

Buffalo and Whiteoak Bayous: A Community Project to Protect Recreational Uses

[Eighteen Total Maximum Daily Loads for Bacteria in Buffalo and Whiteoak Bayous and Tributaries](#)

Adopted April 8, 2009.

Approved by EPA June 11, 2009.

[One TMDL for Vogel Creek Added by Addendum I, April 2013](#)

Via the April 2013 Update to the Texas Water Quality Management Plan.

Approved by EPA August 28, 2013.

[One TMDL for Rolling Fork Creek Added by Addendum II, April 2015](#)

Via the April 2015 Update to the Texas Water Quality Management Plan.

Approved by EPA July 27, 2015.

One TMDL for Horsepen Creek Added by this Addendum III, January 2021

Via the January 2021 Update to the Texas Water Quality Management Plan (SFR-121/2021-02).

Approved by EPA July 29, 2021 (scroll to view or print this addendum).



Addendum Three to Eighteen TMDLs for Bacteria in Buffalo and Whiteoak Bayous and Tributaries

Adding One TMDL for Indicator Bacteria in AU 1014C_01 One TMDL for Indicator Bacteria in Horsepen Creek

Introduction

The Texas Commission on Environmental Quality (TCEQ) adopted *Eighteen Total Maximum Daily Loads for Bacteria in Buffalo and Whiteoak Bayous and Tributaries* (TCEQ, 2009) on April 8, 2009. The total maximum daily loads (TMDLs) were approved by the United States Environmental Protection Agency (EPA) on June 11, 2009. An addendum to the original TMDL was submitted to EPA through the April 2013 Water Quality Management Plan (WQMP) update (TCEQ, 2013). That addendum added one additional assessment unit (AU). A second addendum to the original TMDL was submitted to EPA through the April 2015 WQMP update (TCEQ, 2015). That addendum also added one additional AU. This document represents a third addendum to the original TMDL document.

This addendum includes information specific to one additional AU (Horsepen Creek; 1014C_01) located within the watershed of the approved TMDL project for bacteria in Buffalo and Whiteoak bayous. The concentration of indicator bacteria in this additional AU exceeds the criterion used to evaluate attainment of the primary contact recreation 1 use. This addendum provides the details related to developing the TMDL allocation for this additional AU, which was not specifically addressed in the original TMDL document. For background or other explanatory information, please refer to the [*Technical Support Document for One Total Maximum Daily Load for Indicator Bacteria for Horsepen Creek*](#)¹ (Brady and Millican, 2020). Refer to the original, approved TMDL document for details related to the overall project watershed as well as the methods and assumptions used in developing the original TMDLs.

Problem Definition

TCEQ first identified the bacteria impairment for Horsepen Creek in the *2016 Texas Integrated Report of Surface Water Quality for Clean Water Act Sections 305(b) and 303(d)* (2016 Texas Integrated Report; TCEQ, 2019) and then in each subsequent

¹ <https://www.tceq.texas.gov/assets/public/waterquality/tmdl/22buffalobayou/22-horsepencreek-tds-bacteria-2020october.pdf>

edition through 2020, the latest EPA-approved edition. The impaired AU is 1014C_01. Horsepen Creek is composed of three AUs. The impaired AU is located at the downstream end of the water body. The Horsepen Creek watershed is located entirely within Harris County. Figure 1 shows the Horsepen Creek watershed in relation to the entire watershed of the original TMDLs, which also includes the watersheds from the first two addenda.

The Texas Surface Water Quality Standards (TSWQS; TCEQ, 2018) identify uses for surface waters and numeric and narrative criteria to evaluate attainment of those uses. The basis for the water quality target for the TMDL developed in this report is the numeric criterion for indicator bacteria from the 2018 TSWQS. *Escherichia coli* (*E. coli*) is the indicator bacteria for assessing primary contact recreation 1 use in freshwater.

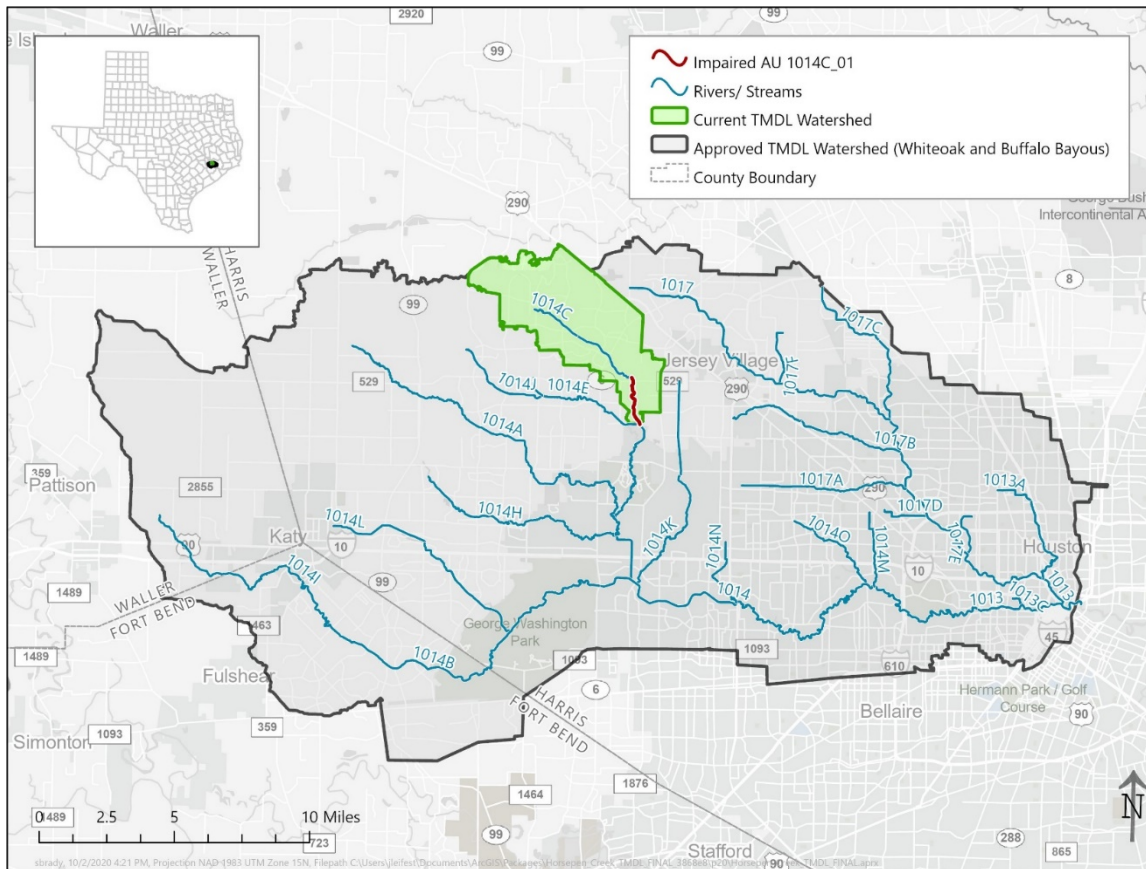


Figure 1. Map showing the previous TMDL watersheds and the current Horsepen Creek TMDL watershed considered in this addendum

Table 1 summarizes the ambient water quality data for the TCEQ surface water quality monitoring (SWQM) station on Horsepen Creek, as reported in the 2020 Texas Integrated Report (TCEQ, 2020a). The data from the assessment indicate nonsupport of

the primary contact recreation 1 use for the AU, because the geometric mean concentration for *E. coli* exceeds the freshwater geometric mean criterion of 126 colony forming units (cfu)/100 milliliters (mL) of water. Monitoring within the Horsepen Creek watershed has occurred at TCEQ SWQM station 20465 (Figure 2).

Table 1. 2020 Texas Integrated Report summary for the Horsepen Creek TMDL watershed

AU	Station	Parameter	Number of Samples	Date Range	<i>E. coli</i> Geometric Mean (cfu/100 mL)
1014C_01	20465	<i>E. coli</i>	28	12/01/11 – 11/30/18	413.6

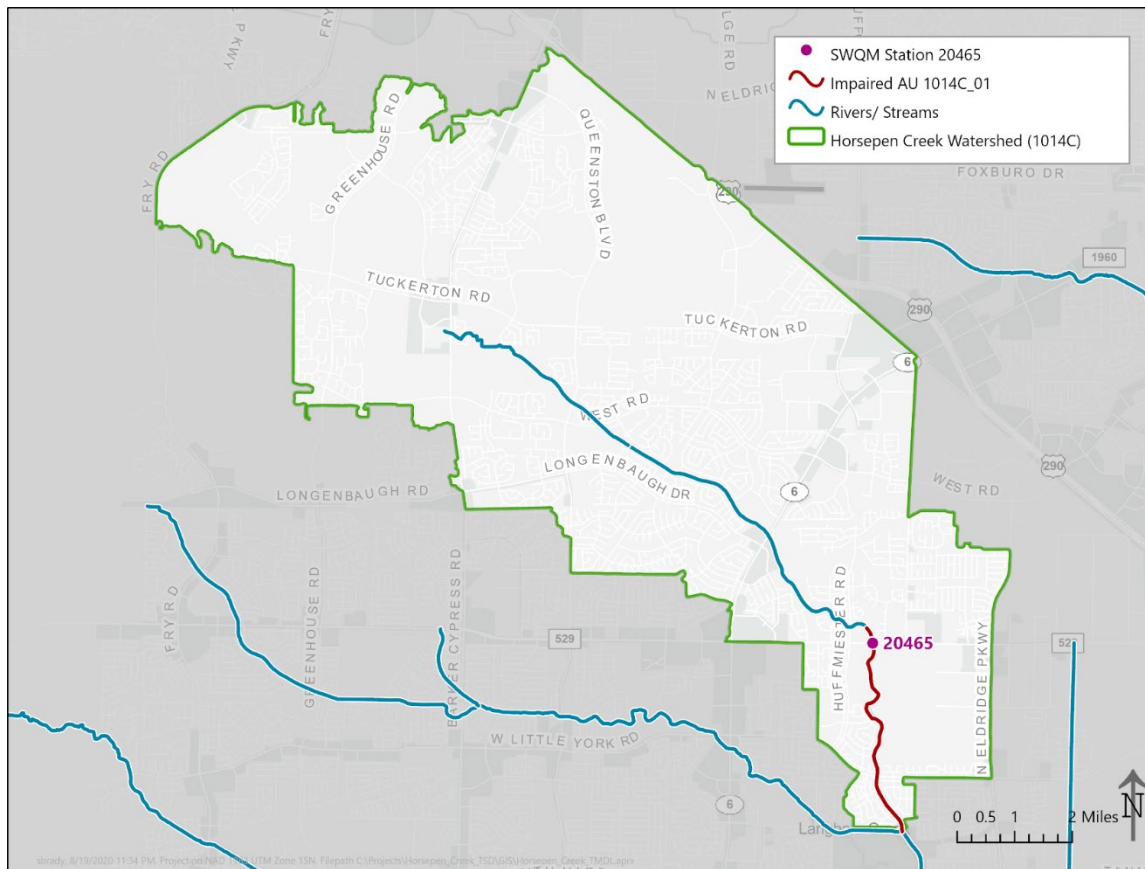


Figure 2. Horsepen Creek TMDL watershed showing the TCEQ SWQM station

Watershed Overview

Horsepen Creek (1014C) is a tributary to Buffalo Bayou (Segment 1014) and is approximately 6.8 miles in length, entirely within Harris County. The Horsepen Creek watershed drains an area of approximately 13,378 acres. Horsepen Creek is a perennial, unclassified freshwater stream.

The 2020 Texas Integrated Report (TCEQ, 2020a) provides the following water body and AU descriptions:

- Horsepen Creek; 1014C - From the Langham Creek confluence upstream to a point 0.1 km (0.06 mi) west of Barker Cypress Road.
 - AU 1014C_01 - From the Langham Creek confluence upstream to where channelization begins, 0.62 km (0.39 mi) north of FM 529.
 - AU 1014C_02 - From 0.62 (0.39 mi) km north of FM 529 upstream to a point 2.4 km (1.5 mi) upstream of SH 6.
 - AU 1014C_03 - From a point 2.4 km (1.5 mi) upstream of SH 6 to 0.1 km (0.06 mi) west of Barker Cypress Road.

Watershed Climate

The Horsepen Creek watershed is within the eastern portion of the state of Texas categorized as subtropical humid (Larkin and Bomar, 1983). The Gulf of Mexico is the principal source of moisture that drives precipitation in the region. Weather data were obtained for the full period of available daily records (December 2000 – September 2020) for the Houston Sugar Land Mem weather station (USW00012977) (Menne et al, 2012). Data from this period indicate that the average monthly high temperature typically reaches a maximum of 94.5 °F in August, and the average monthly low temperature generally reaches a minimum of 43.2 °F in January (Figure 3). Annual rainfall averages 47.8 inches. The wettest month is August (5.7 inches) while February (2.7 inches) is the driest month, with rainfall occurring throughout the year.

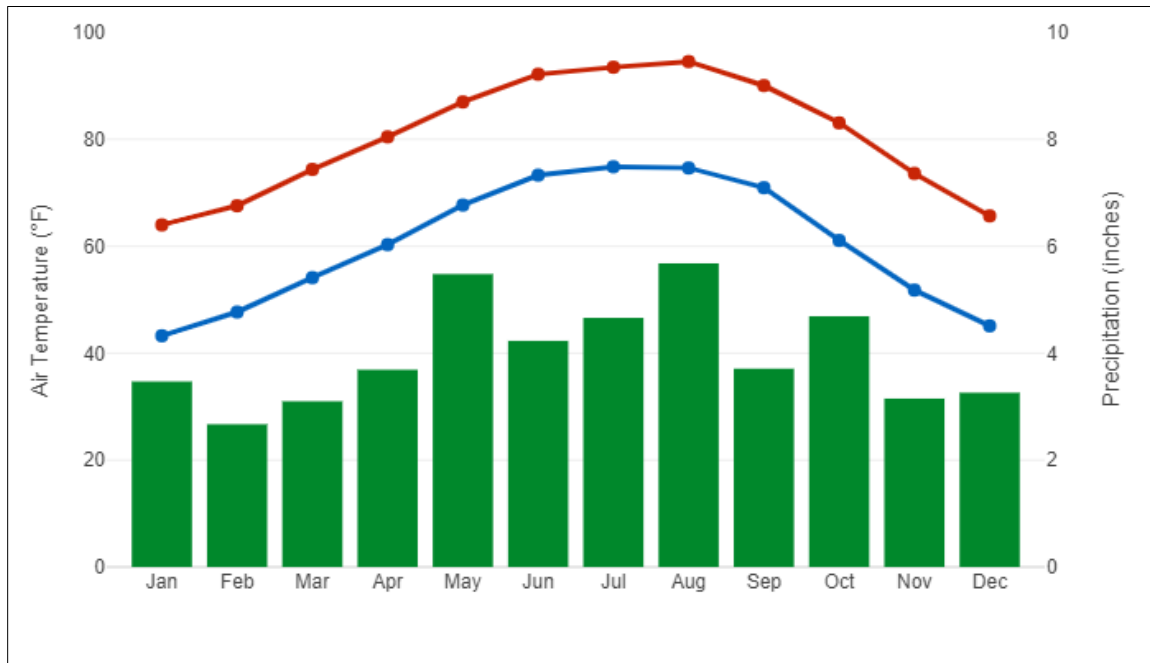


Figure 3. Average minimum and maximum air temperature and total precipitation by month from 2000 through 2020 for the Houston Sugar Land Mem weather station

Watershed Population and Population Projections

As depicted in Figure 1, the Horsepen Creek watershed is geographically located within an unincorporated portion of Harris County. According to the United States Census Bureau (USCB) 2010 Census (USCB, 2010), the Horsepen Creek watershed had an estimated population of 73,514 people in 2010.

Population projections from 2020 through 2070 were developed using data from the 2016 Region H Regional Water Plan (Region H Water Planning Group, 2015) to be consistent with previously completed TMDL addendum in the Buffalo and Whiteoak bayous watershed. Table 2 provides a summary of the population projection for the Horsepen Creek watershed. The procedure used to determine the values shown in Table 2 is detailed in Appendix A.

Table 2. 2010 Population and projected 2020 and 2070 populations for the Horsepen Creek TMDL watershed

Area	2010 U.S. Census Population	2020 Projected Population	2070 Projected Population	Projected Population Increase (2020-2070)	Percent Change (2020-2070)
Horsepen Creek Watershed	73,514	75,892	94,041	18,149	23.9%

Land Cover

The land cover data for the Horsepen Creek watershed were obtained from the United States Geological Survey (USGS) 2016 National Land Cover Database (NLCD; USGS, 2019). The land cover for the Horsepen Creek watershed is shown in Figure 4.

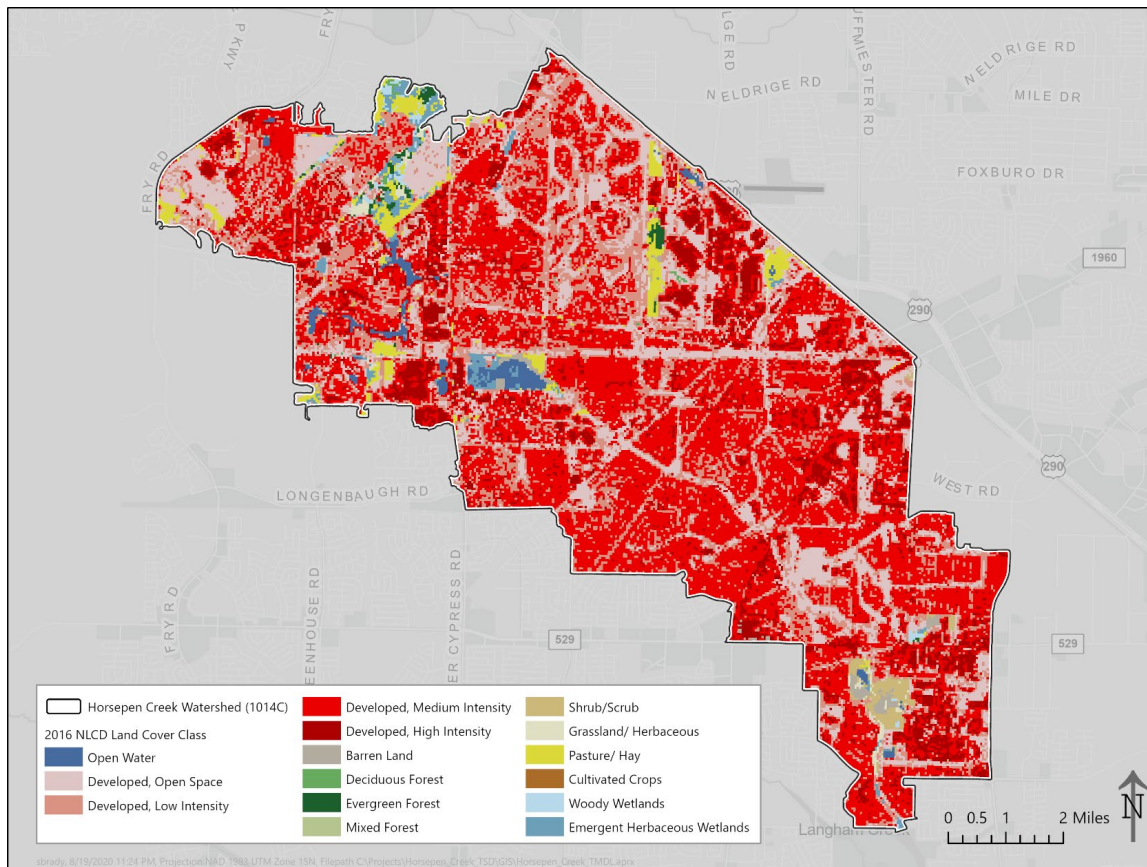


Figure 4. Land cover within the Horsepen Creek TMDL watershed

A summary of the land cover data is provided in Table 3 and indicates that for the Horsepen Creek watershed, Developed, Medium Intensity (42.5%) is the dominant land cover category. When combined, the four Developed categories account for almost 93% of the total land cover in the watershed.

Endpoint Identification

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

Table 3. Land cover within the Horsepen Creek TMDL watershed

2016 NLCD Classification	Area (Acres)	% of Total
Open Water	147.8	1.10%
Developed, Open Space	2,165.6	16.19%
Developed, Low Intensity	3,202.2	23.94%
Developed, Medium Intensity	5,683.2	42.48%
Developed, High Intensity	1,370.1	10.24%
Barren Land	63.7	0.48%
Deciduous Forest	13.6	0.10%
Evergreen Forest	49.0	0.37%
Mixed Forest	3.1	0.02%
Shrub/Scrub	90.6	0.68%
Grassland/Herbaceous	62.1	0.46%
Pasture/Hay	319.2	2.39%
Cultivated Crops	4.0	0.03%
Woody Wetlands	43.2	0.32%
Emergent Herbaceous Wetlands	160.5	1.20%
Total	13,377.83	100%

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. Wastewater treatment facilities (WWTFs) and stormwater discharges from industries, construction, and the separate storm sewer systems of cities are considered point sources of pollution.

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

Except for WWTFs, which receive individual wasteload allocations (WLAs; see the “WLA” 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 WWTF outfalls and stormwater discharges from municipal separate storm sewer systems (MS4s), industries, and construction activities.

Domestic and Industrial WWTFs

As of May 13, 2020, there were 13 domestic and industrial WWTFs (including one with two outfalls) with TPDES permits within the Horsepen Creek watershed (Table 4 and Figure 5).

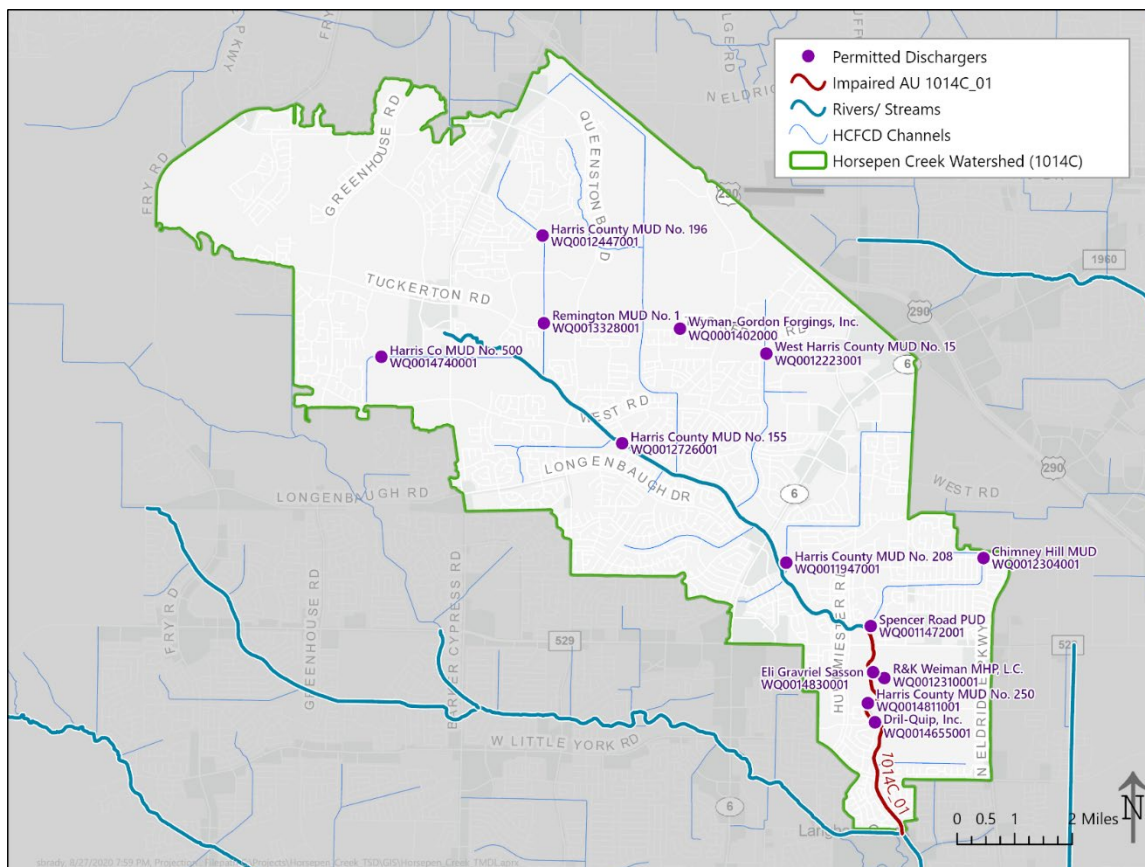


Figure 5. Horsepen Creek TMDL watershed showing WWTFs

Table 4. Permitted WWTFs in the Horsepen Creek TMDL watershed

Permittee	Facility	TPDES Permit No.	Outfall No.	NPDES ^a Permit No.	Daily Average Flow - Permitted Discharge (MGD ^b)
Wyman-Gordon Forgings, Inc.	Wyman Gordon Forgings Cypress Plant	WQ0001402000	1	TX0042129	Intermittent and flow variable ^c
Wyman-Gordon Forgings, Inc.	Wyman Gordon Forgings Cypress Plant	WQ0001402000	2	TX0042129	0.225
Spencer Road Public Utility District (PUD)	Spencer Road WWTF	WQ0011472001	1	TX0026263	0.98
Harris County Municipal Utility District (MUD) No. 208	Copperfield Plant WWTF	WQ0011947001	1	TX0075884	6.7
West Harris County MUD No. 15	West Harris County MUD 15 WWTF	WQ0012223001	1	TX0083496	0.6
Chimney Hill MUD	Chimney Hill MUD WWTF	WQ0012304001	1	TX0085588	1.2
R&K Weiman MHP, L.C.	Weiman MHP WWTF	WQ0012310001	1	TX0085871	0.03
Harris County MUD No. 196	Harris County MUD 196 WWTF	WQ0012447001	1	TX0088838	1.4
Harris County MUD No. 155	Harris County MUD 155 WWTF	WQ0012726001	1	TX0100161	1.55
Remington MUD No. 1	Remington Plant 2	WQ0013328001	1	TX0101371	1.1
Dril-Quip, Inc.	Dril-Quip WWTF	WQ0014655001	1	TX0128287	0.075
Harris Co MUD No. 500	Horsepen Creek WWTF	WQ0014740001	1	TX0129071	0.84
Harris County MUD No. 250	Harris County MUD 250 WWTF	WQ0014811001	1	TX0093581	0.1
Eli Gravriel Sasson	West Houston MHP	WQ0014830001	1	TX0104795	0.099

^aNPDES = National Pollutant Discharge Elimination System.

^bMGD = million gallons per day.

^cNot considered in the TMDL calculations.

TCEQ/TPDES Water Quality General Permits

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

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

A review of active general permit coverage (TCEQ, 2020b) in the Horsepen Creek watershed found one active hydrostatic test water discharge and three pesticide permittees. The hydrostatic test water discharge and pesticide management areas do not have bacteria reporting or limits in their permits. These facilities and management areas were assumed to contain inconsequential amounts of bacteria; therefore, it was unnecessary to allocate bacteria loads based on these activities. No other active general wastewater permit facilities or operations were found.

SSOs

A summary of sanitary sewer overflow (SSO) incidents that occurred during a four-year period from 2016 through 2019 in Harris County was obtained from TCEQ Central Office in Austin. The summary data indicated 83 SSO incidents had been reported within the Horsepen Creek watershed. The SSO incidents reported an estimated overflow that ranged from five to 18,000 gallons per incident.

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, industrial facilities, and construction activities.
2. Stormwater runoff not subject to regulation.

Discharges of stormwater from a Phase II MS4, industrial facility, or construction site must be covered under one of the following TCEQ/TPDES general permits:

- TXR040000 – Phase II MS4 General Permit for small MS4s located in urbanized areas
- TXR050000 – Multi-sector General Permit (MSGP) for industrial facilities

- TXR150000 – Construction General Permit (CGP) for construction activities disturbing more than one acre

A review of active stormwater general permit coverage in the Horsepen Creek watershed found no Phase II MS4 general permits. However, there is currently one Phase I MS4 permit and one combined Phase I and Phase II MS4 permit within the urbanized area of the Horsepen Creek watershed (Table 5). Figure 6 shows the USCB urbanized area (which accounts for MS4 coverage) within the Horsepen Creek watershed. No review of MSGPs or CGPs was conducted because urbanized area is being used to account for all stormwater permits in the TMDL allocations for Horsepen Creek.

Table 5. TPDES MS4 permits associated with the Horsepen Creek TMDL watershed

Entity	TPDES Permit	NPDES Permit	Authorization Type
City of Houston/ Harris County/ Harris County Flood Control District/ Texas Department of Transportation	WQ0004685000	TXS001201	Phase I MS4
Texas Department of Transportation	WQ0005011000	TXS002101	Combined Phase I/II MS4

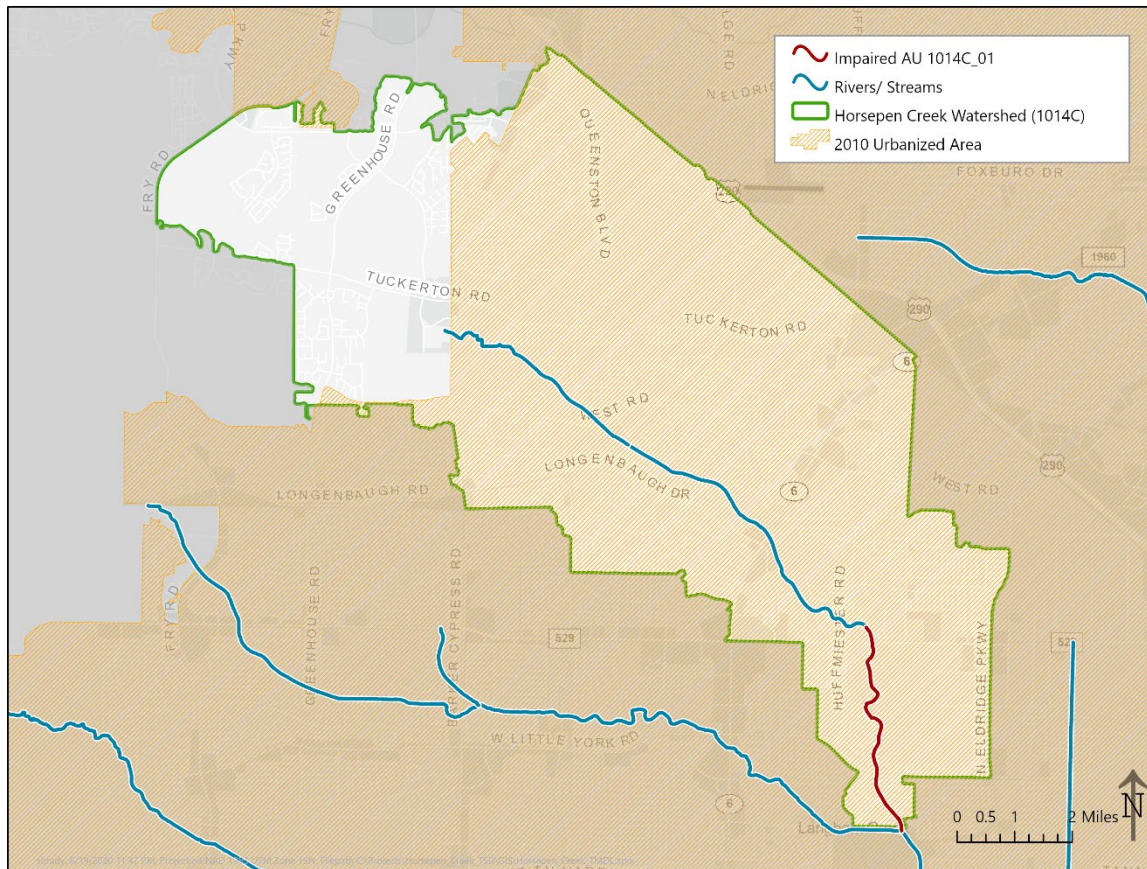


Figure 6. Regulated stormwater area based on urbanized area within the Horsepen Creek watershed

Illicit Discharges

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

Unregulated Sources

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

Unregulated Agricultural Activities and Domesticated Animals

A number of agricultural activities that do not require permits can be potential sources of fecal bacteria loading. However, due to the highly urbanized nature of the Horsepen Creek watershed, livestock were not considered a major source of bacteria loading.

Fecal bacteria from dogs and cats is transported to streams by runoff in both urban and rural areas and can be a potential source of bacteria loading. Table 6 summarizes the estimated number of dogs and cats within the Horsepen Creek watershed. Pet population estimates were calculated as the estimated number of dogs (0.614) and cats (0.457) per household (AVMA, 2018). The number of households in the TMDL watershed was estimated using 2010 Census data (USCB, 2010). The actual contribution and significance of bacteria loads from pets reaching Horsepen Creek is unknown.

Table 6. Estimated households and pet population for the Horsepen Creek TMDL watershed

Estimated Households	Estimated Dog Population	Estimated Cat Population
25,956	15,937	11,862

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 and feral hogs. The *E. coli* contribution from feral hogs and wildlife in the Horsepen Creek watershed cannot be determined based on existing information. However, due to the urbanized nature of the watershed it is assumed that the contribution is minimal.

OSSFs

The estimated number of OSSFs in the Horsepen Creek watershed was determined using data supplied by the Houston-Galveston Area Council. Data from these sources indicate that there are 89 OSSFs located within the Horsepen Creek watershed (Figure 7). Several pathways of the liquid waste in OSSFs afford opportunities for bacteria to enter ground and surface waters, if the systems are not properly operating. Properly designed and operated, however, OSSFs would be expected to contribute virtually no fecal bacteria to surface waters.

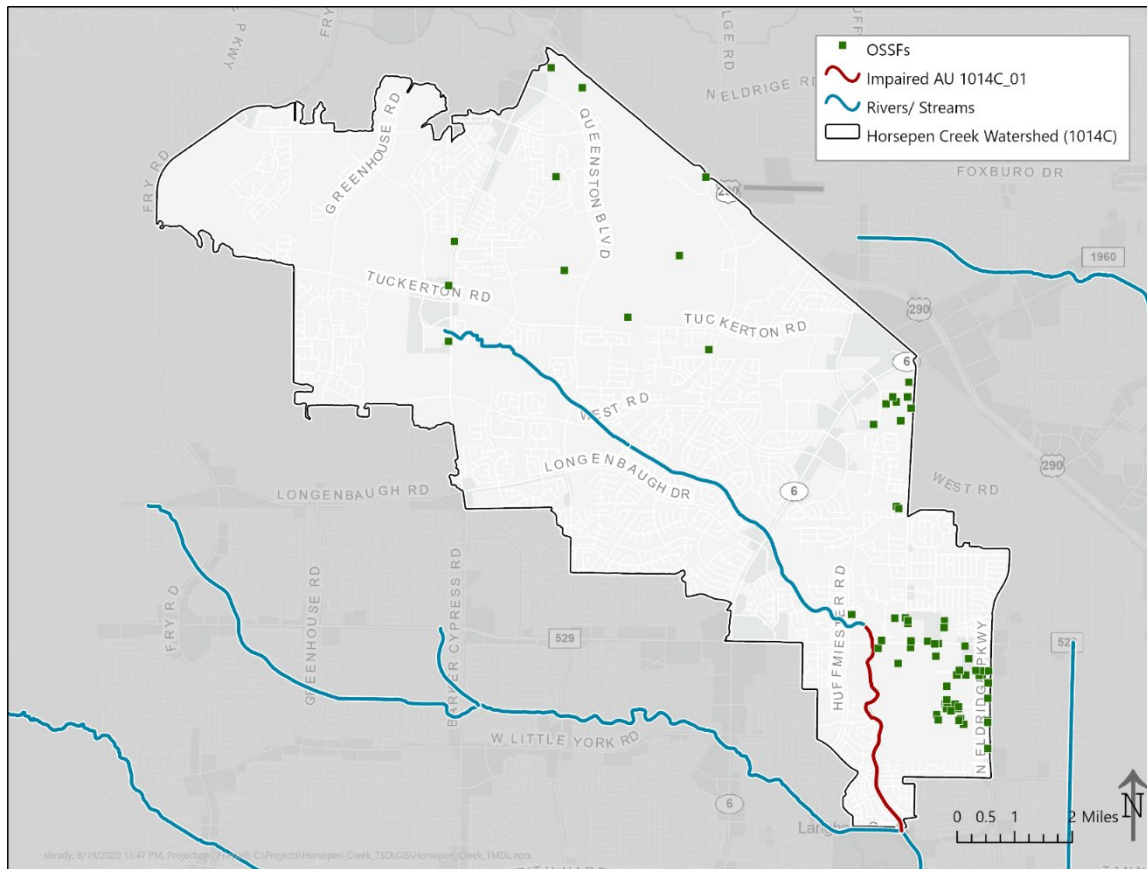


Figure 7. OSSFs located within the Horsepen Creek TMDL watershed

Linkage Analysis

The load duration curve (LDC) method was used to examine the relationship between instream water quality and the source of indicator bacteria loads. Inherent to the use of LDCs as the mechanism of linkage analysis is the assumption of a one-to-one relationship between instream loadings and loadings originating from point sources and the landscape as regulated and non-regulated sources. Further, this one-to-one relationship was also inherently assumed when using the LDC to define the TMDL pollutant load allocation. The LDC method allows for estimation of TMDL loads by utilizing the cumulative frequency distribution of streamflow and measured pollutant concentration data (Cleland, 2003). In addition to estimating stream loads, this method allows for the determination of the hydrologic conditions under which impairments are typically occurring, can give indications of the broad origins of the bacteria (i.e., point source and stormwater), and provides a means to allocate allowable loadings. The technical support document (Brady and Millican, 2020) provides details about the linkage analysis and the LDC method and its application.

For this project, two LDCs were developed. The LDC for SWQM Station 20465 (Figure 8) was developed for informational purposes. The *E. coli* event data plotted on the LDC for station 20465 (Figure 8) indicate that elevated bacteria loadings occur under all three flow regimes, especially during high flows. The allowable load at the single sample criterion (399 cfu/100 mL) is included on the LDC for comparison with individual *E. coli* samples, although it is not used for assessment or allocation purposes.

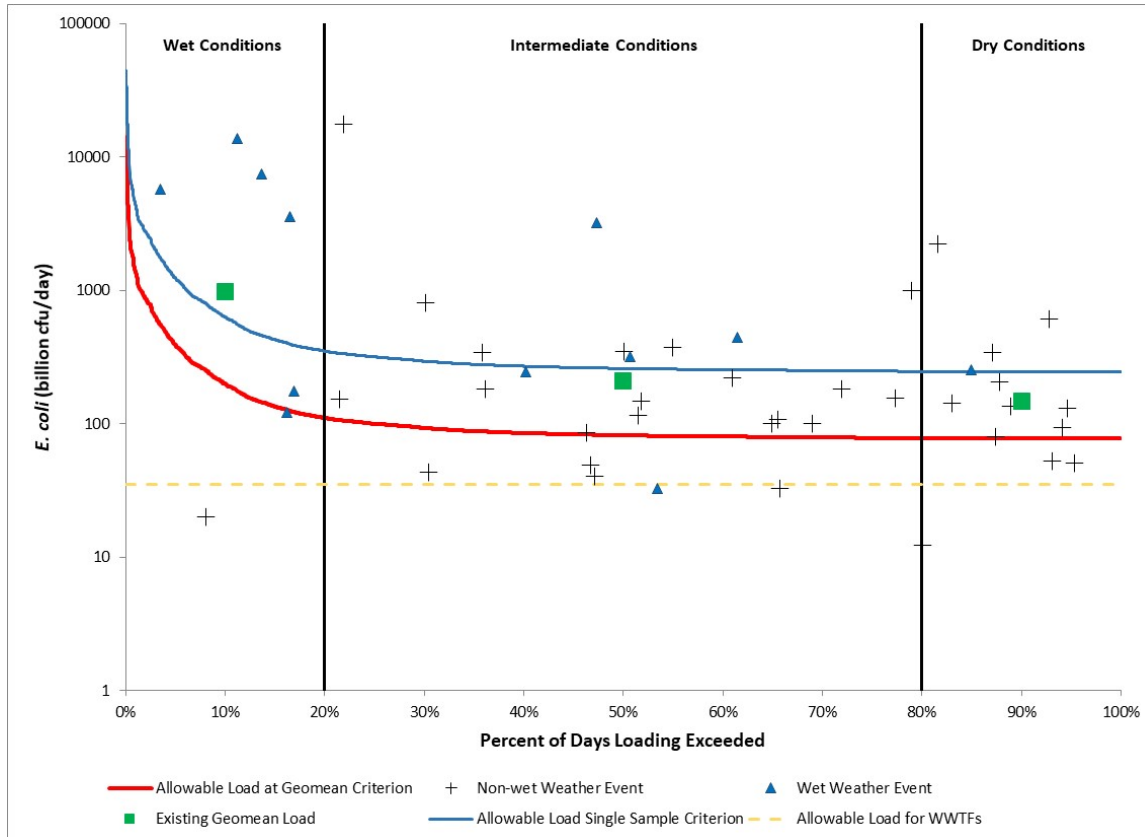


Figure 8. LDC for Horsepen Creek TMDL watershed at TCEQ SWQM Station 20465

The LDC for the watershed outlet (Figure 9) was constructed for developing the TMDL allocation for Horsepen Creek. This was done because the SWQM station is located near the upstream end of AU 1014C_01, and four WWTFs discharge downstream of it. The SWQM station LDC shows the bacteria data, while the outlet LDC just displays the allowable loadings (as no bacteria data were collected at the outlet) and is the basis for TMDL development.

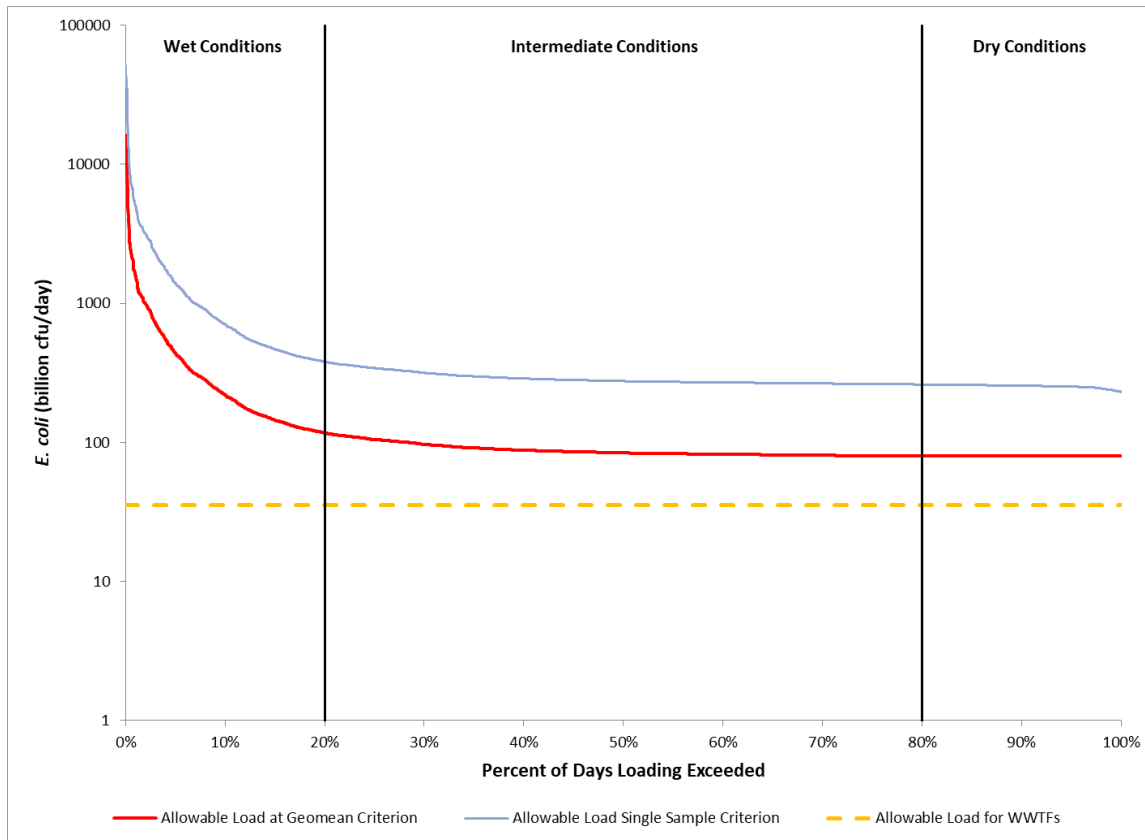


Figure 9. LDC for Horsepen Creek TMDL watershed outlet

MOS

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

Pollutant Load Allocation

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

$$\text{TMDL} = \text{WLA} + \text{LA} + \text{FG} + \text{MOS}$$

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

AU Level TMDL Computation

The TMDL for Horsepen Creek was derived using the median flow within the Wet Conditions flow regime (or 10% flow) of the LDC developed for the Horsepen Creek watershed outlet. This represents the location within the Horsepen Creek watershed that captures all WWTF discharges. The selection of the flow regime intervals was based on general observations of the project LDCs.

MOS

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

WLA

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

WWTFs

TPDES-permitted WWTFs are allocated a daily wasteload (WLA_{WWTF}) calculated as their full permitted discharge flow rate multiplied by one-half the instream geometric mean criterion. One-half of the water quality criterion (63 cfu/100 mL *E. coli*) is used as the WWTF target to provide instream and downstream load capacity and to be consistent with previously completed TMDLs in the Buffalo and Whiteoak bayous watershed. Table 7 presents the WLA for each WWTF in the project watershed.

Table 7. WLAs (in billion cfu/day *E. coli*) for TPDES-permitted facilities in the Horsepen Creek TMDL watershed

TPDES Permit No.	NPDES Permit No.	Permittee	Full Permitted Flow (MGD) ^a	<i>E. coli</i> WLA _{WWTF}
WQ0001402000 ^b	TX0042129	Wyman-Gordon Forgings Inc	0.225	0.54
WQ0011472001	TX0026263	Spencer Road PUD	0.98	2.34
WQ0011947001	TX0075884	Harris County MUD 208	6.7	15.98
WQ0012223001	TX0083496	West Harris County MUD 15	0.6	1.43
WQ0012304001	TX0085588	Chimney Hill MUD	1.2	2.86
WQ0012310001	TX0085871	R & K Weiman MHP LC	0.03	0.07
WQ0012447001	TX0088838	Harris County MUD No 196	1.4	3.34
WQ0012726001	TX0100161	Harris County MUD No 155	1.55	3.70
WQ0013328001	TX0101371	Remington MUD No. 1	1.1	2.62
WQ0014655001	TX0128287	Dril-Quip Inc	0.075	0.18
WQ0014740001	TX0129071	Harris Co MUD No. 500	0.84	2.00
WQ0014811001	TX0093581	Harris County MUD No. 250	0.1	0.24
WQ0014830001	TX0104795	Eli Gravriel Sasson	0.099	0.24
Total			14.899	35.53

^aFull permitted flow from Table 4.

^bOutfall number 2; all others are outfall number 1.

Regulated Stormwater

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

Just over 78% of the Horsepen Creek watershed is covered by urbanized area as defined by the 2010 Census. The urbanized area defines the jurisdiction of the single Phase I MS4 permit and one combined Phase I and Phase II permit. Because the urbanized area covers a substantial portion of the watershed, it is being used to account for all regulated stormwater.

LA

The load allocation (LA) component of the TMDL corresponds to runoff from unregulated sources.

Allowance for FG

The future growth (FG) component of the TMDL equation addresses the requirement of TMDLs to account for future loadings that might occur as a result of population growth, changes in community infrastructure, and development. Specifically, this TMDL component takes into account the probability that new flows from WWTF discharges may occur in the future. The assimilative capacity of water bodies increases as the amount of flow increases.

The allowance for FG will result in protection of existing uses and conform to Texas' antidegradation policy.

The FG component of the TMDL watershed was based on the population projection and current permitted wastewater dischargers for the entire TMDL watershed. Recent population and projected populations for 2010 through 2070 for the TMDL watershed are provided in Table 2. The projected population percentage increase within the watershed was multiplied by the corresponding WLA_{WWTF} to calculate future WLA_{WWTF} . The permitted flows were increased by the expected population growth for the watershed between 2020 and 2070 to determine the estimated future flows.

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

Summary of TMDL Calculations

Table 8 summarizes the TMDL calculations for the Horsepen Creek watershed. The TMDL was calculated based on the median flow in the 0-20 percentile range (10% exceedance, Wet Conditions flow regime) from the LDC developed for the watershed outlet. Allocations are based on the current geometric mean criterion for *E. coli* of 126 cfu/100 mL for each component of the TMDL (with the exception of the WLA_{WWTF} and FG terms, which used one-half the criterion).

Table 8. TMDL allocation summary for Horsepen Creek AU 1014C_01 watershed

Water Body	AU	TMDL	WLA _{WWTF}	WLA _{SW}	LA	FG	MOS
Horsepen Creek	1014C_01	220.415	35.531	129.185	36.183	8.495	11.021

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

The final TMDL allocations (Table 9) needed to comply with the requirements of 40 Code of Federal Regulations (CFR) Section 103.7 include the FG component within the WLA_{WWTF}.

Table 9. Final TMDL allocations for Horsepen Creek AU 1014C_01 watershed

Water Body	AU	TMDL	WLA _{WWTF}	WLA _{SW}	LA	MOS
Horsepen Creek	1014C_01	220.415	44.026	129.185	36.183	11.021

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

Seasonal Variation

Federal regulations in 40 CFR Section 130.7(c)(1) require that TMDLs account for seasonal variation in watershed conditions and pollutant loading. Analysis of the seasonal differences in indicator bacteria concentrations were assessed by comparing *E. coli* concentrations obtained from 11.5 years (2007 through 2019) of routine monitoring collected in the warmer months (May through September) against those collected during the cooler months (October through April). Differences in *E. coli* concentrations obtained in warmer versus cooler months were then evaluated by performing a t-test on the natural log-transformed dataset. This analysis of *E. coli* data indicated that there was no significant difference ($\alpha=.05$) in indicator bacteria between cool and warm weather seasons for Horsepen Creek at station 20465 ($P=.1323$).

Public Participation

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

The [technical support document](#)² for this TMDL addendum (Brady and Millican, 2020) was posted on the TCEQ website on October 5, 2020. A presentation on this addendum was given at the annual spring meeting of the Bacteria Implementation Group (BIG) in Houston on June 2, 2020. The public will have an opportunity to comment on this

² <https://www.tceq.texas.gov/assets/public/waterquality/tmdl/22buffalobayou/22-horsepen creek-tds-bacteria-2020october.pdf>

addendum during the official WQMP update public comment period (February 5 through March 9, 2021). This is an ongoing process, so notice of the public comment period for this addendum will be sent to the stakeholders and posted on the TCEQ's TMDL Program [News webpage](#),³ and the document will be posted on the [WQMP Updates Comments webpage](#).⁴ TCEQ accepted public comments on the original TMDL from June 5 through July 5, 2008. Fifty-five comments were submitted, and none of them referred directly to the AU in this TMDL addendum.

Implementation and Reasonable Assurance

The water body covered by this addendum is within the existing bacteria TMDL watershed for Buffalo and Whiteoak bayous. That TMDL watershed including Horsepen Creek is within the area covered by the implementation plan developed by the BIG for bacteria TMDLs throughout the greater Houston area, which was approved by the commission on January 30, 2013. It outlines an adaptive management approach in which measures are assessed annually by the BIG for efficiency and effectiveness. The iterative process of evaluation and adjustment ensures continuing progress toward achieving water quality goals and expresses stakeholder commitment to the process. Please refer to the original TMDL document for additional information regarding implementation and reasonable assurance.

³ <https://www.tceq.texas.gov/waterquality/tmdl/tmdlnews.html>

⁴ https://www.tceq.texas.gov/permitting/wqmp/WQmanagement_comment.html

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Appendix A.
Method Used to Determine Population Projections
in the Horsepen Creek Watershed

The following steps detail the method used to estimate the 2010 and projected 2070 populations in the Horsepen Creek watershed.

1. Obtained U.S. Census data at the block level.
2. Developed 2010 watershed population using the block level data for the portion of Harris County within the watershed.
3. For blocks not entirely within the watershed, a simple fraction of area within the watershed was proportioned.
4. Obtained 2016 Regional Water Plan information for Region H to be used for population projections.
5. Located relevant Water User Groups (WUGs) with areas within the Horsepen Creek watershed and determined the proportion of each of those areas within the watershed.
6. The Regional Water Plan for Region H has decadal population projections by WUG, and decadal percent increases in population were calculated using those projections.
7. The decadal percent population increases for each WUG were applied proportionally to the 2010 population for the watershed, and these projections were calculated by decade to give the decadal population projections out to 2070.