La Nana Bayou Watershed Protection Plan

Draft Chapter 5 – Pollution Source Assessment

Once potential pollution sources for a watershed are determined, water sampling can assist stakeholders with determining the needed reduction in pollutant load from each source to achieve primary contact water quality standards. The pollutant load is the concentration of bacteria or nutrients that flows through a specific part of a waterbody (like at a monitoring site) at a specific point in time. A waterbody's capacity for taking on pollutants without being considered impaired depends on its hydrological characteristics.

Bacteria load capacities for La Nana Bayou were calculated using the Load Duration Curve (LDC) method with data from the TCEQ Surface Water Quality Monitoring Information System (SWQMIS). This chapter will estimate the relative bacteria load contributions and potential areas for reductions from the various pollution sources identified in chapter 4. Since there are no nutrient standards for water quality in Texas, LDCs for nutrients were not developed; however, nutrient management is still an important consideration. Practices implemented to reduce bacteria issues in the watershed will also mitigate nutrient concerns.

Load Duration Curve Analysis

LDCs categorize water quality information during various flow conditions. First, a flow duration curve (FDC) is constructed using streamflow measurements that summarizes how often a given flow is exceeded, ranked highest to lowest. The FDC is then multiplied by the allowable pollutant concentration (126 mpn/100mL for *E. coli*) minus a margin of safety of 10% to determine the maximum acceptable pollutant load across all flow conditions. Measurements above the FDC line exceed the water quality standard for that parameter while measurements below the line do not. A percent reduction can be calculated based on the difference between the current measured load and the allowable load. For more information, the US EPA has extensive guidance on the development and application of FDCs and LDCs for water quality analysis (EPA 2016).

While LDCs cannot identify a specific pollutant source, they can give clues for the most likely category of pollution the source falls under depending on when the exceedance occurs: high loads during a period of low flow can indicate the issue is a point source pollution problem – like discharge from a pipe – while higher loads during high flow likely indicate nonpoint source pollution from runoff. In La Nana Bayou, the bacteria geomeans for all AUs were above the water quality standard for most of the year, which indicates a diverse set of sources contributing to bacteria loads, requiring a diverse set of management recommendations.

Bacteria LDCs

The following LDCs (**Figure 1**, **Figure 3**, and **Figure 2**) for bacteria were developed from the earliest available data collected at each station through 2021. Quarterly grab sample data and instantaneous flow measurements were downloaded from the TCEQ SWQMIS.

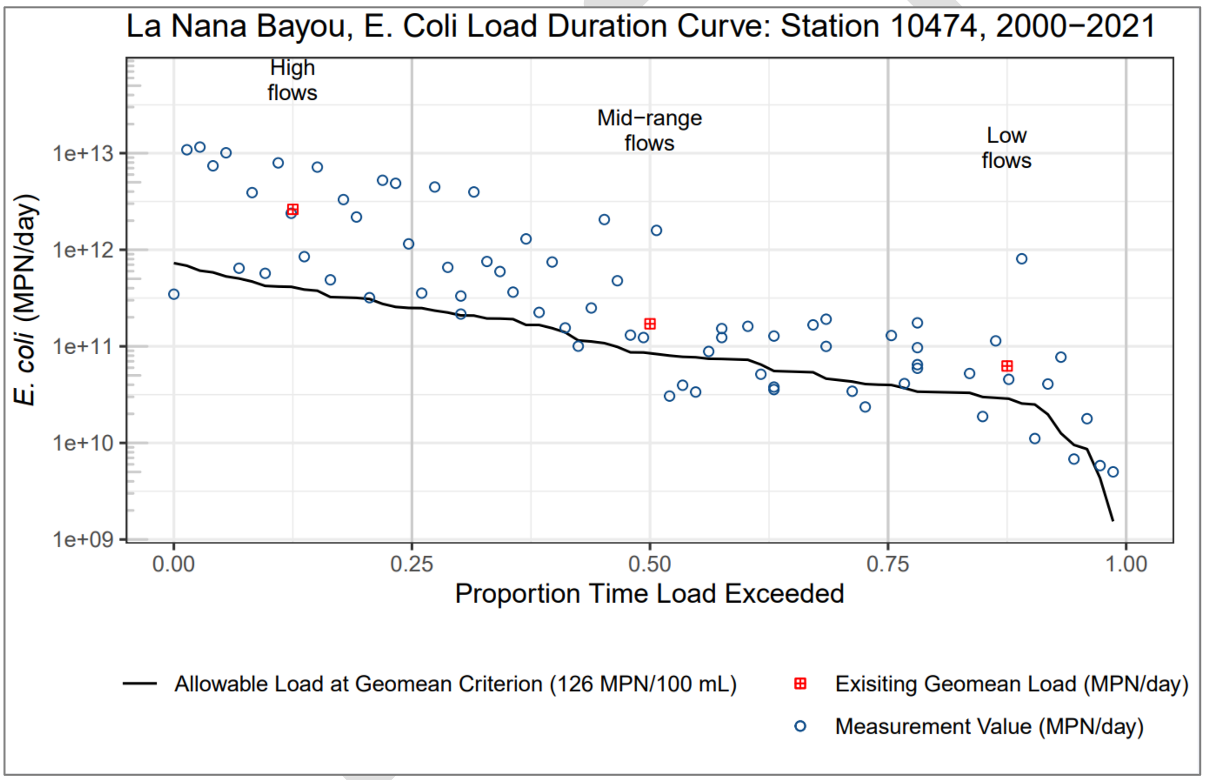

Figure 1 *LDC for E. coli at Station 10474, CR 526, 6.9 miles south of Nacogdoches between FM 2863 and GM 3228.*

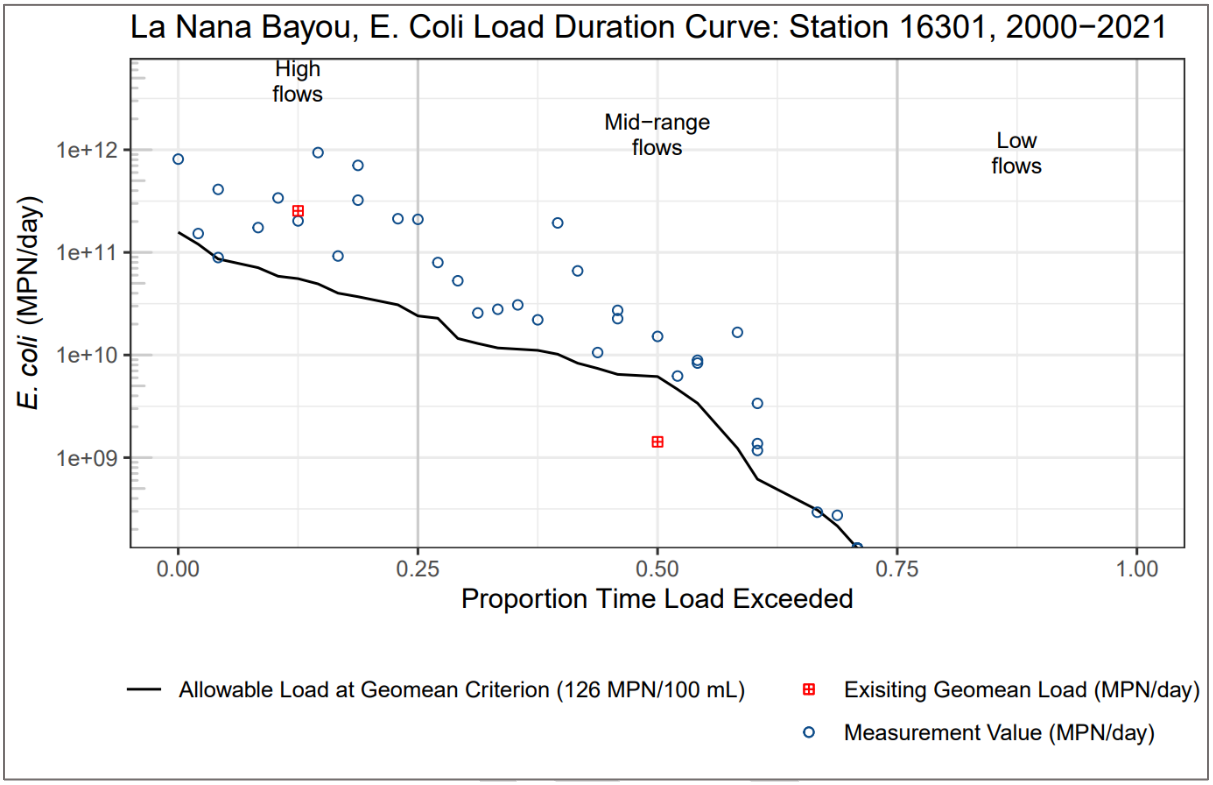

Figure 2 *LDC for E. coli, Station 16301, Loop 224 N in Nacogdoches, 1.2 km east of US BUS 59F / Loop 224 N.*

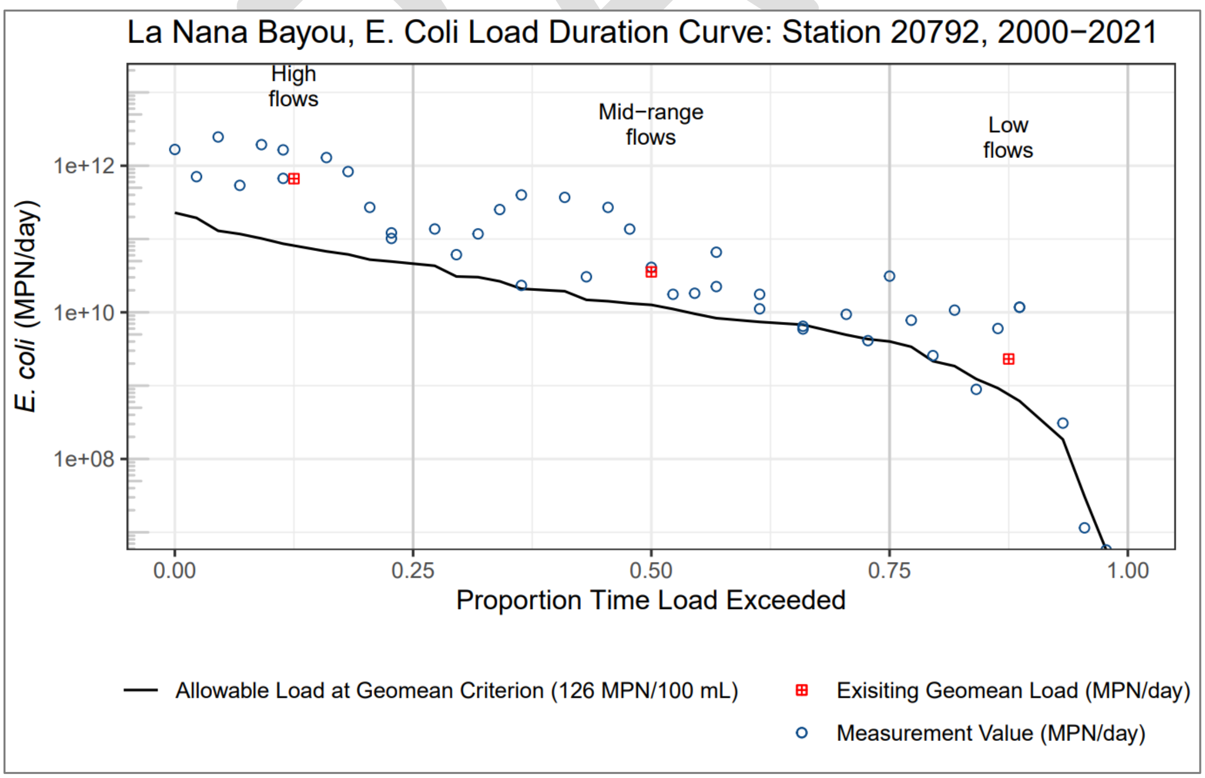

Figure 3 *LDC for E. coli, Station 20792, upstream of E Main St / HWY 7 / HWY 21 in Nacogdoches.*

Annual Load Reduction Needed for Bacteria

Based on the LDC calculations, all three AUs of La Nana Bayou exceed the primary contact recreation water quality standard for bacteria during all flow conditions. Because of the LDCs, we know what La Nana can handle in terms of daily bacteria load without becoming impaired, and we know the current daily load, therefore we can determine the reduction needed to meet water quality standards. **Table 1**, **Table 2**, and **Table 3** below show the needed *E. coli* load reductions that will serve as the basis to determine the goals for recommended management measures.

Table 1 *Estimated E. coli load reductions needed to meet primary contact water quality criteria in AU 0611B_01.*

La Nana Bayou Station: 10474	Flow Condition		
	Lowest Flows	Mid-Range Flows	Highest Flows
Days per year	91.25	182.5	91.25
Median Flow (cubic feet per second)	9.3	27	134
Existing Geomean Concentration (MPN/100 mL)	275	259	742
Allowable Daily Load (Billion MPN)	28.67	83.23	413.08
Allowable Annual Load (Billion MPN)	2,616.06	15,190.01	37,693.74
Existing Daily Load (Billion MPN)	62.57	171.09	2,432.59
Existing Annual Load (Billion MPN)	5,709.65	31,223.92	221,974.23
Annual Load Reduction Needed (Billion MPN)	3,093.59	16,033.90	184,280.49
Percent Reduction Needed	54.18%	51.35%	83.02%
Total Annual Load (Billion MPN)	258,907.80		
Total Annual Load Reduction (Billion MPN)	**203,407.99**		
Total Percent Reduction	**78.56%**		

Table 2 *Estimated E. coli load reductions needed to meet primary contact water quality criteria in AU 0611B_02.*

La Nana Bayou Station: 16301	Flow Condition		
	Lowest Flows	Mid-Range Flows	Highest Flows
Days per year	40.15	127.75	91.25
Median Flow (cubic feet per second)	0.001	2.4	18
Existing Geomean Concentration (MPN/100 mL)	193	451	577
Allowable Daily Load (Billion MPN)	0.0031	7.40	55.49
Allowable Annual Load (Billion MPN)	0.12	945.16	5,063.34
Existing Daily Load (Billion MPN)	0.0047	26.48	254.10
Existing Annual Load (Billion MPN)	0.19	3,383.06	23,186.87
Annual Load Reduction Needed (Billion MPN)	0.07	2,437.90	18,123.53

Percent Reduction Needed	34.72%	72.06%	78.16%
Total Annual Load (Billion MPN)	26,570.12		
Total Annual Load Reduction (Billion MPN)	**20,561.50**		
Total Percent Reduction	**77.39%**		

Table 3 *Estimated E. coli load reductions needed to meet primary contact water quality criteria in AU 0611B_03.*

La Nana Bayou Station: 20792	Flow Condition		
	Lowest Flows	Mid-Range Flows	Highest Flows
Days per year	91.25	182.5	91.25
Median Flow (cubic feet per second)	0.3	3.6	28
Existing Geomean Concentration (MPN/100 mL)	315	405	972
Allowable Daily Load (Billion MPN)	0.92	11.10	86.32
Allowable Annual Load (Billion MPN)	84.39	2,025.34	7,876.30
Existing Daily Load (Billion MPN)	2.31	35.67	665.86
Existing Annual Load (Billion MPN)	210.97	6,510.01	60,760.05
Annual Load Reduction Needed (Billion MPN)	126.58	4,484.67	52,883.75
Percent Reduction Needed	60.00%	68.89%	87.04%
Total Annual Load (Billion MPN)	67,481.03		
Total Annual Load Reduction (Billion MPN)	**57,495.01**		
Total Percent Reduction	**85.20%**		

Nutrient Loads

As previously discussed in chapter 3 and earlier in this chapter, Texas does not currently have nutrient standards for water quality but has set screening levels based on average nutrient concentration of similar waterbodies. The screening level for nitrate is 1.95 mg/L and for total phosphorus is 0.69 mg/L. Only AU 0611B_01 (Station ID 10474) is listed on the 2020 Texas Integrated Report's section of *Water Bodies with Concerns for Use Attainment and Screening Levels* for nutrient concerns in La Nana Bayou. **Figure 4** and **Figure 5** show the measured concentrations of each nutrient by station. The red dashed line on each figure represents the screening criteria level and all points above the red lines are samples with concentrations exceeding the screening criteria. As expected, the downstream segment represented by Station 10474 has the highest nitrate and total phosphorus concentrations.

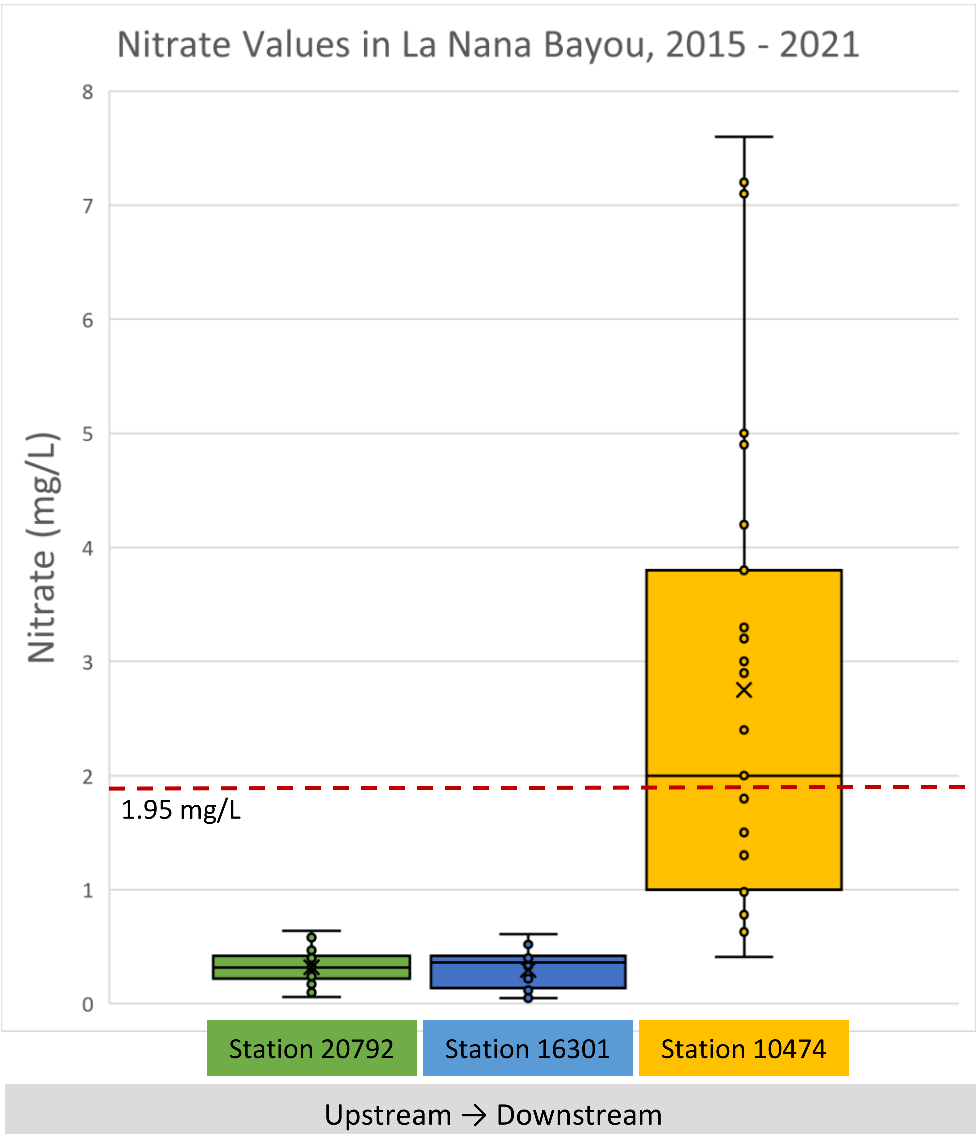

Figure 4 A box-and-whisker plot showing the range of Nitrate concentrations by station. The red dashed line represents the screening level for Nitrate.

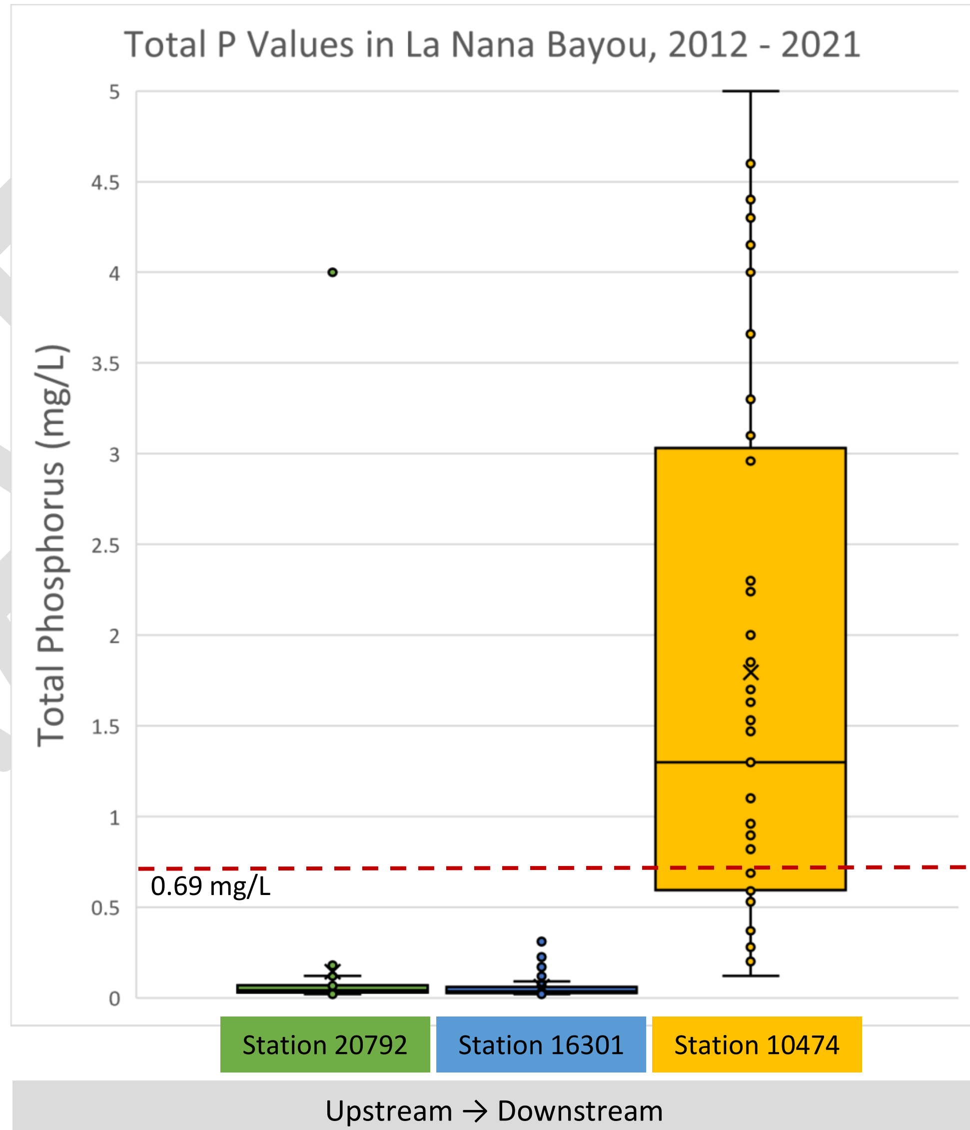

Figure 5 A box-and-whisker plot showing the range of Total Phosphorus (P) concentrations by station. The red dashed line represents the screening level for Total Phosphorus.

GIS Analysis

Using stakeholder input and the best available data, a geographic information systems (GIS) analysis was performed to determine the relative potential load contribution from each subwatershed. Spatial analyses assist with prioritizing when and where management measures should be implemented for the highest need and potential impact. The following estimates show only the potential for bacteria to enter La Nana in each subwatershed relative to the others based on the characteristics from Chapter 2 (slope, soil, land cover, and land use), not the actual amounts expected to enter the creek.

Estimates for animal populations are based on the number of animals each land type can support per acre. Livestock numbers are obtained from the USDA National Agricultural Statistics Survey at the county level. The deer population estimate comes from the Resource Management Unit density survey, and feral hog estimates are from Texas A&M Natural Resources Institute's feral hog calculation method. Sources that are not necessarily tied to land use (WWTFs, OSSFs, and pet waste) are based on the physical location of WWTFs and 911 Addresses from TNRIS.

The chart below (**Figure 6**) shows the range of potential bacteria loading from each pollutant source relative to other sources. Failing OSSFs have the highest potential impact, followed by waste from dogs, livestock, then other wildlife. With only two wastewater permits in the watershed and only one treatment facility, the estimated range for WWTF loadings is relatively small.

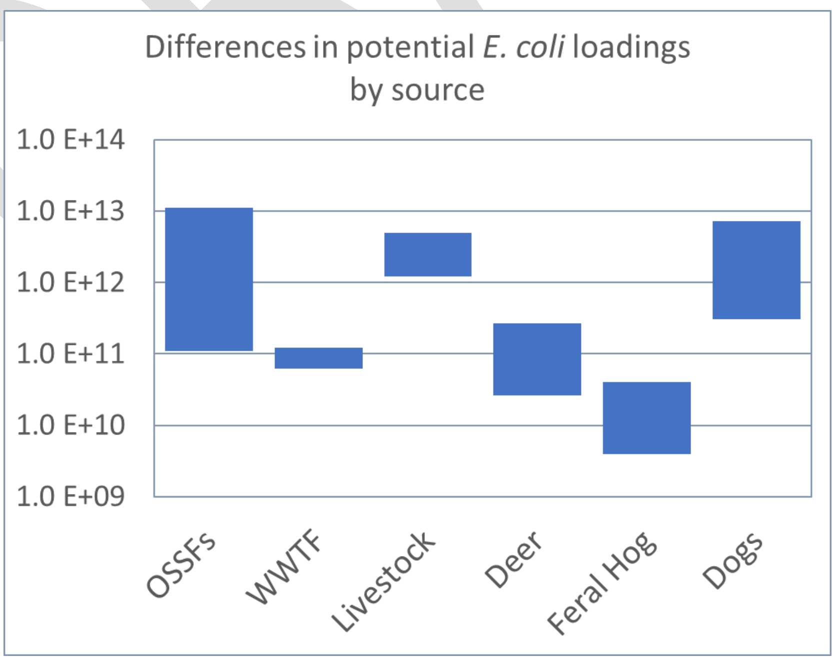

Figure 6 *The ranges for potential bacteria loading by source for La Nana.*

Wastewater Treatment

OSSFs

In the La Nana Bayou Watershed, there is an estimated 2,838 septic systems. This estimate is based on 911 Address data from TNRIS for addresses that are located outside the WWTF service area, and verified by ANRA, the City and County of Nacogdoches, and the Water Supply Corporation.

According to the Nacogdoches County Environmental Services Department Designated Representative, about 30% (or ~851) of the OSSFs in the county are likely failing and contributing excess bacteria to the watershed. The failing OSSFs estimate could also include households that do not have an OSSF on their property at all, so wastewater is entering the watershed untreated. The areas with the highest potential load are mainly outside of the urbanized area of the City of Nacogdoches in Subwatersheds 1, 2, 5, and 6, with the highest concentration of OSSFs being in Subwatershed 1. (**Figure 7**)

Permitted Wastewater Treatment

There are only two facilities in the watershed with permits to release wastewater into La Nana Bayou. One of those, Cal-Tex Lumber, only discharges industrial cooling, storm, and wash water from their milling facility so their potential bacteria load is very minimal. The City of Nacogdoches has a WWTP that can discharge up to 12.88 million gallons of treated effluent daily. The WWTP would have a very high bacteria load into Subwatershed 5 if it were failing (**Figure 8**) but has had no exceedance violations within the last five years of the development of this WPP.

Livestock

Animals contribute bacteria to the watershed in two ways: (1) direct deposition of fecal matter into streams while wading and (2) runoff from pastures and rangeland with elevated levels of bacteria. Alternative water sources and shade structures constructed away from riparian areas reduce the amount of time livestock spend in waterbodies, thus reducing bacteria load from direct deposition (Wagner et al. 2013; Clary et al., 2016). Implementation of best management practices like rotational grazing and grazing livestock in upland pastures (away from waterbodies) has also been shown to reduce the bacteria load (Wagner et al., 2012).

There are approximately 2,900 cattle in the watershed, and a relatively low number of other livestock types (See Chapter 4, Table 5). Subwatersheds 1 and 2 have the most hay/pasture, herbaceous, and shrub land use types, so the potential for bacteria from livestock is the highest in the northern portion of the watershed (**Figure 9**).

Wildlife and Invasive Species

The difference in the designation between "wildlife" and "invasive species" is that wildlife is considered native to the US, like white-tailed deer, and invasive species are nonnative animals like wild pigs (also referred to as feral hogs). While we often have different goals for managing wild animals due to their value to the hunting community or their tendency for property destruction, their impact on water quality is similar (**Figure 10**). Non-domesticated animals tend to live within the same type of habitat or land use: riparian corridors that are not barren or developed. Bacteria from wild animals enters the waterbody through direct deposition when wading and through runoff during a storm event. Feral hogs tend to be particularly destructive which also reduces the riparian's capacity to filter bacteria from other sources.

Domestic Pets

Pets can contribute bacteria to the watershed when their waste is not disposed of properly and it washes into nearby waterbodies during storm events. Dog waste has a particularly high concentration of *E. coli,* so it is important to lower their contribution, but reducing pet waste in the watershed is highly dependent on the actions of pet owners. In rural areas, dogs tend to roam so proper waste disposal may not be practical. In urban areas, pet owner behavior must be influenced through education and conveniently placed waste bins, especially since those areas are more densely populated. **Figure 11** indicates that management efforts should be focused in subwatershed 4 where the most pet owners are located, as well as several popular dog parks and walking trails along the creek.

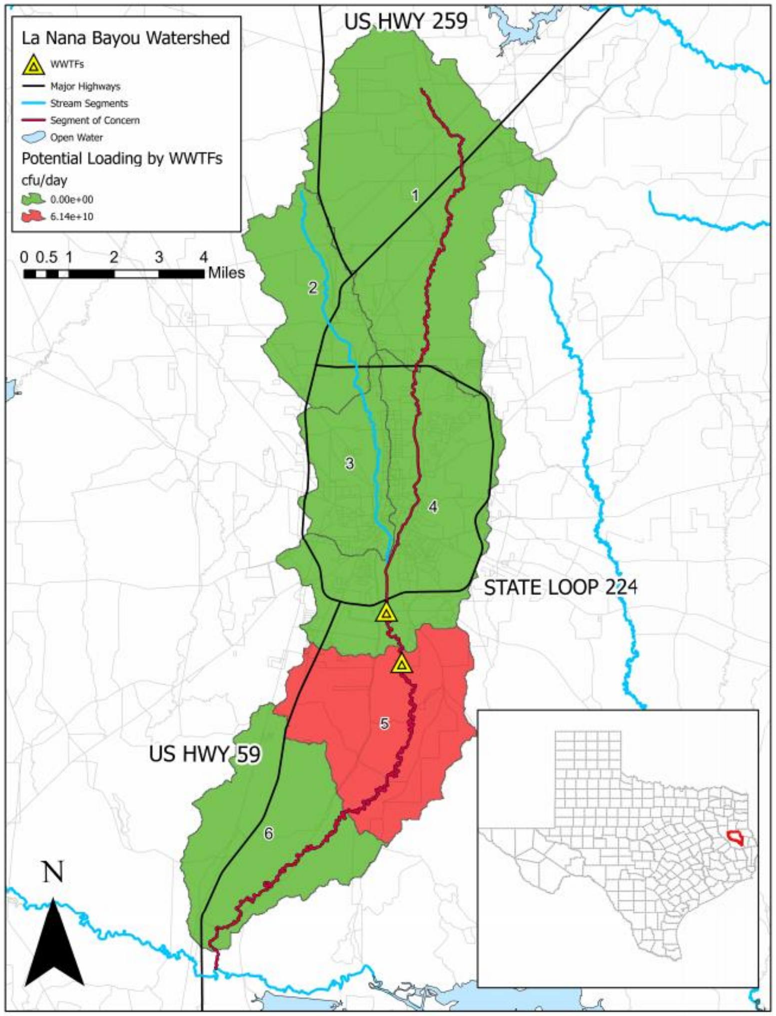

***Figure 8** Estimated load contribution from failing WWTPs.*

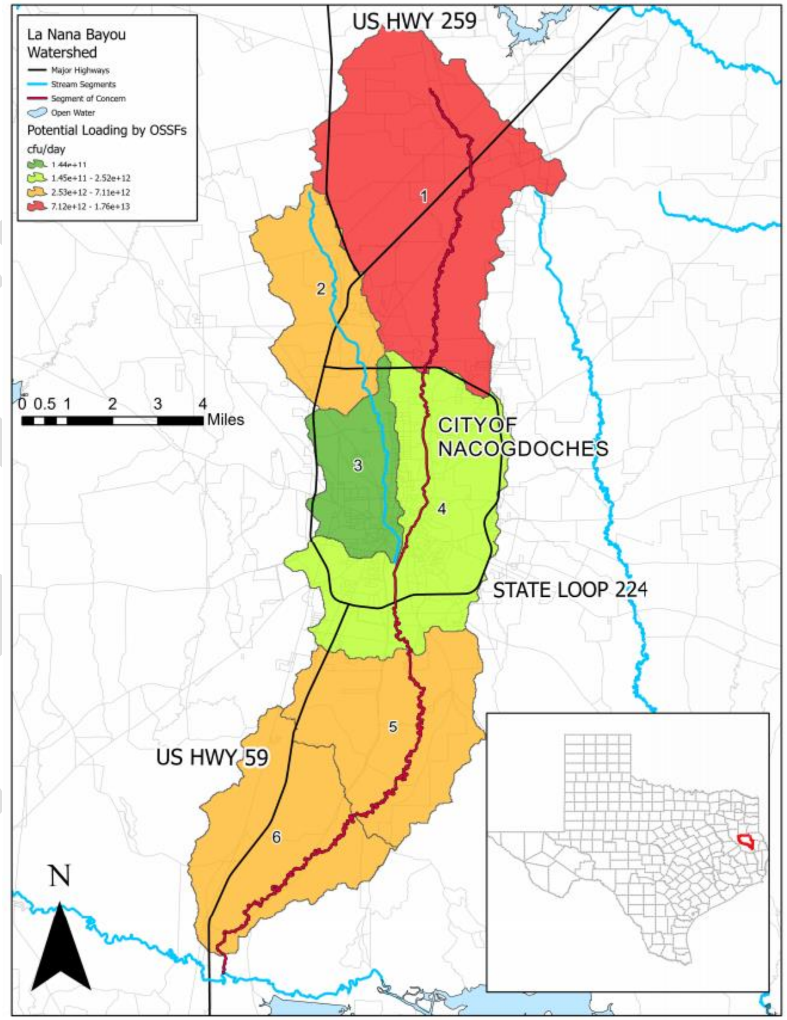

***Figure 7** Estimated load contribution from failing OSSFs.*

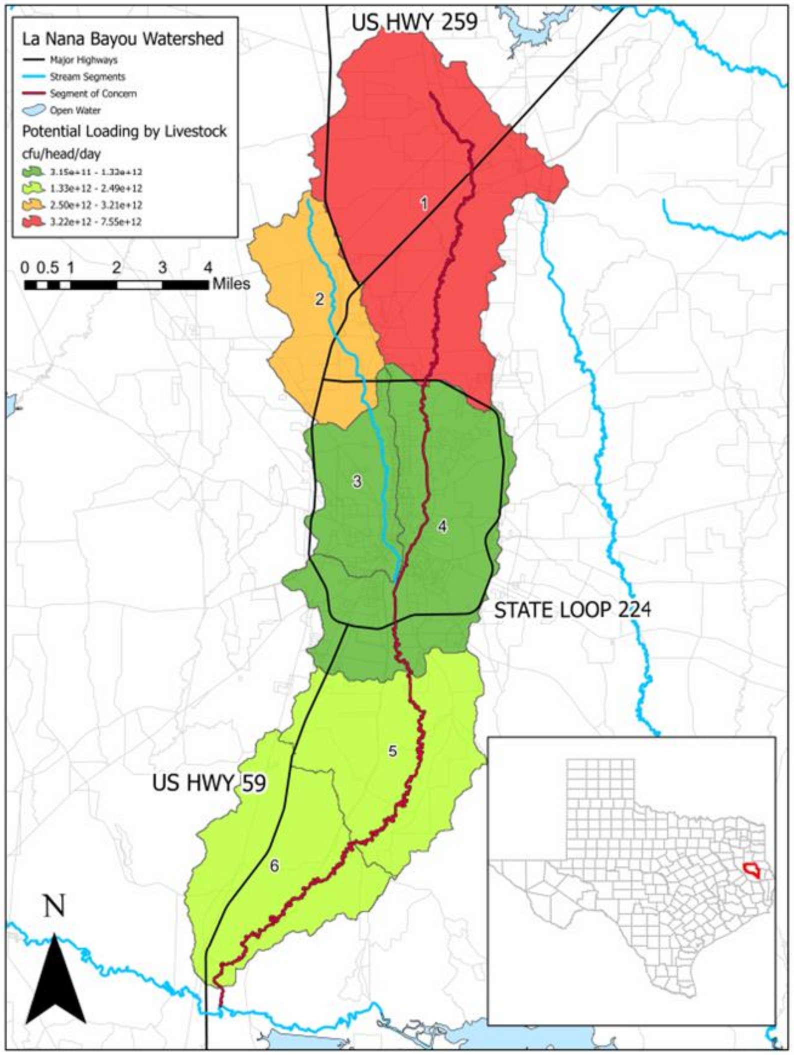

Figure 9 *Estimated load contribution from livestock.*

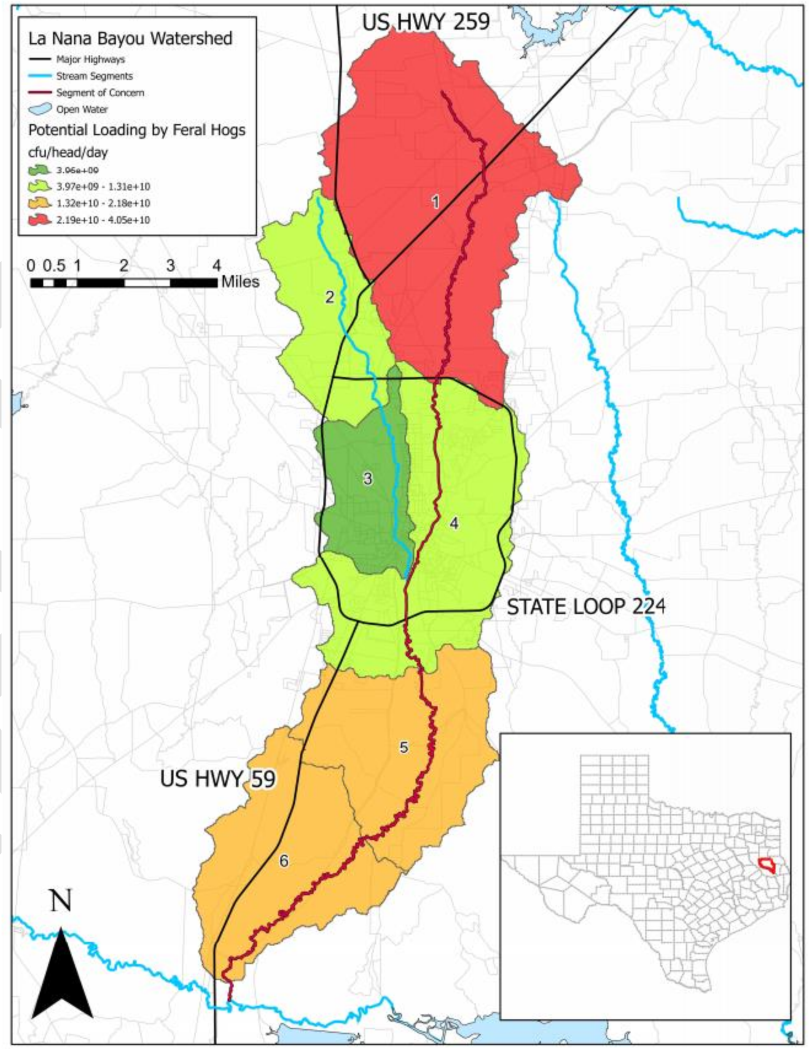

Figure 10 *Estimated load contribution from Feral Hogs.*

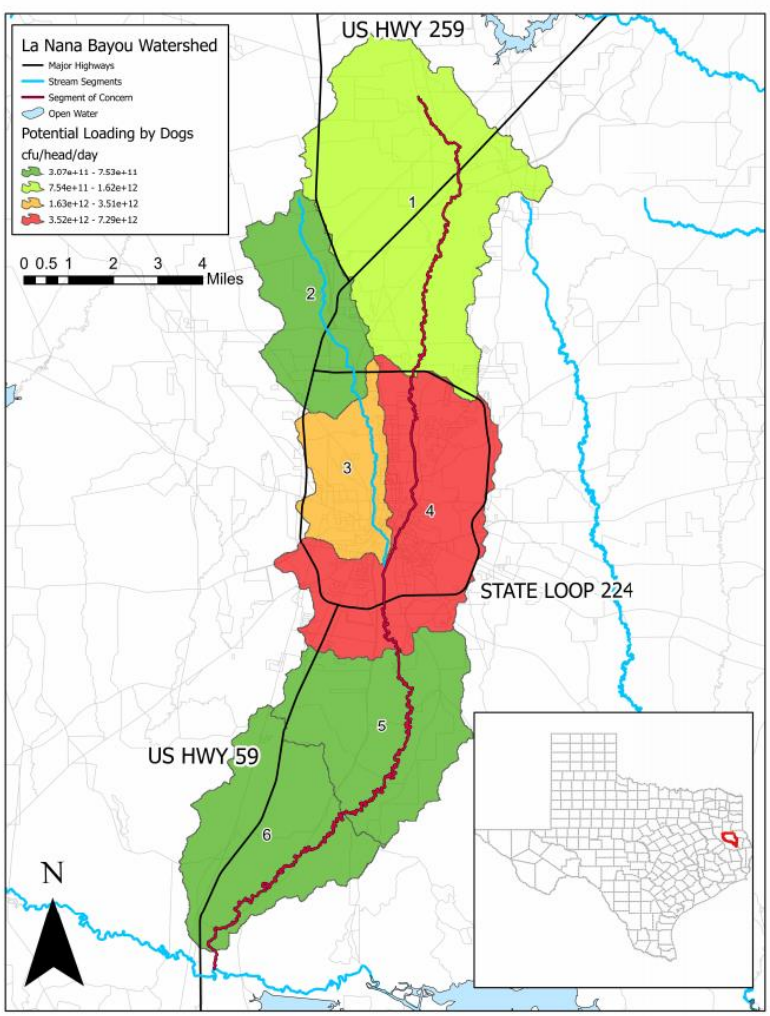

Figure 11 *Estimated load contribution from pets (dogs).*

References

Environmental Protection Agency. Monitoring and Evaluating Nonpoint Source Watershed Projects. (2016, May). *7.9.2 Approaches to Load Estimation.* https://www.epa.gov/sites/default/files/2016-06/documents/nps_monitoring_guide_may_2016-combined_plain.pdf