

SUMMARY REPORT

of the

Canadian and Red River Basins

2009



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ACRONYMS

ALA	Aquatic Life Assessment
AMSL	Above Mean Sea Level
BAC	Basin Advisory Committee
CFS	Cubic Feet per Second
CAFO	Concentrated Animal Feeding Operation
CRIT	Criteria
CRP	Clean Rivers Program
CWA	Clean Water Act
EPA	U.S. Environmental Protection Agency
ESD	RRA Environmental Services Division
FM	Farm to Market Road
HUA	Hydrologic Unit Area
MAX	Maximum
MG/L	Milligrams per Liter
MIN	Minimum
MPN	Most Probable Number
N	Number of Measurements
N/A	Not Applicable
QA	Quality Assurance
QAPP	Quality Assurance Project Plan
RRA	Red River Authority of Texas
RRC	Texas Railroad Commission
SH	State Highway
SWQM	Surface Water Quality Monitoring
SWQMIS	Surface Water Quality Monitoring Information System
TMDL	Total Maximum Daily Load
TCEQ	Texas Commission on Environmental Quality
TPWD	Texas Parks and Wildlife Department
TSWQS	Texas Surface Water Quality Standards
TWQI	Texas Water Quality Inventory
UG/L	Micrograms per Liter
USDOE	United States Department of Energy
USGS	United States Geological Survey
WWTP	Wastewater Treatment Plant

ACTIVITIES AND ACCOMPLISHMENTS

The Clean Rivers Program or CRP began more than eighteen years ago with one goal or mission. Today, that same basic goal expressed in *The Long Term Plan of the Clean Rivers Program* is:

To maintain and improve the quality of water within each river basin in Texas through an ongoing partnership involving the Texas Commission on Environmental Quality (TCEQ), river authorities, other agencies, regional entities, local governments, industry, and citizens. The program's watershed management approach will identify and evaluate water quality issues, establish priorities for corrective action, work to implement those actions, and adapt to changing priorities.

In the Clean River Program's infancy, the watershed management approach was selected as the best method to manage the State's diverse surface water resources. Almost twenty years later that approach, the energy and motivation that helped start the program, is still the driving force of the CRP today.

The Clean Rivers Program has proven to be a success with the cooperation of watershed planning efforts in the Canadian and Red River Basins. A very successful component of the CRP for both basins is the annual Coordinated Monitoring Meeting. At this meeting, monitoring partners gather to plan the monitoring efforts for the next fiscal year. This ensures that the maximum number of sites are selected, without the duplication of efforts, thereby insuring the efficient use of available financial resources. Another important ingredient of the Clean Rivers Program is the Basin Advisory Committee meetings. These meetings are held annually to provide opportunities for you, the stakeholder, to offer your opinion and make a difference. The Authority is very appreciative of all of the time and effort that is invested in these meetings.

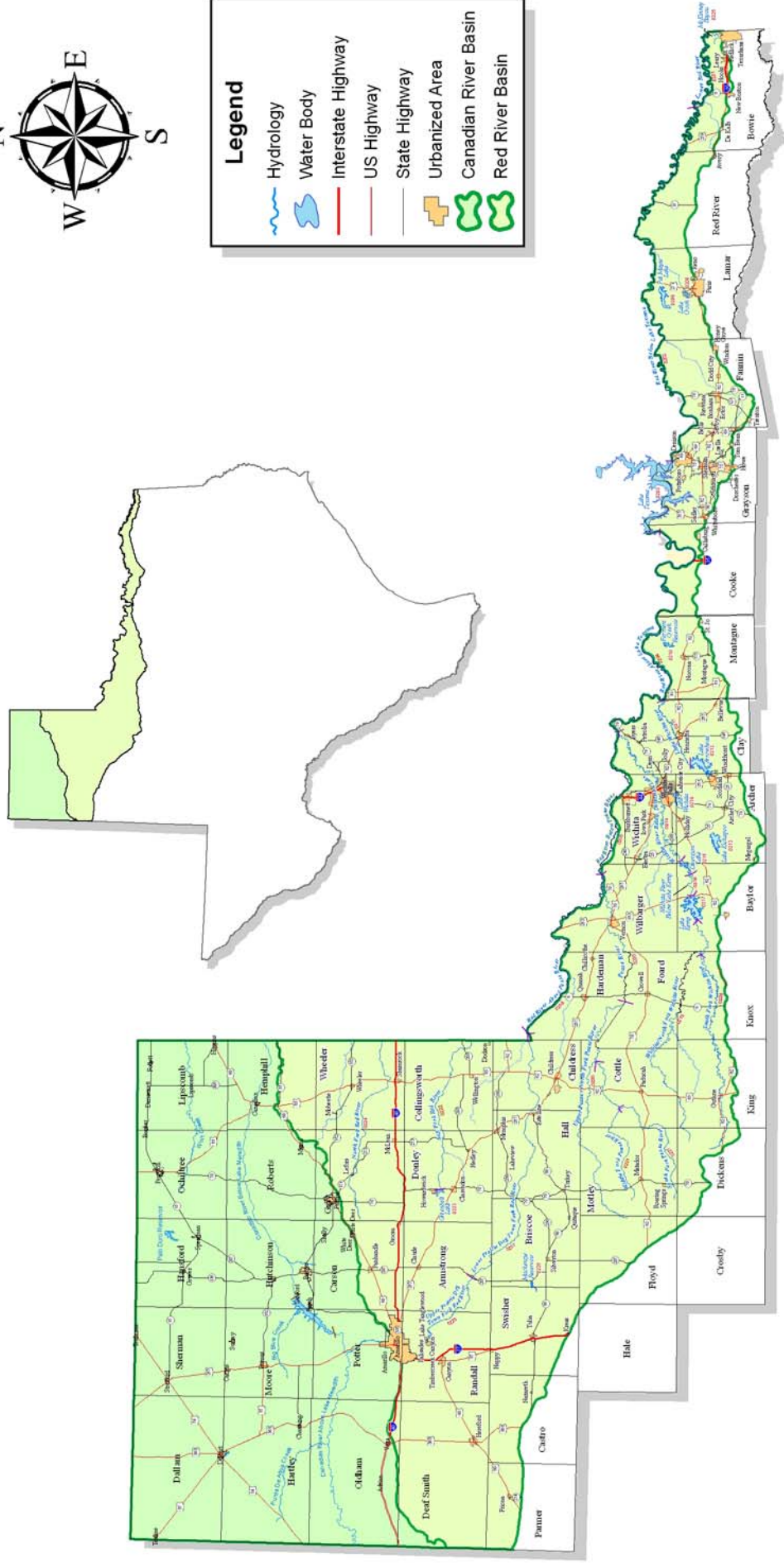
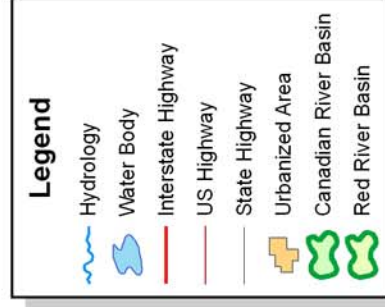
The Red River Authority's mission is the orderly conservation, reclamation, protection and development of the water resources throughout the Red River Basin for the benefit of the public. This also includes the responsibility for and dedication to the water resources of the Canadian River Basin. The Authority is proud of its commitment between federal, state, and local agencies. Common goals are expressed and pursued by all parties involved in the basins' future.

The Red River Authority always welcomes and encourages stakeholder participation and involvement in the planning of the Canadian and Red River Basins' watershed management. For information on how you can be on the Basin Advisory Committee or other public outreach activities, please contact the Authority or refer to the Authority's website at www.rra.dst.tx.us.

To facilitate assessment of the Canadian and Red River Basins, the Authority subdivided each basin into five reaches, also known as sub-watersheds. These reaches, divided by natural hydrology, are composed of classified and unclassified stream or waterbody segments and are identified by the TCEQ in the Texas Surface Water Quality Standards (TSWQS). Refer to the **Vicinity Map** on **page 9** for a visual presentation of the Canadian and Red River Basins. The following paragraphs present a summation, by basin reach, of the Authority's findings during this assessment process.



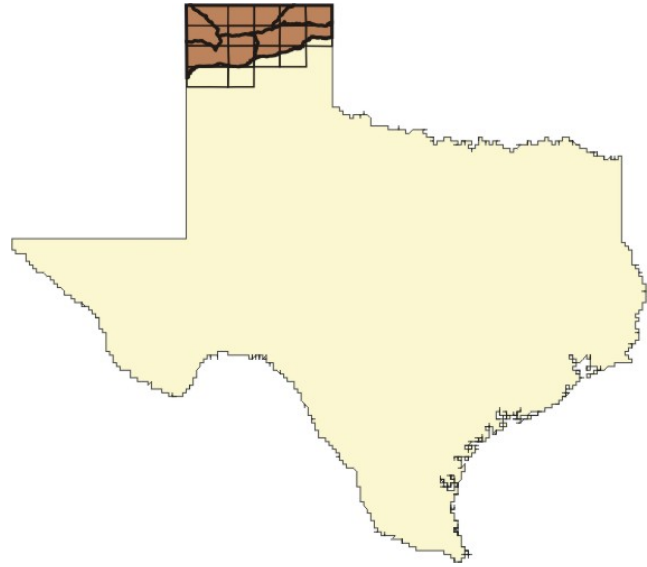
Red and Canadian River Basins Vicinity Map



SIGNIFICANT FINDINGS

Canadian River Basin Overview

The Canadian River Basin includes all or parts of 15 counties in the Texas Panhandle. The headwaters of the Canadian River begin in northeastern New Mexico as a tributary to the Arkansas River and eventually flows into the Mississippi River. The basin was divided into five reaches in order to design the most effective sampling methodology within the limited funds and personnel available. There are five classified stream segments and six unclassified stream segments in the Canadian River Basin.



From a basin-wide perspective, the waters of the Canadian River Basin are generally good in quality. Water quality throughout the vast majority of the basin supports aquatic life and recreational uses. There are two major issues that affect the Canadian River Basin. One is the ongoing drought, while the other is excessive chloride levels. There are no quick fixes for either issue, but the Authority and its stakeholders are working toward the effective management of these ongoing issues.

Canadian River Basin – Reach I

In **Reach I** of the Canadian River Basin there are three identified segments, one classified and two unclassified. The *2008 Texas Water Quality Inventory (TWQI)* lists one portion of the classified stream segment, the Canadian River below Lake Meredith (Segment 0101), with a concern for ammonia. The two unclassified segments, Dixon Creek (Segment 0101A) and Rock Creek (Segment 0101B), are on the *2008 303(d) List* for bacteria. Dixon Creek is also on the list for low dissolved oxygen. Additionally, according to the *2008 TWQI*, Dixon Creek has a concern for bacteria, nitrate, orthophosphorus and chlorophyll *a*, while Rock Creek has a concern for nitrate.

The primary overall concerns in **Reach I** are nutrients and bacteria. The elevated nutrient levels may be the result of wildlife and livestock remaining near water to drink and keep cool in the summer. This increases the likelihood of bacteria spikes when there is runoff. Sources of the elevated nutrients and bacteria vary by segment, but wildlife and agricultural runoff are the most likely causes. Although most nutrient non-point sources cannot be ascribed to a particular source(s) in most cases, the development of a watershed protection plan will aid in identifying and managing water quality concerns like these. Watershed protection plans are developed locally and are stakeholder driven. For trend and screening analysis of the stream segments in **Reach I**, please refer to the Watershed Summaries in **Chapter 3**.

Canadian River Basin – Reach II

Reach II of the Canadian River Basin includes two classified stream segments and three unclassified stream segments. Lake Meredith (Segment 0102), a classified water body, is the largest reservoir in the Canadian River Basin. It is managed by the Canadian River Municipal Water Authority (CRMWA).

Lake Meredith and the Canadian River above Lake Meredith (Segment 0103) are both on the 2008 303(d) List for elevated levels of chloride. Lake Meredith is also on the 2008 303(d) List for total dissolved solids, sulfate and mercury in edible fish tissue (walleye). There is no quick fix to the elevated salts in Lake Meredith and the Canadian River. Since both water bodies are on the 303(d) List as a Category 5C, additional data will need to be collected before a TMDL is scheduled, which should address these concerns.

However, there are projects such as brush control and brine management, which help both the river and the lake. The Canadian River Municipal Water Authority is a sponsor for both types of these projects. Decreasing salt cedar and mesquite densities along the river are seen as positive ways to increase flow in the river and into the lake. Continued monitoring for mercury in Lake Meredith, including tissue collection, is recommended.

East Amarillo Creek (Segment 0103A) is on the 2008 TWQI with a concern for nitrate and chlorophyll a. Finding the sources of these elevated nutrients is going to be difficult because of the urbanization along the creek. One way to track the source of these elevated nutrients would be to add additional monitoring sites along the creek until the source of the concerns is determined. East Amarillo Creek should continue to be monitored to look for long term trends. Big Blue Creek (Segment 0102A) and Punta de Agua Creek (Segment 0103B) were either not assessed or did not have sufficient data for assessment purposes. For trend and screening analysis, please refer to the **Watershed Summaries** in **Chapter 3**.

Canadian River Basin – Reach III

There is only one classified segment in **Reach III**, Rita Blanca Lake (Segment 0105). Although called a lake, Rita Blanca is more like a marsh than a lake. Migratory waterfowl utilize Rita Blanca during migration. It is on the 2008 303(d) List for pH and on the 2008 TWQI with concerns for elevated levels of chlorophyll a, ortho-phosphorus, total phosphorus and ammonia. Trend analysis was not possible due to the insufficient number of data points (**See Appendix B**). Since Rita Blanca is on the 303(d) List as a Category 5C, additional data will need to be collected before a TMDL is scheduled, which should address these concerns.

Canadian River Basin – Reach IV

Reach IV has one classified segment, Palo Duro Creek (Segment 0199) which was not assessed in 2008 due to the lack of available data. There is also one unclassified water body, Palo Duro Reservoir (Segment 0199A). The ongoing drought, combined with the naturally arid nature of this part of the Canadian River Basin, continue to affect the filling of Palo Duro Reservoir. According to The Palo Duro River Authority, the five year average capacity was 2.89 %, while the ten year capacity was 7.63%. With the data collected from one station on the Palo Duro Reservoir, it is on both the 2008 303(d) List for depressed dissolved oxygen and the

2008 TWQI with a concern for elevated levels of ammonia. While both elevated and lower values were noted for certain constituents, trend analysis was not possible due to the insufficient number of data points. Since Palo Duro Reservoir is on the 303(d) List as a Category 5C, additional data will need to be collected before a TMDL is scheduled, which should address these concerns.

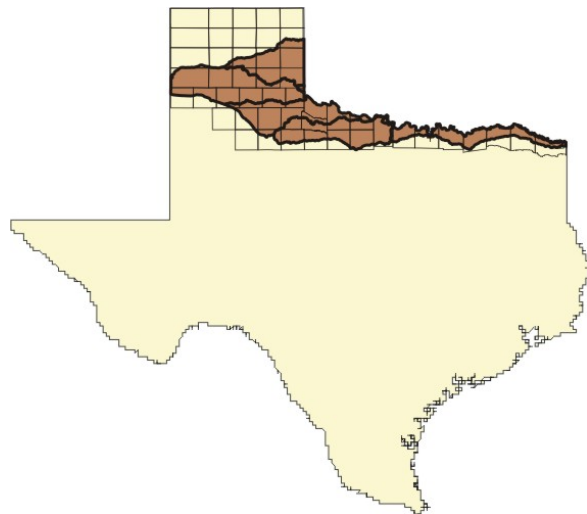
Canadian River Basin – Reach V

As in Reach III, **Reach V** has only one segment, Wolf Creek (Segment 0104). Wolf Creek was removed from the 303(d) List for bacteria in 2008, since the most recent set of data demonstrated that water quality standards are now met and water quality meets the requirements for removal. However, Wolf Creek is on the 2008 TWQI with a concern for elevated chlorophyll *a* levels. This concern was found on the Lake Fryer portion of Wolf Creek, a small impoundment located in the upper portions of the watershed. This concern may originate from runoff into the lake after rainfall events washing nutrients into the lake and/or from animal and human activity in the recreation area around the lake. Continued monitoring on Lake Fryer to follow chlorophyll *a*, nutrient levels and rainfall events is recommended. The additional information that is collected will aid in locating possible sources and whether the elevated chlorophyll *a* levels are resulting from runoff events or from man-made sources around the lake. No trends were indicated during analysis.

Red River Basin Overview

As the second longest river in the State of Texas, the Red River Basin includes all or parts of 43 counties across North Texas. The Red River is an interstate water body that originates in Curry County, New Mexico, as Tierra Blanca Creek and flows across the Texas Panhandle carving the spectacular Palo Duro Canyon of the High Plains. It then leaves the Caprock Escarpment near the eastern boundary of Childress County, where the south bank of the river becomes the boundary between Texas and Oklahoma. It continues its southeasterly direction across Texas into southwestern Arkansas, then turns south into Louisiana, where it discharges into the Mississippi River near Simmesport, Louisiana.

Water resources within the Red River Basin are generally good and support a hearty and robust aquatic life with respect to stream standards. There are continuing issues with the exceptionally high levels of salts, which originate in the western portions of the watershed and affect all water downstream. Only 12 of the 30 classified stream segments have been designated as useable for public water supply due to naturally high occurring concentrations of salt, according to water quality standards. As stated earlier, the basin was divided into five reaches in order to design the most effective sampling methodology within the limited funds and personnel available.



As the State Sponsor of the Red River Chloride Control Project, the Authority will continue to support the Chloride Control Project with trustworthy, reliable scientific methodologies to improve the water quality in the Red River and its tributaries. For more information on the Chloride Control Project and/or the Wichita River Basin Chloride Control Project, please review the Authority's website at www.rra.dst.tx.us or the U.S. Army Corps of Engineer's website at www.swt.usace.army.mil. The Chloride Control Project has removed more than 405 tons of chloride per day entering the river system, without harming the environment.

Red River Basin — Reach I

Reach I of the Red River Basin has nineteen identified segments, eight are classified and eleven are unclassified. Thirteen segments are either on the *2008 303(d) List* and/or the *2008 TWQI for Water Bodies with Concerns for Use Attainment and Screening Levels*. There are eight concerns for elevated chlorophyll *a* levels, six concerns for elevated orthophosphorus levels, three concerns for depressed dissolved oxygen levels, two concerns for elevated ammonia levels and one concern each for elevated nitrate, total phosphorus, bacteria, total dissolved solids, and chloride levels. Mud Creek (Segment 0201A) is on the *2008 303(d) List* for elevated bacteria levels and depressed dissolved oxygen levels. In addition, Smith Creek (Segment 0202G) is on the *2008 303(d) List* for elevated bacteria levels. Specifically, Pat Mayse Lake (Segment 0209) is shown on the *2008 TWQI* as having a concern for manganese in sediment. The *2008 TWQI* shows the remaining six segments as not having any concerns, were not assessed or did not have sufficient data to be assessed.

Although segments with concerns for nutrients are increasing in **Reach I**, chlorophyll *a* is a common concern that can be found up and down the main stem of the Red River. Since Texas and Oklahoma share responsibility for portions of the Red River, it would be useful and advantageous for both states to share data so that each can better manage not only the Red River, but their own resources as well. In other segments with elevated nutrients, most cannot be attributed to a particular source or sources. However, there are some situations where the source of the elevated nutrients may be the result or byproduct of a permitted discharger(s) and agricultural run-off. In segments such as these, continued monitoring is recommended.

For those segments with bacteria exceedances or concerns, methods have been developed that allow the bacteria to be grouped into human and nonhuman sources. Once the source of the host has been identified, more detailed management plans can be implemented. New technologies such as bacterial source tracking are proving to be successful in differentiating between human and non-human varieties of bacteria.

In Pat Mayse Lake, the magnitude of the elevated manganese levels could be determined by increasing the number of sediment sampling sites. The results would show if the concern is uniformly distributed or localized, and perhaps be able to draw a pattern of deposition across the bottom of the lake. Elevated chlorides and total dissolved solids are a continuous concern due to their natural occurrence in the Red River Basin and are best addressed through continued monitoring and the Chloride Control Project. For trend and screening analysis of all of the above concerns, please refer to the **Watershed Summaries** in **Chapter 3**.

Red River Basin — Reach II

In **Reach II**, of the fifteen identified segments, ten are classified segments and five are unclassified segments. **Reach II** is a diverse area with the majority of the population located in the

eastern half, while the western half is home to some of the largest ranches in the state. Petroleum production is very prominent in this reach. Major sources of naturally occurring chlorides are also evident in **Reach II**.

In **Reach II**, seven segments are either on the *2008 303(d) List, 2008 TWQI for Water Bodies with Concerns for Use Attainment and Screening Levels* and/or *2008 TWQI Index of Water Quality Impairments*. Of these concerns, four are for elevated chlorophyll *a*, while three are for orthophosphorus and total phosphorus levels. There are two concerns for depressed dissolved oxygen levels and elevated bacteria, with one concern for nitrate, ammonia and chloride levels. The Little Wichita River (Segment 0211) is on the *2008 303(d) List* for depressed dissolved oxygen levels. The TCEQ has conducted an Use-Attainability Analysis on this segment and a standards change has been recommended for lowering the minimum dissolved oxygen criteria to a less stringent criterion of 3.0 mg/L. In addition, the Wichita River below Lake Diversion Dam (Segment 0214) and Beaver Creek (Segment 0214A) are also on the *2008 303(d) List* for elevated bacteria levels. However, Beaver Creek was removed from the *2008 303(d) List* for depressed dissolved oxygen due to an error in its original inclusion on the list. The South Fork of the Wichita River (Segment 0226) also appears on the *2008 303(d) List* for elevated chloride levels.

The sources of the concerns on segments 0214 and 0214A vary almost by assessment unit. They may range from runoff from a small CAFO and/or farming and ranching operations located along the flood plain of the river. Other possible sources could range from increased wildlife and birds (such as large flocks of wild turkeys) in the more rural sections of the segment to runoff and municipal discharge from large cities located along the river. In Segment 0226, the elevated chloride level is a naturally occurring condition and the most practical method to reduce the chloride levels would be through the Chloride Control Project. The North Fork and Middle Fork of the Wichita River (Segments 0218 and 0218A, respectfully) have been designated as a Category 4c on the *2008 TWQI Index of Water Quality Impairments* for selenium in water. Since selenium is a naturally occurring pollutant that cannot be managed, there are no requirements for the development of TMDLs. For trend and screening analysis of all of the above concerns, please refer to the **Watershed Summaries** in **Chapter 3**.

Red River Basin – Reach III

Reach III contains six identified segments. Three are classified and three are unclassified. Like most of the western half of the basin, **Reach III** is predominately a rural area, consisting of farming, ranching and oil and gas business. The farms are prime land for grazing and hunters also value the area for its natural resources.

Of the six identified segments, three are either on the *2008 303(d) List* and/or the *2008 TWQI for Water Bodies with Concerns for Use Attainment and Screening Levels*. The Red River below the Pease River (Segment 0205) is shown on the *2008 TWQI* as having concerns for elevated chlorophyll *a* and bacteria levels. South Groesbeck Creek (Segment 0206B) is on the *2008 303(d) List* for elevated bacteria levels, but additional data will need to be collected before a TMDL can be scheduled on this water body.

It is also on the *2008 TWQI for Water Bodies with Concerns for Use Attainment and Screening Levels* for elevated nitrate levels. Sources of the elevated bacteria and chlorophyll *a* levels in these segments could be from livestock, birds and other wildlife that have unrestricted access to these water bodies. These animals remain near water to drink and keep cool in the sum-

mer. This increases the likelihood of spikes in bacteria levels when there is runoff. Paradise Creek (Segment 0230A) is on the 2008 303(d) List for elevated bacteria levels and is also on the 2008 TWQI for Water Bodies with Concerns for Use Attainment and Screening Levels for elevated chlorophyll a and nitrate levels. Using new technologies such as bacterial source tracking to determine if the bacteria levels have human or animals origins is necessary since most nutrient and bacteria sources cannot be attributed to one source. Paradise Creek is a good candidate for developing a watershed protection plan which would aid in identification and managing water quality concerns. Watershed protection plans are developed locally and are stakeholder driven. The remaining segments in **Reach III** did not have any concerns or there were insufficient data for assessment. For trend and screening analysis, please refer to the **Watershed Summaries** in **Chapter 3**.

Red River Basin — Reach IV

This reach includes six identified water bodies, three classified segments and three unclassified segments. Of the six identified water bodies in **Reach IV**, four are either on the 2008 303(d) List and/or on the 2008 TWQI for Water Bodies with Concerns for Use Attainment and Screening Levels. Lower Prairie Dog Town Fork of the Red River (Segment 0207) is on the 2008 303(d) List for elevated bacteria levels. It is also on the 2008 TWQI for Water Bodies with Concerns for Use Attainment and Screening Levels for elevated chlorophyll a and orthophosphorus levels. Buck Creek (Segment 0207A) is on the 2008 303(d) List for elevated bacteria levels. TCEQ has indicated that additional data and information are needed before a TMDL can be scheduled. However, the Texas State Soil and Water Conservation Board (TSSWCB) is currently working on a Watershed Protection Plan to remove Buck Creek from its record on the 303(d) List. Buck Creek is also on the 2008 TWQI for Water Bodies with Concerns for Use Attainment and Screening Levels for elevated nitrate levels. The Upper Prairie Dog Town Fork of the Red River (Segment 0229) is on the 2008 303(d) List for elevated pH levels. In addition, (Segment 0229) and Lake Tanglewood (Segment 0229A) are on the 2008 TWQI for Water Bodies with Concerns for Use Attainment and Screening Levels for elevated levels of chlorophyll a, nitrate, orthophosphorus, and total phosphorus. The sources of these concerns are most likely runoff from agricultural fields and grazing pastures. Continued monitoring is recommended for Buck Creek and the Lower Prairie Dog Town Fork of the Red River for these concerns. However, Lake Tanglewood's elevated nutrient levels combined with the effects of possible septic system by-products would require a special study. For trend and screening analysis, please refer to the **Watershed Summaries** in **Chapter 3**.

Red River Basin — Reach V

Reach V includes five identified water bodies, three classified segments and two unclassified segments. Of the five water bodies in this reach, only one, Sweetwater Creek (Segment 0299A), is on the 2008 303(d) List for elevated bacteria levels. It is assigned an overall rating of Category 5c, meaning additional data will be collected before a TMDL is scheduled by the TCEQ. The remaining segments did not reveal any major concerns or did not have sufficient data to be assessed.

Nutrients and bacteria may become issues of concern for this reach in the near future, as increased levels have been observed. Therefore, continued monitoring is the most effective approach for the determination of the water quality issues for this area. For trend and screening analysis, please refer to the **Watershed Summaries** in **Chapter 3**.

RECOMMENDATIONS

Based on the Authority's review and assessment of the water quality data in the Canadian and Red River Basins, the following recommendations are made. These recommendations are presented from a basin wide perspective:

- ◆ Continue with the successful annual Coordinated Monitoring Meeting to develop strategic monitoring plans for both basins,
- ◆ Increase the number of monitoring partners in order for non-monitored locations to receive additional coverage, thereby increasing the amount of data available for future water quality inventories,
- ◆ Support the development of an economical source of bacterial genotyping,
- ◆ Continue to educate the general public about water quality, conservation and protection of our natural resources,
- ◆ Continue to work with agriculture/ranching, industry, and municipal entities toward the improvement of water quality through effective planning strategies,
- ◆ Continue to encourage the USGS to submit their water quality sampling data from the Canadian River at the Texas/New Mexico state line to the TCEQ's SWQMIS database to be used in future assessments,
- ◆ Continue to encourage the State of Oklahoma environmental and water quality agencies to attend the Coordinated Monitoring and Basin Advisory Committee Meetings in order to further a cooperative effort in the improvement of water quality for both basins,
- ◆ Continue support and installation of real time monitoring coverage to allow for quicker responses to abnormal occurrences,
- ◆ Continue research of new and alternative conservation measures, such as brush control and implement field trials, and
- ◆ Continue to be the state sponsor of the Red River Chloride Control Project, pressing for the project's completion and funding so that previously unusable water sources can be utilized without excessive treatment costs.

Over the past five years the Canadian and Red River Basins have experienced varied extremes in weather conditions. They have ranged from a prolonged drought, to scorching heat of hot dry summers, to wildfires that burned more square miles than the size of some small states. In addition, 100 year floods endangered neighborhoods in some cities and filled a number of lakes, while ignoring others. In spite of these extremes, the water quality in the Canadian and Red River Basins remains good. The primary parameters which have concerns for use attainment and/or screening levels in both basins are chloride, chlorophyll a, bacteria, nutrients, and depressed dissolved oxygen. As the sources of these pollutants are discovered, action plans will be developed and implemented. The Authority's recommendations by seg-

ment have been summarized and can be found in **Section 4.1** of this report. Although monitoring efforts do not answer all of the causes for water quality concerns and impairments, they are the most effective method for maintaining awareness and discovery of potential pollutants. With additional water bodies appearing on the *Texas Water Quality Inventory*, the effectiveness of the CRP is resulting in water management strategies being developed to restore these water bodies to a healthy status. With expenses, budgets and overhead continuing to increase, while funding amounts and number of personnel remain approximately the same, the CRP continues to work more efficiently than ever, and like many of its partner agencies, do more with less every year.

The Red River Authority of Texas is very proud of the level of coordination, cooperation and respect that it maintains with the TCEQ, USGS and its cooperating partners, as well as input from the Basin Advisory Committees to provide feedback that results in planning for the basins' future.

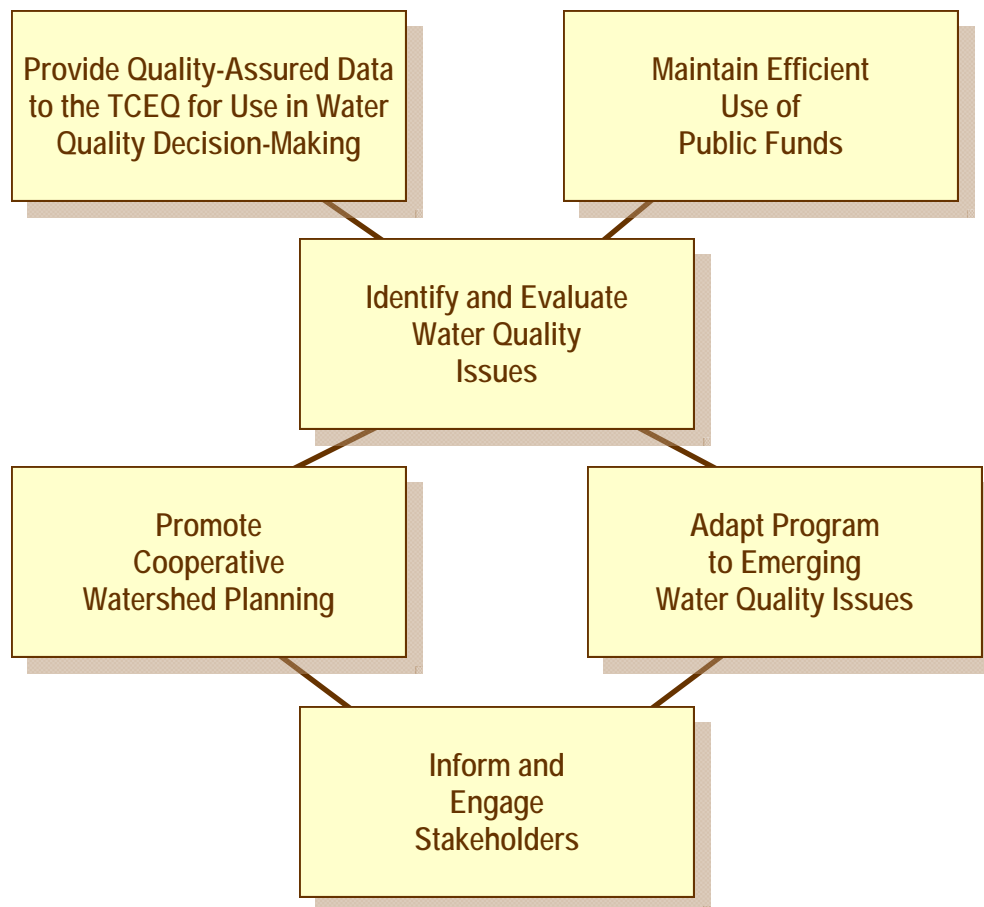
The Red River Authority of Texas, as a fee paying stakeholder and steward of the Canadian and Red River Basins' water resources, hopes that the Clean Rivers Program is maintained and funding sources protected in order that the original purpose of the program continues.

INTRODUCTION

In 1991, the Texas Legislature passed the Texas Clean Rivers Act (Senate Bill 818), which required basin-wide water quality assessments for each river basin in the state. As a result, the Clean Rivers Program (CRP) was implemented. Since the beginning, the Red River Authority of Texas (RRA) has partnered with the Texas Commission on Environmental Quality (TCEQ) to ensure this charge is carried out for the Canadian and Red River Basins in Texas. One of the main objectives of the CRP is to conduct water quality assessments using a watershed approach. This allows for integration and evaluation of the water quality issues in order to establish methodologies for corrective actions and work toward the implementation of those actions. To fund the program, the TCEQ was authorized to assess fees from permit holders of water rights and wastewater discharges. This summary report provides the reader with a comprehensive scientific overview of the water quality in both river basins.

1.1 — CLEAN RIVERS PROGRAM GOALS AND OBJECTIVES

The primary goal of the CRP is to maintain and improve the quality of water within each river basin in Texas through an ongoing partnership involving the TCEQ, river authorities, other agencies, regional entities, local governments, industry, and citizens. In order to accomplish the goals of the CRP, the following objectives were developed:



1.2 — DESCRIPTIVE OVERVIEW OF THE CANADIAN RIVER BASIN'S CHARACTERISTICS

The **Canadian River Basin** includes all or parts of 15 counties in the Texas Panhandle. The headwaters of the Canadian River begin in northeastern New Mexico as a tributary to the Arkansas River and eventually flows into the Mississippi River. The basin was divided into **five reaches** in an attempt to design the most effective sampling plan within the limited budget available. There are five classified stream segments and six unclassified stream segments in the Canadian River Basin.



The largest city in the Texas Panhandle is Amarillo. The relatively flat land gives way to Palo Duro Canyon southeast of the city, the second largest canyon in the United States. North of Amarillo lies Lake Meredith, an artificial reservoir created by the Sanford Dam on the Canadian River. The lake, along with the Ogallala Aquifer, provide drinking water and irrigation for this moderately dry area of the high plains.

Beginning at the northeastern slopes of the Sangre de Cristo Mountains in New Mexico, the Canadian River drops in elevation from 9,000 feet above mean sea level to 3,600 feet above mean sea level. Its drainage area is 12,616 square miles.

In Texas, the Canadian River crosses a relatively flat prairie with a gradual slope to an elevation of 2,870 feet above mean sea level at the Oklahoma border. Average annual precipitation varies from 25 inches in the mountainous upper reaches to 15 inches in eastern New Mexico, and 22 inches near the Texas-Oklahoma border. There are three major reservoirs and four major aquifers in the Texas portion of the Canadian River Basin. More than 250,000 people in the Canadian River Basin in Texas rely on its water resources.

1.3 — SUMMARY OF THE CANADIAN RIVER BASIN'S WATER QUALITY CHARACTERISTICS

Public drinking water supplies occur in two predominant categories: surface water and groundwater. Surface water originates from such sources as manmade lakes and perennial rivers, while groundwater has historically been used to provide a consistently clean, pure water supply. In some areas of the basin one or both supplies are used as sources for urban use, farming, industry, and agriculture. Current drought conditions and diminishing water supplies are at an extremely critical point. Water conservation has become a normal way of life in the Canadian River Basin.

From a basin-wide perspective, the waters of the Canadian River Basin are generally *good* in quality. Water quality throughout the vast majority of the basin supports aquatic life and recreational uses. There are two major issues that affect the Canadian River Basin. One is the ongoing drought, while the other is excessive chloride levels. There are no quick fixes for either issue, but the Authority and its stakeholders are working toward the management of these ongoing issues.

Drought

The Canadian River Basin in Texas has experienced drought conditions since the mid 1990's and still struggles today. Many area lakes have not been at full capacity for several years and most remain uncomfortably lower than normal, with no end to the drought in sight. A return of normal rainfall would be beneficial and significantly improve many problems caused by the continued drought. Until the weather patterns stabilize, preparations need to be taken to maintain a sufficient supply of good quality water to serve the needs of the people within the Canadian River Basin now and in the future.



Minimal flow at Canadian River at US 287 due to Drought Conditions

Chloride

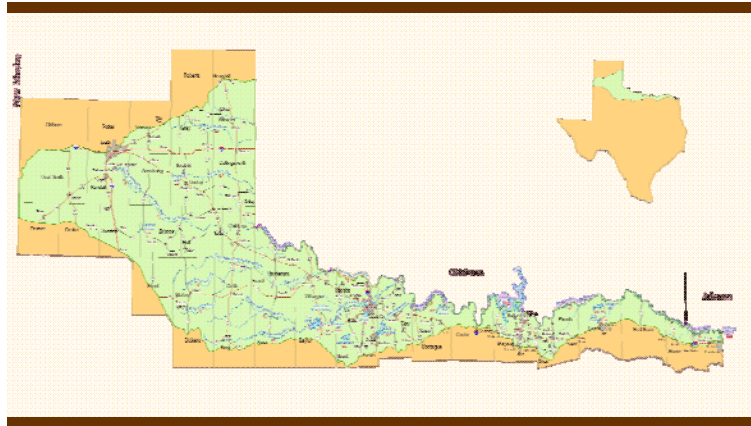
Elevated levels of chloride in the Canadian River Basin originate from dissolution of Permian salt deposits. The chloride flows upward to the Canadian River from a shallow artesian “brine aquifer” near Logan, New Mexico. Lake Meredith is in the course of this brine and serves as a public water supply to more than 500,000 people in the Texas Panhandle. A Salinity Control Project has been implemented to reduce the concentration of chloride in the river system before it enters Lake Meredith. This project has greatly improved the water quality entering Lake Meredith. However, the lake is not currently exhibiting a significant reduction of chloride due to the low water levels experienced from the recent drought.



A Salinity Control Project is in effect to control the amount of chloride entering Lake Meredith

1.4 — DESCRIPTIVE OVERVIEW OF THE RED RIVER BASIN'S CHARACTERISTICS

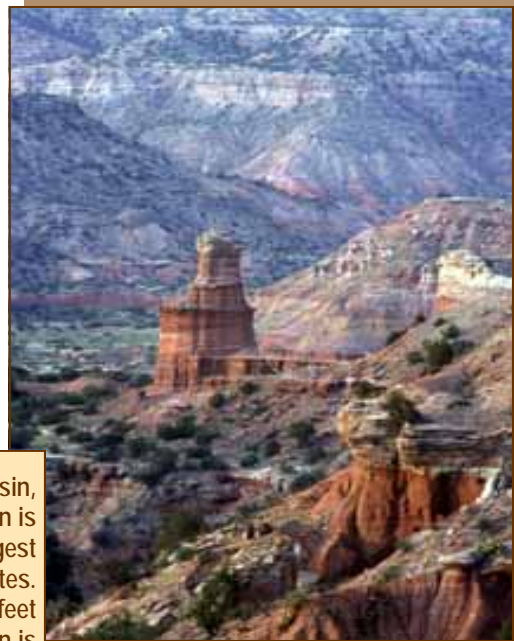
As the second longest river in the State of Texas, the Red River Basin includes all or parts of 43 counties across North Texas. The Red River is an interstate water body that originates in Curry County, New Mexico, as Tierra Blanca Creek and flows across the Texas Panhandle carving the spectacular Palo Duro Canyon of the High Plains. It then leaves the Caprock Escarpment near the eastern boundary of Childress County, where the south bank of the river becomes the



boundary between Texas and Oklahoma. From this point, the Red River continues its southeasterly direction across Texas into southwestern Arkansas, then turns south into Louisiana, where it discharges into the Mississippi River near Simmesport, Louisiana.

The main stem of the Red River has a total length of 1,217 river miles. The North Fork of the Red River starts near Pampa, Texas, while the Salt Fork of the Red River begins about 26 miles east of Amarillo. Both forks exit Texas into Oklahoma and individually rejoin the Red River main stem about 17 miles north of Vernon, Texas. Palo Duro Creek forms near Canyon, Texas and becomes Prairie Dog Town Fork to the east, which in turn becomes the Red River at the 100th meridian. The Red River covers a drainage area of 94,450 square miles and 1,616 stream miles. It crosses through six major eco-regions and contrasting elevations from 495 feet to 4,835 feet above sea level to shape this diverse area. The Red River Basin contains one of the largest capacity reservoir in Texas, Lake Texoma, along with 31 other reservoirs that provide water to a growing population of more than 900,000 people.

The Red River Basin includes parts of the Llano Estacado of the High Plains, which is a nearly level, high tableland with slow to moderate surface drainage and many small, shallow lakes or “playas”. The area east of the High Plains is a broad, nearly level to rolling grass and brush-covered plain with moderate to rapid surface drainage and entrenched streams. Rolling, undulating prairies, and nearly level valleys characterize the eastern portion of the basin.



Located in the Red River Basin, the scenic Palo Duro Canyon is touted as the second largest canyon in the United States. Elevation at its rim is 3,500 feet above sea level. The canyon is 120 miles long by 20 miles at its widest point. In addition, it reaches depths of more than 800 feet.

The upper area or the High Plains of the Red River Basin are underlain by sand, silt, and clay of the Ogallala Formation of Pliocene and Pleistocene Epochs. East of the High Plains are westward-dipping sandstone and shale beds of the Triassic Period Dockum Group (*Osage Plains*). Throughout the Osage Plains, the outcropping rocks are westward-dipping Permian Period and Pennsylvanian Epoch sandstone, shale, limestone, dolomite, and gypsum. The Uplands in this area are capped by alluvial gravel and sand of the Quaternary Period Seymour Formation. Approximately 70 million years ago, the western reaches of the Red River watershed were covered with a shallow salty sea. From Montague County to Arkansas, the basin is underlain by limestone, clay and sand of the Cretaceous Period.

The Red River Basin also has 30 stream segments totaling 1,616 stream miles with 32 significant reservoirs impounding approximately 238,165 surface acres. It contains parts of six eco-regions: the Western High Plains, Southwestern Tablelands, Central Great Plains, Central Oklahoma-Texas Plains, Texas Blackland Prairies, and South Central Plains. The topography of the basin ranges from flat prairies in the western reach at an elevation of approximately 4,835 feet above mean sea level, to rolling hills in eastern Texas with a mean elevation of 495 feet above mean sea level.

The watershed receives an average annual precipitation varying from 15 inches in eastern New Mexico to 55 inches near the Texas-Arkansas border. The average annual runoff in the basin is about 159 acre-feet per square mile of contributing drainage area. Stream flow at the Texas-Arkansas state line averages 11,490 cubic feet per second (CFS) or 8.3 million acre-feet per year.

1.5 — SUMMARY OF THE RED RIVER BASIN'S WATER QUALITY CHARACTERISTICS

Water resources within the Red River Basin are generally good and support a hearty and robust aquatic life with respect to stream standards. However, only 12 of the 30 classified stream segments have been designated as useable for public water supply due to naturally high occurring concentrations of salt, according to water quality standards.

Historically, the Red River Basin was once part of an ancient inland sea. Through geologic processes, this ancient sea became isolated and slowly evaporated over time. The salts from this prehistoric sea continue to plague the basin today. These salts occur naturally either through salt springs and seeps or from artificial or manmade issues such as oil field by-products. The waters of the Wichita, Pease, and Red Rivers contain excessive concentrations of chloride and sulfate, which are particularly evident in the shallow rivers beds.

As the State Sponsor of the **Red River Chloride Control Project**, the Authority will continue to back the Chloride Control Project with good solid science to improve the quality of the water in the Red River and its tributaries. For additional information on the Wichita River Basin portion of the Red River Chloride Control Project, please review the **Water Resource Section** of the Authority's website at www.rra.dst.tx.us.

Maintaining and improving the quality of water within the Canadian and Red River Basins is an ongoing process. To ensure the continued success of the Clean Rivers Program, **Public Involvement** is vital in locating concerns, setting priorities and seeking solutions. The subsequent paragraphs describe components of public involvement and ways to participate.

PUBLIC INVOLVEMENT

2.1 — BASIN ADVISORY COMMITTEE

The Steering Committee, also known as the **Basin Advisory Committee (BAC)**, has been the cement that has bonded and guided the CRP in the Canadian and Red River Basins. BAC Members include representatives from the public, municipal, county, state and federal government, industry, business, agriculture, fee payers, environmental, education, civic organizations, and others.

Basin Advisory Committee Meetings are held in Amarillo and Wichita Falls at least once per year. The meetings are purposely set up to be open, friendly, casual, and informative. They include in depth technical discussions regarding project work plans, monitoring schedules, reports, and any other relevant topics presented by committee members. BAC members are encouraged to bring guests and provide input, not only at the meetings, but throughout the year.

2.2 — RED RIVER VALLEY WATER RESOURCE CONFERENCE

A very successful public outreach program pertaining to the Red River Basin is the **Red River Valley Water Resource Conference**. Hosted by the Authority, in cooperation with the Red River Valley Association, the conference typically comprises



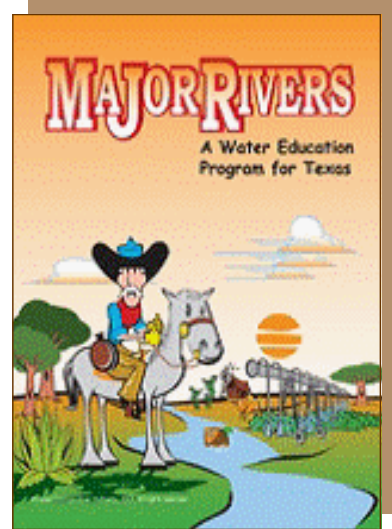
representatives from Texas, Oklahoma, Arkansas and Louisiana. Held in the fall of each year, the focus of the conference is water quality and quantity issues that affect everyone within the Red River Basin, in all four states. Presentations are given by various entities such as the U.S. Army Corps of Engineers, Tulsa, Oklahoma, the Texas Water Development Board, the U.S. Bureau of Reclamation, the Natural Resources Conservation Service, the Texas Parks and Wildlife, the Oklahoma Water Resources Board, the TCEQ's Total Maximum Daily Load (TMDL) and Surface Water Quality Monitoring (SWQM) staff, the Authority's Environmental Services Division staff and others. More information on the Red River Valley Water Resource Conference can be found at www.rrva.org.

2.3 — EDUCATION

An important program sponsored by the Authority is the distribution of the **Major Rivers** educational program to schools within the Canadian and Red River Basins. *Major Rivers* is a water education curriculum designed by the Texas Water Development Board and the Lower Colorado River Authority. It teaches students about Texas' major water resources, how water is treated and delivered to their homes and schools, how to care for their water resources, and how to use them wisely. The program's host, Major Rivers (named for the major rivers



of Texas), and his horse Aquifer cover lessons that include a variety of activities in science, math, language arts, social studies and other subjects. Since 2004, the Authority has provided this curriculum to over 7,000 students in the Canadian and Red River Basins.



Authority personnel also provide presentations to various organizations, clubs, and civic groups to spark interest and awareness in our local natural resource issues. Additionally, the Authority provides all types of information and articles that appear regularly in newspapers throughout the basin.

Members of the Environmental Services Division have assisted yearly in judging entries in the Red River Regional Science and Engineering Fair held at Midwestern State University. This annual event is held for students from Texas Region IX school districts who are in fifth grade through high school and covers entries in 18 categories, including environmental, chemistry and biology.

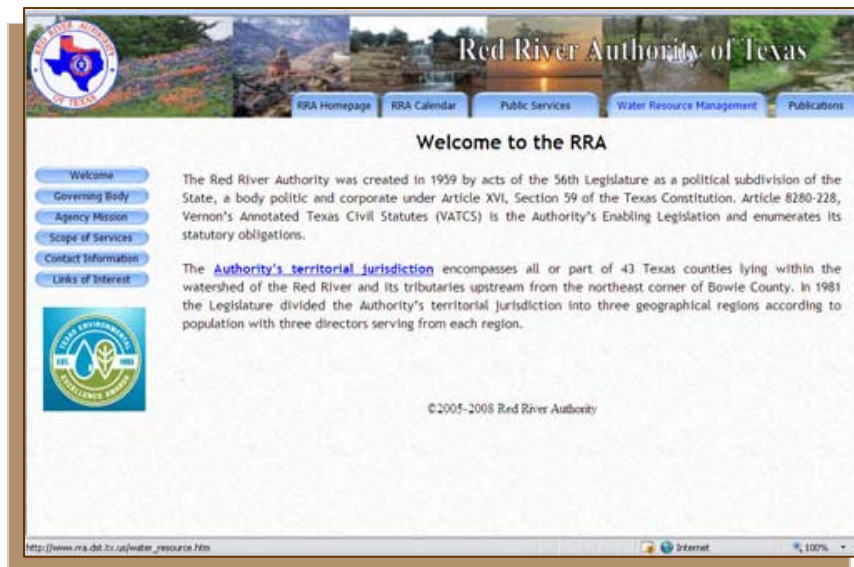
2.4 — COORDINATION / COOPERATION WITH OTHER BASIN ENTITIES

The Authority has coordinated collection and monitoring efforts with other basin entities by holding annual **Coordinated Monitoring Meetings (CMM)**. Entities that have been included in these meeting are the Texas Commission on Environmental Quality, the United States Geological Survey, the City of Sherman, the Texas Parks and Wildlife Department, the Texas State Soil and Water Conservation Board, the Canadian River Municipal Water Authority, and the U.S. Corps of Engineers, to name a few. Goals of this very important meeting are to coordinate sites, parameters of concern, and data collection frequency. More like a workshop, the CMM solicits input from all entities involved in monitoring in order to create monitoring schedules that reduce duplicative efforts. This, in turn, maximizes the funds available for the program.

For the past three years, the Authority has been involved in a Four State Meeting with representatives from Texas, Oklahoma, Louisiana, and Arkansas. The purpose of the meeting is to provide a forum for EPA Region 6 sister states' and tribes' water quality monitoring and assessment staff to meet and discuss common issues and coordinate similar programs dealing with the Red River Basin in all four states. To continue this cooperative effort, the Authority has invited members of this group to participate in our annual Coordinated Monitoring Meeting.

The Coordinated Monitoring Meeting is open to any interested group or entity that would like to attend and/or participate in surface water quality monitoring in the Canadian and Red River Basins.

2.5 — RED RIVER AUTHORITY OF TEXAS ON THE WEB



The Authority maintains an enthusiastic commitment to provide up-to-date scientifically correct information on the Authority's website at www.rra.dst.tx.us.

The website provides information covering all aspects of Authority operations. An entire section of the website, accessible via the **Water Resource Management** tab, is devoted to the Texas Clean Rivers Program. This section provides quick

and easy access to all publications, data and information relating to the Authority's participation in the project.

The **Public Services** tab provides access to information regarding the General and Financial Services, Utility Operations and the Authority's NELAC Accredited Environmental Laboratory.

The **RRA Calendar** lists all public meetings and events scheduled by the Authority, such as the Basin Advisory Committee Meetings, the Coordinated Monitoring Meeting, etc. The calendar also provides meeting agendas, directions to and detailed maps of meeting locations.

The Authority also maintains an online **Publication Library** that includes reports and studies prepared by the Authority, data inventories, digital mapping, general information, links to environmental sites, historical weather data and more.

WATER QUALITY REVIEW

3.1 — WATER QUALITY TERMINOLOGY

To ensure that data collected is technically sound and of good quality, all parameters are collected under the guidance of a **Quality Assurance Project Plan (QAPP)**. A QAPP describes the collection, acquisition and documentation guidelines of the data to ensure that the quality objectives are achieved prior to its submittal to TCEQ or entry into the Authority's database. The QAPP also includes a sampling process design and monitoring schedule, which is based on results from previous Water Quality Assessment Reports conducted under the CRP, specific constituents taken from the **Texas Surface Water Quality Inventory (TWQI)** or the **303(d) List**, and specific requests from TCEQ and the Canadian and Red River Basin Advisory Committees.



In order to accumulate adequate numbers of good quality-assured data sets, the type of monitoring required at each site is determined. This is necessary to determine water quality conditions and impairments. The TCEQ defines the types of monitoring as:

- ◆ **Routine Monitoring** is the traditional type of monitoring designed to delineate overall water quality throughout a river basin. Monitoring should continue for at least five years. This includes water bodies that do not support standards or criteria or are not expected to meet the same.
- ◆ **Systematic Watershed Monitoring** is similar to Routine Monitoring, but with a shorter duration (less than five years). It includes water bodies with parameters causing nonsupport of their standard as described in Categories 4a and 5c (see [page 31](#) for category explanation) and TMDL Implementation Monitoring.
- ◆ **Permit Support Monitoring** - The TCEQ may identify specific areas where additional information on water quality is needed for the permitting process.
- ◆ **Special Studies in Priority Watersheds** involves a monitoring and assessment plan that is designed to answer a specific question, and is not used to generally screen a water body. Monitoring usually continues for at least two years.

The following table lists the parameters collected by the Authority, the potential impacts to a water body if the water quality standard is not met, and possible causes of the pollutants:

PARAMETER	IMPACT	CAUSE
Ammonia	Naturally occurring in surface and wastewater, and is produced by the breakdown of compounds containing organic nitrogen. Elevated ammonia levels are a good indicator of organic pollution and can adversely affect fish and invertebrate reproductive capacity and reduced growth of the young.	Ammonia is excreted by animals and is produced during the decomposition of plants and animals. It is an ingredient in many fertilizers and is also present in sewage, storm water runoff, certain industrial wastewaters, and runoff from animal feedlots.
Chloride	One of the major inorganic ions in water and wastewater. Chloride is an essential element for maintaining normal physiological functions in all organisms. Elevated chloride concentrations can disrupt osmotic pressure, water balance, and acid/base balances in aquatic organisms which can adversely affect survival, growth, and/or reproduction.	Chloride compounds, often known as salts, can be an indicator of natural or manmade pollution, as in the case of oil field brines. Natural weathering and leaching of sedimentary rocks, soils, and salt deposits can release chloride in to the environment. Other sources can be attributed to oil exploration and storage, sewage and industrial discharges, run off from dumps and landfills, and saltwater intrusion.
Chlorophyll-a	Increased nutrients in water bodies create diurnal swings that can stress aquatic life. In the presence of sunlight and abundant food sources photosynthesis increases, DO levels rise and pH levels fall. At night respiration begins and oxygen is consumed. DO levels fall and then pH levels rise.	Chlorophyll-a, is a photosynthetic pigment, that is found in all green plants and algae. The concentration of chlorophyll a is used to estimate phytoplankton biomass in surface water. Results are expressed in µg/L (micrograms per liter).
Dissolved Oxygen (DO)	The amount of oxygen that is freely available in water. Aquatic life needs oxygen to live. DO is vital to fish and other aquatic life. Acceptable ranges of dissolved oxygen levels have been accepted as the single most important indicator of a water body's ability to support desirable aquatic life.	Human activity in the riparian zone can affect water temperatures adversely, and excessive or unusual quantities of organic material combined with bacteria and large algal blooms may cause DO levels to fluctuate. In some segments where DO can fluctuate, aquatic life may not have sufficient oxygen to survive.
<i>Escherichia coli</i> (E. coli)	The current indicator bacteria to determine if the water body is suitable for contact recreation. Is typically not harmful, but their presence, expressed in MPN (most probable number) per 100 mL of water, is an indicator of fecal material contamination which may contain other pathogens.	High number of <i>E. coli</i> can indicate a potential pollution problem. Although <i>E. coli</i> is used as an indicator, it can be potentially harmful. Present in all warm bodied animals and comes from poorly maintained or ineffective septic systems, overflow of domestic wastewater plants and/or runoff from feedlots.
pH	The pH determines whether a water body is acidic, neutral, or basic. The pH of the water can affect the toxicity of many substances. Most aquatic life is adapted to live within a specific pH range. Changes in the pH can control toxic effects of other substances that may be in runoff.	Industrial and wastewater discharge, runoff, accidental spills, and non point sources. Human activity that causes increases in organic matter and bacteria, and over abundant algae.
Nitrites	High levels of nitrates and nitrites can produce Nitrite Toxicity, or "brown blood disease," in fish. This disease reduces the ability of blood to transport oxygen throughout the body.	Nutrients are found in effluent released from wastewater treatment plants, fertilizers, and agricultural runoff carrying animal waste from farms and ranches.
Nitrates	Nitrate additions to surface waters can lead to excessive growth of aquatic plants. High groundwater nitrate levels can cause methemoglobinemia or blue baby syndrome in infants. In elevated concentrations can be used as an indicator of human caused pollution.	Nitrates are used as fertilizers to supply a nitrogen source for plant growth. The presence of nitrates in groundwater occurs from the conversion of nitrogenous matter into nitrates by bacteria and represents the process whereby ammonia in wastewater, is oxidized to nitrite and then to nitrate by bacterial or chemical reactions.
Total Suspended Solids (TSS)	Total Suspended Solids (TSS) is the measure of the total suspended solids in water (organic and inorganic) Increased turbidity can reduce the amount of light to plants which decreases the oxygen production. Additionally, too much sediment can cover habitat, smother benthic organisms, eggs or even clog fish gills.	TSS can have origins from multiple point and non-point sources, but the most common source is soil erosion. A good measure of the upstream land use conditions is how much TSS rises after a heavy rainfall.
Flow	The velocity of the water body at the time of sampling, expressed in CFS (cubic feet per second) or how fast the water is moving. Flow combined with other parameters can be a good indicator of water quality.	Changes in flow can be natural or man made. Natural changes include beavers building dams, overgrowth of vegetation in times of low flow. Manmade changes include new bridges restricting flow, new construction altering landscapes and runoff.

PARAMETER	IMPACT	CAUSE
Total Dissolved Solids (TDS)	An important use of the measure of the quality of drinking water. TDS is a quantification of the material dissolved in water, typically the chloride, and sulfate anions which form salts.	Primary sources for TDS are agricultural and storm water runoff. Other sources include leaching of soil contamination and point source water pollution from industrial or sewage treatment plants. Certain naturally occurring TDS arise from weathering and dissolution of rocks and soils.
Sulfate	Usually dissolved into waters from rocks and soils containing gypsum, iron sulfides, and other sulfur compounds. Sulfides are widely distributed in nature and in high concentrations, sulfate can affect drinking water.	Due to abundance of elemental and organic sulfur; and sulfide mineral, soluble sulfate occurs in almost all natural water. Other sources are the burning of sulfur containing fossil fuels, steel mills, and fertilizers.
Temperature	The temperature of water at the time of collection. An important physical relationship exists between the amount of dissolved oxygen in a body of water and its temperature. As temperatures fluctuate, there is a direct effect on dissolved oxygen levels.	Changes in water temperature can be caused by alteration of the riparian zone encroachment of invasive species (plant and/or animal), drought, soil erosion, or changes in ambient temperatures in lakes, as a result of industrial byproducts such as electrical generation.
Total Organic Carbon (TOC)	A measure of the amount of organic materials suspended or dissolved in water. It represents an estimation of the strength or potential damage that effluent or runoff can cause in a body of water if the <i>Dissolved Oxygen</i> was organically removed from the water. The measurement of TOC, is more rapid, and yields more reproducible results than the measurement of oxygen demand tests. Can be used as a pollution indicator.	Comes from decaying matter. Also from detergents, pesticides, fertilizers, herbicides, industrial chemicals and chlorinated organics.
Conductivity	A measurement of the electrical current carrying capacity of water. Dissolved substances, such as salts, have the ability to conduct electrical current. Salty water has a high conductivity. This can be used as an indicator of how much dissolved solids are polluting the water.	Causes are basically the same as the causes for TDS.
Turbidity	A measure of clarity of a water sample expressed in NTU's (Nephelometric Turbidity Units). The higher the turbidity, the less clear the water. Water that is turbid can adversely affect plant and fish.	Erosion of soil in riparian zone.
Alkalinity	A measure of the acid-neutralizing or buffering capacity of water. The presence of calcium carbonate ions to the buffering system. Alkalinity is a measure of how much acid can be added to a liquid without causing a large change in pH. Alkalinity is important for fish and aquatic life because it protects or buffers against rapid pH changes. Living organisms, especially aquatic life, function best in a pH range of 6.0 to 9.0. Higher alkalinity levels in surface waters will buffer acid rain and other acid wastes and prevent pH changes that are harmful to aquatic life.	Alkalinity is often related to hardness because the main source of alkalinity is usually the result from dissolved carbonate rock formation.
COD	Chemical Oxygen Demand (COD) — A measure of the amount of oxygen required to oxidize all compounds in the water.	COD is an indicator of how much organic load is placed on the oxygen in a water body.
Ortho-phosphorus	Is a soluble form of phosphorus (PO_4) that is applied to urban and agricultural land as fertilizers and is often found in storm water runoff. Is considered the limiting factor of plant growth in a water body.	An element that is essential to plant life but contributes to an increased trophic level (<i>Eutrophication</i>) of water bodies. Phosphorus is commonly known as a man made pollutant. It is an ingredient found in soaps and detergents and is also present in sewage, and runoff from animal feedlots.
Total Phosphorus	An essential nutrient to the growth of organisms and can be the nutrient that limits the primary productivity of water.	In excessive amounts from wastewater, agricultural drainage, and certain industrial wastes, it also contributes to the eutrophication of lakes and other water bodies. Phosphorus is commonly known as a man made pollutant.

3.2 — DATA REVIEW METHODOLOGY

For the Authority's data review, the TCEQ's **2008 Guidance for Assessing and Reporting Surface Water Quality in Texas** was utilized. Quality assured data were extracted from the TCEQ's Surface Water Quality Monitoring Information System (SWQMIS) database. These data were then loaded into Excel spreadsheets and divided by stream segments. The TCEQ analyzes and reports both segments and sub areas of segments known as assessment units (AU). The Authority reviewed the data by stream segment only. Screening was conducted for each parameter against segment-specific standards and/or nutrient screening level, as defined by the **Texas Surface Water Quality Standards (TSWQS)**. A list of these parameters and their segment specific standard and/or nutrient screening level can be found in **Appendix A**.

To properly review the data, a sufficient number of samples were needed to provide a sound base population for analysis. The 2008 assessment performed by the TCEQ included data covering the seven year period of December 1, 1999 through November 30, 2006. The Authority's data review included data covering the period of December 1, 1999 to May 30, 2008. The Authority's Water Quality Screening results are broken down by Basin, Reach and Segment and can be found in **Appendix B**.

Results from the Authority's data review were compared against the TCEQ's assessment results. The TCEQ's assessment results include the following integrated documents:

- ◆ **2008 Texas 303(d) List**
- ◆ **2008 Texas Water Quality Inventory Water Bodies Evaluated**
- ◆ **2008 Texas Water Quality Inventory - Basin Assessment Data by Segment**
- ◆ **2008 Texas Index of Water Quality Impairments**
- ◆ **2008 Texas Water Quality Inventory Water Bodies with Concerns for Use Attainment and Screening Levels**
- ◆ **2008 Texas Water Quality Inventory - Sources of Impairments and Concerns**
- ◆ **2008 Water Bodies and Impairments Added to the Texas 303(d) List**
- ◆ **2008 Texas Water Bodies and Parameters Removed from the 303(d) List**

These reports describe the status of the state's waters, as required by Sections 305(b) and 303(d) of the Federal Clean Water Act. They also summarize the status of the state's surface waters, including concerns for public health, fitness for use by aquatic species and other wildlife, and specific pollutants and their possible sources. These reports can be accessed on the TCEQ's website at <http://www.tceq.state.tx.us/compliance/monitoring/water/quality/data/08twqi/twqi08.html>.

The TCEQ assigns categories to each water body they assess. These categories describe the management strategy associated with each impairment parameter in each segment that affects the beneficial use of the water body, (aquatic life use, general use, fish consumption use or public water supply use), as defined in the **Texas Surface Water Quality Standards (TSWQS)**. Since most water bodies have more than one use, it can fall into more than one category, but its overall category is the highest numbered category assigned to any one use. The list of categories and their associated water management strategies are as follows:

Category 1: Attaining all water quality standards and no use is threatened.

Category 2: Attaining some water quality standards and no use is threatened; and insufficient data and information are available to determine if the remaining uses are attained or threatened.

Category 3: Insufficient data and information are available to determine if any water quality standard is attained.

Category 4: Water quality standard is not supported or is threatened for one or more designated uses but does not require the development of a TMDL.

Category 4a: TMDL has been completed and approved by EPA.

Category 4b: Other pollution control requirements are reasonably expected to result in the attainment of the water quality standard in the near future.

Category 4c: Nonsupport of the water quality standard is not caused by a pollutant.

Category 5: The water body does not meet applicable water quality standards or is threatened for one or more designated uses by one or more pollutants.

Category 5a: A TMDL is underway, scheduled, or will be scheduled.

Category 5b: A review of the water quality standards for the water body will be conducted before a TMDL is scheduled.

Category 5c: Additional data and information will be collected before a TMDL is scheduled.

In addition to categorizing segments, during their assessment, the TCEQ assigns **Levels of Support** to segments that; (1) fall short of not supporting their **TSWQS** or (2) water quality standards have not yet been developed, i.e.. nutrients, sediment, fish tissue, etc. Levels of support codes used are:

CN — There is a near-nonattainment of the water quality standard. These water bodies fall short of not supporting the standard and can not be put on the *303(d) List*.

CS — Concern for water quality based on screening levels. Screening levels are not sufficient to list a water body, so it becomes a concern when concentrations are elevated. The water body will be watched for any potential problem.

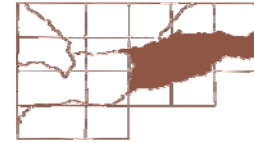
The Authority utilized Microsoft Excel and Statistica® as the primary software applications to analyze possible trends for this report. Templates were designed to automatically calculate and list, by parameter, the following descriptive statistics: mean, median, minimum, maximum, standard deviation, r-square, and p-value. Sample sizes for trends varied by parameter and minimum sample sizes were observed when setting up trend charts.

All data was imported into the templates by segment and/or assessment unit, and then sorted by parameter. When the descriptive statistics indicated a potential trend, regression charts were created to visually aid in the verification of these possible trends. Each chart was checked for date continuity and outliers. Any chart which exhibited data gaps exceeding two years was regenerated utilizing only consecutive data. Outliers were flagged and removed using Statistica®. Data sets containing outliers were reconfigured to exclude those flagged outliers, and the regression and descriptive statistics were recalculated to provide a more accurate representation of that specific parameter in the water body.

Appendix C provides the descriptive statistics used for trend analyses in a tabular format. Regression charts for parameters by segment identified as a potential trend by the descriptive statistics can be found on the Authority's website under the **Publications Section** for the Clean River's Program, at www.rra.dst.tx.us.

3.3 WATERSHED SUMMARIES

CANADIAN RIVER BASIN — REACH I



Reach I of the Canadian River Basin encompasses an area approximately 90 miles long and 40 miles wide. It includes the northern portion of Hemphill County and the southernmost section of Lipscomb County to Hutchinson County and the northern portion of Carson County. It is located on the main stem of the Canadian River and represents a watershed from the Texas-Oklahoma state line to the Sanford Dam on the Canadian River. **Reach I** contains two sub-watersheds totaling 4,790 square miles of contributing drainage with 2,831 square miles in Texas. A map of **Reach I** of the Canadian River Basin is included on [page 37](#).

The largest cities within the reach include Pampa and Borger. Other towns include Canadian, Stinnett, Skellytown, Miami and Sanford, with a total reach population of approximately 50,000.

Permits included in **Reach 1** are 24 municipal and industrial discharges, 18 solid waste disposal sites and 14 concentrated animal feeding operations (CAFOs).

More than 1,200 farms and ranches cover more than 2,600,000 acres of land. Production from these farms and ranches include cattle, swine, poultry, wheat, oats, corn, sorghum, hay, barley, alfalfa, and soybeans. Approximately 55,000 acres are irrigated farm land, while the remainder is devoted to either dry land farming or pasture land for cattle.

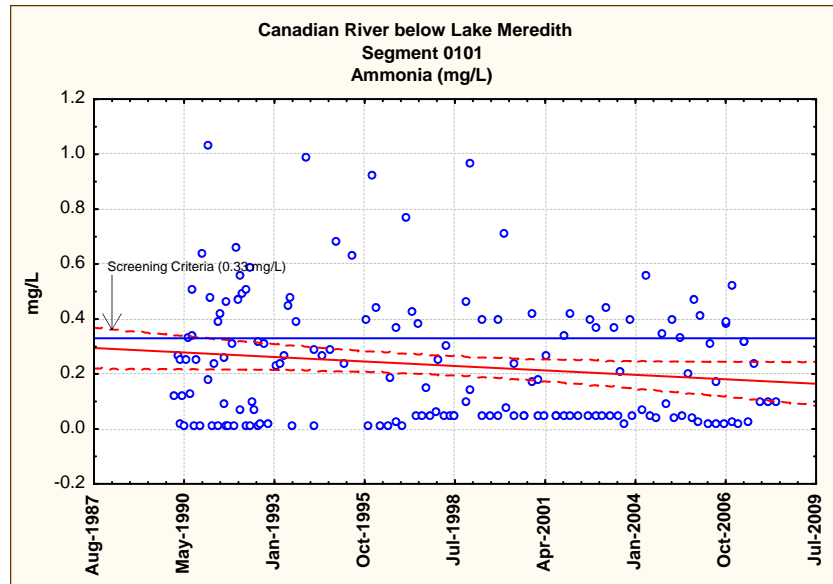
The soils range from sandy alluvial, to dark, reddish clay loams that extend over flat plains, to steep and broken rocky ravines, where the plains break into the Canadian River Valley. Rainfall averages from 19 inches to 21 inches annually.

Reach I includes one classified water body, the Canadian River below Lake Meredith (Segment 0101), which runs from the Texas-Oklahoma State Line up to the Sanford Dam of Lake Meredith. The two unclassified water bodies (both located near the City of Borger) are Dixon Creek (Segment 0101A) and Rock Creek (Segment 0101B). Rock Creek is found on the western side of the city of Borger and is the receiving waters for the Borger wastewater treatment plant treated effluent. Dixon Creek is located on the eastern side of City of Borger. In addition, Dixon Creek is the receiving waters for an effluent discharge from the Phillips Petroleum Plant. Both creeks, which drain into the Canadian River north of Borger, provide the majority of the flow in the Canadian River in this portion of the reach.

The **Canadian River Below Lake Meredith (Segment 0101)** is on the *2008 Texas Water Quality Inventory (TWQI) for Water Bodies with Concerns for Use Attainment and Screening Level* with having an **ammonia** concern. Analyses of the data by the Authority agreed with this assessment. The portion of the river located in Hutchinson County displayed elevated ammonia levels. This whole region is primarily rural with the predominant usage of the land being dependent on location and availability of water. If irrigation is available and the lay of the land is accessible and mostly level, it is likely that some type of cultivation will predominate. However, as the terrain becomes more rugged and/or water availability becomes scarce, the usage of the land turns toward open pasture grazing. Interspersed throughout this reach, and the Ca-

nadian Basin as a whole, is the presence of oil and/or gas production. With the scarcity of open water and the rural open range nature of the surrounding area, it is likely the elevated ammonia levels are the result of birds and animals staying near water not only to drink, but also to keep cool in the heat of the summers. Also because of the availability of water, grazing animals are able to find more food in the low plains close to the creeks and rivers.

Although listed as a concern on the 2008 TWQI, no trend was evident during the analysis of **ammonia** (see chart). Downward trends were present for **nitrate**, **total phosphorus** and **orthophosphorus** due to an increase in rainfall refilling and recharging water resources in this area (See Appendix C). The increase in rainfall has also caused wildlife and livestock to move up and away from the river, which may have been previously their sole source of water, possibly resulting in the reduction of non-point source influences.



The two major contributors to this classified segment of the Canadian River Basin are Dixon Creek (Segment 0101A) and Rock Creek (Segment 0101B).

Dixon Creek (Segment 0101A) is an unclassified water body. It makes its way through the center of the Borger Oilfield, where many of the early oil strikes that touched off the Panhandle Boom of the late 1920s took place. Dixon Creek is typically dry in its upper reaches with only the lowest portions actually having water in the creek, it then goes from dry, to perennial with pools and then to perennial after receiving a discharge from a large industrial discharger located on the creek. This industrial discharger provides a consistent flow into the creek, allowing local ranchers to rely on the creek as a water source for their livestock. If this discharge were to stop, Dixon Creek would be, at best, intermittent with perennial pools.

Dixon Creek is currently on the 2008 303(d) List with a Category 5c for elevated **bacteria** levels and a Category 5b for depressed **dissolved oxygen** levels. Dixon Creek is also on the 2008 Texas Water Quality Inventory for Water Bodies with Concerns for Use Attainment and Screening Levels with a concern (CN) for near-nonattainment for **bacteria** and with having (CS) water quality concerns for **nitrate**, **orthophosphorus** and **chlorophyll a**. The Authority's analysis of the data agreed with the TCEQ's assessment for bacteria, but did not agree with the TCEQ's assessment for dissolved oxygen. The Authority's analysis revealed only 4 out of 61 samples exceeded the standard for dissolved oxygen (See Appendix B). Several years ago, an Aquatic Life Assessment (ALA) was conducted on Dixon Creek by the TCEQ to fully examine the dissolved oxygen situation and to ascertain the full health of the water body. The assessment has been completed, but has not been published.

A downward trend was found in the **orthophosphorus** and **bacteria** levels. However, **nitrate** levels did show an upward trend (See Appendix C). Several factors could be contributing to the increase in nitrate levels, but additional monitoring will be required to ascertain the major contributing sources.

Dixon Creek runs through rural broken country where cattle range freely with few fences. Without the discharge from the Phillips Petroleum plant upstream, Dixon Creek would most likely be dry. Livestock, wildlife, and birds utilize the creek for water, cooling, and shade. Increases in rainfall have refilled and recharged other water sources allowing wildlife and livestock to leave the creek, which may have been their sole source of water. As one of few available water supplies, the creek is also influenced by the influx of nutrients by runoff or animal defecation.

Rock Creek (Segment 0101B) is an unclassified water body with origins in northern Carson County. The upper intermittent portions of the creek remain dry, only having some flow following significant rainfall events. The creek continues northerly through the suburb community of Bunavista, and the center of the Pantex Oilfield, where the terrain begins to change as it approaches the Canadian River. Rock Creek skirts the northwest side of the City of Borger, which discharges treated wastewater effluent into the creek. It is at this point that the creek becomes perennial, except in the driest of times. After skirting the city, Rock Creek merges

with the Canadian River, contributing a consistent flow to an otherwise mostly dry river.



Rock Creek at Electric City

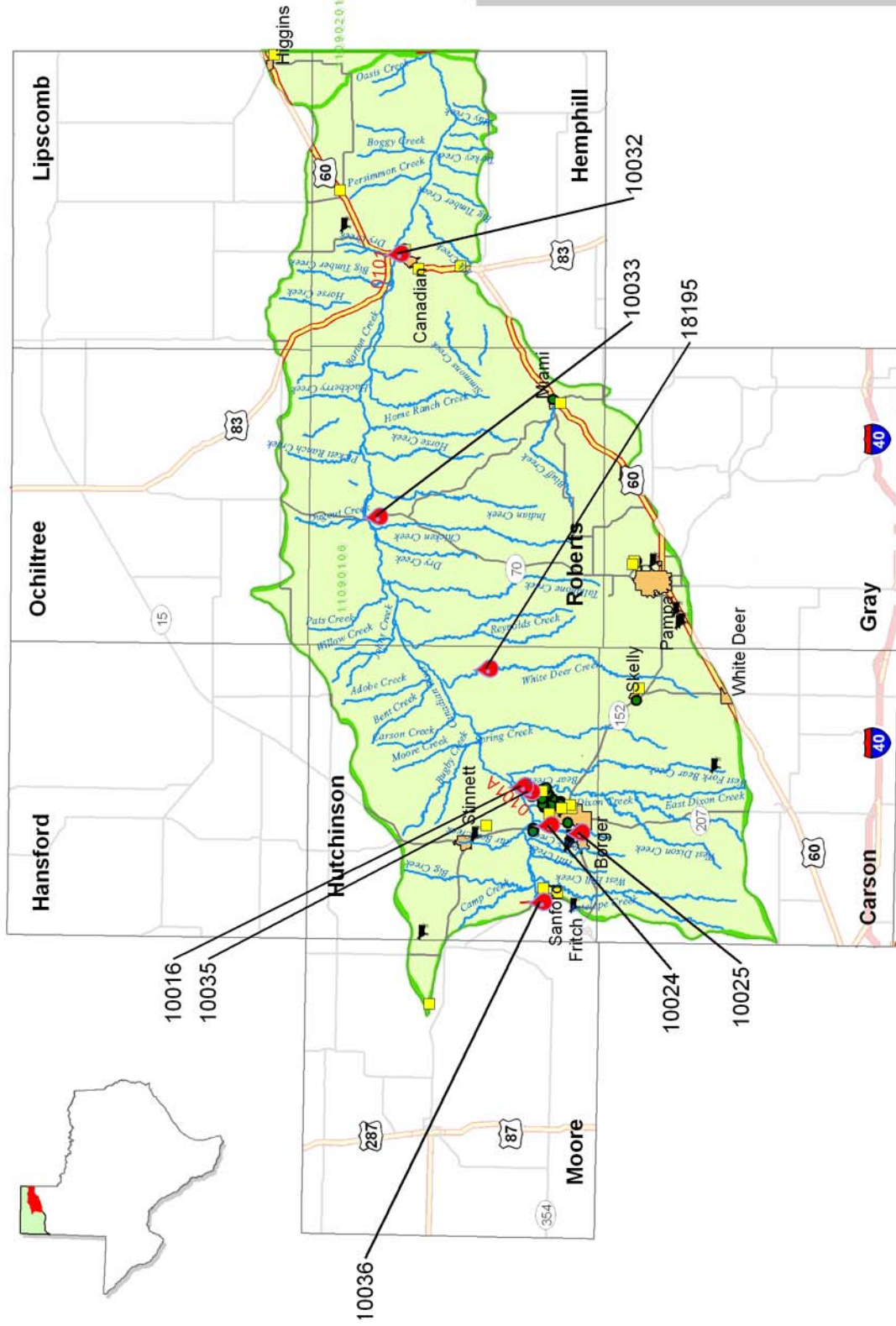
Rock Creek is on the 2008 303(d) List and Texas Index of Water Quality Impairments as a Category 5c for not supporting its *contact recreation use* for elevated **bacteria** levels. This segment is also on the 2008 TWQI for Water Bodies with Concerns for Use Attainment and Screening Levels with having a **(CS)** water quality concern for **nitrate**.

The Authority's analyses of the data agreed with TCEQ's assessment for **bacteria**. Additionally, the Authority's data review found 14 out of 36

samples exceeded the screening criteria for **orthophosphorus** and 8 out of 26 samples exceeded the screening criteria for **chlorophyll a** (See Appendix B). In review of the data, it appears that the long term trend for **nitrate** has been dropping over the past several years, while there appears to be an upward trend of **total phosphorus** and **dissolved oxygen** levels. These particular samples were collected downstream of the City of Borger's wastewater treatment plant outfall. Most wastewater outfalls have elevated levels of nutrients because of the nature of the discharge and increased flow can elevate the **dissolved oxygen** levels (See Appendix C).



Canadian River Basin Reach I



Legend

- MSW / Landfill
- Wastewater Outfall
- CAFO
- Monitoring Station
- Segment Boundary
- Segment ID
- Hydrology
- Urbanized Area
- County Boundary
- HUA Boundary
- Canadian Reach I

Figure 1-1

CANADIAN RIVER BASIN — REACH II



Reach II of the Canadian River Basin is located from the Sanford Dam at Lake Meredith to the Texas-New Mexico State Line and up to Oldham and Hartley Counties. The city of Amarillo, which is the largest city in both the Canadian and the Red River Basins, has a total population of over 174,000 and is divided by both river basins. **Reach II** makes up about a fourth of the northwestern portion of the city, making the total population of the reach approximately 120,000. A map of **Reach II** of the Canadian River Basin can be found on **page 41**.

The economics of the majority of the reach consist of livestock, agribusiness and oil and gas production. Amarillo is also home to a large refinery that produces copper, selenium, nickel, and tellurium. Also found only in this reach is the unique resource of free gaseous helium.

The reach has 13 permitted municipal and industrial dischargers, 14 permitted solid waste disposal sites, and 20 concentrated animal feeding operations.

Agriculture in **Reach II** is composed of ranching and farming, producing cattle, wheat, oats, corn, sorghum, hay, barley, alfalfa, and soybeans. The majority of the area utilizes groundwater to meet its demands.

Located within **Reach II** is **Lake Meredith (Segment 0102)**, the largest reservoir in the Canadian River Basin. Total conservation storage capacity of Lake Meredith is approximately 780,000 acre-feet, with an elevation of 3,011 feet above mean sea level. Managed by the Canadian River Municipal Water Authority (CRMWA), water from Lake Meredith is distributed to eleven area cities located within parts of the Canadian, Red, Colorado and Brazos River Basins. Because of the elevated **chloride** and **sulfate** levels, the water from Lake Meredith is blended with high quality ground water. This blending is designed to maximize yield and improve both quality and quantity of the water delivery to all of its member cities.

Lake Meredith is listed on the 2008 303(d) List for **chloride**, **sulfate** and **total dissolved solids**. Approximately 70% of the chloride in Lake Meredith originates in New Mexico, downstream of the Ute Reservoir Dam near Logan, New Mexico. The CRMWA has implemented a method to reduce the amount of chloride entering Lake Meredith. Shallow wells are intercepting the upward moving brine before it enters the river system. Deep well injection is used to dispose of the highly saline water that is collected by the shallow wells. This has decreased the amount of chloride within the river. Since the river channel has been saturated with salt, it will require many years to desalinate the river.

The Authority analyzed data, collected by the TCEQ and CRMWA, from 18 sites located around the lake. The analysis of this data agreed with TCEQ's assessment. Trend analysis revealed consistent increases in **chloride**, **sulfate**, and **total dissolved solids** levels (**See Appendix C**). These trends may be a result of falling lake levels.

Lake Meredith is also listed on the 2008 303(d) List for **mercury** in edible tissue and has a **(CS)** concern for water quality based on screening levels for **mercury** in edible tissue. The mercuric compound (methyl-mercury) was found in tissue samples collected from walleye.

Walleye is a large cool-water predator sport fish that predominates the food chain in Lake Meredith. Being a longer living creature, the walleye consumes contaminated prey species accumulating the methyl mercury in its tissues over time. According to health authorities, consuming contaminated species has the potential to cause health problems in pregnant women, infants, and young children. The source of the mercury is questionable; however, the U.S. Environmental Protection Agency has speculated that such sources may include atmospheric depositions from unknown origins. An intense survey of possible sources and a long-term action plan is recommended to reduce this problem in Lake Meredith.

Big Blue Creek (Segment 0102A) is an unclassified segment located between the confluence of Lake Meredith in Carson County and the upstream perennial portion of the stream in Moore County. The creek traverses landscapes similar to that of the rest of the Canadian River Basin. Like most of the area around Lake Meredith, the majority of Big Blue Creek is part of the National Parks Service, Lake Meredith Recreation Area. It is a minor tributary to Lake Meredith. The creek is usually perennial and spring fed, but will dry up during long periods without rain. When Big Blue Creek is flowing, it is very shallow in depth, usually less than one foot, and meanders from one bank to the other. According to the TCEQ, Big Blue Creek is meeting all uses that were assessed. The Authority's analyses of the data agreed with their assessment.

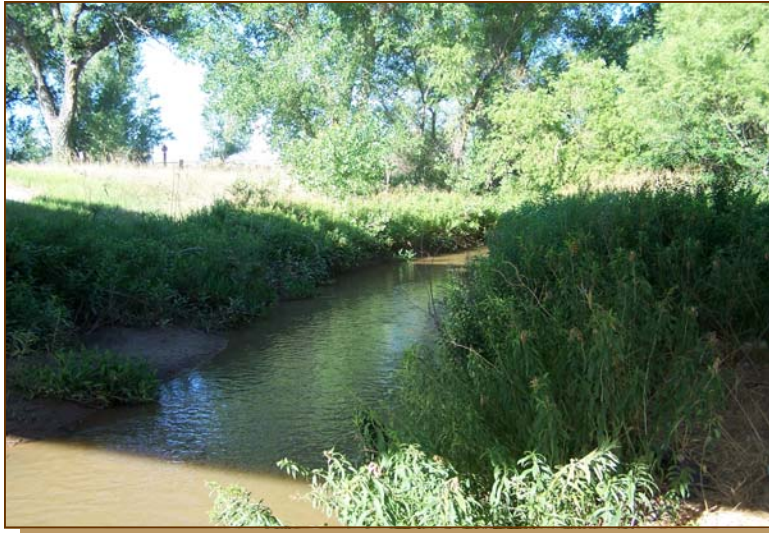
Canadian River above Lake Meredith (Segment 0103) is a classified water body located from a point immediately upstream of the confluence of Camp Creek in Potter County to the New Mexico State Line in Oldham County. This part of the Canadian River runs through cattle grazing land. Gravel mines can be found in areas along the river, as well. Typical flow values in this segment are primarily near or below 50 cubic feet per second (cfs); however, during periods of heavy rainfall, flows do exceed values greater than 1000 cfs. Conversely, during periods of little or no rainfall, flow values are as low as less than 10 cfs.

The Canadian River above Lake Meredith is on the *2008 303(d) List* for exceeding the standard for **chloride**. The Authority's analysis of the data agreed with this assessment. Trend analysis revealed an upward trend for **chloride** and **total dissolved solids (See Appendix C)**. These are naturally occurring and are also influenced by antiquated drilling practices. CRMWA has implemented a plan to reduce the amount of **chloride** entering Lake Meredith by the use of deep well injection to dispose of brine before it enters the river.

East Amarillo Creek (Segment 0103A) is an unclassified stream segment. It originates in northern Amarillo, where the city has impounded the headwaters of the creek into what is known as Thompson Park Lake. Storm water runoff and natural drainage in Amarillo supply the creek with flow. From there, the creek meanders through the moderately populated portions of Amarillo's northern suburban subdivisions. It then traverses through low-rolling to relatively flat pasture land, surfaced by clay and sandy loam. At the stream's mouth, the soil is loose sand. Vegetation along the creek bed includes scrub brush, native grasses, and salt cedars.

East Amarillo Creek has been identified as a perennial (always-flowing) stream. However, consideration should be given to reclassifying it as intermittent with perennial pools, as it can go dry during the hot summer months. The creek has one permitted municipal wastewater treatment plant that will occasionally discharge excess effluent. Most of the flow in the creek comes from natural seeps and springs and urban runoff in the upper portions of the creek. East Amarillo Creek is on the *2008 TWQI for Water Bodies with Concerns for Use Attainment*

and Screening Levels with a (CS) - concern for **chlorophyll a** and **nitrate**. The Authority's analysis of the data agreed with this assessment. Additionally, the Authority's review of the data revealed that **bacteria** and **orthophosphorus** exceeded their screening levels (See screening results in Appendix B). The most likely sources of these problems are runoff from the urbanized areas that flow into the creek. As the creek exits the City of Amarillo, many small fenced properties can be found bordering the creek. Some of these properties are



East Amarillo Creek at US Highway 287

home to small numbers of various types of livestock, which may inadvertently contaminate the creek with effluent. However, there was a downward trend in **orthophosphorus** (See Appendix C). Several factors could be contributing to the decrease in **orthophosphate** levels, but additional monitoring will be required to ascertain this decline.

Punta de Agua Creek (Segment 0103B) is an unclassified water body located from the confluence of the Canadian River to the New Mexico state line in Hartley County. It is an intermittent creek in a remote part of the state. Punta de Agua was not assessed because the creek is dry most of the time and no samples were collected. Its streambed has all but disappeared and native grasses have overrun the creek bottom.

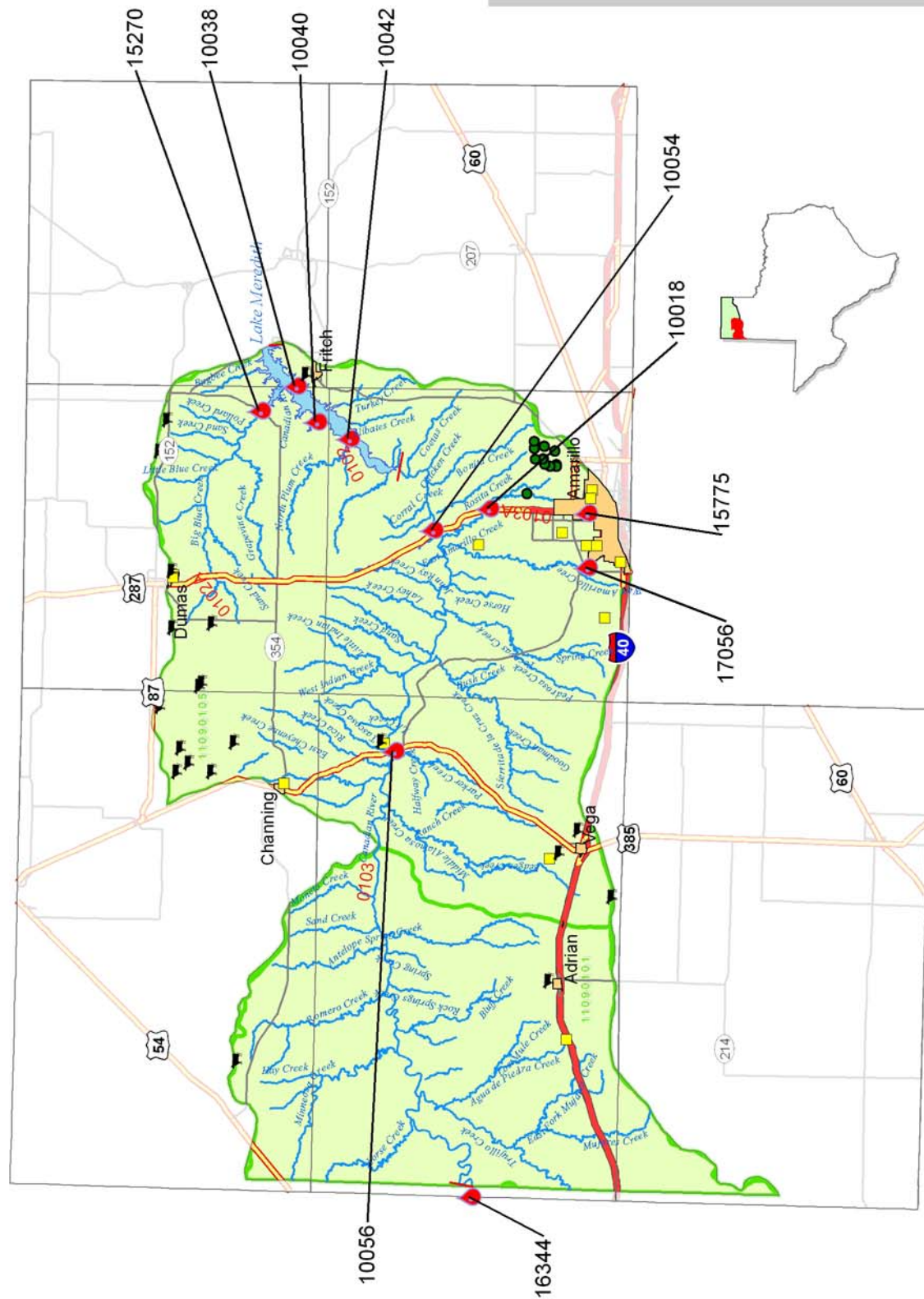


Figure 1-2

CANADIAN RIVER BASIN — REACH III



Reach III of the Canadian River Basin represents the Rita Blanca Creek Watershed upstream to the Texas-New Mexico State Line encompassing Hartley and Dallam Counties. A map of the reach can be found on [page 43](#).

The three sub-watersheds contained in this reach include approximately 3,600 square miles, of which an estimated 1,500 square miles are contributing drainage. Within the reach are 53 CAFO permits and three permitted solid waste disposal sites. The City of Dalhart is the only permitted wastewater discharger in this reach.

There are more than 600 farms and ranches that cover about 1,750,000 acres of land. These farms and ranches produce cattle, wheat, oats, corn, sorghum, hay, barley, alfalfa, and soybeans. As described in the preceding reaches, only a small portion is irrigated farmland. The soils range from sandy alluvial soils to dark and reddish clay loams over flat plain to broken rocky valleys where the plains break into the Canadian River Valley. Dalhart is the largest city in **Reach III** with a population of more than 7,000. The economy of the reach is basically agribusiness, oil and gas production, and hunting. Rainfall averages from 16 inches to a little more than 17 inches, with less than that in recent years.

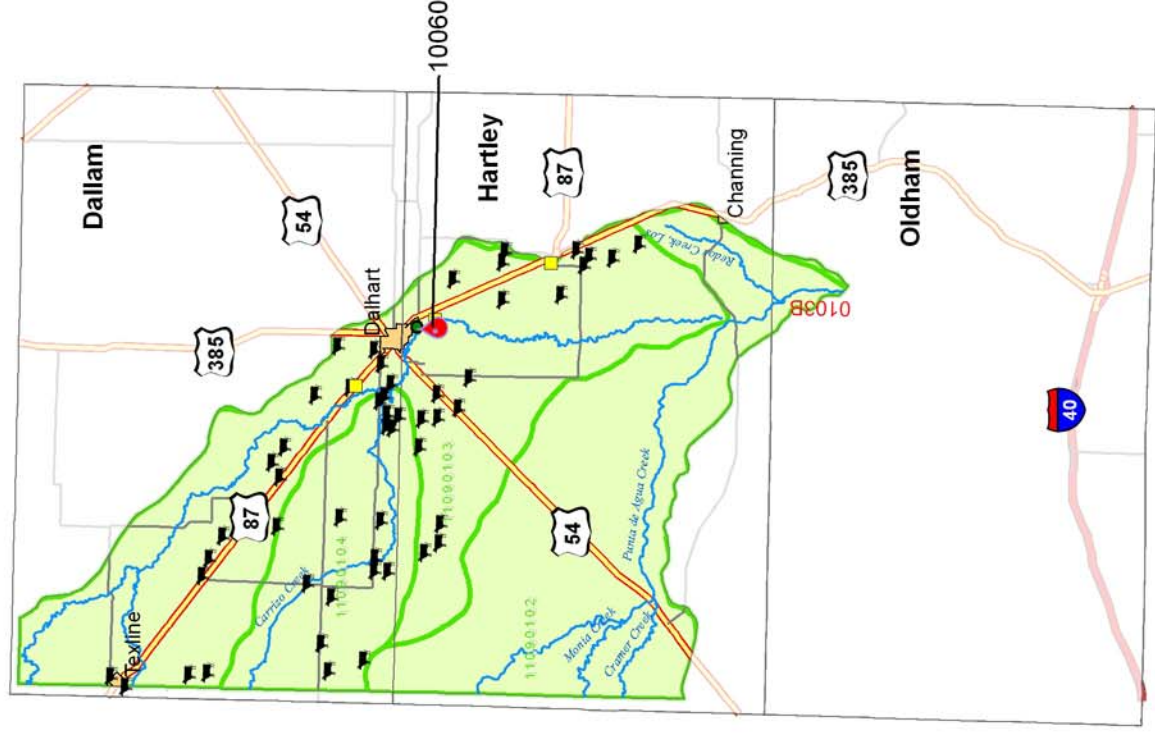
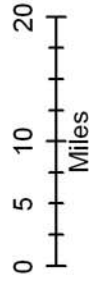
Rita Blanca Lake (Segment 0105) is the only segment located in this reach. It was completed in 1938 for flood control of the Rita Blanca Creek drainage area and by May 1941 it had filled to 75%. Since that time the lake has only filled a couple of times. Rita Blanca has a potential capacity of 12,100 acre-feet and an elevation of 3,860 feet above mean sea level. Although the drainage area above the lake is 1,062 square miles, ongoing drought has almost dried up the lake.

Rita Blanca Lake is unique in that it is the only segment in the Canadian River Basin to be classified as a **Noncontact Recreation** segment. It is on the 2008 303(d) List for **pH**. It also has a **(CS)** concern for water quality based on screening levels for **chlorophyll a**, **orthophosphorus**, **ammonia** and **total phosphorus**. The Authority's analysis of the data agreed with this assessment. Trend analysis was not possible due to the insufficient number of data points. A minimum of 20 data points is necessary to develop the degree of confidence needed for trend analysis ([See Appendix B](#)).

The only inflow Rita Blanca Lake receives is treated effluent from the City of Dalhart wastewater treatment plant and from occasional rainfall runoff. Without a steady inflow and only one source of water, Rita Blanca Lake is now a shallow, marshy wetland. The Texas Parks and Wildlife Department (TPWD) has designated Rita Blanca Lake as a high quality water fowl habitat since it is located in the flyway of migratory waterfowl. Therefore, the local residents do not consider the lake for recreational uses. The most likely source of the **pH** and nutrient concerns is the large number of migratory waterfowl using the lake as a stop over and their contributing to the heavy organic loads in the lake. There is not a good resolution to the problems in Rita Blanca. Until rainfalls return to levels that are more normal and the lake begins to receive inflow from the watershed, Rita Blanca is going to continue to experience similar problems.



Canadian River Basin Reach III



Legend

- MSW / Landfill
- Wastewater Outfall
- CAFO
- Monitoring Station
- 0101 Segment ID
- Hydrology
- County Boundary
- Urbanized Area
- HUA Boundary
- Canadian Reach III

Figure 1-3

CANADIAN RIVER BASIN — REACH IV



Reach IV of the Canadian River Basin includes **Palo Duro Creek (Segment 0199)**, a classified water body, from the northern Texas-Oklahoma state line upstream to its headwaters, including portions of Coldwater Creek, Frisco Creek, and Lower Beaver River. It contains three sub watersheds with 6,500 square miles, of which 3,500 are contributing drainage in Texas. It was not assessed in 2008 and data was not available. A map of **Reach IV** can be found on **page 45**.

Major cities located in **Reach IV** include Dumas, Spearman, Cactus, Stratford, Sunray, and Gruver. Rainfall averages from 19 to 20 inches annually. More than 580 farms and ranches encompassing 1,100,000 acres of land produce cattle, wheat, oats, corn, sorghum, hay, barley, alfalfa, and soybeans. Soils range from sandy alluvial to dark and reddish clay loams over flat plain to broken rocky valleys.

There are 9 permitted municipal and industrial dischargers, 13 permitted solid waste disposal sites and 118 concentrated animal feeding operations. The American Zinc Superfund Site, SUP096, (EPA ID: TXD982813743) is located in this reach near Dumas. More information concerning this site can be found on the TCEQ's website at: www.tceq.state.tx.us/remediation/superfund/state/amzinc.html.

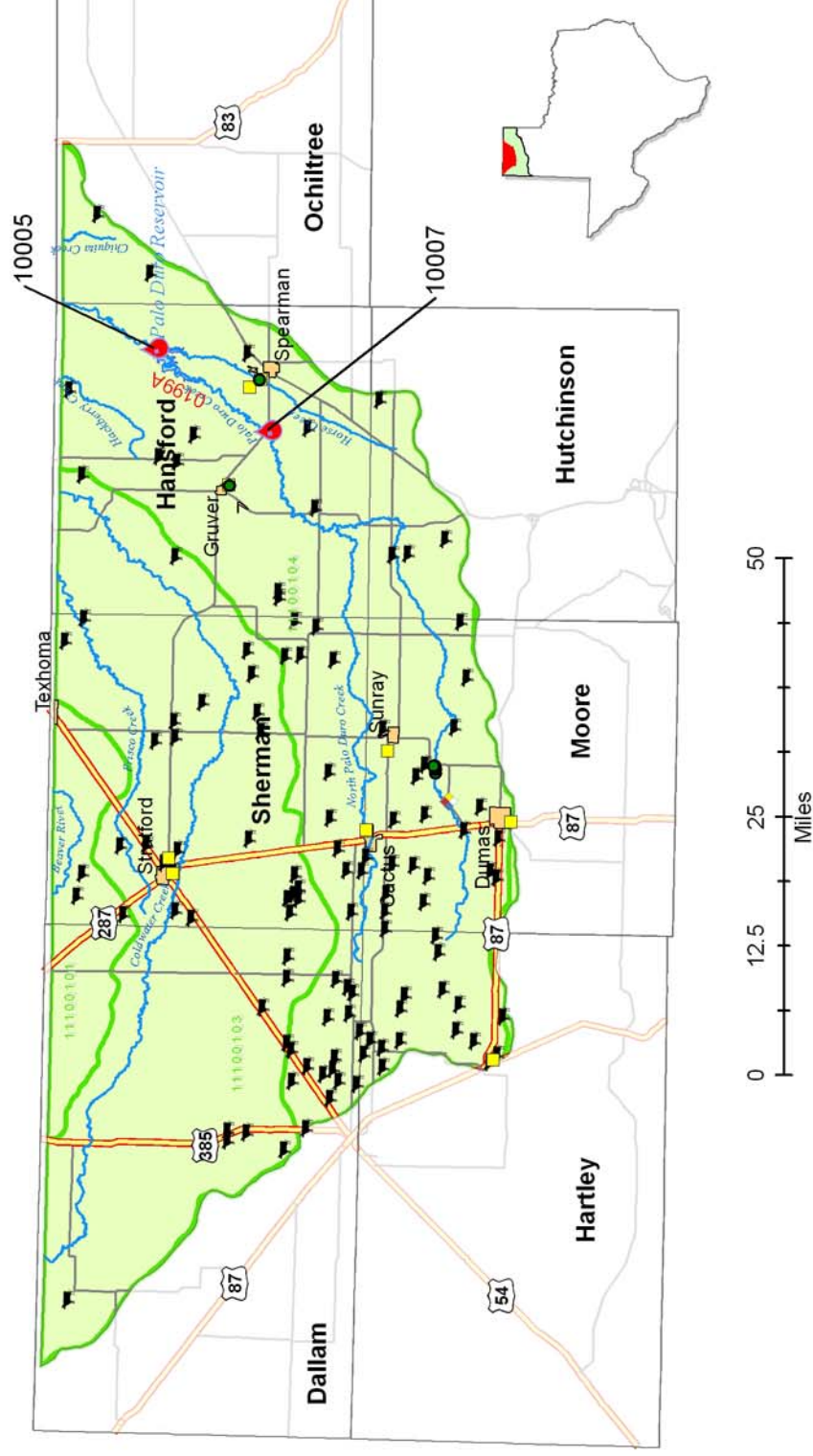
Palo Duro Reservoir (Segment 0199A), with construction completed in 1991, has a total storage capacity of 60,900 acre feet (ac/ft), with a drainage area of about 614 square miles. The naturally arid nature of this region continues to plague the filling of Palo Duro Reservoir. According to The Palo Duro River Authority, the five year average capacity was 2.89 %, while the ten year capacity was 7.63%. The heavy rains that drenched some areas of the Canadian and Red River Basins in 2007 and 2008 only brought the lake level up slightly. However, within a few months, the lake had dropped back to the level where it was prior to the floods.

The Palo Duro Reservoir is on the 2008 303(d) List for **depressed dissolved oxygen** and on the 2008 TWQI for Water Bodies with Concerns for Use Attainment and Screening Levels with a **(CS)** concern for **ammonia**. The Authority's analysis of the data agreed with this assessment. While both elevated and lower values were noted for certain constituents, trend analyses was not possible due to the insufficient number of data points. A minimum of 20 data points is necessary to develop the degree of confidence needed for trend analysis.

Palo Duro Reservoir, like Rita Blanca Lake, is one of very few water bodies in the Panhandle of Texas. It is also relatively shallow and attracts large numbers of migratory waterfowl. Only when and if the lake begins to fill, will these problems begin to improve.



Canadian River Basin Reach IV



Legend

- MSW / Landfill
- Wastewater Outfall
- CAFO
- Superfund Site
- Monitoring Station
- Segment Boundary
- Segment ID
- Hydrology
- County Boundary
- Urbanized Area
- HUA Boundary
- Canadian Reach IV

Figure 1-4

CANADIAN RIVER BASIN — REACH V



Reach V of the Canadian River Basin comprises the Wolf Creek Watershed from the Texas-Oklahoma State Line upstream to its headwaters. It includes the upper eastern section of the Panhandle in Lipscomb and Ochiltree Counties, which is about 65 miles long and 35 miles wide. It consists of three sub-watersheds with 3,589 square miles of contributing drainage. A map of **Reach V** of the Canadian River Basin can be found on **page 47**.

Rainfall averages from 19 inches to 23 inches annually. More than 660 farms and ranches encompass about 1,150,000 acres of land that produce cattle, wheat, oats, corn, sorghum, hay, and barley with dry land farming. Economics of the area are based on agribusiness, oil and gas production, and hunting.

The largest city in **Reach V** is Perryton, which has a population of 7,800. Other towns include Booker, Higgins, Follett, and Darrouzett. The total population of the reach is approximately 11,000.

Reach V contains two municipal wastewater dischargers, six permitted solid waste disposal sites and 29 concentrated animal feeding operations. The City of Perryton Well #2 Federal Superfund Site, SUP103, (EPA ID: TX0001399435) is also located in this reach. More information on this site can be found on the United States EPA website at: www.epa.gov/superfund/sites/npl/nar1528.htm.

Wolf Creek (Segment 0104) is surrounded by typically flat terrain with local escarpments. Brush and grasses grow in the mostly deep, fine sandy loam along its banks. According to the *2008 TWQI for Water Bodies with Concerns for Use Attainment and Screening Levels*, Wolf Creek has a **(CS)** concern for water quality based on screening levels for **chlorophyll a**. This is for the portion of the segment that includes Lake Fryer to the upper end of the segment. The Authority's analysis of the data agreed with their assessment. No trends were evident during analysis. Screening analysis conducted by the Authority revealed only 2 out of 43 samples exceeded the criteria for **chlorophyll a** in the lower portion of Wolf Creek from below Lake Fryer to the point of exiting the state (**See Appendix B**). Wolf Creek was removed from the *2008 303(d) List for bacteria* in 2008. The water quality for **bacteria** has improved, which means the most recent set of data demonstrates that it now meets the requirements for removal from the *303(d) List*. This removal is one of the benefits of continued monitoring efforts where water quality has been less than desirable.



Canadian River Basin Reach V

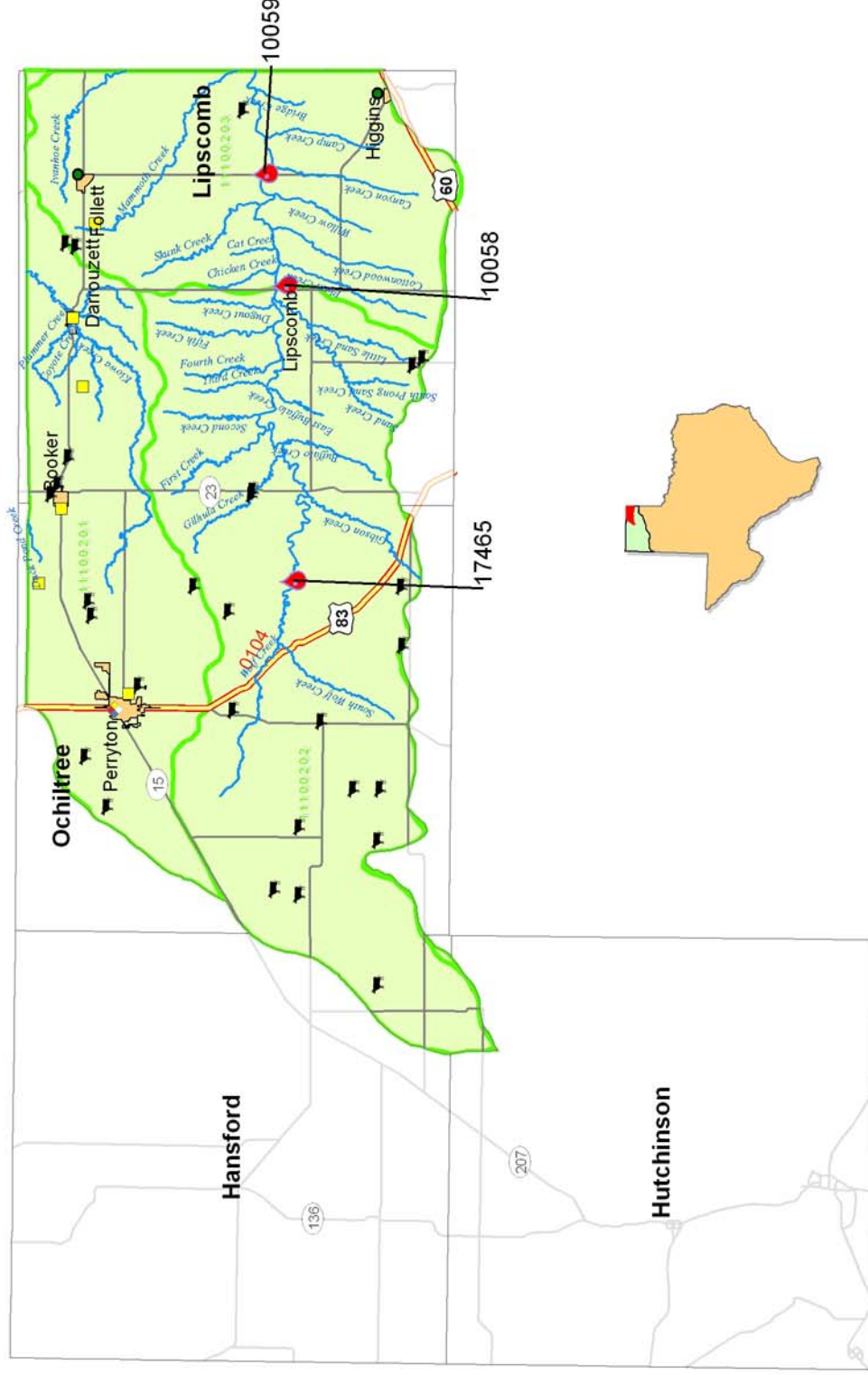
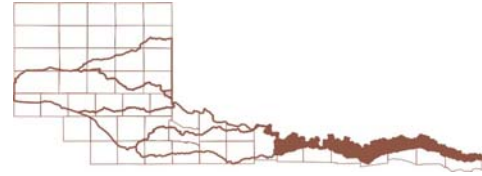


Figure 1-5

RED RIVER BASIN — REACH I



Reach I of the Red River Basin, the easternmost reach of the Texas portion of the Red River Basin, is an area approximately 230 miles long by 35 miles wide. Beginning at Texarkana in Bowie County and ending upstream just inside Clay County, the basin encompasses approximately 6,588 square miles. Maps of the lower and upper portions of **Reach I** can be found on **pages 58 and 59**, respectively.

Numerous small communities and rural areas are characteristic of much of the easternmost areas. Cities within the basin with populations more than 10,000 include Texarkana, Paris, Sherman, Denison, and Gainesville. Smaller cities in these counties include Bonham, Bowie, Clarksville, New Boston, and Nocona. The populations of more than 260 towns and communities account for less than 10,000 people. However, total population of **Reach I** is approximately 350,000.

One of the fastest growing areas in this region is the Sherman-Denison metropolitan area. This area attributes its continued growth of the Dallas/Fort Worth Metroplex growing northward expanding along the Highway 75 corridor. This population growth is also driving the growth of the infrastructure of the suburban areas. This, in turn, effects water quality from the influences of run off from these newly populated areas.

The major reservoirs of **Reach I** include: Pat Mayse Lake, Lake Bonham, Lake Texoma, Moss Lake, and Lake Nocona. Annual rainfall amounts average from 32 inches to 50 inches.

The seven counties located within **Reach I** contain three classified river or stream segments (**0201**, **0202**, and **0204**) and five classified water body segments (lakes and/or reservoirs - **0203**, **0208**, **0209**, **0210**, and **0225**). Nine unclassified stream segments are also in **Reach I** and include: **0201A**, **0202A**, **0202C**, **0202D**, **0202E**, **0202F**, **0202G**, **0203A**, and **0204B**. Unclassified stream segments are characterized as tributaries of classified segments. There are 40 permitted municipal and industrial dischargers, 43 permitted solid waste disposal sites and six concentrated animal feeding operations. Also located in this reach is a State and Federal Superfund Site known as the Sherman Foundry (EPA ID: TXD007318652). Also known as the Old Foundry, it was in operation since before 1947. It is a former cast iron foundry, which produced machine parts from scrap and pig iron, using a mold process. The Foundry shut down in October 2000. In August 2003, most of the solid and liquid hazardous wastes were removed and disposed of properly; leaving approximately 5,170 cubic yards of foundry waste on-site. More information about this site can be found at the TCEQ website at www.tceq.state.tx.us/remediation/superfund/state/sherman.html.

There are approximately 10,000 farms covering three million acres of land that produce mainly wheat, hay, soybeans, corn, milo, cotton, sorghum, turf grasses, wholesale nursery greenery, pecans, peaches, melons, peanuts, and fruits. The farms also raise beef cattle, poultry, goats, dairy cattle, and horses. Soils vary within the reach to more than 40 different types. A variety of trees such as pine and oaks contribute natural resources for the lumber and paper mill industries.

The **Lower Red River (Segment 0201)** is the lowest segment of the Red River and runs from the Arkansas state line in Bowie County to the Arkansas-Oklahoma state line in Bowie County. This segment is on the *2008 TWQI for Water Bodies with Concerns for Use Attainment and Screening Levels* with a **(CS)** - concern for water quality based on screening levels for **chlorophyll a**. The Authority's analysis of the data agreed with this assessment. Trend analysis by the Authority revealed an upward trend for **pH** levels; however, they were well below the standard for this segment (**See Appendix C**). This trend is probably due to effluent discharges and run off after rain fall events.

In addition, screening analysis exhibited exceedances for **chlorophyll a** (**See Appendix B**). **Chlorophyll a**, an indicator of nutrient levels, is a concern that can be found up and down the main stem of the Red River. Run-off and discharges from both sides of the watershed (Texas and Oklahoma), along with the different methods Texas and Oklahoma utilize in their approach to water quality monitoring, contribute to the interpretation of this issue. Both Texas and Oklahoma use a watershed management approach with respect to water quality monitoring. Oklahoma has taken this definition and is applying it to individual USGS Hydrologic Unit Areas (HUAs), which in most cases is the smallest defined drainage system. Whereas in Texas, the term "watershed" is used to broadly define a geographic delineation of an entire river basin and the land that drains into it. For example the Red River Basin in Texas is considered as one watershed, and the Authority has subdivided this into five sub watersheds or Reaches. In Oklahoma there are 67 USGS defined HUAs, while Texas has 207 HUAs.

Mud Creek (Segment 0201A) is an unclassified segment that begins eight and one half miles northwest of DeKalb in northwestern Bowie County and runs southeast to a point just above DeKalb. It then turns northeast to its mouth on the Red River north of New Boston. It is on the *2008 303(d) List* with a 5c for low **dissolved oxygen** and elevated **bacteria** levels. It is also on the *2008 TWQI for Water Bodies with Concerns for Use Attainment and Screening Levels* with a **(CS)** - concern for water quality based on screening levels for **chlorophyll a** and **low dissolved oxygen**. The Authority's analyses of the data agreed with this assessment. While no trends were found in reviewing the data, **total phosphorus**, **ammonia**, **chlorophyll a** and **dissolved oxygen** did exceed screening levels (**See screening results in Appendix B**). In most water bodies in their natural state, **phosphorus** is the limiting factor driving how much growth that water body can sustain and support. When **phosphorus** levels rise in a water body, the increased growth affects everything up the food chain. One of the first indications that some kind of pollutant has been introduced into a water body, are the increased levels of algal growth. With the absence of a sustained flow, mostly due to beaver dams, and the increased algal growth, the **dissolved oxygen** will also remain well below desired levels.



Mud Creek at US Highway 259

Mud Creek is a typical east Texas creek from all appearances. However, somewhere upstream there is something that is causing these problems. Some possible sources that could be contaminating the creek include run-off from fields, animals concentrating near the creek using it as a water source, birds roosting in trees over the creeks and/or the discharge of untreated household waste into the creek.

Bacteria levels also exceeded screening levels in review of the data (See Appendix B), with the most likely causes being mentioned in the previous paragraph. One of the possibilities to resolve this and most bacterial issues in the Red and Canadian River Basins, is the use of a newer technology, known as Bacterial Source Tracking. It can differentiate *E. coli*, the preferred indicator **bacteria**, into subspecies which will allow identification of possible sources, so that the contamination can either be narrowed to specific groups of animals or to a man made source. Hopefully, this will become more available in the near future.

Red River below Lake Texoma (Segment 0202) is a classified segment located from the Arkansas-Oklahoma state line in Bowie County to Denison Dam in Grayson County. It is on the 2008 TWQI for Water Bodies with Concerns for Use Attainment and Screening Levels with a (CS) - concern for water quality based on screening levels for **chlorophyll a**. The Authority's analysis of the data agreed with this assessment. Trend analysis by the authority revealed an upward trend for **chloride**, **chlorophyll a**, **sulfate** and **pH** levels (See Appendix C for graphical presentations). Screening analyses also revealed exceedances for **chlorophyll a** (See Appendix B for results of the Authority's data review). Like most of **Reach I** of the Red River, it receives runoff and flow from Oklahoma, as well as Texas. As stated earlier, since both Texas and Oklahoma contribute to these issues in the Red River, a cooperative effort will be necessary. Monitoring should continue throughout this segment. No other nutrients were shown to exceed the screening criteria.

Bois D' Arc Creek (Segment 0202A) is an unclassified water body that runs from its confluence with the Red River to the upstream perennial portion of the stream southwest of Bonham in Fannin County, Texas. Bois D' Arc Creek rises two miles northwest of Whitewright in southeastern Grayson County, runs northeast across Fannin County, and eventually forms a natural boundary between Fannin and Lamar Counties, before its confluence with the Red River. The



Bois D' Arc Creek at State Highway 78

stream, intermittent in its upper reaches, is 60 miles long. It flows over the permeable, but clay soils of Grayson County, and the highly calcareous catalpa clay of Fannin County. South of Bois D' Arc Creek in Fannin County is a cove that is part of a chalk escarpment. In February 2004 through July 2005, the Authority assisted the TCEQ Water Quality Assessment Team with a flow monitoring study at Bois D' Arc Creek upstream of the Bonham wastewater treatment plant that will help set discharge limits for that permit. Trend and screening analyses were not possible due to a limited number of data sets available and the extended time between those data sets.

Pecan Bayou (Segment 0202C) is an unclassified water body with origins south of Woodland in northwestern Red River County. It is intermittent at places in its upper and middle reaches. The stream meanders for 40 miles to its mouth on the Red River in northeastern Red River County, approximately one mile west of the Bowie County line. The soils along the creek are loam and clay, and the area is primarily agricultural. Fields and pastures are interspersed with heavily wooded areas of pines and various hardwood trees.

Pecan Bayou is on the *2008 TWQI for Water Bodies with Concerns for Use Attainment and Screening Levels* with a **(CS)** - concern for water quality based on screening levels for **chlorophyll a**. The Authority's analysis of the data agreed with this assessment. While no trends were evident, screening analyses confirmed the concern for **chlorophyll a** and also found **depressed dissolved oxygen** levels (**See Appendix B**). There is only one established TCEQ monitoring site on Pecan Bayou. The Authority began monitoring at Pecan Bayou with the intent to use it as a reference stream (one that has either few or no known water quality problems and is typical for the region). However, the first few visits to this site found the creek completely dry. Like most of Texas, this region was in the grip of an extended drought. However, the drought has given way to more typical and seasonal conditions. Now that the weather is returning to more normal conditions and rainfall amounts are more typical for the region, the creek is holding water again. During the most recent years, Pecan Bayou has become somewhat stagnant with little or no visible flow. Chlorophyll a levels have increased most likely from nutrient levels increasing from run off after rain fall events. Low **dissolved oxygen** levels have been recorded during these recent years. One possibility that could cause the creek to slow down and/or even stop is the presence of beaver dams. Any organic material that is flushed into the creek after rainfall events would begin to break down and begin consuming the oxygen in the creek.



Pecan Bayou at FM 1159

Pine Creek (Segment 0202D), an unclassified segment begins in western Lamar County, two miles north of Brookston and runs northeast for 25 miles to its mouth on the Red River, north of Paris. The upper tributaries of Pine Creek have been impounded to form Lake Crook, a water supply lake for the City of Paris. The stream initially traverses flat to gently sloping terrain with some locally steep scarps, surfaced by soils that vary from dark clays to deep loams over clay. Vegetation in this area is mainly hardwoods and grasses. Toward its mouth, the stream descends to low-lying flood plains, surfaced by sands and gravels. The area supports all categories of agribusiness.

Pine Creek is on the *2008 TWQI for Water Bodies with Concerns for Use Attainment and Screening Levels* with a **(CS)** - concern for water quality based on screening levels for **orthophosphorus** and **chlorophyll a**. The Authority's analyses of the data agreed with this assessment. The Authority's trend analyses revealed a downward trend for **nitrate** and **dissolved oxygen** (**See Appendix C**). Further analyses also revealed exceedances in screening criteria

for **chlorophyll a**, **dissolved oxygen** and **orthophosphorus** (See Appendix B). Until the 2006 Assessment, Pine Creek data was assessed with data from Smith Creek, a tributary that flows into Pine Creek and affects the water quality of Pine Creek. Both monitoring sites are less than a quarter of a mile from each other on US 271 just north of the City of Paris. The Pine Creek monitoring site is a few hundred feet upstream of the confluence of Smith Creek and does not have a sustainable flow unless water is flowing over the spillway of Lake Crook. However, Smith Creek does have a steady consistent flow and generally backs up into Pine Creek. Authority monitoring staff have documented reverse flow at this site due to Smith Creek overrunning and blocking Pine Creek. Water quality concerns on Pine Creek are most likely attributed to the Smith Creek influences. Runoff from local fields and possible leakage of some type of untreated effluent may be adding to the issues in Pine Creek. Permanent changes and improvements will only be effective when problems in Smith Creek are resolved. Please see **Segment 0202G** on **page 53** for further information.



Post Oak Creek at FM 1417

Post Oak Creek (Segment 0202E), an unclassified segment originates in north central Grayson County, two and a half miles northwest of the City of Sherman. From there it runs southeasterly for twelve miles to its mouth on Choctaw Creek, two miles southeast of Sherman. It then runs through the City of Sherman, from the northwest to the southeast and is primarily used as storm drainage for a large part of the city.

Post Oak Creek is on the *2008 TWQI for Water Bodies with Concerns for Use Attainment and Screening Levels* with a **(CS)** - concern for water quality based on screening levels for **orthophosphorus** and **chlorophyll a**. The Authority's analysis of the data agreed with the elevated levels of **orthophosphorus**. However, the Authority's analysis of **chlorophyll a** found only 5 out of 23 exceedances (See Appendix B for results of the Authority's data review). Trend analyses indicated a downward trend for **chlorophyll a** (See Appendix C). Since Post Oak Creek flows through the City of Sherman, and most runoff from the

city runs into the creek, there is the possibility that the **orthophosphorus** source may come from specific points somewhere along the creek. Post Oak Creek is subject to great fluctuations (10-20 foot rises) after heavy rain fall events. Establishing multiple monitoring points along the creek through the city on a regular basis and after rain events would be one way to possibly track these concerns.

Choctaw Creek (Segment 0202F) is an unclassified segment which originates three and a half miles southwest of Sherman in central Grayson County and runs northeast for 38 miles to its mouth on the Red River, two and a half miles northwest of Anthony in western Fannin County. The surrounding flat terrain with local shallow depressions is surfaced by clay and sandy loams that support hardwoods, pines, junipers, and native grasses. Choctaw Creek receives runoff from a moderately populated countryside.

The area around the creek also supports cattle and other agribusiness in the watershed. A major tributary to Choctaw Creek is Post Oak Creek.

Choctaw Creek is on the 2008 TWQI for Water Bodies with Concerns for Use Attainment and Screening Levels with a **(CS)** - concern for water quality based on screening levels for **ortho-phosphorus** and **nitrate**. The Authority's analysis of the data agreed with this assessment and no trends were evident for these two parameters. However, during data analyses, **total phosphorus** and **bacteria** exceeded screening levels (See Appendix B). Possible sources of these exceedances could be livestock and wild-life grazing in the fields along the creek, and/or run off from agricultural uses. Another possible source is the discharge from a municipal wastewater treatment plant located on the lower portion of Post Oak Creek, downstream of the City of Sherman. Treatment plants tend to have elevated nutrients and all data indicate that permit effluent limits are being met. Even though the creek maintains a consistent base flow, the flow from Post Oak Creek provides the majority of flow into this creek. The elevated nutrients are not having a negative impact on **dissolved oxygen**, aquatic life or algae growth, as the concentrations of these parameters are meeting water quality criteria.



Choctaw Creek at US 82

Smith Creek (Segment 0202G), a tributary to Pine Creek is a newly designated unclassified water body. It is located from the confluence with Pine Creek north of the City of Paris to its upstream portion south of the City of Paris in Lamar County. The Smith Creek watershed is home to a large permitted industrial discharger, which is the primary source of consistent flow in Smith Creek. Authority monitoring staff have verified through follow-up meetings with staff from the plant that at times when the site was dry the plant had been down for repairs. This permitted discharger utilizes an aerial spray field type of discharge over a series of large fields. Improving water quality in this segment may prove to be difficult, but not impossible.

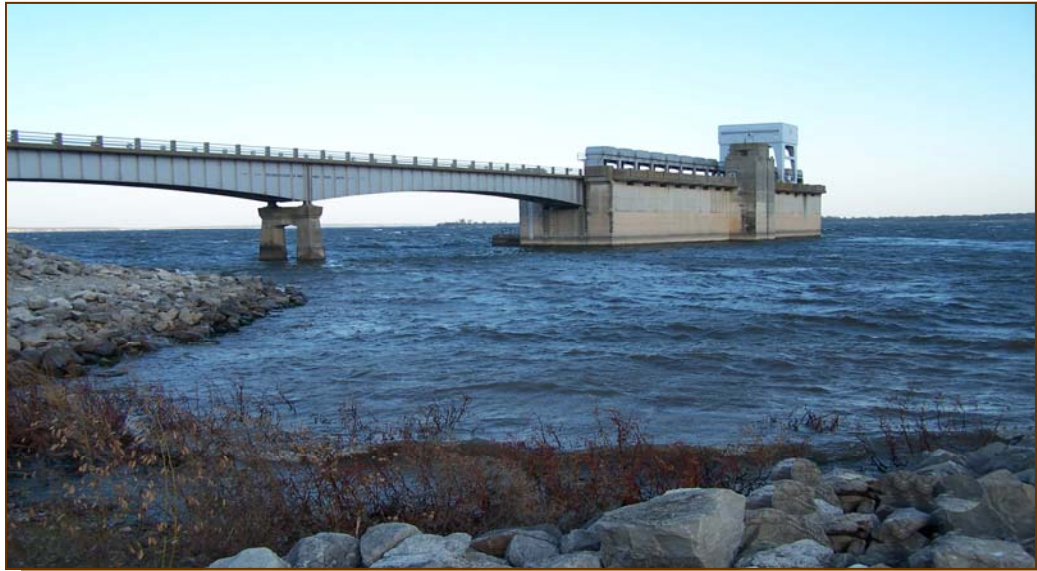


Smith Creek at US Highway 271

Smith Creek is on the 2008 303(d) List as a 5c for **bacteria**. It is also on the 2008 TWQI for Water Bodies with Concerns for Use Attainment and Screening Levels with **(CS)** - concerns for water quality based on screening levels for **ammonia**, low **dissolved oxygen**, **orthophosphorus**, and **total phosphorus**. In addition it has a **(CN)** - concern for near-nonattainment of the water quality standards for low **dissolved oxygen**. The Authority's analyses of the data agreed with the TCEQ's assessment of this segment. Trend analyses revealed a downward trend in **sulfate**, **orthophosphorus** and **chlorophyll a** levels (See Appendix C). This may be the result of repairs made by the discharger to the effluent discharge system. Authority monitoring staff have recorded **dissolved oxygen** readings that ranged from less than 0.5 mg/L to

over 10.0 mg/L and recorded bacteria levels that ranged from just less than 32 MPN to greater than 24,000 MPN. A Special Study for this segment would be the primary means by which to determine the cause of the numerous exceedances, concerns and impairments.

Lake Texoma (Segment 0203) is a classified water body located on the Red River between Texas and Oklahoma in Grayson and Cooke Counties in Texas, and Marshall, Johnson, Bryan, and Love Counties in Oklahoma. It covers more than 89,000 acres and is impounded by the Denison Dam, located five miles northwest of the City of Denison. The lake's capacity is 4,505,000 acre-feet, while 750,000 cubic feet per



Lake Texoma at Denison Dam

second is its discharge capacity. The lake and dam have 1,250 miles of shoreline and 1,127,000 acres of protected land. The drainage area is 39,719 square miles, of which 5,936 square miles is probably non-contributing.

Lake Texoma is on the 2008 TWQI for Water Bodies with Concerns for Use Attainment and Screening Levels with a **(CS)** - concern for water quality based on screening levels in *Finished Drinking Water* for **chloride** and **total dissolved solids**. It also has a **(CS)** - concern for water quality based on screening levels for **orthophosphorus** and **chlorophyll a**. The Authority's analyses of the data agreed with this assessment and did not reveal any trends. The elevated levels of **orthophosphorus** and **chlorophyll a** are more than likely due to upstream sources as the water is impounded. From February 2004 through July 2005, the Authority assisted the TCEQ Water Quality Assessment Team with a flow monitoring study at an unnamed tributary to Lake Texoma, north of the Denison wastewater treatment plant. The purpose of the study was to assist in setting discharge limits for that permit.

Until the completion of the Chloride Control Project, it is likely that Lake Texoma will continue to maintain these high concentrations of **chloride**, **sulfate**, and **total dissolved solids**. These public water supply concerns cannot be resolved without the cooperation of local, state, and federal environmental agencies that have a vested interest in this project. The completion of the Chloride Control Project would effectively reduce these concerns to an acceptable level.

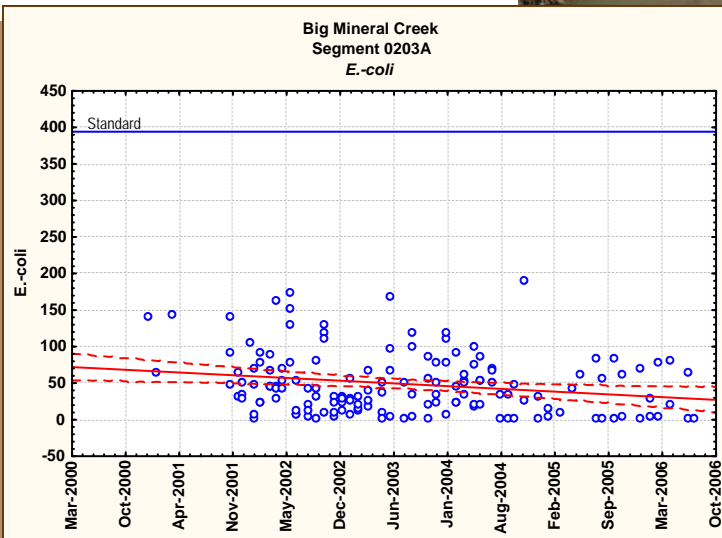
Big Mineral Creek (Segment 0203A) is an unclassified stream segment that originates at the junction of its northern and southern branches, two miles north of Whitesboro in western Grayson County. It runs east for ten miles to its mouth on the Big Mineral Arm of Lake Texoma.

The surrounding terrain is generally flat with occasional shallow depressions, surfaced by clay and sandy loams that support hardwoods, conifers, and various native grasses. The region serves as range and crop land.

Big Mineral Creek is on the 2008 *TWQI For Water Bodies with Concerns for Use Attainment and Screening Levels* with a **(CS)** - concern for **ammonia** and **orthophosphorus**. The Authority's analyses of the data agreed with the assessment. A possible cause for the **am-**



Livestock and wildlife move freely throughout the area near Big Mineral Creek



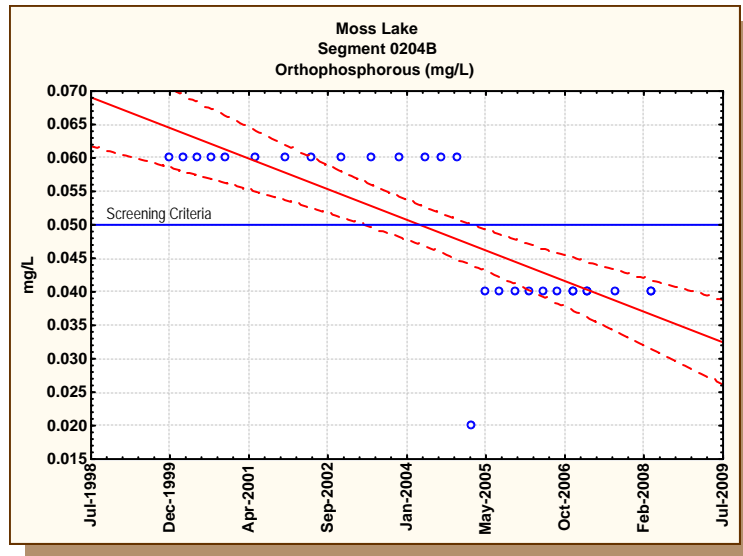
monia and **orthophosphorus** is attributed to the run off from agricultural uses. Livestock and wildlife move freely throughout the area near the stream. In addition, the Authority's data review revealed exceedances of **E. coli bacteria**. However, trend analyses revealed a downward trend of this parameter (see chart). This is most likely due to the reduction of the livestock population near the stream due to recent rainfalls filling stock tanks in this region.

Red River above Lake Texoma (Segment 0204) a classified segment from a point immediately upstream of the confluence of Sycamore Creek in Cooke County to the confluence of the Wichita River in Clay County. The countryside is by and large flat with occasional shallow depressions, surfaced by clay and sandy loams that support hardwoods, conifers, and various native grasses and serves as pasture and crop land. It is also on the 2008 *TWQI for Water Bodies with Concerns for Use Attainment and Screening Levels* with a **(CS)** - concern for water quality based on screening levels for **chlorophyll a** and a **(CN)** - concern for **bacteria** for near-nonattainment of the water quality standards. The Authority's analyses of the data agreed with the TCEQ assessment. However, trend analysis was not possible due to an inadequate amount of available data and/or discrepancy in time between data sets. Screening analyses revealed exceedances for **chlorophyll a** (See Appendix B). No other nutrients were shown to exceed the criteria.

As with other areas of the main stem of the Red River, **chlorophyll a** is an ongoing issue. Until a cooperative effort to improve the water quality in this segment is made by both Texas and

Oklahoma, these conditions and issues will continue to cause concerns. As stated earlier, since both states are responsible for issues in the Red River, finding a resolution will be necessary. Monitoring should continue throughout this segment.

Moss Lake (Segment 0204B) is a classified reservoir impounding Fish Creek. Completed in 1966, its primary purpose was to serve as a water supply for the City of Gainesville. The lake is located at the juncture of the north and south forks of Fish Creek, on Farm Road 1201, 11 miles northwest of Gainesville in north central Cooke County. It has 380 surface acres and is impounded by a 1,500 foot dam. Its drainage area is about 69 square miles and it maintains approximately 23,210 acre-feet of water with a storage capacity of approximately 36,400 acre-feet. Native grasses and several varieties of oak inhabit this region, while agriculture and ranching are the predominant land use. Oil production has also been a part of this area for over eighty years. Moss Lake was not assessed by the TCEQ. The Authority's trend analyses of the data revealed a downward trend in **orthophosphorus** (see chart). This is possibly due to better wastewater management practices over the time period analyzed and/or the use of a different method for its detection. While screening analyses exhibited exceedances in **orthophosphorus**, the higher values were from the earlier years of the sampling.



The Authority's trend analyses of the data revealed a downward trend in **orthophosphorus** (see chart). This is possibly due to better wastewater management practices over the time period analyzed and/or the use of a different method for its detection. While screening analyses exhibited exceedances in **orthophosphorus**, the higher values were from the earlier years of the sampling.

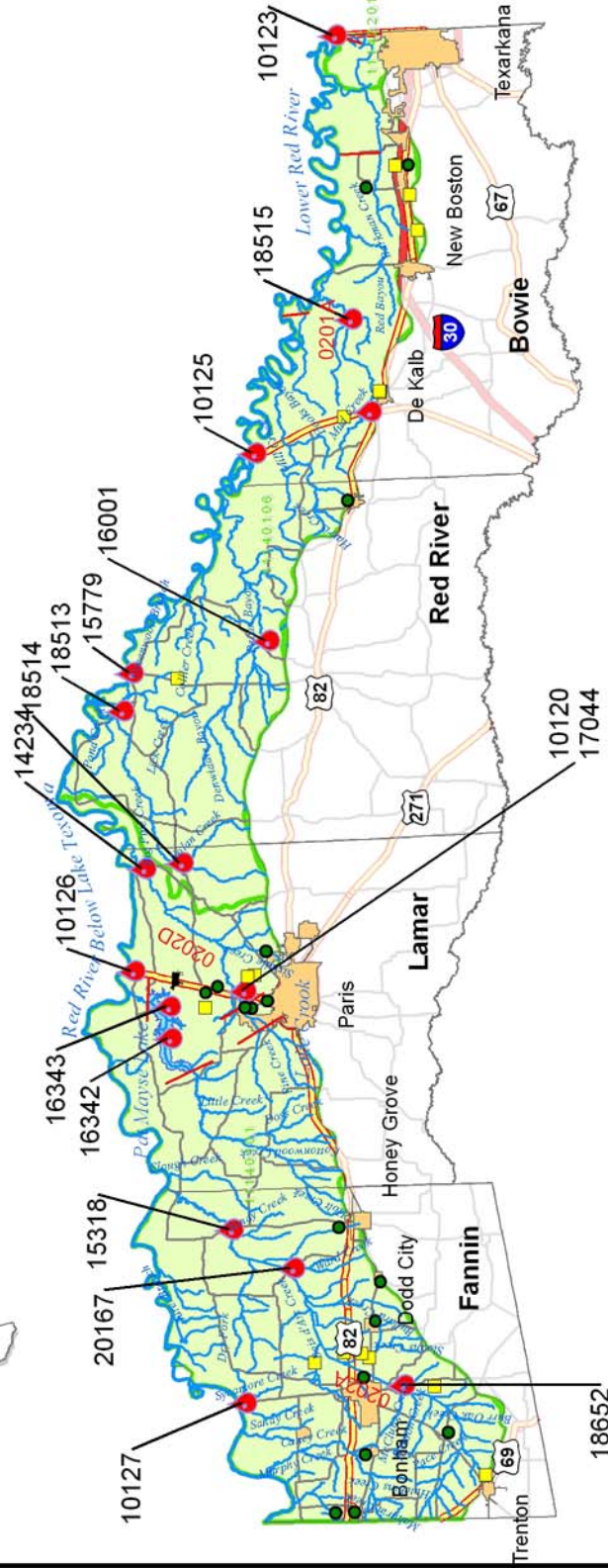
Pat Mayse Lake (Segment 0209) is a classified water body located in north central Lamar County, ten miles north of the City of Paris. The lake was built in 1967 by the U. S. Army Corps of Engineers by impounding the waters of Sanders Creek. The primary uses for the lake are municipal and domestic water supply, flood control, and recreation. Normal capacity is 124,000 acre-feet with a maximum capacity of 517,000 acre-feet.

Pat Mayse is on the 2008 TWQI for Water Bodies with Concerns for Use Attainment and Screening Levels with a **(CS)** - concern for water quality based on screening levels for **manganese** in sediment. The 2008 TWQI - Sources of Impairments and Concerns describes the possible causes from non point sources, such as natural sources or pollution from military base facilities. Continued monitoring is necessary to determine the exact source. The Authority's trend analyses revealed an upward trend for **pH** and **chlorophyll a** levels while a downward trend was noticed for **orthophosphorus** (See Appendix C). This is most likely attributed to run off from agricultural lands, thereby increasing nutrient levels. Screening analyses also exhibited exceedances for **chlorophyll a** and **orthophosphorus** (See Appendix B). While screening analyses exhibited exceedances in **orthophosphorus**, the higher values were from the earlier years of the screening and may be the result from the use of a different method for it's detection. As stated earlier, continued monitoring is the best approach in determining the cause for these concerns.

Farmers Creek Reservoir (Segment 0210), or Lake Nocona as it is locally known, is a classified segment that was formed by a dam on Farmers Creek, about six miles northeast of Nocona in northeastern Montague County. It is owned and operated by the North Montague County Water Supply District. The TCEQ did not find any issues with this water body. The Authority's analyses of the data did not reveal any trends of any parameters. However, during the Authority's data review, exceedances of **orthophosphorus** were revealed (**See Appendix B**). Again, the higher values were from the earlier years of the screening and may be the result from the use of a different method for its detection.



Red River Basin Lower Reach I



Legend

- MSW / Landfill
- Wastewater Outfall
- CAFO
- Monitoring Station
- Segment Boundary
- Segment ID
- Hydrology
- Urbanized Area
- County Boundary
- HUA Boundary
- Red Lower Reach I

Figure 2-1.1



Red River Basin Upper Reach I

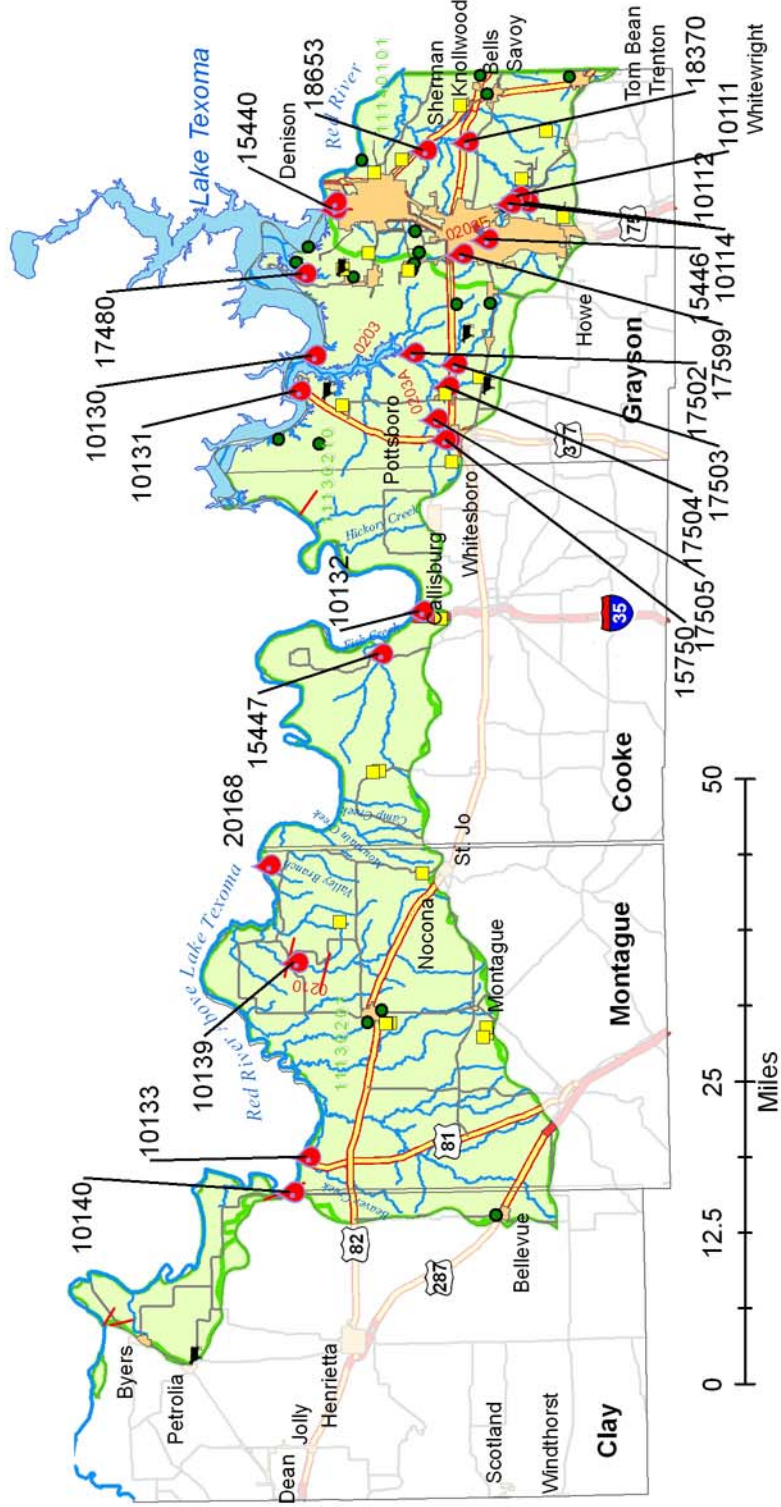
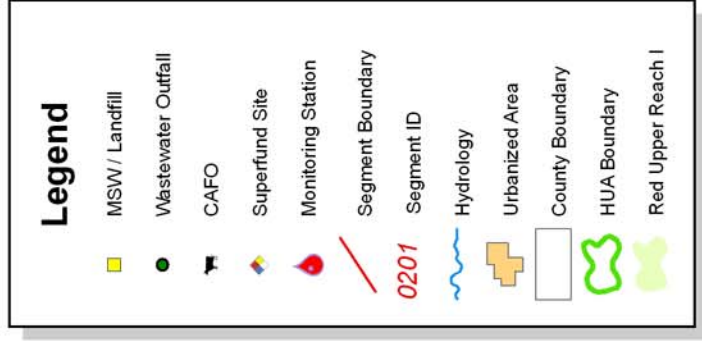
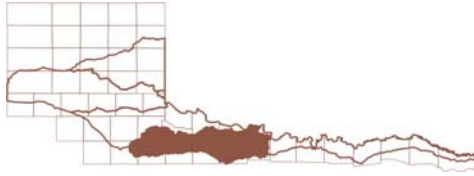


Figure 2-1.2



RED RIVER BASIN — REACH II

Reach II of the Red River Basin represents the Wichita River and Little Wichita River watersheds from the confluence of the Red River in Clay County, west to their headwaters in Dickens County. The area is approximately 170 miles in length and 50 miles wide, or approximately 8,892 square miles. A map of **Reach II** can be found on [page 69](#).

The largest city within this reach is Wichita Falls with a population of 104,197. There are 105 cities, towns, and communities found within the reach with Iowa Park, Henrietta, Electra, Seymour, Archer City, and Holliday leading the list. The county population within **Reach II** is approximately 180,000, equating to 26.2 people per square mile. Without Wichita County, there would only be an estimated 5.8 people per square mile. Major reservoirs include: Lake Arrowhead, Lake Diversion, Lake Kemp, Lake Kickapoo, and Santa Rosa Lake. Annual average rainfall for this reach ranges from 19 to 32 inches.

Reach II is a large, diverse area with most of the large population centers located in the eastern portion, while the western portion contains some of the largest ranches in the state, including the W.T. Waggoner Estate, Four Sixes Ranch, Pitchfork Ranch, and several others. The reach contains approximately 3,800 farms covering more than 5,230,000 acres. These farms raise wheat, grains, hay, alfalfa, sorghum, cotton, pecans, peanuts, peaches, and watermelons. Beef cattle, cow/calf operations, dairies, horses, and some swine and goats are also raised on these ranches. The soil types run the gamut from black, red, gray, chocolate, rich loams to sandy and rough pasture land. There are mesquite trees, juniper, post oaks, cottonwood, native pecan, elm, hackberry, and a wide assortment of other trees. Several species of cacti grow abundantly in some areas.

As early as the first half of the 1900's, **Reach II** has been inundated by oil and gas well activities. Early oilfield practices of dumping brine from the well field onto surrounding soils has contributed to salt scalds, which are areas of bare, heavily eroded soils. Although this type of brine disposal was stopped decades ago, some areas continue to experience the after effects of this type of pollution. Mining in this area includes building stone, sand, gravel, volcanic ash, and bituminous coal. Years ago the area was mined for copper.

There are ten classified stream segments and five unclassified stream segments that total 4,951 square miles of contributing drainage in the reach. There are also 18 permitted municipal and industrial dischargers, 43 permitted solid waste disposal sites and ten CAFOs in this reach.

The Little Wichita River (Segment 0211) is a classified segment located from the dam at Lake Arrowhead to its confluence with the Red River in extreme northeastern Clay County, near Terral, Oklahoma. The river traverses across generally flat terrain with local shallow depressions, surfaced by clay and sandy loam that supports mesquites, salt cedar, cottonwoods, elms, junipers, and native grasses.

The Little Wichita River is on the 2008 303(d) List as a 5b for low **dissolved oxygen** and on the 2008 TWQI for Water Bodies with Concerns for Use Attainment and Screening Levels with

a **(CS)** - concern for **chlorophyll a**. The Authority's analyses of the data agreed with the TCEQ assessment and no trends were evident of any parameters. But, the Authority's screening analyses exhibited some elevated **bacteria** levels in this segment (**See Appendix B**). This is primarily due to livestock and wildlife utilizing what little water is present.

For years, low **dissolved oxygen** and elevated **chlorophyll a** levels have been an ongoing problem in this segment. The physical nature of this segment is in part the source of the problems. When the Little Wichita River was impounded to create Lake Arrowhead in October 1966, the dam stopped any continuous flow into the river below the dam.



Little Wichita River at FM 2332

The City of Wichita Falls owns the water rights to Lake Arrowhead and controls all releases from the reservoir and other water-related operations. The only time the river flows naturally is after rainfall events or when the City of Henrietta requests that the City of Wichita Falls release water from Lake Arrowhead to flow downstream. This is done so that the City of Henrietta can take measures to refill its drinking water supply lake. Because of this faucet like condition "on and off", the river maintains two levels; the low level where the river channel holds a shallow layer of water and the other level, where the river channel is full and flowing or occasionally flooded by precipitation. The drastic change in water levels is likely the cause of the **low dissolved oxygen levels** and **chlorophyll a** issues. When there is no flow, the water in the river becomes stagnant and pooled, thus reducing the **dissolved oxygen** levels. Moreover, any activity or minor runoff into the river will contribute nutrients that could affect the **chlorophyll a** levels, which in turn could also affect the **dissolved oxygen** levels. Consideration should be given to revising the **dissolved oxygen** standard for this segment to reflect its actual conditions.

Lake Arrowhead (Segment 0212), a classified segment located from Lake Arrowhead Dam in Clay County up to the normal pool elevation of 926 feet. It was created by the impounding of the Little Wichita River in December 1966. It is owned and operated by the City of Wichita Falls. Lake Arrowhead is a municipal water supply reservoir that provides a maximum 228,000 acre-feet of water with a 13,500 acre surface area. It has an elevation of 926 feet above mean sea level and a drainage area above the dam of 832 square miles, as well as a 106 mile-long shoreline.

Lake Arrowhead is on the 2008 *TWQI for Water Bodies with Concerns for Use Attainment and Screening Levels* with a **(CS)** - concern for **total phosphorus** and **orthophosphorus**. The Authority's analyses of the data agreed with this assessment. Results of the Authority's trend analyses revealed downward trends for **total dissolved solids**, **sulfate**, **chloride**, and **dissolved oxygen** (**See Appendix C**). In recent years this watershed has received numerous amounts of concentrated rainfall, thus causing the decline of these parameters. Possible causes of these increased levels include run off from dairies, other livestock operations and/or run off from manure being spread on fields as fertilizer.

Lake Kickapoo (Segment 0213) is a classified stream segment located from Kickapoo Dam in Archer County up to the normal pool elevation of 1,045 feet. It impounds the North Fork of the Little Wichita River and has a drainage area of 275 square miles. With its capacity of 106,000 acre-feet and with 6,200 surface acre coverage, Lake Kickapoo serves as a municipal water supply for the City of Wichita Falls.

The TCEQ's assessment of Lake Kickapoo revealed no exceedances. The Authority's analyses of the data agreed with this assessment. Trend analyses was not possible due to the insufficient number and the large amount of time between data points. A minimum of 20 data points is necessary to develop the degree of confidence needed for trend analyses.



Wichita River at FM 810

The **Wichita River below Lake Diversion Dam (Segment 0214)** is a classified segment located from the dam at Lake Diversion flowing northeast across northwestern Archer County, southern Wichita County, and northwestern Clay County, where it joins the Red River just west of the Byers Bend in northern Clay County. It passes through the City of Wichita Falls, then through predominantly flat terrain, where mesquite, salt cedar, cottonwoods, elm, junipers, other low brush, and native grasses cover clay and sandy loam soils.

The Wichita River below Lake Diversion Dam is on the 2008 303(d) List as a 5c for **bacteria**. It is also on the 2008 TWQI for Water Bodies with Concerns for Use Attainment and Screening Levels with a **(CS)** - concern for **chlorophyll a**, **orthophosphorus**, **total phosphorus**, and **nitrate** and a **(CN)** - concern for near-nonattainment of the water quality standards for **bacteria**. After analyzing the data, the Authority agreed with the assessment by TCEQ. Trend analyses revealed upward trends for **chlorophyll a** and **bacteria** (See Appendix C). Screening analyses also revealed exceeded levels for **chlorophyll a**, **orthophosphorus**, and **total phosphorus** (See Appendix B).

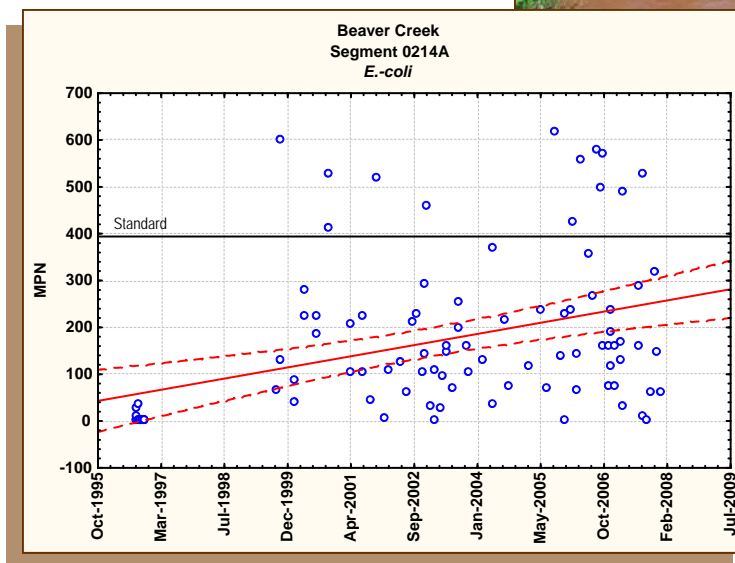
The **nutrient enrichment** and **bacteria** concerns and are most likely associated with the effluent discharge from the River Road Municipal Wastewater Treatment Plant, which is affecting the portion of the segment from FM 2393 to one mile above Eastland Lane. One of the two assessment units that are on the 303(d) List for **bacteria** is the same portion below the wastewater treatment plant, and the other is located from the dam at Lake Diversion to the Beaver Creek confluence. The problems in this portion of the segment could be related to a large number of cattle that are pastured in this area. In addition, a small CAFO and fields that are fertilized with manure are also possible sources of contamination. Additionally, wildlife and birds cannot be ruled out, as feral hogs have been seen in the area and large flocks of wild turkeys roost in the larger trees found closer to the river. Although most of these issues are non

point source in nature, there are various Best Management Practices or BMPs that could be implemented in this and similar areas. They include working with state agencies to control feral hogs and working with local landowners to manage wildlife and riparian habitats. Additionally, cross fencing pastures along riparian areas would allow landowners to move livestock to various selected fenced areas, which would restrict over grazing and give the landowner control over the type and amount of vegetative growth.

Beaver Creek (Segment 0214A) is an unclassified segment that begins two miles southwest of Dixie Mound and five miles west of Crowell in western Foard County. It runs southeast through Wilbarger County to its mouth on the Wichita River, north of Kadane Corner in Wichita County. The creek is impounded in southwest Wilbarger County to form the Santa Rosa Lake. The flow of Beaver Creek is intermittent in its upper reaches above Santa Rosa Lake. It crosses an area of steeply to moderately sloping hills and



Beaver Creek at US 283



flat to rolling terrain with local escarpments, surfaced by shallow and stony to deep sandy and clay loams that support mesquite, salt cedars, elms, cottonwood, junipers, and brush.

Beaver Creek is on the 2008 303 (d) List as a 5c for **bacteria**. It is also on the 2008 TWQI for Water Bodies with Concerns for Use Attainment and Screening Levels with a **(CS)** - concern for **chlorophyll a** and **low dissolved oxygen**, and a **(CN)** - concern for near-nonattainment of the water quality standards for **low dissolved oxygen** in its upper lengths. Beaver Creek was removed from the 303(d) List for **low dissolved oxygen** since its original listing was in error and data were not temporally representative. The Authority's analyses of the data agreed with this assessment. Trend analyses indicated an upward trend for **bacteria** levels (see chart). This is more than likely due to the abundance of wildlife and livestock that inhabit the area. The Authority's screening analyses also indicated exceedances for **chlorophyll a** and **E. coli bacteria** (See Appendix B for the Authority's screening analyses results).

gen, and a **(CN)** - concern for near-nonattainment of the water quality standards for **low dissolved oxygen** in its upper lengths. Beaver Creek was removed from the 303(d) List for **low dissolved oxygen** since its original listing was in error and data were not temporally representative. The Authority's analyses of the data agreed with this assessment. Trend analyses indicated an upward trend for **bacteria** levels (see chart). This is more than likely due to the abundance of wildlife and livestock that inhabit the area. The Authority's screening analyses also indicated exceedances for **chlorophyll a** and **E. coli bacteria** (See Appendix B for the Authority's screening analyses results).

The upper portion of Beaver Creek is extremely turbid. Collecting samples for **chlorophyll a** is difficult because the high turbidity affects the **chlorophyll a** analysis. The low **dissolved oxygen** is probably a result of the extreme turbidity in the creek and a sluggish flow. However, the water quality changes from the upstream site to the downstream site. The differences between **chloride**, **sulfate** and **turbidity** are apparent with the upstream site averaging higher levels of these constituents than the downstream site. These differences may be a result of oilfield brine encroachment into the creek as it flows downstream. Continued monitoring on Beaver Creek is recommended. Beaver Creek is crossed several times by farm-to-market and county roads which would make it a good candidate for a special study to observe the **chloride**, **sulfate**, and **field measurement** changes from the upper end to the lower end of the creek to determine where these changes occur.

Buffalo Creek (Segment 0214B) is an unclassified segment that originates in two forks; North Buffalo Creek and South Buffalo Creek in northwest central Wichita County. The South Fork rises near Electra and runs southeast to join the North Fork. The North Fork begins northeast of Electra and runs southeast before joining the South Fork. In 1964 the North Fork was impounded by the construction of Buffalo Creek Reservoir, just over one mile from its juncture with the South Fork. The consolidated Buffalo Creek runs southeast to its mouth on the Wichita River, southeast of Iowa Park in Wichita County.

The TCEQ did not assess Buffalo Creek because there were not enough data sets to conduct an assessment. The Authority's analyses of the limited available data indicated elevated levels for both **nutrients** and **bacteria**. The monitoring site is located downstream of the City of Iowa Park's wastewater plant, which discharges into Buffalo Creek. Additionally, there are other agricultural and ranching activities which are also present in the watershed. The Authority will continue monitoring on this segment until enough data is collected for an assessment. No trend analyses were developed due to insufficient data on this segment.

Holliday Creek (Segment 0214C) is an unclassified segment that flows from the Lake Wichita Dam to its confluence with the Wichita River. This creek flows through the City of Wichita Falls and primarily receives urban run off. During the 1980's, it became the subject of a flood control project after heavy rains caused extensive flooding within the city limits. After a successful partnership with local, state and federal agencies, many portions of the creek were deepened and channelized within concrete embankments to alleviate the flooding. No monitoring of this segment has been performed since the mid 1990's. Therefore, the Authority was unable to assess this segment due to limited or no available data.

Lake Diversion (Segment 0215) is a classified water body that impounds the Wichita River. It was constructed in 1922 to work in conjunction with Lake Kemp as a flood control impoundment and as a source of water for irrigation. It serves a vast network of irrigation canals and ditches that criss-cross Archer and Wichita Counties. The Wichita County Water Improvement District Number Two (WCWID#2) and the City of Wichita Falls operate and maintain Lake Diversion. When first constructed, the irrigation system was able to supply water to nearly every landowner located downstream in its watershed. Today, the primary use is still irrigation, but increasing population growth has caused many of the canals to become abandoned and fall into disrepair. These outdated and forgotten canals are, for the most part, no longer utilized. In addition, the City of Wichita Falls has constructed a pipeline that extends from the main supply canal at Headquarters Road to the new reverse osmosis plant on the western side of Wichita Falls. This has been accomplished in order to provide additional supplies for potable water uses.

The TCEQ assessed Lake Diversion and found no concerns on the 2008 TWQI. Screening analyses by the Authority agreed with this assessment. In addition, no trends were present.

The **Wichita River below the Lake Kemp Dam (Segment 0216)** is a classified segment located between the dam of Lake Kemp and the headwaters of Lake Diversion. There is only one monitoring site on this segment, which is approximately 13 miles in length, and it is located near the dam. The TCEQ assessed the water quality data from this segment and found no concerns. The Authority's analyses of the data agreed with their assessment and did not reveal any trends.

Lake Kemp (Segment 0217) is a classified water body, formed by impounding the Wichita River, in north central Baylor County. Like Lake Diversion, it was constructed in 1922 as a flood control and irrigation project. Lake Kemp supplies water to Lake Diversion and has been called on to serve as a supplemental water supply for the City of Wichita Falls. The lake has an elevation of 1,142 feet above mean sea level. The deep loamy soil supports grasses and wild upland plants. Junipers and mesquite trees can be found all around the lake, while salt cedars can be found primarily around the shoreline and shallow areas of the lake. The TCEQ assessed water quality data from Lake Kemp and found no concerns. The Authority's analyses of the data agreed with their assessment and did not reveal any trends.

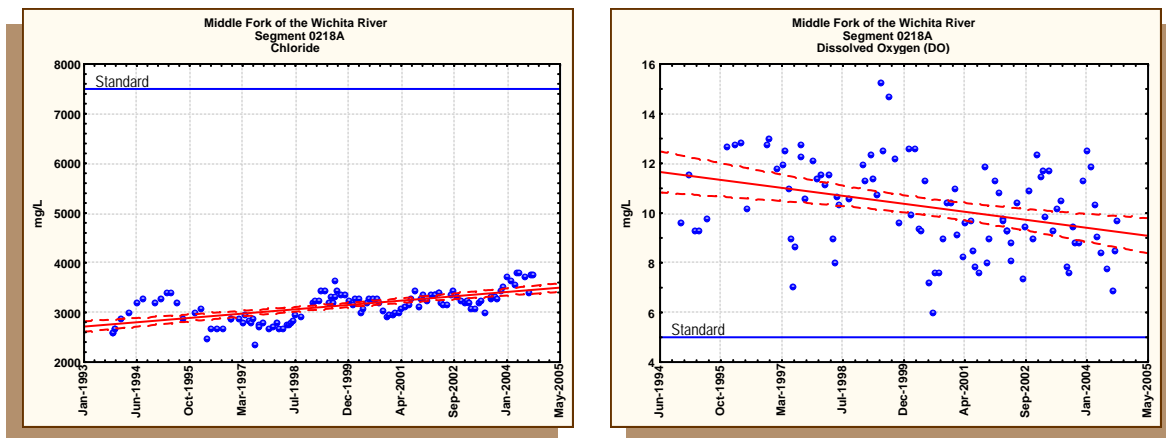


North Fork Wichita River at US 183-283

Wichita/North Fork Wichita River (Segment 0218) is a classified stream segment that begins more than five miles downstream of the confluence of Crooked Creek in Baylor County to a point a little more than five miles downstream of the most upstream crossing of FM 193 in Dickens County. The North Fork (Segment 0218) and Middle Fork (Segment 0218A) of the Wichita River contain elevated concentrations of **selenium (Se)**, a naturally occurring chemical element. Since 1959 the U.S. Army Corps of Engineers (USACE) has studied chloride control in the Wichita and Red River Basins. Published environmental studies by the USACE have found that **selenium** occurs

naturally in the brine springs found in this area. Although the elevated **selenium** is a chronic condition with little hope of improvement, the current levels have not proven to be toxic to fish and wildlife. The TCEQ, in the 2008 TWQI, has assigned Segment 0218 an overall rating of Category 4c for **selenium** in water. A Category 4 rating is one that is not supported or is threatened for one or more designated uses, but does not require the development of a TMDL. A Category 4c is where nonsupport of the water quality standard is not caused by a pollutant. The Authority's analyses of the data agreed with this assessment. Trend analyses revealed an upward trend in the **chloride** and **sulfate** levels. This is a naturally occurring trend for this segment, especially when drought conditions are prevalent. It also revealed a downward trend in the **dissolved oxygen** levels (**See Appendix C**). This is also to be expected with low flows and frequent periods of little or no flow. Screening analyses by the Authority revealed no exceedances (**See Appendix B**).

The **Middle Fork of the Wichita River (Segment 0218A)** is an unclassified segment stretching from the confluence of the North Wichita River southwest of Crowell in Foard County to the upstream perennial portion of the stream located northeast of Guthrie in King County. Like the North Fork, The Middle Fork of the Wichita River, also contains naturally occurring high levels of **selenium**, which is considered a chronic condition with little hope of improvement. The 2008 TWQI has assigned this segment an overall rating of Category 4c, where nonsupport of the water quality standard is not caused by a pollutant. The Authority's analyses of the data agreed with this assessment. Trend analyses revealed an upward trend for **chloride** and a downward trend for **dissolved oxygen** levels (see charts below). As with Segment 0218, this is a naturally occurring trend for this segment, especially when drought conditions are prevalent. Screening analyses by the Authority revealed no exceedances (See Appendix B).



Lake Wichita (Segment 0219) is a water body formed by impounding Holliday Creek. It is located southwest of Wichita Falls in southeastern Wichita County and northeastern Archer County. It has a surface area of 1,224 acres and a capacity of 5,620 acre-feet, with a drainage area of 128.3 square miles above the dam. The 2008 TWQI for Water Bodies with Concerns for Use Attainment and Screening Levels with a (CS) - concern for **chlorophyll a**, **orthophosphorus**, and **total phosphorus**. The Authority's analyses of the data agreed with this assessment and did not reveal any trends. Elevated **phosphorus** levels (from the use of phosphate based soaps and detergents), is usually considered a human caused pollutant where the source can be controlled. In turn, **chlorophyll a** levels will also rise due to these elevated nutrients. Lake Wichita has several subdivisions that dot the shoreline, some of which are considerably older than others. It is quite possible that some of these older subdivisions have septic systems that are outdated and not working properly. It would require a combined effort by city, county and state officials to determine a remedy for this problem.

Holliday Creek above Lake Wichita (Segment 0219A) is located from the headwaters of Lake Wichita to the upstream perennial portion of the stream southwest of Holliday in Archer County. Currently, there is only one monitoring site on this segment, located at the headwaters of Lake Wichita. During the dryer seasons the creek will dry up and remain dry until the region receives one or more significant rain events. When this occurs, it quickly flows into Lake Wichita and then remains pooled until drying up. Very little monitoring has transpired over the recent years; therefore, the Authority was unable to assess this segment due to limited or no available data.

South Fork Wichita River (Segment 0226) is a classified segment located from the confluence with the North Fork Wichita River in Knox County to upstream of U.S. Highway 82 in Dickens County. It is on the 2008 303(d) List as a 5c for **chloride**. It is also on the 2008 TWQI for Water Bodies with Concerns for Use Attainment and Screening Levels with a **(CS)** concern for **ammonia**. The Authority's review of the data agreed with this assessment. Trend analyses revealed upward trends in **sulfate**, **chloride** and **ammonia** levels. A downward trend was indicated for **dissolved oxygen** levels (See Appendix C). This is to be expected with low flows and frequent periods of little or no flow.

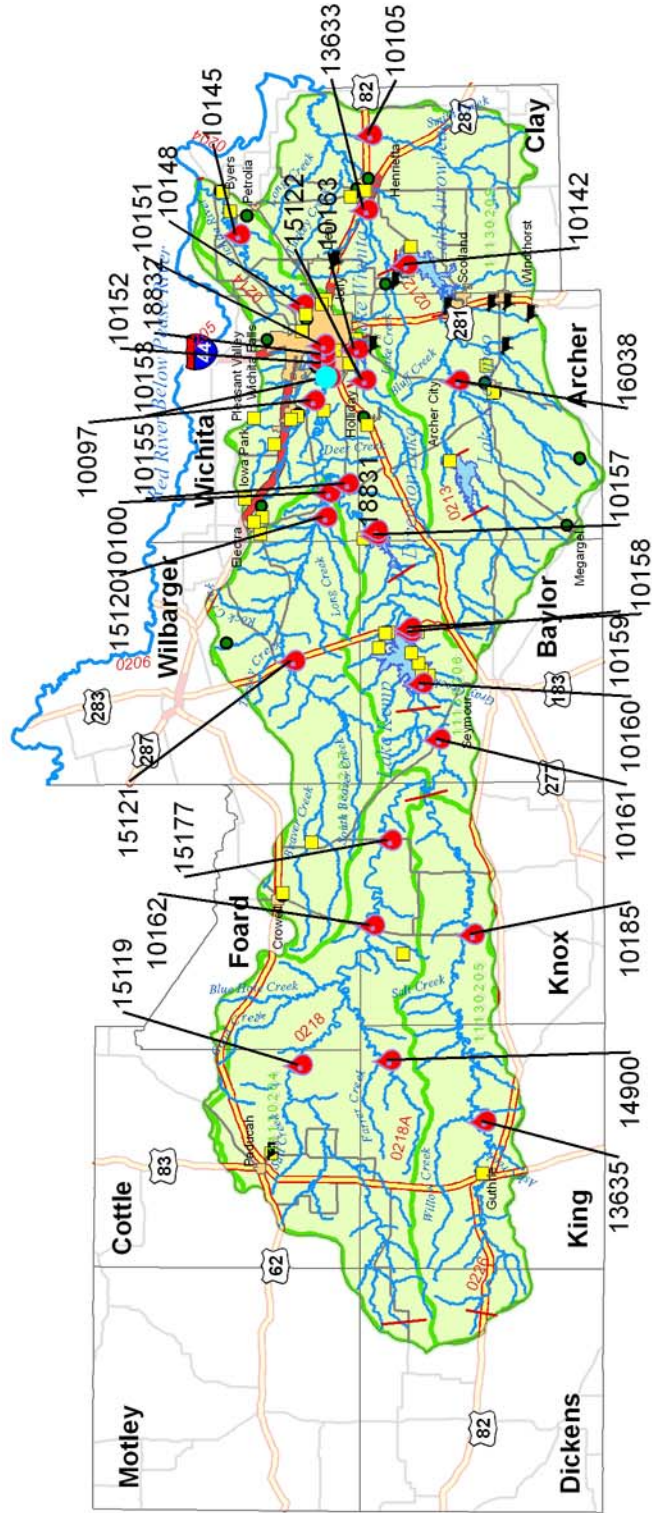


South Fork Wichita River at State Highway 6

Like other areas, in the western regions of the Red River Basin, elevated **chloride** levels occur naturally. The **ammonia** concern is most likely attributed to livestock, wildlife, or runoff from fertilized agricultural lands after rainfall events. The river is utilized as a local water source for animals. Additional data needs to be collected before a suitable action plan for improvement can be considered. Although most of these issues are non point source in nature, there are various Best Management Practices or BMPs that could be implemented in this and similar areas. They include, but are not limited to, working with local landowners to manage wildlife and riparian habitats. Additionally, cross fencing pastures along riparian areas would allow landowners to move livestock to various selected fenced areas which would restrict over grazing. This would allow the landowner control over the type and amount of vegetative growth and would also help to safely manage wildlife habitat.



Red River Basin Reach II

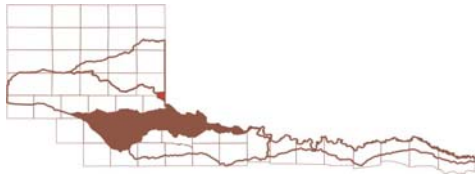


Legend

- MSW / Landfill
- Wastewater Outfall
- CAFO
- Monitoring Station
- Segment Boundary
- Segment ID
- Hydrology
- Urbanized Area
- County Boundary
- HUA Boundary
- Red Reach II



Figure 2-2



RED RIVER BASIN — REACH III

Reach III begins in northern Wichita County and extends westward toward Floyd and Briscoe Counties. It includes the Red River main stem from the confluence of Cache Creek upstream to the confluences of Buck Creek and the Red River.

The size of **Reach III** measures about 195 miles long to a maximum of 50 miles wide. The cities of Vernon and Burkburnett with populations of 11,660 and 10,927, respectfully, are the largest within the reach. The total population is about 26,000 with an estimated average of 4.8 people per square mile. Hardeman County is home to the only two reservoirs within the area: Lake Pauline and Lake Copper Breaks. Rainfall averages range from 19 inches to 24 inches annually within this reach.

Reach III contain 5,734 total square miles of drainage in Texas and Oklahoma, of which 4,845 square miles is in Texas. There are 13 permitted municipal and industrial dischargers, 25 permitted solid waste disposal sites and 12 CAFOs in this reach. A map of **Reach III** can be found on [page 73](#).

This is predominately a rural area comprising agribusiness and oil and gas production. There are approximately 2,050 farms and ranches covering more than 3,000,000 acres that grow mainly cotton, wheat, hay, feed products, alfalfa, soybeans, sorghum, peanuts, sunflowers, and guar (used in ice-cream and as a food thickener). The farms produce beef cattle, horses, hogs, poultry, and sheep. Soil types range from prime farmland to all types of clay and rough terrain.

The **Red River below the Pease River (Segment 0205)** is a classified segment that runs from the confluence of the Wichita River in Clay County to the confluence of the Pease River in Wilbarger County. It is on the 2008 TWQI for Water Bodies with Concerns for Use Attainment and Screening Levels with a **(CS)** - concern for **chlorophyll a** and a **(CN)** – concern for use near-nonattainment of the water quality standards for **bacteria**. The Authority's analyses of the data agreed with the assessment of **chlorophyll a**; however, although limited data was available to screen bacteria, levels appeared to be within acceptable levels (**See Appendix B for results of the Authority's screening**). Trend analyses revealed upward trends for **total dissolved solids, sulfate, and chloride (See Appendix C)**. This portion of the Red River meanders through a countryside made up of small farms and cattle operations. Like most of the western half of the basin, it is rural in nature with few cities and roads. Many of the people who live in this area still utilize septic tanks as their primary means of household waste disposal.

Runoff from cultivated fields and an outfall from a wastewater treatment plant are the most likely contributors to the concerns for **chlorophyll a** and **bacteria**. As stated earlier, the Red River receives contributions from both Texas and Oklahoma, and as such, both states are responsible for environmental issues in the Red River. Hopefully, finding a resolution will be forthcoming in the near future.

The **Red River above the Pease River (Segment 0206)** is a classified segment located from the confluence of the Pease River in Wilbarger County to a point immediately upstream of the confluence of Buck Creek in Hardeman County. This segment has a Category 2 listing. This means that it is attaining some of its water quality standards, no use is threatened, and insufficient data/information is available to determine if the remaining uses are attained or threatened. Screening analyses by the Authority did not reveal any exceedances for this segment (**See Appendix B**). However, trend analyses of the data revealed a downward trend for **nitrate** levels (**See Appendix C**). This is most likely due to the reduced rainfall over the fertilized/cultivated land areas.

South Groesbeck Creek (Segment 0206B) is an unclassified segment that extends from the confluence of the Prairie Dog Town Fork of the Red River in Hardeman County to the upstream perennial portion of the stream east of Childress in Childress County. Deposits of gypsum were discovered in this area in 1890 and is still mined today.

South Groesbeck Creek is on the *2008 TWQI for Water Bodies with Concerns for Use Attainment and Screening Levels* with a **(CS)** - concern for **nitrate** and a **(CN)**—concern for near-nonattainment of the water quality standard for **bacteria**. It is also on the *2008 303(d) List* as a 5c for **bacteria**. The Authority's analyses of the data agreed with this assessment. However, no trends were indicated. Additionally, the Authority's data review revealed elevated levels of **chlorophyll a** and **nitrate** (**See Appendix B**).

The source of the **nitrate** in South Groesbeck Creek is not exactly known, but Groesbeck Creek flows year round, which gives the indication of being a spring fed creek. The watershed of Groesbeck Creek is mostly underlain by the Seymour Aquifer, which is well documented as containing high levels of nitrate and has been known to produce seeps and springs.

The source of the **bacteria** concern is likely attributed to property owners who utilize the creek as a convenient water source for cattle. Authority personnel have documented cattle in or around the creek during monitoring visits at this site. From February 2004 through July 2005, the Authority assisted the TCEQ Water Quality Assessment Team with a flow monitoring study at South Groesbeck. These results will be used for the permitting process for a local effluent discharger.



South Groesbeck Creek at US 287

The **Upper Pease/North Fork of the Pease River (Segment 0220)** is a classified segment extending from the confluence with Canal Creek at the Hardeman-Foard County line to more than three miles upstream of the confluence of Dick Moore Canyon in Floyd County. The TCEQ did not find any exceedances during this period of record. Trend analyses revealed a downward trend for **chlorophyll a** (See Appendix C). Like most of Texas, this rugged region suffered through the effects of drought and naturally drier conditions leaving many of the perennial water sources such as stock tanks, creeks and springs dry or almost dry. The Authority's analyses of the data revealed **bacteria** did exceed screening levels (See Appendix B). This is most likely due to wildlife and livestock remaining near the river for survival.

The **Middle Fork Pease River (Segment 0221)** and the **South Fork Pease River (Segment 0227)** were not assessed due to a lack of data. Collections had been attempted but these segments have been dry for a long period of time. As such, monitoring efforts from these segments were repositioned to better utilize manpower and funding. Like most of the Red and Canadian River Basins, inadequate rainfall has caused many perennial bodies like these to dry up. Since these segments are sandy and braided, it is possible that some moisture may be moving below the surface of the river in the sandy substrate of the river bed.

The **Lower Pease River (Segment 0230)** is a classified segment extending from the confluence with the Red River in Wilbarger County upstream to the confluence with Canal Creek at the Hardeman-Foard County line. The TCEQ did not find any exceedances in this segment during this period of record. The Authority's analyses of the data agreed with this assessment.



Paradise Creek at US 287

Paradise Creek (Segment 0230A) is an unclassified water body east of the City of Vernon. This small perennial creek has experienced elevated levels of **bacteria**. It is on the 2008 303 (d) List as a 5c for **bacteria**. It is also on the 2008 TWQI for Water Bodies with Concerns for Use Attainment and Screening Levels with a (CS) - concern for **nitrate** and **chlorophyll a**. The Authority's analyses of the data agreed with this assessment. Additionally, no significant trends were revealed.

Paradise Creek is intermittent in its upper reaches, only flowing after rainfall events. It runs through rural farming and ranching areas until it approaches the City of Vernon, where it flows around and through the southeastern portions of the city. Run off from portions of the city drain into one side of the creek, while run off from cultivated farm land on the other side are the most likely sources of the elevated **bacteria**, **nitrate** and **chlorophyll a** levels.

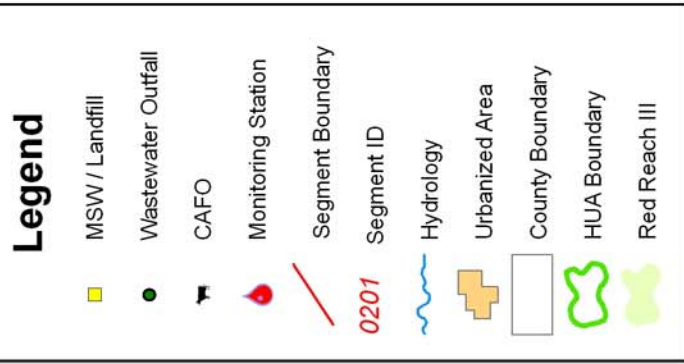
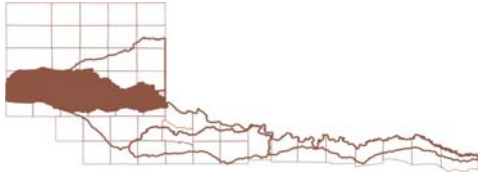


Figure 2-3



RED RIVER BASIN — REACH IV

Reach IV of the Red River Basin is one of the most captivating, scenic areas in the state. The landscape changes are surprisingly dramatic, creating beautiful sights, especially where the Caprock drops off to form the canyons. Elevations range from 1,300 to more than 4,200 feet above mean sea level. It begins in Childress County at the Texas/Oklahoma state line and continues through the Texas Panhandle to Deaf Smith and Parmer Counties at the New Mexico state line. It encompasses the Prairie Dog Town Fork of the Red River from the confluence of Buck Creek. The Caprock Escarpment intersects the center of this mostly rural reach, and contains many farms and ranches. Total population for this reach is approximately 165,000.

Rainfall is sparse ranging from 10 to 19 inches per year. More than 500 playa lakes (buffalo wallows) are located in the western part of **Reach IV**. There are only six small reservoirs in the entire reach that include: Baylor Lake and Lake Childress in Childress County, Mackenzie Reservoir on the Briscoe/Swisher County line, and Buffalo Lake, Bivins Lake and Lake Tanglewood, all located in Randall County.

The five watersheds in this reach encompass drainage areas totaling 7,626 square miles in Texas and New Mexico, of which 7,084 square miles are in Texas. **Reach IV** contains 8 permitted municipal and industrial discharges, 26 permitted solid waste disposal sites and 120 concentrated animal feeding operations. A map of this reach can be found on [page 79](#).

Agriculture plays a significant role in **Reach IV**, as it contains more than 3,900 ranches covering approximately 4,900,000 acres. These ranches produce beef cattle, while farming produces cotton, wheat, corn, sugar beets, soybeans, sorghum, and potatoes.

Located in the flood plain of the Prairie Dog Town Fork of the Red River, Estelline Salt Springs is a group of brine springs less than a mile east of Estelline at the Childress County line in east central Hall County. The springs became active in the late 1800's when they washed out a funnel in the alluvium. In 1964 the U.S. Army Corps of Engineers built a dike around the springs to stop the flow, which prevents more than 240 tons of salt from entering the river system each day.

The Upper and Lower Prairie Dog Town Forks of the Red River converge and form the main tributary of the Red River. Beginning at the junction of the Palo Duro and Tierra Blanca Creeks in central Randall County, it flows 160 miles southeastward through the Palo Duro Canyon, across southwestern Armstrong and northeastern Briscoe Counties. From there it travels eastward across the broken country of central Hall and Childress Counties to its confluence with the North Fork of the Red River, 12 miles northeast of Vernon. When the Prairie Dog Town Fork crosses the 100th meridian at the eastern line of Childress County, its south bank becomes the state boundary between Texas and Oklahoma, as well as the northern county line of Hardeman and Wilbarger Counties.

The **Lower Prairie Dog Town Fork Red River (LPDTF) (Segment 0207)** is a classified segment from a point immediately upstream of the confluence of Buck Creek in Hardeman County to a point upstream of the confluence of Salt Fork Creek in Armstrong County. It is on the *2008 303(d) List* as a 5c for **bacteria**. It is also on the *2008 TWQI for Water Bodies with Concerns for Use Attainment and Screening Levels* with a **(CS)** - concern for **chlorophyll a** and **orthophosphorus**. The Authority's analyses of the data agreed with their assessment. Trend analyses revealed an upward trend for **chlorophyll a** levels (**See Appendix C**).

Rangeland grazing, unrestricted access by cattle and agricultural runoff from fertilized fields and pastures where livestock have access to the river are probable sources for these nutrient levels. This portion of the reach is very inaccessible as few public roads cross through this area. Therefore, wildlife and livestock are able to move freely throughout the region.



Lower Prairie Dog Fork of the Red River at SH 207

Buck Creek (Segment 0207A) is an unclassified stream segment in Childress County. This perennial stream is located in a rural ranching and farming area, in which ranchers graze cattle in the pastures along the creek bank. Because of drought conditions, wildlife also utilize the natural resources of the segment.

Buck Creek is on the *2008 303(d) List* for **bacteria**. It is also on the *2008 TWQI for Water Bodies with Concerns for Use Attainment and Screening Levels* with a **(CS)** - concern for **nitrate**. The Authority's analyses of the data concurred with this assessment. A reliable trend analyses was not possible due to a lack of data points and lapses in time of sample collection. However, screening analyses conducted by the Authority revealed exceedances of **bacteria** and **nitrate** (**See Appendix B**).

The Texas State Soil and Water Conservation Board (TSSWCB), in cooperation with Texas A&M AgriLife Research, conducted an extensive monitoring project at 15 different sites on Buck Creek. The three year study, concluded in 2007, was specifically designed to ascertain the elevated **bacteria** levels that are causing the creek to be on the *303(d) List*. Findings from the study revealed that when data were analyzed as individual sites, several of the sites showed exceeding levels of **E. coli**. However, when the analysis was conducted by grouping sampling sites together by the assessment units that TCEQ utilizes, standards were not exceeded. The data collected under this study will be submitted to be included in their next assessment and will likely result in Buck Creek being removed from the *(303)d List*. Additional information on the Buck Creek study can be found at <http://twri.tamu.edu/buckcreek>. According to Texas AgriLife Research, final results of this study are pending with TCEQ and should be released soon.

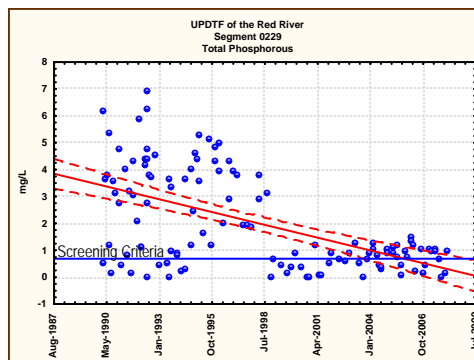
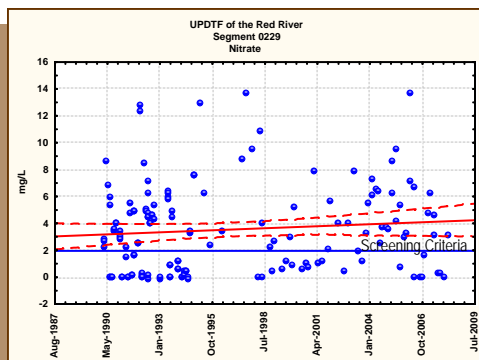
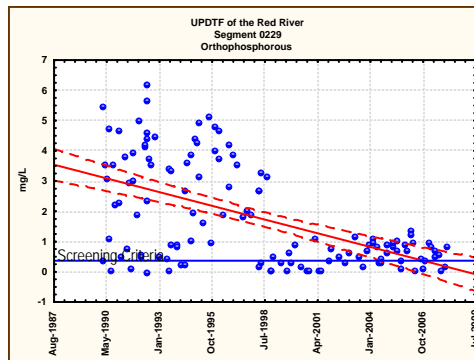
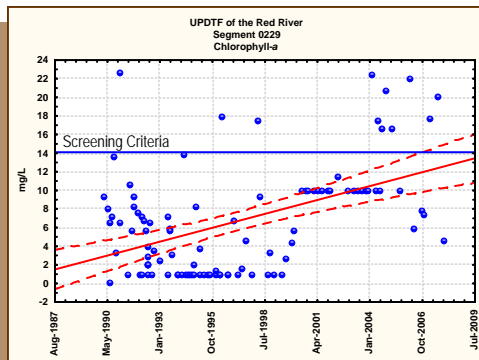
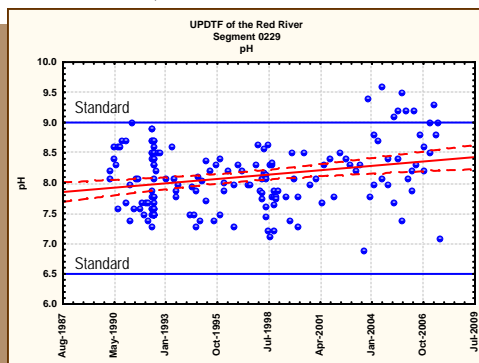
Mackenzie Reservoir (Segment 0228) is a classified segment which impounds Tule Creek. It is located near State Highway 207 in western Briscoe County and eastern Swisher County. When the water was impounded in the 1970s, its purpose was to provide water for the cities of Silverton, Tulia, Floydada, and Lockney. The TCEQ's assessment of the data found no concerns for Lake Mackenzie. Trend analyses revealed an upward trend for **chlorophyll a**, **total phosphorus** and **orthophosphorus** levels (See Appendix C). However, in all cases these trends were well below the standards for this water body. Resumed monitoring will be necessary to determine the cause for these increases.

The **Upper Prairie Dog Town Fork of the Red River (UPDTF) (Segment 0229)** is a classified stream segment. It is located from a point 110 yards upstream of the confluence of Salt Fork Creek in Armstrong County to the Lake Tanglewood Dam in Randall County. It is on the 2008 303(d) List as a 5c for **pH**. This is most likely due to non-point source waste discharge and/or industrial/municipal point source waste discharge upstream. In addition, it is on the 2008 TWQI for Water Bodies with Concerns for Use Attainment and Screening Levels with a

(CS) - concern for **chlorophyll a**, **orthophosphorus**, **total phosphorus** and **nitrate**. The Authority's analyses of the data agreed with this assessment. Trend analyses revealed an upward trend for **chlorophyll a**. This is not unusual with the presence of the existing nutrient concerns. However, a downward trend for **total phosphorus** and **orthophosphorus** were noted (See charts).

This portion of the segment is located below Lake Tanglewood, south of Amarillo. The area upstream of the lake is developing rapidly, as Amarillo grows and expands.

Run-off from fields and pastures could be one of several sources causing these nutrient concerns. Another potential nutrient source could be from damaged or failing septic systems located in the small communities in the area. This and seepage from Lake Tanglewood, combined with



runoff and animals congregating near the water could be potential sources of these problems. A special study would be necessary to resolve these issues.

Lake Tanglewood (Segment 0229A) is an unclassified water body. It extends from the Randall County Dam up to normal pool elevation south of Amarillo impounding the Prairie Dog Town Fork of the Red River.

Lake Tanglewood is on the 2008 TWQI for Water Bodies with Concerns for Use Attainment and Screening Levels with a (CS) - concern for **chlorophyll a**, **orthophosphorus**, **total phosphorus** and **nitrate**. The Authority's analyses of the data agreed with this assessment, but found that **ammonia**, **pH**, and **chloride** also exceeded screening levels (See Appendix B). Trend analyses indicated an upward trend for **ammonia** levels and downward trends for **total phosphorus**, **orthophosphorus** and **nitrate** levels (See Appendix C).



Lake Tanglewood

Lake Tanglewood is a small community that was developed before the current standards for septic systems were in place. Some of the earlier systems were most likely improperly installed or have started to fail due to age and could be the cause of the concerns. While **phosphorus** may be a limiting factor, it is generally considered a human pollutant. In aquatic environments, it can act as a fertilizer and promote undesirable algal growth. However, it is not the only factor. Elevated nutrient levels combined with the effects of septic system by-products could contribute significantly to the nutrient concerns in this reservoir, as well as downstream in the segment. As stated for the previous segment (0229), a special study would be required.



Red River Basin Reach IV



Legend

- MSW / Landfill
- Wastewater Outfall
- CAFO
- Monitoring Station
- Segment Boundary
- Segment ID
- Hydrology
- Urbanized Area
- County Boundary
- HUA Boundary
- Reach IV

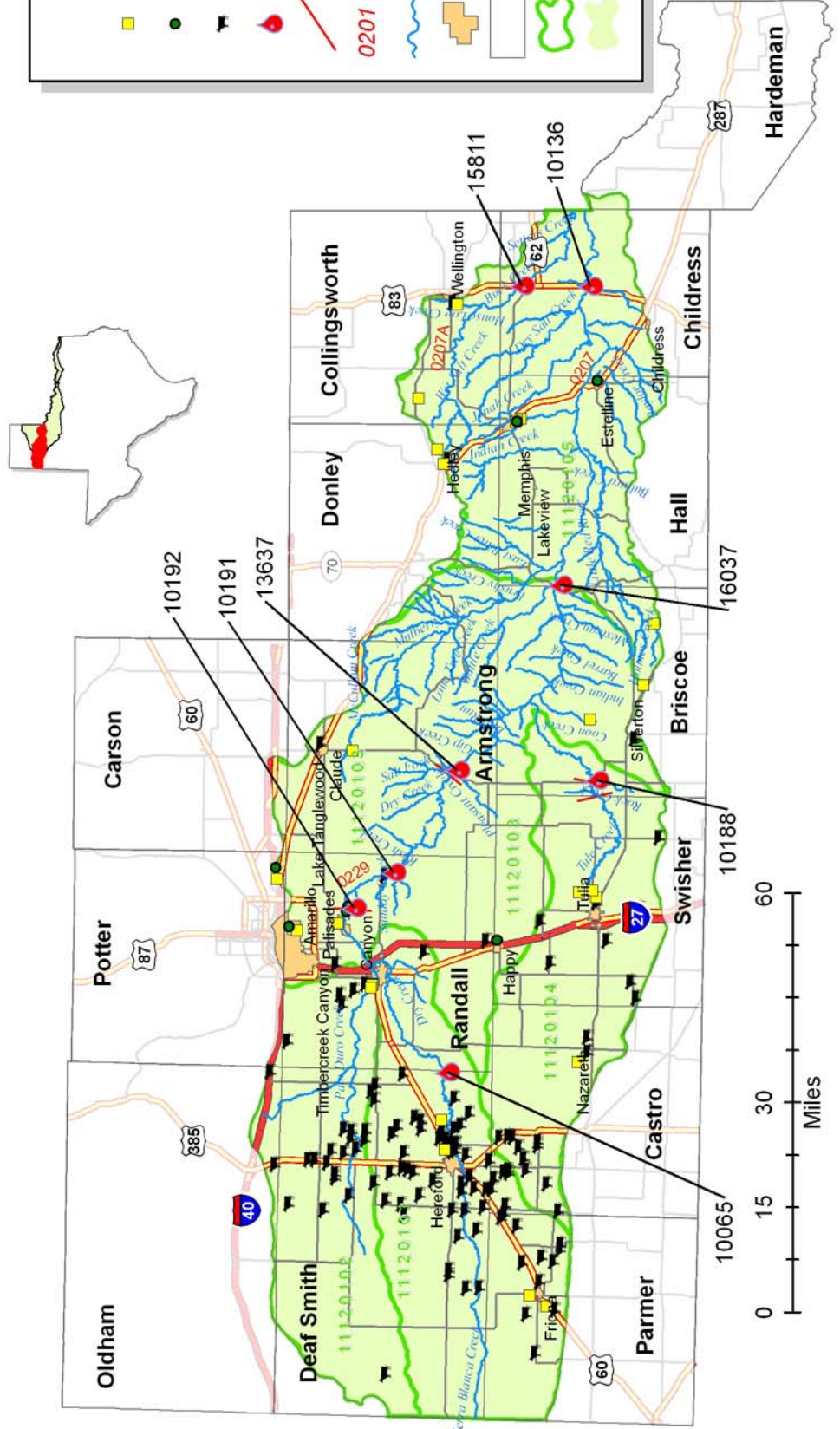
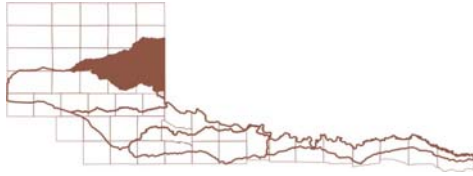


Figure 2-4



RED RIVER BASIN — REACH V

Reach V of the Red River Basin begins at the eastern edge of the Panhandle in Hemphill, Wheeler and Swisher Counties, and extends westward to Amarillo for about 100 miles. Its maximum width is about 75 miles. The reach contains the North Fork of the Red River upstream to the headwaters of M^cClellan Creek, including the headwaters of the Salt Fork of the Red River, Elm Fork of the Red River, and the Washita River. A map of **Reach V** can be found on **page 83**.

Reach V encompasses six sub-watersheds with a contributing drainage of 7,580 square miles in Texas and Oklahoma; 4,124 square miles of the drainage area is in Texas. Predominately farming and ranching are in the area with some oil and gas production. It comprises about 50 small cities below 10,000 people, which include Panhandle, Clarendon, Wheeler, and White Deer. The eastern edge of Amarillo is also located in **Reach V**. Total population in the reach is about 45,000 people. The largest reservoir in this reach is Lake Greenbelt, located in Donley County. Lake M^cClellan, a small lake, is also in this reach, which is underlain by the Ogallala Aquifer in the northern and western areas.

Ranching dominates this reach, with 2,364 ranches covering more than 3.3 million acres. The ranches primarily raise cattle, cotton, grain sorghum, wheat, corn, oats, barley, and alfalfa.

The rolling plains and broken rangeland with sandy clay, dark clay, deep loam, and sandy loam support a variety of native grasses. They also support many varieties of trees such as cottonwood, elm, mesquite, black walnut, chinaberry, willow, hackberry, and oak trees.

There are 4 permitted municipal and industrial dischargers, 18 permitted solid waste disposal sites and 27 concentrated animal feeding operations in the reach. The Pantex Plant Federal Superfund Site, SUP134, (EPA ID: TX4890110) is located in this reach, 17 miles northeast of Amarillo. The Pantex Plant opened in 1942 as a facility for the production of World War II munitions and explosives. During the following years, state and federal entities have used the facility for various purposes. It is currently under the U.S. Department of Energy/National Nuclear Security Administration for the development of high explosive compounds, nuclear weapons assembling/dismantling and interim storage of plutonium/weapon components. Historically, waste management was achieved by the burial or disposal of contaminants in unlined landfills, pits, unlined ditches and playas. These prior practices are the primary result for the release of pollutants into the environment.

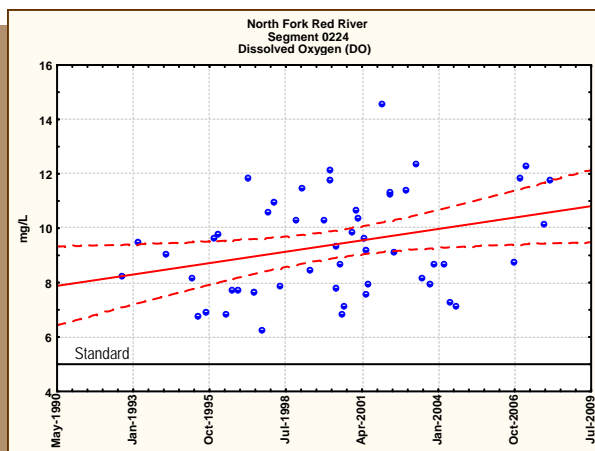
The Pantex Plant is located over the Ogallala aquifer, the main source of groundwater for the region. This groundwater is used for domestic, municipal, and agricultural uses. It is also near the Amarillo water supply well field which produces an annual average of 18 million gallons per day. For a complete overview of this site please visit the United States EPA website at: <http://www.epa.gov/earth1r6/6sf/pdf/files/0604060.pdf>.

The **Salt Fork Red River (Segment 0222)** is a classified segment that runs from the Oklahoma State Line in Collingsworth County to Greenbelt Dam in Donley County. While the TCEQ's assessment did not find any impairments or concerns, the Authority's data analyses revealed levels of *E. coli* exceeding the screening criteria (**See Appendix B for the results of the Authority's data review**). This is most likely due to the livestock and wildlife population in the area. Trend analyses revealed an downward trend for **pH** (**See Appendix C**). Screening analyses did not reveal any exceedances for ortho-phosphorus and pH, as these parameters are well below the standards for this stream.

Lelia Lake Creek (Segment 0222A) is an unclassified water body stretching from the confluence of the Salt Fork Red River north of Hedley in Donley County to the upstream perennial portion of the stream west of Hedley. The lake impounds West and East Lelia Lake Creeks and their tributaries. The TCEQ's assessment did not reveal any impairments or concerns. The Authority's analyses of the data agreed with their assessment. Trend analyses revealed a downward trend for both **dissolved oxygen** and **nitrate** levels (**See Appendix C**). The lack of normal rainfall and low flows averaging less than 3 cfs are the most likely reasons for these trends.

Greenbelt Lake (Segment 0223) is a classified water body on the Salt Fork of the Red River. It was impounded in 1966 by the Greenbelt Dam in Donley County up to the normal pool elevation of 2,664 feet. The reservoir is owned and operated by the Greenbelt Municipal and Industrial Water Authority to supply water for municipal and industrial use. The TCEQ's assessment did not reveal any impairments or concerns. However, screening analysis conducted by the Authority revealed **orthophosphorus** levels exceeding their screening criteria. (**See Appendix B**). Trend analyses revealed a downward trend for **chlorophyll a**, **nitrate**, and **ortho-phosphorus** levels and an upward trend for **total phosphorus** (**See Appendix C**). Additional monitoring will be necessary to determine the reason for these results.

North Fork Red River (Segment 0224) is a classified water body that begins in west central Gray County and flows eastward across Gray and Wheeler Counties, where it is joined by McClellan Creek. It flows through Oklahoma and joins the Red River northeast of the City of Vernon in Wilbarger County. The Authority's analyses of the data did not



North Fork Red River at US 83

find any exceedances. In addition, the TCEQ's assessment did not reveal any impairments or concerns. Trend analyses indicated an upward trend in **dissolved oxygen** levels (**see chart**). Flow in this segment has been steadily increasing over the recent years, thus causing the **dissolved oxygen** levels to rise.

McClellan Creek, part of Segment 0224, is a tributary to the North Fork Red River and has been selected by the Authority to be used as a reference site. A reference site is one that is considered typical of the area and does not generally have any serious water quality problems. However, recent data analysis by the Authority revealed some elevated bacteria levels at this site, most likely due to livestock and wildlife populations in the immediate area.

Sweetwater Creek (Segment 0299A) is an unclassified water body located from the Oklahoma State Line in Wheeler County to the upstream perennial portion of the stream northwest of Wheeler in Wheeler County. It is a tributary of North Fork Red River. It was originally on the 303(d) List in 2002 for not supporting its contact recreation use for **bacteria**, based on fecal coliform exceedances. When the TCEQ changed to ***E. coli*** as the bacteria indicator species, the creek continued to exceed standards. The Authority's analyses of the data agreed with this assessment. Analyses did not indicate any trend in bacteria levels. However, the Authority's data review did reveal ***E. coli*** exceedances (See Appendix B). There are several potential sources for the of elevated levels of bacteria. Several large CAFOs can be found in the watershed and large numbers of cattle can be found grazing on pastures and fields. In addition, birds roosting in the trees that line the creek and wildlife could be affecting the water quality. The only way to discern the actual source of the bacterial exceedances is to find out which warm-blooded animal(s) is the cause of it, since *E. coli* is found in the intestines of warm-blooded animals. It can be identified using a new technology called bacterial source tracking. This method can identify which animal or group of animals produced the bacteria that cause the greatest amount of contamination. At this point, the testing is costly and the source libraries are still incomplete. Continued monitoring on this segment is recommended and as source identification becomes more readily available, decisions can be made at that time to determine proper actions for reducing these levels.



Sweetwater Creek at State Highway 152

The 2008 303(d) has assigned this segment an overall rating of Category 5c, meaning additional data will be collected before a TMDL is scheduled by TCEQ.



Red River Basin Reach V

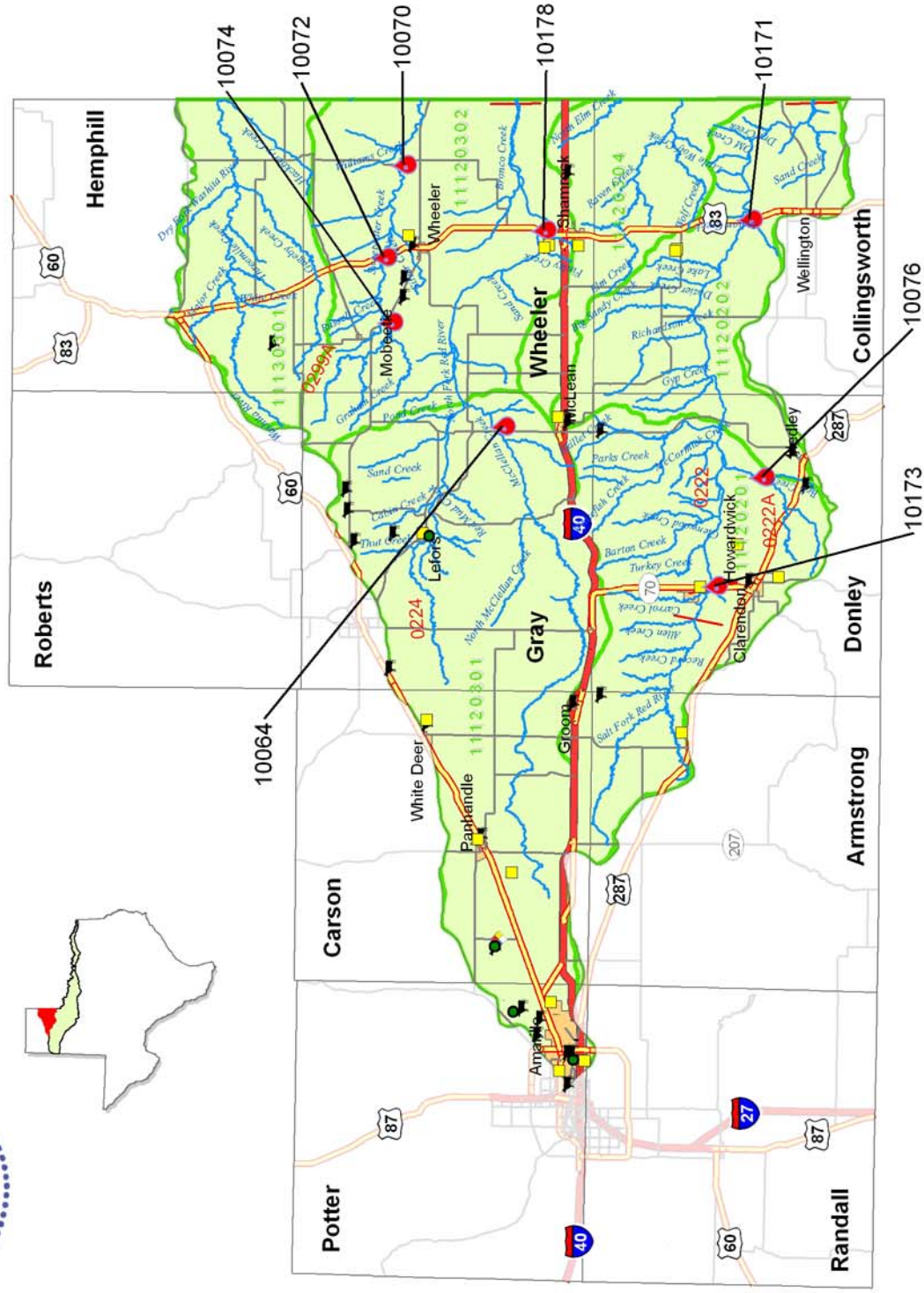
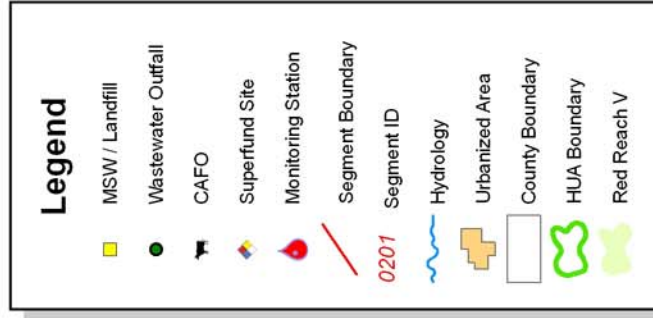
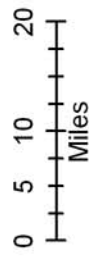


Figure 2-5

RECOMMENDATIONS AND CONCLUSIONS

4.1 — RECOMMENDATIONS

The following recommendations and conclusions are based upon the evaluations presented in this report. Comments received through public participation have also influenced these recommendations and conclusions.

- ◆ **Continue with the successful annual Coordinated Monitoring Meeting to develop strategic monitoring plans for both basins. This reduces duplication of efforts and ensures the efficient use of available financial resources and increases the number of sites to be monitored. In addition, it enables the impairments and concerns as defined in the *Texas Water Quality Inventory* to be adequately addressed, so that all segments and water quality uses can be assessed;**
- ◆ **Increase the number of monitoring partners in order for non-monitored locations to receive additional coverage, thereby increasing the amount of data available for future water quality inventories. Increased coverage will allow for more reliable data in determining the cause(s) for impairments and concerns;**
- ◆ **Support the development of an economical source of bacterial genotyping. This methodology would greatly aid in identifying bacterial sources on affected segments, which in turn would aid in the resolution of those concerns;**
- ◆ **Continue to educate the general public about water quality, conservation and protection of our natural resources;**
- ◆ **Continue to work with agriculture/ranching, industry, and municipal entities toward the improvement of water quality through effective planning strategies;**
- ◆ **Continue to encourage the USGS to submit their water quality sampling data from the Canadian River at the Texas/New Mexico state line to the TCEQ's SWQMIS database to be used in future assessments;**
- ◆ **Continue to encourage the State of Oklahoma environmental and water quality agencies to attend the Coordinated Monitoring and Basin Advisory Committee Meetings in order to further a cooperative effort in the improvement of water quality for both basins;**
- ◆ **Continue support and installation of real time monitoring coverage to allow for quicker responses to abnormal occurrences;**
- ◆ **Continue research of new and alternative conservation measures, such as brush control and implement field trials; and**
- ◆ **Continue to be the state sponsor of the Red River Chloride Control Project, pressing for the project's completion and funding so that previously unusable water sources can be utilized without excessive treatment costs.**

The following tables compile all segments in the Canadian and Red River Basins that are listed on the Texas Water Quality Inventory, their impairment or concern and the Authority's suggested recommendation and priority level. The table legend is located on **page 90**.

RECOMMENDATIONS BY BASIN REACH AND SEGMENT				2008 Texas 303(d) List			Water Bodies with Concerns for Use Attainment and Screening Levels		2008 Index of Water Quality Impairments				RRA Recommendation	RRA Priority
Reach	Seg	Description	Assessment Unit	Cat.	Param	Yr first listed	CS CN	Param of Concern	Cat.	Param	Carry forward	Yr first listed		
C I	0101	Canadian River Below Lake Meredith	0101_01 portion in Hemphill County						2				RT	M
			0101_02 portion in Rob- erts County						2				RT	M
			0101_03 portion in Hut- chinson County				CS	ammonia	2				RT	M
			0101_04 portion above Dixon Creek						2				RT	M
	0101A	Dixon Creek	0101A_01 Dixon Creek downstream of Phillips	5c	bact	2000	CN	bacteria	5c	bact	No	2000	SM	H
				5b	Low DO	2000	CS	nitrate	5b	Low DO	Yes	2000	SM	H
			0101A_02 Dixon Creek upstream of Phillips				CS	Chl - a					SM	H
	0101B	Rock Creek	0101B_01 Perennial stream from the conflu- ence with the Canadian River up to SH 136 in the City of Borger	5c	bact	2006	CS	nitrate	5c	bact	No	2006	SM	H
			0101B_02 Rock Creek above SH 136										SM	H
C II	0102	Lake Meredith	0102_01 Downstream half of lake including Big Blue Creek arm	5c	chloride	2006	CS	Hg in fish	5c	chloride	No	2006	SM	H
					Hg in wall- eye	2002				Hg in walleye	No	2002		
					sulfate	2006				sulfate	No	2006		
					TDS	2006				TDS	No	2006		
			0102_02 Upstream half of lake, above Big Blue Creek arm	5c	chloride	2006	CS	Hg in fish	5c	chloride	No	2006	SM	H
					Hg in wall- eye	2002				Hg in walleye	No	2002		
					sulfate	2006				sulfate	No	2006		
					TDS	2006				TDS	No	2006		
	0102A	Big Blue Creek	0102A_01 Entire creek						2				RT	L
	0103	Canadian River above Lake Meredith	0103_01 Lake Meredith headwaters to Sand Creek	5c	chloride	2006			5c	chloride	No	2006	SM	H
			0103_02 Sand Creek to Punta de Agua Creek		chloride	2006				chloride	No	2006	SM	H
			0103_03 Punta de Agua Creek to New Mexico State Line		chloride	2006				chloride	No	2006	SM	H
	0103A	East Amarillo Creek	0103A_01 Entire water body				CS	Chl - a	2				RT	M
							CS	nitrate						

RECOMMENDATIONS BY BASIN REACH AND SEGMENT (continued)				2008 Texas 303(d) List			Water Bodies with Concerns for Use Attainment and Screening Levels		2008 Index of Water Quality Impairments				RRA Recommendation	RRA Priority
Reach	Seg	Description	Assessment Unit	Cat.	Param	Yr first listed	CS CN	Param of Concern	Cat.	Param	Carry forward	Yr first listed		
C II	0103B	Punta De Agua Creek	0103B_01 Lower 25 miles						3				RT	L
			0103B_02 Remainder						3				RT	L
C III	0105	Rita Blanca Lake	0105_01 Entire water body	5c	pH	2004	CS	Chl - a	5c	pH	No	2004	SM	H
							CS	O-phos						
							CS	ammonia						
							CS	T-phos						
C IV	0199A	Palo Duro Res	0199A_01 Entire wtr body	5c	Low DO	2000	CS	ammonia	5c	Low DO	Yes	2000	SM	H
C V	0104	Wolf Creek	0104_01 Oklahoma State Line to Plum Creek						2				RT	M
			0104_02 Plum Creek to Lake Fryer Dam						2				RT	M
			0104_03 Lake Fryer to upstream end of segment				CS	Chl - a	2				RT	M
R I	0201	Lower Red River	0201_01 Ark SL to Ok				CS	Chl - a	2				RT	M
			0201_02 Remainder										RT	M
	0201A	Mud Creek	0201A_01 Entire water body	5c	bact Low DO	2002 2006	CS CS	Chl - a Low DO	5c	bact Low DO	No No	2002 2006	SM	H
	0202	Red River below Lake Texoma	0202_01 through _04				CS	Chl - a	2				RT	M
	0202A	Bois D' Arc Creek	0202A_01 From conf w/ RR to conf w/ Sandy Crk						3				RT	M
	0202C	Pecan Bayou	0202C_01 Entire wtr body				CS	Chl - a	2				RT	M
	0202D	Pine Creek	0202D_01 from conf w/ RR upstream to Lake Crook				CS	O-phos	2				RT	H
							CS	Chl - a						
	0202E	Post Oak Creek	0202E_01 Entire segment				CS	O-phos	2				RT	M
							CS	Chl - a						
	0202F	Choctaw Creek	0202F_01 Entire water body				CS	nitrate	3				RT	M
							CS	O-phos						
	0202G	Smith Creek	0202G_01 Entire segment	5c	bact	2006	CN	Low DO	5c	bact	No	2006	SM & SS	H
							CS	ammonia						
							CS	Low DO						
							CS	O-phos						
	0203	Lake Texoma	0203_01 Near dam				CS	Cl ⁻ FDW	2				RT	M
							CS	O-phos						
							CS	TDS FDW						
			0203_02 Little Mineral Arm				CS	Cl ⁻ FDW	2				RT	M
							CS	TDS FDW						
							CS	Chl - a						
			0203_03 Mid-lake near Big Mineral Arm				CS	TDS FDW	2				RT	M
							CS	Cl ⁻ FDW						
							CS	Cl ⁻ FDW						
			0203_04 Upper end of lake				CS	Chl - a	2				RT	M
							CS	TDS FDW						
			0203_05 Remainder				CS	Cl ⁻ FDW	2				RT	M
							CS	TDS FDW						

RECOMMENDATIONS BY BASIN REACH AND SEGMENT (continued)				2008 Texas 303(d) List			Water Bodies with Concerns for Use Attainment and Screening Levels		2008 Index of Water Quality Impairments				RRA Recommendation	RRA Priority
Reach	Seg	Description	Assessment Unit	Cat.	Param	Yr first listed	CS CN	Param of Concern	Cat.	Param	Carry forward	Yr first listed		
R I	0203A	Big Mineral Creek	0203A_01 Fr Lk Texoma to upstream of US 377				CS CS	ammonia O-phos	2				RT	L
	0203C	Mustang Creek	0203C_01 Entire segment						2				RT	L
	0203D	Deaver Creek	0203D_01 Entire segment						2				RT	L
	0204	Red River Above Lake Texoma	0204_01 Segment end to Fish Creek				CS CN	Chl - a bact	2				RT	M
			0204_02 Fish Creek to Farmers Creek						2				RT	L
			0204_03 Farmers Creek to Little Wichita River						2				RT	L
			0204_04 Little Wichita River to end of segment						2				RT	L
	0204B	Moss Lake	0204B_01 Entire lake						2				RT	L
	0208	Lake Crook	0208_01 Entire lake						2				RT	L
	0209	Pat Mayse Lake	0209_01 Lower half of lake				CS	Mn in sed	2				RT	M
			0209_02 Upper half of lake				CS	Mn in sed	2				RT	M
	0210	Farmers Creek Reservoir	0210_01 Entire segment						2				RT	M
R II	0225	McKinney Bayou	0225_01 Entire segment						2				RT	L
	0211	Little Wichita River	0211_01 Lower end of segment to East Fork con- fluence										SM	H
			0211_02 East Fork conflu- ence to dam	5b	Low DO	1996	CS	Chl - a	5b	Low DO	No	1996		
	0212	Lake Arrowhead	0212_01 Entire lake				CS CS	T-phos O-phos	2				RT	H
									2				RT	M
	0213	Lake Kickapoo	0213_01 Entire lake						2				RT	M
	0214	Wichita River Below Diversion Lake Dam	0214_01 Lower end of segment to FM 2393				CS CS CS CS	T-phos O-phos Chl - a nitrate					SM	H
				5c	bact	2006	CN CS CS CS	bacteria Chl - a nitrate O-phos T-phos	5c	bact	No	2006	SM	H
							CS	Chl - a					RT	H
			0214_02 FM 2393 to River Road WWTP											
			0214_03 From River Road WWTP to confluence with Buffalo Creek				CS	Chl - a					RT	H
			0214_05 From Beaver Creek to Diversion Dam	5c	bact	2006	CS	Chl - a	5c	bact	No	2006	SM	H
	0214A	Beaver Creek	0214A_01 From Wichita River to confluence with Bull Creek				CN	Low DO					RT	H
			0214A_02 From Bull Creek to Santa Rosa Lake dam	5c	bact	2006	CS CS	Chl - a Low DO	5c	bact	No	2006	SM	H
	0214B	Buffalo Creek	0214B_01 Entire water body						3				RT	M
	0214C	Holliday Creek	0214C_01 Entire water body						3				RT	L

RECOMMENDATIONS BY BASIN REACH AND SEGMENT (continued)				2008 Texas 303(d) List			Water Bodies with Concerns for Use Attainment and Screening Levels		2008 Index of Water Quality Impairments				RRA Recommendation	RRA Priority
Reach	Seg	Description	Assessment Unit	Cat.	Param	Yr first listed	CS CN	Param of Concern	Cat.	Param	Carry forward	Yr first listed		
R II	0215	Diversion Lake	0215_01 Entire lake						2				RT	L
	0216	Wichita River Below Lake Kemp Dam	0216_01 Entire segment						2				RT	L
	0217	Lake Kemp	0217_01 Lower half of lake						2				RT	L
			0217_02 Upper half of lake						2				RT	L
	0218	Wichita/North Fork Wichita River	0218_01 Lower end of segment to conf with South Wichita River										RT	M
			0218_02 From the conf with South Wichita River to Deadman Creek										RT	M
			0218_03 From the conf with Deadman Creek to conf with Middle Wichita River						4c	Se in water	No	2000	RT	M
			0218_04 From the conf with Mid Wichita River to Salt Creek						4c	Se in water	No	2000	RT	M
			0218_05 From Salt Creek to end of segment						4c	Se in water	Yes	2000	RT	M
	0218A	Middle Fork Wich- ita River	0218A_01 Entire segment						4c	Se in water	No	2002	RT	M
	0219	Lake Wichita	0219_01 Entire segment				CS	O-phos	3				RT	M
							CS	T-phos						
							CS	Chl - a						
	0219A	Holliday Creek above Lake Wich- ita	0219A_01 Entire water body						3				RT	L
	0226	South Fork Wich- ita River	0226_01 Lower end of segment to SH 6	5c	chloride	2006			5c	chloride	No	2006	SM	H
			0226_02 From SH 6 to confluence with Willow Creek	5c	chloride	2006	CS	ammonia	5c	chloride	No	2006	SM	H
			0226_03 From conf w Willow Cr to conf w Long Canyon Cr	5c	chloride	2006	CS	ammonia	5c	chloride	No	2006	SM	H
			0226_04 Low-water dam to 0.5 mile upstream	5c	chloride	2006			5c	chloride	No	2006	SM	H
R III	0205	Red River Below Pease River	0205_01 From lower end of segment to IH 44				CS	Chl - a	2				RT	M
			0205_02 China Creek to upstream end of seg- ment				CN	bact	2				RT	M
							CS	Chl - a						

RECOMMENDATIONS BY BASIN REACH AND SEGMENT (continued)				2008 Texas 303(d) List			Water Bodies with Concerns for Use Attainment and Screening Levels		2008 Index of Water Quality Impairments				RRA Recommendation	RRA Priority
Reach	Seg	Description	Assessment Unit	Cat.	Param	Yr first listed	CS CN	Param of Concern	Cat.	Param	Carry forward	Yr first listed		
R III	0206	Red River Above Pease River	0206_01 Downstream segment boundary to Groesbeck Creek						2				RT	L
			0206_02 Groesbeck Creek to upstream segment boundary						2				RT	L
	0206A	Groesbeck Creek	0206A_01 Entire water body						3				RT	L
	0206B	South Groesbeck Creek	0206B_01 Entire segment	5c	bact	2006	CN	bact	5c	bact	No	2006	SM	H
							CS	nitrate						
	0220	Upper Pease/ North Fork Pease River	0220_01 Lower end to Middle Pease confluence						2				RT	M
			0220_02 Middle Pease to end of segment						2				RT	M
	0221	Middle Fork Pease River	0221_01 Lower end of segment to South Pease River confluence						3				RT	M
			0221_02 Middle Pease to end of segment						3				RT	L
	0227	South Fork Pease River	0227_01 Lower end of segment to Motley County line						3				RT	L
			0227_02 Motley County line to end of segment						3				RT	L
	0230	Pease River	0230_01 Red River to confluence with Mule Creek						2				RT	M
			0230_02 County line to end of segment						2				RT	L
	0230A	Paradise Creek	0230A_03 Lower 5 miles of water body	5c	bact	2006	CS	Chl - a	5c	bact	No	2006	SM	H
							CS	nitrate						
			0230A_04 Remainder of water body				CS	Chl - a					RT	L
							CS	nitrate						
R IV	0207	Lower Prairie Dog Town Fork Red River	0207_01 Lower end of segment to US 62/83										RT	L
			0207_02 US 62/83 to Parker Creek										RT	L
			0207_03 Parker Creek to SH 70										RT	L
			0207_04 SH 70 to upstream end of segment	5c	bact	2006	CS	Chl - a	5c	bact	No	2006	SM	H
							CS	O-phos						
	0207A	Buck Creek	0207A_01 From Oklahoma state line to House Log Creek	5c	bact	2000	CS	nitrate	5c	bact	No	2000	TMDL in place	M
	0228	Mackenzie Reservoir	0228_01 Entire segment						2				RT	L

RECOMMENDATIONS BY BASIN REACH AND SEGMENT (continued)				2008 Texas 303(d) List			Water Bodies with Concerns for Use Attainment and Screening Levels		2008 Index of Water Quality Impairments				RRA Recommendation	RRA Priority
Reach	Seg	Description	Assessment Unit	Cat.	Param	Yr first listed	CS CN	Param of Concern	Cat.	Param	Carry forward	Yr first listed		
R IV	0229	Upper Prairie Dog Town Fork Red River	0229_01 Lower end of segment to Palo Duro State Park northern boundary				CS	nitrate					RT	H
							CS	O-phos						
							CS	T-phos						
			0229_02 Palo Duro Can- yon State Park upstream boundary to upper end of segment at Tanglewood Dam	5c	pH	2006	CS	T-phos	5c	pH	No	2006	SS SM	M
							CS	Chl - a						
							CS	nitrate						
	0229A	Lake Tangle wood	0229A_01 Entire lake				CS	O-phos	2				SS SM	H
							CS	Chl - a						
							CS	nitrate						
	0229B	Tierra Blanca Creek	0229B_01 Entire segment						3				RT	L
R V	0222	Salt Fork Red River	0222_01 Oklahoma State Line to Lake Creek conflu- ence						2				RT	M
			0222_02 Lake Creek to upper end of segment						2				RT	L
	0222A	Lelia Lake Creek	0222A_01 Entire water body						2				RT	M
	0223	Greenbelt Lake	0223_01 Entire segment						2				RT	L
	0224	North Fork Red River	0224_01 Oklahoma State Line to confluence with McClellan Creek						2				RT	M
			0224_02 From McClellan Creek to upper end of Segment						2				RT	L
	0299A	Sweetwater Creek	0299A_01 From Okla- homa State Line to conflu- ence with Graham Creek	5c	bact	2002			5c	bact	No	2002	SM	M

Note:	White Indicates No Category Assigned.
Category 1:	Attaining all water quality standards and no use is threatened.
Category 2:	Attaining some water quality standards and no use is threatened; and insufficient data and information are available to determine if the remaining uses are attained or threatened.
Category 3:	Insufficient data and information are available to determine if any water quality standard is attained.
Category 4:	Standard is not supported or is threatened for one or more designated uses but does not require the development of a TMDL. Category 4a - TMDL has been completed and approved by EPA. Category 4b - Other pollution control requirements are reasonably expected to result in the attainment of the water quality standard in the near future. Category 4c - Nonsupport of the water quality standard is not caused by a pollutant.
Category 5:	The water body does not meet applicable water quality standards or is threatened for one or more designated uses by one or more pollutants. Category 5a - A TMDL is underway, scheduled, or will be scheduled. Category 5b - A review of the water quality standards for this water body will be conducted before a TMDL is scheduled. Category 5c - Additional data and information will be collected before a TMDL is scheduled.

Level of Concern:

CN - Concern for near-nonattainment of the Water Quality Standards
CS - Concern for water quality based on screening levels

RRA Recommendation**RT—Routine Monitoring**

The traditional type of monitoring to delineate overall water quality which should continue for at least five years including water bodies that do not support standards or criteria or are not expected to meet the same.

SM—Systematic Monitoring

Similar to routine monitoring except lasting less than five years and/or includes water bodies listed in Categories 4a and 5c and TMDL implementation monitoring.

SS—Special Studies in Priority Watersheds

Involves a monitoring and assessment plan that is designed to answer a specific question and is not used to generally screen a water body, monitoring usually continues for at least two years.

PS—Permit Support Monitoring

The TCEQ may identify specific areas where additional information on water quality is needed for the permitting process.

RRA Priority

L — LOW - Sufficient data, routine baseline monitoring or intermittent/dry water body

M — MEDIUM - Limited data, additional monitoring for partial support or borderline exceedances

H — HIGH - Insufficient data, monitoring for non support of use or monitoring for TMDL

4.2 — CONCLUSIONS



Over the past five years, the Canadian and Red River Basins have experienced extreme weather conditions that have ranged from lingering drought conditions combined with the scorching heat of long hot summers to wildfires that have burned more square miles than the size of some small states. In addition, 100 plus year floods have threatened to submerge whole neighborhoods in some cities, while filling some lakes and ignoring others.



In spite of these extremes, the water quality in the Canadian and Red River Basins has stayed the course and remained overall fairly healthy. The primary parameters which have concerns for a use attainment and/or screening levels in both basins; are chlorophyll a, followed by bacteria then by various nutrients and then low dissolved oxygen. As the source or sources of these pollutants are discovered, action plans will be developed and implemented through the best options available.



At first glance, monitoring additional sites each year may give the impression that more sites spread throughout both basins exhibit various concerns such as bacteria, chlorophyll a and nutrients; therefore, the water quality is not as good as it has been in the past. This first impression is not quite true. By increasing the number of sites monitored we get a better overall picture of both basins which assists in the development of new strategies for improving the water quality of the past. The CRP is actually working more efficiently than ever, and the Authority, like many of its partner agencies are doing more with less every year. Even as expenses, budgets and overhead have increased, funding for

the Clean Rivers Program has remained the same, yet the Authority strives to increase the number of sites monitored each year.

The understanding of water quality problems and the dynamics of cause and effect have increased not only through advancing technology, but through first hand knowledge and experience gained by the Authority and its monitoring partners. The Red River Authority of Texas is very proud of the level of coordination, cooperation and respect that it maintains with the TCEQ, the USGS and its cooperating partners, as well as input from the Basin Advisory Committees to provide feedback that results in planning for the basins' future. This cooperation statewide has led to the development of a proficient and dependable database, which is vital in assessing, permitting, and maintaining the water quality within the Canadian and Red River Basins.

The Red River Authority of Texas hopes, as both a fee paying stakeholder and custodian of the Canadian and Red River Basins' water resources, that the Clean Rivers Program is maintained and funding sources are protected so that the original purpose of the program continues.

APPENDIX A

Segment Specific Surface Water Quality Standards and Screening Criteria

Segment ID	Description	Uses				Standards								Nutrient Screening Criteria				
		Recreation	Aquatic Life	Public Water Supply	Other	Chloride (mg/L)	Sulfate (mg/L)	TDS (mg/L)	DO (mg/L)	pH-low (SU)	pH-HI (SU)	Temp °C	E. coli (MPN) / Fecal (#/100 mL)	Ammonia (mg/L)	Nitrate (mg/L)	T Phos (mg/L)	O Phos (mg/L)	Chl a (µg/L)
0101	Canadian River Below Lake Meredith	CR	H			1,975	760	5,000	5.0	6.5	9.0	35.0	126/200	0.33	1.95	0.69	0.37	14.1
0102	Lake Meredith	CR	E	PS		400	350	1,300	6.0	6.5	9.0	29.4	126/200	0.11	0.37	0.2	0.05	26.7
0103	Canadian River Above Lake Meredith	CR	H			1,050	540	4,500	5.0	6.5	9.0	35.0	126/200	0.33	1.95	0.69	0.37	14.1
0104	Wolf Creek	CR	H			420	125	1,125	5.0	6.5	9.0	33.9	126/200	0.33	1.95	0.69	0.37	14.1
0105	Rita Blanca Lake	NCR	L		WF	200	200	1,000	3.0	6.5	9.0	29.4	126/200	0.11	0.37	0.2	0.05	26.7
0199A	Palo Duro Reservoir	CR				N/A	N/A	N/A	5.0	6.5	9.0	29.4	126/200	0.11	0.37	0.2	0.05	26.7
0201	Lower Red River	CR	H	PS		375	250	1,100	5.0	6.5	9.0	33.9	126/200	0.33	1.95	0.69	0.37	14.1
0202	Red River Below Lake Texoma	CR	H	PS		375	250	1,100	5.0	6.5	9.0	33.9	126/200	0.33	1.95	0.69	0.37	14.1
0203	Lake Texoma	CR	H	PS		600	300	1,500	5.0	6.5	9.0	33.3	126/200	0.11	0.37	0.2	0.05	26.7
0204	Red River Above Lake Texoma	CR	H			2,000	1,200	6,000	5.0	6.5	9.0	33.9	126/200	.33	1.95	0.69	0.37	14.1
0205	Red River Below Pease River	CR	H			5,000	2,000	10,000	5.0	6.5	9.0	33.9	126/200	0.33	1.95	0.69	0.37	14.1
0206	Red River Above Pease River	CR	H			12,000	4,000	25,000	5.0	6.5	9.0	33.9	126/200	0.33	1.95	0.69	0.37	14.1
0207	Lower Prairie Dog Town Fork Red River	CR	H			37,000	5,300	46,200	5.0	6.5	9.0	33.9	126/200	0.33	1.95	0.69	0.37	14.1
0208	Lake Crook	CR	H	PS		75	150	350	5.0	6.5	9.0	32.2	126/200	0.11	0.37	0.2	0.05	26.7
0209	Pat Mayse Lake	CR	H	PS		100	175	350	5.0	6.5	9.0	32.2	126/200	0.11	0.37	0.2	0.05	26.7
0210	Farmers Creek Reservoir	CR	H	PS		200	60	550	5.0	6.5	9.0	33.9	126/200	0.11	0.37	0.2	0.05	26.7
0211	Little Wichita River	CR	H	PS		250	50	500	5.0	6.5	9.0	32.8	126/200	0.33	1.95	0.69	0.37	14.1

Segment ID	Description	Uses				Standards							Nutrient Screening Criteria					
		Recreation	Aquatic Life	Public Water Supply	Other	Chloride (mg/L)	Sulfate (mg/L)	TDS (mg/L)	DO (mg/L)	pH- low (SU)	pH- HI (SU)	Temp °C	E. coli (MPN) / Fecal (#/100 mL)	Ammonia (mg/L)	Nitrate (mg/L)	T Phos (mg/L)	O Phos (mg/L)	Chl a (µg/L)
0212	Lake Arrowhead	CR	H	PS		250	50	500	5.0	6.5	9.0	33.9	126/200	0.11	0.37	0.2	0.05	26.7
0213	Lake Kickapoo	CR	H	PS		100	50	400	5.0	6.5	9.0	32.2	126/200	0.11	0.37	0.2	0.05	26.7
0214	Wichita River Below Diversion Lake	CR	H			1,800	800	5,000	5.0	6.5	9.0	32.2	126/200	0.33	1.95	0.69	0.37	14.1
0215	Diversion Lake	CR	H			1,800	1,100	5,000	5.0	6.5	9.0	32.2	126/200	0.11	0.37	0.2	0.05	26.7
0216	Wichita River Below Lake Kemp	CR	H			1,925	960	5,000	5.0	6.5	9.0	32.2	126/200	0.33	1.95	0.69	0.37	14.1
0217	Lake Kemp	CR	H			7,000	2,500	15,000	5.0	6.5	9.0	33.9	126/200	0.11	0.37	0.2	0.05	26.7
0218	North Fork Wichita River	CR	H			7,500	2,800	16,250	5.0	6.5	9.0	33.9	126/200	0.33	1.95	0.69	0.37	14.1
0219	Lake Wichita	CR	H			1,000	400	1,800	5.0	6.5	9.0	32.2	126/200	0.11	0.37	0.2	0.05	26.7
0220	North Fork Pease River	CR	H			12,000	3,500	30,000	5.0	6.5	9.0	32.8	126/200	0.33	1.95	0.69	0.37	14.1
0221	Middle Fork Pease River	CR	H			870	1,400	2,800	5.0	6.5	9.0	32.8	126/200	0.33	1.95	0.69	0.37	14.1
0222	Salt Fork Red River	CR	H	PS		400	1,400	3,000	5.0	6.5	9.0	33.9	126/200	0.33	1.95	0.69	0.37	14.1
0223	Greenbelt Lake	CR	H			250	200	750	5.0	6.5	9.0	33.9	126/200	0.11	0.37	0.2	0.05	26.7
0224	North Fork Red River	CR	H			800	1,200	2,500	5.0	6.5	9.0	32.8	126/200	0.33	1.95	0.69	0.37	14.1
0225	McKinney Bayou	CR	L	PS		60	90	400	3.0	6.0	8.5	33.9	126/200	0.33	1.95	0.69	0.37	14.1
0226	South Fork Wichita River	CR	H			12,000	3,650	31,000	5.0	6.5	9.0	33.9	126/200	0.33	1.95	0.69	0.37	14.1
0227	South Fork Pease River	CR	H	PS		270	200	1,000	5.0	6.5	9.0	32.8	126/200	0.33	1.95	0.69	0.37	14.1
0228	Mackenzie Reservoir	CR	H			50	200	500	5.0	6.5	9.0	32.2	126/200	0.11	0.37	0.2	0.05	26.7

Segment ID	Description	Uses				Standards								Nutrient Screening Criteria				
		Recreation	Aquatic Life	Public Water Supply	Other	Chloride (mg/L)	Sulfate (mg/L)	TDS (mg/L)	DO (mg/L)	pH- low (SU)	pH- Hi (SU)	Temp °C	<i>E. coli</i> (MPN) / Fecal (#/100 mL)	Ammonia (mg/L)	Nitrate (mg/L)	T Phos (mg/L)	O Phos (mg/L)	Chl <i>a</i> (µg/L)
0229	Upper Prairie Dog Town Fork Red River	CR	H			350	675	2,000	5.0	6.5	9.0	33.9	126/200	0.33	1.95	0.69	0.37	14.1
0230	Pease River	CR	I			12,000	3,500	30,000	4.0	6.5	9.0	32.8	126/200	0.33	1.95	0.69	0.37	14.1
0299A	Sweetwater Creek	CR	H			N/A	N/A	N/A	4.0	6.5	9.0	32.8	126/200	0.33	1.95	0.69	0.37	14.1

Uses		Abbreviation	Description
Recreation		mg/L	milligrams per liter
CR	Contact Recreation	TDS	Total Dissolved Solids
NCR	Noncontact Recreation	DO	Dissolved Oxygen
Aquatic Life		pH	A measure of acidic or alkaline (basic) solutions.
F	Exceptional aquatic life use	SU	Standard Units
H	High aquatic life use	T Phos	Total Phosphorus
I	Intermediate aquatic life use	O Phos	Orthophosphorus
L	Limited aquatic life use	Temp	Temperature
Public Water Supply		°C	Degrees Centigrade
PS	Public water supply	Chl <i>a</i>	Chlorophyll <i>a</i>
Other		µg/L	micrograms per liter
WF	Waterfowl habitat	MPN	Most Probable Number

APPENDIX B

APPENDIX B WATER QUALITY SCREENING RESULTS

Basin / Reach	Seg	Station(s)	Description	Date Start	Date End	Site	Assessment Unit on the TWQI or 303(d) List	TWQI, 303(d), Impairment, Carry Forward Y or N, Year First Listed	Parameter	Storet	Standard or Criteria	Exceeded Screening Criteria Yes / No	Number of Samples Screened	Number > Criteria	Percentage > Criteria
CI	0101	10032, 10034	Canadian River below Lake Meredith	01/10/00	04/14/08	Canadian River Below Lake Meredith	01 & 02	ammonia CS	Ammonia	00610	0.33	Y	57	17	29.82%
									Chl a	32211	14.10	N	67	3	4.48%
									Chloride	00940	1975	N	67	5	7.46%
									DO	00300	5.00	N	57	1	1.75%
									E. coli	31699	126394	N	55	9	16.36%
									Fecal C	31616	200400	N	26	1	3.85%
									Nitrate	00630	1.95	N	51	3	5.88%
									O Phos	00671	0.37	N	51	2	3.92%
									pH	00400	6.5 to 9.0	N	64	0	0.00%
									Sulfate	00945	760	N	67	0	0.00%
									T Phos	00665	0.69	N	64	0	0.00%
									TDS	70300	500	N	66	3	4.55%
CI	0101A	10016, 17045	Dixon Creek	12/08/99	04/14/08	Dixon Creek	01 & 02	bacteria 5c - 2000	Ammonia	00610	0.33	N	39	1	2.56%
									Chl a	32211	14.10	N	28	4	14.29%
									Chloride	00940	1975	N	39	0	0.00%
									DO	00300	5.00	N	39	0	0.00%
									E. coli	31699	126394	Y	61	4	6.56%
									Fecal C	31616	200400	Y	47	13	27.66%
									Nitrate	00630	1.95	Y	31	7	22.58%
									O Phos	00671	0.37	Y	28	4	14.29%
									Chl - a	00671	0.37	Y	40	16	40.00%
									low DO	00945	6.5 to 9.0	N	61	0	0.00%
									5b Sulfate	00945	760	N	39	2	5.13%
									T Phos	00665	0.69	N	64	0	0.00%
CI	0101B	10025, 10024	Rock Creek	12/08/99	04/21/08	Rock Creek	01 & 02	bacteria 5c No 2000	TDS	70300	5000	N	37	1	2.70%
									Ammonia	00610	0.33	N	36	7	19.44%
									Chl a	32211	14.10	Y	26	8	30.77%
									Chloride	00940	1975	N	36	0	0.00%
									DO	00300	5	N	62	3	4.84%
									E. coli	31699	126394	Y	55	16	29.09%
									Fecal C	31616	200400	N	35	8	22.86%
									Nitrate	00630	1.95	Y	37	37	100.00%
									O Phos	00671	0.37	Y	36	14	38.89%
									pH	00400	6.5 to 9.0	N	62	0	0.00%
									Sulfate	00945	760	N	36	3	8.33%
									T Phos	00665	0.69	N	27	4	14.81%
CI	0102	10037, 10036, 10050, 10038, 10045, 10044, 10043, 10051, 10052, 10046, 10039, 10040, 10041, 10047, 10048, 10049, 10042	Lake Meredith	12/07/99	05/19/08	Lake Meredith	01 & 02	chloride 5c No 2006	TDS	70300	5000	N	36	0	0.00%
									Ammonia	00610	0.33	N	38	1	2.63%
									Chl a	32211	14.10	N	39	0	0.00%
									Chloride	00940	1050	Y	177	146	82.48%
									DO	00300	5	N	36	0	0.00%
									E. coli	31699	126394	N	402	0	0.00%
									Fecal C	31616	200400	N	389	0	0.00%
									Nitrate	00630	1.95	N	106	0	0.00%
									O Phos	00671	0.05	Y	39	20	51.28%
									pH	00400	6.5 to 9.0	N	141	0	0.00%
									Sulfate	00945	760	Y	175	143	81.71%
									T Phos	00665	0.69	N	38	0	0.00%
CII	0102A	15270	Big Blue Creek	01/10/01	04/22/08	Big Blue Creek	01	Cat 2	TDS	70300	5000	Y	48	35	72.92%
									Ammonia	00610	0.11	NA	NA	NA	NA
									Chl a	32211	14.10	NA	NA	NA	NA
									Chloride	00940	400	NA	NA	NA	NA
									DO	00300	5	NA	NA	NA	NA
									E. coli	31699	126394	NA	NA	NA	NA
									Fecal C	31616	200400	NA	NA	NA	NA
									Nitrate	00630	1.95	NA	NA	NA	NA
									O Phos	00671	0.37	NA	NA	NA	NA
									pH	00400	6.5 to 9.0	NA	NA	NA	NA
									Sulfate	00945	350	NA	NA	NA	NA
									T Phos	00665	0.69	NA	NA	NA	NA
									TDS	70300	1300	NA	NA	NA	NA

APPENDIX B

Basin / Reach	Seg	Station(s)	Description	Date Start	Date End	Site	Assessment Unit on the TWQI or 303(d) List	TWQI, 303(d), Impairment, Carry Forward Y or N, Year First Listed	Parameter	Storet	Standard or Criteria	Exceeded Screening Criteria Yes / No	Number of Samples Screened	Number > Criteria	Percentage Criteria
CII	0103	10054, 10056, 16344	Canadian River above Lake Meridith	01/2400	04/29/08	Canadian River above Lake Meridith	01, 02, 03	chloride 5c 2006	Ammonia Chl a Chloride DO E. coli	00610 32211 00940 00300 31699	0.33 14.10 1050 5 126294	N N Y N N	98 77 107 119 78	0 5 56 0 8	0.00% 6.49% 52.34% 0.00% 10.26%
								chloride 5c No 2006	Fecal Nitrate O Phos pH Sulfate T Phos TDS	31616 00630 00671 00400 00945 00665 70300	2004000 1.95 0.37 6.5 to 9.0 540 0.69 4500	N N N N N N N	37 78 102 64 107 81 94	4 1 1 0 22 6 20	10.81% 1.28% 0.98% 0.00% 20.56% 7.41% 21.28%
								Chl - a CS	Ammonia Chl a Chloride DO E. coli	00610 32211 00940 00300 31699	0.33 14.10 1050 5 126294	N Y N N Y	29 28 29 51 47	4 11 0 1 13	13.79% 72.41% 24.14% 0.00% 27.66%
								nitrate CS	Fecal C Nitrate O Phos pH Sulfate T Phos TDS	00630 00671 00400 00945 00665 70300	1.95 0.37 6.5 to 9.0 540 0.69 4500	N Y N N N N N	29 29 51 29 26 29 29	2 7 0 2 2 0 12	0.00% 24.14% 0.00% 6.90% 7.69% 0.00% 70.59%
								pH 2004 Chl - a CS	Ammonia Chl a Chloride DO E. coli	00610 32211 00940 00300 31699	0.11 26.7 200 3 126294	N Y N N N	17 18 18 20 20	15 12 3 0 3	83.33% 16.67% 0.00% 15.00% 0.00%
CIII	0105	10060	Rita Blanca Lake	01/29/02	06/14/07	Rita Blanca Lake	01	low DO 5c Yes 2000	Ammonia Chl a Chloride DO E. coli	00610 32211 00940 00300 31699	0.11 26.70 420.00 5.00 126294	N Y N N N	17 19 19 16 14	6 4 0 0 0	35.29% 21.05% 0.00% 0.00% 0.00%
								ammonia CS	Fecal C Nitrate O Phos pH T Phos TDS	00630 00671 00400 00945 00665 70300	0.37 0.05 6.5 to 9.0 125.00 0.20 1125.00	N Y N Y N N	7 18 18 20 18 19	0 7 18 16 0 18	0.00% 38.89% 100.00% 80.00% 0.00% 100.00%
								pH 5c No 2004	Ammonia Chl a Chloride DO E. coli	00610 32211 00940 00300 31699	1000 0.11 26.70 420.00 5.00	N Y Y N N	16 17 19 19 14	3 6 4 0 0	18.75% 35.29% 21.05% 0.00% 0.00%
								ammonia CS	Fecal C Nitrate O Phos pH Sulfate T Phos TDS	00630 00671 00400 00945 00665 70300	0.37 0.05 6.5 to 9.0 125.00 0.20 1125.00	N Y N N Y N	19 19 19 19 19 50	0 3 0 6 0 0	15.79% 84.21% 0.00% 31.58% 0.00% 0.00%
								Chl - a CS	Ammonia Chl a Chloride DO E. coli	00610 32211 00940 00300 31699	0.33 14.10 420.00 5.00 126294	N N N N N	50 43 50 63 62	0 2 3 5 5	0.00% 4.85% 6.00% 4.76% 8.06%
CIV	0199A	10005, 10006	Palo Duro Reservoir	02/23/00	01/09/08	Palo Duro Reservoir	01	ammonia CS	Fecal C Nitrate O Phos pH Sulfate T Phos TDS	00630 00671 00400 00945 00665 70300	0.37 0.05 6.5 to 9.0 125.00 0.20 1125.00	N Y N N Y N	7 19 19 19 19 50	0 3 0 6 0 0	0.00% 15.79% 84.21% 0.00% 0.00% 0.00%
								Chl - a CS	Ammonia Chl a Chloride DO E. coli	00610 32211 00940 00300 31699	0.33 14.10 420.00 5.00 126294	N N N N N	50 43 50 63 62	0 2 3 5 5	0.00% 4.85% 6.00% 4.76% 8.06%
								bacteria MEETS 5c	Fecal C Nitrate O Phos pH Sulfate T Phos TDS	00630 00671 00400 00945 00665 70300	0.37 0.05 6.5 to 9.0 125.00 0.69 4500	N N N N N N N	23 50 64 50 42 50 50	2 0 2 0 0 0 0	8.70% 2.00% 0.00% 4.00% 0.00% 0.00% 0.00%
								Chl - a CS	Ammonia Chl a Chloride DO E. coli	00610 32211 00940 00300 31699	0.33 14.10 420.00 5.00 126294	N N N N N	50 43 50 63 62	0 2 3 5 5	0.00% 4.85% 6.00% 4.76% 8.06%
								ammonia CS	Fecal C Nitrate O Phos pH Sulfate T Phos TDS	00630 00671 00400 00945 00665 70300	0.37 0.05 6.5 to 9.0 125.00 0.20 1125.00	N Y N N Y N	7 19 19 19 19 50	0 3 0 6 0 0	0.00% 15.79% 84.21% 0.00% 31.58% 0.00%
CV	0104	10059, 10058	Wolf Creek OK- St. Line to Lake Fryer	12/07/99	04/14/08	Wolf Creek	01 & 02	ammonia CS	Fecal C Nitrate O Phos pH Sulfate T Phos TDS	00630 00671 00400 00945 00665 70300	0.37 0.05 6.5 to 9.0 125.00 0.20 1125.00	N Y N N Y N	7 19 19 19 19 50	0 3 0 6 0 0	0.00% 15.79% 84.21% 0.00% 31.58% 0.00%
								Chl - a CS	Ammonia Chl a Chloride DO E. coli	00610 32211 00940 00300 31699	0.33 14.10 420.00 5.00 126294	N N N N N	50 43 50 63 62	0 2 3 5 5	0.00% 4.85% 6.00% 4.76% 8.06%
								bacteria MEETS 5c	Fecal C Nitrate O Phos pH Sulfate T Phos TDS	00630 00671 00400 00945 00665 70300	0.37 0.05 6.5 to 9.0 125.00 0.69 4500	N N N N N N N	23 50 64 50 42 50 50	2 0 2 0 0 0 0	8.70% 2.00% 0.00% 4.00% 0.00% 0.00% 0.00%
								Chl - a CS	Ammonia Chl a Chloride DO E. coli	00610 32211 00940 00300 31699	0.33 14.10 420.00 5.00 126294	N N N N N	50 43 50 63 62	0 2 3 5 5	0.00% 4.85% 6.00% 4.76% 8.06%
								ammonia CS	Fecal C Nitrate O Phos pH Sulfate T Phos TDS	00630 00671 00400 00945 00665 70300	0.37 0.05 6.5 to 9.0 125.00 0.20 1125.00	N Y N N Y N	7 19 19 19 19 50	0 3 0 6 0 0	0.00% 15.79% 84.21% 0.00% 31.58% 0.00%

APPENDIX B WATER QUALITY SCREENING RESULTS

Basin / Reach	Seg	Station(s)	Description	Date Start	Date End	Site	Assessment Unit on the TWQI or 303(d) List	TWQI, 303(d), Impairment, Carry Forward Y or N, Year First Listed	Parameter	Storet	Standard or Criteria	Exceeded Screening Criteria Yes / No	Number of Samples Screened	Number > Criteria	Percentage > Criteria
RI	0201	10123	Lower Red River	01/26/00	05/22/08	Lower Red River	01	CS	Ammonia	00610	0.33	N	30	1	3.33%
									Chl a	32211	14.10	Y	22	8	36.36%
									Chloride	00940	375.00	N	30	0	0.00%
									DO	00300	5.00	N	29	0	0.00%
									E. coli	31699	126/394	N	24	0	0.00%
									Fecal C	31616	20/400	NA	NA	NA	NA
									Nitrate	00630	1.95	NA	NA	NA	NA
									O Phos	00671	0.37	NA	NA	NA	NA
									pH	00400	6.5 to 9.0	N	30	0	0.00%
									Sulfate	00945	250.00	N	30	1	3.33%
RI	0201A	15319	Mud Creek	01/25/00	08/23/07	Mud Creek	01	CS	T Phos	00665	0.69	N	29	0	0.00%
									TDS	70300	1100.00	N	30	1	3.33%
									Ammonia	00610	0.33	Y	19	4	21.05%
									Chl a	32211	14.10	Y	16	8	50.00%
									Chloride	00940	375.00	N	19	0	0.00%
									DO	00300	5.00	Y	27	15	55.56%
									E. coli	31699	126/394	Y	44	13	29.55%
									Fecal C	31616	20/400	Y	15	5	33.33%
									Nitrate	00630	1.95	N	19	0	0.00%
									O Phos	00671	0.37	N	19	4	21.05%
RI	0202	10125, 10126, 15779, 10127	Red River below Lake Texoma	12/21/99	12/10/07	Red River Below Lake Texoma	01, 02, 03, 04, 05	CS	Sulfate	00945	250.00	N	27	1	3.70%
									Sulfate	00945	250.00	N	19	0	0.00%
									T Phos	00665	0.69	Y	16	4	25.00%
									TDS	70300	1100.00	N	19	0	0.00%
									Ammonia	00610	0.33	N	112	0	0.00%
									Chl a	32211	14.10	Y	100	42	42.00%
									Chloride	00940	375	N	112	10	8.93%
									DO	00300	5.00	N	135	0	0.00%
									E. coli	31699	126/394	N	110	10	9.09%
									Fecal C	31616	20/400	N	57	5	8.77%
RI	0202A	15318	Bois D Arc Creek	11/29/00	07/16/07	Bois D Arc Creek	01	CS	Nitrate	00630	1.95	N	111	0	0.00%
									O Phos	00671	0.37	N	112	1	0.89%
									pH	00400	6.5 to 9.0	N	136	0	0.00%
									Sulfate	00945	250	N	112	23	20.54%
									T Phos	00665	0.69	N	103	1	0.97%
									TDS	70300	1100	N	112	10	8.93%
									Ammonia	00610	0.33	N	12	0	0.00%
									Chl a	32211	14.10	NA	NA	NA	NA
									Chloride	00940	375	N	12	0	0.00%
									DO	00300	5	N	19	0	0.00%
RI	0202C	16001	Pecan Bayou	09/26/00	12/11/07	Pecan Bayou	01	CS	E. coli	31699	126/394	NA	NA	NA	NA
									Fecal C	31616	20/400	N	10	1	10.00%
									Nitrate	00630	1.95	N	12	0	0.00%
									O Phos	00671	0.37	N	12	0	0.00%
									pH	00400	6.5 to 9.0	N	19	0	0.00%
									Sulfate	00945	250.00	N	12	0	0.00%
									T Phos	00665	0.69	NA	NA	NA	NA
									TDS	70300	1100.00	N	12	0	0.00%
									Ammonia	00610	0.33	N	26	2	7.69%
									Chl a	32211	14.10	Y	22	6	27.27%

APPENDIX B WATER QUALITY SCREENING RESULTS

Basin / Reach	Seg	Station(s)	Description	Date Start	Date End	Site	Assessment Unit on the TWQI or 303(d) List	Parameter	Storet	Standard or Criteria	Exceeded Screening Criteria Yes / No	Number of Samples Screened	Number > Criteria	Percentage > Criteria
RI	0202D	10120, 10118	Pine Creek	12/21/99	12/11/07	Pine Creek	01	Ammonia	00610	0.33	N	35	6	17.14%
								Chl a	32211	14.10	Y	23	8	34.78%
								Chloride	00940	375.00	N	35	1	2.86%
								DO	00300	5.00	Y	65	22	33.85%
								E. coli	31699	126/394	N	32	8	25.00%
								Fecal C	31616	200/400	N	44	7	15.91%
								Nitrate	00630	1.95	N	33	2	6.06%
								O Phos	00671	0.37	Y	35	12	34.29%
								pH	00400	6.5 to 9.0	N	65	0	0.00%
								Sulfate	00945	250.00	N	35	5	14.29%
								T Phos	00665	0.69	N	24	1	4.17%
								TDS	70300	1100.00	N	35	0	0.00%
								Ammonia	00610	0.33	N	32	0	0.00%
								Chl a	32211	14.10	N	23	5	21.74%
RI	0202E	17599, 10115	Post Oak Creek	12/21/99	12/10/07	Post Oak Creek	01	Chloride	00940	375.00	N	31	0	0.00%
								DO	00300	5.00	N	72	5	6.94%
								E. coli	31699	126/394	Y	59	13	22.03%
								Fecal C	31616	200/400	N	11	3	27.27%
								Nitrate	00630	1.95	Y	19	14	73.68%
								O Phos	00671	0.37	Y	17	15	88.24%
								pH	00400	6.5 to 9.0	N	72	0	0.00%
								Sulfate	00945	250.00	N	17	5	29.41%
								T Phos	00665	0.69	Y	17	13	76.47%
								TDS	70300	1100.00	N	17	6	35.29%
								Ammonia	00610	0.33	Y	28	13	46.43%
								Chl a	32211	14.10	N	24	1	4.17%
								Chloride	00940	375.00	N	28	0	0.00%
								DO	00300	5.00	Y	44	29	65.91%
RI	0202G	17044	Smith Creek	09/26/00	12/11/07	Smith Creek	01	E. coli	31699	126/394	Y	32	25	78.13%
								Fecal C	31616	200/400	Y	27	19	70.37%
								Nitrate	00630	1.95	N	28	0	0.00%
								O Phos	00671	0.37	Y	28	22	78.57%
								pH	00400	6.5 to 9.0	N	44	0	0.00%
								Sulfate	00945	250.00	N	28	10	35.71%
								T Phos	00665	0.69	Y	24	15	62.50%
								TDS	70300	1100.00	N	28	2	7.14%
								Ammonia	00610	0.11	N	100	8	8.00%
								Chl a	32211	26.70	Y	100	19	19.00%
								Chloride	00940	600.00	N	100	0	0.00%
								DO	00300	5.00	N	102	3	2.94%
								E. coli	31699	126/394	N	102	3	2.94%
								Fecal C	31616	200/400	N	32	0	0.00%
RI	0203	10130, 10131, 15440, 17460, 18369	Lake Texoma	11/27/01	12/18/07	Lake Texoma	01, 02, 03, 04, 05	Nitrate	00630	0.37	N	100	8	8.00%
								O Phos	00671	0.05	Y	100	30	30.00%
								pH	00400	6.5 to 9.0	N	102	0	0.00%
								Sulfate	00945	300.00	N	100	13	13.00%
								T Phos	00665	0.20	N	100	4	4.00%
								TDS	70300	1500.00	N	100	1	1.00%
								chloride in finished drinking water CS entire lake						
								Ophos CS near dam						
								TDS in finished drinking water CS entire lake						
								Chl-a CS upper end of lake						

APPENDIX B WATER QUALITY SCREENING RESULTS

Basin / Reach	Seg	Station(s)	Description	Date Start	Date End	Site	Assessment Unit on the TWQI or 303(d) List	TWQI, 303(d), Impairment, Carry Forward Y or N, Year First Listed	Parameter	Storet	Standard or Criteria	Exceeded Screening Criteria Yes / No	Number of Samples Screened	Number > Criteria	Percentage > Criteria
RI	0203A	15320, 15750, 17502, 17505, 17589	Big Mineral Creek	09/28/00	07/19/06	Big Mineral Creek	01	CS	Ammonia	00610	0.33	NA	NA	NA	NA
									Chl a	32211	14.10	NA	NA	NA	NA
									Chloride	00940	600.00	NA	NA	NA	NA
									DO	00300	5.00	0	16	0	0.00%
									E.coli	31699	126594	N	167	8	4.79%
									Fecal C	31616	200400	Y	15	5	33.33%
									Nitrate	00630	1.95	NA	NA	NA	NA
									O Phos	00671	0.37	NA	NA	NA	NA
									pH	00400	6.5 to 9.0	N	16	0	0.00%
									Sulfate	00945	300.00	NA	NA	NA	NA
									T Phos	00665	0.69	NA	NA	NA	NA
									TDS	70300	1500.00	NA	NA	NA	NA
RI	0204	10132, 10133	Red River above Lake Texoma-whole segment	12/13/99	04/09/08	Red River above Lake Texoma	01	CS	Ammonia	00610	0.33	N	22	0	0.00%
									Chl a	32211	14.10	Y	16	12	75.00%
									Chloride	00940	2000.00	N	15	1	6.67%
									DO	00300	5.00	N	41	1	2.44%
									E.coli	31699	126594	N	18	1	5.56%
									Fecal C	31616	200400	N	2	2	12.50%
									Nitrate	00630	1.95	N	16	0	0.00%
									O Phos	00671	0.37	N	23	1	4.35%
									pH	00400	6.5 to 9.0	N	40	0	0.00%
									Sulfate	00945	1200.00	N	15	0	0.00%
									T Phos	00665	0.69	N	23	2	8.70%
									TDS	70300	6000.00	N	16	0	0.00%
RI	0204B	15447	Moss Lake	11/30/99	04/01/08	Moss Lake	01	Cat 2	Ammonia	00610	0.11	N	25	0	0.00%
									Chl a	32211	26.70	N	28	0	0.00%
									Chloride	00940	2000.00	N	29	0	0.00%
									DO	00300	5.00	N	25	0	0.00%
									E.coli	31699	126594	N	20	0	0.00%
									Fecal C	31616	200400	N	9	0	0.00%
									Nitrate	00630	0.37	N	26	0	0.00%
									O Phos	00671	0.05	Y	28	14	50.00%
									pH	00400	6.5 to 9.0	N	25	0	0.00%
									Sulfate	00945	1200.00	N	29	0	0.00%
									T Phos	00665	0.20	N	26	0	0.00%
									TDS	70300	6000.00	N	54	0	0.00%
RI	0209	16342, 16343	Pat Mayse Lake	01/06/00	05/22/08	Pat Mayse Lake	01 & 02	Manganese in Sediment CS	Ammonia	00610	0.11	N	64	4	6.25%
									Chl a	32211	26.70	Y	66	14	21.21%
									Chloride	00940	100.00	N	66	0	0.00%
									DO	00300	5.00	N	57	0	0.00%
									E.coli	31699	126594	N	42	2	4.76%
									Fecal C	31616	200400	N	11	0	0.00%
									Nitrate	00630	0.37	N	66	0	0.00%
									O Phos	00671	0.05	Y	66	44	66.67%
									pH	00400	6.5 to 9.0	N	57	2	3.51%
									Sulfate	00945	175.00	N	66	0	0.00%
									T Phos	00665	0.20	N	64	0	0.00%
									TDS	70300	350.00	N	66	0	0.00%
RI	0210	10139	Farmers Creek Reservoir	12/01/99	12/11/07	Farmers Creek Reservoir	01	Cat 2	Ammonia	00610	0.11	N	34	0	0.00%
									Chl a	32211	26.70	N	34	0	0.00%
									Chloride	00940	200.00	N	34	6	17.65%
									DO	00300	5.00	N	16	0	0.00%
									E.coli	31699	126594	N	22	0	0.00%
									Fecal C	31616	200400	N	16	0	0.00%
									Nitrate	00630	0.37	N	34	0	0.00%
									O Phos	00671	0.05	Y	32	20	62.50%
									pH	00400	6.5 to 9.0	N	16	0	0.00%
									Sulfate	00945	60.00	N	34	0	0.00%
									T Phos	00665	0.20	N	34	0	0.00%
									TDS	70300	550.00	N	34	4	11.76%
RII	0211	10141, 13633, 17479	Little Wichita River	09/19/00	01/07/08	Wichita River	02	CS	Ammonia	00610	0.33	N	39	1	2.56%
									Chl a	32211	14.10	Y	35	15	42.86%
									Chloride	00940	250.00	N	40	2	5.00%
									DO	00300	5.00	Y	42	14	33.33%
									E.coli	31699	126594	N	35	7	20.00%
									Fecal C	31616	200400	Y	16	5	31.25%
									Nitrate	00630	1.95	N	40	0	0.00%
									O Phos	00671	0.37	N	39	3	7.69%
									pH	00400	6.5 to 9.0	N	42	0	0.00%
									Sulfate	00945	50.00	N	41	3	7.32%
									T Phos	00665	0.69	N	40	0	0.00%
									TDS	70300	500.00	N	41	5	12.20%

APPENDIX B

Basin / Reach	Seg	Station(s)	Description	Date Start	Date End	Site	Assessment Unit on the TWQI or 303(d) List	TWQI, 303(d), Carry Forward Y or N, Year First Listed	Parameter	Storet	Standard or Criteria	Exceeded Screening Criteria Yes / No	Number of Samples Screened	Number > Criteria	Percentage Criteria
R11	0212	10142, 20181, 20190, 20191, 20203, 20204, 20205	Lake Arrowhead	05/11/00	12/12/07	Lake Arrowhead	01	Tphos CS	Ammonia	00610	0.11	N	78	1	1.28%
									Chl a	32211	26.70	N	17	0	0.00%
									Chloride	00940	250.00	N	17	0	0.00%
									DO	00300	5.00	N	22	0	0.00%
									E. coli	31699	126394	N	10	0	0.00%
									Fecal C	31616	200400	N	8	0	0.00%
									Nitrate	00630	0.37	N	17	1	5.88%
									O Phos	00671	0.05	Y	79	76	96.20%
									pH	00400	6.5 to 9.0	N	22	0	0.00%
									Sulfate	00945	50.00	N	17	0	0.00%
R11	0213	10143	Lake Kickapoo	Ins Data	Ins Data	Lake Kickapoo	01	Cat 2	T Phos	00665	0.20	Y	78	13	16.67%
									TDS	70300	500.00	N	17	1	5.88%
									Ammonia	00610	0.11	NA	NA	NA	NA
									Chl a	32211	26.70	NA	NA	NA	NA
									Chloride	00940	100.00	NA	NA	NA	NA
									DO	00300	5.00	NA	NA	NA	NA
									E. coli	31699	126394	NA	NA	NA	NA
									Fecal C	31616	200400	NA	NA	NA	NA
									Nitrate	00630	0.37	NA	NA	NA	NA
									O Phos	00671	0.05	NA	NA	NA	NA
R11	0214	10155, 10156	Wichita River below Lake Diversion Dam	01/19/00	03/12/08	Wichita River below Lake Diversion Dam	01, 02, 03 & 05	bacteria 5c 2006	pH	00400	6.5 to 9.0	NA	NA	NA	NA
									Sulfate	00945	50.00	NA	NA	NA	NA
									T Phos	00665	0.20	NA	NA	NA	NA
									TDS	70300	400.00	NA	NA	NA	NA
									Ammonia	00610	0.33	N	177	11	6.21%
									Chl a	32211	14.10	89	147	60.54%	
									Chloride	00940	1800.00	N	183	18	9.84%
									DO	00300	5.00	N	250	7	2.80%
									E. coli	31699	126394	N	220	43	19.55%
									Fecal C	31616	200400	N	113	21	18.58%
R11	0214A	15120, 15121	Beaver Creek-ALL	01/19/00	01/08/08	Beaver Creek	01 & 02	low DO	Chl a	32211	14.10	Y	39	3	4.84%
									Chloride	00940	1800.00	N	62	5	8.06%
									DO	00300	5.00	N	93	15	16.13%
									E. coli	31699	126394	Y	88	21	23.86%
									Fecal C	31616	200400	N	37	4	10.81%
									Nitrate	00630	1.95	N	62	1	1.61%
									O Phos	00671	0.37	N	60	2	3.33%
									pH	00400	6.5 to 9.0	N	93	1	1.08%
									Sulfate	00945	800.00	N	63	0	0.00%
									T Phos	00665	0.69	N	49	0	0.00%
R11	0214B	10097	Buffalo Creek	09/06/06	01/08/08	Buffalo Creek	01	Cat 3	TDS	70300	5000.00	N	62	1	1.61%
									Ammonia	00610	0.33	NA	NA	NA	NA
									Chl a	32211	14.10	NA	NA	NA	NA
									Chloride	00940	1800.00	NA	NA	NA	NA
									DO	00300	5.00	N	14	0	0.00%
									E. coli	31699	126394	Y	14	1	7.14%
									Fecal C	31616	200400	NA	NA	NA	NA
									Nitrate	00630	1.95	NA	NA	NA	NA
									O Phos	00671	0.37	NA	NA	NA	NA
									pH	00400	6.5 to 9.0	N	14	0	0.00%
Sulfate	00945	800.00	NA	NA	NA	NA									
T Phos	00665	0.69	NA	NA	NA	NA									
TDS	70300	5000.00	NA	NA	NA	NA									

APPENDIX B WATER QUALITY SCREENING RESULTS

Basin / Reach	Seg	Station(s)	Description	Date Start	Date End	Site	Assessment Unit on the TWQI or 303(d) List	TWQI, 303(d), Impairment, Carry Forward Y or N, Year First Listed	Parameter	Storet	Standard or Criteria	Exceeded Screening Criteria Yes / No	Number of Samples Screened	Number > Criteria	Percentage > Criteria
RII	0215	10157	Diversion Lake	06/30/99	12/12/07	Diversion Lake	01	Cat 3	Ammonia	00610	0.11	N	19	1	5.26%
									Chl a	32211	26.70	N	19	0	0.00%
									Chloride	00940	1800.00	N	19	0	0.00%
									DO	00300	5.00	N	17	0	0.00%
									E. coli	31699	126394	N	10	0	0.00%
									Fecal C	31616	200400	N	9	0	0.00%
									Nitrate	00630	0.37	N	19	0	0.00%
									O Phos	00671	0.05	Y	19	12	63.16%
									pH	00400	6.5 to 9.0	N	17	0	0.00%
									Sulfate	00945	1100.00	N	18	0	0.00%
									T Phos	00665	0.20	N	19	0	0.00%
									TDS	70300	5000.00	N	19	0	0.00%
									Ammonia	00610	0.33	N	59	3	5.08%
RII	0216	10158	Wichita River below Lake Kemp	12/02/99	09/28/04	Wichita River below Lake Kemp	01	Cat 2	Chl a	32211	14.10	NA	NA	NA	NA
									Chloride	00940	1925.00	N	64	0	0.00%
									DO	00300	5.00	N	64	0	0.00%
									E. coli	31699	126394	NA	NA	NA	NA
									Fecal C	31616	200400	NA	NA	NA	NA
									Nitrate	00630	1.95	NA	NA	NA	NA
									O Phos	00671	0.37	N	64	0	0.00%
									pH	00400	6.5 to 9.0	N	64	0	0.00%
									Sulfate	00945	980.00	N	64	1	1.56%
									T Phos	00665	0.69	N	58	0	0.00%
									TDS	70300	5000.00	N	36	0	0.00%
									Ammonia	00610	0.11	N	34	2	5.88%
									Chl a	32211	26.70	N	34	0	0.00%
RII	0217	10159, 10160	Lake Kemp	05/10/00	12/12/07	Lake Kemp	01 & 02	Cat 2	Chloride	00940	7000.00	N	34	0	0.00%
									DO	00300	5.00	N	30	0	0.00%
									E. coli	31699	126394	N	19	0	0.00%
									Fecal C	31616	200400	N	15	0	0.00%
									Nitrate	00630	0.37	N	34	0	0.00%
									O Phos	00671	0.05	Y	34	18	52.94%
									pH	00400	6.5 to 9.0	N	30	0	0.00%
									Sulfate	00945	2500.00	N	34	0	0.00%
									T Phos	00665	0.20	N	34	0	0.00%
									TDS	70300	15000.00	N	34	0	0.00%
									Ammonia	00610	0.33	N	184	6	3.26%
									Chl a	32211	14.10	N	24	2	8.33%
									Chloride	00940	7500.00	N	200	36	18.00%
RII	0218	10161, 15177, 10162, 15119	Wichita River North Fork	12/21/99	12/05/06	Wichita / North Fork Wichita River	01, 02, 03, 04, 05	Se in water 4c No & Yes 2000	DO	00300	5.00	N	204	0	0.00%
									E. coli	31699	126394	N	16	1	6.25%
									Fecal C	31616	200400	N	18	2	11.11%
									Nitrate	00630	1.95	N	25	0	0.00%
									O Phos	00671	0.37	N	197	4	2.03%
									pH	00400	6.5 to 9.0	N	205	0	0.00%
									Sulfate	00945	2800.00	N	200	19	9.50%
									T Phos	00665	0.69	N	117	12	6.82%
									TDS	70300	16250.00	N	176	24	20.51%
									Ammonia	00610	0.33	N	58	1	1.72%
									Chl a	32211	14.10	NA	NA	NA	NA
									Chloride	00940	7500.00	N	60	0	0.00%
									DO	00300	5.00	N	60	0	0.00%
RII	0219A	14900	Middle Fork Wichita River	10/26/93	09/13/04	Middle Fork Wichita River	01	Se in water 4c No 2002	E. coli	31699	126394	NA	NA	NA	NA
									Fecal C	31616	200400	NA	NA	NA	NA
									Nitrate	00630	1.95	NA	NA	NA	NA
									O Phos	00671	0.37	N	58	0	0.00%
									pH	00400	6.5 to 9.0	N	60	0	0.00%
									Sulfate	00945	2800.00	N	60	0	0.00%
									T Phos	00665	0.69	N	54	0	0.00%
									TDS	70300	16250	N	33	0	0.00%
									Ammonia	00610	0.33	N	58	1	1.72%
									Chl a	32211	14.10	NA	NA	NA	NA
									Chloride	00940	7500.00	N	60	0	0.00%
									DO	00300	5.00	N	60	0	0.00%
									E. coli	31699	126394	NA	NA	NA	NA
									Fecal C	31616	200400	NA	NA	NA	NA

APPENDIX B WATER QUALITY SCREENING RESULTS

Basin / Reach	Seg	Station(s)	Description	Date Start	Date End	Site	Assessment Unit on the TWQI or 303(d) List	<div>TWQI, 303(d), Impairment, Carry Forward Y or N, Year First Listed</div>	Parameter	Storet	Standard or Criteria	Exceeded Screening Criteria Yes / No	Number of Samples Screened	Number > Criteria	Percentage > Criteria
R II	0219	10163	Lake Wichita	01/07/02	07/12/07	Lake Wichita	01	CS	Ammonia	00610	0.11	N	11	1	9.09%
									Chl a	32211	26.70	Y	11	11	100.00%
									Chloride	00940	1000.00	N	11	1	9.09%
									DO	00300	5.00	N	10	1	10.00%
									E.coli	31699	126594	NA	NA	NA	NA
									Fecal C	31616	200400	NA	NA	NA	NA
									Nitrate	00630	0.37	N	15	0	0.00%
									O Phos	00671	0.05	Y	11	10	90.91%
									pH	00400	6.5 to 9.0	N	10	1	10.00%
									Sulfate	00945	400.00	N	11	1	9.09%
R II	0226	13635, 13636	South Fork Wichita River	01/03/00	09/09/04	South Fork Wichita River	01, 02, 03 & 04	CS	T Phos	00665	0.20	Y	11	4	36.36%
									TDS	70300	1800.00	NA	NA	NA	NA
									Ammonia	00610	0.33	Y	168	50	29.76%
									Chl a	32211	14.10	NA	NA	NA	NA
									Chloride	00940	12000.00	Y	172	120	69.77%
									DO	00300	5.00	N	170	10	5.88%
									E.coli	31699	126594	NA	NA	NA	NA
									Fecal C	31616	200400	NA	NA	NA	NA
									Nitrate	00630	1.95	NA	NA	NA	NA
									O Phos	00671	0.37	N	160	0	0.00%
R III	0205	10134, 16733	Red River Below Pease	12/03/99	01/07/08	Red River Below Pease	01 & 02	5c	Sulfate	00945	3650.00	N	172	0	0.00%
									T Phos	00665	0.69	N	130	6	4.62%
									TDS	70300	31000.00	N	94	34	36.17%
									Ammonia	00610	0.33	N	73	0	0.00%
									Chl a	32211	14.10	Y	19	9	47.37%
									Chloride	00940	5000.00	N	86	0	0.00%
									DO	00300	5.00	N	91	0	0.00%
									E.coli	31699	126594	N	23	4	17.39%
									Fecal C	31616	200400	N	25	2	8.00%
									Nitrate	00630	1.95	N	26	0	0.00%
R III	0206	10135	Red River above Pease	09/18/00	03/11/08	Red River above Pease	01 & 02	Cat 2	O Phos	00671	0.37	N	82	1	1.22%
									pH	00400	6.5 to 9.0	N	91	0	0.00%
									Sulfate	00945	2000.00	N	87	1	1.15%
									T Phos	00665	0.69	N	67	8	11.94%
									TDS	70300	10000.00	N	58	1	1.72%
									Ammonia	00610	0.33	N	31	1	3.23%
									Chl a	32211	14.10	N	31	2	6.45%
									Chloride	00940	12000.00	N	32	0	0.00%
									DO	00300	5.00	N	27	0	0.00%
									E.coli	31699	126594	N	11	1	9.09%
R III	0208B	16000	South Grosbeck Creek	09/18/01	03/11/08	South Grosbeck Creek	01	bacteria	Fecal C	31616	200400	N	22	4	18.18%
									Nitrate	00630	1.95	N	31	0	0.00%
									O Phos	00671	0.37	N	32	5	15.63%
									pH	00400	6.5 to 9.0	N	26	0	0.00%
									Sulfate	00945	4000.00	N	32	0	0.00%
									T Phos	00665	0.69	N	31	1	3.23%
									TDS	70300	25000.00	N	31	0	0.00%
									Ammonia	00610	0.33	N	27	0	0.00%
									Chl a	32211	14.10	Y	26	7	26.92%
									Chloride	00940	12000.00	N	28	0	0.00%
R III	0220	10167, 10168	Upper Pease, North Fork Pease River	09/09/01	03/11/08	Upper Pease, North Fork Pease River	01 & 02	Cat 2	DO	00300	5.00	N	31	0	0.00%
									E.coli	31699	126594	Y	31	9	29.03%
									Fecal C	31616	200400	NA	NA	NA	NA
									Nitrate	00630	1.95	Y	27	25	92.59%
									O Phos	00671	0.37	N	25	0	0.00%
									pH	00400	6.5 to 9.0	N	31	0	0.00%
									Sulfate	00945	4000.00	N	28	0	0.00%
									T Phos	00665	0.69	N	28	0	0.00%
									TDS	70300	25000.00	N	28	0	0.00%
									Ammonia	00610	0.33	N	37	1	2.63%
R III	0220	10167, 10168	Upper Pease, North Fork Pease River	09/09/01	03/11/08	Upper Pease, North Fork Pease River	01 & 02	Cat 2	Chl a	32211	14.10	N	37	2	5.41%
									Chloride	00940	12000.00	N	38	6	15.79%
									DO	00300	5.00	N	47	0	0.00%
									E.coli	31699	126594	Y	22	9	40.91%
									Fecal C	31616	200400	N	41	3	7.32%
									Nitrate	00630	1.95	N	38	2	5.26%
									O Phos	00671	0.37	N	37	2	5.41%
									pH	00400	6.5 to 9.0	N	47	0	0.00%
									Sulfate	00945	3500.00	N	38	0	0.00%
									T Phos	00665	0.69	N	38	1	2.63%
R III	0220	10167, 10168	Upper Pease, North Fork Pease River	09/09/01	03/11/08	Upper Pease, North Fork Pease River	01 & 02	Cat 2	TDS	70300	30000.00	N	37	0	0.00%

APPENDIX B

WATER QUALITY SCREENING RESULTS

Basin / Reach	Seg	Station(s)	Description	Date Start	Date End	Site	Assessment Unit on the TWQI or 303(d) List	TWQI, 303(d), Impairment, Carry Forward Y or N, Year First Listed	Parameter	Storet	Standard or Criteria	Exceeded Screening Criteria Yes / No	Number of Samples Screened	Number > Criteria	Percentage > Criteria
R III	0221	10170	Middle Fork Pease River	Ins Data	Ins Data	Middle Fork Pease River	01 & 02	Cat 3	Ammonia	00610	0.33	NA	NA	NA	NA
									Chl a	32211	14.10	NA	NA	NA	NA
									Chloride	00940	870.00	NA	NA	NA	NA
									DO	00300	5.00	NA	NA	NA	NA
									E coli	31699	126594	NA	NA	NA	NA
									Fecal C	31616	200400	NA	NA	NA	NA
									Nitrate	00630	1.95	NA	NA	NA	NA
									O Phos	00671	0.37	NA	NA	NA	NA
									pH	00400	6.5 to 9.0	NA	NA	NA	NA
									Sulfate	00945	1400.00	NA	NA	NA	NA
									T Phos	00665	0.69	NA	NA	NA	NA
									TDS	70300	2800.00	NA	NA	NA	NA
R III	0230	10165	Pease River near Vernon	01/12/00	11/12/07	Pease River	01 & 02	Cat 2	Ammonia	00610	0.33	N	30	5	16.67%
									Chl a	32211	14.10	N	30	1	3.33%
									Chloride	00940	12000.00	N	31	0	0.00%
									DO	00300	4.00	N	31	0	0.00%
									E coli	31699	126594	N	15	1	6.67%
									Fecal C	31616	200400	N	22	3	13.64%
									Nitrate	00630	1.95	N	30	1	3.33%
									O Phos	00671	0.37	N	30	3	10.00%
									pH	00400	6.5 to 9.0	N	31	0	0.00%
									Sulfate	00945	3500.00	N	31	0	0.00%
									T Phos	00665	0.69	N	30	2	6.67%
									TDS	70300	30000.00	N	29	0	0.00%
									Ammonia	00610	0.33	N	20	0	0.00%
R III	0230A	10094, 17800	Paradise Creek	09/17/02	11/12/07	Paradise Creek	03 & 04	bacteria 5c 2006	Chl a	32211	14.10	Y	20	16	80.00%
									Chloride	00940	12000.00	N	20	0	0.00%
									DO	00300	4.00	N	36	2	5.56%
									E coli	31699	126594	N	36	9	25.00%
									Fecal C	31616	200400	N	22	3	13.64%
									Nitrate	00630	1.95	Y	20	9	45.00%
									O Phos	00671	0.37	N	20	4	20.00%
									pH	00400	6.5 to 9.0	N	36	1	2.78%
									Sulfate	00945	3500.00	N	20	0	0.00%
									T Phos	00665	0.69	N	20	1	5.00%
									TDS	70300	30000.00	N	20	0	0.00%
									Ammonia	00610	0.33	N	57	1	1.75%
									Chl a	32211	14.10	N	47	10	21.28%
R IV	0207	10136, 16037, 13637	Lower Prairie Dog Town Fork Red River	01/12/00	01/21/08	Lower Prairie Dog Town Fork Red River	01, 03, 04	bacteria 5c 2006	Chloride	00940	37000.00	N	57	1	1.75%
									DO	00300	5.00	N	73	2	2.74%
									E coli	31699	126594	Y	47	14	29.79%
									Fecal C	31616	200400	N	54	11	20.37%
									Nitrate	00630	1.95	N	56	10	17.86%
									O Phos	00671	0.37	N	57	9	15.79%
									pH	00400	6.5 to 9.0	N	73	0	0.00%
									Sulfate	00945	5300.00	N	57	1	1.75%
									T Phos	00665	0.69	N	50	4	8.00%
									TDS	70300	46200.00	N	57	11	19.30%
									Ammonia	00610	0.33	N	14	0	0.00%
									Chl a	32211	14.10	N	10	0	0.00%
									Chloride	00940	37000.00	N	14	0	0.00%
R IV	0207A	15811	Buck Creek	09/12/00	06/20/05	Buck Creek	01	bacteria 5c 2000	DO	00300	5.00	N	22	0	0.00%
									E coli	31699	126594	Y	21	9	42.86%
									Fecal C	31616	200400	Y	15	5	33.33%
									Nitrate	00630	1.95	Y	14	12	85.71%
									O Phos	00671	0.37	N	15	1	6.67%
									pH	00400	6.5 to 9.0	N	22	0	0.00%
									Sulfate	00945	5300.00	N	14	0	0.00%
									T Phos	00665	0.69	N	9	0	0.00%
									TDS	70300	46200.00	N	14	0	0.00%
									Ammonia	00610	0.11	N	24	0	0.00%
									Chl a	32211	21.00	Y	24	4	16.67%
									Chloride	00940	50.00	N	24	0	0.00%
									DO	00300	5.00	N	24	0	0.00%
R IV	0228	10188	Mackenzie Reservoir	03/12/97	07/17/07	Mackenzie Reservoir	01	Cat 2	E coli	31699	126594	N	15	0	0.00%
									Fecal C	31616	200400	N	15	0	0.00%
									Nitrate	00630	0.37	N	24	0	0.00%
									O Phos	00671	0.05	N	23	0	0.00%
									pH	00400	6.5 to 9.0	N	24	0	0.00%
									Sulfate	00945	200.00	N	24	0	0.00%
									T Phos	00665	0.20	N	24	0	0.00%
									TDS	70300	500.00	N	24	0	0.00%

APPENDIX B

WATER QUALITY SCREENING RESULTS

Basin / Reach	Seg	Station(s)	Description	Date Start	Date End	Site	Assessment Unit on the TWQI or 303(d) List	TWQI, 303(d), Impairment, Carry Forward Y or N, Year First Listed	Parameter	Storet	Standard or Criteria	Exceeded Screening Criteria Yes / No	Number of Samples Screened	Number > Criteria	Percentage > Criteria
RIV	0229	10191, 18317	Upper Prairie Dog Town Fork Red River	01/10/00	01/02/08		01 & 02	pH 5c 2006	Ammonia	00610	0.33	N	47	3	6.38%
									Chl a	32211	14.10	Y	46	23	50.00%
									Chloride	00940	350.00	N	48	13	27.08%
									DO	00300	5.00	N	46	3	6.52%
									E. coli	31699	126394	N	41	4	9.76%
									Fecal C	31616	200400	N	13	3	23.08%
									Nitrate	00630	1.95	Y	48	33	68.75%
									O Phos	00671	0.37	Y	48	34	70.83%
									pH	00400	6.5 to 9.0	N	46	11	23.91%
									T Phos	00945	675.00	N	48	7	14.58%
RIV	0229A	10192, 16870	Lake Tanglewood	02/22/00	11/15/07	01	01	pH 5c No 2006	T Phos	00665	0.69	Y	48	28	58.33%
									TDS	70300	2000.00	N	45	6	13.33%
									Ammonia	00610	0.11	Y	29	13	44.83%
									Chl a	32211	26.70	Y	30	15	50.00%
									Chloride	00940	350.00	Y	30	20	66.67%
									DO	00300	5.00	N	30	2	6.67%
									E. coli	31699	126394	N	21	0	0.00%
									Fecal C	31616	200400	N	13	0	0.00%
									Nitrate	00630	0.37	Y	30	29	96.67%
									O Phos	00671	0.05	Y	30	29	96.67%
RV	0222	10171	Salt Fork Red River	02/02/00	01/14/08	01 & 02	01 & 02	Cat 2	pH	00400	6.5 to 9.0	Y	30	16	53.33%
									Sulfate	00945	675.00	N	30	0	0.00%
									T Phos	00665	0.20	Y	30	30	100.00%
									TDS	70300	2000.00	N	30	1	3.33%
									Ammonia	00610	0.33	N	35	0	0.00%
									Chl a	32211	14.10	N	17	0	0.00%
									Chloride	00940	400.00	N	38	0	0.00%
									DO	00300	5.00	N	38	0	0.00%
									E. coli	31699	126394	Y	12	4	33.33%
									Fecal C	31616	200400	N	27	3	11.11%
RV	0222A	10076	Leila Lake Creek	02/02/00	03/12/08	01	01	Cat 2	Nitrate	00630	1.95	N	17	4	23.53%
									O Phos	00671	0.37	N	38	0	0.00%
									pH	00400	6.5 to 9.0	N	38	0	0.00%
									Sulfate	00945	1400.00	N	38	20	52.63%
									T Phos	00665	0.69	N	43	0	0.00%
									TDS	70300	3000.00	N	27	4	14.81%
									Ammonia	00610	0.33	N	36	0	0.00%
									Chl a	32211	14.10	N	38	1	2.63%
									Chloride	00940	400.00	N	38	0	0.00%
									DO	00300	5.00	N	31	1	3.23%
RV	0223	10173	Greenbelt Lake	02/10/00	02/12/08	01	01	Cat 2	E. coli	31699	126394	N	26	1	7.14%
									Fecal C	31616	200400	N	14	1	7.14%
									Nitrate	00630	1.95	N	37	6	16.22%
									O Phos	00671	0.37	N	38	0	0.00%
									pH	00400	6.5 to 9.0	N	31	0	0.00%
									Sulfate	00945	1400.00	N	37	0	0.00%
									T Phos	00665	0.69	N	37	0	0.00%
									TDS	70300	3000.00	N	36	0	0.00%
									Ammonia	00610	0.11	N	22	0	0.00%
									Chl a	32211	26.70	N	22	0	0.00%
RV	0224	10178	North Fork Red River	12/07/99	01/15/08	01 & 02	01 & 02	Cat 2	Chloride	00940	280.00	N	22	0	0.00%
									DO	00300	5.00	N	20	0	0.00%
									E. coli	31699	126394	N	20	0	0.00%
									Fecal C	31616	200400	N	20	0	0.00%
									Nitrate	00630	1.95	N	24	5	20.83%
									O Phos	00671	0.37	N	28	5	17.86%
									pH	00400	6.5 to 9.0	N	27	0	0.00%
									Sulfate	00945	1200.00	N	53	0	0.00%
									T Phos	00665	0.69	N	47	0	0.00%
									TDS	70300	2500.00	N	40	1	2.70%

APPENDIX B

WATER QUALITY SCREENING RESULTS

Basin / Reach	Seg	Station(s)	Description	Date Start	Date End	Site	Assessment Unit on the TWQI or 303(d) List	TWQI, 303(d), Impairment, Carry Forward Y or N, Year First Listed	Parameter	Storet	Standard or Criteria	Exceeded Screening Criteria Yes / No	Number of Samples Screened	Number > Criteria	Percentage > Criteria
RV	0239A	10074, 10072	Sweetwater Creek	12/07/99	01/15/08	Sweetwater Creek	01	bacteria 5c 2000	Ammonia	00610	0.33	N	35	1	2.86%
									Chl a	32211	14.10	N	31	0	0.00%
									Chloride	00940	12000.00	N	35	0	0.00%
									DO	00300	4.00	N	51	1	1.96%
									E. coli	31639	126394	Y	46	14	29.17%
								bacteria 5c 2002	Fecal C	31616	200400	N	21	4	19.05%
									Nitrate	00630	1.95	N	35	0	0.00%
									O Phos	00671	0.37	N	35	2	5.71%
									pH	00400	6.5 to 9.0	N	51	0	0.00%
									Sulfate	00945	3500.00	N	35	0	0.00%
									T Phos	00665	0.69	N	32	1	3.13%
									TDS	70300	30000.00	N	35	0	0.00%

Category 1: Attaining all water quality standards and no use is threatened.

Category 2: Attaining some water quality standards and no use is threatened; and insufficient data and information are available to determine if the remaining uses are attained or threatened.

Category 3: Insufficient data and information are available to determine if any water quality standard is attained.

Category 4: Water quality standard is not supported or is threatened for one or more designated uses but does not require development of a TMDL.

Category 4a – TMDL has been completed and approved by EPA.

Category 4b – Other pollution control requirements are reasonably expected to result in the attainment of the water quality standard in the near future.

Category 4c – Nonsupport of the water quality standard is not caused by a pollutant.

Category 5: The water body does not meet applicable water quality standards or is threatened for one or more designated uses by one or more pollutants which may be suitable for development of a TMDL

Category 5a – A TMDL is underway, scheduled, or will be scheduled.

Category 5b – A review of the water quality standards for this water body will be conducted before a TMDL is scheduled.

Category 5c – Additional data and information will be collected before a TMDL is scheduled.

2008 Texas Water Quality Inventory and 303(d) List (EPA Approved 7/9/2008)			
2008 Texas 303(d) List	Concerns for Use Attainment and Screening Levels	Water Quality Impairments	Water Bodies and Parameters Removed
Parameter Cat. Year First Listed	305b Parameter Concern	TWQI Parameter Cat. Carry forward Year First Listed	Removed Parameter 2006 Parameter Cat. Add Info

Level of Concern:

CN - Concern for near-nonattainment of the Water Quality Standards

CS - Concern for water quality based on screening levels

* Original listing was in error, data were not temporally representative.

APPENDIX C

APPENDIX C

DESCRIPTIVE STATISTICS

In the following table all fecal coliform data was measured in CFUs/100mL, E-coli in CFUs/100mL until roughly August 2001 when the new methodology called for results to be measured in MPN, chlorophyll-a in µg/L, temperature in °C, and pH in pH standard units. All other parameters are reported in mg/L unless previously noted in the prior statement above.

Basin Reach	Seg	Station(s)	Date Start	Date End	Site	Seg	Parameter	Storet	N	Mean	Median	Min	Max	Standard Deviation	R ²	p-value
CI	0101	10032 10034	01/23/90	04/21/08	Canadian River Below Lake Meredith	0101	Ammonia	00610	158	0.23	0.18	0.01	1.03	0.22	0.02	0.06
							Chloride	00940	174	1086.85	861.50	243.00	2740.00	536.09	0.00	0.65
							Chlorophyll a	32211	147	9.64	9.27	1.00	107.00	11.07	0.01	0.29
							DO	00300	178	9.34	9.25	4.90	16.80	2.03	0.01	0.28
							E. coli	31699	56	207.79	65.50	3.00	2000.00	366.60	0.00	1.00
							Fecal C	31616	101	108.27	60.00	1.00	1080.00	170.66	0.00	0.66
							Nitrate	00630	170	0.99	0.83	0.01	3.47	0.89	0.08	0.00
							O Phos	00671	131	0.10	0.06	0.01	0.41	0.10	0.10	0.00
							pH	00400	178	7.97	8.00	6.80	8.50	0.34	0.01	0.24
							Sulfate	00945	174	406.40	484.50	61.00	1240.00	220.79	0.01	0.19
							T Phos	00665	131	0.10	0.06	0.01	0.41	0.10	0.08	0.00
							TDS	70300	163	2669.98	2090.00	770.00	6450.00	1279.59	0.01	0.31
							Temp	00010	185	16.51	16.40	0.80	35.55	8.50	0.00	0.48
							Ammonia	00610	46	0.12	0.06	0.01	2.34	0.34	0.00	0.90
							Chloride	00940	46	534.93	484.00	53.00	2780.00	384.37	0.08	0.06
CI	0101A	10016 17045	01/23/90	04/21/08	Dixon Creek	0101A	Chlorophyll a	32211	21	9.79	10.00	6.52	13.40	1.65	0.06	0.29
							DO	00300	84	8.86	8.74	2.72	16.96	2.60	0.00	0.52
							E. coli	31699	65	432.89	330.00	7.00	1500.00	387.84	0.01	0.50
							Fecal C	31616	52	377.37	271.00	9.00	1330.00	357.55	0.12	0.01
							Nitrate	00630	45	2.41	1.40	0.02	9.12	2.47	0.11	0.03
							O Phos	00671	40	0.29	0.19	0.03	1.24	0.29	0.13	0.02
							pH	00400	138	7.87	7.83	7.40	8.30	0.19	0.07	0.02
							Sulfate	00945	46	447.19	438.50	67.00	900.00	137.46	0.00	0.91
							T Phos	00665	28	0.34	0.32	0.08	0.73	0.19	0.09	0.11
							TDS	70300	44	2410.52	1703.00	183.00	32005.00	4595.02	0.01	0.50
							Temp	00010	86	15.63	15.39	0.70	30.90	8.49	0.01	0.29
							Ammonia	00610	38	0.22	0.12	0.02	1.38	0.29	0.04	0.23
							Chloride	00940	38	511.74	522.50	10.00	1260.00	245.92	0.07	0.11
							Chlorophyll a	32211	23	10.00	8.20	2.00	31.80	6.92	0.01	0.64
							DO	00300	67	10.13	10.10	4.40	17.80	2.95	0.23	0.00
CI	0101B	10025 10024	01/23/90	04/21/08	Rock Creek	0101B	E. coli	31699	57	362.49	167.00	4.00	2909.00	568.27	0.01	0.48
							Fecal C	31616	36	218.50	165.00	0.90	760.00	221.15	0.00	0.99
							Nitrate	00630	30	7.84	6.56	0.36	20.30	5.83	0.19	0.02
							O Phos	00671	32	0.32	0.20	0.04	1.49	0.36	0.05	0.24
							pH	00400	67	8.01	8.00	7.50	8.50	0.24	0.05	0.06
							Sulfate	00945	38	463.92	425.00	34.00	833.00	183.10	0.13	0.03
							T Phos	00665	24	0.28	0.21	0.06	0.82	0.20	0.27	0.01
							TDS	70300	38	1811.29	1850.00	159.00	3400.00	661.17	0.24	0.00
							Temp	00010	67	12.81	11.20	1.30	26.70	7.44	0.01	0.56
							Ammonia	00610	116	15.69	15.90	3.30	28.30	8.22	0.01	0.30
							Chloride	00940	173	479.73	481.00	340.00	640.00	71.38	0.82	0.00
							Chlorophyll a	32211	177	485.03	485.00	340.00	733.00	78.77	0.10	0.05
							DO	00300	48	1535.06	1520.00	1130.00	2130.00	255.39	0.82	0.00
							E. coli	31699	36	9.40	9.40	6.70	12.00	2.06	0.01	0.56
							Fecal C	31616	141	8.45	8.50	7.70	8.80	0.17	0.28	0.00
CI	102	10037 10036 10050 10038 10045 10044 10043 10051 10052 10046 10039 10040 10041 10047 10048 10049 10042	1/8/90	05/19/08	Lake Meredith	102	Nitrate	00630	389	2.75	1.00	0.90	150.00	8.06	0.04	0.00
							O Phos	00671	35	0.05	0.04	0.02	0.06	0.01	0.59	0.00
							pH	00400	135	8.47	8.50	8.12	8.80	0.13	0.21	0.00
							Sulfate	00945	106	0.05	0.04	0.01	0.22	0.04	0.07	0.00
							T Phos	00665	38	0.06	0.05	0.05	0.16	0.02	0.05	0.18
							TDS	70300	39	0.06	0.06	0.02	0.18	0.03	0.82	0.00
							Temp	00010	39	8.01	10.00	1.00	10.00	2.97	0.10	0.05

APPENDIX C

DESCRIPTIVE STATISTICS

Basin Reach	Seg	Station(s)	Date Start	Date End	Site	Seg	Parameter	Storet	N	Mean	Median	Min	Max	Standard Deviation	R ²	p-value
CII	0102A	15270	1/8/90	05/19/08	Big Blue Creek	0102A	Ammonia	00610	20	0.05	0.04	0.01	0.10	0.03	0.01	0.74
							Chloride	00940	20	39.12	23.65	5.00	300.00	64.19	0.00	0.78
							Chlorophyll a	32211	11	5.03	2.00	0.80	22.50	6.35	0.37	0.05
							DO	00300	32	9.49	9.37	5.38	14.34	2.44	0.21	0.01
							<i>E. coli</i>	31699	30	168.60	44.00	1.00	1200.00	288.51	0.00	0.89
							Fecal C	31616	24	172.42	33.00	1.00	1000.00	272.04	0.02	0.57
							Nitrate	00630	20	0.17	0.10	0.02	0.68	0.18	0.03	0.48
							O Phos	00671	20	0.05	0.04	0.01	0.22	0.05	0.05	0.37
							pH	00400	33	8.36	8.39	8.08	8.60	0.13	0.01	0.60
							Sulfate	00945	20	146.53	135.35	90.10	229.00	42.97	0.00	0.88
							T Phos	00665	11	0.06	0.06	0.01	0.10	0.03	0.52	0.01
							TDS	70300	20	523.20	509.00	434.00	640.00	64.61	0.03	0.47
							Temp	00010	33	14.98	13.20	0.00	36.14	10.50	0.16	0.02
							Ammonia	00610	202	0.07	0.05	0.01	1.25	0.13	0.02	0.04
CII	0103	10054 10056 16344	01/23/90	04/29/08	Canadian River above Lake Meridith	0103	Chloride	00940	196	822.55	871.00	1.00	2120.00	468.47	0.07	0.00
							Chlorophyll a	32211	118	11.21	10.00	1.00	233.00	25.96	0.02	0.12
							DO	00300	247	9.48	9.20	5.77	15.85	2.09	0.00	0.35
							<i>E. coli</i>	31699	106	454.11	42.00	1.00	10500.00	1527.63	0.01	0.26
							Fecal	31616	111	456.02	40.00	1.00	11100.00	1324.68	0.00	0.56
							Nitrate	00630	159	0.25	0.18	0.01	3.51	0.33	0.00	0.38
							O Phos	00671	201	0.10	0.04	0.01	4.87	0.36	0.02	0.08
							pH	00400	249	8.21	8.26	7.00	8.80	0.22	0.01	0.14
							Sulfate	00945	214	420.88	433.50	1.00	930.00	172.55	0.01	0.14
							T Phos	00665	135	0.81	0.07	0.01	19.00	2.59	0.02	0.09
							TDS	70300	148	2447.98	2485.00	10.00	5460.00	1177.07	0.10	0.00
							Temp	00010	251	15.38	15.50	-0.10	31.00	8.68	0.00	0.96
							Ammonia	00610	54	0.28	0.08	0.01	2.26	0.53	0.07	0.06
							Chloride	00940	54	127.04	108.50	20.00	310.00	85.82	0.01	0.45
CII	0103A	10017 10018	01/23/90	04/29/08	East Amarillo Creek	0103A	Chlorophyll a	32211	42	15.18	10.00	1.00	59.10	13.85	0.02	0.33
							DO	00300	89	9.93	9.50	2.20	16.60	2.52	0.03	0.12
							<i>E. coli</i>	31699	65	553.78	179.00	1.00	8164.00	1220.76	0.00	0.96
							Fecal C	31616	64	237.57	109.00	1.00	1120.00	315.41	0.00	0.70
							Nitrate	00630	57	4.38	2.78	0.04	16.40	4.29	0.05	0.10
							O Phos	00671	50	0.24	0.15	0.01	1.05	0.24	0.12	0.02
							pH	00400	86	8.21	8.20	7.40	8.93	0.29	0.02	0.23
							Sulfate	00945	54	140.09	80.60	10.00	2100.00	296.27	0.00	0.66
							T Phos	00665	41	0.34	0.20	0.02	1.10	0.31	0.13	0.02
							TDS	70300	50	602.46	527.00	142.00	1850.00	369.29	0.00	0.82
							Temp	00010	91	13.02	13.98	0.20	31.37	8.11	0.03	0.09
							Ammonia	00610	16	1.21	0.25	0.06	5.54	1.71	0.10	0.21
							Chloride	00940	18	173.61	167.50	127.00	297.00	43.68	0.00	0.98
							Chlorophyll a	32211	18	737.99	323.00	10.00	244.00	749.29	0.59	0.00
CIII	0105	10060	03/27/91	06/14/07	Rita Blanca Lake	0105	DO	00300	20	11.20	10.40	4.91	20.00	3.86	0.04	0.39
							<i>E. coli</i>	31699	20	135.00	22.50	2.00	697.00	214.51	0.01	0.65
							Fecal C	31616	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
							Nitrate	00630	17	0.56	0.20	0.04	2.02	0.72	0.20	0.06
							O Phos	00671	17	0.91	0.65	0.15	2.53	0.75	0.53	0.00
							pH	00400	36	9.16	9.20	7.70	10.50	0.74	0.15	0.09
							Sulfate	00945	30	73.40	73.50	1.00	159.00	33.61	0.19	0.08
							T Phos	00665	31	3.45	3.10	1.40	8.39	1.74	0.02	0.55
							TDS	70300	16	654.00	830.00	590.00	1540.00	241.00	0.06	0.35
							Temp	00010	20	13.82	13.10	2.60	26.50	7.48	0.02	0.51

APPENDIX C

DESCRIPTIVE STATISTICS

Basin Reach	Seg	Station(s)	Date Start	Date End	Site	Seg	Parameter	Storet	N	Mean	Median	Min	Max	Standard Deviation	R ²	p-value
CIW	0199A	10005 10006	02/23/00	01/08/08	Palo Duro Res.	0199A	Ammonia	00610	15	0.10	0.05	0.05	0.35	0.09	0.02	0.56
							Chloride	00940	19	17.26	9.00	5.00	130.00	28.46	0.03	0.45
							Chlorophyll a	32211	17	17.35	16.60	4.31	39.40	8.53	0.02	0.53
							DO	00300	16	9.15	8.20	5.00	12.80	2.53	0.04	0.46
							E. coli	31699	13	2.69	1.00	1.00	11.00	3.15	0.24	0.08
							F Temp	00010	16	15.09	14.90	2.90	28.00	11.26	0.00	0.82
							Fecal	31616	7	NA	NA	NA	NA	NA	NA	NA
							Nitrate	00630	17	0.13	0.05	0.04	0.39	0.12	0.12	0.14
							O Phos	00671	16	0.08	0.06	0.04	0.22	0.05	0.07	0.27
							pH	00400	16	8.23	8.30	7.70	8.60	0.26	0.01	0.71
							Sulfate	00945	19	12.11	10.00	4.00	65.00	13.64	0.00	0.91
							T Phos	00665	16	0.14	0.12	0.05	0.35	0.08	0.00	0.81
							TDS	70300	19	245.79	210.00	163.00	760.00	134.55	0.00	0.89
CV	0104	10059 10058	07/17/90	04/14/08	Wolf Creek	0104	Ammonia	00610	84	0.04	0.04	0.01	0.12	0.03	0.02	0.21
							Chloride	00940	85	285.38	253.00	70.00	3300.00	347.91	0.00	0.93
							Chlorophyll a	32211	64	3.47	3.63	1.00	7.40	1.91	0.04	0.11
							DO	00300	132	9.77	9.90	3.10	16.19	2.31	0.04	0.02
							E. coli	31699	76	170.84	97.00	5.00	1633.00	250.93	0.04	0.09
							Fecal C	31616	68	143.09	100.00	1.00	580.00	136.69	0.01	0.35
							Nitrate	00630	92	0.09	0.03	0.01	1.80	0.22	0.02	0.20
							O Phos	00671	83	0.08	0.06	0.01	0.40	0.08	0.01	0.35
							pH	00400	106	8.10	8.10	7.70	8.52	0.20	0.12	0.19
							Sulfate	00945	85	66.62	66.60	10.00	140.00	24.41	0.00	0.54
							T Phos	00665	72	0.07	0.07	0.01	0.18	0.04	0.50	0.00
							TDS	70300	82	755.34	731.50	84.00	1530.00	249.50	0.01	0.28
							Temp	00010	138	18.37	19.45	2.40	32.19	8.11	0.12	0.00
RI	0201	10123	06/20/90	05/22/08	Lower Red River	0201	Ammonia	00610	59	0.08	0.06	0.01	0.45	0.07	0.04	0.13
							Chloride	00940	61	140.16	122.00	21.00	333.00	73.98	0.06	0.06
							Chlorophyll a	32211	49	10.09	10.00	0.20	28.80	7.46	0.12	0.02
							DO	00300	59	8.64	8.30	5.70	13.00	1.72	0.02	0.25
							E. coli	31699	21	30.00	14.00	1.00	120.00	33.84	0.02	0.51
							Fecal C	31616	36	255.50	39.50	2.00	2000.00	459.86	0.00	0.90
							Nitrate	00630	12	0.13	0.10	0.03	0.28	0.09	0.07	0.40
							O Phos	00671	6	NA	NA	NA	NA	NA	NA	NA
							pH	00400	88	7.87	7.90	7.10	8.40	0.28	0.07	0.04
							Sulfate	00945	61	141.23	143.00	23.00	375.00	69.87	0.02	0.32
							T Phos	00665	52	0.16	0.16	0.01	0.31	0.06	0.01	0.58
							TDS	70300	56	635.04	618.00	252.00	1150.00	211.20	0.00	0.73
							Temp	00010	60	19.35	19.80	1.80	32.80	8.33	0.00	0.99
RI	0201A	15319	06/20/90	05/22/08	Mud Creek	0201A	Ammonia	00610	19	0.11	0.12	0.02	0.20	0.05	0.01	0.70
							Chloride	00940	24	18.39	16.75	5.00	43.50	9.45	0.00	0.96
							Chlorophyll a	32211	15	23.34	12.00	2.00	77.50	24.62	0.15	0.16
							DO	00300	40	5.36	5.49	0.60	12.10	3.09	0.12	0.03
							E. coli	31699	48	202.48	115.00	4.00	1081.00	242.62	0.00	0.74
							Fecal C	31616	24	225.33	160.00	2.00	700.00	200.45	0.11	0.11
							Nitrate	00630	24	0.16	0.04	0.02	1.30	0.32	0.11	0.12
							O Phos	00671	24	0.33	0.10	0.03	2.44	0.58	0.01	0.62
							pH	00400	40	6.99	6.90	6.08	7.20	0.45	0.05	0.17
							Sulfate	00945	24	14.80	10.00	1.00	35.00	9.61	0.03	0.45
							T Phos	00665	16	0.46	0.33	0.10	1.06	0.32	0.00	0.87
							TDS	70300	24	122.13	123.00	4.00	248.00	50.48	0.05	0.31
							Temp	00010	40	17.41	17.55	1.80	30.16	7.35	0.00	0.87

APPENDIX C

DESCRIPTIVE STATISTICS

Basin Reach	Seg	Station(s)	Date Start	Date End	Site	Seg	Parameter	Storet	N	Mean	Median	Min	Max	Standard Deviation	R ²	p-value
RI	0202	10125 10126 15779 10127	01/23/90	12/10/07	Red River Below Lake Texoma	0202	Ammonia	00610	210	0.05	0.05	0.01	0.40	0.04	0.00	0.35
							Chloride	00940	210	187.98	179.50	8.20	427.00	97.92	0.28	0.00
							Chlorophyll a	32211	136	11.90	10.00	1.00	37.10	7.69	0.11	0.00
							DO	00300	236	9.26	9.00	5.50	16.97	1.86	0.01	0.22
							<i>E. coli</i>	31699	113	413.49	33.00	1.00	24000.00	2374.01	0.02	0.15
							Fecal C	31616	99	192.27	71.00	1.00	2100.00	349.13	0.00	1.00
							Nitrate	00630	179	0.19	0.17	0.01	1.30	0.18	0.00	0.82
							O Phos	00671	162	0.05	0.06	0.02	0.09	0.02	0.13	0.00
							pH	00400	232	7.93	7.99	7.00	8.70	0.33	0.05	0.00
							Sulfate	00945	207	166.17	160.00	12.00	370.00	76.44	0.10	0.00
							T Phos	00665	166	0.14	0.11	0.03	1.04	0.12	0.00	0.62
							TDS	70300	153	770.14	740.00	45.00	2364.00	305.95	0.02	0.07
							Temp	00010	92	18.90	18.50	1.70	33.00	7.97	0.00	0.75
							Ammonia	00610	24	0.06	0.07	0.02	0.12	0.03	0.27	0.06
RI	0202A	15318	01/23/90	12/10/07	Bois D' Arc Creek	0202A	Chloride	00940	24	26.74	11.45	10.00	90.00	27.73	0.01	0.76
							Chlorophyll a	32211	16	6.24	5.00	2.00	10.90	3.25	0.02	0.75
							DO	00300	40	8.92	9.00	5.16	12.81	1.78	0.02	0.48
							<i>E. coli</i>	31699	57	3045.67	104.00	43.00	24000.00	7894.04	0.11	0.38
							Fecal C	31616	27	206.76	180.00	3.00	600.00	153.93	0.04	0.39
							Nitrate	00630	24	0.28	0.24	0.02	1.04	0.28	0.07	0.34
							O Phos	00671	24	0.11	0.09	0.03	0.24	0.07	0.01	0.75
							pH	00400	30	8	8	8	8	0	0	0
							Sulfate	00945	24	50.33	36.00	10.00	130.00	40.56	0.03	0.54
							T Phos	00665	16	0.36	0.16	0.11	1.74	0.52	0.15	0.30
							TDS	70300	24	295.07	260.50	72.00	627.00	166.63	0.05	0.45
							Temp	00010	40	17.66	17.00	2.70	34.50	9.59	0.01	0.63
							Ammonia	00610	26	0.23	0.11	0.01	3.04	0.58	0.06	0.23
							Chloride	00940	24	25.62	22.25	10.00	57.50	14.65	0.00	0.81
RI	0202C	16001	01/23/90	12/10/07	Pecan Bayou	0202C	Chlorophyll a	32211	20	8.90	6.65	2.00	26.40	7.07	0.10	0.19
							DO	00300	43	6.79	6.30	0.90	12.60	2.81	0.07	0.09
							<i>E. coli</i>	31699	30	256.67	45.50	2.00	3100.00	618.25	0.08	0.14
							Fecal C	31616	27	121.11	87.00	17.00	470.00	118.24	0.00	0.84
							Nitrate	00630	26	0.10	0.04	0.02	0.68	0.16	0.21	0.02
							O Phos	00671	26	0.15	0.06	0.02	2.06	0.39	0.09	0.14
							pH	00400	43	7.27	7.20	6.48	9.00	0.50	0.02	0.31
							Sulfate	00945	26	44.70	35.70	10.00	160.00	37.79	0.01	0.56
							T Phos	00665	22	0.15	0.12	0.05	0.34	0.08	0.11	0.14
							TDS	70300	26	188.31	155.00	10.00	586.00	129.15	0.02	0.53
							Temp	00010	43	17.44	17.20	2.40	32.39	8.05	0.00	0.89
							Ammonia	00610	45	0.37	0.12	0.02	6.80	1.04	0.00	0.93
							Chloride	00940	45	74.03	35.00	3.50	1197.00	176.72	0.00	0.90
							Chlorophyll a	32211	19	9.70	10.00	2.88	24.00	5.13	0.01	0.72
RI	0202D	10120 10118	01/23/90	12/10/07	Pine Creek	0202D	DO	00300	106	6.78	6.30	1.10	12.68	2.73	0.05	0.03
							<i>E. coli</i>	31699	32	195.59	70.50	5.00	830.00	228.25	0.00	0.71
							Fecal C	31616	54	216.69	176.00	1.00	600.00	159.87	0.01	0.44
							Nitrate	00630	33	0.21	0.16	0.02	0.80	0.20	0.17	0.02
							O Phos	00671	32	0.22	0.15	0.04	0.71	0.19	0.00	0.81
							pH	00400	106	7.41	7.40	6.95	8.10	0.24	0.06	0.01
							Sulfate	00945	45	103.09	70.00	1.00	510.00	107.99	0.00	0.98
							T Phos	00665	29	0.35	0.23	0.05	1.27	0.30	0.03	0.34
							TDS	70300	45	317.53	245.00	21.00	877.00	221.58	0.00	0.86
							Temp	00010	108	19.71	20.17	3.64	30.40	7.71	0.14	0.00

APPENDIX C

DESCRIPTIVE STATISTICS

Basin Reach	Seg	Station(s)	Date Start	Date End	Site	Seg	Parameter	Storet	N	Mean	Median	Min	Max	Standard Deviation	R ²	p-value
RI	0202E	17599 10115	01/23/90	12/10/07	Post Oak Creek	0202E	Ammonia	00610	35	0.07	0.05	0.02	0.28	0.05	0.00	0.70
							Chloride	00940	33	55.60	35.00	10.00	475.00	78.38	0.01	0.62
							Chlorophyll a	32211	20	6.16	5.00	1.70	15.90	4.02	0.44	0.00
							DO	00300	95	9.39	9.30	0.80	18.60	2.85	0.02	0.15
							E. coli	31699	54	644.11	130.00	2.00	7701.00	1478.66	0.00	0.85
							Fecal C	31616	35	245.60	200.00	13.00	1300.00	262.84	0.01	0.50
							Nitrate	00630	34	0.71	0.63	0.08	1.91	0.50	0.00	0.90
							O Phos	00671	31	0.26	0.21	0.04	0.58	0.15	0.04	0.27
							pH	00400	95	7.81	7.80	7.10	8.27	0.21	0.04	0.04
							Sulfate	00945	33	105.12	110.00	19.20	200.00	39.21	0.03	0.37
							T Phos	00665	27	0.19	0.15	0.05	1.00	0.18	0.02	0.47
							TDS	70300	33	433.45	444.00	23.00	1024.00	179.60	0.01	0.50
							Temp	00010	97	17.74	17.80	2.54	36.39	8.11	0.11	0.00
RI	0202F	16123 18370	01/23/90	12/10/07	Choctaw Creek	0202F	Ammonia	00610	31	0.13	0.09	0.02	1.22	0.21	0.01	0.68
							Chloride	00940	27	138.67	85.00	9.00	401.00	124.91	0.09	0.13
							Chlorophyll a	32211	19	8.44	5.00	1.00	75.90	16.51	0.11	0.16
							DO	00300	96	8.56	8.10	1.40	13.80	2.28	0.00	0.51
							E. coli	31699	59	522.98	214.00	10.00	9200.00	1254.04	0.00	0.84
							Fecal C	31616	23	192.87	100.00	1.00	660.00	205.54	0.05	0.32
							Nitrate	00630	29	14.08	3.80	0.04	112.00	26.42	0.16	0.06
							O Phos	00671	17	5.52	5.00	0.04	17.40	4.64	0.01	0.78
							pH	00400	96	7.87	7.90	7.50	8.20	0.15	0.09	0.00
							Sulfate	00945	27	173.65	150.00	10.00	325.00	102.65	0.00	0.81
							T Phos	00665	23	3.41	1.68	0.03	11.13	3.51	0.13	0.16
							TDS	70300	25	768.36	622.00	125.00	1660.00	431.39	0.00	0.81
							Temp	00010	96	19.20	19.80	3.80	32.50	7.71	0.08	0.00
							Ammonia	00610	26	0.35	0.28	0.02	1.04	0.29	0.00	0.80
RI	0202G	17044	01/23/90	12/10/07	Smith Creek	0202G	Chloride	00940	28	117.16	106.00	21.10	340.00	64.41	0.07	0.17
							Chlorophyll a	32211	23	5.02	5.00	0.70	10.00	3.03	0.24	0.02
							DO	00300	43	4.03	3.90	0.20	9.10	2.26	0.00	0.92
							E. coli	31699	29	1187.72	754.00	72.00	4025.00	1089.23	0.00	0.90
							Fecal C	31616	27	5023.30	1200.00	100.00	6000.00	11494.64	0.01	0.55
							Nitrate	00630	28	0.16	0.08	0.02	0.73	0.19	0.03	0.40
							O Phos	00671	26	1.22	0.90	0.07	3.54	1.03	0.23	0.01
							pH	00400	44	7.30	7.30	7.00	7.60	0.14	0.14	0.01
							Sulfate	00945	28	207.24	139.00	25.40	600.00	156.05	0.18	0.02
							T Phos	00665	23	0.93	0.85	0.06	1.95	0.53	0.11	0.12
							TDS	70300	28	573.71	492.50	214.00	1130.00	249.20	0.12	0.08
							Temp	00010	44	18.36	18.50	3.30	29.70	6.85	0.02	0.40
							Ammonia	00610	100	0.05	0.06	0.01	0.21	0.04	0.01	0.44
							Chloride	00940	100	360.00	338.10	33.50	594.00	126.22	0.00	0.56
RI	0203	10130 10131 15440 17480 18369	11/27/01	12/18/07	Lake Texoma	0203	Chlorophyll a	32211	96	16.66	16.00	2.88	41.90	9.10	0.00	0.64
							DO	00300	102	10.05	9.80	3.10	13.50	2.16	0.11	0.10
							E. coli	31699	102	1.00	43.90	1.00	2419.00	257.08	0.00	0.92
							Fecal	31616	32	2.00	16.19	1.00	300.00	53.64	0.04	0.30
							Nitrate	630.00	23	0.11	0.09	0.02	0.32	0.09	0.02	0.54
							O Phos	00671	22	0.05	0.05	0.04	0.07	0.01	0.08	0.20
							pH	00400	27	8.28	8.30	780.00	8.70	0.23	0.17	0.03
							Sulfate	00945	21	241.10	253.00	108.00	308.00	50.29	0.06	0.28
							T Phos	00665	25	0.09	0.07	0.03	0.16	0.03	0.13	0.08
							TDS	70300	23	1044.65	1044.00	639.00	1350.00	174.82	0.00	0.88
							Temp	00010	102	18.50	19.03	6.50	30.80	7.82	0.00	0.71

APPENDIX C

DESCRIPTIVE STATISTICS

Basin Reach	Seg	Station(s)	Date Start	Date End	Site	Seg	Parameter	Storet	N	Mean	Median	Min	Max	Standard Deviation	R ²	p-value
RI	203A	15320 15750 17502 17503 17589	04/15/97	07/19/06	Big Mineral Creek	203A	Ammonia	00610	12	0.63	0.79	0.09	1.98	0.68	0.11	0.28
							Chloride	00940	12	83.75	89.98	53.00	145.00	30.36	0.00	0.85
							Chlorophyll a	32211	4	NA	NA	NA	NA	NA	NA	NA
							DO	00300	29	9.35	9.16	5.50	14.55	2.53	0.06	0.22
							E. coli	31699	178	49.50	171.14	1.00	8325.00	714.13	0.05	0.01
							Fecal	31616	26	242.50	358.42	1.00	1340.00	331.28	0.00	0.78
							Nitrate	00630	12	0.34	0.47	0.03	1.50	0.41	0.02	0.62
							O Phos	00671	12	0.58	0.75	0.06	3.37	0.88	0.27	0.40
							pH	00400	29	7.78	7.83	7.41	8.62	0.30	0.00	0.88
							Sulfate	00945	12	110.00	98.70	16.00	140.00	36.68	0.07	0.40
							T Phos	00665	4	NA	NA	NA	NA	NA	NA	NA
							TDS	70300	12	511.00	477.08	108.00	747.00	173.84	0.12	0.28
							Temp	00010	29	17.04	17.45	2.71	32.90	8.67	0.04	0.28
							Ammonia	00610	71	0.06	0.05	0.01	0.30	0.05	0.02	0.24
RI	0204	10132 10133	08/12/92	04/09/08	Red River above Lake Texoma	0204	Chloride	00940	80	986.94	1085.00	170.00	2060.00	420.49	0.00	0.57
							Chlorophyll a	32211	58	21.59	10.80	1.00	110.00	26.84	0.14	0.00
							DO	00300	105	9.45	9.00	4.00	15.20	2.55	0.01	0.37
							E. coli	31699	18	151.61	41.00	1.00	1600.00	370.95	0.18	0.08
							Fecal C	31616	51	1352.98	100.00	1.00	5000.00	7032.10	0.00	0.65
							Nitrate	00630	64	0.73	0.10	0.01	12.84	2.23	0.04	0.10
							O Phos	00671	70	0.09	0.06	0.01	0.63	0.11	0.01	0.48
							pH	00400	107	8.00	8.00	7.05	8.50	0.28	0.00	0.52
							Sulfate	00945	80	681.40	718.00	97.00	2410.00	315.24	0.05	0.04
							T Phos	00665	64	0.32	0.20	0.03	1.46	0.28	0.00	0.96
							TDS	70300	55	2612.51	2730.00	696.00	4830.00	948.56	0.02	0.34
							Temp	00010	113	18.98	20.00	1.76	38.50	8.50	0.01	0.40
							Ammonia	00610	25	0.05	0.05	0.05	0.10	0.01	0.01	0.60
							Chloride	00940	29	6.41	7.00	5.00	8.00	1.02	0.29	0.00
RI	0204B	15447	11/30/99	04/01/08	Moss Lake	0204B	Chlorophyll a	32211	28	8.53	10.00	1.00	16.90	3.35	0.04	0.29
							DO	00300	54	178.78	178.00	144.00	212.00	16.72	0.05	0.12
							E. coli	31699	20	10.30	2.00	1.00	150.00	32.98	0.00	0.97
							Fecal	31616	9	NA	NA	NA	NA	NA	NA	NA
							Nitrate	00630	26	0.09	0.09	0.04	0.20	0.05	0.00	0.83
							O Phos	00671	28	0.05	0.05	0.02	0.06	0.01	0.59	0.00
							pH	00400	25	8.83	9.00	6.20	11.90	1.43	0.00	0.88
							Sulfate	00945	29	15.21	16.00	10.00	18.00	1.93	0.20	0.01
							T Phos	00665	26	0.06	0.06	0.05	0.10	0.01	0.04	0.30
							TDS	70300	25	283.20	283.00	253.00	325.00	19.17	0.03	0.43
							Temp	00010	25	8.11	8.20	7.01	8.50	0.29	0.14	0.07
							Ammonia	00610	64	0.06	0.05	0.05	0.20	0.03	0.01	0.55
							Chloride	00940	66	6.42	7.00	4.00	10.00	1.53	0.07	0.03
							Chlorophyll a	32211	66	16.50	10.00	1.64	41.10	9.14	0.42	0.00
RI	0209	10138 16342 16343	01/06/00	05/20/08	Pat Mayse Lake	0209	DO	00300	57	9.03	8.90	5.60	12.00	1.60	0.02	0.26
							E. coli	31699	42	72.48	1.00	1.00	2400.00	373.40	0.08	0.08
							Fecal	31616	11	49.36	1.00	1.00	270.00	104.27	0.02	0.66
							Nitrate	00630	66	0.11	0.05	0.04	0.35	0.09	0.00	0.95
							O Phos	00671	66	0.05	0.06	0.04	0.06	0.01	0.72	0.00
							pH	00400	57	7.89	8.00	6.50	9.20	0.69	0.12	0.01
							Sulfate	00945	66	13.27	13.00	6.00	20.00	3.11	0.04	0.10
							T Phos	00665	64	0.06	0.06	0.05	0.12	0.01	0.00	0.82
							TDS	70300	66	101.14	101.00	67.00	132.00	12.80	0.00	0.03
							Temp	00010	57	19.42	20.90	6.80	32.30	8.33	0.02	0.28

APPENDIX C

DESCRIPTIVE STATISTICS

Basin Reach	Seg	Station(s)	Date Start	Date End	Site	Seg	Parameter	Storet	N	Mean	Median	Min	Max	Standard Deviation	R ²	p-value
RI	0210	10139	12/01/99	12/11/07	Farmers Creek Reservoir	0210	Ammonia	00610	34	0.05	0.05	0.05	0.07	0.00	0.00	0.96
							Chloride	00940	34	169.00	164.00	124.00	215.00	30.36	0.04	0.27
							Chlorophyll a	32211	34	9.79	10.00	6.58	11.20	1.06	0.20	0.01
							DO	00300	16	9.35	9.14	6.60	12.90	2.19	0.06	0.35
							E. coli	31699	22	3.09	1.00	1.00	15.00	4.06	0.18	0.05
							Fecal	31616	16	2.13	1.00	1.00	6.00	1.82	0.05	0.38
							Nitrate	00630	34	0.05	0.05	0.04	0.10	0.02	0.06	0.15
							O Phos	00671	32	0.05	0.06	0.02	0.06	0.01	0.52	0.00
							pH	00400	16	8.31	8.30	7.90	8.60	0.17	0.02	0.62
							Sulfate	00945	34	43.35	44.00	32.00	57.00	7.44	0.09	0.08
							T Phos	00665	34	0.05	0.05	0.05	0.06	0.00	0.61	0.00
							TDS	70300	34	499.00	500.00	398.00	688.00	64.73	0.04	0.24
							Temp	00010	16	18.00	18.86	5.96	29.90	10.18	0.02	0.64
RII	0211	10141 13633 17479	10/08/90	01/07/08	Wichita River	0211	Ammonia	00610	64	0.08	0.05	0.01	0.35	0.06	0.04	0.14
							Chloride	00940	66	71.26	48.00	5.00	307.00	63.45	0.01	0.38
							Chlorophyll a	32211	56	15.48	10.10	1.00	51.30	12.50	0.00	0.88
							DO	00300	68	6.40	6.25	1.20	11.53	2.97	0.00	0.72
							E. coli	31699	35	482.43	138.00	10.00	6867.00	1215.08	0.06	0.17
							Fecal C	31616	36	165.58	85.00	1.00	618.00	168.35	0.10	0.06
							Nitrate	00630	70	0.14	0.10	0.01	1.08	0.17	0.01	0.45
							O Phos	00671	62	0.15	0.07	0.02	0.76	0.14	0.00	0.78
							pH	00400	68	7.77	7.78	7.10	8.90	0.38	0.05	0.05
							Sulfate	00945	67	13.58	8.00	1.00	121.00	17.71	0.05	0.06
							T Phos	00665	63	0.30	0.26	0.06	0.87	0.19	0.04	0.12
							TDS	70300	62	404.63	346.00	152.00	1710.00	236.20	0.05	0.08
							Temp	00010	72	18.31	20.27	2.58	31.00	8.63	0.01	0.42
RII	0212	10142 20181 20190 20191 20203 20204 20205	05/11/00	12/12/07	Lake Arrowhead	0212	Ammonia	00610	77	0.02	0.01	0.01	0.10	0.02	0.17	0.00
							Chloride	00940	17	105.76	107.00	44.00	152.00	28.04	0.30	0.02
							Chlorophyll a	32211	17	12.20	10.00	8.66	24.00	4.30	0.16	0.11
							DO	00300	22	8.79	8.00	6.20	12.70	1.92	0.19	0.04
							E. coli	31699	10	1.70	1.50	1.00	3.00	0.82	0.07	0.47
							Fecal	31616	8	NA	NA	NA	NA	NA	NA	NA
							Nitrate	00630	17	0.34	0.05	0.04	4.92	1.18	0.10	0.21
							O Phos	00671	54	0.11	0.11	0.08	0.14	0.01	0.08	0.04
							pH	00400	22	8.54	8.50	8.00	9.00	0.23	0.20	0.04
							Sulfate	00945	17	15.88	16.00	8.00	22.00	3.98	0.43	0.00
							T Phos	00665	75	0.17	0.16	0.09	0.25	0.03	0.17	0.00
							TDS	70300	16	383.88	376.00	296.00	506.00	64.31	0.34	0.02
							Temp	00010	22	22.39	26.75	5.01	32.40	9.81	0.22	0.03
RII	0213	10143	08/15/90	08/05/03	Lake Kickapoo	0213	Ammonia	00610	10	0.06	0.04	0.01	0.26	0.08	0.11	0.36
							Chloride	00940	10	51.00	55.00	29.00	61.00	10.36	0.00	0.99
							Chlorophyll a	32211	10	6.69	7.95	1.00	10.30	3.79	0.16	0.24
							DO	00300	60	8.47	7.27	3.10	13.05	2.47	0.16	0.00
							E. coli	31699	4	NA	NA	NA	NA	NA	NA	NA
							Fecal	31616	5	NA	NA	NA	NA	NA	NA	NA
							Nitrate	00630	13	1.11	0.06	0.01	6.80	2.52	0.01	0.80
							O Phos	00671	10	0.05	0.06	0.01	0.08	0.02	0.10	0.39
							pH	00400	60	8.29	8.39	7.50	8.47	0.21	0.54	0.00
							Sulfate	00945	10	12.50	14.50	1.00	18.00	5.48	0.26	0.13
							T Phos	00665	9	NA	NA	NA	NA	NA	NA	NA
							TDS	70300	7	NA	NA	NA	NA	NA	NA	NA
							Temp	00010	63	20.86	27.50	5.52	28.60	10.01	0.15	0.00

APPENDIX C DESCRIPTIVE STATISTICS

Basin Reach	Seg	Station(s)	Date Start	Date End	Site	Seg	Parameter	Storet	N	Mean	Median	Min	Max	Standard Deviation	R ²	p-value
RII	0214	10155 10156	01/22/90	03/12/08	Wichita River below Lake Diversion Dam	0214	Ammonia	00610	291	0.17	0.05	0.01	5.42	0.48	0.01	0.11
							Chloride	00940	328	1113.39	1080.00	61.00	7700.00	619.73	0.00	0.27
							Chlorophyll a	32211	167	20.61	13.10	1.00	81.00	17.90	0.04	0.00
							DO	00300	437	9.47	9.10	3.85	18.86	2.74	0.02	0.01
							E. coli	31699	261	686.10	74.00	1.00	24200.00	2935.43	0.02	0.03
							Fecal C	31616	194	245.51	100.00	1.00	2600.00	424.27	0.00	0.60
							Nitrate	00630	260	0.66	0.42	0.01	3.12	0.75	0.00	0.65
							O Phos	00671	272	0.22	0.09	0.01	1.02	0.25	0.03	0.01
							pH	00400	433	7.93	7.90	5.00	9.30	0.38	0.00	0.74
							Sulfate	00945	333	582.11	586.00	41.60	1800.00	289.71	0.00	0.66
							T Phos	00665	218	0.40	0.28	0.03	1.47	0.35	0.01	0.14
							TDS	70300	281	2830.93	2930.00	88.00	6108.00	1246.14	0.00	0.49
							Temp	00010	435	19.48	20.50	0.30	33.70	8.09	0.01	0.02
RII	0214A	15120 15121	01/22/90	03/12/08	Beaver Creek	0214A	Ammonia	00610	72	0.12	0.06	0.01	1.08	0.16	0.04	0.08
							Chloride	00940	87	628.05	237.00	10.00	4358.60	843.02	0.07	0.01
							Chlorophyll a	32211	34	12.01	10.00	2.61	31.30	6.31	0.10	0.06
							DO	00300	165	7.70	7.30	3.22	14.16	2.61	0.02	0.07
							E. coli	31699	100	167.68	129.00	1.00	620.00	166.61	0.15	0.00
							Fecal C	31616	58	176.71	119.00	1.00	1950.00	267.50	0.00	0.84
							Nitrate	00630	73	0.26	0.17	0.02	3.59	0.44	0.00	0.66
							O Phos	00671	70	0.10	0.07	0.01	0.46	0.10	0.00	0.76
							pH	00400	166	7.83	7.80	5.20	8.70	0.35	0.03	0.02
							Sulfate	00945	87	140.83	113.00	1.00	1800.00	197.49	0.06	0.03
							T Phos	00665	49	0.21	0.19	0.05	0.47	0.11	0.05	0.13
							TDS	70300	82	1391.21	766.00	22.00	8266.00	1533.95	0.07	0.01
							Temp	00010	165	17.48	17.70	0.50	32.20	8.40	0.01	0.35
							Ammonia	00610	4	NA	NA	NA	NA	NA	NA	NA
RII	0214B	10097	01/22/90	03/12/08	Buffalo Creek	0214B	Chloride	00940	8	NA	NA	NA	NA	NA	NA	NA
							Chlorophyll a	32211	4	NA	NA	NA	NA	NA	NA	NA
							DO	00300	72	9.57	9.12	5.79	15.80	2.29	0.00	0.81
							E. coli	31699	23	105.61	63.00	1.00	480.00	129.28	0.44	0.00
							Fecal C	31616	9	NA	NA	NA	NA	NA	NA	NA
							Nitrate	00630	4	NA	NA	NA	NA	NA	NA	NA
							O Phos	00671	4	NA	NA	NA	NA	NA	NA	NA
							pH	00400	72	7.74	7.70	6.94	8.91	0.27	0.00	0.84
							Sulfate	00945	8	NA	NA	NA	NA	NA	NA	NA
							T Phos	00665	4	NA	NA	NA	NA	NA	NA	NA
							TDS	70300	8	NA	NA	NA	NA	NA	NA	NA
							Temp	00010	72	18.79	18.76	1.90	34.20	7.96	0.01	0.45
							Ammonia	00610	19	0.07	0.05	0.05	0.41	0.08	0.00	0.81
							Chloride	00940	18	1065.44	1055.00	788.00	1380.00	155.78	0.14	0.13
RII	0215	10157	06/30/99	12/12/07	Diversion Lake	0215	Chlorophyll a	32211	19	11.59	10.00	1.65	24.00	5.56	0.17	0.08
							DO	00300	17	9.28	8.45	5.90	13.02	2.21	0.01	0.71
							E. coli	31699	10	26.20	1.00	1.00	190.00	60.86	0.42	0.04
							F Temp	00010	17	18.20	23.70	5.10	31.60	10.87	0.00	0.93
							Fecal	31616	9	1.56	1.00	1.00	4.00	1.01	0.01	0.78
							Nitrate	00630	19	0.06	0.05	0.04	0.10	0.02	0.16	0.09
							O Phos	00671	18	0.05	0.06	0.02	0.06	0.01	0.57	0.00
							pH	00400	17	8.22	8.29	7.90	8.50	0.19	0.17	0.10
							Sulfate	00945	17	706.29	697.00	510.00	959.00	118.01	0.32	0.02
							T Phos	00665	19	0.05	0.05	0.03	0.07	0.01	0.23	0.04
							TDS	70300	18	2865.56	2940.00	2020.00	3700.00	430.19	0.15	0.11

APPENDIX C

DESCRIPTIVE STATISTICS

Basin Reach	Seg	Station(s)	Date Start	Date End	Site	Seg	Parameter	Storet	N	Mean	Median	Min	Max	Standard Deviation	R ²	p-value
RII	0216	10158	03/23/90	01/28/04	Wichita River below Lake Kemp	0216	Ammonia	00610	17	0.12	0.08	0.01	0.38	0.10	0.02	0.11
							Chloride	00940	138	1103.12	1100.00	860.00	1369.00	95.74	0.07	0.00
							Chlorophyll a	32211	25	3.60	1.00	1.00	10.00	3.79	0.20	0.03
							DO	00300	121	9.47	9.35	5.30	14.00	1.74	0.01	0.41
							E. coli	31699	0	NA	NA	NA	NA	NA	NA	NA
							F Temp	00010	45	18.27	17.60	5.50	28.86	7.83	0.00	0.70
							Fecal	31616	19	40.53	8.00	1.00	246.00	66.39	0.01	0.68
							Nitrate	00630	28	0.06	0.05	0.01	0.14	0.04	0.24	0.01
							O Phos	00671	113	0.01	0.01	0.01	0.02	0.00	0.31	0.00
							pH	00400	139	7.98	8.01	7.40	8.50	0.25	0.01	0.41
							Sulfate	00945	143	751.20	750.00	550.00	946.56	79.18	0.00	0.55
							T Phos	00665	117	0.04	0.04	0.01	0.11	0.02	0.18	0.00
							TDS	70300	66	2949.85	2970.00	2230.00	3660.00	302.60	0.03	0.18
RII	0217	10159 10160	05/10/00	12/12/07	Lake Kemp	0217	Ammonia	00610	34	0.05	0.06	0.05	0.24	0.04	0.03	0.31
							Chloride	00940	34	1075.00	1071.12	838.00	1440.00	130.41	0.00	0.74
							Chlorophyll a	32211	34	10.00	10.75	4.29	23.00	3.75	0.00	0.73
							DO	00300	30	8.56	9.31	5.90	13.45	2.29	0.03	0.32
							E. coli	31699	19	1.00	7.63	1.00	97.00	21.91	0.12	0.14
							F Temp	00010	30	21.86	16.83	3.36	28.00	9.94	0.01	0.57
							Fecal	31616	15	1.00	7.47	1.00	84.00	21.22	0.00	0.84
							Nitrate	00630	31	0.07	0.05	0.04	0.18	0.04	0.35	0.00
							O Phos	00671	32	0.05	0.06	0.02	0.06	0.01	0.22	0.01
							pH	00400	30	8.19	8.15	7.90	8.40	0.13	0.02	0.40
							Sulfate	00945	34	711.00	717.76	597.00	976.00	83.39	0.07	0.12
							T Phos	00665	34	0.05	0.06	0.05	0.17	0.02	0.01	0.52
							TDS	70300	34	2875.00	2878.24	1890.00	4090.00	426.43	0.00	0.74
RII	0218	10161 15177 10162 15119	05/11/90	12/05/06	Wichita / North Fork Wichita River	0218	Ammonia	00610	349	0.10	0.07	0.01	0.50	0.08	0.00	0.44
							Chloride	00940	384	4586.48	4680.75	212.56	10278.30	2128.87	0.08	0.00
							Chlorophyll a	32211	42	7.07	10.00	1.00	30.40	5.69	0.38	0.00
							DO	00300	378	9.31	9.10	5.15	15.40	2.03	0.05	0.00
							E. coli	31699	16	120.70	40.00	1.00	690.00	180.96	0.14	0.16
							Fecal C	31616	34	84.79	18.50	1.00	440.00	123.12	0.01	0.64
							Nitrate	00630	57	0.21	0.09	0.01	1.05	0.26	0.02	0.31
							O Phos	00671	360	0.03	0.02	0.01	1.20	0.10	0.04	0.00
							pH	00400	371	7.91	7.90	7.50	8.30	0.18	0.05	0.00
							Sulfate	00945	369	2106.64	2231.20	556.00	3354.80	549.91	0.05	0.00
							T Phos	00665	318	0.19	0.05	0.01	7.43	0.73	0.01	0.03
							TDS	70300	162	10881.36	11150.00	940.00	21500.00	4653.85	0.02	0.12
							Temp	00010	391	19.28	20.50	1.90	35.50	8.40	0.00	0.54
RII	218A	14900	05/11/90	12/05/06	Middle Fork Wichita River	218A	Ammonia	00610	94	0.15	0.12	0.02	0.49	0.08	0.00	0.91
							Chloride	00940	117	3144.86	3200.00	2370.10	3820.00	299.97	0.41	0.00
							Chlorophyll a	32211	42	7.07	10.00	1.00	30.40	5.69	0.38	0.00
							DO	00300	101	10.25	10.20	6.02	15.30	1.81	0.12	0.00
							E. coli	31699	NA	NA	NA	NA	NA	NA	NA	NA
							Fecal C	31616	NA	NA	NA	NA	NA	NA	NA	NA
							Nitrate	00630	NA	NA	NA	NA	NA	NA	NA	NA
							O Phos	00671	92	0.01	0.01	0.01	0.02	0.01	0.54	0.00
							pH	00400	107	7.90	7.90	7.55	8.29	0.14	0.12	0.00
							Sulfate	00945	117	2309.78	2309.11	1918.70	2500.00	72.64	0.03	0.07
							T Phos	00665	91	0.04	0.05	0.01	0.07	0.02	0.35	0.00
							TDS	70300	51	8685.69	8710.00	7580.00	9970.00	576.23	0.42	0.00
							Temp	00010	117	19.10	19.42	4.30	34.30	7.56	0.01	0.44

APPENDIX C

DESCRIPTIVE STATISTICS

Basin Reach	Seg	Station(s)	Date Start	Date End	Site	Seg	Parameter	Storet	N	Mean	Median	Min	Max	Standard Deviation	R ²	p-value
RII	0219	10163	08/15/90	07/12/07	Lake Wichita	0219	Ammonia	00610	15	0.10	0.05	0.01	0.46	0.11	0.18	0.12
							Chloride	00940	15	453.80	370.00	48.00	1040.00	313.09	0.07	0.34
							Chlorophyll a	32211	15	75.92	45.90	11.50	233.00	63.54	0.18	0.11
							DO	00300	14	10.27	10.60	3.50	14.70	3.29	0.07	0.36
							E. coli	31699	10	68.90	8.00	1.00	410.00	129.70	0.09	0.41
							F Temp	00010	14	19.61	26.90	4.90	32.70	11.30	0.16	0.15
							Fecal	31616	6	115.67	45.50	2.00	500.00	192.34	0.13	0.48
							Nitrate	00630	19	0.07	0.05	0.01	0.16	0.05	0.07	0.27
							O Phos	00671	15	0.10	0.07	0.04	0.21	0.05	0.18	0.11
							pH	00400	14	8.44	8.61	7.80	9.10	0.45	0.03	0.59
							Sulfate	00945	15	170.27	122.00	9.00	524.00	157.32	0.12	0.21
							T Phos	00665	15	0.20	0.18	0.07	0.33	0.08	0.13	0.19
							TDS	70300	11	1352.00	1120.00	328.00	2460.00	690.24	0.00	0.95
							Ammonia	00610	268	0.19	0.17	0.02	0.59	0.13	0.13	0.00
RII	0226	13635 13636	01/03/90	09/09/04	South Fork Wichita River	0226	Chloride	00940	410	10192.54	11540.50	29.50	24100.00	6653.83	0.06	0.00
							Chlorophyll a	32211	27	6.76	1.00	1.00	68.50	14.05	0.01	0.70
							DO	00300	348	9.17	9.10	2.66	15.20	2.33	0.05	0.00
							E. coli	31699	NA	NA	NA	NA	NA	NA	NA	NA
							Fecal C	31616	23	37.61	16.00	1.00	186.00	53.54	0.01	0.64
							Nitrate	00630	52	0.28	0.05	0.01	10.70	1.48	0.02	0.33
							O Phos	00671	329	0.02	0.02	0.01	0.45	0.04	0.00	1.00
							pH	00400	378	7.77	7.80	7.07	8.60	0.26	0.12	0.00
							Sulfate	00945	393	2730.10	2890.50	1080.00	3742.90	515.96	0.08	0.00
							T Phos	00665	283	0.12	0.05	0.01	5.99	0.49	0.01	0.07
							TDS	70300	143	23340.77	27400.00	460.00	44100.00	12102.97	0.09	0.00
							Temp	00010	124	18.44	20.00	0.00	33.50	8.94	0.01	0.20
							Ammonia	00610	163	0.06	0.04	0.01	0.28	0.05	0.00	0.68
							Chloride	00940	170	1625.47	1600.00	150.00	3480.00	672.54	0.11	0.00
RIII	0205	10134 16733	01/22/90	01/07/08	Red River below Pease River	0205	Chlorophyll a	32211	29	21.13	12.10	1.00	189.00	36.06	0.05	0.24
							DO	00300	171	9.88	9.60	3.60	16.00	2.28	0.00	0.37
							E. coli	31699	17	170.88	33.00	8.00	1200.00	323.26	0.00	0.87
							Fecal C	31616	40	302.60	108.00	5.00	2300.00	482.65	0.01	0.61
							Nitrate	00630	53	0.75	0.06	0.01	8.99	1.72	0.02	0.37
							O Phos	00671	167	0.03	0.02	0.01	0.31	0.04	0.00	0.59
							pH	00400	175	8.07	8.10	6.70	8.70	0.23	0.00	0.98
							Sulfate	00945	168	1047.49	1100.00	340.00	1700.00	284.61	0.04	0.01
							T Phos	00665	140	0.30	0.12	0.01	6.94	0.69	0.01	0.19
							TDS	70300	107	4334.24	4600.00	278.00	8590.00	1680.19	0.10	0.00
							Temp	00010	175	18.29	19.20	0.00	33.00	8.39	0.00	0.91
							Ammonia	00610	51	0.15	0.05	0.01	3.52	0.49	0.04	0.14
							Chloride	00940	46	6929.78	7160.00	3140.00	10100.00	1568.61	0.13	0.45
							Chlorophyll a	32211	50	9.66	7.04	1.00	80.10	15.44	0.02	0.36
							DO	00300	43	8.86	8.30	6.20	16.90	2.07	0.00	0.69
RIII	0206	10135	08/20/90	03/11/08	Red River above Pease River	0206	E. coli	31699	11	128.88	86.70	1.00	437.00	134.14	0.01	0.74
							Fecal C	31616	38	207.21	95.50	1.00	1900.00	344.85	0.04	0.22
							Nitrate	00630	55	0.83	0.67	0.11	2.39	0.58	0.11	0.01
							O Phos	00671	51	0.16	0.04	0.01	1.20	0.24	0.03	0.20
							pH	00400	40	7.88	7.90	7.47	8.21	0.17	0.10	0.62
							Sulfate	00945	46	2348.48	2450.00	1390.00	2890.00	311.75	0.07	0.08
							T Phos	00665	50	0.29	0.06	0.01	3.88	0.72	0.04	0.17
							TDS	70300	43	14806.74	14400.00	8400.00	22700.00	3110.01	0.57	0.12
							Temp	00010	43	20.49	22.92	3.70	35.40	9.34	0.03	0.26

APPENDIX C

DESCRIPTIVE STATISTICS

Basin Reach	Seg	Station(s)	Date Start	Date End	Site	Seg	Parameter	Storet	N	Mean	Median	Min	Max	Standard Deviation	R ²	p-value
R III	0206B	16000	08/20/90	03/11/08	South Groesbeck Creek	0206B	Ammonia Chloride	00610	25	0.06	0.05	0.05	0.11	0.02	0.01	0.57
							Chlorophyll a	32211	26	13.80	10.00	3.00	43.80	9.08	0.00	0.86
							DO	00300	42	10.22	10.52	6.30	13.80	1.94	0.00	0.79
							E. coli	31699	31	281.26	210.00	29.00	770.00	232.48	0.00	0.93
							Fecal C	31616	7	NA	NA	NA	NA	NA	NA	NA
							Nitrate	00630	25	3.48	3.48	2.76	4.35	0.43	0.50	0.27
							O Phos	00671	25	0.08	0.06	0.02	0.18	0.05	0.09	0.16
							pH	00400	42	7.52	7.52	7.18	7.80	0.16	0.00	0.83
							Sulfate	00945	28	1726.07	1760.00	560.00	2070.00	240.93	0.09	0.12
							T Phos	00665	28	0.08	0.06	0.04	0.38	0.07	0.09	0.13
							TDS	70300	26	4886.54	4855.00	4450.00	5510.00	289.32	0.10	0.12
							Temp	00010	44	20.42	22.69	8.30	30.00	6.16	0.01	0.46
R III	0220	10167 10168	11/30/94	03/11/08	Upper Pease / North Fork Pease River	0220	Ammonia Chloride	00610	47	0.04	0.05	0.02	0.13	0.03	0.00	0.84
							Chloride	00940	67	7420.05	7914.30	755.99	13500.00	3671.43	0.00	0.64
							Chlorophyll a	32211	36	7.52	10.00	1.00	17.40	3.75	0.44	0.00
							DO	00300	85	9.05	8.80	6.20	13.00	1.55	0.01	0.48
							E. coli	31699	21	760.86	52.00	1.00	3898.00	1110.61	0.00	0.97
							Fecal C	31616	57	150.30	15.00	1.00	2000.00	370.51	0.00	0.79
							Nitrate	00630	44	0.30	0.08	0.02	3.07	0.61	0.01	0.57
							O Phos	00671	54	0.10	0.04	0.01	0.90	0.16	0.04	0.15
							pH	00400	87	7.91	7.90	7.30	8.60	0.19	0.01	0.33
							Sulfate	00945	67	2452.23	2500.00	427.00	3900.00	803.17	0.00	0.95
							T Phos	00665	50	0.12	0.06	0.01	1.30	0.25	0.01	0.44
							TDS	70300	54	17091.65	19000.00	2280.00	28500.00	6924.54	0.00	0.67
							Temp	00010	98	19.94	20.72	0.00	37.00	9.30	0.02	0.17
R III	0221	10170	08/20/90	05/24/07	Middle Fork Pease River	0221	Ammonia Chloride	00610	9	NA	NA	NA	NA	NA	NA	NA
							Chloride	00940	9	NA	NA	NA	NA	NA	NA	NA
							Chlorophyll a	32211	9	NA	NA	NA	NA	NA	NA	NA
							DO	00300	10	6.66	6.72	0.30	9.70	2.47	0.05	0.54
							E. coli	31699	3	NA	NA	NA	NA	NA	NA	NA
							Fecal C	31616	7	NA	NA	NA	NA	NA	NA	NA
							Nitrate	00630	11	0.03	0.02	0.01	0.06	0.02	0.15	0.24
							O Phos	00671	8	NA	NA	NA	NA	NA	NA	NA
							pH	00400	10	7.92	8.01	7.40	8.11	0.26	0.00	0.99
							Sulfate	00945	9	NA	NA	NA	NA	NA	NA	NA
							T Phos	00665	9	NA	NA	NA	NA	NA	NA	NA
							TDS	70300	6	NA	NA	NA	NA	NA	NA	NA
							Temp	00010	26	20.86	21.70	2.50	37.00	10.28	0.02	0.51
R III	0230	10165	02/06/90	11/12/07	Pease River	0230	Ammonia Chloride	00610	72	0.23	0.07	0.01	2.71	0.45	0.00	0.88
							Chloride	00940	75	3134.65	3320.00	156.00	5350.00	1144.77	0.00	0.69
							Chlorophyll a	32211	69	7.93	10.00	1.00	47.20	7.28	0.00	0.63
							DO	00300	74	10.19	9.79	0.49	18.98	2.94	0.03	0.18
							E. coli	31699	20	104.85	86.50	1.00	410.00	100.54	0.03	0.47
							Fecal C	31616	64	276.63	98.50	1.00	4150.00	660.34	0.00	0.88
							Nitrate	00630	89	0.89	0.26	0.01	13.50	2.18	0.00	0.66
							O Phos	00671	72	0.31	0.06	0.01	3.10	0.69	0.00	0.74
							pH	00400	66	7.90	7.91	7.50	8.30	0.17	0.00	0.78
							Sulfate	00945	75	1553.42	1680.00	174.00	2960.00	593.02	0.02	0.20
							T Phos	00665	69	0.34	0.08	0.01	3.86	0.77	0.02	0.29
							TDS	70300	61	7800.03	8050.00	1060.00	12800.00	2440.70	0.03	0.22
							Temp	00010	84	19.38	19.72	2.10	37.81	8.71	0.07	0.01

APPENDIX C

DESCRIPTIVE STATISTICS

Basin Reach	Seg	Station(s)	Date Start	Date End	Site	Seg	Parameter	Storet	N	Mean	Median	Min	Max	Standard Deviation	R ²	p-value
R III	0230A	10094 17600	02/06/90	11/12/07	Paradise Creek	0230A	Ammonia	00610	26	0.07	0.05	0.02	0.25	0.05	0.06	0.21
							Chloride	00940	26	895.72	728.00	19.30	2110.00	688.99	0.02	0.47
							Chlorophyll a	32211	22	49.32	38.70	4.00	152.00	42.48	0.00	0.79
							DO	00300	49	10.59	10.40	3.00	17.10	3.25	0.01	0.46
							E. coli	31699	30	194.23	134.00	10.00	759.00	182.61	0.00	0.81
							Fecal C	31616	35	737.26	180.00	1.00	14900.00	2486.20	0.01	0.55
							Nitrate	00630	23	1.93	1.86	0.02	6.28	1.61	0.16	0.07
							O Phos	00671	21	0.49	0.07	0.01	6.50	1.41	0.00	0.78
							pH	00400	49	8.27	8.25	7.55	9.20	0.29	0.01	0.43
							Sulfate	00945	26	672.34	566.00	21.60	1500.00	474.45	0.02	0.47
							T Phos	00665	22	0.23	0.18	0.02	0.97	0.21	0.05	0.32
							TDS	70300	24	2589.54	2160.00	224.00	6030.00	1731.01	0.07	0.20
							Temp	00010	51	18.45	17.30	5.90	32.41	7.67	0.02	0.34
R IV	0207	10136 16037 13637	01/22/90	01/21/08	Lower Prairie Dog Town Fork Red River	0207	Ammonia	00610	147	0.09	0.05	0.01	2.00	0.18	0.00	0.98
							Chloride	00940	143	11024.70	8400.00	18.00	42000.00	10449.59	0.02	0.13
							Chlorophyll a	32211	68	5.26	5.00	0.90	20.00	4.45	0.16	0.00
							DO	00300	155	9.21	8.80	0.05	17.60	2.54	0.00	0.43
							E. coli	31699	44	202.00	85.50	1.00	1056.00	261.18	0.00	0.66
							Fecal C	31616	92	501.93	29.00	0.20	13300.00	1677.95	0.03	0.10
							Nitrate	00630	109	0.97	0.32	0.01	14.10	2.02	0.11	0.00
							O Phos	671.00	123	0.08	0.05	0.01	0.39	0.09	0.00	0.46
							pH	00400	168	8.01	8.00	7.00	8.80	0.31	0.02	0.08
							Sulfate	00945	142	2330.14	2280.00	18.00	5800.00	1335.10	0.01	0.24
							T Phos	00665	118	0.55	0.09	0.01	16.00	1.87	0.03	0.08
							TDS	70300	131	21937.56	13800.00	240.00	75800.00	19835.49	0.02	0.12
							Temp	00010	181	18.24	18.00	0.80	36.39	8.90	0.01	0.19
R IV	0207A	15811	01/22/90	01/21/08	Buck Creek	0207A	Ammonia	00610	17	0.05	0.04	0.02	0.11	0.03	0.00	0.81
							Chloride	00940	17	440.34	280.00	167.90	2900.00	644.35	0.09	0.25
							Chlorophyll a	32211	10	5.28	5.00	3.10	10.00	1.76	0.01	0.76
							DO	00300	32	10.39	10.33	6.53	13.50	1.85	0.07	0.14
							E. coli	31699	30	429.30	276.00	27.00	1400.00	393.89	0.01	0.65
							Fecal C	31616	30	467.47	315.00	38.00	1600.00	411.55	0.02	0.49
							Nitrate	00630	17	3.28	3.40	0.75	6.33	1.53	0.00	0.81
							O Phos	00671	18	0.09	0.04	0.01	0.55	0.13	0.00	0.88
							pH	00400	32	7.94	7.96	7.60	8.20	0.14	0.03	0.32
							Sulfate	00945	17	1705.77	1800.00	771.00	2110.00	381.75	0.03	0.48
							T Phos	00665	9	NA	NA	NA	NA	NA	NA	NA
							TDS	70300	17	3093.41	3174.00	2522.00	3464.00	255.79	0.23	0.05
							Temp	00010	32	15.75	12.61	5.02	31.30	7.51	0.03	0.36
R IV	0228	10188	03/12/97	07/17/07	Mackenzie Reservoir	0228	Ammonia	00610	81	0.09	0.05	0.01	1.10	0.22	0.02	0.18
							Chloride	00940	81	14.90	15.00	7.00	24.00	4.14	0.18	0.00
							Chlorophyll a	32211	76	3.53	1.45	0.80	11.20	3.36	0.39	0.00
							DO	00300	311	7.36	7.80	0.00	12.10	4.00	0.00	0.96
							E. coli	31699	15	1.13	1.00	1.00	2.00	0.35	0.06	0.36
							F Temp	00010	310	13.38	10.45	3.80	28.60	8.35	0.00	0.58
							Fecal	31616	61	1.54	1.00	1.00	11.00	1.82	0.03	0.17
							Nitrate	00630	116	0.08	0.02	0.01	1.51	0.27	0.00	0.64
							O Phos	00671	80	0.03	0.02	0.01	0.10	0.02	0.07	0.00
							pH	00400	309	8.10	8.20	6.80	8.80	0.41	0.15	0.00
							Sulfate	00945	81	126.37	130.00	78.00	196.00	28.25	0.27	0.00
							T Phos	00665	80	0.03	0.02	0.01	0.08	0.02	0.49	0.00
							TDS	70300	60	428.83	426.00	304.00	676.00	86.97	0.04	0.12

APPENDIX C

DESCRIPTIVE STATISTICS

Basin Reach	Seg	Station(s)	Date Start	Date End	Site	Seg	Parameter	Storet	N	Mean	Median	Min	Max	Standard Deviation	R ²	p-value
RIV	0229	10191 18317	01/30/90	03/26/08	Upper Prairie Dog Town Fork Red River	0229	Ammonia	00610	29	1.83	0.22	0.05	18.77	4.79	0.21	0.01
							Chloride	00940	29	332.55	357.00	113.00	423.00	70.48	0.00	0.96
							Chlorophyll a	32211	102	6.68	5.86	0.20	22.80	5.78	0.23	0.00
							DO	00300	37	5.60	5.70	0.20	11.50	3.36	0.52	0.00
							E. coli	31699	50	74.66	56.00	1.00	279.00	71.47	0.00	0.97
							Fecal C	31616	94	118.56	85.50	1.00	530.00	122.34	0.01	0.48
							Nitrate	00630	151	3.55	3.18	0.01	13.70	3.22	0.01	0.23
							O Phos	00671	29	2.20	0.99	0.14	6.22	1.99	0.31	0.00
							pH	00400	166	8.10	8.10	6.90	9.60	0.52	0.07	0.00
							Sulfate	00945	29	215.90	209.00	33.00	772.00	121.50	0.05	0.26
							T Phos	00665	122	2.02	1.16	0.02	6.98	1.79	0.32	0.00
							TDS	70300	27	1096.59	1120.00	618.00	1520.00	192.00	0.05	0.29
							Temp	00010	37	17.85	19.10	2.90	27.70	5.48	0.07	0.11
RIV	0229A	10192 16870	02/22/00	11/15/07	Lake Tanglewood	0229A	Ammonia	00610	28	0.20	0.09	0.05	0.63	0.20	0.20	0.02
							Chloride	00940	30	356.27	378.50	242.00	408.00	47.79	0.09	0.10
							Chlorophyll a	32211	28	28.19	18.70	3.00	97.20	24.00	0.01	0.65
							DO	00300	30	9.43	9.75	2.48	15.20	3.46	0.06	0.18
							E. coli	31699	21	2.00	1.00	1.00	9.00	2.28	0.21	0.04
							F Temp	00010	30	15.53	16.60	3.17	27.50	8.08	0.01	0.70
							Fecal	31616	13	2.77	2.00	1.00	9.00	2.28	0.00	0.83
							Nitrate	00630	30	7.00	7.28	0.18	12.20	3.32	0.60	0.00
							O Phos	00671	30	0.89	0.99	0.04	1.88	0.45	0.14	0.04
							pH	00400	29	9.09	9.20	8.20	9.90	0.49	0.03	0.38
							Sulfate	00945	29	227.21	226.00	198.00	252.00	15.87	0.15	0.04
							T Phos	00665	30	1.08	1.15	0.34	1.87	0.42	0.19	0.02
							TDS	70300	30	1192.00	1165.00	860.00	2344.00	250.22	0.08	0.14
RV	0222	10171	01/24/90	01/14/08	Salt Fork Red River	0222	Ammonia	00610	101	0.06	0.05	0.01	0.21	0.04	0.00	0.59
							Chloride	00940	104	272.34	280.00	169.00	357.00	47.25	0.03	0.10
							Chlorophyll a	32211	35	3.85	2.00	0.80	10.00	3.75	0.02	0.44
							DO	00300	104	9.62	9.05	6.10	16.00	2.25	0.03	0.07
							E. coli	31699	12	415.50	169.00	19.00	2100.00	608.25	0.09	0.34
							Fecal C	31616	49	188.84	77.00	3.00	1200.00	269.60	0.00	0.79
							Nitrate	00630	50	1.36	1.43	0.22	2.45	0.49	0.00	0.91
							O Phos	00671	90	0.02	0.01	0.01	0.06	0.02	0.29	0.00
							pH	00400	101	8.01	8.00	7.70	8.30	0.14	0.06	0.02
							Sulfate	00945	104	1320.14	1386.17	540.00	1840.00	266.80	0.03	0.10
							T Phos	00665	69	0.04	0.02	0.00	0.73	0.09	0.00	0.88
							TDS	70300	44	2613.64	2714.50	1470.00	3800.00	436.54	0.00	0.85
							Temp	00010	104	19.17	19.05	0.50	35.50	9.51	0.00	0.96
RV	0222A	10076	01/24/90	01/14/08	Lelia Lake Creek	0222A	Ammonia	00610	49	0.06	0.05	0.01	0.25	0.03	0.10	0.03
							Chloride	00940	52	58.52	59.50	13.00	76.00	9.05	0.00	0.77
							Chlorophyll a	32211	51	6.52	10.00	1.00	18.20	4.31	0.01	0.47
							DO	00300	43	11.17	11.80	5.90	14.90	2.37	0.11	0.03
							E. coli	31699	26	62.81	40.50	10.00	201.00	55.32	0.00	0.94
							Fecal C	31616	26	83.78	36.00	0.30	560.00	123.56	0.00	0.86
							Nitrate	00630	50	1.16	0.84	0.04	3.49	0.99	0.15	0.01
							O Phos	00671	51	0.05	0.06	0.01	0.07	0.01	0.24	0.00
							pH	00400	44	7.99	8.00	7.50	8.40	0.20	0.10	0.04
							Sulfate	00945	51	200.06	208.00	48.00	246.00	32.95	0.05	0.13
							T Phos	00665	50	0.05	0.05	0.01	0.16	0.02	0.22	0.00
							TDS	70300	49	699.08	692.00	608.00	856.00	50.20	0.00	0.90
							Temp	00010	44	16.02	15.55	3.50	31.76	7.31	0.00	0.76

APPENDIX C

DESCRIPTIVE STATISTICS

Basin Reach	Seg	Station(s)	Date Start	Date End	Site	Seg	Parameter	Storet	N	Mean	Median	Min	Max	Standard Deviation	R ²	p-value
RV	0223	10173	02/10/00	02/12/08	Greenbelt Lake	0223	Ammonia	00610	22	0.05	0.05	0.05	0.05	0.00	0.00	1.00
							Chloride	00940	22	66.45	67.50	56.00	81.00	6.43	0.01	0.74
							Chlorophyll a	32211	22	6.88	10.00	1.00	10.00	3.60	0.22	0.03
							DO	00300	20	9.31	9.05	6.60	11.90	1.90	0.03	0.47
							E. coli	31699	17	1.06	1.00	1.00	2.00	0.24	0.01	0.67
							F Temp	00010	20	16.72	17.25	4.30	28.40	9.96	0.01	0.72
							Fecal	31616	7	NA	NA	NA	NA	NA	NA	NA
							Nitrate	00630	21	0.04	0.04	0.04	0.05	0.01	0.77	0.00
							O Phos	00671	21	0.05	0.04	0.02	0.06	0.01	0.58	0.00
							pH	00400	18	8.39	8.40	8.10	8.60	0.13	0.11	0.17
							Sulfate	00945	22	118.95	121.50	104.00	137.00	9.08	0.00	0.79
							T Phos	00665	22	0.06	0.06	0.05	0.06	0.01	0.74	0.00
							TDS	70300	21	449.24	450.00	400.00	528.00	29.31	0.18	0.06
RV	0224	10178	07/16/90	01/15/08	North Fork Red River	0224	Ammonia	00610	50	0.04	0.04	0.01	0.18	0.03	0.19	0.00
							Chloride	00940	53	438.84	435.00	329.17	647.00	56.28	0.03	0.25
							Chlorophyll a	32211	33	4.23	1.92	1.00	36.50	6.70	0.00	0.97
							DO	00300	52	9.41	9.18	6.31	14.60	1.87	0.09	0.03
							E. coli	31699	6	NA	NA	NA	NA	NA	NA	NA
							Fecal C	31616	43	1179.51	46.00	2.00	42600.00	6492.59	0.03	0.28
							Nitrate	00630	36	0.14	0.10	0.02	0.80	0.17	0.05	0.19
							O Phos	00671	50	0.03	0.02	0.01	0.15	0.03	0.03	0.25
							pH	00400	52	8.01	8.04	7.40	8.30	0.21	0.03	0.23
							Sulfate	00945	53	517.63	443.00	217.00	1240.00	225.44	0.04	0.14
							T Phos	00665	49	0.03	0.02	0.00	0.11	0.03	0.12	0.01
							TDS	70300	41	1688.29	1610.00	1130.00	2700.00	371.45	0.07	0.10
							Temp	00010	52	16.65	16.15	0.86	35.42	8.67	0.04	0.17
RV	0299A	10074 10072	08/28/91	01/15/08	Sweetwater Creek	0299A	Ammonia	00610	37	0.14	0.03	0.01	3.30	0.54	0.06	0.16
							Chloride	00940	37	33.92	30.40	3.00	200.00	32.08	0.00	0.89
							Chlorophyll a	32211	32	5.33	5.00	1.00	12.50	2.91	0.01	0.56
							DO	00300	55	9.75	10.20	1.90	14.00	2.72	0.00	0.72
							E. coli	31699	46	282.85	211.00	1.00	1200.00	283.97	0.03	0.25
							Fecal C	31616	24	316.63	142.50	17.00	1200.00	351.80	0.00	0.98
							Nitrate	00630	38	0.25	0.08	0.01	1.90	0.42	0.01	0.67
							O Phos	00671	37	0.12	0.06	0.01	1.24	0.20	0.10	0.06
							pH	00400	55	8.10	8.10	7.49	8.60	0.23	0.00	0.84
							Sulfate	00945	37	27.68	18.90	10.00	185.00	29.43	0.04	0.21
							T Phos	00665	33	0.11	0.09	0.02	0.70	0.11	0.03	0.33
							TDS	70300	37	344.22	343.00	31.00	1080.00	142.46	0.04	0.21
							Temp	00010	55	14.34	14.50	2.47	26.00	7.74	0.02	0.31

N – the number of individual samples which the data set is comprised of

Mean – or more specifically the arithmetic mean, or average is calculated by adding up all terms in a data set and dividing by N

Median – the number located in the middle of the data set when arranged from lowest to highest value

Min – the least of a set of numbers, specifically the smallest value in the data set

Max – the largest of a set of numbers, specifically the largest value in the data set

Standard Deviation – a measure of the variability or dispersion of a given data set; higher standard deviation values are commonly associated with data sets spread out over a large range; the standard deviation measure how well data is clustered around the mean of the data set

R² – or coefficient of determination, is the square of the correlation coefficient, r; it is a relative measure of how well the linear regression "fits" the data on a scale from 0 to 1.0; the higher the value, the better the line "fits" the data and the "stronger" the relationship between the two independent variables

p-value – a measure of uncertainty or the chance that you are observing can be attributed to pure chance alone, occurring in your data set, but not in the general population; for example a p-value of 0.01 would indicate that there is a 1.0% chance the relationship shows up in your data set but not in the general population