

## Element C: Management Measures

### Selecting Management Measures: 38 Action Areas

The project team worked with over 40 stakeholders through a series of workshops, mapping exercises, and one on one interviews to understand what projects have been done in the past, what projects are underway, and what could be done in the future. Stakeholders were asked about activities of any kind that might have an impact on water quality in the watershed. Through this exercise, over 100 specific project ideas were identified. From this pool of project ideas, similar ideas were merged into what became the “38 Action Areas.” The term Action Area arose from meetings and is synonymous with management measures or BMPs. Some Action Areas are related but represent different phases or aspects of an activity or project. For purposes of the WPP, the 38 Action Areas were grouped into the four NPS quadrants - Wastewater, Flow and Dredging, Urbanization, and Wildlife/Natural Areas.

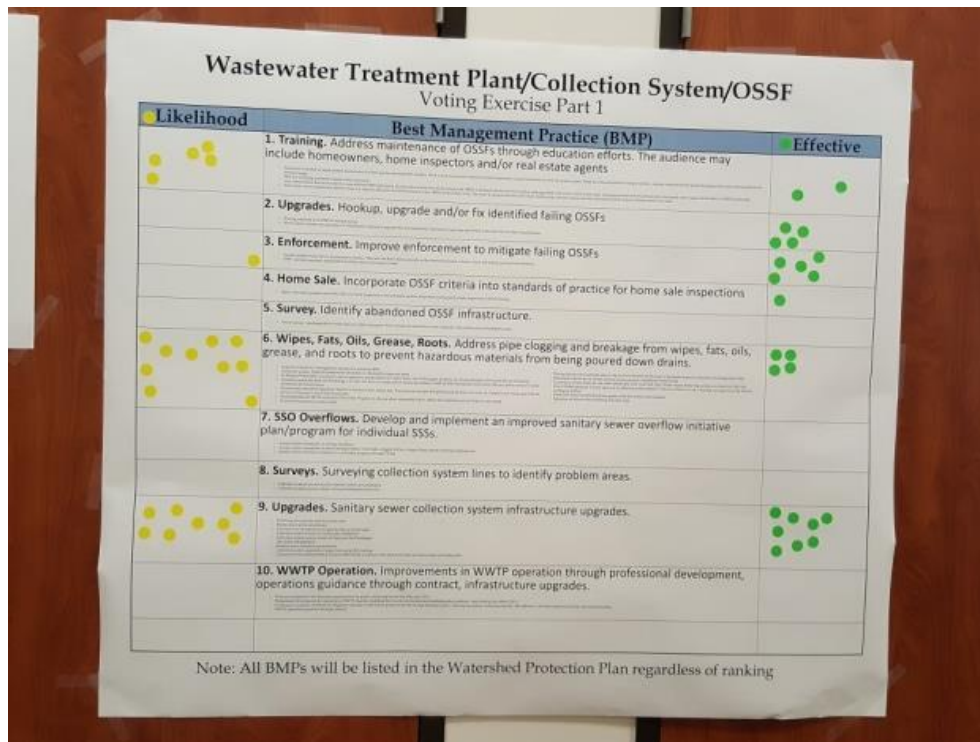


Figure C- 1. Quadrant 1, Wastewater Action Areas poster during the voting exercise

### Ranking the 38 Action Areas

Participants prioritized the 38 action areas through a workshop and email voting exercise. Participants were asked to vote their preference based on two considerations- which projects were likely to happen and which projects were likely to be effective. The votes were merged and tallied for each project. After the tally, one more task was required: weighting the votes. Since dots for voting were handed out to participants for each NPS quadrant (i.e., wastewater, urbanization, flow, wildlife), and since each quadrant had different numbers of Action Areas, the final votes needed to be weighted to be able to rank Action Areas from among all quadrants. The final weighted totals were used to rank the Action Areas. The 38 Action Areas are listed on the table below (Table C-1), and are ranked by their vote preference.

**Table C- 1. The 38 Action Areas prioritized by stakeholders including voting results**

Action Area (No. and Project)		Highland Bayou NPS Quadrant	Votes Likely	Votes Effective	Total Votes	Weighted Totals	Final Rank
<b>9</b>	Sanitary Sewer Upgrades	Wastewater	10	10	20	15.38	<b>1</b>
<b>6</b>	Wipes, Fats, Oils, Grease	Wastewater	10	5	15	11.54	<b>2</b>
<b>11</b>	Improved Flow within Highland Bayou	Flow	9	12	21	11.31	<b>3</b>
<b>13</b>	Culvert Maintenance At Diversion	Flow	8	9	17	9.15	<b>4</b>
<b>19</b>	Pet Waste Education	Urbanization	6	3	9	9.00	<b>5</b>
<b>24</b>	Green Infrastructure & Stormwater Wetlands	Urbanization	4	5	9	9.00	<b>6</b>
<b>30</b>	Stormwater Infrastructure Assessment	Urbanization	2	7	9	9.00	<b>7</b>
<b>23</b>	Landscaping Debris Ordinances	Urbanization	2	6	8	8.00	<b>8</b>
<b>37</b>	Landowner Conservation Plans	Wildlife/Natural Areas	6	6	12	7.38	<b>9</b>
<b>34</b>	Preserve Existing Natural Areas	Wildlife/Natural Areas	5	2	7	7.00	<b>10</b>
<b>26</b>	Illegal Dumping Prevention	Urbanization	7	4	11	6.77	<b>11</b>
<b>35</b>	Restore and Repair Riparian Zones	Wildlife/Natural Areas	1	9	10	6.15	<b>12</b>
<b>21</b>	Water Conservation	Urbanization	3	3	6	6.00	<b>13</b>
<b>31</b>	Feral Hog Workshops	Wildlife/Natural Areas	8	1	9	5.54	<b>14</b>
<b>32</b>	Feral hog Hunting and Trapping	Wildlife/Natural Areas	4	5	9	5.54	<b>15</b>
<b>1</b>	OSSF Training	Wastewater	5	2	7	5.38	<b>16</b>
<b>3</b>	OSSF Enforcement	Wastewater	2	5	7	5.38	<b>17</b>
<b>27</b>	Residential Waste Disposal	Urbanization	2	2	4	4.00	<b>18</b>
<b>12</b>	Flow within Canal Communities	Flow	5	2	7	3.77	<b>19</b>
<b>14</b>	Living Shorelines	Wildlife/Natural Areas	3	3	6	3.23	<b>20</b>
<b>2</b>	OSSF Upgrades	Wastewater	0	4	4	3.08	<b>21</b>
<b>22</b>	Landscaping Education	Urbanization	2	1	3	3.00	<b>22</b>
<b>38</b>	Bacteria Source Tracking and Wildlife Surveys	Wildlife/Natural Areas	1	3	4	2.46	<b>23</b>
<b>10</b>	WWTP Operation Improvements	Wastewater	2	1	3	2.31	<b>24</b>
<b>17</b>	Regional Detention Wetlands	Urbanization	2	2	4	2.15	<b>25</b>

Action Area (No. and Project)		Highland Bayou NPS Quadrant	Votes Likely	Votes Effective	Total Votes	Weighted Totals	Final Rank
15	Review of Bulkhead Standards	Urbanization	1	1	2	1.08	26
20	Stray Animals	Urbanization	1	0	1	1.00	27
25	Watershed Signage	Wildlife/Natural Areas	1	0	1	1.00	28
29	Stormwater Program improvements	Urbanization	1	0	1	1.00	29
4	OSSF Criteria incorporated into home sales	Wastewater	0	1	1	0.77	30
8	Surveying collection systems	Wastewater	0	1	1	0.77	31
36	Natural Resource Education	Wildlife/Natural Areas	1	0	1	0.62	32
16	Shoreline Protection	Wildlife/Natural Areas	1	0	1	0.54	33
5	OSSF Pollution Survey	Wastewater	0	0	0	0.00	34
7	SSO Initiative TCEQ	Wastewater	0	0	0	0.00	35
18	Pet Waste Ordinances	Urbanization	0	0	0	0.00	36
28	Construction Site Erosion Control	Urbanization	0	0	0	0.00	37
33	Pigeon Feeding	Wildlife/Natural Areas	0	0	0	0.00	38

## Voting Results: 10 Priority Action Areas & 28 Additional Action Areas

The top ten vote-getting Action Areas became Priority Action Areas, and the project team prepared detailed tables identifying Action Area background, goals, objectives, costs, technical resources, timelines, and milestones. The remaining 28 Action Areas are still considered viable project areas for this WPP, and brief narratives about project directions and resources have been written for them following the Priority Tables. For the 10 Priority Action Areas, per the outline of EPA's 9 element watershed plan, project details are assigned to their respective elements in this WPP document:

Element C- Management Measures: Goals, Objectives, Likely Project Lead

Element D- Financial and Technical Resources: Costs, technical resources, and funding sources

Element F- Implementation Schedule: Divided into near-, medium- and long-term time horizons

Element G- Milestones: Progress points for projects and strategies

### Priority Action Area Table Definitions

*Problem.* This section of the tables provides a brief narrative of the problem the Action Area is intended to address.

*Goals.* What are the primary water quality goals this action area is supposed to achieve?

*Approach.* What is the approach or strategy that the action area will take to reach its goals?

*Location.* Are there targeted locations for this Action Area or is it intended to be applied as a watershed-wide activity?

*Objectives.* What specific phases or steps need to be undertaken to implement this action area?

*Likely Lead.* What organization or agency is the likely lead for each objective?

*Load Reduction Effectiveness.* To what extent is the action area believed to be effective? Using ‘Low,’ ‘Medium,’ and ‘High,’ what is the estimated impact this will have on water quality? Priority action areas with a high impact on water quality were used to calculate load reductions in Element B, previous chapter.

*Likelihood of Success.* What likelihood does the action area or strategy have of succeeding attributed to voluntariness, cost, interest, level of difficulty, or any other reason? What additional information needed to implement successfully?

*Technical and Financial Needs.* What resources are necessary for implementation activities? These can range from personnel time to infrastructure investments.

## Priority #1: Action Area (9) Infrastructure Upgrades to the Sanitary Sewer Collection System

**Problem:** The centralized collection system for wastewater treatment plants (WWTPs) includes a network of sewer lines, lift stations, and other infrastructure. Sanitary sewer pipes, if broken or malfunctioning, can release raw sewage into the runoff where it flows into streets and stormwater conveyances. These releases of sewage are called Sanitary Sewer Overflows, SSOs. SSOs associated with fats, oils, and grease (FOG) and wipes are discussed in Action Areas 6. Infiltration and inflow (I/I) are other contributing factors for SSOs. I/I is caused by unwanted water entering the collection system through manhole covers, sewer cleanouts, illicit connections, or damaged pipes. I/I volumes can overwhelm the collection system and WWTPs. Collection system problems resulting from I/I include: (1) back flooding of sewers into streets and private properties; (2) decreased capacity of the wastewater collection system; and (3) increasing collection system operating costs, e.g. adding to energy, maintenance, and repair costs by extending the run time for pumps and pump stations. SSO discharges may also result in substantial regulatory fines.

For GCHD's Water Pollution Division, the biggest complaint received from residents is sewage overflows, many from centralized sewage systems.

### Goals:

- To reduce the volume of raw sewage discharging from failing sanitary sewer system infrastructure.

**Approach:** Collection systems need routine maintenance to identify and eliminate SSOs and I/I issues. A combination of sewer system surveys, repairs, and monitoring technologies can be utilized to bring a system into proper working order and reduce the release of untreated sewage into neighborhoods and ditches. This may include the replacement of corroded lines, failing lift stations, and repairs at specific line locations. Municipalities in the watershed are in the process of multi-year infrastructure improvement programs which will reduce the volume of raw sewage flowing into the environment and waterways.

Hitchcock and La Marque have both participated in TCEQ's SSOI program and are in different phases of assessment and implementation. Through the SSOI program, a plan for SSO reduction is submitted to TCEQ including a system inventory, sewer map update, inspections and testing, and system rehabilitation with multiple phases of construction. Video technology is used to survey the collection system and peak flow is measured to identify I/I. La Marque is in the process of issuing substantial capital improvement bonds for their SSO program. The City of Hitchcock completed their SSOI program agreement in 2013 and is continuing system rehabilitation construction activities for SSO reduction. While MUD 12 has not participated in TCEQ's SSOI program, they perform wastewater collection system surveys and also report information to TCEQ.

The GCHD offers inspections of WWTP operations for compliance with state and federal regulations as a contract service, and have assisted Hitchcock and La Marque as recent as 2015.

**Location:** Collection system infrastructure for three WWTPs occurs along highways and throughout

neighborhoods in Hitchcock, La Marque, and Bayou Vista. The Galveston County MUD 12 WWTP and La Marque’s Westside WWTP discharge into Highland Bayou. While the City of Hitchcock’s WWTP lies outside of the Highland Bayou Watershed boundaries and discharges to the Highland Bayou Diversionary Canal, much of its collection system is within the Highland Bayou Watershed.

<b>Implementation Objectives</b>	<b>Likely Lead Entity</b>
1. Adopt or update infrastructure management programs to plan and budget for proactive/preventative maintenance activities.	Wastewater service providers: City of Hitchcock, City of La Marque, MUD 12, City of Texas City
2. Identify areas in the collection system where I/I or aging infrastructure is a problem.	Wastewater service providers: City of Hitchcock, City of La Marque, MUD 12, City of Texas City
3. Rehabilitate collection system infrastructure to prevent SSOs and I/I.	Wastewater service providers: City of Hitchcock, City of La Marque, MUD 12, City of Texas City
4. Upgrade or repair private line connections to the wastewater collection system. Performed as necessary.	Residents with guidance from the wastewater service provider.

**Estimated Bacteria and/or Nutrient Load Reduction**

Reduction Effectiveness: High - Infrastructure repairs and surveying technologies are proven methods for reducing SSOs and leakages.

Likelihood of Success: High –Hitchcock has completed a five year agreement through the TCEQ SSOI program. La Marque is currently participating in the TCEQ SSOI program. These are existing and new commitments to infrastructure improvements that will improve their collection systems.

Technical and Financial Needs: Each wastewater service provider is responsible for their respective infrastructure improvements, have separate funding and approval processes. Constant maintenance of the collection system is necessary to ensure proper operation and parts can be expensive making ongoing operations a costly undertaking. See Element D for more information.

## Priority #2: Action Area (6) Fats, Oils, and Grease and Wipes in the Sanitary Sewer Collection System

**Problem:** The accumulation of FOG and wipes is a common problem resulting in sanitary sewer system overflows, malfunctions, and failures. As sewer lines clog and eventually break, raw sewage flows into local waterways or occur as backups into homes and businesses. The issue spans from private lines to the publicly maintained collection system. For private lines, homeowners and commercial customers are responsible for costs associated with blockages on private property. For a blockage on the public side of the collection system, costs can be substantial and some maintenance costs are passed along the all sewer rate payers. The utility provider may also face regulatory fines for the discharge of SSO volumes into the environment.

### Goals:

- Minimize the introduction of SSO raw sewage into local waterways.
- Reduce the deposition FOG and wipes from entering sewer lines.
- Encourage proper disposal practices through education and outreach to residents and commercial entities on items that should not enter their drains.

**Approach:** *Commercial Practices.* Preventing FOG and wipes will reduce the incidence of blockages and other failures to the SSS and the release of raw sewage. Developing or strengthening regulations and policies that specifically address FOG for food service establishments and other commercial users is a priority. Wastewater treatment providers can employ a variety of requirements for users in their service area including:

- Local limits for oil and grease substances from animal or vegetable sources or from hydrocarbons discharges in wastewater to the sewage system;
- a minimum recovery charge per typical blockage incident attributed to the improper disposal of grease;
- outside interceptors for all new or remodeled food service establishments; and
- the development and implementation of a FOG best management plan as well as a grease interceptor cleaning log for food service establishments.

Rules can also be established for licensed waste haulers:

- grease interceptor cleaning practice standards;
- cleaning log requirements; and
- an expectation of communicating pertinent information to personnel of the food service establishment they service.

*Public Education.* Municipal wastewater entities can improve FOG awareness among their customer base by utilizing existing educational materials. Cease the Grease is a kitchen grease awareness campaign through the GBF that offers educational materials and an opportunity to learn from neighboring communities through GBF's Cease the Grease workgroup. In addition to keeping FOG out of our drains, GBF publicizes recycling locations for kitchen grease disposal and encourages the establishment of new recycling receptacles. Establishing more convenient recycling receptacles for residents is another way municipalities and other organizations can partner with GBF. Apartment complexes are a good option for pilot efforts as they offer an easy avenue for delivering educational material, measuring participation and surveying participants. Depending on the location and

partnerships the organization has in place, GBF can provide various levels of support with acquiring the recycling receptacle, maintaining the unit, or coordinating with the oil hauler.

Educating residents about wipes is important, especially since wipes are marketed to consumers as being flushable. Flushable is interpreted by the consumer to mean that the item can fit through a 4 inch pipe, not that the material should be flushed to the sanitary sewer or is septic safe. Patty Potty is an existing campaign that offers educational materials aiming to improve awareness among residents and businesses about what not to flush down the toilet.

**Location:** Developed areas of the watershed serviced by a centralized wastewater collection system.

Implementation Objectives	Likely Lead Entity
1. Regulation and Policy for FOG in commercial settings: <ol style="list-style-type: none"> <li>1. Compile existing regulations within the watershed and share.</li> <li>2. Examine, establish, and/or update regulations as necessary to address gaps.</li> <li>3. Include enforcement measures</li> <li>4. Perform outreach to promote participation and aid in compliance.</li> </ol>	Wastewater treatment providers including City of Hitchcock, City of La Marque and MUD 12; County agencies; County Commissioners
2. Utilize existing educational messaging related to cooking grease –Cease the Grease campaign materials: <ol style="list-style-type: none"> <li>1. Join the Cease the Grease workgroup.</li> <li>2. Utilize available online social media materials and website content.</li> </ol>	Wastewater treatment providers including City of Hitchcock, City of La Marque and MUD 12; County agencies; County Commissioners
3. Pilot project - establish one Cease the Grease kitchen grease collection station at an apartment complex.	Wastewater treatment providers including City of Hitchcock, City of La Marque and MUD 12; County agencies; County Commissioners; GBF
4. Utilize existing educational messaging related to wipes - Patty Potty campaign materials: <ol style="list-style-type: none"> <li>1. Bolster online presence using free Patty Potty materials on social media sites and webpages.</li> <li>2. Join the Patty Potty Patrol for access to videos, inserts, and public service announcements. Save Water Texas Coalition members receive a discount. Project ideas include: showing a Patty Potty video clip on the topic of flushable wipes in movie theatres (as the San Jacinto River Authority currently does); and setting up a standup cardboard cut-out of Patty Potty with a</li> </ol>	Wastewater treatment providers including City of Hitchcock, City of La Marque and MUD 12; County agencies; County Commissioners



<p>“don’t flush wipes” message in the City Hall lobby.</p>	
<p>5. Utilize utility bills for distribution of educational material to homeowners:</p> <ol style="list-style-type: none"> <li>1. Publicize costs for damages to sewer infrastructure to city taxpayers. “Cleaning out wipes that go down the drain is costing tax dollars”. Include a list of annual repairs for pump stations with costs, photos, the dos and don’ts of flushing and drains.</li> </ol>	<p>Wastewater treatment providers including City of Hitchcock, City of La Marque and MUD 12; WCID 19.</p>
<p>6. Host education and outreach workshops for residents and commercial entities.</p>	<p>Wastewater treatment providers including City of Hitchcock, City of La Marque and MUD 12; County agencies; County Commissioners; AgriLife</p>

**Estimated Bacteria and/or Nutrient Load Reduction**

Reduction Effectiveness: Potentially high if education leads to physical improvement of private lines to public collection system; See Element B for discussion of the data gaps related to this activity. Educational activity if leading to behavior changes would lead to avoided bacterial loads in the future.

Likelihood of Success: High – The educational component is largely available and ready for communities to utilize and educate homeowners and business. The costs and staff time associated with clearing sewer blockages or repairing equipment is significant versus the costs of homeowner education. To maximize existing resources, communities within the watershed should share existing practices and publicity activities with one another.

Technical and Financial Needs: High – The educational component is largely available and ready for communities to utilize and educate homeowners and business. The costs and staff time associated with clearing sewer blockages or repairing equipment is significant versus the costs of homeowner education. To maximize existing resources, communities within the watershed should share existing practices and publicity activities with one another.

### Priority #3: Action Area (11) Stream Flow Within the Highland Bayou Channel

**Problem:** Flow within the Highland Bayou channel is currently impeded by accumulated sediment introduced to the bayou from urbanization and large storms including Hurricane Ike in 2008. The diversionary canal project in the late 1970’s resulted in the most significant alteration to the bayou. The diversion succeeded in its design to provide flood protection for properties in the watershed, but recreational use and habitat quality has declined with the decreased flow and water depth. Detrimental changes to bayou hydrology and water quality are a result.

Streamflow management and maintenance responsibilities including potential modification to the channel were consistent topics of discussion for stakeholders during workgroup meetings. Within the canal communities of Bayou Vista and Omega Bay there is a recognized need for maintenance dredging of Highland Bayou. Many of the canal subdivisions have drafts that are deeper than the main channel of the bayou, 17’ in canals versus 4’ in the main channel. Several residents have requested debris be removed from the Bayou to improve flow conditions.

The bayou’s slow and typically warm conditions provide an ideal environment for bacteria to grow. Increased flow may benefit water quality conditions and decrease the concentration of bacteria present in the bayou.

**Goals:**

- Improve flow conditions within the Highland Bayou channel by improving channel flow and by removing impediments to flow, such as fallen trees and sediment accumulation.

**Approach:** Improving the flow within the Highland Bayou channel may be achieved directly through dredging and debris removal activities. Before these activities are approved, further investigation to establish the scope of the project. Dredging and debris removal will not reduce future contributions of accumulated sediment and plant debris to the bayou. To accomplish this, the assessment of factors contributing to the decreased flow and introduction of sediment are needed.

**Location:** Highland Bayou Segment 2424A\_01 originating from the headwaters to FM 2004, upstream areas within Jack Brooks Park as well as the residences downstream. Highland Bayou Segments 2424A\_01 and 2424A\_02 adjacent to unincorporated place, Freddiesville.

Implementation Objectives	Likely Lead Entity
1. Determine causes of flow reduction by requesting a study to identify contributing factors.	Galveston County Engineering with the USACE would perform the study. Other potential partners include the City of Hitchcock, City of La Marque, and MUD 12.
2. Conduct a sediment source study to find the cause of sediment entering the bayou.	Galveston County Engineering with the USACE would perform the study. Other

	potential partners include the City of Hitchcock, City of La Marque, and MUD 12.
3. Selectively remove sediment and clear vegetation from the channel as recommended during assessments performed by the USACE.	Galveston County Engineering as the permit applicant would coordinate dredging activities with the USACE. Other potential partners include City of Hitchcock, City of La Marque, MUD 12 and Resource Agencies.
4. Selectively remove accumulations of woody debris impeding flow within the channel in residential areas as recommended during assessments performed by the USACE.	Galveston County Engineering as the permit applicant would coordinate tree removal with the USACE. Other potential partners include City of Hitchcock, City of La Marque, and MUD 12.

**Estimated Bacteria and/or Nutrient Load Reduction**

Reduction Effectiveness: Likely to be low, as direct sources are not addressed by this activity. However, it is assumed that an improved flow regimen in the waterway would lead to a reduction in bacteria loading. A load reduction estimate for this action area is not estimated in Element B.

Likelihood of Success: Medium – As the highest ranking priority among the stakeholders and a discussion topic that dominated many workgroup meetings, the level of commitment for this action area is expected to be high. State and federal involvement will be necessary due to regulatory requirements for activities within the bayou channel. These efforts will span the length of the watershed and coordination between several entities will be necessary for successful implementation. The next steps are to prepare studies. Natural resource agencies have expressed caution be used when modifying stream habitat by removing plant debris that provide beneficial structure for aquatic organisms.

Technical and Financial Needs: Applicants for studies or dredging projects through the USACE may receive project support and financial assistance, though matching funds are a requirement. See Element D for more information.

## Priority #4: Action Area (13) Culvert Dam Maintenance in the Highland Bayou Channel

**Problem:** Accumulated sediment and plant debris are obstructing the flow of Highland Bayou within Jack Brooks Park. There are two separate locations where culverts are at least partially blocked by accumulated sediment both upstream and downstream of culverts. The culverts represent the intercept point where the diversionary canal drains old Highland Bayou to the south and away from the current channel. Obstruction of flow within the culvert has been a long standing concern for residents. In 1996, dozens of volunteers removed brush and trash from Highland Bayou during a cleanup effort adjacent to the culverts that comprise the earthen dam in Jack Brooks Park.

The bayou’s slow and typically warm conditions provide an ideal environment for bacteria to grow. Increased flow may benefit water quality conditions and decrease the concentration of bacteria present in the bayou. It would not impact the load from bacteria sources.

**Goals:**

- Improve flow within the Highland Bayou channel, via the culvert
- Investigate maintenance needs for culverts within Jack Brooks Park.

**Approach:** Improving the flow within the Highland Bayou channel may be achieved directly through removing sediment and plant debris from the culverts within Jack Brooks Park. Before the culverts can be cleaned out, more information is needed on what maintenance activities are allowed, the process in which work is performed, and which parties are responsible for performing maintenance for these culverts.

Sediment and debris removal will not reduce future contributions of accumulated sediment and plant debris within these culverts. Increased flow could lower bacteria levels through dilution with contributing waters through the dam and culvert.

**Location:** Highland Bayou at the diversionary canal dam and culverts in Jack Brooks Park.

Implementation Objectives	Likely Lead Entity
1. Request information from the USACE about culverts to determine maintenance needs (potential removal of sediment and debris) to improve flow.	Galveston County Engineering; Municipalities; MUDs, AgriLife; USACE
2. Remove sediment and clear vegetation from culverts.	Galveston County Engineering; Municipalities; MUDs, AgriLife; USACE
3. Establish a management/maintenance agreement.	Galveston County Engineering; Municipalities; MUDs, AgriLife; USACE

### **Estimated Bacteria and/or Nutrient Load Reduction**

Reduction Effectiveness: Likely to be low, as direct sources are not addressed by this activity. However, it is assumed that an improved flow regimen in the waterway would lead to increased flow volumes and a concurrent a reduction in bacteria concentrations. A load reduction estimate for this action area is not estimated in Element B.

Likelihood of Success: High – As a top priority among the stakeholders, the level of commitment is expected to be high. More information is needed regarding the need for maintenance in these areas and the parties responsible for maintenance activities. Resource agencies have expressed caution about modifying stream habitat by removing plant debris that provide beneficial structure for aquatic organisms.

Technical and Financial Needs: The USACE provides project support and offers financial assistance, though matching funds are a requirement for applicants. See Element D tables for specific needs.

## Priority #5: Action Area (19) Pet Waste Education

**Problem:** It is estimated that there are over 5,000 dogs in the watershed, generating tons of feces per year. Leaving pet waste in parks, yards or on sidewalks contributes a substantial amount of bacteria to surface waters. A single gram of dog feces can carry an estimated 23 million bacteria along with viruses and parasites. Bacteria and other living organisms travel with pet fecal material into our local waterways making it dangerous for swimming and ingesting. On the ground, fecal material can be harmful for children or even other pets. Due to the presence of suburban development within the Highland Bayou Watershed, pet waste is assumed to be a large source of bacterial contamination.

**Goals:**

- Reduce bacteria loads from pet waste.
- Encourage pet owners to pick up pet waste by providing pet waste stations in public areas.
- Provide education and outreach to pet owners on proper pet waste management and impact of pet waste on water quality.

**Approach:** To reduce bacteria loads from pet waste, it is important that it is disposed of in the garbage and not left on the ground. Since many cats use litter and remain indoors the focus here is on dogs. Feral or stray animals were discussed separately and are covered under Action Area (20).

Existing educational materials will be utilized to improve dog-owner awareness and result in behavior change. The H-GAC and the TCWP are local entities that have developed pet waste education and outreach materials that are available online. Materials available include fact sheets and posters that can be utilized in common areas within apartment complexes, public buildings or park bulletin boards.

Pet waste education would be coordinated with the installation of pet waste stations to maximize participation. Pet waste stations with bag dispensers encourage pet owners to pick up after their pets in public areas. Aside from refilling bags, the stations require little maintenance. Stakeholders recommended parks with trash cans and regular trash pickup as the most suitable location option.

The Moses-Karankawa Bayous Alliance has provided pet waste educational materials at several public events within the watershed (See Element E). More than 500 pet waste bag dispensers have been distributed during these events.

Location: Watershed-wide. High public-use areas including city parks, county parks, public buildings, and large apartment complexes are best for pet waste stations. High public use areas will be prioritized higher than individual households for educational materials.

Implementation Objectives	Likely Lead Entity
1. Distribute pet waste educational material to residents during public events including H-GAC’s Trash Bash, La Marque Bayou Fest, and Hitchcock’s Good Ole Days Celebration; at libraries, city hall, and other public facilities;	City of Hitchcock; City of La Marque; City of Bayou Vista; MUD 12; WCID 19; HOAs; Galveston County; AgriLife

through mailers, utility inserts, Homeowners Association (HOAs), and various civic organizations.	
2. Install pet waste stations with bag dispensers in parks and other public spaces.	City of Hitchcock; City of La Marque; City of Bayou Vista; MUD 12; HOAs; Galveston County
3. Distribute pet waste bag dispensers to residents during public events including H-GAC's Trash Bash, La Marque Bayou Fest, and Hitchcock's Good Ole Days Celebration; through HOAs and civic organizations.	City of Hitchcock; City of La Marque; City of Bayou Vista; MUD 12; WCID 19; HOAs; Galveston County; AgriLife

**Estimated Bacteria and/or Nutrient Load Reduction**

Reduction Effectiveness: High – Bacteria load reductions could be high. Effectiveness will be determined by rates in behavior change among dog-owners. Load reduction estimates are included in Element B.

Likelihood of Success: Medium to High. A sustained education effort is necessary to educate dog-owners in the watershed. While parks and other public areas where owners take their dogs to play and walk are ideal for outreach and deployment of pet waste stations, real load reductions will be seen at the neighborhood level where most dog owners allow their dogs outside (i.e., yards or neighborhood walks). As with any educational effort, the real outcome sought is behavior change, resulting in actual load reductions.

Technical and Financial Needs: Low– Funding and labor for the installation of pet waste stations and for the delivery of education and outreach materials is minimal. Maintenance of the pet waste stations would include staff time within the scope of the participating agencies' capabilities. More information is included in Element D.

## Priority #6: Action Area (24) Green Infrastructure and Stormwater Treatment Wetlands

**Problem:** Impervious and low pervious surfaces alter stormwater runoff behavior, impacting both the quantity and quality of water. Buildings, pavement, and compacted landscapes cover much of the land in suburban communities. Impervious surfaces allow water to flow over the landscape more quickly, prevent opportunities for ground infiltration. This contributes to increased quantities of runoff, and potentially increased flooding. As new development brings additional impervious surface to the watershed, the volume of stormwater runoff will increase unless site development standards change.

**Goals:**

- Reduce the amount of stormwater runoff entering local waterways by retaining rainfall on site or in neighborhood and regional detention features.
- Treat stormwater runoff using GI and SWW

**Approach:** GI consists of designed systems that mimic the natural hydrology of an area, allowing water to infiltrate into the soil and reducing runoff. In addition, GI may reduce some flooding by encouraging infiltration and providing more time for filtration by retaining water during rain events - treating water where it falls. Designs are site specific and can be easily incorporated into new or existing yards, parking lots or landscapes. GSI is intended to work together with “gray infrastructure” (roads, bridges, etc.) that makes life possible along the Gulf Coast. Native vegetation should be used when possible as these plants are well adapted to local conditions of prolonged wet and then dry spells, requiring little to no additional water once plant populations are established. Rainwater harvesting systems also promote water conservation by providing an alternative water resource.

There are several locations in Galveston County providing local GI examples including the City of Dickinson Public Library rain garden, the San Leon Elementary School rain water harvesting system and the Texas City Tanger Outlet Center water conservation measures. Tanger Outlet Center has 11 water cisterns with 90,000 gallons of water storage capacity designed for landscape irrigation. The Ghirardi Family WaterSmart Park in League City showcases eight stormwater BMPs in one location: rain gardens, WaterSmart landscapes, vegetated swales, pervious pavers, a vegetated buffer, rainwater harvesting, a green roof, and compost for turf grass management. Incorporating GI on public buildings and in public spaces increases their visibility and serves as an educational opportunity to reach both residential and commercial audiences.

Municipalities should consider updating local development codes to ensure that either these kinds of practices are required or at a minimum not prohibited through arcane standards. The nearby community of League City proposed an ordinance for Low Impact Development as an alternative to conventional drainage, detention, and storm water conveyance systems in 2013. Example incentives and regulations to encourage GI for stormwater retrofits are available in the “Retrofit Policies” section of EPA’s “Managing Wet Weather with GI Municipal Handbook”. <https://www.epa.gov/green-infrastructure/green-infrastructure-municipal-handbook>.

Educating public officials, staff, developers and residents about GI will be necessary to build awareness



in the watershed. Online resources are available, including: Center for Watershed Protection, EPA’s “Soak up the Rain”, EPA’s “GI Municipal Handbook”, and the Low Impact Development (LID) Center located in Maryland. For GI guidance that considers local soil and climate conditions H-GAC offers “Designing for Impact: A Regional Guide to Low Impact Development” and the Texas Coastal Watershed Program offers technical assistance through their Stormwater Program. In 2015 they published the Ghirardi Family WaterSmart Park Stormwater BMP Assessment Report. Communities in the watershed can request rain barrel workshops (GBF) to educate residents on water conservation and provide participants with a rain barrel they can install the same day.

SWW can be constructed as retrofits of existing detention and conveyance systems, adding beauty, habitat and water quality benefits. Existing basins have wetland characteristics and can be converted relatively easily. SWW encounter relatively dramatic and frequent changes in water depth. They account for the variable stormwater flow and provide an alternative to stormwater detention basins. A misconception about this BMP is the risk of mosquitoes, which are not an issue in well-designed SWW. Objectives in approach for promoting stormwater treatment wetlands are much like the GI suggestions above. Existing workshops are available and can be offered to public entities and developers. Public entities will be approached to gauge interest in utilizing stormwater treatment wetlands. Planning and land development ordinances to consider these stormwater detention retrofits into wetlands and incorporate SWW into new development projects may encourage participation.

**Location:** Highly developed areas of the watershed, including commercial and residential sections of the watershed.

Implementation Objectives	Likely Lead Entity
1. Update development codes to allow for GI projects during new development and stormwater retrofits; example ordinances are available for reference.	City of Hitchcock; City of La Marque; City of Bayou Vista; MUD 12; County agencies; Developers; AgriLife
2. GI for public buildings and in public spaces: <ol style="list-style-type: none"> <li>1. Identify public entities interested in utilizing GI.</li> <li>2. Design and implement GI projects including rain gardens, permeable pavement, bio-swales, vegetated curb extensions, rain water harvesting cisterns and WaterSmart landscaping.</li> </ol>	City of Hitchcock; City of La Marque; City of Bayou Vista; MUD 12; County agencies; Developers; AgriLife
3. Educate residents and public entities about GI: <ol style="list-style-type: none"> <li>1. Distribute educational materials about GI practices, how they can be used locally, and their impact on water quality.</li> <li>2. Partner with AgriLife to host GI workshops, lectures and field trips to educate homeowners, businesses and municipal officials.</li> <li>3. Partner with GBF to host rain barrel</li> </ol>	AgriLife; GBF; Galveston Bay Estuary Program

workshops for residents to promote water conservation.	
<p>4. Encourage the use of constructed stormwater treatment wetlands:</p> <ol style="list-style-type: none"> <li>1. Host constructed SWW workshops for public entities and developers.</li> <li>2. Identify public entities interested in utilizing stormwater treatment wetlands and establish ordinances to consider these practices.</li> <li>3. Retrofit existing stormwater detention facilities into stormwater treatment wetlands where feasible.</li> <li>4. Incorporate stormwater treatment wetlands during new development projects.</li> </ol>	AgriLife; GBEP; GBF
<b>Estimated Bacteria and/or Nutrient Load Reduction</b>	
<p>Reduction Effectiveness: Medium to High, dependent on design, site selection and maintenance. Effectiveness on load reductions is contingent on use of these practices in areas that intercept runoff load from existing development. Load reductions were calculated and are included in Element B.</p> <p>Likelihood of Success: Medium – Project timelines require sustained commitment and then maintenance of the features, ideally intermittently. Education is needed for proper siting and design standards. Garden Clubs may be an avenue for outreach. Misconceptions about these practices are known obstacles to their consideration and use, requiring targeted education. Maintenance needs are expected to be different than for conventional practices but are not anticipated to be unreasonable. For stormwater treatment wetlands, the size of the wetland relative to the contributing watershed is the most important determining factor in how well the wetland will function.</p> <p>Technical and Financial Needs: High – Funding to identify, plan and implement projects; Resource management and technical expertise is needed from partner agencies/organizations.</p>	

## Priority #7: Action Area (30) Stormwater Infrastructure Assessment Surveys

**Problem:** Drainage does not stop at jurisdictional boundaries, but responsibility for infrastructure maintenance does. Sustainability of the stormwater system is critical for proper drainage. A survey would identify, inventory, and map this infrastructure in municipalities, and ideally identify opportunities for improved volume capacity and chances for where water quality practices could be implemented or prevent SSO discharges into the stormwater drainage system.

Stormwater infrastructure includes above and below ground conveyances for stormwater. Drainage District 2 (GCDD2) maintain drainage ditches north of Highland Bayou, and including large channels and detention basins. Improvements within GCDD2 are sized and maintained to accommodate runoff anticipated from maximum buildout conditions and using a 100-year rainfall event. The current system of ditches are built out to accommodate this growth, and GCDD2 focuses most of their efforts on maintenance activities. Roadside ditches within city limits are maintained by municipalities. Galveston County Road and Bridge is responsible for construction, repair and maintenance of county streets and drainage systems. The watershed area south of Highland Bayou is outside GCDD2 and the evaluation of stormwater infrastructure for repair, maintenance and upgrades is performed by several entities in an uncoordinated fashion.

A comprehensive countywide drainage plan was created in 2012 to identify potential drainage and flood control projects both inside and outside of municipalities, following damages during hurricane Ike in 2008. A large database of drainage conditions and facilities across Galveston county was assembled, including representative drainage channel characteristics, estimated culvert capacities, planning level dimensions of proposed projects, and bridge and culvert descriptions. Projects for localized street drainage and storm sewer improvements were not part of the Galveston County Master Drainage Plan because responsibilities are typically covered by local communities and subdivision developers (Klotz, 2012).

### Goals:

- Assess stormwater drainage system infrastructure to improve system management and identify maintenance needs and opportunities for where water quality practices could be implemented.

**Approach:** Stormwater infrastructure inventories could be later utilized to assess and prioritize sources of NPS pollution. The inventory should identify infrastructure along with attribute information for asset management purposes; including enough information to allow the local jurisdiction to locate individual structures, record inspection results, prioritize maintenance needs, and issue maintenance work orders. At a minimum the map of the existing stormwater system should include outfall locations and intercepts with municipally owned conveyances. As new construction occurs, the map should be updated with relevant information. If existing outfalls/intakes are modified, add relevant information to the map. An assessment may include assigning risk, determining remaining life, replacement cost, or determining a maintenance schedule. Stormwater system components commonly included in infrastructure inventories are inlets, catch basins, stormwater drainage pipes and conveyances, swales and drainage ditches, culverts, outfalls, streams and receiving water bodies, manholes, weirs, spillways,

energy dissipaters, headwalls, structural stormwater controls, and BMP or structural device type.

**Location:** All areas of the watershed serviced by drainage infrastructure.

Implementation Objectives	Likely Lead Entity
1. Compile and review previous storm drainage system studies to determine the scope for an updated assessment.	Galveston County Storm Water Collaborative; Municipalities; Galveston County Engineering; GCDD2
2. Inventory stormwater infrastructure components: <ol style="list-style-type: none"> <li>1. Establish data objectives, requirements, and the data collection schedule.</li> <li>2. Inventory and map public stormwater system.</li> <li>3. Develop a plan to maintain and update inventory data.</li> </ol>	Galveston County Storm Water Collaborative; Municipalities; Galveston County Engineering
3. Characterize stormwater system components in the inventory to prioritize improvement needs and pollution prevention measures.	Galveston County Storm Water Collaborative; Municipalities; Galveston County Engineering

**Estimated Bacteria and/or Nutrient Load Reduction**

Reduction Effectiveness: No load reductions directly from this action area. Primary benefit is for assessment and planning purposes, leading to the ability to prioritize opportunities for implementation of water quality practices and projects such as SWW or GI.

Likelihood of Success: Medium - The action area will require coordination between various local agencies and departments. Drainage system maintenance needs are ongoing, requiring a long term commitment from participating entities.

Technical and Financial Needs: High – The level of complexity for a stormwater infrastructure inventory will vary between communities, depending on the existing system and resources for inventorying. See Element D.

## Priority #8: Action Area (23) Landscaping and Landscaping Debris Ordinances

**Problem:** Grass clippings, leaves, mulch and other plant matter swept or blown onto the road, driveway or into storm drains introduce stormwater pollution to local waterways. Yard and household wastes contribute nutrients, fertilizers, pesticides, and bacteria to our bayous. Storm drains, streets and other stormwater drainage infrastructure are not part of the sanitary sewer system and stormwater is not treated. Stormwater carries lawn debris and discharges directly to local waterways.

**Goals:**

- Decrease and minimize the introduction of lawn debris and nutrients into stormwater.

**Approach:** By preventing landscaping debris from entering stormwater, homeowners and landscaping contractors play a critical role in reducing the pollutant load associated with these materials. Strengthening existing ordinances will ensure that communities have the tools to encourage residents and landscaping contractors to keep lawn debris out of storm drains.

The canal community of Bayou Vista has an ordinance against blowing lawn clippings and other refuse into canals. Bayou Vista residents are encouraged to call and request a warning or ticket be issued if they observe violations. The City of La Marque trains their landscaping contractors in these recommended practices; La Marque does not yet have ordinances to prohibit the disposal of landscaping debris in the stormwater system.

Public education and outreach for landscaping practices is covered under Action Area (22) in the section following the Priority Action Area tables. It is important; however, to communicate ordinance requirements to individuals and entities affected to encourage participation.

**Location:** Entire watershed.

Implementation Objectives	Likely Lead Entity
1. Develop new or strengthen existing ordinances addressing lawn clipping and landscaping debris management. Example ordinances are widely available for reference.	City of La Marque, City of Hitchcock, City of Texas City; City of Bayou Vista
2. Communicate landscaping ordinance requirements or landscaping best practices to residents and landscaping contractors.	City of La Marque, City of Hitchcock, City of Texas City; City of Bayou Vista
3. Develop enforcement measures for the ordinance including penalties due following multiple offenses.	City of La Marque, City of Hitchcock, City of Texas City; City of Bayou Vista
4. Publicize contact information for reporting violations or poor disposal practices.	City of La Marque, City of Hitchcock, City of Texas City; City of Bayou Vista

**Estimated Bacteria and/or Nutrient Load Reduction**

Reduction Effectiveness: Low – At this time, these actions are unlikely to result in a sizeable load

reduction overall, but may provide water quality improvements to localized sections. Preventing lawn clippings and debris from entering waterways will reduce nutrients and the carbon entering the waterway, but is unlikely to lessen bacteria loads since this is not understood to be a source of bacteria.

**Likelihood of Success: Medium** – The contribution of landscape clipping and debris into stormwater or directly into the bayou was brought up regularly by stakeholders as an important issue within the watershed. The level of commitment for this Action Area is expected to be high. At least one community in the watershed has an ordinance to address this issue with active participation from residents. When an enforcement component is included in the ordinance, participation increases. In the case of Bayou Vista, enforcement officers play a role in educating residents about the ordinance.

**Technical and Financial Needs: Low** – Example ordinances are widely available, even from neighboring communities.

## Priority #9: Action Area (37) Landowner Conservation Plans

**Problem:** Land mismanagement can result in soil erosion and the destruction of important natural features such as riparian areas, wetlands, and shorelines. While most land owners are assumed to be good stewards of the land, there are some who may lack the knowledge of good land management practices. There are many incentives and BMPs landowners may not be aware of. Landowner participation in conservation and habitat management plans can reduce the amount of bacteria and nutrients entering waterways by addressing issues related to water quality, soil erosion and sedimentation.

**Goals:**

- Increase landowner participation in existing conservation and habitat management plans to decrease bacteria and nutrient loading and enhance water quality within the watershed.

**Approach:** The Natural Resources Conservation Service (NRCS), Texas State Soil and Water Conservation Board (TSSWCB) and Texas Wildlife Department (TPWD) administer a variety of voluntary programs which provide landowners with the technical and/or financial assistance to combine sustainable land stewardship activities with land production activities. Conservation and habitat management plans are typically coupled with agricultural activities. Highland Bayou Watershed does not have a significant agricultural sector, but stakeholders identified several private landowners that may be interested and ranked this item among the top ten Priority Action Areas.

*NRCS.* Conservation plans developed through NRCS are customized documents that outline the use and BMPs of the natural resources on public or private lands. Landowners benefit from NRCS conservation planning through increased productivity of agricultural land by conserving the soil, increasing rangeland health, improving water quality, and managing livestock waste. Conservation plans are also developed to improve habitat for fisheries, upland game birds, and other wildlife. Technical assistance can include engineering designs, operation and maintenance agreements, and information to support federal, state and local permits. Support provided by NRCS instills confidence in the design, implementation, and monitoring of a plan that is voluntary, flexible and specific to the property.

*TSSWCB.* Local Soil and Water Conservation Districts through TSSWCB develop site-specific Water Quality Management Plans (WQMPs) for landowners upon request. WQMPs provide agricultural producers with traditional, voluntary, incentive-based programs to comply with state water quality laws. Plans include improved land treatment practices, production practices and management and technology measures to achieve a level of pollution prevention or abatement consistent with state water quality standards. By contacting the directors of the soil and water conservation district, a farmer or rancher can get assistance on all phases of conservation. Districts are designed to deliver a local program, based on local needs, that best conserves and promotes the wise use of natural resources. Districts also work with the USDA-Farm Service Agency, Texas Agricultural Extension Service, Texas Forest Service, U.S. Forest Service and others when necessary to assist agricultural landowners/operators meet individual land use needs.

TPWD. Voluntary implementation efforts to establish more desirable wildlife habitat away from the riparian corridor is another approach to reduce bacteria entering local waterways. The Texas Landowner Incentive Program is a collaborative effort through TPWD funded with multiple partnerships to meet the needs of private, non-federal landowners wishing to enact good conservation practices on their lands for the benefit of healthy terrestrial and aquatic ecosystems.

**Location:** Large, privately owned properties. Properties adjacent to riparian corridors are considered the most critical.

Implementation Objectives	Likely Lead Entity
1. Identify existing conservation and habitat management plans within the watershed.	AgriLife; County agencies; NRCS; TSSWCB; TPWD; Resource agencies/organizations
2. Identify interested landowners to participate in conservation and habitat management plans. Facilitate communication between voluntary programs and potential participants. <ol style="list-style-type: none"> <li>1. Host landowner workshops addressing land management practices.</li> <li>2. Distribute educational materials to landowners regarding land stewardship practices.</li> <li>3. Develop and implement individual NRCS conservation plans, WQMPs, and LIP participation.</li> </ol>	AgriLife; Landowners; County agencies; Resource agencies/organizations

**Estimated Bacteria and/or Nutrient Load Reduction**

Reduction Effectiveness: Low to Medium - The agricultural sector in the watershed is not as sizeable as in the past, and it continues to decline. Established landowner conservation plans are anticipated to be low in this highly urbanized watershed. Success is contingent identifying willing land owners with large acreage properties.

Likelihood of Success: Medium – The assistance programs identified above may already have involved landowners within the watershed. Additional information is needed to anticipate an increase in participation. Landowners may acknowledge the importance of good land stewardship practices and conservation plans but financial incentives offered through agency programs are necessary to increase the adoption of these plans. To increase implementation, financial assistance through the assistance programs is the primary need to overcome cost prohibitive obstacles. These are long range planning opportunities and the maintenance for continued effectiveness must be considered.

Technical and Financial Needs: Property acquisition can be a very capital intensive effort. Consideration for recreational opportunities and multi-use developments could be combined with land management and preservation efforts. See Element D.



## Priority #10: Action Area (34) Preserve Existing Natural Areas

**Problem:** Undeveloped lands allow stormwater to infiltrate into the ground, much more so than in developed areas. Undeveloped natural and agricultural lands are under pressure for development – highways, residential and commercial building sites, and other uses. The decline of natural areas leads to water quality degradation, loss of habitat for wildlife, a decline in scenic beauty and livability for residents. Many stakeholders have expressed concern for the changes in landscape they have observed over the years. Riparian zones are a critical feature of natural areas because they buffer the flow of runoff to waterways and stabilize soil. Many sections of Highland Bayou shoreline has been converted to developed uses and open lawns. Riparian zone restoration is covered under Action Area (35).

**Goals:**

- Preserve priority undeveloped lands in their natural state and protect the water quality benefits of undeveloped land.
- Improve land management practices of undeveloped areas by providing education on habitat value for wildlife and water quality.

**Approach:** Conservation and restoration of coastal prairie, wetlands and other natural areas is an essential component of water quality management. These natural lands slow stormwater runoff and allow nutrients and bacteria to infiltrate into the ground. Targeted land acquisition can protect sensitive areas from developed and maintains it natural cover.

Natural lands are often protected in an uncoordinated and fragmented fashion. A regional planning approach may focus and coordinate conservation, planning and investment efforts to achieve land preservation goals and objectives. Artist Boat, the GBF, the Audubon Society, the Nature Conservancy, and Scenic Galveston are several resource and conservation organizations already acquiring property for preservation in areas near the watershed. Within the watershed, the University of Houston (UH) Coastal Center (UHCC) manages about 300 acres of highly endangered coastal tallgrass prairie habitat. UHCC maintains areas of pristine prairie, and, when possible, restores areas invaded by exotic species or disturbed by human activity. UHCC provides access and equipment to support environmental research and supports outreach activities with public groups.

Back the Bay is an educational campaign through the GBEP that aims to engage citizens in the Houston-Galveston region in lifestyle and habitat changes to improve water quality, conserve water, and protect fish and wildlife habitat. Back the Bay provides residents with tips to preserve Galveston Bay and information to understand their connection to the bay. Back the Bay also seeks to involve local governments in voluntary conservation measures.

Communities are able to protect natural lands and habitat through various regulatory techniques. During the building permit process, communities can require that developers show due diligence with respect to the U.S. Army Corps of Engineers Section 404 mitigation for destroyed wetlands. This review would enable communities to align mitigation activities with other comprehensive land use planning efforts. The H-GAC Eco-Logical online mapping tool can be used to identify valuable habitat areas.

Landowner conservation plans are covered separately under Action Area (37).

**Location:** Acquisition opportunities will be evaluated for undeveloped properties. Properties with portions in the riparian zone should be given preference. See Map-8 in Appendix A, Ecological.

Implementation Objectives	Likely Lead Entity
1. Support acquisition and conservation of undeveloped natural lands: <ol style="list-style-type: none"> <li>1. Review area conservation plans and consult with resource and conservation organizations to identify protected lands within the watershed.</li> <li>2. Identify and prioritize properties with the potential for conservation management.</li> <li>3. Acquire undeveloped natural lands and encourage conservation easements.</li> </ol>	Municipalities; MUDs; County agencies; AgriLife; Resource agencies/organizations; GBEP; GBF; Artist Boat; Houston Wilderness
2. Provide education for public entities and residents on loss of habitat for wildlife utilizing Back the Bay materials and other existing programs.	Municipalities; MUDs; County agencies; AgriLife; GBEP
3. Use regulatory techniques to preserve natural lands: <ol style="list-style-type: none"> <li>1. Require inquiry through the USACE for Section 404 mitigation needs during the building permit process.</li> <li>2. Enact ordinances to protect certain trees from removal or discourage developers from cutting down all trees prior to construction.</li> </ol>	Municipalities; MUDs; County agencies; AgriLife; Resource agencies/organizations

**Estimated Bacteria and/or Nutrient Load Reduction**

Reduction Effectiveness: Low – Preservation of existing natural areas will provide no reduction to current bacteria loads; however, without preservation the bacteria load will increase with the additional impervious surface promised by future development.

Likelihood of Success: Coordination among agencies and conservation groups will be necessary for property acquisition. Priority site selection should include meaningful water quality benefits. The need to mix and match various funding sources can be challenging. Land acquisition costs are high.

Technical and Financial Needs: Property acquisition can be a very capital intensive effort. Consideration for recreational opportunities and multi-use developments could be combined with land management and preservation efforts. See Element D.

## 28 Additional Action Areas

The remaining 28 Action Areas, those that did not become Priority Action Areas after the voting exercise, are still considered viable project areas for this WPP, and brief narratives about project directions and resources are provided for each. The Action Areas are grouped by quadrant and are listed in the order they were presented during the voting exercise. For complete project rankings, see Table C-1.

### Quadrant 1: Wastewater Action Areas

#### **Action Area (1) Address maintenance of OSSFs through education efforts**

This action area is intended to improve maintenance of OSSFs by educating home owners about proper OSSF operation and maintenance. Incorporating OSSF criteria into standards of practice for home sale inspections is covered under Action Area 4.

Education for OSSF owners about malfunctioning septic systems may help them identify problems and prompt them to properly maintain their systems. The Texas A&M AgriLife Extension Service offers OSSF workshops for home owners, creates and distributes OSSF educational materials that outline maintenance needs (<http://ossf.tamu.edu/>), and stress responsibility towards improving water quality in the bayou as well as the health risks and economic burden of illnesses that can be caused by untreated effluent from malfunctioning OSSFs. The GCHD has OSSF permitting, fees, and inspection information available on their Consumer Health Services webpage. Additional resources for homeowners include a septic system quiz, a list of OSSF installers, and information on why septic systems fail. The GCHD will continue existing OSSF education programs. Mailouts notifying residents of septic online resources were suggested by stakeholders. Households having OSSFs would first need to be identified to ensure a targeted approach.

#### **Action Area (2) Hookup to central system or upgrade failing OSSFs**

Where feasible, expanding service area boundaries shifts wastewater management from private, onsite systems to a professionally managed, centralized treatment system. This option is available when municipalities are prepared to make the capital investments to expand their service areas. Hitchcock recently completed such an expansion towards the Freddieville area. Due to the limited use of septic systems in the area, the impact of this activity on load reductions is expected to be limited at best.

#### **Action Area (3) Improve enforcement to mitigate failing OSSFs**

After 1997, Galveston County stopped issuing permits for the construction of standard drain field OSSF systems in clay soils or in areas where the shallow groundwater surface was less than 2 feet deep. In these conditions common to the watershed, there were frequent instances of untreated septage flowing from drain fields. Older systems in the watershed have been “grandfathered” and home owners have not been required to replace them with alternative systems. Funding levels limit the number of inspectors who can make inspections and identify failing systems. Currently, calls from neighbors or others to report a discharge are the typical cause for an OSSF inspection. An increased budget for better inspection and enforcement would result in better identification of malfunctioning OSSFs. This, in turn, would result in an increase in repairs or replacement of malfunctioning systems. GHCD currently funds and trains new

inspectors. The Highland Bayou Watershed group will help solicit grant funding for the additional resources to support these activities. This activity is being pursued in other watersheds in the county, and partnerships with those watershed efforts could provide efficiencies of scale.

#### **Action Area (4) Incorporate OSSF criteria into standards of practice for home sale inspections**

Currently, home inspectors are not required to inspect OSSFs for home buyers, nor is there an accepted standard procedure for inspections. Without a standard procedure, the methods to determine the operational status of OSSFs may vary with the inspector's knowledge of OSSFs. Buyers may not be aware of an undersized, under-maintained, or improperly functioning system. In order to ensure consistency and competency of OSSF inspections at the a point of sale, rules specifying standardized procedures for OSSF inspections, at the sale of the home for all types of OSSF systems, must be developed and enforced. A thorough inspection will provide the home buyer the information needed to determine if their lifestyle and water usage is within the capabilities of the OSSF associated with the home that is being sold.

Texas A&M AgriLife Extension Service is developing an inspection manual for conventional OSSFs. The manual provides step-by-step guidance for inspecting the septic tank and treatment area. A checklist is used to determine the operation status and identify inspection and maintenance frequencies. Texas A&M AgriLife Extension Service will recommend that inspectors in Galveston County follow the manual for conventional systems until such time that the rules required to standardize inspection of OSSFs are established (statewide or in Galveston County). The watershed group will work with the GCHD, GBF, TREC and other watershed groups to advance this action area.

The H-GAC hosts a course on OSSF visual inspection for home inspectors. Participants learn how to identify failing OSSFs through visual inspection during this one-day course and will receive six continuing education hours from the Texas Real Estate Commission. (<http://www.h-gac.com/community/water/ossf.aspx>)

#### **Action Area (5) Target areas for intensive water quality sampling based on OSSF pollution**

Sampling efforts alone will not contribute directly to reduced bacteria counts; rather, the information obtained from sampling would be used to prioritize implementation efforts, and stakeholders expect to see decreases in bacteria counts as failing OSSFs are repaired or replaced. The recommended monitoring schedule included in Element I describes existing and recommended sampling programs to assess progress towards attaining water quality standards during the implementation activities within the Highland Bayou. Before sampling locations can be selected for water quality monitoring, it is important to identify the location or likely of all OSSFs (both permitted and non-permitted) to improve the monitoring strategy. H-GAC has an online mapping system for OSSFs in the region, as well as local knowledge on behalf of the staff of GCHD could be used to support the goals of this activity. Several ambient sampling locations could then be selected by the GCHD on Highland Bayou. Stakeholder workgroup members plan to seek grant funding for sustained sampling and analysis.

## **Action Area (6) Fats, Oils, and Grease and Wipes in the Sanitary Sewer Collection System**

FOG and wipes were ranked by stakeholders as #2 among the priority action areas. The goals, approach, and implementation objectives for this action area are discussed in the corresponding *Priority Action Area Table*.

## **Action Area (7) Develop and implement an improved sanitary sewer overflow initiative plan/program**

The SSO Initiative is a voluntary program initiated in 2004 by the TCEQ, in an effort to address an increase in SSOs due to aging collection systems throughout the state and encourage corrective action before there is harm to human health and safety or the environment. Breaks, leaks, and overflows in these systems, collectively referred to as sanitary sewage overflows (SSOs), create overflows of untreated sewage into the stormwater system and ultimately waterways.

(<http://www.tceq.state.tx.us/field/ssoinitiative>)

Hitchcock and La Marque have both participated in TCEQ's SSOI program and are in different phases of assessment and implementation to reduce SSOs. Through the SSOI program, a plan for SSO reduction is submitted to TCEQ including a system inventory, sewer map update, inspections and testing, and system rehabilitation with multiple phases of construction. La Marque is in the process of issuing substantial capital improvement bonds for their SSO program. The City of Hitchcock completed their SSOI program agreement in 2013 and is continuing system rehabilitation construction activities for SSO reduction. While MUD 12 has not participated in TCEQ's SSOI program, they perform wastewater collection system surveys and also report information to TCEQ. Collection system improvements made by the City of Hitchcock, the City of La Marque and MUD 12 regarding SSO reduction is a continuous endeavour that each of these wastewater service providers are committed to overcome. Stakeholder workgroup members proposed owners and operators of WWTPs in the Highland Bayou Watershed revisit their SSO reduction plan/program if completed and implement an SSOI plan/program if the entity has not participated in the SSOI through TCEQ, aiming for each WWTP in the watershed to have an implemented plan.

The TCEQ is responsible for distributing educational materials about existing SSOI programs. Sanitary sewer system owners and operators are responsible for developing and implementing any SSOI plans. When appropriate, stakeholder workgroup members who are owners and operators should collaborate during the development or implementation of their respective SSOI plans. The stakeholder workgroup plans to seek funding for these activities from federal or state grant programs such as the CWA 319(h) grant program.

## **Action Area (8) Surveying collection system lines to identify problem areas**

This action area specifically addresses the survey of collection system lines to identify problem areas. In order to address blockages effectively, a program expanded to entire sanitary sewer system is ideal. System rehabilitation projects (replacement of damaged or corroded lines, etc.) combined together with improved monitoring technologies can bring an aging collection system into proper working order and reduce the number of SSO discharges. La Marque, as an SSOI participant, documents their progress within and annual progress report. For sewer pipes, lift stations, manholes, etc., the frequency of inspections is included as a required operations and maintenance activity. The evaluation of I/I in the

sanitary sewer is covered by the annual report through flow monitoring (wastewater treatment facility, lift stations, rainfall records, etc.), dye or smoke testing to identify leaks and illegal connections, and/or system and mapping updates.

Analog closed-circuit television (CCTV) technology is an industry standard for pipe inspection and are designed for small diameter (less than 60 inch diameter) pipelines to provide high resolution images of infrastructure. Barriers for this technology are flow (the vehicle used to transport the CCTV cameras can only be used with low or no flows in the pipe), and high volumes of sediment or debris. Man-entry pipe inspection is typically done for larger pipes. These inspections would typically involved two inspectors to enter and document the pipe condition using photo and video as well as other general condition assessments. La Marque has used CCTV inspection robot cameras to inspect their lines.

### **Action Area (9) Infrastructure Upgrades to the Sanitary Sewer Collection System**

Infrastructure upgrades to the sanitary sewer collection system were ranked by stakeholders as #1 among the priority action areas. The goals, approach, and implementation objectives for this action area are discussed in the corresponding *Priority Action Area Table*.

### **Action Area (10) Improvements in WWTP operation**

The objective of this action area is to improve treatment operations at facilities permitted by the TCEQ to treat domestic wastewater. In 2008, the TCEQ instituted a state-wide requirement to include water quality based bacteria effluent limitations and monitoring requirements for facilities permitted to treat domestic wastewater. All new permits issued after 2008 for these types of facilities will contain the new state-wide requirements. Facilities with existing permits to treat domestic sewage will be required to incorporate the new requirements when they seek permit renewals or amendments. All three permitted WWTPs in the watershed treat domestic wastewater and therefore have a potential to contribute to the bacteria load and are operating under permits issued after the new permit requirements were initiated Table A-3.

The TCEQ has issued notices of violations to WWTPs in the watershed and, as of 2015; one facility is under enforcement orders issued by the TCEQ for violating their permits. In the last five years La Marque has had three TCEQ inspections and Galveston County MUD 12 has had two, none resulting in enforcement actions. Two formal enforcement actions were reported for the City of Hitchcock. There have been nine reported effluent exceedances for both Hitchcock and La Marque and one for Galveston County MUD 12 between 7-31-2012 and 7-31-2015. The GCHD offers inspections of WWTP operations for compliance with state and federal regulations as a contract service and have assisted Hitchcock and La Marque as recent as 2015. During the comprehensive compliance inspection, samples from the effluent are collected to verify compliance with the permit, adequate operations of the processing units are verified, and records are reviewed for compliance with TCEQ permit requirements. Results are reported annually to the wastewater service provider and are publicly available. Stakeholders suggested these facilities continue to participate in this voluntary program and that the MUD 12 WWTP consider joining as well.

Workshops for plant operators, specifically addressing bacteria and troubleshooting methods, were recommended by stakeholders. There are various professional development opportunities for public

works employees that offer free CEUs. Texas A&M Engineering Extension Service (TEEX) offers a two-week training cycle for wastewater personnel interested in obtaining a TCEQ Class-C license exam. Sequentially delivered courses, offered at a reduced tuition, are taught over a two week period. <https://teex.org/>

## **Quadrant 2: Stream Flow and Dredging Action Areas**

### **Action Area (11) Stream Flow within the Highland Bayou Channel, Improve flow within Highland Bayou by dredging sediment and clearing vegetation**

Stream flow within the Highland Bayou channel was ranked by stakeholders as #3 among the priority action areas. The goals, approach, and implementation objectives for this action area are discussed in the corresponding *Priority Action Area Table*.

### **Action Area (12) Flow within the canal communities. Dredging of canals with beneficial uses for dredge material and partnership for volunteer planting**

This action refers to improving the flowing water in the various canal communities along Highland Bayou. Over time, the flow of water throughout the watershed has noticeably decreased according to stakeholders, they believe attributed in part to sediment accumulation. Differences in depths between the canals (17') and the bayou (4') result in 'trapped' water in the canals, resulting in stagnant flow and eutrophic conditions. Multiple fish kills have been observed in these communities. Bayou Vista, to improve water flow in its canals, has installed SolarBee water mixers, what have proven expensive and delivered mixed results. In addition to contributing to the ecological health of the watershed, leaders in local communities have expressed a need to dredge for recreational boating. As such, this action area may fulfill multiple priorities.

A principle action identified for this activity involves the removal of sediment build-up. Improved flow and tidal exchange may result in lower bacteria levels. Reducing sediments in these areas can provide a number of secondary benefits. For example, excavated dredge material can be used to create living shorelines (see action 14), restore habitats, and enhance natural vegetation, all of which can further contribute water quality benefits. The US Army Corps of Engineers and Galveston County have completed a number of projects in recent years using dredged material for beach nourishment and shoreline restoration.

Organizations such as the GBF, Texas Parks and Wildlife, the GBEP, the Galveston County Consolidated Drainage District, and the US Army Corp of Engineers (USACE) can collaborate with communities to remove dredge material and use it for sustainable purposes (refer to Element D for further information). Further, these organizations can assist in water quality studies and sediment reduction studies. USACE should be contacted prior to conducting and dredging and habitat restoration projects.

### **Action Area (13) Culvert Dam Maintenance in the Highland Bayou Channel**

Culvert dam maintenance in the Highland Bayou channel was ranked by stakeholders as #4 among the priority action areas. The goals, approach, and implementation objectives for this action area are discussed in the corresponding *Priority Action Area Table*.

**Action Area (14) Encourage living shorelines as an alternative form of shoreline protection when possible**

This action refers to stabilizing the shoreline using native vegetation alone or in combination with offshore sills. Living shorelines provide a natural alternative to ‘hard’ shorelines like stone sills or bulkheads, and provide numerous benefits including nutrient pollution remediation, fish habitat provision, and buffering of land from waves and storms. Living Shorelines are composed of materials such as wetland plants, soil, stone, oyster reefs, dredge material, submerged aquatic vegetation and other organic resources. Due to the aquatic make-up of these shorelines, they help to improve water quality by removing nutrients such as nitrogen and phosphorous from the water, and even trapping sediments during storm events.

For areas along Highland Bayou, and even in the canal communities, living shorelines can be added around bank edges to reduce erosion and stabilize the shoreline. The use of this alternative approach has proven to be successful along the nearby diversionary canal in Hitchcock, Texas. GBF along with community partners graded the shoreline back from the waterline in order to plant smooth cordgrass; due to the low wave energy in this area no hard structure was deemed necessary. The result yielded beautiful vegetation, and prevention of coastal erosion.

GBF and its partners aids in project design, material selection, permit application, construction, plant selection and installation, and may even be available help identify grant funding opportunities. On average the creation of such projects from concept to completion averages from 5-7 years.

**Action Area (15) Review of bulkhead standards to include maintenance enforcement**

The installation of bulkheads in the Highland Bayou Watershed region is regulated by many local entities within the region. Cities such as the City of La Marque have ordinances for the design, and construction of bulkheads. Generally an inspection is conducted to test the integrity of the bulkhead and ensure it is in compliance with local codes. In some instances the code may include language stating the owner must “maintain” the installation. Such language is subject to interpretation by each individual person and cannot be measured. For these reasons, bulkheads decline over time and fail to prevent erosion of sediment into waterways. A solution may be requiring inspections to be conducted biannually, every five years, or what the local entity deems appropriate. For guidance, local jurisdictions should gather model ordinances and assess for suitability for local adoption. Communities should also review their ordinances over time to assess effectiveness, and improvement areas.

**Action Area (16) Shoreline protection for the railroad south of Bayou Vista to maintain boat access and Reduce erosion**

A berm located south of Bayou Vista is experiencing severe erosion from wakes created by passing boats. This berm not only acts as a buffer against the wakes, it also supports rail road tracks. To maintain canal access for boaters and minimize erosion of the berm, several solutions were discussed by stakeholders. Areas that would benefit from coastal erosion protection have multiple solutions that both solve the problem of erosion and benefit the environment. Texas Parks and Wildlife Department administers a Boating Access Grant that can potentially dredge an area and use the dredge material to fill low lying



areas that are prone to flooding. Dredge materials could also be used to create “living shorelines.” The site would need to be assessed for suitability, as living shorelines are not always possible. Another solution mentioned by the stakeholder group is to use rip-rap materials to control erosion, and fill the areas subject to flooding. Collaboration between multiple entities would be necessary, likely involve Bayou Vista, MUD 12, the U.S. Army Corps of Engineers, Burlington Norther and Santa Fe Railway (BNSF), and natural resource agencies. The property is owned by MUD 12 and the railroad is operated by BNSF.

### **Action Area (17) Combine detention areas into multi-use areas (regional stormwater detention facilities) where possible**

Stormwater detention is a requirement for new development throughout the Highland and Marchand Bayous watershed, except in limited instances. New development must provide detention of sufficient runoff volume so as to minimize the impact of the development in terms of flooding. Most of the Highland-Marchand Bayou Watershed falls within GCDD2, with a small part in the extreme NW falling in Galveston County Drainage District No 1. South of the Highland Bayou main stem there is no separate drainage district, and Galveston County drainage rules apply. GCDD2 defers to Galveston County drainage rules, such that the entire watershed is governed by Galveston County rules.

Regional stormwater detention refers to consolidating smaller, individual detention projects into larger more extensive projects. Concentrating detention regionally provides more opportunity for better maintenance and many more opportunities for multiple uses of detention basins, such as athletic fields, playgrounds, and picnic areas. Larger detention facilities also enable the incorporation of SWW into the detention basins. SWW are one of the very best practices for cleaning polluted stormwater runoff. Well-designed SWW also add a measure of beauty and ecology. Birdwatching stations, for example, can be designed into the basins.

There is local recognition of the value of larger detention facilities. For example, regional detention is referred to as a policy preference in the Galveston County Consolidated Drainage District drainage manual. There is currently no known activity to push for regional detention in this watershed.

The water quality impact of SWW is significant (Jacob et al, 2012; International Stormwater BMP Database, 2014). Bacteria (*E. coli*) removal can easily be as high as 80-90%. Nitrate nitrogen (NO<sub>3</sub>) removal frequently exceeds 70% (International Stormwater BMP Database, 2014). These numbers put SWW in the highest performing group of GI practices. A very important example of a multi-use detention facility that incorporates the full gamut of cleansing wetlands, nature trails, and athletic facilities can be found in the Exploration Green Park, now under construction in Clear Lake.

(<http://www.explorationgreen.org>)

## **Quadrant 3: Urbanization & Development Action Areas**

### **Action Area (18) Pet waste ordinances and bylaws**

Municipal ordinances and HOA bylaws can provide an incentive for residents to dispose of waste properly. Common areas and parks are good areas to publicize these rules. Model ordinances are available online, and should be reviewed by localities for suitability and opportunities to improve applicability.

Together with these rules is the need for enforcement and willingness to follow through on penalties for violations.

### **Action Area (19) Pet waste education**

Pet waste education was ranked by stakeholders as #5 among the priority action areas. The goals, approach, and implementation objectives for this action area are discussed in the corresponding *Priority Action Area Table*.

### **Action Area (20) Reduce the population of stray animals**

Reducing stray pet populations can decrease the bacteria that enter our local waterbodies. Registration requirements include spaying and neutering pets in Bayou Vista, Hitchcock, La Marque, and unincorporated Galveston County. Many spay/neuter programs, including some shelters offer a reduced price for these services. Stakeholder workgroup members can partner with local shelters and veterinarians to provide education on the benefits of spaying and neutering.

### **Action Area (21) Encourage water conservation through education**

Through the installation of rain barrels and rain gardens using native plants, residents can learn about water use, conservation, and its impact on polluted runoff. Communities interested in water conservation education can contact GBF and Texas A&M Agrilife's Texas Coastal Watershed Program. The Texas Coastal Watershed Program's WaterSmart program has a track record of successful demonstration projects around Galveston County.

GBF has developed a workshop on the environmental benefits of collecting rainwater, and proper rain barrel installation instructions and tips. Registration is \$35, which includes one 35-gallon barrel + one connector kit, and workshop registration. Workshop participants can purchase a maximum of 2 barrels + 2 kits. Attendees are encouraged to ask questions and take advantage of the resources offered, which help improve water quality in Galveston Bay. (<http://www.galvbay.org/rainbarrel>)

### **Action Area (22) Effective landscaping practices through education**

Improper management of landscaping debris, fertilizers, and pesticides was a prominent concern of stakeholders. These materials, in excess, lead to increased BOD and can contribute to fish kills, and there is a need for public education about water quality impacts associated with landscaping practices. Homeowner education for spraying pesticides (e.g. *Cutter*® Backyard™ Bug Control Spray and similar products) was specifically recommended by stakeholders, including, how much to use, when to spray in relation to rain events, and for the homeowner to consider nearby waterbodies. Education for lawn contractors was also brought up by stakeholders as essential to reducing the amount of the above mentioned materials entering surface waters.

Stakeholders in the watershed will work with programs like WaterSmart, Grow-Green and Earth-Kind Landscaping to provide materials to homeowners about proper application rates for fertilizer and pesticides. Resources for sustainable landscape management are also available through AgriLife Extension's Master Gardener and Master Naturalist programs, and Texas A&M's Texas Coastal

Watershed Program. Soil nutrient tests are offered free through AgriLife Extension for homeowners and landscape managers to utilize soil nutrient analysis to ensure proper fertilizer application rates.

**Action Area (23) Use landscaping debris ordinances to discourage homeowners from contributing lawn clippings and debris into stormwater**

Landscaping debris ordinances were ranked by stakeholders as #8 among the priority action areas. The goals, approach, and implementation objectives for this action area are discussed in the corresponding *Priority Action Area Table*.

**Action Area (24) Encourage the use of green infrastructure and stormwater treatment wetlands through demonstration projects, ordinances, and education**

GI and stormwater treatment wetlands were ranked by stakeholders as #6 among the priority action areas. The goals, approach, and implementation objectives for this action area are discussed in the corresponding *Priority Action Area Table*.

**Action Area (25) Install educational watershed signage**

Many residents do not know what a watershed is and are certainly not aware that everyone lives in a watershed. Recognizing the connection between runoff entering our storm drains and Galveston Bay can help residents and visitors recognize Highland Bayou as a valuable natural resource, promoting awareness and stewardship. Installation of educational watershed signage within parks, along watershed boundaries, and on roads can help promote awareness and educate citizens. Stakeholder workgroup members mentioned that including a map of the watershed, or pictures on signs could be positive ways to attract attention. Initial funding for watershed signage is only the first step. Maintenance and replacement issues were brought up by stakeholders as a potential barrier for this action area. Likely lead agencies for this effort are municipal public works departments, Galveston County Parks and Cultural Services Department, the Galveston County Road and Bridge Department, and GCHD.

**Action Area (26) Discourage illegal dumping through education and programs**

Illegal dumping refers to the unlawful disposal of used tires, construction debris, appliances, vehicles, boats, as well as household, commercial and industrial wastes in places other than permitted facilities such as landfills and transfer stations. Illegal dumping impairs water quality through the inflow of debris, chemicals, oils, and fuels that are hazardous to aquatic life and recreational uses. While illegal dumping is not necessarily a direct source of bacteria or nutrients, stakeholders expressed concern for litter near waterways and throughout the surrounding communities. According to stakeholders, problem areas for illegal dumping include vacant properties, dead end streets, the ditches along I-45, and within Highland Bayou Park.

To deter illegal dumping, municipal entities could establish a hotline, websites, social media platforms, or apps for residents to report illegal dumping. For example, the GBF's GBAN allows residents to report sightings of illegal dumping online or through a smart phone app, which are then relayed to the appropriate enforcement agency. Other prevention actions include installing signs with phrases such as, "No dumping", "Violators will be prosecuted", "Illegal dumping is a crime", "Do Not Litter", etc. Lead organizations can also use resources from the "Don't Mess with Texas Campaign" (see Element E for

more information). During this planning process, stakeholders reported that although the installation of signs works in some cases, it can have the counter-intuitive result of encouraging dumping in those areas. Another approach to illegal dumping may involve collaborating with not-for-profit organizations, municipalities, and state and county agencies to provide locations to dispose of materials properly. The City of Dickinson offers monthly tire recycling for any Galveston resident.

Trash Bash is an annual event where thousands of volunteers gather along Texas waterways to do their part in cleaning up the environment by participating in the largest single day waterway cleanup in the state of Texas. The Virginia Point Peninsula Preserve is located at the mouth of Highland Bayou just south of Bayou Vista. <http://www.trashbash.org/>

### **Action Area (27) discourage residential waste from entering the environment or sanitary sewer system**

Residential waste includes solutions and compounds commonly found in homes and garages. This may include fuel, oil, paint, solvents, cleaners, detergents, fertilizers, pesticides, and in particular pharmaceuticals. Residents are known to pour these outdoors in lawns or gutters where it flows into nearby waterways, or down kitchen and bathroom drains into the collection system; once in the system, these wastes may find their way into the environment through SSOs, leaks or WWTP discharges. WWTPs and OSSFs are not designed to treat many of the waste items described here. Once dispersed into the watershed, residential waste can impair water quality, harm aquatic life and make contact recreation and fishing problematic. One frequent misconception is that pouring kerosene or gasoline on fire ant mounds is an effective ant control practice, when in fact that is not true.

This action area seeks to educate residents and provide options for the proper disposal of these items. Activities that can address residential waste include household hazardous waste collection events, stormwater inlet marking with phrases such as “Only Rain Down the Drain” and “Drains to the Bay”, public awareness campaigns and signs. The “National Take Back Prescription Initiative” is one of many take back programs offered to help decrease the occurrence of accidental poisoning, overdose, and abuse posed by unwanted prescription medicines. Ensuring proper disposal also keeps prescriptions from being flushed down the toilet making it through the sewage treatment process and into our waterways. Local police departments can join this campaign to offer an alternative for residents looking to clean out their medicine cabinets. There are several tire recycling events in Galveston County. Galveston County residents may drop off up to 5 tires for recycling at the Dickinson Public Works building located at 3120 Deats Road from 7–10:30 a.m, the first Friday of every month. This free service is not available for commercial disposal and residents must be able to load and stack tires into the recycling trailer. The City of Dickinson’s Public Works Department can be contacted with questions. H-GAC has a list of places that you can drop off hazardous household waste. <http://www.recycleinfo.org/recycling-galveston-county.html>

### **Action Area (28) Improve erosion control practices during construction and development**

Construction and development activities usually disturb acres of soil surface and which can remain exposed for months or more. Disturbed surfaces include the construction pad, roads, maintenance yards, and newly excavated detention ponds. If not managed properly, erosion at these sites can transport

significant sediment into drainage conveyances and eventually waterways. Erosion adds turbidity to the water column, and the accumulation of eroded sediment in waterways removes flow capacity and can harm habitat for aquatic species. As development encroaches into the watershed, particularly in the highland bayou headwaters (AUs 2424A\_4 and 2424A\_5), the potential for sediment erosion is high. Drainage District 2 has observed and characterized soils in the watershed as highly erodible, and the district frequently has to manage sediment removal from their conveyances.

Construction erosion BMPs range from hydraulic seed spreaders to silt fencing and traps. The objective in these situations is to stabilize the surface or collect sediment via traps. Developments or common plans of development larger than acre within a regulated MS4 are subject to local ordinances governing erosion and sediment control during the construction phase. There are very few areas in the watershed that are unincorporated and fall outside of a regulated MS4. MS4 municipalities in the watershed have used a ‘model ordinance’ approach when they adopted their local ordinance and which do not prescribe specific practices. This approach can allow for flexibility and innovation, but it can also result in minimal compliance. As with all BMPs, effective erosion control BMPs comes down to proper installation and maintenance during the construction phase. The image below (Figure C-1) was taken north of the watershed in 2016. The practice shown is clearly not being maintained and sediment is flowing freely into the stormwater collection system. While communities may inspect sites using municipal inspectors, this duty is usually outsourced to third-party, consultant enforcement and reporting, which is the case for communities in the watershed.



**Figure C- 2. Example of a failing stormwater BMP; Photo taken just north of the watershed**

There are opportunities for communities to recommend higher standards for erosion control BMPs and to form cooperative agreements for inspection and enforcement. Multiple violations may result in penalties until the violations are remedied by the developer or its contractors. Similarly, the MS4 program requires the inclusion of language for educating the public about stormwater, and could form the basis for a municipally led outreach program relating to this action area. Also, the GBF’s GBAN program provides an online tool for collecting reports of pollution in the area, and this tool could be used to report failing erosion control BMPs or observations of excessive erosion.

**Action Area (29) Evaluate existing stormwater strategies for education needs and opportunities to collaborate**

In the past, the Galveston County ‘stormwater collaborative’ of public sector professionals would meet monthly at County offices to share knowledge and ideas about stormwater management and the Phase II regulatory program. If the group still exists, it should be made aware of the Highland Bayou WPP process and consulted about ways to mutually support the goals of these two efforts.

EPAs Phase II Stormwater rules came into force in 1999 and require that municipalities be responsible for regulating unpermitted discharges into their stormwater conveyances, or MS4s (Municipal Separate Storm Sewer System). Phase II requires that municipalities adopt ordinances and programs to address six areas of activity (minimum control measures) and which relate to several NPS pollutants of concern and stormwater, generally speaking. As noted in Action Area 28, most communities have taken the approach of adopting a ‘model ordinance’ which are usually generic and not tailored to local conditions or the priorities of the communities that adopt them. Municipalities in the basin should revisit their stormwater and construction site ordinances to assess for opportunities to update known weak points as understood through previous enforcement actions. This may mean enhanced inspection frequencies or clearer standards about erosion abatement practices.

Cooperative agreements or MOUs could be utilized by municipalities in the watershed and nearby watersheds such as Dickinson Bayou to pool limited resources to address issues common to all communities, such as education or the creation of construction site standards. Street sweeping is one activity that sometimes falls under a community’s Phase II program, but the equipment can be costly to purchase and maintain under any one community’s annual budget. One minimum control measure within the Phase II program is a requirement to have an outreach program to educate the public on stormwater and stormwater pollution. No communities in the basin are formally integrating existing educational programs offered by a range of entities such Texas A&M AgriLife Extension Service, TCEQ, GBEP, or H-GAC into their Phase II outreach programs. Even short-term activities such as storm drain inlet stenciling can provide an educational benefit and enhance a community’s compliance with Phase II rules.

### **Action Area (30) Stormwater Infrastructure Assessment Surveys**

Stormwater infrastructure assessment surveys were ranked by stakeholders as #7 among the priority action areas. The goals, approach, and implementation objectives for this action area are discussed in the corresponding *Priority Action Area Table*.

## **Quadrant 4: Agricultural/Wildlife/Land Management Action Areas**

### **Action Area (31) Host feral hog awareness and training workshops to promote the reduction of feral hog populations**

Feral hog populations are known to live within the watershed, although numbers are not estimated. Their ability to disturb the natural soil cover is surprising for people unaware of the damage they can do. Disturbed areas contribute sediment erosion, and feral hog fecal matter is a likely source of bacteria in the watershed. Feral hogs also carry disease and are a nuisance, non-native species. To address this, stakeholders identified hosting feral hog awareness and training workshops to promote education about methods for reducing feral hog populations. In 2013, stakeholders hosted a successful feral hog workshop at Carbide Park on a Saturday in 2013, which included free bar-b-q. Other organizations that have

experience with these types of activities and which could be involved in future efforts include the Texas A&M AgriLife Extension Service and the UH Coastal Center.

### **Action Area (32) Participate in feral hog hunting and trapping programs**

In addition to hosting feral hog awareness and training workshops, stakeholders identified a need to promote feral hog hunting and trapping programs. Stakeholders suggested that sterilization or extermination is necessary to be truly effective. During this planning process stakeholder suggested developing a feral hog bounty program, which could include tracking how many hogs are killed. While this program should be watershed wide, stakeholders identified areas near Jack Brooks Park as being a high priority. Organizations or groups which could take the lead on this project include the Texas Youth Hunting Program, through Texas Wildlife Association. The Harris County National Wild Turkey Federation may also be willing to host a feral hog hunting event. Other possibilities include hiring a consultant trapper for public property and private homeowners responsible for trapping on private land. There are state regulations that govern the transport of non-native species across county lines, and there are Galveston County restrictions on hunting and trapping in the county. The specifics of these rules need to be better understood by the watershed group when designing a hunting and trapping program.

### **Action Area (33) Discourage the public from feeding pigeons and other birds**

Stakeholders have reported pigeons in large numbers throughout the canal communities in the lower reach of the watershed. Pigeons are seen at bayou access points and nesting under boat houses. Stakeholders reported seeing large numbers of pigeons at Louis Bait Camp. Such a high volume of birds will inevitably contribute to the bacteria and nutrient load of the waterway through bird droppings. The presence wild birds is natural and desirable. It is appropriate to consider bacterial loadings resulting from wildlife as part of natural or ambient conditions, and this is mentioned in the proposed monitoring program described in Element I. To reduce the attractiveness for wildlife, food sources can be kept to a minimum by prohibiting feeding by the public and removing trash (Environmental Protection Agency, 2001). Stakeholders suggested an education program be established to inform the public about the harmful effects caused by feeding waterfowl, both on the environment and the overall health of their population.

### **Action Area (34) Preserve existing natural areas**

The preservation of existing natural areas was ranked by stakeholders as #10 among the priority action areas. The goals, approach, and implementation objectives for this action area are discussed in the corresponding *Priority Action Area Table*.

### **Action Area (35) Restore and repair riparian zones**

A riparian zone is the strip of land along a river or stream. It is a transition zone and captures surface runoff from higher ground, filtering out sediment and nutrients before it reaches the waterway. In particular, vegetation traps sediment before it reaches rivers, and stabilizes the shoreline, reducing erosion. Likewise, soil microbes that thrive in this moist environment break down chemical pollutants like hydrocarbons, further protecting water quality. Their natural functions can counteract the effects of polluted runoff from pavement and buildings, protecting water quality and the river channel itself.

There are a number of projects that can be employed to restore and repair these zones. Projects identified during this planning process include 1) restoring native vegetation during projects within riparian areas, 2) utilizing native plants for bank stabilization or capturing pollutants in storm water runoff, 3) hosting a riparian and stream ecosystem workshop in the watershed, and 4) Identifying property owners and providing assistance in evaluating their property for restoration projects. The Texas Riparian and Stream Ecosystem workshop is a free, one-day workshop through the Texas Riparian Association where Texas A&M AgriLife Extension co-presents with local watershed protection groups to provide stakeholders with classroom presentations and field demonstrations highlighting the hydrology, natural healthy riparian function and possible causes of riparian degradation. <http://texasriparian.org/>

The GBEP has worked to restore and repair riparian zones in the region. GBEP recently partnered with City of League City to enhance and restore riparian areas within Clear Creek Nature Park – located next to the tidally influenced reaches of Clear Creek, a tributary of Galveston Bay. Other potential partners include the Texas Riparian Association, USDA, USFWS, TPWD, and TSSWCB.

### **Activity Area (36) Encourage use of the bayou by the public as a natural resource through education**

Stakeholders expressed an interest in seeing more swimming or direct contact recreation in Highland Bayou as they had in years past. Residents and visitors recognize Highland Bayou as a valuable natural asset to the community.

A few stakeholders expressed the “education of youngsters as being the most critical part” because children are more likely to incorporate what they learn into their daily lives. In addition, they will typically remind adults of the environmental impacts of their actions. Artist Boat offers youth eco-art workshops and kayak adventures to student groups on bayous leading into Galveston Bay. (<http://www.artistboat.org/eco-art-adventures.html>) Students on these field trips learn how their everyday actions on land can have a long reaching impact water quality and the health of the environment. The EPA supports environmental education projects that promote environmental awareness and stewardship through the Environmental Education Grant proposal process.

Texas Parks and Wildlife Department describes involving residents in outdoor recreation as a “critical component of conservation”, citing numerous studies that confirm the connection between outdoor recreation and caring for natural resources. The Texas Parks and Wildlife Department provides 50% matching funds to municipalities, counties, MUDs, and other local units of government with a population less than 500,000 to acquire and develop parkland or to renovate existing public recreation areas.

### **Action Area (37) Promote landowner involvement with existing conservation plans and cost share programs**

Landowner conservation plans were ranked by stakeholders as #9 among the priority action areas. The goals, approach, and implementation objectives for this action area are discussed in the corresponding *Priority Action Area Table*.

### **Action Area (38) Bacteria source tracking (BST) and wildlife surveys**



BST analysis on ambient surface water samples is used to identify the animal species sources of fecal bacteria contamination in water samples. BST is a relatively new approach that compares water quality monitoring samples to a bacteria DNA library, which is prepared using known sources from within the watershed. This enables watershed planning participants to determine the most significant contributors of bacteria. Utilizing BST results was recommended by stakeholders to adjust implementation efforts and facilitate adaptive management during watershed planning. <http://texasbst.tamu.edu/>.

First, funding for BST analysis would be needed to initiate efforts for under this action area. Funding for targeted BST analysis within the Highland Bayou Watershed will be pursued as a part of the implementation strategy. Costs to perform this analysis have come down sharply in recent years, enhancing the feasibility of this type of monitoring in future years. A report describing the results of the BST analysis at the subwatershed level for the Highland Bayou Watershed was proposed with a focus on evaluating human sources (WWTPs, sanitary sewer collection systems), domestic animals (both pets and livestock), and feral hogs.

While BST analysis alone will not reduce bacteria entering Highland Bayou and its tributaries, the information obtained can be used to prioritize efforts targeting specific sources. The recommended monitoring schedule included in Element I includes BST analysis to supplement existing sampling programs to assess progress towards attaining water quality standards during the implementation activities within the Highland Bayou Watershed.