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Implementation Plan for Two Total Maximum Daily Loads for Indicator Bacteria in the Oyster Creek Watershed

Assessment Units 1109_01 and 1110_01

By Stakeholders of the Oyster Creek Watershed
With Support from the Houston-Galveston Area Council

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Total Maximum Daily Load Team
Texas Commission on Environmental Quality
MC-203
P.O. Box 13087
Austin, Texas 78711-3087
E-mail: tmdl@tceq.texas.gov

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Abbreviations

AA	authorized agent
AU	assessment unit
BMP	best management practice
CAFO	concentrated animal feeding operation
cfu	colony forming units
CMP	conservation management plan
CRP	Clean Rivers Program
E. coli	*Escherichia coli*
EIH	Environmental Institute of Houston
EPA	Environmental Protection Agency (United States)
EQIP	Environmental Quality Incentives Program
FG	future growth
FM	farm-to-market
FOG	fats, oils, grease, and wipes
H-GAC	Houston-Galveston Area Council
I-Plan	implementation plan
mL	milliliter
MOS	margin of safety
MS4	municipal separate storm sewar system
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
SWMU	subwatershed management unit
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
TSD	technical support document
TSSWCB	Texas State Soil and Water Conservation Board
TWDB	Texas Water Development Board
USDA	United States Department of Agriculture
USFWS	United States Fish and Wildlife Service
WEP	Water and Environmental Program
WLA	wasteload allocation
WQMP	water quality management plan
WWTF	wastewater treatment facility

Executive Summary

In 2024, the Texas Commission on Environmental Quality (TCEQ) adopted *Two Total Maximum Daily Loads for Indicator Bacteria in the Oyster Creek Watershed* (assessment units (AUs) 1109_01 and 1110_01).

This implementation plan, or I-Plan:

- Describes the steps that watershed stakeholders and the TCEQ will take toward achieving 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 uses in AUs 1109_01 and 1110_01 by reducing concentrations of bacteria to levels established in the TMDL. This I-Plan will benefit, not only to 1109_01 and 1110_01, but to all water bodies in the TMDL watershed as a protective measure.

Escherichia coli (*E. coli*) and Enterococci are two widely used indicator bacteria to assess attainment of the contact recreation use in water—*E. coli* in freshwater and Enterococci in saltwater. The criteria for assessing attainment of the contact recreation 1 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/100 mL (milliliter) for *E. coli* in freshwater 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 bacteria in the Oyster Creek watershed. Management measures are related to nonpoint sources (mostly unregulated), such as pet or wildlife fecal waste.

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 I-plan are:

1. Promote safe on-site sewage facility (OSSF) use and maintenance.
2. Support land management initiatives.
3. Maintain and Improve wastewater treatment facility (WWTF) and collection system function.
4. Reduce stormwater sources such as pet waste and illegal dumping.
5. Promote feral hog management.

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 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 Oyster Creek 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 appropriate formal or informal action.

This I-Plan contains the following components:

- Description of management measures that will be implemented to achieve the water quality target.
- Schedule for implementing activities.
- Follow-up 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.
- Review strategy that stakeholders will use to periodically review and revise the plan to ensure progress in improving water quality.

Watershed Overview

The Oyster Creek watershed comprises 146.7 square miles within Fort Bend and Brazoria counties and is composed of three water bodies: Oyster Creek Tidal (Segment 1109), Oyster Creek Above Tidal (Segment 1110) and an unclassified water body, Upper Oyster Creek Above Tidal (1110A) (Figure 1). Oyster Creek Tidal is composed of a single AU (1109_01) that begins in the city of Lake Jackson and traverses about 25 miles southeast to its confluence with the Gulf

Intracoastal Waterway. The tidal AU has a watershed area of 23.6 square miles. Other cities that are found in the Oyster Creek Tidal watershed include Clute and Richwood.

Oyster Creek Above Tidal is composed of three AUs (1110_01, 1110_02, and 1110_03) and one unclassified waterbody (1110A_01) that begins 4.3 kilometers (2.7 miles) upstream of Scanlan Road, and travels to the city of Lake Jackson where it terminates at its confluence with Oyster Creek Tidal (Segment 1109). Segment 1110 has a watershed area of 123.1 square miles, including Upper Oyster Creek Above Tidal (1110A). The Oyster Creek Above Tidal watershed contains all or part of six cities, towns, and villages: Rosharon, Bonney, Holiday Lakes, Angleton, Bailey's Prairie, and Lake Jackson.

For this document, the TMDL watershed (the full Oyster Creek watershed) is divided into two subwatersheds, Oyster Creek Tidal and Oyster Creek Above Tidal (Figure 1). The Oyster Creek Above Tidal subwatershed will refer to the upstream portion of the TMDL watershed, including the unclassified water body 1110A_01 (Figure 1).

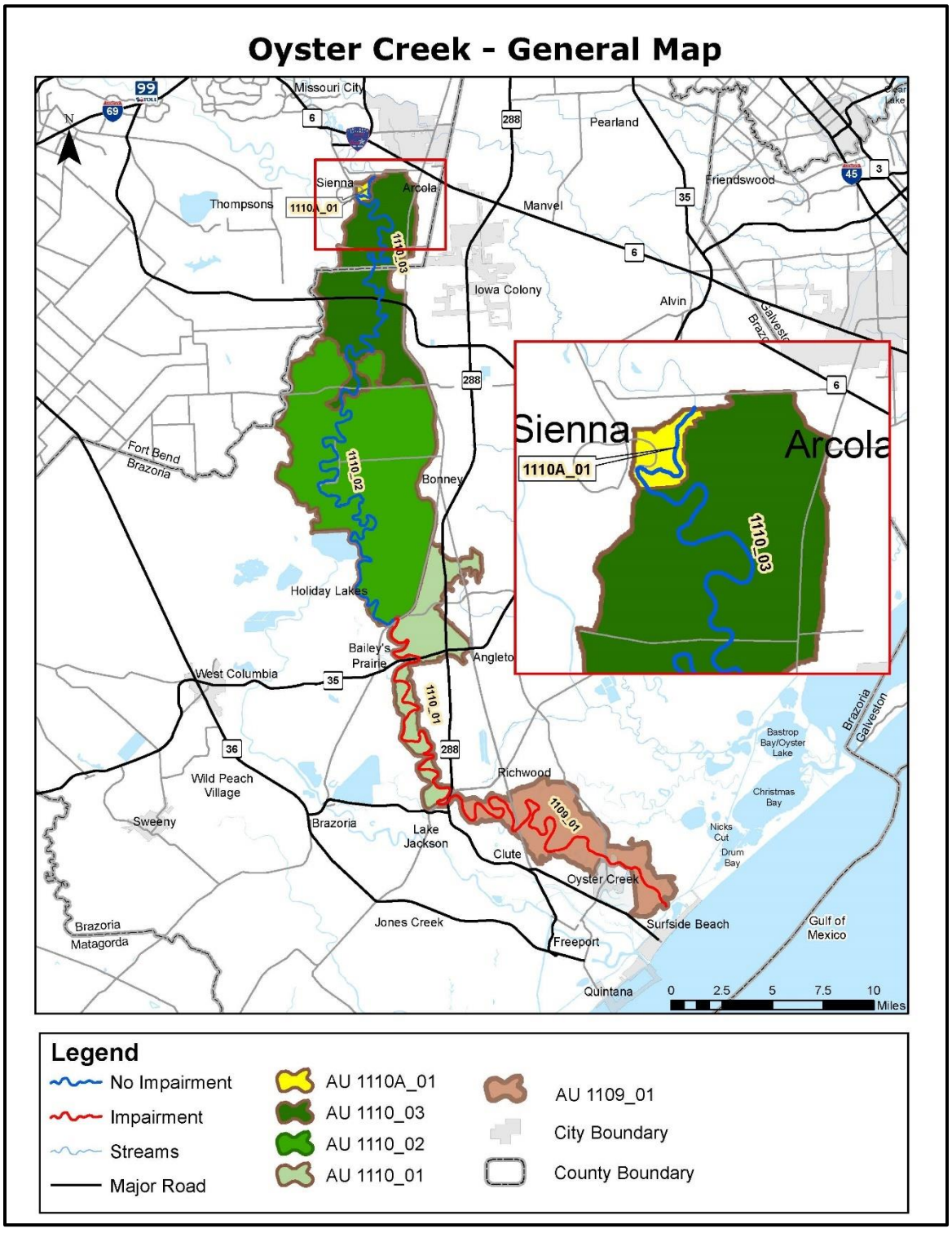

Figure 1. Map of the TMDL watershed

Summary of TMDLs

Table 1 summarizes the allocations developed for *Two TMDLs for Indicator Bacteria in the Oyster Creek Watershed* (TCEQ, 2024). 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

AU	Criterion (cfu/ 100 mL)	TMDL	WLA_{WWTF} [a]	WLA_{SW} [b]	LA [c]	FG [d]	MOS [e]
1109_01	35	569.334	8.691	31.900	494.728	5.548	28.467
1110_01	126	1,244.524	31.003	69.114	1,062.413	19.768	62.226

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 measure 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 in 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 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

The Oyster Creek watershed was divided into five subwatershed management units (SWMU) to assist in estimating fecal bacteria source contributions. The

units follow the AU reaches as the AUs were developed by considering common land use features and similar watershed characteristics. (Table 2, Figure 2).

The estimated nonpoint source pollutant loadings within each SWMU were determined to set management measure priorities. The Houston-Galveston Area Council (H-GAC) utilized landcover analysis for the Oyster Creek watershed and source load calculations that have been developed in previous H-GAC region watershed-based plans (H-GAC, 2018 and EPA, 2001). 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 2. AUs, SWMUs, and SWMU acreage

AU	SWMU	SWMU Area (acres)
1110A_01	1	535
1110_03	2	21,913
1110_02	3	43,672
1110_01	4	12,447
1109_01	5	18,223

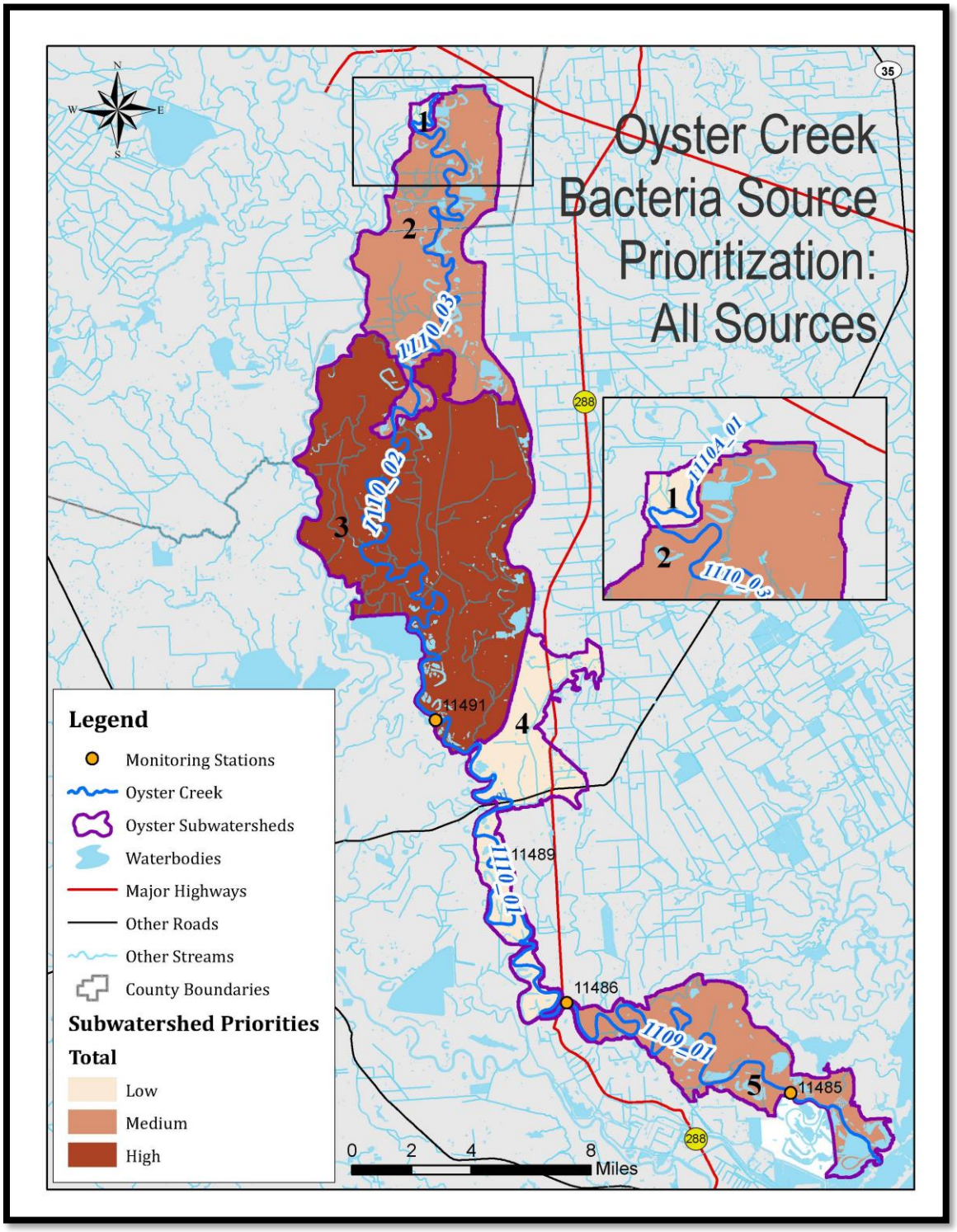

Figure 2. SWMUs showing priority areas for managing all sources

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

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 subwatersheds regardless of which standard criterion was applicable, *E. coli* or Enterococci. Bacteria data collected in the Oyster Creek watershed include both indicator bacteria because the watershed has both fresh and tidal waters. Enterococci were collected in the tidal water body (Segment 1109) and *E. coli* were collected in freshwater (all remaining water bodies). 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 (e.g., dogs, OSSFs, and cattle). Estimating source populations within the Oyster Creek watershed are described more fully within the technical support document (TSD)—*Technical Support Document for Two Total Maximum Daily Loads for Indicator Bacteria in the Oyster Creek Watershed* (H-GAC, 2022).

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 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.

The estimated individual source loadings and total loading for all sources in each watershed can be found in Table 4. For this I-Plan, cattle were the only livestock used, as they account for around 90% of the loadings from livestock. Using the information from Table 4, 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.

Table 3. Representative unit source loads

Bacteria Source	Number in Watershed	Representative Unit	Representative Unit Daily Load (billion cfu/day)
Cattle	9,523	1 Cow	2.70
OSSF	3,212 (707 failing)	1 Failing OSSF	3.71
SSO [a]	91	1 SSO	4.93
Feral Hogs	2,023	1 Feral Hog	4.45
Dogs	19,488	1 Dog	2.50
Deer	3,830	1 Deer	0.175

[a] SSO: sanitary sewer overflow

The reduction of indicator bacteria needed to attain the contact recreation standards for each AU was determined during TMDL development. This load reduction is essentially the difference between the geometric mean load of observed data between 0-10% flows and the TMDL calculated at 5% flow on the load duration curve (H-GAC, 2022). Table 6 provides the percentage reduction and the load reduction needed within the Oyster Creek Tidal and Oyster Creek Above Tidal subwatersheds to meet the contact recreation standard.

An interim step was made for Upper Oyster Creek Above Tidal and Oyster Creek Above Tidal (SWMUs 1-4) to account for each subwatershed area, since a load reduction needs to be determined for each SWMU. This is done by determining the proportional area for each SWMU, dividing the SWMU area by the total AU area, and then multiplying that proportion by the AU load reduction. Table 7 presents the total load reduction by SWMUs.

Multiplying the load reduction values from Table 7 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 8. 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 source reductions and source 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 prove 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 rural and natural land cover in the Oyster Creek watershed would suggest a larger wildlife contribution, but, with exception of deer, 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 help reduce loading from wildlife.

Table 4. Estimated source loadings of fecal bacteria

Watershed	AU	SWMU	OSSF	Cattle	Deer	Feral Hogs	SSOs	Dogs	Total
Upper Oyster Creek Above Tidal	1110A_01	1	0	9.12	0.22	11.08	< 0.01	5,713.41	5,733.83
Oyster Creek Above Tidal	1110_03	2	267.86	5,377.77	147.16	2,075.05	< 0.01	5,952.98	13,820.82
Oyster Creek Above Tidal	1110_02	3	1,617.56	13,669.07	339.61	4,344.36	< 0.01	11,673.05	31,643.65
Oyster Creek Above Tidal	1110_01	4	500.11	3,297.34	85.81	1,124.14	< 0.01	6,467.45	11,474.85
Oyster Creek Tidal	1109_01	5	238.92	3,357.49	97.45	1,449.05	< 0.01	18,913.69	24,056.61
		Total	**2,624.45**	**25,710.78**	**670.25**	**9,003.69**	**0.01**	**48,720.57**	**86,729.76**

All loads are expressed in billion cfu/day.

Table 5. Percentage source contribution of fecal indicator bacteria

Watershed	AU	SWMU	OSSF	Cattle	Deer	Feral Hogs	SSOs	Dogs	Total
Upper Oyster Creek Above Tidal	1110A_01	1	0.00%	0.16%	0.00%	0.19%	< 0.01%	99.64%	100.00%
Oyster Creek Above Tidal	1110_03	2	1.94%	38.91%	1.06%	15.01%	< 0.01%	43.07%	100.00%
Oyster Creek Above Tidal	1110_02	3	5.11%	43.20%	1.07%	13.73%	< 0.01%	36.89%	100.00%
Oyster Creek Above Tidal	1110_01	4	4.36%	28.74%	0.75%	9.80%	< 0.01%	56.36%	100.00%
Oyster Creek Tidal	1109_01	5	0.99%	13.96%	0.41%	6.02%	< 0.01%	78.62%	100.00%
		Total	**3.03%**	**29.64%**	**0.77%**	**10.38%**	**< 0.01%**	**56.18%**	**100.00%**

All loads are expressed in billion cfu/day.

Table 6. Estimated reductions in fecal indicator bacteria

Watershed	Water Body ID	SWMU	Estimated Loading of Bacteria at 5% flow	Percent Reduction	Bacteria Reduction
Oyster Creek Above Tidal	1110	1-4	10,866.98	87.56%	9,514.98
Oyster Creek Tidal	1109	5	15,869.18	97.27%	15,436.66

All loads are expressed in billion cfu/day.

Table 7. SWMU estimated reductions in fecal indicator bacteria

Watershed	AU	SWMU	Area (acre)	% TMDL Watershed	SWMU Load Reduction
Upper Oyster Creek Above Tidal	1110A_01	1	535.33	0.68%	64.83
Oyster Creek Above Tidal	1110_03	2	21,913.33	27.89%	2,653.84
Oyster Creek Above Tidal	1110_02	3	43,672.03	55.59%	5,288.96
Oyster Creek Above Tidal	1110_01	4	12,446.51	15.84%	1,507.35
Total	(Above Tidal)	**1-4**	**78,567.20**	**100.00%**	**9,514.98**
Oyster Creek Tidal	1109_01	**5**	**18,223.07**	**100%**	**15,436.66**

All loads are expressed in billion cfu/day.

Table 8. Estimated source load reductions

Watershed	AU	SWMU	OSSF	Cattle	Deer	Feral Hogs	SSOs	Dogs	Total
Upper Oyster Creek Above Tidal	1110A_01	1	0.00	1.38	0.03	1.68	0.15	867.37	870.62
Oyster Creek Above Tidal	1110_03	2	40.66	816.42	22.34	315.02	0.0019	903.74	2,098.18
Oyster Creek Above Tidal	1110_02	3	245.12	2,075.14	51.56	659.53	0.0030	1,772.12	4,803.48
Oyster Creek Above Tidal	1110_01	4	75.92	500.58	13.03	170.66	0.67	981.84	1,742.70
Oyster Creek Tidal	1109_01	5	153.27	2,153.86	62.51	929.58	4.12	12,133.31	15,436.66
		Total	**515.48**	**5,548.10**	**149.49**	**2,076.77**	**0.0054**	**16,661.80**	**24,951.64**

All loads are expressed in billion cfu/day.

Activities and Milestones

H-GAC held a series of public meetings in the watershed from December 2017 and through 2018 to facilitate the development of the Oyster Creek I-Plan. H-GAC presented general water quality information to San Jacinto-Brazos Coastal Basin stakeholders during public meetings. These meetings provided information on water quality impairments, TMDL development, and typical water quality management strategies. Attendees were encouraged to participate in future meetings in the Oyster Creek watershed as coordination committee team members.

The Oyster Creek coordination committee formed in January 2019 and has continued to meet through 2024. The group reviewed water quality in Oyster Creek and discussed appropriate management measure activities. Five Oyster Creek coordination committee meetings were held prior to the development of this plan. The implementation activities presented in this report represent the stakeholders' effort and are described in the following section.

The Oyster Creek coordination committee met on May 23, 2019, and members were asked to fill out a questionnaire which covered potential bacteria sources and management measures. The attendees were asked to determine if each fecal bacteria source was a concern and rank the concern on a high, medium, or low scale. A rank of five was considered high, three was considered medium, and one was considered low.

Table 9 presents a summary of the questionnaire results covering 11 key fecal bacteria sources commonly found in watersheds. OSSFs in the watershed ranked high, while domesticated animals, collections systems, wastewater, and urban and rural stormwater ranked medium-high. Illegal dumping, feral hogs and pet waste were ranked as medium concerns. Concentrated animal feeding operations (CAFOs) and manure applications were considered medium-low concerns.

The Oyster Creek watershed includes three CAFOs. The CAFOs are authorized by the CAFO general permit (TXG920000) to manage wastes that can include fecal bacteria. Like WWTFs, fecal bacteria from CAFOs are not expected to be a significant source when managed correctly. Manure application was not identified as a watershed concern, as no permits for manure applications were found in the watershed.

Table 9. Results of the Oyster Creek watershed stakeholder questionnaire

Fecal Source	Watershed Concern	Rank
OSSF	Y	5
Animal Husbandry	Y	4
Collection System	Y	4
Wastewater	Y	4
Urban Stormwater	Y	4
Rural Stormwater	Y	4
Dumping	Y	3
Pet Wastes	Y	3
Feral Hogs	Y	3
CAFO	Y	2
Manure Application	N	2

Management Measures

The Oyster Creek stakeholders identified five key management measures to address water quality concerns.

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

Management Measure 1
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 (see Figure 3).

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 high concern.

The estimated number of OSSFs are provided in Table 10. The total number includes those systems with permits, plus an estimated number that might be found in the Oyster Creek watershed without a permit (H-GAC, 2022). The exact number of failing systems is unknown, but studies estimate the approximately 12% of systems are expected to be in failing condition (Reed, Stowe, and Yanke, 2001). However, considering the number of systems without a permit and the poorly draining coastal soils, a larger rate, 20%, is used in this I-Plan.

Table 10. Estimated number of OSSFs and daily bacteria load

Watershed	Water Body ID	SWMU	Total Systems	Failing Systems (20% Rate)	Representative Load	Estimated Daily Bacteria Load (OSSFs)
Oyster Creek Above Tidal	1110	1-4	3,212	643	3.71	2,385.53
Oyster Creek Tidal	1109	5	322	64	3.71	238.92
		Total	**3,534**	**707**	**3.71**	**2,624.45**

All loads are expressed in billion cfu/day

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

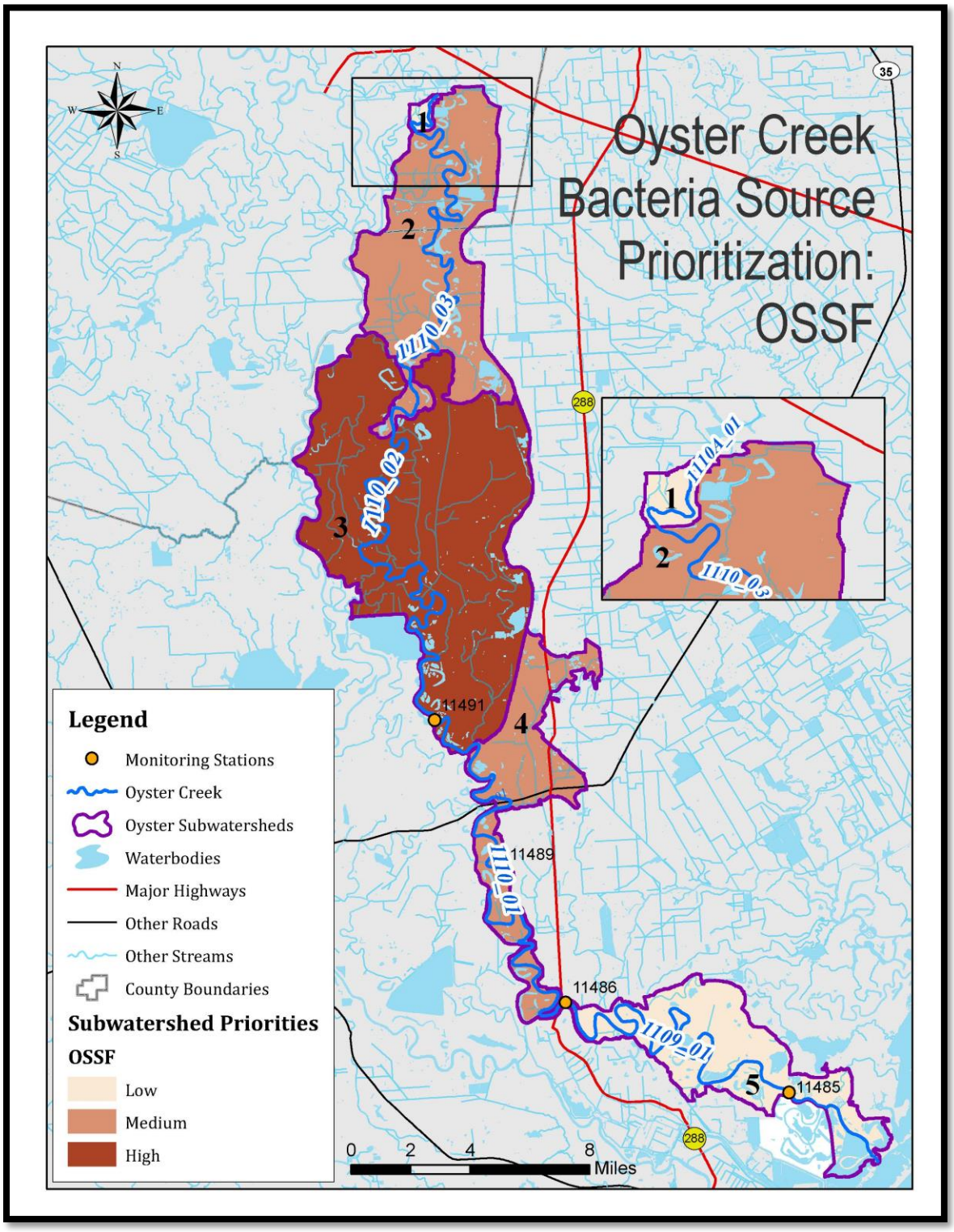

Figure 3. Priority areas for OSSF in the Oyster Creek watershed

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 AAs in the Oyster Creek watershed, including Brazoria and Fort Bend counties and TCEQ's Region 12 Office, regulate OSSF permitting and inspection. 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.

Education Component

Given the finite 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 The Texas State Soil and Water Conservation Board (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 were assigned to subwatersheds based on land use, location of permitted and non-permitted systems, and allocated loads from the TMDL. Figure 3 shows how implementation in each SWMU will be prioritized.

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 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 Oyster Creek watershed. Brazoria and Fort Bend counties are the AAs for their perspective portion of the watershed. TCEQ's Region 12 Office oversee OSSFs within city limits.
- **H-GAC** provides OSSF technical and outreach assistance to homeowners, real estate agents, 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.
- The **United States Department of Agriculture (USDA)** Rural Utilities Service (RUS) administers programs that provide infrastructure or infrastructure improvements to rural communities.
- The **watershed coordinator** will 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 and TCEQ Region 12. The AAs can assist with the permitting process within their respective jurisdictions. 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 out operations, funding for repairs or replacements, and in limited circumstances, providing connections to centralized wastewater

treatment. Estimated costs for Management Measure 1 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 1.

- **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 (TGLO, 2022), 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.

- 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 monies 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 Environmental Protection Agency (EPA) grant program (EPA, 2013), administered by TCEQ and TSSWCB, provides funding to implement 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 the Texas Water Development Board (TWDB, 2022) 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 **Water and Environmental Program (WEP)** provides technical assistance and financing to address water and wastewater infrastructure needs of rural communities with populations of 10,000 or fewer. 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:

- 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 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 Oyster Creek project page.

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 or medium priority areas through the SEP or similar program.

Year 3:

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

Year 5:

- Support, at minimum, two homeowners within the high or medium priority areas through the SEP or similar program.
- Provide one five-year Management Measure 1 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 515.48 billion cfu/day or 188,150.89 billion cfu/year.

To express this reduction into more quantifiable terms, the OSSF load reductions were converted into unit reductions. The OSSF load reduction, 515.48 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 139 failing OSSFs that need to be repaired or replaced (Table 11).

Table 11. OSSF load reduction and number to be managed

Watershed	Water Body ID	SWMU	Total OSSF Load Reduction	Representative Unit Daily Load	OSSFs to be managed
Oyster Creek Above Tidal	1110	1-4	362.17	3.71	98
Oyster Creek Tidal	1109	5	153.31	3.71	41
		Total	**515.48**	**3.71**	**139**

All loads are expressed in billion cfu/day.

Based on the estimated 707 failing OSSFs within the Oyster Creek watershed (Table 10), 139 OSSFs is a conservative target reduction estimate. Addressing more than the 139 estimated systems will provide greater capacity for meeting the total bacteria reduction needed to meet water quality standards. This expanded capacity could be used to assist other measures that might be more difficult to implement in meeting reduction targets.

Additionally, it is important to note that the number of failing systems should not increase for this measure to be effective. After repairing or replacing 139 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 12 presents an overview of Management Measure 1.

Table 12. Management Measure 1: 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	188,150.89 billion cfu/year
Technical and financial assistance	**Technical**: Brazoria and Fort Bend counties and TCEQ Region 12 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.
Educational 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 in total. • **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 1 progress report.
Interim, measurable milestones	• Number of homeowner workshops and home inspector trainings held. • Number of OSSFs addressed.
Monitoring component	• **Environmental**: Clean Rivers Program (CRP) ambient monitoring data • **Programmatic**: Five-year report
Responsible parties	Watershed coordinator, AAs, H-GAC, Texas A&M AgriLife Extension, real estate agents/ inspectors, TGLO, USDA RUS.

Management Measure 2

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 (Figure 4).

Livestock are present throughout the Oyster Creek watershed. Stakeholders ranked this source as a medium-high concern (Table 9). Table 13 presents the estimated cattle population. TSSWCB staff reviewed the estimated cattle population numbers during the development of the TSD. As stated earlier, while other types of livestock are mentioned in the TMDL (horses, domesticated pigs, sheep, and poultry), cattle were the only livestock used for calculations in this I-Plan, as they account for the bulk of loadings from livestock. Additionally, actions taken to address cattle under this measure will also cover other livestock.

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 is highly dependent upon proximity to these resources, especially water. Their fecal loading is also strongly tied to resource use 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 13. Cattle population and estimated daily bacteria load

Watershed	Water Body ID	SWMU	Cattle Population	Representative Unit Load	Estimated Daily Bacteria Load (Cattle)
Oyster Creek Above Tidal	1110	1-4	8,279	2.7	22,353.29
Oyster Creek Tidal	1109	5	1,244	2.7	3,357.49
		Total	**9,523**	**2.7**	**25,710.78**

All loads are expressed in billion cfu/day.

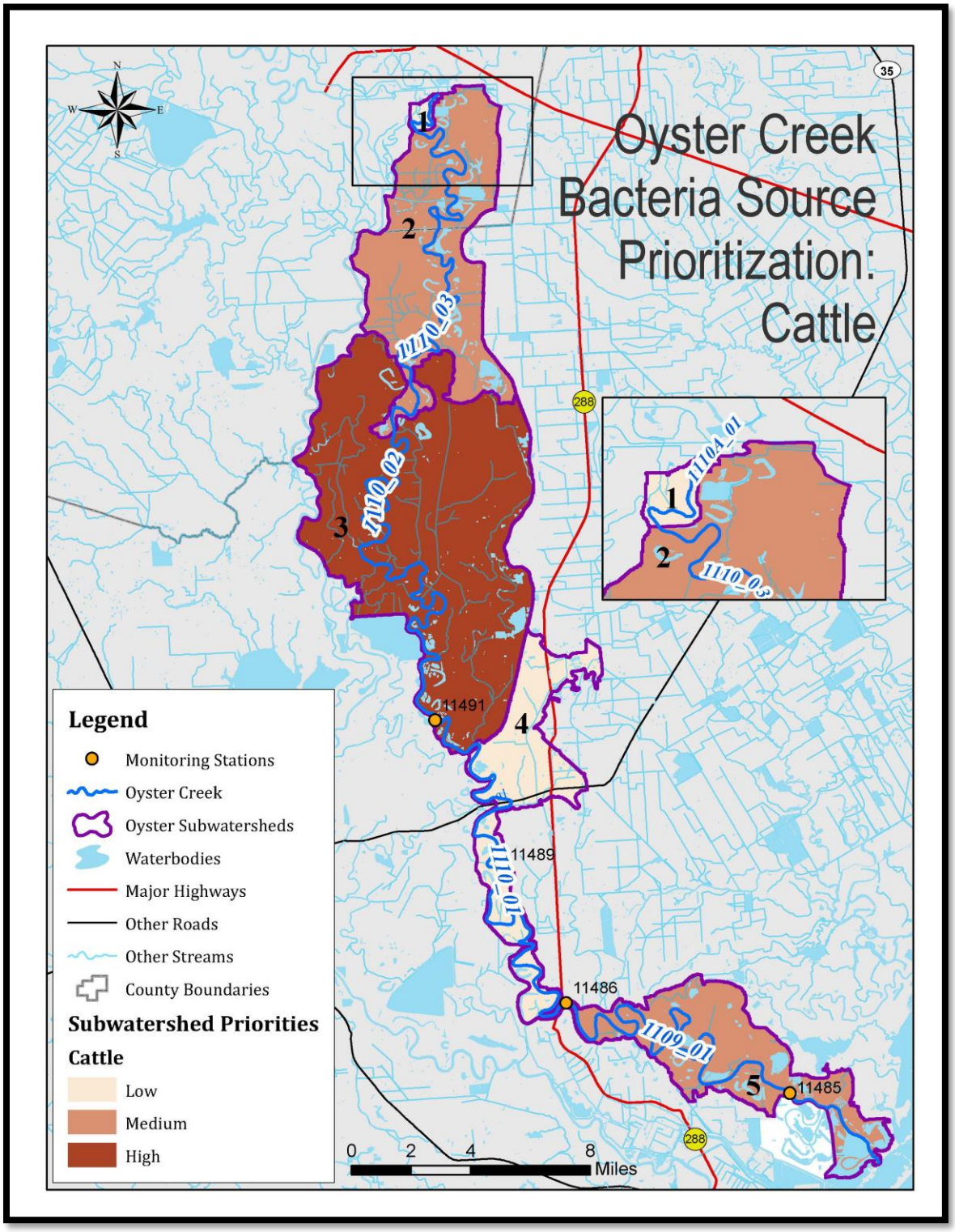

Figure 4. Priority areas to address Cattle in the Oyster Creek watershed

Recommended Management Measure 2 activities include promoting and implementing voluntary water quality management plans (WQMPs) and conservation management plans (CMPs), as well as 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 best management practices (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 riparian habitats and serving as sinks for multiple water quality pollutants including bacteria. Implementation of Management Measure 2 can work in concert with the execution of Management Measure 4.

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

Education Component

Education is crucial to successfully implement Management Measure 2. 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

Priorities were assigned to subwatersheds based on land use and allocated loads taken from the TMDL. Subwatershed 3 is a high-priority area for implementing

this measure. Subwatersheds 2 and 5 are medium-priority areas for implementation. Subwatersheds 1 and 4 are low priority for implementation (Figure 4).

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 2, 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.

- **Drainage Districts**, along with other county agencies, local governments, and landowners, present an opportunity to maintain and improve riparian zones. Drainage districts, with assistance from other stakeholders, identify drainage channels for restoration. There are four districts in the Oyster Creek watershed: Fort Bend County Drainage District, Angleton Drainage District, Iowa Colony Drainage District, and Velasco Drainage District.

- **SWCDs** work with federal and state agencies, particularly the TSSWCB, to provide 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. Waters Davis SWCD operates in Brazoria County, and Coastal Plains SWCD operates in Fort Bend County.

- **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.

- **United States Fish and Wildlife Service (USFWS)** holds conservation lands in the Oyster Creek watershed and is a stakeholder. The Brazoria National Wildlife Refuge staff can provide conservation assistance to implement riparian restoration.

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

- A **Watershed Coordinator** should be retained to oversee the implementation of the Oyster Creek I-Plan. 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.

- **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, 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 Oyster Creek watershed. Estimated costs for the voluntary Management Measure 2 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 2.

- **WQMPs** 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, that 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, riparian restoration, and technicians.

- **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** program 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 Program 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 Oyster Creek project page.

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 4. Develop a proposal for a minimum of one available funding grant.

Year 3:

- Develop, at minimum, two grazing management plans or WQMPs and two CMPs.
- Initiate one demonstration riparian corridor project in coordination with Management Measure 4.

Year 4:

- Develop, at minimum, two grazing management plans or WQMPs and 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, two grazing management plans or WQMP and two CMPs.
- Complete one demonstration riparian corridor project.
- Provide one five-year Management Measure 2 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. The load reduction surrogate for this measure is based on the number of cattle within the Oyster Creek watershed because cattle make up the bulk of the livestock population. Estimated indicator bacteria reductions for cattle populations are presented in Table 14. Reducing fecal loads from cattle results in an estimated daily load reduction of 5,548.10 billion cfu/day or 2,025,054.73 billion cfu/year.

A subsequent step is taken to determine how this reduction may be implemented. A representative unit daily load is used (2.7 billion cfu/day for cattle; see Table 3) to determine the number of cattle to be managed under a WQMP or a CMP. Table 14 presents the calculation where the total daily load reduction needed is divided by the daily load per representative unit. This yields a total of 2,055 units needed to reduce loadings in the Oyster Creek watershed by 5,548.10 billion cfu/day. This I-Plan is not recommending that this number of cattle be removed from the watershed. The units to be reduced are referring to the number of cattle to be managed under WQMPs or CMPs such that fecal loading from them would be prevented from entering Oyster Creek or its tributaries.

In prior publications, TSSWCB and USDA NRCS determined that a WQMP or CMP would reasonably address 50 livestock units (H-GAC, 2018). The cattle 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 5,548.10 billion cfu/day. This gives an estimated 41 management plans needed to address the required reduction throughout the Oyster Creek watershed (Table 14). Table 15 presents an overview of Management Measure 2.

Table 14. Estimated cattle bacteria load reduction, number to be managed, and management plans

Watershed	Water Body ID	SWMU	Total Estimated Load Reduction (Cattle)	Representative Unit Daily Load	Cattle to be managed	Management Plans
Oyster Creek Above Tidal	1110	1-4	3,393.66	2.7	1,257	25
Oyster Creek Tidal	1109	5	2,154.44	2.7	798	16
		Total	**5,548.10**	**2.7**	**2,055**	**41**

All loads are expressed in billion cfu/day

Table 15. Management Measure 2: 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	2,025,054.73 billion cfu/year
Technical and financial assistance	**Technical**: Local SWCDs, 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.
Educational 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 a minimum of two WQMPs and two CMPs per year. Initiate and complete one demonstration riparian corridor project. • **Year 4**: Host at least one riparian buffer workshop and at least one agricultural BMP workshop. • **Year 5**: Provide five-year Management Measure 2 progress report.
Interim, measurable milestones	• Number of workshops held. • Number of grazing management plans developed. • Number of WQMPs developed. • Number of Status Reviews on existing WQMPs. • Number of CMPs developed. • Completion of demonstration riparian corridor project • Area or stream miles of preserved, protected, or enhanced riparian corridor.
Monitoring component	• **Environmental**: CRP ambient monitoring data • **Programmatic**: Five-year report
Responsible parties	TSSWCB, NRCS, SWCDs, watershed coordinator; drainage districts, Texas A&M AgriLife Extension, TPWD, USFWS, landowners/ producers

Management Measure 3

Maintain and Improve Wastewater Treatment Facility and 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 (Figure 5).

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.

SSOs were considered a source surrogate for this management measure. As reported in the TSD (H-GAC, 2022), there were 91 SSOs between 2016 and 2021, releasing an estimated volume of 241,321 gallons of untreated or partially treated effluent. SSOs were not reported for SWMUs 2 and 3 for the period between 2016 and 2021. It should be noted that the number of SSOs are often considered underreported and volumes underestimated. Stakeholders ranked failing WWTFs and collections systems as a medium-high concern.

The city of Lake Jackson reported the majority of the SSOs. Unlike other jurisdictions, the city reports all SSOs, regardless of size. To standardize the Oyster Creek reported SSOs and prevent overestimating the loading from Lake Jackson, the reported SSOs found in Table 16 are those with a volume of 10,000 gallons or more. This leaves a total of six reported SSOs between 2016 and 2021.

Table 16. Estimated daily bacteria load for SSOs

Watershed	Water Body ID	SWMU	Reported SSOs (2016-2021)	Reported SSOs (Day)	Representative Unit Daily Load (SSOs)	Estimated Daily Load (SSO)
Oyster Creek Above Tidal	1110	1-4	3	0.0014	4.93	0.00675
Oyster Creek Tidal	1109	5	3	0.0014	4.93	0.00675
		Total	**6**	**0.0027**	**4.93**	**0.01351**

* All loads are expressed in billion cfu/day.

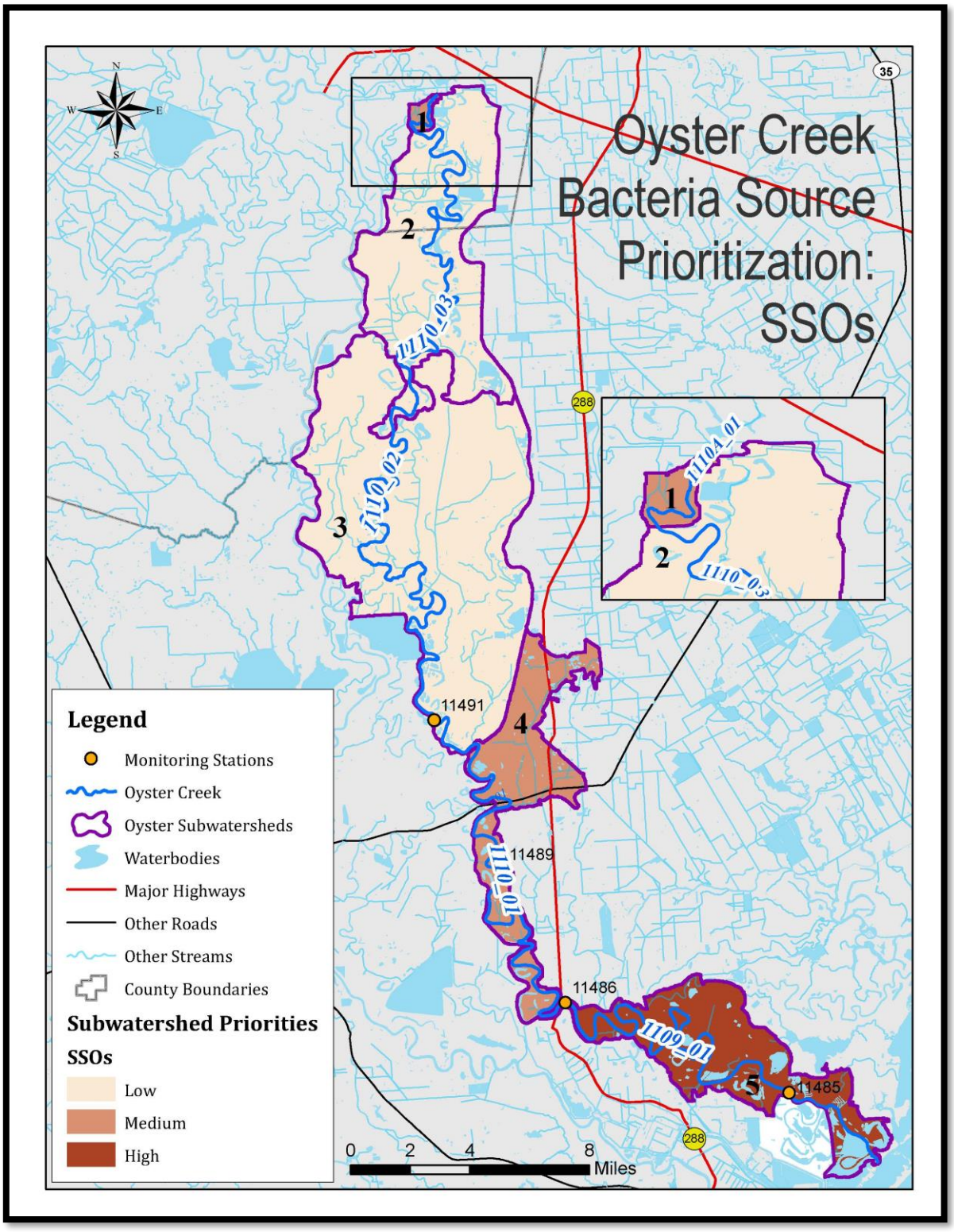

Figure 5. Priority areas to target for improving WWTF and collection system function

To estimate a daily load contributed by SSOs, a daily SSO was calculated by dividing the number of SSOs by the number of days in the six-year reporting period. This number can then be multiplied by the SSO representative daily unit, 4.93 billion cfu/day, to arrive at a daily load. Table 16 presents the estimated daily bacteria load from SSOs. The estimated daily load is 0.01351 billion cfu per day or 4.93 billion cfu per year.

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 two of these that have ready-made informational flyers and brochures that can be adapted for the Oyster Creek watershed.

Priority Areas

Priorities were assigned to subwatersheds based on land use, wastewater treatment service area boundaries, reported SSOs, and allocated loads from the TMDL. Subwatersheds 4 and 5 are high-priority areas for implementation. Subwatershed 1 is a medium-priority area and subwatersheds 2 and 3 are low priority areas for implementation (Figure 5).

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.

- **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 collection systems. Routine maintenance of these complex systems requires the planning and dedication of 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 to 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 Development** 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 municipalities, water districts, and others 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 as 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 help them meet permit requirements. Management Measure 3 outreach activities are estimated to cost between $0 and $30,000 each year. A range is provided for workshop costs, as in some instances there may be no costs associated with the workshop, and 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 below is not an exhaustive funding list for Management Measure 3. Visit the funding resource pages for TCEQ (TCEQ, 2019) and EPA (EPA, 2019) for more extensive lists.

- TWDB offers the **Clean Water State Revolving Fund,** 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:

- 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 outreach workshop.
- Delivery of at least two operator trainings and technical assistance 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 Oyster Creek project page.

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/FOG campaign 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 3 progress report.
- Assess the FOG blockage prevention campaign.

Estimated Load Reductions

The implementation measures listed in this I-Plan, including asset management, supporting compliance and 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.

Table 17 provides the estimated load reduction needed for SSOs and the number of SSOs that should be prevented. Similar to the reported SSOs, the number of SSOs were converted from a daily number to in this case a 5-year average in line with the I-Plan schedule. Over five years, the goal is to prevent two SSOs of 10,000 gallons or more. This number should be considered the minimum prevention as SSO recorded for the period are likely under-reported. It is estimated that if the SSOs were prevented, the daily load reduction is estimated to be 0.0054 billion cfu/day or 1.96 billion cfu/year.

Ultimately, the goal is zero reportable SSOs, in line with the expectation of the permit. Additionally, this source does not include any WWTF effluent concerns. Therefore, any targeted improvements in WWTF and collection system operations and maintenance will contribute to the success of this I-Plan and help to offset possible shortfalls in implementing other management measures. Table 18 presents a summary of Management Measure 3.

Table 17. Total SSOs load reduction and SSOs to be managed

Watershed	Water Body ID	SWMU	Total SSO Load Reduction	Representative Unit Daily Load	SSOs to be Managed (Day)	SSOs to be Managed (5-Yr)
Oyster Creek Above Tidal	1110	1-4	0.0010	4.93	0.0002	0.380
Oyster Creek Tidal	1109	5	0.0043	4.93	0.0009	1.604
		Total	**0.0054**	**4.93**	**0.0011**	**1.984**

All loads are expressed in billion cfu/day

Table 18. Management Measure 3: Improve WWTF and sanitary sewer collection function

Key Element	Summary
Causes and Sources	Human fecal sources from poorly maintained wastewater infrastructure
Potential load reduction	1.96 billion cfu/year
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.
Educational 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 3 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.
Monitoring component	• **Environmental**: CRP ambient monitoring data • **Programmatic**: Five-year report
Responsible parties	Local governments, TCEQ, TEEX, USDA RUS, water professional associations, watershed coordinator

Management Measure 4

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 (Figure 6).

Stormwater, particularly in an urban setting, contains fecal indicator bacteria from permitted and unpermitted sources, e.g., pet wastes, collection systems, etc. The Oyster Creek watershed is a mix of urban, suburban, and rural land covers. Developed land cover makes up the third largest land cover type in the watershed, with several small to medium sized developments along the waterway. As the size and density of these communities continue to grow, the stormwater contribution is also expected to expand.

Watershed stakeholders ranked developed and rural stormwater as a medium-high concern. Pet waste is a common fecal source ascribed to stormwater. Oyster Creek stakeholders indicated that pet waste was a medium priority, and bacteria contributions are a potentially important source.

Due to a lack of other stormwater fecal bacteria source data, pet numbers, through their waste, serve as a surrogate for other potential stormwater bacteria sources (Figure 6). The estimated dog population and estimated daily load is presented in Table 19. This estimate is potentially higher than what would be found if an accurate census could be performed. However, as this represents the total load from all potential stormwater sources, and can include contributions from wildlife, this estimate, 48,720.57 billion cfu/day, will be used.

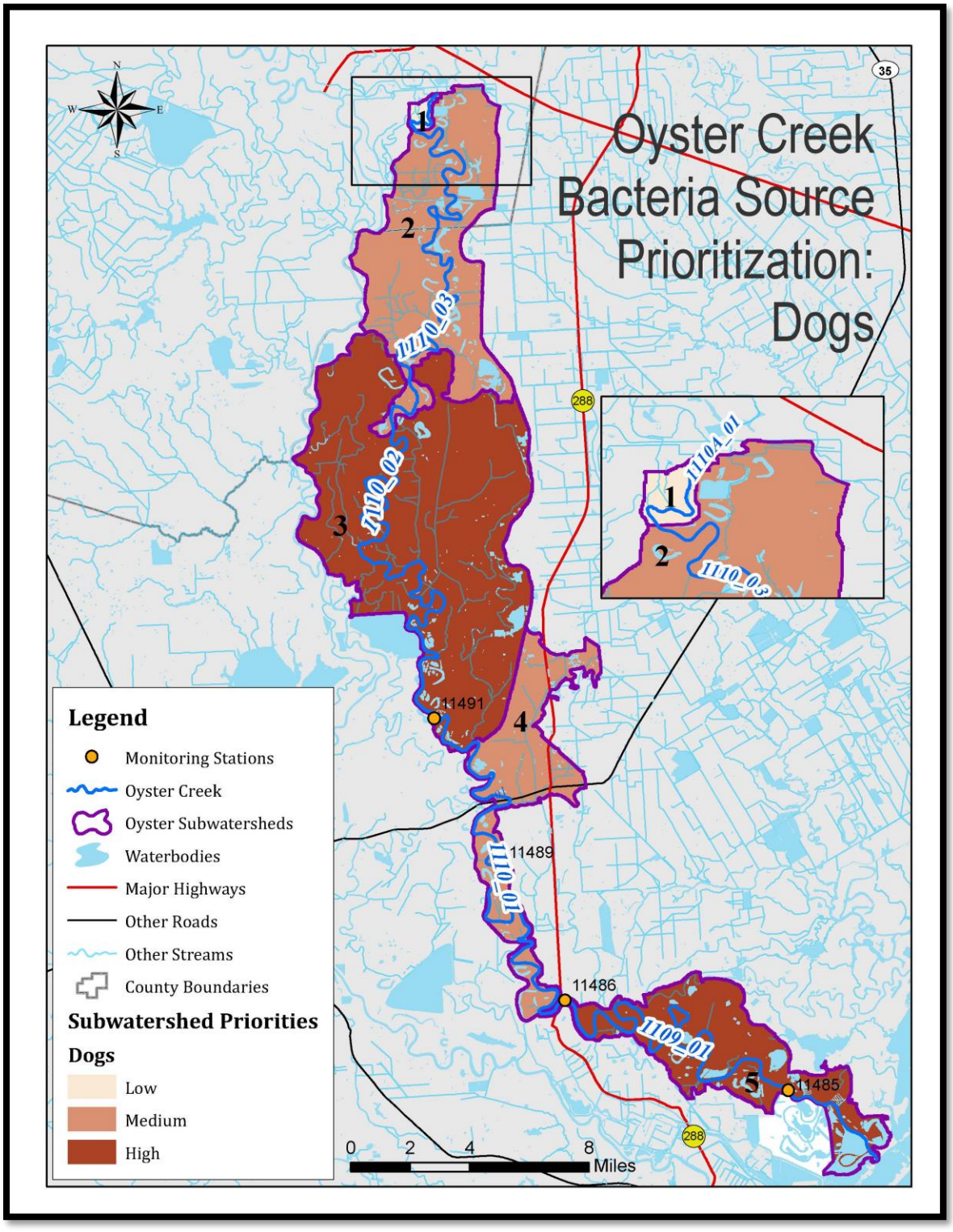

Figure 6. Priority areas to address dog waste in the Oyster Creek watershed

Table 19. Estimated dog population and daily load

Watershed	Water Body ID	SWMU	Dog Population	Representative Load	Estimated Daily Bacteria Load (Dogs)
Oyster Creek Above Tidal	1110	1-4	11,923	2.50	29,806.88
Oyster Creek Tidal	1109	5	7,565	2.50	18,913.69
		Total	**19,488**	**2.50**	**48,720.57**

All loads are expressed in billion cfu/day.

Reducing the amount of uncollected dog waste that can be transferred to water bodies in the project area is an identified action of Management Measure 4. Providing pet waste bag dispensers and collection stations in areas of higher pet density (e.g., parks, neighborhoods, and apartments) encourages pet owners to pick up pet waste before it can be transported to streams.

Pet waste management strategies become less effective in rural communities where dogs are often kept outside, and waste collection is not practical and is not required by a city or community ordinance. However, addressing feral dog populations can assist with this measure.

Management Measure 4 also seeks to identify and reduce illegal dump sites where fecal wastes and other pollutants might be illegally released to the Oyster Creek watershed. Local governments and stakeholders should assist in identifying and eliminating these potential sites.

Preserving and enhancing the riparian areas in coordination with Management Measure 2, can build additional watershed 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. Landowners interested in conservation and habitat enhancement can use voluntary state and federal programs for assistance.

The goal of this management measure is to install and maintain a minimum of 12 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 2.

Education Component

Education is crucial to successfully implementing this management measure. Campaigns and programs designed to educate on the potential impact activities have on stormwater exist; however, more targeted distribution of those materials should be implemented. Methods for distributing materials include but are not limited to public service announcements/newspaper articles, utility

bill inserts, direct mailers, and pet waste stations in public areas, and at community events.

Priority Areas

Priorities were assigned to subwatersheds based on human household distribution within the watershed and allocated loads from the TMDL. High-priority areas for implementing this measure are subwatersheds 3 and 5. Medium-priority areas are subwatersheds 1, 2, and 4 (Figure 6).

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.

- **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.

- **Drainage Districts** present an opportunity along with other county agencies, local governments, and landowners to maintain and improve riparian zones. Drainage districts, with assistance from other stakeholders, identify drainage channels for restoration. There are four districts covering the Oyster Creek watershed: Fort Bend County Drainage District, Angleton Drainage District, Iowa Colony Drainage District, and Velasco Drainage District.

- **H-GAC** manages pet waste outreach programs and coordinates pet waste reduction measures with other organizations. H-GAC has also been successful in applying 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.

- **USFWS** holds conservation lands in the Oyster Creek watershed and is a stakeholder. The Brazoria National Wildlife Refuge staff can provide conservation assistance to implement riparian restoration.

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

- The **Watershed Coordinator** would be charged to work with local stakeholders regarding pet waste and illegal dumping 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

H-GAC, EPA, and TCEQ have materials and resources for municipalities that manage and implement stormwater 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 Oyster Creek 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 4, 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 TSSWCB, that 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.

- Under **EPA Environmental Education Grants**, EPA 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 objective of the **Urban Water Small Grants**, administered by EPA, 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 to, understanding of, and stewardship of local urban waterways.

- TWDB offers the **Clean Water State Revolving Fund,** 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.

- 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:

- 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 that collaborate to install pet waste stations and identify target locations for illicit discharge monitoring and illegal dumping. As the implementation period progresses, numbers of pet waste stations installed, educational material distribution events, and stormwater outreach events will be tracked to assess progress. Late phase implementation metrics will include continued tracking of previously listed metrics in addition to numbers of riparian projects completed and 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 Oyster Creek project page.

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 three 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 2. Develop a proposal for a minimum of one available funding grant.
- Initiate one demonstration riparian corridor project in coordination with Management Measure 2.
- 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 2.

Year 4 and 5:

- Install and maintain at least three 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 4 progress report.

Estimated Loading 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 4. 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 are calculated to be 16,661.80 billion cfu/day (Table 20) or 6,081,556.27 billion cfu/year.

To convert the load reduction into relatable terms, the load reduction, 16,661.80 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 6,665 total units would need to be managed from the Oyster Creek watershed (Table 20).

Management Measure 4 does not recommend the removal of 6,665 dogs. Rather, Management Measure 4 is seeking to change pet owner actions with 6,665 representing the removal of pet waste from the equivalent of 6,665 dogs through active collection and the installation of pet waste stations. With an average of 0.614 dogs per household (AVMA, 2018), approximately 10,855 households would need to remove the waste from their dogs to account for 6,665 dogs in the watershed. Additional reductions will come from addressing other stormwater sources (e.g., illegal waste dumping), and restoring or enhancing riparian zones in coordination with Management Measure 2. Table 21 presents a summary of Management Measure 4.

Table 20. Estimated dog load reduction and waste removal

Watershed	Water Body ID	SWMU	Total Dog Load Reduction	Representative Unit Daily Load	# of Dogs from which Waste Would be Removed
Oyster Creek Above Tidal	1110	1-4	4,525.25	2.50	1,810
Oyster Creek Tidal	1109	5	12,136.54	2.50	4,855
		Total	**16,661.80**	**2.50**	**6,665**

All loads are expressed in billion cfu/day.

Table 21. Management Measure 4: 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, illegal dumping, and other stormwater sources
Potential load reduction	6,081,556.27 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.
Educational 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. • **Years 2–5**: Install and maintain at least three 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 1. • **Years 2–3**: Coordinate a stormwater outreach event as part of a watershed workshop. • **Years 4–5**: Conduct illicit discharge and illegal dumping detection investigations. • **Year 5**: Provide five-year Management Measure 4 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. • Number of individuals, groups, or communities reached. • Area or stream miles of preserved, protected, or enhanced riparian corridor
Monitoring component	• **Environmental**: CRP ambient monitoring data • **Programmatic**: Five-year report
Responsible parties	Watershed coordinator, local governments, drainage districts, H-GAC, Texas A&M AgriLife Extension, USFWS, TPWD

Management Measure 5
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 (Figure 7). Stakeholders ranked feral hogs as a medium concern.

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 Oyster Creek watershed; areas that remain undeveloped are ideal habitat for wildlife. There are few data sources that consistently estimate wildlife populations except for TPWD deer population estimates. Source loadings included deer as a source to serve as a surrogate for wildlife. However, this management measure does not make any recommendation for reducing fecal bacteria sources from deer or other native wildlife.

Management Measure 5 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-impaired water bodies in Texas due to their tendency to wallow in mud and spend time in water. The feral hog population (H-GAC, 2022) and estimated daily load for feral hogs is provided in Table 22.

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.

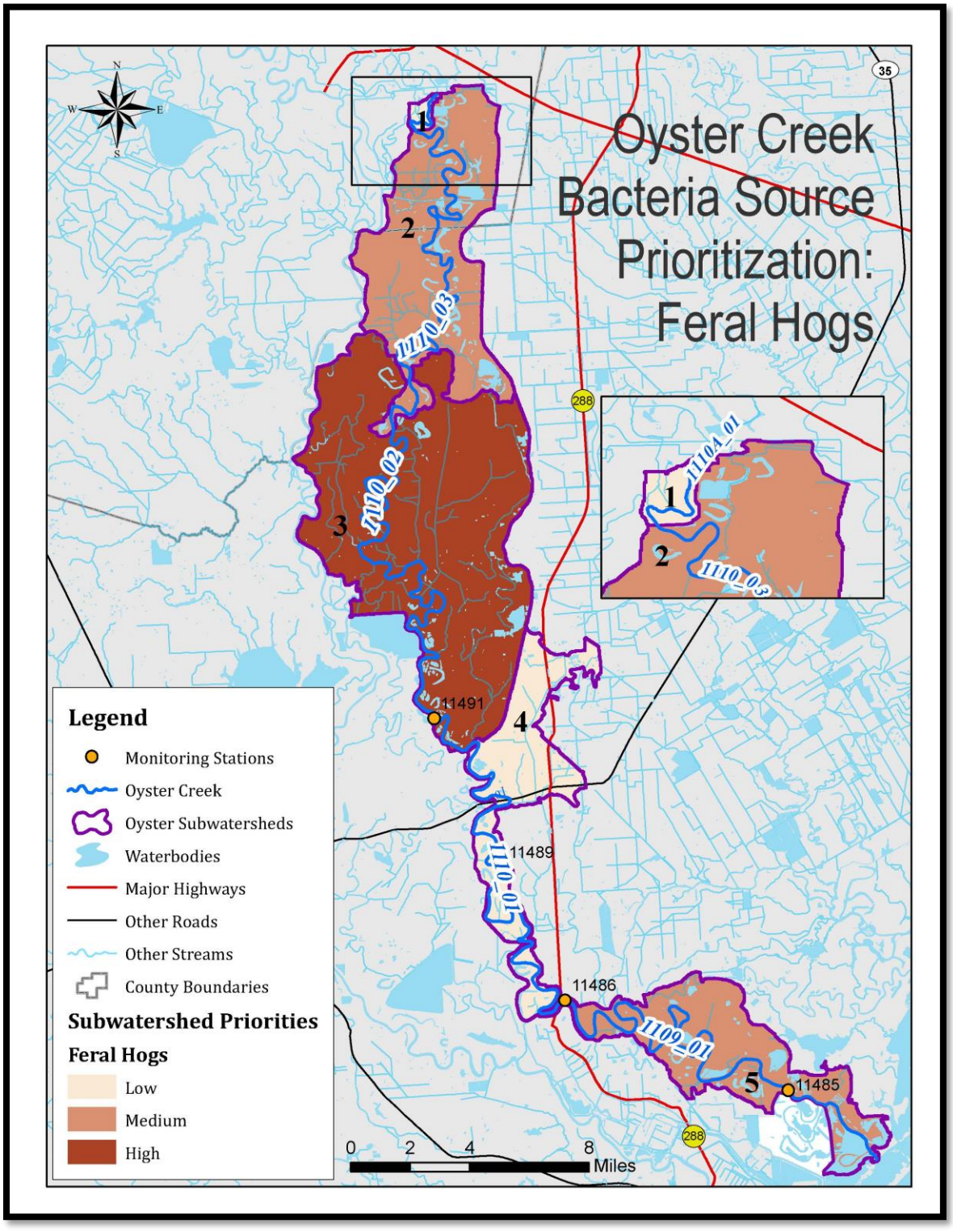

Figure 7. Priority areas to address feral hog populations in the Oyster Creek watershed

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 one feral hog workshop.

Table 22. Feral hog population and estimated daily bacteria load

Watershed	Water Body ID	SWMU	Feral Hog Population	Representative Load	Estimated Daily Bacteria Load (Feral Hogs)
Oyster Creek Above Tidal	1110	1-4	1,698	4.45	7,554.64
Oyster Creek Tidal	1109	5	326	4.45	1,449.05
		Total	**2,024**	**4.45**	**9,003.69**

All loads are expressed in billion cfu/day.

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

Priorities were assigned to subwatersheds based on land use for suitable habitat for feral hogs and allocated loads from the TMDL. The high-priority area for implementing this measure is subwatershed 3. Medium-priority areas are subwatersheds 2, and 5. Subwatersheds 1 and 4 are low priority for implementation (Figure 7).

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 to landowners, city and county governments, and communities, 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.

- **Landowners, Local Governments, and Communities** engage with resource agents to manage feral hogs on private and public lands.
- **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 Oyster Creek watershed. Estimated costs for Management Measure 5 activities are estimated to range from $0 to $15,000/year. Below is one common financial program that might be used to implement Management Measure 5.

- The **Clean Water Act Section 319(h) Nonpoint Source Grant Program** is an EPA grant program, administered by TCEQ and TSSWCB, that 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:

- 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, numbers of outreach material distribution efforts, landowners implementing voluntary control measures, feral hogs removed, and 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 Oyster Creek project page.

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 a 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.

Year 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 3 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 2,076.77 billion cfu/day or 758,039.88 billion cfu/year.

The representative unit approach was applied to the feral hog load reduction by dividing the load reduction, 2,076.77 billion cfu/day, by the representative unit daily load for feral hogs, 4.45 billion cfu/day (Table 23). A total of 467 feral hogs were estimated for removal from the Oyster Creek watershed to accomplish the potential load reduction.

As feral hog reproductive rates are quite high, the population after the removal of 467 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 a level feral hog population (Texas AgriLife

Extension, 2012). Once the 467 feral hogs are removed, an additional number of feral hogs would require removal just to maintain the remaining population size.

Additional indicator bacteria removal capacity could be augmented by increasing the number of feral hogs removed each year, addressing other feral animal populations, and expanding the indicator bacteria reduction from other management measure sources. Table 24 presents a summary of Management Measure 5.

Table 23. Feral hog load reduction and estimated feral hogs to be removed

Watershed	Water Body ID	SWMU	Total Feral Hog Load Reduction	Representative Unit Daily Load	Feral Hogs to be Removed
Oyster Creek Above Tidal	1110	1-4	1,146.94	4.45	258
Oyster Creek Tidal	1109	5	929.83	4.45	209
		Total	**2,076.77**	**4.45**	**467**

All loads are expressed in billion cfu/day.

Table 24. Management Measure 5: Promote feral hog management

Key Element	Summary
Causes and Sources	Direct and indirect deposits of feces form feral hogs
Potential load reduction	758,039.88 billion cfu/year
Technical and 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.
Educational 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 one feral hog workshop each year. • **Year 5**: Provide five-year Management Measure 5 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.
Monitoring component	• **Environmental**: CRP ambient monitoring data • **Programmatic**: Five-year report
Responsible parties	Watershed coordinator, Texas A&M AgriLife Extension

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.
- **Measurable Milestone** – A measure undertaken to cause an improvement in water quality.

Water Quality Indicators

The goal for this I-Plan is attainment of the geometric mean criterion for the contact recreation use in each of the affected water bodies. The measure of success for each water body is a declining trend of the geometric mean concentration of the indicator bacteria.

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

Measurable Milestones

Implementation tracking helps stakeholders to determine if progress is being made toward meeting the goals of the TMDL and I-Plan. Tracking also allows stakeholders to identify whether specific actions are working or not and make any changes that may be necessary to get the I-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.

References

AVMA (American Veterinary Medical Association). 2018. 2017-2018 U.S. Pet Ownership Statistics. https://www.avma.org/resources-tools/reports-statistics/us-pet-ownership-statistics.

EPA. 2001. Protocol for Developing Pathogen TMDLs, EPA 841-R-00-002. Office of Water (4503F), United States Environmental Protection Agency, Washington, DC. 132pp. nepis.epa.gov.

EPA. 2013. Nonpoint Source Program and Grants Guidelines for States and Territories. Issued April 12, 2013. Webpage accessed on 5/21/2019. www.epa.gov/nps/cwa-ss319-grant-current-guidance.

EPA. 2019. Funding Sources for Small and Rural Wastewater Systems. Webpage accessed 5/21/2019. www.epa.gov/small-and-rural-wastewater-systems/funding-sources-small-and-rural-wastewater-systems.

H-GAC. 2018. A Watershed Protection Project for the West Fork San Jacinto River and Lake Creek Watersheds. H-GAC, West Fork Partnership, GBEP, TCEQ and EPA. Plan approved in 2018. gbep.texas.gov/wp-content/uploads/2020/04/17-70286-Final-Report.pdf.

H-GAC. 2022. Technical Support Document for Two Total Maximum Daily Loads for Indicator Bacteria in the Oyster Creek Watershed. Houston-Galveston Area Council. July 2022. www.tceq.texas.gov/downloads/water-quality/tmdl/oyster-creek-recreational-114/tsd_oystercreek_as-478.pdf.

Reed, Stowe and Yanke, LLC. 2001. Study to Determine the Magnitude of, and Reasons for, Chronically Malfunctioning On-site Sewage Facility Systems in Texas. Texas On-site Wastewater Treatment Council. www.tceq.texas.gov/assets/public/compliance/compliance_support/regulatory/ossf/StudyToDetermine.pdf.

Teague. 2009. Spatially Explicit Load Enrichment Calculation Tool to Identify Potential *E. coli* Sources in Watersheds. Soil and Water Division of ASABE. July 2009.

Texas AgriLife Extension. 2012. Feral Hog Population Growth, Density, and Harvest in Texas. Texas A&M University. Webpage accessed on June 18, 2021. nri.tamu.edu/media/3203/sp-472-feral-hog-population-growth-density-and-harvest-in-texas-edited.pdf.

TCEQ. 2019. Water and Wastewater Funding Sources. Webpage accessed 5/21/2019. www.tceq.texas.gov/assistance/water/water-and-wastewater-funding-sources.

TCEQ. 2024. Two Total Maximum Daily Loads for Indicator Bacteria in the Oyster Creek Watershed. www.tceq.texas.gov/downloads/water-quality/tmdl/oyster-creek-recreational-114/114b-as-480-oyster-creek-bacteria-tmdl.pdf.

TGLO. 2022. Coastal Management Program. Webpage accessed on 12/28/2022. www.glo.texas.gov/coast/grant-projects/cmp/index.html

TWDB. 2022. Clean Water State Revolving Fund Loan Program. Webpage accessed on 12/28/2022. www.twdb.texas.gov/financial/programs/CWSRF/

USDA. 2019. Water and Environmental Programs. Webpage accessed on 5/20/2019. www.rd.usda.gov/programs-services/all-programs/water-environmental-programs.

USDA. 2024. National Agricultural Statistics Service 2022 Census of Agriculture. Online at: www.nass.usda.gov/Publications/AgCensus/2022/index.php.