Adopted: July 19, 2023
AS-466
Approved by EPA October 11, 2023

Four Total Maximum Daily Loads for Indicator Bacteria in Neches River Tidal

Assessment Units 0601_01, 0601_02, 0601_03, and 0601_04

Water Quality Planning Division, Office of Water
TEXAS COMMISSION ON ENVIRONMENTAL QUALITY

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The preparation of this report was financed in part through grants from
the United States Environmental Protection Agency.

This total maximum daily load report is based in large part on the report titled:
"Technical Support Document for Four Total Maximum Daily Loads
for Indicator Bacteria in Neches River Tidal,"
by Michael Schramm of the Texas Water Resources Institute.

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Abbreviations

AU	assessment unit
BMP	best management practice
CCN	certificate of convenience and necessity
CFR	Code of Federal Regulations
cfs	cubic feet per second
cfu	colony forming units
CGP	construction general permit
E. coli	*Escherichia coli*
EPA	Environmental Protection Agency (United States)
FDC	flow duration curve
FG	future growth
GIS	geographic information system
I-Plan	implementation plan
LA	load allocation
LDC	load duration curve
MCM	minimum control measure
MGD	million gallons per day
mL	milliliter
MOS	margin of safety
MS4	municipal separate storm sewer system
MSGP	multi-sector general permit
NLCD	National Land Cover Database
NOAA	National Oceanic and Atmospheric Administration
NPDES	National Pollutant Discharge Elimination System
NRCS	Natural Resources Conservation Service
OSSF	on-site sewage facility
SSO	sanitary sewer overflow
SSURGO	Soil Survey Geographic
SWMP	Stormwater Management Program
SWQM	surface water quality monitoring
TAC	Texas Administrative Code
TCEQ	Texas Commission on Environmental Quality

TMDL	total maximum daily load
TPDES	Texas Pollutant Discharge Elimination System
TPWD	Texas Parks and Wildlife Department
TSSWCB	Texas State Soil and Water Conservation Board
TWDB	Texas Water Development Board
TWRI	Texas Water Resources Institute
UA	urbanized area
U.S.	United States
USCB	U.S. Census Bureau
USDA	U.S. Department of Agriculture
USGS	U.S. Geological Survey
WLA	wasteload allocation
WQBELs	water quality-based effluent limits
WQMP	Water Quality Management Plan
WWTF	wastewater treatment facility

Executive Summary

This report describes total maximum daily loads (TMDLs) for Neches River Tidal, where concentrations of indicator bacteria exceed the criterion used to evaluate attainment of the primary contact recreation 1 use. The Texas Commission on Environmental Quality (TCEQ) first identified the impairments to Neches River Tidal in the *2012 Texas Integrated Report of Surface Water Quality for Clean Water Act Sections 305(b) and 303(d)* (Texas Integrated Report, TCEQ, 2013).

This report will consider four bacteria impairments in four assessment units (AUs) of Neches River Tidal. The impaired water body and identifying AUs are:

- Neches River Tidal (AUs 0601_01, 0601_02, 0601_03, and 0601_04)

The Neches River Tidal is located along the East Texas Gulf Coast and forms the boundary between Jefferson and Orange counties. The Neches River Tidal begins at the Neches River Saltwater Barrier and flows for about 30 miles to its termination into Sabine Lake. The Neches River Tidal watershed is just under 211 square miles and includes portions of Jasper, Orange, and Jefferson counties.

Enterococci are widely used as indicator bacteria to determine attainment of the contact recreation use in saltwater. The criterion for determining attainment of the contact recreation use is expressed as the number of bacteria, typically given as colony forming units (cfu) in 100 milliliters (mL) of water. The primary contact recreation 1 use is not supported in saltwater when the geometric mean of all samples for the assessment period exceeds 35 cfu per 100 mL.

Within the Neches River Tidal watershed, sources of bacteria include domestic and industrial wastewater treatment facilities (WWTFs), regulated stormwater runoff, sanitary sewer overflows (SSOs), illicit discharges, on-site sewage facilities (OSSFs), agricultural activities, and contributions from wildlife and domesticated animals.

A review of the TCEQ Central Registry for active permits found 29 permitted domestic and industrial WWTFs in the Neches River Tidal watershed. Nine of them have effluent limits for bacteria. There were also 10 Phase II municipal separate storm sewer system (MS4) authorizations, two Phase I MS4 permits, and 34 Multi-Sector General Permit (MSGP) authorizations with stormwater discharges. Approximately 23% (49 square miles) of the watershed was regulated under stormwater permits.

A modified load duration curve (LDC) analysis was done for the TMDL watershed to quantify allowable pollutant loads, as well as TMDL allocations for point and nonpoint sources of bacteria. Wasteload allocations (WLAs) were

established for WWTFs discharging to the AUs. The WLA was calculated as the full permitted daily-average flow rate multiplied by the instream geometric mean criterion. Future growth (FG) of existing or new domestic point sources was determined for the TMDL watershed using population growth projections.

The TMDL calculations in this report will guide determination of the assimilative capacity of each water body under changing conditions, including FG. WWTFs will be evaluated case by case.

Compliance with these TMDLs is based on keeping indicator bacteria concentrations, Enterococci, in the Neches River Tidal below the geometric mean criterion of 35 cfu per 100 mL for attainment of the primary contact recreation 1 use.

Introduction

Section 303(d) of the federal Clean Water Act requires all states to identify waters that do not meet, or are not expected to meet, applicable water quality standards. States must develop a TMDL for each pollutant that contributes to the impairment of a water body included on a state's 303(d) list of impaired waters. TCEQ is responsible for ensuring that TMDLs are developed for impaired surface waters in Texas.

A TMDL is like a budget—it determines the amount of a particular pollutant that a water body can receive and still meet applicable water quality standards. TMDLs are the best possible estimates of the assimilative capacity of the water body for a pollutant under consideration. A TMDL is commonly expressed as a load with units of mass per period of time, but may be expressed in other ways.

The TMDL Program is a major component of Texas' overall process for managing the quality of its surface waters. The program addresses impaired or threatened streams, reservoirs, lakes, bays, and estuaries (water bodies) in, or bordering on, the state of Texas. The program's primary objective is to restore and maintain water quality uses—such as drinking water supply, recreation, support of aquatic life, or fishing—of impaired or threatened water bodies.

This TMDL report addresses impairments to the primary contact recreation 1 use due to elevated levels of indicator bacteria in Neches River Tidal (Segment 0601). These TMDLs take a watershed approach to addressing indicator bacteria impairments. While TMDL allocations were developed only for the impaired AUs identified in this report, the entire project watershed and all WWTFs that discharge within it are included within the scope of this TMDL report. Information in this report was derived from the *Technical Support Document for*

Four Total Maximum Daily Loads for Indicator Bacteria in Neches River Tidal (Schramm and Jha, 2020)[1].

Section 303(d) of the Clean Water Act and the implementing regulations of the United States (U.S.) Environmental Protection Agency (EPA) in Title 40 of the Code of Federal Regulations (CFR), Chapter 1, Part 130 (40 CFR 130) describe the statutory and regulatory requirements for acceptable TMDLs. EPA provides further direction in its *Guidance for Water Quality-Based Decisions: The TMDL Process* (EPA, 1991). This TMDL report has been prepared in accordance with those regulations and guidelines.

TCEQ must consider certain elements in developing a TMDL. They are described in the following sections of this report:

- Problem Definition
- Endpoint Identification
- Source Analysis
- Linkage Analysis
- Margin of Safety
- Pollutant Load Allocation
- Seasonal Variation
- Public Participation
- Implementation and Reasonable Assurance

Upon adoption of the TMDL report by the commission and subsequent EPA approval, these TMDLs will become an update to the state's Water Quality Management Plan (WQMP).

Problem Definition

TCEQ first identified the impairments of the primary contact recreation 1 use of Neches River Tidal AUs 0601_02, 0601_03, and 0601_04 in the 2012 Texas Integrated Report (TCEQ, 2013). The impairment of the primary contact recreation 1 use of AU 0601_01 was first identified in the 2014 Texas Integrated Report (TCEQ, 2015). The AU impairments were identified in each subsequent edition through the EPA-approved 2022 Texas Integrated Report (TCEQ, 2022). The term TMDL watershed will be used to describe the combined area of the four AU watersheds depicted in Figure 1.

Recent surface water Enterococci monitoring within the TMDL watershed has occurred for all the impaired AUs (Table 1). Enterococci data collected from

[1] www.tceq.texas.gov/downloads/water-quality/tmdl/neches-river-tidal-recreational-118/118-as-471-neches-tidal-bacteria-tsd-2020-july.pdf

December 1, 2011 through November 30, 2018, were used to determine attainment of the primary contact recreation 1 use as reported in the 2022 Texas Integrated Report (TCEQ, 2022). Data assessed indicate non-support of the primary contact recreation 1 use because the geometric mean concentrations of available samples exceed the geometric mean criterion of 35 cfu/100 mL for Enterococci.

Table 1. 2022 Texas Integrated Report Summary for the impaired AUs

Water Body	AU	Parameter	TCEQ SQWM Station	Data Range	Number of Samples	Geometric Mean (cfu/100 mL)
Neches River Tidal	0601_04	Enterococci	10575, 20774	12/01/2013 – 11/30/2020	47	67.89
Neches River Tidal	0601_03	Enterococci	10570	12/01/2013 – 11/30/2020	25	97.59
Neches River Tidal	0601_02	Enterococci	10566	12/01/2013 – 11/30/2020	26	57.61
Neches River Tidal	0601_01	Enterococci	10563	12/01/2013 – 11/30/2020	26	40.98

Watershed Overview

The Neches River Tidal watershed is 210.75 square miles and is located along the East Texas Gulf Coast (Figure 1). The Neches River Tidal flows approximately 30 miles along the boundary between Jefferson and Orange counties, from the Neches River Saltwater Barrier into Sabine Lake. The saltwater barrier was constructed in 2003 and prevents saltwater from intruding upstream of the segment during low flows.

Parts of the watershed are highly urbanized and include portions of the cities of Beaumont, Port Arthur, and Port Neches. The watershed is flat and low-lying and has been highly modified with canals and levees to facilitate development and control flood risk. The lower 20 miles of the Neches River Tidal south of Interstate 10 has been deepened and is maintained as a deep-water ship channel serving multiple ports and industrial terminals along the segment. The Neches River Tidal consists of a single classified Segment (0601) and four AUs (0601_01, 0601_02, 0601_03, and 0601_04).

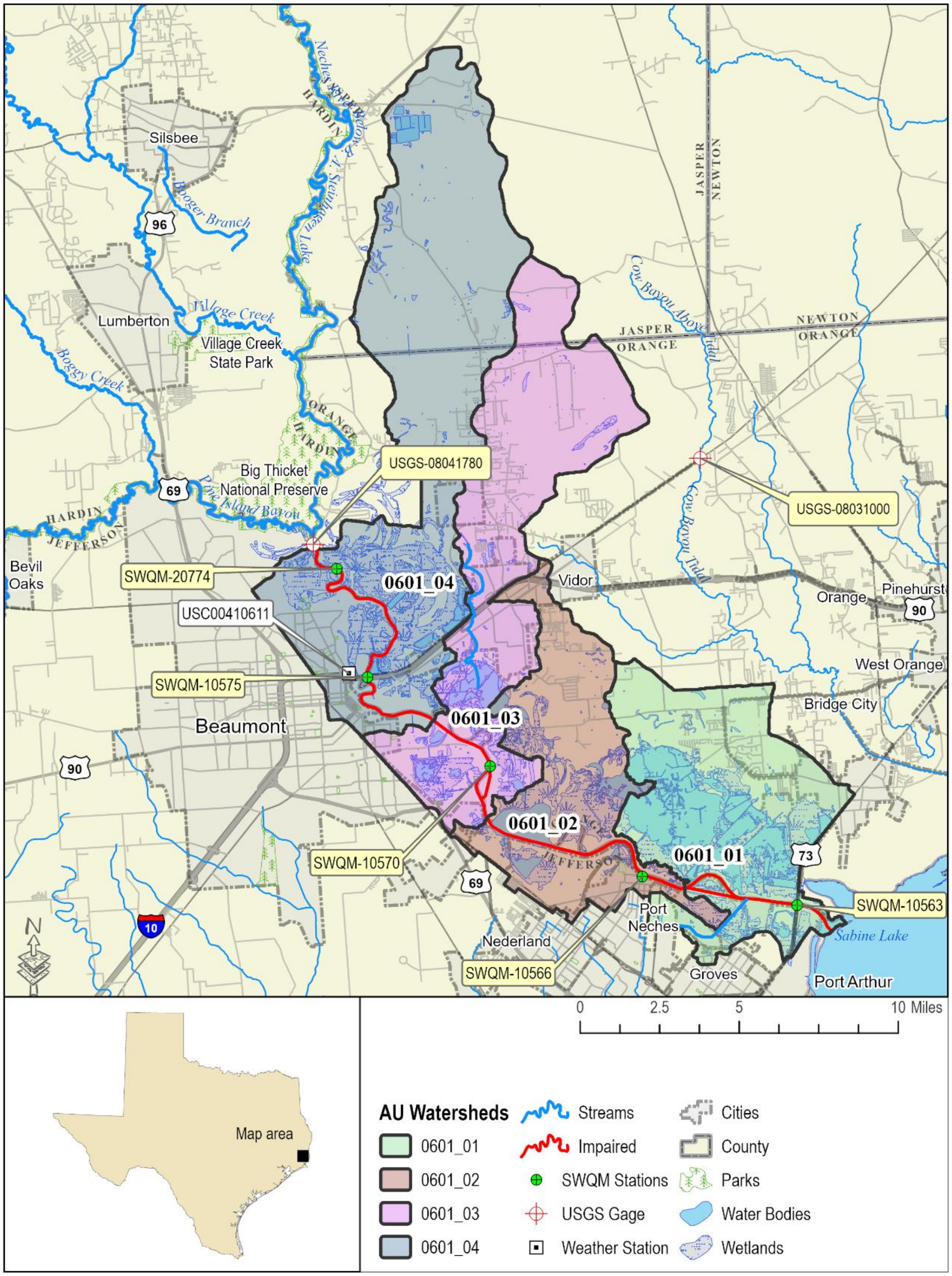

Figure 1. Map of the TMDL watershed

The 2022 Texas Integrated Report (TCEQ, 2022) provides the following AU descriptions for the water bodies considered in this document:

- Segment 0601 (Neches River Tidal) – From the confluence with Sabine Lake in Orange County to the Neches River Saltwater Barrier, which is at a point 0.8 kilometers (0.5 miles) downstream of the confluence of Pine Island Bayou, in Orange County.
  - AU 0601_04 – Top of last oxbow below Kansas City Southern Railroad bridge to saltwater barrier at National Hydrography Dataset reach code 12020003000017.
  - AU 0601_03 – Top of the U.S. National Defense Reserve Fleet Basin to top of last oxbow below Kansas City Southern Railroad bridge 0.44 kilometers upstream of National Hydrography Dataset reach code 12020003000013.
  - AU 0601_02 – Top of first oxbow to top of the U.S. National Defense Reserve Fleet Basin at top of National Hydrography Dataset reach code 12020003008459.
  - AU 0601_01 – Lower boundary to top of first oxbow, above Bird Island Bayou confluence at National Hydrography Dataset reach code 12020003000004.

Climate and Hydrology

Precipitation and temperature data for the period of 2002 through 2018 were retrieved from the National Oceanic and Atmospheric Administration's (NOAA's) National Climatic Data Center for Beaumont Station USC00410611 (NOAA, 2019), located in the upstream portion of the watershed. The highest average monthly precipitation occurs in August at 7.36 inches and the lowest average monthly precipitation occurs in April at 3.82 inches (Figure 2). The highest average monthly maximum temperatures occur in August (93.1˚ F) and the lowest average monthly minimum temperatures occur in January (43.0˚ F). The average annual precipitation was 63.9 inches, with a low of 34 inches occurring in 2011 and high of 93.4 inches occurring in 2017 (Figure 3).

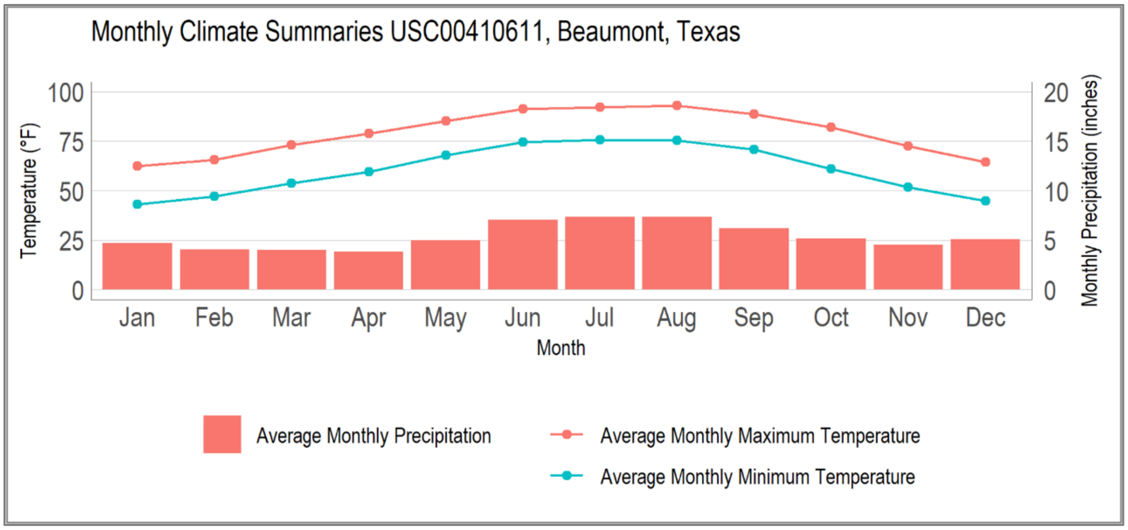

Figure 2. Average monthly temperature and precipitation from January 2002 through December 2018 at Beaumont, Texas Station USC00410611

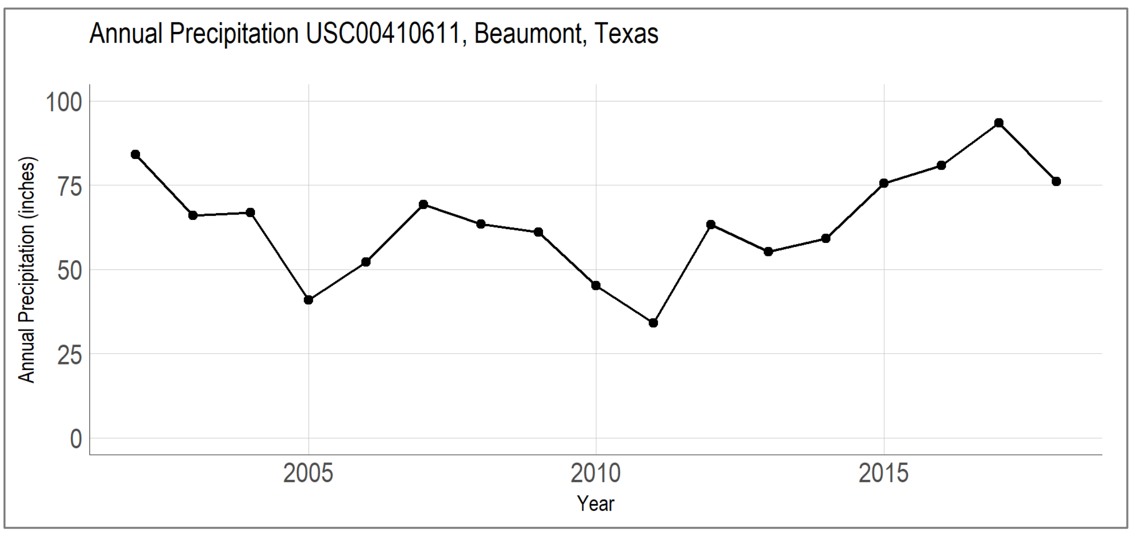

Figure 3. Annual precipitation from 2002 through 2018 at Beaumont, Texas Station USC00410611

Population and Population Projections

Watershed population estimates were developed using 2010 United States Census Bureau (USCB) census block geographic units and population data (USCB, 2010a). Census blocks are the smallest geographic units used by USCB to tabulate population data. Using the methodology outlined in Appendix A, the TMDL watershed 2010 population is estimated at 49,837 people (Figure 4, Table 2).

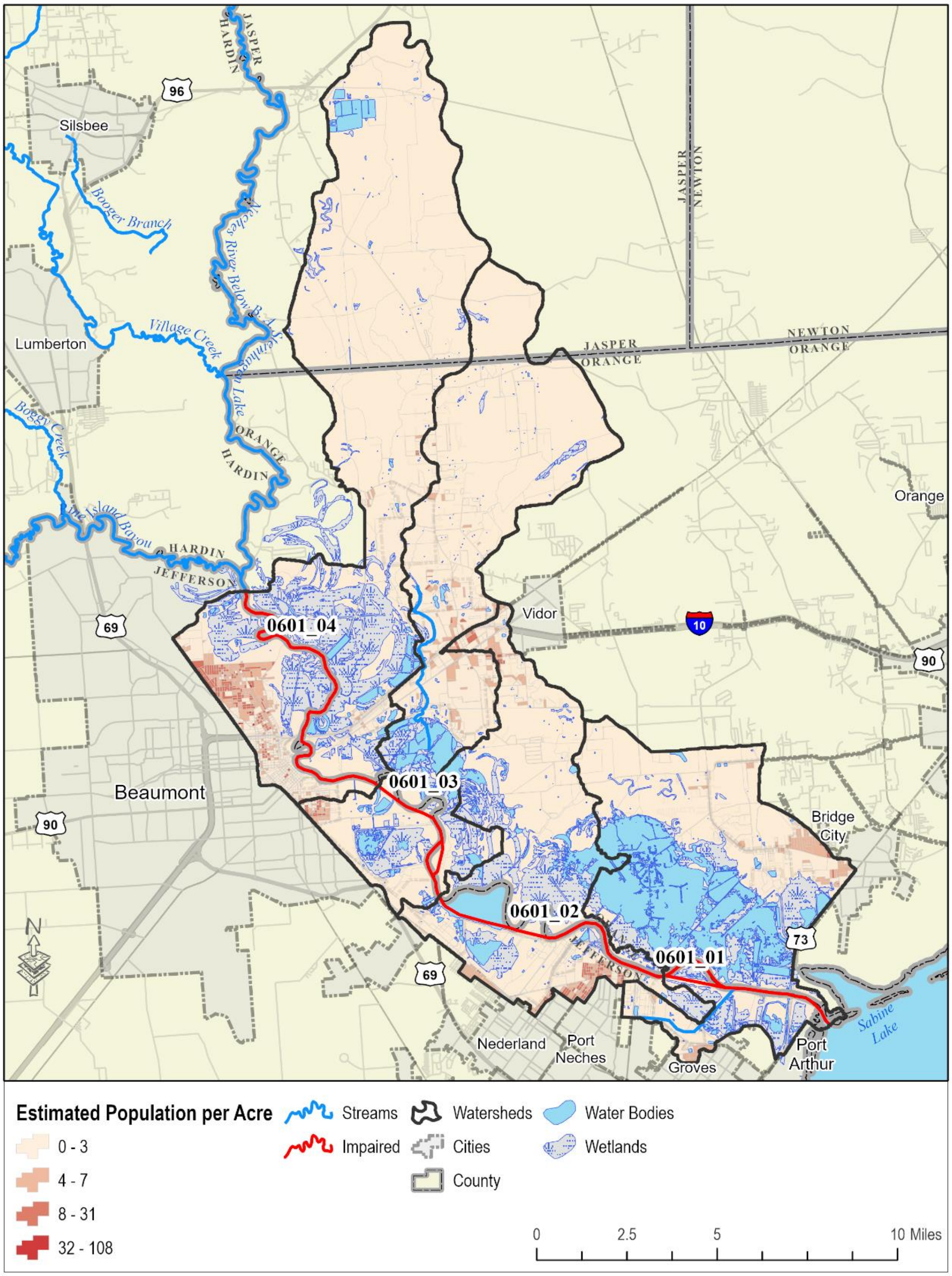

Figure 4. 2010 population density estimates using USCB census block data

Population projections in Table 2 were estimated from the Texas Water Development Board (TWDB) 2021 Regional Water Plan Population and Water Demand Projection data (TWDB, 2019). The population projections indicate a

39.5% increase for Jefferson County, 12.7% increase for Orange County, and a 2.6% increase for Jasper County from 2020 through 2070. The 2070 TMDL watershed population was estimated to be 65,920 (25.1% increase) using the steps outlined in Appendix A.

Table 2. Population estimates and projections

AU	2010 U.S. Census	2020 Population Projected	2070 Population Projection	Projected Increase (2020–2070)	Percentage Increase (2020-2070)
0601_04	18,395	19,466	26,093	6,627	34.0%
0601_03	13,849	14,617	16,891	2,274	15.6%
0601_02	10,772	11,394	14,472	3,078	27.0%
0601_01	6,821	7,202	8,464	1,262	17.5%
Total	**49,837**	**52,679**	**65,920**	**13,241**	**25.1%**

Land Cover

The land cover data for the TMDL watershed was obtained from the United States Geological Survey (USGS) 2016 National Land Cover Database (NLCD) (USGS, 2019a) and is displayed in Figure 5.

The following are the land cover categories and definitions represented in the NLCD are found in the TMDL watershed:

- **Open Water** – Areas of open water, generally with less than 25% cover of vegetation or soil.
- **Developed, Open Space** – Areas with a mixture of some constructed materials, but mostly vegetation in the form of lawn grasses. Impervious surfaces account for less than 20% of total cover. These areas most commonly include large-lot single-family housing units, parks, golf courses, and vegetation planted in developed settings for recreation, erosion control, or aesthetic purposes.
- **Developed, Low Intensity** – Areas with a mixture of constructed materials and vegetation. Impervious surfaces account for 20% to 49% of total cover. These areas most commonly include single-family housing units.
- **Developed, Medium Intensity** – Areas with a mixture of constructed materials and vegetation. Impervious surfaces account for 50% to 79% of total cover. These areas most commonly include single-family housing units.
- **Developed, High Intensity** – Highly developed areas where people reside or work in high numbers. Examples include apartment complexes, row

houses, and commercial/industrial. Impervious surfaces account for 80% to 100% of the total cover.

- **Barren Land (Rock/Sand/Clay)** – Areas of bedrock, desert pavement, scarps, talus, slides, volcanic material, glacial debris, sand dunes, strip mines, gravel pits, and other accumulations of earthen material. Generally, vegetation accounts for less than 15% of total cover.
- **Deciduous Forest** – Areas dominated by trees generally greater than five meters tall, and greater than 20% of total vegetation cover. More than 75% of the tree species shed foliage simultaneously in response to seasonal change.
- **Evergreen Forest** – Areas dominated by trees generally greater than five meters tall, and greater than 20% of total vegetation cover. More than 75% of the tree species maintain their leaves all year. Canopy is never without green foliage.
- **Mixed Forest** – Areas dominated by trees generally greater than five meters tall, and greater than 20% of total vegetation cover. Neither deciduous nor evergreen species are greater than 75% of total tree cover.
- **Shrub/Scrub** – Areas dominated by shrubs; less than five meters tall with shrub canopy typically greater than 20% of total vegetation. This class includes true shrubs, young trees in an early successional stage or trees stunted from environmental conditions.
- **Grassland/Herbaceous** – Areas dominated by graminoid or herbaceous vegetation, generally greater than 80% of total vegetation. These areas are not subject to intensive management such as tilling but can be used for grazing.
- **Pasture/Hay** – Areas of grasses, legumes, or grass-legume mixtures planted for livestock grazing or the production of seed or hay crops, typically on a perennial cycle. Pasture/hay vegetation accounts for greater than 20% of total vegetation.
- **Cultivated Crops** – Areas used for the production of annual crops, such as corn, soybeans, vegetables, tobacco, and cotton, and also perennial woody crops such as orchards and vineyards. Crop vegetation accounts for greater than 20% of total vegetation. This class also includes all land being actively tilled.
- **Woody Wetlands** – Areas where forest or shrub land vegetation accounts for greater than 20% of vegetative cover and the soil or substrate is periodically saturated with or covered with water.
- **Emergent Herbaceous Wetlands** – Areas where perennial herbaceous vegetation accounts for greater than 80% of vegetative cover and the soil or substrate is periodically saturated with or covered with water.

A summary of the land cover data is provided in Table 3. As depicted in Table 3 and Figure 5, the Neches River Tidal watershed is characterized by substantial amounts of wetlands and open water, with development along the western side of the Neches River Tidal. The percentage of forested lands increases in northern portions of the watershed, as it extends into Jasper County (Figure 5).

The predominant land cover types in the AU watersheds are as follows:

- AU 0601_04 – Wetlands and Open Water (44%), Forest (27%) and Developed (17%).
- AU 0601_03 – Wetlands and Open Water (44%), Developed (23%), and Forest (20%).
- AU 0601_02 – Wetlands and Open Water (58%), Developed (27%), and Pasture/Hay (11%).
- AU 0601_01 – Wetlands and Open Water (66%), Developed (16%), and Pasture/Hay (12%).

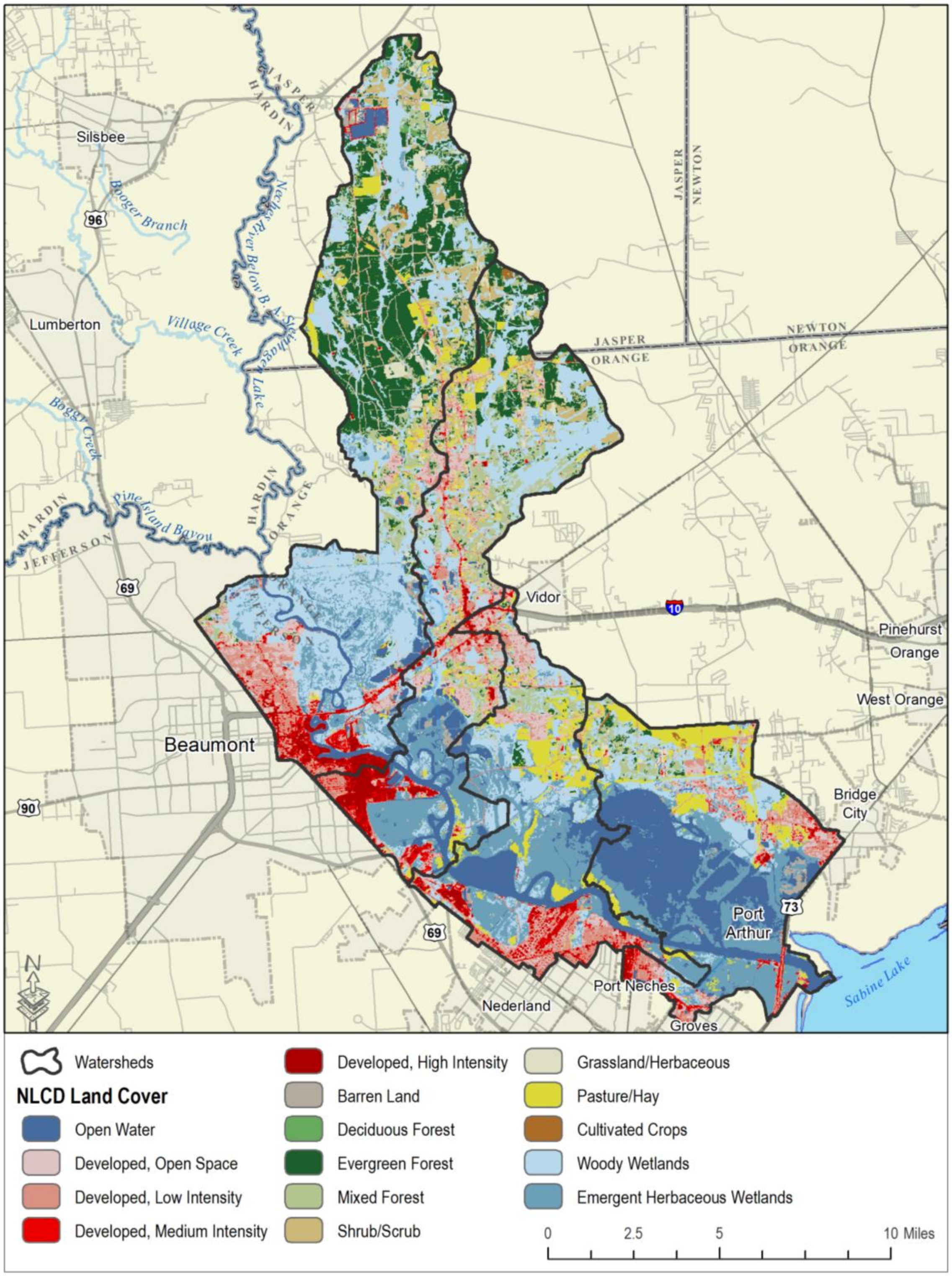

Figure 5. **2016 land cover map**

Table 3. Land cover percentages

2016 NLCD Classification	0601_04 Area	% Total	0601_03 Area	% Total	0601_02 Area	% Total	0601_01 Area	% Total
Open Water	2,125	4.2%	2,017	6.1%	3,176	14.0%	8,888	31.5%
Developed, Open Space	3,177	6.2%	2,909	8.8%	1,912	8.4%	1,375	4.9%
Developed, Low Intensity	3,061	6.0%	2,469	7.5%	2,607	11.5%	1,999	7.1%
Developed, Medium Intensity	1,223	2.4%	1,080	3.3%	971	4.3%	739	2.6%
Developed, High Intensity	1,134	2.2%	1,183	3.6%	539	2.4%	279	1.0%
Barren Land	212	0.4%	182	0.6%	85	0.4%	263	0.9%
Deciduous Forest	123	0.2%	11	0.0%	0	0.0%	0	0.0%
Evergreen Forest	10,770	21.1%	2,918	8.8%	249	1.1%	329	1.2%
Mixed Forest	3,081	6.0%	3,599	10.9%	772	3.4%	927	3.3%
Shrub/Scrub	2,819	5.5%	1,442	4.4%	37	0.2%	100	0.4%
Grassland/Herbaceous	1,427	2.8%	791	2.4%	75	0.3%	217	0.8%
Pasture/Hay	1,659	3.3%	1,716	5.2%	2,436	10.7%	3,283	11.6%
Cultivated Crops	79	0.2%	115	0.3%	2	0.0%	58	0.2%
Woody Wetlands	16,546	32.5%	8,365	25.3%	3,743	16.5%	3,380	12.0%
Emergent Herbaceous Wetlands	3,508	6.9%	4,210	12.8%	6,134	27.0%	6,356	22.5%
Total	**50,944**	**100%[a]**	**33,007**	**100%**	**22,738**	**100%[a]**	**28,193**	**100%**

All areas are expressed in acres.

[a] Total differs slightly from 100% due to rounding

Soils

Soils within the Neches River Tidal watershed are characterized by hydrologic groups that describe infiltration and runoff potential. These data are provided by the U.S. Department of Agriculture (USDA) Natural Resources Conservation Service (NRCS) Soil Survey Geographic database (SSURGO) (USDA NRCS, 2018). The SSURGO data assigns different soils to one of seven possible runoff potential classifications or hydrologic groups. These classifications are based on the estimated rate of water infiltration when soils are not protected by vegetation, are thoroughly wet, and receive precipitation from long-duration storms. The four main groups are A, B, C, and D, with three dual classes (A/D, B/D, C/D). The SSURGO database defines the following classifications.

- **Group A** – Soils having high infiltration rate (low runoff potential) when thoroughly wet. These consist mainly of deep, well-drained to excessively drained sands or gravelly sands. These soils have a high rate of water transmission.

- **Group B** – Soils having a moderate infiltration rate when thoroughly wet. These consist of moderately deep or deep, moderately well-drained or well-drained soils that have moderately fine texture to moderately coarse texture. These soils have a moderate rate of water transmission.
- **Group C** – Soils having a slow infiltration rate when thoroughly wet. These consist chiefly of soils having a layer that impedes the downward movement of water or soils of moderately fine texture or fine texture. These soils have a slow rate of water transmission.
- **Group D** – Soils having a very slow infiltration rate (high runoff potential) when thoroughly wet. These consist chiefly of clays that have a high shrink-swell potential, soils that have a high water table, soils that have a claypan or clay layer at or near the surface, and soils that are shallow over nearly impervious material. These soils have a very slow rate of water transmission.
- Soils with dual hydrologic groupings indicate that drained areas are assigned the first letter, and the second letter is assigned to undrained areas. Only soils that are in group D in their natural condition are assigned to dual classes.

A summary of the soil hydrologic groups within the TMDL watershed is shown in Table 4. Most of the Neches River Tidal watershed is characterized by soils with very slow infiltration and high runoff, with isolated areas of high infiltration and low runoff. The AU 0601_01 and AU 0601_02 watersheds are predominately composed of Type D soils (Table 4, Figure 6). The majority of soils in the AU 0601_03 and AU 0601_04 watersheds are in dual soil group C/D, generally indicating slow or very slow infiltration under most conditions.

Table 4. Hydrologic soil group percentages

Soil Group	0601_04 Acres	% Total	0601_03 Acres	% Total	0601_02 Acres	% Total	0601_01 Acres	% Total
A	2,770	5.4	2,174	6.6	605	2.7	292	1.0
C	3,284	6.5	1,224	3.7	269	1.2	0	0.0
C/D	27,400	53.8	19,038	57.7	2,007	8.8	111	0.4
D	17,489	34.3	10,571	32.0	19,857	87.3	27,783	98.6
Total	**50,943**	**100.0**	**33,007**	**100.0**	**22,738**	**100.0**	**28,186**[a]	**100.0**

[a] Acreage is less than the total acreage of the watershed due to missing soil type data.

Water Rights Review

Surface water rights in Texas are administered and overseen by TCEQ. A search of TCEQ's Texas Water Rights Viewer, active water rights database, and geographic information system (GIS) files, indicated that, within the Neches

River Tidal watershed, there are 15 active surface water rights (TCEQ, 2019a, 2019b).

Most authorized uses on the Neches River Tidal are for industrial use and include provisions stating that water diverted but not consumed be returned to the river. Self-reported diversion data found during a review of the water-use data file (TCEQ, 2019b) and the Texas Water Rights Viewer (TCEQ, 2019a), also indicate that most major water right diversions from Neches River Tidal return water to the river.

A review of final actions on water rights permit applications (TCEQ, 2020a) for fiscal years 2018, 2019, and 2020 found no new water rights for the Neches River Tidal had been granted during that period, although one water right had been amended. The review of the water-right authorizations indicates they will not significantly impact streamflow estimates and are therefore not considered in the development of TMDL load allocations.

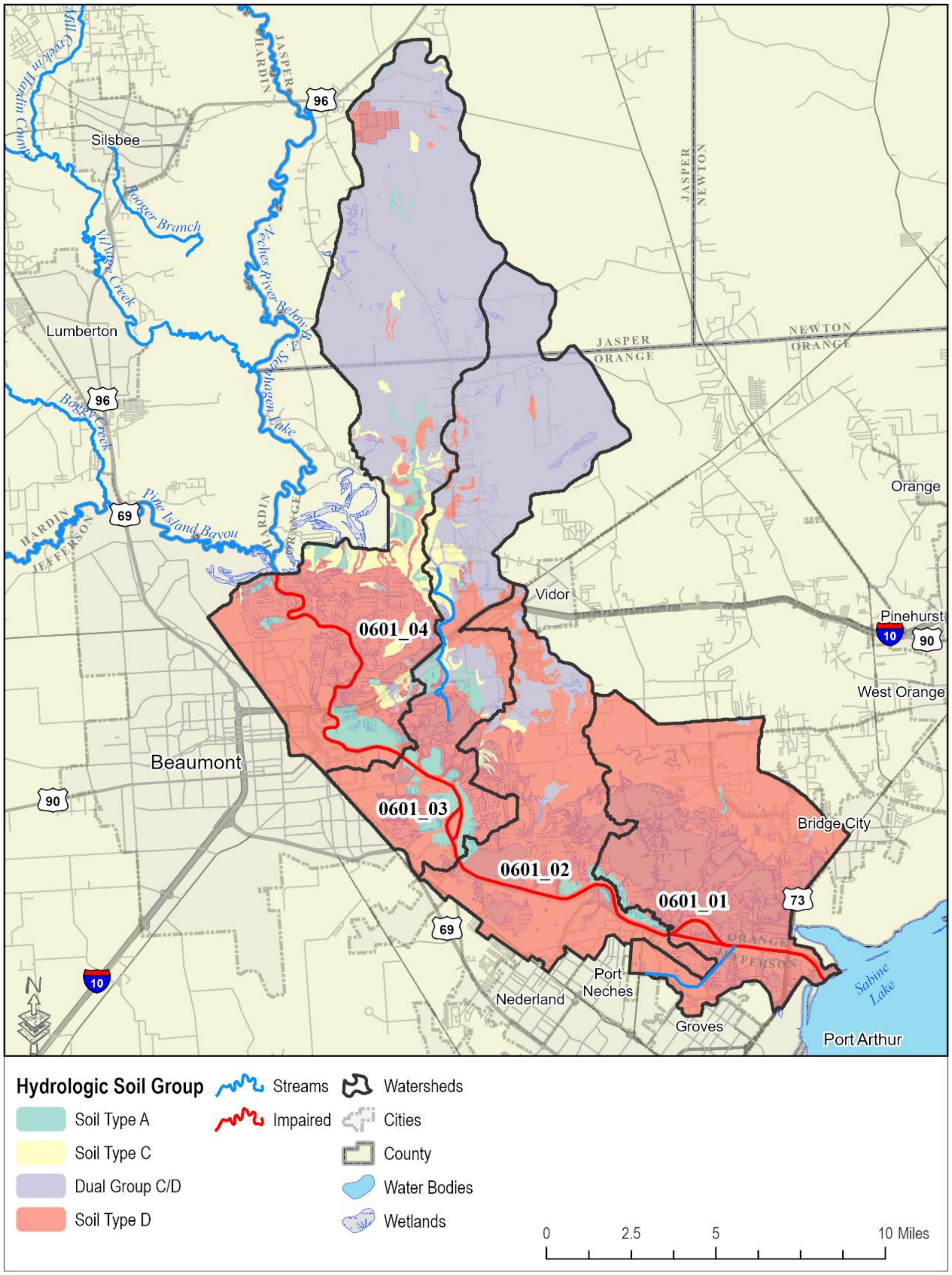

Figure 6. Hydrologic soil groups

Endpoint Identification

All TMDLs must identify a quantifiable water quality target that indicates the desired water quality condition and provides a measurable goal for the TMDL. The TMDL endpoint also serves to focus the technical work to be accomplished and as a criterion against which to evaluate future conditions.

The endpoint for the TMDLs in this report is to maintain concentrations of Enterococci below the geometric mean criterion of 35 cfu/100mL, which is protective of the primary contact recreation 1 use in saltwater (TCEQ, 2018a).

Source Analysis

Pollutants may come from several sources, both regulated and unregulated. Regulated pollutants, 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. WWTFs and stormwater discharges from industries, construction activities, and MS4s 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 permits.

Except for WWTFs, which receive individual 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 TMDL watershed include domestic and industrial WWTF outfalls, SSOs, and stormwater discharges from MS4s, industrial sites, and regulated construction activities.

Domestic and Industrial Wastewater Treatment Facilities

As of December 2018, there were 29 facilities with individual TPDES permits (Table 5, Figure 7) (TCEQ, 2019c) that discharged within the Neches River Tidal watershed. Nine of these facilities have bacteria effluent limits. Within the watershed, 23 industrial facilities were covered by TPDES permits for wastewater discharges that include stormwater. Discharges are reported in units of million gallons per day (MGD). The authorized stormwater discharges at these facilities are discussed further in the TPDES-Regulated Stormwater section.

Table 5. Permitted domestic and industrial WWTFs ordered from upstream to downstream

AU	TPDES Number	NPDES[a] Number	Permittee	Outfall Number[b]	Bacteria Limits (cfu/100 mL)[c]	Discharge Type[d]	Permitted Discharge (MGD)
0601_04	WQ0014049001	TX0117277	Vidor MHP No. 1 LLC	001	126 (*E. coli*[e])	WW	0.0225 (daily average)
0601_04	WQ0000493000	TX0003891	WestRock Texas LP	001	35	WW, IW, SW	65 (daily average)
0601_04	WQ0005188000	TX0136824	Jefferson Railport Terminal I (Texas) LLC[f]	001, 002	None	IW, SW	Intermittent and flow-variable
0601_04	WQ0001971000	TX0067695	Optimus Steel LLC[g]	001	None	IW, SW	1.64 (daily average)
				002, 004, 007	None	SW	Intermittent and flow-variable
0601_03	WQ0010875001	TX0023795	Orange County Water Control and Improvement District No. 1	001	126 (*E. coli*)	WW	3.0 (annual average)
0601_03	WQ0000462000	TX0004227	ExxonMobil Oil Corporation	001	None	IW, SW	Intermittent and flow-variable
0601_03	WQ0003426000	TX0118737	ExxonMobil Oil Corporation	001	None	IW, SW	Intermittent and flow-variable
				002	None	IW	3.0 (daily average)
				003	None	SW	Intermittent and flow-variable
0601_03	WQ0001727000	TX0062677	Neches River Treatment Corporation and Lower Neches Valley Authority	001	35	WW, IW	21.0 (daily average)
0601_03	WQ0001872000	TX0052825	Arkema Inc.	001	None	SW, PME	Intermittent and flow-variable
0601_03	WQ0001202000	TX0003662	Martin Operating Partnership LP	002, 003, 006, 007	None	IW, SW	Intermittent and flow-variable
				004	None	IW, SW	0.22 (daily average dry-weather flow)
				005	None	IW, SW, PME	0.0658 (daily average dry-weather flow)
				008	None	IW, SW	0.208 (daily average dry-weather flow)
0601_03	WQ0000647000	TX0006726	Chemtrade Refinery Services Inc.	001	None	SW	Intermittent and flow-variable

AU	TPDES Number	NPDES[a] Number	Permittee	Outfall Number[b]	Bacteria Limits (cfu/100 mL)[c]	Discharge Type[d]	Permitted Discharge (MGD)
0601_03	WQ0004074000	TX0116921	Martin Operating Partnership LP	001	None	IW, SW, PME	Intermittent and flow-variable
0601_03	WQ0005143000	TX0135836	Natgasoline LLC	001	None	IW, SW, PME	3.5 (daily average)
				002	None	IW, SW	Intermittent and flow-variable
0601_02	WQ0000473000	TX0004669	Lucite International Inc.	001	None	IW, SW, PME	9.99 (daily average)
				002, 004, 005, 006, 008, 011, 015, 018, 020, 021	None	IW, SW	Intermittent and flow-variable
				101	35	WW, IW	Flow-variable
0601_02	WQ0001595000	TX0007277	Air Liquide Large Industries US LP	002	None	IW, SW, FB	0.175 (daily average)
0601_02	WQ0001151000	TX0005746	Sunoco Partners Marketing & Terminals LP	001	None	IW, SW	5.0 (daily maximum)
0601_02	WQ0000316000	TX0002909	Phillips 66 Gulf Coast Properties LLC and Phillips 66 Pipeline LLC	001, 003, 005	None	IW, SW	Intermittent and flow-variable
				002	35	WW, IW, SW	Continuous and flow-variable
0601_02	WQ0010477004	TX0022926	City of Port Neches	001	35	WW	4.98 (annual average)
0601_02	WQ0002487000	TX0087602	Lion Elastomers LLC	001	None	IW, SW	0.253 (daily average dry-weather flow)
0601_01	WQ0000511000	TX0005070	Huntsman Petrochemical LLC, Huntsman Propylene Oxide LLC (now known as Indorama Ventures Propylene Oxides LLC), Bluehall Incorporated, and TPC Group LLC	001, 002, 004, 009, 010	None	IW, SW, PME	Flow-variable/ Intermittent and flow-variable
				301	35	WW, IW, SW	15.0 (daily average)
0601_01	WQ0004840000	TX0129887	TPC Group LLC	201	None	SW	Intermittent and flow-variable
0601_01	WQ0000336000	TX0006696	Entergy Texas Inc.	001	None	CW, PME, SW	1,306 (daily average)
				801	89 (Daily Max)	WW	Intermittent and flow-variable

AU	TPDES Number	NPDES[a] Number	Permittee	Outfall Number[b]	Bacteria Limits (cfu/100 mL)[c]	Discharge Type[d]	Permitted Discharge (MGD)
0601_01	WQ0004731000	TX0062448	INEOS Calabrian Corp	001	None	IW, SW	0.25 (daily average)
0601_01	WQ0004874000	TX0131598	Kinder Morgan Petcoke LP	001	None	IW, SW	Intermittent and flow-variable
0601_01	WQ0000491000	TX0004201	Total Petrochemicals and Refining USA Inc.	001	None	IW, SW	7.1 (daily average)
				002, 003, 005, 007	None	IW, SW	Intermittent and flow-variable
0601_01	WQ0005236000	TX0137855	Bayport Polymers LLC (formerly Total Petrochemicals & Refining USA Inc)	001	None	IW	0.81 (daily average)
				003[h]	None	IW, SW	Continuous flow-variable
0601_01	WQ0004135000	TX0119369	BASF TOTAL Petrochemical LLC	002	None	IW	2.0 (daily average)
0601_01	WQ0001674000	TX0064718	Integrity-Golden Triangle Marine Services LLC	001	None	IW, SW	0.048 (daily average)
				002	None	SW	Intermittent and flow-variable
0601_01	WQ0005328000	TX0141682	Marine Fueling Services Inc.	001	None	IW	0.035 (daily average)

[a] NPDES: National Pollutant Discharge Elimination System.

[b] Outfalls for these facilities that discharge outside of the Neches River Tidal watershed are not included.

[c] The indicator bacteria for permit limits is Enterococci unless otherwise specified.

[d] Abbreviations as follows: WW (treated domestic wastewater), IW (treated industrial wastewater), SW (stormwater), FB (filter backwash), CW (once through cooling water), and PME (previously monitored effluent).

[e] *E. coli*: *Escherichia coli*

[f] WQ0005188000 authorization was cancelled in August 2018. This record is included for completeness.

[g] WQ0001971000 was renewed January 24, 2020 and Outfall 003 was removed.

[h] WQ 0005236000 Outfall 003 is routed to WQ0000491000.

Figure 7. Regulated sources

TCEQ/TPDES Water Quality General Permits

Certain types of activities must be covered by one of several TCEQ/TPDES 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)

The following general permit authorizations are not considered to affect the bacteria loading in the TMDL watershed and were excluded from this investigation:

- TXG640000 – conventional water treatment plants
- TXG670000 – hydrostatic test water discharges
- TXG830000 – water contaminated by petroleum fuel or petroleum substances
- TXG870000 – pesticides (application only)
- WQG100000 – wastewater evaporation

A review of active general permit coverage in the Neches River Tidal watershed as of December 31, 2018 (TCEQ, 2019d) indicated one general permit authorization for a concrete production facility. This permit authorizes the discharge of stormwater and is implicitly included in the regulated stormwater allocations. No other active general permits with a potential bacteria loading were found for the Neches River Tidal watershed.

Sanitary Sewer Overflows

SSOs are unauthorized discharges that must be addressed by the responsible party, either the TPDES permittee or the owner of the collection system that is connected to a permitted system. These overflows in dry weather most often result from blockages in the sewer collection pipes caused by tree roots, grease, and other debris. Inflow and infiltration are typical causes of overflows under conditions of high flow in the WWTF system. Blockages in the line may exacerbate the inflow and infiltration problem. Other causes, such as a collapsed sewer line, may occur under any condition.

The TCEQ Central Office in Austin provided statewide data on SSOs from January 2016 through December 2018 (TCEQ, 2019e) and basin-wide data on SSOs from 2005 through 2015 (TCEQ, 2019f). The number and volume of overflow incidents in the TMDL watershed are included in Table 6.

Table 6. Summary of reported SSO events from 2005 through 2018 (in gallons)

Year	Estimated Incidents	Total Volume[a]	Minimum Volume	Maximum Volume
2005	22	70,510	15	28,000
2006	31	98,646	1	80,000
2007	65	286,336	10	100,000
2008	64	297,137	6	144,000
2009	71	56,909	4	20,000
2010	79	91,813	1	78,000
2011	85	2,173,910	1	535,000
2012	67	475,657	3	460,000
2013	38	4,122	1	600
2014	49	8,246	1	1,975
2015	69	132,450	2	60,000
2016	95	25,545	1	3,500
2017	52	21,416	<1	3,239
2018	51	31,055	5	10,000
Total	**838**	**3,773,752**		

[a] Some reported SSOs did not include a volume.

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 MS4 entities, stormwater discharges associated with regulated industrial activities, and construction activities.
2) Stormwater runoff not subject to regulation.

TPDES MS4 Phase I and II rules require municipalities and certain other entities in urbanized areas (UAs) to obtain permit coverage for their stormwater systems. A regulated MS4 is a publicly owned system of conveyances and includes ditches, curbs, gutters, and storm sewers that do not connect to a wastewater collection system or treatment facility. Phase I permits are individual permits for large and medium-sized MS4s with populations of 100,000 or more based on the 1990 United States Census, whereas the Phase II General Permit regulates other MS4s within a UA as defined by USCB.

The purpose of an MS4 permit is to reduce discharges of pollutants in stormwater to the "maximum extent practicable" by developing and implementing a stormwater management program (SWMP). The SWMP describes the stormwater control practices that the regulated entity will implement, consistent with permit requirements, to minimize the discharge of pollutants. MS4 permits require that SWMPs specify the best management practices (BMPs) to meet several minimum control measures (MCMs) that, when implemented in concert, are expected to result in significant reductions of pollutants discharged into receiving water bodies. Phase II MS4 MCMs include all of the following:

- Public education, outreach, and involvement.
- Illicit discharge detection and elimination.
- Construction site stormwater runoff control.
- Post-construction stormwater management in new development and redevelopment.
- Pollution prevention and good housekeeping for municipal operations.
- Industrial stormwater sources.

Phase I MS4 individual permits have their own set of MCMs that are similar to the Phase II MCMs, but Phase I permits have additional requirements to perform water quality monitoring and implement a floatables program. The Phase I MCMs include all of these activities:

- MS4 maintenance activities.
- Post-construction stormwater control measures.
- Detection and elimination of illicit discharges.
- Pollution prevention and good housekeeping for municipal operations.
- Limiting pollutants in industrial and high-risk stormwater runoff.
- Limiting pollutants in stormwater runoff from construction sites.
- Public education, outreach, involvement, and participation.
- Monitoring, evaluating, and reporting.

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 UAs
- TXR050000 – 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

TCEQ Central Registry (2019d) includes a Phase I MS4 permit held by the City of Beaumont and Jefferson County Drainage District No. 6 that covers the Beaumont jurisdictional boundaries and a statewide combined Phase I and II MS4 permit held by the Texas Department of Transportation for rights-of-way in the Beaumont UA (Table 7).

The Neches River Tidal watershed includes 23 industrial WWTFs (Table 5) with regulated stormwater. The areas of permitted facilities were estimated using the most recently available remote imagery in ArcGIS and permit information (TCEQ, 2019c; TCEQ, 2020b). This spatial data was used to determine the area of regulated stormwater outside of Phase I MS4 or UA areas.

The TCEQ Central Registry of active stormwater general permits in the Neches River Tidal watershed as of December 31, 2018 found 10 Phase II MS4 general permit authorizations (Table 7), 34 MSGP authorizations, and 13 CGP authorizations (TCEQ, 2019d). A review of MSGP authorizations in the Neches River Tidal watershed found most were within an MS4 regulated area or covered by an associated industrial WWTF permit. For these reasons, areas authorized under an MSGP, CGP, or a concrete production facility were not specifically determined since the majority occur in an MS4 or another regulated stormwater area.

Table 7. MS4 permit authorizations

Entity	Authorization Type	TPDES Permit No./ NPDES ID	Location
City of Beaumont, Jefferson County Drainage District No. 6	Phase I MS4	WQ0004637000/ TXS000501	Jurisdictional boundary of Beaumont, TX
Texas Department of Transportation	Combined Phase I and Phase II MS4	WQ0005011000/ TXS002101	TXDOT rights-of-way located within Phase I MS4s and Phase II UAs
City of Vidor	Phase II MS4	TXR040028	Area within the City of Vidor limits that is located within the Beaumont UA
Orange County Drainage District	Phase II MS4	TXR040029	Area within the Orange County limits that is located within the Beaumont and Port Arthur UAs

Entity	Authorization Type	TPDES Permit No./ NPDES ID	Location
Orange County	Phase II MS4	TXR040030	Area within Orange County that is located outside the city limits that is located within the Beaumont and Port Arthur UAs
Jefferson County	Phase II MS4	TXR040129	Area within the Jefferson County limits that is located within the Port Arthur UA
Jefferson County Drainage District 7	Phase II MS4	TXR040130	Area within the Drainage District 7 limits that is located within Port Arthur UA
City of Port Neches	Phase II MS4	TXR040131	Area within the City of Port Neches limits that is located within the Port Arthur UA
City of Bridge City	Phase II MS4	TXR040429	Area within Bridge City limits that is located within the Port Arthur UA
City of Nederland	Phase II MS4	TXR040133	Area within the City of Nederland limits that is located within the Port Arthur UA
City of Groves	Phase II MS4	TXR040134	Area within the City of Groves limits that is located within the Port Arthur UA
City of Port Arthur	Phase II MS4	TXR040143	Area within the City of Port Arthur limits that is located within the Port Arthur UA

The total area of regulated stormwater for each AU watershed was estimated as the jurisdictional boundary of Beaumont, 2010 UAs for Beaumont and Port Arthur (USCB, 2010b), and the estimated area of regulated entities that are not within the Phase I or Phase II MS4 permitted areas (Table 8). The total area of regulated stormwater in the Neches River Tidal TMDL watershed is 49.05 square miles, as shown in Figure 7. The total regulated stormwater areas listed in Table 8 indicate the total area within each AU plus the regulated area for each upstream AU.

Table 8. Area of regulated stormwater

AU	Total (square miles)	Percent of Watershed Area
0601_04	16.24	20.4
0601_03	30.67	23.4
0601_02	42.18	25.3
0601_01	49.05	23.3

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. Examples of illicit discharges identified in the *Illicit Discharge Detection and Elimination Manual: A Handbook for Municipalities* (NEIWPCC, 2003) include:

Direct Illicit Discharges:

- Sanitary wastewater piping that is directly connected from a home to the storm sewer.
- Materials that have been dumped illegally into a storm drain catch basin.
- A shop floor drain that is connected to the storm sewer.
- A cross-connection between the sanitary sewer and storm sewer systems.

Indirect Illicit Discharges:

- An old and damaged sanitary sewer line that is leaking fluids into a cracked storm sewer line.
- A failing septic system that is leaking into a cracked storm sewer line or causing surface discharge into the storm sewer.

Unregulated Sources

Unregulated sources of bacteria are generally nonpoint. Nonpoint source loading enters the impaired water body through distributed, nonspecific locations, which may include urban runoff not covered by a permit, wildlife, various agricultural activities, agricultural animals, failing OSSFs, unmanaged and feral animals, 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. Activities, such as livestock grazing close to water bodies and the use of manure as fertilizer, can contribute Enterococci to nearby water bodies.

Table 9 provides estimated numbers of selected livestock in the TMDL watershed based on the 2017 Census of Agriculture conducted by the USDA (USDA, 2019). Those populations were determined based on GIS calculations of

2016 NLCD suitable habitat in the watershed, which included areas classified as Pasture/Hay and Grassland/Herbaceous. The area of suitable habitat within the watershed area (within the corresponding county) was then divided by the total area of the county classified as Pasture/Hay and Grassland/Herbaceous. The resulting ratio of suitable habitat was multiplied by USDA county-level livestock estimates. The Texas State Soil and Water Conservation Board (TSSWCB) staff reviewed the watershed estimated livestock numbers. These livestock numbers, however, were not used to develop an allocation of allowable bacteria loading to livestock.

Table 9. Estimated livestock population

AU	Cattle and Calves	Hogs and Pigs	Goats and Sheep	Horses
0601_04	740	22	53	56
0601_03	617	28	59	48
0601_02	686	30	62	51
0601_01	967	43	89	73
Totals	**3,010**	**123**	**263**	**228**

Fecal matter 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 10 summarizes the estimated number of dogs and cats in the TMDL watershed. Pet population estimates were calculated as the estimated number of dogs (0.614) and cats (0.457) per household (AVMA, 2018). The actual contribution and significance of bacteria loads from pets reaching the water bodies is unknown.

Table 10. Estimated households and pet population

AU	Estimated Households	Estimated Dog Population	Estimated Cat Population
0601_04	7,784	4,779	3,557
0601_03	5,679	3,487	2,595
0601_02	4,640	2,849	2,120
0601_01	2,693	1,654	1,231
Totals	**20,796**	**12,769**	**9,504[a]**

[a] Total differs slightly due to rounding

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 deer, the Texas Parks and Wildlife Department (TPWD) has published data showing deer population-density estimates by Resource Management Unit and Ecoregion in the State (TPWD, 2018). The Neches River Tidal watershed lies within Resource Management Unit 13, with an average deer density of 208.46 acres per deer within suitable habitat over the period 2005 through 2016 (TPWD, 2018). Suitable NLCD classes for deer habitat classified in the 2016 NLCD include Pasture/Hay, Shrub/Scrub, Grassland/Herbaceous, Deciduous Forest, Evergreen Forest, Mixed Forest, Woody Wetlands, and Emergent Herbaceous Wetlands. Based on acres of suitable habitat, there are an estimated 438 deer in the TMDL watershed (Table 11).

For feral hogs, a study by Timmons et. al (2012) estimated feral hog density within suitable habitat in Texas to be one hog per 39 acres The average hog density (12.65 hogs/square mile) was multiplied by hog habitat area for the TMDL watersheds. Habitat deemed suitable for hogs followed as closely as possible to the land cover selections of the study and includes the following classifications from the 2016 NLCD classes suitable for feral hogs in the watershed, which include Pasture/Hay, Shrub/Scrub, Grassland/Herbaceous, Deciduous Forest, Evergreen Forest, Mixed Forest, Woody Wetlands, and Emergent Herbaceous Wetlands. Based on acres of suitable habitat, there are an estimated 2,334 feral hogs in the TMDL watershed (Table 11).

Table 11. Estimated deer and feral hog population

AU	Suitable Habitat (Acres)	Estimated Number of Deer	Estimated Number of Feral Hogs
0601_04	39,931	192	1,024
0601_03	23,052	111	591
0601_02	13,446	65	345
0601_01	14,593	70	374
Total	**91,022**	**438**	**2,334**

On-Site Sewage Facilities

Private residential OSSFs, commonly referred to as septic systems, consist of various designs based on physical conditions of the local soils. Typical designs consist of 1) one or more septic tanks and a drainage or distribution field (anaerobic system) and 2) aerobic systems that have an aerated holding tank and often an above ground sprinkler system for distributing the liquid. In simplest terms, household waste flows into the septic tank or aerated tank, where solids settle out. The liquid portion of the water flows to the distribution system, which may consist of buried perforated pipes or an above ground sprinkler system.

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. However, properly designed and operated OSSFs contribute virtually no fecal bacteria to surface waters. For example, less than 0.01% of fecal coliforms originating in household wastes move further than 6.5 feet down gradient of the drainfield of a septic system (Weiskel et al., 1996). Reed, Stowe, and Yanke LLC (2001) provide estimated failure rates of OSSFs for different regions of Texas. The Neches River Tidal watershed is located within both Region IV and Region V, which have reported failure rates of about 12% and 19% respectively, providing insight into expected failure rates for the area.

Estimates of the number of OSSFs within the Texas Coastal Zone (coastal zone) portion of the TMDL watershed were determined using the TCEQ Nonpoint Source Program Coastal On-Site Sewage Inventory Database (TCEQ, 2018b). Estimates of the number of OSSFs in the TMDL watershed outside of the coastal zone were determined using 911 addresses to estimate residence locations (Arctur and Maidment, 2018), which were verified with aerial imagery data. OSSFs were estimated to be households that were outside of city boundaries and Certificate of Convenience and Necessity (CCN) areas (PUC, 2017). Table 12 and Figure 8 show the total estimated OSSFs and the estimated OSSF density in the TMDL watershed.

Table 12. Estimated OSSFs in each AU watershed

AU	Estimated OSSFs
0601_04	1,221
0601_03	946
0601_02	965
0601_01	927
Total	4,059

Bacteria Survival and Die-off

Bacteria are living organisms that survive and die. Certain enteric bacteria can survive and replicate in organic materials if appropriate conditions prevail (e.g., warm temperature). Fecal organisms can survive and replicate from improperly treated effluent during their transport in pipe networks, and they can survive and replicate in organic-rich materials such as improperly treated compost and sewage sludge (or biosolids). While die-off of bacteria has been demonstrated in natural water systems due to the presence of sunlight and predators, the potential for their re-growth is less understood. Both replication and die-off are instream processes and are not considered in the bacteria source loading estimates in the TMDL watershed.

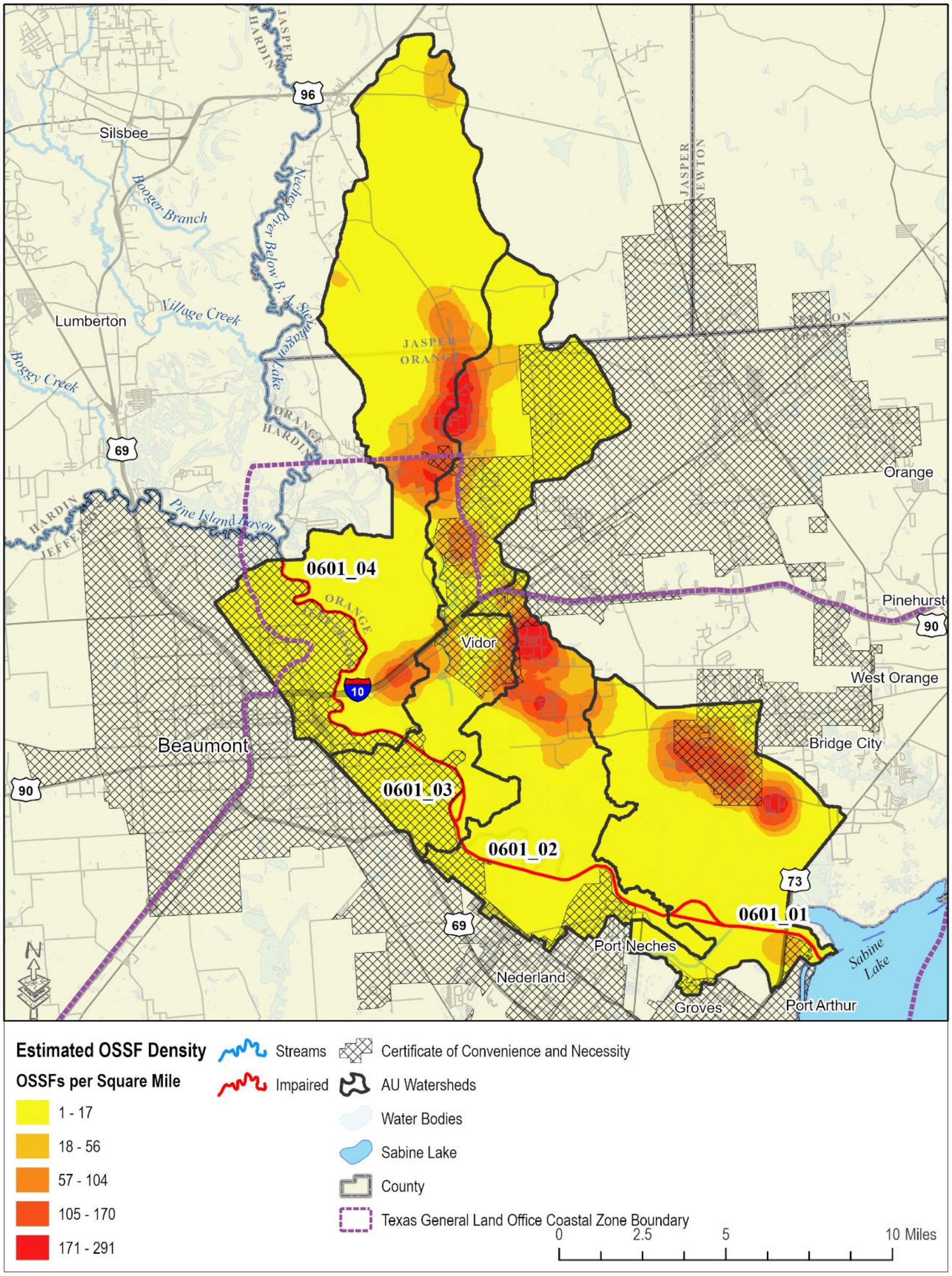

Figure 8. **Estimated OSSF density**

Linkage Analysis

Establishing the relationship between instream water quality and the source of loadings is an important component in developing a TMDL. It allows for the evaluation of management options that will achieve the desired endpoint. This relationship may be established through a variety of techniques.

Generally, if high bacteria concentrations are measured in a water body at low to median flows in the absence of runoff events, the main contributing sources are likely to be point sources and direct deposition. During ambient flows, these inputs to the system will increase pollutant concentrations depending on the magnitude and concentration of the sources. As flows increase in magnitude, the impact of point sources like direct deposition is typically diluted and would therefore be a smaller part of the overall concentrations.

Bacteria load contributions from regulated and unregulated stormwater sources are greatest during runoff events. Rainfall runoff, depending upon the severity of the storm, can carry fecal bacteria from the land surface into the receiving water body. Generally, this loading follows a pattern of higher concentrations in the water body as the first flush of storm runoff enters the receiving water body. Over time, the concentrations decline because the sources of indicator bacteria are attenuated as runoff washes them from the land surface and the volume of runoff decreases following the rain event.

Modified Load Duration Curve Analysis

LDCs are graphs of the frequency distribution of loads of pollutants in a water body. LDC analyses are used to examine the relationship between instream water quality and broad sources of bacteria loads which are the basis of the TMDL allocations.

In watersheds where there are tidal exchanges along the Texas coast, the flow is adjusted to address tidal influences. The LDC developed through this approach is called a modified LDC. Modified LDCs assume that combining freshwater with seawater increases the loading capacity in the tidal river. In the case of these TMDLs, the loads shown are of Enterococci bacteria in cfu/day. Modified LDCs are derived from modified flow duration curves (FDCs). The modified LDCs represent the maximum acceptable load in the stream that will result in achievement of the TMDL water quality target. The basic steps to generate modified LDCs include all of the following:

- Generating a daily freshwater flow record – the mean daily freshwater flow record incorporating actual daily average permitted discharges was developed for the most downstream TCEQ SWQM station within each AU using a drainage area ratio methodology and the mean daily streamflow reported at USGS Gauge 08041780 (Figure 9).

- Generating a daily tidal volume record – the daily tidal seawater volume record was generated using salinity to streamflow regressions and mass-balance equations. The tidal seawater volumes were added to the daily freshwater flow record.
- Accounting for full permitted discharges – the actual daily average permitted discharges are removed from the streamflow and the full permitted daily average discharges and FG discharges are added.
- Developing the modified FDCs – the mean daily streamflow including seawater volume, full permitted discharges, and FG is plotted against the exceedance probability of the mean daily streamflow for each day.
- Converting the modified FDCs to modified LDCs – the mean daily streamflow for each day is multiplied by the primary contact recreation 1 use geometric mean criterion and a conversion factor to produce a graph of the frequency distribution of allowable loads.
- Overlaying the modified LDCs with available indicator bacteria loading measurements to understand under what flow conditions indicator bacteria loading exceeds the primary contact recreation 1 use geometric mean criterion.

Hydrologic data in the form of tidally filtered mean daily streamflow were available for USGS Gauge 08041780 (Neches River Saltwater Barrier), located at the most upstream point of AU 0604_04 (USGS, 2019b) (Figure 9). The USGS Gauge 08041780 reflects baseline streamflow coming into the Neches River Tidal (Segment 0601) from Neches River below B. A. Steinhagen Lake (Segment 0602). Additionally, mean daily streamflow were available at USGS Gauge 08031000 (Cow Bayou near Mauriceville, TX), and were used to calculate the additional streamflow contributed by each AU watershed downstream of USGS Gauge 08041780. The period of record for developing the modified FDCs was from June 8, 2003 through December 31, 2018.

The method used to develop the necessary streamflow records for the four modified FDCs/LDC locations (TCEQ SWQM station locations) involved a drainage area ratio approach (Asquith et al., 2006). Prior to applying the drainage area ratio, mean daily streamflow at Cow Bayou was naturalized by subtracting permitted WWTF facility daily discharge volumes as reported in discharge monitoring reports (EPA, 2019a; EPA 2019b). No Water Rights were identified upstream of the Cow Bayou USGS Gauge (TCEQ, 2019a).

The drainage area ratio approach involves multiplying a USGS gauging station daily streamflow value by a factor to estimate the flow at a desired TCEQ SWQM station location. The factor is determined by dividing the drainage area above the desired monitoring station location by the drainage area above the USGS gauge (Table 13) and applying a streamflow percentile exponent factor. The resulting streamflow record is the naturalized flow from only the contributing watershed at each SWQM station.

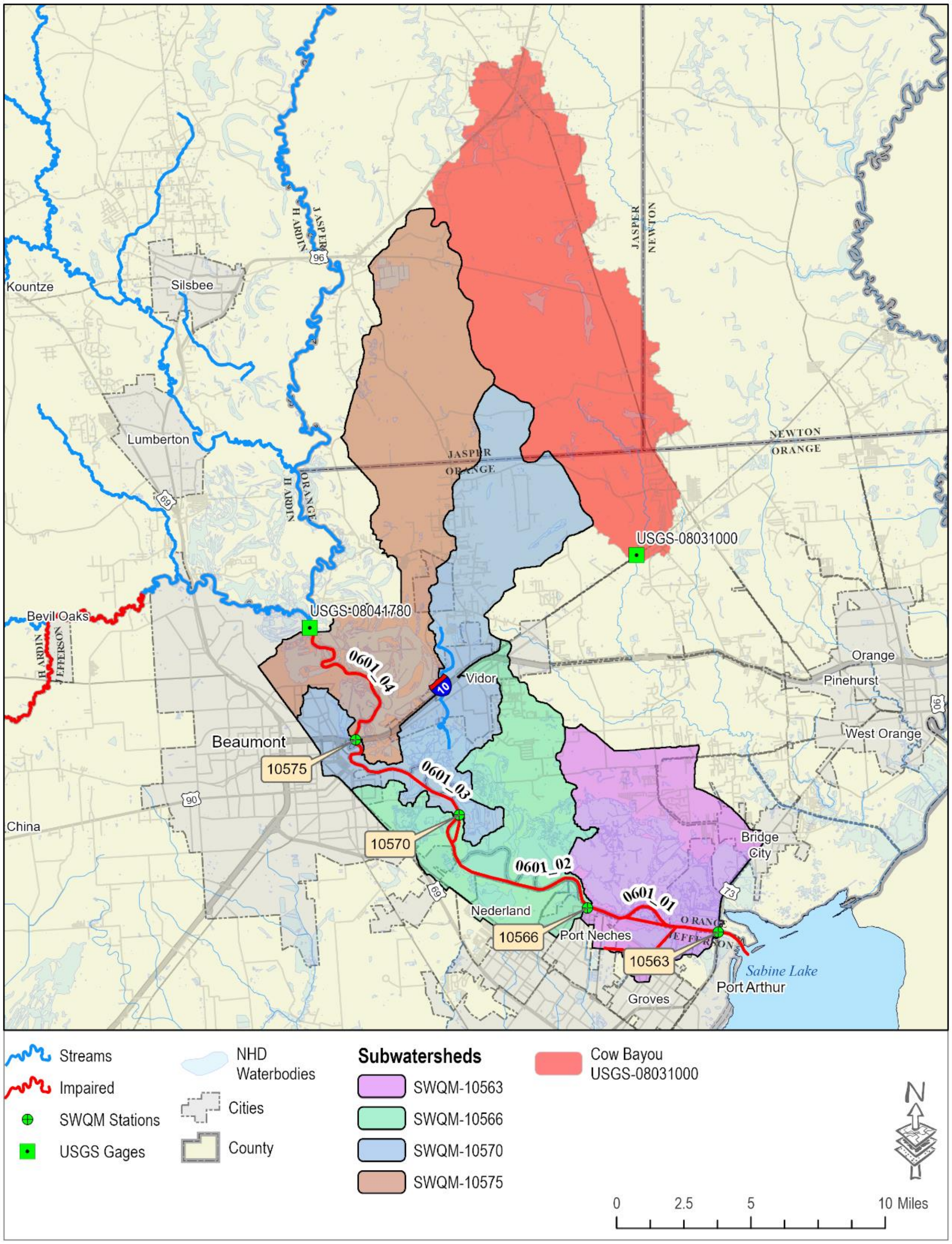

Figure 9. USGS streamflow gauges and SWQM stations used in streamflow development

Table 13. Drainage area ratios used at each SWQM station

AU	Location	Drainage Area (square miles)	Drainage Area Ratio
0601_04	SWQM Station 10575	71.45	0.80
0601_03	SWQM Station 10570	124.20	1.40
0601_02	SWQM Station 10566	164.62	1.85
0601_01	SWQM Station 10563	208.88	2.35
n/a	Cow Bayou – USGS 08031000	88.90	n/a

Next, the tidally filtered streamflow from USGS Gauge 08041780 (Neches River Saltwater Barrier) were added to account for streamflow upstream of Neches River Tidal (Segment 0601). Lastly, the permitted facility reported discharges in discharge monitoring reports upstream of each station were added to complete the estimated streamflow for each AU SWQM station.

As part of the development of the modified FDC/LDC method, it was necessary to estimate the daily tidal exchange at each SWQM station and add it to the freshwater streamflow. A regression relationship was developed between estimated daily freshwater streamflow and measured salinity for each SWQM station. The resulting predicted salinities were inserted into an equation (ODEQ, 2006) to calculate the volume of seawater that would flow through the SWQM station cross-section over the period of a day. The total modified daily flow volume for Neches River Tidal is then computed as the daily seawater volume plus the daily freshwater volume.

Flows used in the TMDL must consider the full permitted discharge and FG of permitted WWTFs. First, the actual permitted facility reported discharges used for estimating the volume of seawater were removed. Then the full permitted discharges (Table 14) (for facilities with daily average numeric flow limits) and calculated FG above each SWQM station were added to the calculated daily flows. Detailed information about the daily flow estimation method is available in the *Technical Support Document for Four Total Maximum Daily Loads for Indicator Bacteria in Neches River Tidal* (Schramm and Jha, 2020)[2].

[2] www.tceq.texas.gov/downloads/water-quality/tmdl/neches-river-tidal-recreational-118/118-as-471-neches-tidal-bacteria-tsd-2020-july.pdf

Table 14. Full permitted daily discharges used for modified FDC development

AU	SWQM Station	TPDES Number	Outfall	Permittee	Full Permitted Discharge (MGD)
0601_04	10575	WQ0014049001	001	Vidor MHP No. 1 LLC	0.0225
0601_04	10575	WQ0000493000	001	WestRock Texas LP	65.0
0601_04	10575	WQ0001971000	001	Optimus Steel LLC	1.64
0601_03	10570	WQ0010875001	001	Orange County Water Control and Improvement District No. 1	3.0
0601_03	10570	WQ0003426000	002	ExxonMobil Oil Corporation	3.0
0601_03	10570	WQ0001727000	001	Neches River Treatment Corporation and Lower Neches Valley Authority	21.0
0601_03	10566	WQ0005143000	001	Natgasoline LLC	3.5
0601_02	10566	WQ0000473000	001	Lucite International Inc.	9.99
0601_02	10566	WQ0001595000	002	Air Liquide Large Industries US LP	0.175
0601_02	10563	WQ0010477004	001	City of Port Neches	4.98
0601_01	10563	WQ0000511000	301	Huntsman Petrochemical LLC, Huntsman Propylene Oxide LLC (now known as Indorama Ventures Propylene Oxides LLC), Bluehall Incorporated, and TPC Group LLC	15.0
0601_01	10563	WQ0004731000	001	INEOS Calabrian Corp	0.25
0601_01	10563	WQ0000336000	001	Entergy Texas Inc.	1,306.0
0601_01	10563	WQ0000491000	001	Total Petrochemicals and Refining USA Inc.	7.1
0601_01	10563	WQ0005236000	001	Bayport Polymers LLC (formerly Total Petrochemicals & Refining USA Inc)	0.81
0601_01	10563	WQ0004135000	002	BASF TOTAL Petrochemical LLC	2.0
0601_01	10563	WQ0001674000	001	Integrity-Golden Triangle Marine Services LLC[a]	0.048
0601_01	10563	WQ0005328000	001	Marine Fueling Services Inc.[a]	0.035
				SWQM Station 10575 Total	**66.6625**
				SWQM Station 10570 Total	**93.6625**
				SWQM Station 10566 Total	**107.3275**
				SWQM Station 10563 Total	**1443.5505**

[a] Outfalls for WQ0001674000 and WQ0005328000 discharge downstream of SWQM Station 10563 but are included in the total to account for all full permitted discharges in the TMDL watershed.

After development of the daily streamflow record, the modified FDCs were generated by calculating the exceedance probability for each daily streamflow record and plotting the mean daily flow against the exceedance probability. Exceedance values along the x axis represent the percentage of days that flow was at or above the associated flow value on the y axis. Exceedance values near 100% occur during low flow or drought conditions while values approaching 0% occur during periods of high flow or flood conditions.

The modified FDCs were converted to modified LDCs by multiplying each streamflow value by the primary contact recreation 1 use geometric mean criterion (35 cfu/100 mL) and a conversion factor, resulting in units of cfu/day. The resulting modified LDCs plot each bacteria load value (y axis) against its exceedance value (x axis). Exceedance values along the x axis represent the percent of days that the bacteria load was at or above the allowable load on the y axis.

Historical bacteria data from June 8, 2003 through December 31, 2018 were obtained from TCEQ's Surface Water Quality Monitoring Information System for SWQM stations 10575, 10570, 10566, and 10563. Bacteria concentrations were converted to a daily load by multiplying the measured concentration by the streamflow value on the day the measurement was collected and a conversion factor. The resulting measured daily load points were plotted against the load exceedance for the day the sample was collected.

The plots of the modified LDCs display the frequency and magnitude at which measured loads exceed the maximum allowable loadings for the geometric mean criterion. Measured loads that are above the maximum allowable loading curve indicate an exceedance of the water quality criterion, while those below the curve show compliance.

A useful refinement of the modified LDC approach is to divide the curve into flow-regime regions to analyze exceedance patterns in smaller portions of the duration curves. This approach can support determination of the streamflow conditions under which exceedances are occurring. A commonly used set of regimes, provided in Cleland (2003), is based on the following five intervals along the x axis of the FDCs and LDCs: 0–10% (high flows); 10–40% (moist conditions); 40–60% (mid-range flows); 60–90% (dry conditions); and 90–100% (low flows). The flow regime intervals were selected based on general observation of the developed modified LDCs.

The high flow regime (0–10% exceedance) is used for the TMDL calculations. The median loading of the high flow regime (5% exceedance) is used because it represents a reasonable yet high value for the allowable pollutant load allocation.

Modified Load Duration Curve Results

The modified LDCs developed for each AU watershed are shown in Figures 10–13. Based on these modified LDC results, the following broad linkage statements can be made:

- For AU 0601_04, historical Enterococci data indicate elevated bacteria occurs under all flow conditions, with the highest exceedances under moist conditions (Figure 10).
- For AU 0601_03, historical Enterococci data indicate elevated bacteria occurs under all flow conditions, with the highest exceedances occurring under low flows (Figure 11).
- For AU 0601_02, historical Enterococci data indicate elevated bacteria occurs under all flow conditions, with the highest exceedances occurring under dry conditions and low flows (Figure 12).
- For AU 0601_01, historical Enterococci data indicate elevated bacteria occurs under all flow conditions, with the highest exceedances occurring under dry conditions and low flows (Figure 13).

Regulated stormwater comprises between 20 and 25% of each AU watershed, and, in addition to unregulated sources, likely contributes to loadings under moist and high flow conditions. The compliance history of permitted dischargers indicates periodic exceedances of permitted bacteria limits from domestic and industrial discharges that may contribute to loadings under dry and low flow conditions. Other sources of bacteria loadings under all flow regimes may include SSOs, OSSFs, wildlife, feral hogs, and livestock. However, the actual contributions of bacteria loadings directly attributable to these sources cannot be determined using modified LDCs.

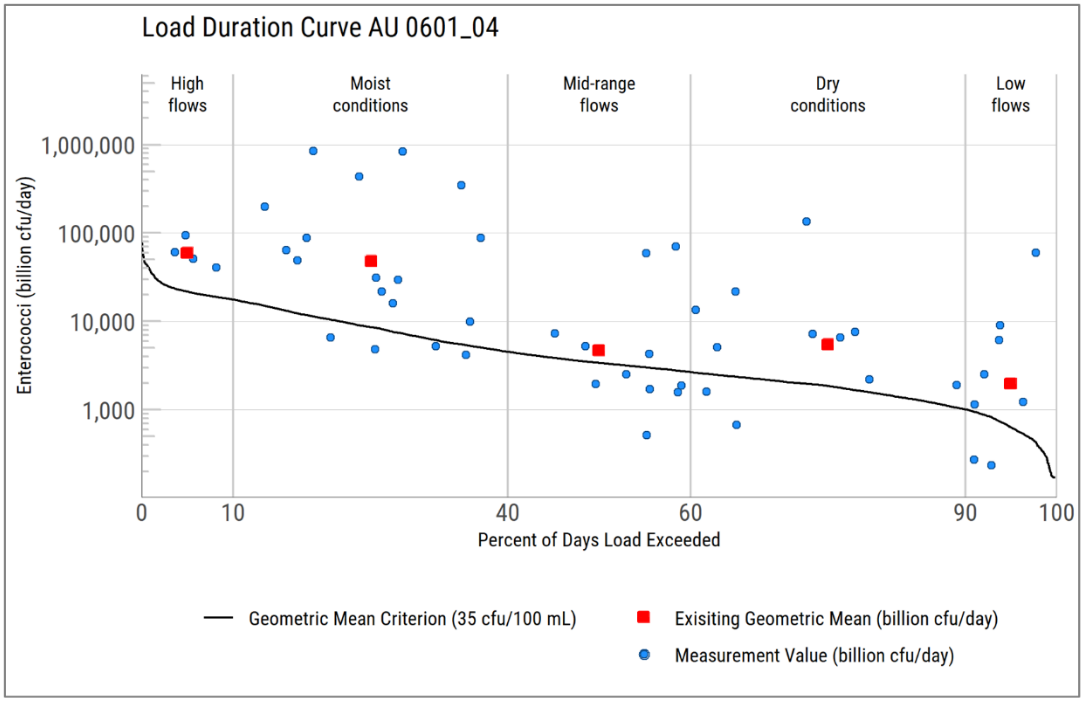

Figure 10. Modified LDC for AU 0601_04 at SWQM Station 10575

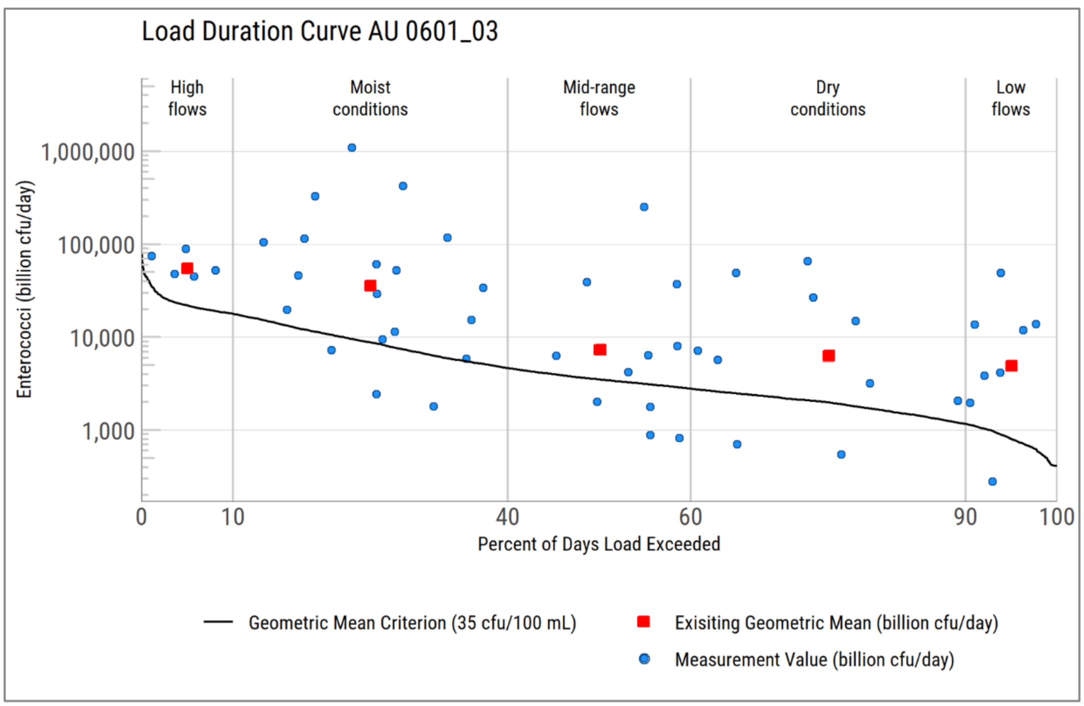

Figure 11. Modified LDC for AU 0601_03 at SWQM Station 10570

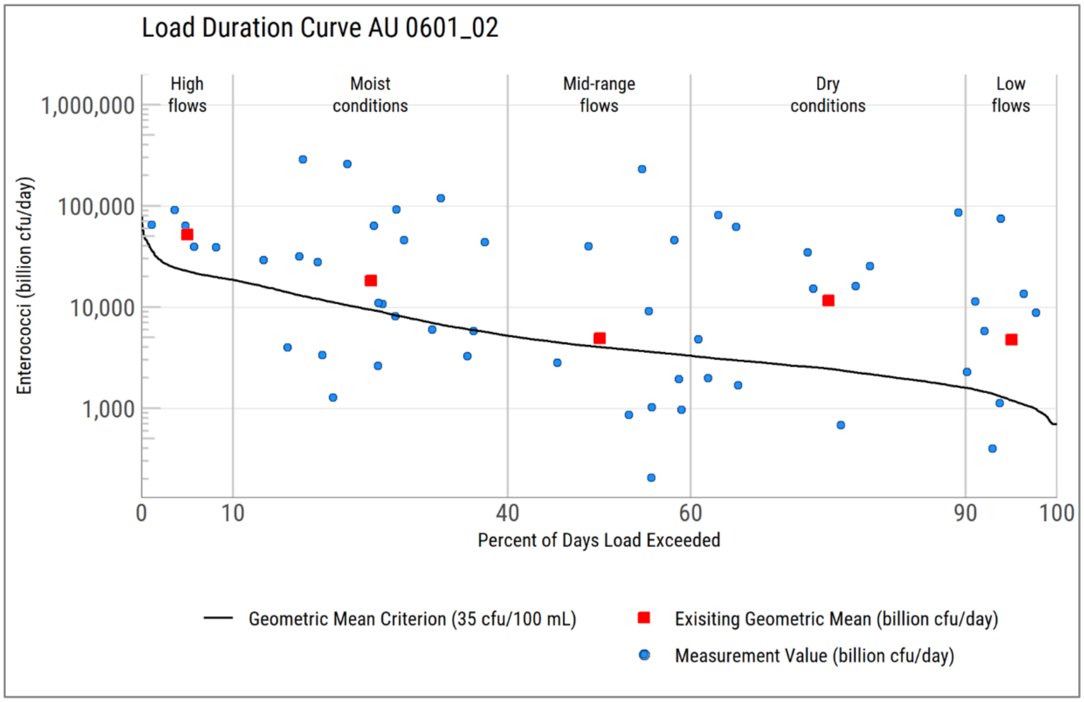

Figure 12. Modified LDC for AU 0601_02 at SWQM Station 10566

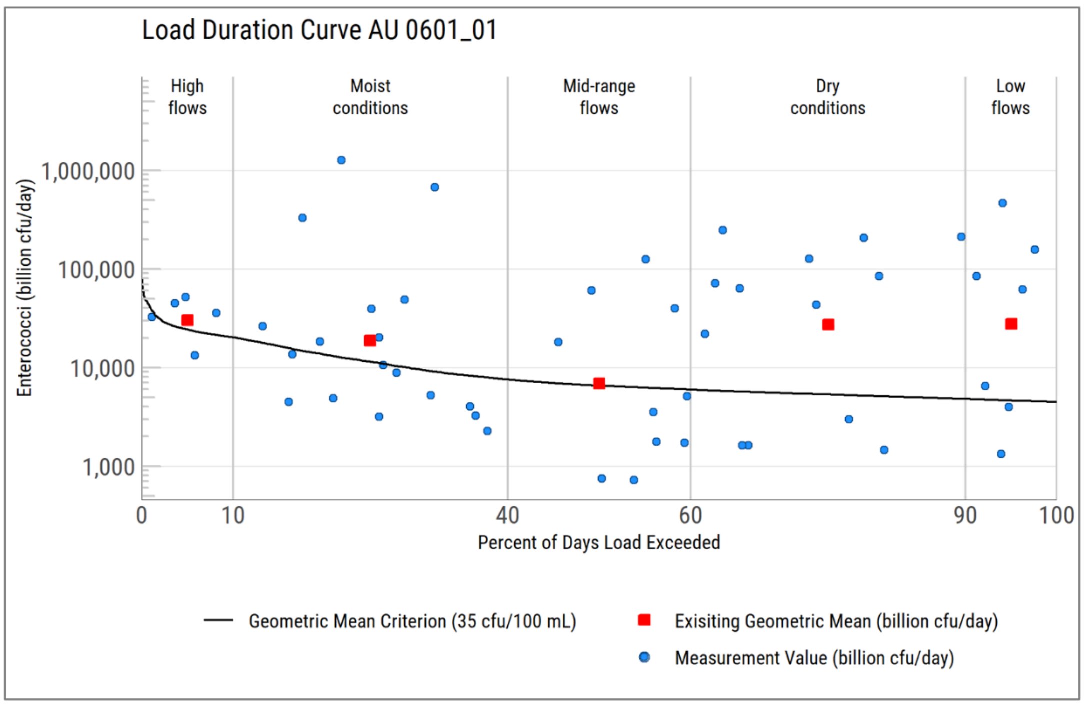

Figure 13. Modified LDC for AU 0601_01 at SWQM Station 10563

Margin of Safety

The margin of safety (MOS) is used to account for uncertainty in the analysis used to develop the TMDL and thus provide a higher level of assurance that the goal of the TMDL will be met. According to EPA guidance (EPA, 1991), the MOS can be incorporated into the TMDL using either of the following two methods:

1) Implicitly incorporating the MOS using conservative model assumptions to develop allocations.
2) Explicitly specifying a portion of the TMDL as the MOS and using the remainder for allocations.

The 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. These TMDLs incorporate 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

TMDLs can be expressed in terms of mass per time, toxicity, or other appropriate measures [40 CFR 130.2(i)]. For Enterococci, TMDLs are expressed as cfu/day, and represent the maximum one-day load the stream can assimilate while still attaining the standards for surface water quality.

The TMDL components for the impaired AUs are derived using the median flow within the high-flow regime (or 5% flow) of the modified LDCs developed for each of the AU watersheds. For the remainder of this report, each section will present an explanation of the TMDL component first, followed by the results of the calculation for that component.

Assessment Unit-Level TMDL Calculations

The TMDLs for the impaired AUs were developed as pollutant load allocations based on information from the modified LDCs developed for TCEQ SWQM stations 10575, 10570, 10566, and 10563 (Figure 1). The bacteria modified LDCs were developed by multiplying the streamflow values along the modified FDC by the primary contact recreation 1 use geometric mean criterion for Enterococci (35 cfu/100 mL) and by the conversion factor to convert to loading in cfu per day. This effectively displays the modified LDC as the TMDL curve of maximum allowable loading:

TMDL (billion cfu/day) = Criterion * Flow * Conversion Factor

Where:

Criterion = 35 cfu/100 mL Enterococci

Flow = 5% exceedance flow from modified FDC in cubic feet per second (cfs)

Conversion Factor (to billion cfu/day) = 28,316.8 mL/cubic foot (ft^3) * 86,400 seconds/day ÷ 1,000,000,000

Table 15 shows the TMDL values at the 5% load duration exceedance.

Table 15. Summary of allowable loadings

AU	5% Exceedance Flow (cfs)	5% Exceedance Load (Billion cfu/day)	TMDL (Billion cfu/day)
0601_04	25,662	21,974.371	21,974.371
0601_03	25,962	22,231.261	22,231.261
0601_02	26,675	22,841.803	22,841.803
0601_01	28,916	24,760.772	24,760.772

All loads are expressed in billion cfu/day.

Margin of Safety Formula

The MOS is applied only to the allowable loading for a watershed. Therefore, the MOS is expressed mathematically as the following:

MOS = 0.05 * TMDL

Where:

TMDL = total maximum daily load

The MOS calculations for each AU are shown in Table 16.

Table 16. MOS calculations

AU	TMDL	MOS
0601_04	21,974.371	1,098.719
0601_03	22,231.261	1,111.563
0601_02	22,841.803	1,142.090
0601_01	24,760.772	1,238.039

All loads are expressed in billion cfu/day.

Wasteload Allocation

The WLA is the sum of loads from regulated sources. The WLA consists of two parts — the wasteload that is assigned to TPDES-regulated WWTFs (WLA_{WWTF}) and the wasteload that is assigned to regulated stormwater dischargers (WLA_{SW}).

$$WLA = WLA_{WWTF} + WLA_{SW}$$

Wastewater Treatment Facilities

Determination of the WLA_{WWTF} requires development of a daily WLA for each TPDES-permitted facility. The full permitted daily average flow of each WWTF is multiplied by the instream geometric criterion for the water body and the conversion factor. This calculation is expressed by:

$$WLA_{WWTF} \text{ (billion cfu/day)} = \text{Criterion} * \text{Flow} * \text{Conversion Factor}$$

Where:

Criterion = 35 cfu/100 mL for Enterococci; 126 cfu/100 mL for *E. coli*

Flow = full permitted flow (MGD)

Conversion Factor (to billion cfu/day) = 3,785,411,800 mL/million gallons ÷ 1,000,000,000

Using this equation, each WWTF's allowable loading was calculated using the permittee's full permitted flow. The individual results were summed for each AU. The saltwater Enterococci primary contact recreation 1 use geometric mean criterion of 35 cfu/100 mL is used as the WWTF target. Two TPDES-permitted WWTFs (WQ0014049001 and WQ0010875001) have *E. coli* limits specified in their permits. For these, the freshwater *E. coli* primary contact recreation 1 use geometric mean criterion of 126 cfu/100 mL was used as the WWTF target.

Table 17 shows the load allocations for each WWTF and sums the load allocations, providing a total WLA_{WWTF} for the AUs.

Since the pollutant load allocations are developed in terms of Enterococci as the indicator bacteria, the Enterococci loadings from Table 17 will be used in subsequent computations. Three industrial permits (WQ0000473000, WQ0000316000, and WQ0000336000) are authorized to discharge treated effluent with a human waste component. Their permits include effluent limits for Enterococci and monitoring requirements. These permits, however, do not have numeric final permitted flows for the outfalls with the human waste component. They are included in Table 17 for completeness but will not receive an individual WLA.

Regulated Stormwater

Stormwater discharges from MS4s, industrial facilities, concrete production, and construction activities are considered regulated point sources. Therefore, the WLA calculations must also include an allocation for regulated stormwater discharges (WLA_{SW}). A simplified approach for estimating the WLA_{sw} for these areas was used in the development of these TMDLs due to the limited amount of data available, the complexities associated with simulating rainfall runoff, and the variability of stormwater loading.

The percentage of land area in each watershed that is under the jurisdiction of stormwater permits was used to estimate the amount of the overall runoff load that should be allocated as the regulated stormwater contribution in the WLA_{SW} component of the TMDL. The load allocation (LA) component of the TMDL corresponds to direct nonpoint source runoff and is the difference between the total load from stormwater runoff and the portion allocated to WLA_{SW}.

Table 17. Wasteload allocations for TPDES-permitted facilities

AU	TPDES Number	Outfall	Permittee	Bacteria Limit (cfu/100 mL)	Full Permitted Flow (MGD)	*E. coli* WLA_{WWTF} (billion CFU/day)	Enterococci WLA_{WWTF} (billion CFU/day)
0601_04	WQ0014049001	001	Vidor MHP No. 1 LLC	126 (*E. coli*)	0.0225	0.107	0.030
0601_04	WQ0000493000	001	WestRock Texas LP	35 (Enterococci)	65.0	310.025	86.118
0601_03	WQ0010875001	001	Orange County Water Control and Improvement District No. 1	126 (*E. coli*)	3.0	14.309	3.975
0601_03	WQ0001727000	001	Neches River Treatment Corporation and Lower Neches Valley Authority	35 (Enterococci)	21.0	100.162	27.823
0601_02	WQ0010477004	001	City of Port Neches	35 (Enterococci)	4.98	23.753	6.598
0601_02	WQ0000473000	101	Lucite International Inc.	35 (Enterococci)	n/a	n/a	n/a
0601_02	WQ0000316000	002	Phillips 66 Gulf Coast Properties LLC and Phillips 66 Pipeline LLC	35 (Enterococci)	n/a	n/a	n/a
0601_01	WQ0000511000	301	Huntsman Petrochemical LLC, Huntsman Propylene Oxide LLC (now known as Indorama Ventures Propylene Oxides LLC), Bluehall Incorporated, and TPC Group LLC	35 (Enterococci)	15.0	71.544	19.873
0601_01	WQ0000336000	801	Entergy Texas Inc.	89 (Daily Max, Enterococci)	n/a	n/a	n/a
				0601_04 Total	**65.0225**	**310.132**	**86.148**
				0601_03 Total	**89.0225**	**424.603**	**117.946**
				0601_02 Total	**94.0025**	**448.356**	**124.544**
				0601_01 Total	**109.0025**	**519.900**	**144.417**

WLA_{SW} is the sum of loads from regulated stormwater sources and is calculated as:

$$WLA_{SW} = (TMDL - WLA_{WWTF} - FG - MOS) * FDA_{SWP}$$

Where:

TMDL = total maximum daily load

WLA_{WWTF} = sum of all WWTF loads

FG = sum of future growth loads from potential regulated facilities

MOS = margin of safety load

FDA_{SWP} = fractional proportion of drainage area under jurisdiction of stormwater permits

The FDA_{SWP} must be calculated to arrive at the fractional proportion of the drainage area under jurisdiction of stormwater permits. FDA_{SWP} was calculated by first totaling the area of each stormwater permit and authorization. The stormwater sources and area estimates were discussed in the "TPDES Regulated Stormwater" section. Those area estimates were determined for each category and summed up to determine the total area under stormwater jurisdiction in each AU. To arrive at the proportion, the area under stormwater jurisdiction was then divided by the total watershed area. The estimated watershed areas in Table 18 are cumulative, each AU accounts for the upstream area contribution by adding the total area of regulated stormwater for the AU and that of the upstream AU and then dividing by the watershed area.

Table 18. Regulated stormwater FDA_{SWP} calculations

AU	Estimated Area of Regulated Stormwater (square miles)	Watershed Area (square miles)	FDA_{SWP}
0601_04	16.24	79.60	0.204
0601_03	30.67	131.17	0.234
0601_02	42.18	166.70	0.253
0601_01	49.05	210.75	0.233

A value for FG is necessary to complete the WLA_{SW}. The calculation for FG is presented in the later section “Allowance for Future Growth,” but the results will be included here for continuity. The WLA_{SW} calculations are presented in Table 19.

Table 19. Regulated stormwater load calculations

AU	TMDL	WLA_{WWTF}	FG	MOS	FDA_{SWP}	WLA_{SW}
0601_04	21,974.371	86.148	21.623	1,098.719	0.204	4,236.648
0601_03	22,231.261	117.946	29.604	1,111.563	0.234	4,907.483
0601_02	22,841.803	124.544	31.260	1,142.090	0.253	5,450.609
0601_01	24,760.772	144.417	36.249	1,238.039	0.233	5,438.702

All loads are expressed in billion cfu/day.

With the WLA_{SW} and WLA_{WWTF} terms, the total WLA term can be determined by adding the two parts (Table 20).

Table 20. WLA calculations

AU	WLA_{WWTF}	WLA_{SW}	WLA
0601_04	86.148	4,236.648	4,322.796
0601_03	117.946	4,907.483	5,025.429
0601_02	124.544	5,450.609	5,575.153
0601_01	144.417	5,438.702	5,583.119

In UAs currently regulated by an MS4 permit, development and/or re-development of land must include the implementation of the control measures and programs outlined in an MS4's approved SWMP. Although additional flow may occur from development or redevelopment, loading of the pollutant of concern should be controlled or reduced through the implementation of BMPs as specified in both the TPDES permit and the approved SWMP.

An iterative, adaptive management approach will be used to address stormwater discharges. This approach encourages the implementation of structural or non-structural controls, implementation of mechanisms to evaluate the performance of the controls, and finally, allowance to adjust (e.g., more stringent controls or specific BMPs) as necessary to protect water quality.

Implementation of Wasteload Allocations

The TMDLs in this document will result in protection of existing uses and conform to Texas' antidegradation policy. The three-tiered antidegradation policy in the Texas Surface Water Quality Standards prohibits an increase in loading that would cause or contribute to degradation of an existing use. The antidegradation policy applies to point source pollutant discharges. In general, antidegradation procedures establish a process for reviewing individual proposed actions to determine if the activity will degrade water quality.

TCEQ intends to implement the individual WLAs through the permitting process as monitoring requirements and/or effluent limitations as required by the amendment of Title 30, Texas Administrative Code (TAC) Chapter 319, which became effective November 26, 2009. WWTFs discharging to TMDL water bodies will be assigned an effluent limit based on the TMDL. Monitoring requirements are based on permitted flow rates and are listed in 30 TAC Section 319.9.

Permit requirements are implemented during the routine permit renewal process. However, there may be a more economical or technically feasible means of achieving the goal of improved water quality, and circumstances may warrant changes in individual WLAs after these TMDLs are adopted. Therefore, the individual WLAs, as well as the WLAs for stormwater, are non-binding until implemented via a separate TPDES permitting action, which may involve preparation of an update to the state's WQMP. Regardless, all permitting actions will comply with the TMDLs.

The executive director or commission may establish interim effluent limits and/or monitoring-only requirements during amendment or renewal of a permit. These interim limits will allow a permittee time to modify effluent quality to attain the final effluent limits necessary to meet TCEQ- and EPA-approved TMDL allocations. The duration of any interim effluent limits may not be any longer than three years from the date of permit re-issuance. Compliance schedules are not allowed for new permits.

Where a TMDL has been approved, domestic WWTF TPDES permits will require conditions consistent with the requirements and assumptions of the WLAs. For TPDES-regulated municipal stormwater, construction stormwater, and industrial stormwater discharges, water quality-based effluent limits (WQBELs) that implement the WLA for stormwater may be expressed as BMPs or other similar requirements, rather than as numeric effluent limits.

The November 26, 2014 memorandum from EPA relating to establishing WLAs for stormwater sources states:

> "Incorporating greater specificity and clarity echoes the approach first advanced by EPA in the 1996 Interim Permitting Policy, which anticipated that where necessary to address water quality concerns, permits would be modified in subsequent terms to include "more specific conditions or limitations [which] may include an integrated suite of BMPs, performance objectives, narrative standards, monitoring triggers, numeric WQBELs, action levels, etc."

Using this iterative, adaptive BMP approach to the maximum extent practicable is appropriate to address the stormwater components of this TMDL.

Updates to Wasteload Allocations

These TMDLs are, by definition, the total of the sum of the WLA (including FG), the sum of the LA, and the MOS. Changes to individual WLAs may be necessary in the future to accommodate growth or other changing conditions. These changes to individual WLAs do not ordinarily require a revision of the TMDL report; instead, changes will be made through updates to the state's WQMP. Any future changes to effluent limitations will be addressed through the permitting process and by updating the WQMP.

Load Allocation

The LA is the sum of loads from unregulated sources, and is calculated as:

LA = TMDL - WLA - FG - MOS

Where:

TMDL = total maximum daily load

WLA_{WWTF} = sum of all WWTF loads

WLA_{SW} = sum of all regulated stormwater loads

FG = sum of future growth loads from potential regulated facilities

MOS = margin of safety load

Table 21 summarizes the LA.

Table 21. LA calculations

AU	TMDL	WLA_{WWTF}	WLA_{SW}	FG	MOS	LA
0601_04	21,974.371	86.148	4,236.648	21.623	1,098.719	16,531.233
0601_03	22,231.261	117.946	4,907.483	29.604	1,111.563	16,064.665
0601_02	22,841.803	124.544	5,450.609	31.260	1,142.090	16,093.300
0601_01	24,760.772	144.417	5,438.702	36.249	1,238.039	17,903.365

All loads are expressed in billion cfu/day.

Allowance for Future Growth

The FG component of the TMDL equation addresses the requirement to account for future loadings that may occur due to population growth, changes in community infrastructure, and development. Specifically, this TMDL component considers 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 will result in protection of existing uses and conform to Texas' antidegradation policy.

To account for the FG, the loadings from WWTFs are included in the FG computation, which is based on the WLA_{WWTF} formula. The FG equation includes an additional term to account for project population growth within WWTF service areas between 2020 and 2070, based on TWDB Regional Water Plan Population and Water Demand Projections (TWDB, 2019).

$$FG \text{ (billion cfu/day)} = Criterion * (\%POP_{2020-2070} * WWTF_{FP}) * Conversion\ Factor$$

Where:

Criterion = 35 cfu/100 mL (Enterococci)

$\%POP_{2020-2070}$ = estimated percentage increase in population between 2020 and 2070

$WWTF_{FP}$ = full permitted discharge (MGD)

Conversion Factor (to billion cfu/day) = 3,785,411,800 mL/million gallons ÷ 1,000,000,000

Table 22 summarizes the FG.

Table 22. FG calculations

AU	Full Permitted Flow (MGD)	Percentage Population Increase (2020–2070)	FG Flow (MGD)	FG
0601_04	65.0225	25.1%	16.321	21.623
0601_03	89.0225	25.1%	22.345	29.604
0601_02	94.0025	25.1%	23.595	31.260
0601_01	109.0025	25.1%	27.360	36.249

All loads are expressed in billion cfu/day.

Compliance with these TMDLs is based on keeping the bacteria concentrations in the selected waters below the limits that were set as criteria for the individual sites. FGs of existing or new point sources are not limited by these TMDLs if 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 modified LDCs and tables in this TMDL report will guide determination of the assimilative capacity of the water bodies under changing conditions, including FG.

Summary of TMDL Calculations

The TMDLs were calculated based on the median flow in the 0–10 percentile range (5% exceedance, high flow regime) for flow exceedance based on the modified LDCs developed at TCEQ SWQM stations 10575, 10570, 10566, and 10563.

Allocations are based on the current geometric mean criterion for Enterococci of 35 cfu/100 mL for each component of the TMDLs. The TMDL allocations for the Neches River Tidal AUs are summarized in Table 23.

Table 23. TMDL allocations

AU	TMDL	WLA_{WWTF}	WLA_{SW}	LA	FG	MOS
0601_04	21,974.371	86.148	4,236.648	16,531.233	21.623	1,098.719
0601_03	22,231.261	117.946	4,907.483	16,064.665	29.604	1,111.563
0601_02	22,841.803	124.544	5,450.609	16,093.300	31.260	1,142.090
0601_01	24,760.772	144.417	5,438.702	17,903.365	36.249	1,238.039

All loads are expressed in billion cfu/day.

The final TMDL allocations (Table 24) needed to comply with the requirements of 40 CFR 130.7 include the FG component within the WLA_{WWTF}.

Table 24. Final TMDL allocations

AU	TMDL	WLA_{WWTF}	WLA_{SW}	LA	MOS
0601_04	21,974.371	107.771	4,236.648	16,531.233	1,098.719
0601_03	22,231.261	147.550	4,907.483	16,064.665	1,111.563
0601_02	22,841.803	155.804	5,450.609	16,093.300	1,142.090
0601_01	24,760.772	180.666	5,438.702	17,903.365	1,238.039

All loads are expressed in billion cfu/day.

Seasonal Variation

Federal regulations require that TMDLs account for seasonal variation in watershed conditions and pollutant loading [40 CFR 130.7(c)(1)]. Analysis of the seasonal differences in indicator bacteria concentrations were assessed by comparing Enterococci concentrations obtained from 16 years (2003 through 2018) 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 Enterococci concentrations obtained in warmer versus cooler months were then evaluated by performing a Wilcoxon Rank Sum test (also known as the "Mann-Whitney" test). The test was considered significant at the $\alpha = 0.05$ level.

The Wilcoxon Rank Sum test detected a significant difference in seasonal Enterococci concentrations for AU 0601_04 ($W = 54$, $p = 0.0275$), with warm season samples higher than cool season samples on average. The Wilcoxon Rank Sum test did not detect a significant difference in seasonal Enterococci concentrations in AUs 0601_03, 0601_02, or 0601_01. Seasonal variation is addressed in these TMDLs by incorporating many years of flow and bacteria data spanning all seasons for development of the modified LDCs.

Public Participation

TCEQ maintains an inclusive public participation process. From the inception of the investigation, 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.

TCEQ and the Texas Water Resources Institute (TWRI) are jointly coordinating public participation in development of both the TMDLs and the implementation plan (I-Plan). The first of a series of public meetings to engage stakeholders was held on August 22, 2019 in Beaumont to discuss the project and make the public aware of the TMDLs. A webinar was held on April 9, 2020 to initiate I-Plan development and additional webinars were held in August 2020 to provide information on TMDL allocations and WLAs. Meetings were held in 2021 to develop management measures to include in the I-Plan.

Notices of meetings were posted on the project webpages for both TCEQ and TWRI. At least two weeks prior to scheduled meetings, TWRI issued media releases and formally invited stakeholders to attend. To ensure that absent or new stakeholders could get information about past meetings and pertinent material, the TCEQ project webpage[3] provided meeting summaries, presentations, and documents produced for stakeholder review.

Implementation and Reasonable Assurance

The issuance of TPDES permits consistent with TMDLs provides reasonable assurance that WLAs in this TMDL report will be achieved. Per federal requirements, each TMDL is included in an update to the Texas WQMP as a plan element.

[3] www.tceq.texas.gov/waterquality/tmdl/nav/118-nechestidal-bacteria

The WQMP coordinates and directs the state's efforts to manage water quality and maintain or restore designated uses throughout Texas. The WQMP is continually updated with new, more specifically focused plan elements, as identified in federal regulations [40 CFR 130.6(c)]. Commission adoption of a TMDL is the state's certification of the associated WQMP update.

Because the TMDLs do not reflect or direct specific implementation by any single pollutant discharger, TCEQ certifies additional elements to the WQMP after the I-Plan is approved by the commission. Based on the TMDLs and I-Plan, TCEQ will propose and certify WQMP updates to establish required WQBELs for specific TPDES wastewater discharge permits.

For MS4 entities, where numeric effluent limitations are infeasible, the permits require that the MS4 develop and implement BMPs under each MCM, which are a substitute for effluent limitations, as allowed by federal rules. How a regulated MS4 meets each MCM is not prescribed in detail in the MS4 permits but is included in the permittee's SWMP. During the permit renewal process, TCEQ revises MS4 permits as needed to require the implementation of other specific revisions in accordance with an approved TMDL and I-Plan.

Strategies for achieving pollutant loads in TMDLs from both point and nonpoint sources are reasonably assured by the state's use of an I-Plan. TCEQ is committed to supporting implementation of all TMDLs adopted by the commission.

I-Plans for Texas TMDLs use an adaptive management approach that allows for refinement or addition of methods to achieve environmental goals. This adaptive approach reasonably assures that the necessary regulatory and voluntary activities to achieve pollutant reductions will be implemented. Periodic, repeated evaluations of the effectiveness of implementation methods ascertain whether progress is occurring and may show that the original distribution of loading among sources should be modified to increase efficiency. I-Plans will be adapted as necessary to reflect needs identified in evaluations of progress.

Key Elements of an I-Plan

An I-Plan includes a detailed description and schedule of the regulatory and voluntary management measures to implement the WLAs and LAs of particular TMDLs within a reasonable time. I-Plans also identify the organizations responsible for carrying out management measures, and a plan for periodic evaluation of progress.

Strategies to optimize compliance and oversight are identified in an I-Plan when necessary. Such strategies may include additional monitoring and reporting of effluent discharge quality to evaluate and verify loading trends, adjustment of an inspection frequency or a response protocol to public complaints, and escalation of an enforcement remedy to require corrective action of a regulated entity contributing to an impairment.

TCEQ works with stakeholders and interested governmental agencies to develop and support I-Plans and track their progress. Work on the I-Plan begins during development of TMDLs. Because these TMDLs address agricultural sources of pollution, TCEQ will also work in close partnership with TSSWCB when developing the I-Plan. TSSWCB is the lead agency in Texas responsible for planning, implementing, and managing programs and practices for preventing and abating agricultural and silvicultural nonpoint sources of water pollution. The cooperation required to develop an I-Plan will become a cornerstone for the shared responsibility necessary to carry it out.

Ultimately, the I-Plan identifies the commitments and requirements to be implemented through specific permit actions and other means. For these reasons, the approved I-Plan may not approximate the predicted loadings identified category by category in the TMDLs and its underlying assessment. The I-Plan is adaptive for this very reason; it allows for continuous update and improvement.

In most cases, it is not practical or feasible to approach all TMDL implementation as a one-time, short-term restoration effort. This is particularly true when a challenging wasteload reduction or load reduction is required by the TMDL, there is high uncertainty with the TMDL analysis, there is a need to reconsider or revise the established water quality standard, or the pollutant load reduction would require costly infrastructure and capital improvements.

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Appendix A. Population and Population Projections

The following steps detail the method used to estimate the 2010 and projected 2070 populations in the AU watersheds.:

Estimate 2010 watershed population

1) Obtained 2010 USCB data at the block level.
2) Developed 2010 watershed population using the USCB block level data for the portion of the census blocks located within the watershed.
3) For the census blocks that were partially located in the watershed, estimated population by multiplying the block population to the proportion of its area within the watershed.

Estimate 2020–2070 watershed population

4) Obtained decadal percentage increases in population using the decadal population projections for Jasper, Jefferson, and Orange counties from the 2021 Regional Water Plan Population and Water Demand Projection data (TWDB, 2019).
5) For the counties that were partially located in the watershed, estimated population by multiplying the county population by the proportion of its area within the watershed.
6) Calculated the population percentage increase from the published USCB 2010 county populations and the 2020 county population projections (TWDB, 2019). Multiplied the county projected increases by the 2010 watershed population to calculate the 2020 watershed population.
7) Calculated the projected population percentage increase from 2020 to 2070 from the TWDB Regional Water Plan Population and Water Demand Projections data (TWDB, 2019). Multiplied the county projected increases by the 2020 watershed population to calculate the 2070 watershed population.