Watershed Implementation Plan
Old Fort Bayou

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UNITED STATES ENVIRONMENTAL PROTECTION AGENCY

MISSISSIPPI DEPARTMENT OF ENVIRONMENTAL QUALITY

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1.1 Development of a WIP

1.1.1 What is a WIP?

State and federal agencies and organizations have been moving toward a watershed approach to water resource management since the late 1980's.[1] The watershed approach offers a flexible framework to address water quality and other issues within a specific drainage area. Management actions taken within a specific watershed are usually pursuant to an approved watershed plan. A watershed implementation plan is a strategy that provides assessment and management information for a geographically defined watershed, including analyses, actions, participants and resources related to developing and implementing the plan.[2]

Watershed plans vary to a degree based on the specific water resource impairments identified for the watershed and the concerns and goals of stakeholders involved in the planning process. Most watershed plans, however, include a vision, goals, assessment of current pollutant loads, future load reductions expected from implementing best management practice, a strategy for educating the public, and expectations for monitoring and adapting the plan. In addition, the U.S. Environmental Protection Agency (EPA) requires nine elements be included in any watershed plan funded with incremental Clean Water Act Section 319 funds and strongly recommends they be included in all watershed plans intended to address water quality impairments (See Table 1).[3]

Table 1: Cross Walk for Required 9 Key Elements for WIP

Required 9 Key Elements for 319 Grant	Location in WIP
Causes and Sources	Section 2: Watershed Assessment
Expected Load Reductions	Appendix D: Old Fort Bayou Fecal Coliform Bacteria Total Maximum Daily Load Reduction Plan
NPS Management Measures	Appendix F: Management Actions
Project Costs and Implementing Authorities	Appendix F: Management Actions
Education and Outreach	Section 3.1.2: Education and Outreach Activities and Appendix F: Management Actions
Implementation Schedule	Appendix F: Management Actions
Milestones	Appendix F: Management Actions
Adaptations and Revisions	Section 3.2.2: Adaptive Management and Plan Revision and Appendix F: Management Actions
Monitoring	Section 3.2.1: Monitoring Plan

States are encouraged to develop statewide watershed planning frameworks to guide watershed plans in their jurisdictions. In 2008 the Mississippi Department of Environmental

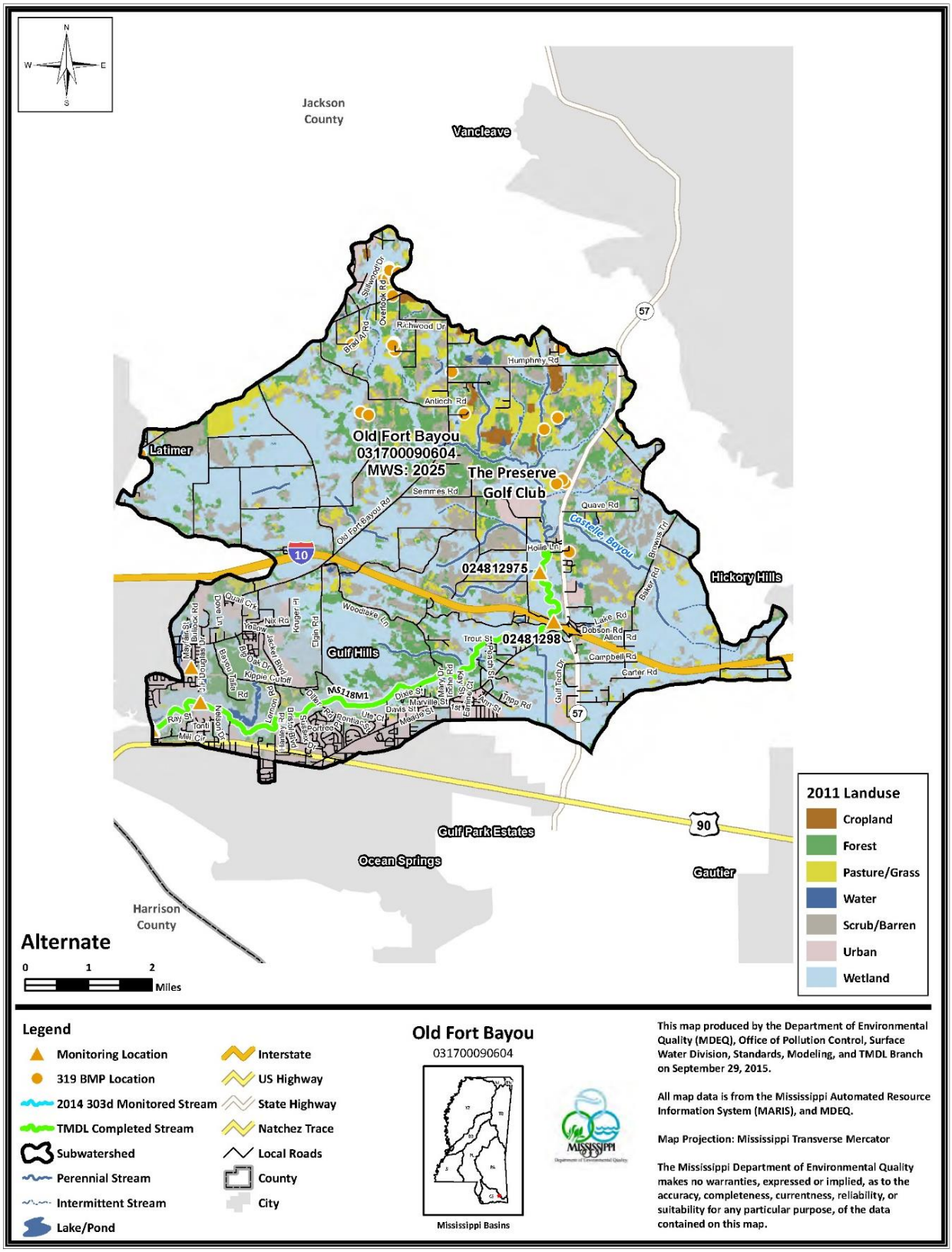
Quality's (MDEQ) Basin Management Branch published "Guidance for Developing A Watershed Implementation Plan." This guide, including the nine elements defined by the EPA for watershed plans receiving Section 319 funding, provides the framework for developing the Old Fort Bayou Watershed Implementation Plan.

1.1.2 Why create a WIP for Old Fort Bayou?

Developing a watershed plan for Old Fort Bayou Watershed is a key step in implementing the Coastal Nutrient Reduction Strategy and improving water quality in the watershed.[4] The Old Fort Bayou Watershed (HUC 031700090604) is 32,082 acres and includes parts of the City of Ocean Springs, the City of Gautier and Jackson County. See Figure 1. Old Fort Bayou (Waterbody ID MS118M1) is a tributary of the Back Bay of Biloxi and Biloxi Bay and, as a result, was listed on the EPA's 1998 Section 303(d) list of impaired waterbodies for fecal coliform levels that did not meet water quality standards. Results were determined based on monitoring and modeling.[5] NPDES permitted sites were included in the modeling, but the results showed that over 97% of the allocated load was due to nonpoint sources and did not come from a single source.[6] Fecal coliform is an indicator of pathogenic bacteria and can come from a variety of nonpoint sources including livestock, pet waste and faulty septic systems. Nutrients and sediment were not monitored in the study, but given the urban nature of the watershed and continuing residential and commercial development, they are likely environmental stressors in the watershed. These nonpoint source pollutants can come from excess fertilizers, herbicides and insecticides from agricultural lands and residential areas; oil, grease and toxic chemicals from urban runoff; and sediment from improperly managed construction sites, crop and forest lands, and eroding streambanks. Addressing causes of nonpoint source pollution in Old Fort Bayou Watershed requires a holistic approach to develop solutions is a primary benefit of creating a watershed plan.

A watershed action plan was completed for the Old Fort Bayou Watershed in 2007. The plan was sponsored by the Land Trust for the Mississippi Coastal Plain with funding assistance from the EPA and technical assistance from MDEQ's Coastal Streams Basin Team. The planning process included significant stakeholder participation, but there were limited resources available at the time for mapping and analysis and the action plan did not have all nine elements of watershed planning required by the EPA for Section 319 funding and now recommended for all watershed plans intended to address water quality impairments. This Watershed Implementation Plan for Old Fort Bayou Watershed serves to update the existing action plan to include these nine elements of watershed planning, re-engage stakeholders in the watershed, include significant mapping and analysis using best available data in GIS, and address the TMDL for fecal coliform.

Figure 1: Old Fort Bayou Watershed



A significant amount of resources have and will be directed to priority watersheds along the Mississippi Gulf Coast to improve water quality and help coastal ecosystems recover following the *Deepwater Horizon Oil Spill*. Old Fort Bayou was designated as one of Mississippi's priority watershed in MDEQ's Nonpoint Source Pollution Control Section 319(h) Grant Program Work Plan for Grant Years 2018 and 2019.[7] An approved Watershed Implementation Plan and organized partnership for Old Fort Bayou Watershed will improve the chances of bringing funding to the area.

The Old Fort Bayou Watershed Implementation Plan will also help coordinate and build momentum around the many conservation activities already taking place in the watershed. The Natural Resource Conservation Service (NRCS), Jackson County Soil and Water Conservation District (SWCD), and Mississippi Soil and Water Conservation Commission (SWCC) are actively working in the watershed. The Land Trust for the Mississippi Coastal Plain (LTMCP), The Nature Conservancy (TNC) and the U.S Fish and Wildlife Service protect and manage a significant amount of acreage in the watershed. The Director of Golf Operations at The Preserve Golf Club continues to implement Best Management Practices (BMP) that forward the Club's designation as certified Audubon Signature Sanctuary and is a leader in developing the BMP manual for Golf Course BMPs in Louisiana and Mississippi. Current activities and related plans are further discussed in Section 1.3.

1.1.3 Process and Acknowledgements

In May 2018, MDEQ enlisted the Land Trust for the Mississippi Coastal Plain (LTMCP), in partnership with Mississippi State University's Gulf Coast Community Design Studio, to facilitate the development of a Watershed Implementation Plan for Old Fort Bayou Watershed. The Watershed Implementation Plan is an update to the 2007 Action Plan for Old Fort Bayou Watershed that was facilitated by LTMCP. This Old Fort Bayou Watershed Implementation Plan is funded partly through a U.S. Environmental Protection Agency (EPA) FY2015 Nonpoint Source Grant (#C999486615), CFDA 66.460, Nonpoint Source Implementation, awarded on August 18, 2015.

The first step in the planning process was to assemble a Watershed Implementation Team representing various stakeholders in Old Fort Bayou Watershed. See Section 1.2.1. This team includes a Steering and Technical Advisory Committee made up primarily of local leadership, staff from various public agencies and private firms with expertise related to the watershed planning, and residents and an Education and Outreach Subcommittee to guide the education and public engagement strategy.

The Steering and Technical Advisory Committee first met on June 27, 2018 to revisit priorities and goals identified in the 2007 Action Plan based on current conditions. Information from this working meeting was used to identify current challenges and opportunities and develop a vision and goals for watershed planning in Old Fort Bayou to guide the committee and future work. See Sections 1.2.2 – 1.2.4. The Steering and Technical Advisory Committee then set to work collecting and analyzing available data related to Old Fort Bayou Watershed and participated in a day-long boat trip to explore and document current conditions from the water on August 24, 2018. This information is included in Section 2 and has informed the management and monitoring plans included in Section 3.

BMI Environmental Services, LLC, in partnership with Nutter & Associates was hired as a project consultant between August and December 2018 to analyze available water quality data for Old Fort Bayou as compared to the TMDL and approved thresholds. See Appendix D: Old Fort Bayou Fecal Coliform Bacteria Total Maximum Daily Load Reduction Plan.

GCCDS also secured a grant through the National Oceanic and Atmospheric Administration's (NOAA) Gulf of Mexico Bay Watershed Training and Education Program (B-WET) to work with students at St. Martin High School. St. Martin High School is adjacent to Old Fort Bayou and was an ideal setting to start engaging students and the larger community around stormwater and water quality issues and opportunities for improvement in the watershed. Over the course of the fall term, students did water quality testing at and learned about BMPs at two sites on Old Fort Bayou. Student work was presented at the final Watershed Advisory Team Meeting on December 17, 2018 and has been incorporated throughout the plan from the visioning and goal setting to data collection and recommendations. More information about the year-long project is included in Appendix E. In addition to student involvement, several teachers and administrators from St. Martin High School and Jackson County School District served on the Education Subcommittee. The Education Subcommittee was critical to reviewing the education and outreach-related strategies included in the 2007 Action Plan and providing recommendations for future activities included in Section 3.1.3.

1.2 Looking Forward

1.2.1 Watershed Implementation Team

Steering & Technical Advisory Committee

Ankerson	Scott	City of Gautier
Baker	Jessica	Jackson County
Bauman	Kacie	National Wild Turkey Federation
Brown	Donna	Gulf Hills Hotel & Conference Center
Catchot	Marcus	Jackson County
Chubb	Patrick	Mississippi Power
Coats	Michele	Jackson County
Coleman	Lindsey	Jackson County Soil and Water Conservation District
Dickerson	Cody	City of Gautier
Franklin	Terry	City of Ocean Springs
Freiman	Mike	Mississippi Department of Environmental Quality
Galle	Edward	Jackson County Soil & Water Conservation District
Greco	Tony	Nutter & Associates
Hereford	Scott	Mississippi Sandhill Crane National Wildlife Refuge
Holden	Linda	Landowner, Jackson County
Ivy	Nick	MS Soil and Water Conservation Commission
Kelly	Jim	3Point Eco-Logical, LLC
Knight	Charles	MS Department of Wildlife, Fisheries and Parks
Lewis	Larry	BMI Environmental Services
Lott	John	MS Natural Resources Conservation Service
Martin	Carolyn	City of Ocean Springs

Mayson	Frazer	Nutter & Associates
McLeod	Caitlin	MSU Extension - Jackson County
Middleton	Lance	MS Soil and Water Conservation Commission
Miles	Stephen	The Preserve Golf Club/ LA-MS Golf Course Superintendents Association
Miller	Kimberly	Allen Engineering (Gautier and Ocean Springs)
Mohrman	Tom	The Nature Conservancy of Mississippi
Morgan	Ramona	City of Gautier
Morgan	Wade	City of Ocean Springs
Parshotam	Ajay	Mississippi Department of Environmental Quality
Perkins	Adriene	Mississippi Department of Environmental Quality
Perrott	Coen	Mississippi Department of Environmental Quality
Phillips	Jereme	Mississippi Sandhill Crane National Wildlife Refuge
Price	Rhonda	Mississippi Department of Marine Resources
Segrest	Natalie	Mississippi Department of Environmental Quality
Sparks	Eric	MSU Coastal Research & Extension Center
Steckler	Judy	Land Trust for the Mississippi Coastal Plain
Smith-Incer	Liz	National Park Service
Stringfellow	Darrell	Jackson County
Thompson	Charles	Mississippi Department of Environmental Quality
Upton	Doug	Mississippi Department of Environmental Quality
Waldrup	Chad	MS Natural Resources Conservation Service
Wittmann	Jennifer	MS Department of Marine Resources
Williams	Darryl	EPA Region IV

Education and Outreach Subcommittee

Banks	Amber	St. Martin High School
Baker	Jessica	Jackson County
Coleman	Lindsey	Jackson County Soil and Water Conservation District
Culver	Michelle	EPA Gulf of Mexico Program Fellow
Goyette	Nick	Land Trust for the Mississippi Coastal Plain
Heise	Mike	St. Martin High School
Holland	Dina	St. Martin High School
Middleton	Lance	MS Soil and Water Conservation Commission
Miles	Stephen	The Preserve Golf Club/ LA-MS Golf Course Superintendents Association
Morgan	Wade	City of Ocean Springs
Parton	Yvonne	Ocean Springs Library System
Rivers	Chris	St. Martin High School
Scarborough	Shea	St. Martin High School
Schadler	Cherie	MDEQ Mobile Classroom

Smith-Incer	Liz	National Park Service
Steckler	Judy	Land Trust for the Mississippi Coastal Plain
Veeder	Debra	Adopt-a-Stream/MS Department of Wildlife, Fisheries and Parks
Wells	Melissa	Mississippi Department of Environmental Quality
Westfall	Penny	Jackson County School District
Wyman	Tracy	Gulf Coast Community Design Studio, MSU

1.2.2 Assets, Concerns and Challenges

The assets and challenges noted below were documented at the June 27, 2018 meeting of the Old Fort Bayou Steering and Technical Advisory Committee. For this exercise, committee members were asked to revisit and rank the priorities identified in the 2007 Action Plan and add any additional priorities.

Assets to be Protected:

- Marsh areas and streamside buffers
- Vistas and intrinsic beauty
- Public access to the bayou and status as blueway
- Greenspace and land in conservation
- Rural character of upper watershed

Concerns/Challenges:

- Lack of public awareness
- Lack of water quality data and monitoring
- Erosion/sedimentation from development
- Lack of knowledge and infrequent use of Low Impact Development strategies
- Protection of marsh and streamside buffers
- Coordination of planning efforts (comprehensive planning, watershed planning, etc.)
- Enforcement of ordinances intended to protect watershed and water quality
- Lack of funding and/or prioritization of funding for watershed-related projects

1.2.3 Vision

The vision statement for Old Fort Bayou Watershed as noted below is a compilation of input documented at the June 27, 2018 meeting of the Old Fort Bayou Steering and Technical Advisory Committee and from the 80 students who participated in the NOAA Gulf of Mexico Bay Watershed Education and Training Program during the fall term at St. Martin High School.

The community envisions a cleaner watershed for healthier humans and ecosystems; where residents and visitors have access to the bayou and wholesome recreational opportunities; and where stakeholders are educated and actively engaged in protecting the watershed.

1.2.4 Goals and Objectives

This WIP will address the Total Maximum Daily Load (TMDL) for fecal coliform for listed tributaries to the Back Bay of Biloxi and Biloxi Bay including Old Fort Bayou as approved by MDEQ in 2002. According to the TMDL, "under existing conditions Old Fort Bayou showed no impairment based on the Secondary Contact standard".[8] Despite this, the TMDL recommends a 35% reduction of the fecal loads from runoff from the watersheds surrounding the Back Bay of Biloxi and Biloxi Bay.[9] While there is insufficient data to determine if Old Fort Bayou suffers from elevated levels of nutrients (phosphorus and nitrogen), problems with erosion and sedimentation, and/or other environmental stressors, it is likely that other water quality indicators need to be addressed given the urban/suburban nature of the lower watershed, new development, and existing golf courses. See Section 2.4.5 Current Status of Water Bodies. As such, this WIP also recommends taking measures to reduce nutrient loads and sediments coming from nonpoint sources in the watershed. The following goals were developed by the Steering and Technical Advisory Committee and Education Subcommittee for the Old Fort Bayou WIP along with input from the students who participated in the NOAA Gulf of Mexico Bay Watershed Education and Training Program during the fall term at St. Martin High School.

1. **Better understand and reduce pollutants entering the water system**
    a. Update and continue to monitor water quality in Old Fort Bayou Watershed and add indicators including, but not limited to Total Nitrogen and Total Phosphorus
    b. Identify specific contributors of pathogens and target to reduce harmful bacteria entering the water system
    c. Promote and enforce litter prevention

2. **Reduce erosion and sedimentation to improve water quality and protect navigability of Old Fort Bayou**
    a. Identify and target key sources of erosion
    b. Encourage policies and practices to promote the use of Low Impact Development strategies and reduce stormwater runoff in the watershed
    c. Protect and re-establish riparian buffers where possible

3. **Protect and improve quality access points and recreational opportunities on and around Old Fort Bayou**
    a. Re-assess, update and promote Old Fort Bayou blueway and supporting infrastructure
    b. Coordinate planning and development of future public access points, keeping in line with current Best Management Practices
    c. Support environmentally-sensitive recreation and economic development opportunities that allow for preservation of marshes and riparian buffers

4. **Increase environmental awareness, stewardship and stakeholder participation in the watershed**
    a. Build momentum of the Steering and Technical Advisory Committee for the Old Fort Bayou WIP and establish an Old Fort Bayou Watershed Partnership
    b. Implement and continue to improve plan for education and outreach in the watershed
    c. Create meaningful opportunities for schools, civic organizations and residents to participate in water quality monitoring and stewardship activities

1.3 Related Plans and Projects

A significant amount of planning and plan implementation has and is being done that relates to watershed planning in Old Fort Bayou watershed. Relevant plans and projects are described below. Data and recommendations from these plans and projects have also been incorporated into Section 2: Watershed Assessment and Section 3: Management and Monitoring Plans.

Project Title: Old Fort Bayou Watershed Action Plan
Funder: Environmental Protection Agency, Region IV
Awardee: Land Trust for the Mississippi Coastal Plain
Geographic Scope: Old Fort Bayou
Deliverables: Watershed partnership and action plan for Old Fort Bayou Watershed with two primary objectives: 1) create a safe and beautiful blueway for residents and visitors and 2) restore geomorphic stability thus decreasing bank erosion and sediment loading in downstream inchannel environs.
End Date: Spring 2007

Project Title: Old Fort Bayou Watershed Education and Civic Engagement
Funder: National Oceanic and Atmospheric Administration (NOAA) Gulf of Mexico Bay Watershed Education and Training Program (B-WET)
Awardee: Mississippi State University's Gulf Coast Community Design Studio
Project Partners: Land Trust for the Mississippi Coastal Plain, Jackson County School District, Jackson County staff and leadership, and NOAA National Centers for Environmental Information's Center for Coasts, Oceans and Geophysics
Geographic Scope: Old Fort Bayou Watershed
Deliverables: Educational programming and field experiences to introduce students to watershed dynamics with a focus on Old Fort Bayou Watershed and concurrent planning efforts. Several students will be selected to work with the Jackson County Planning Department, under the guidance of GCCDS staff, to increase the County's capacity around Low Impact Development practices and reducing stormwater runoff.
End Date: August 2019

Project Title: Old Fort Bayou/Tuxachanie Creek Watershed Nonpoint Source Pollution Demonstration Project
Funder: Mississippi Department of Environmental Quality
Project Partners: Mississippi Soil and Waters Conservation Commission, Mississippi Department of Environmental Quality, United States Environmental Protection Agency, United States Department of Agriculture Natural Resources Conservation Service, and the Jackson County Soil and Water Conservation District
Geographic Scope: Agricultural land in Rotten Bayou Watershed
Deliverables: Installed Best Management Practices on agricultural land (fencing, nutrient management, water & sediment control basins, critical area planning, etc.)
End Date: June 2006

Plan Title: Jackson County Bicycle, Pedestrian and Trails Master Plan
Funder: Gulf Regional Planning Commission
Awardee: Jackson County
Project Partners: Cities of Gautier, Moss Point, Ocean Springs and Pascagoula

Geographic Scope: Jackson County, Mississippi
Deliverables: Master plan
End Date: July 2018

Plan Title: Plan for Opportunity
Funder: US Department of Housing and Urban Development
Awardees: Gulf Regional Planning Commission, Gulf Coast Community Design Studio, South Mississippi Planning and Development District, Ohio State University, Kirwin Institute, Mississippi Center for Justice, Steps Coalition
Geographic Scope: Hancock, Harrison and Jackson Counties
Deliverables: Regional 20 year plan addressing water, land use, transportation, housing, food and resiliency
End Date: Completed December 2013; 20 year Plan

Plan Title: Mississippi Gulf Region Water and Wastewater Plan
Funder: US Department of Housing and Urban Development
Awardee: Mississippi Department of Environmental Quality; planning assistance provided by Mississippi Engineering Group, Inc. (MSEG)
Geographic Scope: Lower 6 Counties, Mississippi
Deliverables: Regional plan to identify the most critical water, wastewater, and stormwater infrastructure needs within the Gulf Region and to prioritize those needs within the framework of an implementation plan for allocation of the funds designated by Governor Barbour.
End Date: Completed April 2006; Plan through 2025

Plan Title: Mississippi Sandhill Crane National Wildlife Refuge Comprehensive Conservation Plan
Author: U.S. Department of the Interior, Fish and Wildlife Service, Southeast Region
Geographic Scope: Mississippi Sandhill Crane National Wildlife Refuge, Jackson County, MS
Deliverables: 15-year plan to provide long-term guidance for management decisions; define goals, objectives, and strategies needed to accomplish refuge purposes; and identify anticipated future need.
End Date: Approved September 2007; Plan through 2023

In addition to the aforementioned plans, the jurisdictions' Small Municipal Separate Storm Sewer System (MS4) General Permit Reports are also relevant; particularly Section I: Summary of Implementation Activities by Minimum Measure and Best Management Practice which includes best management practices related to stormwater. The reports include strategies ranging from public education and involvement to pre- and post-construction stormwater controls. Per ACT7, S-2 of the MS4 General Permit, the "coverage recipient is to annually summarize the progress made in implementing the conditions of the permit and the elements of the Storm Water Management Program (SWMP)." The MS4 plans for Jackson County and the Cities of Gautier and Ocean Springs were reviewed and incorporated, where applicable, in Section 3: Management and Monitoring Plan.

Section 2: Watershed Assessment

2.1 History and Land Use

2.1.2 Historical Context

Old Fort Bayou is a tidal creek navigable by canoe and Kayak from Old Fort Bayou Road to the Biloxi Bay. The bayou has a maximum width of 1000 feet north of Ocean Springs, but generally ranges between 250 and 350 feet from its mouth at Back Bay for a distance upstream of about 2-3 miles. At the ferry landing and bridge sites on the south shore, the bayou has a width of about 300 feet and is not fordable.[10] Because of this, development has been focused towards the southwest portion of the watershed and has included residential settlements, lumber and farming industries, ferries and watercraft construction, and tourist amenities.

Old Fort Bayou, Ocean Springs, MS. 1901
Source: Detroit Photographic Company. Library of Congress < https://www.loc.gov/item/2008678157/>.

Bayou Puerto is the ancestral name for the area that most of us refer to today as Gulf Hills. The terrain in the Bayou Puerto region is relatively high considering its propinquity to the Gulf of Mexico. This small, isolated, primarily Roman Catholic settlement came into existence in the mid-19th Century. The settlement was flanked by descendants of French and Spanish colonials and Americans. These early Spanish and Portuguese settlers were recent immigrants and not descendants of the Spanish colonials who have anecdotally been linked with the Spanish Camp across Old Fort Bayou on the Fort Point peninsula at Ocean Springs.[11]

Historical records and journals of the era indicate that Fort Bayou was an important inland waterway in the "lake trade", the commerce between New Orleans and the Mississippi Gulf Coast. Locally, this exchange consisted primarily of charcoal and naval stores from Ocean Springs and other areas on the Mississippi Sound, often called "The Lake", via Lake Pontchartrain to New Orleans. Returning vessels brought hardware, tools, cloth, medicine, and staple goods to this region. [12]

Although not a primary boat building center, some watercraft construction did occur on Fort Bayou and Bayou Puerto. Although most of the boats built here were probably small sailing

vessels, i.e. catboats, and fishing skiffs, there was some schooner construction on Fort Bayou. Boat repair yards probably existed on both bayous.[13]

Lumber

The Winter Park Lumber Company, was a co-partnership between Parker Earle (1831-1917), his sons, Franklin S. Earle (1856-1929) and Charles T. Earle (1861-1901), and V.R. Holladay. The Earle family had relocated to Ocean Springs from southern Illinois, in the late 1880s. The Earle Farm property was situated just northeast of the Bayou Puerto community. It is very likely that both men and women from this area found employment as day laborers in the tomato fields, vineyards, and fruit orchards of the Earles. This commercial agricultural venture consisted of nearly 840 contiguous acres. Unfortunately, the Earle Farm went into bankruptcy. The Earle Farm, became the Rose Farm in 1897, when it was sold to Joseph B. Rose (1841-1902).[14]

Ferries

The earliest recorded ferry operation across Old Fort Bayou was run by Captain Antonio M. Franco (1834-1891). It was a flat boat large enough for "drayage animals and their burden and operated by a hand pulled rope".[15]

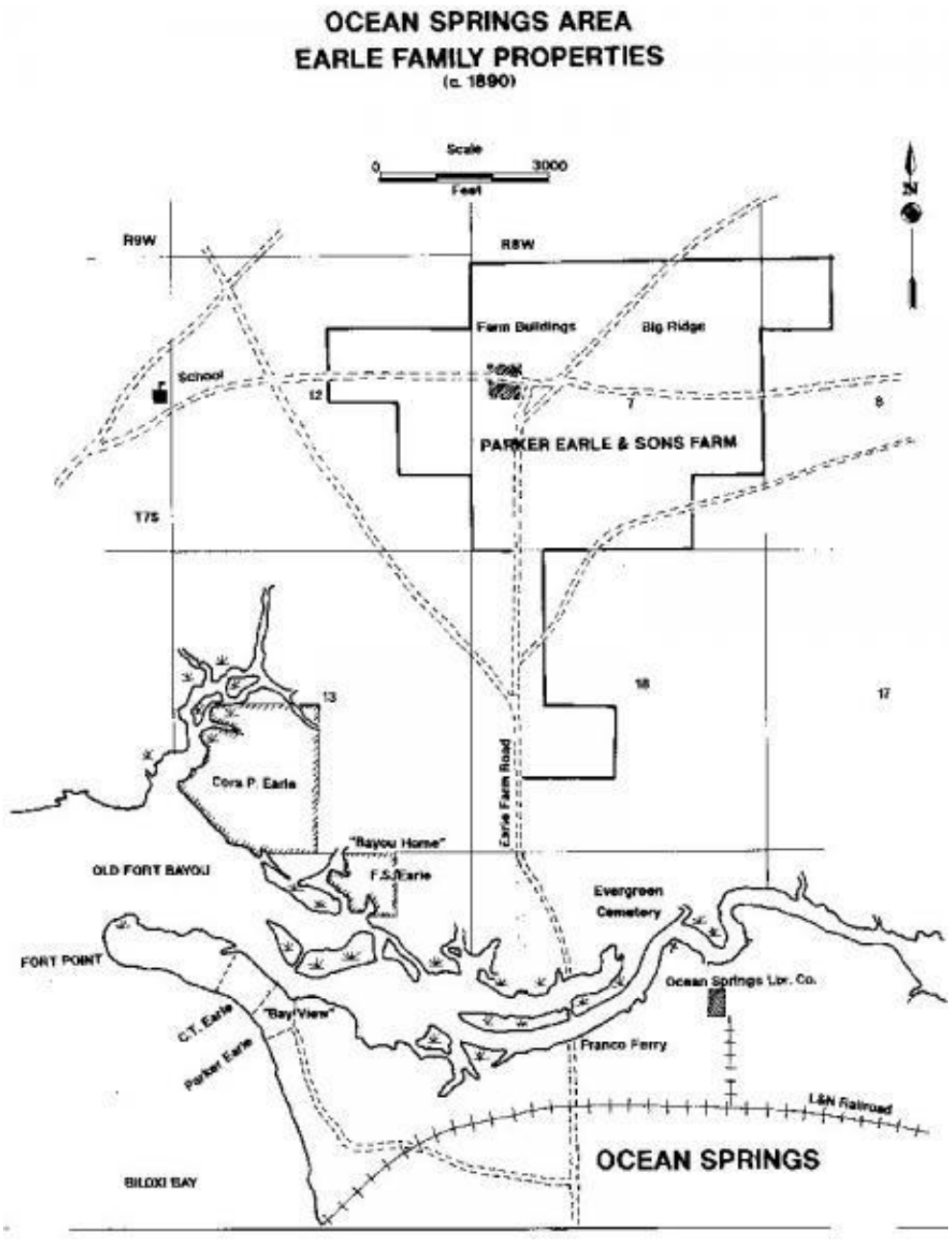
Antonio M. Franco was born on April 11, 1834 at Lisbon, Portugal. He went to sea at the age of eleven and ended his maritime commercial ventures after the Civil War. Franco then began several land-based enterprises.

By January 1874, Antonio and his wife, Jane Franco, had spent $850 for approximately two and a half acres on Washington Avenue and Old Fort Bayou. Here they erected their home, which is now part of the Aunt Jenny's Catfish Restaurant on Washington Avenue. After her husband passed away in 1891, Jane Franco continued in the business of transporting people, animals, and freight across Old Fort Bayou at Ocean Springs.[16]

In the fall of 1891, Parker Earle (1831-1917), and his sons, Franklin S. Earle (1856-1929) and Charles T. Earle (1861-1901), started their own ferryboat service across Old Fort Bayou to improve their business operations north of Ocean Springs. The Earle ferry landing was located at Washington Avenue at the head of the main artery on Old Fort Bayou.[17]

Old Fort Bayou Ferry (pre-1901)
Source: Bellande, Ray L. Ocean Springs Archives. Old Fort Bayou: Ferries & Bridges (1875-2002).

In June 1893, the Jackson County Board of Supervisors declared "that the ferry on Old Fort Bayou Road, No. 61, in Beat No. 4, known and called "Franco Ferry" be and same is declared a public ferry and that Mrs. A. Franco be granted a license to keep and maintain said ferry for a term of one year." At the same time, Franklin S. Earle representing the Winter Park Land and Live Stock Improvement Company submitted an application requesting that the Board reconsider their licensing of Mrs. Franco as the public ferryman on Old Fort Bayou at Ocean Springs. His request was "denied and refused" by the county officials.[18]



Parker Earle & Sons Farm Plat
Source: Bellande, Ray L. Ocean Springs Archives. Jackson County, Mississippi Natural Resources & Horn Island

Farming

H.D. Money (1869-1936), who was the proprietor of the Rose farm north of Fort bayou, was also a proponent of sheep raising. Colonel Money had fruit and pecan orchards on his large farm.

In September 1915, Money reported to The Ocean Springs News that his experience with sheep raising, although on a small scale, was very profitable. The decline of commercial sheep raising north of Fort Bayou can be traced to the passage of Chapter 263-House Bill No. 91 by the Mississippi legislature in 1926. The stock law was passed to prevent all live stock (cattle, horses, mules, jacks, jennets, sheep, goats, and hogs) from running at large upon open or unfenced lands. Animals were restricted to a safe enclosure. The statue also sought to prevent the spread of Texas fever ticks. In 1930, Bonnet v. Brown (No. 28288) tested the stock law in the Supreme Court of Mississippi. The original suit had been filed at George County. Another crushing blow to sheep husbandry in the area was the 1934 screw worm epidemic. It did serious damage to regional flocks and almost destroyed the sheep industry in Jackson County.[19]

Tourist Amenities

Starting in the early 20th Century, tourism interests shifted from the mineral springs on Fort Bayou to the beach environment where saltwater bathing and seafood were popular. Excursion trains from New Orleans brought day and weekend tourist to the coast, and particularly to Ocean Springs where there were already some amenities such as bath houses, piers, hotels and boarding houses. The pecan and citrus industry at Ocean Springs and shipyards at Moss Point and Pascagoula also contributed to the demand for housing in the area at this time.[20]

By 1915, the game of golf had become popular in the United States. Mr. H.F. Miller, manager of the Chicago Association of Commerce speaking on the future of Ocean Springs said, "the golf club is a most important thing. Develop that; it will bring people, it will bring trade; develop good eighteen-hole links, and the big hotel that I hear agitated will come of its own accord".[21]

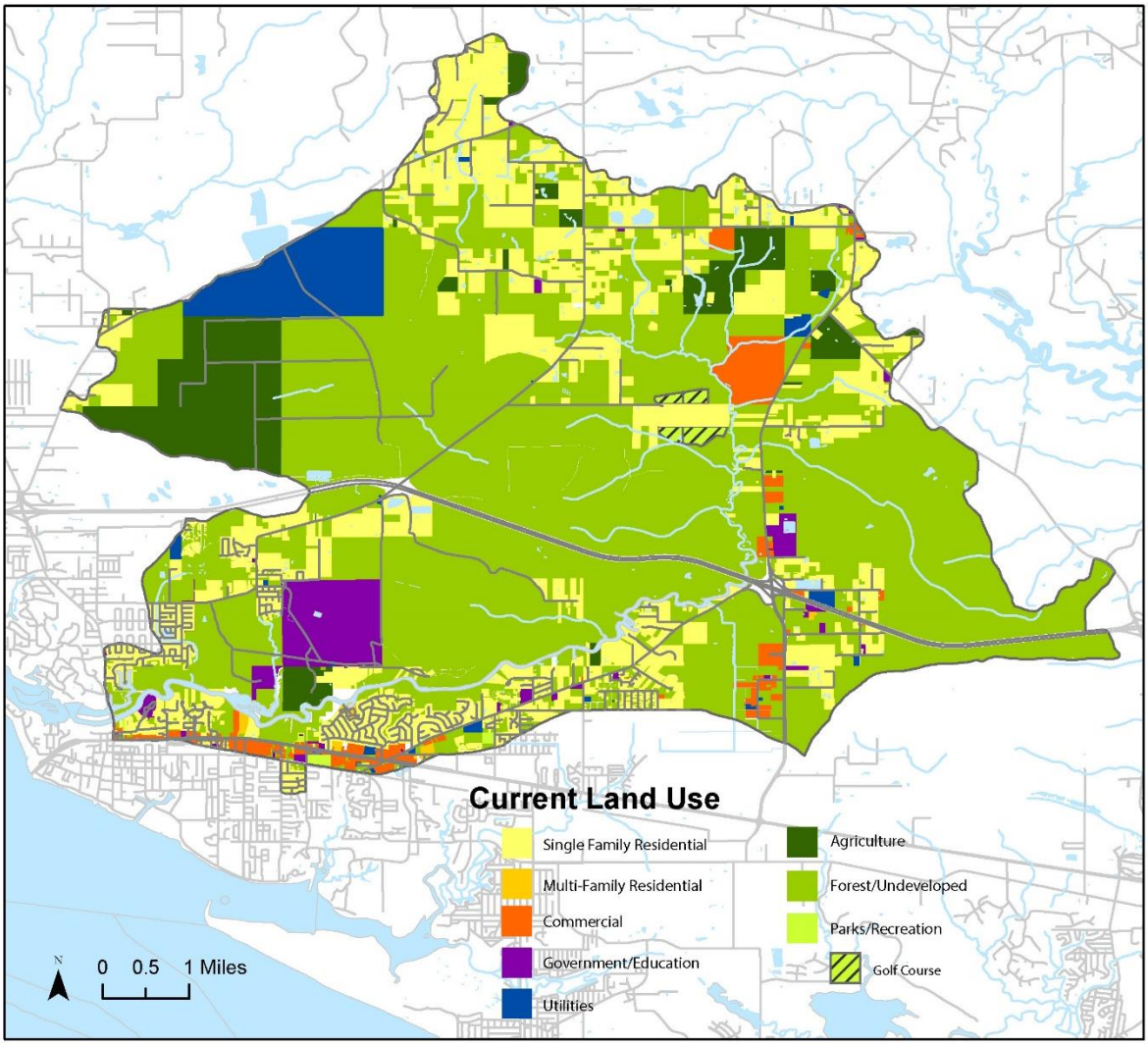
In 1927, the Branigar brothers, from Chicago, Illinois, developed Gulf Hills just north of Ocean Springs and Old Fort Bayou. The development included a golf course, clubhouse and 13 upscale homes. Interestingly, the original 13 homes did not have kitchens or laundry facilities, so residents took all meals at the clubhouse and their laundry was picked up and returned clean and folded by clubhouse employees. According to legend, the resort was developed for Chicago crime figure, Al Capone and remnants of a "Speak Easy" and Gambling Casino still remain. The clubhouse was also home to a lounge called "The Pink Pony" that attracted many well-known entertainers including Elvis Presley. Over the past 70 plus years, Gulf Hills has been bought and sold many times until 1998 when it was bought by the residents.[22]

Today, the upper watershed remains rural in nature with horse and cattle farms and rural estates; however, since Hurricane Katrina, the rural nature is quickly converting into a more suburban landscape with smaller-lot residential homes and subdivisions. The lower watershed is bordered by the St. Martin community to the north and the City of Ocean Springs to the south. Subdivisions are quickly becoming a primary source of nonpoint source pollution and creating added pressure along the bayou's waterfront. Fishing, boating and birdwatching are the primary recreational uses on the bayou. City and County boat launches, unique dining, lodging and golfing are available to visitors and residents; this along with significant conservation areas makes the bayou an attractive waterway for locating a canoe and kayak trail.[23]

2.1.3 Current and Future Land Use

The watershed is primarily undeveloped (62%) and lower density, single family residential (21%). The remainder of the watershed is agricultural (7.4%) with relatively little commercial development (2.3%). The Preserve Golf Course is within the watershed boundary and adjacent to Old Fort Bayou and makes up 0.4% of the land area.[24] See Figure 2. Gulf Hills also operates a golf course adjacent to Old Fort Bayou at the confluence of the bayou and Back Bay of Biloxi, although just out of the watershed boundary for HUC 031700090604. A considerable amount of the undeveloped and forested land in the watershed is publicly owned and the majority of that is in conservation. Conservation is further discussed in Section 2.3.5.

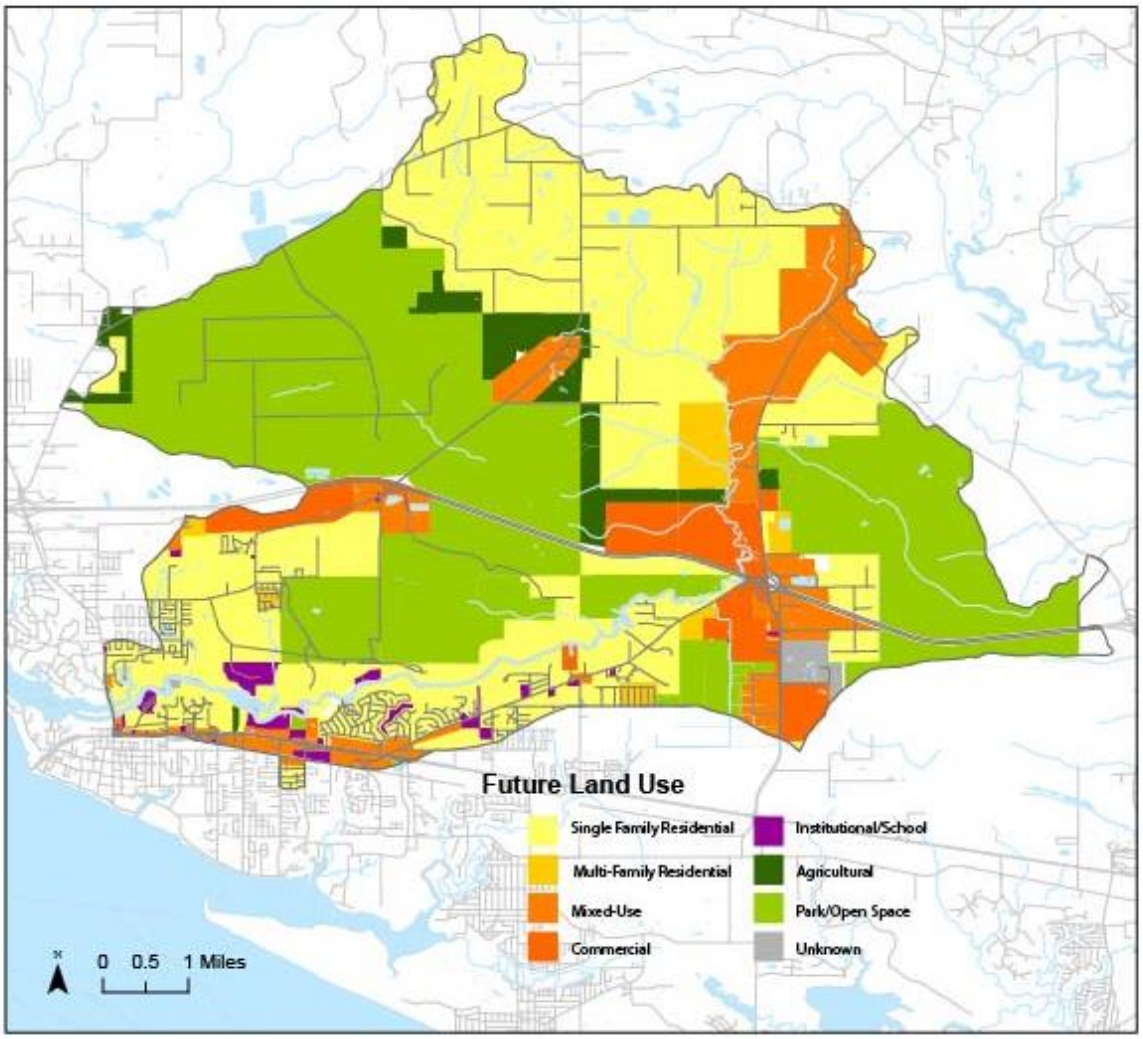
Figure 2: Current Land Use



Source: Land use data from Gulf Regional Planning Commission (2013). Map by Gulf Coast Community Design Studio. Projection: NAD 1983 State Plane Mississippi East FIPS 2301 Feet.

According to a study by the Gulf Regional Planning Commission in 2013 assessing future land use as determined in jurisdiction's comprehensive plans, the majority of development is expected to occur in single-family residential (18% increase), with additional increases in commercial and mixed-use development.[25] See Figure 3. Single-family residential development is anticipated to occur in the more rural areas of the upper watershed, potentially replacing some of the current agricultural land, as well as the forested/undeveloped land. Commercial and mixed-use development is projected more along the major transportation corridors including I-10 and MS-57. Currently, there is a considerable amount of development occurring in the St. Martin area just north of Old Fort Bayou.[26] It does seem that the jurisdiction's comprehensive plans need to be updated to include more of the recent additions to protected lands in conservation. Compare Figure 3: Future Land Use to Figure 8: Land in Conservation.

Figure 3: Future Land Use



Source: Land use data from Gulf Regional Planning Commission (2013). Map by Gulf Coast Community Design Studio. Projection: NAD 1983 State Plane Mississippi East FIPS 2301 Feet.

2.2 Human Resources

2.2.1 Demographics

As of the 2010 Census, there were 20,235 people living in the watershed. Of the total population, 76% are White, 12% are Black/African American, 6% are Hispanic/Latino(a), and 4% are Asian. The fact that a significant percent of the population is Hispanic and Asian suggests that consideration should be given to tailoring education and outreach such that it can overcome potential language barriers.

According to the American Community Survey's 2012-2016 5-year estimates, 8% of the population is living below the poverty limit. This is well below the national poverty rate (12.3%) and below the 20% threshold that is considered the rate of high poverty for rural areas and tipping point at which poverty will continue to grow in neighborhoods.[27] [28] [29]

There is a total of 8,851 housing units within Old Fort Bayou Watershed. Of the built housing units, 82% are occupied and 18% are vacant. This is a relatively high vacancy rate compared to the vacancy rate for Jackson County (13%) and the U.S. (11%), but fairly consistent with the vacancy rate for Mississippi as a whole (15%). The majority of the housing in the watershed is owner occupied (73%) which may be a positive factor in improving environmental stewardship in the watershed. [30]

A significant number of households in the watershed are home to seniors (35%) and children (28%). These are important factors to consider when developing programming, education and outreach strategies, and waterway access points.

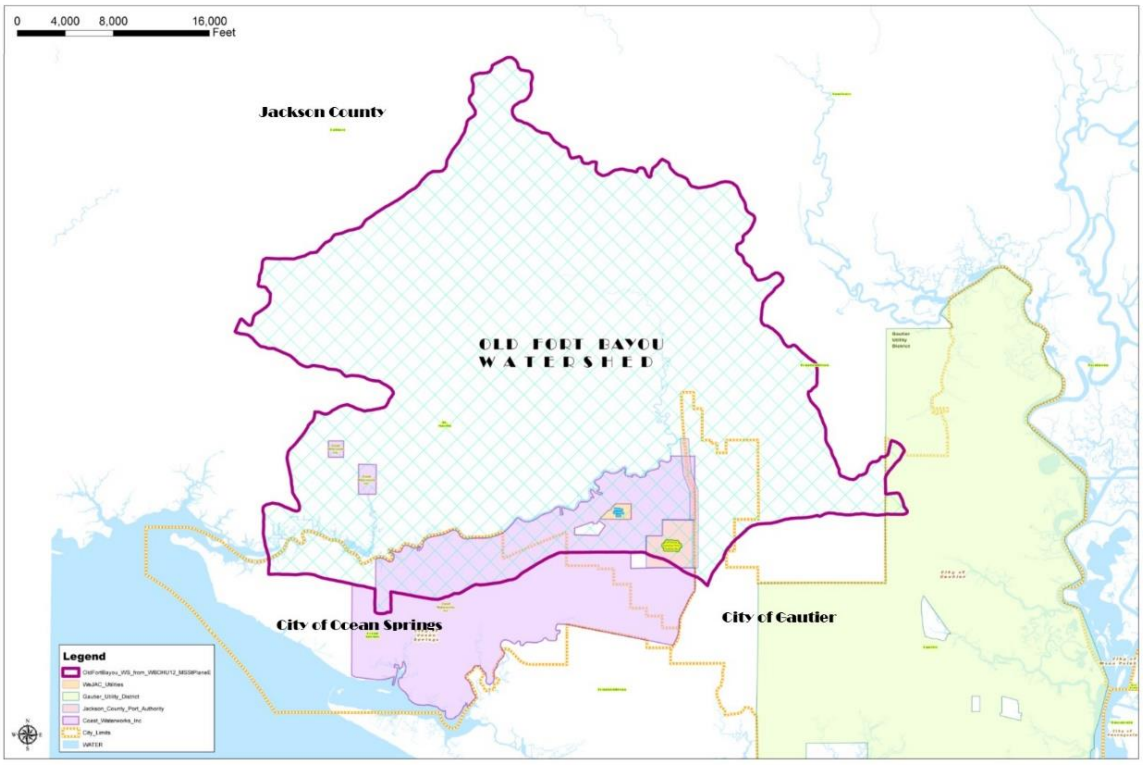
2.2.2 Municipal

Old Fort Bayou Watershed is a multi-jurisdictional watershed. The watershed includes part of the City of Ocean Springs to the southwest, part of Gautier to the southeast, and spans into Jackson County to the north. Multiple water and sewer districts have jurisdiction in the area including West Jackson County Utility District, Gautier Utility District, Coast Water Works Inc., and Jackson County Port Authority. The complex and multi-jurisdictional nature of Old Fort Bayou watershed presents a challenge for, but also a greater justification for planning and collaboration in the watershed around issues of water quality. See Figure 4.

The Mississippi Sandhill Crane National Wildlife Refuge, owned and operated by the U.S. Department of the Interior's Fish and Wildlife Service, is also a significant stakeholder in the watershed. The Refuge was established in 1975 in Jackson County for the protection and recovery of this critically endangered bird and the restoration of its unique habitat, wet pine savanna (e.g., pitcher plant bogs). The vast majority of wet pine savanna (95-97%) has been altered; thus, the Refuge plays a critical role as a representative remnant of this ecosystem. The Mississippi Sandhill Crane Refuge consists of three separate units totaling approximately 19,300 acres: the Gautier, Ocean Springs, and Fontainebleau units. Each unit lies within the limited nesting range of the endangered Mississippi sandhill crane. The purpose of the Mississippi Sandhill Crane Refuge is threefold: To provide protection and management for the endangered Mississippi sandhill crane, by restoring, improving, and maintaining nesting, feeding, and roosting habitat within the refuge; to protect and conserve unique savanna habitat of south

Mississippi; and to provide opportunities for environmental education and interpretation and wildlife-dependent recreation to refuge visitors.[31]

Figure 4: City Boundaries and Utility Districts in Old Fort Bayou Watershed



Source: Jackson County GIS Department (2018).

2.2.3 Civic Infrastructure

There are several civic organizations that are active in Old Fort Bayou Watershed and important to current and future watershed protection strategies. These include, but are not limited to the Land Trust for the Mississippi Coastal Plain, The Nature Conservancy, and the Mississippi State University Extension Service. Brief descriptions of each organization are included below.

Land Trust for the Mississippi Coastal Plain

The Land Trust for the Mississippi Coastal Plain (LTMCP) was founded in 2000 and works in the six coastal counties of Mississippi. The organization strives to conserve, promote and protect open spaces and green places of ecological, cultural or scenic significance in the counties of the Mississippi Coastal Plain. LTMCP is accredited by the Land Trust Accreditation Commission, an independent program of the Land Trust Alliance, and has worked with landowners and local authorities to protect over 8000 acres of valuable wetlands and environmentally significant land in the region.

The Nature Conservancy

The Nature Conservancy (TNC) is an international 501(c)(3) organization managed from its worldwide office in Arlington, Virginia USA. Since 1956, TNC has been working to conserve lands and waters along the Gulf Coast that have provided a sense of place and connection to our natural heritage for many generations. TNC has local Boards of Trustees, land holdings, and activities in all of the Gulf Coast states, including an office and significant landholdings in Old Fort Bayou Watershed. TNC has played a key role in protecting and restoring many important landscapes on the coast including areas with unique native plant communities, habitat for the federally endangered species, acres of oyster reefs, and rare geologic formations rich with fossils. The Nature Conservancy also employs scientists that have long been first-hand observers of the health of the region's coastal ecosystems.

Mississippi State University Extension Service

The Mississippi State University Extension Service, in general, provides research-based information, educational programs, and technology transfer focused on issues and needs of the people of Mississippi, enabling them to make informed decisions about their economic, social, and cultural well-being. Core programs include agriculture and natural resources, family and consumer education, enterprise and community resource development and 4-H youth development. The MSU Extension also coordinates the Master Gardener Volunteer program. Through this program, individuals are trained and certified in consumer horticulture and related areas. The program allows the local Extension Service to reach a larger gardening audience. Continuing education is offered to encourage long-term commitments and most certified Master Gardeners serve five to seven years.

The Coastal Research and Extension Center (CREC) focuses more on coastal environments and is located minutes away in Biloxi. The CREC aims to provide education and outreach specifically for Mississippi's coastal residents in regard to almost every aspect of the coastal environment - fisheries, wetland management, marine industry, recreation, economics and law.

Other Civic Organizations

Other civic organizations near the Old Fort Bayou Watershed also have the potential to play a much larger role in environmental stewardship in the watershed. For example, the Walter Anderson Museum of Art located in downtown Ocean Springs is based on Walter Anderson's vision for communities that exist in harmony with their environment. He greatly valued and was inspired by nature, particularly coastal ecosystems, as is evident in this internationally-renowned artwork. The Mississippi Wildlife Federation's Habitat Stewards Program is also very active on the coast and would be a great partner. The Mississippi Habitat Stewards Program is a volunteer program that supports management and conservation on public lands in coastal Mississippi. In addition, garden clubs and local chapters of Keep America Beautiful can easily refocus their work to promote environmental priorities in the watershed.

2.3 Physical Setting

2.3.1 Soils and Geology

The soil and geology of a drainage area make up the hydrogeologic setting of a watershed. The type and distribution of the materials that affect the surface and substrate are important to

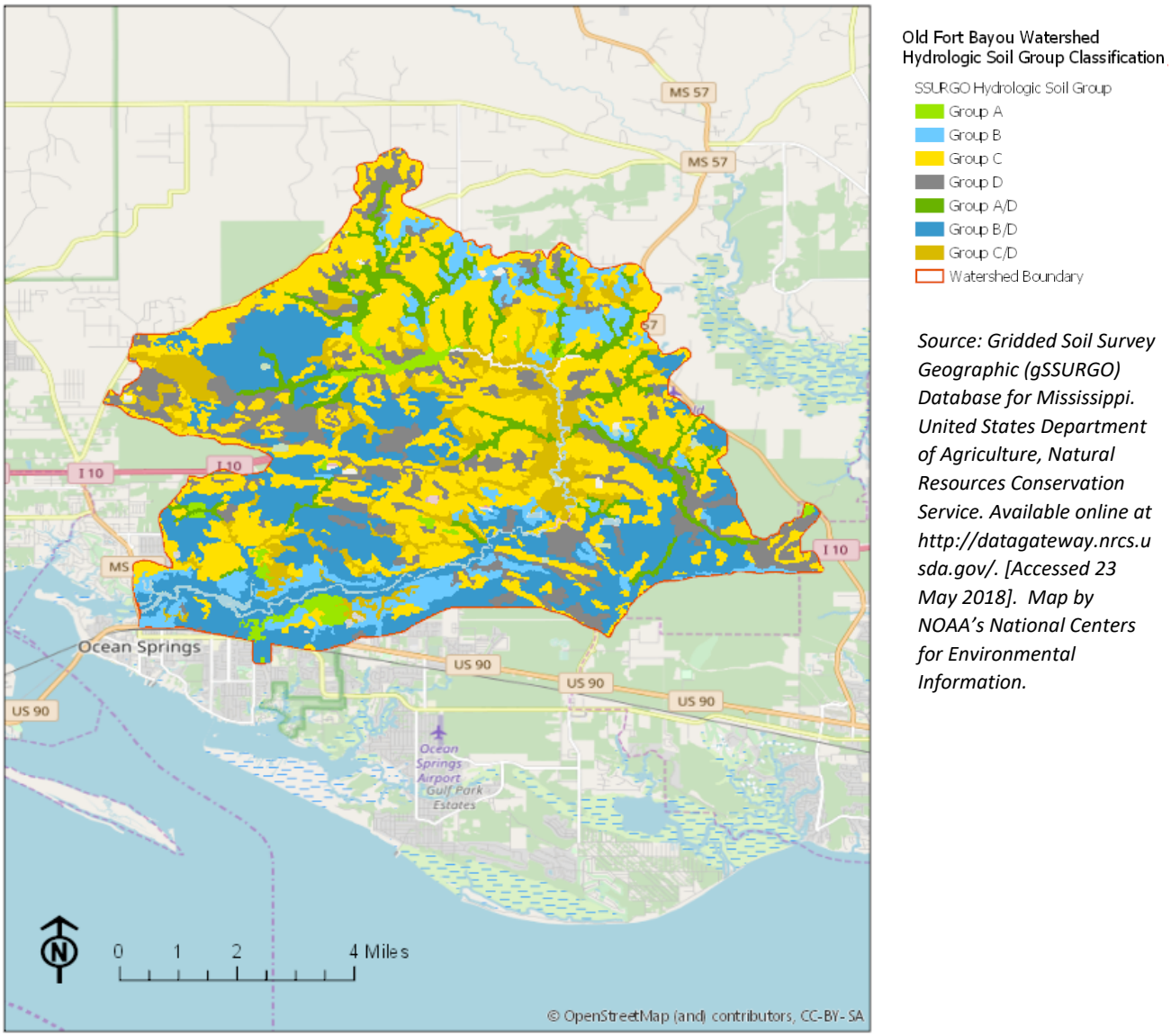
understand in watershed planning because they greatly influence the response of surface water both to precipitation and contaminants. In addition, the hydrogeologic conditions influence which Best Management Practices are most suitable for a given area. A good understanding of the soil types and geologic characteristics of a watershed will both improve the effectiveness and efficiency of strategies recommended and implemented through a watershed implementation plan.

The geological makeup of the Old Fort Bayou Watershed, and most of the Mississippi Gulf Coast, is characterized by sedimentary formations of estuarine and deltaic origin.[32] Old Fort Bayou Watershed falls entirely within the Coastal Terraces (Pamlico Coastal Terrace, Big Ridge and Good Hope). The Coastal Terraces formed during the Pleistocene period, the first epoch of the Quaternary period. A report on the surface geology of Jackson County has recently been completed by MDEQ's Office of Land and Water Resources and is under review. It is intended to be made public early 2019.[33]

The primary importance of geology in watershed planning is its effect on soil characteristics, described below, and groundwater aquifers, further discussed in Section 2.4.1. Soil texture and particle size determine how surface water will travel over or through the ground. The majority of the watershed consists of sandy loam soils with the predominant soil types being Bayou sandy loam in the lower end of the watershed and Vancleave loamy sand in the upper areas of the watershed. Bayou sandy loam is known for poor drainage and unsuitability for farming while Vancleave loamy sand is known for draining relatively well and being suited for farming. [34] See Appendix A: Soil Survey.

Soils can be assigned to hydrologic soil groups based on factors such as measured rainfall, runoff, and infiltration data. The slope of the soil surface, however, is not considered when assigning hydrologic soil groups.[35] Soils in the United States are assigned to four groups (A, B, C, and D) and three dual classes (A/D, B/D, and C/D). Group A soils have the highest rate of infiltration and group D has the slowest infiltration rate. Hydrologic Soil data from the National Resources Conservation Service (NRCS) Gridded Soil Survey Geographic Database (gSSURGO) was assessed for Old Fort Bayou Watershed. In Old Fort Bayou watershed, only 10% of the land falls into categories A and B, meaning the soils in these areas have higher infiltration rates. Forty-eight percent falls into categories C and D and have soils that have much slower infiltration rates. See Figure 5.

Figure 5: Dominant Hydrologic Soil Groups Rotten Bayou Watershed



Source: Gridded Soil Survey Geographic (gSSURGO) Database for Mississippi. United States Department of Agriculture, Natural Resources Conservation Service. Available online at http://datagateway.nrcs.usda.gov/. [Accessed 23 May 2018]. Map by NOAA's National Centers for Environmental Information.

The types and location of soils often determine what managerial, structural or vegetative activities are feasible. Areas that contain soils with high infiltration rates are directly responsible for infiltrating precipitation and feeding the upper reaches of the watershed with groundwater inflow that function to moderate flows and maintain a cool water temperature regime. Protection of these areas is extremely important to maintain existing high water quality. These areas are also are more suitable for the installation of BMPs that function to increase infiltration. On the other hand, areas that contain soils with slow infiltration rates tend to be more susceptible to erosion if not properly managed and vegetated. The majority of Old Fort Bayou is comprised of soils with much lower infiltration rates. The areas with poor drainage are also not well-suited for septic systems. Section 2.4.6 further explores the extent of nonfunctioning septic systems in Old Fort Bayou Watershed. Several of the areas identified as

having poor drainage, particularly near the northern tip of the watershed do appear to coincide with some of the nonfunctioning septic systems previously identified.

2.3.2 Ecoregion

Ecoregions are generally defined as an area with a relatively homogeneous ecosystem. Geographic areas are assigned to different ecoregions based on biotic and abiotic characteristics including geology, physiography, vegetation, climate, soils, land use, wildlife and hydrology.[36] Ecoregions are intended to provide a geographic area for ecosystem assessment, monitoring and management.[37] Traditionally, ecoregions and watersheds have been treated as two separate frameworks for environmental assessment and management, but more recently are being used in coordination with one another:

> Although ecoregions and watersheds are intended for different purposes, they can be complementary. Ecoregions provide the spatial framework within which the quality and quantity of environmental resources, and ecosystems in general, can be expected to exhibit a particular pattern. Where watersheds are relevant and can be defined, they are necessary for studying the relationships of natural and anthropogenic phenomena with water quality, as well as for providing the spatial unit for reference areas within ecoregions at all scales.[38]

Old Fort Bayou Watershed spans two, level III ecoregions. The very northern portion of the watershed, less than one-third of the watershed, is in the Southeastern Plains ecoregion and the southern portion of the watershed is in the Southern Coastal Plains ecoregion. While there is a distinct divide between the two ecoregions for mapping and analysis purposes, ecoregion boundaries rarely form abrupt edges.[39]

The Southeastern Plains are a mix of cropland, pasture, woodland, and forest. Natural vegetation consisted predominantly of longleaf pine, with smaller areas of oak-hickory-pine and Southern mixed forest. Elevations and relief are greater than in the Southern Coastal Plain, but generally less than in much of the Piedmont. Streams in this area are generally lower-gradient and have sandy bottoms.[40]

The Southern Coastal Plain consists of mostly flat plains, but also includes barrier islands, coastal lagoons, marshes, and swampy lowlands along the Gulf and Atlantic coasts. Forests historically consisted of longleaf pine, slash pine, pond pine, beech, sweetgum, southern magnolia, white oak, and laurel oak, but is now mostly slash and loblolly pine with oak-gum-cypress forest in some low-lying areas, citrus groves in Florida, pasture for beef cattle, and urban areas.[41]

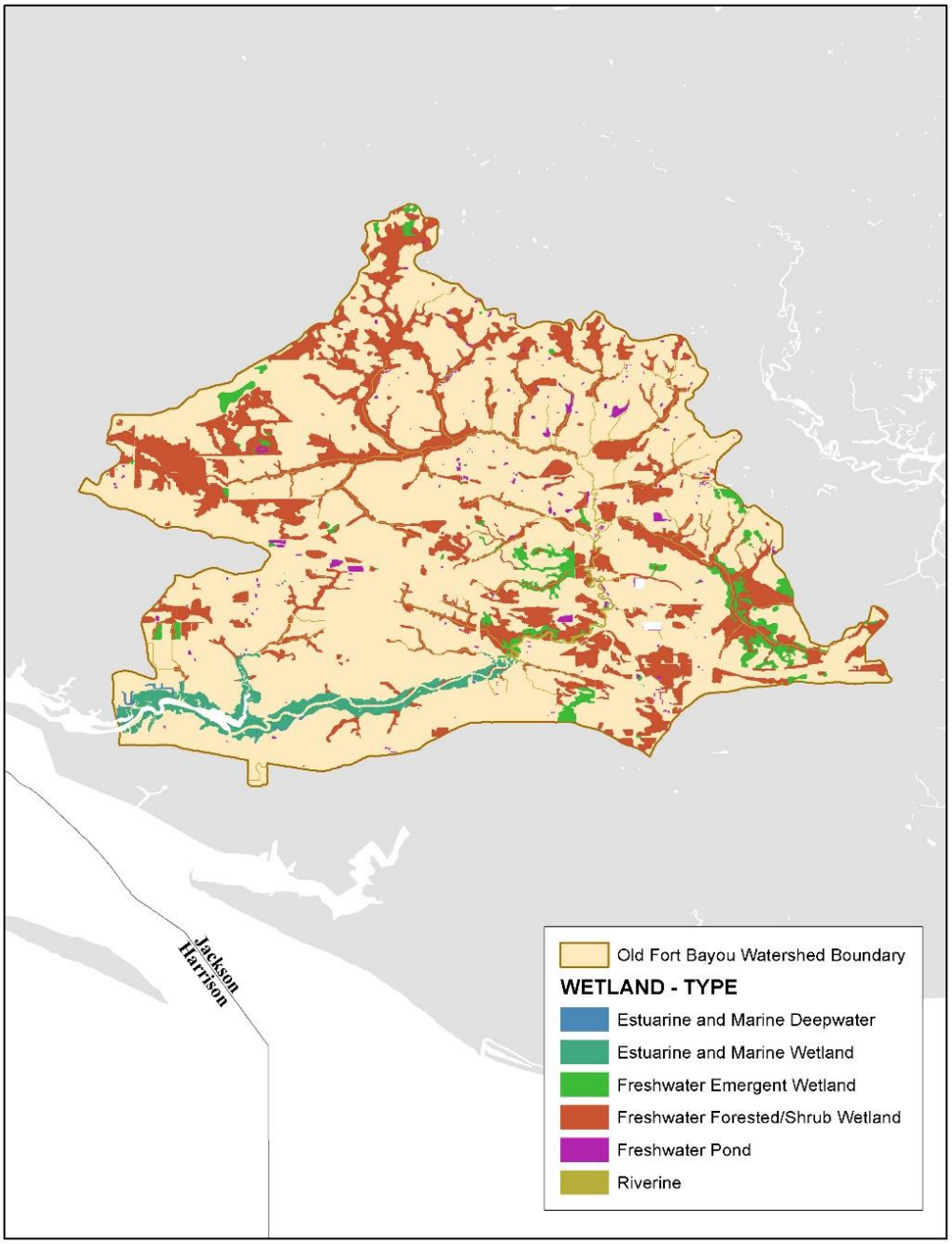
2.3.3 Wetlands

Wetlands are critical to protecting water quality and moderating water quantity. Some of these "wetland services" that protect water quality and quantity include providing erosion control, flood protection, filtration, critical habitat and carbon sequestration. Coastal wetland losses occur as a result of both human activity and natural processes. Human activities such as urban development can remove wetlands, harden shorelines and change overall hydrology. Natural processes such as erosion and inundation from sea level rise and storms can also affect wetlands.[42] Following the State's passage of the Coastal Wetland Protection Act, wetland loss

due to development fell dramatically while coastal erosion became the major contributor of wetland loss.[43]

Old Fort Bayou watershed is comprised of a mix of wetland environments including estuarine, freshwater and riverine, the most common being freshwater forested/scrub wetlands that extend throughout the reaches of the watershed. Overall, just over 30% of the land area in the watershed is classified as "wetlands" as defined by the Mississippi Department of Marine Resources (MDMR). See Figure 6.

Figure 6: Wetlands in Old Fort Bayou Watershed



Source: Map and analysis by the Mississippi Department of Marine Resources Coastal Preserves Program (2018).

Wetlands in Old Fort Bayou watershed are under the jurisdiction of MDMR's Coastal Program according to Section 57-15-6 of the Mississippi Code of 1972. Old Fort Bayou watershed is part of the Mississippi Coastal Zone which includes Hancock, Harrison and Jackson Counties. Implementation of the Coastal Program is the primary responsibility of the Office of Coastal Zone Management and includes administering the Coastal Preserves Program, Wetlands Permitting, and other special projects. Wetland activities that are regulated include:

> Dredging, excavating or removing of soil, mud, sand, gravel, flora, fauna, or aggregate of any kind from any coastal wetlands; dumping, filling or depositing of any soil, stones, sand, gravel, mud aggregate or of any kind or garbage, either directly or indirectly, on or in any coastal wetlands; killing or materially damaging any flora or fauna on or in any coastal wetlands; and the erection on coastal wetlands of structures which materially affect the ebb and flow of the tide; and the erection of any structure on suitable sites for water dependent industry. The use of the term "indirectly" in this definition covers the possibility of activities located outside of coastal wetlands which cause dumping, filling, or depositing in coastal wetlands.[44]

Applications for wetlands activities in the Mississippi Coastal Zone are submitted through MDMR, but may also be reviewed by the U.S. Army Corps of Engineers (USACE) under the Memorandum of Agreement with the Mobile and Vicksburg Districts of the USACE.[45]

2.3.4 Climate and Climate Change

Old Fort Bayou Watershed, and Mississippi in general, are located in a humid subtropical climate region, characterized by temperate winters; long, hot summers; and rainfall that is fairly evenly distributed through the year. The region, however, is subject to periods of both drought and flood, and determining "average" conditions is challenging. Prevailing southerly winds provide moisture for high humidity and potential discomfort from May through September. Locally violent and destructive thunderstorms are a threat on an average of about 60 days each year. Eight hurricanes have struck Mississippi's coast since 1895, and tornadoes are a particular danger, especially during the spring season.[46]

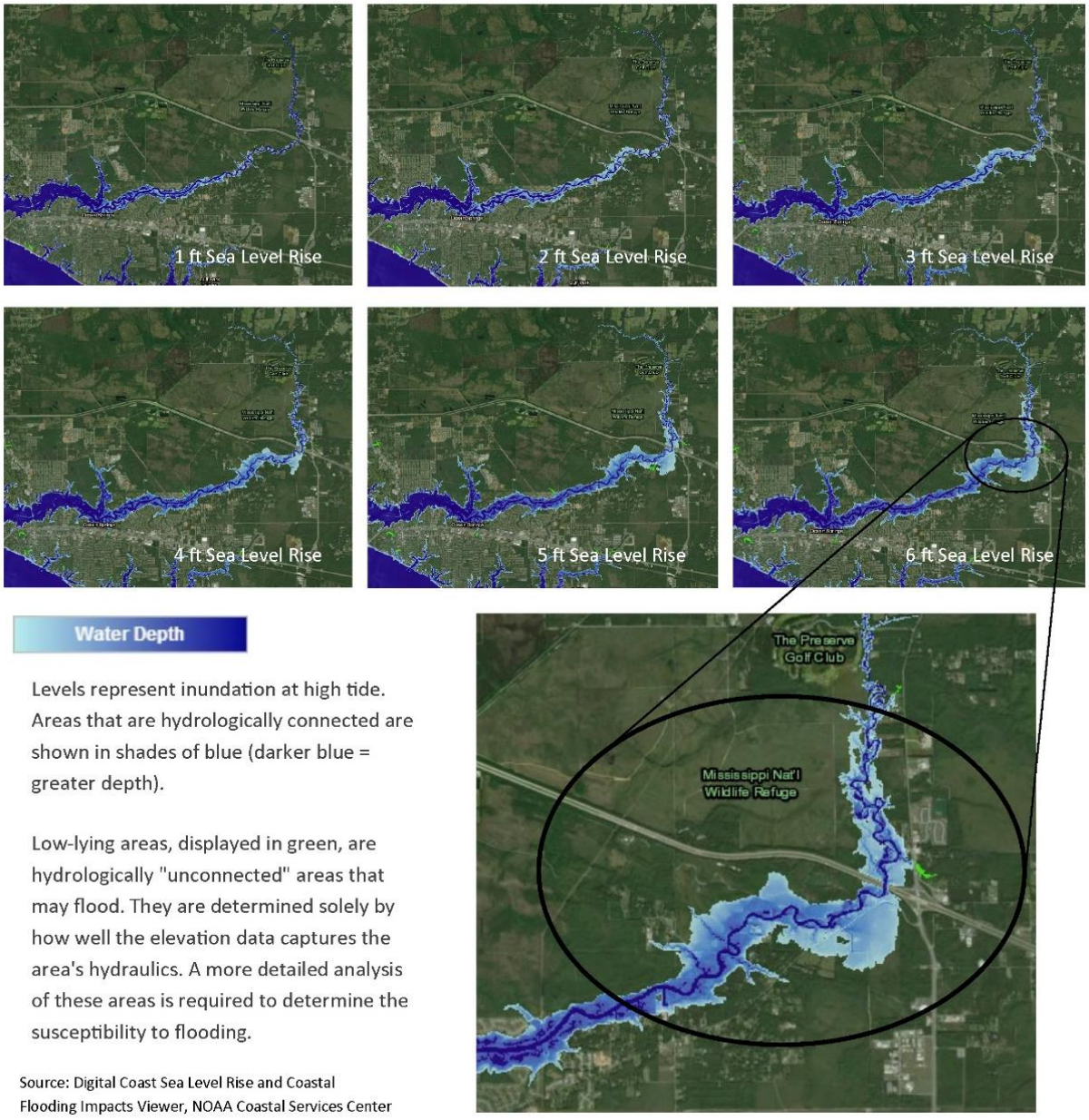
Normal mean annual temperatures are 68°F along the coast. Low temperatures have dropped to 16°F below zero while high temperatures exceed 90°F over 100 days each year. Temperatures routinely exceed 100°F at many places in the state each year and drop to zero or lower an average of once in five years in the state. Normal precipitation ranges from about 50 to 65 inches across the state from north to south.[47]

Climate change is likely to affect several processes that will impact watershed dynamics in coastal Mississippi and Old Fort Bayou Watershed including sea level rise and frequency and duration of rainfall events. There are various estimates of sea level rise resulting from climate change, but even according to the most conservative predictions, substantial flooding of coastal area appears to be likely. There is also a limited amount of local and regional sea level rise data available for the Mississippi Gulf Coast. Based on available data, Mississippi expects a minimum sea level rise of approximately 10 inches by the year 2100. However, gaps in the data available and a lack of long-term historical trends may affect the accuracy of this prediction.[48] Sea level rise is likely to have a significant impact on wetlands in the area:

> A rise in sea level inundates the coastal vegetated lands, converting them into areas of open water and resulting in a loss of wetland functions. Although new wetlands may be created further towards the inland if the coastal topography is ideal (i.e., in the presence of gradually increasing slope), whether or not they can make up the loss due to sea level rise largely depends on the extent of land development on the newly flooded area, as well as the rate at which the replacing wetland ecosystem functions can be fully established.[49]

NOAA's Digital Coast Sea Level Rise and Coastal Flooding Impacts Viewer is a tool for visualizing impacts of sea level rise from one foot to five feet. When comparing the impacts of sea level rise in Old Fort Bayou Watershed (See Figure 7) to anticipated future development as shown in Figure 3 it is apparent that a substantial amount of land slated for development in the watershed could be compromised by sea level rise. In addition, the estuarine and marine wetlands shown in Figure 6 should be protected as natural buffers in anticipation of sea level rise along with regular flood events.

Figure 7: Sea Level Rise and Coastal Flooding Impacts on Old Fort Bayou Watershed



In addition to sea level rise, moisture deficits and drought are likely to increase across the Mississippi Gulf Coast.[50] This could have an effect on vegetation important for soil stabilization and habitat, as well as ground water recharge. Alternately, heavy rainfall events have been and are likely to continue increasing. Intense rainfall events contribute to stormwater runoff increasing flooding, erosion and influx of pollutants into the water system.

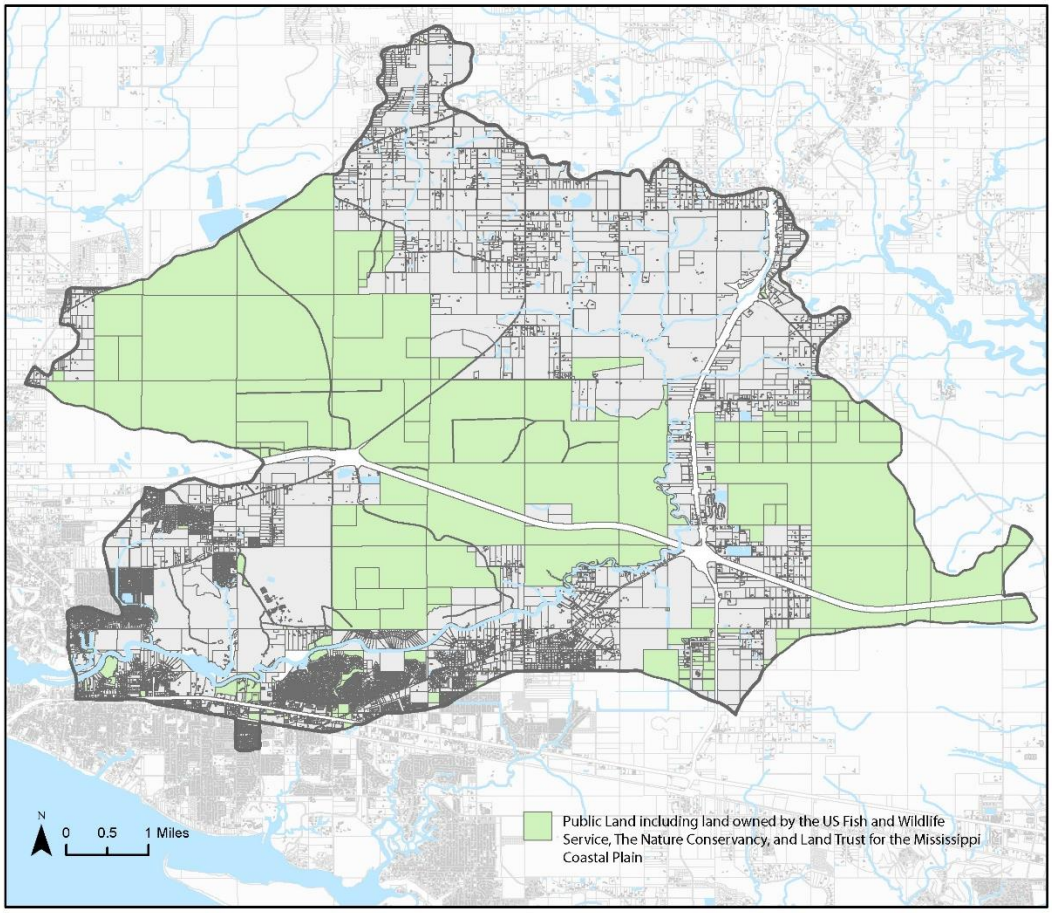
2.3.5 Conservation Mapping

In 2010 the Land Trust for the Mississippi Coastal Plain and consultant, CDM Smith, undertook a project known as Conservation Legacy to develop a toolkit for conserving land in a more

strategic manner in the six coastal counties of Mississippi. One of the products was a Map of Potential Conservation Lands that is a model of the suitability of land for conservation based on ranked environmental and land use conditions including wetlands, hydrological soil groups, flood zones, elevation/slope, upland forest and important ecosystems.[51]

A significant portion of the watershed (40%) is currently in conservation under the management of the Land Trust for the Mississippi Coastal Plain, The Nature Conservancy, and the U.S. Fish and Wildlife Service. See Figure 8.

Figure 8: Land in Conservation

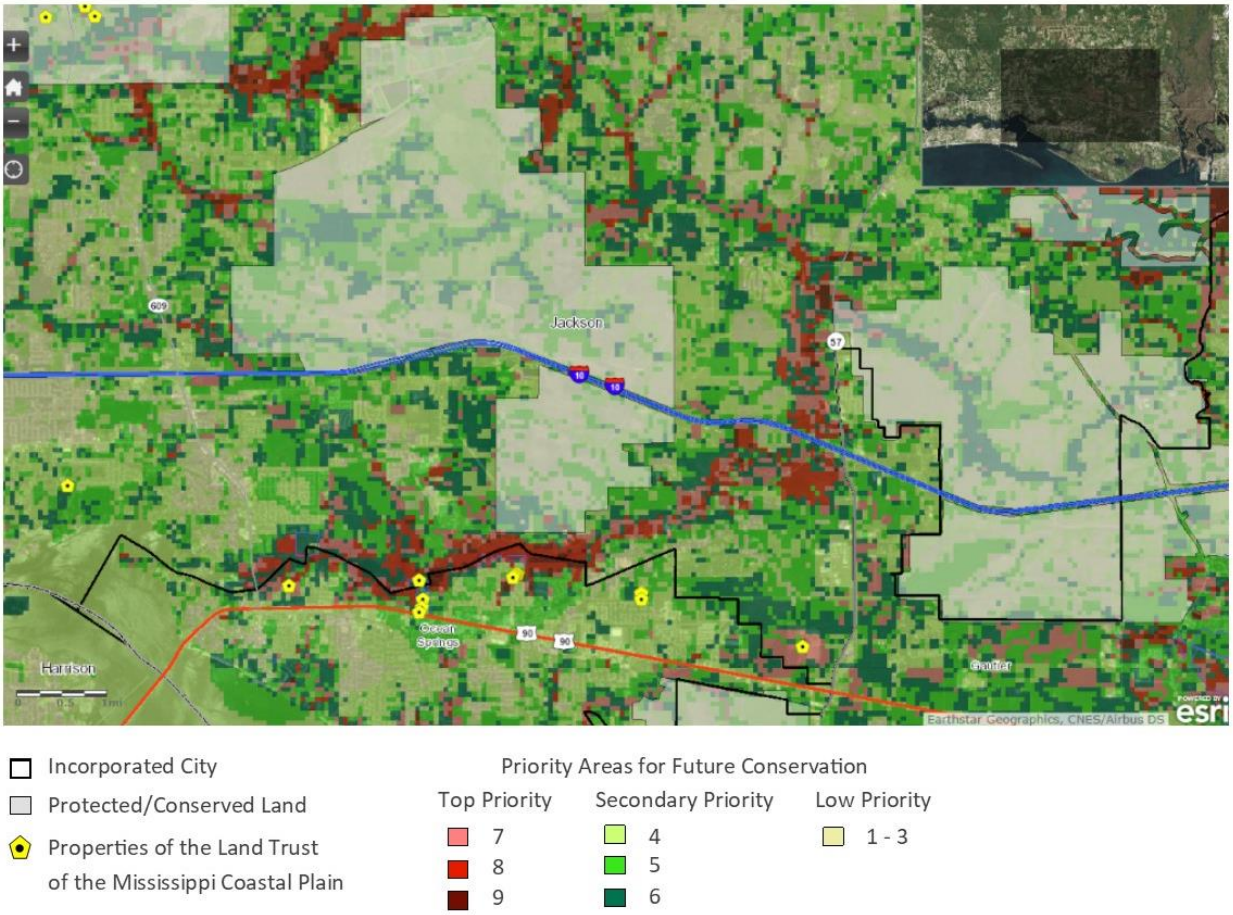


Source: Jackson County Tax Assessor. (2018). Map by GCCDS. Projection: NAD 1983 State Plane Mississippi East FIPS 2301 Feet.

The area in conservation is roughly the middle third of the watershed, separating the rural agricultural areas to the north from the more urban and developed areas in the south. These protected lands offer a nice buffer for runoff from the agricultural areas, unfortunately a lot of the higher priority areas (6/7/8) in terms of conservation are along the waterway in areas that are more developed. See Figure 9. Protection of remaining undeveloped areas along Old Fort Bayou should be a priority in terms of planning and management strategies for Old Fort Bayou Watershed. The Land Trust for the Mississippi Coastal Plain can play a significant role here in that unlike many conservation agencies, they see value in protecting smaller properties in critical areas for reasons such as their value as wetlands and buffers, potential for future

connections, and/or value for cultural or educational purposes. As seen in Figure 9, LTMCP already owns and manages a number of properties along Old Fort Bayou.

Figure 9: Conservation Priority Areas in Old Fort Bayou Watershed.



Source: Land Trust for the Mississippi Coastal Plain. Conservation Legacy: Potential Conservation Lands Map. <http://gis.co.harrison.ms.us/landtrust/>. Accessed 4 December 2018.

2.4 Water Resources

2.4.1 Groundwater

There are 16 major aquifers and various minor aquifers throughout Mississippi. The groundwater resources found in these aquifers supplies over 90% of Mississippi's drinking water supply. In the coastal counties, drinking water and potable water is mainly supplied through the Grand Gulf Aquifer System which includes, in ascending order, the Catahoula, Hattiesburg, Pascagoula and Graham Ferry aquifers.[52]

The wells in Old Fort Bayou are supplied by the Graham Ferry and Pascagoula aquifers. There are relatively few notable concerns related to water quantity and quality associated with these aquifers. The Graham Ferry and Pascagoula aquifers tend to be higher in iron and manganese

which can affect the flavor and color of the water.[53] The Mississippi Department of Health monitors the water quality for the public water supply wells and all public wells are currently compliant for volatile organic chemicals, synthetic organic chemicals and nitrate concentration.[54] The Mississippi Gulf Region Water and Wastewater Plan did note that levels of organic color have been documented in excess of Secondary Drinking Water Standards in Jackson County, but no specifics were given.[55]

The Graham Ferry and Pascagoula aquifers are almost entirely fresh water and there is relatively little concern about the possibility of saltwater intrusion. A study done by MDEQ in 2002 found that while salt concentrations in the well water in the area are naturally higher, they have not increased at a rate that would provide evidence of saltwater intrusion. The study also found that saltwater intrusion is unlikely due to extraction of groundwater in the deeper confined aquifers.[56] The deeper sands of the aquifer system are recharged at their outcrop, north of Old Fort Bayou Watershed. According to MDEQ's Office of Land and Water Resources:

> *The aquifers providing potable water in the Old Fort Bayou Watershed area are confined, meaning that there is a clay interval above the aquifer which protects it from contamination from the surface. Recharge for these aquifers is to the north of the watershed and, activities at the surface in the watershed will not have any adverse effects on the aquifers. Several aquifers are available for use in the Old Fort Bayou area, and the water quality is quite good. Ground water resources are abundant in the Old Fort Bayou Watershed, and there is no anticipation of having any problems with either water supply or water quality for the foreseeable future.*[57]

The Gulf Region Water and Wastewater Plan, however, noted that all three coastal counties project "steady increases in water demands that cannot be met by current water supply, treatment, and distribution infrastructure." The improved infrastructure was and is being planned and implemented based on the projected 2025 demand.[58] A report on the groundwater resources of Jackson County has recently been completed by MDEQ's Office of Land and Water Resources and is under review. It is intended to be made public early 2019.[59]

The Preserve Golf Club primarily irrigates using water from a well to a 90 ft aquifer. Prior to a redesign in 2014 the Club used water solely from a well to a 400 ft aquifer, which had plenty of water, but the water was sodic (Sodic water is high in sodium (Na+) concentration relative to concentrations of calcium (Ca2+) and magnesium (Mg2+) and considered poor quality for golf course irrigation). While the better quality water from the 90 ft aquifer is sufficient during months with "normal" rainfall, during drier months the Club has to supplement with less desirable water from the 400 ft aquifer. So far, this solution has sufficed, but if periods of drought become more frequent an alternative solution may need to be considered.[60]

2.4.2 Access and Recreation

The coast and its upland waterways provide the opportunity for a wide range of recreational activities. In a public opinion survey conducted in the Southern Mississippi Planning and Development District on 65 outdoor recreational activities, nine out of the 45 most popular were water related. The most popular activities include fishing, canoeing, kayaking, rafting, and tubing.[61] Old Fort Bayou is well positioned in terms of public access and recreation opportunities. The Bayou became a designated blueway under the direction of the Land Trust for the Mississippi Coastal Plain following the development of the 2007 Action Plan. Public

access and recreation opportunities are well documented in the blueway guide. See Appendix G: Old Fort Bayou Blueway Guide. The access and recreation opportunities associated with Old Fort Bayou Blueway are beneficial for the watershed for two main reasons. First, when coupled with educational signage, these access sites serve to connect people with their waterways and increase environmental stewardship. In addition, nature-based recreation is a growing market in south Mississippi and responding to this growing demand would likely prove beneficial both in terms of economic development and property values.

The original blueway guide was produced in 2010 and is available for download on the Land Trust for the Mississippi Coastal Plain's website and in print at their office and the Ocean Springs Chamber of Commerce. The blueway guide was updated in 2018 as part of a National Heritage Area Grant through the Department of Marine Resources. The effort was part of the Nature-based Tourism Plan for Coastal Mississippi approved in 2016 and included the development of a Blueways Design Guide. The updated brochure is available on the Mississippi Gulf Coast National Heritage Area's website. LTMCP currently has funding to print the updated brochure. It is important to note that the Jackson County Bicycle, Pedestrian and Trails Master Plan, also developed in 2018, includes blueway recommendations applicable to Old Fort Bayou that include extending the blueway to include Bayou Talla.[62] Bayou Talla is a significant offshoot of Old Fort Bayou that is adjacent to the St. Martin Schools that are part of the Jackson Country School District. Improved access points near the schools represent a significant opportunity for monitoring, education and outreach. In addition, LTMCP is currently working on a new kayak launch adjacent to The Inlets development in Ocean Springs on Old Fort Bayou that is anticipated to be accessible to the public starting in the spring of 2019. These anticipated additions of blueway infrastructure will need to be added to the Old Fort Bayou Blueway brochure.

2.4.3 Wildlife and Fisheries

Old Fort Bayou Watershed supports a broad diversity of wildlife. The Mississippi National Heritage Inventory keeps a database of critical species known as species of "special concern". After review by the U.S. Fish and Wildlife Service office in Hancock County, several of the species identified as being of "special concern" and possibly in Jackson County are listed as threatened (See Appendix B: Mississippi National Heritage Inventory and C: Federally Endangered, Threatened, and Candidate Species in Mississippi).[63] Critical species confirmed or likely in Old Fort Bayou Watershed include the following:

- Mississippi Sandhill Crane (Endangered/Critical Habitat)
- Gulf Sturgeon (Threatened/Critical Habitat)
- Alabama Red-bellied Turtle (Endangered)
- Black Pinesnake (Threatened)
- Gopher Tortoise (Threatened)
- Dusky Gopher Frog (Endangered/Critical Habitat)
- Louisiana Quillwort (Endangered)

2.4.4 Designated Use Classifications and Water Quality Standards

Old Fort Bayou is classified as suitable for "Recreation" from Biloxi Bay to Bayou Talla and suitable for "Fish and Wildlife" from Bayou Talla to its headwaters. Waters in the Recreation classification are suitable for primary contract recreation such as swimming, while waters in the Fish and Wildlife classification are suitable for secondary contact recreations (i.e. kayaking, where full body immersion is unlikely), fish consumption and aquatic life uses.[64]

Seasonal water quality monitoring has been regularly performed by MDEQ at a state ambient monitoring station (#0481299) near the mouth of the Bayou in the area classified for Recreation. Very little has been documented upstream of this monitoring station.[65] As such, the available water quality data from the station at the mouth of the bayou was analyzed based on the water quality standards for the Recreation classification with a focus on bacteriological indicators.

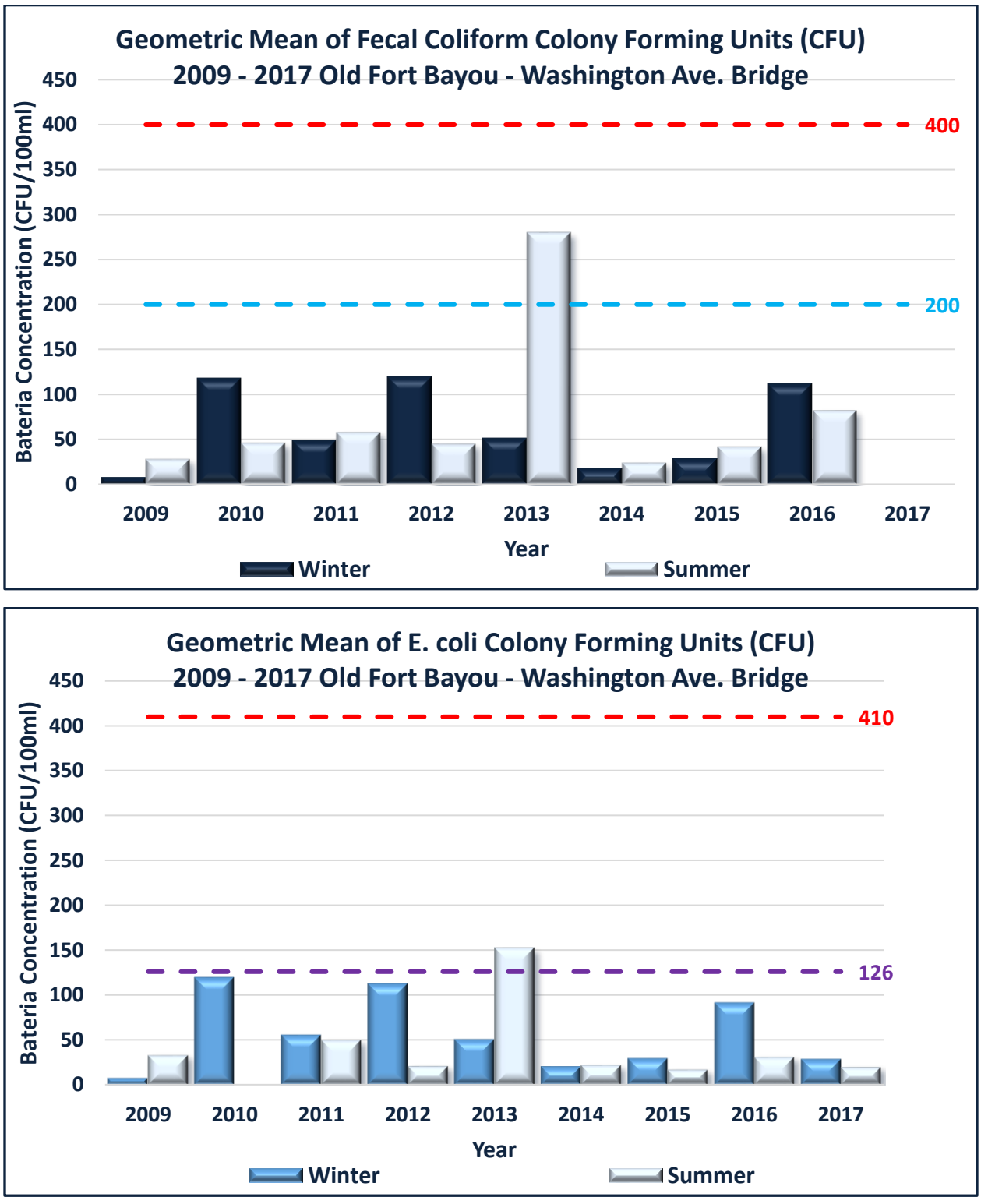
The current water quality standards for bacteria for Recreation set a threshold based on a geometric mean of 126 culturable e. coli bacteria per 100 ml, and state that the samples analyzed during a 30-day period not exceed 410 e. coli per 100 ml more than 10% of the time. In addition, there should be a minimum of five samples taken over a 30-day period with no less than 12 hours between individual samples.[66] Additional standards exist for dissolved oxygen, dissolved solids, pH and temperature, but due to lack of data for these indicators and the focus on the fecal coliform TMDL, did not play a significant role in determining the current status of water quality in Old Fort Bayou. Results are further discussed in Section 2.4.5.

It is important to note that due to current land uses and the likelihood of future development within the watershed it seems important to also monitor nutrients such as Total Phosphorus (TP) and Total Nitrogen (TN). There are several proposed thresholds that should be considered if future monitoring is arranged. The State of Mississippi, for example, has developed numeric nutrient thresholds for non-tidal streams and rivers to protect aquatic life in Mississippi. The recommended thresholds for TN in southeast Mississippi rivers and streams range from 0.31 to 0.68 mg/l, depending on the approach.[67]

2.4.5 Current Status of Water Bodies

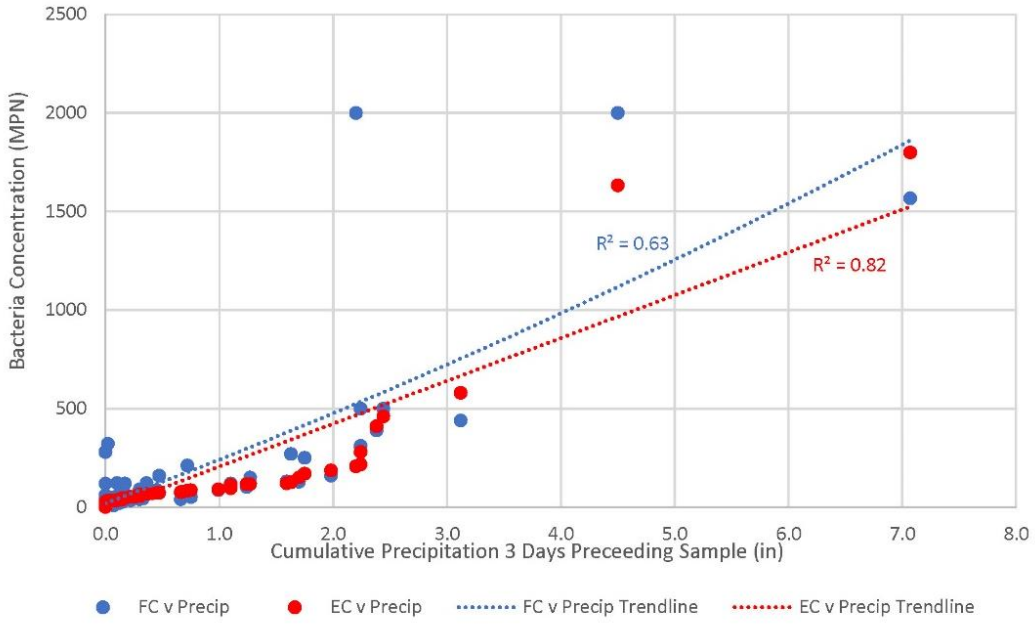
BMI Environmental Services, in partnership with Nutter & Associates, analyzed available water quality data for Old Fort Bayou as compared to the TMDL and approved thresholds. See Appendix D: Old Fort Bayou Fecal Coliform Bacteria Total Maximum Daily Load Reduction Plan. Based on available bacterial data, it was determined that Old Fort Bayou was generally in compliance with MDEQ water quality standards for the Recreation classification between 2009 and 2017. Elevated levels of fecal indicator bacteria were correlated with periods of heavier rainfall and so can be attributed to stormwater runoff and nonpoint sources. When the main sources of fecal indicator bacteria are from point sources elevated concentrations are usually seen during periods with less rainfall (i.e. low flow). These findings are consistent with the 2002 TMDL where 97% of the allocation was determined to be from nonpoint sources.[68] See Figures 10 and 11.

Figure 10: MDEQ Seasonal Data for Bacteria Concentrations - Washington Ave. Bridge



Source: Mississippi Department of Environmental Quality, Water Quality Assessment Branch.

Figure 11: Comparison of Bacteria Concentration and Recent Precipitation



Source: BMI Environmental Services, LLC and Nutter & Associates, Inc. Prepared for Land Trust for the Mississippi Coastal Plain. (2018). Old Fort Bayou Fecal Coliform Bacteria Total Maximum Daily Load Reduction Plan. Pg 7.

To supplement the fecal indicator bacteria water quality data from the MDEQ station at the mouth of Old Fort Bayou, GCCDS took students from the Marine Science classes at St. Martin High School to monitor water quality at two sites along Old Fort Bayou on Monday, December 5, 2018. The project was funded through a grant from NOAA's Gulf of Mexico Bay Watershed Education and Training Program (B-WET) to the Gulf Coast Community Design Studio. The project will continue through August 2019 and it is anticipated that another round of water quality testing will be done in the spring of 2019. While the MDEQ ambient water quality testing team was not able to accompany the students on the fall field trip, they will hopefully be able to test alongside students on the spring field trip. More information on the project is included as Appendix E: B-Wet Old Fort Bayou Watershed Education & Civic Engagement.

The students used Earth Force® Low Cost Water Monitoring kits and collected information on water temperature, turbidity, pH, Dissolved Oxygen, Phosphorus and Nitrates. Volunteers from local nonprofits and various state and federal agencies including the Land Trust for the Mississippi Coastal Plain (LTMCP), NOAA National Centers for Environmental Information's Center for Coast, Oceans and Geophysics (NCEI), EPA Gulf of Mexico Program, National Park Service, Mississippi Department of Wildlife, Fisheries and Parks, and The Nature Conservancy accompanied the students on the field trip to assist with data collection. Compiled results are below in Table 2.

Table 2: St. Martin High School B-WET Program Water Quality Testing Results.

The Preserve Golf Club

901 MS-57, Vancleave, MS (upstream)

Indicator	Result	Rating
Water Temperature	20.1°C	
pH	6.3	Good
Turbidity	30.6 JTU	Good
Dissolved Oxygen	66% Saturation	Fair
Phosphate	1.5 ppm	Good
Nitrate	5 ppm	Fair

Twelve Oaks

1112 Hanley Rd, Ocean Springs, MS (downstream)

Indicator	Result	Rating
Water Temperature	23.2°C	
pH	6.1	Good
Turbidity	15.8 JTU	Good
Dissolved Oxygen	67% Saturation	Fair
Phosphate	1.7 ppm	Good
Nitrate	5.1 ppm	Fair

Source: St. Martin High School student data from November 5, 2018 using Earth Force® Low Cost Water Monitoring kits. The last measurable rainfall was 0.81 inches on October 26, 2018.

While results from the students' water quality testing cannot be held to the same level of scientific scrutiny as the water quality analyzed above or other water quality data typically utilized by MDEQ, it is useful in that it suggests that water quality can be improved, and other water quality indicators should be more closely monitored in the future. It is interesting to note that nutrients (phosphate and nitrogen) actually read slightly higher downstream, nearer to the urbanized areas and not upstream adjacent to The Preserve Golf Course and more of the rural/agricultural land uses. The students did test for fecal coliform, but the tests included in the Earth Force® Low Cost Water Monitoring kit only offer a positive or negative reading. Tests at both sites showed positive results indicating higher levels of fecal coliform. However, given the inaccuracies likely with this testing method, the student bacterial water quality data should not override the results from MDEQ's testing documented above.

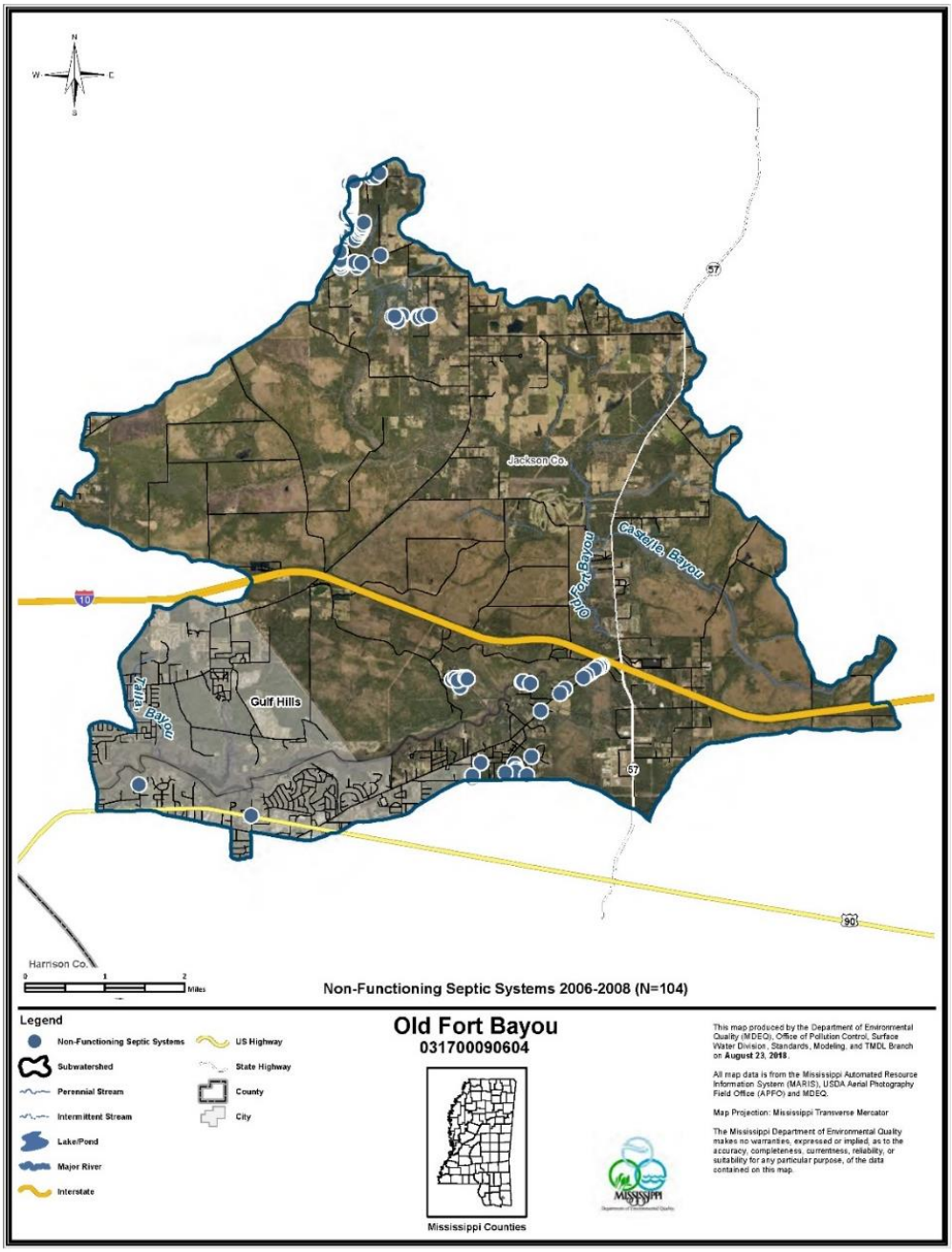
2.4.6 Sources of Pollutions

There were four municipal or industrial facilities that were permitted to discharge into Old Fort Bayou under the National Pollutant Discharge Elimination System (NPDES) in the 2002 TMDL. All four facilities have since been connected to municipal services. The 2002 TMDL report and the 2018 analysis of water quality data by BMI Environmental Services and Nutter & Associates found that NPDES point sources are not the cause of elevated levels of fecal indicator bacteria. As such, the majority of the 2018 report utilized land use data, windshield and boat reconnaissance surveys and stakeholder feedback to start to identify potential nonpoint pollutant sources and/or opportunities for implementing Best Management Practices (BMP).[69]

Pathogens such as fecal coliform and e. coli can come from waste from humans from failing septic systems or discharge from sewer treatment plants, domestic animal waste such as from pets or livestock, or wildlife. Basic levels of testing do not provide enough data to determine the specific source, however additional testing can be done that will give a better indication of where the pathogens are coming from. Based on results from geospatial data and watershed reconnaissance, the 2018 analysis divided the watershed into three subunits. Each subunit (north, middle and south) had common characteristics that suggested similarities in sources of

pathogenic loading and therefore similar prescriptions for recommended BMPs. The northern unit is more rural and has some agricultural uses and low-intensity development. In this unit, sources more common to rural areas such as runoff from livestock operations or failing septic systems are more likely. The middle unit consists mainly of conservation lands. Sources of pathogens in this area are more likely from wildlife or the fairly limited development along US Highway 57 and Old Fort Bayou corridor. The lower unit has higher intensity development and developing areas. According to the report, nonpoint source loading from stormwater runoff, sewer system overflows and direct deposits are likely the greatest course of anthropogenic pathogen loading.[70] While it is likely that there are still impacts from nonfunctioning septic tanks, the most recent inventory was conducted between 2006 and 2008. See Figure 12. Given infrastructure improvements made since 2008, it is likely that the impact has been reduced, although it would still be worthwhile to conduct a current inventory to see where there may still be higher concentrations of nonfunctioning septic systems.

Figure 12: Nonfunctioning Septic Systems in Old Fort Bayou Watershed (2008)



Nutrients such as nitrogen and phosphorus often come from fertilizers and pesticides used in agriculture and on residential lawns and gardens. While there is very little available data from which to draw conclusions, results from the St. Martin High School student's testing suggest that more nutrient loading may be coming from the downstream urban areas as compared to the more rural development and golf course upstream.

Various activities throughout the watershed seem to be intensifying erosion and sedimentation. New residential and commercial construction that exposes soil without adequately managing for these changes both during and after construction can have a significant impact on the hydrology

downstream. This seems to be a significant current problem and one that is likely to worsen if not aggressively managed in the future. See Figure 13.

Figure 13: Erosion in Old Fort Bayou Watershed

Source: Elizabeth Englebretson. Photos taken June 18, 2018 and August 24, 2018.

While litter is not well monitored within the watershed it is a visible source of pollution that ends up in the stormwater system and waterways. The Mississippi Coastal Cleanup managed by the Mississippi State University Extension Service does have one cleanup location in Old Fort Bayou Watershed at the Washington Avenue boat launch in Ocean Springs. The Mississippi Coastal Cleanup is an annual coastwide effort to remove trash and debris from Mississippi's coastline, waterways and barrier islands. Data is collected as part of this effort to categorize major sources of marine debris entering the coastal environment and to track change.

According to the 2017 Mississippi Coastal Cleanup report, there were only three volunteers at that site and less than a half mile was covered. Six pounds of litter were reportedly collected and of the litter collected, the majority was single-use plastics such as straws, bottles and bags. The current site is at the lower end of Old Fort Bayou and there are likely opportunities to add an additional site or sites further upstream and/or invite boaters to join the cleanup from the water to increase the impact. In addition, there is an opportunity to work with restaurants in the watershed and particularly those on Old Fort Bayou to reduce the use of single-use plastics and educate residents. Plastic Free Gulf Coast is an effort currently supported by the NOAA Marine Debris Prevention Program focused on reducing the use of single-use plastics within the five Gulf States through outreach, education, and providing alternatives to restaurants and consumers. The two lead partners on the project are MSU's Gulf Coast Community Design Studio and Coastal Research and Extension Center. The program has been working closely with two restaurants in Hancock and Harrison Counties, but currently does not have any participating restaurants in Jackson County.

In addition to litter in the waterways and along the roadways, there is evidence of illegal dumping of larger items in some of the more rural areas. See Figure 14. Currently, Jackson County, Ocean Springs and Gautier all contract with Waste Management for residential and commercial garbage pick-up. Curbside recycling and pickup of regular and some bulky items is available to all residents. Large items, including tires, that cannot be picked up curbside can be

disposed of at no cost at the Jackson County Landfill. Since cost and convenience do not seem to be large barriers for residents in Old Fort Bayou Watershed, additional efforts may need to focus on making residents aware of their options for proper disposal and/or the consequences of illegal dumping.

Figure 14: Illegal Dumping in Old Fort Bayou Watershed

Source: Elizabeth Englebretson. Photos taken June 18, 2018.

Section 3: Management and Monitoring Plan

3.1 Watershed Management Actions

Best Management Practices (BMPs) are techniques used to manage and improve water quantity and quality. The goal of BMPs are to reduce or eliminate contaminants collected by stormwater as it moves into streams and rivers. Best management practices can be structural (i.e. permeable paving, living shorelines or bioretention areas) or nonstructural (i.e. wetland conservation or policies and ordinances that require or incentivize individuals to implement measures to improve water quality or manage the quantity of water coming off their property). Section 3.1.1 gives a summary of best management practices that have been completed since the development of the 2007 Old Fort Bayou Action Plan while Section 3.1.2 describes recommended best practices to be implemented in the future.

3.1.1 Current Management Actions

Old Fort Bayou/Tuxachanie Creek Watershed Nonpoint Source Pollution Demonstration Project

The Old Fort Bayou/Tuxachanie Creek Watershed Nonpoint Source Pollution Demonstration Project was the result of a partnership between the Mississippi Soil and Waters Conservation Commission, Mississippi Department of Environmental Quality, United States Environmental Protection Agency, United States Department of Agriculture Natural Resources Conservation Service, and the Jackson County Soil and Water Conservation District. The primary goals of the project were:

1. To improve water quality and protect high quality waters by demonstrating the economic benefits of selected BMPs in targeted areas,
2. To apply BMPs to agricultural land in the demonstration project so as to reach the desired outcome of reduced runoff, nutrients and sedimentation, and
3. To inform and educate the public about BMPs that benefit water quality.[71]

The project began in November 2001 and concluded in September 2006 and resulted in the installation of a significant number of BMPs within the rural area of the 102,000-acre watershed (See Table 3). Education and outreach included demonstration farms, educational field days, press releases and fact sheets. The total project cost was $376,867. Appendix J contains the final report for the Old Fort Bayou/Tuxachanie Creek Watershed Nonpoint Source Pollution Demonstration Project.

Table 3: Summary of Best Management Practices Installed

BMP	Number of Practices	Number of Acres	Total Tons of Soil Saved Per Year
Establishment of Permanent Vegetation	1	3	12
Fencing	26	46,000 ft	
Heavy Use Area Protection	12		
Nutrient Management	9	724	2,916
Pasture & Hayland Planting	15	404	1,667
Pond	1	80	560
Stream Crossing	1		
Streambank & Shoreline Protection	1	70	560
Water & Sediment Control Basin	5	186	1,696
Tank/Trough	11		
Chiseling	1	56	224
Total	**83**	**1,523**	**7,635**

NPDES Phase II Stormwater Management Plans

All three jurisdictions that overlap with Old Fort Bayou Watershed have NPDES Phase II Stormwater Management Plans are on file with the Mississippi Department of Environmental Quality. The purpose of the plans is to address any existing water quality issues and to prevent water quality impairment resulting from stormwater runoff within the jurisdiction's MS4 permitted area. The City of Gautier's plan is still under review, but has been considered as part of this watershed planning work. The City of Ocean Springs and Jackson County have both submitted their annual reports for 2017. Per ACT7, S-2 of the MS4 General Permit, the "coverage recipient is to annually summarize the progress made in implementing the conditions of the permit and the elements of the Storm Water Management Program (SWMP)." Section I of the annual report is a Summary of Implementation Activities by Minimum Measure and Best Management Practice which includes best management practices related to stormwater. The reports include extensive lists of strategies that have and will be implemented ranging from public education and involvement to pre- and post-construction stormwater controls. See Appendix K: Jackson County and Ocean Springs MS4 2017 Annual Reports. Strategies documented for all three jurisdictions are very similar and as evident by the 2017 annual reports, Ocean Springs and Jackson County appear to be following through with implementation to an above average degree. The Old Fort Bayou Watershed Implementation Plan does recommend some ways to improve and/or expand strategies included in the jurisdictions Stormwater Management Plans (See Section 3.1.2: Planned Management Actions and Section 3.1.3: Future Outreach and Education Activities)

Conservation Lands

The U.S. Fish and Wildlife Service (FWS), The Nature Conservancy (TNC) and the Land Trust for the Mississippi Coastal Plain (LTMCP) all have significant landholdings in Old Fort Bayou Watershed as described above. FWS and TNC both own and manage larger parcels in the middle of the watershed, while LTMCP has a number of smaller properties in the lower watershed along Old Fort Bayou. All three entities employ a range of BMPs on their properties.

Best Management Practices used by FWS focus on the restoration of the endangered Mississippi sandhill cranes and their habitat, the wet pine savanna as documented in the Mississippi Sandhill Crane National Wildlife Refuge Comprehensive Conservation Plan. This involves restoring or maintaining the local hydrology, increasing water for crane nesting areas, and creating shallow-water areas. FWS also implements other BMPs including, but not limited to:

- Nuisance wildlife management
- Invasive species management
- Farming for wildlife (i.e. cultivating upland sites to provide winter feeding areas for the cranes)
- Fire management (i.e. prescribed burns)

A significant portion of the Conservation Plan also focuses on education and outreach strategies.[72]

The Nature Conservancy has a Management Plan for their Old Fort Bayou Nature Preserve-Mitigation Bank that focuses on restoration and management efforts within the nature preserve. In addition, the property also has an Ecological Restoration Plans and Mitigation Banking Instrument that aid in guiding restoration efforts. TNC's East Gulf Coastal Plain Ecoregional Plan depicts the Old Fort Bayou area as an Area of Conservation Interest. TNC implements a number of BMPs focused on wet pine savanna restoration on their Old Fort Bayou Mitigation Bank. These include:

- Prescribed burns
- Invasive species management
- Native vegetation plantings
- Management of vernal ponds for endangered species
- Erosion control of roads and trails

The Land Trust for the Mississippi Coastal Plain also implements BMPs on their properties in the watershed. BMPs have included removal of invasive species, planting native vegetation and erosion control. LTMCP is also dedicated to providing quality access through low impact trails and education to the public around the natural landscapes and BMPs on their properties.

The Preserve Golf Club

The Preserve Golf Club, located in Vancleave and adjacent to Old Fort Bayou, has been a certified Audubon Signature Sanctuary since 2007. As such, The Preserve has been dedicated to protecting the natural environment in addition to providing a high quality golf experience. In addition to being home to approximately 32 acres of mitigated wetlands, The Preserve is a showcase of many Best Management Practices. See Appendix L: Case Study - The Preserve Golf Club. Several of the BMPs are listed below:

- Vegetative buffer strips
- Irrigation system to minimize drift and maximize water use efficiency
- Special management zones (i.e. no or limited spray)
- Bridge crossings over sensitive areas
- Habitat management (i.e. controlled burns) and restoration
- Native plantings and removal of invasive species
- Wildlife management (i.e. bird and bat houses)

- Proper storage of fertilizers and pesticides
- Cleaning areas and protocols for equipment that comes in contact with chemicals

In addition to implementing an extensive range of BMPs at The Preserve, the Director of Golf Operations has been very involved in developing the BMP manual for golf courses in Louisiana and Mississippi. The manual is still in progress and hopefully will be completed in 2019. The Director has also been very involved on the Old Fort Bayou Watershed Steering and Technical Advisory Committee and is a key partner in the work with St. Martin High School students. The Preserve has the potential to be an even more visible leader and influencer in terms of Best Management Practices both in the watershed and larger region.

3.1.2 Planned Management Actions

Previous sections in the WIP have described challenges and opportunities facing Old Fort Bayou Watershed (Section 2.4.6 Sources of Pollutions) and identified the goals and objectives for restoring the watershed (Section 1.2.4 Goals and Objectives). The following management strategies are organized around these challenges and opportunities and are recommended based on their ability to address the goals for restoring and enhancing Old Fort Bayou Watershed. A full listing of potential management strategies recommended for Old Fort Bayou Watershed including responsible parties, potential funders, estimated costs and a recommended implementation timeline is included in Appendix F: Management Actions. Where applicable, expected reductions to fecal coliform loads are indicated to demonstrate ability to meet and/or exceed the goal of a 35% reduction as put forth by the 2002 TMDL. Actual reductions in fecal indicator bacteria loading can only be determined with a better understanding of sources of contaminants and modeling based on the size and location of BMPs to be installed. While this level of data does not exist for the Old Fort Bayou Watershed Implementation Plan, there is little doubt that a combination of the strategies recommended below will accomplish the goals set forth in the 2002 TMDL and this planning document.

Old Fort Bayou Watershed Partnership

Since watershed boundaries do not correspond to municipal boundaries and often include multiple jurisdictions, watershed plans are usually under the care of a watershed partnership. A formal watershed partnership was not established as part of this planning work, however, the active participation of the Steering and Technical Advisory Committee, including the Education and Outreach Subcommittee, has contributed greatly to the development of the Old Fort Bayou Watershed Implementation Plan and all that has been accomplished in Old Fort Bayou Watershed to date. Up to this point, however, the meetings and activities of the committees have been coordinated by a paid facilitator. According to a study of watershed management organizations conducted at the University of Oregon, “many [watershed groups] were unable to sustain themselves once the sponsoring agency withdrew its provisional leadership” and that “volunteer coordinators, or part-time coordinators loaned from partner agencies, are inadequate to maintain effective group leadership.”[73] In the short term, there is already a Jackson County Stormwater Task Force coordinated by Jackson County with participation from the four cities in Jackson County. Since this task force already deals with many overlapping areas including stormwater management BMPs and outreach and education, it would be an easy transition for this group to adopt responsibility for the Old Fort Bayou Watershed Implementation Plan. Per the County’s 2017 MS4 annual report, the task force is considering

expanding participation to include citizen members. Adding additional members to the task force who have served on the Old Fort Bayou Watershed Steering and Technical Advisory Committee would both support the goals of the MS4 jurisdictions and forward the work of the Old Fort Bayou Watershed Implementation Plan. Another option would be for The Mississippi Department of Environmental Quality to consider funding a watershed coordinator grant program similar to what was done in California through the Department of Conservation.[74]

Data Gaps

Seasonal water quality monitoring has been regularly performed by MDEQ at a state ambient monitoring station (#0481299) near the mouth of Old Fort Bayou. Data on fecal indicator bacteria recorded at this monitoring station from 2009 to 2017 is included in Section 2.4.5. Aside from this, little data has been collected. Significant data gaps remain and are described below. In general, ambient water quality data should continue to be collected, but from multiple sites throughout the watershed to give a more comprehensive picture of sources of impairments in Old Fort Bayou.

Primary Source(s) of Pathogens

Findings from both the 2002 TMDL report and this watershed assessment indicate that pathogens are most likely coming from nonpoint sources. As noted in Section 2.4.6, pathogens can come from many different nonpoint sources and current available data does not allow for identifying specific sources. Additional bacteria monitoring may be helpful in delineating inputs. In addition, the most recent survey of septic systems in Old Fort Bayou Watershed was conducted by the Mississippi Department of Health in 2008. It would be beneficial to update the survey in coordination with outreach and education efforts to inform septic system owners of proper maintenance procedures.

Nutrients

Very little data exists on nutrient loads (Total Nitrogen and Total Phosphorus) in the watershed. Students from St. Martin High School did test for nutrients at two sites on Old Fort Bayou as part of the B-WET program on November 5, 2018 and the results are included in Section 2.4.5. This data, however, was not collected according to accepted scientific protocols so cannot be used to draw any firm conclusions. That said, comparing results from the upstream site and the downstream site suggest that more nutrient loading may be coming from the downstream urban areas as compared to the more rural development and golf course upstream.

Erosion and Sediment Delivery Rates

Based on visual surveys of the watershed and anecdotal information from longtime residents, sedimentation in Old Fort Bayou appears to be a growing concern. Main sources appear to be cleaned/cleared drainage ditches and new construction. Methodologies such as semi-quantitative models developed for erosion and sediment yield assessments at the basin scale can be used to more narrowly define sources of erosion and sediment. After source and quantity are identified, a sediment delivery procedure can be used to determine how sediment is being naturally transported from the source of erosion to a specific location in the waterway. Employing such a model in

Old Fort Bayou Watershed could help identify where to target BMPs so that more significant results can be realized with fewer investment dollars.

Priority Projects

Conservation & Restoration at Bayou Talla

The Land Trust for the Mississippi Coastal Plain is currently negotiating acquisition of several properties totaling 13.98 acres along Old Fort Bayou and Bayou Talla. See Figure 15. These properties have significant conservation value in terms of preserving riparian buffers in critical areas of the watershed and offer connectivity to other properties owned and managed by LTMCP. The property that extends north along Bayou Talla connects to property owned by Jackson County School District and home to St. Martin Schools. This connectivity offers additional opportunities for access, education and outreach.

Figure 15: Potential Area for Conservation and Restoration Activities

St. Martin High School also has access to an outdoor classroom and trail which has not been managed or used for a period of time. LTMCP has proposed working with students and a group of Navy Volunteers stationed in Pascagoula, MS to restore the trail and outdoor classroom.

Golf Courses

The Preserve Golf Club located at the northern end of Old Fort Bayou is a leader in golf course BMPs and has already implemented an impressive list as described above. The

Golf Course Superintendents Association of America (GCSAA) has been leading a national effort to encourage voluntary use of BMPs on golf courses. The motivation behind the effort is to protect water quality through voluntary measures and to avoid top-down regulation that may unnecessarily hinder golf operations. Florida has already developed their state-specific manual of best management practices and is leading the charge. Mississippi and Louisiana have made significant progress in developing their joint manual which should be completed in 2019. GCSAA is encouraging all manuals to be completed and BMPs to be implemented by 2020. While there are still additional BMPs that can be implemented at The Preserve, as mentioned above, The Preserve has the potential to be an even more visible leader and influencer in terms of Best Management Practices both in the watershed and larger region.

Further downstream on Old Fort Bayou is Gulf Hills Golf Course. The area is historically significant and includes a hotel and number of single-family homes. See Section 2.1.2. Though technically just outside of the Old Fort Bayou Watershed (HUC 031700090604) boundary, it is included in the recommendations because it drains into Old Fort Bayou as it is about to enter the Back Bay of Biloxi. The manager of the Gulf Hills Hotel and Conference Center was active on the Steering Committees for the 2007 Old Fort Bayou Watershed Action Plan and the 2018 Watershed Implementation Plan, including hosting the third meeting of the Steering and Technical Advisory Committee on September 25, 2018. While less has been done to date in terms of BMPs targeted specifically at water quality compared to The Preserve, because of close proximity to the hotel and residential area there is a significant opportunity for implementing BMPs coupled with outreach and education.

Urban Ordinances & Low Impact Development

One of the top concerns identified in the watershed assessment was water quality impairments and increased risk of flooding during intense rain events due to stormwater runoff in the more developed areas. Development has increased over the past several years and is likely to continue. All three jurisdictions have ordinances aimed at controlling stormwater runoff, yet in general, the region is much less comfortable with principles and strategies related to Low Impact Development than many other areas of the Country.

The B-Wet program with St. Martin High School students has focused on Low Impact Development strategies for addressing stormwater runoff. See Appendix E. The program will continue through August 2019 and includes a summer internship for four students to work with the Jackson County Planning Department to identify barriers to addressing stormwater issues and recommend solutions. Recommendations may include revisions to existing ordinances, additional capacity around enforcement and/or ways to educate on and incentivize the use of Low Impact Development technologies. Given the similarity in stormwater controls between the jurisdictions in Old Fort Bayou Watershed and along the coast it is very likely that recommendations resulting from this work will be applicable to a much larger area.

Conservation and Restoration

Conservation and Riparian Buffers

As part of the Conservation Legacy Project, the Land Trust for the Mississippi Coastal Plain has a map of Potential Conservation Lands that is a model of the suitability of land for conservation based on ranked environmental and land use conditions including wetlands, hydrological soil groups, flood zones, elevation/slope, upland forest and important ecosystems. Areas that are in Old Fort Bayou watershed and currently undeveloped were identified as being relatively high priority areas (See Figure 9) in terms of conservation and should be considered in planning and management strategies for Old Fort Bayou Watershed. See Section 2.3.5. LTMCP should continue to work with Jackson County, Ocean Springs, Gautier and private landowners within the watershed to acquire property or easements that will protect critical land within the watershed. The focus of these efforts should be on preserving, expanding and restoring riparian buffers along Old Fort Bayou.

In addition, the Mississippi Sandhill Crane National Wildlife Refuge has established a partnership with Wildlife Mississippi, also known as the Mississippi Fish and Wildlife Foundation, to conserve private lands near the refuge through conservation easements. Conservation efforts should continue to be pursued and coordinated across the watershed.

Living Shorelines and Marsh Restoration

Streamside buffers and living shorelines are very effective in improving water quality and habitat along waterways. A living shoreline describes a natural approach to shoreline stabilization that reduces erosion while preserving or creating habitat along the shoreline. A visual survey done of Old Fort Bayou by members of the Steering and Technical Advisory Committee on August 24, 2018 revealed that while many healthy marsh areas remain intact, there are also quite a few opportunities to remove derelict structures and hardened shorelines and replace them with living shorelines.

Results of these efforts would be further enhanced by some type of incentive program for homeowners who willingly implement BMPs along the shorelines. The Scenic Streams Program and Partners for Fish and Wildlife Program are two examples designed to promote voluntary conservation and best management practices. The Scenic Streams program, under the leadership of the Department of Wildlife, Fisheries and Parks, began in 1999 and opened the door for participants in the program to be able to receive tax incentives that are or may become available. The Southeast Region Partners for Fish and Wildlife Program is a branch of the US Fish and Wildlife Service that provides technical and financial assistance to private landowners interested in improving habitat as they maintain their primary land management goals.

Recreation and Ecotourism

Blueway

Old Fort Bayou is currently a successful blueway. Plans for an expansion up Bayou Talla and updates to both printed material and signage are in the works. See Section 2.4.2.

Access to Old Fort Bayou is seen as a positive thing and these plans are encouraged so long as they are coupled with education and outreach on environmental stewardship.

No Wake Zones

As evident from the boat tour of Old Fort Bayou on August 24, 2018, there are areas along the waterway where significant scouring is occurring. Some of this scouring may be the result of increases in stormwater runoff due to development, but some may be due to wake from boat traffic. Further observation of boat traffic could help to determine the level to which waves caused from water vehicles travelling at higher speeds is a problem in Old Fort Bayou. Signage or other means of educating the public on water quality impairments caused by scouring associated with wave action may be necessary.

Watershed Signage

In addition to blueway signage, the addition of Old Fort Bayou Watershed signage strategically installed around the watershed is recommended as a low-cost tool for increasing community awareness of the watershed.

Promotion of Conservation Areas Open to the Public

The Mississippi Sandhill Crane National Wildlife Refuge Comprehensive Conservation Plan states that public use and visitation are encouraged at the Refuge in four priority areas including wildlife observation, wildlife photography, environmental education and interpretation. A public use development plan was apparently drafted by the Refuge in 1985, but there is no record of the plan being submitted or approved.[75] The Conservation Plan indicated that a Visitor Services Plan would be developed, but to date no plan has been completed.[76] Developing a Visitor Services Plan in line with the goals and objectives of the Old Fort Bayou Watershed Implementation Plan should be considered a high priority for the Refuge as a critical stakeholder in Old Fort Bayou Watershed.

Waste and Wastewater

Nonfunctioning Septic Systems

According to a survey done by the Mississippi Department of Health (MSDH) in 2008, there were pockets of nonfunctioning septic systems in Old Fort Bayou Watershed. See Figure 13. The most significant clusters were in the northern tip of the watershed and in the south-central area. Following Hurricane Katrina, sewer and water districts across coastal Mississippi were able to tie-in many areas that were previously on septic systems, primarily using funds through the Coastal Impact Assistance Program (CIAP). An updated assessment of remaining nonfunctioning septic systems should be conducted, coupled with an educational campaign about the risks of nonfunctioning septic systems and proper maintenance. An example program is being implemented in the town of Bluffton, South Carolina following recommendations in the May River Watershed Action Plan. The programming utilizes the Coast-A-Syst model of home assessment and action.[77]

Litter

Coastal Cleanup Extension & Other Cleanup Events/Incentives

The Mississippi Coastal Cleanup does have one cleanup location in Old Fort Bayou Watershed at the Washington Avenue boat launch in Ocean Springs, however, it has had very few volunteers and is limited in geographic scope. See Section 2.4.6. Additional efforts to increase the number of volunteers is recommended, in addition to adding a cleanup site or sites further upstream. It would also be beneficial to add cleanup efforts from the water. This could be accomplished by inviting boaters to join the Mississippi Coastal Cleanup to increase the impact or by adding a cleanup component to other events such as Battle on the Bayou. Mississippi Power's Renew Our Rivers Program is another potential partner that can help with future cleanups from the water. Finally, restaurants on Old Fort Bayou and/or other businesses or organizations could also offer a reward or incentive to patrons to who document litter collection efforts along the bayou or in the watershed.

Trash Catches in Commercial Area

Where there are curb and gutter drainage systems, especially in commercial areas, litter can easily be washed down the storm drains and into waterways. Trash catches or drain guards installed at the catch basins would help prevent litter from entering the waterways.

Street sweeping

Roadway litter and debris are evident throughout the watershed and larger region and easily make their way into waterways through the drainage system. Regular street sweeping should be coordinated through the county and city road maintenance departments.

Adopt-a-Roadway

Currently, adopt-a-highway programs are administered by the federal and state departments of transportation. Eligible roadways include federal and state highways. Through these programs, public and private organizations and individuals agree to clean a one to two mile segment of the highway a certain number of times per year. In exchange, dedication signage and clean-up materials are provided by the Department of Transportation. These programs not only serve to clean-up roadway litter, but also help deter litter in the first place. Drivers and pedestrians that see Adopt-a-Roadway signage and witness volunteers picking up garbage are more likely to think twice about littering in that area.

Urban BMPs

Nonstructural

Ordinance Updates

It is likely that an assessment of the jurisdictions' ordinances related to stormwater management will indicate that improvements can be made.

Related ordinances include stormwater management ordinances; ordinances for stormwater runoff, illicit discharges, and illegal connections; flood damage protection ordinances; and building codes. This assessment is to be completed for Jackson County as part of the B-WET program underway with St. Martin High School as described above and in Appendix E.

Coastal Technical Manual

Effective stormwater management requires connecting the dots from policy implementation to proper construction and installation of best management practices. Many of the jurisdictions on the coast are looking to implement policies that would allow, incentivize or require pre and post-construction best management practices addressing stormwater runoff, but are unfamiliar with some of the technical aspects or unclear about the implications of certain policies. The State of Georgia addressed this concern and information gap by creating a Stormwater Management Manual. The Georgia Stormwater Management Manual has several volumes including a Policy Guidebook, Technical Handbook and Coastal Supplement. Jurisdictions in Georgia refer to these volumes in their policies and ordinances so that standards and guidelines are clear for all affected parties.

The Mississippi Department of Environmental Quality has developed a similar manual called *Erosion Control, Sediment Control and Stormwater Management on Construction Sites and Urban Areas*, however, it does not have as many technical details as the Georgia Manual, does not have a coastal supplement and is not used as effectively by jurisdictions in Mississippi as the Georgia Manual is in Georgia. MDEQ should consider adding a coastal supplement to their technical manual so it is more relevant to jurisdictions on the coast or adopting Georgia's *Coastal Stormwater Supplement to the Georgia Stormwater Management Manual*. In addition, MDEQ should look to partner with the Mississippi Alabama Sea Grant Consortium, Grand Bay National Estuarine Research Reserve (NERR), or similar organizations and agencies to provide training to jurisdictions and engineers on how to use the manual.

Fertilizer Ordinance

Preliminary water quality data recorded by students at St. Martin High School suggest that more of the nutrients entering Old Fort Bayou are coming from the more urban area of the watershed and most likely from fertilizer use. To address fertilizer use in urban areas many jurisdictions in Florida have adopted some form of a fertilizer ordinance based off of the Florida Department of Environmental Quality's Model Ordinance for Florida-Friendly Fertilizer Use on Urban Landscapes. See Appendix H: Model Ordinance for Florida-Friendly Fertilizer Use on Urban Landscapes. The jurisdictions in Old Fort Bayou Watershed should consider adopting some form of fertilizer ordinance, in coordination with education and outreach to property owners and lawn care businesses about responsible fertilizer use, as a means of reducing nutrients entering Old Fort Bayou.

Structural

Pre and Post Construction

Any type of construction or earthwork exposes soil and makes areas more susceptible to erosion. Best management practices for controlling impacts from construction are extremely important, especially given the increase in development following the recession. For most development, a Stormwater Pollution Prevention Plan is required in which the developer must show what best management practices they intend to implement to minimize impacts downstream.

In most jurisdictions on the coast, if a site is over five acres, the site is the jurisdiction of MDEQ. A Stormwater Pollution Prevention Plan (SWPPP), Large Construction Notice of Intent (LCNOI) and permit are required and must be filed with MDEQ and the jurisdiction. Under five acres is the jurisdiction's responsibility. Most jurisdictions require that development under five acres have a permit, Small Construction Notice of Intent (SCNOI) and SWPPP. Usually if a site is under one acre the jurisdiction does not require a plan or permit.

MDEQ has a technical guide to assist in the development of these plans titled *Erosion Control, Sediment Control and Stormwater Management on Construction Sites and Urban Areas*. Volume one, *Erosion and Sediment Control Manual*, covers BMPs through construction and volume two, *Stormwater Runoff Management Manual*, covers post construction BMPs. There does not appear to be a lack of regulation or guidance concerning pre and post construction BMPs, however, there are currently active construction sites that do not have adequate controls in place. See Figure 16. The issue appears to be more with lack of capacity to enforce the SWPPP's. As development continues to increase in Old Fort Bayou Watershed, MDEQ and the jurisdictions need to view erosion and stormwater control as a priority and increase their capacity to monitor and enforce SWPPP's.

Figure 16: Active Construction Sites in Old Fort Bayou Watershed

Source: Elizabeth Englebretson. Photos taken June 18, 2018

Drainage swale maintenance

The drainage systems in Old Fort Bayou Watershed are primarily open, grassy swales. This is an excellent starting point in terms of stormwater management because there are theoretically more opportunities for infiltration than with piped, curb and gutter systems. In order to function at an optimal level, however, swales need to be properly maintained. Maintenance typically involves litter control and maintaining the grass or wetland plant cover. Sediment needs to be removed once it has exceeded 25 percent of the original design volume, but scouring ditches without revegetating only creates more problems downstream. Grass should be mowed to a height of 3-4 inches and alternate planting should be considered where appropriate or where grass has not been successfully established. In addition, during construction it is important to stabilize the embankment either with a temporary grass cover or with natural or synthetic erosion control products. General maintenance guidelines can be found online at http://water.epa.gov/polwaste/npdes/swbmp/Grassed-Swales.cfm

Small Scale Urban BMPs

Rain barrels and rain gardens are examples of smaller scale urban BMPs that can have a significant positive impact on water quality if implemented throughout a community. There are many opportunities in the more developed areas where these practices can be encouraged. Local garden clubs would be excellent organizations to educate and encourage the community in regards to these practices along with encouraging the use of native plants. In addition, small, highly-visible demonstration projects can be implemented at businesses and organizations in and around the watershed. Coupled with educational signage,

these projects can serve to inform community members about BMPs. Organizations like the Walter Anderson Museum of Art and the Mary C O'Keefe Cultural Center would be excellent sites for demonstration projects that also incorporate artistic components.

Agricultural and Rural BMPs

Nonstructural

Logging BMPs

Forested areas within Old Fort Bayou Watershed are periodically used for harvesting lumber. The Mississippi Forestry Commission (MFC) encourages BMPs in regards to forestry and logging and has a guide called *Best Management Practices for Forestry in Mississippi*. MFC could go a step further, however, and incentivize implementation of these practices. In Missouri, the Missouri Department of Conservation implemented a cost-share program designed to be a partnership between the logger and property owner.[78] The MDC pays loggers $10 to $20 per acre and landowners $5 for every acre in which they implement BMPs. Funding was provided through a Natural Resources Conservation Service Conservation Innovation Grant.

Ordinances can also help improve logging practices through regulation and/or incentives. An example of such an ordinance is from Carbon County, Utah, where County Commissioners passed a Timber Harvest Ordinance. Property owners are required to submit an application and obtain a permit to harvest timber when it will exceed a certain tonnage. The ordinance also called for the selection and appointment of a professional County Forester. This person administers the ordinance by reviewing permit applications, issuing permits to qualifying applicants, and inspecting logging jobs on private land. Other forest practices addressed include road maintenance, winter operations, site preparation, regeneration, revegetation, chemical management, and prescribed burns.[79] Jackson County should consider using a similar mechanism to increase the implementation of logging BMPs.

Structural

The following structural, agricultural BMPs are recommended by the Jackson County Soil and Water Conservation District, Mississippi Soil and Water Conservation Commission and Natural Resources Conservation Service based on remaining opportunities following the implementation of the Old Fort Bayou/Tuxachanie Creek Watershed Nonpoint Source Pollution Demonstration Project that concluded in 2006.

During the development of this Watershed Implementation Plan the Jackson County Soil and Water Conservation District in coordination with the Mississippi Soil and Water Conservation Commission and United States Department of Agriculture Natural Resources Conservation Service assessed the remaining opportunities for BMPs in the more rural area in the northern part of the watershed; taking into account investments that were made between 2001 and

2006 as part of the Old Fort Bayou/Tuxachanie Creek Watershed Nonpoint Source Pollution Demonstration Project. Table 4 below is a result of that assessment. Brief descriptions of each strategy included in the table can be found below in the subsection on Agricultural and Rural BMPs: Structural.

Table 4: Summary of BMPs Recommended for Old Fort Bayou Watershed

Practice	Average Unit NRCS Cost	Units	Total Cost
Critical Area Planting	$248.10	32 acres	$7,939.20
Fence	$1.91	12,499 ft	$23,873.09
Grade Stabilization Structures	$5,000	5	$25,000.00
Heavy Use Area	$1.04	8,000 acres	$8,320.00
Pipeline	$1.75	3,600 ft	$6,300.00
Stream Bank Protection	$1.54	1,588 acres	$2,445.52
Grassed Waterways	$1,648	13	$21,424.00
Pond	$3.77	2,120 acres	$7,992.40
Tank/Trough	$4,600	10	$46,000.00
TOTAL			**$149,294.21**

Heavy Use Area Protection

Heavy use area protection methods reinforce locations that are frequented by livestock by establishing vegetative cover, surfacing with suitable materials, or installing needed structures. Heavy use protection areas are often combined with tanks or troughs that hold drinking water for livestock.

Fencing

Fencing should be strategically placed to exclude livestock from areas that should be protected from grazing or access, such as waterways.

Pond (Alternative Water Source)

Ponds can be installed by constructing a dam or an embankment or by excavating a pit or dug out. Ponds can serve to catch and store runoff and act as a water source for livestock.

Critical Area Planting

Appropriate vegetation should be planted in areas that are critically eroded or likely to experience erosion. It is important for water quality for any eroded/erodible areas to be planted, it is emphasized here for rural and agricultural zones because these areas can easily go overlooked on larger plots of land.

Tank/Trough

A watering facility to be able to hold water for the purpose of livestock to drink.

Grade Stabilization Structures

An earthing, concrete, or other structure(s) built across a drainage to prevent gully erosion.

Pipeline

A waterline from existing water wells, troughs, or other water sources.

Stream Bank Protection

A vegetative, structural or combination treatment of streams designed to stabilize the stream and reduce erosion.

Grassed Waterways

Broad, shallow, and typically saucer-shaped channels designed to move surface water across farmland without causing soil erosion. The vegetative cover in the waterway slows the water flow and protects the channel surface from the eroding forces of runoff water.

3.1.3 Education and Outreach Activities

Education and outreach efforts are critical to informing the community about challenges and opportunities that affect the water quality in Old Fort Bayou Watershed and causing large-scale behavior change needed to improve impairments coming from nonpoint sources. Outreach efforts were planned and initiated as part of the 2007 Action Plan. The Education and Outreach Subcommittee assembled as part of the development of this Watershed Implementation Plan revisited the strategies recommended in the Action Plan at a work session on August 27, 2018 and determined if the strategies had been completed, implemented in-part, not implemented and/or no longer a priority. Aside from completion of the blueway, most strategies had not been completed, but remained important. As such they have been included in some form in the recommended education and outreach activities that follow.

While education and outreach were not specifically included in the scope of work of developing this Watershed Implementation Plan, a significant degree of education occurred as the Steering and Technical Advisory Committee regularly met and interacted with others outside the committee during the planning period. In addition, as a result of funding from NOAA's Gulf of Mexico Bay Watershed Education and Training Program (B-WET), GCCDS has been able to implement a comprehensive watershed education program focused specifically on Old Fort Bayou Watershed with students at St. Martin High School. Programming will continue through August 2019 and is documented in Appendix E. In addition, the Jackson County Soil and Water Conservation District and Mississippi Sandhill Crane National Wildlife Refuge have been providing education and outreach programming and materials to local school groups and at other events as documented in the jurisdictions' MS4 plans and the Mississippi Sandhill Crane National Wildlife Refuge Comprehensive Conservation Plan. LTMCP and TNC also regularly disseminate information and programming as part of their missions.

As mentioned above, education and outreach will be key to both the success of the Old Fort Bayou Watershed Implementation Plan and overarching goal of improving water quality by reducing impairments from nonpoint sources in the watershed. A full listing of potential education and outreach activities recommended for Old Fort Bayou Watershed including responsible parties, potential funders, estimated costs and a recommended implementation timeline is included in Appendix H: Management Action.

Education in Schools

Programming started with funding through the B-WET program at St. Martin High School should be continued and expanded to include St. Martin Middle and Elementary Schools. In addition, Ocean Springs' schools should include programming focused on watershed dynamics and stormwater runoff specific to Old Fort Bayou Watershed. The two schools in the Ocean Springs School District in closest proximity to Old Fort Bayou are the Ocean Springs Upper Elementary School and Pecan Park Elementary School.

Arts Organizations

There are several arts organizations in Ocean Springs that would be excellent partners in terms of both demonstrating small-scale urban BMPs and watershed outreach and education with an art component. The Walter Anderson Museum of Art (WAMA) located in downtown Ocean Springs is based on Walter Anderson's vision for communities that exist in harmony with their environment. He greatly valued and was inspired by nature, particularly coastal ecosystems, as is evident in this internationally-renowned artwork. This joint vision of art and environmental stewardship and proximity to Old Fort Bayou make WAMA an ideal candidate for a future partner in outreach and education. The Mary C O'Keefe Cultural Center would be another ideal partner. The Mary C offers programming in art, music, theater and cooking and is home to the Ocean Springs Museum of History. A rain garden or water feature onsite with a music component created by rainwater would be a beautiful addition to the site. Complimented by signage and educational programming or an exhibit, the Mary C could be a very effective partner in outreach efforts.

Low Impact Development

Jurisdictions along the Mississippi Gulf Coast, including those in Old Fort Bayou Watershed, seem to be much less comfortable in implementing Low Impact Development (LID) strategies than other areas of the County and do relatively little to promote or incentivize the use of LID with private developers. Efforts are needed to educate the jurisdictions on Low Impact Development techniques and to provide the jurisdictions and developers with tools to increase their capacity to promote and use LID. Some of this will be accomplished with the help of student interns over the summer of 2019 through the B-WET program with St. Martin High School. In the least, the students under the guidance of GCCDS and LTMCP will be able to do a thorough assessment of barriers to implementing LID strategies and develop solid recommendations applicable to the County and others in the region.

Facebook Page

Facebook is a popular tool for outreach and education. In terms of watershed planning, a Facebook page is typically created and maintained by a watershed partnership. While

there is not a watershed partnership for Old Fort Bayou Watershed, the Jackson County Stormwater Task Force, with more participation from members of the Old Fort Bayou Watershed Steering and Technical Advisory Committee could serve this role.

Plastic Free

Plastic Free Gulf Coast is an effort currently supported by the NOAA Marine Debris Prevention Program focused on reducing the use of single-use plastics within the five Gulf States through outreach, education, and providing alternatives to restaurants and consumers. The two lead partners on the project are MSU's Gulf Coast Community Design Studio and Coastal Research and Extension Center. The program has been working closely with two restaurants in Hancock and Harrison Counties, but currently does not have any participating restaurants in Jackson County. Restaurants along Old Fort Bayou should be encouraged to participate in this program.

Projects for Scout Troops

Many Boy and Girl Scout troops are active in Old Fort Bayou Watershed. Often these young men and women are looking for volunteer projects to help complete requirements of their programs. Appendix I includes sample projects for Boy Scouts related to the Soil and Water Conservation Badge. The Mississippi Sandhill Crane National Wildlife Refuge also recommends developing a fire ecology merit badge.

Septic System Maintenance

In the absence of funding to tie-in additional areas on septic system, an educational campaign about the risks of nonfunctioning septic system and proper maintenance should target areas in the watershed where high concentrations of septic systems remain. An example program is being implemented in the town of Bluffton, South Carolina following recommendations in the May River Watershed Action Plan. The programming utilizes the Coast-A-Syst model of home assessment and action.[80]

Signage

Strategically placed signage with an educational component can be a very cost-effective way to increase community members' awareness of water quality challenges and best management practices. Educational signage should be installed when publically accessible BMPs are installed. If not already present, signage should be added at public access point or trails. It is also recommended that general Old Fort Bayou Watershed Signs be added strategically throughout the watershed. Signage should be consistent with the recently completed National Heritage Area's Blueways Design Guide.

Pet Waste

While the current level of pathogen testing does not distinguish between septic waste, domestic animal waste and wildlife, anecdotally, there appears to be an excessive amount of pet waste that is left on the ground. Bacteria in pet waste does break down naturally, however the ecosystem cannot handle the number of domestic dogs typically concentrated in a small area. The natural ecosystem can only handle two canines in a square mile. In urban areas, there are often as many as 125 dogs per square mile. Education around proper disposal of pet waste should be distributed by the local jurisdictions, property owners associations, and local pet-related businesses such as

veterinary clinics. Signage and waste receptacles should also be provided in areas where people frequently walk pets.

Promote Use of Native Plants

Use of native plants, especially in areas that tend to remain wet, are susceptible to erosion, or are near waterways, can have a positive and substantial effect on water quality. Many residents would likely be willing to use native plants in place of grass or invasive varieties if they knew what to plant and the benefits of doing so. Local garden clubs and nurseries would be ideal promoters of the use of native plants.

3.2 Plan Evaluation and Revision

3.2.1 Monitoring Plan

MDEQ

Post-BMP monitoring locations will be selected using best professional judgment and will be targeted to reflect water quality downstream of BMP activity. Once BMP installation is complete, and there has been sufficient time for the stream to stabilize, post BMP monitoring will be initiated. Post BMP monitoring will be conducted in a way that allows for comparison with the pre-implementation data. Because recovery periods of streams can be dependent on type and amount of BMPs installed, more than 1 year of post BMP data may be needed to observe a change in water quality. In some cases, it may take 5 or more years to see full benefits of BMPs. All data collection efforts will be conducted using trained personnel following established Standard Operating Procedures and adhering to agency Quality Assurance protocols.[81]

Restore Corps

Climb Community Development Corporation (Climb CDC) is a nonprofit Mississippi community development agency whose mission is to promote strong communities by providing individuals access to opportunities that inspire self-reliance. As part of its workforce training program, CLIMB CDC formed a Gulf Coast Restore Corps that is part of the national Corps Network. The Restore Corps will participate in projects related to the restoration of the Gulf of Mexico from the effects of the 2010 Oil Spill. The team is able to provide services including monitoring water quality, conducting visual waterway assessments, and implementing or providing ongoing maintenance for restoration/recreation projects. Fees for services are relatively minimal and are determined at the time the services are requested. If state agencies such as MDEQ are not able to continue monitoring in Old Fort Bayou in the future, consideration should be given to partnering with paid and semi-professional groups like the Gulf Coast Restore Corps for periodic monitoring and assessment.

Schools

As mentioned in Sections 1.3 and 3.1, the Gulf Coast Community Design Studio secured funding from NOAA's Gulf of Mexico Bay Watershed Education and Training Program (B-WET) for the 2018-2019 school year to work with 10th through 12th grade students enrolled in environmental science-related classes at St. Martin High School and several interns over the summer. See Appendix E. The grant funding not only allowed GCCDS staff to work with students during the

2018-2019 school year, but provided supplies to teachers to continue the program in future years. St. Martin High School is encouraged to keep monitoring water quality in Old Fort Bayou and Bayou Talla. Programming and monitoring capabilities should also be expanded to included St. Martin Middle and Elementary School Students. The Land Trust for the Mississippi Coastal Plain properties along Old Fort Bayou in Ocean Springs also offer excellent opportunities for school groups from Ocean Springs to monitor water quality downstream in Old Fort Bayou.

Other Potential Partners

Other potential partners include Research and Education to Advance Conservation and Habitat (REACH) and the EPA's Gulf of Mexico Program.

3.2.2 Adaptive Management and Plan Revision

The goals, objectives and resulting strategies and recommendations included in the Old Fort Bayou Watershed Implementation Plan have been determined based on an assessment conducted in 2018. Environmental and socioeconomic conditions are ever changing. These conditions, as well as any implemented Best Management Practices, will likely have an impact on the watershed and water quality in Old Fort Bayou. As such, it is recommended that an integrated assessment of Old Fort Bayou Watershed be conducted on a routine basis and that adjustments or amendments be made to the Old Fort Bayou Watershed Implementation Plan as justified by the results of the assessments. According to the Mississippi Coastal Nutrient Reduction Strategy, "five years is considered adequate for observing near-field changes in water quality from the implementation of various management practices in the watershed."[82] The Old Fort Bayou Watershed Partnership should begin conducting its first assessment and plan revision in 2023.

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