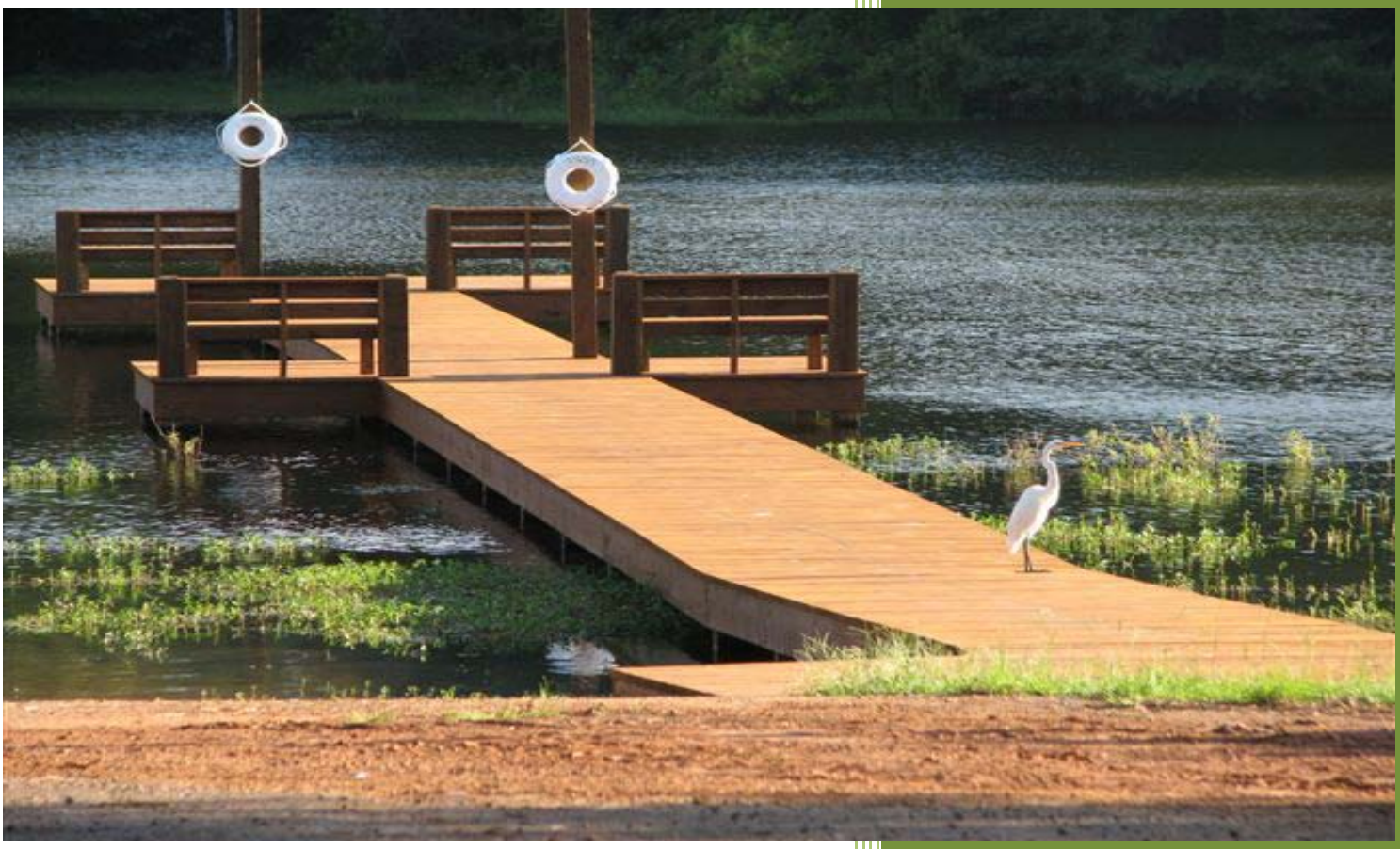
Texas Clean Rivers Program 2009

Cypress Creek Basin Summary Report



Prepared by Water Monitoring Solutions, Inc.

for the

Northeast Texas Municipal Water District

in cooperation with the Texas Commission on Environmental Quality.

The preparation of this report was financed through grants from the Texas Commission on Environmental Quality.

Foreword

The Clean Rivers Program (CRP) is a water quality monitoring, assessment, and public outreach program administered by the TCEQ and funded by state collected fees. The Northeast Texas Municipal Water District (NETMWD) coordinates the CRP for the Cypress Creek Basin.

As a participant in the Clean Rivers Program, NETMWD submits its Basin Summary Report to the TCEQ and CRP partners. This report and others submitted throughout the State are used to develop and prioritize programs that will

- protect the quality of healthy waterbodies and
- improve the quality of impaired waterbodies.

Under the CRP, biologists and field staff collect water quality and biological samples, field parameters and measure flow at sites throughout the Cypress Creek Basin.

Monitoring and analysis are the basis for maintaining good water quality within the Cypress Creek Basin. Within a cooperative program directed by the Northeast Texas Municipal Water District (NETMWD) these activities are an integral part of the State's Clean Rivers Program. Other entities participating in the Cypress Creek Basin Clean Rivers Program include the following:

Caddo Lake Institute

Northeast Texas Community College

Pilgrim's Pride Corporation

Titus Co. Fresh Water Supply District #1

Texas Parks and Wildlife Department

United States Geological Survey

East Texas Baptist University

U. S. Steel Tubular Products, Inc.

Luminant

AEP SWEPCO

City of Marshall

City of Longview

Franklin County Water District

NETMWD contracts with Water Monitoring Solutions, Inc. to fulfill the sampling and reporting requirements of the CRP.

Cover photo courtesy of Tommy Spruill, Titus County Fresh Water Supply District #1.

Table of Contents

Foreword i

Table of Contents ii

List of Tables iv

List of Figures v

Executive Summary vi

Introduction 1

Trends 6

Segment Review 15
- Segment 0400 - Paw Paw and Cross Bayous 17
- Segment 0401 - Caddo Lake 18
- Segment 0401A - Harrison Bayou 24
- Segment 0401B - Kitchen Creek 24
- Segment 0402 - Big Cypress Creek below Lake O' the Pines 25
- Segment 0402A - Black Cypress Bayou (unclassified water body) 29
- Segment 0402B - Hughes Creek (unclassified water body) 32
- Segment 0402C - Haggerty Creek (unclassified water body) 32
- Segment 0402D - Flat Creek (unclassified water body) 32
- Segment 0402E - Kelley Creek (unclassified water body) 33
- Segment 0403 - Lake O' the Pines 34
- Segment 0404 - Big Cypress Creek below Lake Bob Sandlin 38
- Segment 0404A - Ellison Creek Reservoir (unclassified water body) 43
- Segment 0404B - Tankersley Creek (unclassified water body) 45
- Segment 0404C - Hart Creek (unclassified water body) 46
- Segment 0404D - Welsh Creek (unclassified water body) 47
- Segment 0404E - Dry Creek (unclassified water body) 48
- Segment 0404F - Sparks Branch (unclassified water body) 48
- Segment 0404I - Boggy Creek (unclassified water body) 48
- Segment 0404J - Prairie Creek (unclassified water body) 49
- Segment 0404K - Walkers Creek (unclassified water body) 49
- Segment 0404L - Swauano Creek (unclassified water body) 50
- Segment 0404M - Greasy Creek (unclassified water body) 50
- Segment 0404N - Lake Daingerfield (unclassified water body) 50
- Segment 0405 - Lake Cypress Springs 51
- Segment 0405A - Big Cypress Creek (unclassified water body) 54
- Segment 0405B - Panther Creek (unclassified water body) 55
- Segment 0405C - Blair Creek (unclassified water body) 55
- Segment 0406 - Black Bayou 56
- Segment 0407 - James' Bayou 59

- Segment 0407A - Beach Creek (unclassified water body) 62
- Segment 0407B - Frazier Creek (unclassified water body) 62
- Segment 0408 - Lake Bob Sandlin 63
- Segment 0408A - Lake Monticello (unclassified water body) 64
- Segment 0408B - Andy's Creek (unclassified water body) 64
- Segment 0408C - Brushy Creek (unclassified water body) 64
- Segment 0408D - Blundell Creek (unclassified water body) 65
- Segment 0409 - Little Cypress Creek 66
- Segment 0409A - Lilly Creek (unclassified water body) 69
- Segment 0409B - South Lilly Creek (unclassified water body) 70
- Segment 0409D - Lake Gilmer (unclassified water body) 71

Biological 72

Conclusions and Recommendations 85

Citations 88

Appendix A 90

Appendix B 94

Appendix C 103

List of Tables

- Table I-1: Parameters as listed in the 2008 §303(d) List for the Cypress Creek Basin 4
- Table T- 1: Rows of data for the Cypress Creek Basin 7
- Table T- 2: Overview of basin trends 8
- Table A-1: Parameters as listed on the 2008 Texas §303(d) List for the Cypress Creek Basin 17
- Table 0401-1: Non-supporting parameters and parameters of concern for Segment 0401 19
- Table 0401-2: FY 2009 coordinated monitoring for Segment 0401 19
- Table 0402-1: Non-supporting parameters and parameters of concern for Segment 0402 26
- Table 0402-2: FY 2009 coordinated sampling scheduled for Segment 402 26
- Table 0402-3: pH sample exceedances for AU402_01 27
- Table 0402-4: Non-supporting parameters and parameters of concern for Segment 0402A 29
- Table 0403-1: FY 2009 coordinated monitoring for Segment 0403 35
- Table 0404-1: Non-supporting parameters and parameters of concern for Segment 0404 39
- Table 0404-2: FY 2009 coordinated monitoring for Segment 0404 39
- Table 0404-3: Nutrient sample exceedances on AU 0404_02 41
- Table 0404-4: Metals results for Ellison Creek Reservoir 44
- Table 0404-5: Non-supporting parameters and parameters of concern for Segment 0404B 45
- Table 0404-6: Diel results for station 15836 49
- Table 0405-1: Non-supporting parameters and parameters of concern for Segment 0405 52
- Table 0405-2: FY 2009 coordinated monitoring for Segment 0405 52
- Table 0405-3: Diel results for station 16939 53
- Table 0406-1: Non-supporting parameters and parameters of concern for Segment 406 57
- Table 0406-2: Diel results for station 16157 58
- Table 0407-1: Non-supporting parameters and parameters of concern for Segment 0407 60
- Table 0408-1: Parameters of concern for Segment 0408 63
- Table 0409-1: Non-supporting parameters and parameters of concern for Segment 0409 67
- Table 0409-2: FY 2009 coordinated monitoring for Segment 0409 67
- Table B-1: Results of Mercury in fish tissue sampling in Caddo Lake from 1983 – 2000 74
- Table B-2: Results of Mercury in fish tissue sampling in Caddo Lake from 1983 – 2000 75
- Table B-3: Biological monitoring conducted by CRP with average RBA, IBI and HQI by segment from 2001 - 2008 80
- Table B-4: Species richness, number of darter species and darter richness by segment 82
- Table AA-1: Aquatic Life Use for Cypress Creek Basin 91
- Table AA-2: Water quality criteria 92
- Table AA-3: Water quality screening levels 92
- Table AA-4: Toxics screening levels in water 93

List of Figures

- Figure I-1: The Cypress Creek Basin is composed of five main watersheds 2
- Figure I-2: Annual precipitation at Lake Bob Sandlin since 1979 4
- Figure I-3: Bald eagle perched with a fish at Lake Bob Sandlin 5
- Figure T-1: Locations of statistically significant trends in the Cypress Creek Basin 11
- Figure T-2: pH sample results for station 10321 12
- Figure T-3: DO grab sample results for station 15249 13
- Figure T-4: Total phosphorus results for station 10308 14
- Figure T-5: Chlorophyll a results for station 16156 14
- Figure A-1: View facing west at Caddo Lake Turtle Shell 16
- Figure 0401-1: Stations located in Segment 0401 (Caddo Lake) 18
- Figure 0401-2: Results for pH sampling on Caddo Lake near Harrison Bayou 21
- Figure 0401-3: Diel results in Clinton Lake near Devil's Elbow 22
- Figure 0401-4: Caddo Lake 23
- Figure 0402-1: Stations located in Segment 0402 25
- Figure 0402-2: pH has been significantly increasing over the past decade 28
- Figure 0402-3: Diel results for station 16705 30
- Figure 0402-4: Hughes Creek at SH 155 33
- Figure 0403-1: Stations located in Segment 0403 (Lake O' the Pines) 34
- Figure 0403-2: Chlorophyll a results for station 10296 36
- Figure 0403-3: View northeast from the dam at Lake O' the Pines 37
- Figure 0404-1: Stations located in Segment 0403 (Lake O' the Pines) 38
- Figure 0404-2: Total phosphorus results for station 10308 41
- Figure 0404-3: Big Cypress Creek at SH 37 north of Winnsboro 42
- Figure 0404-4: Lead results for station 14473 43
- Figure 0404-5: Zinc results for station 14473 43
- Figure 0404-6: Walkers Creek at US 271 47
- Figure 0405-1: Stations located in Segment 0405 (Lake Cypress Springs) 51
- Figure 0405-2: Diel results for station 17518 54
- Figure 0405-3: South shore of Lake Cypress Springs 55
- Figure 0406-1: Stations located in Segment 0406 (Black Bayou) 56
- Figure 0406-2: E. coli results for station 10314 57
- Figure 0406-3: Dissolved oxygen results for station 16157 58
- Figure 0407-1: Stations located in Segment 0407 (James' Bayou) 59
- Figure 0407-2: Diel results for station 10319 60
- Figure 0407-3: Dissolved oxygen results for station 10321 61
- Figure 0407-4: James' Bayou at CR 1775 (station 10321) 62
- Figure 0408-1: Stations located in Segment 0408 (Lake Bob Sandlin) 63
- Figure 0409-1: Stations located in Segment 0409 (Little Cypress Creek) 66
- Figure 0409-2: E. coli results for station 16861 68
- Figure 0409-3: Middle Lilly Creek at County Road 3322 (station 20135) 70
- Figure B-1: Fish tissue monitoring stations in the Cypress Creek Basin 73
- Figure B-2: Electrofishing in progress on Hughes Creek at SH 155 77
- Figure B-3: Electrofishing in progress on Hughes Creek at SH 155 78
- Figure B-4: Etheostoma proeliare (Cypress darter) 82
- Figure B-5: A habitat assessment in progress on Hughes Creek at SH 155 84

Executive Summary

The *2008 Texas §303(d) List* currently identifies fourteen stream sub-segments in the Cypress Creek Basin that are non-supporting of water quality criteria for one or more parameters. The routinely identified non-supporting parameters are dissolved oxygen, pH, *E. coli*, and Mercury in fish tissue. The *2008 Texas Water Quality Inventory* includes nutrients and chlorphyll *a* as water quality concerns in the basin.

The majority of listings for the Cypress Creek Basin include concerns for low dissolved oxygen and low pH. Most stream reaches approaching Caddo Lake are wetland habitat where the water bodies are characterized by low DO and low pH due to shallow depths, low flow, little mixing and elevated temperatures. Despite their inability to meet stream criteria in many of these reaches, most stream segments tend to support diverse biota.

Near the headwaters of the Cypress Creek Basin are Lake Cypress Springs and Lake Monticello. These reservoirs discharge directly into Lake Bob Sandlin, the largest of these reservoirs. Lake Bob Sandlin plays a key role in the hydrology of the Big Cypress Creek watershed. Releases from the reservoir occur primarily to maintain freeboard at the dam. There are no in-stream flow requirements meaning that there are no releases required to supplement flow during periods of drought or low flow. Average annual rainfall and releases from Lake Bob Sandlin have been much lower over the past nine years than compared to previous decades. During these times, Big Cypress Creek becomes dominated by municipal and industrial treated effluent. Wastewater effluent tends to have higher conductivity, TDS and nutrients than natural conditions. All of these parameters have exhibited statistically significant increasing trends in the Big Cypress Creek watershed below Lake Bob Sandlin.

A comprehensive review of all of the historical data in the TCEQ Surface Water Quality Monitoring Information System (SWQMIS) database for the basin was performed. All surface water quality data, spanning as many as forty years for some segments, were reviewed and evaluated. Trend analyses were performed on data from monitoring stations with at least ten years of data, regular sampling and with a minimum of twenty to thirty data points. No statistical trends were observed in the Little Cypress Creek or Black Cypress Creek watersheds indicating that water quality has remained relatively stable over the period of record. Most of the water quality trends were discovered in Big Cypress Creek and its impoundments beginning in Lake Cypress Springs and Lake Bob Sandlin and ending in the headwaters of Caddo Lake.

Five main statistical trends were observed through these analyses:

- Increasing trends for specific conductance/TDS
- Increasing trends for pH
- Increasing trends for Phosphorus in Big Cypress Creek below Lake Bob Sandlin and corresponding increasing chlorophyll *a* trends in Lake O' the Pines
- Decreasing DO in the upper portion of Caddo Lake
- Decreasing DO and pH along with increasing chlorophyll *a* in Black Bayou

The increasing trends for Specific Conductance/TDS in all of the downstream segments below Lake Bob Sandlin indicate that the Big Cypress Creek watershed is becoming more effluent dominated over the past decade. Reduced freshwater inflow from decreased average annual rainfall and releases from Lake Bob Sandlin has contributed to these increasing trends. Increased nutrients, associated with effluent and non-point sources, showed increasing phosphorus trends in Big Cypress Creek below Lake Bob Sandlin. Nutrient enrichment leads to higher primary productivity which is measured using chlorophyll *a*. The increasing phosphorus trends in Big Cypress Creek at stations 13631 (US 259) and 10308 (SH 11) have resulted in increasing trends for chlorophyll *a* in Lake O' the Pines at the mid-lake and dam stations. As primary producers consume the available carbon dioxide in the water column through the process of photosynthesis, carbonic acid is reduced, resulting in higher pH as exhibited in Big Cypress Creek below Lake Bob Sanldin (Segment 0404) and below Lake O' the Pines (Segment 0402).

The *2008 Texas Water Quality Inventory* was reviewed and compared to the historical data in SWQMIS. The data supported most of the current impairment concerns and listings in the assessment.

Historical mercury in fish tissue data showed that mercury was detectable in fish collected throughout the entire basin regardless of species or trophic level, and that the highest concentrations were found in fish obtained from Caddo Lake, Pruitt Lake and Lake Daingerfield. PCBs were detected in fish tissue sampled from Ellison Creek Reservoir. The Department of State Health Services has issued fish consumption advisories for these lakes and reservoirs.

A review of the biological assessments conducted by CRP from 2001 to 2008 indicated that fish populations tended to score in the High category of the Index of Biotic Integrity (IBI) in all segments. The results of benthic sampling and habitat assessments tend to score in the Intermediate/High range for both Rapid Bioassessment (RBA) and Habitat Quality Index (HQI). Most segments tended to support diverse fish and benthic populations with over eighty fish and 285 benthic taxa being collected over the past eight years.

Thirteen darter species have been identified in the Cypress Creek Basin. Darters are sensitive to water quality impairments, habitat disturbance, and serve as indicators of overall water quality. They tend to be found in relatively high abundance throughout the basin with an average of seven species per segment. However, only three taxa were collected in Black Bayou (Segment 0406) during the UAA performed by TCEQ in July 2003 and 2004 while no darters were found at station 10314. Darters had been collected at this station in September 1994 and August 1995. Segment 0406 is included in the *2008 Texas §303(d) List* for having low DO and low pH, and station 10314 exhibited decreasing trends for both of these parameters along with an increasing trend for chlorophyll *a*. These water quality impairments appear to have negatively affected the biological community in Black Bayou since it had the lowest average IBI and RBA scores along with the fewest number of darter taxa of any segment in the basin.

Conclusions

The eutrophication process appears to be occurring throughout much of the Cypress Creek Basin. This is evidenced by the increasing pH trends in Big Cypress Creek below Lake Bob Sandlin and below Lake O' the Pines. This is further evidenced by the increasing nutrient trends in Segment 0404 followed by increasing chlorophyll *a* trends in Lake O' the Pines. Additionally, elevated *E. coli* in Segment 0404 & Little Cypress Creek indicate possible impacts from non-point sources and/or improperly treated effluents. At present, the biota of the Cypress Creek Basin do not appear to have been negatively affected by these water quality impairments, with the exception of Black Bayou, which had the lowest average IBI and RBA scores and fewest number of darter taxa.

Although low dissolved oxygen concentrations in the summer and low pH often naturally occur in East Texas, these issues are exacerbated through excessive nutrient inputs. Efforts to reduce nutrient loadings, such as those used in the Lake O' the Pines TMDL, should be considered across the entire Cypress Creek Basin.

Introduction

A Basin Summary Report is a requirement of the Clean Rivers Program (CRP) every five years. The purpose of the report is to provide a comprehensive review of water quality conditions, significant trends, and issues throughout the Cypress Creek Basin.

The objectives of this report are to:

- Identify and locate water quality issues
- Determine significant water quality trends
- Compare the *2008 Texas Water Quality Inventory* to historical data
- Examine the effects of water quality impairments on the biota

The Cypress Creek Basin

All of the land area within the Cypress Creek Basin drains primarily from the northwest to the southeast and eventually feeds into Caddo Lake (Figure I-1). Starting from the top of the basin, note that before

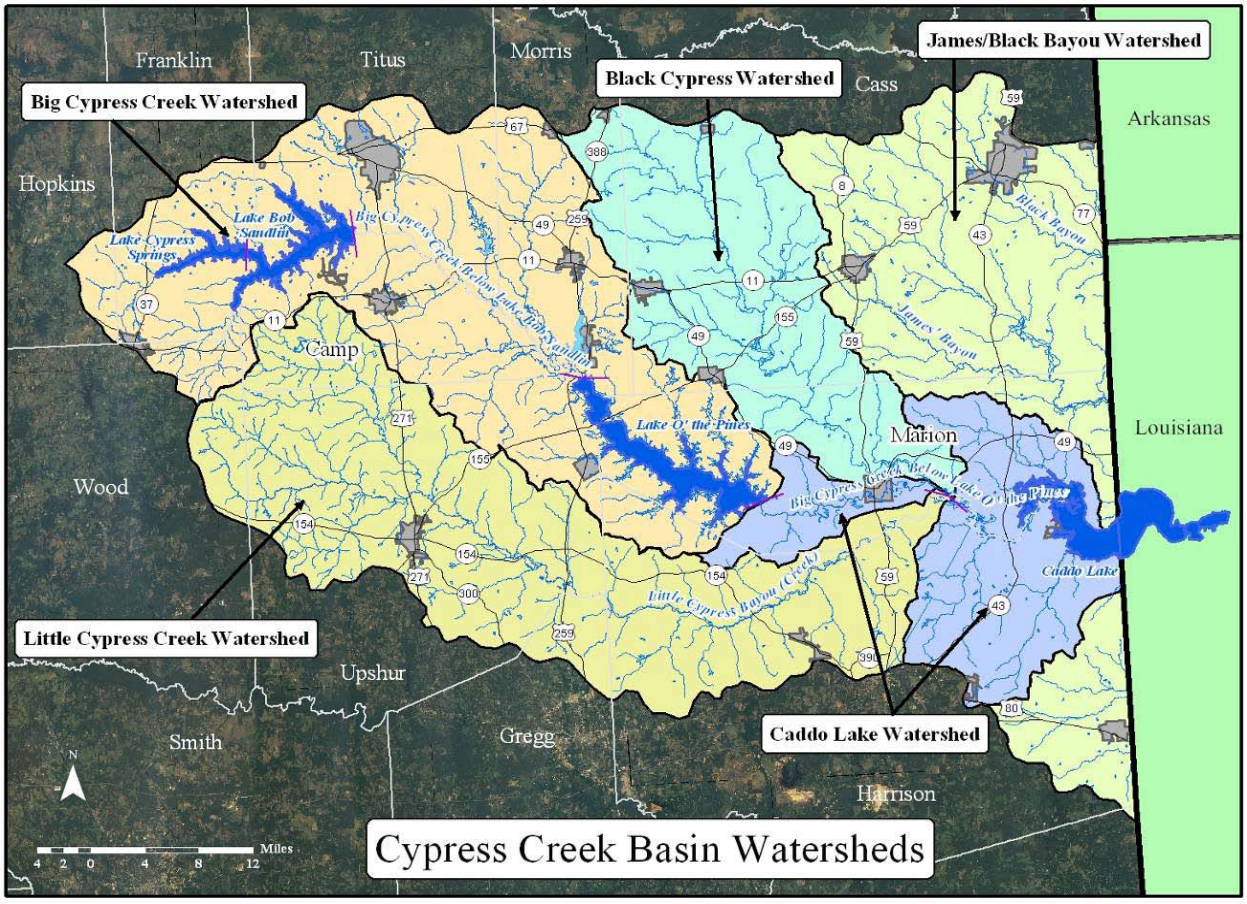


Figure I-1: *The Cypress Creek Basin is composed of five main watersheds*

entering Caddo Lake, some surface water first enters from smaller sub-watersheds through tributaries, or streams. The major tributaries that drain into Caddo Lake include Big Cypress Creek, Little Cypress Creek, James Bayou, Harrison Bayou, Kitchen Creek, and Black Cypress Bayou. The 6,000 square mile Cypress Creek Watershed extends upstream from Caddo Lake at the Texas-Louisiana state line, to the westernmost extreme of the Cypress Creek Basin in Hopkins County.

This watershed, which includes several reservoirs, is formed in the southern part of Hopkins and Franklin Counties and flows eastwardly into Camp, Titus, Morris, Marion, and Harrison Counties. Big Cypress Creek is the boundary between Camp and Titus, Camp and Morris, and Morris and Upshur counties. Big Cypress Creek, above Lake O' the Pines, is intermittent in its headwaters. The stream runs through flat to rolling terrain surfaced by sandy and clay loams that support water-tolerant hardwoods, conifers, and grasses. Big Cypress Bayou flows into Caddo Lake through a jungle-like bottomland where cypress trees are common.

There are nine designated segments with 41 sub-segments within the Cypress Creek Basin. The *2008 §303(d) List* currently identifies fourteen stream sub-segments that are non-supporting of water quality criteria for one or more parameters. **Table I-1** details the parameters of concern.

Common Parameters of Concern

In the segment narratives that follow, the types of pollutants that are routinely identified as concerns in the Cypress Creek Basin are low dissolved oxygen, low pH, bacteria, and mercury in edible tissue.

Nutrients (ammonia-nitrogen, nitrate-nitrogen, orthophosphorus and total phosphorus) are essential for life. However, elevated concentrations of nutrients can cause excessive growth in aquatic plants and may lead to algae blooms. Excessive algal growth may cause low dissolved oxygen concentrations, can lead to fish kills, and decreased species diversity within a water body. The main sources of nutrient pollution within the basin are improperly treated effluent, malfunctioning septic systems, and agricultural non-point sources. Some nutrient loading may also be naturally occurring through biotic decomposition.

Many East Texas waters have a naturally low pH and limited buffering capacity (alkalinity). The pH can also be reduced by acidic industrial run-off or discharges and acid rain. The long-term effect of low pH on the ecology and biota of the watershed is currently undetermined.

Low pH increases methyl-mercury, making mercury available for uptake into aquatic organisms throughout the food chain. Bioaccumulation of mercury in the edible tissue of many fish species to the point of becoming a human health concern has prompted the Department of State Health Services (DSHS) to issue fish consumption advisories around the basin.

E. coli bacteria are indicators of recent input of fecal matter that may contain pathogens harmful to human health. People should not swim in waters with high bacterial counts since they may come in contact with or ingest these pathogens. All warm blooded animals contain *E. coli* in their fecal matter.

Common sources of fecal bacteria include improperly treated effluent, malfunctioning septic systems, livestock and wildlife.

Table I-1: *Parameters as listed in the 2008 §303(d) List for the Cypress Creek Basin*

Segment	Description	Parameter
0401	Caddo Lake	Low DO, Low pH, Mercury in Tissue
0401A	Harrison Bayou	Low DO
0402	Big Cypress Bayou below Lake O' the Pines	Low pH Mercury in Tissue
0402A	Black Cypress Bayou	Low DO, Bacteria, Mercury in Tissue
0404	Big Cypress Creek below Lake Bob Sandlin	Bacteria
0404A	Ellison Creek Reservoir	PCBs in Tissue, Sediment Toxicity
0404B	Tankersley Creek	Bacteria
0404C	Hart Creek	Bacteria
0404N	Lake Daingerfield	Mercury in Tissue
0405	Lake Cypress Springs	Low DO
0406	Black Bayou	Low DO, Low pH, Bacteria
0407	James' Bayou	Low DO, Low pH, Bacteria
0409	Little Cypress Bayou (Creek)	Low DO, Bacteria
0409B	South Lilly Creek	Bacteria

Rainfall and Releases

The uppermost reservoirs in the watershed are Lake Cypress Springs and Lake Monticello. Water from both reservoirs is released directly into Lake Bob Sandlin. Lake Bob Sandlin plays a key role in the hydrology of Segment 0404 (Big Cypress Creek). The Titus County Freshwater Supply District Number 1 has recorded daily rainfall and releases from Lake Bob Sandlin since 1979 (Figure I-3).

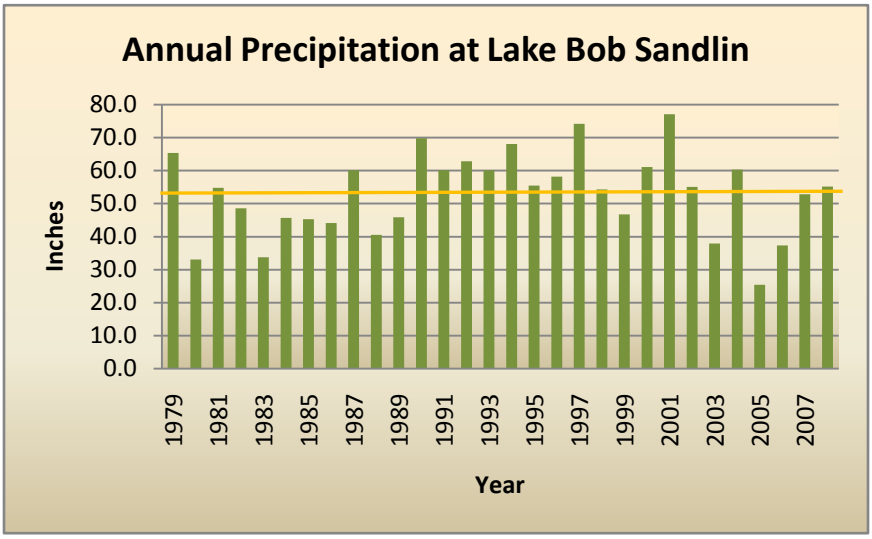


Figure I-2: *Annual precipitation at Lake Bob Sandlin 1979 - 2008*

Due to annual variability and in order to make general assumptions about the influence of fresh water inflow on the water quality over periods of time, the average annual rainfall and releases by decade were calculated and compared. The 1990's was the wettest decade on record with an average of 60.97 inches of rain per year. Average rainfall from 2000 through 2008 was at 50.90 inches; and the 1980's were the driest with an average of 45.19 inches per year.

Figure I-3: *Bald eagle perched with a fish at Lake Bob Sandlin*

Lake Bob Sandlin reached conservation level in 1980 and began releasing water in 1983. From 1983 through 1989, the average annual volume released was 74,510 acre-feet. In the 1990's, the average annual release increased to 129,272 acre-feet; and over the past nine years, from 2000 to 2008, the annual releases were the lowest on record with an average of 70,699 acre-feet entering Big Cypress Creek.

Releases from Lake Bob Sandlin occur primarily to maintain freeboard at the dam. There are no in-stream flow requirements meaning that there are no releases required to supplement flow during periods of drought or low flow. During these times, Segment 0404 becomes dominated by treated municipal and industrial effluent. An area of interest in this report is the relationship between annual rainfall, releases from Lake Bob Sandlin, and their effects on the water quality since wastewater effluent tends to have higher conductivity, TDS and nutrients than ambient conditions. These parameters show significant trends along with water quality concerns and impairments throughout the much of the basin.

The 2009 Cypress Creek Basin Summary Report is divided into three main chapters:

- Trends
- Assessment
- Biological

In the Trends chapter, statistically significant trends are identified using historical data from routine monitoring stations that had a minimum of ten years of sample history with at least twenty to thirty data points. In the Assessment section, the historical data are compared against concerns and impairments listed in the *2008 Texas Water Quality Inventory* and *2008 §303(d) List*. Toxins in fish tissue and the results of biological assessments are discussed in the Biological chapter of the report.

Temperature data from reservoir profiles entered by the TCEQ regional offices does not properly export from Surface Water Quality Monitoring Information System (SWQMIS), so the mixed surface layer for these stations could not be determined. Therefore, only the surface sample data, typically collected at 0.3 meters, were evaluated and used for trend analyses and for the segment review.

Trends

Discussion for the trends portion of this report begins with the uppermost segments of the watershed and follows the path of the flow of the water to the next downstream segment. Basin-wide trends are discussed at the end of this section. All data used for trend analyses were obtained from SWQMIS.

Analyses of Trends

Trend analyses for this report were conducted by following the TCEQ CRP guidance document. Trend analyses were then extended on stations with significant historical data; and where appropriate, the trends were compared among stations within a segment and between segments.

A comprehensive review of all of the historical records for the basin was performed. Water quality sampling began forty years ago on some segments. All surface water quality data was reviewed and evaluated for the entire Cypress Creek Basin.

Table T- 1: *Data Points and Date Range for the Cypress Creek Basin*

Cypress Basin Data Review				
Segment Name	**Segment Number**	**Data Points**	**Date Range**	
Caddo Lake	0401	20,548	September 4, 1968	May 16, 2008
Big Cypress Creek below Lake O' the Pines	0402	27,364	September 4, 1968	May 17, 2008
Lake O' the Pines	0403	23,129	January 25, 1972	February 13, 2008
Big Cypress Creek below Lake Bob Sandlin	0404	30,754	September 10, 1968	May 17, 2008
Lake Cypress Springs	0405	12,400	January 26, 1972	May 5, 2008
Black Bayou	0406	7,434	September 12, 1968	May 1, 2008
James' Bayou	0407	10,434	September 12, 1968	May 2, 2008
Lake Bob Sandlin*	0408	9,380	October 29, 1981	May 12, 2008
Little Cypress Creek	0409	19,370	September 26, 1973	May 22, 2008
Total		**160,835**		

**Segment 0408: Construction on Lake Bob Sandlin began in 1974 and filled in 1980.*

Trend analyses were conducted at stations with at least ten years of historical data, had regular sampling, and twenty to thirty data points. Relatively few stations in the Cypress Creek Basin had enough historical data for long-term trend analyses. Also note that in some cases, trend analyses was not conducted on the entire historical record so that data from two or more stations with in a segment could be compared across a similar date range.

Trends were calculated using a linear regression with a ninety percent confidence interval. A trend was identified as statistically significant when meeting two criteria: the T-stat value was greater than the absolute value of two, and the p-value was less than 0.1. When determined applicable, contributing factors such as flow, flow severity, recent significant rain events, and other parameters were reviewed for anomalies or to determine the possibility of targeted sampling and its impact on the trend. In these cases, trends that did not pass these evaluations were not included in this section.

Non-Detectable Results and Data Discrepancies

Data are reported as non-detectable when a sample result is below the detection limit of the laboratory instrumentation or method used in the analysis of the parameter. For the purposes of trend analyses, all non-detectable values were reduced to one half of the lowest detected value. This approach to non-detectable results assumes that the actual value lies somewhere between zero and the method detection limit. In all cases where the results were reported at or above the detection limit, the values were left unchanged.

It should also be noted that when comparing laboratory results with varying detection limits, the reliability of the data can be impacted, especially in situations where the method detection limit is at or near the screening level or criterion for the parameter of concern. Subtle variations in laboratory methodologies are another possible source of error. Unless the datum was remarked or guidance was provided by TCEQ, all data used for trend analyses were assumed to be valid and accurate.

Basin Trends Overview

No Concern Concerning Trend Not supporting

Segment Name	Segment Number	Station ID	Parameters					
			Sp Cond/ TDS	DO	pH	Secchi	Chlorophyll *a*	Nutrients
Lake Cypress Springs	0405	10313	↑	↑	↑			
		10312	↑					
Lake Bob Sandlin	0408	16158	↑		↑	↑		
Big Cypress Creek Below Lake Bob Sandlin	0404	10308	↑		↑			↑
		13631	↑					↑
Lake O' the Pines	0403	10300				↓		
		10297	↑			↑		
		16156	↑				↑	
		10296	↑				↑	
Big Cypress Creek Below Lake O' the Pines	0402	15511			↑			
		16254	↑		↑			
		10295	↓					
Caddo Lake	0401	15249	↑	↓				
James' Bayou	0407	10321	↑		↑			
Black Bayou	0406	10314	↓	↓	↓		↑	

Table T- 2: *Overview of basin trends*

Trend analyses on the Cypress Creek Basin was completed for the following parameters: Specific Conductance/TDS, Dissolved Oxygen, pH, Secchi (Transparency), Chlorophyll a, and Nutrients (ammonia-nitrogen, nitrate-nitrogen, orthophosphorus and total phosphorus). Only stations with parameters that had statistically significant trends are discussed in this report. State criteria and screening levels can be found in Appendix A.

Table T-2 illustrates the overall results for the trend analyses of the Cypress Creek Basin. Lake Cypress Springs, in southern Franklin County, is the farthest upstream segment in the basin. Both stations on Lake Cypress Springs showed an increasing trend for specific conductance/TDS; station 10312 also had increasing trends for DO and pH.

Water is released from Lake Cypress Springs into Lake Bob Sandlin. Only station 16158 at the mid-lake location had enough data for trend analyses. Specific conductance/TDS, pH and Secchi depth are increasing significantly at this station.

Water released from Lake Bob Sandlin flows into Segment 0404 (Big Cypress Creek) and flows past station 10308 at SH 11 and station 13631 at US 259 before entering Lake O' the Pines. The data for both stations had increasing trends for specific conductance/TDS, total phosphorus and orthophosphorus. Station 10308, in the upper part of the segment, also had increasing trends for nitrate and pH. Segment 0404 is the only segment in the basin with increasing trends for nutrients.

Of note are decreasing trends for Lead and Zinc at station 14473 in Segment 0404A (Ellison Creek Reservoir). These trends are discussed in the segment review section of this report.

The farthest upstream site in Segment 0403 (Lake O' the Pines) is station 10300, about one km south of US 259. This station is located in a transitional zone and has a wide and braided channel. A transition zone is a reach where the habitat and stream morphology changes from stream to reservoir conditions. There is a decreasing trend for Secchi depth (Transparency) at this station which is typical of waters that are heavily vegetated and actively productive at the basic trophic levels of the ecosystem. However, the next downstream station 10297 on the upper end of Lake O' the Pines had an increasing trend for the same parameter meaning the water is becoming less turbid by the time it reaches the open water area of the reservoir. The mid-lake station (16156) and the station closest to the dam (10296) both had increasing trends for specific conductance/TDS and chlorophyll *a*. The dam and mid-lake sites of this segment are the only stations in the reservoir with increasing trends for chlorophyll *a*.

Segment 0402 is Big Cypress Creek (Bayou) below Lake O' the Pines and three stations had significant trends in this segment. Station 15511 at US 59 and 16254 at the City of Marshall public water supply intake showed increasing trends for pH. Station 16254 also had an increasing trend for specific conductance/TDS. The most downstream site (10295) at SH 43 was the only site in this basin where the specific conductance/TDS trend was significantly decreasing.

Black Cypress Bayou, a major tributary to Big Cypress Creek (Bayou) below Lake O' the Pines, discharges into Big Cypress Creek east of Jefferson. Water quality on Black Cypress Bayou has remained consistent throughout the period of record and no trends were observed for this segment.

Segment 0409 (Little Cypress Creek (Bayou) flows from Wood County west to Marion County before its confluence with Big Cypress Creek (Bayou). Over the past 35 years, the Little Cypress Creek (Bayou) watershed was regularly sampled at two locations: upstream at US 259 and downstream at US 59. No trends were identified for either station indicating stable water quality conditions throughout the period of record.

Big Cypress Creek flows into Segment 0401 (Caddo Lake), located on the Texas-Louisiana border. Station 15249, located near the "turtle shell" near Uncertain, was the only location with any significant trends in this segment. This station had increasing trends for specific conductance and pH, and a decreasing trend for DO.

Station 10314, located in Segment 0406 (Black Bayou) at Cass CR 4659, approximately 1.3 miles east of the Louisiana state border was the only station with significant trends in this segment. There were decreasing trends for specific conductance/TDS, DO, and pH, while chlorophyll *a* was significantly increasing.

The James' Bayou watershed is bordered on the east by the Louisiana and Arkansas State borders and on the west by Black Cypress watershed. Two stations in this segment had sufficient data for trend analyses. At station 10259 (Frazier Creek at US 59), there was an increasing trend for specific conductance/TDS and at station 10321 (James' Bayou at Cass CR 1775), there was an increasing trend for DO.

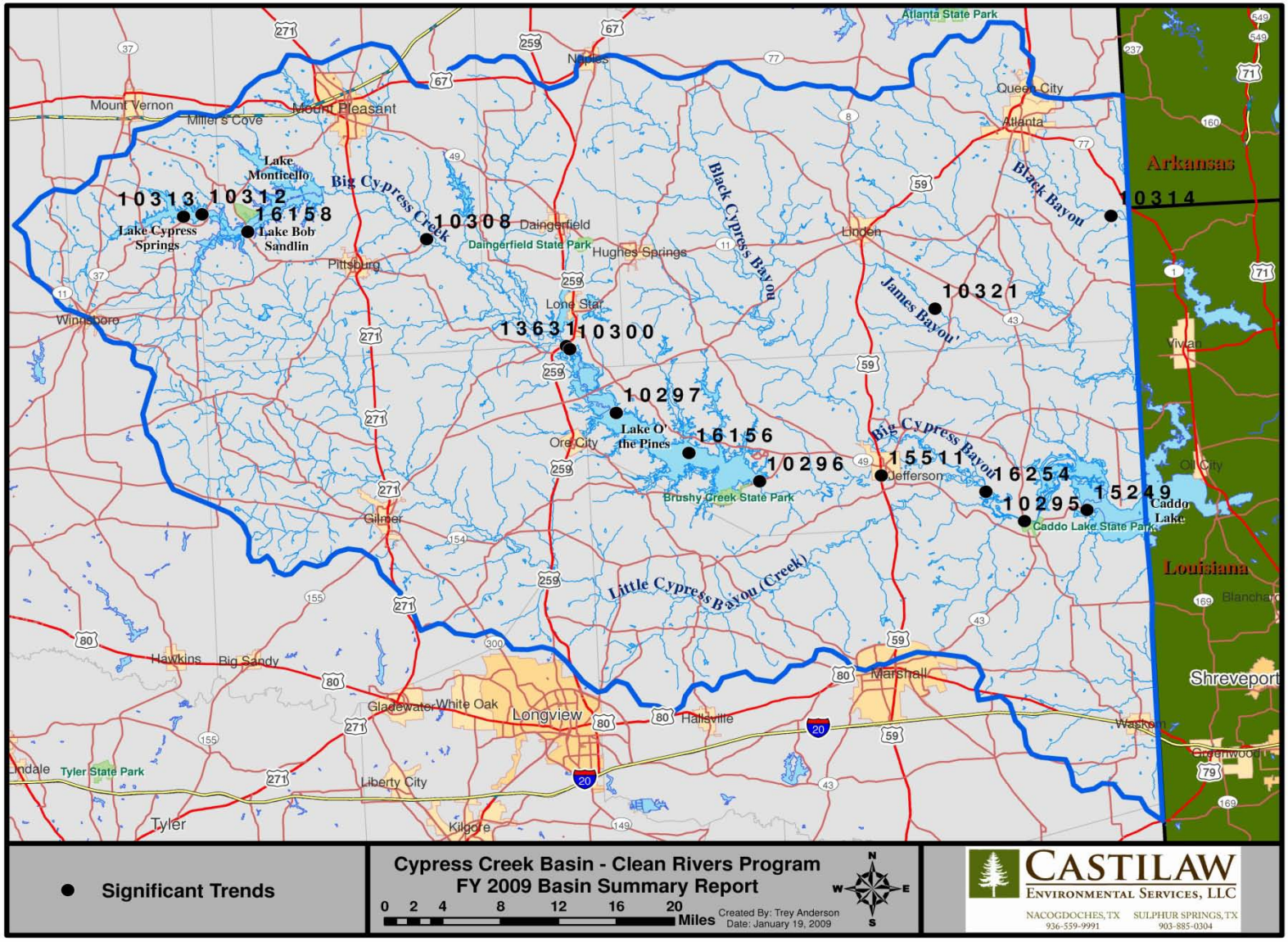


Figure T-1: *Locations of statistically significant trends in the Cypress Creek Basin*

Trend Observations

Many of these trends were based upon samples collected over the past ten years.

Specific Conductance/TDS is Increasing Significantly throughout the Cypress Creek Basin

Eighteen sites in the basin had significant trends. Out of those stations, twelve sites had a statistically significant increasing trend for specific conductance and Total Dissolved Solids (TDS). Trends for specific conductance and TDS were combined since they are directly related. As the amount of dissolved solids increases (TDS), specific conductance will also increase.

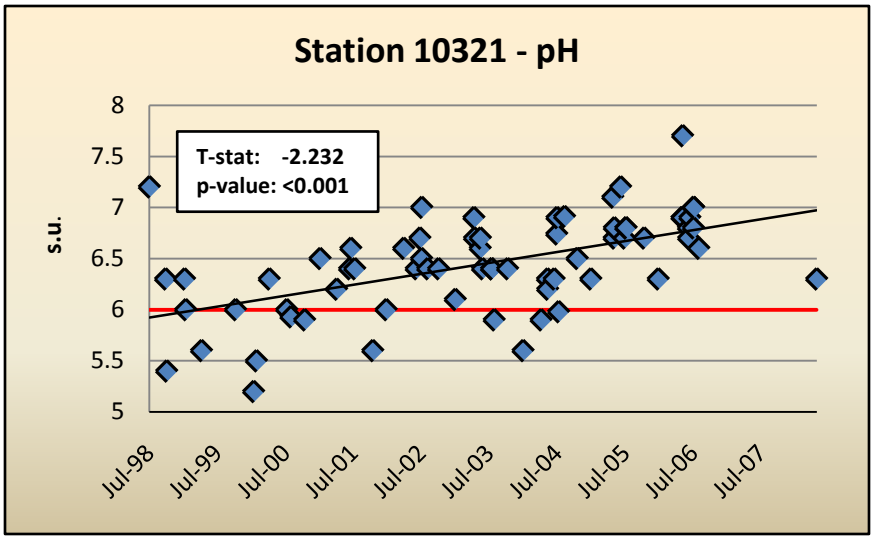


***Figure T-2**: pH sample results for station 10321*

As discussed in the introduction, the average annual releases from Lake Bob Sandlin and average annual rainfall during the present decade have been much lower than in the 1990's. Due to low rainfall combined with limited releases, Segment 0404 has become more effluent dominated than in previous decades.

Specific conductance is often increased by wastewater discharges. Reduced instream flows and high evaporation rates during periods of drought also contribute to the increase in dissolved solids (as demonstrated in Lake Cypress Springs, Lake Bob Sandlin and Lake O' the Pines). An increase in specific conductance is a significant concern because Big Cypress Creek and its impoundments serve as municipal and industrial water supplies. High TDS can increase water treatment costs as well as interfere with industrial processes.

pH is Significantly Increasing Throughout Most of the Cypress Creek Basin

Much of the Cypress Creek Basin tends to have low pH due to the acidic composition of the soils in the watershed. There are significant increasing trends for pH in Segments 0402, 0404, 0405, 0407, and 0408. The increase in pH in the lower portion of the basin is especially significant since these segments are on the *2008 Texas §303(d) List* for not supporting the pH criterion. While there is a concern for low pH in much of Caddo Lake, most stations have met the criterion over the past few years.

The increasing pH trend throughout much of the basin is concerning because it may serve as an indicator of eutrophication. Nutrient enrichment leads to increased primary productivity. During

photosynthesis, carbonic acid in the water column is reduced, thereby increasing pH. Since most pH grab samples tend to be collected during the mid-morning to mid-afternoon hours, the peak hours for photosynthesis, pH readings will tend to be at their highest resulting in an increasing pH trend at the station. Additional sampling, including diel monitoring, should be performed to determine if these trends are caused by eutrophication or by natural cycles.

Concerning Trends in Black Bayou (Segment 0406)

Black Bayou is currently on the *2008 Texas §303(d) List* for not supporting stream criteria for having low DO and low pH. This segment has significantly decreasing trends for both of these parameters in addition to an increasing trend for chlorophyll *a*. Station 10314 (Black Bayou at the Cass CR 4659) was the only station in the segment with enough data to perform trend analyses and is the farthest downstream station in the watershed. Decreased DO concentrations combined with increasing trends for chlorophyll *a* are indications of possible nutrient enrichment and the impaired water quality may be adversely affecting the biota.

A Use Attainability Analysis was conducted on this segment in 2003 and 2004 (Rogers and Harrison, 2007). The results of the study showed that only three darter species were collected at the upstream station (16157) while no darters were captured at the downstream station (10314) during either sampling event. The absence of darters is concerning since darters had been collected at this station in the 1990's, an average of seven darter species have been collected in the other segments, and at least one darter species has been found at all stations monitored since 2002. Additionally, this segment had the lowest average IBI and RBA scores in the Cypress Creek Basin. This topic is discussed in further detail in the Biological section of the report.

Dissolved Oxygen is Significantly Decreasing in the upper portion of Caddo Lake

Oxygen enters a water body via the atmosphere and through photosynthesis; oxygen is consumed through respiration in all aerobic organisms living in the water column. DO grab sample values were significantly decreasing in the upper portion of Caddo Lake at the mid-lake station near Uncertain.

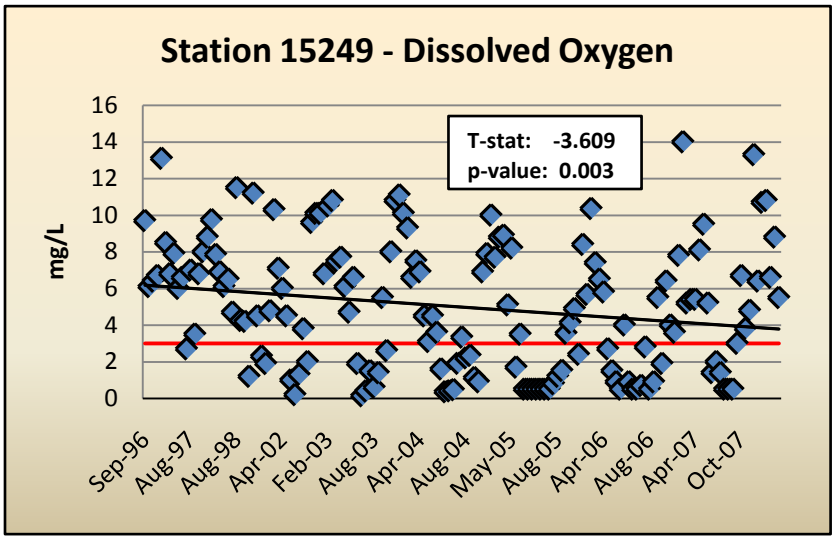


***Figure T-3**: DO grab sample results for station 15249*

Station 15249 was the only station in Caddo Lake with any significant trends. The site is located at the Turtle Shell where Boat Lanes 1K and 1L intersect. Depending on the season, aquatic vegetation tends to cover between 35% and 95% of the water surface and the station has an average depth of 0.8 meters. This decreasing

DO trend is concerning due to the issues with low DO across much of the lake. DO appears to be cycling and is lowest during the summer with grab samples near 0 mg/L.

Increasing Nutrients in Big Cypress Creek lead to Increasing Chlorophyll *a* in Lake O' the Pines

High concentrations of nutrients can lead to excessive algal growth which can cause taste and odor problems in drinking water and may lead to fish kills.

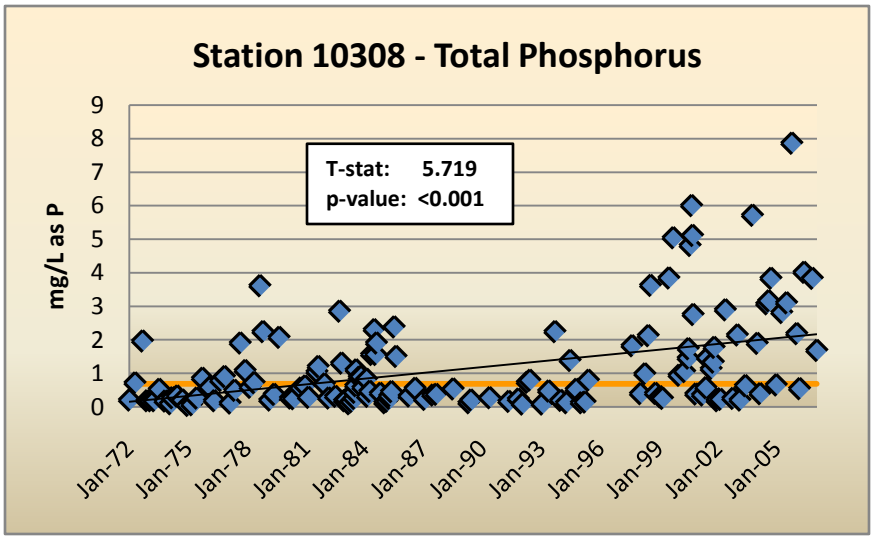


Figure T-4: *Total phosphorus results for station 10308*

Segment 0404 historical data showed increasing trends for nitrate-nitrogen, total phosphorus and ortho-phosphorus at station 10308 (Big Cypress Creek at Hwy 11) and an increasing trend for orthophosphorus at station 13631 (Big Cypress Creek at US 259). The nutrient enriched water flows into Lake O' the Pines and results in increased algal growth. Chlorophyll *a* is significantly increasing at both the mid-lake and the dam stations in Lake O' the Pines as a result of the high nutrient loads being transported in Segment 0404.

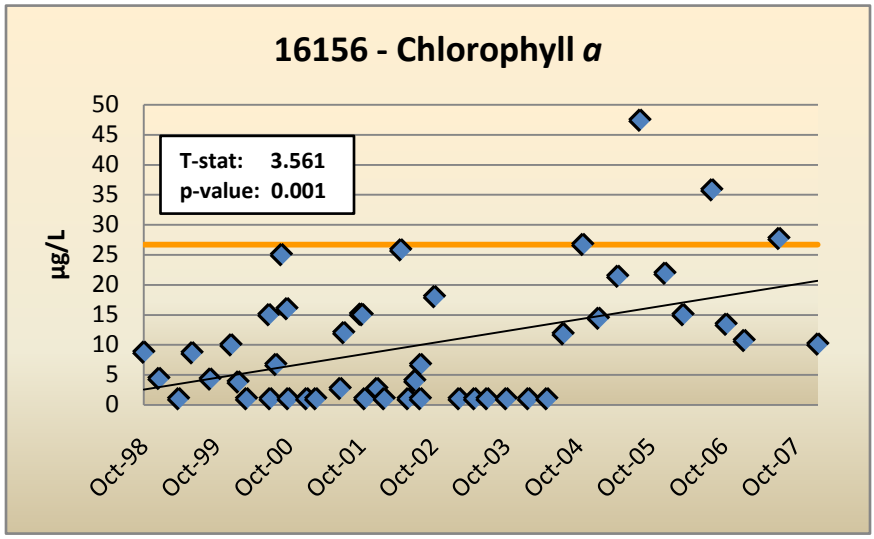


Figure T-5: *Chlorophyll a results for station 16156*

Increases in chlorophyll *a* in the lower portion of the reservoir are concerning since an increase in chlorophyll *a* often results in wider daily ranges of DO and pH. At present, DO has not been significantly effected at these stations. However, these trends provide evidence that confirms the findings of the TMDL study that phosphorus loading into Lake O' the Pines is providing the precursors for increased phytoplankton productivity in the lake which may result in lower night-time dissolved oxygen concentrations in the future.

Segment Review

The Segment Review section of this report details water quality impairments and concerns as shown in the *2008 Texas §303(d) List* and *2008 Texas Water Quality Inventory*. Available historical data results are compared by parameter to the concerns and impairments listed in the 2008 TCEQ assessments. Comments and recommendations are included for each parameter.

Discussion for the Segment Review begins by covering each segment in numerical order. Our approach to the segments shown in the *2008 Texas §303(d) List* is to examine each segment by individual station in order to gain an understanding of the water quality within its Assessment Unit (AU). Each segment is discussed by its sub-segment(s) and Assessment Unit(s) in alphabetical and numerical order. Finally, available data for each station within an AU are addressed. Assessment Units are discussed in numerical order, and in the case of streams, the lowest numbered AU includes the most downstream reach while the highest numbered AU includes the uppermost portion. In reservoir segments, the lowest numbered AU includes the area near the dam while the highest numbered AU includes the headwaters of the lake or reservoir.

Ammonia-nitrogen is listed as a concern for screening level in Segments 0401, 0405 and 0407. Ammonia-nitrogen is a parameter of interest since it is a nutrient that serves as a food source for aquatic plants and algae and high concentrations of ammonia can cause fish kills. In January 2008, TCEQ issued a Corrective Action Memo for the analysis of ammonia-nitrogen samples. TCEQ determined that although laboratories follow the same method for ammonia-nitrogen analysis, slight variations in procedures resulted in samples with low concentrations of ammonia-nitrogen to be reported as detectable by some laboratories while they were reported as non-detectable by others. It should be noted that this issue is a possible source of error for ammonia-nitrogen results and were considered when making comments about the historical data.

Metals in water and sediment are addressed in this section; however, mercury and PCBs in fish tissue are discussed in the Biological section of the report.

Figure A-1: *View facing west at Caddo Lake, mid-lake station (15249)*

Table A-1: *Parameters as listed on the 2008 Texas §303(d) List for the Cypress Creek Basin*

Segment	Description	Parameter
0401	Caddo Lake	Low DO, Low pH, Mercury in Tissue
0401A	Harrison Bayou	Low DO
0402	Big Cypress Bayou below Lake O' the Pines	Low pH Mercury in Tissue
0402A	Black Cypress Bayou	Low DO, Bacteria, Mercury in Tissue
0404	Big Cypress Creek below Lake Bob Sandlin	Bacteria
0404A	Ellison Creek Reservoir	PCBs in Tissue, Sediment Toxicity
0404B	Tankersley Creek	Bacteria
0404C	Hart Creek	Bacteria
0404N	Lake Daingerfield	Mercury in Tissue
0405	Lake Cypress Springs	Low DO
0406	Black Bayou	Low DO, Low pH, Bacteria
0407	James' Bayou	Low DO, Low pH, Bacteria
0409	Little Cypress Bayou (Creek)	Low DO, Bacteria
0409B	South Lilly Creek	Bacteria

Segment 0400 - Paw Paw and Cross Bayous

Paw Paw and Cross Bayous are located in an area south of Caddo Lake and flow directly into Louisiana. There are no listings or concerns, no CRP monitoring stations, and no USGS gage stations on this segment.

Segment 0401 - Caddo Lake

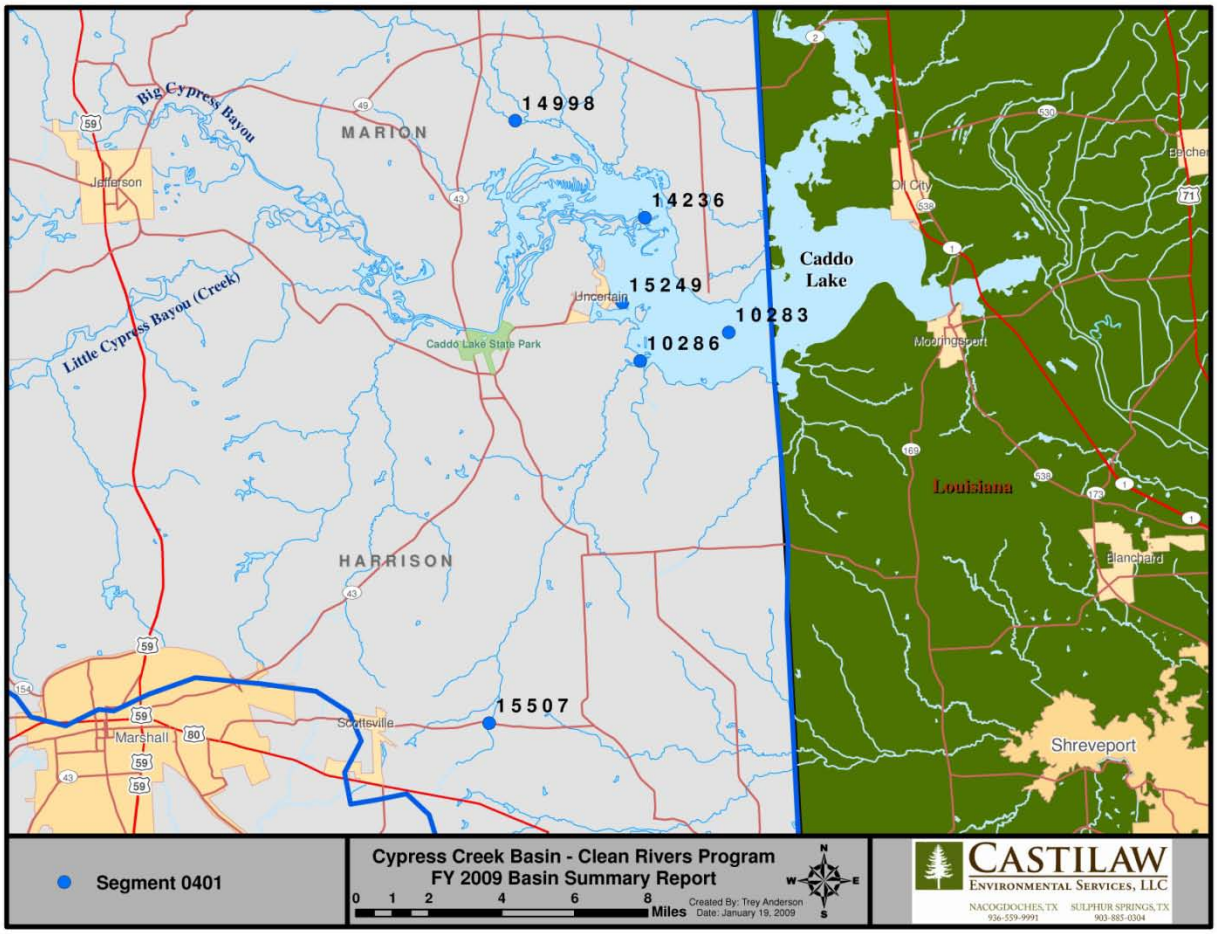


Figure 0401-1: *Stations located in Segment 0401 (Caddo Lake)*

The Caddo Lake Watershed covers approximately 330 square miles and includes Caddo Lake and the segment of Big Cypress Creek below Lake O' the Pines Ferrell's Bridge Dam (the downstream boundary of Segment 0402). Caddo Lake is listed in the *2008 §303(d) List* for low pH, low dissolved oxygen and mercury in fish tissue. In the *2008 Texas Water Quality Inventory*, Segment 0401 has been identified as not supporting water quality criteria for having low pH and depressed 24-Hour DO Average concentrations.

The "turtle shell" station 15249 near Uncertain and the areas of Harrison Bayou and Clinton Lake are listed for having low dissolved oxygen; the Goose Prairie arm is listed for having low pH. In addition, there are concerns about high concentrations of manganese in sediments and ammonia-nitrogen in water in the lower 5,000 acres and in Clinton Lake. Mercury in fish tissue is a concern throughout the lake. The Texas Department of State Health Services (DSHS) has issued a fish consumption advisory on Caddo Lake for mercury in fish tissue. This topic is discussed in the Biological section of the report.

Table 0401-1: *Non-supporting parameters and parameters of concern for Segment 0401*

0401 AUID	Description	DO, 24 HR Avg.	DO, 24 HR Min	DO, Grab Min	Low pH	NH3	Toxics in Sediment	Toxics in Fish
01	Lower 5000 Acres					CS	CS	CS
02	Harrison Bayou Arm	NS	NS		NS			CS
03	Goose Prairie Arm			CS	NS			CS
05	Clinton Lake	NS	NS		NS	CS		CS
07	Mid-lake near Uncertain						CS	CS
08	Remainder of Segment							CS
0401A	Harrison Bayou	NS	NS					
0401B	Kitchen Creek			CN				

AUID = Assessment Unit ID
CS = Concern for Screening Level
NS = Non-supporting
CN = Concern for Near Non-attainment

The Caddo Lake Watershed Protection Plan, initiated in 2006, is a program designed to protect the water quality and aquatic life of Caddo Lake. With assistance from federal, state and local organizations, this effort is being lead by basin stakeholders, with the Northeast Texas Municipal Water District selected as watershed coordinator. The current issues identified include management of aquatic vegetation, pollution affecting water quality, threats to habitats and floodplain management.

Coordinated monitoring for FY 2009 includes quarterly and monthly sampling scheduled at the stations shown in **Table 0401-2**.

Table 0401-2: *FY 2009 coordinated monitoring for Segment 0401*

Sampling Location	Station ID	Lab Analyses	24 HR DO	Field Parameters
CADDO LAKE MID LAKE	10283	4		12
CADDO LAKE 0.25 MI. NE OF THE MOUTH OF HARRISON BAYOU	10286		4	12
CADDO LAKE AT DEVILS ELBOW IN UPPER LAKE NEAR CLINTON LAKE	14236		4	12
CADDO LAKE AT JUNCTION OF BOAT LANES 1K AND 1L IN TURTLE SHELL	15249	4		12

Assessment Unit 0401_01

The lower 5,000 acres of this segment were the farthest downstream AU assessed. Station 10283 is located near the middle of the lake and was the only station in this AU of Caddo Lake. This is the only routinely monitored station that is representative of a lake conditions. The area is primarily open-water

with little aquatic plant and tree canopy coverage. The average depth was 2.1 meters, the median pH was 6.9 s.u., and the average of all ten 24-Hour DO Average was 7.3 mg/L. The *2008 Texas Water Inventory* lists AU 0401_01 with a concern for screening level for ammonia in water and manganese in sediment.

Ammonia

Out of all 109 ammonia-nitrogen samples collected in this AU, nearly half were non-detectable and sixteen percent were above the screening level. However, over half (sixty percent) of the samples collected from July 1998 to April 2003 were above the screening level. Only three other samples collected from 1973 to 1998 and from 2003 to 2008 were above the screening level. Conventional samples (including ammonia-nitrogen) are being collected at station 10283 during FY 2009.

Manganese in Sediment

Ten sediment samples were collected at station 10283 and analyzed for manganese over the past decade. Four of the ten samples exceeded criterion of 1,100 mg/kg (as Mn dry weight) and had an average concentration of 1,562 mg/kg. These data support the concern; however, since the TCEQ began using the "clean metals" techniques in 2001, no sample has exceeded the screening level for this parameter.

Assessment Unit 0401_02

AU 0401_02 is the Harrison Bayou Arm of Caddo Lake in far northwest Harrison County. Station 10286 was the only site in the AU with data for the assessment. The site is located on Caddo Lake near Harrison Bayou, south of Goose Island, and northeast of County Road Nine. This station is primarily a wetland with an average depth of 0.8 meters and field notes showed that aquatic plant coverage ranges from fifty percent to 95%, depending upon the season. AU 0401_02 is listed for having low pH, and for not meeting the 24-Hour DO Average and Minimum criteria.

Dissolved Oxygen

Eighteen diel measurements were performed at station 10286 from 1996 to 2008. Fifteen of the eighteen (83%) samples were below criterion for 24-Hour DO Average and 78% were below criterion for 24-Hour DO Minimum. Most of the low DO values were during the summer months. These data support the listing of this AU for low 24-Hour DO Average and Minimum. Starting in FY 2009, diel measurements will be performed at this station throughout the year without a seasonal bias.

pH

There were 114 pH samples collected at this station from 1982 to 2008, with regular sampling beginning in 2002. Ten percent of the samples at this station were below pH criterion; however, no sample has been below criterion since 2004. The median value for pH at this site was 6.4 s.u. Historically; pH values are increasing at this station, although not at a statistically significant rate. Monthly field sampling at this station is being conducted by the Caddo Lake Institute.

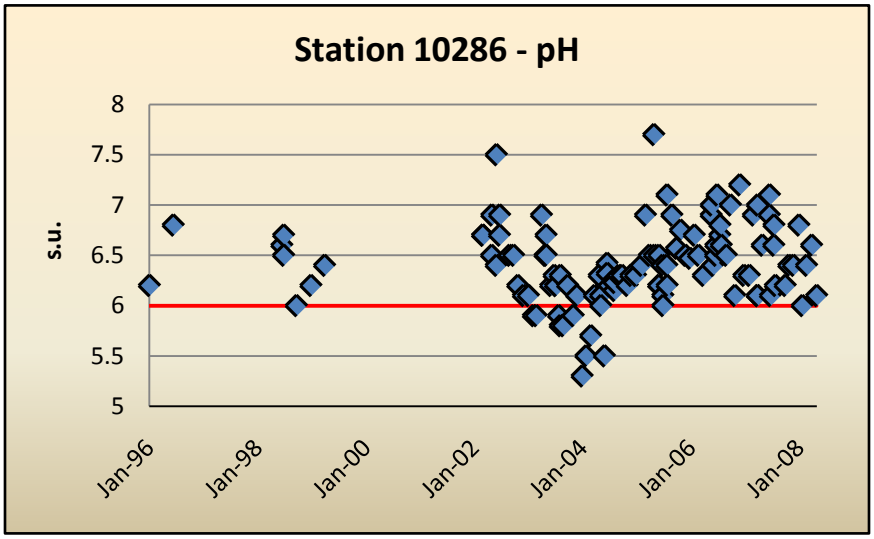


Figure 0401-2: *Results for pH sampling on Caddo Lake near Harrison Bayou*

Assessment Unit 0401_03

The Goose Prairie Arm of Caddo Lake branches from the west bank of the lake. Station 15275 was the only site with data available in this AU and was sampled eight times between June 1997 and April 1999. This AU is listed as a concern for screening level of DO grab samples and for not supporting the pH criterion.

Dissolved Oxygen

The average DO was 3.6 mg/L, but half of the samples did not meet DO grab sample criterion. Due to the limited dataset, this AU is listed as a concern for screening level rather than as non-supporting. Additional monitoring should be conducted at this station to provide adequate data for the assessment.

pH

This AU is listed for not supporting the pH criterion although only seven data points were available for this station. Two of the low pH values were 5.8 and 5.9 s.u. The median value for pH at this site was low at 6.0 s.u. The assessment of this AU is based upon a limited amount of data collected almost a decade ago. Additional monitoring should be conducted at this station to provide adequate and current information for the assessment.

Assessment Unit 0401_05

Clinton Lake is the border between Marion and Harrison Counties, northeast of Uncertain. The only site in AU 0401_05 was station 14236, located at Devils Elbow near Clinton Lake. This AU is listed for not supporting the 24-Hour DO Average and Minimum, for having low pH, and has a concern for not meeting the ammonia screening level. This area of Caddo Lake functions as a wetland with an average depth of 1.2 meters and much of the water surface is covered by floating and emergent vegetation.

Dissolved Oxygen

There were eighteen diel measurements conducted between April 2000 and July 2007. Fifteen of the eighteen events (83%) were below the criterion for 24-Hour DO Average while fourteen samples failed to meet the 24-Hour DO Minimum. These data support the assessment. Four diels are scheduled to be conducted at this station in FY 2009.

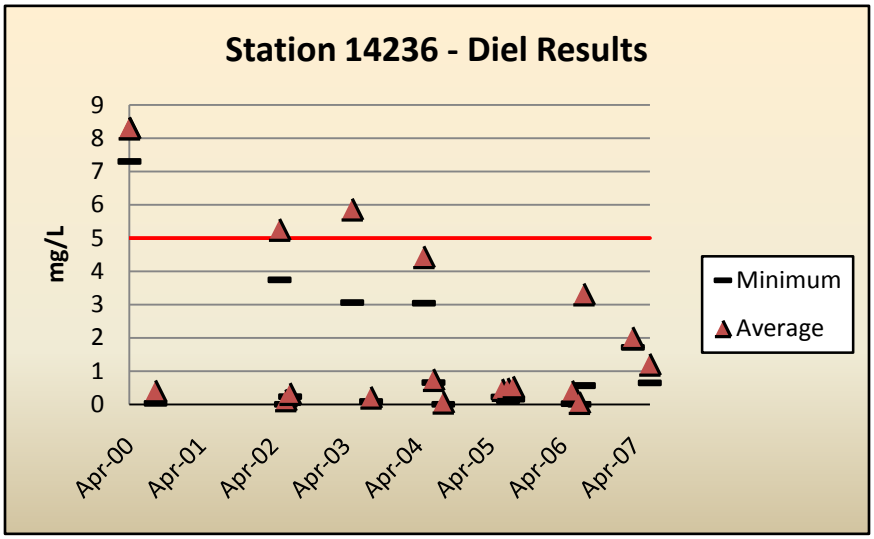


Figure 0401-3: *Diel results in Clinton Lake near Devil's Elbow*

pH

There were 109 pH measurements made at station 14236 from October 1994 to May 2008. Eleven measurements (ten percent) did not meet the pH criterion. The median pH at this site was 6.3 s.u. The overall values for this parameter are increasing, although not at a statistically significant rate, and no measurements have been below the state criterion since April 2006. Monthly sampling at this station is being conducted by the Caddo Lake Institute.

Ammonia

The AU is listed as a concern exceeding the screening level for ammonia. Station 14236 had nine ammonia-nitrogen samples on record from 1994 to 1999. The results showed that three samples exceeded screening level while three samples were reported as non-detectable. Due to concerns about variations in laboratory methodologies for this parameter at low levels, additional monitoring should be conducted in order to provide adequate data for the assessment.

Assessment Unit 0401_07

AU 0401_07 is described as the mid-lake portion of Caddo Lake, downstream of Uncertain. The AU lists a concern for meeting screening level for manganese in sediment. Station 15249 was the farthest upstream site in Caddo Lake and is located near the shore, at the end of FM 2198 and southeast of Uncertain. Station 17867 was located downstream, approximately 0.25 miles east of Pine Island off of Boat Road 1G. This area of Caddo Lake is primarily wetland with an average depth of 0.85 meters and has thirty percent to 95% aquatic plant coverage, depending upon the season.

Manganese in Sediment

Seven manganese samples were collected from these sites between July 2001 and August 2007. Three of the samples exceeded the screening level of 1,100 mg/kg (as Mn dry weight) while the average was 984 mg/kg. These data support the concern for this parameter; however, additional monitoring should be conducted in order to provide enough data points for a complete assessment.

Dissolved Oxygen

AU 0401_07 is not listed as a concern for not supporting the DO criterion; however, eleven out of seventeen diel measurements conducted at station 15249 failed to meet the 24-Hour DO Average and Minimum criteria. Additionally, DO grab sample values for this station are significantly decreasing. The AU should also be listed for not supporting DO criteria.

Monthly sampling at this station is being performed by the Caddo Lake Institute.

Figure 0401-4: *Caddo Lake*

TCEQ is presently considering dividing Caddo Lake into two segments, with one segment being named "Caddo Lake" and the other being named "Caddo Swamp". Dissolved oxygen criteria for freshwater wetlands can be as low as 2.0 mg/L for the 24-Hour DO Average and 1.5 mg/L for the 24-Hour DO Minimum. Using the existing diel data, most assessment units in Caddo Lake will not meet these criteria. The following will not meet the 24-Hour DO Average criterion if it is reduced to 2.0 mg/L:

- 67% AU 0401_02 Harrison Bayou Arm
- 67% AU 0401_05 Clinton Lake
- 41% AU 0401_07 Mid-lake near Uncertain

The 24-Hour DO Minumum data showed similar percentages of non-support.

Segment 0401A - Harrison Bayou

Segment 0401A (Harrison Bayou) is an unclassified waterbody and is a tributary of Caddo Lake. The sub-segment extends parallel to SH 43 and to the Louisiana border. The middle three miles and lower five miles of the segment are on the *§303(d) List* for not supporting the 24-Hour DO Average and Minimum criteria. There were three stations in Harrison Bayou that were assessed for DO:

- Station 15507 (Harrison Bayou at FM 1998, ten miles east of Marshall)
- Station 15508 (Harrison Bayou at FM 134, four miles south of Karnack)
- Station 15509 (Harrison Bayou at CR 2607, east of the Longhorn Army Ammunition Plant)

Dissolved Oxygen

There were 32 diel measurements made in this segment and all of the measurements from station 15507, the farthest upstream site, were above the criteria for both the 24-Hour DO Average and Minimum. Nine out of thirteen diels conducted in the middle portion of the reach, at station 15508, were above the criteria. Only one of the nine diels from station 15509, the most downstream site, met the 24-Hour DO criteria. Overall, 38% and 34% of the diel measurements failed to meet the criteria for 24-Hour DO Average and Minimum, respectively.

These data demonstrate that this segment does not support the 24-Hour DO Average and Minimum criteria. Further study of this segment should be conducted in order to identify a source of the impairment or to determine if the impairment is due to natural conditions.

Segment 0401B - Kitchen Creek

Kitchen Creek, an unclassified waterbody, is a tributary of Caddo Lake. The stream crosses Highway 49 near Smithland and drains into Clinton Lake east of Goat Island. This segment is listed as a concern for near non-attainment for DO grab sample.

Dissolved Oxygen

Station 14998 (Kitchen Creek at CR 3416) was the only station with data available for the segment. The average DO grab sample was 5.3 mg/L and two out of fourteen samples failed to meet the DO grab sample criterion. Nine diel measurements were conducted at this station from 2004 to 2007. Two of the diels met the 24-Hour DO Average criterion while seven met the 24-Hour DO Minimum criterion. The available data supports the low DO concerns for this sub-segment.

Segment 0402 - Big Cypress Creek below Lake O' the Pines

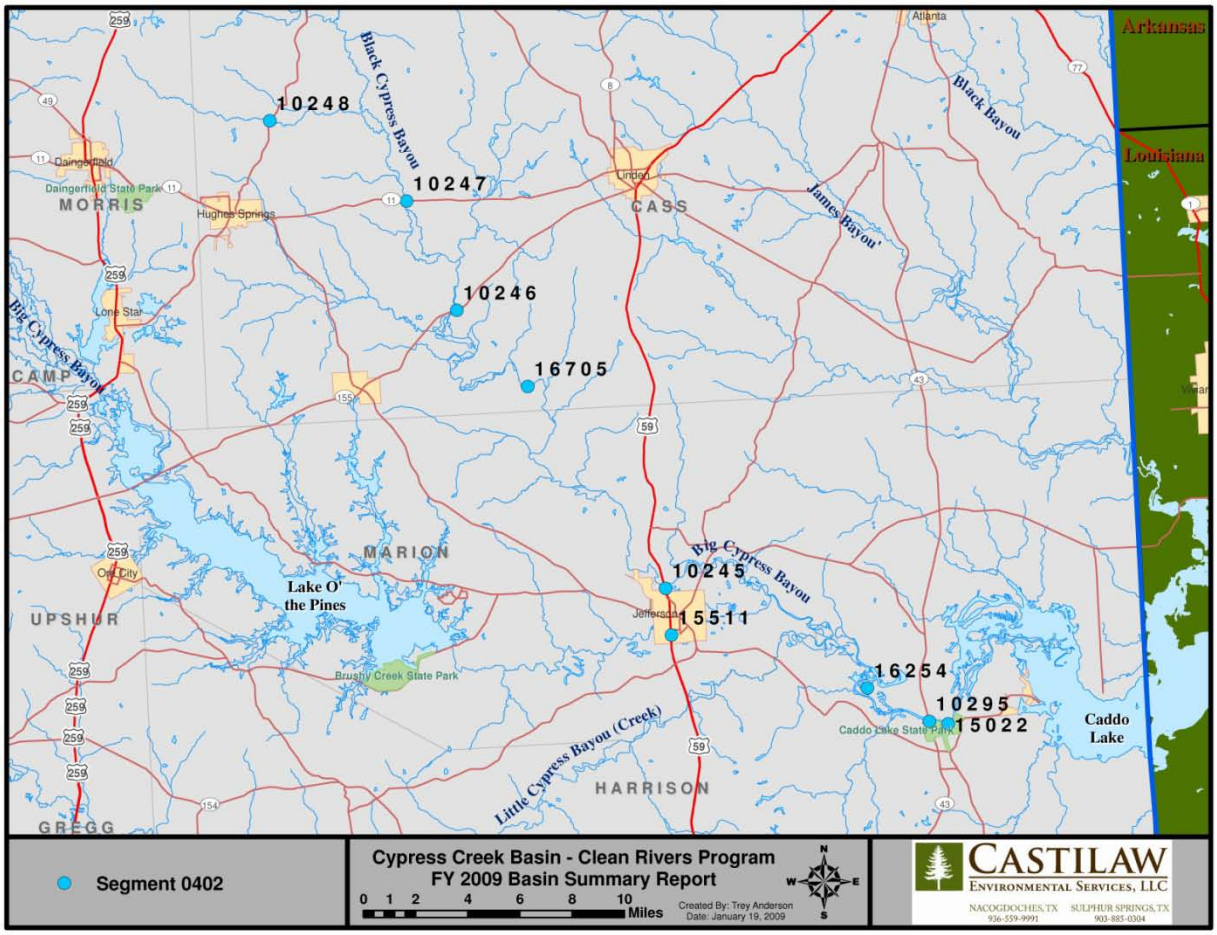


Figure 0402-1: *Stations located in Segment 0402 (Big Cypress Creek below Lake O' the Pines)*

Segment 0402 is the reach of Big Cypress Creek from a point 12.3 kilometers (7.6 miles) downstream of SH 43 in Harrison/Marion County to Ferrell's Bridge Dam below Lake O' the Pines.

This segment is on the *2008 §303(d) List* for having low pH and mercury in edible tissue. All Assessment Units do not meet the screening level for Mercury in fish tissue; this parameter is discussed in the Biological section of this report.

Table 0402-1: *Non-supporting parameters and parameters of concern for Segment 0402*

0402 AUID	Description	DO, 24 HR Avg.	Low pH	Chlorophyll *a*	Mercury in Fish
01	Lower 9 miles		NS	CS	NS
02	11 mi. below Black Cypress Creek	CN	NS		NS
03	Middle 15 mi. near Jefferson				NS
04	Upper 7 miles				NS

AUID = Assessment Unit ID
CS = Concern for Screening Level
NS = Non-supporting
CN = Concern for Near Non-attainment

Coordinated monitoring for FY 2009 includes quarterly and monthly sample collection at the stations shown below in **Table 0402-2**. Four biological assessments are also scheduled in this segment.

Table 402-2: *FY 2009 coordinated sampling scheduled for Segment 402*

Sampling Location	Station ID	Lab Analyses	24 HR DO	Metals in Water	Bacteria	Field	Flow
BLACK CYPRESS CREEK AT SH 49	10243	4			4	4	4
BLACK CYPRESS CREEK AT US 59	10245	4			4	4	4
BLACK CYPRESS BAYOU AT SH 155	10246			5			
BLACK CYPRESS BAYOU AT FM 250	10248	4			4	4	4
BIG CYPRESS CREEK APPROX. 1.2KM DOWNSTREAM OF SH43 AT CADDO LAKE STATE PARK BOAT RAMP	15022	4				12	4
BIG CYPRESS BAYOU AT US 59	15511	4			4	4	4
BIG CYPRESS CREEK AT THE CITY OF MARSHALL PUBLIC WATER SUPPLY INTAKE	16254	4	4			4	4
BLACK CYPRESS CREEK AT CASS CR1617	16705	4				4	4
KELLEY CREEK AT FM250*	16934		2			2	2
HUGHES CREEK AT SH155*	16936		2			2	2

** - Biological sampling scheduled at this station for RBA, IBI, and HQI during index and critical periods*

Assessment Unit 0402_01

Assessment Unit 0402_01 is identified as the lower nine miles of Big Cypress Creek below Lake O' the Pines. These nine miles were sampled at two locations:

- 10295 located at the crossing of State Highway 43, is the farthest upstream site
- 15022 downstream at the boat ramp in Caddo Lake State Park

pH

AU 0402_01 is on the *2008 §303(d) List* for having low pH. Historical pH data were combined for stations 10295 and 15022. Out of 223 samples collected, 27 had pH less than 6 s.u. Station 10295, at the upstream end of the segment, had nine percent of its samples below the criterion. The median value for pH at this site is 6.4 s.u.. Since 1998, eighteen percent of the samples have failed to meet criterion for the AU. **Table 0402-3** illustrates how the samples failing to meet criterion are higher over the past decade. These data support the assessment for low pH.

Table 0402-3: Table 0402-3: *pH sample exceedances for AU402_01*

Station ID	Percent of Samples Failing to Meet pH Criterion for AU 0402_01	
	Since 1972	Since 1998
15022	18%	18%
10295	9%	19%
Total	**12%**	**18%**

Chlorophyll *a*

The assessment lists this AU as a concern for not meeting the screening level for Chlorophyll *a*. Ninety-six percent of the chlorophyll samples were collected at station 10295. Out of the 120 samples collected from 1972 to 2004; 24% were reported as non-detectable and fifteen percent exceeded the screening level. Using data collected since 1998, 33% of the chlorophyll *a* samples exceeded the 14.4 µg/L screening level. These data demonstrate the concern for not meeting the screening level. The results follow the same pattern as pH where the samples that failed to meet screening level from the past decade are substantially higher than the historic values.

Assessment Unit 0402_02

AU 0402_02 is defined as the lower eleven miles of Big Cypress Creek below the confluence with Black Cypress Creek. Station 15135 (Big Cypress Creek below the Spillway) was the farthest upstream site and is located immediately below Lake O' the Pines. Station 16254 is located at the City of Marshall intake, approximately five miles upstream of SH 43.

Dissolved Oxygen

There is a concern for near non-attainment of the 24-Hour DO Average for this AU. Four of the 25 diel measurements (sixteen percent) performed at station 16254 from 2000 to 2007 failed to meet the criterion. In contrast, all but one of the diels at 10295 (located downstream of this station) met the DO criterion. For the entire AU, five out of 31 (sixteen percent) samples were below criterion. These data support the concern for non-attainment of the 24-Hour DO Average criterion. Diel measurements are scheduled to be performed at station 16254 in FY 2009.

pH

AU 0402_02 is listed for having low pH. The bulk of the pH samples were taken at station 16254. All ten of the 86 pH samples (twelve percent) that fell below the stream criterion were collected prior to February 2004. In addition, the pH at this station has been significantly increasing over the past decade. When pH data from 16254 and 15135 are combined, a total of 117 pH measurements have been recorded into SWQMIS. Of those measurements, nine percent were below the state criterion. The median value for pH at this site was 6.6 s.u.

This AU meets the criterion for pH and should be listed as a concern for near non-attainment rather than as non-supporting.

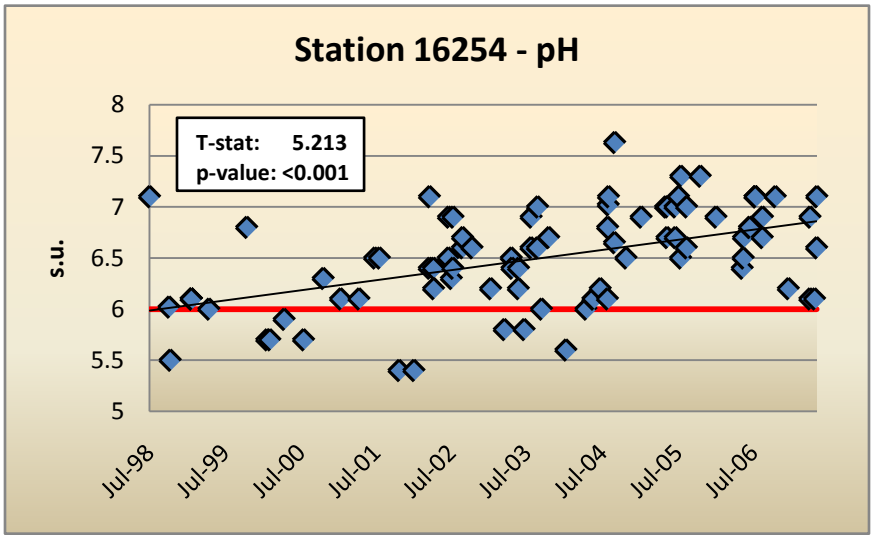


Figure 0402-2: *pH has been significantly increasing over the past decade.*

Segment 0402A - Black Cypress Bayou

(unclassified water body)

Black Cypress Bayou is a perennial stream and the segment boundaries are from the confluence with Big Cypress in Marion County up to FM 250 in Cass County. Sub-segment 0402A is on the *2008 §303(d) List* for having low DO, elevated bacteria and mercury in fish tissue. This sub-segment has not been previously listed for elevated bacteria levels.

Table 0402-4: *Non-supporting parameters and parameters of concern for Segment 0402A*

0402A AUID	Description	DO, 24 HR Avg.	DO, 24 HR Min	Chl. *a*	*E. coli*	Acute Toxics	Chronic Toxics
01	Lower 15 miles	NS				CN	CN
02	Middle 17 miles near CR 1617	NS	NS		NS		
03	Middle 1 mile, Pruitt Lake	CN	NS	CS		CN	CN
04	Middle 13 miles near FM 250	CN			NS		
05	Upper 10 miles	NS	NS				

AUID = Assessment Unit ID
CS = Concern for Screening Level
NS = Non-supporting
CN = Concern for Near Non-attainment

Assessment Unit 0402A_01

AU 0402A_01 is defined as the lower fifteen miles of Black Cypress Bayou to its confluence with Big Cypress Creek. Station 10245, located on Black Cypress Bayou at US Highway 59 north of Jefferson, was the only station with data reported in this AU.

Dissolved Oxygen

AU 0402A_01 is listed as not supporting the 24-Hour DO Average criterion. The listing is based upon six diel measurements that were made at station 10245 between 2000 and 2005. Only one event in August 2000 failed to meet the 24-Hour DO Average criterion. Additional diels should be conducted at this station in order to have adequate data for the assessment.

Copper and Lead

Dissolved copper and lead in water are listed as parameters of concern for acute and chronic toxicity in the *2008 Texas Water Quality Inventory*. There is no known source for these metals in the watershed. Since the implementation of "clean metals" sampling protocols, all samples except one have been non-detectable for lead; however, the listing is a carry forward from the *2002 Texas Water Quality Inventory* and TCEQ stated that it will remain listed until there is sufficient data to indicate that there is not a problem in this AU. All six copper samples collected using "clean metals" protocols have been detectable with some values ranging above the acute and chronic toxicity limits.

Assessment Unit 0402A_02

AU 0402A_02 is the middle seventeen miles of Black Cypress Bayou near County Road 1617. This AU is on the *2008 §303(d) List* for low DO, *E. coli*, and mercury in fish tissue as well as acute and chronic toxics in water. Station 16705, located on Black Cypress Bayou at CR 1617 in southern Cass County, was the only station with sampling data reported for the AU.

Dissolved Oxygen

AU 0402A_02 is listed for not supporting both the 24-Hour DO Average and Minimum criteria. Six out of ten diel measurements performed at station 16705 between 2000 and 2006 were below the 24-Hour DO Average criterion while three out of ten did not meet the 24-Hour DO Minimum criterion. These data show that this station does not meet the 24-Hour DO Average and Minimum criteria.

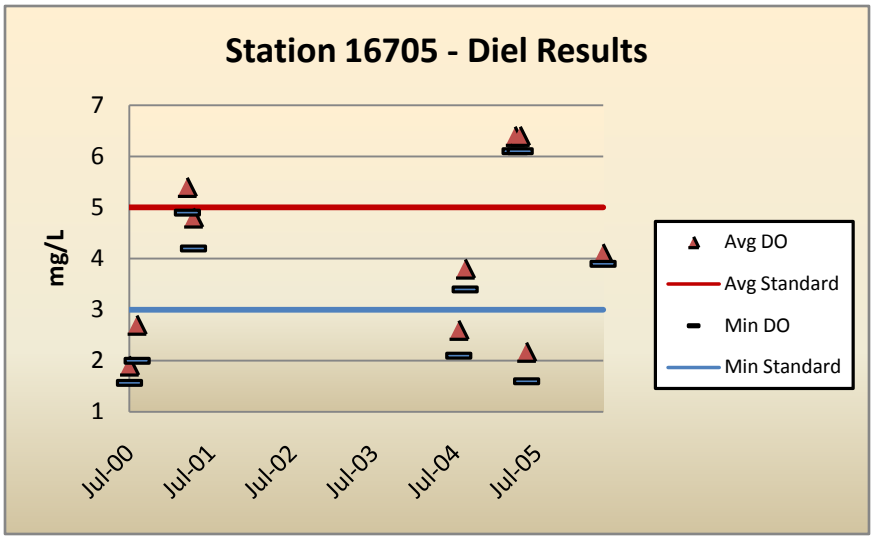


Figure 0402-3: *Diel monitoring results for station 16705*

E. coli

Sample results showed that *E. coli* was highest at the upstream station 10247 and became lower as the water flowed downstream. By the time it reached the most downstream site (10245), the water met the state criterion for this parameter. Station 16705 is listed for not supporting the *E. coli* single sample criterion of 394 MPN/100mL. While this site had a geometric mean of 79.7 MPN/100 mL, exactly ten percent (three out of thirty) of the single samples exceeded the state criterion. Although no single sample has exceeded criterion since 2003, listing and delisting of unclassified water bodies did not occur in the *2008 Texas Water Quality Inventory*. TCEQ states that this AU should be delisted in 2010 assessment.

Assessment Unit 0402A_03

AU 0402A_03 is a small reach located in southeastern Cass County and is identified as the middle one mile, Pruitt Lake. Station 10246 (Black Cypress Creek at SH 155) is the only station in this AU.

Dissolved Oxygen

AU 0402A_03 is listed for not supporting the 24-Hour DO Minimum criterion, and showed a concern for near non-attainment of the 24-Hour DO Average criterion. Nine diel measurements were conducted

from May 2003 to October 2004. Three did not meet the 24-Hour DO Minimum criterion while two were below the 24-Hour DO Average criterion. Based upon limited data, this station does not meet the 24-Hour DO Average and Minimum criteria; however, an additional diel needs to be performed in order to have sufficient samples to properly assess the AU.

Chlorophyll *a*

AU 0402A_03 is listed as a concern for not meeting the screening level for Chlorophyll *a*. Three of the fifteen (twenty percent) chlorophyll samples collected from 1996 to 2004 exceeded the screening level while five were reported as non-detectable. No samples have been collected at this station since October 2004. Additional monitoring is recommended to confirm the listing for this parameter.

Cadmium and Copper

Dissolved cadmium and copper in water are listed as parameters of concern for acute and chronic toxicity in the *2008 Texas Water Quality Inventory*. There is no known source for these metals in the watershed. Since the implementation of "clean metals" techniques, all cadmium samples have been reported as non-detectable with values of <0.1 µg/L. However, all five copper samples collected in 2007 and 2008 have been detectable with some values ranging above the acute and chronic toxicity limits. Sampling for these metals is currently on-going by TCEQ.

Assessment Unit 0402A_04

AU 0402A_04 is described as the middle thirteen miles near FM 250. There was one station on this reach of Black Cypress Creek, located at SH 11 in eastern Cass County between Hughes Springs and Linden. This AU is listed for concern for near non-attainment of 24-Hour DO Average and for not meeting the *E. coli* criterion.

Dissolved Oxygen

Five diel measurements were made at station 10247 from November 2000 to July 2004. One of the five diels did not meet the 24-Hour DO Average criterion. All of the diels met the 24-Hour Minimum criterion. Additional diels are needed in order to have sufficient data for the assessment of this AU.

E. coli

AU 0402A_04 is listed for not meeting the *E. coli* geometric mean criterion. Station 10247 had a geometric mean of 128.8 MPN/100mL. Out of the nineteen samples reported, only one exceeded the single sample criterion of 394 MPN/100mL. This sample was collected during a drought in July 2006, and was the last sample reported for station 10247. Continued sampling should be conducted at this station.

Assessment Unit 0402A_05

AU 0402A_05 is the upper ten miles of the segment. Station 10248 (Black Cypress Creek at FM 250) was the only station in the AU and is located in eastern Cass County, north of Hughes Springs.

Dissolved Oxygen

The AU is listed for not supporting the 24-Hour DO Average and Minimum criteria. Four diel measurements were made between August 2000 and May 2001. Only the August 2000 diel did not meet stream criteria for 24-Hour DO Average and Minimum. The field notes for this event reported that there was no flow with standing water only; therefore, these data should not be included in the assessment. Additional diels should be performed in order to have sufficient data for the assessment of this AU.

Segment 0402B - Hughes Creek

(unclassified water body)

Segment 0402B is listed with concerns for impaired habitat and benthic macroinvertebrate community. Biological monitoring was conducted at station 16936 (Hughes Creek at SH 155) near Avinger in 2001 and again in 2008. The results of these events are discussed in the Biological section of the report. Two aquatic life use monitoring efforts are scheduled at this location in 2009.

Segment 0402C - Haggerty Creek

(unclassified water body)

There are no concerns or impairments listed in the *2008 Texas Water Quality Inventory* for this stream. Station 14997 (Haggerty Creek at CR 2116) was sampled seven times from October 2005 to August 2006 during the 2005 - 2006 drought. No flow was reported for most sampling events and the resulting data showed low dissolved oxygen grab samples as well as having one low 24-Hour DO Average and Minimum values. Monitoring at this station should be conducted during ambient flow conditions to provide appropriate assessment data.

Segment 0402D - Flat Creek

(unclassified water body)

There are no concerns or impairments listed for this stream. Station 16935 (Flat Creek at SH 11) was sampled four times from October 2000 to August 2001. No flow and low flow were reported for three of the sampling events and the resulting data showed low DO grab sample readings as well as low 24-Hour DO Average and Minimum for the single diel performed at this station. Monitoring should be conducted during ambient flow conditions in order to provide appropriate assessment data.

Segment 0402E - Kelley Creek

(unclassified water body)

Segment 0402E is listed with concerns for impaired habitat and benthic macroinvertebrate community. Biological monitoring was conducted at station 16934 (Kelley Creek at FM 250) near Hughes Springs in 2001. The results of this monitoring effort are discussed in the Biological section of the report. Two aquatic life use monitoring events are scheduled at this location in 2009.

Figure 0402-4: *Hughes Creek at SH 155 (station 16936)*

Segment 0403 Lake O' the Pines

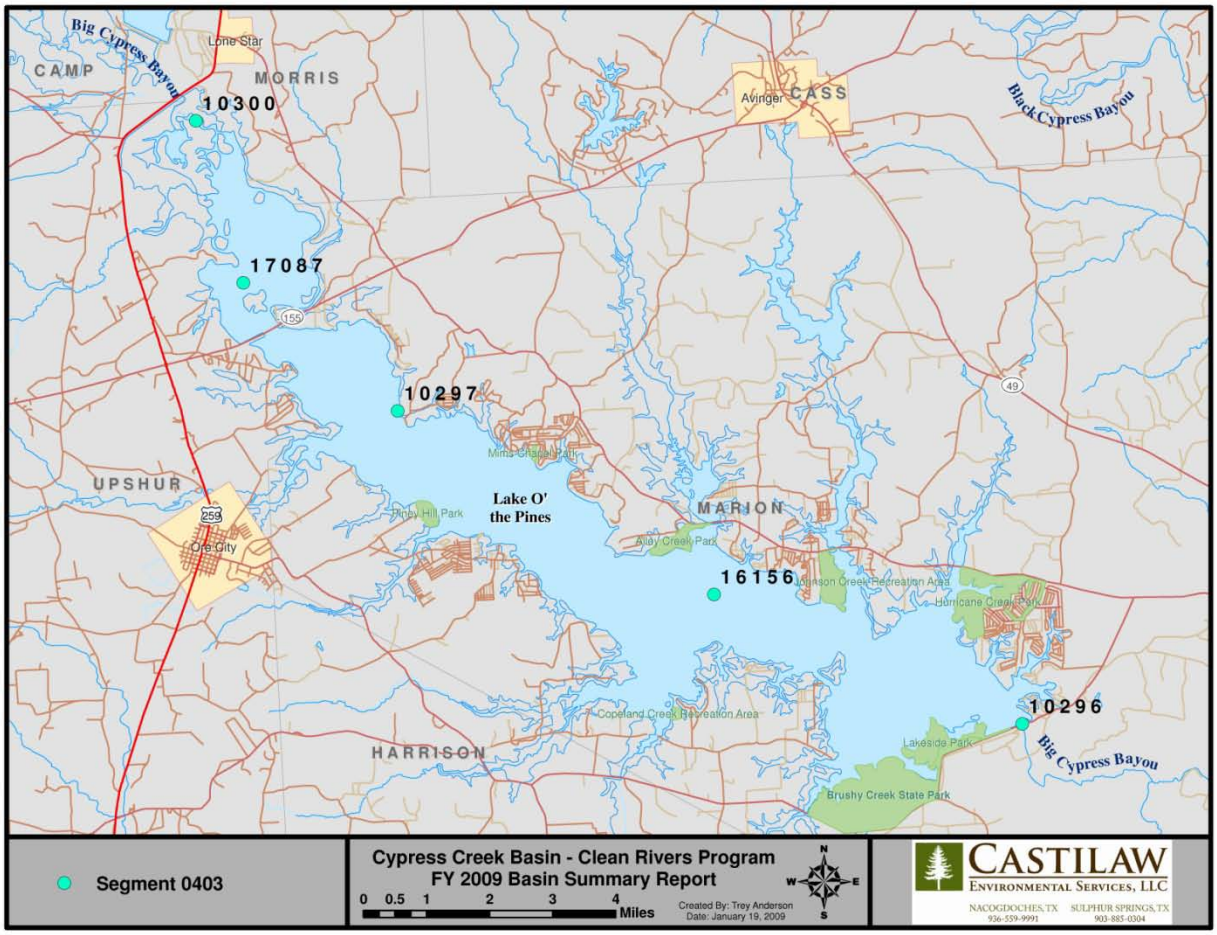


Figure 0403-1: *Sampling stations located in Segment 0403 (Lake O' the Pines)*

Lake O' the Pines is listed in the 2008 Texas Water Quality Inventory as non-supporting the 24-Hour DO Minimum criterion in the upper 3700 acres. While there is a history of the segment being listed on the *Texas §303(d) List* for depressed DO, there are no current listings for Lake O' the Pines.

Lake O' the Pines TMDL *(Segment 0403)*

A Total Maximum Daily Load (TMDL) study was conducted on this segment for concerns of non-supporting DO concentrations. The TMDL concluded that the low dissolved oxygen in Lake O' the Pines (LOP) was a result of phosphorus loading from Big Cypress Creek and its tributaries in Segment 0404. The distribution of dissolved oxygen throughout LOP depends on the interplay of the lake's physical properties and the biological processes of photosynthesis and respiration.

A TMDL was developed for LOP under the guidance of TCEQ and U.S. Environmental Protection Agency (EPA). The final project report was approved by EPA in June 2006. A TMDL implementation plan, designed to achieve a 56% phosphorus reduction**,** was developed by watershed stakeholders and approved by TCEQ in July 2008. Project milestones include tracking implementation activities in eight

categories including point source discharge permits, confined animal feeding operations, forestry operations, on-site sewage facilities, marine sanitation, land application, and activities that support education and management in the watershed. The review strategy included community and stakeholder input. It was determined that phosphorus loadings, dissolved oxygen, and nutrient monitoring will be the water quality indicators to monitor progress of the project. Dissolved Oxygen monitoring will take place via three continuous monitoring stations in LOP and by water quality sampling in Big Cypress Creek. The detailed report can be found at the TCEQ website listed in the bibliography of this report.

Due to the current TMDL for depressed dissolved oxygen concentrations and phosphorus loading, stations with less than ten years of results were analyzed for consideration of additional sampling. Stations with less than two samples per year were not included in the assessment for this report due the limited number of data points.

Coordinated monitoring for FY 2009 includes quarterly collection at the stations shown in **Table 0403-2**.

Table 0403-1: *FY 2009 coordinated monitoring for Segment 0403*

Sampling Location	Station ID	Lab Analyses	Field	Flow
LAKE O' THE PINES MID LAKE NEAR DAM	10296	4	4	4
LAKE O' THE PINES IN RIVER CHANNEL 30M FROM NORTHEAST TEXAS MUNICIPAL WATER DISTRICT INTAKE	10297	4	4	4
LAKE O' THE PINES MID LAKE OPPOSITE FM729 BRIDGE ON ALLEY CREEK	16156	4	4	4
LAKE O' THE PINES, 1.4KM N OF SH155	17087	4	4	4

Assessment Unit 0403_01

AU 0403_01 is the lower 5000 acres of LOP including stations near the dam. Three stations in this AU were sampled from July 2000 to July 2002:

- Station 10296 in the middle of the lake near the dam
- Station 16448 at the mouth of Brushy Creek
- Station 16452 at Hurricane Creek Cove

Chlorophyll *a*

There have been 122 samples collected at station 10296 from 1973 to 2008 and 28% were reported as non-detectable. Four samples exceeded screening levels. There is a statistically significant increasing trend for chlorophyll *a* which is discussed in the Trends section of this report. In order to compare these datasets across a similar date range, only the results from 1998 to 2008 were used for trend analysis at station 16156 (mid-lake). The trend during this ten year period had a much higher T-stat and lower p-value than the trend using the entire dataset. Also of note, in 2006, the laboratory method for

chlorophyll *a* analysis was changed to use the Fluorometric Method. This method provides more accurate and repeatable results than the Spectrophotometric Method used prior to 2006. Chlorophyll *a* monitoring should be continued since recent results are near the screening level.

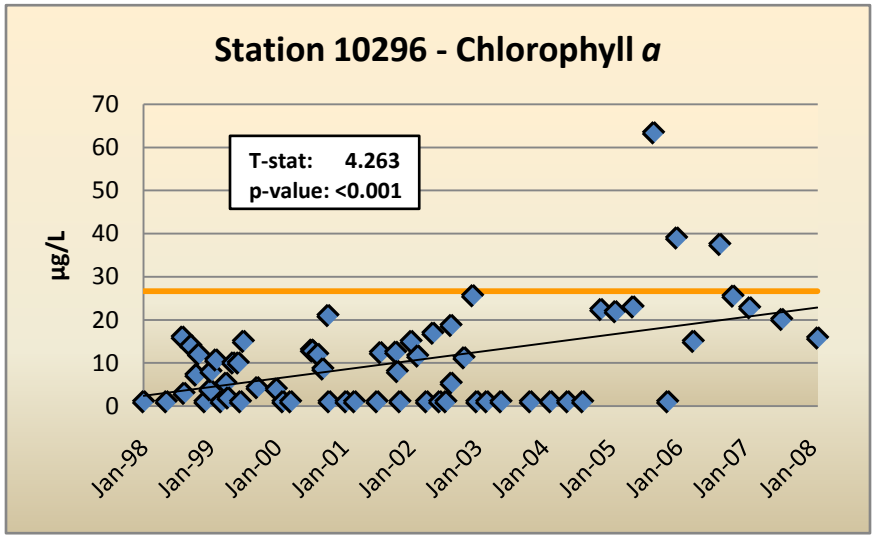


Figure 0403-2: *Chlorophyll a results for station 10296*

Total Phosphorus

Total Phosphorus was sampled 64 times at station 10296 between September 1997 and February 2008. Seventy percent of the samples were reported as non-detectable. Since 1997, five percent of the samples were above the screening level. TCEQ is scheduled to collect field parameters, conventionals and E. coli samples at station 10296 four times in FY 2009.

Assessment Unit 0403_02

AU 0403_02 is the middle 5000 acres of LOP. There were three stations that transect the lake near its mid-point. Station 16156 was at mid-lake opposite the FM 729 crossing and equidistant from both banks. Station 16449 was located in Arms Creek approximately eleven kilometers southeast of Ore City. Finally, station 16450 was on the north side of the lake about 200 meters north of the FM 729 Bridge.

Chlorophyll *a*

There have been 51 chlorophyll *a* samples collected in this AU since 1998; four of those samples either met or exceeded the screening level. From 1998 to the present, chlorophyll *a* values have been increasing at a statistically significant rate. The results from station 16156 comprised 92% of the data for this AU. The non-detected values at this station were obtained early in the sampling record and the values began increasing in 2004. Some of the higher values may be the result of the laboratory method change in 2006. TCEQ is scheduled to collect field parameters, conventionals, and *E. coli* samples at station 16156 four times in FY 2009.

Assessment Unit 0403_03

AU 0403_03 is described as the middle 5000 acres below SH 155. This AU is in the upper middle end of the lake and below what is identified as the lower part of a transition zone where the habitat and flow regime changes from riverine to reservoir conditions. There are no impairments or concerns listed for this AU. Very few samples have been collected at station 10297, located in the river channel southeast of SH 155. One diel failed to meet the 24-Hour DO Average and Minimum criteria in February 2002. There were no samples below criterion for DO grab samples, or above the total phosphorus and chlorophyll *a* screening levels. TCEQ is scheduled to collect field parameters, conventionals, and *E. coli* samples at station 10297 four times in FY 2009.

Assessment Unit 0403_04

AU 0403_04 is described as the upper 3700 acres of the segment. There are no impairments or concerns listed for this AU. It should be noted that chlorophyll *a* is increasing in this area of the lake, but not at a statistically significant rate.

Figure 0403-3: *View northeast from the dam at Lake O' the Pines*

The stations in this AU were located in a transition zone and were located on the far upstream boundary of this segment. From upstream to downstream the widths of the banks widen and velocity decreases as water enters the lake. There were two stations in this AU where the data was used for this assessment. Station 10300 is located southeast of US 259 on the Camp and Upshur County line. Diel data from station 10300 and station 17087, north of SH 155, were analyzed.

Dissolved Oxygen

There have been thirteen diel measurements made in this AU. Four (31%) failed to meet criterion for 24-Hour DO Minimum while two (fifteen percent) failed to meet criterion for 24-Hour DO Average. The samples that failed to meet criterion at station 10300 were collected in late spring to summer from 1999 to 2001. TCEQ is scheduled to sample for field parameters, conventionals, and *E. coli* at station 17087 four times in FY 2009.

Segment 0404 - Big Cypress Creek below Lake Bob Sandlin

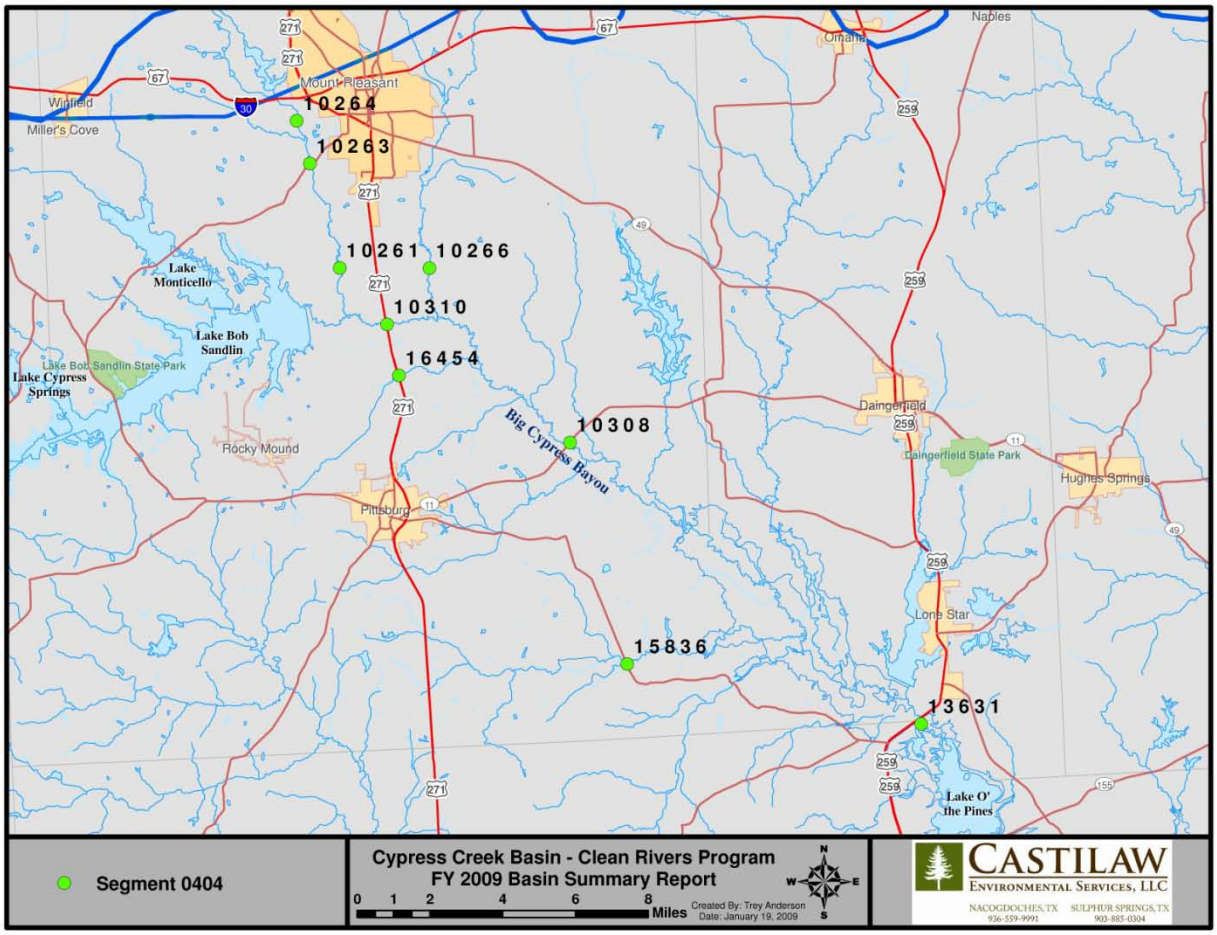


Figure 0404-1: *Sampling stations located in Segment 0403 (Lake O' the Pines)*

The *Texas 2008 §303(d) List* includes Big Cypress Creek, Tankersley Creek and Hart Creek for high levels of bacteria. Ellison Creek Reservoir is listed for PCBs in fish tissue and sediment toxicity. Lake Daingerfield is listed for high mercury levels in fish tissue.

The *2008 Texas Water Quality Inventory* lists concerns for low dissolved oxygen, elevated nutrient concentrations and toxics in fish tissue and sediment. Big Cypress, Tankersley, Hart and Dry Creeks have concerns for screening levels for nutrients. Big Cypress, Hart, Prairie and Walkers Creeks are listed for depressed dissolved oxygen levels. Lake Daingerfield, located near Daingerfield State Park, is listed as a concern for mercury in fish tissue. The Texas Department of State Health Services has issued fish consumption advisories for Lake Daingerfield for mercury in fish tissue and for Ellison Creek Reservoir due to PCBs in fish tissue.

Table 0404-1: *Non-supporting parameters and parameters of concern for Segment 0404*

0404 AUID	Description	DO grab	DO, 24 HR Min	DO, 24 HR Avg.	Nutrients	*E. coli*	Sediment Toxics	Toxics in Fish
01	Lower 15 miles		CN	CN	CS			
02	Upper 18 miles				CS	NS		
0404A	Ellison Creek Reservoir						NS	CS
0404B	Tankersley Creek							
01	Lower 3 miles				CS	NS		
02	Middle 2 miles					NS		
03	3 miles below Tankersley Lake					NS		
0404C	Hart Creek	CN			CS	NS		
0404E	Dry Creek				CS			
0404J	Prairie Creek	CN						
0404K	Walkers Creek	CN						
0404N	Lake Daingerfield							CS

AUID = Assessment Unit ID
NS = Non-supporting
CS = Concern for Screening Level
CN = Concern for Near Non-attainment

Coordinated monitoring for FY 2009 are shown in **Table 0404-2.**

Table 0404-2: *FY 2009 coordinated monitoring for Segment 0404*

Sampling Location	Station ID	Lab Analyses	Bacteria	Metals in Water	24 HR DO	Flow	Field
BIG CYPRESS CR BRIDGE ON SH 11	10308	4	4			4	4
ELLISON CREEK RESERVOIR AT DAM WEST OF LONE STAR STEEL	14473			4			4
WALKERS CREEK AT US271	16454				4	4	4

Assessment Unit 0404_01

Assessment Unit 0404_01 is identified as the lower fifteen miles of Big Cypress Creek above Lake O' the Pines. These fifteen miles were sampled at three locations. From downstream to upstream they are:

- Station 13631 on Big Cypress Creek at US 259, south of Lone Star
- Station 15257 on Big Cypress Creek at FM 997, southwest of Lone Star
- Station 16458 on Big Cypress Creek at Greasy Creek, approximately 6.4 miles west of Lone Star

The majority of the data for this AU were generated from the farthest downstream station (13631).

Dissolved Oxygen

The *2008 Texas Water Quality Inventory* lists this AU as a concern for near non-attainment of the 24-Hour DO Average and Minimum criteria. Out of ten diels performed at station 13631, thirty percent were below criterion for 24-Hour DO Average and twenty percent for 24-Hour DO Minimum. All three diels at Station 15257 were above criteria for both parameters.

Collectively, there have been thirteen diels conducted in this AU. Three samples (23%) failed to meet criterion for 24-Hour DO Average while two samples (fifteen percent) failed to meet criterion for 24-Hour DO Minimum. These data support listing this AU as having a concern for near non-attainment for 24-Hour DO Average and Minimum criteria.

Nutrients

This AU is also listed as a concern for screening level for Nitrate-nitrogen. Historically, there have been 58 samples collected at station 13631 between 1980 and 1994 and there were no samples on record from late 1994 to early 2003. Nine samples were collected from March 2003 to December 2004. Four out of nine (44%) samples exceeded the screening level. The mean for Nitrate-nitrogen samples was 0.62 mg/L; however, the high percentage of samples that exceeded the screening level supports the concern for this parameter.

Assessment Unit 0404_02

Assessment Unit 0404_02 is identified as the upper eighteen miles of Big Cypress Creek. These eighteen miles were sampled at five locations. From downstream to upstream they are:

- Station 10307 – Big Cypress Creek at Fish Camp, approximately ten kilometers west of Pittsburg
- Station 10308 – Big Cypress Creek at SH 11, east of Pittsburg
- Station 16457 – Big Cypress Creek below Walker's Creek
- Station 10310 – Big Cypress Creek at US 271, north of Pittsburg
- Station 10311 – Big Cypress Creek below the Spillway of Lake Bob Sandlin

Although data were available from all sites, the majority of the data assessed for this AU were from station 10308 at the lower end of the reach. The TCEQ is scheduled to sample at station 10308 in FY 2009 for field parameters, conventionals, *E. coli*, and flow.

Nutrients

The *2008 Texas Water Quality Inventory* lists this AU as a concern for screening level for Nitrate-nitrogen, Total Phosphorus, and Orthophosphorus. Eighty-three Nitrate-nitrogen samples were collected at station 10308 from January 1972 to October 2004. Of those, 41% exceeded the screening level. Station 10310 had three sample results with one exceeding the screening level while station 10311 had two samples and both were below the screening level. Collectively, the AU has a total of 91 samples for Nitrate-nitrogen with 42% exceeding the screening level.

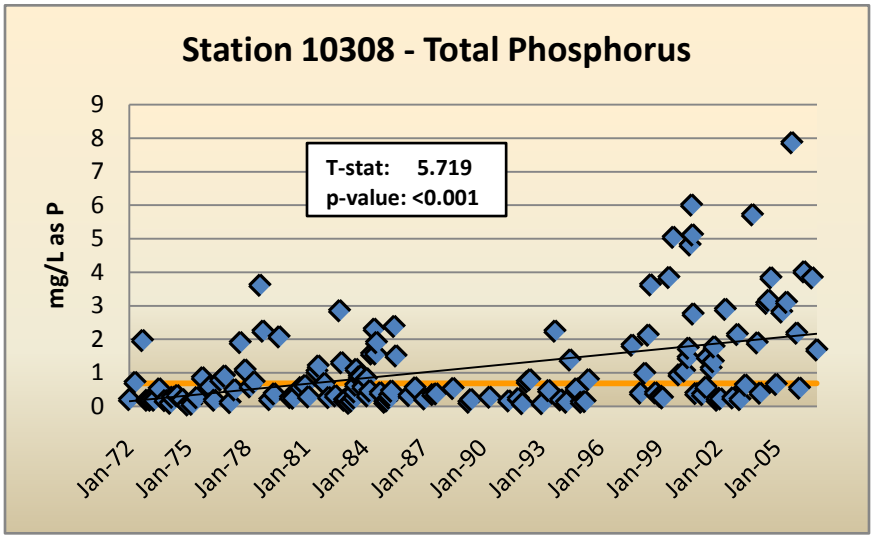


***Figure 0404-2**: Total phosphorus results for station 10308*

Total Phosphorus was sampled 142 times at station 10308 with 44% above the screening level. Station 10311 had ten samples on record with all below the screening level. Seven of nine samples collected at station 16457 were above the level. For all samples in the AU combined, Total Phosphorus was sampled 168 times between 1972 and 2007 with 44% of the samples above the screening level.

Fifty-three out of 110 samples (48%) were above the screening level for Orthophosphorus at station 10308. Station 10311 had no samples exceeding the screening level and station 16457 exceeded the level with 78% of its samples. For the entire AU, there were 136 Orthophosphorus samples and almost half (48%) exceeded the screening level. Since 1998, the percentage of samples that exceeded criterion has been significantly higher for Nitrate-nitrogen, Total Phosphors and Orthophosphorus.

***Table 0404-3:** Nutrient sample exceedances on AU 0404_02*

Nutrient Parameter	Percent of Samples Exceeding Criteria for AU 0404_02	
	Since 1972	Since 1998
Total Phosphorus	44%	60%
Orthophosphorus	48%	63%
Nitrate-nitrogen	42%	62%

E. coli

This AU is included in the *2008 Texas §303(d) List* as impaired for *E. coli*. The first samples for *E. coli* were collected in December 2000. Station 10308 had 55 results with twenty above the single sample criterion. Station 10311 had thirteen samples and fifteen percent exceeded the single sample criterion. Station 10310 had four samples with one above the single sample criterion.

There have been 72 samples collected in this reach with 32% above the single sample criterion. The geometric mean for these samples was 286 MPN/100mL. These data support the assessment that this AU does not meet the *E. coli* criterion.

The TCEQ is scheduled to sample station 10308 in FY 2009 for conventionals, bacteria, and flow with field parameters.

***Figure 0404-3**: Big Cypress Creek at SH 37 north of Winnsboro*

Segment 0404A - Ellison Creek Reservoir

(unclassified water body)

The entire Ellison Creek Reservoir is on the *2008 §303(d) List* for PCBs in fish tissue and sediment toxicity. This sub-segment was first listed for these parameters in the *2006 §303(d) List*.

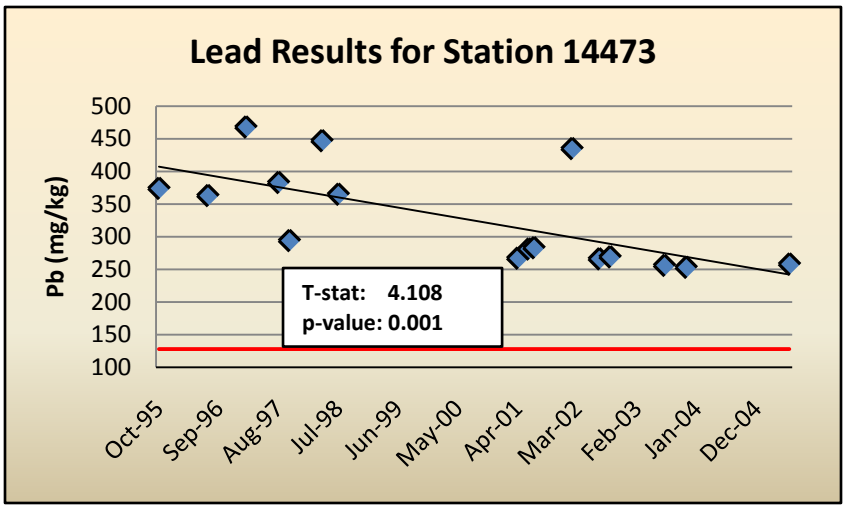


Figure 0404-4: *Lead results for station 14473*

Two statistically significant trends were calculated for station 14473, located near the spillway. Sediment samples for Lead and Zinc were collected from 1995 to 2005, and the results showed decreasing trends for both parameters. No additional sediment sampling has taken place since 2005. Despite the decreasing trends for these parameters, they both exceeded the screening levels. Future sampling could confirm if this statistically significant trend is continuing.

Cadmium, Manganese, and Nickel are also metals of concern in this segment. None of these parameters had statistically significant trends. Trend analysis was not performed on Iron because there were only two samples on record from 2003 and 2005.

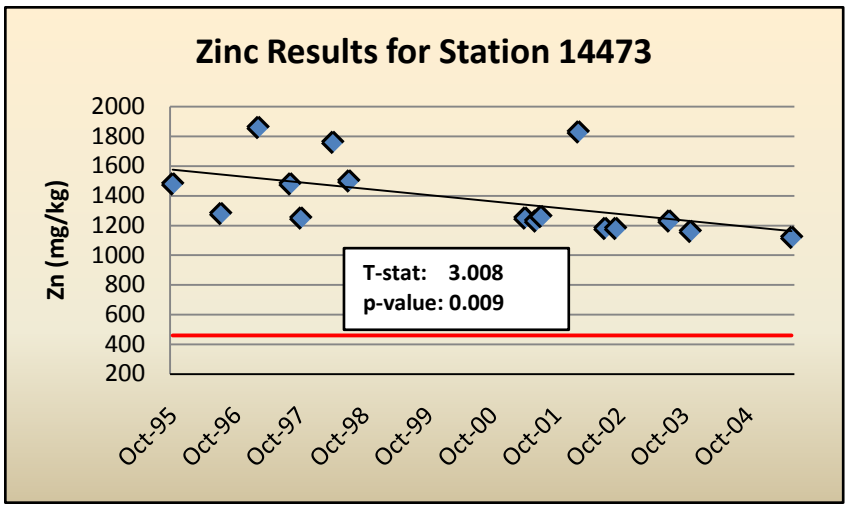


Figure 0404-5: *Zinc results for station 14473*

Metals in Sediment at Ellison Creek Reservoir on June 28 – 29, 2005

Station ID	Cadmium 5 MMol/Kg	Iron 40,000 Mg/Kg	Lead 128 Mg/Kg	Manganese 1,100 Mg/Kg	Nickel 48.60 Mg/Kg	Zinc 459 Mg/Kg
14473	11.0	82,800	258	2360	59.3	1120
14994	9.4	81,500	228	2230	51.9	1160
18767	10.5	81,700	255	2350	59.5	1090
18768	0.6	2,480	6.99	232	3.05	39.7
18769	12.0	83,300	267	2630	60.2	1210
18770	11.9	83,000	302	2250	63.8	1270
18771	7.6	55,000	147	1740	45.8	728
18772	8.1	93,100	146	1370	43.7	785
18773	9.0	54,500	194	2610	55.0	995
18774	8.6	78,800	179	2110	60.1	875
18775	0.71	3,940	5.85	169	3.91	59.6
18776	6.4	62,400	123	1220	49.1	704
18777	3.4	31,800	47.6	538	22.6	335
18778	1.4	10,800	13.5	292	7.73	124
18779	3.2	34,600	34.4	542	18.8	264
18780	3.2	33,300	33.7	498	18.6	256

Table 0404-4: *Metals results for Ellison Creek Reservoir*

Highly Exceeds **Exceeds Screening Level** **Meets Screening Level**

The above table shows the results of one sampling event for metals in sediment conducted in June 2005 on Ellison Creek Reservoir. The values in the heading of each column are the screening levels. The station number is on the far left column and the results by parameter are color coded. Green cells are for values that met the screening levels. The orange cells exceeded the screening level, and the red cells were the four highest values for each parameter.

Segment 0404B - Tankersley Creek

(unclassified water body)

The entire sub-segment is on the *2008 §303(d) List* for not supporting the bacteria criterion. The lower three miles of the stream have nutrient concerns for Nitrate-nitrogen, Orthophosphorus and Total Phosphorus. The three mile reach below Tankersley Lake is listed for having impaired fish and benthic macroinvertebrate communities which is discussed in the Biological section of this report.

Table 0404-5: *Non-supporting parameters and parameters of concern for Segment 0404B*

0404B AUID	Description	DO	Nutrients	*E. coli*	Sediment Toxics	Toxics in Fish
01	Lower 3 miles		CS	NS		
02	Middle 2 miles			NS		
03	3 miles below Tankersley Lake			NS		

AUID = Assessment Unit ID
CS = Concern for Screening Level
NS = Non-supporting
CN = Concern for Near Non-attainment

Assessment Unit 0404B_01

Assessment Unit 0404B_01 is identified as the lower three miles of Tankersley Creek to its downstream border. This AU was sampled at one location, station 10261 located at FM 3417, south of Mount Pleasant. Tankersley Creek discharges into Big Cypress Creek on its east bank in southern Titus County.

Nutrients

The *2008 Texas Water Quality Inventory* lists this AU as a concern for screening level for Nitrate-nitrogen, Total Phosphorus, and Orthophosphorus. There were eighteen nitrate samples taken from 1983 to 2003 and 61% exceeded the screening level. The last sample below the screening level was in February 1993. Samples for Total Phosphorus were collected 34 times and orthophosphorus had 36 results during this same time period. Ninety-one percent of the total phosphorus and 89% of the Orthophosphorus samples exceeded the screening levels. These data support the nutrient concerns.

E. coli

This AU is listed as not supporting the *E. coli* single sample and geometric mean criteria. Station 10261 had thirty samples for *E. coli* with 60% above the single sample criterion. The geometric mean was 609 MPN/100mL. These data support the *E. coli* listing.

Assessment Unit 0404B_02

AU 0404B_02 is identified as the middle two miles of Tankersley Creek southwest of Mount Pleasant. This AU was sampled at station 10263, located at the FM 127 crossing in southern Titus County.

E. coli

The *2008 Texas §303(d) List* includes this AU for not supporting the *E. coli* single sample and geometric mean criteria. Half of the twelve samples collected at station 10263 exceeded the single sample criterion and the geometric mean was at 391 MPN/100mL. These data support listing of this AU.

Assessment Unit 0404B_03

The farthest upstream AU with an impairment listing on Tankersley Creek is described as the three miles below Tankersley Lake. There were two sites in the AU:

- Station 10264, located at FM 889
- Station 15513, located below Tankersley Lake at US 67, West of Mount Pleasant

E. coli

The *2008 Texas §303(d) List* includes this AU for not supporting the *E. coli* single sample and geometric mean criteria. Half of the samples collected at station 10264 exceeded the single sample criterion and the geometric mean was 343 MPN/100mL. Upstream at station 15513, three out of twelve samples exceeded the single sample criterion and the station exceeded the geometric mean criterion with 152 MPN/100mL. Overall for the AU, 44% exceed the single sample criterion and had a geometric mean of 262 MPN/100mL. Of note, these data indicated that bacterial concentrations were increasing as water moved downstream in this reach of Tankersley Creek. The available data support the listing for *E. coli*.

Segment 0404C - Hart Creek

(unclassified water body)

Hart Creek is included on the *2008 Texas §303(d) List* for bacteria. This sub-segment was first listed for bacteria in the *2006 §303(d) List*. The stream has non-attainment concerns for dissolved oxygen and concerns for Nitrate-nitrogen.

Nutrients

Nutrient sampling in this sub-segment has been sporadic and often included only one or two data points per station. Station 10266 was the only location with more than two samples. No samples exceeded the screening level for Total Phosphorus or Orthophosphorus. Nitrate-nitrogen was sampled only once and was below the screening level.

Assessment Unit 0404C_01

AU 0404C_01 is identified as the entire water body. There were two stations with data available:

- Station 10266 at the Titus County Road SE 12, southeast of Mount Pleasant
- Station 10272 at SH 49

Dissolved Oxygen

There is a concern for near non-attainment for DO grab sample. Two out of 24 grab samples from station 10266 were below the criterion while five of eight samples were below the criterion at station 10272. Combined, 22% of the DO grab samples were below the criterion. These data support the low DO concern.

Nutrients

The *2008 Texas Water Quality Inventory* lists this AU as a concern for screening level for Nitrate-nitrogen. No Nitrate-nitrogen samples have been collected in this AU since 1987. The *2008 Texas Water Quality Inventory* showed eight samples on record with six samples exceeding the screening level.

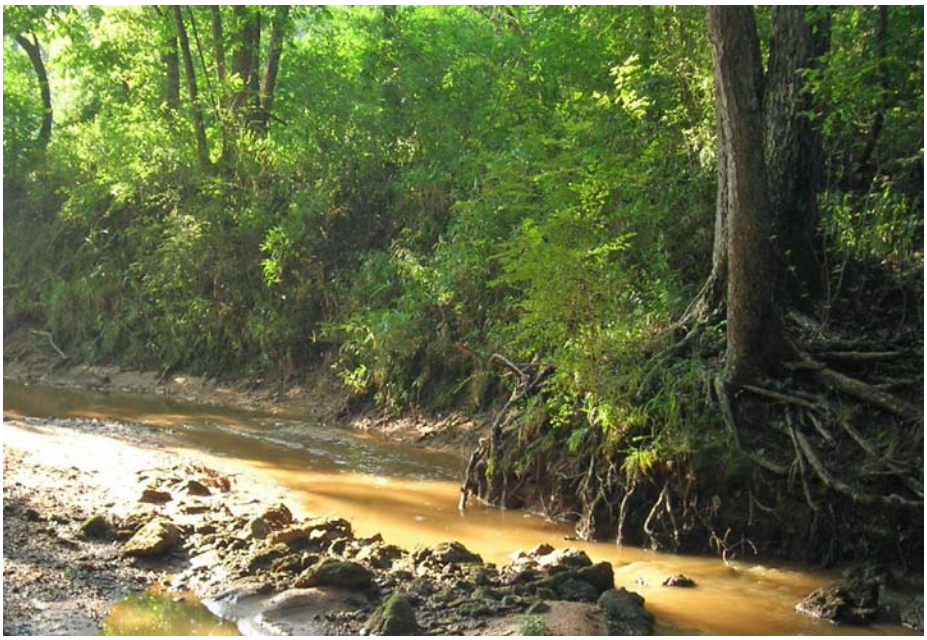


Figure 0404-6: *Walkers Creek at US 271*

E. coli

The entire sub-segment is listed on the *2008 Texas §303(d) List* for exceeding the *E. coli* criterion. Six out of sixteen samples (38%) exceeded the single sample criterion at station 10266, while the geometric mean was 379 MPN/100mL. Upstream at station 10272, eight of thirteen samples exceeded the single sample criterion and the geometric mean was 390 MPN/100mL. Overall, 48% of the samples exceeded the single sample criterion and had a combined geometric mean of 383 MPN/100mL. These data support the *E. coli* listing.

Segment 0404D - Welsh Creek

(unclassified water body)

Welsh Creek extends from the Titus County Dam up to normal pool level located between Mt. Pleasant and Daingerfield. Welsh Reservoir impounds Swauano and Justiss Creeks. There are three sample sites in the reservoir and no concerns were identified for this sub-segment.

Segment 0404E - Dry Creek

(unclassified water body)

The *2008 Texas Water Quality Inventory* lists this stream as a concern for screening level for Nitrate-nitrogen. Dry Creek enters Big Cypress Creek from the west bank, flowing past Pittsburg in northeast Camp County. This segment was sampled only once in 1983 and again in 1987. Regular sampling began in 2000. Due to infrequent sampling, only samples from 2000 to present were considered in this analysis.

Assessment Unit 0404E_01

AU 0404E_01 is described as the entire water body. There were two stations with data on Dry Creek. Station 10274 was located downstream at the Titus County Road SE 12 crossing and the upstream site was station 10272, at SH 49.

Nutrients

The *2008 Texas Water Quality Inventory* qualifies the listing as having limited data since the assessment is based upon only eight samples. There were no Nitrate-nitrogen samples observed for this AU since 2000. Total Phosphorus and Orthophosphorus were collected from July 2000 to January 2002. The combined sites had nine samples for each parameter with three Total Phosphorus and three Orthophosphorus samples exceeding the screening level. The available data indicates that there are possible nutrient concerns for this sub-segment and additional sampling should be conducted.

Segment 0404F - Sparks Branch

(unclassified water body)

Sparks Branch was assessed for DO grab sample minimum and criterion in the *2006 Texas Water Quality Inventory.* Since there were only three samples, the parameter was not evaluated and the sub-segment showed no concerns or impairments in the *2008 Texas Water Quality Inventory*.

Segment 0404I - Boggy Creek

(unclassified water body)

There are no concerns or impairments listed in the *2008 Texas Water Quality Inventory* for this sub-segment.

Segment 0404J - Prairie Creek

(unclassified water body)

Prairie Creek flows on the southern border of Camp County before its confluence with Big Cypress Creek near US 259. The *2008 Texas Water Quality Inventory* lists concerns for near non-attainment of the 24-Hour DO Average and Minimum criteria. The assessment is qualified as being limited to five diel measurements; however, six diels are on record from August 2000 to February 2002.

Table 0404-6: *Diel results for Station 15836*

Sampling Date Range	Number of Samples	Min. D.O. (mg/L)	Mean D.O. (mg/L)	Max D.O. (mg/L)
August 18 – 19, 2000	97	0.2	0.3	0.6
August 19 – 20, 2000	97	0.2	0.2	0.3
May 14 – 15, 2001	97	6.0	6.1	7.8
June 11 – 12, 2001	97	2.9	3.3	4.6
July 27 – 28, 2001	97	1.5	1.8	3.6
February 24 – 25, 2002	97	9.1	9.6	10.5

Four of six (67%) of the samples were below the criteria for both 24-Hour DO Average and Minimum. All samples that were below criteria were collected in the summer months of 2000 and 2001. The limited dataset for this AU supports the concern for near non-attainment of the 24-Hour DO Average and Minimum criteria. Additional diels are needed in order to have adequate data to assess this AU.

Segment 0404K - Walkers Creek

(unclassified water body)

Walkers Creek runs east to west in Camp County, north of Pittsburg. There were two stations on Walkers Creek:

- Station 16454 at US 271
- Station 16714 located at the confluence with Big Cypress Creek

The City of Harvard Wastewater Treatment Plant discharges approximately halfway between the two stations. Diels from both stations were assessed.

Dissolved Oxygen

This AU has concerns for near non-attainment of the 24-Hour DO Average and Minimum. Two of the five diels conducted at station 16714 between September 2000 to May 2008 were below criteria for 24-Hour DO Average and Minimum while two out of three diels from the upstream station (16454) were below criteria for both parameters. The *2008 Texas Water Quality Inventory* shows that the assessment is

based upon limited data. More data are needed to properly assess this AU. Four diels are scheduled to be performed at Walkers Creek in FY 2009 by NETMWD.

Segment 0404L - Swauano Creek

(unclassified water body)

Swauano Creek runs southwest of Cookville in southeast Titus County. The upper reach is intermittent and flows approximately nineteen miles to its confluence with Big Cypress Creek. There was one station on Swauano Creek located east of Mount Pleasant at SH 49. There are no concerns or impairments listed in the *2008 Texas Water Quality Inventory* for this sub-segment.

Segment 0404M - Greasy Creek

(unclassified water body)

Greasy Creek begins approximately two miles north of Cox in Upshur County. It extends southeast for approximately four miles before its confluence with Big Cypress Creek. There was one station southeast of Pittsburg at FM 557. There are no concerns or impairments listed in the *2008 Texas Water Quality Inventory* for this sub-segment.

Segment 0404N - Lake Daingerfield

(unclassified water body)

Lake Daingerfield is an eighty acre reservoir which was completed in 1935 as a Civilian Conservation Corps project. There was one station in the headwaters, in the Lake Daingerfield State Park. This segment was identified as having a concern for the screening level of mercury in fish tissue and DSHS has issued a fish consumption advisory. Mercury in edible tissue is discussed in the Biological section of the report.

Segment 0405 - Lake Cypress Springs

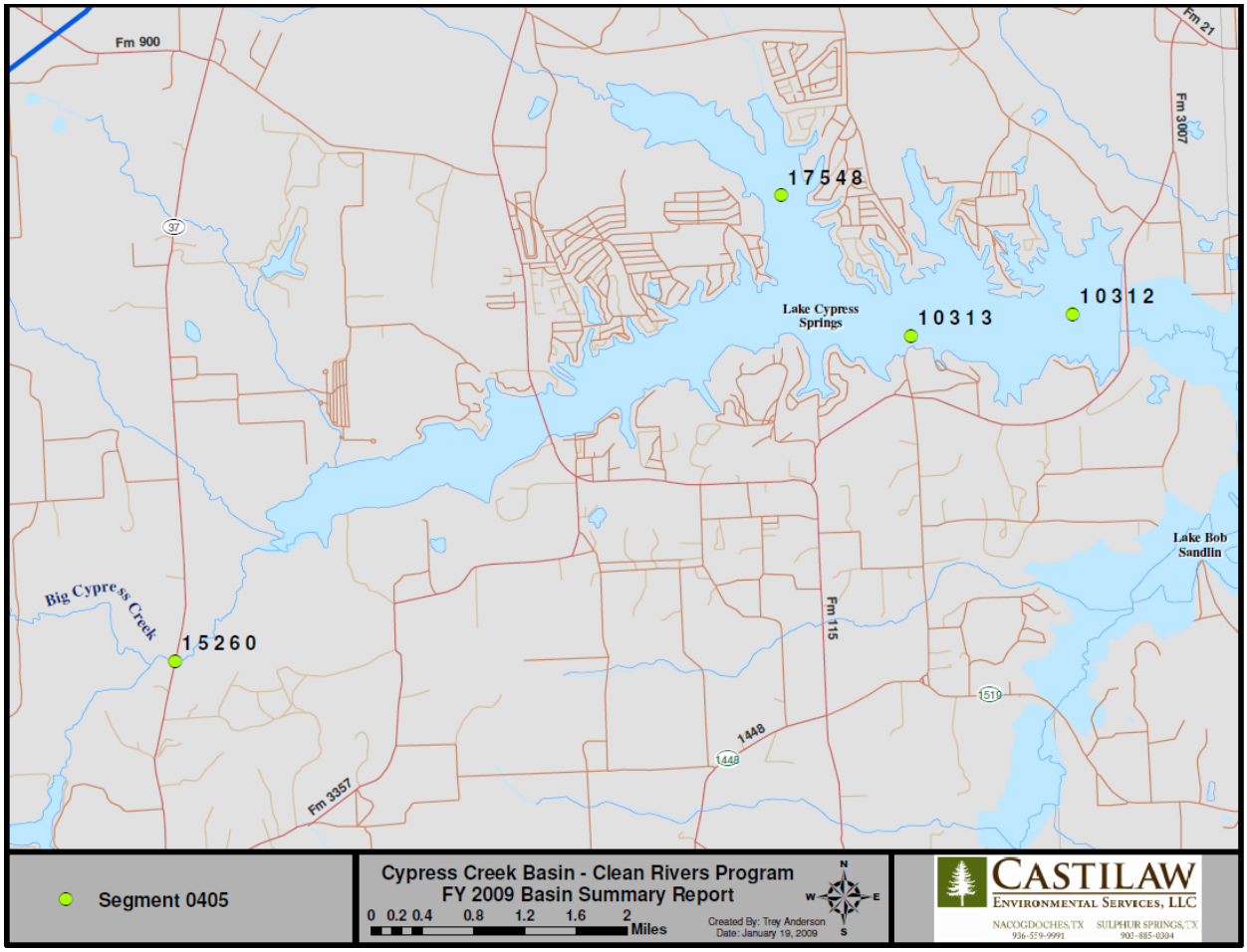


Figure 0405-1: *Sampling stations located in Segment 0405 (Lake Cypress Springs)*

Lake Cypress Springs was first included on the *2006 §303(d) List* for low dissolved oxygen and the *2008 §303(d) List* includes the reservoir for low DO in the Panther Arm of the reservoir.

The *2008 Texas Water Quality Inventory* lists concern for non-attainment of the 24-hour DO Average criterion for the upper 2,600 acres. Concerns for not meeting the screening level of ammonia and 24-Hour DO Average, 24-Hour DO Minimum and DO grab sample concentrations are also listed for the Panther Arm of the reservoir.

It should be noted that many stations on Lake Cypress Springs were not representative of the lake as a whole. These sites were originally chosen for the purpose of studying the effects of non-point source pollution. Many of these stations are located in the transition zone where water velocity changes from lotic to lentic conditions. Data from these stations should not be considered in the assessment of this reservoir.

Table 0405-1: *Non-supporting parameters and parameters of concern for Segment 0405*

0405 AUID	Description	DO	DO, 24 HR Avg.	DO, 24 HR Min.	Nutrients
01	Lower 800 acres				
02	Upper 2600 acres		CN		
03	Panther Arm	CS	NS	NS	CS

AUID = Assessment Unit ID
CS = Concern for Screening Level
NS = Non-supporting
CN = Concern for Near Non-attainment

Coordinated monitoring for FY 2009 includes quarterly sampling by TCEQ regional field staff at the stations shown in **Table 0405-2**.

Table 0405-2: *FY 2009 coordinated monitoring for Segment 0405*

Sampling Location	Station ID	Lab Analyses	24 HR DO	Flow	Field
LAKE CYPRESS SPRINGS MID-LAKE NEAR DAM	10312	4	4		4
LAKE CYPRESS SPRINGS AT FM 115	10313	4	4		4
BIG CYPRESS CREEK AT SH 37	15260	4	4	4	4
LAKE CYPRESS SPRINGS MID-COVE IN PANTHER CREEK COVE	17548	4	4		4
LAKE CYPRESS SPRING WEST END 2.4KM SW OF FM 115	20346	4	4		4

Assessment Unit 0405_01

AU 0405_01 is described as the lower 800 acres of Lake Cypress Springs. This reach extends to the downstream boundary at the dam that discharges into the east bank of Lake Bob Sandlin near the Franklin and Titus County line. There were no concerns or impairments listed in the *2008 Texas Water Quality Inventory* for this AU.

Assessment Unit 0405_02

This AU is identified as the upper 2,600 acres of Lake Cypress Springs. The downstream boundary of this reach is FM 115 in south Franklin County. It extends to the upstream transitional area on the west side of the lake where the flow regime changes from stream to reservoir. The following stations were located within this AU, in order from downstream to upstream:

- 10313 located at FM 115
- 16937 upstream near the west bank, at North Shore
- 17872 the Lakeview mid-lake site on open water in the main body
- 16939 the farthest upstream site in a transition zone

Dissolved Oxygen

The majority of the diel measurements were made at station 17872 with six events and all met the 24-Hour DO criteria. Stations 16937 and 16939 had two events each. All samples were above the criteria at station 16937; however, both diels at station 16939 failed to meet the 24-Hour DO Average criterion and the 2001 sample failed to meet 24-Hour DO Minimum criterion.

***Table 0405-3**: Diel results for station 16939*

Sampling Date Range	Number of Samples	Min. D.O. (mg/L)	Average D.O. (mg/L)	Max D.O. (mg/L)
July 13 – 14, 2001	97	2.2	4.1	8.0
July 01 – 02, 2002	97	3.7	4.2	5.2

No diels have been performed in this AU since 2002. The only station with concerns was in the transition zone in the west end of the reservoir. This station was not representative of the lake; therefore, these data should not be considered in the assessment of this AU.

Assessment Unit 0405_03

AU 0405_03 is described as the Panther Arm on the north bank of the reservoir. Most of the data collected within the AU came from coves in the Panther Arm; therefore, these data are not representative of reservoir conditions. There were four stations located within the AU. From downstream to upstream they were:

- 17548 located at a mid-cove site on the Panther Arm
- 16940 at a tall tree approximately 600 meters west of FM 2723
- 17518 upstream on the east bank on Frog Creek
- 16938 the farthest upstream in Panther Creek Arm in a transition zone

Dissolved Oxygen

Collectively, there have been 54 DO grab samples taken with only four below the criterion. None of the DO grab samples from stations 17548, 16938, and 16940 were below the criterion. Four of the sixteen DO grabs recorded for station 17518 (in the Frog Creek Arm) were below the criterion. Since station 17518 is located in a transition zone and is not representative of the assessment unit, these data should not be considered in the assessment. These data do not support the concern for low DO grab values. TCEQ stated that this AU will likely be delisted in the 2010 assessment since these stations are located in a transistion zone and are not representative of the AU.

The *2008 Texas §303(d) List* shows an impairment for depressed 24-Hour DO Average and Minimum. The majority of the diel data were from station 17518 with four events performed between July 2002 and April 2004. All diels from this station failed to meet criteria for both parameters. The *2008 Texas Water Quality Inventory* qualifies the assessment of this AU as having limited data since there was only seven diels with four not meeting the criteria.

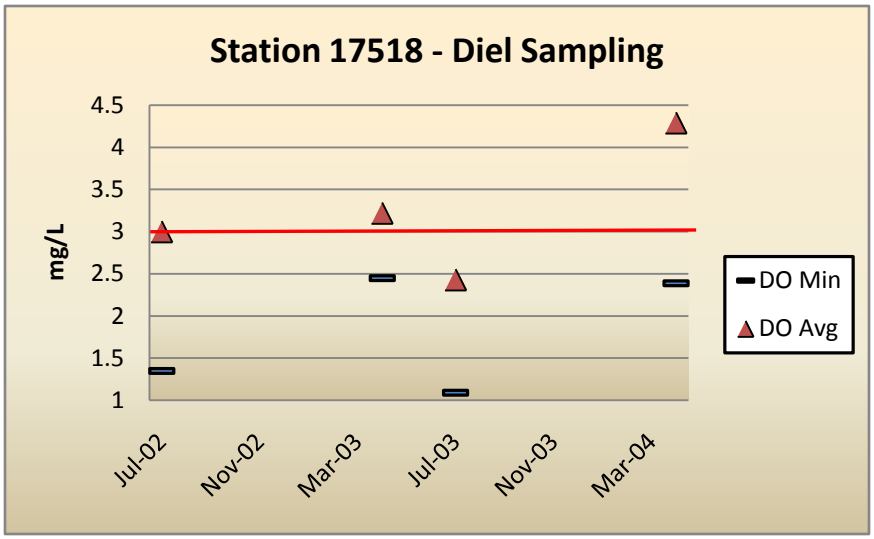


***Figure 0405-2**: Diel results for station 17518. The red line indicates the 24-Hour DO Minimum criterion.*

Nutrients

None of the nineteen ammonia-nitrogen samples collected at station 17548 exceeded the screening level while 84% were non-detectable. Approximately 50% of the samples reported for stations 17518, 16938, and 16940 exceeded the screening level. Collectively for the AU, seventeen out of 51 ammonia-nitrogen samples exceeded the screening level. These available data support the concern for elevated ammonia concentrations in this AU.

Segment 0405A - Big Cypress Creek

(unclassified water body)

Big Cypress Creek originates in Hopkins County near the Franklin County line and flows southeast into Lake Cypress Springs. There was one station in this sub-segment located at SH 37, north of Winnsboro. There are no concerns or impairments listed in the *2008 Texas Water Quality Inventory* for this sub-segment.

Segment 0405B - Panther Creek

(unclassified water body)

Panther Creek rises near Purley in Franklin County. The stream, which is intermittent in its upper reaches, originally ran southeast for 6.5 miles to its confluence with Big Cypress Creek before Lake Cypress Springs was impounded in 1970. There was one station on Panther Creek at Franklin County Road 4260 SE. There are no concerns or impairments listed in the *2008 Texas Water Quality Inventory* for this sub-segment.

Segment 0405C - Blair Creek

(unclassified water body)

Blair Creek rises eight miles southwest of Mount Vernon and flows south for three miles to Lake Cypress Springs. There was one station on this segment at Franklin County Road 3330 SE. There are no concerns or impairments listed in the *2008 Texas Water Quality Inventory* for this sub-segment.

Figure 0405-3: *South shore of Lake Cypress Springs*

Segment 0406 - Black Bayou

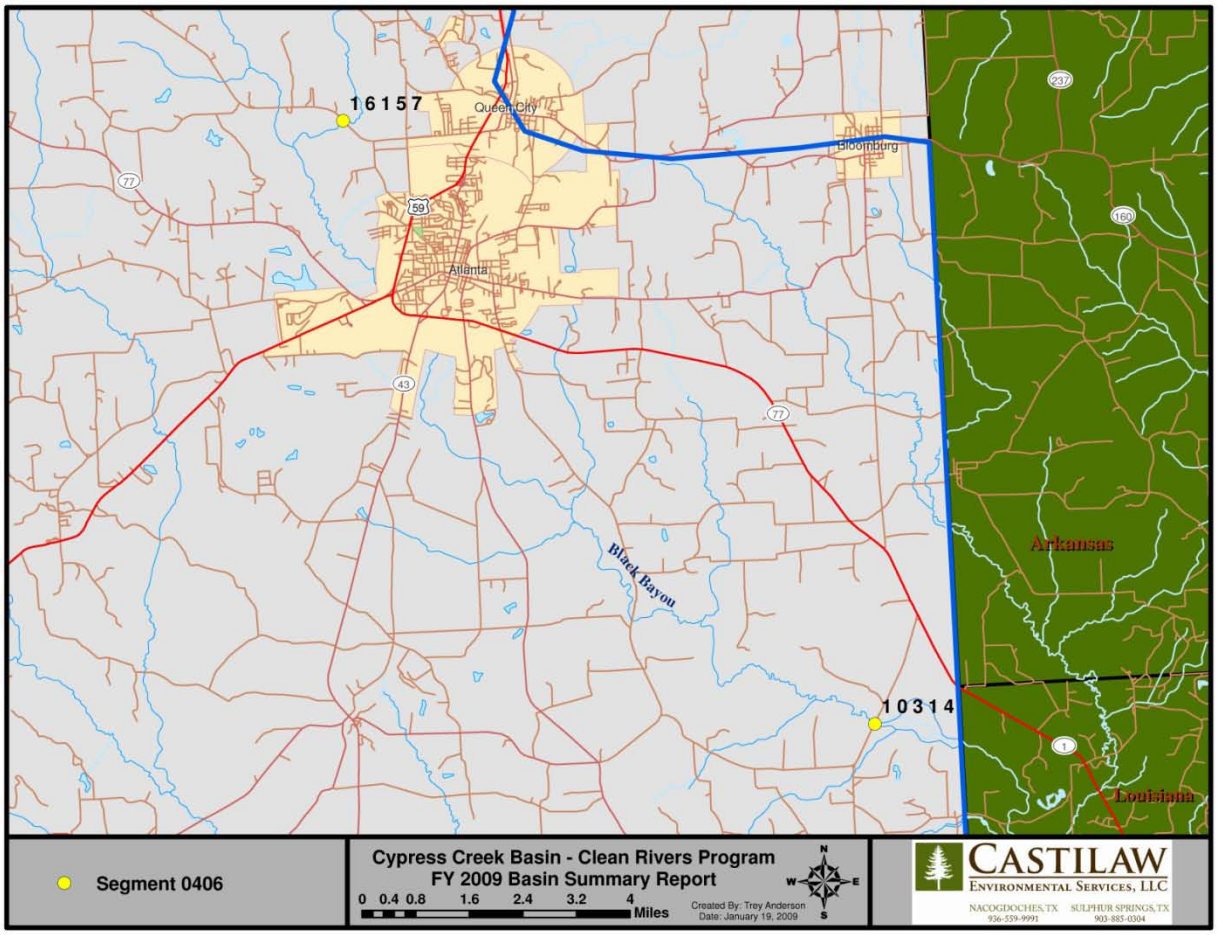


Figure 0406-1: *Sampling stations located in Segment 0406 (Black Bayou)*

Black Bayou is included in the *2008 §303(d) List* for depressed dissolved oxygen concentrations, low pH, and elevated bacterial counts. The entire 24-mile reach of Black Bayou is on the *2008 §303(d) List* for not supporting the dissolved oxygen grab minimum concentration and for having low pH. Bacteria was added to the *§303(d) List* in 2006 and pH was added in 2008. The lower twelve miles is listed for not meeting stream criteria for bacteria. The *2008 Texas Water Quality Inventory* also lists this entire segment as a concern for not meeting the DO grab sample criterion.

Coordinated monitoring for FY 2009 includes quarterly sampling for conventionals, bacteria, field parameters and flow at stations 10314 and 10318.

***Table 0406-1**: Non-supporting parameters and parameters of concern for Segment 406*

0406 AUID	Description	DO, Grab Min.	pH	Bacteria
01	Lower 12 miles	NS	NS	NS
02	Upper 12 miles	NS	NS	

AUID = Assessment Unit ID
CS = Concern for Screening Level
NS = Non-supporting
CN = Concern for Near Non-attainment

Assessment Unit 0406_01

This AU is described as the lower twelve miles and included only one station, 10314, located at Cass CR 4659. This site is approximately 1.3 miles west of the Louisiana State Line.

Dissolved Oxygen

There have been 245 DO grab samples taken from September 1968 to July 2007. Eighteen percent of those samples failed to meet criterion. Additionally, 39% of readings from 1998 to 2007 failed to meet criterion for DO grab sample minimum. These data support the DO grab sample listing.

pH

There have been 193 pH readings taken at station 10314 from February 1972 to July 2007 with ten percent of the measurements not supporting the criterion. The median pH was 6.5 s.u. These available data support the pH listing.

E. coli

Three of the twenty *E. coli* samples collected at station 10314 exceeded the single sample criterion and the geometric mean was 150 MPN/100 mL. These data support the bacteria listing.

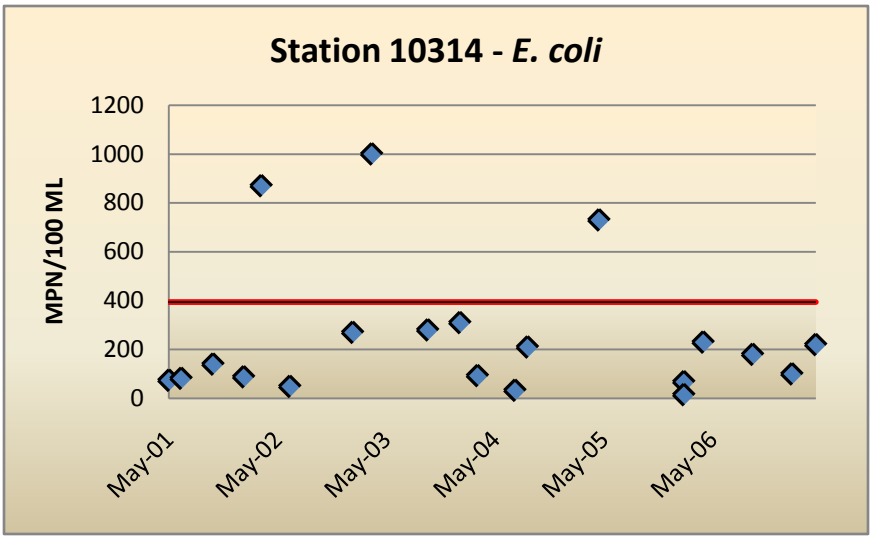


***Figure 0406-2**: E. coli results for station 10314*

Assessment Unit 0406_02

AU 0406_02 is identified as the upper twelve miles and includes only one station, 16157, located at FM 2791 approximately 2.4 miles west of Queen City. The *2008 Texas Water Quality Inventory* lists this AU for not supporting the DO grab sample minimum and for having low pH.

Dissolved Oxygen

Thirty-three percent of the 27 DO measurements made at station 16157 from November 1998 to April 2006 failed to meet the DO grab sample minimum criterion. These data support the DO grab sample listing.

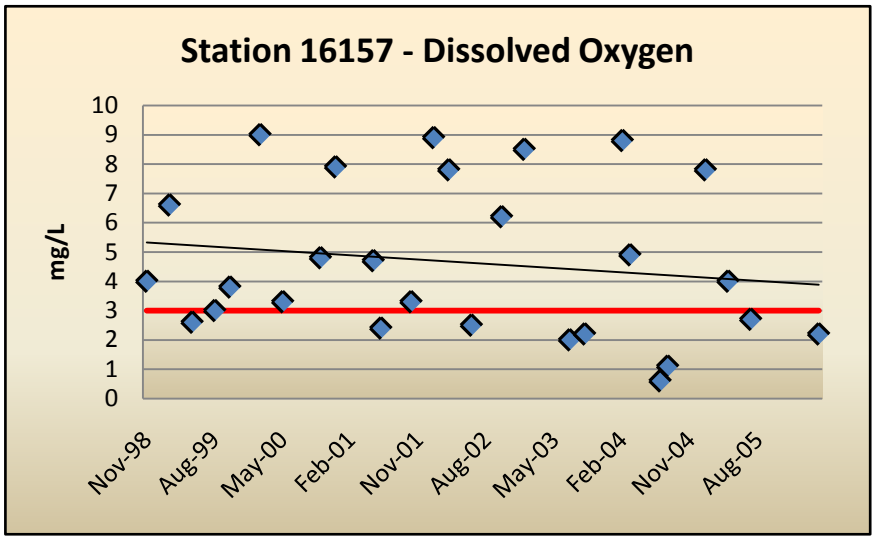


***Table 0406-2**: Diel results for station 16157*

All four of the diel measurements performed from May 1999 to July 2003 failed to meet the 24-Hour DO criteria. These data indicate a concern for non-support of the 24-Hour DO Average and Minimum criteria and further supports the low DO grab sample assessment.

Sampling Date Range	Number of Samples	Min. D.O. (mg/L)	Mean D.O. (mg/L)	Max D.O. (mg/L)
May 31 – June 1,1999	48	2.9	3.5	3.7
August 16 – 17, 1999	48	0.9	1.4	1.8
August 30 – 31, 2000	48	0.6	1.0	1.8
July 8 – 9, 2003	48	1.0	2.0	3.0

***Figure 0406-3**: Dissolved oxygen results for station 16157. The red line indicates the DO grab sample criterion.*

pH

Five out of 27 (nineteen percent) pH measurements made at station 16157 were below the criterion. These data support the listing for low pH.

Segment 0407 - James' Bayou

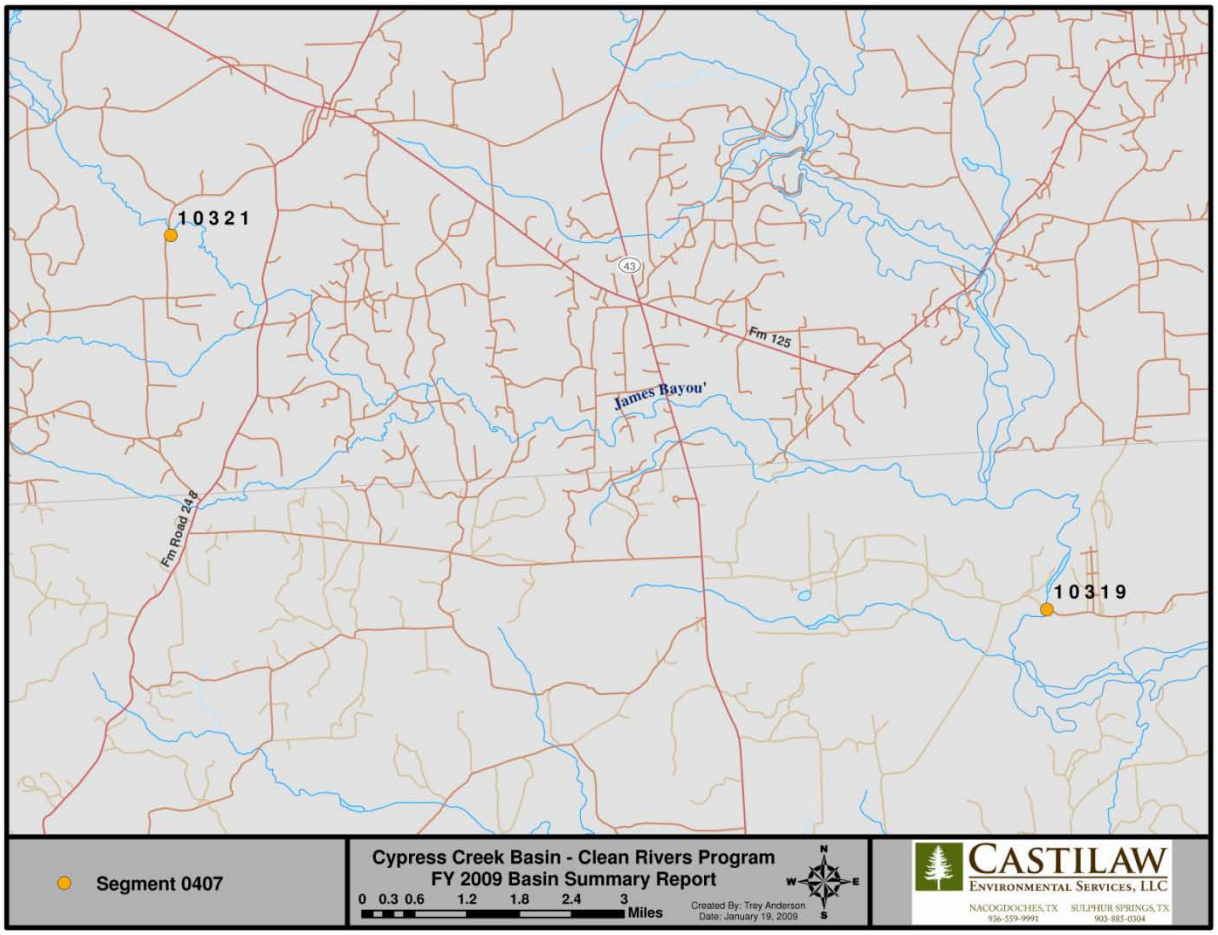


Figure 0407-1: *Sampling stations located in Segment 0407 (James' Bayou)*

James' Bayou is included in the *2008 Texas §303(d) List* for depressed 24-Hour DO along the entire segment. The upper 25 miles is also listed for having low pH and high bacteria counts. Bacteria and pH were added to the §303(d) List for this segment in 2006. The *2008 Texas Water Quality Inventory* also lists the lower fifteen miles of this segment as a concern for not meeting the ammonia screening level.

Coordinated monitoring for FY 2009 includes quarterly sampling by NETMWD for field parameters and flow at station 10321 (James' Bayou at Cass CR 1775) southwest of Kildare.

Table 0407-1: *Non-supporting parameters and parameters of concern for Segment 0407*

0407 AUID	Description	DO	DO, 24 HR Avg.	DO, 24 HR Min	NH3-N	pH	Bacteria
1	Lower 15 miles	CN	NS	NS	CS		
2	Upper 25 miles	NS	NS	NS		NS	NS

AUID = Assessment Unit ID
NS = Non-supporting
CS = Concern for Screening Level
CN = Concern for Near Non-attainment

Assessment Unit 0407_01

AU 0407_01 is defined as the lower fifteen miles of James' Bayou. The downstream boundary is at the Louisiana State Line in Marion County. Station 10319, at CR 3312, was the only station in this AU.

Dissolved Oxygen

Since 1998, 22% of the samples failed to meet the criterion for DO grab sample. Eleven diel measurements have been made and 45% failed to meet the 24-Hour DO Average criterion while 36% failed to meet the 24-Hour DO Minimum criterion. These data support the listings for low DO grab sample, 24-Hour DO Average and Minimum.

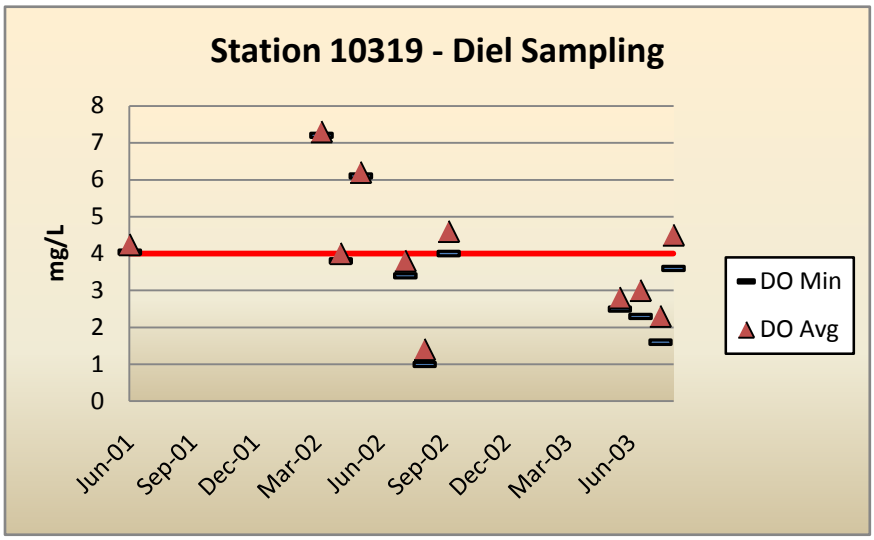


Figure 0407-2: *Diel results for station 10319*

Ammonia

Sixty-five ammonia-nitrogen samples have been collected at Station 10319 from May 1972 to May 2007. Over half of those samples (35) were reported as non-detectable and only one sample (collected in 1982) exceeded the screening level. These data do not support the ammonia listing; however, TCEQ stated that the listing will remain until there is sufficient data to indicate otherwise.

Assessment Unit 0407_02

This AU is identified as the upper 25 miles of James' Bayou which extends upstream to Club Lake Road northwest of Linden. There were three stations in the AU:

- 10320 at FM 248, south of Kildare
- 10321 at Cass County Road 1775
- 18200 at SH 11, west of Linden

Ninety-four percent of the data for the AU were collected at station 10321.

Dissolved Oxygen

Seventy-three DO samples have been taken since 1998. Of those samples, 41% failed to meet DO grab sample criterion.

Twenty-one diels have been conducted at station 10321 and 38% failed to meet the criterion for 24-Hour DO Average while 43% failed to meet the 24-Hour DO Minimum criterion. These data support the low DO grab sample, 24-Hour DO Average and Minimum listings for this reach.

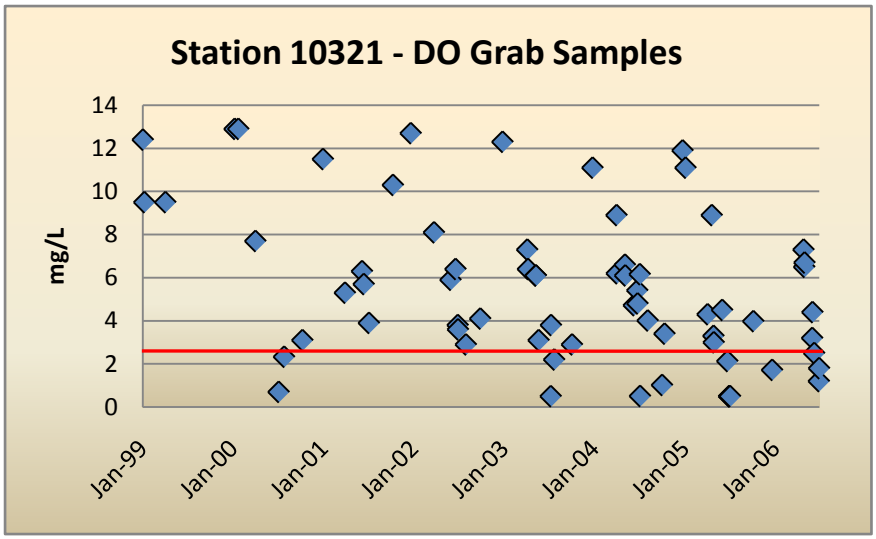


Figure 0407-3: *Dissolved oxygen results for station 10321*

pH

pH data were available for stations 10320 and 10321. Since both stations were in close proximity and there was only limited data from station 10320, results from both stations were combined for the analysis. Twelve percent of the 100 pH samples collected from 1981 to 2008 were below the pH criterion and the median pH value was 6.5 s.u. Since 1998, fifteen percent of the samples were below the pH criterion and the median value for this period was 6.4 s.u. These data support the low pH listing.

Bacteria

E. coli sampling did not begin until 2001. While sixteen percent of the *E. coli* samples exceeded the single sample criterion, the geometric mean criterion was also exceeded with 154 MPN/100 mL. These data support the *E. coli* listing.

Segment 0407A - Beach Creek
(unclassified water body)

Beach Creek originates three miles northwest of Linden in central Cass County and flows southeast for seven miles to its mouth on Iron Ore Lake, near Linden. The stream is intermittent in its upper and middle reaches. The lone station on Beach Creek was located at FM 125. There are no concerns or impairments listed in the *2008 Texas Water Quality Inventory* for this sub-segment.

Segment 0407B - Frazier Creek
(unclassified water body)

Frazier Creek originates five miles southwest of Douglassville in Cass County and flows southeast for 31 miles to its confluence with Jims Bayou to form James Bayou in Marion County. There were two stations on Frazier Creek:

- Station 17619, located at FM 248 northeast of Kildare
- Station 10259, located at US 59 northeast of Linden

There are no concerns or impairments listed in the *2008 Texas Water Quality Inventory* for this sub-segment.

Figure 0407-4: *James' Bayou at CR 1775 (station 10321)*

Segment 0408 - Lake Bob Sandlin

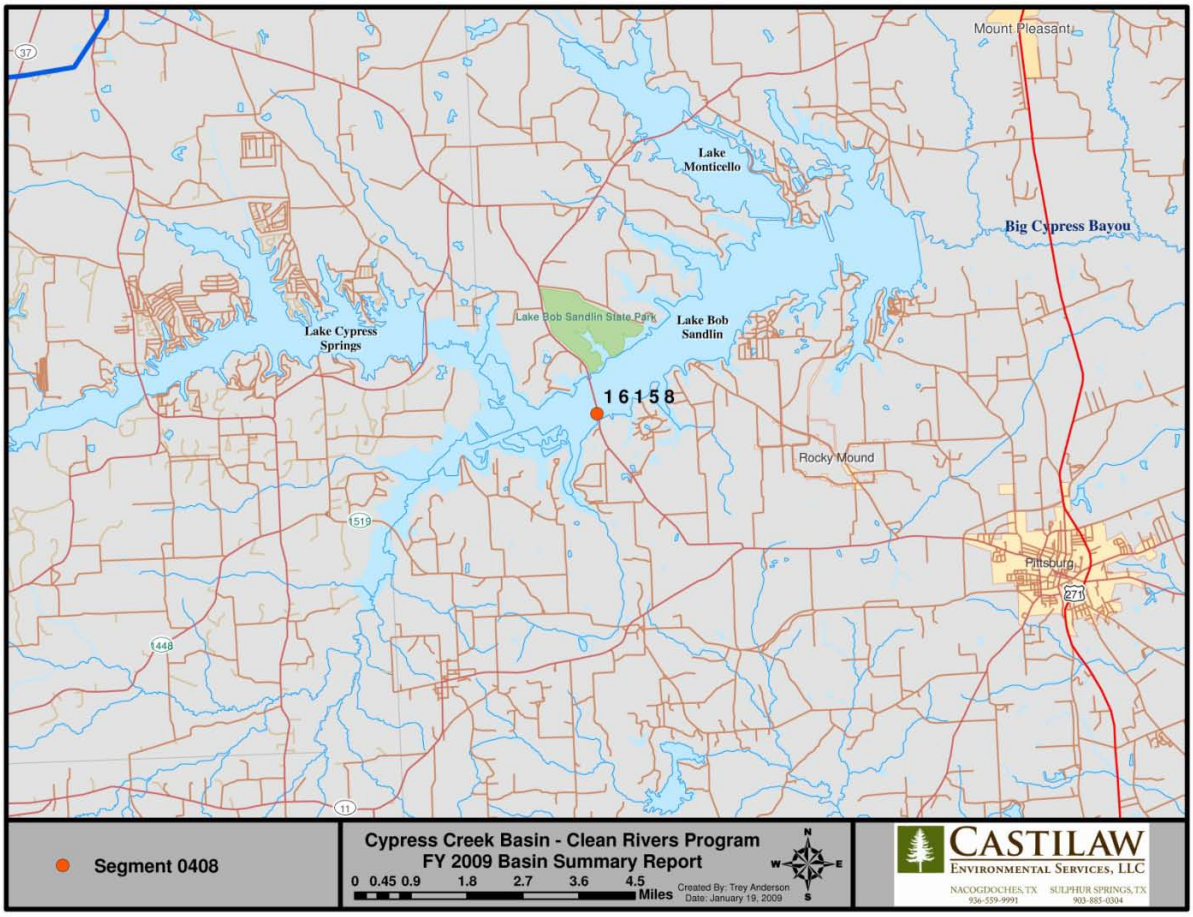


Figure 0408-1: *Sampling stations located in Segment 0408 (Lake Bob Sandlin)*

No segments of Lake Bob Sandlin are included in the *2008 Texas §303(d) List.* The *2008 Texas Water Quality Inventory* includes the lower 2,000 acres of the reservoir near the dam for concerns for non-attainment of cadmium in water.

Coordinated monitoring for FY 2009 includes quarterly sampling for conventionals, bacteria, and field parameters at station 16158 at FM 21, station 17059 at the Mt. Pleasant raw water intake, and at station 17060 at the City of Pittsburg raw water intake.

Table 0408-1: *Parameters of concern for Segment 0408*

0408 AUID	Description	Metals
01	Lower 2000 acres near dam	CN
02	Middle 4460 acres	
03	Upper 3000 acres	

AUID = Assessment Unit ID
CS = Concern for Screening Level
NS = Non-supporting
CN = Concern for Near Non-attainment

Assessment Unit 0408_01

The *2008 Texas Water Quality Inventory* lists this AU as a concern for near non-attainment cadmium. Nineteen cadmium samples have been collected in the AU and all but one were reported as non-detectable. The detectable sample was collected prior to the implementation of "clean metals" techniques. According to TCEQ, metals were not evaluated in the *2008 Texas Water Inventory*, but this listing will likely be removed in the next assessment.

Assessment Unit 0408_02
Assessment Unit 0408_03

There are no parameters or concerns listed in the *2008 Texas §303(d) List* and the *2008 Texas Water Quality Inventory*. These assessment units fully support the criteria.

Segment 0408A - Lake Monticello
(unclassified water body)

Lake Monticello is approximately eight miles southwest of Mount Pleasant in Titus County. This waterbody was not assessed and was not included in the *2008 Texas Water Quality Inventory.*

Segment 0408B - Andy's Creek
(unclassified water body)

Andy's Creek, also known as Anders Creek, rises five miles southeast of Mount Vernon in Franklin County and runs southeast for six miles to its mouth on Lake Bob Sandlin. There is one sampling site on Andy's Creek at Titus CR 2910. There are no concerns or impairments listed in the *2008 Texas Water Quality Inventory* for this sub-segment.

Segment 0408C - Brushy Creek
(unclassified water body)

Brushy Creek originates north of Winnsboro in Franklin County and is joined by the South Fork of Brushy Creek, which rises six miles southeast of Winnsboro in Wood County. The South Fork runs northeast for six miles, briefly forming part of the Wood-Franklin county line. There is one sampling site located on Brushy Creek at FM 115. There are no concerns or impairments listed in the *2008 Texas Water Quality Inventory* for this sub-segment.

Segment 0408D - Blundell Creek

(unclassified water body)

Blundell Creek originates three miles south of Mount Vernon in Franklin County. The stream is intermittent in its upper and middle reaches. There is one sampling site on Blundell Creek at Franklin CR 4130, southwest of Winfield. There are no concerns or impairments listed in the *2008 Texas Water Quality Inventory* for this sub-segment.

Segment 0409 - Little Cypress Creek

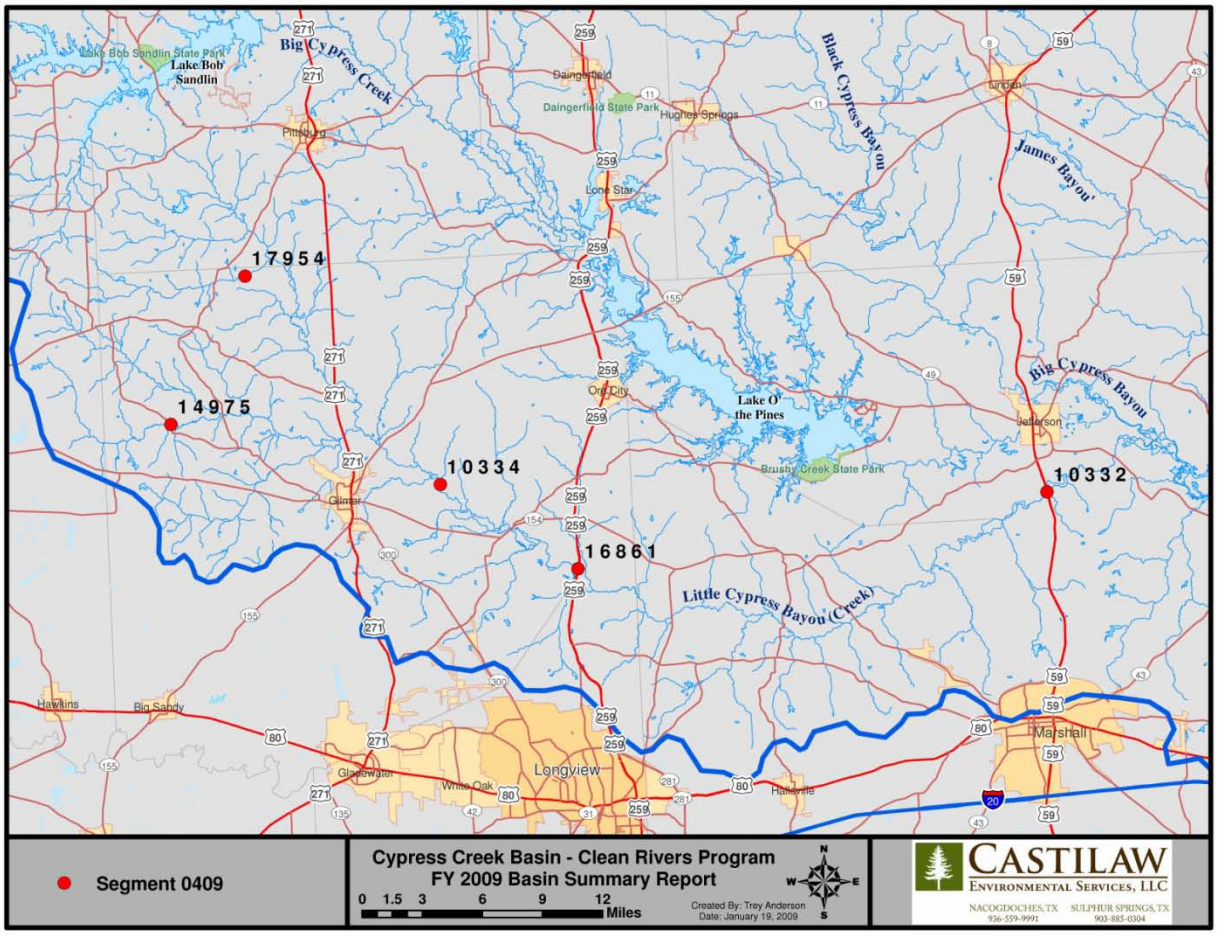


Figure 0409-1: *Sampling stations located in Segment 0409 (Little Cypress Creek)*

Little Cypress Creek originates near FM 2088 in Wood County and flows approximately ninety miles to its confluence with Big Cypress Creek on the Harrison/Marion County line. This segment was included in the *2008 Texas §303(d) List* for low dissolved oxygen levels and elevated bacteria counts. Bacteria was first added to the *§303(d) List* for this segment in 2006.

Segment 0409 is also listed in the *2008 Texas Water Quality Inventory* as having a concern for near non-attainment for DO and bacteria in the 25 mile segment below Highway 271. This reach is also listed as a concern for near non-attainment due to impaired benthic macroinvertebrate community structures, and discussed in the Biological section of this report.

Table 0409-1: *Non-supporting parameters and parameters of concern for Segment 0409*

0409 AUID	Description	DO, 24 HR Avg.	DO, 24 HR Min	DO, Grab	*E. coli*
01	Lower 25 miles	NS			NS
02	Middle 18 miles above Hwy. 154	NS			NS
03	Middle 25 miles below Hwy. 271	NS	CN		CN
04	Upper 25 miles				NS
0409B	Entire segment			CS	NS

AUID = Assessment Unit ID
NS = Non-supporting
CS = Concern for Screening Level
CN = Concern for Near Non-attainment

Coordinated monitoring for FY 2009 includes quarterly sampling by TCEQ regional staff and NETMWD at the stations shown in **Table 0409-2**.

Table 0409-2: *FY 2009 coordinated monitoring for Segment 0409*

Sampling Location	Station ID	Lab Analyses	Bacteria	Field Parameters	Flow
LITTLE CYPRESS CREEK AT US 59	10332	4	4	4	4
LITTLE CYPRESS CREEK AT FM 450	15773	4	4	4	4
LITTLE CYPRESS BAYOU AT US 271	16017	4	4	4	4
LAKE GILMER AT DAM APPROX. 1.5 MILES EAST OF FM 852	17478	4	4	4	4
SOUTH LILLY CREEK AT WOODCHUCK ROAD	17953		4	4	4
SOUTH LILLY CREEK AT FM 2454	17954	4	4	4	4
LAKE GILMER AT UPSHUR CR 852 IN OLD KELSEY CREEK CHANNEL	18825	4	4		4
LILLY CREEK AT FM 556	20153	4	4	4	4

Assessment Unit 0409_01

AU 0409_01 is described as the lower 25 miles of Little Cypress Creek. The downstream boundary is the confluence with Big Cypress Creek on the Harrison/Marion County line. Station 10332 (Little Cypress Creek at US Highway 59) was the only station with data in this AU.

Dissolved Oxygen

This AU is on the *2008 Texas §303(d) List* for not meeting the 24-Hour DO Average criterion. Out of eleven diel measurements, 45% failed to meet the criterion for 24-Hour DO Average. These data support the listing.

E. coli

This AU is listed for exceeding the *E. coli* criteria. Sampling for *E. coli* began in 2001 and four out of 24 (seventeen percent) samples exceeded the single sample criterion for *E. coli*. The geometric mean for these samples was 112 MPN/100 mL. These data do not support the listing for exceeding the *E. coli* criteria.

Assessment Unit 0409_02

This AU is identified as the middle eighteen miles above SH 154. There are two sites in this AU:

- Station 15773, located at FM 450 in Harrison County
- Station 16861, located at US 259 in Upshur County

Dissolved Oxygen

This reach is on the *2008 Texas §303(d) List* for not supporting the 24-Hour DO Average criterion. Ten diel measurements were made at station 15773 and sixtey percent failed to meet the criterion for 24-Hour DO Average. Out of nine diels at station 16861, 56% failed to meet the 24-Hour DO Average criterion. Collectively, 58% failed to meet the criterion in this AU. These data support the listing for not meeting the 24-Hour DO Average criterion.

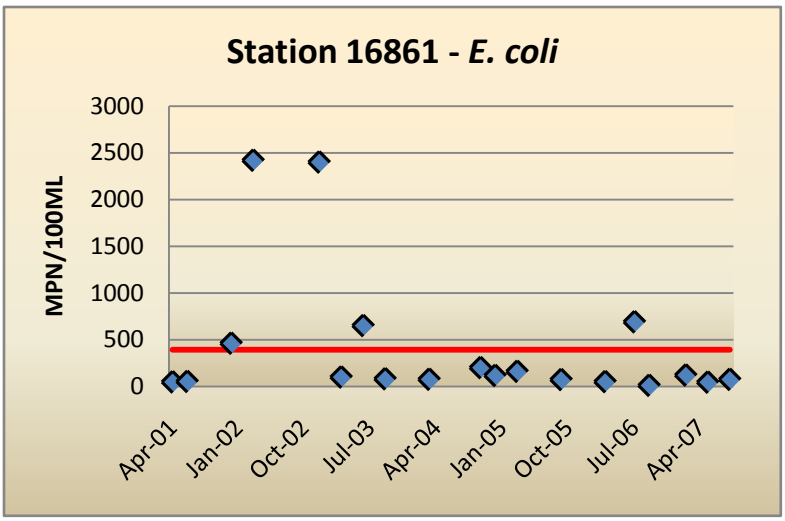


Figure 0409-2: *E. coli results for station 16861*

E. coli

The AU is listed as not supporting the *E. coli* criteria. Five of 22 samples (22%) collected in this AU exceeded the single sample criterion while the geometric mean was 120 MPN/100 mL. Since this AU did not meet the single sample *E. coli* criterion, it supports the listing for *E. coli*.

Assessment Unit 0409_03

AU 0409_03 is the middle 25 miles below US 271 northeast of Gilmer. There were three stations in this AU:

- Station 10333, located at SH 154
- Station 10334, located at FM 555
- Station 10335, located at SH 155

Dissolved Oxygen

This reach is on the *2008 Texas §303(d) List* for not supporting the 24-Hour DO Average criterion. The AU is listed as a concern for near non-attainment of the 24-Hour DO Minimum criterion. Collectively, there were 26 diels performed at stations 10334 and 10335 and 69% failed to meet the 24-Hour DO Average criterion while fifteen percent failed to meet the 24-Hour DO Minimum criterion.

Twelve diels were performed at station 10334 and 75% failed to meet the 24-Hour DO Average criterion and fourteen percent failed to meet the 24-Hour DO Minimum criterion. At station 10335, 64% and seventeen percent of the diels did not meet the 24-Hour DO Average and Minimum criteria, respectively. These data support the listing and concerns for not meeting the 24-Hour DO Average and Minimum criteria.

E. coli

The AU is listed as a concern for near non-attainment of the *E. coli* criteria. Out of the four samples on record, one sample exceeded the single sample criterion and the geometric mean was 171 MPN/100 mL. These data support the concern for this parameter; however, additional sampling is needed in order to provide adequate data for the assessment.

Assessment Unit 0409_04

This AU is the upper 25 miles of the segment and had two stations:

- Station 16017, located at US 271 north of Gilmer
- Station 14975, located at FM 852

E. coli

This AU is on the *2008 Texas §303(d) List* for not supporting the *E. coli* single sample and geometric mean criteria. Out of twenty samples collected in this reach (sixteen from station 14975), 25% exceeded the single sample criterion and the geometric mean was 244 MPN/100 mL. These data support the *E. coli* listing.

Segment 0409A - Lilly Creek

(unclassified water body)

Lilly Creek originates two miles west of Pine in Camp County and flows southeast for nine miles to its confluence with Little Cypress Creek. There is one sampling site on Lilly Creek at US Highway 271 north of Gilmer. There are no concerns or impairments listed for this sub-segment.

Segment 0409B - South Lilly Creek

(unclassified water body)

South Lilly Creek is a branch of Lilly Creek and the sub-segment extends from its confluence with Lilly Creek to approximately two miles west of FM 1647 in Upshur County. South Lilly Creek is included in the *2008 Texas §303(d) List* for not meeting the bacteria criteria. This sub-segment was first added to the *§303(d) List* in 2006. The *2008 Texas Water Quality Inventory* also lists South Lilly Creek as a concern for depressed dissolved oxygen concentrations.

There were two stations in this segment:

- Station 17954, located at FM 2454
- Station 17953, located at Woodchuck Road

Coordinated monitoring for FY 2009 includes quarterly sampling as shown in **Table 0409-2**.

Figure 0409-3: *Middle Lilly Creek at CR 3322 (station 20135)*

Dissolved Oxygen

There is a concern for screening level for DO grab sample values in this sub-segment. Collectively, there have been fifty DO samples collected, and 23 failed to meet the screening level for DO grab sample. Both stations had similar percentages of samples below the screening level. These data support the DO grab sample concern.

E. coli

The *2008 Texas §303(d) List* includes *E. coli* due to exceeding the single sample and geometric mean criteria. There have been nineteen samples collected in the sub-segment; nine at station 17954, and ten at station 17953. Combined, 32% of the samples exceeded the single sample criterion while the geometric mean was 279 MPN/100 mL. These data support the listing for not meeting the *E. coli* criteria.

NETMWD is scheduled to perform quarterly monitoring for field parameters and *E. coli* in FY 2009 at these stations.

Segment 0409D - Lake Gilmer

(unclassified water body)

Lake Gilmer is located in central Upshur County. There were two stations on this reservoir:

- Station 17478 near the dam
- Station 18825 at Upshur FM 852

This AU was assessed in the *2006 Texas Water Quality Inventory* for DO, nutrients, bacteria and toxins in fish tissue. There are no concerns or impairments listed for this sub-segment.

Biological

The Biological chapter is divided into three parts:

- Toxins in fish tissue
- Review of the 2008 Texas Water Quality Inventory listings
- Evaluation of biological assessments performed in the Cypress Creek Basin

Toxins in Fish Tissue

The Texas Department of State Health Services (DSHS) monitors fish for the presence of contaminants and alerts the public through bans or advisories when fish consumption may pose a threat to human health. DSHS has issued fish consumption advisories for Caddo Lake, Big Cypress Creek in Marion County, Pruitt Lake, and Lake Daingerfield due to mercury in fish tissue. In December 2005, DSHS issued a fish consumption advisory for all fish species in Ellison Creek Reservoir due to high levels of PCBs.

The *2008 Texas §303(d) List* includes Segments 0401, 0402, 0402A, and 0404N for not supporting the Mercury in tissue screening level, and Segment 0404A for having elevated levels of PCBs in fish tissue. With the exception of Segment 0406, fish tissues have been sampled from every segment in the Cypress Creek Basin, and mercury was detectable in fish tissue in all of them. At least two samples exceeded the 0.52 µg/g Mercury in fish tissue screening level in Segments 0401, 0402, 0403, and 0404.

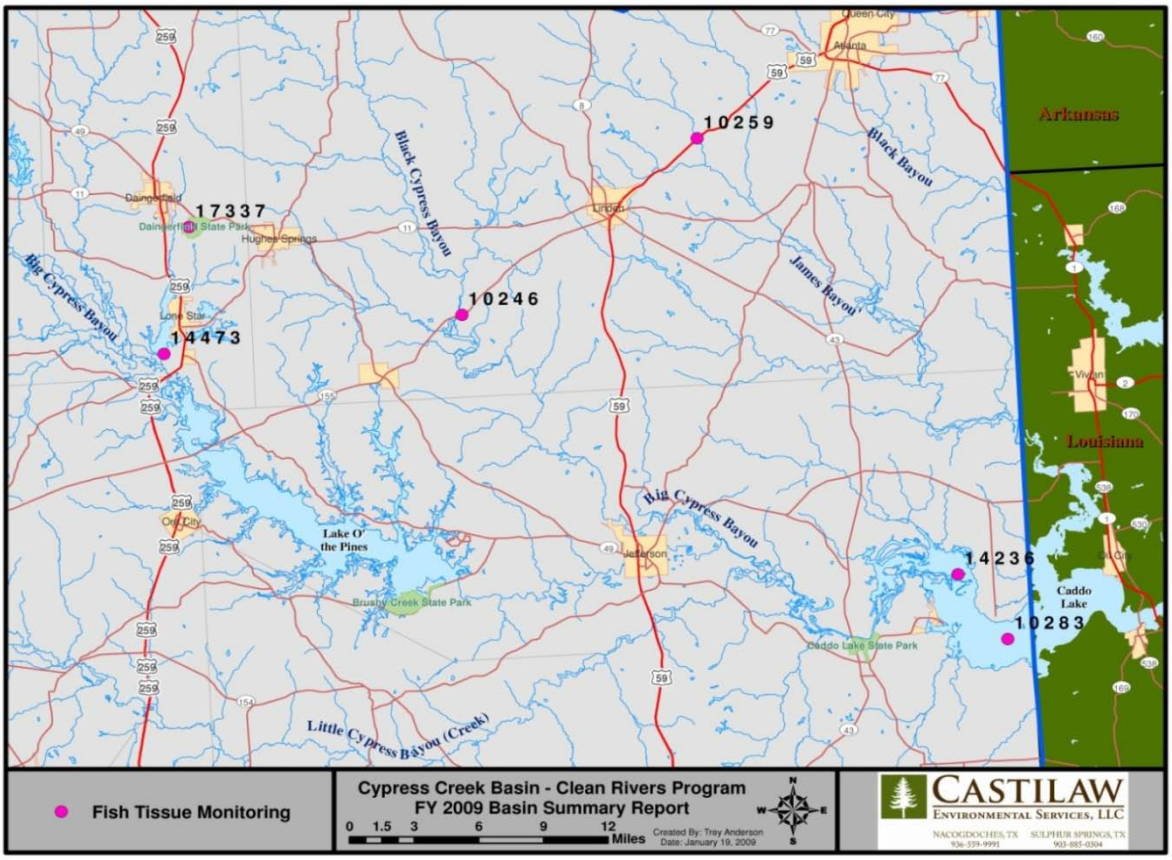


Figure B-1: *Fish tissue monitoring stations in the Cypress Creek Basin*

Segment 0401 - Caddo Lake

The most extensive tissue monitoring in the basin has been conducted in Caddo Lake at six stations across twelve events from 1983 to 2000 (Table B-1). Thirty-six samples were collected at station 14236 and nineteen samples came from station 10283 (Figure B-1). The remaining samples came from stations 10281, 10282, 10285, and 14946. Tissue samples were collected from eight fish species and included fifteen whole fish, 57 edible filets, two livers and four hearts. The mean mercury concentration was 0.52 µg/g, with 28% of the samples exceeding the screening level. Half of the largemouth bass samples exceeded the screening level including eighteen out of 34 filets along with one of the heart samples and both liver samples. A largemouth bass filet had the highest concentration of mercury at 1.35 µg/g. With the exception of one whole spotted gar, no other samples exceeded the screening level. However, it should also be noted that mercury was detectable in every fish species in Caddo Lake regardless of trophic level or functional feeding group.

Table B-1: *Results of Mercury in fish tissue sampling in Caddo Lake from 1983 - 2000*

Segment 0401 Caddo Lake **Mercury in Fish Tissue 1983 – 2000**			
Fish Species	**# of Individuals**	**Hg Detected**	**Exceeded Screening Level**
Black Crappie	1	1	
Chain Pickerel	2	2	
Channel Catfish	8	8	
Freshwater Drum	1	1	
Largemouth Bass	50	50	21
Spotted Gar	3	3	1
White Bass	1	1	
Yellow Bass	12	12	
TOTAL	**78**	**78**	**22**

These results are consistent with the findings of Crowe (1996) and Chumchal, *et al.* (2008). In both studies, all fish collected from Caddo Lake had detectable levels of mercury. Crowe (1996) showed that there was a direct correlation between largemouth bass size and the level of mercury in its tissues. Chumchal *et al.* (2008) further demonstrated that mercury permeates all levels of the food chain and that every organism living in and around Caddo Lake had detectable levels of mercury in its tissue including water hyacinth, mussels, turtles, alligators, cottonmouths, and raccoons.

Segment 0402A - Black Cypress Bayou at SH 155 - Pruitt Lake

Fish tissue samples were collected during four events from 1994 to 1998 at station 10246 (Black Cypress Bayou at SH 155) which is the lower end of Pruitt Lake (Figure B-1). Forty-four filet samples from eleven fish species were analyzed and 81% of these samples exceeded the screening level (Table B-2). The mean mercury concentration for all species was almost twice the screening level at 0.92 µg/g, and a bowfin filet had the highest level of mercury with 2.86 µg/g. Tissues from seven of the eleven fish species exceeded the screening level and mercury was detectable in every sample collected at this station.

Table B-2: *Results of Mercury in fish tissue sampling in Caddo Lake from 1983 - 2000*

Station 10246 - Black Cypress Bayou at SH 155 – Pruitt Lake Mercury in Fish Tissue 1994 – 1998			
Fish Species	**# of Individuals**	**Hg Detected**	**Exceeded Screening Level**
Bigmouth Buffalo	2	2	
Black Crappie	2	2	
Bowfin	3	3	3
Common Carp	2	2	
Channel Catfish	1	1	
Freshwater Drum	3	3	3
Flathead Catfish	5	5	5
Largemouth Bass	10	10	10
Longnose Gar	1	1	1
Spotted Bass	4	4	4
Spotted Gar	4	4	4
TOTAL	**37**	**37**	**30**

These data are consistent with the findings in Twidwell (2000) where five out of six largemouth bass collected in August 1997 had concentrations of mercury above the screening level and was detectable in all tissue samples.

Segment 0402D - Lake Daingerfield

Tissue samples were collected from August to November 2000 at station 17337 (Lake Daingerfield Headwaters, Figure B1). Only three fish species were collected including five channel catfish, one blue catfish and eleven largemouth bass. Thirteen out of seventeen of the filet samples exceeded the screening level with a mean mercury concentration of 0.57 µg/g. All of the largemouth bass, blue catfish and one of the channel catfish samples exceeded the screening level, but mercury was not detected in two of the channel catfish filets.

Segment 0404A - Ellison Creek Reservoir

Seven filet and five whole fish samples were collected and analyzed for PCBs at station 14473 (Ellison Creek Reservoir at the Dam) on June 17, 2002 (Figure B-1). Only three fish species were collected including channel catfish, white crappie and largemouth bass. Three of the seven filet samples had detectable levels of PCBs ranging from 0.15 to 0.18 mg/kg. All five of the channel catfish whole fish and all three of the white crappie filets were below the detection limit of 0.05 mg/kg. Both of the largemouth bass and one of the channel catfish filets were above the detection limit. Additional sampling has been conducted by DSHS, but data were not available in SWQMIS for review.

Segments 0403 – 0409

Fish tissue samples were collected on seven occasions from 1989 to 2006 in Segment 0403 (Lake O' the Pines). Thirty-two filet samples from five fish species were analyzed for mercury in tissue and six percent exceeded the screening level. The mean mercury concentration was 0.20 µg/g with a maximum of 0.66 µg/g. Both samples that exceeded the screening level were largemouth bass filets. Three channel catfish samples were not detectable.

None of the fish tissue samples exceeded the Mercury in tissue screening level for samples collected in:

- Lake Cypress Springs (Segment 0405) near mid-lake
- Frazier Creek at US 59 (Segment 0407B, Station 10259)
- Lake Bob Sandlin (Segment 0408)
- Lake Gilmer (Segment 0409D)

It should be noted that although none of the samples exceeded the screening level, mercury was at detectable levels in all of the fish samples obtained in these segments. In general, channel catfish had the lowest amount and largemouth bass had the highest amount of mercury. Mean mercury concentrations ranged from 0.03 µg/g to 0.4 µg/g for these segments.

Unfortunately, mercury in fish tissue across the Cypress Creek Basin will most likely persist, since mercury does not decay. Once mercury enters a stream or impoundment, it can remain for decades, cycling between the sediment and biota, provided conditions that favor methylation (such as low pH) are present (Twidwell, 2000).

Segment Discussion

The following section discusses the available data in SWQMIS as compared to listings in the *2008 Texas Water Quality Inventory*.

Biological assessments are important in determining whether a segment meets its aquatic life use designation and determining the chronic affects of pollutants on the biota of the stream. The presence and absence of intolerant benthic and fish species along with the number of species collected (richness) are useful indicators of long-term water quality. While intolerant organisms may survive brief periods of water quality impairment, these species are much less likely to endure the impairment over a longer period of time. The presence of intolerant species indicates that the stream has likely had good water quality over an extended period of time.

Figure B-2: *Electrofishing in progress on Hughes Creek at SH 155*

Biological assessments include fish sampling, benthic macroinvertebrate collection, and habitat assessment using physical measurements, description of the stream channel, and identification of the riparian vegetation. Organisms are identified, enumerated, and assigned value using trophic and tolerance levels. A score is the result of tallying these values using a series of metrics. The Rapid Bioassessment (RBA) score is computed for benthic macroinvertebrates; the Index of Biotic Integrity (IBI), fish; the Habitat Quality Index (HQI), habitat measurements.

Segment 0402B - Hughes Creek
Segment 0402E - Kelley Creek

Both Hughes and Kelley Creeks are listed as concerns for impaired habitat and near non-attainment of the benthic Aquatic Life Use (ALU) designation. Both sub-segments have high ALU ratings.

Three biological monitoring events have taken place at station 16936 (Hughes Creek at SH 155, Figure B-2). The first event was conducted in June 2001 and the other two were conducted in July and October 2008. Benthics scores range from 24 in 2001 to 29 in July 2008. The average RBA score was 26.7 (Intermediate), but the 2008 scores were much closer with 29 in July and 27 in October.

The HQI has also changed from the 2001 event to 2008. HQI was 16.5 in 2001 and 19.5 in 2008. This discrepancy is likely due to the clear cut in the field next to the right bank. Field notes from the 2008 habitat assessment state that the field appeared to have been clear cut five to seven years ago. Also of note is that the October sampling event occurred just over two weeks after Hurricane Ike and many trees along the stream corridor had been felled, thereby reducing bank stability. Some of these negative effects on the HQI score were offset by other metrics, especially since the stream was deeper and had a wider wetted width than during the July assessment. It should be noted that although habitat and benthics had Intermediate ratings, the IBI was in the Exceptional range for both events in 2008.

The only monitoring event that has been performed in Kelley Creek was conducted in June 2001 at station 16934 (Kelley Creek at FM 250, Figure B-2). The RBA scored 26 (Intermediate) and the HQI was nineteen (Intermediate). Both the RBA and HQI scored near the High category rating. The IBI score was not available; however, the HQI and RBA are similar to scores for other stations in the segment.

Additional monitoring is needed to properly assess these segments. Presently, CRP has two biological assessments scheduled in Hughes and Kelley Creeks in FY 2009.

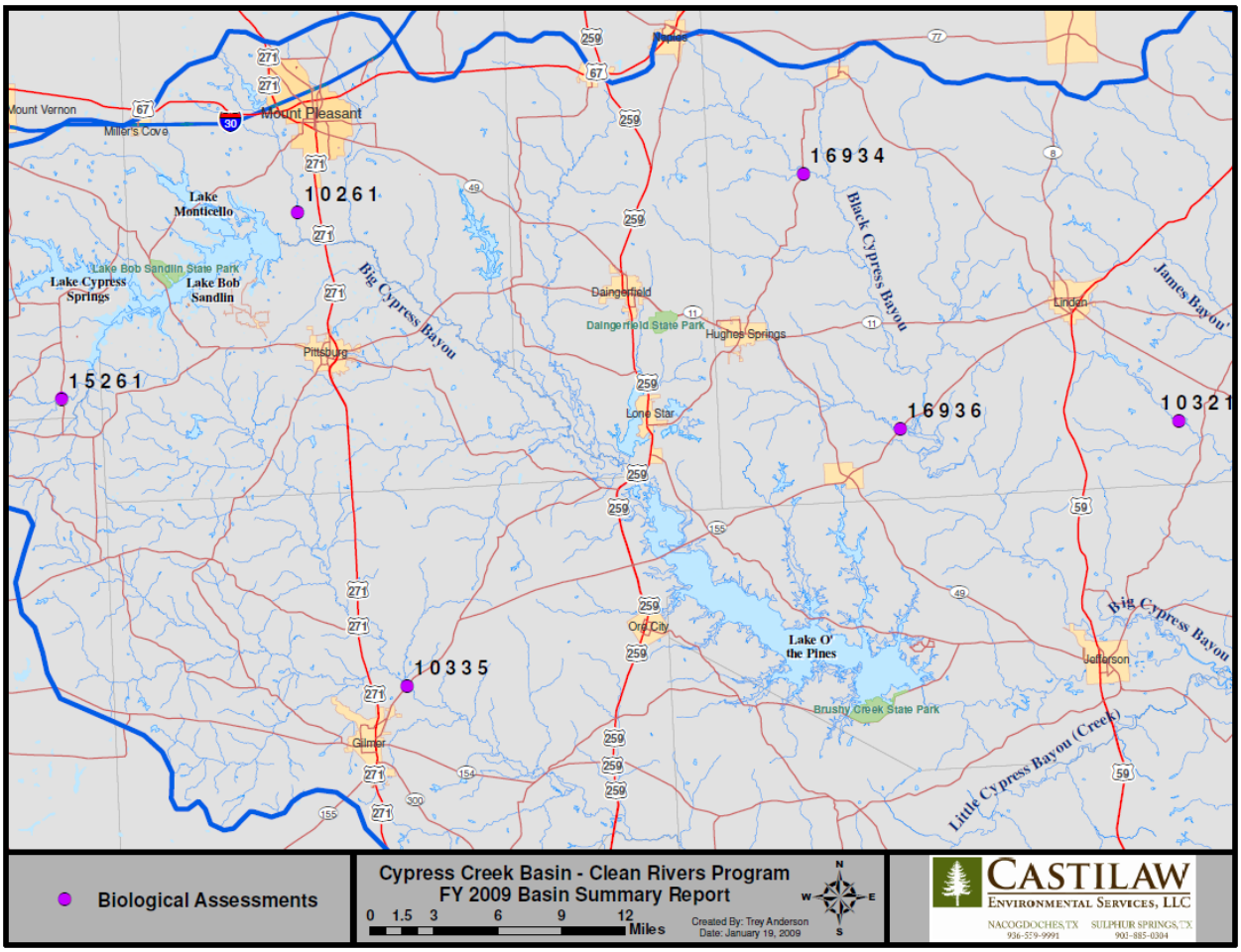


Figure B-3: *Biological monitoring stations in the Cypress Creek Basin*

Segment 0404B_03 - Tankersley Creek

Tankersley Creek is listed as concerns for near non-attainment of designated use for benthic and fish communities since this segment has a High ALU rating. Three biological assessments have been conducted at station 10261 (Tankersley Creek at FM 3417, Figure B-2). The first event was conducted in August 2001 and the other two events occurred in June and August 2003. The average RBA score was 28.3 (High) and the average IBI was 52 (High) when using the statewide IBI ratings. The RBA scores ranged from 22 in 2001 to 34 in June 2003. IBI scores are from fifty in June 2003 to 54 in 2001. Additional monitoring should be conducted to provide adequate data for the assessment, but the available data showed that this reach of Tankersley Creek supports the High ALU designation.

Segment 0408C - Brushy Creek

Segment 0408C is listed as a concern for habitat screening level. Two assessments were performed at station 15261 (Brushy Creek at FM 115) in June and August 2002. The habitat score for both events was seventeen (Intermediate). The habitat score showed the station to have limited in-stream cover, moderately unstable stream banks, and unstable bottom substrates. No additional information was available about the station. The stream scored on the borderline of Intermediate/High for both RBA (27.5) and IBI (47) using the statewide scoring method.

Segment 0409_03 - Little Cypress Creek

Assessment Unit 0409_03 is listed as a concern for near non-attainment for benthics. Two events have been conducted at station 10335 (Little Cypress Creek at SH 155, Figure B2) in July and August 2004. The RBA scores were well within the High category both times with an average of 31.5. The fish community was also high scoring between the High and Exceptional ratings using the statewide metrics. These results do not support the benthic concern and show that this AU meets its High ALU designation.

Biological Assessments

Biological assessments have been conducted by CRP in all but Segments 0406 and 0403 since 2001. With the exception of the UAA performed in 2003 and 2004 (Rogers and Harrison, 2007), there have been no other fish or benthic sampling in Segment 0406 since 1995. A total of 57 biological assessments have been conducted in the Cypress Creek Basin since 2001. The average RBA falls into the Intermediate category; average IBI, High; average HQI, Intermediate (Table B-3). In general, the Cypress Creek Basin supports diverse benthic and fish populations despite regular periods of drought, flooding, summertime low DO and typically turbid water conditions. Overall, 286 benthic taxa and 83 fish species have been collected in the basin. Additionally, out of all of the fish collected over the past eight years, no diseased fish have been noted.

Eleven biological assessments have been conducted at station 10321 (James Bayou at CR 1775) from 2001 to 2006, the most for any station in the basin (Figure B-2). This station is classified as a perennial stream, but goes dry during extended periods of drought. RBA scores have ranged from 22 during the 2006 drought up to 34 in 2004. The average RBA score for this station is 28.1, or Intermediate. IBI scores

were from 42 during the 2006 drought to 56 in August 2003. Using the state-wide metrics, this station had an average IBI of 50.8 which is in the High category. The HQI ranged from 16.5 in August 2002 to 21.5 in June 2002 with an average score of 19.5 (Intermediate/High category). Interestingly, the assessors scored the HQI at 19.5 during the 2006 drought. There was not enough information available to determine the cause for the discrepancy in HQI scores.

Table B-3: *Biological monitoring conducted by CRP with average RBA, IBI and HQI by segment from 2001 – 2008*

CRP Biological Monitoring June 2001 - October 2008				
Segment	**RBA**	**IBI**	**HQI**	**# Events**
0401	29.5 **High**	48.0 **High**	18.0 **Intermediate**	2
0402	25.3 **Intermediate**	52.2 **Exceptional**	19.4 **High**	3
0404	27.5 **Intermediate**	48.9 **High**	21.5 **High**	8
0405	29.0 **High**	47.3 **High**	19.2 **High**	6
0407	26.9 **Intermediate**	49.8 **High**	19.3 **High**	15
0408	26.7 **Intermediate**	45.7 **High**	18.0 **Intermediate**	6
0409	25.8 **Intermediate**	48.9 **High**	16.7 **Intermediate**	14
Scoring Ranges:				
Exceptional	>36	>52	26 - 31	
High	29 - 36	42 - 51	20 - 25	
Intermediate	22 - 28	36 - 41	14 - 19	
Limited	<22	<36	<13	

Although these scores are often viewed individually, each one describes only a single part of the overall stream health and each part can have an impact on the scores of the others. For example, poor habitat quality normally leads to less diverse benthic communities; and fewer benthos, a primary food source for invertivorous fish, often leads to lower IBI scores. Additionally, these scores and taxa lists should be evaluated across similar watersheds and within the same ecoregion in order to gain a better understanding of the overall health of the biotic community.

For example, the UAA for Segment 0406 consisted of sampling at upstream station 16157 (Black Bayou at FM 2791) and downstream station 10314 (Black Bayou at CR 4659) in June/July 2003 and again in July 2004. The average IBI scored in the High category at 44.5; RBA in the Limited range at 20.5, and HQI in the High category at 21. These results showed that Segment 0406 met its aquatic life use designation; that there were no significant biological concerns with the exception of the apparent absence of darters at station 10314; and that the IBI, RBA, and HQI scores were fairly typical of East Texas streams (Rogers and Harrison, 2007).

However, much different conclusions are drawn when comparing these results to those from the rest of the Cypress Creek Basin. Although Segment 0406 had the second highest average HQI score, it had the lowest average IBI and RBA scores in the basin. The next lowest average IBI score was 45.7 in Segment 0408 and average RBA score was 25.3 in Segment 0402. Furthermore, only three darter species were collected at the upstream station in 2003 and only one in the 2004 sampling, while no darters were captured at station 10314 during either event. According to the historical data, slough darters (*Etheostoma gracile*) had been collected at this station during events conducted in September 1994 and August 1995. On average, seven darter taxa have been found in the other segments and at least one darter species has been collected from every station sampled since 2002.

In 2006, the IBI scoring method changed from using a uniform, state-wide format to using ecoregion specific scoring metrics. This change has had little impact on the historical data since most IBI's in the basin were already in the High to Exceptional range. However, the Ecoregion 33 & 35 IBI does not use the number of darter species metric, but uses the number of Cyprinid species instead. Cyprinids were selected as indicator species because darter richness varies greatly among Texas river basins and have distributional limitations, with many western basins having few if any darters present (Linam *et al.*, 1999). Both groups are benthic invertivores and are sensitive to water quality impairments and habitat disturbance, but the Cypress Creek Basin, unlike most of Texas, supports a diverse darter population. Darters typically comprise over fifteen percent of the species richness in most segments (Table B-4). Thirteen darter taxa have been collected in the basin while ten species have been collected in Segment 0404 alone.

Table B-4: *Species richness, number of darter species and darter richness by segment*

Historical Fish Sampling Results			
Segment	**Species Richness**	**Number of Darter Species**	**Darter Richness**
0401	29	3	10%
0402	58	9	16%
0404	57	10	18%
0405	31	5	16%
0407	61	8	13%
0408	37	6	16%
0409	59	10	17%

Out of the eight *Etheostoma* species of darters collected in the basin, *Etheostoma gracile* (Slough darter), *Etheostoma chlorosomum* (Bluntnose darter) and *Etheostoma proeliare* (Cypress darter, Figure B-3) have been found in all segments. *Etheostoma aspriegene* (Mud darter) has only been collected in Segment 0409. The *Percina* species of darters were not as abundant as *Etheostoma spp.* while the majority of the taxa have been identified in Segments 0404 and 0407. Five different *Percina* species have been found in the basin with *Percina sciera* (Dusky darter) being the most common.

Figure B-4: *Etheostoma proeliare (Cypress darter)*

It should be noted that darters are the most imperiled group of North American fishes, with roughly one-third of all darters in some degree of decline (Boschung and Mayden, 2004). Darter species richness varies greatly among river basins and has decreased in their relative proportion of species richness in Texas streams by more than half since 1953 (Anderson et al. 1995). Relative abundance of invertivorous species decreases with degradation, possibly in response to variability in the invertebrate food supply, which in turn reflects alterations of water quality, energy sources, and/or instream habitat (Karr et al. 1986). For these reasons, careful attention should be paid to this group of fishes due to their present abundance and sensitivity to water quality impairments and habitat disturbance.

The average HQI score in the basin is on the borderline of Intermediate and High. Some components of the habitat assessment metrics include the number of riffles, types of substrate, and emergent vegetation. Many streams in the basin will have a reduced HQI score due in part to these metrics (Crowe and Hambleton, 1998). Most perennial streams in East Texas function as glide/pool rather than as riffle/run. Streams typically have low velocity and due to the murkiness of the water, it is often difficult to determine where a pool begins and ends without making stream width and depth measurements.

Riffles are not common in the watershed and are mostly found in the western portion of the basin. When riffles are present, they are usually in small, intermittent streams that often become completely dry without pools during extended periods of drought. While it is common to find aquatic plants along stream margins, due to the high turbidity, erosional sediments and heavy tree canopy, emergent macrophytes are rarely encountered within the stream channel.

Even though the riparian zone may be completely natural and show few, if any, signs of human impact, the HQI may still score at the low end of the High range or at the upper end of the Intermediate range. For example, Frazier Creek is considered an ecoregion reference stream and has been classified as a "Least Disturbed Stream" (Bayer *et al.*, 1992; Linam *et al*., 1999). Due to these designations, one would expect HQI scores for Frazier Creek to be in the High or Exceptional categories. However, the assessors scored the habitat at 18.5 (Intermediate) during both monitoring events in 2003.

While diverse habitats such as riffles and emergent vegetation are important to supporting diverse biota, an ecoregion-specific habitat assessment should be developed to better describe streams within the Cypress Creek Basin especially when considering that least impacted reference sites should represent realistic, attainable conditions for aquatic ecosystems (Omemik, 1995).

RBA's in the Cypress Creek Basin often fall into the Intermediate category, as well (Crowe and Bayer, 2005, Rogers and Harrison, 2007). One might infer that impaired water quality is negatively affecting benthic diversity; however, the benthic population is very diverse with over 285 species collected in the watershed. Over 170 benthic taxa have been found in Segment 0404, followed by 145 in Segment 0407 and 125 in Segment 0409.

If impaired water quality was having a negative impact on the benthic community, then it should also negatively affect the fish community, which is not the case in the basin. The lack of diverse habitats in the basin likely has as much impact on RBA scores as impaired water quality. Additionally, some of the state-wide scoring metrics are not applicable and/or carry too much weight for the types of benthos found in this region. The present metrics include the abundance of EPT taxa (Ephemeroptera, Plecoptera, Trichoptera) and percent Elmidae.

Although species within the EPT families are found in the basin, due to the lack of riffles, emergent plants, clear water and rock/gravel substrate, these species are not abundant. Many species of mayflies (Ephemeroptera) and stone flies (Plecoptera) in particular have fine gills that cannot function efficiently in the turbid waters commonly found in the basin, thus are seldom present in abundant numbers. These organisms, along with the caddisflies (Trichoptera) and riffle beetles (Elmidae) require stable substrates, such as gravel or rock bed streams. Only a few species within these four families are adapted to the turbid water and silty bottomed streams commonly found in East Texas. While the lack of diverse habitat plays a major role in limiting the number of intolerant benthic species, ecoregion-specific RBA metrics should also be developed to more adequately evaluate the benthic community.

Segment Rankings

Segments 0404 and 0407 appeared to have the most diverse biota in the Cypress Creek Basin followed by Segment 0409. Segment 0404 has an Intermediate ALU designation (except Tankersley and Hart Creeks, which have site specific High ALU designation); however, it had the third best IBI average score, the most darter taxa, the highest average fish species richness, and the highest average number of intolerant fish species. This segment also had a moderate RBA average, the second highest average benthic richness and the highest HQI average in the basin.

Segment 0407 also has an Intermediate ALU designation, but the segment had the second highest average IBI score, third in fish species richness, and was tied for the most number of intolerant fish species. The benthic community was not as diverse and scored in the middle of all segments in RBA average, species richness and number of intolerant species. The HQI average was in at the low end of the High range.

Segment 0409 should also be mentioned due to its diverse fish population. This segment had the lowest average HQI score and second lowest average RBA. However, it was tied for first with the number of darter species and was second in average fish species richness and average number of intolerant species.

Based upon the results of the UAA performed in Segment 0406, this was the most impaired segment in the basin. Although this segment had one of the highest average HQI scores, it had the lowest average IBI and RBA scores. The apparent absence of darters at station 10314 is especially concerning since at least one darter species has been collected from every station monitored since 2002 and had been found at this station on both events in 1994 and 1995. Additional biological monitoring should be conducted in this segment to corroborate the results of the UAA.

Figure B-5: *A habitat assessment in progress on Hughes Creek at SH 155*

Conclusions and Recommendations

Conclusions

Nutrient enrichment appears to be a significant threat to the water quality and the biological community in the Cypress Creek Basin. The results of trend analyses and the segment review show that the process of eutrophication is occurring throughout much of the basin, except in Black Cypress Creek and Little Cypress Creek. As a result of the lack of freshwater inflow in the Big Cypress Creek watershed due to lower than average annual rainfall and reduced releases from Lake Bob Sandlin, the water has become increasingly more dominated by effluent over the past decade. This is demonstrated by the statistically significant increasing pH and Specific Conductance/Total Dissolved Solids trends in Big Cypress Creek below Lake O' the Pines and Big Cypress Creek below Lake Bob Sandlin (Segments 0402 and 0404, respectively). Elevated nutrient concentrations have resulted in increased phytoplankton productivity in these watersheds. As primary producers consume the available carbon dioxide in the water column through the process of photosynthesis, carbonic acid is reduced, resulting in higher pH.

Other signs of eutrophication are the increasing phosphorus trends at stations 13631 and 10308 in Segment 0404 and the resulting increasing chlorophyll *a* trends at the mid-lake (16156) and dam (10296) stations in Lake O' the Pines. These effects continue downstream with an increasing pH trend at the mid-lake station (15249) in Caddo Lake near Uncertain.

A similar increasing trend for Chlorophyll *a* and a decreasing trend for DO are occurring in Segment 0406. These water quality impairments appear to be negatively impacting the biota of Black Bayou. This segment had the lowest average IBI and RBA scores in the basin. Darters were not collected at station 10314 during the UAA study, but had been found at this station in 1994 and 1995. The absence of darters is especially concerning since they are abundant across much of the Cypress Creek Basin, and are sensitive to water quality impairments and habitat disturbance.

Elevated *E. coli* in Segments 0404 and 0409 are concerning since this is often associated with improperly treated effluent and non-point sources such as malfunctioning septic systems and agricultural run-off. With the exception of Segment 0406, the impaired water quality has caused no significant adverse affects on the biological communities, especially when considering that 0404 and 0409 support some of the most diverse fish populations in the watershed. However, the biological record is limited, and the majority of the assessments have been conducted over the past ten years. Continued nutrient inputs into the basin will likely lead to the reduction of intolerant species as demonstrated by the UAA on Black Bayou (Segment 0406).

Low DO concentrations in the summer and low pH occur naturally in East Texas. Excessive nutrient inputs increase primary productivity which leads to wider daily swings in DO and pH. Eventually, these impairments negatively impact the biological community as demonstrated in Blcak Bayou. Efforts to reduce nutrient loadings, such as those used in the Lake O' the Pines TMDL, should be considered across most of the Cypress Creek Basin.

Recommendations

Routine monitoring on the main stem and reservoir stations where significant trends were identified should be continued in order to determine if these trends endure over the coming years. These trends can also be used to determine if signs of eutrophication are changing or reversing as Best Management Practices and TMDL measures are implemented across the basin.

Since nutrient enrichment leads to increased primary productivity and results in wider DO and pH swings over a 24-hour period, regular diel monitoring should be conducted at stations with nutrient, *E. coli* and/or chlorophyll *a* concerns or impairments. Additionally, diels should be performed throughout the entire year, especially where DO and pH concerns or impairments exist. Diel data are useful in evaluating the process of eutrophication in a stream and are helpful in separating seasonal cycles from chronic impairments.

Sediment Oxygen Demand (SOD) testing should be conducted in the wetland areas of Caddo Lake. These data will be useful in evaluating the amount of oxygen that sediment and organisms associated with the sediment require on a daily or per square meter basis. At present, the sediment is assumed to be an oxygen "sink" although there are no SOD data available from Caddo Lake to support this assumption. SOD testing could be used to determine overall impact of the sediment on the DO dynamics in Caddo Lake.

Fish sampling should be conducted in support of environmental flows from Lake O' the Pines that are scheduled to begin later in the year. The U.S. Army Corps of Engineers will begin varying the releases from Lake O' the Pines in order to emulate natural flow cycles, including periods of high and low flow. It is anticipated that the same total amount of water may be released on an annual basis; however, that water may no longer be released uniformly. Environmental flows are expected to affect fish assemblages in Segment 0402. In order to document current conditions, a special study on the fish populations of Segment 0402 should be conducted. Fish sampling should also be performed on Little Cypress Creek which has one small impoundment (Lake Gilmer) and Black Cypress Creek (which has no impoundments) to serve as controls. This special study should be repeated every few years in order to document changes in fish community structures over time.

At least one more biological assessment should be conducted in Segment 0406 at station 10314 to corroborate the results of the UAA and to determine if darters are no longer present at this location.

Citations

Anderson, A.A., C. Hubbs, K.O. Winemiller, and R.J. Edwards. 1995. Texas freshwater fish assemblages following three decades of environmental change. Southwestern Naturalist 40: 314-321.

Bayer, C.W., J.R. Davis, S.R. Twidwell, R. Kleinsasser, G.W. Linam, K. Mayes, and E. Hornig. 1992. Texas aquatic ecoregion project: an assessment of least disturbed streams. Unpublished report. Texas Natural Resource Conservation Commission, Austin, Texas. 406 pp.

Blair, Michelle. 2008. "Re: Segment 407". Email to Randy Rushin. Sent: November 14, 2008.

Blair, Michelle. 2009. "Re: Re: Fwd: Draft FY09 Cypress Creek Basin Summary Report". Email to Randy Rushin. Sent: February 19, 2009.

Chumchal, M, P. Smith, G. Cobb, T. Rainwater, F. Bailey. 2008. Final Report: Assessment of mercury contamination and biomagnification in the food web of Caddo Lake. Caddo Lake Institute. Marshall, Texas. 33 pp.

Crowe, Arthur. 2009. "Re: Basin Summary Report". Email to Randy Rushin. Sent: March 12, 2009.

Crowe, Arthur. 1996. A survey of mercury concentrations in the Cypress Creek and Upper Sabine River Basins of Northeast Texas. Texas Natural Resource Conservation Commission. Austin, Texas.

Crowe, A. and C. Bayer. 2005. A biological, physical, and chemical survey of a least-impacted watershed: Black Cypress Bayou (Creek), Texas, 1998 to 2005. TCEQ AS-197. Texas Commission on Environmental Quality, Austin, Texas.

Crowe, A. and F. Hambleton. 1998. Cypress Creek Basin aquatic life use and dissolved oxygen concentrations during low-flow, high-stress summer conditions, 1995-1996. TNRCC AS-157\SR. Texas Natural Resource Conservation Commission, Austin, Texas. 58 pp.

Karr, J.R., K.D. Fausch, P.L. Angermeier, P.R.Yant, and I.J. Schlosser. 1986. Assessing biological integrity in running waters, a method and its rationale. Special Publication 5. Illinois Natural History Survey, Champaign, Illinois. 28 pp.

Linam, G., L.J. Kleinsasser and K.B. Mayes. 2002. Regionalization of the index of biotic integrity for Texas streams. River Studies Report No. 17. Texas Parks and Wildlife Department, Austin, Texas.

Rogers, A and B. Harrison. 2007. DRAFT Use Attainability Analysis, Segment 0406. Texas Commission on Environmental Quality, Austin, Texas.

State of Texas. Texas Administrative Code. Chapter 307, in Part One, of Title 30.
http://secure.sos.state.tx.us/pls/pub/readtac$ext.ViewTAC?tac_view=4&ti=30&pt=1&ch=307&rl=Y
(Accessed December 30, 2008).

TCEQ. 2006. Lake O' the Pines: A TMDL Project for Dissolved Oxygen.
http://www.tceq.state.tx.us/implementation/water/tmdl/19-lakeopines.html#tmdls
(Accessed December 26, 2008).

TCEQ. Surface Water Quality Procedures. Volume One and Two.
http://www.tceq.state.tx.us/compliance/monitoring/water/quality/data/wqm/mtr/swqm_procedures.html
(Accessed October 3, 2008).

TCEQ. 2008. SWQM Guidance and Forms
http://www.tceq.state.tx.us/compliance/monitoring/water/quality/data/wqm/mtr/swqm_resources.html#biopacket
(Accessed September 3, 2008).

TCEQ. 2006. Texas Water Quality Inventory and 303(d) List.
http://www.tceq.state.tx.us/assets/public/compliance/monops/water/08twqi/2008_303d.pdf
(Accessed December 26, 2008).

TCEQ. 2008. Texas Water Quality Inventory and 303(d) List.
http://www.tceq.state.tx.us/assets/public/compliance/monops/water/08twqi/2008_303d.pdf
(Accessed December 26, 2008).

TCEQ. 2009. Texas Clean Rivers Program Guidance, FY 2008-09.
http://www.tceq.state.tx.us/compliance/monitoring/crp/guidance/guide-0809.html
(Accessed September 24, 2008).

Twidwell, S. 2000. Bioaccumulation of Mercury in Selected East Texas Water Bodies. TNRCC AS-180. Texas Natural Resource Conservation Commission, Austin. Texas.

Appendix A

Water Quality Standards

- Aquatic Life Uses
- Water Quality Criteria
- Screening Levels

TCEQ assesses water quality data using the criteria shown below. When 10% or more of the sample data exceeds the criteria for DO, pH or *E. coli*, the segment is listed as not supporting the stream criteria for a parameter. When 20% or more of the sample data exceeds the screening level for Ammonia-nitrogen, Nitrate-nitrogen, Phosphorus or Chlorophyll *a*, the segment is listed as a screening level concern. The tables below list the criteria by parameter.

Table AA-1: *Aquatic Life Use for Cypress Creek Basin. CR: Contact Recreation; H - High; I - Intermediate; PS - Public Supply*

Segment Number	Segment Name	Recreation	Aquatic Life Use	Domestic Water Supply	DESCRIPTION
0401	Caddo Lake	CR	H	PS	from the Louisiana State Line in Harrison/Marion County to a point 12.3 kilometers (7.6 miles) downstream of SH 43 in Harrison/Marion County, up to the normal pool elevation of 168.5 feet
0402	Big Cypress Creek below Lake O' the Pines	CR	H	PS	from a point 12.3 kilometers (7.6 miles) downstream of SH 43 in Harrison/Marion County to Ferrell's Bridge Dam in Marion County
0403	Lake O' the Pines	CR	H	PS	from Ferrell's Bridge Dam in Marion County to a point 1.0 kilometer (0.6 mile) downstream of US 259 in Morris/Upshur County, up to the normal pool elevation of 228.5 feet
0404	Big Cypress Creek below Lake Bob Sandlin	CR	I	PS	from a point 1.0 kilometer (0.6 mile) downstream of US 259 in Morris/Upshur County to Fort Sherman Dam in Camp/Titus County
0405	Lake Cypress Springs	CR	H	PS	from Franklin County Dam in Franklin County up to the normal pool elevation of 378 feet
0406	Black Bayou	CR	I	PS	from the Louisiana State Line in Cass County to FM 96 in Cass County
0407	James' Bayou	CR	I	PS	from the Louisiana State Line in Marion County to Club Lake Road northwest of Linden in Cass County
0408	Lake Bob Sandlin	CR	H	PS	from Fort Sherman Dam in Camp/Titus County to Franklin County Dam in Franklin County, up to the normal pool elevation of 337.5 feet
0409	Little Cypress Creek (Bayou)	CR	H	PS	from the confluence with Big Cypress Creek in Harrison County to a point 1.0 kilometer (0.6 mile) upstream of FM 2088 in Wood County

Table AA-2: *Water quality criteria*

Water Quality Criteria			
Parameter	**Criteria**		**Calculation Used for Impairment**
Dissolved Oxygen	Grab Sample	3 mg/L	10% of samples below criterion
	24-Hour DO Average	5 mg/L	
	24-Hour Minimum	3 mg/L	
Dissolved Oxygen for Segments 0404, 0406, and 0407*	Grab Sample	3 mg/L	10% of samples below criterion
	24-Hour DO Average	4 mg/L	
	24-Hour Minimum	3 mg/L	
pH	6.0 - 8.5 standard units		10% of samples below criterion
pH for Segment 0408*	6.5 - 9.0 standard units		10% of samples below criterion
pH for Segment 0409*	5.5 - 8.5 standard units		10% of samples below criterion
E. coli	Geometric Mean	126 MPN/100 mL	Geometric mean above criterion
	Single Sample	394 MPN/100 mL	25% of single samples above criterion

** - Segment specific criteria*

Table AA-3: *Water quality screening levels*

Water Quality Screening Levels			
Parameter	**Stream**	**Reservoir**	**Calculation Used for Concern**
Ammonia-nitrogen	0.33 mg/L as N	0.11 mg/L as N	20% of samples are above the screening level
Nitrate-nitrogen	1.95 mg/L as N	0.37 mg/L as N	
Total Phosphorus	0.69 mg/L as P	0.2 mg/L as P	
Ortho-phosphate	0.37 mg/L as P	0.05 mg/L as P	
Chlorophyll *a*	14.1 µg/L	26.7 µg/L	

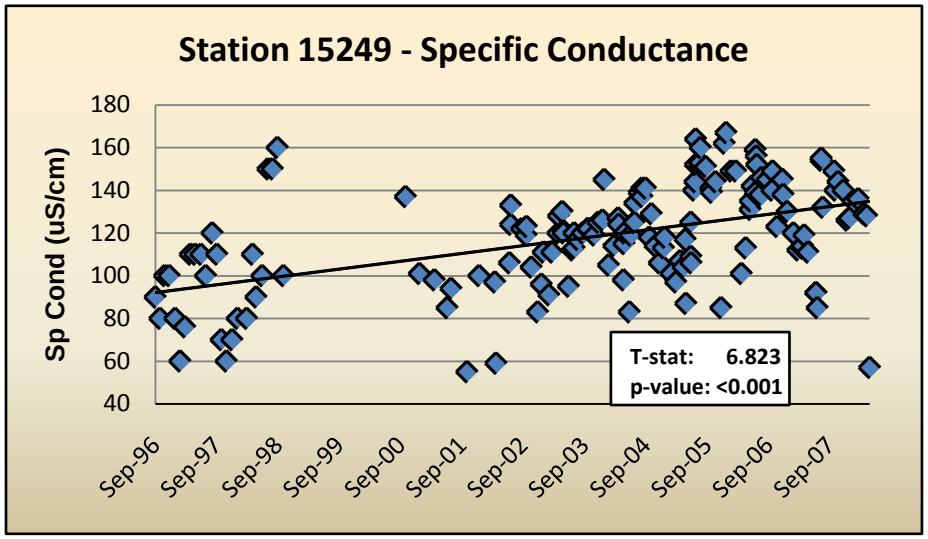
Table AA-4: *Toxics screening levels in water*

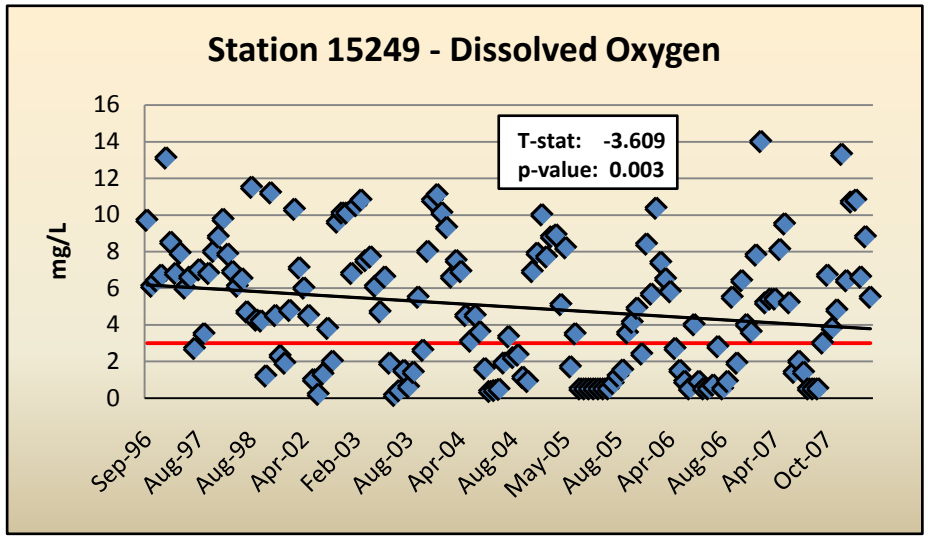
Toxics Screening Levels in Water		
Parameter	**Criteria (as Dry Wt.)**	**Calculation Used for Concern**
Arsenic (As)	33 mg/kg	Average value for all samples.
Cadmium (Cd)	5 mg/kg	
Chromium (Cr)	111 mg/kg	
Copper (Cu)	149 mg/kg	
Iron (Fe)	40,000 mg/kg	
Lead (Pb)	128 mg/kg	
Manganese (Mn)	1,100 mg/kg	
Mercury (Hg)	1.6 mg/kg	
Nickel (Ni)	48.6 mg/kg	
Polychlorinated Biphenyls (PCBs)	0.13 µg/kg	
Silver (Si)	2.2 mg/kg	
Zinc (Zn)	459 mg/kg	

Appendix B

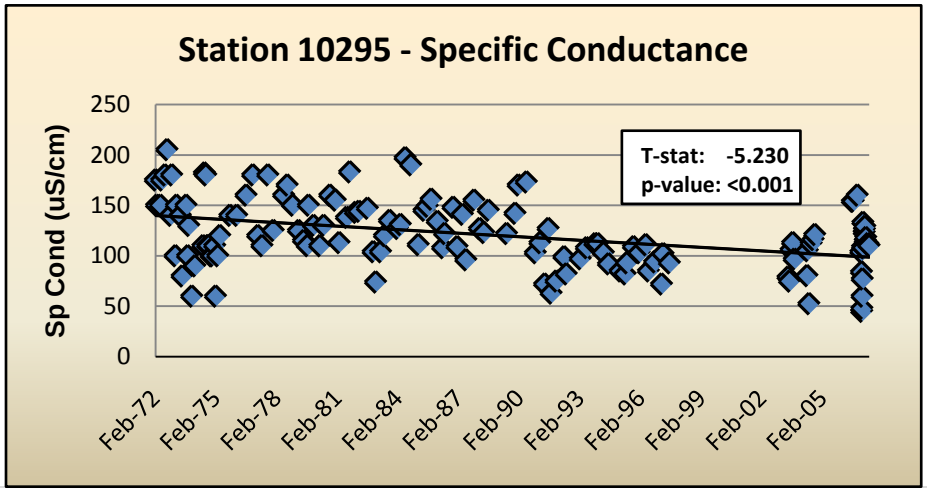
Statistically Significant Trends

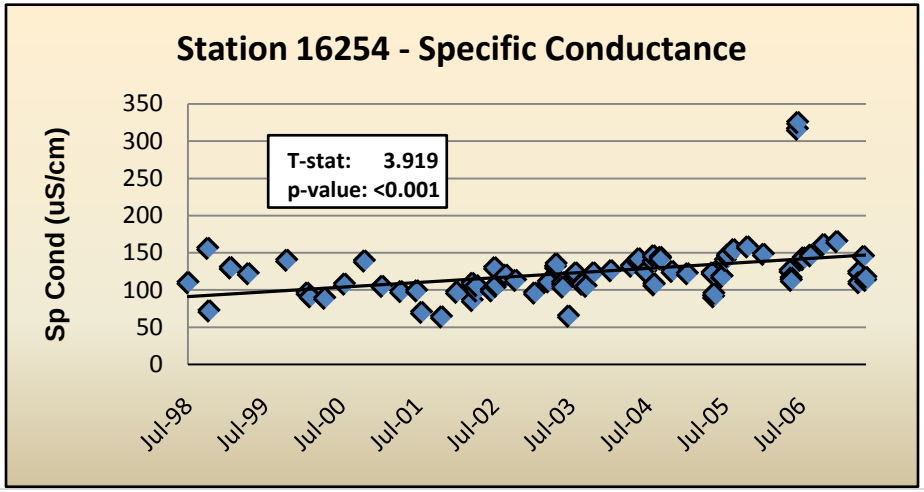
Significant Trends for the Cypress Creek Basin
Segment 0401 - Caddo Lake

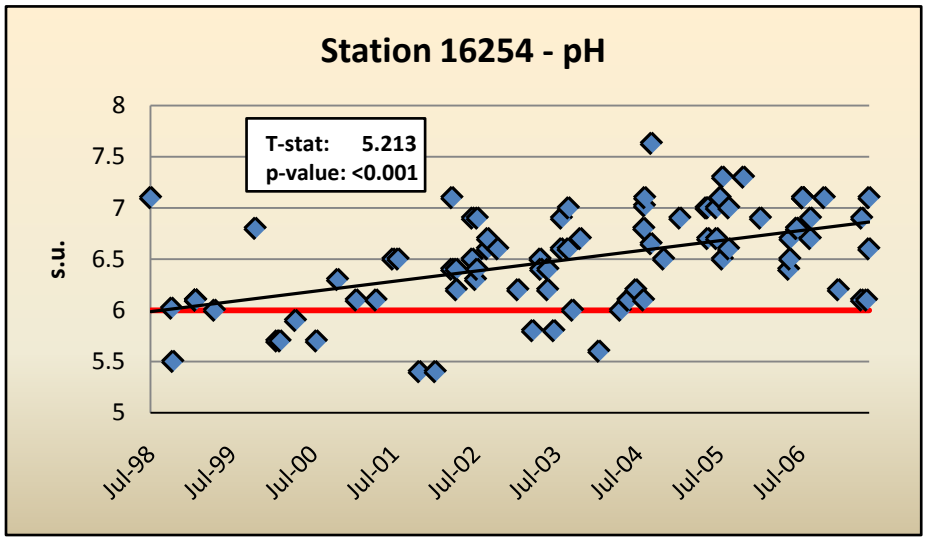


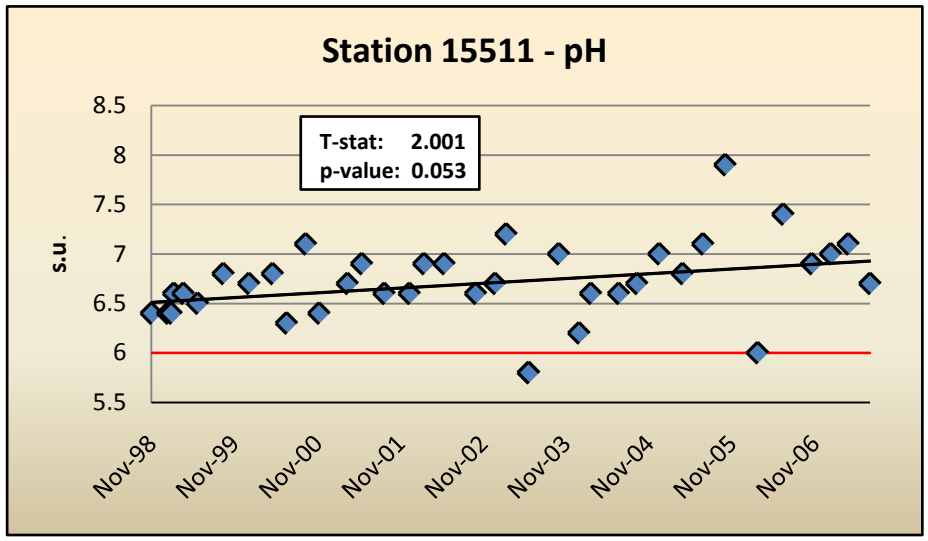


Segment 0402 – Big Cypress Creek below Lake O' the Pines

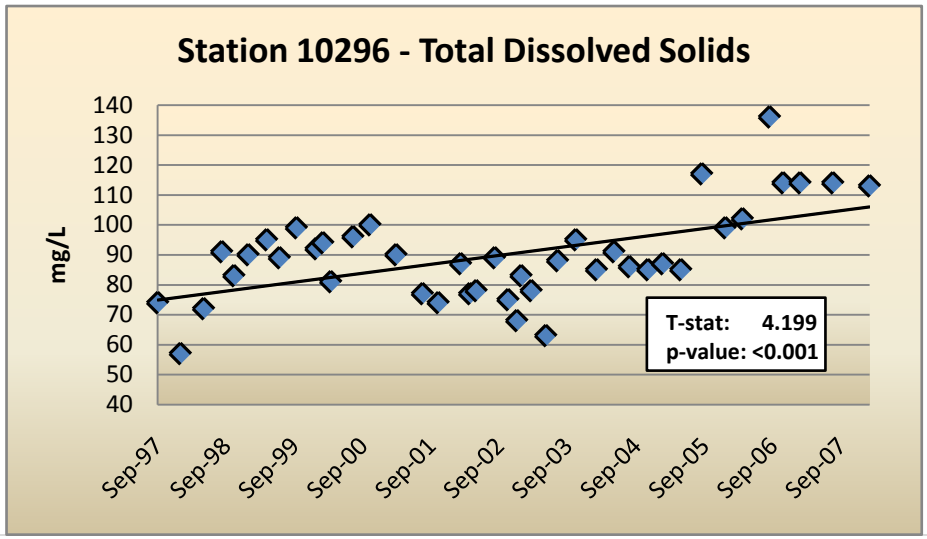


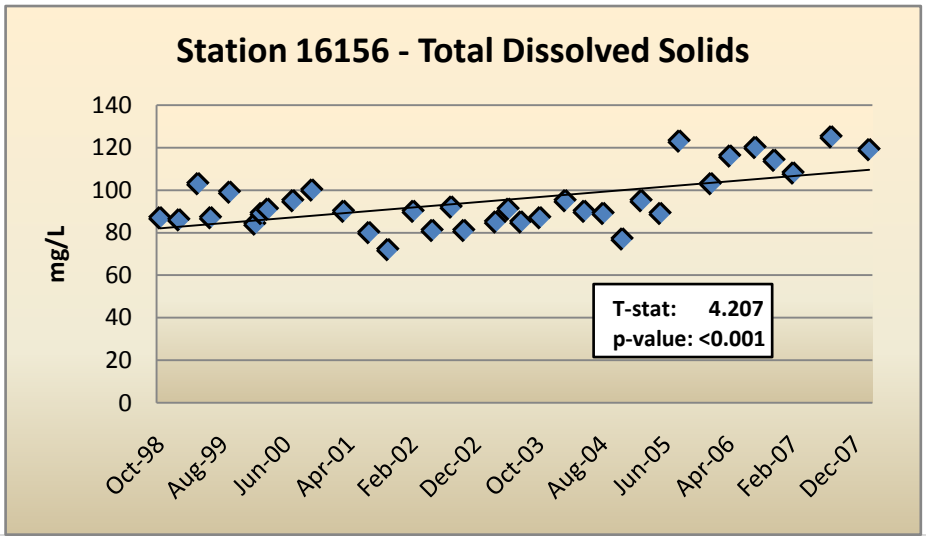


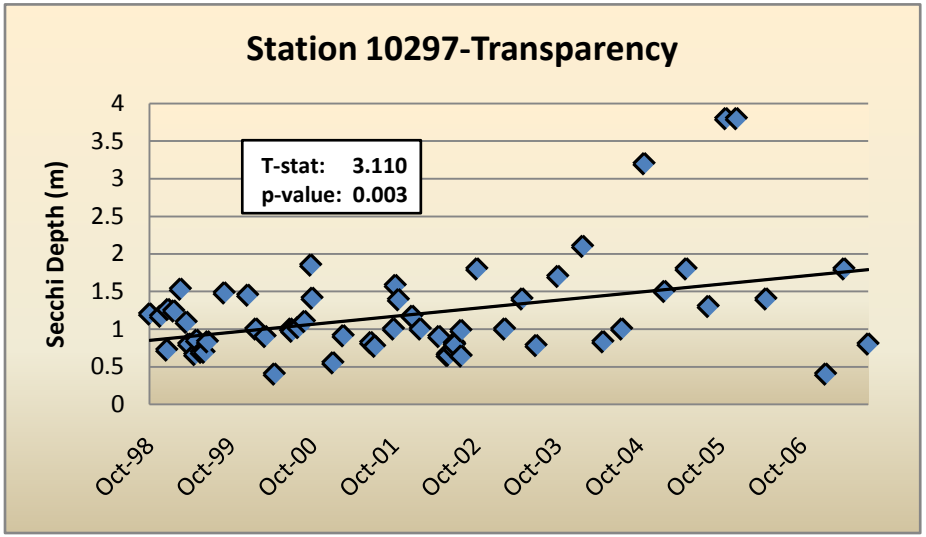


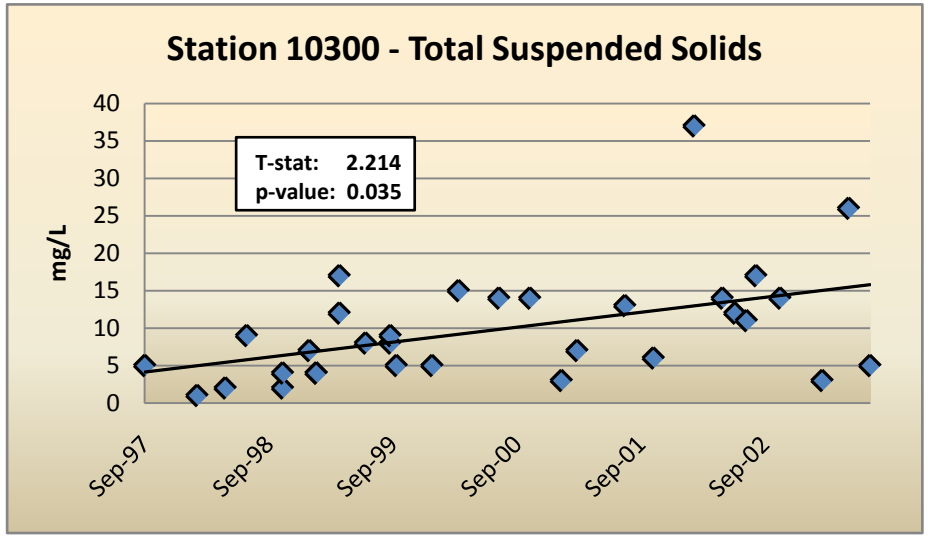


Segment 0403 – Lake O' the Pines

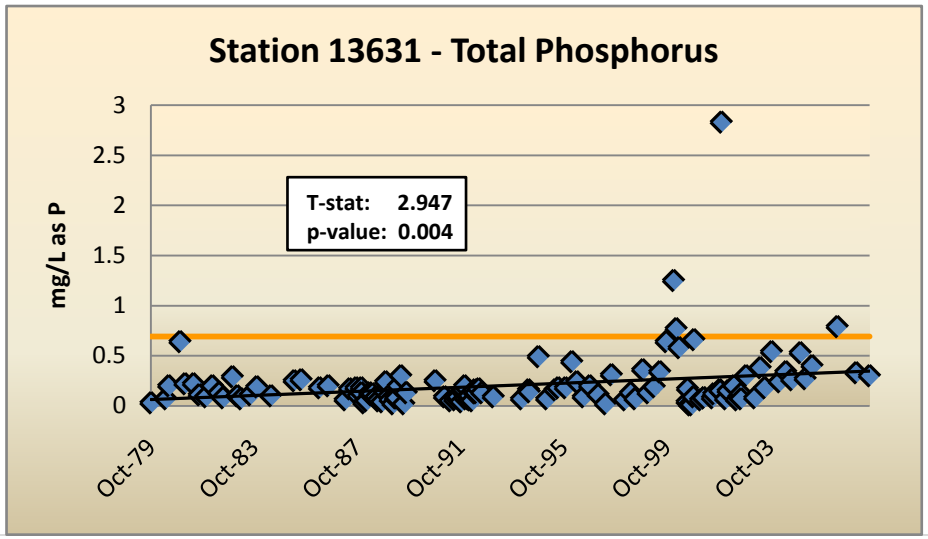


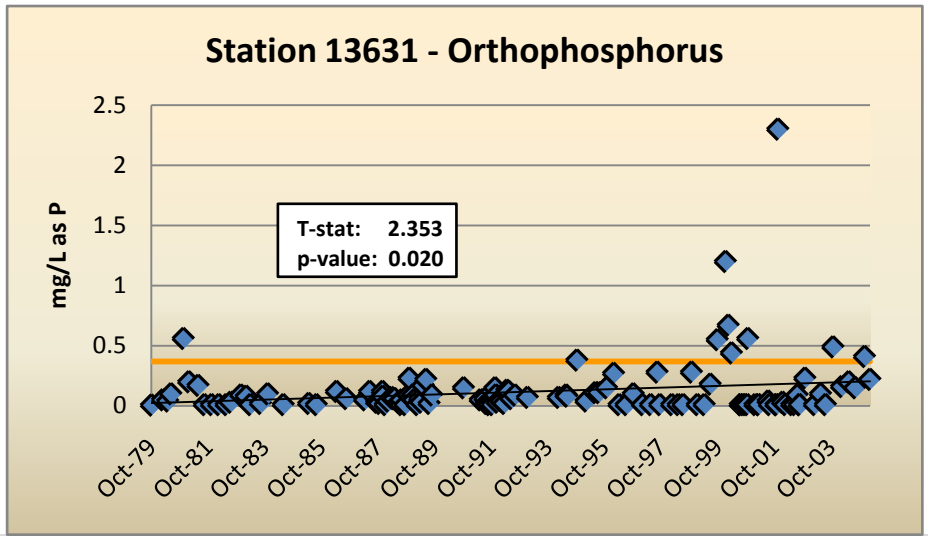


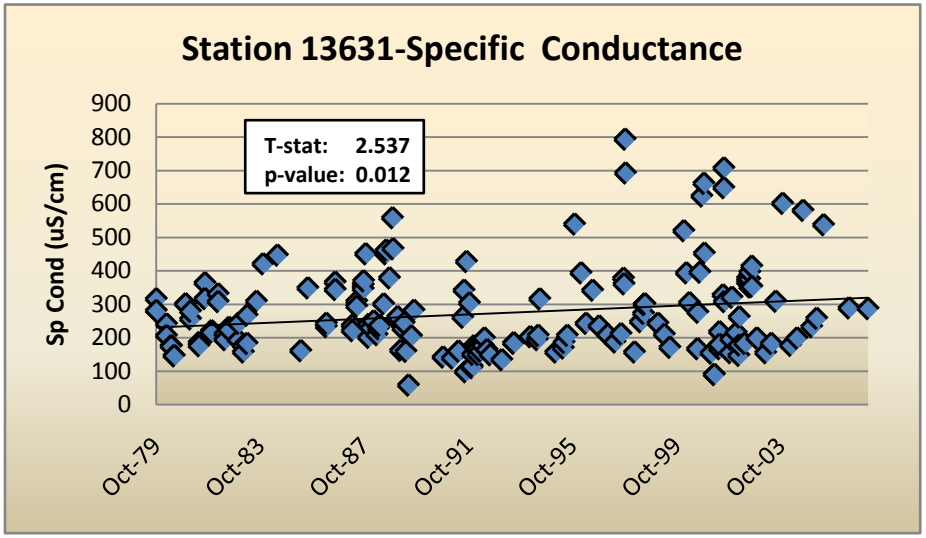


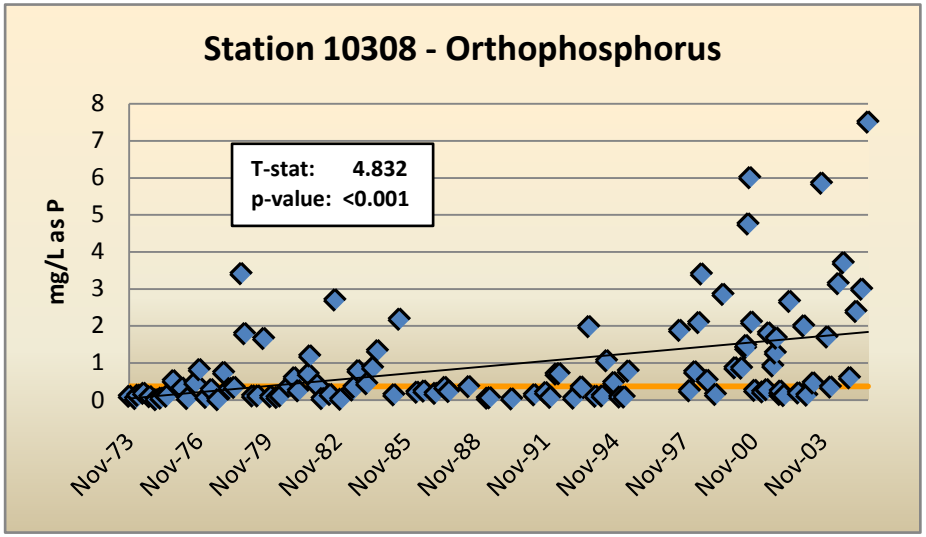


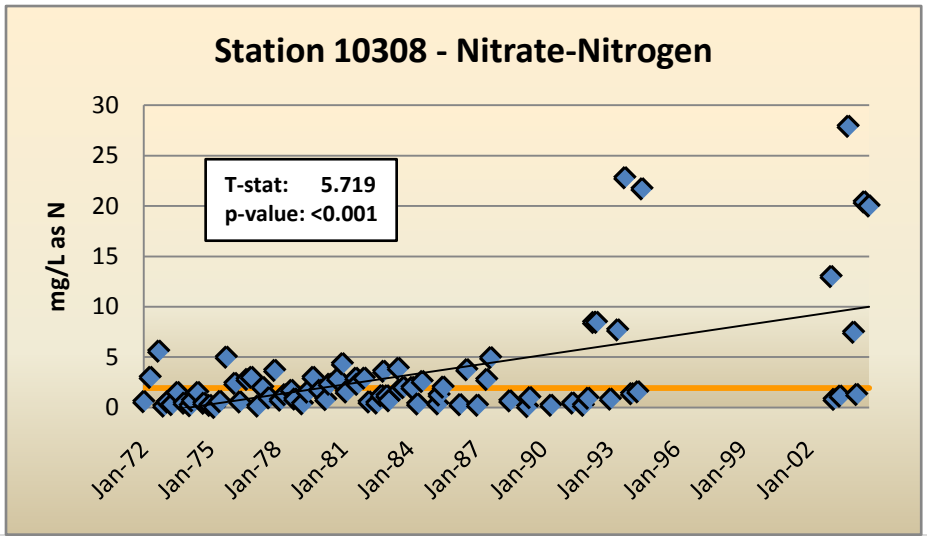
Segment 0404 – Big Cypress Creek below Lake Bob Sandlin

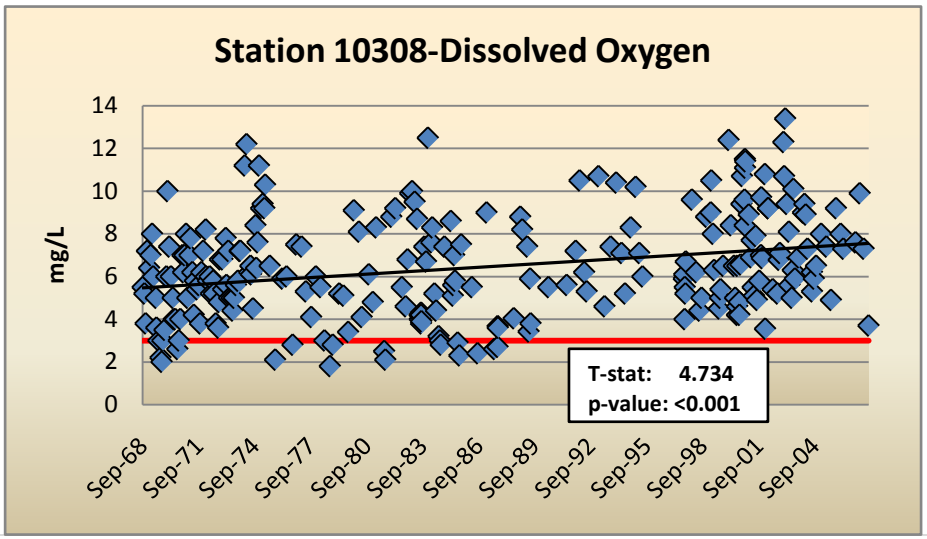


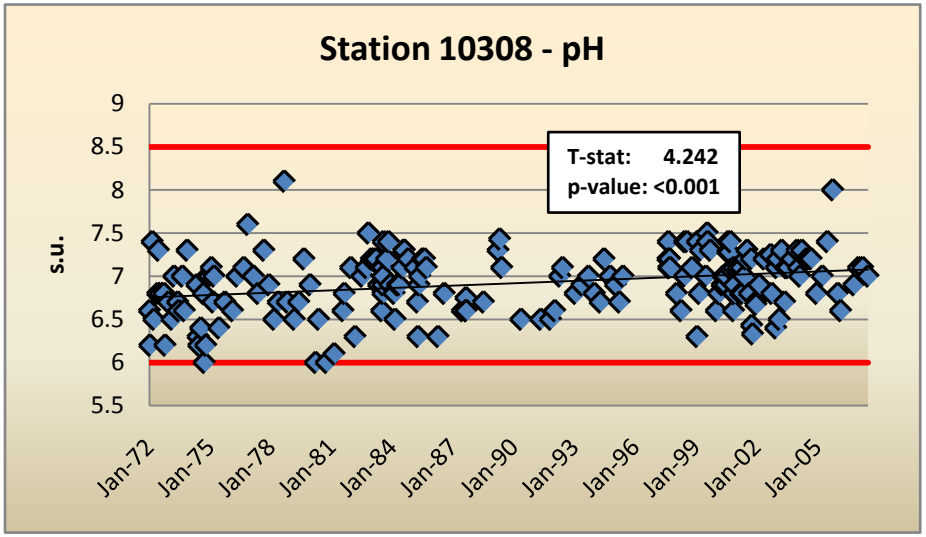


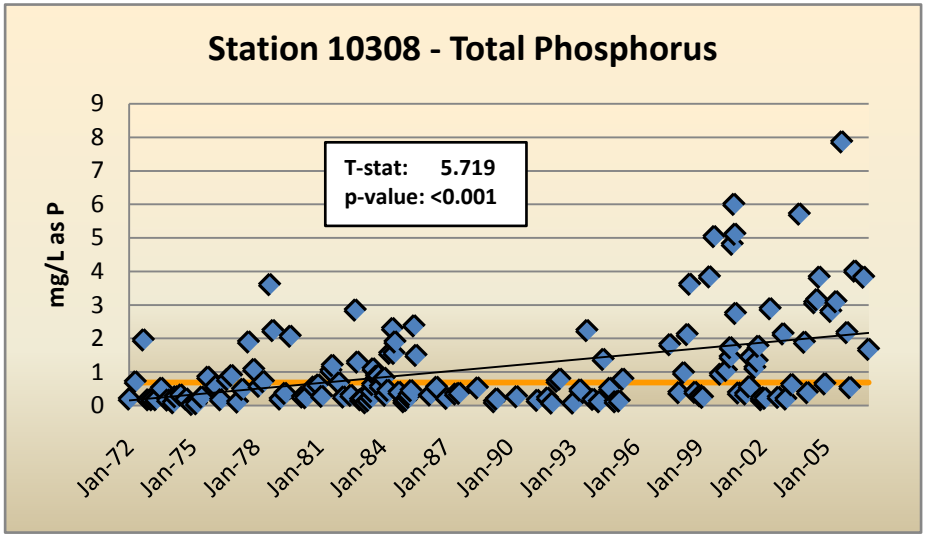

Station 13631-Specific Conductance
Sp Cond (uS/cm)
T-stat: 2.537
p-value: 0.012
900
800
700
600
500
400
300
200
100
0
Oct-79
Oct-83
Oct-87
Oct-91
Oct-95
Oct-99
Oct-03


Station 10308 - Orthophosphorus
mg/L as P
T-stat: 4.832
p-value: <0.001
8
7
6
5
4
3
2
1
0
Nov-73
Nov-76
Nov-79
Nov-82
Nov-85
Nov-88
Nov-91
Nov-94
Nov-97
Nov-00
Nov-03

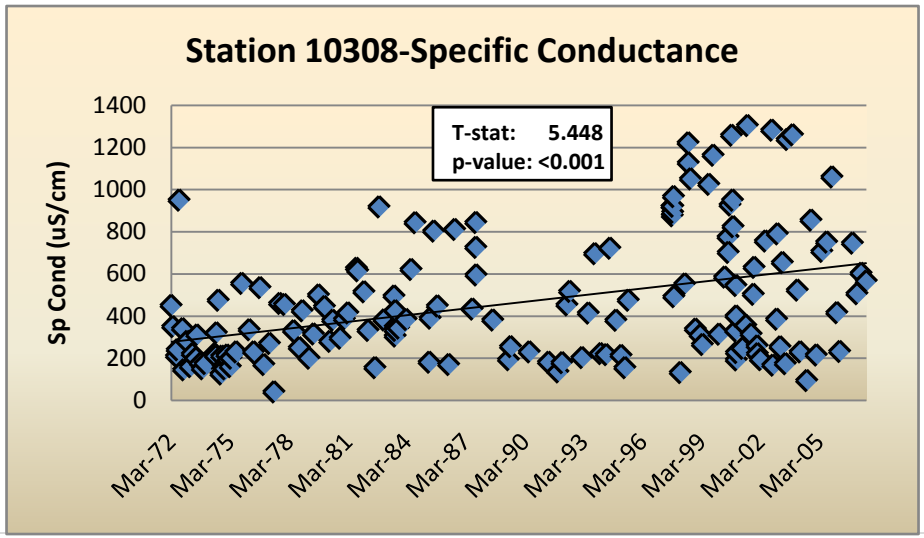

Station 10308 - Nitrate-Nitrogen
mg/L as N
T-stat: 5.719
p-value: <0.001
30
25
20
15
10
5
0
Jan-72
Jan-75
Jan-78
Jan-81
Jan-84
Jan-87
Jan-90
Jan-93
Jan-96
Jan-99
Jan-02

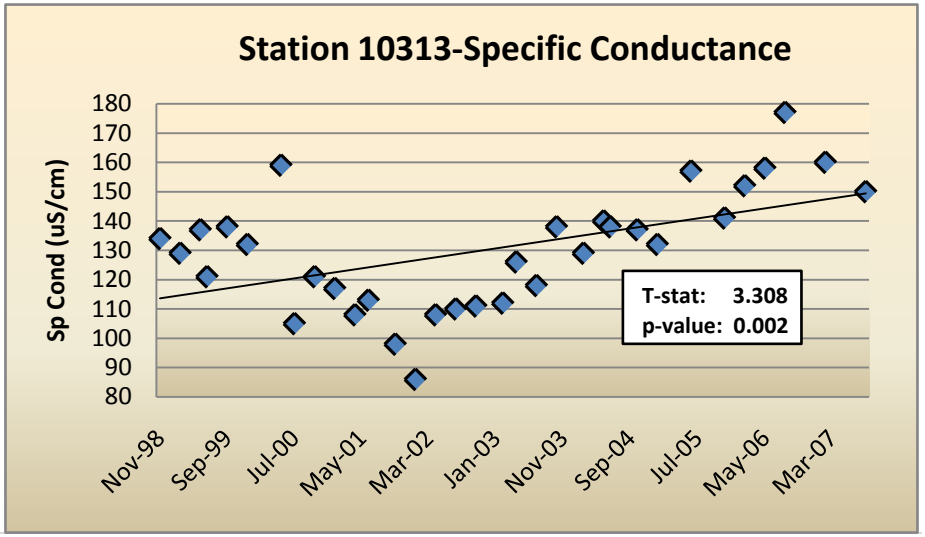

Station 10308-Dissolved Oxygen
mg/L
T-stat: 4.734
p-value: <0.001
14
12
10
8
6
4
2
0
Sep-68
Sep-71
Sep-74
Sep-77
Sep-80
Sep-83
Sep-86
Sep-89
Sep-92
Sep-95
Sep-98
Sep-01
Sep-04

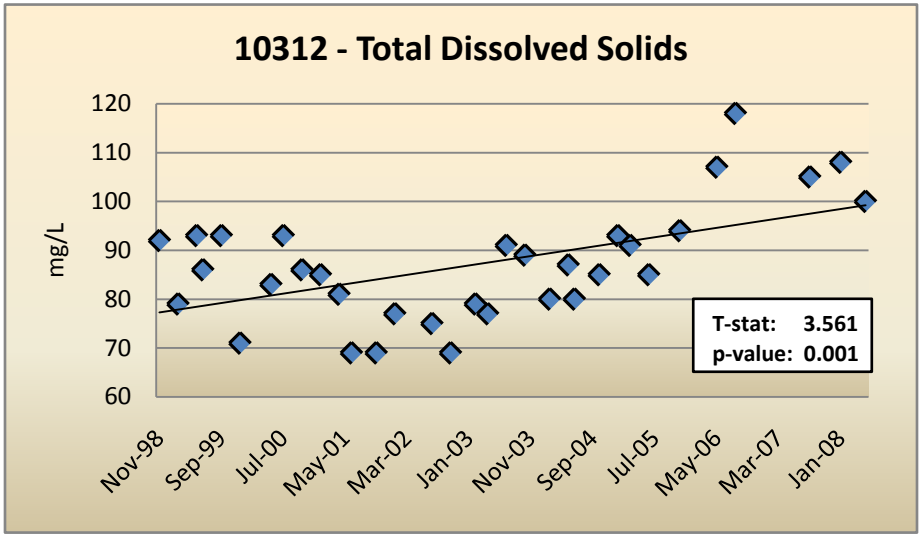


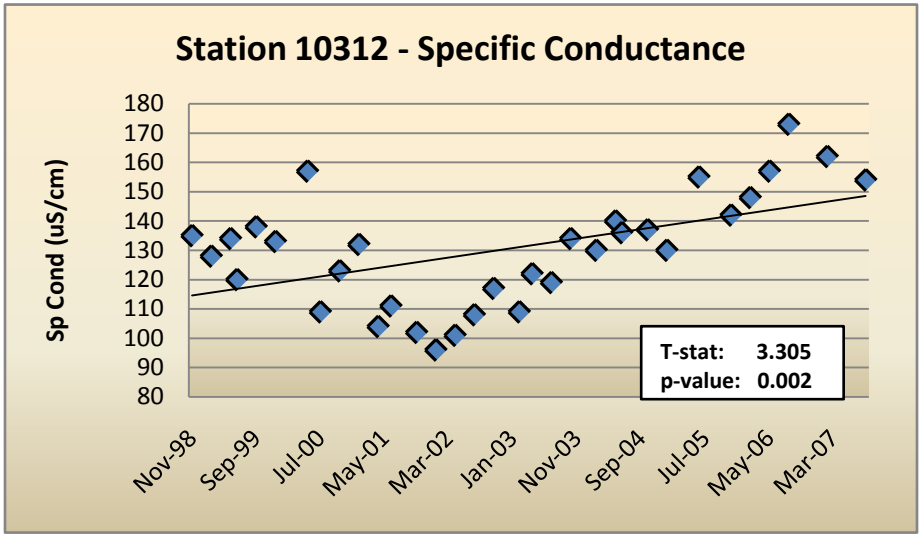


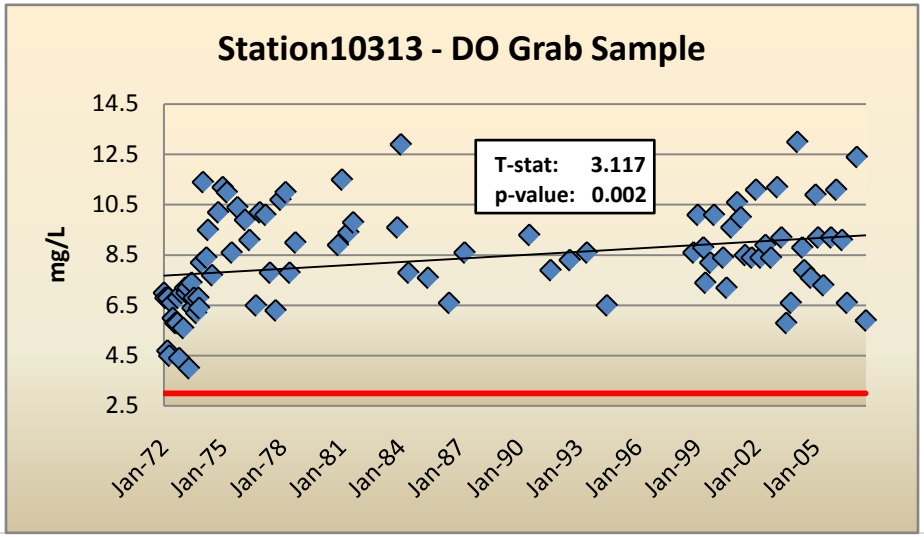
Segment 0405 – Lake Cypress Springs

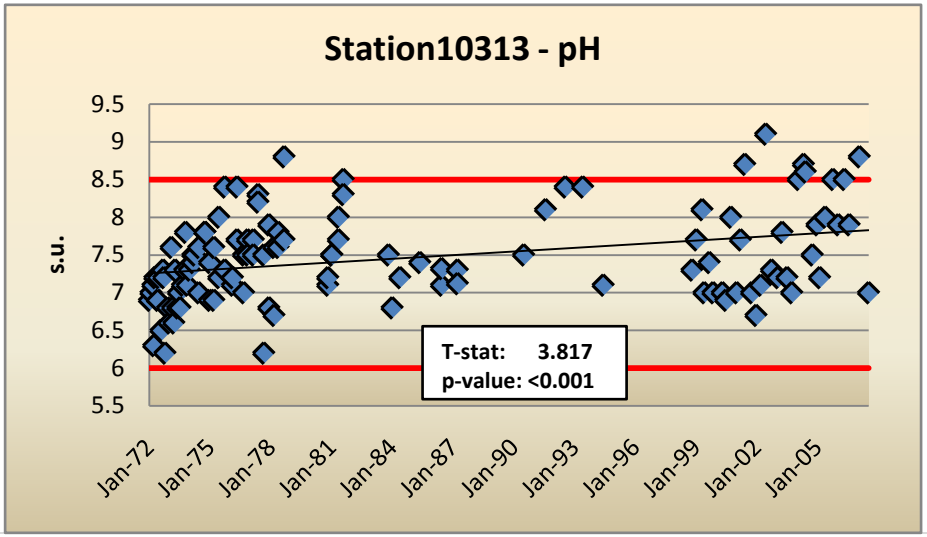




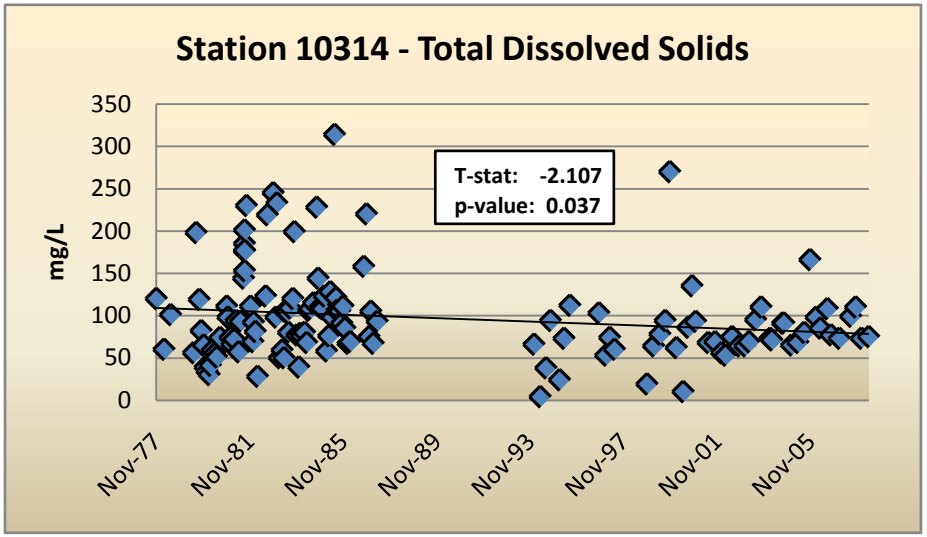

10312 - Total Dissolved Solids
mg/L
120
110
100
90
80
70
60
Nov-98
Sep-99
Jul-00
May-01
Mar-02
Jan-03
Nov-03
Sep-04
Jul-05
May-06
Mar-07
Jan-08
T-stat: 3.561
p-value: 0.001

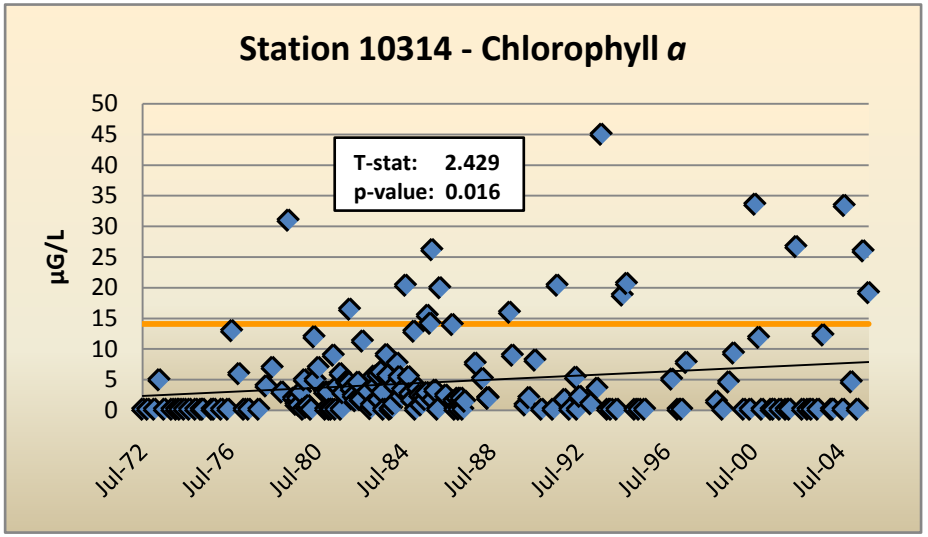

Station 10312 - Specific Conductance
Sp Cond (uS/cm)
180
170
160
150
140
130
120
110
100
90
80
Nov-98
Sep-99
Jul-00
May-01
Mar-02
Jan-03
Nov-03
Sep-04
Jul-05
May-06
Mar-07
T-stat: 3.305
p-value: 0.002


Station10313 - DO Grab Sample
mg/L
14.5
12.5
10.5
8.5
6.5
4.5
2.5
Jan-72
Jan-75
Jan-78
Jan-81
Jan-84
Jan-87
Jan-90
Jan-93
Jan-96
Jan-99
Jan-02
Jan-05
T-stat: 3.117
p-value: 0.002

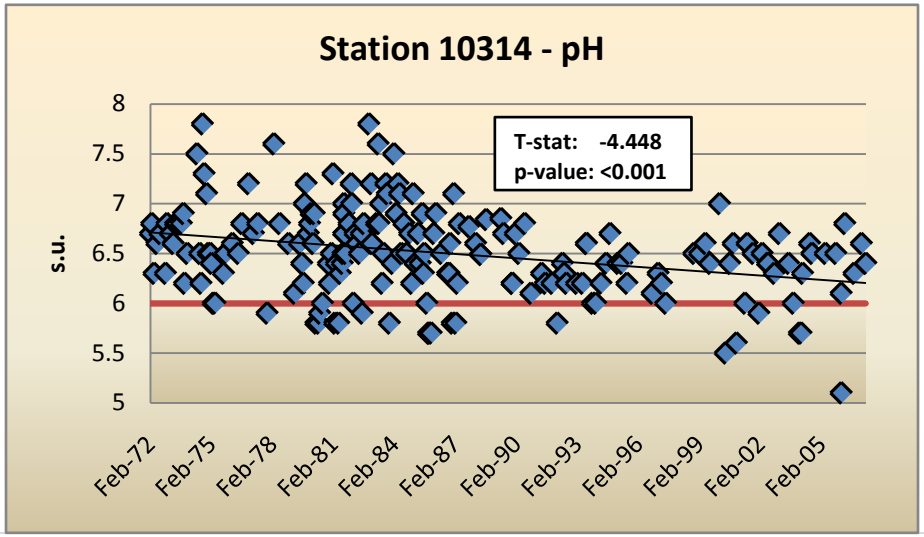

Station10313 - pH
s.u.
9.5
9
8.5
8
7.5
7
6.5
6
5.5
Jan-72
Jan-75
Jan-78
Jan-81
Jan-84
Jan-87
Jan-90
Jan-93
Jan-96
Jan-99
Jan-02
Jan-05
T-stat: 3.817
p-value: <0.001

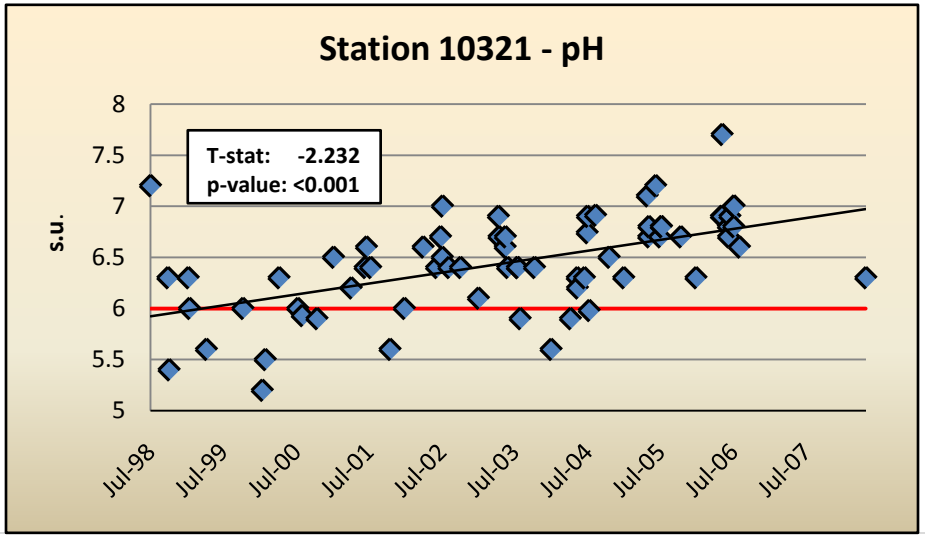
Segment 0406 – Black Bayou



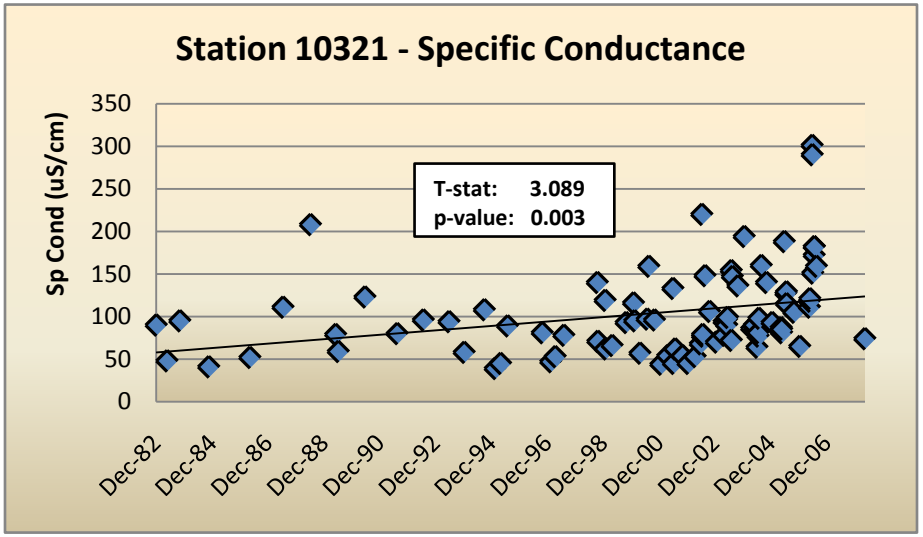


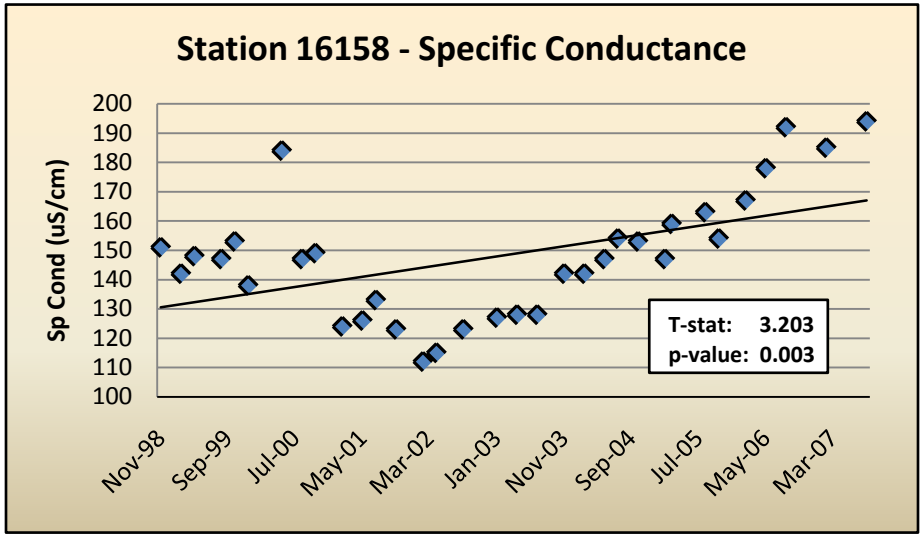
Segment 0407 – James' Bayou

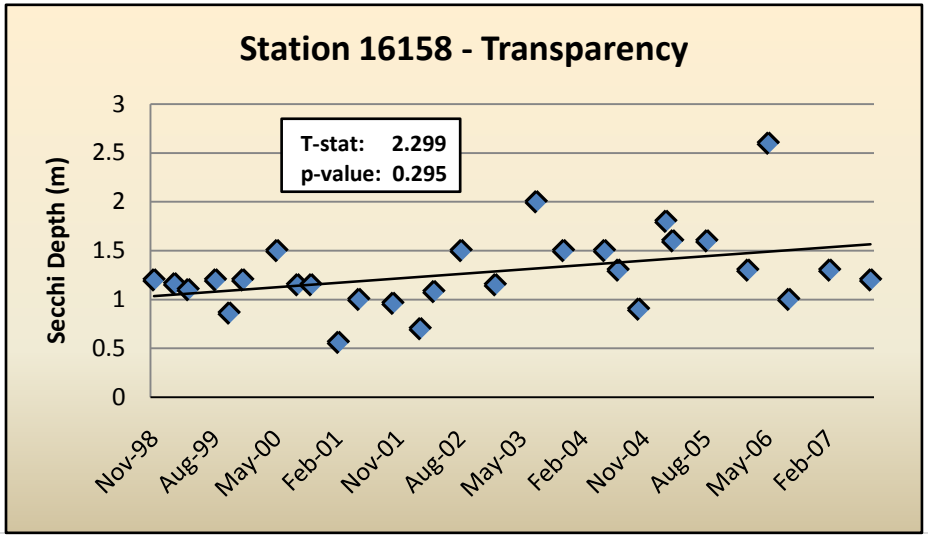


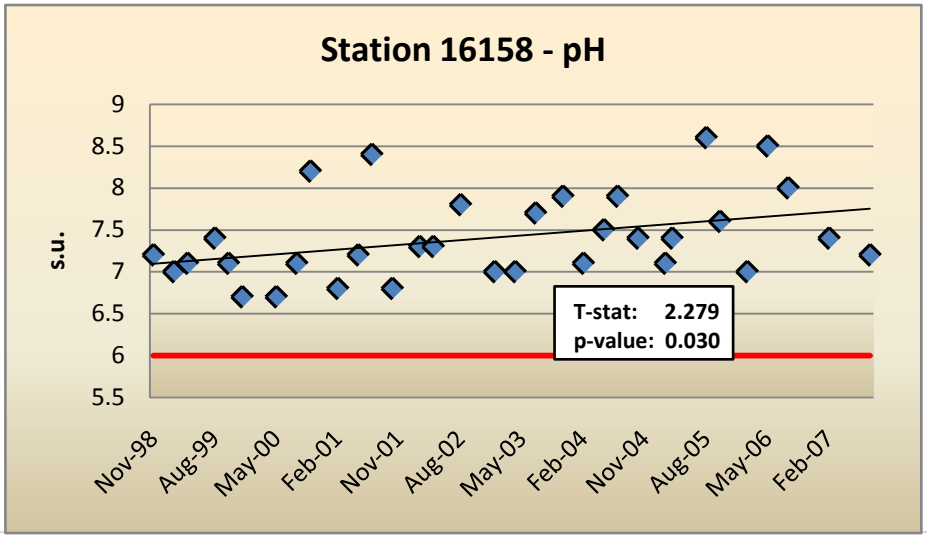


Segment 0408 – Lake Bob Sandlin









Appendix C

Average RBA and IBI Scores by Segment
Taxonomic List of Fish Collected by Segment

Average RBA and IBI Scores for each Segment

RBA Averages				IBI Averages		
Segment	HBI	I/T Ratio	Richness	Number Intolerant Species	Species Richness	Number of Events
0401	5.27	1.33	23.50	1	16	2
0402	6.36	0.73	22.80	2	17	5
0404	5.29	1.38	27.50	2.5	22.5	2
0405	5.12	1.73	28.50	1.7	18.3	6
0407	5.72	0.85	26.47	2.5	20.4	15
0408	6.49	0.20	22.00	0.33	15.8	6
0409	6.02	0.73	24.93	2.4	21.7	14

Taxonomic List of Fish Collected in the Cypress Creek Basin

Ameiurus melas
Ameiurus natalis
Amia calva
Aphredoderus sayanus
Aplodinotus grunniens
Carpiodes carpio
Centrarchus macropterus
Cyprinella lutrensis
Cyprinella venustus
Cyprinus carpio
Dorosoma cepedianum
Dorosoma petenense
Elassoma zonatum
Erimyzon oblongus
Erimyzon sucetta
Esox americanus
Esox niger
Etheostoma asprigene
Etheostoma chlorosomum
Etheostoma fusiforme
Etheostoma gracile
Etheostoma histrio
Etheostoma parvipinne
Etheostoma proeliare
Etheostoma whipplei
Fundulus blairae
Fundulus chrysotus
Fundulus notatus
Fundulus olivaceus
Gambusia affinis
Hybognathus hayi
Hybognathus nuchalis
Ictalurus furcatus
Ictalurus punctatus
Ictiobus cyprinellus
Labidesthes sicculus
Lepisosteus oculatus
Lepisosteus osseus
Lepomis cyanellus
Lepomis gulosus
Lepomis humilis
Lepomis macrochirus
Lepomis marginatus
Lepomis megalotis
Lepomis microlophus
Lepomis punctatus
Lepomis symmetricus
Luxilus chrysocephalus
Lythrurus fumeus
Lythrurus umbratilis
Micropterus punctulatus
Micropterus salmoides
Minytrema melanops
Morone chrysops
Morone mississippiensis
Moxostoma poecilurum
Notemigonus crysoleucas
Notropis antherinoides
Notropis atrocaudalis
Notropis blennius
Notropis chalybaeus
Notropis cornutus
Notropis oxyrhyncus
Notropis sabinae
Notropis shumardi
Notropis texanus
Notropis volucellus
Noturus gyrinus
Noturus nocturnus
Opsopoeodus emiliae
Palaemonetes
Percina caprodes
Percina carbonaria
Percina macrolepida
Percina maculata
Percina sciera
Pimephales promelas
Pimephales vigilax
Pomoxis annularis
Pomoxis nigromaculatus
Psopoeodus emiliae
Pylodictis olivaris
Semotilus atromaculatus

Taxonomic List of Fishes by Segment

Segment 0401A

Ameiurus natalis
Aphredoderus sayanus
Centrarchus macropterus
Elassoma zonatum
Erimyzon oblongus
Esox americanus
Etheostoma chlorosomum
Etheostoma gracile
Etheostoma proeliare
Fundulus notatus
Gambusia affinis
Labidesthes sicculus
Lepomis cyanellus
Lepomis gulosus
Lepomis macrochirus
Lepomis megalotis
Lepomis microlophus
Lepomis punctatus
Lythrurus fumeus
Lythrurus umbratilis
Micropterus punctulatus
Minytrema melanops
Notemigonus crysoleucas
Notropis antherinoides
Notropis atrocaudalis
Notropis texanus
Palaemonetes
Pimephales vigilax
Semotilus atromaculatus

Segments 0402, 0402A – E

Ameiurus melas
Ameiurus natalis
Amia calva
Aphredoderus sayanus
Aplodinotus grunniens
Centrarchus macropterus
Cyprinella lutrensis
Cyprinella venustus
Cyprinus carpio
Dorosoma cepedianum
Elassoma zonatum
Erimyzon oblongus
Erimyzon sucetta
Esox americanus
Etheostoma chlorosomum
Etheostoma gracile
Etheostoma histrio
Etheostoma parvipinne
Etheostoma proeliare
Etheostoma whipplei
Fundulus chrysotus
Fundulus notatus
Gambusia affinis
Hybognathus nuchalis
Ictiobus cyprinellus
Labidesthes sicculus
Lepisosteus oculatus
Lepisosteus osseus
Lepomis cyanellus
Lepomis gulosus
Lepomis macrochirus
Lepomis marginatus
Lepomis megalotis
Lepomis microlophus
Lepomis punctatus
Lepomis symmetricus
Luxilus chrysocephalus
Lythrurus fumeus
Lythrurus umbratilis
Micropterus punctulatus
Micropterus salmoides
Minytrema melanops
Morone chrysops
Notemigonus crysoleucas
Notropis antherinoides
Notropis atrocaudalis
Notropis chalybaeus
Notropis shumardi
Notropis texanus
Notropis shumardi
Notropis texanus
Notropis texanus

Segments 0404, 0404A - J

Ameiurus melas
Ameiurus natalis
Amia calva
Aphredoderus sayanus
Carpiodes carpio
Centrarchus macropterus
Cyprinella lutrensis
Cyprinella venustus
Cyprinus carpio
Dorosoma cepedianum
Dorosoma petenense
Elassoma zonatum
Erimyzon oblongus
Esox americanus
Etheostoma chlorosomum
Etheostoma gracile
Etheostoma histrio
Etheostoma proeliare
Etheostoma whipplei
Fundulus notatus
Fundulus olivaceus
Gambusia affinis
Ictalurus furcatus
Ictalurus punctatus
Ictiobus cyprinellus
Labidesthes sicculus
Lepisosteus oculatus
Lepomis cyanellus
Lepomis gulosus
Lepomis macrochirus
Lepomis marginatus
Lepomis megalotis
Lepomis microlophus
Lepomis punctatus
Lepomis symmetricus
Lythrurus fumeus
Lythrurus umbratilis
Micropterus punctulatus
Micropterus salmoides
Minytrema melanops
Morone chrysops
Morone mississippiensis
Notemigonus crysoleucas
Notropis antherinoides
Notropis texanus
Noturus gyrinus
Noturus nocturnus
Percina caprodes
Percina carbonaria
Percina macrolepida
Percina maculata
Percina sciera
Pimephales promelas
Pimephales vigilax
Pomoxis annularis
Pomoxis nigromaculatus
Pylodictis olivaris

Segment 0405A - C

Ameiurus melas
Ameiurus natalis
Aphredoderus sayanus
Cyprinella lutrensis
Cyprinella venustus
Esox americanus
Etheostoma chlorosomum
Etheostoma gracile
Etheostoma parvipinne
Etheostoma proeliare
Fundulus notatus
Gambusia affinis
Labidesthes sicculus
Lepomis cyanellus
Lepomis gulosus
Lepomis macrochirus
Lepomis megalotis
Lepomis microlophus
Lepomis punctatus
Lythrurus fumeus
Lythrurus umbratilis
Micropterus punctulatus
Micropterus salmoides
Minytrema melanops
Notemigonus crysoleucas
Notropis atrocaudalis
Opsopoeodus emiliae
Percina macrolepida
Pimephales vigilax
Pomoxis annularis
Semotilus atromaculatus

Segment 0407

Ameiurus melas
Ameiurus natalis
Amia calva
Aphredoderus sayanus
Centrarchus macropterus
Cyprinella lutrensis
Cyprinella venustus
Dorosoma cepedianum
Elassoma zonatum
Erimyzon oblongus
Erimyzon sucetta
Esox americanus
Esox niger
Etheostoma chlorosomum
Etheostoma fusiforme
Etheostoma gracile
Etheostoma proeliare
Fundulus chrysotus
Fundulus notatus
Fundulus olivaceus
Gambusia affinis
Ictalurus punctatus
Labidesthes sicculus
Lepisosteus oculatus
Lepomis cyanellus
Lepomis gulosus
Lepomis humilis
Lepomis macrochirus
Lepomis marginatus
Lepomis megalotis
Lepomis microlophus
Lepomis punctatus
Lepomis symmetricus
Luxilus chrysocephalus
Lythrurus fumeus
Lythrurus umbratilis
Micropterus punctulatus
Micropterus salmoides
Minytrema melanops
Moxostoma poecilurum
Notemigonus crysoleucas
Notropis antherinoides
Notropis atrocaudalis
Notropis blennius
Notropis chalybaeus
Notropis cornutus
Notropis oxyrhyncus
Notropis sabinae
Notropis texanus
Notropis volucellus
Noturus gyrinus
Noturus nocturnus
Opsopoeodus emiliae
Percina caprodes
Percina macrolepida
Percina maculata
Percina sciera
Pimephales promelas
Pimephales vigilax
Pomoxis annularis
Pomoxis nigromaculatus

Segments 0408, 0408C, 0408D

Ameiurus natalis
Amia calva
Aphredoderus sayanus
Centrarchus macropterus
Cyprinella venustus
Erimyzon oblongus
Esox americanus
Etheostoma chlorosomum
Etheostoma gracile
Etheostoma proeliare
Fundulus notatus
Gambusia affinis
Labidesthes sicculus
Lepomis cyanellus
Lepomis gulosus
Lepomis macrochirus
Lepomis marginatus
Lepomis megalotis
Lepomis microlophus
Lepomis punctatus
Lepomis symmetricus
Luxilus chrysocephalus
Lythrurus fumeus
Lythrurus umbratilis
Micropterus punctulatus
Micropterus salmoides
Minytrema melanops
Notemigonus crysoleucas
Notropis atrocaudalis
Notropis texanus
Opsopoeodus emiliae
Percina macrolepida
Percina maculata
Percina sciera
Pimephales vigilax
Pomoxis annularis
Semotilus atromaculatus
Pomoxis annularis
Semotilus atromaculatus
Semotilus atromaculatus

Segments 0409, 0409A, 0409B

Ameiurus melas
Ameiurus natalis
Amia calva
Aphredoderus sayanus
Centrarchus macropterus
Cyprinella venustus
Cyprinus carpio
Dorosoma cepedianum
Elassoma zonatum
Erimyzon oblongus
Erimyzon sucetta
Esox americanus
Etheostoma asprigene
Etheostoma chlorosomum
Etheostoma fusiforme
Etheostoma gracile
Etheostoma histrio
Etheostoma parvipinne
Etheostoma proeliare
Etheostoma whipplei
Fundulus blairae
Fundulus chrysotus
Fundulus notatus
Fundulus olivaceus
Gambusia affinis
Hybognathus hayi
Ictalurus punctatus
Labidesthes sicculus
Lepisosteus oculatus
Lepisosteus osseus
Lepomis cyanellus
Lepomis gulosus
Lepomis humilis
Lepomis macrochirus
Lepomis marginatus
Lepomis megalotis
Lepomis microlophus
Lepomis punctatus
Lepomis symmetricus
Luxilus chrysocephalus
Lythrurus fumeus
Lythrurus umbratilis
Micropterus punctulatus
Micropterus salmoides
Minytrema melanops
Morone mississippiensis
Notemigonus crysoleucas
Notropis antherinoides
Notropis texanus
Noturus gyrinus
Noturus nocturnus
Opsopoeodus emiliae
Percina maculata
Percina sciera
Pimephales vigilax
Pomoxis annularis
Pomoxis nigromaculatus
Psopoeodus emiliae
Semotilus atromaculatus