Chapter 5 Watershed Protection Plan Implementation Strategies

Introduction

The watershed approach was used to direct the implementation strategies. The guiding principles of this approach interlace partnership with stakeholders of various backgrounds with science backed management techniques for the specific watershed. An analysis was completed to identify major sources of *E. coli* in the watershed, their potential loading distribution, and actual *E. coli* loads are outlined previously in Chapter 4. Recommended management strategies to achieve needed *E. coli* reductions in Rowlett Creek watershed were developed based on local knowledge, load estimations, and understanding of current water quality problems across the watershed. This information combined was used to make informed decisions regarding management measures to most effectively improve water quality in the watershed.

The WPP implementation strategies receive input from stakeholders to not only address the readily data available sources, but also the unmodeled sources of water quality degradation. This plan implementation focuses on these identified sources: urban stormwater, per waste, feral cats, livestock, agricultural runoff, lawn residue runoff, limited NPS runoff education resources, illegal dumping and litter. These are not representative of all the sources of bacteria in the watershed but are the largest contributors that can be managed to mitigate the pollution.

Management Measures

The management measures detailed are suggestions with identified entities whose voluntary participation would be needed, or recommended, for the measure to be carried out. Because the watershed has multiple sources of *E. coli*, many different management options will be recommended to reduce the most amount of *E. coli* from the highest sources. Because a diverse approach was used, options can be chosen that are the most feasibly managed while also having the highest chance of producing *E. coli* reductions. This is not an exhaustive list of measures but guidance to address the various known sources of pollution learned throughout this analysis to mitigate bacterial pollution. Many of the practices outlined can additionally help reduce the nutrient levels found in the segment to improve the overall stream health. The management measures described are:

1. Mitigate urban stormwater runoff problems
2. Reduce pet waste runoff and promote proper disposal
3. Expand and promote BMPs for feral cat populations
4. Promote the development of WQMPs or conservation plans
5. Conduct Urban NPS Pollution Education programs
6. Reduce illegal dumping and litter
7. Promote BMPs for urban lawn care management
8. Promote adaptive urban flood management

The loading estimates presented with each recommendation are based on the predicted worst-case scenario loadings that were defined in Chapter 4 at mid-range flow rates. Not all sources could be modeled so not all management measures can have a quantifiable *E. coli* load reduction. These measures are still known to have a potential reduction on water quality pollutants that further the objectives of reducing *E. coli* and nutrient concerns. The estimates cannot predict actual loadings or load

reductions that are occurring in the streams of the watershed. Actual reductions depend on several factors that cannot all be accounted for thus adaptive implementation strategies may be needed. Financial and technical resources for these measures are included in Chapter 6.

Management Measure 1: Mitigate urban stormwater runoff problems

A source of *E. coli* and nutrients entering water bodies in the watershed is stormwater generated in urban areas. Due to the high percentage of total land cover being developed in the watershed, the chances of bacteria loading from urban impervious surfaces is relatively high. The main objective of this management measure is to collaborate with local municipalities to identify and install green infrastructure (GI) BMPs to manage stormwater runoff that can serve as demonstrations for stakeholders and residents throughout the watershed. Additionally, expand existing stormwater management education and outreach programs to educate residents and stakeholders on stormwater BMPs. GI BMPs can also be described as nature-based solutions or blue-green infrastructure, these practices are using nature-based or green engineering to mitigate stormwater pollution. Options include rain gardens, rain barrels/cisterns, permeable pavements, bioswales, bioretention, green roofs, and riparian buffers. Projects should include monitoring the effectiveness of the BMPs implemented and apply modifications as necessary to make sure water quality requirements are being met for the watershed.

These BMPs can be designed based on the precipitation amount, amount of pollutant reduction needed, location for implementation. Load reduction will depend on the location, size, and type of design installed. Thus, the most effective BMP can be installed based on each site selected under technical guidance. The entities involved in executing the recommendations include Texas A&M AgriLife, Texas A&M Forest Service, Texas Water Resources Institute, cities, counties, contractors, and property owners. Table 5-1 summarizes management measures for urban stormwater management.

Table 5-1 Management Measure 1: Mitigate urban stormwater runoff problems

Pollutant Source: Urban Stormwater Runoff			
Problem: Fecal bacteria, nutrient loading, and erosion from stormwater runoff in developed areas			
Objectives: 1. Identify and implement green infrastructure (GI) (i.e., LID) BMPs in coordination with cities, counties, and property owners 2. Organize general stormwater management education and outreach programs. 3. Educate residents about stormwater BMPs 4. Monitor the effectiveness of BMPs.			
Location: Entire watershed			
Critical Areas: Urban areas of the watershed that are already developed			
Goal: Reduce E. coli loading associated with urban stormwater runoff through implementation of green stormwater infrastructure BMPs as appropriate and increase awareness of stormwater pollution and management.			
Description: Potential locations and types of GI BMPs for stormwater management demonstration projects will be identified in coordination with the local cities, counties, public works, and property owners. Examples of GI include green roofs, riparian buffers, vegetated bioswales, bioretention, permeable pavement, etc.			
Implementation Strategy			
Participants	**Recommendations**	**Period**	**Costs**

Cities, counties, property owners, contractors	Identify and install GI BMPs as funding becomes available	2025-2034	~$6-$45/sqft
Texas A&M Forest Service, cities, counties, TWRI	Conduct riparian, wetland, and/or stream restoration projects and monitoring	2025-2034	~$500,000/project
TWRI, AgriLife Extension, property owners, cities, counties, regional entities	Deliver education and outreach to property owners on stormwater BMPs, in multiple languages where applicable	2025-2034	N/A
Estimated Load Reduction			
Installation of stormwater GI BMPs that reduce runoff or treat bacteria will result in direct reductions in bacteria loading. Potential load reductions were not calculated because the size, type, and location of projects installed will determine the potential load reductions and these have not yet been identified.			
Effectiveness	Moderate to High: The effectiveness of GI BMPs at reducing bacteria and nutrient loadings is dependent on the design, site, and maintenance of the BMP		
Certainty	Moderate: Installation of GI BMPs requires sustained commitment from city officials or property owners.		
Commitment	Moderate to High: Urban stormwater management is a priority for cities.		
Needs	High: Support in the form of financial, technical, and educational resources is needed to identify the best application of and adoption of GI solutions.		

Management Measure 2: Reduce pet waste runoff and promote proper disposal

Due to the amount of urban area within the watershed, dog waste is a large potential contributor to *E. coli* loads in the watershed, and through analysis was identified as the greatest source. There are an estimated 134,975 dogs within the watershed. Most dogs live either in or near a human dwelling, or in an animal shelter, making managing their waste much simpler than other potential sources in the watershed. If not properly managed, dog waste is transported downstream during storm events, mostly via overland flow. Picking up and properly disposing of pet waste is a simple and effective way to reduce *E. coli* and excess nutrients in the watershed. Recommendations for management include installing and maintaining pet waste collection stations in public areas like parks and trails and expanding education campaigns showing the environmental benefits of properly disposing of pet waste. Education and outreach should target residents that are renters living in multi-family housing complexes and the property managers since they have the densest pet populations and concentration of pet waste per land area. Also, develop and implement K-12 student education through educator programs to teach students who are pet caretakers, additionally children usually share what they learned with family members that can access some hard-to-reach audiences. Pet waste stations for multi-family properties and HOA managed dog parks should be supported with resources. Installing GI BMPs near dog parks, trails, multi-family complexes close to the waterways can help further reduce bacterial and nutrient loading from pet waste. Table 5-2 summarizes management measures for reducing pet waste runoff.

Due to the large portion of contributions linked to dogs in the watershed, making up an estimated 57% of *E. coli* loading, measures to reduce pet waste will provide the greatest reductions. Assuming 12% of pet owners reached change their behavior with a 75% effectiveness at removing bacteria, disposing of dog waste could result in an annual *E. coli* reduction of 1.40E+16 cfu. The complete explanation of the calculations and assumptions used for this estimate are in Appendix C.

Table 5-2 Management Measure 2: Reduce pet waste runoff and promote proper disposal

<table>
<tr><th colspan="4">Pollutant Source: Pet Waste (Dog)</th></tr>
<tr><td colspan="4">Problem: Improperly disposed dog waste is left on land surfaces and runoff leads to bacteria and nutrient loading into streams</td></tr>
<tr><td colspan="4">Objectives: 1. Expand education and outreach to residents on impacts of pet waste and need for proper disposal. 2. Properly stock, maintain, and install pet waste stations</td></tr>
<tr><td colspan="4">Location: Enite watershed</td></tr>
<tr><td colspan="4">Critical Areas: Multi-family residences and other high pet concentration areas in close proximity to waterways</td></tr>
<tr><td colspan="4">Goal: Reduce the amount of dog waste in the watershed that may wash into water bodies during runoff events by providing educational and physical resources to increase stakeholder awareness of the water quality and potential health issues caused by excessive dog waste.</td></tr>
<tr><td colspan="4">Description: Expand distribution of educational messaging regarding the need to properly dispose of pet waste in the watershed. Specifically target renters, multi-family property management, K-12 educators, and general public. Stock, maintain, or replace existing dog waste stations in parks and other public areas to facilitate increased proper disposal of dog waste.</td></tr>
<tr><th colspan="4">Implementation Strategy</th></tr>
<tr><th>Participants</th><th>Recommendations</th><th>Period</th><th>Costs</th></tr>
<tr><td>Cities, counties, property owners, HOAs, ISDs</td><td>Develop and provide educational resources and outreach, in multiple languages where applicable</td><td>2025-2034</td><td>$50,000</td></tr>
<tr><td>Cities, counties, property owners, HOAs</td><td>Provide needed maintenance supplies for at least 50 pet waste disposal stations @ $85/station</td><td>2025-2034</td><td>$4,250</td></tr>
<tr><td>Cities, counties, property owners, HOAs</td><td>Install/replace 25 pet waste disposal stations @ $500/station</td><td>2025-2034</td><td>$12,500</td></tr>
<tr><td>Cities, counties, HOAs</td><td>Identify and install GI BMPs as funding becomes available for onsite treatment of runoff</td><td>2025-2034</td><td>~$6-$45/sqft</td></tr>
<tr><td>Cities, counties, HOAs</td><td>Development/adoption and enforcement of proper pet waste disposal ordinances and by-laws</td><td>2025-2034</td><td>N/A</td></tr>
<tr><th colspan="4">Estimated Load Reduction</th></tr>
<tr><td colspan="4">Load reductions resulting from this management measure are reliant on changes in people's behavior. Assuming 12% of targeted individuals respond by properly disposing of pet waste, the annual load reduction would be approximately 1.40E+16 cfu of E. coli per year (Appendix C).</td></tr>
<tr><td>Effectiveness</td><td colspan="3">High: Collecting and properly disposing of dog waste is known to prevent E. coli and nutrients from entering local waterways and will directly reduce the quantity of E. coli in the watershed.</td></tr>
</table>

Certainty	Low: Many dog owners already collect and properly dispose of dog waste. Those who do not may be a difficult audience to reach or convince that dog waste should be collected and discarded properly despite their respective reasons for not doing so.
Commitment	Moderate: Most parks, trails, and residential complexes currently have pet waste stations. However, maintenance is less frequently conducted than needed. Meanwhile, little to no enforcement occurs to fine owners that do not pick up after their pets.
Needs	Moderate to High: Pet waste stations are relatively inexpensive, and the additional work required to maintain stations should be minimal. Installation of GI BMPs need financial, technical, and educational resources support.

Management Measure 3: Expand and Promote BMPs for feral cat populations

Due to the amount of urban area within the watershed, feral cat waste is another large potential contributor to *E. coli* loads in the watershed, and through analysis was identified as the second greatest source. There are an estimated 98,800 feral cats within the watershed, though this number can only be assumed based on some national estimates. Most feral cats live outdoors near a human dwelling and stay in what are referred to as colonies with populations of 10-200, making managing their waste more complicated than household pets. Implementing trap-neuter-release (TNR) style programs can reduce feral cat colony populations, though this requires intensive long-term (e.g., 10+ years) management to produce these results. Successful programs incorporate strong adoption/fostering efforts, coordinate with cat colony caregivers, make constant trapping efforts, and implement strategies to reduce pet abandonment. Providing financial resources for current TNR programs that are locally active, education and outreach on the BMPs for feral cat colonies and TNR programs can reduce the *E. coli* and nutrient loading in the watershed. Table 5-3 summarizes management measures for feral cat populations.

Recommendations include providing low-cost pet and feral cat sterilizations, providing cat traps for current or new programs, and educating pet owners and colony caregivers on BMPs. Some BMPs for managing feral cat colonies include increasing the number of trapped feral cats introduced into adoption programs if cat disposition is suitable for a household, rather than returning them outdoors. Several local operations support and provide these BMPs, these include the Humane Society of North Texas, Feral Friends, City of Garland TNR Program, and Texas Coalition for Animal Protection. Additional resources can be found at North Texas — TNR Texas. It's important to educate residents and other stakeholders about the impacts feral cats have on water quality and educational materials on BMPs should be developed in collaboration with local animal rescues and clinics, and TNR programs. Education and outreach should target residents who are renters living in multi-family housing complexes and property managers since they have dense populations and higher pet abandonment. Installing GI BMPs for waste runoff management near colonies, such as rain gardens or small sand pits where cats can eliminate waste without it running directly into stormwater systems. Some plants and substrates can be considered for these BMPs that can either act as a deterrent (e.g., lavender, Texas verbena/*Verbena halei*, horsemint/*Monarda citriodora*, pebbles, etc.) or attractant (e.g., sand, wood chips, catmint/Nepeta x faassenii, etc.).

It must be stated that the efficacy of TNR programs has been highly debated, though several studies have shown they can be effective at reducing populations. Assuming 57% of annual feral cat population are

sterilized from 4 14-day long capture events with a 3% success rate over 10 years brings a 25% successful population reduction, the estimated annual load reduction would be approximately 1.62E+15 cfu of *E. coli* per year. A more detailed explanation of the calculations and assumptions used for this estimate are in Appendix C.

Table 5-3 Management Measure 3: Expand and promote BMPs for feral cat populations

<table>
<tr><th colspan="4">Pollutant Source: Feral Cat Waste</th></tr>
<tr><td colspan="4">Problem: Fecal bacteria loading into streams through runoff in developed urban areas from feral cats</td></tr>
<tr><td colspan="4">Objectives: 1. Reduce fecal bacteria loading from feral cats through implementation of management programs. 2. Expand education and outreach to residents and stakeholders on BMPs. 3. Monitor the effectiveness of BMPs.</td></tr>
<tr><td colspan="4">Location: Enite watershed</td></tr>
<tr><td colspan="4">Critical Areas: Urban areas in close proximity to waterways</td></tr>
<tr><td colspan="4">Goal: Reduce the amount of feral cat waste in the watershed that may wash into water bodies during runoff events by providing educational and physical resources to manage feral cat population increase stakeholder awareness of the water quality and potential health issues.</td></tr>
<tr><td colspan="4">Description: Expand and implement Trap-Neuter-Return (TNR) type programs across the watershed to reduce feral cat colony populations over the course of 10 years of implementation. Educate residents and stakeholders on water quality impacts and the BMPs for managing cat colonies. Voluntarily implement efforts to reduce feral cat populations throughout the watershed by reducing food supplies, bait trapping feral cats, reducing pet abandonment, and increasing adoption.</td></tr>
<tr><th colspan="4">Implementation Strategy</th></tr>
<tr><th>Participants</th><th>Recommendations</th><th>Period</th><th>Costs</th></tr>
<tr><td>Cities, property owners, HOAs, local rescues</td><td>Provide educational resources and outreach on BMPs to residents, in multiple languages where applicable</td><td>2025-2034</td><td>$50,000</td></tr>
<tr><td>Local vet clinics, local rescues, cities, counties, residents</td><td>Provide low-cost pet and feral cat sterilization for at least 400 cats @ $50/cat</td><td>2025-2034</td><td>$20,000</td></tr>
<tr><td>Local vet clinics, local rescues, cities, counties</td><td>Provide cat trapping supplies for 40 traps @ $120/trap</td><td>2025-2034</td><td>$4,800</td></tr>
<tr><td>Cities, counties, HOAs</td><td>Identify and install GI BMPs as funding becomes available for onsite treatment of runoff</td><td>2025-2034</td><td>~$6-$45/sqft</td></tr>
<tr><th colspan="4">Estimated Load Reduction</th></tr>
<tr><td colspan="4">Load reductions resulting from this management measure are reliant on assumed high trapping rates and changes in people’s behavior. Assuming 57% of annual feral cat population are sterilized for 10-year program, the annual load reduction would be approximately 1.62E+15 cfu of E. coli per year (Appendix C).</td></tr>
<tr><td>Effectiveness</td><td colspan="3">Moderate: Reduction in feral cat population will result in a direct decrease in bacterial loading to the streams. However, sterilizing enough cats to decrease their overall population will be difficult.</td></tr>
</table>

Certainty	Low: Increasing resident participation, even after receiving education and related resources, in TNR programs is difficult and thus limits the program capacity. Feral cats can often be difficult to track and then successfully capture.
Commitment	Moderate to High: TNR programs already exist throughout the watershed and reducing feral cat populations is important to conservation groups, animal rescues/activists, and the public. Meanwhile, not all Department of Animal Services in this watershed have TNR programs or partnerships with NGOs that do.
Needs	Moderate to High: Low-cost clinic programs are relatively inexpensive for providing services to cats as well as the educational resources and outreach needed. Significant funding is needed to expand shelter availability to increase adoptions.

Management Measure 4: Promote the development of WQMPs or conservation plans

E. coli from livestock is a small contributor of *E. coli*, and a potential source of nutrients, in the watershed. Livestock waste is mostly transported during runoff events, from upland areas to downstream waters. With livestock, fecal deposition is dependent on the location of food, water, and shelter, and is therefore easier to control than other types of wildlife that aren't contained. Moving feeding locations and adjusting fencing to control their location can reduce *E. coli* runoff. Due to the potential *E. coli* load from livestock, these adjustments have the potential to reduce the amount of *E. coli* that ends up in runoff and into waterbodies within the watershed.

A water quality management plan (WQMP) or conservation plan (CP) is a site-specific plan developed through and approved by soil and water conservation districts or NRCS for agricultural or silvicultural lands. The plan includes appropriate land treatment practices, production practices, management measures, technologies or a combination of two or more practices. The purpose of WQMPs is to achieve a level of pollution prevention within state water quality standards. The NRCS, TSSWCB, and local SWCDs provide technical assistance for developing plans, some CPs offer financial assistance for landowners. There is a goal of developing and implementing up to 10 plans in the watershed. Agriculture lands are sparse in the watershed and are mainly found in subwatersheds 1, 2, and 5. The implementation of these plans estimate an annual *E. coli* reduction of 1.40E+16 cfu. The complete explanation of the calculations and assumptions used for this estimate are in Appendix C.

Several equestrian stables are found along Rowlett and Cottonwood Creeks, depending on operation practices these may not qualify as agriculture use under some local government land appraisal districts. This also may apply to some small-scale or hobby farms that exist around the area. Thus, these operations may need different access to resources for implementing BMPs based on their uses. Some BMPs identified for stables include on-site composting of manure, vegetated filtering strips, and bioswales to reduce bacteria and sediment loading into the waterways. Table 5-4 summarizes management measures for livestock.

Table 5-4 Management Measure 4: Promote the development of WQMPs or conservation plans

Pollutant Source: Livestock

Problem: Direct and indirect fecal bacteria and nutrient loading due to livestock in streams, riparian degradation and overgrazing

Objectives: 1. Work with landowners to develop property-specific CPs and WQMPs to protect water quality and provide technical and financial assistance. 2. Reduce fecal loading from livestock in riparian areas. 3. Educate producers, hobby farm owners, and equestrian stable managers on BMPs

Location: Subwatershed 1, 2 and 5, and properties near waterways

Critical Areas: Properties with creek and riparian zone access

Goal: Reduce E. coli loading from livestock through education and developing WQMPs/CPs focused on minimizing the time spent by livestock in the riparian zones and better use of grazing resources across the property.

Description: CPs and WQMPs will be developed with operators to implement BMPs that reduce water quality impacts from overgrazing, time spent in and near streams or riparian areas, and runoff from grazed lands. Practices will be identified and developed in consultation with NRCS, TSSWCB and local SWCDs as appropriate. Education program delivery to support and promote implementation adoption from livestock producers, hobby farm operations (i.e., small-scale farms), and equestrian stables.

Implementation Strategy

Participants	Recommendations	Period	Costs
Producers, NRCS, TSSWCB, SWCDs	Develop, implement, and provide financial assistance for up to 5 livestock WQMPs/CPs @ $15,000/plan	2025-2034	$75,000
AgriLife Extension, SWCDs, cities, hobby farmers, stable managers	Deliver education and outreach programs and workshops to landowners, in multiple languages where applicable	2025-2034	N/A

Estimated Load Reduction

Prescribed management will reduce loadings associated with livestock by reducing runoff from pastures and rangeland as well as reducing direct deposition by livestock. Implementation of 10 WQMPs and CPs is estimated to reduce annual loads from livestock by 6.14E+13 cfu of E. coli per year in the watershed (Appendix C). Reductions related to education and outreach for hobby farms and non-grazing equestrian stables are not quantified but will result in load reductions that vary by operation size and applicable practices.

Effectiveness	High: Decreasing the time that livestock spend in riparian areas and reducing runoff through effectively managing vegetative cover will directly reduce nonpoint source contributions of bacteria and other pollutants to creeks.
Certainty	Moderate: Landowners acknowledge the importance of good land stewardship practices and management plan objectives. However, financial incentives are often needed to promote WQMP and CP implementation.
Commitment	Moderate: Landowners are willing to implement stewardship BMPs shown to improve productivity. Costs are often prohibitive, so financial incentives are needed to increase implementation rates.
Needs	High: Financial costs are a major barrier to promote implementation. Education and outreach are needed to demonstrate benefits of plan development and implementation to producers and BMPs to small-scale farms and equestrian stable owners.

Table 5-5 Management Measure 5: Conduct Urban NPS pollution education workshops.

Pollutant Source: Landowners and Residents Without Education Resources			
Problem: Due to lack of knowledge about stormwater, pet waste, lawn, grazing lands, and water resource management, landowners and residents might not adopt BMPs for them			
Objectives: 1. Promote and expand education and outreach efforts in the watershed. 2. Develop and expand education and outreach efforts for K-12 students in the area. 3. Provide technical assistance and training on watershed education.			
Location: Entire watershed			
Critical Areas: K-12 schools and colleges			
Goal: Educate landowners, residents, and students about sources of E. coli and other pollutants in the watershed and various ways to manage them.			
Description: Education delivery will mainly focus on BMPs for urban stormwater pollution using GI, pet waste, and landscape and water resource management. Work with local ISD educators to determine existing needs in their schools and what would be helpful. Develop or integrate existing educational materials for schools and provide training opportunities for teachers to learn the materials and how to administer them effectively.			
Implementation Strategy			
Participants	**Recommendations**	**Period**	**Costs**
AgriLife Extension, TWRI, Counties, Watershed Coordinators	Develop and deliver educational and outreach materials to residents, landowners, and colleges	2025-2034	N/A
AgriLife Extension, TWRI, ISDs, Watershed Coordinators	Develop and deliver education and outreach materials to teachers and students. Train teachers on watershed protection planning.	2025-2034	~$25,000
Estimated Load Reduction			
Load Reductions from this management measure were not quantified, though if behaviors change they will reduce loads.			
Effectiveness	Low to Moderate: While there may not be a direct correlation to water quality improvement, education and outreach is an effective tool to create awareness and behavior change.		
Certainty	Moderate: Predicting behavior change is difficult but can be tracked through surveys, tests, and other evaluation methods.		
Commitment	Moderate to High: There is a lot of interest in the watershed in GI and working with youth and general public to develop environmental conservation programming.		
Needs	Moderate: Some financial and technical resources will be required to develop educational materials and coordinate training.		

Management Measure 5: Conduct Urban NPS Pollution Education workshops

The main objective is to continue and expand the existing NPS Pollution Education workshops educating landowners and residents on identifying sources of *E. coli*, nutrients and other pollutants in the watershed that originate from urban sources. Often, new and/or small acreage landowners and multi-

family property managers may be unaware of BMPs and the resources available for implementation. Educating property managers, landowners, and residents to manage stormwater, pet waste, lawn, grazing lands, and water resource management is very important to prevent *E. coli* and nutrients from getting into nearby water bodies. A key aspect of conducting educational workshops is to expand these opportunities for K-12 schools to teach educators about urban NPS pollution and its BMPs, so these can be integrated into lessons delivered to students. These education workshops will further protect and improve local water resources by ensuring that appropriate persons are informed about new techniques, requirements, and resources. Table 5-5 summarizes management measures for urban NPS pollution education.

Table 5-6 Management Measure 6: Reduce illegal dumping and litter

Pollutant Source: Illegal Dumping and Litter			
Problem: Illegal dumping of waste and littler accumulation in and along waterways			
Objectives: 1. Promote and expand education and outreach efforts in the watershed. 2. Install and maintain trash receptacles in public areas and along water bodies 3. Support cleanups and other efforts to reduce illegal dumping with various stakeholders.			
Location: Entire watershed			
Critical Areas: Focus on urban areas, trails, and bridges near waterways or riparian zones			
Goal: Reduce litter and illegal dumped waste that reaches the waterways throughout the watershed.			
Description: Education and outreach materials will be developed and delivered to residents throughout the watershed on the proper disposal of waste materials (both nonhazardous and hazardous). Working with various volunteer organizations and related stakeholders to support cleanup efforts and outreach to reduce illegal dumping and littering.			
Implementation Strategy			
Participants	**Recommendations**	**Period**	**Costs**
AgriLife Extension, cities, counties, nonprofits	Develop and deliver educational and outreach materials to residents, in multiple languages where applicable	2025-2034	~$5,000
Cities, counties, municipalities, HOAs	Expand enforcement of illegal dumping ordinances in common dumping areas, and install and maintain at least 15 trash receptacles on trails and walkways, or other identified problem areas @ $500-$1,000/receptacle	2025-2034	$7,500-$15,000
Cities, counties, nonprofits, HOAs, residents, regional entities	Coordinate multiple cleanup events and similar reducing illegal dumping program events	2025-2034	N/A
Estimated Load Reduction			
E. coli load reductions are likely minimal from this management measure and were not quantified. Though, preventing illegal dumping, especially animal carcasses or food products, near waterways can reduce bacteria loads as these attract wildlife that can directly deposit into streams.			
Effectiveness	Low: Preventing illegal dumping near waterways is likely to reduce bacteria loads by a small amount because, no noted instances were from animal carcasses.		

Certainty	Moderate: Anticipating changes in resident behavior due to education and outreach is difficult at best. Reaching residents that illegally dump is more difficult.
Commitment	Moderate: Stakeholders indicate illegal dumping and littering occurs. However, enforcement can be difficult, and commitment of limited resources will likely remain low in some areas.
Needs	Moderate: Some financial resources will be required to install and maintain trash receptacles and develop educational materials. Though, information could be incorporated into ongoing watershed/stormwater-related educational and outreach efforts.

Management Measure 6: Reduce illegal dumping and litter

Based on stakeholder input, illegal dumping occurs in creeks within the watershed. The waste mostly consists of trash and debris that washes into and accumulates in the creeks. Figure ## shows pictures of trash accumulated along parts of Rowlett Creek in the Rowlett Creek Preserve. Due to the nature of the materials being dumped, it is unlikely that it is a major contributor to bacteria loads in the watershed. Despite that, reducing all types of pollution in the watershed increases the overall health and water quality of the watershed, and should be addressed. The development and delivery of educational and community outreach materials on proper trash disposal could be constructive. Installing and maintaining trash receptacles in and around the local public trails, walkways, and parks will reduce the amount of trash accumulating into waterways. It is also recommended that coordinating multiple cleanup events along and in streams within the watershed will reduce pollutants entering the waterways. Table 5-6 summarizes management measures to reduce illegal dumping and litter.

Management Measure 7: Promote BMPs for urban lawn care management

Nitrogen levels in the form of TKN, or organic forms, were found to be above screening levels, though these are not required to be met doing so can improve watershed health. Urban lawn residue and waste runoff carries grass clippings, leaf litter, fertilizers, and pesticides. Making it a common contributor to excess nutrients, bacteria, and other pollutants in urban watersheds if not properly managed. Educating homeowners and property managers on the BMPs for lawn care management can reduce the pollutants impacting the Rowlett Creek watershed. BMPs include properly disposing of grass clippings and fallen leaves, soil testing before applying fertilizers, and installing GI BMPs in areas near creeks. Household lawns are a likely greater contributor for this source however, there are several golf courses found on or next to the creeks of this watershed and are contributing sources. Conducting soil tests in both agricultural and urban areas can determine soil composition and nutrient levels existing. Therefore, soil testing is included to prevent nutrient runoff into nearby waterways by ensuring the proper rates and timing of fertilizer applications. This practice can also be applied to water resource management to create adaptive watering regimes so there is no excess used which increases the runoff. Installing and/or maintaining GI within golf courses can help reduce the loadings, as most properties in this watershed already implement the other practices. Similarly, the manicured or landscaped public parks can be high in fertilizer as well. Table 5-7 summarizes management measures for urban lawn care BMPs.

Table 5-7 Management Measure 7: Promote BMPs for urban lawn care management

Pollutant Source: Lawn Residue and Waste

Problem: Improper lawn care management in the form of excessive lawn residue waste, fertilizer, and pesticide runoff into streams leads to bacteria and nutrient loading			
Objectives: 1. Promote and expand education and outreach to landowners on lawn care BMPs.			
Location: Enite watershed			
Critical Areas: Urban areas and golf course properties near waterways			
Goal: Reduce bacteria, nutrient, and chemical runoff from lawns in the watershed that may wash into waterways during precipitation events**.**			
Description: Expand distribution of educational messaging on proper lawn care management to reduce excess runoff of bacteria and nutrients. Educate landowners on water resource management BMPs for lawn care and landscaping, proper disposal of lawn clippings, and proper application of fertilizers, pesticide, and other chemicals.			
Implementation Strategy			
Participants	**Recommendations**	**Period**	**Costs**
AgriLife Extension, TWRI, Regional Entities, HOAs	Develop and deliver lawn care education and outreach resources	2025-2034	N/A
AgriLife Extension, TWRI, Regional Entities, HOAs, golf courses, Cities, Counties,	Conduct workshops on soil testing, ways to determine nutrients application amounts, and water resource management	2025-2034	~$20,000
Landowners, Golf Courses, Cities	Conduct soil tests before applying fertilizer and watering regimes	2025-2034	~$12/test
Cities, counties, property owners, contractors	Identify and install GI BMPs as funding becomes available	2025-2034	~$6-$45/sqft
Estimated Load Reduction			
Load reductions from this management measure were not quantified though, if behaviors change, they will reduce loads. No load reductions for nutrients currently exist, though a reduction will be beneficial to water quality and stream health as TKN and nitrate are above screening levels and a concern.			
Effectiveness	Moderate: Installation of GI BMPs can reduce bacteria and nutrient loadings but is dependent on the design, site, and maintenance of the BMP. Additionally, extra time and effort involved may hinder implementation.		
Certainty	Low: Anticipating changes in landowner behavior due to education and outreach is difficult.		
Commitment	Moderate: Many stakeholders indicate that soil testing is necessary however, administration may be difficult in all the areas. The issue is not a high priority and commitment of limited resources will likely remain low.		
Needs	Moderate: Some financial resources will be required to develop educational materials in languages other than English. Information could be incorporated into ongoing watershed related educational and outreach efforts.		

Management Measure 8: Promote adaptive urban flood management

Urban flooding occurs when a greater portion of the land is made up of impervious surfaces such as concrete and buildings, causing rainwater to travel across the ground faster and quickly accumulate. This can also be exacerbated by erosion which accumulates sediment and debris creating blockages in stormwater infrastructure. Increasing the surface area of green spaces can offset impervious surface areas and reduce stormwater runoff. Though no direct measures were calculated for the bacteria, these impacts do contribute to bacteria and nutrient loading in the watershed and BMPs can reduce loadings. Promoting the development of local city Adaptive Flood Management Plans that incorporate aspects of water quality management can improve long-term management of water resources. By developing long-term adaptive management plans city municipalities and utility districts can identify and outline measures to best manage urban stormwater infrastructure to reduce flooding and its water quality impacts triggered by increasing precipitation intensity and drought events over the coming decades. This should include guidance and implementation strategy on the number, location, and type of stormwater BMPs that not only mitigate flooding but also treat stormwater runoff pollution. Examples would include vegetated bioswales, stormwater tree trenches, and other blue and green infrastructure. Other recommendations include converting existing developed land to green spaces and implementing erosion control measures throughout the watershed. Table 5-8 summarizes management measures for urban adaptive flood management.

Table 5-8 Management Measure 8: Promote adaptive urban flood management.

Pollutant Source: Urban Flooding and Sediment			
Problem: Intense precipitation events in urban areas lead to flooding intensified by erosion sediment buildup increase bacteria and nutrient loading			
Objectives: 1. Develop collaborative flood resiliency/adaptation plans that incorporate water quality concerns. 2. Identify and install GI BMPs in coordination with cities, counties, and municipalities. 3. Promote and expand education of flooding impacts on water quality and BMPs**,** 4. Monitor the effectiveness of BMPs.			
Location: Entire watershed			
Critical Areas: Urban areas with minimal green space and construction areas			
Goal: Reduce urban flooding throughout the watershed			
Description: Developing and implementing collaborative adaptive flood management plans that incorporate water quality concerns with holistic resource management strategies. Install and promote GI BMPs to mitigate flooding and erosion issues in identified concern areas**.** Promote and expand education of urban flooding impacts on water quality to residents and stakeholders. These practices can also be used to mitigate the occurrence of illicit discharge of wastewater.			
Implementation Strategy			
Participants	**Recommendations**	**Period**	**Costs**
AgriLife Extension, TWRI, City Planners, Regional Entities, Watershed Coordinators	Coordinate with stakeholders to develop local adaptive flood management plans that incorporate water quality concerns	2025-2034	N/A

Cities, counties, Regional Entities, contractors	Identify and install GI BMPs as funding becomes available	2025-2034	~$6-$45/sqft
Cities, Counties, Regional Entities	Perform routine stormwater infrastructure assessments for identification of illicit discharges, proper storm drain management, and identify erosion and prevent erosion	2025-2034	$16,000
Estimated Load Reduction			
Installation of stormwater GI BMPs that reduce runoff or treat bacteria will result in direct reductions in bacteria loading. Potential load reductions were not calculated because the size, type, and location of projects installed will determine the potential load reductions and these have not yet been identified.			
Effectiveness	Moderate to High: The effectiveness of GI BMPs at reducing bacteria and nutrient loadings is dependent on the design, site, and maintenance of the BMP. Developing long term planning strategies can reduce loading but it depends on adoption.		
Certainty	Moderate: Adoption of adaptive flood plans and installation of GI BMPs requires sustained commitment from city officials or property owners.		
Commitment	Moderate to High: Urban stormwater management is a priority for cities and regional entities.		
Needs	High: Support in the form of financial, technical, and educational resources is needed to identify the best application of and adoption/implementation of adaptive flood management planning and related GI solutions.		

Table 5-9 Summary of expected load reductions.

Management Measure	Summarized E. coli Load Reduction
Pet waste management	1.39668E+16
Feral cat population management	1.62008E+15
Agricultural management	3.06993E+13
Total reduction	1.56176E+16
Total reduction needed*	8.1753E+15

*Defined in CH 4

Expected Loading Reductions

Reducing *E. coli* loads across the watershed and the amount of *E. coli* in the river is the goal of these management measures. The total estimated reduction from the management measures with calculated load reductions (2, 3, and 4) would reduce the annual load by 1.56E+16 cfu. Based on the LDC analyses, a combination of the management measures would more than reduce yearly *E. coli* loads by the necessary 8.18E+15 cfu. The greatest expected load reductions will result from the measures recommended for pet waste, feral cats, and livestock, respectively (Table 5-9). The stormwater management measures recommended will result in load reductions, depending on the number, size and type of GI BMPs designed and installed the load reductions could be significant while addressing the high flow events that occur which can be challenging for many of the other suggested management measures. The other recommendations, such as education and outreach, will result in load reductions from changes in people's behavior but are not easily quantified. Applying all these management

measures can help meet the *E. coli* water quality standards and reduce nitrogen levels in the Rowlett Creek watershed.

Table 5-10 Management measures summary.

Management Measure	Participants	Estimated Unit Cost	Implementation goals (years after implementation begins)						Total Cost
			0-1	2-3	4-5	6-7	8-9	10	
Urban Stormwater Runoff									
Identify and install green infrastructure BMPs	Cities, counties, property owners, contractors	~$6-$45/sqft	As many as possible						Varies
Riparian, wetland, and stream restoration	Texas A&M Forest Service, cities, counties, TWRI	~$500,000/project	As needed						Varies
Deliver education and outreach on stormwater BMPs	TWRI, AgriLife Extension, property owners, cities, counties, regional entities	N/A	As many as possible						N/A
Proper Pet Waste Disposal									
Develop and deliver education and outreach resources and materials	Cities, counties, property owners, HOAs, ISDs	$5,000/year	1	2	2	2	2	1	$50,000
Maintenance supplies for at least 50 pet waste stations	Cities, counties, property owners, HOAs	$85/station	5	10	10	10	10	5	$4,250
Install 25 pet waste stations	Cities, counties, property owners, HOAs	$500/station	5	5	5	5	5		$12,500
Identify and install GI BMPs	Cities, counties, HOAs	~$6-$45/sqft	As many as possible						varies
Pet waste disposal ordinances and by-laws	Cities, counties, HOAs	N/A	As needed						N/A
Feral Cat Management									
Develop and deliver educational resources and outreach	Cities, property owners, HOAs, local rescues	$5,000/year	1	2	2	2	2	1	$50,000
Feral cat and pet sterilization for at least 400 cats	Local vet clinics, local rescues, cities, counties, residents	$50/cat	40	80	80	80	80	40	$20,000
Provide cat trapping supplies for 40 traps	Local vet clinics, local rescues, cities, counties	$120/trap	10	20	10				$4,800
Identify and install GI BMPs	Cities, counties, HOAs	~$6-$45/sqft	As many as possible						varies

WQMPs and Conservation Plans									
Provide financial assistance for 5 WQMPs/CPs	Producers, NRCS, TSSWCB, SWCDs	$15,000/plan	1	2	2				$75,000
Deliver education and outreach workshops	AgriLife Extension, SWCDs, cities, hobby farmers, stable managers	N/A	As needed						N/A
Urban NPS Pollution Education									
Develop and deliver educational and outreach materials	AgriLife Extension, TWRI, Counties, Watershed Coordinators	N/A	As needed						N/A
Deliver K-12 educator workshops	AgriLife Extension, TWRI, ISDs, Watershed Coordinators	$5,000/event		2	2				~$25,000
Reduce Illegal Dumping and Litter									
Develop and deliver educational and outreach materials	AgriLife Extension, cities, counties, nonprofits	$500/year	1	2	2	2	2	1	~$5,000
Install and maintain at least 15 trash receptacles and enforce ordinances	Cities, counties, municipalities, HOAs	$500-$1,000/receptacle			5	5	5		$7,500-$15,000
Coordinate cleanup events	Cities, counties, nonprofits, HOAs, residents, regional entities	N/A	1	2	2	2	2	1	N/A
Urban Lawn Care Management									
Develop and deliver education and outreach resources	AgriLife Extension, TWRI, Regional Entities, HOAs	N/A	As needed						N/A
Soil testing workshops	AgriLife Extension, TWRI, Regional Entities, HOAs, golf courses, Cities, Counties,	~$5,000/event		1	1	1	1		~$20,000
Conduct soil testing	Landowners, Golf Courses, Cities	~$12/test	As needed						Varies

Identify and install GI BMPs	Cities, counties, property owners, contractors	~$6-$45/sqft	As needed						varies
Adaptive Urban Flood Management									
Develop local adaptive flood management plans that incorporate water quality	AgriLife Extension, TWRI, City Planners, Regional Entities, Watershed Coordinators	N/A	1						N/A
Identify and install GI BMPs	Cities, counties, Regional Entities, contractors	~$6-$45/sqft	As many as possible						varies
Stormwater infrastructure assessments	Cities, Counties, Regional Entities	$800	2	4	4	4	4	2	$16,000