Mission and Aransas Rivers Watershed: Bacteria in Waters Used for Contact Recreation

- **Two TMDLs Adopted May 25, 2016**
  Approved by EPA August 9, 2016
- **Two TMDLs Added by Addendum October 2017**
  Approved by EPA February 8, 2018 (scroll to view or print this addendum)

Water Quality Planning Division, Office of Water

TEXAS COMMISSION ON ENVIRONMENTAL QUALITY

Addendum One to Two Total Maximum Daily Loads for Indicator Bacteria in the Tidal Segments of the Mission and Aransas Rivers

Two Total Maximum Daily Loads for Indicator Bacteria in Aransas River Above Tidal and Poesta Creek

For Segments 2004 and 2004B

Assessment Units 2004_02 and 2004B_02

Introduction

The Texas Commission on Environmental Quality (TCEQ) adopted *Two Total Maximum Daily Loads for Indicator Bacteria in the Tidal Segments of the Mission and Aransas Rivers: Segments 2001 and 2003* (TCEQ, 2016a) on May 25, 2016. The total maximum daily loads (TMDLs) were approved by the United States Environmental Protection Agency (EPA) on August 9, 2016. This document represents an addendum to the original TMDL document.

This addendum includes information specific to two additional assessment units (AUs) located within the watershed of the approved TMDL project for bacteria in tidal segments of the Mission and Aransas Rivers. Concentrations of indicator bacteria in these AUs exceed the criteria used to evaluate attainment of the water quality standard for contact recreation. This addendum presents the new information associated with the two additional AUs. For background or other explanatory information, please refer to the *Technical Support Document for Total Maximum Daily Loads for Indicator Bacteria in Aransas River Above Tidal and Poesta Creek: Segments 2004 and 2004B* (Schramm, 2017). Refer to the original, approved TMDL document for details related to the overall Mission and Aransas Rivers watershed as well as the methods and assumptions used in developing all of these TMDLs.

This addendum focuses on the watersheds of two additional AUs. These watersheds, including the regulated facilities within them, were addressed in the original TMDL. This addendum provides the details related to developing the TMDL allocations for these additional AUs, which were not specifically addressed in the original document.

Problem Definition

The TCEQ first identified the bacteria impairments within the Aransas River Above Tidal and Poesta Creek segments included within this addendum in the *2014 Texas Integrated Report of Surface Water Quality for Clean Water Act Sections 305(b) and 303(d)* (2014 Integrated Report; TCEQ, 2015a) (Table 1). The impaired AUs are Aransas River Above Tidal (2004_02) and Poesta Creek (2004B_02), as shown in Figure 1. The project watershed is predominately in Bee County (98 percent of the watershed). Live Oak County includes approximately 1.5 percent of the watershed. San Patricio and Refugio counties each include less than 1 percent of the watershed area.

The Texas Surface Water Quality Standards (TSWQS) (TCEQ, 2010) provide numeric and narrative criteria to evaluate attainment of designated uses. The basis for water quality targets for all TMDLs developed in this report will be the numeric criteria for bacterial indicators from the 2010 TSWQS. *Escherichia coli* (*E. coli*) are the preferred indicator bacteria for assessing contact recreation use in freshwater.

Table 1. Synopsis of Integrated Report for addendum water bodies

Source: (TCEQ, 2015a)

Water Body	Segment	AU	Parameter	Contact Recreation Use	Year First Impaired	Category
Aransas River Above Tidal	2004	2004_02	*E. coli*	Nonsupport	2014	5c
Poesta Creek	2004B	2004B_02	*E. coli*	Nonsupport	2014	5c

Table 2 summarizes the ambient water quality data for the TCEQ water quality monitoring (WQM) stations on each impaired water body, as reported in the 2014 Integrated Report. The 2014 assessment data indicates non-support of the primary contact recreation use for the two addendum AUs, because the geometric mean concentrations exceed the geometric mean criterion of 126 most probable number (MPN)/100 milliliters (mL) *E. coli*. Figure 2 shows the location of the surface water quality monitoring (SWQM) stations as well as the United States Geological Survey (USGS) gage in the project watershed.

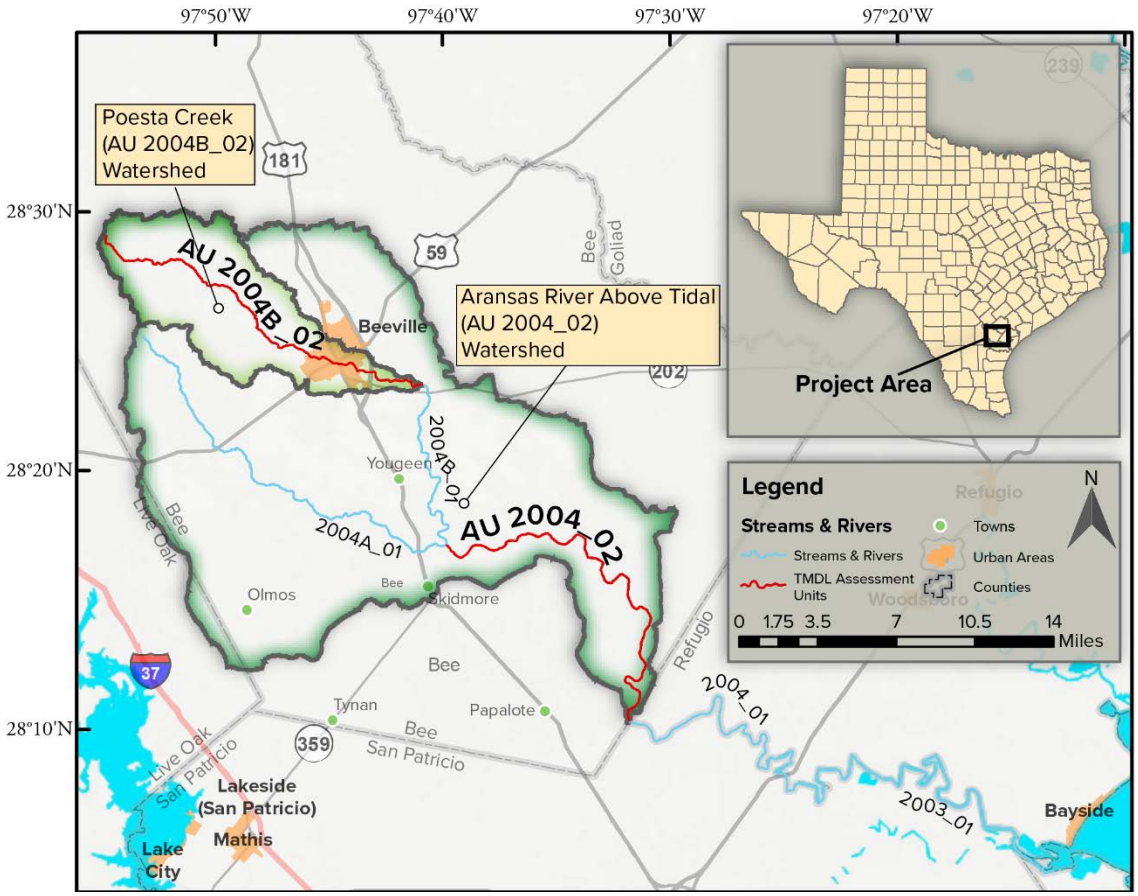

Figure 1. Total contributing drainage area for the study, including AUs 2004_02 and 2004B_02

Source: TCEQ Assessment Units (TCEQ, 2015b)

Table 2. 2014 Integrated Report summary for the addendum TMDL AUs

(The geometric mean criterion for primary contact recreation use is 126 MPN/100 mL of *E. coli*.)

Source: (TCEQ, 2015a)

Water Body	AU	Parameter	No. of Samples	Data Range	Station *E. coli* Geometric Mean (MPN/100 mL)
Aransas River Above Tidal	2004_02	*E. coli*	50	2005–2012	166
Poesta Creek	2004B_02	*E. coli*	21	2005–2012	311

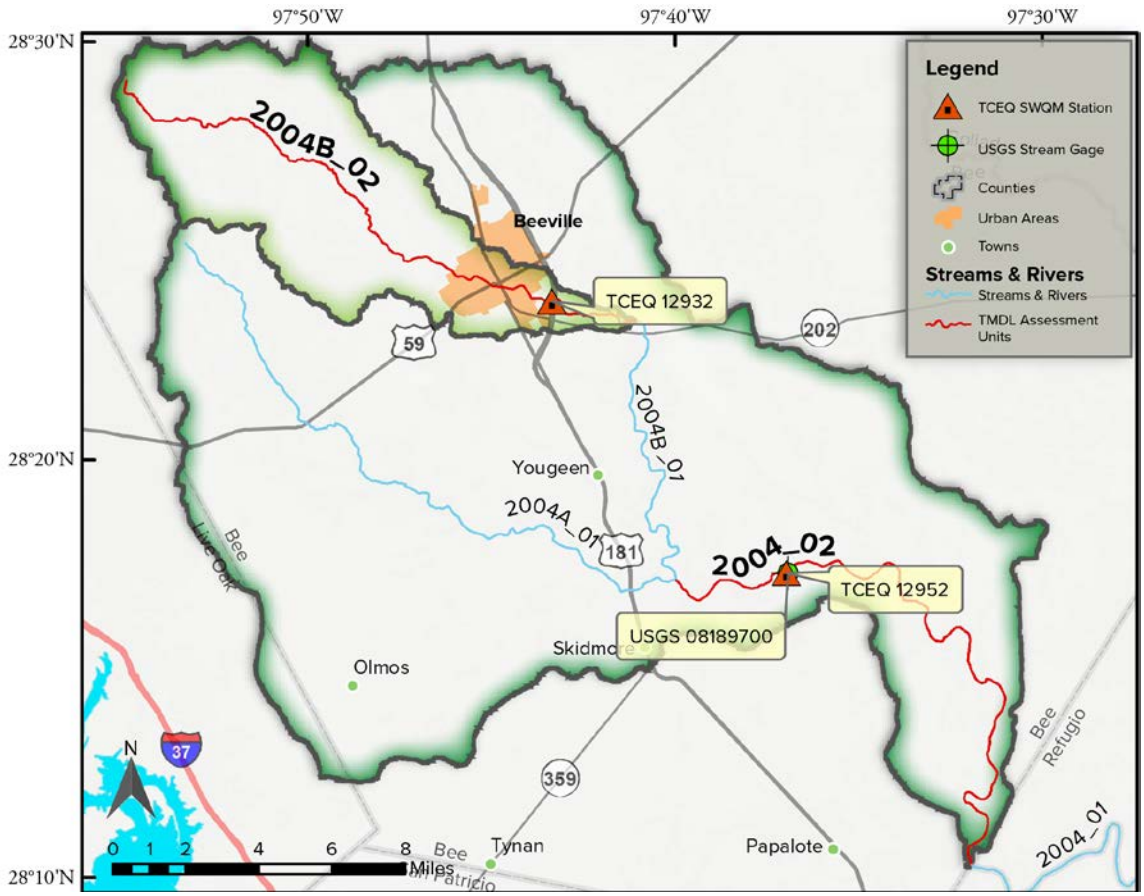

Figure 2. SWQM station and USGS streamflow gage locations in the Aransas River Above Tidal and Poesta Creek watersheds

Sources: TCEQ SWQM stations from TCEQ (TCEQ, 2012); USGS stream gage stations from USGS (USGS, 2011)

Watershed Overview

Both water bodies included in this study are located within the Aransas River watershed shown in Figure 3. Both water bodies are located upstream of the Aransas River Tidal (Segment 2003) and will be added to the existing TMDL, *Two Total Maximum Daily Loads for Indicator Bacteria in the Tidal Segments of the Mission and Aransas Rivers* (TCEQ, 2016a), through a Water Quality Management Plan (WQMP) update. This study incorporates a watershed approach where the drainage area upstream of each AU outlet is considered. The locations of Aransas River Above Tidal (AU 2004_02) and Poesta Creek (AU 2004B_02) in relation to the original Mission and Aransas Rivers TMDL project boundaries are shown in Figure 3. The full project watershed corresponds to the watershed for Aransas River Above Tidal (AU 2004_02), and the Poesta Creek (AU 2004B_02) watershed is a subwatershed within that area.

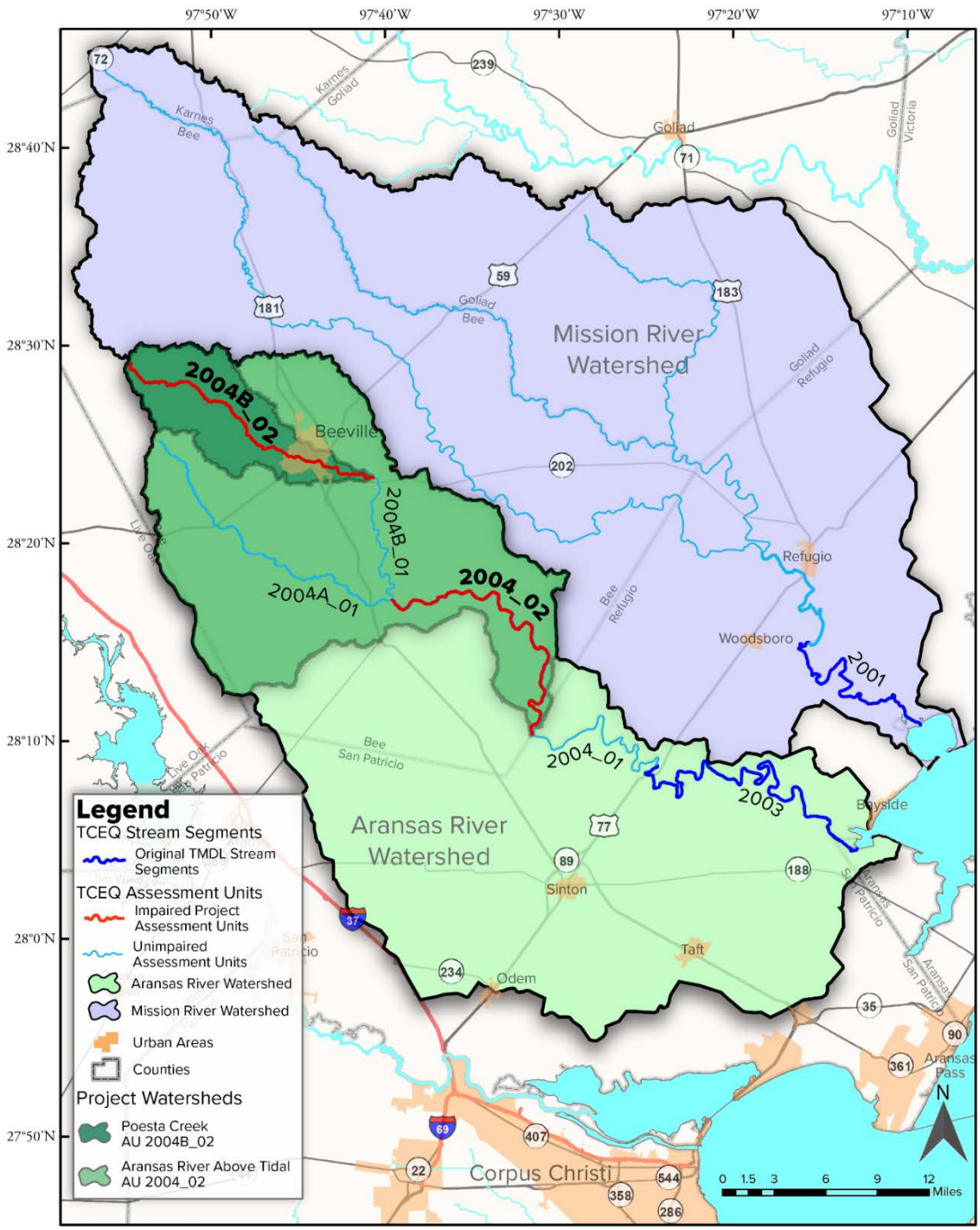

Figure 3. Addendum project boundaries in relation to original TMDL project watersheds.

The headwaters of Poesta Creek (Segment 2004B) begin in Bee County northwest of Beeville and flow 28.7 miles southeast to Aransas Creek (Segment 2004A) forming the Aransas River Above Tidal (Segment 2004). The Aransas River Above Tidal begins at the confluence of Aransas and Poesta Creeks and flows 34.9 miles to a point just upstream of US 77. The Aransas River Tidal (Segment 2003) begins at this point and flows 28.3 miles to Copano Bay.

The drainage area for the impaired AU of Poesta Creek (AU 2004B_02) is 52.3 square miles and located entirely within Bee County. The drainage area for the impaired AU of Aransas River Above Tidal (AU 2004_02) includes the drainage area for Poesta Creek and is 314.4 square miles.

The 2014 Integrated Report (TCEQ, 2015a) provides the following segment and AU descriptions for the water bodies considered in this document:

- Segment 2004 (Aransas River Above Tidal) - From a point 1.6 kilometers (1.0 mile) upstream of US 77 in Refugio/San Patricio County to the confluence of Poesta Creek and Aransas Creek in Bee County
    - 2004_02 – From the confluence with Papalote Creek to the upstream end of segment at the confluence with Aransas Creek and Poesta Creek
- Segment 2004B (Poesta Creek) - From the confluence with the Aransas River to the headwaters of the stream about 7.5 km upstream of FM 673
    - 2004B_02 –From the confluence with Talpacate Creek to the headwaters of the stream approximately 7.5 km upstream of FM 673

Monthly normal air temperature data from the Beeville Chase Station USW00012925 weather station (NOAA, 2016) indicate the daily mean air temperature from 1981-2010 was 73.0˚F. Minimum average daily temperature reached a low of 46.3˚F in January. Maximum average daily temperature reached a peak of 97.4˚F in July (Figure 4).

Monthly normal precipitation data, also from the Beeville Chase Station USW00012925 weather station (NOAA, 2016), indicate Beeville's mean annual rainfall from 1981-2010 was 31.96 inches (NOAA, 2016). Rainfall normally peaks in September (4.76 inches) with lowest totals occurring in December (1.55 inches) (Figure 4). Average annual precipitation values across the study area from the PRISM Climate Group at Oregon State (2012) indicate average annual rainfall ranges from 29 to 33 inches per year across the watershed, with a clear east to west decreasing gradient (Figure 5).

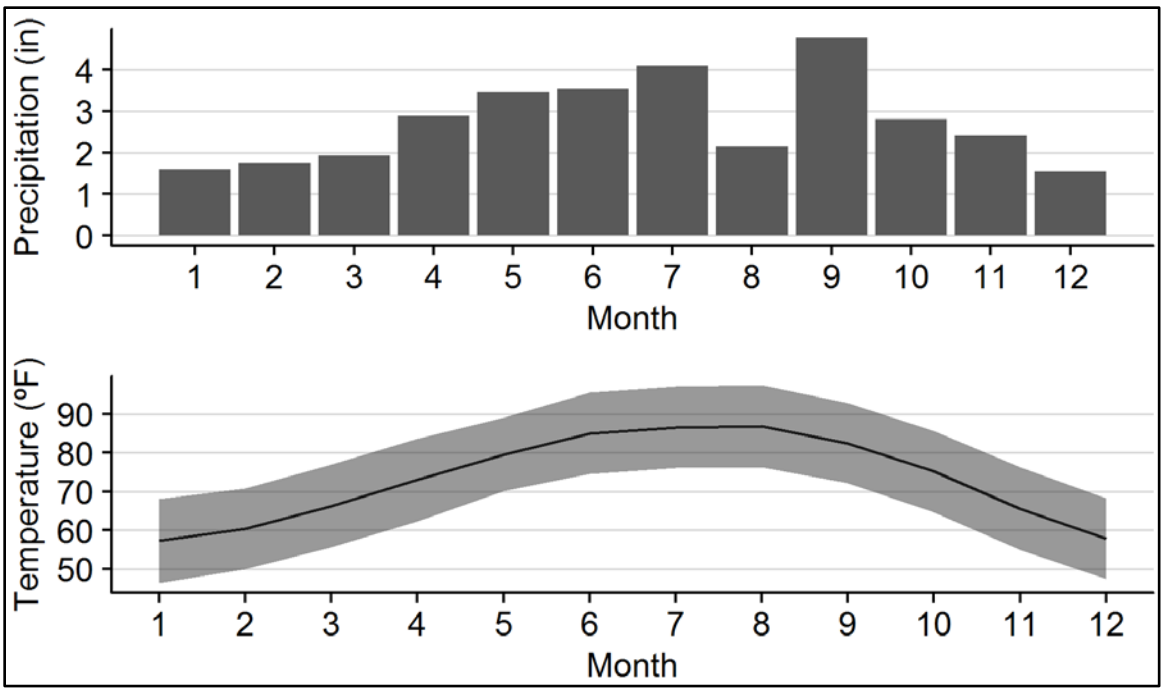

Figure 4. Beeville normal monthly precipitation by month and normal average, maximum, and minimum air temperature by month from 1981-2010

Source: (NOAA, 2016)

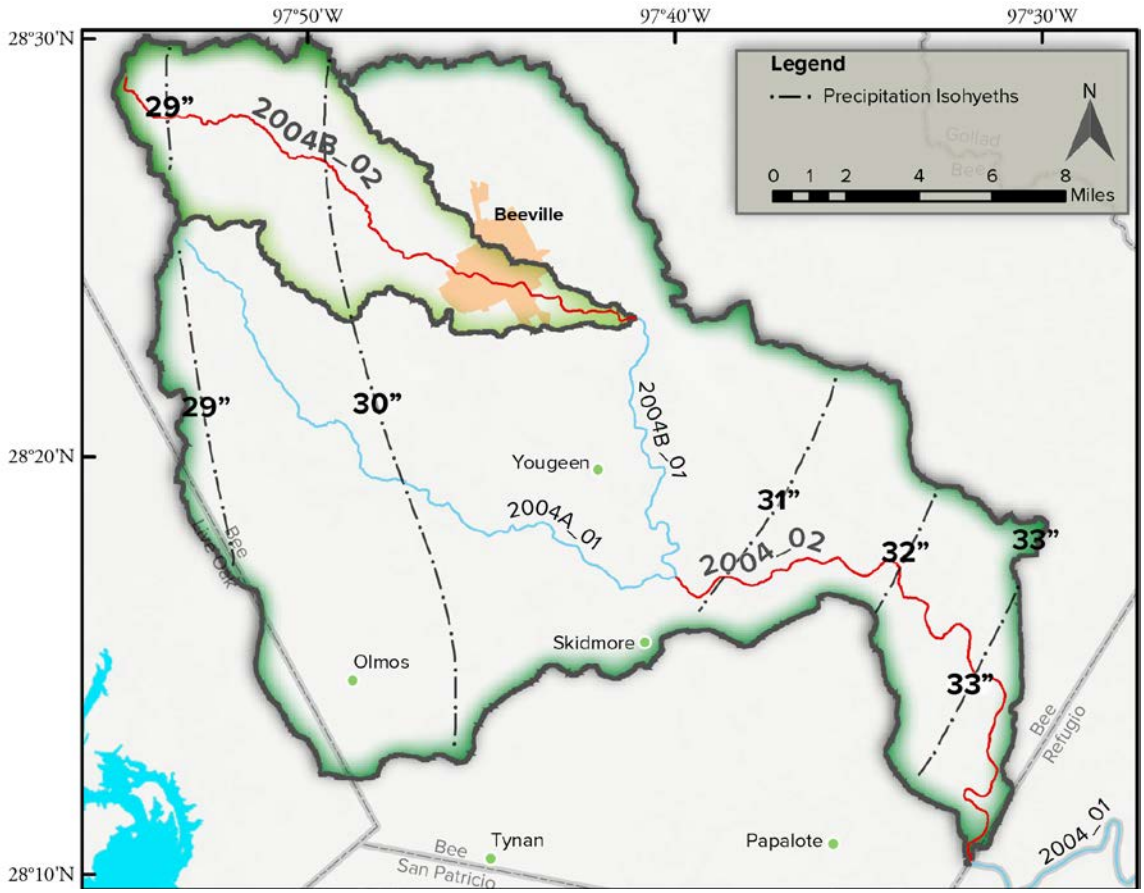

Figure 5. Average annual rainfall (inches) across the study area from 1981-2010

Source: PRISM Climate Group at Oregon State University (2012)

Land use and land cover for the study area (Figure 6) was obtained from the 2011 National Land Cover Database (NLCD) (USGS, 2015). The total Aransas River Above Tidal (AU 2004_02) watershed area is 201,226.6 acres and predominately composed of Pasture/Hay (32.5 percent) and Shrub/Scrub (30.7 percent) (Table 3). The Poesta Creek (AU 2004B_02) watershed, located within the Aransas River Above Tidal watershed, is 33,441.7 acres. The majority of land cover in the Poesta Creek watershed is also Shrub/Scrub (42.3 percent) and Pasture/Hay (32.8 percent). Urban development comprises less than 8 percent of the Aransas River Above Tidal watershed and nearly 15 percent of the Poesta Creek watershed.

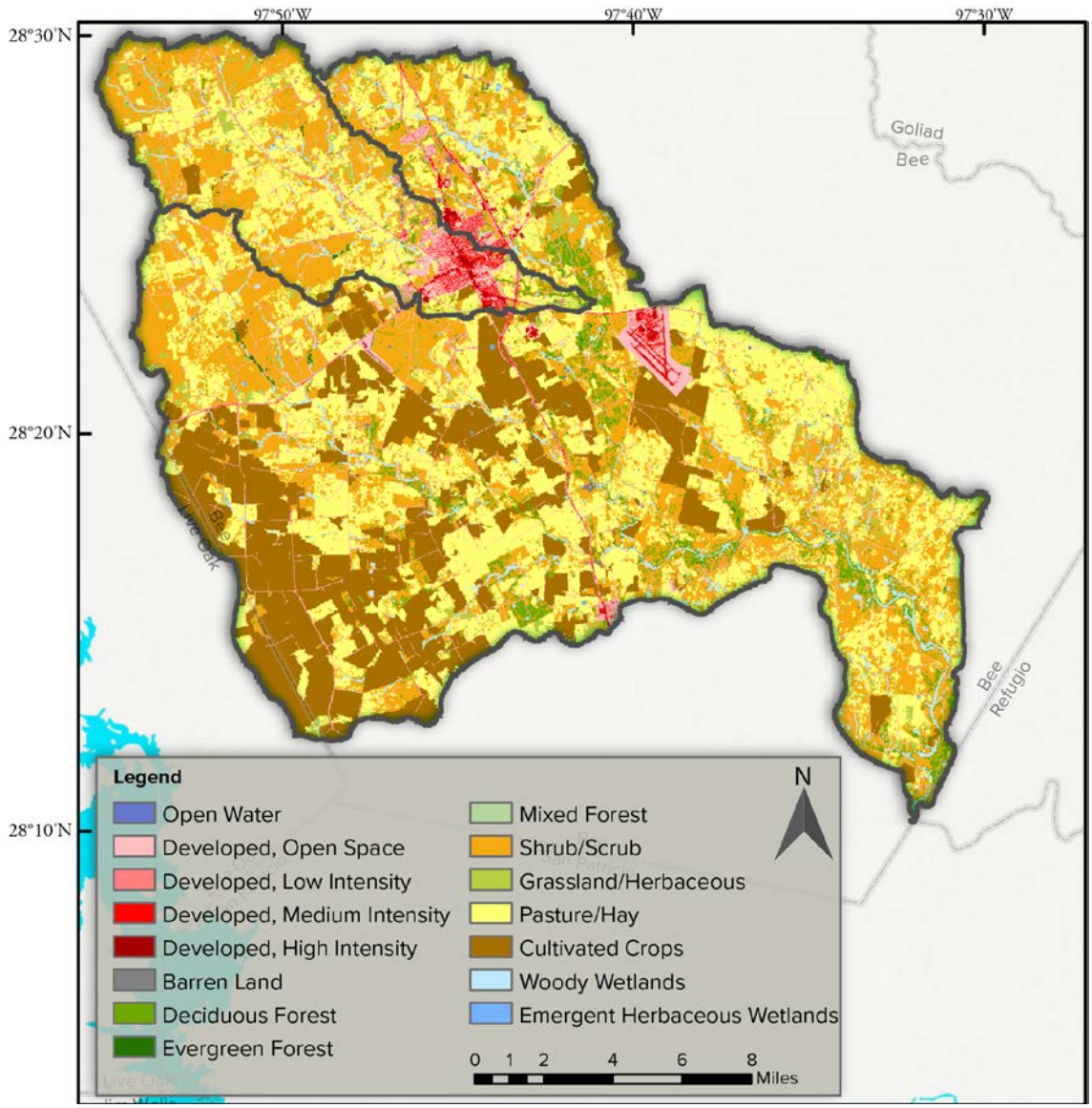

Figure 6. Land use/land cover across the study area

Source: (USGS, 2015)

Table 3. Land use/land cover for the study area

Source: (USGS, 2015)

Land Use/Land Cover	Aransas River Above Tidal (2004_02)		Poesta Creek (2004B_02)	
	Acres	Percent of Total	Acres	Percent of Total
Open Water	33.4	<0.1%	-	-
Developed, Open Space	9,891.4	4.9%	2,361.6	7.1%
Developed, Low Intensity	3,695.5	1.8%	1,430.0	4.3%
Developed, Medium Intensity	1,747.4	0.9%	772.6	2.3%
Developed, High Intensity	473.3	0.2%	218.8	0.7%
Barren Land	452.8	0.2%	166.4	0.5%
Deciduous Forest	7,763.6	3.9%	393.2	1.2%
Evergreen Forest	252.0	0.1%	45.4	0.1%
Mixed Forest	71.2	<0.1%	3.3	<0.1%
Shrub/Scrub	61,769.2	30.7%	14,145.4	42.3%
Grassland/Herbaceous	6,171.7	3.1%	1,585.5	4.7%
Pasture/Hay	65,329.3	32.5%	10,955.4	32.8%
Cultivated Crops	37,717.7	18.7%	432.8	1.3%
Woody Wetlands	5,752.0	2.9%	924.5	2.8%
Emergent Herbaceous Wetlands	106.1	0.1%	6.9	<0.1%
Total	**201,226.6**	**100%**	**33,441.7**	**100%**

Endpoint Identification

The endpoint for the TMDL is to maintain the concentration of *E. coli* below the geometric mean criterion of 126 MPN/100mL. This endpoint was applied to both AUs addressed by this TMDL. This endpoint is identical to the geometric mean criterion for primary contact recreation in the 2010 TSWQS (TCEQ, 2010).

Source Analysis

Regulated Sources

Permitted sources are regulated under the Texas Pollutant Discharge Elimination System (TPDES) and the National Pollutant Discharge Elimination System (NPDES) programs. Wastewater treatment facility (WWTF) outfalls and stormwater discharges from industries and construction sites represent the regulated sources in the project watershed.

Domestic and Industrial Wastewater Treatment Facilities

Three facilities in the project watershed treat domestic wastewater (Figure 7). The City of Beeville Moore Street WWTF (TPDES permit number 10124-002) discharges directly into the impaired Poesta Creek (AU 2004B_02). The Chase Field WWTF (TPDES permit number 10124-004) operated by the City of Beeville

discharges into the mainstem of the impaired Aransas River Above Tidal (AU 2004_02) slightly downstream of USGS streamflow gage 08189700. The Skidmore Water Supply Corporation (WSC; TPDES permit number 14112-001) discharges into an unnamed tributary that flows into the impaired Aransas River Above Tidal (AU 2004_02). Table 4 summarizes final permitted discharges and recent discharges obtained from the EPA (2017) Enforcement and Compliance History Online (ECHO) website. Permitted discharges in the watershed range from 0.131 to 3.0 million gallons per day (MGD).

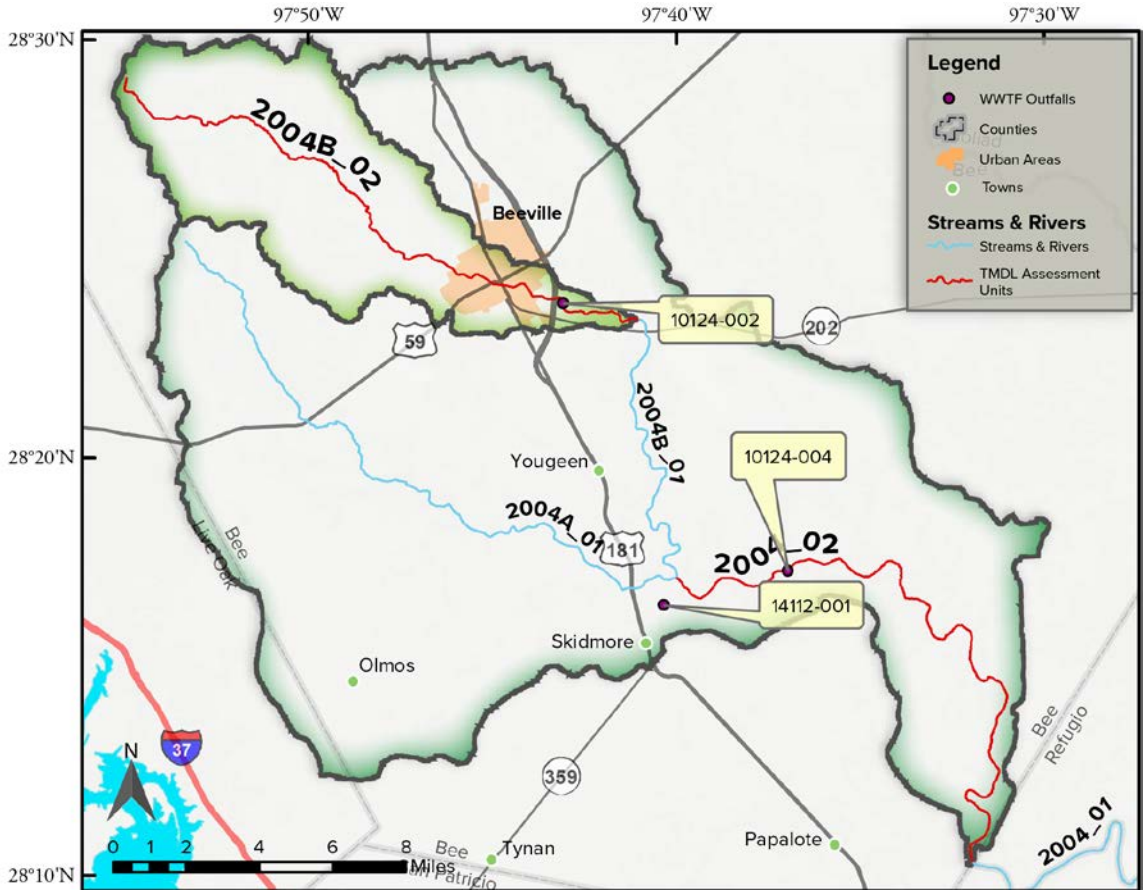

Figure 7. WWTF outfall locations across the project watershed.

Sanitary Sewer Overflows

Sanitary sewer overflows (SSOs) are unauthorized discharges that must be addressed by the responsible party. The TCEQ Region 14 office maintains a database of SSO data reported by municipalities (personal communication with TCEQ Region 14 on January 11, 2017). These SSO data typically contain estimates of the total gallons spilled, responsible entity, and a general location of the spill. Table 5 provides a summary of SSOs that occurred within the project AUs from August 2009 through December 2016. Fifteen separate

incidents reported by two facilities occurred in the project watershed during this timeframe.

Table 4. Permitted WWTFs in the project watersheds

Source: Individual TPDES Permits

TPDES Permit Number	NPDES Permit Number	Facility	AU	TMDL Receiving Waters	Final Permitted Discharge (MGD)	Average Discharge (MGD)[1]
10124-002	TX0047007	City of Beeville - Moore Street WWTF	2004B_02	Poesta Creek	3.0	2.03
10124-004	TX0113859	City of Beeville - Chase Field WWTF	2004_02	Aransas River Above Tidal	2.5	0.43
14112-001	TX0119407	Skidmore WSC WWTF	2004_02	Aransas River Above Tidal	0.131	0.05

[1] Average discharge from January 2009 through October 2016

Table 5. Summary of SSO incidents reported in project watersheds from August 2009 through December 2016

Source: Personal communication TCEQ Region 14 (Jan 11, 2017)

AU	Number of Incidents[1]	Mean Volume (gallons)	Median Volume (gallons)	Minimum Volume (gallons)	Maximum Volume (gallons)	Total Volume (gallons)
2004_02	15	25,221.429	10,000	350	93,750	353,100
2004B_02	11	24,310.000	9,000	350	93,750	243,100

[1] Total number of reported incidents. One incident reported that an unknown volume was discharged during the event. Therefore, the number of incidents used to calculate statistics included in the table are 14 and 10 for AU 2004_02 and 2004B_02 respectively.

TPDES-Regulated Stormwater

TPDES general permits cover stormwater discharges from Phase II urbanized areas, industrial facilities, and construction sites over one acre. A review of active stormwater general permits in the project watershed resulted in eight active industrial site permits (Stormwater Multi-Sector General Permit for Industrial Facilities, TXR050000; six of those permits occurred in the 2004B_02 Poesta Creek watershed), as of January 20, 2017 (TCEQ, 2017) (Table 6). The project watershed contains no municipal separate storm sewer system (MS4) permits. The acreage associated with active industrial stormwater general permits was estimated by importing location information into a Geographic Information System and measuring the estimated disturbed area from available aerial imagery. Construction permits (Stormwater General Permit for Construction Activities, TXR150000) were summarized by average daily acreage

for permits issued over the entire available period of record (January 2003 through May 2016). Over that time period, twenty construction permits were issued in the Aransas River Above Tidal (AU 2004_02) watershed, seven of which were in the Poesta Creek (AU 2004B_02) watershed.

Table 6. Summary of land area covered by stormwater permits in project watersheds as of January 20, 2017

Source: TCEQ Central Registry (TCEQ, 2017)

AU	Industrial General Permits (number)	Industrial General Permits (acres / % of watershed)	Construction Permits (number)	Construction Permits (average acres / % of watershed)	Total Area of Permits (acres / % of watershed)
2004_02	8	46.3 / 0.023%	20	104.9 / 0.052%	151.2 / 0.075%
2004B_02	6	27.9 / 0.083%	7	20.5 / 0.062%	48.4 / 0.145%

Unregulated Sources

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

Wildlife and Unmanaged Animal Contributions

E. coli 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 the potential for bacteria contributions from wildlife. Riparian corridors of streams and rivers naturally attract wildlife. With direct access to the stream channel, direct deposition of wildlife waste can be a concentrated source of bacteria loading to a water body. Wildlife also deposit fecal bacteria onto land surfaces, where rainfall runoff may wash bacteria into nearby streams.

For deer, Texas Parks and Wildlife Department (TPWD) biologists provided estimates for deer management units in Bee County, including deer management units 8E, 9, and 11. Based on estimates from 2011 through 2016, an average of one whitetail deer per 34.5 acres of habitat was calculated across the watershed. This density was applied to land classified in the 2011 NLCD as pasture/hay, cultivated crops, shrub/scrub, grassland/herbaceous, deciduous forest, evergreen forest, mixed forest, woody wetlands, and emergent herbaceous wetlands (TWRI, 2009) (Table 7).

For feral hogs, an estimate of one hog per 33.3 acres was applied to land classified in the 2011 NLCD as pasture/hay, cultivated crops, shrub/scrub,

grassland/herbaceous, deciduous forest, evergreen forest, mixed forest, woody wetlands, and emergent herbaceous wetlands (TWRI, 2009) (Table 7).

Table 7. Estimated deer and feral hog populations in project watershed

Sources: Estimates derived from previous watershed studies (TWRI, 2009) and communication with TPWD staff.

AU	Deer	Feral Hogs
2004_02	5,360	5,554
2004B_02	826	856

Domesticated Animals

The estimated livestock numbers in Table 8 are provided to demonstrate that livestock are a potential source of bacteria in the project watersheds. Livestock counts were estimated using county level data available from the 2012 Census of Agriculture (USDA, 2014). These numbers, however, are not used to develop an allocation of allowable bacteria loading to livestock.

Table 8. Livestock estimates for project watersheds

Source: Estimates derived from USDA Census of Agriculture (USDA, 2014)

AU	Cattle and Calves	Hogs	Chickens	Goats and Sheep	Horses
2004_02	10,472	26	604	749	491
2004B_02	1,643	4	96	118	77

Fecal matter 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 9 summarizes the estimated number of dogs and cats for each AU of the TMDL addendum watersheds. Pet population estimates were calculated as the estimated number of dogs (0.584) and cats (0.638) per household (AVMA, 2012). The actual contribution and significance of fecal coliform loads reaching the water bodies of the impaired watersheds is unknown.

Table 9. Estimated households and pet populations

Sources: Estimates derived from United States Census Bureau (USCB) Census Blocks (USCB, 2010) and American Veterinary Medical Association (AVMA) pet estimates (AVMA, 2012)

AU	Estimated Number of Households	Estimated Dog Population	Estimated Cat Population
2004_02	8,748	5,109	5,581
2004B_02	4,884	2,852	3,116

Onsite Sewage Facilities

Estimates of the number of OSSFs in the project watershed were determined using 2010 Census block data. OSSFs were estimated to be households that were outside of city boundaries and Certificate of Convenience and Necessity (CCN) areas. Table 10 and Figure 8 show the total estimated OSSFs in the project watersheds.

Table 10. OSSF estimate for the project watersheds

Source: Estimates derived from Census Blocks (USCB, 2010) and CCNs (Public Utility Commission of Texas, 2017).

AU	Estimated OSSFs
2004_02	2,545
2004B_02	763

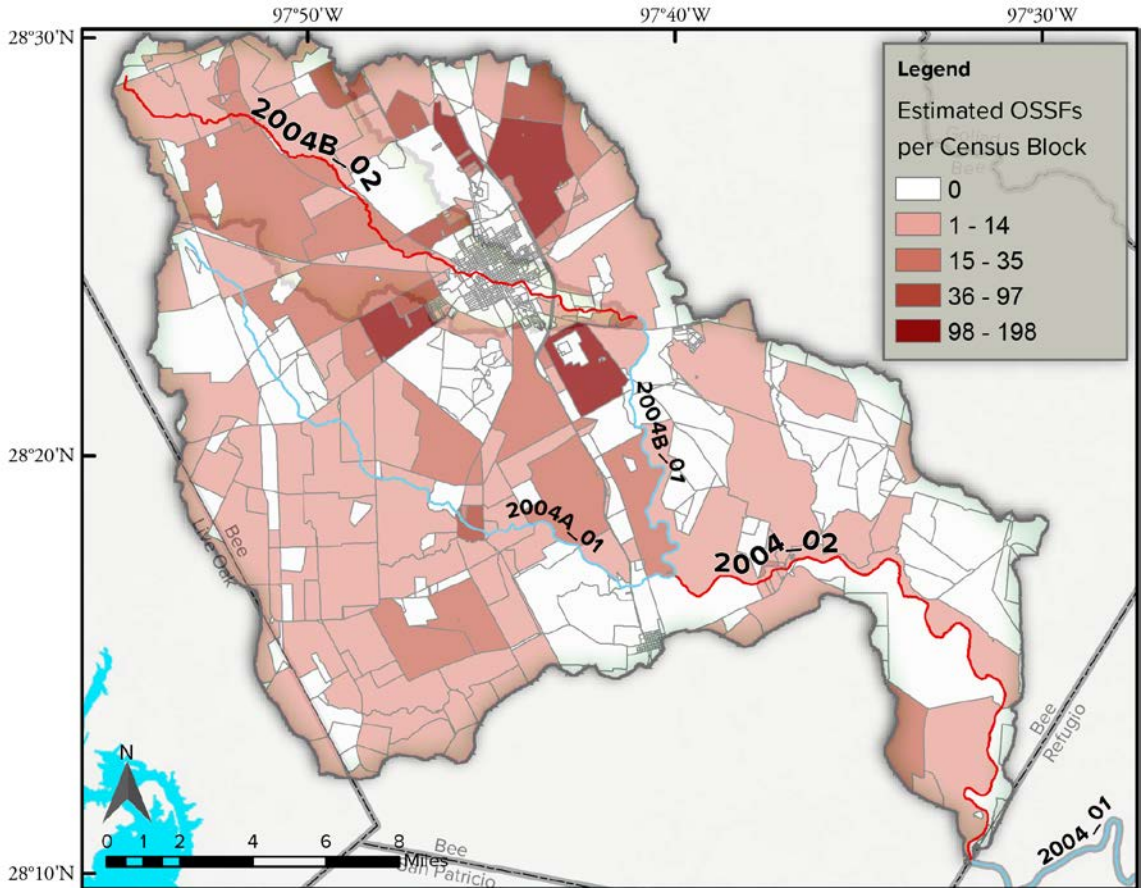

Figure 8. OSSF estimates for the project watersheds

Sources: Estimates derived from Census Blocks (USCB, 2010) and CCNs (Public Utility Commission of Texas, 2017).

Linkage Analysis

Load duration curves (LDCs) were 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 LDCs to define the TMDL pollutant load allocation. That is, the allocation of pollutant loads was based on apportioning the loadings based on flows assigned to WWTFs, a fractional proportioning of the remaining flow based on the area of the watershed under stormwater regulation, and assigning the remaining portion to the non-regulated stormwater. The Technical Support Document (Schramm, 2017) provides details about the analyses, tools, and their applications.

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 TMDLs covered by this report incorporate an explicit MOS by setting a target for indicator bacteria loads that is 5 percent lower than the geometric mean criterion.

Pollutant Load Allocation

The TMDL component for the two impaired AUs covered in this report are derived using the median flow within the high flow regime (or 5 percent flow) of the LDC developed for the outlet of each AU watershed.

Based on the LDCs to be used in the pollutant load allocation process with historical *E. coli* data added to the graphs (Figures 9 and 10), the following broad linkage statements can be made. For the Aransas River Above Tidal (AU 2004_02) watershed, *E. coli* loading exceedances occur frequently at high flows and are generally below or near the loading criterion at mid-range and low flows. However, elevated loadings occur under all flow conditions for the Poesta Creek (AU 2004B_02) watershed.

Regulated stormwater comprises a minor portion of both watersheds. Therefore, non-regulated stormwater likely contributes to the majority of high flow-related loadings in both watersheds. Elevated loadings in Poesta Creek (AU 2004B_02) at low and median flow conditions cannot be attributed exclusively

to WWTFs due to the WWTF outfall location occurring downstream of the SWQM sampling station. Therefore, other sources of bacteria loadings under lower flow conditions in the absence of overland flow contributions (i.e., without stormwater contribution) are most likely to contribute bacteria directly to the water. These sources may include direct deposition of fecal material from sources such as wildlife, feral hogs, and livestock. However, the actual contributions of bacteria loadings directly attributable from these sources cannot be determined using LDCs.

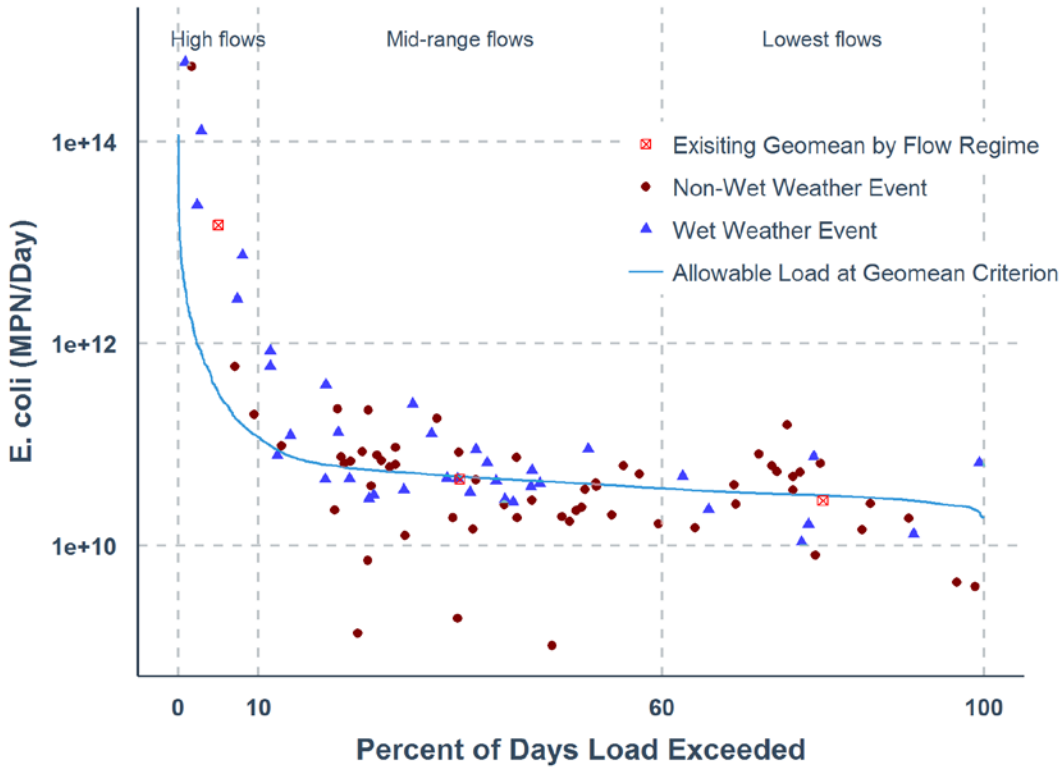

Figure 9. Load Duration Curve for Aransas River Above Tidal (AU 2004_02).

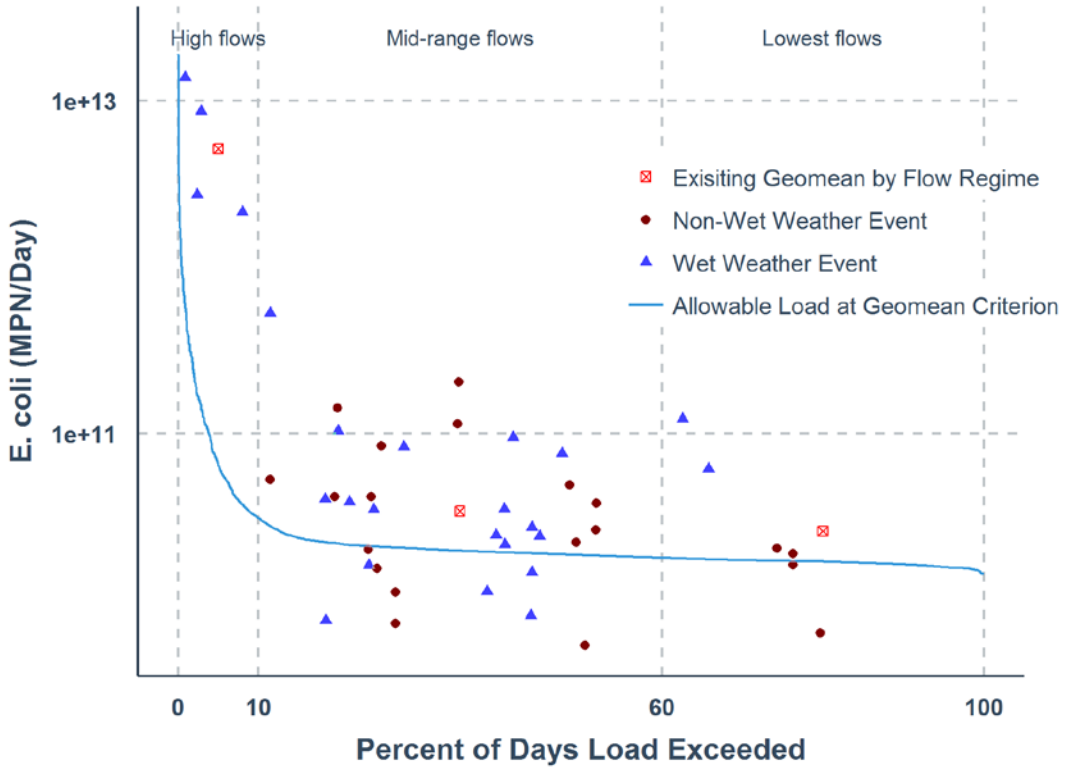

Figure 10. Load Duration Curve for Poesta Creek (AU 2004B_02).

Wasteload Allocation

The wasteload allocation (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 the instream geometric mean criterion and reduced to account for the required MOS. The *E. coli* primary contact recreation geometric mean criterion of 126 MPN/100mL is used as the WWTF target. Table 11 presents the wasteload allocations for each individual WWTF located in the project watersheds.

Table 11. Summary of WLAs for WWTFs in the project watersheds

TPDES / NPDES Permit	Facility	AU	Final Permitted Discharge (MGD)	*E. coli* WLA_{WWTF} (Billion MPN/day)
10124-002 / TX0047007	City of Beeville – Moore Street WWTF	2004B_02[1]	3.0	13.593
2004B_02 Total WLA_{WWTF}			3.0	13.593
10124-004 / TX0113859	City of Beeville – Chase Field WWTF	2004_02	2.5	11.328
14112-001 / TX0119407	Skidmore WSC WWTF	2004_02	0.131	0.594
2004_02 Total WLA_{WWTF}			5.631	25.515

[1] The total WLA_{WWTF} for AU 2004_02 includes WWTFs in AU 2004B_02

Regulated Stormwater

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

Load Allocation

The load allocation (LA) component of the TMDL corresponds to runoff from unregulated sources. It is calculated by subtracting the sum of the WLA_{WWTF}, WLA_{SW}, MOS, and future growth (FG) allocations from the total TMDL allocation.

Future Growth

The 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. The assimilative capacity of streams increases as the amount of flow increases. Increases in flow allow for additional indicator bacteria loads if the concentration are at or below the contact recreation standard.

Three domestic WWTFs are located in the project watersheds. To account for the FG component of the impaired AUs, the loadings from all WWTFS are included in the FG computation, which is based on the WLA_{WWTF} formula. The FG equation contains an additional term to account for project population growth within the WWTF service areas between 2010 and 2070, based on data obtained from the Texas Water Development Board (TWDB) 2017 State Water Plan (TWDB, 2017).

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

TMDL Calculations

Table 12 summarizes the TMDL calculations for the project watersheds. Each of the TMDLs was calculated based on median flow in the 0-10 percentile range (5 percent exceedance, high flow regime) for flow exceedance from the LDC developed for the outlet of each AU. Allocations are based on the current geometric mean criterion for *E. coli* of 126 MPN/100mL for each component of the TMDL.

The final TMDL allocations (Table 13) needed to comply with the requirements of 40 Code of Federal Regulations (CFR) § 103.7 include the FG component within the WLA_{WWTF}. The WLA_{WWTF} for each AU includes the sum of the WWTF allocations for that AU and all upstream AUs. Similarly, the WLA_{SW} for each AU includes the sum of all regulated stormwater areas of that AU and upstream AUs. The LA component of the final TMDL allocations is comprised of the sum of loadings arising from within each AU and all upstream AUs that are associated with unregulated sources.

In the event that the criterion changes due to a change in the designated recreational use, Appendix A provides guidance for recalculating the allocations in Table 13.

Table 12. TMDL allocation summary for project watersheds

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

AU	TMDL	MOS	WLA_{WWTF}	WLA_{SW}	LA	FG
2004_02	319.170	15.959	25.515	0.206	274.505	2.985
2004B_02	63.891	3.195	13.593	0.066	45.447	1.590

Table 13. Final TMDL allocations for project watersheds

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

AU	TMDL	WLA_{WWTF}[1]	WLA_{SW}	LA	MOS
2004_02	319.170	28.500	0.206	274.505	15.959
2004B_02	63.891	15.183	0.066	45.447	3.195

[1] WLA_{WWTF} includes the future potential allocation to wastewater treatment facilities

Seasonal Variation

Federal regulations in 40 CFR §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 collected in warmer months (May-September) against those collected during cooler months (November-March). The months of April and October were considered transitional between the warm and cool seasons and were excluded from the seasonal analysis. Differences in seasonal concentrations were then evaluated with a Wilcoxon Rank Sum test (also known as the "Mann-Whitney" test). The Wilcoxon Rank Sum test was chosen for its ability to handle non-normal data without requiring data transformation. The test was considered significant at the α=0.05 level.

The Wilcoxon Rank Sum test did not detect a significant difference in seasonal *E. coli* measurements in the Aransas River Above Tidal (AU 2004_02) (W=709.5, p=0.357, Figure 11a). A significant difference was detected in seasonal *E. coli* measurements for Poesta Creek (AU 2004B_02) (W=228.5, p<0.001, Figure 11b), indicating that higher *E. coli* concentrations typically occur during the warm season.

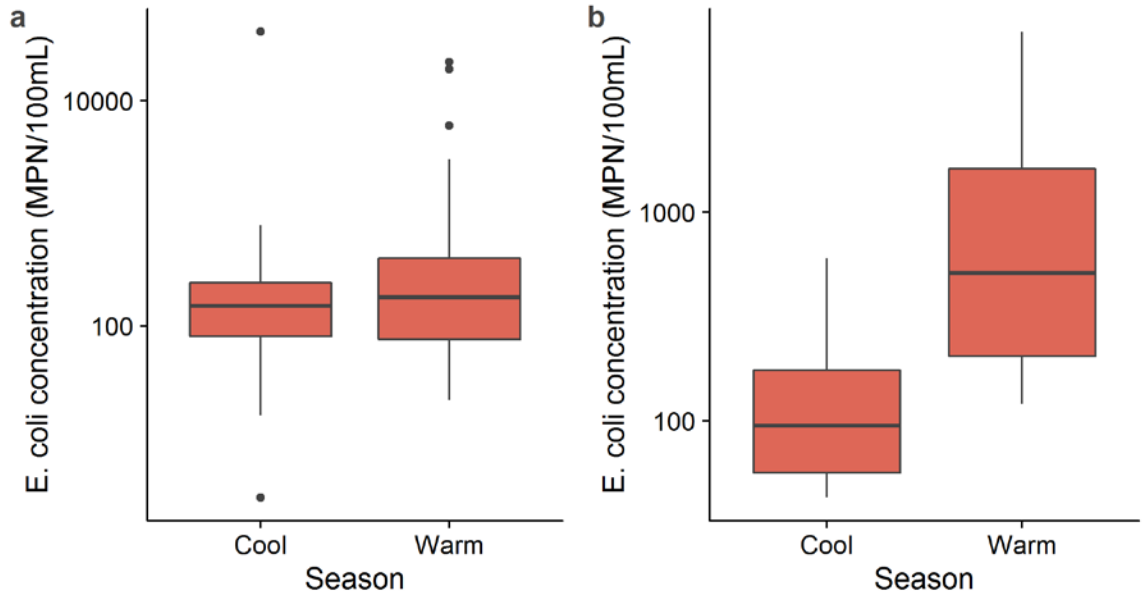

Figure 11. Distribution of *E. coli* concentrations by season in (a) Aransas River Above Tidal (AU 2004_02) and (b) Poesta Creek (AU 2004B_02).

Public Participation

The TCEQ maintains an inclusive public participation process. From the inception of the TMDL study, the TCEQ 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.

Regular stakeholder meetings have been held and TCEQ solicited stakeholder comments at each project milestone. As a contractor to TCEQ, the Texas Water Resources Institute (TWRI) provided technical support and presentations at stakeholder meetings. Ten meetings were held in the project watershed between January 2012 and August 2013 to keep the public aware of the original TMDL and to engage public participation in development of the Implementation Plan (I-Plan).

Stakeholders were consulted on the addendum to these TMDLs through a public meeting on August 10, 2017, where the results of the study were presented by the TWRI project manager. 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 online News page at <www.tceq.texas.gov/waterquality/tmdl/tmdlnews.html>, and the document will be posted at <www.tceq.texas.gov/permitting/wqmp/WQmanagement_updates.html>.

The technical support document for these TMDL additions (Schramm, 2017) was posted on the TMDL project page at: <www.tceq.texas.gov/assets/public/waterquality/tmdl/76copano/76-aransas-poesta-tsd.pdf> on August 3, 2017. The public will have an opportunity to comment on this addendum during a 30-day WQMP update public comment period (November 10 through December 12, 2017).

TCEQ accepted public comments on the original TMDLs and I-Plan during the period October 23, 2015 through November 23, 2015. Two comments were submitted, and neither of them referred directly to the AUs in this TMDL addendum.

Implementation and Reasonable Assurance

The two segments and AUs covered by this addendum are within the existing bacteria TMDL watersheds of the Mission and Aransas Rivers, which drain to Copano Bay. These watersheds are within the area covered by the I-Plan developed with the assistance of local stakeholders. The I-Plan (TCEQ, 2016b) was approved by the TCEQ on May 25, 2016. It outlines an adaptive management approach in which measures are periodically assessed 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.

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Appendix A

Equations for Calculating TMDL Allocations for Contact Recreation Standard Changes

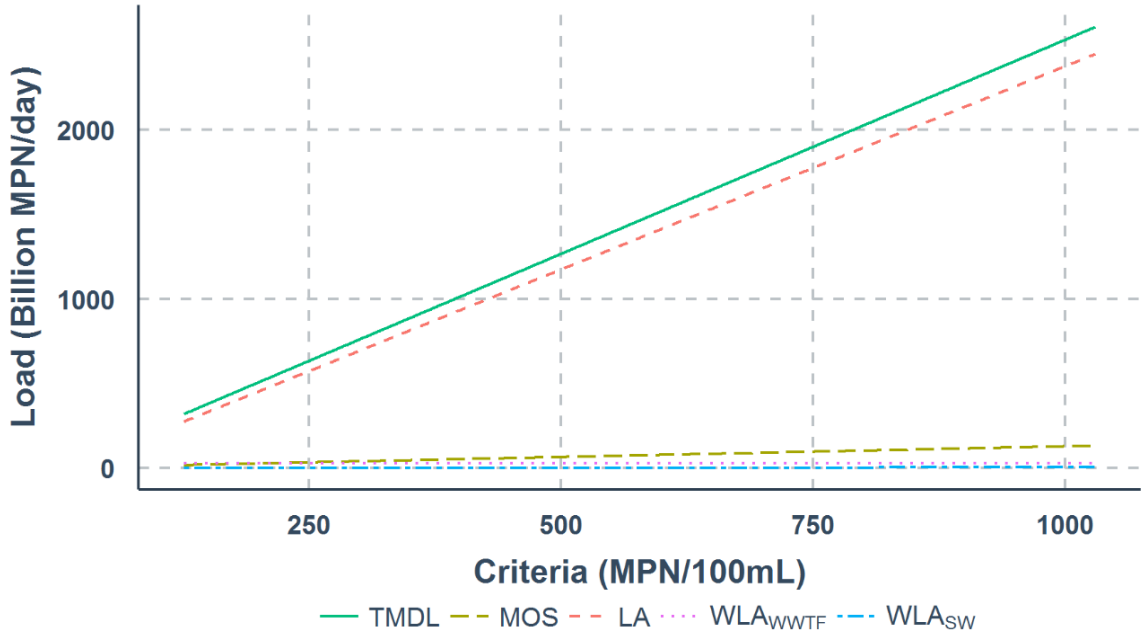

Figure A-1. *E. coli* allocation loads for Aransas River Above Tidal (AU 2004_02) as a function of water quality criteria

Equations for calculating new TMDL and allocations (in billion MPN/day *E. coli*) for Aransas River Above Tidal (AU 2004_02):

TMDL = 2.533095 × Std
MOS = 0.1266547 × Std
LA = 2.404635 × Std – 28.478676
WLA_{WWTF} = 28.50005
WLA_{SW} = 0.00180483 × Std – 0.02137504

Where:

Std = Revised Water Quality Standard
MOS = Margin of Safety
LA = Total load allocation (non-permitted source contributions)
WLA_{WWTF} = Wasteload allocation (permitted WWTF + future growth) [Note: WWTF load held at existing primary contact (126 MPN/100mL) criteria]
WLA_{SW} = Wasteload allocation (permitted stormwater)

Table A-1. Summary of allocation loads for Aransas River Above Tidal (AU 2004_02) at selected revised water quality standards

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

Std (MPN/100mL)	TMDL	MOS	LA	WLA_{WWTF}[1]	WLA_{SW}
126	319.170	15.959	274.505	28.50005	0.206
630	1595.850	79.792	1486.441	28.50005	1.116
1030	2609.087	130.454	2448.295	28.50005	1.838

[1] WLA_{WWTF} includes the future potential allocation to wastewater treatment facilities and held at the primary contact (126 MPN/100mL) criteria

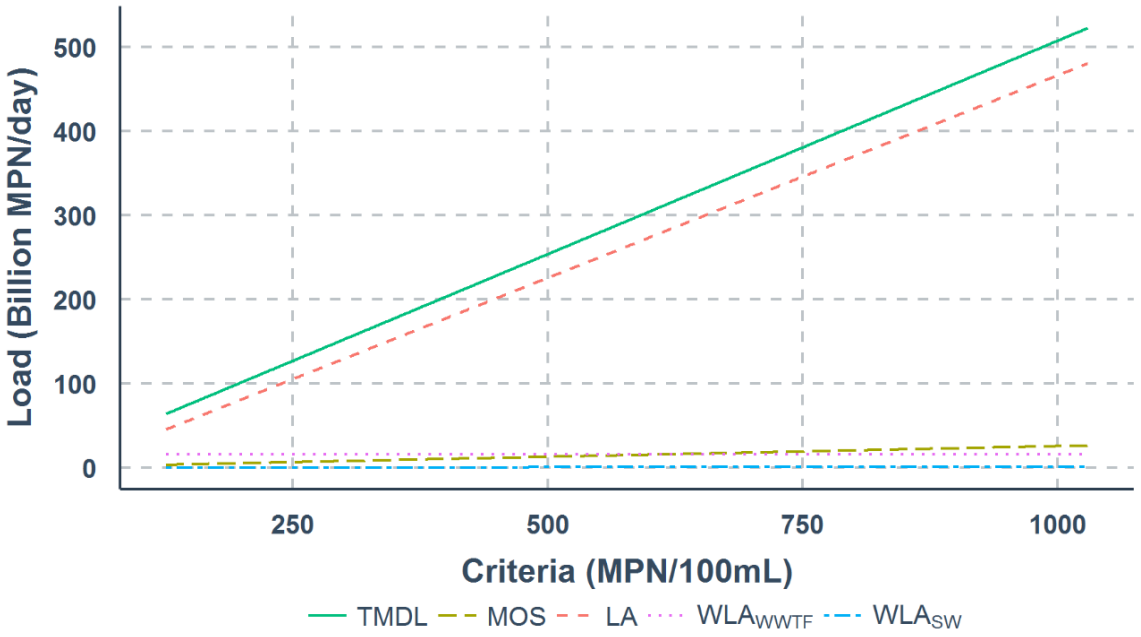

Figure A-2. *E. coli* allocation loads for Poesta Creek (AU 2004B_02) as a function of water quality criteria

Equations for calculating new TMDL and allocations (in billion MPN/day *E. coli*) for Poesta Creek (AU 2004B_02):

$$TMDL = 0.5070740 \times Std$$
$$MOS = 0.02535370 \times Std$$
$$LA = 0.4810218 \times Std - 15.1618148$$
$$WLA_{WWTF} = 15.18383$$
$$WLA_{SW} = 0.00069849 \times Std - 0.02202$$

Where:

Std = Revised Water Quality Standard

MOS = Margin of Safety
LA = Total load allocation (non-permitted source contributions)
WLA_{WWTF} = Wasteload allocation (permitted WWTF + future growth) [Note: WWTF load held at existing primary contact (126 MPN/100mL) criteria]
WLA_{SW} = Wasteload allocation (permitted stormwater)

Table A-2. Summary of allocation loads for Poesta Creek (AU 2004B_02) at selected revised water quality standards

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

Std (MPN/100mL)	**TMDL**	**MOS**	**LA**	**WLA_{WWTF}[1]**	**WLA_{SW}**
126	63.891	3.195	45.447	15.18383	0.066
630	319.457	15.973	287.882	15.18383	0.418
1030	522.286	26.114	480.291	15.18383	0.697

[1] WLA_{WWTF} includes the future potential allocation to wastewater treatment facilities and held at the primary contact (126 MPN/100mL) criteria