Water Body or Region Name: A Community Project to Protect Contact Recreation Uses

Fifteen Total Maximum Daily Loads for Indicatior Bacteria in Watersheds Upstream of Lake Houston
Adopted April 6, 2011
Approved by EPA June 29, 2011

Six TMDLs Added by Addendum October 2013
Approved by EPA February 14, 2014

Two TMDLs Added by Addendum October 2019
Approved by EPA March 11, 2020

One TMDL Added by This Addendum
Via the October 2020 Texas Water Quality Management Plan Update. Approved by EPA March 8, 2021 (scroll to view or print this addendum)

Appendix II. Addendum 3 to Fifteen Total Maximum Daily Loads for Indicator Bacteria in Watersheds Upstream of Lake Houston

Adding One TMDL for AU 1008I_01

One Total Maximum Daily Load for Indicator Bacteria in Walnut Creek

Introduction

The Texas Commission on Environmental Quality (TCEQ) adopted *Fifteen Total Maximum Daily Loads for Indicator Bacteria in Watersheds Upstream of Lake Houston* (TCEQ, 2011) on April 6, 2011. The total maximum daily loads (TMDLs) were approved by the United States Environmental Protection Agency (EPA) on June 29, 2011. An addendum to the original TMDL was submitted to EPA through the October 2013 Water Quality Management Plan (WQMP) update (TCEQ, 2013). That addendum added six additional assessment units (AUs). A second addendum to the original TMDL was submitted to EPA through the October 2019 WQMP update (TCEQ, 2019a). That addendum added two additional AUs. This document represents a third addendum to the original TMDL document.

This addendum includes information specific to one additional AU (Walnut Creek; 1008I_01) located within the watershed of the approved TMDL project for bacteria in water bodies upstream of Lake Houston. 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 Walnut Creek* (Adams 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 Walnut 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, 2019b) and then in each subsequent edition through 2020, the latest EPA-approved edition. The impaired AU is 1008I_01. Walnut Creek is composed of only one AU that encompasses the entire water body. The

Walnut Creek watershed is located within portions of Grimes, Waller, and Montgomery counties. Figure 1 shows the Walnut 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.

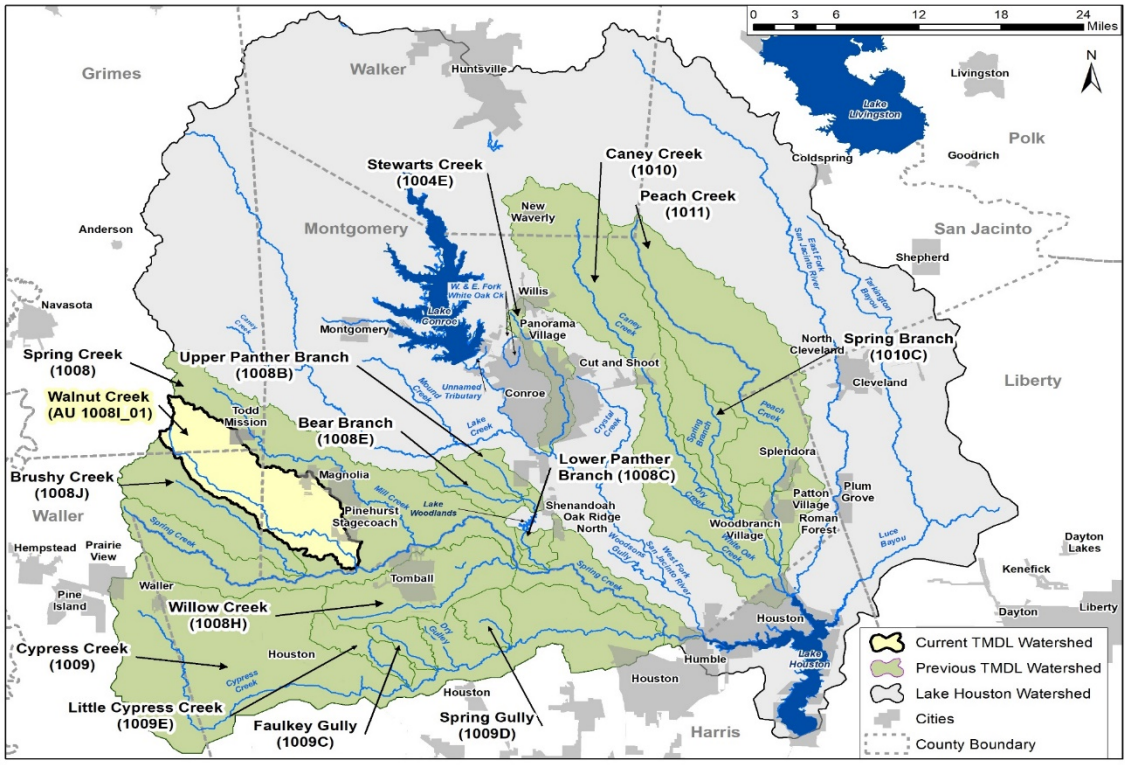

Figure 1. Map showing the previous TMDL watersheds and the current Walnut Creek TMDL watershed considered in this addendum

Table 1 summarizes the ambient water quality data for the TCEQ surface water quality monitoring (SWQM) station on Walnut 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 Walnut Creek watershed has occurred at TCEQ SWQM station 20462 (Figure 2).

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

AU	Station	Parameter	Number of Samples	Date Range	*E. coli* Geometric Mean (cfu/100 mL)
1008I_01	20462	E. coli	25	12/01/11 – 11/30/18	171.1

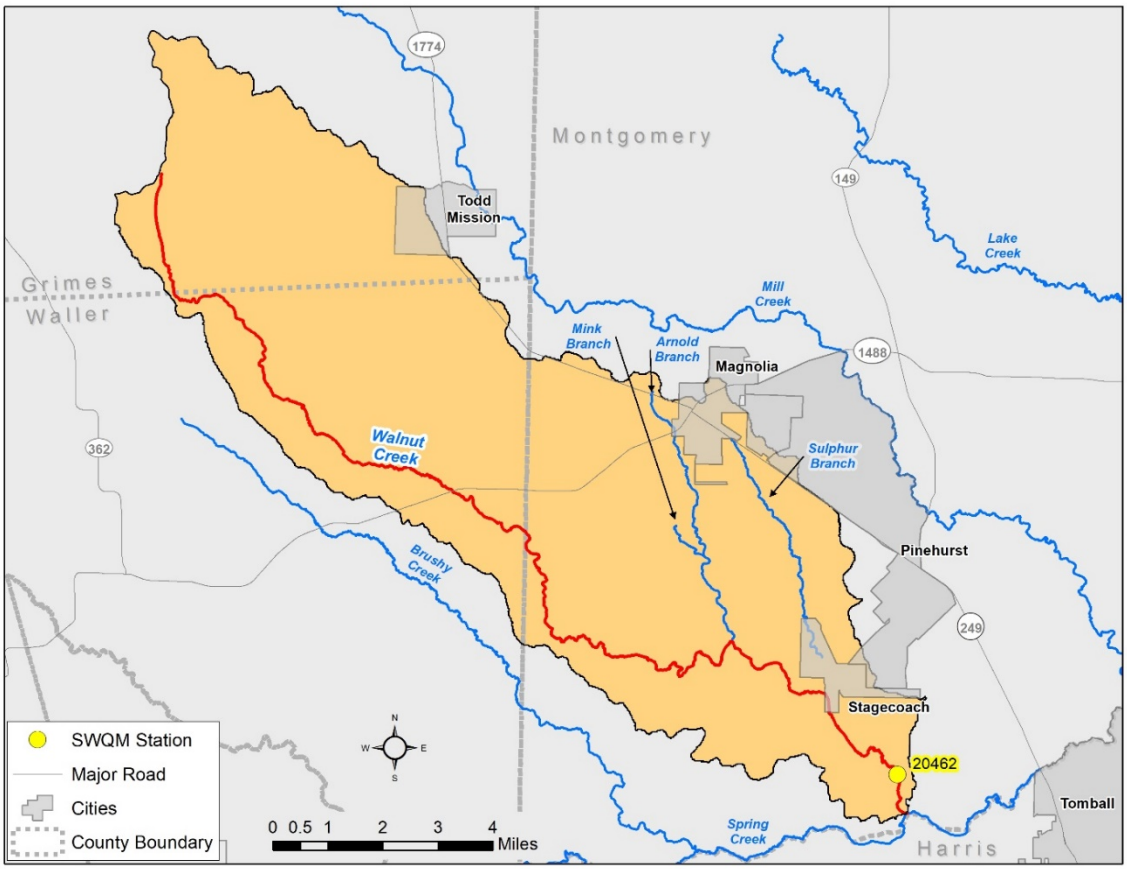

Figure 2. Walnut Creek TMDL watershed showing the TCEQ SWQM station

Watershed Overview

Walnut Creek (1008I) is a tributary to Spring Creek (Segment 1008) and is approximately 25.5 miles in length, with portions in Grimes, Waller, and Montgomery counties. The Walnut Creek watershed drains an area of approximately 48,987 acres. Walnut Creek is a perennial, unclassified freshwater stream.

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

- Walnut Creek; AU 1008I_01 – From the Spring Creek confluence to a point 41.1 km (25.5 mi) upstream.

Watershed Climate

The Walnut Creek watershed is within the Upper Coast and East Texas climatic divisions 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 15-year period from January 2005 through December 2019 from the National Climatic Data Center for the Conroe North Houston Regional Airport (NOAA, 2020). Data from this 15-year period indicate that the average monthly high temperature typically reaches a maximum of 95.0 °F in August, and the average monthly low temperature generally reaches a minimum of 38.4 °F in January (Figure 3). Annual rainfall averages 46.0 inches. The wettest month is October (5.2 inches) while February (2.9 inches) is the driest month, with rainfall occurring throughout the year.

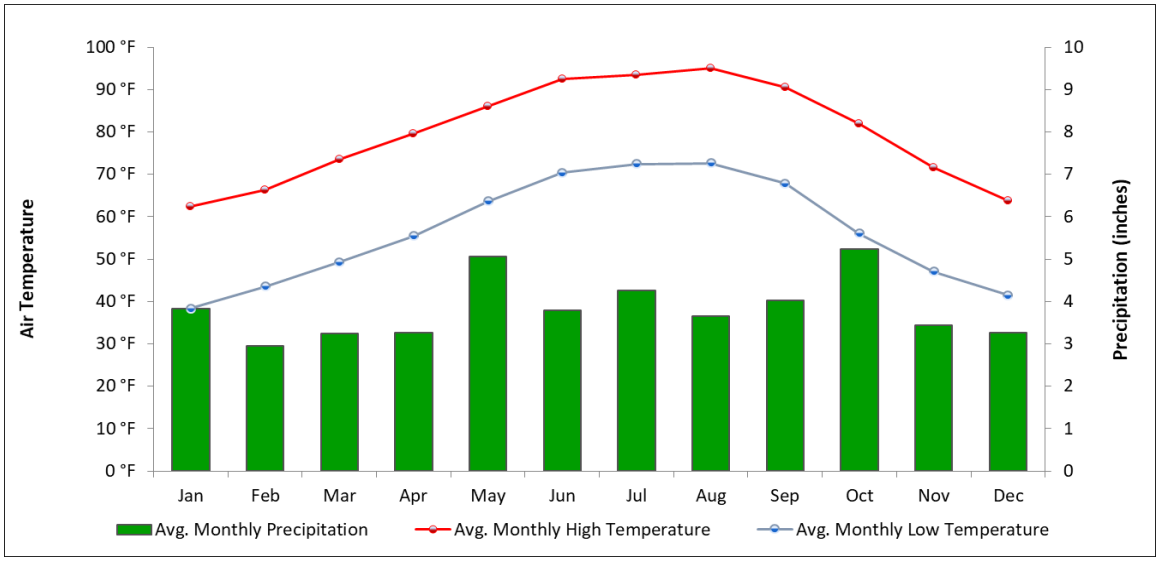

Figure 3. Average minimum and maximum air temperature and total precipitation by month from 2005 through 2019 for the Conroe North Houston Regional Airport weather station

Watershed Population and Population Projections

As depicted in Figure 2, the Walnut Creek watershed is geographically located within portions of Grimes, Waller, and Montgomery counties. The watershed is predominantly rural with four cities (Magnolia, Stagecoach, Pinehurst, and Todd Mission) located at least partially in the watershed. The rural nature of the watershed is evident in that the predominant current population density found throughout the watershed is zero to one person per acre. According to the United States Census Bureau (USCB) 2010 Census

(USCB, 2010), the Walnut Creek watershed had an estimated population of 20,748 people in 2010.

Population projections from 2020 through 2070 were developed using data from the 2016 Region G Regional Water Plan (Region G (Brazos) Water Planning Group, 2015) and the 2016 Region H Regional Water plan (Region H Water Planning Group, 2015). Table 2 provides a summary of the population projection for the Walnut 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 Walnut Creek TMDL watershed

Area	2010 U.S. Census Population	2020 Projected Population	2070 Projected Population	Projected Population Increase (2020-2070)	Percent Change (2020-2070)
Walnut Creek Watershed	20,748	24,666	73,499	48,833	198.0%

Land Cover

The land cover data for the Walnut Creek watershed were obtained from the United States Geological Survey (USGS) 2016 National Land Cover Database (NLCD) (USGS, 2019). The land cover for the Walnut Creek watershed is shown in Figure 4. A summary of the land cover data is provided in Table 3 and indicates that for the Walnut Creek watershed, Evergreen Forest (41.1%) and Developed, Open Space (16.4%) are the dominant land cover categories comprising approximately 57.5% of the total land cover.

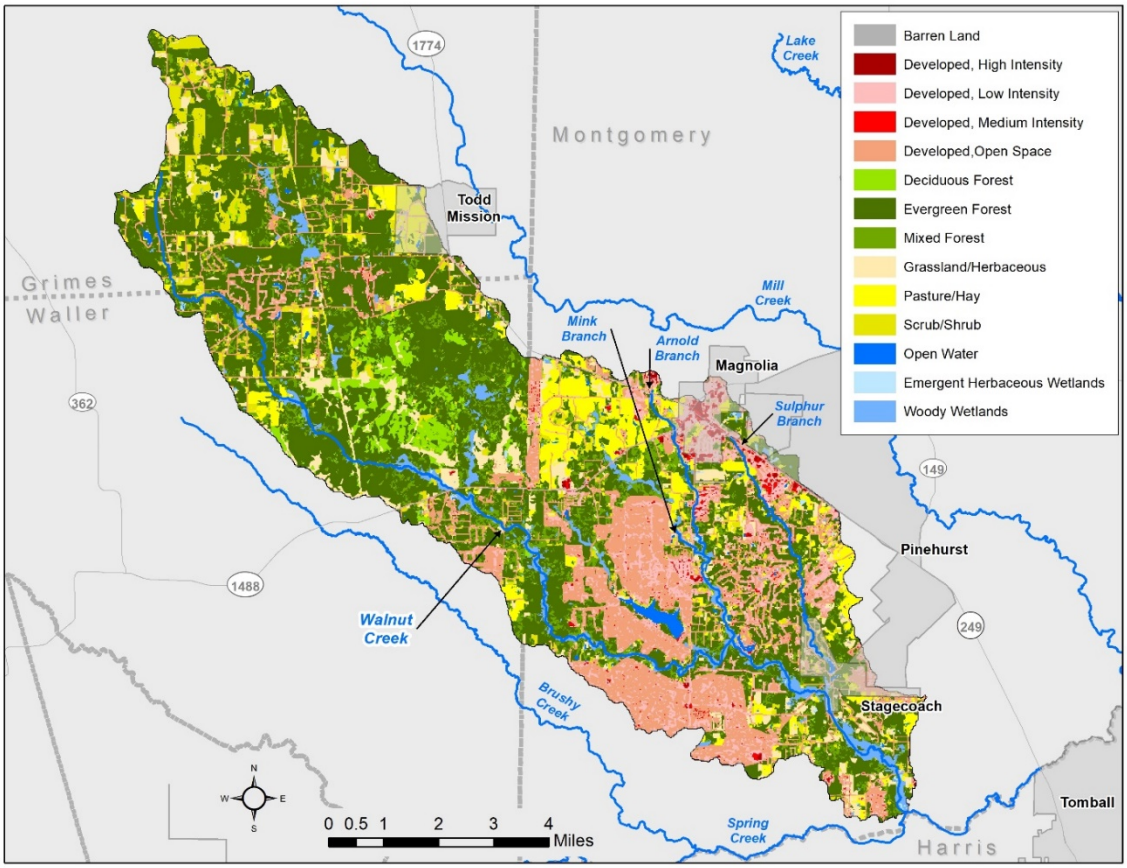

Figure 4. Land cover within the Walnut Creek TMDL watershed

Table 3. Land cover within the Walnut Creek TMDL watershed

2016 NLCD Classification	Area (Acres)	% of Total
Barren Land	51.6	0.1%
Developed, High Intensity	144.5	0.3%
Developed, Low Intensity	3,449.8	7.0%
Developed, Medium Intensity	473.0	1.0%
Developed, Open Space	8,018.5	16.4%
Deciduous Forest	1,397.6	2.9%
Evergreen Forest	20,117.9	41.1%
Mixed Forest	3,933.8	8.0%
Grassland/Herbaceous	2,765.4	5.6%

2016 NLCD Classification	Area (Acres)	% of Total
Pasture/Hay	3,521.0	7.2%
Scrub/Shrub	2,654.5	5.4%
Open Water	376.6	0.8%
Emergent Herbaceous Wetlands	115.0	0.2%
Woody Wetlands	1,967.4	4.0%
Total	**48,986.6**	**100%**

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.

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 July 3, 2020, there were six domestic WWTFs with TPDES permits and one proposed facility with a pending permit application within the Walnut Creek watershed (Table 4 and Figure 5).

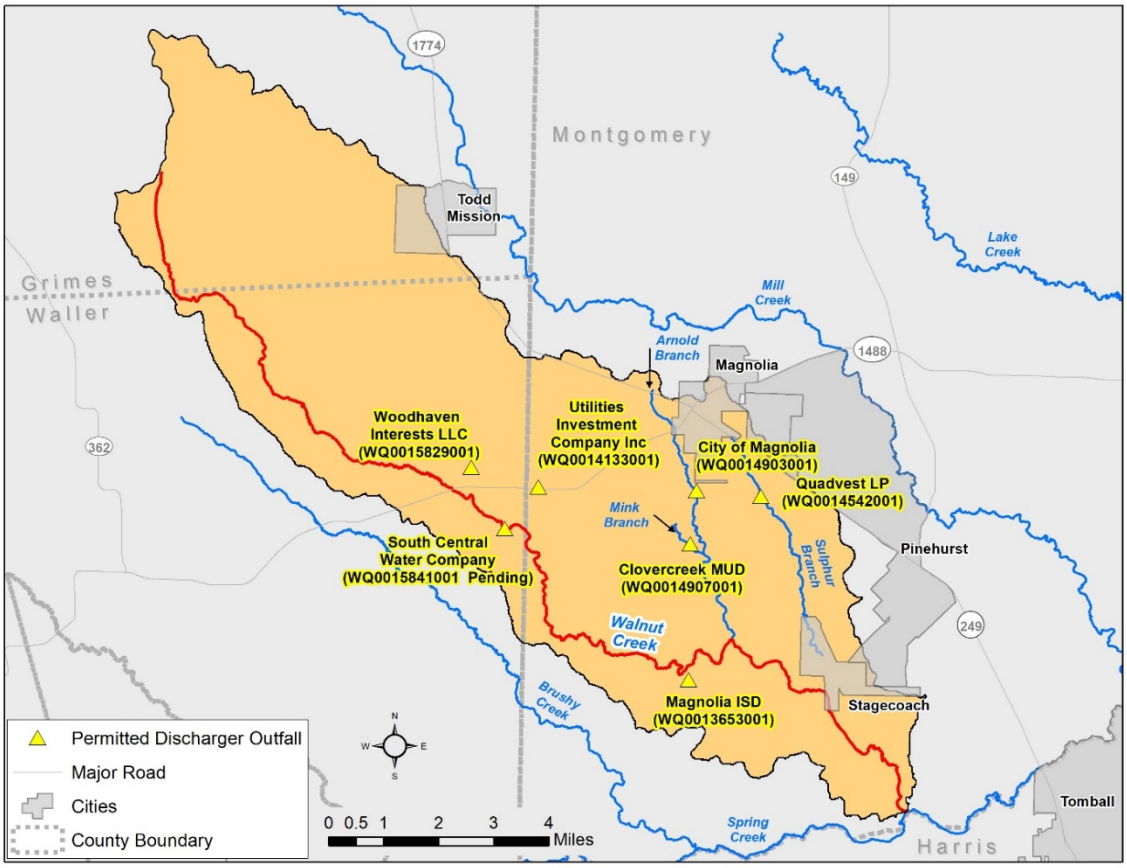

Figure 5. Walnut Creek TMDL watershed showing WWTFs

Table 4. Permitted domestic WWTFs in the Walnut Creek TMDL watershed

Permittee	Facility	TPDES No.	NPDES [a] No.	Daily Average Flow - Permitted Discharge (MGD) [b]	Daily Average Flow - Recent Discharge [c] (MGD)
Magnolia Independent School District (ISD)	J. L. Lyons Elementary School WWTF	WQ0013653001	TX0110663	0.015	0.005
Utilities Investment Company Inc.	Ranchcrest WWTF	WQ0014133001	TX0119857	0.49	0.061

Quadvest L.P.	Magnolia Lakes WWTF	WQ0014542001	TX0126934	0.15	0.048
City of Magnolia	City of Magnolia WWTF	WQ0014903001	TX0072702	2.0	0.330
Clovercreek Municipal Utility District (MUD)	Clovercreek MUD WWTF	WQ0014907001	TX0097969	0.12	0.050
Woodhaven Interests, LLC	Woodhaven WWTF	WQ0015829001	TX0139637	0.45	-------[d]
South Central Water Company	Fair Oaks WWTF	WQ0015841001[e]	TX0139751	0.10	-------[d]

[a] NPDES = National Pollutant Discharge Elimination System.
[b] MGD = million gallons per day.
[c] Reflects discharge data available from June 1, 2015 through May 31, 2020.
[d] No available records.
[e] Pending permit application as of July 3, 2020.

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 Walnut Creek watershed as of May 20, 2020, found three concrete production facilities covered by the general permit. The same review revealed three pesticide permittees were covered by the general permit. The concrete production facilities 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 the project counties (Grimes, Waller, and Montgomery) was obtained from the TCEQ Central Office in Austin. The summary data indicated no SSO incidents were reported for any locations within the Walnut Creek watershed.

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 (TCEQ, 2020b) in the Walnut Creek watershed as of May 20, 2020, found one Phase II MS4 general permit, three MSGPs, and eight active CGPs within the Walnut Creek watershed. In addition, there is currently one combined Phase I and Phase II MS4 permit within the urbanized area of the Walnut Creek watershed (Table 5). Figure 6 shows the USCB urbanized area (which accounts for MS4 coverage) within the Walnut Creek watershed.

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

Entity	TPDES Permit	NPDES Permit	Authorization Type
Texas Department of Transportation	WQ0005011000	TXS002101	Combined Phase I/II MS4
Montgomery County	TXR040000 (General Permit)	TXR040348	Phase II MS4

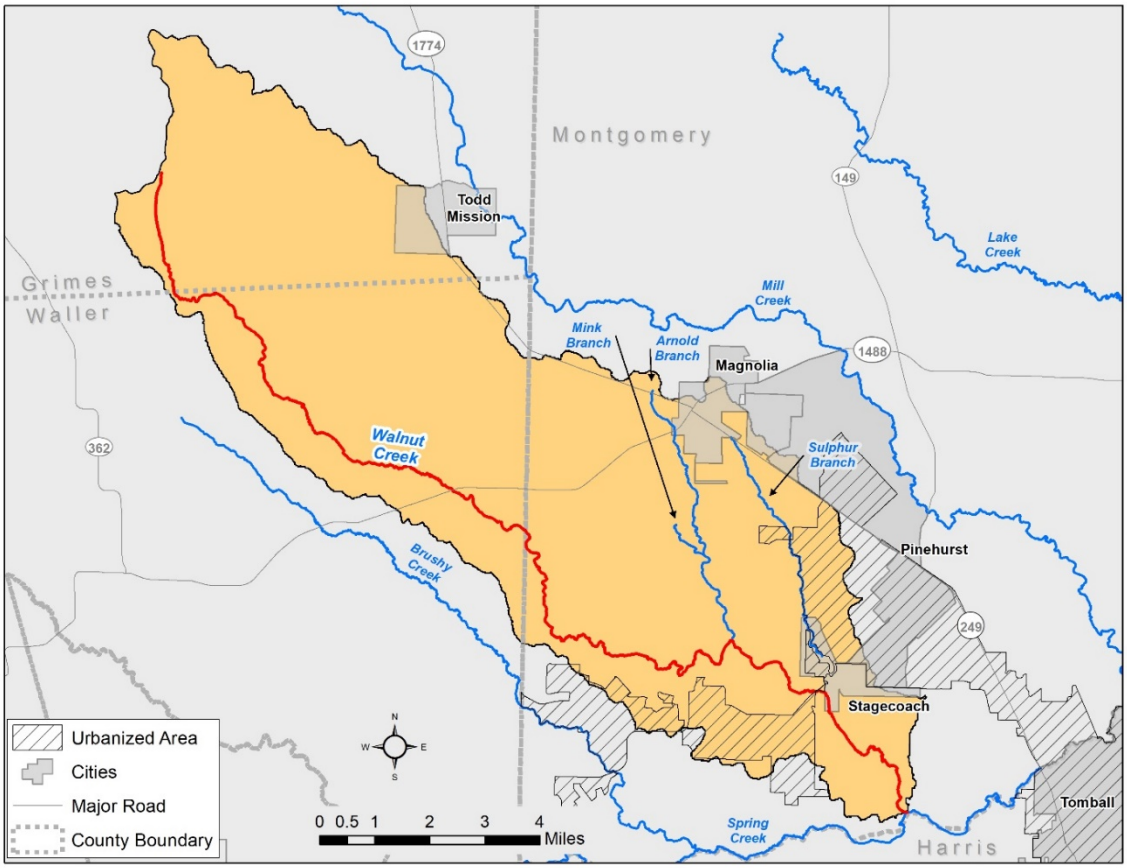

Figure 6. Regulated stormwater area based on urbanized area within the Walnut Creek watershed

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

Several agricultural activities that do not require permits can be potential sources of fecal bacteria loading. The number of livestock within the TMDL watershed was estimated from county-level data obtained from the 2017 Census of Agriculture (USDA NASS, 2019). The county-level data for Grimes, Waller, and Montgomery counties were refined to better reflect actual numbers within the Walnut Creek watershed. The refinement was performed by dividing the total area of the watershed within each county by the total area of each county. This ratio was then applied to the county-level livestock data (Table 6). A further refinement to the Cattle and Calves estimated population was performed by dividing the ratio-derived estimate by one-half using data provided by the Texas State Soil and Water Conservation Board staff (TSSWCB; TSSWCB, 2020). The livestock numbers in Table 6 are provided to demonstrate that livestock are a potential source of bacteria in the TMDL watershed. These livestock numbers are not used to develop an allocation of allowable bacteria loading to livestock.

Table 6. Estimated distributed domesticated animal populations within the Walnut Creek TMDL watershed, based on proportional area

Cattle and Calves	Hogs and Pigs	Sheep and Lambs	Goats	Horses and Ponies	Mules, Burros, and Donkeys	Poultry	Deer (captive)
1,938	83	128	168	390	63	921	114

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 7 summarizes the estimated number of dogs and cats within the Walnut 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 Walnut Creek is unknown.

Table 7. Estimated households and pet population for the Walnut Creek TMDL watershed

Estimated Households	Estimated Dog Population	Estimated Cat Population
7,045	4,326	3,220

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. Wildlife and feral hogs are naturally attracted to the riparian corridors of water bodies. With direct access to the stream channel, the direct deposition of wildlife

and feral hog waste can be a concentrated source of bacteria loading to a water body. Fecal bacteria from wildlife and feral hogs are also deposited onto land surfaces, where they may be washed into nearby water bodies by rainfall runoff.

Quantitative estimates of wildlife are inexact and often limited to discrete taxa groups or geographical areas of interest so that even county-wide approximations of wildlife numbers are difficult or impossible to acquire. Bird diversity is high in the counties where the TMDL watershed is located (eBird, 2020), but population sizes for individual species are not known. However, population estimates for feral hogs and deer are readily available for the TMDL watershed, although the *E. coli* contribution from them could not be determined based on existing information.

For feral hogs, the Institute of Renewable Natural Resources (IRNR; IRNR, 2013) estimated a range of feral hog densities within suitable habitat in Texas (1.33 to 2.45 hogs/square mile). The average hog density (1.89 hogs/square mile) was multiplied by the hog-habitat area (56.99 square miles) in the Walnut Creek watershed. Habitat deemed suitable for hogs followed as closely as possible to the land cover selections of the IRNR study and include from the 2016 NLCD categories: Forest, Wetlands, Pasture/Hay, Scrub/Shrub, and Grassland/Herbaceous. Using this methodology, there are an estimated 108 feral hogs in the Walnut Creek watershed.

For deer, the Texas Parks and Wildlife Department (TPWD) published data showing deer population-density estimates by Deer Management Unit (DMU) and Ecoregion in the state (TPWD, 2020). The Walnut Creek watershed is located entirely within the Urban Houston DMU which has no deer density data. Due to the close proximity of the Walnut Creek watershed to DMU 14, density data from this DMU was used to estimate deer populations for the Walnut Creek watershed. For the 2018 TPWD survey year, the estimated deer population density for DMU 14 was 25.25 deer/1,000 acres and applies to all habitat types within the DMU area. Applying this value to the entire area of the watershed returns an estimated 1,237 deer within the Walnut Creek watershed.

On-site Sewage Facilities

The estimated number of OSSFs in the Walnut Creek watershed was determined using data supplied by Grimes County 911 Addressing for Grimes County, and the Houston-Galveston Area Council supplied data for Montgomery and Waller counties. Data from these sources indicate that there are 5,162 OSSFs located within the Walnut 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.

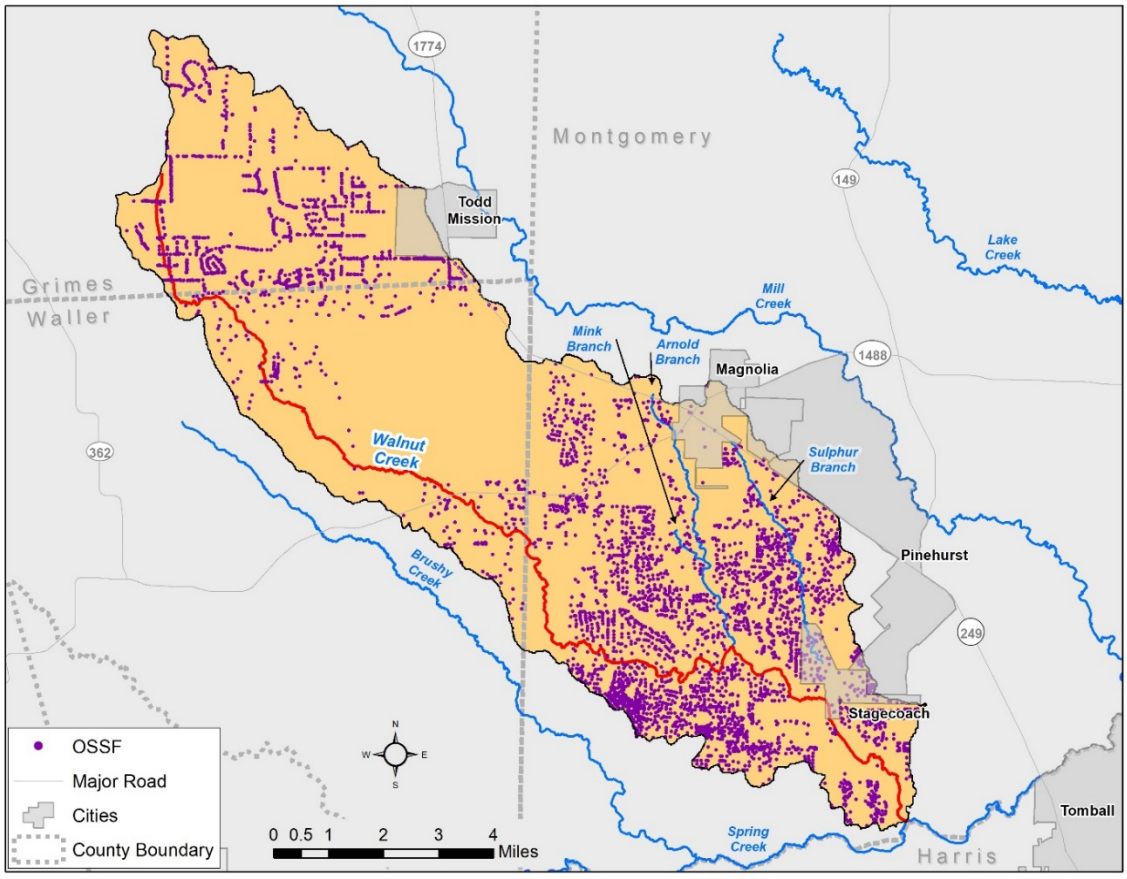

Figure 7. OSSFs located within the Walnut Creek TMDL watershed

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 (Adams and Millican, 2020) provides details about the linkage analysis and the LDC method and its application.

The *E. coli* event data plotted on the LDC for station 20462 in Figure 8 show a subtle pattern of increasing tendency for the *E. coli* event data to plot below the geometric mean criterion allowable loading curve as flows decrease, which is indicated in a left to right direction along the graph. This pattern of decreasing occurrence of exceedances in the event data are summarized by the geometric means of the existing data plotted for each of the three flow regimes as compared to the allowable load line for the geometric mean criterion. 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.

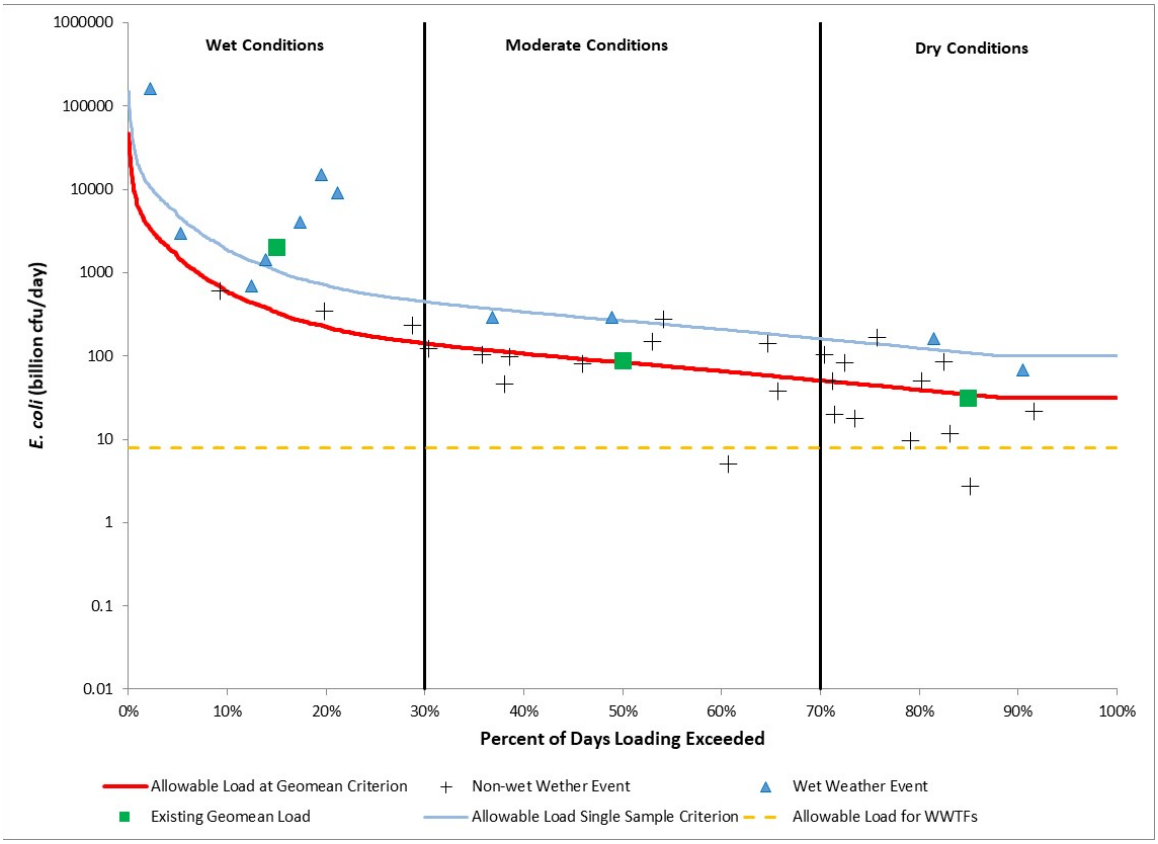

Figure 8. LDC for Walnut Creek TMDL watershed at TCEQ SWQM Station 20462

Margin of Safety

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

Pollutant Load Allocation

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

TMDL = WLA + LA + FG + MOS

Where:

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

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

FG = loadings associated with future growth from potential regulated facilities

MOS = margin of safety load

AU Level TMDL Computation

To be consistent with previously completed TMDLs in the Lake Houston watershed, the TMDL for Walnut Creek was derived using the median flow within the Wet Conditions flow regime (or 15% flow) of the LDC developed for SWQM station 20462. This station represents the location within Walnut Creek where an adequate number of *E. coli* samples has been collected.

Margin of Safety Calculation

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

Wasteload Allocation

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

Wastewater Treatment Facilitities

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 Lake Houston watershed. Table 8 presents the WLA for each WWTF in the project watershed.

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.

Table 8. WLAs (in billion cfu/day *E. coli*) for TPDES-permitted facilities in the Walnut Creek TMDL watershed

TPDES Permit No.	NPDES Permit No.	Permittee	Full Permitted Flow (MGD)[a]	*E. coli* WLA_{WWTF}
WQ0013653001	TX0110663	Magnolia ISD	0.015	0.036
WQ0014133001	TX0119857	Utilities Investment Company Inc.	0.49	1.169
WQ0014542001	TX0126934	Quadvest L.P.	0.15	0.358
WQ0014903001	TX0072702	City of Magnolia	2.0	4.770
WQ0014907001	TX0097969	Clovercreek MUD	0.12	0.286
WQ0015829001	TX0139637	Woodhaven Interests, LLC	0.45	1.073
WQ0015841001[b]	TX0139751	South Central Water Company	0.10	0.238
Total			**3.325**	**7.930**

[a] Full permitted flow from Table 4.
[b] Pending permit application as of July 3, 2020.

A portion of the Walnut Creek watershed lies within the jurisdiction of one Phase II MS4 permit and one combined Phase I and Phase II permit. Three MSGPs, eight CGPs, and three concrete production facilities exist within the Walnut Creek watershed. For this TMDL, the acreage associated with the three MSGPs and the three concrete production facilities was estimated by importing the location information associated with the facilities into a geographic information system and measuring the estimated disturbed area based on the most recently available aerial imagery. Additionally, the disturbed areas associated with each of the eight CGPs within the Walnut Creek watershed were summed. The area associated with the 2010 Houston urbanized area (which accounts for the MS4 permits) along with the areas associated with the MSGPs, concrete production facilities, and CGPs located within the Walnut Creek watershed provide stormwater coverage for Walnut Creek. The percentage of land under the jurisdiction of stormwater permits in the Walnut Creek watershed is 13.82%.

Load Allocation

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

Allowance for Future Growth

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

The allowance for FG 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 9 summarizes the TMDL calculations for the Walnut Creek watershed. The TMDL was calculated based on the median flow in the 0-30 percentile range (15% exceedance, Wet Conditions flow regime) from the LDC developed for SWQM station 20462. 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 9. TMDL allocation summary for Walnut Creek AU 1008I_01 watershed

Water Body	AU	TMDL	WLA_{WWTF}	WLA_{SW}	LA	FG	MOS
Walnut Creek	1008I_01	335.982	7.930	40.845	254.706	15.702	16.799

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

The final TMDL allocations (Table 10) 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 10. Final TMDL allocations for Walnut Creek AU 1008I_01 watershed

Water Body	AU	TMDL	WLA_{WWTF}	WLA_{SW}	LA	MOS
Walnut Creek	1008I_01	335.982	23.632	40.845	254.706	16.799

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 10 years (2010 through 2019) of routine monitoring collected in the warmer months (April through September) against those collected during the cooler months (October through March). Differences in *E. coli* concentrations obtained in warmer versus cooler months were then evaluated by performing a Wilcoxon Rank Sum test on the natural log transformed dataset. This analysis of *E. coli* data indicated that there was no significant difference (α=0.05) in indicator bacteria concentrations between cool and warm weather seasons for Walnut Creek AU 1008I_01 (p=0.3308). Seasonal variation was also addressed by using all available flow and bacteria records (covering all seasons) from the period of record used in LDC development for this project.

Public Participation

TCEQ maintains an inclusive public participation process. From the inception of 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 for this TMDL addendum (Adams and Millican, 2020) was posted on the TCEQ website on August 20, 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 addendum during the official WQMP update public comment period (November 6 through December 9, 2020). 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, and the document will be posted on the WQMP Updates webpage. TCEQ accepted public comments on the original TMDL from November 19 through December 20, 2010. Two comments were submitted, and neither 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 watersheds upstream of Lake Houston. Those TMDL watersheds including Walnut Creek are 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.

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

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

1. Obtained U.S. Census data at the block level.
2. Developed 2010 watershed populations using the block level data for the portion of the three counties (Grimes, Montgomery, and Waller) 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 Regions G and H to be used for population projections.
5. No large cities are in the watershed for Grimes or Waller counties (only the small community of Todd Mission (Grimes) and rural areas), which indicates there are no direct TWDB projections for Todd Mission and other rural areas.
6. The Regional Water Plans for Regions G and H do, however, provide projections for a category called “County – Other”, which were used to determine growth rates for Todd Mission and other rural areas in Grimes and Waller counties.
7. For Montgomery County, populations projections were available for the cities of Magnolia and Stagecoach and were used along with “County – Other” to determine population projections.
8. From the Regional Water Plans for Regions G and H, the decadal population projections were available for Magnolia, Stagecoach, and “County – Other”, and decadal percent increases in population were calculated using those projections.
9. The decadal percent population increases for each county were applied to the 2010 population for the watershed locations of Magnolia, Stagecoach, and the portions of the three counties in the watershed, and these projections were summed by decade to give the decadal population projections out to 2070.