Coordinating Implementation of a Watershed Protection Plan for Double Bayou

Final Report

East Fork Double Bayou at Humphrey Road.

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Submitted to TCEQ June 2021

Contract No. 582-18-80345

Published by the Texas Commission on Environmental Quality, October 2024
AS-507

Prepared for:
Galveston Bay Estuary Program
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This project was funded by the Texas Commission on Environmental Quality
and the United States Environmental Protection Agency

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Suggested citation: Glenn, Stephanie; Bare, Ryan; Roberts, McKenzie. Geotechnology Research Institute/Houston Advanced Research Center. 2021. Coordinating Implementation of a Watershed Protection Plan for Double Bayou Final Report. Contract No. 582-18-80345, Galveston Bay Estuary Program. Austin: Texas Commission on Environmental Quality (AS-507).

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Abbreviations

BST	Bacterial Source Tracking
EPA	U.S. Environmental Protection Agency
E. coli	Escherichia coli
FIB	Fecal Indicator Bacteria
GBEP	Galveston Bay Estuary Program
GBP	Galveston Bay Plan, 2nd Edition
HARC	Houston Advanced Research Center
HGAC	Houston-Galveston Area Council
NPS	Nonpoint Source
OSSF	Onsite Sewage Facilities
PS	Point Source
SELECT	Spatially Explicit Load Enrichment Calculation Tool
SWQIMS	Surface Water Quality Information System
TAMU	Texas A&M University
TCEQ	Texas Commission on Environmental Quality
TSSWCB	Texas State Soil and Water Conservation Board
USGS	U.S. Geologic Survey
WPP	Watershed Protection Plan
WQMP	Water Quality Management Plan
WWTF	Wastewater Treatment Facility

Executive Summary

The Double Bayou Watershed is situated in the eastern portion of the Lower Galveston Bay watershed on the Upper Texas Gulf Coast and is comprised of two main subwatersheds: East Fork Double Bayou and West Fork Double Bayou. The Double Bayou Watershed drains 98 square miles (61,445 acres) of predominantly rural and agricultural land directly into the Trinity Bay system and, ultimately, into Galveston Bay. Today, the lands and waters in and around Double Bayou support: rice farming, cattle grazing, oil production, small town and country living, industry and commercial navigation, sailing, paddling, crabbing, oystering, recreational fishing, and wildlife watching.

The West Fork of Double Bayou (Segment 2422B) is listed as impaired (not meeting its water quality standards) on the 2020 Texas Integrated Report 303(d) for low dissolved oxygen (aquatic life usage listed since 2004) and for elevated levels of bacteria (recreation use listed since 2006). In addition, the East Fork of Double Bayou (Segment 2422D) is listed as impaired for bacteria in water (recreation use listed since 2014) (TCEQ 2020a).

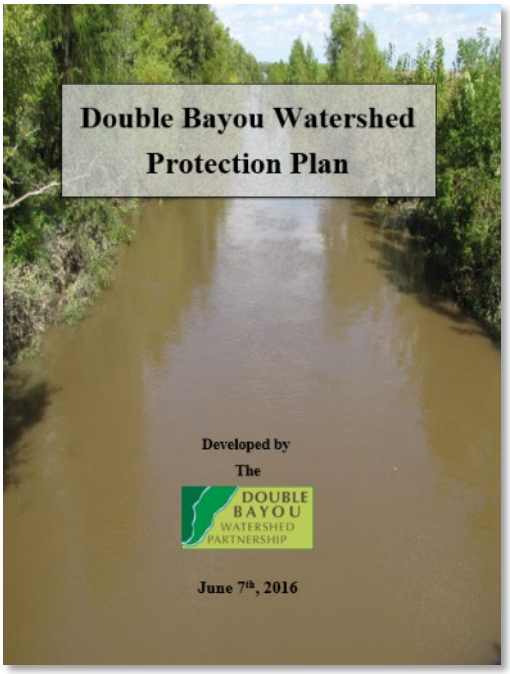


Figure 1. Cover of the Double Bayou Watershed Protection Plan.

The Texas State Soil and Water Conservation Board (TSSWCB) and the Galveston Bay Estuary Program (GBEP) provided funding to develop a Watershed Protection Plan (WPP) for the Double Bayou Watershed based on criteria that included the ongoing activities and level of stakeholder interest, presence on the Texas Integrated Report (303(d) list), and the potential for success (Figure 1). Public meetings were held in Anahuac and Double Bayou. Shortly thereafter, the Double Bayou Watershed

Partnership was formed to guide the WPP development process. The Partnership works with citizens, businesses, public officials and state and federal agencies to improve water quality in the Double Bayou Watershed. The Partnership recognizes that success in improving and protecting water resources depends on the people who live, work, and recreate in the watershed. As of July 19, 2016, the stakeholder-approved and Environmental Protection Agency (EPA)-reviewed Double Bayou WPP was final. The Double Bayou WPP serves as a guidance document for restoring and protecting nonpoint source (NPS) water quality.

The *Coordinating Implementation of a Watershed Protection Plan for Double Bayou* project, jointly funded through GBEP and TSSWCB, brought together the Partnership to successfully implement stakeholder-approved management measures outlined in the Double Bayou WPP. Management measures and milestones reached during this project include the creation of new and maintenance of pre-existing Water Quality Management Plans (WQMPs), the removal of feral hogs, additional stakeholder meetings and outreach activities, the replacement and maintenance of Onsite Sewage Facilities (OSSF) in the watershed, and water quality monitoring. Initial analysis of the water quality data shows Fecal Indicator Bacteria (FIB) concentrations remain higher in the West Fork compared to East Fork, and that the Wastewater Treatment Facility (WWTF) is not a major contributor of point source (PS) fecal waste.

Introduction

The *Coordinating Implementation of a Watershed Protection Plan for Double Bayou* project funded water quality data analysis efforts, continued stakeholder coordination, and began implementation of management measures detailed in the WPP. These efforts are critical to bridge the gap between management measures developed through the Double Bayou WPP process and implementation activities. Water quality monitoring results were evaluated by the Houston Advanced Research Center (HARC) to describe ongoing changes in water quality. Water quality monitoring is critical in helping determine effectiveness, placement, and prioritization of management measures. The results can be used to support adaptive management, understand changes in water quality, track implementation progress, and update stakeholders about current water quality conditions.

Implementation Project Goals:

- Support and facilitate Double Bayou WPP stakeholders in prioritizing management measures to improve water quality.
- Evaluate progress of implementation projects toward achieving milestones established in the WPP.
- Analyze data of known and acceptable quality for surface water quality monitoring of both West Fork and East Fork stations.
- Communicate water quality to stakeholders supporting adaptive management to expand public knowledge and participation in the Double Bayou implementation project.

The Implementation of the Double Bayou WPP project was jointly funded by TSSWCB and GBEP. The TSSWCB-funded portion supported water quality monitoring,

stakeholder meetings and communication, education and outreach, data analysis and development of visuals, and website maintenance including updated project materials and milestone tracking progress. The data and materials discussed in this report includes monitoring and project activities through the end of the GBEP project period which concludes May 31, 2021. The TSSWCB-funded portion of the project extends beyond the GBEP project period and is not scheduled to be completed until Aug. 31, 2022.

This project also leveraged other activities occurring in the watershed. Through TSSWCB project #16-04 *Implementing Agricultural Nonpoint Source Components of the Cedar Bayou and Double Bayou Watershed Protection Plans*, implementation of WQMPs identified in the Double Bayou WPP is underway. In addition, a 2017 study funded by the Galveston Bay Estuary Program Bacterial Source Tracking (BST) on Tributaries of Trinity and Galveston Bays[1] was conducted at five sites around Galveston Bay, one of which was located in the Double Bayou watershed. Results from the BST study are used in the current project to help guide the implementation of voluntary management measures described in the stakeholder-approved and EPA-accepted Double Bayou WPP.[2]

The *Coordinating Implementation of a Watershed Protection Plan for Double Bayou* project supports plan priorities, action plans, and actions outlined in the The Galveston Bay Plan, 2nd edition.[3] The Galveston Bay CCMP, 2nd edition was developed by GBEP and approved by TCEQ and the EPA's National Estuary Program in 2018. Specifically, the Double Bayou WPP satisfies the following CCMP plan priorities. The Ensure Safe Human and Aquatic Life Use plan priority is supported through the implementation of an approved WPP, outreach and education activities geared toward watershed stakeholders including the Double Bayou Live digital stakeholder series, the hosting of NPS workshops such as the Watershed Texas Stream and Riparian Workshop, as well as the role of the Double Bayou WPP to improve contact recreation safety. In addition, the Protect and Sustain Living Resources plan priority is supported through the eradication of the highly invasive feral hog. The Engage Communities plan priority is supported by engaging the local community through stakeholder activities such as the hosting of meetings to provide updates. Lastly, the Inform Science-Based Decision Making plan priority is exemplified by increasing access to water quality data collected in the watershed through presentations and the Double Bayou interactive data viewer.

- **Plan Priority: Ensure Safe Human and Aquatic Life Use**
  - ***Action Plan***: Improve Water Quality Through Nonpoint Source Pollution Abatement (NPS)
    - ***Actions***: NPS-1: Support Watershed-Based Plan Development and Implementation
    - NPS-2: Support Nonpoint Source Education and Outreach Campaigns

[1] gbep.texas.gov/wp-content/uploads/2020/09/18-80240-TWRI_BST_Final-Report.pdf
[2] www.doublebayou.org/watershed-protection-planning/wpp-document
[3] wayback.archive-it.org/414/20220305034426/https:/gbep.texas.gov/wp-content/uploads/2021/10/CCMP_2ndEdition_FINAL-DRAFT_Lead-Implementers.pdf

        - NPS-3: Implement Nonpoint Source Best Management Practices
        - NPS-4: Host Nonpoint Source Workshops
    - ***Action Plan***: Improve Water Quality Through Point Source Pollution Abatement (PS)
        - ***Actions***: PS-1: Support Stormwater Education Program
        - PS-2: Achieve Sanitary Sewer System Capacity and Ensure Integrity
        - PS-3: Ensure Wastewater Treatment Facility Compliance
    - ***Action Plan***: Promote Public Health and Awareness (PHA)
        - ***Actions***: PHA-3: Improve Contact Recreation Safety Through Watershed-Based Plan

- **Plan Priority: Protect and Sustain Living Resources**
    - ***Action Plan***: Support Species Conservation (SC)
        - ***Actions***: Invasive Species Management

- **Plan Priority: Engage Communities**
    - ***Action Plan***: Preserve Galveston Bay Through Stakeholder and Partner Outreach (SPO)
        - ***Actions***: SPO-1: Workshops and Events; SPO-4: Local Government Outreach
    - ***Action Plan***: Support Public Education and Awareness Initiatives (PEA)
        - ***Actions***: PEA-1: Key Issue Engagement; PEA-2: Adult Education

- **Plan Priority: Inform Science-Based Decision Making**
    - ***Action Plan***: Increase Access to Galveston Bay Ecosystem Information (ACS)
        - ***Actions***: ACS-1: Track Ecosystem Health Indicators

Project Significance and Background

The Double Bayou watershed is located on the Upper Texas Gulf Coast and is part of the Galveston Bay watershed. Situated in the eastern portion of the Lower Galveston Bay, it is comprised of two main subwatersheds; the East Fork and West Fork, which are also the two primary waterways in the watershed (Figure 2). The Double Bayou watershed drains directly into Trinity Bay of the Galveston Bay system. The majority (93%) of the watershed lies within Chambers County, Texas. The remaining 7% of the watershed is located in Liberty County, Texas.

Early Project Background

GBEP facilitated funding for an initial study in 2009, from grants under the American Recovery and Reinvestment Act, the EPA, state sources and United States Geological Survey (USGS), to explore whether a voluntary WPP could be beneficial for the Double Bayou Watershed. The funding provided resources for the HARC to: (a) assemble and analyze existing water quality data for the watershed, (b) collect new water quality samples for both forks of Double Bayou and analyze the data, and (c) share the information with key stakeholders, as well as the general public.

The Watershed Protection Plan

In 2012, HARC worked with the USGS and Shead Conservation Solutions with funding from TSSWCB/EPA and GBEP/TCEQ to develop a WPP for Double Bayou. Through the WPP process, stakeholders in the Double Bayou watershed including community leaders, elected officials, landowners, nonprofit organizations, and representatives of relevant local, state, and federal agencies met through a series of larger stakeholder meetings and smaller workgroup meetings to collaborate on the development of the WPP.

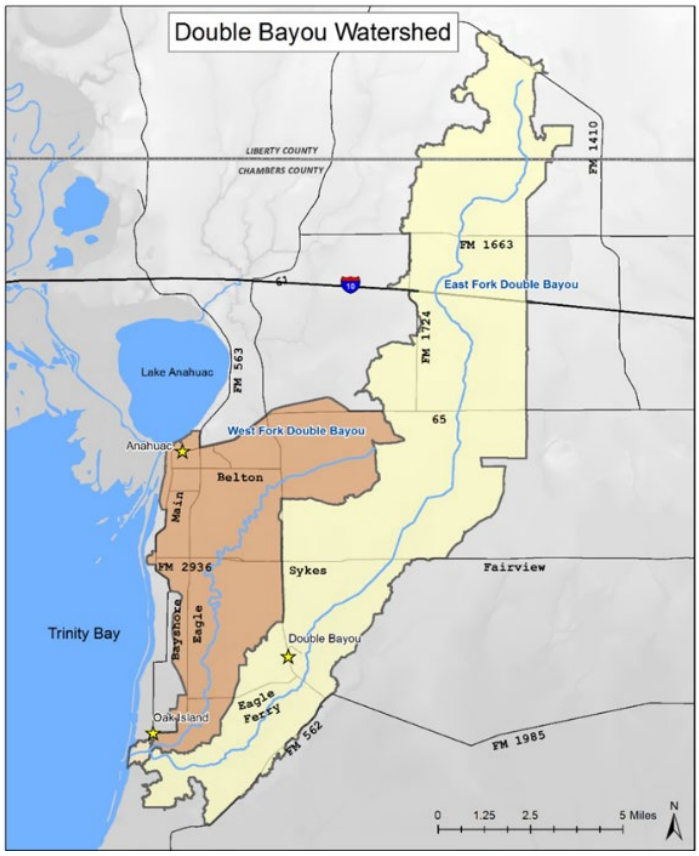


Figure 2. Double Bayou Watershed

Water quality was monitored on both the East and West Forks throughout the WPP process, and stakeholders were informed about results of the water quality monitoring and analysis. HARC developed the water quality data analysis and Spatially Explicit Load Enrichment Calculation Tool (SELECT) modeling, prepared graphs and exhibits of water quality data and SELECT modeling results, and prepared drafts of the WPP document chapters for stakeholder review and comment. Shead Conservation Solutions was responsible for the public participation component of the project, including maintaining communications with stakeholders through email and U.S. mail, preparing and distributing media items, providing notices of meetings and events,

facilitating meetings, and preparing meeting documents. Working with the stakeholders, ideas for water quality management measures were discussed and analyzed by the three main workgroups (Agriculture/Wildlife/Feral Hog, Recreation/Hunting, and WWTF/Septic) for inclusion in the Double Bayou WPP.

The Double Bayou WPP development process engaged stakeholders and included water quality monitoring, data assessment, and potential pollutant load modeling. The goal of the Double Bayou WPP was to provide a roadmap to improve the water quality of Double Bayou through a voluntary, collaborative approach that incorporates stakeholder ideas in the planning process. The Double Bayou WPP presented the current state of the watershed, discussed water quality sampling and results, described stakeholder-identified causes and sources of pollution, outlined stakeholder-recommended management measures, and included specifications for the technical and financial framework required for implementation. The Double Bayou WPP was developed using EPA's nine key elements for successful watershed-based plans. The Double Bayou WPP[4] was approved by stakeholders and accepted by the EPA in July 2016.

[4] www.doublebayou.org/watershed-protection-planning/wpp-document

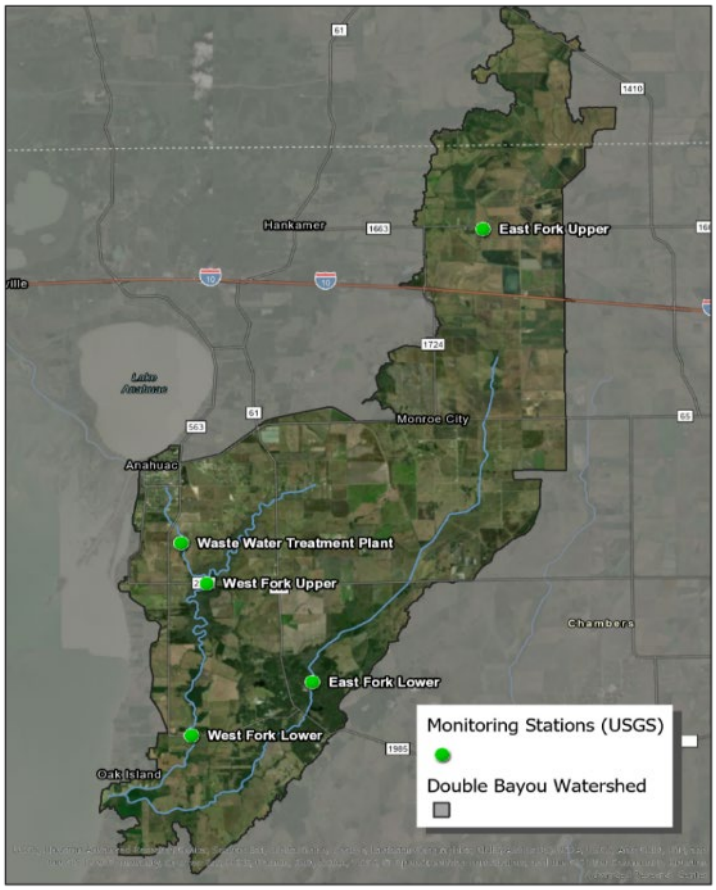


Figure 3. USGS monitoring stations as used in WPP development (monitoring funded by TSSWCB and GBEP) and implementation phase (monitoring funded by TSSWCB).

Methods

Water quality monitoring in support of the implementation phase is funded by TSSWCB and conducted by Partnership partner, USGS. For the implementation project, USGS personnel began collecting the first water quality samples since Phase I (development of the WPP) concluded in June of 2015. The Phase II sampling period began in January of 2020. A total of 80 water quality samples (70 routine and 10 targeted samples) are scheduled to be collected over the 24-month sampling period. USGS was able to conduct monitoring during COVID-19 due to strict safety procedures which ensure the health of their field team and watershed residents.

The Phase II (implementation of the WPP) water quality monitoring schedule allowed USGS to collect samples at all four Double Bayou sites including East Fork Lower, East Fork Upper, West Fork Lower, and West Fork Upper once every other month (Figure 3). In addition, samples are collected at the WWTF site once per quarter. Eight routine sampling trips have occurred through March of 2021. Routine samples are assessed to monitor ambient water quality during normal flow conditions in the bayous. In addition, one flow event monitoring trip, targeted toward rainy conditions which are

intended to capture runoff, has been collected during the implementation sampling period.

Each monitoring event includes field, conventional, flow, and bacteria parameter groups. Field parameters are pH, temperature, specific conductance, turbidity, and dissolved oxygen. Conventional parameters are suspended solids, sulfate, chloride, nitrite+nitrate as nitrogen, ammonia nitrogen, total kjeldahl nitrogen, orthophosphorus, and total phosphorus. Bacteria parameters are *E. coli* and enterococci (tidal and nontidal sites). Flow parameters are quantitative and collected by gage, electric, mechanical, or Doppler, including severity. Additionally, one 24-hour multi-parameter sonde deployment occurred in September 2020. The goal of this sampling event was to monitor dissolved oxygen concentrations in the bayou over a 24-hour period. The *Coordinating Facilitation and Implementation of the Double Bayou Watershed Protection Plan and Monitoring for Implementation Effectiveness Quality Assurance Project Plan,* developed in coordination with the TSSWCB, documents sampling methods, analytical methods, and quality control in further detail.

For the purposes of this report, data collected between September 2015 and March 2021 are classified as Phase II (Appendix A). Phase II data were acquired and analyzed to provide an update on FIB concentrations in the watershed (TCEQ 2020b). The Phase II data set stems from two sources: 1) TCEQ's Surface Water Quality Information System (SWIQMS) database and 2) the most recent data report obtained from USGS on March 29, 2021. To evaluate FIB results, samples were selected based on stream type by filtering for enterococci at tidal and *E. coli* at nontidal stations. Initial calculations were performed for routine samples only to best represent ambient FIB concentrations. Where possible, samples were grouped by the watershed's stream segments of the Anahuac Ditch, East Fork, and West Fork to allow for comparison. Geometric means were evaluated against the primary contact recreation criteria for enterococci and *E. coli,* which are 35 MPN/100 mL and 126 MPN/100 mL, respectively (SWQMP 2019). Exceedance of individual grab samples was determined based on the related single sample primary contact recreation criteria of 130 MPN/100 mL for enterococci and 399 MPN/100 mL for *E. coli* (30 TAC § 307.7[5]). Lastly, event samples were analyzed based on the associated single sample criteria.

All data analyzed in this report are current through March 2021 (Appendix A). Data that become available through SWQIMS or collected by USGS after March 2021 will be analyzed as part of the TSSWCB final deliverable.

[5]texreg.sos.state.tx.us/public/readtac$ext.TacPage?sl=R&app=9&p_dir=&p_rloc=&p_tloc=&p_ploc=&pg=1&p_tac=&ti=30&pt=1&ch=307&rl=7

Results and Observations

Bacteria Water Quality Monitoring

Since Phase I monitoring concluded in June of 2015, a total of 109 FIB samples have been collected by TCEQ and USGS in the Double Bayou Watershed. The West Fork, classified as tidal, has 26 enterococci samples while the East Fork, which is tidal in the southern portion and nontidal to the north, includes 20 enterococci and eight *E. coli* records. An additional five *E. coli* samples were collected at the WWTF. Representing current concentrations of FIB, geometric means were computed by stream segment and stream type using the newly acquired Phase II data (Table 1).

Table 1. Phase II number of samples (n), geometric mean concentrations, and exceedance by stream segment and stream type.

Stream Segment	Stream Type	n	Geometric Mean (MPN/100 mL)	Exceedance
West Fork	Tidal	26	125.8	**Yes**
East Fork (entero)	Tidal	19	74.6	**Yes**
East Fork (*E. coli*)	Nontidal	8	82.6	No
Anahuac Ditch	Nontidal	5	1.1	No

The East and West Fork have Phase II enterococci geometric mean concentrations that exceed the primary recreation contact criterion in the tidal portions of the stream segments. The West Fork's enterococci geometric mean of 125.8 MPN/100 mL is higher than the East Fork's 74.6 MPN/100 mL. However, the *E. coli* geometric mean in the nontidal portion of the East Fork does not exceed the associated primary contact recreation criterion of 126 MPN/100 mL. In addition, the Anahuac Ditch's geometric mean is well below the associated primary contact recreation criterion.

Table 2. Phase II number of samples (n), number of single sample exceedances, and percent exceedance by stream segment and type.

Stream Segment	Stream Type	n	Number of Exceedance	Exceedance
West Fork	Tidal	26	**14**	54%
East Fork (entero)	Tidal	19	**6**	22%
East Fork (*E. coli*)	Nontidal	8	0	
Anahuac Ditch	Nontidal	5	0	0%

In addition to geometric mean concentrations, single grab sample exceedances were evaluated (Table 2). On the West Fork, 14 of 26 (54%) enterococci samples exceeded the primary recreation contact single sample criterion. Percent exceedance was found to be lower on the East Fork, where six of 19 enterococci and 0 *E. coli* samples (22% or six of 27 total samples) were more than the respective single sample criteria. There are only

two nontidal sampling stations in the watershed—the East Fork Upper and the Anahuac Ditch, resulting in fewer total *E. coli* samples. However, none of the Phase II *E. coli* samples exceed the respective single sample criterion for *E. coli* of 399 MPN/100 mL.

Table 3. Phase II number of event samples (n), FIB event concentrations, and single sample event exceedances by station and stream type.

Station	Stream Type	n	FIB Concentration (MPN/100 mL)	Single Sample Exceedance
8042558 (entero)	Tidal	1	7,800	**Yes**
8042554 (entero)	Tidal		4,500	**Yes**
8042546 (*E. coli*)	Nontidal	1	16,000	**Yes**
8042548 (entero)	Tidal	1	7,000	**Yes**
Anahuac Ditch	Nontidal	1	4	No

To supplement the routine ambient analysis, Phase II targeted event samples were evaluated based on exceedance of primary contact single sample criteria (Table 3). One targeted event monitoring trip occurred on December 14, 2020. All mainstem sampling stations had elevated FIB concentrations that exceeded the related criteria. However, the concentration of *E. coli* at the Anahuac Ditch downstream of the WWTF effluent remained low.

Bacteria Source Tracking

The *Bacterial Source Tracking (BST) on Tributaries of Trinity and Galveston Bays*[6] project, conducted by Texas A&M AgriLife Research and funded by GBEP, was completed in 2020. The project collected *E. coli* samples from one monitoring site downstream of the East and West Fork Double Bayou confluence, in addition to four other sites around Galveston Bay.

[6] gbep.texas.gov/wp-content/uploads/2020/09/18-80240-TWRI_BST_Final-Report.pdf

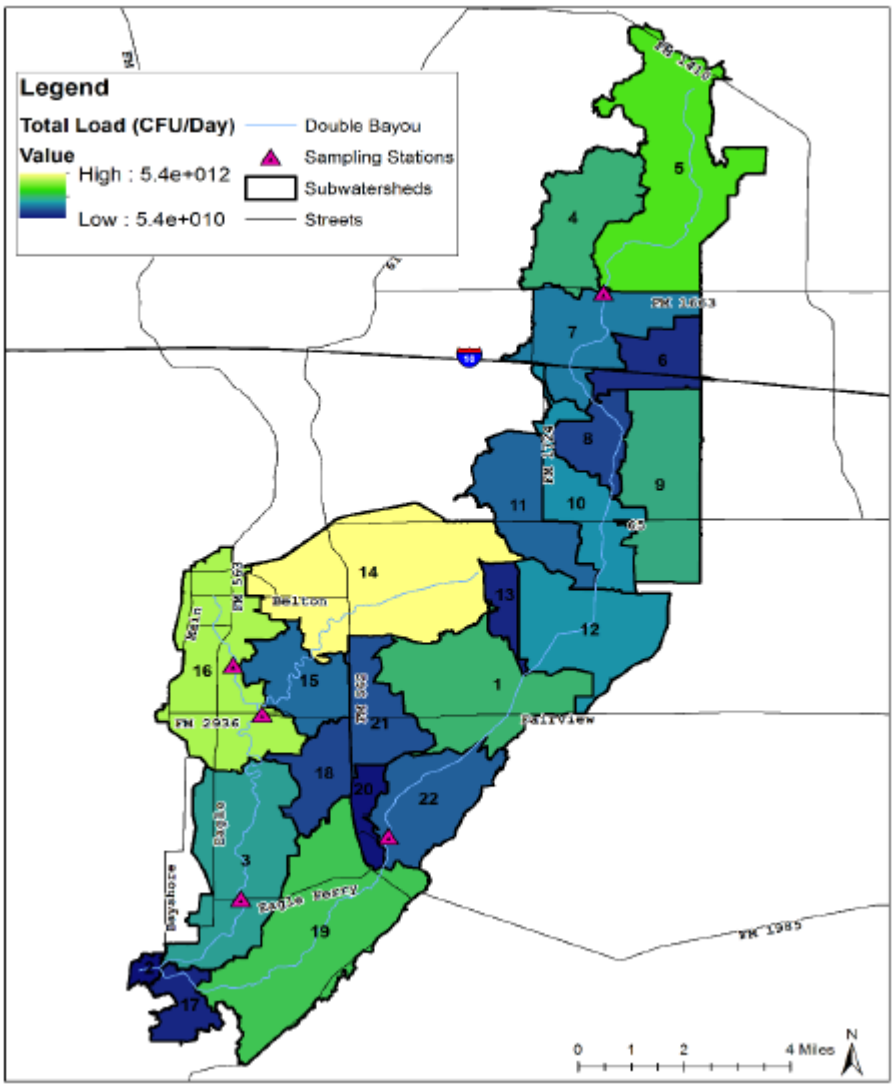
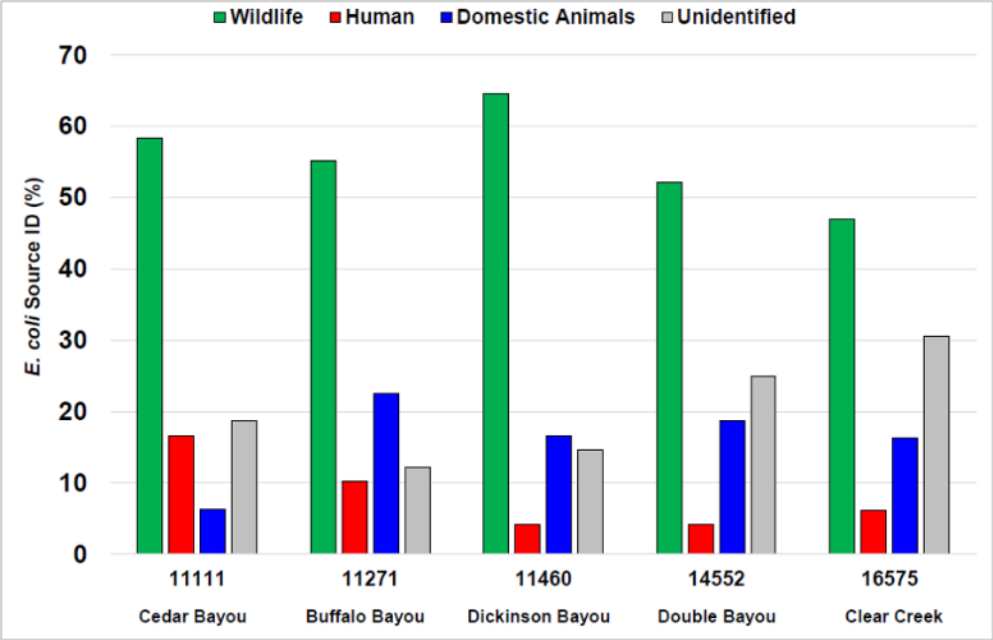


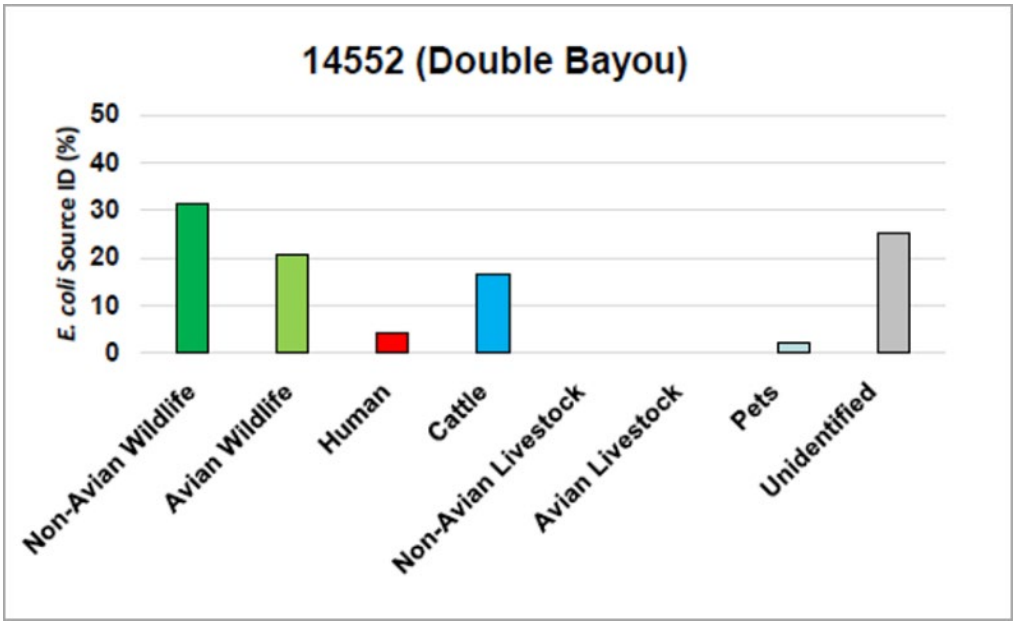
Figure 4. Total SELECT results

The percentage of *E. coli* source ID represents the portion of bacterial source load from PS and NPSs of fecal waste related to a category of pollution. Double Bayou was the most rural watershed where *E. coli* isolates were collected (Figure 2). The Double Bayou watershed results indicate that the portion of bacterial load from human sources was lower than most of the other sites surrounding Galveston Bay (Figure 2). However, Double Bayou had the second highest portion of bacterial load stemming from domestic animals which includes livestock. Wildlife was found to be the highest contributor to the bacterial source load accounting for about half of the total load. In addition, about a quarter of the bacterial source load was unable to be identified by BST.



*Special thanks to Dr. Terry Gentry for providing graphs of BST results.

Figure 5. Three-way split of BST results at five sites around Galveston Bay*



*Special thanks to Dr. Terry Gentry for providing graphs of BST results.

Figure 6. Seven-way split of BST results for the Double Bayou sampling site*

In the BST results for Double Bayou, the number one source category was identified as wildlife. Wildlife accounted for just over half of the *E. coli* source ID, comprised of approximately 30% non-avian wildlife, and 20% avian wildlife. At 30%, the non-avian wildlife is the single largest category contributing to *E. coli* source. After non-avian wildlife, the second highest loading category is cattle, making up about 18% of the total load. This fits the rural and agricultural landscape of the watershed. Lastly, the human source category was on the low end; however, bacteria from human sources have a higher potential to cause infection and illness in humans.

Feral Hogs

The Chambers County Sheriff's office has launched a highly successful feral hog eradication program which began in December of 2019. To date, county staff have removed a total of 402 feral hogs. This equates to 43% of the bacteria load reduction goal. The actual number of feral hogs removed is likely higher due to private landowner eradication efforts. The trapping efforts by the Chambers County Sheriff's Office mark substantial progress toward increasing public safety, reducing damage, and improving water quality conditions across Chambers County and within the Double Bayou Watershed.

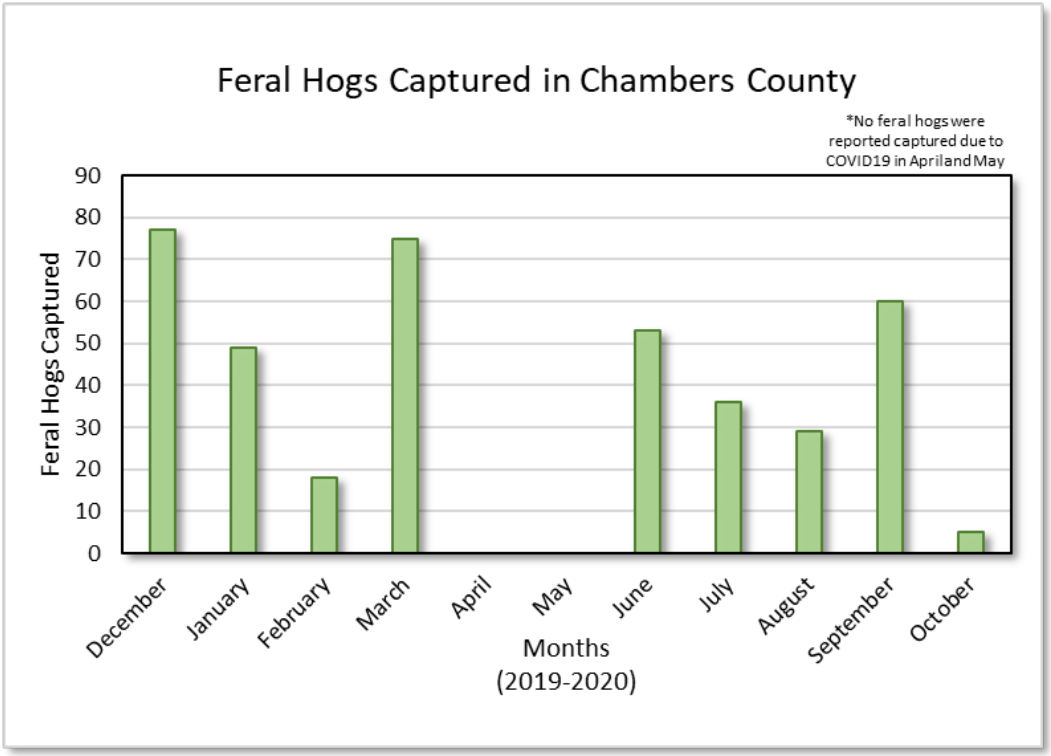


Figure 7. Feral Hogs captured in Chambers County

Discussion

Throughout the project, HARC continued to host and maintain the Double Bayou Partnership website[7] to serve as a public clearinghouse for all project and watershed related information. Presentations, documents, and results were posted to the website, which serves to disseminate information to stakeholders and the public.

Bacteria Water Quality Monitoring

The West Fork was the first stream segment in the watershed to be placed on the 303(d) list for elevated bacteria concentrations and has been declared impaired in seven consecutive Texas Integrated Report's since 2006. The East Fork was first placed on the 303(d) list in 2014 and has been listed in four consecutive Texas Integrated Report's (TCEQ 2019a). The association of the West Fork having a longer history of impairment and historically higher concentrations of FIB compared to the East Fork is evident in Phase II samples. When evaluated by stream segment and stream type, the West Fork has an elevated enterococci geometric mean concentration compared to the East Fork in the tidally influenced portions (Table 1). Furthermore, the West Fork had a more than double single sample percent exceedance compared to the East Fork (Table 2). Although the tidal sections of the West and East Forks resulted in geometric mean and single sample exceedances, the nontidal portion of the East Fork did not exceed the geometric mean primary contact criterion or have any single sample exceedances for *E. coli* (Table 2). However, all mainstem event samples collected during the Dec. 14, 2020, monitoring trip resulted in FIB concentrations higher than the respective single sample criteria (Table 3). The high event concentrations indicate that intense rainfall events result in the flushing of NPS fecal waste into the waterways of the watershed.

The Anahuac Ditch, which receives effluent from the WWTF and drains to the West Fork, has had no Phase II routine or event geometric mean or single sample exceedances to date. In addition, the routine geometric mean concentration of *E. coli* was very low compared to the other stream segments, and the event monitoring trip resulted in a low grab sample concentration of 4 MPN/100 mL (Table 1). The Anahuac Ditch was the only sampling station to not exceed single sample criteria during the Dec. 14, 2020, rain event. Low concentrations of FIB and a lack of exceedances during routine conditions in the Anahuac Ditch aligns with the WPP's assessment that the WWTF is not a major contributor to *E. coli* loads during ambient conditions. In addition, the low concentration of the one event monitoring trip conducted thus far during Phase II indicates that the WWTF performed well and was not overwhelmed by infiltration and inflow. The Phase II samples suggest that the WWTF is a not major contributor of routine or event point source fecal waste to the watershed.

The Phase II FIB results can aid the placement and prioritization of management measures during implementation through adaptive management. To have the greatest

[7] doublebayou.org/

potential of reducing NPS loads and improving water quality in the watershed, management measures should be geared toward the West Fork subwatershed when possible. Ideal management measures include the continued education and outreach of stakeholders who live in the City of Anahuac, which contains the highest density population and developed land cover and is located in the West Fork's drainage. In addition, structural management measures geared toward preventing fecal waste loadings from reaching the waterways during rain events should be prioritized during implementation. Management measures such as continued implementation of WQMPs, removal of feral hogs, stabilization of shores or restoration of riparian habitat through the instillation of living shorelines, and continued outreach and education are critical to lowering the overall concentrations of FIB and potential pathogens within the watershed.

Bacteria Source Tracking

During the Double Bayou Watershed Protection Plan[8] development process, SELECT was used to estimate potential pollutant loadings for bacteria sources across the Double Bayou Watershed. Cattle and feral hogs were found to be the two highest potential contributors of fecal waste pollution (Figure 6). To gain further insight and validate SELECT results, Double Bayou stakeholders recommended utilizing BST as a management tool in the implementation phase of the WPP. BST can shed light on the proportion of bacterial load coming from three to seven pollutant categories including wildlife, human, and domestic animals further divided into non-avian wildlife, avian wildlife, human, cattle, non-avian livestock, pets, and an unidentified category.

During the SELECT process, Double Bayou stakeholders elected to exclude any avian livestock because no significant populations were known to exist in the watershed. The BST results provide further evidence supporting the avian livestock contributions—or lack thereof—in the watershed. In addition, stakeholders noted that horses are typically used to support cattle ranching operations and goats are not used for agricultural production but are kept by some landowners for subsistence use. The populations of these non-avian livestock are spread out over the watershed (not concentrated for agricultural production). As a result, low populations of non-avian livestock other than cattle—in this case horses (294) and goats (211)—were correctly represented in the SELECT model with low disbursed populations occurring in the watershed linked to less than 1% of the bacterial source load. The stakeholder assumption for a third category—pets including domesticated pets such as dogs and cats—not being a major contributor to bacteria loadings is also supported by the BST results.

At 30%, the non-avian wildlife is the single largest category contributing to *E. coli* source loads. This group includes feral hogs, which are known to be prevalent in the watershed. This group also includes native wildlife such as deer, raccoons, and

[8] www.doublebayou.org/wp-content/uploads/2016/07/EntireWPPFinal6-7-16modB.pdf

possums. The Double Bayou WPP stated that "Wildlife is likely a large contributor to bacteria loads in the watershed"; this assumption is supported by the BST results. Management measures that have resulted in the removal of feral hogs from the watershed are expected to show a decline in the bacteria concentrations within the bayous. However, during the 2017 BST study Texas Water Resources Institute (TWRI) was unable to distinguish between isolates of different non-avian species, such as deer and feral hogs. Feral hogs are a known contributor of bacteria in our waterways and are being recommended to differentiate their load contributions from other source of non-avian wildlife. In addition, recent studies indicate a higher potential for bacteria generated by feral hog to infect humans. TWRI is aware of the need to differentiate feral hogs from other non-avian sources and plans to do so, should funding be secured.

Overall, the BST results support conclusions of the stakeholder inputs into the SELECT modeling process that cattle and non-avian wildlife (which includes feral hogs) are the leading contributors to instream bacteria concentrations in the watershed. The BST milestone—long awaited by stakeholders and recommended in the WPP—has been met. The results show the importance of the stakeholders informing the SELECT process and the success of stakeholder-driven watershed planning efforts. Although, at least for now, a substantial portion of the *E. coli* source loads remain unidentified.

Feral Hogs

SELECT results highlighted feral hogs as the second highest potential source of bacteria contributions in the watershed. Stakeholders agreed that feral hogs and their bacteria contributions are a high priority to focus management measure efforts during implementation. Because feral hogs typically traverse waterways, the direct deposition of fecal waste by feral hogs into streams or bayous is a highly concentrated delivery mechanism of bacteria impacting instream water quality. In addition, feral hogs are responsible for economic and ecological impacts because they cause damage to crops, lawns and public spaces, as well as riparian habitats that help support a healthy Double Bayou Watershed.

Figure 8. Double Bayou Park signage indicating closure due to feral hog removal in progress.

At the time of WPP development, the total feral hog population in the watershed was estimated to be 1,519. To determine an estimate of feral hogs that should be removed, the number of hogs for each subwatershed within the larger Double Bayou watershed was analyzed according to a bacteria load reduction goal. The process estimated that 927 hogs required removal to meet established bacteria load reduction goals. However, the estimated Double Bayou Watershed feral hog population should be considered a moving benchmark due to their high rate of reproduction and ability to move in and out of the watershed. Local experts have estimated the total Chambers County feral hog population to be higher.

Management Measure Milestones

HARC evaluated and tracked progress toward milestones success throughout this portion of the project. During the implementation phase of the Double Bayou WPP, many of the milestones established in the WPP were met or are ongoing. Five management measures were completed including the hiring of a WQMP technician, a BST study, and the convening of a Watershed Texas Stream and Riparian Workshop. An additional 9 management measures are ongoing including development and recertification of WQMPs, water quality monitoring, and the distribution of outreach materials such as GBEP invasive species and Lone Star Healthy Streams materials.

The goal of the implementation phase is to improve the water quality of Double Bayou. Now that the implementation phase of the watershed protection efforts has been underway, the partnership has started tracking progress of stakeholder identified management measures that were outlined in the WPP. Table 4 shows a selection of management measures that have been completed or are in progress across a variety of categories including wastewater, agricultural, and water quality monitoring. Refer to the WPP for a full list of management measures. The targeted number per implementation period has either been met or is tracking to be exceeded in addition to other ongoing efforts.

Table 4. Watershed milestones for stakeholder-developed management measures

Category	Management Measures	Number per Implementation Years 1 to 3	Status
Wastewater	Collection system study (smoke test and video lines) (high priority)	1	Completed
Septic Systems	Identify OSSFs in watershed and maintain OSSF database	1	In Progress
Agricultural	Water Quality Management Plan (WQMP)	12 (3,4,5)*	In Progress

Category	Management Measures	Number per Implementation Years 1 to 3	Status
Agricultural	WQMP Technician (new position-shared with Cedar Bayou)	1	Completed
Monitoring	Targeted water quality monitoring	96	In Progress
Monitoring	Bacterial source tracking	1	Completed
Education & Outreach	Watershed Texas Riparian & Stream Ecosystem workshop	1	Completed
Education & Outreach	Galveston Bay Foundation Action Work (GBAN) application	1	Completed
O & E: Wastewater	Galveston Bay Foundation's Cease the Grease campaign	3	In Progress
O & E: Wastewater	San Jacinto River Authority No Wipes in the Pipes/Patty Potty campaign	1	In Progress
O & E: Septic	Septic systems maintenance workshop, exploring aerobic component addition	3	In Progress
O & E: Agriculture	Lone Star Healthy Streams (LSHS) program materials for distribution (feral hogs, horse, and cattle)	1	In Progress
O & E: Recreation	Illegal boater dumping awareness campaign/Galveston Bay Action Network	1	In Progress
O & E: Wildlife & Invasive	GBEP invasive species materials for distribution	1	In Progress

*The total number of WQMP measures implemented over Years 1 to 3 totaled to be 12, with three implemented in the first year, four in the second year, and five in the third year.

Stakeholder Meetings

HARC facilitated two in-person stakeholder meetings and two virtual stakeholder presentations (Double Bayou Live!) to provide updates on the status of WPP implementation efforts, progress in water quality monitoring and results, and to continue seeking input and further ideas as appropriate. HARC coordinated meetings, secured meeting locations, and prepared and disseminated meeting materials, notices,

and agendas. Meeting materials were submitted to the TCEQ Project Manager prior to dissemination. Meeting agendas and invitations are included in Appendix B.

In cooperation with all project partners, HARC conducted a general stakeholder meeting on May 23, 2018. The topics for this meeting included an overview of events since the previous meeting, introduction of initial implementation activities such as WQMPs, introduction of the Bay-wide BST sampling project, overview of data since last meeting, an overview of Texas A&M University's (TAMU) OSSF program, and a presentation on Houston-Galveston Area Council's (H-GAC) Coastal Communities Project.

Preparations for the May 2018 stakeholder meeting included:

- Scheduling specific tasks for the meeting.
- Securing the meeting location and projector screen from the county.
- Preparing and sending email invitations and reminder emails to stakeholders.
- Preparing and sending a meeting flyer by U.S. mail to those not using email regularly or at all (approx. 100).
- Maintaining an RSVP list.
- Developing agendas confirming refreshment sponsor.
- Planning the meeting space; and preparing meeting handouts.

All meeting documents—for sending by email or U.S. mail, posting on the website, or for handouts—were approved by GBEP prior to public dissemination.

In cooperation with all the project partners, HARC conducted a second stakeholder meeting on Feb. 19, 2019. The primary topics for the meeting were presentation and discussion of: WQMPs progress and opportunities in the watershed, introduction of new WWTF director with overview of updates and changes to the WWTF, and the presentation of the Galveston Bay Foundation's G-BAN application.

Preparations for the second stakeholder meeting included:

- Scheduling of specific tasks.
- Securing the meeting location from the County.
- Preparing and sending invitations and reminder emails to stakeholders.
- Maintaining an RSVP list.
- Developing an agenda.
- Recruiting and coordinating with invited speakers.
- Preparing and reviewing PowerPoint presentations.
- Confirming refreshment sponsor.
- Planning the meeting space.

- Preparing meeting handouts.
- Setting up the meeting space; facilitating the meeting.
- Preparing draft meeting notes.

All meeting documents were approved by the TSSWCB prior to public dissemination.

However, due to COVID-19 further in-person stakeholder meetings were not possible.

In response to COVID-19 guidelines issued by public health officials for social distancing and group meetings, all external and public in-person events from March 2020 through the current time are being postponed. This resulted in the cancellation of the May 2020 Double Bayou stakeholder meeting previously scheduled, as well as cancellation of the scheduled OSSF workshop. HARC canceled booking of the Double Bayou Community Center and informed H-GAC, USGS, and all partners of the cancellation of the meeting. The meeting was originally postponed to fall of 2020, but in-person meetings were still cancelled due to COVID-19.

To maintain communication with stakeholders and provide resources during COVID-19, HARC produced two digital stakeholder meetings for distribution through the Partnership website.

HARC worked with partners in summer of 2020 to develop the next stakeholder meeting virtually. HARC investigated different software methods to deliver results in a downloadable or streaming method and began preparing digital resources for stakeholder meeting materials. HARC met with H-GAC to start preparations for filming an overview on the H-GAC Coastal Communities Project. HARC developed material for updated information on water quality monitoring data and data results and on feral hog counts and county control measures.

HARC met with H-GAC to film the Double Bayou Coastal Communities overview. HARC edited the video and prepared the material for posting on the website. HARC sent the Coastal Communities video to TSSWCB and GBEP for review, and it was approved. HARC filmed the HARC Double Bayou December 2020 Stakeholder Update. HARC sent the HARC Double Bayou December 2020 Stakeholder Update to TSSWCB and GBEP for review, and it was approved. HARC concluded the development of two initial presentations for the digital stakeholder web series and posted them (Implementation – The Double Bayou Watershed Protection Plan[9]). Announcements, approved by TSSCB and GBEP, were sent via email to the stakeholder list and through mailed postcards.

Education and Outreach

Education and Outreach was conducted at the May 23, 2018, and Feb. 19, 2019, stakeholder meetings through an overview of the TAMU OSSF program and H-GAC's coastal communities outreach project. HARC coordinated with H-GAC to discuss

[9] www.doublebayou.org/watershed-protection-planning/implementation

opportunities for H-GAC's Coastal Communities program to provide opportunities for outreach in Double Bayou. HARC contacted TWRI and TSSWCB to begin discussions regarding holding a landowner riparian restoration workshop in Chambers County. HARC contacted Extension Program Specialist, Ryan Gerlich, on Oct. 19, 2018, regarding the Homeowner Septic System Maintenance Workshop to be hosted in Chambers County in fall of 2019. In February of 2019 HARC completed coordination with TWRI and H-GAC to arrange a Chambers County Landowner Riparian Workshop to be held on May 1, 2019, at the Eddie V. Gray Wetland Center in Baytown, Texas.

HARC coordinated with the Anahuac WWTF to arrange a stakeholder tour (Figure 9). HARC circulated the WWTF tour announcement to TSSWCB and GBEP for review, sent a WWTF tour invitation to Double Bayou stakeholders, and posted the announcement to the Double Bayou website. HARC and partners conducted a City of Anahuac Wastewater Treatment Plant Tour for the Partnership on May 30, 2019. The tour was led by the Plant Operator Bobby Brasuell and covered the City of Anahuac Wastewater Treatment Plant and a lift station. TSSWCB, GBEP, and HARC were in attendance.

Figure 9. Anahuac Wastewater Treatment Facility stakeholder tour.

On April 16, 2019, HARC corresponded with Becki Begley of Coastal Communities regarding H-GAC's Supplemental Environmental Project for OSSF replacement, multilingual outreach materials (Spanish and Vietnamese), and a new Pharmaceutical Collection Box Systems Project. Three OSSFs have been replaced with two pending replacements on the East Fork of Double Bayou.

HARC sent an email invitation for the Texas Riparian & Stream Ecosystem Workshop – Double Bayou/Cedar Bayou to the Double Bayou list serve and posted the announcement to Double Bayou website. HARC circulated the stakeholder email invitation and website announcement for the upcoming Texas Riparian & Stream Ecosystem Workshop – Double Bayou/Cedar Bayou to TSSWCB and GBEP for review. HARC provided the presentation "Double Bayou Watershed Protection Planning: Past, Present & Future" at the Texas Riparian & Stream Ecosystem Workshop – Double Bayou/Cedar Bayou.

HARC developed a draft Sway digital newsletter that included web maps, narrative, and images. HARC provided GBEP and TSSWCB with a draft fall 2019 Double Bayou Watershed Partnership newsletter for review and approval before finalizing the draft newsletter content and the digital newsletter multi-media content. HARC then delivered the fall 2019 newsletter to stakeholders via an email blast and provided a copy of the email blast containing the fall newsletter to GBEP and TSSWCB for approval (Appendix B).

HARC provided GBEP and TSSWCB with a draft *Double Bayou Watershed Partnership Newsletter: Fall 2020* for review and approval. HARC finalized the draft newsletter content and the digital newsletter multi-media content, then delivered the fall 2020 newsletter to stakeholders via an email blast. HARC also provided a copy of the email

blast containing the fall newsletter to GBEP and TSSWCB for approval. Both newsletters were posted to the Double Bayou website).[10]

Summary

Since 2012, HARC with partners USGS and Shead Conservation Solutions and the Double Bayou Partnership, with funding from TSSWCB/EPA and GBEP/TCEQ, have worked to improve water quality in the Double Bayou watershed. The development of a WPP for Double Bayou was the first important milestone in the process. Establishment of the Double Bayou Partnership included stakeholders such community leaders, elected officials, landowners, nonprofit organizations, and representatives of relevant local, state, and federal agencies that met through a serious of larger stakeholder meetings and smaller workgroup meetings to collaborate on the development of the WPP. Water quality was monitored on both the East and West Forks throughout the WPP process, and HARC developed visuals and figures to inform stakeholders about results of the water quality monitoring and analysis.

Double Bayou WPP implementation process *Coordinating Implementation of a Watershed Protection Plan for Double Bayou* continued to engage stakeholders and included water quality monitoring, data analysis, and milestone tracking. The goal of the Double Bayou Watershed Partnership is implementation of management measures aimed at reducing fecal waste as measured by FIB concentrations in the bayous.

Water quality monitoring started as part of the *Coordinating Implementation of a Watershed Protection Plan for Double Bayou* project. Initial analysis of the data show bacteria concentrations remain higher in the West Fork compared to the East Fork and that the WWTF is a not major contributor of point source FIB loads. Monitoring thus far shows that when possible, implementation activities should be geared toward the West Fork and management measures that prevent event-based fecal waste loadings are a priority.

The *Coordinating Implementation of a Watershed Protection Plan for Double Bayou* project brought together the Double Bayou Watershed Partnership and successfully implemented numerous milestones from the stakeholder-derived management measures. The creation, implementation, and continued maintenance of WQMPs, the removal of feral hogs, continued stakeholder education and outreach, replacing OSSFs, and water quality monitoring all work together to help improve the water quality in the Double Bayou watershed.

[10] www.doublebayou.org/watershed-protection-planning/partnership-newsletters

References

SWQMP (2019). *Draft 2020 Guidance for Assessing and Reporting Surface Water Quality in Texas – In Compliance with Sections 305(b) and 303(d) of the Federal Clean Water Act*. Surface Water Quality Monitoring Program Monitoring and Assessment Section, Water Quality Planning Division. Retrieved from Austin, Texas. www.tceq.texas.gov/assets/public/waterquality/swqm/assess/gawg/2020/2020_guidance.pdf

TCEQ (2020a). *2020 Texas Integrated Report Texas 303(d) List (Category 5)*. Retrieved from Austin, Texas. www.tceq.texas.gov/assets/public/waterquality/swqm/assess/20txir/2020_303d.pdf

TCEQ (2020b). *Texas Surface Water Quality Monitoring Information System (SWQMIS).* Surface Water Quality Monitoring data from the Texas Commission on Environmental Quality. Retrieved from Austin, Texas. www.tceq.texas.gov/waterquality/monitoring

Appendix A. Phase II FIB Data

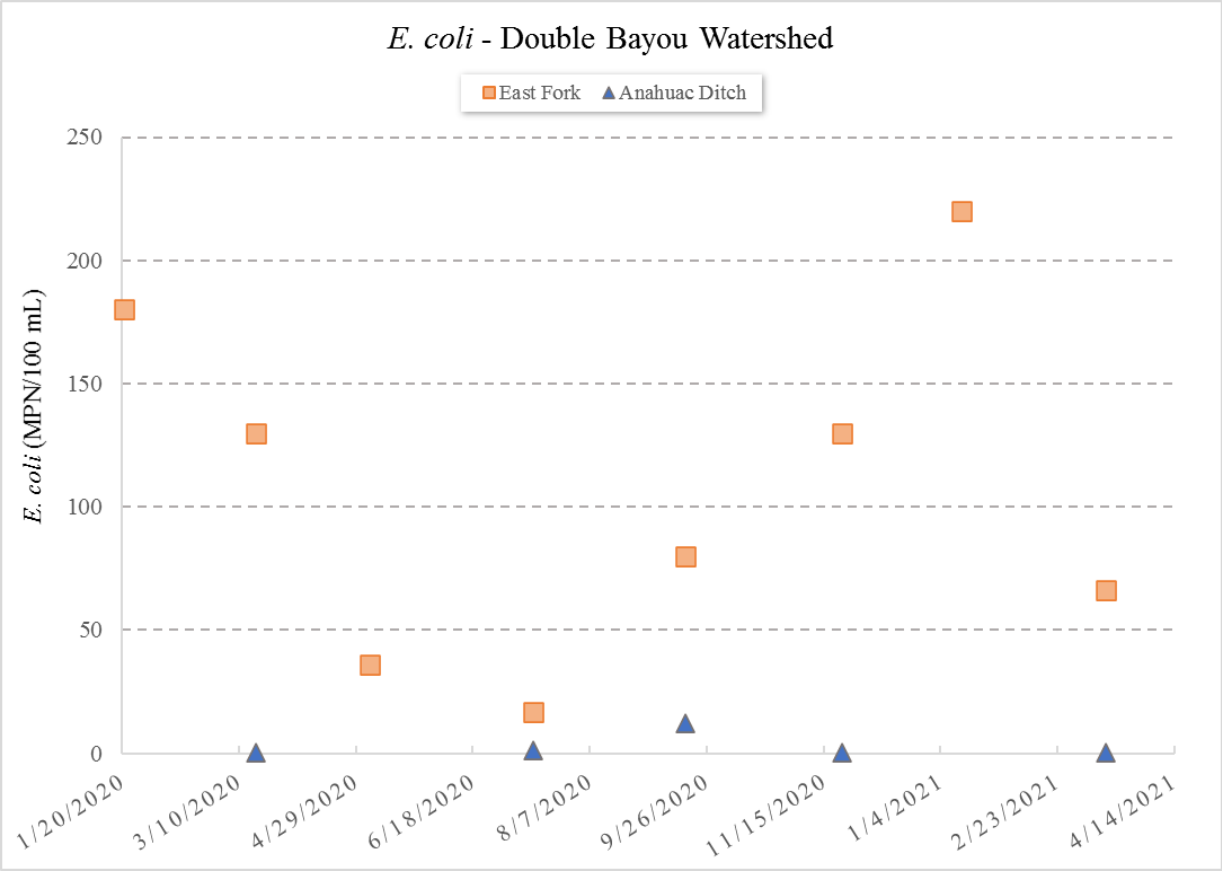


Figure 10. Phase II nontidal routine *E.coli* samples in the East Fork and Anahuac Ditch

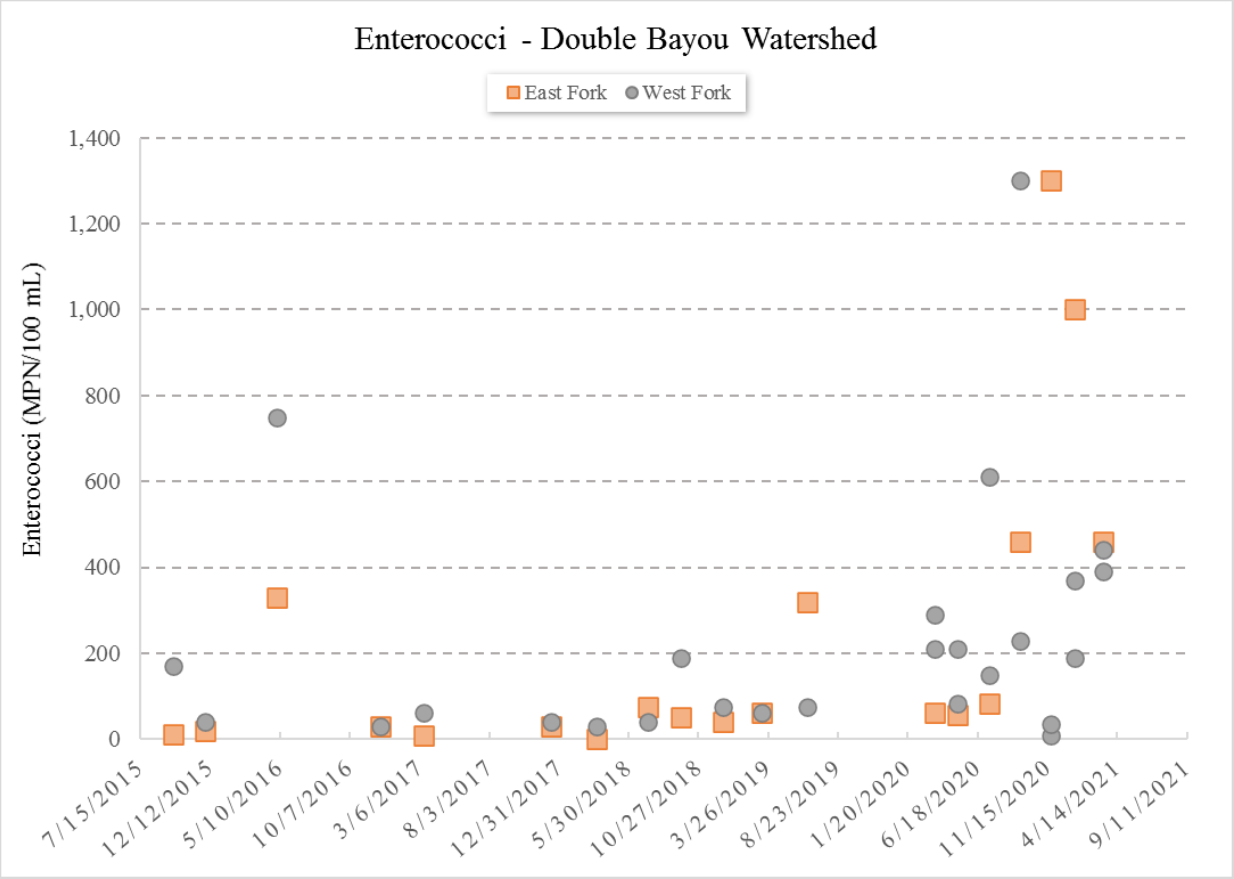
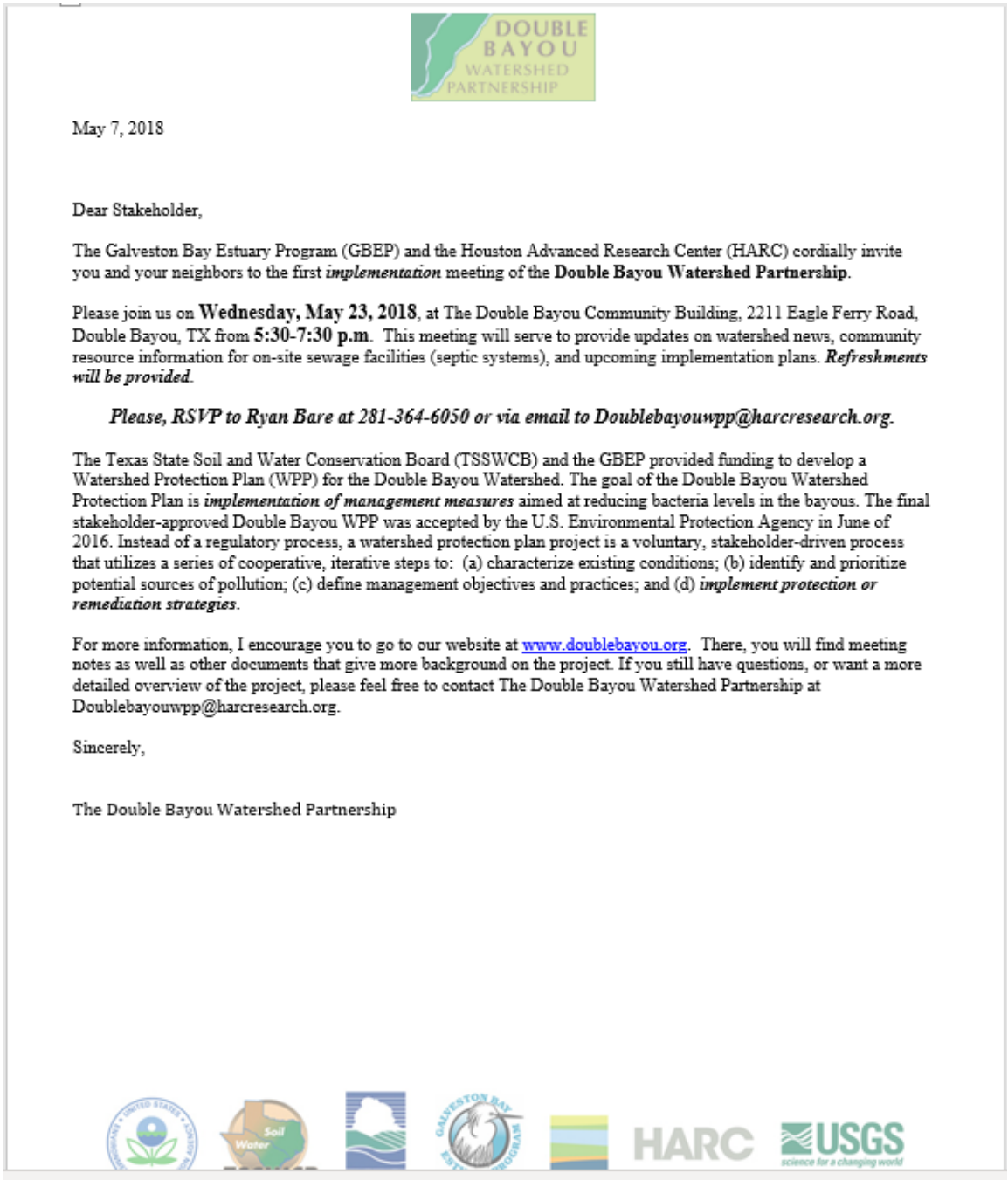


Figure 11. Phase II tidal routine enterococci samples in the East Fork and West Fork

Appendix B. Agendas and Stakeholders List Materials



DOUBLE BAYOU WATERSHED PARTNERSHIP

May 7, 2018

Dear Stakeholder,

The Galveston Bay Estuary Program (GBEP) and the Houston Advanced Research Center (HARC) cordially invite you and your neighbors to the first ***implementation*** meeting of the **Double Bayou Watershed Partnership**.

Please join us on **Wednesday, May 23, 2018**, at The Double Bayou Community Building, 2211 Eagle Ferry Road, Double Bayou, TX from **5:30-7:30 p.m**. This meeting will serve to provide updates on watershed news, community resource information for on-site sewage facilities (septic systems), and upcoming implementation plans. ***Refreshments will be provided***.

Please, RSVP to Ryan Bare at 281-364-6050 or via email to Doublebayouwpp@harcresearch.org.

The Texas State Soil and Water Conservation Board (TSSWCB) and the GBEP provided funding to develop a Watershed Protection Plan (WPP) for the Double Bayou Watershed. The goal of the Double Bayou Watershed Protection Plan is ***implementation of management measures*** aimed at reducing bacteria levels in the bayous. The final stakeholder-approved Double Bayou WPP was accepted by the U.S. Environmental Protection Agency in June of 2016. Instead of a regulatory process, a watershed protection plan project is a voluntary, stakeholder-driven process that utilizes a series of cooperative, iterative steps to: (a) characterize existing conditions; (b) identify and prioritize potential sources of pollution; (c) define management objectives and practices; and (d) ***implement protection or remediation strategies***.

For more information, I encourage you to go to our website at www.doublebayou.org. There, you will find meeting notes as well as other documents that give more background on the project. If you still have questions, or want a more detailed overview of the project, please feel free to contact The Double Bayou Watershed Partnership at Doublebayouwpp@harcresearch.org.

Sincerely,

The Double Bayou Watershed Partnership

Double Bayou Watershed Partnership
Stakeholder Meeting
May 23, 2018
5:30 P.M.
Double Bayou Community Building

5:00 **Refreshments and Sign In**

5:30 **Welcome, Introductions and Agenda Review** – *Stephanie Glenn*

- Thanks to:
  - Jerry Shadden, Trinity Bay Conversation District, for the dinner
  - Chambers County Precinct Two, for the meeting room
- Goals/Agenda for Today's Meeting:
  - Welcome Back
  - Updates on implementation and plan
  - Learn about next steps
- Introductions (note any elected officials)
- Logistics: Remind everyone about dinner, restrooms, available documents

5:40 **Overview**– *Stephanie Glenn / Ryan Bare*

- Brief update on where we are; BST project details (Stephanie)
- Water Quality Review (Ryan)

6:00 **Implementation Update** – *Brian Koch*

- Catch-up on TSSWCB progress
- SWCD Technician/Introduction of Jimmy Weaver

6:10 **Overview of Water Quality Management Plans** – *Brian Koch*

6:30 **OSSF survey and pump out/inspections** – *Ryan Gerlich*

- OSO Watershed in Corpus Christi Area, Double Bayou Watershed

7:00 **Galveston Bay: Coastal Communities Outreach** – *Becki Begley*

- H-GAC's Coastal Communities Outreach Project

7:25 **Final Wrap-up, Announcements**

7:30 **Adjourn**

Stakeholder meeting
February 19th from 5:30-7:30 pm
@ Double Bayou Community Building

View this email in your browser

DOUBLE BAYOU WATERSHED PARTNERSHIP

Dear Double Bayou Stakeholders,

The execution of the Double Bayou Watershed Protection Plan is in full swing. Learn about current activities and more at the *2019 Double Bayou Watershed Partnership implementation meeting*!

Join Us:

Tuesday, February 19th

from 5:30-7:30 pm

at the Double Bayou Community Building

2211 Eagle Ferry Rd

Boots are on the ground actively implementing the management measures designed and selected by you with promising results. The agenda includes a Water Quality Management Plan update and overview and a wastewater treatment infrastructure update and overview.

We hope to see you there!

Happy New Year,
The Double Bayou Watershed Protection Plan Team

TEXAS STATE Soil & Water CONSERVATION BOARD
TCEQ
GALVESTON BAY ESTUARY PROGRAM
HARC
USGS science for a changing world

Funding provided through a Clean Water Act §319(h) Nonpoint Source Grant from the Texas State Soil and Water Conservation Board and the U.S. Environmental Protection Agency.

Double Bayou Watershed Partnership
Stakeholder Meeting

February 19th, 2019
5:30 P.M.
Double Bayou Community Building

5:00 **Refreshments and Sign In**

5:30 **Welcome, Introductions and Agenda Review** – *Stephanie Glenn*

- Thanks to:
  - Chambers County Precinct Two, for the meeting room
- Goals/Agenda for Today's Meeting:
  - Updates on implementation and plan
  - Upcoming
- Introductions (note any elected officials)

5:40 **Overview**– *HARC*

- TSSWCB grant
- WPP milestones – short list/progress
- SEP funding
- Landowner Riparian & Stream Ecosystem workshop – early April
- TWRI request for BST sample collection
- Soil Health Workshop in Victoria - April 23rd and 24th

6:00 **Water Quality Management Plans Overview/Update** – *Jimmy Weaver*

- WQMP overview
- WQMP progress update

6:20 **Wastewater Infrastructure** – *Bobby Brasuell*

- WWTF overview
- Infrastructure upgrade status update

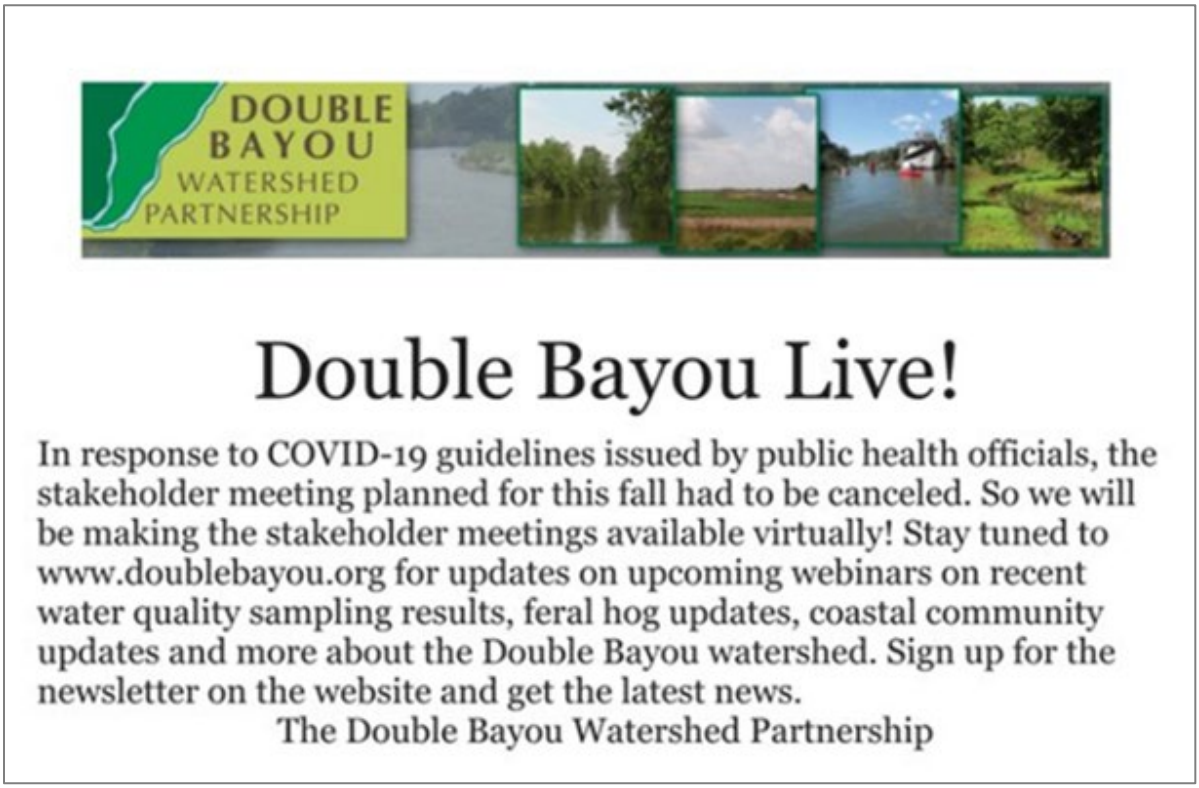
6:40 **Galveston Bay Action Network (GBAN)** – *Sarah Gossett*

- GBAN is a pollution reporting and monitoring app that will report across the four counties that touch Galveston Bay (Brazoria, Chambers, Harris, and Galveston Counties).

7:00 **Final Wrap-up, Announcements**

7:05 **Adjourn**

Double Bayou Watershed Protection Plan Implementation: 2020
DOUBLE BAYOU WATERSHED PARTNERSHIP
TEXAS STATE Soil & Water CONSERVATION BOARD
HARC
USGS
science for a changing world


DOUBLE BAYOU WATERSHED PARTNERSHIP
Double Bayou Live!
In response to COVID-19 guidelines issued by public health officials, the stakeholder meeting planned for this fall had to be canceled. So we will be making the stakeholder meetings available virtually! Stay tuned to www.doublebayou.org for updates on upcoming webinars on recent water quality sampling results, feral hog updates, coastal community updates and more about the Double Bayou watershed. Sign up for the newsletter on the website and get the latest news.
The Double Bayou Watershed Partnership

Double Bayou Digital Stakeholder Web Series

View this email in your browser

Dear Double Bayou Stakeholders,

The Double Bayou Watershed Protection Plan (WPP) Team is happy to announce Double Bayou Live! Two Web Series presentations are now available 1) Double Bayou Watershed Protection Plan Implementation Overview: 2020 and 2) Coastal Communities: Double Bayou Watershed Update presented by H-GAC. Additional Web Series topics will be released on a rolling schedule and are expected to include an in-depth review of feral hog management activities.

The Double Bayou implementation update presentation includes details on implementation activities occurring in 2020 such as WPP milestones, water quality samples, and more.

The Coastal Communities update covers the H-GAC Coastal Communities' Plan roadmap, outreach resources, and other useful information.

The presentations can be accessed through the Double Bayou website under the General Meetings tab.

*Visit **DoubleBayou.Org** to stay up to date on watershed activities.*

Thank You,
The Double Bayou Watershed Protection Plan Team

Funding provided through a Clean Water Act §319(h) Nonpoint Source Grant from the Texas State Soil and Water Conservation Board and the U.S. Environmental Protection Agency.

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General Meetings
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Double Bayou Watershed Protection Plan Implementation: 2020
HARC
USGS
vimeo
Double Bayou Watershed Protection Plan Implementation: 2020 from HARC on Vimeo.
Outreach Toolbox & Roadmap
Project website
Roadmap messaging
H-GAC & partner resources
Model ordinances
Links to funding, training, and meeting opportunities
FOG
vimeo
Double Bayou Virtual Stakeholder Meeting: Update on H-GAC's Coastal Communities Program from HARC on Vimeo.
Search ...
UPCOMING
In response to COVID-19 guidelines issued by public health officials, the Introduction to Septic Systems Workshop scheduled on March 31st has been postponed until further notice.
SUBSCRIBE TO OUR MAILING LIST
Sign-up for our mailing list to stay up to date with Double Bayou watershed activities and planning efforts
Subscribe
CONTACT
The Double Bayou Watershed Partnership
doublebayouwpp@harcresearch.org

Appendix C. Double Bayou Newsletters 2019 & 2020

Link: Double Bayou Watershed Partnership Newsletter: Fall 2019[11]

Link: Double Bayou Watershed Partnership Newsletter: Fall 2020[12]

[11] sway.cloud.microsoft/s/2sJpdVSfLpMEqdTM/embed
[12] sway.cloud.microsoft/GX1XsFjKtuItOGZQ?ref=email