Lake Houston, East Fork San Jacinto River, West Fork San Jacinto River, and Crystal Creek Watersheds: A Community Project to Protect Recreational Uses

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Seven Total Maximum Daily Loads for Indicator Bacteria in Lake Houston, East Fork San Jacinto River, West Fork San Jacinto River, and Crystal Creek Watersheds[1]

Adopted August 24, 2016.

Approved by EPA October 7, 2016.

One TMDL for Indicator Bacteria in Mound Creek Added by this Addendum I, October 2018[2]

Via the October 2018 Update to the Texas Water Quality Management Plan.

Approved by EPA February 22, 2019.

One TMDL for Indicator Bacteria in White Oak Creek Added by this Addendum II, January 2023[3]

Via the January 2023 Update to the Texas Water Quality Management Plan (SFR-121/2023-02).

Approved by EPA May 26, 2023.

One TMDL for Indicator Bacteria in Winters Bayou Added by this Addendum III, April 2024

Via the April 2024 Update to the Texas Water Quality Management Plan (SFR-121/2024-03).

Approved by EPA July 15, 2024 (scroll to view or print this addendum).

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[1] https://www.tceq.texas.gov/downloads/water-quality/tmdl/houston-galveston-recreational-42/82b-ewfsjr-tmdl-adopted.pdf
[2] https://www.tceq.texas.gov/downloads/water-quality/tmdl/houston-galveston-recreational-42/82c-ewfsj-bacteria-tmdl-addendum-one.pdf
[3] https://www.tceq.texas.gov/downloads/water-quality/tmdl/houston-galveston-recreational-42/82g-ewfsj-bacteria-tmdl-addendum02-2023jan.pdf

Appendix VII. Addendum Three to Seven Total Maximum Daily Loads for Indicator Bacteria in Lake Houston, East Fork San Jacinto River, West Fork San Jacinto River, and Crystal Creek Watersheds

Adding one TMDL for AU 1003A_01

One TMDL for Indicator Bacteria in Winters Bayou

Introduction

TCEQ adopted *Seven Total Maximum Daily Loads for Indicator Bacteria in Lake Houston, East Fork San Jacinto River, West Fork San Jacinto River, and Crystal Creek Watersheds* (TCEQ, 2016) on August 24, 2016. The United States (U.S.) Environmental Protection Agency (EPA) approved the TMDLs on October 7, 2016. Two addenda to the original TMDLs were submitted to EPA through the October 2018 and January 2023 WQMP updates, respectively (TCEQ, 2018 and TCEQ, 2023a). Those addenda added two assessment units (AUs). This document is the third addendum to the original TMDL report.

This third addendum includes information specific to one additional AU for Winters Bayou (AU 1003A_01). This AU is located within the watershed of the approved original TMDLs for the East and West Fork of the San Jacinto River. The concentration of indicator bacteria in this additional AU exceeds the criterion used to evaluate support of the primary contact recreation 1 use.

This addendum details the development of the added TMDL allocation for this additional AU, which was not specifically addressed in the original TMDL report. For background or other explanatory information, please refer to the *Technical Support Document for One Total Maximum Daily Load for Indicator Bacteria in Winters Bayou*[4] (Adams and Millican, 2024). Refer to the original, approved TMDL document for details about the overall project watershed as well as methods and assumptions used in developing the original TMDLs.

[4] https://www.tceq.texas.gov/downloads/water-quality/tmdl/houston-galveston-recreational-42/as-488_winters_bayou_add_tsd_draft.pdf/

Problem Definition

TCEQ first identified the indicator bacteria impairment for Winters Bayou in the *2022 Texas Integrated Report of Surface Water Quality for Clean Water Act Sections 305(b) and 303(d)* (Texas Integrated Report; TCEQ, 2022a), the latest EPA-approved edition. The water body only includes one AU, which is the impaired AU 1003A_01 being addressed in this addendum. Figure VII-1 shows the watershed added in this addendum in relation to the entire watershed of the original TMDLs, and also includes the watersheds from the two previously approved addenda.

The Texas Surface Water Quality Standards (TCEQ, 2022b) identify uses for surface waters and numeric and narrative criteria to evaluate attainment of those uses. The basis for the water quality target for the TMDL developed in this addendum is the numeric criterion for indicator bacteria from the 2022 Texas Surface Water Quality Standards. *Escherichia coli* (*E. coli)* are the indicator bacteria for assessing primary contact recreation 1 use in freshwater.

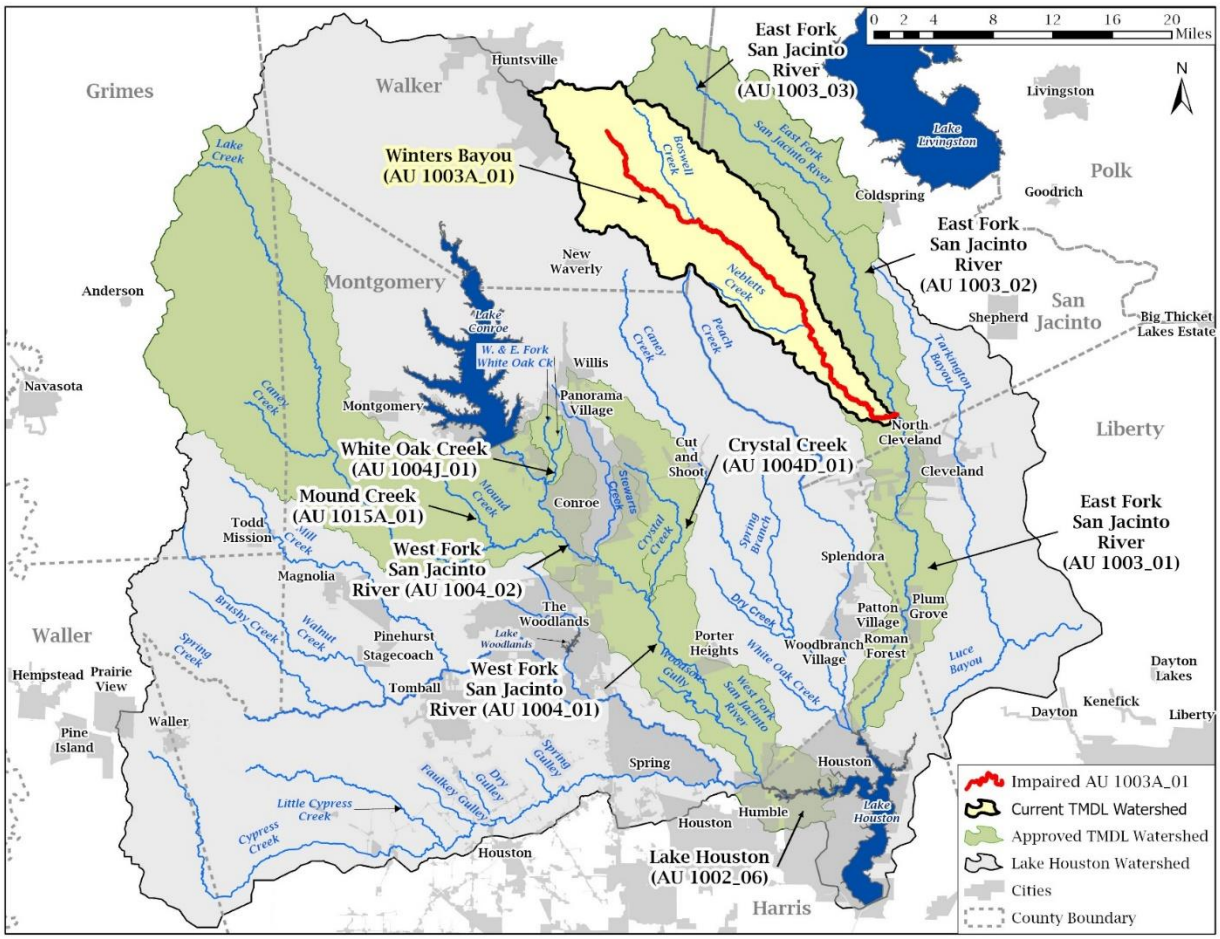

Figure VII-1. Map showing the previously approved TMDL watersheds and the Winters Bayou AU 1003A_01 watershed added by this addendum

Table VII-1 summarizes the ambient water quality data for the TCEQ surface water quality monitoring (SWQM) stations in the water body, as reported in the 2022 Texas Integrated Report. The data from the assessment indicate nonsupport of the primary contact recreation 1 use for the AU, because the geometric mean concentration for *E. coli* exceeds the freshwater geometric mean criterion of 126 cfu/100mL of water. Figure VII-2 shows the locations of the TCEQ SWQM stations that were used in evaluating water quality in the 2022 Texas Integrated Report for the water body added by this addendum.

Table VII-1. 2022 Texas Integrated Report summary

AU	TCEQ SWQM Station	Parameter	Number of Samples	Date Range	*E. coli* Geometric Mean (cfu/100 mL)
1003A_01	21417; 21933; 21935; 21936; 21937	*E. coli*	63	Dec. 1, 2013 – Nov. 30, 2020	164.06

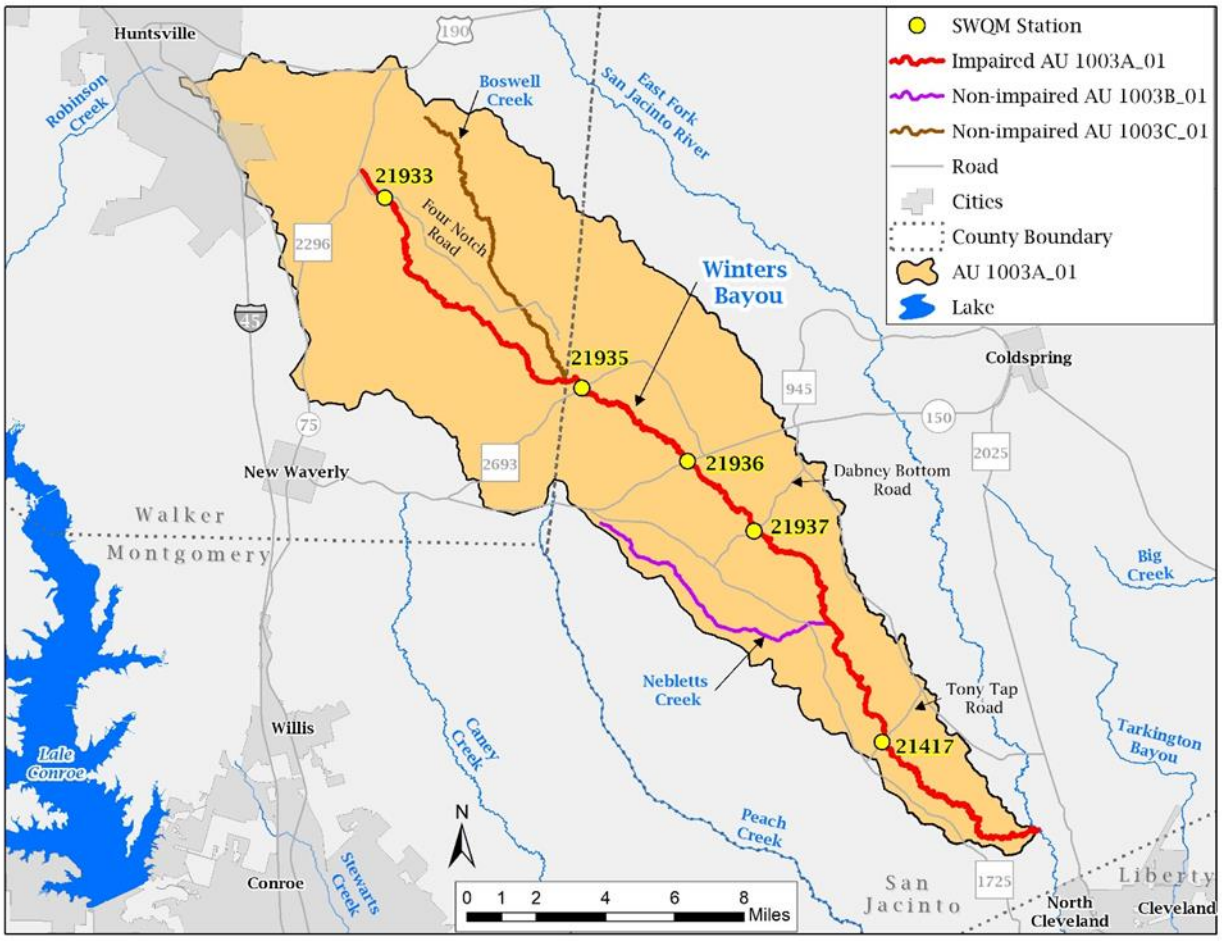

Figure VII-2. Active TCEQ SWQM stations

Watershed Overview

The Winters Bayou watershed drains 170.7 square miles (109,265 acres) and is located within Walker and San Jacinto Counties. Winters Bayou is an unclassified, perennial freshwater stream that is a tributary of the East Fork San Jacinto River (Segment 1003) that eventually flows into Lake Houston.

The Winters Bayou watershed includes the contributing subwatersheds of Nebletts Creek (AU 1003B_01) and Boswell Creek (AU 1003C_01), along with that of AU 1003A_01, and is located within the Lake Houston watershed in the San Jacinto River Basin.

The 2022 Texas Integrated Report provides the following water body and AU description:

- Winters Bayou (1003A) - From the confluence with East Fork San Jacinto River to 0.17 miles upstream of Dorrell Road at the confluence of Phelps Creek.
    - AU 1003A_01 – From the confluence with East Fork San Jacinto River to 0.17 miles upstream of Dorrell Road at the confluence of Phelps Creek.

Climate

The Winters Bayou watershed is within the Upper Coast and East Texas climatic divisions, which are categorized as subtropical humid (Larkin & Bomar, 1983). The Gulf of Mexico is the principal source of moisture that drives precipitation in the region. For the 10-year period from 2012–2022, weather data were obtained from the National Oceanic and Atmospheric Administration (NOAA) National Centers for Environmental Information for the Conroe North Houston Regional Airport (NOAA, 2022). Data from this 10-year period indicate that the average high temperatures typically peak in August (94.6 °F). During winter, the average low temperature generally reaches a minimum of 38.2 °F in January (Figure VII-3). Annual rainfall averages 49.3 inches. The wettest month was May (7.4 inches), while February (2.5 inches) was the driest month, with rainfall occurring throughout the year.

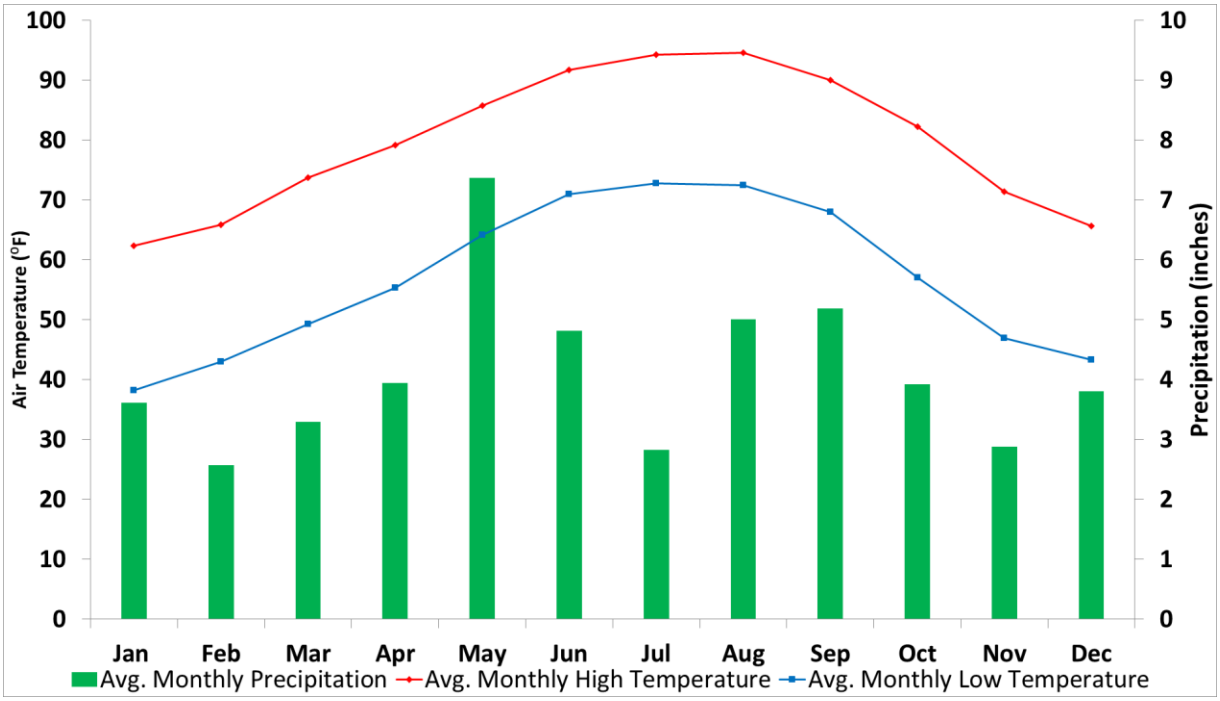

Figure VII-3. Average monthly temperature and precipitation (2012–2022) at the Conroe North Houston Regional Airport weather station

Population and Population Projections

The Winters Bayou watershed is located in Walker and San Jacinto counties. The only current predominant population density for this watershed is a small portion of the City of Huntsville. According to the 2020 U.S. Census Bureau (USCB) data, the added Winters Bayou watershed had an estimated population of 7,494 people in 2020 (USCB, 2021).

A population projection through 2070 was developed using data from the Water User Group (WUG) data from the 2021 Texas Water Development Board (TWDB) Regional Water Plan (TWDB, 2021). Table VII-2 provides a summary of the population projection for the added TMDL watershed.

Table VII-2. 2020 – 2070 population projection

Area	2020 Estimated Population	2070 Projected Population	Projected Population Increase (2020 – 2070)	Percent Change (%)
Winters Bayou	7,494	8,127	633	8%

The following steps detail the method used to estimate the 2020 and projected 2070 populations in the Winters Bayou watershed.

1. Obtained 2020 USCB data at the block level.
2. Developed the 2020 watershed population using the USCB block level data for the portion of census blocks located within the watershed.
3. For the census blocks that were partially located in the watershed, population was estimated by multiplying the block population to the proportion of its area in the watershed.
4. Obtained the WUG data from the 2021 TWDB Regional Water Plan to be used for population projections (TWDB, 2021).
5. Projected 2070 populations were allocated based on proportion of the WUG area within the TMDL watershed.
6. Subtracted the 2020 watershed population from the 2070 population projections to determine the projected population increase. Subsequently, divided the projected population increase by the 2020 watershed population to determine the percentage population increase for the TMDL watershed.

Land Cover

The land cover data for the Winters Bayou watershed were obtained from U.S. Geological Survey (USGS) 2019 NLCD (USGS, 2021). The land cover for the addendum TMDL watershed is shown in Figure VII-4. A summary of the land cover data is provided in Table VII-3 and indicates that the addendum TMDL watershed is mostly rural with evergreen forest (50.43%) and pasture/hay (18.54%) as the dominant land covers.

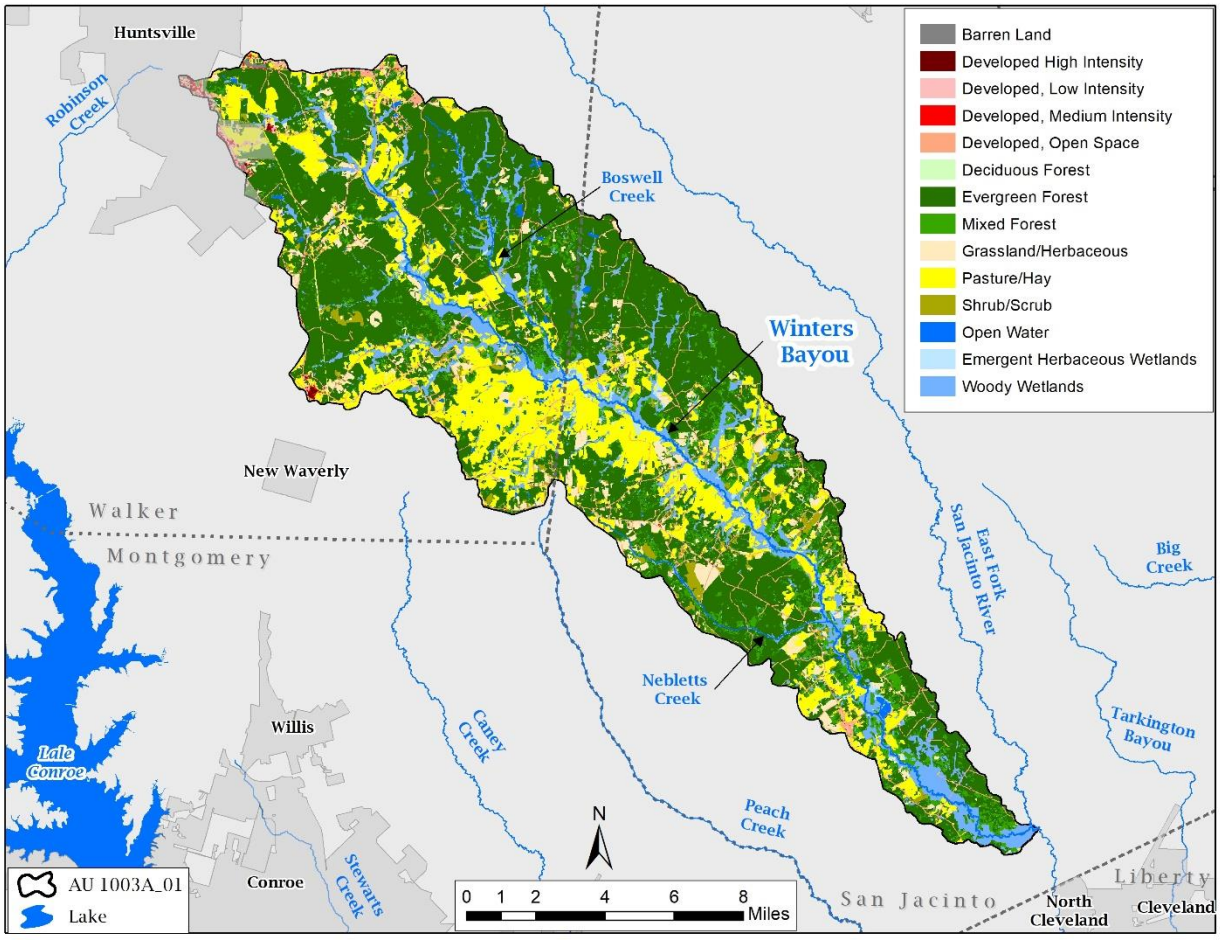

Figure VII-4. Land cover map showing classifications

Table VII-3. Land cover classification by area and percentage

2019 NLCD Land Cover Classifications	Area (Acres)	% of Total
Barren Land	101.12	0.09%
Developed, High Intensity	114.74	0.11%

2019 NLCD Land Cover Classifications	Area (Acres)	% of Total
Developed, Low Intensity	1,294.11	1.18%
Developed, Medium Intensity	332.90	0.30%
Developed, Open Space	3,933.44	3.60%
Deciduous Forest	76.23	0.07%
Evergreen Forest	55,102.45	50.43%
Mixed Forest	7,966.98	7.29%
Grassland/Herbaceous	5,134.01	4.70%
Pasture/Hay	20,258.85	18.54%
Shrub/Scrub	2,596.26	2.38%
Open Water	765.18	0.70%
Emergent Herbaceous Wetlands	556.51	0.51%
Woody Wetlands	11,032.23	10.10%
Total	**109,265.01**	**100%**

Endpoint Identification

The endpoint for the TMDL is to maintain the concentration of *E. coli* below the geometric mean criterion of 126 colony forming units per 100 milliliters (cfu/100 mL), which is protective of the primary contact recreation 1 use in freshwater.

Source Analysis

Pollutants may come from several sources, both regulated and unregulated. Pollutants in regulated discharges, referred to as “point sources,” come from a single definable point, such as a pipe, and are regulated by permit under the Texas Pollutant Discharge Elimination System (TPDES) program. Wastewater treatment facilities (WWTFs) and stormwater discharges from industries, construction activities, and the separate storm sewer systems of cities are considered point sources of pollution.

Unregulated sources are typically nonpoint source in origin, meaning the pollutants originate from multiple locations and rainfall runoff washes them into surface waters. Nonpoint sources are not regulated by permit.

Except for WWTFs, which receive individual wasteload allocations (WLAs; see the Wasteload Allocation section), the regulated and unregulated sources in this section are

presented to give a general account of the different sources of bacteria expected in the watershed. These are not meant to be used for allocating bacteria loads or interpreted as precise inventories and loadings.

Regulated Sources

Regulated sources are controlled by permit under the TPDES program. The regulated sources in the Winters Bayou watershed include one WWTF outfall and stormwater discharges from regulated industrial activities.

Domestic and Industrial WWTFs

As of March 25, 2022, there was one municipal WWTF and one industrial WWTF with TPDES permits within the Winters Bayou watershed (Table VII-4, Figure VII-5).

Table VII-4. TPDES-permitted WWTFs discharging in the Winters Bayou watershed

AU	TPDES Number	NPDES[a] Number	Permittee	Outfall Number	Bacteria Limits (cfu/ 100 mL)	Primary Discharge Type	Daily Average Flow – Permitted Discharge (MGD[b])
1003A_01	WQ0014996001	TX0028169	Universal Forest Products Texas LLC	001	63	Treated domestic wastewater	0.02
1003A_01	WQ0004249000	TX0123421	Steely Lumber Co., Inc.	001	N/A	Wet decking wastewater, utility wastewater, and stormwater	Report

[a] NPDES: National Pollutant Discharge Elimination System

[b] MGD = million gallons per day

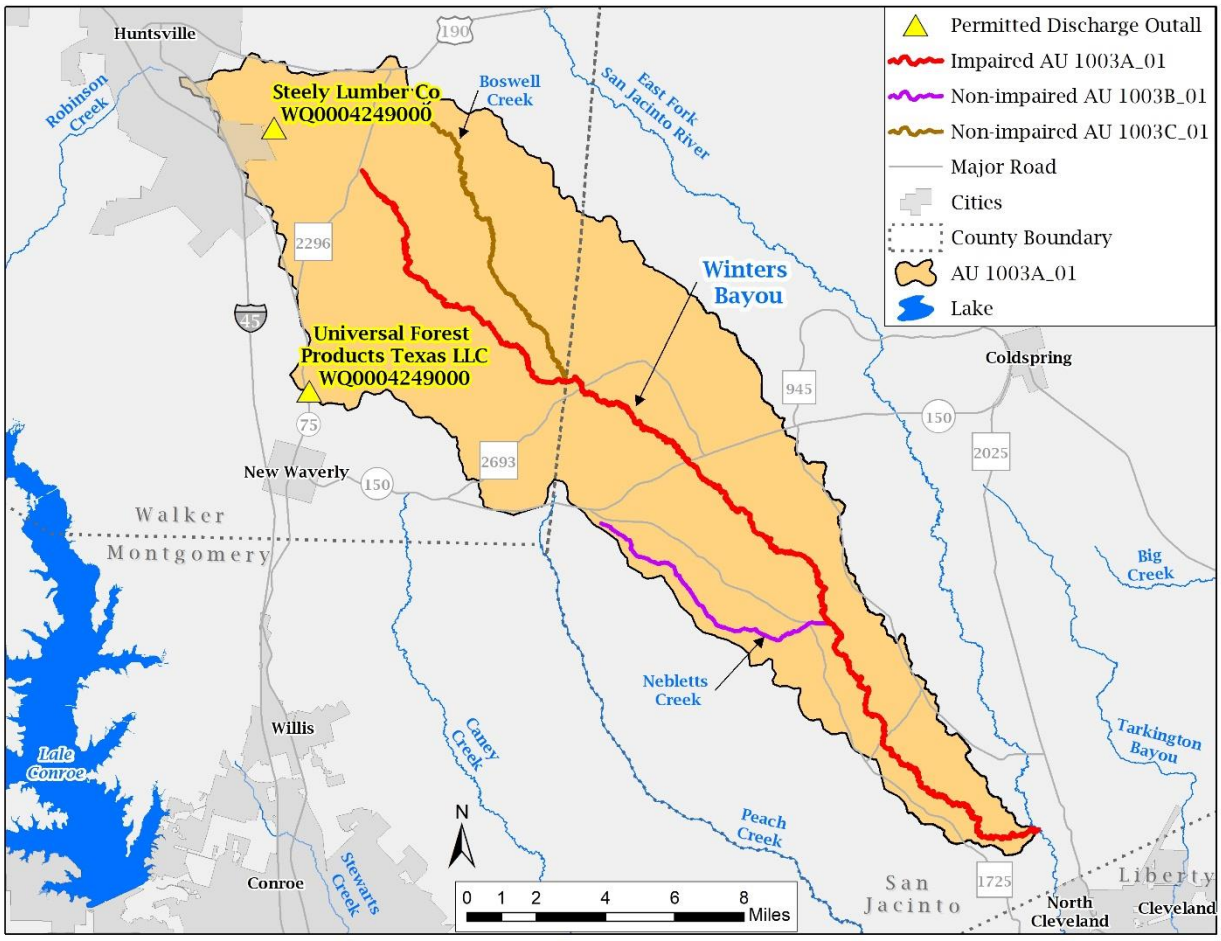

Figure VII-5. WWTFs in the Winters Bayou watershed

TCEQ/TPDES Water Quality General Permits

Certain types of activities are required to be covered by one of several TCEQ/TPDES wastewater general permits:

- TXG110000 – concrete production facilities
- TXG130000 – aquaculture production
- TXG340000 – petroleum bulk stations and terminals
- TXG640000 – conventional water treatment plants
- TXG670000 – hydrostatic test water discharges
- TXG830000 – water contaminated by petroleum fuel or petroleum substances
- TXG870000 – pesticides (application only)
- TXG920000 – concentrated animal feeding operations
- WQG100000 – wastewater evaporation
- WQG200000 – livestock manure compost operations (irrigation only)

A review of active general permit coverage (TCEQ, 2023b) in the Winters Bayou watershed as of January 12, 2023, found one active permit for a concrete production facility. The regulated areas do not have bacteria reporting or limits in their permits. They were assumed to contain inconsequential amounts of bacteria; therefore, it was unnecessary to allocate bacteria loads based on these activities. No other active wastewater general permit authorizations were found.

Sanitary Sewer Overflows

A summary of sanitary sewer overflow (SSO) incidents that occurred during a six-year period from 2016 through 2022 in Walker and San Jacinto counties was obtained from TCEQ Central Office in Austin (TCEQ, 2023c). The summary data indicated that five SSO incidents had been reported within the Winters Bayou watershed. The SSOs had a total discharge of 2,610 gallons, with a minimum of 60 gallons and a maximum of 2,000 gallons.

TPDES-Regulated Stormwater

When evaluating stormwater for a TMDL allocation, a distinction must be made between stormwater originating from an area under a TPDES-regulated discharge permit and stormwater originating from areas not under a TPDES-regulated discharge permit. Stormwater discharges fall into two categories:

1. Stormwater subject to regulation, which is any stormwater originating from TPDES-regulated municipal separate storm sewer system (MS4) entities, stormwater discharges associated with regulated industrial facilities, and construction activities.
2. Stormwater runoff not subject to regulation.

Discharges of stormwater from a Phase II MS4 area, regulated industrial facility, construction area, or other facility involved in certain activities must be covered under the following TCEQ/TPDES general permits:

- TXR040000 – Phase II MS4 General Permit for MS4s located in urbanized areas
- TXR050000 – Multi-sector general permit (MSGP) for industrial facilities
- TXR150000 – Construction general permit (CGP) for construction activities disturbing more than one acre or are part of a common plan of development disturbing more than one acre

A review of active stormwater general permit authorizations (TCEQ, 2023b) in the Winters Bayou watershed as of March 1, 2023 found no active MSGP authorizations or CGP authorizations within the watershed. There are currently no Phase I MS4 permits and no Phase II MS4 authorizations within the Winters Bayou watershed.

Illicit Discharges

Pollutant loads can enter water bodies from MS4 outfalls that carry authorized sources as well as illicit discharges under both dry- and wet-weather conditions. The term "illicit discharge" is defined in TPDES General Permit TXR040000 for Phase II MS4s as "Any discharge to a municipal separate storm sewer system that is not entirely composed of stormwater, except discharges pursuant to this general permit or a separate authorization and discharges resulting from emergency firefighting activities." Illicit discharges can be categorized as either direct or indirect contributions.

Unregulated Sources

Unregulated sources of bacteria are nonpoint and can originate from wildlife and feral hogs, various agricultural activities, agricultural animals, land application fields, urban runoff not covered by a permit, failing on-site sewage facilities (OSSFs), and domestic pets.

Unregulated Agricultural Activities and Domesticated Animals

A number of agricultural activities that do not require permits can be potential sources of fecal bacteria loading. Livestock are present throughout the more rural portions of the project watershed.

Table VII-5 provides estimated numbers of selected livestock in the watershed based on the 2017 Census of Agriculture conducted by U.S. Department of Agriculture (USDA NASS, 2019). The county-level data for San Jacinto and Walker counties were refined to better reflect actual numbers within the Winters Bayou watershed. The refinement was performed by dividing the total area of suitable grazing land in the watershed by the total area of suitable grazing land in San Jacinto and Walker counties. This ratio was then applied to the county-level livestock data. These livestock numbers, however, were not used to develop an allocation of allowable bacteria loading to livestock.

Table VII-5. Estimated livestock populations

AU	Cattle and Calves	Hogs and Pigs	Poultry	Sheep and Lambs	Goats	Horses	Mules and Burros
1003A_01	5,307	58	6,578	149	252	384	74

Fecal bacteria from dogs and cats is transported to water bodies by runoff in both urban and rural areas and can be a potential source of bacteria loading. Table VII-6 summarizes the estimated number of dogs and cats within the Winters Bayou watershed. Pet population estimates were calculated as the estimated number of dogs (0.614) and cats (0.457) per household (AVMA, 2018). The number of households in the

Winters Bayou watershed was estimated using 2010 Census data (USCB, 2010). The actual contribution and significance of bacteria loads from pets reaching the Winters Bayou watershed is unknown.

Table VII-6. Estimated households and pet population

AU	Estimated Households	Estimated Dog Population	Estimated Cat Population
1003A_01	2,931	1,800	1,339

Wildlife and Unmanaged Animals

Fecal bacteria are common inhabitants of the intestines of all warm-blooded animals, including wildlife such as mammals and birds. In developing bacteria TMDLs, it is important to identify by watershed the potential for bacteria contributions from wildlife. Wildlife are naturally attracted to riparian corridors of water bodies. With direct access to the stream channel, the direct deposition of wildlife waste can be a concentrated source of bacteria loading to a water body. Fecal bacteria from wildlife are also deposited onto land surfaces, where they may be washed into nearby water bodies by rainfall runoff.

For feral hogs, a study by Timmons et al. (2012) estimated a range of feral hog densities within suitable habitat in Texas from 8.9 to 16.4 hogs per square mile. The average hog density (12.65 hogs/square mile) was multiplied by the hog-habitat area of 159.64 square miles in the Winters Bayou watershed. Habitat deemed suitable for hogs includes the following classifications from the 2019 NLCD land cover: Forest, Wetlands, Pasture/Hay, Shrub/Scrub, and Grassland/Herbaceous. Using this methodology, the estimated feral hog population is 2,019 in the Winters Bayou watershed.

For deer, the Texas Parks and Wildlife Department (TPWD) has published data showing deer population-density estimates by Deer Management Unit (DMU) and Ecoregion in the state (TPWD, 2023). The Winters Bayou watershed is located entirely within DMU 14. For the 2022 TPWD survey year, the estimated deer population density for DMU 14 was 25.61 deer per 1,000 acres and applies to all habitat types within the DMU. Applying this value to the entire area of the Winters Bayou watershed returns an estimated 2,798 deer within the Winters Bayou watershed. The *E. coli* contribution from feral hogs and wildlife in the TMDL watershed could not be determined based on existing information.

On-site Sewage Facilities

The estimated number of OSSFs in the Winters Bayou watershed was determined using data supplied by San Jacinto County 911 for San Jacinto County and Walker County data

was supplied by the Houston-Galveston Area Council. Data from these sources indicate that there are approximately 2,633 OSSFs located within the Winters Bayou watershed (Figure VII-6). Several pathways of the liquid waste in OSSFs afford opportunities for bacteria to enter ground and surface waters, if the systems are not properly operating. Properly designed and operated, however, OSSFs would be expected to contribute virtually no fecal bacteria to surface waters.

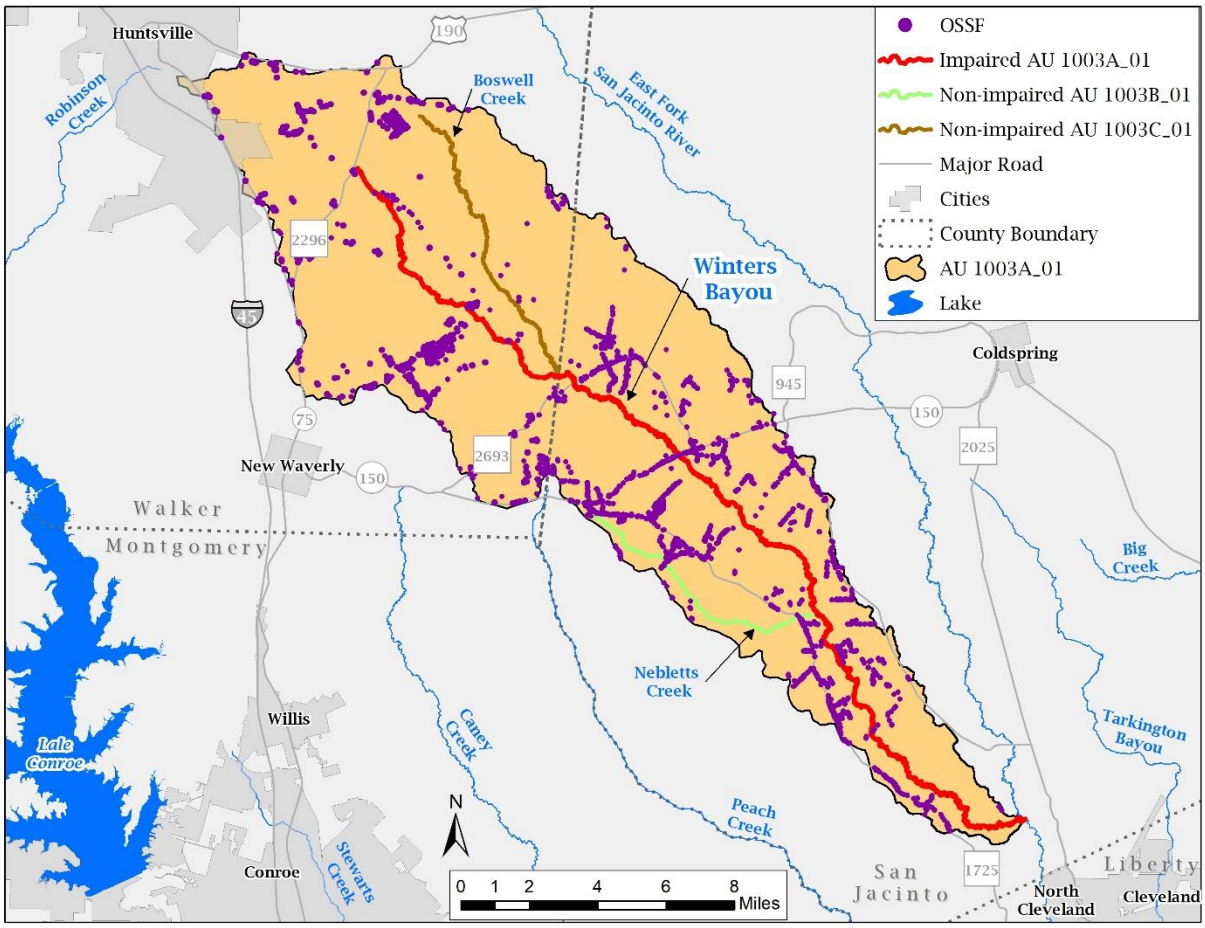

Figure VII-6. Estimated OSSFs located within the Winters Bayou watershed

Linkage Analysis

The load duration curve (LDC) method was used to examine the relationship between instream water quality and the source of indicator bacteria loads. Inherent to the use of LDCs as the mechanism of linkage analysis is the assumption of a one-to-one relationship between instream loadings and loadings originating from point sources as regulated and from the landscape as unregulated sources. Further, this one-to-one relationship was also inherently assumed when using the LDC to define the TMDL pollutant load allocation. The LDC method allows for estimation of TMDL loads by

utilizing the cumulative frequency distribution of streamflow and measured pollutant concentration data (Cleland, 2003). In addition to estimating stream loads, this method allows for the determination of the hydrologic conditions under which impairments are typically occurring, can give indications of the broad origins of the bacteria (i.e., point or nonpoint source), and provides a means to allocate allowable loadings. The technical support document for this addendum (Adams and Millican, 2024) provides details about the linkage analysis along with the LDC method and its application.

The *E. coli* event data plotted on the LDC for TCEQ SWQM Station 21417 in Figure VII-7 show exceedances of the geometric mean criterion in wet conditions and were mostly below the geometric mean criterion in both moderate and dry conditions. The allowable load at the single sample criterion (399 cfu/100 mL) is included on the LDC for comparison with individual *E. coli* samples, although it is not used for assessment or allocation purposes.

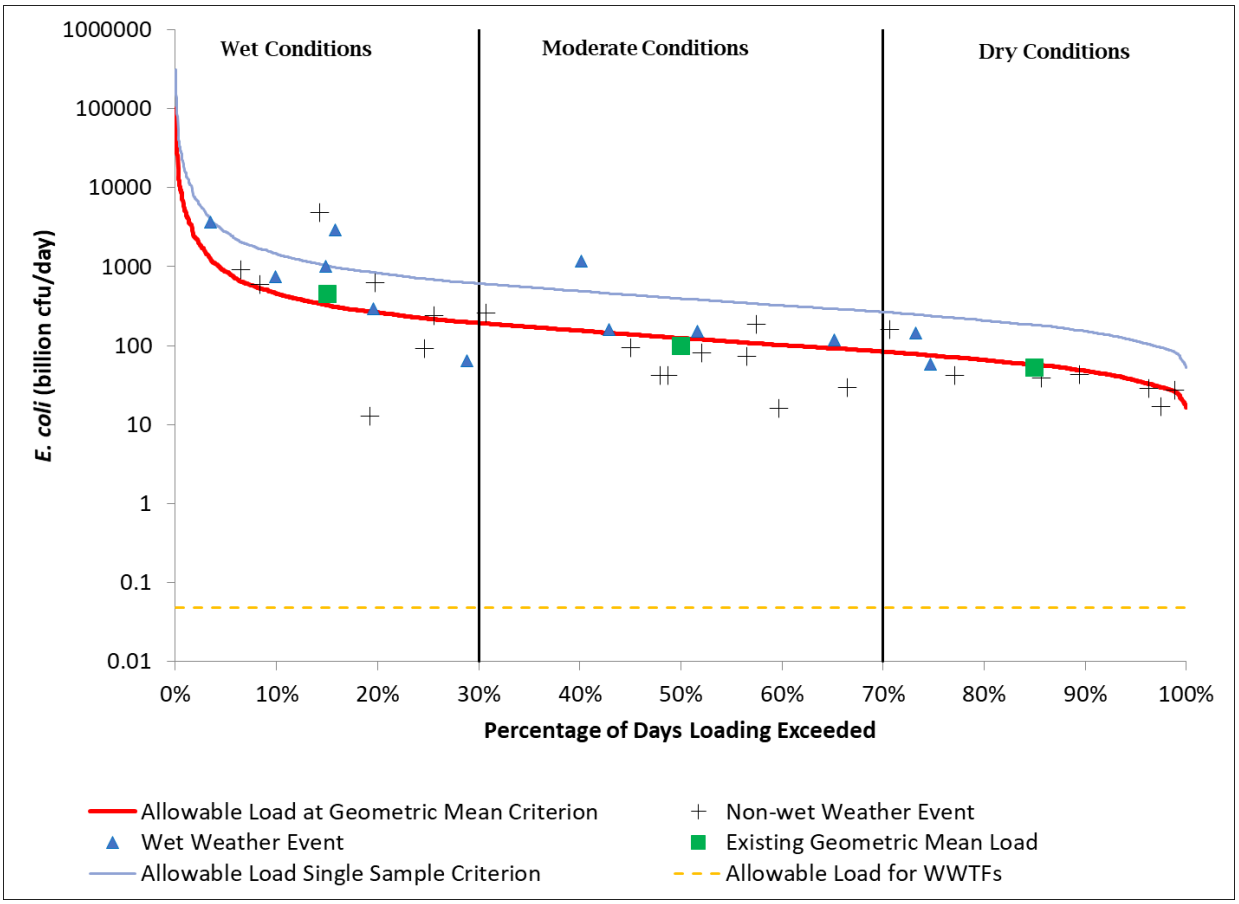

Figure VII-7. LDC for TCEQ SWQM Station 21417

Margin of Safety

The margin of safety (MOS) is designed to account for any uncertainty that may arise in specifying water quality control strategies for the complex environmental processes that affect water quality. Quantification of this uncertainty, to the extent possible, is the basis for assigning an MOS. The TMDL in this report incorporates an explicit MOS of 5% of the total TMDL allocation.

Pollutant Load Allocation

The TMDL represents the maximum amount of a pollutant that the stream can receive in a single day without exceeding water quality standards. The pollutant load allocations for the selected scenarios were calculated using the following equation:

TMDL = WLA + LA + FG + MOS

Where:

WLA = wasteload allocations, the amount of pollutant allowed by regulated dischargers

LA = load allocations, the amount of pollutant allowed by unregulated sources

FG = loadings associated with future growth from potential regulated facilities

MOS = margin of safety load

For the remainder of this report some calculations have been rounded and may not lead to the exact final amounts listed in the text, tables, or figures.

AU-Level TMDL Calculation

To be consistent with previously completed TMDLs in the original watershed, the TMDL for Winters Bayou was derived using the median flow within the wet conditions flow regime (or 15% load duration exceedance) of the LDC developed for TCEQ SWQM Station 21417. This station represents the location within Winters Bayou where an adequate number of *E. coli* samples was collected.

Margin of Safety Calculation

The TMDL in this report incorporates an explicit MOS of 5%.

Wasteload Allocation

The WLA is the sum of loads from regulated sources, which are WWTFs and regulated stormwater.

Wastewater Treatment Facilities

TPDES-permitted WWTFs are allocated a daily wasteload (WLA_{WWTF}) calculated as their full permitted discharge flow rate multiplied by one-half the instream geometric mean criterion. One-half of the water quality criterion (63 cfu/100 mL *E. coli*) is used as the WWTF target to provide instream and downstream load capacity and to be consistent with the original TMDL report. Table VII-7 presents the WLA_{wwtf} and the resulting total allocation for Winters Bayou (AU 1003A_01).

Table VII-7. WLAs for TPDES-permitted facilities

AU	TPDES Number	Permittee	Bacteria Limit (cfu/100 mL *E. coli*)	Full Permitted Flow (MGD)	WLA_{WWTF} (billion cfu/day *E. coli*)
1003A_01	WQ0014996001	Universal Forest Products TX LLC	63	0.02	0.048

Regulated Stormwater

Stormwater discharges from MS4, industrial, and construction areas are also considered regulated point sources. Therefore, the WLA calculations must also include an allocation for regulated stormwater discharges (WLA_{SW}). The percentage of the land area included in the project watershed that is under the jurisdiction of stormwater permits is used to estimate the amount of the overall runoff load that should be allocated as the permitted stormwater contribution in the WLA_{SW} component.

There are no MS4 permits in the Winters Bayou watershed. The acreage associated with the general stormwater permit for one concrete production facility was estimated by importing the location information associated with the facility into a geographic information system, and measuring the estimated disturbed area based on the most recently available aerial imagery. For this TMDL, the area disturbed associated with the concrete production facility represents the regulated stormwater coverage for Winters Bayou AU 1003A_01, which is about 0.0006% of the watershed.

Load Allocation

The load allocation (LA) component of the TMDL corresponds to direct nonpoint runoff and is the difference between the total load from stormwater runoff and the portion allocated to WLA_{SW}.

Allowance for Future Growth

The future growth (FG) component of the TMDL equation addresses the requirement of TMDLs to account for future loadings that might occur as a result of population growth,

changes in community infrastructure, and development. Specifically, this TMDL component takes into account the probability that new flows from WWTF discharges may occur in the future. The assimilative capacity of water bodies increases as the amount of flow increases. The allowance for FG in this TMDL report will result in protection of existing uses and conform to Texas' antidegradation policy.

The FG component of the TMDL watershed was based on the population projections for the entire TMDL watershed. Recent population and projected population growth between 2020 and 2070 for the TMDL watershed are provided in Table VII-2. The projected population percentage increase within the watershed was multiplied by the corresponding WLA_{WWTF} to calculate future WLA_{WWTF}. The permitted flows were increased by the expected population growth for AU 1003A_01 between 2020 and 2070 to determine the estimated future flows.

FG of existing or new point sources is not limited by this TMDL as long as the sources do not cause bacteria to exceed the limits. The assimilative capacity of water bodies increases as the amount of flow increases. Consequently, increases in flow allow for increased loadings. The LDC and tables in this TMDL report will guide determination of the assimilative capacity of the water body under changing conditions, including FG.

Summary of TMDL Calculations

Table VII-8 summarizes the TMDL calculations for the Winters Bayou watershed. The TMDL was calculated based on the median flow in the 0-30 percentile range (15% exceedance, wet conditions flow regime) from the LDC developed for the TCEQ SWQM Station 21417. Allocations are based on the current geometric mean criterion for *E. coli* of 126 cfu/100 mL for each component of the TMDL (with the exception of the WLA_{WWTF} and FG terms, which use one-half the criterion).

Table VII-8. TMDL allocation summary

All loads expressed as billion cfu/day *E. coli*

Water Body	AU	TMDL	MOS	WLA_{WWTF}	WLA_{SW}	LA	FG
Winters Bayou	1003A_01	326.567	16.328	0.048	0.186	310.000	0.005

The final TMDL allocations (Table VII-9) needed to comply with federal requirements include the FG component within the WLA_{WWTF} (40 CFR Section 103.7).

Table VII-9. Final TMDL allocation

All loads expressed as billion cfu/day *E. coli*

Water Body	AU	TMDL	MOS	WLA_{WWTF}	WLA_{SW}	LA
Winters Bayou	1003A_01	326.567	16.328	0.053	0.186	310.000

Seasonal Variation

Federal regulations require that TMDLs account for seasonal variation in watershed conditions and pollutant loading [40 CFR Section 130.7(c)(1)]. Analysis of the seasonal differences in indicator bacteria concentrations were assessed by comparing *E. coli* concentrations obtained from nine years (2013 through 2022) of routine monitoring data collected in the warmer months (May through September) against those collected during the cooler months (November through March). The months of April and October were considered transitional between warm and cool seasons and were excluded from the seasonal analysis. Differences in *E. coli* concentrations obtained in warmer versus cooler months were then evaluated by performing a Wilcoxon Rank Sum test (also known as the "Mann-Whitney" test). This analysis of *E. coli* data indicated that there was no significant difference (α=0.05) in indicator bacteria between cool and warm weather seasons for Winters Bayou. Seasonal variation was also addressed by using all available flow and indicator bacteria records (covering all seasons) from the period of record used in LDC development for this project.

Public Participation

TCEQ maintains an inclusive public participation process. From the inception of TMDL development, the project team sought to ensure that stakeholders were informed and involved. Communication and comments from the stakeholders in the watershed strengthen TMDL projects and their implementation.

The technical support document for this TMDL addendum (Adams and Millican, 2024) was published on the TCEQ website on March 6, 2024. Project staff presented information about this addendum at the annual spring meeting of the H-GAC Bacteria Implementation Group in Houston, Texas on May 23, 2023. The public had an opportunity to comment on this addendum during the public comment period (May 10 through June 11, 2024) for the WQMP update in which this addendum is included. Notice of the public comment period for this addendum was emailed to stakeholders and posted on the TCEQ's TMDL Program News webpage.[5] Notice of the comment period, along with the document, was also posted on the WQMP Updates webpage.[6] TCEQ accepted public comments on the original TMDL report from June 18 through July 19, 2010. No comments were submitted.

[5] www.tceq.texas.gov/waterquality/tmdl/tmdlnews.html
[6] www.tceq.texas.gov/permitting/wqmp/WQmanagement_updates.html

Implementation and Reasonable Assurance

The water body covered by this addendum is within the existing bacteria TMDL watershed for the East and West Fork of the San Jacinto River. That TMDL watershed, including Winters Bayou, is within the area covered by the I-Plan developed by stakeholders for the TMDL watershed, which was approved by the Commission on January 30, 2013. The I-Plan outlines an adaptive management approach in which measures are assessed annually by the stakeholders for efficiency and effectiveness. The iterative process of evaluation and adjustment ensures continuing progress toward achieving water quality goals and expresses stakeholder commitment to the process. Please refer to the original TMDL document for additional information regarding implementation and reasonable assurance.

References

Adams, Todd, and Jimmy Millican. Texas Institute for Applied Environmental Research. 2024. Technical Support Document for One Total Maximum Daily Load for Indicator Bacteria in Winters Bayou. Austin: Texas Commission on Environmental Quality (AS-488). Online. www.tceq.texas.gov/downloads/water-quality/tmdl/houston-galveston-recreational-42/as-488_winters_bayou_add_tsd_draft.pdf/.

AVMA [American Veterinary Medical Association]. 2018. 2017–2018 U.S. Pet Ownership Statistics. www.avma.org/resources-tools/reports-statistics/us-pet-ownership-statistics.

Cleland, B. 2003. TMDL Development From the "Bottom Up" — Part III: Duration Curves and Wet-Weather Assessments. www.researchgate.net/publication/228822472_TMDL_Development_from_the_Bottom_Up-_PART_III_Durations_Curves_and_Wet-Weather_Assessments.

Larkin, Thomas J., G. Bomar. 1983. Climatic Atlas of Texas. LP-192. Texas Department of Water Resources. www.twdb.texas.gov/publications/reports/limited_printing/doc/LP192.pdf.

NOAA. 2022. Station USW00053902, Conroe North Houston Regional Airport TX, US. Retrieved Apr. 22, 2022, from National Climatic Data Center: www.ncdc.noaa.gov/cdo-web/search.

TCEQ. 2016. Seven Total Maximum Daily Loads for Indicator Bacteria in Lake Houston, East Fork San Jacinto River, West Fork San Jacinto River, and Crystal Creek Watersheds. www.tceq.texas.gov/downloads/water-quality/tmdl/houston-galveston-recreational-42/82b-ewfsjr-tmdl-adopted.pdf

TCEQ. 2018. Addendum One to Seven Total Maximum Daily Loads for Indicator Bacteria in Lake Houston, East Fork San Jacinto River, West Fork San Jacinto River, and Crystal Creek Watersheds: One Total Maximum Daily Load for Indicator Bacteria in Mound Creek. www.tceq.texas.gov/downloads/water-quality/tmdl/houston-galveston-recreational-42/82c-ewfsj-bacteria-tmdl-addendum-one.pdf

TCEQ. 2022a. 2022 Texas Integrated Report of Surface Water Quality for Clean Water Act Sections 305(b) and 303(d). Retrieved May 5, 2023, from: www.tceq.texas.gov/waterquality/assessment/22twqi/22txir

TCEQ. 2022b. Texas Surface Water Quality Standards, Title 30 Texas Administrative Code 307. texreg.sos.state.tx.us/public/readtac%24ext.ViewTAC?tac_view=4&ti=30&pt=1&ch=307&rl=Y.

TCEQ. 2023a. Addendum Two to Seven Total Maximum Daily Loads for Indicator Bacteria in Lake Houston, East Fork San Jacinto River, West Fork San Jacinto River, and Crystal Creek Watersheds: One Total Maximum Daily Load for Indicator Bacteria in White Oak Creek. www.tceq.texas.gov/downloads/water-quality/tmdl/houston-galveston-recreational-42/82g-ewfsj-bacteria-tmdl-addendum02-2023jan.pdf

TCEQ. 2023b. Water Quality and General Permits & Registration Search. Retrieved Jan. 12, 2023 from: www2.tceq.texas.gov/wq_dpa/index.cfm.

TCEQ. 2023c. Statewide SSO Report Jan. 2016 – Dec. 2022. Personal communication with Nicole Reed. Received Apr. 5, 2023.

Timmons J., Higginbotham B., Lopez R., Cathey J., Mellish J., Griffin J, Sumrall A., Skow, K. 2012. *Feral Hog Population Growth, Density and Harvest in Texas*. agrilife.org/bexarcounty/files/2012/07/ESP-472-Feral-Hog-Population-Growth-Density-Harvest-in-Texas.pdf.

TPWD. 2023. White-tailed Deer (WTD) Federal Aid Report 2022 Charts and Tables. Personal communication from A. Cain received Apr. 17, 2023.

TWDB. 2021. Complete Regional Population Projections by Water User Group. 2021 Regional Water Plan Population and Water Demand Projection. Retrieved Nov. 28, 2022 from www.twdb.texas.gov/waterplanning/data/projections/2022/popproj.asp.

USCB. 2010. 2010 Census Block Shapefiles. Retrieved Nov. 28, 2022: www.census.gov/cgi-bin/geo/shapefiles/index.php; Tabular data from 2010 Census Block Households and Families. Retrieved Nov. 28, 2022, from data.census.gov/cedsci/.

USCB. 2021. 2020 Census Block Shapefiles. Retrieved Apr. 20, 2023, from: www.census.gov/cgi-bin/geo/shapefiles/index.php; Tabular data from 2020 Census Block Redistricting Data (PL 94-171). Retrieved Apr. 20, 2023, from: data.census.gov/cedsci/.

USDA NASS [National Agricultural Statistics Service]. 2019. State and County Data, Volume 1, Part43A, Inventory and Sales (2017 Census). Retrieved Jan. 12, 2023, from: www.nass.usda.gov/Publications/AgCensus/2017/Full_Report/Census_by_State/index.php.

USGS. 2021. National Land Cover Database 2019 Land Cover Conterminous United States. Retrieved Feb. 23, 2023, from: www.mrlc.gov/data?f%5B0%5D=year%3A2019.