6	mg/m3
311500030060-01S	7/28/2004	Corrected Chlorophyl A	40.3	mg/m3
311500030060-01S	11/8/2006	Corrected Chlorophyl A	18.2	mg/m3
311500030060-01S	11/8/2006	Corrected Chlorophyl A	25.2	mg/m3
311500030060-01S	5/1/2007	Corrected Chlorophyl A	59.3	mg/m3
311500030060-01S	7/30/2007	Corrected Chlorophyl A	24.91	mg/m3
311500030060-01S	7/30/2007	Corrected Chlorophyl A	24.72	mg/m3
311500030060-01S	10/28/2008	Corrected Chlorophyl A	67.8	mg/m3
311500030060-01S	2/18/2009	Corrected Chlorophyl A	27.3	mg/m3
311500030060-02	11/13/2003	Corrected Chlorophyl A	53.8	mg/m3
311500030060-02	1/28/2004	Corrected Chlorophyl A	38.9	mg/m3
311500030060-02	4/28/2004	Corrected Chlorophyl A	26.1	mg/m3
311500030060-02	7/28/2004	Corrected Chlorophyl A	44.6	mg/m3
311500030060-02	11/8/2006	Corrected Chlorophyl A	30.1	mg/m3
311500030060-02	3/20/2007	Corrected Chlorophyl A	40.7	mg/m3
311500030060-02	5/1/2007	Corrected Chlorophyl A	87.4	mg/m3
311500030060-02	7/30/2007	Corrected Chlorophyl A	36.34	mg/m3
311500030060-02	10/28/2008	Corrected Chlorophyl A	73.1	mg/m3
311500030060-02	2/18/2009	Corrected Chlorophyl A	38.8	mg/m3
311500030060-02	8/4/2009	Corrected Chlorophyl A	92.3	mg/m3
311500030060-03	11/13/2003	Corrected Chlorophyl A	58.5	mg/m3
311500030060-03	1/28/2004	Corrected Chlorophyl A	20.7	mg/m3
311500030060-03	4/28/2004	Corrected Chlorophyl A	34.5	mg/m3
311500030060-03	7/28/2004	Corrected Chlorophyl A	32.3	mg/m3
311500030060-03	11/8/2006	Corrected Chlorophyl A	34.8	mg/m3
311500030060-03	3/20/2007	Corrected Chlorophyl A	52.7	mg/m3
311500030060-03	5/1/2007	Corrected Chlorophyl A	88.4	mg/m3
311500030060-03	7/30/2007	Corrected Chlorophyl A	75.12	mg/m3
311500030060-03	10/28/2008	Corrected Chlorophyl A	77.5	mg/m3
311500030060-04	11/13/2003	Corrected Chlorophyl A	49.2	mg/m3
311500030060-04	1/28/2004	Corrected Chlorophyl A	30.7	mg/m3
311500030060-04	4/28/2004	Corrected Chlorophyl A	25.3	mg/m3
311500030060-04	7/28/2004	Corrected Chlorophyl A	44.8	mg/m3
311500030060-04	11/8/2006	Corrected Chlorophyl A	32.7	mg/m3
311500030060-04	3/20/2007	Corrected Chlorophyl A	44.5	mg/m3
311500030060-04	5/1/2007	Corrected Chlorophyl A	80.8	mg/m3
311500030060-04	7/30/2007	Corrected Chlorophyl A	42.05	mg/m3

WQM Station	Date	Parameter	Value	Units
311500030060-04	10/28/2008	Corrected Chlorophyl A	76.1	mg/m3
311500030060-05	11/13/2003	Corrected Chlorophyl A	45.8	mg/m3
311500030060-05	1/28/2004	Corrected Chlorophyl A	27.5	mg/m3
311500030060-05	4/28/2004	Corrected Chlorophyl A	24.8	mg/m3
311500030060-05	7/28/2004	Corrected Chlorophyl A	22.3	mg/m3
311500030060-05	11/8/2006	Corrected Chlorophyl A	36.4	mg/m3
311500030060-05	3/20/2007	Corrected Chlorophyl A	36.1	mg/m3
311500030060-05	5/1/2007	Corrected Chlorophyl A	47.9	mg/m3
311500030060-05	7/30/2007	Corrected Chlorophyl A	41.67	mg/m3
311500030060-01B	5/29/2001	Nitrogen, Ammonia	0.62	mg/L
311500030060-01B	4/28/2004	Nitrogen, Ammonia	0.06	mg/L
311500030060-01S	6/22/1998	Nitrogen, Ammonia	<0.05	mg/L
311500030060-01S	3/6/2001	Nitrogen, Ammonia	<0.05	mg/L
311500030060-01S	5/29/2001	Nitrogen, Ammonia	0.47	mg/L
311500030060-01S	11/10/2003	Nitrogen, Ammonia	<0.05	mg/L
311500030060-01S	1/28/2004	Nitrogen, Ammonia	<0.05	mg/L
311500030060-01S	4/28/2004	Nitrogen, Ammonia	0.07	mg/L
311500030060-01S	7/28/2004	Nitrogen, Ammonia	<0.05	mg/L
311500030060-02	6/22/1998	Nitrogen, Ammonia	<0.05	mg/L
311500030060-02	3/6/2001	Nitrogen, Ammonia	<0.05	mg/L
311500030060-02	5/29/2001	Nitrogen, Ammonia	0.44	mg/L
311500030060-02	11/10/2003	Nitrogen, Ammonia	<0.05	mg/L
311500030060-02	1/28/2004	Nitrogen, Ammonia	<0.05	mg/L
311500030060-02	4/28/2004	Nitrogen, Ammonia	0.06	mg/L
311500030060-02	7/28/2004	Nitrogen, Ammonia	<0.05	mg/L
311500030060-03	6/22/1998	Nitrogen, Ammonia	<0.05	mg/L
311500030060-03	3/6/2001	Nitrogen, Ammonia	<0.05	mg/L
311500030060-03	5/29/2001	Nitrogen, Ammonia	0.4	mg/L
311500030060-03	11/10/2003	Nitrogen, Ammonia	<0.05	mg/L
311500030060-03	1/28/2004	Nitrogen, Ammonia	<0.05	mg/L
311500030060-03	4/28/2004	Nitrogen, Ammonia	0.07	mg/L
311500030060-03	7/28/2004	Nitrogen, Ammonia	<0.05	mg/L
311500030060-04	11/10/2003	Nitrogen, Ammonia	<0.05	mg/L
311500030060-04	1/28/2004	Nitrogen, Ammonia	<0.05	mg/L
311500030060-04	4/28/2004	Nitrogen, Ammonia	0.06	mg/L
311500030060-04	7/28/2004	Nitrogen, Ammonia	<0.05	mg/L
311500030060-05	11/10/2003	Nitrogen, Ammonia	<0.05	mg/L
311500030060-05	1/28/2004	Nitrogen, Ammonia	<0.05	mg/L
311500030060-05	4/28/2004	Nitrogen, Ammonia	0.06	mg/L
311500030060-05	7/28/2004	Nitrogen, Ammonia	<0.05	mg/L
311500030060-01B	5/29/2001	Nitrogen, Kjeldahl	1.71	mg/L
311500030060-01B	4/28/2004	Nitrogen, Kjeldahl	1.06	mg/L
311500030060-01S	6/22/1998	Nitrogen, Kjeldahl	1.04	mg/L
311500030060-01S	3/6/2001	Nitrogen, Kjeldahl	0.98	mg/L
311500030060-01S	5/29/2001	Nitrogen, Kjeldahl	1.53	mg/L
311500030060-01S	11/10/2003	Nitrogen, Kjeldahl	1.54	mg/L
311500030060-01S	1/28/2004	Nitrogen, Kjeldahl	1.69	mg/L
311500030060-01S	4/28/2004	Nitrogen, Kjeldahl	0.92	mg/L
311500030060-01S	7/28/2004	Nitrogen, Kjeldahl	1.04	mg/L
311500030060-01S	11/8/2006	Nitrogen, Kjeldahl	1.19	mg/L
311500030060-01S	5/1/2007	Nitrogen, Kjeldahl	1.31	mg/L
311500030060-01S	7/30/2007	Nitrogen, Kjeldahl	1.41	mg/L

WQM Station	Date	Parameter	Value	Units
311500030060-01S	10/28/2008	Nitrogen, Kjeldahl	1.44	mg/L
311500030060-02	6/22/1998	Nitrogen, Kjeldahl	0.95	mg/L
311500030060-02	3/6/2001	Nitrogen, Kjeldahl	0.93	mg/L
311500030060-02	5/29/2001	Nitrogen, Kjeldahl	1.47	mg/L
311500030060-02	11/10/2003	Nitrogen, Kjeldahl	1.47	mg/L
311500030060-02	1/28/2004	Nitrogen, Kjeldahl	1.71	mg/L
311500030060-02	4/28/2004	Nitrogen, Kjeldahl	0.96	mg/L
311500030060-02	7/28/2004	Nitrogen, Kjeldahl	1.01	mg/L
311500030060-02	11/8/2006	Nitrogen, Kjeldahl	1.19	mg/L
311500030060-02	3/20/2007	Nitrogen, Kjeldahl	1.27	mg/L
311500030060-02	5/1/2007	Nitrogen, Kjeldahl	1.44	mg/L
311500030060-02	7/30/2007	Nitrogen, Kjeldahl	1.07	mg/L
311500030060-02	10/28/2008	Nitrogen, Kjeldahl	1.48	mg/L
311500030060-02	2/18/2009	Nitrogen, Kjeldahl	1.58	mg/L
311500030060-02	5/5/2009	Nitrogen, Kjeldahl	1.63	mg/L
311500030060-03	6/22/1998	Nitrogen, Kjeldahl	1.18	mg/L
311500030060-03	3/6/2001	Nitrogen, Kjeldahl	1.13	mg/L
311500030060-03	5/29/2001	Nitrogen, Kjeldahl	1.5	mg/L
311500030060-03	11/10/2003	Nitrogen, Kjeldahl	1.61	mg/L
311500030060-03	1/28/2004	Nitrogen, Kjeldahl	1.98	mg/L
311500030060-03	4/28/2004	Nitrogen, Kjeldahl	1.32	mg/L
311500030060-03	7/28/2004	Nitrogen, Kjeldahl	1.09	mg/L
311500030060-03	11/8/2006	Nitrogen, Kjeldahl	1.2	mg/L
311500030060-03	3/20/2007	Nitrogen, Kjeldahl	1.47	mg/L
311500030060-03	5/1/2007	Nitrogen, Kjeldahl	1.42	mg/L
311500030060-03	7/30/2007	Nitrogen, Kjeldahl	1.27	mg/L
311500030060-03	10/28/2008	Nitrogen, Kjeldahl	1.51	mg/L
311500030060-03	2/18/2009	Nitrogen, Kjeldahl	1.53	mg/L
311500030060-03	5/5/2009	Nitrogen, Kjeldahl	0.86	mg/L
311500030060-04	11/10/2003	Nitrogen, Kjeldahl	1.59	mg/L
311500030060-04	1/28/2004	Nitrogen, Kjeldahl	1.67	mg/L
311500030060-04	4/28/2004	Nitrogen, Kjeldahl	1.04	mg/L
311500030060-04	7/28/2004	Nitrogen, Kjeldahl	1.09	mg/L
311500030060-04	11/8/2006	Nitrogen, Kjeldahl	1.28	mg/L
311500030060-04	3/20/2007	Nitrogen, Kjeldahl	1.27	mg/L
311500030060-04	5/1/2007	Nitrogen, Kjeldahl	1.5	mg/L
311500030060-04	7/30/2007	Nitrogen, Kjeldahl	1.1	mg/L
311500030060-05	11/10/2003	Nitrogen, Kjeldahl	1.62	mg/L
311500030060-05	1/28/2004	Nitrogen, Kjeldahl	1.75	mg/L
311500030060-05	4/28/2004	Nitrogen, Kjeldahl	0.96	mg/L
311500030060-05	7/28/2004	Nitrogen, Kjeldahl	0.96	mg/L
311500030060-05	11/8/2006	Nitrogen, Kjeldahl	1.32	mg/L
311500030060-05	3/20/2007	Nitrogen, Kjeldahl	1.29	mg/L
311500030060-05	5/1/2007	Nitrogen, Kjeldahl	1.34	mg/L
311500030060-05	7/30/2007	Nitrogen, Kjeldahl	1.17	mg/L
311500030060-01B	5/29/2001	Nitrogen, Nitrate as N	0.1	mg/L
311500030060-01B	4/28/2004	Nitrogen, Nitrate as N	<0.05	mg/L
311500030060-01S	6/22/1998	Nitrogen, Nitrate as N	<0.05	mg/L
311500030060-01S	3/6/2001	Nitrogen, Nitrate as N	0.34	mg/L
311500030060-01S	5/29/2001	Nitrogen, Nitrate as N	0.15	mg/L
311500030060-01S	11/10/2003	Nitrogen, Nitrate as N	<0.05	mg/L
311500030060-01S	1/28/2004	Nitrogen, Nitrate as N	0.15	mg/L

WQM Station	Date	Parameter	Value	Units
311500030060-01S	4/28/2004	Nitrogen, Nitrate as N	<0.05	mg/L
311500030060-01S	7/28/2004	Nitrogen, Nitrate as N	<0.05	mg/L
311500030060-02	6/22/1998	Nitrogen, Nitrate as N	0.05	mg/L
311500030060-02	3/6/2001	Nitrogen, Nitrate as N	0.32	mg/L
311500030060-02	5/29/2001	Nitrogen, Nitrate as N	0.15	mg/L
311500030060-02	11/10/2003	Nitrogen, Nitrate as N	<0.05	mg/L
311500030060-02	1/28/2004	Nitrogen, Nitrate as N	0.16	mg/L
311500030060-02	4/28/2004	Nitrogen, Nitrate as N	<0.05	mg/L
311500030060-02	7/28/2004	Nitrogen, Nitrate as N	<0.05	mg/L
311500030060-03	6/22/1998	Nitrogen, Nitrate as N	<0.05	mg/L
311500030060-03	3/6/2001	Nitrogen, Nitrate as N	0.87	mg/L
311500030060-03	5/29/2001	Nitrogen, Nitrate as N	0.2	mg/L
311500030060-03	11/10/2003	Nitrogen, Nitrate as N	<0.05	mg/L
311500030060-03	1/28/2004	Nitrogen, Nitrate as N	0.14	mg/L
311500030060-03	4/28/2004	Nitrogen, Nitrate as N	<0.05	mg/L
311500030060-03	7/28/2004	Nitrogen, Nitrate as N	<0.05	mg/L
311500030060-04	11/10/2003	Nitrogen, Nitrate as N	<0.05	mg/L
311500030060-04	1/28/2004	Nitrogen, Nitrate as N	0.14	mg/L
311500030060-04	4/28/2004	Nitrogen, Nitrate as N	<0.05	mg/L
311500030060-04	7/28/2004	Nitrogen, Nitrate as N	<0.05	mg/L
311500030060-05	11/10/2003	Nitrogen, Nitrate as N	<0.05	mg/L
311500030060-05	1/28/2004	Nitrogen, Nitrate as N	0.14	mg/L
311500030060-05	4/28/2004	Nitrogen, Nitrate as N	<0.05	mg/L
311500030060-05	7/28/2004	Nitrogen, Nitrate as N	<0.05	mg/L
311500030060-01S	11/8/2006	Nitrogen, Nitrate/Nitrite as N	0.48	mg/L
311500030060-01S	5/1/2007	Nitrogen, Nitrate/Nitrite as N	0.06	mg/L
311500030060-01S	7/30/2007	Nitrogen, Nitrate/Nitrite as N	0.4	mg/L
311500030060-01S	10/28/2008	Nitrogen, Nitrate/Nitrite as N	<0.05	mg/L
311500030060-02	11/8/2006	Nitrogen, Nitrate/Nitrite as N	0.48	mg/L
311500030060-02	3/20/2007	Nitrogen, Nitrate/Nitrite as N	<0.05	mg/L
311500030060-02	5/1/2007	Nitrogen, Nitrate/Nitrite as N	<0.05	mg/L
311500030060-02	7/30/2007	Nitrogen, Nitrate/Nitrite as N	0.29	mg/L
311500030060-02	10/28/2008	Nitrogen, Nitrate/Nitrite as N	0.08	mg/L
311500030060-02	2/18/2009	Nitrogen, Nitrate/Nitrite as N	0.28	mg/L
311500030060-02	5/5/2009	Nitrogen, Nitrate/Nitrite as N	<0.05	mg/L
311500030060-03	11/8/2006	Nitrogen, Nitrate/Nitrite as N	0.49	mg/L
311500030060-03	3/20/2007	Nitrogen, Nitrate/Nitrite as N	<0.05	mg/L
311500030060-03	5/1/2007	Nitrogen, Nitrate/Nitrite as N	<0.05	mg/L
311500030060-03	7/30/2007	Nitrogen, Nitrate/Nitrite as N	0.12	mg/L
311500030060-03	10/28/2008	Nitrogen, Nitrate/Nitrite as N	0.06	mg/L
311500030060-03	2/18/2009	Nitrogen, Nitrate/Nitrite as N	0.37	mg/L
311500030060-03	5/5/2009	Nitrogen, Nitrate/Nitrite as N	<0.05	mg/L
311500030060-04	11/8/2006	Nitrogen, Nitrate/Nitrite as N	0.48	mg/L
311500030060-04	3/20/2007	Nitrogen, Nitrate/Nitrite as N	<0.05	mg/L
311500030060-04	5/1/2007	Nitrogen, Nitrate/Nitrite as N	<0.05	mg/L
311500030060-04	7/30/2007	Nitrogen, Nitrate/Nitrite as N	0.15	mg/L
311500030060-05	11/8/2006	Nitrogen, Nitrate/Nitrite as N	0.46	mg/L
311500030060-05	3/20/2007	Nitrogen, Nitrate/Nitrite as N	<0.05	mg/L
311500030060-05	5/1/2007	Nitrogen, Nitrate/Nitrite as N	0.07	mg/L
311500030060-05	7/30/2007	Nitrogen, Nitrate/Nitrite as N	0.29	mg/L
311500030060-01B	5/29/2001	Nitrogen, Nitrite as N	0.13	mg/L
311500030060-01B	4/28/2004	Nitrogen, Nitrite as N	<0.05	mg/L

WQM Station	Date	Parameter	Value	Units
311500030060-01S	6/22/1998	Nitrogen, Nitrite as N	<0.05	mg/L
311500030060-01S	3/6/2001	Nitrogen, Nitrite as N	0.43	mg/L
311500030060-01S	5/29/2001	Nitrogen, Nitrite as N	0.13	mg/L
311500030060-01S	11/10/2003	Nitrogen, Nitrite as N	<0.05	mg/L
311500030060-01S	1/28/2004	Nitrogen, Nitrite as N	<0.05	mg/L
311500030060-01S	4/28/2004	Nitrogen, Nitrite as N	<0.05	mg/L
311500030060-01S	7/28/2004	Nitrogen, Nitrite as N	<0.05	mg/L
311500030060-02	6/22/1998	Nitrogen, Nitrite as N	<0.05	mg/L
311500030060-02	3/6/2001	Nitrogen, Nitrite as N	0.42	mg/L
311500030060-02	5/29/2001	Nitrogen, Nitrite as N	0.13	mg/L
311500030060-02	11/10/2003	Nitrogen, Nitrite as N	<0.05	mg/L
311500030060-02	1/28/2004	Nitrogen, Nitrite as N	<0.05	mg/L
311500030060-02	4/28/2004	Nitrogen, Nitrite as N	<0.05	mg/L
311500030060-02	7/28/2004	Nitrogen, Nitrite as N	<0.05	mg/L
311500030060-03	6/22/1998	Nitrogen, Nitrite as N	<0.05	mg/L
311500030060-03	3/6/2001	Nitrogen, Nitrite as N	0.96	mg/L
311500030060-03	5/29/2001	Nitrogen, Nitrite as N	0.12	mg/L
311500030060-03	11/10/2003	Nitrogen, Nitrite as N	<0.05	mg/L
311500030060-03	1/28/2004	Nitrogen, Nitrite as N	<0.05	mg/L
311500030060-03	4/28/2004	Nitrogen, Nitrite as N	<0.05	mg/L
311500030060-03	7/28/2004	Nitrogen, Nitrite as N	<0.05	mg/L
311500030060-04	11/10/2003	Nitrogen, Nitrite as N	<0.05	mg/L
311500030060-04	1/28/2004	Nitrogen, Nitrite as N	<0.05	mg/L
311500030060-04	4/28/2004	Nitrogen, Nitrite as N	<0.05	mg/L
311500030060-04	7/28/2004	Nitrogen, Nitrite as N	<0.05	mg/L
311500030060-05	11/10/2003	Nitrogen, Nitrite as N	<0.05	mg/L
311500030060-05	1/28/2004	Nitrogen, Nitrite as N	<0.05	mg/L
311500030060-05	4/28/2004	Nitrogen, Nitrite as N	<0.05	mg/L
311500030060-05	7/28/2004	Nitrogen, Nitrite as N	<0.05	mg/L
311500030060-01S	6/22/1998	Nitrogen, Organic	1.04	mg/L
311500030060-02	6/22/1998	Nitrogen, Organic	0.95	mg/L
311500030060-03	6/22/1998	Nitrogen, Organic	1.18	mg/L
311500030060-01S	6/22/1998	Nitrogen, Total	1.04	mg/L
311500030060-02	6/22/1998	Nitrogen, Total	1	mg/L
311500030060-03	6/22/1998	Nitrogen, Total	1.18	mg/L
311500030060-01B	5/29/2001	Phosphorous, Ortho	0.189	mg/L
311500030060-01B	4/28/2004	Phosphorous, Ortho	0.019	mg/L
311500030060-01S	6/22/1998	Phosphorous, Ortho	0.063	mg/L
311500030060-01S	3/6/2001	Phosphorous, Ortho	0.022	mg/L
311500030060-01S	5/29/2001	Phosphorous, Ortho	0.138	mg/L
311500030060-01S	11/10/2003	Phosphorous, Ortho	0.031	mg/L
311500030060-01S	1/28/2004	Phosphorous, Ortho	0.045	mg/L
311500030060-01S	4/28/2004	Phosphorous, Ortho	0.017	mg/L
311500030060-01S	7/28/2004	Phosphorous, Ortho	0.038	mg/L
311500030060-01S	11/8/2006	Phosphorous, Ortho	0.05	mg/L
311500030060-01S	5/1/2007	Phosphorous, Ortho	0.042	mg/L
311500030060-01S	7/30/2007	Phosphorous, Ortho	0.074	mg/L
311500030060-02	6/22/1998	Phosphorous, Ortho	0.049	mg/L
311500030060-02	3/6/2001	Phosphorous, Ortho	0.019	mg/L
311500030060-02	5/29/2001	Phosphorous, Ortho	0.14	mg/L
311500030060-02	11/10/2003	Phosphorous, Ortho	0.036	mg/L
311500030060-02	1/28/2004	Phosphorous, Ortho	0.035	mg/L

WQM Station	Date	Parameter	Value	Units
311500030060-02	4/28/2004	Phosphorous, Ortho	0.02	mg/L
311500030060-02	7/28/2004	Phosphorous, Ortho	0.032	mg/L
311500030060-02	11/8/2006	Phosphorous, Ortho	0.046	mg/L
311500030060-02	3/20/2007	Phosphorous, Ortho	0.013	mg/L
311500030060-02	5/1/2007	Phosphorous, Ortho	0.033	mg/L
311500030060-02	7/30/2007	Phosphorous, Ortho	0.063	mg/L
311500030060-02	5/5/2009	Phosphorous, Ortho	0	mg/L
311500030060-02	8/4/2009	Phosphorous, Ortho	0	mg/L
311500030060-03	6/22/1998	Phosphorous, Ortho	0.048	mg/L
311500030060-03	3/6/2001	Phosphorous, Ortho	0.054	mg/L
311500030060-03	5/29/2001	Phosphorous, Ortho	0.128	mg/L
311500030060-03	11/10/2003	Phosphorous, Ortho	0.037	mg/L
311500030060-03	1/28/2004	Phosphorous, Ortho	0.032	mg/L
311500030060-03	4/28/2004	Phosphorous, Ortho	0.039	mg/L
311500030060-03	7/28/2004	Phosphorous, Ortho	0.032	mg/L
311500030060-03	11/8/2006	Phosphorous, Ortho	0.04	mg/L
311500030060-03	3/20/2007	Phosphorous, Ortho	0.016	mg/L
311500030060-03	5/1/2007	Phosphorous, Ortho	0.029	mg/L
311500030060-03	7/30/2007	Phosphorous, Ortho	0.033	mg/L
311500030060-03	5/5/2009	Phosphorous, Ortho	0	mg/L
311500030060-03	8/4/2009	Phosphorous, Ortho	0	mg/L
311500030060-04	11/10/2003	Phosphorous, Ortho	0.037	mg/L
311500030060-04	1/28/2004	Phosphorous, Ortho	0.029	mg/L
311500030060-04	4/28/2004	Phosphorous, Ortho	0.022	mg/L
311500030060-04	7/28/2004	Phosphorous, Ortho	0.029	mg/L
311500030060-04	11/8/2006	Phosphorous, Ortho	0.046	mg/L
311500030060-04	3/20/2007	Phosphorous, Ortho	0.01	mg/L
311500030060-04	5/1/2007	Phosphorous, Ortho	0.025	mg/L
311500030060-04	7/30/2007	Phosphorous, Ortho	0.045	mg/L
311500030060-05	11/10/2003	Phosphorous, Ortho	0.033	mg/L
311500030060-05	1/28/2004	Phosphorous, Ortho	0.03	mg/L
311500030060-05	4/28/2004	Phosphorous, Ortho	0.021	mg/L
311500030060-05	7/28/2004	Phosphorous, Ortho	0.029	mg/L
311500030060-05	11/8/2006	Phosphorous, Ortho	0.042	mg/L
311500030060-05	3/20/2007	Phosphorous, Ortho	0.012	mg/L
311500030060-05	5/1/2007	Phosphorous, Ortho	0.063	mg/L
311500030060-05	7/30/2007	Phosphorous, Ortho	0.052	mg/L
311500030060-01B	5/29/2001	Phosphorous, Total	0.318	mg/L
311500030060-01B	4/28/2004	Phosphorous, Total	0.102	mg/L
311500030060-01S	6/22/1998	Phosphorous, Total	0.098	mg/L
311500030060-01S	3/6/2001	Phosphorous, Total	0.06	mg/L
311500030060-01S	5/29/2001	Phosphorous, Total	0.242	mg/L
311500030060-01S	11/10/2003	Phosphorous, Total	0.135	mg/L
311500030060-01S	1/28/2004	Phosphorous, Total	0.126	mg/L
311500030060-01S	4/28/2004	Phosphorous, Total	0.092	mg/L
311500030060-01S	7/28/2004	Phosphorous, Total	0.142	mg/L
311500030060-01S	11/8/2006	Phosphorous, Total	0.155	mg/L
311500030060-01S	5/1/2007	Phosphorous, Total	0.096	mg/L
311500030060-01S	7/30/2007	Phosphorous, Total	0.181	mg/L
311500030060-01S	10/28/2008	Phosphorous, Total	0.126	mg/L
311500030060-02	6/22/1998	Phosphorous, Total	0.132	mg/L
311500030060-02	3/6/2001	Phosphorous, Total	0.06	mg/L

WQM Station	Date	Parameter	Value	Units
311500030060-02	5/29/2001	Phosphorous, Total	0.209	mg/L
311500030060-02	11/10/2003	Phosphorous, Total	0.134	mg/L
311500030060-02	1/28/2004	Phosphorous, Total	0.129	mg/L
311500030060-02	4/28/2004	Phosphorous, Total	0.107	mg/L
311500030060-02	7/28/2004	Phosphorous, Total	0.13	mg/L
311500030060-02	11/8/2006	Phosphorous, Total	0.14	mg/L
311500030060-02	3/20/2007	Phosphorous, Total	0.088	mg/L
311500030060-02	5/1/2007	Phosphorous, Total	0.102	mg/L
311500030060-02	7/30/2007	Phosphorous, Total	0.174	mg/L
311500030060-02	10/28/2008	Phosphorous, Total	0.131	mg/L
311500030060-02	2/18/2009	Phosphorous, Total	0.1	mg/L
311500030060-02	5/5/2009	Phosphorous, Total	0.144	mg/L
311500030060-03	6/22/1998	Phosphorous, Total	0.066	mg/L
311500030060-03	3/6/2001	Phosphorous, Total	0.137	mg/L
311500030060-03	5/29/2001	Phosphorous, Total	0.216	mg/L
311500030060-03	11/10/2003	Phosphorous, Total	0.156	mg/L
311500030060-03	1/28/2004	Phosphorous, Total	0.171	mg/L
311500030060-03	4/28/2004	Phosphorous, Total	0.155	mg/L
311500030060-03	7/28/2004	Phosphorous, Total	0.13	mg/L
311500030060-03	11/8/2006	Phosphorous, Total	0.14	mg/L
311500030060-03	3/20/2007	Phosphorous, Total	0.123	mg/L
311500030060-03	5/1/2007	Phosphorous, Total	0.108	mg/L
311500030060-03	7/30/2007	Phosphorous, Total	0.167	mg/L
311500030060-03	10/28/2008	Phosphorous, Total	0.131	mg/L
311500030060-03	2/18/2009	Phosphorous, Total	0.113	mg/L
311500030060-03	5/5/2009	Phosphorous, Total	0.154	mg/L
311500030060-04	11/10/2003	Phosphorous, Total	0.14	mg/L
311500030060-04	1/28/2004	Phosphorous, Total	0.128	mg/L
311500030060-04	4/28/2004	Phosphorous, Total	0.11	mg/L
311500030060-04	7/28/2004	Phosphorous, Total	0.121	mg/L
311500030060-04	11/8/2006	Phosphorous, Total	0.146	mg/L
311500030060-04	3/20/2007	Phosphorous, Total	0.083	mg/L
311500030060-04	5/1/2007	Phosphorous, Total	0.104	mg/L
311500030060-04	7/30/2007	Phosphorous, Total	0.149	mg/L
311500030060-05	11/10/2003	Phosphorous, Total	0.139	mg/L
311500030060-05	1/28/2004	Phosphorous, Total	0.137	mg/L
311500030060-05	4/28/2004	Phosphorous, Total	0.1	mg/L
311500030060-05	7/28/2004	Phosphorous, Total	0.12	mg/L
311500030060-05	11/8/2006	Phosphorous, Total	0.139	mg/L
311500030060-05	3/20/2007	Phosphorous, Total	0.081	mg/L
311500030060-05	5/1/2007	Phosphorous, Total	0.126	mg/L
311500030060-05	7/30/2007	Phosphorous, Total	0.157	mg/L
311500030060-01S	3/6/2001	Secchi Depth	50	cm
311500030060-01S	5/29/2001	Secchi Depth	44	cm
311500030060-01S	8/27/2001	Secchi Depth	26	cm
311500030060-01S	11/10/2003	Secchi Depth	31	cm
311500030060-01S	1/28/2004	Secchi Depth	33	cm
311500030060-01S	4/28/2004	Secchi Depth	48	cm
311500030060-01S	7/28/2004	Secchi Depth	23	cm
311500030060-02	3/6/2001	Secchi Depth	50	cm
311500030060-02	5/29/2001	Secchi Depth	28	cm
311500030060-02	8/27/2001	Secchi Depth	15	cm

WQM Station	Date	Parameter	Value	Units
311500030060-02	11/10/2003	Secchi Depth	35	cm
311500030060-02	1/28/2004	Secchi Depth	32	cm
311500030060-02	4/28/2004	Secchi Depth	44	cm
311500030060-02	7/28/2004	Secchi Depth	21	cm
311500030060-02	5/5/2009	Secchi Depth	32	cm
311500030060-02	8/4/2009	Secchi Depth	17	cm
311500030060-03	3/6/2001	Secchi Depth	21	cm
311500030060-03	5/29/2001	Secchi Depth	22	cm
311500030060-03	8/27/2001	Secchi Depth	13	cm
311500030060-03	11/10/2003	Secchi Depth	22	cm
311500030060-03	1/28/2004	Secchi Depth	28	cm
311500030060-03	4/28/2004	Secchi Depth	27	cm
311500030060-03	7/28/2004	Secchi Depth	18	cm
311500030060-03	5/5/2009	Secchi Depth	0	cm
311500030060-03	8/4/2009	Secchi Depth	12	cm
311500030060-04	11/10/2003	Secchi Depth	32	cm
311500030060-04	1/28/2004	Secchi Depth	33	cm
311500030060-04	4/28/2004	Secchi Depth	37	cm
311500030060-04	7/28/2004	Secchi Depth	20	cm
311500030060-05	11/10/2003	Secchi Depth	41	cm
311500030060-05	1/28/2004	Secchi Depth	28	cm
311500030060-05	4/28/2004	Secchi Depth	41	cm
311500030060-05	7/28/2004	Secchi Depth	21	cm
311500030060-01S	5/5/2009	Turbidity, Field	13	NTU
311500030060-01S	8/4/2009	Turbidity, Field	54	NTU
311500030060-01S	5/5/2009	Turbidity, Field	11	NTU
311500030060-01S	8/4/2009	Turbidity, Field	57	NTU
311500030060-01S	11/10/2003	Turbidity, Field	27	NTU
311500030060-01S	1/28/2004	Turbidity, Field	27	NTU
311500030060-01S	4/28/2004	Turbidity, Field	14	NTU
311500030060-01S	7/28/2004	Turbidity, Field	51	NTU
311500030060-01S	11/8/2006	Turbidity, Field	73	NTU
311500030060-01S	7/30/2007	Turbidity, Field	36	NTU
311500030060-01S	3/6/2001	Turbidity, Field	11	NTU
311500030060-01S	3/6/2001	Turbidity, Field	11	NTU
311500030060-01S	5/29/2001	Turbidity, Field	45	NTU
311500030060-01S	5/29/2001	Turbidity, Field	50	NTU
311500030060-01S	8/27/2001	Turbidity, Field	33	NTU
311500030060-01S	8/27/2001	Turbidity, Field	35	NTU
311500030060-01S	11/10/2003	Turbidity, Field	26	NTU
311500030060-01S	1/28/2004	Turbidity, Field	27	NTU
311500030060-01S	4/28/2004	Turbidity, Field	20	NTU
311500030060-01S	7/28/2004	Turbidity, Field	58	NTU
311500030060-01S	11/8/2006	Turbidity, Field	73	NTU
311500030060-01S	7/30/2007	Turbidity, Field	43	NTU
311500030060-02	3/6/2001	Turbidity, Field	12	NTU
311500030060-02	5/29/2001	Turbidity, Field	53	NTU
311500030060-02	8/27/2001	Turbidity, Field	42	NTU
311500030060-02	11/10/2003	Turbidity, Field	30	NTU
311500030060-02	1/28/2004	Turbidity, Field	29	NTU
311500030060-02	4/28/2004	Turbidity, Field	16	NTU
311500030060-02	7/28/2004	Turbidity, Field	52	NTU

WQM Station	Date	Parameter	Value	Units
311500030060-02	11/8/2006	Turbidity, Field	61	NTU
311500030060-02	3/20/2007	Turbidity, Field	31	NTU
311500030060-02	7/30/2007	Turbidity, Field	36	NTU
311500030060-02	5/5/2009	Turbidity, Field	15	NTU
311500030060-02	8/4/2009	Turbidity, Field	66	NTU
311500030060-03	3/6/2001	Turbidity, Field	53	NTU
311500030060-03	5/29/2001	Turbidity, Field	56	NTU
311500030060-03	8/27/2001	Turbidity, Field	50	NTU
311500030060-03	11/10/2003	Turbidity, Field	40	NTU
311500030060-03	1/28/2004	Turbidity, Field	99	NTU
311500030060-03	4/28/2004	Turbidity, Field	73	NTU
311500030060-03	7/28/2004	Turbidity, Field	68	NTU
311500030060-03	11/8/2006	Turbidity, Field	65	NTU
311500030060-03	3/20/2007	Turbidity, Field	83	NTU
311500030060-03	7/30/2007	Turbidity, Field	23	NTU
311500030060-03	5/5/2009	Turbidity, Field	14	NTU
311500030060-03	8/4/2009	Turbidity, Field	95	NTU
311500030060-04	11/10/2003	Turbidity, Field	37	NTU
311500030060-04	1/28/2004	Turbidity, Field	29	NTU
311500030060-04	4/28/2004	Turbidity, Field	18	NTU
311500030060-04	7/28/2004	Turbidity, Field	47	NTU
311500030060-04	11/8/2006	Turbidity, Field	68	NTU
311500030060-04	3/20/2007	Turbidity, Field	44	NTU
311500030060-04	7/30/2007	Turbidity, Field	22	NTU
311500030060-05	11/10/2003	Turbidity, Field	28	NTU
311500030060-05	1/28/2004	Turbidity, Field	31	NTU
311500030060-05	4/28/2004	Turbidity, Field	22	NTU
311500030060-05	7/28/2004	Turbidity, Field	44	NTU
311500030060-05	11/8/2006	Turbidity, Field	56	NTU
311500030060-05	3/20/2007	Turbidity, Field	40	NTU
311500030060-05	7/30/2007	Turbidity, Field	31	NTU
311500030060-01S	6/22/1998	Solids, Suspended	44	mg/L
311500030060-02	6/22/1998	Solids, Suspended	32	mg/L
311500030060-03	6/22/1998	Solids, Suspended	35	mg/L

APPENDIX C

RESPONSE TO COMMENTS

Comment received via e-mail from John D. Marshall of Roosevelt, OK on August 7, 2011.

Comment: I live at cold springs on the north side of lake Tom Steed, our water is pumped from the lake and supposedly filtered enough for us to drink. I've been here 3 years, I cant afford to filter the water myself or buy bottled water. I have 2 55 gallon fish tanks and had planed on raising african chiclids like I did before I moved here. I cant even keep pleco's that are hard to kill alive in this water. Nothing but native fish like minnows and blusegills will live. The only other fish that survive are goldfish and ghost shrimp (I found the ghost shrimp in the lake, they arnt native, probably used as bait, walmart sells them). Now I cant keep a tropical fish alive in this water and we're expected to pay for it as drinking water?

When they flush the lines I have water blacker than my coffee coming out of my faucets, there's nothing anyone can say that will convince me that cant hurt our health. 3 people have ended up with colostomy bags that lived here. The manganese deposits have coated my fish tanks, have ruined 2 faucets and a shower head that were new 3 years ago. I've got samples of the deposits and I've had a blood test that said my manganese was slightly high and I've lost a lung to cancer bout a yr after I moved here. I've also got a sample of the black water, dead algae that's settled in the lines I guess.

I've got a 13 yr old son who has to drink this "water " and I'm worried what its doing to him long term, like the interaction with disinfectants.

Response: *This statement is about the general drinking water quality of a community by Lake Tom Steed. It does not concern the pollutants this TMDL is intended to address nor does it provide comments on the specifics of this TMDL. Nevertheless, Mr. Marshall's concerns have been noted and this statement has been referred to ODEQ's Environmental* Complaints and *Local Services for further investigation.*