Angelina & Neches River Authority

2013 Basin Highlights Report

For the Upper Portion of the Neches River Basin

TCEQ

The Texas Clean Rivers Program

Watershed Characterization of Selected Portions of the Lower Angelina Sub-Basin

Ayish Bayou, Attoyac Bayou, and Sam Rayburn Reservoir

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ANRA

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Introduction

About the Angelina & Neches River Authority

The Angelina & Neches River Authority (ANRA), originally named the Sabine & Neches Conservation District, was created in 1935 by the Texas legislature as a conservation and reclamation district. The legislature divided the territory of the Sabine & Neches Conservation District into the Sabine River Authority and the Neches River Conservation District in 1949. It was not until 1971 that the Neches River Conservation District was activated and began operating as a water resource agency. In 1977, Senate Bill 125 changed the name of the Neches River Conservation District to the Angelina & Neches River Authority.

ANRA's office is located in Lufkin, Texas. ANRA's territorial jurisdiction consists of 8,500 square miles that lie wholly or in part of the following counties: Van Zandt, Smith, Henderson, Newton, Cherokee, Anderson, Rusk, Houston, Nacogdoches, San Augustine, Shelby, Angelina, Trinity, Sabine, Polk, Jasper, and Orange.

ANRA has the responsibility for monitoring, protecting, and enhancing water resources in the Neches River Basin. ANRA's functions in the basin include:

- water quality monitoring
- drinking water and wastewater analysis
- on-site sewage facility permitting
- water and wastewater utilities
- water resources development
- regional wastewater/composting facilities
- other regional planning efforts

About the Clean Rivers Program

The Texas Clean Rivers Act, enacted in 1991 by the Texas legislature, requires that each Texas River Basin conduct ongoing water quality assessments, integrating water quality issues using a watershed management approach. The Clean Rivers Program (CRP) implements the Clean Rivers Act through water quality monitoring, assessment, and public outreach. Currently, monitoring in the state of Texas includes over 1800 sites and regional water quality assessments within the 23 major river and coastal basins and their sub-watersheds.

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

About The Basin Highlights Report

This Basin Highlights Report is produced annually by ANRA, and typically provides an overview of the previous year's events and ongoing programs in the upper and middle portions of the Neches River Basin that are

relevant to the Clean Rivers Program (CRP). In an effort to address impaired water bodies in the basin, the 2013 report focuses on water bodies that do not currently meet *Texas Surface Water Quality Standards* and those listed in the 2012 *Texas Integrated Report of Surface Water Quality for Clean Water Act, Sections 305(b) and 303(d)*.

The 2013 Basin Highlights Report was prepared by the Angelina & Neches River Authority in cooperation with the Texas Commission on Environmental Quality (TCEQ) under the authorization of the Texas Clean Rivers Act.

Sam Rayburn Reservoir at Shirley Creek

Attoyac Bayou at US 59

List of Acronyms and Abbreviations

ALU	Aquatic Life Use
ANRA	Angelina & Neches River Authority
AU	Assessment Unit
BMP	Best Management Practice
CFS	Cubic feet per second
CN	Concern for near-nonattainment
CR	County Road
CRP	Clean Rivers Program
CS	Concern for water quality based on screening levels
CWA	Clean Water Act
CZR	Control Zone Rayburn
DO	Dissolved oxygen
DSHS	Department of State Health Services
EPA	Environmental Protection Agency
FM	Farm-to-Market road
FS	Fully Supporting
FY	Fiscal Year
Hg	Mercury
hr	hour
HUC	Hydrologic Unit Code
HWY	Highway
I/I	Inflow and Infiltration
ISD	Independent School District
km	kilometer
LNVA	Lower Neches Valley Authority
mg/L	milligrams per liter
MGD	Million Gallons per Day
mi	miles
mL	milliliter
MPN	Most Probable Number
MSW	Municipal Solid Waste
NA	Not Assessed
NC	No Concern
NHD	National Hydrography Dataset

NPDES	National Pollution Discharge Elimination System
NS	Non-Supporting
OSSF	On-site Sewage Facility
oz	ounce
PCR	Primary Contact Recreation
PWS	Public Water Supply
QAO	Quality Assurance Officer
RUAA	Recreational Use Attainability Analysis
SFASU	Stephen F. Austin State University
SH	State Highway
sq	square
SU	Standard Units
SWQM	Surface Water Quality Monitoring
SWQMIS	Surface Water Quality Monitoring Information System
TAC	Texas Administrative Code
TCEQ	Texas Commission on Environmental Quality
TDS	Total Dissolved Solids
TMDL	Total Maximum Daily Load
TPDES	Texas Pollution Discharge Elimination System
TSSWCB	Texas State Soil and Water Conservation Board
TSWQS	Texas Surface Water Quality Standards
TWDB	Texas Water Development Board
TWRI	Texas Water Resources Institute
UAA	Use Attainability Analysis
USACE	United States Army Corps of Engineers
USGS	United States Geological Survey
WAP	Watershed Action Planning
WPP	Watershed Protection Plan
WQS	Water Quality Standards
WSC	Water Supply Corporation
WWTF	Wastewater Treatment Facility
WWTP	Wastewater Treatment Plant

Water Quality

Texas Surface Water Quality Standards

Texas Surface Water Quality Standards (TSWQS) are state rules adopted by the Texas Commission on Environmental Quality (TCEQ) that are designed to establish numerical and narrative goals for water quality throughout the state. TSWQS are developed to maintain the quality of surface waters in Texas so that they support public health and enjoyment, and protect aquatic life, consistent with the sustainable economic development of the state. TSWQS describe the physical, chemical, and biological conditions to be attained in waters in the state, as well as identifying uses and criteria associated with those uses. TSWQS also provide a basis on which the TCEQ regulatory programs [such as Permitting, Total Maximum Daily Load (TMDL), Non-Point Source (NPS), and Monitoring/Assessment] can establish reasonable methods to implement and attain the state's goals for water quality.

Section 304(a)(1) of the Federal Clean Water Act (CWA) requires development of criteria for water quality that accurately reflects the latest scientific knowledge. Criteria are based solely on data and scientific judgments on pollutant concentrations and environmental or human health effects. Section 304(a) also provides guidance to states and tribes in adopting water quality standards. Criteria are developed for the protection of aquatic life as well as for human health. Criteria are numerical numbers representing a specific use for the water body. For example, for high aquatic life use, the dissolved oxygen 24-hour minimum criteria is 3.0 mg/L. Impairments occur when water quality conditions do not meet assigned uses/criteria as defined in the TSWQS.

As defined in the TSWQS, a water body can be assigned specific uses including aquatic life, public water supply, and contact recreation use. Other uses, such as oyster waters, do not apply in the Upper Neches Basin. Designated uses typically have corresponding numerical criteria. There are general criteria that cover the entire state, but if sufficient information is available for a given water body, then site-specific standards may be developed and assigned to that water body.

- ***Aquatic Life Use (ALU)*** has corresponding 24-hour dissolved oxygen criteria. Water bodies have assigned/presumed ALU. ALU categories are exceptional, high, intermediate, limited, and minimal.

- ***General Use*** criteria are used to protect overall water quality rather than a single specific use. Parameters used to gauge support for this use include chloride, sulfate, total dissolved solids (TDS), pH, and temperature. A water body is classified as Fully Supporting for general use if it meets all of these criteria. Parameters such as ammonia, nitrates, phosphorus, and chlorophyll-*a* are used in the assessment to screen for nutrient concerns.

- ***Public water supply use*** includes criteria for chlorides, sulfates, and TDS in drinking water. Criteria for these parameters are set so that public water supplies are capable of treating and delivering water of acceptable quality.

- ***Contact recreation use*** is assessed using criteria for bacteria indicators such as *E. coli* (for freshwater). Contact recreation use refers to the ability of the water body to support activities that involve physical contact with the water, such as swimming and wading. There are both primary and secondary contact recreation uses.

    - Primary contact recreation activities, such as swimming, are presumed to involve a significant risk of ingestion of water.

    - Secondary contact recreation activities, such as fishing, are presumed to involve a less significant risk of water ingestion than primary contact recreation due to limited body contact

incidental to shoreline activity. The difference between secondary contact 1 and 2 are the frequency that the secondary contact recreation activities occur due to physical characteristics of the water body or limited public access.

Many of our state's water resources cannot currently meet their existing, designated, presumed, and attainable uses because of pollution problems from a combination of point sources, such as sewage treatment plants and industrial dischargers, and nonpoint sources, such as pollutants carried by rainfall runoff from forests, agriculture lands, abandoned mine lands, etc.

Through the Clean Rivers Program, the TCEQ and its partners continually help monitor and evaluate the quality of water bodies throughout the state by measuring parameters such as dissolved oxygen, temperature, pH, dissolved minerals, toxic substances, and bacteria.

Surface Water Quality Parameters

ANRA monitoring personnel collect both field and conventional parameters at monitoring stations, with stations being monitored on a quarterly basis.

Field measurements are collected on-site by direct monitoring in the water body.

TABLE 2-1 Field Parameters

Parameter	Potential Impacts	Possible Sources/Causes
pH	pH is a measure of whether water is acidic or basic. Most aquatic organisms are adapted to live within a specific pH range. pH can also affect the toxicity of many substances, which generally increase in solubility as pH decreases. The ability of water to resist changes in pH (its buffering capacity) is essential to aquatic life.	pH can be affected by industrial and wastewater discharges, runoff, and accidental spills. Natural variation in seasons may also affect pH.
Dissolved Oxygen (DO)	DO is a measure of the amount of dissolved oxygen that is available in the water. DO is vital for aquatic organisms to live. Where DO is too low, aquatic organisms may have insufficient oxygen to live.	DO is temperature-dependent, with water being able to hold more dissolved oxygen at lower temperatures due to the solubility of gases increasing as the temperature decreases. The amount of oxygen present usually decreases with depth, rising temperatures, and with the oxidation of organic matter and pollutants. Bacteria and algal blooms may cause DO to decrease as decomposition of organic matter consumes oxygen in the water, resulting in hypoxic (low oxygen) areas.
Specific Conductance	Specific Conductance is the measure of the water's capacity to carry an electrical current and is indicative of the amounts of dissolved solids present in a water body.	Dissolved salt-forming substances such as sulfate, chloride, and sodium increase the conductivity of the water.
Temperature	Water temperature affects the oxygen content of the water (dissolved oxygen). Temperature also has an impact on cold-blooded animals.	Water temperature may be affected by alterations to the riparian zone, changes in ambient temperature, and discharges.
Flow	Flow is a measurement of the velocity of the water, measured in cubic feet per second (CFS). Flow combined with other parameters can be a good indicator of water quality.	Flow can be affected by both natural and man-made sources.

Conventional parameters are also evaluated as part of the monitoring plan. During routine monitoring events, water samples are collected for laboratory analysis of conventional parameters. Conventional parameters include nutrients, minerals, and particulates. For routine monitoring stations, ANRA collects and analyzes samples for the following conventional parameters:

TABLE 2-2 Conventional Parameters

Parameter	Potential Impacts	Possible Sources/Causes
Ammonia-Nitrogen	Ammonia, which is produced from the breakdown of nitrogen-containing compounds, is found naturally in waters. In excess, algal blooms may occur. Elevated ammonia levels are indicative of organic pollution. These elevated levels can cause stress on aquatic organisms, as well as damage to tissue and gills.	Ammonia enters into a body of water via excretion of nitrogenous wastes, decomposition of plants and animals, and runoff. Ammonia is an ingredient in many fertilizers. It is also present in sewage, wastewater discharges, and storm water runoff.
Chloride	Chloride is one of the major inorganic ions in water and wastewater. It is an essential element for maintaining normal physiological functions in all organisms. Elevated chloride concentrations can adversely affect survival, growth, and/or reproduction of aquatic organisms.	An elevated chloride concentration can be indicative of natural or man-made pollution. Natural sources of chloride include the weathering and leaching of sedimentary rocks, soils, and salt deposits. Other possible sources include oil exploration and storage, sewage and industrial discharges, and landfill runoff.
Chlorophyll-*a*	Chlorophyll-*a* is an indicator of algal biomass in a water body. Increased concentrations indicate potential eutrophication or nutrient loading. Diurnal shifts in DO and pH resulting from increased photosynthesis and respiration can cause stress to aquatic organisms.	Chlorophyll-*a* is a photosynthetic pigment that plays a vital role in photosynthesis. It is found in most plants, cyanobacteria, and algae. When chlorophyll-*a* levels are consistently high or variable, this may be indicative of algal blooms.
***Escherichia coli* (*E. coli*)**	*E. coli* is an indicator of fecal contamination. Fecal contamination is a health concern to the general public, and its presence indicates a risk for contact recreation. The presence of *E. coli* in the water indicates that pathogenic organisms may be present.	*E. coli* is abundant in the gastro-intestinal tract of warm-blooded animals. Elevated bacterial levels are indicative of a potential pollution problem. Reasons for the presence of fecal coliforms such as *E. coli* include failing septic systems, animal wastes, and inadequately treated sewage.
Nitrate + Nitrite-Nitrogen	Elevated levels of nitrite and nitrate can produce nitrite toxicity in fish ("brown blood disease") and methemoglobinemia ("blue baby syndrome") in infants by reducing the oxygen-carrying capacity of blood. In surface water, high levels of nitrates can lead to excessive growth of aquatic plants. High levels of nitrates are also indicative of human-caused pollution.	As part of the nitrogen cycle, nitrogenous compounds are converted from ammonia to nitrite and then to nitrate by bacterial and chemical processes. Potential sources include effluent discharges from wastewater treatment plants, fertilizers, and agricultural runoff.
Total Phosphorus	Phosphorus is essential to the growth of organisms, and is considered a growth-limiting nutrient. Elevated levels in water may stimulate the growth of photosynthetic aquatic macro- and microorganisms. Elevated phosphorus levels contribute to eutrophication and may cause algal blooms.	Phosphorus is commonly known as a man-made pollutant. It is present in industrial and domestic wastewater discharges, as well as agricultural and storm water runoff. It is a an ingredient in soaps and detergents, and is used extensively in the treatment of boiler waters. Phosphates are also used by some water supplies during treatment.

TABLE 2-2 Conventional Parameters (continued)		
Parameter	**Potential Impacts**	**Possible Sources/Causes**
Total Dissolved Solids (TDS)	TDS, reported in mg/L, is a measure of the total dissolved particles in water. Typically, it is comprised of chlorides, sulfates, and other salt-forming anions. TDS is an important measure of drinking water quality.	TDS can occur naturally from dissolution of carbonate and salt deposits in rocks and soils. Other sources include agricultural and storm water runoff, effluent discharges from industrial and domestic wastewater treatment plants, and oil exploration.
Total Suspended Solids (TSS)	TSS, reported in mg/L, is a measure of the total suspended particles in water. High levels of TSS increase the turbidity of the water, reducing light penetration which subsequently decreases oxygen production by plants.	Elevated TSS can result from multiple point and non-point sources. Soil erosion and runoff are two primary sources.
Sulfate	Sulfate is essential for plant growth, and low levels (under 0.5 mg/L) can be detrimental to algal growth. Excessive levels of sulfate can form strong acids and change the pH of the water. Excessively high levels may be toxic to cattle and other animals. Sulfate can also affect drinking water.	Sulfate occurs in almost all natural waters due to an abundance of elemental and organic sulfur in the environment. It usually enters into water bodies by water passing over rock or soil containing minerals like gypsum, as well as runoff from agricultural lands, industrial discharges, and sewage treatment plant discharges. Sulfate can also enter water bodies from atmospheric deposition from such sources as burning fossil fuels.

FIGURE 2-1 SEAL AutoAnalyzer 3 for automated analysis of nutrient parameters

The Texas Integrated Report

The 303(d) list is a listing of impaired water bodies. The state must identify all water bodies where required pollution controls are not sufficient to attain or maintain applicable surface water quality standards. In Texas, this list is compiled by the TCEQ and is a part of the *Texas Integrated Report for Clean Water Act Sections 305(b) and 303(d)*, also known more simply as the *Texas Integrated Report*. This report is prepared by TCEQ and submitted to the US Environmental Protection Agency (EPA) every two years in even numbered years.

The *Texas Integrated Report* describes the condition of all surface water bodies that were evaluated for the assessment period. For the 2012 assessment, the TCEQ included data collected during a seven-year period (December 1, 2003 – November 30, 2010). The timeframe was extended to ten years, if needed, to attain the minimum number of data points needed for the assessment.

As part of the assessment, water bodies are placed into one of five categories which indicate the water quality status of the water body. The categories are as follows:

TABLE 2-3 Categories of Water Bodies on the 303(d) List

Category	Description
1	Attaining the water quality standard and no use is threatened.
2	Attaining some of the designated uses; no use is threatened; and insufficient or no data and information are available to determine if the remaining uses are attained or threatened.
3	Insufficient or no data and information to determine if any designated use is attained. Many of these water bodies are intermittent streams and small reservoirs.
4	Standard is not supported or is threatened for one or more designated uses but does not require the development of a Total Maximum Daily Load (TMDL). **4a** All TMDLs have been completed and approved by EPA. **4b** Other control requirements are reasonably expected to result in the attainment of all standards. **4c** Nonsupport of the water quality standard is not caused by a pollutant.
5	The water body does not meet applicable water quality standards or is threatened for one or more designated uses by one or more pollutants. **5a** TMDLs are underway, scheduled, or will be scheduled for one or more parameters. **5b** A review of the standards for one or more parameters will be conducted before TMDLs are scheduled. **5c** Additional data or information will be collected for one or more parameters before TMDLs are scheduled.

If the measured values for a water body are found to be consistently exceeding the criteria for its use, then that water body must be listed as impaired, which simply means that the water body is not supporting its use. When a water body is determined to be impaired, several things must happen:

- The water body must be listed on the 303(d) list.
- An evaluation must be undertaken to discover what is preventing the water body from supporting its use(s) or if the use(s) are inappropriate for the water body.
- Steps must then be taken to either remedy the problem, collect additional data or information, or to evaluate which uses are appropriate for the water body in question. These steps can include:
    - additional monitoring
    - development of a Total Maximum Daily Load (TMDL)
    - preparation of a Watershed Protection Plan (WPP)
    - a review of the water quality standards

The most recent version of the *Texas Integrated Report*, as well as draft reports and reports from previous years, can be found at the following website:

http://www.tceq.texas.gov/waterquality/assessment/305_303.html

Tools to Address Water Quality Impairments

The Watershed Action Planning (WAP) process, established in 2011, is the state's coordinated approach to develop, coordinate, and track action to address water quality issues. The WAP process coordinates planning and activities among numerous agencies and interested parties, including the TCEQ, the Texas State Soil and Water Conservation Board (TSSWCB), the Texas Clean Rivers Program (CRP) partners, and stakeholders from the watershed. The WAP process is a flexible approach that utilizes a range of strategy options for addressing impaired water bodies on the 303(d) List and other water quality issues and provides a framework that each program area, partner agency, and stakeholder can use for planning, budgeting, and implementing activities to address water quality issues. The WAP process can also be used to address potential water quality issues before they develop to the level of an impairment.

A major product of the WAP process, the **Watershed Action Planning Strategy Table**, is a comprehensive strategy for protecting and improving the quality of water bodies. This table lists:

- impaired and special interest water bodies
- the recommended strategies to improve water quality in impaired segments to protect water bodies of special interest
- the status of each strategy
- the lead agency and program for tracking each strategy

The Watershed Action Planning Strategy Table can be located at the following location:

http://www.tceq.texas.gov/assets/public/implementation/water/wap/wap_allbasins.pdf

A critical aspect of the WAP process in input from stakeholders. The type of data and information to be gathered through local watershed discussions include:

- **Watershed Evaluation** – Develop and prepare watershed maps, land use classifications, and models, and identify data gaps and data acquisition projects.

- **Pollution Sources** - Identify potential point and nonpoint sources of pollution, evaluate pollution sources, identify pollution control practices, identify data gaps and data acquisition projects.

- **Water Quality Monitoring** - Identify water quality monitoring sites, identify water quality indicators, identify data gaps and data acquisition projects.

- **Watershed Stakeholders** - Identify key stakeholders, characterize stakeholder support, and identify issues of concern and watershed goals.

- **Public** – Characterize public support and identify issues of concern and watershed goals.

- **Watershed Planning Strategy** – Identify what option(s) (e.g. Use Attainability Analysis, Total Maximum Daily Load, Watershed Protection Plan, etc.) the public and local stakeholders recommend be considered to address each water quality issue.

Multiple tools are available to address water quality issues. Use Attainability Analysis (UAA), Best Management Practices (BMPs), Watershed Protection Plans (WPPs) and Total Maximum Daily Loads (TMDLs) are some of these tools.

- A **Use Attainability Analysis (UAA)** is a structured scientific assessment of the characteristics (physical, chemical, or biological) of a water body. If there is a general consensus among stakeholders and resource agencies that a presumed or designated use may not be appropriate, then a UAA may be conducted to evaluate the appropriate use(s) for that water body. UAAs can also be used to develop site-specific uses. In Texas, there are two types of UAAs that are available tools to assess the appropriateness of a water body's presumed or designated use. These types of UAAs are Aquatic Life Use UAAs (ALU UAA) and Recreational UAAs (RUAA).

- **Best Management Practices (BMPs)** are structural or non-structural practices which are intended to minimize the impacts of development on water bodies. Nonpoint Source BMPs are used to reduce or control impacts to water bodies from nonpoint sources, most commonly by reducing pollutant loading. There are many types of BMPs to address specific needs and site characteristics. Categories of BMPs include:

    - Preventative Practices
    - Cleanup Practices
    - Erosion Control Practices
    - Sediment Control Practices
    - Runoff Control Practices
    - Channel Protection Practices
    - Habitat Restoration Practices
    - In-Stream Remediation Practices
    - Other BMPs (such as public education)

- **Watershed Protection Plans (WPPs)** are a voluntary, proactive approach to integrating activities and prioritizing implementation of BMPs. They address complex water quality problems that cross multiple jurisdictions with the goal of improving, restoring or maintaining water quality within a particular watershed. Through the WPP process, the State of Texas encourages stakeholders and local landowners to holistically address all of the sources and causes of impairments and threats to resources within a watershed. Developed and implemented through diverse, well integrated partnerships, a WPP helps assure the long-term health of a watershed with strategies for protecting unimpaired waters and for restoring impaired waters.

- A **Total Maximum Daily Load (TMDL)** is a calculation of the maximum amount of a pollutant that a water body can receive and still meet water quality standards. It is the sum of the allowable loads of a single pollutant from all contributing point and nonpoint sources. The calculation must include a margin of safety to ensure that the water body can be used for the purposes the State has designated. The calculation must also account for seasonal variation in water quality. Once a TMDL and TMDL Implementation Plan (I-Plan) has been developed, the TMDL will be put into action and pollutant loads will be reduced through regulatory and voluntary activities. For example, discharge permits for any point sources associated with the water body may need to be modified to include more strict limitations on their output in order to reduce the amount of pollution in their discharge.

These and other tools, along with public education and the diligent work of stakeholders, resource agencies, and volunteers can and do make a difference. The quality of a water body can be improved to a point where it is capable of supporting its use(s), and the water body can then be removed from the 303(d) list of impaired water bodies.

Impaired Water Bodies in the Upper Neches Basin

TABLE 2-4 Impairments in the Upper Neches Basin (As listed in the 2012 Texas Integrated Report)

Segment ID	Segment Name	Impairment Description	Category	Year First Listed
0604	Neches River Below Lake Palestine	mercury in edible tissue	5c	2010
0604A	Cedar Creek (unclassified water body)	bacteria	5b	2000
0604B	Hurricane Creek (unclassified water body)	bacteria	5b	2000
0604C	Jack Creek (unclassified water body)	bacteria	5b	2000
0604D	Piney Creek (unclassified water body)	depressed dissolved oxygen	5c	2004
0604M	Biloxi Creek (unclassified water body)	bacteria depressed dissolved oxygen	5b 5c	2004 2006
0604T	Lake Ratcliff (unclassified water body)	mercury in edible tissue	5c	2002
0605	Lake Palestine	pH	5a	2006
0605A	Kickapoo Creek in Henderson County (unclassified water body)	bacteria depressed dissolved oxygen	5b 5c	2000 2006
0606	Neches River Above Lake Palestine	bacteria depressed dissolved oxygen pH	5b 5c 5b	2008 2004 2002
0606A	Prairie Creek (unclassified water body)	bacteria	5b	2002
0606D	Black Fork Creek (unclassified water body)	bacteria	5c	2012
0610	Sam Rayburn Reservoir	mercury in edible tissue	5c	1996
0610A	Ayish Bayou (unclassified water body)	bacteria	5b	2000
0611	Angelina River Above Sam Rayburn Reservoir	bacteria	5c	2000
0611A	East Fork Angelina River (unclassified water body)	bacteria	5b	2002
0611B	La Nana Bayou (unclassified water body)	bacteria	5b	2000
0611C	Mud Creek (unclassified water body)	bacteria	5b	2010
0611D	West Mud Creek (unclassified water body)	bacteria	5b	2010
0612	Attoyac Bayou	bacteria	5b	2004
0615	Angelina River/Sam Rayburn Reservoir	depressed dissolved oxygen impaired fish community mercury in edible tissue	5b 5c 5c	2002 2002 2002
0615A	Paper Mill Creek (unclassified water body)	bacteria	5c	2006

Water Bodies with Concerns for Use Attainment and Screening Levels

TABLE 2-5 Concerns in the Upper Neches Basin (As listed in the 2012 Texas Integrated Report)			
Segment ID	**Segment Name**	**Parameter(s)**	**Level of Concern***
0604	Neches River Below Lake Palestine	ammonia chlorophyll-a mercury in edible tissue	CS CS CS
0604A	Cedar Creek (unclassified water body)	ammonia nitrate orthophosphorus total phosphorus	CS CS CS CS
0604B	Hurricane Creek (unclassified water body)	ammonia depressed dissolved oxygen	CS CS
0604C	Jack Creek (unclassified water body)	ammonia depressed dissolved oxygen nitrate orthophosphorus total phosphorus	CS CS CS CS CS
0604D	Piney Creek (unclassified water body)	ammonia depressed dissolved oxygen	CS CS
0604M	Biloxi Creek (unclassified water body)	ammonia total phosphorus	CS CS
0604N	Buck Creek (unclassified water body)	ammonia	CS
0605	Lake Palestine	chlorophyll-a depressed dissolved oxygen pH manganese in sediment	CS CS **CN** CS
0605A	Kickapoo Creek (unclassified water body)	ammonia chlorophyll-a depressed dissolved oxygen bacteria	CS CS CS CS
0606	Neches River Above Lake Palestine	nitrate orthophosphorus total phosphorus depressed dissolved oxygen	CS CS CS **CN**
0606A	Prairie Creek (unclassified water body)	ammonia	CS
0606D	Black Fork Creek (unclassified water body)	ammonia	CS
0610	Sam Rayburn Reservoir	ammonia arsenic in sediment iron in sediment manganese in sediment	CS CS CS CS
0610A	Ayish Bayou (unclassified water body)	ammonia depressed dissolved oxygen	CS CS
0611	Angelina River Above Sam Rayburn Reservoir	ammonia bacteria depressed dissolved oxygen	CS **CN** CS
0611A	East Fork Angelina River (unclassified water body)	bacteria	**CN**

*Level of Concern: **CN** – Concern for near-nonattainment of Water Quality Standards
CS – Concern for water quality based on screening levels

TABLE 2-5 Concerns in the Upper Neches Basin (As listed in the 2012 Texas Integrated Report) - **Continued**			
Segment ID	***Segment Name***	***Parameter(s)***	***Level of Concern****
0611B	La Nana Bayou (unclassified water body)	ammonia bacteria depressed dissolved oxygen nitrate orthophosphorus total phosphorus	CS **CN** CS CS CS CS
0611C	Mud Creek (unclassified water body)	ammonia bacteria depressed dissolved oxygen	CS **CN** CS
0611D	West Mud Creek (unclassified water body)	ammonia nitrate	CS CS
0611Q	Lake Nacogdoches (unclassified water body)	ammonia	CS
0611R	Lake Striker (unclassified water body)	ammonia	CS
0612	Attoyac Bayou	ammonia depressed dissolved oxygen	CS CS
0615	Angelina River/Sam Rayburn Reservoir	depressed dissolved oxygen orthophosphorus total phosphorus	CS CS CS
0615A	Paper Mill Creek (unclassified water body)	depressed dissolved oxygen	**CN**

*Level of Concern: **CN** – Concern for near-nonattainment of Water Quality Standards
CS – Concern for water quality based on screening levels

A more detailed discussion of water quality impairments and concerns will be presented for individual water bodies and segments.

Watershed Characterization Report

About the Watershed Characterization Report

The Watershed Characterization Report serves to characterize impaired water bodies and/or water bodies of interest. This is accomplished by reviewing data, mapping land use and permits, tracking watershed events, and recording information from site visits and communication with monitoring personnel, stakeholders, and local residents. The goal of this report is to describe the key sources that are most likely to impact water quality. Additionally, the report is designed to provide a collection of local knowledge for use in prioritizing monitoring efforts. The Watershed Characterization Report will also provide useful information about the watershed that can be used for Watershed Action Planning activities.

Watershed Characterization Report Contents

The FY 2012-2013 Clean Rivers Program Guidance Document lists the information to be included in a Watershed Characterization Report. For each segment or water body discussed in the report, the following information will be presented:

TABLE 3-1 Watershed Characterization Report Contents

REPORT SECTION	DESCRIPTION
Segment Description	Description of the segment, assessment unit boundaries, historically monitored sites, and site(s) believed to be responsible for the impairment or interest.
Hydrologic Characteristics	Discussion of streamflow variability, reservoir dynamics, seasonality of flow, and typical flow trends.
Description of Water Quality Issue	Identification of why the water body is listed and when it first appeared on the 303(d) List, or why a water body is an area of interest. Information provided includes the number of samples, parameter(s) of impairment or concern, assessment results, and the appropriate state standards for comparison.
Land Use & Natural Characteristics	Description of the land surrounding the segment, utilizing Google Earth satellite imagery or GIS, to include cities, agricultural lands, location(s) of permitted discharges, landfills, quarry operations, industrial areas, animal feeding operations and oil/gas operations. Other information, such as topography, slope, soils, vegetation, wildlife, average annual precipitation, average high and low temperatures, and eco-regions may also be included.
Potential Cause of Water Quality Issue	Identification of possible causes of the water quality issue using satellite imagery, watershed surveys, and communication with stakeholders and staff from state and local agencies.
Potential Stakeholders	Identification of companies, agencies or organizations who have a vested interest in the area and who may have a representative serve as a stakeholder.
Recommended Actions	Proposed next steps based on the potential causes of impairment or interest, number of years on the 303(d) List, quality of the listing data and knowledge of the site.
Maps	Inclusion of Google Earth aerial images or GIS renderings beginning at the watershed level and "drilling down" to the monitoring site level. Maps define segment and AU boundaries, watersheds, monitoring sites, permitted discharges and animal feeding operations.
Ongoing Projects	Description of current or future projects that will occur in the segment (e.g. TMDLs, special studies, NPS projects, etc.)
Major Watershed Events	Anticipated or known occurrences that have the potential to either positively or negatively impact water quality (e.g., new/amended permits, fish kills, flood/drought, implementing management measures, land development).
Images	Photographic images of the watershed and areas of interest

The FY 2013 Upper Neches Basin Highlights Report has been developed to present a watershed characterization of impaired water bodies and/or water bodies of interest in the Lower Angelina sub-basin. More specifically, the FY 2013 Highlights Report will focus on **Ayish Bayou**, **Attoyac Bayou**, and **Sam Rayburn Reservoir**. Other water bodies in the Lower Angelina sub-basin will be discussed in future watershed characterization reports.

Flow Methodology

Throughout the descriptions of the watersheds and inflows, distances are referenced in miles and estimated mean annual flows in cubic feet per second (CFS) using the National Hydrography Dataset Plus (NHDPlus) v2.1. The Q0001F values from the Extended Unit Runoff Method (EROM) are used for estimated flows. These flow values are calculated based on land cover, land elevation, rainfall, temperature, and latitude data for a given drainage area, and they are then further refined using recorded data from USGS gages in the area and known transfers and withdrawals from the water body. This estimated flow data is very useful and informative, but they are estimates and not measured in-stream flows. For more information about the NHDPlus and the EROM flow data, please visit http://www.horizon-systems.com/NHDPlus/.

The Lower Angelina Sub-Basin

Profile of the Lower Angelina Sub-Basin

Population

The Lower Angelina sub-basin includes, partially or wholly, Angelina, Jasper, Nacogdoches, Newton, Rusk, Sabine, Shelby and San Augustine counties. The sub-basin includes the following cities: Chireno, Garrison, Nacogdoches, Lufkin, Huntington, Broaddus, Pineland, Browndell, San Augustine, and Appleby. Based upon 2010 census data 299,867 persons reside within the counties included in the sub-basin. The population of census blocks with their centroids within the sub-basin is 90,064. The City of Nacogdoches, with a population of 32,996, is located entirely within the Lower Angelina sub-basin.

TABLE 4-1 Population of Counties in the Lower Angelina Sub-Basin

County	Population
Angelina	86,711
Jasper	35,710
Nacogdoches	64,524
Newton	14,445
Rusk	53,330
Sabine	10,834
San Augustine	8,865
Shelby	25,448
TOTAL	299,867

Land Characteristics and Use

In the Lower Angelina sub-basin, evergreen forest, shrub, woody wetlands, young forest, grassland, and piney hardwood are emergent. Land coverage in the northern part of the sub-basin includes hay, pasture, shrub, developed open space, and developed low intensity regions located around Lufkin and Nacogdoches. Within the southern portion of the sub-basin, land use includes emergent herbaceous and mixed forest. There are areas of willow oak, water oak, and blackgum located at the upper reaches of Sam Rayburn reservoir. Carrizo-Wilcox, Sparta, Yegua Jackson, and Gulf Coast are the aquifers which supply the region. This South-Central Plains Ecoregion includes floodplains, low terraces, southern tertiary uplands, and tertiary uplands.

The area is very rural and heavily agricultural. Poultry and cattle operations are common within the Lower Angelina sub-basin, particularly in the Attoyac Bayou (Segment 0612) watershed,

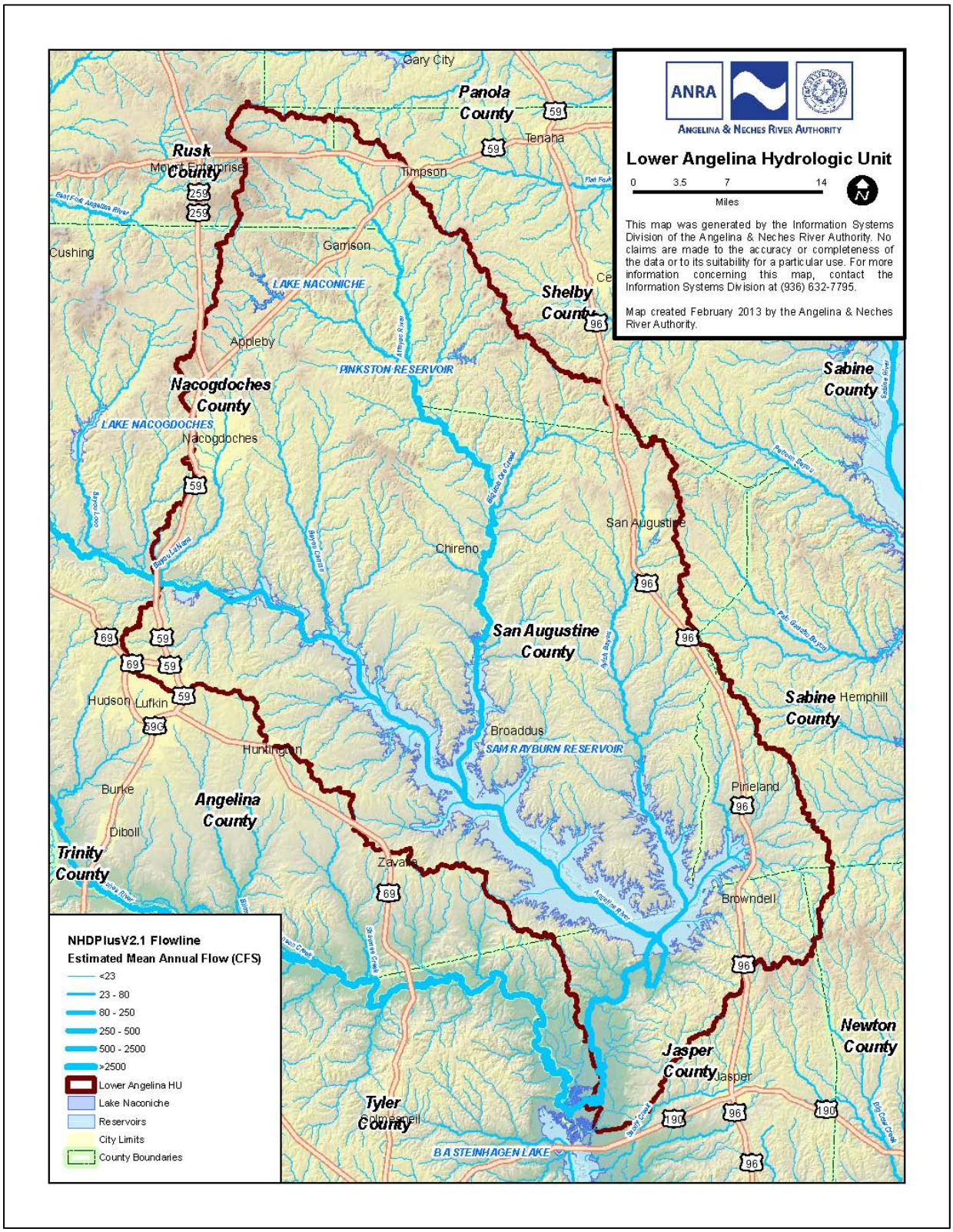
TABLE 4-2 Livestock Inventory by County (based on the 2007 Census of Agriculture)

County	Broilers & Meat-Type Chickens	Layers & Pullets	Cattle & Calves	Horses & Ponies
Angelina	1,285,540	62,012	22,293	2,285
Jasper	Not Reported	2,184	13,657	1,826
Nacogdoches	19,372,881	1,035,970	46,328	1,928
Newton	5,354	1,839	5,354	714
Rusk	1,537,072	Cannot be disclosed	48,924	Not Reported
Sabine	Cannot be disclosed	236	6,080	436
San Augustine	5,710,598	217,840	13,232	529
Shelby	24,186,885	2,022,396	42,722	Not Reported

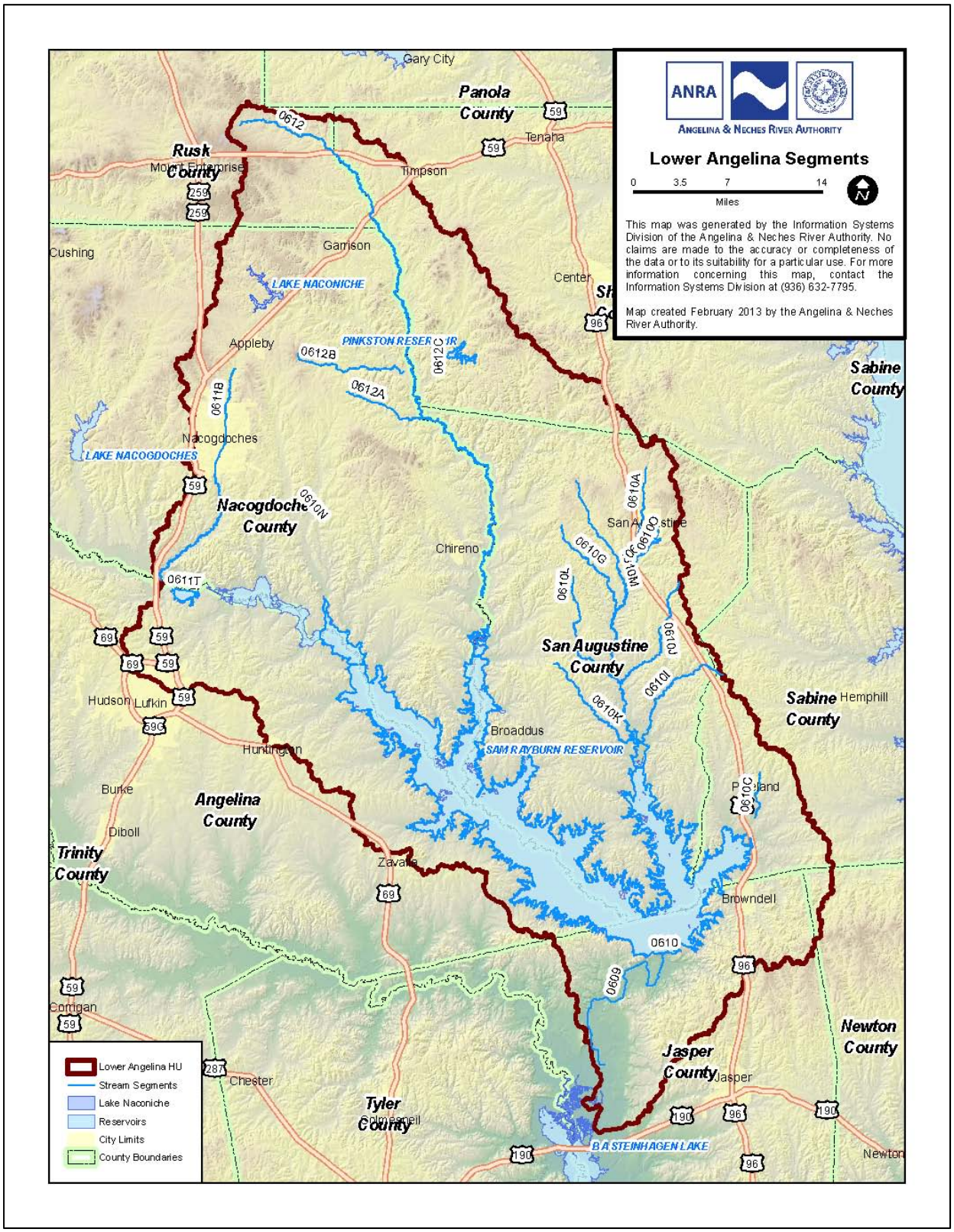
TABLE 4-3 Segments included in the Lower Angelina Sub-Basin		
Segment ID	**Segment Name**	**Length or Acreage**
0609	Angelina River Below Sam Rayburn Reservoir	13 miles
0610	Sam Rayburn Reservoir	106,666 acres
0610A	Ayish Bayou (unclassified water body)	32 miles
0611B	La Nana Bayou (unclassified water body)	32 miles
0612	Attoyac Bayou	82 miles
0612A	Terrapin Creek (unclassified water body)	8.5 miles
0612B	Waffelow Creek (unclassified water body)	10.5 miles
0612C	Pinkston Reservoir (unclassified water body)	523 acres
0615	Angelina River/Sam Rayburn Reservoir	5,068 acres
0615A	Papermill Creek (unclassified water body)	9 miles

Maps of the Lower Angelina Sub-Basin

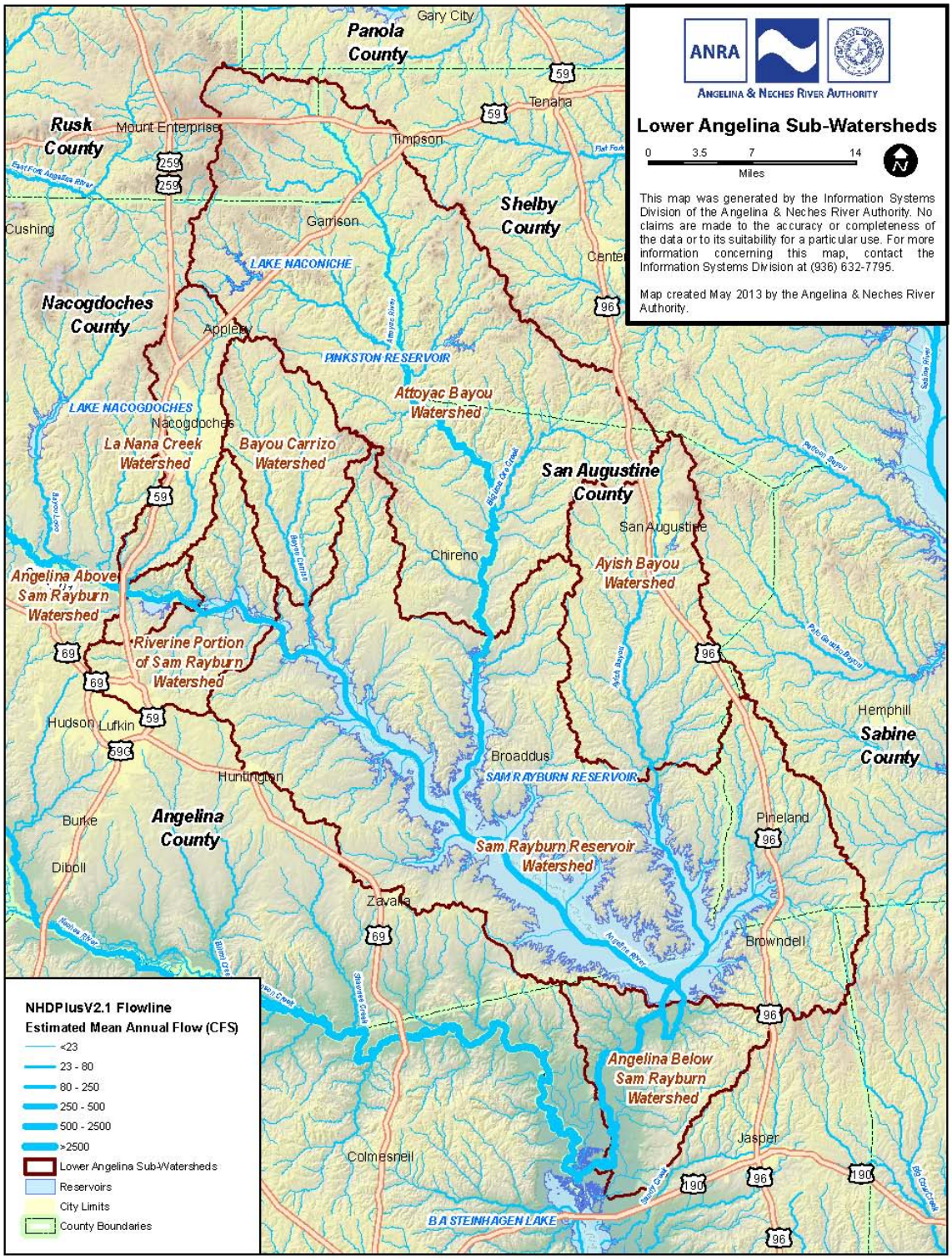
MAP 4-1 Lower Angelina Sub-Basin Hydrologic Unit



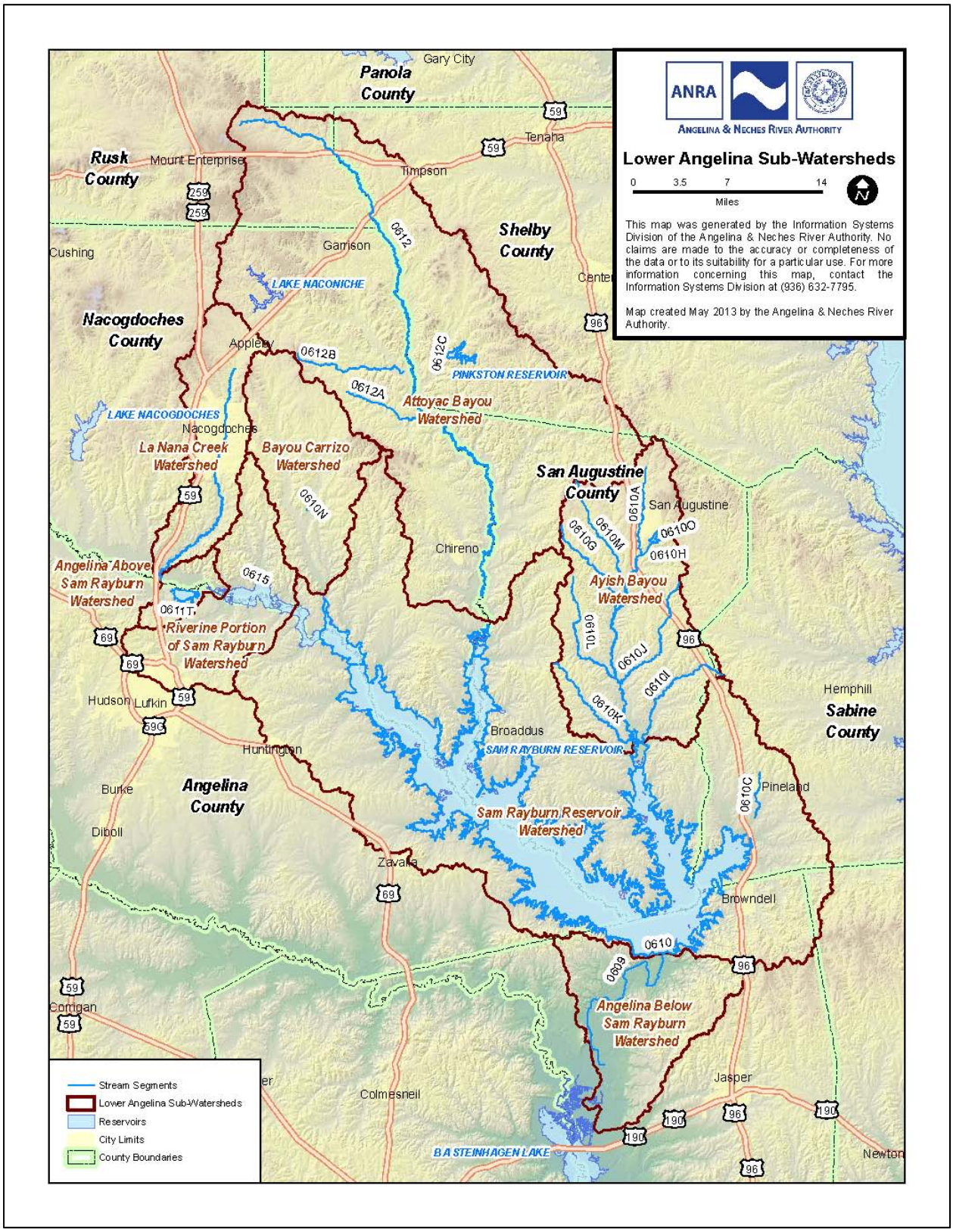
MAP 4-2 Lower Angelina Sub-Basin Segments



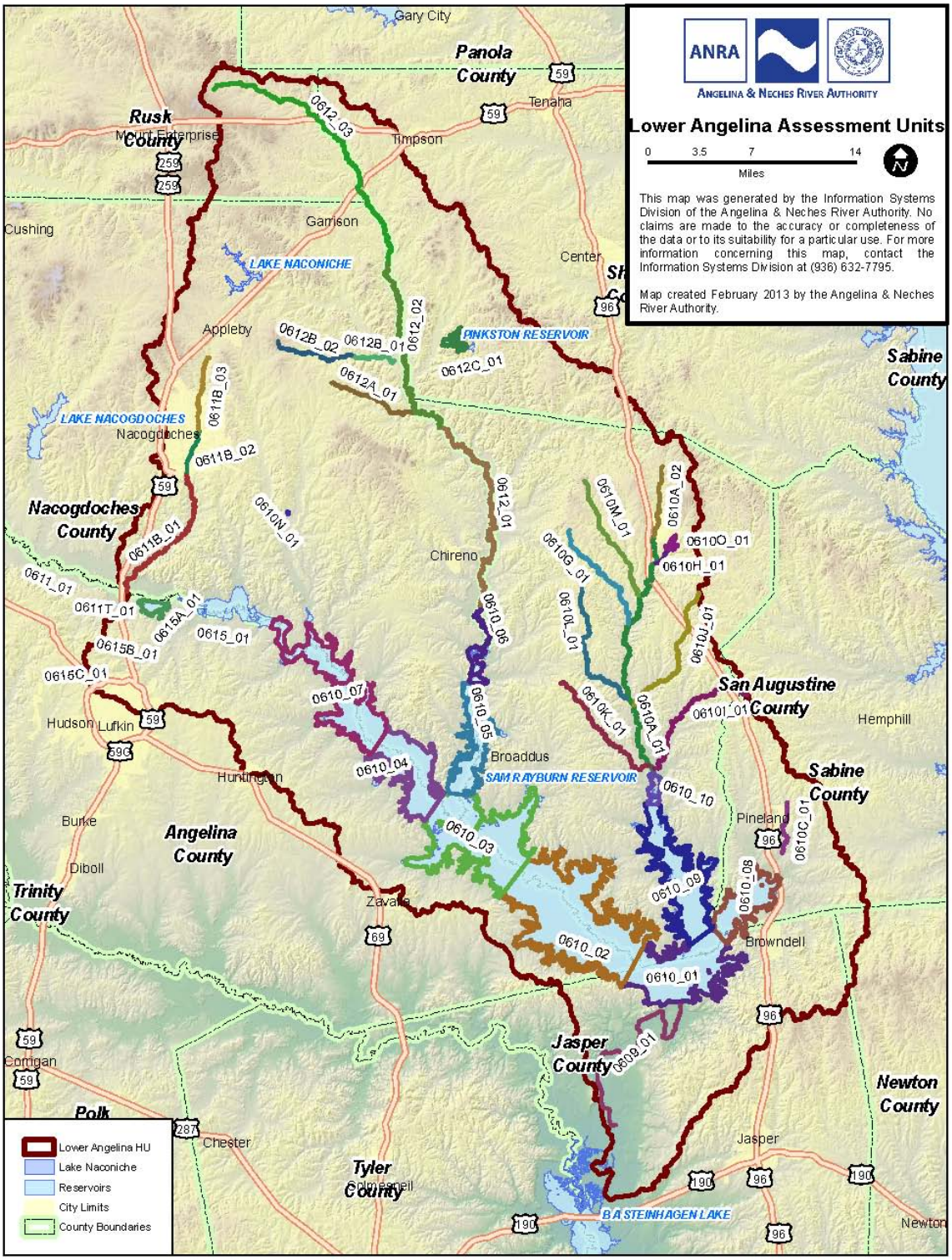
MAP 4-3 Lower Angelina Sub-Basin Sub-Watersheds



MAP 4-4 Lower Angelina Sub-Basin Sub-Watersheds with Segment IDs



MAP 4-5 Lower Angelina Sub-Basin Assessment Units



Permitted Discharges in the Lower Angelina Sub-Basin

There are thirty-two permitted discharges included in the Lower Angelina sub-basin.

TABLE 4-4 Permitted Discharges in the Lower Angelina Sub-Basin

Segment ID	Permit Number	Outfall	NPDES Number	Permittee	County	TCEQ Region
0609	10998-001	001	031283	Brookeland FWSD	Jasper	10 - Beaumont
0610	00368-000	001	001643	Donohue Industries Inc.	Angelina	10 - Beaumont
0610	00368-000	002	001643	Donohue Industries Inc.	Angelina	10 - Beaumont
0610	00368-000	004	001643	Donohue Industries Inc.	Angelina	10 - Beaumont
0610	00368-000	005	001643	Donohue Industries Inc.	Angelina	10 – Beaumont
0610	01820-000	001	046892	Temple-Inland Forest Products Corp	Sabine	10 - Beaumont
0610	01820-000	002	046892	Temple-Inland Forest Products Corp	Sabine	10 - Beaumont
0610	01820-000	003	046892	Temple-Inland Forest Products Corp	Sabine	10 - Beaumont
0610	03848-000	001	113689	TIN Inc	Sabine	10 - Beaumont
0610	10249-001	001	027154	City of Pineland	Sabine	10 - Beaumont
0610	10268-001	001	022349	City of San Augustine	San Augustine	10 - Beaumont
0610	10947-001	001	054224	Shirley Creek Marina Inc.	Nacogdoches	10 - Beaumont
0610	11337-001	001	031275	Westwood WSC	Jasper	10 - Beaumont
0610	11620-001	001	056154	Angelina & Neches River Authority	Angelina	10 - Beaumont
0610	11772-001	001	057673	City of Broaddus	San Augustine	10 - Beaumont
0610	11895-001	001	068039	Texas Airstream Harbor Inc	Angelina	10 - Beaumont
0610	13092-001	001	099082	Brookeland ISD	Sabine	10 - Beaumont
0610	13161-001	001	098744	Stephen F Austin State University	San Augustine	10 - Beaumont
0610	13903-001	001	118419	Community Estates Inc	Nacogdoches	10 - Beaumont
0610	14693-001	001	066753	Rogers, Gordon Dean	Angelina	10 - Beaumont
0610A	10268-002	001	122351	City of San Augustine	San Augustine	10 - Beaumont
0610A	10788-001	001	023701	Rayburn Country MUD	Jasper	10 - Beaumont
0611	14201-001	001	123021	Angelina County WCID No 3	Angelina	10 - Beaumont
0611	14729-001	001	128937	Redland Water Supply Corp	Angelina	10 - Beaumont
0611B	04198-000	001	121053	Cal-Tex Lumber Co Inc.	Nacogdoches	10 - Beaumont
0611B	10342-004	001	055123	City of Nacogdoches	Nacogdoches	10 - Beaumont
0611B	13927-001	001	118613	D & M WSC	Nacogdoches	10 - Beaumont
0612	11304-001	001	076503	City of Garrison	Nacogdoches	10 - Beaumont
0612	13917-001	001	118915	Chireno ISD	Nacogdoches	10 - Beaumont
0612A	14027-001	001	118354	Martinsville ISD	Nacogdoches	10 - Beaumont
0612C	14352-001	001	124940	City of Center	Shelby	10 - Beaumont
0615A	11588-001	001	054127	Moffett Twin-Oaks Mobile Home Property Trust	Angelina	10 - Beaumont

TABLE 4-5 Site-Specific Uses for Classified Segments

Segment #	Segment Name	Designated Uses			
		Recreation	Aquatic Life	Domestic Water Supply	Other
0609	Angelina River Below Sam Rayburn Reservoir	PCR	H	PS	
0610	Sam Rayburn Reservoir	PCR	H	PS	
0611	Angelina River Above Sam Rayburn Reservoir	PCR	H	PS	
0612	Attoyac Bayou	PCR	H	PS	
0615	Angelina River/Sam Rayburn Reservoir	PCR	H	PS	

PCR = Primary Contact Recreation
H = High Aquatic Life Use
PS = Public Supply

TABLE 4-6 Site-Specific Criteria for Classified Segments in the Lower Angelina Sub-Basin

Segment #	Segment Name	Criteria*						
		Chloride (mg/L)	Sulfate (mg/L)	TDS (mg/L)	Dissolved Oxygen (mg/L)	pH Range (SU)	*E. coli* bacteria #/100 mL	Temp (°F)
0609	Angelina River Below Sam Rayburn Reservoir	70	50	250	5.0	6.0-8.5	126	90
0610	Sam Rayburn Reservoir	100	100	400	5.0	6.0-8.5	126	93
0611	Angelina River Above Sam Rayburn Reservoir	125	50	250	5.0	6.0-8.5	126	90
0612	Attoyac Bayou	75	50	200	5.0	6.0-8.5	126	90
0615	Angelina River/Sam Rayburn Reservoir	150	100	500	5.0	6.5-9.0	126	93

* The criteria for chloride, sulfate, and TDS are listed as the maximum annual averages for the segment. Dissolved oxygen criteria are listed as minimum 24-hours means at any site within the segment. The pH criteria are listed as minimum and maximum values expressed in standard units at any site within the segment. The criteria for temperature are listed as maximum values at any site within the segment.

TABLE 4-7 Nutrient Screening Levels for the Lower Angelina Sub-Basin

Water Body Type	Nutrient Parameter	Screening Level
Freshwater Stream	Ammonia-N	0.33 mg/L
	Nitrate-N	1.95 mg/L
	Total Phosphorus	0.69 mg/L
	Chlorophyll-*a*	14.1 µg/L
Reservoir	Ammonia-N	0.11 mg/L
	Nitrate-N	0.37 mg/L
	Total Phosphorus	0.20 mg/L
	Chlorophyll-a	26.4 µg/L

WATERSHED CHARACTERIZATION
Segment 0610A – Ayish Bayou (unclassified water body)

Ayish Bayou at SH 147

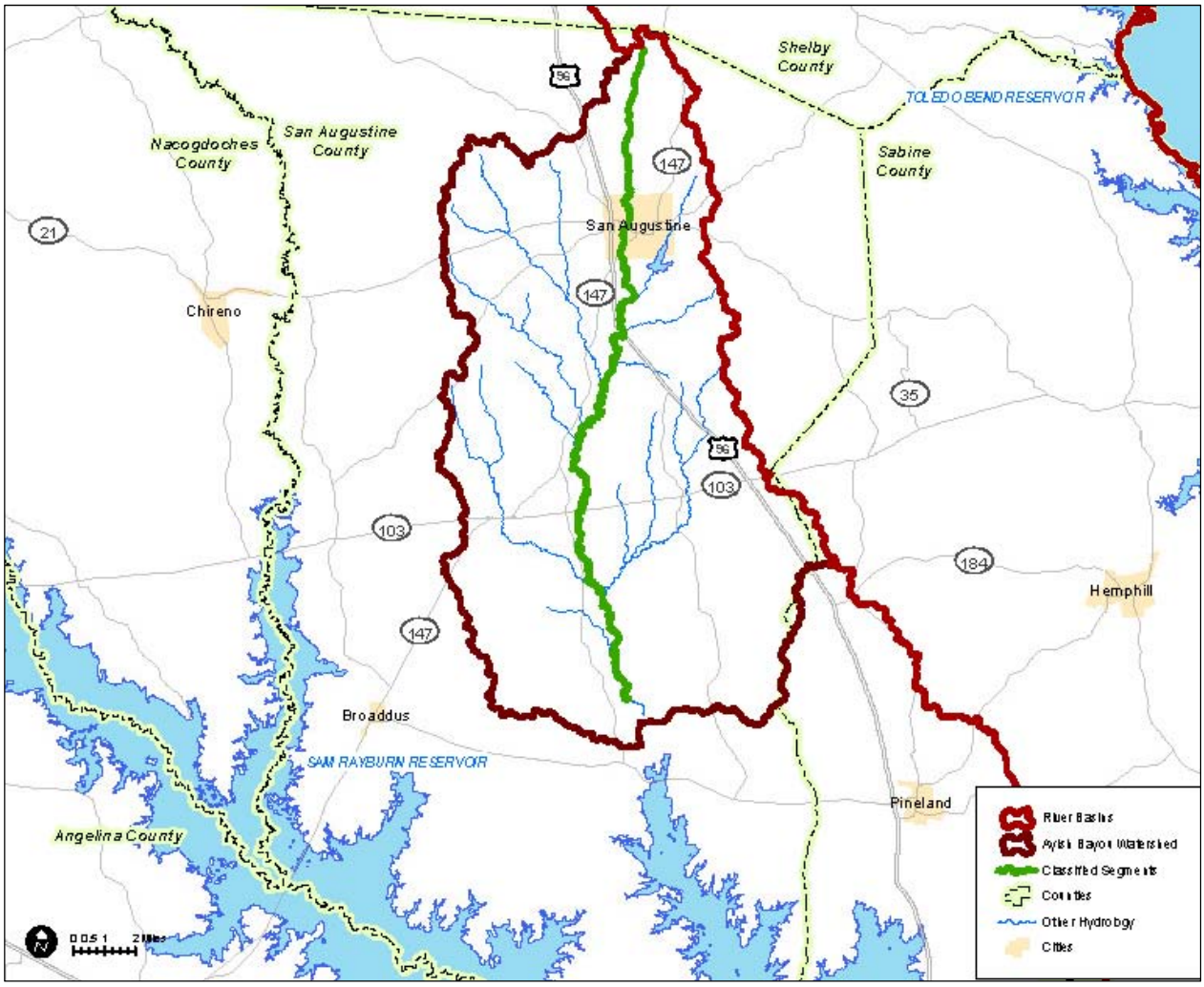
Ayish Bayou at SH 103

Segment Description

Ayish Bayou (Segment 0610A) is an unclassified 32 mile-length perennial freshwater stream extending from the confluence with Sam Rayburn Reservoir south of San Augustine in San Augustine County to the dam impounding Bland Lake, approximately 0.1 km upstream of FM 1279 near the City of San Augustine.

The Ayish Bayou watershed is 123,540 acres (193 sq. miles) and drains into the northeast arm of Sam Rayburn Reservoir. It is primarily situated in San Augustine County, but does extend very slightly into Sabine (903 acres) and Shelby (13 acres) Counties.

MAP 5-1 Ayish Bayou Segment Map



Assessment Units

There are two assessment units located in Segment 0610A.

TABLE 5-1 Assessment Units in Ayish Bayou (Segment 0610A)	
Assessment Unit (AU) ID	**Description**
0610A_01	From the headwaters of Sam Rayburn Reservoir, per WQS App. D, about 2.4 km north of FM 83 upstream to confluence with unnamed tributary about 0.4 km SW of intersection of SH 147 and AT and SF Railroad at NHD RC 12020005000036.
0610A_02	From the confluence with unnamed tributary about 0.4 km SW of intersection of SH 147 and AT and SF Railroad in the City of San Augustine upstream to the Bland Lake dam, per WQS App. D.

Monitoring Stations

In FY 13, Ayish Bayou is monitored by ANRA at the following station:

TABLE 5-2 Monitoring Stations in Ayish Bayou (Segment 0610A)		
Assessment Unit (AU) ID	**Monitoring Station ID**	**Description**
0610A_01	15361	AYISH BAYOU AT SH 103 0.8 KM EAST OF FM 705

Beginning in FY 14, ANRA will be adding an additional monitoring station to be located in 0610A_02.

Within the Ayish Bayou watershed, there have been numerous historical monitoring sites, including several sites on tributaries to the Ayish. Many of these stations have not been monitored in several years. Based upon the dates and sample counts, it appears that many of these stations were monitored as part of a special study.

TABLE 5-3 Historical Monitoring Stations in the Ayish Bayou Watershed (Segment 0610A)					
Station ID	**Segment ID**	**Short Description**	**Long Description**	**Sample Count**	**Last Sampled Date**
20164	0610O	SAN AUGUSTINE CITY LAKE MID LAKE NEAR DAM	SAN AUGUSTINE CITY LAKE MID LAKE NEAR DAM 140 M NORTH AND 51 M EAST OF DAM RELEASE	2	9-Oct-06
10483	0610A	AYISH BAYOU AT US 96	AYISH BAYOU AT US 96 5.86 KM SOUTHWEST OF SAN AUGUSTINE	51	11-Jun-84
15357	0610L	TURKEY CREEK AT FM 705	TURKEY CREEK AT FM 705 0.4 KM UPSTREAM OF AYISH BAYOU CONFLUENCE 3.6 KM SOUTH OF SH 103	10	19-Aug-97
15358	0610K	SANDY CREEK AT FM 705	SANDY CREEK AT FM 705 2.11 KM NORTH OF FM 83/ FM 705 INTERSECTION	10	19-Aug-97
15359	0610I	CHIAMON BAYOU AT FM 1751	CHIAMON BAYOU AT FM 17516.19 KM SOUTH OF FM 1751/SH 103 INTERSECTION 6.0 KM SOUTH OF CHINQUAPIN	9	19-Aug-97
15360	0610J	CHINQUAPIN CREEK AT FM 1751	CHINQUAPIN CREEK AT FM 1751 1.8 KM SOUTH OF CHINQUAPIN	11	19-Aug-97
15362	0610G	CANEY CREEK AT SH 147	CANEY CREEK AT SH 147 1.26 KM UPSTREAM OF AYISH BAYOU CONFLUENCE	10	21-Aug-97
15363	0610M	VENADO CREEK AT SH 147	VENADO CREEK AT SH 147 2.35 KM UPSTREAM OF AYISH BAYOU CONFLUENCE 7.10 KM SOUTHWEST OF SAN AUGUSTINE	10	21-Aug-97
15364	0610A	AYISH BAYOU AT SH 147	AYISH BAYOU AT SH 147 706 M EAST OF US 96 0.2 KM SOUTH OF SAN AUGUSTINE	24	28-Aug-07
15365	0610A	AYISH BAYOU AT FM 3230	AYISH BAYOU AT FM 3230 3.7 KM NORTH NORTHWEST OF SAN AUGUSTINE	9	21-Aug-97
15366	0610H	CARRIZO CREEK AT FM 2213	CARRIZO CREEK AT FM 2213 3.2 KM SOUTH OF SAN AUGUSTINE	10	21-Aug-97

Hydrologic and Land Use Characteristics

The Ayish Bayou flows from the north into Sam Rayburn Reservoir. Its watershed encompasses just under 123,540 acres (193 sq miles) and includes portions of three counties. It is primarily situated in San Augustine County, but extends very slightly into Sabine and Shelby Counties.

The City of San Augustine is the only incorporated city within the watershed and it is fully contained in the watershed.

TABLE 5-4 Area of Ayish Bayou Watershed by County

County	Area (in acres)
Sabine	903
Shelby	13
San Augustine	122,624
TOTAL	123,540

Based upon 2010 census data, there are 2,373 households within the watershed, with a population of 4,812. Of those numbers, 1,000 households and 2,104 people are located within the city limits of the City of San Augustine.

Annual rainfall in the Ayish Bayou watershed from 1971 - 2000 varied from a minimum of 51.8 inches to a maximum of 53.5 inches. For the period of 1981 - 2010, rainfall varied from a minimum of 53.1 inches to a maximum of 55.2 inches.

The Ayish Bayou is 33.7 miles long from the intermittent headwaters, all the way downstream to the riverine portion of the Ayish arm of Sam Rayburn Reservoir north of FM 83. The uppermost 1.7 miles are upstream of the Bland Lake Dam and are not assessed by the TCEQ as part of the general segment. All flow values are approximated from the National Hydrography Dataset Plus v2.1, and are estimates of the mean annual flows based primarily on rainfall averages and land elevations. They are not observed flow rates, but are a reasonable indicator of how the size of streams in an area relate to one another.

Typical land cover directly surrounding the flow channel appears to be two-thirds narrow riparian forested buffer surrounded by open fields and one-third forested.

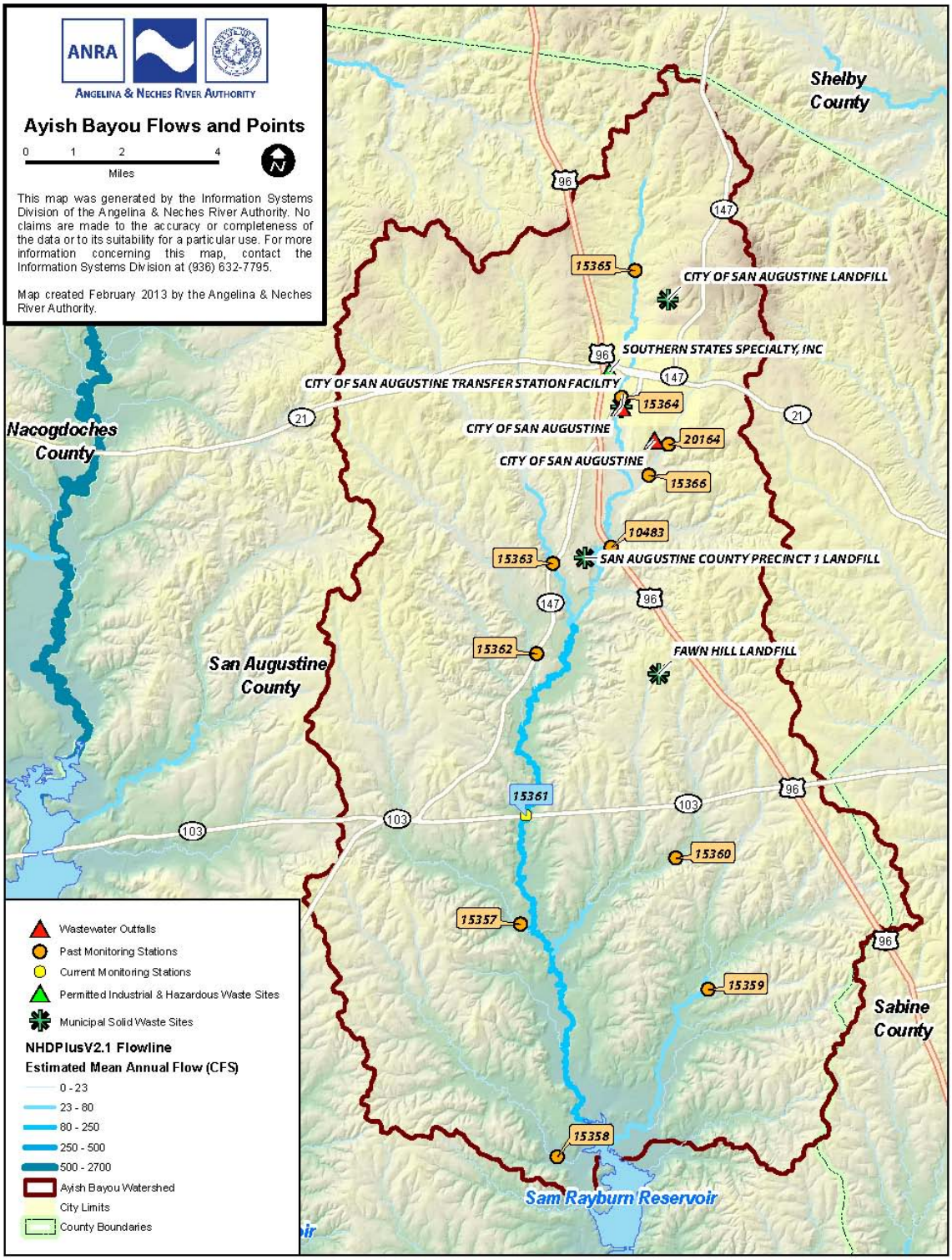
There have been four permitted Municipal Solid Waste Sites in the Ayish Bayou Watershed, but they are all listed as closed or inactive. Most do not appear on the aerial imagery. There is a single permitted industrial waste offsite storage site within the City of San Augustine Limits.

There are two permitted discharges in the watershed.

TABLE 5-5 Permitted WWTP Discharges in the Ayish Bayou Watershed

Segment ID	Permittee Name	TPDES Permit No.	Permitted Discharge
0610A	City of San Augustine	10268-001	0.900000 MGD
0610A	City of San Augustine	10268-002	0.095000 MGD

MAP 5-2 Ayish Bayou Mean Annual Flows, Permitted Facilities, and Monitoring Stations

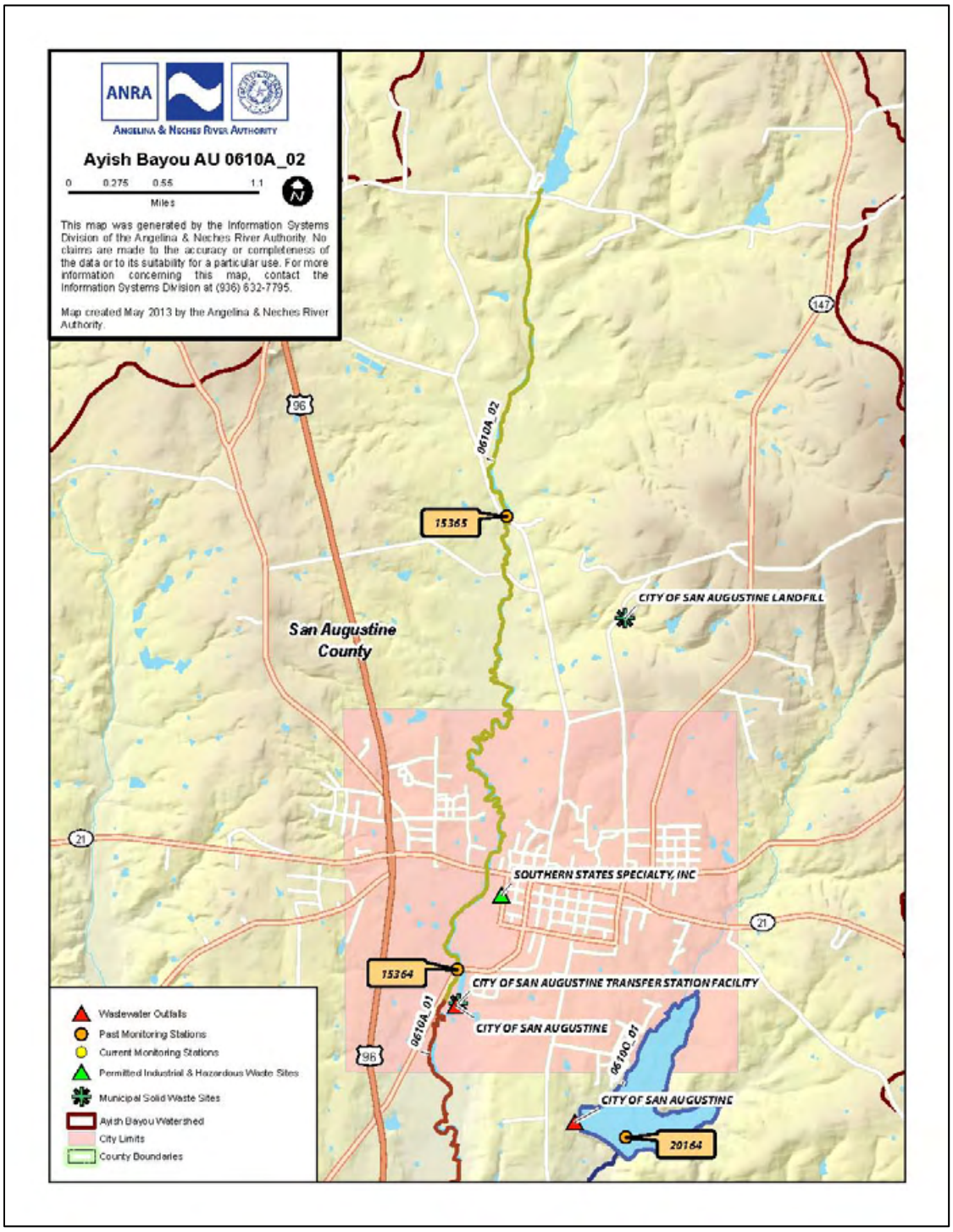


Maps of the Ayish Bayou's two assessment units follow, beginning with AU 0610A_02 at the headwaters and moving south to AU 0610A_01 at the discharge into Sam Rayburn Reservoir.

Assessment Unit 0610A_02

From the confluence with unnamed tributary about 0.4 km SW of intersection of SH 147 and AT and SF Railroad in the City of San Augustine upstream to the Bland Lake dam, per WQS App. D.

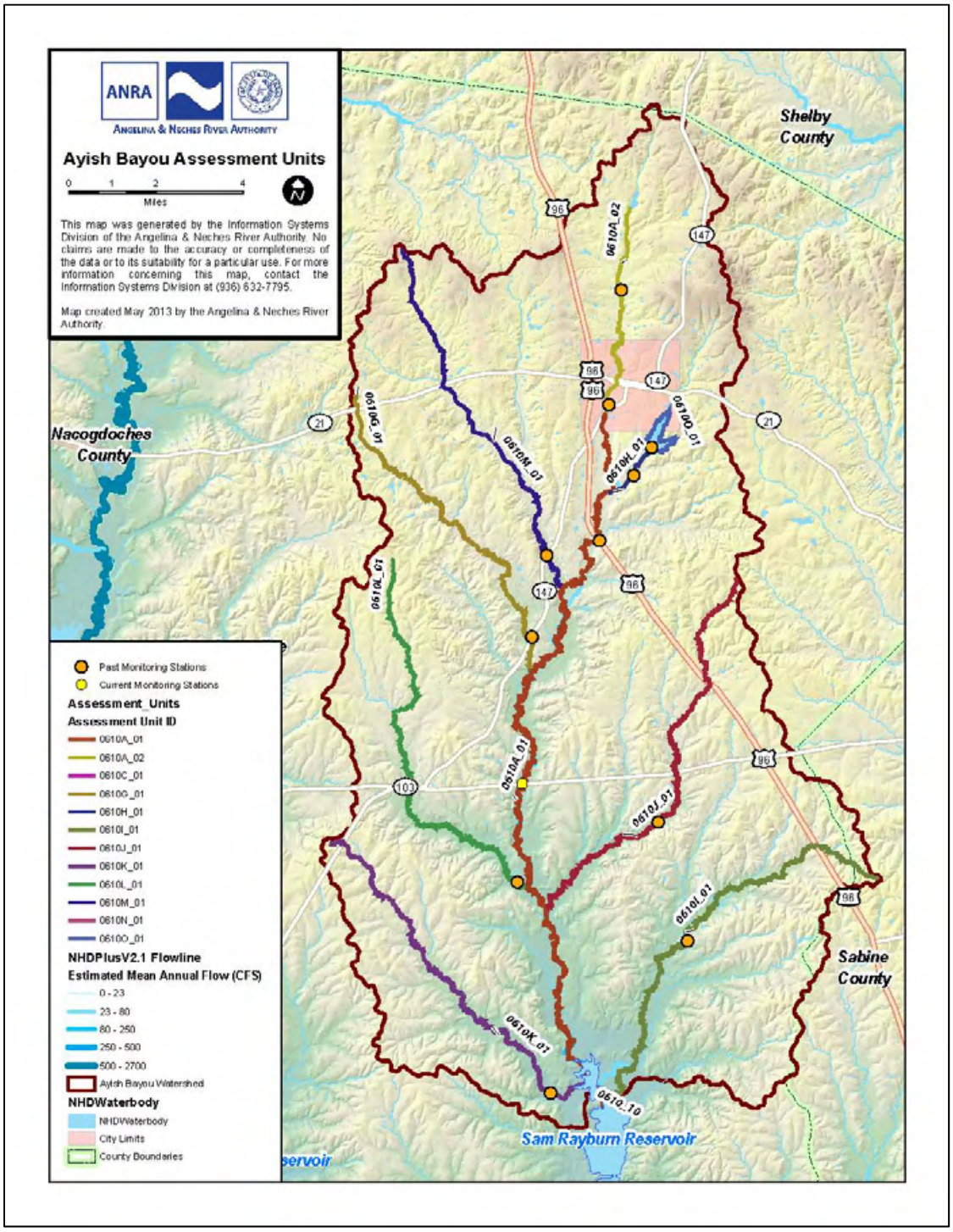
MAP 5-3 Ayish Bayou Assessment Unit AU 0610A_02



Assessment Unit 0610A_01

From the headwaters of Sam Rayburn Reservoir, per WQS App. D, about 2.4 km north of FM 83 upstream to confluence with unnamed tributary about 0.4 km SW of intersection of SH 147 and AT and SF Railroad at NHD RC 12020005000036.

MAP 5-4 Ayish Bayou Assessment Unit AU 0610A_01



The following section details the Ayish Bayou watershed and its tributaries, beginning with AU 0610A_02 at the headwaters, and moving downstream to AU 0612_01 and its discharge into Sam Rayburn Reservoir. Within each assessment unit, information will be presented detailing tributaries, drainage areas, flows, land cover and land use, monitoring stations, and potential point or non-point sources of pollution.

Assessment Unit 0610A_02

Ayish Bayou Headwaters (33.7 miles to Sam Rayburn Reservoir)

The Ayish Bayou watershed begins just inside the southern border of Shelby County. An annual average rainfall of 53.7 inches and a series of natural springs feed into Bland Lake, a man-made lake constructed in 1893 by Jeff Bland, which drains 2 sq miles and becomes the headwaters of the Ayish Bayou with an estimated yearly mean flow of 10.8 CFS. The uppermost portion of the watershed also contains 867 acres of the Sabine National Forest which drains into the Ayish Bayou less than one mile downstream of Bland Lake. Land cover in the watershed above Bland Lake is primarily forested, with a few open fields.

FIGURE 5-1 Ayish Bayou Headwaters / Bland Lake

Bland Lake Dam (31.9 miles to Sam Rayburn Reservoir)

South of the Bland Lake Dam, the Ayish Bayou flows under FM 1279, travels 2.3 miles, and crosses FM 3230 (Historical Monitoring Station 15365). Downstream of FM 3230 there are approximately 1.5 stream miles to the northern limit of the City of San Augustine.

San Augustine City Limits (28.5 miles to Sam Rayburn Reservoir)

Approximately one mile to the east of this section of the bayou is the site of the City of San Augustine Landfill, which was permitted from March of 1975 through April of 1995 (TCEQ MSW permit no. 637). The bayou then runs for about 2.25 stream miles within the city limits, primarily in sparsely populated areas, but receiving inflows from unnamed tributaries that collect runoff within the urbanized portions of the city limits. While within the city limits, the bayou flows under three streets: Columbia Street, SH 21, and SH 147/Broadway. Sampling has been performed in the past at the SH 147/Broadway crossing (Historical Monitoring Station 15364). Also within the city limits, below SH 21 and above SH 147 about one-tenth of a mile to the east of the bayou is the location of a permitted industrial waste site. The site is owned by Southern States Specialty Inc. and is located at 209 S Bolivar St in the City of San Augustine. It is permitted for off-site storage of commercial waste.

FIGURE 5-2 Ayish Bayou within the City Limits of San Augustine

Transition to AU_0610A_01 (26.2 miles to Sam Rayburn Reservoir)

Just upstream of the City of San Augustine Wastewater Treatment Facility (WWTF) outfall, Ayish Bayou transitions from assessment unit 0610A_02 into assessment unit 0610A_01.

Assessment Unit 0610A_01

City of San Augustine WWTP

Just south of Broadway, still within the city limits, is the City of San Augustine Wastewater Treatment Facility (TPDES permit no. 10268-001). This facility is permitted to discharge a maximum of 0.9 million gallons per day of treated effluent. The City of San Augustine Transfer Station Facility is also permitted as a Municipal Solid Waste Site (TCEQ MSW permit no. 40024) at the same location.

FIGURE 5-3 City of San Augustine WWTP

City Lake and Carrizo Creek (Confluence with Carrizo Creek, 23.8 miles to Sam Rayburn Reservoir)

The southeast corner of the city limits contains the upper third of City Lake, the water supply for the City of San Augustine. City Lake has a surface area of 188 acres, and extends south about a half mile past the city limits. It drains 6 sq miles including the southeastern third of the city limits. Its primary inflow is Carrizo Creek, which drains 3.8 sq miles and crosses FM 353 and SH 21. The lake contributes 23.6 CFS to the downstream portion of Carrizo Creek, which then travels 1.2 miles, crossing FM 2213 and gains an additional 5 CFS before contributing a total of 28.6 CFS to the bayou. The city has a wastewater permit which allows them to discharge 0.095 MGD from the drinking water treatment plant back into City Lake. Sampling has been performed on the lake in the past (Historical Monitoring Station 20164) and also on the lower portion of Carrizo Creek at the FM 2213 crossing (Historical Monitoring Station 15366).

FIGURE 5-4 City Lake in San Augustine

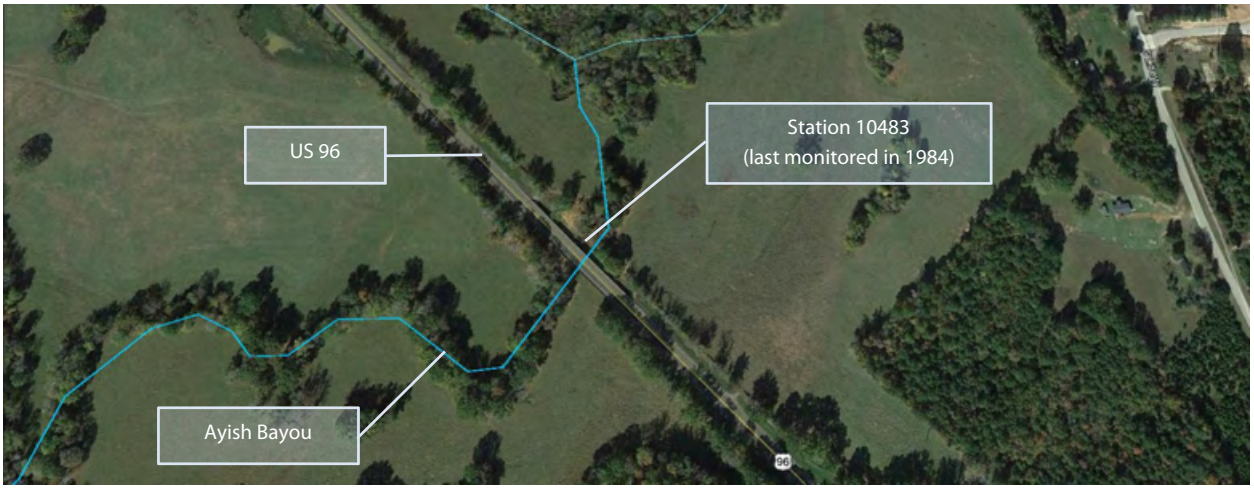
Confluence with Steep Creek (21.9 miles to Sam Rayburn Reservoir)

Two stream miles further downstream is the confluence with Steep Creek, a four mile long stream that flows from the east through forested land. It drains 5.8 sq miles and contributes 22.6 CFS, which gives us a combined 94 CFS just below the confluence.

US 96 Crossing (21.8 miles to Sam Rayburn Reservoir)

Ayish Bayou then crosses under US 96. Monitoring has been performed here in the past (Historical Monitoring Station 10483), although it was last sampled in 1984. The land adjacent to the monitoring site is privately owned, and no public access is available because the property is fenced, with the fence extending under the bridge and preventing access to sampling personnel. Aerial imagery depicts that the surrounding land use is pasture.

FIGURE 5-5 Ayish Bayou – US 69 Crossing



Downstream of US 96, the bayou passes through several large open fields and a quarter mile east of the location of the San Augustine County Precinct 1 Landfill (TCEQ MSW permit no. 864), which had its permit canceled in 1976.

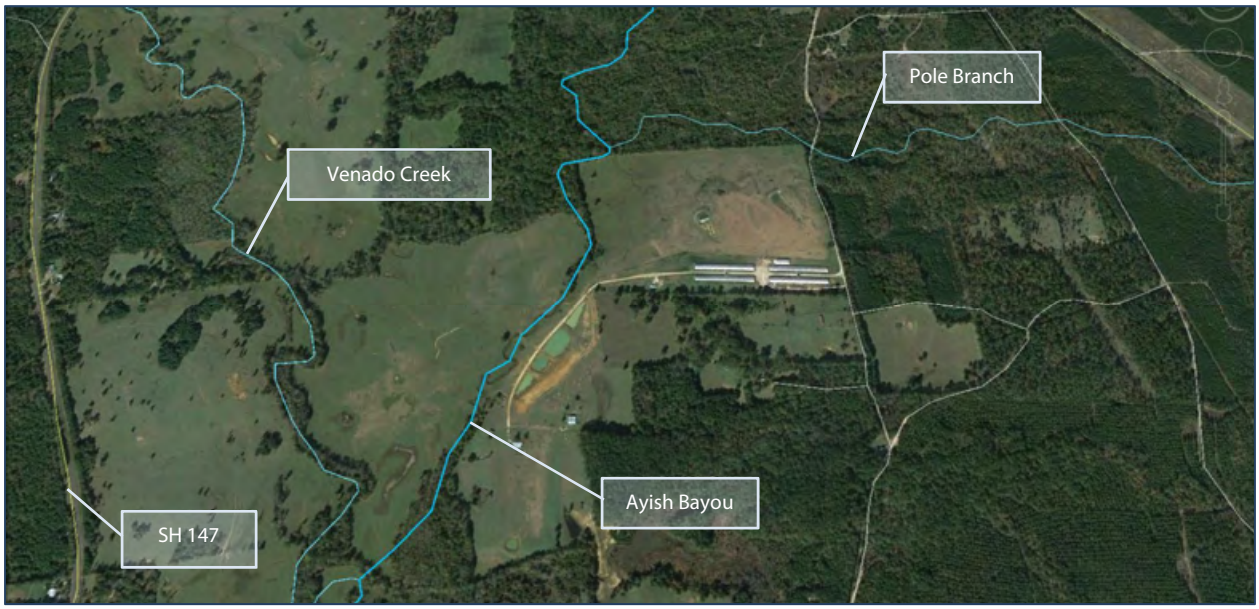
Confluence with Pole Branch (20 miles to Sam Rayburn Reservoir)

After 1.8 stream miles Ayish Bayou reaches the confluence with Pole Branch, a two mile long stream that flows from the east crossing Hwy 96 and passing through moderate to lightly forested land, a large percentage of which appears to be floodplain for the bayou. Pole Branch drains 2.3 sq miles and contributes 11.6 CFS.

Confluence with Venado Creek (19.1 miles to Sam Rayburn Reservoir)

Continuing one mile downstream through a narrow forested riparian strip bordered by large fields is the confluence with Venado Creek (Segment 0610M), a four mile long stream that flows from the northwest. The stream begins in some large fields, passing through heavily forested land, crossing agricultural property, additional forested land, and then crossing Hwy 147 (Historical Monitoring Station 15363) and additional fields. Venado Creek drains 22 sq miles and contributes 58.5 CFS, which puts the mean annual flow of Ayish Bayou at 145.7 CFS below the confluence.

FIGURE 5-6 Confluences with Pole Branch and Venado Creek



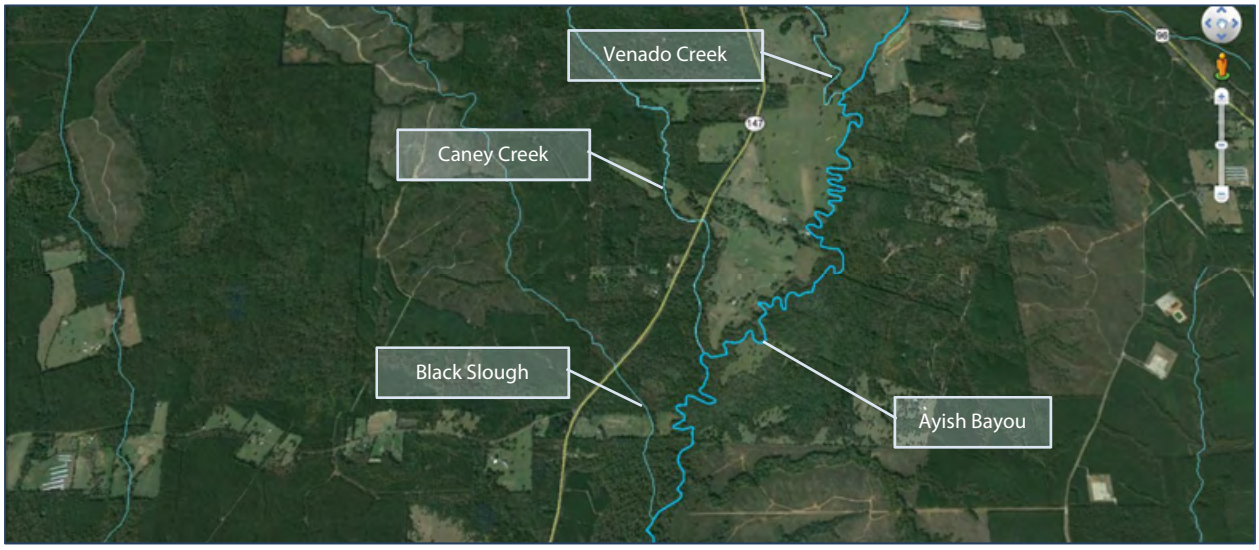
Confluence with Caney Creek (15.6 miles to Sam Rayburn Reservoir)

Ayish flows for another 3.5 stream miles to the next confluence. Caney Creek (Segment 0610G) is a five mile long stream draining 12.3 sq miles and contributing 38.1 CFS. It flows from the northwest, mostly through forested land and crossing Hwy 147 (Historical Monitoring Station 15362).

Confluence with Black Slough (14.3 miles to Sam Rayburn Reservoir)

Another 1.3 miles through forest is the confluence with Black Slough, which flows from the northwest. Flowing though forest and large fields with narrow strips of riparian forest, and crossing Hwy 147, Black Slough drains 5.3 sq miles and contributes 20.8 CFS.

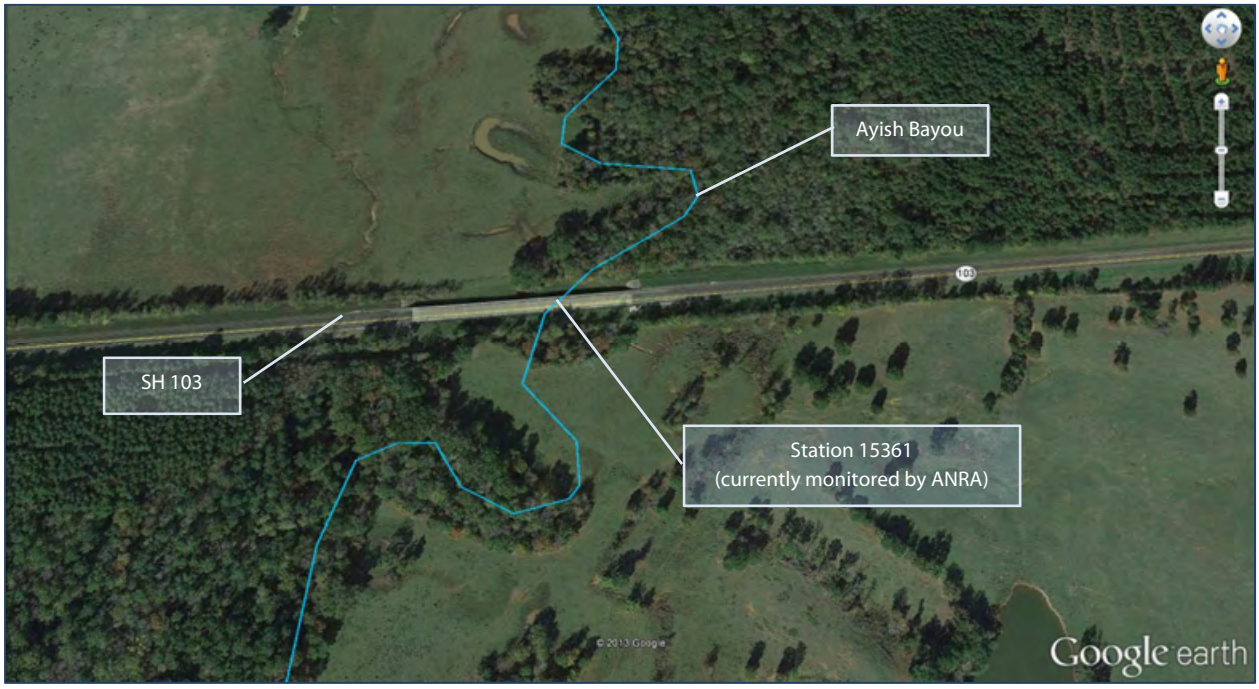
FIGURE 5-7 Confluences with Caney Creek and Black Slough



HWY 103 Crossing (11.2 miles to Sam Rayburn Reservoir)

In the next 6.8 stream miles, the bayou is bordered on opposite sides by forest and open fields, almost in a checkerboard pattern. The Angelina National Forest uses the Ayish Bayou as its eastern border from this section all the way south to Sam Rayburn Reservoir. In this section, the bayou passes under Hwy 103, where ANRA monitors on a quarterly basis (Monitoring Station 15361).

FIGURE 5-8 Monitoring Station 15361 – Attoyac Bayou at SH 103



Monitoring Station 15361 Ayish Bayou at SH 103 4/12/2012

A 360° panorama of this monitoring station is located at http://www.anra.org/divisions/water_quality/crp/monitoring_sites/15361/15361.html

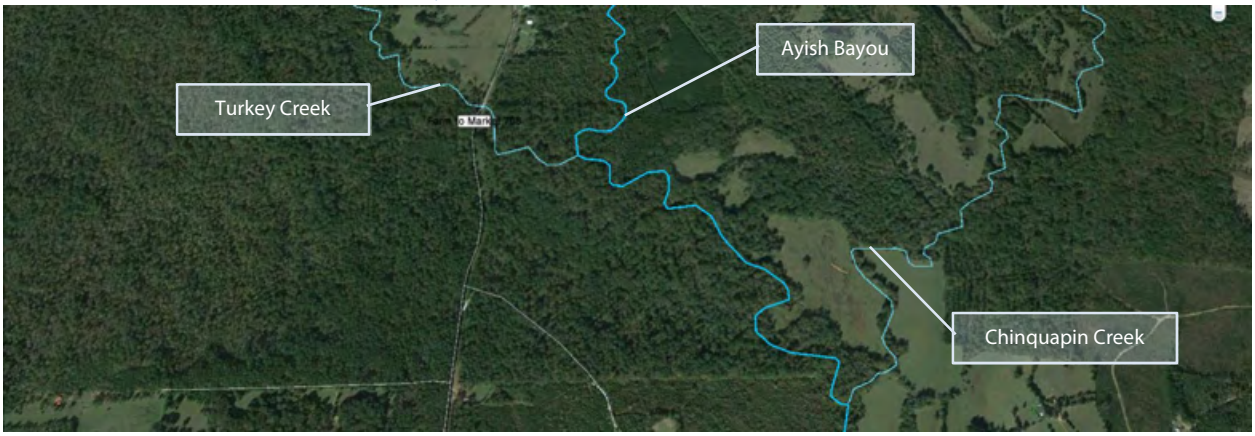
Confluence with Turkey Creek (7.6 miles to Sam Rayburn Reservoir)

Downstream of SH 103 is the confluence with Turkey Creek (Segment 0610L). Turkey Creek is a twenty-one mile long stream that runs almost entirely within the boundaries of the Angelina National Forest to the west of Ayish Bayou. The land cover near Turkey Creek is either forested or thin strips of riparian forest bordered by open fields, and it crosses Hwy 103 (Historical Monitoring Station 15357). Turkey Creek drains 18.5 sq miles and contributes 49.1 CFS, which brings Ayish Bayou's total annual mean flow below the confluence to 208.6 CFS.

Confluence with Chinquapin Creek (6.6 miles to Sam Rayburn Reservoir)

One stream mile below Turkey Creek is the confluence with Chinquapin Creek (Segment 0610J). This 16.3 mile long stream starts approximately 3.5 miles directly east of the Pole Creek confluence. Chinquapin has several tributaries of its own. The land cover directly surrounding Chinquapin is thin strips of riparian forest bordered by open fields, with about 25% being more heavily forested. One of the tributaries, Caney Creek, has within its watershed the Fawn Hill Landfill (TCEQ MSW permit no. 871), which was permitted in 1976 and is still listed as active. The landfill was not identified on the aerial imagery. The overall Chinquapin watershed contains several oil/gas well sites and several poultry growing operations. It also tends more towards open fields and less to forested areas than the Ayish Bayou watershed as a whole. Chinquapin crosses Hwy 96, Hwy 103, and FM 1751 (Historical Monitoring Station 15360), draining an area of 20 sq miles and contributing 54 CFS of flow.

FIGURE 5-9 Confluences with Turkey Creek and Chinquapin Creek



Confluence with an Unnamed Tributary (3.5 miles to Sam Rayburn Reservoir)

Three miles further downstream is a confluence with an unnamed tributary. This tributary flows from the west and is 3.3 miles long. It is almost entirely in dense forest, but does run beside two moderately sized open fields. It crosses Hwy 147, drains an area of 3.8 sq miles, and contributes a flow of 15.9 CFS.

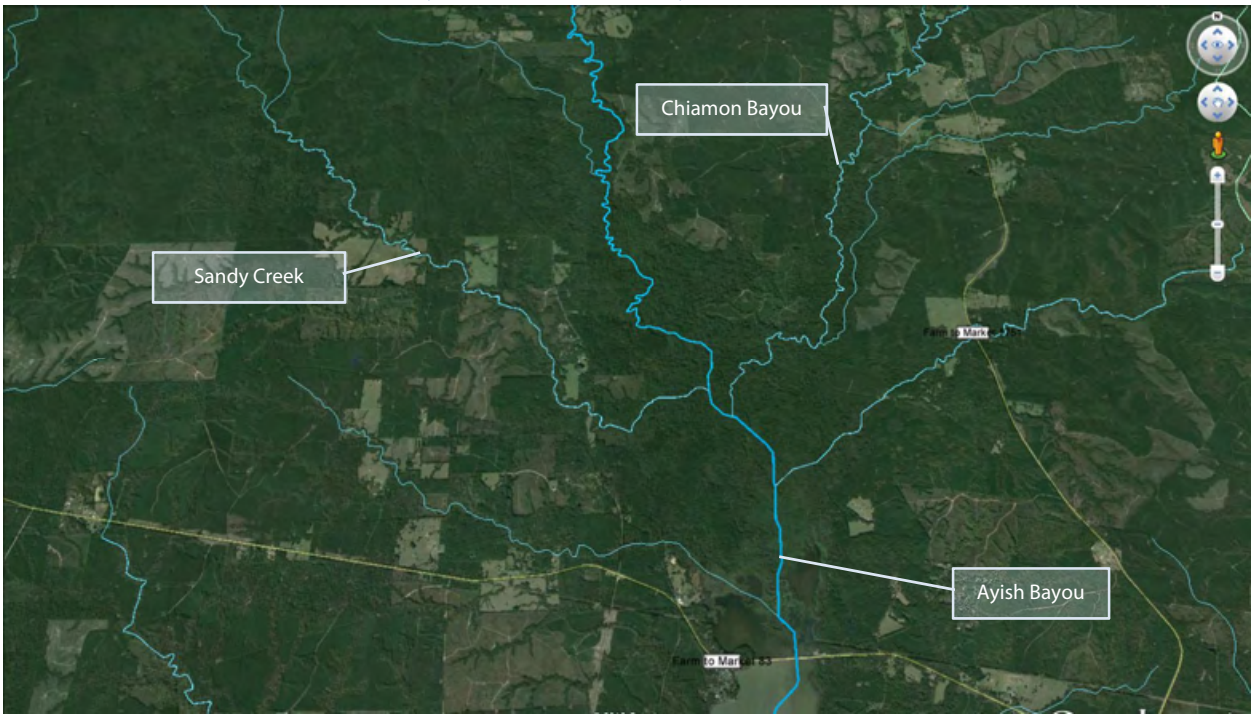
Confluence with Sandy Creek (1 mile to Sam Rayburn Reservoir)

The confluence with Sandy Creek (Segment 0610K) is located an additional 2.5 stream miles downstream. Sandy Creek flows 14.5 stream miles from the northwest, mostly through dense forest, but also though a few thin strips of riparian forest bordered by open fields. It then crosses Hwy 147 and flows into the bayou, draining an area of 17.4 sq miles and contributing 46.5 CFS of flow.

Confluence with Chiamon Bayou (0.7 miles to Sam Rayburn Reservoir)

Approximately 0.3 miles further downstream is the confluence with Chiamon Bayou (Segment 0610I). Chiamon Bayou is 18 miles long and flows in from the northeast. Its headwaters are in Sabine County and it has numerous small tributaries. Chiamon crosses Hwy 96 and FM 1751. Land cover is very similar to the rest of the watershed. It drains 29 sq miles and contributes 97 CFS.

FIGURE 5-10 Confluences with Sandy Creek and Chiamon Bayou



Discharge to Sam Rayburn Reservoir

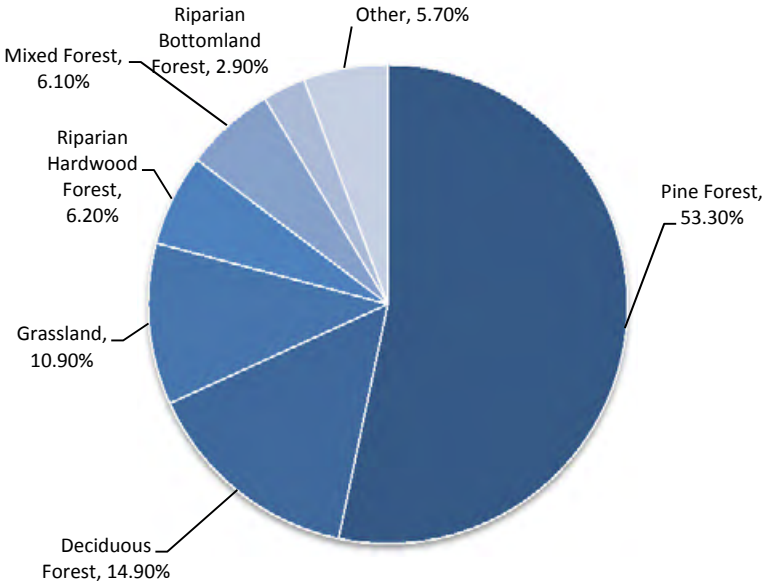
From the confluence with Chiamon Bayou, the Ayish Bayou flows into Sam Rayburn Reservoir at an estimated yearly mean flow of 271 CFS.

FIGURE 5-11 Discharge to Sam Rayburn Reservoir

Land Cover

There is a total of 123,601 acres located within the Ayish Bayou watershed. The vast majority of the land is forested, including pine, deciduous, and mixed forests. Only 58 acres (0.05%) of the land is classified as agricultural.

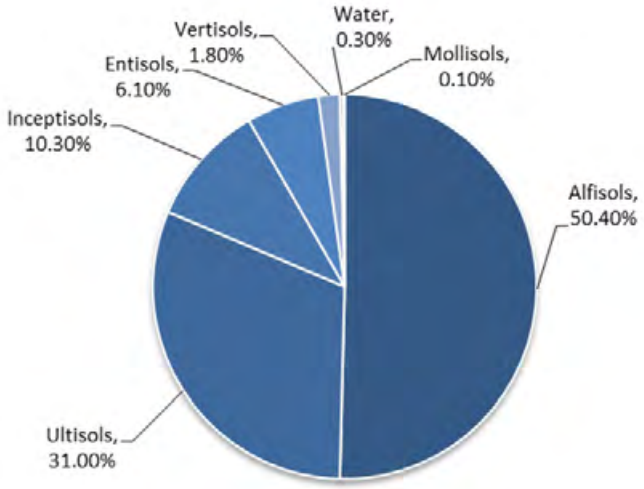
TABLE 5-6 Ayish Bayou Generalized Land Cover **From the TPWD Texas Ecological Systems Classification Project Phase 2**		
Land Cover	**Percentage**	**Acres**
Pine Forest	53.3%	65,936
Deciduous Forest	14.9%	18,429
Grassland	10.9%	13,421
Riparian Hardwood Forest	6.2%	7,642
Mixed Forest	6.1%	7,502
Riparian Bottomland Forest	2.9%	3,609
Riparian Mixed Forest	1.3%	1,575
Riparian Herbaceous	1.3%	1,571
Mesic Deciduous Forest	1.2%	1,537
Mesic Mixed Forest	0.5%	604
Urban Low	0.3%	417
Open Water	0.3%	395
Deciduous Shrubland	0.1%	169
Urban High	0.1%	159
Flatwoods Pine Forest	0.1%	153
Riparian Marsh	0.1%	89
Riparian Swamp	0.1%	86
Flatwoods Hardwood Forest	0.1%	65
Agriculture	0.05%	58
Riparian Deciduous Shrubland	0.04%	54
Marsh	0.03%	41
Flatwoods Mixed Forest	0.03%	38
Barren	0.03%	37
Swamp	0.01%	15
Flatwoods Marsh	0.00%	0
Total	**100.0%**	**123,601**



The category "Other" includes all categories with <2.0% of land cover.

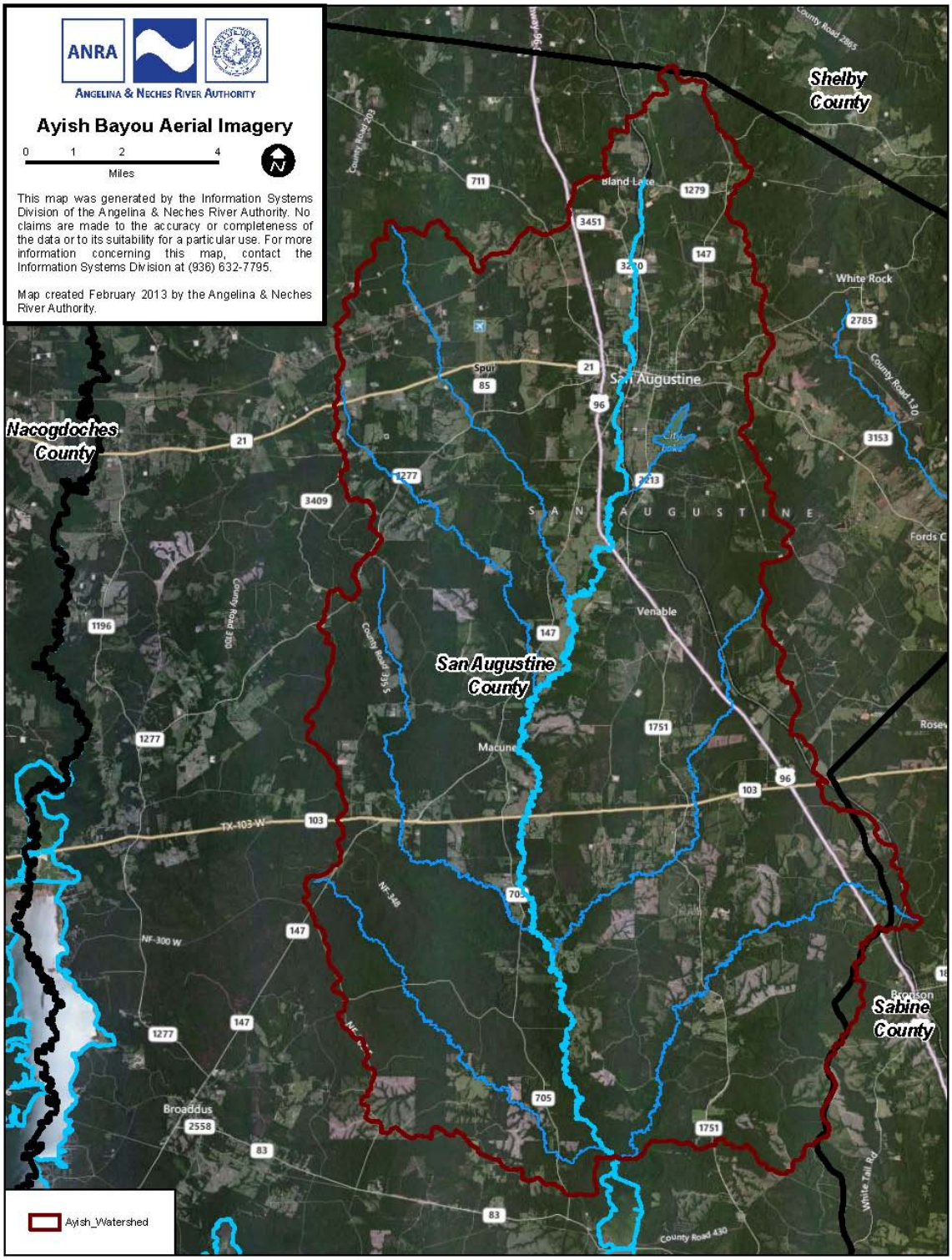
Soils

TABLE 5-7 Ayish Bayou Soil Types **(from NRCS)**		
Soil Type	**Percentage**	**Acres**
Alfisols	50.4%	62,276
Ultisols	31.0%	38,316
Inceptisols	10.3%	12,698
Entisols	6.1%	7,524
Vertisols	1.8%	2,203
Water	0.3%	347
Mollisols	0.1%	165
Total	**100.0%**	**123,530**

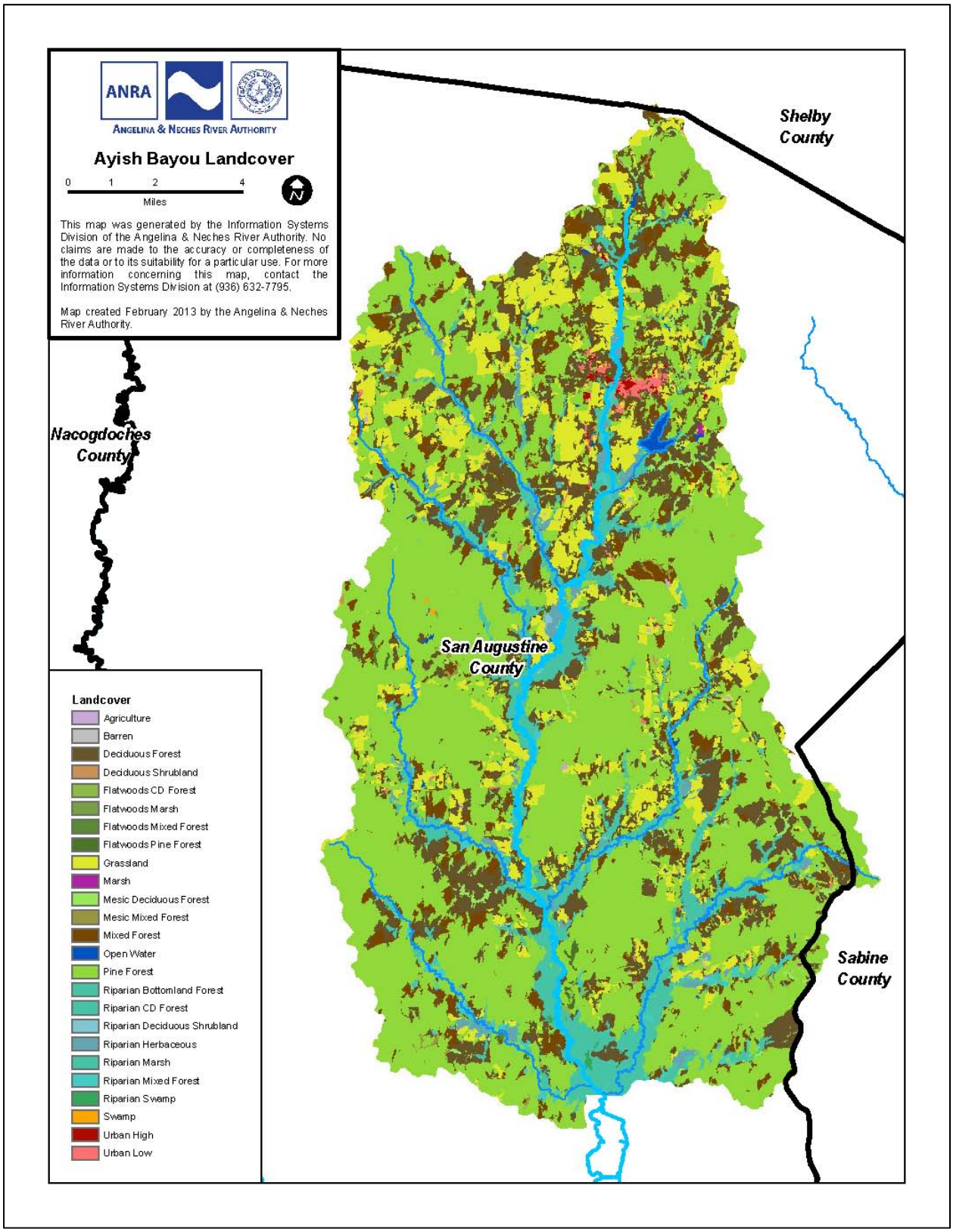


NOTE: The difference in Total Acres from the Land Cover data and the Soil Types data is due to the difference in resolution in the GIS information.

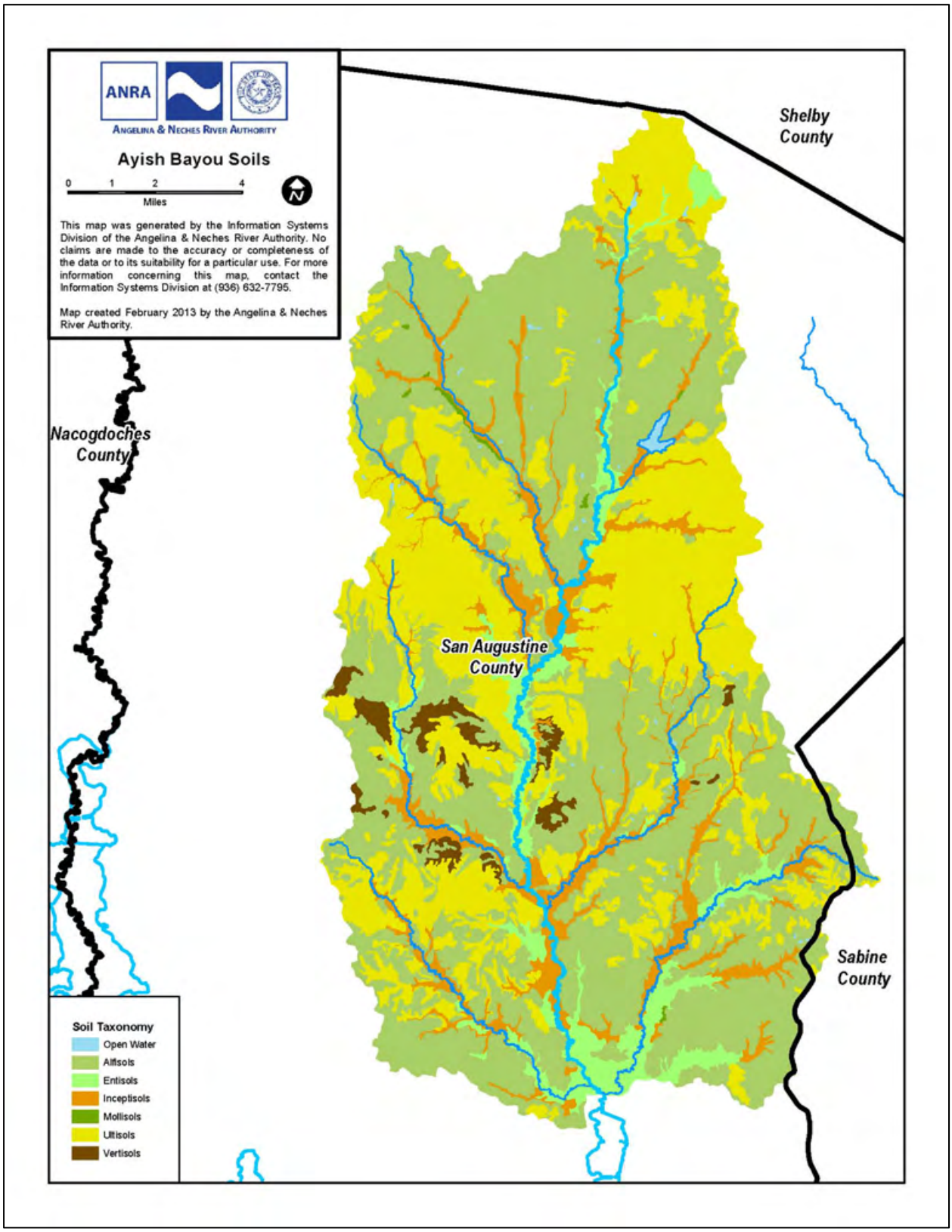
MAP 5-5 Ayish Bayou Aerial Imagery



MAP 5-6 Ayish Bayou Area Land Cover



MAP 5-7 Ayish Bayou Area Soils



Description of Water Quality Issues

Site-Specific Uses and Criteria

Ayish Bayou has a designated High ALU and corresponding dissolved oxygen criteria of 5.0 mg/L (average)/3.0 mg/L (minimum) in Appendix D of the TSWQS. The perennial stream has a primary contact recreation use with a corresponding *E. coli* geometric mean criteria of 126 MPN/100 mL.

Impairments and Concerns

Ayish Bayou (Segment 0610A) is listed on the 2012 303(d) List for not supporting primary contact recreation due to bacteria impairments. Both Assessment Units are listed as category 5b, and were first listed in 2000.

In AU 0610A_01, the geometric mean for *E. coli* exceeded the criterion of 126 MPN/100 mL with a value of 209.15 MPN/100 mL, based upon 24 samples assessed. A concern for Ammonia-N was also identified, with 9 of 25 samples (36%) exceeding the nutrient screening level of 0.33 mg/L. A concern for dissolved oxygen grab screening level was also identified in the 2012 assessment, with 9 of 28 values falling below the criterion of 5.0 mg/L.

In AU 0610A_02, the geometric mean for *E. coli* exceeded the standard with a value of 212.04 MPN/100 mL, based upon 12 samples assessed.

TABLE 5-8 Impairments in Segment 0610A as listed in the 2012 Texas Integrated Report

Segment Name	Segment ID	Assessment Unit	Impairments	Category	Date First Listed
Ayish Bayou	0610A	0610A_01	Bacteria	5b	2000
		0610A_02	Bacteria	5b	2000

TABLE 5-9 Concerns for Use Attainment and Screening Levels in Segment 0610A as listed in the 2012 Texas Integrated Report

Segment Name	Segment ID	Assessment Unit	Concerns	Level of Concern
Ayish Bayou	0610A	0610A_01	Ammonia-Nitrogen	CS
			Depressed Dissolved Oxygen	CS

Potential Causes of Water Quality Issues

Numerous potential sources of pollution, both point and non-point, were identified based on aerial imagery. Further evaluation is needed to determine the sources of impairments and concerns within the watershed. In regards to the bacterial impairments, it must also be considered that the presumed standard for primary contact recreation may not be appropriate for this segment.

Point Sources	The City of San Augustine Wastewater Treatment Facility (TPDES Permit No. WQ0010268001) discharges into an unnamed tributary and thence into Ayish Bayou.
Non-Point Sources	Failing On-Site Sewage Facilities (OSSFs)
	Agricultural-related operations
	Wildlife, such as deer and feral hogs

Additional studies involving the collection of 24-hr dissolved oxygen samples are needed to further evaluate the dissolved oxygen concerns in order to determine if the water quality standard is appropriate or if there is a water quality issue that is resulting in the depressed dissolved oxygen levels.

Potential Stakeholders

- Local Municipalities (City of San Augustine)
- Landowners
- Angelina & Neches River Authority
- Texas Commission on Environmental Quality
- Texas State Soil and Water Conservation Board
- Natural Resource Conservation Service
- Texas Department of Agriculture
- Texas Railroad Commission
- Texas Parks and Wildlife
- US Geological Survey
- US Fish and Wildlife Service
- AgriLife Extension

Recommended Actions

ANRA is currently (FY 13) conducting monitoring in this segment at station 15361. An additional monitoring station will be added in FY 14.

The bacteria impairments are listed as Category 5b, which indicates a review of the water quality standards will be conducted before a TMDL will be scheduled. This water body may be a potential site for a Recreational Use Attainability Analysis (RUAA) to determine the recreational uses of this water body. Additionally, bacterial source tracking may be a useful tool to determine the source of bacteria. It may be possible to utilize Clean Water Act § 319 funding to develop a Watershed Protection Plan (WPP), if appropriate.

ANRA has also been granted authority by TCEQ to regulate On-Site Sewage Facilities (OSSF) in the unincorporated portion of San Augustine County, including the areas in the Ayish Bayou watershed. On-site

reconnaissance of OSSFs and mapping of complaint investigations can possibly identify failing systems for replacement, reducing a nonpoint source of bacteria.

Ongoing Projects

ANRA monitors Ayish Bayou at SH 103 (Monitoring Station 15361) in AU 0610A_01. Beginning in FY 14, ANRA will begin monitoring Ayish Bayou in the City of San Augustine at West Columbia St., located in AU 0610A_02. This site has not previously been monitored. The addition of this site will allow ANRA to provide water quality data for both of Ayish Bayou's assessment units.

The Ayish Bayou is scheduled for an RUAA through TCEQ.

Major Watershed Events

In 2010, the Texas Water Development Board (TWDB) approved a loan in the amount of $1,050,000 from the Clean Water State Revolving Fund – Disadvantaged Communities Program to the City of San Augustine to finance wastewater system improvements. The City of San Augustine had been under enforcement actions due to effluent monitoring violations, which were the result of excessive stormwater inflow and infiltration (I/I). The funds will allow the City of San Augustine to address deficiencies in the wastewater collection system.

WATERSHED CHARACTERIZATION
Segment 0612 – Attoyac Bayou

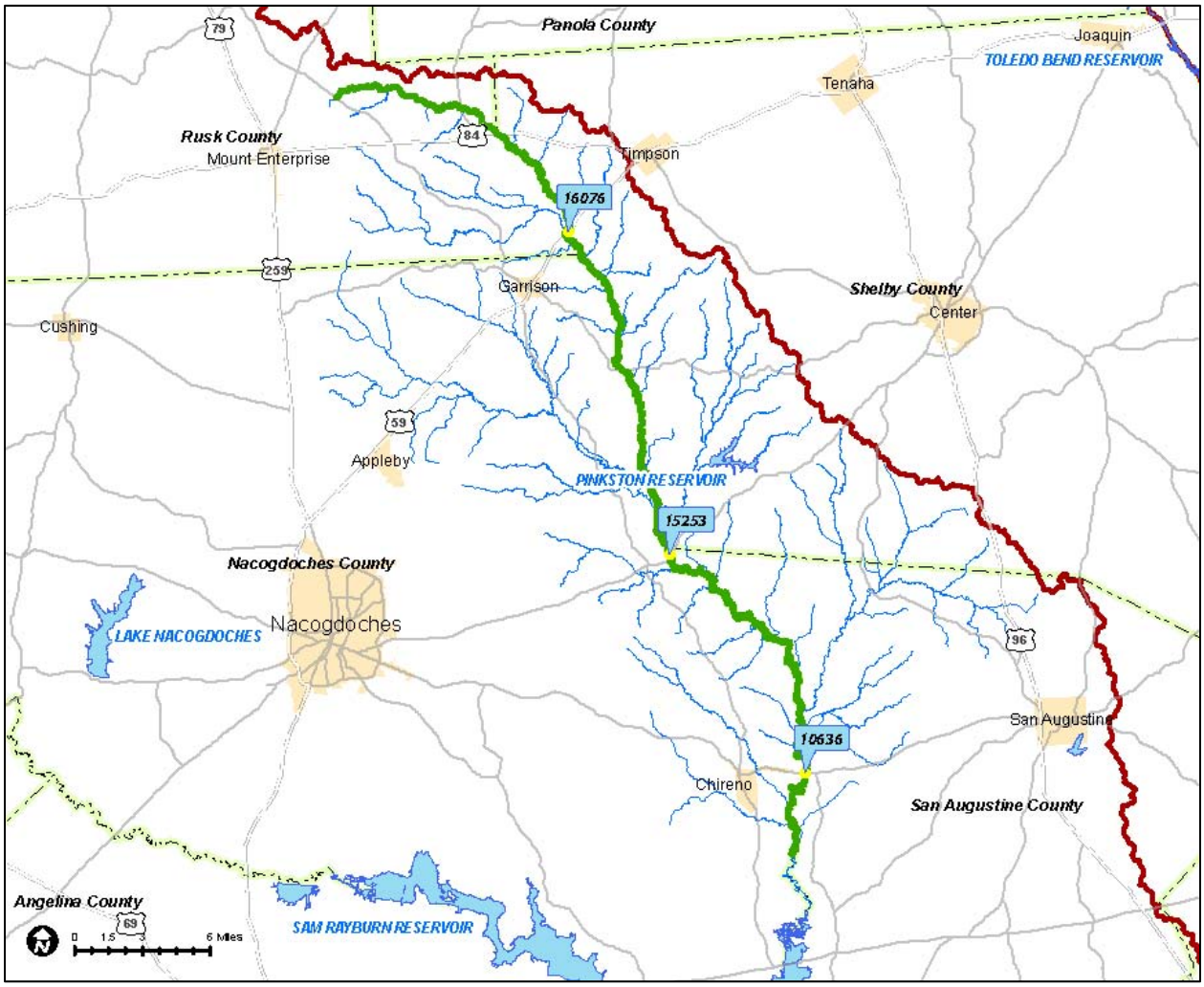
Attoyac Bayou at SH 7

Segment Description

Attoyac Bayou (Segment 0612) is a freshwater perennial stream measuring 81.7 miles in length from a point 3.9 km (2.4 miles) downstream of Curry Creek in Nacogdoches/San Augustine County to FM 95 in Rusk County. The designated uses for this segment include the following: high aquatic life, general, contact recreation, and public water supply. The area surrounding the watershed is managed for agricultural (cattle and poultry), silvicultural, recreational, and wildlife uses. The watershed contains many rural residents. This segment has three assessment units that are listed on the 303(d) list due to bacteria.

The water body is a classified segment in Appendix A of the Texas Surface Water Quality Standards (30 TAC 307.10).

MAP 6-1 Attoyac Bayou Segment Map



Assessment Units

There are three assessment units located in the Attoyac Bayou (Segment 0612).

TABLE 6-1 Assessment Units in the Attoyac Bayou (Segment 0612)	
Assessment Unit (AU) ID	**Description**
0612_01	From the lower boundary approximately at confluence with Granberry Branch upstream to confluence with Polly Branch.
0612_02	From a point immediately upstream of Polly Branch confluence upstream to confluence with Bear Bayou.
0612_03	From a point immediately upstream of Bear Bayou upstream to upper boundary at FM 95.

Monitoring Stations

ANRA monitors Attoyac Bayou at the following stations:

TABLE 6-2 Monitoring Stations in the Attoyac Bayou (Segment 0612)		
Assessment Unit (AU) ID	**Monitoring Station ID**	**Description**
0612_01	10636	ATTOYAC BAYOU AT SH 21 0.71 KM WEST OF INTERSECTION OF SH 21/ FM 1196 4.77 KM EAST OF CHIRENO
0612_02	15253	ATTOYAC BAYOU AT SH 7 1.75 KM NORTHEAST OF MARTINSVILLE
0612_03	16076	ATTOYAC BAYOU AT US 59 4.12 KM NORTHEAST OF GARRISON

Monitoring of the Attoyac (and its tributaries) has also been conducted by Stephen F. Austin State University (SFASU) as part of the development of a Watershed Protection Plan to address bacterial impairments. This project was funded by a Clean Water Act § 319 grant administered by the Texas Soil and Water Conservation Board. Monitoring stations listed in **BLUE** were also routinely monitored by ANRA as part of the CRP program.

TABLE 6-3 Watershed Protection Plan Monitoring Stations in the Attoyac Bayou Watershed					
Station ID	**Segment ID**	**Short Description**	**Long Description**	**Sample Count** (as of 6/2013)	**Last Sampled Date**
20841	0612	ATTOYAC BAYOU AT FM 138	ATTOYAC BAYOU AT FM 138 9.65 KM SOUTHEAST OF US 59 IN GARRISON	46	5/14/2012
20842	0612	ATTOYAC BAYOU AT US 84	ATTOYAC BAYOU AT US 84 10.29 KM NORTHWEST OF INTERSECTION WITH US 59 IN TIMPSON	46	5/14/2012
20843	0612	NACONICHE CREEK AT FM 95	NACONICHE CREEK AT FM 95 APPROXIMATELY 9 KM N OF INTERSECTION WITH SH 7 IN MARTINSVILLE	46	5/14/2012
20844	0612	BIG IRON ORE CREEK AT FM 354	BIG IRON ORE CREEK AT FM 354 APPROXIMATELY 9.65 KM N OF INTERSECTION WITH SH 21 AND NE OF SAN AUGUSTINE	57	5/14/2012
20845	0612	WEST CREEK AT FM 2913	WEST CREEK AT FM 2913 2.57 KM N OF INTERSECTION WITH SH 7	46	5/14/2012
10636	**0612**	**ATTOYAC BAYOU AT SH 21**	**ATTOYAC BAYOU AT SH 21 0.71 KM WEST OF INTERSECTION OF SH 21/ FM 1196 4.77 KM EAST OF CHIRENO**	**284**	**Currently Monitored**
15253	**0612**	**ATTOYAC BAYOU AT SH 7**	**ATTOYAC BAYOU AT SH 7 1.75 KM NORTHEAST OF MARTINSVILLE**	**91**	**Currently Monitored**
16083	0612B	WAFFELOW CREEK AT FM 95	WAFFELOW CREEK AT FM 95 3.65 MI NORTH NORTHWEST OF MARTINSVILLE	56	5/14/2012
16084	0612A	TERRAPIN CREEK AT SH 95	TERRAPIN CREEK AT SH 95 1 MI SOUTH OF MARTINSVILLE	56	5/14/2012
16076	**0612**	**ATTOYAC BAYOU AT US 59**	**ATTOYAC BAYOU AT US 59 4.12 KM NORTHEAST OF GARRISON**	**131**	**Currently Monitored**

Hydrologic and Land Use Characteristics

The Attoyac Bayou flows from the north into Sam Rayburn Reservoir. Its watershed encompasses slightly more than 364,350 acres (569 square miles) and includes portions of four counties. Rusk and Nacogdoches County are on the west and Shelby and San Augustine County to the east. Approximately two thirds of the border between Rusk and Shelby Counties is demarcated by the Attoyac Bayou, as well as the entire shared border between Nacogdoches and Shelby Counties, and the shared border between Nacogdoches and San Augustine Counties.

TABLE 6-4 Area of Attoyac Bayou Watershed by County

County	Area (in acres)
Rusk	45,742
Shelby	102,748
Nacogdoches	152,923
San Augustine	62,937
TOTAL	364,350

There are four incorporated cities within the watershed. The City of Garrison and The City of Chireno are fully within the watershed, and 114 acres of the northeastern portion of The City of Appleby and 55 acres of the southwestern limits of the City of Timpson are within the watershed.

Based upon 2010 census data, there are 4,968 households within the watershed, with a population of 10,239. Of those numbers, 386 households and 899 people are located within the city limits of the City of Garrison, and 184 households and 386 people are located within the city limits of the City of Chireno.

Annual rainfall in the Attoyac Bayou watershed from 1971 - 2000 varied from a minimum of 49.1 inches to 53.4 inches. For the period of 1981 - 2010, rainfall varied from a minimum of 49.4 inches to a maximum of 54.8 inches.

The Attoyac Bayou is 92 miles long from the intermittent headwaters, all the way downstream to the riverine portion of Sam Rayburn Reservoir just north of where the Attoyac arm of Sam Rayburn crosses SH 103. All flow values are approximated from the National Hydrography Dataset Plus v2.1, and are estimates of the mean annual flows based primarily on rainfall averages and land elevations. They are not observed flow rates, but are a reasonable indicator of how the size of streams in an area relate to one another.

NOTE:

There is a slight discrepancy between the length of the Attoyac Bayou that we are describing in this section and the segment description from the TCEQ. The segment description from TCEQ lists the Attoyac Bayou as 81.7 miles in length. For this discussion, we are utilizing the National Hydrography Dataset's segments, which do not break in exactly the same places.

Typical land cover directly surrounding the flow channel appears to be one-third narrow riparian forested buffer surrounded by open fields and two-thirds forested.

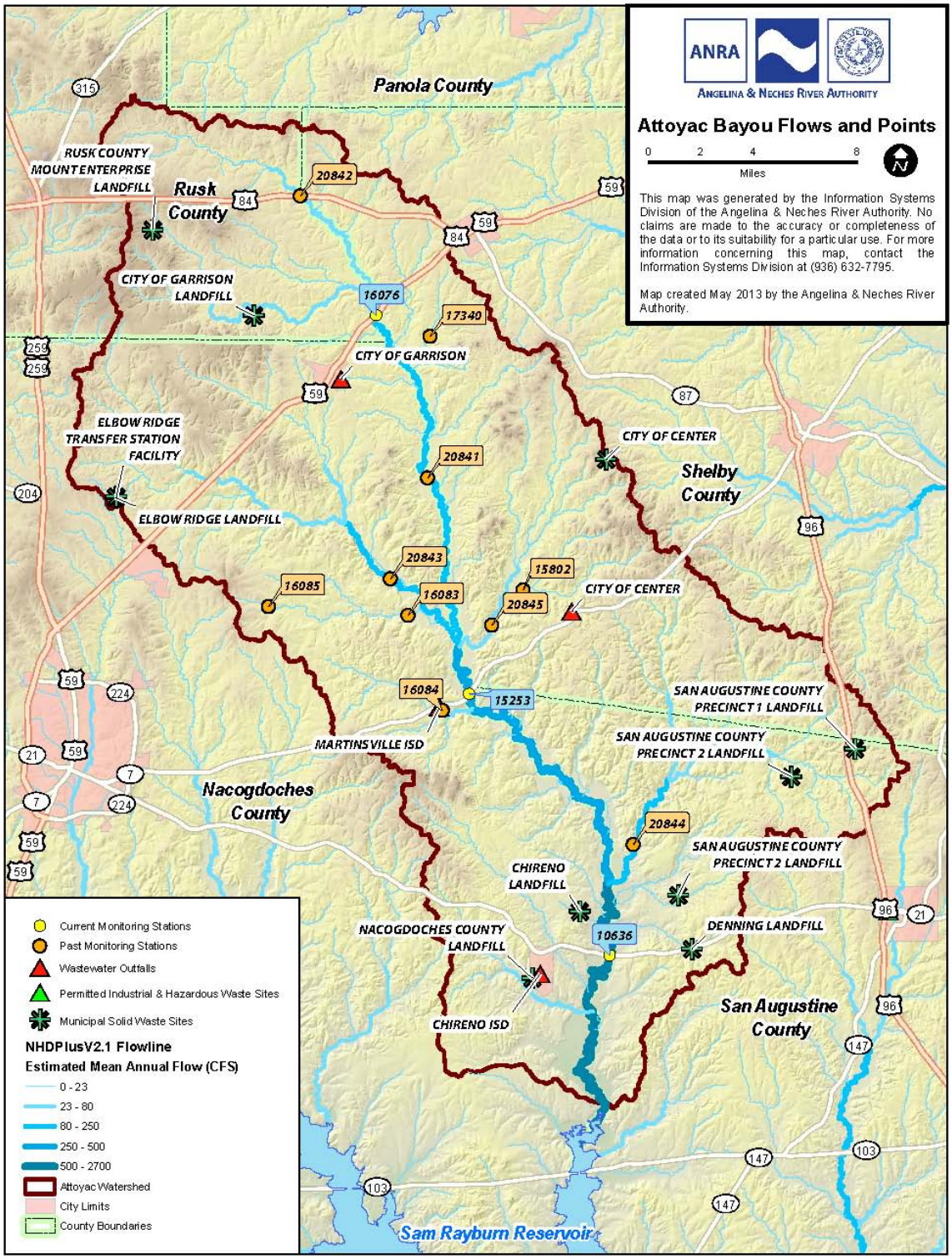
There have been several permitted Municipal Solid Waste Sites in the Attoyac Bayou Watershed, but they are all listed as closed or inactive. Most do not appear on the aerial imagery.

There are four permitted discharges in the watershed.

TABLE 6-5 Permitted WWTP Discharges in the Attoyac Bayou Watershed

Segment ID	Permittee Name	TPDES Permit No.	Permitted Discharge
0612	City of Garrison	11304-001	0.120000 MGD
0612	Chireno ISD	13917-001	0.010000 MGD
0612A	Martinsville ISD	14027-001	0.008000 MGD
0612C	City of Center	14352-001	0.020000 MGD

MAP 6-2 Attoyac Bayou Mean Annual Flows, Permitted Facilities, and Monitoring Stations

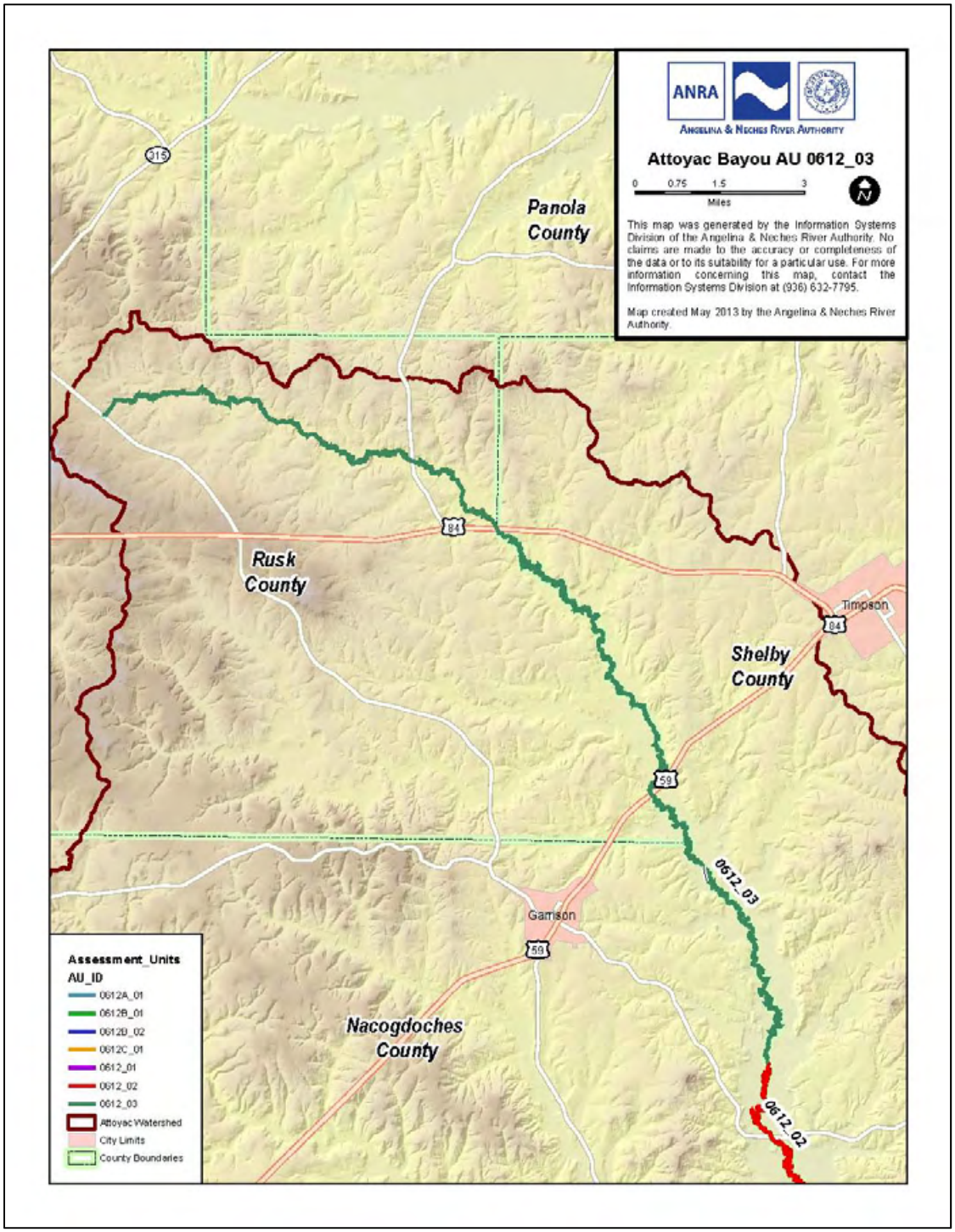


Maps of the Attoyac Bayou's three assessment units follow, beginning with AU 0612_03 at the headwaters and moving south to AU 0612_01 at the discharge into Sam Rayburn Reservoir.

Assessment Unit 0612_03

From a point immediately upstream of Bear Bayou upstream to upper boundary at FM 95.

MAP 6-3 Attoyac Bayou Assessment Unit AU 0612_03



Assessment Unit 0612_02

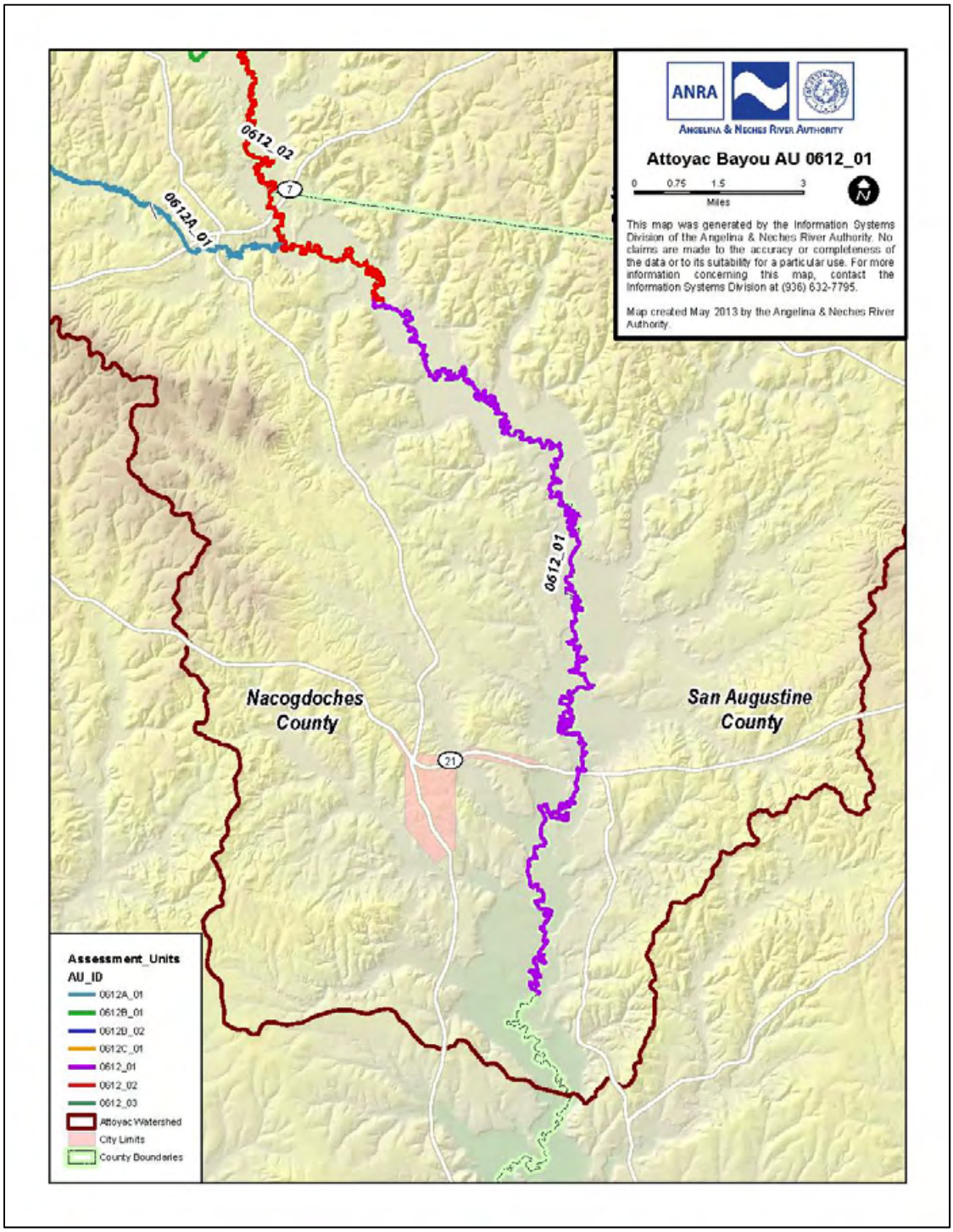
From a point immediately upstream of Polly Branch confluence upstream to confluence with Bear Bayou.

MAP 6-4 Attoyac Bayou Assessment Unit AU 0612_02

Assessment Unit 0612_01

From the lower boundary approximately at confluence with Granberry Branch upstream to confluence with Polly Branch.

MAP 6-5 Attoyac Bayou Assessment Unit AU 0612_01



The following section details the Attoyac Bayou watershed and its tributaries, beginning with AU 0612_03 at the headwaters, and moving downstream to AU 0612_01 and its discharge into Sam Rayburn Reservoir. Within each assessment unit, information will be presented detailing tributaries, drainage areas, flows, land cover and land use, monitoring stations, and potential point or non-point sources of pollution.

Assessment Unit 0612_03

Attoyac Headwaters (92 miles to Sam Rayburn Reservoir)

The headwaters of the Attoyac Bayou are in a 170 acre pine forest just southwest of FM 95 in Rusk County, approximately 2.5 miles northeast of the City of Mount Enterprise. This uppermost portion of the Attoyac is intermittent and is approximately 2.4 miles long. It drains 3 sq miles and has an estimated mean annual flow of 12.6 CFS. The Bayou then runs through a half mile of narrow riparian forest buffer surrounded by open fields, crosses CR 3122, and changes classification to perennial.

Confluence with Moore Branch (88 miles to Sam Rayburn Reservoir)

After flowing 1.2 miles through forested land, there is a confluence with Moore Branch, a 3 mile long intermittent stream that flows in from the southeast. Moore Branch drains 3 sq miles and contributes 12.3 CFS.

FIGURE 6-1 Confluence with Moore Branch

FM 1971 Crossing (82.4 Miles to Sam Rayburn Reservoir)

Below Moore Branch the Attoyac continues for 5.8 miles through mostly forested land, but with about 1 mile of the stream being bordered on the south by open field. This section of the Attoyac crosses CR 3181 and FM 1971.

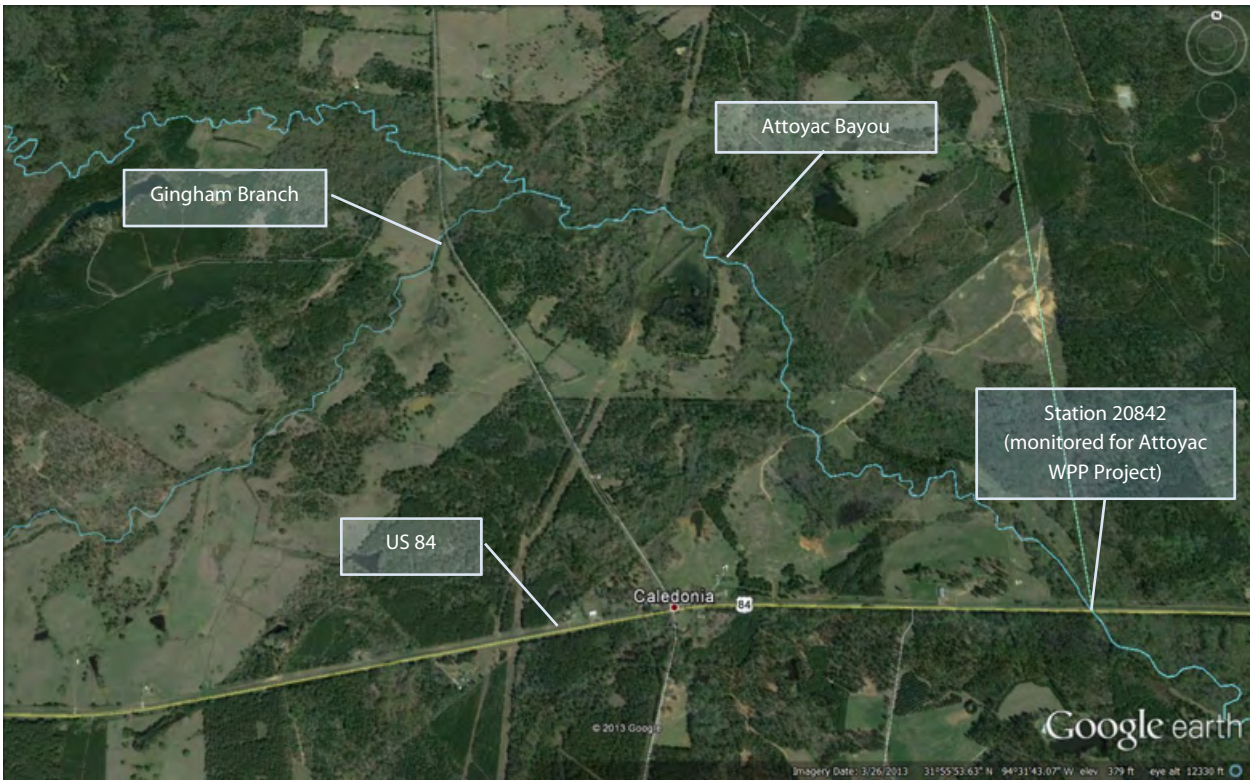
Confluence with Gingham Branch (82.2 miles to Sam Rayburn Reservoir)

One fourth of a mile past FM 1971 is the confluence with Gingham Branch, a 3.4 mile long perennial stream. Flowing from the southwest through a mix of forest and narrow strips of riparian forest bordered by open fields, and crossing US 84 and FM 1971, Gingham drains 2.2 sq miles and contributes 10.1 CFS. Below the confluence with Gingham Branch, the Attoyac Bayou is estimated to have an annual mean flow of 52 CFS.

US 84 Crossing (82.3 miles to Sam Rayburn Reservoir)

The Attoyac Bayou continues for another 2.4 stream miles through mostly narrow to medium strips of riparian forest bordered by open fields and crossing a right of way for a power line or a pipeline, before crossing under US 84. Sampling was performed at US 84 by Stephen F. Austin State University (SFASU) as part of a Clean Water Act § 319 grant to develop a watershed protection plan for the Attoyac Bayou (Monitoring Station ID 20842).

FIGURE 6-2 Confluence with Gingham Branch, US 84 Crossing, and Monitoring Station 20842



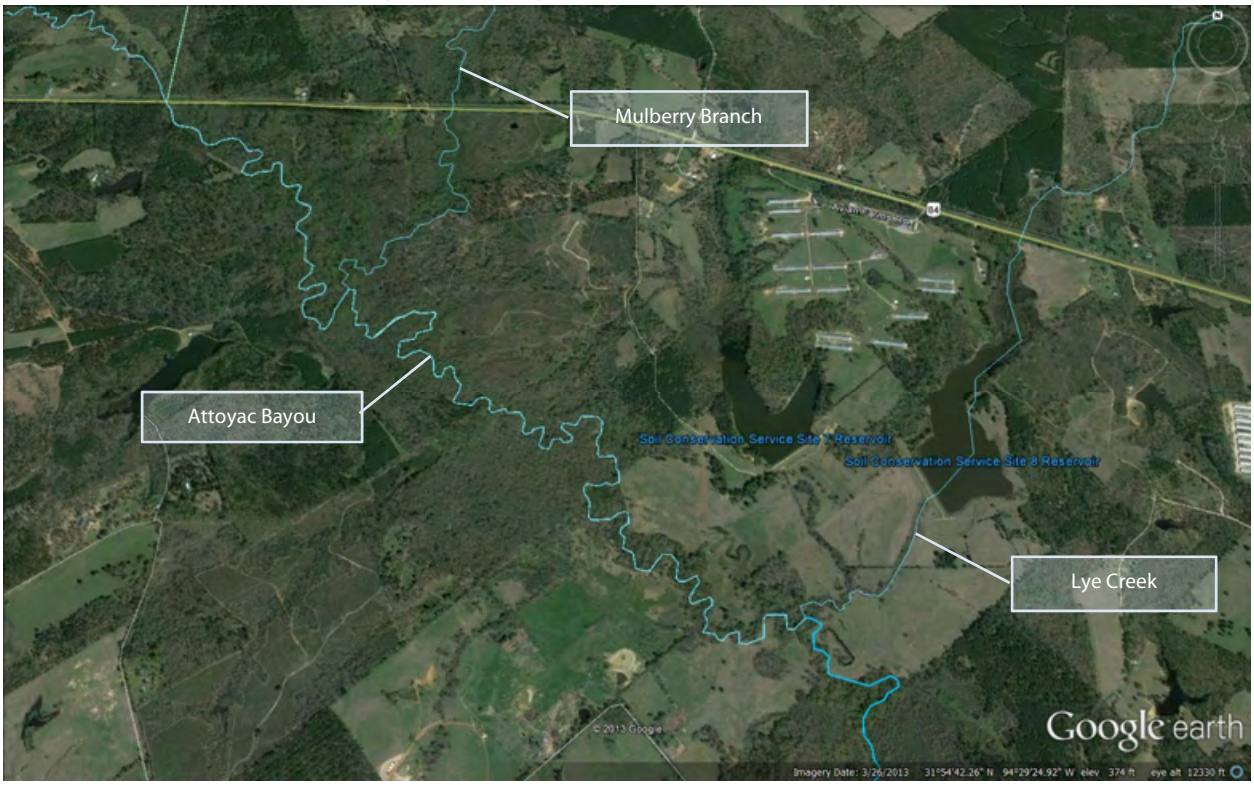
Confluence with Mulberry Branch (78.4 miles to Sam Rayburn Reservoir)

Below US 84 the Attoyac becomes the delineator for the Rusk County eastern border, and travels 1.5 more miles to the confluence with Mulberry Branch. Mulberry is a 3.8 mile long perennial stream flowing from the north and crossing US 84. It flows mostly through forest, draining 3.6 sq miles and contributing 14.5 CFS of flow.

Confluence with Lye Creek (75.5 miles to Sam Rayburn Reservoir)

The Attoyac Bayou continues for 2 miles through forest, and then 0.8 miles though medium strips of riparian forest surrounded by open fields, before reaching the confluence with Lye Creek. The creek is approximately 2 miles long, but is dammed up to create a 32 acre on-channel impoundment (Soil Conservation Service Site 8 Reservoir) half a mile upstream of the confluence. There is also another 15 acre impoundment (Soil Conservation Service Site 7 Reservoir) to the west that may possibly contribute flow to the last half mile of Lye Creek during rainfall events. The area surrounding the impoundments appears to be agricultural in nature. Lye Creek crosses US 84 just upstream of the impoundment. Lye Creek drains an area of 4.7 sq miles and contributes 17.8 CFS, bringing the total mean annual flow below the confluence to 84.2 CFS.

FIGURE 6-3 Confluences with Mulburry Branch and Lye Creek



Confluence with Golondrina Creek (69.8 miles to Sam Rayburn Reservoir).

The Attoyac Bayou flows for another 1.3 miles through forest, crossing CR 3281, and continuing for 4.3 miles through narrow strips of riparian forest surrounded by open fields, before reaching the confluence with Golondrina Creek.

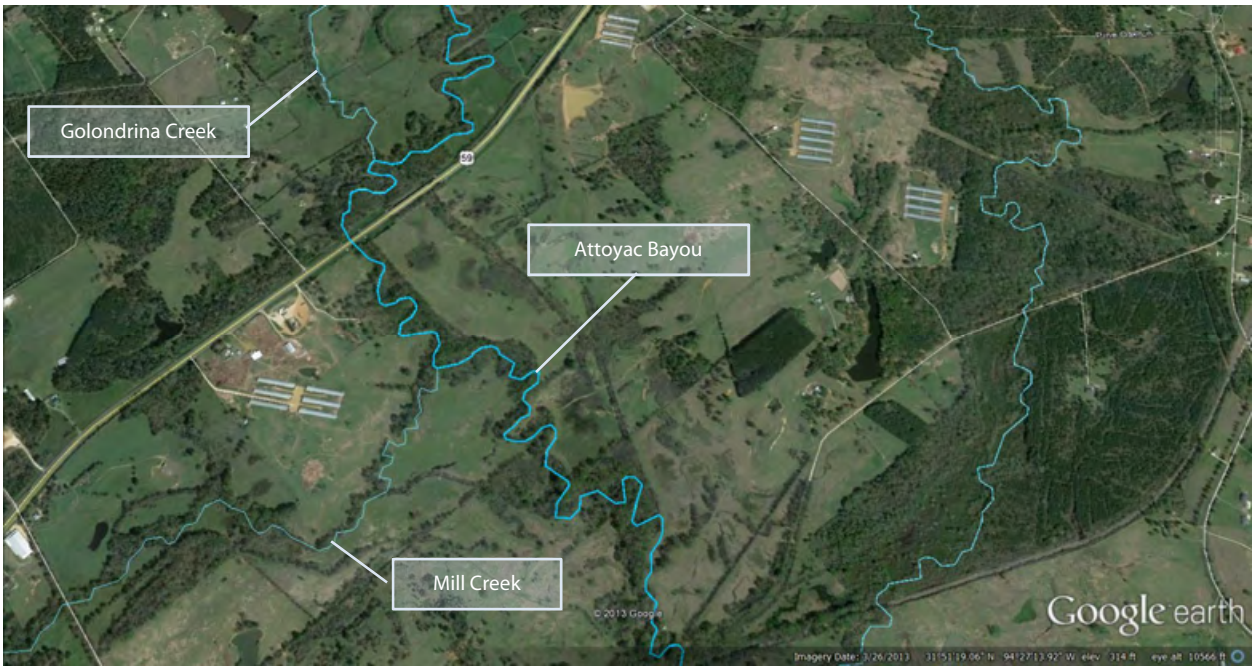
Golondrina Creek is 19.2 miles long with headwaters at US 84, about 3.4 miles east of Mount Enterprise. Golondrina has two major tributaries, Sandy Creek and Caney Creek. Sandy Creek flows from the west, drains an area of 7.6 sq miles, and contributes 23.3 CFS. Caney Creek, which flows from the northwest, drains an area of 9.7 sq miles and contributes 28.9 CFS.

From its headwaters, Golondrina flows past the Rusk County Mount Enterprise Landfill (TCEQ MSW permit no. 1157) which is closed. It crosses several county roads before reaching a confluence with Sandy Creek. Golondrina then passes just north of the City of Garrison Landfill (TCEQ MSW permit no. 893) which is also closed. It then crosses FM 95, has a confluence with Caney Creek, and continues to the confluence with the Attoyac.

Golondrina and its tributaries flow mostly through forest with approximately one third of their courses being open fields with narrow riparian forest buffer. The area appears to have a large quantity of oil/gas drilling sites and also multiple poultry operations.

At the confluence just above US 59, Golondrina drains an area of 9 sq miles and contributes 77.6 CFS.

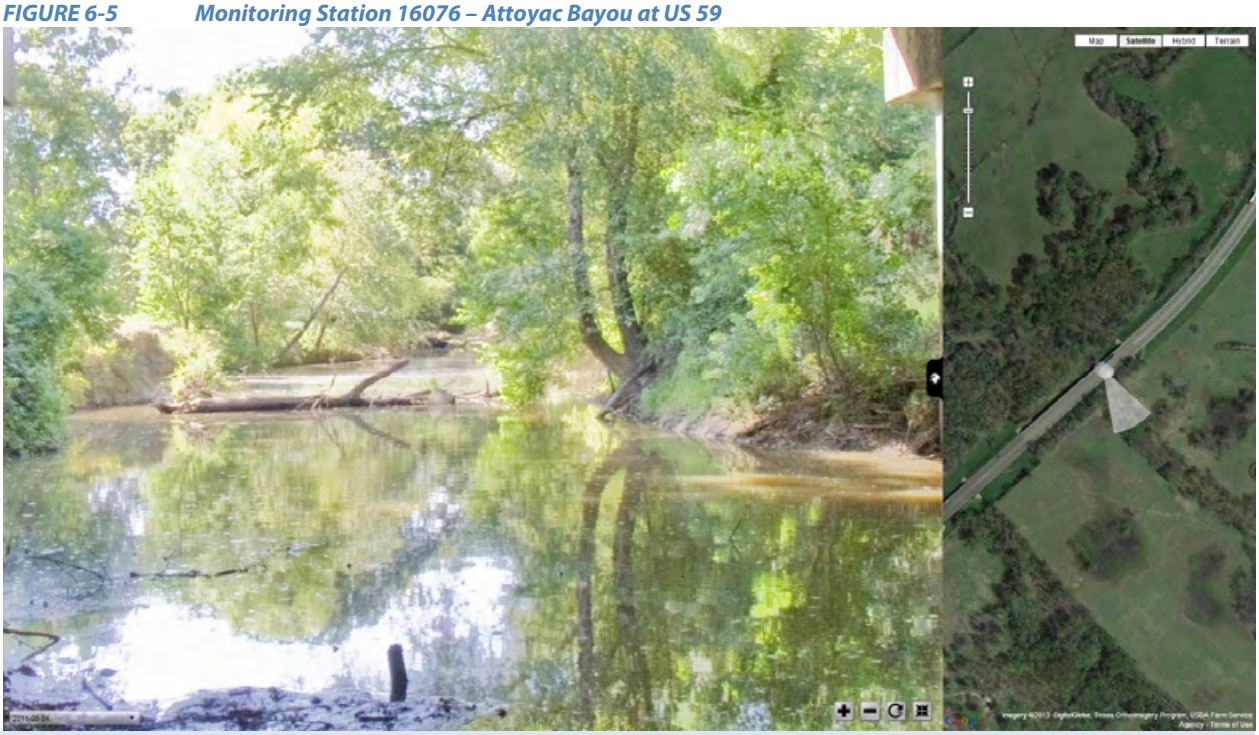
FIGURE 6-4 Confluences with Golandrina Creek and Mill Creek



Monitoring Station 10676 – Attoyac Bayou at US 59 (69.5 miles to Sam Rayburn Reservoir)

Routine monitoring is performed quarterly at US 59 by ANRA (Monitoring Station 16076). SFASU also sampled at this location for the Attoyac WPP project.

FIGURE 6-5 Monitoring Station 16076 – Attoyac Bayou at US 59



Monitoring Station 16076 Attoyac Bayou at US 59 8/4/2011

A 360° panorama of this monitoring station is located at http://www.anra.org/divisions/water_quality/crp/monitoring_sites/16076/16076.html

Confluence with Mill Creek (69 miles to Sam Rayburn Reservoir)

Located one-half mile downstream of US 59 is the confluence with Mill Creek; a 3.6 mile perennial stream flowing from the west. Mill Creek flows roughly west to east approximately three quarters of a mile north of the Garrison city limits. It crosses FM 95, CR 195, US 59, and CR 3286, draining an area of 5 sq miles and contributing 18.5 CFS to the Attoyac Bayou.

Rusk/Nacogdoches County Line (67.5 miles to Sam Rayburn Reservoir)

After an additional 1.5 miles, the Attoyac Bayou crosses the county line between Rusk and Nacogdoches Counties. The Attoyac Bayou demarcates the boundary between Nacogdoches and Shelby Counties. At this location, the Attoyac Bayou is estimated have an annual mean flow of 137.3 CFS.

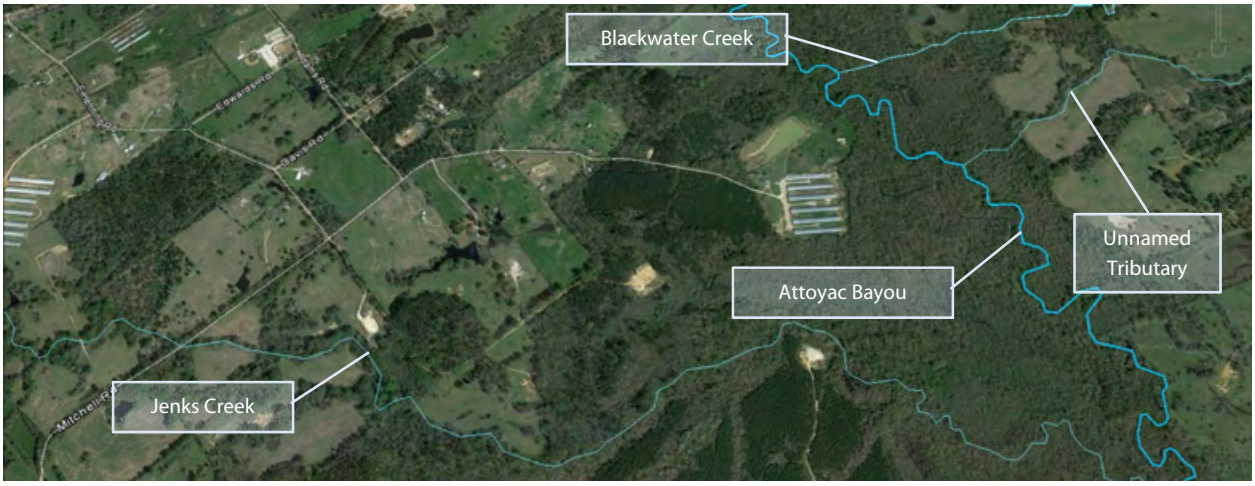
Confluence with Hardage Creek (66.5 miles to Sam Rayburn Reservoir)

The confluence with Hardage Creek is located one mile downstream from the Rusk/Nacogdoches County line. The perennial portion of Hardage Creek is 4.7 miles long, and flows from the northeast, crossing US 59 and two county roads. It flows mostly through forest with about one third of its eastern bank bordered by fields with possible narrow forested buffer strips. Hardage Creek above US 59 is intermittent and has a 30 acre impoundment within its length. It also has an unnamed intermittent tributary to the east. The intermittent section and tributary both begin just above US 84. At the confluence with the Attoyac Bayou, Hardage Creek drains an area of 10.9 sq miles and contributes 30.2 CFS.

Confluence with Blackwater Creek (65.5 miles to Sam Rayburn Reservoir)

Another mile downstream is the confluence with Blackwater Creek. Blackwater is 5 miles long and includes Lake Timpson (212 Acres). Samples have been collected on Lake Timpson in the past, although it is not currently being monitored. Blackwater flows from the northeast through an area that is approximately two-thirds forest and one-thirds fields. The portion above Lake Timpson crosses one county road, and the portion below crosses two county roads. Blackwater Creek drains an area of 7.5 sq miles and contributes 25.2 CFS of flow.

FIGURE 6-6 Confluence with Blackwater Creek



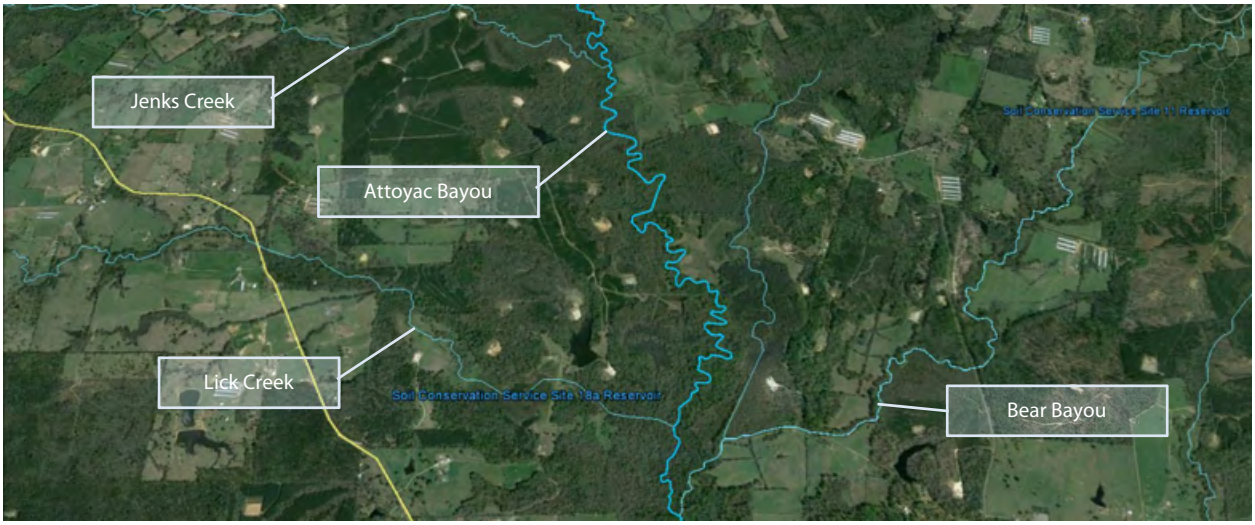
Confluence with Jenks Creek (63.6 miles to Sam Rayburn Reservoir)

Jenks Creek flows from the west. This stream is intermittent, with headwaters just within the Garrison city limits. The City of Garrison WWTP (TPDES permit no. 11304-001) is permitted for up to 0.12 MGD of effluent discharge. The land cover surrounding the creek is approximately two-thirds forest and one-third field. Jenks Creek drains an area of 3.6 sq miles and contributes 14.7 CFS of flow.

Confluence with Lick Creek 60.1 miles to Sam Rayburn Reservoir)

Lick Creek flows from the west and is 3.6 miles in length. It drains an area of 3.6 sq miles and contributes 14.6 CFS. The creek crosses FM 138. Above FM 138, land cover is primarily open fields with buffer. Below FM 138, land cover is approximately one-third field with buffer and two-thirds forest. Below FM 138 is also Soil Conservation Service Site 18a Reservoir (26 acres) which is a flood control reservoir that is generally drained in the summer. Below the confluence with Lick Creek, the Attoyac has a mean annual flow of 181.5 CFS.

FIGURE 6-7 Confluences with Jenks Creek, Lye Creek, and Bear Bayou



Next, Attoyac Bayou reaches a confluence with Bear Bayou. The confluence with Bear Bayou marks the end of AU 0612_03 and the beginning of AU 0612_02.

Assessment Unit 0612_02

Confluence with Bear Bayou (59.6 miles to Sam Rayburn Reservoir)

Half a mile further through forest interspersed with oil/gas drilling sites is the confluence with Bear Bayou. Bear Bayou flows from the northeast for 4 miles through deep forest, 0.3 miles through Soil Conservation Service Site 11 Reservoir, and 3.6 miles though open fields with narrow forested buffer. About four-tenths of a mile upstream of the Attoyac confluence, Bear Bayou has a 2.3 mile long unnamed tributary that contributes 8.2 CFS. Bear Bayou drains a total of 9.9 sq miles and contributes 30.9 CFS.

FM 138 Crossing (57.2 miles to Sam Rayburn Reservoir)

Routine monitoring was conducted by SFASU at Attoyac Bayou at FM 138 (Monitoring Station 20841) as part of the Attoyac Bayou Watershed Protection Plan Project.

FIGURE 6-8 Attoyac Bayou WPP Monitoring Station 20841 – Attoyac Bayou at FM 138

Confluence with Stockman Creek (54.2 miles to Sam Rayburn Reservoir)

The Attoyac Bayou continues for 4.4 miles through open fields with narrow forested buffer, crossing FM 138, and receiving inflow from an unnamed intermittent tributary which flows from the northeast for 2 miles and contributes 6 CFS before reaching the confluence with Stockman Creek. Stockman flows 4.8 miles from the northeast. The land cover is one-third deep forest and two-thirds open field with narrow buffer. Stockman Creek also crosses FM 138 and is impounded to create the 23.5 acre Soil Conservation Service Site 12 Reservoir. Stockman drains an area of 4.8 sq miles and contributes 18.5 CFS.

Confluence with Unnamed Intermittent Tributary (47.6 miles to Sam Rayburn Reservoir)

A confluence with an unnamed tributary is located an additional 6.5 miles downstream. The tributary is 3.3 miles long and flows from the northeast through deep forest, draining an area of 2.1 sq miles and contributing a flow of 10.2 CFS. Below this confluence, the Attoyac Bayou has a mean annual flow of 210.7 CFS.

Confluence with Naconiche Creek (44.4 miles to Sam Rayburn Reservoir)

After an additional 1.1 miles through forest and 2.2 miles through open field with narrow buffer, the Attoyac Bayou reaches a confluence with Naconiche Creek.

Naconiche Creek is the largest tributary to the Attoyac, contributing 165.5 CFS of flow to the Attoyac's 203.7 CFS, or nearly half (45%) of the estimated flow at the confluence.

Naconiche flows 29.2 miles from the northwest, and drains an area of 115 sq miles. The headwaters in Rusk County are classified as intermittent, and begin approximately 0.75 miles north of the Nacogdoches County line, and 0.4 miles south of CR 3267 in Rusk County. The perennial portion is fully within Nacogdoches County.

The first six stream miles of Naconiche Creek, along with 2.9 miles of Telesco Creek, and 2.8 miles of Cedar Branch, feed into the recently completed 692 acre Lake Naconiche. All together, the lake drains an area of approximately 27 sq miles.

Within the Cedar Branch watershed is the Elbow Ridge Landfill (TCEQ MSW permit no. 753) and Transfer Station (TCEQ MSW permit no. 40167).

The land cover near the streams is typical of the overall watershed (two-thirds forest and one-third open fields with narrow forested buffers around the stream channels). Poultry operations and natural gas drilling sites are abundant around Lake Naconiche.

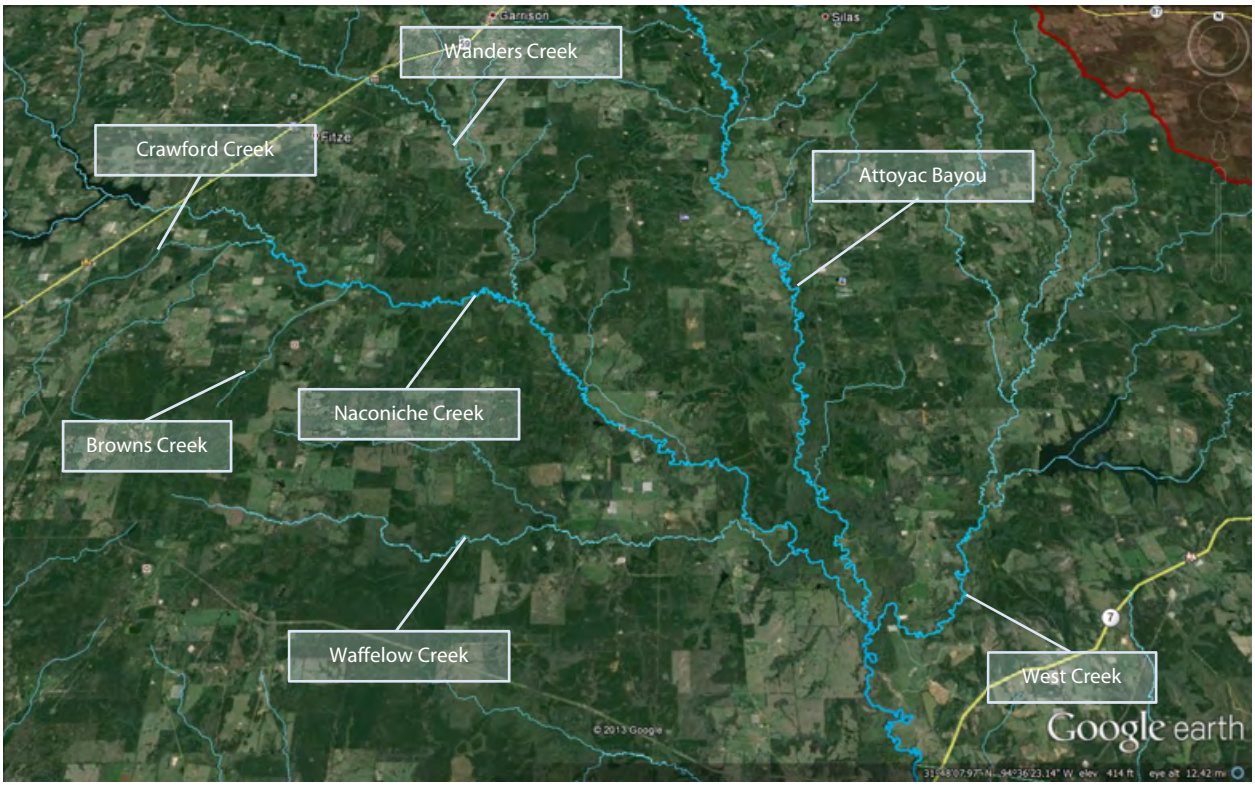
Naconiche Creek crosses US 59 directly below the dam and is estimated to have a yearly mean flow of 67.7 CFS, but this estimate does not account for the lake because it was impounded after the estimates were created. Lake Naconiche is a flood control reservoir and is not used for drinking water or power generation, so presumably the only water lost is via evaporation.

Numerous tributaries contribute flow to Naconiche Creek:

Crawford Creek:	Located 2.7 miles downstream from US 59 is the confluence with Crawford Creek, which flows from the southwest, draining an area of 10.2 sq miles and contributing a flow of 28.9 CFS.
Browns Creek:	Located 2.3 miles further downstream is the confluence with Browns Creek, which also flows from the southwest, draining an area of 3.9 sq miles and contributing a flow of 14.9 CFS.
Wanders Creek:	Located 4.1 miles further downstream is the confluence with Wanders Creek, which flows from the north, draining an area of 27.6 sq miles and contributing a flow of 60.6 CFS.
Unnamed Tributary:	Located 6 miles further downstream, after Naconiche Creek crosses FM 95 (Monitoring Station 20843, sampled by SFASU as part of the Attoyac Bayou WPP project), is a confluence with an unnamed intermittent tributary. The tributary flows from the northwest and also crosses FM 95 (twice). It is 4.3 miles long, drains an area of 5 sq miles, and contributes 18.6 CFS.
Waffelow Creek:	Located 3.2 miles further downstream is the confluence with Waffelow Creek. Waffelow flows in from the west, contributing a flow of 47.9 CFS and draining an area of 20 sq miles. Waffelow crosses FM 95 (Monitoring Station 16083, sampled by SFASU as part of the Attoyac Bayou WPP project) and FM 1878 (Historical Monitoring Station 16085). Land cover for Waffelow Creek is more forested than typical for the watershed. About one-fifth of the surrounding land is open fields with a narrow forested buffer.

Downstream of the confluence with Waffelow Creek [1.8 miles (0.4 miles of which is through open field with no buffer)], Naconiche Creek flows into the Attoyac Bayou. At the Naconiche confluence, the Attoyac drains 149 sq miles of land, and Naconiche drains 115 sq miles. The combined mean annual flow at the confluence is 369 CFS.

FIGURE 6-9 Tributaries to Naconiche Creek



Confluence with West Creek (44.1 miles to Sam Rayburn Reservoir)

The confluence with West Creek is located 0.3 stream miles south of the Naconiche confluence. West Creek is 17 miles long and drains 49.4 sq miles. The stream flows from the northeast, crossing FM 138 and FM 2913 (Monitoring Station 20845, monitored by SFASU as part of the Attoyac Bayou WPP project). West Creek contributes 98.5 CFS of flow. Land cover is typical of the watershed as a whole, but the surrounding area has fewer poultry operations than typical, with less than 10 being noted on aerial imagery. Numerous gas wells are located within this portion of the watershed.

West Creek has three major tributaries.

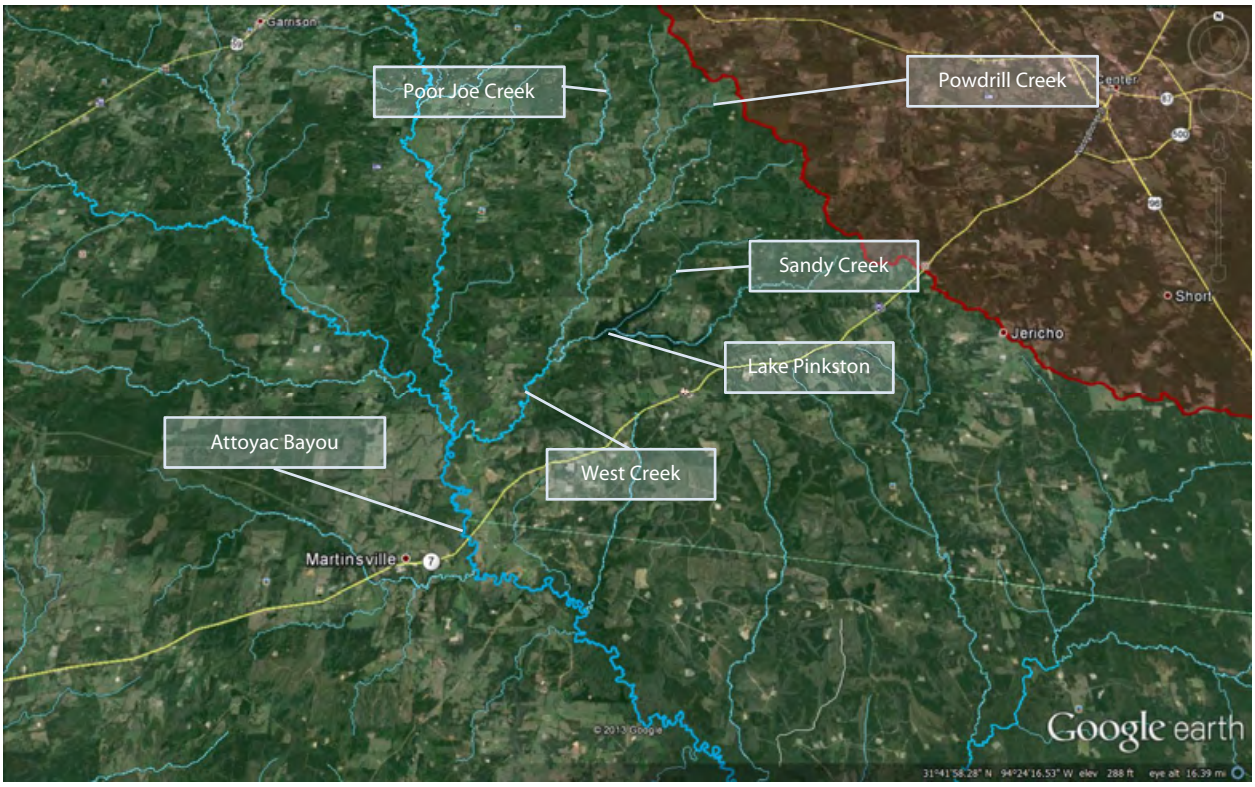
Powdrill Creek: This stream flows from the northeast, also crossing FM 138. It drains 8.4 sq miles and contributes 28.2 CFS. Within the Powdrill Creek watershed is the City of Center Landfill site (TCEQ MSW permit no. 1475).

Poor Joe Creek: Poor Joe Creek flows from the north, also crossing FM 138. It drains 7.7 sq miles and contributes 26.2 CFS.

Sandy Creek: Sandy Creek flows from the northeast, draining 14.4 sq miles and contributing 41.4 CFS. Lake Pinkston (525 acres) is on the main stem of Sandy Creek. Sampling has been performed on Pinkston in the past (Historical Monitoring Station 15802). Just south of Lake Pinktson is the location of the Aiken Surface Water Treatment Facility, where the City of Center has a wastewater discharge permit (TPDES permit no. 14352-001) to discharge up to 0.20 MGD of filter backwash.

Combined flow at the confluence of West Creek and Attoyac Bayou is 401 CFS.

FIGURE 6-10 Tributaries to West Creek



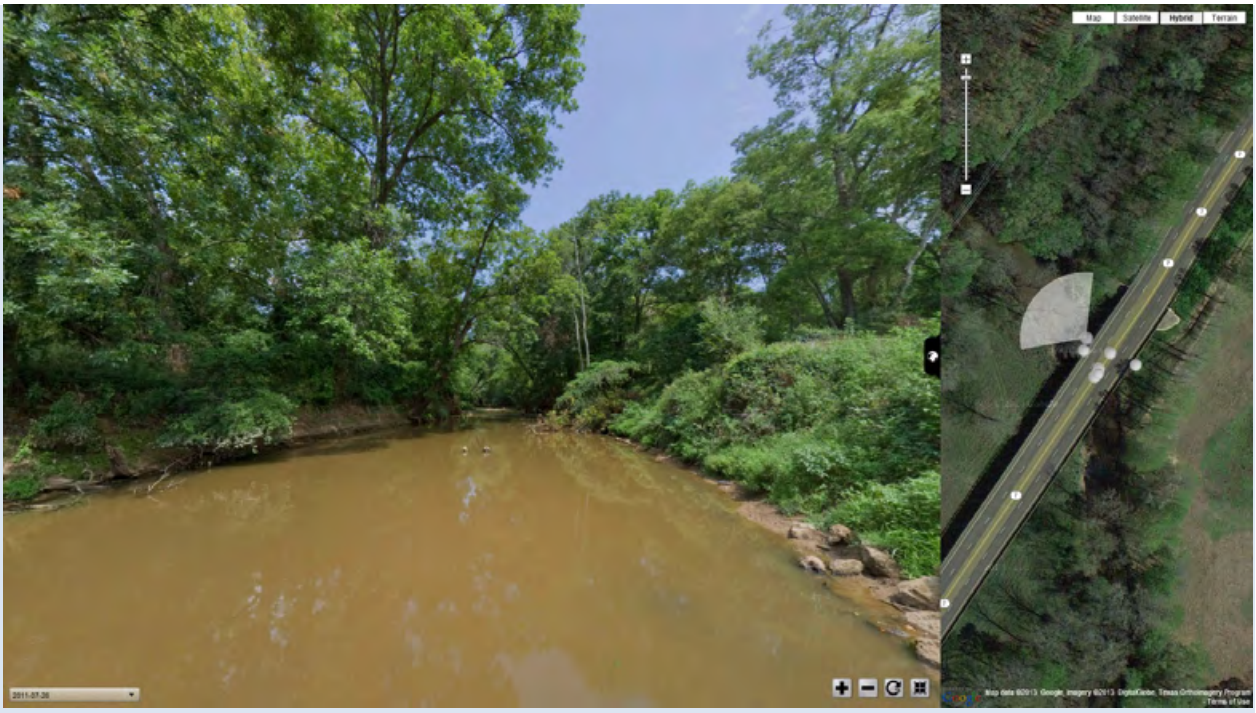
Shelby County/San Augustine County Line (40.4 miles to Sam Rayburn Reservoir)

Further downstream (3.7 miles through mostly fields with narrow forested buffer), is the intersection of Nacogdoches, Shelby and San Augustine Counties. At this point, the eastern bank of the Attoyac Bayou becomes San Augustine County rather than Shelby County.

Monitoring Station 15253 - Attoyac Bayou at SH 7

The Attoyac Bayou continues for 1.5 miles through fields with buffer before reaching the confluence with Terrapin Creek. A monitoring station is located on the Attoyac at the SH 7 crossing (Monitoring Station 15253, monitored quarterly by ANRA and by SFASU as part of the Attoyac Bayou WPP project).

FIGURE 6-11 Monitoring Station 15253 – Attoyac Bayou at SH 7



Monitoring Station 15253 Attoyac Bayou at SH 7 7/26/2011
A 360° panorama of this monitoring station is located at http://www.anra.org/divisions/water_quality/crp/monitoring_sites/15253/15253.html

Confluence with Terrapin Creek (38.9 miles to Sam Rayburn Reservoir)

Terrapin Creek is 10.4 miles long and flows in from the west. It drains an area of 56 sq miles, and contributes 52.8 CFS. Terrapin crosses SH 7 and FM 95 (Monitoring Station 16084, sampled by SFASU as part of the Attoyac Bayou WPP project). Just upstream of the FM 95 crossing is the Martinsville ISD permitted wastewater discharge (TPDES permit no. 14027-001). Martinsville ISD is permitted to discharge up to 0.008 MGD. Terrapin flows almost exclusively through forest, but has two perennial tributaries that flow in from the south through land cover that is more typical of the watershed as a whole.

Kingham Creek: This stream drains an area of 3.8 sq miles and contributes 15.6 CFS of flow.

Bakers Branch: This stream drains an area of 3 sq miles and contributes 13.4 CFS of flow.

Confluence with Dean Creek (34.6 miles to Sam Rayburn Reservoir)

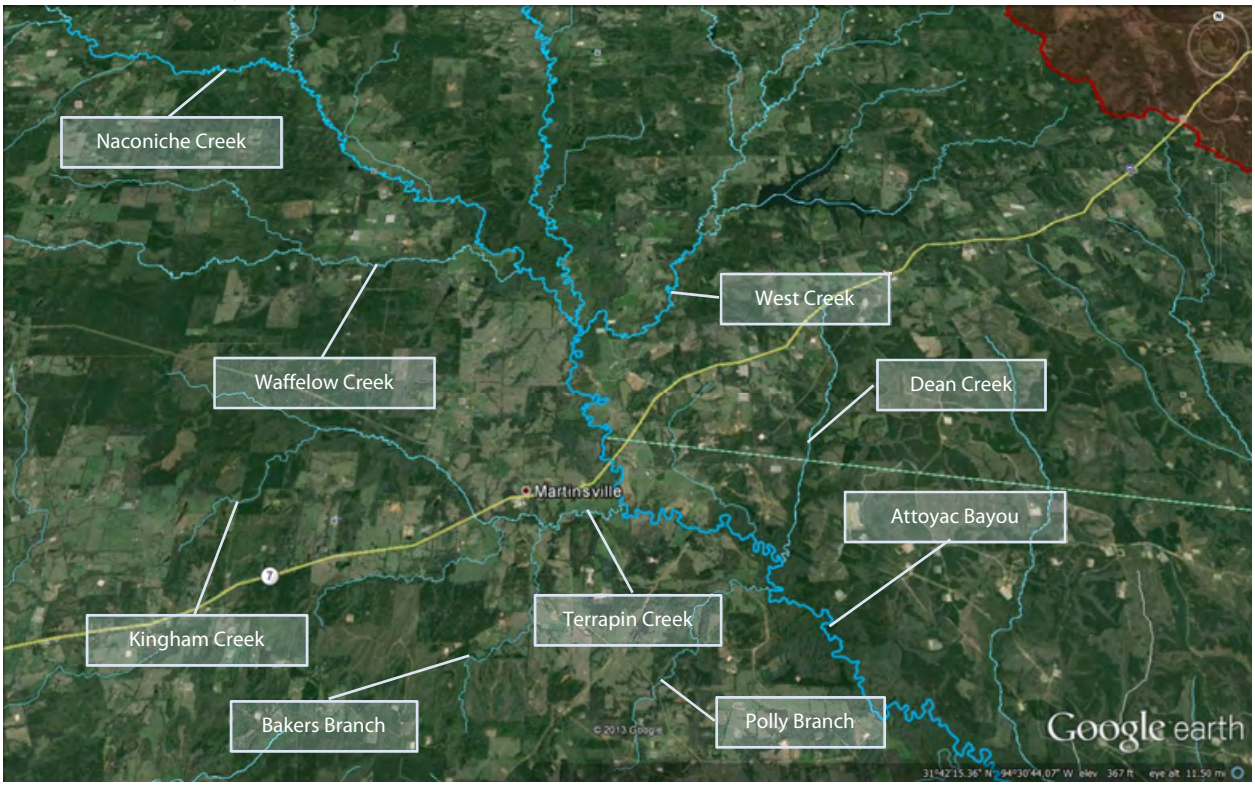
The confluence with Dean Creek is located an additional 4.2 miles downstream. Dean Creek flows from the north through forest for 4.3 miles, draining an area of 7 sq miles and contributing a flow of 24.8 CFS.

Confluence with Polly Branch (33.9 miles to Sam Rayburn Reservoir)

Attoyac continues an additional 0.75 miles mostly through forest before reaching the confluence with Polly Branch. This stream is intermittent, and land cover is typical for the watershed. Polly Branch drains 4 sq miles and contributes a flow of 16.5 CFS.

The confluence with Polly Branch marks the end of AU 0612_02 and the beginning of AU 0612_01.

FIGURE 6-12 Confluences with Naconiche Creek, Waffelow Creek, West Creek, Terrapin Creek, Dean Creek, and Polly Branch



Assessment Unit 0612_01

Confluence with Tandakee Creek (28.8 miles to Sam Rayburn Reservoir)
The confluence with Tandakee Creek is located five miles further downstream. This perennial stream crosses FM 95, and displays the type of land cover typical for the watershed. It drains an area of 4.5 sq miles and contributes a flow of 18.4 CFS.

Confluence with Horsepen Branch (26.8 miles to Sam Rayburn Reservoir)

The confluence with Horsepen Branch is located 2.1 miles further downstream. This perennial stream travels mostly through forest before crossing FM 95. It drains an area of 2.9 sq miles and contributes a flow 13.7 CFS.

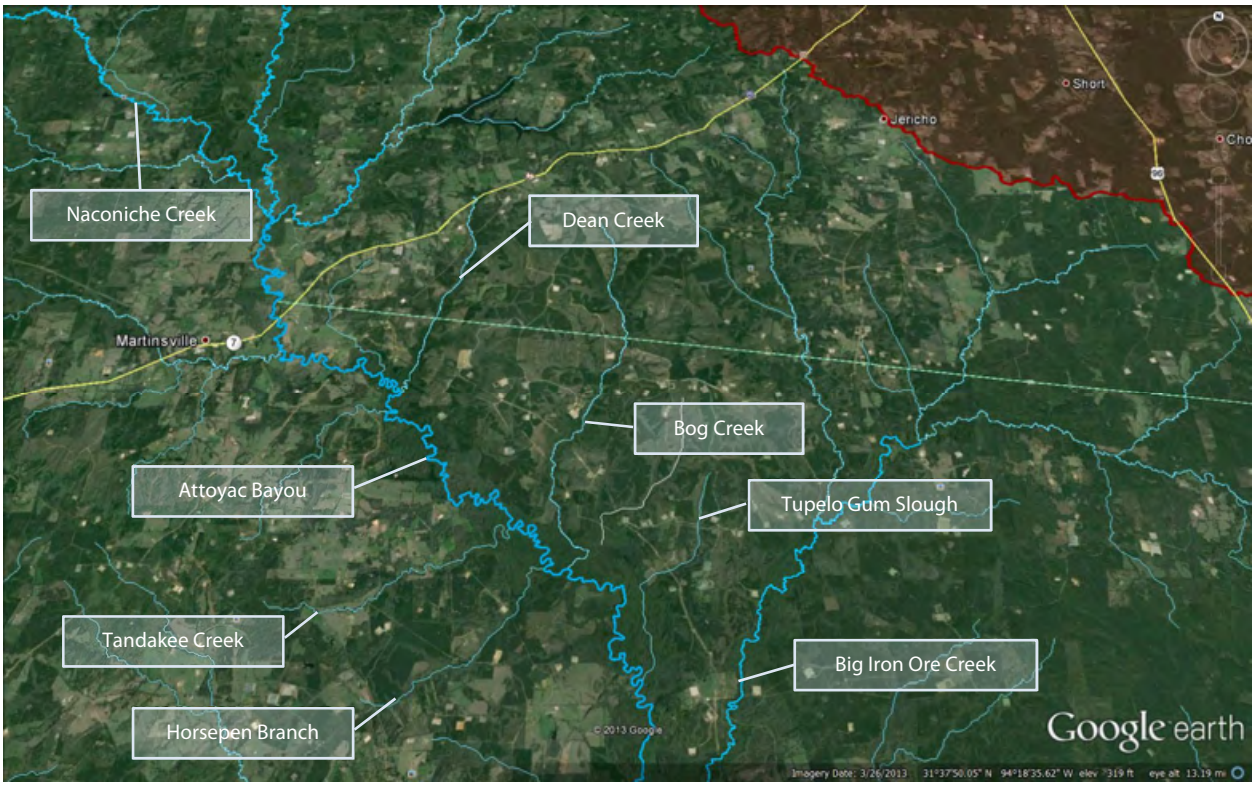
Confluence with Bog Creek (26.4 miles to Sam Rayburn Reservoir)

Bog Creek flows from the north. It begins in Shelby County, with its headwaters located in an open field with narrow forest buffer. The typical land cover is mostly forest otherwise. The stream is 7 miles long and crosses several county roads. It drains an area of 9.5 sq miles and contributes a flow of 31.2 CFS.

Confluence with Tupelo Gum Slough (22.7 miles to Sam Rayburn Reservoir)

Tupelo Gum Slough flows from the north and is 4.4 miles long with one on-channel impoundment (Spring Lake, 7.7 acres). Tupelo drains 2 sq miles and contributes 10.6 CFS.

FIGURE 6-13 Confluences with Tandakee Creek, Horsepen Branch, Bog Creek, and Tupelo Gum Slough



Confluence with Big Iron Ore Creek (19.4 miles to Sam Rayburn Reservoir)

Big Iron Ore Creek is the second largest tributary of Attoyac Bayou. It flows from the northeast from headwaters near Bland Lake Road in northern San Augustine County. Two Municipal Solid Waste sites are located in its upper watershed: San Augustine County Precinct 1 Landfill (TCEQ MSW permit no. 863) and San Augustine County Precinct 2 Landfill (TCEQ MSW permit no. 868). Oil/Gas drilling operations are abundant in the watershed. Big Iron Ore Creek is 20.7 miles long, drains an area of 83 sq miles, and contributes a mean annual flow of 147.8 CFS.

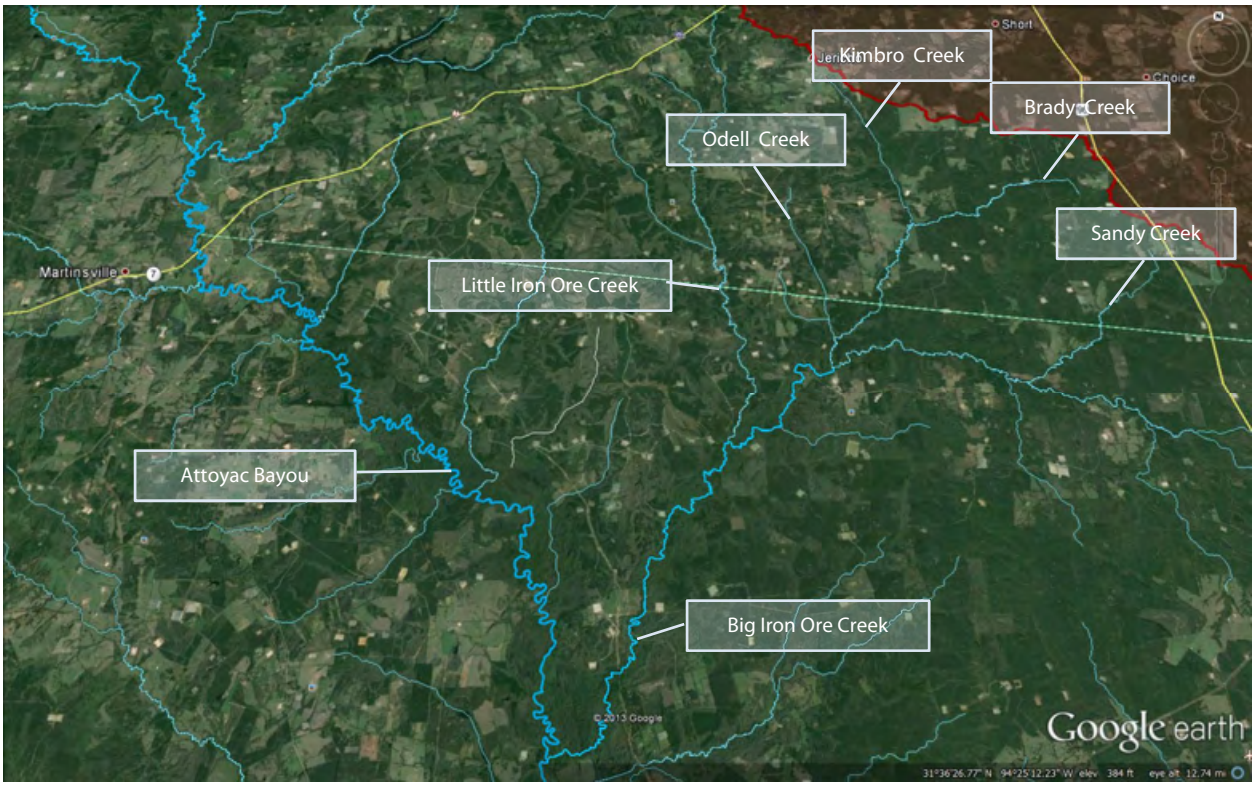
Big Iron Ore crosses US 96, FM 711, several county roads, and FM 354. The FM 354 crossing was a monitoring station for the Attoyac Bayou WPP project (Monitoring Station 20844).

There are three major tributaries from the north:

Sandy Creek:	This stream is 2.5 miles long, contributing a flow of 24.2 CFS and draining an area of 6.4 sq miles.
Odell Creek:	This stream is 2.2 miles long, contributing a flow of 46.7 CFS and draining an area of 16.2 sq miles. It is fed by Kimbro Creek and Brady Creek.
Little Iron Ore Creek:	This stream is 4.6 miles long, contributing a flow of 58.6 CFS and draining an area of 22.8 sq miles.

Below the confluence with Big Iron Ore, the Attoyac Bayou has a mean annual flow of 553 CFS.

FIGURE 6-14 Confluences Little Iron Ore Creek and Big Iron Ore Creek



Confluence with Price Creek and Blue Creek (18.1 miles to Sam Rayburn Reservoir)

Price Creek drains 10 sq miles and contributes 32.9 CFS. Blue Creek drains 5.4 sq miles and contributes 21.2 CFS. Both streams flow mostly through forest. Within the Blue Creek watershed is the San Augustine County Precinct 2 Landfill (TCEQ MSW permit no. 869).

Confluence with Black Branch (16.5 miles to Sam Rayburn Reservoir)

Black Branch flows from the northwest, mostly through forest, draining an area of 4.7 sq miles and contributing a flow of 19.3 CFS. It crosses CR 392 and has a 33 acre on-channel impoundment called Scoggins Lake.

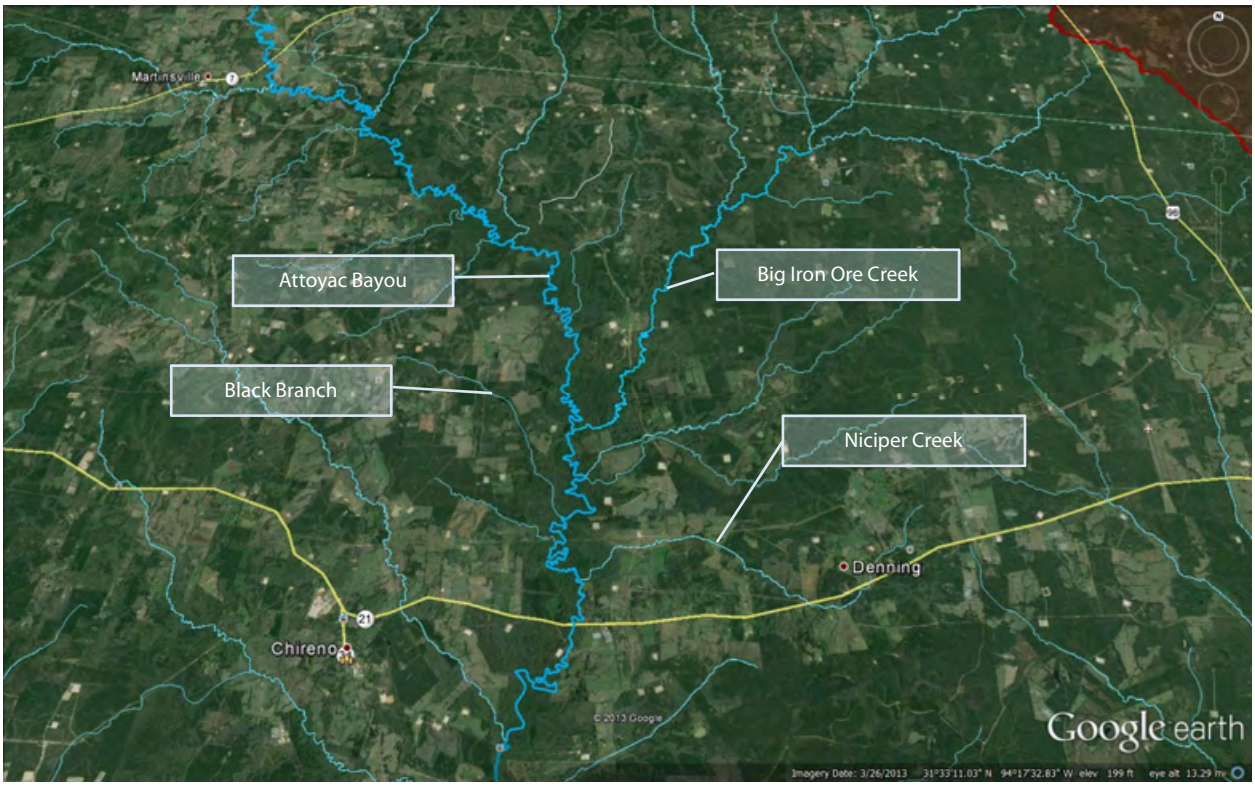
Confluence with Unnamed Tributary (15.5 miles to Sam Rayburn Reservoir)

This unnamed tributary flows from the northwest, draining 1.3 sq miles and contributing a flow of 7.9 CFS. The drainage area contains the site of the Chireno Landfill (TCEQ MSW permit no. 1462).

Confluence with Niciper Creek (13.6 miles to Sam Rayburn Reservoir)

Niciper Creek flows from the east and twice crosses SH 21. The Denning Landfill site (TCEQ MSW permit no. 1530) is located in between SH 21 crossings. The land cover is three-quarters open field and one-quarter forest. Niciper Creek has an 8.5 sq mile drainage area and contributes 29.3 CFS of flow.

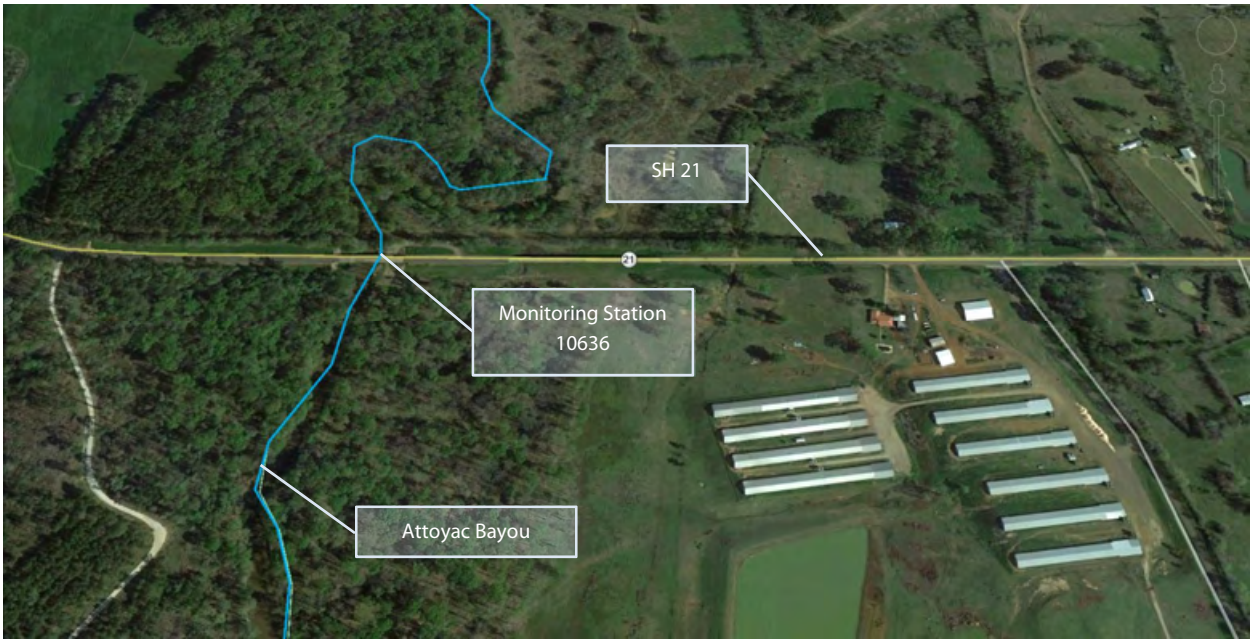
FIGURE 6-15 Confluences with Big Iron Ore Creek, Black Branch, and Niciper Creek

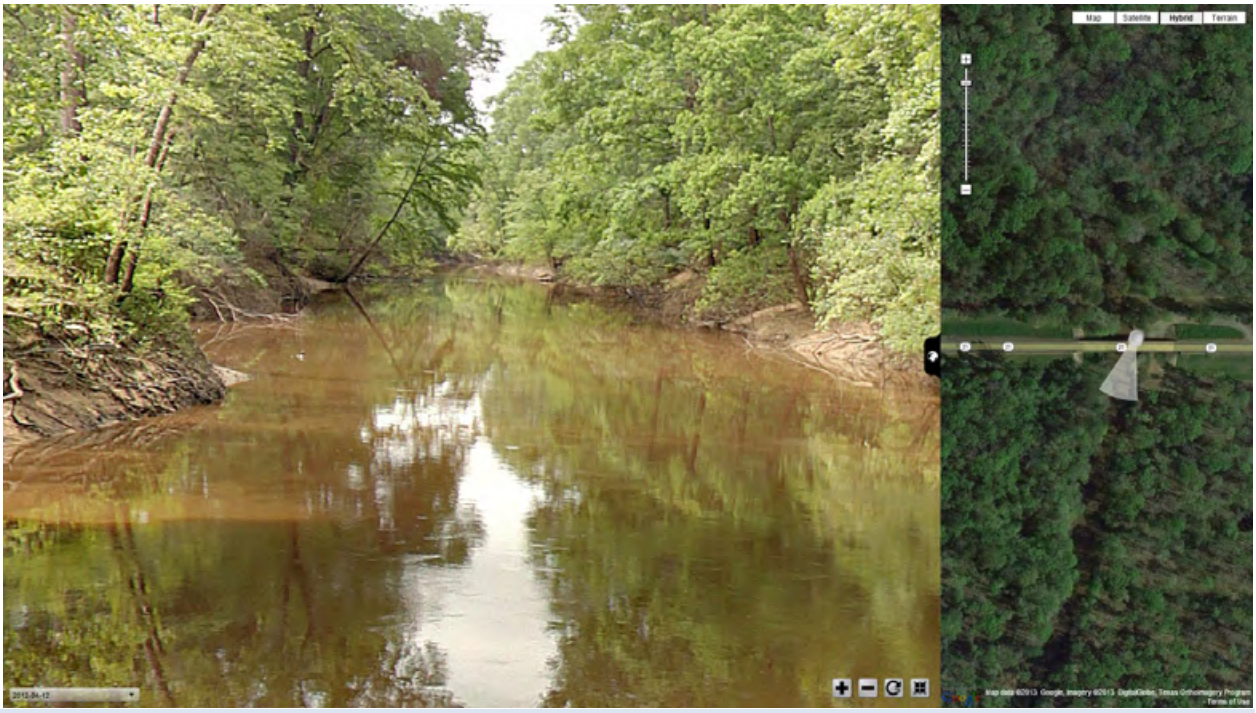


Monitoring Station 10636 – Attoyac Bayou at SH 21(12.8 miles to Sam Rayburn Reservoir)

A monitoring station is located on Attoyac Bayou at the SH 21 crossing (Monitoring Station 10636). ANRA performs routine quarterly monitoring at this location. Additionally, SFASU sampled here as part of the Attoyac Bayou WPP project.

FIGURE 6-16 Monitoring Station 10636 – Attoyac Bayou at SH 21





Monitoring Station 10636 Attoyac Bayou at SH 21 4/12/2012
A 360° panorama of this monitoring station is located at http://www.anra.org/divisions/water_quality/crp/monitoring_sites/10636/10636.html

Confluence with Amaladeros Creek (9.2 miles to Sam Rayburn Reservoir)

Amaladeros Creek flows from the northwest and drains an area of 18.2 sq miles, including a portion of the City of Chireno. It contributes 49.8 CFS of flow. Land cover near stream is mostly fields with a narrow buffer. Amaladeros Creek crosses CR 350, CR 353, FM 95, and SH 21 before reaching its confluence with Attoyac Bayou.

Confluence with Polysot Creek (8.2 miles to Sam Rayburn Reservoir)

Polysot Creek flows from the northwest, draining an area of 19 sq miles, including the majority of the City of Chireno. Polysot contributes a flow of 53.1 CFS. This watershed includes the Nacogdoches County Landfill (MSW permit 894) and Chireno ISD permitted discharge (TPDES permit no 13917-001). Land cover near the stream is typical of the overall watershed.

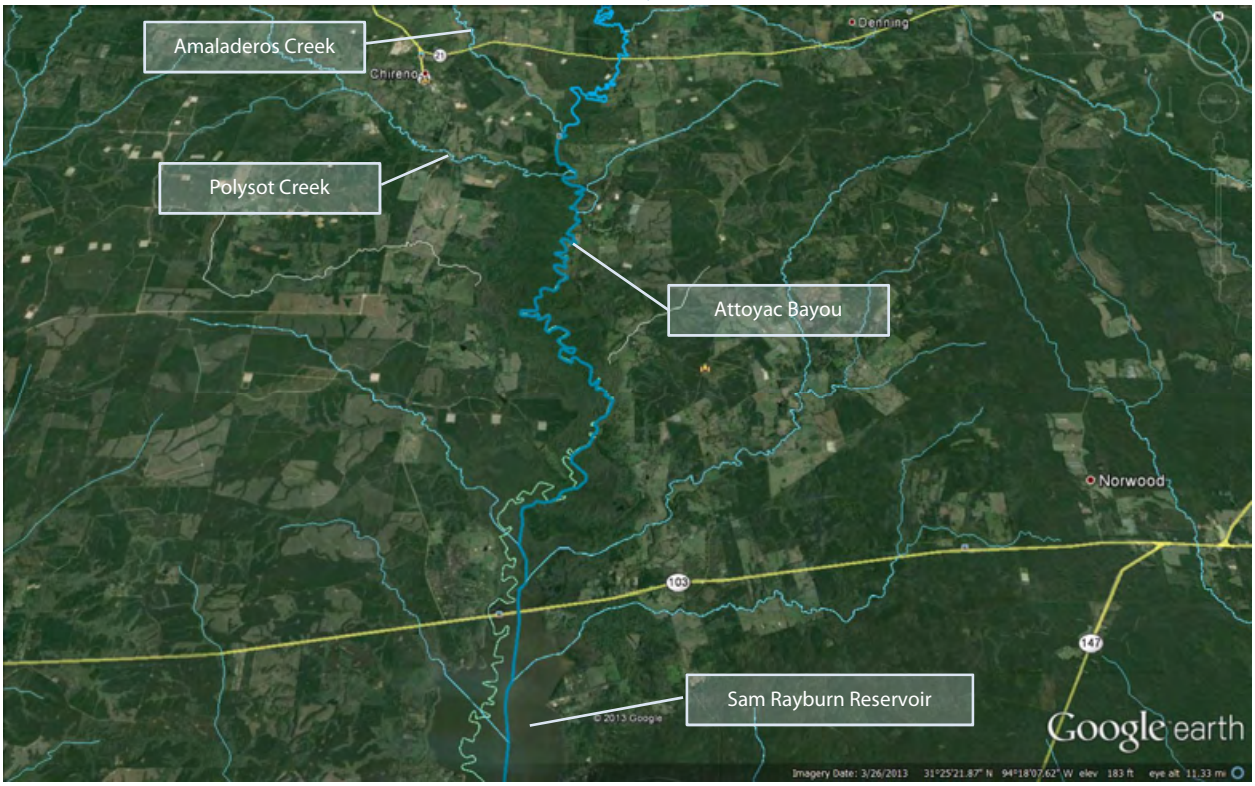
Confluence with Curry Creek (6.8 miles to Sam Rayburn Reservoir)

Curry Creek flows from the northeast, draining an area of 6.5 sq miles and contributing a flow of 24.2 CFS. Land cover near the stream is typical of the overall watershed.

Discharge into Sam Rayburn Reservoir (0 miles to Sam Rayburn Reservoir)

The western bank of the Attoyac Bayou becomes part of the Angelina National Forest. Attoyac Bayou discharges an estimated mean annual flow of 547.8 CFS into Sam Rayburn Reservoir.

FIGURE 6-17 Confluences with Amaladeras Creek and Polysot Creek

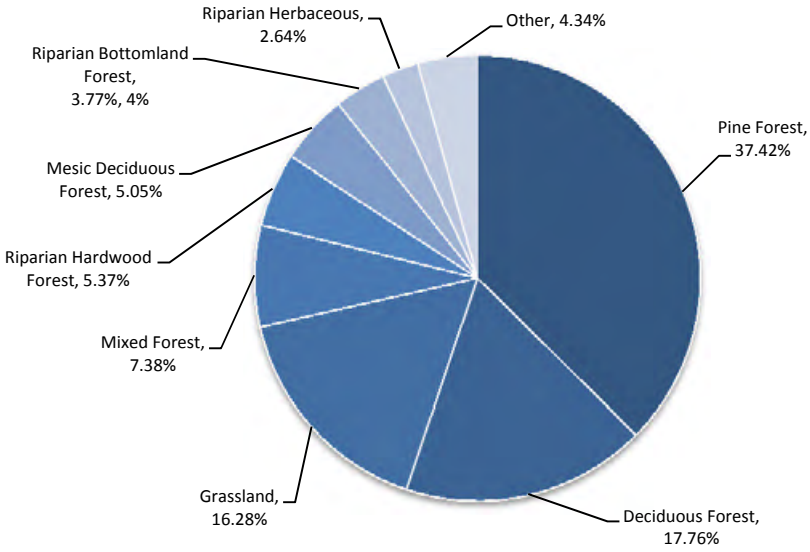


Land Cover

There is a total of 364,471 acres located within the Attoyac Bayou watershed. The vast majority of the land is forested (approximately 75% coverage), including pine, deciduous, hardwoods, and mixed forests. There are 744 acres (0.20%) of the land classified as agricultural.

TABLE 6-6 Attoyac Bayou Generalized Land Cover
From the TPWD Texas Ecological Systems Classification Project Phase 2

Land Cover	Percentage	Acres
Pine Forest	37.42%	136,373
Deciduous Forest	17.76%	64,742
Grassland	16.28%	59,349
Mixed Forest	7.38%	26,885
Riparian Hardwood Forest	5.37%	19,561
Mesic Deciduous Forest	5.05%	18,399
Riparian Bottomland Forest	3.77%	13,740
Riparian Herbaceous	2.64%	9,620
Mesic Mixed Forest	1.65%	6,017
Riparian Mixed Forest	0.91%	3,305
Open Water	0.48%	1,757
Riparian Swamp	0.28%	1,032
Urban Low	0.27%	975
Agriculture	0.20%	744
Riparian Marsh	0.09%	331
Flatwoods Hardwood Forest	0.08%	276
Deciduous Shrubland	0.07%	270
Riparian Deciduous Shrubland	0.07%	264
Barren	0.06%	215
Urban High	0.06%	205
Marsh	0.05%	171
Flatwoods Pine Forest	0.03%	92
Flatwoods Mixed Forest	0.02%	91
Floodplain Mixed Forest	0.01%	49
Swamp	0.00%	5
Evergreen Shrubland	0.00%	0
Grand Total	100.00%	364,471



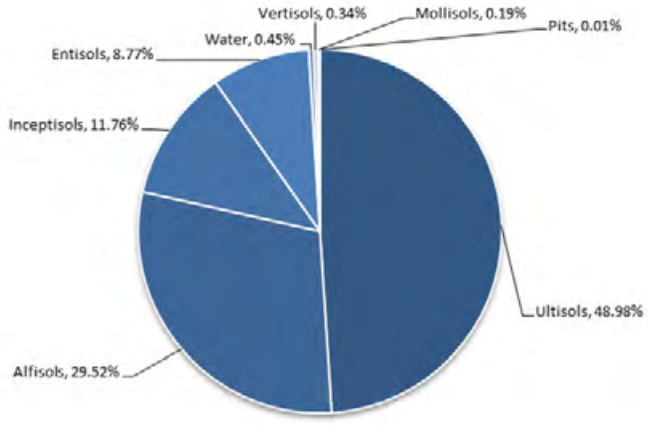
The category "Other" includes all categories with <2.0% of land cover.

NOTE: The difference in Total Acres from the Land Cover data and the Soil Types data is due to the difference in resolution in the GIS information.

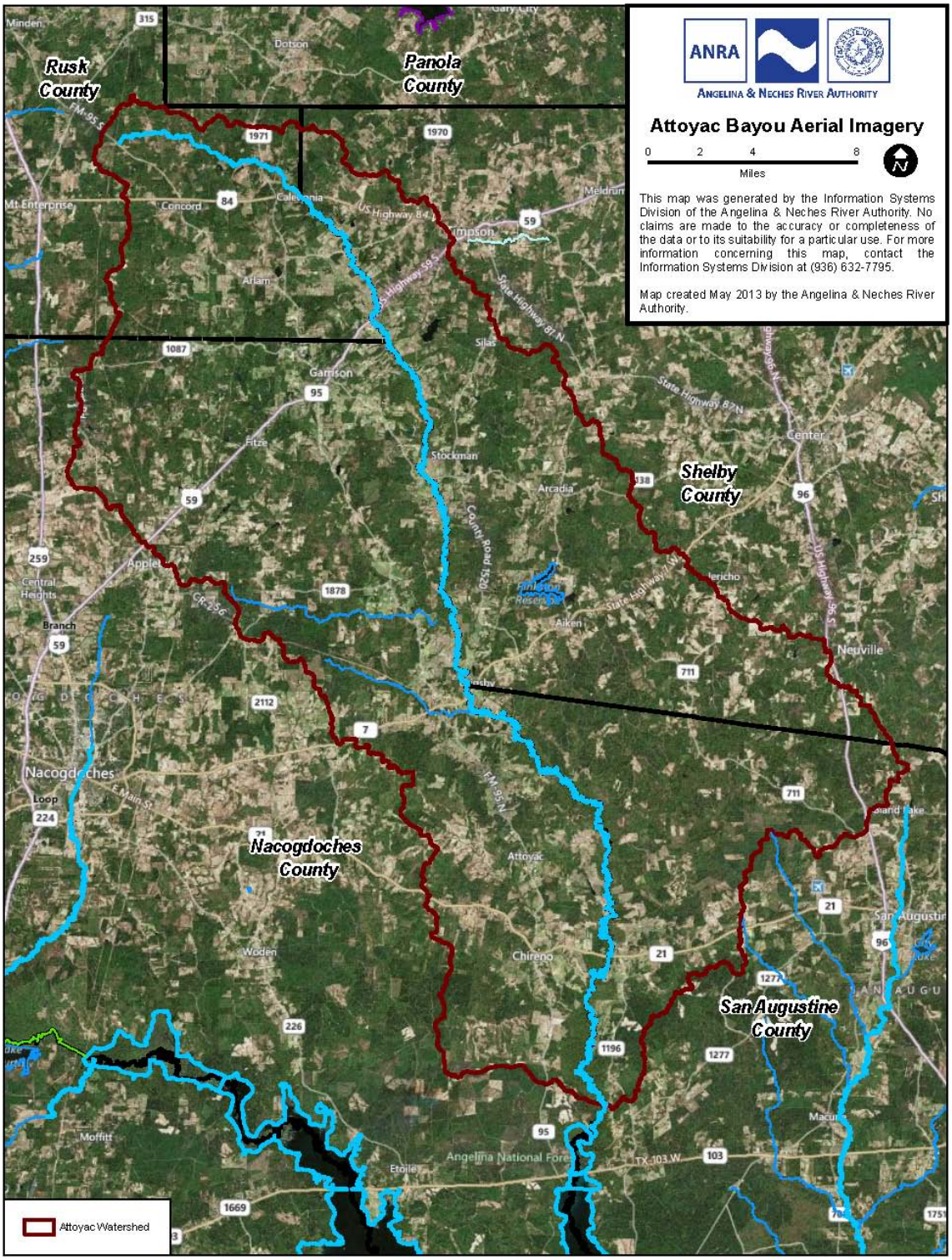
Soils

TABLE 6-7 Attoyac Bayou Soil Types
(from NRCS)

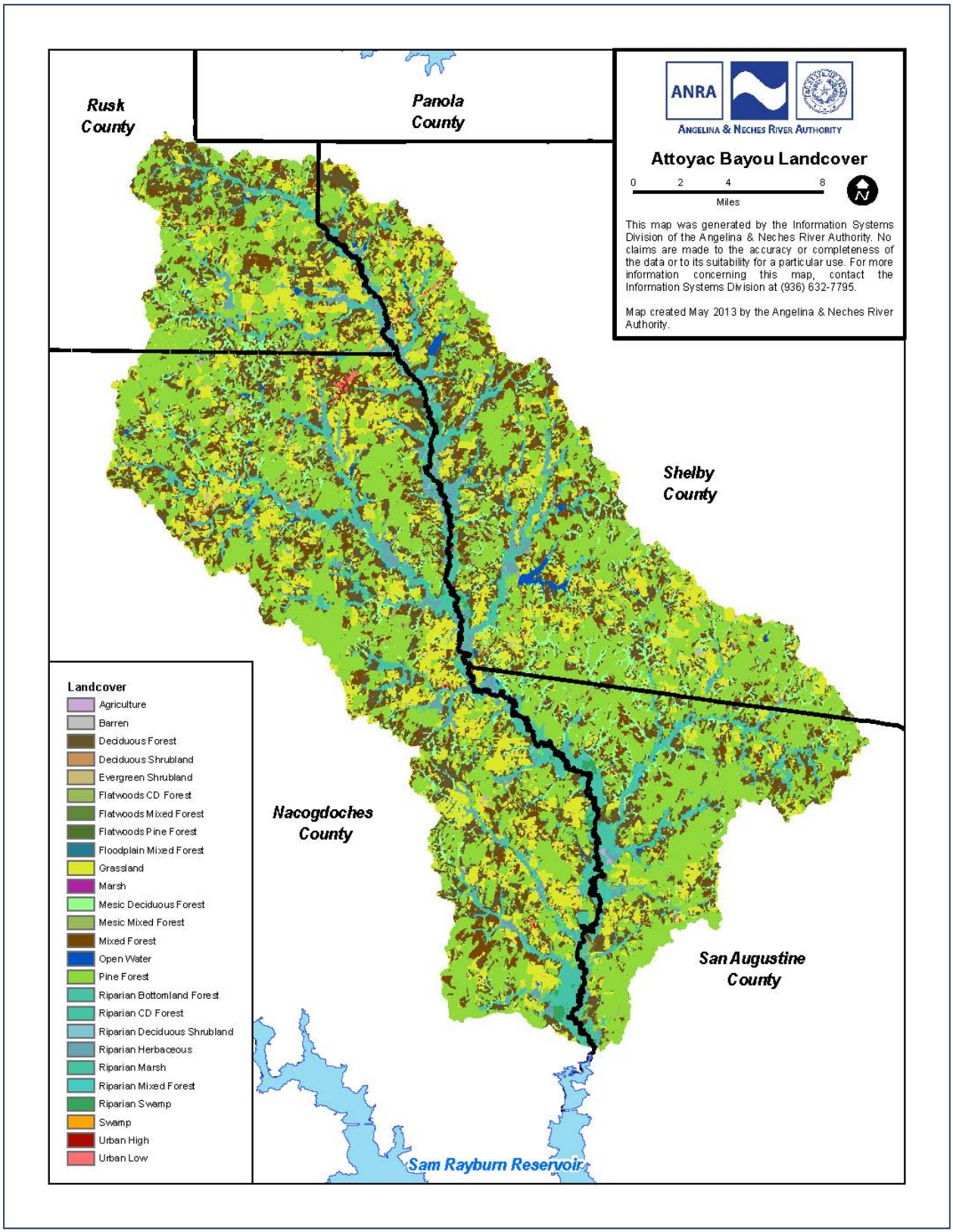
Soil Type	Percentage	Acres
Ultisols	48.98%	178,441
Alfisols	29.52%	107,551
Inceptisols	11.76%	42,829
Entisols	8.77%	31,943
Water	0.45%	1,641
Vertisols	0.34%	1,240
Mollisols	0.19%	679
Pits	0.01%	25
TOTAL	100.00%	364,350



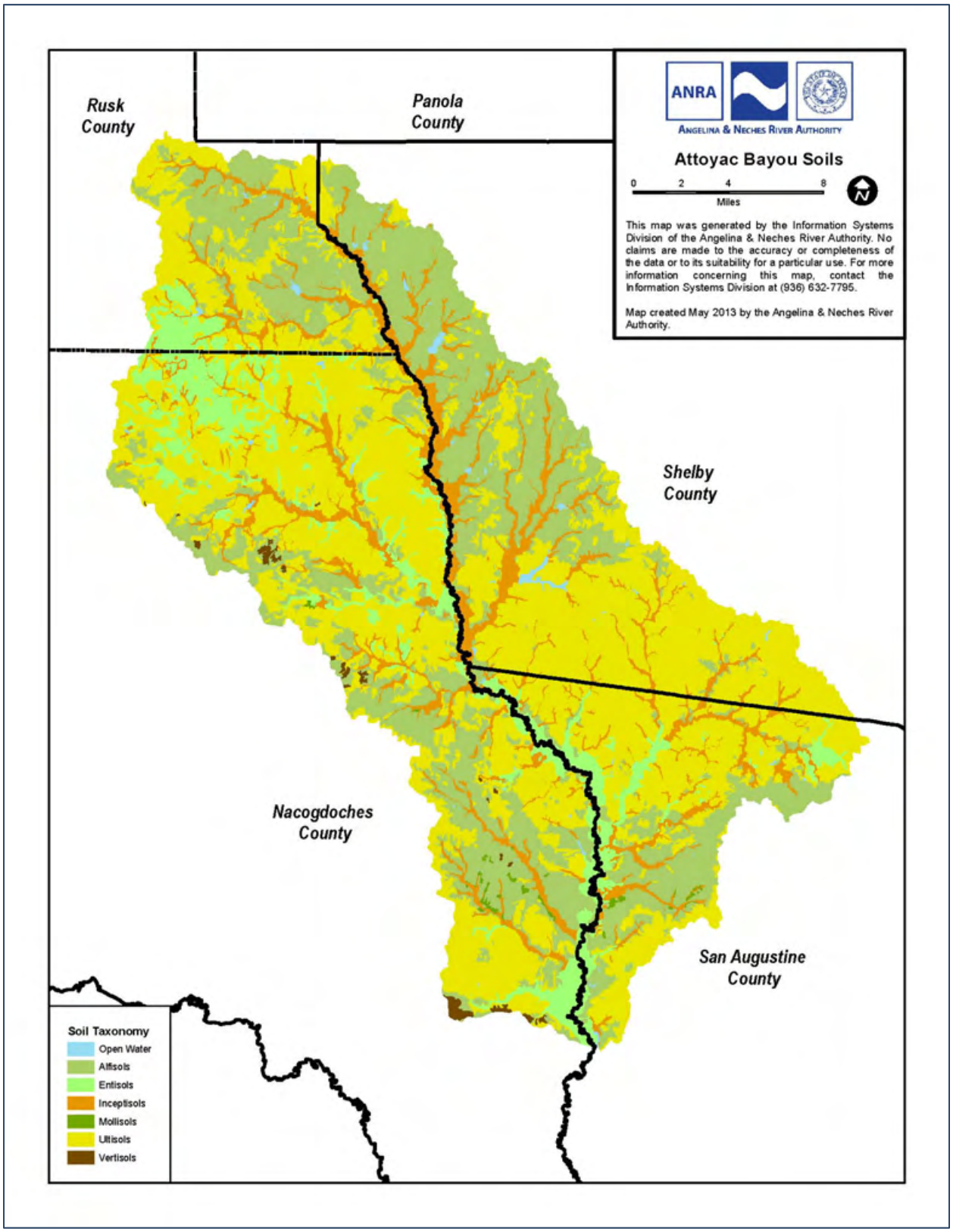
MAP 6-6 Attoyac Bayou Aerial Imagery



MAP 6-7 Attoyac Bayou Area Land Cover



MAP 6-8 Attoyac Bayou Area Soils



Description of Water Quality Issues

Site-Specific Uses and Criteria

Attoyac Bayou has a designated Public Water Supply use and a High ALU and corresponding DO criteria. Attoyac Bayou also has a designated contact recreation use with a corresponding *E. coli* geometric mean criteria of 126 MPN/100 mL.

Impairments and Concerns

Attoyac Bayou (Segment 0612) is listed on the 2012 303(d) List for not supporting contact recreation due to bacteria impairments. All three Assessment Units are listed as category 5b, and were first listed in 2004.

In AU 0612_01, the geometric mean for *E. coli* exceeded the standard of 126 MPN/100 mL with a value of 235.67 MPN/100 mL, based upon 35 samples assessed.

In AU 0612_02, the geometric mean for *E. coli* exceeded the standard of 126 MPN/100 mL with a value of 234.00 MPN/100 mL, based upon 48 samples assessed. This AU also had a concern for dissolved oxygen grab screening level, with 6 of 46 values below the screening level of 5.0 mg/L. A concern for ammonia was also identified for this AU, with 14 of 48 samples exceeding the nutrient screening level of 0.33 mg/L.

In AU 0612_03, the geometric mean for *E. coli* exceeded the standard of 126 MPN/100 mL with a value of 288.18 MPN/100 mL, based upon 60 samples assessed. This AU also had a concern for dissolved oxygen grab screening level, with 11 of 33 values below the screening level of 5.0 mg/L. A concern for ammonia was also identified for this AU, with 17 of 37 samples exceeding the nutrient screening level of 0.33 mg/L.

TABLE 6-8 Impairments in Segment 0612 as listed in the 2012 Texas Integrated Report

Segment Name	Segment ID	Assessment Unit	Impairments	Category	Date First Listed
Attoyac Bayou	0612	0612_01	Bacteria	5b	2004
		0612_02	Bacteria	5b	2004
		0612_03	Bacteria	5b	2004

TABLE 6-9 Concerns for Use Attainment and Screening Levels in Segment 0612 as listed in the 2012 Texas Integrated Report

Segment Name	Segment ID	Assessment Unit	Concerns	Level of Concern
Attoyac Bayou	0612	0612_02	Ammonia	CS
			Depressed Dissolved Oxygen	CS
		0612_03	Ammonia	CS
			Depressed Dissolved Oxygen	CS

Potential Causes of Water Quality Issues

Point Sources

There are numerous point sources within the watershed, including WWTPs for the City of Garrison and Martinsville ISD. Several municipal solid waste sites also reside within the basin.

Non-Point Sources

As much of the watershed is in the unincorporated portion of the county, On-Site Sewage Facilities (OSSFs) are prevalent in the watershed. Failing OSSFs may be a contributing factor to bacterial impairments.

Livestock and poultry operations may be contributing factors to both bacterial impairments and nutrient concerns, although preliminary data from Bacterial Source Tracking (BST) analysis conducted as part of the Attoyac Bayou WPP project would suggest that their contribution to bacterial impairments is minimal in relation to other non-point sources.

The area is largely rural. The likelihood of wildlife contributing to increased *E. coli* bacteria levels is significant. Deer, feral hogs, and domestic livestock may contribute to bacteria in the segment. Based upon preliminary data from the Attoyac Bayou WPP project, feral hogs have been identified as a primary source of bacterial contamination. Stakeholders from the Attoyac Bayou Partnership have indicated that there is a significant problem with feral hogs in this watershed.

Additional studies are necessary to determine the cause of bacterial impairments and nutrient sources. An RUAA has been completed, and the data is being evaluated to determine if the appropriate contract recreation criteria is being applied to the water body.

Additional studies involving the collection of 24-hr dissolved oxygen samples are also needed to further evaluate the dissolved oxygen concerns.

Potential Stakeholders

- Local Municipalities (Cities of Garrison, Timpson, Chireno, and Martinsville)
- Attoyac Bayou Partnership
- Landowners
- Poultry and Cattle operations
- Texas Water Resources Institute
- AgriLife Extension
- Texas State Soil and Water Conservation Board
- Texas Commission on Environmental Quaity
- Natural Resource Conservation Service
- Texas Department of Agriculture
- Texas Railroad Commission
- Texas Parks and Wildlife
- US Geological Survey
- US Fish and Wildlife Service

Recommended Actions

ANRA is currently conducting routine monitoring in this segment at multiple monitoring stations. Additional monitoring stations will be added in this watershed in FY 14, including monitoring stations at West Creek at 2913 (Monitoring Station 20845, previously sampled as part of the Attoyac Bayou WPP project) and the main pool of Lake Naconiche. The West Creek sampling site will increase the monitoring in the Attoyac Bayou and allow us to more effectively monitor the effectiveness of BMPs implemented as part of the Attoyac Bayou WPP. The Lake Naconiche main pool has not previously been monitored on a routine basis, so adding this station will allow for the collection of data and future assessment of this water body.

ANRA has also been granted authority by TCEQ to regulate On-Site Sewage Facilities (OSSF) in the unincorporated portion of San Augustine County, including the areas in that portion of the Attoyac Bayou watershed. On-site reconnaissance of OSSFs and mapping of complaint investigations can possibly identify failing systems for replacement, reducing a nonpoint source of bacteria. To assist with this goal, ANRA applied for and received funding through TCEQ as part of the FY 13 Federal Clean Water Act § 319 Non-Point Source grant program to initiate a mapping project of septic systems around Sam Rayburn Reservoir and the unincorporated portion of San Augustine County. A component of this project will also include identification and replacement of failing OSSFs in the Attoyac Bayou watershed in both San Augustine and Nacogdoches Counties during Year 2 (FY 15) of the project. Also during Year 2, additional monitoring will be conducted on the Attoyac Bayou and its tributaries within the lower portion of the watershed to address not only the effectiveness of BMPs implemented as part of the WPP but also the effective reduction in bacterial loading from replacing failing OSSFs in the watershed. The 319 Grant project is scheduled to begin in September 2013.

As part of the Attoyac Bayou WPP project, a RUAA has been completed to determine the recreational uses of this water body. Additionally, bacterial source tracking has been utilized to determine the source of bacteria. The outcome of these studies have yet to be determined, but will be incorporated into the Watershed Protection Plan being developed as part of a Federal Clean Water Act § 319 Non-Point Source Program grant administered by the TSSWCB.

Concerns for dissolved oxygen are based upon grab samples, but 24-hr sampling is needed to further evaluate if the water quality standard is appropriate or if there is indeed a water quality problem that is resulting in decreased dissolved oxygen levels. Dissolved oxygen levels in East Texas can typically be low (below 5.0 mg/L) while still sustaining a diverse biological community.

Ongoing Projects

Development of a Watershed Protection Plan for Attoyac Bayou

The Development of a Watershed Protection Plan for Attoyac Bayou project collected additional water quality and stream flow data to help develop a better understanding of *E. coli* loadings in the water body. Local stakeholder input helped facilitate the accurate identification of *E. coli* sources in the watershed. The project is currently in the process of developing an effective watershed protection plan to restore water quality.

Project Goals and Objectives

- To assess the current water quality conditions and impairments in the Attoyac Bayou watershed through targeted water quality sampling and analysis
- To conduct a watershed source survey and develop a comprehensive GIS inventory
- To analyze water quality data using Load Duration Curves and spatially explicit modeling
- To conduct bacterial source tracking and evaluate the sources of *E. coli* present in the watershed that are actually contributing to the Bayou's bacteria load
- To conduct a Recreational Use Attainability Analysis to determine the most appropriate water quality standard for the Attoyac Bayou
- To establish and provide direction for a stakeholder group that will serve as a decision making body in the assessment of the Attoyac Bayou and facilitate the development of a Watershed Protection Plan (WPP).

In July 2010, Stephen F. Austin State University (SFASU) field personnel began collecting surface water samples and submitting them to the ANRA Environmental Laboratory for analysis of nutrients and bacteria.

A subset of samples was sent to Texas A&M University for bacterial source tracking analysis. Sampling was performed biweekly at 10 routine stations, quarterly at 4 wastewater treatment facilities, and at 2 sites, additional stormwater sampling occurs in response to rainfall events. Sampling was occasionally sporadic due to prolonged drought conditions. Laboratory and field data from the study was submitted to TSSWCB for inclusion in the TCEQ's Surface Water Quality Monitoring Information System (SWQMIS).

As of July 2013, the Watershed Protection Plan is in the process of being developed and finalized.

The Development of a Watershed Protection Plan for Attoyac Bayou project is a collaborative effort by several partner agencies. Funding for the project is provided by the Texas State Soil and Water Conservation Board (TSSWCB) through a Clean Water Act, Section 319(h) grant from the U.S. Environmental Protection Agency (EPA).

Partner agencies for the project include the Texas Water Resources Institute (TWRI), AgriLife Research & Extension, Stephen F. Austin State University (SFASU), the Angelina & Neches River Authority, and Castilaw Environmental Services, LLC.

The project website is http://attoyac.tamu.edu. The project website includes links to download project documents, including the draft RUAA document and draft sections of the Watershed Protection Plan.

Major Watershed Events

As part of the Attoyac Bayou WPP project, intensive monitoring was conducted in the Attoyac Bayou watershed for a two-year period. During this timeframe, East Texas was experiencing a severe drought, and it has not yet been determined how this will be addressed in regards to assessment of the data by TCEQ's Surface Water Quality Monitoring (SWQM) program. All data collected was submitted to SWQMIS.

Also as part of this project, a RUAA was conducted in 2012. Because very few signs of contact recreation were observed, it is possible that the segment may need to be reclassified from primary contact recreation to secondary contact recreation. If the segment is reclassified, the bacteria geometric means are below the current criterion for secondary contact recreation (630 MPN/100 mL). Following a reclassification, the segment should no longer be considered impaired for bacteria and would therefore be removed from the 303(d) list.

WATERSHED CHARACTERIZATION
Segment 0610 – Sam Rayburn Reservoir

Sam Rayburn Reservoir at SH 147 Bridge

Segment Description

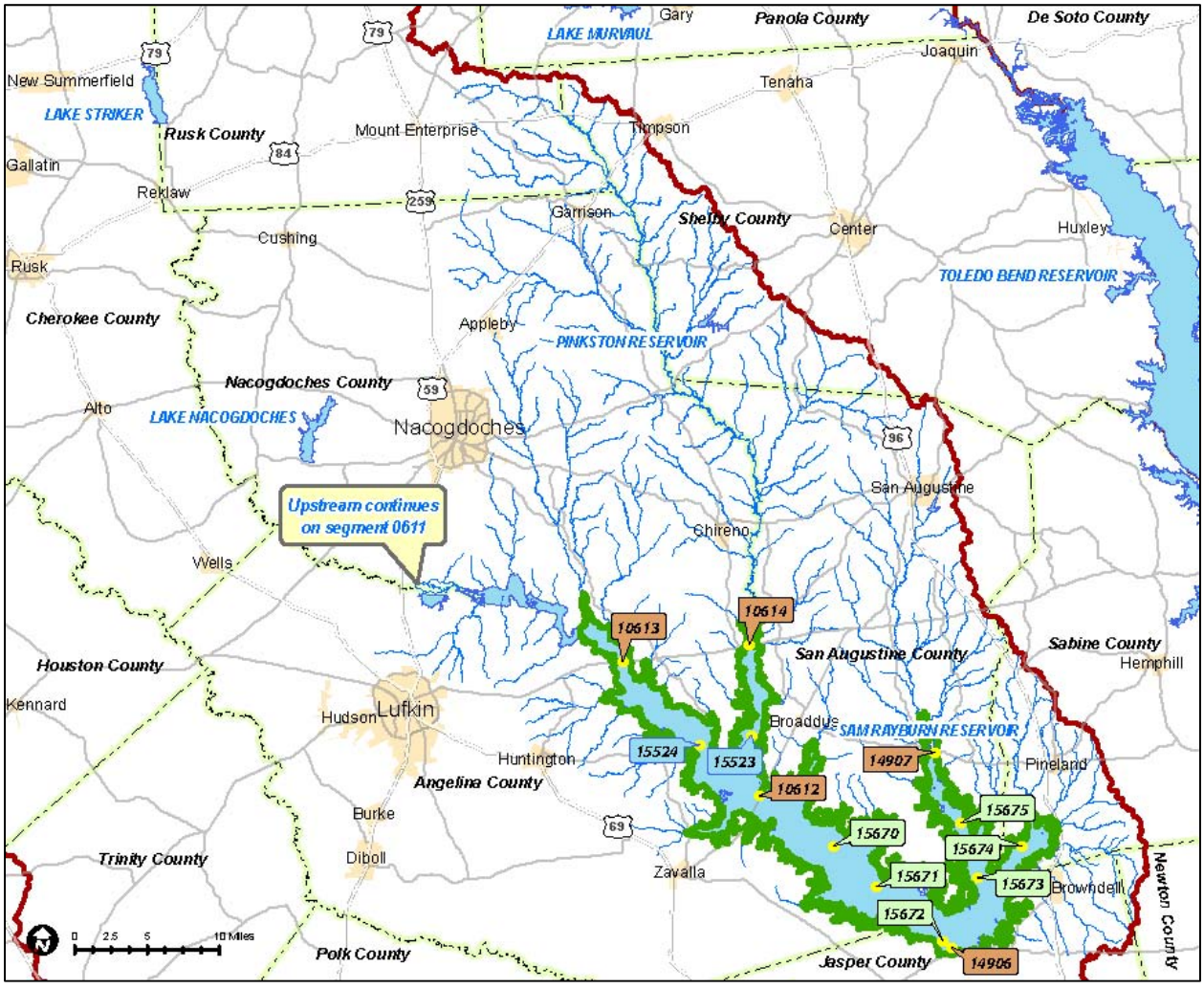
The Sam Rayburn watershed is 491,388 acres, of which approximately 108,129 acres (22%) is reservoir surface.

Sam Rayburn Reservoir (Segment 0610) includes the area from Sam Rayburn Dam in Jasper County to a point 5.6 kilometers (3.5 miles) upstream of Marion's Ferry on the Angelina River Arm in Angelina/Nacogdoches County and to a point 3.9 km (2.4 miles) downstream of Curry Creek on the Attoyac Bayou Arm in Nacogdoches/San Augustine County, up to the normal pool elevation of 164.4 feet (except on the Angelina River Arm). Sam Rayburn Reservoir impounds both the Angelina River and Attoyac Bayou.

Sam Rayburn Reservoir is designed to control and regulate floods, generate hydroelectric power, and conserve water for municipal, industrial, agricultural, and recreational purposes. The designated uses are general use, high aquatic life use, public water supply use, primary contact recreation, and fish consumption. Located around Sam Rayburn are various contact recreational areas including trails, campgrounds, boating ramps, marinas, designated swimming areas, and group areas.

Multiple locations within Sam Rayburn Reservoir are listed on the 303(d) list due to the presence of mercury (Hg) in edible fish tissue.

MAP 7-1 Sam Rayburn Segment Map

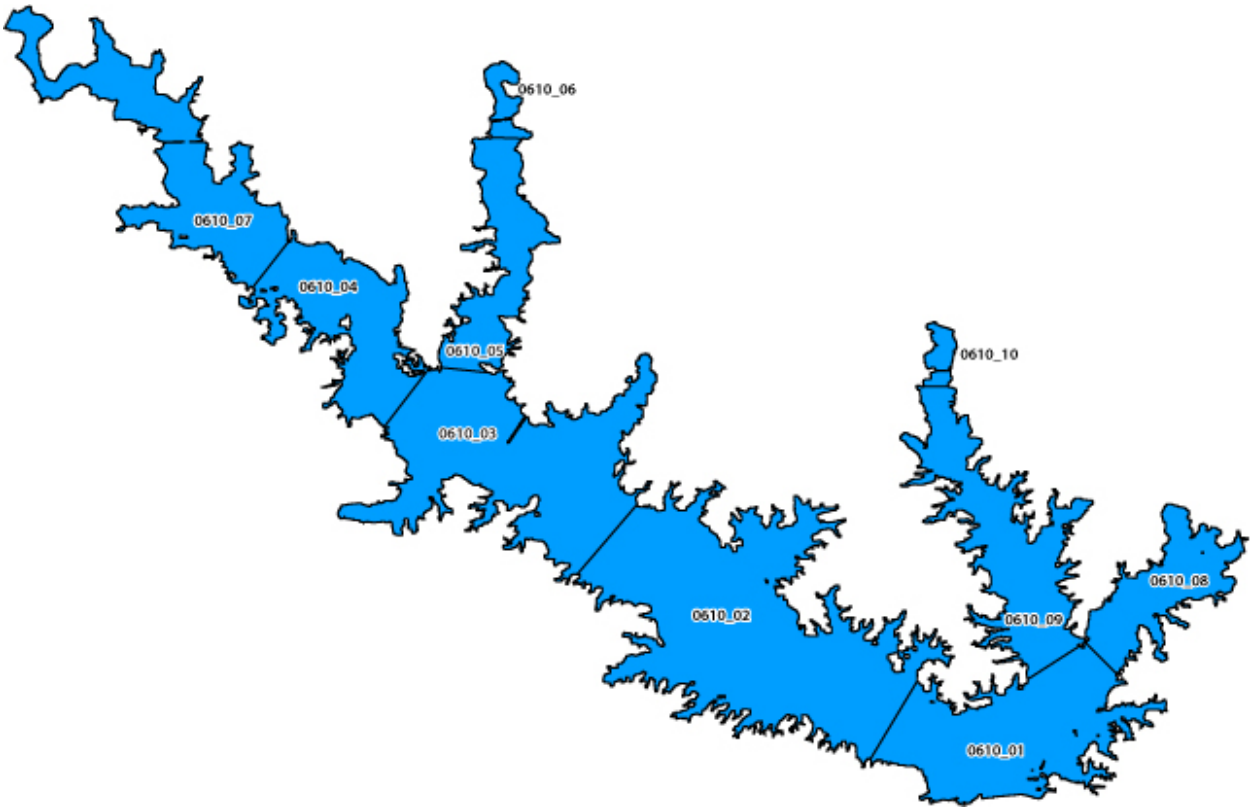


Assessment Units

Sam Rayburn Reservoir is split into 10 assessment units for monitoring and assessment purposes.

TABLE 7-1 Assessment Units in the Sam Rayburn Reservoir (Segment 0610)			
Assessment Unit (AU) ID	**Description**	**Acres**	**Square Miles**
0610_01	Sam Rayburn main pool by the dam to the Bear Creek and Ayish Arms	13,892.6	21.7
0610_02	Sam Rayburn lower Angelina River arm	27,963.1	43.7
0610_03	Sam Rayburn mid-Angelina River arm (area around SH 147)	18,722.2	29.3
0610_04	Sam Rayburn upper mid-Angelina River arm	9,258.2	14.5
0610_05	Sam Rayburn lower Attoyac Bayou arm	6,605.8	10.3
0610_06	Sam Rayburn upper Attoyac Bayou arm	1,136.0	1.8
0610_07	Sam Rayburn upper Angelina arm	12,038.1	18.8
0610_08	Sam Rayburn Bear Creek arm	6,225.8	9.7
0610_09	Sam Rayburn lower Ayish Bayou arm	11,202.1	17.5
0610_10	Sam Rayburn upper Ayish Bayou arm	808.3	1.3

FIGURE 7-1 Sam Rayburn Segment Assessment Units



Monitoring Stations

There are numerous monitoring stations on Sam Rayburn Reservoir, with monitoring currently or historically being conducted by the Angelina & Neches River Authority, Lower Neches Valley Authority (LNVA), TCEQ Region 10, and the United States Geological Survey (USGS).

TABLE 7-2 Monitoring Stations in Sam Rayburn Reservoir (Segment 0610) by Assessment Unit

Assessment Unit (AU) ID	Monitoring Station ID	Description	Monitoring Entity
0610_01	14906	SAM RAYBURN RESERVOIR AT MAIN POOL APPROXIMATELY 0.70 KM NORTH OF THE POWER PLANT INTAKE AT REC RD 255/ANGELINA RIVER	TCEQ Region 10
0610_02	15671	SAM RAYBURN RESERVOIR USGS SITE FC 7.21 KM SOUTHWEST OF FM 3173/FM 705 INTERSECTION	LNVA
0610_02	15670	SAM RAYBURN RESERVOIR USGS SITE GC 9.84 KM SOUTHEAST OF SH 147 6.56 KM NORTHEAST OF FM 2743/ FM 3373 INTERSECTION	LNVA
0610_03	10612	SAM RAYBURN RESERVOIR AT SH 147 BRIDGE 9.75 KM SOUTHWEST OF BROADDUS AND 12.4 KM NORTHEAST OF ZAVALLA	TCEQ Region 10
0610_04	15524	SAM RAYBURN RESERVOIR NEAR SHIRLEY CREEK IN THE ANGELINA RIVER CHANNEL 5.13 KM NE OF FM 2109/ FM 2801 INTERSECTION	ANRA
0610_05	15523	SAM RAYBURN RESERVOIR ADJACENT TO ALLIGATOR COVE IN THE ATTOYAC RIVER CHANNEL 3.94 KM NORTHWEST OF FM 3185/ SH 147 INTERSECTION	ANRA
0610_06	10614	SAM RAYBURN RESERVOIR WEST SHORE AT SH 103 6.6 MILES EAST OF ETOILE	TCEQ Region 10
0610_07	21100	SAM RAYBURN RESERVOIR ON ANGELINA RIVER CHANNEL 0.75 KM DOWNSTREAM OF MARIONS FERRY BOAT RAMP 4.2 KM NORTH AND 2.2 KM EAST OF FM 1669/ SH 103 INTERSECTION NEAR LUFKIN	ANRA
0610_07	10613	SAM RAYBURN RESERVOIR AT SH 103 3.73 KM WEST-SOUTHWEST OF ETOILE	TCEQ Region 10
0610_08	15674	SAM RAYBURN RESERVOIR USGS SITE LC 1.7 KM NORTHWEST OF MILL CREEK PARK SWIMMING AREA 3.96 KM NW OF ST LOOP 149/ US 96 INTERSECTION	LNVA
0610_09	15673	SAM RAYBURN RESERVOIR USGS SITE AC 2.5 KM EAST NORTHEAST OF FM 705/FM 3127 INTERSECTION	LNVA
0610_09	15675	SAM RAYBURN RESERVOIR USGS SITE MC 4.86 KM EAST NORTHEAST OF FM 3173/FM 705 INTERSECTION 8.8 KM DOWNSTREAMM OF FM 83	LNVA
0610_10	14907	SAM RAYBURN RESERVOIR AT FM 83 BRIDGE CROSSING 13.5 KM WEST OF PINELAND	TCEQ Region 10

Monitoring stations (both current and historical) as listed in SWQMIS are included in the following table. Stations that are currently being monitored are listed in **BLUE**.

TABLE 7-3 Current and Historical Monitoring Stations in Sam Rayburn Reservoir (Segment 0610)				
Station ID	**Short Description**	**Long Description**	**Sample Count** (as of 6/2013)	**Last Sampled Date**
10611	SAM RAYBURN INTAKE STRUCTURE	SAM RAYBURN RESERVOIR IN POWERHOUSE INTAKE STRUCTURE OF DAM 7.2 KM NORTHEAST OF SH 63/REC RD 255 INTERSECTION	12	5/1/1987
10612	**SAM RAYBURN RESERVOIR AT SH147**	**SAM RAYBURN RESERVOIR AT SH 147 BRIDGE 9.75 KM SOUTHWEST OF BROADDUS AND 12.4 KM NORTHEAST OF ZAVALLA**	**730**	**3/6/2013**
10613	**SAM RAYBURN RESERVOIR AT SH103**	**SAM RAYBURN RESERVOIR AT SH 103 3.73 KM WEST-SOUTHWEST OF ETOILE**	**827**	**3/5/2013**
10614	**SAM RAYBURN RESERVOIR AT SH103**	**SAM RAYBURN RESERVOIR WEST SHORE AT SH 103 6.6 MILES EAST OF ETOILE**	**154**	**3/5/2013**
10615	SAM RAYBURN RES AT MARIONS	SAM RAYBURN RESERVOIR AT MARIONS FERRY 3.08 KM NORTH OF FM 1669/ SH 103 INTERSECTION	48	3/18/2011
10616	SAM RAYBURN RES AT PIPELINE	SAM RAYBURN RESERVOIR AT PIPELINE 4.71 KM UPSTREAM OF MARIONS FERRY	10	8/31/1989
14906	**SAM RAYBURN RES AT MAIN POOL**	**SAM RAYBURN RESERVOIR AT MAIN POOL APPROXIMATELY 0.70 KM NORTH OF THE POWER PLANT INTAKE AT REC RD 255/ANGELINA RIVER**	**362**	**3/6/2013**
14907	**SAM RAYBURN RESERVOIR AT FM 83**	**SAM RAYBURN RESERVOIR AT FM 83 BRIDGE CROSSING 13.5 KM WEST OF PINELAND**	**160**	**3/5/2013**
15451	TWIN DIKES MARINA AT SAM RAYBU	SAM RAYBURN RESERVOIR AT TWIN DIKES MARINA IN ALLIGATOR CREEK COVE 1.47 KM NW OF INTERSECTION OF RR 255 AND FM 1007	0	n/a
15522	SAM RAYBURN NR VEACH BASIN	SAM RAYBURN RESERVOIR NEAR VEACH BASIN IN THE ANGELINA RIVER CHANNEL 7.3 KM EAST OF FM 3373/FM2743 INTERSECTION	70	5/30/2007
15523	**SAM RAYBURN NR ALLIGATOR COVE**	**SAM RAYBURN RESERVOIR ADJACENT TO ALLIGATOR COVE IN THE ATTOYAC RIVER CHANNEL 3.94 KM NORTHWEST OF FM 3185/ SH 147 INTERSECTION**	**79**	**9/20/2012**
15524	**SAM RAYBURN AT SHIRLEY CREEK**	**SAM RAYBURN RESERVOIR NEAR SHIRLEY CREEK IN THE ANGELINA RIVER CHANNEL 5.13 KM NE OF FM 2109/ FM 2801 INTERSECTION**	**91**	**9/20/2012**
15525	SAM RAYBURN AT KINGTOWN	SAM RAYBURN RESERVOIR AT KINGTOWN APPROXIMATELY 0.28 MI UPSTREAM OF THE ANGELINA RIVER CHANNEL IN CARIZZO BAYOU	14	8/20/1996
15526	SAM RAYBURN NR NEEDMORE POINT	SAM RAYBURN RESERVOIR BETWEEN NEEDMORE POINT AND POWELL PARK IN THE AYISH BAYOU CHANNEL 2.66 KM EAST OF FM 3127/FM 705 INTERSECTION	70	5/30/2007
15527	SAM RAYBURN NR MILL CREEK PARK	SAM RAYBURN RESERVOIR 1.46 KM NW OF MILL CK PARK SWIMMING AREA IN THE BEAR CK CHANNEL 2.6 KM NW OF ST LOOP149/ST SPUR165 INTERSECTION	74	8/13/2008
15666	SAM RAYBURN RESERVOIR SITE NC	SAM RAYBURN RESERVOIR USGS SITE NC 5.62 KM WSW OF FM 1277/SH 147 INTERSECTION EQUIDISTANT BETWEEN SHORES AT POWER LINE CROSSING	73	8/26/1999
15667	SAM RYBURN RESERVOIR SITE IC	SAM RAYBURN RESERVOIR USGS SITE IC 5.8 KM WEST OF FM 1277/SH 147 INTERSECTION 220 M NORTH OF POWER LINE CROSSING	118	8/26/1999
15668	SAM RAYBURN RESERVOIR SITE KC	SAM RAYBURN RESERVOIR USGS SITE KC 220 M SOUTH OF SH 103 3.2 KM WSW OF ETOILE	60	8/25/1999
15669	SAM RAYBURN RESERVOIR SITE JC	SAM RAYBURN RESERVOIR USGS SITE JC 6 KM NORTHEAST OF FM 2109/FM 2801 INTERSECTION 16.41 KM EAST OF CITY OF HUNTINGTON	95	6/9/2006
15670	**SAM RAYBURN RESERVOIR SITE GC**	**SAM RAYBURN RESERVOIR USGS SITE GC 9.84 KM SOUTHEAST OF SH 147 6.56 KM NORTHEAST OF FM 2743/ FM 3373 INTERSECTION**	**135**	**4/12/2012**
15671	**SAM RAYBURN RESERVOIR SITE FC**	**SAM RAYBURN RESERVOIR USGS SITE FC 7.21 KM SOUTHWEST OF FM 3173/FM 705 INTERSECTION**	**152**	**4/12/2012**
15672	SAM RAYBURN RESERVOIR SITE CC	SAM RAYBURN RESERVOIR USGS SITE CC 1.96 KM NORTH NORTHWEST OF POWER PLANT INTAKE STRUCTURE 1.18 KM NORTHEAST OF EBENEZER PARK	166	8/3/2010
15673	**SAM RAYBURN RESERVOIR SITE AC**	**SAM RAYBURN RESERVOIR USGS SITE AC 2.5 KM EAST NORTHEAST OF FM 705/FM 3127 INTERSECTION**	**109**	**4/12/2012**
15674	**SAM RAYBURN RESERVOIR SITE LC**	**SAM RAYBURN RESERVOIR USGS SITE LC 1.7 KM NORTHWEST OF MILL CREEK PARK SWIMMING AREA 3.96 KM NW OF ST LOOP 149/ US 96 INTERSECTION**	**75**	**4/12/2012**
15675	**SAM RAYBURN RESERVOIR SITE MC**	**SAM RAYBURN RESERVOIR USGS SITE MC 4.86 KM EAST NORTHEAST OF FM 3173/FM 705 INTERSECTION 8.8 KM DOWNSTREAMM OF FM 83**	**94**	**4/12/2012**
16784	SAM RAYBURN AT SAN AUGUSTINE	SAM RAYBURN RESERVOIR AT SAN AUGUSTINE PARK SWIMMING AREA 5.77 KM SOUTH OF FM 83/FM 1751 INTERSECTION	35	7/2/2001
16785	SAM RAYBURN AT EAST END	SAM RAYBURN RESERVOIR AT EAST END SWIMMING AREA 3.58KM EAST OF POWERHOUSE INTAKE STRUCTURE3.2KM W OF FM 1007/REC RD 255 INTERSECTION	41	7/2/2001
16786	SAM RAYBURN AT EBENEZER PARK	SAM RAYBURN RESERVOIR AT EBENEZER PARK SWIMMING AREA 1.56 KM NORTHWEST OF POWER PLANT INTAKE KM NE OF SH 63/REC RD 255 INTERSECTION	41	7/2/2001
16787	SAM RAYBURN AT MILL CREEK PARK	SAM RAYBURN RESERVOIR AT MILL CREEK PARK SWIMMING AREA 2.7 KM EAST NORTHEAST OF US 96 AND ST LOOP 149 INTERSECTION IN BROOKLAND	41	7/2/2001
16788	SAM RAYBURN AT ETOILE PARK	SAM RAYBURN RESERVOIR AT ETOILE PARK BOAT RAMP 420 M NORTH OF SH 103 1.9 MILES WEST OF CITY OF ETOILE	10	8/13/1999
16790	SAM RAYBURN AT CASSEL-BOYKIN	SAM RAYBURN RESERVOIR AT CASSEL-BOYKIN PARK BOAT RAMP 1.48 KM NORTHWEST OF SH 147/FM 3123 INTERSECTION	10	8/13/1999
16791	SAM RAYBURN AT JACKSON HILL	SAM RAYBURN RESERVOIR AT JACKSON HILL MARINA SWIMMING AREA 1.5MI NORTHWEST OF SH 147 AND FM 2851 INTERSECTION	39	7/2/2001
16792	SAM RAYBURN AT HANKS CREEK	SAM RAYBURN RESERVOIR AT HANKS CREEK PARK BOAT RAMP AT END OF FM 2801 10.3MI EAST OF CITY OF HUNTINGTON	10	8/13/1999
16793	SAM RAYBURN AT SHIRLEY CREEK	SAM RAYBURN RESERVOIR AT SHIRLEY CREEK MARINA BOAT RAMP 5.6MI SOUTHEAST OF FM226 AND SH103 INTERSECTION IN ETOILE	11	8/13/1999
21100	**SAM RAYBURN RESERVOIR ON ANGELINA RIVER CHANNEL 0.75 KM DOWNSTREAM OF MARIONS FERRY BOAT RAMP**	**SAM RAYBURN RESERVOIR ON ANGELINA RIVER CHANNEL 0.75 KM DOWNSTREAM OF MARIONS FERRY BOAT RAMP 4.2 KM NORTH AND 2.2 KM EAST OF FM 1669/ SH 103 INTERSECTION NEAR LUFKIN**	**6**	**9/20/2012**

Hydrologic and Land Use Characteristics

The Sam Rayburn watershed encompasses 491,338 acres (767.7 square miles) and includes portions of six counties: San Augustine, Sabine, Newton, Nacogdoches, Jasper, and Angelina Counties.

There are five incorporated cities in the watershed. The Cities of Pineland, Browndell, and Broaddus are completely within the watershed. The Cities of Huntington and Zavalla are only partially within the watershed. Broaddus is 296 acres, Browndell is 1,550 acres, and Pineland is 1,241 acres. The City of Huntington has 1,724 total incorporated acres, with 643 acres of the northern side of the city located within the Sam Rayburn watershed. The City of Zavalla has 1,339 total incorporated acres, with 39 acres of the northernmost edge and 38 acres of the easternmost edge located within the watershed.

TABLE 7-4 Area of Sam Rayburn Watershed by County

County	Acres	Square Miles
San Augustine	157,035	245.4
Sabine	60,433	94.4
Newton	4,115	6.4
Nacogdoches	93,028	145.4
Jasper	44,541	69.6
Angelina	132,186	206.5
TOTAL	491,338	767.7

Based upon 2010 census data, there are 10,096 households within the watershed, with a population of 15,600.

Rainfall in the Sam Rayburn watershed from 1971 - 2000 ranged from a minimum of 53.1 inches to a maximum of 56.7 inches. For the period of 1981 - 2010, rainfall varied from a minimum of 50.6 inches to a maximum of 56.4 inches.

There are 20 permitted discharges in Segment 0610 (and Segment 0610A, which flows to 0610).

TABLE 7-5 Permitted WWTP Discharges in Segment 0610

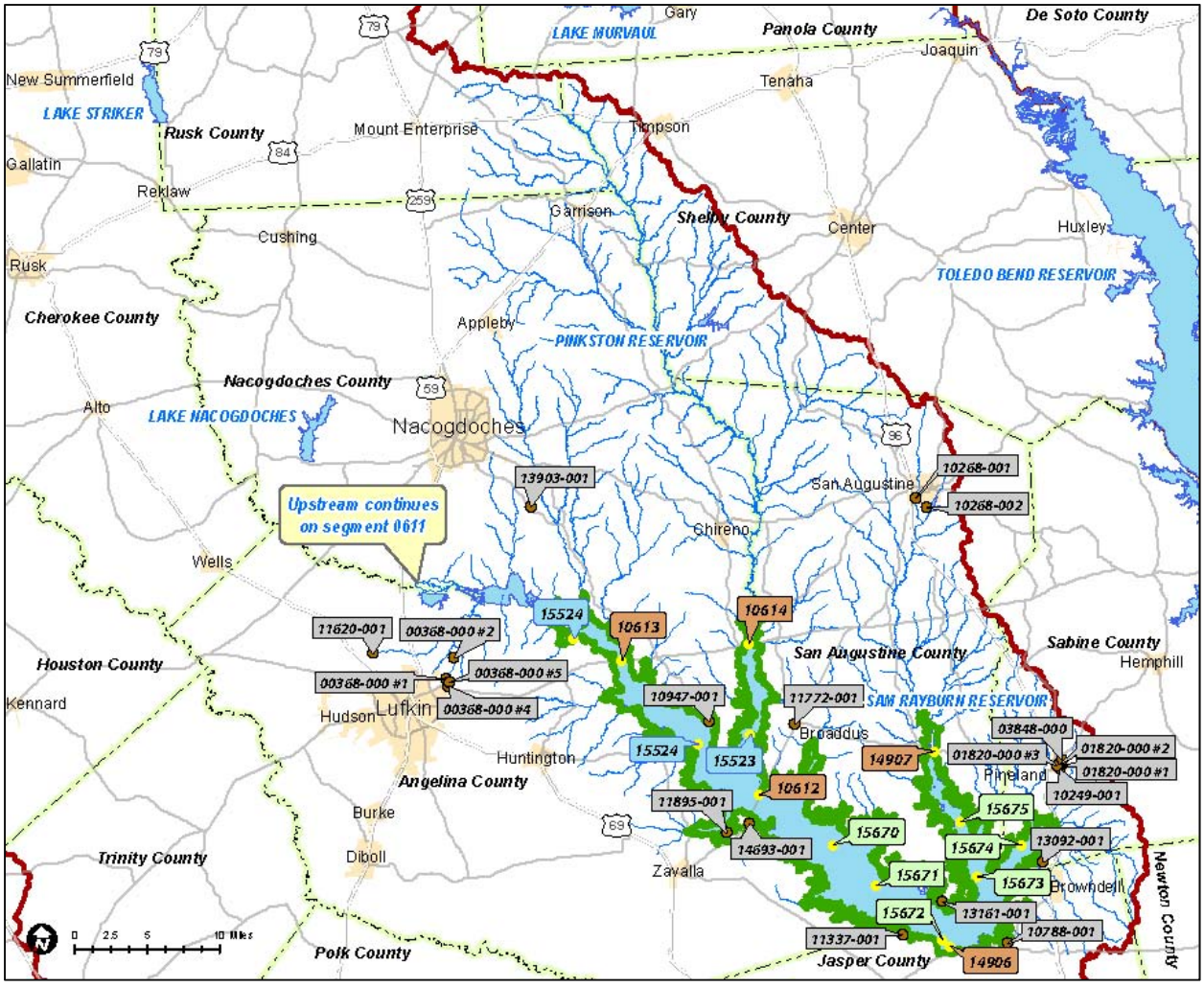
Segment ID	Permittee Name (Outfall)	TPDES Permit No.
0610	Donohue Industries Inc. (001) – Transferred to Verdant Industries	00368-000
0610	Donohue Industries Inc. (002) – Transferred to Verdant Industries	00368-000
0610	Donohue Industries Inc. (004) – Transferred to Verdant Industries	00368-000
0610	Donohue Industries Inc. (005) – Transferred to Verdant Industries	00368-000
0610	Temple-Inland Forest Products Corp (001) – Stormwater	01820-000
0610	Temple-Inland Forest Products Corp (002) – Stormwater	01820-000
0610	Temple-Inland Forest Products Corp (003) – Stormwater	01820-000
0610	TIN Inc	03848-000
0610	City of Pineland	10249-001
0610	Westwood WSC	11337-001
0610	Angelina & Neches River Authority	11620-001
0610	City of Broaddus	11772-001
0610	Texas Airstream Harbor Inc	11895-001
0610	Brookeland ISD	13092-001
0610	Stephen F Austin State University	13161-001
0610	Community Estates Inc	13903-001
0610	Rogers, Gordon Dean	14693-001
0610	Shirley Creek Marina (permit cancelled)	10947-001
0610A	City of San Augustine	10268-001
0610A	Rayburn Country Municipal Utility District	10788-001

Twelve permitted Municipal Solid Waste Sites are located in the Sam Rayburn watershed. However, all MSW sites are listed as closed, post closure, or inactive.

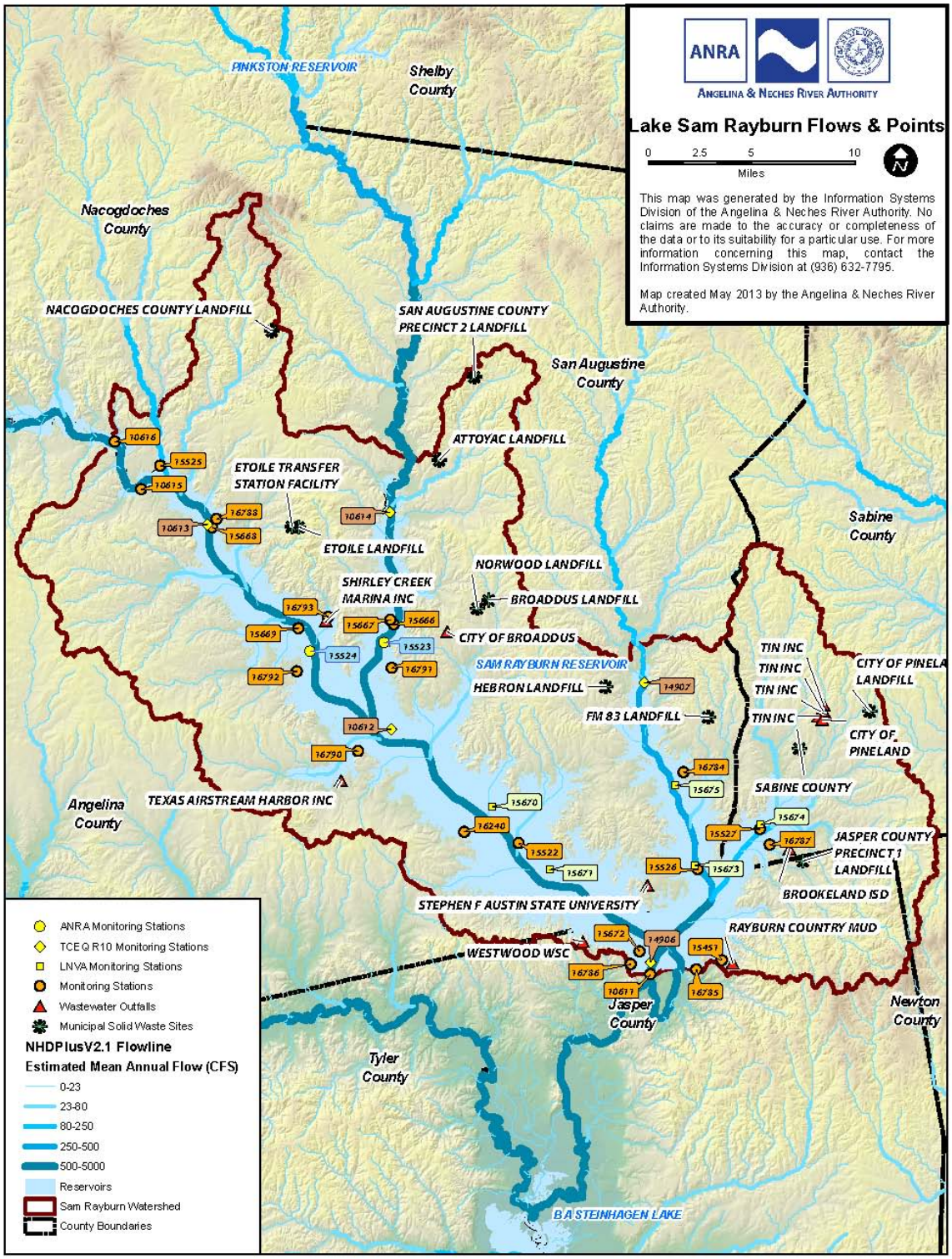
TABLE 7-6 Permitted Municipal Solid Waste Sites in Segment 0610				
TCEQ MSW Permit No.	**Facility**	**Facility Status**	**Permit Status**	**Status Data**
330	City of Pineland Landfill	Closed	Revoked	9/20/1994
865	Attoyac Landfill	Post Closure	Issued	8/25/2008
866	Broaddus Landfill	Closed	Issued	8/25/2008
867	Norwood Landfill	Post Closure	Issued	1/31/2011
870	San Augustine County Precinct 2 Landfill	Closed	Issued	5/3/1976
872	FM 83 Landfill	Post Closure	Issued	3/12/2009
873	Hebron Landfill	Post Closure	Issued	5/10/2013
895	Etoile Landfill	Post Closure	Issued	8/23/1996
896	Nacogdoches County Landfill	Closed	Revoked	8/23/1996
905	Jasper County Precinct 1 Landfill	Closed	Revoked	5/17/1976
1682	Sabine County	Closed	Withdrawn	3/22/1993
40166	Etoile Transfer Station Facility	Inactive	Issued	5/28/2010

The map below shows permitted discharges (by permit number), as well as monitoring stations.

MAP 7-2 Sam Rayburn Permitted Discharges and Monitoring Stations



MAP 7-3 Sam Rayburn Mean Annual Flows, Permitted Facilities, and Monitoring Stations

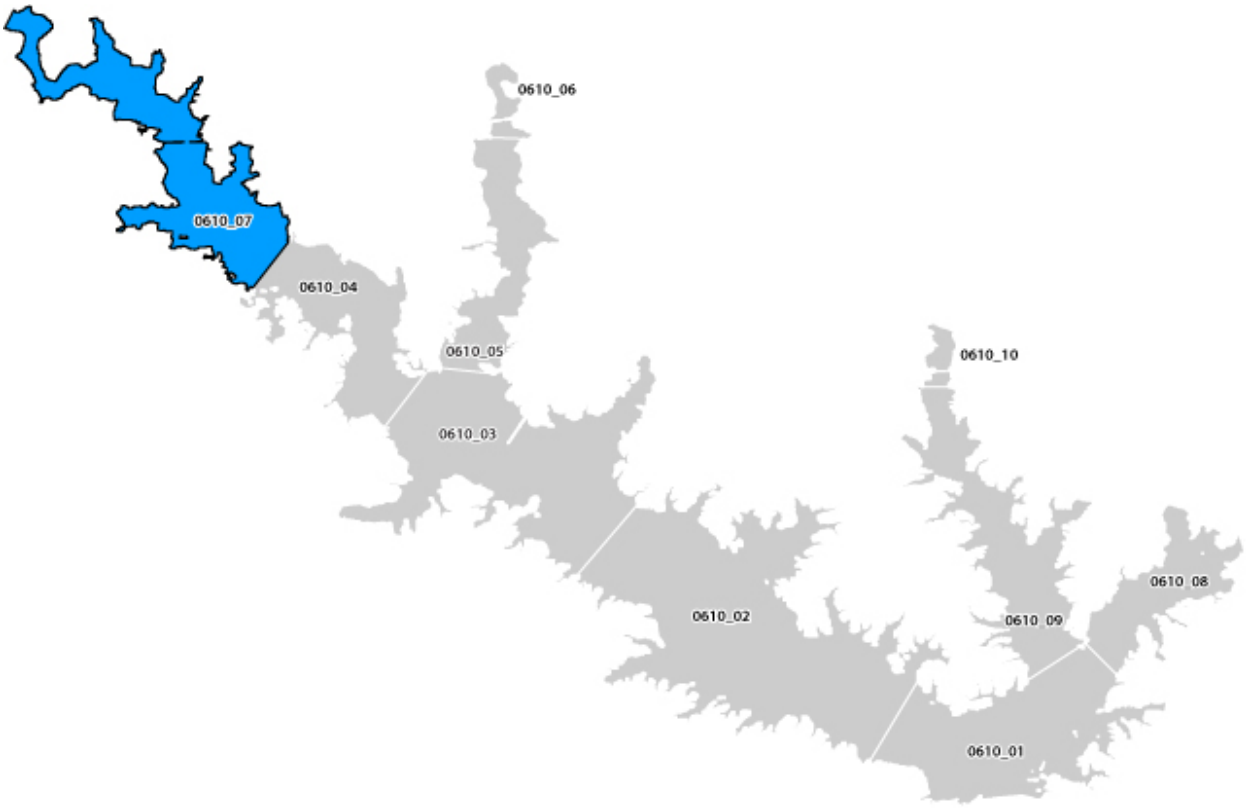


The watershed characterization of Sam Rayburn Reservoir is presented by assessment unit. The assessment units are not presented in numerical order, but are presented beginning upstream and following the path of the Angelina River down to the dam. As the Attoyac Bayou, Ayish Bayou, and Bear Creek arms are reached, they will be discussed, with the Sam Rayburn main pool at the dam presented last.

Assessment Unit 0610_07

Upper Angelina River arm of Sam Rayburn Reservoir

FIGURE 7-2 Sam Rayburn Reservoir Assessment Unit 0610_07



Assessment Unit 0610_07 covers 18.8 sq miles of reservoir surface. It begins approximately 3.3 miles northwest of the Marion's Ferry boat ramp and extends down to approximately 5.3 miles southeast of the SH 103/Angelina River channel crossing. The most upstream and most significant inflow to this AU is segment 0615, the riverine portion of Sam Rayburn Reservoir/Angelina River. Segment 0615 contributes 1,200 CFS to Sam Rayburn Reservoir. Segment 0615 will be further detailed in a future watershed characterization.

Historical Monitoring Station 10616

Approximately 0.25 mile into the AU is a pipeline crossing where sampling has been performed in the past (Historical Monitoring Station 10616). This station was last monitored in 1989.

Inflow from an Unnamed Intermittent Tributary

Approximately 0.75 mile into the AU, an unnamed intermittent tributary from the north drains 1.5 sq miles and contributes 7.8 CFS. Land cover around the tributary is mostly forested. Several drilling pad sites are located in the area near this tributary.

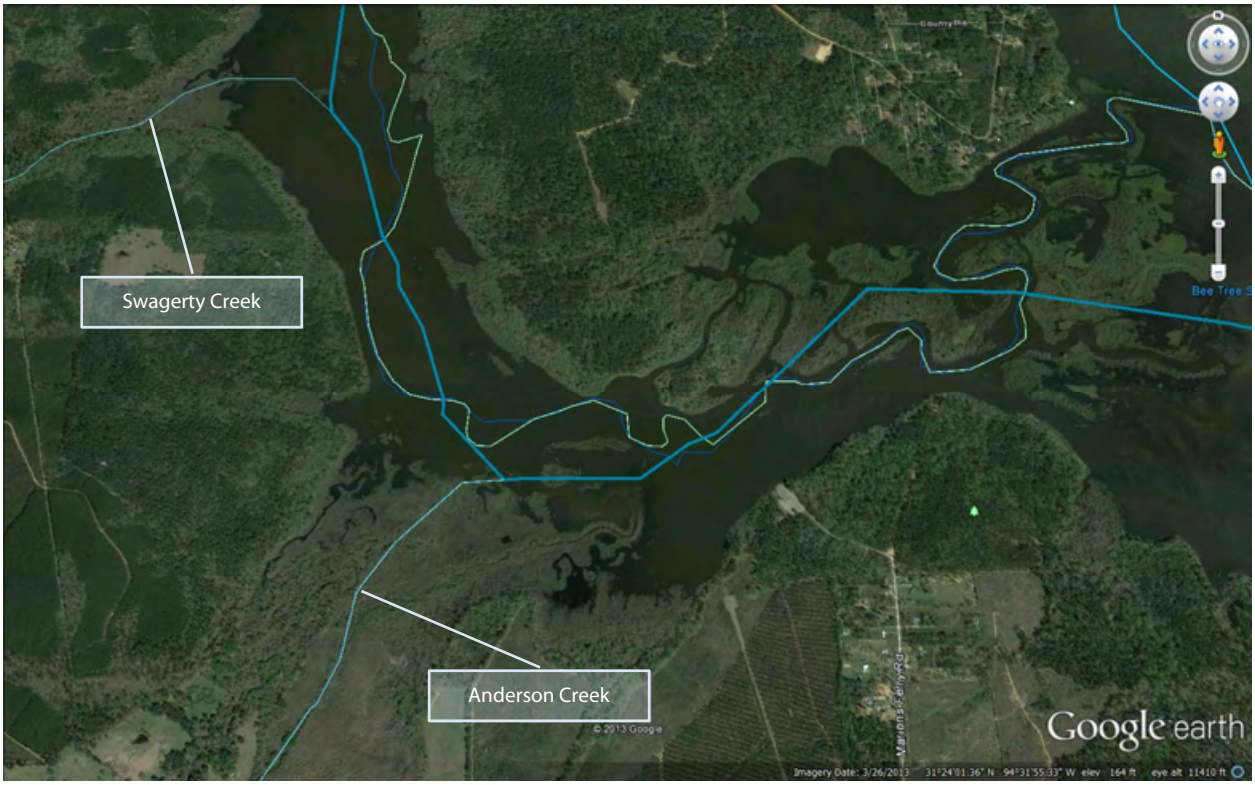
Inflow from Swagerty Creek

Swagerty Creek flows into Sam Rayburn from the south, and is located approximately 1.75 miles into the AU. This perennial stream drains 1.7 sq miles and contributes a flow of 8.4 CFS. Land cover near the stream is mostly forested.

Inflow from Anderson Creek

Anderson Creek flows in from the southwest, approximately 2.8 miles into the AU. draining 12.7 sq miles and contributing 34 CFS. This perennial stream crosses CR 145A and CR 147F. Land cover near flow is mostly forested with the exception of 0.1 mile of open field with no buffer directly downstream of CR 147F.

FIGURE 7-3 Inflow from Swagerty Creek and Anderson Creek



Historical Monitoring Station 10615 – Marion's Ferry Park

Marion's Ferry Park is located 3.7 miles into the AU. Sampling was conducted here in the past (Historical Monitoring Station 10615) but had to be discontinued in 2011 due to extreme drought conditions.

FIGURE 7-4 Marion's Ferry Park

FIGURE 7-5 Historical Monitoring Station 10615- Marion's Ferry Park

Historical Monitoring Station 10615 Sam Rayburn at Marion's Ferry (during drought) 9/22/2011

A 360° panorama of this monitoring station is located at http://www.anra.org/divisions/water_quality/crp/monitoring_sites/10615/10615.html

Monitoring Station 21100 - Sam Rayburn Reservoir on Angelina River Channel Downstream of Marion's Ferry Boat Ramp

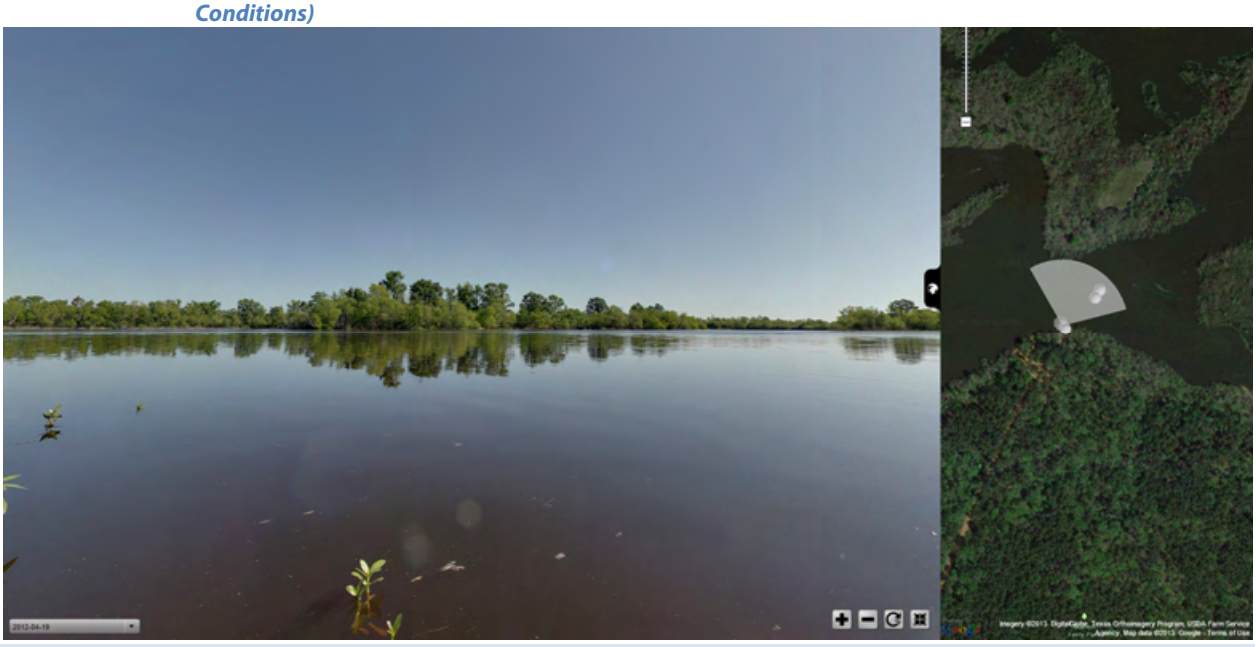
Routine monitoring for this segment by ANRA was relocated from the Marion's Ferry boat ramps to approximately 0.5 mile downstream of the ramps (Monitoring Station 21100). This location is situated directly over the Angelina River channel, so there is typically water present even during drought conditions.

FIGURE 7-6 Monitoring Station 21100 Angelina River Channel Downstream of Marion's Ferry (during Extreme Drought Conditions)

Monitoring Station 20100 Sam Rayburn on Ang. River Channel, downstream of Marion's Ferry 9/22/2011

A 360° panorama of this monitoring station is located at http://www.anra.org/divisions/water_quality/crp/monitoring_sites/21100/21100.html

FIGURE 7-7 Monitoring Station 21100 Angelina River Channel Downstream of Marion's Ferry (during Normal Conditions)



Monitoring Station 20100 Sam Rayburn on Ang. River Channel, downstream of Marion's Ferry 8/8/2012

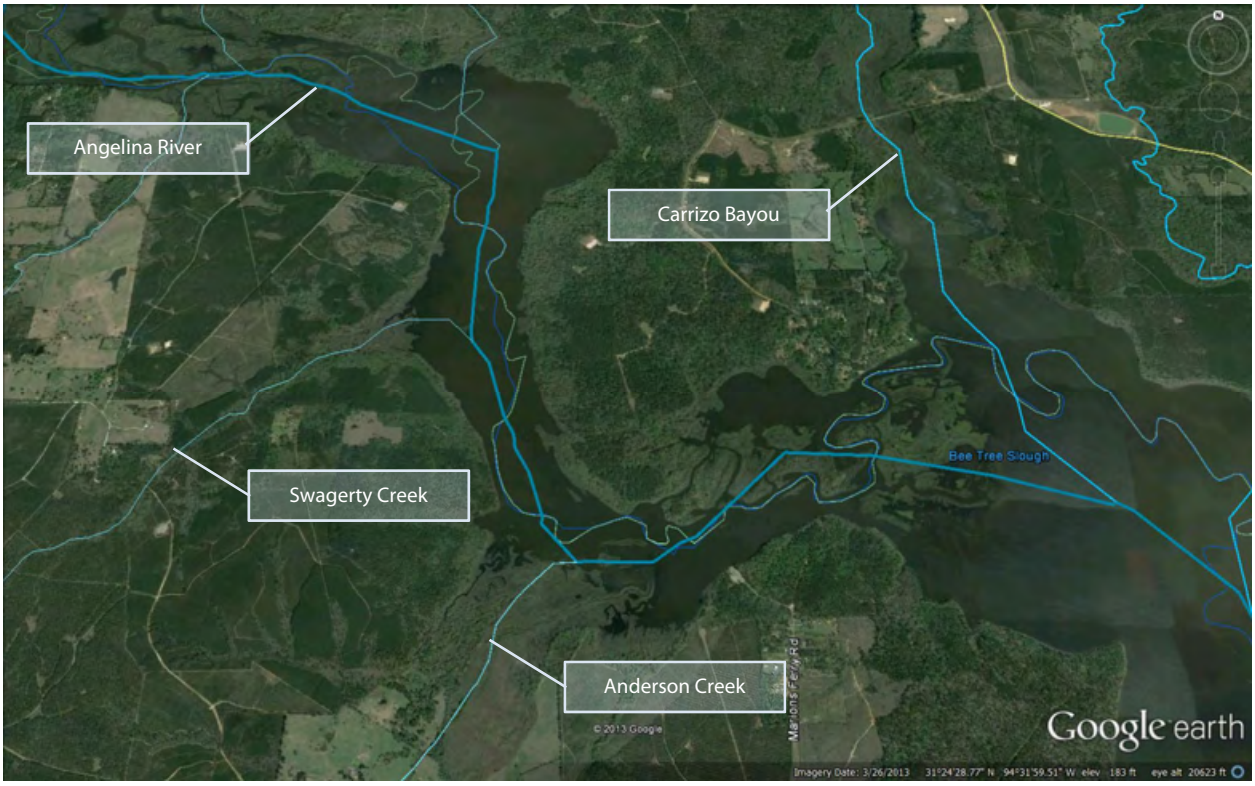
A 360° panorama of this monitoring station is located at http://www.anra.org/divisions/water_quality/crp/monitoring_sites/21100/21100.html

Inflow from Carrizo Bayou

The inflow from Carrizo Bayou is located 5.1 miles into the AU. Carrizo Bayou flows into Sam Rayburn Reservoir from the north, contributing a flow of 157 CFS. The final mile of Carrizo is included in this watershed, and runs through forest, due south, approximately 0.5 miles west of and parallel to FM 226. It crosses CR 552 in Nacogdoches County before draining into the reservoir. The residential neighborhood known as Kingstown is on the eastern bank of the cove created by the inflow from Carrizo. Sampling has been performed in the past in this cove (Historical Monitoring Station 15525). This station was last monitored in 1996.

Carrizo Bayou will be discussed in further detail in a future watershed characterization.

FIGURE 7-8 Inflow from Carrizo Bayou



Inflow from Moss Creek

The inflow from Moss Creek is located approximately 5.7 miles into the AU. This perennial stream flows in from the north, draining an area of 48 sq miles and contributing a flow of 86 CFS. Moss Creek is 18.4 miles long and has its headwaters about half a mile southwest of the intersection of CR 344 and CR 341 in Nacogdoches County. It crosses CR 338, CR 350, SH 21, CR 425, CR 420, and FM 226 on its path to Sam Rayburn Reservoir. Above SH 21, land cover is a mixture of forest and narrow forested buffer bordered by open fields. Below SH 21, land cover is mostly forest. Moss Creek has three perennial tributaries:

Rector Creek:	Flows from the northwest, beginning just below SH 21 near a suburban residential area, draining 5.2 sq miles, and contributing 20.2 CFS.
Lick Creek:	Flows from the northeast, beginning near the intersection of CR 434 and CR 433, draining 6.3 sq miles and contributes 23.2 CFS. The Nacogdoches County Landfill (TCEQ MSW permit no. 896) is located within its drainage area.
Oil Springs Branch:	Flows from the north, draining 4.6 sq miles and contributing 17.7 CFS.

Inflow from Lavaca Creek

Located 7.2 miles into the AU and 0.75 miles upstream of SH 103 is the confluence with Lavaca Creek. Lavaca Creek flows in from the north, draining an area of 6 sq miles and contributing a flow of 22 CFS. The drainage area is approximately 40% open fields, but land cover near the flow is forested. The Angelina National Forest encompasses 64 acres of the drainage area.

FIGURE 7-9 Inflows from Moss Creek and Lavaca Creek

Monitoring Station 10613 - SH 103 Crossing

State Hwy 103 crosses Sam Rayburn Reservoir 7.9 miles into the AU. Sampling is performed quarterly here by TCEQ Region 10 (Monitoring Station 10613). On the northeast side of the SH 103 crossing is Etoile Park, where sampling has been performed in the past (Historical Monitoring Stations 16788). Sampling has also been performed just downstream of the crossing in the past by the USGS. (Historical Monitoring Station 15668)

Inflows from Brushy Creek and Odell Creek

Located 3.4 miles downstream of SH 103 are the inflows from Brushy Creek and Odell Creek.

Brushy Creek flows from the northwest, draining an area of 4.2 sq miles and contributing a flow of 16.2 CFS. Brushy Creek's intermittent headwaters cross SH 103 and FM 1669. Land cover is forested with the exception of a 0.25 mile long section bordered on the west by a narrow forested riparian strip buffering an open field.

Odell Creek drains an area of 24 sq miles, discharging a flow of 53.7 CFS. Odell Creek begins as intermittent in a forested area directly north of the City of Huntington. It crosses FM 1669, flows for approximately 0.3 miles through an open field with a very narrow tree/brush line buffer, and then flows within a narrow forested buffer through multiple fields. Odell Creek has two tributaries:

Tubbs Creek: Flows from the south, draining 3.3 sq miles and contributing 13.3 CFS. Land cover near flow is narrow buffer strips within open fields.

Linston Creek: Flows from the west, draining 10.3 sq miles and contributing a flow of 19.1 CFS. Land cover 2/3 narrow to medium buffer, and 1/3 forest. Linston receives inflows from Mill Creek, which drains 3.6 sq miles and contributes 13.9 CFS.

Located approximately 4.5 miles downstream of SH 103 are the inflows from Duranzo Creek and Brush Creek from the north, and Gilliland Creek from the southwest.

Inflow from Duranzo Creek

Duranzo Creek drains 16.5 sq miles and contributes a flow of 44.8 CFS. Duranzo Creek is formed by the confluence of Morton Creek and Martin Creek, approximately 0.2 miles northeast of FM 226.

Morton Creek: Flows from the north, draining 5.8 sq miles and contributing 21.4 CFS. It flows mostly with buffered fields on the west and forest on the east and is located within the Angelina National Forest (except for the final 0.6 miles of stream).

Martin Creek: Flows from the northeast, draining 5.2 sq miles and contributing 19.9 CFS. It flows through an even mix of buffered fields and forest within the Angelina National Forest until the final 0.4 miles, during which it only has National Forest land on the east bank.

Duranzo Creek serves as the western border of the Angelina National Forest from the confluence to the reservoir. It crosses FM 266 and SH 103 before flowing into the Sam Rayburn Reservoir. From the Duranzo Creek confluence to the downstream confluence with Ayish Bayou, the northern shoreline of Sam Rayburn is part of the Angelina National Forest.

Inflow from Brush Creek

Brush Creek is intermittent and drains 1.9 sq miles, contributing a flow of 9.6 CFS. The sites of the Etoile Transfer Station Facility (TCEQ MSW permit no. 40166) and the Etoile Landfill (TCEQ MSW permit no. 895) are located within its drainage area.

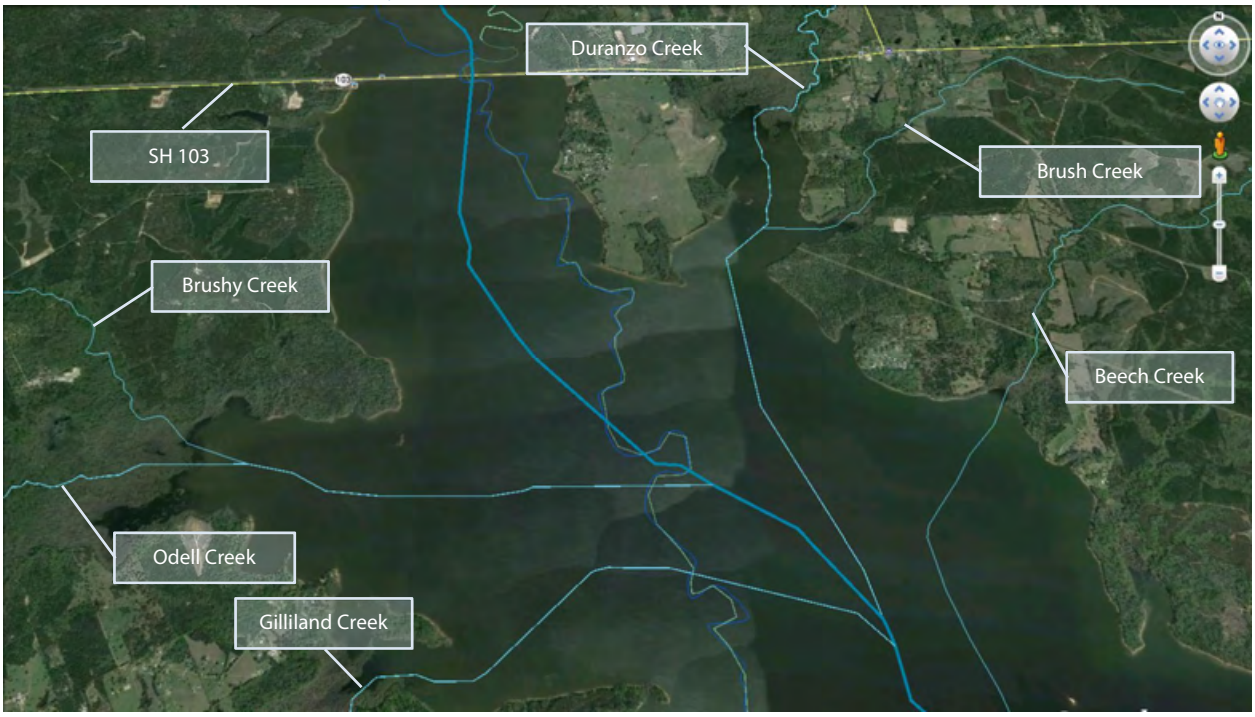
Inflow from Gilliland Creek

Gilliland Creek drains an area of 8.4 sq miles and contributes 26.5 CFS. It begins as intermittent before crossing FM 2109, and then crosses CR 188 and CR 193A and CR 192. Land Cover near the stream is half forest, half narrow forest buffer in fields.

Inflow from Beech Creek

The confluence with Beech Creek is located 5.75 miles downstream of SH 103. Beech Creek, which is intermittent, flows in from the northeast (crossing FM 226), draining an area of 2.2 sq mile and contributing 10.8 Land cover is approximately 75% forest and 25% medium buffer in fields.

FIGURE 7-10 Inflows from Brushy Creek, Odell Creek, Duranzo Creek, Brush Creek, Gilliland Creek, and Beech Creek



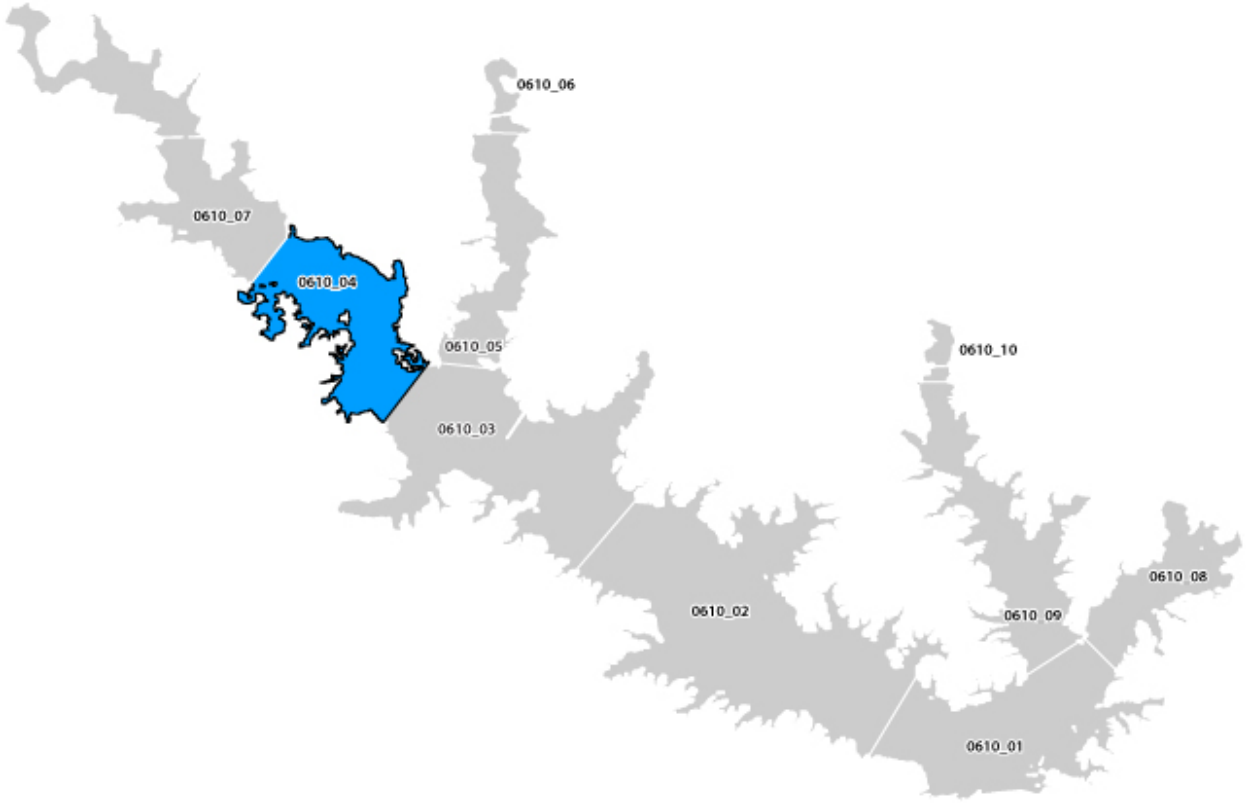
Transition from AU 0610_07 to AU 0610_04

Below the inflow from Beech Creek is the transition from the lower boundary of AU 0610_07 (upper Angelina River arm to AU0610_04 (upper mid-Angelina River arm).

Assessment Unit 0610_04

Sam Rayburn upper mid-Angelina River Arm

FIGURE 7-11 Sam Rayburn Reservoir Assessment Unit 0610_04



This assessment unit covers 14.5 sq miles of reservoir surface. It begins approximately 5.3 miles southeast of the SH 103 bridge over the Angelina River channel, directly adjacent to AU 0610_07 (which contributes 1,346 CFS). It ends approximately 6.6 miles downstream, just upstream of the confluence with the Attoyac arm of the reservoir.

Inflows from an Unnamed Tributary and Stanley Creek

Approximately 1.5 miles into the AU are inflows from the southwest for both an unnamed tributary and Stanley Creek.

The unnamed tributary is intermittent and has a drainage area of 2.5 sq miles. It contributes a flow of 11.5 CFS. This tributary crosses CR 192 and CR 193A, and displays land cover typical for the watershed.

Stanley Creek is a perennial stream with a drainage area of 13.6 sq miles. It contributes a flow of 37.7 CFS. Stanley Creek crosses CR 323 and FM 2109, with land cover that is mostly forest with one field with narrow buffer. One intermittent tributary contributes 2.5 CFS. A portion of this creek runs through Angelina National Forest.

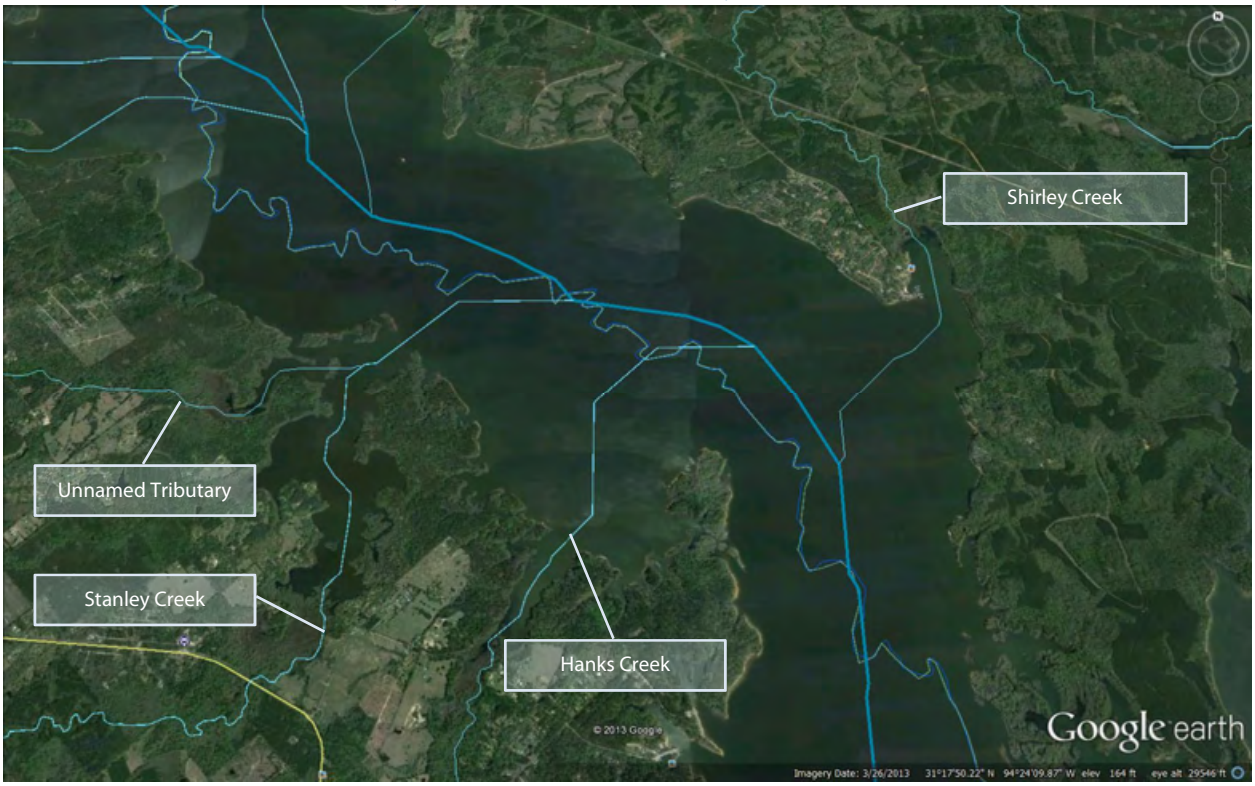
A further 0.5 miles downstream the Angelina National Forest expands, and the southwest shoreline from this location down to the dam is National Forest.

Inflows from Hanks Creek and Shirley Creek

The confluence with Hanks Creek is located an additional 0.5 miles downstream. Hanks Creek has a drainage area of 4.6 sq miles and contributes a flow of 17.7 CFS. Land cover mostly forested, with one field with medium buffer. Hanks Creek crosses FM 2109.

The confluence with Shirley Creek is located 1 mile further downstream around the point of a peninsula.

FIGURE 7-12 Inflows from Stanley Creek, Hanks Creek, and Shirley



Historical Monitoring Station 15669 – Hanks Creek

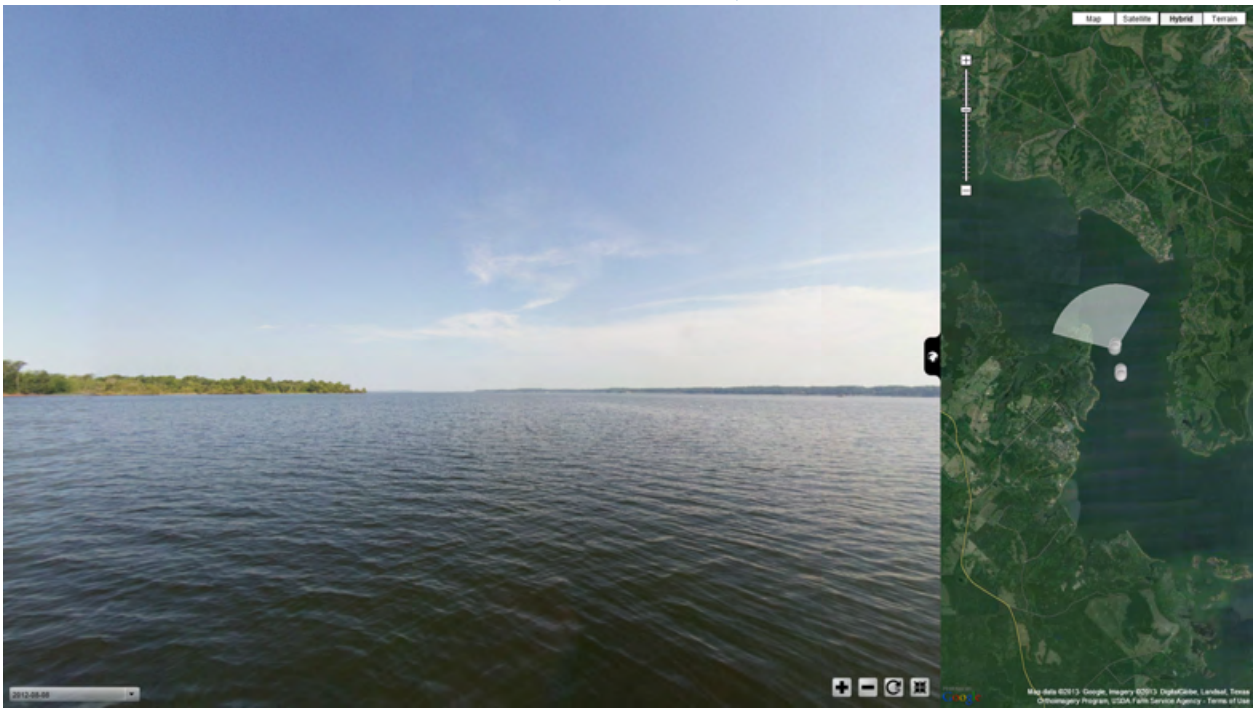
This location has been monitored in the past by the USGS (Historical Monitoring Station 15669).

Monitoring Station 15524 - Shirley Creek

Sampling is currently performed quarterly by ANRA at this location (Monitoring Station 15524).

Shirley Creek has a drainage area of 3.7 sq miles and contributes an inflow of 15.5 CFS. Land cover in this area is forested.

FIGURE 7-13 Monitoring Station 15524 – Sam Rayburn near Shirley Creek



Monitoring Station 15524 Sam Rayburn near Shirley Creek 8/8/2012

A 360° panorama of this monitoring station is located at http://www.anra.org/divisions/water_quality/crp/monitoring_sites/15524/15524.html

Monitoring at Station 15524 - Sam Rayburn near Shirley Creek

Historical Monitoring Station 16792 – Hanks Creek Park

On the southeast side of the peninsula is Hanks Creek Park. This USACE park offers a public swim beach, boat launch ramps, camping and day use facilities. Monitoring has been performed in the past at the boat ramp (Historical Monitoring Station 16792). ANRA also performs bacteriological monitoring of the swim beach area during summer months for the USACE.

FIGURE 7-14 Hanks Creek Park

Historical Monitoring Station 16793 - Shirley Creek Marina and Campground

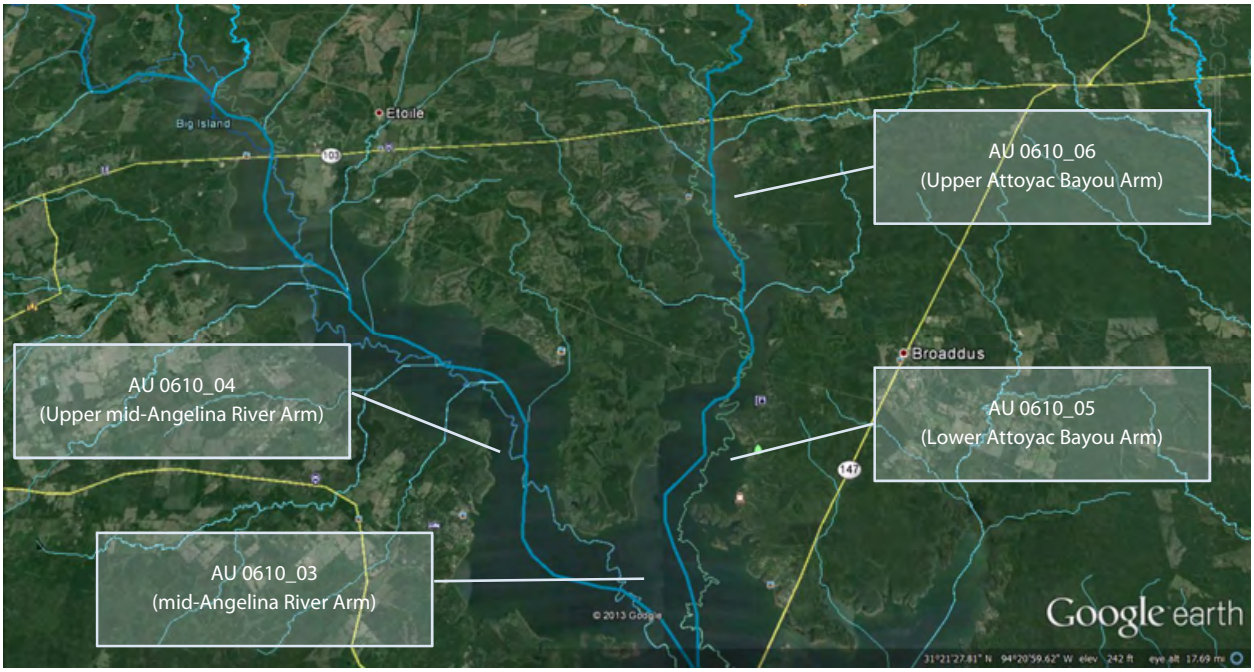
Directly to the west of the Shirley Creek inflow is Shirley Creek Marina and Campground. The Marina is privately owned and offers a swim beach, boat launch ramps, camping, RV parking and day use facilities. The Marina had a permitted discharge of up to 0.005700 MGD (TDPES permit no. 10947-001), but the previous owners allowed the system to fail and the permit to lapse. The treatment plant was recently replaced by a large aerobic on-site sewage system by the new owner. Sampling has been performed in the past at the Shirley Creek boat ramp (Historical Monitoring Station 16793).

FIGURE 7-15 Shirley Creek Marina and Campground

Transition from AU 0610_04 (upper mid-Angelina River Arm) to AU 0610_03 (mid-Angelina River Arm)

The transition from AU 0610_04 (Upper mid-Angelina River Arm) to AU 0610_03 (mid-Angelina River Arm) is located a further 3.7 miles downstream. In addition to receiving inflow from AU 0610_04 AU 0610_03 also receives inflows from AU 0610_06 (Sam Rayburn upper Attoyac Bayou arm) and AU 0610_05 (Sam Rayburn lower Attoyac Bayou arm). The two assessment units on the Attoyac Bayou arm that discharge to AU 0610_03 will be presented prior to the discussion of AU 0610_03.

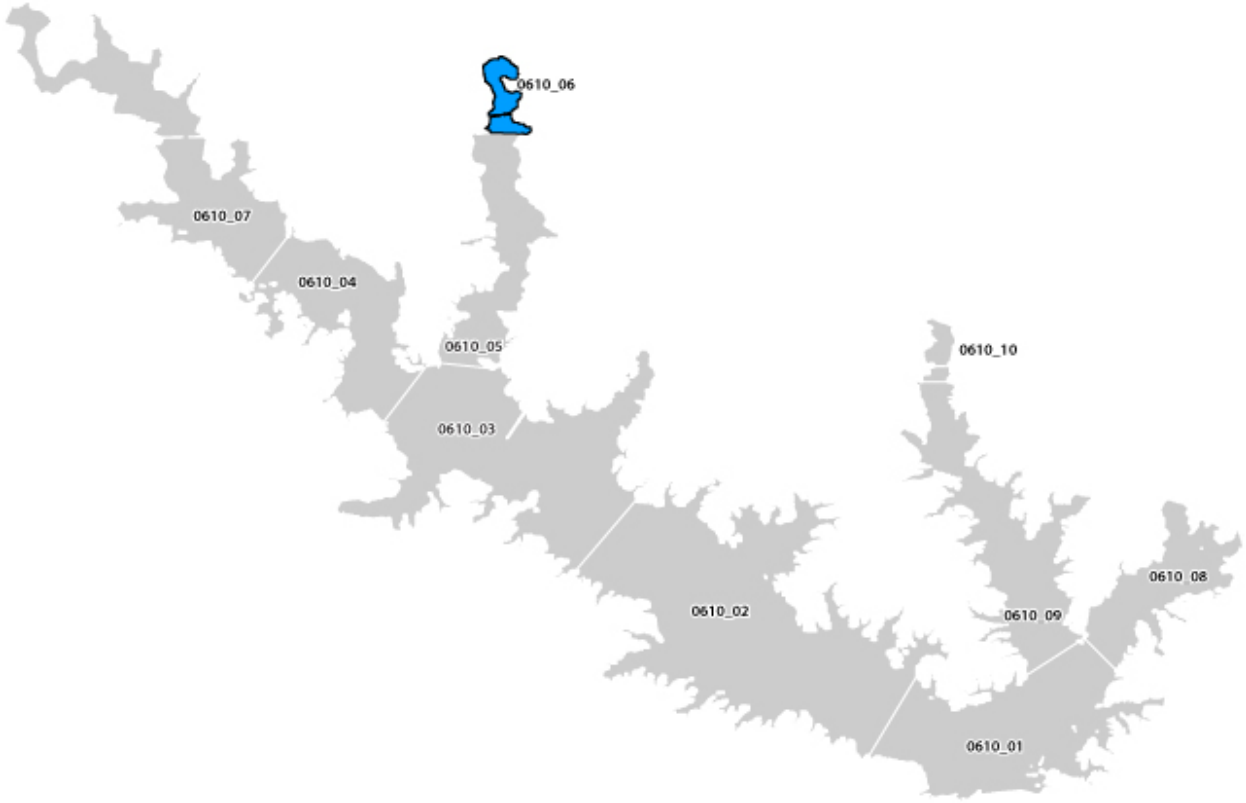
FIGURE 7-16 Transition from AU 0610_04 to AU 0610_03



Assessment Unit 0610_06

Sam Rayburn upper Attoyac Bayou Arm

FIGURE 7-17 Sam Rayburn Reservoir Assessment Unit 0610_06



AU 0610_06 includes 1.8 sq miles of reservoir surface. It begins approximately at the confluence of the Attoyac Bayou and Granberry Branch, 5.1 miles north of the SH 103 crossing and ends approximately 0.75 miles downstream of the SH 103 crossing. Its primary inflow is the Attoyac Bayou, which contributes 548 CFS. It includes the SH 103 crossing, one active monitoring station, and has two previously permitted Municipal Solid Waste sites in its drainage area.

Inflow from Lagroule Creek

The northernmost inflow below the Attoyac Bayou is Lagroulle Creek, which flows in from the west. It meets Sam Rayburn Reservoir approximately 1.5 miles north of the SH 103 crossing. This stream drains an area of 8.8 sq miles, crossing FM 95 and contributing 29.2 CFS. Land cover is mostly narrow forested buffer in open fields. Based on aerial imagery, the fields appear to be pine plantations that have been clear cut.

Inflow from Spears Creek

Three quarters of a mile north of the SH 103 crossing is a perennial inflow from the northeast. Spears Creek drains 20.7 sq miles, contributes 54 CFS and has two major tributaries; Brushy Creek and Sandy Creek.

Brushy Creek: Drains an area of 10.6 sq miles, contributing 33.9 CFS of flow. The upper 2.4 stream miles are intermittent and flow exclusively through deep forest. The remaining 4.1 miles are perennial and flow through about 2/3 forest, and 1/3 buffered fields. The stream crosses FM 1277. There are 2 MSW permitted sites

in the watershed: San Augustine County Precinct 2 Landfill (TCEQ MSW permit no. 870) and Attoyac Landfill (TCEQ MSW permit no. 865). There are also several poultry operations just north of FM 1277.

Sandy Creek: Drains an area of 6.5 sq miles, contributing 7.7 CFS, flowing mostly through forest and crossing FM 1277. Sandy Creek has one intermittent tributary named Rocky Creek which drains 1.8 sq miles and contributes 9.4 CFS.

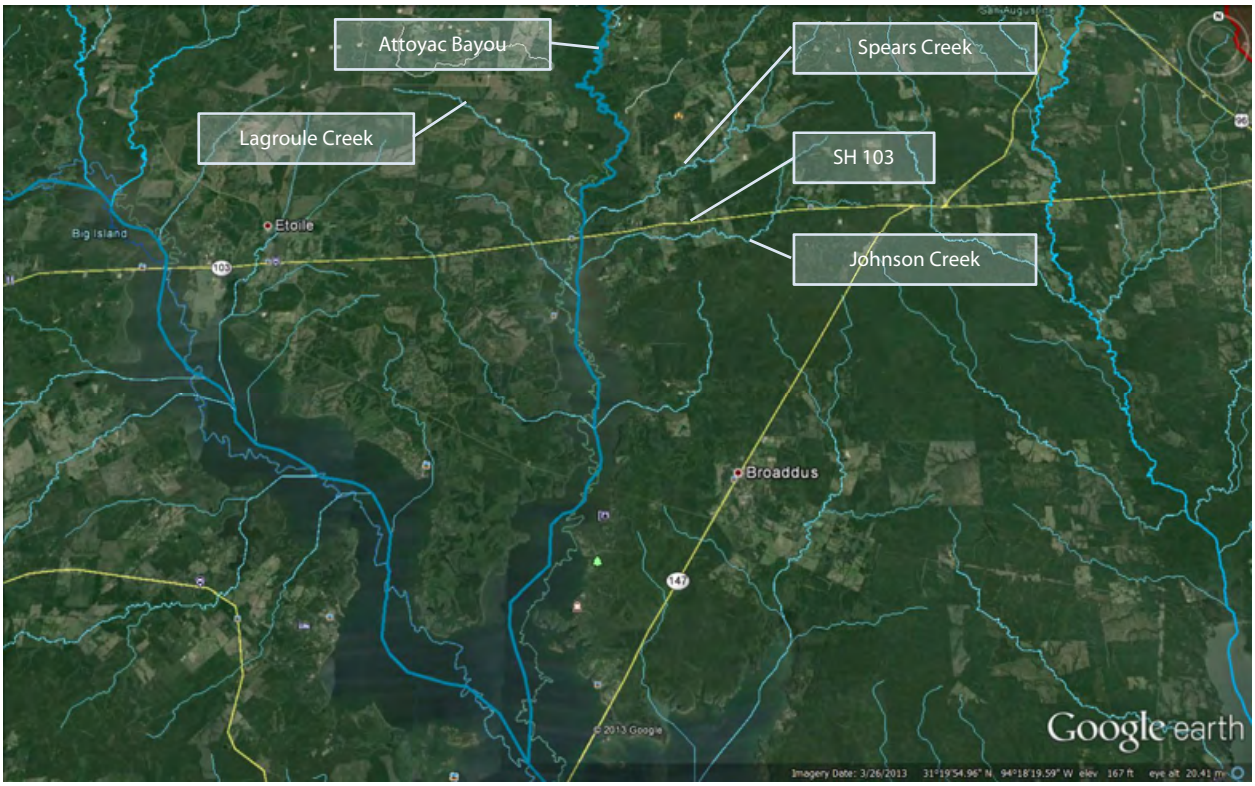
Monitorig Station 10614 - SH 103 Crossing

At the SH 103 crossing, sampling is performed by TCEQ Region 10 (Monitoring Station 10614).

Inflow from Johnson Creek

Half a mile downstream of the SH 103 crossing is an inflow from the east. Johnson Creek drains 13.8 sq miles and contributes 39.1 CFS. Land cover is almost entirely forest. Johnson Creek crosses SH 103 and FM 1277.

FIGURE 7-18 Inflows from Lagroule Creek, Spears Creek, and Johnson Creek



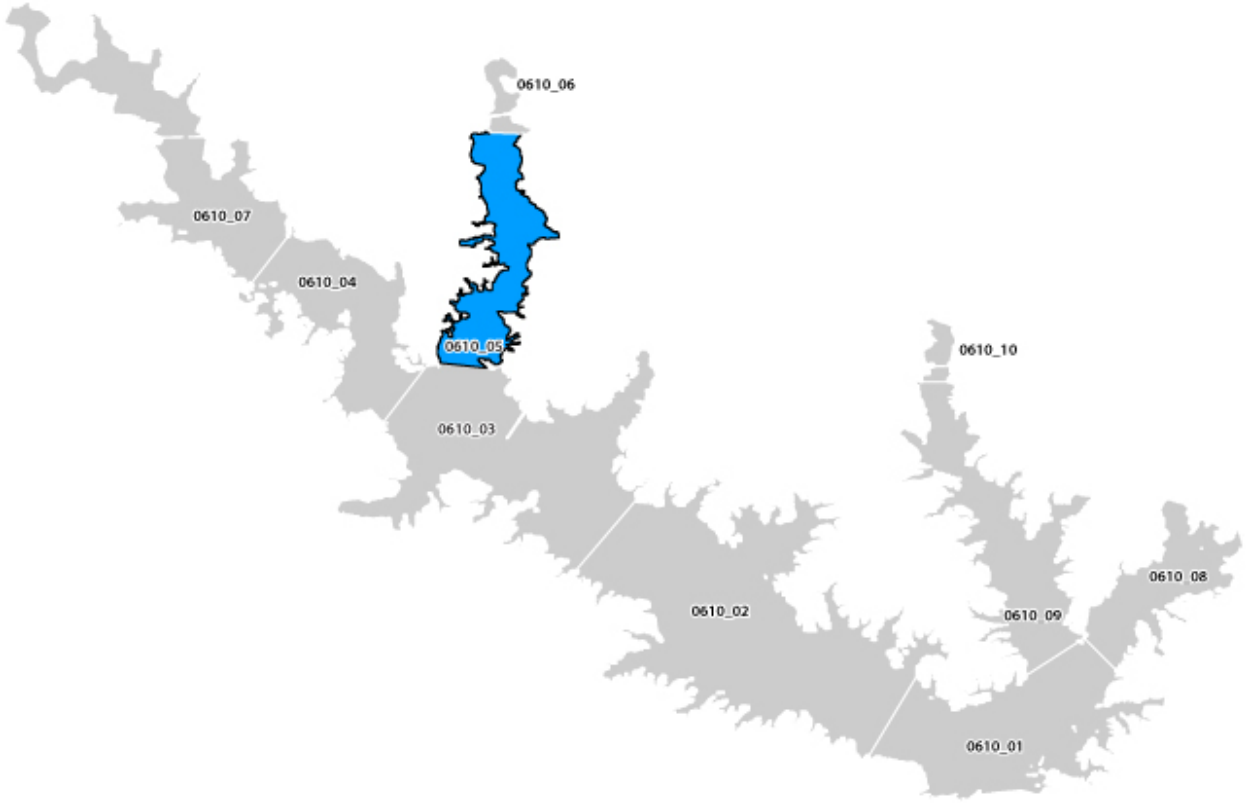
Transition from AU 0610_06 (upper Attoyac Bayou arm) to AU 0610_05 (lower Attoyac Bayou arm)

The transition from AU 0610_06 to AU 0610_05 is 0.75 miles downstream of the SH 103 crossing.

Assessment Unit 0610_05

Sam Rayburn lower Attoyac Bayou Arm

FIGURE 7-19 Sam Rayburn Reservoir Assessment Unit 0610_05



AU 0610_05 encompasses 10.3 sq miles of reservoir surface. It begins 0.75 miles below the SH 103 bridge over the Attoyac Bayou, and extends 8.9 miles south to the mouth of the Attoyac arm of the reservoir. It includes three inactive sampling sites, one active sampling site, a powerline crossing, and Jackson Hill Park and Marina. There are 7 small- to medium-sized neighborhoods on the eastern shore, and one small neighborhood on the western shore. Otherwise, the shoreline is forested. The shoreline itself appears mostly undeveloped, but there are numerous pine plantations in the drainage area; some buffered by less than 200 ft of undeveloped forest from the water's edge. AU 0610_06 (the upper portion of the Attoyac arm) contributes 615 CFS.

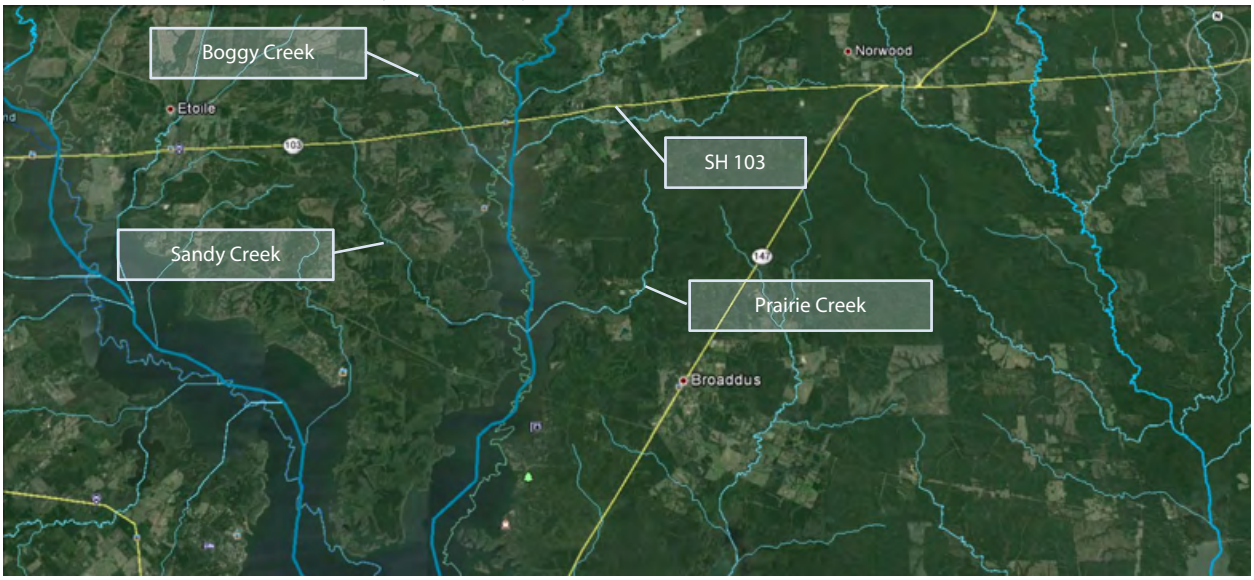
Inflow from Boggy Creek

At the northwest corner of the AU is an inflow from Boggy Creek. This intermittent creek flows from the northwest and crosses SH 103. It drains an area of 3.2 sq miles and contributes 14.1 CFS. The land cover is 1/3 buffered field and 2/3 forest.

Inflows from Sandy Creek and Prairie Creek

Located at a distance of 4.4 miles into the AU, Sandy Creek flows in from the northwest and Prairie Creek from the northeast. Sandy Creek is perennial, while Prairie Creek is intermittent. Sandy Creek drains an area of 6 sq miles and contributes 22 CFS. Prairie Creek drains an area of 7.2 sq miles and contributes 24.3 CFS.

FIGURE 7-20 Inflows from Boggy Creek, Sandy Creek, and Prairie Creek



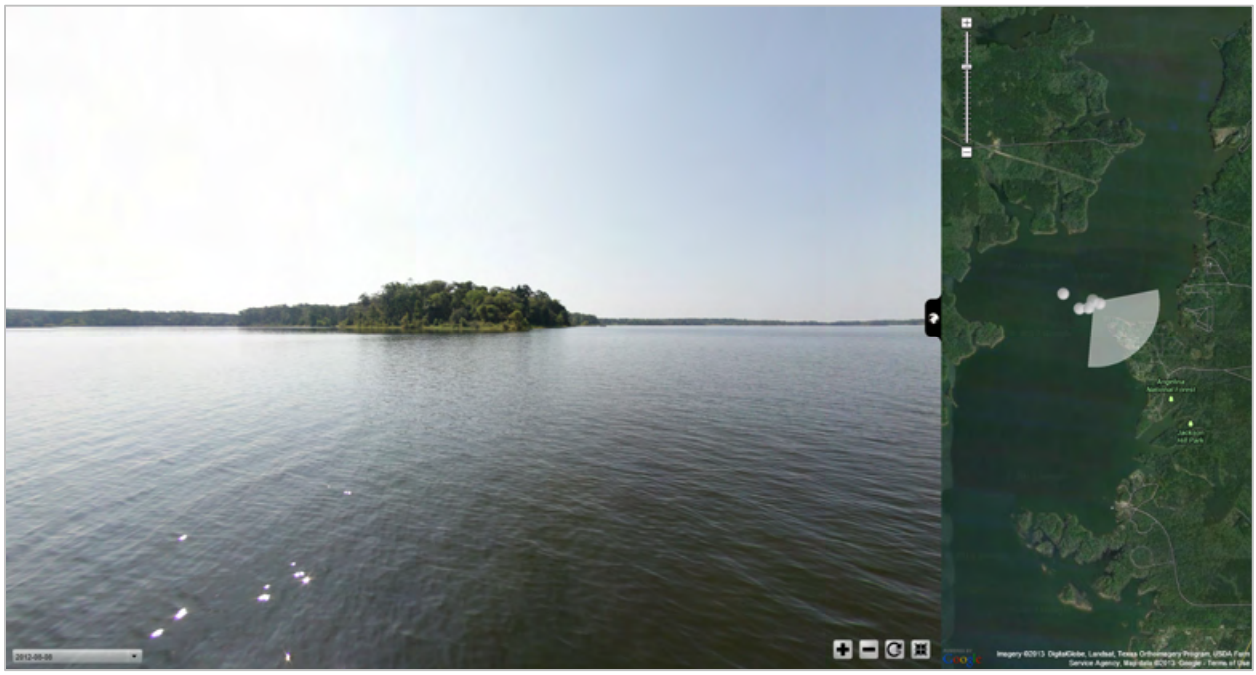
Historical Monitoring Stations 15666 and 15667

A powerline crossing is located 5.6 miles into the AU. The USGS has sampled at 2 sites near this crossing in the past (Historical Monitoring Stations 15666 and 15667).

Monitoring Station 15523 – Sam Rayburn Reservoir Adjacent to Alligator Cove

At a distance of 6.8 miles into the AU is the Alligator Cove sampling site, where ANRA samples quarterly for routine parameters (Monitoring Station 15523).

FIGURE 7-21 Monitoring Station 15523 - Sam Rayburn Reservoir Adjacent to Alligator Cove



Monitoring Station 15523 Sam Rayburn near Alligator Cove **8/8/2012**

A 360° panorama of this monitoring station is located at http://www.anra.org/divisions/water_quality/crp/monitoring_sites/15523/15523.html

Historical Monitoring Station 16791 – Jackson Hill Park and Marina

8 miles into the AU, on the eastern shore is the Jackson Hill Park and Marina. Jackson Hill offers a swim beach, boat launch ramps, camping, lodging and day use facilities. Monitoring has been performed in the past at the boat ramps (Historical Monitoring Station 16791).

FIGURE 7-22 Jackson Hill Park and Marina

Boat ramp at Jackson Hill Park and Marina

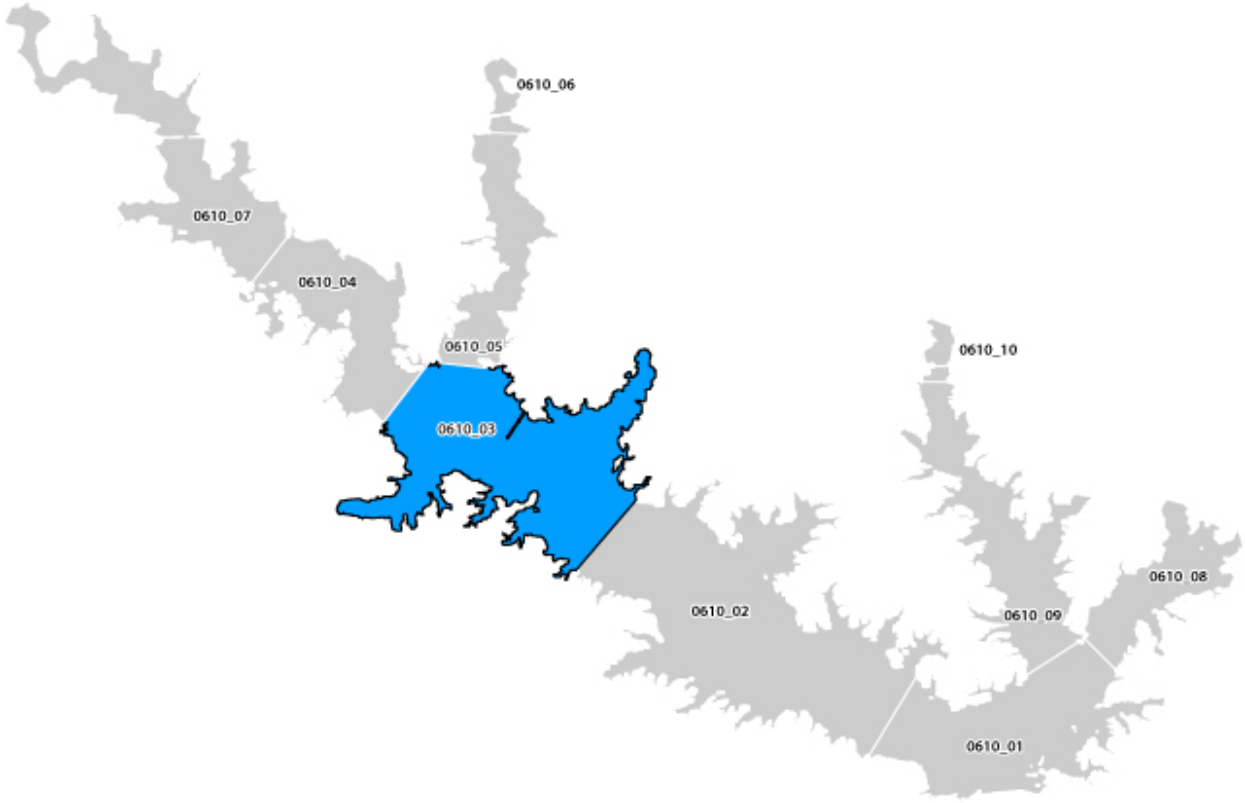
Transition from AU 0610_05 (lower Attoyac Bayou arm) to AU 0610_03 (mid-Angelina River arm)

The transition from AU 0610_05 to AU 0610_03 occurs after a total distance of 8.9 miles.

Assessment Unit 0610_03

Sam Rayburn mid-Angelina River arm (area around SH 147)

FIGURE 7-23 Sam Rayburn Reservoir Assessment Unit 0610_03



This AU begins approximately 3.8 miles upstream of the SH 147 crossing and ends approximately 4.8 miles downstream of the crossing. It includes the confluence of the Angelina River and the Attoyac Bayou, the Pophers Creek arm, the Harvey Creek arm, the SH 147 crossing, Cassels Boykin Park, one active sampling site, one inactive site, and two permitted wastewater outfalls.

AU 0610_04 (the upper mid-Angelina River arm) contributes 1356 CFS and AU 0610_05 (the lower Attoyac Bayou arm) contributes 616 CFS to this assessment unit.

Inflow from Pophers Creek

On the southern side of the reservoir, across from the Attoyac arm, is the Pophers Creek arm. Pophers Creek flows from the west and drains 17.7 sq miles, including the northernmost portion of the City of Zavalla. It contributes a flow of 41.6 CFS. Pophers Creek crosses CR 319 and FM 2109, and land cover is almost exclusively forest. Pophers Creek has four intermittent tributaries, one of which crosses US 69.

The Pophers Creek arm of the reservoir is just northwest of SH 147. On its southeastern shore is a mobile home park called Texas Airstream Harbor, Inc., which is permitted to discharge 0.010000 MGD (TPDES permit no. 11895-001).

Historical Monitoring Station 16790 – Cassels-Boykin Park

Also on the southeastern shore of the Pophers Creek arm is Cassels-Boykin Park, which has five boat ramps and hosts many of the numerous fishing tournaments held on Sam Rayburn Reservoir each year. Sampling has been performed in the past at the eastern boat ramps (Historical Monitoring Station 16790).

FIGURE 7-24 Cassels-Boykin Park

Monitoring Station 10612 – SH 147 Crossing

TCEQ Region 10 monitors Sam Rayburn Reservoir at the SH 147 crossing (Monitoring Station 10612).

Below the SH 147 crossing, a large portion of the southwestern shoreline is not only designated as Angelina National Forest, but is actually owned by the US Forest Service, so it is largely uninhabited natural pine forest (as opposed to the pine plantations common on the northeastern side of the reservoir.)

Inflow from Harvey Creek

At a distance of 2.6 miles below SH 147 is the inflow from Harvey Creek from the north. Harvey Creek drains 24 sq miles, contributing a flow of 56.4 CFS. This stream begins as intermittent north of SH 147 in forest, before crossing SH147. Harvey Creek passes 0.2 miles east of the Broaddus Landfill (TCEQ MSW permit no. 866 and 1 mile east of Norwood Landfill (TCEQ MSW permit no. 867). Land cover is forest and buffered fields. Harvey Creek has two intermittent tributaries from the northeast:

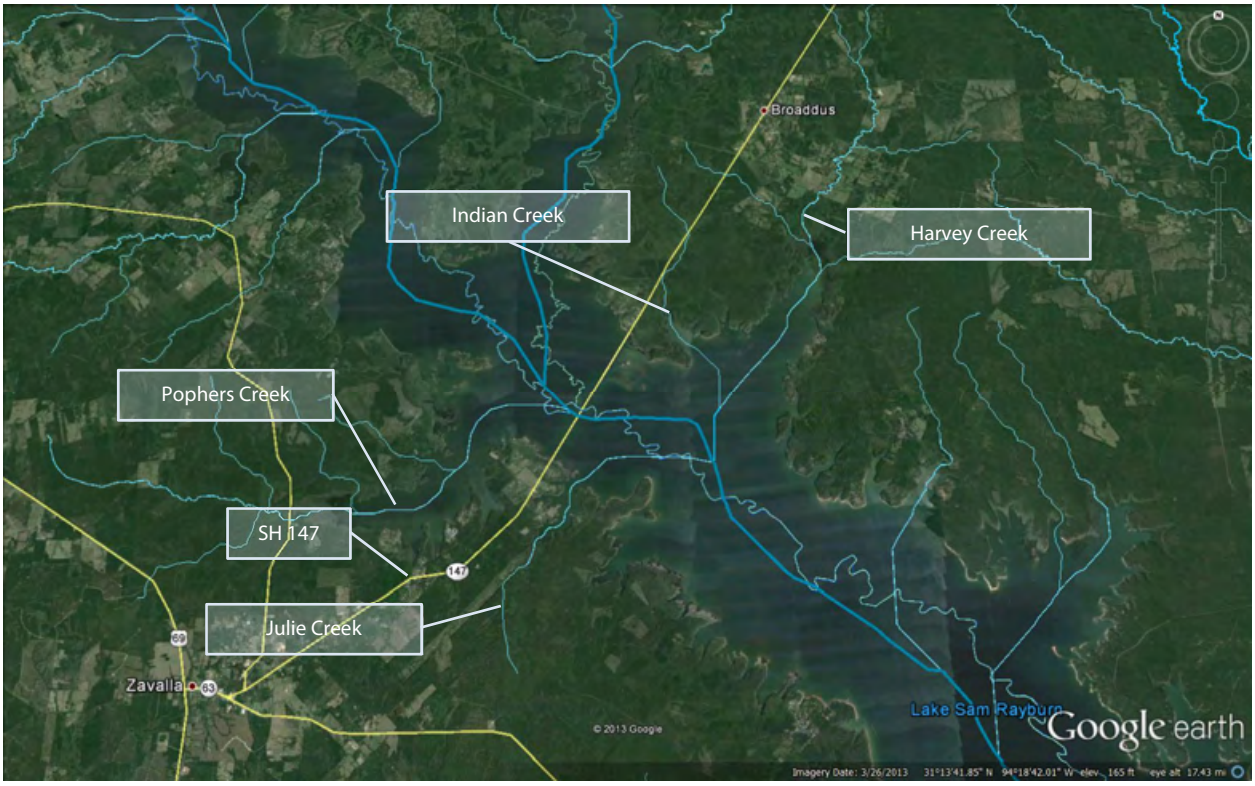
Caney Creek:	Drains most of the City of Broaddus and crosses SH 147. The City has a discharge to Caney Creek that is permitted for up to 0.135000 MGD of treated effluent (TPDES permit no. 11772-001). The drainage area and flow have not been calculated by NHDPlus for Caney Creek.
Owl Creek:	Drains 4.6 sq miles and contributes 17.9 CFS. It flows mostly through forest and crosses SH 147.

The entire Harvey Creek arm of the reservoir drains approximately 42 sq miles, and contributes 85.9 CFS.

Inflows from Indian Creek and Julie Creek

Indian Creek and Julie Creek also flow into Sam Rayburn Reservoir in this general vicinity.

FIGURE 7-25 Inflows from Pophers Creek, Harvey Creek, Indian Creek, and Julie Creek



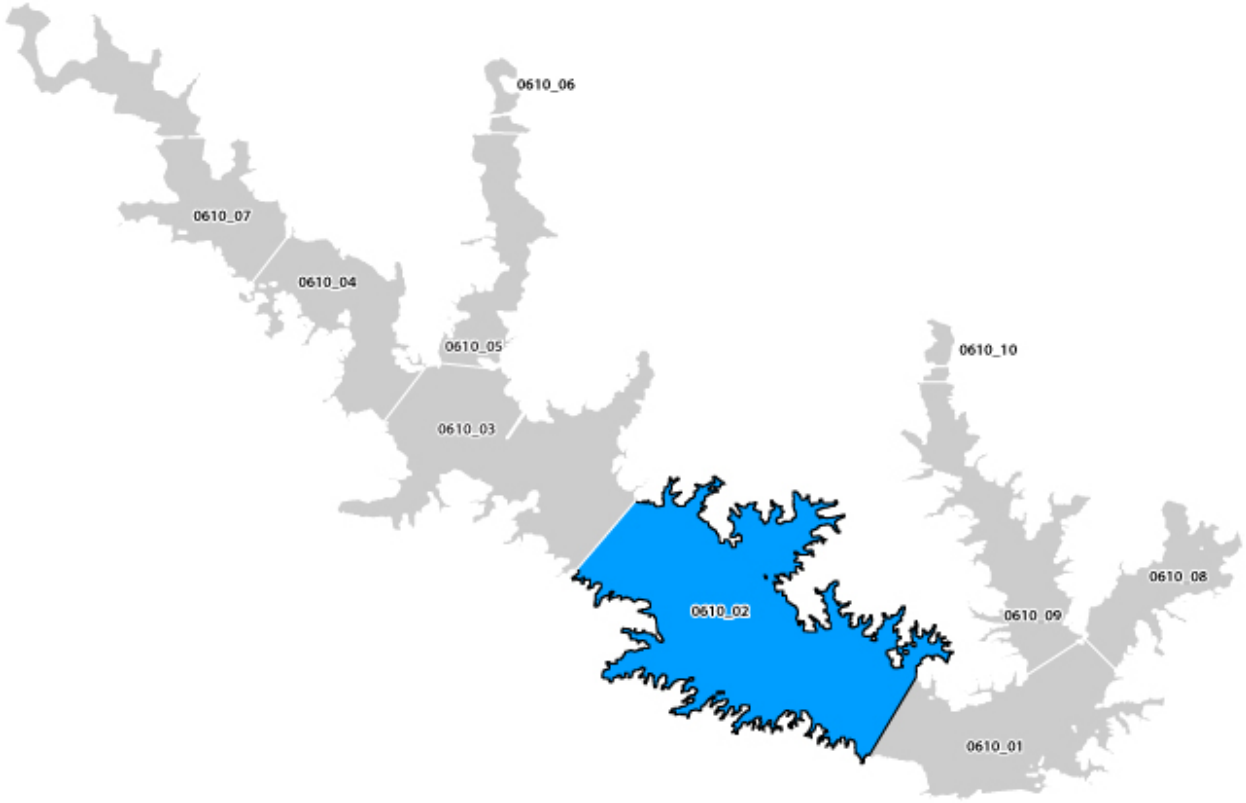
Transition from AU 0610_03 (mid-Angelina River arm) to AU 0610_02 (lower Angelina River arm)

The transition from AU 0610_03 to AU 0610_02 occurs 4.8 miles downstream of the SH 147 crossing.

Assessment Unit 0610_02

Sam Rayburn lower Angelina River Arm

FIGURE 7-26 Sam Rayburn Reservoir Assessment Unit 0610_02



This AU encompasses 43.7 sq miles of reservoir surface. It begins 4.8 miles southeast of the SH 147 bridge, and extends 11.6 miles southeast to a point about half a mile northwest of the intersection of Angelina, San Augustine and Jasper Counties. It includes two inactive sampling sites, two active sampling sites, and one permitted wastewater discharge.

Monitoring Stations 15670 and 16240

Approximately 2.3 miles into the AU there are two sampling sites. One centered on the river channel is currently sampled by LNVA (Monitoring Station 15670). The other is near a youth camp on the southwestern shoreline and has been sampled in the past (Historical Monitoring Station16240).

Inflow from Lucas Creek

The inflow from Lucas Creek is located 2.6 miles into the AU. Lucas Creek is intermittent and flows in from the north, draining into a 380 acre arm of the reservoir that has several subdivisions around its parameter. Other than the housing right near the shore, the area is dominated by forest. Lucas contributes only 10.4 CFS, but this area of the northern shore combined with Lucas contributes 32.8 CFS and drains 10.3 sq miles.

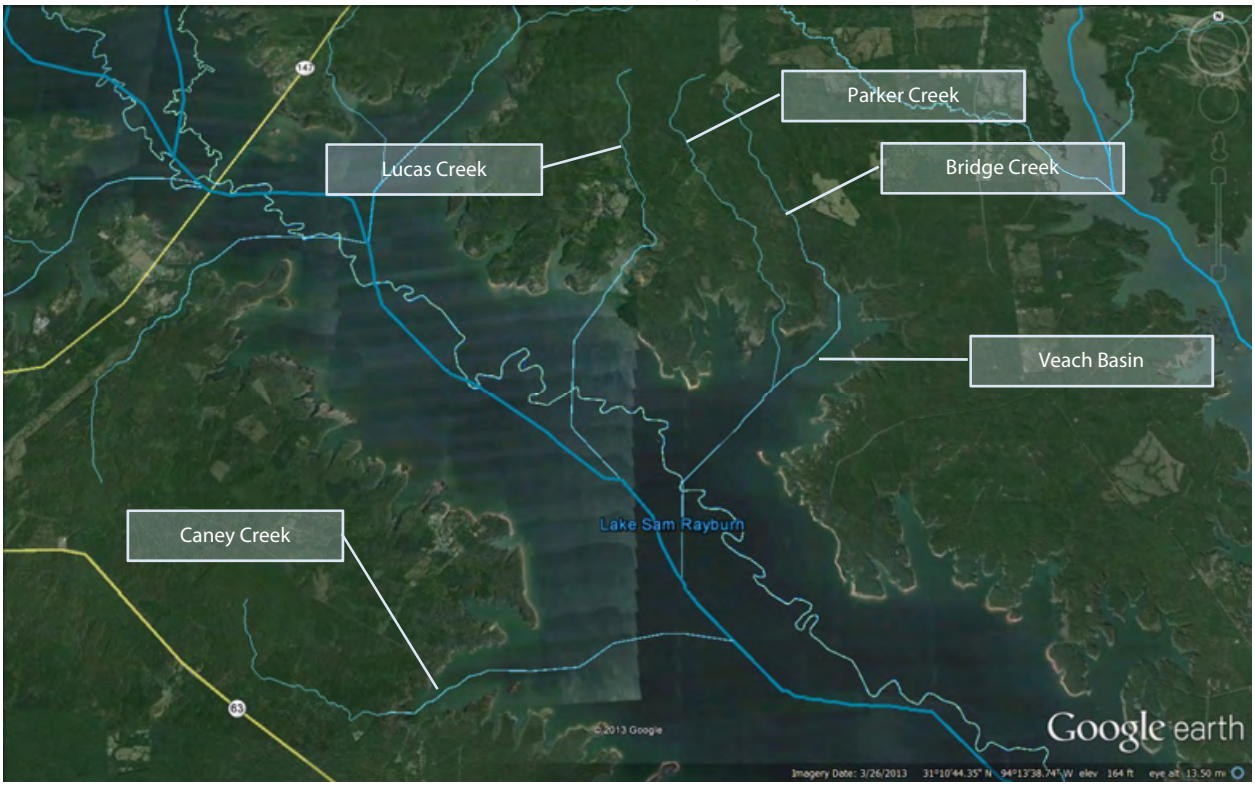
Inflow from Veach Basin

Located 4.7 miles into the AU, on the northern side of the reservoir, is a 3,600 acre arm of the reservoir called Veach Basin. Veach Basin is fed by two intermittent streams named Parker Creek and Bridge Creek. These streams feed from the northwest through undisturbed forest. Veach Basin drains 22 sq miles, and contributes a flow of 57.3 CFS. This site has been sampled previously (Historical Monitoring Station 15522).

Inflow from Caney Creek

At the same distance into the AU, Caney Creek flows in from the west. Land cover around this stream is forest. The Caney Creek arm of the reservoir drains 17.5 sq miles, and contributes 48.4 CFS.

FIGURE 7-27 Inflows from Lucas Creek, Veach Basin, and Caney Creek



Westwood WSC WWTF

The Westwood WSC Wastewater Treatment Facility (TPDES permit no. 11337-001) is located 11 miles into the AU on the southern shore in Jasper County. This facility is permitted to discharge up to 0.025000 MGD of treated effluent.

Transition from AU 0610_02 (lower Angelina River arm) to AU 0610_01 (main pool by the dam to the Bear Creek and Ayish Bayou arms)

The transition from AU 0610_02 to AU 0610_01 (the main pool) occurs after a total of 11.6 miles. Because AU 0610_01 also receives inflows from the Ayish Bayou arm and the Bear Creek arm, those AUs will be presented prior to the discussion of the reservoir's main pool.

Assessment Unit 0610_10

Sam Rayburn upper Ayish Bayou arm

FIGURE 7-28 Sam Rayburn Reservoir Assessment Unit 0610_10

AU 0610_10 covers 1.3 sq miles of reservoir surface. It begins approximately 1.8 miles north of the FM 83 crossing and extends down approximately 0.6 miles downstream of the crossing. Its watershed includes a small subdivision on the western shore and one active sampling site.

The Ayish Bayou Arm

The Sam Rayburn watershed north of the Ayish Bayou arm of the reservoir begins 2 miles north of the FM 83 crossing with a 263 CFS inflow from the Ayish Bayou. The western shoreline is designated Angelina National Forest, and the eastern shoreline is privately owned with the exception of a USACE park.

Inflow from Copelle Creek

Half a mile upstream of FM 83, Copelle Creek flows into the reservoir. It drains 3.6 sq miles and contributes 15.4 CFS while flowing through land cover consisting of 2/3 forest and 1/3 buffered fields. Copelle Creek crosses FM 705.

Monitoring Station 14907

TCEQ Region 10 samples at the FM 83 crossing (Monitoring Station 14907). Anthony Harbor subdivision is on the western shore just south of FM 83.

FIGURE 7-29 Sam Rayburn Reservoir Ayish Bayou Arm

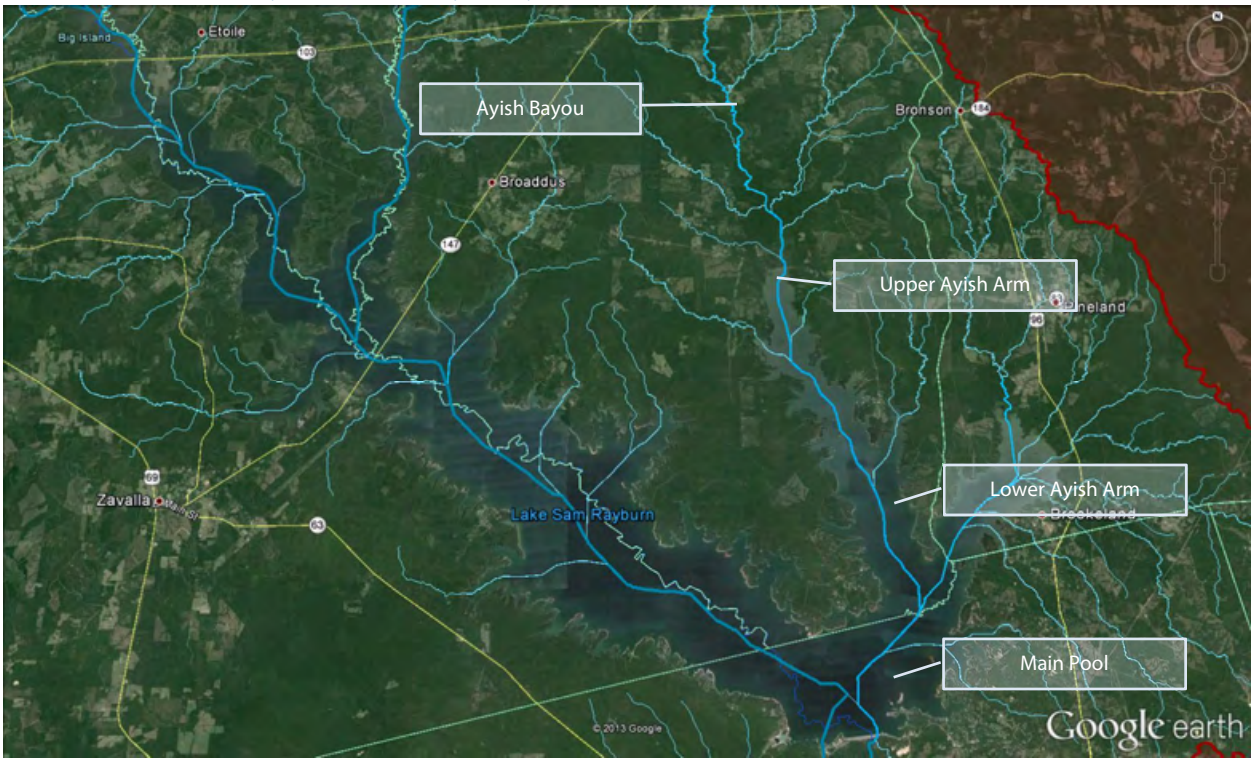
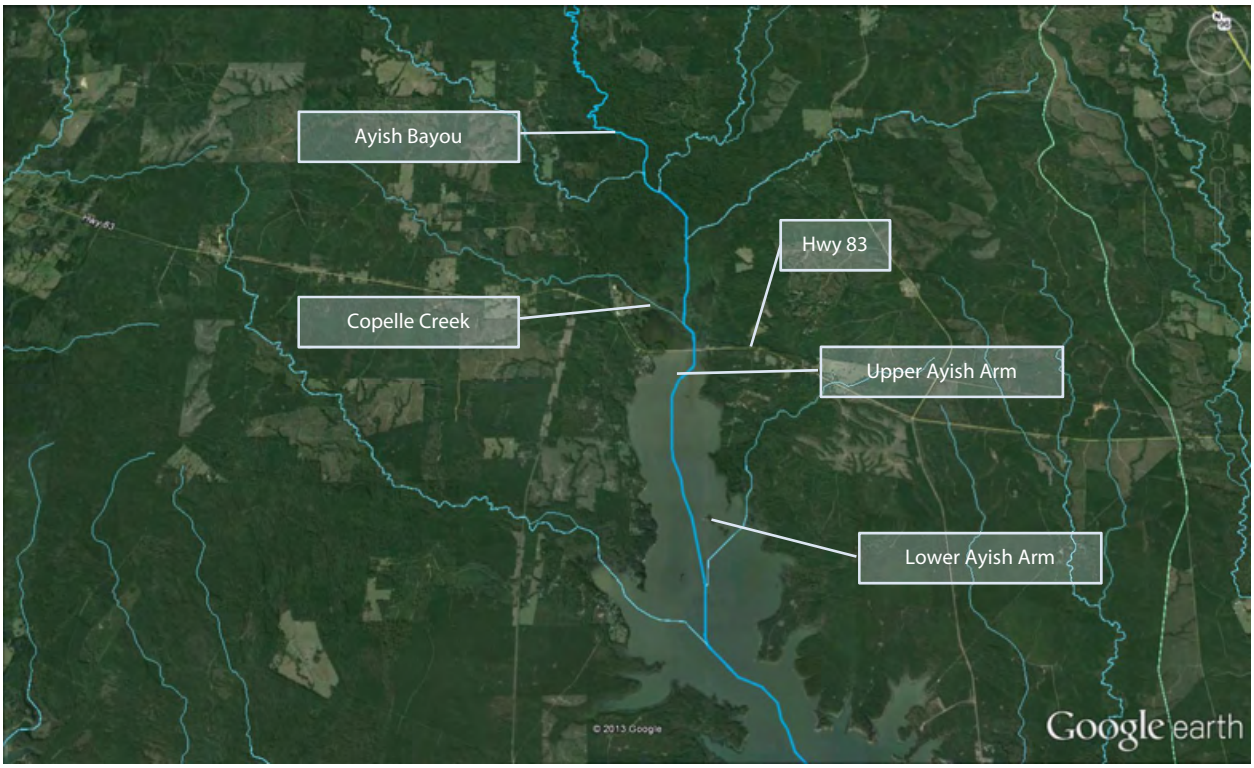


FIGURE 7-30 Inflow from Copelle Creek



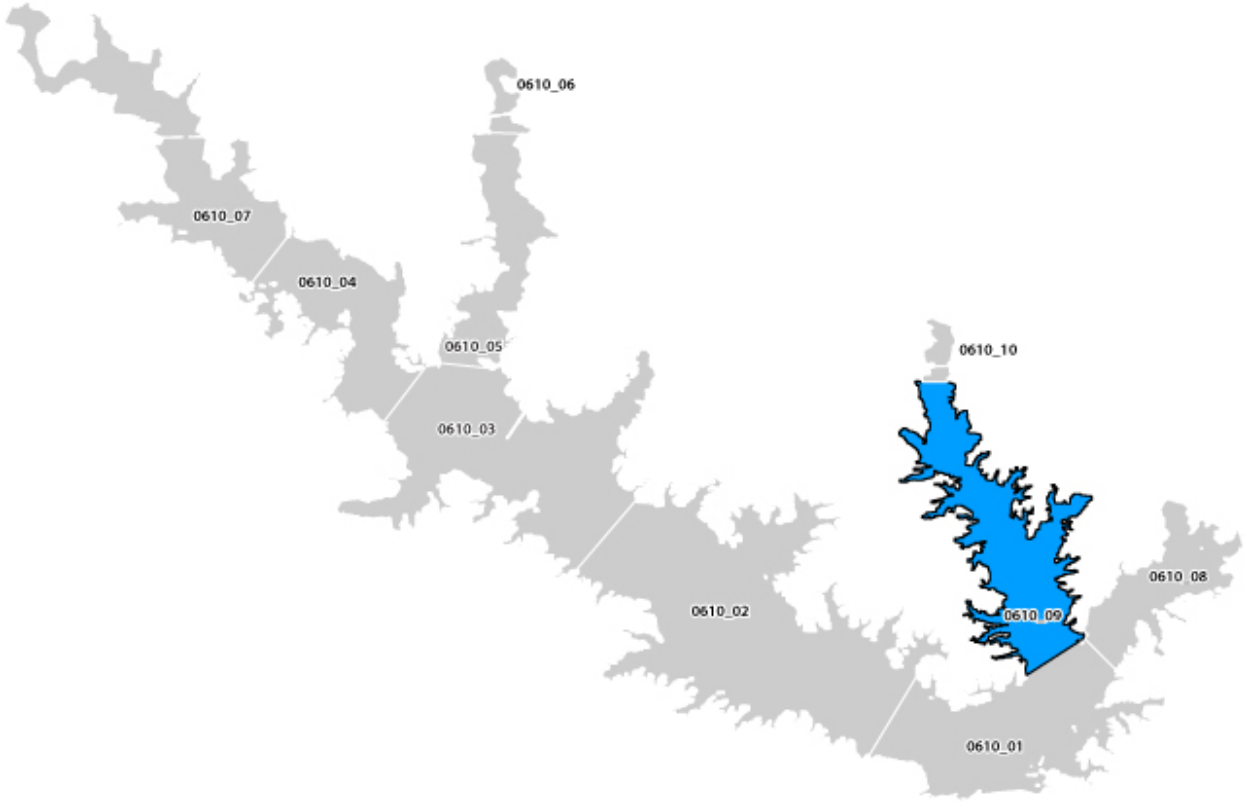
Transition from AU 0610_10 (upper Ayish Bayou arm) to AU 0610_09 (lower Ayish Bayou arm)

The transition from AU 0610_10 into AU 0610_09 is located 0.6 miles south of the FM 83 crossing.

Assessment Unit 0610_09

Sam Rayburn lower Ayish Bayou Arm

FIGURE 7-31 Sam Rayburn Reservoir Assessment Unit 0610_09



This AU covers 17.5 sq miles of reservoir surface. It begins approximately 0.6 miles south of the FM 83 crossing and extends 11.1 miles downstream to the mouth of the Attoyac arm of the reservoir. The entire western shore is designated Angelina National Forest, but only a single 530-acre tract of the shoreline itself is owned by the US Forest Service. The eastern shore is almost entirely privately owned, with the exception of one 300-acre tract designated Angelina National Forest and owned by the US Forest Service, and San Augustine Park, a 250-acre USACE park. The drainage area contains two previously permitted MSW sites, two inactive monitoring sites, and two active monitoring sites.

The primary (and northernmost) inflow is from AU 0610_10 (upper Ayish Arm), which contributes approximately 300 CFS.

Inflow from Tilde Creek

At the northwestern most part of the AU is an inflow with Tilde Creek. Tilde Creek, which is intermittent, has within its drainage area the location of the Hebron Landfill (TCEQ MSW permit no. 873). Tilde Creek does not appear on the Google Earth imagery.

Inflow from Briar Branch

The inflow from Briar Branch, which flows from the northeast, is located at a distance of 2.3 miles into the AU. This intermittent stream drains an area of 4 sq mile and contributes 17.4 CFS of flow. Crosses FM 83. Land cover is primarily medium strips of forested buffer within fields, but just upstream of where Briar Branch crosses FM 83 is a field with little to no buffer.

Inflow from Couchatana Creek

Couchatana Creek flows in from the west, approximately 2.9 miles into the AU. Couchatana Creek is perennial, but begins as intermittent above FM 83. The perennial portion crosses FM 705, traveling through an area that is mostly forested. Couchatana Creek has a drainage area of 17 sq miles and contributes a flow of 40 CFS..

Historical Monitoring Station 16784 - San Augustine Park

Located approximately 5.2 miles into the AU, on the eastern shore, is San Augustine Park. This USACE park offers a public swim beach, boat launch ramps, camping and day use facilities. Monitoring has been performed in the past at the boat ramps (Historical Monitoring Station 16784). ANRA also performs bacteriological monitoring of the swim beach area during summer months for the USACE.

Directly to the east of San Augustine Park is the Parkway subdivision. Numbers from the 2010 census indicate that San Augustine Park and Parkway combined include approximately 219 households, but only 168 permanent residents.

FIGURE 7-32 San Augustine Park

Monitoring Station 15675

Located 5.8 miles into the AU is monitoring site 15675, which USGS has sampled in the past and LNVA currently samples.

Inflows from Buck Branch and Sandy Creek

A cove located 8 miles into the AU on the northeastern shore receives inflows from Buck Branch and Sandy Creek. The western shore of this cove is the peninsula which houses Parkway and San Augustine Park.

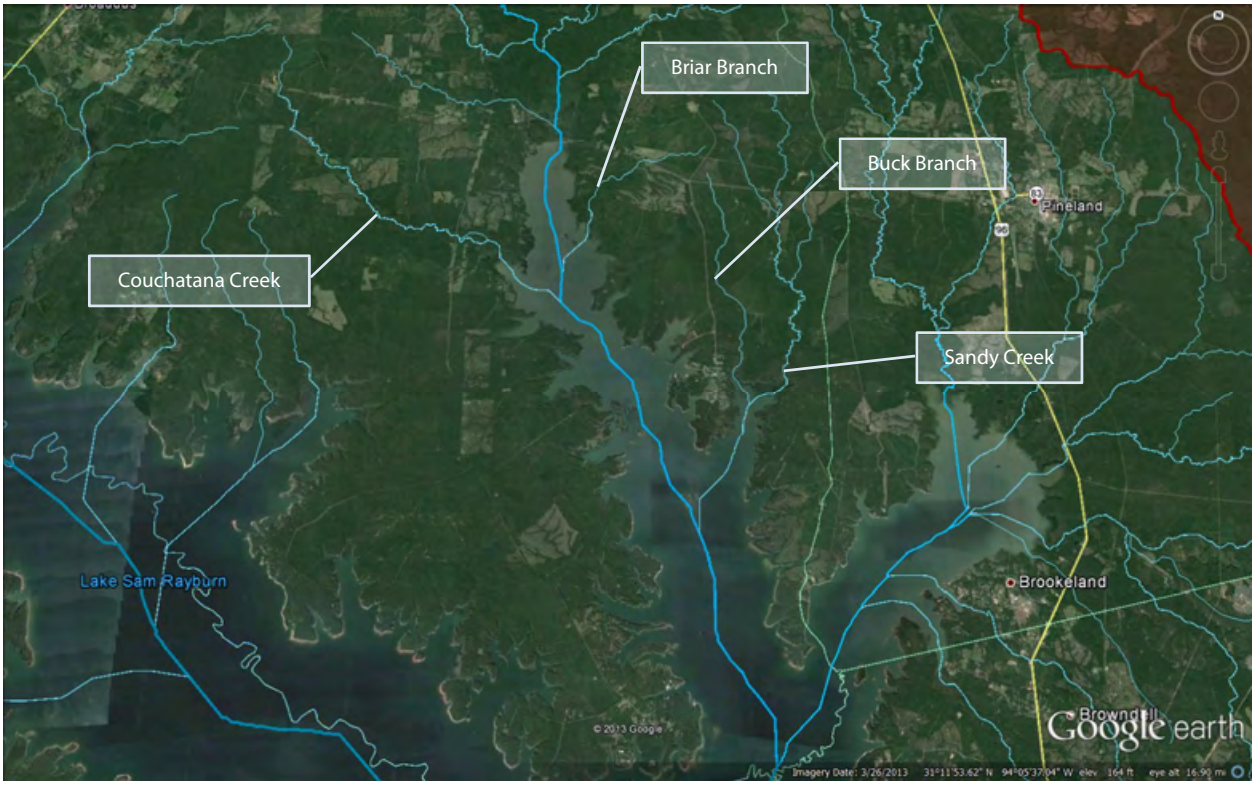
Buck Branch is an intermittent stream with a drainage area of 3 sq miles and contributes a flow of 13.9 CFS. Buck Branch crosses FM 83, and flows 0.4 miles west of the FM 83 Landfill (TCEQ MSW permit no. 872). Land cover is mostly forest.

Sandy Creek is a perennial stream, draining an area of 9.6 sq miles and contributing a flow of 32.4 CFS. Sandy Creek has 2 intermittent tributaries, Huckleberry Creek and an unnamed tributary, and all three streams cross FM 83. Land cover is mostly forest. There are very few houses located in the drainage area.

Monitoring Stations 15673 and 15526

Two monitoring stations are located approximately 0.5 miles upstream of the transition from AU 0610_09 to AU 0610_01. Monitoring Station 15673 has been sampled by the USGS in the past and is currently sampled by LNVA. Monitoring Station 15526 has also been sampled in the past.

FIGURE 7-33 Inflows from Briar Branch, Couchatana Creek, Buck Branch, and Sandy Creek



Transition from AU_0610_09 (lower Ayish Bayou arm) to AU_0610_01 (main pool by the dam to the Bear Creek and Ayish arms)

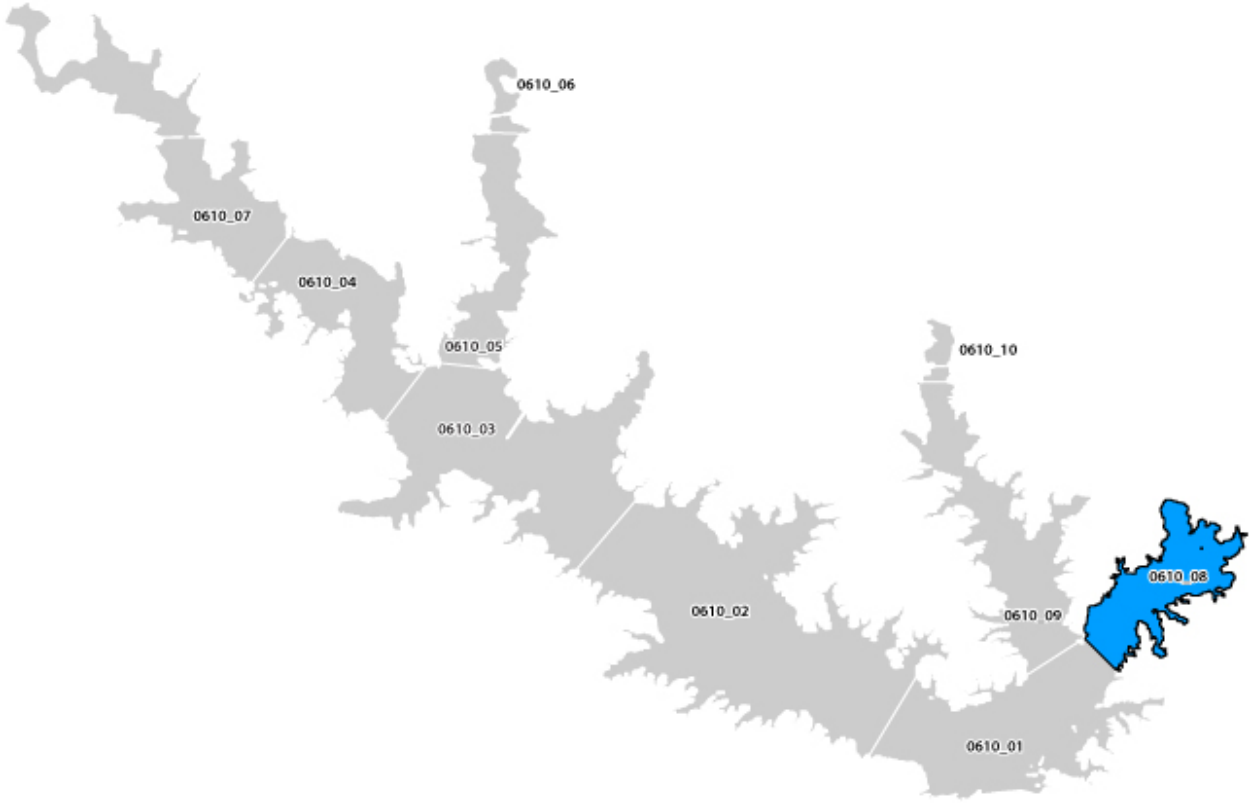
The Ayish Bayou arm of the reservoir drains into the main pool, contributing 346 CFS and having drained a total of 277 sq miles (including the Ayish Bayou watershed).

Prior to presenting a discussion of AU 0610_01, there is one more AU contributing flow to the main pool that will be discussed.

Assessment Unit 0610_08

Sam Rayburn upper Bear Creek Arm

FIGURE 7-34 Sam Rayburn Reservoir Assessment Unit 0610_08



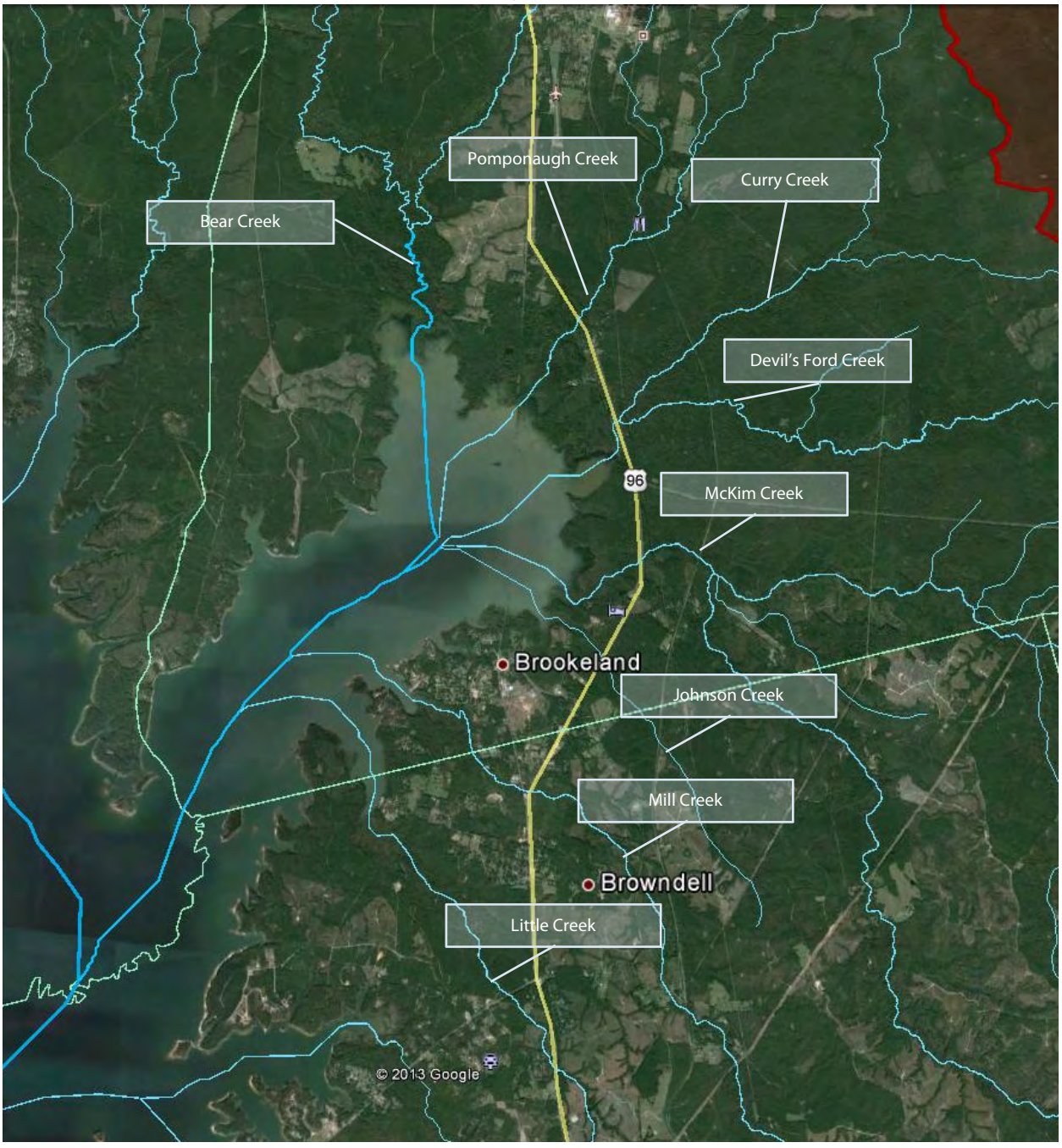
Just to the east of the Ayish arm is the Bear Creek arm of the reservoir. Other than the main pool, the Bear Creek arm of the reservoir is the most populated. It drains 140 sq miles, (42 sq miles are Sabine National Forest).

The AU covers 9.7 sq miles of reservoir surface, beginning 1000 ft upstream of US 96 at the Devils Ford/Curry Creek crossing and extending southeast 6.4 miles to the mouth of the Bear Creek Arm of the reservoir. It drains approximately 140 sq miles, 54 of which are Sabine National Forest. The AU contains two inactive sampling sites, and one active site. The drainage area contains the incorporated Cities of Pineland and Browndell, four previously permitted MSW sites, and six permitted wastewater outfalls.

There are numerous inflows into the Bear Creek arm of Sam Rayburn Reservoir. The following streams (beginning with the northernmost inflow and moving clock-wise) discharge into Sam Rayburn:

- Bear Creek
- Pomponaugh Creek
- Curry Creek / Devils Ford Creek
- McKim Creek
- Johnson Creek
- Unnamed Intermittent Stream
- Mill Creek
- Little Creek

FIGURE 7-35 Inflows to the Bear Creek Arm of Sam Rayburn Reservoir



Inflow from Bear Creek

Bear Creek flows from the north, draining 36 sq miles, and contributing 82.3 CFS of flow. It begins approximately 1 mile southeast of Bronson, an unincorporated community at the intersection of US 96 and SH 184. It flows mostly though lightly forested land, receives inflow from an unnamed intermittent tributary, and then crosses US 96.

Below US 96, Bear Creek flows through heavily forested land, crossing Clearview Cemetery Road. After an additional 3.4 miles, Bear Creek reaches a confluence with Sandy Creek from the north. After another 0.4 miles, Bear Creek reaches a confluence with Jack Williams Creek. After 0.7 miles, Bear Creek crosses Bear Creek Road,

and then FM 83. After another 4 miles, Bear Creek has a confluence with Easley Creek from the northeast. Bear Creek then passes through a detached 530-acre tract of Sabine National Forest before empting into the reservoir.

Sandy Creek:	Drains 8.4 sq miles, contributing a flow of 29.6 CFS. Begins north of Bronson and flows through the community, crossing 15 streets. Land cover is primarily narrow strips of riparian forest buffering large fields or harvested pine plantations.
Jack Williams Creek:	Drains 3.5 sq miles, and contributes a flow of 15.9 CFS. Land cover is primarily narrow strips of forest buffering pine plantations.
Easley Creek:	Drains an area of 7.5 sq miles, and contributes a flow of 27.1 CFS, This perennial stream begins 3.75 miles north of the City of Pineland near FM 1, flows mostly through forested land. The stream crosses one field with what look like a small on-channel impoundment, then flows through the western portion of the city limits. Easley Creek travels through the city park, crosses Maple Street, then just east of West Sabine High School, before crossing FM 83 smf US 96, then through medium forest buffer within pine plantations before empting into Bear Creek.

Inflow from Pomponaugh Creek

Approximately 1.4 miles southeast of the mouth of Bear Creek is the mouth of Pomponaugh Creek.

Pomponaugh Creek drains an area of 14.8 sq miles, contributing 44.2 CFS. It flows mostly within Sabine National Forest, but the headwaters and one tributary run partially through private land. Pomponaugh begins above FM 83 in a medium forested buffer surrounded by what appears (based upon aerial imagery) to be a recently clear cut pine plantation, crosses FM 83 and enters the Sabine National Forest. It then continues for 2 miles through narrowly buffered fields, crosses FM 2426, and flows another 1.5 miles through narrowly buffered pine plantation before reaching a confluence with Rush Branch from the northeast.

Rush Branch is a perennial stream draining 3.3 sq miles, and contributing 15.2 CFS. It is entirely within the Sabine National Forest, with headwaters 2 miles upstream of FM 2426 in deep forest. Downstream of the FM 2426 crossing it flows 2.4 miles to its confluence with Pomponaugh Creek.

Approximately 1 mile downstream of the confluence with Rush Branch, Pomponaugh crosses FM 1148, flows 0.3 miles across a narrowly buffered field, then 1 mile through forest to reach the confluence with Little Sandy Creek from the north.

Little Sandy Creek (Segment 0610C) drains 4.75 sq miles, including the portion of the City of Pineland that is east of FM 1. It contributes 19.8 CFS. Within the city limits, Temple-Inland (TIN INC.) is permitted to discharge storm water runoff in 4 locations. Also within the city limits is the City of Pineland Wastewater Treatment Facility (TCEQ permit no. 10249-001), which is permitted to discharge up to 0.214000 MGD of treated effluent. Land cover upstream of the city is an even mix of narrowly buffered fields and narrowly buffered pine plantations.

After crossing FM 83 and entering the city limits, Little Sandy flows through a 3-acre lake named Temple-Eastex Lake B-2. This is the location of the most upstream outfall that TIN INC has permitted for storm water runoff. It then flows just to the east of several more lakes, the largest of which is the 12.3-acre Temple-Eastex Lake D. Two of the remaining three permitted discharges for TIN INC are into/from these lakes. The final discharge from TIN INC is immediately upstream of FM 2426, approximately 0.25 miles west of the Little Sandy Creek crossing.

The permitted discharge for the City of Pineland Wastewater Treatment Facility is located approximately 0.2 miles downstream of the FM 2426 crossing. 0.4 miles downstream of the treatment facility, Little Sandy exits

the City Limits, enters the Sabine National Forest, and then continues 2.5 miles through forest (The middle third is narrowly buffered pine plantation) to its confluence with Pomponaugh Creek.

Downstream of the confluence with Little Sandy, Pomponaugh continues 1.6 miles through deep forest and crosses US 96 before draining into Lake Sam Rayburn.

Inflows from Curry Creek and Devils Ford Creek

The inflows of Curry Creek from the northeast and Devils Ford Creek from the east are located 1 mile to the southeast. Both streams are entirely within the Sabine National Forest. Land cover in the entire drainage area is deep forest, with less than one-fifth appearing to be pine plantations.

Curry Creek drains 9 sq miles and contributes 31.2 CFS. It begins above FM 2426, 2.8 miles northeast of the City of Pineville. Just below the FM 2426 crossing, it flows half a mile to the east of the location of the City of Pineland Landfill (TCEQ MSW Permit 330).

Devils Ford Creek drains 8.2 sq miles and contributes 29.3 CFS.

Inflow from McKim Creek

Approximately 2 miles southwest is the inflow of McKim Creek, which flows in from the southeast. McKim Creek drains 27 sq miles and contributes 69.9 CFS. The drainage area covers portions of 3 counties (Sabine, Jasper, and Newton). The portion in Sabine County (approximately 11.5 sq miles) is Sabine National Forest. McKim Creek has three perennial tributaries; East Prong McKim Creek, West Prong McKim Creek, and Rock Creek. The Land cover within the National Forest is approximately 80% deep forest, and 15% medium buffered fields, and 5% pine plantation. The land cover outside the National Forest is dominated by narrowly buffered pine plantations. McKim creek crosses US 96 before draining into the reservoir.

East Prong McKim Creek:	Flows from the south, almost entirely within Newton County. It drains 7.7 sq miles and contributes 28.6 CFS.
West Prong McKim Creek:	Flows from the south, entirely within Jasper County. It drains 3 sq miles and contributes 14.6 CFS. Crosses Jasper CR 202
Rock Creek:	Flows from the south, mostly within Jasper County. It drains 9.4 sq miles and contributes 33.1 CFS

Inflow from Johnson Creek

The inflow from Johnson Creek is located 0.3 miles to the southwest. Johnson is intermittent, drains 2.6 sq miles and contributes 13 CFS. Land cover is forest and pine plantation. Johnson Creek crosses US 96. The stream is 3.3 miles long. The final 1.2 miles are in Sabine County (within the Sabine National Forest), with the remainder located in Jasper county on private property.

Inflow from an Unnamed Intermittent Stream

An inflow from a small unnamed intermittent stream is located 0.6 miles to the southwest. Brookeland ISD has a permitted discharge for up to 0.004000 MGD of treated effluent (TPDES permit no. 13092-001). Flow has not been estimated for this stream.

Historical Monitoring Station 16787 - Mill Creek Park

Mill Creek Park is located 0.3 miles to the west. This USACE park offers a public swim beach, boat launch ramps, camping and day use facilities. Monitoring has been performed in the past at the swim beach (Historical Monitoring Station 16787). During the summer months, ANRA monitors the designated swim beach area for the USACE, testing for bacterial contamination.

FIGURE 7-36 Mill Creek Park

Mill Creek Park

Inflow from Mill Creek

The inflow from Mill Creek is located directly southwest of Mill Creek Park. Mill Creek drains an area of 14.2 sq miles, including most of the city limits of Browndell. It flows from the southeast and contributes 45 CFS. Mill Creek begins just west of the intersection of CR 231 and CR 232 in Jasper County. Land cover is mostly medium forested buffer surrounded by pine plantations (even within the city limits), but there are a few properties near CR 200/Old Hwy 8 where the flow is unbuffered in an open field or has only a single row of trees on either bank. In this same area, Mill Creek enters the city limits and crosses FM 1007. It flows for 2.9 miles within the city limits, crossing Old Hwy 8, and passing approximately 0.2 miles north of the site of Jasper County Precinct 1 Landfill (TCEQ MSW permit no. 905). Mill Creek then exits the city limits while crossing US 96, continuing for 0.75 miles and crossing into Sabine County. It then flows for an additional 0.7 miles, passing a KOA campground and a small residential neighborhood before draining into the reservoir.

Inflow from Little Creek

The inflow from Little Creek is located 1.4 miles to the southwest. Little Creek drains 6.7 sq miles and contributes 26.4 CFS. Little Creek drains the southwest fifth of the Browndell city limits. Land cover is dominated by narrowly buffered pine plantations. It begins 0.8 miles east of the intersection of US 96 and SH 255, crosses SH 255, and flows for roughly 3.8 mile before, crossing US 96. It then flows 1 mile past a couple of residential areas before crossing FM 1007, then flowing 2 more miles to the reservoir in a cove with a small residential neighborhood on the eastern shore.

There are three sampling sites on the Bear Creek arm of the reservoir. Monitoring Station 15674 is 1.2 miles northwest of the Mill Creek Park swim beach and 0.4 miles from the northern bank of the reservoir. It has been sampled in the past by USGS and is currently sampled by LNVA.

Historical Monitoring Station 15527 is 1 mile northwest of the Mill Creek Park swim beach (approximately 1200 ft from Station 15674).

Monitoring Station 16787, which is at the Mill Creek Park swim beach, has also been sampled in the past. It has already been previously discussed in this section of the watershed characterization report.

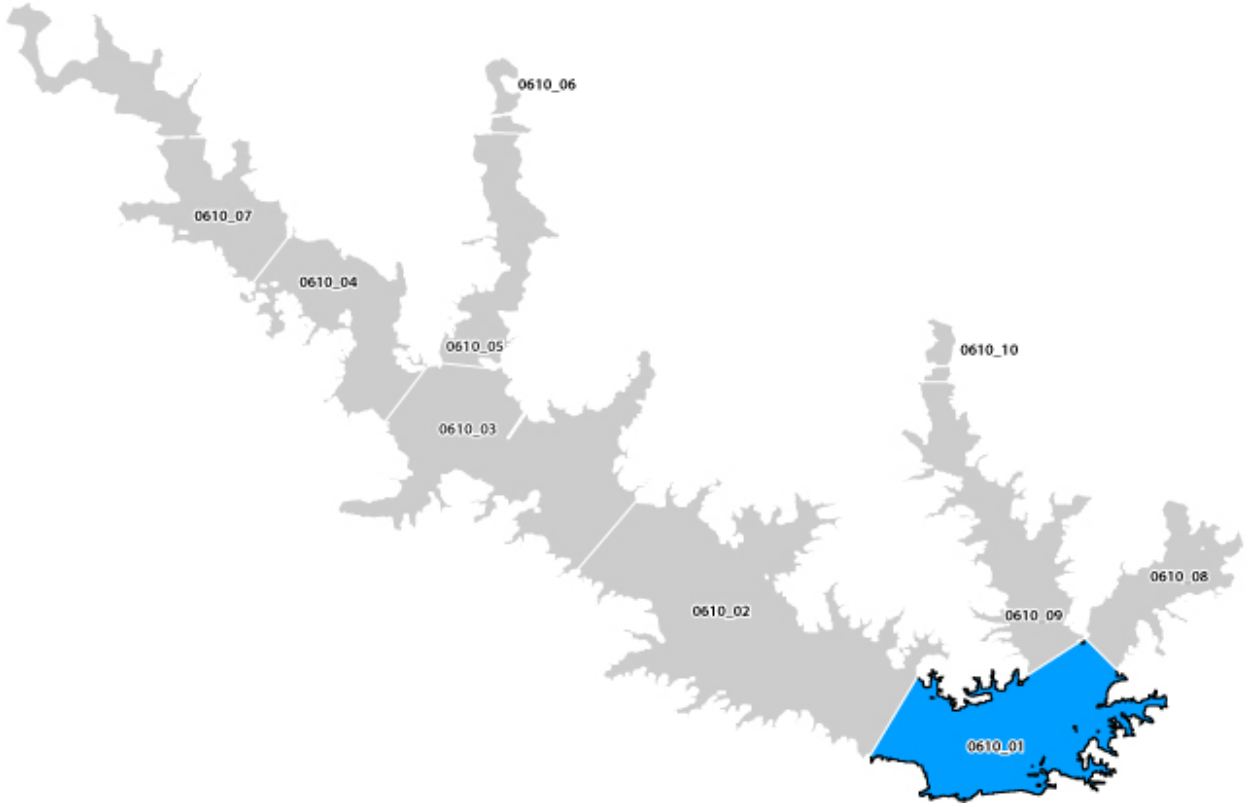
Transition from AU 0610_08 (Bear Creek arm) to AU 0610_01 (main pool by the dam to the Bear Creek and Ayish Bayou arms)

Approximately 1.5 miles downstream of the Little Creek confluence, the Bear Creek Arm (AU 0610_08) contributes a flow of 211 CFS to the Main Pool (AU 0610_01).

Assessment Unit 0610_01

Sam Rayburn main pool by the dam to the Bear Creek and Ayish Arms

FIGURE 7-37 Sam Rayburn Reservoir Assessment Unit 0610_01



This AU covers 21.7 sq miles of reservoir surface. It begins in the northwest at the mouth of the lower Angelina arm of the reservoir, and in the northeast at the mouths of the lower Ayish arm and the Bear Creek arm of the reservoir. It extends down to the dam. It contains 5 inactive sampling sites, and one active sampling site. Its drainage area contains two permitted wastewater outfalls.

Sam Rayburn Main Pool

Major Inflows to the Sam Rayburn Reservoir Main Pool

As mentioned previously, the main pool of Sam Rayburn Reservoir has three major inflows:

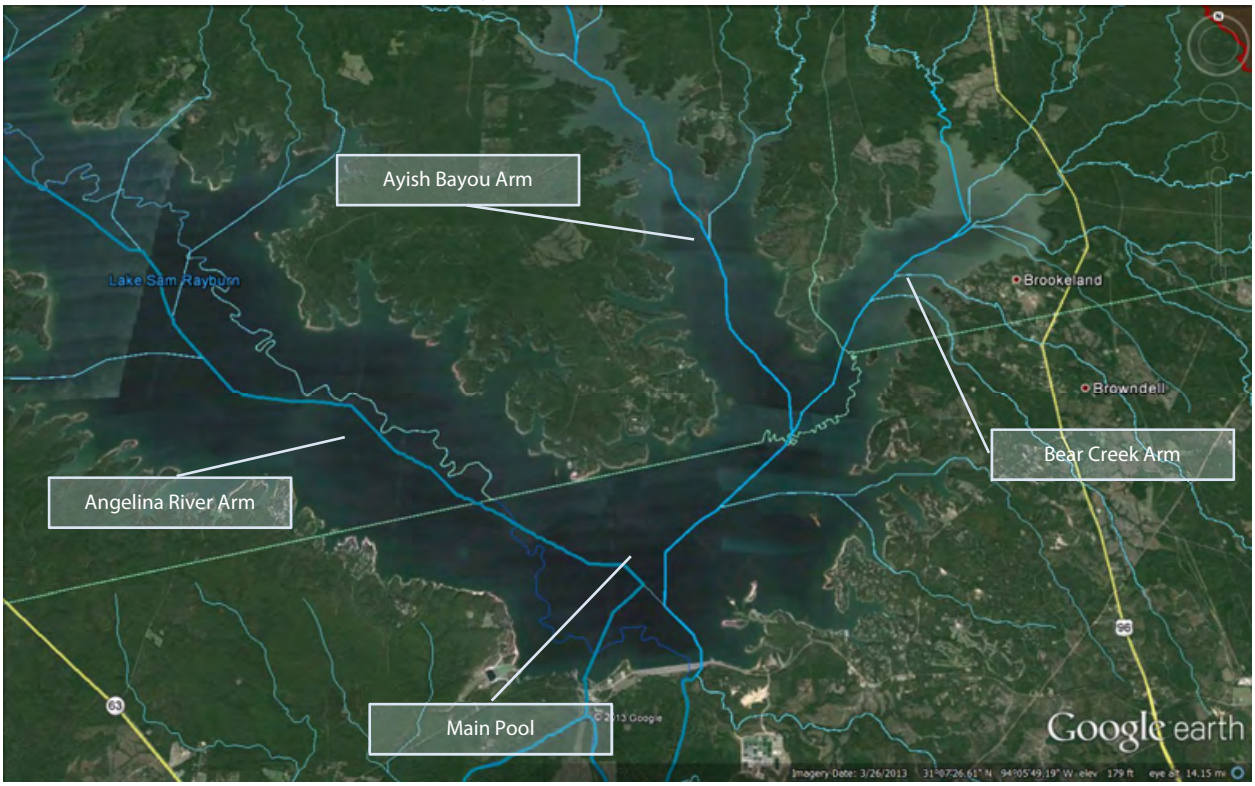
Lower Angelina arm (0610_02): Contributes 1760 CFS

Lower Ayish Arm (0610_09): Contributes 346 CFS

Bear Creek arm (0610_08): Contributes 221 CFS.

All of the major inflows have been previously discussed in detail in this report.

FIGURE 7-38 Major Inflows to the Sam Rayburn Reservoir Main Pool



Half a mile downstream of the inflow from the lower Angelina arm is the intersection of Angelina, San Augustine and Jasper Counties. Approximately 2.4 miles northeast of this intersection, in San Augustine County, is the SFA Piney Woods Conservation Center, which is permitted to discharge up to 0.020000 MGD (TPDES permit no. 13161-001).

Ebenezer Park

The western shore of the main pool is part of the Angelina National Forest, and includes Ebenezer Park, a USACE park. Ebenezer Park is the only area where horses are allowed on Sam Rayburn. The Equestrian area contains 10 campsites. There are also 17 ordinary camp sites, a swim beach, and day use facilities. Sampling has been performed in the past at Monitoring Station 16786, which is in the main pool, approximately 0.9 miles northeast of the swim beach. During the summer months, ANRA monitors the designated swim area for the USACE, testing for bacterial contamination.

An emergency spillway is also located on the Ebenezer Park grounds.

FIGURE 7-39 Ebenezer Park

Monitoring Station 14096

Monitoring Station 14906, which is currently sampled by LNVA, is in the main pool a little over 0.5 miles directly north of the power generation intake structure.

Inflows from Tiger Creek and an Unnamed Stream

The eastern shore of the main pool is easily the most densely populated shoreline on the reservoir. It has multiple waterfront subdivisions, and also has two intermittent inflows from the southeast (Tiger Creek and an unnamed stream). Both cross FM 1007.

Rayburn Country Municpal Utility District Wastewater Treatment Plant

Also on the eastern shore in Alligator Creek Cove is the Rayburn Country Municipal Utility District (MUD) Treatment Plant (TPDES permit no. 10788-001) which is permitted to discharge up to 0.300000 MGD of treated effluent into the reservoir via Alligator Creek.

Twin Dykes Marina

Finally, on the southeastern shore of the main pool is Twin Dykes Marina, a USACE park offering camping, boat ramps, screened shelters and day use facilities. Sampling has been performed in the past at the Twin Dykes boat ramps in Alligator Creek Cove (Historical Monitoring Station 15451)

At one time, there was a swim beach at the east end of the dam, and sampling was performed there (Historical Monitoring Station 16785), but it has been closed.

Intake Structure

There is also a public park on the dam near the intake structure, and sampling has been performed in the past at the intake structure (Monitoring Station 10611)

The estimated yearly mean outflow at the intake is 2253 CFS, which is contributed to segment 0609 (Angelina River Below Sam Rayburn)

FIGURE 7-40 Sam Rayburn Dam

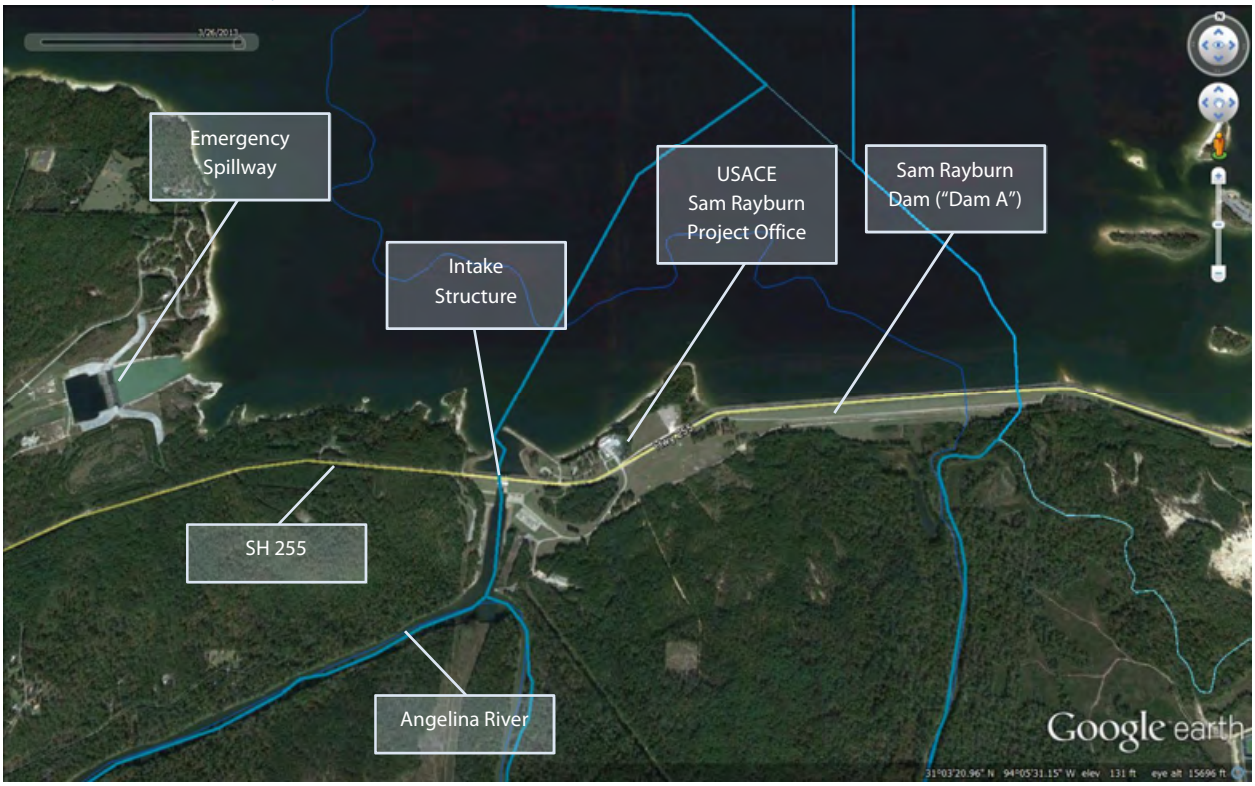


FIGURE 7-41 Sam Rayburn Intake Structure

FIGURE 7-42 Downstream side of Sam Rayburn Dam

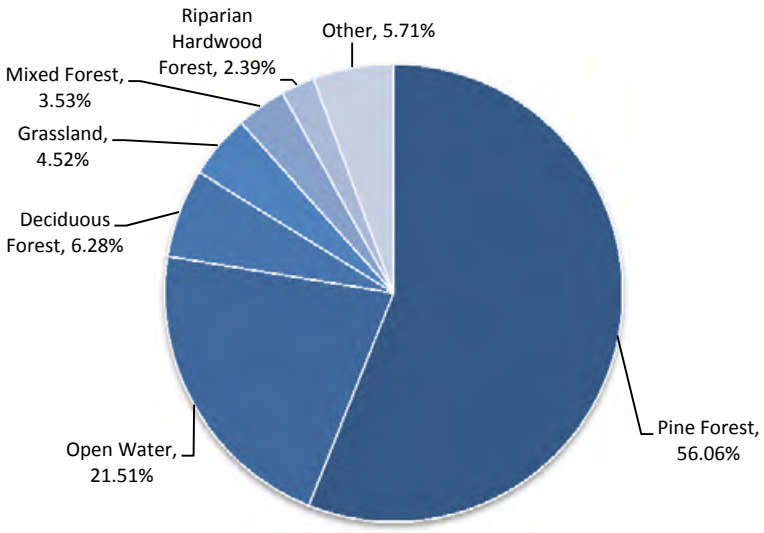
FIGURE 7-43 Angelina River Below Sam Rayburn Dam

Land Cover

There is a total of 491,551 acres located within the Sam Rayburn Reservoir watershed. The vast majority of the land is forested, including pine, deciduous, and mixed forests. Much of the land surrounding Sam Rayburn Reservoir is National Forest.

TABLE 7-7 Sam Rayburn Watershed Generalized Land Cover
From the TPWD Texas Ecological Systems Classification Project Phase 2

Land Cover	Percentage	Acres
Pine Forest	56.06%	275,542
Open Water	21.51%	105,731
Deciduous Forest	6.28%	30,866
Grassland	4.52%	22,207
Mixed Forest	3.53%	17,373
Riparian Hardwood Forest	2.39%	11,765
Riparian Bottomland Forest	1.33%	6,556
Riparian Mixed Forest	0.78%	3,818
Flatwoods Pine Forest	0.58%	2,861
Mesic Deciduous Forest	0.54%	2,661
Riparian Herbaceous	0.54%	2,645
Mesic Mixed Forest	0.34%	1,690
Urban Low	0.33%	1,622
Flatwoods Hardwood Forest	0.25%	1,228
Floodplain Marsh	0.15%	760
Floodplain Swamp	0.13%	624
Flatwoods Mixed Forest	0.12%	603
Floodplain Hardwood Forest	0.11%	548
Agriculture	0.10%	483
Deciduous Shrubland	0.09%	447
Urban High	0.07%	338
Riparian Marsh	0.06%	316
Riparian Swamp	0.06%	314
Floodplain Bottomland Forest	0.03%	152
Marsh	0.03%	129
Barren	0.02%	87
Floodplain Mixed Forest	0.01%	67
Riparian Deciduous Shrubland	0.01%	65
Flatwoods Marsh	0.01%	37
Swamp	0.00%	7
Evergreen Shrubland	0.00%	5
Floodplain Herbaceous	0.00%	1
Floodplain Deciduous Shrubland	0.00%	1
TOTAL	100.00%	491,551

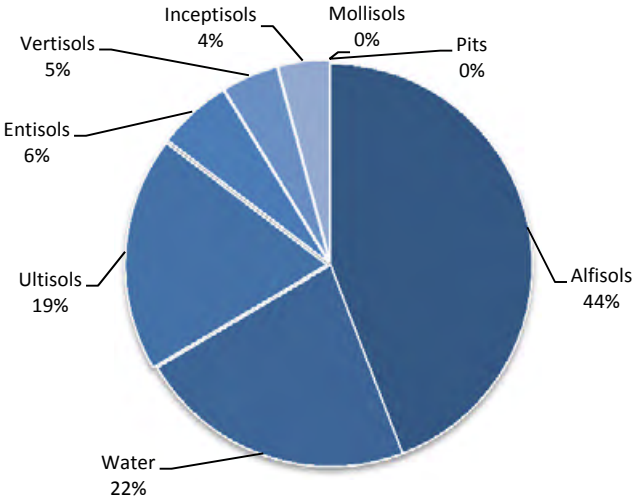


The category "Other" includes all categories with <2.0% of land cover.

NOTE: The difference in Total Acres from the Land Cover data and the Soil Types data is due to the difference in resolution in the GIS information.

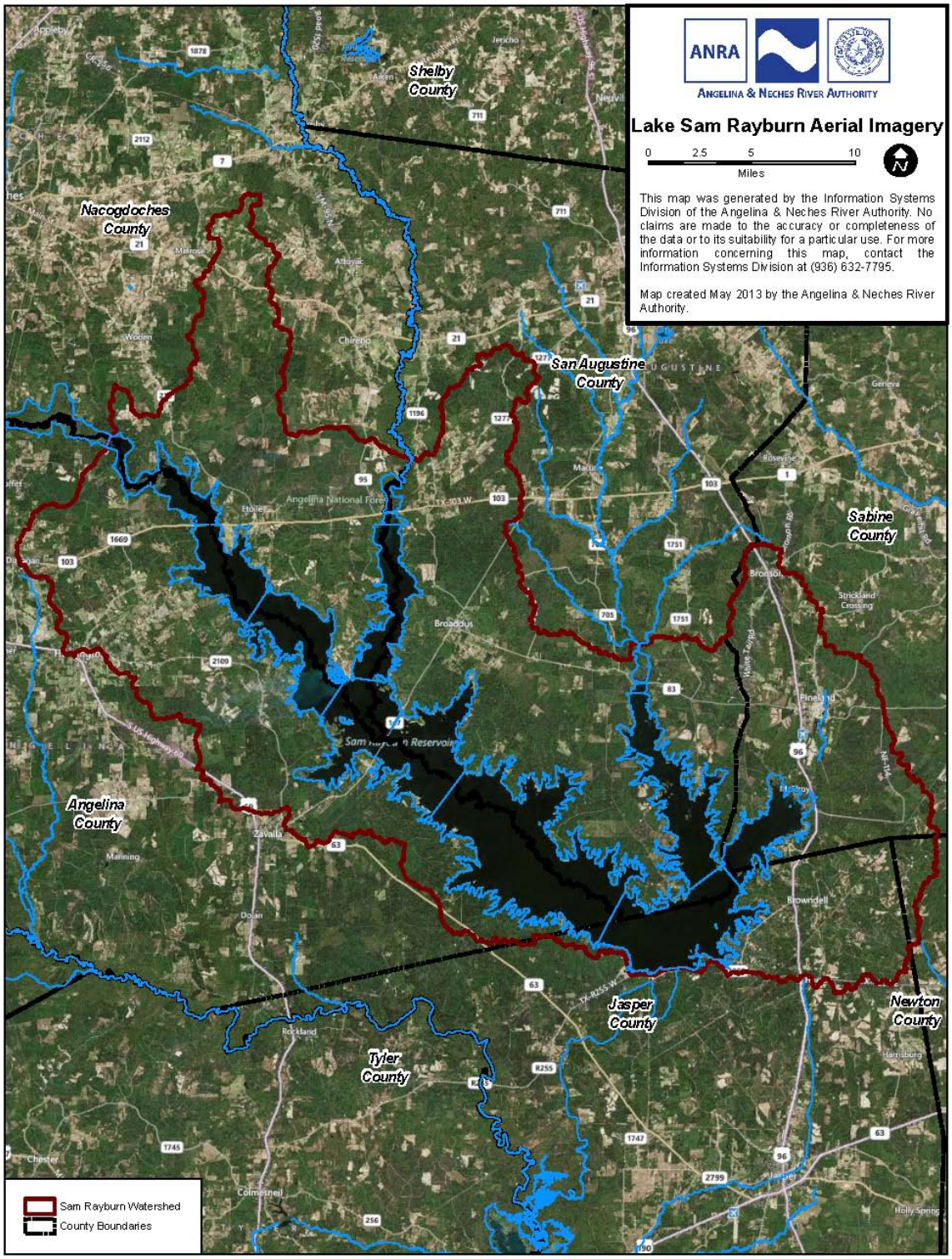
Soils

TABLE 7-8 Sam Rayburn Watershed Soil Types **(from NRCS)**		
Soil Type	**Percentage**	**Acres**
Alfisols	44.19%	217,102
Water	22.33%	109,739
Ultisols	18.82%	92,458
Entisols	5.95%	29,218
Vertisols	4.54%	22,288
Inceptisols	4.16%	20,464
Pits	0.01%	43
Mollisols	0.01%	27
TOTAL	100.00%	491,338

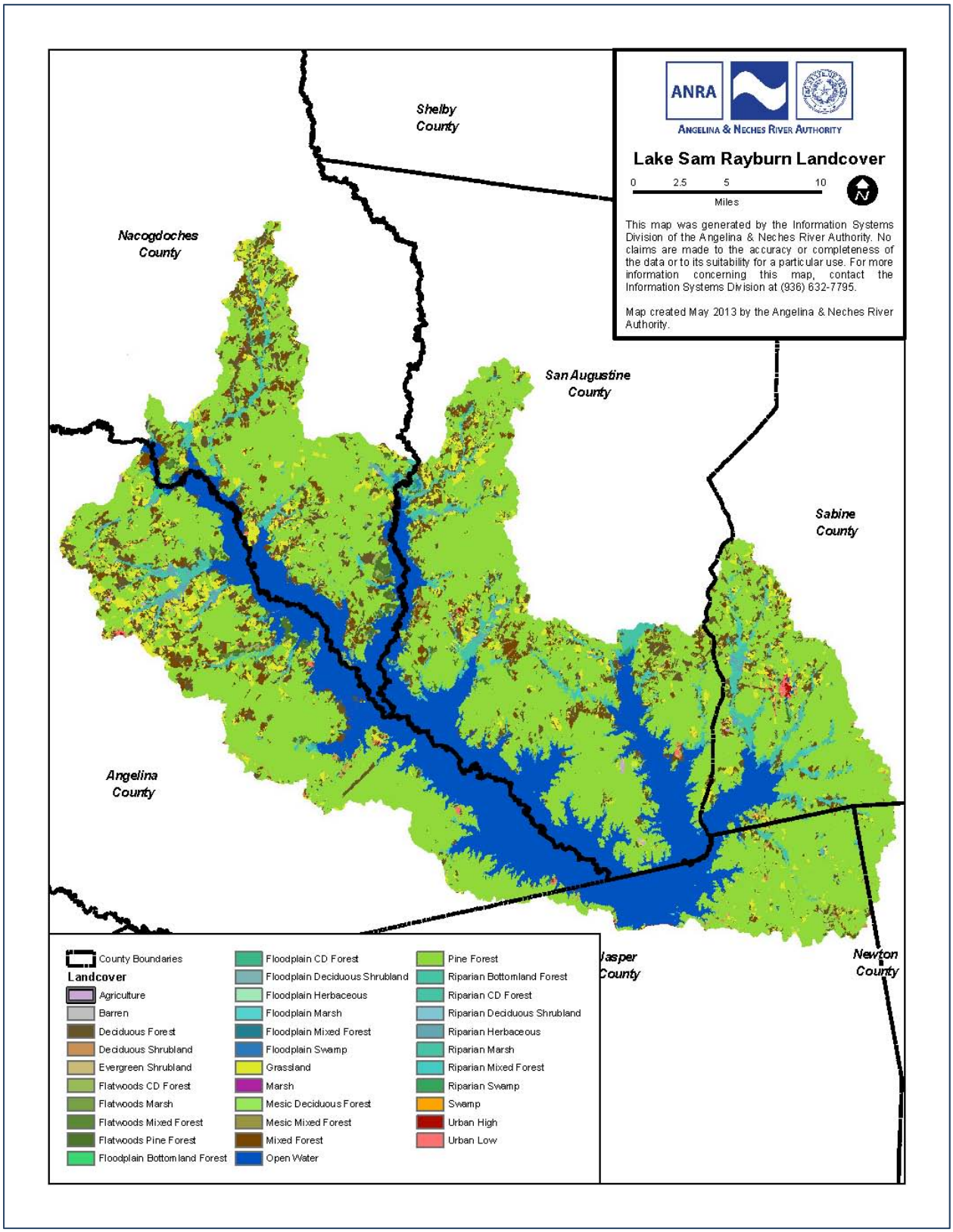


The shore of Sam Rayburn Reservior at Shirley Creek

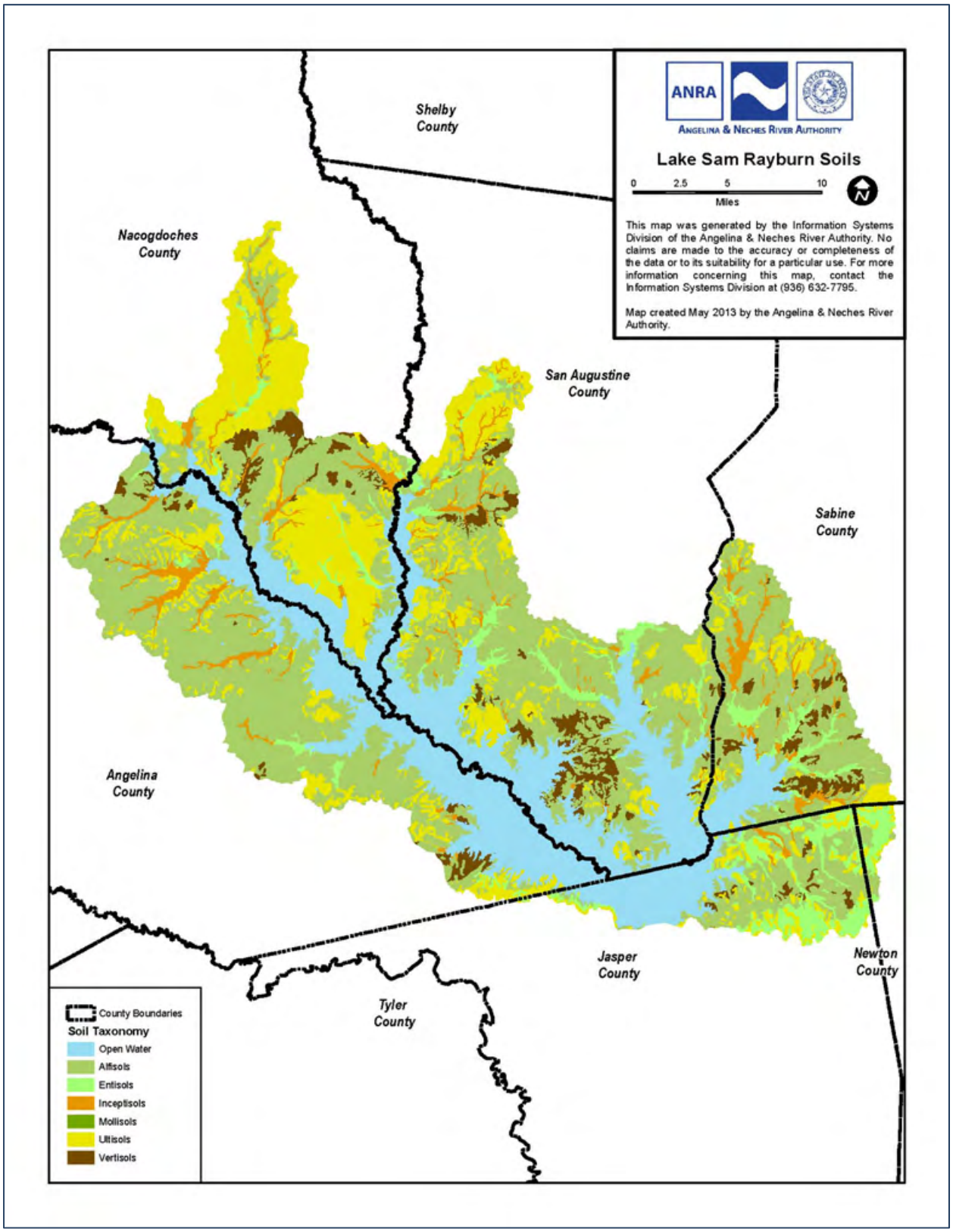
MAP 7-4 Sam Rayburn Reservoir Aerial Imagery



MAP 7-5 Sam Rayburn Reservoir Area Land Cover



MAP 7-6 *Sam Rayburn Reservoir Area Soils*



Description of Water Quality Issues

Site-Specific Uses and Criteria

Sam Rayburn Reservoir has a designated Public Water Supply use and a High ALU and corresponding DO criteria. Sam Rayburn Reservoir also has a designated primary contact recreation use with a corresponding *E. coli* geometric mean criteria of 126 MPN/100 mL.

Impairments and Concerns

Impairments for Mercury in Edible Tissue

All assessment units of Sam Rayburn Reservoir are listed as impaired for mercury in edible fish tissue.

TABLE 7-9 Impairments in Segment 0610 as listed in the 2012 Texas Integrated Report

Segment Name	Segment ID	Assessment Unit	Impairments	Category	Date First Listed
Sam Rayburn Reservoir	0610	0610_01	Mercury in edible tissue	5c	1996
		0610_02	Mercury in edible tissue	5c	1996
		0610_03	Mercury in edible tissue	5c	1996
		0610_04	Mercury in edible tissue	5c	1996
		0610_05	Mercury in edible tissue	5c	1996
		0610_06	Mercury in edible tissue	5c	1996
		0610_07	Mercury in edible tissue	5c	1996
		0610_08	Mercury in edible tissue	5c	1996
		0610_09	Mercury in edible tissue	5c	1996
		0610_10	Mercury in edible tissue	5c	1996

The Texas Department of State Health Services (then known as the Texas Department of Health) issued a fish consumption advisory for Sam Rayburn Reservoir in 1995 (Advisory 12).

Advisory Area: Sam Rayburn Reservoir

Contaminant of Concern: Mercury (Hg)

Species Affected: Freshwater drum and largemouth bass

Consumption Advice: Adults should limit consumption of freshwater drum and largemouth bass to no more than two (2) eight ounce (8 oz) meals per month.

Children under twelve (12) years old should limit consumption of freshwater drum and largemouth bass to no more than two (2) four ounce (4 oz) meals per month.

The advisory is available on the Texas Department of State Health Service's (DSHS) website:

Map of Consumption Advisory
http://www.dshs.state.tx.us/seafood/MapsPDF/AdvisoryMaps/SamRayburn.pdf

Fish and Shellfish Consumption Advisory Adv-12
http://www.dshs.state.tx.us/seafood/PDF2/Active/ADV-12_signed_TBR_SRR_BAS_CDL_BCC.pdf

Assessment of Risk for Consumption of Fish Taken From Sam Rayburn Reservoir
http://www.dshs.state.tx.us/seafood/PDF2/Risk-Characterization/SAM-RAYBURN-RC-1995.pdf

Concerns for Ammonia

Concerns for ammonia were identified for 7 of the 10 assessment units in Sam Rayburn Reservoir

TABLE 7-10 Summary of Ammonia Assessment Results for Sam Rayburn Reservoir (Segment 0610) As listed in the 2012 Texas Integrated Report

Assessment Unit (AU)	AU Description	# Assessed	# Exceeded	% Exceeded	Mean Exceedance (mg/L)	Criteria (mg/L)	Level of Support
0610_01	Main Pool by the Dam	60	27	45.0%	0.25	0.11	CS
0610_02	Lower Angelina River Arm	37	27	76.0%	0.25	0.11	CS
0610_03	Mid-Angelina River Arm (SH 147)	51	22	43.1%	0.25	0.11	CS
0610_04	Upper Mid-Angelina River Arm	43	30	69.8%	0.31	0.11	CS
0610_05	Lower Attoyac Bayou Arm	31	30	96.8%	0.34	0.11	CS
0610_06	Upper Attoyac Bayou Arm	27	0	0.00%		0.11	NC
0610_07	Upper Angelina River Arm	40	4	10.0%	0.16	0.11	NC
0610_08	Bear Creek Arm	37	29	78.3%	0.27	0.11	CS
0610_09	Lower Ayish Bayou Arm	42	32	76.2%	0.25	0.11	CS
0610_10	Upper Ayish Bayou Arm	27	0	0.00%		0.11	NC

CS = Concern for Screening Level
NC = No Concern

Concerns for Toxics in Sediment

Concerns for toxics in sediment were listed for two assessment units.

TABLE 7-11 Concerns for Use Attainment and Screening Levels for Sam Rayburn Reservoir (Segment 0610) Toxics in Sediment – As Listed in the 2012 Texas Integrated Report

Segment Name	Segment ID	Assessment Unit	Concerns	Level of Concern
Sam Rayburn Reservoir	0610	0610_01	Manganese in sediment	CS
		0610_03	Arsenic in sediment	CS
			Iron in sediment	CS
			Manganese in sediment	CS

CS = Concern for Screening Level
NC = No Concern

Potential Causes of Water Quality Issues

Point Sources

There are numerous point sources within the watershed, including WWTPs.

Non-Point Sources

On-Site Sewage Facilities (OSSFs) are prevalent in the watershed.

Urban Stormwater Runoff

For the metals impairments, including mercury, atmospheric deposition is the most likely source.

Potential Stakeholders

- United States Army Corps of Engineers
- Angelina & Neches River Authority
- Lower Neches Valley Authority
- Industrial, municipal, and agricultural entities serviced by LNVA
- City of Beaumont
- City of Lufkin
- City of Jasper
- Local Municipalities in the watershed (Cities of Huntington, Zavalla, Broaddus, Browndell, and Pineland)
- Texas Commission on Environmental Quality
- Texas State Soil and Water Conservation Board
- Natural Resource Conservation Service
- Texas Department of Agriculture
- Texas Railroad Commission
- Texas Parks and Wildlife
- US Geological Survey
- US Fish and Wildlife Service
- US Forest Service
- Brookeland WSC
- Rayburn Country MUD
- Temple-Inland, Inc.
- Landowners
- Recreational users

Recommended Actions

Routine monitoring on Sam Rayburn Reservoir is currently being performed by ANRA, LNVA, and TCEQ Region 10. Additional sampling, including targeted monitoring, may be necessary to determine the source(s) of the ammonia concerns in the reservoir. Additional studies may also be warranted to test for toxics in fish tissue or in sediment.

On-site reconnaissance of OSSFs and mapping of complaint investigations can possibly identify failing systems for replacement. In addition to being a source of bacteria, OSSFs may also be contributing to the ammonia concerns. ANRA applied for and received funding through TCEQ as part of the FY 13 Federal Clean Water Act § 319 Non-Point Source grant program to initiate a mapping project of septic systems around Sam Rayburn Reservoir and the unincorporated portion of San Augustine County. A component of this project will also include identification and replacement of failing OSSFs in the Attoyac Bayou watershed in both San Augustine and Nacogdoches Counties during Year 2 (FY 15) of the project. The 319 Grant project is scheduled to begin in September 2013.

Ongoing Projects

Water Quality Monitoring

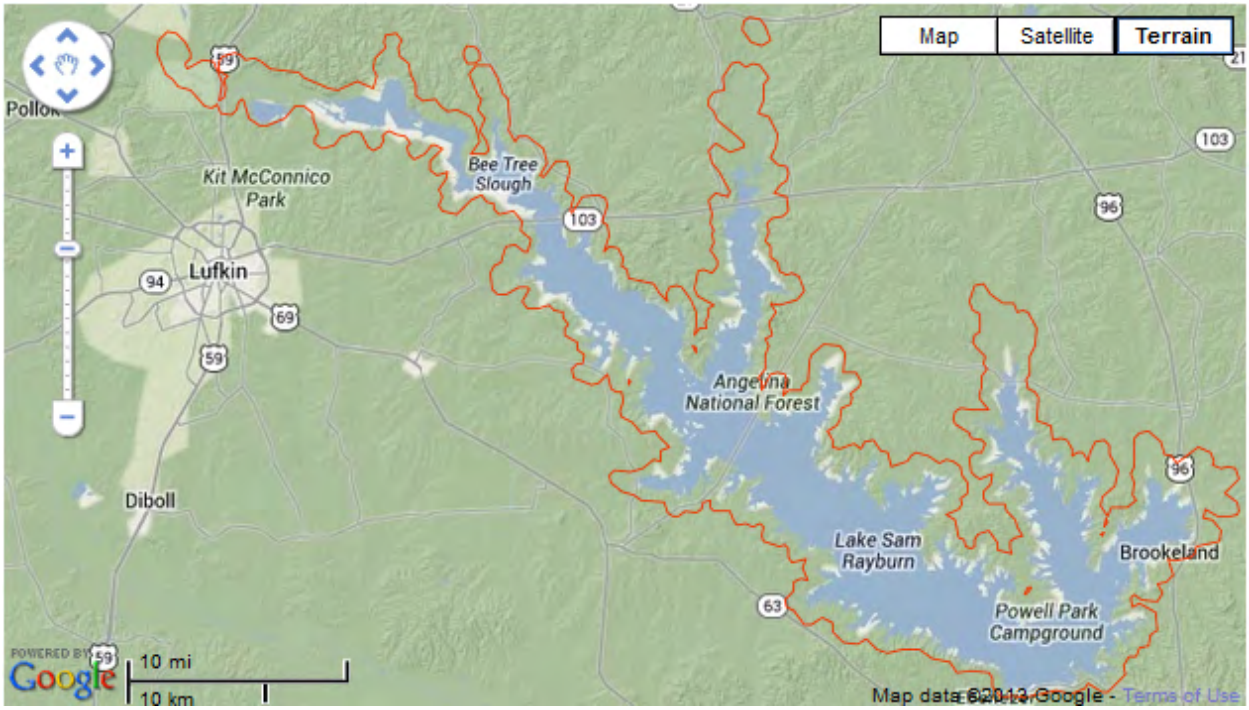
Water quality monitoring is conducted in Sam Rayburn Reservoir by ANRA, LNVA, and TCEQ Region 10. ANRA samples for routine parameters quarterly at three (3) monitoring stations.

Control Zone Rayburn

Control Zone Rayburn (CZR) is ANRA's program to regulate On-site Sewage Facilities (OSSF) near the Sam Rayburn Reservoir and in San Augustine County.

The ANRA area of jurisdiction includes the unincorporated portion of the county of San Augustine, and the portions of the other four counties surrounding Sam Rayburn Reservoir that fall within the regulated zone surrounding the lake. The regulated zone around Sam Rayburn Reservoir begins at the USACE take line (171 ft contour) and extends 2000 feet outward. If any part of a subdivision lies within the regulated zone, then the entire subdivision is within ANRA's jurisdiction. ANRA provides permitting and licensing of all new septic systems in the regulated zone, real estate septic inspections and license transfers, and responds to septic complaints and sewer nuisances.

FIGURE 7-44 Approximate Map of the 2000-ft Regulated Zone Around Sam Rayburn Reservoir



Major Watershed Events

The drought significantly impacted the water levels in Sam Rayburn Reservoir. During the Drought of 2011, several reservoirs in the basin reached record or near record low levels. This impacted not only recreational uses of the water, but also jeopardized drinking water supplies for municipalities that depend upon surface water. On November 19, 2011, Sam Rayburn Reservoir reached a low of 150.80 ft, nearly matching the record of 150.75 ft set August 10, 1996. According to Floyd Boyett of the USACE, the primary reason Sam Rayburn levels did not break the record (probably in dramatic fashion) was the saltwater barrier in Beaumont. Prior to the completion of the barrier in 2003, releases from Sam Rayburn were required to keep saltwater from intruding upstream into the Neches River. With the barrier in place, the USACE was able to retain much more water in the reservoir during Spring and Summer 2011, and even completely halt releases from November 2011 to May 2012.

FIGURE 7-45 Sam Rayburn Reservoir Water Surface Elevation above Datum

08039300
Sam Rayburn Res nr Jasper, TX
Elevation of reservoir water surface above datum, ft

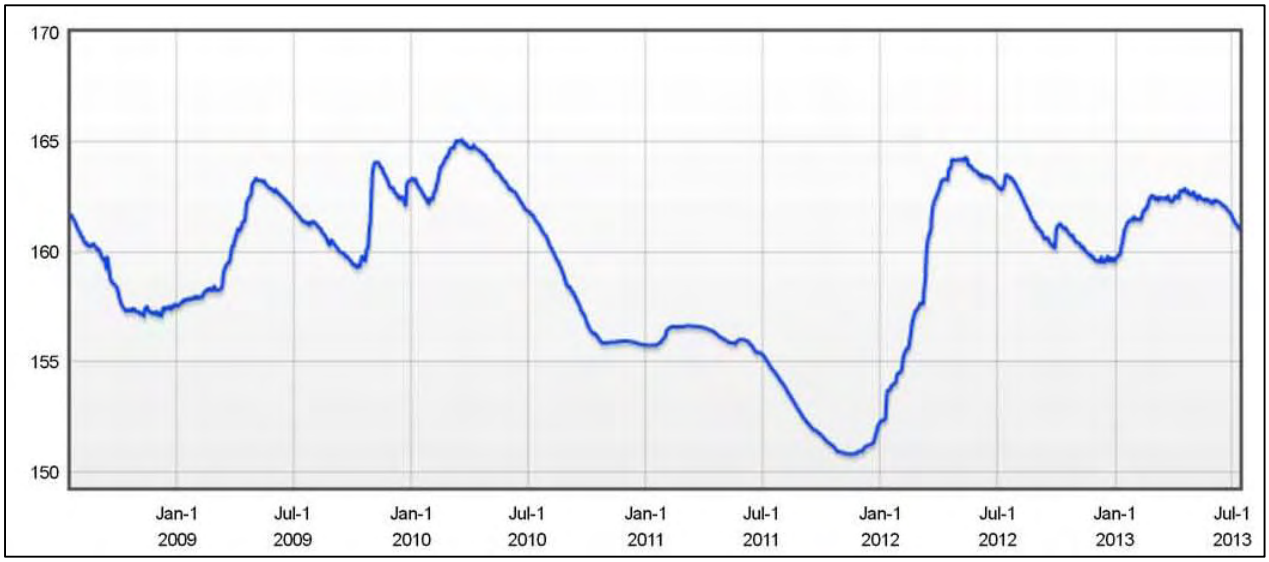


FIGURE 7-46 Sam Rayburn Angelina Arm at SH 103 Bridge during Drought Conditions – 9/22/2011

FIGURE 7-47 Sam Rayburn at SH 147 Bridge during Drought Conditions – 9/22/2011

Relocation of Monitoring Stations due to Extreme Drought Conditions

10615 - Sam Rayburn at Marion's Ferry

Due to the drought, it became necessary in 2011 to create a new monitoring location near Marion's Ferry to replace Monitoring Station 10615. Station 10615 is located directly at the boat ramp, which is not on the river channel, so as the reservoir receded, sampling became impossible. A new monitoring station (21100) was created three quarters of a kilometer downstream of the boat ramp on the main river channel.

FIGURE 7-48 Effects of Extreme Drought on Monitoring Station 10615

APPENDICES

APPENDIX A - LIST OF TABLES, FIGURES, AND MAPS

APPENDIX A - LIST OF TABLES, FIGURES, AND MAPS

Maps are listed in **BOLD**
Figures depicting monitoring stations are listed in **BLUE BOLD**

ACKNOWLEDGMENTS

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2013 Upper Neches Basin Highlights Report

The 2013 Basin Highlights Report was prepared by the Angelina & Neches River Authority
in cooperation with the Texas Commission on Environmental Quality (TCEQ)
under the authorization of the Texas Clean Rivers Act.