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Draft Implementation Plan for One Total Maximum Daily Load for Indicator Bacteria in the Cotton Bayou Watershed

Assessment Unit 0801C_01

By Stakeholders of the Cotton Bayou Watershed with Support from the Houston-Galveston Area Council

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Cotton Bayou watershed stakeholders

Organizations that took part in the development of this document include:
Texas State Soil and Water Conservation Board
city of Mont Belvieu

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Abbreviations

AA	authorized agent
AU	assessment unit
BMP	best management practice
cfu	colony forming units
CMP	conservation management plan
CRP	Clean Rivers Program
E. coli	*Escherichia coli*
EPA	United States Environmental Protection Agency
EQIP	Environmental Quality Incentives Program
FOG	fats, oils, grease, and wipes
H-GAC	Houston-Galveston Area Council
mL	milliliter
NRCS	Natural Resources Conservation Service
OSSF	on-site sewage facility
RUS	Rural Utilities Service
SARE	Sustainable Agriculture Research and Education
SEP	Supplemental Environmental Project
SSO	sanitary sewer overflow
SWCD	Soil and Water Conservation District
TCEQ	Texas Commission on Environmental Quality
TEEX	Texas A&M Engineering Extension Service
TGLO	Texas General Land Office
TMDL	total maximum daily load
TPWD	Texas Parks and Wildlife Department
TSSWCB	Texas State Soil and Water Conservation Board
TWDB	Texas Water Development Board
USDA	United States Department of Agriculture
WEP	Water and Environmental Program
WQMP	water quality management plan
WWTF	wastewater treatment facility

Executive Summary

In 2024, the Texas Commission on Environmental Quality (TCEQ) adopted *One Total Maximum Daily Load for Indicator Bacteria in Cotton Bayou Tidal* (Assessment Unit (AU) 0801C_01).

This implementation plan, or I-Plan:

- Describes the steps that watershed stakeholders and TCEQ will take to achieve the pollutant reductions identified in the total maximum daily load (TMDL) report.
- Outlines the schedule for implementation activities.

The goal of this I-Plan is to restore the primary contact recreation 1 use in AU 0801C_01 by reducing concentrations of bacteria to levels established in the TMDL. This I-Plan will benefit, not only to 0801C_01, but to all water bodies within the TMDL watershed as a protective measure.

Escherichia coli (*E. coli*) and Enterococci are widely used as indicator bacteria to assess attainment of the contact recreation—*E. coli* in freshwater and Enterococci in saltwater. The criteria for assessing attainment of the contact recreation use are expressed as the number of bacteria, typically given as colony forming units (cfu). The primary contact recreation 1 use is not attained when the geometric mean of indicator bacteria samples exceeds the geometric mean criterion of 126 cfu per 100 milliliters (mL) for *E. coli* in freshwater streams or 35 cfu/100 mL for Enterococci in saltwater, including tidal water bodies.

This I-Plan includes five management measures that will be used to reduce indicator bacteria in the Cotton Bayou watershed. Management measures are related to nonpoint sources (mostly unregulated), such as pet or wildlife fecal waste in the watershed. Control actions are related to point sources (regulated discharges), such as implementing industrial or domestic wastewater treatment facilities (WWTFs) permits or municipal separate storm sewer systems and their associated stormwater management programs. No control actions are included in this plan.

Summary of Management Measures

For each of the management measures chosen, this plan names the responsible parties, technical and financial needs, monitoring and outreach efforts, and a schedule of activities. Implementation of management measures will be dependent upon the availability of funding. The management measures in this plan are:

1) Reduce stormwater sources such as pet waste and illegal dumping.

2) Promote safe on-site-sewage facility (OSSF) use and maintenance.
3) Support land management initiatives.
4) Promote feral hog management.
5) Improve WWTF and sanitary sewer collection system function.

The stakeholders and TCEQ will review progress under TCEQ's adaptive management approach. Stakeholders may adjust the plan periodically based on progress reviews.

Introduction

To keep Texas' commitment to restore and maintain water quality in impaired rivers, lakes, and bays, TCEQ works with stakeholders to develop an I-Plan for each adopted TMDL. A TMDL is a technical analysis that:

- Determines the amount of a particular pollutant that a water body can receive and still meet applicable water quality standards.
- Sets limits on categories of sources that will result in achieving standards.

This I-Plan is designed to guide activities that will achieve the water quality goals for the Cotton Bayou Tidal watershed, as defined in the TMDL report. It is a flexible tool that governmental and nongovernmental organizations involved in implementation use to guide their activities to improve water quality. The participating partners may accomplish the activities described in the plan through rule, order, guidance, or other formal or informal action.

This I-Plan includes the following components:

- Descriptions of management measures that will be implemented to achieve the water quality target.
- Schedules for implementing activities.
- A tracking and monitoring plan to determine the effectiveness of the management measures undertaken.
- Measurable outcomes and other considerations TCEQ and stakeholders will use to decide whether the I-Plan has been properly executed, water quality standards are being achieved, or the plan needs to be modified.
- Communication strategies TCEQ will use to share information with stakeholders.
- Strategies that stakeholders will use to periodically review and revise the plan to ensure progress in improving water quality.

Watershed Overview

The Cotton Bayou watershed is 16.2 square miles and is located near the northern border of Galveston Bay (Figure 1). Cotton Bayou flows approximately 5.4 miles, beginning about 0.74 miles upstream of Interstate Highway 10 and terminating at its confluence with Cotton Lake. Cotton Bayou Tidal makes up the last 0.7 miles of the water body. The entire watershed is in Chambers County.

Most of the land in the watershed is cultivated, grassland, and woody. However, development is increasing near Mont Belvieu and other areas experiencing the effects of urban sprawl. Cotton Bayou Tidal consists of a single AU (0801C_01).

The 2022 Texas Integrated Report (TCEQ, 2022) provides the following water body and AU description:

- Cotton Bayou Tidal 0801C (AU 0801C_01) – From the confluence of Cotton Lake southeast of Mont Belvieu to a point upstream 1.19 kilometers (0.74 miles) near The Plantation neighborhood in Chambers County.

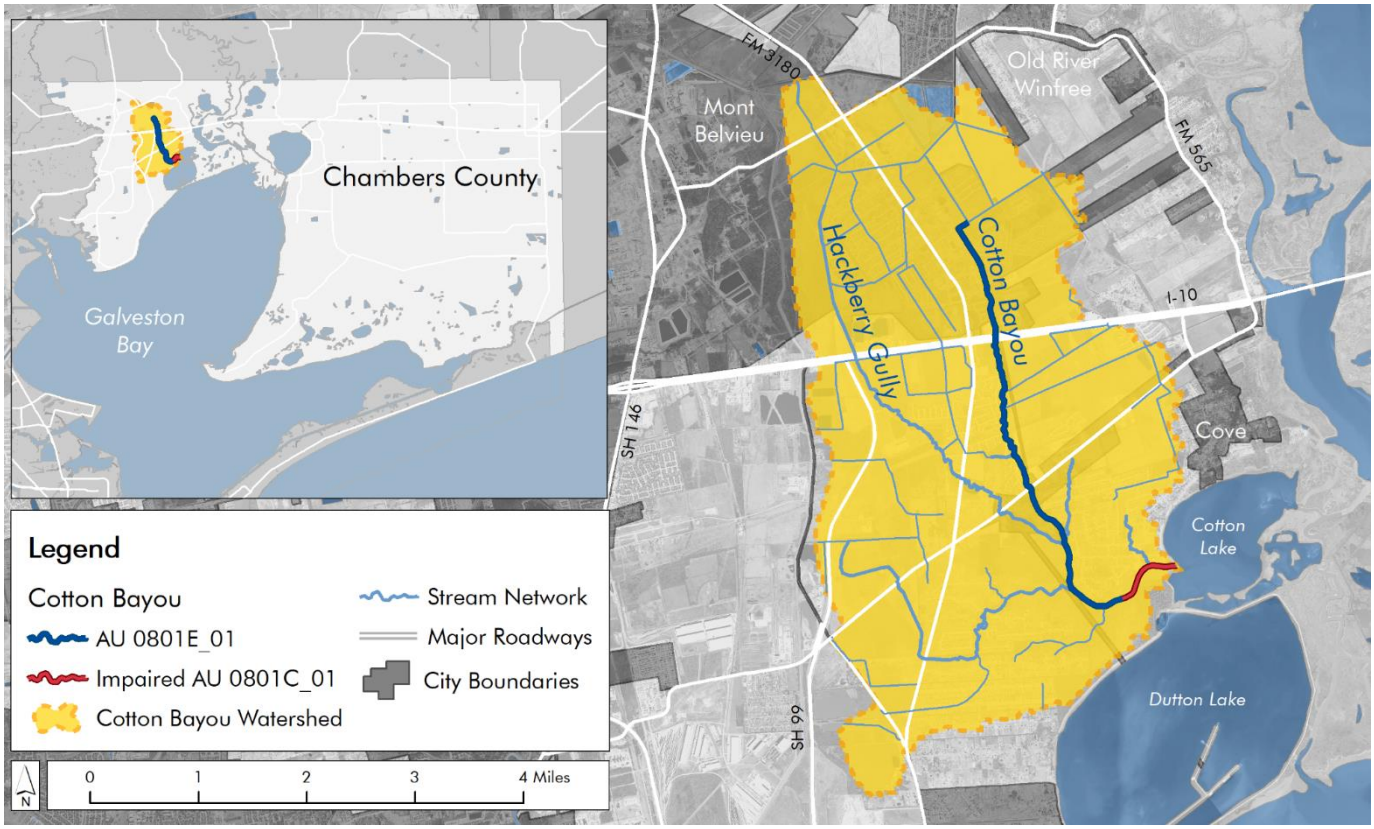

Figure 1. Map of the TMDL watershed

Summary of TMDLs

Table 1 summarizes the allocations developed for *One Total Maximum Daily Load for Indicator Bacteria in Cotton Bayou Tidal.* See the TMDL report for additional background information, including the problem definition, endpoint identification, source analysis, linkages between sources and receiving waters, and pollutant load allocations.

Table 1. TMDL allocation summary for Cotton Bayou Tidal AU 0801C_01

AU	TMDL	WLA_{WWTF} [a]	WLA_{SW} [b]	LA [c]	FG [d]	MOS [e]
0801C_01	89.169	6.554	24.389	45.068	8.700	4.458

All loads are expressed in billion cfu/day.

[a] WLA_{WWTF}: wasteload allocation for WWTFs

[b] WLA_{SW}: wasteload allocation for stormwater

[c] LA: load allocation

[d] FG: future growth

[e] MOS: margin of safety

Implementation Strategy

This I-Plan documents five management measures to reduce bacteria loads. Stakeholders selected management measures based on feasibility, costs, support, and timing. Activities may be phased in based on the needs of the stakeholders, availability of funding, and the progress made towards improving water quality.

Adaptive Implementation

All I-Plans use an adaptive management approach in which stakeholders periodically assess measures for efficiency and effectiveness. This adaptive management approach is one of the crucial elements of the I-Plan. The iterative process of evaluation and adjustment ensures continuing progress toward achieving water quality goals and expresses stakeholder commitment to the process.

The stakeholders will periodically assess progress using the schedule of implementation, interim measurable milestones, water quality data, and the communication strategy included in this I-Plan. If stakeholders find that there has been insufficient progress or that implementation activities have improved water quality, the implementation strategy can be adjusted.

Source Load Calculations

For this document, the TMDL watershed (the full Cotton Bayou watershed) is divided into two subwatersheds. The Cotton Bayou Tidal subwatershed includes the TMDL water body. The Cotton Bayou Above Tidal subwatershed covers the remaining upstream portion of the TMDL watershed. (Table 2, Figure 2)

The estimated nonpoint source pollutant loadings within each subwatershed were determined to set management measure priorities. The Houston-Galveston Area Council (H-GAC) utilized landcover analysis for the Cotton Bayou watershed and source load calculations that have been developed in previous watershed-based plans where source modeling (e.g., SELECT) in the H-GAC region was used (H-GAC, 2018 and EPA, 2001).

Table 2. Watershed acreage

Watershed	Area (acres)
0801C_01	581
0801E_01	9,770

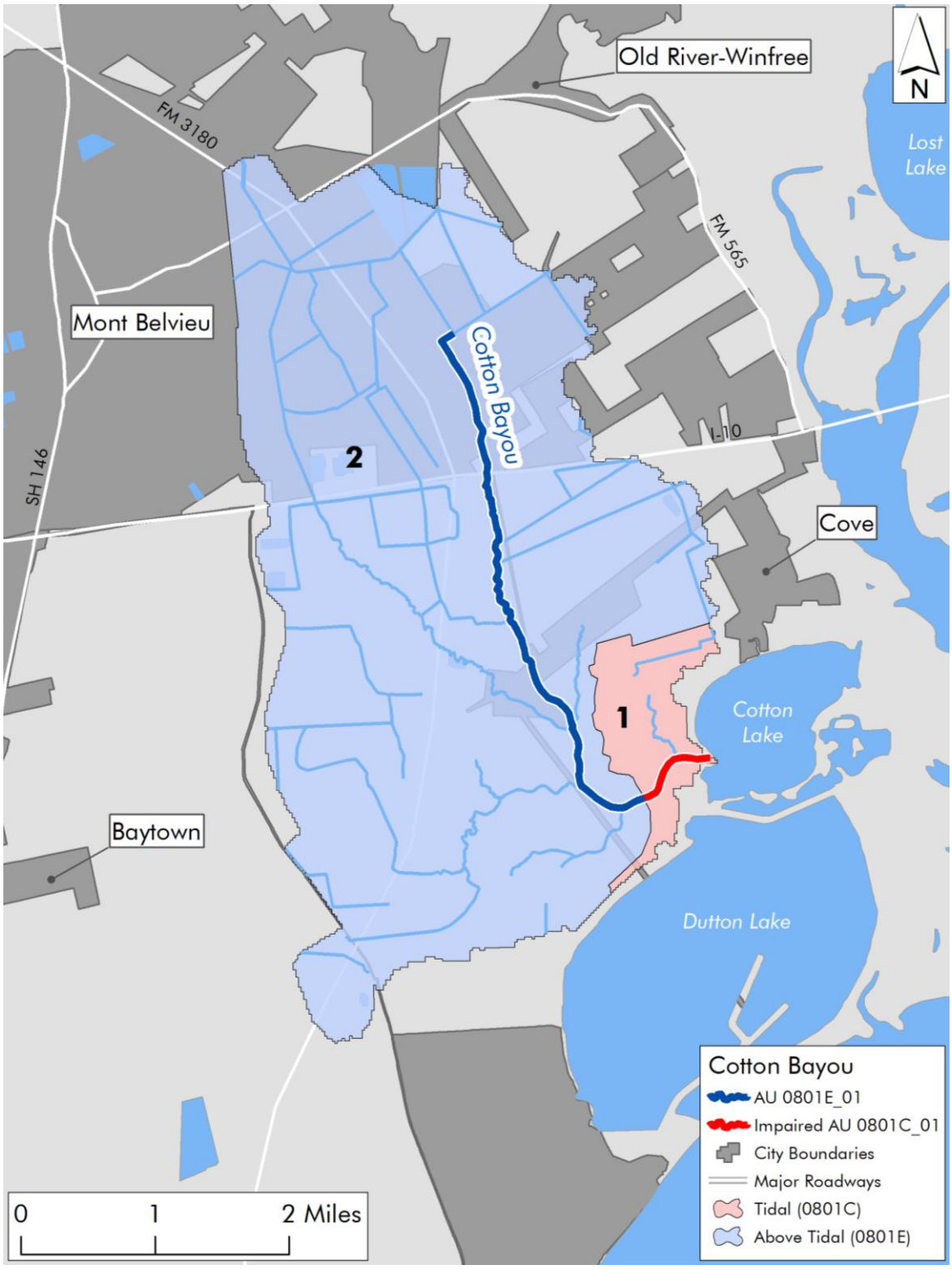

Figure 2. AUs showing priority areas for managing all sources

The source load calculation was carried out by multiplying the estimated total source population, described in the management measure sections, by the daily load per representative unit (e.g., one OSSF) (Teague, 2009; Table 3). National

livestock populations including cattle, horses, sheep, and goats were most recently assessed in a 2022 census by the USDA (USDA, 2024). This I-Plan included the new population data in the calculations that follow. Because of this inclusion, calculations for livestock throughout this plan may be slightly different than those calculated in the TSD and TMDL documents that support this I-Plan.

The loads in Table 3 were developed using *E. coli* (Teague, 2009; EPA, 2001; H-GAC, 2018). The representative units (Table 3) and their daily loads were applied uniformly across the watersheds regardless of which standard criterion was applicable, *E. coli* or Enterococci. Bacteria data collected in the Cotton Bayou watershed include both fecal indicator bacteria because the watershed has both fresh and tidal waters. Enterococci were collected in the tidal water body (AU 0801C_01) and both Enterococci and *E. coli* were collected in the freshwater body (AU 0801E_01). It was assumed that *E. coli* and Enterococci are present in all sources. Source loadings were determined using Table 3 and the estimated watershed source populations. The loads were then expressed in percentage load by source. The tables that follow include loadings in cfu per day of *E. coli* and not Enterococci, with the presumption that management measures will result in proportional bacteria reductions to both indicators, *E. coli* or Enterococci, as well as to any potential fecal pathogens.

Table 3. Representative unit source loads

Bacteria Source	Number in Watershed	Representative Unit	Representative Unit Daily Load (billion cfu/day)
OSSF	789 (95 failing)	1 Failing OSSF	3.71
Cattle	489	1 Cow	2.70
Sheep and Goats	17	1 Sheep or Goat	9.00
Horses	11	1 Horse	0.21
Deer	48	1 Deer	0.175
Feral Hogs	207	1 Feral Hog	4.45
Dogs	1,865	1 Dog	2.50

The estimated individual source loadings and total loading for all sources in each watershed can be found in Table 4. Using this information, the percentage each source load contributes can be determined by dividing the individual source load by the total estimated source load for each watershed. Table 5 presents those percentages.

During TMDL development, the reduction of indicator bacteria needed to attain the contact recreation standards was determined. Table 6 provides the percentage reduction and the load reduction needed within the Cotton Bayou Tidal and Cotton Bayou Above Tidal watersheds to meet the contact recreation standard (H-GAC, 2022).

Multiplying the load reduction values from Table 6 by the percentage source contribution (Table 5) yields the daily load reduction needed for each source and the total reduction by all sources for each watershed. The daily source load reduction values are presented in Table 7. To reach an annual source load reduction, each load is multiplied by 365. The load reduction values will be reviewed more closely within each management measure that follows.

The total source reduction and unit reductions are estimates. They present one solution to meeting the contact recreation standard. In practice, implementing the I-Plan will likely produce opportunities to act on certain measures while others may prove to be more difficult. Due to the availability of funding or other technical assistance, some actions might be more practical. Therefore, completing the actions within one management measure and expanding beyond the estimated reductions expressed for that measure might be used to alleviate another measure that is discovered to be more difficult to implement.

The amount of natural land cover in the Cotton Bayou watershed would suggest a large wildlife contribution, but beyond estimates for deer populations, no additional reliable data exists. Deer are used in this assessment as a surrogate for all wildlife. Efforts under the I-Plan to reduce indicator bacteria will need to account for the fact that no reduction measures will be implemented to address fecal sources from wildlife. Other actions will have to account for this loading. Riparian restoration efforts described in this document may reduce loading from wildlife.

For the remainder of this report, each management measure may include some calculations that have been rounded and may not lead to the exact final amounts listed in the text, tables, or figures.

Table 4. Estimated source loadings of fecal indicator bacteria

Watershed	AU	OSSF	Cattle	Sheep and Goat	Horse	Deer	Feral Hog	Dog	Total Load
Cotton Bayou Above Tidal	0801E	304.22	1,277.10	144.00	2.31	8.10	872.20	4,327.50	6,935.43
Cotton Bayou Tidal	0801C	48.23	43.20	9.00	0.00	0.54	48.95	335.00	484.92
	Total	**352.45**	**1,320.30**	**153.00**	**2.31**	**8.64**	**921.15**	**4,662.50**	**7,420.35**

All loads are expressed in billion cfu/day.

Table 5. Percentage source contribution of fecal indicator bacteria

Watershed	AU	OSSF %	Cattle %	Sheep and Goat %	Horse %	Deer %	Feral Hog %	Dog %	Total %
Cotton Bayou Above Tidal	0801E	4.39%	18.41%	2.08%	0.03%	0.11%	12.58%	62.40%	**100.00%**
Cotton Bayou Tidal	0801C	9.95%	8.91%	1.86%	0.00%	0.11%	10.09%	69.08%	**100.00%**
	Whole Watershed Percent Contribution to Total	**4.75%**	**17.79%**	**2.06%**	**0.03%**	**0.12%**	**12.41%**	**62.84%**	**100.00%**

Table 6. Estimated reductions in fecal indicator bacteria

Watershed	Estimated Loading of Bacteria	Percentage Reduction	Bacteria Reduction
Cotton Bayou Above Tidal	6,935.43	98.80%	6,852.09
Cotton Bayou Tidal	484.92	98.80%	479.09

All loads are expressed in billion cfu/day.

Table 7. Estimated source load reductions

Watershed	AU	OSSF	Cattle	Sheep and Goat	Horse	Deer	Feral Hog	Dog	Total
Cotton Bayou Above Tidal	0801E	300.57	1,261.75	142.27	2.28	8.00	861.72	4,275.50	6,852.09
Cotton Bayou Tidal	0801C	47.65	42.68	8.89	0.00	0.53	48.36	330.98	479.09
	Total	348.22	**1,304.43**	**151.16**	**2.28**	**8.53**	**910.08**	**4,606.48**	**7,331.18**

All loads are expressed in billion cfu/day.

Activities and Milestones

To facilitate the development of the Cotton Bayou I-Plan, H-GAC, under contract with TCEQ, held a series of public meetings in the Cotton Bayou watershed from August 2022 through 2023. The public meetings were used to present general water quality information to stakeholders. The meetings provided information on water quality impairments, TMDL development, and typical management strategies.

Cotton Bayou stakeholders reviewed water quality in the Cotton Bayou watershed and discussed appropriate management measure activities. Three public meetings were held prior to the development of this report. The Cotton Bayou stakeholders responded to a questionnaire that covered potential sources of bacteria loading. The attendees determined if each fecal source was a concern and ranked it on a scale of zero (no concern) to three (highest concern).

The implementation activities presented in this report represent the stakeholders' effort and are described in the following section.

Management Measures

This I-Plan includes five management measures.

1) Reduce stormwater sources such as pet waste and illegal dumping.
2) Promote safe OSSF use and maintenance.
3) Support land management initiatives.
4) Promote feral hog management.
5) Improve WWTF and sanitary sewer collection system function.

Management Measure 1

Reduce Stormwater Sources Such as Pet Waste and Illegal Dumping

The purpose of this management measure is to develop and implement strategies to reduce stormwater sources of fecal wastes, including pet waste and illegal dumping in priority areas.

Pet waste is a common fecal source ascribed to stormwater. Due to a lack of other potential fecal source data, pet waste source loads (represented by dogs) are provided here as a surrogate for other potential stormwater sources. The estimated dog population and associated load is presented in Table 8.

One purpose of this management measure is to reduce the amount of uncollected pet waste that can be transferred to water bodies in the project area. However, this strategy is less effective in rural communities where dogs are kept largely outside, and waste collection is not required by city or community ordinance.

Recognizing that domestic pets in rural portions of the Cotton Bayou watershed likely have larger areas to roam and that picking up pet waste is likely not feasible for all owners, management actions should target areas with denser housing and pet populations. Providing waste bag dispensers and collection stations in areas of higher pet density (parks and neighborhoods) encourages pet owners to pick up pet waste before it can be transported to water bodies. Addressing feral dog populations can also assist with this measure.

Management Measure 1 also seeks to identify and reduce illegal dump sites and illicit discharges where fecal wastes and other pollutants might be illegally released in the Cotton Bayou watershed. Local governments and stakeholders should assist in identifying and eliminating these potential sites.

Additionally, developing a stormwater demonstration project, like preserving and enhancing the riparian areas in coordination with Management Measure 3, can build the capacity to improve water quality. Local governments and

drainage districts can work together to enhance current and future drainage projects by incorporating riparian zone management as identified in Management Measure 3.

The goal of this management measure is to install and maintain 30 pet waste stations, deliver education and outreach materials on pet waste, conduct a general stormwater education workshop, conduct illicit discharge and illegal dumping investigations, and complete one demonstration riparian corridor project in coordination with Management Measure 3.

Table 8. Dog population and estimated daily bacteria load

Watershed	AU	Dog Population	Representative Load	Estimated Daily Bacteria Load (Dogs)
Cotton Bayou Above Tidal	0801E	1,731	2.50	4,327.50
Cotton Bayou Tidal	0801C	134	2.50	335.00
	Total	**1,865**		**4,662.50**

All loads are expressed in billion cfu/day.

Education Component

Recognizing that enforcement of ordinances is problematic, education is crucial to successfully implement this management measure. The most effective way to reduce the potential for loading from pet waste is to provide education and outreach materials to pet owners about the negative impact it can have on area water bodies. Educational efforts could also present information about water quality degradation caused by illegal dumping and illicit discharges, as well as the benefits of riparian restoration efforts.

Priority Areas

Areas of high human population distribution within the watershed will be high-priority areas for implementing this measure.

Responsible Parties and Funding

Each organization listed below will be responsible only for expenses associated with its own efforts and as funds become available. The entities mentioned in this section provide resources of technical and financial assistance for Management Measure 1, but funding sources for this management measure are not necessarily limited to the listed entities. This is not an exhaustive list and readers should consider whether they might have responsibility for implementing this management measure.

- **Local Governments** can actively promote pet waste reduction measures by offering public education on the handling of pet wastes at apartments, parks, and other public spaces. Additionally, local governments can actively work with drainage districts and the Texas Department of Transportation to enhance road and drainage projects to include the benefit of water quality features within the project. These partners may also help to identify target locations to conduct channel investigations for illicit discharges and illegal dumping.

- **H-GAC** manages pet waste outreach programs and coordinates pet waste reduction measures with other organizations. H-GAC has also been successful in applying for grant funding to acquire pet wastes stations for local communities. H-GAC can also provide planning assistance with road construction and other areas where water quality enhancements can be encouraged.

- **Texas A&M AgriLife Extension** and extension agents provide outreach and assistance to a variety of topics including pet wastes and riparian zone management.

- **Texas Parks and Wildlife Department (TPWD)** is a watershed stakeholder and can provide conservation assistance to implement riparian restoration.

- **The watershed coordinator** is recommended to be retained by H-GAC to oversee the implementation of the Cotton Bayou I-Plan, as funding allows. The watershed coordinator would be charged to work with local stakeholders, identify technical and funding opportunities, coordinate with federal, state, and local partners to assist with implementation, and to track implementation success and consider actions or activities that need to be changed, including I-Plan revisions.

Technical Assistance

H-GAC, the United States Environmental Protection Agency (EPA), and TCEQ have materials and resources for municipalities that manage and implement stormwater best management practices (BMPs).

Financial Assistance

Federal, state, and local agencies provide support to entities and individuals as they seek to reduce the amount of pet waste entering water bodies within the Cotton Bayou watershed. Contributions from local governments in terms of technical and financial assistance will be key to reducing pet wastes. Most pet waste stations are placed on public property, including parks. Estimated costs for successfully carrying out Management Measure 1, ranging from $0 to $500,000 over five years. A range is provided for workshop costs as in some instances there might be no costs while in other instances there may be a cost for presenters, facility fees, certificates, or other charges that might be incurred.

- **Clean Water Act Section 319(h) Nonpoint Source Grant Program** is an EPA grant program, administered by TCEQ and the Texas State Soil and Water Conservation Board (TSSWCB), provides funding for implementation of nonpoint source management measures. The funds require a 40% match and may be used to fund pet waste management programs, illicit discharge investigations, stormwater education, and riparian restoration.

- **EPA Environmental Education Grants** is a program that seeks grant proposals from eligible applicants to support environmental education projects that promote environmental stewardship and help develop knowledgeable and responsible students, teachers, and citizens. This grant program provides financial support for projects that design, demonstrate, or disseminate environmental education practices, methods, or techniques as described in the Environmental Education Grant Program solicitation notices.

- The EPA's **Urban Water Small Grants'** objective is to fund projects that will foster a comprehensive understanding of local urban water issues, identify and address these issues at the local level, and educate and empower the community. The Urban Waters Small Grants Program seeks to help restore and protect urban water quality and revitalize adjacent neighborhoods by engaging communities in activities that increase their connection, understanding, and stewardship of local urban waterways.

- **Clean Water State Revolving Fund**, administered by the Texas Water Development Board (TWDB), offers the loan program, authorized by the Clean Water Act, to serve low-cost financial assistance for planning, acquisition, design, and construction of wastewater, reuse, and stormwater infrastructure that include stormwater BMPs.

- The United States Department of Agriculture (USDA) Rural Utilities Service (RUS) **Water and Environmental Program (WEP)** provides technical assistance and financing to addressing water and wastewater infrastructure needs of rural communities with populations of 10,000 or less. WEP provides loans, grants and loan guarantees for drinking water, sanitary sewer, solid waste, and storm drainage facilities in rural areas.

Measurable Milestones

Contingent upon the receipt of proposed project funding, the measurable milestones are as follows.

- Number of pet waste stations installed.
- Number of educational materials developed and delivered.
- Number of workshops and trainings held.

- Number of illicit discharge and illegal dumping detection investigations completed.
- Area or stream miles of preserved, protected, or enhanced riparian corridor.

Monitoring Component

Early programmatic monitoring of this management measure will consist of tracking the number of local partners identified for collaboration on pet waste station installation and identification of target locations for illicit discharge monitoring and illegal dumping. As the implementation period progresses, number of pet waste stations installed, number of educational material distribution events, and number of stormwater outreach events will be tracked to assess progress. Late phase implementation metrics will include continued tracking of previously listed metrics in addition to number of riparian projects completed and number of illicit discharge and illegal dumping investigations conducted. The watershed coordinator will provide a five-year report, to TCEQ, summarizing all activities related to this management measure. This report will also be posted for the public, by H-GAC, on the Cotton Bayou project page.[1]

Implementation Schedule

The implementation schedule is as follows. Contingent upon the receipt of proposed project funding, the responsible parties as identified above will:

Year 1:

- Identify willing local partners to develop and submit proposals for funding of pet waste stations and educational material delivery.
- Identify, with local community support, locations to conduct channel investigations for illicit discharges and illegal dumping.

Years 2 and 3:

- Install and maintain at least seven pet waste collection stations per year.
- Deliver education and outreach materials on pet waste to pet owners and local community residents.
- Identify partners for one demonstration riparian corridor project in coordination with Management Measure 3. Develop a proposal for a minimum of one available funding grant.
- Initiate one demonstration riparian corridor project in coordination with Management Measure 3.

[1] www.h-gac.com/watershed-based-plans/cotton-bayou-tmdl

- Provide a stormwater outreach event as part of a general workshop with local communities covering fecal bacteria, source identification, nutrient enrichment, and riparian corridor protection in conjunction with Management Measure 3.

Year 4 and 5:

- Install and maintain at least eight pet waste collection stations per year.
- Deliver education and outreach materials on pet waste to pet owners and local community residents.
- Conduct illicit discharge and illegal dumping detection investigations.
- Complete one demonstration riparian corridor project.
- Provide one five-year Management Measure 1 progress report.

Estimated Load Reductions

Reducing pet wastes, removing illicit discharges and illegal dump sites, and increasing community outreach should help to reduce indicator bacteria sources.

Pet numbers are used as a surrogate for the likely indicator bacteria reduction expected from Management Measure 1. By supporting the installation of pet waste disposal stations, increasing pet waste and illegal dumping education to local communities, and seeking opportunities to improve riparian corridors, potential indicator bacteria loading reductions needed are calculated to be 4,606.48 billion cfu/day or 1,681,365.20 billion cfu/year. (Table 7).

To convert the load reduction into relatable terms, the load reduction, 4,606.48 billion cfu/day was divided by the representative unit daily load from Table 3, 2.5 billion cfu/day. The results of this calculation found that 1,843 total units would need to be managed from the Cotton Bayou watershed (Table 9).

Management Measure 1 does not recommend the removal of 1,843 dogs. Rather, Management Measure 1 is seeking to change pet owner actions, representing the removal of pet waste from the equivalent of 1,843 dogs through active collection and the installation of pet waste stations. With an average of 0.614 dogs per household (AVMA, 2018), approximately 3,001 households would need to remove the waste from their dogs to account for 1,843 dogs in the watershed. Additional reductions will come from addressing other stormwater sources (e.g., illegal waste dumping) and installing BMPs like restoring or enhancing riparian zones in coordination with Management Measure 3. Table 10 presents a summary of Management Measure 1.

Table 9. Estimated dog load reduction and waste removal

Watershed	AU	Total Dog Load Reduction	Representative Unit Daily Load	# of Dogs from which Waste would be Removed
Cotton Bayou Above Tidal	0801E	4,275.50	2.50	1,710
Cotton Bayou Tidal	0801C	330.98	2.50	133
	Total	**4,606.48**		**1,843**

All loads are expressed in billion cfu/day.

Table 10. Management Measure 1: Reduce stormwater sources such as pet waste and illegal dumping

Key Element	Summary
Causes and Sources	Direct and indirect deposits of pet feces not properly disposed of by pet owners
Potential Load Reduction	1,681,365.20 billion cfu/year
Technical and Financial Assistance	**Technical**: Materials and resources to manage and implement stormwater BMPs can be provided by H-GAC, EPA, and TCEQ. **Financial**: • $0–10,000 for pet waste station installation. • $0–10,000 for stormwater outreach. • $0-500,000 to assist communities to identify opportunities to address stormwater and illegal dumping.
Education Component	Workshops, technical presentations, and one-on-one meetings.
Schedule of Implementation	• **Year 1**: Identify local partners to develop and submit proposals for funding of pet waste stations and educational material delivery. Develop proposals for pet waste stations. Work with communities to identify locations to conduct channel investigations for illicit discharges and illegal dumping. • **Years 2–5**: Install and maintain seven to eight pet waste stations per year and distribute associated education and outreach materials. Plan and complete a stormwater/riparian demonstration project in coordination with Management Measure 3. • **Years 2–3**: Coordinate a stormwater outreach event as part of a watershed workshop. Develop a proposal for a minimum of one available funding grant. • **Years 4–5**: Conduct illicit discharge and illegal dumping detection investigations. • **Year 5**: Complete one demonstration riparian corridor project in coordination with Management Measure 2. Provide five-year Management Measure 1 progress report.
Interim, Measurable Milestones	• Number of pet waste stations installed. • Number of workshops held. • Completion of stormwater/riparian demonstration project. • Number of illicit discharge and illegal dumping detection investigations completed.
Indicators of Progress	• Number of pet waste stations installed. • Number of individuals, groups, or communities reached. • Completion of watershed workshop, stormwater/ riparian demonstration project, and at least one illicit discharge and illegal dumping investigation. • Area or stream miles of preserved, protected, or enhanced riparian corridor.
Monitoring Component	• **Environmental**: Clean Rivers Program (CRP) ambient monitoring data • **Programmatic**: Five-year report
Responsible Parties	Watershed coordinator, local governments, H-GAC, Texas A&M AgriLife Extension, TPWD

Management Measure 2

Promote Safe OSSF Use and Maintenance

The purpose of this management measure is to develop and implement strategies that reduce fecal waste from failing OSSFs in priority areas.

When functioning properly, OSSFs are a viable wastewater treatment option. However, limited awareness and lack of maintenance can lead to system failures. A failing system would be a direct source of untreated or partially treated human fecal waste. Stakeholders ranked failing OSSFs as a medium-high concern.

The estimated number of OSSFs in the Cotton Bayou watershed are provided in Table 11. The total number includes those systems with permits (the OSSF estimate provided in the TMDL document) plus an estimated number that might be found in the Cotton Bayou watershed without a permit. The exact number of failing systems is unknown, but studies estimate that approximately 12% of systems are expected to be in failing condition (Reed, Stowe, and Yanke, 2001).

This management measure outlines the strategy to target priority areas within the Cotton Bayou watershed for education and engagement on appropriate maintenance of OSSFs, as well as identifying resources available to local governments and individuals to repair or replace failing OSSFs. In certain limited situations where conditions permit, OSSFs may be abandoned and left in place as wastewater is connected to a centralized wastewater system.

It is recommended that a watershed coordinator work with authorized agents (AAs) to engage with communities and notify them of available workshops and trainings for homeowner OSSF maintenance. The watershed coordinator will also coordinate with H-GAC on potential sources of funding including the Supplemental Environmental Project (SEP) and other potential funding sources to provide financial support to remediate or replace failing OSSFs.

The goal of this management measure is to host three homeowner workshops or home inspector training courses and support nine homeowners through the SEP or similar program.

Table 11. Estimated number of OSSFs and daily bacteria load

Watershed	AU	Total Systems	Failing OSSFs (12% Rate)	Representative Load	Estimated Daily Bacteria Load (OSSFs)
Cotton Bayou Above Tidal	0801E	684	82	3.71	304.22
Cotton Bayou Tidal	0801C	105	13	3.71	48.23
	Total	**789**	**95**		352.45

All loads are expressed in billion cfu/day.

Education Component

Given the finite amount of funding available through the programs listed in the financial assistance section below, homeowner education is crucial to successfully implement this management measure. A variety of educational workshops, trainings, and informational materials are currently available through the Texas A&M AgriLife Extension Office and H-GAC. These educational opportunities may address available financial resources for qualifying homeowners with failing OSSFs, training for home inspectors to conduct visual inspections, and other resource materials to encourage homeowners to maintain, repair, and replace their OSSFs as necessary. However, awareness of available resources and materials, management practices, and their benefits should be assessed to allow for adjustments that encourage adoption.

Promotion methods include emails, targeted mailers advertising workshops and trainings, notices in newsletters and local newspapers, participation in local fairs and events, and coordination with AAs. Promotion efforts will be coordinated with TSSWCB, TCEQ, Texas A&M AgriLife Extension, real estate agents or inspectors, H-GAC, and other agencies as appropriate with a goal of increasing participation in the programs each year.

Priority Areas

Priorities are based on land use, location of permitted and grandfathered systems, and allocated loads taken from the TMDL. Areas south of I-10 and subwatershed (Cotton Bayou Tidal) are high-priority areas for implementing this measure.

Responsible Parties and Funding

Each organization listed below will be responsible only for expenses associated with its own efforts and as funds become available. The entities mentioned in this section provide resources of technical and financial assistance for

Management Measure 4, but funding sources for this management measure are not necessarily limited to listed entities. This is not an exhaustive list and readers should consider whether they might have responsibility for implementing this management measure.

- **AAs** are designated by TCEQ to regulate OSSFs, within the Cotton Bayou watershed. Chambers County is the AA for this watershed.
- **H-GAC** provides OSSF technical and outreach assistance to homeowners, realtors, and inspectors. Additionally, H-GAC manages an SEP for TCEQ addressing the maintenance, repair, and replacement of OSSFs.
- **Real Estate agents or inspectors** can educate prospective buyers on OSSF function and provide a point-of-sale inspection of the OSSF, through real estate transactions. Once inspected, repairs and replacements can be made as part of the transaction.
- **Texas A&M AgriLife Extension** and extension agents provide technical assistance and outreach to homeowners and water professionals that address maintenance, repairs, and replacement of OSSFs.
- The **Texas General Land Office (TGLO)** provides funding and technical assistance to local governments and nonprofits in the coastal zone to address parks and open space access and nonpoint sources of pollution, including failing OSSFs.
- **USDA RUS** administers programs that provide infrastructure or infrastructure improvements to rural communities.
- The **watershed coordinator** would work with local stakeholders to identify technical and funding opportunities, coordinate with federal, state, and local partners to assist with implementation, and track implementation success and adapt the plan as necessary.

Technical Assistance

The repair and replacement of OSSFs requires licensed personnel and permits through respective county offices. Chambers County can assist with the permitting process. H-GAC and Texas A&M AgriLife Extension offer education, programs, and training associated with OSSF maintenance, operations, and services. The design, construction, installation, and maintenance of new systems should be coordinated with local licensed service providers that can provide technical assistance to homeowners as needed.

Financial Assistance

Federal, state, and local agencies provide support to address failing OSSF systems through technical assistance to improve maintenance, including holding tank pump outs and funding for repairs or replacements, and in limited

cases providing connections to centralized wastewater treatment. Estimated costs for Management Measure 2 activities are estimated to range from $0 to $100,000 per year within the first five years of implementation. Below are several common financial programs that might be used to implement Management Measure 2.

- **Coastal Zone Management Program** is a program that is administered by the TGLO, with funding from the National Oceanic and Atmospheric Administration's Coastal Zone Management Program, provides funding assistance to local governments and nonprofits in the Texas coastal zone to address parks, open space access, and nonpoint sources of pollution, including failing OSSFs, that affect the Texas coastal zone and the Gulf of Mexico.

- The **SEP** program, administered by TCEQ, directs fines, fees, and penalties for environmental violations toward environmentally beneficial projects. H-GAC's SEP provides funding for the inspection, tank pump out, repair, and replacement of failing conventional septic systems or aerobic OSSFs using money from businesses or individuals that fail to comply with environmental laws. Funding is available to homeowners who meet certain income restrictions. No matching funds are required. Geographic restrictions may apply. H-GAC also augments the program with additional grant funding from local governments and private organizations.

- The **Clean Water Act Section 319(h) Grant Program** is an EPA grant program, administered by TCEQ and TSSWCB, provides funding for implementation of nonpoint source management measures. The funds require a 40% match and may be used to fund OSSF education, repairs, and replacements.

- The **Clean Water State Revolving Fund** administered by TWDB offers the loan program, authorized by the Clean Water Act, to serve low-cost financial assistance for planning, acquisition, design, and construction of wastewater, reuse, and stormwater infrastructure.

- USDA RUS's **WEP** provides technical assistance and financing to addressing water and wastewater infrastructure needs of rural communities with populations of 10,000 or less. WEP provides loans, grants, and loan guarantees for drinking water, sanitary sewer, solid waste, and storm drainage facilities in rural areas (USDA, 2019).

Measurable Milestones

Contingent upon the receipt of proposed project funding, the measurable milestones are as follows.

- Number of homeowner workshops conducted.

- Number of home inspector trainings conducted.
- Number of homeowners with failing OSSFs supported through maintenance, repair, replacement, or abandonment (limited).

Monitoring Component

Programmatic monitoring of this management measure will consist of tracking the number of homeowner education workshops and real estate agent training courses are held as well as the number of homeowners assisted with OSSF remediation through SEP or other funding sources. The watershed coordinator will provide a five-year report to TCEQ, summarizing all activities related to this management measure. This report will also be posted for the public, by H-GAC, on the Cotton Bayou project page.[2]

Implementation Schedule

The implementation schedule is as follows. Contingent upon the receipt of proposed project funding, the responsible parties as identified above will:

Year 1:

- Host one homeowner workshop.
- Support, at minimum, one homeowner within the high or medium priority areas through the SEP or similar program.

Year 2:

- Host one home inspection training course for real estate agents and home inspectors.
- Support, at minimum, two homeowners within the high priority areas through the SEP or similar program.

Year 3:

- Support, at minimum, two homeowners within the high priority areas through the SEP or similar program.

Year 4:

- Host one homeowner workshop or host one home inspector training course.
- Support, at minimum, two homeowners within the high priority areas through the SEP or similar program.

Year 5:

- Support, at minimum, two homeowners within the high priority areas through the SEP or similar program.

[2] www.h-gac.com/watershed-based-plans/cotton-bayou-tmdl

- Provide one five-year Management Measure 2 progress report.

Estimated Load Reductions

By repairing or replacing failing OSSFs, promoting proactive homeowner maintenance, providing training opportunities and encouraging more inspections, the potential indicator bacteria loading reductions are estimated at 348.22 billion cfu/day or 127,100.30 billion cfu/year.

To express this reduction into more quantifiable terms, the OSSF load reductions were converted into unit reductions. The OSSF load reduction, 348.22 billion cfu/day, was divided by the representative unit daily load for OSSFs from Table 3, 3.71 billion cfu/day. (The representative unit daily load for failing OSSFs is not simply a measure of one unit but includes the concentration of indicator bacteria in one flush, the per capita daily discharge volume, and the number of persons per household. Each of these terms is multiplied together to get representative daily load for one failing OSSF.) This yields a total of 94 failing OSSFs that need to be repaired or replaced (Table 12).

It is also important to note that the number of failing systems should not increase for this measure to be effective. This means that even after addressing 94 OSSFs, this management measure requires that the number of failing systems remain constant or decrease. The implementation of workshops and trainings will educate homeowners and home inspectors on proper OSSF maintenance with the goal of keeping the number of failing OSSFs from increasing. Table 13 presents a summary of Management Measure 2.

Table 12. OSSF load reduction and number to be managed

Watershed	AU	Total OSSF Load Reduction	Representative Unit Daily Load	OSSFs to be managed
Cotton Bayou Above Tidal	0801E	300.57	3.71	81
Cotton Bayou Tidal	0801C	47.65	3.71	13
	Total	348.22		**94**

All loads are expressed in billion cfu/day.

Table 13. Management Measure 2: Promote safe OSSF use and maintenance

Key Element	Summary
Causes and Sources	Human fecal sources from untreated or insufficiently treated household sewage discharged from failing OSSFs
Potential Load Reduction	127,100.30 billion cfu/year
Technical and Financial Assistance	**Technical**: Chambers county for permitting; H-GAC and Texas A&M AgriLife Extension for education, programs, and training. **Financial**: • $0–10,000 for workshops and training events. • $0-100,000 to repair, replace, or abandon OSSFs.
Education Component	Workshops, technical presentations, and one-on-one meetings. Local promotional outreach such as emails; targeted mailers; notices in newsletters and newspapers; participation in fairs and events; and coordination with AAs.
Schedule of Implementation	• **Year 1**: Host one homeowner workshop. • **Years 1–5**: Address a minimum of nine OSSFs. • **Year 2**: Host one home inspector training course. • **Year 4**: Host one homeowner workshop or one home inspector training course. • **Year 5**: Provide five-year Management Measure 2 progress report.
Interim, Measurable Milestones	• Number of homeowner workshops and home inspector trainings held. • Number of OSSFs addressed.
Indicators of Progress	• Number of technical assistance activities provided. • Number of OSSFs addressed
Monitoring Component	• **Environmental**: CRP ambient monitoring data • **Programmatic**: Five-year report
Responsible Party	Watershed coordinator, AAs, H-GAC, Texas A&M AgriLife Extension, real estate agents/ inspectors, TGLO, USDA RUS

Management Measure 3

Support Land Management Initiatives

The purpose of this management measure is to develop and implement strategies to reduce bacteria loading from livestock into water bodies.

Livestock are present in the Cotton Bayou watershed. Table 14 presents the estimated livestock population based on 2022 agricultural census data (USDA, 2024). Because this plan references updated data, calculations will be slightly different than numbers the TSSWCB staff reviewed during the development of the TSD (TCEQ, 2023). For the purposes of this plan, livestock are considered to be the sum of estimated populations of cattle, sheep and goats, and horses. While the fate and transport of fecal bacteria deposited on upland surfaces is not always certain, practices that manage livestock behavior and time spent grazing, particularly in riparian areas, can reduce potential bacteria loads reaching nearby water bodies.

Livestock grazing behavior can be modified by the availability and location of food, shelter, and water. Cattle grazing in particular is highly dependent upon proximity to these resources, especially water. Livestock fecal loading is also strongly tied to resource utilization as it is directly related to the amount of time an animal spends in an area. Therefore, reducing the amount of time livestock spend in riparian areas through rotational grazing, adding alternative watering facilities, or moving supplemental feeding locations can directly reduce potential bacteria loads reaching nearby water bodies.

Table 14. Livestock population and estimated daily bacteria load

Watershed	AU	Livestock Population	Representative Load	Estimated Daily Bacteria Load (Livestock)
Cotton Bayou Above Tidal	0801E	500	Cattle: 2.70, Sheep/Goats: 9.00, Horses: 0.21	1,423.41
Cotton Bayou Tidal	0801C	17	Cattle: 2.70, Sheep/Goats: 9.00, Horses: 0.21	52.20
	Total	517		**1,475.61**

All loads are expressed in billion cfu/day.

Recommended Management Measure 3 activities include the promotion and implementation of voluntary water quality management plans (WQMPs), conservation management plans (CMPs), restoring riparian buffers, and providing technical assistance and outreach. The USDA Natural Resources

Conservation Service (NRCS) and TSSWCB give technical and financial assistance to producers for planning and implementing BMPs that protect and improve water quality. NRCS offers a variety of programs to implement operation-specific conservation plans that will meet producer goals and outline how BMPs will be implemented. TSSWCB, through local Soil and Water Conservation Districts (SWCDs), gives technical and financial assistance to develop and implement WQMPs through planning, implementation, and maintenance of each practice.

Additionally, managing riparian corridors and drainage areas can improve water quality and address stormwater management concerns. Restoring tree canopies, natural vegetation, and wetlands can benefit water bodies by improving aquatic and adjacent habitats and serving as sinks for multiple water quality pollutants including bacteria. Implementation of Management Measure 3 can work in concert with the execution of Management Measure 1.

The goal of this management measure is to promote and establish at least five grazing management plans or WQMPs and five CMPs, provide educational outreach, and complete one riparian corridor project.

Education Component

Education is crucial to successfully implement Management Measure 3. A variety of educational workshops, trainings, and informational materials are currently available to ranchers and landowners, providing information on how to combine agricultural production with environmental actions. These actions may address water quality, reduce soil erosion and sedimentation, provide livestock waste management, and result in soil enhancements that can increase yields.

However, awareness of available resources and materials, management practices, and their benefits should be assessed to allow for adjustments that encourage adoption. Promotion methods include emails, targeted mailers advertising workshops and trainings, notices in newsletters and local newspapers, participation in local fairs and events, and coordination with school agricultural programs. Promotion efforts will be coordinated with TSSWCB, local SWCDs, drainage districts, NRCS, Texas A&M AgriLife Extension, schools, H-GAC, and other agencies as appropriate with a goal of increasing participation in the programs each year.

Priority Areas

Areas of suitable agricultural land cover within the watershed will be high-priority areas for implementing this measure.

Responsible Parties and Funding

Each organization listed below will be responsible only for expenses associated with its own efforts and as funds become available. The entities mentioned in this section provide resources of technical and financial assistance for

Management Measure 3, but funding sources for this management measure are not necessarily limited to listed entities. This is not an exhaustive list and readers should consider whether they might have responsibility for implementing this management measure.

- **The Trinity Bay SWCD** works with federal and state agencies, particularly the TSSWCB, providing technical assistance and funding for flood control, water quality enhancement, water supply, invasive species control, and other conservation initiatives. SWCDs will work with stakeholders to implement agriculture outreach, grazing management plans, and WQMPs.

- **Texas A&M AgriLife Extension** and extension agents will provide technical assistance and outreach to agriculture producers and landowners on a variety of topics, including the latest research in animal, crop, and soil science, and protection of the environment.

- **TSSWCB** will work with stakeholders to provide outreach and technical assistance and expand the use of WQMPs.

- **NRCS** will work with stakeholders to provide outreach and technical assistance and expand the use of CMPs.

- **TPWD** can provide conservation assistance to implement riparian restoration.

- The **watershed coordinator** would be charged to work with local stakeholders to identify technical and funding opportunities, coordinate with federal, state, and local partners to assist with implementation, and to track implementation success and consider actions or activities that need to be changed, including plan revisions.

- **Landowners and Producers** may work with the NRCS and SWCDs as appropriate to develop WQMPs or CMPs and obtain funding to implement BMPs according to the site-specific plans.

Technical Assistance

Developing and implementing practices to reduce runoff from agricultural lands requires substantial technical expertise. Technical assistance can be obtained from local SWCDs, TSSWCB, local NRCS offices, and local Texas A&M AgriLife Extension offices. Producers requesting planning assistance may work with the local SWCD and local NRCS offices to define operation-specific management goals and objectives and develop management plans that prescribe effective practices that will achieve stated goals while also improving water quality.

Financial Assistance

Federal, state, and local agencies, many of which are identified above, provide support to landowners and producers as they seek to implement BMPs in the

Cotton Bayou watershed. Estimated costs for the voluntary Management Measure 3 activities are estimated to range from $0 to $1,000,000 within the first five years of implementation. Below are several common financial programs that might be used to implement Management Measure 3.

- **WQMP Program** are property-specific plans that outline the BMPs most appropriate to improve the quality of land and water on the property. The TSSWCB may provide financial assistance to private property owners in implementing individual WQMPs, as funding allows.

- **Clean Water Act Section 319(h) Grant Program** is an EPA grant program, administered by TCEQ and TSSWCB, provides funding for implementation of nonpoint source management measures. The funds require a 40% match and may be used to support education programs, watershed implementation and riparian restoration.

- **Sustainable Agriculture Research and Education (SARE)** provides grants and educational programs to advance agricultural innovation which promotes profitability, stewardship of the land, air, and water, and quality of life for farmers, ranchers, and their communities. Southern SARE is the regional component that includes Texas and grants go towards land, crop, and livestock management.

- **NRCS Agricultural Management Assistance** helps agriculture producers use conservation to manage risk and solve natural resource issues through natural resources conservation.

- **NRCS Conservation Stewardship Program** helps agriculture producers maintain and improve their existing conservation systems and adopt additional conservation activities to address priority resource concerns. Participants earn CSP payments for conservation performance—the higher the performance, the higher the payment.

- **Environmental Quality Incentives Program (EQIP)** is a voluntary program that provides financial and technical assistance to agricultural producers through contracts up to a maximum term of ten years. These contracts provide financial assistance to help plan and implement conservation practices that address natural resource concerns and for opportunities to improve soil, water, plant, animal, air, and related resources on agricultural land and nonindustrial private forestland. An additional purpose of EQIP is to help producers meet federal, state, tribal, and local environmental regulations.

Measurable Milestones

Contingent upon the receipt of proposed project funding, the measurable milestones are:

- Number of grazing management plans developed.
- Number of WQMPs developed.
- Number of status reviews performed on existing WQMPs.
- Number of CMPs developed.
- Area or stream miles of preserved, protected, or enhanced riparian corridor.
- Number of education/outreach programs supported or implemented.
- Completion of demonstration riparian corridor project.

Monitoring Component

Early programmatic monitoring of this management measure will consist of tracking the number of local partners identified for collaborating on the development of a riparian corridor project as well as the execution of a riparian buffer workshop in the first year of implementation. As the implementation period progresses, number of grazing management plans/WQMPs, number of CMPs, and number of riparian buffer and BMP workshop events will be tracked to assess progress. Late phase implementation metrics will include continued tracking of previously listed metrics in addition to number of riparian projects completed. The watershed coordinator will provide a five-year report to TCEQ summarizing all activities related to this management measure. This report will also be posted for the public, by H-GAC, on the Cotton Bayou project page. [3]

Implementation Schedule

The implementation schedule is as follows. Contingent upon the receipt of proposed project funding, the responsible parties as identified above will:

Year 1:

- Provide, at minimum, one riparian buffer (or related) workshop for drainage districts, local governments, and agriculture producers/landowners.

Year 2:

- Provide, at minimum, one agriculture BMP (or related) workshop for agriculture producers/landowners.
- Identify partners, including drainage districts, for one demonstration riparian corridor project in coordination with Management Measure 1.
- Develop a proposal for a minimum of one available funding grant.

Year 3:

- Develop, at minimum, one to two grazing management plans or WQMPs and one to two CMPs.

[3] www.h-gac.com/watershed-based-plans/cotton-bayou-tmdl

- Initiate one demonstration riparian corridor project in coordination with Management Measure 1.

Year 4:

- Develop, at minimum, one to two additional grazing management plans or WQMPs and one to two CMPs.
- Continue development of one demonstration riparian corridor project.
- Provide, at minimum, one riparian buffer, agriculture BMP, or related workshop for drainage districts, local governments, and agriculture producers/landowners.

Year 5:

- Develop, at minimum, one to two additional grazing management plans or WQMP and one to two CMPs.
- Complete one demonstration riparian corridor project.
- Provide one five-year Management Measure 3 progress report.

Estimated Load Reductions

Implementing grazing, cross fencing, watering facilities, nutrient management, and other BMPs identified by local SWCDs provides the potential for indicator bacteria loading reductions. Estimated indicator bacteria reductions for livestock populations are presented in Table 15. Reducing fecal loads from livestock results in an estimated daily load reduction of 1,457.87 billion cfu/day or 532,122.55 billion cfu/year. (Table 7).

A subsequent step is taken to determine how this reduction may be implemented. A representative unit daily load is used to determine the number of livestock to be managed under a WQMP or a CMP. Table 12 presents the calculation where the total daily load reduction needed is divided by the daily load per representative unit. This yields a total of 511 units needed to reduce loadings in the Cotton Bayou watershed by 1,457.87 billion cfu/day. This I-Plan is not recommending that this number of livestock be removed from the watershed. The units to be reduced are referring to the number of livestock to be managed under WQMPs or CMPs such that fecal loading from them would be prevented from entering Cotton Bayou or its tributaries.

TSSWCB and USDA NRCS have determined that a plan would reasonably address 50 livestock units (H-GAC, 2018). The livestock unit load reduction can then be divided by 50 to arrive at the estimated number of WQMPs or similar plans that would be needed to reduce the load by 1,457.87 billion cfu/day. This gives an estimated 11 management plans needed to address the required reduction throughout the Cotton Bayou watershed (Table 15). Table 16 presents an overview of Management Measure 3.

Table 15. Estimated livestock bacteria load reduction, number to be managed, and management plans

Watershed	AU	Total Estimated Bacteria Load Reduction (Livestock)	Representative Unit Daily Load	Livestock to be Managed	Management Plans
Cotton Bayou Above Tidal	0801E	1,406.30	Cattle: 2.70, Sheep/Goats: 9.00, Horses: 0.21	494	10
Cotton Bayou Tidal	0801C	51.57	Cattle: 2.70, Sheep/Goats: 9.00, Horses: 0.22	17	1
	Total	**1,457.87**		**511**	**11**

All loads are expressed in billion cfu/day.

Table 16. Management Measure 3: Support land management initiatives

Key Element	Summary
Causes and Sources	Fecal deposition from cattle, horses, and sheep/goats in pastures, rangeland, and in water bodies
Potential Load Reduction	532,122.55 billion cfu/year
Technical and Financial Assistance	**Technical**: Local SWCDs, TSSWCB, NRCS offices, and Texas A&M AgriLife Extension offices. **Financial**: $0–30,000 for WQMPs. $0–1,000,000 for CMPs. $0–10,000 for technical assistance workshops.
Education Component	Workshops, technical presentations, and one-on-one meetings. Local promotional outreach such as emails; targeted mailers; notices in newsletters and newspapers; participation in fairs and events; and coordination with school agricultural programs.
Schedule of Implementation	• **Year 1**: Host at least one riparian buffer workshop. • **Year 2**: Host at least one agricultural BMP workshop. Develop proposal for one demonstration riparian corridor project and identify partners. • **Years 3–5**: Develop one to two WQMPs and one to two CMPs per year. Initiate and complete one demonstration riparian corridor project. • **Year 4**: Host at least one riparian buffer workshop or at least one agricultural BMP workshop. • **Year 5**: Provide five-year Management Measure 3 progress report.
Interim, Measurable Milestones	• Number of grazing management plans developed. • Number of workshops held. • Number of WQMPs completed. • Number of Status Reviews on existing WQMPs. • Number of CMPs completed. • Completion of demonstration riparian corridor project. • Area or stream miles of preserved, protected, or enhanced.
Indicators of Progress	• Number of technical assistance activities provided. • Number of plans completed.
Monitoring Component	• **Environmental**: CRP ambient monitoring data • **Programmatic**: Five-year report
Responsible Parties	TSSWCB, NRCS, SWCDs, watershed coordinator; Texas A&M AgriLife Extension, TPWD, landowners/ producers

Management Measure 4

Promote Feral Hog Management

The purpose of this management measure is to develop and implement strategies to reduce fecal deposition by feral animal populations, specifically feral hogs, in priority areas.

Fecal bacteria are common inhabitants of the intestines of all warm-blooded animals. Feral hogs and most types of wildlife are attracted to water, increasing the likelihood of direct deposition of fecal bacteria into the water, and for fecal bacteria to be picked up off adjacent land during rainfall events.

While wildlife inhabits all parts of the Cotton Bayou watershed, areas that remain undeveloped are ideal habitat for wildlife. Developed areas account for less than 36% of the Cotton Bayou watershed, leaving large parts available for wildlife use. Other than TPWD deer population estimates, there are few data sources that consistently estimate wildlife population. Source loadings included deer as a source to serve as a surrogate for wildlife. However, Management Measure 4 does not make any recommendation for reducing indicator bacteria sources from deer or other native wildlife.

Management Measure 4 recommends managing the feral hog population. TPWD considers feral hogs a nonnative, invasive species. They can adapt to a variety of habitats and have high reproductive rates. Feral hogs have been identified as a large contributor of fecal bacteria to impaired water bodies in Texas due to their tendency to wallow in mud and spend time in water. The population and estimated daily load for feral hogs is provided in Table 17.

There are numerous control efforts available to mitigate feral hog populations employed across the state. These measures, especially in priority areas, along with technical and financial assistance, are needed to reach the overall goal of this plan. Activities will be targeted towards priority areas where landowners should be contacted to discuss the economic savings of managing feral hogs, specific methods to do so, and available programs that can provide assistance.

Table 17. Feral hog population and estimated daily bacteria load

Watershed	AU	Feral Hog Population	Representative Load	Estimated Daily Bacteria Load (Feral Hogs)
Cotton Bayou Above Tidal	0801E	196	4.45	872.20
Cotton Bayou Tidal	0801C	11	4.45	48.95
	Total	**207**		**921.15**

All loads are expressed in billion cfu/day.

The promotion and implementation of BMPs focused on managing the feral hog populations within priority subwatersheds can lead to instream water quality improvements by minimizing fecal deposition.

The goal of this management measure is to coordinate feral hog outreach programs and conduct at least one feral hog workshop.

Education Component

Education is crucial to successfully implement this management measure. A variety of educational workshops, trainings, and informational materials are available to residents, providing information about how feral hog populations degrade water quality. However, awareness of available resources and materials, management practices, and their benefits should be assessed to allow for adjustments that encourage adoption. Promotion methods include emails, targeted mailers advertising workshops and trainings, notices in newsletters and local newspapers, participation in local fairs and events, and coordination with school agricultural programs. Promotion efforts will be coordinated with TSSWCB, TCEQ, local Texas A&M AgriLife Extension offices, and other agencies as appropriate with a goal of increasing participation in the programs each year.

Priority Areas

Areas of natural land cover within the watershed will be high-priority areas for implementing this measure.

Responsible Parties and Funding

Each organization listed below will be responsible only for expenses associated with its own efforts and as funds become available. The entities mentioned in this section provide resources of technical and financial assistance for Management Measure 4, but funding sources for this management measure are not necessarily limited to listed entities. This is not an exhaustive list and

readers should consider whether they might have responsibility for implementing this management measure.

- **Texas A&M AgriLife Extension** and extension agents provide outreach and assistance on a variety of topics including feral hogs.
- The **watershed coordinator** would be charged to work with local stakeholders in the management of the feral hog population to identify technical and funding opportunities, coordinate with federal, state, and local partners to assist with implementation, and to track implementation success and consider actions or activities that need to be changed, including plan revisions.

Technical Assistance

Numerous resources are available to assist landowners and managers in the management of feral hog populations. Texas A&M AgriLife Extension offers technical materials and workshops on feral hog impacts and control methods. TPWD also offers general information about identification and regulations regarding control measures for feral hogs.

Financial Assistance

Federal, state, and local agencies provide support to entities and individuals as they seek to manage feral hog populations in the Cotton Bayou watershed. Estimated costs for Management Measure 4 activities are estimated to range from $0 to $15,000 per year. Below is one common financial program that might be used to implement Management Measure 4.

- **Clean Water Act Section 319(h) Nonpoint Source Grant Program** is an EPA grant program, administered by TCEQ and TSSWCB, provides funding for implementation of nonpoint source management measures. The funds require a 40% match and may be used to fund feral hog education workshops and outreach programs.

Measurable Milestones

Contingent upon the receipt of proposed project funding, the measurable milestones are as follows.

- Number of educational programs delivered per year.
- Number of educational materials developed and disseminated.
- Number of individuals reached.
- Number of voluntary efforts implemented.
- Number of feral hogs removed per year.

Monitoring Component

Early programmatic monitoring of this management measure will consist of tracking the coordination efforts in scheduling feral hog outreach programs. As the implementation period progresses, number of outreach material distribution efforts, number of landowners implementing control measures, number of feral hogs removed, and number of feral hog workshops held will be tracked to assess progress. Late phase implementation metrics will include continued tracking of previously listed metrics. The watershed coordinator will provide a five-year report to TCEQ, summarizing all activities related to this management measure. This report will also be posted for the public, by H-GAC, on the Cotton Bayou project page.[4]

Implementation Schedule

The implementation schedule is as follows. Contingent upon the receipt of proposed project funding, the responsible parties as identified above will:

Year 1:

- Coordinate and schedule feral hog outreach programs.

Years 2 and 3:

- Conduct at least one feral hog workshop.
- Track feral hog outreach efforts (materials created or disseminated or individuals reached), identify landowners and track implementation of voluntary control measures (fencing deer feeders, and others), including feral hog removal numbers.

Years 4 and 5:

- Track feral hog outreach efforts (materials created or disseminated or individuals reached), identify landowners and track implementation of voluntary control measures (fencing deer feeders, and others), including feral hog removal numbers.
- Provide one five-year Management Measure 4 progress report.

Estimated Load Reductions

By promoting the use of physical controls for feral hog management, such as fencing, educating residents on the effects of feral hog populations on water quality, and other controls, potential indicator bacteria loading reductions are estimated to be 910.08 billion cfu/day or 332,179.20 billion cfu/year.

The representative unit approach was applied to the feral hog load reduction by dividing the load reduction, 910.08 billion cfu/day, by the representative unit

[4] www.h-gac.com/watershed-based-plans/cotton-bayou-tmdl

daily load for feral hogs, 4.45 billion cfu/day (Table 18). A total of 205 feral hogs were estimated for removal from the Cotton Bayou watershed to accomplish the potential load reduction.

As feral hog reproductive rates are quite high, the population after the removal of 205 feral hogs would need to be maintained. Studies by the Texas AgriLife Extension have suggested that the feral hog population needs to be culled each year by 50-70% to maintain the current level of feral hog population (Texas AgriLife Extension, 2012). Additional indicator bacteria removal capacity could be provided by increasing the number of feral hogs removed, addressing other feral animal populations, or expanding the indicator bacteria reduction from other management measure sources as documented by stakeholders. Table 19 presents a summary of Management Measure 4.

Table 18. Feral hog load reduction and feral hogs to be removed.

Watershed	AU	Total Feral Hog Load Reduction	Representative Unit Daily Load	Feral Hogs to be Removed
Cotton Bayou Above Tidal	0801E	861.72	4.45	194
Cotton Bayou Tidal	0801C	48.36	4.45	11
	Total	**910.08**		**205**

All loads are expressed in billion cfu/day.

Table 19. Management Measure 4: Promote feral hog management

Key Element	Summary
Causes and Sources	Direct and indirect deposits of feces from feral hogs
Potential Load Reduction	332,179.20 billion cfu/year
Technical Financial Assistance	**Technical**: Texas A&M AgriLife Extension and TPWD offer technical materials and workshops. **Financial**: $0–15,000 for voluntary feral hog reduction measures. $0–10,000 for technical assistance such as workshops and other outreach programs.
Education Component	Workshops, technical presentations, and one-on-one meetings. Local promotional outreach such as emails; targeted mailers; notices in newsletters and newspapers; participation in fairs and events; and coordination with school agricultural programs.
Schedule of Implementation	**Years 1–5**: Track voluntary measures in coordination with landowners, including outreach efforts and feral hog control measures. **Years 2–3**: Conduct at least one feral hog workshop. **Year 5**: Provide five-year Management Measure 4 progress report.
Interim, Measurable Milestones	Number of feral hogs removed each year. Number of voluntary efforts implemented. Complete a minimum of one feral hog program. Successfully develop and disseminate outreach materials.
Indicators of Progress	Number of technical assistance activities provided. Number of feral hogs removed. Tracking the amount of outreach materials delivered.
Monitoring Component	• **Environmental**: CRP ambient monitoring data • **Programmatic**: Five-year report
Responsible Parties	Watershed coordinator, Texas A&M AgriLife Extension

Management Measure 5

Improve WWTF and Sanitary Sewer Collection System Function

The purpose of this management measure is to develop and implement strategies that reduce fecal waste from WWTFs and sanitary sewer collection systems in priority areas.

WWTFs collect and treat public wastewater, converting that wastewater into effluent before returning it to surface water or for other designated uses. Correctly functioning WWTFs contribute negligible amounts of bacteria to surface water, as defined by state-regulated permits.

As reported in the TSD (H-GAC, 2022), there were nine SSOs between 2016 and 2021, releasing an estimated volume of 5,191.2 gallons of untreated or partially treated effluent. SSOs were not reported for AU 0801E. Converting the impacts of these events into daily bacteria load estimates comparable to other sources assessed in this analysis is difficult due to the variation in scope of each event and unpredictability of their rates of occurrence. Therefore, daily loads were not calculated. However, as SSO events pose a high risk to human health and can introduce large volumes of untreated waste into area waterways, watershed stakeholders identified it as a priority for management.

This management measure outlines the strategy to target priority areas to reduce the instances of WWTF and collection system failures through asset management programs, which require life-cycle continuous repair and replacement; supporting compliance and enforcement efforts; regionalization of smaller facilities with chronic problems (when appropriate); and supporting operator workshops and training programs.

The success of this management measure relies on the efforts of the permit holders continuing to implement their operational best practices. As noted previously, when operated properly, WWTFs are not likely to contribute high levels of indicator bacteria. This plan encourages the continued use of best practices and recommends developing long-term replacement strategies to prevent future SSOs.

The goal of this management measure is to develop and conduct a fats, oils, grease, and wipes (FOG) prevention campaign, two technical assistance workshops, and one general outreach workshop.

Education Component

Operator education, in the form of workshops and training programs, is crucial to successfully implement this management measure. WWTF operators, utilities, and subscriber system owners should provide FOG outreach to utility customers to reduce the number of sewer blockages. There are several regional FOG educational programs that target homeowners and business owners—particularly multifamily homes. “Cease the Grease” and “Protect Our Pipes” are just two of these that have ready-made informational flyers and brochures that can be adapted for the Cotton Bayou watershed.

Priority Areas

Priorities were assigned to subwatersheds based on land use, wastewater treatment service area boundaries, reported SSOs, and allocated loads taken from the TMDL. The high-priority area for implementing this measure is subwatershed two.

Responsible Parties and Funding

Each organization listed below will be responsible only for expenses associated with its own efforts and as funds become available. The entities mentioned in this section provide resources of technical and financial assistance for Management Measure 5, but funding sources for this management measure are not necessarily limited to listed entities. This is not an exhaustive list and readers should consider whether they might have responsibility for implementing this management measure.

- **Local Governments** and political subdivisions of the state, including cities and municipal utility districts, hold wastewater permits that include indicator bacteria permit limits. Local governments also maintain the collection system. Routine maintenance of these complex systems requires the planning and dedication of enough resources to conduct inspections, life-cycle replacement costs, and continual training to prevent failures requiring repairs. Local governments holding stormwater permits are required to report annually on their efforts to inspect and continually maintain sanitary sewers within their jurisdictions to prevent SSOs.

- **TCEQ** oversees programs that address point sources of pollution impacting the waters of the state, including wastewater permits. This includes conducting inspections and enforcement of permit holders, setting rules and regulations, and requiring self-reporting by permit holders. TCEQ offers wastewater technical assistance and encourages the participation in its Sanitary Sewer Overflow Initiative Program. This is a voluntary program which began in 2004 to address an increase in SSOs due to aging collection systems throughout the state and encourage corrective actions. Participating operators are not subjected to formal enforcement by TCEQ for most

SSO violations, so long as an SSO plan is in place. Participation allows the operator to direct resources to corrective actions rather than towards penalties and ongoing SSOs will not affect the system's compliance-history rating.

- **Texas A&M Engineering Extension Service (TEEX)** is the state extension agency that offers training programs and technical assistance to public safety workers, including those involved in water and wastewater.
- **USDA Rural Department** administers programs that provide infrastructure or infrastructure improvements to rural communities.
- **Water Professional Associations** like the Association of Water Board Directors, Texas Water Utilities Association, Water Environment Association of Texas, and Water Environment Federation are sources of information and provide a forum through conferences and meetings to educate water districts on the latest technology, laws, and rules that can affect their daily operation.
- The **watershed coordinator** would be charged to work with local stakeholders on issues related to wastewater collection systems to identify technical and funding opportunities, coordinate with federal, state, and local partners to assist with implementation, and to track implementation success and consider actions or activities that need to be changed, including plan revisions.

Technical Assistance

Numerous trade and professional associations listed above, along with TCEQ, EPA, and TEEX, provide educational and technical assistance to utility districts and municipalities.

Financial Assistance

Federal, state, and water professional associations provide support to wastewater operators, which can assist them to meet permit requirements. Management Measure 5 outreach activities are estimated to range between $0 and $30,000 each year. A range is provided for workshop costs as in some instances there might be no costs while in other instances there may be a cost for presenters, facility fees, certificates, or other charges that might be incurred. In some cases, a fee to attendees might offset these costs.

Permittee operation and maintenance costs covering infrastructure repair and replacement are highly variable and such costs are left to permittees to plan. The permittee might seek outside sources of funding. Estimates are that mid-sized cities spend approximately $1,000,000 to $5,000,000 per year on addressing aging systems. The list found below is not an exhaustive funding list for Management Measure 5. Additional information and more extensive lists of

potential sources of financial assistance can be found on the funding resource pages for TCEQ (TCEQ, 2019) and EPA (EPA, 2019).

- **Clean Water State Revolving Fund**, administered by TWDB, offers a loan program, authorized by the Clean Water Act, to serve low-cost financial assistance for planning, acquisition, design, and construction of wastewater, reuse, and stormwater infrastructure.

- USDA RUS's **WEP** provides technical assistance and financing to addressing water and wastewater infrastructure needs of rural communities with populations of 10,000 or less. WEP provides loans, grants, and loan guarantees for drinking water, sanitary sewer, solid waste, and storm drainage facilities in rural areas.

Measurable Milestones

Contingent upon the receipt of proposed project funding, the measurable milestones are as follows.

- Development of a permittee list, with a focus on those with chronic problems, to invite to the technical assistance workshops.
- Reduction of the number of SSOs due to infrastructure repairs and replacements.
- Initiation of at least one FOG outreach campaign and general education workshop.
- Delivery of at least two operator trainings and workshops.

Monitoring Component

Early programmatic monitoring of this management measure will consist of tracking the development of a campaign to prevent FOG blockages as well as a list of permittees to target for outreach. As the implementation period progresses, number of operator technical assistance workshops held, number of home and business owner outreach events held, and number of FOG blockage prevention materials distributed will be tracked to assess progress. The watershed coordinator will provide a five-year report to TCEQ, summarizing all activities related to this management measure. This report will also be posted for the public, by H-GAC, on the Cotton Bayou project page.[5]

[5] www.h-gac.com/watershed-based-plans/cotton-bayou-tmdl

Implementation Schedule

The implementation schedule is as follows. Contingent upon the receipt of proposed project funding, the responsible parties as identified above will:

Year 1:

- Develop a target permittee list.
- Devise a FOG blockage prevention campaign.

Year 2:

- Conduct a technical assistance workshop on technology, rules and regulation changes, operation and maintenance, reuse, and program assistance.
- Conduct a FOG blockage prevention campaign.

Year 3:

- Conduct one home and business owner general outreach workshop.
- Conduct a FOG blockage prevention campaign.

Year 4:

- Conduct a technical assistance workshop on technology, rules and regulation changes, operation and maintenance, reuse, and program assistance.
- Conduct a FOG blockage prevention campaign.

Year 5:

- Provide one five-year Management Measure 5 progress report.
- Assess the FOG blockage prevention campaign.

Estimated Load Reductions

The implementation measures listed in this I-Plan (asset management, supporting compliance/enforcement efforts and regionalization of smaller facilities [when and where appropriate]) may reduce fecal waste by humans through improved WWTF operation and the sanitary collection system maintenance. Any improvement in WWTF, collection system operation and maintenance will contribute to the success of this I-Plan and help to offset possible shortfalls in implementing other management measures. Estimated load reductions attributed to SSOs were not calculated due to the variation in scope of each event and unpredictability of their rates of occurrence. Table 20 presents a summary of Management Measure 5.

Table 20. Management Measure 5: Improve WWTF and sanitary sewer collection function

Key Element	Summary
Causes and Sources	Human fecal sources from SSO incidents and poorly maintained wastewater infrastructure
Potential Load Reduction	Not estimated
Technical and Financial Assistance	**Technical**: Trade and professional associations, along with TCEQ, EPA, and TEEX. **Financial**: • $0–30,000 for technical assistance workshops for WWTF and collection system operators. • $0–15,000 for one FOG campaign workshop. • $0–30,000 for FOG blockage prevention outreach campaign.
Education Component	Workshops, technical presentations, and one-on-one meetings. Distribution of informational flyers and brochures.
Schedule of Implementation	• **Year 1**: Develop permittee list. Devise FOG blockage prevention campaign. • **Years 2 and** 4: Conduct technical assistance workshop for WWTF and collection system operators. • **Years 2–5:** Conduct and assess FOG blockage prevention campaign. • **Year 3:** Conduct one home and business owner general outreach/FOG campaign workshop. • **Year 5:** Provide five-year Management Measure 5 progress report, including assessment of the FOG blockage prevention campaign.
Interim, Measurable Milestones	• List of permittees to include in technical assistance workshops. • Number of technical assistance workshops held. • Completion of home and business owner general outreach workshop. • Successful implementation of FOG campaign. • Reduction of the number of SSOs due to infrastructure repairs and replacements
Indicators of Progress	• Number of technical assistance workshops held. • Number of FOG workshops held. • Number of individuals and organizations reached. • Number of wastewater infrastructure repairs made.
Monitoring Component	• **Environmental**: CRP ambient monitoring data • **Programmatic**: Five-year report
Responsible Party	Local governments, TCEQ, TEEX, USDA RUS, water professional associations, watershed coordinator

Sustainability

TCEQ, responsible parties, and other stakeholders in TMDL implementation projects periodically assess the results of the planned activities, along with other information, to evaluate the effectiveness of the I-Plan. Responsible parties and other stakeholders evaluate several factors, such as the pace of implementation, the effectiveness of BMPs, load reductions, and progress toward meeting water quality standards.

The responsible parties and other stakeholders will track progress using both implementation milestones and water quality indicators. These terms are defined as:

- **Water Quality Indicator** – A measure of water quality conditions for comparison to preexisting conditions, constituent loadings, and water quality standards.
- **Implementation Milestone** – A measure of administrative actions undertaken to cause an improvement in water quality.

Water Quality Indicators

As a partner with the TCEQ CRP, the H-GAC CRP will continue routine water quality monitoring during implementation as funding and resources allow. CRP data will be used to monitor surface water quality and measure bacteria loadings (especially in priority areas). Additional monitoring partners for the Cotton Bayou watershed are the Environmental Institute of Houston and the TCEQ Region 12 Office. The indicators that will be used to measure improvement in water quality are *E. coli* in freshwater and Enterococci in saltwater. Monitoring data collected by CRP will be evaluated by the watershed coordinator to assess impacts of this I-Plan on surface water quality.

The watershed coordinator will also work with the CRP partner to acquire funding to expand monitoring efforts, if needed.

Implementation Milestones

Implementation tracking helps stakeholders to determine if progress is being made toward meeting goals of the TMDL and I-Plan. Tracking also allows stakeholders to evaluate actions taken, identify those that may not be working, and make any changes that may be necessary to get the plan back on target. Measurable milestones track the completion of activities meant to reduce pollutant loadings. Schedules and milestones for this I-Plan are included in the descriptions of each management measure.

Communication Strategy

TCEQ will work with responsible parties and other stakeholders to hold meetings or obtain annual I-Plan updates for up to five years, so stakeholders may evaluate their progress. Responsible parties and stakeholders will continue to provide annual updates and/or take part in any meetings over the five-year period to evaluate implementation efforts. At the completion of the scheduled I-Plan activities, stakeholders will assemble and evaluate the actions, overall impacts, and results of their implementation efforts.

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