2012 Basin Summary Report

A Summary of Water Quality in the Colorado River Basin — 2007 – 2011

Prepared by Clean Rivers Program Partners:

Lower Colorado River Authority
Upper Colorado River Authority
Colorado River Municipal Water District

This report summarizes water quality activities in the Colorado River basin between January 2007 and December 2011. It was prepared by the Lower Colorado River Authority (LCRA) and Upper Colorado River Authority (UCRA), with contributions from the Colorado River Municipal Water District (CRMWD) and the City of Austin. The report was financed through grants from the Texas Commission on Environmental Quality (TCEQ).

Cover Photo: Colorado River near LaGrange

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Acronyms

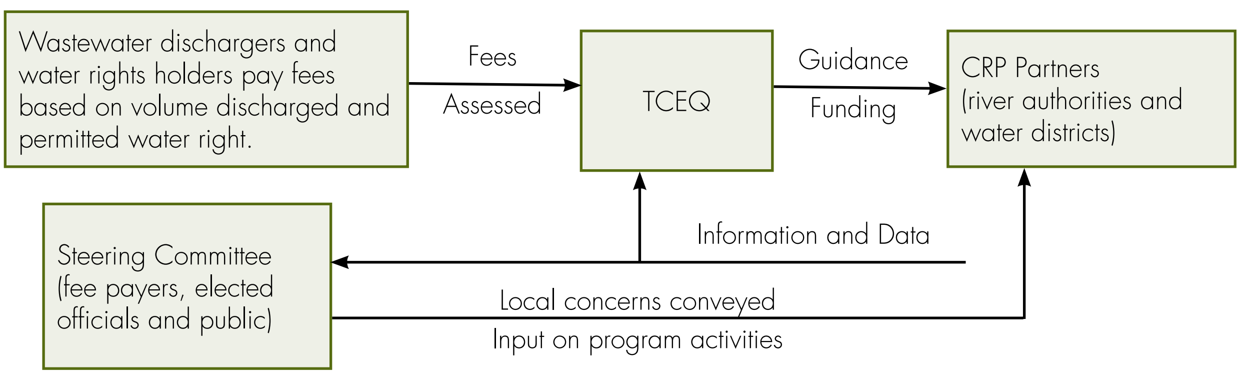
ALU -	Aquatic Life Use
BMP -	Best Management Practices
CFU -	Colony Forming Units
COA -	City of Austin
CRP -	Clean Rivers Program
CRWN -	Colorado River Watch Network
EPA -	United States Environmental Protection Agency
LCRA -	Lower Colorado River Authority
mg/L -	milligrams per liter (parts per million)
RRC -	Texas Railroad Commission
SWQMIS -	Surface Water Quality Monitoring Information System
TCEQ -	Texas Commission on Environmental Quality
TDS -	Total Dissolved Solids
TPWD -	Texas Parks and Wildlife Department
TSS	Total Suspended Solids
TMDL -	Total Maximum Daily Load
TSSWCB -	Texas State Soil and Water Conservation Board
TSWQS -	Texas Surface Water Quality Standards
UCRA -	Upper Colorado River Authority
USDA -	United States Department of Agriculture
USGS -	United States Geological Survey
WWTP -	Wastewater Treatment Plant

Texas Clean Rivers Program

With the passage of Senate Bill 818 in 1991, the Clean Rivers Program (CRP) established a statewide coalition of water monitoring agencies to collect data and disseminate water quality information on a regional level. Today, CRP partners and the TCEQ collect data from 1,850 water monitoring sites throughout the state. The data are used for many reasons including development of Texas Surface Water Quality Standards (TSWQS), determining if water bodies meet TSWQS, modeling trends, baseline data for water quality protection projects and to help establish wastewater permit limits.

The program is administered by TCEQ and funded by fees paid by municipal and industrial dischargers and water rights holders, such as LCRA. Steering committees provide input on local water quality concerns and help guide CRP activities (Figure 1). This system of statewide funding and local resource management encourages locally driven watershed protection efforts.

Figure 1. CRP Funding and Public Input



Long-term objectives for CRP are to:

- Provide quality-assured data to TCEQ for use in water quality decision-making
- Identify and evaluate water quality issues
- Promote cooperative watershed planning
- Inform and engage stakeholders and
- Maintain efficient use of public funds
- Adapt the program to emerging water quality issues

Introduction

To accomplish these objectives, approximately $430,000 was allocated to the Colorado River basin annually between 2007 and 2011. During this reporting period, CRP partners LCRA, UCRA and CRMWD monitored water quality and coordinated outreach efforts in their respective basins (Figure 2), often providing their own funding or matching grants to leverage resoures. Additionally, the City of Austin and Hays County contributed water quality data and in-kind services to help meet program objectives. In 2011, CRMWD opted out of the program and UCRA began to monitor water quality in the Upper Colorado River basin.

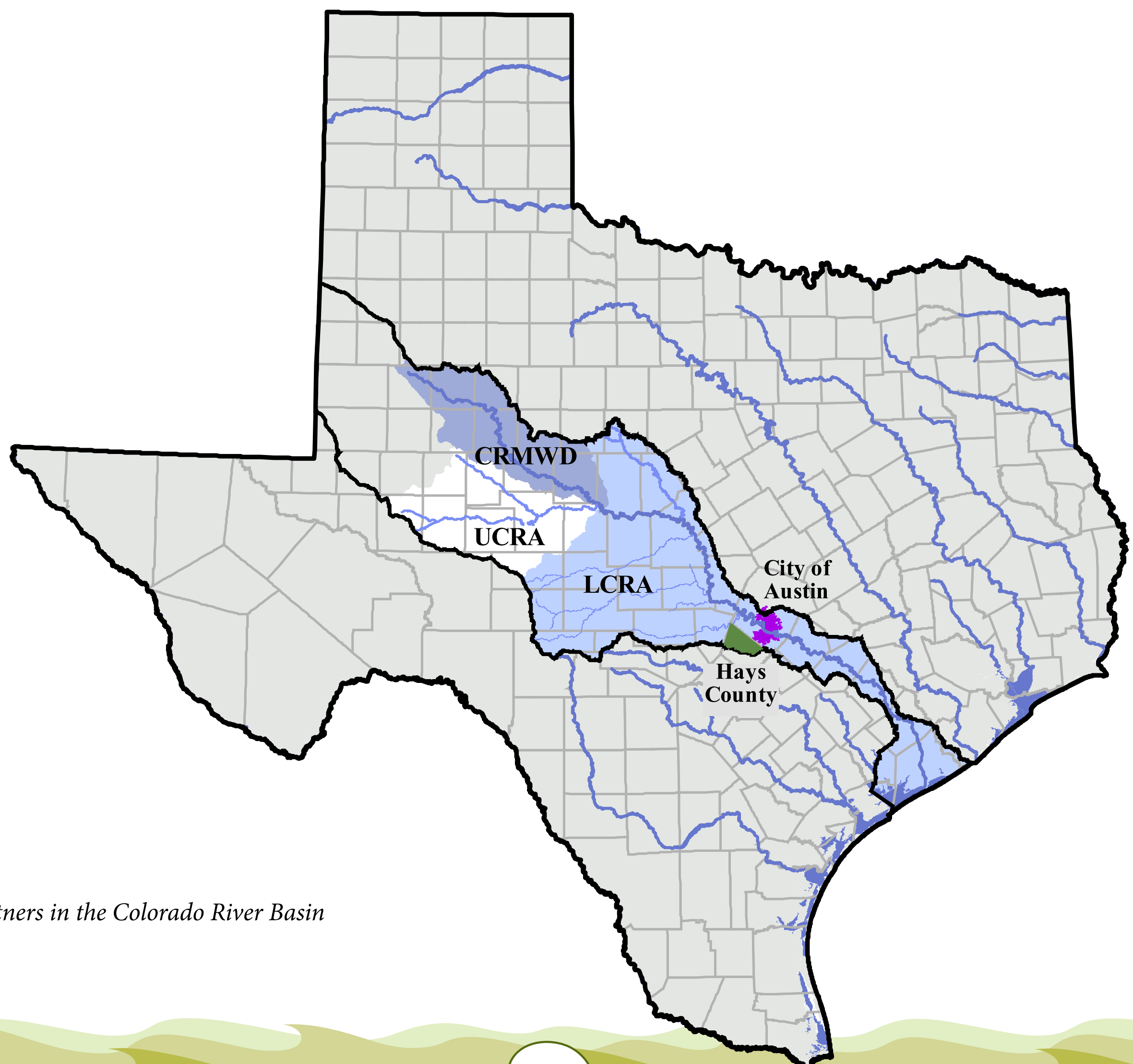


Figure 2. CRP Partners in the Colorado River Basin

Colorado River Basin Characteristics

The Colorado River begins in the West Texas Plains and flows southeast more than 600 miles before emptying into Matagorda Bay. A wide range of topography, geology, soils, climate and human influences shape the river. The river basin is divided into nine watersheds (Figure 3). Topography is extremely varied as elevation changes from nearly 3,000 feet in upper watershed to sea level near the coastal watershed.

Watersheds in the Colorado River Basin	
Watershed	Square Miles
Upper	6,000
Concho River	6,700
Pecan Bayou	2,200
Lake Buchanan	5,650
Lake LBJ	5,000
Lake Travis	1,830
Lake Austin	700
Lower Basin	2,200
Coastal Watershed	2,800

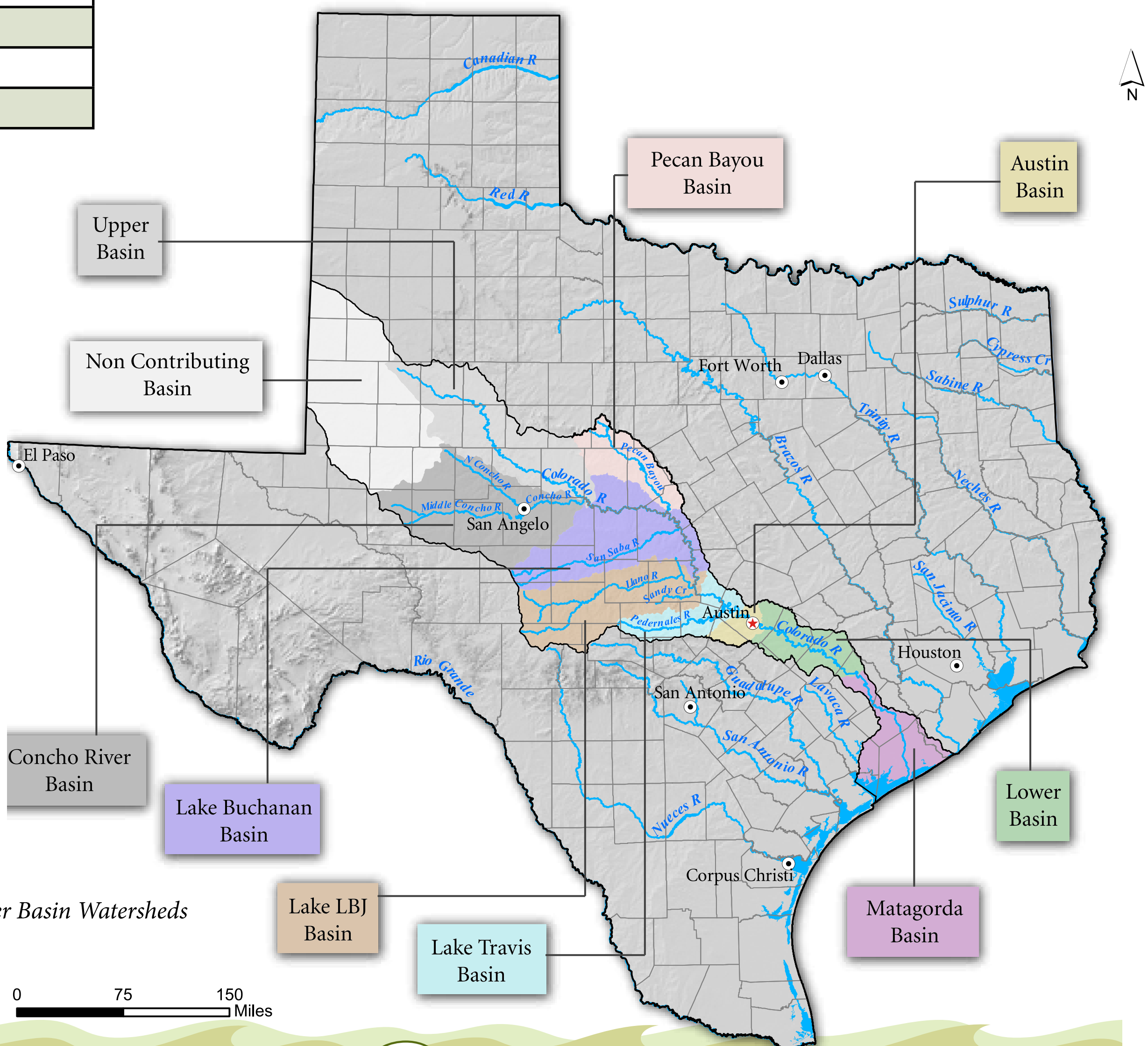


Figure 3. Colorado River Basin Watersheds

Introduction

As with all surface water, the Colorado River is directly influenced by geology, soils, climate, vegetation and land uses. These physical factors make up unique geographic areas, or ecoregions. The Colorado River flows through eight ecoregions (Figure 4).

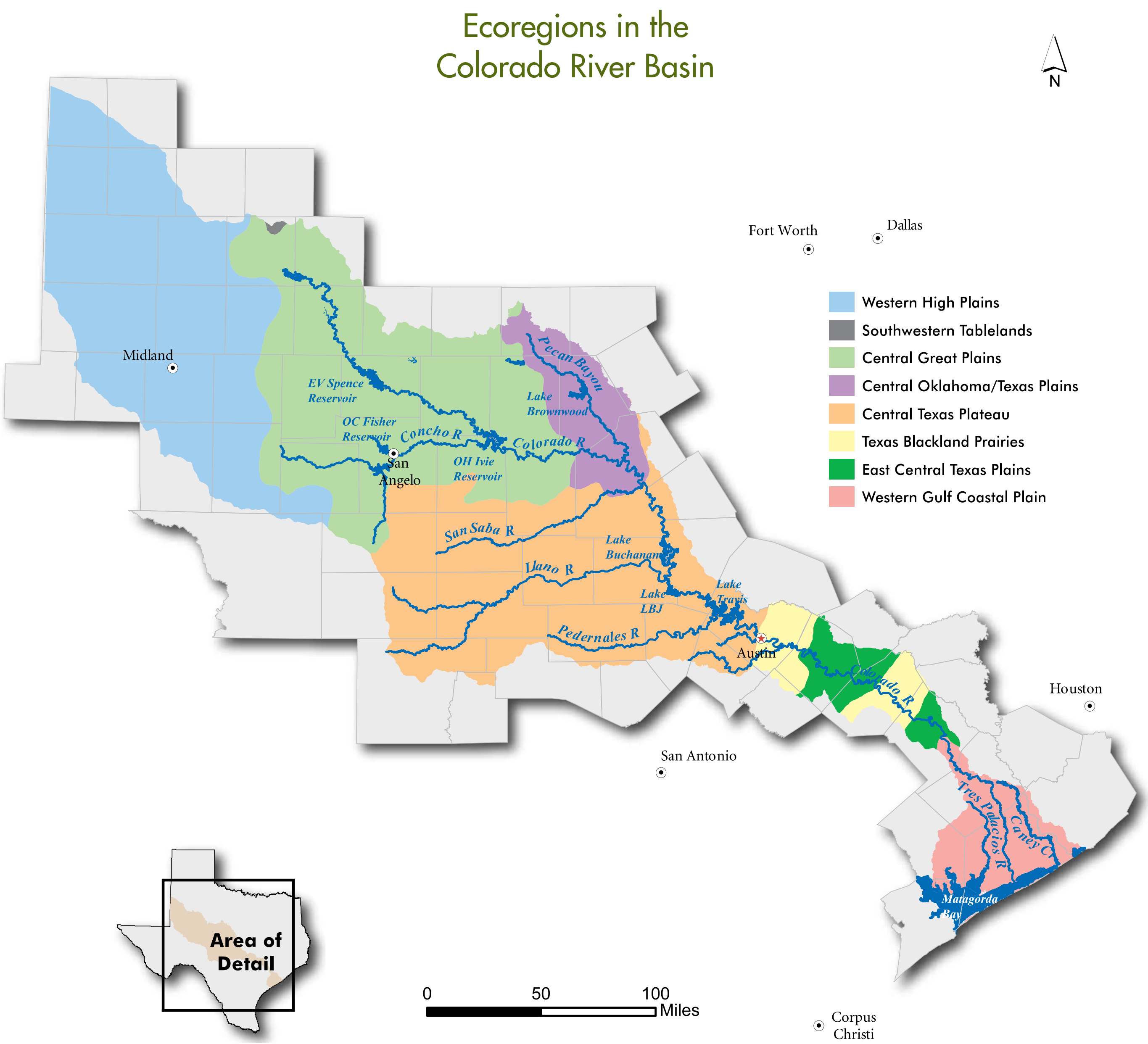


Figure 4. Ecoregions in the Colorado River Basin

Water Quality Overview

The upper Colorado and Concho river basins correspond with the Central Great Plains Ecoregion, where soils typically have elevated levels of minerals and salts, and streams contain high levels of chloride and sulfate. Streams in the Central Great Plains tend to be turbid. Long-term drought in the upper basin has concentrated chloride and sulfate levels in reservoirs making some them comparable to brackish water in Matagorda Bay.

Chloride and sulfate levels in the North Concho River west of San Angelo, and nitrogen levels in the Concho River east of San Angelo are typically high. Conversely, the South Concho River is influenced by major springs south of San Angelo and contains some of the best water quality in the basin.

South Concho River South of San Angelo

In the middle portion of the basin, the Central Texas Plateau Ecoregion corresponds with the Pedernales, Llano and San Saba river basins. Dominated by limestone and granite bedrock, the steep terrain of the Edwards Plateau gives rise to clear, fast-flowing, perennial streams. The principal tributaries – the San Saba, Llano and Pedernales rivers - play an important part in diluting the salinity and suspended sediment from upstream flows. pH is typically higher in this region due to limestone deposits in the Hill Country. This region includes the Texas Hill Country and the Highland Lakes: Buchanan, Inks, , Marble Falls, Travis, Lake Austin, and Lady Bird Lake.

Llano River in Llano County

Downstream of Austin, the Colorado River flows through the East Central Texas Plains and Blackland Prairies ecoregions to Columbus where the Western Gulf Coastal Plains define flat topography and coastal marshes. Below Austin, the limestone canyons of the Hill Country give way to deep clay soils. Water in this region tends to be cloudy, with higher amounts of total suspended solids (TSS). Treated wastewater from Austin and the surrounding area affect flow and water quality downstream of Austin.

Colorado River near Bastrop

Introduction

Effects of Weather on Water Quality

The upper Colorado River basin is in a semi-arid region of Texas that typically receives less than 20 inches of rainfall per year. A decade-long drought in the region has left many streams dry and reservoirs at fractions of their capacity. In the middle basin, where flows have historically been higher because of springs and more frequent rains, a recent drought has lowered lakes to levels not seen since the drought of the 1950s. In 2011 many of the Highland Lakes' tributaries went dry and inflows were reduced to the lowest level ever recorded. Gauged inflows totaled 127,699 acre-feet, about 10 percent of the historical average.

O.H. Ivie Reservoir at 16% of capacity in 2012

Colorado River upstream of Lake Buchanan

Introduction

These drought and low flow conditions typically concentrate dissolved solids and decrease dissolved oxygen levels in water. Water quality is also impacted when dry conditions are interrupted by intense flood events. Stormwater runoff increases bacteria levels and suspended solids until sustained stream flows dilute dissolved solids. This report cites weather and drought conditions as causes of water quality problems.

Colorado River at the same site upstream of Lake Buchanan during the 2011 Drought

Public Involvement

Public participation has always been a key component of the Clean Rivers Program. From 2007 to 2011, CRP partners continued to engage stakeholders through steering committee meetings and by supporting education, outreach and volunteer monitoring.

Steering Committee Activity

Steering Committees provide insight into local water quality issues and help prioritize water quality improvement projects and monitoring. Three steering committees represent the upper, middle and lower regions of the basin (Figure 5). Members include representatives from city and county government, industrial and agricultural interests, state agencies, environmental organizations and the public. Thirteen steering committee meetings were held between 2007 and 2011 in San Angelo, Austin, Bay City and Matagorda. Topics included monitoring and local impacts on water quality such as drought, wildfire, wastewater discharge permits, animal feeding operations and harmful algal blooms. Meeting minutes are posted on the LCRA Clean Rivers web site at http://lcra.org/water/quality/crp/index.html.

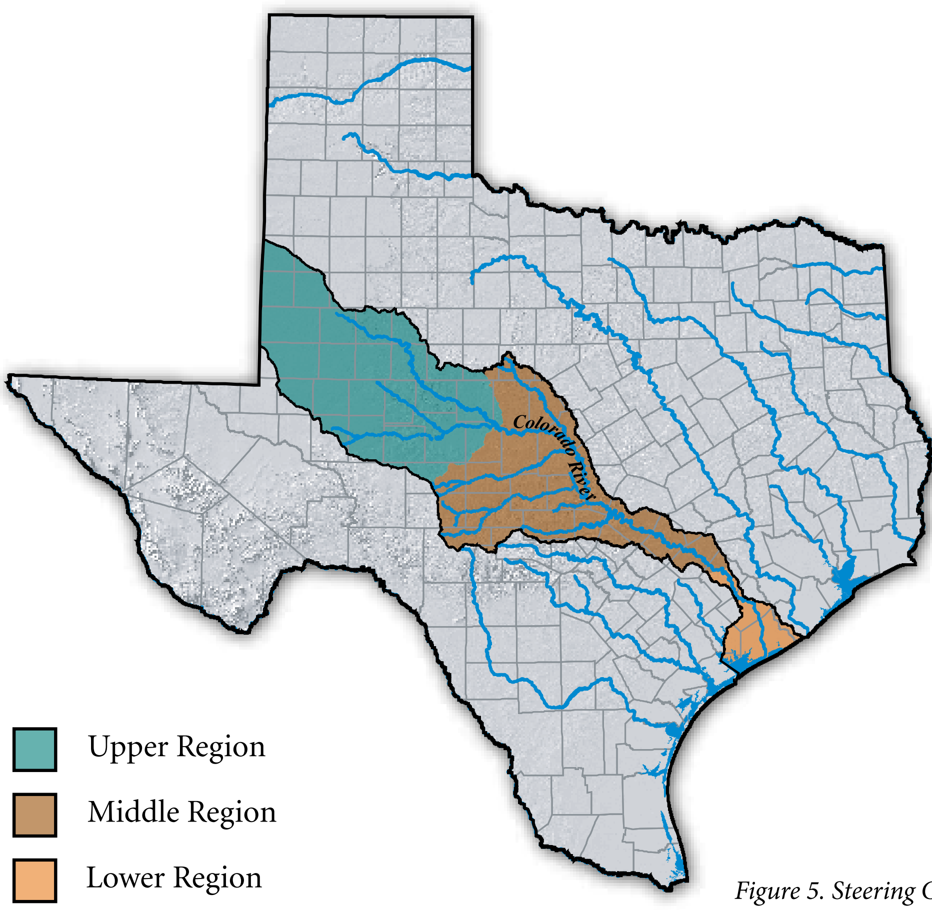


Figure 5. Steering Committee Regions

Volunteer Monitoring

The Colorado River Watch Network (CRWN) began in 1988, when a handful of Austin citizens began sampling local creeks. Today CRWN is the largest regional network of volunteer monitors in Texas. Volunteers are citizens, teachers, students, scouts and groups such as the Austin Youth River Watch. On average 120 volunteers sample for dissolved oxygen, pH, specific conductivity and temperature at 100 sites annually. Many also test for E.coli bacteria and nitrate. Between 2007 and 2011, the number of sites supported by LCRA grew from 103 to 133. The success of the program is due largely to dedicated volunteers who contributed 22,837 hours from 2007 to 2011.

In 2011, fourteen CRWN volunteers began monitoring the Highland Lakes for invasive zebra mussels. Zebra mussels have been in the northeastern United States since the 1980's, but have only recently been found in Texas. The zebra mussel watchers will provide early detection of the species which threatens aquatic ecosystems and water utilities.

Volunteer monitor Phil Wyde installs a zebra mussel sampler on Inks Lake

Public Involvement

Environmental Outreach

The Colorado River basin CRP partners are dedicated to educating children and adults about water quality issues in their watersheds. Numerous outreach events were held throughout the basin between 2007 and 2011. The events included topics on water conservation, nonpoint-source pollution (NPS), brush control and watershed protection projects. Many were hosted at LCRA and UCRA facilities. Some of the most effective outreach took place at schools and in local creeks. These on-site outreach activities provided an important component – the ability to interact with natural surroundings.

CRWN volunteers review bacteria testing procedures at a workshop.

LCRA Outreach

The CRWN program supported 90 outreach events that reached approximately 10,000 people during the five-year reporting period. Events included the Austin Cave Festival, The Texas Coastal Expo and The Texas Nature Project. Presentations and hands-on events were also provided for Master Naturalists, the Austin Bastrop River Corridor Partnership, and numerous Earth Day and World Water Monitoring Day events. CRWN also supported the Texas Parks Mussel Watch program and the Colorado River Foundation by providing staff and logistical assistance to those programs.

LCRA hosted seven Stewardship Workshops for CRWN volunteers at Lake Buchanan, Bastrop and Austin. The workshops provided educational opportunities on conducting watershed assessments, implementing best management practices, data analyses and algae identification.

UCRA Outreach

UCRA aims to educate and empower the community regarding water issues of the Concho River Basin and surrounding subwatersheds. This includes a focus on non-point source pollution, water conservation and overall watershed protection. This is accomplished through a multi-faceted approach including participation in regular festivals and school events, teacher trainings, summer camps, field trips, media events, grade-level curriculum development and the creation of a student ambassador group. Partnerships have been a key component in all of these activities. UCRA works closely with the San Angelo Museum of Fine Arts, the City of San Angelo, Angelo State University and Girl Scouts of Central Texas in the planning an implementation of programs. From 2007 to spring of 2012, UCRA engaged over 6,200 people through outreach activities and over 4,700 people through programs based in the UCRA Water Education Center. Following is a description of some of these education programs.

Since 2008, UCRA has been a partner in San Angelo's annual EcoFair event hosted by the San Angelo Museum of Fine Arts. This event draws over 3,000 people and includes eco-related activities and art, non-profit education booths, canoeing, fishing, live music and food venues. The water program includes varied hands-on activities such as a "Stormwater Pollution Bracelet", fish prints and the Enviroscape Watershed Model. Elementary schools also request a booth every year at their annual Family Math and Science Nights held at both Santa Rita Elementary and Fort Concho Elementary. These events draw between 400 and 500 people.

UCRA also hosts teacher trainings, often in cooperation with the Region XV Educational Service Center. This is an excellent way to influence teachers from the region on topics such as water quality testing, watersheds, conservation and groundwater/surface water. In 2010, UCRA hosted Texas Stream Team trainings for area middle and high school teachers. In the spring of 2009, the Texas Marine Educators Association hosted a program with 25 teachers from all over the state entitled "A River Runs Through It." They visited the Water Education Center and sites along the Concho River.

Along with major festivals and teacher trainings, UCRA engages the public through innovative programs aimed at the youth in the community. One of these programs, "Aqua Squad" began in 2008 and is a group of 10 middle school students who are selected to serve as water ambassadors for our community. They spend two weeks in the summer immersed in the study of water issues. Through the support of a federal grant in partnership with the Art Museum and San Angelo ISD, they participate in customized workshops led by staff from renowned museums.

Public Involvement

In 2008, Aqua Squad travelled to Washington D.C. and worked with the exhibition staff of the Smithsonian National Museum of Natural History. In 2011, they travelled to the Shedd Aquarium in Chicago, where they learned to design strategies for water re-use. They will apply these strategies to help educate the San Angelo community through presentations at events around San Angelo. In 2012, Aqua Squad will travel to the San Diego Zoo Research Center and Museum of Photographic Arts.

Aqua Squad - Education at work

As part of this same program involving art and science in partnership with the San Angelo Museum of Fine Arts and San Angelo ISD, UCRA hosts Camp Odyssey. Now in its second year, this week-long summer camp focuses on a systemic approach to our local water situation. This is a half-day camp serving 4th and 5th graders in the mornings and 6th through 8th graders in the afternoon. In 2011, campers journeyed to the headwaters of the Concho River, visited the area lakes (including the dry O.C. Fisher Lake), and toured both the Water Treatment Plant and the WWTP and Compost Facility.

UCRA also partners with the Art Museum on another successful camp that was implemented in 2010 entitled "Art of Nature." This camp is based out of the UCRA Water Education Center during the month of June and engages campers to explore the Concho River by canoeing, fishing and learning about watersheds and NPS pollution.

UCRA's outreach programs have grown extensively over the last 5 years. Beyond the festivals and school wide events, UCRA reaches classrooms in communities such as Christoval, Eldorado, Grape Creek and Brady through both customized curriculum and in-class visits. In 2009-2010, UCRA visited the 4th and 5th grade classrooms of Glenmore Elementary in San Angelo for a multi-visit curriculum unit on watersheds. And since 2010, water studies have been a part of the 7th grade curriculum for all students in San Angelo ISD. This program alone reaches over 900 students annually.

In addition to the programs described above, UCRA Education has significant roles in other projects including the education and outreach for the City of San Angelo Stormwater Program, and as consistent mentors in the program for San Angelo ISD's project-based program for Gifted and Talented Students entitled the Texas Research Institute for Young Scholars.

CRMWD Outreach

As a major water supplier in arid West Texas, the Colorado Municipal Water District recognizes the value of water conservation efforts. CRMWD focused outreach efforts on teaching students where their water comes from and the importance of conservation. They accomplish this through Major Rivers, a fourth-grade curriculum developed by educators and major water providers in Texas. The curriculum provides students with a concept of the hydrologic cycle, watershed protection and water development for future uses. In 2007, 2008, and 2009, CRMWD supplied Major Rivers education materials to schools in Ector County and Big Spring Independent School Districts.

Permit Application Review and Response

Wastewater discharges in the state are regulated by TCEQ and generally require a level of treatment to remove harmful pathogens and pollutants. For example, discharges from WWTPs can contain nutrients like nitrogen and phosphorus, while mining activities may release TSS or TDS and metals into waterways. Other facilities or activities can release nonpoint-source discharges that don't come from a specific point but still convey pollutants into local water bodies.

To help meet its responsibility of protecting the water quality of the Colorado River and its tributaries, LCRA monitors permit applications submitted through other agencies that regulate activities with the potential to impact water quality. LCRA's goal, through the Application Review and Response Process (ARRP), is to minimize the effects from pollutants entering the water bodies of the lower Colorado River basin. This is achieved by reviewing and making recommendations on permit applications for projects or facilities with regulated discharge and waste disposal within the watershed.

The ARRP committee is a multidisciplinary professional team within LCRA that examines permits to identify potential threats to water quality. LCRA uses public participation processes in place to work with permitting agencies and the applicant to address any concerns. Over 100 permit applications are reviewed a year. ARRP has been instrumental in securing more protective requirements for a multitude of permits through formal and informal actions including recommendations, collaboration, mediation and contested case hearings when necessary. ARRP also actively participates in rule-making, policy and other regulatory issues on federal, state and local levels that relate to water quality protection, and frequently collaborates with other entities and concerned citizens interested in protecting water quality.

The majority of permits which LCRA reviews are issued through the TCEQ; however some permits are also issued under the authority of the United States Environmental Protection Agency(EPA), Texas Railroad Commission (RRC), Texas Parks and Wildlife Department (TPWD), United States Army Corp of Engineers, and cities and counties throughout the region.

In this five years reporting period, ARRP processed over 750 notices for new and amended permit applications and renewals for activities including industrial and municipal wastewater discharges and disposal; municipal and private landfill and solid waste disposal; hazardous waste; concentrated animal feeding operations; mining activities, including sand and gravel production; an airport; pipelines; geothermal discharges; and oil and gas waste disposal.

ARRP successfully achieved inclusion of more protective measures in over 18 permits exceeding the protection that may have otherwise been afforded by the proposed limits originally presented by the applicant or issuing agency.

Two domestic wastewater discharge permits were successfully negotiated with the City of Burnet and the Hays County Water Control and Improvement District No. 1 in the Belterra Subdivision. They are among the most stringent discharge permits in the state. Collaboration with the permittees and TCEQ resulted in agreements to beneficially reuse effluent and release wastewater discharges only after all possible beneficial use has been exhausted, thus reducing the volume of wastewater that either of these entities will discharge to tributaries of the lower Colorado River basin. Any wastewater to be discharged will be treated to a very high quality to remove phosphorus and nitrogen and minimize impacts to the water quality of the receiving streams; one of which is a major tributary to Lake Travis, and the other a recharge stream for the Edwards Aquifer.

LCRA also worked with the City of Fredericksburg to reach an agreed schedule for the City to implement measures to reduce nutrient loading to the Pedernales River, a major tributary of Lake Travis.

Water Quality Analysis

The watershed summaries in this section describe water quality based on chemical and biological data collected by six agencies from 221 monitoring sites in the Colorado River basin. To ensure comparability among data sets, all water samples were collected and analyzed according to an approved Quality Assurance Project Plan. Data was obtained the TCEQ surface water quality database (SWQMIS). Two methods of analyses were used: trend analysis, and a review of how water quality compares to Texas Surface Water Quality Standards using the 2010 Texas Integrated Report for Clean Water Act Sections 305(b) and 303(d).

To discuss the complex issues surrounding water quality monitoring and assessment, we must first establish a common vocabulary. This technical discussion is an overview of water quality terms and processes. A list of water quality parameters, their sources and impacts can be found in Appendix A.

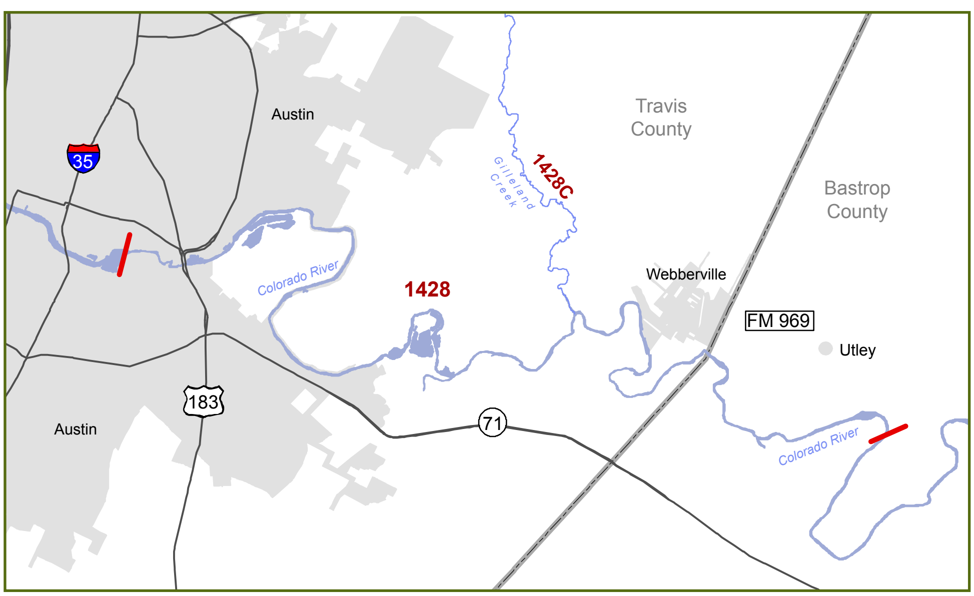
Technical Discussion

Classified Segments

Classified segments are streams, rivers, bays, estuaries or reservoirs that serve as the geographic unit for assigning water quality standards and applying water quality management strategies. They are identified by four-digit codes. The first two digits correspond to the river basin in which they are located, and the last two digits distinguish a specific area within the basin. For example, Segment 1428 is in basin 14 (the Colorado River basin) and 28 represents the river between Longhorn Dam, in Austin and Utley. **All classified water bodies have segment-specific water quality standards that are assigned by TCEQ and are described in TSWQS.**

Unclassified Segments

Unclassified segments are small, often intermittent water bodies for which specific water quality standards are not typically assigned. Unclassified waters are assessed based on flow and the criteria for the classified segment into which they flow. That said, in some cases site specific standards have been assigned to unclassified streams by TCEQ. The same naming convention applies with the addition of a letter to denote the associated segment. For example, 1428C is Gilleland Creek; a tributary of the Colorado River between Austin and Ultey.



Trend Analysis

Trends analyses were performed on data from one monitoring site in each classified segment and select unclassified segments over a 10-year period, 2001 through 2010. Data met the following criteria unless otherwise noted in the watershed summary:
1. At least 20 data points were collected within the 10-year period,
2. Data points were fairly evenly distributed over most of the 10 year period

Trends were examined for the following water quality parameters:
1. Temperature,
2. pH,
3. chlorophyll a,
4. E. coli or enterococci (depending on the site location),
5. nitrate+nitrite nitrogen,
6. total kjeldahl nitrogen (TKN)
7. ammonia nitrogen,
8. total phosphorus,
9. total suspended solids (TSS)
10. total dissolved solids (TDS),
11. sulfate,
12. chloride,
13. dissolved oxygen deficit (a measure of the theoretical amount of oxygen water can hold vs. the actual amount measured based on water temperature), and
14. secchi depth, in reservoirs only. (a measure of water transparency).

When applicable, graphs in this report display criteria (solid red line) designated in the TSWQS or screening levels (dashed red line) based on historical data. The statistical methodology for determining trends is listed in Appendix B. Summary tables for all trends (over time, flow-influenced and the relationship to loading) are in Appendix C. For the purpose of brevity, some trends were not graphed in the Watershed Summary Sections.

Water Quality Standards

As the state regulatory agency, TCEQ establishes water quality standards for surface water in Texas. The standards are made up of two components; designated uses and criteria. Designated uses are purposes for which water is used. They include general use, aquatic life use (ALU) and contact recreation use. Criteria are numeric or narrative limits used to compare water quality data or conditions.

Water Quality Analysis

The designated uses and their associated criteria include:

General Use – Temperature, pH, chloride, sulfate and TDS criteria are used to gauge support for this use. In the Colorado River basin, pH criterion is a range between 6.5 and 9.0 standard units as outlined in the Texas Surface Water Quality Standards. Criteria for chloride, sulfate and TDS varies by segment.

Aquatic Life Use - There five levels of aquatic life use; exceptional, high, intermediate, limited and minimal. Aquatic life use is assessed using dissolved oxygen, and fish and benthic macroinvertebrate (aquatic bugs) community evaluation. Results from intensive field surveys are used to calculate aquatic life use. For more about biological monitoring and aquatic life use criteria see Appendix D. As a general rule, perennial streams are presumed to support a high aquatic life use. Water bodies that have designations other than high will be identified in each watershed summary section.

Contact Recreation - This use refers to how well a water body can safely support activities that involve physical contact such as swimming. The standard for contact recreation is a measure of bacteria levels. In freshwater, the indicator is Escherichia coli bacteria (E.coli), though fecal coliform bacteria have historically been used. Enterococci bacteria are the indicator in coastal water bodies. Criteria for fecal coliform, E.coli and enterococci are 200, 126 and 35 colony forming units (CFU), respectively. Because of the high salt content of many West Texas waters, TCEQ also uses enterococcus as the bacteriological indicator in select inland water bodies. This is the case in Segment 1412 in the upper basin where the criteria 33 CFU.

Assessment of Water Quality Data

Every two years, TCEQ compares all available quality assured-data to the Texas Surface Water Quality Standards (or to screening levels when no standards have been established) and publishes the results in the Texas Integrated Report for Clean Water Act Sections 305(b) and 303(d). The Integrated Report defines each water body as one of the following:

1. Meets or Supports status – At least ten data points were available to assess and the water body meets Texas Surface Water Quality Standards or supports the water body's designated use(s).

2. Concern status – a) Sufficient data to perform a full assessment were not collected, but the limited data indicate standards are not met, or b) standards have not yet been established, as is the case with nutrients. If standards have not been established, the data are compared to screening levels.

3. Impaired status – Sufficient amount of data are available and the water body does not meet state standards. TCEQ publishes impaired water bodies in the 303(d) List, part of the integrated report.

Water Quality Analysis

Water bodies may or may not support their designated uses based on a comparison of monitoring data to the water body's standards. In the simplest terms, if monitoring data indicate that a water body fully supports its uses, then the water body meets the state standards and water quality is considered good. If water quality data indicate a concern status based on the above definition, resources are allocated to collect more data and verify the concern. If monitoring data indicate that the water body does not support any of its designated uses, then it is said to be impaired and may have poor water quality. Impaired water bodies are placed on the TCEQ 303(d) List and are sometimes referred to as "listed." The 303(d) list refers to the section of the Clean Water Act that requires states to identify impaired water bodies.

Restoring Impaired Water Bodies

The first step to restoring impaired waters is to dermine the cause(s) of the impairment. This usually involves a special study that may include a historical water quality data review, targeted monitoring or a detailed watershed analysis. Once the cause of the impairment is identified, one of the following projects is usually put into place to address the impairment:

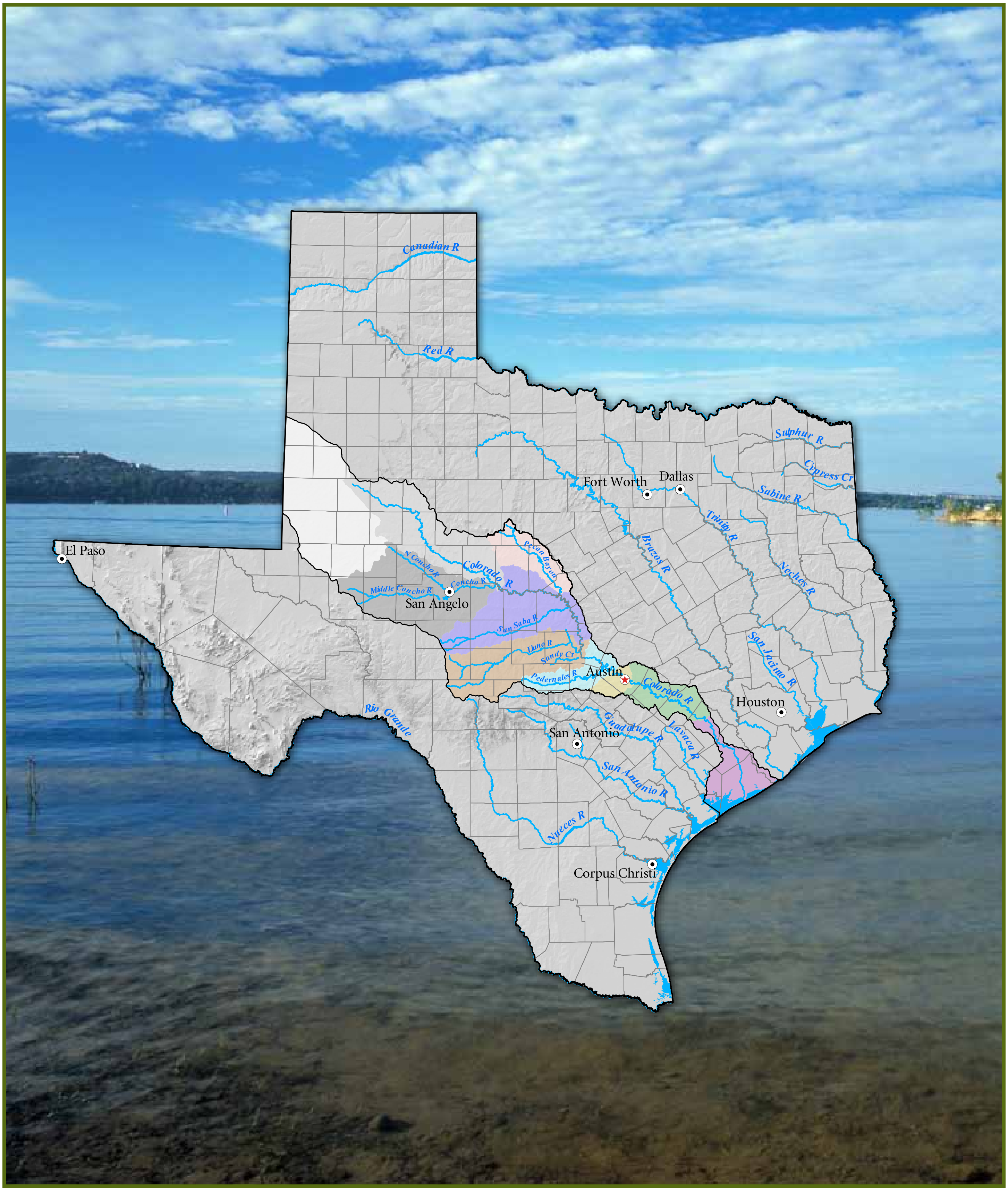
- **Total Maximum Daily Load (TMDL)** – a scientific model used to determine the amount or "load" of a pollutant that a water body can receive yet still support its designated uses. Once the load is allocated among all potential sources, an implementation plan outlines strategies to reduce pollutants. Implementation plans are enforced through regulatory compliance.

- **Watershed Protection Plan (WPP)** – A stakeholder-drivent process to address causes of the identified impairments and develop strategies to reduce pollutant loads. Compliance with WPP strategies is voluntary rather than regulatory.

- **Use Attainability Analysis (UAA)** - Where TMDL and WPP strategies are designed to improve water quality by limiting pollutants, a UAA can help determine whether the level of use originally assigned to the water body is appropriate. For example, in the late 1980s most rivers and streams were assigned a high aquatic life use. Since then, routinely collected data have shown that some water bodies do not meet a high aquatic life use; not because of pollution, but because natural conditions prevented high aquatic life use from being attained. TCEQ has performed UAAs to establish a more appropriate level of aquatic life use in the TSWQS.

- **Recreational Use Attainability Analysis (RUAA)** – Similar to a UAA, it confirms the level of recreational use that takes place in a stream. UAAs and RUAAs can result in a revision to TSWQS.

In 2010, TCEQ, the Texas State Soil and Water Conservation Board (TSSWCB) and CRP partners from around the state developed a process called watershed action planning (WAP) to help identify watershed restoration projects for impaired water bodies. On its simplest level, input is gathered from local stakeholders, agency staff and community leaders. The information, which describes potential sources of pollution, geographic factors in the watershed, community interest in a project, etc is stored in a database and used by TCEQ and other resource agencies prioritize their water quality protection efforts across the state. The WAP process is mentioned throughout this document as a source of information and as a basis of recommendations.



Canadian R
Red R
Sulphur R
Cypress Cr
Fort Worth
Dallas
Sabine R
Trinity R
El Paso
Brazos R
Neches R
Pecan Bayou
N Concho R
Colorado R
Concho R
Middle Concho R
San Angelo
San Saba R
Llano R
Sandy Cr
Austin
Pedernales R
Colorado R
Houston
San Jacinto R
Rio Grande
San Antonio
Guadalupe R
Lavaca R
San Antonio R
Nueces R
Corpus Christi

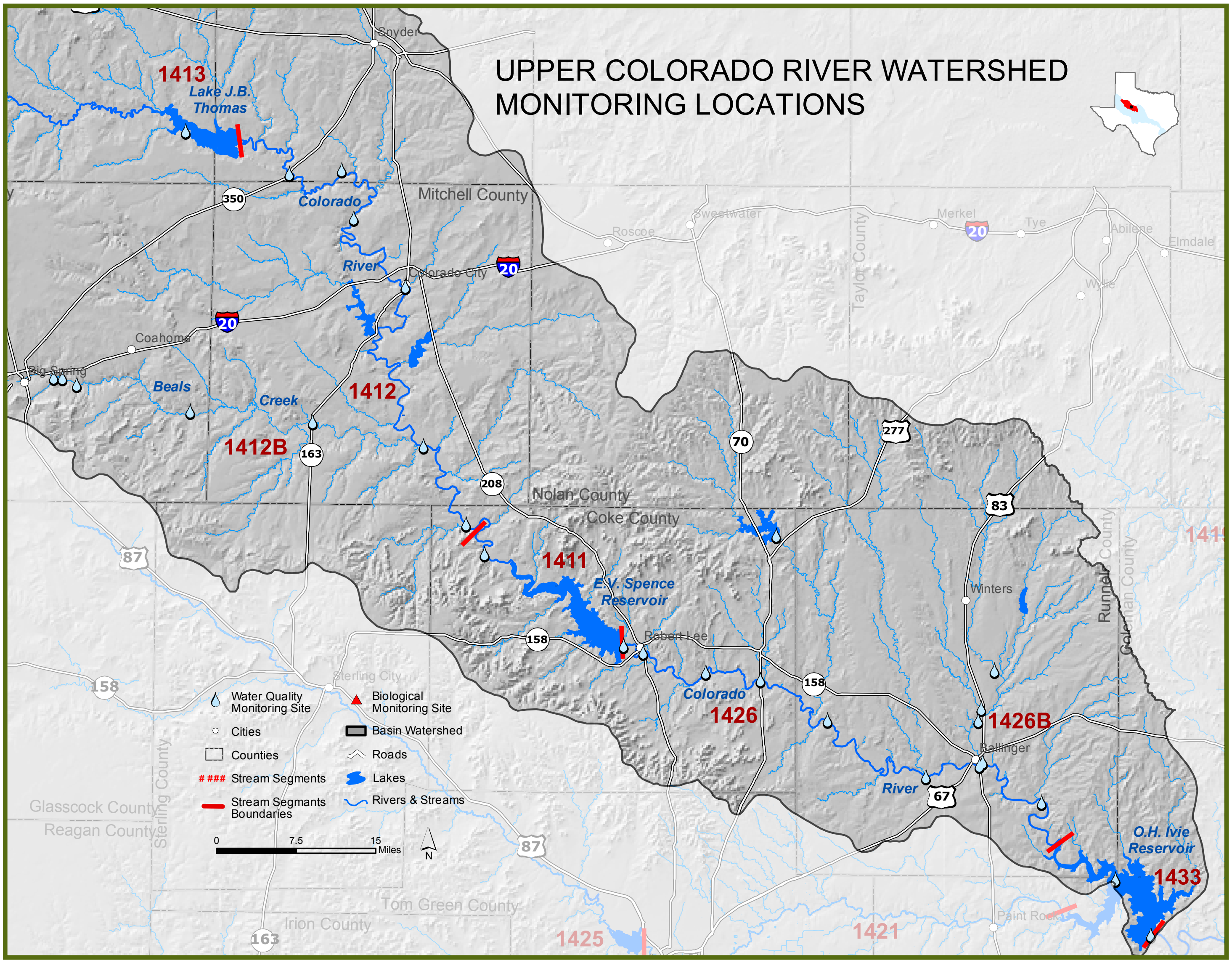
Watershed Summaries

The watershed summaries on the following pages provide detailed information about the status of water quality in each of the nine watersheds in the basin. The watersheds, listed from west to east, are:

- Upper Colorado River Watershed
- Concho River Watershed
- Pecan Bayou Watershed
- Lake Buchanan Watershed
- Lake LBJ Watershed
- Lake Travis Watershed
- Austin Metropolitan Watershed
- Lower Colorado River Watershed
- Coastal Watershed

Each summary includes watershed maps accompanied by a narrative description of each watershed. Watershed summaries are further broken down into segment discussion and include information from the TCEQ's 2010 Water Quality Inventory and from a 10-year trend analysis performed by LCRA. A good understanding of the technical process discussed above will help the reader interpret data presented in the watershed summaries.

Upper Colorado River Watershed



During the reporting period, 26 sites were routinely monitored on the following segments.

Segment 1411 - E. V. Spence Reservoir
Segment 1412 - Colorado River Below Lake J. B. Thomas
Segment 1412B - Beals Creek
Segment 1413 - Lake J. B. Thomas
Segment 1426 - Colorado River Below E. V. Spence Reservoir
Segment 1426B - Elm Creek
Segment 1433 - O. H. Ivie Reservoir

Upper Colorado River Watershed

The area of the Upper Colorado River Watershed is 12,000 square miles. It is situated mostly in the Rolling Plains and High Plains ecoregions. Semiarid climatic conditions exist over most of the watershed. Annual average precipitation ranges from less than 14 inches in its western portion to approximately 21 inches in its eastern portion. Many of the tributaries and drainage features of the watershed are either ephemeral or intermittent.

The majority of the watershed is used for agriculture. Farming is common, and irrigation with groundwater is often necessary in the High Plains ecoregion due to the semiarid conditions. Much of the upper watershed is also used to graze livestock.

Based on the 2010 Integrated Report and trend analyses, water quality in the Upper Colorado River watershed is largely impacted by drought conditions, though high levels of TDS can be at least partially attributed to naturally occurring geologic deposits and historic oil field contamination. Chlorophyll a and nutrients levels are high (Table 1) throughout the watershed.

Table 1. Summary of Impairments and Concerns for the Upper Colorado River Watershed

Segment	Name	Use	Parameter	Status
1411	E.V. Spence	General Use	Sulfate	Impairment
1411	E.V. Spence	General Use	TDS	Impairment
1411	E.V. Spence	General Use	Chlorophyll a	Concern
1411	E.V. Spence	General Use	Harmful Algal Bloom	Concern
1412	CR below Thomas	Contact Recreation	Bacteria	Impairment
1412	CR below Thomas	General Use	Depressed Dissolved Oxygen	Concern
1412	CR below Thomas	General Use	Chlorophyll a	Concern
1412B	Beals Creek	Contact Recreation	Bacteria	Impairment
1412B	Beals Creek	Aquatic Life Use	Selenium in Water	Impairment
1412B	Beals Creek	General Use	Orthophosphorus	Concern
1412B	Beals Creek	General Use	Total Phosphorus	Concern
1412B	Beals Creek	General Use	Nitrate	Concern
1412B	Beals Creek	General Use	Chlorophyll a	Concern
1412B	Beals Creek	General Use	Ammonia	Concern
1413	J.B. Thomas	General Use	TDS	Impairment
1413	J.B. Thomas	General Use	Chloride	Impairment
1426	CR below Spence	General Use	Chlorophyll a	Concern
1426	CR below Spence	General Use	Harmful Algal Bloom	Concern
1426B	Elm Creek	General Use	Chlorophyll a	Concern
1426B	Elm Creek	General Use	Nitrate	Concern

Upper Colorado River Watershed

Segment 1411

E. V. Spence Reservoir is an impoundment on the Colorado River near the community of Robert Lee. It drains about 4,000 square miles and, when full, has a surface area of 15,893 acres. Because of extreme drought conditions, the reservoir only contained a fraction of its capacity during the reporting period. As this report was published, it was at 0.41% of capacity.

E.V. Spence Reservoir at 4 percent of capacity in April, 2010

Data collected from multiple sites on the reservoir indicate elevated levels of TDS and sulfate. Sources of TDS and sulfate include geologic formation and historical oil field contamination. Chlorophyll a levels and golden algae blooms reached concern status in the reservoir. Fish kills associated with golden algae occurred in the reservoir in 2008, 2009 and 2011. Repeated fish kills have essentially eliminated fish communities in the lake. Long-term drought and low reservoir levels continue to contribute to algal blooms.

A TMDL, which was approved by EPA in 2003, is currently being implemented for E.V. Spence Reservoir. It uses point source controls, modification of reservoir operations, water quality enhancement diversions, and oil well plugging as means for controlling TDS loading. However, with the lake at such low levels little can be done to improve conditions without significant inflow.

There were no statistically significant trends.

Golden Algae Fish Kills

High nutrient levels and other factors can cause explosive growth of algae. During an "algal bloom," dissolved oxygen levels in water bodies can fluctuate from very high levels during the day to very low or lethal levels at night. While any algae bloom can kill fish by depriving them of oxygen, some algae also produce toxins that are a harmful to aquatic fish or plants.

Golden algae fish kill on E.V. Spence Reservoir

Since 1985, Prymnesium parvum, or golden algae, has caused a number of fish kills in Texas water bodies. While golden algae can occur in stock tanks and reservoirs, it is usually kept in check by competition with healthy populations of red and green algae. A bloom of golden algae is often triggered by significant temperature swings, cloudy weather or rising salinity levels. A minor bloom may kill or harm some fish, but serious kills can result when golden algae increases dramatically and produces toxins that coat fishes'' gills, leading to asphyxiation. For more information, see the TPWD Web site at www.tpwd.state.tx.us/landwater/water/environconcerns/hab/.

Segment 1412

This segment of the Colorado River begins below the Lake J. B. Thomas Dam in Scurry County and ends about 99 miles downstream near the rivers' confluence with Little Silver Creek in Coke County. The watershed consists mainly of agricultural land. Colorado City is located in the middle of the segment along IH 20.

Monitoring data collected near Colorado City indicate elevated levels of bacteria and chlorophyll a and low levels of dissolved oxygen. Potential sources of bacteria include urban runoff, failing wastewater lines and inadequate septic systems. A portion of the area upstream of the monitoring site consists of farms and rangeland. Runoff from these operations – and wildlife in the area - could be a source of bacteria in the river as well. Depressed dissolved oxygen concentrations are likely associated with low flow conditions, which are common in the watershed.

A superfund site, the former Col-Tex Refinery, is located approximately one mile upstream of the monitoring site. Remediation of organic chemicals at the refinery is ongoing, but it is not a likely source of bacteria.

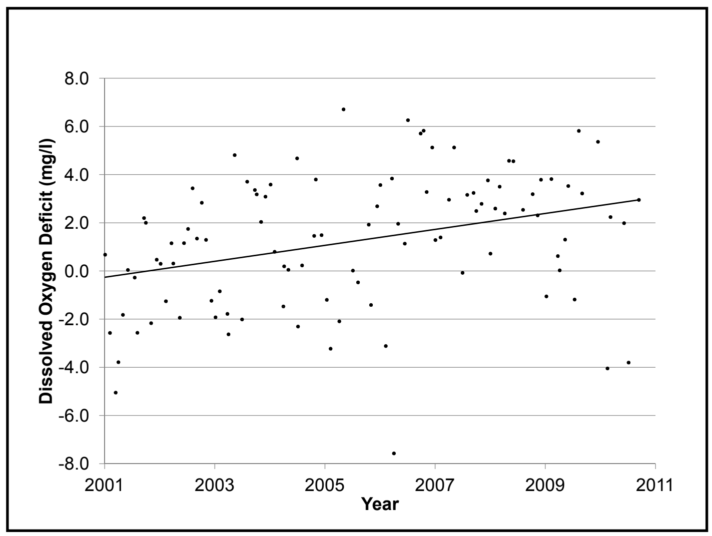


Figure 6. Dissolved oxygen deficit trend in Segment 1412 near Colorado City

Trend analyses were performed at two locations in Segment 1412: one at Colorado City and one at the rivers' confluence with Beals Creek. While no statistically significant trends were found at the downstream site, the Colorado City site showed an increase in dissolved oxygen deficit (Figure 6) and a decrease in nitrate. These trends coincide with drought conditions and low flow regimes.

Segment 1412B

Beals Creek begins just upstream of Big Spring and ends about 60 miles downstream at its confluence with the Colorado River. The watershed drains an area of approximately 2,000 square miles and consists mainly of agricultural land.

Beals Creek, a tributary of the Colorado River in the upper basin

Oil and gas production activities occur in the watershed.

Monitoring data collected near Big Spring indicate elevated levels of bacteria and selenium and concern levels of total phosphorous, nitrate, chlorophyll a, and ammonia. Potential sources of bacteria include wildlife and homes and businesses located along the creek. Potential sources of selenium include runoff from an industrial section of Big Spring or from natural sources. Based on USGS and Texas Water Development Board data, moderate concentrations of selenium have been found in groundwater and soils in the area. Nutrients are likely from the Big Spring WWTP, which discharges treated effluent into Beals Creek upstream of the monitoring site.

Trend analysis of data collected from the creeks' confluence with the Colorado River showed increasing chloride, TDS, and sulfate (Figure 7-9). This is likely due to drought- related low flows and dissolution of minerals from surface or near-surface geologic deposits.

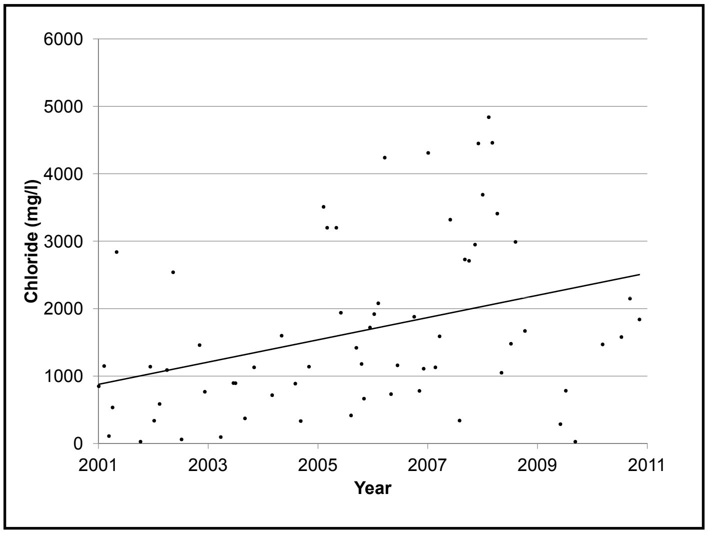


Figure 7. Chloride trend in Beals Creek

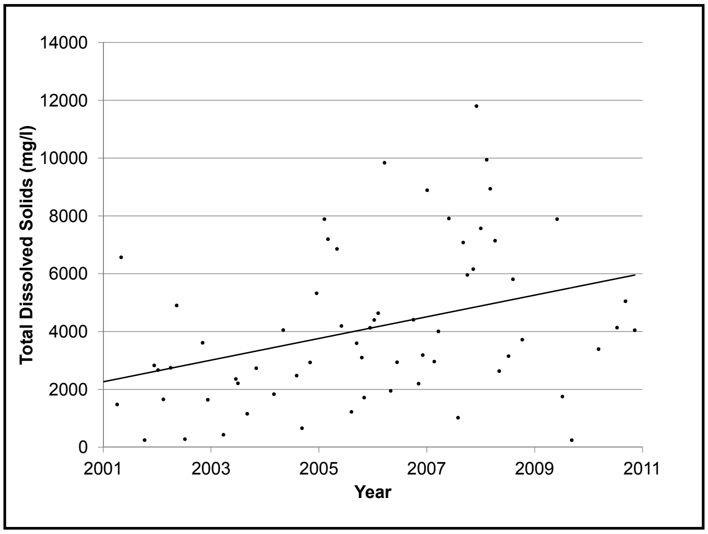


Figure 8. TDS trend in Beals Creek

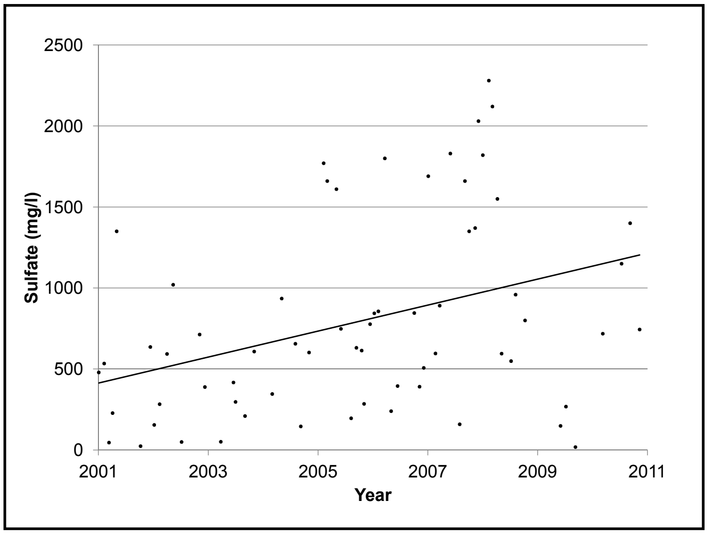


Figure 9. Sulfate trend in Beals Creek

Upper Colorado River Watershed

Segment 1413

Lake J. B. Thomas is an impoundment on the Colorado River in Scurry County. The lake has a surface area of 7,708 square acres with a conservation storage capacity of 204,604 acre feet of water. Historically, the lake has maintained only a fraction of its storage capacity. The watershed contains oil and gas deposits that have been in production since the 1930s. Seeps that have resulted from oil and gas production activities, including abandoned or inadequately plugged wells, have been identified in the watershed. These seeps typically produce high saline water and contaminate surface water.

Monitoring data indicate elevated levels of chloride and TDS. These concentrations are due to regional geology, prolonged drought and historical oil and gas production activities. Soils in the watershed are highly mineralized and dissolution of these minerals into surface water readily occurs. Annual precipitation in the area between December 01, 2001 and November 30, 2010 ranged from 14.6 to 35.3 inches with a mean of 22.7 inches. The reservoir was at 0.9% of capacity at print time. Evaporation coupled with low precipitation has concentrated minerals in the water.

Trend analysis showed an increase in TDS, sulfate, chloride and chlorophyll a (Figures 10-13) and a decreasing trend for nitrates. These trends coincide with declining lake levels.

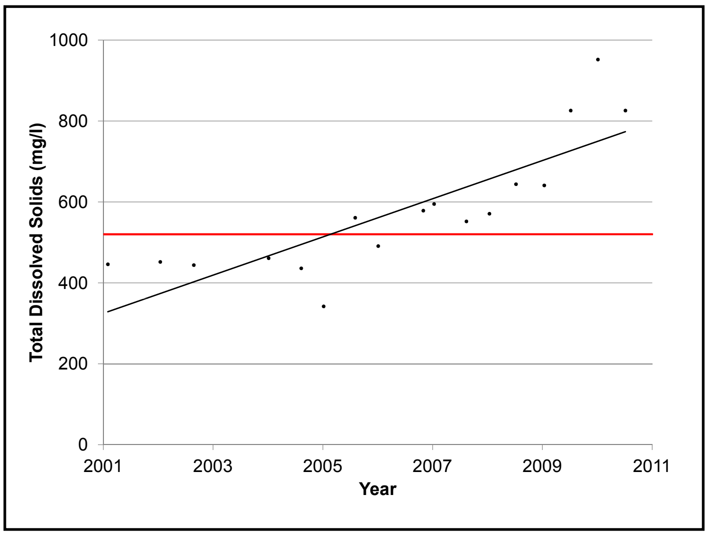


Figure 10. TDS trend in Lake J.B. Thomas

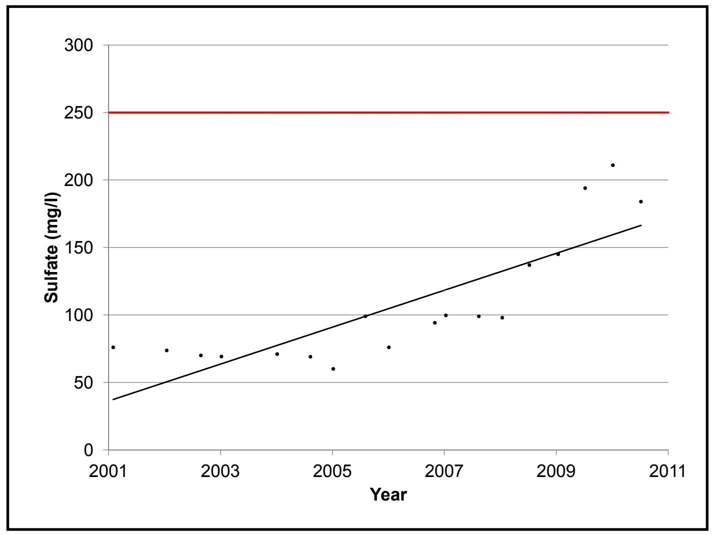


Figure 11. Sulfate trend in Lake J.B. Thomas

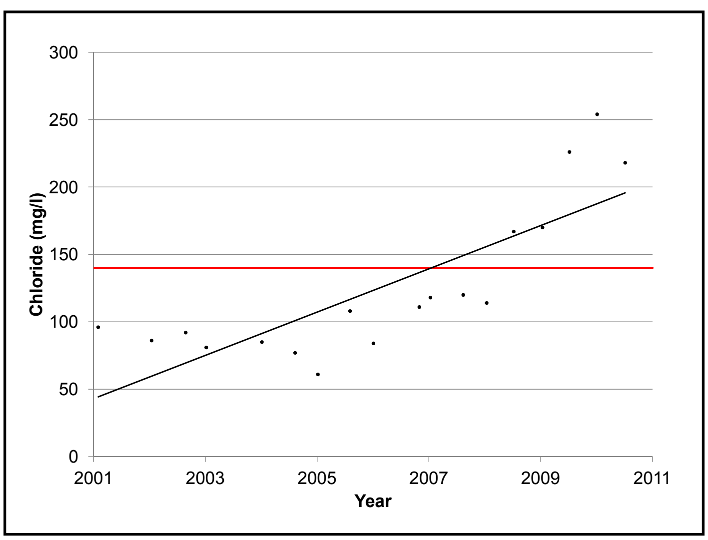


Figure 12. Chloride trend in Lake J.B. Thomas

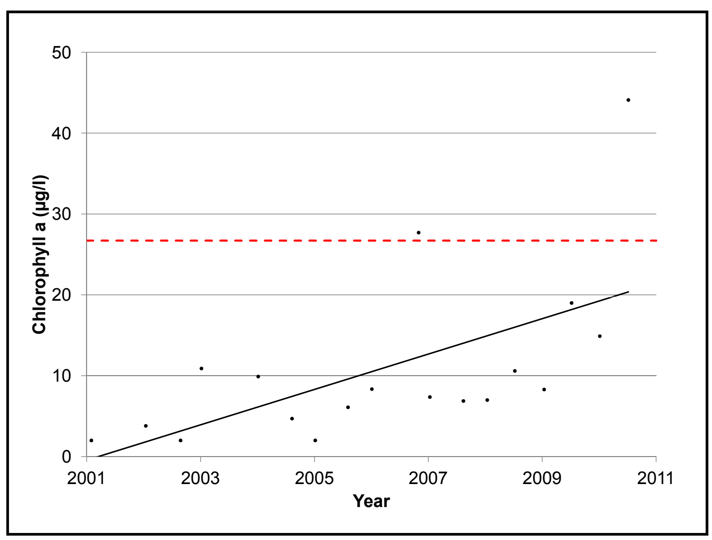


Figure 13. Chlorophyll a trend in J.B. Thomas

Segment 1426

This segment of the Colorado River begins just below E. V. Spence Reservoir and ends about 72 miles downstream near the headwaters of O.H. Ivie Reservoir in Runnels County. The watershed is rural and has become infested with saltcedar (Tamarisk sp.), a highly competitive non-native tree that increases salt content of soils and consumes large amounts of water through evapotranspiration. The segment drains approximately 1,800 square miles.

Colorado River below E.V. Spence Reservoir

Monitoring data collected at several locations indicate impairment levels of chloride and TDS and concern levels of chlorophyll a. The most likely cause is the ongoing drought and naturally-occurring and man-made sources of TDS. A concern for harmful alga blooms has also been identified as several fish kills in the lower part of the segment have been attributed to golden algae.

A TMDL for chloride and TDS was completed and approved by EPA in 2007. Implementation, which includes saltcedar removal and oil well plugging as means for controlling dissolved solids loading, is ongoing.

Trend analyses were performed on two sites in Segment 1426: one upstream of Ballinger and the rivers' confluence with Elm Creek and the other downstream of the confluence with Elm Creek. Both sites exhibited an increase in nitrate and decreases in chloride (Figures 14-17). The upper site also showed a decrease in TDS (Figure 18). One possible explanation for the decreasing chloride is the successful implementation of the TMDL measures. Causes of the increase in nitrate at both sites are unknown.

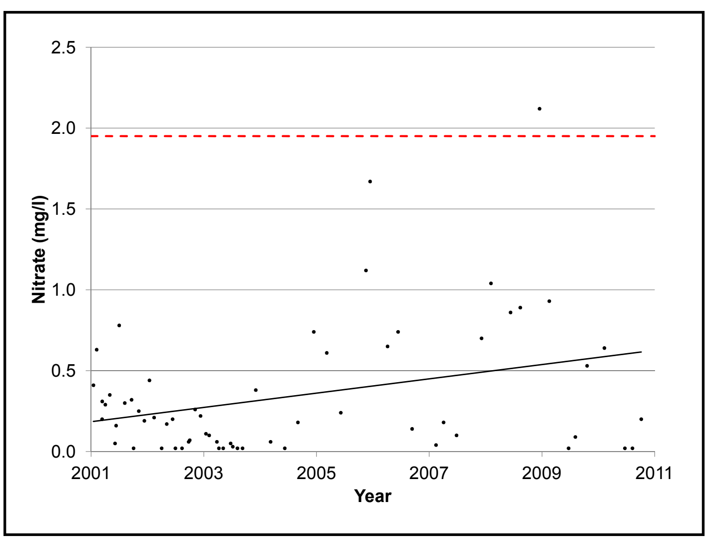


Figure 14. Nitrate trend for Segment 1426 upstream of Ballinger

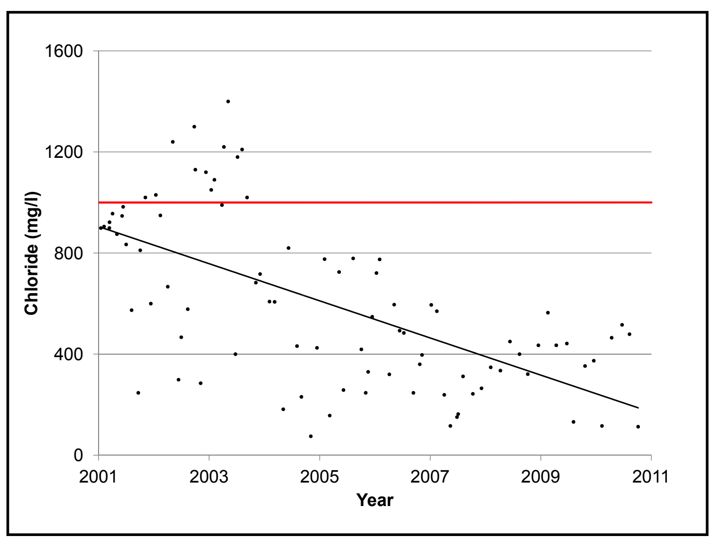


Figure 15. Chloride trend for Segment 1426 upstream of Ballinger

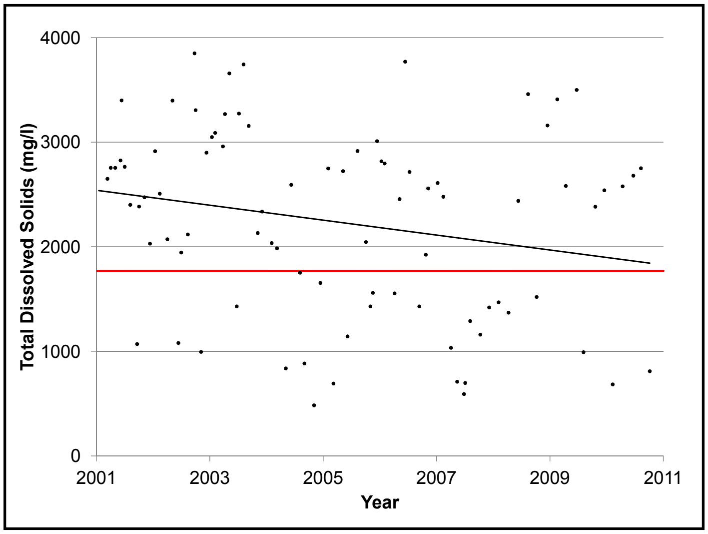


Figure 16. CTDS trend for Segment 1426 upstream of Ballinger

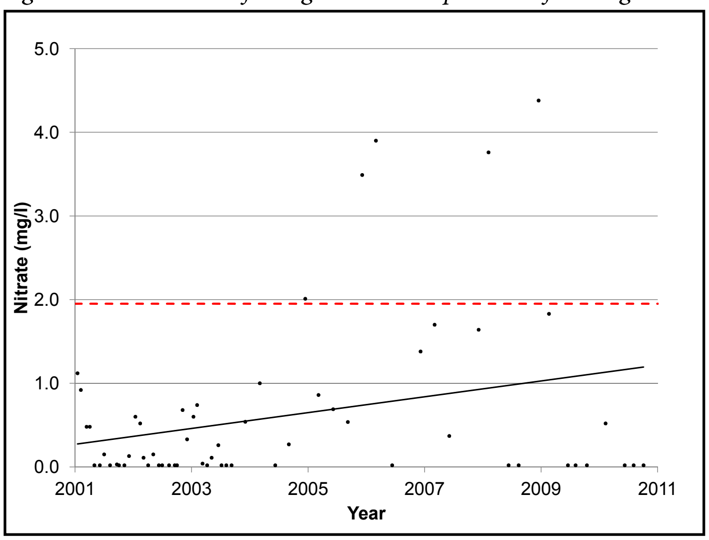


Figure 17. Nitrate trend for Segment 1426 downstream of Ballinger

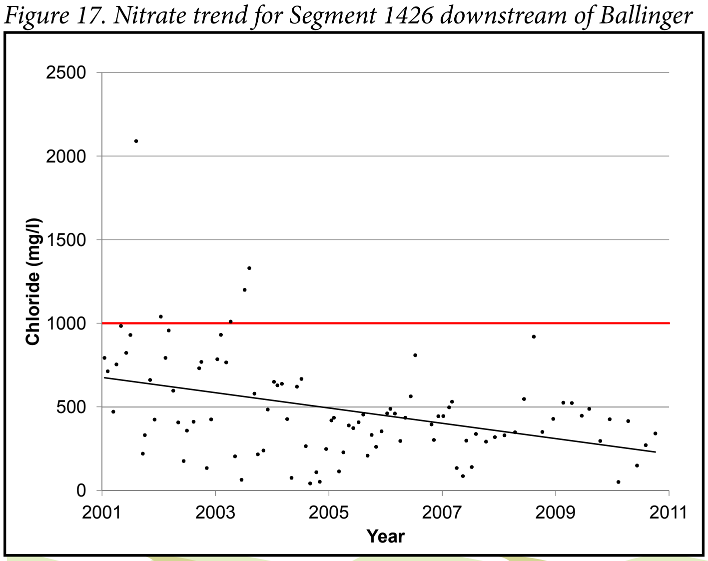


Figure 18. Chloride trend for Segment 1426 downstream of Ballinger

Segment1426B

Elm Creek begins about 15 miles north of Ballinger and ends in Ballinger at its confluence with the Colorado River. The watershed is rural and water quality meets all applicable surface water quality standards.

Monitoring data collected near the confluence with the Colorado River indicates concern levels of chlorophyll a and nitrate. The chlorophyll a is likely associated with drought conditions. The nitrate is likely due to influence of shallow groundwater in the region known for high nitrate levels.

Trend analysis showed an increase in chlorophyll a (Figure 19). While water quality in the creek remains relatively good, the drought is the most likely cause of chlorophyll a trends. The drought, lack of inflows and resulting stagnation provided ideal growing conditions for phytoplankton and elevated chlorophyll a.

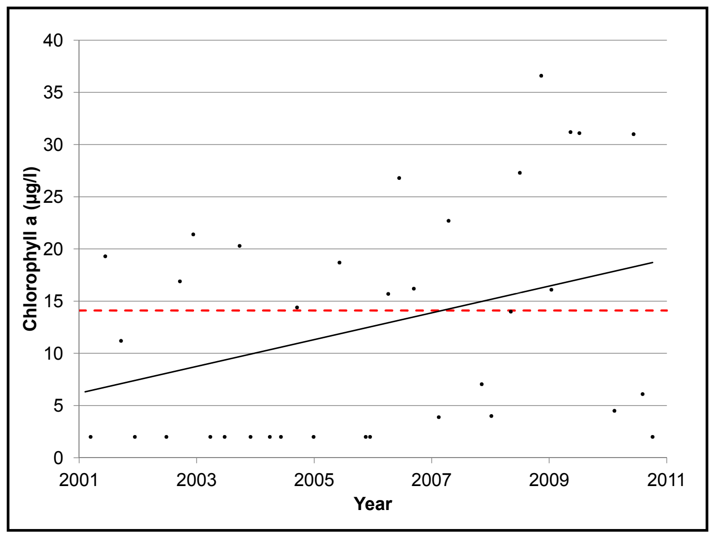


Figure 19. Chlorophyll a trend for Elm Creek

Segment 1433

O. H. Ivie Reservoir is an impoundment on the Colorado and Concho rivers in Coleman and Concho counties. The contributing area is approximately 1,820 square miles. When full, the reservoir holds 554,335 acre feet of water. However because of the severe drought in the region, the reservoir was only at a fraction of capacity during the reporting period. The reservoir was 16% of capacity when this report was printed.

Water in O.H. Ivie Reservoir meets all surface water quality standards. Trend analyses showed a decrease in chloride, sulfate, TDS and TSS (Figures 20-23), likely due to TMDL implementation actions being performed upstream. The cyclical nature of the data in each of the graphs corresponds to rain followed by drought.

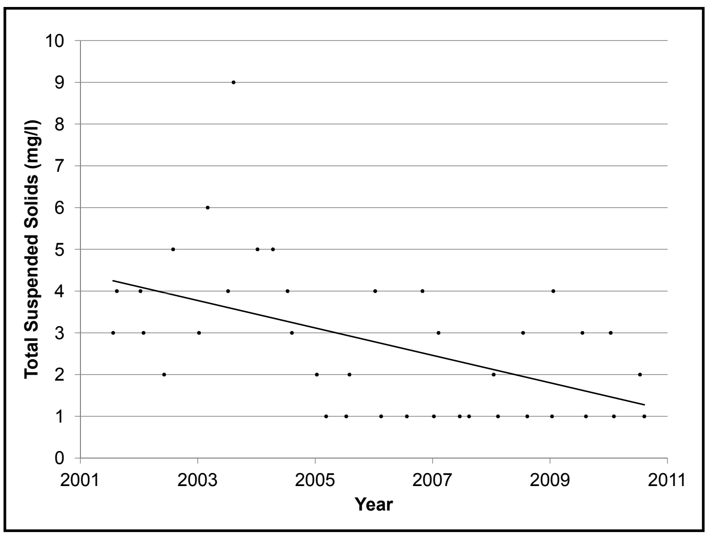


Figure 20. TSS trend for O.H. Ivie Reservoir

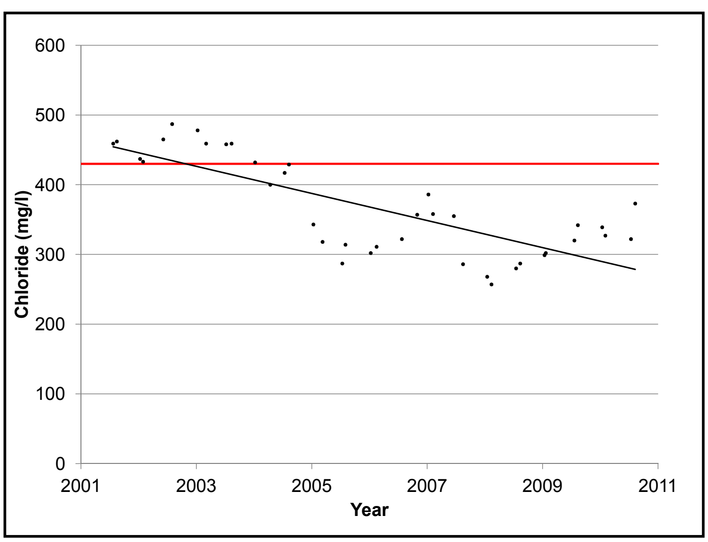


Figure 21. Chloride trend for O.H. Ivie Reservoir

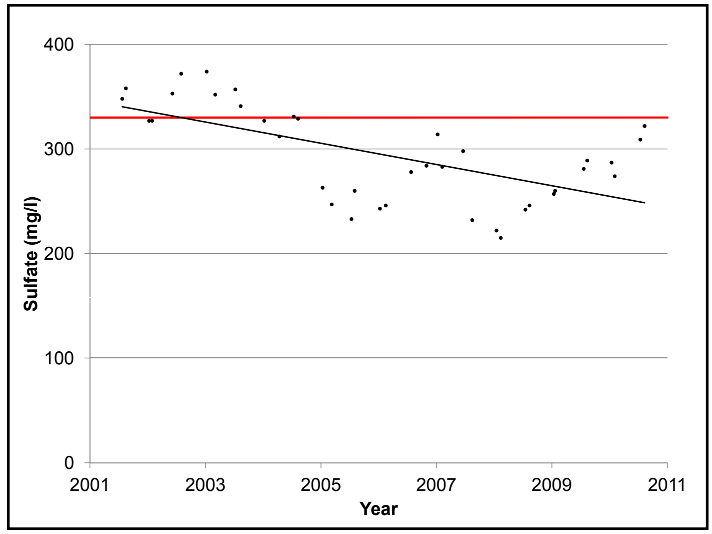


Figure 22. Sulfate trend for O.H. Ivie Reservoir

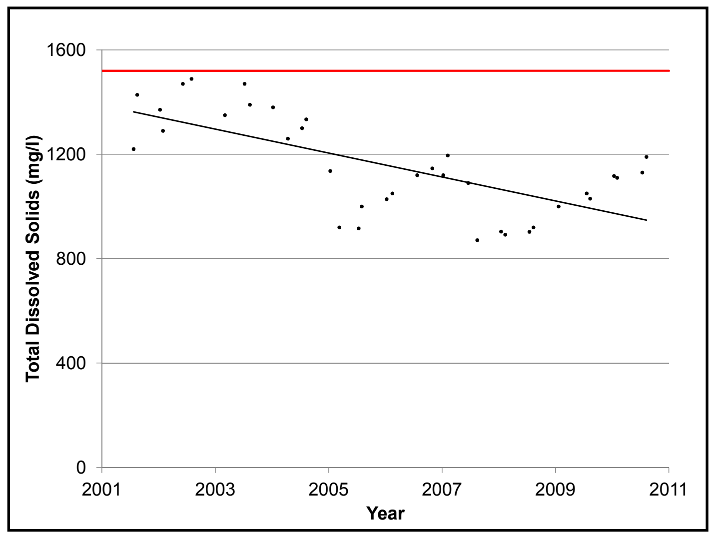
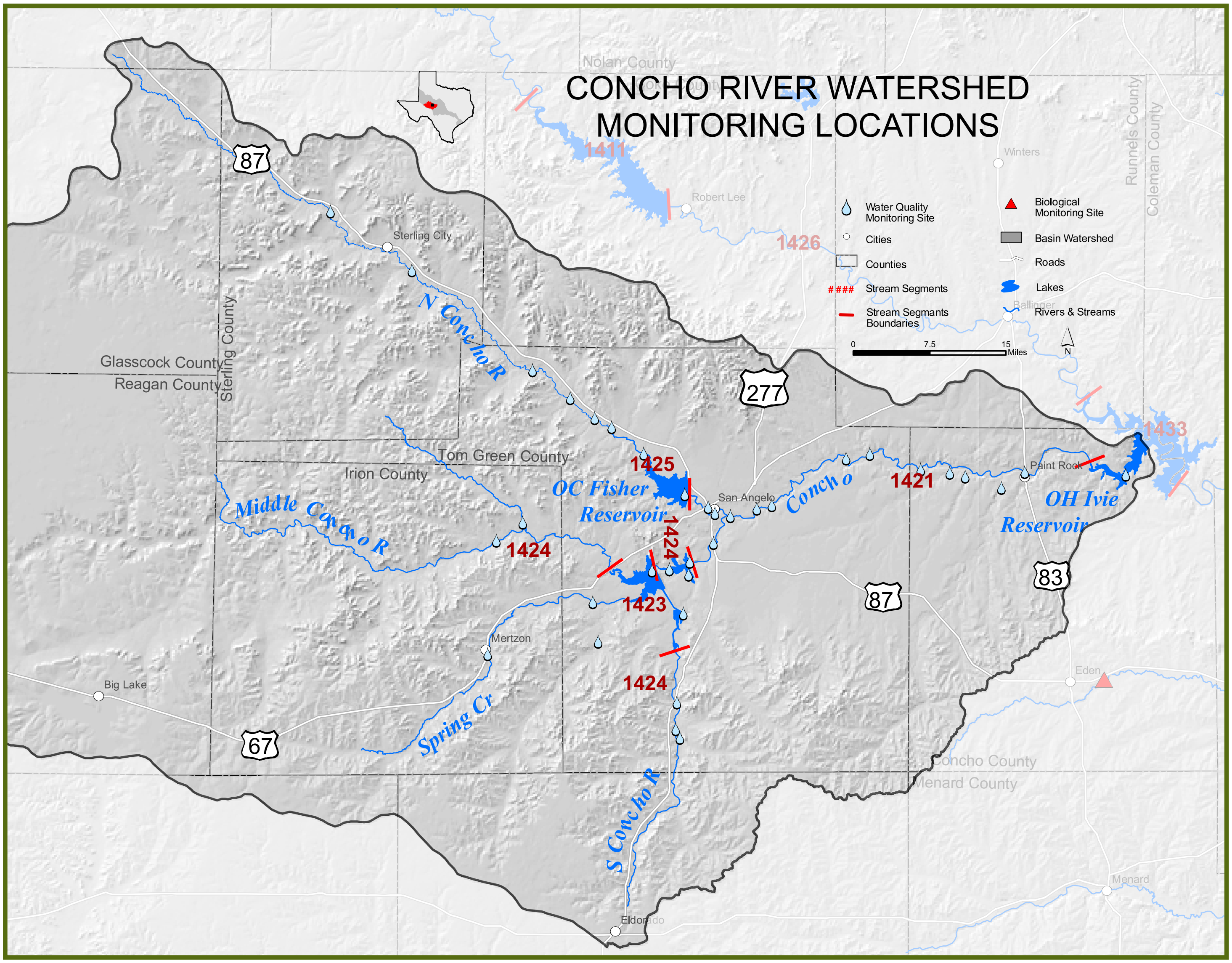


Figure 23. TDS trend for O.H. Ivie Reservoir

Future Challenges for the Upper Colorado River Watershed

- Lack of rainfall and low flows are prevalent throughout the upper watershed. Many of the water quality issues are due to the ongoing drought.
- Golden algae blooms will likely remain a significant challenge in the watershed. UCRA will monitor and document fish kills and continue to cooperate with TPWD in an effort to combat the problem.

Concho River Watershed



During the reporting period, 35 sites were routinely monitored on the following segments.

Segment 1421 - Concho River
Segment 1422 - Lake Nasworthy
Segment 1423 - Twin Buttes Reservoir
Segment 1423A - Spring Creek
Segment 1424 - Middle and South Concho Rivers
Segment 1425 - OC Fisher Lake
Segment 1425A - North Concho River

Concho River Watershed

With an area of approximately 6,700 square miles, the Concho River Watershed is the largest in the Colorado River basin. It is situated at the convergence of the High Plains, the Rolling Plains and Edwards Plateau ecoregions. Semiarid climatic conditions exist over most of the watershed with annual average precipitation ranging from less than 14 inches in its western portion to 21 inches in the eastern portion. Many of the tributaries are ephemeral or intermittent in nature.

The principal rivers in the watershed are the North, Middle and South Concho rivers, and the main Concho River. The rivers are impounded several times near San Angelo. The confluence of the Middle Concho and South Concho river is located at Lake Nasworthy west of San Angelo. The South Concho River continues below Lake Nasworthy to its confluence with the North Concho River above Bell Street Dam in east San Angelo to form the Concho River, which continues east to O.H. Ivie Reservoir.

The middle and south Concho rivers are impounded in the north and south pools of Twin Buttes Reservoir, respectively. The pools, which are connected by an equalization channel, serve as municipal water supply for the city of San Angelo. From Twin Buttes Reservoir, water is released into Lake Nasworthy, immediately downstream. Downstream of Lake Nasworthy, the Concho River flows through town and converges with released water from O.C. Fisher Lake on the North Concho River. The Concho River flows, sometimes sparsely, through pastures and irrigated fields to O.H. Ivie Reservoir about 60 miles downstream of San Angelo.

The North, Middle and main Concho rivers valleys are characterized by broad floodplains that contain fluvially deposits of gravel, sand and clay and form shallow alluvial aquifers. The South Concho River, including Spring and Dove creeks are characterized by much narrower and steeper valleys. These waterways are primarily fed by springs from the northern edge of the Edwards-Trinity Aquifer.

Based on the 2010 TCEQ Integrated Report, several concerns and impairments have been identified (Table 2). Nutrients have been identified as a concern throughout the basin. Bacteria, dissolved oxygen and biology has an impaired status in the Concho River in San Angelo.

Table 2. Summary of Impairments and Concerns for the Concho River Watershed

Segment	Name	Use	Parameter	Status
1421	Concho River	Aquatic Life	Dissolved Oxygen	Impairment
1421	Concho River	Aquatic Life	Macrobenthic Community	Impairment
1421	Concho River	Contact Recreation	Bacteria	Impairment
1421	Concho River	General Use	Chlorophyll a	Concern
1421	Concho River	General Use	Nitrate	Concern
1421	Concho River	General Use	Orthophosphorus	Concern
1422	Nasworthy	General Use	Orthophosphorus	Concern
1423	Twin Buttes	General Use	Orthophosphorus	Concern
1423A	Spring Creek	General Use	Nitrate	Concern
1425	O.C. Fisher	Aquatic Life	Dissolved Oxygen	Concern
1425	O.C. Fisher	General Use	Ammonia	Concern
1425	O.C. Fisher	General Use	Chlorophyll a	Concern
1425	O.C. Fisher	General Use	Orthophosphorus	Concern
1425A	North Concho River	Contact Recreation	Bacteria	Concern
1425A	North Concho River	General Use	Chlorophyll a	Concern

Concho River Watershed

Segment 1421

Segment 1421 includes the Concho River downstream of San Angelo and parts of the north and south forks of the Concho River in San Angelo up to O.C. Fisher Lake and Twin Buttes Reservoir, respectively. The Concho River and its tributaries drain approximately 800,000 acres.

North Concho River in San Angleo

Below San Angelo, the segment extends downstream approximately 45 river miles to Paint Rock in an area known as the Lipan Flats. The area is comprised of rich farmland and sits atop of the Lipan Aquifer, known for groundwater with high nitrogen concentrations.

Monitoring data collected in the upper reaches near San Angelo indicate low levels of dissolved oxygen, impaired benthic macroinvertebrate communities and high levels of bacteria. Elevated levels of nutrients warrant a concern status at several monitoring sites in the Concho River.

As presented in the Concho River Basin Watershed Protection Plan submitted to the TSSWCB in May of 2011, the bacteria impairment is likely attributable to avian sources.

The aquatic life impairments are due to a combination of low flows and urban stormwater runoff. Biological monitoring, including a study commissioned by TCEQ and conducted by USGS in 2008, continues to show an impaired biological community.

The overriding cause of elevated nutrients is most likely low flows in the Concho River caused by drought, brush infestation, and increasingly heavy irrigation withdrawals. The number of irrigation wells in the Lipan Flats region increased dramatically during the 1990s, from approximately 200 to over 1,000. The source of nitrate is not known with certainty, although leaching of nitrates from the soil into shallow groundwater due to long-term intensive farming activity is considered by many to be a likely candidate.

Data from two sites were reviewed for trends; one in San Angelo and one downstream near Paint Rock. The data collected in San Angelo showed a marked improvement in water quality with decreasing trends in chloride and sulfate over the 10 year period (Figures 24 and 25).

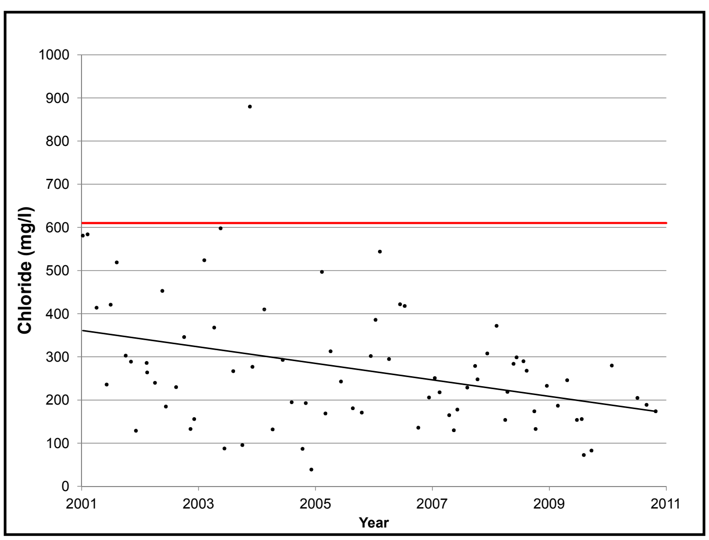


Figure 24. Chloride trend for the Concho River in San Angelo

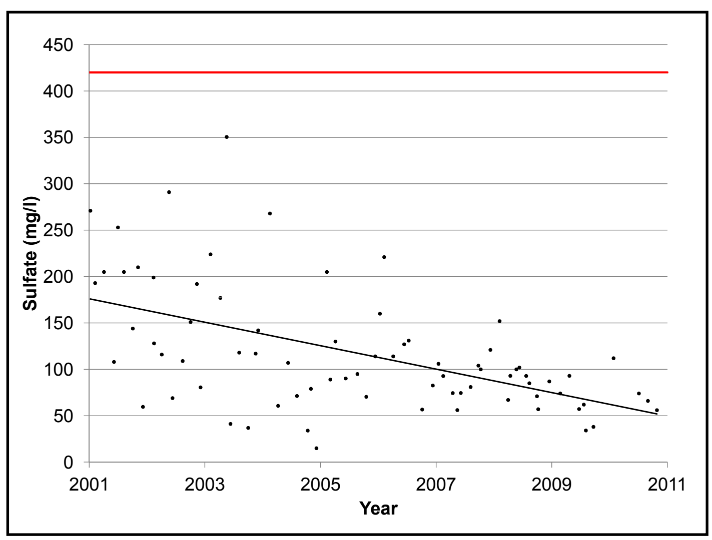


Figure 25. Sulfate trend for the Concho River in San Angelo

Concho River Watershed

The trends are likely due to inflows of water from Lake Nasworthy, a requirement of the Concho River Watermaster Program. Water releases from Lake Nasworthy, which typically has good water quality, have been required by the Watermaster since 2005. The dissolved oxygen deficit however, exhibits an increasing trend (Figure 26). This coincides with the aquatic life use impairment and is likely due to urban stormwater runoff from San Angelo.

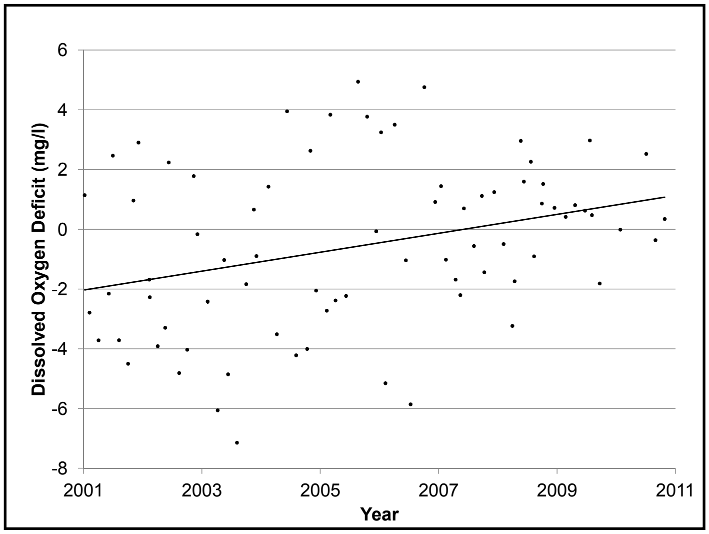


Figure 26. Dissolved oxygen deficit trend for the Concho River in San Angelo

Analysis of data collected near Paint Rock shows an increasing trend in chloride (Figure 27). The trend is likely attributable to lower inflows from the Lipan Aquifer due to drought, increased irrigation withdrawals, and brush infestation.

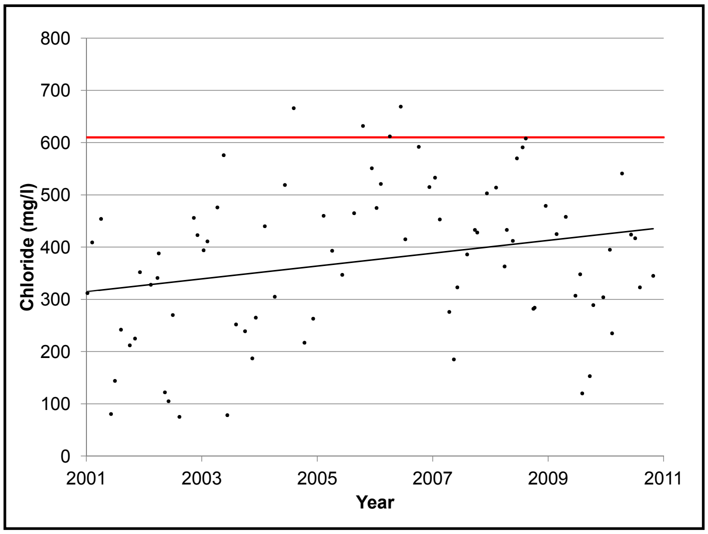


Figure 27. Chloride trend for the Concho River in Paint Rock

UCRA submitted a revised Concho River Basin Watershed Protection Plan to TSSWCB in 2011. The plan identified four major projects to address urban stormwater runoff problems:

- Preparation of a municipal stormwater ordinance including water quality modeling of the urban watershed.
- Development of a Stormwater Master Plan for the City of San Angelo.
- Removal of 50,000 cubic yards of anoxic sludge from the Concho River in San Angelo. The project, which cost $1.5 million, was completed in March, 2010.
- River bank stabilization in San Angelo. The $4 million project was partially financed by using Clean Water Act 319(h) funds.

North Concho River during bank stabilization project

Concho River Watershed

Segment 1422

Lake Nasworthy is an impoundment on the South Concho River, just below Twin Buttes Reservoir. Water released from Twin Buttes Reservoir is the primary source of water for Lake Nasworthy. The lake holds approximately 14,000 acre feet of water at conservation pool.

Water quality in the lake is generally good. While Lake Nasworthy meets all applicable state water quality standards, elevated levels of orthophosphorus are a concern status. The likely source of orthophosphorus in Lake Nasworthy is water from Twin Buttes Reservoir, which also has elevated levels of orthophosphorus.

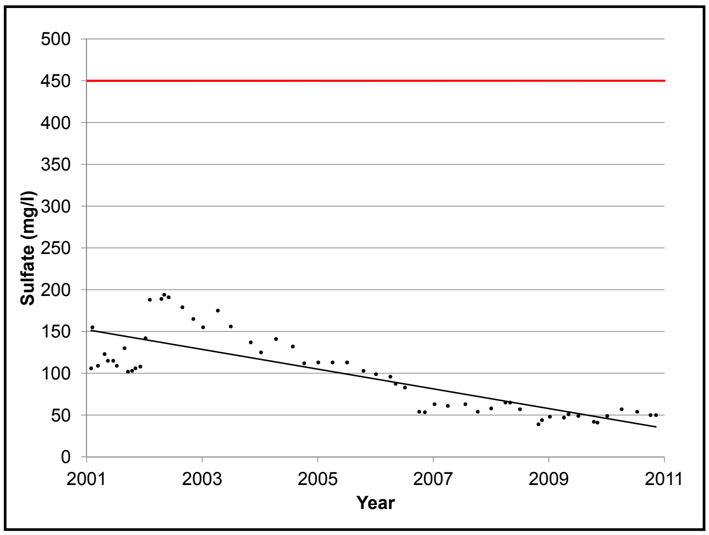


Figure 28. Sulfate trend for Lake Nasworthy

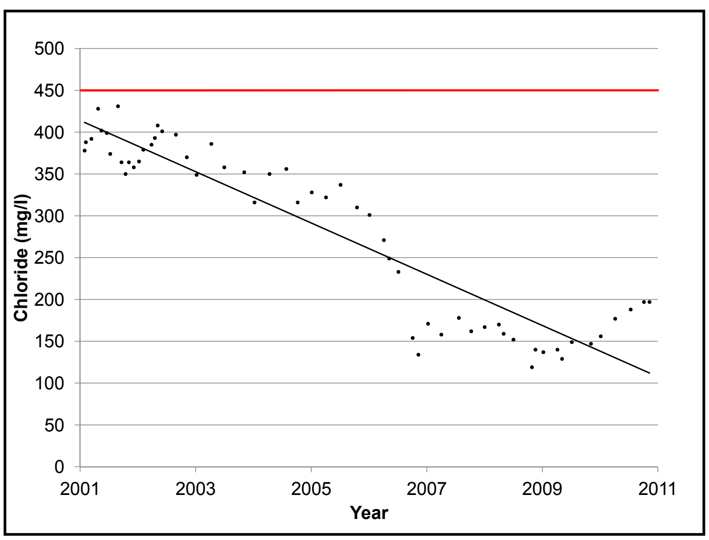


Figure 29. Chloride trend for Lake Nasworthy

The trend analyses illustrate increasingly good water quality in the lake. Sulfate, chloride and TDS have decreased. pH has increased, but it is well within the acceptable range. The decrease in salts is likely a result of the quality of pass-through water from Twin Buttes Reservoir (Figures 28-30).

Lake Nasworthy with the South Concho River in the foreground

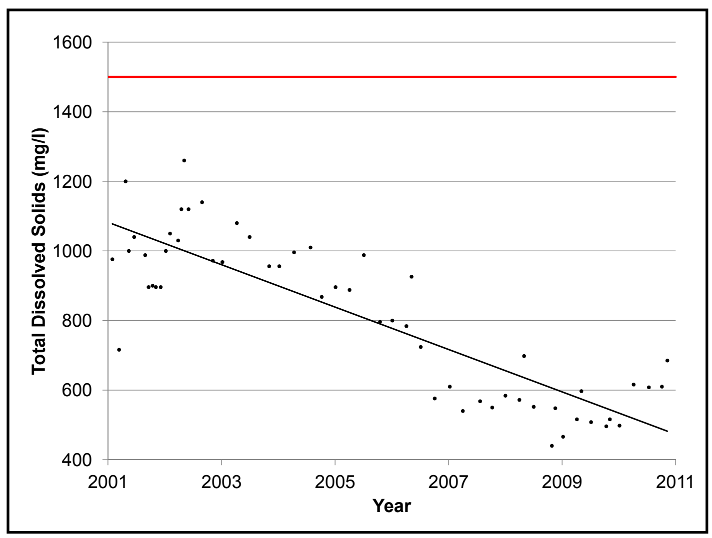


Figure 30. TDS trend for Lake Nasworthy

Segment 1423

Twin Buttes Reservoir is an impoundment on the south and middle forks of the Concho River and on Spring and Dove creeks. It impounds water from a drainage area of approximately 2.2 million acres.

While elevated levels of orthophosphorus indicate a concern status, monitoring data show that water quality in Twin Buttes Reservoir is good and meets applicable surface water quality standards. A possible source for the orthophosphorus is farming operations that are located near the reservoir and along Spring Creek, Dove Creek, and the South Concho River.

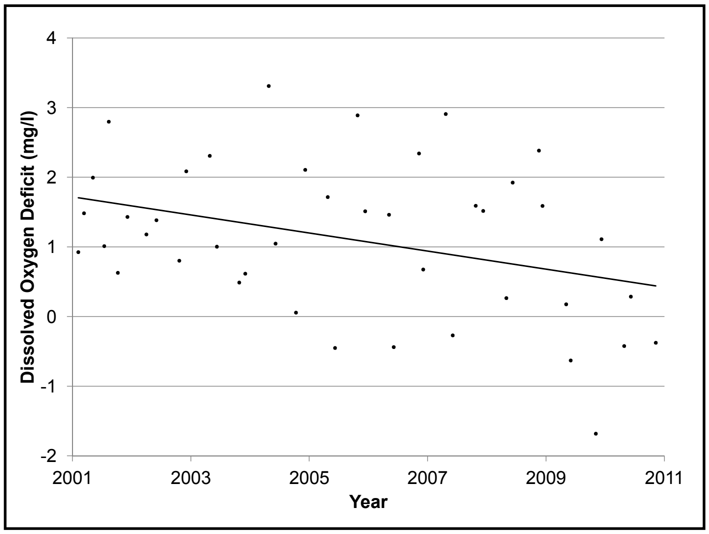


Figure 31. Dissolved oxygen deficit trend for Twin Buttes Reservoir

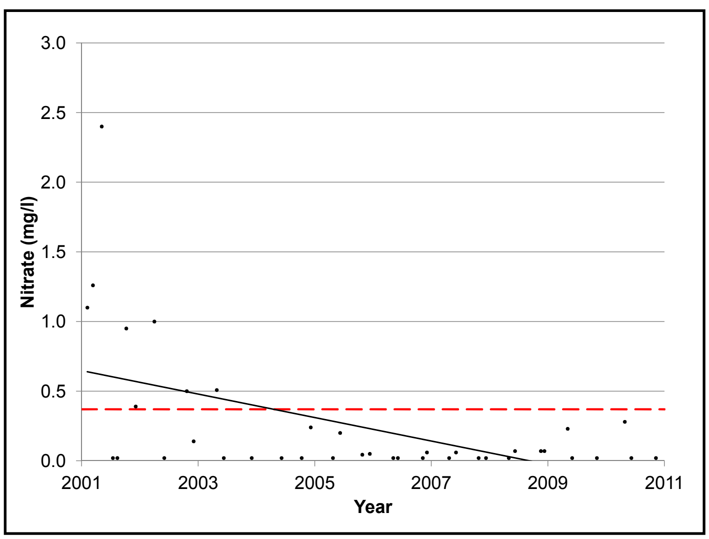


Figure 32. Nitrate trend for Twin Buttes Reservoir

Trend analyses indicate improving water quality (Figures 31-34). The reservoir received significant runoff inflows at the end of 2004. The resulting dilution caused decreases in chloride and sulfate subsequent sampling events. If reservoir levels continue to decline from diminishing inflows, use and evaporation, water quality can be expected to consequently decline.

Twin Buttes Reservoir at less than 10% of capacity

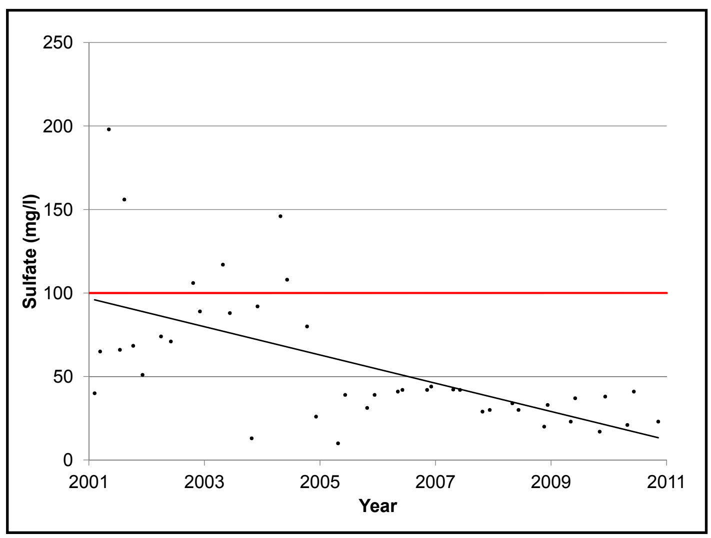


Figure 33. Sulfate trend for Twin Buttes Reservoir

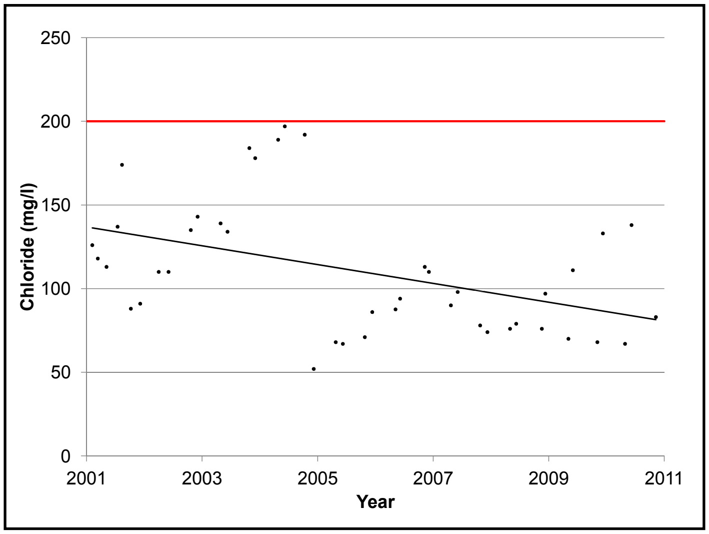


Figure 34. Chloride trend for Twin Buttes Reservoir

UCRA conducted an ongoing water enhancement program through control of invasive brush species project in and around Twin Buttes Reservoir. The project was carried out in partnership with United States Bureau of Reclamation, City of San Angelo, and TSSWCB. It was completed in early summer of 2012. A total of 1200 acres of saltcedar, 2,700 acres of willow baccharis, and 5250 acres of mesquite were treated by aerial application of herbicide.

Aerial application of herbicide on Twin Buttes Reservoir

Segments 1423A

Spring Creek, a tributary of Twin Buttes Reservoir, is a rural stream with perennial flows. As the name implies, the stream is spring-fed and contains some of the best water quality in the Concho River basin. The creek is about 40 miles long.

While elevated levels of nitrate indicate a concern status, monitoring data collected near the headwaters of Twin Buttes Reservoir show that water quality meets applicable surface water quality standards.

Data collected from Spring Creek near Mertzon indicates a concern for elevated levels of nitrate based on the 2010 Integrated Report. Data from another site approximately 20 miles downstream, near the headwaters of Twin Buttes Reservoir, indicate nitrate values are well below the screening level and are decreasing (Figure 35).

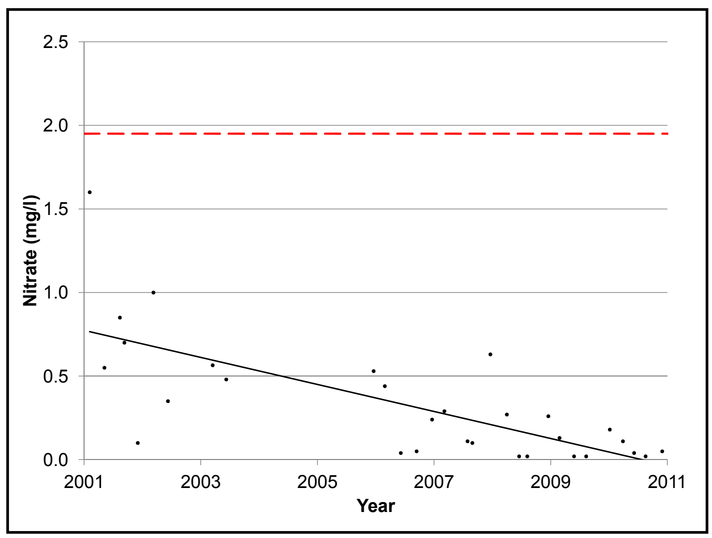


Figure 35. Nitrate trend for Spring Creek

Segment 1424

Segment 1424 consists of the Middle Concho and South Concho rivers. Although the South and Middle Concho rivers are included in the same segment, the two rivers have very different characteristics. The South Concho River is a perennial spring-fed stream created by several large springs that form its headwaters. The Middle Concho River flows intermittently and has been dry during most of the reporting period. Because of its constant flows, the South Concho River generally has better water quality. The watersheds surrounding both streams have historically been used almost entirely for agriculture, consisting primarily of rangeland and farmland. Most of the farmland is located in the northwestern portion of the watershed.

South Concho River

Water quality in the Middle and South Concho rivers is good. No impairments or concerns have been identified. Trend analysis indicated decreasing chloride and ammonia levels on the South Concho River near Christoval.

Segment 1425

O.C. Fisher Lake is an impoundment on the North Concho River west of San Angelo. The watershed is over 900,000 acres with the primary land use being agricultural. Its upper reaches of the North Concho River (Segment 1425A) consist of unimproved pastures with occasional fields of row crops irrigated with groundwater. The lake held only a fraction of its total capacity during most of the reporting period, and it completely dried-up in 2011.

Lake O.C. Fisher at less than 1% of capacity in May, 2011

The lake currently meets all surface water quality standards, but data show a concern status for ammonia, chlorophyll a, depressed dissolved oxygen and orthophosphorus. These concerns are related to the extreme low levels of the lake and the associated poor water quality resulting from the process of the lake drying-up.

Figures 36-38, on the following page, show the relationship of lake levels and diminishing water quality. The lake contents were decreasing prior to 2005 and water quality was declining. The lake captured water in 2005 then began a steady decline in water levels. The changes in water quality coincide with changes in lake levels.

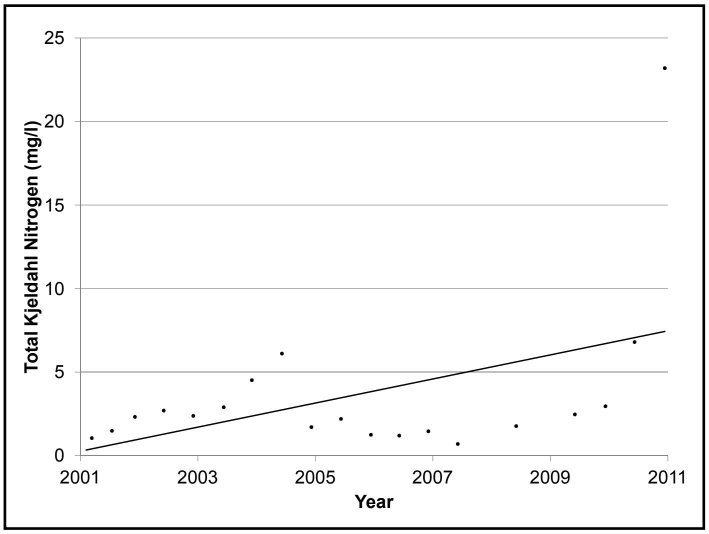


Figure 36. TKN trend for Lake O.C. Fisher

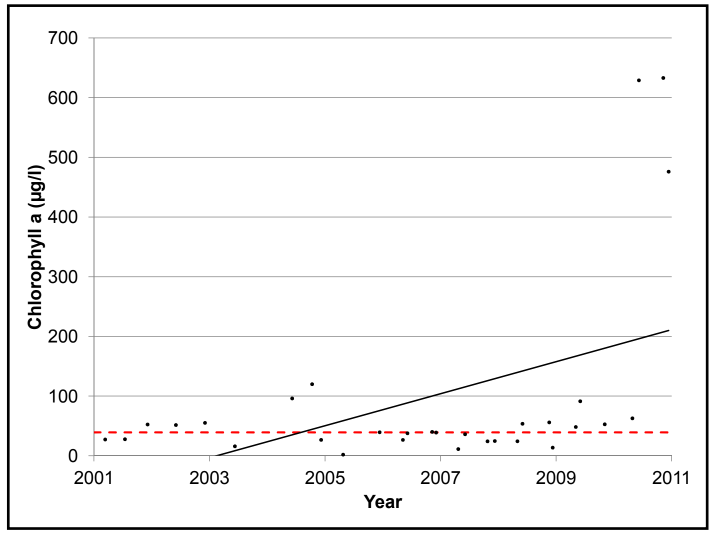


Figure 38. Chlorophyll a trend for Lake O.C. Fisher

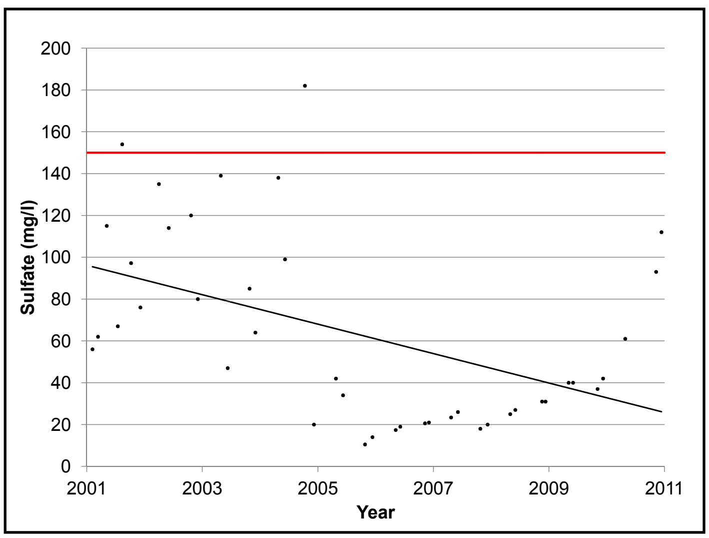


Figure 37. Sulfate trend for Lake O.C. Fisher

Segment 1425A

This segment consists of the North Concho River from the headwaters of O.C. Fisher Lake near San Angelo in Tom Green County upstream to the Glasscock/Howard County line. The watershed is primarily used for agriculture with irrigation taking place near the headwaters. The stream, which is intermittent, is about 104 miles long.

Water quality data indicate concern levels for bacteria and chlorophyll a. The bacteria concern is a carry forward from sampling that was done in the 1980s. Bacteria exceedances have not been occurring in recent sampling events. The site is currently dry. The concern will likely be dropped when flows are again established and enough samples are collected to statistically eliminate the concern. The chlorophyll a concern is likely attributable to low flows. Trend analysis indicates decreasing nitrate levels (Figure 39).

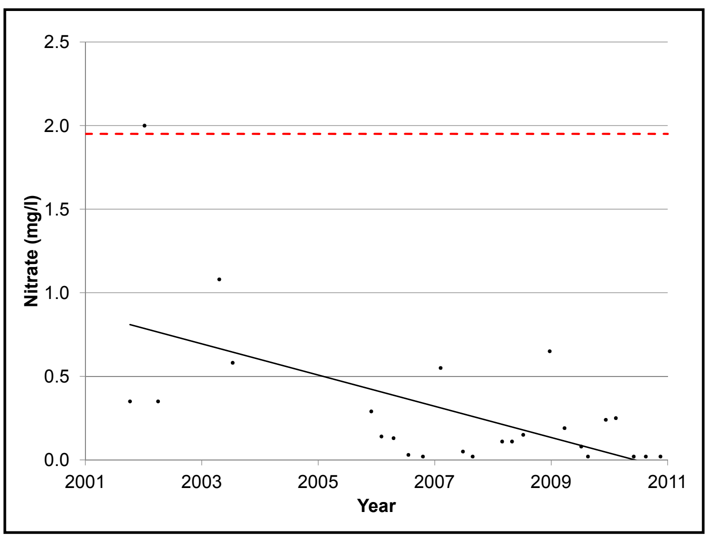
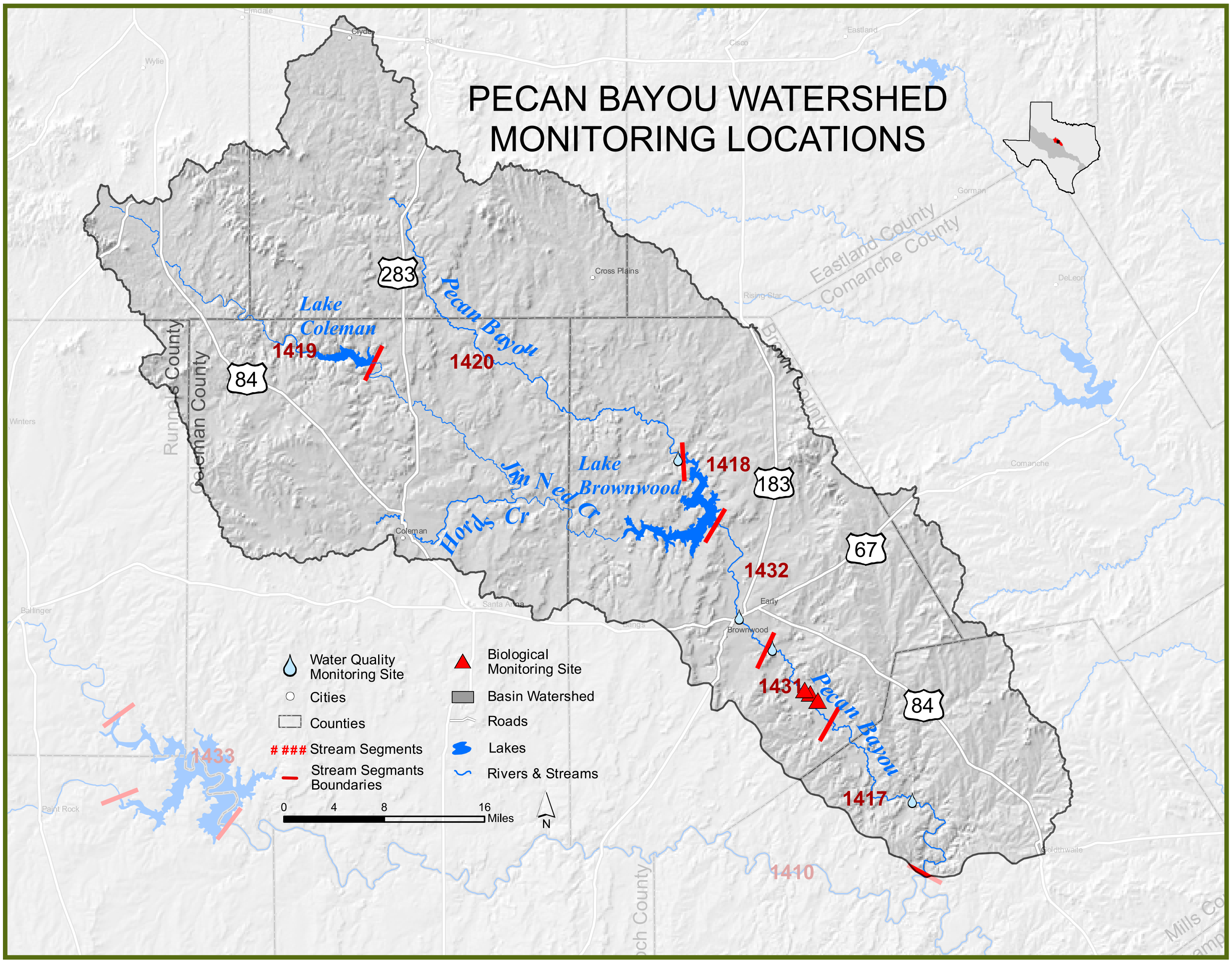


Figure 39. Nitrate trend for the North Concho River

Future Challenges for the Concho River Watershed

- Lack of precipitation and low flows continue to impact water quality in the Concho River basin.
- Bacteria levels in urban areas are problematic. UCRA has submitted an application to the EPA Urban Waters Small Grants Program to perform bacteria source tracking and develop and implement BMPs to address the issue.
- Golden algae will remain a significant challenge. While there has been no significant impacts to fish communities, UCRA will monitor and document fish kills and continue to cooperate with TPWD to combat the problem.

Pecan Bayou Watershed



During the reporting period 19 sites were routinely monitored on the following segments.

Segment 1417 – Lower Pecan Bayou
Segment 1418 – Lake Brownwood
Segment 1419 – Lake Coleman
Segment 1420 – Pecan Bayouabove Lake Brownwood
Segment 1431 – Mid Pecan Bayou
Segment 1432 – Upper Pecan Bayou

Pecan Bayou Watershed

The Pecan Bayou headwaters are southeast of Abilene. The 2,200 square mile watershed is part of the fertile Central Oklahoma-Texas Plains Ecoregion. Flat terrain and sluggish flow make the bayou more akin to an East Texas stream than other Colorado River tributaries. The stream flows to the southeast and into the Colorado River in Mills County above Lake Buchanan. Several small tributaries provide intermittent flows to the bayou. Jim Ned Creek, a major tributary, forms Lake Coleman and merges with Pecan Bayou to form Lake Brownwood, near the City of Brownwood.

According to the 2010 Integrated Report, there are no concerns or impairments in the upper watershed. Below the City of Brownwood, elevated bacteria levels have created an impairment for contact recreation and elevated nutrient levels have created a concern status (Table 3).

Table 3. Summary of Impairments and Concerns for the Pecan Bayou Watershed

Segment	Name	Use	Parameter	Status
1417	Lower Pecan Bayou	Aquatic Life	Chlorophyll a	Concern
1417	Lower Pecan Bayou	Aquatic Life	Nitrate	Concern
1418	Lake Brownwood	Aquatic Life	Manganese (Sediment)	Concern
1431	Mid Pecan Bayou	Contact Recreation	E. coli	Impairment
1431	Mid Pecan Bayou	Aquatic Life	Total Phosphorus	Concern
1431	Mid Pecan Bayou	Aquatic Life	Orthophosphorus	Concern
1431	Mid Pecan Bayou	Aquatic Life	Nitrate	Concern

Segment 1417

The most downstream segment of Pecan Bayou is undeveloped and includes mostly pasture land. This segment supports its designated uses according to the 2010 Integrated Report, but chlorophyll and nitrate levels are a concern. High chlorophyll and nitrate levels may be a result of influences identified in Segment 1431 upstream.

Trend analyses indicate that bacteria and total suspended solids in Segment 1417 have decreased. Lower TSS levels are probably due to reduced runoff during the ongoing drought. Since bacteria correlates to runoff and, in some cases TSS, lower bacteria levels are understandable.

Pecan Bayou near the confluence with the Colorado River

Pecan Bayou Watershed

Segment 1418

Lake Brownwood is an impoundment of Pecan Bayou and Jim Ned Creek. The reservoir has a surface area of approximately 7,300 acres at conservation pool elevation. It was built in the early 1930s as a municipal and agricultural water supply for the region.

While Lake Brownwood supports its designated uses, in 2008, TCEQ identified a concern for aquatic life due to high levels of manganese found in sediment. The Abilene Regional Office of TCEQ plans to monitor for the heavy metal in 2012 to collect more data and substantiate the concern. The source of manganese in Lake Brownwood is unknown; it is a naturally occurring element that has been found in high concentrations in pockets throughout Texas.

Trend analysis revealed an increase in dissolved oxygen deficit (Figure 40), the difference between how much dissolved oxygen is in the water versus the maximum amount of dissolved oxygen the water could potentially hold. As expected dissolved oxygen levels fluctuate seasonally, with high values in the warmer months and lower values in the winter time. Although the trend is significant, recent data show a return toward lower deficits.

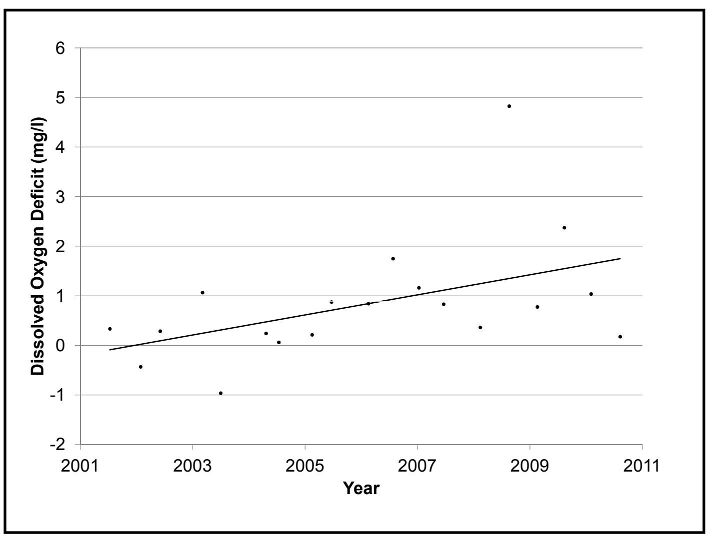


Figure 40. Dissolved oxygen deficit trend in Lake Brownwood

Segment 1419

Lake Coleman is an impoundment on Jim Ned Creek in Coleman County. The lake, which was impounded in 1966, has a surface area of approximately 2,000 acres at the normal pool elevation. Monitoring data indicate that the lake supports its designated uses.

Trend analysis showed a sharp rise in chlorophyll a concentrations from 2006 to 2010 (Figure 40). The drought, lack of inflows and resulting stagnation provided ideal growing conditions for phytoplankton and are probably responsible for the increase in chlorophyll a.

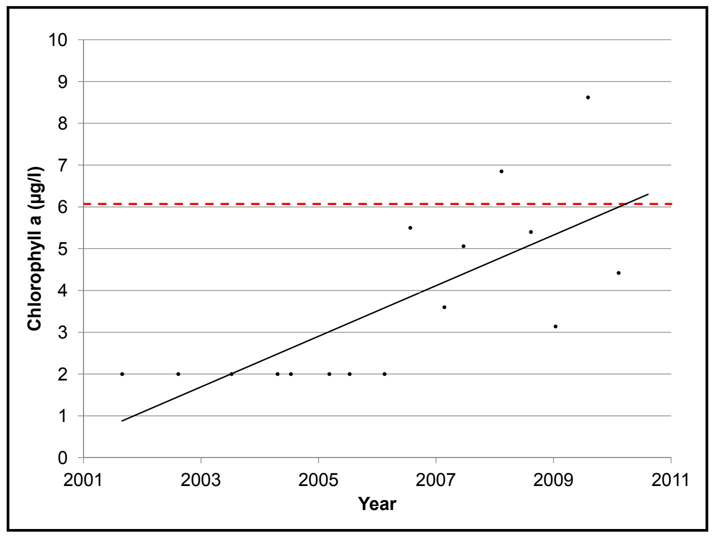


Figure 41. Chlorophyll a trend in Lake Coleman

Segment 1420

Pecan Bayou above Lake Brownwood is approximately 51 miles long. The uppermost portion begins as little more than a trickle. In its upper reaches, the stream is narrow and much of the riparian corridor is intact. As it flows southeast, the stream picks up flow from two tributaries: Little Pecan Bayou and Turkey Creek. Below State Highway 283, the riparian corridor is less intact and row crops are more prominent.

The 2010 Integrated Report shows that the lake supports its designated uses with a concern status for elevated levels of chlorophyll a. Not surprisingly, trend analysis showed an increase in chlorophyll a over time (Figure 42). The trend is likely a result of drought. Stagnant pools in the stream provided favorable conditions for phytoplankton blooms.

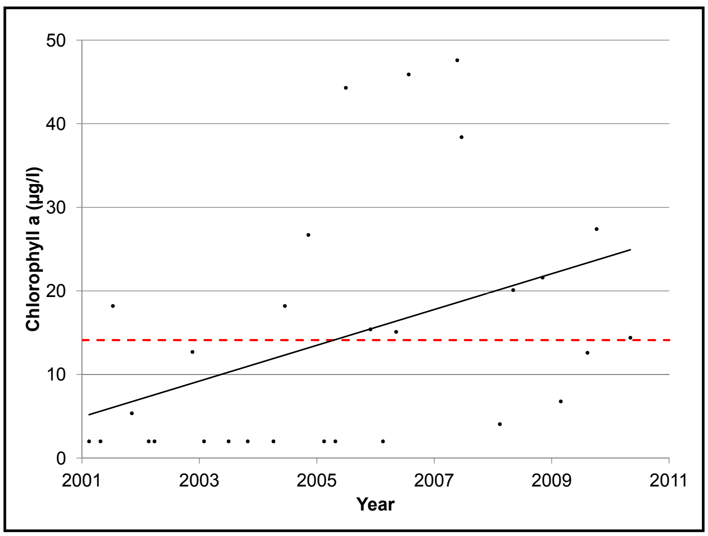


Figure 42. Chlorophyll a trend in Pecan Bayou above Lake Brownwood

Segment 1431

Lake Coleman is an impoundment on Jim Ned Creek in Coleman Mid Pecan Bayou is approximately 13 miles long. The City of Brownwood is located at the headwaters of the segment. Immediately downstream of the city, the surrounding watershed is primarily used for hay production and row crops. There is a concentrated animal feeding operation (CAFO) in the upper end of the segment and the City of Brownwood WWTP discharges into Willis Creek, about 1.5 miles upstream of the monitoring site.

Segment 1431 was first placed on the 2006 303(d) List for not supporting contact recreation due to elevated levels of E. coli. High bacteria counts were found in subsequent assessments. Based on the 2010 Integrated Report, the geometric mean for E. coli data was 257 CFU, exceeding the criterion of 126. The 2010 Integrated Report also identified concerns for high levels of nitrate, total phosphorus and orthophosphorus.

Trend analyses verified the concern for nutrients. Total phosphorus (Figure 43) and chlorophyll a (Figure 44) increased significantly during the period of record. Like other nutrient trends exhibited in the basin, chlorophyll and phosphorus levels were probably influenced by drought conditions.

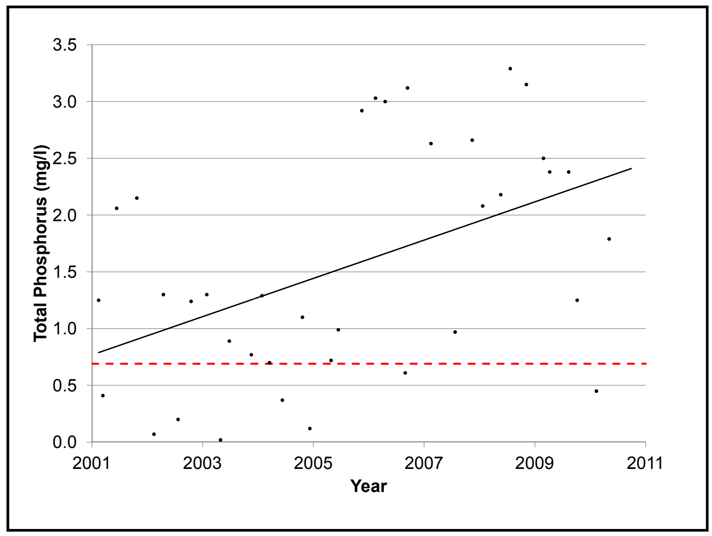


Figure 43. Total phosphorus trend in mid Pecan Bayou

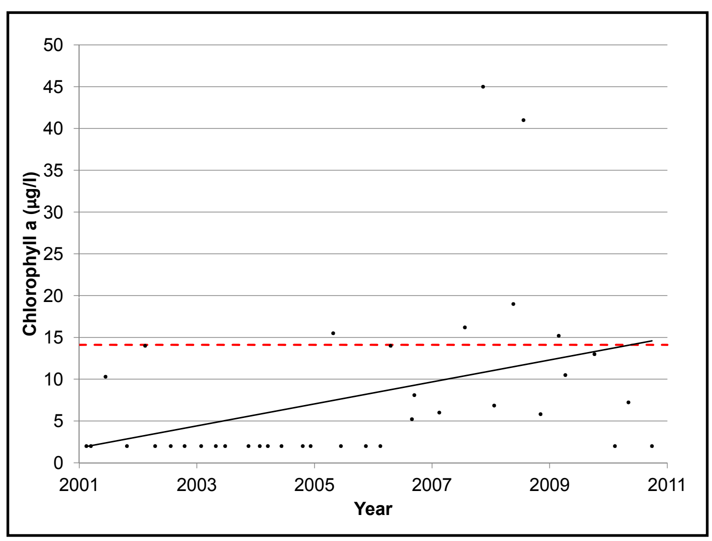
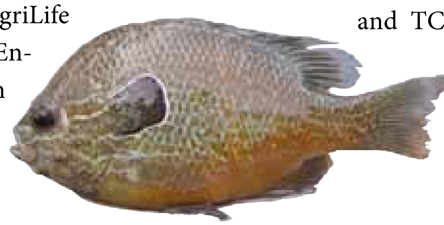


Figure 44. Chlorophyll a trend in mid Pecan Bayou

Pecan Bayou Watershed

Potential sources of bacteria and nutrients include the City of Brownwood WWTP discharge, urban stormwater runoff, the CAFO, wildlife or a combination of these. A Recreational Use Attainability Analysis was begun in August, 2010 to determine if contact recreation occurred in the segment. Texas AgriLife Extension Service and Texas Institute for Applied Environmental Research completed the study – which was funded by a grant from the Texas Soil and Water Conservation Board and EPA - in January, 2012. The study is pending TCEQ approval.



Aquatic Life

The level of aquatic life use support has not been established for the segment. TCEQ and LCRA began collecting biological data for a UAA in 2010. Data collection will continue through 2012 and TCEQ will prepare a report and assign an aquatic life use designation prior to the next Texas Surface Water Quality Standards Revision.

LCRA staff seining Pecan Bayou

Segment 1432

Upper Pecan Bayou is not, as it's name implies, the uppermost segment in the watershed. The name is a relic of old segment descriptions assigned by TCEQ and its predecessor agencies in the early days of delineating Texas streams. The segment, which is actually downstream of Lake Brownwood, is approximately 15 miles long. Monitoring data indicate that the lake supports its designated uses. Trend analyses for Upper Pecan Bayou indicate increasing chlorophyll a (Figure 45) and sulfate and TDS. Drought conditions are likely responsible for the increasing trends.

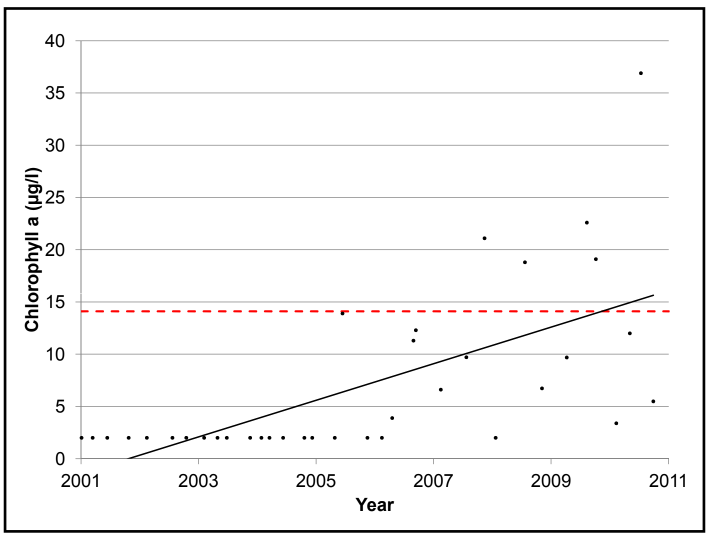
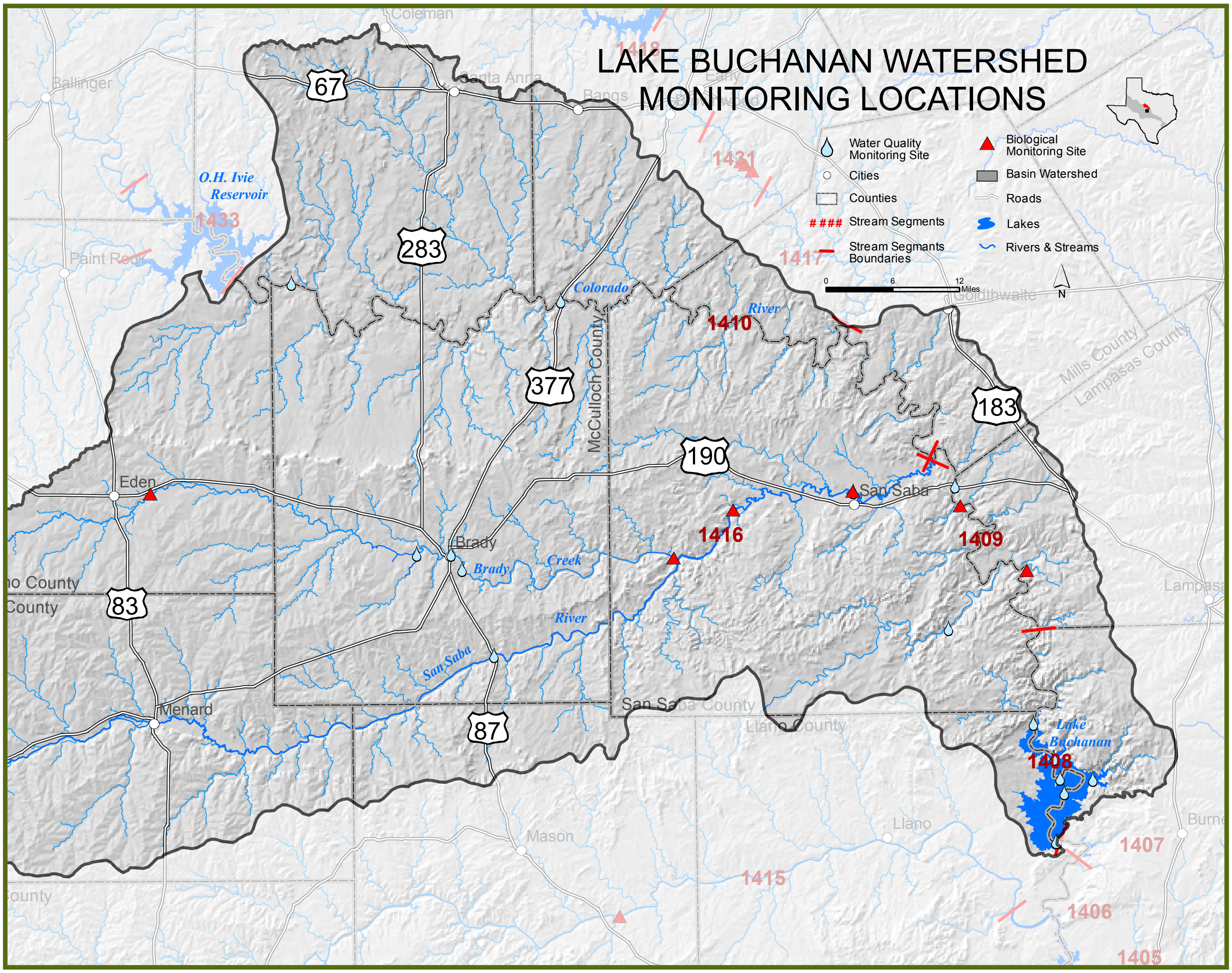


Figure 45. Chlorophyll a trend in Upper Pecan Bayou

Future Challenges for the Pecan Bayou Watershed

- Completion of the Segment 1431 UAA to develop aquatic life use standards for Segment 1431
- Approval and implementation of the Segment 1431 RUAA
- Verification of manganese in Lake Brownwood sediment

Lake Buchanan Watershed



During the reporting period 14 sites were routinely monitored on the following segments.

Segment 1408 – Lake Buchanan
Segment 1409 – Colorado River above Lake Buchanan
Segment 1410 – Colorado River below O. H. Ivie Reservoir
Segment 1416 – San Saba River
Segment 1416A – Brady Creek

Lake Buchanan Watershed

The Lake Buchanan Watershed is 5,650 square miles. It is situated mostly in the Central Great Plains and the Central Texas (Edwards) Plateau, with each ecoregion contributing slightly different characteristics to water quality. In the uppermost portion of the watershed, the Central Great Plains receives about 20 inches of rainfall annually. Intermittent streams are common and soils consist of sand and clays, which contribute to turbidity. The Edwards Plateau contains a sparse network of perennial streams that flow over granite and limestone substrate. Streams in the Edwards Plateau are relatively clear.

The Lake Buchanan watershed begins where the Colorado River flows from the dam at O.H. Ivie Reservoir. As the river flows to the southeast, freshwater from Pecan Bayou, the San Saba River and several small perennial streams dilute the dissolved solids common in the upper basin.

Water quality in the majority of the watershed meets TSWQS. The two exceptions are San Saba River and Brady Creek. The San Saba River does not meet contact recreation standards due to elevated bacteria levels found at one site, and Brady Creek contains elevated nutrients and low levels of dissolved oxygen (Table 4).

Table 4. Summary of Impairments and Concerns for the Lake Buchanan Watershed

Segment	Name	Use	Parameter	Status
1416	San Saba River	Contact Rec.	E.Coli	Impairment
1416A	Brady Creek	Aquatic Life	Dissolved Oxygen	Impairment
1416A	Brady Creek	General Use	Chlorophyll a	Concern
1416A	Brady Creek	General Use	Nitrate	Concern
1416A	Brady Creek	General Use	Total Phosphorus	Concern
1416A	Brady Creek	General Use	Orthophosphorus	Concern

Lake Buchanan during the 2011 drought

Lake Buchanan Watershed

Segment 1408

Lake Buchanan is an impoundment of the Colorado River in Burnett and Llano counties. At 22,335 surface acres, the reservoir, which was impounded in 1937, is the largest of the Highland Lakes. Monitoring data indicate that the lake supports its designated uses.

Based on data collected near Buchanan Dam, the lake has experienced increased trends for chlorophyll a and ammonia (Figures 46 and 47, on the following page), and decreasing trends for transparency (Figure 48) and nitrate (Figure 49). Chloride, sulfate and TDS trends were also significant, but slight and well within TSWQS. The causes of increasing chlorophyll a can be attributed to drought, stormwater runoff from nutrient-rich lands and eutrophication. The nitrate and transparency trends are more likely a reaction to increasing chlorophyll a and algae blooms in the lake while chloride and sulfate are drought related.

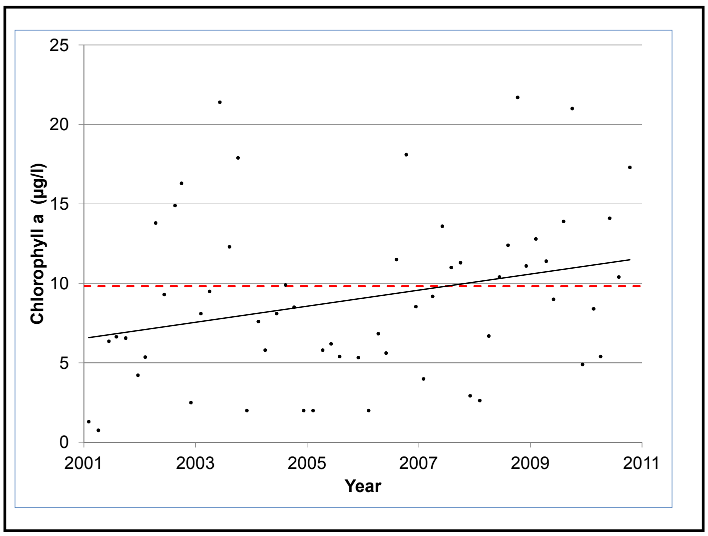


Figure 46. Chlorophyll a trend in Lake Buchanan

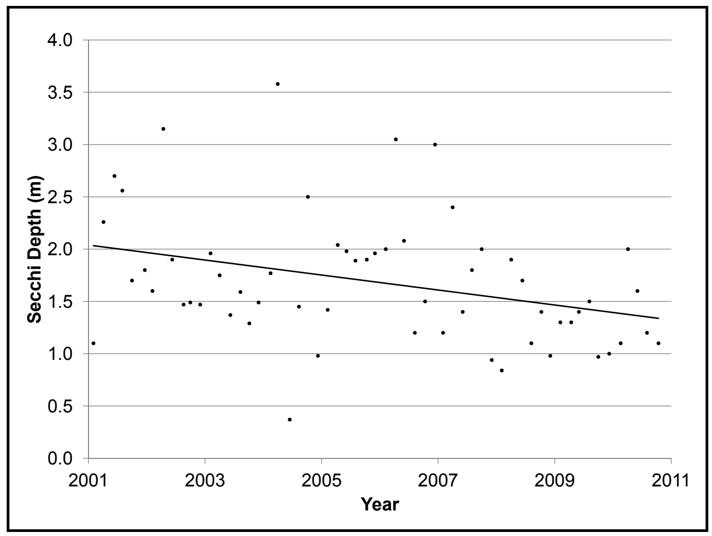


Figure 48.Transparency trend in Lake Buchanan

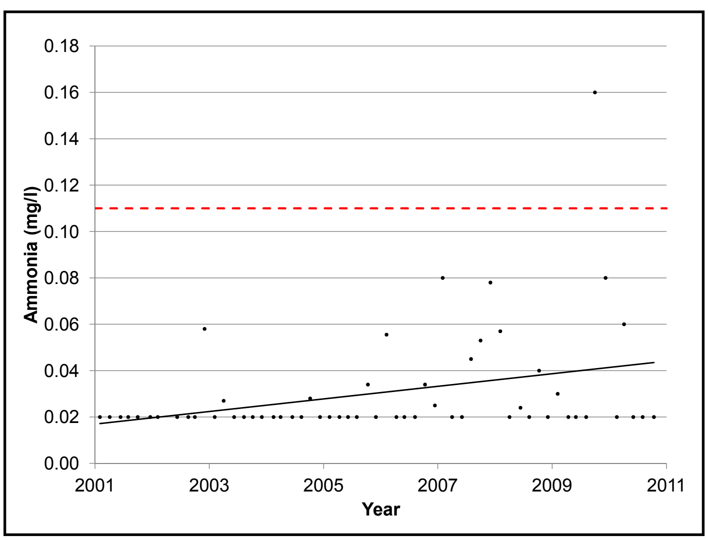


Figure 47. Ammonia trend in Lake Buchanan

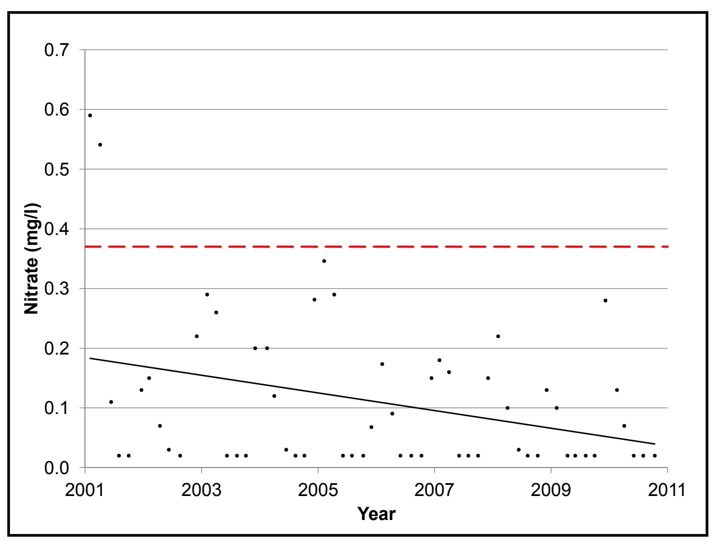


Figure 49. Nitrate trend in Lake Buchanan

Segment 1409

Colorado River above Lake Buchanan is located downstream of the confluence of the San Saba and Colorado rivers in San Saba County. The segment is approximately 37 miles long. At its upper reaches the landscape is made up of pastures and irrigated cropland. Chloride and TDS are diluted as the San Saba River and smaller perennial streams supply fresh water into the Colorado River. Bedrock becomes the dominant substrate and water in this region tends to be clearer than upstream.

Water quality in Segment 1409 is good. According to the TCEQ 2010 Integrated Report, this stretch of the river met all designated uses. Data collected since then indicate a concern for chlorophyll a; which may be a result of persistent drought conditions. Trend analysis indicated an increase in sulfate over time, which is likely a result of prolonged drought.

Above Lake Buchanan, the Colorado River supports a high aquatic life use based on biological data collected at two sites during 11 monitoring events (Appendix D).

Colorado River above Lake Buchanan

Lake Buchanan Watershed

Segment 1410

Colorado River below O.H. Ivie Reservoir is located between the confluence of the Colorado and San Saba rivers and the O.H. Ivie Reservoir dam. The segment is approximately 138 miles long. Water is released from O.H. Ivie Reservoir to slowly flow through farmland and ranches where it is used to irrigate hay, wheat, cotton and pecan orchards.

According to the TCEQ 2010 Integrated Report, Segment 1410 met all designated uses. Like other segments in the Lake Buchanan watershed, more recently collected data indicates high levels of chlorophyll a, which are probably a result of persistent drought conditions.

Trends were detected for pH and dissolved oxygen deficit. The decrease in pH over time is minor and presents no concern to water quality. Although the absolute concentration of dissolved oxygen has been within water quality standards, the relative amount of dissolved oxygen has been decreasing over time (Figure 50).

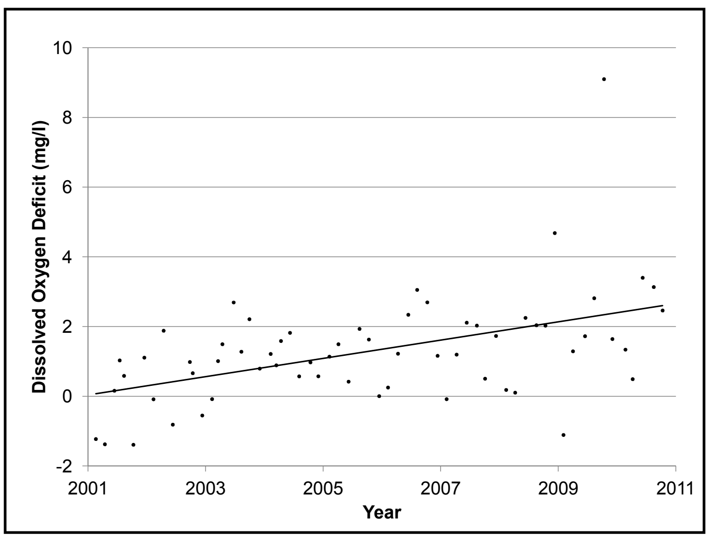


Figure 50. Dissolved oxygen deficit trend in Segment 1410

Segment 1416

The San Saba River begins in Schleicher County where the North and Middle prongs of the San Saba River converge. It flows approximately 168 miles downstream to the confluence with the Colorado River in San Saba County. The San Saba River watershed is predominantly rural. Near its headwaters, flow is sparse and the landscape is natural, dotted with a few ranch houses among the oaks and mesquites along the river. As the river flows past the City of Menard, the landscape changes to irrigated hay fields and row crops. Downstream of Menard, the river winds through unimproved pastures and pecan orchards before reaching the City of San Saba.

The San Saba River fully supports its general and aquatic life uses according to TCEQ's 2010 Integrated Report. It does not support contact recreation based on E.coli data collected near the town of San Saba. The segment was first placed on the 303(d) List in 2008. Data collected since the original listing indicate that the water body continues to be impaired.

Potential causes of Impairment include a Cattle Auction Barn located four miles upstream of the monitoring site, stormwater runoff from San Saba and agricultural and wildlife nonpoint sources.

The San Saba River supports a high aquatic life use based on biological data collected at two sites during 14 monitoring events (Appendix D).

Trend analysis on the San Saba River showed a decreasing trend for chlorophyll a (Figure 51). The cause of the decrease is unknown. The majority of measured concentrations of chlorophyll a were well within screening criterion for TSWQS.

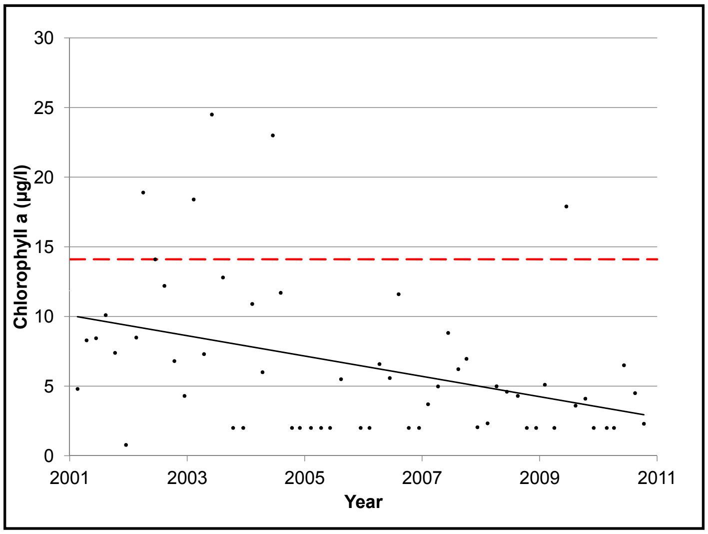


Figure 51. Decreasing trend in chlorophyll a for the San Saba River

Segment 1416A

The Brady Creek watershed is approximately 784 square miles in area. It is primarily rural with agricultural uses. The entire length of the creek is approximately 90 miles. The towns of Brady, Melvin and Eden are located in the middle and upper regions of the watershed.

Brady Creek fully supports its general and contact recreation uses according to TCEQ's 2010 Integrated Report. Its ALU is not supported. It was first placed on the 2004 303(d) List based on low levels of dissolved oxygen. The 2004 listing, which was based on grab samples, was confirmed through 24-hour monitoring and the creek remains on the 2010 303(d) List. The 2010 Integrated Report also identified concerns for elevated levels of chlorophyll a, total phosphorus, orthophosphorus and nitrate.

Stormwater runoff and low flows are the causes of the impairment. All stormwater runoff from the city flows into Brady Creek. Urban runoff contributes nutrients which stimulate algal blooms and may contribute to periodic fish kills seen in the creek. The problem is exacerbated by low flow regimes caused by low water dams and by Brady Lake Dam which impound water upstream of the monitoring site. Agriculture practices may play a role as well. Just a few miles upstream of the monitoring site, fields planted in row crops provide the potential for nutrient contributions from tilled soil and fertilizer.

Biological monitoring was performed on Brady Creek at two sites in support of the Brady Creek WPP. The site upstream of Brady, near Mertzon resulted in IBI scores that indicate an intermediate ALU. The site below Brady, near the creeks confluence with the San Saba resulted in an Exceptional ALU (Appendix D).

Trend analysis showed a statistically significant increase in chloride concentrations (Figure 52). The cause is likely due to prolonged drought conditions resulting in an accumulation of dissolved solids.

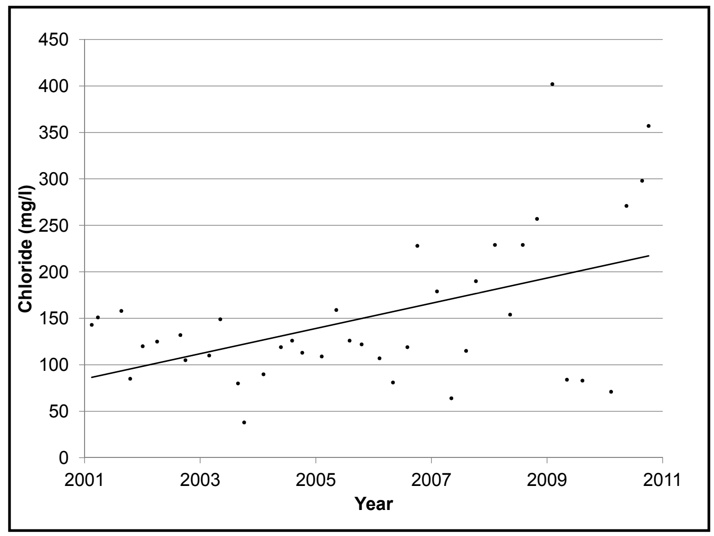


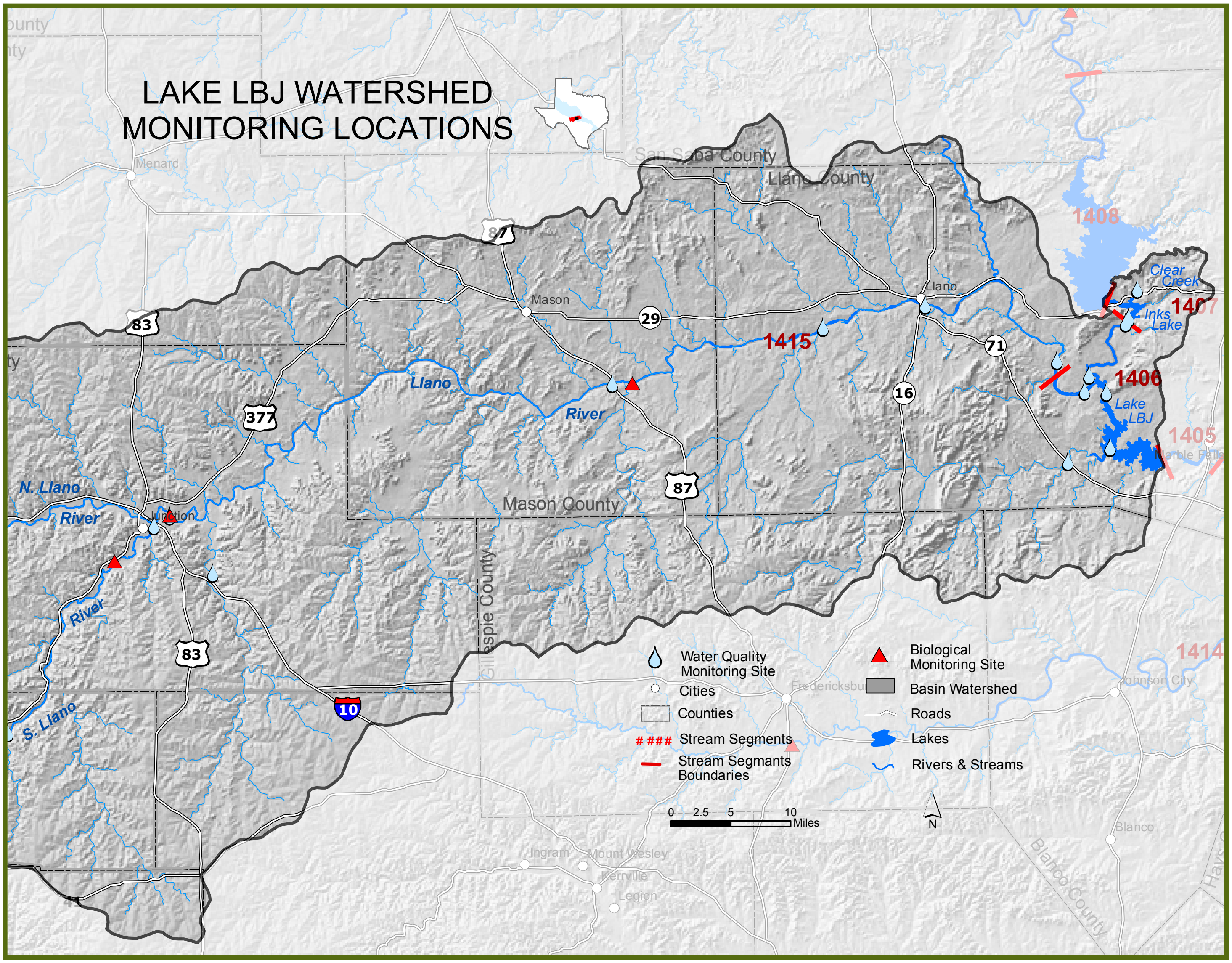
Figure 52. Chloride trend in Brady Creek

The Brady Creek Master Plan, produced in 2004 by UCRA identified and implemented BMPs to lessen the impact of stormwater on the creek. UCRA also received a Clean Water Act 319(h) grant from TCEQ to develop the Brady Creek Watershed Protection Plan. Stakeholders have been identified and a draft Public Participation Plan was submitted to TCEQ. Water quality monitoring is ongoing and a draft plan expected in 2013.

Future Challenges for the Lake Buchanan Watershed:

- Addressing the San Saba River bacteria impairment
- Elevated nutrient levels in segments 1408, 1409, 1410 and 1416A
- Completion and approval of the Brady Creek WPP.

Lake LBJ Watershed



During the reporting period 14 sites were routinely monitored on the following segments.

Segment 1406 – Lake LBJ
Segment 1407 – Inks Lake
Segment 1407A - Clear Creek
Segment 1415 – North Llano and Llano Rivers

Lake LBJ Watershed

The Lake LBJ watershed begins where the Colorado River is released from Buchanan Dam in Burnet and Llano counties. Immediately below Buchanan Dam, the river flows into the headwaters of Inks Lake, a pass-through reservoir with little detention time. Below Inks Dam the river flows about ten miles to the community of Kingsland, where it merges with the Llano River before flowing into Lake LBJ.

The 5,000 square mile watershed is entirely within the Edwards Plateau. Steep hills with rock and limestone substrate create clear, cool, fast flowing streams like the Llano and James rivers. Perennial streams in the watershed are spring fed and typically more alkaline because of the limestone geology. Severe drought during the reporting period dramatically decreased stream flows in the watershed.

Water quality in the watershed is generally good. According to the 2010 Integrated Report, LBJ and Inks Lakes periodically have low levels of desolved oxygen and Clear Creek has an impairment due to pH, sulfate and TDS levels. (Table 5).

Table 5. Summary of impairments and Concerns for the Lake LBJ watershed

Segment	Name	Use	Parameter	Status
1406	Lake LBJ	Aquatic Life	Dissolved Oxygen	Concern
1407	Inks Lake	Aquatic Life	Manganese in Sediment	Concern
1407	Inks Lake	Aquatic Life	Dissolved Oxygen	Concern
1407A	Clear Creek	Aquatic Life	Cadmium in Water	Concern
1407A	Clear Creek	Aquatic Life	Aluminum in Water	Impairment
1407A	Clear Creek	General Use	pH	Impairment
1407A	Clear Creek	General Use	Sulfate	Impairment
1407A	Clear Creek	General Use	TDS	Impairment

Segment 1406

Lake LBJ is impounded where the Colorado and Llano rivers converge in Burnet and Llano counties. The 6,256 acre reservoir was completed in 1950 to supply hydroelectric power to the area.

Development around the lake has the potential to impact water quality. Granite Shoals, Sunrise Beach, Horseshoe Bay and, Kingsland have grown from bedroom communities to small cities with infrastructure and permitted sewage facilities. The Highland Lakes Watershed Ordinance and the On-Site Sewage Facility Ordinance, which are administered by LCRA, help reduce the impact of development in the area.

Horseshoe Bay on Lake LBJ

Lake LBJ Watershed

Monitoring data indicate a concern in the headwaters for low levels of dissolved oxygen. The cause is water releases from Inks Lake Dam during summer months when stratification occurs. When water is released under normal (non-flood) conditions, it comes from depths that contain very little dissolved oxygen.

Trend analysis identified decreases in nitrate and sulfate (Figures 53 and 54). The trends do not appear to be related. The cause of the decreases is unknown. Concentrations of each constituent falls within TSWQS and water quality in the reservoir remains good.

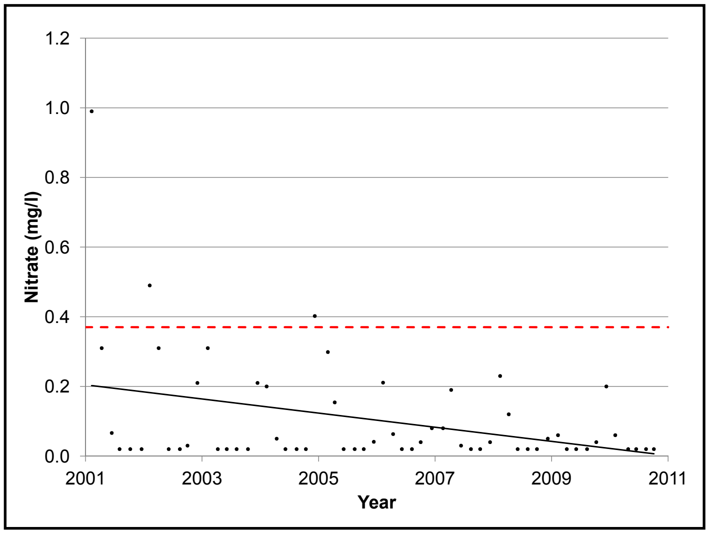


Figure 53. Nitrate trend in Lake LBJ

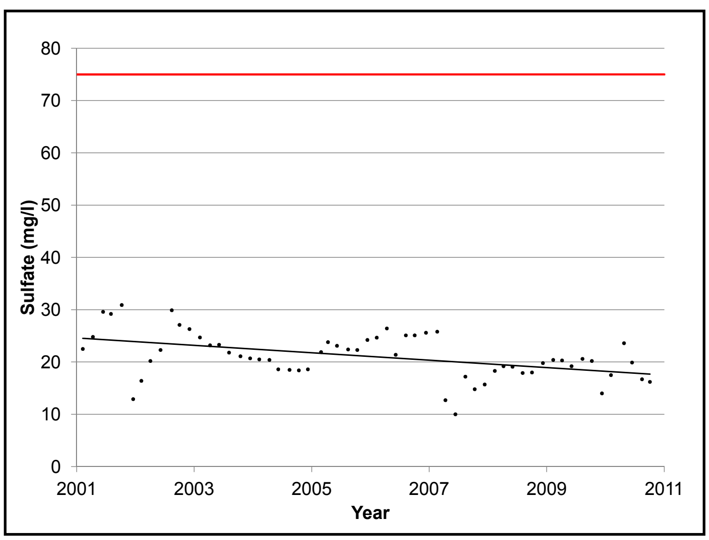


Figure 54. Sulfate trend in Lake LBJ

On-Site Sewage Facility Ordinance

Septic systems are an integral part of rural America. They can be an efficient way to remove household waste and protect the environment when properly designed and maintained. TCEQ delegated authority to LCRA in September 1971. Since then, LCRA has regulated the installation and operation of on-site sewage facilities around the upper Highland Lakes. Regulating over 21,000 systems in a four-county area ensures that the best available technology is used to treat septic wastes so pollutants such as phosphorus and nitrogen don't leach into the Highland Lakes.

Highland Lakes Watershed Ordinance

Stormwater runoff carries pollution — pesticides, soil, nutrients, toxics and other residues from everyday human activities. LCRA actively manages stormwater runoff around the Highland Lakes through the Highland Lakes Watershed Ordinance.

Through a permitting process, the ordinance requires developers to stabilize land and minimize sediment migration. Water quality is protected by limiting stormwater runoff, creating buffer zones and installation of erosion and sediment controls.New quarries and mines are also covered under the HLWO and must implement measures similar to other development.

Segment 1407

Inks Lake is a 777 acre impoundment on the Colorado River, just downstream of Buchanan Dam. Monitoring data indicate the lake supports its designated uses, but concerns for low dissolved oxygen and manganese in sediment have been identified by TCEQ. Water releases from the bottom of Buchanan Dam are the source low dissolved oxygen. The cause of manganese in sediments is not known, but similar to Lake Brownwood, natural sources are suspected.

Trend analyses showed that the lake became less transparent over the period of record (Figure 55). Chloride, sulfate and TDS decreased also decreased slightly and remained within the TSWQS.

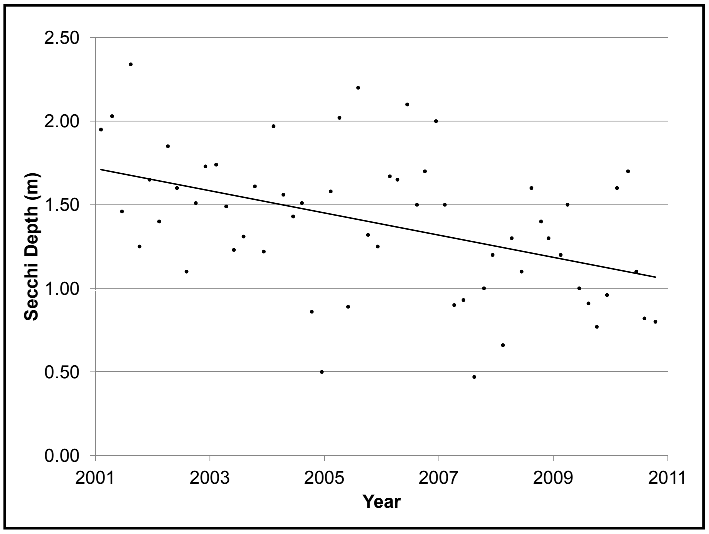


Figure 55. Secchi depth trend in Inks Lake

Segment 1407A

Clear Creek is an intermittent tributary of Inks Lake. The creek is about 4.5 miles long. The watershed is comprised mostly of ranchland. The impairment for pH, TDS, sulfate and aluminum in water and the concern for cadmium in water are due to acid mine drainage.

A 23-acre tailings pile - a remnant of an abandoned graphite mine – is located on the banks of the creek. Stormwater runoff from the pile results in low pH and heavy metals in the creek. The mine which began operations in 1915 is owned by Greensmiths, Inc., who purchased the facility in 2000 and began using reclaimed tailings materials to landscape golf courses. TCEQ and Greensmiths are developing engineering solutions to prevent runoff and improve water quality in Clear Creek.

There were not enough data to perform trend analysis on Clear Creek.

Salts left in Clear Creek during the 2011 drought

Lake LBJ Watershed

Segment 1415

The Llano River begins in the town of Junction, where the North Llano and South Llano rivers converge. The river, including the north and south forks, is approximately 231 miles long. With an average flow of 40 cfs, the North Llano River remains perennial, but flow is sluggish during most summers. Flows in the South Llano River have historically been about double those in the North. Large springs west of Junction provide the base flow the South Llano River.

Headwaters of the South Llano River at the Seven Hundred Springs

Below Junction the Llano River flows east to the town of Llano. This area, known as the Llano Uplift, contains granite and limestone outcrops that produce clear fast-flowing streams. Below the town of Llano, the river flows into the Colorado River and the headwaters of Lake LBJ.

The Llano River watershed remains largely rural. Soils and geology in the watershed lend themselves to ranching more than to farming. There are fewer irrigated fields compared to the surrounding watersheds. Monitoring data collected between 2007 and 2011 indicate the river supports its designated uses. Trend analysis was performed on data from two sites in this segment: one site on the main stem of the Llano River and another on the North Llano River. Both sites showed a slight decrease in TDS and the Llano River site showed a decrease in sulfate. All values were within TSWQS.

As part of EPA's Healthy Watersheds Initiative, TSSWCB has begun a watershed protection plan on the north and south Llano rivers. Using a stakeholders-driven process, the project will characterize historical and current water quality conditions and use models to define conditions and educate the public about water quality in the watersheds.

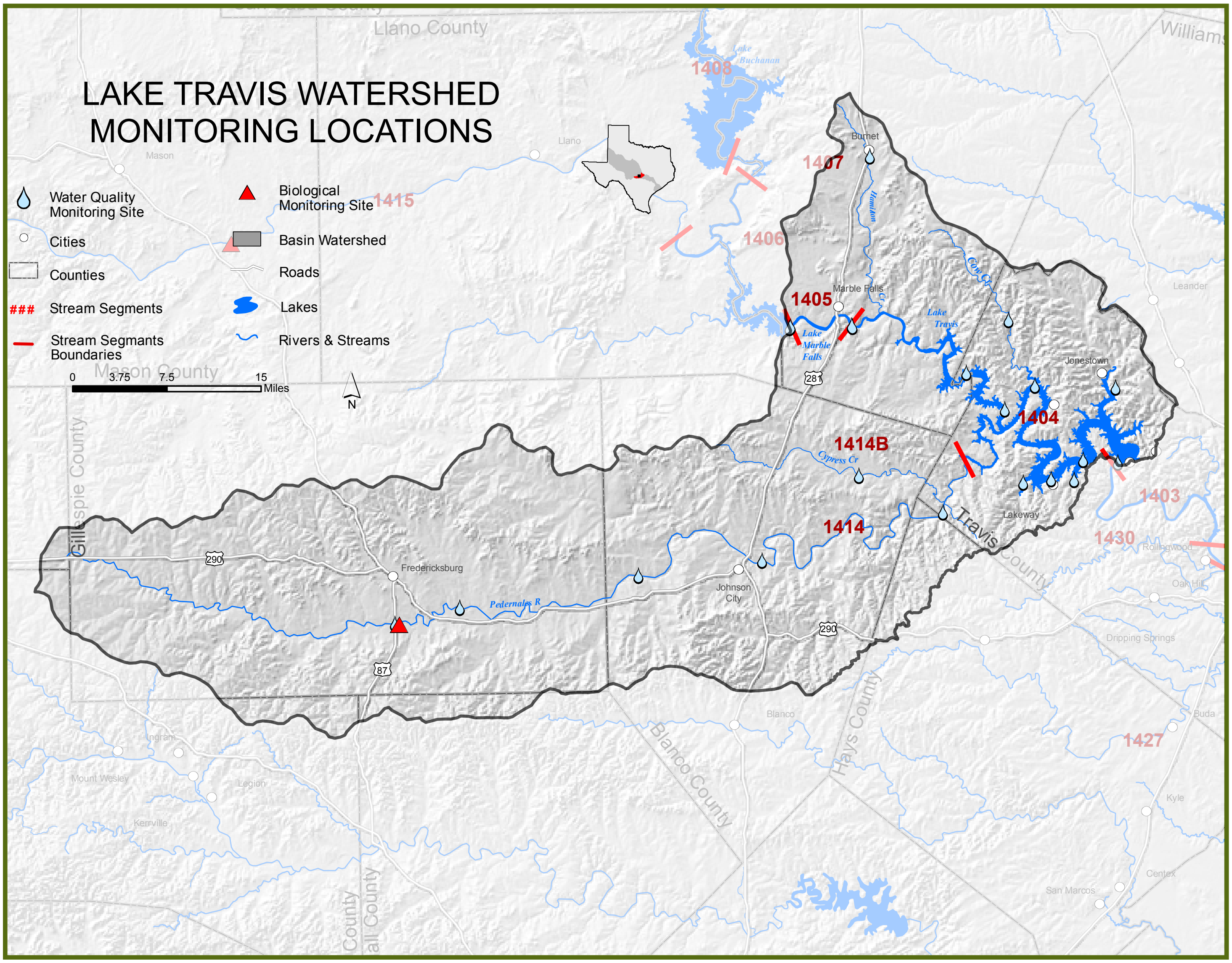
The WPP will identify brush type, density, and canopy cover; geology and soils data; water needs; hydrologic characterization and potential water yield from BMP implementation. The project began in 2011 and is scheduled to be complete in 2014.

Future Challenges for the Lake LBJ Watershed

- Continued development, an increase in impervious cover and the potential for increase in NPS pollution
- Completion of the Llano River WPP

The Llano River supports a high aquatic life use based on biological data collected during 22 monitoring events (Appendix E) at three sites.

Lake Travis Watershed



During the reporting period 10 sites were routinely monitored on the following segments.

Segment 1404 – Lake Travis
Segment 1405 – Lake Marble Falls
Segment 1414 – Pedernales River
Segment 1414B – Cypress Creek

Lake Trvis Watershed

Located in the Texas Hill Country, the Lake Travis watershed, including the Pedernales River and lakes Travis and Marble Falls, is approximately 1,830 square miles. The watershed lies within the Edwards Plateau, a region distinguished by rocky terrain and clear perennial streams. Growth and development have dramatically changed the landscape in the region over the last 20 years. Water Quality remains good with no impairments.

Lack of rainfall between 2008 and 2011 lowered the lake to levels not seen since the drought of record during the 1950s. In 2011, inflows to the Highland Lakes were only 25 percent of the historical average, the lowest since Lake Travis was created.

Lake Travis at 47 percent of capacity during the 2011 drought

Based on the 2010 Integrated Report, water quality throughout the watershed met State standards, though concerns for low levels of dissolved oxygen in Lake Travis were identified (Table 6).

Table 6. Summary of impairments and Concerns for the Lake Travis Watershed

Segment	Name	Use	Parameter	Status
1404	Lake Travis	Aquatic Life	Dissolved Oxygen	Concern

Lake Travis Watershed

Segment 1404

Mansfield Dam impounds Lake Travis on the Colorado and Pedernales rivers in western Travis County. The reservoir, which is about 18,929 surface acres, was originally designed to contain floodwaters. It is one of the clearest reservoirs in Texas and is a popular recreation destination.

Ongoing LCRA initiatives to protect the lake include the Highland Lakes Watershed Ordinance and the Colorado River Environmental Models (CREMs). The watershed ordinance (see LBJ Watershed Summary) manages nonpoint source pollution around the lake, and CREMS is a modeling tool used to determine how various development scenarios impact water quality.

Colorado River Environmental Models

The Colorado River Environmental Model (CREMS) began in 2002 as a long-term project to build a predictive tool using water quality models and databases that assist LCRA in making policy decisions related to water quality in the Highland Lakes. The principal objectives of the project are to develop data and modeling tools that assess

1) proposed nutrient standards;
2) effectiveness of LCRA's Highland Lakes Watershed Ordinance;
3) effectiveness of TCEQ's Watershed Protection Rules which ban wastewater discharge into the lake; and
4) impacts of nonpoint-source and point source pollution loads on lake water quality.

The Lake Travis model has been used by LCRA and other resource agencies to make science-based decisions about permitting and land use around the lake. The LBJ model was finalized in 2011 and the Buchanan model will be finalized and available in 2012.

Monitoring data from sites near Lakeway indicate a concern for low dissolved oxygen, first noted in the TCEQ 2010 Integrated Report. It is likely a result of lake mixing, a natural phenomenon that can periodically cause dissolved oxygen levels to drop as deep, cold, oxygen-depleted water rises and mixes into the water column.

Trend analysis on Lake Travis indicated a decrease in E. coli, sulfate and TDS concentrations. While trends were significant and represent an improvement in water quality, they were slight and well below criteria.

Segment 1405

Max Starcke Dam forms Lake Marble Falls on the Colorado River near the town of Marble Falls. With a surface area of 545 acres, it is the smallest reservoir in the chain of Highland Lakes.

Lake Marble Falls

All water quality standards for the lake were attained. Trend analysis showed that chlorophyll a (Figure 56) increased, while nitrate (Figure 57), sulfate and TSS decreased over time. While chlorophyll a values are currently not high enough to warrant a concern, a continuation of the increasing trend will warrant a concern status in future TCEQ water quality assessments. The nitrate trend is likely due to normal limnological activity and the relationships between nutrients and planktonic chlorophyll. Sulfate and TSS are related to the amount of inflows received by the reservoir.

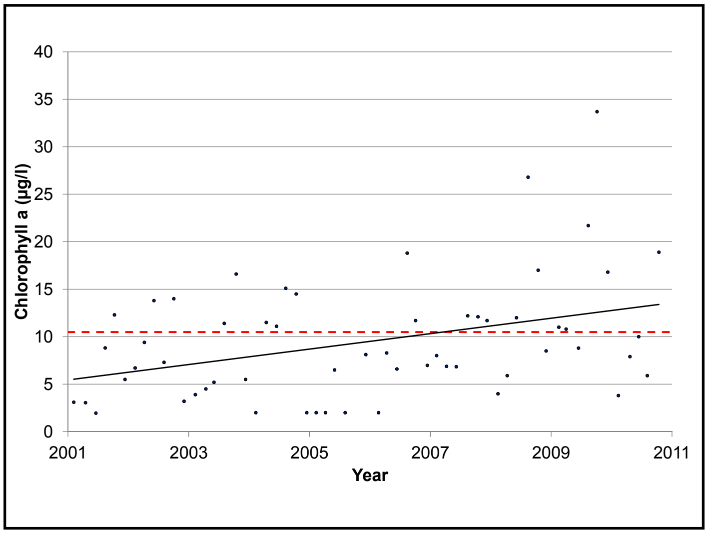


Figure 56. Chlorophyll a trend in Lake Marble Falls

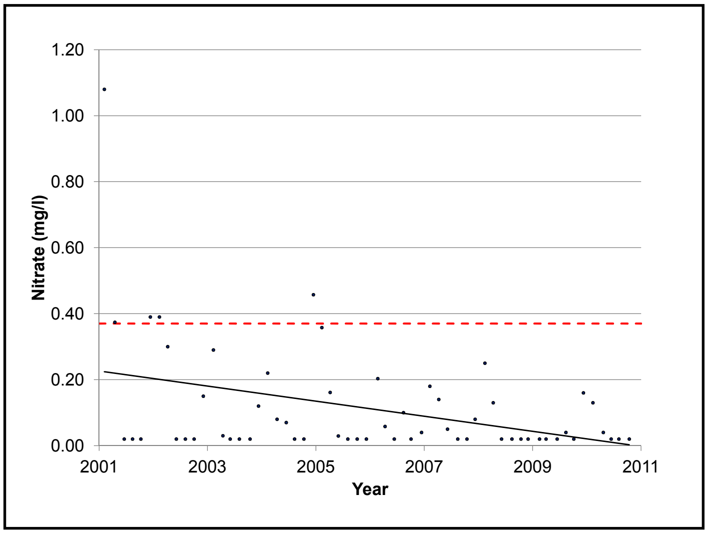


Figure 57. Nitrate trend in Lake Marble Falls

Segment 1414

The headwaters of the Pedernales River are located near Harper, Texas in Kimble County. The river flows east through Fredericksburg, Stonewall and Johnson City before reaching the mouth of Lake Travis. It is approximately 125 miles long. In the upper reaches, it is intermittent; though occasional intense thunderstorms over the watershed create heavy rainfall that dramatically increase flow in the river. These surges of water carry large amounts of silt and organic debris downstream and into Lake Travis.

Monitoring data collected from sites near Harper, Fredericksburg and Johnson City show that the river meets all applicable water quality standards.

Pedernales River at Highway 71 in 2007

Pedernales River at Highway 71 in 2008 under drought conditions

The Pedernales River supports a high aquatic life use based on biological data collected during five monitoring events upstream of Fredericksburg (Appendix D).

Trend analysis showed that chloride (Figure 58) increased and nitrate (Figure 59) decreased. Fluctuations in chloride and nitrate levels are attributable to the weather patterns and drought.

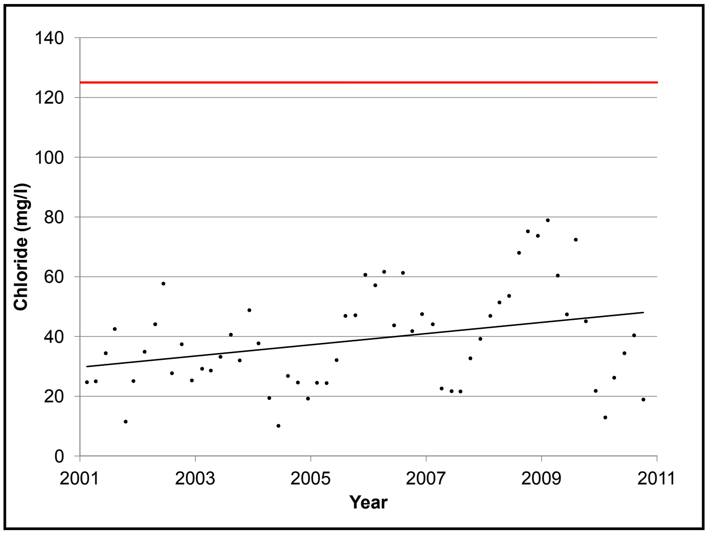


Figure 58. Chloride trend in the Pedernales River

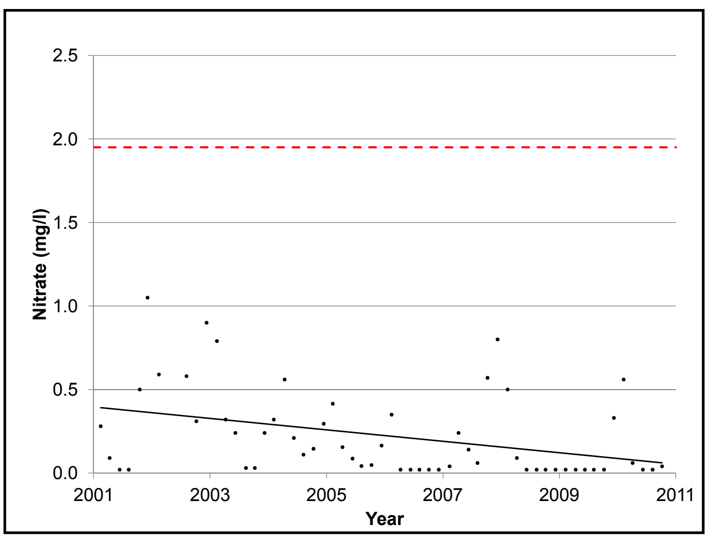
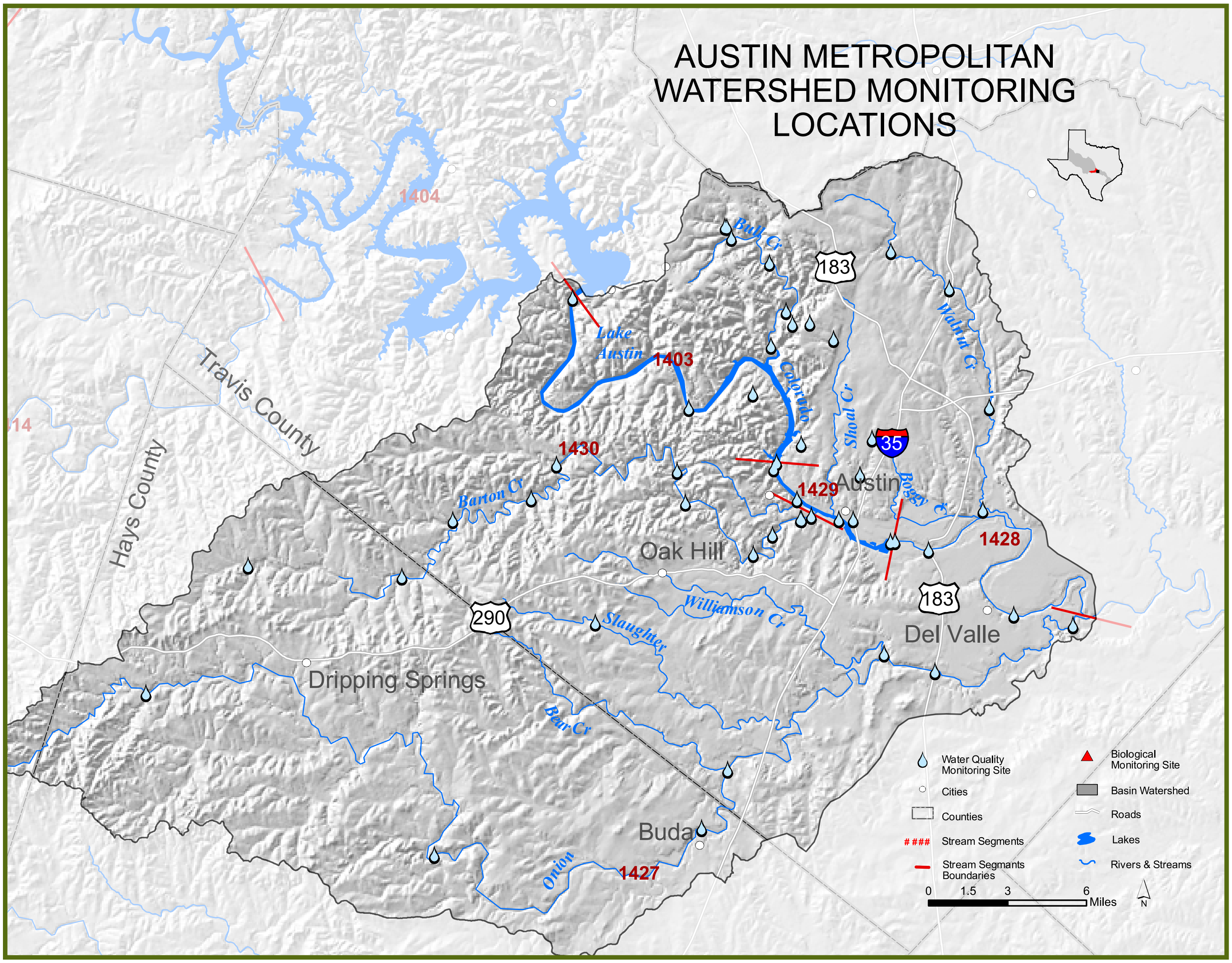


Figure 59. Nitrate trend in the Pedernales River

Future Challenges for the Lake Travis Watershed

- Managing stormwater runoff from a developing watershed

Austin Watershed



During the reporting period 43 sites were routinely monitored on the following segments.

Segment 1403 – Lake Austin
Segment 1403A – Bull Creek
Segment 1403J – Spicewood tributary to Shoal Creek
Segment 1403K – Taylor Slough South
Segment 1403R – Westlake Davenport tributary to Lake Austin

Segment 1427 – Onion Creek
Segment 1427A – Slaughter Creek
Segment 1429 – Lady Bird Lake
Segment 1429B – Eanes Creek
Segment 1429C – Waller Creek
Segment 1430 – Barton Creek

Austin Watershed

The Austin Metropolitan watershed encompasses about 700 square miles on the eastern edge of the Central Texas or Edwards Plateau. The Edwards Aquifer intermittently surfaces in the watershed to form springs, clear streams and groundwater recharge features. Lake Austin and Lady Bird Lake are narrow and shallow in comparison to the Highland Lakes. Rather than lakes, they resemble large rivers that cut through Austin and create a natural boundary that bisects and defines the city. Once a sleepy college town, the City of Austin has grown into an urban center with a population of more than 750,000, making it the most densely urbanized watershed in the Colorado River basin. Monitoring by the City of Austin indicates that some urban creeks have elevated bacteria levels and the upper end of Lake Austin periodically contains low levels of dissolved oxygen (Table 7). No significant trends were detected in Austin watersheds with the exception on Onion Creek.

Austin skyline with Lady Bird Lake in the foreground

Table 7. Impairments and concerns in Austin watershed based on the 2010 Integrated Report.

Segment	Name	Use	Parameter	Status
1403	Lake Austin	Aquatic Life	Manganese (Sediment)	Concern
1403	Lake Austin	Aquatic Life	Dissolved Oxygen	Impairment
1403A	Bull Creek	Aquatic Life	Dissolved Oxygen	Impairment
1403J	Spicewood trib	Aquatic Life	Nitrate	Concern
1403J	Spicewood trib	Aquatic Life	E.coli	Impairment
1403K	Taylor Slough South	Aquatic Life	Nitrate	Concern
1403K	Taylor Slough South	Aquatic Life	E.coli	Impairment
1403R	Westlake Davenport trib	Aquatic Life	E.coli	Impairment
1427A	Slaughter Creek	Aquatic Life	Dissolved Oxygen (24-hr)	Concern
1427A	Slaughter Creek	Aquatic Life	Macrobenthic community	Impairment
1429B	Eanes Creek	Contact Recreation	E.coli	Impairment
1429C	Waller Creek	Contact Recreation	E.coli	Impairment
1429C	Waller Creek	Aquatic Life	Macrobenthic community	Impairment
1429C	Waller Creek	Aquatic Life	Dissolved Oxygen	Concern
1429C	Waller Creek	Aquatic Life	Sediment toxicity	Concern
1430	Barton Creek	Aquatic Life	Sediment Toxicity	Concern
1430	Barton Creek	Aquatic Life	Dissolved Oxygen	Concern

Austin Watershed

Segment 1403

Lake Austin is impounded by Tom Miller Dam, on the Colorado River in Austin. Lake Austin is a narrow and shallow lake that, by size and fluvial properties, is more akin to a river than the upstream Highland Lakes. Water moves through the lake relatively quickly; retained only a few hours in the 20 miles between Mansfield dam and Tom Miller Dam. Land around the lake is developed with little natural riparian corridor. The lake, which is approximately 1,830 surface acres, is used extensively for recreation.

Historical data indicate frequent low dissolved oxygen levels near the headwaters of the lake near Mansfield dam and high levels of manganese in sediment near Tom Miller Dam. The low DO levels are caused by hypolimnetic releases of oxygen-depleted water from Mansfield Dam. In an effort to increase dissolved oxygen, LCRA installed an aerator in Mansfield Dam to oxygenate the water in the upper end of Lake Austin. Sampling continues to measure improvements in dissolved oxygen levels. The source of manganese is unknown, though manganese is a common element and is also present in the sediment of other reservoirs in the Colorado River basin.

The invasive aquatic plant hydrilla (Hydrilla vericillata) continues to be problematic in Lake Austin. Warmer water temperatures in Lake Austin have likely contributed to increased hydrilla production. In 2012, sterile triploid Asian grass carp will be stocked into the lake to combat the problem. The fish, which eat hydrilla, will be stocked as part of cooperative efforts between COA, LCRA and lakeside property owners.

Segment 1403A

Bull Creek is a perennial, spring-fed tributary of Lake Austin. About 40 percent of the watershed is developed. The remaining 60 percent remains in a natural state and is protected from further development by the City of Austin. The U.S. Fish and Wildlife Service is currently evaluating a proposal to list the Jollyville Plateau Salamander (*Eurycea nana*), which is endemic to the springs of Bull Creek, as an endangered species.

Based on data collected from the upper portion of the creek, the stream frequently exhibits low dissolved oxygen levels. Water in the upper end of the creek is strongly influenced by groundwater from springs, typically low in DO. Benthic macroinvertebrate data collected by COA (outside of the CRP) indicate that Bull Creek maintains high aquatic life uses. COA biological assessments indicate that Bull Creek is the highest quality watershed evaluated as part of it's Citywide Environmental Integrity Index program. COA will initiate a two year study beginning in 2013 to collect additional diel DO data as part of the CRP to better evaluate the temporal and spatial extent of low DO in Bull Creek.

Bull Creek near the headwaters

Segment 1403J

This small tributary to Shoal Creek, known as Spicewood Springs Tributary, is in the upper portion of the Shoal Creek watershed, which lies on the north side of Lady Bird Lake in Austin. It begins near the west side of the MoPac Expressway in north Austin, where Spicewood Springs discharge. The shallow, spring fed stream is only about a half mile long, but it is important habitat for a very small population of threatened Jollyville Plateau salamanders (*Eurycea nana*).

Water quality data collected near the springs indicate elevated levels of bacteria and nitrate. Wastewater lines cross and run longitudinally and the creek is influenced by adjacent roadways and residential lawns. COA staff has reported high bacteria counts, algae and sewage from leaking lines at the site during some monitoring events. Elevated stream nutrient concentrations suggest that wastewater is a likely source of fecal contamination at this site. At the request of COA, the TCEQ is initiating a TMDL for bacteria in this segment beginning in fiscal year 2013. There was not enough data to perform a trend analysis on the stream.

Headwater spring of the Shoal Creek tributary

Segment 1403K

The Taylor Slough watershed is located on the north side of Lake Austin. The headwaters of the stream begin about a mile upstream of its confluence with Lake Austin. The watershed is a dense urban landscape composed mostly of single-family residences. Sewer mains cross the creek at several locations in the watershed. Water quality data collected from Reed Park in the downstream portion of the stream indicate elevated levels of bacteria and nitrate.

Taylor Slough in Reed Park

The watershed is highly urbanized. Potential sources of bacteria include urban runoff and pet waste from Reed Park, where water quality samples are collected. Given the elevated nutrient concentrations found during monitoring, wastewater lines located near the creek likely contribute to the impairment. At the request of COA, the TCEQ is initiating a TMDL for bacteria in this segment beginning in fiscal year 2013. There were not enough data from Taylor Slough to run trend analysis.

Segment 1403R

Westlake Davenport Tributary to Lake Austin is located on the south side of Lake Austin on Austin's west side. The watershed area is about three quarters of a square mile. The watershed is an urban landscape composed of clustered residential housing and a portion of the stream flows through a golf course that was previously irrigated with treated wastewater effluent. The stream is approximately two miles long.

The stream is intermittent and has only had periodic flows since it was listed on the 2006 303(d) List. COA recently completed a two year special study to evaluate the bacteria impairment in Westlake-Davenport Tributary. The study, which was funded by TCEQ, concluded that the tributary is now fully supporting designated contact recreation use. The improvement in water quality is due to the removal of wastewater effluent irrigation of the adjacent golf course and a retrofit of a wastewater lift station. The TCEQ plans to delist the tributary in 2012. There was not enough data to perform trend analyses on the stream.

Segment 1427

The headwaters of Onion Creek are located in Blanco County. The creek flows intermittently about 78 miles to the east to its confluence with the Colorado River in Travis County. The stream interacts with groundwater as it flows over and into limestone fissures in the Edwards Aquifer recharge zone southwest of Austin.

Whirlpool on Onion Creek formed over Cripple Crawfish Cave

Austin Watershed

Monitoring data collected from several sites on the creek indicate that applicable water quality standards are met. Two sites were examined for trends, one above and one below the urbanized areas in the watershed. A significant trend for nitrate was detected at the upper location (Figure 60). Spikes in nitrate levels in 2007 and 2010 may be the result of build-up of nutrients during dry periods that are washed into the stream during wet periods, as recently documented in a cooperative study funded in part by the COA and LCRA (see http://pubs.usgs.gov/sir/2011/5018/). Based on screening levels the spikes do not represent a threat to water quality.

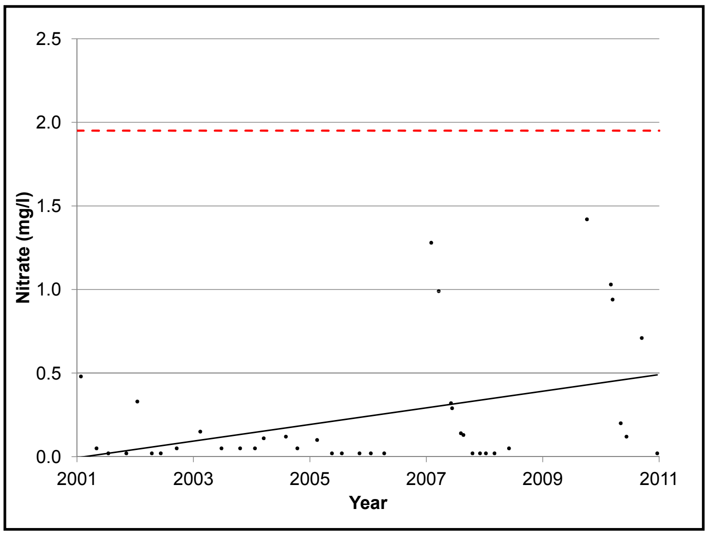


Figure 60. Nitrate trend on Onion Creek.

Segment 1427A

Located in southern Travis County, the Slaughter Creek watershed is approximately 31 square miles. While the watershed is urban, the riparian area surrounding the creek remains largely intact. The lower watershed consists primarily of densely clustered housing subdivisions and the upper watershed is less developed.

From the headwaters near SH 290, the stream flows to the east about 17 miles to confluence with Onion Creek. A six-mile section of the creek near Loop 1 (MoPac) lies over the Edwards Aquifer recharge zone and this mid-reach portion of the creek does not maintain baseflow under normal conditions. Monitoring data on the creek indicate elevated levels of bacteria and low levels of dissolved oxygen.

There are no permitted wastewater discharges into Slaughter Creek, but wastewater lines and septic systems are located throughout the watershed. Urban stormwater runoff could be a source of organics and cause oxygen depletion. A UAA was conducted by TCEQ in 2004. The findings were inconclusive due to drought conditions and accurate ALU designations were not determined. TCEQ Water Quality Standards Team is slated to begin biological monitoring in FY 2012 in an effort to collect enough data to determine an ALU.

Segment 1429

Lady Bird Lake (formerly Town Lake) is formed where Longhorn Dam impounds the Colorado River in Austin. The lake extends upstream approximately five miles to Tom Miller Dam. It has a surface area of approximately 500 acres.

Known as a pass-through lake, water moves quickly from the headwaters below Tom Miller Dam toward Longhorn Dam on the east side of Interstate 35 in Austin. Retention time is a mere one hour and the lake flows quickly during its five-mile journey through downtown Austin. The Lady Bird Lake watershed is densely urbanized. COA in cooperation with the Lewisville Aquatic Ecosystem Research Facility have successfully developed methods for reintroduction and expansion of a more diverse, native community of aquatic macrophytes to Lady Bird Lake. Additionally, COA is attempting to control the invasive Giant Cane (Arundo donax) with a combination of mechanical cutting and herbicide application in the riparian areas of Lady Bird Lake. COA recently developed the Austin Lakes Index to holistically track the status of Lady Bird Lake, Lake Austin and Lake Walter E. Long. Austin Lake Index scores will be updated on an annual basis, and available from the COA Watershed Protection Department webpage in fiscal year 2013.

While a concern level for nitrate has been identified, monitoring data collected from several sites on the lake indicate that applicable water quality standards are met.
There were no significant trends detected for this Lady Bird Lake.

Segment 1429B

The Eanes Creek watershed is located on the south side of Lady Bird Lake in West Austin. The Eanes Creek Watershed consists primarily of dense residential development. The lower portion of the watershed lies over the southern Edwards Aquifer recharge zone. The creek is intermittent upstream of the recharge zone and ephemeral over the recharge zone.

The stream has been on the 303(d) list since 1999 303(d) for not supporting contact recreation due to elevated levels of fecal coliform bacteria. Intermittency of the stream prevents regular monitoring. Very few samples were collected during the period of record. Consequently it will continue to have an impaired status until more data can be collected. An RUAA may be needed to remove the impairment from the 303(d) list. Because the creek only flows in response to stormwater runoff, the data used to generate the impairment listing in 1999 were most likely not representative of ambient conditions.

Segment 1429C

The Waller Creek watershed is located on the north side of Lady Bird Lake in downtown Austin. The headwaters begin in North Austin and the stream flows about five miles to its confluence with Lady Bird Lake.

Waller Creek is heavily urbanized. Greenbelt and natural filters are non-existent and it is frequently reduced to concrete-lined channels. Sewer lines cross the creek and stormwater outlets drain runoff from downtown Austin into the creek. Signs of transient populations in the creek are evident during monitoring events.

Monitoring data collected from several sites on the creek showed elevated levels of bacteria and toxins in sediment. Concern levels for aquatic life were also found due to low levels of dissolved oxygen and sediment toxicity. Potential sources of bacteria include pet and human waste, leaking wastewater infrastructure and urban runoff. These sources contribute pollutants from multiple locations and in variable amounts making it difficult to track sources and loading.

Construction of the Waller Creek Tunnel, a major channelization project, began in 2011 and is ongoing. Once complete, the project will alter the original flow and habitat in the creek. The tunnel will be used to recirculate water from Lady Bird Lake thru Waller Creek during non-storm conditions. The tunnel project, in combination with significant redevelopment efforts similar to the San Antonio River Walk, will dramatically alter lower Waller Creek in the future. The COA has requested that TCEQ initiate a TMDL for bacteria for the upstream portions of the watershed unaffected by the tunnel. No water quality improvement projects are planned for the lower portion of the creek prior to the completion of the tunnel in 2014.

Segment 1430

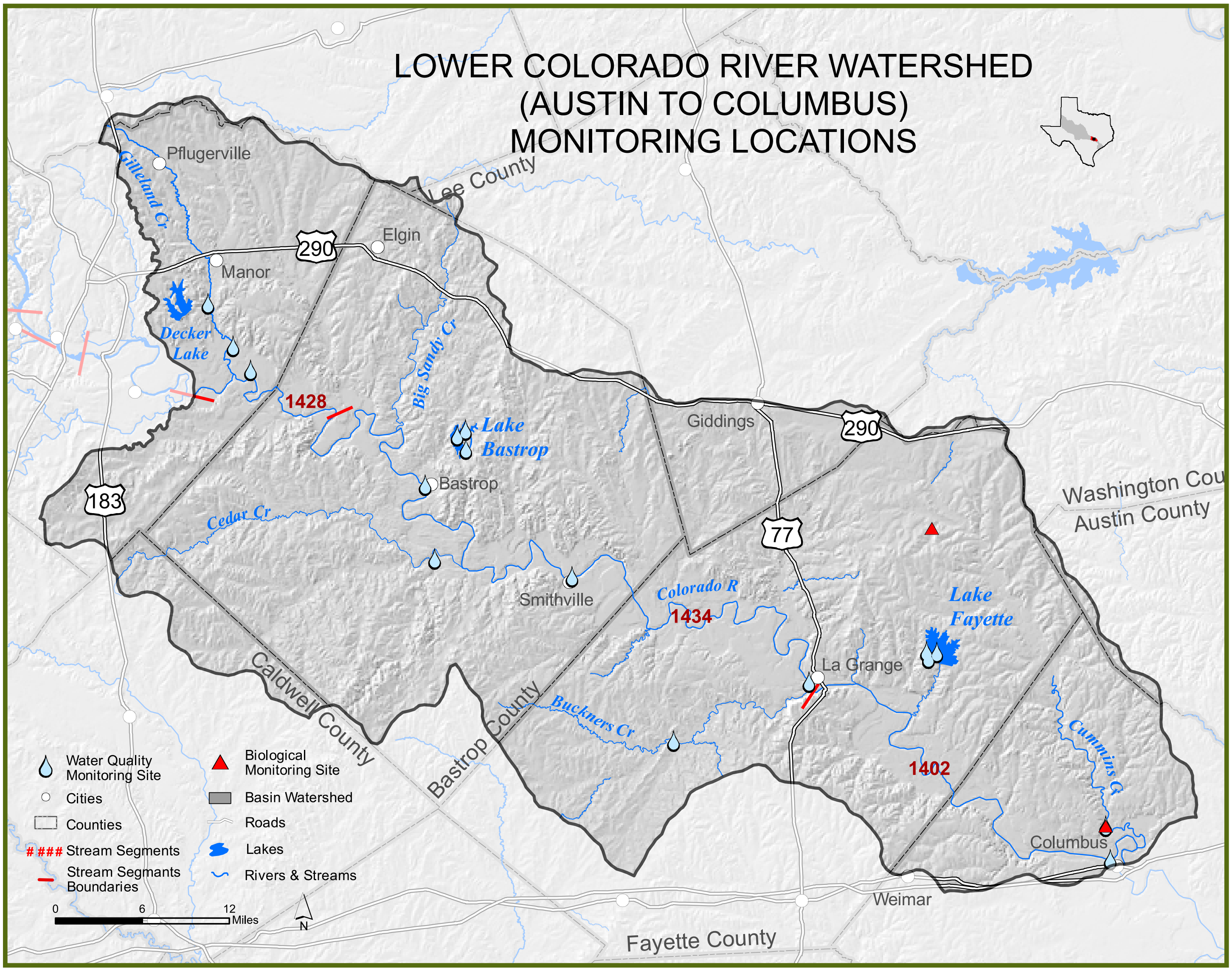
Barton Creek is the largest tributary to Lady Bird Lake. The headwaters are located near Dripping Springs. The creek flows intermittently about 38 miles to its confluence with the lake. Eight square miles of the watershed are in the Edwards Aquifer Recharge Zone, where water travels into caves and sinkholes recharging the aquifer. Groundwater resurfaces near Barton Springs Pool in Austin.

While Barton Creek met applicable Surface Water Quality Standards, monitoring data indicates concern levels for dissolved oxygen and for toxicity in sediment at Barton Springs. The source of low dissolved oxygen is groundwater at the springs. The toxicity concern is based on studies done by the City of Austin, USGS and TCEQ on polycyclic aromatic hydrocarbons, chemical compounds present in high concentrations in coal-tar based pavement sealants that are known to impact aquatic life. The COA was the first city in the United States to ban coal-tar based pavement sealants.

Future Challenges for the Austin Watersheds

- Removal of streams from the CWA 303(d) List for bacteria. COA has requested TCEQ to initiate TMDL for bacteria for segments 1403J, 1403K, 1428B, and 1429C in fiscal year 2013.
- Changes to the structure and water quality of Waller Creek will need to be evaluated once the floodwater tunnel is completed.
- In Barton and Onion creeks, wastewater disposal outside of the COA jurisdiction is accomplished by individual on-site facilities or via centralized land application under the TCEQ Texas Land Application Permit program. While not specifically prohibited by rule, wastewater discharge to the Barton Springs Contributing Zone has not yet occurred. As population growth continues to occur in this region, however, the possibility that a development will seek an application for wastewater discharge in the recharge zone continues to increase over time.
- Under the recently adopted LCRA Water Management Plan, the flow regime of the Colorado River through Lake Austin and Lady Bird Lake may change under drought conditions. Less water released for downstream agricultural interests during warm summer months will increase growth of aquatic macrophytes in Lake Austin and increase the frequency and duration of nuisance algae blooms in both lakes and downstream in the Colorado river. Significantly lower flows may also cause a DO deficit in the Colorado River below Lady Bird Lake.

Lower Colorado River Basin Watershed



During the reporting period 15 sites were routinely monitored on the following segments.

Segment 1402 - Colorado River below La Grange
Segment 1402C - Buckners Creek
Segment 1428 – Colorado River between Austin
Segment 1428B - Walnut Creek
Segment 1428C – Gilleland Creek
Segment 1434 – Colorado River between Utley and La Grange
Segment 1434C – Buckners Creek

Lower Colorado River Basin Watershed

The lower Colorado River watershed below Austin encompasses an area of about 2,195 square miles. Water typically flows more slowly here than in the river above Austin because of the flat terrain. The watershed is situated mostly in the Texas Blackland Prairies and the East Central Texas Plains ecoregions, where clay and sandy soils give the water a cloudy appearance. Annual rainfall averages 35 inches per year.

From November to February, when water is not being released for downstream irrigation, treated effluent from WWTPs can make up a majority of the flow in the Colorado River. Elevated nutrients and bacteria are problematic in the watershed (Table 8).

Table 8. Summary of Impairments and Concerns for the Colorado River Watershed below Austin

Segment	Name	Use	Parameter	Status
1402	Colorado River below La Grange	General Use	Orthophosphorus	Concern
1402	Colorado River below La Grange	General Use	Nitrate	Concern
1402C	Buckners Creek	Aquatic Life	Dissolved Oxgygen (24-hr)	Impairment
1428	Colorado River below Lady Bird Lake	Contact Recreation	E. coli	Impairment
1428	Colorado River below Lady Bird Lake	Aquatic Life	Macrobenthic Community	Concern
1428	Colorado River below Lady Bird Lake	Aquatic Life	Fish Community	Concern
1428	Colorado River below Lady Bird Lake	General	Nitrate	Concern
1428	Colorado River below Lady Bird Lake	General	Orthophosphorus	Concern
1428	Colorado River below Lady Bird Lake	General	Total Phosphorus	Concern
1428B	Walnut Creek	Contact Recreation	E.Coli	Impairment
1428C	Gilleland Creek	Contact Recreation	E. coli	Impairment
1428C	Gilleland Creek	General	Nitrate	Concern
1428C	Gilleland Creek	General	Orthophosphorus	Concern
1434	Colorado River above La Grange	General	Nitrate	Concern
1434	Colorado River above La Grange	General	Orthophosphorus	Concern

Segment 1428

The Colorado River below Lady Bird Lake is approximately 41 miles long. It begins at Longhorn Dam and ends near the river's intersection with FM 969 northwest of Bastrop. The upper end of the segment is the urbanized while the lower end is mostly rural. About 70 million gallons of treated effluent are discharged into this segment from City of Austin WWTPs each day.

The Colorado River below Austin is impacted by water releases for irrigation from LCRA and from City of Austin wastewater discharges.

Lower Colorado River Basin Watershed

According to the 2010 Integrated Report, the upper end of the segment - near Longhorn Dam – has elevated bacteria levels, and farther downstream near Webberville, nutrients are at concern levels. While a source of bacteria has not been determined, recently collected data show reduced bacteria numbers. The reduction in bacteria should facilitate the removal of the Segment 1428 from the 303(d) List in the 2012 Integrated Report. The source of nutrients is likely a cumulative effect of wastewater discharges. Nitrogen levels are typically higher in the winter when flows are low.

Trend analysis showed an increase in the dissolved oxygen deficit and an increase in ammonia (Figures 61 and 62). Concentrations of ammonia remain within screening levels.

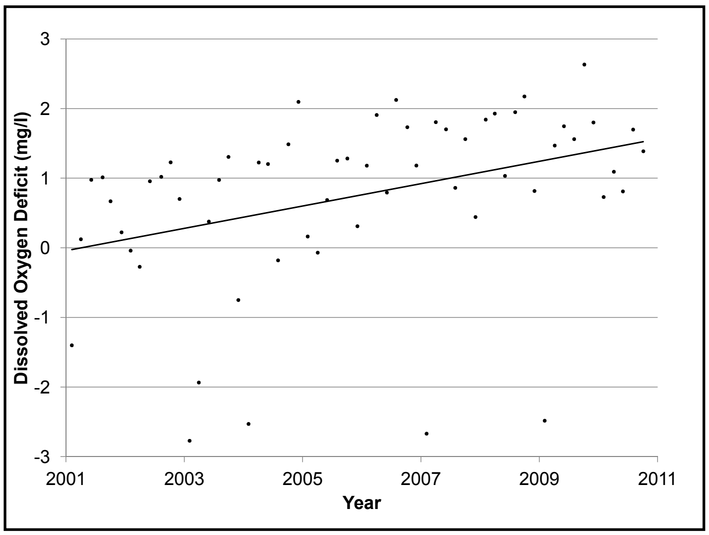


Figure 61. Dissolved oxygen deficit trend in Segment 1428

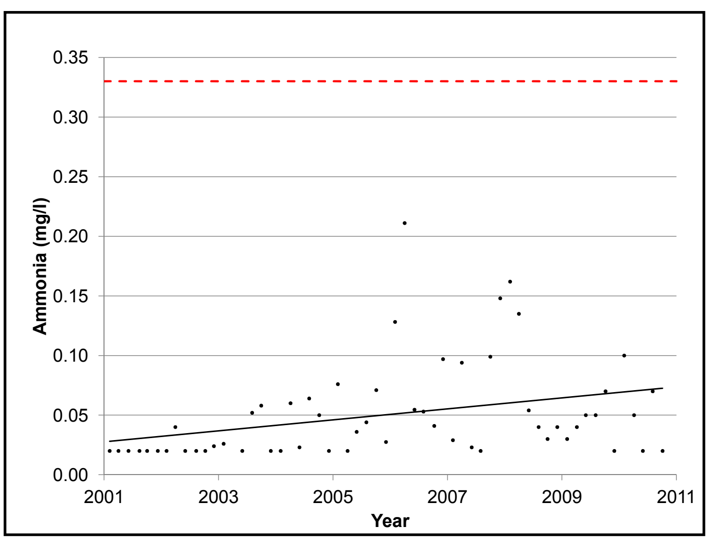


Figure 62. Ammonia trend in segment 1428

Segment 1428B

Walnut Creek begins in Northeast Austin and ends about 20 miles downstream where it flows into the Colorado River, just below Longhorn Dam. The watershed is urban, comprised mostly of residential housing and commercial uses.

Walnut Creek in North Austin

Data collected from several sites in the creek indicate elevated levels of bacteria. The uppermost reach, near Loop 1 has an impaired status due to bacteria. Potential sources of bacteria include urban runoff and leaking wastewater lines. COA conducted longitudinal bacteria sampling and mapped on-site sewage facilities near the impaired site in an effort to isolate the sources. A small outfall was found that could be the source of bacteria. COA is currently investigating wastewater infrastructure to identify and repair leaks. Routine monitoring at the creek will continue in 2012. The COA has requested TCEQ to initiate a TMDL for bacteria in Walnut Creek in fiscal year 2013. There were not enough data from Walnut Creek to perform trend analysis.

Segment 1428C

Gilleland Creek begins near Pflugerville and ends approximately 31 miles downstream where it flows into the Colorado River downstream of Austin. In 1999, based on data collected near the confluence with the Colorado River, the creek was given an impaired status due to bacteria levels. Elevated nitrate levels have been found at the same site.

Flow in the creek is predominantly from treated wastewater. Through a contract with TCEQ, LCRA developed the Gilleland

Creek TMDL. The TMDL was adopted by TCEQ Commissioners in August, 2007 and by EPA in April, 2009. An implementation plan - including waste load allocations, stormwater prevention, education and other controls - was approved by TCEQ Commissioners in February, 2011. Implementation is ongoing.

A trend analysis of data from Gilleland Creek showed significant trends in total phosphorus and nitrate concentrations (Figures 63 and 64, respectively). Total phosphorus declined over the last 10 years, while nitrate increased. Nitrate consistently exceeds TCEQ screening criterion. One explanation for the trends is improvements at the Pflugerville WWTP (the largest discharge into the creek) to meet the 1 milligram per liter (mg/L) phosphorus permit limit. Nitrate levels in the creek have increased with the volume of discharge.

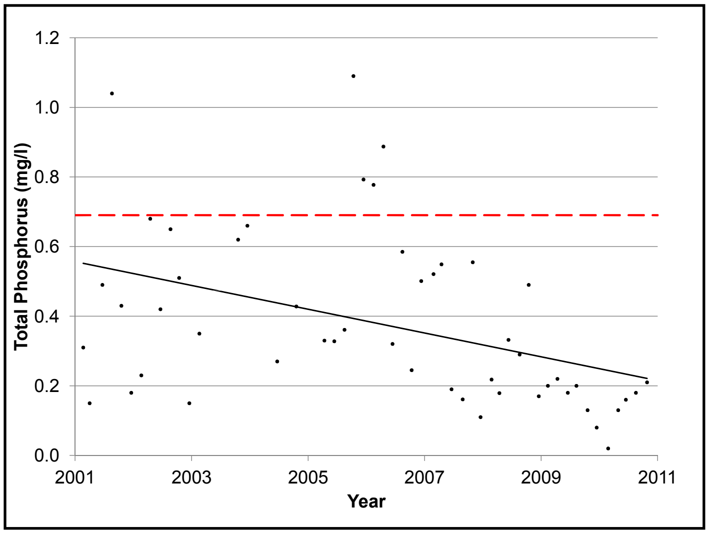


Figure 63. Total phosphorus trend in Gilleland Creek

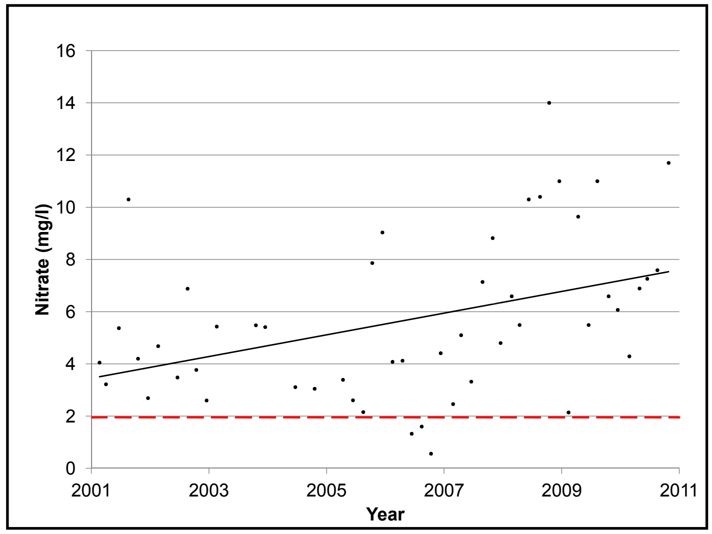


Figure 64. Nitrate trend in Gilleland Creek

Segment 1434

The Colorado River between Utley and La Grange begins at FM 969 near Bastrop and ends at SHH 71 in La Grange. The segment is approximately 74 miles long. With the exception of Bastrop, Smithville and La Grange, this section of the river flows through mostly farmland. The water is turbid due to sandy loams and clay soils in the East Central Texas Plains Ecoregion.

Monitoring data collected from near La Grange indicates a level of concern for nutrients in the main stem of the river. The source is likely treated wastewater discharges upstream; Segment 1428, upstream, was identified with the same concerns.

Trend analysis indicated an increasing trend in dissolved oxygen deficit (Figure 65). This is not surprising, as Segments 1428 and 1434 are contiguous and dissolved oxygen is likely being consumed through biological processes in this part of the river which is sometimes wastewater-dominant.

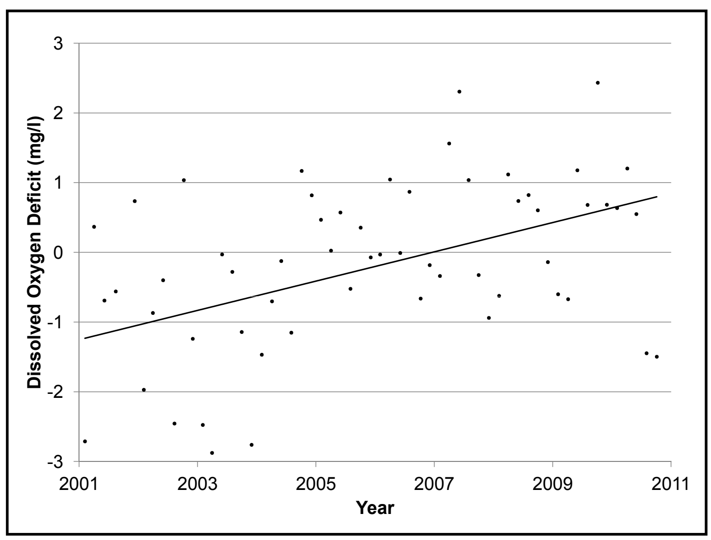


Figure 65. Dissolved oxygen deficit trend in Segment 1434

Lower Colorado River Basin Watershed

Bastrop Wildfire

On Labor Day Weekend 2011, wildfires began near Hwy. 290 and the town of Paige. A separate wildfire began off FM 1441 near Hwy. 21. As a result of strong, gusty winds in excess of 30 mph and ongoing drought, the wildfires quickly joined and continued to burn, moving in a southeasterly direction. Ultimately the Bastrop County Complex Fire scorched over 34,000 acres and destroyed 1,600 homes. Much of the area known as Lost Pines, including habitat for the endangered Houston Toad and Bastrop State Park was lost. Recovery of this unique ecosystem will be measured in years.

In response to this natural disaster, LCRA developed a water quality monitoring plan in order to assess the impact to Alum Creek and the Colorado River. The plan identified ambient and stormwater monitoring for approximately 185 parameters including routine water chemistry, metals, semi-volatile organic compounds and volatile organic compounds. Monitoring stations were located at the Colorado River at Bastrop (upstream control Point), Colorado River at Colovista (where fire reached the river), Colorado River at Smithville (downstream of all the fire activity), and Alum Creek (tributary watershed where 80% of the fire occurred).

Copperas Creek in Bastrop State Park after the Bastrop County Complex Fire

Not surprisingly, TSS were elevated during and immediately after periods of stormwater runoff. These concentrations were about 2.5 times higher in Alum Creek than other monitoring locations, indicating significant soil erosion occurring in the watershed.

The volatile organics and semi-volatile organics were either below or slightly above detectable limits. For parameters with a water quality criterion, the concentrations have generally been below the water quality criteria. Metals are not in ranges expected to cause harm to human health or aquatic life.

The Lost Pines Recovery Team has finalized the Lost Pines Habitat Recovery Master Plan. This 5-year, multi- million dollar effort will accelerate recovery of native vegetation and significantly reduce soil erosion. Significant efforts by the Team to fund the plan are underway, primarily through grants and donations.

Bastrop State Park images taken six weeks after the Bastrop County Complex Fire

Lower Colorado River Basin Watershed

Segment 1402

Colorado River below La Grange begins in LaGrange and ends 150 miles downstream near Bay City. The segment traverses two watersheds: the lower Colorado River watershed and the coastal watershed. The lower portion of the segment is below Columbus and discussed in the Coastal Watershed Summary. The upper portion, which includes the area from La Grange to Interstate 10 in Columbus, is mostly rural. Data from the Colorado River near La Grange indicates elevated nutrient levels

Segment 1402C

Located on the south side of the Colorado River near La Grange, the Buckners Creek watershed is about 176 square miles. The stream begins at the headwaters near the community of Rosanky in Bastrop County and ends 26 miles downstream at its confluence with the Colorado River. The Buckners Creek watershed is rural. The majority of the watershed has been cleared, but land along the riparian area surrounding the creek remains intermittently intact, particularly in the upper end of the watershed.

Monitoring data indicates an impairment for low levels of dissolved oxygen. Potential causes of low dissolved oxygen include decomposition of organic matter coupled with slow flows and inadequate mixing.

Trend analysis indicates chloride, sulfate, TDS and chlorophyll a concentrations have increased over time (Figures 66-69). Trends were related to flow and may be a result of droughts in 2008 and 2011.

Buckners Creek on the Colorado River

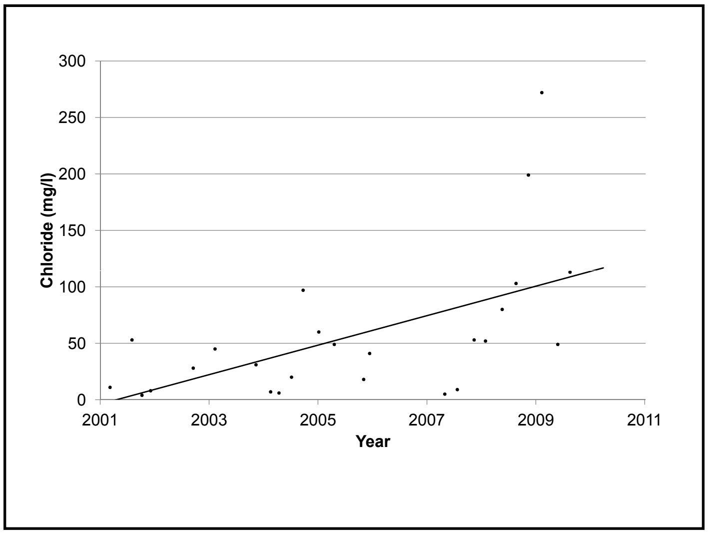


Figure 66. Chloride trend in Buckners Creek

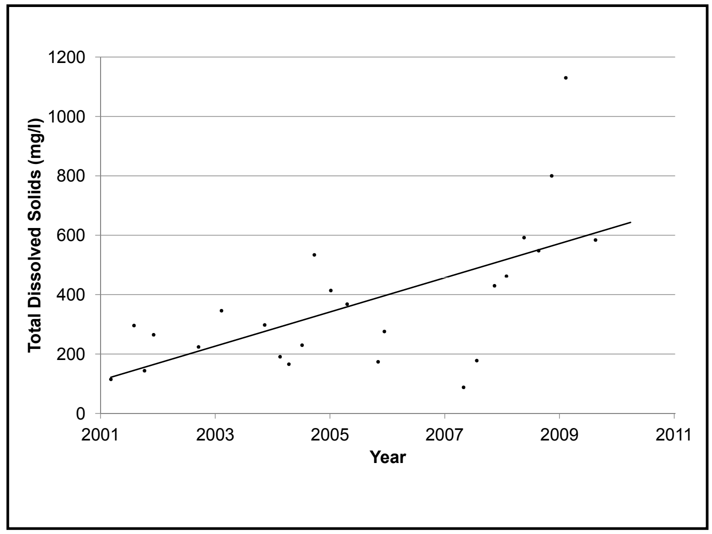


Figure 68. TDS trend in Buckners Creek

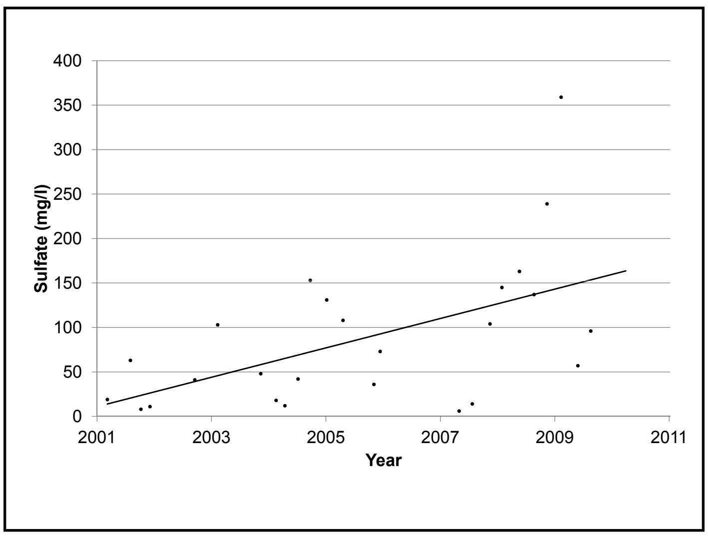


Figure 67. Sulfate trend in Buckners Creek

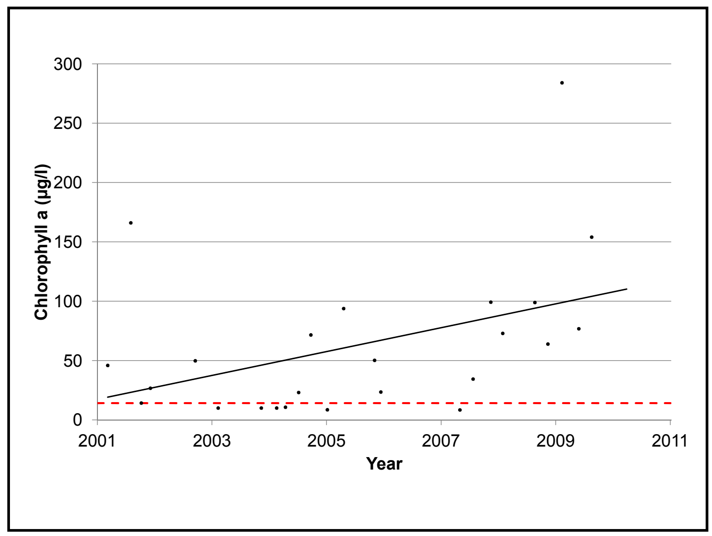
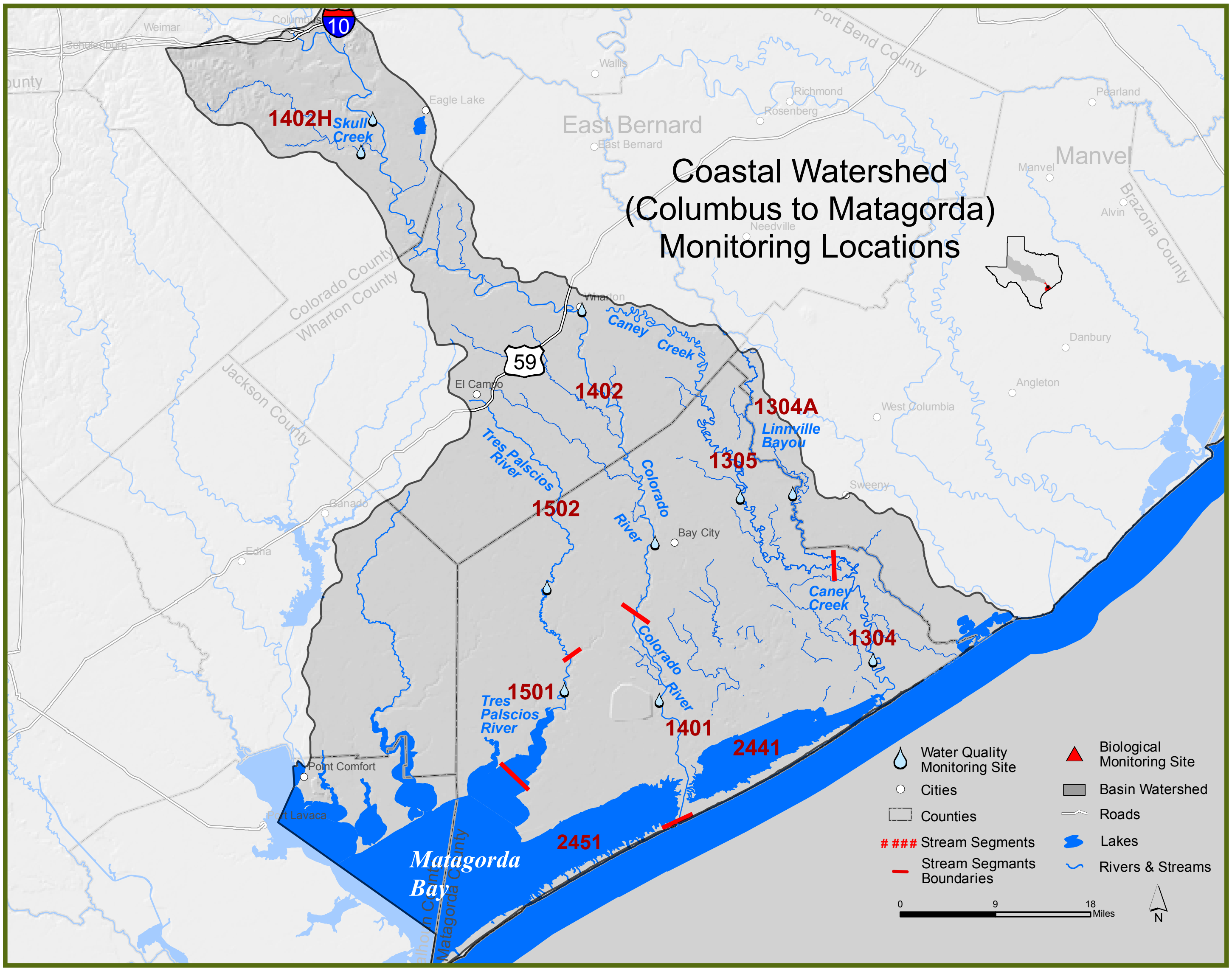


Figure 69. Chlorophyll a trend in Buckners Creek

Future Challenges for the Watershed below Austin

- Continue to monitor effects of the Bastrop Wildfire
- Continued implementation of the Gilleland Creek TMDL
- The US Fish and Wildlife Service continues to evaluate the listing of several freshwater musselspecies that may occur in the Colorado River Basin as endangered species. The impact of the listing of these mussels on the wastewater disposal and water management plans for the Colorado River is yet to be determined.

Coastal Watershed



During the reporting period 7 sites were routinely monitored on the following segments.

Segment 1304 – Caney Creek (Tidal Portion)
Segment 1304A – Linnville Bayou
Segment 1305 – Caney Creek
Segment 1401 – Colorado River (Tidal Portion)
Segment 1402 – Colorado River
Segment 1402H – Skull Creek
Segment 1501 – Tres Palacios River (Tidal Portion)
Segment 1502 – Tres Palacios River

Coastal Watershed

The Colorado River coastal watershed begins just downstream of the City of Columbus in Colorado County. The watershed lies within the Western Gulf Coastal Plains Ecoregion, a belt of flat prairies along the Gulf of Mexico. It is an area of approximately 2,800 square miles and typically receives 40 to 54 inches of rain per year.

From Columbus, the Colorado River flows to the east through Wharton and Bay City before entering Matagorda Bay. Here the river mixes with brackish water to create unique ecosystems with diverse populations of fresh water and salt-water species. Several streams in the watershed frequently exhibit low dissolved oxygen and bacteria levels that exceed TSWQS.

Rice is an important crop and an economic driver in the region. LCRA typically releases water from the Highland Lakes from March to October to supply rice farmers with irrigation water. Because of drought conditions in the basin, releases for irrigation will be much reduced in 2012.

The three tidally influenced segments in the Colorado River basin (1304, 1401 and 1501) are impaired for contact recreation (Table 9). One reason for this could be the type of bacteriological indicator used by TCEQ to assess coastal waters. Prior to 2006, fecal coliform was the primary bacterial indicator in tidal water bodies. In 2006 TCEQ began to use Enterococcus to measure attainment of contact recreation standards. The result was an increase in bacteria listings along the Texas Coast, including three tidally influenced segments in the Colorado River basin. While not definitive, the increase may be a result of using Enterococcus or an incorrect criterion. This and other potential causes are discussed in the following segment summaries.

Segment	Name	Use	Parameter	Status
1304	Caney Creek (Tidal)	Contact Recreation	Enterococcus	Impairment
1304	Caney Creek (Tidal)	Aquatic Life	Dissolved Oxygen	Concern
1304A	Linnville Bayou	Contact Recreation	E.Coli	Impairment
1305	Caney Creek (above Tidal)	Contact Recreation	Enterococcus	Impairment
1305	Caney Creek (above Tidal)	Aquatic Life	Dissolved Oxygen	Impairment
1305	Caney Creek (above Tidal)	Aquatic Life	Orthophosphorus	Concern
1401	Colorado River (Tidal)	Contact Recreation	Enterococcus	Impairment
1401	Colorado River (Tidal)	General Use	Nitrate	Concern
1401	Colorado River (Tidal)	General Use	Chlorophyll a	Concern
1402	Colorado River below La Grange	General Use	Chlorophyll a	Concern
1402	Colorado River below La Grange	General Use	Orthophosphorus	Concern
1402	Colorado River below La Grange	General Use	Nitrate	Concern
1402H	Skull Creek	Aquatic Life	Dissolved Oxygen (24-hr)	Impairment
1402H	Skull Creek	Contact Recreation	E.Coli	Impairment
1501	Tres Palacios River (Tidal)	Contact Recreation	Enterococcus	Impairment
1501	Tres Palacios River (Tidal)	Aquatic Life	Dissolved Oxygen	Impairment
1501	Tres Palacios River (Tidal)	General Use	Chlorophyll a	Concern
1502	Tres Palacios River (Above Tidal)	Aquatic Life	Habitat	Concern
1502	Tres Palacios River (Above Tidal)	Aquatic Life	Macrobenthic Community	Concern

Coastal Watershed

Segment 1304

The tidally influenced portion of Caney Creek is located between the confluence of Linnville Bayou and the Intracoastal Waterway. This 32-mile segment is a slow flowing meandering stream with oxbow lakes and sloughs along its riparian area.

Row crop agriculture and ranching are common. The majority of land in the segment is undeveloped, though subdivisions line the banks of the creek near East Matagorda Bay below the community of Sargent.

Data collected from Caney Creek near East Matagorda Bay indicate that bacteria levels are frequently higher than contact recreation criterion and low levels of dissolved oxygen are a concern.

In 2009 LCRA added another sampling site to confirm the impairment and isolate and delineate potential sources of bacteria. The new site, located upstream of housing developments, also exhibited bacteria above the criterion for contact recreation. While more study needs to be done to definitively determine the sources of bacteria, potential sources include malfunctioning septic systems along the creek, agricultural runoff, wildlife, or the use of Enterococcus as an indicator or an incorrect criterion. Dissolved oxygen levels are likely a function of sluggish flows and tidal influence (salt water does not retain DO well).

There were five significant trends in the tidal portion of Caney Creek: sulfate, chloride, TDS, ammonia and nitrate. However, the causes could not be determined because of the chemical variability associated with tidally influenced waters. None of the trends indicate a decline in water quality.

Tidal portion of Caney Creek

Segment 1304A
Linneville Bayou

Linnville Bayou is a freshwater tributary of Caney Creek. The Linnville Bayou watershed is approximately 111 square miles and is typical of Texas' coastal prairies; flat with loamy clay soils. The watershed is rural and primarily used for row crop agriculture and ranching.

Data collected from Linnville Bayou downstream of State Highway 35 showed elevated levels of bacteria. Causes of the impairment are unknown, but with average annual precipitation of 54 inches, nonpoint source runoff likely contributes to bacteria levels.

Trend analysis indicates decreasing trends for chloride, sulfate and nitrate and an increase for dissolved oxygen deficit (Figures 70-73). Trends are attributed to the removal of wastewater discharge from the Conoco-Phillips Refinery in 2004. Chloride, sulfate and nitrate levels decreased dramatically when the discharge was moved to the Brazos River basin. Similarly, the increase in dissolved oxygen deficit is due to reduced flows in the bayou.

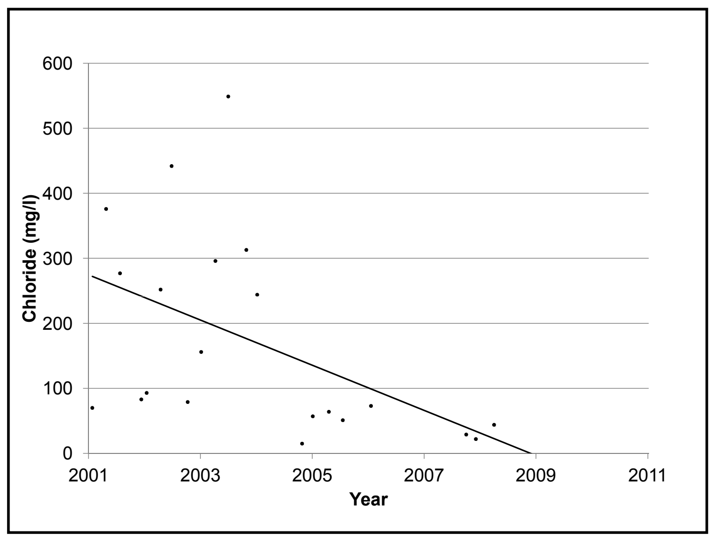


Figure 70. Chloride trend in Linneville Bayou

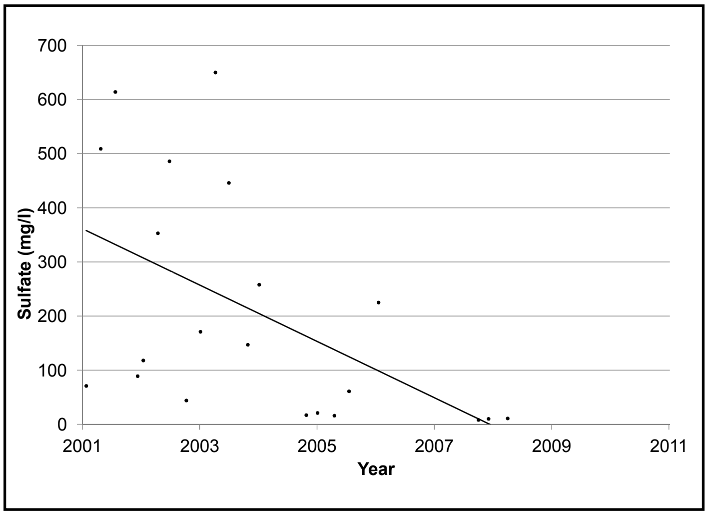


Figure 71. Sulfate trend in Linneville Bayou

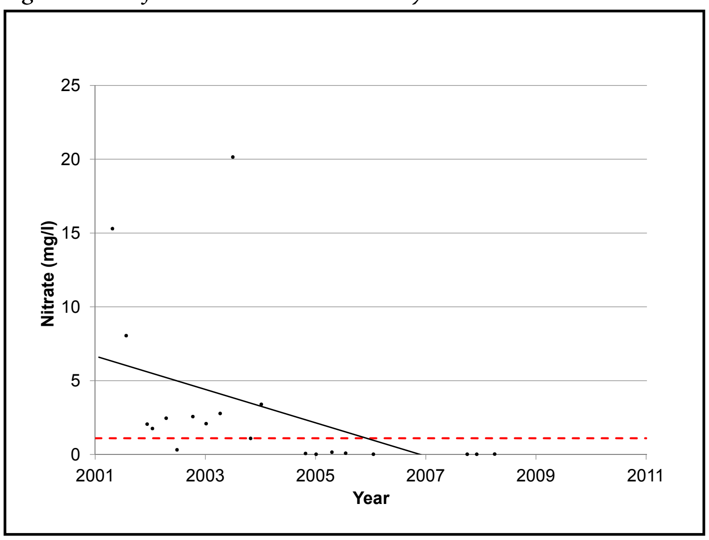


Figure 72. Nitrate trend in Linneville Bayou

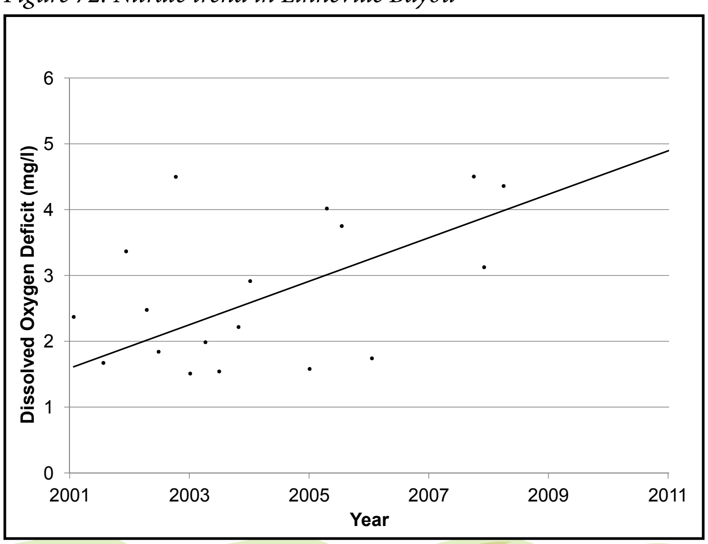


Figure 73. Dissolved oxygen deficit trend in Linneville Bayou

Segment 1305

The headwaters of Caney Creek are located near Wharton. The above-tidal portion of the creek flows southeast through the community of Boling and ends at the confluence with Linnville Bayou in Matagorda County. It is a meandering creek, frequently winding back into itself creating oxbow lakes and natural dams that slow the water and create stagnant pools during low flow conditions. Segment 1305 is approximately 98 miles.

Data collected from near State Highway 35 show high levels of bacteria and orthophosphorus, and low levels of dissolved oxygen. Potential sources of bacteria include wildlife and agricultural practices such as plowing to the creek bank and watering cattle in-stream. Further study needs to occur to determine bacteria sources. TCEQ initiated an RUAA to determine the extent of recreation on the creek. The final report was not available at print time, but should be considered during the next Water Quality Standards Review.

Caney Creek typically has sluggish flows and standing pools of stagnant water, which prohibits mixing and oxygenation. The lack of aeration coupled with the breakdown of naturally occurring organic materials are likely sources of low DO and orthophosphorus. Based on the results of a Use Attainability Analysis performed by TCEQ, a site specific criterion for DO was assigned to the upper end of the segment. If approved by EPA, seasonally lower DO criteria will be implemented in the 2012 TCEQ water quality assessment.

Segment 1401

The tidal portion of the Colorado River begins downstream of Bay City and flows to its convergence with Matagorda Bay. The watershed surrounding the 27 mile segment is rural and much of it is farmed. A small subdivision is located along the river near the monitoring site.

Monitoring data collected about 12 miles upstream of the Intracoastal Waterway indicate elevated levels of bacteria and nutrients. Potential sources of bacteria include failing septic systems from the subdivision, wildlife, agricultural runoff and the use of Enterococcus as an indicator or an incorrect criterion.

There were two significant trends in the tidal portion of the Colorado River: sulfate and chloride. The trends are a function of sampling time and tide.

Coastal Watershed

Segment 1402

Segment 1402 of the Colorado River begins in LaGrange and ends 150 miles downstream near Bay City. The segment traverses two watersheds: the lower Colorado River watershed and the coastal watershed. The upper portion of the segment is discussed above in the Lower Colorado River Watershed Summary.

The lower portion flows sluggishly over the flat landscape. Farm land comprises most of the land use. Sediment deposition and episodic floods created a floodplain rich with nutrients and earth materials. Gravel mining is a major industry in the region. Data collected from sites near Columbus, Wharton and LaGrange indicate that the segment fully supports it designated uses, but has concern levels of nutrients. There were no statistically significant trends in Segment 1402.

Skulll Creek near Columbus

Segment 1402H

The Skull Creek watershed is located downstream of Columbus on the south side of the Colorado River. It is approximately 112 square miles. Much of the riparian area in the upper watershed has been cleared and is used for grazing pastures. In the lower watershed, the riparian corridor remains intact with the exception of gravel operations located near its confluence of the Colorado River. The stream is approximately 30 miles long.

Monitoring data collected near the creeks confluence of the Colorado River indicate impairments for low levels of dissolved oxygen and elevated levels of bacteria.

Potential causes of low dissolved oxygen include decomposition of organic matter and sluggish flow regimes. TCEQ completed an aquatic life monitoring project that found that the creek supports a diverse aquatic community despite chronic low dissolved oxygen levels. Fish, macroinvertebrate and habitat samples indicate a high aquatic life use. TCEQ plans a Water Quality Standards review with the potential to assign a new standard.

Cattle, deer, feral hog and other wildlife likely contribute bacteria, and stormwater runoff from gravel operations may impact the stream, but further study is needed to determine sources of pollutants. Trend analysis indicates that chloride and sulfate concentrations have increased over time, but remain well within TSWQS.

Segment 1501

The Segment 1501 is the tidally-influenced portion of the Tres Palacios River. It begins below State Highway 35 and ends approximately eight miles downstream where the river flows into Tres Palacios Bay. The surrounding watershed is rural and much of the land along the river is used for farming.

Monitoring data collected near the confluence of Tres Palacios Bay indicate concern levels of chlorophyll a and impairment levels of bacteria and dissolved oxygen. In an effort to delineate a potential sources of bacteria, LCRA began monitoring at an additional site monitoring site upstream of the historical site. Preliminary data indicate that high bacteria levels were common at both sites. Potential sources include failing septic systems in a nearby subdivision, stormwater runoff, livestock, wildlife or the application of Enterococcus as an indicator organism as discussed above.

Dissolved oxygen levels are likely a function of tidal influence (salt water does not retain DO well) and sluggish flows. A study done by TPWD in 2007 found that dissolved oxygen concentrations were not a major factor in determining the biological structure and ecosystem health. TCEQ plans a Water Quality Standard review with the potential to assign a new Standard.

Segment 1502

The headwaters of the Tres Palacios River are located where the drainage crosses US Highway 59. The above-tidal portion flows approximately 45 miles to its end below State Highway 35. The upper end of Segment 1502 is narrow with steep banks, more reminiscent of a small creek than a river. A narrow riparian area is maintained as the stream winds through cultivated farmland. Data collected from a monitoring site upstream of State Highway 35 show concern levels for aquatic life support based on biological monitoring. No statistically significant trends were found.

Upper reaches of the Tres Palacios River

Future Challenges for the Matagorda Bay Watershed

- Complete Caney Creek RUAA
- Determination of Enterococcus as an appropriate bacteriological indicator

Conclusions and Recommendations

Conclusions

There have been many accomplishments in the Colorado River Basin in the past five years. Clean Rivers partners, UCRA, CRMWD and LCRA have improved their monitoring network, generating huge amounts of publicly available quality-assured data. They have participated and led watershed protection projects such as the Gilleland Creek TMDL, the Brady Creek WPP and Concho River WPP projects to improve water quality and lessen the impact of urban development. Outreach efforts have reached thousands of Colorado River basin residents, providing an essential element in protecting the resource: knowledge and understanding.

Water Quality Conditions

Drought in the upper basin continues to cause water quality and quantity problems. High levels of dissolved solids are exacerbated by the ongoing drought and long-time CRP partner CRMWD opted out of the program in 2011 to dedicate resources to finding new sources of water for its customers. Implementation of the TMDLs on E.V. Spence Reservoir and the Colorado River below E.V. Spence Reservoir is ongoing, but rain will be necessary to significantly reduce TDS any appreciable amount.

Selenium levels in Beals Creek are high. TCEQ and CRMWD monitoring have not revealed the source(s) of the heavy metal and a special study may be necessary to isolate the cause. Golden algae has become a persistent problem in upper basin reservoirs. Fish kills were reported in the upper Colorado River and in J.B. Thomas, E.V. Spence and Brady Creek reservoirs. TPWD and UCRA continue to collect data to discover more about golden algae in hopes of preventing future kills.

The Concho River basin also displays elevated TDS levels in dispersed pockets throughout its watershed. Brush Control in the region has improved fresh water inflows from springs that could have otherwise been lost to evapotranspiration. UCRA continues to apply for grants to develop NPS projects on Brady Creek and the Concho River.

Most water bodies in the middle portion of the basin, from Lake Buchanan to Columbus, support their designated uses. The San Saba River and several small creeks in Austin do not support contact recreation because of elevated bacteria levels. Nutrient and salt levels are on the decline in the majority of water bodies in the Hill Country.

Some monitoring sites in the coastal basins, including Caney Creek, Tres Palacios and Colorado rivers have high bacteria levels and have been placed on the TCEQ 303(d) List of impaired waters. A use attainability analysis for Caney Creek which is impaired for E.coli, was completed and will be considered with the next Water Quality Standards Review.

Recommendations

Clean Rivers partners in the Colorado River basin should continue to monitor and provide quality assured data to TCEQ for assessment. Additionally, the partners should seek opportunities to work with state, federal and local agencies to implement water quality improvement projects based on newly acquired data and steering committee input.

The following water-quality protection efforts have been identified as priorities for the next biennium:

- Continue to coordinate water quality monitoring by LCRA, UCRA, City of Austin and TCEQ regional offices to ensure geographic coverage and the most efficient use of resources and funds;
- Continue to leverage resources by working with in-kind contributors such as City of Austin and Hays County;
- Investigate and report causes of impairment and assist the state with the Watershed Action Planning process to help prioritize appropriate actions;
- Continue to collect biological data to accurately assess aquatic life use in perennial streams;
- Improve public awareness on water quality issues through outreach and educational programs;
- Support brush removal efforts through public education, monitoring, and pursuing partnerships with interested parties;
- Continue to work with TCEQ NPS program and RRC to remediate oilfield contamination of surface water;
- Continue to support TPWD and other resource agencies to investigate golden algae blooms in the Colorado River basin;
- Completion of the Segment 1431 UAA to develop aquatic life use standards for Segment 1431;
- Support efforts to complete and implement the Segment 1431 RUAA;
- Complete and submit the Brady Creek WPP for approval by TCEQ; and
- Collect relevant data to evaluate the Highland Lakes Discharge Ban.

Appendix A

Water Quality Constituents

The following table lists the parameters collected by the CRP Partners and their potential impacts to water and possible sources:

Parameter	Cause/Source	Impact
Ammonia	Ammonia is excreted by animals and is produced during the decomposition of plants and animals. Produced by the breakdown of compounds containing organic nitrogen. It is also an ingredient in many fertilizers and is present in sewage and stormwater runoff.	Elevated ammonia levels are a good indicator of organic pollution and can adversely affect fish and invertebrate reproductive capacity and stunt growth.
Chloride	Natural weathering and leach¬ing of sedimentary rocks, soils, and salt. Other sources include oil exploration and storage, sewage and industrial discharges.	Chloride, a salt, is an essential element for maintaining normal physiological functions in all organisms. Elevated chloride concentrations can disrupt water balance and acid/base balances in aquatic organisms which can adversely affect survival, growth, and/or reproduction.
Chlorophyll a	Chlorophyll a is a photosynthetic pigment, found in all green plants and algae. The concentration of chlorophyll a is used to estimate phytoplankton biomass in surface water.	In the presence of sunlight and abundant food sources, photosynthesis increases. Excessive chlorophyll a can cause extreme cyclical swings in DO and pH.
Dissolved Oxygen (DO)	Excessive amounts of organic material and algal blooms may cause DO levels to fluctuate. The resulting low levels of DO can stress or kill aquatic life.	Dissolved oxygen is vital to fish and other aquatic life. It is the most frequently used indicator of a water body's ability to support aquatic life.
Escherichia coli (E. coli)	Bacteria present in warm bod¬ied animals. It may come from poorly maintained or ineffective septic systems, overflow of domestic wastewater plants and/or runoff from feedlots.	The primary indicator bacteria used to determine if a fresh water body is suitable for contact recreation. Typically not harmful, but their presence is an indicator of fecal matter contamination which may contain other pathogens.
pH	Industrial and wastewater discharges, runoff, accidental spills, and non point sources. Human activity that causes increases in organic matter and bacteria, and over abundant algae.	Most aquatic organisms function best in a pH range of 6.0 to 9.0. Higher alka¬linity levels in surface waters will buffer acid rain and other acid wastes and prevent pH changes that are harmful to aquatic life. The pH of water can affect the toxicity of many substances.
Nitrate	Nitrates are used as fertilizers to supply a nitrogen source for plant growth. The presence of nitrates in groundwater occurs from the conversion of nitroge¬nous matter into nitrates by bacteria and represents the process whereby ammonia in wastewater, is oxi¬dized to nitrite and then to nitrate by bacterial or chemical reactions.	Nitrate additions to surface waters can lead to exces- sive growth of aquatic plants. High groundwater nitrate levels can cause methemoglobinemia or blue baby syndrome in infants.
Total Suspended Solids (TSS)	Sources may include point and nonpoint sources. The most common source is soil erosion. Land disturbance in riparian areas typically increases TSS levels.	Increased turbidity can reduce the a amount of light to plants which decreases the oxygen production. Addi- tionally, excessive TSS levels increase sedimentation and can blanket habitat smother benthic organisms or eggs.
Total Dissolved Solids (TDS)	Sources of TDS include weathering and dissolution of rocks and soils, agricultural and stormwater runoff and point source discharges.	TDS is a quantification of the materials dissolved in water, typically chloride and sulfate anions which form salts.

Appendix A

Parameter	Cause/Source	Impact
Sulfate	Soluble sulfate occurs in almost all natural waters. It is often dissolved into waters from rocks and soils containing gypsum, iron sulfides, and other sulfur compounds. Other sources include the burning of sulfur-containing fossil fuels and fertilizers.	Sulfate can affect taste and odor of drinking water.
Temperature	Natural changes in water temperature occur seasonally. Changes can also be caused by alteration of the riparian zone, drought, or as a result of industrial uses such as electrical generation.	Colder water typically contains higher amounts of DO. As temperatures fluctuate, there is a direct effect on dissolved oxygen levels.
Alkalinity	A measure of the acid-neutralizing or buffering capac- ity of water, alkalinity corresponds with the hardness of water. The main source of alkalinity is usually the result from dissolved carbonate rock formation.	Alkalinity is important for fish and aquatic life because it protects or buffers against rapid pH changes.
Orthophosphorus	An element that is essential to plant life phosphorus is an ingredient found in soaps and detergents and is also present in sewage, and runoff from animal feedlots.	Is considered the limiting factor of plant growth in most water bodies. Excessive amounts of orthophosphorus causes excessive plant growth and eutrophication.
Total Phosphorus	An essential nutrient, required for growth of organisms. Sources include wastewater, agricultural drainage, and certain industrial wastes.	Excessive amounts of total phosphorus increase primary productivity and algal growth. It also contrib¬utes to the eutrophication of lakes.

Appendix B

Trend Analysis Methodology

Trend analysis was conducted following procedures outlined by TCEQ

Data Source

Trend analysis data was obtained through SWQMIS, the State's database of water quality data.

Dataset Size

For inclusion, datasets must have had at least 20 points within the 10-year period and those points must have covered at least 2/3 of the time period. Data were excluded if there was no flow measurement associated with it. If multiple measurements were collected in the same month, the sample set with the most complete data was used. If different analytical methods were used (e.g, chlorophyll a – parameter IDs 32211 and 70953), they were consolidated in order to create sufficiently large datasets.

Censored Data

To avoid creating trends based on changing reporting and detection limits, censored data were converted to a common parameter-based value. These are listed below:

chlorophyll a	2 or dropped <
E. coli/enterococci	1 or dropped <
NO2+NO3	0.02
NH3	0.02
TKN	0.2
total phosphorus	0.02
chloride	dropped < or >
sulfate	dropped < or >
secchi depth	dropped < or >

Statistical Criteria

Simple linear regression was performed. The following two criteria were required to be met in order to reject Ho:

t-statistic	$> \lvert 2.00 \rvert$
p-value	< 0.10

Appendix C

Upper Watershed

Segment 1411 - Site 13863

Parameter	TSWQS	n	Minimum	P_{25}	Median	P_{75}	Maximum	Mean	Range	t score	p value	Flow
Temperature	34.4	18	4.60	7.81	13.42	28.57	29.71	17.55	25.11	-0.673	0.510	NA
Secchi Depth	-	18	0.42	0.56	0.75	0.86	1.52	0.79	1.1	-1.939	0.069	NA
pH	6.5 - 9.0	18	7.90	8.32	8.41	8.51	8.70	8.40	0.80	-1.644	0.119	NA
TSS	-	18	1.0	7.3	9.5	14.0	21.0	10.3	20.0	0.328	0.747	NA
Ammonia	0.11	18	0.020	0.020	0.020	0.028	0.060	0.026	0.040	0.311	0.759	NA
Total Kjeldahl Nitrogen	-	-	-	-	-	-	-	-	-	-	-	NA
Nitrate	0.37	18	0.020	0.020	0.020	0.038	0.130	0.036	0.110	-1.625	0.122	NA
Total Phosphorus	0.2	18	0.020	0.045	0.060	0.060	0.570	0.092	0.550	-1.212	0.242	NA
Chloride	440	18	427.0	533.3	661.0	977.3	1160.0	732.3	733.0	-1.050	0.309	NA
Sulfate	360	18	271.0	333.8	400.5	594.5	768.0	461.3	497.0	-1.525	0.146	NA
Bacteria	126	16	1	1	1	2	13	3	12	0.911	0.377	NA
Chlorophyll	5	18	6.4	13.2	22.1	34.3	59.4	24.3	53.0	1.049	0.309	NA
Total Dissolved Solids	1660	17	1059.2	1624.3	1776.0	2320.0	3053.0	1945.7	1993.8	-0.923	0.370	NA
Dissolved Oxygen Deficit	-	18	-1.77	-0.66	0.03	0.76	1.80	0.06	3.57	-1.105	0.284	NA

Segment 1412 - Site 12363

Parameter	TSWQS	n	Minimum	P_{25}	Median	P_{75}	Maximum	Mean	Range	t score	p value	Flow
Temperature	33.9	107	3.40	10.59	19.40	24.99	33.80	17.79	30.40	0.344	0.732	N
pH	6.5 - 9.0	107	7.00	7.40	7.55	7.70	8.37	7.59	1.37	-4.373	0.000	N
TSS	-	106	4.0	18.5	34.0	56.8	555.0	45.7	551.0	0.376	0.708	N
Ammonia	0.33	38	0.050	0.050	0.050	0.068	0.460	0.074	0.410	0.344	0.733	N
Total Kjeldahl Nitrogen	-	33	0.460	0.890	1.170	1.430	5.300	1.463	4.840	-1.977	0.057	N
Nitrate	1.95	60	0.020	0.020	0.055	0.143	1.240	0.170	1.220	-2.041	0.046	N
Total Phosphorus	0.69	36	0.050	0.090	0.130	0.185	0.610	0.171	0.560	-1.091	0.283	N
Chloride	4740	105	260.0	1580.0	2220.0	3390.0	8710.0	2505.8	8450.0	0.031	0.975	N
Sulfate	1570	105	104.0	830.0	1240.0	1550.0	2020.0	1170.4	1916.0	0.590	0.557	Y (-)
Bacteria	-	32	1	50	270	1546	19000	1717	18999	1.924	0.064	Y (-)
Chlorophyll	14.1	35	2.0	11.0	20.5	46.1	440.0	44.3	438.0	-1.394	0.172	Y (-)
Total Dissolved Solids	9210	98	765.0	3820.0	5031.2	7142.0	16800.0	5598.3	16035.0	1.172	0.244	Y (-)
Dissolved Oxygen Deficit	-	106	-7.57	-1.00	1.47	3.27	6.71	1.26	14.28	3.234	0.002	N

Segment 1412 - Site 17002

Parameter	TSWQS	n	Minimum	P_{25}	Median	P_{75}	Maximum	Mean	Range	t score	p value	Flow
Temperature	35	103	3.95	12.58	20.20	25.46	34.10	19.33	30.15	0.617	0.539	N
pH	6.5 - 9.0	103	7.70	8.10	8.20	8.32	8.74	8.22	1.04	-0.969	0.335	Y (-)
TSS	-	103	7.0	30.0	57.0	93.5	2050.0	104.2	2043.0	0.433	0.666	Y (+)
Ammonia	0.33	-	-	-	-	-	-	-	-	-	-	-
Total Kjeldahl Nitrogen	-	-	-	-	-	-	-	-	-	-	-	-
Nitrate	1.95	27	0.020	0.020	0.030	0.240	0.470	0.125	0.450	-0.615	0.544	N
Total Phosphorus	0.69	-	-	-	-	-	-	-	-	-	-	-
Chloride	4740	103	104.0	920.0	1470.0	1840.0	4040.0	1460.2	3936.0	-0.364	0.717	Y (-)
Sulfate	1570	103	80.7	485.0	1090.0	1440.0	2210.0	976.2	2129.3	0.889	0.376	Y (-)
Bacteria	-	-	-	-	-	-	-	-	-	-	-	-
Chlorophyll	14.1	-	-	-	-	-	-	-	-	-	-	-
Total Dissolved Solids	9210	100	466.0	2314.0	3836.0	4964.3	8007.0	3630.9	7541.0	0.156	0.877	Y (-)
Dissolved Oxygen Deficit	-	103	-4.59	-1.63	-0.51	0.54	7.91	-0.39	12.50	1.371	0.173	Y (+)

Red text denotes statistically significant trends.

Segment 1412B - Site 12156

Parameter	TSWQS	n	Minimum	P_{25}	Median	P_{75}	Maximum	Mean	Range	t score	p value	Flow
Temperature	33.9	67	3.40	11.59	18.70	24.36	33.40	17.90	30.00	1.742	0.086	N
pH	6.5 - 9.0	67	7.47	7.88	8.10	8.31	9.00	8.10	1.53	-1.951	0.055	N
TSS	-	66	2.0	10.0	20.5	37.5	890.0	44.6	888.0	-0.965	0.338	N
Ammonia	0.33	30	0.020	0.020	0.038	0.050	0.538	0.057	0.518	-0.076	0.940	N
Total Kjeldahl Nitrogen	-	12	0.680	0.935	1.225	1.513	2.210	1.298	1.530	-0.102	0.920	N
Nitrate	1.95	42	0.020	0.020	0.020	0.143	1.640	0.241	1.620	-0.084	0.934	N
Total Phosphorus	0.69	30	0.040	0.060	0.070	0.128	0.330	0.108	0.290	0.364	0.719	N
Chloride	4740	65	27.4	768.0	1180.0	2540.0	4840.0	1661.3	4812.6	3.013	0.004	Y (+)
Sulfate	1570	65	18.2	297.0	631.0	1150.0	2280.0	794.4	2261.8	3.087	0.003	Y (+)
Bacteria	-	25	4	30	80	310	5000	476	4996	2.102	0.046	N
Chlorophyll	14.1	29	2.0	7.0	18.3	33.7	113.0	23.6	111.0	-0.969	0.341	N
Total Dissolved Solids	9210	63	244.0	2205.0	3597.0	5885.0	11800.0	4118.7	11556.0	2.966	0.004	N
Dissolved Oxygen Deficit	-	67	-5.39	-0.61	0.70	1.69	5.26	0.62	10.65	1.141	0.258	N

Segment 1413 - Site 12367

Parameter	TSWQS	n	Minimum	P_{25}	Median	P_{75}	Maximum	Mean	Range	t score	p value	Flow
Temperature	32.2	19	4.60	7.01	8.35	26.09	29.95	15.84	25.35	0.280	0.783	NA
Secchi Depth	-	19	0.06	0.27	0.31	0.40	0.82	0.34	0.76	0.166	0.870	NA
pH	6.5 - 9.0	19	7.30	8.26	8.33	8.50	8.65	8.31	1.35	-0.098	0.923	NA
TSS	-	18	3.0	13.3	17.0	23.8	46.0	18.9	43.0	0.094	0.926	NA
Ammonia	0.11	18	0.020	0.020	0.020	0.050	0.120	0.039	0.100	0.489	0.631	NA
Total Kjeldahl Nitrogen	-	2	0.530	0.568	0.605	0.643	0.680	0.605	0.150	-	-	NA
Nitrate	0.37	18	0.020	0.020	0.020	0.028	0.200	0.034	0.180	-2.389	0.029	NA
Total Phosphorus	0.2	18	0.020	0.060	0.060	0.070	0.100	0.063	0.080	1.729	0.102	NA
Chloride	140	18	61.0	85.3	109.5	155.3	254.0	126.0	193.0	5.484	0.000	NA
Sulfate	250	18	60.0	71.7	96.1	127.7	211.0	107.0	151.0	5.957	0.000	NA
Bacteria	126	15	1	1	1	2	19	4	18	1.808	0.092	NA
Chlorophyll	5	18	2.0	5.1	7.8	10.8	44.1	10.9	42.1	2.972	0.009	NA
Total Dissolved Solids	520	17	342.0	451.8	561.0	641.0	952.0	577.6	610.0	5.670	0.000	NA
Dissolved Oxygen Deficit	-	19	-1.03	-0.36	0.22	0.90	2.00	0.33	3.03	-1.561	0.136	NA

Segment 1426 - Site 13651

Parameter	TSWQS	n	Minimum	P_{25}	Median	P_{75}	Maximum	Mean	Range	t score	p value	Flow
Temperature	32.8	88	4.60	13.26	21.30	26.66	34.58	20.22	29.98	0.297	0.768	Y (-)
pH	6.5 - 9.0	88	7.00	7.80	7.94	8.11	8.40	7.93	1.40	-4.989	0.000	Y (+)
TSS	-	88	3.0	17.0	31.0	46.0	188.0	35.2	185.0	-0.230	0.819	N
Ammonia	0.33	38	0.020	0.030	0.050	0.060	0.150	0.055	0.130	-0.081	0.936	N
Total Kjeldahl Nitrogen	-	15	0.200	0.835	1.050	1.330	2.150	1.075	1.950	-0.027	0.978	N
Nitrate	1.95	62	0.020	0.053	0.200	0.508	2.120	0.344	2.100	2.622	0.011	N
Total Phosphorus	0.69	38	0.020	0.020	0.030	0.080	0.260	0.057	0.240	-1.288	0.206	N
Chloride	1000	88	75.0	327.8	532.0	881.0	1400.0	595.9	1325.0	-7.364	0.000	N
Sulfate	1110	87	102.0	550.0	933.0	1200.0	2070.0	946.2	1968.0	2.223	0.029	Y (-)
Bacteria	126	28	4	30	42	73	157	53	153	-1.302	0.204	N
Chlorophyll	14.1	35	2.0	5.8	13.6	25.9	75.0	17.6	73.0	-0.022	0.983	N
Total Dissolved Solids	1770	85	484.0	1430.0	2456.0	2826.0	3850.0	2229.8	3366.0	-2.064	0.042	Y (-)
Dissolved Oxygen Deficit	-	87	-3.79	-0.72	0.02	0.88	2.55	-0.03	6.34	-0.410	0.682	Y (+)

Red text denotes statistically significant trends.

Appendix C

Segment 1426 - Site 17244

Parameter	TSWQS	n	Minimum	P_{25}	Median	P_{75}	Maximum	Mean	Range	t score	p value	Flow
Temperature	32.8	97	6.33	14.01	21.40	27.00	37.77	20.28	31.44	-0.196	0.845	Y (-)
pH	6.5 - 9.0	97	7.81	8.00	8.18	8.30	8.73	8.19	0.92	-5.243	0.000	Y (-)
TSS	-	97	6.0	20.0	32.0	42.0	145.0	37.0	139.0	-0.615	0.540	Y (+)
Ammonia	0.33	28	0.020	0.020	0.038	0.047	0.160	0.039	0.140	0.343	0.734	Y (+)
Total Kjeldahl Nitrogen	-	-	-	-	-	-	-	-	-	-	-	-
Nitrate	1.95	60	0.020	0.020	0.140	0.683	4.380	0.614	4.360	2.200	0.032	N
Total Phosphorus	0.69	28	0.020	0.020	0.020	0.070	0.160	0.049	0.140	-0.637	0.529	Y (+)
Chloride	1000	97	42.0	296.0	426.0	629.0	2090.0	482.3	2048.0	-4.110	0.000	Y (-)
Sulfate	1110	97	48.0	372.0	671.0	938.0	2400.0	673.0	2352.0	0.877	0.383	Y (-)
Bacteria	126	17	6	15	40	79	2419	206	2413	-0.100	0.922	Y (+)
Chlorophyll	14.1	27	4.0	6.1	16.4	27.9	85.6	20.2	81.6	-1.382	0.179	N
Total Dissolved Solids	1770	94	290.0	1103.0	1632.5	2156.8	5450.0	1701.8	5160.0	-1.627	0.107	Y (-)
Dissolved Oxygen Deficit	-	97	-4.28	-1.10	-0.31	0.66	7.85	-0.30	12.13	0.558	0.578	N

Segment 1426B - Site 15536

Parameter	TSWQS	n	Minimum	P_{25}	Median	P_{75}	Maximum	Mean	Range	t score	p value	Flow
Temperature	32.8	59	3.20	13.09	21.80	26.66	38.90	19.96	35.70	0.638	0.526	Y (-)
pH	6.5 - 9.0	59	7.60	7.99	8.10	8.20	9.20	8.11	1.60	1.462	0.149	N
TSS	-	59	3.0	13.0	19.0	35.5	99.0	25.9	96.0	1.163	0.250	N
Ammonia	0.33	45	0.020	0.020	0.050	0.050	0.243	0.048	0.223	0.069	0.945	N
Total Kjeldahl Nitrogen	-	22	0.200	0.675	0.810	1.165	1.790	0.909	1.590	0.669	0.511	N
Nitrate	1.95	45	0.020	0.020	0.100	1.050	6.720	1.008	6.700	0.117	0.908	Y (+)
Total Phosphorus	0.69	44	0.020	0.020	0.020	0.090	0.220	0.058	0.200	1.086	0.283	N
Chloride	1000	59	37.0	129.0	345.0	420.0	754.0	312.6	717.0	2.413	0.019	N
Sulfate	1110	59	39.0	153.5	337.0	487.5	1310.0	347.3	1271.0	1.697	0.095	N
Bacteria	126	28	1	17	31	74	2000	182	1999	1.609	0.119	N
Chlorophyll	14.1	35	2.0	2.0	11.2	19.8	36.6	12.6	34.6	2.091	0.044	N
Total Dissolved Solids	1770	58	295.0	656.5	1248.5	1534.8	2830.0	1175.9	2535.0	1.297	0.200	N
Dissolved Oxygen Deficit	-	59	-7.43	-0.56	0.27	1.03	4.25	0.14	11.68	-2.400	0.020	N

Segment 1433 - Site 12511

Parameter	TSWQS	n	Minimum	P_{25}	Median	P_{75}	Maximum	Mean	Range	t score	p value	Flow
Temperature	33.9	38	7.00	9.83	21.05	27.75	30.30	19.13	23.30	-0.212	0.833	NA
Secchi Depth	-	38	0.19	1.90	2.25	2.79	4.10	2.31	3.91	0.679	0.501	NA
pH	6.5 - 9.0	38	7.80	8.16	8.23	8.38	8.70	8.26	0.90	-0.527	0.602	NA
TSS	-	38	1.0	1.0	3.0	4.0	9.0	2.8	8.0	-3.541	0.001	NA
Ammonia	0.11	36	0.020	0.020	0.020	0.045	0.119	0.035	0.099	0.127	0.900	NA
Total Kjeldahl Nitrogen	-	17	0.510	0.630	0.670	0.750	0.870	0.690	0.360	-1.952	0.069	NA
Nitrate	0.37	36	0.020	0.020	0.030	0.130	0.240	0.070	0.220	-1.468	0.151	NA
Total Phosphorus	0.2	37	0.020	0.020	0.020	0.020	0.070	0.022	0.050	-1.893	0.066	NA
Chloride	430	38	257.0	311.8	349.0	432.8	487.0	366.6	230.0	-7.290	0.000	NA
Sulfate	330	38	215.0	257.8	288.0	328.5	374.0	294.6	159.0	-4.717	0.000	NA
Bacteria	126	34	0	1	1	1	10	2	10	2.090	0.044	NA
Chlorophyll	39.3	35	2.0	2.0	3.2	5.8	14.3	4.6	12.3	-0.098	0.922	NA
Total Dissolved Solids	1520	36	871.0	1021.0	1125.0	1308.5	1489.0	1155.3	618.0	-5.376	0.000	NA
Dissolved Oxygen Deficit	-	38	-3.81	-0.12	0.63	1.05	2.00	0.42	5.81	-0.822	0.416	NA

Red text denotes statistically significant trends.

Concho Watershed

Segment 1421 - Site 12401

Parameter	TSWQS	n	Minimum	P_{25}	Median	P_{75}	Maximum	Mean	Range	t score	p value	Flow
Temperature	32.2	80	4.40	12.35	21.46	27.02	33.10	20.22	28.70	0.806	0.423	Y (-)
pH	6.5 - 9.0	80	7.60	8.00	8.20	8.33	9.00	8.16	1.40	-2.761	0.007	N
TSS	-	57	4.0	23.0	31.0	42.0	96.0	35.3	92.0	-0.548	0.586	N
Ammonia	0.33	46	0.020	0.020	0.020	0.045	0.300	0.054	0.280	-1.952	0.057	N
Total Kjeldahl Nitrogen	-	-	-	-	-	-	-	-	-	-	-	-
Nitrate	1.95	60	0.020	0.060	0.990	3.913	25.000	3.121	24.980	1.579	0.120	Y (+)
Total Phosphorus	0.69	36	0.020	0.020	0.066	0.101	0.260	0.070	0.240	-0.474	0.638	Y (-)
Chloride	610	80	75.1	274.5	393.5	467.5	669.0	375.2	593.9	2.269	0.026	N
Sulfate	420	79	48.3	204.0	283.0	376.0	619.0	291.7	570.7	1.140	0.258	N
Bacteria	126	31	2	8	12	29	365	35	363	-0.732	0.470	N
Chlorophyll	14.1	24	2.0	13.0	28.1	38.2	161.0	35.8	159.0	-1.842	0.078	Y (-)
Total Dissolved Solids	1730	69	360.0	1010.0	1319.0	1570.6	2279.0	1265.8	1919.0	1.833	0.071	N
Dissolved Oxygen Deficit	-	80	-3.47	-0.22	0.41	1.19	4.83	0.54	8.31	-1.152	0.253	N

Segment 1421 - Site 12409

Parameter	TSWQS	n	Minimum	P_{25}	Median	P_{75}	Maximum	Mean	Range	t score	p value	Flow
Temperature	32.2	76	5.50	13.80	21.84	27.63	33.81	20.75	28.31	0.684	0.496	N
pH	6.5 - 9.0	76	7.31	7.80	8.01	8.24	9.37	8.05	2.06	1.418	0.160	Y (+)
TSS	-	51	1.0	10.0	13.0	18.0	91.0	16.4	90.0	-1.797	0.078	N
Ammonia	0.33	31	0.020	0.020	0.040	0.119	0.820	0.121	0.800	-3.499	0.001	N
Total Kjeldahl Nitrogen	-	-	-	-	-	-	-	-	-	-	-	-
Nitrate	1.95	46	0.020	0.020	0.155	0.625	7.000	0.551	6.980	-2.324	0.025	Y (-)
Total Phosphorus	0.69	23	0.020	0.020	0.020	0.082	0.560	0.077	0.540	0.012	0.990	N
Chloride	610	76	39.0	173.3	244.5	309.3	880.0	272.1	841.0	-3.365	0.001	Y (-)
Sulfate	420	76	15.0	71.2	100.0	142.5	350.5	117.0	335.5	-5.395	0.000	Y (-)
Bacteria	126	17	16	42	99	140	460	123	444	1.104	0.286	N
Chlorophyll	14.1	10	2.0	13.5	20.9	34.1	80.0	26.5	78.0	-1.203	0.260	N
Total Dissolved Solids	1730	63	329.0	610.5	828.0	974.5	1662.0	831.4	1333.0	-1.634	0.107	Y (-)
Dissolved Oxygen Deficit	-	76	-7.14	-2.39	-0.43	1.43	4.94	-0.56	12.08	2.898	0.005	Y (+)

Segment 1422 - Site 12418

Parameter	TSWQS	n	Minimum	P_{25}	Median	P_{75}	Maximum	Mean	Range	t score	p value	Flow
Temperature	33.9	62	6.70	14.30	19.55	24.75	31.20	19.06	24.50	-0.078	0.938	NA
Secchi Depth	-	61	0.27	0.43	0.52	0.61	1.20	0.55	0.93	0.698	0.488	NA
pH	6.5 - 9.0	62	7.89	8.20	8.30	8.40	8.60	8.26	0.71	4.976	0.000	NA
TSS	-	49	5.0	11.0	16.0	21.0	30.0	16.5	25.0	-0.550	0.585	NA
Ammonia	0.11	58	0.020	0.020	0.020	0.020	0.140	0.026	0.120	-1.446	0.154	NA
Total Kjeldahl Nitrogen	-	48	0.690	0.838	0.910	1.045	1.900	0.959	1.210	-1.715	0.093	NA
Nitrate	0.37	59	0.020	0.020	0.020	0.020	0.500	0.041	0.480	-1.822	0.074	NA
Total Phosphorus	0.2	56	0.020	0.020	0.020	0.070	0.140	0.042	0.120	-0.568	0.572	NA
Chloride	450	58	119.0	167.8	319.0	373.0	431.0	281.7	312.0	-18.378	0.000	NA
Sulfate	450	58	39.0	54.8	103.0	128.8	194.0	99.7	155.0	-10.624	0.000	NA
Bacteria	126	50	1	2	19	32	430	33	429	0.785	0.436	NA
Chlorophyll	16.91	55	2.0	6.6	11.2	15.5	36.6	12.0	34.6	1.280	0.206	NA
Total Dissolved Solids	1500	56	440.0	582.0	878.0	990.0	1260.0	807.7	820.0	-12.205	0.000	NA
Dissolved Oxygen Deficit	-	61	-2.39	0.58	0.95	1.70	4.43	1.09	6.81	-0.718	0.475	NA

Red text denotes statistically significant trends.

Appendix C

Segment 1423 - Site 12422

Parameter	TSWQS	n	Minimum	P_{25}	Median	P_{75}	Maximum	Mean	Range	t score	p value	Flow
Temperature	32.2	42	9.20	14.10	20.25	24.50	29.70	19.51	20.50	0.142	0.887	NA
Secchi Depth	-	35	0.13	0.28	0.48	1.10	3.15	0.78	3.02	1.101	0.278	NA
pH	6.5 - 9.0	41	7.46	8.20	8.30	8.40	8.75	8.30	1.29	0.586	0.561	NA
TSS	-	20	1.0	7.0	11.5	43.3	76.0	23.8	75.0	-3.407	0.003	NA
Ammonia	0.11	39	0.020	0.020	0.020	0.065	1.590	0.092	1.570	0.632	0.531	NA
Total Kjeldahl Nitrogen	-	17	0.330	0.840	1.150	1.270	3.330	1.253	3.000	0.316	0.756	NA
Nitrate	0.37	39	0.020	0.020	0.044	0.235	2.400	0.256	2.380	-3.794	0.001	NA
Total Phosphorus	0.2	31	0.020	0.020	0.020	0.100	0.330	0.065	0.310	-1.757	0.089	NA
Chloride	200	42	52.0	78.3	104.0	134.8	197.0	110.6	145.0	-3.025	0.004	NA
Sulfate	100	42	10.0	30.3	41.5	73.3	198.0	57.2	188.0	-4.976	0.000	NA
Bacteria	126	29	1	1	1	4	20	4	19	1.955	0.061	NA
Chlorophyll	14.44	29	2.0	4.2	9.0	15.0	250.0	20.4	248.0	0.663	0.513	NA
Total Dissolved Solids	700	29	282.0	393.0	426.0	482.0	712.0	447.1	430.0	-1.892	0.069	NA
Dissolved Oxygen Deficit	-	42	-1.68	0.34	1.15	1.87	3.31	1.11	4.99	-2.386	0.022	NA

Segment 1423A - Site 12161

Parameter	TSWQS	n	Minimum	P_{25}	Median	P_{75}	Maximum	Mean	Range	t score	p value	Flow
Temperature	32.2	38	6.70	11.77	21.67	27.43	30.70	19.91	24.00	0.190	0.850	Y (-)
pH	6.5 - 9.0	38	7.60	7.90	8.04	8.14	8.52	8.03	0.92	-0.350	0.728	N
TSS	-	-	-	-	-	-	-	-	-	-	-	-
Ammonia	0.33	33	0.020	0.020	0.020	0.052	0.623	0.059	0.603	-1.654	0.108	N
Total Kjeldahl Nitrogen	-	-	-	-	-	-	-	-	-	-	-	N
Nitrate	1.95	30	0.020	0.050	0.210	0.518	1.600	0.326	1.580	-5.532	0.000	N
Total Phosphorus	0.69	21	0.020	0.020	0.020	0.020	0.020	0.020	0.000	-	-	N
Chloride	200	38	42.0	89.9	110.5	130.5	296.0	116.3	254.0	-2.402	0.021	Y (-)
Sulfate	100	38	18.0	82.9	97.9	181.6	379.0	129.9	361.0	-4.277	0.000	Y (-)
Bacteria	126	18	1	5	12	20	60	15	59	-1.097	0.288	N
Chlorophyll	14.1	-	-	-	-	-	-	-	-	-	-	-
Total Dissolved Solids	700	20	399.0	538.8	552.2	596.0	640.0	558.2	241.0	0.173	0.864	N
Dissolved Oxygen Deficit	-	38	-0.20	0.85	1.98	2.80	4.74	1.95	4.95	-5.457	0.000	N

Segment 1423B - Site 12166

Parameter	TSWQS	n	Minimum	P_{25}	Median	P_{75}	Maximum	Mean	Range	t score	p value	Flow
Temperature	32.2	38	6.90	13.43	20.47	25.95	30.80	19.72	23.90	0.221	0.826	Y (-)
pH	6.5 - 9.0	38	7.33	7.68	7.81	8.08	8.50	7.85	1.17	-0.795	0.431	Y (+)
TSS	-	-	-	-	-	-	-	-	-	-	-	-
Ammonia	0.33	33	0.020	0.020	0.020	0.046	0.210	0.044	0.190	-3.023	0.005	N
Total Kjeldahl Nitrogen	-	-	-	-	-	-	-	-	-	-	-	-
Nitrate	1.95	30	0.020	0.053	0.300	0.484	1.250	0.376	1.230	-4.262	0.000	N
Total Phosphorus	0.69	21	0.020	0.020	0.020	0.020	0.100	0.024	0.080	1.351	0.192	Y (-)
Chloride	200	38	30.1	37.3	45.0	53.0	107.0	47.5	76.9	-4.318	0.000	N
Sulfate	100	37	1.0	17.0	20.0	23.0	36.0	20.1	35.0	-0.898	0.375	N
Bacteria	126	17	2	6	12	15	1000	70	998	1.244	0.232	Y (-)
Chlorophyll	14.1	-	-	-	-	-	-	-	-	-	-	-
Total Dissolved Solids	700	20	334.0	352.0	359.0	387.3	496.0	370.2	162.0	-0.563	0.580	N
Dissolved Oxygen Deficit	-	38	-0.71	1.12	1.85	3.05	6.17	2.20	6.88	-2.551	0.015	N

Red text denotes statistically significant trends.

Segment 1424 - Site 12427

Parameter	TSWQS	n	Minimum	P_{25}	Median	P_{75}	Maximum	Mean	Range	t score	p value	Flow
Temperature	32.2	39	8.90	16.66	22.50	25.05	29.10	21.19	20.20	-0.056	0.956	N
pH	6.5 - 9.0	39	7.40	7.65	7.77	7.90	8.33	7.79	0.93	-0.249	0.805	N
TSS	-	20	1.0	1.0	2.5	4.3	9.0	3.2	8.0	-1.908	0.072	Y (-)
Ammonia	0.11	36	0.010	0.020	0.050	0.050	0.146	0.047	0.136	-3.049	0.004	N
Total Kjeldahl Nitrogen	-	20	0.180	0.228	0.240	0.310	1.100	0.324	0.920	-0.633	0.534	N
Nitrate	0.37	33	0.100	1.000	1.150	1.370	2.100	1.167	2.000	1.667	0.105	Y (+)
Total Phosphorus	0.2	29	0.020	0.020	0.020	0.020	0.130	0.024	0.110	-1.114	0.275	N
Chloride	150	39	22.0	29.0	32.0	37.5	53.0	33.4	31.0	-6.880	0.000	N
Sulfate	150	39	2.0	11.0	12.0	13.5	24.0	12.7	22.0	-1.538	0.132	N
Bacteria	126	26	1	14	20	36	79	26	78	1.439	0.163	N
Chlorophyll	9.82	18	2.0	2.0	2.0	2.0	3.0	2.1	1.0	1.624	0.123	N
Total Dissolved Solids	700	28	312.0	347.0	367.0	382.5	550.0	370.0	238.0	-0.729	0.472	N
Dissolved Oxygen Deficit	-	39	-2.20	0.58	1.18	1.60	2.97	1.06	5.17	-0.214	0.832	Y (-)

Segment 1425 - Site 13651

Parameter	TSWQS	n	Minimum	P_{25}	Median	P_{75}	Maximum	Mean	Range	t score	p value	Flow
Temperature	32.22222	43	5.20	13.50	19.20	23.45	29.00	18.40	23.80	-1.064	0.293	NA
Secchi Depth	-	36	0.05	0.21	0.31	0.45	1.20	0.36	1.15	0.725	0.473	NA
pH	6.5 - 9.0	42	7.00	8.12	8.40	8.60	8.90	8.29	1.90	-1.985	0.054	NA
TSS	-	21	13.0	26.0	50.0	108.0	156.0	64.7	143.0	0.174	0.864	NA
Ammonia	0.11	40	0.010	0.050	0.050	0.193	6.470	0.334	6.460	1.326	0.193	NA
Total Kjeldahl Nitrogen	-	19	0.700	1.475	2.320	2.930	23.200	3.642	22.500	2.071	0.053	NA
Nitrate	0.37	39	0.020	0.025	0.050	0.188	7.500	0.337	7.480	-1.682	0.101	NA
Total Phosphorus	0.2	32	0.020	0.088	0.145	0.230	1.340	0.220	1.320	1.701	0.099	NA
Chloride	150	42	16.9	54.5	145.5	226.8	732.0	169.9	715.1	0.005	0.996	NA
Sulfate	150	42	10.5	25.3	44.5	96.2	182.0	63.2	171.5	-3.375	0.002	NA
Bacteria	126	31	1	1	15	160	1600	253	1599	-0.372	0.712	NA
Chlorophyll	39.13	30	2.0	26.7	39.8	55.8	633.0	96.5	631.0	2.775	0.010	NA
Total Dissolved Solids	700	30	226.0	312.8	434.5	642.5	1790.0	559.3	1564.0	1.626	0.115	NA
Dissolved Oxygen Deficit	-	43	-1.85	0.32	1.34	3.21	11.94	2.10	13.79	1.725	0.092	NA

Segment 1425A - Site 12171

Parameter	TSWQS	n	Minimum	P_{25}	Median	P_{75}	Maximum	Mean	Range	t score	p value	Flow
Temperature	32.2	33	6.20	11.50	20.81	27.50	30.40	19.59	24.20	0.428	0.671	N
pH	6.5 - 9.0	32	7.38	7.70	7.80	8.01	8.50	7.85	1.12	0.411	0.684	N
TSS	-	-	-	-	-	-	-	-	-	-	-	-
Ammonia	0.33	28	0.010	0.020	0.032	0.101	0.200	0.062	0.190	-1.882	0.071	Y (-)
Total Kjeldahl Nitrogen	-	-	-	-	-	-	-	-	-	-	-	-
Nitrate	1.95	25	0.020	0.030	0.140	0.350	2.000	0.298	1.980	-3.579	0.002	N
Total Phosphorus	0.69	20	0.020	0.020	0.020	0.033	0.186	0.040	0.166	-0.900	0.379	N
Chloride	150	32	91.0	177.5	221.0	380.3	647.0	287.3	556.0	1.254	0.219	Y (-)
Sulfate	150	32	50.0	97.3	121.0	176.3	388.0	138.6	338.0	-0.403	0.690	Y (-)
Bacteria	126	18	4	12	33	76	548	72	544	-1.499	0.152	N
Chlorophyll	14.1	8	5.0	5.8	10.0	19.8	55.1	16.7	50.1	-1.002	0.350	N
Total Dissolved Solids	700	19	548.0	871.5	1100.8	1446.5	1850.0	1147.5	1302.0	0.540	0.596	N
Dissolved Oxygen Deficit	-	33	-0.81	1.98	2.67	3.59	5.03	2.67	5.83	0.720	0.477	N

Red text denotes statistically significant trends.

Appendix C

Pecan Bayou Watershed

Segment 1417 - Site 12394

Parameter	TSWQS	n	Minimum	P_{25}	Median	P_{75}	Maximum	Mean	Range	t score	p value	Flow
Temperature	32.2	59	6.18	11.30	19.91	26.42	28.88	18.98	22.70	0.340	0.735	N
pH	6.5 - 9.0	59	7.60	7.93	8.10	8.24	9.40	8.12	1.80	1.727	0.090	N
TSS	-	59	8.0	17.0	28.0	39.0	105.0	32.7	97.0	-2.311	0.024	Y (+)
Ammonia	0.33	59	0.020	0.020	0.020	0.052	0.145	0.040	0.125	-0.544	0.589	N
Total Kjeldahl Nitrogen	-	59	0.518	0.755	0.944	1.537	12.900	1.371	12.382	-0.424	0.673	N
Nitrate	1.95	58	0.020	0.020	0.145	0.480	8.910	1.156	8.890	-0.921	0.361	N
Total Phosphorus	0.69	59	0.020	0.100	0.156	0.301	1.020	0.234	1.000	0.502	0.617	N
Chloride	310	59	19.7	48.4	72.6	110.0	221.4	85.9	201.7	-0.305	0.761	Y (-)
Sulfate	120	59	12.5	38.2	59.8	86.5	182.1	66.4	169.6	-0.189	0.851	N
Bacteria	126	59	3	31	71	220	5790	86	5787	-3.275	0.002	N
Chlorophyll	14.1	58	1.9	9.4	21.7	38.7	295.0	41.3	293.2	0.271	0.787	N
Total Dissolved Solids	1025	59	204.0	316.5	418.2	539.0	881.0	444.2	677.0	0.156	0.876	Y (-)
Dissolved Oxygen Deficit	-	59	-5.66	0.12	1.02	2.04	5.15	0.73	10.81	0.665	0.509	N

Segment 1418 - Site 12395

Parameter	TSWQS	n	Minimum	P_{25}	Median	P_{75}	Maximum	Mean	Range	t score	p value	Flow
Temperature	32.2	19	7.60	10.30	24.91	27.95	31.00	19.87	23.40	-0.075	0.941	NA
Secchi Depth	-	19	0.55	0.89	1.10	1.50	2.30	1.20	1.75	-0.268	0.792	NA
pH	6.5 - 9.0	19	7.60	8.20	8.30	8.37	8.60	8.27	1.00	-1.066	0.301	NA
TSS	-	19	1.0	3.0	4.0	6.5	11.0	4.8	10.0	-0.201	0.843	NA
Ammonia	0.11	16	0.050	0.050	0.050	0.050	0.070	0.053	0.020	0.892	0.387	NA
Total Kjeldahl Nitrogen	-	16	0.370	0.440	0.495	0.603	0.680	0.518	0.310	1.483	0.159	NA
Nitrate	0.37	18	0.040	0.040	0.050	0.070	0.280	0.073	0.240	-0.867	0.398	NA
Total Phosphorus	0.2	17	0.020	0.020	0.020	0.020	0.020	0.020	0.000	-	-	NA
Chloride	150	19	28.0	35.5	52.0	64.5	81.0	51.5	53.0	0.032	0.974	NA
Sulfate	100	19	22.0	26.0	33.0	37.5	49.0	33.6	27.0	0.093	0.927	NA
Bacteria	126	12	1	1	1	4	20	4	19	0.808	0.436	NA
Chlorophyll	26.7	15	2.0	2.0	2.0	6.9	11.6	4.2	9.6	1.994	0.066	NA
Total Dissolved Solids	500	19	210.0	251.0	272.0	283.0	376.0	274.0	166.0	0.587	0.565	NA
Dissolved Oxygen Deficit	-	19	-0.96	0.23	0.78	1.05	4.83	0.83	5.79	2.199	0.041	NA

Segment 1419 - Site 12398

Parameter	TSWQS	n	Minimum	P_{25}	Median	P_{75}	Maximum	Mean	Range	t score	p value	Flow
Temperature	33.9	17	7.10	9.90	27.70	28.50	29.30	20.91	22.20	-0.744	0.468	NA
Secchi Depth	-	17	0.20	1.00	1.30	1.50	1.80	1.20	1.6	-1.441	0.169	NA
pH	6.5 - 9.0	17	7.71	8.20	8.30	8.40	8.60	8.30	0.89	2.312	0.034	NA
TSS	-	17	1.0	1.0	4.0	5.0	9.0	3.8	8.0	0.191	0.851	NA
Ammonia	0.11	16	0.050	0.050	0.050	0.065	0.100	0.060	0.050	0.242	0.812	NA
Total Kjeldahl Nitrogen	-	15	0.350	0.535	0.590	0.630	0.740	0.581	0.390	1.337	0.202	NA
Nitrate	0.37	16	0.040	0.040	0.050	0.093	0.190	0.074	0.150	0.358	0.725	NA
Total Phosphorus	0.2	16	0.020	0.020	0.020	0.020	0.020	0.020	0.000	-	-	NA
Chloride	150	17	21.0	34.0	58.0	70.0	100.0	54.5	79.0	1.512	0.150	NA
Sulfate	100	17	17.0	31.0	45.0	54.0	76.0	43.0	59.0	1.405	0.179	NA
Bacteria	126	13	1	1	1	2	10	2	9	1.444	0.174	NA
Chlorophyll	6.07	16	2.0	2.0	2.6	5.1	8.6	3.7	6.6	3.972	0.001	NA
Total Dissolved Solids	500	14	180.0	233.5	301.0	333.5	416.0	289.4	236.0	1.450	0.171	NA
Dissolved Oxygen Deficit	-	17	-4.86	0.11	0.34	0.69	2.90	0.11	7.76	-0.859	0.403	NA

Red text denotes statistically significant trends.

Segment 1420 - Site 16732

Parameter	TSWQS	n	Minimum	P_{25}	Median	P_{75}	Maximum	Mean	Range	t score	p value	Flow
Temperature	32.2	29	7.96	15.20	20.06	28.00	31.09	20.48	23.13	0.736	0.468	NA
Secchi Depth	-	29	0.10	0.20	0.33	0.52	0.88	0.39	0.78	-3.031	0.005	NA
pH	6.5 - 9.0	29	7.38	8.00	8.10	8.27	8.60	8.08	1.22	0.781	0.441	NA
TSS	-	31	3.0	11.5	15.0	22.5	72.0	19.6	69.0	1.231	0.228	NA
Ammonia	0.33	29	0.050	0.050	0.050	0.080	0.190	0.069	0.140	0.020	0.985	NA
Total Kjeldahl Nitrogen	-	29	0.360	0.680	0.850	0.950	1.570	0.857	1.210	0.798	0.432	NA
Nitrate	1.95	30	0.020	0.040	0.050	0.180	1.790	0.198	1.770	-1.392	0.174	NA
Total Phosphorus	0.69	29	0.020	0.020	0.020	0.020	0.020	0.020	0.000	-	-	NA
Chloride	500	31	15.8	39.0	59.0	84.0	269.0	71.3	253.2	-0.638	0.528	NA
Sulfate	500	31	10.7	25.5	38.0	75.5	214.0	58.1	203.3	-1.198	0.240	NA
Bacteria	126	23	1	9	21	46	83	30	82	-1.277	0.215	NA
Chlorophyll	14.1	29	2.0	2.0	12.6	20.1	47.6	14.4	45.6	2.335	0.027	NA
Total Dissolved Solids	1500	31	187.0	266.0	310.0	442.0	1080.0	381.6	893.0	-0.821	0.418	NA
Dissolved Oxygen Deficit	-	30	-4.43	-0.33	1.46	2.58	14.29	1.58	18.71	-0.732	0.470	NA

Segment 1431 - Site 12505

Parameter	TSWQS	n	Minimum	P_{25}	Median	P_{75}	Maximum	Mean	Range	t score	p value	Flow
Temperature	32.2	39	7.30	14.50	19.10	24.25	29.00	18.93	21.70	0.526	0.602	N
pH	6.5 - 9.0	39	7.20	7.60	7.70	7.80	8.30	7.72	1.10	0.730	0.470	N
TSS	-	37	1.0	10.0	14.0	22.0	258.0	23.2	257.0	-0.619	0.540	Y (+)
Ammonia	0.33	38	0.020	0.020	0.020	0.068	0.170	0.045	0.150	-0.636	0.529	N
Total Kjeldahl Nitrogen	-	36	0.440	0.740	0.830	0.993	1.450	0.879	1.010	1.733	0.092	N
Nitrate	1.95	38	0.060	5.183	8.640	15.525	128.000	13.011	127.940	1.914	0.063	N
Total Phosphorus	0.69	37	0.020	0.720	1.290	2.380	3.290	1.550	3.270	3.132	0.003	Y (-)
Chloride	410	39	22.0	81.0	124.0	161.5	197.0	120.2	175.0	1.880	0.068	Y (-)
Sulfate	120	39	20.0	65.0	88.0	113.5	142.0	88.7	122.0	1.238	0.223	N
Bacteria	126	33	33	93	195	270	10610	791	10577	-1.001	0.325	Y (+)
Chlorophyll	14.1	37	2.0	2.0	2.0	10.5	45.0	7.9	43.0	2.412	0.021	N
Total Dissolved Solids	1100	38	227.0	460.5	584.0	686.0	884.0	571.7	657.0	1.763	0.086	N
Dissolved Oxygen Deficit	-	39	-2.70	0.28	0.95	1.93	5.33	1.20	8.03	-0.756	0.454	N

Segment 1432 - Site 12508

Parameter	TSWQS	n	Minimum	P_{25}	Median	P_{75}	Maximum	Mean	Range	t score	p value	Flow
Temperature	32.2	38	5.40	12.95	19.95	25.55	29.30	18.81	23.90	0.928	0.359	N
pH	6.5 - 9.0	38	7.00	7.60	7.88	8.10	8.55	7.82	1.55	-2.414	0.021	N
TSS	-	34	1.0	7.0	10.5	15.8	210.0	17.7	209.0	-0.454	0.653	Y (+)
Ammonia	0.33	35	0.020	0.020	0.020	0.020	0.410	0.045	0.390	-0.876	0.387	N
Total Kjeldahl Nitrogen	-	35	0.360	0.525	0.640	0.780	1.580	0.697	1.220	-0.191	0.850	N
Nitrate	1.95	37	0.020	0.020	0.130	0.310	14.500	0.834	14.480	-1.647	0.108	N
Total Phosphorus	0.69	35	0.020	0.020	0.020	0.080	2.440	0.176	2.420	-1.513	0.140	N
Chloride	200	37	1.0	44.0	80.0	123.0	285.0	91.1	284.0	0.878	0.386	Y (-)
Sulfate	150	37	1.0	45.0	68.0	84.0	104.0	63.2	103.0	2.173	0.036	Y (-)
Bacteria	126	32	1	40	111	277	22000	1128	21999	0.254	0.801	N
Chlorophyll	14.1	36	2.0	2.0	2.0	10.1	36.9	7.0	34.9	4.867	0.000	Y (-)
Total Dissolved Solids	800	36	210.0	315.3	479.0	601.5	719.0	462.3	509.0	2.457	0.019	Y (-)
Dissolved Oxygen Deficit	-	38	-3.72	0.57	1.40	2.33	6.45	1.51	10.17	-0.169	0.867	N

Red text denotes statistically significant trends.

Appendix C

Lake Buchanan Watershed

Segment 1408 - Site 12344

Parameter	TSWQS	n	Minimum	P_{25}	Median	P_{75}	Maximum	Mean	Range	t score	p value	Flow
Temperature	32.2	59	9.20	14.89	23.30	25.30	29.72	20.21	20.52	0.372	0.711	NA
Secchi Depth	-	59	0.37	1.30	1.59	1.97	3.58	1.69	3.21	-2.671	0.010	NA
pH	6.5 - 9.0	58	6.70	8.05	8.30	8.48	8.67	8.20	1.97	0.525	0.602	NA
TSS	-	58	1.0	2.0	3.0	4.0	7.0	3.4	6.0	-1.433	0.157	NA
Ammonia	0.11	58	0.020	0.020	0.020	0.028	0.160	0.030	0.140	2.569	0.013	NA
Total Kjeldahl Nitrogen	-	59	0.190	0.382	0.450	0.530	1.160	0.469	0.970	0.150	0.882	NA
Nitrate	0.37	58	0.020	0.020	0.049	0.158	0.590	0.111	0.570	-2.654	0.010	NA
Total Phosphorus	0.2	56	0.020	0.020	0.020	0.020	0.290	0.031	0.270	-2.191	0.033	NA
Chloride	150	59	29.2	43.9	47.5	54.3	62.8	48.4	33.6	-3.780	0.000	NA
Sulfate	100	59	17.8	23.7	27.1	30.8	41.0	27.7	23.2	-6.044	0.000	NA
Bacteria	126	55	0	1	1	1	10	1	10	1.431	0.158	NA
Chlorophyll	9.82	58	0.8	5.4	8.5	12.1	21.7	9.0	20.9	2.161	0.035	NA
Total Dissolved Solids	600	59	211.0	240.0	249.0	265.0	298.0	251.6	87.0	-2.708	0.009	NA
Dissolved Oxygen Deficit	-	59	-1.83	-0.21	0.36	1.14	3.18	0.45	5.01	-0.237	0.813	NA

Segment 1409 - Site 12355

Parameter	TSWQS	n	Minimum	P_{25}	Median	P_{75}	Maximum	Mean	Range	t score	p value	Flow
Temperature	32.8	58	7.14	11.96	21.20	27.18	31.50	19.96	24.36	0.302	0.764	N
pH	6.5 - 9.0	58	7.79	8.00	8.10	8.20	8.40	8.09	0.61	2.873	0.006	Y (-)
TSS	-	59	7.0	17.0	27.0	36.5	166.0	34.4	159.0	-0.988	0.327	Y (+)
Ammonia	0.33	59	0.020	0.020	0.020	0.032	0.081	0.030	0.061	1.541	0.129	N
Total Kjeldahl Nitrogen	-	59	0.200	0.355	0.480	0.711	2.360	0.568	2.160	-1.722	0.090	Y (+)
Nitrate	1.95	58	0.020	0.170	0.261	0.381	1.460	0.287	1.440	-1.798	0.077	Y (+)
Total Phosphorus	0.69	58	0.020	0.020	0.020	0.065	0.220	0.051	0.200	-0.455	0.651	Y (+)
Chloride	200	59	18.4	36.2	42.1	52.1	86.0	45.0	67.6	-1.854	0.069	N
Sulfate	200	59	10.8	16.6	22.7	31.4	62.9	25.9	52.1	-2.345	0.022	Y (+)
Bacteria	126	59	1	26	56	160	1900	61	1899	-1.340	0.185	Y (+)
Chlorophyll	14.1	58	2.0	5.7	9.3	13.5	102.0	13.1	100.0	-0.685	0.496	N
Total Dissolved Solids	900	58	199.0	295.5	330.0	350.0	447.2	327.6	248.2	-1.204	0.234	N
Dissolved Oxygen Deficit	-	58	-2.29	0.26	0.65	1.16	3.05	0.63	5.34	0.946	0.348	N

Segment 1410 - Site 12358

Parameter	TSWQS	n	Minimum	P_{25}	Median	P_{75}	Maximum	Mean	Range	t score	p value	Flow
Temperature	32.8	62	7.54	12.05	20.93	28.05	32.06	20.06	24.52	-0.222	0.825	N
pH	6.5 - 9.0	62	6.70	7.86	8.00	8.16	8.38	7.93	1.68	-2.620	0.011	N
TSS	-	63	3.0	11.0	16.0	23.0	276.0	21.2	273.0	-0.380	0.705	Y (+)
Ammonia	0.33	60	0.020	0.020	0.020	0.020	0.110	0.028	0.090	-0.209	0.835	N
Total Kjeldahl Nitrogen	-	63	0.480	0.656	0.780	1.040	3.030	0.933	2.550	1.065	0.291	Y (-)
Nitrate	1.95	54	0.020	0.020	0.020	0.028	0.744	0.076	0.724	-1.145	0.257	Y (+)
Total Phosphorus	0.69	60	0.020	0.020	0.020	0.060	0.241	0.040	0.221	-0.215	0.830	Y (+)
Chloride	500	63	39.6	122.7	192.0	325.5	611.0	226.1	571.4	0.695	0.490	N
Sulfate	455	63	22.5	71.1	106.5	201.5	345.0	135.7	322.5	0.684	0.496	N
Bacteria	126	61	1	8	21	46	2580	24	2579	-1.244	0.218	N
Chlorophyll	14.1	62	2.0	2.0	6.3	11.7	76.4	9.4	74.4	-0.845	0.401	N
Total Dissolved Solids	1475	62	249.0	507.3	648.0	990.5	1663.2	734.9	1414.2	0.568	0.572	N
Dissolved Oxygen Deficit	-	62	-1.39	0.49	1.20	2.00	9.10	1.30	10.49	4.252	0.000	N

Red text denotes statistically significant trends.

Segment 1416 - Site 12392

Parameter	TSWQS	n	Minimum	P_{25}	Median	P_{75}	Maximum	Mean	Range	t score	p value	Flow
Temperature	32.2	58	8.55	13.23	21.09	27.94	30.30	20.28	21.75	0.394	0.695	Y (-)
pH	6.5 - 9.0	58	7.77	7.99	8.10	8.15	8.40	8.07	0.63	4.161	0.000	Y (-)
TSS	-	59	8.0	18.5	27.0	37.5	1470.0	54.2	1462.0	-1.162	0.250	N
Ammonia	0.33	57	0.020	0.020	0.020	0.030	0.163	0.031	0.143	0.748	0.457	N
Total Kjeldahl Nitrogen	-	59	0.200	0.320	0.427	0.520	2.130	0.479	1.930	-0.503	0.617	N
Nitrate	1.95	59	0.060	0.295	0.410	0.507	1.318	0.438	1.258	-2.491	0.016	Y (+)
Total Phosphorus	0.69	59	0.020	0.020	0.020	0.060	1.310	0.059	1.290	-1.058	0.295	N
Chloride	50	59	13.1	21.0	25.4	29.7	38.9	25.4	25.8	-0.080	0.937	N
Sulfate	50	59	11.2	16.5	19.1	23.6	33.1	20.3	21.9	-0.747	0.458	Y (+)
Bacteria	126	59	24	95	150	250	24000	182	23976	-2.039	0.046	N
Chlorophyll	14.1	58	0.8	2.0	4.9	8.4	24.5	6.5	23.7	-3.088	0.003	N
Total Dissolved Solids	425	58	189.2	295.8	316.5	336.2	401.0	313.8	211.8	-0.934	0.354	Y (+)
Dissolved Oxygen Deficit	-	58	-2.73	0.30	0.72	1.18	3.39	0.66	6.12	0.158	0.875	Y (-)

Segment 1416A - Site 14232

Parameter	TSWQS	n	Minimum	P_{25}	Median	P_{75}	Maximum	Mean	Range	t score	p value	Flow
Temperature	32.2	41	5.90	14.50	22.30	25.90	29.90	20.15	24.00	1.153	0.256	N
pH	6.5 - 9.0	40	7.60	7.88	8.25	8.50	9.60	8.24	2.00	1.082	0.286	Y (-)
TSS	-	39	3.0	23.0	32.0	54.0	139.0	40.6	136.0	-0.653	0.518	N
Ammonia	0.33	38	0.020	0.020	0.020	0.058	0.440	0.064	0.420	0.807	0.425	N
Total Kjeldahl Nitrogen	-	36	1.110	1.460	1.750	2.350	4.290	1.899	3.180	0.600	0.552	N
Nitrate	1.95	40	0.040	2.220	5.540	7.518	12.050	5.466	12.010	-2.014	0.051	N
Total Phosphorus	0.69	36	0.280	1.180	1.885	2.368	3.580	1.833	3.300	-1.267	0.214	Y (-)
Chloride	-	39	38.0	106.0	125.0	169.0	402.0	150.7	364.0	3.431	0.001	N
Sulfate	-	39	23.0	50.0	66.0	73.5	106.0	64.0	83.0	-2.222	0.032	Y (-)
Bacteria	126	36	1	10	27	85	2400	31	2399	-1.533	0.134	Y (+)
Chlorophyll	14.1	36	8.8	17.8	44.5	88.9	356.0	70.5	347.2	0.691	0.494	N
Total Dissolved Solids	-	42	218.4	555.0	656.0	764.0	1080.0	652.2	861.6	0.636	0.528	Y (-)
Dissolved Oxygen Deficit	-	40	-16.73	-1.72	0.53	2.30	5.40	-0.16	22.13	-1.047	0.302	N

Lake LBJ Watershed

Segment 1406 - Site 12324

Parameter	TSWQS	n	Minimum	P_{25}	Median	P_{75}	Maximum	Mean	Range	t score	p value	Flow
Temperature	34.4	59	10.30	14.90	23.79	27.34	31.10	21.46	20.80	0.559	0.579	NA
Secchi Depth	-	59	0.40	1.10	1.33	1.59	1.98	1.30	1.58	1.093	0.279	NA
pH	6.5 - 9.0	59	7.70	7.92	8.14	8.30	8.60	8.13	0.90	2.581	0.012	NA
TSS	-	58	1.0	3.0	4.0	6.0	17.0	4.7	16.0	-1.812	0.075	NA
Ammonia	0.11	56	0.020	0.020	0.020	0.030	0.270	0.039	0.250	0.307	0.760	NA
Total Kjeldahl Nitrogen	-	59	0.120	0.366	0.427	0.540	1.370	0.456	1.250	1.340	0.185	NA
Nitrate	0.37	59	0.020	0.020	0.030	0.137	0.990	0.104	0.970	-2.913	0.005	NA
Total Phosphorus	0.2	57	0.020	0.020	0.020	0.020	0.373	0.030	0.353	0.143	0.887	NA
Chloride	125	59	12.4	28.3	37.0	42.4	52.4	35.8	40.0	-1.969	0.054	NA
Sulfate	75	59	10.0	18.5	20.6	24.0	30.9	21.1	20.9	-3.966	0.000	NA
Bacteria	126	57	0	1	1	2	84	5	84	0.147	0.884	NA
Chlorophyll	10.29	58	1.9	6.6	9.0	12.9	22.4	9.7	20.5	1.827	0.073	NA
Total Dissolved Solids	500	58	157.0	226.0	238.6	254.3	279.0	237.2	122.0	-1.202	0.234	NA
Dissolved Oxygen Deficit	-	59	-1.30	-0.05	0.72	1.97	10.27	1.19	11.58	-0.648	0.520	NA

Red text denotes statistically significant trends.

Appendix C

Segment 1407 - Site 12336

Parameter	TSWQS	n	Minimum	P_{25}	Median	P_{75}	Maximum	Mean	Range	t score	p value	Flow
Temperature	32.2	59	9.50	14.31	22.25	26.20	30.40	20.65	20.90	0.536	0.594	NA
Secchi Depth	-	59	0.47	1.10	1.43	1.65	2.34	1.39	1.87	-3.782	0.000	NA
pH	6.5 - 9.0	59	7.60	8.06	8.35	8.50	8.77	8.28	1.17	0.206	0.838	NA
TSS	-	59	1.0	3.0	4.0	5.0	11.0	3.9	10.0	0.090	0.929	NA
Ammonia	0.11	57	0.020	0.020	0.020	0.040	0.360	0.040	0.340	-0.628	0.532	NA
Total Kjeldahl Nitrogen	-	59	0.080	0.465	0.513	0.615	1.000	0.525	0.920	0.541	0.591	NA
Nitrate	0.37	59	0.020	0.020	0.020	0.050	0.342	0.057	0.322	-1.907	0.061	NA
Total Phosphorus	0.2	53	0.020	0.020	0.020	0.020	0.200	0.027	0.180	-1.410	0.164	NA
Chloride	150	59	29.2	40.7	47.2	53.5	62.9	46.8	33.7	-5.817	0.000	NA
Sulfate	100	59	17.8	23.5	27.3	31.7	42.8	27.9	25.0	-6.301	0.000	NA
Bacteria	126	58	0	1	2	8	51	5	51	1.690	0.096	NA
Chlorophyll	26.7	58	2.0	10.1	13.9	17.0	44.2	15.6	42.2	1.032	0.306	NA
Total Dissolved Solids	600	59	205.0	238.1	253.0	263.5	293.0	250.2	88.0	-4.775	0.000	NA
Dissolved Oxygen Deficit	-	59	-2.35	-0.82	0.29	1.08	4.23	0.25	6.59	0.951	0.346	NA

Segment 1415 - Site 17425

Parameter	TSWQS	n	Minimum	P_{25}	Median	P_{75}	Maximum	Mean	Range	t score	p value	Flow
Temperature	32.2	35	11.00	17.00	20.50	25.40	30.20	20.65	19.20	0.419	0.678	N
pH	6.5 - 9.0	35	7.10	7.75	7.90	8.00	8.40	7.85	1.30	1.785	0.083	Y (+)
TSS	-	31	1.0	1.5	4.0	6.0	15.0	4.3	14.0	-1.708	0.098	Y (+)
Ammonia	0.33	32	0.020	0.020	0.020	0.020	0.070	0.027	0.050	-0.710	0.483	N
Total Kjeldahl Nitrogen	-	29	0.120	0.200	0.200	0.220	1.170	0.273	1.050	-0.808	0.426	N
Nitrate	1.95	30	0.020	0.025	0.085	0.168	1.740	0.181	1.720	-1.148	0.260	N
Total Phosphorus	0.69	33	0.020	0.020	0.020	0.020	0.020	0.020	0.000	-	-	N
Chloride	50	32	13.0	17.9	19.0	21.1	37.9	20.0	24.9	0.989	0.331	N
Sulfate	50	33	12.0	14.5	16.0	18.0	23.0	16.4	11.0	-1.752	0.089	N
Bacteria	126	33	1	16	42	86	1100	88	1099	0.373	0.711	N
Chlorophyll	14.1	31	2.0	2.0	2.0	2.0	8.0	2.2	6.0	0.330	0.744	N
Total Dissolved Solids	350	32	220.0	253.5	268.5	284.5	306.0	268.3	86.0	-3.227	0.003	N
Dissolved Oxygen Deficit	-	35	-3.69	-0.38	0.30	1.17	3.63	0.29	7.32	0.866	0.393	N

Segment 1415 - Site 12386

Parameter	TSWQS	n	Minimum	P_{25}	Median	P_{75}	Maximum	Mean	Range	t score	p value	Flow
Temperature	32.2	58	8.90	14.23	23.30	28.25	33.70	22.05	24.80	0.345	0.732	N
pH	6.5 - 9.0	57	7.60	8.20	8.40	8.50	8.68	8.33	1.08	0.792	0.432	N
TSS	-	58	1.0	3.0	4.0	7.0	148.0	8.2	147.0	-1.051	0.298	N
Ammonia	0.33	54	0.020	0.020	0.020	0.020	0.088	0.026	0.068	1.442	0.155	N
Total Kjeldahl Nitrogen	-	58	0.110	0.200	0.236	0.303	1.050	0.294	0.940	-0.593	0.556	N
Nitrate	1.95	56	0.020	0.020	0.020	0.125	1.664	0.130	1.644	-1.921	0.060	N
Total Phosphorus	0.69	54	0.020	0.020	0.020	0.020	0.120	0.026	0.100	-1.700	0.095	N
Chloride	50	58	7.5	20.2	22.2	25.7	35.1	22.8	27.6	-1.539	0.129	Y (+)
Sulfate	50	58	6.4	11.1	12.6	16.2	26.4	13.8	20.1	-2.459	0.017	Y (+)
Bacteria	126	58	1	20	32	138	7700	357	7699	-1.202	0.234	N
Chlorophyll	14.1	56	0.8	2.0	2.0	2.0	3.6	2.0	2.8	0.481	0.632	Y (+)
Total Dissolved Solids	350	58	141.5	189.3	200.0	219.9	259.2	203.5	117.7	-2.115	0.039	Y (+)
Dissolved Oxygen Deficit	-	58	-2.84	-0.79	-0.55	-0.06	7.99	-0.36	10.83	-1.274	0.208	N

Red text denotes statistically significant trends.

Lake Travis Watershed

Segment 1404 - Site 12302

Parameter	TSWQS	n	Minimum	P_{25}	Median	P_{75}	Maximum	Mean	Range	t score	p value	Flow
Temperature	34.4	60	11.40	16.98	24.55	27.55	30.70	21.97	19.30	0.309	0.758	NA
Secchi Depth	-	60	0.90	2.30	3.06	4.02	8.10	3.29	7.2	-1.139	0.259	NA
pH	6.5 - 9.0	60	7.50	8.03	8.20	8.40	8.60	8.19	1.10	-0.324	0.747	NA
TSS	-	56	1.0	1.0	2.0	2.0	4.0	1.9	3.0	-2.145	0.036	NA
Ammonia	0.11	60	0.020	0.020	0.020	0.020	0.098	0.024	0.078	1.288	0.203	NA
Total Kjeldahl Nitrogen	-	61	0.170	0.226	0.270	0.330	0.640	0.292	0.470	1.358	0.180	NA
Nitrate	0.37	61	0.020	0.020	0.030	0.174	0.450	0.104	0.430	-0.821	0.415	NA
Total Phosphorus	0.2	58	0.004	0.020	0.020	0.020	0.416	0.027	0.412	-1.599	0.115	NA
Chloride	100	61	22.3	29.5	31.9	35.7	42.1	32.6	19.8	-1.432	0.157	NA
Sulfate	75	61	15.0	20.2	22.1	23.3	27.6	21.8	12.6	-3.321	0.002	NA
Bacteria	126	58	1	1	1	3	27	4	26	-2.073	0.043	NA
Chlorophyll	5	58	0.6	2.0	2.2	4.0	11.9	3.4	11.3	0.428	0.670	NA
Total Dissolved Solids	400	60	205.0	220.0	226.9	235.3	328.0	229.2	123.0	0.774	0.442	NA
Dissolved Oxygen Deficit	-	59	-1.38	-0.30	0.47	1.31	4.13	0.59	5.51	0.825	0.413	NA

Segment 1405 - Site 12319

Parameter	TSWQS	n	Minimum	P_{25}	Median	P_{75}	Maximum	Mean	Range	t score	p value	Flow
Temperature	32.2	59	9.70	14.76	23.75	28.48	32.50	22.02	22.80	0.400	0.690	NA
Secchi Depth	-	59	0.40	1.03	1.48	1.60	2.32	1.35	1.92	-0.092	0.927	NA
pH	6.5 - 9.0	59	7.60	8.06	8.20	8.30	8.50	8.17	0.90	2.968	0.004	NA
TSS	-	59	1.0	3.0	4.0	6.0	13.0	4.4	12.0	-2.293	0.026	NA
Ammonia	0.11	58	0.020	0.020	0.020	0.026	0.137	0.031	0.117	0.018	0.985	NA
Total Kjeldahl Nitrogen	-	59	0.200	0.334	0.400	0.479	1.080	0.422	0.880	1.823	0.073	NA
Nitrate	0.37	59	0.020	0.020	0.029	0.145	1.080	0.113	1.060	-3.077	0.003	NA
Total Phosphorus	0.2	56	0.020	0.020	0.020	0.020	0.040	0.020	0.020	-0.579	0.565	NA
Chloride	125	59	12.9	29.2	38.3	43.2	54.4	37.0	41.5	-2.037	0.046	NA
Sulfate	75	59	10.0	18.9	21.3	23.9	31.4	21.3	21.4	-3.837	0.000	NA
Bacteria	126	58	1	1	2	5	610	21	609	0.507	0.614	NA
Chlorophyll	26.7	58	2.0	5.3	8.2	12.1	33.7	9.5	31.8	2.983	0.004	NA
Total Dissolved Solids	500	53	174.0	236.0	248.6	268.0	302.0	249.5	128.0	-3.074	0.003	NA
Dissolved Oxygen Deficit	-	59	-2.28	-0.51	-0.11	0.68	2.05	0.07	4.33	0.044	0.965	NA

Segment 1414 - Site 12369

Parameter	TSWQS	n	Minimum	P_{25}	Median	P_{75}	Maximum	Mean	Range	t score	p value	Flow
Temperature	32.2	60	10.37	15.40	23.12	28.68	32.80	21.82	22.43	0.469	0.641	Y (-)
pH	6.5 - 9.0	60	7.90	8.17	8.33	8.40	8.60	8.30	0.70	3.342	0.001	Y (-)
TSS	-	59	1.0	4.5	7.0	10.5	780.0	21.5	779.0	-0.730	0.468	Y (+)
Ammonia	0.33	59	0.020	0.020	0.020	0.020	0.092	0.026	0.072	1.883	0.065	N
Total Kjeldahl Nitrogen	-	59	0.170	0.200	0.268	0.363	2.200	0.340	2.030	-0.438	0.663	N
Nitrate	1.95	57	0.020	0.020	0.090	0.320	1.050	0.222	1.030	-2.997	0.004	Y (+)
Total Phosphorus	0.69	55	0.020	0.020	0.020	0.020	0.640	0.031	0.620	-0.642	0.523	Y (+)
Chloride	125	59	10.1	25.1	37.4	47.5	78.9	39.0	68.8	2.535	0.014	Y (-)
Sulfate	75	59	5.9	26.4	30.2	34.8	48.6	30.2	42.7	1.593	0.117	Y (-)
Bacteria	126	59	1	3	20	61	21000	437	20999	-0.689	0.494	Y (+)
Chlorophyll	14.1	57	1.9	2.0	2.0	2.1	6.4	2.4	4.5	-1.330	0.189	Y (+)
Total Dissolved Solids	525	60	175.8	273.5	291.4	321.8	396.0	295.7	220.2	2.025	0.047	Y (-)
Dissolved Oxygen Deficit	-	60	-2.00	-0.63	-0.20	0.14	1.75	-0.20	3.75	-0.004	0.997	N

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Austin Metropolitan Watershed

Segment 1403 - Site 12294

Parameter	TSWQS	n	Minimum	P_{25}	Median	P_{75}	Maximum	Mean	Range	t score	p value	Flow
Temperature	32.2	59	11.10	14.47	20.90	24.06	28.48	19.97	17.38	0.563	0.576	NA
Secchi Depth	-	59	0.59	1.50	1.98	2.21	4.00	1.93	3.41	-0.708	0.482	NA
pH	6.5 - 9.0	59	7.0	7.9	8.0	8.2	8.4	8.0	1.4	0.574	0.568	NA
TSS	-	59	1.000	2.000	3.000	4.000	7.000	2.864	6.000	-1.645	0.105	NA
Ammonia	0.11	57	0.020	0.020	0.020	0.023	0.104	0.029	0.084	1.507	0.137	NA
Total Kjeldahl Nitrogen	-	59	0.159	0.250	0.303	0.397	6.180	0.436	6.021	-1.603	0.114	NA
Nitrate	0.37	59	0.020	0.025	0.100	0.199	0.590	0.138	0.570	-1.631	0.108	NA
Total Phosphorus	0.2	57	0.0	0.0	0.0	0.0	0.1	0.0	0.1	-1.903	0.062	NA
Chloride	100	59	16.6	30.0	32.2	36.5	73.6	33.4	57.0	0.900	0.372	NA
Sulfate	75	59	13	20	23	26	43	23	30	-0.248	0.805	NA
Bacteria	126	59	1.0	2.0	4.0	8.0	110.0	7.7	109.0	-2.021	0.048	NA
Chlorophyll	5	57	1.1	2.0	2.3	4.8	16.3	4.1	15.2	0.572	0.570	NA
Total Dissolved Solids	600	59	178.20	232.60	246.00	253.50	314.00	244.11	135.80	1.238	0.221	NA
Dissolved Oxygen Deficit	-	58	-1.70	-0.37	0.20	0.65	3.15	0.31	4.84	-0.545	0.588	NA

Segment 1403A - Site 12216

Parameter	TSWQS	n	Minimum	P_{25}	Median	P_{75}	Maximum	Mean	Range	t score	p value	Flow
Temperature	32.2	23	8.80	15.43	22.50	27.30	30.59	21.61	21.79	-0.390	0.701	Y (-)
pH	6.5 - 9.0	24	6.20	7.85	7.96	8.05	8.40	7.87	2.20	1.093	0.286	Y (+)
TSS	-	21	0.6	1.0	1.0	1.0	608.0	30.0	607.4	0.244	0.809	N
Ammonia	0.33	21	0.020	0.020	0.020	0.020	0.046	0.023	0.026	0.386	0.704	N
Total Kjeldahl Nitrogen	-	5	0.100	0.170	0.200	0.200	0.260	0.186	0.160	0.121	0.909	N
Nitrate	1.95	21	0.020	0.050	0.130	0.510	1.140	0.302	1.120	0.728	0.475	Y (+)
Total Phosphorus	0.69	5	0.020	0.020	0.020	0.020	0.040	0.024	0.020	0.807	0.465	N
Chloride	100	9	34.4	40.8	41.8	48.0	57.1	43.5	22.7	0.739	0.481	N
Sulfate	75	10	38.8	47.3	52.3	53.8	84.2	54.6	45.4	0.191	0.852	N
Bacteria	126	15	10	52	88	131	650	127	640	0.950	0.358	Y (-)
Chlorophyll	14.1	-	-	-	-	-	-	-	-	-	-	-
Total Dissolved Solids	600	-	-	-	-	-	-	-	-	-	-	-
Dissolved Oxygen Deficit	-	23	-1.80	-0.58	-0.01	0.53	4.58	0.29	6.38	-0.122	0.904	Y (-)

Segment 1403J - Site 16316

Parameter	TSWQS	n	Minimum	P_{25}	Median	P_{75}	Maximum	Mean	Range	t score	p value	Flow
Temperature	32.2	26	14.60	18.30	21.40	23.65	25.20	20.83	10.60	1.502	0.146	N
pH	6.5 - 9.0	26	6.80	7.13	7.30	7.40	7.60	7.27	0.80	-0.308	0.761	N
TSS	-	2	4.0	4.0	4.0	4.0	4.0	4.0	0.0	-	-	N
Ammonia	0.33	24	0.020	0.020	0.020	0.020	0.220	0.032	0.200	-0.865	0.396	N
Total Kjeldahl Nitrogen	-	23	0.156	0.215	0.350	0.553	2.870	0.486	2.714	-0.005	0.996	N
Nitrate	1.95	25	1.580	2.270	2.540	3.090	3.720	2.651	2.140	1.164	0.256	N
Total Phosphorus	0.69	24	0.060	0.060	0.060	0.060	0.360	0.075	0.300	-0.271	0.789	N
Chloride	100	2	48.0	50.3	52.5	54.8	57.0	52.5	9.0	-	-	N
Sulfate	75	2	44.0	45.5	47.0	48.5	50.0	47.0	6.0	-	-	N
Bacteria	126	26	74	528	730	980	2400	890	2326	0.315	0.756	N
Chlorophyll	14.1	2	3.0	3.0	3.0	3.0	3.0	3.0	0.0	-	-	N
Total Dissolved Solids	600	2	460.0	475.0	490.0	505.0	520.0	490.0	60.0	-	-	N
Dissolved Oxygen Deficit	-	26	-1.09	1.58	1.94	2.54	3.78	1.90	4.87	-2.848	0.009	N

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Segment 1427 - Site 12436

Parameter	TSWQS	n	Minimum	P_{25}	Median	P_{75}	Maximum	Mean	Range	t score	p value	Flow
Temperature	35	53	10.10	16.86	21.80	28.60	32.47	21.72	22.37	0.092	0.927	Y (-)
pH	6.5 - 9.0	53	7.60	7.82	7.94	8.05	8.20	7.93	0.60	0.108	0.914	Y (+)
TSS	-	50	1.0	2.0	2.0	4.0	130.0	5.7	129.0	-0.925	0.360	N
Ammonia	0.33	52	0.020	0.020	0.020	0.024	0.109	0.027	0.089	2.018	0.049	N
Total Kjeldahl Nitrogen	-	53	0.120	0.206	0.278	0.420	3.680	0.424	3.560	-1.166	0.249	N
Nitrate	1.95	53	0.020	0.040	0.236	0.469	1.610	0.360	1.590	-1.112	0.271	Y (+)
Total Phosphorus	0.69	51	0.020	0.020	0.020	0.020	0.148	0.027	0.128	0.229	0.820	N
Chloride	100	53	13.0	26.1	31.2	38.0	65.6	32.1	52.6	1.198	0.236	Y (+)
Sulfate	100	53	20.4	37.8	49.2	56.0	79.6	47.9	59.2	-0.578	0.565	N
Bacteria	126	52	4	12	34	87	5500	164	5496	-0.640	0.525	N
Chlorophyll	14.1	51	0.6	2.0	2.0	3.7	13.7	3.3	13.1	0.518	0.607	N
Total Dissolved Solids	500	53	167.0	282.0	322.5	350.0	421.0	315.5	254.0	-0.189	0.850	Y (+)
Dissolved Oxygen Deficit	-	53	-5.21	-1.89	-0.82	-0.22	10.53	-0.88	15.74	-0.637	0.527	N

Segment 1427 - Site 12451

Parameter	TSWQS	n	Minimum	P_{25}	Median	P_{75}	Maximum	Mean	Range	t score	p value	Flow
Temperature	35	47	5.60	15.36	22.40	25.90	30.00	20.56	24.40	-0.640	0.525	N
pH	6.5 - 9.0	46	7.00	7.73	7.90	8.00	9.80	7.91	2.80	2.007	0.051	Y (+)
TSS	-	41	1.0	1.0	1.0	1.0	10.0	1.4	9.0	-1.566	0.125	N
Ammonia	0.33	44	0.006	0.020	0.020	0.020	0.340	0.029	0.334	-0.947	0.349	N
Total Kjeldahl Nitrogen	-	36	0.100	0.168	0.200	0.220	0.820	0.216	0.720	-0.183	0.856	Y (-)
Nitrate	1.95	39	0.020	0.020	0.050	0.245	1.420	0.243	1.400	2.575	0.014	N
Total Phosphorus	0.69	37	0.020	0.020	0.020	0.020	0.120	0.023	0.100	-0.857	0.397	N
Chloride	100	35	12.0	16.5	19.0	21.0	27.0	18.7	15.0	1.394	0.172	N
Sulfate	100	36	22.0	33.0	38.0	44.3	288.0	46.9	266.0	1.846	0.073	Y (-)
Bacteria	126	39	5	22	38	83	520	70	515	0.299	0.767	N
Chlorophyll	14.1	29	2.0	2.0	2.0	2.0	2.0	2.0	0.0	-	-	N
Total Dissolved Solids	500	32	242.0	294.0	311.5	336.5	394.0	317.2	152.0	2.036	0.050	N
Dissolved Oxygen Deficit	-	44	-1.94	0.06	0.71	1.24	5.05	0.95	6.99	-0.324	0.748	Y (-)

Segment 1427A - Site 12186

Parameter	TSWQS	n	Minimum	P_{25}	Median	P_{75}	Maximum	Mean	Range	t score	p value	Flow
Temperature	35	15	9.30	17.15	20.00	24.10	27.10	19.56	17.80	-2.121	0.052	N
pH	6.5 - 9.0	15	6.60	7.35	7.70	7.90	8.00	7.56	1.40	-0.032	0.975	N
TSS	-	15	2.0	4.0	4.0	5.0	18.0	5.5	16.0	-1.543	0.145	N
Ammonia	0.33	14	0.020	0.050	0.050	0.050	0.050	0.046	0.030	5.180	0.000	N
Total Kjeldahl Nitrogen	-	15	0.200	0.265	0.390	0.480	0.980	0.421	0.780	-0.611	0.551	N
Nitrate	1.95	15	0.020	0.040	0.040	0.200	0.700	0.153	0.680	0.575	0.575	N
Total Phosphorus	0.69	15	0.020	0.025	0.060	0.060	0.060	0.046	0.040	0.408	0.689	N
Chloride	100	15	15.0	32.5	39.4	42.5	59.0	38.0	44.0	0.975	0.346	N
Sulfate	100	15	30.0	85.5	91.0	100.5	139.0	89.0	109.0	1.157	0.267	N
Bacteria	126	13	2	10	30	98	2400	289	2398	-1.022	0.327	N
Chlorophyll	14.1	12	3.0	3.0	3.0	6.7	19.5	6.4	16.5	-0.454	0.659	N
Total Dissolved Solids	500	14	5.0	401.3	476.0	512.0	574.0	402.0	569.0	3.803	0.002	N
Dissolved Oxygen Deficit	-	15	-3.94	0.02	0.99	2.47	7.86	1.67	11.80	0.190	0.852	N

Red text denotes statistically significant trends.

Appendix C

Segment 1429 - Site 12476

Parameter	TSWQS	n	Minimum	P_{25}	Median	P_{75}	Maximum	Mean	Range	t score	p value	Flow
Temperature	32.2	48	12.24	18.70	22.43	26.02	29.40	21.97	17.16	1.399	0.168	NA
Secchi Depth	-	34	1.00	1.40	1.60	2.00	2.70	1.70	1.70	-0.621	0.539	NA
pH	6.5 - 9.0	48	7.0	7.6	7.8	7.9	8.6	7.8	1.6	0.641	0.525	NA
TSS	-	45	0.500	2.400	3.000	4.300	13.000	3.591	12.500	-0.236	0.814	NA
Ammonia	0.11	45	0.020	0.020	0.028	0.040	0.160	0.037	0.140	-1.320	0.194	NA
Total Kjeldahl Nitrogen	-	41	0.110	0.200	0.284	0.380	0.740	0.305	0.630	0.816	0.419	NA
Nitrate	0.37	45	0.020	0.150	0.210	0.340	0.760	0.240	0.740	-0.878	0.385	NA
Total Phosphorus	0.2	45	0.0	0.0	0.0	0.0	0.2	0.0	0.2	-1.632	0.110	NA
Chloride	75	16	17.2	26.7	28.0	29.5	32.4	27.2	15.2	-0.143	0.888	NA
Sulfate	75	45	15	22	24	27	52	25	38	1.556	0.127	NA
Bacteria	126	19	3.0	9.5	23.0	39.0	230.0	50.1	227.0	-1.183	0.252	NA
Chlorophyll	39.13	43	0.7	3.5	5.6	11.5	25.0	7.9	24.3	1.116	0.271	NA
Total Dissolved Solids	400	-	-	-	-	-	-	-	-	-	-	-
Dissolved Oxygen Deficit	-	48	-1.72	0.30	0.96	1.41	3.63	0.88	5.35	-0.506	0.615	NA

Segment 1429C - Site 15962

Parameter	TSWQS	n	Minimum	P_{25}	Median	P_{75}	Maximum	Mean	Range	t score	p value	Flow
Temperature	32.2	34	8.82	17.50	22.05	27.58	31.50	21.97	22.68	0.910	0.370	N
pH	-	34	7.40	7.70	7.90	8.00	8.30	7.90	0.90	-0.039	0.969	N
TSS	6.5 - 9.0	7	2.0	3.5	5.0	5.5	140.0	23.6	138.0	-0.361	0.730	N
Ammonia	-	32	0.020	0.030	0.050	0.073	0.420	0.073	0.400	-0.186	0.854	N
Total Kjeldahl Nitrogen	0.11	29	0.440	0.570	0.652	0.870	2.830	0.839	2.390	-0.709	0.484	N
Nitrate	-	31	0.050	0.430	0.710	0.905	1.790	0.729	1.740	-0.318	0.753	N
Total Phosphorus	0.37	31	0.030	0.134	0.170	0.200	0.380	0.170	0.350	-0.442	0.662	Y (+)
Chloride	0.2	5	60.1	64.8	64.9	72.1	72.2	66.8	12.1	-1.094	0.336	N
Sulfate	75	5	54.5	58.0	60.0	61.4	65.0	59.8	10.5	-0.600	0.581	N
Bacteria	75	30	40	558	845	1475	24000	1927	23960	0.565	0.577	Y (+)
Chlorophyll	126	5	0.7	2.6	4.2	4.7	8.7	4.2	8.0	-0.704	0.520	N
Total Dissolved Solids	39.13	5	5.0	362.0	372.0	389.0	436.0	312.8	431.0	-0.022	0.983	N
Dissolved Oxygen Deficit	400	34	-4.40	0.51	1.26	1.92	4.65	0.81	9.05	-0.767	0.449	N

Segment 1430 - Site 13555

Parameter	TSWQS	n	Minimum	P_{25}	Median	P_{75}	Maximum	Mean	Range	t score	p value	Flow
Temperature	32.8	33	9.00	13.10	22.62	27.00	30.60	20.93	21.60	0.681	0.501	Y (-)
pH	6.5 - 9.0	34	7.19	7.80	7.90	8.00	8.30	7.86	1.11	0.198	0.844	Y (+)
TSS	-	29	0.8	1.0	1.0	1.0	4.0	1.3	3.2	0.493	0.626	N
Ammonia	0.33	29	0.020	0.020	0.020	0.030	0.160	0.031	0.140	-0.536	0.596	N
Total Kjeldahl Nitrogen	-	12	0.200	0.200	0.200	0.200	0.260	0.208	0.060	2.695	0.021	Y (-)
Nitrate	1.95	22	0.040	0.090	0.140	0.265	1.370	0.284	1.330	0.823	0.420	N
Total Phosphorus	0.69	12	0.020	0.020	0.020	0.020	0.020	0.020	0.000	-	-	N
Chloride	50	5	25.0	29.1	29.9	31.3	36.7	30.4	11.7	-1.627	0.179	N
Sulfate	50	5	36.6	43.5	49.3	50.0	50.0	45.9	13.4	0.331	0.757	N
Bacteria	126	7	1	6	14	33	54	21	53	-0.475	0.651	Y (+)
Chlorophyll	14.1	10	2.0	2.0	2.0	2.0	2.0	2.0	0.0	-	-	N
Total Dissolved Solids	500	-	-	-	-	-	-	-	-	-	-	-
Dissolved Oxygen Deficit	-	33	-1.94	-0.10	0.48	1.10	4.04	0.48	5.98	-1.036	0.308	N

Red text denotes statistically significant trends.

Lower Watershed

Segment 1428 - Site 12466

Parameter	TSWQS	n	Minimum	P_{25}	Median	P_{75}	Maximum	Mean	Range	t score	p value	Flow
Temperature	35	59	11.60	16.09	22.40	25.07	29.60	21.15	18.00	0.299	0.766	Y (+)
pH	6.5 - 9.0	59	7.30	7.74	7.80	7.90	8.07	7.82	0.77	0.339	0.736	N
TSS	-	58	1.0	9.0	14.5	24.0	128.0	21.3	127.0	-0.114	0.910	Y (-)
Ammonia	0.33	58	0.020	0.020	0.040	0.060	0.211	0.051	0.191	2.556	0.013	N
Total Kjeldahl Nitrogen	-	58	0.200	0.405	0.503	0.587	1.460	0.550	1.260	1.766	0.083	N
Nitrate	1.95	57	0.759	1.250	2.170	4.040	9.160	2.942	8.401	1.722	0.091	Y (-)
Total Phosphorus	0.69	58	0.077	0.220	0.450	0.732	2.000	0.554	1.923	1.976	0.053	Y (-)
Chloride	100	58	22.6	34.0	39.4	45.3	71.8	40.9	49.2	1.535	0.130	Y (-)
Sulfate	100	58	19.4	26.3	32.5	42.1	63.3	35.2	43.9	1.209	0.231	Y (-)
Bacteria	126	58	9	28	42	118	2700	142	2691	0.121	0.904	Y (+)
Chlorophyll	14.1	56	0.5	2.0	2.0	3.6	18.3	3.1	17.8	0.200	0.842	N
Total Dissolved Solids	500	59	210.6	258.5	279.0	305.9	372.0	286.7	161.4	1.563	0.123	Y (-)
Dissolved Oxygen Deficit	-	59	-2.77	0.34	1.02	1.56	2.63	0.75	5.40	2.996	0.004	Y (-)

Segment 1428B - Site 17469

Parameter	TSWQS	n	Minimum	P_{25}	Median	P_{75}	Maximum	Mean	Range	t score	p value	Flow
Temperature	35	14	8.80	16.57	20.42	26.68	29.30	20.64	20.50	-0.648	0.528	N
pH	6.5 - 9.0	14	7.73	7.79	7.96	8.06	9.10	8.00	1.37	2.722	0.017	N
TSS	-	10	1.0	1.7	3.0	4.0	8.8	3.3	7.8	-0.344	0.739	N
Ammonia	0.33	11	0.020	0.020	0.020	0.027	0.040	0.024	0.020	0.630	0.543	N
Total Kjeldahl Nitrogen	-	1	1.060	1.060	1.060	1.060	1.060	1.060	0.000	-	-	N
Nitrate	1.95	11	0.020	0.105	0.300	0.510	1.120	0.367	1.100	0.469	0.649	Y (+)
Total Phosphorus	0.69	1	0.020	0.020	0.020	0.020	0.020	0.020	0.000	-	-	N
Chloride	100	10	35.0	76.3	108.0	197.5	2200.0	343.6	2165.0	-1.202	0.260	N
Sulfate	100	-	-	-	-	-	-	-	-	-	-	N
Bacteria	126	10	35	76	108	198	2200	344	2165	-1.202	0.260	N
Chlorophyll	14.1	-	-	-	-	-	-	-	-	-	-	N
Total Dissolved Solids	500	-	-	-	-	-	-	-	-	-	-	N
Dissolved Oxygen Deficit	-	13	-1.49	-1.16	-0.66	0.35	0.77	-0.42	2.27	0.442	0.666	Y (+)

Segment 1428C - Site 17257

Parameter	TSWQS	n	Minimum	P_{25}	Median	P_{75}	Maximum	Mean	Range	t score	p value	Flow
Temperature	35	51	7.40	15.31	18.70	26.30	28.40	19.74	21.00	-0.017	0.987	Y (-)
pH	6.5 - 9.0	51	7.80	8.02	8.10	8.20	8.40	8.10	0.60	1.522	0.134	N
TSS	-	51	1.0	8.0	14.0	22.0	98.0	18.3	97.0	0.298	0.767	N
Ammonia	0.33	49	0.020	0.020	0.020	0.030	0.320	0.037	0.300	-0.814	0.420	N
Total Kjeldahl Nitrogen	-	51	0.200	0.505	0.720	1.085	6.000	0.953	5.800	-1.472	0.147	N
Nitrate	1.95	50	0.560	3.338	5.235	7.230	14.000	5.659	13.440	3.023	0.004	N
Total Phosphorus	0.69	51	0.020	0.180	0.320	0.516	1.090	0.378	1.070	-3.136	0.003	Y (-)
Chloride	100	51	44.8	98.9	139.0	202.7	593.0	156.9	548.2	1.533	0.132	Y (-)
Sulfate	100	51	32.4	71.8	81.5	92.0	226.0	83.4	193.6	0.308	0.759	Y (-)
Bacteria	126	51	26	74	100	175	3100	213	3074	0.640	0.525	N
Chlorophyll	14.1	49	0.5	2.0	2.0	2.0	41.4	3.6	40.9	-1.558	0.126	N
Total Dissolved Solids	500	51	218.0	496.3	609.0	712.2	886.0	597.4	668.0	0.920	0.362	Y (-)
Dissolved Oxygen Deficit	-	51	-4.58	-0.40	0.17	0.50	11.51	0.07	16.10	-0.621	0.537	N

Red text denotes statistically significant trends.

Appendix C

Segment 1434 - Site 12293

Parameter	TSWQS	n	Minimum	P_{25}	Median	P_{75}	Maximum	Mean	Range	t score	p value	Flow
Temperature	35	59	9.90	15.23	23.70	28.26	32.39	22.24	22.49	0.079	0.937	N
pH	6.5 - 9.0	59	7.60	8.00	8.20	8.30	8.60	8.17	1.00	0.197	0.844	Y (-)
TSS	-	58	1.0	6.0	22.5	49.5	670.0	58.8	669.0	-0.830	0.410	Y (+)
Ammonia	0.33	58	0.020	0.020	0.020	0.040	0.181	0.038	0.161	1.950	0.056	N
Total Kjeldahl Nitrogen	-	58	0.060	0.394	0.505	0.666	1.850	0.619	1.790	0.854	0.397	N
Nitrate	1.95	58	0.566	1.303	1.775	2.323	5.710	2.117	5.144	1.278	0.206	Y (-)
Total Phosphorus	0.69	58	0.115	0.265	0.360	0.514	1.240	0.423	1.125	1.783	0.080	Y (-)
Chloride	100	58	14.0	34.8	40.7	45.8	66.4	40.6	52.4	1.166	0.248	Y (-)
Sulfate	100	58	12.7	29.2	34.7	45.8	65.8	37.3	53.1	0.685	0.496	Y (-)
Bacteria	126	58	1	16	26	49	5250	293	5249	-1.110	0.272	Y (+)
Chlorophyll	14.1	57	0.9	2.0	2.0	4.1	46.6	4.9	45.7	-1.180	0.243	N
Total Dissolved Solids	500	59	128.0	255.5	279.8	308.5	397.0	280.6	269.0	0.421	0.676	Y (-)
Dissolved Oxygen Deficit	-	59	-4.01	-0.79	-0.12	0.71	2.43	-0.22	6.44	3.965	0.000	Y (+)

Coastal Watersheds

Segment 1304 - Site 12148

Parameter	TSWQS	n	Minimum	P_{25}	Median	P_{75}	Maximum	Mean	Range	t score	p value	Flow
Temperature	35	80	7.46	19.45	24.12	28.10	33.08	23.55	25.62	0.448	0.655	NA
pH	6.5 - 9.0	78	7.19	7.40	7.70	8.03	8.70	7.74	1.51	0.652	0.517	NA
TSS	-	77	4.0	13.0	17.0	25.0	76.0	21.9	72.0	-0.119	0.906	NA
Ammonia	0.46	74	0.020	0.020	0.037	0.093	2.000	0.120	1.980	-2.319	0.023	NA
Total Kjeldahl Nitrogen	-	74	0.432	0.825	1.085	1.558	3.780	1.228	3.348	-1.238	0.220	NA
Nitrate	1.1	73	0.020	0.020	0.150	0.470	2.100	0.374	2.080	-3.177	0.002	NA
Total Phosphorus	0.66	75	0.020	0.205	0.320	0.415	0.713	0.325	0.693	0.462	0.645	NA
Chloride	-	77	5.0	65.2	1440.0	3470.0	11100.0	2497.5	11095.0	2.789	0.007	NA
Sulfate	-	77	3.0	25.3	241.0	535.0	1480.0	349.4	1477.0	2.358	0.021	NA
Bacteria	35	68	1	20	41	97	15531	317	15530	-1.272	0.208	NA
Chlorophyll	21	73	1.4	2.0	11.1	18.8	316.0	19.4	314.6	0.859	0.393	NA
Total Dissolved Solids	-	67	129.0	354.0	3074.0	7280.0	20155.0	5006.5	20026.0	2.147	0.035	NA
Dissolved Oxygen Deficit	-	79	-0.86	1.43	2.23	4.01	7.94	2.86	8.80	-1.458	0.149	NA

Segment 1304A - Site 12145

Parameter	TSWQS	n	Minimum	P_{25}	Median	P_{75}	Maximum	Mean	Range	t score	p value	Flow
Temperature	35	22	12.50	16.81	23.84	26.72	32.82	22.26	20.32	-1.722	0.100	N
pH	6.5 - 9.0	22	6.83	7.47	7.54	7.70	8.03	7.55	1.20	0.856	0.402	N
TSS	-	21	1.0	8.0	11.0	17.0	96.0	17.8	95.0	-0.377	0.710	N
Ammonia	0.46	21	0.020	0.038	0.120	0.180	4.340	0.436	4.320	-0.457	0.652	N
Total Kjeldahl Nitrogen	-	21	0.424	0.800	1.280	1.850	6.950	1.849	6.526	-1.631	0.119	N
Nitrate	1.1	20	0.020	0.060	1.425	2.623	20.150	3.123	20.130	-2.121	0.047	N
Total Phosphorus	0.66	21	0.090	0.200	0.324	0.390	0.940	0.351	0.850	-1.245	0.228	N
Chloride	-	21	15.0	57.0	83.0	277.0	549.0	170.7	534.0	-2.453	0.023	N
Sulfate	-	21	8.2	21.0	118.0	353.0	650.0	206.0	641.9	-2.714	0.013	N
Bacteria	35	18	30	61	84	200	1296	236	1266	1.850	0.082	N
Chlorophyll	21	20	2.0	10.0	10.0	10.0	240.0	21.7	238.0	-0.767	0.452	N
Total Dissolved Solids	-	19	228.0	415.0	684.0	1315.0	1910.0	851.6	1682.0	-1.701	0.106	N
Dissolved Oxygen Deficit	-	20	-0.39	1.72	2.42	3.82	5.50	2.73	5.88	3.754	0.001	N

Red text denotes statistically significant trends.

Segment 1305 - Site 12154

Parameter	TSWQS	n	Minimum	P_{25}	Median	P_{75}	Maximum	Mean	Range	t score	p value	Flow
Temperature	32.2	22	10.28	16.30	19.73	22.88	28.20	19.75	17.92	1.950	0.065	N
pH	6.5 - 9.0	22	7.20	7.43	7.70	7.80	8.10	7.62	0.90	3.501	0.002	N
TSS	-	21	1.0	6.0	11.0	32.0	52.0	17.5	51.0	-2.046	0.054	Y (+)
Ammonia	0.33	21	0.020	0.050	0.070	0.080	0.210	0.070	0.190	-1.342	0.195	N
Total Kjeldahl Nitrogen	-	19	0.410	0.600	0.780	1.035	1.980	0.860	1.570	-0.928	0.366	N
Nitrate	1.95	20	0.020	0.068	0.110	0.273	1.610	0.265	1.590	-1.948	0.066	N
Total Phosphorus	0.69	21	0.120	0.160	0.290	0.480	0.940	0.376	0.820	-0.574	0.572	N
Chloride	200	21	11.0	24.0	38.0	43.0	72.0	36.5	61.0	0.170	0.867	N
Sulfate	75	21	4.0	7.0	8.0	15.0	82.0	13.5	78.0	-1.553	0.136	N
Bacteria	126	21	10	41	97	170	4900	351	4890	-0.069	0.946	N
Chlorophyll	11.4	21	2.0	2.0	2.0	2.0	143.0	12.9	141.0	0.616	0.545	N
Total Dissolved Solids	1000	20	212.0	252.0	350.0	403.0	516.0	337.9	304.0	0.464	0.648	N
Dissolved Oxygen Deficit	-	21	0.97	2.55	2.91	3.48	6.14	3.15	5.17	1.924	0.069	Y (-)

Segment 1401 - Site 12281

Parameter	TSWQS	n	Minimum	P_{25}	Median	P_{75}	Maximum	Mean	Range	t score	p value	Flow
Temperature	35	58	6.41	18.09	22.60	27.91	33.40	22.93	26.99	0.850	0.399	NA
pH	6.5 - 9.0	58	7.20	7.87	8.08	8.26	8.59	8.04	1.39	-0.343	0.733	NA
TSS	-	59	7.0	16.0	27.0	51.5	506.0	61.4	499.0	-1.807	0.076	NA
Ammonia	0.46	58	0.020	0.020	0.021	0.058	0.250	0.052	0.230	1.187	0.240	NA
Total Kjeldahl Nitrogen	-	59	0.200	0.603	0.900	1.120	2.520	0.972	2.320	1.814	0.075	NA
Nitrate	1.1	59	0.020	0.260	0.750	1.425	4.960	0.952	4.940	0.579	0.565	NA
Total Phosphorus	0.66	59	0.068	0.199	0.250	0.332	0.707	0.281	0.639	0.897	0.373	NA
Chloride	-	59	6.2	37.9	354.0	1283.6	8990.0	1073.1	8983.8	2.843	0.006	NA
Sulfate	-	59	4.8	34.6	74.9	188.1	1210.0	163.2	1205.2	2.810	0.007	NA
Bacteria	35	57	0	10	20	160	180000	3443	180000	1.564	0.124	NA
Chlorophyll	21	58	0.8	5.2	9.9	18.9	114.0	16.9	113.2	1.235	0.222	NA
Total Dissolved Solids	-	25	171.6	544.0	1145.0	5044.0	18949.0	3736.1	18777.4	1.289	0.210	NA
Dissolved Oxygen Deficit	-	58	-8.35	-1.19	-0.22	0.47	6.73	-0.41	15.08	-0.374	0.710	NA

Segment 1402 - Site 12284

Parameter	TSWQS	n	Minimum	P_{25}	Median	P_{75}	Maximum	Mean	Range	t score	p value	Flow
Temperature	32.2	59	8.60	16.35	24.43	29.65	33.00	23.00	24.40	0.311	0.757	N
pH	6.5 - 9.0	59	7.05	7.85	8.01	8.33	8.70	8.06	1.65	0.243	0.809	Y (-)
TSS	-	59	9.0	20.0	29.0	47.5	966.0	85.1	957.0	0.173	0.863	Y (+)
Ammonia	0.33	58	0.020	0.020	0.037	0.072	0.240	0.054	0.220	1.524	0.133	N
Total Kjeldahl Nitrogen	-	58	0.230	0.513	0.635	0.856	2.350	0.736	2.120	1.026	0.309	Y (+)
Nitrate	1.95	59	0.020	0.534	1.030	1.705	3.182	1.186	3.162	-0.324	0.747	N
Total Phosphorus	0.69	59	0.090	0.190	0.255	0.360	0.780	0.289	0.690	1.284	0.204	N
Chloride	100	59	9.4	38.8	45.7	51.2	79.6	44.6	70.2	1.552	0.126	Y (-)
Sulfate	100	59	9.9	28.2	33.7	40.7	54.0	33.6	44.2	0.151	0.881	N
Bacteria	126	57	1	8	43	120	3600	221	3599	-0.179	0.858	N
Chlorophyll	14.1	57	0.5	3.0	14.9	25.6	83.4	18.3	82.9	-0.802	0.426	Y (-)
Total Dissolved Solids	500	59	101.0	267.8	301.0	327.5	439.0	295.4	338.0	0.527	0.600	Y (-)
Dissolved Oxygen Deficit	-	59	-4.88	-0.27	0.18	0.98	3.44	0.24	8.32	-0.428	0.670	Y (+)

Red text denotes statistically significant trends.

Appendix C

Segment 1402C - Site 16160

Parameter	TSWQS	n	Minimum	P_{25}	Median	P_{75}	Maximum	Mean	Range	t score	p value	Flow
Temperature	32.2	26	8.80	15.50	20.05	25.95	31.46	20.30	22.66	0.653	0.520	N
pH	6.5 - 9.0	26	6.50	6.70	7.10	7.53	8.63	7.20	2.13	0.228	0.822	N
TSS	-	24	7.0	20.8	35.0	48.3	167.0	46.1	160.0	-0.095	0.925	N
Ammonia	0.33	25	0.020	0.050	0.050	0.070	0.370	0.084	0.350	-1.596	0.124	N
Total Kjeldahl Nitrogen	-	23	0.500	1.275	1.510	1.850	2.970	1.552	2.470	0.228	0.822	N
Nitrate	1.95	25	0.020	0.040	0.040	0.130	3.720	0.240	3.700	1.478	0.152	N
Total Phosphorus	0.69	22	0.060	0.118	0.205	0.275	0.420	0.205	0.360	-0.196	0.847	N
Chloride	100	25	4.0	11.0	45.0	60.0	272.0	56.5	268.0	3.236	0.004	Y (-)
Sulfate	100	25	6.0	19.0	63.0	131.0	359.0	87.4	353.0	3.082	0.005	Y (-)
Bacteria	126	24	3	15	97	203	2400	278	2397	-0.585	0.565	Y (+)
Chlorophyll	14.1	24	8.4	13.3	47.9	81.1	284.0	62.8	275.6	2.165	0.041	Y (-)
Total Dissolved Solids	500	24	88.0	187.8	297.0	480.0	1130.0	368.9	1042.0	3.812	0.001	Y (-)
Dissolved Oxygen Deficit	-	26	-2.40	1.33	2.35	3.81	7.98	2.69	10.38	-0.706	0.487	N

Segment 1402H - Site 16805

Parameter	TSWQS	n	Minimum	P_{25}	Median	P_{75}	Maximum	Mean	Range	t score	p value	Flow
Temperature	32.2	25	9.11	14.60	21.40	25.21	29.60	20.34	20.49	0.302	0.766	N
pH	6.5 - 9.0	26	6.40	6.80	7.05	7.35	8.00	7.12	1.60	1.877	0.072	N
TSS	-	23	4.0	10.0	18.0	36.5	63.0	26.0	59.0	0.545	0.591	Y (+)
Ammonia	0.33	24	0.020	0.020	0.020	0.050	0.090	0.034	0.070	0.483	0.634	Y (+)
Total Kjeldahl Nitrogen	-	23	0.420	0.695	0.900	1.075	1.470	0.928	1.050	-0.624	0.539	N
Nitrate	1.95	24	0.020	0.020	0.020	0.103	1.520	0.125	1.500	-0.757	0.457	N
Total Phosphorus	0.69	25	0.020	0.060	0.120	0.150	0.270	0.112	0.250	0.435	0.667	Y (+)
Chloride	100	25	7.0	11.0	18.0	35.0	96.0	25.6	89.0	2.224	0.036	N
Sulfate	100	25	2.0	4.0	5.0	5.0	12.0	5.0	10.0	2.676	0.013	N
Bacteria	126	24	1	10	58	151	8164	692	8163	-0.187	0.853	N
Chlorophyll	14.1	24	2.0	2.0	6.3	15.8	36.4	10.7	34.4	0.765	0.452	N
Total Dissolved Solids	500	25	77.0	100.0	145.0	191.0	534.0	176.6	457.0	1.580	0.127	N
Dissolved Oxygen Deficit	-	25	0.64	2.14	2.86	4.05	7.07	3.02	6.43	1.296	0.207	N

Segment 1501 - Site 12515

Parameter	TSWQS	n	Minimum	P_{25}	Median	P_{75}	Maximum	Mean	Range	t score	p value	Flow
Temperature	35	72	7.34	17.47	24.09	29.03	32.97	23.07	25.63	0.746	0.458	NA
pH	6.5 - 9.0	72	7.08	7.60	7.87	8.18	8.80	7.87	1.72	1.725	0.089	NA
TSS	-	73	6.0	19.0	27.0	41.0	540.0	54.3	534.0	-1.736	0.087	NA
Ammonia	0.46	71	0.020	0.020	0.050	0.104	0.760	0.085	0.740	2.443	0.017	NA
Total Kjeldahl Nitrogen	-	71	0.620	0.985	1.370	1.615	2.760	1.388	2.140	0.251	0.803	NA
Nitrate	1.1	73	0.020	0.020	0.280	0.640	4.970	0.600	4.950	-0.468	0.641	NA
Total Phosphorus	0.66	72	0.070	0.149	0.225	0.350	0.786	0.258	0.717	0.036	0.971	NA
Chloride	-	72	4.1	45.4	848.0	2950.0	9100.0	1856.6	9095.9	1.566	0.122	NA
Sulfate	-	73	2.3	10.0	117.0	372.0	1250.0	248.6	1247.7	1.334	0.186	NA
Bacteria	35	68	1	30	86	335	24000	733	23999	-1.554	0.125	NA
Chlorophyll	21	70	2.0	3.0	16.4	34.2	104.0	22.5	102.0	1.244	0.218	NA
Total Dissolved Solids	-	61	93.0	318.0	2090.0	5620.0	20345.0	3985.6	20252.0	1.823	0.073	NA
Dissolved Oxygen Deficit	-	72	-5.72	0.02	1.35	3.04	7.36	1.55	13.09	0.188	0.851	NA

Red text denotes statistically significant trends.

Segment 1502 - Site 12517

Parameter	TSWQS	n	Minimum	P_{25}	Median	P_{75}	Maximum	Mean	Range	t score	p value	Flow
Temperature	32.2	28	9.47	16.80	21.28	27.55	30.10	21.45	20.63	0.628	0.536	N
pH	6.5 - 9.0	28	7.20	7.78	7.90	8.00	8.60	7.89	1.40	1.756	0.090	Y (-)
TSS	-	27	9.0	37.5	48.0	71.5	247.0	57.1	238.0	-1.588	0.124	Y (+)
Ammonia	0.33	26	0.020	0.020	0.020	0.020	0.480	0.068	0.460	0.722	0.477	Y (+)
Total Kjeldahl Nitrogen	-	24	0.310	0.743	0.920	1.218	1.780	0.973	1.470	1.066	0.298	Y (+)
Nitrate	1.95	27	0.020	0.180	0.420	0.870	3.460	0.709	3.440	0.706	0.486	Y (+)
Total Phosphorus	0.69	25	0.120	0.190	0.280	0.560	0.880	0.365	0.760	1.904	0.069	Y (+)
Chloride	250	26	7.0	117.3	139.5	178.0	253.0	137.1	246.0	-0.049	0.961	Y (-)
Sulfate	100	27	5.0	18.0	23.0	28.5	43.0	22.3	38.0	0.726	0.474	Y (-)
Bacteria	35	24	1	52	86	173	24192	1124	24191	-1.058	0.301	Y (+)
Chlorophyll	21	26	2.0	2.0	3.4	13.7	148.0	18.6	146.0	1.511	0.143	N
Total Dissolved Solids	800	25	191.0	484.0	560.0	632.0	832.0	534.0	641.0	0.046	0.964	Y (-)
Dissolved Oxygen Deficit	-	28	-2.68	0.46	0.83	1.34	3.01	0.73	5.69	0.853	0.401	N

Red text denotes statistically significant trends.

Appendix D

Routine Biological Monitoring & Aquatic Life Use

Thirteen locations along the Colorado River and its major tributaries were routinely sampled during the reporting period. Each sample event involved intensive fish and aquatic insect (benthic macroinvertebrate) collections, as well as aquatic habitat analysis. The resulting data were used to calculate aquatic life use scores based on an ecoregional index of biological integrity shown in the tables below.

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Summary of Routine Biological Monitoring in the Colorado River basin

Segment	# samples	Site	Mean BM IBI	Mean Fish IBI	LCRA Recommeded ALU		
1305	4	17498	-	-	37.8	Intermediate	Intermediate
1409	7	12355	31.9	High	50.4	High	High
1409	4	20641	35.3	High	49.5	High	High
1414	5	17472	35.0	High	52.4	Exceptional	High
1415	9	17009	38.7	Exceptional	53.1	Exceptional	High
1415	9	17363	36.6	Exceptional	51.6	High	High
1415	4	17471	38.8	Exceptional	52.0	Exceptional	High
1416	10	12392	32.4	High	47.0	High	High
1416	4	20662	36.3	Exceptional	53.5	Exceptional	High
1402A	6	12249	32.0	High	50.5	High	High
1416A	4	20411	36.5	Exceptional	49.5	High	High
1416A	3	20661	22.3	Intermediate	36.7	Intermediate	Intermediate
1434D	2	20809	30.5	High	45.5	High	High

Aquatic life use criteria

Level	Dissolved Oxygen (Grab or 24-hour average)	Dissolved Oxygen (24-hour minimum)	Fish Community (IBI Score)	Benthic Community (IBI Score)	Habitat Index Score
Central Texas Plateau Ecoregion					
Exceptional	6.0	6.0	>52	>36	26-31
High	5.0	5.0	42-51	29-36	20-25
Intermediate	4.0	4.0	30-41	22-28	14-19
Limited	3.0	3.0	<30	<22	<14
Central Texas Oklahoma Ecoregion					
Exceptional	6.0	6.0	>49	>36	26-31
High	5.0	5.0	41-48	29-36	20-25
Intermediate	4.0	4.0	35-40	22-28	14-19
Limited	3.0	3.0	<35	<22	<14

Appendix E

Water Quality Monitoring Sites Contributing Data to this Report

Segment	Site	Description
1304	12148	CANEY CREEK TIDAL MID CHANNEL AT CHAMBLESS RD
1304	12149	CANEY CREEK TIDAL CANEY CREEK AT STEVENS RD SOUTH OF HAWKINSVILLE
1304A	12141	LINVILLE BAYOU 35 M UPSTREAM OF FM 324/HASEMA ROAD
1304A	12145	LINVILLE BAYOU MID CHANNEL IMMEDIATELY UPSTREAM OF SH 35 WEST OF OLD OCEAN
1305	12154	CANEY CREEK AT SH 35 APPROXIMATELY 3.75 KM NE OF VAN VLECK
1305	17498	CANEY CREEK ABOVE TIDAL IMMEDIATELY UPSTREAM OF UNNAMED RD ON RUNNELS-PIERCE RANCH 175 M UPSTREAM OF SPRR CROSSING 2MI ESE OF FM 1728
1305	20468	CANEY CREEK AT HILL ROAD SOUTH OF PLEDGER IN MATAGORDA COUNTY
1401	12281	COLORADO RIVER TIDAL AT SELKIRK ISLAND 2 MI DOWNSTREAM FROM FM 521 SW OF WADSWORTH
1402	12284	COLORADO RIVER AT SH 35 BRIDGE AT BAY CITY
1402	12286	COLORADO RIVER APPROXIMATELY 367 METERS DOWNSTREAM OF SH 183 IN WHARTON
1402	12287	COLORADO RIVER AT FM 950 AT GARWOOD
1402	12290	COLORADO RIVER AT OLD HWY 71 IN COLUMBUS
1402	12292	COLORADO RIVER AT SH 71 AT LA GRANGE
1402	18351	COLORADO RIVER APPROXIMATELY 15 M OFF EAST BANK IMMEDIATELY DOWNSTREAM OF US ALT 90 NEAR ALTAIR
1402A	12249	CUMMINS CREEK APPROXIMATELY 58 M DOWNSTREAM OF FM 109 NORTH OF COLUMBUS
1402A	17015	CUMMINS CREEK AT VENGHAUS GEORGE RD 3.9KM WEST OF THE INTERSECTION OF FM109 AND ZIMMERSCHEIDT RD SW OF FRELSBURG
1402C	16160	BUCKNERS CREEK APPROX 200FT UPSTREAM OF FAYETTE CR154
1402G	17016	FAYETTE RESERVOIR AT THE INTAKE 45.0M NE OF THE INTAKE CANAL FOR THE FAYETTE POWER PLANT
1402G	17017	FAYETTE RESERVOIR AT THE MID POINT OF THE LAKE OVER CEDAR CREEK CHANNEL APPROX 150 YDS NORTH OF THE BAFFLE DIKE
1402G	17018	FAYETTE RESERVOIR AT THE DISCHARGE 45.0M NE OF THE DISCHARGE CANAL CONFLUENCE WITH FAYETTE RESERVOIR
1402H	16805	SKULL CREEK AT COLORADO CR16 SOUTH OF ALTAIR
1403	12294	LAKE AUSTIN NEAR TOM MILLER DAM TO THE WEST OF LAKE AUSTIN BLVD
1403	12295	LAKE AUSTIN APPROX 1/2 KM DOWNSTREAM OF CONFLUENCE WITH BULL CREEK
1403	12297	LAKE AUSTIN NEAR METROPOLITAN PARK TO THE SOUTH OF CITY PARK RD AND TO THE EAST OF WESTON RD
1403	12300	LAKE AUSTIN MID CHANNEL AT HEADWATERS 45 M UPSTREAM OF LOW WATER CROSSING DOWNSTREAM MANSFIELD DAM
1403	13912	LAKE AUSTIN USGS SITE DC NEAR QUINLAN PARK/SELMA HUGHES PARK 330 M UPSTREAM OF UNNAMED CONFLUENCE AT EAST END OF SELMA HUGHES PARK RD
1403	17497	LAKE AUSTIN AT LOOP 360/CAPITOL OF TEXAS HIGHWAY AT PUBLIC BOAT RAMP IN AUSTIN
1403	17640	LAKE AUSTIN APPROX 1.35 MILES UPSTREAM OF QUINLAN PARK BOAT RAMP 5 M OFF PRIVATE DOCK
1403A	12215	BULL CREEK AT FM 2222 WEST OF LAKEWOOD DRIVE WEST OF AUSTIN
1403A	12216	BULL CREEK AT LOOP 360 1 MILE NORTH OF FM 2222 INTERSECTION WEST OF AUSTIN
1403A	12218	BULL CREEK AT SPICEWOOD SPRINGS RD 5TH CROSSING TO THE WEST OF YUCCA MOUNTAIN RD
1403A	16312	BULL CREEK 250 FEET UPSTM OF CONFLUENCE WITH W BULL CREEK NEAR THE INTERSECTION OF FM2222 AND LOOP 360
1403A	16322	BULL CREEK 0.29MI SOUTH OF THE EASTERN INTRSCTION OF WYNDHAM DR AND CORLEY DR

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Segment	Site	Description
1403B	16311	WEST BULL CREEK APPROX UPSTREAM OF THE CONFLUENCE WITH BULL CREEK AT RR2222 AND LAKEWOOD DR
1403B	17468	WEST BULL CREEK 70 METERS WEST OF INTERSECTION OF JESTER BLVD AND RR 2222 AND 290M DOWNSTREAM OF THE CONFLUENCE WITH COW FORK BULL CREEK
1403D	16309	SPRING IN BARROW PRESERVE AT HEAD OF UNNAMED TRIB TO BULL CREEK 300FT WEST OF THE INTERSEC OF LONG POINT DR AND VALLEY DR
1403E	16308	STILLHOUSE HOLLOW SPRING AT THE HEAD OF STILLHOUSE HOLLOW A TRIB TO BULL CREEK UPSTREAM OF RIM ROCK DR IN AUSTIN TX
1403H	16320	UNNAMED TRIB TO BULL CREEK 0.26MI WEST OF SOUTHERN PICKFAIR DR AND BRIGHTLING LANE INTRSCTION
1403H	17467	BULL CREEK TRIBUTARY 5 230 M UPSTREAM OF CONFLUENCE WITH BULL CK AND 268M SOUTH 204M EAST OF CORLEY DR AND OLD LAMPASAS TRAIL
1403I	16321	UNNAMED TRIB TO BULL CREEK 0.33MI WEST OF SOUTHERN PICKFAIR DR AND BRIGHTLING LN INTRSCTION
1403J	16316	SPICEWOOD TRIB OF SHOAL CREEK AT SPICEWOOD SPRING DR AT CEBERRY N OF WOOD HOLLOW DR AT FAR WEST
1403K	17294	TAYLOR SLOUGH SOUTH 20 M DOWNSTREAM OF PECOS STREET SOUTH OF RIVER ROAD IN AUSTIN
1403R	16310	UNNAMED TRIB TO LAKE AUSTIN IMMEDIATELY DOWNSTREAM OF WESTLAKE DR
1404	12302	LAKE TRAVIS NEAR DAM AT LCRA TRAVIS COUNTY PARK
1404	12307	LAKE TRAVIS IN BIG SANDY CREEK COVE 1.25 KM DOWNSTREAM OF THE CONFLUENCE WITH LIME CREEK/BRUSHY CREEK 1.4 KM WEST OF FM 973
1404	12309	LAKE TRAVIS AT ARKANSAS BEND TO THE WEST OF RANCH ROAD 620
1404	12311	LAKE TRAVIS MID LAKE ADJACENT TO LAKEWAY/TO THE NORTH OF CORINTHIAN ROAD
1404	12313	LAKE TRAVIS MID LAKE AT CONFLUENCE WITH COW CREEK ARM AT PACE BEND APPROXIMATELY 2.02 KILOMETERS TO THE SOUTH OF FM 1431
1404	12314	LAKE TRAVIS PEDERNALES RIVER ARM AT OLD FERRY RD CROSSING TO THE SOUTH OF PEDERNALES POINT
1404	12315	LAKE TRAVIS MID LAKE 0.8 MILES UPSTREAM CONFLUENCE OF PEDERNALES RIVER ARM AT POST OAK BEND/TO THE WEST OF BRASADA
1404	12316	LAKE TRAVIS NEAR SPICEWOOD EAST OF SHAW RD AND NORTH OF MULE SHOE BEND RD
1404	12318	LAKE TRAVIS AT HEADWATERS DOWNSTREAM MAX STARCKE DAM APPROX 2.72 KILOMETERS EAST OF US HWY 281
1404	15428	LAKE TRAVIS IN THE HURST CREEK ARM APPROX 200 YDS UPSTREAM OF HURST HARBOR NEAR LADIN LANE IN LAKEWAY SUBDIVISION
1404	20070	LAKE TRAVIS IN BEE CREEK COVE 191 M NORTH AND 443 M WEST OF THE INTERSECTION OF BEE CREEK ROAD AND CORY LANE
1404A	17050	HAMILTON CREEK AT THE LOW WATER DAM IMMEDIATELY DOWNSTREAM OF US281 0.50M SOUTH OF SH29 IN BURNET
1404B	17054	COW CREEK AT COW CREEK ROAD 3.6MI NORTH OF FM1431
1405	12319	LAKE MARBLE FALLS NEAR MAX STARCKE DAM/TO SOUTHEAST OF COMINO REAL RD
1405	12323	LAKE MARBLE FALLS AT THE HEADWATERS APPROX 822 METERS NORTH OF FM 2147
1406	12324	LAKE LYNDON B JOHNSON NEAR ALVIN WIRTZ DAM APPROX 658 METERS NORTH OF FM 2147
1406	12327	LAKE LYNDON B JOHNSON AT CONFLUENCE WITH SANDY CREEK APPROX 453 METERS TO THE NORTH OF BLUE MOUNTAIN RD
1406	12330	LAKE LYNDON B JOHNSON AT CONFLUENCE WITH LLANO RIVER ARM NEAR KINGSLAND APPROX 51 METERS TO THE SOUTHWEST OF SCENIC RD
1406	12331	LAKE LYNDON B JOHNSON AT FM 2900 BRIDGE
1406	12333	LAKE LYNDON B JOHNSON AT KINGSLAND COVE APPROXIMATELY 0.9 MI UPSTREAM OF SH 1431
1406	12335	LAKE LYNDON B JOHNSON AT HEADWATERS 125 YDS DOWNSTREAM INKS DAM APPROX 506 METERS TO THE WEST OF STATE PARK RD 4
1406A	12214	SANDY CREEK APPROXIMATELY 73 M DOWNSTREAM OF SH 71 SOUTH OF KINGSLAND
1407	12336	INKS LAKE NEAR INKS DAM APPROX 161 METERS TO THE NORTHEAST OF ROY INKS DAM
1407	12343	INKS LAKE AT THE HEADWATERS
1407A	18710	CLEAR CREEK 1.28 KM UPSTREAM OF SH 29

Segment	Site	Description
1408	12344	LAKE BUCHANAN NEAR BUCHANAN DAM APPROX 475 METERS TO THE WEST OF CORONADO RD
1408	12347	LAKE BUCHANAN AT ROCKY POINT APPROX 1.3.KM NORTHWEST OF ROCKY RIDGE
1408	12349	LAKE BUCHANAN AT CONFLUENCE OF COUNCIL AND MORGAN CREEKS APPROX 302 METERS SOUTH OF LAKESHORE RD
1408	12350	LAKE BUCHANAN APPROXIMATELY 3/4 MILES SOUTH OF GARRET ISLAND NEAR 30 DEG 50 SEC APPROX 1.5 KM TO THE SOUTH OF GARRET ISLAND
1408	12352	LAKE BUCHANAN NEAR BEAVER CREEK COVE ADJACENT TO PARADISE POINT APPROX 1.4 KM TO THE SOUTH OF RANCH ROAD 2341
1408	12353	LAKE BUCHANAN NEAR LAKE HEADWATER APPROX 687 METERS TO THE NORTHEAST OF LLANO TOW VALLEY RD
1409	12355	COLORADO RIVER AT US 190 EAST OF SAN SABA
1409	20641	COLORADO RIVER 1.04 KILOMETERS DOWNSTREAM OF LYNCH CREEK CONFLUENCE
1409A	12274	CHEROKEE CREEK AT FM 501 5 MILES WEST OF BEND
1410	12358	COLORADO RIVER BRIDGE ON US 377 AT WINCHELL
1410	13667	COLORADO RIVER AT FM 503 1.2 MI UPSTREAM OF BOIS D'ARC CREEK 1.8 MI NE OF STACY 10.5 MI DOWNSTREAM FROM O.H. IVIE RESERVOIR
1411	12359	E V SPENCE RESERVOIR MID LAKE NEAR DAM APPROX 4.5 KM TO THE WEST OF STATE HIGHWAY 208
1411	12360	E V SPENCE RESERVOIR FM 2059 BRIDGE NEAR SILVER
1411	13863	E V SPENCE RESERVOIR SITE AL 1.75 KM WEST OF THE INTERSECTION OF FM ROAD 1904 AND ST LOOP 229
1412	12362	COLORADO RIVER AT PAN AMERICAN OIL CO BRIDGE 4.7 MILES WEST OF SILVER/COLORADO RV AT MITCHELL COUNTY RD
1412	12363	COLORADO RIVER AT SH 163 BRIDGE IN COLORADO CITY MITCHELL COUNTY TEXAS
1412	12364	COLORADO RIVER UPSTREAM FROM BRIDGE ON US 80 AT COLORADO CITY APPROX 1 KM TO THE NORTH OF I-20
1412	12365	COLORADO RIVER AT FM 1808 NW OF COLORADO CITY
1412	12366	COLORADO RIVER SH 350 SW OF IRA APPROX 183 METERS TO THE EAST OF STATE HWY 350
1412	17002	COLORADO RIVER AT MITCHELL CR343/PECAN CROSSING 7.5KM WEST OF SH208 AND 25.0KM SOUTH OF COLORADO CITY AT IH20
1412	17003	COLORADO RIVER AT FM2835/SHEPPARD CROSSING 8.0KM EAST OF SH350 AND 5.3KM SE OF THE TOWN OF IRA
1412	R1440	Champion Creek Reservoir near dam
1412A	12167	LAKE COLORADO CITY 25 M UPSTREAM OF DAM APPROXIMATELY 120 M W TO DAM SPILLWAY SW OF COLORADO CITY
1412B	12156	BEALS CREEK 35 M DOWNSTREAM OF SH 163 APPROXIMATELY 11 MI SOUTH OF WESTBROOK
1412B	12157	BEALS CREEK AT FM821
1412B	12158	BEALS CREEK 75 M DOWNSTREAM OF VALVERDE ROAD SE OF BIG SPRING
1412B	12159	BEALS CREEK AT EAST MID WAY ROAD/OLD ABILENE HIGHWAY APPROX 1MI EAST OF FM700 IN BIG SPRINGS
1412B	12160	BEALS CREEK 25 M DOWNSTREAM OF N BOUND FM 700 EAST OF BIG SPRING
1413	12367	LAKE J B THOMAS NEAR DAM APPROX 369 METERS TO THE NORTH OF SOURDOUGH RD
1414	12369	PEDERNALES RIVER AT CR 962 AT HAMMETT'S CROSSING APPROX 532 METERS TO THE EAST OF HAMMETS ROAD
1414	12372	PEDERNALES RIVER 1/2 MI DOWNSTREAM OF SH 281 NEAR JOHNSON CITY APPROX 424 METERS TO THE SOUTH OF BRADFORD
1414	12375	PEDERNALES RIVER AT FM 1320
1414	12377	PEDERNALES RIVER AT GOEHMAN LANE CROSSING EAST OF FREDRICKSBURG OFF OF US 290 E APPROX 1.5 KM TO THE NORTH OF US HWY290
1414	17472	PEDERNALES RIVER AT US 87 APPROX 3.0 MILES SOUTH OF FREDERICKSBURG
1414B	12258	CYPRESS CREEK AT FM 962
1415	12383	LLANO RIVER COUNTY ROAD 6.5 MILES UPSTREAM FROM KINGSLAND/LLANO RIVER AT RANCH ROAD 3404

Appendix E

Segment	Site	Description
1415	12386	LLANO RIVER 0.4 MILE DOWNSTREAM FROM BRIDGE ON SH 16 AT LLANO
1415	12388	LLANO RIVER AT SCOTTS CROSSING WEST OF LLANO APPROX 840 M NORTH OF RANCH RD 152
1415	14231	LLANO RIVER AT YATES CROSSING ON RR 385 15 MI EAST OF JUNCTION IN KIMBLE COUNTY
1415	16338	LLANO RIVER APPROX 4.0KM DOWNSTREAM OF RR 2768 ON SOUTH BANK OF RESIDENT LAWN
1415	16701	SOUTH LLANO RIVER ON EDWARDS CR408 OFF US377 IN EDWARDS COUNTY
1415	17009	SOUTH LLANO RIVER AT SOUTH LLANO STATE PARK IMMEDIATELY DOWNSTREAM OF LOW WATER CROSSING 225M S OF US377 AND CRISP HOLLOW CREEK
1415	17363	LLANO RIVER APPROX 2 MILES DOWNSTREAM OF US 87 EAST OF HEDWIGS HILL
1415	17425	NORTH LLANO RIVER 570 FT UPSTREAM FROM THE CONFLUENCE OF THE LLANO/SOUTH LLANO RIVER CONFLUENCE IN JUNCTION
1415	17470	LLANO RIVER 60 M UPSTREAM OF US 87
1415	17471	LLANO RIVER AT HYDROMET STATION 290M DOWNSTREAM OF KIMBLE COUNTY ROAD 310 EAST OF JUNCTION
1415	18197	SOUTH LLANO RIVER APPROXIMATELY 10 MI UPSTREAM OF SOUTH LLANO RIVER STATE PARK 204 YD UPSTREAM OF SECOND US 377 CROSSING
1415A	13550	JOHNSON FORK CREEK AT FM 2169 1.8 KM NORTH OF IH 10 AT SEGOVIA KIMBLE COUNTY DOWNSTREAM OF PAKS CORP. DISCHARGE AT 2ND ROAD CROSSING
1415C	12210	JAMES RIVER/AT JAMES RIVER RD AT UPPER MASON COUNTY ROAD CROSSING 14 MILES SOUTHWEST OF MASON
1416	12392	SAN SABA RIVER AT SH 16 NORTH OF SAN SABA
1416	17004	SAN SABA RIVER IMMEDIATELY DOWNSTREAM OF US87
1416	20662	SAN SABA RIVER AT COUNTY ROAD 340/COTTON BELT ROAD
1416A	14232	BRADY CREEK 2.81 KM DOWNSTREAM OF RR 714
1416A	17005	BRADY CREEK AT ELM STREET IN BRADY IMMEDIATELY DOWNSTREAM OF LOW WATER CROSSING
1416A	20411	BRADY CREEK AT SAN SABA COUNTY ROAD 261 APPROXIMATELY 750 METER UPSTREAM OF CONFLUENCE WITH SAN SABA RIVER
1416B	12179	BRADY CREEK RESERVOIR MID LAKE NEAR DAM/SOUTHEAST BOUND OFF RANCH ROAD 3022
1416C	20661	BRADY CREEK IMMEDIATELY DOWNSTREAM OF COUNTY ROAD 3034
1417	12394	LOWER PECAN BAYOU AT FM 573 SOUTHWEST OF MULLIN
1418	12395	LAKE BROWNWOOD AT DAM APPROX 192 METERS TO THE SOUTH OF PENNSULA ROAD
1418	12396	LAKE BROWNWOOD SH 279 NORTH OF BROWNWOOD APPROX 315 METERS EAST OF AVOLYN RD
1418	12397	LAKE BROWNWOOD MID LAKE NORTH OF GOAT ISLAND APPROX 454 METERS TO THE EAST OF COUNTY RD 454
1419	12398	LAKE COLEMAN NEAR DAM APPROX 970 METERS TO SOUTHWEST OF FM 1274
1420	16732	PECAN BAYOU 1MI UPSTREAM OF FM2559 NEAR LAKE BROWNWOOD
1421	12401	CONCHO RIVER BRIDGE ON US83 AT PAINT ROCK
1421	12402	CONCHO RIVER AT FM381
1421	12403	CONCHO RIVER AT FM1692 SOUTH OF MILES
1421	12404	CONCHO RIVER AT COUNTY ROAD 4.5 MI NE OF VERIBEST AT MULLINS CROSSING RD
1421	12405	CONCHO RIVER AT VERIBEST PARK APPROX 388 METERS TO THE NORTHEAST OF VERIBEST PARK RD
1421	12407	CONCHO RIVER AT FM380 NEAR VERIBEST
1421	12408	CONCHO RIVER DOWNSTREAM FROM LOOP 306 EAST OF SAN ANGELO/APPROXI 1.6 KM TO THE EAST OF LOOP 306

Segment	Site	Description
1421	12409	CONCHO RIVER 235 M DOWNSTREAM OF S BELL ST AND 540 M DOWNSTREAM FROM CONFLUENCE OF NORTH AND SOUTH FORKS IN SAN ANGELO
1421	12412	NORTH CONCHO RIVER 20M UPSTREAM OF IRVING STREET DAM IN SAN ANGELO TOM GREEN COUNTYTEXAS
1421	12416	CONCHO RIVER SOUTH FORK AT US87
1421	15886	NORTH CONCHO RIVER AT CADDO ST IN SAN ANGELO
1421	17348	CONCHO RIVER SOUTH FORK IMMEDIATELY UPSTREAM OF THE LONE WOLF PUMP STATION APPROX 1.2 KM UPSTREAM OF THE CONCHO RIVER CONFLUENCE
1421	20324	North Concho River 18.3 meters upstream of the W 7th Street bridge in the City of San Angelo
1421A	12257	DRY HOLLOW CREEK AT HEADWATERS OF CHANDLER LAKE APPROXIMATELY 484 M TO THE EAST OF PRIVATE ROAD 1775
1421B	12255	KICKAPOO CREEK AT FM 380
1421B	18002	MIDDLE KICKAPOO CREEK AT BARROW RANCH DUGOUT SPRING HOLE 2.05KM N 62M W OF FM765 AT FM2402
1421C	12254	LIPAN CREEK APPROX 900M UPSTREAM OF THE CONFLUENCE OF THE CONCHO RIVER ON PRIVATE PROPERTY
1422	12418	LAKE NASWORTHY 40 M WEST OF DAM CENTERPOINT APPROX 1.3 KM TO THE NORTH OF COUNTRY CLUB RD
1422	12419	LAKE NASWORTHY IN RIVER CHANNEL IN SOUTH CONCHO ARM 880 M WEST AND 220 M NORTH OF SOUTH COUNTRY CLUB ROAD AT LAS LOMAS COURT
1422	12421	LAKE NASWORTHY MIDDLE COVE 120 M DOWNSTREAM OF CENTER POINT OF CONFLUENCE OF MIDDLE CONCHO AND SPRING CREEK CHANNELS
1423	12422	TWIN BUTTES RESERVOIR AT DAM 695 M SOUTH AND 195 M WEST OF INTAKE STRUCTURE TO LAKE NASWORTHY
1423	12425	TWIN BUTTES RESERVOIR SOUTH POOL RIVER CHANNEL NEAR DAM APPROX 21 METERS TO THE WEST OF MOTL DAM
1423A	12161	SPRING CREEK S BANK 20 M DOWNSTREAM OF FM2335 NEAR TANKERSLEY
1423A	17346	SPRING CREEK AT LAKE AVENUE CROSSING IN MERTZON
1423B	12166	DOVE CREEK AT BRIDGE SE BOUND ON FM2335 NEAR KNICKERBOCKER
1424	12427	SOUTH CONCHO RIVER IMMEDIATELY DOWNSTREAM OF US 277 AT CHRISTOVAL
1424	16903	MIDDLE CONCHO RIVER AT FM853 NORTH OF MERTZON
1424	17349	CONCHO RIVER SOUTH FORK AT GARDNER DAM APPROX 1.2 KM UPSTREAM OF CONFLUENCE WITH IRRIGATION CANAL NORTH OF CHRISTOVAL
1424	18712	SOUTH CONCHO RIVER 175 M DOWNSTREAM OF ANSON SPRING APPROXIMATELY 6.3 KM SOUTH OF CHRISTOVAL
1424	18869	SOUTH CONCHO RIVER 600 M UPSTREAM OF CONFLUENCE OF COLD CREEK ON PRIVATE PROPERTY
1424A	12165	WEST ROCKY CREEK AT FM 853 43.4 KM/27 MI NORTHEAST OF MERTZON
1424B	18711	COLD CREEK 817 M UPSTREAM OF CONFLUENCE WITH SOUTH CONCHO RIVER APPROXIMATELY 5 KM SOUTH OF CHRISTOVAL
1425	12429	O C FISHER RESERVOIR MID LAKE 425 M WEST OF DAM RELEASE CONTROL TOWER
1425A	12170	NORTH CONCHO RIVER/O C FISHER LAKE 1425 APPROXIMATELY 24 M DOWNSTREAM OF FM 2288 10 MILES NORTH OF SAN ANGELO TEXAS
1425A	12171	NORTH CONCHO RIVER AT COUNTY ROAD BRIDGE 0.6 MILE SOUTHWEST OF CARLSBAD
1425A	16779	N CONCHO RIVER AT SHERWOOD LANE CROSSING 2.1MI SE OF STERLING CITY .75MI SOUTH OF SH87
1425A	16780	NORTH CONCHO RIVER 664 METERS UPSTREAM OF WILLOW CREEK CONFLUNCE 6.2MI NW OF STERLING CITY ON SH87.
1425A	17245	NORTH CONCHO RIVER AT POST OAK ROAD 2.6 KM DOWNSTREAM OF CHAULK CREEK CONLFUENCE NORTHWEST OF SAN ANGELO
1425A	17350	NORTH CONCHO RIVER AT RR 2034 SOUTHWEST OF WATER VALLEY
1425A	17351	NORTH CONCHO RIVER AT EAST CARLSBAD LOOP ROAD/JONES CROSSING 0.9 KM DOWNSTREAM OF MULE CREEK CONFLUENCE SOUTHEAST OF CARLSBAD

Segment	Site	Description
1426	12430	COLORADO RIVER BRIDGE ON US 83 IN BALLINGER
1426	12431	COLORADO RIVER AT US 67 IN BALLINGER APPROXIMATELY 91 METERS TO THE EAST OF US 67 AND 158 METERS TO THE SOUTHWEST OF 13TH STREET
1426	12432	COLORADO RIVER AT US 277 SOUTH OF BRONTE
1426	13651	COLORADO RIVER AT FM 2111 0.4 MI UPSTREAM FROM ROCKY CREEK 5.0 MI SW OF BALLINGER
1426	15147	COLORADO RIVER 100 YDS DOWNSTREAM OF CITY OF ROBERT LEE WWTP .6 MI UPSTREAM OF SH 158
1426	15200	QUARRY CREEK 0.3 MI DOWNSTREAM OF SH 383 1.0 MI SOUTH OF NORTON
1426	16900	COLORADO RIVER AT DOUBLE BARREL ROAD SW OF BRONTE
1426	16901	COLORADO RIVER AT FM3115 SOUTH OF MAVERICK
1426	17244	COLORADO RIVER AT BLAIR RANCH APPROX 0.75 KM DOWNSTREAM OF MUSTANG CREEK CONFLUENCE SOUTHEAST OF BALLINGER
1426	17475	COLORADO RIVER 0.25 MI DOWNSTREAM ROBERT LEE DAM IMPOUNDING E V SPENCE RESERVOIR WEST OF ROBERT LEE
1426	17655	CITY OF BRONTE WWTP OUTFALL PERMIT WQ0010390-001
1426	17656	CITY OF ROBERT LEE WWTP OUTFALL PERMIT 0013901-001 IMMEDIATELTY UPSTREAM OF SH 158
1426	18338	COLORADO RIVER USGS STATION IMMEDIATELY DOWNSTREAM OF SH 208 IN ROBERT LEE TEXAS
1426A	12180	OAK CREEK RESERVOIR MID LAKE NEAR DAM OFF BONNER POINT AND WEST OFF RANCH RD 3399
1426B	12169	ELM CREEK AT BALLINGER CITY PARK APPROX 71 M W TO CITY RD AND 120 M NE TO CROSSON RD UPSTREAM FROM STORAGE DAM
1426B	12207	ELM CREEK APPROXIMATELY 15 M DOWNSTRAM OF COUNTY ROAD 330 4 MILES NORTH OF BALLINGER
1426B	15536	ELM CREEK AT THE BALLINGER WWTP DISCHARGE PERMIT 10325-003 1.32 KM DOWNSTREAM OF US 67
1426B	17654	CITY OF WINTER WWTP OUTFALL PERMIT WQ0010320-001 SEWAGE DISPOSAL PONDS 236 METERS EAST OF KICKAPOO CREEK AND SH158
1426B	17657	CITY OF BALLINGER WWTP NO 2 PERMIT WQ0010325-003 200 METERS EAST OF THE INTERSECTION OF 3RD ST AND BLUM AVE
1426C	17474	BLUFF CREEK AT RUNNELS CR 351/HATCHELL-EAGLE-BRANCH ROAD
1426D	16899	COYOTE CREEK AT RUNNELS CR 342 NORTH OF BALLINGER
1427	12434	ONION CREEK AT MCMORRIS RANCH 1.70 KM UPSTREAM OF COLORADO RIVER CONFLUENCE APPROX 450 METERS TO THE SOUTHEAST OF THREE ISLAND RD
1427	12435	ONION CREEK AT LOW WATER CROSSING UPSTREAM FROM FM 973/ONION CREEK AT FM 973
1427	12436	ONION CREEK AT US 183 SOUTHEAST OF AUSTIN
1427	12440	ONION CREEK AT LOWER FALLS IN MCKINNEY FALLS STATE PARK 125 METERS DOWNSTREAM OF WILLIAMSON CREEK CONFLUENCE
1427	12446	ONION CREEK AT IH 35 APPROX 1.8 KM TO THE WEST OF I-35
1427	12447	ONION CREEK AT TWIN CREEKS ROAD 200 METERS UPSTREAM OF BEAR CREEK CONFLUENCE
1427	12448	ONION CREEK 0.7 MILE NORTH OF BUDA NEXT TO MOPAC RAILROAD TRACKS/ONION CK AT GARISON
1427	12451	ONION CREEK AT FM 150 0.61 KM DOWNSTREAM OF FLAT CREEK CONFLUENCE
1427	12455	ONION CREEK AT HAYS CR 198/ONION CREEK AT PURSLEY ROAD
1427	17275	ONION CREEK 0.8 KM UPSTREAM OF RIVER PLANTATION DRIVE WEST OF INTERSECTION RIVER PLATATION DRIVE AND SAHALEE LANE SOUTH OF AUSTIN
1427	17276	ONION CREEK IMMEDIATELY DOWNSTREAM OF FM 150 0.75 KM UPSTREAM OF JACKSON BRANCH SOUTHEAST OF DRIPPING SPRINGS
1427	GS200	Slaughter Creek at FM 2304

Segment	Site	Description
1427	GS201	Bear Creek near Brodie Lane
1427A	12184	SLAUGHTER CREEK APPROXIMATELY 36 M DOWNSTREAM OF IH 35 SOUTH
1427A	12185	SLAUGHTER CREEK AT OLD SAN ANTONIO ROAD SOUTH OF AUSTIN APPROXIMATELY 305 M UPSTREAM OF IH-35
1427A	12186	SLAUGHTER CREEK APPROXIMATELY 21 M DOWNSTREAM OF FM 1826 SOUTH OF AUSTIN
1427A	17964	SLAUGHTER CREEK IMMEDIATELY DOWNSTREAM OF FM 2304
1427B	13653	WILLIAMSON CREEK AT US 290 IN OAK HILL 0.76 MI EAST OF INTERSECTION OF US 290 AND SH 71 7.7 MI SW OF STATE CAPITOL
1427B	17963	WILLIAMSON CREEK IMMEDIATELY DOWNSTREAM OF MANCHACA ROAD
1427C	12189	BEAR CREEK APPROXIMATELY 38 M DOWNSTREAM OF FM 1826 EAST OF DRIFTWOOD
1427C	17965	BEAR CREEK NEAR FRATE BARKER ROAD 1.54 KM UPSTREAM OF FM 1626 CROSSING
1428	12466	COLORADO RIVER AT COUNTY PARK IN WEBBERVILLE APPROX 334 METERS TO THE WEST OF WATER ROAD
1428	12469	COLORADO RIVER AT FM 973 AT DEL VALLE
1428	12474	COLORADO RIVER BRIDGE ON US 183 SOUTHEAST OF AUSTIN/COLORADO RIVER ON LOCKHART BRIDGE NEXT TO US 183 BRIDGE
1428	12475	COLORADO RIVER JUST DOWNSTREAM LONGHORN DAM IN AUSTIN /COLORADO RI APPROXIMATELY 129 METERS TO THE EAST OF PLEASANT VALLEY RD
1428	20161	WALTER E. LONG LAKE MID LAKE NEAR DAM 200 M NORTH AND 30 M WEST OF THE DECKER CREEK RELEASE
1428B	12231	WALNUT CREEK AT SOUTHERN PACIFIC RR APPROXIMATELY 26 M DOWNSTREAM OF AUSTIN AND NORTHWESTERN 1.2 MILES SOUTH OF FM 969 IN EAST AUSTIN
1428B	12232	WALNUT CREEK AT WEBBERVILLE ROAD/FM 969 APPROXIMATELY 61 M DOWNSTREAM OF IT IN EAST AUSTIN
1428B	15743	WALNUT CREEK AT IH35 WEST FRONTAGE ROAD IN AUSTIN
1428B	16187	WALNUT CREEK ADJACENT TO NE DISTRICT PARK 681 FT EAST OF THE INTERSECTION OF CRYSTAL BROOK DR AND UTE DR IN AUSTIN
1428B	17251	WALNUT CREEK IMMEDIATELY DOWNSTREAM OF LOOP 1/MOPAC EXPWY IN AUSTIN
1428B	17469	WALNUT CREEK 5 M DOWNSTREAM OP OLD MANOR ROAD AND 175 M EAST OF INTERSECTION OF OLD MANOR ROAD AND FERGUSON CUTOFF NORTH OF PRESERVE
1428C	12235	GILLELAND CREEK AT FM 973 SOUTH OF MANOR
1428C	12236	GILLELAND CREEK AT US 290 NORTH OF MANOR
1428C	12237	GILLELAND CREEK AT CAMERON ROAD NEAR PFLUGERVILLE
1428C	15954	GILLELAND CREEK IMMEDIATELY UPSTREAM OF RAILROAD AVE NORTH OF FM1825 IN PFLUGERVILLE
1428C	17257	GILLELAND CREEK IMMEDIATELY DOWNSTREAM OF WEBBERVILLE ROAD/FM 969 EAST OF AUSTIN
1428C	20474	GILLELAND CREEK AT LOW WATER CROSSING IN NORTHEAST METROPOLITAN PARK
1429	12476	TOWN LAKE AT LONGHORN DAM APPROXIMATELY 179 METERS SOUTH OF CANTERBURY RD AND APPROX 338 METERS EAST OF PEDERNALES RD
1429	12477	TOWN LAKE AT IH-35 APPROX 234 METERS TO THE NORTH OF RIVERSIDE RD
1429	12483	TOWN LAKE AT LAMAR BRIDGE
1429	12484	TOWN LAKE/COLORADO RIVER AT BARTON CREEK
1429	12486	TOWN LAKE NEAR HEADWATER/TOWN LAKE NEAR AT REDBUD ROAD
1429	14064	TOWN LAKE SITE AT MOPAC BRIDGE
1429	14067	TOWN LAKE USGS SITE CC 45 METERS DOWNSTREAM FROM SOUTH 1ST ST

Appendix E

Segment	Site	Description
1429	14068	TOWN LAKE USGS SITE CR IMMEDIATELY DOWNSTREAM FROM SOUTH 1ST ST
1429A	13652	SHOAL CREEK AT 12TH STREET IN AUSTIN 0.6 MI WEST OF STATE CAPITOL
1429B	15964	EANES CREEK IMMEDIATELY UPSTREAM OF CONFLUENCE WITH TOWN LAKE IN ZILKER PARK IN AUSTIN
1429C	12222	WALLER CREEK AT 2ND STREET/RED RIVER STREET IN AUSTIN/TO THE NORTHWEST OF TOWNLAKE
1429C	12228	WALLER CREEK AT DENSON AVENUE IN AUSTIN
1429C	15962	WALLER CREEK AT 24TH STREET ON UT CAMPUS IN AUSTIN
1429C	16331	WALLER CREEK AT AVENUE H AT THE ELISABET NEY MUSEUM
1429D	16103	EAST BOULDIN CREEK AT BEND239M UPSTREAM OF SOUTH 1ST STREET IN AUSTIN
1429D	17296	EAST BOULDIN CREEK 55 M UPSTREAM OF RIVERSIDE DRIVE IN AUSTIN
1430	12488	BARTON CREEK JUST UPSTREAM UPPER DAM OF SWIMMING POOL UPSTREAM BARTON SPRINGS IN AUSTIN APPROX 75 METERS TO THE SOUTH OF WILLIAM BARTON RD
1430	12489	BARTON CREEK AT 2208 FOREST BEND DRIVE 3.9 KM DOWNSTREAM OF LOOP 360 APPROX 73 METERS TO THE NORTH OF FOREST BEND RD
1430	12490	BARTON CREEK AT LOOP 360 IN WEST AUSTIN
1430	12492	BARTON CREEK 1.85 KM DOWNSTREAM OF LOST CREEK BLVD
1430	12495	BARTON CREEK AT SH 71 5.3 MILES NORTHWEST OF OAK HILL
1430	12496	BARTON CREEK IMMEDIATELY UPSTREAM OF RAWHIDE TRAIL 5.96 KILOMETERS UPSTREAM OF SH 71
1430	12497	BARTON CREEK IMMEDIATELY DOWNSTREAM OF SHIELD RANCH ROAD 5.49 KM DOWNSTREAM OF HAYS CR 185
1430	12498	BARTON CREEK AT HAYS CR 185/TRAUTWEIN ROAD
1430	13555	BARTON CREEK AT LOST CREEK BLVD
1430	13693	BARTON CREEK DOWNSTREAM BARTON SPRINGS AT BARTON SPRINGS ROAD 1.6 MI SW OF STATE CAPITOL BUILDING
1430	14902	BARTON CREEK AT BARTON CREEK BLVD 6 MI EAST OF BEE CAVE
1430	15959	BARTON CREEK AT THE END OF PATTERSON LANE OFF FM2244 EAST OF INTERSECTION OF SH71 AND FM2244
1430	18187	BARTON CREEK 668 METERS DOWNSTREAM OF BARTON CREEK BLVD 317 SOUTH OF INTERSECTION OF CABIN RD AND CANYON RIM DR IN TRAVIS COUNTY
1430A	15696	BARTON SPRINGS 0.4 MI UPSTREAM FROM BARTON SPRINGS RD IN AUSTIN
1430B	12500	BARTON CREEK AT HAYS CR 169/BELL SPRINGS ROAD
1431	12504	PECAN BAYOU AT FM 2126 SE OF BROWNWOOD
1432	12508	PECAN BAYOU AT US 377/ US 67 AT BROWNWOOD
1433	12511	O H IVIE RESERVOIR NEAR DAM
1433	12512	O H IVIE RESERVOIR IN CONCHO RIVER ARM AT FM 1929
1433	12513	O H IVIE RESERVOIR IN COLORADO RIVER ARM AT ABILENE PUMP STATION
1434	12293	COLORADO RIVER DOWNSTREAM SH 95 1 MI AT OLIVE RD IN SMITHVILLE
1434	12462	COLORADO RIVER AT LOOP 150 SOUTH OF BASTROP
1434	12463	COLORADO RIVER AT FM 969 SE OF WEBBERVILLE
1434	16182	WILBARGER CREEK APPROX 200FT UPSTREAM OF LOOP 212 IN MANOR

Segment	Site	Description
1434	17328	DOGWOOD CREEK 1.08 KM DOWNSTREAM OF SH95 SOUTH OF ELGIN
1434	17473	BIG SANDY CREEK AT US 290 APPROX 4.5 MI SOUTHEAST OF ELGIN AND APPROX
1434B	16176	CEDAR CREEK APPROX 200FT DOWNSTREAM OF FM304
1434C	17019	LAKE BASTROP NEAR DISCHARGE CANAL APPROX 450M NE OF THE DISCHARGE CANAL AND 75YDS FROM THE BOY SCOUT CAMP SHORELINE
1434C	17020	LAKE BASTROP OFF TRIANGLE POINT OVER SPICER CREEK CHANNEL APPROX 185M EAST OF LANDMARK/TRIANGLE POINT
1434C	17021	LAKE BASTROP NEAR THE INTAKE 23M SW OF THE INTAKE STRUCTURE FOR THE SIM GIDEON POWER PLANT
1501	12515	TRES PALACIOS CREEK AT FM 521
1501	20636	TRES PALACIOS RIVER 260 METERS SOUTH AND 90 METERS EAST FROM THE INTERSECTION OF LIVE OAK BLVD AND RIVERSIDE DRIVE
1502	12517	TRES PALACIOS CREEK AT FM 456

THE TEXAS CLEAN RIVERS PROGRAM

LCRA
ENERGY • WATER • COMMUNITY SERVICES

UCRA
Upper Colorado River Authority
"Keeping and Eye on West Texas Waters"

CRMWD
Colorado River Municipal Water District

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