2021

Texas Clean Rivers Program Basin Summary Report

Lower Neches Basin and Neches-Trinity Coastal Basin

LNVA
LOWER NECHES VALLEY AUTHORITY

THE TEXAS CLEAN RIVERS PROGRAM

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0. Executive Summary

In 1933, the 43rd Legislature of the State of Texas created the Lower Neches Valley Authority (LNVA) in order to fulfill the need for an organization that would protect freshwater supply, increase the availability of freshwater in storage, and improve distribution systems in the Neches River Basin and Neches Trinity Coastal Basin. Almost 90 years later, the LNVA continues to provide for the present and long-term freshwater needs of municipal, agricultural, and industrial customers with an affordable water supply, and enhances economic development in the LNVA's jurisdiction. As with other water authorities in Texas, the LNVA is charged with protecting natural resources through conservation, storage, and distribution of quality freshwater to its customers. The LNVA provides raw water for industrial, municipal, agricultural, and mining uses.

The Texas Legislature passed the Texas Clean Waters Act, in 1991, to ensure rivers and streams across the state are protected and sustainably utilized, without jeopardizing the integrity of the resource. As a result, the Texas Clean Rivers Program (CRP) was born. This program, in coordination with the Texas Commission on Environmental Quality (TCEQ) and regional water authorities across the state, is tasked with water quality monitoring, basin health assessments, and to engage stakeholders on how to improve the quality of surface water within each river basin of Texas. Currently, fifteen (15) regional water authorities, which are made up of twelve (12) river authorities, one (1) water district, one (1) council of governments, and one (1) international water commission, possess contracts with the TCEQ to conduct water quality monitoring, assessments, and stakeholder outreach in the 23 major river and coastal basins of Texas. The LNVA monitors and assesses surface water quality in the lower Neches Basin. The upper portion of the Neches Basin is monitored and assessed by the Angelina & Neches River Authority, based in Lufkin, Texas.
Completing a basin summary report every five to six years is one of the requirements of the Texas Clean Rivers Program. The basin summary report provides a comprehensive review of water quality data and covers the lower Neches and Neches-Trinity Coastal Basins.

Basin Impacts, Activities, and Accomplishments

Since the previous basin summary report submitted in 2015, there have been a number of historic events in southeast Texas and throughout the world. These events have presented a number of challenges for the LNVA's Clean Rivers Program to overcome.

Hurricane Harvey

In August of 2017, Hurricane Harvey made landfall in Texas causing catastrophic flooding in southeast Texas. The flooding damaged the LNVA Saltwater Barrier Administration building and laboratory, which serves as a home office for LNVA's CRP. Monitoring efforts were put on hold for a period of time while the Saltwater Barrier laboratory was rebuilt. Due to these extraordinary circumstances, LNVA CRP staff made a presentation about the obstacles faced in the aftermath of Hurricane Harvey at the 2018 Surface Water Quality Monitoring Conference in Bandera, Texas.

In addition to reconstruction of the Saltwater Barrier, where the LNVA water quality lab resides, other alterations were made following this flood of record to better prepare the LNVA for catastrophic events. The Continuous Ambient Monitoring Station (CAMS) 749 located on Pine Island Bayou (PIB) near the Hwy 69 bridge was one targeted improvement. This monitoring station was originally installed in June 2008 by the TCEQ in cooperation with the LNVA to monitor water quality concerns on PIB. Due to flooding from Hurricane Harvey, CAMS749 data logging equipment was destroyed, resulting in the loss

of months of data. In an attempt to reduce the risk of future loss, the data logging equipment was relocated to a higher elevation, which would allow data collection to continue during flood conditions of Hurricane Harvey's magnitude.

In addition to the data logging equipment relocation, the original water quality measurement technology was upgraded from a YSI 6920 V2 to a YSI EXO3 sonde. This sonde measures water quality parameters of pH, dissolved oxygen, turbidity, conductivity, depth, and temperature. These measurements can be found on TCEQ's website (https://www.tceq.texas.gov/cgi-bin/compliance/monops/water_daily_summary.pl?cams=749). CAMS749 has been extremely beneficial to LNVA customers when water is being diverted directly from PIB instead of the LNVA's primary water supply, the Neches River, as the water qualities of the two sources can differ greatly. CAMS749 allows downstream customers to identify variations in water quality in advance to prepare for any change in water treatment operations.

Tropical Storm Imelda

In September of 2019, Tropical Storm Imelda produced over forty inches of rain in some areas of southeast Texas, including the City of Beaumont and the Houston metropolitan area. The rainfall resulted in catastrophic flooding and prompted evacuations. Most of the flood related damage was concentrated in Jefferson County as the highest rainfall total was 44.29 inches recorded 2 miles south-southwest of Fannett, Texas (Latto & Berg, 2020). Over 5,100 homes were estimated to be damaged in Jefferson County alone.

Mussel Discovery (Louisiana pigtoe)

Currently under review for federal species protection, the Louisiana pigtoe (*Pleurobema Riddellii*) was thought to have a specific, preferred habitat type. The discovery of 2,209 Louisiana pigtoes within the LNVA canal system has raised new questions about the preferred habitat of this species and the extent of existing populations. This community represents the largest known Louisiana pigtoe population located to date. Since the initial discovery of this mussel in a LNVA canal, Louisiana pigtoes have been collected throughout portions of the LNVA's canal system sustaining year-round water delivery. Man-made canals with muddy bottoms and concrete structures were not considered suitable habitat for the Louisiana pigtoe; however, in seventeen days of surveys, LNVA's environmental consultant recorded and relocated 26 of the 32 species of mussel known to southeast Texas. To date, 32,966 individual specimens, including 2,264 Louisiana pigtoes, were identified within the lower Neches Basin and LNVA canal system. These findings have aided Authority staff in the identification of preferred Louisiana pigtoe habitats within the Neches River, Angelina River, Sabine Basin, and other portions of the LNVA canal yet to be surveyed. The LNVA looks forward to acting as a partner with adjacent river authorities, the Texas Parks and Wildlife Department, the Texas Comptroller, and the United States Fish and Wildlife Service in the continued efforts to learn more about the health of Louisiana and other proposed endangered species throughout this region.

TPC Explosion

An explosion at the TPC chemical plant, an LNVA industrial customer, occurred in the early morning hours on November 27, 2019 in the City of Port Neches. The explosion occurred in the area of the facility that manufactures or processes butadiene, a chemical whose long-term exposure has been linked to cardiovascular disease and cancers. TCEQ and EPA investigated the explosion and monitored air quality in the area after the explosion occurred. The LNVA spill response team, which is largely made up by LNVA CRP staff, was deployed to collect water samples at several locations on the canal to ensure

the water supply had not been contaminated. A second explosion occurred that resulted in a tower and other debris being scattered through the area. A mandatory evacuation for residents within a half mile from the facility, and a shelter in place was instituted for the city of Groves, and for Orange County residents south of IH-10. In total, four process towers fell, or were compromised, in the explosion. Fires continued to burn for days in the aftermath of the event.

Training

LNVA's CRP staff attended Surface Water Quality Monitoring (SWQM) workshops held by the Environmental Institute of Houston at the University of Houston-Clear Lake in 2019 and 2020. These workshops focus on water quality and hydrology monitoring, while highlighting the methodology of SWQM procedures. Biological and physical habitat monitoring was also included in this workshop training for aquatic life monitoring assessments. Fish collection, utilizing electroshocking and seining, and benthic macroinvertebrates collection, utilizing five-minute kick net sampling, were methods included in the physical monitoring skills. Stream morphology recognition, instream channel characteristic identification, and biological and physical habitat data recording were other skills taught. At the conclusion of the workshop, LNVA staff received certificates of completion for the water quality, hydrology, and biological and physical habitat monitoring courses.

Sampling and Assessments

The LNVA added Aquatic Life Monitoring (ALM) in fiscal years 2019 and 2020 to Beech Creek and Cypress Creek located in the Village Creek segment of 0608. ALM is a tool used to determine attainment of existing aquatic life use in a stream. Monitoring is conducted in the index period, which runs from March 15th to October 15th. One round of sampling is conducted during the non-critical period of the index in either March through June or October through November. These periods are when aquatic life would be least stressed. Another round of sampling is performed in the critical period, which runs July until September, when temperatures are at their highest and flows potentially at their lowest, when aquatic life would be most stressed.

Water Monitoring Solutions was contracted to monitor both creeks for habitat, benthic, nekton, 24-hour dissolved oxygen, flow, and water chemistry. LNVA CRP staff assisted with the monitoring project and gained valuable biological monitoring experience. The contractor completed a round of sampling in the critical period in August of 2019; however, non-critical sampling in October was postponed due to Tropical Storm Imelda and other precipitation events. Once all of the required sampling for an assessment is complete, a summary report of the findings will be created.

COVID-19

The COVID-19 pandemic brought about a new challenge in the world. In order to ensure the safety of staff, the LNVA instituted remote working and alternating schedules to limit close interaction. Throughout the pandemic, CRP staff were able to accomplish every deliverable and monitoring requirement except for routine monitoring on three Lake Sam Rayburn sites due to safety protocols temporarily. As the protocols for COVID-19 evolved, staff were able to conduct routine monitoring through the end of the year. As virtual meetings became the new normal, LNVA's Steering Committee and Coordinated Monitoring meetings were held in virtual formats.

Partner Participation

LNVA's Clean Rivers Program Steering Committee is a diverse group of stakeholders representing a variety of interests in the basin, including concerned citizens, environmental groups, industry, and a

variety of state agencies. Steering Committee meetings take place every year to discuss the status of LNVA's CRP, review contracts, budgets, water quality issues, basin studies and reporting, and establish water quality monitoring priority within the basin. LNVA's Steering Committee members provide a wealth of knowledge and practical ideas to assist in improving water quality monitoring and basin assessments.

Additionally, the LNVA participated in the coordination committee for the Hillebrandt Bayou and Neches River Tidal Total Maximum Daily Load (TMDL) Project and Implementation Plans and the Sandy and Wolf Creek Implementation Plans (I-Plans). The Agri-Life Extension Service developed these projects, which are facilitated by the Texas Water Research Institute and the TCEQ. In an effort to keep the projects on a state level, the projects attempt to address contact recreation concerns for bacteria in their waterbodies through local stakeholder input. The LNVA, through its CRP, will provide education, outreach, and participation information to its stakeholders and the public about these projects.

Public Outreach

Public education and outreach have been a priority for the LNVA for decades. CRP staff have provided water quality education materials to schools and organizations within the basin, and even participated as science fair judges. The LNVA continues to support water quality monitoring volunteers through the Texas Stream Team Program. The LNVA also provides the Major Rivers educational curriculum materials to schools and the public during educational events. Other events like the Neches River Rally, a paddling tour for kayakers, and the Neches River Festival River Day (an educational event for local high school seniors) allow CRP staff the opportunity to interact with the community about the importance of the Clean Rivers Program, the Neches River, and its water quality. Although some of these events were cancelled due to COVID-19 in 2020, the LNVA has resumed these educational outreach opportunities in 2021.

Monitoring

The Surface Water Quality Monitoring (SWQM) Program is an integral part of the CRP in the basin. The LNVA is responsible for monitoring 23 locations in the lower Neches Basin for surface water quality. The data collection, resulting from the LNVA quarterly sampling, accounts for most of the data provided to TCEQ in the lower Neches Basin. This data is put through strict quality assurance guidelines and is included for assessment in the Texas Integrated Report as a requirement of the Clean Waters Act.

Significant Findings

Texas surface water quality standards define the water quality goals of a water body or portion thereof, in part, by designating the intended use or uses for that waterbody. The state of Texas adopted water quality standards to protect public health or welfare, enhance the quality of water, and serve the purposes of the Clean Water Act. The inability of a Texas waterbody to meet the Texas stream standards for a seven-to-ten-year assessment period is outlined in the Integrated Report, which is updated every two years and shown in Tables ES.1 and ES.2.

As show below, Table ES.1 summarizes the status of the water quality use designations, according to the 2020 Texas Integrated Report, for each segment in the LNVA's assessment area in the lower Neches and Neches Trinity Coastal Basins. The status of the designated use for each segment for impairments or concerns is designated by color.

Segment Number	Segment Names	General Use Criteria	Contact Recreation	Domestic Water Supply	Fish Consumption	Aquatic Life
0601	Neches River Tidal	★	★	★	★	★
0602	Neches River Below B.A. Steinhagen Lake	★	★	★	★	★
0603	B.A. Steinhagen Lake	★	★	★	★	★
0607	Pine Island Bayou	★	★	★	★	★
0608	Village Creek	★	★	★	★	★
0609	Angelina River Below Sam Rayburn Reservoir	★	★	★	★	★
0610	Sam Rayburn Reservoir	★	★	★	★	★
0701	Taylor Bayou Above Tidal	★	★	N/A	★	★
0702	Intracoastal Waterway Tidal	★	★	N/A	★	★
0703	Sabine-Neches Canal Tidal	★	★	N/A	★	★
0704	Hillebrandt Bayou	★	★	N/A	★	★

Legend	
★	There is a use concern or a non-support of a particular parameter in that use category
★	All parameters fully support that particular use designation
N/A	Not a use for that particular segment

Table 0.1 Status of Water Quality Use Designation per Segment

Segment	Station #	Station Name	pH	Total Organic Carbon	Nitrite + Nitrate	Alkalinity	Hardness	Chlorophyll-*a*	Specific Conductivity/ Total Dissolved Solid	Chloride
	Segment 0601 Neches Tidal									
0601	10575	Neches River @ I10	↓							
	Segment 0602 Neches below BA Steinhagen									
0602	10581	Neches River @ 1013	↑			↑D	↑D		↑D	
0602	10580	Neches River @ HWY 96						↓		
0602	15343	Neches River@ Lakeview					↑D			
	Segment 0603 B.A. Steinhagen									
0603	10582	B.A. Steinhagen	↓							↓D
	Segment 0608 Village Creek									
0608B	15354	Big Sandy Creek			↓D					
0608A	10529	Beech Creek	↑							
0608F	15356	Turkey Creek					↑D			
0608	13625	Village Creek @418	↑D						↑D	
0608	10609	Village Creek @ 96	↓	↑						
	Segment 0702 Intracoastal Tidal									
0702	17426	Intercoastal Waterway		↑						
	Segment 0703 Sabine Neches Canal Tidal									
0703	10652	Taylor Bayou		↑	↑					

Legend		
Box Colors		Positive water quality trend
		Cautionary water quality trend; data suggests related to increases or decreases in flow; trends to keep an eye on for target monitoring
		No cause for trend identified yet; target monitoring to determine cause
		Trend exists and should be watched, but is slight according to data analyzed for this assessment
Symbols	↑	Increasing Trend
	↓	Decreasing Trend
	D	Trend appears drought related; drought related increasing or decreasing trends may disappear in next assessment

Table 0.2 Trends found in LNVA Data Assessment

Recommendations

Recommendations to address water quality impairments and concerns are shown in Table 4.1. The water quality data assessed in the 2020 Texas Integrated Report does not meet all surface water quality standards and assessment criteria for the Lower Neches and Neches-Trinity Basin. Each segment in both basins have listed impairments and/or concerns. Significant progress has been made to address some of these issues, but additional resources and coordination with partnering agencies will be required to target them all. The LNVA is committed to this effort and will work closely with TCEQ and other agencies to identify additional funding and resources for basin improvement opportunities. The LNVA will also use the results of the trend analysis in order to develop future special studies and target monitoring.

1. Introduction

The Texas Clean Rivers Program was established in 1991. It is a state fee-funded, non-regulatory program that was created to provide a framework and forum for managing water quality issues with a holistic state-wide approach. The focus of the program is to work at the watershed level within each river basin and coordinate the efforts of the organizations included in each basin. There are currently 15 regional water authorities that have CRP contracts with the TCEQ to conduct water quality monitoring assessments and stakeholder outreach in the 23 major river and coastal basins of Texas. Of the 15, 12 are river authorities; one a water district; one a council of governments; and an international water commission. The map below shows the basins in Texas as well as the CRP partner agencies.

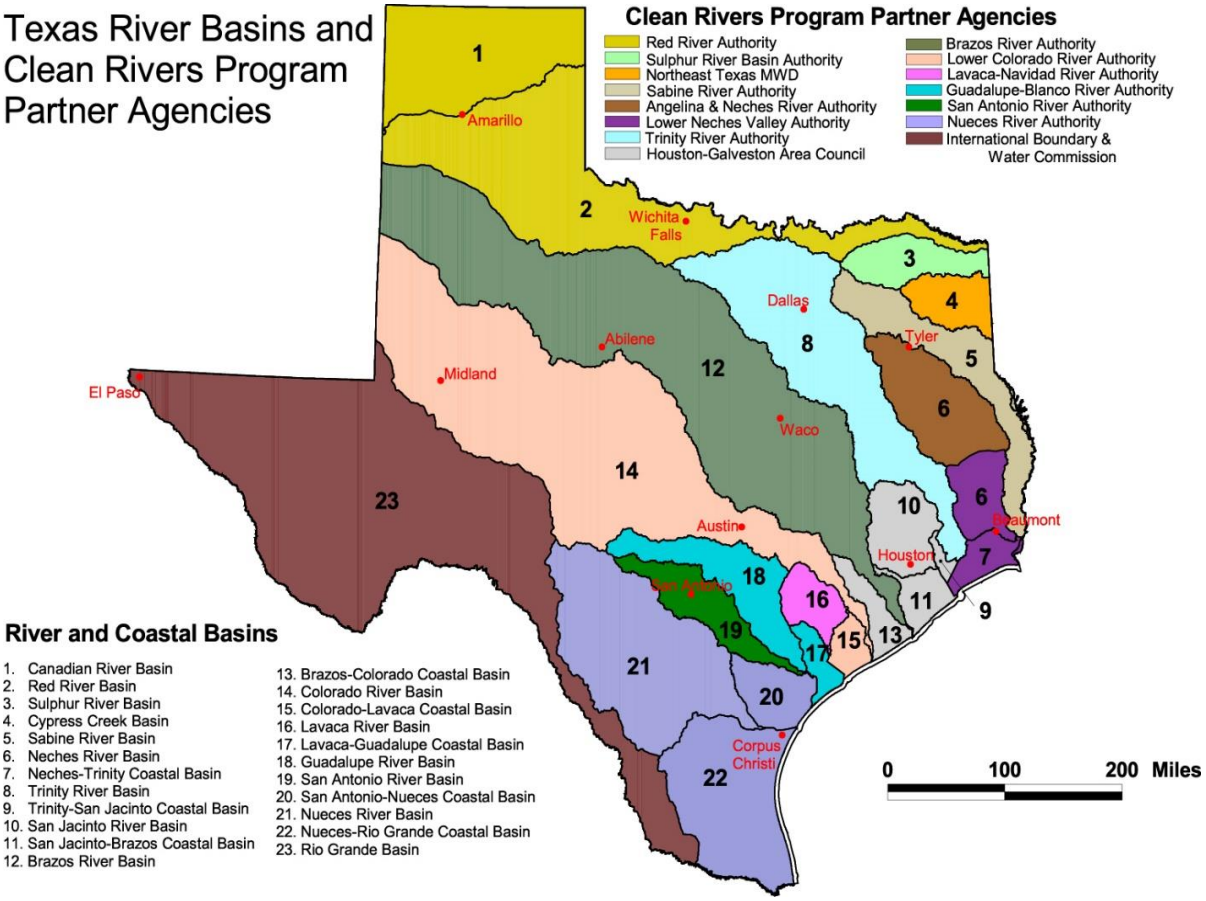

Figure 1.1 Texas River Basins and Clean Rivers Program Partners (Image from www.tceq.texas.gov)

1.1. CRP Goal and Objectives

The goal of the Clean Rivers Program is to maintain and improve the quality of surface water within each river basin in Texas through an ongoing partnership involving the Texas Commission on Environmental Quality, river authorities, other state agencies, regional entities, local governments, industry, and citizens. The program's watershed approach will identify and

evaluate water quality issues, establish priorities for corrective action, work to implement those actions and adapt to changing priorities.

There are six program objectives for the Clean Rivers Program. These objectives are:

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

In order to accomplish the program goal and objectives, the Clean Rivers Program is divided into six different tasks. These tasks are as follows:

- Task 1 - Project Administration
- Task 2 - Quality Assurance
- Task 3 - Water Quality Monitoring
- Task 4 - Data Management
- Task 5 - Data Analysis and Reporting
- Task 6 - Stakeholder Participation and Public Outreach
- Task 7 - Special Projects

Under the Task 5 for Data Analysis and Reporting, completing this Basin Summary Report every 5-6 years is one of the requirements of the program. The purpose of the Basin Summary Report is to provide a comprehensive review of water quality data and involves a detailed discussion of data analysis findings. This report serves to develop a greater understanding of basin water quality conditions, identify trends and changes, and aid in making decisions regarding water quality issues in each river and coastal basin in Texas.

The primary focus in the basin is data collection from the surface water quality monitoring program (Task 3) to obtain information on the physical, chemical, and biological characteristics of the watershed. The LNVA is responsible for CRP monitoring activities within the Lower Neches River and Neches-Trinity Coastal Basins. The LNVA has increased monitoring efforts over the years and maintained a routine monitoring program in the basin. Additional monitoring stations are incorporated to provide important water quality data on impaired segments and/or improve spatial coverage in the basin as funding is available. All CRP monitoring is conducted in accordance with a TCEQ approved Quality Assurance Project Plan (QAPP) and TCEQ's *Surface Water Quality Monitoring Procedures Manual*.

1.2. Coordination and Cooperation in the Basin

In order to ensure the most cost-effective monitoring of the Neches River Basin and Neches-Trinity Coastal Basin, the CRP program relies on a cooperative effort between agencies within the basin. The LNVA coordinates monitoring activities in the lower portion of the Neches River

Basin with TCEQ's Surface Water Quality Monitoring (SWQM) program, and TCEQ's Region 10 Field Office located in Beaumont. The upper portion of the Neches River Basin is monitored by Angelina River Authority headquartered in Lufkin, TX. The LNVA participates in the annual Coordinated Monitoring Meeting for the Neches River Basin which is attended by all water quality monitoring agencies in the basin and TCEQ. the Texas Water Research Institute and the Texas State Soil and Water Conservation Board are other agencies involved in this coordination effort.

1.3. Physical and Water Characteristics by Basin

1.3.1. Lower Neches River Basin Physical Characteristics

Texas is divided into 10 natural regions or ecoregions, as shown in Figure 1.2: Piney Woods, Gulf Prairies and marshes, Post Oak Savanah, Blackland Prairies, Cross Timbers, South Texas Plains, Edwards Plateau, Rolling Plains, High Plains, and the Trans-Pecos. The Lower Neches River Basin assessment area is located in the region known as the Piney Woods. The lower Neches Basin encompasses approximately 3,318 square miles consisting of Hardin County and portions of Tyler, Jasper, Jefferson, Liberty, Polk, and Orange Counties. Cities include Jasper, Silsbee, Kountze, Lumberton, Sour Lake, Port Neches and portions of Beaumont/Port Arthur.

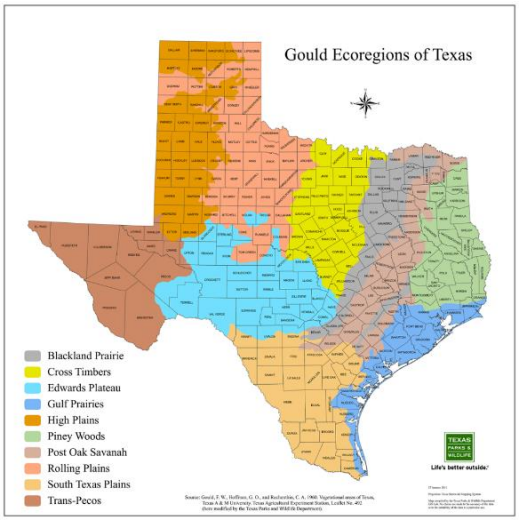

Figure 1.2 Gould Ecoregions

The Piney Woods is geographically located between the Sabine River to the east and the Trinity River to the west, as shown in Figure 1.3. This region is part of a pine-hardwood forest extending into Louisiana, Arkansas, and Oklahoma. The annual rainfall from 1999-2020 for the Texas portion of the Piney Woods ranged from approximately 29 to 81 inches, and the temperature averages a humid 67 degrees. The soils in this region are generally acidic and pale to dark gray sands or sandy loams. Elevations throughout the Texas Piney Woods range from approximately 50-500 feet above sea level.

Figure 1.3 Piney Woods Ecoregion

The Piney woods region can be described as pine and pine-hardwood forests with scattered areas of cropland, planted pastures, and native pastures. Timber and cattle production are important industries in the region. The lower basin has a

variety of trees, shrubs, and vines that grow together in assemblages based on soil type, flood duration, and water depth. This region is heavily forested with loblolly and shortleaf pine, and species of oaks, magnolia, elms, water tupelo, bald cypress, and sweet gum. Shrubs and vines are thick in this part of Texas with common species of American beautyberry, southern wax myrtle, holly, flowering dogwood, wild grapes, and greenbrier.

1.3.1.a. Lower Neches River Basin Water Quality Characteristics

Within the floodplains of the lower Neches River, water levels fluctuate in pools, sloughs, and oxbows due to high precipitation, overbank flooding, and subsurface groundwater. Several Big Thicket National Preserve Units are located in this portion of the basin.

Major tributaries in the Lower Neches River Basin include Village Creek (Segment 0608) and Pine Island Bayou (Segment 0607). Wolf Creek, Sandy Creek, Big Sandy Creek, Turkey Creek, Hickory Creek, Beech Creek, Cypress Creek, Little Pine Island Bayou, and Willow Creek are additional tributaries monitored by LNVA.

The quality of surface water tends to reflect the characteristics of the soils within the watershed. The streams in the Lower Neches River Basin meander through forested areas, acidic soils, and sandy loams. Soils consist of sand, silt, and large deposits of colloidal clay that drain poorly. Many area streams are low gradient, sluggish, and course through low-lying "swampy" areas where depressed levels of dissolved oxygen and low pH develop naturally. Periods of low stream flow and warm weather further contribute to low dissolved oxygen levels. While nature accounts for some of the water quality shortcomings, other water quality problems cannot be attributed to the environment. Impairments to surface water are generally attributed to point and non-point source pollution. While point sources are regulated, such as discharge from a municipal or industrial wastewater treatment plant, non-point sources are largely unregulated. Non-point source pollution occurs when rainfall runoff transports contaminants over the land surface into adjacent water bodies. Not only can pollutants on land be washed into waterways, airborne contamination can precipitate out or be deposited directly in the water bodies. Runoff from agricultural fields increasing nutrient levels and animal waste increasing bacteria levels are examples of non-point source pollution.

1.3.2. Neches-Trinity Coastal Basin Physical Characteristics

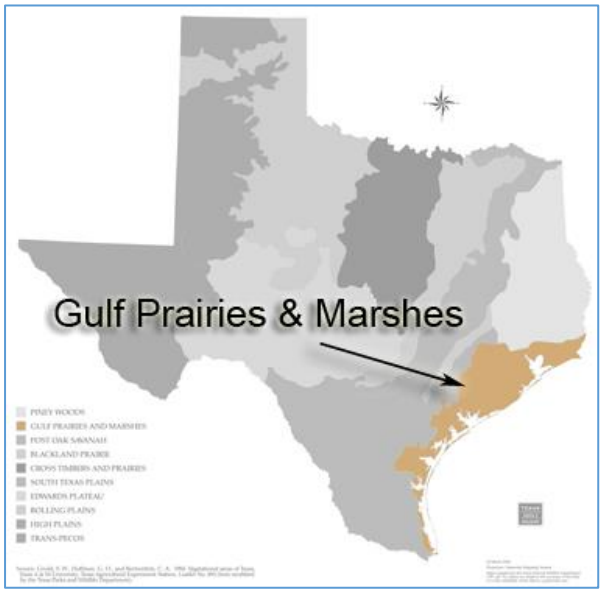

Figure 1.4 Gulf Prairies & Marshes Ecoregion

The Neches-Trinity Coastal Basin is situated in southeast Texas within the Western Gulf Prairies and Marshes ecoregion, as shown in Figure 1.4. This coastal basin includes four classified segments with a drainage area of 769 square miles. Low gradient streams, dredged waterways, and estuaries adjacent to the Gulf of Mexico characterize the water bodies in the coastal basin. This land is relatively flat with an elevation of less than 150 feet. This region is dissected by rivers and streams flowing into the Gulf of Mexico with bands of marsh bordering the coast. Soils are fine textured and made up of dark clay, clay loam, and sandy clay loam which drain poorly; therefore, much of the soils remain wet for parts of the year. The region includes barrier islands along the coast, salt grass marshes surrounding bays and estuaries, remnant tallgrass prairies, oak parklands and mottes scattered along the coast, and tall woodlands in the river bottomlands. Annual rainfall from 1999 to 2020 ranged from approximately 36 to 83 inches, and temperature was a humid 71 degrees. The growing season is usually more than 300 days, with high humidity and warm temperatures being common. Native vegetation consists of tallgrass prairies and live oak woodlands. Brush species, such as mesquite and acacias, are more common now than in the past. Although much of the native habitat has been lost to agriculture and urbanization, the region still provides important habitat for migratory birds and spawning areas for fish and shrimp. The southernmost portion of this basin is comprised of coastal marshes that receive the bulk of their nutrients and sediments from the Neches and Trinity Rivers to the north. Several bayous, streams, tidal channels, and canals flow through this coastal basin with common vegetation of oaks, sweetgum, common reed, cordgrasses, sedges, bulrushes, and rushes. Historically, the flora was mostly tallgrass prairies and Post Oak savannas, but fire suppression, agriculture, and urban development have resulted in invasive species and various types of oak becoming more common. Large areas of the coastal basin have been converted to national wildlife refuges. Roseate Spoonbills, Laughing Gulls, River Otters, the endangered Houston Toad, and the American alligator are animals native to the coastal basin.

1.3.2.a. Neches-Trinity Coastal Basin Water Quality Characteristics

The Neches-Trinity Coastal Basin consists of four segments which are routinely monitored by the TCEQ Region 10 Field Office. Taylor Bayou (Segment 0701) and Hillebrandt Bayou (Segment 0704) are the primary inland drainage ways. The headwaters of Taylor and Hillebrandt Bayous originate in the northern and western parts of Jefferson County and southeast Liberty County. From there, the bayous meander south and southeasterly, before emptying into the

Intracoastal Waterway, Sabine Lake, and Sabine Pass. Taylor Bayou North Fork, Shallow Prong Lake, Bayou Din, and Alligator Bayou are other tributaries and waterbodies in the coastal basin monitored by TCEQ. Water bodies in the Neches-Trinity Coastal Basin are tidally influenced and tend to be brackish in all segments. Area water bodies with low dissolved oxygen have sluggish flow and/or low atmospheric aeration capabilities, which can be further aggravated by point and non-point source pollution. These conditions contribute to depressed dissolved oxygen concentrations in the basin. Non-point sources of pollution due to municipal, agricultural and industrial uses may also contribute to the water quality impairments and concerns for bacteria and nutrients.

1.4. Level III and Level IV Ecoregions

The Gould Ecoregion Map is based off of natural regions. Usually, it is a region which is distinguished by its common natural features of geography, geology, and climate. The Gould natural ecoregion map was developed in 1960. Later Ecoregion maps used a hierarchical, ecological region approach and can be identified through the analysis of spatial patterns and the composition of biotic and abiotic phenomena affecting or reflecting differences in ecosystem quality and integrity. These phenomena include geology, physiography, vegetation, climate, soils, land use, wildlife, and hydrology. The relative importance of each characteristic varies from one ecological region to another regardless of the hierarchical level. A Roman numeral hierarchical scheme has been adopted for different levels of ecological regions. Level I is the coarsest level, dividing North America into 15 ecological regions. Level II divides the continent into 52 regions. At level III, the continental United States contains 104 ecoregions. Level IV has 84 ecoregions. Level IV, which has 84 ecoregions, is a further refinement of level III ecoregions for the State of Texas as shown in Figure 1.5. This report will reference both the Gould natural ecoregions and the updated Level III and Level IV Ecoregion maps.

Figure 1.5 Level III and Level IV Ecoregions of Texas (U.S. Environmental Protection Agency, 2004)

1.5. Drought Conditions in Texas

Since the year 2000, the longest duration of drought in Texas lasted 271 weeks beginning on May 4, 2010 and ending on July 7, 2015, as shown in Figure 1.6. The level of drought is categorized D1 through D4, with D4 being the most extreme. There will be several instances in this report where a direct correlation exists between drought and its effects on certain water quality parameters. The decrease in flow and overall water volume can lead to increased levels

of conductivity, chlorides, sulfates, and total dissolved solids. Temperature increases in the water column can enhance algal production and promote algal blooms, which result in lower dissolved oxygen concentrations. Nutrient levels often decreased during droughts in rivers and streams with no significant loading from point and agricultural non-point sources. Where point sources of pollution are present, water quality can deteriorate due to less dilution, particularly for nutrients. Storage and buildup of material and changing geochemistry during droughts can result in large post-drought flood loadings of constituents such as major ions, nutrients, and carbon, which can result in lower oxygen levels further downstream. Weathering of silicate minerals produces alkalinity, removing carbon from the atmosphere in this process.

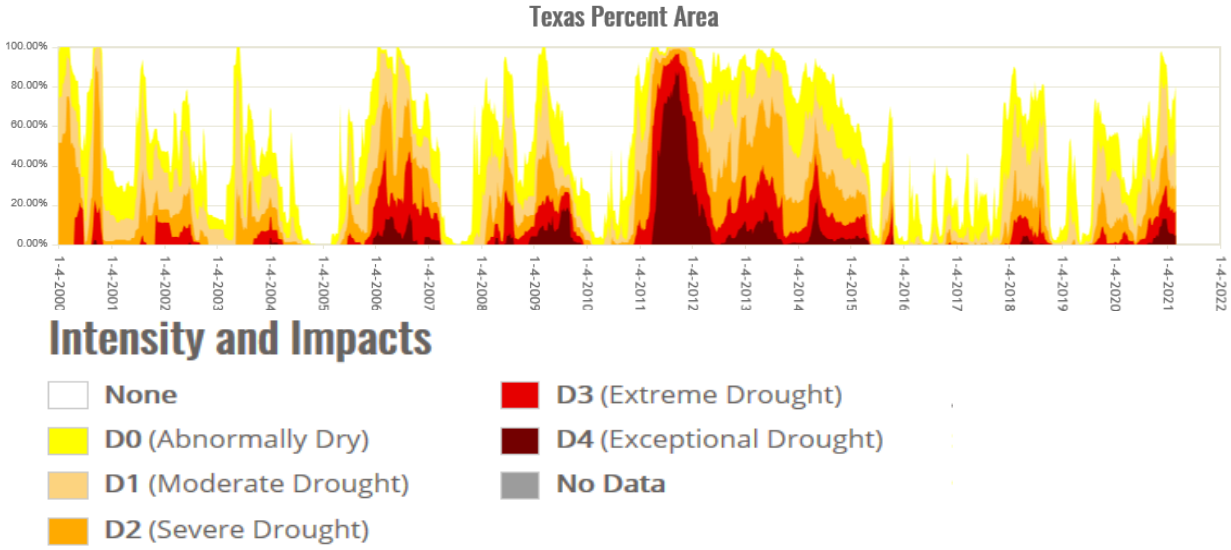

Figure 1.6 Historical Texas Drought Representation (www.drought.gov)

2. Public Involvement

Maintaining and improving the quality of water in each of the 23 river basins throughout Texas through partnerships with TCEQ, local governments, industry, regional governments, and river authorities like LNVA is the main goal of the Clean Rivers Program. The other important partner in this program are the citizens of Texas. Promoting cooperative watershed planning requires input from informed and engaged stakeholders. Stakeholders in LNVA's program range from concerned citizens, representatives of local industry and municipalities, state and federal agencies, tribal groups and environmental groups, to the general public. These stakeholders make up LNVA's CRP Steering Committee.

LNVA's CRP Steering Committee meets annually to discuss water quality issues within the basin. At these meetings, members are able to voice their local or regional concerns and work together to create realistic water quality objectives and basin priorities. Through these meetings, monitoring priorities are established, and the need or want for special studies are discussed. Having a diverse basin-wide committee helps open the platform for different interests, concerns, and priorities of each watershed to be represented. LNVA's annual meetings are open to the public and are posted on the website at https://lnva.dst.tx.us/.

Because public participation is essential to meeting the goals of the Clean Rivers Program, LNVA participates in a number of activities, events, and public outreach programs targeting audiences of all ages. Major Rivers is one education program the LNVA has sponsored and distributed to local elementary schools for years. Major Rivers is an educational program developed by the Texas Water Development Board to educate students about Texas' major water resources, as shown in Figure 2.1. It was developed for students in 4th or 5th grade and uses the character Major Rivers and his horse Aquifer to make learning about water fun. Not only does Major Rivers discuss Texas' major water resources, but it also teaches how to care for these resources and use them wisely. Major Rivers is a great tool to get students interested in their water basin and all the waterways of Texas.

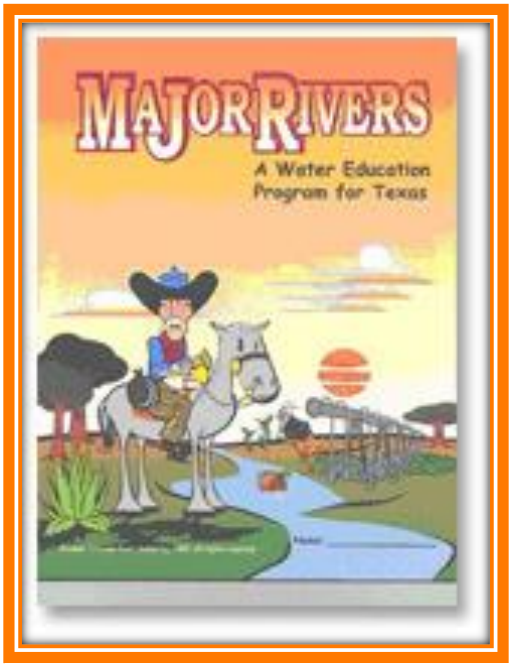

Figure 2.1 Major Rivers Educational Workbook

During the COVID pandemic, the Texas Water Development Board made Major Rivers information available on their website for teachers and students to continue water resource education virtually. The materials are available for viewing and printing at www.twdb.texas.gov/conservation/education/kids/MajorRivers/index.asp.

Figure 2.2 LNVA CRP Display Board

In addition to school outreach programs, the LNVA engages the younger generation by attending various public events. At these events, the LNVA provides visual aids and handouts educating the public on what the Clean Rivers Program is and why water quality is important, as shown in Figure 2.2. One event the LNVA participates in annually is the Neches River Festival River Day (NRF), which focuses on the area's high school seniors, as shown in Figure 2.3. The NRF works to celebrate the Southeast Texas area and its greatest natural resource, the Neches River. The actual festival takes place over a week with this one day dedicated to science. The event also highlights local organizations and how they are working to improve the environment in and around the Neches River. The one-day focus allows the LNVA to set up its educational booth and have staff ready to answer any questions the seniors may have.

More recently, the annual Outdoor Exposition held at the Crestwood Baptist Church in Kountze, Texas is another event LNVA staff attends. The event features a cook off, an archery tournament, and several educational booths aimed at teaching youth about the great outdoors.

Figure 2.3 LNVA staff at the 2019 Neches River Festival held at Cattail Marsh in Beaumont, Texas

Not all events require travel for LNVA staff, as the annual Neches River Rally held by the Big Thicket Association begins at the LNVA Salt Water Barrier. In this Rally, paddlers follow the 4 mile Cooks Lake Paddling trail that begins and ends at the Salt water Barrier. During this event, the LNVA opens its doors and provides tours of the Salt Water Barrier facility and laboratory.

Figure 2.4 Texas Stream Team Kit

All of these events provide great opportunities to not only educate the public but also recruit new members for LNVA's Texas Stream Team. Since 2009, the LNVA has been involved in the Texas Stream Team program. Operating out of Texas State University in San Marcos, Stream Team is a statewide volunteer network that began in 1991. Stream Team trains volunteers to monitor water bodies they select on a monthly basis. After being trained, citizens are able to test for parameters such as dissolved oxygen, pH, water temperature, and conductivity. The LNVA provides volunteers within their basin with the water quality test kits, supplies, and refill agents needed for Stream Team monitoring activities, as shown in Figure 2.4. LNVA staff are currently in the process of becoming Stream Team trainers to train citizens in the area to become part of the program in addition to providing supplies.

Public participation diminished greatly in 2020 due to the COVID-19 global pandemic. In order to stop the spread of the virus nationwide protocols were implemented in an effort to stem the spread of the virus. Remaining six feet apart, wearing masks, and not gathering in large groups were newly created social guidelines. These guidelines made public interaction near impossible; however, COVID-19 did not put a stop to all public outreach. LNVA staff held their annual Steering Committee meeting virtually through Zoom and attended many meetings online. As things slowly get back to a new normal, keeping the virtual option open for meetings would allow the LNVA to reach even more citizens and gain more input from those who could not make an in-person meeting.

3. Water Quality Review

This water quality review chapter is made up of terminology descriptions and watershed summaries within the lower Neches and Neches-Trinity Coastal Basins. The LNVA collects field, conventional, and bacteria parameters. Dissolved oxygen (mg/L and % saturation), temperature, specific conductance, pH, salinity (tidal waters only), secchi-disk transparency, days since last precipitation (significant enough to influence water quality), flow severity (freshwater streams and rivers), flow method (gage, electric, mechanical, weir, doppler) stream discharge (freshwater streams and rivers), method of stream discharge measurement (freshwater streams and rivers) are field parameters. Total alkalinity, sulfate, chloride, total hardness, total suspended solids, turbidity, ammonia, nitrate + nitrite, and total phosphorus are conventional parameters. *Escherichia coli (E. coli)* for freshwater streams and rivers and *Enterococcus* for tidal waters are bacteria parameters.

3.1. Terminology

This section describes the types of parameters tested for in LNVA's Clean Rivers Program, and why these parameters are important.

Bacteria

Bacteria monitoring consists of *E.coli* in freshwater environments and *Enterococcus* in saltwater marine environments, as shown in Figure 3.1. These bacteria are used as indicators of the presence of fecal material in waters. *E.coli* and *Enterococcus* are present naturally in the digestive system of humans and all warm-blooded animals and therefore are found in all surface waters. Although wildlife is a common source, contamination can also come from improperly treated wastewater or faulty septic systems. Bacteria levels are important to monitor because elevated levels can indicate a possible health risk to those coming in contact with the water.

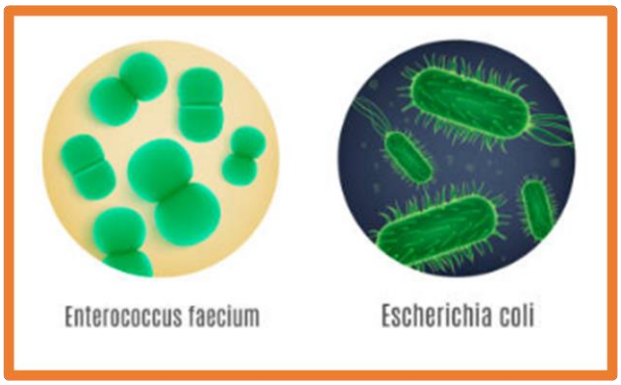

Figure 3.1 *E.coli and Enterococcus*

Chloride

Nearly all-natural waterways contain the element chloride. The chloride ion is found most commonly as a component of salt (sodium chloride) and is a major component of dissolved solids. Chloride naturally enters water when rocks and sediments dissolve through weathering. Unnatural sources of chloride can be due to oil exploration and storage, sewage and industrial discharges, runoff from dumps and landfalls, and saltwater intrusion. Although chloride is an essential element needed in small amounts for normal cell functions in plants and animal life, elevated levels can be cause for concern. Having too high of chloride concentrations interferes

with osmoregulation, the process to maintain proper concentration of salts and other solutes in bodily fluids, of aquatic organisms. This can adversely affect survival, growth, and reproduction of aquatic life. Elevated chloride concentrations in fresh water can also cause problems for raw water distribution systems as it corrodes metals within and contaminates water.

Conductivity

Conductivity is the ability of water to conduct electrical current. This current relies heavily on the amount of inorganic dissolved solids such as chloride, sulfate, and sodium in the stream. Elevated levels of conductivity indicate higher amounts of dissolved salts which can impact drinking water and/or aquatic habitat.

Dissolved Oxygen (DO)

Dissolved oxygen is the amount of oxygen dissolved in water available to aquatic life. The amount of oxygen available for aquatic organisms tells a lot about the health of a stream and the quality of the water. Water obtains oxygen by diffusion from atmospheric oxygen and through the process of photosynthesis. DO levels are greatly affected by stream flow, temperature, and decaying organic matter. The stream standard for DO varies throughout Texas, but 5.0 mg/L based on a 24-hour average is a common high aquatic life use standard according to the *Texas Surface Water Quality Standards*.

Hardness

The hardness of the water describes the amount of dissolved minerals present in water, specifically calcium and magnesium, as shown in Figure 3.2. "Hard" water is high in dissolved minerals, while "softer" water has less dissolved minerals. The hardness of water is important because of its effect on the toxicity of certain metals. Calcium and magnesium are not toxic; therefore, they are absorbed by living organisms more readily than other metals. In hard water, metal ions also form insoluble precipitates that are not able to be taken in by an organism. As a result, the harder the water is present, the lower toxicity of other metals exists in aquatic life.

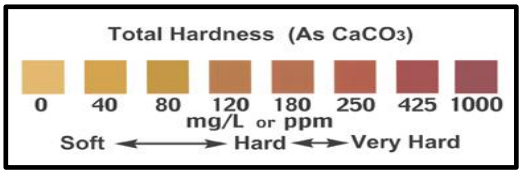

Figure 3.2 Total Hardness

Metals

Some metals are essential to plant and animal growth; however, other metals can negatively affect water consumers, wastewater treatment systems, and receiving waters. Metals can be beneficial in smaller amounts, but can also become toxic to organisms in higher concentrations. "Heavy metals," which include copper (Cu), iron (Fe), cadmium (Cd), zinc (Zn), mercury (Hg), and lead (Pb), are the most toxic to aquatic organisms. The toxicity of these metals depends heavily on temperature, pH, hardness, alkalinity, suspended solids, redox potential, and dissolved organic carbon in the water. High concentrations of metals can be a health threat to both aquatic and human life. Metals can affect drinking water supplies and accumulate in fish tissue to levels not suitable for human consumption. Metals are monitored through the chemical analysis of water, sediment, and fish tissue. The freshwater acute and chronic criteria

for metals, such as Cd, Cu, Pb, Nickel, and Zn, are based on site specific hardness data collected during metals sampling and surface water quality monitoring.

Nutrients

Nitrate, nitrite, and ammonia, which are compounds of nitrogen, and total phosphorus are nutrients routinely monitored. These nutrients are essential for plant and animal growth, but can also be harmful in higher amounts. All animals produce nitrogenous waste; however, ammonia is the primary waste product in aquatic animals. Some algae and bacteria use ammonia for growth and reproduction through a process called nitrification, which is the breakdown of ammonia into nitrite and conversion into nitrate.

Monitoring nitrogen present in the forms of ammonia and total nitrate-nitrite can help identify pollutants being introduced into a stream. In high concentrations, nitrogen compounds can be lethal to the aquatic community. In a process called eutrophication, excess nitrogen can cause a boom in the growth of aquatic plants and algae, but as they decompose, they consume dissolved oxygen which can result in fish kills. Fertilizers, agricultural runoff carrying animal waste, wastewater treatment plant effluent are unnatural sources of nitrogen compounds.

Phosphorus can be introduced to a stream through the same unnatural sources contributing to higher nitrogen levels. Phosphorus is also a critical nutrient for all life and is found most commonly in the form of phosphate, which helps in the formation of DNA, cellular energy, and cell membranes. In higher concentrations, like nitrogen, phosphorus can also cause eutrophication.

pH

pH acts specifies the acidity or basicity of the water is on a scale of 0 (acidic) to 14 (basic), as shown in Figure 3.3. Most aquatic life are adapted to live within a certain narrow pH range, but all fish die if the pH goes below 4 or above 12. Most Texas waters are mildly acidic due to tannic acids produced from rotting forest material. A range from 6.0 to 8.5 pH units is the common stream standard in the Neches Basin, according to the *Texas Surface Water Quality Standards (TSWQS)*. pH is affected daily by the processes of respiration and photosynthesis, but are also affected by the type of rock and soil in the stream, the amount of dead organic matter, and industrial and waste water discharges.

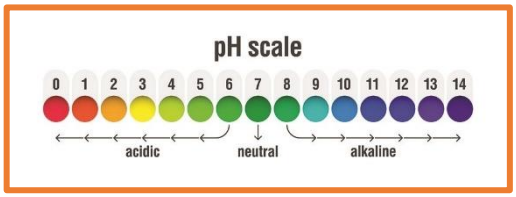

Figure 3.3 pH Scale

Stream Flow

Stream flow refers to the amount of water flowing in a river, which is measured in cubic feet per second (cfs). Flow is an important parameter because it greatly affects the water quality. Low flow conditions correspond with lower amounts of dissolved oxygen, which can create critical conditions for aquatic life. The main factor affecting flow is precipitation run-off.

Sulfate

Sulfates are a combination of sulfur and oxygen and are found naturally in most waters as minerals in sediment and rock. Industrial discharges, sewage treatment plant discharges, and runoff from fertilizers used on agricultural land are unnatural sources of sulfates. Sulfate is necessary for plant growth; however, in high levels, sulfate can cause a bitter taste to drinking water and scale buildup in water pipes. Standards for sulfates varies across Texas. Typical values for the lower Neches River Basin range from 15 to 20 mg/L, while values for the Neches-Trinity Coastal Basin range from 30 to 55 mg/L.

Temperature

Temperature is an important parameter to monitor because of its influence on biological activity and growth, as well as its effect on the water chemistry. The temperature of the water determines what organisms can survive and affects the dissolved oxygen, as colder water contains more oxygen than warmer water. Ambient conditions such as solar radiation and heat transfer from the atmosphere greatly affects water temperature, but it can also be affected by human activities such as water releases from reservoirs, removal of trees from the riparian zone, and use of water to cool manufacturing equipment.

Total Dissolved Solids (TDS)

Total dissolved solids in water, which mainly consist of carbonates, bicarbonates, chlorides, and sulfates, are sometimes referred to as total salinity. Higher levels of TDS can affect the permeability of ions in aquatic organisms, as well as affect the aesthetic quality of the water, corrode plumbing, and reduce crop yields. Mineral springs, carbonate and salt deposits, and seawater intrusion are natural sources of TDS, while unnatural sources are a result of oil and natural gas exploration, drinking water treatment chemicals, agricultural runoff, and wastewater discharges. TDS water quality standards varies across Texas. Generally TDS levels in the lower Neches River Basin are below 200 mg/L, while levels in the Neches-Trinity Coastal Basin can range from 300 to 5,000 mg/L.

Total Organic Carbon (TOC)

Total organic carbon is a measure of the amount of organic compounds contained in a water sample. Organic carbon-containing compounds can either be dissolved in water or exist in water as undissolved, suspended material, or liquid. This organic matter can enter water naturally and through man-made sources/processes.

Total Suspended Solids (TSS)

Total suspended solids is the measure of solid particles found suspended in the water column that can be trapped by a filter. Higher TSS increases the turbidity of the water which reduces the amount of light that can penetrate the water column and decreases the oxygen produced by photosynthesis. Large amounts of suspended solids can also clog fish gills but eventually the solids settle to the bottom to become sediment. TSS is often elevated after events of high flow that accelerate erosion but can also be elevated by sheet erosion where water flowing over land causes a thin layer of soil to be introduced into a waterway.

Turbidity

Turbidity refers to the cloudiness of the water and its transparency due to the presence of suspended solids, as shown in Figure 3.4. Turbidity increases with higher levels of suspended solids and other matter such as clay, silt, organic and inorganic matter, plankton, and other microscopic organisms. High turbidity affects the amount of light able to penetrate the water column and affects ecological productivity. High turbidity in drinking water is also aesthetically displeasing and can pose a health concern.

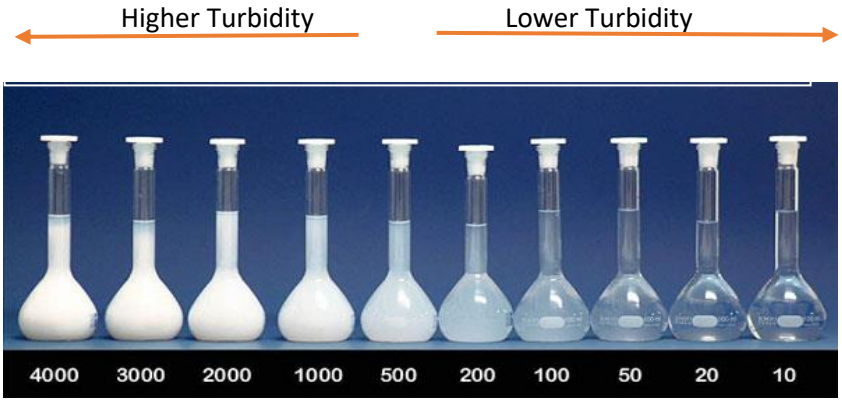

Figure 3.4 Turbidity Scale (This Photo by Unknown Author is licensed under CC BY-NC-ND)

Water Quality Terminology

Ambient Water Reporting Limit (AWRL)

For surface water to be evaluated for compliance with Texas Surface Water Quality Standards (TSWQS) and screening levels, data must be reported at or below specified levels. The AWRL is the highest acceptable level that can be reported for a given parameter. These limits adopted by CRP apply to all data collected and submitted to the program. A current list of AWRLs is available on the TCEQ web page at: https://www.tceq.texas.gov/assets/public/waterquality/crp/QA/awrlmaster.pdf

Aquatic Life Use (ALU)

Each classified segment in the TSWQS is assigned an aquatic life use (ALU) category. The five categories are exceptional, high, intermediate, limited, or minimal aquatic life use. The categories are assigned based on physical, chemical, and biological characteristics of the water body. Support of the ALU category is based on the assessment of dissolved oxygen criteria, toxic substances in water criteria, ambient water and sediment toxicity test results, and indices for habitat, benthic macroinvertebrate, and fish community, provided the minimum number of samples needed are available.

Assessment Unit (AU)

Segments are further divided into assessment units (AU). Support of criteria and uses are examined for each AU, the smallest geographic area of use support reported in the assessment. Segments can have one or multiple AUs, and each AU has a unique six or seven-digit identifier describing the location of the specific area assessed. For example: in 0601A_01, the 0601A represents the segment ID, and the 01 represents the AU.

Contact Recreation Use (PCR, SCR, NCR)

To assess the ability of water to support certain activities, bacteria indicators such as *E. coli* and *Enterococcus* are monitored. Recreational use consists of five (5) categories: Primary contact recreation 1 are activities with a significant risk of ingestion of water (such as swimming), and has a geometric mean criterion for *E. coli* of 126 colony forming unit (cfu) per 100 milliliters (mL) and an additional single sample criterion of 399 cfu per 100 mL. Primary contact recreation 2 includes activities involving a significant risk of ingestion of water (i.e., swimming, diving, wading and whitewater sports), but occurs less frequently than for primary contact recreation 1 due to physical characteristics of the water body or limited public access. The geometric mean for the standard is 206 cfu/ 100 mL for primary contact 2. Secondary contact recreation 1 covers activities with limited body contact and a less significant risk of ingestion of water (such as fishing) with a geometric mean criterion for *E. coli* of 630 cfu per 100 mL. Secondary contact recreation 2 is similar to secondary contact 1, but activities occur less frequently. Secondary contact recreation 2 has a geometric mean criterion for *E. coli* of 1,030 cfu per 100 mL. Noncontact recreation are activities with no significant risk of ingestion of water, where contact recreation should not occur due to unsafe conditions. Noncontact recreation has a geometric mean criterion for *E. coli* of 2,060 cfu per 100 mL.

General Use

General use criteria are set to safeguard general water quality rather than for protection of one specific use. The general use criteria are established for each segment to ensure healthy conditions and aesthetics. Water temperature, pH, chloride, sulfate, TDS, and nutrients are parameters monitored for general use criteria.

Geometric Mean (Geomean)

Geomean is a mathematical term defined as an average indicating the central tendency or typical value of a set of numbers. The TSWQS uses the geomean of bacteria samples in freshwater and saltwater to determine compliance with the contact recreation use criteria.

Quality Assurance Project Plan (QAPP)

A QAPP is a plan that clearly outlines quality assurance (QA) policy, management structure, and procedures, which are used to implement the QA requirements necessary to verify and validate surface water quality data collected. Every contractor with the TCEQ and Clean Rivers Program must follow an approved QAPP to collect data for the program. The QAPP is reviewed and updated annually to ensure all field, laboratory, and data management procedures are included. QAPPs are developed and implemented in accordance with provisions of the Quality Management Plan for the Clean Rivers Program.

Segment (Classified and Unclassified)

A classified segment is a water body or portion of a water body individually defined in Appendix A of the Texas Surface Water Quality Standards. These segments have designated uses and water quality criteria. Each segment is given a number identifying the river basin and segment. For example: the Neches River Tidal segment number is 0601. The next upstream most segment is 0602. A segment is intended to have relatively homogenous chemical, physical, and

hydrological characteristics. A segment provides a basic unit for assigning site specific standards and water quality management programs in Texas. Classified segments may include streams, rivers, bays, estuaries, lakes, or reservoirs.

Unclassified streams are water bodies not defined in Appendix A of the TSWQS. For assessment purposes, unclassified segments will be referenced to the classified segments described in the Appendix A. These smaller tributaries are often assumed to meet the same criteria as the larger classified segments. Each unclassified water body is given a number which ties it to the classified segment with a letter designation. For example: 0601A is a small stream flowing into Segment 0601 of the Neches River. This also applies to certain unclassified water bodies given site specific descriptions and criteria and listed in Appendix D of the TSWQS.

Surface Water Quality Monitoring (SWQM)

The Surface Water Quality Monitoring (SWQM) Program at TCEQ monitors and evaluates physical, chemical, and biological characteristics of aquatic systems as a basis for implementing effective policy. The SWQM program works in conjunction with the Clean Rivers Program, coordinating the collection of physical, chemical, and biological samples from more than 1,800 surface water sites statewide. This data may be used by TCEQ to characterize existing conditions, identify emerging problems, evaluate the effectiveness of water quality control programs, or identify trends. This data may also be used to determine compliance with the Texas Surface Water Quality Standards through the Texas Integrated Report.

SWQM data and assessment results provide a basis for effective policies promoting the protection, restoration, and wise use of surface water in Texas. The collection of this data is a collaboration by the TCEQ central office, TCEQ regional offices, river authorities, state contractors, researchers, universities, and other units of government involved in the Texas Clean Rivers Program.

Texas Integrated Report

The Texas Integrated Report works to describe the status of Texas' natural waters based on historical data, and how these waters stand in accordance to the *Texas Surface Water Quality Standards (TSWQS)*. This report provides resource managers with a tool for making informed decisions when directing agency programs. The Texas Integrated Report helps satisfy a requirement of the federal Clean Water Act Sections 305(b) and 303(d). The TCEQ produces a new report every two years in even-numbered years, as required by law. The 303(d) List must be approved by the Environmental Protection Agency (EPA) prior to finalization. Each river basin in Texas is assigned a TCEQ assessor who works closely with CRP planning agencies and other data collectors to ensure adequate water quality data for assessment.

Texas Surface Water Quality Standards (TSWQS)

Texas Surface Water Quality Standards are state rules (Texas Administrative Code, Title 30, Chapter 307) written and adopted by the TCEQ under the authority of the Clean Water Act and Texas Water Code. The Standards establish explicit goals for the quality of streams, lakes, and bays throughout the state. The Standards also identify appropriate uses for the state's surface

waters, including aquatic life, contact or non-contact recreation, and source of public water supply (or drinking water). Statewide standards may be revised on a site-specific basis when sufficient information is available.

Total Maximum Daily Load (TMDL)

A scientific model or study which determines the maximum amount of a pollutant a water body can receive while both attaining and maintaining its water quality standards. A TMDL allocates this allowable amount, or load, to point and non-point sources in the watershed. A Category 5 water body may require a TMDL usually prepared for one or more parameters on the Texas 303(d) List of Impaired Waters. TMDLs must be submitted to the EPA for review and approval.

Use Attainability Analysis (UAA)

A UAA addresses possible and existing uses for a body of water while using historical, biological, physiochemical, and habitat data to evaluate the specific body of water. This evaluation consists of a multi-step assessment of physical, chemical, biological, and economic factors affecting the attainment of a use. UAAs are used to determine if existing criteria and uses described in the TSWQS are appropriate.

3.2. Data Review Methodology

The data analysis and review methods used to evaluate water quality conditions in this report are based on the TCEQ's *Guidance for Assessing and Reporting Surface Water Quality in Texas* which is available at the following website: https://www.tceq.texas.gov/assets/public/waterquality/swqm/assess/20txir/2020_guidance.pdf. These methods detail the framework for development of the 2020 Texas Integrated Report. The 2020 assessment period of record for the last seven years is from December 1, 2011 through November 30, 2018. Samples from this seven-year time frame are evaluated, if necessary. If the minimum sample number is not met, the most recent samples collected in the preceding three years (December 1, 2008 through November 30, 2011) can be included to meet the sample requirements. At least 10 samples (20 for bacteria) over the seven-year period of record are required for assessment of use attainment (listing and delisting). The Texas Integrated Report satisfies the requirements of the federal Clean Water Act Sections 305(b) and 303(d). The TCEQ produces a new report every two years in even-numbered years, as required by law. The 303(d) List must be approved by the EPA before finalization.

The 2020 Texas Integrated Report is used as a reference tool for this report to show impairments and concerns existing in each segment of the lower Neches and Neches –Trinity Coastal Basins. The 2018 Texas Surface Water Quality Standards (TSWQS) were used to determine designated use support for the classified segments in the Lower Neches River and Neches-Trinity Coastal Basins, as shown in Tables 3.1 and 3.2. Each segment is assigned a water quality use category by the TCEQ, which indicates the status of water quality in the segment. Categories 4 and 5 are further subdivided to communicate the plans TCEQ has for addressing a particular water quality impairment.

Neches River Basin Designated Uses and Numeric Criteria

Segment No.	Neches River Basin Segment Names	Recreation Use	Aquatic Life Use	Domestic Water Supply Use	Other Uses	Cl^{-1} (mg/L)	SO_4^{-2} (mg/L)	TDS (mg/L)	Dissolved Oxygen (mg/L)	pH Range (SU)	Indicator Bacteria[1] #/100 mL	Temperature (degrees F)
0601	Neches River Tidal	PCR1	I						3.0	6.0-8.5	35	95
0602	Neches River Below B. A. Steinhagen Lake	PCR1	H	PS		50	50	200	5.0	6.0-8.5	126	91
0603	B. A. Steinhagen Lake	PCR1	H	PS		50	50	200	5.0	6.0-8.5	126	93
0604	Neches River Below Lake Palestine	PCR1	H	PS		50	50	200	5.0	6.0-8.5	126	91
0605	Lake Palestine	PCR1	H	PS		50	50	200	5.0	6.5-9.0	126	90
0606	Neches River Above Lake Palestine	PCR1	I	PS		100	50	300	4.0	6.0-8.5	126	95
0607	Pine Island Bayou	PCR1	H	PS		150	50	300	3.0	6.0-8.5	126	95
0608	Village Creek	PCR1	H	PS		150	75	300	5.0	5.5-8.0	126	90
0609	Angelina River Below Sam Rayburn Reservoir	PCR1	H	PS		70	50	250	5.0	6.0-8.5	126	90
0610	Sam Rayburn Reservoir	PCR1	H	PS		100	100	400	5.0	6.0-8.5	126	93
0611	Angelina River Above Sam Rayburn Reservoir	PCR1	H	PS		125	50	250	5.0	6.0-8.5	126	90
0612	Attoyac Bayou	PCR1	H	PS		75	50	200	5.0	6.0-8.5	126	90
0613	Lake Tyler/Lake Tyler East	PCR1	H	PS		50	50	200	5.0	6.5-9.0	126	93
0614	Lake Jacksonville	PCR1	H	PS		50	75	750	5.0	6.5-9.0	126	93
0615	Angelina River/Sam Rayburn Reservoir	PCR1	H	PS		150	100	500	5.0	6.5-9.0	126	93

1 The indicator bacteria for freshwater is *E. coli* and for saltwater is Enterococci.

Table 3.1 Neches River Basin Uses and Numeric Criteria

Neches-Trinity Coastal Basin Designated Uses and Numeric Criteria

Segment No.	Neches-Trinity Coastal Basin Segment Names	Recreation Use	Aquatic Life Use	Domestic Water Supply Use	Other Uses	Cl^{-1} (mg/L)	SO_4^{-2} (mg/L)	TDS (mg/L)	Dissolved Oxygen (mg/L)	pH Range (SU)	Indicator Bacteria[1] #/100 mL	Temperature (degrees F)
0701	Taylor Bayou Above Tidal	PCR1	I			400	100	1,100	4.0	6.5-9.0	126	95
0702	Intracoastal Waterway Tidal	PCR1	H						4.0	6.5-9.0	35	95
0703	Sabine-Neches Canal Tidal	PCR1	H						4.0	6.5-9.0	35	95
0704	Hillebrandt Bayou	PCR1	I			250	100	600	4.0[2]	6.5-9.0	126	95

1 The indicator bacteria for freshwater is *E. coli* and for saltwater is Enterococci.
2 The 24-hour minimum dissolved oxygen criterion is 2.5 mg/L.

Table 3.2 Neches-Trinity Coastal Basin Designated Uses and Numeric Criteria

Aquatic life use, contact recreation, and domestic water supply are the primary uses assigned to water bodies in the *Texas Surface Water Quality Standards*. The TCEQ has established screening levels to provide a quantitative basis for evaluating water quality concerns. Support of aquatic life use is based on assessment of dissolved oxygen, toxic substances in water (metals and organics) and sediment, and biological screening levels for habitat, macrobenthos, and fish criteria. Each criteria set is evaluated independently of the others, and the use support level is identified when any of the individual criteria are not attained. Support of designated uses and water quality criteria are classified as fully supporting (FS), no concern (NC), use concern (CN), screening level concern (CS), and not supporting (NS).

The contact recreation use is designated for most water bodies in Texas, except where primary and secondary contact recreation should not occur because of unsafe conditions. Full support of the contact recreation use does not guarantee water is completely safe of disease-causing organisms. Samples collected for *E. coli* bacteria are used to determine support of the contact recreation use for non-tidal segments, and *Enterococcus* bacteria are used in tidal segments. Use support is determined based on geometric mean, which should not exceed 126 colonies

per 100 ml for *E. coli* and 35 colonies per 100 ml *for Enterococcus*. Water bodies either fully support or do not support the contact recreation use based on the above criteria.

Nutrients and chlorophyll *a* stream standards are currently being developed by TCEQ for Texas water bodies; therefore, screening levels were statistically derived from long-term SWQM monitoring data. The 85th percentile values for each parameter in freshwater streams, tidal streams, reservoirs, and estuaries are listed in Table 3.3. If the screening level is exceeded more than 20 percent of the time using the binomial method, a concern for water quality is identified based on the number of exceedances for a given sample size.

Water Body Type	Nutrients	Screening Level (mg/L)
Freshwater Stream	NH_3-N	0.33
	NO_3-N	1.95
	OP	0.37
	TP	0.69
	Chl *a*	14.1
Reservoir	NH_3-N	0.11
	NO_3-N	0.37
	OP	0.05
	TP	0.20
	Chl *a*	26.7
Tidal Stream	NH_3-N	0.46
	NO_3-N	1.10
	OP	0.46
	TP	0.66
	Chl *a*	21.0
Estuary	NH_3-N	0.10
	NO_3-N	0.17
	OP	0.19
	TP	0.21
	Chl *a*	11.6

Table 3.3 TCEQ Screening Levels for Nutrient Parameters

General use criteria are established in the *TSWQS* to safeguard water quality conditions in each segment. Criteria for each parameter, including water temperature, pH, chloride, sulfate, and total dissolved solids (TDS), are assigned to the classified segment based on physical, chemical, and biological characteristics. Although other concerns are reported for general use, attainment for unclassified water bodies is not assessed and therefore not reported. Support of general use water quality criteria based on water temperature and pH can be classified as fully supporting or not supporting. Criteria, established in the TSWQS for chloride, sulfate, and TDS, represent annual averages.

LNVA's data review process utilized surface water quality monitoring data collected by the LNVA and TCEQ and stored in the Surface Water Quality Monitoring Information System

(SWQMIS) database for Basin 6 (Neches) and Basin 7 (Neches-Trinity). The data from each segment was imported into Microsoft Excel, displaying the Segment ID, Station ID, Station Description, Start Date, Start Time, Start Depth, End Date, End Time, End Depth, Submitting Entity, Collecting Entity, Monitoring Type, Composite Category, Composite Type, Parameter Name, Parameter Code, GTLT, Value, RFA/Tag ID, Station Latitude, Station Longitude, and Comments for each parameter of each sampling event. Twenty (20) years of data (January 1999- January 2020) was queried to perform a trend analysis on certain parameters.

Laboratory results reporting less than the Limit of Quantification (LOQ) value were adjusted to one-half of the value, which assumes the value for the sampling event was directly in-between zero (0) and the LOQ value. Trend analysis was not performed for situations where more than half of the reported values were below the LOQ value. All values reported above the LOQ were left alone for the analysis. Varying LOQ values over the 20-year period could impact trend analysis results.

pH, temperature, specific conductance, flow, dissolved oxygen, turbidity, dissolved metals in water, ammonia-nitrogen, total nitrate plus nitrite, total phosphorus, *E. coli*, *Enterococcus* and chlorophyll-*a are* the parameters queried in this report. The tributaries or unclassified water bodies in each segment were assessed using the same criteria established for the associated classified segment.

The trend analysis was performed for all the priority parameters, if the minimum twenty (20) sampling events was available. The priority parameters are temperature, conductivity, pH, dissolved oxygen, stream flow, secchi disc, turbidity, hardness, chloride, sulfate, total dissolved solids, bacteria, ammonia nitrogen, total suspended solids, nutrients (nitrogen, nitrate, total phosphorus, and orthophosphate phosphorus), and chlorophyll-*a*.

The dataset for each station was queried to display the 'Value' for each 'Parameter Name' in order of oldest to newest by 'End Date' for the selected priority parameters. Simple linear regression was then performed in Microsoft Excel for trend analysis for the station's priority parameters. Trend analysis was performed both for the parameter value against time and the parameter value against stream flow, when applicable. Trend analysis was deemed significant versus time when t-statistic was equal or greater than the absolute value of 2 and had a p-value less than 0.1. Trend analysis was deemed significant versus flow when R-squared was greater than 0.1, skewness was less than 2, and kurtosis was less than 3.

T-statistic is an estimate of the standard deviation of the coefficient and the amount it varies across cases. P-value is the level of significance within a statistical hypothesis test representing the probability of occurrence. R-squared is the measurement to how close the values of the data fit the regression line. Skewness measures the relative size of the two tails on the bell curve. Kurtosis measures the relative size of the pointedness of the peak on the distribution curve.

The results of the trend analysis revealed statistically significant trends at several stations within the Neches and Neches-Trinity Coastal Basin.

The following tables are the designated uses and numeric criteria for all of the segments in Neches and Neches-Trinity Coastal Basins from the 2018 *Texas Surface Water Quality Standards*.

3.3. Watershed Summaries

The following section includes watershed segment summaries made of watershed characteristics, maps of the sample stations in each segment, a chart of the 2020 impairments or concerns found, the data assessment results for that segment, as well as, recommendations for actions to improve or preserve water quality. The order of the watershed summaries follows the watersheds in each basin from upstream to downstream.

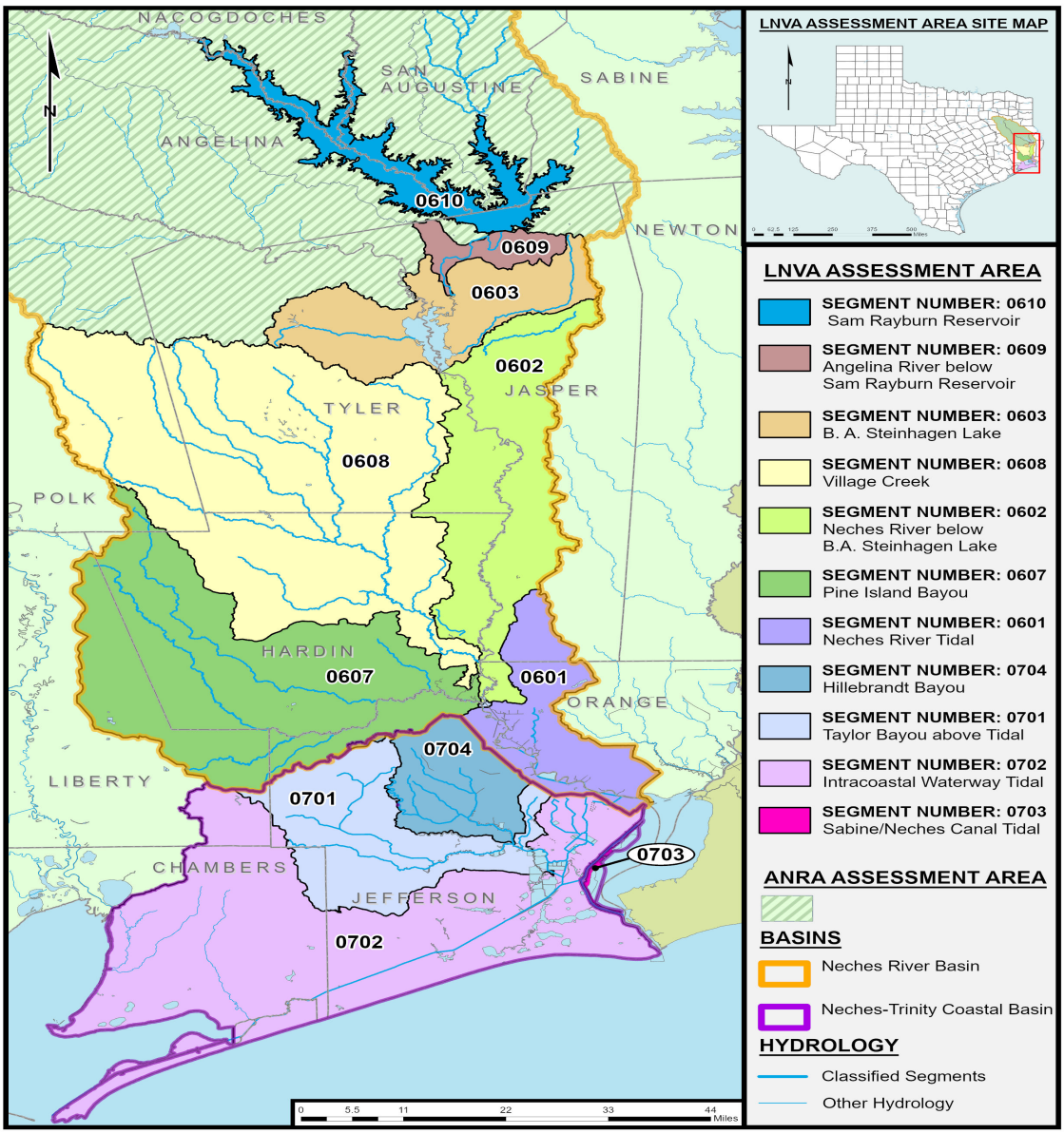

Figure 3.5 LNVA's Assessment Area by Segment

3.3.1. Segment 0610: Sam Rayburn Reservoir

Segment 0610, Sam Rayburn Reservoir, is described in the *Texas Surface Water Quality Standards* as from the Sam Rayburn Dam to a point 3.5 miles upstream of Marion's Ferry on the Angelina River Arm and to a point 2.4 miles downstream of Curry Creek on the Attoyac Bayou Arm, up to normal pool elevation of 164.4 feet, as shown in Figure 3.6.

Figure 3.6 Sam Rayburn Reservoir

The Sam Rayburn Reservoir encompasses 106,666 acres with a variety of recreational areas, which includes hiking trails, campgrounds, boating ramps, marinas, and swimming areas. The Trail between the Lakes, a well-marked, 28-mile hiking trail running from US Hwy 96 near Sam Rayburn to the Lakeview Recreation Area on Toledo Bend, wanders through pine and hardwood forests, up and down East Texas' hills, across stream corridors, through the Sabine National Forest, and along Lake Toledo Bend connecting the Sam Rayburn and Toledo Bend Reservoirs. The trail also crosses roads at a number of locations, providing access to shorter hikes.

The Sam Rayburn Reservoir is designed for flood regulation and control, hydroelectric power generation, and water supply for municipal, industrial, agricultural, and recreational purposes, as shown in Figure 3.7. The reservoir is located in the Angelina Neches River Authorities assessment area. Cooperative monitoring between TCEQ, ANRA, and LNVA take place throughout the reservoir and its tributaries.

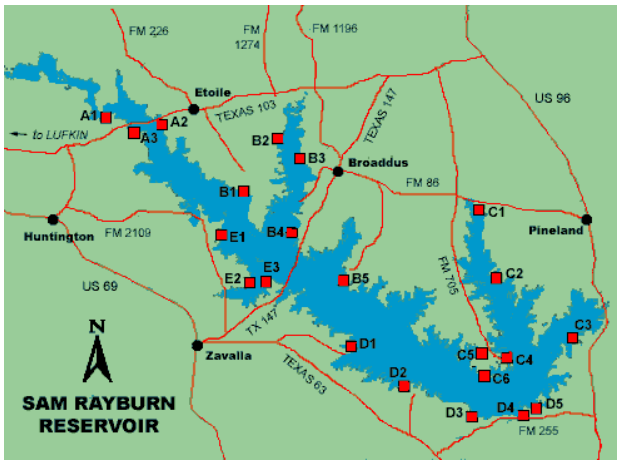

Figure 3.7 Public access points on Sam Rayburn Reservoir. Image courtesy of www.tpwd.texas.gov

LNVA is currently monitoring three stations, #15671, #15673, and #15674, in the Sam Rayburn Reservoir, as shown in Figure 3.8.

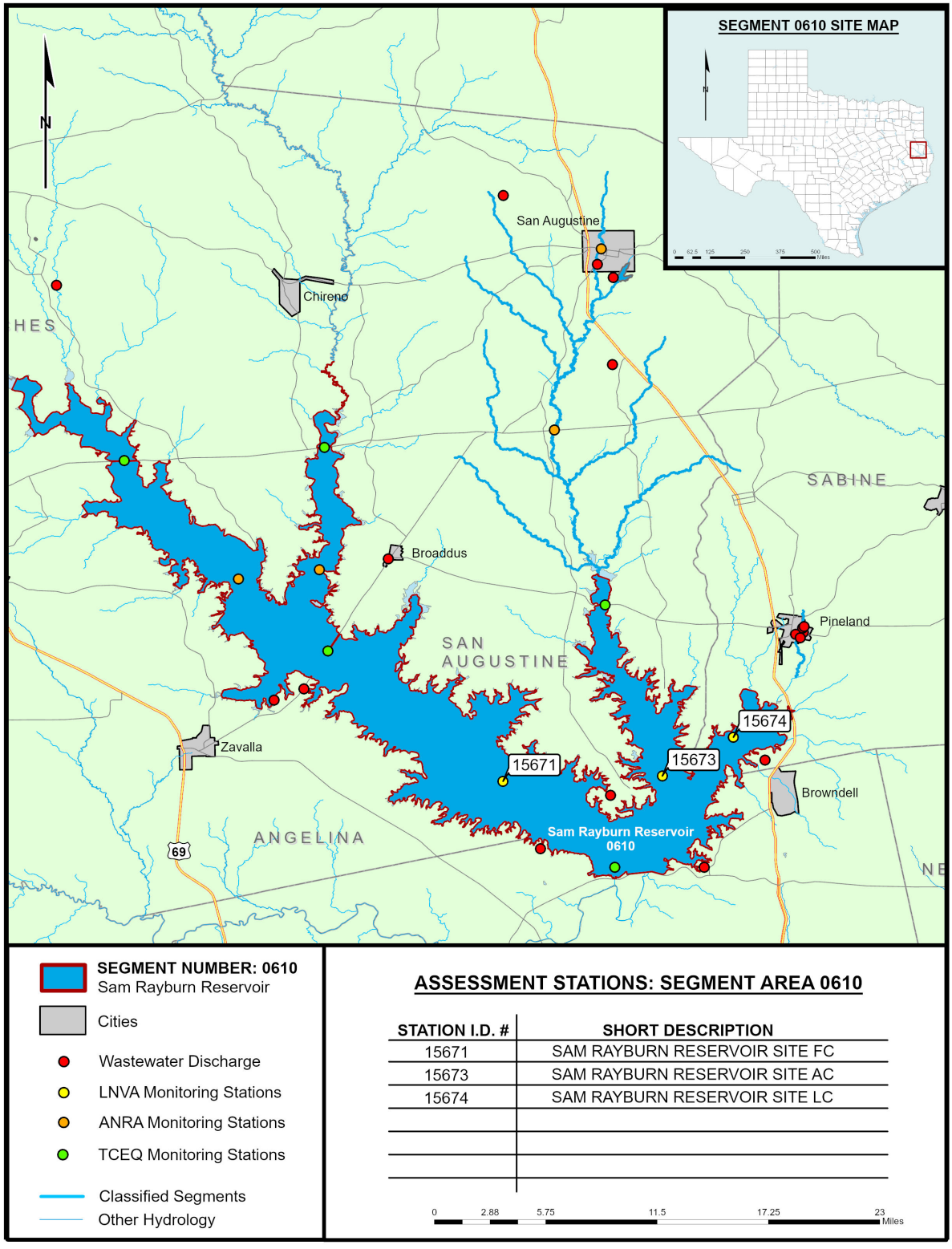

Figure 3.8 Segment 0610: Sam Rayburn Reservoir Assessment Area

Data Assessment Results

The designated uses for Segment 0610 are general use, high aquatic life use, public water supply use, contact recreation, and fish consumption. All assessment units within the segment are impaired for mercury (Hg) and dioxins in edible tissue as shown in Table 3.4. Ayish Bayou (0610A) is not supporting contact recreation for *E.coli*. Bayou Carrizo (0610P) has a concern for *E.coli*.

Segment #	Segment Name	Impairment/Concern listed in 2020 Texas Integrated Report	Reason for Impairment/Concern
0610	Sam Rayburn Reservoir	Not supporting fish consumption due to mercury and dioxin	Unknown sources; Atmospheric deposition for mercury
		Screening level concern for iron and manganese in sediment	Source Unknown
0610A	Ayish Bayou	Not supporting contact recreation for E.coli	Nonpoint Source; Unknown Sources
0610P	Bayou Carrizo	Concern for *E.coli*	Source Unknown

Table 3.4 Segment 0610 Impairments

The 2020 Integrated Report has Segment 0610 not supporting fish consumption due to mercury and dioxin. There is a screening level concern for aquatic life use for iron and manganese levels. Segment 610 is under fish advisory 51, signed in January 2014. This advisory is issued as a result of sampling of the Neches River Basin. Fish samples collected from Lake B.A. Steinhagen, Neches River, and Sam Rayburn Reservoir indicated the presence of dioxins and mercury at concentrations exceeding health assessment guidelines established by the Texas Department of State Health Services (DSHS). Consumption of fish from the Neches River Basin may pose a threat to human health. The specific consumption advisory can be found at: https://dshs.texas.gov/seafood/PDF2/FishConsumptionAdvisoryBaNNews/ADV-51_signed.

Segment 0610A has an impairment for contact recreation due to *E.coli*. Segment 0610P has a concern for *E.coli*. Nonpoint or unknown sources may be the reason for this impairment and concern as runoff containing animal waste can create elevated bacteria levels.

The sources of impairment and concerns throughout this summary report reflect “possible” source information, which include activities, facilities, or conditions occurring in the watershed keeping water from meeting the criteria to prevent the attainment of designated uses. This list of possible sources is not exhaustive, and does not constitute defined targets for water quality management actions.

Recommendations

ANRA will continue monitoring to address the impairments and concerns in Segment 0610. LNVA will continue to collect routine data at three monitoring stations to aid in this effort. The DSHS should update fish studies and re-evaluate fish advisories. The most recent data assessment and specific recommendations for impairments for Sam Rayburn Reservoir was completed by ANRA in their 2020 Basin Summary Report and can be found on their website at https://www.anra.org/divisions/water_quality/crp/reports.html.

3.3.2. Segment 0609: Angelina River Below Sam Rayburn Reservoir

Figure 3.9 Station 10610: Angelina River @ SH 63

Segment 0609, Angelina River below Sam Rayburn Reservoir, is defined in the *TSWQS* as from a point immediately upstream of its confluence of Indian Creek in Jasper County to Sam Rayburn Dam in Jasper County. The Angelina River has very clear waters, as compared to Segments 0607 and 0608, and ranges from 75-150 feet in width. This river meanders through the rolling hills of the heart of the East Texas Piney Woods (Level III Ecoregion 35) and forested bottomlands containing bald cypress, pine, and hardwood trees. Whitetail deer, squirrel, wild turkey, quail, dove, and duck are common wildlife to the area. The 153,000-acre Angelina National Forest borders the upper part of Segment 0609 with land use including recreational use and public property near the national forest. Longleaf pine is the dominant tree type in the southern part of the segment, while loblolly and shortleaf pine are dominant in the northern section. Flow is generally high as compared to other segments in the basin, because of the Sam Rayburn Reservoir dam releases. Segment 0609 lies within Jasper County approximately ten miles northwest of the City of Jasper. The segment extends thirteen (13) river miles from the tailrace below Sam Rayburn Reservoir dam towards the headwaters of B.A. Steinhagen Lake. Another 5.2 miles of old riverbed exists along the lower side of the dam upstream from the confluence with the tailrace. The drainage area of Segment 0609 is 107 square miles with land use characterized as sparsely populated and heavily forested with minimal area of non-irrigated cropland located in the southeast quadrant of the watershed.

The LNVA monitors one station, #10610, Angelina @ SH 63, in this segment as shown in Figures 3.9 and 3.10.

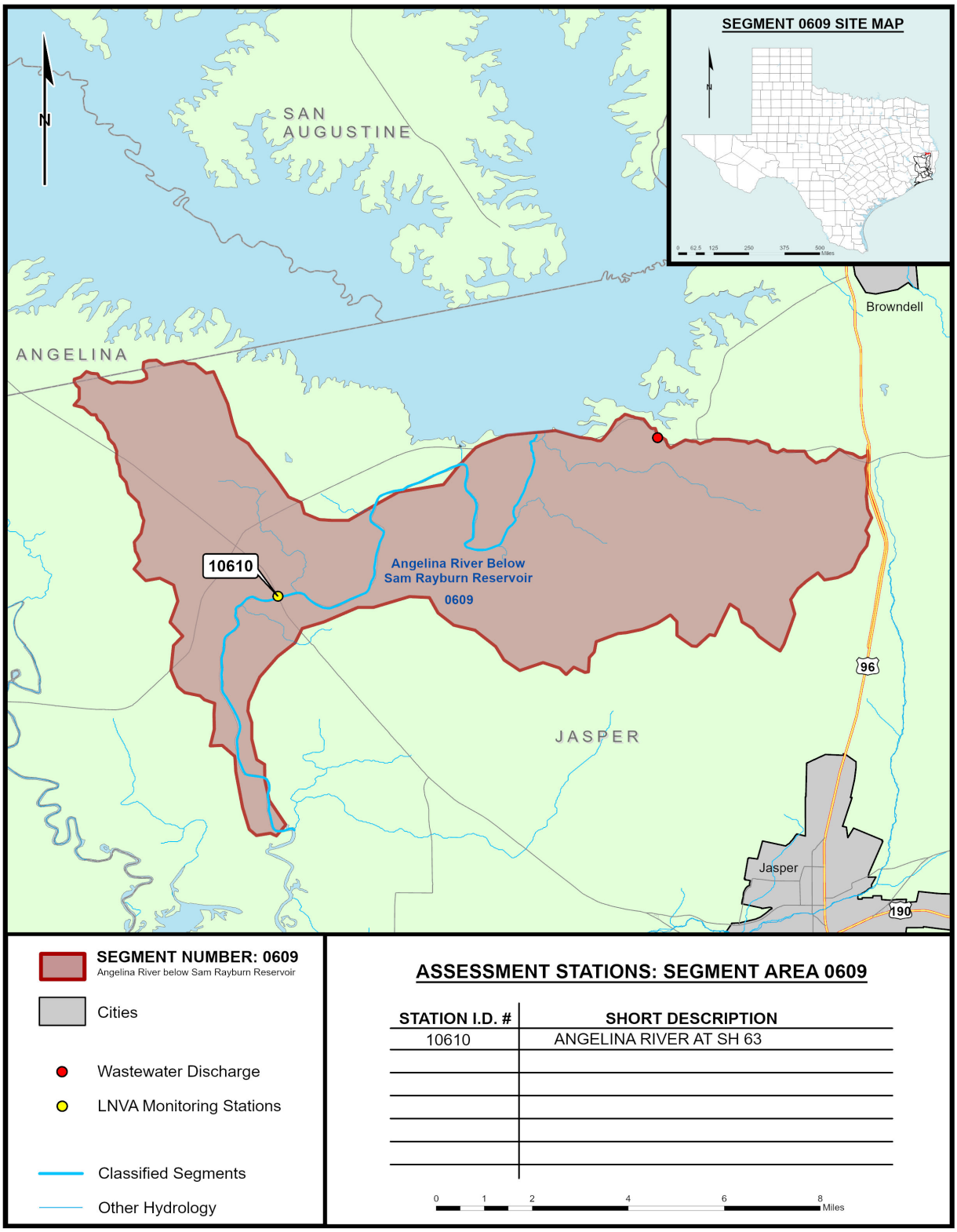

Figure 3.10 Segment 0609: Angelina River below Sam Rayburn Reservoir Assessment Area

Data Assessment Results

Segment 0609 is designated for primary contact recreation use, high aquatic life use, and public water supply as shown in Table 3.5. Overall, water quality in the segment is very good. The contact recreation use, aquatic life use, general use, and public water supply are fully

supported in the segment. Fish consumption use is the only use not supported in this segment due to dioxins and mercury in fish tissue, which is the only reason it was added to the Texas 303(d) List. Advisory 51, the same advisory affecting the Sam Rayburn Reservoir, was issued by the DSHS in January of 2014 for the Angelina River. The following is a link to the advisory: https://dshs.texas.gov/seafood/PDF2/FishConsumptionAdvisoryBaNNews/ADV-51_signed.pdf.

Segment #	Segment Name	Impairment/Concern Listed in 2020 Texas Integrated Report	Reason for Impairment
0609	Angelina River below Sam Rayburn Reservoir	Not supporting fish consumption use due to mercury and dioxins in edible tissue	Atmospheric Deposition-Toxics; Industrial Point Source Discharge; Source Unknown

Table 3.5 Segment 0609 Impairments

Due to the releases from Sam Rayburn Reservoir, dissolved oxygen concentrations peak during winter months while lower concentrations occur during summer months when the reservoir is stratified. During summer lake stratification, colder water sinks to the bottom while the warmer waters rise to the surface. At this time circulation is limited to the upper lake level, and the colder water near the bottom is depleted of oxygen. The situation is reversed during the winter when the entire water column is at or near the same temperature; therefore, allowing full circulation and replenishment of oxygen. Figures 3.11 and 3.12 demonstrate how the average dissolved oxygen is affected by the time of year and ambient temperature.

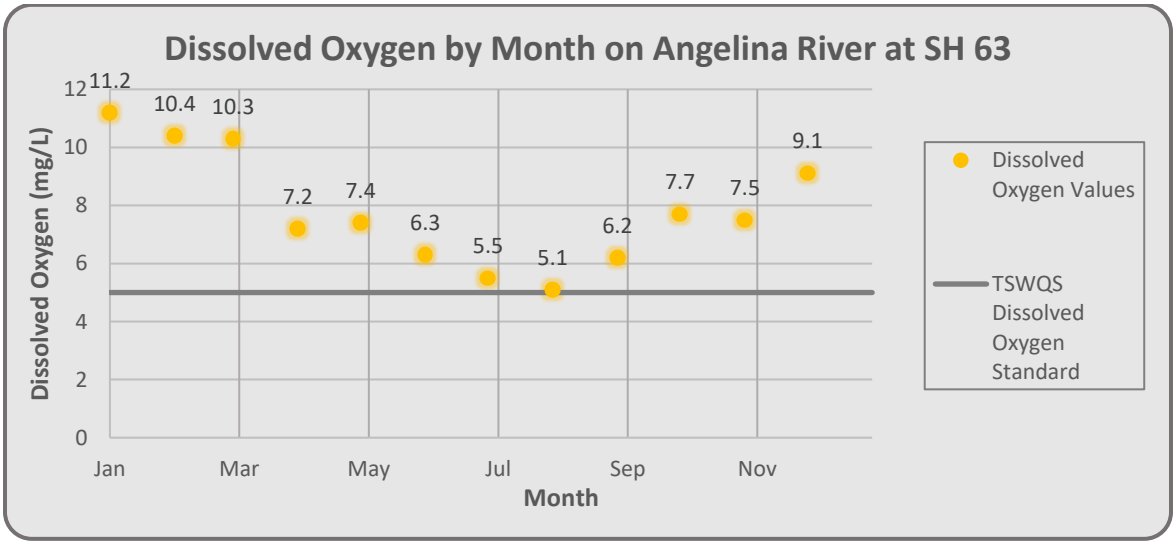

Figure 3.11 Monthly Dissolved Oxygen on the Angelina River

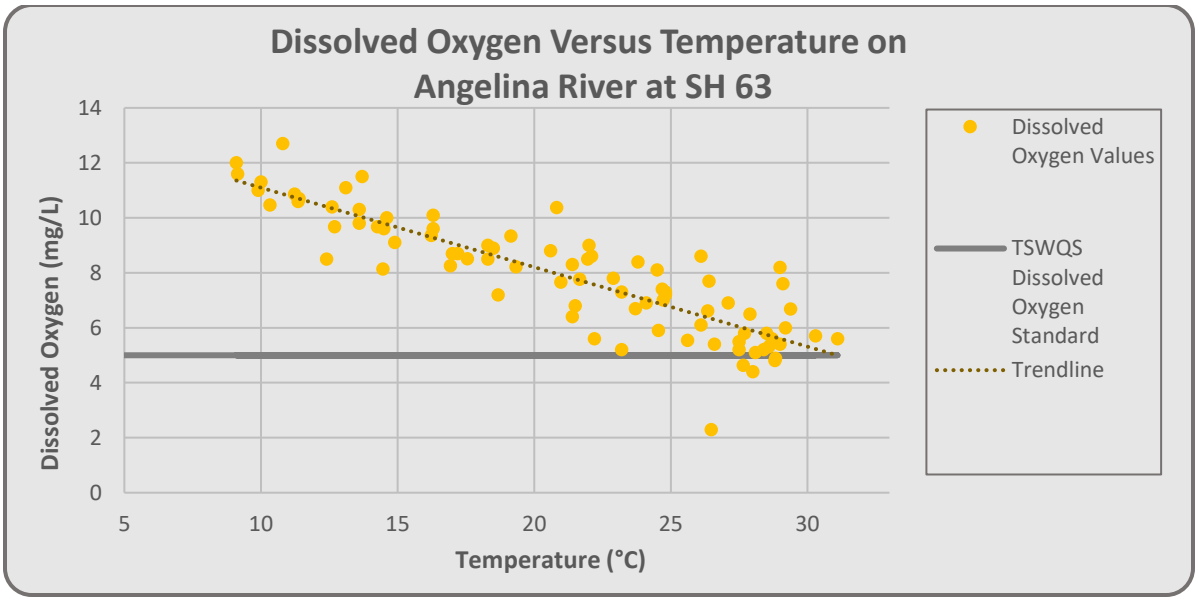

Figure 3.12 Dissolved Oxygen Versus Temperature on the Angelina River

Flow is controlled by the U.S. Army Corps of Engineers, Fort Worth District from the powerhouse (hydroelectric generation) and flood gates at the Sam Rayburn Reservoir dam located just upstream. Since the permanent LNVA Neches River Saltwater Barrier went into operation in 2003, additional releases from the Sam Rayburn Reservoir are no longer required to prevent saltwater intrusion in the lower Neches River channel, which has resulted in an atypical flow regime in this river segment. In other segments, dissolved oxygen is strongly influenced by flow patterns; however, due to the artificial flow in this segment, the fluctuations in dissolved oxygen have greater correlation with water temperature.

Recommendations

LNVA should continue routine monitoring on the segment to maintain baseline water quality data to ensure stream standards are being met. The Texas Department State Health Services should routinely update the fish consumption advisories affecting this segment and both Sam Rayburn Reservoir and Lake B.A. Steinhagen, located upstream and downstream, respectively.

3.3.3. Segment 0603: B.A. Steinhagen Lake

B.A. Steinhagen Lake is a reservoir managed by the U.S. Army Corps of Engineers covering over 13,000 acres and is situated in the piney woods. B.A. Steinhagen assists Sam Rayburn Reservoir in flow regulation, produces electric generation, and supplies raw water to the LNVA and City of Beaumont's intakes. The lake is defined as from Town Bluff in Jasper/Tyler County to a point immediately upstream of the confluence of Hopson Mill Creek on the Neches River Arm in Jasper/Tyler County and to a point immediately upstream of the confluence of Indian Creek on the Angelina River arm in Jasper County, up to the normal pool elevation of 83 feet. B.A. Steinhagen Lake is located off of Hwy 190 between Woodville and Jasper where it impounds the Neches and Angelina Rivers. The Angelina River (Segment 0609), Sandy Creek (Segment

0603A) and Wolf Creek (Segment 0603B) are major tributaries Lake B.A. Steinhagen. The Sandy Creek segment, from the confluence of B.A. Steinhagen Lake southwest of Jasper County to the confluence of Big and Little Sandy Creeks in the City of Jasper, is 23 miles long. The Wolf Creek segment, from the confluence of B.A. Steinhagen Lake southeast of Colmesneil in Tyler County to the upstream perennial portion of the stream south of Colmesneil in Tyler County, is twelve (12) miles long. Segment 0603 mainly has pine-hardwood forests including large expanses of loblolly and shortleaf pine. Soils are acidic and sandy, which supports upland longleaf pine woodlands, longleaf pine savannas, and hardwood slope forests. Segment 0603 is largely represented by the ecological region called the Southern Tertiary Uplands, which is hillier than the Flatwoods to the south like in Segment 0602. The soils generally drain well and are more permeable. Land use is primarily for timber production, public land use, pasture and livestock production, recreation and wildlife habitat. The land is covered by mixed forest, evergreen forest, deciduous forest, and pine plantations. Wolf Creek drains areas of pine forest and pastureland, while Sandy Creek is a forested sub-watershed with pasturelands and its upper reaches drain the City of Jasper. The Sandy Creek (0603A) watershed is primarily rural with large swaths of pine forests contributing to the local forest and paper industries, as shown in Figure 3.13. The city of Jasper is the only municipality in the Sandy Creek (0603A) watershed. The Wolf Creek (0603B) watershed is also primarily rural with a large amount of pine forests. The town of Colmesneil, on the northwestern edge of the watershed, is the only municipality in the watershed. Both watersheds have relatively limited cattle grazing and agricultural production.

Figure 3.13 Station 10484: Sandy Creek @ FM 777

The LNVA performs routine water quality monitoring on Sandy Creek at Station 10484 and Wolf Creek at Station 15344, while TCEQ Region 10 monitors B.A. Steinhagen Lake on the main pool near the dam at Station 10582, as shown in Figure 3.14.

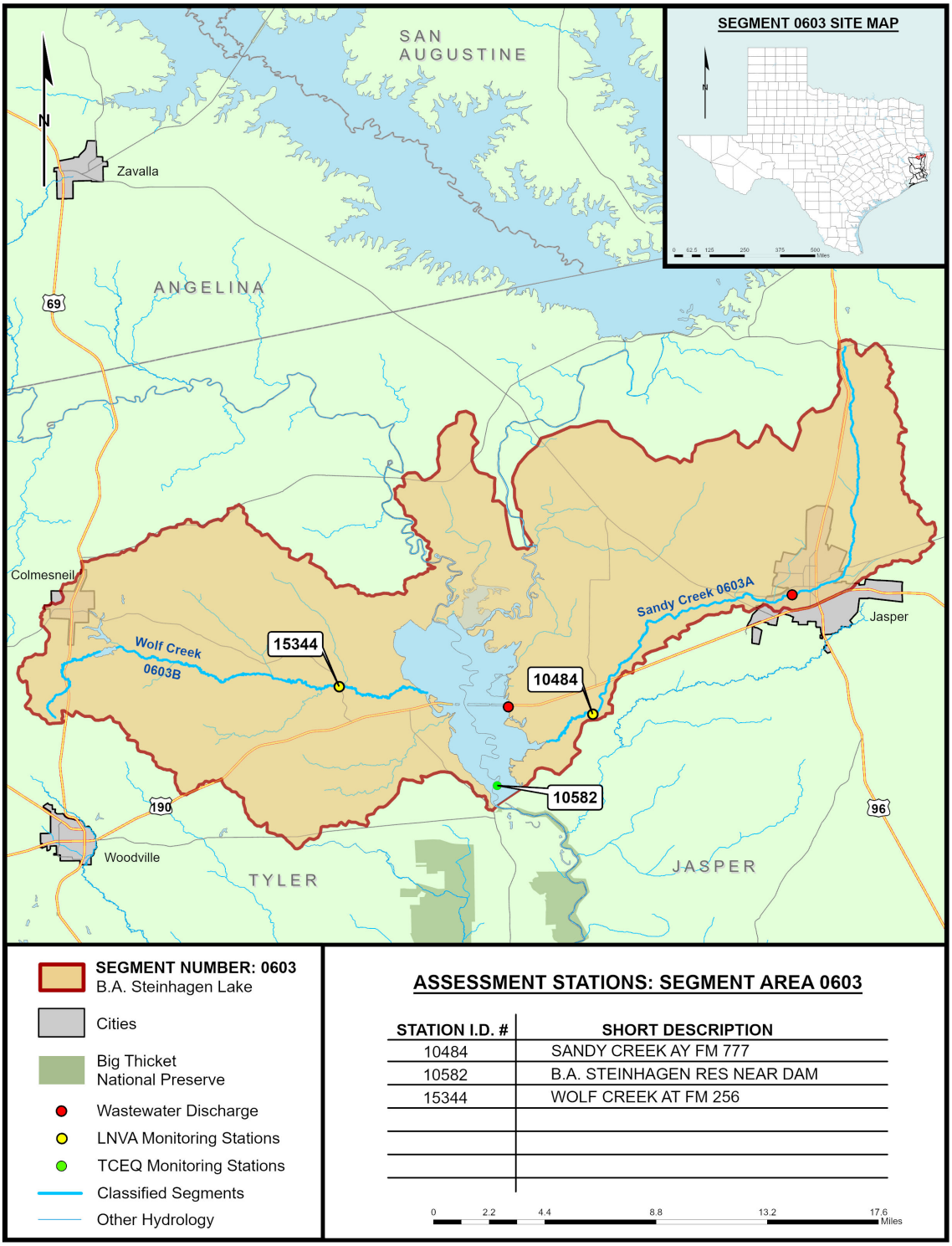

Figure 3.14 Segment 0603: B.A. Steinhagen Lake Assessment Area

Data Assessment Results

Segment 0603 is designated for high aquatic life use, primary contact recreation, and public water supply, as shown in Table 3.6. This segment fully supports the high aquatic life use for dissolved oxygen and the general use criteria parameters. These parameters include pH, temperature, chloride, sulfate, chlorophyll-*a*, nutrients and total dissolved solids. It also has

good water quality for public water supply. The uses that are not supported are fish consumption due to mercury and dioxin in edible tissue in 0603 B.A. Steinhagen Lake and contact recreation use due to bacteria in 0603A Sandy Creek and 0603B Wolf Creek.

Segment #	Segment Name	Impairment/Concern Listed in 2020 Texas Integrated Report	Reason for Impairment
0603	B.A. Steinhagen Lake	Not supporting fish consumption use due to mercury and dioxins in edible tissue	Atmospheric Deposition-Toxics; Industrial Point Source Discharge; Other Unknown Source
0603A	Sandy Creek	Not supporting contact recreation use due to bacteria	Nonpoint Source-Agriculture and Grazing in Riparian Zone or Shoreline Zones
0603B	Wolf Creek	Not supporting contact recreation use due to bacteria	Nonpoint Source-Agriculture and Livestock Grazing or Feeding Operations

Table 3.6 Segment 0603 Impairments

Figure 3.15 Station 10582: B.A. Steinhagen near dam

Segment 0603 is under Advisory 51 for fish consumption issued by the Department of Safety and Health Services as previously described for Segment 0602. This impairment due to mercury and dioxins is thought to be attributed to atmospheric deposition, industrial point source discharge, or other unknown sources. The main source of dioxins is incineration and unintentional by-products of chlorine bleaching. Mercury is naturally found in the sediment as a result of normal breakdown of the earth's crust by wind and water. Once in the atmosphere, it can travel long distances. Inorganic mercury can enter the environment from ore deposits, burning of fuels or trash, or emissions from factories. Non-air deposition contributions, including sources such as soil erosion, tributaries, and waste streams, and factors influencing methylation of mercury to methyl mercury concentrations in fish tissue are not well understood. In addition, basin water quality data shows no mercury in water or sediment exists in water bodies with mercury in fish tissue concerns or impairments. Mercury in edible fish tissue in this segment is a concern in fish. The issue of mercury in fish tissue is regional, encompassing other water bodies in East Texas in addition to B.A. Steinhagen Lake. The level of mercury contamination in fish tissue is the result of bioaccumulation, and there are no risks to the public in other recreational activities.

Figure 3.16 Station 15344: Wolf Creek @ FM 256

The primary contact recreation use is not supported due to elevated *E.coli* bacteria in Segments 0603A, Sandy Creek, and 0603B, Wolf Creek. Seventy (70) samples were assessed for bacteria at Station #10484, and the geometric mean was 409 colonies per 100 milliliters (mL). The criterion for bacteria is 126 colonies per 100mL. Wolf Creek at FM 256, Station 15344, had 70 samples assessed for the bacteria and the geometric mean is 569 colonies per 100mL, as shown in Figure 3.16. Historically, bacteria counts seem to be influenced by periods of high flow after rainfall events. For example, in April of 2012, both Sandy and Wolf Creek had one very high *E.coli* count. Wolf Creek had a flow rate of 288 cubic feet per second (cfs) with 13,000 colonies per 100 mL. Sandy Creek had a flow rate of 86 (cfs) with 2,400 colonies per 100 mL. This was seen again at Sandy Creek in February of 2018, with a flow of 101 cfs with an *E.coli* count of 1400 colonies per 100 mL. These events are likely due to the buildup of *E. coli* in soils and sediments during periods of no rainfall, then being washed into the streams after a major rain event. In addition, Wolf Creek and Sandy Creek are both located in watersheds with large forested areas with an abundance of wildlife contributing to bacteria levels in the soil and sediment. Sandy Creek also flows through the City of Jasper, which discharges wastewater effluent and stormwater runoff to the segment.

Urban runoff/storm sewers, manure runoff, sewage discharges in unsewered areas, failing on-site sewage facilities, and wildlife are factors influencing high *E. coli* counts. The average stream flow for both of these creeks is less than 50 cfs.

TCEQ has contracted with the Texas Water Resources Institute (TWRI) for the Sandy Creek and Wolf Creek TMDL project. The tasks of this project were to:

- acquire existing (historical) data,
- perform the appropriate activities necessary to allocate *E. coli* loadings,
- assist TCEQ in preparing a TMDL document, and
- engage the public through education and outreach activities related to water quality impairments in the project area.

The purpose of this report is to provide technical documentation and supporting information for developing the bacteria TMDLs for the Sandy Creek and Wolf Creek watersheds. This report contains information on historical data, watershed characteristics, a summary of historical bacteria data confirming the State of Texas 303(d) listings of impairment due to the presence of indicator bacteria (*E. coli*), development of load duration curves (LDCs), and application of the LDC approach for the pollutant load allocation process. The TCEQ, with Agri-Life, will be completing a TMDL and I-plan for Sandy and Wolf Creek to address the contact recreation impairments for bacteria.

Sandy Creek and Wolf Creek are currently primary contact recreation 1 use streams, as the associated criterion for *E. coli* is a geometric mean of 126 cfu per 100 mL. Some statistically significant emerging trends in the data analysis show a decrease in pH at Station 10582, as shown by Figure 3.17. As soil profiles dry out during a drought, there is an accumulation of cations like Calcium, Magnesium, Potassium, and Sodium resulting in higher pH levels, and when significant rainfall occurs, the pH levels will begin to drop.

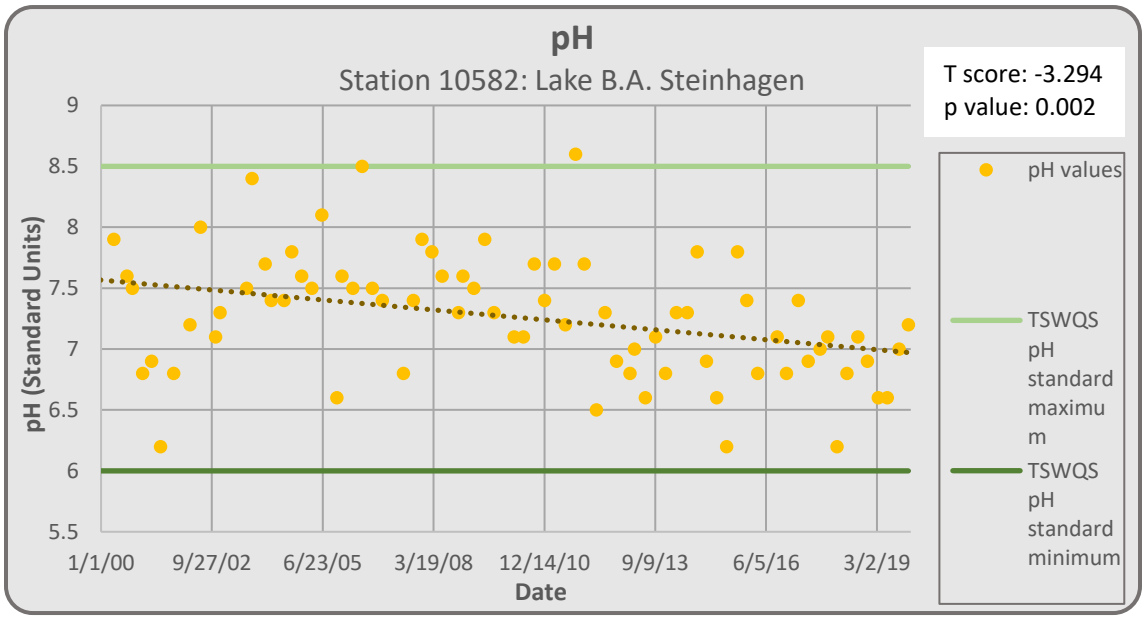

Figure 3.17 Historical pH in Lake B.A. Steinhagen

This same phenomenon can be seen with chloride levels, as shown in Figure 3.18. Decreasing chloride levels correlate to lower salt concentrations in the water column. These changes by data point correlate with the various stages of drought the state was experiencing during the time span assessed, as previously shown in Figure 1.6. This is most evident in the drop in chloride sample values after 2014.

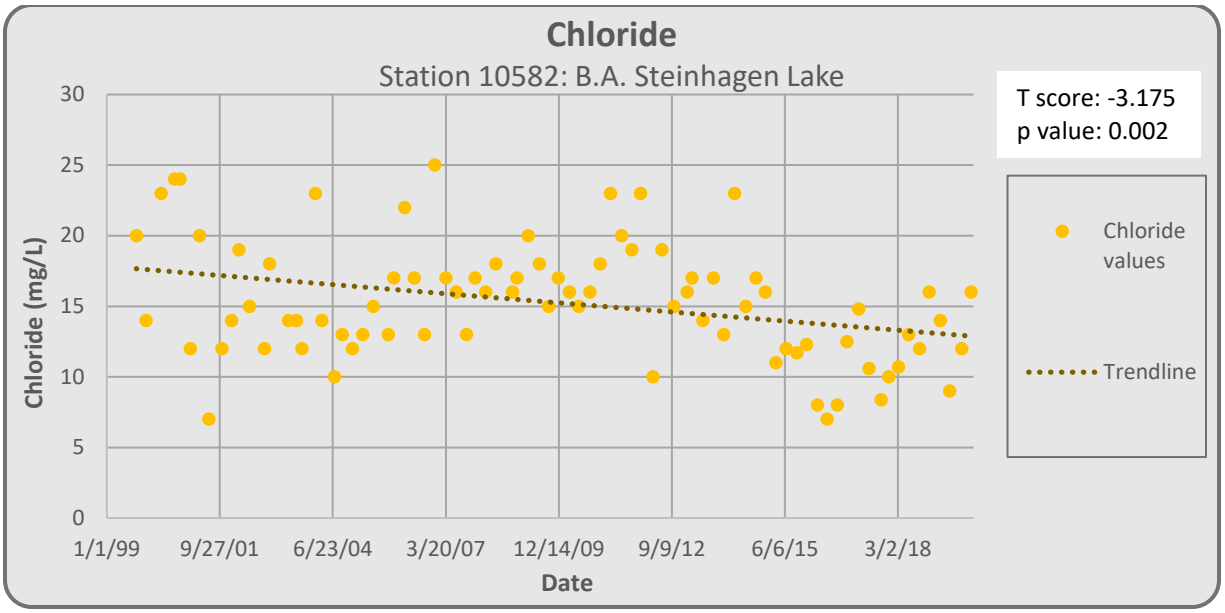

Figure 3.18 Historical Chloride in Lake B.A. Steinhagen

Recommendations

The LNVA and TCEQ Region 10 will continue to coordinate routine monitoring in the segment. The TCEQ has initiated watershed TMDL and I-plan projects to address the contact recreation use concerns. Mercury and dioxins in fish tissue sampling should continue in B.A. Steinhagen Lake with updates to current advisories being issued promptly by the Texas DSHS. Recommendations from the Texas mercury-impaired waters advisory group can be found in the Chapter 4. Conclusions and Recommendations of this report.

3.3.4. Segment 0608: Village Creek Watershed

Figure 3.19 American Holly in Village Creek Watershed

The Village Creek Watershed, Segment 0608, is located in the region of southeast Texas known as the Big Thicket National Preserve, which is part of the piney woods ecoregion of East Texas. The Village Creek Watershed is made up of a number of tributaries flowing southeasterly into the Neches River. The drainage area for this watershed is approximately 1,113 square miles. Village Creek, the main tributary in this watershed, is defined in the 2018 *Texas Surface Water Quality Standards* as from the confluence with the Neches River in Hardin County to the confluence of Big Sandy Creek and Lake Kimball in Hardin County. Unclassified water bodies feeding into Village Creek include Beech Creek, Big Sandy Creek, Cypress Creek, Mill Creek, Turkey Creek, and Lake Kimball, or Segments 0608A, 0608B, 0608C, 0608E, 0608F, and 0608G, respectively. Village Creek is a free-flowing clear water stream with mostly sandy bottoms,

which makes it popular for recreation. The tributaries to Village Creek vary in flow and possess water conditions with muddy bottoms.

Prior to the lumber industry boom in the 1800s, the Big Thicket was made up of tall longleaf pine, as shown in Figure 3.20, and hardwood forests with dense understories of plant growth teeming with an abundance of wildlife. By the end of the logging boom and the development of the clear-cutting method, much of the original native species of trees had been replaced with quicker growing species like the loblolly and short leaf pines. According to the National Park Service, only in the most remote, hard to reach areas of the preserve could the original "old growth" trees be found.

Figure 3.20 Longleaf pine forest (left), juvenile longleaf pine trees (center), and longleaf pine needles (right). Photos courtesy of www.wikipedia.org

Today, after decades of conservation efforts and coordination with industry, the Village Creek watershed is made up of the Big Thicket Preserve, state parks, and conservation sanctuaries, as shown in Figure 3.21. The placement of these protected lands ensures the protection of water quality and movement of plant and animals throughout the watershed without negatively impacting the economy of the lumber industry. Village Creek State Park is located in Hardin County and covers more than 1,000 acres of thick forests. This recreational destination is popular with campers, hikers, kayakers, and canoers.

Figure 3.21 Longleaf Pines Locations Map

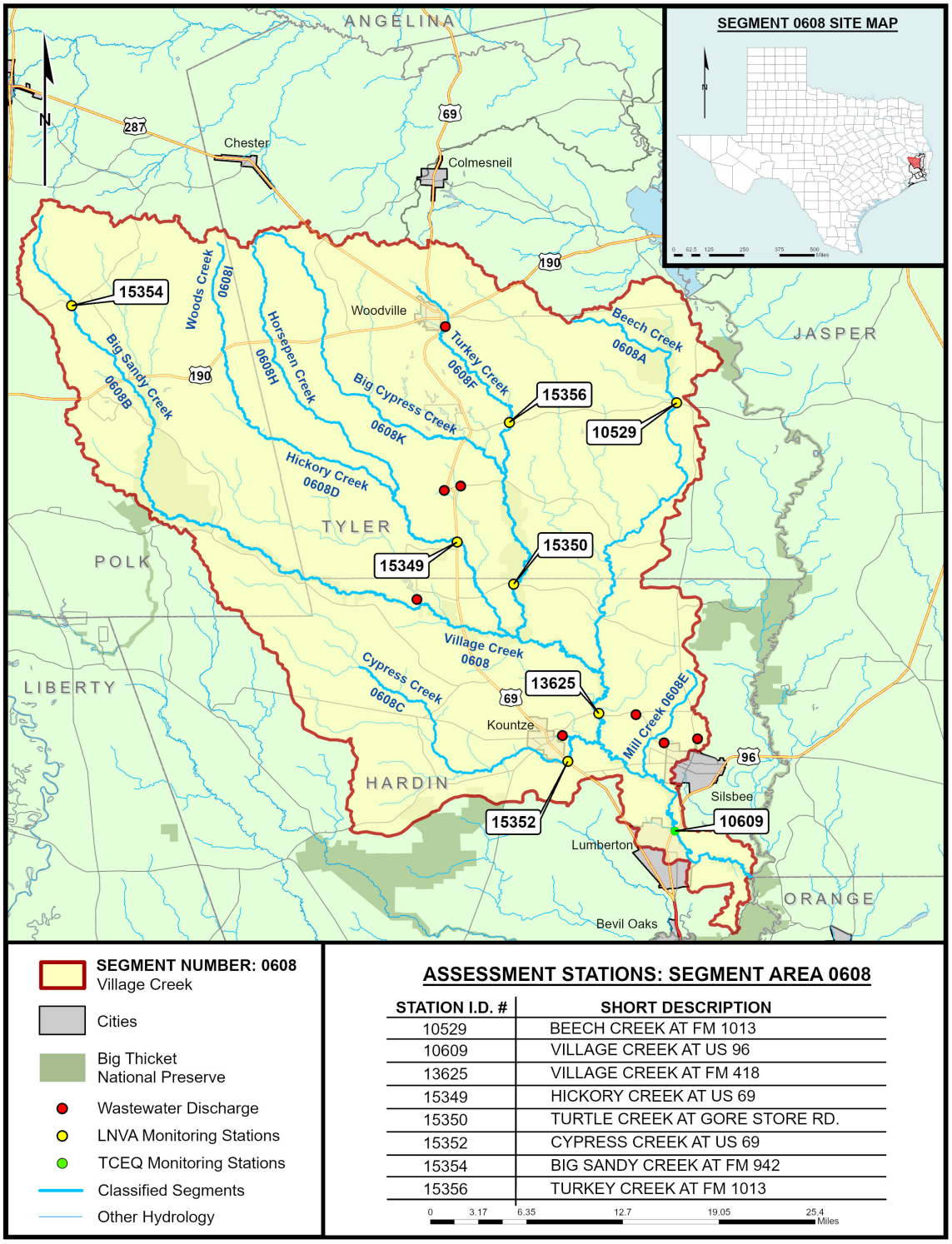

Figure 3.22 Segment 0608: Village Creek Watershed Assessment Area

Data Assessment Results

According to the 2020 Texas Integrated Report, Village Creek is not meeting the TSWQS screening level for mercury in fish tissue and does not support fish tissue consumption due to mercury, as shown in Table 3.7. In 2009, the Texas Department of State Health Services issued a fish consumption advisory (ADV-39) for Village Creek. Consumption limitations are recommended due to elevated levels of mercury in fish tissue samples taken from black crappie, gar, and largemouth bass; however, no restrictions were recommended for blue catfish, channel catfish, spotted bass, or

freshwater drum. Mercury is an element occurring naturally in the environment in several forms. Elemental mercury is a metallic silver white liquid, and when combined with other elements, forms mercury compounds. These compounds are called organic mercury when carbon is present and inorganic mercury when carbon is absent. Mercury can be found naturally in the environment due to a breakdown of the earth's crust by wind and water. Air, water, and soil can contain mercury naturally, as well as some human activities. The organic form, methylmercury, occurs when mercury settles from the water column into sediment.

Segment #	Segment Name	Impairments/Concerns from 2020 Integrated Report	Reason for Impairment
0608	Village Creek	Screening level concern for mercury in edible fish tissue	Atmospheric Deposition-Toxics; Natural Sources; Unknown Source
		Not supporting fish consumption due to mercury in edible tissue	Atmospheric Deposition-Toxics; Unknown Source
0608A	Beech Creek	Non-support for dissolved copper	Unknown Source
		Use concern for bacteria in water	Source Unknown, Nonpoint Source
		Screening level concern for habitat	Source Unknown
0608B	Big Sandy Creek	Screening level concern for dissolved oxygen grab	Source Unknown; Non-Point Source
0608C	Cypress Creek	Non-support of dissolved oxygen 24 hour minimum and average	Natural Conditions-Water Quality Standards Use Attainability Analyses Needed; Source Unknown
		Screening level concern for impaired habitat	Unknown Source
		Use concern for *E.coli*	Unknown Source, Non-Point Source
0608E	Mill Creek	Not supporting aquatic life use due to dissolved oxygen 24 hour minimum and average	Natural Sources; Industrial Point Source Discharge; Municipal Point Source Discharge
0608G	Lake Kimball	Not supporting fish consumption due to mercury in edible tissue	Atmospheric Deposition-Toxics; Unknown Source

Table 3.7 Segment 0608 Impairments

Small aquatic plants and fish absorb the methylmercury and enter the food chain as larger fish eat the smaller fish. The concentration of mercury will increase as predation continues. As a result, predatory fish contain higher levels of mercury than non-predatory fish. More information about the fish advisory for Village Creek can be found at: https://www.dshs.texas.gov/seafood/advisories-bans.aspx.

Lower Neches Valley Authority currently monitors Village Creek at FM 418, Station #13625, and TCEQ Region 10 monitors Village Creek at Hwy 96, Station #10609 in segment 0608. The overall water quality data assessment shows trends for several different parameters. One of these is an increase in pH levels during the assessment period at Station #13625, Village Creek @ FM 418, as shown in Figure 3.24.

Figure 3.24 Station #13625: Village Creek @ FM 418

The minimum pH for the 84 data points collected was 4.8 mg/L, and the range of pH from 2012-2018 was 5.5mg/L to 7.5 mg/L, as shown in Figure 3.25. While there is no definite visual relationship between pH and stream flow demonstrated in the graph below, the data analysis suggests that there is an inverse correlation between the two, as shown in Figure 3.26. The reason for the increasing trend in pH at this location could be related to the pervasive drought between 1999-2014. Periods of low rainfall can concentrate levels of minerals like calcium, magnesium, and sodium in the water column that will cause an increase in pH levels. If rainfall levels are higher during the next assessment, this trend may no longer exist.

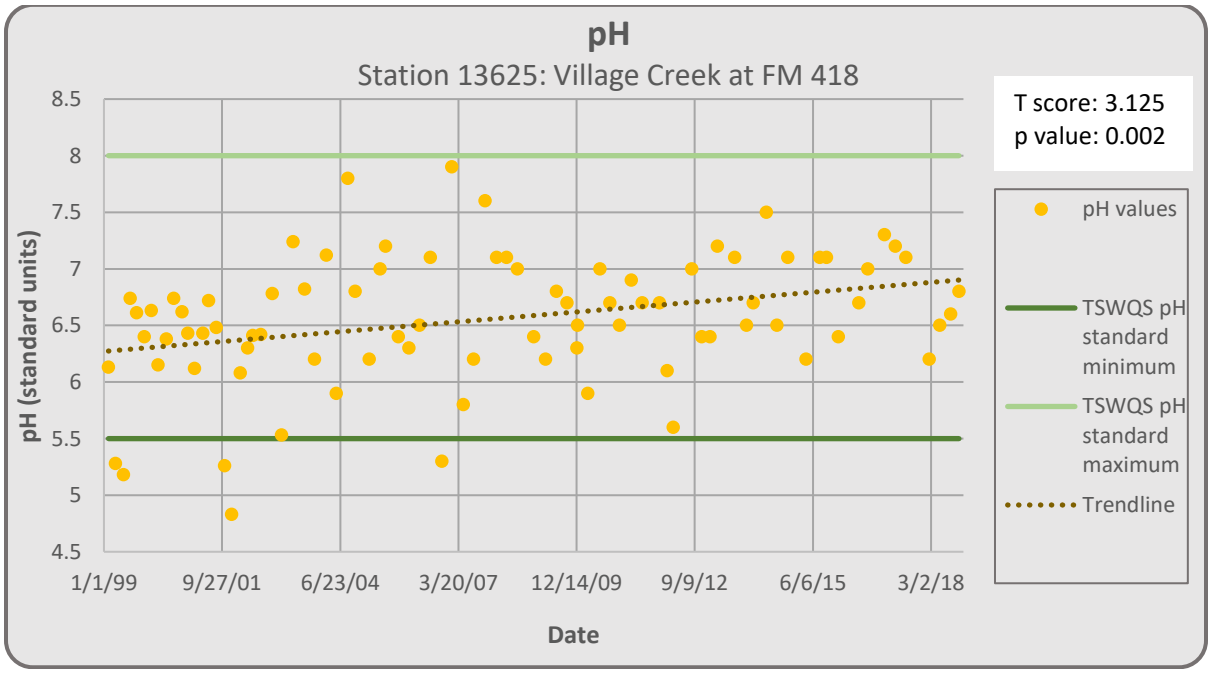

Figure 3.25 Historical pH in Village Creek at FM 418

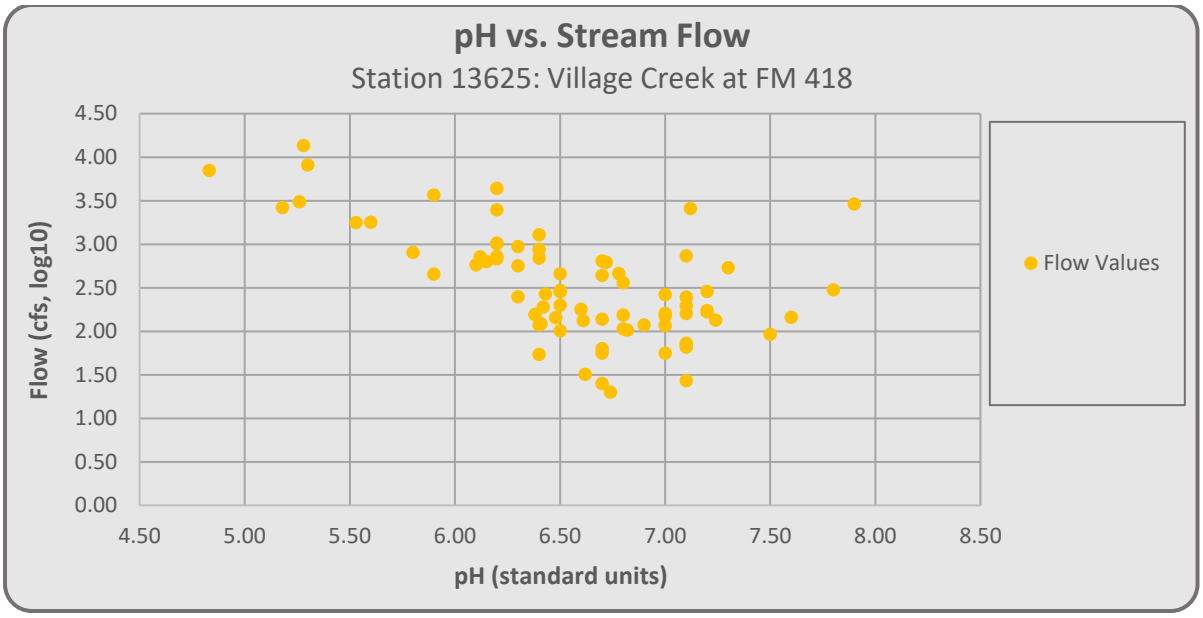

Figure 3.26 Historical pH Versus Stream Flow in Village Creek at FM 418

Conversely, pH is showing a decreasing trend at Station #10609, Village Creek @ Hwy 96, as shown in Figure 3.27. pH levels decrease at this station when flow levels are high, as shown in Figure 3.28. These results suggest flushing of backwater, swampy areas where organic decay of forest litter occurs, which may result in lower pH levels within Village Creek. In 2010, the stream standard for pH was revised for the Village Creek Watershed from to 6.0-8.5 mg/L to 5.5-8.0 mg/L, which is more representative of the naturally acidic conditions. Cypress-tupelo swamps and baygall flats are the surrounding forest types, which are comprised of sweet bay magnolia, galberry, tupelo, mayhaw trees, and other riparian species.

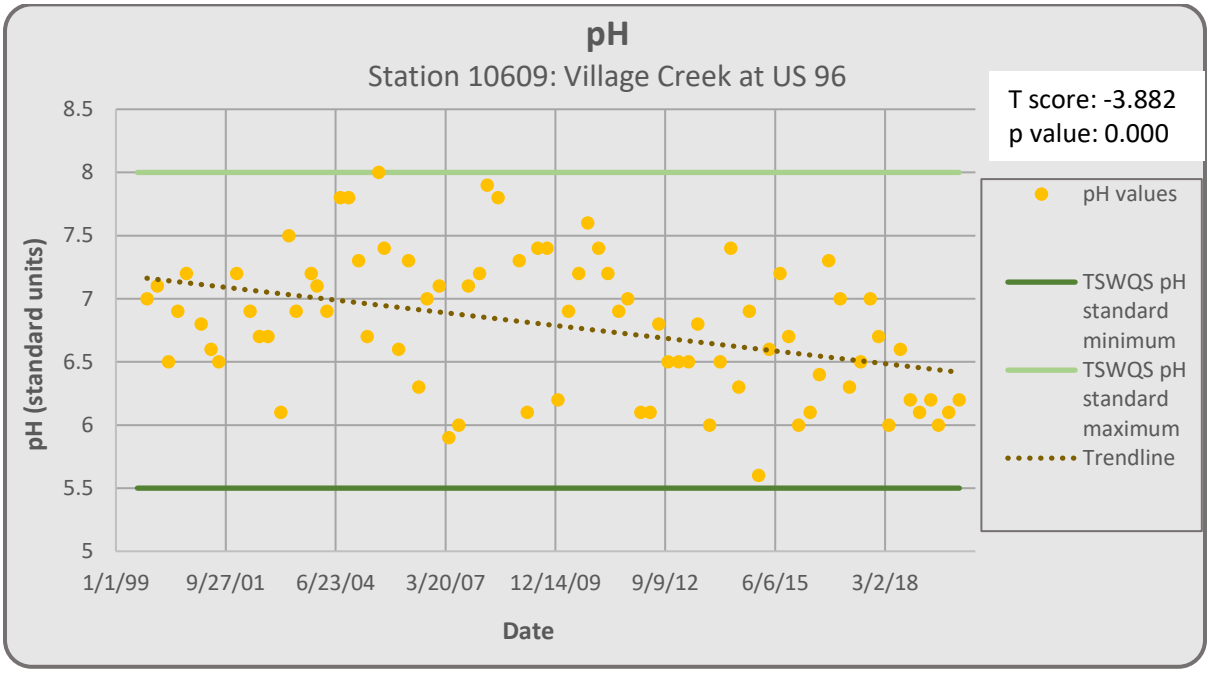

Figure 3.27 Historical pH in Village Creek at US 96

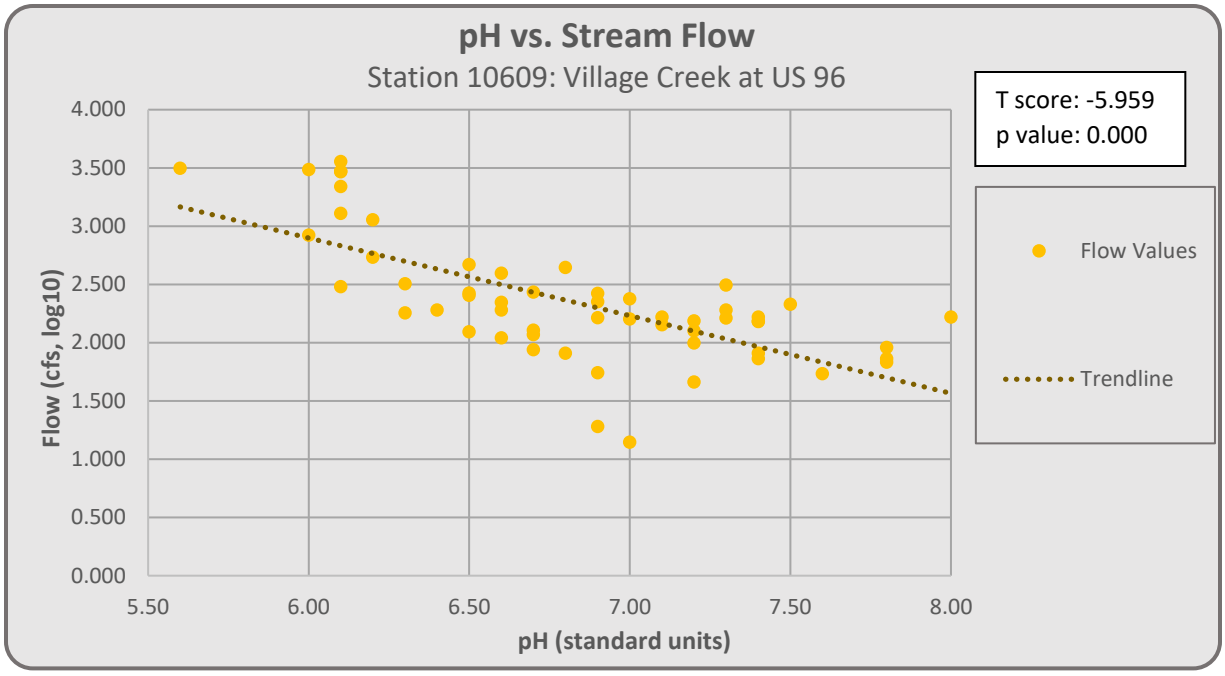

Figure 3.28 Historical pH Versus Stream Flow in Village Creek at US 96

Data also shows an increasing trend in the level of Total Organic Carbon (TOC), as shown in Figure 3.29 TOC is the amount of carbon or decaying organic material in the water column. Although the actual cause of increasing TOC at this station has yet to be determined, runoff introduces decaying organic material from the forest floor, potentially resulting in an increase in TOC. The increasing TOC in combination with the decrease in pH could suggest also suggest a specific source, but further monitoring would be required to determine if this is the case.

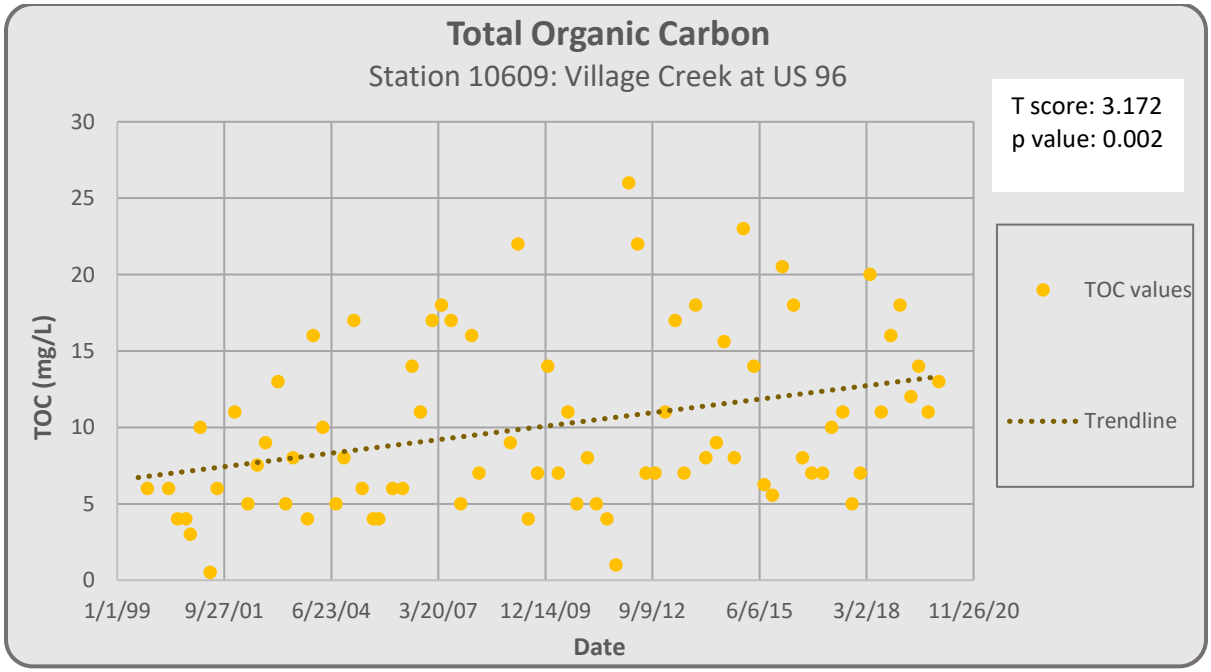

Figure 3.29 Historical Organic Carbon in Village Creek at US 96

Total dissolved solids (TDS) at this site can be attributed to periods of drought followed by intense rainfall. TDS refers to any salts, minerals, metals, cations, or anions dissolved in water. Increased levels of TDS can be attributed to runoff and non-point wastewater discharges. Highly dissolved solids can affect the permeability of ions and aquatic organisms. As shown in Figure 3.30, TDS levels have exhibited an increasing trend over time. The average TDS concentration is 51 mg/L, well below the stream standard of 300 mg/L. Pulse flow events replace portions of the water column with unsaturated water and can result in lower TDS values. Adversely in periods of decreased flow, TDS increases as shown in Figure 3.31. TDS values begin to decrease after 2014 which suggests the increase over time was due to the extended drought.

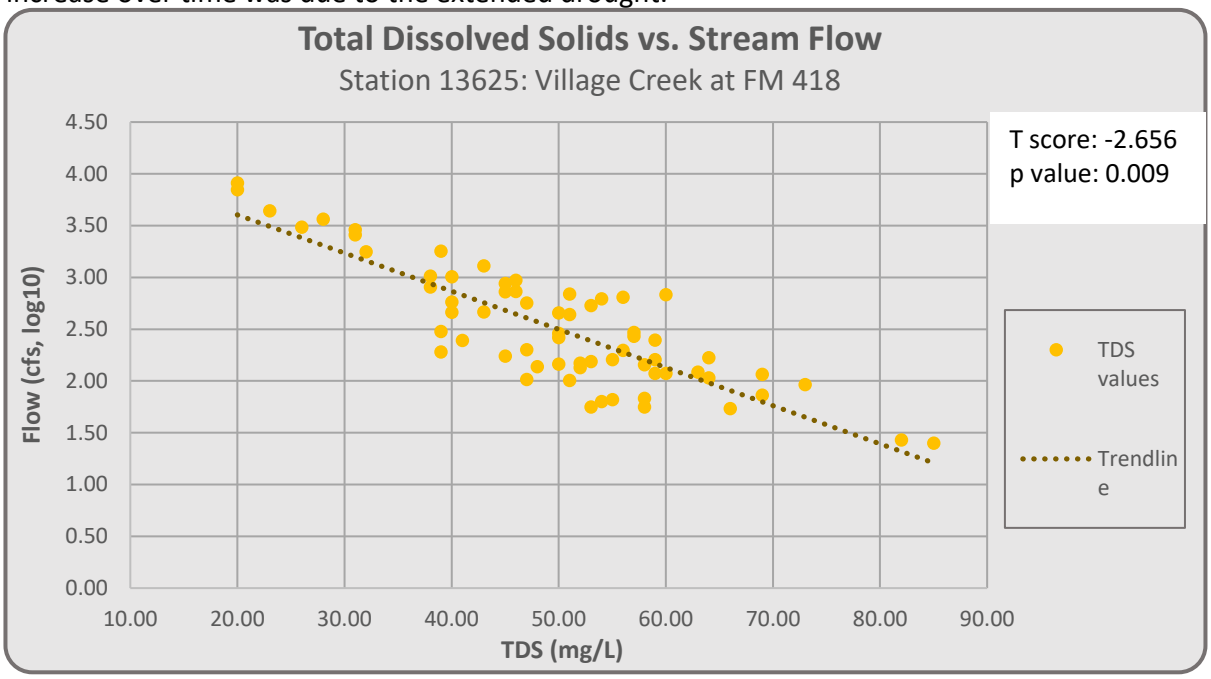

Figure 3.30 TDS Versus Stream Flow in Village Creek at FM 418

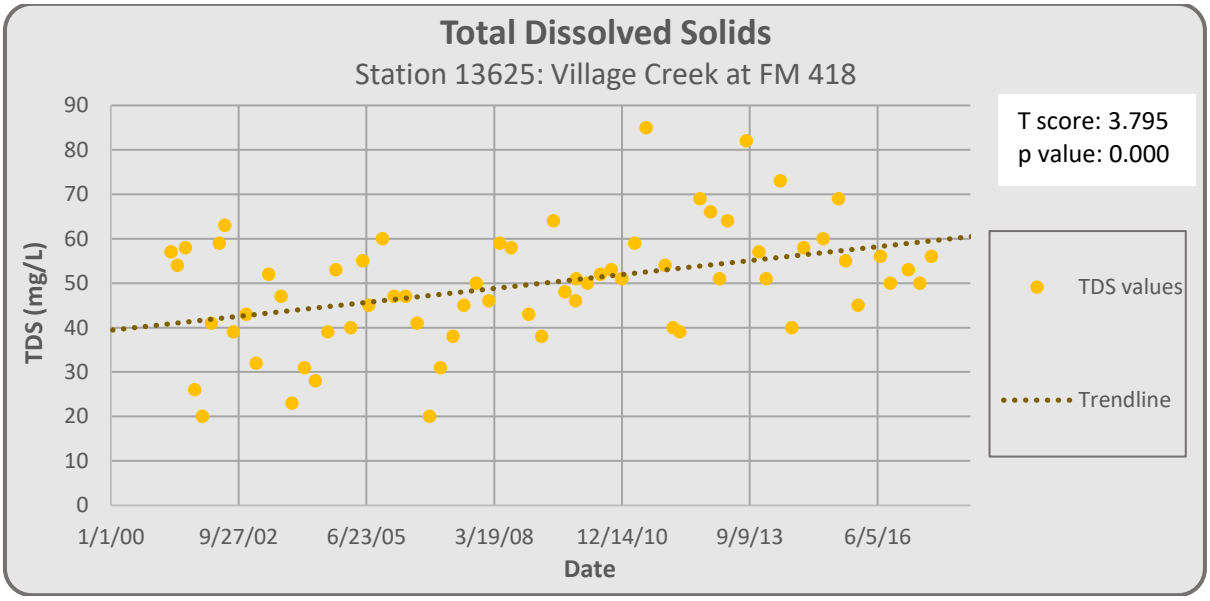

Figure 3.31 Historical TDS in Village Creek at FM 418

3.3.4.a. Segment 0608A: Beech Creek

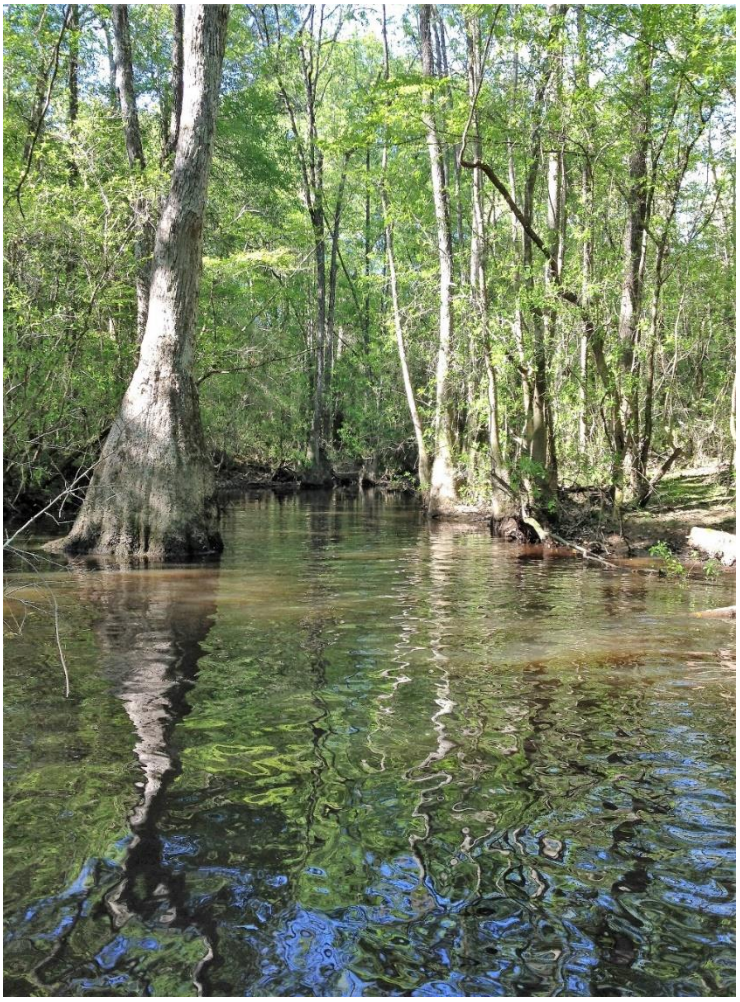

Figure 3.32 Station #10529: Beech Creek @ FM 1013. Photo courtesy of Water Monitoring Solutions during the ALM

Beech Creek is listed in the 2020 Texas Integrated Report for a non-support of the 2018 stream standards for copper, a screening level concern for habitat, and a recreation use concern for *E.coli*. LNVA currently monitors Station #10529, Beech Creek @ FM 1013, as shown in Figure 3.32. Beech Creek historically has low pH levels where dark stained water indicate tannins are present. Tannins are bi-product of the decomposition process as leaves break down in the water column and are often associated with marsh and swamp areas. As this vegetation breaks down, leaching occurs, water color becomes dark in appearance, and pH levels often drop below 7 promoting an acidic environment. As shown in Figure 3.33, the pH of Beech Creek is also showing an increase in pH levels over time. The correlation with flow was not statistically significant here, as shown in Figure 3.34. No specific cause for the increase in pH has been identified. The LNVA will continue to collect pH data to see if the trend continues and if more specific monitoring is required. The median pH level at Beech Creek is 5.8 mg/L. Beech is currently meeting the stream standard of 5.5-8.0 mg/L, but it's definitely naturally on the more acidic side of the pH scale.

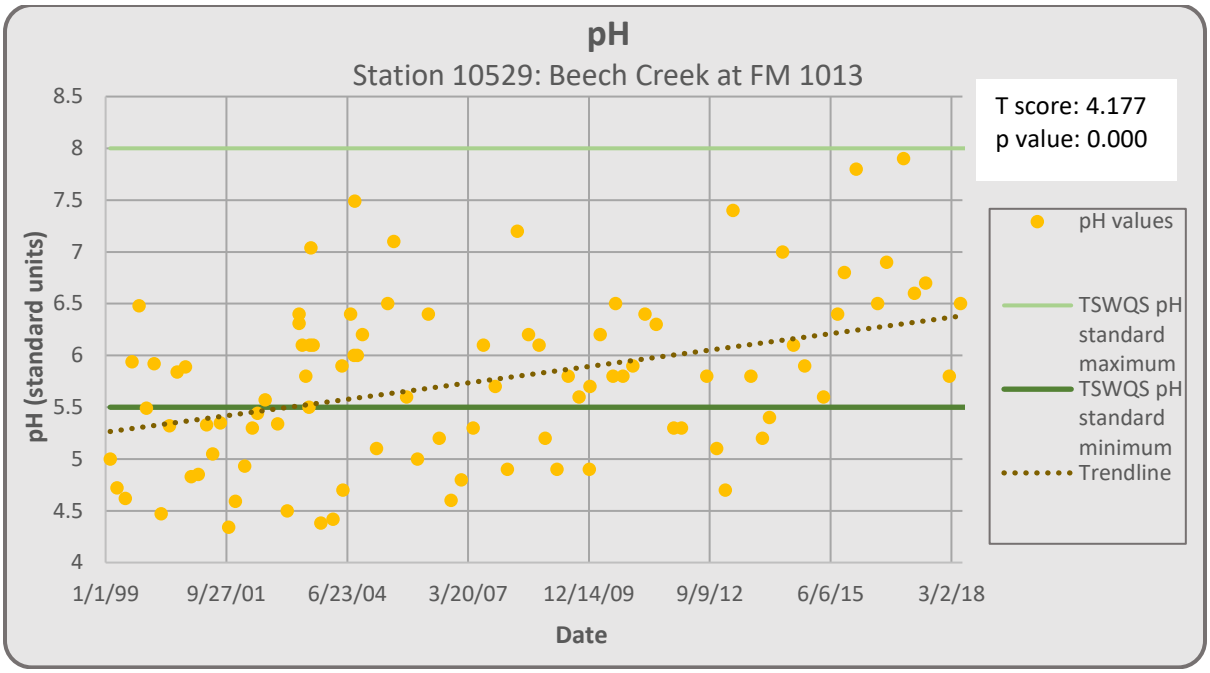

Figure 3.33 Historical pH in Beech Creek at FM 1013

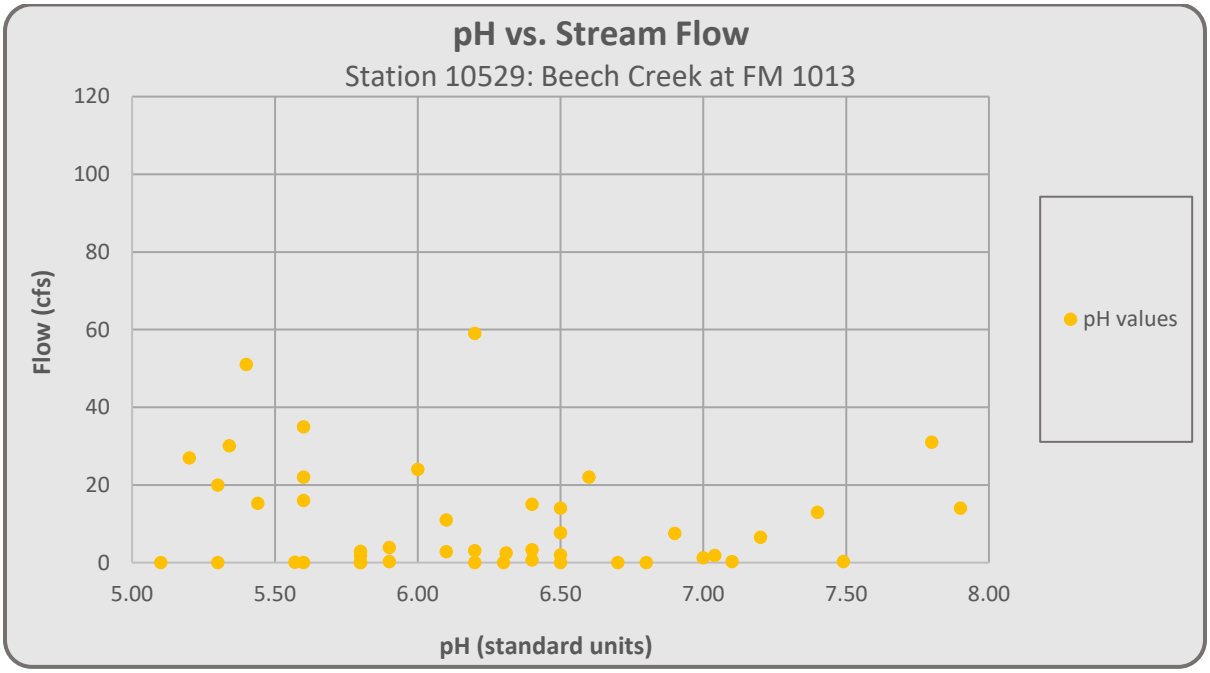

Figure 3.34 pH Versus Stream Flow in Beech Creek at FM 1013

There is a correlation between stream flow and *E.coli* bacteria levels, as shown in Figure 3.35 Timing of *E.coli* sampling with runoff from rainfall is crucial when comparing flow with bacteria levels. The cause of the bacteria concern in Beech Creek is thought to be from nonpoint source origins such as livestock runoff or wildlife waste. Bacteria levels as a whole have remained consistent over time, as shown in Figure 3.36. The steam standard for *E.coli* is 126 indicator bacteria per 100mL.

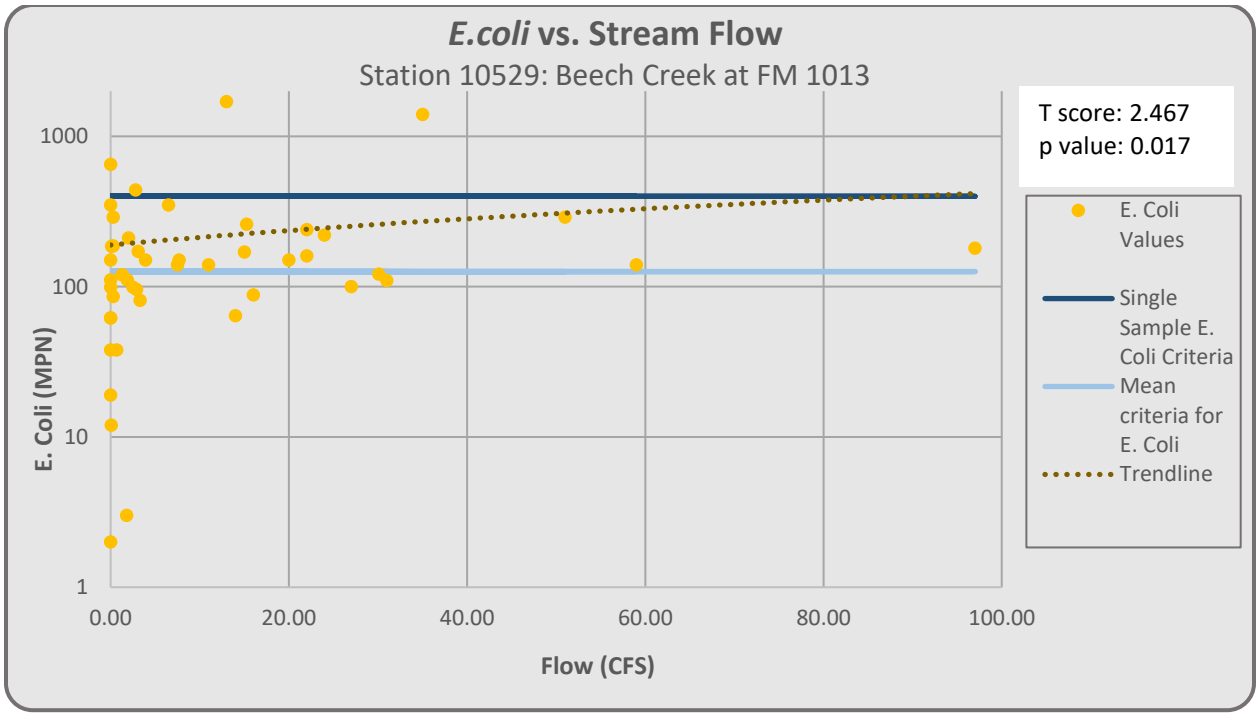

Figure 3.35 *E.coli* Versus Stream Flow in Beech Creek

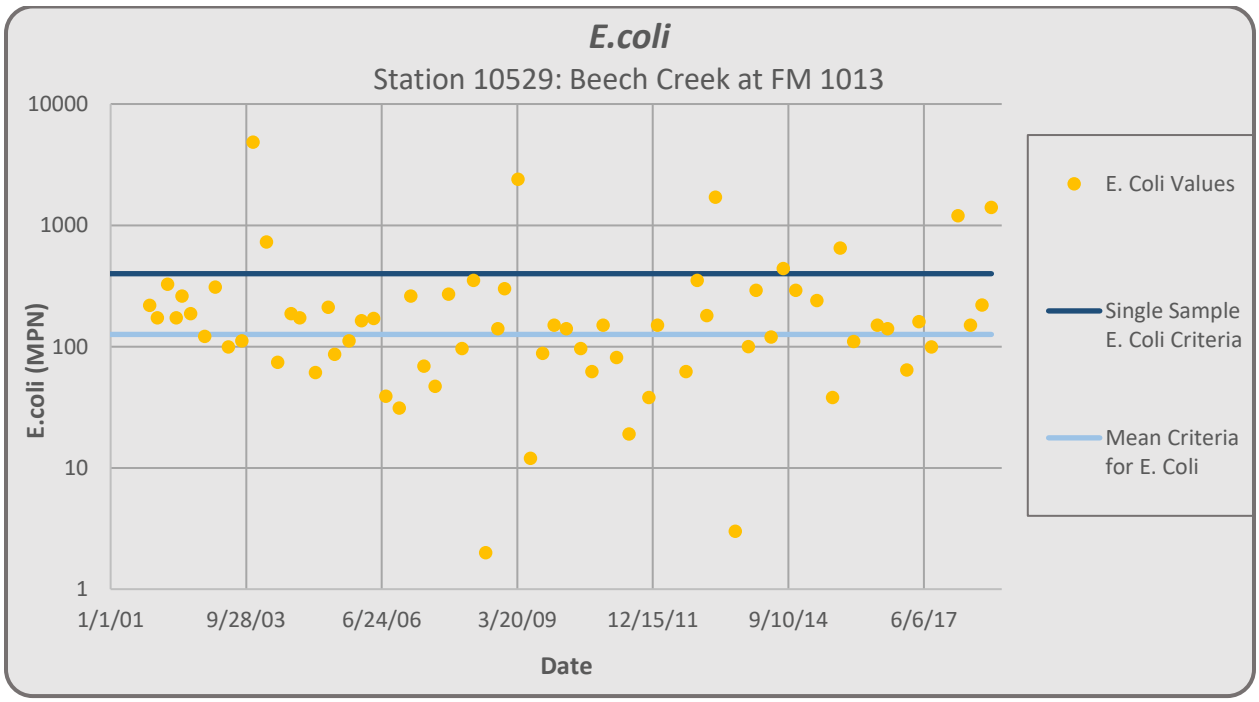

Figure 3.36 Historical *E.Coli* in Beech Creek

The mean of the *E.coli* data assessed for this report is 244 mg/L. This impairment developed in the last five-year period of data collection, which could be attributed to a rise in the population of feral hogs in the area. When the drought ended in 2015, increased rainfall runoff would have flushed fecal waste left by the hogs into the creek.

Beech Creek is the only creek in the Village Creek watershed with an impairment for metals. Metals in water assessments are based on dissolved freshwater or saltwater acute and chronic criteria for aquatic life protection established in the water quality standards. The criteria for cadmium, copper, lead, nickel, and zinc are based on the hardness concentrations from the segment. Hardness values in the Village Creek watershed tend to be less than 30 mg/L, which means calculated metals values are also lower. Acute criteria apply to all waters of the state and at all flows above one-fourth of the 7Q2, which is the 7-day minimum, two-year recurrence interval of low flow in a stream. The chronic criteria apply outside of the mixing zones in unclassified perennial steams when the stream flow is greater than the 7Q2 and in intermittent streams supporting significant aquatic life. For the purposes of monitoring compliance with the standards, individual measurements are compared against acute criteria, and the averages for each parameter are compared to the chronic criteria to determine aquatic life use support.

Beech Creek is currently listed for a non-support of aquatic life use due to elevated levels of copper. This impairment was first listed in the 2014 Texas Integrated Report 303(d) List. At that time, only one sample exceeded the acute criteria of 2.46 ug/L. Copper is naturally abundant in nature from geological deposits and the weathering of rocks and soils. One elevated sample doesn't necessarily indicate a water impairment, so more metals data is required to determine if this listing is valid.

Another concern for Beech Creek is habitat. The source of this concern is thought to be nonpoint sources, livestock and wild animals. In order to get further information about this stream in regards to whether or not its meeting its designated high aquatic life use, the LNVA contracted a water monitoring company to conduct aquatic life monitoring on Beech Creek in 2019 and 2020. One sampling event will carry over into 2021 due to delays from weather events. The average DO for Beech Creek is 6.4 mg/L, which is above the stream standard of 5 mg/L. More information about aquatic life monitoring for Beech Creek will continue in segment 0608C Cypress Creek. One issue LNVA staff has noticed at the Beech Creek sampling station is its a popular spot for trash dumping. This trash ranges from household garbage and food wrappers to large appliances, as shown in Figure 3.34 The remote bridge location over FM 1013 has provided the opportunity for littering. In the future, the LNVA hopes to organize cleanup days at this site and others like it.

Figure 3.37 Washing Machine Discarded in Beech Creek

3.3.4.b. Segment 0608C: Cypress Creek

Figure 3.38 Station #15352: Cypress Creek. Photo courtesy of Water Monitoring Solutions during ALM.

Like Beech Creek 0608A, Cypress Creek is listed for concerns for impaired habitat and bacteria, as well as not supporting aquatic life use due to depressed dissolved oxygen. Cypress Creek has naturally low flow conditions. Aquatic Life Monitoring (ALM) was conducted in 2019-2021 at Beech and Cypress Creeks. This data will be used in determining when TCEQ will perform a UAA. Data from a UAA can result in changes to screening levels that more accurately reflect the natural stream conditions. ALM events are conducted during the Index period, March through October, with at least one-half to two-thirds of the samples in the critical period. The critical period is when aquatic life would be most stressed with higher temperatures and lower flow. Water chemistry, streamflow, nekton (fish), macrobenthics, and habitat are assessed. Preliminary results show between intermediate and high aquatic life use on Cypress and Beech Creek.

3.3.4.c. Segment 0608B: Big Sandy Creek

Big Sandy Creek is listed in the 2020 Texas Integrated Report with a screening level concern for dissolved oxygen, as shown in Figure 3.38. The stream standard for dissolved oxygen is 5 mg/L. The LNVA currently monitors station #15354 at FM 942 as shown in Figures 3.39 and 3.40, which was relocated in 2014 from Big Sandy @ HWY 190, Station #15353. Big Sandy @ FM 1276 (#20316) was also monitored historically. The relocation of sampling location was to be more representative of the whole segment. LNVA's data assessement included data from both stations #15353 and #15354. Big Sandy Creek is characterized with steep stream banks, clear

Figure 3.40 Station #15354: Big Sandy @ FM 942, looking downstream.

Figure 3.39 Station #15354, Big Sandy @ FM 942, looking upstream.

water, and a sandy substrate. The reduction in dissolved oxygen seems to correspond with the site changes in 2014 and 2015, as shown in Figure 3.41. The current sampling location doesn't have as much natural flowing conditions as previous sites. Data show when stream flow is higher, there is an upward trend for higher dissolved oxygen concentrations, as shown in Figure 3.42.

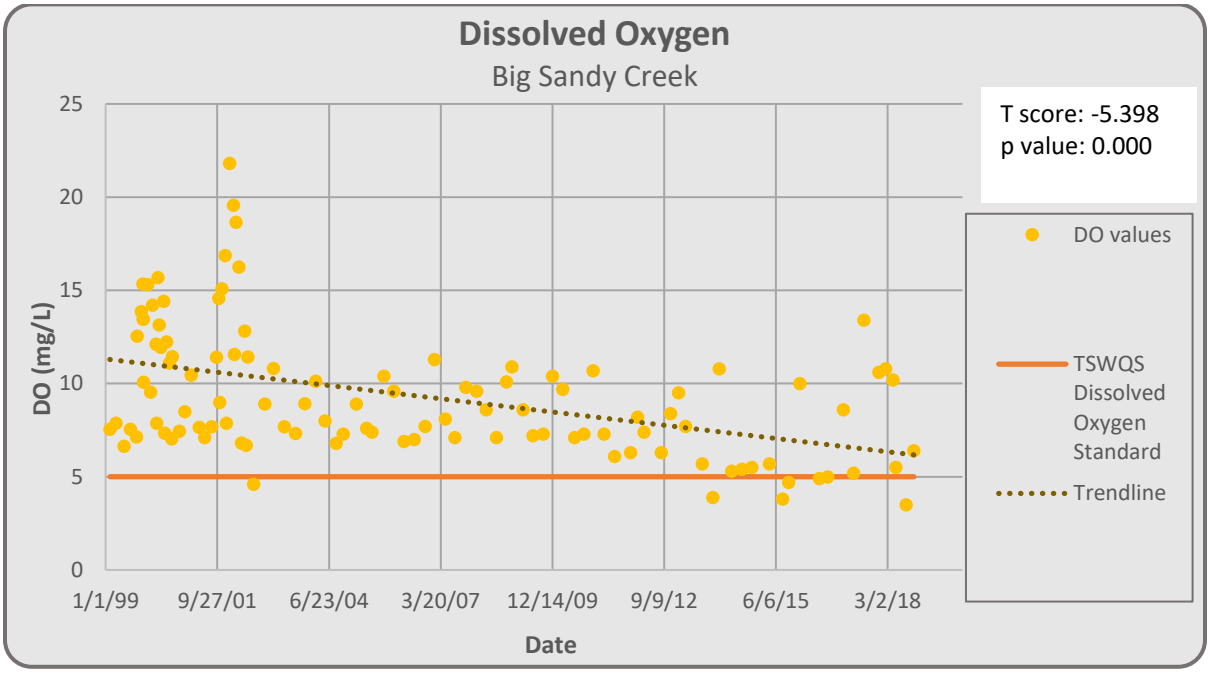

Figure 3.41 Historical Dissolved Oxygen in Big Sandy Creek

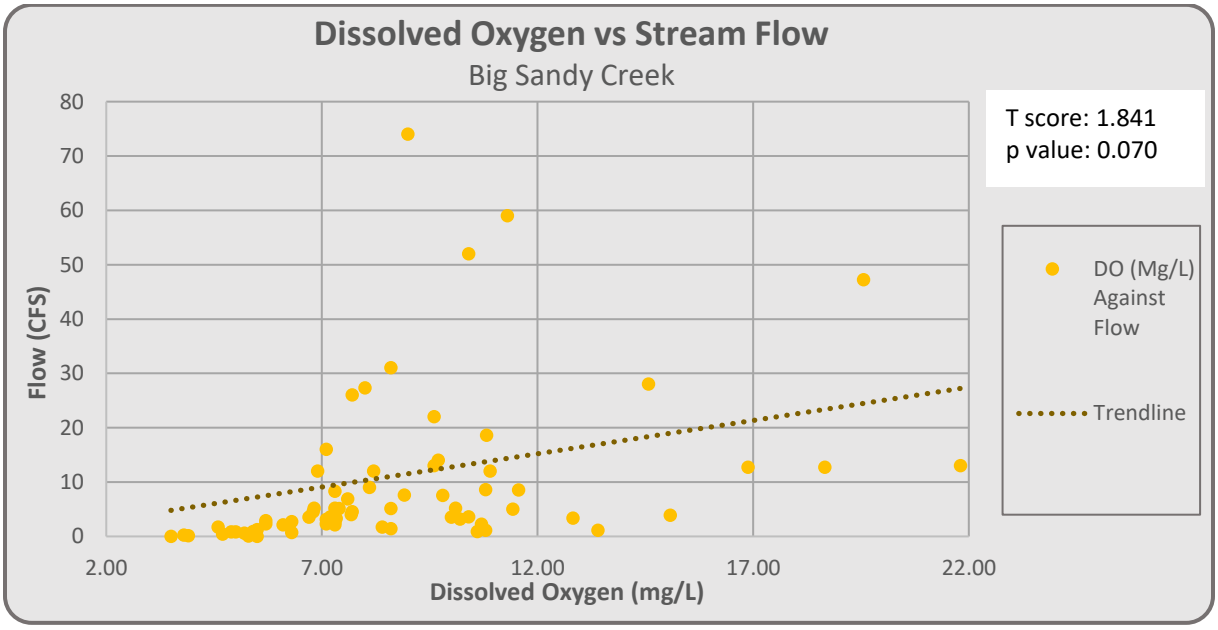

Figure 3.42 Dissolved Oxygen Versus Stream Flow in Big Sandy Creek

A decrease in nitrate + nitrite is one significant trend, as shown in Figure 3.43. Drought conditions can concentrate nutrient levels because of the decrease in dilution from rainfall runoff. There is a decrease in the nitrate + nitrite starting in 2014, which corresponds with prolonged periods of drought ending, as shown in Figure 3.44. Future data assessments will determine if this trend persists.

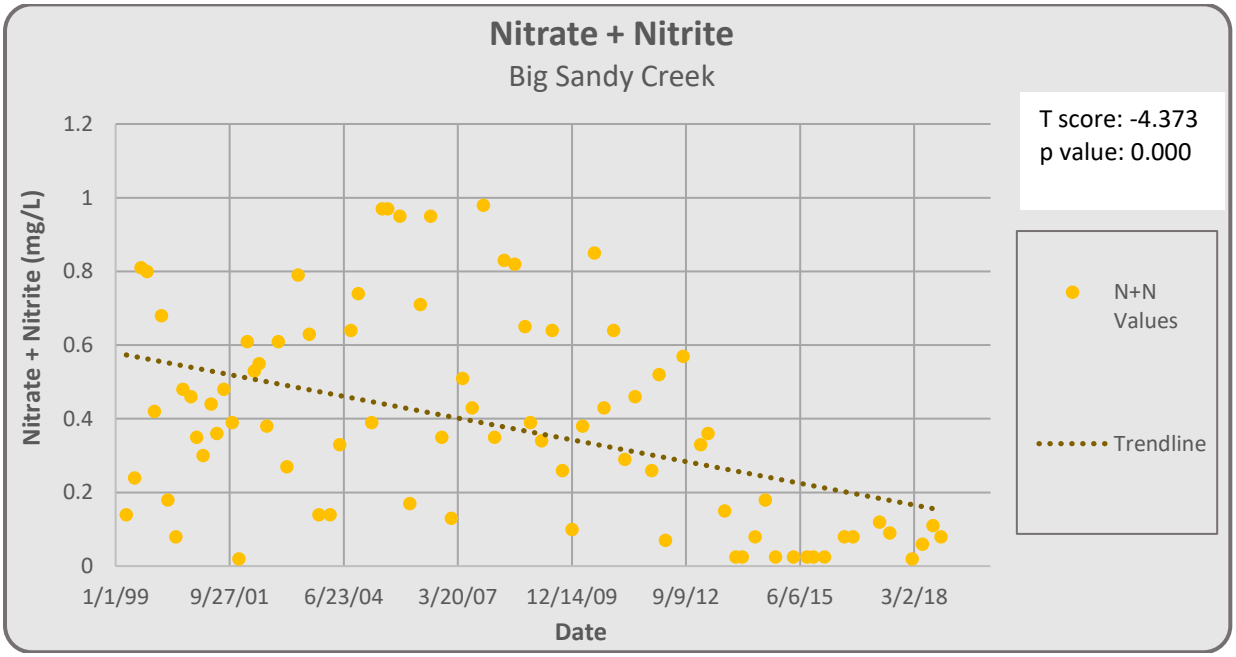

Figure 3.43 Historical Nitrate + Nitrite in Big Sandy Creek

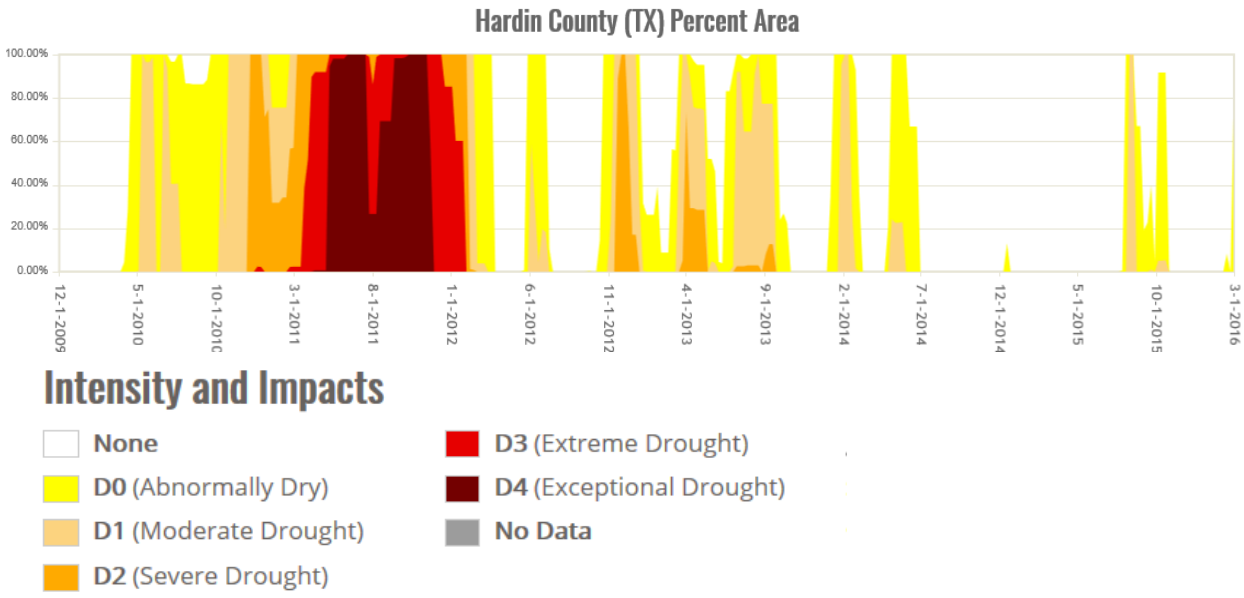

Figure 3.44 Historical Drought Percentage Area in Hardin County (www.drought.gov)

3.3.4.c. Segment 0608D: Hickory Creek

The LNVA monitors Hickory @ 69, Station #15349, which is not listed on the 2020 Texas Integrated Report for any concerns or impairments. There were no significant trends found during LNVA's data assessment. Hickory Creek demonstrates stream bed variation with deeper wider channels upstream and narrowing channels with more downstream as shown in Figure 3.45.

Figure 3.45 Station #15349: Hickory Creek Upstream (left) and Downstream (right)

3.3.4.d. Segment 0608E: Mill Creek

Mill Creek is listed for not supporting aquatic life use due to depressed dissolved oxygen. Depressed dissolved oxygen may impact the diversity and abundance of aquatic life within the segment. Like Cypress, Mill Creek is a low gradient stream subject to perennial pools with little to no flow. This nonsupport is carries forward from previous sampling. The LNVA will be conducting 24-hour dissolved oxygen sampling on Mill Creek in 2022 and 2023 to update data. Mill Creek is the only site in Village Creek downstream of a point source wastewater discharge site. The impairment for dissolved oxygen on Mill Creek is thought to be caused by both natural and industrial/municipal point source discharges.

3.3.4.e. Segment 0608F: Turkey Creek

Turkey Creek is not listed on the 2020 Texas Integrated Report for any impairments or concerns. LNVA monitors Turkey Creek @ Gore Store Rd, Station #15350 and Turkey Creek @ FM 1013, Station # 15356. Turkey Creek runs through both forested areas and pasture areas used for grazing cattle. A 3.4-mile hiking trail runs alongside Turkey Creek, which is maintained by the National Park Service Big Thicket National Preserve. An increase in hardness at station #15356 is evident, as shown in Figure 3.47. Hardness is the amount of calcium and magnesium in the water, which can come from rocks and soil in the streambed.

Figure 3.46 Station #15350: Turkey Creek @ Gore Store Road

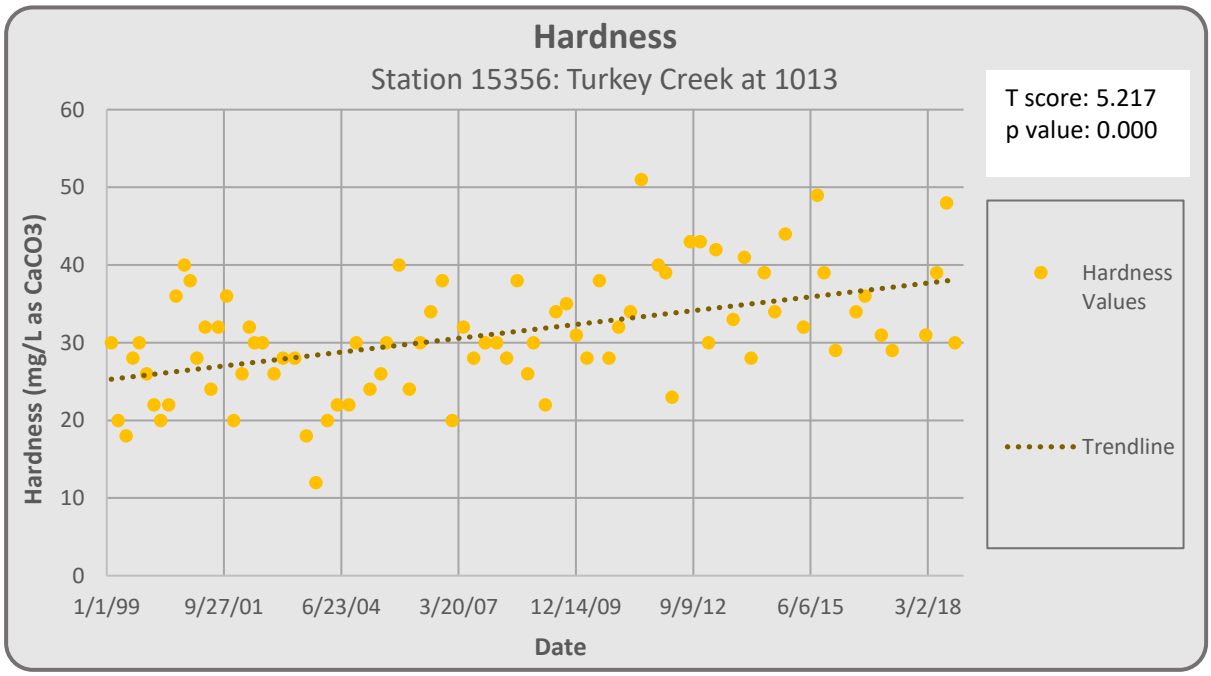

Figure 3.47 Historical Hardness in Turkey Creek

3.3.4.f. Segment 0608G: Lake Kimball

Lake Kimball is a small manmade lake 35 miles northwest of Beaumont in Hardin and Tyler Counties. A fish advisory was issued in 1999 warning the consumption of all fish should be limited due to mercury in fish tissue like Village Creek. More information for this advisory can be found at https://www.dshs.texas.gov/seafood/advisories-bans.aspx. The lake provides fishing facilities for the Wildwood Resort Community. In more recent years, Lake Kimball has been drained several times in order to complete maintenance projects on its dam. There is no current monitoring at this sample location.

Recommendations

The source of the impairments found in the Village Creek Watershed can be attributed to either natural conditions or non-point source pollution. The LNVA and TCEQ should continue routine monitoring at these sites to ensure data associated with water quality concerns are current. For example, while pH was found to be a concern in previous assessments, pH levels have displayed increasing trends associated with higher flows. For situations where limited data sets exist, the LNVA and TCEQ need to identify specific monitoring beneficial for upcoming monitoring schedules and data collection. Preliminary results from the ALM monitoring on Beech and Cypress Creeks indicate healthy fish communities at these sites in spite of the naturally occurring lower dissolved oxygen levels. Once the entire ALM data set has been analyzed, TCEQ may conduct an UAA to address the accuracy of the current standard for dissolved oxygen. The coordinated projects associated with this program are instrumental in gaining a scientific assessment of the health of this watershed and its associated tributaries.

3.3.5. Segment 0602: Neches River Below B.A. Steinhagen Watershed Characteristics

Figure 3.49 Sunrise at the LNVA Saltwater Barrier

The Neches River below B. A. Steinhagen Lake is defined in the *TSWQS* as a river segment from the Neches River Saltwater Barrier as shown in Figure 3.44, which is at a point 0.8 kilometers (0.5 miles) downstream of the confluence of Pine Island Bayou, [a point 11.3 kilometers (7.0 miles) upstream of IH 10] in Orange County to Town Bluff Dam in Jasper/Tyler County. Situated in a broad flood plain, the segment is 84 miles long with major tributaries of Village Creek and Pine Island Bayou. Stream discharge is regulated by Town Bluff Dam at Lake B.A. Steinhagen and varies depending on releases from Sam Rayburn Reservoir and upstream Neches Rivers inflows. Segment 0602 is situated in the ecological region termed the "piney woods". The segment is dominated by loblolly and shortleaf pines, but several oak species, sweetgum, flowering dogwood, and longleaf pine are present throughout. A thick understory grows in forested areas and includes American beautyberry, greenbriers, sumac, hawthorns, and some grass species. In the floodplains, which includes sections of the Neches River, riparian species such as bald cypress, water tupelo, water hickory, and red maple thrive. Soils are sandy loams, acidic sands, and some silty substrates, with poorly drained soils in the floodplains, flatwoods, and low terraces. Bottomland forests provide abundant wildlife habitat to many native species. Louisiana pine snakes, shown in Figure 3.49, are thought to be found in the piney woods and are listed as threatened in Tex. Historically, their range extended

Figure 3.48 Louisiana pine snake (www.fws.gov)

through the piney woods in west Louisiana to east Texas, but today the range of the Louisiana Pine Snake is the southern parts of the Sabine and Angelina National Forests.

Land use is livestock grazing, hunting, timber production, improved pasture, recreation, wildlife habitat, oil and gas production, and both state and federal land. Mixed forest, as well as evergreen forest, deciduous forest, pine plantations, and forested wetlands is land cover in the segment. The Big Thicket National Preserve manages a total of 106,684 acres. In Segment 0602, five (5) management units border the watershed, which include the Beaumont Unit, Lower Neches River Corridor Unit, Neches Bottom, Jack Gore Baygall Unit, and the Upper Neches River Corridor Unit.

Three stations are monitored by the LNVA in segment 0602, including #10581, #15343, and #10579, with TCEQ monitoring one station, #10580 as shown in Figure 3.50.

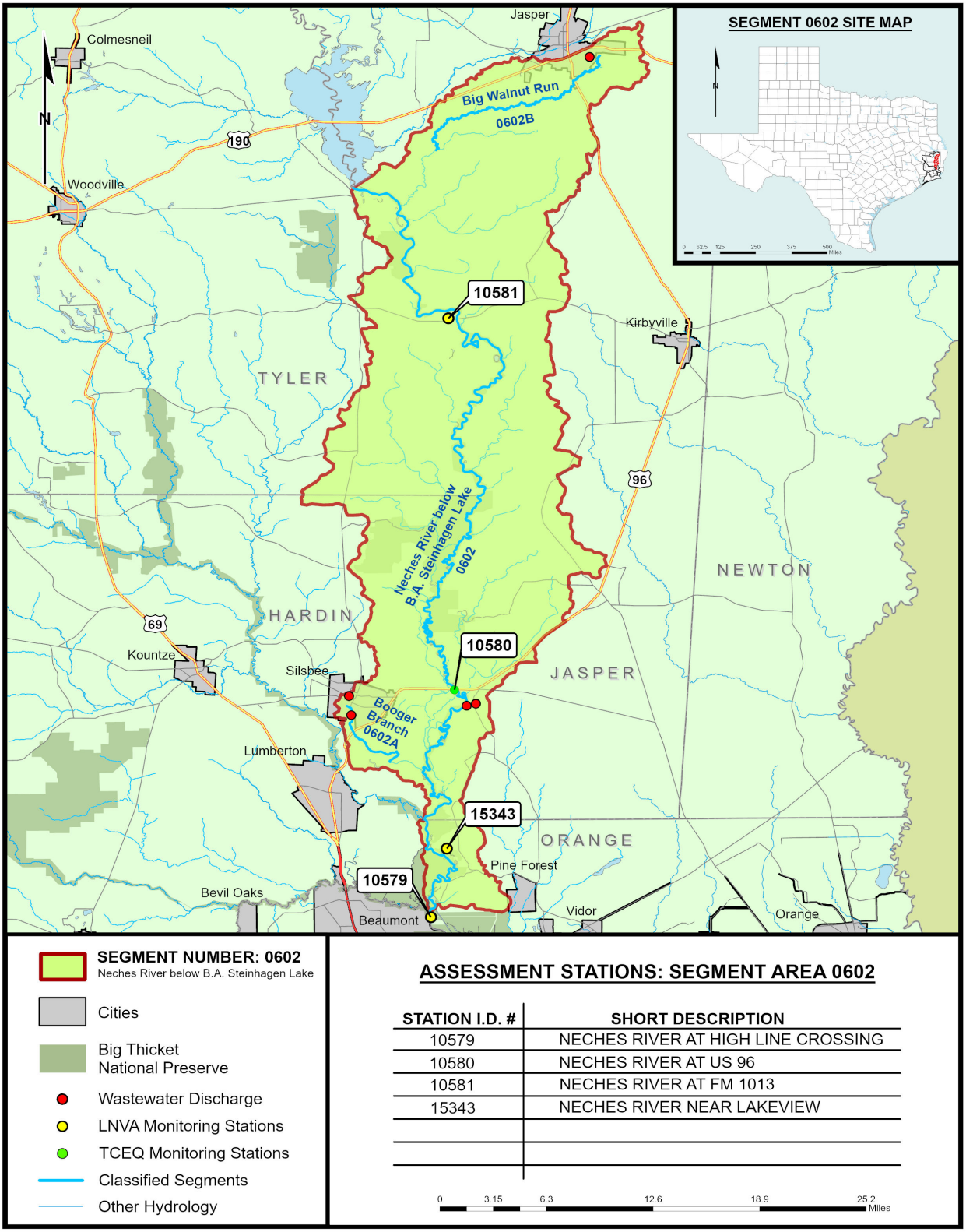

Figure 3.50 Neches River below B.A. Steinhagen Lake Assessment Area

Data Assessment Results

In the *TSWQS's*, Segment 0602 uses are designated as primary contact recreation, high aquatic life use, and public water supply. Current assessments show an impairment for fish consumption due to mercury and dioxin and a concern for mercury in edible fish tissue as

shown in Table 3.8. There is currently a fish consumption advisory for the Neches River from the Department of Safety and Health Services for mercury and dioxins. A link for more information about Advisory 51 can be found at https://dshs.texas.gov/seafood/advisories-bans.aspx. Mercury is naturally found in the sediment as a result of normal breakdown of the earth's crust by wind and water. Inorganic mercury can enter the environment from ore deposits, burning of fuels or trash, or emissions from factories. Non-air deposition contributions, including sources such as soil erosion, tributaries, waste streams, and factors influencing methylation of mercury to methyl mercury concentrations in fish tissue are not well understood. In addition, basin water quality data shows no mercury in water or sediment exists in water bodies with mercury in fish tissue concerns or impairments. Mercury can travel long distances in the atmosphere before being deposited on land. As a result, mercury can bio-accumulate in fish in areas where no obvious source of mercury pollution exists. The main source of dioxins is incineration and unintentional by-products of chlorine bleaching.

Segment #	Segment Name	Impairment/ Concern Listed in 2020 Texas Integrated Report	Reason for Impairment
0602	Neches River below B.A. Steinhagen	Not supporting fish consumption due to mercury and dioxin	Atmospheric Deposition-Toxics; Industrial Point Source Discharge; Unknown Source
		Concern for mercury in edible tissue	Source Unknown

Table 3.8 Segment 0602 Impairments

Results from the current assessment show no impairment for the contact recreation use. In addition, there are no impairments pH, temperature, chloride, sulfate, and total dissolved solids. Aquatic life use is also unimpaired for dissolved oxygen, nutrients, and chlorophyll-*a*. During periods of normal flow rates, pH, conductivity, total dissolved solids, hardness, and total alkalinity show an increasing trend at Station #10581 as shown in Figures 3.51 and 3.52, while chlorophyll-*a* levels are decreasing at Station #10580 as shown in Figures 3.53.

The question concerning the increases in pH, total alkalinity, and hardness is whether the pH is increasing due to alkalinity or whether the alkalinity is increasing as a result of higher pH, which could reduce the demand on the alkalinity to buffer the pH from getting more acidic. Alkalinity is the capacity of water to resist acidification. The increase in hardness is likely drought related due to evaporation increasing the mineral content in the water column. It is evident in the graph of alkalinity and hardness for Station #10581 where the values begin to decrease after 2014 with the drought ending in 2015. Station #15343 is also seeing a trend for increased total hardness. The two highest concentrations of total hardness at this station taken after 2014 where during dry periods. There is an inverse correlation with flow. The correlation coefficient between these two parameters is -0.57. A relationship is determined if the correlation coefficient lies between +-0.50 and +-1.

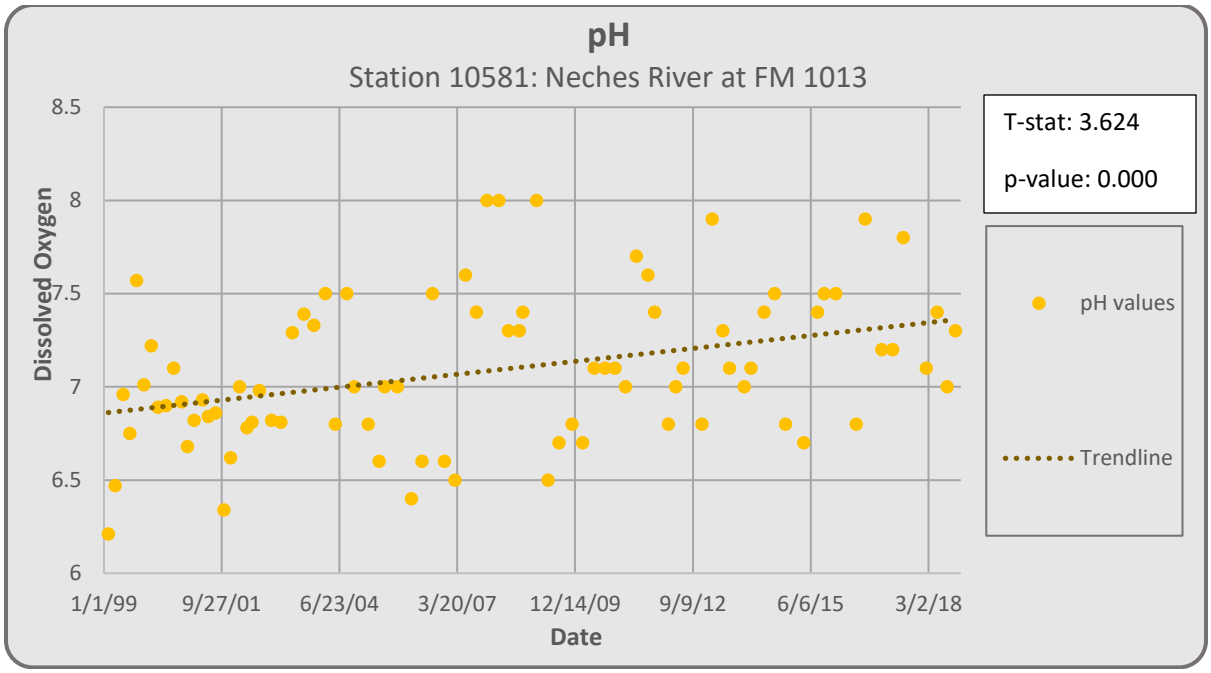

Figure 3.51 Historical pH in the Neches River near FM 1013

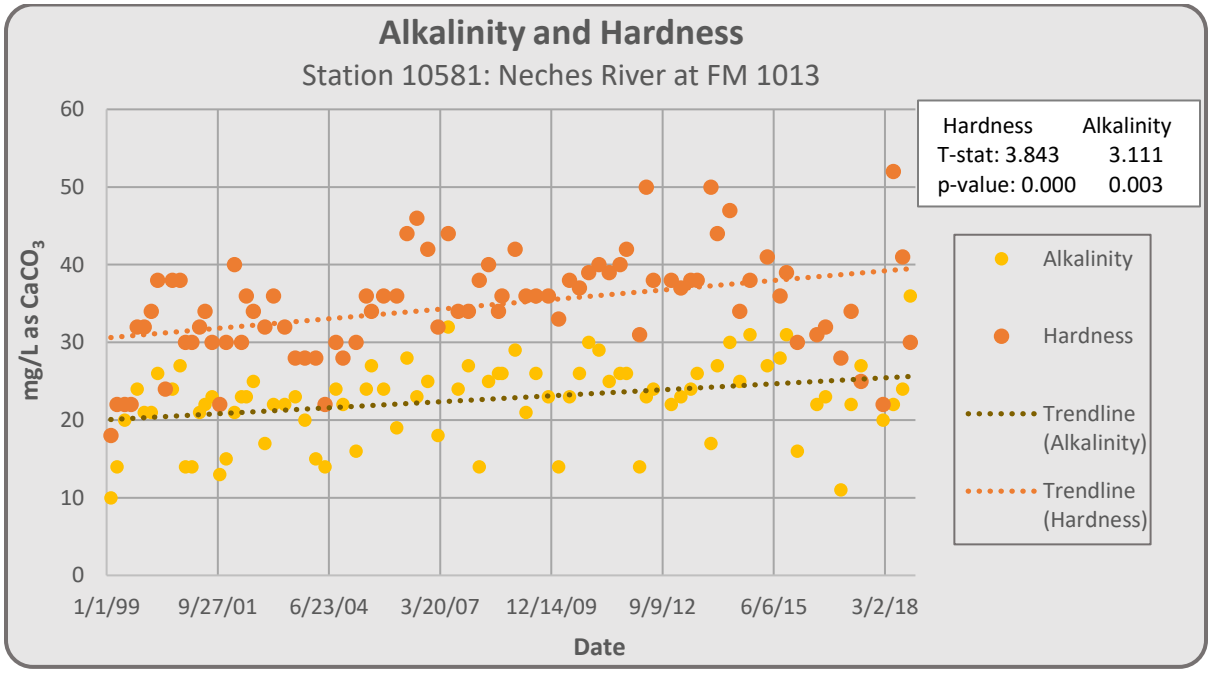

Figure 3.52 Historical Alkalinity and Hardness in the Neches River near FM 1013

Chlorophyll-*a* is a measure of algae growing in a waterbody. High levels of chlorophyll-*a* may indicate elevated nutrient levels introduced from fertilizers, septic systems, urban runoff, and sewage treatment. A trend showing decreasing values is a favorable for this portion of the Neches River.

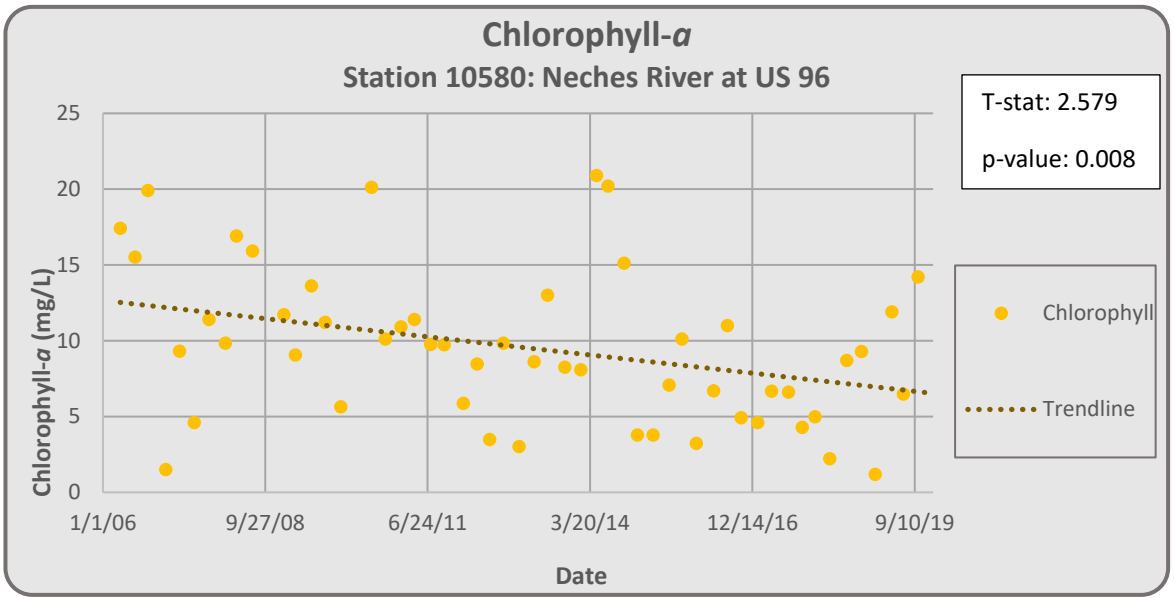

Figure 3.53 Historical Chlorophyll-a in the Neches River at US 96

Increasing specific conductance values correlate to periods of low flow as shown in Figure 3.54. As salts and minerals become more concentrated during periods of low flow, specific conductance rises; however, specific conductance drops significantly as a result of high flows over the last 5-year period. The highest specific conductance values directly correlate with periods of drought over the last two decades. Conversely, during high flow periods, specific conductance levels decrease.

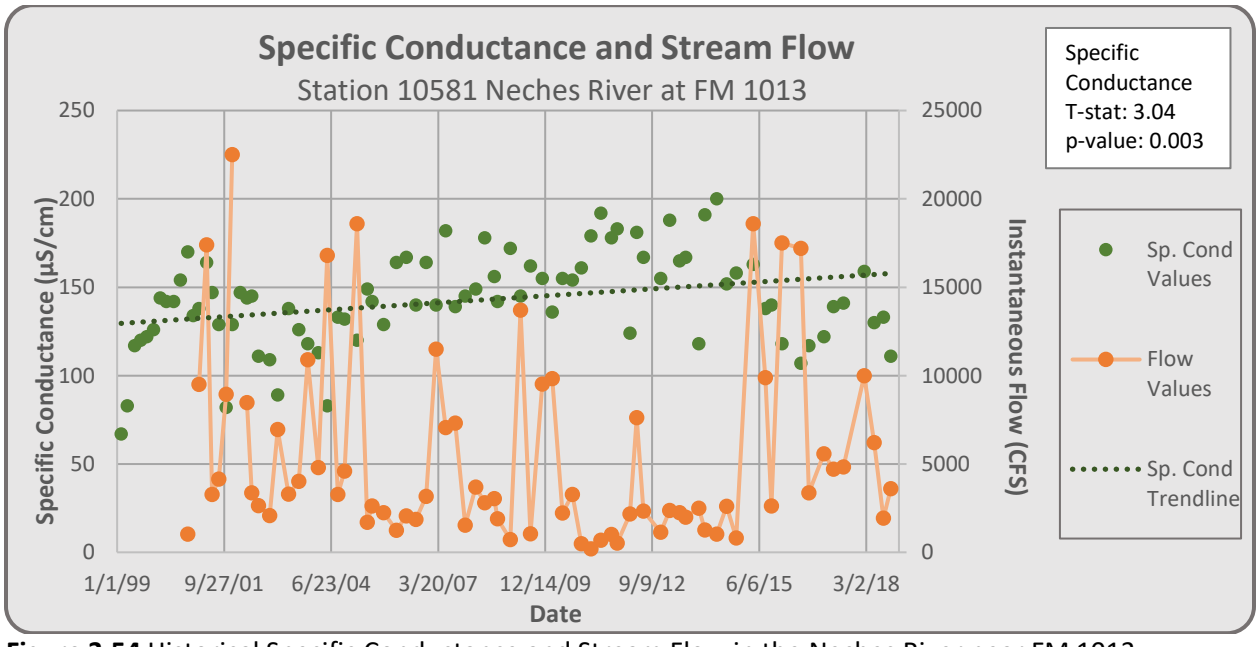

Figure 3.54 Historical Specific Conductance and Stream Flow in the Neches River near FM 1013

Recommendations

Advisory 51 for the mercury and dioxin in fish tissue was issued in 2014. The LNVA recommends assisting the TDSHS in updating the data to provide current insight into the issue of mercury and dioxin in fish tissue. In order to address the mercury in fish tissue, The LNVA and TCEQ should contact the TDSHS for more information on when fish advisories are updated. Recommendations from the TDSHS's mercury advisory group are located in the Chapter 4. Recommendation and Conclusions. Surface water quality monitoring of the routine stations in Segment 0602 should be continued by the TCEQ and LNVA to maintain baseline water quality data collection, and ensure stream standards and nutrient screening levels are still being met.

3.3.6. Segment 0607: Pine Island Bayou Watershed

Texas Surface Water Quality Standards describe Pine Island Bayou as spanning from the confluence with the Neches River in Hardin/Jefferson County to FM 787 in Hardin County. True to its namesake, the Pine Island Bayou is prolific with a heavy pine component throughout the segment. In addition, the bayou's 81-mile length is also home to a high diversity of other flora and fauna. Loblolly pines are accompanied by sweetgums, multiple oak species, and southern magnolias. Understory components are also diverse with holly, yaupon, sweet bay, wax myrtle, and American beautyberry. Little Pine Island Bayou, which flows from southeastern Polk County southeast through Hardin County to the Jefferson county line at Bevil Oaks, and Willow Creek, which originates northeast of Devers in Liberty County and flows northeast for 15 miles before reaching its confluence with Pine Island Bayou in Jefferson County, are the only two major tributaries for Pine Island Bayou (PIB). Boggy Creek is a smaller tributary flowing from west of Lumberton to its confluence with PIB, south of Lumberton in Hardin County. A tributary is defined as a smaller stream or river that flows into a larger stream. Tributaries play an important role and can affect the overall health of the main waterway through the sediment and water they carry with them from different areas. For this reason, tributaries are closely monitored by the Clean Rivers Program as well as the connected main river systems. PIB's drainage basin is made up of 657 square miles, which is used primarily for timber, pastureland, agriculture, and oil and gas production. The upper reaches of the segment are heavily forested, while the lower reaches provide drainage for the communities of Sour Lake, Pinewood Estates, Bevil Oaks, and northern Beaumont. The streambeds of PIB consist of sand and clay substrate with acidic soils and poorly drained. The level IV ecoregion of the segment is Flatwoods (35f). Throughout segment 0607, there are six routine sites monitored quarterly by LNVA, and one site on Boggy Creek is monitored by TCEQ Region 10, as shown in Figure 3.57.

Figure 3.55 The understory of PIB gains color from the bright purple berries of the American beautyberry.

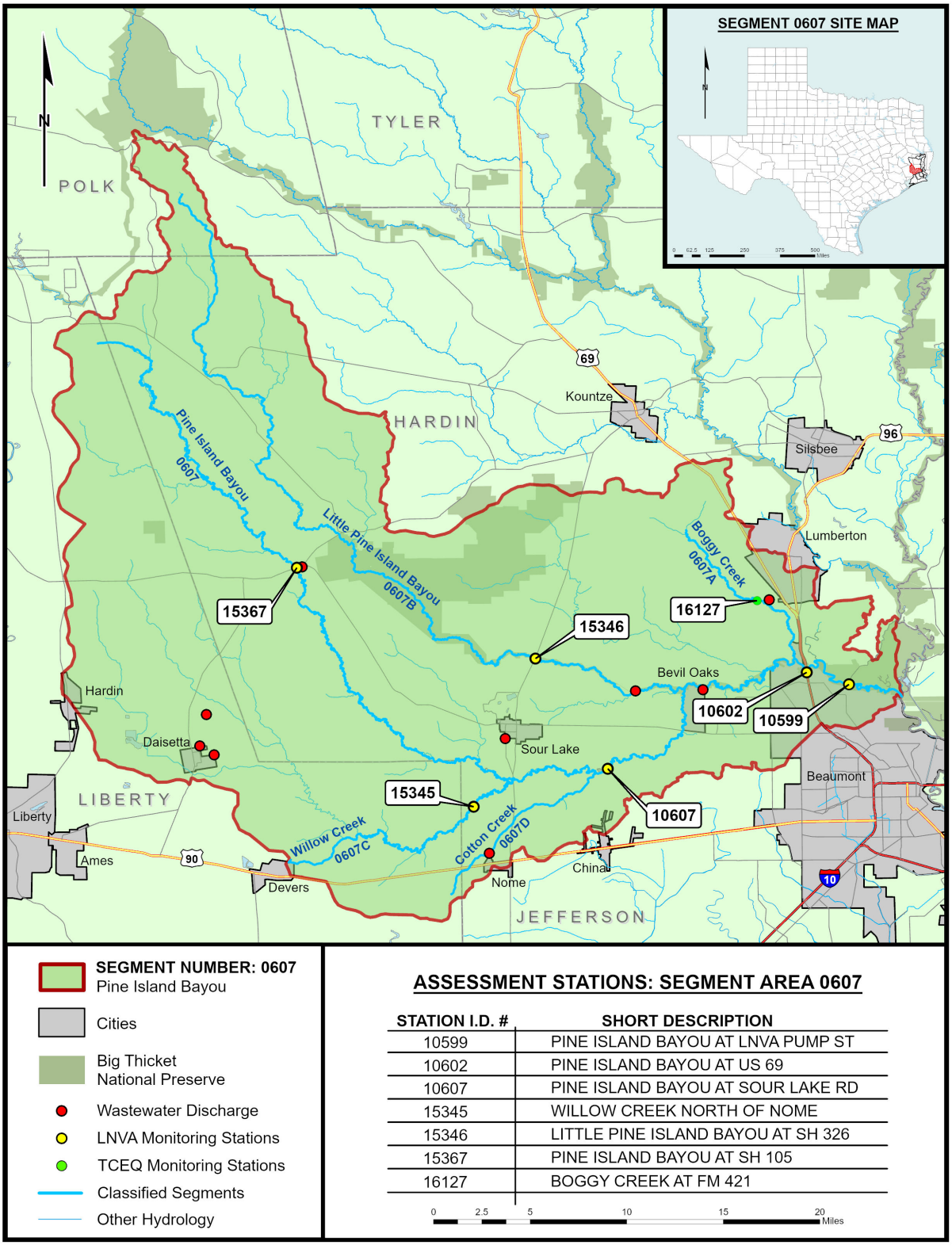

Figure 3.57 Segment 0607: Pine Island Bayou Watershed Assessment Area

TCEQ's Continuous Water Quality Monitoring Network (CWQMN) station, CAMS749, is located within segment 0607. The CWQMN station is located upstream of the LNVA Beaumont Irrigation (B.I.) Pumping Station, which was first constructed in 1898, on Pine Island Bayou and has actively collected data since June 2008. The purpose of CWQMN station is to collect "near

real-time" water quality data on the bodies of water and provide this data on TCEQ's website, as shown in Figure 3.53.

Parameter Measured	Morning											Parameter Measured	POC
	Mid	1:00	2:00	3:00	4:00	5:00	6:00	7:00	8:00	9:00	10:00		
Surface Water Temperature	***7.1***	7.2	7.3	7.4	7.5	7.5	7.6	7.6	7.7	**7.8**	NA	Surface Water Temperature	1
Sample Depth	0.320	***0.318***	0.318	0.320	0.320	0.320	0.333	0.338	0.340	**0.347**	NA	Sample Depth	1
Surface Specific Conductance	***104***	104	105	105	106	107	107	108	**109**	109	NA	Surface Specific Conductance	1
Turbidity	***62.00***	62.25	62.25	62.25	**63.00**	63.00	62.50	62.50	62.50	63.00	NA	Turbidity	1
Total Dissolved Solids	***67***	68	68	68	69	69	70	70	**71**	71	NA	Total Dissolved Solids	1
Surface Dissolved Oxygen	**10.9**	10.8	10.8	10.8	10.8	10.7	10.7	10.7	10.7	***10.6***	NA	Surface Dissolved Oxygen	1
Surface Water pH	**6.6**	6.6	6.6	6.6	6.6	6.6	6.6	6.6	6.6	6.6	NA	Surface Water pH	1
Parameter Measured	Mid	1:00	2:00	3:00	4:00	5:00	6:00	7:00	8:00	9:00	10:00	Parameter Measured	POC
	Morning												
	Maximum values for each parameter are **bold** within the table. Minimum values are ***bold italic***.												

PLEASE NOTE: This data has not been verified by the TCEQ and may change. This is the most current data, but it is not official until it has been certified by our technical staff.

Figure 3.58 TCEQ's CAMS749 Data Display (https://www.tceq.texas.gov/cgi-bin/compliance/monops/water_daily_summary.pl?cams=749)

The water quality data at CAMS749 is collected using a YSI multiprobe instrument, as show in in Figure 3.54. The LNVA cleans and maintains the site and calibrates the YSI multiprobe on a monthly basis. In addition, CAMS749 provides LNVA municipal/industrial customers with near real-time data about raw water pumped from PIB into LNVA's canal system. Customers are able to react 2-4 days in advance of raw water entering their facilities, allowing appropriate operational adjustments based on changing water quality parameters. In addition, information from this site is used for engineering and design of new facilities and budgeting purposes. The LNVA is also collecting 24 HR dissolved oxygen at several stations where special monitoring has been assigned.

Figure 3.59 The EXO is the YSI instrument used to monitor CWQMN station CAMS749

Data Assessment Results

Pine Island Bayou's designated uses are contact recreation, high aquatic life use, and water supply, as shown in Table 3.9. It is listed in the integrated report with an impairment for aquatic life due to depressed dissolved oxygen. PIB has been on the Texas Integrated Report 303(d) list for depressed dissolved oxygen in water since 2000. The low dissolved oxygen levels are thought to be due to natural conditions. The slow moving, low flow conditions of the bayou paired with high ambient summer temperatures and decaying organic material present in the water can lead to low dissolved oxygen levels.

Segment #	Segment Name	2020 Texas Integrated Report Impairment/Concern	Reason for Impairment
0607	Pine Island Bayou	Screening level concern for dissolved oxygen grab in 0607_01	Non-Point source-Natural Conditions. Water Quality Standards Use Attainability Analyses Needed ; Non-point Source-Natural Sources
		Nonsupport for dissolved oxygen grab in 0607_01	Non-Point source-Natural Conditions. Water Quality Standards Use Attainability Analyses Needed ; Non-point Source-Natural Sources
		Nonsupport for dissolved oxygen 24 hour minimum and average (AU 01-04)	Non-Point source-Natural Conditions. Water Quality Standards Use Attainability Analyses Needed ; Non-point Source-Natural Sources
0607A	Boggy Creek	Nonsupport for dissolved oxygen 24 hour minimum and average	Non-Point source-Natural Conditions ; Water Quality Standards Use Attainability Analyses Needed ; Non-Point source-Natural conditions-Streambank Modifications/Destabilization; Source Unknown
		Concern for impaired habitat	Non-Point source-Loss of riparian habitat
		Use concern for E. Coli	Non-Point source; Source unknown
0607B	Little Pine Island Bayou	Nonsupport for dissolved oxygen 24 hour minimum and average	Non-Point source-Natural Conditions. Water Quality Standards Use Attainability Analyses Needed ; Non-point Source-Natural Sources
		Use concern for E. Coli	Non-point source; Source unknown
		Use concern for dissolved oxygen grab	Source unknown
		Screening level concern for dissolved oxygen grab	Source unknown
0607C	Willow Creek	Nonsupport for dissolved oxygen 24 hour minimum and average	Non-Point source-Natural Conditions. Water Quality Standards Use Attainability Analyses Needed ; Non-point Source-Natural Sources ; Source unknown

Table 3.9 Segment 0607 Impairments

The *Texas Surface Water Quality Standards (TSWQS)* concentration for dissolved oxygen in PIB was originally 5.0 mg/L. Based on the Use-Attainability Analyses (UAA's) performed on PIB and the results they've produced it was suggested that this standard be changed from 5.0 mg/L to 3.0 mg/L. The change was adopted in the 2014 revision of the TSWQS and is awaiting approval by the Environmental Protection Agency. LNVA is working with TCEQ to obtain additional 24-hour dissolved oxygen data that could help demonstrate that the new standard is being attained and that PIB can be delisted from the 303(d) list for impairments. In 2020, LNVA began doing quarterly 24-hour dissolved oxygen monitoring events at Station #15367 (PIB at South Highway 105 and 770 Intersection) to enhance this dataset.

Figure 3.62 Station #10599: PIB @ LNVA 1st Pumping Station

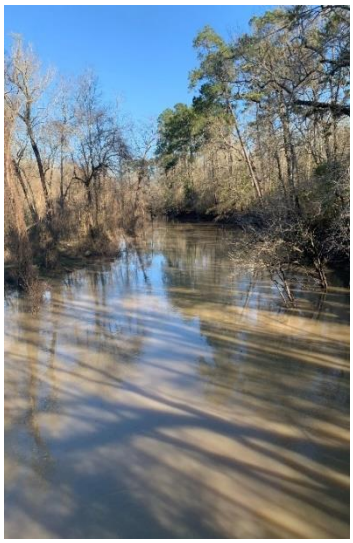

Figure 3.63 Station #10607: PIB @ Old Sour Lake Road

There are currently four CRP sites that LNVA monitors for routine water quality parameters on Pine Island Bayou. These include Station #10599 (PIB at LNVA Lower Pump Station), Station #10602 (PIB at US 69), Station #10607 (PIB at Old Sour Lake Road), and Station #15367 (PIB at South Highway 105 and 770 Intersection).

Dissolved oxygen values of each site are compared to the *TSWQS* standard of 3.0 mg/L as shown in Figure 3.64.

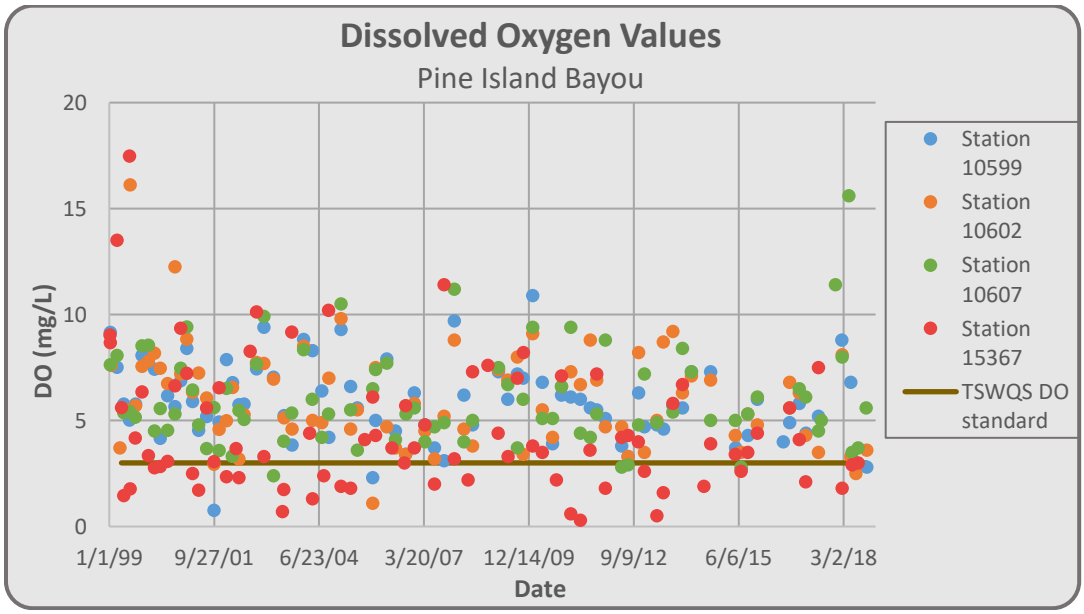

Figure 3.64 Historical Dissolved Oxygen on Pine Island Bayou

3.3.6.a. Segment 0607A Boggy Creek

Figure 3.65 Station #16127: Boggy Creek

Station #13127, located on the small tributary Boggy Creek connecting to PIB, is monitored by TCEQ. The station is 1.09 miles southwest of FM 421 and US 69 intersection near Lumberton. Boggy Creek is listed in the 2020 Texas Integrated Report for habitat impairment, recreational use concern for E. coli, and nonsupport of aquatic life due to depressed dissolved oxygen. Boggy Creek exhibits similar dissolved oxygen characteristics as other portions of PIB. Monitoring data indicates Boggy Creek may also meet the new dissolved oxygen standard level of 3.0 mg/L as shown in Figure 3.66. The data shows increasing levels of dissolved oxygen during the indicated timeframe; however, the site was dropped in 2004, causing a data gap, until being picked up again in 2013 by TCEQ. To contribute additional data to the regular quarterly monitoring conducted by TCEQ, the LNVA began conducting quarterly 24-hour dissolved oxygen collections on Boggy Creek in 2020. The additional data requires further assessment by TCEQ to determine if Boggy Creek meets the current dissolved oxygen standard.

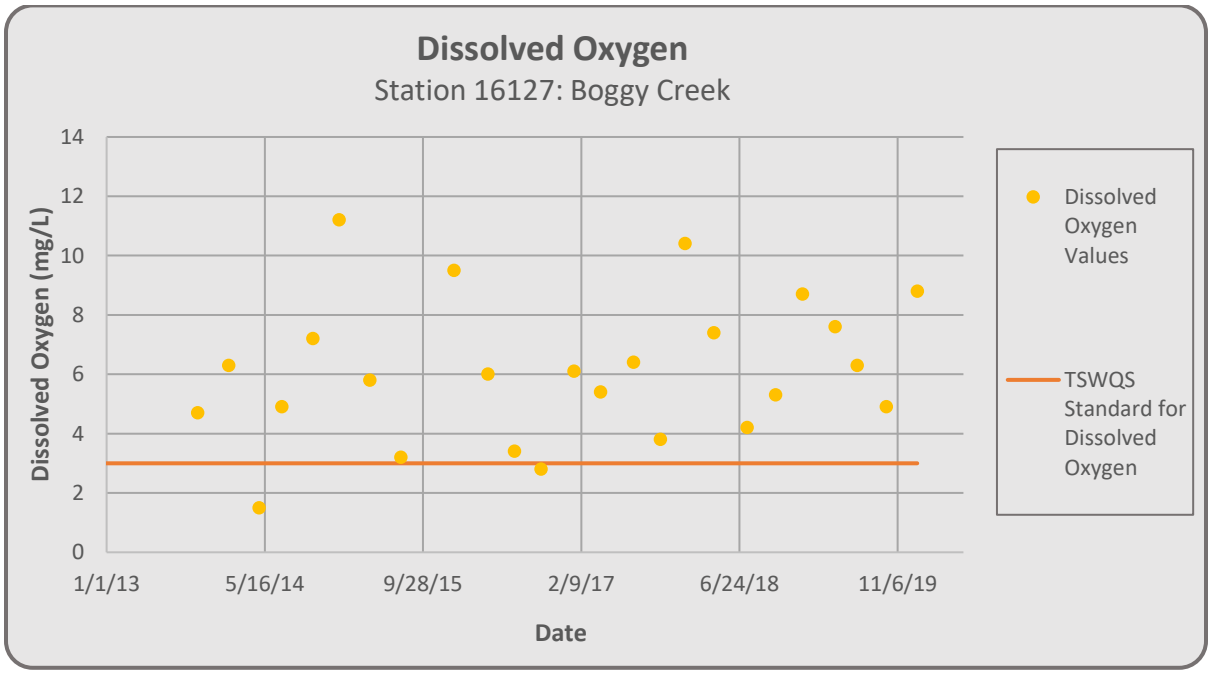

Figure 3.66 Historical Dissolved Oxygen on Boggy Creek

The presence of bacteria in waterbodies is greatly affected by heavy rainfall events, which can displace *E. coli* into streams. These bacteria live in the intestines of healthy humans and animals and are present in fecal matter. *E. coli* can also enter streams from faulty sewer systems. Boggy Creek does not meet the bacteria standards of 126 MPN due to elevated levels,

resulting in a use concern, as shown in Figure 3.67. The elevated levels of *E.coli* are thought to be a result of nonpoint sources such as wildlife and livestock manure. Monitoring will be continued on Boggy Creek by both LNVA and TCEQ.

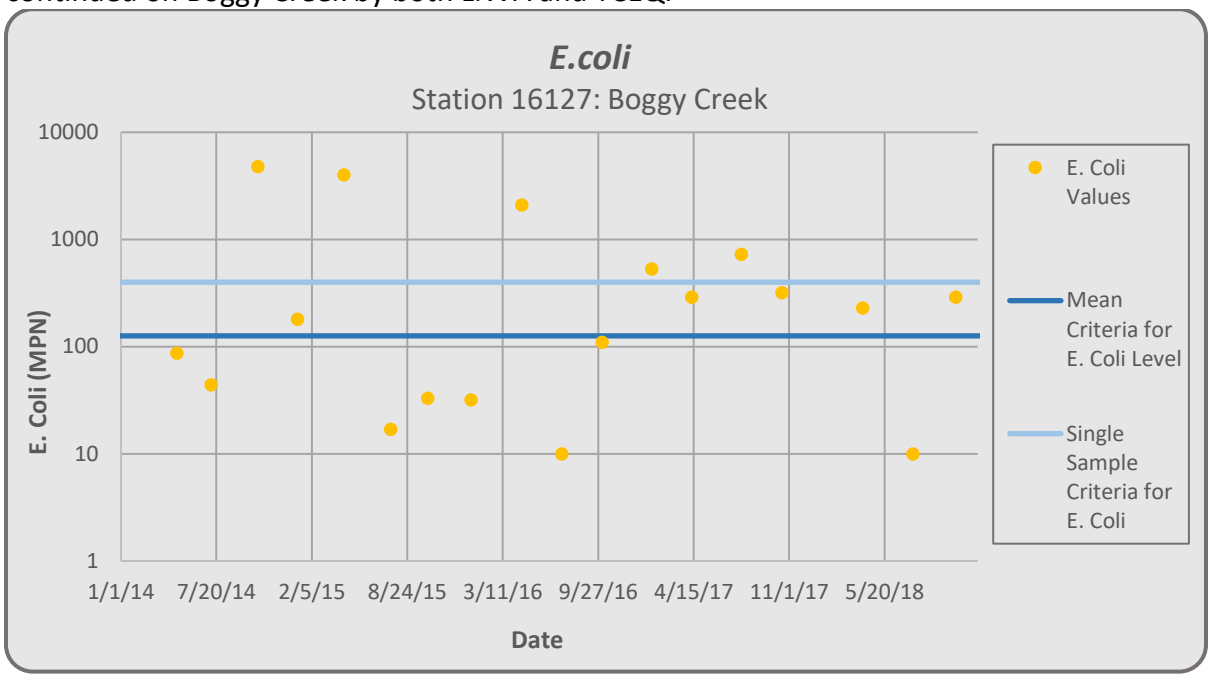

Figure 3.67 Historical *E.coli* in Boggy Creek

3.3.6.b. Segment 0607B Little Pine Island Bayou

Little Pine Island Bayou (LPIB), like PIB and Boggy Creek, is listed in the 2020 Texas Integrated report for not supporting aquatic life due to depressed dissolved oxygen levels. The LNVA routinely monitors one site on Little Pine Island Bayou located on South Highway 326 in Sour Lake, Station #15346, as shown in Figure 3.68. Along with regular monitoring, 24-hour dissolved oxygen events were conducted quarterly by the LNVA in fiscal year 2020. This additional sampling may provide supporting evidence that LPIB is also reaching attainment with the 2018 TSWQS dissolved oxygen standard of 3.0 mg/L as shown in Figure 3.69.

Figure 3.68 Station 15346: Little Pine Island Bayou at SH 326

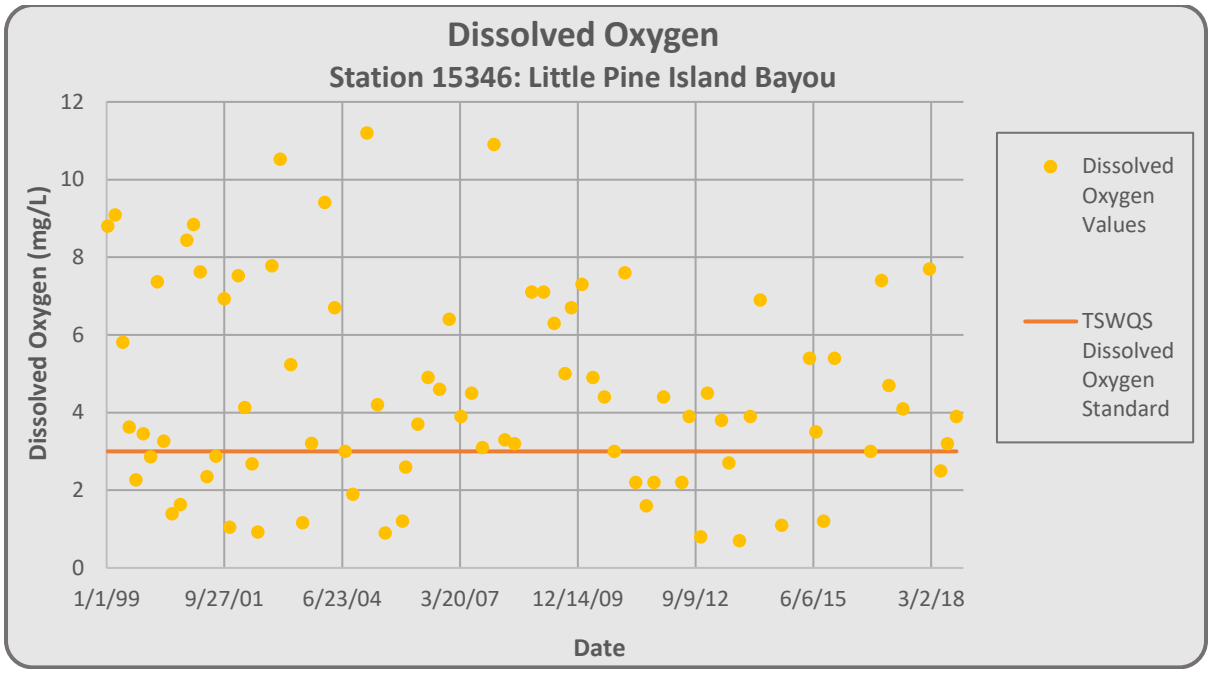

Figure 3.69 Historical Dissolved Oxygen in Little Pine Island Bayou

3.3.6.c. Segment 0607C Willow Creek

Willow Creek is the last segment in the Pine Island Bayou drainage basin, and is also listed in the 2020 Texas Integrated report for nonsupport of aquatic life due to depressed dissolved oxygen levels, as shown in Figure 3.70.

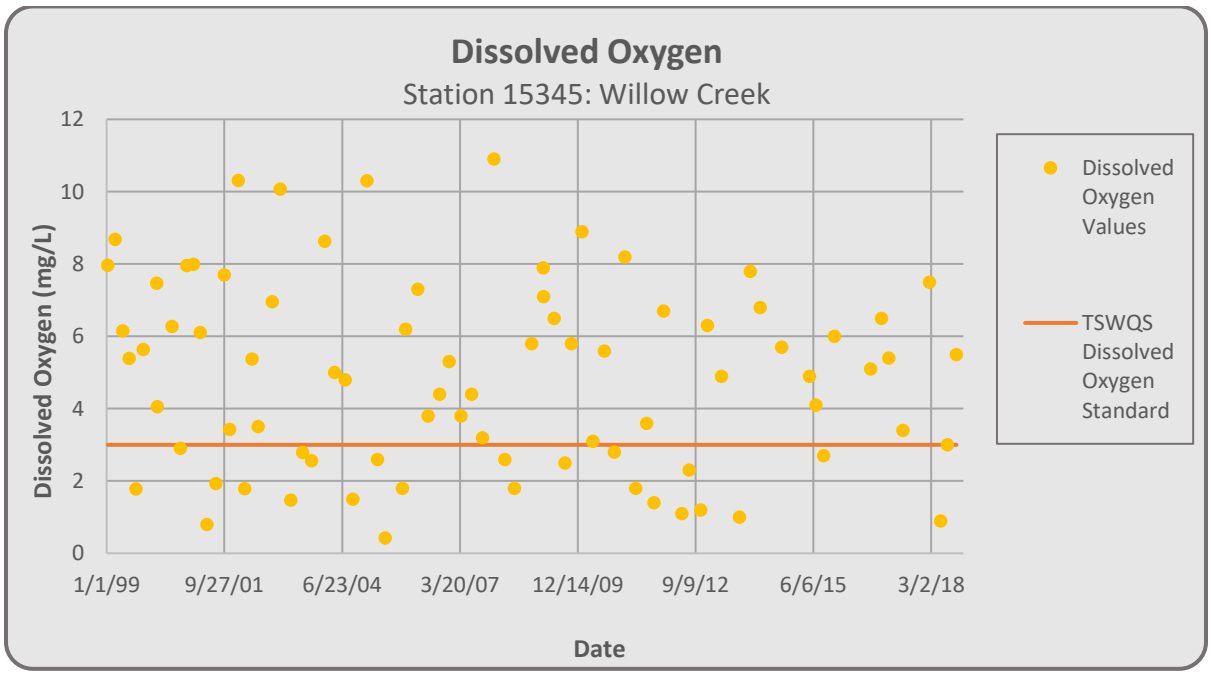

Figure 3.70 Historical Dissolved Oxygen in Little Pine Island Bayou

Figure 3.71 Station #15345: Willow Creek

There is currently only one site being routinely monitored on Willow Creek by the LNVA, Station #15345, as shown in Figure 3.71. Continued sampling will be required in order to provide TCEQ with enough data to access whether Willow Creek is meeting the current standard for dissolved oxygen.

Recommendations

The dissolved oxygen impairments in segment 0607 are currently attributed to natural sources and natural conditions. The routine sampling and 24-hour dissolved oxygen monitoring should continue for Segment 0607. The 24-hour dissolved oxygen monitoring should also be extended to 0607C, Willow Creek, to verify the status and future needs of this segment. Aquatic life monitoring events may be required in Pine Island Bayou watershed to access the ability of the waterbody to support aquatic life. The TCEQ has a Use Attainability Analysis (UAA) study planned for Segment 0607B, Little Pine Island Bayou.

Routine monitoring of bacteria should also be continued, and a recreational use attainability analysis (RUAA) is recommended to determine the level of recreational use. A RUAA is a specific type of UAA conducted to evaluate and determine what category of recreational use is appropriate for a particular water body.

3.3.7. Segment 0601: Neches River Tidal Watershed

The Neches River Tidal (0601) is the segment of the Neches River from Sabine Lake in Orange County to the Neches River Saltwater Barrier, a half-mile downstream of the confluence of Pine Island Bayou. Segment 0601 is classified as a tidal stream segment with intermediate aquatic life use and primary contact recreation use designations. Tidal exchange and fresh water inflows are the hydrologic influences in this segment. The substrates in this area consist primarily of sand, silt, and clay and consists of low, flat plains with some of the area being tidal marshes with bayous. Common reed and grasses, including little bluestem, yellow Indiangrass, switchgrass, and salt meadow cord grass, are prevalent in the lower part of Segment 0601. Few trees are present in this portion of the segment; however, further upstream near the Saltwater

Barrier, the vegetation is dominated by water tolerant trees such as water tupelo, bald cypress, willow, and oaks. The tidal influence has become more prevalent and is negatively impacting this wetland ecosystem, despite multiple years of historic flows.

A dredged navigation channel from the mouth of the river to the Port of Beaumont is maintained by the U.S. Army Corps of Engineers (USACE). The navigation channel is currently dredged to 40 feet deep and 400 feet wide in order to accommodate marine traffic and large vessels. The land in the segment consists of low, flat plains with some of the area being tidal marshes with bayous. Operational maintenance has resulted in spoils and dredge along the water's edge in some areas. Land use is primarily oil and gas production, along with marshland, wildlife and waterfowl habitat, cropland, and urban/industrial. Beaumont, Nederland, Port Neches, and Groves are cities located along Segment 0601.

Star Lake Canal (Segment 0601A) is a tidally influenced, dredged canal receiving industrial effluents, which discharge into the Neches River. The canal was constructed in the late 1940's and has been utilized for industrial and storm water purposes by chemical and manufacturing facilities.

The LNVA Neches River Saltwater Barrier was designed and constructed by the U.S. Army Corps of Engineers to protect critical freshwater intakes on the Neches River and Pine Island Bayou. The saltwater intrusion from the Gulf of Mexico and Sabine Lake to the Neches River Tidal segment can be substantial during periods of drought and low-flow conditions. Since 2003, the permanent Saltwater Barrier (SWB) has conserved billions of gallons of freshwater stored in Sam Rayburn Reservoir previously used to "flush" saltwater from the lower Neches River channel. The Neches River SWB also improves navigation and provides additional access to the river for recreational activities. The $32 million project included a 4,500-squarefoot administration building with a water quality laboratory, control room, and conference room, a 2,000-square-foot boathouse; public boat ramps; public restrooms; an access road, and parking lots.

TCEQ Region 10 currently monitors five stations in Segment 0601 and 0601A, while the LNVA monitors one station in segment 0601, as shown in Figure 3.72.

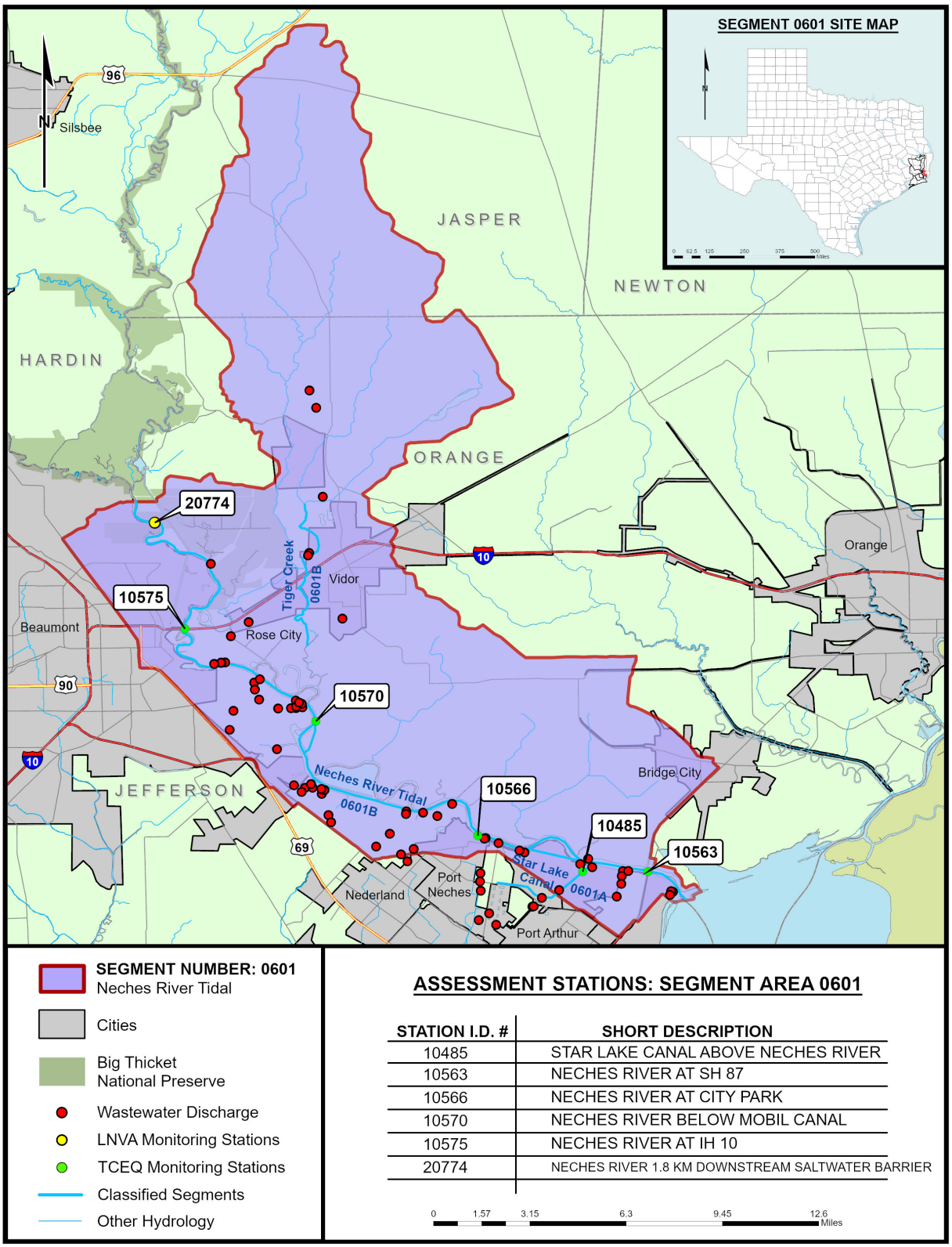

Figure 3.72 Segment 0601: Neches River Tidal Assessment Area

Data Assessment Results

Segment 0601 is designated in the current TSWQS with intermediate aquatic life use and primary contact recreation. This segment is currently listed in the 2020 Texas Integrated Report for not supporting fish consumption due to polychlorinated biphenyls and a contact recreation use impairment for bacteria, as shown in Table 3.10. There is also an aquatic life use concern for malathion. On December 29, 2011, the Texas Department of State Health Services (TDSHS) issued Advisory 46 limiting the consumption of gafftopsail catfish from Texas waters of Sabine Lake in Jefferson and Orange counties. Laboratory testing showed levels of polychlorinated biphenyls, or PCBs, exceeding TDSHS standards in samples of gafftopsail catfish collected from the lake. The advisory also covers contiguous Texas waters, including Sabine Pass and portions of the Sabine and Neches rivers; therefore, the Neches River Tidal segment is not supporting fish consumption use due to PCBs in edible tissue. The TDSHS did not find elevated levels of contaminants in samples of alligator gar, black and red drum, sand trout, southern flounder, spotted seatrout, or striped bass. PCBs are industrial chemicals once used as coolants and lubricants in electrical equipment and for other industrial purposes. The U.S. EPA banned PCBs in 1979, but equipment containing PCBs did not have to be replaced. PCBs break down very slowly in the environment and can accumulate in animals such as fish. Long-term consumption of PCBs may cause cancer as well as reproductive, immune system, developmental and liver problems in humans. Elevated levels of PCBs in fish do not pose a health risk for people participating in recreational activities on Sabine Lake or the Neches River Tidal. The 2020 Integrated Report lists non-point source pesticide use as the potential cause for the malathion.

Segment #	Segment Name	Impairment/Concern Listed in 2020 Texas Integrated Report	Reason for Impairment
0601	Neches River Tidal	Not supporting contact recreation use due to bacteria in Neches River Tidal	Source Unknown
		Not supporting fish consumption due to polychlorinated biphenyls in edible tissue	Source Unknown
		Impairment for aquatic life use due to malathion (lower segment only)	Nonpoint Source pesticide application; Source Unknown
0601A	Star Lake Canal	Not supporting contact recreation use due to bacteria	Source Unknown
		Concern for aquatic life use due to malathion	Nonpoint source pesticide application; Source Unknown
		Concern for Ammonia	Source Unknown

Table 3.10 Segment 0601 Impairments

To address the bacteria concerns in Segment 0601, the Texas State Soil & Water Conservation Board, the Texas A&M AgriLife Extension, and the Texas Water Resources Institute have entered into a partnership with TCEQ to begin a Texas Watershed Steward program for stakeholders in the Neches River Tidal watershed. This program will engage area stakeholders in using a watershed approach to identify the potential sources of the bacterial issues, increase public awareness and involvement, coordinate agency efforts in the watershed, and measure success through monitoring. Through this process, stakeholders were able to assist in determining if a Total Maximum Daily Load (TMDL) project or a watershed protection plan is the best approach to help manage the bacterial issues. A TMDL is a plan developed by TCEQ for restoring impaired waters that identifies the maximum amount of a pollutant that can enter a water body while still meeting water quality standards. The TMDL is submitted to EPA for approval, followed by an implementation plan (I-Plan), which is developed and submitted to TCEQ. This process can take two to three years. In contrast, a watershed protection plan is a community driven management plan using the watershed approach to address the bacterial concerns. A watershed protection plan is a streamlined effort developed and approved by stakeholders, allowing immediate implementation. As a living document, the plan can revised as needed, but can also take two to three years to develop. A TMDL and I-plan project h for the Neches Rival Tidal Segment was the path forward decision after a number of public meetings starting in 2019. The indicator bacteria for this segment is *Enterococcus* due to the brackish nature of the Neches River Tidal segment. Data from the TCEQ Surface Water Quality Information System (SWQMIS) will be used in this project, and more information about the status of the TMDL on Segment 0601 Neches River Tidal can be found on TCEQ's website at: https://www.tceq.texas.gov/waterquality/tmdl/nav/118-nechestidal-bacteria.

Enterococcus water quality standards are based on the geometric mean of bacteria sample results. Concentrations must not exceed 35 MPN/100mL. In the data assessment conducted by LNVA, the geometric mean of samples collected in the segment from March 1999 to January 2020 from all of the site locations were all above the water quality standard except Station #20774, which is the most upstream sample location. Higher concentrations of bacteria levels coincide with limited precipitation events during a period of extended drought, as shown in Figures 3.73 and 3.74.

The lowest geometric means were found at Station #20774, downstream of the Neches River SWB, and Station #10566, Neches River @ City Park, with values of 139 MPN/100 mL and 234 MPN/100 mL, respectively. The highest geometric mean in Segment 0601 was found at Station #10575, Neches River at I10, with a value of 431 MPN/ 100 mL. The highest geometric mean in Segment 0601A was calculated from samples collected at Star Lake Canal, Station #10485, with a value of 1005 MPN/100 mL.

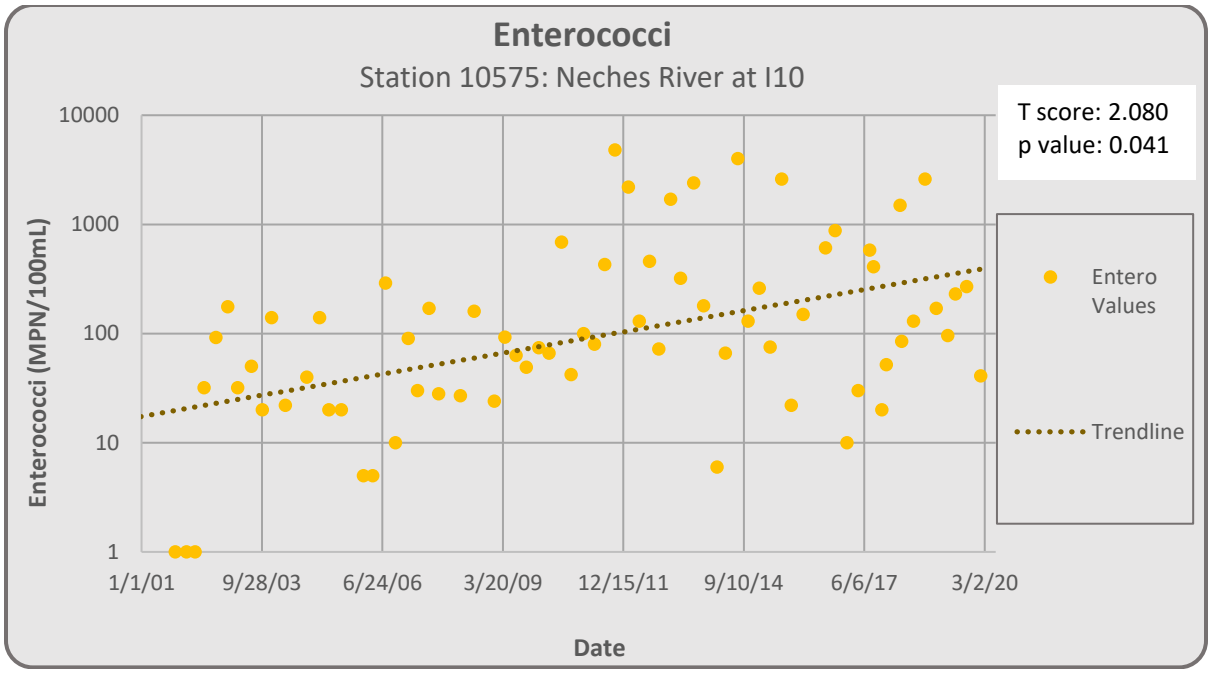

Figure 3.73 Historical Enterococci in Neches River at I10

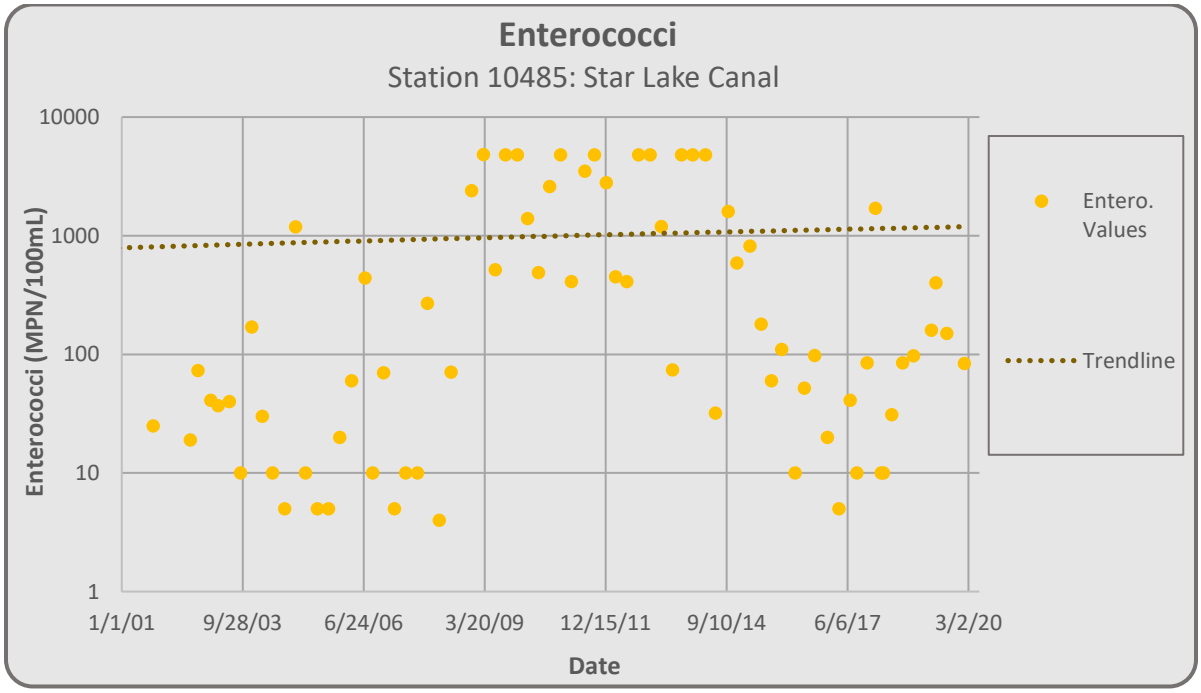

Figure 3.74 Historical Enterococci in Star Lake Canal

The 2020 Integrated Report lists the potential causes of elevated bacteria levels, resulting in a nonsupport classification, as originating from unknown sources. These sources can be divided into two categories: regulated or unregulated. A regulated source, also known as a point source, is going to have a permit issued under the Texas Pollutant Discharge Elimination System (TPDES) program. Wastewater treatment facility and stormwater discharges from industry, construction activities, and municipal storm sewer systems are examples of regulated sources.

There are currently 76 facilities in the basin with permits for either domestic or industrial wastewater. Wildlife, runoff from agricultural practices, and improper residential discharges are unregulated, or nonpoint, sources.

Star Lake Canal (0601A) is listed specifically for a nonsupport of contact recreation for bacteria, a concern for aquatic life use due to malathion, and a general use concern for ammonia. The segment is a tidally influenced, dredged canal receiving industrial wastewater and storm water discharges from industrial facilities. Residential, industrial, and recreational activities are land uses around Star Lake Canal.

In July 2000, Star Lake Canal, along with Jefferson Canal and Molasses Bayou, was declared a Superfund Site by the United States Environmental Protection Agency (EPA). The site is currently defined as the lengths of two industrial canals, the Star Lake Canal and the Jefferson Canal, from their origins to the Neches River. The Star Lake Canal joins the Jefferson Canal in an area between State Highway 366 and Sara Jane Road (a.k.a. Atlantic Highway). These sites were added to the National Priorities List based on evidence that hazardous substances, including chromium, copper, polynuclear aromatic hydrocarbons (PAHs), and polychlorinated biphenyls (PCBs) have migrated or could potentially migrate to Molasses Bayou, Star Lake Canal, Neches River, Sabine Lake, and their associated wetlands.

The EPA is currently preparing an agreement to implement the remedy selected in the Record of Decision (ROD), which includes excavation and disposal of soil/sediment, containment with soil, clay, and/or armor caps, and monitored natural recovery for the seven areas of the site. The EPA issued the ROD for the site in September 2013. An administrative order on consent to complete the remedial design (RD) was signed in September 2016. As part of the RD, plans were made to conduct a Preliminary Design Investigation (PDI) starting July 31, 2017. The PDI was delayed by of the impact of Hurricane Harvey in August of 2017 resulting in torrential precipitation and flooding in the area. The site experienced mild to moderate flooding for a few days due to the rain. The PDI Report was finalized in August of 2018. After a review of the material presented in the Final PDI Report, the EPA concluded the data supports a decision to revise some of the areas identified in the ROD as requiring remediation. The work plan for the RD was approved in October of 2018, and a work plan for the Treatability Study (TS) was approved in February of 2019. Work on the ESD, RD, and the TS is ongoing at this time. The TS should be complete by the end of 2019, and the RD is expected to be completed during the summer of 2021. The homepage for the Star Lake Canal superfund site on EPA's website can be found at: https://.epa.gov/supercpad/cursites/csitinfo.cfm?id=0605043.

Results from current assessment results indicate an aquatic life use concern for chronic malathion in water based on the freshwater/saltwater chronic criteria (0.01 µg/L) for both the Neches River Tidal and Star Lake Canal. Malathion is an organophosphate insecticide registered for use in the United States since 1956. The insecticide is used in the agricultural production of a wide variety of food and feed crops to control many types of insects such as aphids, leafhoppers, and Japanese beetles, in the USDA's Cotton Boll Weevil Eradication Program and Fruit Fly (Medfly) Control Program, by home gardeners for outdoor residential uses on

vegetable gardens, fruit trees, and a variety of ornamentals, and in public health pest control programs for controlling mosquito-borne illnesses. Malathion applications are very common in Southeast Texas for the eradication of mosquitoes, and poses little risks to human health as long as labeled application rates and safety precautions are followed. Malathion is very toxic to insects, including honeybees. Elevated levels of malathion in water may be caused by aerial spraying applications made along drainage canals and waterways near the Neches River Tidal and Star Lake Canal. No recent data has been collected to validate these concerns. The last sampling event for malathion in Segment 0601 took place in 2013.

The analytical reporting limit laboratories were able to reach for malathion was 0.5 µg/L when it was last sampled. Water quality laboratories are now currently able to reach the water quality standard limit of 0.1 µg/L. Malathion was sampled from 1999 to 2013 at Station #10563, Neches River Tidal at SH 87, with only one result over the 0.5 µg/L laboratory reporting limit. This result was collected on October 4th, 2012 with a concentration 0.96 µg/L. The only way to truly assess potential malathion concerns is to conduct more sampling to compare the results against the new reporting limit. Malathion assessment results are similar for Star Lake Canal as ten samples were collected with only one sample, a value of 0.51 µg/L, above the laboratory reporting limit at Station #10485.

Star Lake Canal is also listed with a screening level concern for ammonia. Ammonia sources are classified as nonpoint in origin and may be the result of fertilization practices, potable water treatments, and other unknown sources. Ammonia is produced from decomposition of organic matter, including plants, animals, and animal wastes. The screening level for Ammonia is 0.46 mg/L in a tidal stream. Data analysis of 79 data points for ammonia indicate slightly increasing levels over the last twenty years, as shown in Figure 3.75. The majority of the data is showing results below the screening level for ammonia. Data associated with elevated ammonia levels largely coincided with dry weather conditions in fall and water months.

Data indicates pH levels decreasing at Station #10575, Neches River at I10, as shown in Figure 3.76. From January 1999 to January 2020, pH levels have ranged from 6.1 to 8.0 with a mean of 7.06. This decreasing trend appears to have started in 2012. There is a correlation between lowering pH levels and increasing nutrient levels, as a slight change in pH can increase the solubility of phosphorus and other nutrients. Future assessments will be needed to see if this decreasing trend in pH correlates with other changes within the segment.

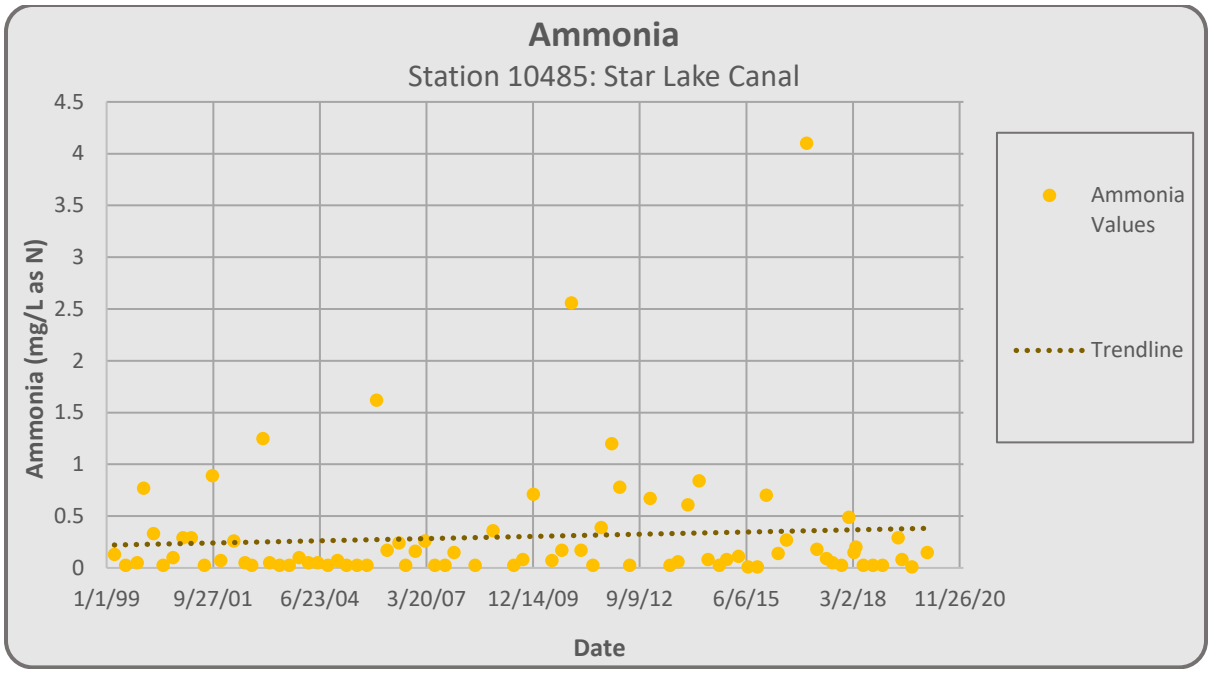

Figure 3.75 Historical Ammonia in Star Lake Canal

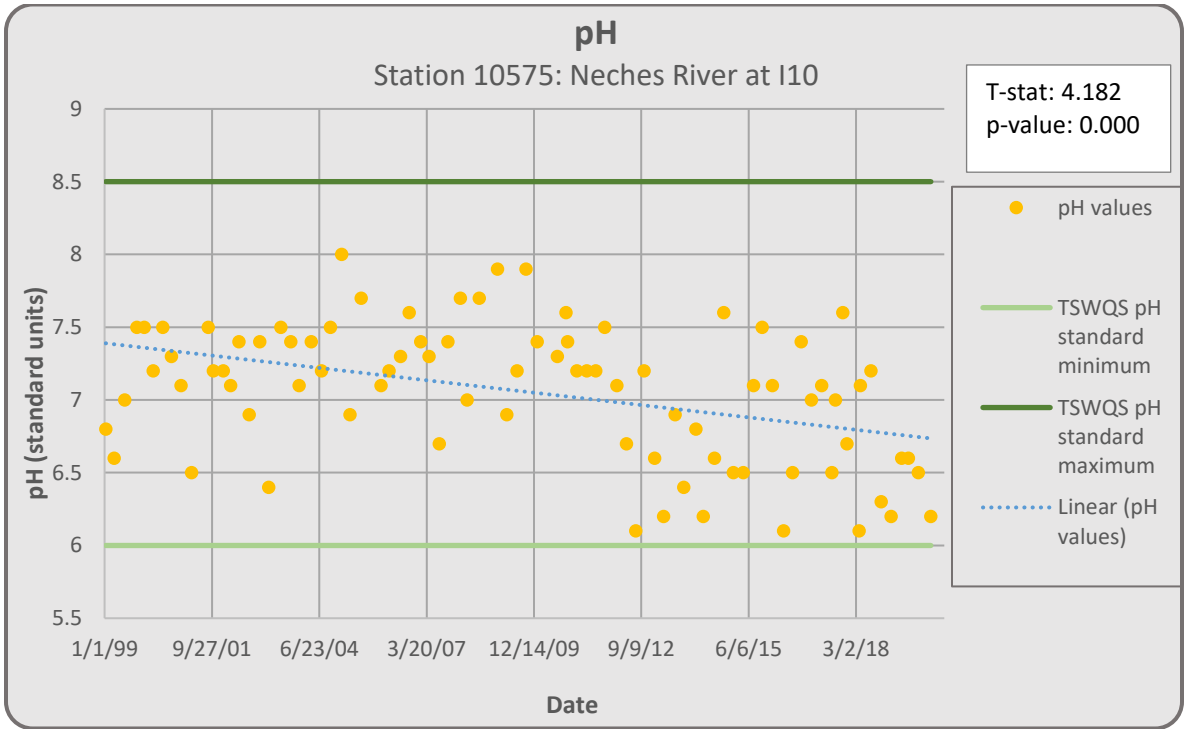

Figure 3.76 Historical pH in Neches River at I10

Recommendations

To address the malathion in water concerns, the TCEQ should conduct more sampling for malathion now that water quality laboratories are able to reach the water quality standard. Water quality impairments due to elevated bacteria should continue to be monitored by the LNVA and TCEQ Region 10. The TMDL and I-plan project is currently in progress to address

bacteria concerns for segment 0601. The Department of Safety and Health Services should continue to monitor fish from Sabine Lake for changes or trends in contaminants or contaminant concentrations necessitating a change in the fish consumption advice. Continued monitoring for routine parameters should be continued to ensure whether concerns for ammonia and decreasing levels of pH are due to naturally occurring processes.

3.3.8. Segment 0704: Hillebrandt Bayou Watershed

Hillebrandt Bayou is a freshwater stream from the confluence of Taylor Bayou in Jefferson County originating near SH 124 in a south easterly direction fourteen miles to the confluence of Taylor Bayou. Hillebrandt Bayou extends from the southern part of Level III Ecoregion South Central Plains (35) to Level IV Ecoregion Northern Humid Gulf Coastal Prairies (34a).

In the northern part of Segment 0704, water oak, pecan, southern live oak, American elm, and loblolly pine are common resembling the floodplain forests of Ecoregion 35. Bald cypress and water tupelo are more prevalent in the inundated portions of the bayou. Prairie land is abundant in the southern section of Segment 0704, and as Hillebrandt Bayou converges with Taylor Bayou, low flat plains with freshwater and saltwater marsh grass are abundant. Soils consist of fine-textured sands, silt, and clayey substrates, and low gradient rivers, streams, and bayous are common. Drainage near Hillebrandt Bayou is generally poor due to the substrate types, and soils remain wet most of the year. Land use is improved pasture, cultivated cropland, urban and industrial development, oil and gas production, recreational parks, and golf courses. Exotic species found near Hillebrandt Bayou are the Chinese tallow tree, Chinese privet, and fire ants. These species are of concern because they can eliminate or drastically reduce local wildlife and plant populations.

Figure 3.77 Station #10607: Hillebrandt Bayou

Hillebrandt Bayou accepts storm drainage from approximately 70% of the City of Beaumont, as the City's wastewater treatment system discharges into Hillebrandt Bayou below SH 124 through a series of wetlands called Cattail Marsh. Cattail Marsh is a wildlife refuge for more than 350 species of birds annually including pelicans, egrets, roseate spoonbills, ducks, ibis, doves and red-winged blackbirds. Cattail Marsh includes 900-acres of wetlands and offers a variety of recreational activities with more than eight miles of gravel levee roads for jogging, hiking, biking, horseback riding, bird watching, wildlife photography, and picnicking. This natural and innovative process has attracted the interest of environmentalists and wildlife professionals from across the state. In addition to Hillebrandt Bayou receiving effluent from the Cattail Marsh system, Willow Marsh Bayou, Kidd Gully, Pevitot Gully, and Bayou Din are

tributaries conveying additional flows from agricultural land and golf courses in the area. Flow in Hillebrandt Bayou can be affected by the Taylor Bayou saltwater barrier and navigational locks located in Port Arthur.

Three stations are routinely monitored by TCEQ Region 10 for field parameters, conventional lab parameters, and bacteria, as shown in Figure 3.78.

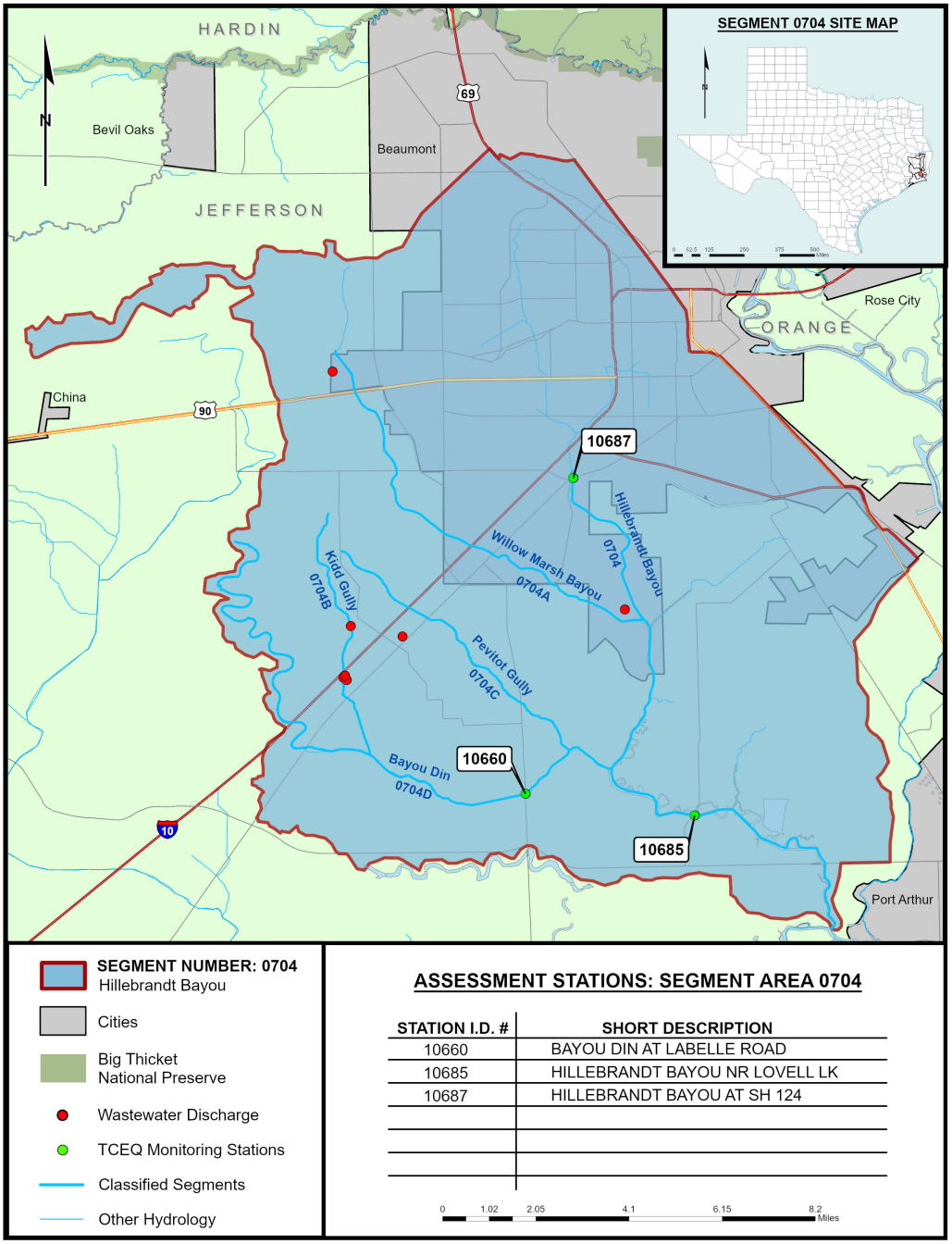

Figure 3.78 Segment 0704: Hillebrandt Bayou Watershed

Data Assessment Results

Segment 0704 is designated in the *TSWQS,*for primary contact recreation, intermediate aquatic life use, and general use criteria. The 2020 Integrated Report lists Segment 0704 Hillebrandt Bayou with contact recreation use concerns due to elevated bacteria levels as shown in Table 3.11. The TCEQ has a TMDL and I-plan project underway for this segment, and the draft TMDL is available for comment at https://www.tceq.texas.gov/assets/public/waterquality/tmdl/118hillebrandt/118-hillebrandt-bacteria-tmdl-comment.pdf.

Segment #	Segment Name	Impairment Listed in 2020 Texas Integrated Report	Reason for Impairment
0704	Hillebrandt Bayou	Not supporting contact recreation use due to bacteria	Urban Runoff/Storm Sewers
		Not supporting aquatic life use due to depressed dissolved oxygen	Natural Conditions-Water Quality Standards Use Attainability Analyses Needed; Unspecified Urban Stormwater; Source Unknown
		Concern for chlorophyll-*a*	Source Unknown
		Concern for depressed dissolved oxygen (screening level/DO minimum)	Natural Conditions-Water Quality Standards Use Attainability Analyses Needed; Source Unknown
0704D	Bayou Din	Concern for dissolved oxygen screening level	Source Unknown; Nonpoint Source
		Screening level concern for nitrate	Source Unknown
		Concern for chlorophyll-*a*	Source Unknown

Table 3.11 Segment 0607 Impairments

The draft report states historical *E. coli* data indicate elevated bacteria loading primarily occurs under high flows, moist conditions, and mid-range flows with the highest bacteria loading existing in high flow conditions. Under dry conditions and low flow conditions, loadings fall below the geometric mean criterion. Other contributions of bacteria occur during mid-range, dry, and low flow conditions is in the absence of overland flow. Direct deposition of fecal material from wildlife, feral hogs, birds, or livestock may be *E.coli* sources. LNVA's data assessment mirrored the findings of the draft TMDL. At all three station locations, the minimum values are 1 MPN/100 ML with mean values of 309, 742, and 1983 MPN at Stations #10685, #10660, and #10687, respectively. The maximum values are outliers. Non-point source pollution is the likely source of these high bacteria levels. Data collected at Station #10687, Hillebrandt Bayou at SH 124, is primarily a result of stormwater and urban runoff from

the City of Beaumont, as shown in Figure 3.79. *E. coli* counts below the wastewater treatment facility are much lower. There is a significant difference in the downstream bacteria levels at Station #10685, Neches River Tidal at SH 87, on Hillebrandt Bayou as compared to upstream levels where non-point sources of bacteria exist. The outliers were left in the graph to demonstrate that the higher values are not typical for the segment and should be linked to a specific runoff event.

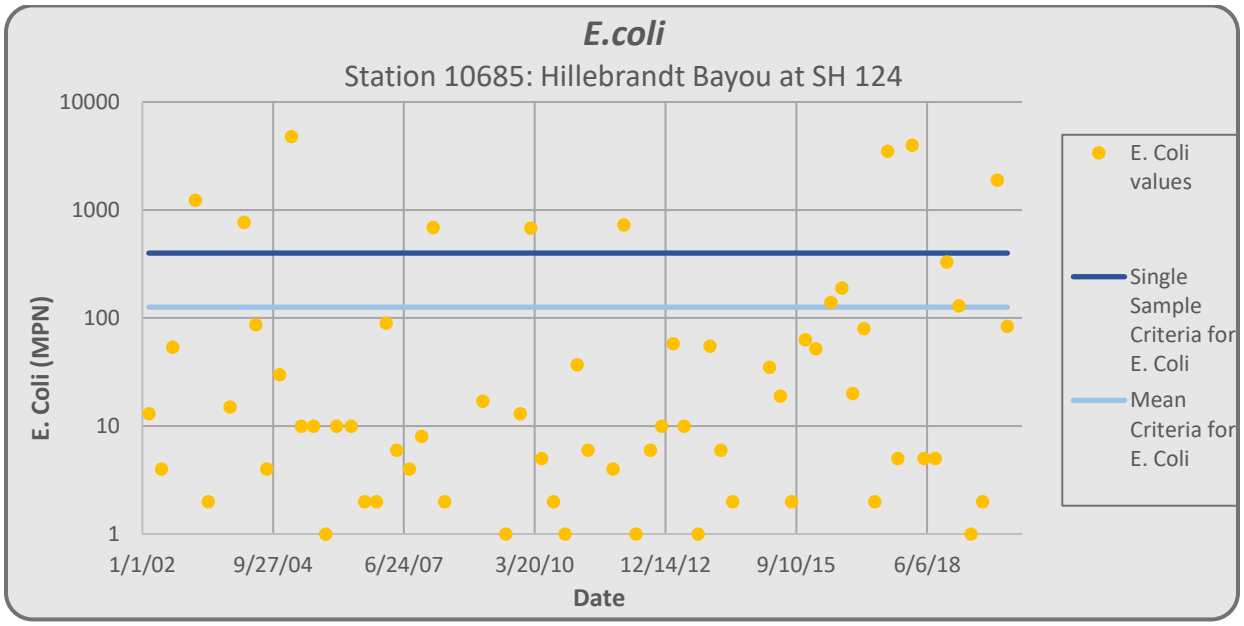

Figure 3.79 Historical *E.coli* in Hillebrandt Bayou at SH 124

The TCEQ conducted an Aquatic Life Use Attainability Analysis on Hillebrandt Bayou to evaluate the chronically depressed dissolved oxygen in the segment from April 1, 2009 to March 31, 2010. As a result, a 24-hour minimum dissolved oxygen criterion of 2.5 mg/L was applied to Segment 704 in the 2014 water quality standards. As with previous assessments, 24-hour surveys continue to indicate depressed dissolved oxygen levels in assessment unit 0704_01. Aquatic life use supports general use for pH, water temperature, chloride, sulfate, and TDS in the entire segment.

Recommendations

The TCEQ should continue routine monitoring on Hillebrandt Bayou. A TMDL and I-plan is in progress for Hillebrandt Bayou by TCEQ to address the contact recreation impairments for bacteria in this segment. Chlorophyll-*a* should continue being monitored as stream standards for nutrients develop.

3.3.9. Segment 0701: Taylor Bayou Above Tidal

Taylor Bayou Above Tidal is defined as the portion of the bayou between the Taylor Bayou Saltwater Barrier and the confluence of Hillebrandt Bayou, which includes Shallow Prong Lake on Big Hill Bayou. Taylor Bayou, 34 miles long, ranges from 8 to 13 feet in depth, and is characterized as low gradient with sluggish flow. Shallow Prong Lake is a 150-acre reservoir. Segment 0701 is located in the ecoregion known as the Western Gulf Coastal Plain (34) and has a mix of two ecoregions present: the Northern Humid Gulf Coastal Prairies (34a) and the Texas-Louisiana Coastal Marshes (34g). The Western Gulf Coastal Plain is generally about 50 to 90 miles wide, relatively flat, and adjacent to the Gulf of Mexico. The natural dominant vegetation in this segment is grasslands, but further inland are some forest and savanna-type vegetation. Soils, which are fine textured and made up of sands, silts, and clays, and even some salt domes, drain poorly and much of the segment stays wet for most of the year. Historically, tall grass covered the area with some oak stands in the southern part of the ecoregions. Some loblolly pines still exist today in the northern part of the Northern Humid Gulf Coastal Prairies. Vegetation in the northern part of Segment 0701 is similar to the floodplain forests of Ecoregion 35, and the south region includes pecan, southern live oak, cedar elm, and ash trees. Even closer to the coast, freshwater and saltwater coastal marsh vegetation is very abundant, like at Shallow Prong Lake on Big Hill Bayou. Cordgrass marshes are extensive, in addition to rushes, sedges, bulrushes, and cattails. In the coastal marshes, few to no trees are present as shown in Figure 3.80. Historically, animal populations included bison, pronghorn, and red wolves. Segment 0701 is generally flat plains with much of the area covered by wetlands and tidal marshes with bayous, lakes, and canals. Land use is primarily pasture/hay and cultivated crops of rice, grain, sorghum, cotton, and soybeans. There are also urban/industrial uses, oil and gas production, waterfowl and wildlife habitat throughout Segment 0701. An industrial hazardous waste incinerator operated by Veolia Environmental Services is located about 3.5 miles west of Taylor Bayou at SH 73. The Veolia facility is located on 3,300 rural acres, which only 450 acres are involved in waste activity approximately ten miles west of Port Arthur, TX. The 150 million British thermal unit per hour rotary kiln-based incinerator occupies 16 acres. Veolia's Port Arthur Treatment Complex is permitted to handle all six RCRA hazardous waste code categories (ignitable, toxic, corrosive, acute hazardous, extraction procedure toxic, and reactive) as well as most PCB wastes. Veolia ES-Port Arthur accepts waste solvents, solvent/oil mixtures, organic and inorganic chemical wastes, pesticide wastes, petroleum wastes, aqueous wastes, contaminated soils and sludges, PCBs and capacitors, as well as other wastes.

Figure 3.80 Station #10668: Taylor Bayou @ Hwy 73

The TCEQ currently monitors two sites in Segment 0701: Station #10642, Shallow Prong Lake on BH Bayou, and Station #10668, Taylor Bayou @ SH 73, as shown in Figure 3.81.

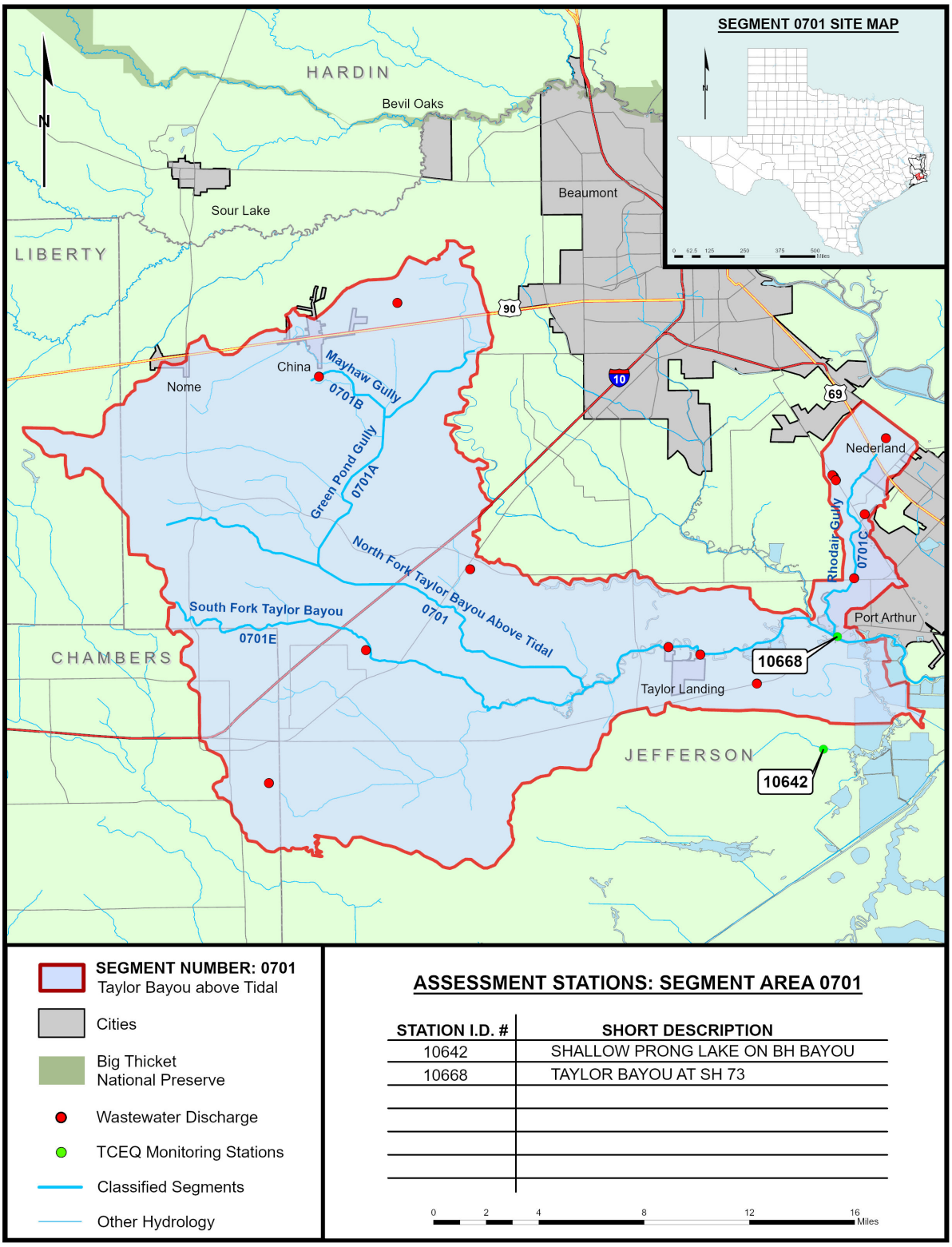

Figure 3.81 Segment 0701: Taylor Bayou Above Tidal Assessment Area

Data Assessment Results

Segment 0701 is designated for primary contact recreation use and intermediate aquatic life use, as shown in Table 3.12. Irrigation return flows from rice fields, storm water runoff, and municipal and industrial discharges are the principal sources of flow in the segment and its major tributary, Hillebrandt Bayou. The Taylor Bayou Saltwater Barrier near the mouth of the bayou minimizes tidal impact and saltwater intrusion, but the segment is still highly tidally influenced. For Taylor Bayou Above Tidal, DO impairments on assessment units 0701_01 and 0701_02 are carry forwards from previous assessments. A concern for chlorophyll-*a* screening level is also present in assessment units 0701_01, 0702_02, and 0702_03. General use for total dissolved solids (TDS), pH, and water temperature is fully supporting, as well as the contact recreation use for bacteria. In Shallow Prong Lake (0701D), there is a concern for fish consumption use due to arsenic in edible tissue. Arsenic can enter the water from natural deposits or from agricultural or industrial pollution. There is also an impairment for depressed dissolved oxygen in this segment. Shallow Prong Lake surveys have resulted in historically low dissolved oxygen levels. The waterbody is a shallow marsh lake receiving little water exchange with the surrounding environment and no direct discharges into the system, which contribute to the low dissolved oxygen levels. These conditions coupled with high temperatures will lower DO; however, current water quality standards indicate this segment is not supporting the aquatic life use.

Segment #	Segment Name	Impairment Listed in 2020Texas Integrated Report	Reason for Impairment
0701	Taylor Bayou Above Tidal	Not supporting aquatic life use due to depressed dissolved oxygen	Natural Conditions-Water Quality Standards Use Attainability Analyses needed; Natural Sources; Source unknown
		Concern for chlorophyll-*a*	Source Unknown
0701D	Shallow Prong Lake	Concern for arsenic in edible tissue	Source Unknown
		Concern for dissolved oxygen	Source Unknown; Non-point Source
		Concern for ammonia in water	Source Unknown
		Nonsupport for dissolved oxygen minimum grab	Source Unknown; Non-point Source

Table 3.12 Segment 0701 Impairments

Chlorophyll-*a* is the green pigment that absorbs sunlight and converts it into chemical energy needed to fix CO_2 into carbohydrates. Nutrients such as ammonia-nitrogen and total phosphorus feed algae, thus increased nutrient levels in the watershed, will contribute to

chlorophyll-*a* concentrations. Flow values were not measured during these sampling events; however, low-flow, pooled conditions similar to ponds and lakes is commonly observed in the segment, which contributes to increased algae growth and chlorophyll-*a*. Chlorophyll-*a* can be detrimental to water bodies if algal blooms are present. An algal bloom is a rapid increase or accumulation in the population of algae in an aquatic system. Algal blooms may occur in freshwater as well as marine environments. Typically, only one or a small number of phytoplankton species are involved, and some blooms may be recognized by discoloration of the water resulting from the high density of pigmented cells. Algal blooms consume a high amount of oxygen in the water during respiration, which affects the viability of aquatic life.

Generally, high levels of chlorophyll-*a* indicate poor water quality, but low to moderate amounts of algae and nutrients in a waterbody can enhance aquatic life and fish populations. However, in Segment 0701, chlorophyll-*a* is present in excessive amounts and the long-term persistence of chlorophyll-*a* is a problem.

Recommendations

Chlorophyll-*a* and nutrients should be routinely monitored in the segment to continue baseline data collection for the development of nutrient standards. As part of the ongoing monitoring coordination, the LNVA will work closely with the TCEQ to develop a monitoring strategy that may help identify the source(s) of chlorophyll-*a* due to nutrients. Metals in fish tissue should be routinely monitored. The TCEQ should conduct a use attainability analysis study in this segment as routine monitoring for dissolved oxygen should continue to aid in the possible change of the stream standard.

3.3.10. Segment 0702: Intracoastal Waterway Tidal

Segment 0702 begins at the confluence of Galveston Bay at Port Bolivar in Galveston County and ends at the confluence of the Sabine-Neches/Port Arthur Canal in Jefferson County. This segment also includes Taylor Bayou Tidal from the confluence with the Intracoastal Waterway up to the Taylor Bayou Saltwater Barrier downstream of SH 73 in Jefferson County. The segment is 63 miles long and includes the unclassified segment Alligator Bayou (0702A). Discharges to the segment, including Alligator Bayou, are primarily from municipal and industrial facilities (31 permitted outfalls) with a smaller amount from agricultural runoff. Segment 0702 is primarily located in the Level IV Ecoregion known as Texas-Louisiana Coastal Marshes (34g). This ecoregion is 539 square miles, and is comprised of flat plains with most of the land covered in standing water, beach ridges, cheniers (defined as a sandy or shelly beach ridge), canals, and tidal marshes with bayous meandering throughout. The highest elevation in this segment is 30 feet above mean sea level, and the soil is made up of clay and silt with some shell fragments and sand on cheniers/beach ridges. The reference peak elevation is located at High Island (thirty feet) which is situated atop an old salt dome. This ecoregion has many freshwater and saltwater coastal marshes and a wetter, more humid climate than Ecoregion 35 to the northeast. Dominant vegetation is cordgrass marshes, bulrushes, spikesedges, maidencane, and cattails in the freshwater marshes and saltgrass, seashore paspalum, Olney

bulrush, and marshhay cordgrass in the brackish areas, and smooth cordgrass, black needlerush, and saltmarsh bulrush in the more saline marshes. The marshes in this segment provide wintering grounds for ducks and geese and breeding and rearing grounds for fish and shrimp such as brown shrimp, white shrimp, blue crabs, red drum, southern flounder, and spotted seatrout. Due to the ecologically rich areas in Segment 0702, fishing is both recreationally popular as well as commercially important. Land use includes extensive agricultural land for cultivated crops and pasture/hay, marshland, wildlife and waterfowl habitat, oil and gas production, and intensive urban/industrial development in the easternmost portion of the watershed.

Two stations in the segment are routinely monitored by the TCEQ Region 10 office in Beaumont, as shown in Figure 3.82.

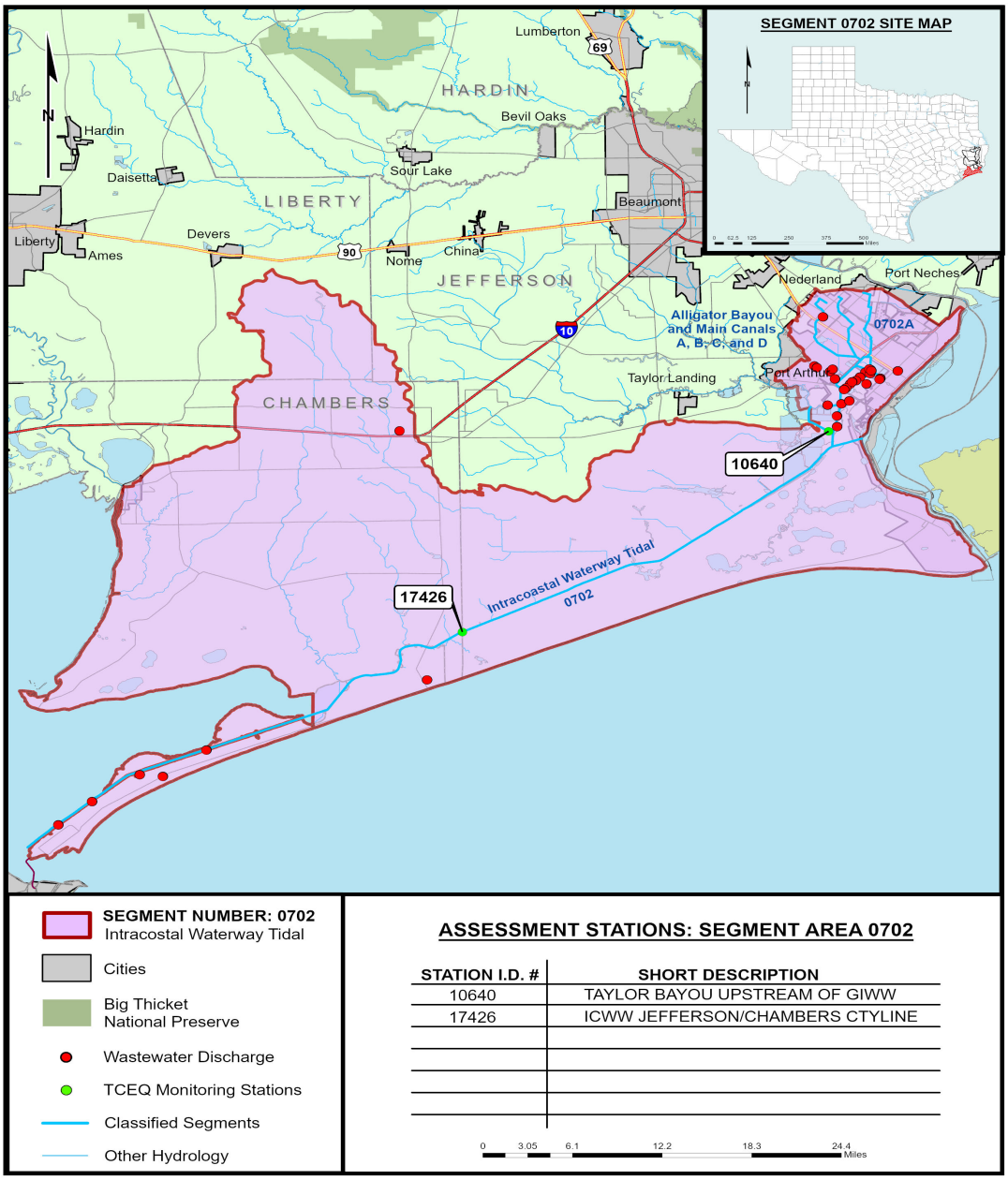

Figure 3.82 Segment 0702: Intracoastal Waterway Tidal Assessment Area

Data Assessment Results

In the 2020 Texas Integrated Report, Segment 0702 Intracoastal Waterway Tidal is not supporting fish consumption due to PCBs and dioxin in edible tissue, not supporting contact recreation due to bacterial, and has a concern for chlorophyll-*a* in Taylor Bayou Tidal, as shown in Table 3.13. Also, in Alligator Bayou, 0702A, there is a concern for chlorophyll-*a* and lead in sediment, and is not supporting aquatic life use due to acute toxicity in water and sediment toxicity.

Segment #	Segment Name	Impairment Listed in 2018 Texas Integrated Report	Reason for Impairment
0702	Intracoastal Waterway Tidal	Not supporting contact recreation use due to bacteria	Non-Point Source; Source Unknown
		Not supporting fish consumption due to polychlorinated biphenyls and dioxin in edible tissue	Industrial Point Source Discharge; Unknown Source
		Concern for chlorophyll-*a*	Source Unknown
0702A	Alligator Bayou	Not supporting aquatic life use due to acute toxicity in water and sediment toxicity	Petroleum/Natural Gas Activities; Industrial Point Source Discharge; Source Unknown
		Concern for lead in sediment	Petroleum/Natural Gas Activities; Industrial Point Source Discharge; Source Unknown
		Concern for chlorophyll-*a*	Source Unknown

Table 3.13 Segment 0702 Impairments

There are currently two fish consumption advisories in place including the portion of the Intracoastal Waterway (0702_03) from the eastern most boundary of East Bay to Port Bolivar. On June 26, 2013, the Texas DSHS issued a fish consumption advisory for Galveston Bay that warns the public to limit their consumption of spotted sea trout, catfish, and blue crab due to elevated levels of dioxins and polychlorinated biphenyls (PCBs) in the three species.
On March 27, 2014, the Texas DSHS issued another fish consumption advisory for Galveston Bay due to the presence of oil in the water. The advisory warns the public to discard fish, shrimp, or crabs that have oil on them or a hydrocarbon smell or taste.

Segment 0702 is designated for primary contact recreation use and high aquatic life use. The aquatic life use for dissolved oxygen grab samples (minimum value) is fully supporting and the general use criteria are fully supporting for pH and water temperature throughout the segment. Water quality standards for chloride, sulfate and total dissolved solids are not applicable to tidal segments. Alligator Bayou is classified as Category 5c on the 303(d) list for toxicity in sediment; therefore, additional data and information will be collected before a TMDL is

scheduled. Two assessment units in the segment, 0702_01 and 0702_02, are not supporting the contact recreation use due to *Enterococcus,* and were added to the 303(d) list in 2012. This portion of the segment is designated a 5c waterbody in the Texas Integrated Report, so more information will be needed before a management strategy is selected. Runoff from nonpoint sources would be a likely source of bacteria into the water.

There is an emerging trend for Total Organic Carbon (TOC) at Station #17426, Intracoastal Waterway, as shown in Figure 3.83. TOC is the amount of carbon found in an organic compound and is used as an indicator of water "cleanliness". Organics compounds combine with other elements to produce molecules that can prove harmful to the environment once they are discharged. The maximum concentration of TOC in this data assessment is 14 mg/L. The drinking water standard for TOC is 25 mg/L, so while assessment values are low, it will still be important to watch to see if the trend continues in future assessments. TOC isn't necessarily harmful to humans directly, but can be an indicator that organic discharges are present. The source of TOC in this segment is potentially an industrial effluent.

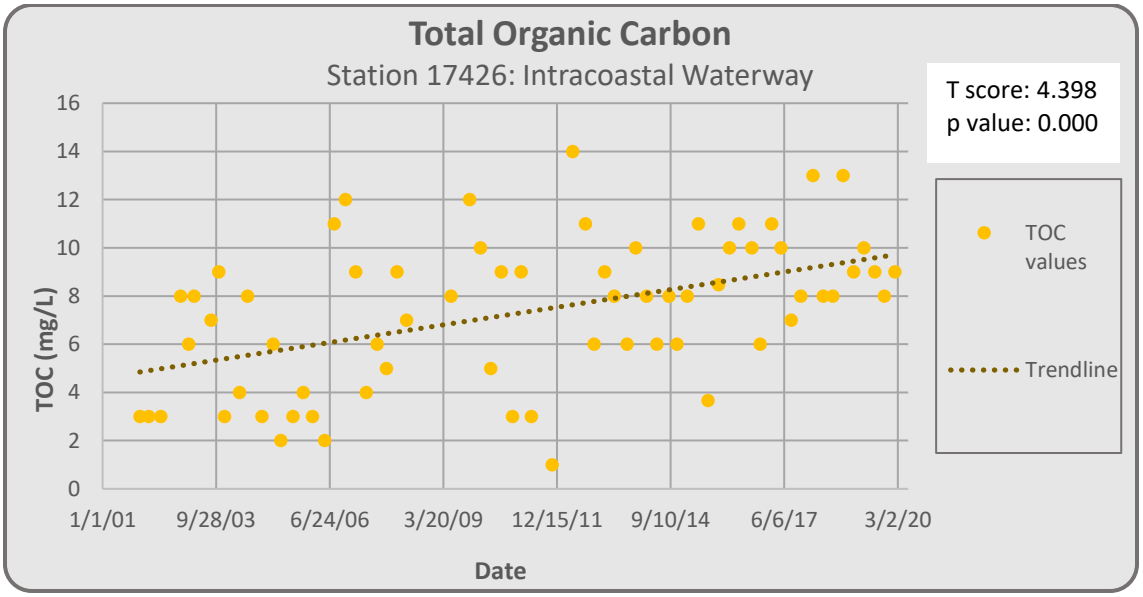

Figure 3.83 Historical Total Organic Carbon in Intercoastal Waterway

Recommendations

Taylor Bayou/Intracoastal Waterway are considered tidal streams. A concern for nutrients due to high chlorophyll-*a* is an ongoing issue in the segment. More intensive sampling for Chlorophyll-a is recommended to determine possible sources of the chlorophyll-*a*. The TCEQ should continue routine monitoring of bacteria in this segment in order to get more data to determine potential sources.

3.3.11. Segment 0703 Sabine Neches Canal Tidal

Figure 3.84 Station #10683, Sabine-Neches Canal near TOPCO

Segment 0703 is defined in the *Texas Surface Water Quality Standards* as from the confluence with Sabine Pass at the southern tip of Pleasure Island in Jefferson County to the Sabine Lake seawall at the northern tip of Pleasure Island in Jefferson County. This water body is considered a tidal stream and is 16 miles in length. The ecoregion encompassing Segment 0703 is Western Gulf Coastal Plain (34), and more specifically Ecoregion IV known as Texas Louisiana Coastal Marshes (34g). There is extensive freshwater and saltwater coastal marshes consisting of grasses, sedges, and rushes. There are few trees found in this segment, and soils consist of clay and silt, with sand and shell fragments on cheniers or beach ridges. Most of the area is covered by standing water, and bayous, lakes, and canal course through low lying areas. The piney woods area (Segments 0602, 0603, 0607, 0609) supply nutrients and flow to Segment 0703. The Sabine-Neches Canal exchanges water with Sabine Lake, and a large amount of marine traffic navigates between the Port of Houston and Port Arthur, including both large vessels and smaller recreational boats. Land use includes urban/industrial development, oil and gas production, as well as marshland, wildlife, and waterfowl habitat. Pleasure Island, a local fishing and recreational hotspot, lies adjacent to the east side of Segment 0703. This island is 18 miles long and was constructed in 1899 by the U.S. Army Corps of Engineers using dredge spoils from the creation of the Sabine-Neches Intracoastal Waterway.

Two stations in Segment 0703, Sabine Neches Tidal, are routinely monitored by TCEQ Region 10, as shown in Figure 3.85.

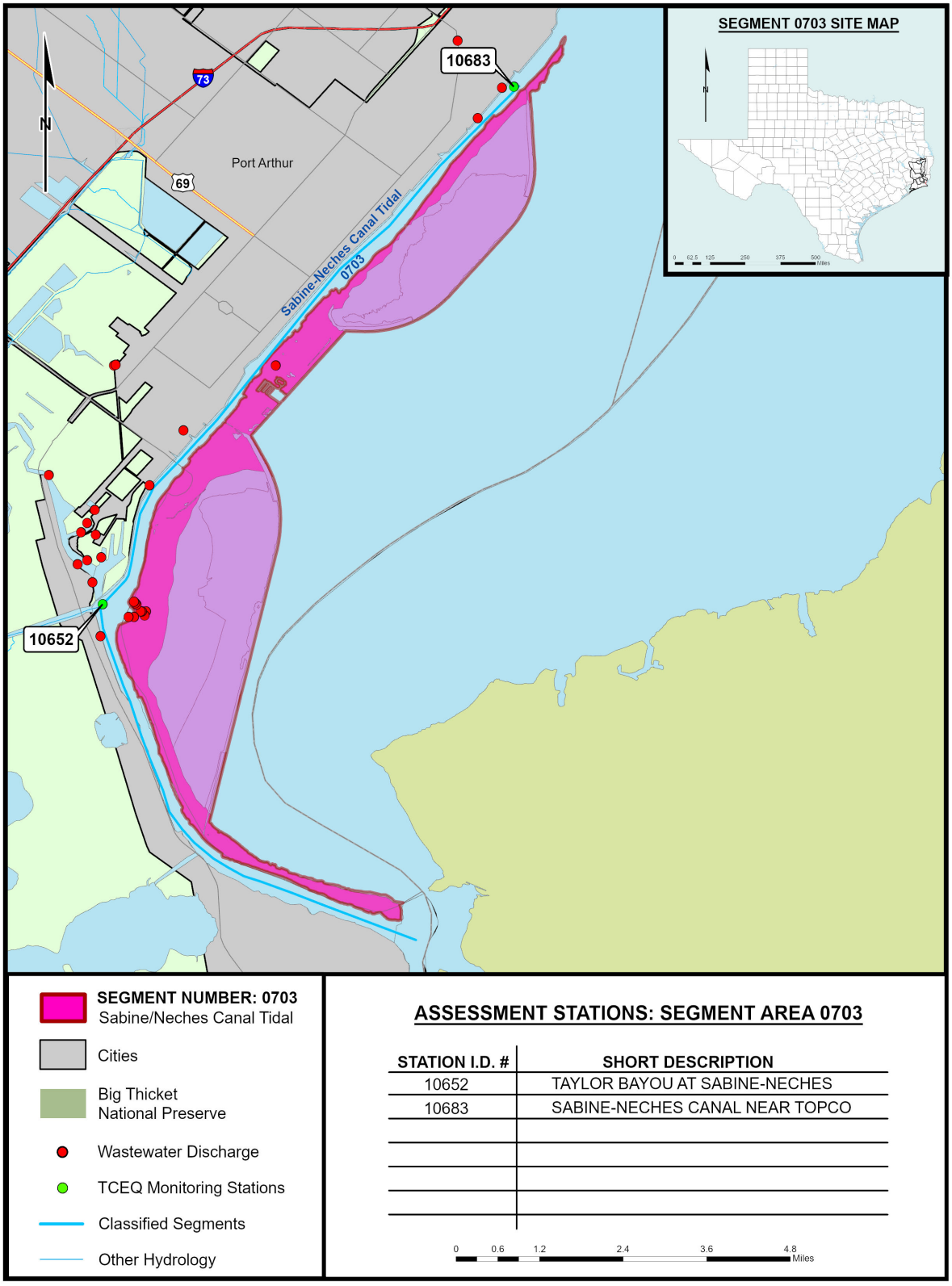

Figure 3.85 Segment 0703: Sabine Neches Canal Tidal Assessment Area

Data Assessment Results

Segment 0703 Sabine Neches Tidal is not supporting contact recreation use due to bacteria. The source of this impairment is unknown, as shown in Table 3.14. As a Category 5c waterbody, additional data or information will be collected and/or evaluated before a management strategy is selected. The *Enterococcus* is likely due to non-point sources from surface runoff. Texas Integrated Report indicates the segment is fully supporting the aquatic life use for dissolved oxygen, and the general use criteria for pH and water temperature. In addition, there are no concerns for chlorophyll *a* and nutrients. Water quality standards for chloride, sulfate and total dissolved solids (TDS) are not applicable to the tidal segments.

Segment #	Segment Name	Impairment Listed in 2020 Texas Integrated Report	Reason for Impairment
0703	Sabine-Neches Canal Tidal	Not supporting contact recreation use due to bacteria	Source Unknown

Table 3.14 Segment 0703 Impairments

There are emerging trends for nitrates and total organic carbon (TOC), as shown in Figures 3.86 and 3.87, respectively. The maximum amount for TOC was 18 mg/L with a median of 6 mg/L. The maximum concentration for nitrates+nitrite was 0.21 mg/L with a median of 0.1 mg/L. These concentrations are low, but future assessments will determine if this trend persists and could point to a possible effluent source.

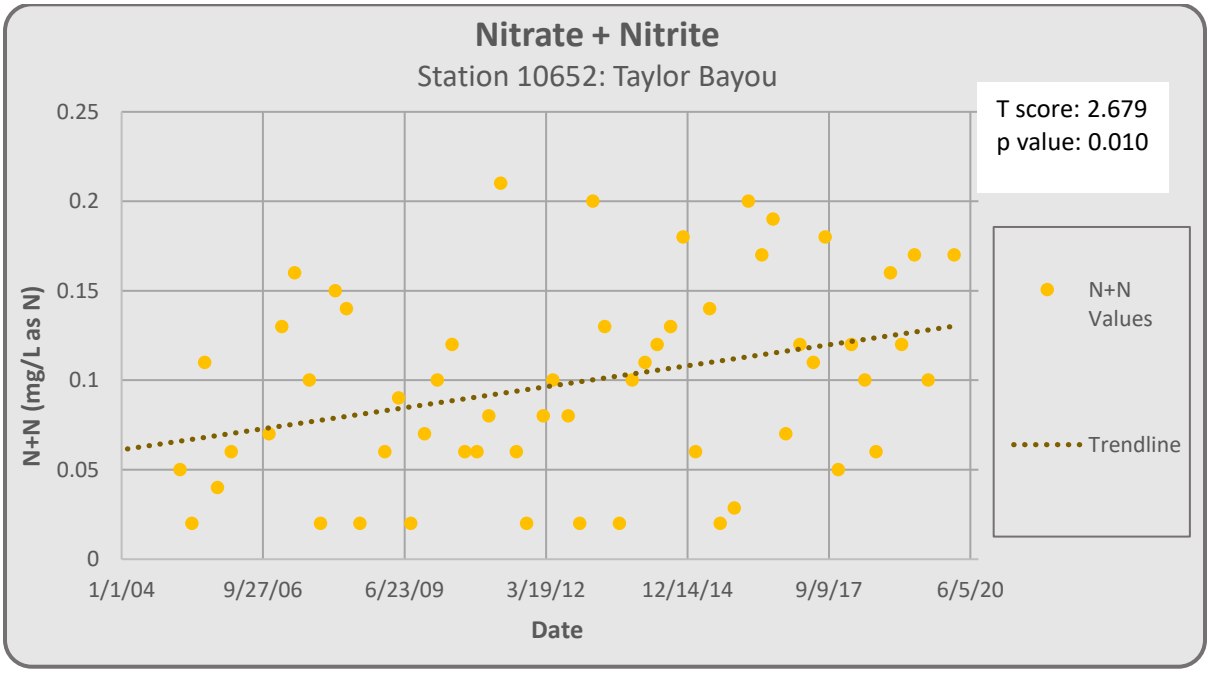

Figure 3.86 Historical Nitrates+Nitrite in Intercoastal Waterway

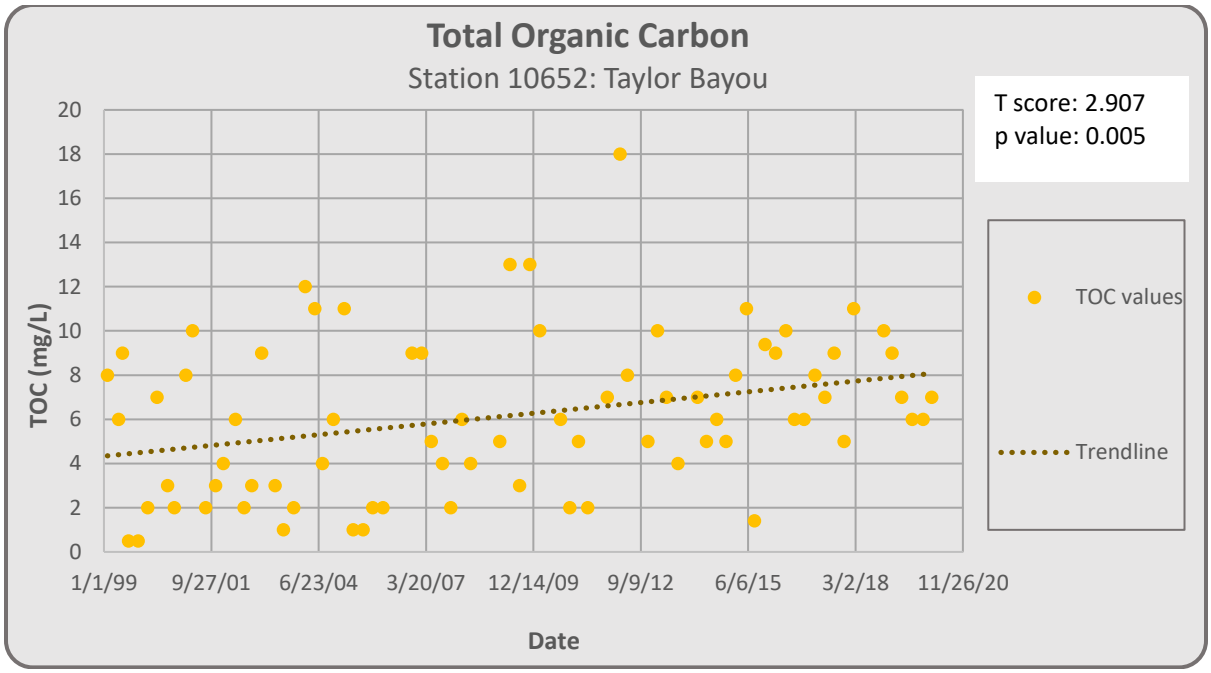

Figure 3.87 Historical Total Organic Carbon in Taylor Bayou

Recommendations

The LNVA recommends TCEQ Region 10 to continue routine monitoring in this segment to assess the source(s) of the recent increase in the *Enterococcus* bacteria levels and to ensure stream standards and nutrient screening levels are being met.

4. Recommendations and Conclusions

This chapter includes recommendations to address the impairments and concerns in the lower Neches Basin and Neches-Trinity Coastal Basin. Recommendations for fish consumption listed from the mercury advisory group of the Department of State Health Services. Concerns and impairments listed in the 2020 Texas Integrated Report for each stream in each segment and the actions already been taken to address these issues and recommendations for future actions are shown in Table 4.1.

4.1. Mercury Advisory Group Recommendations for Fish Consumption

- Eat smaller, younger fish. These fish generally contain lower levels of contaminants than larger, older fish.
- Remove skin, dark muscle tissue, and fat from fish. This practice reduces the risk of exposure to many organic contaminants, including PCBs, pesticides, and dioxins that readily accumulate in the fatty tissues.
- Do not eat internal organs of fish as it may contain high levels of contaminants.
- Eat fish from a variety of water bodies to reduce risk of exposure to any one contaminant or group of contaminants.
- Follow the DSHS safe eating guidelines for water bodies listed in this booklet. Eating a few fish meals from any area of concern probably has little or no human health risk, but eating contaminated fish frequently and regularly over a long period of time creates potential human health risks.
- The DSHS recommends people eat some commercially caught fish or substitute other sources of lean protein (i.e., chicken, venison, or soy products) for recreationally caught fish.

Table 4.1 Recommendations to Address Water Quality Impairments and Concerns

Segment #	Segment Name	Impairments and Concerns Listed in 2020 Texas Integrated Report	Reason for Impairment	Actions Taken	Future Action Recommended
0601	Neches River Tidal	Not supporting contact recreation use due to bacteria in Neches River Tidal	Source unknown	LNVA & TCEQ routine monitoring; Total Maximum Daily Load and Implementation Plan drafted	Continue routine bacteria monitoring, Total Maximum Daily Load and Implementation Plan finalized by TCEQ
		Not supporting fish consumption due to polychlorinated biphenyls in edible tissue	Source unknown	Advisory issued Department of State Health Services (Dec 29, 2011)	Updated fish tissue sampling by Department of State Health Services
		Concern for aquatic life use due to malathion (lower segment only)	Source unknown	TCEQ organics in water monitoring	Routine monitoring for organics in water
0601A	Star Lake Canal	Not supporting contact recreation use due to bacteria (Enterococcus)	Source unknown	TCEQ Region 10 Routine Monitoring	Additional sampling by TCEQ Region 10 needed in order to reevaluate primary contact recreation use
		Concern for aquatic life use due to malathion	Source unknown	TCEQ organics in water monitoring	Routine monitoring for organics in water
		Screening level concern for ammonia	Non-point source; Pesticide application	TCEQ Region 10 Routine Monitoring	Additional sampling by TCEQ Region 10 needed
0602	Neches River below B.A. Steinhagen	Not supporting fish consumption use due to mercury and dioxins in edible tissue	Atmospheric Deposition-Toxics; Industrial point source discharge; Source unknown	Advisory issued Department of State Health Services (January 24, 2014)	Updated fish tissue sampling by Department of State Health Services
		Concern for mercury in edible tissue	Source unknown	TCEQ sampled fish tissue for toxics	Update fish tissue sampling by Department of State Health Services; TCEQ continue monitoring

0603	B.A. Steinhagen	Not supporting fish consumption use due to mercury and dioxins in edible tissue	Atmospheric Deposition-Toxics; Industrial Point Source Discharge; Other unknown source	Advisory issued Department of State Health Services (January 24, 2014)	Updated fish tissue sampling by Department of State Health Services
0603A	Sandy Creek	Not supporting contact recreation use due to bacteria	Non-Point Source-Agriculture and Grazing in Riparian Zone or Shoreline Zones	LNVA Routine Monitoring; Total Maximum Daily Load and Implementation Plan under development	More data is recommended; Total Maximum Daily Load and Implementation plan finalized
0603B	Wolf Creek	Not supporting contact recreation use due to bacteria	Non-Point Source-Agriculture and Livestock Grazing or Feeding Operations	LNVA Routine Monitoring; Total Maximum Daily Load and Implementation Plan under development	More data is recommended; Total Maximum Daily Load and Implementation Plan finalized
0607	Pine Island Bayou	Not supporting aquatic life use due to depressed dissolved oxygen	Natural Conditions-Water Quality Standards Use Attainability Analyses needed; Natural sources	LNVA Routine Monitoring, Continuous Water Quality Monitoring Network Real_time Monitoring Station; Intermediate Aquatic Life Use category proposed by TCEQ in 2014 Texas Surface Water Quality Standards; 24 HR dissolved oxygen collected by LNVA in FY20-21 at station #15367 Pine Island Bayou @ 105	2018 Texas Surface Water Quality Standards includes approved lower dissolved oxygen standard; LNVA will continue monitoring based on lower standard for future assessments; 24 HR dissolved oxygen data will continue to be collected in FY22 by LNVA
0607A	Boggy Creek	Not supporting aquatic life use due to depressed dissolved oxygen	Natural Conditions-Water Quality Standards Use Attainability Analyses Needed; Natural Sources; Streambank Modifications/Destablization ; Unknown Source	TCEQ Region 10 Routine Monitoring; 24 HR Dissolved Oxygen collected by TCEQ; LNVA collected 24 HR DO in FY 20-21; Intermediate Aquatic Life Use category in 2018 Texas State Water Quality Standards	TCEQ Region 10 will continue monitoring based on lowered standard; 24 HR dissolved oxygen data will continue to be collected in FY 22 by LNVA

		Concern for bacteria	Source Unknown; Non-Point Source	TCEQ Region 10 Routine Monitoring	TCEQ Region 10 continue routine monitoring; TCEQ schedule a Recreational Use Attainability Analysis
		Concern for impaired habitat in Boggy Creek	Non-Point Source-Loss of riparian habitat	TCEQ Biological Assessment; LNVA collected 24 hour dissolved oxygen	TCEQ Region 10 continue routine monitoring with assessment using lowered standard; LNVA will keep monitoring 24 hour dissolved oxygen
0607B	Little Pine Island Bayou	Not supporting aquatic life use due to depressed dissolved oxygen	Natural Conditions-Water Quality Standards Use Attainability Analyses Needed; Natural Sources; Source unknown	LNVA routine monitoring and 24 hour dissolved oxygen collection in FY 20-21 ; Intermediate Aquatic Life Use category in 2018 Texas Surface Water Quality Standards	LNVA will continue routine monitoring based on lowered standard for dissolved oxygen; Use attainability analysis under development
		Concern for bacteria	Non-Point Source; Source Unknown	LNVA Routine Monitoring	LNVA continue routine monitoring; TCEQ schedule a Recreational Use Attainability Analysis
0607C	Willow Creek	Not supporting aquatic life use due to depressed dissolved oxygen	Natural Conditions-Water Quality Standards Use Attainability Analyses Needed; Natural Sources; Source unknown	LNVA routine monitoring ; Intermediate Aquatic Life Use category in 2018 Texas Surface Water Quality Standards	LNVA will continue routine monitoring based on lowered standard for dissolved oxygen
0608A	Beech Creek	Not supporting aquatic life use due to elevated copper	Source unknown	TCEQ Region 10 metals sampling	More metals data should be collected before management strategy is determined
		Concern for *E.coli*	Non-point source; Source unknown	LNVA Routine Monitoring	LNVA will continue routine monitoring

		Screening level concern for impaired habitat	Source unknown	LNVA Routine Monitoring	LNVA will continue routine monitoring
0608B	Big Sandy Creek	Screening level concern for dissolved oxygen	Source unknown; Non-point source	LNVA Routine Monitoring	LNVA will continue routine monitoring
0608C	Cypress Creek	Not supporting aquatic life use due to depressed dissolved oxygen	Natural Conditions-Water Quality Standards Use Attainability Analyses Needed; Source Unknown	LNVA Routine Monitoring; Aquatic Life Monitoring	TCEQ should review standards to see if possible Texas Surface Water Quality Standards revision is necessary; LNVA will add 24 hour dissolved oxygen to a future monitoring schedule
		Concern for impaired habitat	Unknown Source	LNVA Routine Monitoring	LNVA will continue routine monitoring
		Concern for bacteria	Unknown source; Non-Point Source	LNVA Routine Monitoring	LNVA will continue routine monitoring
0608E	Mill Creek	Not supporting aquatic life use due to depressed dissolved oxygen	Natural sources; Industrial point source discharge; Municipal point source discharge	TCEQ Routine Monitoring	More data should be collected before a management plan is developed; LNVA adding 24 hr dissolved oxygen collection in FY 22
0608G	Lake Kimball	Not supporting fish consumption use due to mercury in edible tissue	Atmospheric deposition-toxics; Source unknown	Advisory issued Department of State Health Services (September 21, 2009 and April 23, 1999)	Updated fish tissue sampling by Department of State Health Services
0609	Angelina River below Sam Rayburn Reservoir	Not supporting fish consumption for mercury and dioxin	Atmospheric Deposition-Toxics; Source unknown	Advisory issued Department of State Health Services (January 24, 2014)	Updated fish tissue sampling by Department of State Health Services

0610	Lake Sam Rayburn Reservoir	Not supporting fish consumption due to mercury	Source unknown; Atmospheric deposition for mercury	Advisory issued Department of State Health Services	Updated fish tissue sampling by Department of State Health Services
		Screening level concern for iron and manganese	Sources unknown	Routine collection of metals in sediment by TCEQ	TCEQ continue routine collection
0610A	Ayish Bayou	Not supporting contact recreation for *E.coli*	Non-point source and unknown sources	Routine Monitoring Angelina Neches River Authority	Continued monitoring by Angelina Neches River Authority
0610P	Bayou Carrizo @ SH	Not supporting contact recreation for *E.coli*	Non-point source and unknown sources	Routine Monitoring Angelina Neches River Authority	Continued monitoring by Angelina Neches River Authority
0701	Taylor Bayou Above Tidal	Not supporting aquatic life use due to depressed dissolved oxygen	Natural Conditions-Water Quality Standards Use Attainability Analyses needed; Natural Sources; Source unknown	TCEQ Region 10 Routine Monitoring	TCEQ continue routine monitoring and collect new 24 hour dissolved oxygen measurements; TCEQ should schedule a Use Attainability Analysis
		Concern for chlorophyll-*a*	Source unknown	TCEQ Region 10 Routine Monitoring	Continue routine monitoring; develop a nutrient standard
0701D	Shallow Prong Lake	Concern for arsenic in edible tissue	Source unknown	TCEQ Region 10 sampled for fish tissue	Update fish tissue sampling to see if advisory necessary by Department State Health Services
		Concern for dissolved oxygen	Source unknown; Non-point source	TCEQ Region 10 Routine Monitoring	TCEQ continue routine monitoring
		Concern for ammonia in water	Source Unknown	TCEQ Region 10 Routine Monitoring	TCEQ continue routine monitoring
		Nonsupport for dissolved oxygen minimum grab	Source unknown; Non-point source	TCEQ Region 10 Routine Monitoring	TCEQ continue routine monitoring

	Waterway Tidal	Not supporting contact recreation use due to bacteria	Non-point source; Source unknown	TCEQ Region 10 Routine Monitoring	Consider a secondary contact recreation use standard
		Not supporting fish consumption due to polychlorinated biphenyls and dioxin in edible tissue	Industrial point source discharge; Source unknown	Advisory issued Department of State Health Services (January 26, 2013)	Updated fish tissue sampling by Department of State Health Services
		Concern for chlorophyll-*a* in Taylor Bayou Tidal	Source unknown	TCEQ Region 10 Routine Monitoring	Continue routine monitoring; develop a nutrient standard
0702A	Alligator Bayou	Not supporting aquatic life use due to acute toxicity in water and sediment toxicity	Petroleum/Natural gas activities; Industrial point source discharge; Source unknown	TCEQ toxicity sampling	Complete Total Maximum Daily Load; keep monitoring to determine source
		Concern for lead in sediment	Petroleum/Natural gas activities; Industrial point source discharge; Source unknown	TCEQ metals sampling	Continue monitoring for metals in sediment
		Concern for chlorophyll-a	Source unknown	TCEQ Region 10 Routine Monitoring	Continue routine monitoring; develop a nutrient standard
0703	Sabine-Neches Canal Tidal	Not supporting contact recreation use due to bacteria	Source unknown	TCEQ Region 10 Routine Monitoring	Consider secondary or noncontact recreation use standards; Recreational Use Attainability Analysis
0704	Hillebrandt Bayou	Not supporting contact recreation use due to bacteria	Urban runoff/Storm sewers	TCEQ Region 10 Routine Monitoring; Total Maximum Daily Load and Implementation plan drafted	Total Maximum Daily Load and Implementation plan finalized; Recreational Use Attainability Analysis

		Not supporting aquatic life use due to depressed dissolved oxygen	Natural Conditions-Water Quality Standards Use Attainability Analyses needed; Unspecified urban stormwater; Source unknown	TCEQ Region 10 Routine Monitoring; TCEQ completed a Use Attainability Analysis on Hillebrandt Bayou; Revised 24-hour minimum dissolved oxygen criterion	24 Hour dissolved oxygen measurements needed for assessment with new standard; continue routine monitoring
		Concern for chlorophyll-a	Source Unknown	TCEQ Region 10 Routine Monitoring	Continue monitoring; develop nutrient standard
		Concern for depressed dissolved oxygen (screening level/DO minimum)	Natural Conditions-Water Quality Standards Use Attainability Analyses needed; Source unknown	TCEQ Region 10 Routine Monitoring	24 Hour dissolved oxygen measurements needed for assessment with new standard; continue routine monitoring
0704D	Bayou Din	Screening level concern for nitrate	Source unknown	TCEQ Region 10 Routine Monitoring	Continue monitoring; develop nutrient standard
		Concern for chlorophyll-a	Source unknown	TCEQ Region 10 Routine Monitoring	Continue monitoring; develop nutrient standard

4.2. Conclusions

Since 1991, The LNVA has been involved in the Texas Clean Rivers Program and worked closely with the TCEQ and the CRP Steering Committee to address water quality issues in the Lower Neches River and Neches-Trinity Coastal Basins. The issues identified are well documented and CRP water quality data has been instrumental to this effort. The majority of the water quality issues in these two basins are currently being addressed. The LNVA's role through the years has primarily been surface water quality monitoring, data management, data analysis, reporting, and public education/outreach.

LNVA's CRP Steering Committee is a diverse group of basin stakeholders, representing a variety of interests. Steering Committee meetings are hosted by the LNVA to discuss the status of current CRP contracts/budgets, address state/local water quality issues, review basin reports and special projects in the basin, and establish water quality monitoring priorities. This group of basin stakeholders has changed through the years, but they consistently provide meaningful input and practical ideas to improve water quality conditions throughout the basin.

Public education and outreach through CRP are a priority for LNVA. Basin water quality reports, water conservation materials, and the Major Rivers educational curriculum have been distributed to schools, organizations, and the general public throughout the basin. The Stream Team Volunteer Monitoring Program has enhanced our efforts to educate the public about the importance of water quality.

LNVA's Surface Water Quality Monitoring (SWQM) Program continues to be the primary focus of CRP in the basin. SWQM data collected by LNVA's environmental staff provides quality assured data for the Texas Integrated Report prepared by the TCEQ and submitted biennially to the EPA. The LNVA monitors surface water quality on a quarterly basis at 23 routine stations in the Lower Neches River Basin.

Since June 2008, the Continuous Water Quality Monitoring Network (CWQMN) Station on Pine Island Bayou (CAMS 749) has been in operation by the LNVA after installation by the TCEQ. The real-time surface water quality data (pH, Temperature, Dissolved Oxygen, Conductivity, Turbidity) collected at this station is available on-line, 24-hours per day.

The water quality in the Lower Neches and Neches-Trinity Coastal Basin segments do not meet all state water quality standards and assessment criteria. All of the segments have listed impairments and/or concerns. Some of these impairments and concerns can be attributed to natural conditions within the basin. The specific causes of those that aren't natural will require further study. Significant progress has been made to address some of these issues. Additional monitoring efforts to target specific impairments, as well as more coordination with agencies like the Texas Department of State Health Services and the Texas Commission on Environmental Quality will be required.

5. Basin Summary Report Acronyms

ALM- Aquatic Life Monitoring
ANRA- Angelina & Neches River Authority
CAMS- Continuous Ambient Monitoring Station
CRP- Clean Rivers Program
EPA-Environmental Protection Agency
LDC-Load Duration Curve
LNVA-Lower Neches Valley Authority
LOQ- Limit of Quantification
LPIB-Little Pine Island Bayou
PAH-Polynuclear Aromatic Hydrocarbon
PCB- Polychlorinated Biphenyls
PIB-Pine Island Bayou
QAPP-Quality Assurance Project Plan
RCRA-Resource Conservation and Recovery Act
RD-Remedial Design
ROD-Record of Decision
RUAA-Recreational Use Attainability Analysis
SWQM-Surface Water Quality Monitoring
SWQMIS-Surface Water Quality Monitoring Information System
TCEQ-Texas Commission on Environmental Quality
TDS-Total Dissolved Solids
TDSHS- Texas Department of State Health Services
TOC-Total Organic Carbon
TMDL-Total Maximum Daily Load
TPDES- Texas Pollutant Discharge Elimination System
TS- Treatability Study
TSWQS- Texas Surface Water Quality Standards
USDS-United States Department of Agriculture
UAA- Use Attainability Analysis

6. Helpful Websites

Angelina & Neches River Authority: www.anra.org
Environmental Protection Agency: www.epa.gov
Department of State Health Service: www.dshs.texas.gov
Lower Neches Valley Authority: www.lnva.org
National Integrated Drought Information System: www.drought.gov
Texas Commission on Environmental Quality: www.tceq.texas.gov

7. References

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