Watershed Implementation Plan
Rotten Bayou

September 2015

Prepared For:

Land Trust for the Mississippi Coastal Plain
P.O. Box 245
Biloxi, Mississippi 39533
228.435.9191
www.ltmpc.org

Prepared By:

Gulf Coast Community Design Studio
Mississippi State University, College of Architecture, Art + Design
769 Howard Avenue
Biloxi, Mississippi 39530
228.436.4661
www.gccds.org

GCCDS
Gulf Coast Community Design Studio
Mississippi State University College of Architecture Art + Design

With Acknowledgements for Contributions Made By:

City of Diamondhead
5000 Diamondhead Circle
Diamondhead, Mississippi 39525

Diamondhead Country Club and Property Owners Association
7600 Country Club Circle
Diamondhead, Mississippi 39525

Hancock County
854 Highway 90
Bay St Louis, Mississippi 39520

Harrison County
1801 23rd Ave
Gulfport, Mississippi 39501

Steering, Technical, and Education and Outreach Committees

Table of Contents

Section 1: Watershed Planning

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 Elements for WIP

Required WIP Element for 319 Grant	Location in WIP
Watershed Description and Background	Section 2: Watershed Assessment
Implementation	Section 3.1: Watershed Management Actions
Project Goals	Section 1.2.4: Goals
Project Costs	Appendix H: Management Actions
Education and Outreach	Section 3.2: Education and Outreach Activities
Implementation Schedule	Appendix H: Management Actions
Milestones	Appendix H: Management Actions
Adaptations and Revisions	Section 3.3.2: Adaptive Management and Plan Revision
Monitoring	Section 3.3.1: Monitoring Plan

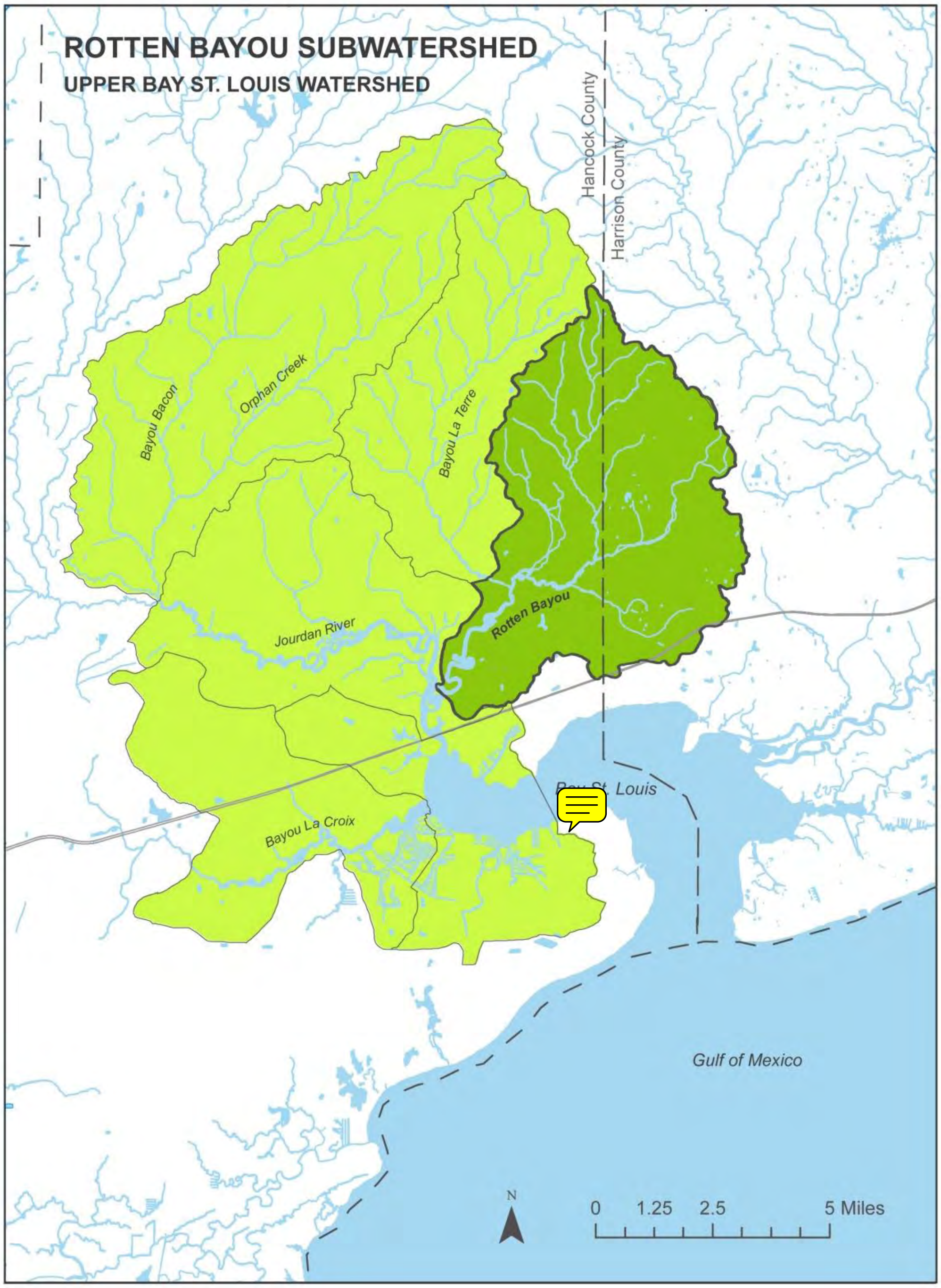
States are encouraged to develop statewide watershed planning frameworks to guide watershed plans in their jurisdictions. In 2008 the Mississippi Department of Environmental Quality's (MDEQ) Basin Management Branch published "Guidance for Developing A Watershed

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 Rotten Bayou Watershed Implementation Plan.

1.1.2 Why create a WIP for Rotten Bayou?

Developing a watershed plan for Rotten Bayou Watershed is a key step in implementing the Coastal Nutrient Reduction Strategy and improving water quality in the watershed.[4] The Rotten Bayou Watershed (HUC 031700109-002) is 22,446 acres and lies in Hancock and Harrison Counties. See Figure 1. Rotten Bayou itself is a tributary of the Bay of St. Louis and was listed on the EPA's 2006 Section 303(d) list of impaired waterbodies for organic enrichment, low dissolved oxygen, turbidity, and nutrient levels that did not meet water quality standards. The main contributors to these environmental stressors do not come from a single source and so require a holistic approach to develop solutions. Nonpoint source pollution can come from excess fertilizers, herbicides and insecticides from agricultural lands and residential areas; oil, grease and toxic chemicals from urban runoff; sediment from improperly managed construction sites, crop and forest lands, and eroding streambanks; and bacteria and nutrients from livestock, pet wastes and faulty septic systems. Addressing causes of nonpoint source pollution in Rotten Bayou Watershed is a primary benefit of creating a watershed plan.

Figure 1: Rotten Bayou Subwatershed



Source: Map by Gulf Coast Community Design Studio

In 2011, U.S. Department of Agriculture's Natural Resources Conservation Services (NRCS) announced the availability of up to 50 million dollars to help rehabilitate sixteen priority watersheds in the five Gulf States over a three-year period. The initiative is part of the *Gulf Coast Ecosystem Restoration Task Force,* created by Executive Order by President Obama in response to degradation of watersheds within the region, intensified by the Deep Horizon oil spill. Rotten Bayou Watershed and Bayou LaTerre Watershed in the Jourdan River Basin in Mississippi are among the sixteen priority watersheds.[5] An approved Watershed Implementation Plan and organized partnership for Rotten Bayou Watershed will improve the chances of bringing funding to the area.

A Rotten Bayou Watershed Implementation Plan will also help coordinate and build momentum around the many conservation activities already taking place in the watershed. Natural Resource Conservation Service (NRCS), Soil and Water Conservation District (SWCD), Soil and Water Conservation Commission (SWCC), U.S. Geological Survey (USGS) and Mississippi State University's Water Resources Research Institute (WRRI) are actively working and funding activities within the Rotten Bayou Watershed as part of an innovative water and wildlife conservation effort along the Gulf Coast called the Gulf of Mexico Initiative (GoMI). Current activities and related plans are further discussed in Section 1.3.

1.1.3 Process and Acknowledgements

In 2012, MDEQ enlisted the Land Trust for the Mississippi Coastal Plain (LTMCP) to guide planning work, education efforts and the implementation of restoration actions in Rotten Bayou Watershed pursuant to an approved Watershed Implementation Plan. Since 2006, LTMCP has worked to develop partnerships and plans for six watersheds in southern Mississippi including Old Fort Bayou, Red Creek, Turkey Creek, Tuxachanie-Tchoutacabouffa, Upper Bay St. Louis and West Boley Creek. The larger Upper Bay St. Louis Watershed includes the Rotten Bayou subwatershed.

The Rotten Bayou Watershed Project is funded partly through the EPA's Non-point Source Grant C9994866-11-0 and partly through State and local match. LTMCP hired Mississippi State University's Gulf Coast Community Design Studio in December 2013 to facilitate the development of the Watershed Implementation Plan and related outreach and design work. The first step in the planning process was to assemble a Watershed Implementation Team representing various stakeholders in Rotten Bayou Watershed. See Section 1.2.1. This team includes a Steering Committee made up primarily of local leadership and residents, a Technical Advisory Committee consisting of staff from various public agencies and private firms with expertise related to the watershed planning, and an Education and Outreach Committee to guide the public engagement portion of the work.

The Steering Committee first discussed assets and concerns related to the watershed and water quality and determined a vision and goals for watershed planning in Rotten Bayou that would guide the committee and future work. See Sections 1.2.2 – 1.2.4. The Steering Committee and Technical Advisory Committee then set to work collecting and analyzing available data related to Rotten Bayou Watershed. This information is included in Section 2 and has informed the ongoing outreach and education efforts, as well as the management and monitoring plans included in Section 3. Natural Capital Development and Anchor QEA, LLC were hired as project consultants between June and December 2014 to analyze available draft water quality data for Rotten Bayou as compared to the TMDL and approved thresholds. See Appendix C: Rotten Bayou Water Quality Assessment. The Education and Outreach Subcommittee was critical to the implementation of public engagement activities carried out during the planning period and development of a plan for future activities. See Section 3.2.

1.2 Looking Forward

1.2.1 Watershed Implementation Team

Steering Committee

Adam	Hootie	Hancock County Emergency Management Agency
Bilbo	Holly	City of Diamondhead
Bonck	Pat	Harrison County Planning and Zoning
Chubb	Patrick	Mississippi Power
Collard	Mike	Diamondhead Water & Sewer District (through 2014)
Coyne	Mary	Devil's Elbow POA/Diamondhead Resident
Depreo	Nancy	Seymour Engineering/Diamondhead Resident
Flores	Karen	Diamondhead Garden Club/Diamondhead Resident
Holcomb	Hank	Diamondhead Resident
Isaacs	Mark	Solar Boat Tours
Kinchen	Darrell	Diamondhead POA/Diamondhead Resident
Knobloch	Ernie	Diamondhead City Council/Diamondhead Resident
Koch	David	Hancock County Resident
Ladner	Marcus	Hancock County Resident
Ladner	Tony-Wayne	Hancock County, District 5 Supervisor
Ladner	Marlin	Harrison County, District 3 Supervisor
Ladner	Robyn	Harrison County Planning and Zoning
Lee	Eddy	Diamondhead Resident
Lopez	Joseph	Diamondhead City Council/Diamondhead Resident
Necaise	Ty	Harrison County Resident
Nolan	Janell	Coast Electric Power Association/Diamondhead Resident
Pyron	Jason	Diamondhead Resident
Reed	Clovis	City of Diamondhead/Diamondhead Resident
Rice	Karen	Keep Diamondhead Beautiful/Diamondhead Resident
Schafer	Tommy	Diamondhead City Council/Diamondhead Resident
Sentell	Brook	Diamondhead POA/Diamondhead Resident
Sheehy	Ray	Diamondhead Resident
Sites	Karen	Diamondhead Resident
Sloan	Dan	Diamondhead Resident
Steckler	Judy	Land Trust for the Mississippi Coastal Plain
Sullivan	Richard	City of Diamondhead
Thomas	Scott	Stetson Engineers/Diamondhead Water and Sewer District Commissioner/Diamondhead Resident
Yanez	Tracy	Mississippi Power/Diamondhead Resident

Technical Advisory Team

Alexander	Constance	US EPA Region 4
Baker	Beth	MSU REACH

Beard	Russell	NOAA Center for Coasts, Oceans, and Geophysics/Diamondhead Resident
Boos	Jerry	EPA Gulf of Mexico Program
Bray	Leah	Natural Capital
Caviness-Reardon	Kim	MS Department of Environmental Quality
Dahmash	Zoffee	MS Department of Environmental Quality
Darby	Elaine	Anchor QEA
Depreo	Nancy	Compton Engineering/Diamondhead Resident
Freiman	Mike	MS Department of Environmental Quality
Fulton	Marty	Natural Resources Conservation Service
Gallo	Cory	Mississippi State University
Harrington	Tyree	Natural Resources Conservation Service
Harris	Jared	MSU REACH (through 2014)
Hicks	Matt	US Geological Survey
Ingram	Richard	MS Water Resources Research Institute
Jackson	Greg	MS Department of Environmental Quality
Kotey	Napolean	US EPA Region 4
Lagasse	Mickey	Compton Engineering
Miller	Christian	Auburn, MASGC, Mobile Bay Estuary Program
Murphy	Mike	The Nature Conservancy
Perrott	Coen	MS Department of Environmental Quality
Pierce	Troy	EPA Gulf of Mexico Program
Ray	Tim	MSU Extension – Harrison County/Diamondhead Resident
Rose	Kathryn	NOAA National Coastal Data Development Center
Schenck-Gardner	Betsy	NOAA National Coastal Data Development Center
Segrest	Natalie	MS Department of Environmental Quality
Stephenson	Christian	MSU Extension – Hancock County
Thomas	Scott	Stetson Engineers/Diamondhead Water and Sewer District Commissioner/Diamondhead Resident
Upton	Doug	MS Department of Environmental Quality
Utroska	Steven	MS Department of Environmental Quality
Viskup	Barbara	MS Department of Environmental Quality
Vowell	Patrick	MS Soil & Water Conservation Commission
Wilkerson	Wayne	MS Water Resources Research Institute (through 2013)
Williams	Darryl	US EPA Region 4

Education and Outreach Subcommittee

Allen	Jeanne	EPA Gulf of Mexico Program
Beiser	Laura	MS Department of Environmental Quality
Chapman	Janet	MS Department of Environmental Quality
D'Aquilla	Beth	Harrison County Soil and Water Conservation District
Dore	Norma	Hancock County Soil and Water Conservation District

Estapa	Tammy	East Hancock Elementary
Foster	Jim	Heritage Trails Partnership
Graham	Larissa	Grand Bay NERR
Inabinet	Margaret	La Terre Bioregional Center/Harrison County Resident
Schadler	Cherie	Bayou Town Productions/Harrison County Resident
Steckler	Judy	Land Trust for the Mississippi Coastal Plain
Veeder	Debra	Mississippi Wildlife Federation
Walrod	Melanie	Pass Christian Library

1.2.2 Assets, concerns and challenges

The assets, concerns and challenges noted below were documented at the December 2013 meeting of the Rotten Bayou Steering Committee.

Assets:

- Habitat/Wildlife
- People/community
- Recreation
- Local support for Nature Tourism
- Water Quality
- Connection to Bay of St. Louis
- Limited Farmland
- Good Stormwater Management
- Supportive Government
- Funding
- Monitoring Plan in Place
- Concurrent Work
- GIS Database of Drainage
- Proactive Golf Course Management

Concerns/Challenges:

- Erosion/Sedimentation
- Pollution
- Stormwater Drainage
- Plan Implementation
- Water Quality
- Plan Content
- Wildlife
- Stakeholder Participation
- Access/Boating
- Development
- Failing Septic Tanks
- Coordination with other Work/Plans

1.2.3 Vision

The community envisions a clean bayou and watershed that exceeds water quality standards, provides habitat for native wildlife and creates meaningful recreational and stewardship opportunities for residents and visitors.

1.2.4 Goals and Objectives

This WIP will address the Total Maximum Daily Load (TMDL) for nutrients, organic enrichment and low dissolved oxygen for listed tributaries to St. Louis Bay including Rotten Bayou as approved by MDEQ in 2007. According to the TMDL, the model showed that no reductions in organic material are needed in Rotten Bayou in order to meet water quality standards. The model did show that reductions in nutrients, specifically total nitrogen (TN) are needed.[6] The TMDL recommends a 9%-19% reduction of the TN loads entering the listed tributaries to meeting a target of 1.5 mg/l.[7] This recommendation, however, is not specific to Rotten Bayou and an assessment of current conditions shows that Rotten Bayou and its tributaries are not currently exceeding TN loads of 1.5 mg/l. See Section 2.4.6 Current Status of Water Bodies. While this WIP does not recommend a specific reduction in TN or total phosphorus (TP), it does recommend taking measures to reduce nutrient loads coming from nonpoint sources in the watershed. The following goals were developed by the Steering Committee for the Rotten Bayou WIP.

1. **Reduce erosion and sedimentation to improve water quality, wildlife habitat and navigability of Rotten Bayou**
    a. Identify and target key sources of erosion
    b. Protect and re-establish riparian buffers where possible
    c. Restore areas of Rotten Bayou and major tributaries that have experienced extreme siltation that is impacting water quality, habitat and navigability

2. **Reduce pollutants entering water system**
    a. Reduce TN and TP levels in Rotten Bayou
    b. Reduce number of nonfunctioning septic systems in the watershed and other sources of harmful bacteria
    c. Reduce litter entering the drainage system and waterways

3. **Reduce stormwater runoff and improve drainage to decrease risk of flooding**
    a. Encourage policies and practices aimed at minimizing the creation of new impervious surfaces
    b. Encourage conservation of critical wetlands and natural water holding areas
    c. Encourage designs and practices that increase on-site infiltration

4. **Improve access to recreational opportunities on and around Rotten Bayou**
    a. Increase the number of access points to Rotten Bayou that are open to the public
    b. Promote opportunities for the public to recreate on or near Rotten Bayou in environmentally sensitive ways
    c. Facilitate designation of Rotten Bayou as a blueway

5. **Increase stewardship and stakeholder participation within the watershed**
    a. Plan for the longevity of the Rotten Bayou Watershed Partnership
    b. Develop and implement plan for continued education and outreach
    c. Create opportunities for citizen participation and stewardship

1.3 Related Plans and Projects

A significant amount of planning and plan implementation has been done that relates to watershed planning in Rotten 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 Summary and Section 3: Management and Monitoring Plan.

Project Title: Gulf of Mexico Bay - Watershed Education and Training Program (B-WET)
Funder: National Oceanic and Atmospheric Administration (NOAA)
Awardee: Mississippi State University's Gulf Coast Community Design Studio
Description: Grant awarded to provide watershed-related education to fifth grade students at East Hancock Elementary School. Project partners include NOAA's Coastal Data Development Center, Land Trust for the Mississippi Coastal Plain, and Mississippi Wildlife Federation's Adopt-a-Stream Program.
Geographic Scope: East Hancock Elementary School, Hancock County. The school is located just outside of the western border of Rotten Bayou Watershed, but the majority of the students live within the watershed boundary.
Deliverables: 4-day, in-class workshop; 2 field trips; exhibitions of student work; online photo documentation and mapping; water quality data for 2 locations in Rotten Bayou Watershed.
End Date: June 2015

Project Title: Implementing LID Strategies in Diamondhead, Mississippi
Funder: Mississippi Department of Environmental Quality
Awardee: Mississippi State University's Water Resources Research Institute
Geographic Scope: City of Diamondhead
Deliverables: Model Stormwater Ordinances & Schematic for Demonstration Project
End Date: December 2014

Project Title: Rotten Bayou Watershed Agricultural Nonpoint Source Pollution Project
Funder: Mississippi Department of Environmental Quality
Project Partners: Hancock & Harrison County Soil and Water Conservation Districts
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: September 2014

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: Building a Plan for the Watersheds of the Upper Bay of St. Louis
Funder: US Environmental Protection Agency, Region IV
Awardee: Land Trust for the Mississippi Coastal Plain; Plan prepared by Eco-Logic Restoration Services, LLC.
Geographic Scope: Upper Bay of St. Louis Watershed
Deliverables: Action plan
End Date: Completed Spring 2007; No timeline included

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

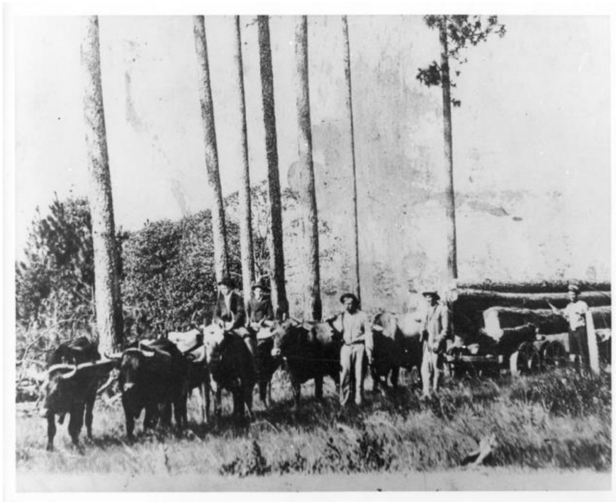
Section 2: Watershed Assessment

2.1 History and Land Use

2.1.2 Historical Context

Record of human activity and settlement in Rotten Bayou watershed dates back to the early 1700's with the Choctaw Indians. While the largest Choctaw town in the area was about one half mile from Caesar (near present-day Picayune), there are reports of smaller settlements in the Diamondhead area. Rotten Bayou, or *Banshawah* meaning "decayed stream" as the Choctaw called it, got its name because of the odor that resulted from the Indians dressing their game on the shores of the Bayou.[8] Over the years, Yellow Fever, war and colonial initiatives such as the Indian Removal Act of 1830 greatly reduced the native population in Hancock County.[9]

Early Spanish, French and English settlers, who called the area West Florida, lived primarily along the Pearl River. The early pioneers lived off the land as hunters and trappers with a few supplemental subsistence crops. A few raised cash crops such as tobacco, indigo, rice or cotton.[10] Later, logging became a source of income. There was an abundance of timber along the banks of the rivers and creeks in the area that was hand-hewn and shipped along the Pearl River to New Orleans where residents used wood for building, heating and cooking. Lumber cut in Hancock County was also shipped as far away as Central and South America. Following a hurricane in the late 1700's that leveled a good deal of trees in the area, residents began processing pine-tar. Both the pine-tar and byproduct, charcoal, were exported to New Orleans and other areas. Much of this activity, however, was occurring along the Pearl River in the Pearlington-Logtown area and not in the Rotten Bayou Watershed.[11] By the 1840's a small number of logs were being transported down the Jourdan and Wolf Rivers, but little commercial activity was reported along Rotten Bayou.[12] The first mill in the watershed appears to have been established sometime in the mid to late 1800's at the junction of Rotten Bayou and Bayou LaTerre in the old community of Fenton by a young Frenchman named Adolphe Kergosien.[13] According to Nollie W. Hickman in Mississippi Harvest (as cited in Ellis, 2000), by 1840, 10 sawmills were operating in Hancock County and western Harrison County in what was known as the Three Rivers Mission area encompassing the Wolf River to the East, the Jourdan River in the middle and the Pearl River to the West.[14]



The heavy lumbering business in the area took its toll on the waterways. J.E. Farve described the change:

> The town of Kiln got its name from the tar and charcoal kilns. I remember when charcoal was sent by schooner down Bayou LaTerre, and the bayou was 60 feet deep – but now, we can wade across it at times, because the erosion from the loss of trees caused sand to wash in and fill up the bottoms.[15]

The effects of erosion and sedimentation can still be seen in the bayous and waterways, especially in places like Devil's Elbow of Rotten Bayou, though now as a result of increased development as opposed to lumbering.

By the early 1900's, oil of turpentine was being produced in Hancock County. R. R. Perkins, president of Imperial Naval Stores Company, operated a branch in the community of Fenton just north of Diamondhead. The oil was hauled in barrels by wagon to Gulfport and loaded onto barges for delivery to its final destinations.

FENTON, MISS.

FENTON, MISS.—The Fenton Turpentine Company, which is a branch of the Imperial Naval Stores Company, have a well equipped turpentine still at Fenton; Cuevas Mill and Store at Fenton is also another enterprise that is well

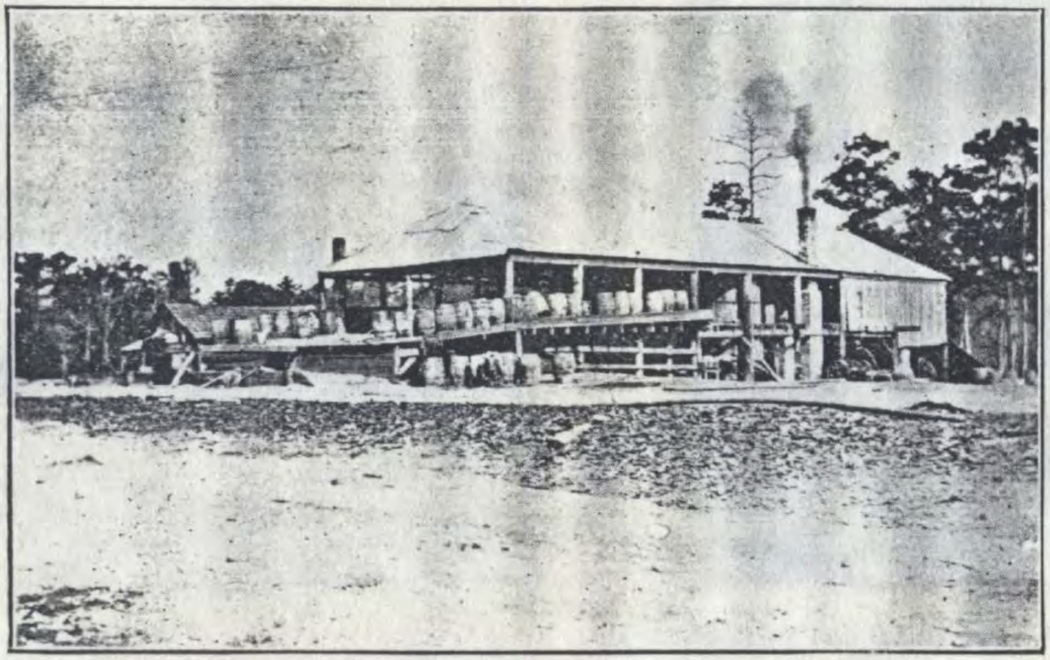
View at Fenton, Miss., Showing the Fenton Turpentine Still.

known in the County. F. Mauffray, also operates a large general store at Fenton.

The *Great Depression* saw the decline of the lumber industries in the area and the *Prohibition* spurred an easy transition to distilling alcohol. Father Henry McInerny stated:

> With the proliferation of kilns for distilling turpentine and for curing lumber, it probably seemed fairly logical to experiment with distilling alcohol. In the days of prohibition, it made this option all the more lucrative. However, it seems that it was not until after the depression and the loss of the lumber and sawmill business here that, for many people, it was probably done out of necessity as much as anything. It has been told to me, by one who knows, that at the height of its popularity, there were probably up to 50 stills operating in these parts.[16]

Whiskey making was a big business in the area and saw large growth spurts after the Mississippi Prohibition Act was passed in 1908 and again after the National Prohibition Act was passed in 1918. Kiln liquor had a reputation for its quality and high alcohol content as far north as Milwaukee and there were tales of giant stills hidden under piles of sawdust from the area's lumbering days.[17]



The Fenton Still's output is 2,500 Barrels of Spirits and 10,000 Barrels of Rosin.

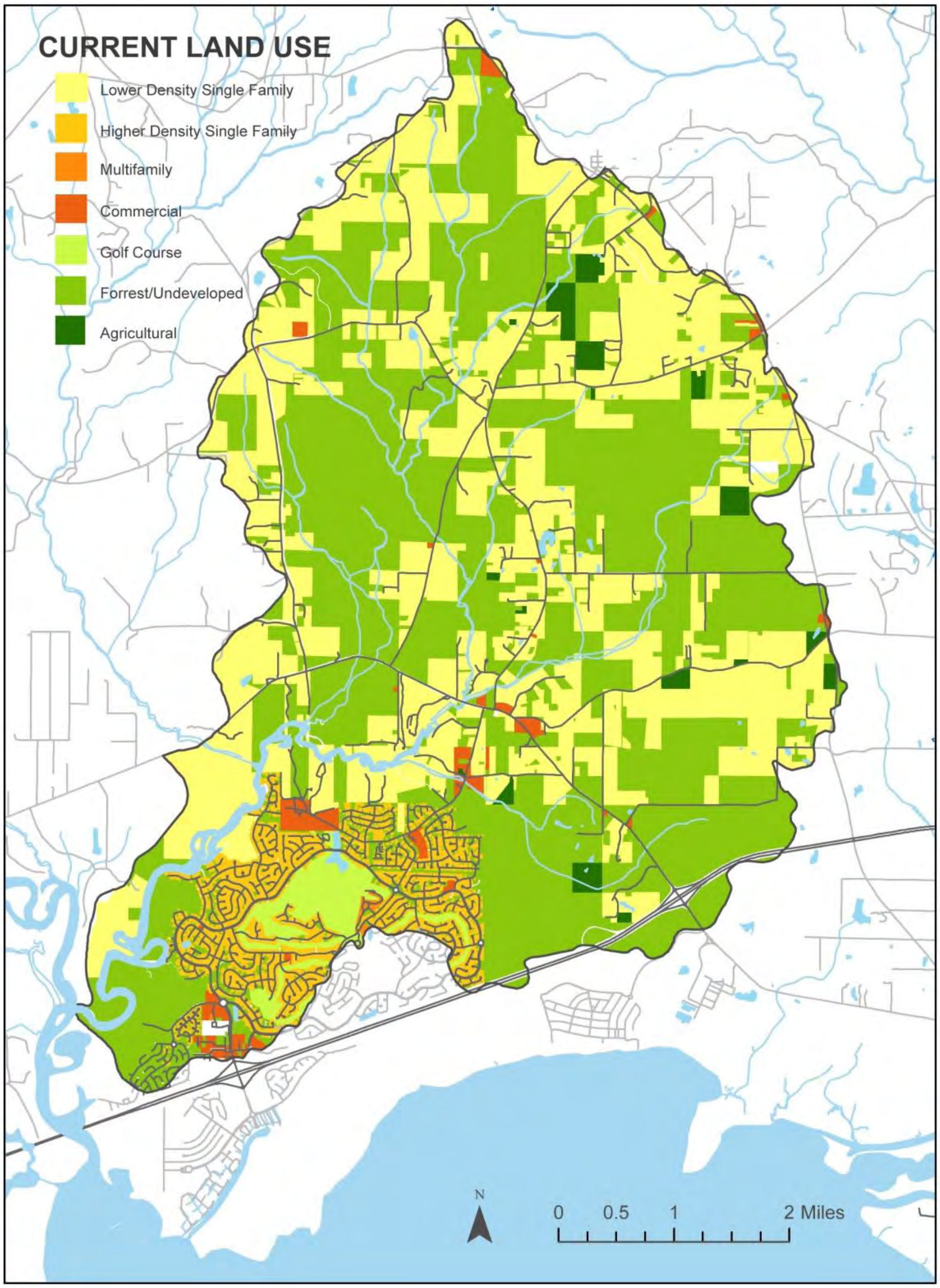
The Catholic church had a large presence in the Three Rivers Mission area and by the 1840's there were three reported Catholic churches in the watershed. One was called St. Joseph and was located on Rotten Bayou and another was located on Kiln-Delisle Road between Kapalama Road and Fenton Road. A third church called St. Joseph Chapel was located on Fenton Road that remained until the 1980's.[18] St. Joseph's Cemetery, also known as Rotten Bayou Cementary, is located just north of Diamondhead. The cemetery was said to be a burial place long before there were any marked graves. Early funeral processions came by boat through Jourdan River and Rotten Bayou before there were any roads in the area. The Moran (Morin) family owned the land in the early 1800's before Francois Cuevas (descendent of Juan Cuevas of Cat Island) married Felicity Moran.[19] The Cuevas' later donated the 40-acre cemetery to Hancock County in 1893.[20]

By the mid-1960's, Federal interstate highways were being constructed in stretches across the coast. Plans for Diamondhead, what was to be the largest residential/resort community in the south were announced in 1969. The project was named Diamondhead because it was on the highest ground on the Mississippi Gulf Coast and was to feature Hawaiian-style architecture and landscaping. The 6,500-acre property, formerly owned by the Gex family, was located north of St. Louis Bay with two miles of shoreline on the Bay and another nine miles on Rotten Bayou. The master plan, when fully completed, was expected to exceed $100,000,000 and include a shopping center, schools, churches and other amenities including a 36-hole golf course.[21] As of the 2010 census, there were 8,425 people living in Diamondhead and on February 6, 2012, Diamondhead became Mississippi's 111th city.

2.1.3 Current and Future Land Use

The watershed is primarily undeveloped (51.8%) and lower density, single family residential (43%). The remainder of the watershed is golf course (2.1%), agricultural (1.6%), commercial (1.4%) and multi-family residential (0.1%).[22] See Figure 2. Only about 0.1% of land in Rotten Bayou Watershed is publically owned.

Figure 2: Current Land Use



Source: Land use data from Gulf Regional Planning Commission. Map by Gulf Coast Community Design Studio

In terms of opportunity for future development, there are currently 2,017 parcels considered "vacant and undeveloped," though due to wetland and flood plain constraints not all of these parcels are likely to be suitable for development. There are some plans for additional commercial development in the City of Diamondhead and opportunities for more residential development, particularly single family, throughout the watershed that will likely impact stormwater runoff in the future. The increase in commercial land use could be about 4% in the watershed according to the jurisdictions' comprehensive plans.[23] Within Diamondhead there is approximately one square mile of remaining developable land.[24] The planned increase in residential development is harder to determine because Harrison County does not distinguish between agriculture and rural single family residential in the future plan use component of their comprehensive plan.

2.2 Human Resources

2.2.1 Demographics

As of the 2010 Census, there were 25,619 people living in the watershed, of which 8,425 live in the city limits of Diamondhead. Of the total population, 90.3% are White, 4.5% are Black/African American, 2.5% are Hispanic/Latino(a), and 0.7% are Asian. According to the American Community Survey's 2011-5 year estimates, 15.5% of the population is living below the poverty limit. This is fairly consistent with the national poverty rate (15.1%) 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.[25][26][27]

There are a total of 11,537 housing units within Rotten Bayou Watershed. Of the built housing units, 85.3% are occupied and 14.7% are vacant. This is a relatively high vacancy rate compared to the national vacancy rate (7.9%), but consistent with the vacancy rate for the three coastal counties (14.3%) and indicates that the population has still not recovered since Hurricane Katrina. The majority of the housing in the watershed is owner occupied (85.7%) which may be a positive factor in improving environmental stewardship in the watershed.[28]

2.2.2 Municipal

Rotten Bayou Watershed is a multi-jurisdictional watershed. The watershed is almost perfectly divided in half between Hancock County to the west and Harrison County to the east. Mississippi's newest city, Diamondhead, makes up the southwestern quadrant of the watershed. Further complicating bureaucracy in the watershed is the existence of the Diamondhead Country Club and Property Owners Association (DPOA) that maintains a level of control over platted residential property in Diamondhead. The DPOA is further discussed in Section 2.2.3.

Multiple water and sewer districts have jurisdiction in the area including Diamondhead Water and Sewer District, Hancock County Water and Sewer District, and the Harrison County Utility Authority. The complex and multi-jurisdictional nature of Rotten Bayou watershed presents a challenge for, but also a greater justification for planning and collaboration in the watershed around issues of water quality.

2.2.3 Civic Infrastructure

There are several civic organizations that are active in Rotten Bayou Watershed and important to current and future watershed protection strategies. These include, but are not limited to the Diamondhead Property Owners Association, Keep Diamondhead Beautiful, Diamondhead Garden Club, Rotary Club of Central Hancock County, Hancock and Harrison County Master Gardeners, Land Trust for the Mississippi Coastal Plain and the Mississippi State University Extension Service. Brief descriptions of each organization are included below.

Diamondhead Country Club and Property Owners Association

The Diamondhead Property Owners Association (DPOA) is a non-profit corporation tasked with managing and developing civic and recreational assets in the community of Diamondhead. The mission of the organization is to "protect and preserve the assets and amenities of the Diamondhead POA, to seek and implement programs for improvements that will enhance quality of life, and to provide sound competent governance and financial and operational management for all POA functions." The POA is committed to serving all members and residents of the larger community. Currently, the POA owns and operates a country club with two restaurants and banquet services; two golf courses; three pools; tennis facilities; several parks and walking trails; a marina; and an airport. All amenities are open to and regularly used by the public at large though some require membership dues.

In addition to the main property owners association, the Devil's Elbow community within Diamondhead has a separate POA. Devil's Elbow is a creole-designed, private community nestled along Rotten Bayou. Residents of Devil's Elbow are strong advocates for preserving the natural habitat of Rotten Bayou and regularly enjoy boating, kayaking, fishing, and bird-watching.

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.

Keep Diamondhead Beautiful

Keep Diamondhead Beautiful was established in December 2013 by resolution of the City of Diamondhead. The Keep Diamondhead Beautiful Committee focuses on beautifying the City of Diamondhead, involving the community in the beautification efforts, continuing to support the sense of pride that already exists in the City of Diamondhead by encouraging the citizens and the administration to provide a clean and litter free environment, by helping to develop landscaping and maintenance plans and projects for the safety and beauty of the City of Diamondhead.

Diamondhead Garden Club

The Diamondhead Garden Club has been an active community partner since 1972. Members have worked to landscape many areas of the community and hold monthly meetings featuring speakers that cover topics ranging from birds and plants to conservation and best practices. The Garden Club sponsors an annual flower show that also features educational exhibits. These Educational Exhibits always focus on information that educates the public about the environmental and beautification goals of the National Garden Clubs, Inc.

Mississippi State University Extension Service

The Mississippi State University Extension Service 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. Master Gardener programs are active in both Hancock and Harrison Counties.

Rotary Club of Central Hancock County

Rotary is an organization of business and professional persons united worldwide who provide humanitarian service, encourage high ethical standards in all vocations, and help build goodwill and peace in the world. The Rotary Club of Central Hancock County has several key focus areas including clean water and participates with other civic organizations in the Mississippi Coastal Cleanup, watershed cleanup activities and community gardening.

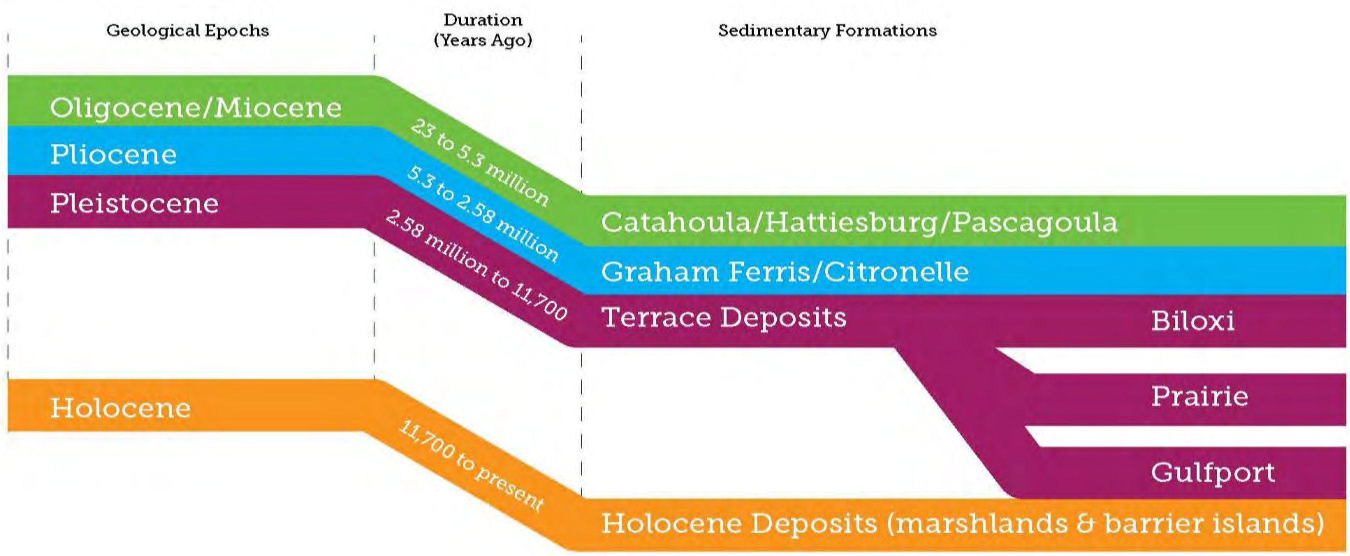
2.3 Physical Setting

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 Rotten Bayou Watershed, and most of the Mississippi Gulf Coast, is characterized by sedimentary formations of estuarine and deltaic origin ranging from the late Oligocene to the Holocene epochs.[29] See Figure 3. According to MDEQ's Office of Geology, there is still a lot of uncertainty around the geology in Gulf region extending from east Texas to the Florida line and the last published study was in 1944.[30]

Figure 3: Chronology of the Formation of the Coastal Geology

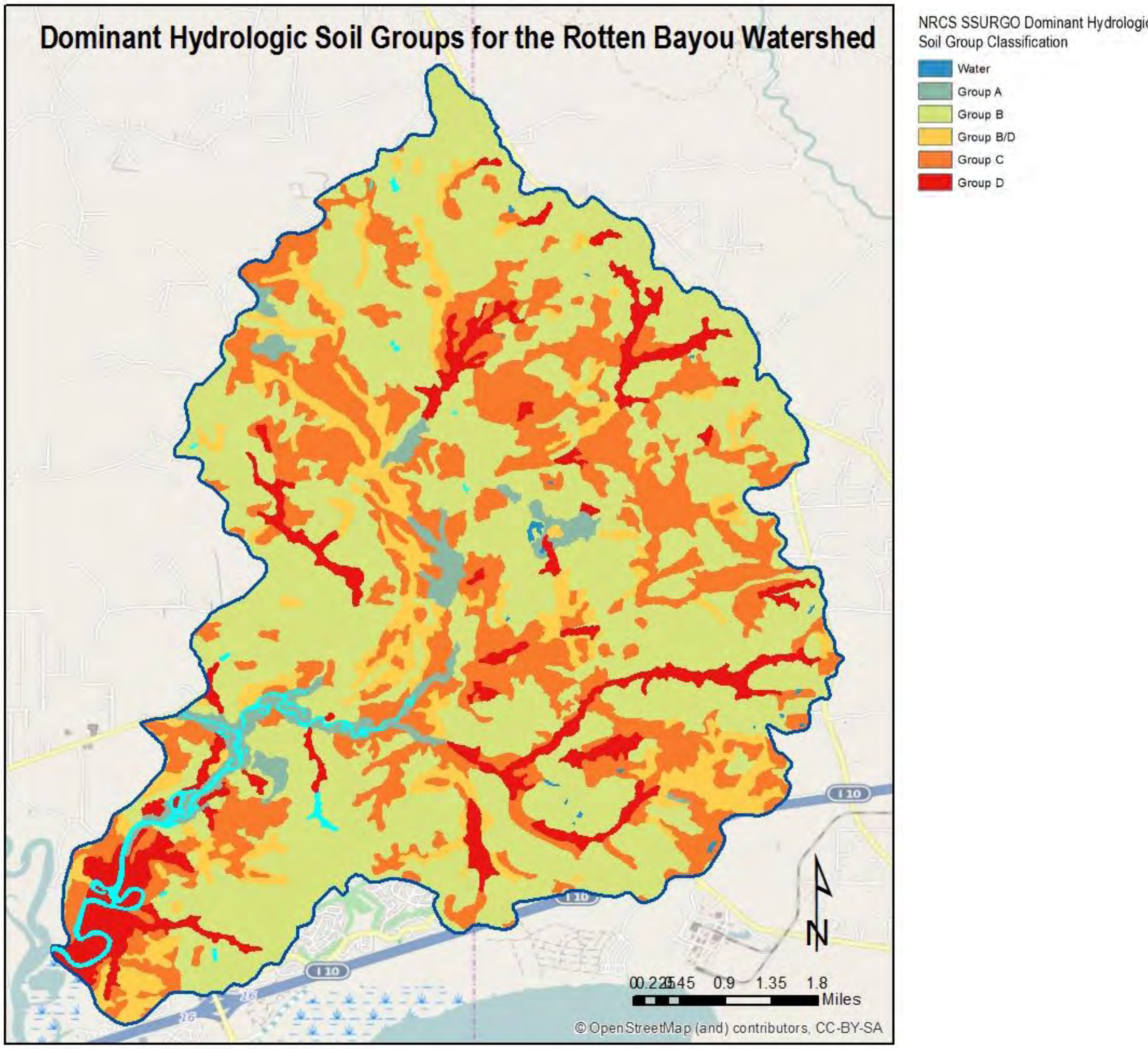


Source: Ohio State University. (2012). Mississippi Gulf Coast Water Assessment.

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 silt and sandy loam soils. Predominate soils are Poarch, Atmore, and Harleston in the uplands and Bigbee-Bibb in the bottomlands.[31]

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.[32] 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 Rotten Bayou Watershed. In Rotten Bayou watershed, 56% of the land falls into categories A and B, meaning the soils in these areas have higher infiltration rates. Thirty-three percent falls into categories C and D and have soils that have much slower infiltration rates. See Figure 4.

Figure 4: 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 11/25/2014]. Map by NOAA's National Coastal Data Development Center.

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 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 Rotten Bayou Watershed. Several of the areas identified as having poor drainage do appear to coincide with some of the nonfunctioning septic systems identified, especially in Harrison County.

2.3.2 Ecoregion

Ecoregions are generally defined as an area with a relative 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.[33] Ecoregions are intended to provide a geographic area for ecosystem assessment, monitoring and management.[34] 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.[35]

Rotten Bayou Watershed extends into two ecoregions. The northern portion 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.[36]

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.[37]

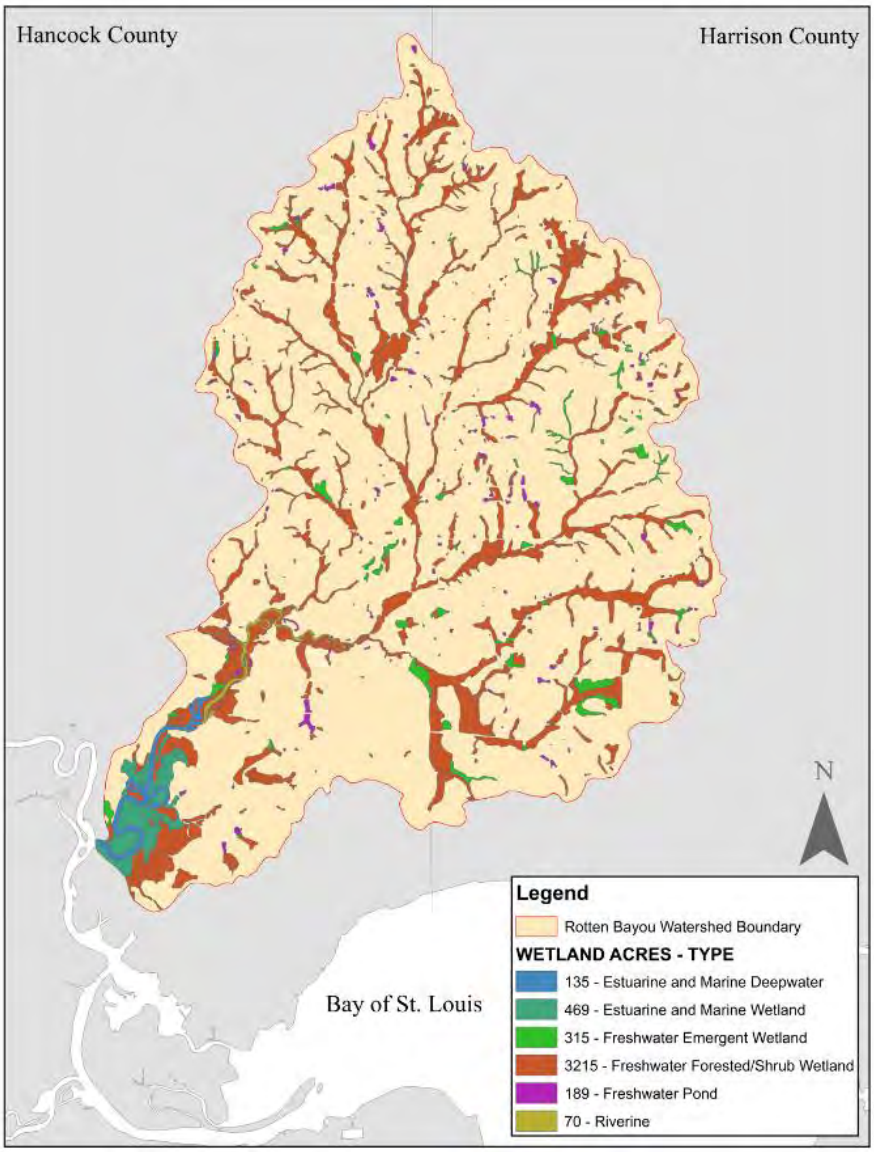
The Southern Coastal Plain consists of mostly flat plains, but also includes barrier islands, coastal lagoons, marshes, and swampy lowlands along the Gulf and Atlantic coasts. Forests historically consisted of longleaf pine, slash pine, pond pine, beech, sweetgum, southern magnolia, white oak, and laurel 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.[38]

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.[39] 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.[40]

Rotten 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, about 20% of the land area in the watershed is classified as "wetlands" as defined by the Mississippi Department of Marine Resources (MDMR). See Figure 5.

Figure 5: Wetlands in Rotten Bayou Watershed



Source: Map and analysis by the Mississippi Department of Marine Resources Coastal Preserves Program (2014).

Wetlands in Rotten Bayou watershed are under the jurisdiction of MDMR's Coastal Program according to Section 57-15-6 of the Mississippi Code of 1972. Rotten 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.[41]

Applications for wetlands activities in the Mississippi Coastal Zone are submitted through MDMR, but also reviewed by the U.S. Army Corps of Engineers (USACE) under the Memorandum of Agreement with the Mobile and Vicksburg Districts of the USACE.[42]

2.3.4 Climate and Climate Change

Rotten 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.[43]

Normal mean annual temperatures are 68F along the coast. Low temperatures have dropped to 16F below zero while high temperatures exceed 90F over 100 days each year. Temperatures routinely exceed 100F 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.[44]

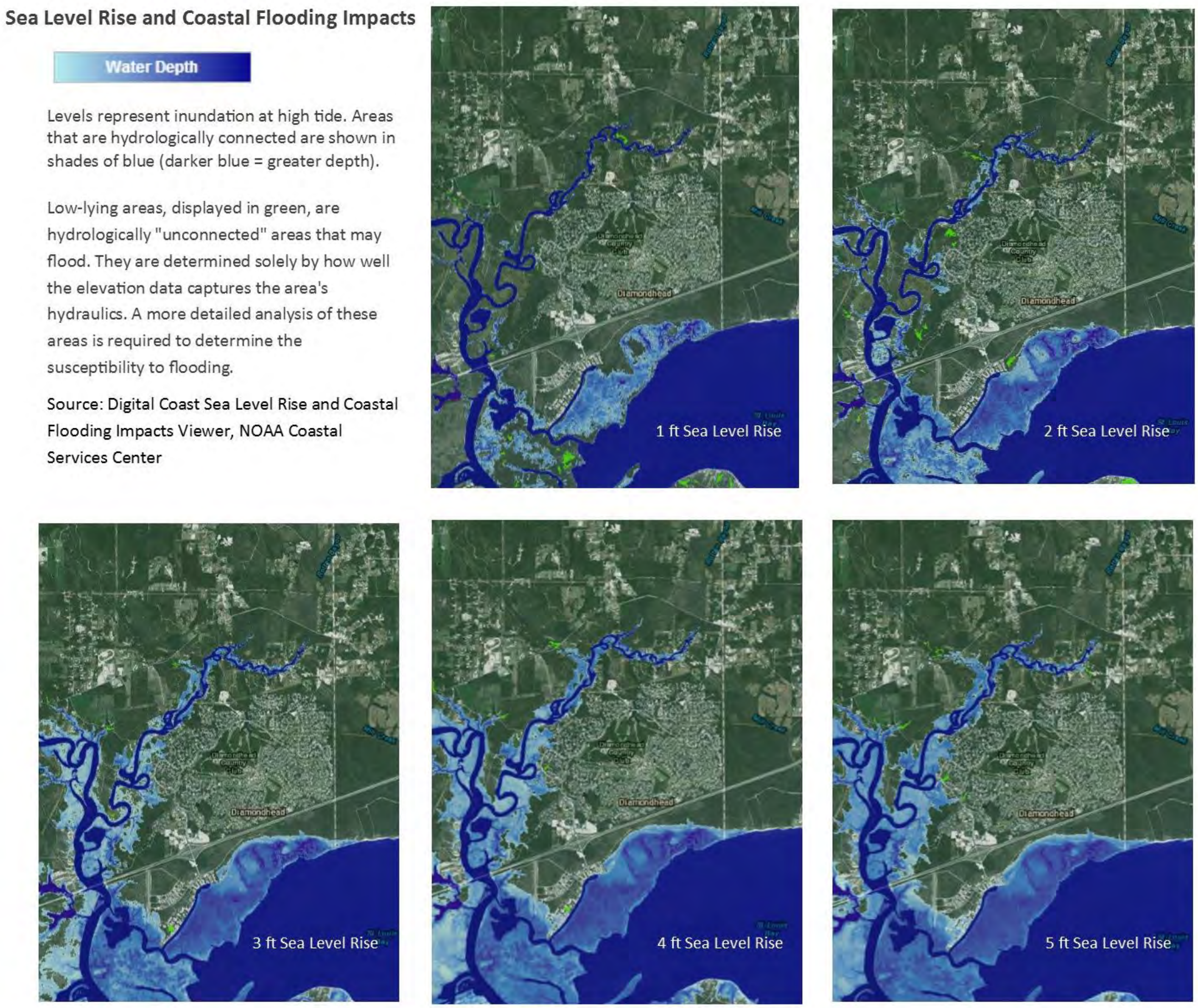
Climate change is likely to affect several processes that will impact watershed dynamics in coastal Mississippi and Rotten Bayou watershed including sea level rise and frequency and duration of rainfall events. There are various estimates of sea level rise resulting from climate change, but even according 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.[45] 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.[46]

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 Rotten Bayou Watershed (See Figure 6) to existing wetland habitat shown in Figure 5 it is apparent that a substantial amount of wetland habitat in the watershed could be compromised by sea level rise. This is important in terms of planning to protect inland wetlands and allowing for buffers around waterways wherever possible.

Figure 6: Sea Level Rise and Coastal Flooding Impacts on Rotten Bayou Watershed



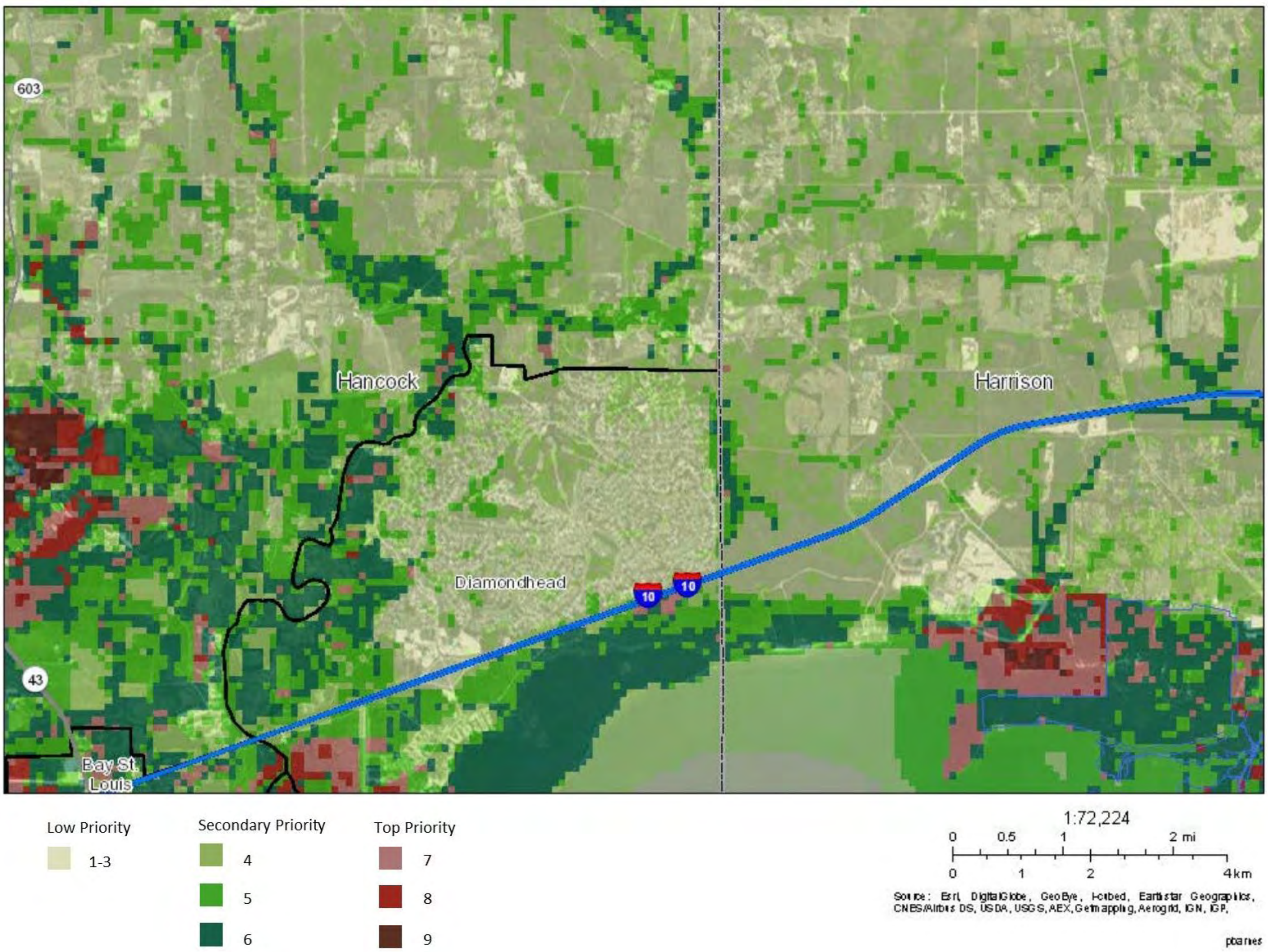
In addition to sea level rise, moisture deficits and drought are likely to increase across the Mississippi Gulf Coast.[47] This could have an effect on vegetation important for soil stabilization and habitat, as well as ground water recharge. Alternately, heavy rainfall events have been and are likely 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.[48]

Areas that are in Rotten Bayou watershed and currently undeveloped were identified as being relatively high priority (6/7/8) areas in terms of conservation and should be considered in planning and management strategies for Rotten Bayou Watershed. See Figure 7.

Figure 7: Conservation Priority Areas in Rotten 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 2014.

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.[49]

There are four public wells located within Rotten Bayou Watershed (See Table 2). It is unclear how much of the population is supplied by private well, although it is estimated that 38% of the Gulf region's population is serviced by private wells.[50] The earliest record of a water well within the watershed is for a domestic well drilled in 1925. Through the 1980's the number of wells drilled remained steady, but have since declined.[51]

Table 2: Public Wells in Rotten Bayou Watershed

PERMIT #	OWNER_NAME	AQUIFER	DATE DRILLED
MS-GW-12542	DIAMONDHEAD WATER AND SEWER DISTRICT	UPPER PASCAGOULA	9/1/1971
MS-GW-14652	DIAMONDHEAD WATER AND SEWER DISTRICT	LOWER GRAHAM FERRY	10/1/1993
MS-GW-16560	DIAMONDHEAD WATER AND SEWER DISTRICT	LOWER PASCAGOULA	1/26/2009
MS-GW-16561	DIAMONDHEAD WATER AND SEWER DISTRICT	LOWER PASCAGOULA	4/14/2009

Source: Mississippi Department of Environmental Quality, Office of Land and Water Resources. 2014

The wells in Rotten 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.[52] 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.[53]

The Graham Ferry and Pascagoula aquifers are almost entirely fresh water, but potentially have more contact with surface waters from the Gulf of Mexico or estuarine waters in coastal areas. The danger of saltwater intrusion into coastal aquifers is an important concern in the watershed. 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.[54] The deeper sands of the aquifer system are recharged at their outcrop, significantly north of Rotten Bayou Watershed. The shallower areas of the system, however, can by impacted directly by actions or development within the watershed.[55]

2.4.2 Water Conservation

The main factor affecting groundwater quantity in the area is the amount of water being pumped from the aquifers. MDEQ's Office of Land and Water Resources considers the population sparse and the groundwater abundant in Rotten Bayou Watershed. They also acknowledge the existence of many smaller aquifers that could be available for use, but have never been produced due to lack of demand.[56] The Gulf Region Water and Wastewater Plan, however, notes that Hancock and Harrison counties all project "steady increases in water demands that cannot be met by current water supply, treatment, and distribution infrastructure." The improved infrastructure is being planned and implemented based on the projected 2025 demand.[57]

At the present time no effluent water is being utilized for irrigation purposes. There are, however, several opportunities to use effluent for irrigation especially in Diamondhead including on the existing golf courses and new ball fields being constructed by the Diamondhead Property Owners Association off Noma Drive.[58]

2.4.3 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.[59] Rotten Bayou, however, has no designated public access sites where people can go to recreate on or near the bayou. Hancock County, in general has significantly fewer water-related access sites as compared to the other coastal counties in Mississippi (See Table 3). Lack of access to Rotten Bayou and its tributaries, is a likely contributor to an existing disconnect between residents of and visitors to Rotten Bayou Watershed and the health of the local waterways.

Table 3: Public Water Access Sites and Amenities of Mississippi Coastal Counties

Type of Amenity	# of Sites with Amenity in Hancock County	# of Sites with Amenity in Harrison County	# of Sites with Amenity in Jackson County	# of Sites with Amenity in Coastal Counties
Boat Launch/Ramp	15	22	44	81
Marina/Harbor	11	18	17	46
Boat Slips	3	11	10	24
Fishing Pier	16	34	36	86
Fishing	7	11	14	32
Shoreline/Beach Access	4	8	9	21
Swimming In Open Water	1	5	4	10
Canoeing/Kayaking	0	0	1	1
Total Access Points	35	78	80	191

Source: Ohio State University. (2012). Mississippi Gulf Coast Water Assessment. Water Assessment. Pg 41.

Currently the only way the public can access Rotten Bayou is via the boat launch at Diamondhead Marina and by traveling a considerable distance up the Jourdan River into Rotten Bayou. While there is fairly limited opportunity to offer public access sites along Rotten Bayou as it is primarily bordered by private, residential land, there are, however, several options that are being explored through this planning process. Increasing the number of water access points along Rotten Bayou and in Hancock County, in general, would be beneficial along several lines. First, when coupled with educational signage, these access sites could 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.

2.4.4 Wildlife and Fisheries

The Watersheds support a broad diversity of wildlife. Mississippi National Heritage Inventory keeps a database of critical species known as species of "special concern". Several of the species identified as being of “special concern” and possibly in Hancock and/or Harrison Counties are listed as threatened (See Appendix B: Mississippi National Heritage Inventory). After reviewing the list, the U.S. Fish and Wildlife Service office in Hancock County advised that the Gulf Sturgeon, listed “threatened” nationally and “endangered” statewide, is not present in Rotten Bayou. They added that there is a possibility that Gopher Tortoise, listed “threatened” nationally and “endangered” statewide, is present in the upland areas of the watershed and that the Pearl Darter, listed as a “candidate” nationally and “endangered” statewide, is present in Rotten Bayou, although there have not been any reported sightings.[60]

2.4.5 Designated Use Classifications and Water Quality Standards

Rotten Bayou’s beneficial use is designated as “Fish and Wildlife” and is intended for fishing and for maintaining waterways for the support of fish, aquatic life, and wildlife.[61] Waters that meet the Fish and Wildlife Criteria are also considered suitable for secondary contact recreation defined as “incidental contact with the water during activities such as wading, fishing, and boating, that are not likely to result in full body immersion”.[62]

Applicable water quality standards included DO concentrations maintained at a daily average of not less than 5.0 milligrams per liter (mg/l) with an instantaneous minimum of not less than 4.0 mg/l.[63] Water quality standard for nutrients for tributaries of the St. Louis Bay are further defined as follows:

> Waters shall be free from materials attributable to municipal, industrial, agricultural or other discharges producing color, odor, taste, total suspended or dissolved solids, sediment, turbidity, or other conditions in such degree as to create a nuisance, render the waters injurious to public health, recreation or to aquatic life and wildlife or adversely affect the palatability of fish, aesthetic quality, or impair the water for any designated use.[64]

In addition to the thresholds adopted by MDEQ and directly applicable to the Rotten Bayou Watershed Implementation Plan, there are several other proposed thresholds that are considered in this planning work (See Table 4). The State of Mississippi, for example, has developed draft numeric nutrient thresholds for non-tidal streams and rivers to protect aquatic life uses in Mississippi. The recommended thresholds for TN in southeast Mississippi rivers and streams ranges from 0.31 to 0.68 mg/l, depending on the approach. The proposed threshold for TP ranges from 0.01 to 0.05 mg/l, depending on the approach.[65]

In addition, the Gulf of Mexico Alliance (GOMA), under the direction of MDEQ, completed a study of sources and effects of nutrients as a basis for protection of estuarine and near-coastal waters for St. Louis Bay.[66] Based on empirical and mechanistic modeling results, the preliminary annual geometric mean threshold recommendations are 0.6 to 0.8 mg/l for TN and 0.06 to 0.08 mg/l for TP.

Table 4: Various Targets and Thresholds for Tributaries to St. Louis Bay and for St. Louis Bay

Various Targets and Thresholds for Tributaries to St. Louis Bay and for St. Louis Bay

	TMDL Targets and Thresholds for Tributaries to St. Louis Bay (MDEQ 2007)		Draft Revised Stream Nutrient Thresholds for Southeast Mississippi Rivers and Streams (MDEQ 2011)	Threshold Recommendations for St. Louis Bay Based on Modeling Results (GOMA 2013)
Parameter	Target* (lbs/day)	Threshold (mg/l)	Threshold (mg/l)	Threshold (mg/l)
Total Nitrogen	5,810	1.5	0.31 – 0.68	0.6 – 0.8
Total Phosphorus	387	0.1	0.01 – 0.05	0.06 – 0.08

Notes:
*Includes Jourdan River loads
lbs/day = pounds per day
mg/l = milligrams per liter
TMDL = total maximum daily load

Source: Anchor QEA, LLC. Prepared for Land Trust of the Mississippi Coastal Plain. (2014). Rotten Bayou Water Quality Assessment. Pg. 3.

It is important to note that monitoring and water quality standards for “Fish and Wildlife” are not intended to support contact recreation such as swimming and water skiing. While there are currently no public access sites on Rotten Bayou, there are private land owners that have docks directly on Rotten Bayou and report regularly engaging in what would be considered contact recreation in the waterway. While the number of residential lots on Rotten Bayou appears to be relatively few, anecdotal evidence purports that more people might actually be swimming in the bayou than suggested by the number of lots. In a survey of participants in the *Watershed Harmony* program through the Hancock County Library System’s Summer Reading Program, 10 out of 30 respondents reported that their family currently swims in Rotten Bayou and 19 said they would like to swim in Rotten Bayou if given the opportunity. Based on existing interest and concerns of residents around water quality suitability in Rotten Bayou for recreational activities such as swimming, MDEQ has been monitoring pathogens at two locations in Rotten Bayou as part of the Rotten Bayou watershed planning effort. Results are further discussed in Section 2.4.6.

2.4.6 Current Status of Water Bodies

Nutrients

USGS has been monitoring data the following four gauges within Rotten Bayou watershed since 2012. The first stage of monitoring was completed in 2014. Monitoring has since been suspended to allow for BMP installation. Once the grant-funded BMPs are installed, MDEQ and USGS will re-instate monitoring activities in an effort to show water quality improvements. See Figure 8.

- 02481661 – Tributary to Bayou LaSalle near Vidalia, Mississippi
- 02481663 – Rotten Bayou near Fenton, Mississippi
- 0248166310 – Mill Creek at Fenton, Mississippi
- 0248166590 – Rotten Bayou Tributary No. 1 at Diamondhead, Mississippi

Figure 8: Location of USGS Gauges in Rotten Bayou Watershed

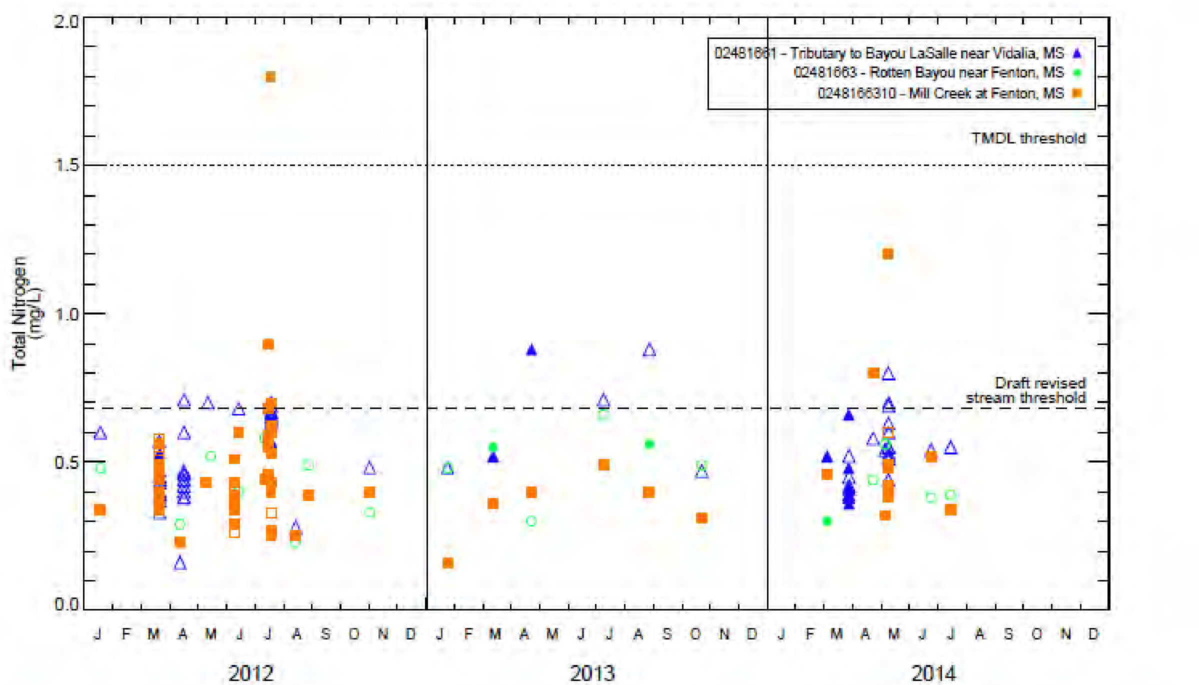
Source: Anchor QEA, LLC. Prepared for Land Trust of the Mississippi Coastal Plain. (2014). Rotten Bayou Water Quality Assessment. Figure 1.

Analysis of the data, however, is not projected to be completed until 2016. The Rotten Bayou Watershed Implantation Plan to address the TMDL in Rotten Bayou is being funded through September 2015. As a result of this mismatch in project timing, Land Trust for the Mississippi Coastal Plain procured the services of Anchor QEA to assess the draft and provisional data from USGS for use in the Watershed Implementation Plan.

As part of their assessment, Anchor QEA downloaded flow and TN/TP concentration data from the USGS website on September and October 2014 and compared the concentrations to all three thresholds discussed in Section 2.4.5. It is important to note that three of the gauges are freshwater (i.e. non-tidal), while the gauge in Diamondhead is tidally influenced. Because of this, it is impossible to discern the influence of Rotten Bayou Watershed from St. Louis Bay on nutrient concentrations detected at this gauge.[67]

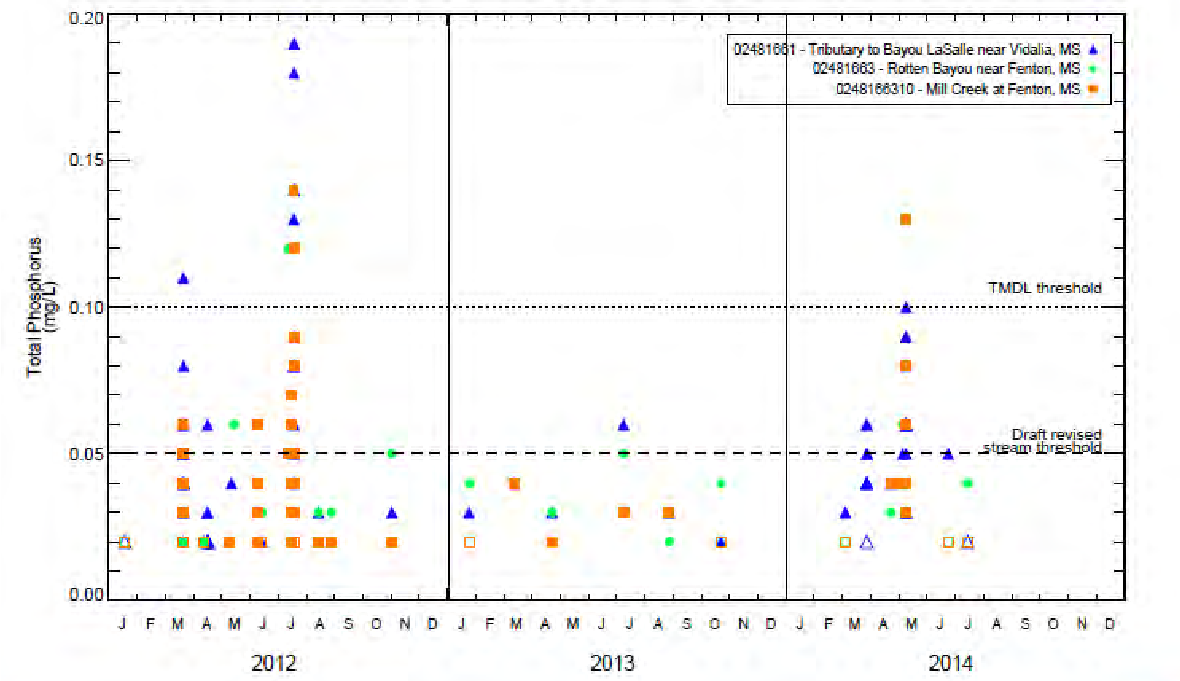
Few TN and TP measurements from 2012 to 2014 exceeded the nutrient TMDL thresholds at the freshwater gauges (Figures 9 and 10). For TN, none of the measurements exceeded the nutrient TMDL threshold with the exception of one measurement on July 18, 2012, at 4:15 pm at 0248166310 Mill Creek at Fenton. For TP, 8% and 4% of samples at 02481661 Tributary to Bayou LaSalle near Vidalia and at 0248166310 Mill Creek at Fenton, respectively, exceeded the TMDL threshold; these exceedances appear to have been during storm events. Only one sample taken at 02481663 Rotten Bayou near Fenton exceeded the TP TMDL threshold; this sample was collected on July 12, 2012.[68]

Figure 9: Temporal of Total Nitrogen Concentration at Three Freshwater Gauges near Rotten Bayou



Source: Anchor QEA, LLC. Prepared for Land Trust of the Mississippi Coastal Plain. (2014). Rotten Bayou Water Quality Assessment. Figure 2.

Figure 10: Temporal of Total Phosphorus Concentration at Three Freshwater Gauges near Rotten Bayou



Source: Anchor QEA, LLC. Prepared for Land Trust of the Mississippi Coastal Plain. (2014). Rotten Bayou Water Quality Assessment. Figure 3.

Some TN and TP concentrations from the freshwater gauges were higher than the draft revised stream nutrient thresholds for southeast Mississippi. Thirteen percent and 7% of the samples exceeded the TN threshold at 02481661 Tributary to Bayou LaSalle near Vidalia and at 0248166310 Mill Creek at Fenton, respectively. These samples, however, appear to have been taken during storm events as multiple samples were taken on a single day. No TN measurement at 02481663 Rotten Bayou near Fenton exceeded the threshold. A similar pattern of exceedances is observed for TP data.[69]

The St. Louis Bay thresholds were developed based on tidally influenced monitoring data in St. Louis Bay. Table 5 summarizes annual geometric means of TN and TP for the tidal gauge near Rotten Bayou from 2012 to 2014. At this gauge, the annual geometric means exceeded the St. Louis Bay thresholds for both TN and TP in 2013 and 2014.[70]

Table 5: Annual Geometric Means at the Tidal Gauge at Diamondhead

Nutrient	Annual Geometric Mean (mg/l)		
	2012	2013	2014
Total Nitrogen	0.68	1.15	1.02
Total Phosphorus	0.060	0.106	0.090

Notes:
- Recommended thresholds for St. Louis Bay based on modeling (GOMA 2013): Total Nitrogen 0.6 to 0.8 mg/l, Total Phosphorus [illegible] to 0.08 mg/l
- The tidal g[illegible] 0248166590 – Rotten Bayou Tributary No. 1 at Diamondhead.
- Non-detect values were set to the detection limit prior to calculation.

mg/l = milligrams per liter

Source: Anchor QEA, LLC. (2014). Rotten Bayou Water Quality Assessment.

Based on analysis of the best available data, it was concluded that the TN and TP concentrations measured at the three freshwater gauges in Rotten Bayou Watershed are generally below or near the various Mississippi nutrient threshold concentrations with the exception of data collected during a few storm events in 2012 and 2014. The TN and TP concentrations from the tidal gauge in Diamondhead exceeded the thresholds in two of the three monitoring years.[71] Limitations of the data analyzed for the Rotten Bayou Watershed Implementation Plan are discussed in the full report. See Appendix C: Rotten Bayou Water Quality Assessment. Based on these preliminary findings the report recommended focusing BMPs for controlling runoff and stormwater in the drainage areas upland of the Diamondhead and Mill Creek gauges.[72]

Pathogens

At the request of the Rotten Bayou Watershed Partnership's Steering Committee and learning that Rotten Bayou is being used for primary contact recreation including swimming and jet skiing, MDEQ began testing for pathogens including Fecal Coliform and E. Coli in the fall of 2014. Two locations were chosen for testing. The first location was the bridge at Rotten Bayou and Kiln-Delisle Road, just north of the confluence with Mill Creek. This site was chosen to give some indication of the impacts of nonfunctioning septic system concentrations in western Harrison County (See Figure 11). This section of Rotten Bayou is non-tidal. The second location was a private pier about three miles up Rotten Bayou. This section of the bayou is tidal, but is one of the main areas where residents are swimming.

The first set of testing was done between September 22 and October 8, 2014. This was during the "non-contact" recreational season when people are less likely to be coming in direct contact with the water. The second set of testing was done between March 18 and April 7, 2015; the "contact" recreational season when people are more likely to be in direct contact with the water. As described in Section 2.4.5, Rotten Bayou currently has a "Fish and Wildlife" classification. For this classification, the allowable concentrations of pathogens are a geomean of 200 colonies/100 ml for the contact season and 2000 colonies/100 ml for the non-contact season, as well as 400 colonies/100 ml 10% of the time for the contact season and 4000 colonies/100 ml 10% of the time for the non-contact season.

A Summary of results of the first year of pathogen testing in Rotten Bayou are displayed in Table 6. Results from the bridge location were above the standard during the contact season based on both the geomean and the 10% rule. While this level of pathogen testing does not distinguish between waste from humans, domestic animals or wildlife, the results could be an indication that there is still a problem with nonfunctioning septic systems in western Harrison County (See Figure 11). Results from the pier location were under the standard for the contact season based on the geomean, but above the standard based on the 10% rule. Both standards need to be met to be in compliance. Because this section of the bayou is tidal, the source or sources of the pathogens could be upstream or downstream. While the discharge location for Diamondhead Water and Sewer District is below Interstate 10 and just south of Rotten Bayou, this cannot be ruled out as a potential source of pathogens further upstream because of the tidal nature of the bayou. Both locations were under the standard for both the geomean and 10% rule for the non-contact season.

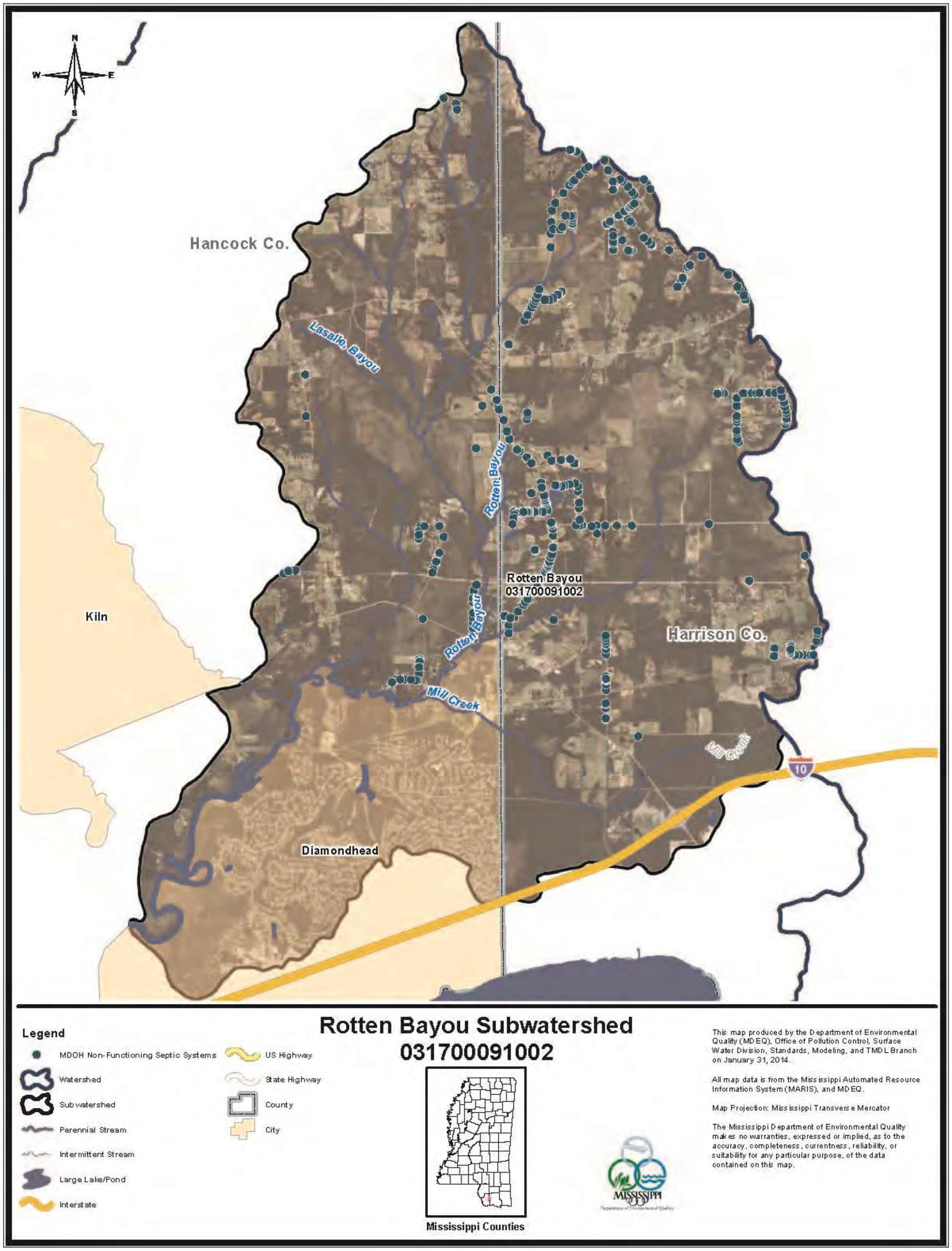
Table 6: Results from Pathogen Testing in Rotten Bayou Compared to Water Quality Standards for Waterways with a "Fish and Wildlife" Designation

Location	Season	Geomean	Standard	10%	Standard
Bridge	Contact	311	200	889	400
Pier	Contact	132	200	1062	400
Bridge	Non-contact	196	2000	439	4000
Pier	Non-contact	145	2000	865	4000

Source: MDEQ (2015)

While both locations exceeded standards for pathogens during the contact season, MDEQ is hesitant to draw any standing conclusions based on the full data set. Results appeared to be highly variable in response to rainfall and consistent impairment usually results in levels of Fecal Coliform at least one, if not two, orders of magnitude higher. MDEQ is considering monitoring at both sites on Rotten Bayou for another year to see if results are any more conclusive.[73] If consistent impairment is determined a TMDL for pathogens may be ordered for the bayou.

Figure 11: Nonfunctioning Septic Systems in Rotten Bayou Watershed



Erosion/sedimentation

Erosion and sedimentation appear to be major stressors affecting water quality in Rotten Bayou. While no streambank erosion rates are available for the watershed, several smaller engineering studies have been done that cite erosion and sedimentation as primary contributors to reductions in hydraulic capacity. Of particular significance is a study done by Compton Engineering in 2012 detailing erosion and sedimentation in the western portion of Diamondhead that drains into Devil's Elbow, an oxbow feature of Rotten Bayou. The report notes that "In recent years Devil's Elbow has filled with sediment downstream of the discharge point of the primary drainage ditch for western Diamondhead and investigation indicates that it was cleaning and clearing work conducted on this drainage ditch (post Hurricane Katrina) that caused erosion along the ditch and down-gradient deposition to occur."[74] The report documents specific source of erosion and suggestions for preventing, treating and controlling this type of nonpoint source pollution. In addition to areas immediately draining to Devil's Elbow, many other areas through Diamondhead and Hancock and Harrison Counties are susceptible to erosion and contributing to sedimentation in the watershed. See Figure 12.

Figure 12: Erosion in Rotten Bayou Watershed

Source: Kelsey Johnson. Photos taken between March and November 2014

2.4.7 Sources of Pollutions

Currently there are no municipal or industrial facilities within the watershed that are permitted under the National Pollutant Discharge Elimination System. As such, most of the pollution noted above can be attributed to nonpoint sources. The Diamondhead Water and Sewer District does have a permitted discharge location downstream of Rotten Bayou and north of Interstate 10. Due to the tidal influence into Rotten Bayou the effects of this discharge should be more closely connected with planning in the watershed in the future.

Nutrients such as nitrogen and phosphorus often come from fertilizers and pesticides used in agriculture and on residential lawns and gardens. According to the Mississippi State University Extension Service, there are relatively few agriculture practices and no commercial row crop ventures that would require the most use of fertilizers and pesticides within the watershed.[75] This seems to be supported by the relatively low TN and TP concentrations from the gauges near Vidalia and Fenton that respond to water draining from the upper and most rural parts of the watershed. TN and TP concentrations are higher at the Diamondhead and Mill Creek gauges that include more dense residential and some commercial land uses, as well as two golf courses. Home pesticide and fertilizer use, as well as use for golf course maintenance are more likely to be significant contributors to nutrient loads in Rotten Bayou. Again, it is important to note that the Diamondhead gauge is tidally influenced and so it is currently not clear what nutrients are coming from development and the golf course versus the St. Louis Bay.

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. If after further testing pathogens are determined to be a significant problem in Rotten Bayou, more fine-tuned testing to determine sources may be warranted. Regardless, potential sources such as concentrations of reported nonfunctioning septic in western Harrison County, discharge from Diamondhead Water and Sewer District and waste from pets and livestock that is not properly disposed of or controlled should be addressed.

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. Most of the stormwater system in Rotten Bayou watershed utilizes swales and ditches as opposed to drains and pipes. Drainage swales can be much better for water quality when properly maintained because they allow for infiltration and can help slow the flow of water. However, when these ditches are cleared or cleaned in ways that remove vegetation and expose soils, they become sources of sediments that end up in the waterways. The use of recreational vehicles such as ATVs near waterways is a popular pastime on the coast. When soils are disturbed near waterways and trails are not properly reinforced excess sediment can end up in the waterways hindering flow, navigability and critical habitat. An example of this is on the utility easement in Diamondhead that abuts Rotten Bayou off Bayou Drive just south of the confluence with Bayou La Terre.

While litter is not specifically monitored within the watershed it is a very visible source of pollution that ends up in the stormwater system and waterways. Litter is visible on the sides of the roads and drainage ditches throughout most of the county portions of the watershed. The main sources appear to be loose debris from pick-up truck beds, purposeful disposal of litter from vehicles, unsecured garbage placed roadside for collection and illegal dumping of larger items. See Figure 13. There is very little litter in the residential area of Diamondhead and the Diamondhead Property Owners Association's maintenance crew regularly picks up any visible litter on their rounds in this area. There is more visible garbage in the commercial area of Diamondhead just north of Interstate 10. Currently there is no curbside recycling in Hancock County or Diamondhead which may be a hindrance to improving the anti-litter mentality in those areas.

Figure 12: Sources of Litter in Rotten Bayou Watershed.

Source: Kelsey Johnson. Photos taken between March and November 2014

2.5 Key Findings: Challenges and Opportunities

The following section summarizes the important findings from the watershed assessment that inform the strategies and best management practices identified in Section 3: Management and Monitoring Plan.

Historical Context

Two significant historical events that affected hydrology in the watershed are the heavy logging in area that resulted in erosion and sedimentation and the development of Diamondhead which added a significant amount of impervious surfaces and human activity.

Current and Future Land Use

The vast majority of the land in the watershed is and will likely continue to be privately owned, single-family residential. There is still some potential for commercial development throughout the watershed and approximately one square mile of remaining developable land in the City of Diamondhead.

Hydrology

Tying Best Management Practices with soil suitability based on hydrology will improve the effectiveness and efficiency of watershed planning and management in Rotten Bayou Watershed.

Wetlands

Wetland protection, including upland wetlands, and the conservation of priority lands as advised by the Land Trust for the Mississippi Coastal Plain's Conservation Mapping database will be critical to ensuring the long-term hydraulic functions of the watershed given the likelihood of future development and effects of climate change.

Access and Recreation

Lack of access to Rotten Bayou and its tributaries, is a likely contributor to an existing disconnect between residents and visitors of Rotten Bayou Watershed and the health of the local waterways.

Nutrients

TN and TP concentrations at the three freshwater gauges are generally below or near the various Mississippi nutrient threshold concentrations with the exception of data collected during a few storm events. The TN and TP concentrations from the tidal gauge in Diamondhead exceeded the thresholds in two of the three monitoring years. The report recommended focusing on preserving/restoring streamside buffers and installing BMPs for controlling runoff and stormwater in the drainage areas upland of the Diamondhead and Mill Creek gauges.

Pathogens

Concentrations of pathogens in Rotten Bayou appear to be a concern, although further testing is needed to make any real conclusions. Concentrations on the bayou at Kiln-Delisle Road, just north of the confluence with Mill Creek, appear to be of greater concern. Concentrations of reported nonfunctioning septic systems in western Harrison County may be a significant contributor to these higher concentrations. In addition, while the discharge location for Diamondhead Water and Sewer District is downstream from the second testing site and just outside the watershed, it cannot be ruled out as a contributor to spikes in concentrations of pathogens in this tidal section of the bayou.

Erosion and Sedimentation

Erosion and sedimentation appear to be major stressors affecting water quality. Main sources include cleaned/cleared drainage ditches, new construction and informal trails used by recreational vehicles such as ATVs.

Litter

Litter is a very visible problem throughout the watershed. The main sources appear to be loose debris from pick-up truck beds, purposeful disposal of litter from vehicles, unsecured garbage placed roadside for collection and illegal dumping of larger items.

Section 3: Management and Monitoring Plan

3.1 Watershed Management Actions

Best Management Practices (BMPs) are techniques used to manage and improve stormwater quantity and quality. The goal of BMPs is 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 during the development of the WIP while Section 3.1.2 describes recommended best practices to be implemented in the future.

3.1.1 Current Management Actions

Agricultural Nonpoint Source Pollution Project

The agricultural nonpoint source pollution project in Rotten Bayou Watershed 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 Hancock 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 and effectiveness of selected BMPs in targeted areas,
2. To apply BMPs to agricultural land in the project area as to reach the desired outcome of reduced runoff, cattle access/nutrients to the stream and sedimentation, and
3. To inform and educate the public about BMPs that benefit water quality.

The project began in September 2011 and concluded in September 2014 and resulted in the installation of a significant number of BMPs within the rural area of the watershed (See Table 7 and Figure 14). Education and outreach included demonstration farms, educational field days, press releases and fact sheets. Total project cost was $496,814.01. Appendix D contains the final report for the Agricultural Nonpoint Source Pollution Project.

Table 7: Summary of Best Management Practices Installed

BMP	Number of Practices	Number of Acres	Total Tons of Soil Saved Per Year
Critical Planting Area	6	10	51
Fencing	19	24,563 ft	
Nutrient Management	12	250.5	762.7
Pasture and Hayland Planting	2	38	144
Heavy Use Area Protection	3		
Tank/Trough	6		
Pond (Alternative Water Source)	14		
Water and Sediment Control Basin	4	4	118.2
Total	**66**	**302.5**	**1,075.9**

Diamondhead Cardinal Golf Course

Between June 2014 and December 2014 a partnership consisting of Land Trust for the Mississippi Coastal Plain, Gulf Coast Community Design Studio (GCCDS), Diamondhead Country Club and Property Owners Association (DPOA) and Mississippi Water Resources Research Institute installed a series of BMPs on Diamondhead's Cardinal Golf Course including a dry swale on hole one, naturalized stream segment on hole two, and native planting area on hole six. Cory Gallo, Associate Professor of Landscape Architecture at Mississippi State University, working through the Mississippi Water Resources Research Institute, designed the dry swale at hole two and suggested plantings for the native planting area on hole six. Diamondhead Country Club and Property Owners Association was able to implement both of these BMPs with their own staff and resources.

The stream naturalization at hole two was a more involved project and GCCDS worked closely with Diamondhead Country Club and Property Owners Association staff on this project. In December 2015, GCCDS staff worked alongside DPOA staff to not only do the stream restoration, but to train the DPOA staff in techniques including terracing the streambank, installing erosion control, and planting and maintaining the native vegetation. Educational signage designed by GCCDS was installed at the tee box of each hole where a BMP was installed. Project square footage for all three BMPs was 36,640 sq ft and is estimated to treat a runoff volume of 19,125 cu ft for the 90th percentile rain event. Total project budget including design work, materials and educational signage was $8,600. Maintenance costs are estimated to be $550-$600 per month during the growing season (8-9 months of the year) and projected to decrease significantly once vegetation is established. See Appendix E for design work and before and after photographs.

Duck Pond

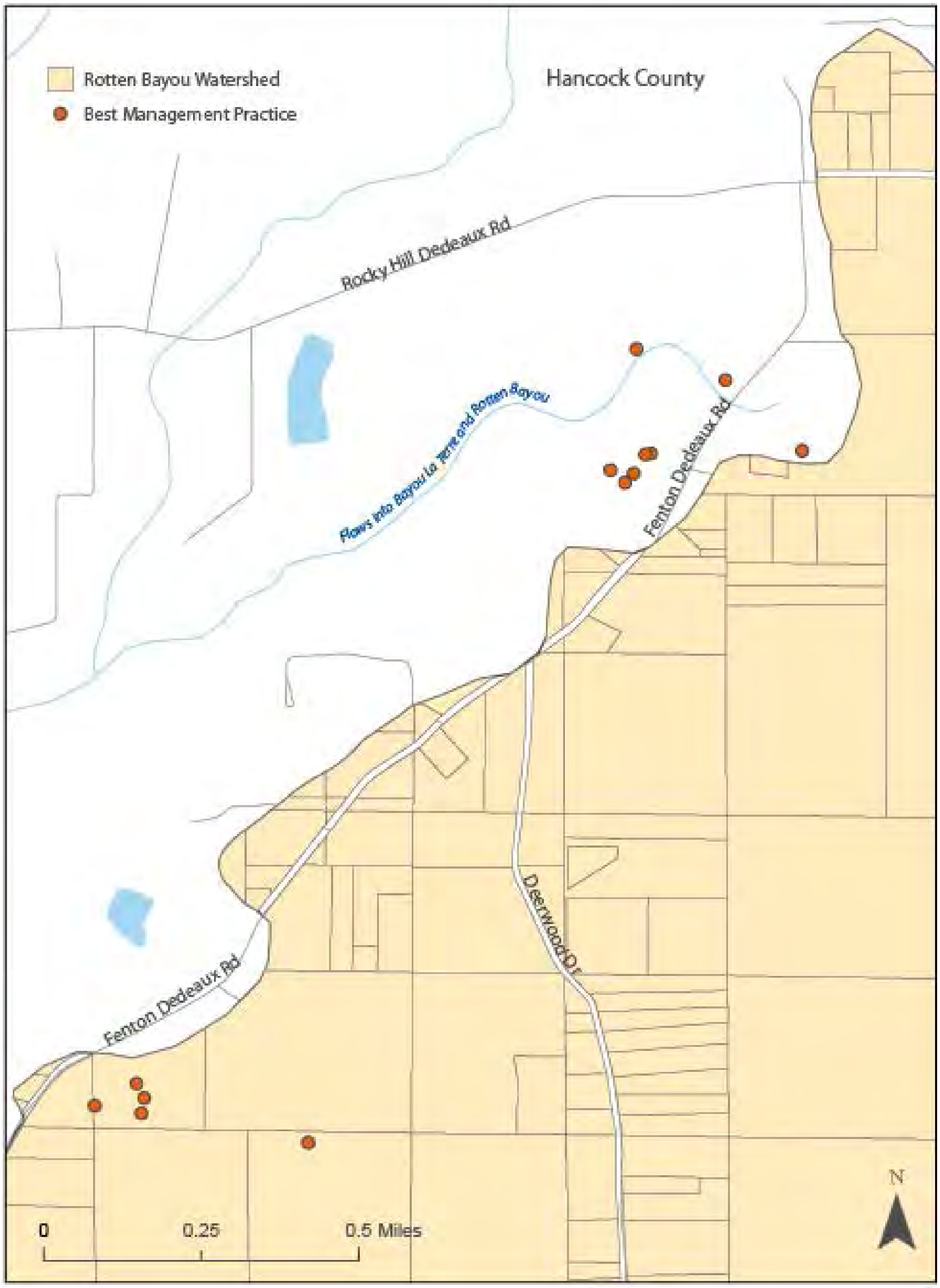
The steering committee for the Rotten Bayou Watershed Partnership selected the area adjacent to the overflow of the duck pond at the front of Diamondhead as the site for a demonstration project. The property is owned by the Diamondhead Property Owners Association and open to the public.

The project includes a stream naturalization, native plantings and multiple levels of filtration that will accomplish the following:

- improve water quality and decrease sedimentation downstream;
- decrease stormwater velocity and erosion of the stream and around the overflow;
- provide habitat for butterflies and songbirds;
- and provide a park atmosphere for the community to enjoy.

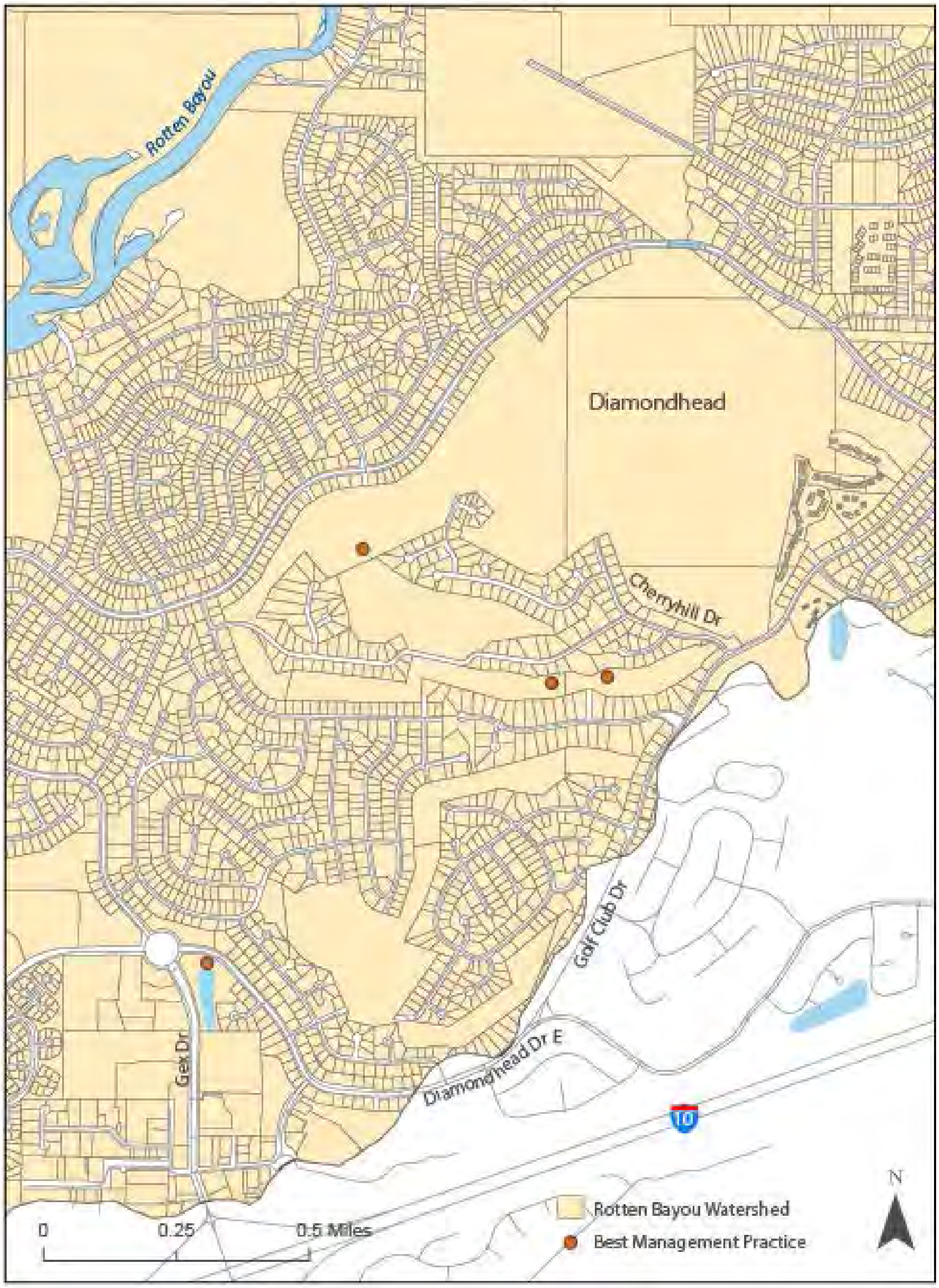
Landscaping will include native vegetation and educational signage at an existing deck overlook will inform community members how they might use similar species of plants at their own homes. Work on the project was be completed between July 20 and September 10, 2015. See Appendix F for project designs and details

Figure 14: Agricultural BMPs Installed During the Project Period



Source: Mississippi Soil and Water Conservation Commission (2015). Map by GCCDS.

Figure 15: Urban BMPs Installed During the Project Period



Source: GCCDS.

3.1.2 Planned Management Actions

Previous sections in the WIP have described challenges and opportunities facing Rotten Bayou Watershed (Section 2.4.7 Sources of Pollutions and Section 2.5 Key Findings: Challenges and Opportunities) 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 Rotten Bayou Watershed. A full listing of potential management strategies recommended for Rotten Bayou Watershed including responsible parties, potential funders, estimated costs and a recommended implementation timeline is included in Appendix H: Management Actions.

Rotten Bayou Watershed Partnership

Continued support from Steering Committee members and the committee members' ability to secure commitments of both time and resources from the stakeholders and/or entities they represent will be the difference between success and failure for the Rotten Bayou Watershed Partnership and Watershed Implementation Plan. The active participation of the Steering Committee, including the Technical Advisory Committee and Education and Outreach Committee, has contributed greatly to all that has been accomplished in Rotten 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."[76] In the short term, the Steering Committee will nominate a Rotten Bayou Watershed Coordinator to continue to facilitate regular meetings and activities of the Rotten Bayou Watershed Partnership and oversee progress on the Rotten Bayou Watershed Implementation Plan. The Steering Committee should also look into funding options for a paid leader for the Rotten Bayou Watershed Partnership. The Mississippi Department of Environmental Quality should consider funding a watershed coordinator grant program similar to what was done in California through the Department of Conservation.[77]

Data Gaps

Visual Survey

A thorough visual survey of the waterways in Rotten Bayou Watershed would help identify specific locations where streamside BMPs are most needed. A visual survey could include the following:

Number of Sites with Buffers Present

Number of Sites with Active Erosion

Number of Sites with Livestock Access

Number of Sites with Hardened Shorelines

Number of Sites with Visible Evidence of Eutrophication

Climb Community Development Corporation's Restore Corps could be employed to conduct the survey. See Section 3.3.

Erosion and Sediment Delivery Rates

Based on visual surveys of the watershed and anecdotal information from longtime residents, sedimentation in Rotten Bayou appears to be a growing concern. Main sources appear to be cleaned/cleared drainage ditches, new construction and informal trails used by recreational vehicles such as ATVs. 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 Rotten Bayou Watershed could help identify where to target BMPs so that more significant results can be realized with fewer investment dollars.

Primary Source(s) of Pathogens

While it is speculated that some pathogen loading in Rotten Bayou may be a result of nonfunctioning septic systems (See Figure 11), current available data does not allow for identifying specific impacts due to septic systems. Additional bacteria monitoring may be helpful in delineating inputs from septic systems versus wildlife. In addition, the most recent survey of septic systems in Rotten Bayou Watershed was conducted by the Mississippi Department of Health in 2010. It would be beneficial to update the survey in coordination with outreach and education efforts to inform septic system owners of proper maintenance procedures.

Priority Projects

County Demonstration Project

Early in 2014, the Rotten Bayou Watershed Partnership began working with Sacred Heart Catholic Church located at the top of Rotten Bayou Watershed. The church is prominent in the community, draws its membership from the watershed, and was experiencing problems with stormwater runoff. The property on which the church is located is also home to the Cursillo center which caters to members of the Catholic faith throughout the region. The church was seen not only as a potential partner in conducting education and outreach related to Rotten Bayou Watershed, but also as a good location for a demonstration best management project that would be highly visible to residents in the more rural areas of Harrison and Hancock Counties.

Plans were made to install a rain barrel at the Cursillo center near one of the church gardens and to construct a rain garden at the church to address a specific area where flooding was routinely occurring. See Appendix G for preliminary rain garden designs. Due to recent changes with church leadership and poor timing related to other major church projects, the leadership at Sacred Heart Catholic Church felt they could not go ahead with the projects at that time. It is highly recommended that this or a similar, highly-visible demonstration project be installed in the more rural, residential part of the watershed.

Utility Easement

Many residents in Diamondhead are familiar with the utility easement that runs between Bayou Drive in Diamondhead and Rotten Bayou. This section of the utility easement has experienced high levels of erosion due to frequent and unauthorized ATV use. The erosion appears to be negatively impacting a wetland habitat along the bayou and reducing the navigability of the waterway. The Rotten Bayou Watershed Partnership sees stopping ATV use on the site and regrading and replanting the eroded landscape as a high priority area in the watershed.

The utility easement and property to the south has a very high conservation value and could potentially be a tremendous asset to the community in terms of access to the bayou and recreation near the bayou. Currently, Purcell Corporation owns the property with the utility easement and land to the south along Rotten Bayou. Mississippi Power Corporation holds the easement. Early in 2014, the Land Trust for the Mississippi Coastal Plain and Gulf Coast Community Design Studio began talking with the Purcell Corporation and Mississippi Power about the possibility of addressing the erosion issues and longer term possibility of providing community access and trails. See Appendix G. At the present time, Mississippi Power is supportive of the concept. Purcell Corporation does not feel it is currently in the company's best interest to allow public access or to donate or sell the land for conservation purposes, but acknowledges that circumstances may change in the future. The Rotten Bayou Watershed Partnership, along with the City of Diamondhead and the Diamondhead Country Club and Property Owners Association, should continue to inquire about the status of this area and look for ways to put it into conservation.

City Hall

The Rotten Bayou Watershed Partnership also considered demonstration projects at several locations around Diamondhead City Hall. The city was in the midst of addressing drainage issues on the north end of City Hall property. Unfortunately, due to the proximity to existing housing, a section of the drainage area needed to be piped. The drainage area is part of a creek that feeds directly into Rotten Bayou and there remain opportunities for creek restoration between the area that was piped and Rotten Bayou. In addition, there are remnants of an existing trail that could be enhanced for public use. Finally, the area east of the building consistently floods during rain events and lack of vegetation has made the land susceptible to erosion. The space is currently not utilized, but has the potential to be a beautiful public area that can accommodate both stormwater and passive recreation. See Appendix G.

Country Club Rain Garden

The Water Resources Research Institute, as part of their funded work listed in Section 1.3, identified an area on the front lawn of the Diamondhead County Club located between the main building, practice putting green and golf cart parking lot that is an excellent candidate for a rain garden. Currently there is a rock garden/landscaping feature in this area that is not serving any sort of drainage function. The Rotten Bayou Watershed Partnership considered this area for a demonstration project because of its visibility to the public; ability to filter water coming off the club roof, putting green and parking lot; and opportunity for educational signage that could also point towards other BMPs installed on the Cardinal Golf Course during the project period. While this project was not undertaken during the grant period, it remains a worthwhile and attainable project. See Appendix G.

Conservation and Restoration

Conservation

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 Rotten Bayou watershed and currently undeveloped were identified as being relatively high priority areas (See Figure 7) in terms of conservation and should be considered in planning and management strategies for Rotten Bayou Watershed. See Section 2.3.5. The LTMCP should continue to work with the City of Diamondhead, the Diamondhead Country Club and Property Owners Association, Purcell Corporation and private landowners within the watershed to acquire property or easements that will protect critical land within the watershed.

Living Shorelines and Streamside Buffers

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. The recommended visual survey of the waterways in Rotten Bayou Watershed would give a clearer indication of the extent of existing streamside buffers and hardened shorelines. Depending on the results of this survey, outreach and education should be conducted targeting individual property owners. Results of these efforts would be further enhanced by some type of incentive program for homeowners who willingly implement BMPs along the shorelines.

Dredging and Beneficial Use

Currently there are several locations along Rotten Bayou where dredging is desired for increased navigability and/or necessary for habitat restoration. One location is Devil's Elbow (See Section 2.4.6) and the other is where the utility easement off Bayou Drive in Diamondhead intersects the bayou. The Rotten Bayou Watershed Partnership should stay informed of any projects proposing dredging along Rotten Bayou and, where dredging is determined necessary, ensure that the dredge material is used for beneficial uses including development of wetland habitats.

Recreation and Ecotourism

Bayou Access

Rotten Bayou and its tributaries are almost entirely bordered by private property. With very few opportunities for the public to access or even view Rotten Bayou, it is difficult for watershed residents and visitors to understand their connection to this important waterway. There are a few remaining opportunities to provide access to the bayou or allow for recreation near the bayou. One such example is the utility easement running from Bayou Drive in Diamondhead, west to Rotten Bayou. See *Priority Projects* in Section 3.1.2 Planned Management Actions. The feasibility of this project is contingent on the willingness of current landowners. There are also several other residential properties along Rotten Bayou that are prone to flooding and either have not been developed or have not been redeveloped since Hurricane Katrina. These properties should be considered for conservation and as possible access points to the bayou.

Blueway

Rotten Bayou is navigable by kayak from the Jourdan River up to Kiln-Delisle Road; about 6 stream miles. It is a beautiful and often secluded waterway that would make an excellent addition to the Mississippi Gulf Coasts' growing list of blueways. Rotten Bayou's designation as a blueway would forward the goals of this WIP by increasing access to and awareness of Rotten Bayou. Increasing access and awareness is critical to improving water quality in Rotten Bayou because many people in the watershed currently do not feel a connection to the bayou because of lack of access due to private ownership along the bayou. Increasing access points as discussed above will be important to Rotten Bayou becoming a successful blueway. Currently, unless one owns property on the bayou, the only ways to access Rotten Bayou are from Jordan River launches, Diamondhead Marina or roadway overpasses.

Waste and Wastewater

Nonfunctioning Septic Systems

According to a survey done by the Mississippi Department of Health (MSDH) in 2010, pockets of nonfunctioning septic systems remain in Rotten Bayou Watershed. See Figure 11. The most significant clusters are in the western part of Harrison County. 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). Western Harrison County was able to tie in areas just north of Interstate 10, but currently does not have funding to connect any areas still reported as nonfunctioning.[78] In the absence of funding to tie-in additional areas on septic systems, an educational campaign about the risks of nonfunctioning septic systems and proper maintenance should target areas in the watershed where high concentrations of septic systems remain.

Diamondhead Water and Sewer District

Diamondhead Water and Sewer District is in the process of relocating its discharge site and wastewater treatment plant. While the discharge point for Diamondhead Water and Sewer District is south of the watershed, due to the tidal influence into Rotten Bayou the effects of this discharge should be more closely connected with planning in the watershed in the future. There is also an opportunity for the Diamondhead Water and Sewer District to work with the DPOA and City of Diamondhead so that effluent can be dispersed on land for irrigation of the Diamondhead Golf Courses and other appropriate sites.

Litter

Curbside recycling

Harrison County currently operates a curbside recycling program. Prior to Hurricane Katrina, Hancock County also had a curbside recycling program, but residents must now bring their recyclable materials to drop-off centers in order to have them recycled. This added inconvenience can be a deterrent to waste management best practices. The Hancock County Solid Waste Authority and local jurisdictions, in collaboration with the Mississippi Recycling Coalition, should work towards reinstating and promoting curbside recycling in Hancock County.

Trash Catches in Commercial Area

The majority of the drainage system in the watershed is made up of swales and ditches, but there are a few areas, especially in the commercial area of Diamondhead, that have curb and gutter. Litter in these areas 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 prominent throughout the watershed 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.

Keep Diamondhead Beautiful Extension

Keep Diamondhead Beautiful (KDB) became a registered affiliate of Keep America Beautiful in 2014. The mission of the organization is focused on "beautifying the City of Diamondhead, involving the community in the beautification efforts, continuing to support the sense of pride that already exists in the City of Diamondhead by encouraging the citizens and the administration to provide a clean and litter free environment, by helping to develop landscaping and maintenance plans and projects for the safety and beauty of the City of Diamondhead."

The City of Diamondhead is relatively litter-free, except for some litter around fast food locations and shopping centers. Roadway litter and illegal dumbing appear to be more of a concern outside of city limits, however, there are no Keep America Beautiful affiliates active in areas of the watershed outside of Diamondhead. Since Diamondhead has relatively few litter problems and the county areas surrounding Diamondhead are essentially a gateway to the city, it would be beneficial for KDB to extend its mission and reach to include other areas in Rotten Bayou Watershed outside of city limits.

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. While there are no eligible roadways in Rotten Bayou Watershed, a similar program modeled after the Adopt-a-Highway program could help reduce roadway litter in critical areas of the watershed.

Urban BMPs

Nonstructural

Permeable paving

Currently, the City of Diamondhead's zoning ordinance does not allow for pervious paving options in commercial parking areas, loading facilities or access drives. By allowing and even encouraging the use of pervious paving options the city would be furthering the environmental goals established in the 25 Year Comprehensive Plan and taking necessary steps to protect water quality in Rotten Bayou and the watershed. See Appendix I: Recommended Ordinance Changes.

Stormwater ordinance

Diamondhead's current stormwater ordinance is relatively vague and often not clear on where responsibility lies with the city or with the developer. Mississippi's Water Resources Research Institute has reviewed the stormwater ordinance and made specific recommendations for language that should be modified to make the document more effective. See Appendix I.

Building code

Under current regulations, smaller residential lots in Diamondhead can be filled to elevate land which reduces the area water can be stored within the watershed and may increase flood risk downstream. A grading supplement should be added to the building code to minimize fill allowed on these lots. See Appendix I.

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

Currently, higher levels of Total Nitrogen (TN) and Total Phosphorus (TP) are being recorded at the gage in Diamondhead indicating that more of the nutrients entering Rotten 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 J: Model Ordinance for Florida-Friendly Fertilizer Use on Urban Landscapes. The City of Diamondhead should consider adopting some form of fertilizer ordinance, in coordination with education and outreach to property owners about responsible fertilizer use, as a means of reducing nutrients entering Rotten Bayou.

Urban Wildlife Population Control

Wildlife populations within urban areas can reach unnatural levels that are not adequately supported by the environment and can negatively affect water quality. Common examples are deer, Canada geese, raccoons, and squirrels. Water quality at the pond off Gex Drive in Diamondhead is an example of a human altered environment that is inviting unnatural levels of geese that are negatively impacting the quality of water flowing into Rotten Bayou. To control populations of urban wildlife, the types, number and health of the populations in comparison to habitat availability should be regularly monitored. Methods of control may include habitat modification or animal relocation.

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 uptick 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 the City of Diamondhead, if the 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 city. Between 10,000 square feet and five acres is the city's responsibility. The city requires that development in this size range have a permit, Small Construction Notice of Intent (SCNOI) and SWPPP. Under 10,000 square feet does not require a plan or permit.

In Hancock and Harrison Counties, if the site is over five acres, the site is the jurisdiction of the MDEQ. A SWPPP, LCNOI and permit are required. Between one and five acres are the Counties' responsibility. The counties require that development in this size range have a permit, SCNOI and SWPPP. Under one acre 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 15. The issue appears to be more with lack of capacity to enforce the SWPPP's. As development continues to increase in Rotten 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 15: Active Construction Site in Rotten Bayou Watershed

Source: Kelsey Johnson. Photo taken April 2015

Drainage swale maintenance

The drainage systems in Rotten 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. The Diamondhead Garden Club would be an excellent organization to educate and encourage the community in regards to these practices. In addition, specific species of native vegetation were incorporated in the Diamondhead Duck Pond Demonstration Project to provide residents with examples of plants that can be used in rain gardens or other wet areas of their yards.

Agricultural and Rural BMPs

Nonstructural

Logging BMPs

Forested areas within Rotten Bayou Watershed are routinely used for harvesting lumber. Some of these areas are fairly close to Rotten Bayou. An example is the area adjacent to Rotten Bayou Cemetery on the border of Diamondhead and Harrison County. 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.[79] 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.[80] Hancock and Harrison Counties should consider using a similar mechanism to increase the implementation of logging BMPs.

Structural

The following structural, agricultural BMPs were implemented as part of the Rotten Bayou Watershed Agricultural Nonpoint Source Pollution Project and are recommended for continued implementation.

Water and Sediment Control Basin

Water and sediment control basins are designed to trap sediment, reduce erosion, reform the land surface and improve water quality. The basins usually consist of a short embankment or combination ridge and channel generally constructed across the slope and minor watercourses.

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.

3.2 Education and Outreach Activities

Education and outreach efforts were critical to developing the Rotten Bayou WIP and informing the community about challenges and opportunities that affect the water quality in Rotten Bayou Watershed. Outreach efforts began in the spring of 2014 and have continued through the duration of the project period. Activities included developing various materials and signage, hosting workshops, and coordinating activities with local schools. Section 3.2.1 gives a summary of education and outreach activities that have been completed during the development of the WIP while Section 3.2.2 describes recommended activities to be implemented in the future.

3.2.1 Summary of Activities Conducted During the Planning Period

Goals

1. Increase awareness of watershed and Rotten Bayou Watershed Plan
2. Improve stakeholder knowledge of watershed dynamics
3. Inspire residents and stakeholders to take action
4. Develop a plan for ongoing educational opportunities and engagement

ROTTEN Bayou Watershed Partnership

Materials Produced

Logo
Facebook Page
Brochure and Survey
Water Quality Testing Collection Forms
Outreach Maps
Golf Course Signage
Rotten Bayou Watershed Signage
Diamondhead Duck Pond Demonstration Project Signage
Press Releases

Table 8: Activities

Activity	Date	Audience
Kick-Off/Watershed Harmony Performance at Delisle Elementary	April 4, 2014	Youth, Educators, Leadership
Outreach/Watershed Harmony Performance at Diamondhead Community Center	June 17, 2014	Youth, Community
Outreach/Watershed Harmony Performance at Kiln Library	June 19, 2014	Youth, Community
Outreach/Watershed Harmony Performance at Randolph School Community and Senior Center	July 1, 2014	Youth, Seniors, Community
Rotten Bayou Stormwater Workshop at Diamondhead Country Club and Golf Course	July 15, 2014	Leadership, Professionals
Presentation to Hancock County Chamber of Commerce Greenways & Byways Committee and Beautification Committee	September 12, 2014	Leadership
Presentation to Rotary Club of Central Hancock County	October 2, 2014	Leadership, Community
Outreach/Watershed Harmony Performance at Sacred Heart Catholic Church	October 5, 2014	Youth, Community
B-Wet Workshop at East Hancock Elementary School	October 14-17, 2014	Youth, Educators
MS Coastal Clean Up – Rotten Bayou Site	October 18, 2014	Community
B-Wet Exhibits at Diamondhead City Hall and East Hancock Library	November-December 2014	Community
Workshop with City of Diamondhead	November 17, 2014	Leadership
Workshop with Diamondhead Property Owners Association	November 17, 2014	Leadership
Workshop with Diamondhead Garden Club	November 19, 2014	Leadership, Community
Presentation at Bays & Bayous Symposium, Mobile	December 3, 2014	Region
B-Wet Fall Field Trip	December 15, 2014	Youth, Educators
Golf Course Stream Naturalization/Workshop	December 16, 2014	Professionals

From Policy to Practice: Lessons learned from Georgia's Stormwater Management Approach	March 26-27, 2015	Leadership, Professionals
Presentation at Mississippi Water Resources Conference, Jackson	April 7, 2015	State
Outreach at Celebrate the Gulf	April 11, 2015	Community
B-Wet Spring Field Trip	April 21, 2015	Youth, Educators
B-Wet In-class Wrap-up	April 24, 2015	Youth, Educators
B-Wet Exhibition as Part of Diamondhead Spring Pilgrimage	April 22-24, 2015	Community
Demonstration Project and Educational Signage at Diamondhead Duck Pond	July-September 2015	Community

3.2.3 Future Outreach and Education Activities

A full listing of potential education and outreach activities recommended for Rotten Bayou Watershed including responsible parties, potential funders, estimated costs and a recommended implementation timeline is included in Appendix H: Management Action.

Facebook Page

The Rotten Bayou Watershed Partnership's Facebook Page (www.facebook.com/rottenbayou) has been the primary means of communicating with interested residents. Facebook is free and allows the partnership to update residents on current happenings and gather feedback on pertinent issues. During the project period, staff at the Gulf Coast Community Design Studio created and maintained the Facebook page. As the project concludes, one to two people who plan to continue as members of the Rotten Bayou Watershed Partnership should be nominated by the Steering Committee to be administrators of the Facebook page.

MS Coastal Cleanup

Rotten Bayou is a registered site of the Mississippi Coastal Cleanup. In the past volunteers have met at the Diamondhead Marina to clean up trash in the immediate area. The Rotten Bayou Watershed Partnership became actively involved in the cleanup at this site in October 2014 and should continue to participate to encourage the cleanup efforts to extend further up Rotten Bayou.

Projects for Scout Troops

Many Boy and Girl Scout troops are active in Rotten Bayou Watershed. Often these young men and women are looking for volunteer projects to help complete requirements of their programs. Appendix K includes sample projects for Boy Scouts related to the Soil and Water Conservation Badge. As updates are made to the Rotten Bayou WIP more sample projects should be developed and disseminated to active troops.

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.

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. Currently, educational signage has been installed at the locations where BMPs were completed on Diamondhead's Cardinal Golf Course and at the Duck Pond Demonstration Project located off Gex Drive in Diamondhead. See Appendices E and F. Similar signage should be installed where possible when publically accessible BMPs are installed. In addition, if publically accessible access point or trails are created on or near Rotten Bayou, signage with an educational component should be included in the plans.

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, the DPOA, and local pet-related businesses such as veterinary clinics. Signage and waste receptacles should also be provided in areas where people frequently walk pets.

Education in Schools

During the project period, Bayou Town Productions worked with the Rotten Bayou Watershed Partnership to schedule performances of their Watershed Harmony Puppet show at schools and libraries that are either in the watershed or cater to residents who live in the watershed (See Table 6: Activities). The Partnership should continue to work with Bayou Town Productions and other providers of educational programs to coordinate regular sessions in the schools, libraries and other community venues. The Mississippi Department of Transportation, for example, does an anti-litter presentation geared towards kindergarten through third grade.[81] This program was not engaged during the project period, but would be an excellent partner to consider for future outreach and education efforts.

During the project period the Gulf Coast Community Design Studio secured funding from NOAA's Gulf of Mexico Bay-Watershed Education and Training Program (Gulf B-WET) for the 2014-2015 school year to work with fifth graders at East Hancock Elementary School (See Appendix L: Elementary Education for Rotten Bayou Watershed). The grant funding not only allowed GCCDS staff to work with students during the 2014-2015 school year, but provided supplies and training to teachers to continue the program in future years. The Rotten Bayou Watershed Partnership should check in with East Hancock Elementary School at the beginning of each school year to encourage reuse of the program and materials and see if there is any way the Partnership can be of assistance. In addition, some of the children in the watershed go to Delisle Elementary School, part of the Pass Christian School District. There may be an opportunity for this program to be shared with Delisle Elementary School so that more children in the watershed are reached.

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. The Diamondhead Garden Club and Pine Hills Nursery, the only nursery in Rotten Bayou Watershed, would be ideal promoters of the use of native plants. Both have been involved with the Rotten Bayou Watershed Project and the Rotten Bayou Watershed Partnership should continue to work with these and other potential partners to promote the use of native plants and other BMPs (See Section 3.1.2).

Establish More Connections with County Residents

Establishing connections with residents in rural areas can be a challenge given the dispersed nature of development. Often churches or civic organizations can be a good and efficient way to connect with county residents. During the funded project period, the Rotten Bayou Watershed Partnership was able to work with Sacred Heart Catholic Church, a church located at the top of the watershed that draws its membership from the Fenton/Dedeaux communities. The timing of the project, however, did not align well with changes in church leadership and all of the planned work and educational activities could not be completed. The Rotten Bayou Watershed Partnership should continue to work with Sacred Heart Catholic Church, other churches in the area, and organizations such as the Knights of Columbus to better engage county residents.

Workshops with Local Leadership

While several of the workshops conducted during the Rotten Bayou Watershed project period focused on educating local leadership on BMPs that would improve water quality in Rotten Bayou, continuing education with this particular stakeholder group is needed (See Table 6: Activities). In addition, while there was significant participation from leadership in Diamondhead at the workshops and some representation from both Hancock and Harrison Counties, more effort needs to be made to encourage leadership from the counties to attend future trainings. Two specific areas where more training is needed are swale maintenance and adopting and enforcing ordinances.

3.3 Plan Evaluation and Revision

3.3.1 Monitoring Plan

MDEQ

MDEQ, in conjunction with USGS, conducted water quality monitoring prior to the implementation of BMP activities. Monitoring was suspended to allow for BMP installation. Once BMP installation is completed, MDEQ and USGS will re-instate monitoring activities in an effort to show water quality improvements. The timeline and extent of future monitoring is still to be determined. MDEQ is also considering monitoring Rotten Bayou for pathogens including Fecal Coliform and E. Coli for an additional year.

Research and Education to Advance Conservation and Habitat (REACH)

REACH plans to collect storm runoff samples from the following locations just downstream of where BMPs have been installed in Rotten Bayou Watershed:

- Dry Swale on hole one of Diamondhead's Cardinal Golf Course.
- Naturalized stream segment on hole two of Diamondhead's Cardinal Golf Course.
- Control Site at hole one of Diamondhead's Cardinal Golf Course.
- Stream naturalization adjacent to overflow at Diamondhead Duck Pond.

Diamondhead Country Club and Property Owners Association is also looking to implement BMPs on holes two and seven of the Pine Golf Course this summer. If these are installed, REACH plans to monitor these as well. All of the golf course samples are run through the MDEQ for TN, nitrate-nitrite, ammonia, ortho-phosphorus and suspended sediment.

Sample and discharge readings were taken at Diamondhead Duck Pond prior to the stream naturalization. One set of samples will be run for nutrients including nitrate-nitrite, ammonia, ortho-phosphorus, TP, TN, and total suspended solids. The other set will be sent to the USDA and run for fecal coliforms and e. coli. REACH plans to monitor these sites through October 2015.

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 and USGS are not able to continue monitoring Rotten Bayou in the future, the Rotten Bayou Watershed Partnership should consider 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 3.2, the Gulf Coast Community Design Studio secured funding from NOAA's Gulf of Mexico Bay-Watershed Education and Training Program (Gulf B-WET) for the 2014-2015 school year to work with fifth graders at East Hancock Elementary School. See Appendix L: Elementary Education for Rotten Bayou Watershed. The grant funding not only allowed GCCDS staff to work with students during the 2014-2015 school year, but provided supplies and training to teachers to continue the program in future years. The Rotten Bayou Watershed Partnership should contact East Hancock Elementary School at the beginning of each school year to encourage continued monitoring of Rotten Bayou and information sharing between the school, Rotten Bayou Watershed Partnership and larger community.

Watchful Stewards Program

Much of the information about changes in Rotten Bayou over time was gathered anecdotally from people who either live or recreate on the bayou. Since there is currently no direct public access to Rotten Bayou, it will be important for the Rotten Bayou Watershed Partnership to maintain relationships with people who have constant visual or physical contact with the bayou. The partnership may want to consider instating a more formal Watchful Stewards Program where residents can regularly report on changes to the bayou environment or concerns or opportunities that should be addressed by the partnership.

3.3.2 Adaptive Management and Plan Revision

The goals, objectives and resulting strategies and recommendations included in the Rotten Bayou Watershed Implementation Plan have been determined based on an assessment conducted between 2012 and 2015. 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 Rotten Bayou. As such, the Rotten Bayou Watershed Partnership should plan to conduct an integrated assessment of Rotten Bayou Watershed on a routine basis and make adjustments or amendments to the Rotten 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 Rotten Bayou Watershed Partnership should begin conducting its first assessment and plan revision in 2020.

[1] U.S. Environmental Protection Agency. *Handbook for Developing Watershed Plans to Restore and Protect Our Waters.* (2008). Pg. 2-2. <http://www.epa.gov/owow/nps/watershed_handbook>
[2] U.S. Environmental Protection Agency. *Handbook for Developing Watershed Plans to Restore and Protect Our Waters.* (2008). Pg. 2-2. <http://www.epa.gov/owow/nps/watershed_handbook>
[3] U.S. Environmental Protection Agency. *Handbook for Developing Watershed Plans to Restore and Protect Our Waters.* (2008). Pg. 2-14. <http://www.epa.gov/owow/nps/watershed_handbook>
[4] FTN Associates, Ltd. Prepared for Mississippi Department of Environmental Quality. *Mississippi Coastal Nutrient Reduction Strategies.* (2011). Pg. 1. <http://www.deq.state.ms.us/Mdeq.nsf/pdf/WMB_MSCoastalNutrientReductionStrategies/$File/Mississippi%20Coastal%20Nutrient%20Reduction%20Strategies.pdf?OpenElement>
[5] U.S. Department of Agriculture. Press Release No. 0499.11. *Agriculture Secretary Vilsack Announces $50 Million for Gulf Coast Restoration.* (2011). <http://www.usda.gov/wps/portal/usda/usdahome?contentidonly=true&contentid=2011/12/0499.xml>.
[6] Mississippi Department of Environmental Quality, Office of Pollution Control Standards, Modeling, and TMDL Branch. Total Maximum Daily Load For Nutrients and Organic Enrichment/Low DO In Listed Tributaries to St. Louis Bay Coastal Streams Basin. (2007). Pgs. 7-8.
[7] Mississippi Department of Environmental Quality, Office of Pollution Control Standards, Modeling, and TMDL Branch. Total Maximum Daily Load For Nutrients and Organic Enrichment/Low DO In Listed Tributaries to St. Louis Bay Coastal Streams Basin. (2007). Pg. 35.
[8] Scharff, Robert G. *Louisiana's Loss, Mississippi's Gain: A History of Hancock County, Mississippi from the Stone Age to the Space Age.* (1999). Lawrenceville, VA: Brunswick Publishing Corporation. Pg. 61.
[9] Ellis, Dan. *Kiln Kountry: Home of Brett Farve.* (2000). Self Published. Pg. 4.
[10] Scharff, Robert G. *Louisiana's Loss, Mississippi's Gain: A History of Hancock County, Mississippi from the Stone Age to the Space Age.* (1999). Lawrenceville, VA: Brunswick Publishing Corporation. Pg. 28.
[11] Scharff, Robert G. *Louisiana's Loss, Mississippi's Gain: A History of Hancock County, Mississippi from the Stone Age to the Space Age.* (1999). Lawrenceville, VA: Brunswick Publishing Corporation. Pg. 75.
[12] Scharff, Robert G. *Louisiana's Loss, Mississippi's Gain: A History of Hancock County, Mississippi from the Stone Age to the Space Age.* (1999). Lawrenceville, VA: Brunswick Publishing Corporation. Pg. 173.
[13] Hancock County Historical Society. Website. Accessed January 2014. < http://www.hancockcountyhistoricalsociety.com/reference/alphabetfile.htm?page=194>
[14] Hickman, Nollie W. *Mississippi Harvest: Lumbering in the Longleaf Pine Belt, 1840-1915.* (2009). Jackson, MS: University Press of Mississippi.
[15] Ellis, Dan. *Kiln Kountry: Home of Brett Farve.* (2000). Self Published. Pg. 27.
[16] Ellis, Dan. *Kiln Kountry: Home of Brett Farve.* (2000). Self Published. Pg. 24.
[17] Ellis, Dan. *Kiln Kountry: Home of Brett Farve.* (2000). Self Published. Pg. 25.
[18] Ellis, Dan. *Kiln Kountry: Home of Brett Farve.* (2000). Self Published. Pg. 29.
[19] Scharff, Robert G. *Louisiana's Loss, Mississippi's Gain: A History of Hancock County, Mississippi from the Stone Age to the Space Age.* (1999). Lawrenceville, VA: Brunswick Publishing Corporation. Pg. 177-178.
[20] Hancock County Historical Society. Website. Accessed January 2014. < http://www.hancockcountyhistoricalsociety.com/reference/cemetery.htm?cemetery=ROT>.
[21] Scharff, Robert G. *Louisiana's Loss, Mississippi's Gain: A History of Hancock County, Mississippi from the Stone Age to the Space Age.* (1999). Lawrenceville, VA: Brunswick Publishing Corporation. Pg. 599-600.
[22] Gulf Regional Planning Commission. Current Land Use Inventory GIS Database. (2013). Analysis by Gulf Coast Community Design Studio.
[23] Gulf Regional Planning Commission. Future Land Use Inventory GIS Database. (2013). Analysis by Gulf Coast Community Design Studio.
[24] Gallo, Cory. Mississippi State University, Water Resources Research Institute. Presentation for MDEQ and Rotten Bayou Watershed Implementation Team. 21 March 2013.
[25] U.S. Census Bureau. Income, Poverty, and Health Insurance Coverage in the United States: 2010. (2011). <http://www.census.gov/prod/2011pubs/p60-239.pdf>.

[26] U.S. Department of Agriculture. Geography of Poverty. <http://www.ers.usda.gov/topics/rural-economy-population/rural-poverty-well-being/geography-of-poverty.aspx#.Uwyu5IW5FO1>. Accessed 25 February 2014.
[27] Glaster, George C. *Consequences from the Redistribution of Urban Poverty during the 1990's: A Cautionary Tale.* (2003). National Poverty Center Working Paper Series #03-9. <http://moodle.technion.ac.il/pluginfile.php/129000/mod_resource/content/0/Galster_A_Cautionary_Tale_consequences_from_the_redistribution_of_urban_poverty_during_the_1990s.pdf>.
[28] U.S. Census Bureau. (2010). 1990-2010 Decennial Census. Table QT-H1. General Housing Characteristics.
[29] Plan for Opportunity. Water Assessment. Pg 18.
[30] Starnes, James. Mississippi Department of Environmental Quality. Office of Geology. Phone Conversation 1 December 2014.
[31] United States Department of Agriculture. Natural Resource Conservation Service. *Custom Soil Resource Report for Hancock County, Mississippi, and Harrison County, Mississippi: Soil Survey for Rotten Bayou Watershed*. <http://websoilsurvey.sc.egov.usda.gov>. Accessed 20 August 2014.
[32] United States Department of Agriculture. Natural Resource Conservation Service. (2007). *National Engineering Handbook*. Part 630 Hydrology. Pg. 7-1.
[33] United States Environmental Protection Agency. Western Ecological Division. Ecoregion Maps and GIS Resources. <www.epa.gov/wed/pages/ecoregions/htm>. Accessed 21 November 2014.
[34] Bailey, Robert G. and James M. Omernik. (1997). *Distinguishing between Watersheds and Ecoregions*. Journal of the American Water Resources Association. Vol. 33, No. 5. Pg. 937.
[35] Bailey, Robert G. and James M. Omernik. (1997). *Distinguishing between Watersheds and Ecoregions*. Journal of the American Water Resources Association. Vol. 33, No. 5. Pg. 937.Pgs 945-947
[36] United States Environmental Protection Agency. Western Ecological Division. Ecoregion Maps and GIS Resources. <www.epa.gov/wed/pages/ecoregions/htm>. Accessed 21 November 2014.
[37] United States Environmental Protection Agency. Western Ecological Division. Ecoregion Maps and GIS Resources. <www.epa.gov/wed/pages/ecoregions/htm>. Accessed 21 November 2014.
[38] United States Environmental Protection Agency. Western Ecological Division. Ecoregion Maps and GIS Resources. <www.epa.gov/wed/pages/ecoregions/htm>. Accessed 21 November 2014.
[39] United States Environmental Protection Agency. Coastal Wetlands. <http://water.epa.gov/type/wetlands/cwt.cfm>. Accessed 1 December 2014.
[40] Plan for Opportunity. Water Assessment. Pg 68.
[41] State of Mississippi. Mississippi Code of 1972. Section 57-15-6. Pg VIII-4.
[42] Mississippi Department of Marine Resources. Coastal Zone Management < http://www.dmr.state.ms.us/index.php/coastal-zone-management/wetland-permitting>. Accessed 25 November 2014.
[43] Mississippi State University. Department of Geosciences. <http://geosciences.msstate.edu/scClimate.htm>. Accessed 5 December 2014.
[44] Mississippi State University. Department of Geosciences. <http://geosciences.msstate.edu/scClimate.htm>. Accessed 5 December 2014.
[45] Ohio State University. (2012). *Mississippi Gulf Coast Water Assessment*. Pg 81.
[46] Ohio State University. (2012). *Mississippi Gulf Coast Water Assessment*. Pg 68.
[47] Ohio State University. (2012). *Mississippi Gulf Coast Water Assessment*. Pg 86.
[48] CDM Smith, Inc. Prepared for Land Trust for the Mississippi Coastal Plain. *Conservation Legacy: Conservation Mapping Report*. (2011). Pg. 3. <http://www.ltmcp.org/links/conservation-legacy/>.
[49] Ohio State University. (2012). *Mississippi Gulf Coast Water Assessment*. Pg 22.
[50] Ohio State University. (2012). *Mississippi Gulf Coast Water Assessment*. Pg 44.
[51] Phillips, Patrick. Mississippi Department of Environmental Quality, Office of Land and Water Resources. Email correspondence 15 October 2014.
[52] Ohio State University. (2012). *Mississippi Gulf Coast Water Assessment*. Pg 23.
[53] Ohio State University. (2012). *Mississippi Gulf Coast Water Assessment*. Pg 76.
[54] Ohio State University. (2012). *Mississippi Gulf Coast Water Assessment*. Pg 23.
[55] Phillips, Patrick. Mississippi Department of Environmental Quality, Office of Land and Water Resources. Email correspondence 5 December 2014.

[56] Phillips, Patrick. Mississippi Department of Environmental Quality, Office of Land and Water Resources. Email correspondence 15 October 2014.
[57] Ohio State University. (2012). *Mississippi Gulf Coast Water Assessment*. Pg 46.
[58] Collard, Michael. Diamondhead Water and Sewer District. Email correspondence. 10 December 2012.
[59] Mississippi Department of Wildlife, Fisheries and Parks (October 2008) 2009-2014 Statewide Comprehensive Outdoor Recreation Plan, table I.
[60] Necaise, Paul. U.S Fish and Wildlife Service. Coastal Biologist, Hancock County. Personal Communication. 2 February 2015.
[61] Mississippi Department of Environmental Quality, Office of Pollution Control. (2007*). State of Mississippi Water Quality Criteria for Intrastate, Interstate, and Coastal Waters.* Pg. 17.
[62] Mississippi Department of Environmental Quality, Office of Pollution Control. (2007*). State of Mississippi Water Quality Criteria for Intrastate, Interstate, and Coastal Waters.* Pg. 17.
[63] Anchor QEA, LLC. Prepared for Land Trust of the Mississippi Coastal Plain. (2014). *Rotten Bayou Water Quality Assessment.* Pg. 1.
[64] Mississippi Department of Environmental Quality, Office of Pollution Control. (2007). *Total Maximum Daily Load for Nutrients and Organic Enrichment/Low DO in Listed Tributaries to St. Louis Bay Coastal Streams Basin.* Pg. 5.
[65] Tetra Tech, Inc. Prepared for Mississippi Department of Environmental Quality, Office of Pollution Control. (2011). *Revised Draft Nutrient Thresholds to Protect Aquatic Life Uses in Mississippi Non-Tidal Streams and Rivers*.
[66] Tetra Tech, Inc. Prepared for Gulf of Mexico Alliance. (2013). *Sources, Fate, Transport, and Effects (SFTE) of Nutrients as a Basis for Protection Criteria in Estuarine and Near-Coastal Waters: Saint Louis Bay, Mississippi Pilot Study.*
[67] Anchor QEA, LLC. Prepared for Land Trust of the Mississippi Coastal Plain. (2014). *Rotten Bayou Water Quality Assessment.* Pg. 3.
[68] Anchor QEA, LLC. Prepared for Land Trust of the Mississippi Coastal Plain. (2014). *Rotten Bayou Water Quality Assessment.* Pg. 6.
[69] Anchor QEA, LLC. Prepared for Land Trust of the Mississippi Coastal Plain. (2014). *Rotten Bayou Water Quality Assessment.* Pg. 6.
[70] Anchor QEA, LLC. Prepared for Land Trust of the Mississippi Coastal Plain. (2014). *Rotten Bayou Water Quality Assessment.* Pg. 6.
[71] Anchor QEA, LLC. Prepared for Land Trust of the Mississippi Coastal Plain. (2014). *Rotten Bayou Water Quality Assessment.* Pg. 8.
[72] Anchor QEA, LLC. Prepared for Land Trust of the Mississippi Coastal Plain. (2014). *Rotten Bayou Water Quality Assessment.* Pg. 8.
[73] Alley, Valerie. Mississippi Department of Environmental Quality, Office of Pollution Control. Email communication 8 July 2015.
[74] Compton Engineering, Inc. Prepared for Diamondhead Property Owners Association. (2012). *Sedimentation and Erosion Remediation and Maintenance Plan for Drainage Ditches Discharging into Devil's Elbow, Diamondhead, Hancock County, Mississippi, Project # 211-066*. Pg 5.
[75] Ray, Tim. Mississippi State University Extension Service, Harrison County. Email correspondence 14 January 2014.
[76] University of Oregon. Ecosystem Workforce Program. (2009). Keys to Success for Watershed Management Organizations. Pg 6.
[77] California Department of Conservation. Watershed Coordinator Grant Program. <http://www.conservation.ca.gov/dlrp/wp/grants/Pages/wcgp_intro.aspx>. Accessed 12 May 2015.
[78] Harrison County Utility Authority. Virgil Gillespie, Board Director. *Personal Communication*. 4 May 2015.
[79] Missouri Department of Conservation. BMP Cost-Share Funds Available for Loggers and Landowners. 30 January 2013. < http://mdc.mo.gov/newsroom/bmp-cost-share-funds-available-loggers-and-landowners>. Accessed 12 June 2015.
[80] Utah State University Extension. *Utah Forest News: Utah Forest Landowner Education Program Newsletter*. Fall 2000. Volume 4, Number 4. <https://forestry.usu.edu/files/uploads/UFN/Fall00.pdf>. Accessed 12 June 2015
[81] Mississippi Department of Transportation. *Don't Trash Mississippi*. <http://sp.mdot.ms.gov/Maintenance/thinkgreen/Pages/home.aspx>. Accessed 15 June 2015.

[82] Mississippi Department of Environmental Quality. 2011. Prepared by FTN Associates, Ltd. *Mississippi Coastal Nutrient Reduction Strategies*. Pg 44.

United States Department of Agriculture

Natural Resources Conservation Service

A product of the National Cooperative Soil Survey, a joint effort of the United States Department of Agriculture and other Federal agencies, State agencies including the Agricultural Experiment Stations, and local participants

Custom Soil Resource Report for Hancock County, Mississippi, and Harrison County, Mississippi

Soil Survey for Rotten Bayou Watershed

August 20, 2014

Preface

Soil surveys contain information that affects land use planning in survey areas. They highlight soil limitations that affect various land uses and provide information about the properties of the soils in the survey areas. Soil surveys are designed for many different users, including farmers, ranchers, foresters, agronomists, urban planners, community officials, engineers, developers, builders, and home buyers. Also, conservationists, teachers, students, and specialists in recreation, waste disposal, and pollution control can use the surveys to help them understand, protect, or enhance the environment.

Various land use regulations of Federal, State, and local governments may impose special restrictions on land use or land treatment. Soil surveys identify soil properties that are used in making various land use or land treatment decisions. The information is intended to help the land users identify and reduce the effects of soil limitations on various land uses. The landowner or user is responsible for identifying and complying with existing laws and regulations.

Although soil survey information can be used for general farm, local, and wider area planning, onsite investigation is needed to supplement this information in some cases. Examples include soil quality assessments (http://www.nrcs.usda.gov/wps/portal/nrcs/main/soils/health/) and certain conservation and engineering applications. For more detailed information, contact your local USDA Service Center (http://offices.sc.egov.usda.gov/locator/app?agency=nrcs) or your NRCS State Soil Scientist (http://www.nrcs.usda.gov/wps/portal/nrcs/detail/soils/contactus/?cid=nrcs142p2_053951).

Great differences in soil properties can occur within short distances. Some soils are seasonally wet or subject to flooding. Some are too unstable to be used as a foundation for buildings or roads. Clayey or wet soils are poorly suited to use as septic tank absorption fields. A high water table makes a soil poorly suited to basements or underground installations.

The National Cooperative Soil Survey is a joint effort of the United States Department of Agriculture and other Federal agencies, State agencies including the Agricultural Experiment Stations, and local agencies. The Natural Resources Conservation Service (NRCS) has leadership for the Federal part of the National Cooperative Soil Survey.

Information about soils is updated periodically. Updated information is available through the NRCS Web Soil Survey, the site for official soil survey information.

The U.S. Department of Agriculture (USDA) prohibits discrimination in all its programs and activities on the basis of race, color, national origin, age, disability, and where applicable, sex, marital status, familial status, parental status, religion, sexual orientation, genetic information, political beliefs, reprisal, or because all or a part of an individual's income is derived from any public assistance program. (Not all prohibited bases apply to all programs.) Persons with disabilities who require alternative means

for communication of program information (Braille, large print, audiotape, etc.) should contact USDA's TARGET Center at (202) 720-2600 (voice and TDD). To file a complaint of discrimination, write to USDA, Director, Office of Civil Rights, 1400 Independence Avenue, S.W., Washington, D.C. 20250-9410 or call (800) 795-3272 (voice) or (202) 720-6382 (TDD). USDA is an equal opportunity provider and employer.

Contents

How Soil Surveys Are Made

Soil surveys are made to provide information about the soils and miscellaneous areas in a specific area. They include a description of the soils and miscellaneous areas and their location on the landscape and tables that show soil properties and limitations affecting various uses. Soil scientists observed the steepness, length, and shape of the slopes; the general pattern of drainage; the kinds of crops and native plants; and the kinds of bedrock. They observed and described many soil profiles. A soil profile is the sequence of natural layers, or horizons, in a soil. The profile extends from the surface down into the unconsolidated material in which the soil formed or from the surface down to bedrock. The unconsolidated material is devoid of roots and other living organisms and has not been changed by other biological activity.

Currently, soils are mapped according to the boundaries of major land resource areas (MLRAs). MLRAs are geographically associated land resource units that share common characteristics related to physiography, geology, climate, water resources, soils, biological resources, and land uses (USDA, 2006). Soil survey areas typically consist of parts of one or more MLRA.

The soils and miscellaneous areas in a survey area occur in an orderly pattern that is related to the geology, landforms, relief, climate, and natural vegetation of the area. Each kind of soil and miscellaneous area is associated with a particular kind of landform or with a segment of the landform. By observing the soils and miscellaneous areas in the survey area and relating their position to specific segments of the landform, a soil scientist develops a concept, or model, of how they were formed. Thus, during mapping, this model enables the soil scientist to predict with a considerable degree of accuracy the kind of soil or miscellaneous area at a specific location on the landscape.

Commonly, individual soils on the landscape merge into one another as their characteristics gradually change. To construct an accurate soil map, however, soil scientists must determine the boundaries between the soils. They can observe only a limited number of soil profiles. Nevertheless, these observations, supplemented by an understanding of the soil-vegetation-landscape relationship, are sufficient to verify predictions of the kinds of soil in an area and to determine the boundaries.

Soil scientists recorded the characteristics of the soil profiles that they studied. They noted soil color, texture, size and shape of soil aggregates, kind and amount of rock fragments, distribution of plant roots, reaction, and other features that enable them to identify soils. After describing the soils in the survey area and determining their properties, the soil scientists assigned the soils to taxonomic classes (units). Taxonomic classes are concepts. Each taxonomic class has a set of soil characteristics with precisely defined limits. The classes are used as a basis for comparison to classify soils systematically. Soil taxonomy, the system of taxonomic classification used in the United States, is based mainly on the kind and character of soil properties and the arrangement of horizons within the profile. After the soil scientists classified and named the soils in the survey area, they compared the individual soils with similar soils in the same taxonomic class in other areas so that they could confirm data and assemble additional data based on experience and research.

The objective of soil mapping is not to delineate pure map unit components; the objective is to separate the landscape into landforms or landform segments that have similar use and management requirements. Each map unit is defined by a unique combination of soil components and/or miscellaneous areas in predictable proportions. Some components may be highly contrasting to the other components of the map unit. The presence of minor components in a map unit in no way diminishes the usefulness or accuracy of the data. The delineation of such landforms and landform segments on the map provides sufficient information for the development of resource plans. If intensive use of small areas is planned, onsite investigation is needed to define and locate the soils and miscellaneous areas.

Soil scientists make many field observations in the process of producing a soil map. The frequency of observation is dependent upon several factors, including scale of mapping, intensity of mapping, design of map units, complexity of the landscape, and experience of the soil scientist. Observations are made to test and refine the soil-landscape model and predictions and to verify the classification of the soils at specific locations. Once the soil-landscape model is refined, a significantly smaller number of measurements of individual soil properties are made and recorded. These measurements may include field measurements, such as those for color, depth to bedrock, and texture, and laboratory measurements, such as those for content of sand, silt, clay, salt, and other components. Properties of each soil typically vary from one point to another across the landscape.

Observations for map unit components are aggregated to develop ranges of characteristics for the components. The aggregated values are presented. Direct measurements do not exist for every property presented for every map unit component. Values for some properties are estimated from combinations of other properties.

While a soil survey is in progress, samples of some of the soils in the area generally are collected for laboratory analyses and for engineering tests. Soil scientists interpret the data from these analyses and tests as well as the field-observed characteristics and the soil properties to determine the expected behavior of the soils under different uses. Interpretations for all of the soils are field tested through observation of the soils in different uses and under different levels of management. Some interpretations are modified to fit local conditions, and some new interpretations are developed to meet local needs. Data are assembled from other sources, such as research information, production records, and field experience of specialists. For example, data on crop yields under defined levels of management are assembled from farm records and from field or plot experiments on the same kinds of soil.

Predictions about soil behavior are based not only on soil properties but also on such variables as climate and biological activity. Soil conditions are predictable over long periods of time, but they are not predictable from year to year. For example, soil scientists can predict with a fairly high degree of accuracy that a given soil will have a high water table within certain depths in most years, but they cannot predict that a high water table will always be at a specific level in the soil on a specific date.

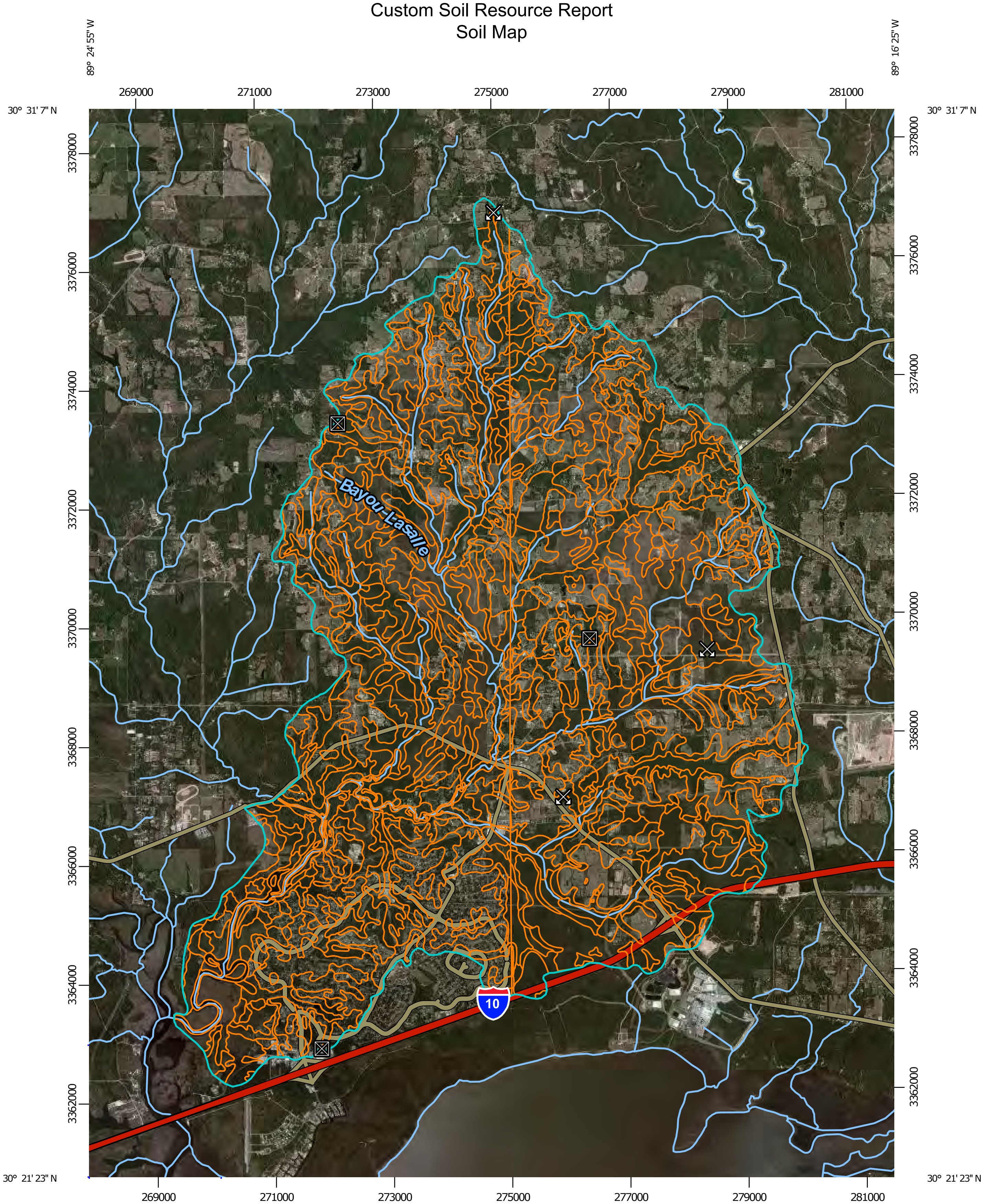
After soil scientists located and identified the significant natural bodies of soil in the survey area, they drew the boundaries of these bodies on aerial photographs and identified each as a specific map unit. Aerial photographs show trees, buildings, fields, roads, and rivers, all of which help in locating boundaries accurately.

Soil Map

The soil map section includes the soil map for the defined area of interest, a list of soil map units on the map and extent of each map unit, and cartographic symbols displayed on the map. Also presented are various metadata about data used to produce the map, and a description of each soil map unit.

Appendix A: Soil Survey

Custom Soil Resource Report
Soil Map



Map Scale: 1:87,800 if printed on A portrait (8.5" x 11") sheet.

Meters: 0, 1000, 2000, 4000, 6000

Feet: 0, 4000, 8000, 16000, 24000

N

Map projection: Web Mercator Corner coordinates: WGS84 Edge tics: UTM Zone 16N WGS84

MAP LEGEND

Area of Interest (AOI)

- Area of Interest (AOI)

Soils

- Soil Map Unit Polygons
- Soil Map Unit Lines
- Soil Map Unit Points

Special Point Features

- Blowout
- Borrow Pit
- Clay Spot
- Closed Depression
- Gravel Pit
- Gravelly Spot
- Landfill
- Lava Flow
- Marsh or swamp
- Mine or Quarry
- Miscellaneous Water
- Perennial Water
- Rock Outcrop
- Saline Spot
- Sandy Spot
- Severely Eroded Spot
- Sinkhole
- Slide or Slip
- Sodic Spot
- Spoil Area
- Stony Spot
- Very Stony Spot
- Wet Spot
- Other
- Special Line Features

Water Features

- Streams and Canals

Transportation

- Rails
- Interstate Highways
- US Routes
- Major Roads
- Local Roads

Background

- Aerial Photography

MAP INFORMATION

The soil surveys that comprise your AOI were mapped at 1:20,000.

Please rely on the bar scale on each map sheet for map measurements.

Source of Map: Natural Resources Conservation Service
Web Soil Survey URL: http://websoilsurvey.nrcs.usda.gov
Coordinate System: Web Mercator (EPSG:3857)

Maps from the Web Soil Survey are based on the Web Mercator projection, which preserves direction and shape but distorts distance and area. A projection that preserves area, such as the Albers equal-area conic projection, should be used if more accurate calculations of distance or area are required.

This product is generated from the USDA-NRCS certified data as of the version date(s) listed below.

Soil Survey Area: Hancock County, Mississippi
Survey Area Data: Version 10, Dec 23, 2013

Soil Survey Area: Harrison County, Mississippi
Survey Area Data: Version 10, Dec 23, 2013

Your area of interest (AOI) includes more than one soil survey area. These survey areas may have been mapped at different scales, with a different land use in mind, at different times, or at different levels of detail. This may result in map unit symbols, soil properties, and interpretations that do not completely agree across soil survey area boundaries.

Soil map units are labeled (as space allows) for map scales 1:50,000 or larger.

Date(s) aerial images were photographed: Jan 22, 2010—Jun 2, 2011

The orthophoto or other base map on which the soil lines were compiled and digitized probably differs from the background imagery displayed on these maps. As a result, some minor shifting of map unit boundaries may be evident.

Map Unit Legend

Hancock County, Mississippi (MS045)			
Map Unit Symbol	**Map Unit Name**	**Acres in AOI**	**Percent of AOI**
At	Atmore silt loam	1,441.1	6.4%
Be	Beauregard silt loam	56.7	0.3%
Bg	Bigbee-Bibb complex, frequently flooded	455.0	2.0%
EsA	Escambia loam, 0 to 2 percent slopes	281.5	1.3%
EsB	Escambia loam, 2 to 5 percent slopes	253.5	1.1%
EuB	Eustis loamy fine sand, 2 to 5 percent slopes	110.7	0.5%
HA	Handsboro association	320.5	1.4%
HlA	Harleston fine sandy loam, 0 to 2 percent slopes	479.7	2.1%
HlB	Harleston fine sandy loam, 2 to 5 percent slopes	225.8	1.0%
MaB	Malbis fine sandy loam, 2 to 5 percent slopes	216.6	1.0%
MaC	Malbis fine sandy loam, 5 to 8 percent slopes	252.0	1.1%
McB	McLaurin fine sandy loam, 2 to 5 percent slopes	36.5	0.2%
McC	McLaurin fine sandy loam, 5 to 8 percent slopes	159.5	0.7%
PoA	Poarch fine sandy loam, 0 to 2 percent slopes	103.4	0.5%
PoB	Poarch fine sandy loam, 2 to 5 percent slopes	3,077.0	13.7%
PoC	Poarch fine sandy loam, 5 to 8 percent slopes	1,312.0	5.8%
PoD	Poarch fine sandy loam, 8 to 12 percent slopes	401.0	1.8%
RuB	Ruston fine sandy loam, 2 to 5 percent slopes	127.3	0.6%
RuC	Ruston fine sandy loam, 5 to 8 percent slopes	116.0	0.5%
SaA	Saucier fine sandy loam, 0 to 2 percent slopes	24.0	0.1%
SaB	Saucier fine sandy loam, 2 to 5 percent slopes	666.4	3.0%
SaC	Saucier fine sandy loam, 5 to 8 percent slopes	453.2	2.0%
SaD	Saucier fine sandy loam, 8 to 12 percent slopes	203.7	0.9%

Hancock County, Mississippi (MS045)			
Map Unit Symbol	Map Unit Name	Acres in AOI	Percent of AOI
ScB	Saucier-Susquehanna complex, 2 to 5 percent slopes	13.9	0.1%
ScD	Saucier-Susquehanna complex, 5 to 12 percent slopes	12.8	0.1%
SmD	Smithdale fine sandy loam, 8 to 12 percent slopes	47.3	0.2%
Su	Smithton fine sandy loam, frequently flooded	489.4	2.2%
W	Water	253.0	1.1%
Subtotals for Soil Survey Area		**11,589.4**	**51.6%**
Totals for Area of Interest		**22,446.7**	**100.0%**

Harrison County, Mississippi (MS047)			
Map Unit Symbol	Map Unit Name	Acres in AOI	Percent of AOI
At	Atmore silt loam	651.5	2.9%
Es	Escambia silt loam	91.4	0.4%
EtB	Eustis loamy sand, 0 to 5 percent slopes	20.2	0.1%
EuE	Eustis and Poarch soils, 8 to 17 percent slopes	22.3	0.1%
HlA	Harleston fine sandy loam, 0 to 2 percent slopes	458.9	2.0%
HlB	Harleston fine sandy loam, 2 to 5 percent slopes	1,710.3	7.6%
Lr	Lakeland fine sand	60.8	0.3%
Nh	Nahunta silt loam	42.2	0.2%
Pm	Plummer loamy sand	106.5	0.5%
PoA	Poarch fine sandy loam, 0 to 2 percent slopes	127.9	0.6%
PoB	Poarch fine sandy loam, 2 to 5 percent slopes	3,712.7	16.5%
PoC	Poarch fine sandy loam, 5 to 12 percent slopes	622.4	2.8%
Ps	Ponzer and Smithton soils	629.2	2.8%
RuB	Ruston fine sandy loam, 2 to 5 percent slopes	954.3	4.3%
RuC	Ruston fine sandy loam, 5 to 8 percent slopes	545.8	2.4%
RuD	Ruston fine sandy loam, 8 to 12 percent slopes (smithdale)	150.5	0.7%
SfB	Saucier fine sandy loam, 2 to 5 percent slopes	488.3	2.2%
SfC	Saucier fine sandy loam, 5 to 8 percent slopes	113.3	0.5%
ShC	Saucier, Smithton, and Susquehanna soils, rolling	22.8	0.1%

Harrison County, Mississippi (MS047)			
Map Unit Symbol	**Map Unit Name**	**Acres in AOI**	**Percent of AOI**
SnB	Saucier-Susquehanna complex, 2 to 5 percent slopes	44.5	0.2%
SsE	Smithdale fine sandy loam, 12 to 17 percent slopes	1.3	0.0%
St	Smithton fine sandy loam	250.1	1.1%
W	Water	30.1	0.1%
Subtotals for Soil Survey Area		**10,857.2**	**48.4%**
Totals for Area of Interest		**22,446.7**	**100.0%**

Map Unit Descriptions

The map units delineated on the detailed soil maps in a soil survey represent the soils or miscellaneous areas in the survey area. The map unit descriptions, along with the maps, can be used to determine the composition and properties of a unit.

A map unit delineation on a soil map represents an area dominated by one or more major kinds of soil or miscellaneous areas. A map unit is identified and named according to the taxonomic classification of the dominant soils. Within a taxonomic class there are precisely defined limits for the properties of the soils. On the landscape, however, the soils are natural phenomena, and they have the characteristic variability of all natural phenomena. Thus, the range of some observed properties may extend beyond the limits defined for a taxonomic class. Areas of soils of a single taxonomic class rarely, if ever, can be mapped without including areas of other taxonomic classes. Consequently, every map unit is made up of the soils or miscellaneous areas for which it is named and some minor components that belong to taxonomic classes other than those of the major soils.

Most minor soils have properties similar to those of the dominant soil or soils in the map unit, and thus they do not affect use and management. These are called noncontrasting, or similar, components. They may or may not be mentioned in a particular map unit description. Other minor components, however, have properties and behavioral characteristics divergent enough to affect use or to require different management. These are called contrasting, or dissimilar, components. They generally are in small areas and could not be mapped separately because of the scale used. Some small areas of strongly contrasting soils or miscellaneous areas are identified by a special symbol on the maps. If included in the database for a given area, the contrasting minor components are identified in the map unit descriptions along with some characteristics of each. A few areas of minor components may not have been observed, and consequently they are not mentioned in the descriptions, especially where the pattern was so complex that it was impractical to make enough observations to identify all the soils and miscellaneous areas on the landscape.

The presence of minor components in a map unit in no way diminishes the usefulness or accuracy of the data. The objective of mapping is not to delineate pure taxonomic classes but rather to separate the landscape into landforms or landform segments that have similar use and management requirements. The delineation of such segments on the map provides sufficient information for the development of resource plans. If intensive use of small areas is planned, however, onsite investigation is needed to define and locate the soils and miscellaneous areas.

An identifying symbol precedes the map unit name in the map unit descriptions. Each description includes general facts about the unit and gives important soil properties and qualities.

Soils that have profiles that are almost alike make up a *soil series*. Except for differences in texture of the surface layer, all the soils of a series have major horizons that are similar in composition, thickness, and arrangement.

Soils of one series can differ in texture of the surface layer, slope, stoniness, salinity, degree of erosion, and other characteristics that affect their use. On the basis of such differences, a soil series is divided into *soil phases*. Most of the areas shown on the detailed soil maps are phases of soil series. The name of a soil phase commonly indicates a feature that affects use or management. For example, Alpha silt loam, 0 to 2 percent slopes, is a phase of the Alpha series.

Some map units are made up of two or more major soils or miscellaneous areas. These map units are complexes, associations, or undifferentiated groups.

A *complex* consists of two or more soils or miscellaneous areas in such an intricate pattern or in such small areas that they cannot be shown separately on the maps. The pattern and proportion of the soils or miscellaneous areas are somewhat similar in all areas. Alpha-Beta complex, 0 to 6 percent slopes, is an example.

An *association* is made up of two or more geographically associated soils or miscellaneous areas that are shown as one unit on the maps. Because of present or anticipated uses of the map units in the survey area, it was not considered practical or necessary to map the soils or miscellaneous areas separately. The pattern and relative proportion of the soils or miscellaneous areas are somewhat similar. Alpha-Beta association, 0 to 2 percent slopes, is an example.

An *undifferentiated group* is made up of two or more soils or miscellaneous areas that could be mapped individually but are mapped as one unit because similar interpretations can be made for use and management. The pattern and proportion of the soils or miscellaneous areas in a mapped area are not uniform. An area can be made up of only one of the major soils or miscellaneous areas, or it can be made up of all of them. Alpha and Beta soils, 0 to 2 percent slopes, is an example.

Some surveys include *miscellaneous areas*. Such areas have little or no soil material and support little or no vegetation. Rock outcrop is an example.

Hancock County, Mississippi

At—Atmore silt loam

Map Unit Setting

National map unit symbol: c4w1
Elevation: 20 to 400 feet
Mean annual precipitation: 40 to 75 inches
Mean annual air temperature: 61 to 72 degrees F
Frost-free period: 200 to 335 days
Farmland classification: Not prime farmland

Map Unit Composition

Atmore and similar soils: 85 percent
Minor components: 12 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Atmore

Setting

Landform: Depressions
Landform position (three-dimensional): Dip
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Loamy marine deposits

Typical profile

H1 - 0 to 16 inches: silt loam
H2 - 16 to 39 inches: loam
H3 - 39 to 60 inches: clay loam

Properties and qualities

Slope: 0 to 2 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Poorly drained
Runoff class: Very high
Capacity of the most limiting layer to transmit water (Ksat): Moderately high (0.20 to 0.60 in/hr)
Depth to water table: About 0 to 12 inches
Frequency of flooding: None
Frequency of ponding: None
Available water storage in profile: High (about 12.0 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 4w
Hydrologic Soil Group: B/D

Minor Components

Escambia

Percent of map unit: 3 percent
Landform: Coastal plains
Landform position (two-dimensional): Shoulder
Landform position (three-dimensional): Crest
Down-slope shape: Linear

Across-slope shape: Linear

Harleston

Percent of map unit: 3 percent
Landform: Stream terraces
Landform position (two-dimensional): Shoulder
Landform position (three-dimensional): Tread
Down-slope shape: Linear
Across-slope shape: Linear

Plummer

Percent of map unit: 3 percent
Landform: Flats
Landform position (three-dimensional): Dip
Down-slope shape: Convex
Across-slope shape: Convex

Smithton

Percent of map unit: 3 percent
Landform: Terraces
Landform position (three-dimensional): Tread, dip
Down-slope shape: Linear
Across-slope shape: Linear

Be—Beauregard silt loam

Map Unit Setting

National map unit symbol: c4w3
Elevation: 50 to 450 feet
Mean annual precipitation: 48 to 75 inches
Mean annual air temperature: 63 to 70 degrees F
Frost-free period: 200 to 335 days
Farmland classification: Not prime farmland

Map Unit Composition

Beauregard and similar soils: 85 percent
Minor components: 12 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Beauregard

Setting

Landform: Coastal plains
Landform position (two-dimensional): Shoulder
Landform position (three-dimensional): Crest
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Loamy alluvium

Typical profile

H1 - 0 to 9 inches: silt loam

H2 - 9 to 19 inches: silt loam
H3 - 19 to 60 inches: silt loam
H4 - 60 to 64 inches: silty clay loam

Properties and qualities

Slope: 0 to 1 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Moderately well drained
Runoff class: Medium
Capacity of the most limiting layer to transmit water (Ksat): Moderately low to moderately high (0.06 to 0.20 in/hr)
Depth to water table: About 18 to 36 inches
Frequency of flooding: None
Frequency of ponding: None
Available water storage in profile: Very high (about 12.6 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 2w
Hydrologic Soil Group: C

Minor Components

Atmore

Percent of map unit: 3 percent
Landform: Depressions
Landform position (three-dimensional): Dip
Down-slope shape: Linear
Across-slope shape: Linear

Escambia

Percent of map unit: 3 percent
Landform: Coastal plains
Landform position (two-dimensional): Shoulder
Landform position (three-dimensional): Crest
Down-slope shape: Linear
Across-slope shape: Linear

Harleston

Percent of map unit: 3 percent
Landform: Stream terraces
Landform position (two-dimensional): Shoulder
Landform position (three-dimensional): Tread
Down-slope shape: Linear
Across-slope shape: Linear

Smithton

Percent of map unit: 3 percent
Landform: Terraces
Landform position (three-dimensional): Tread, dip
Down-slope shape: Linear
Across-slope shape: Linear

Bg—Bigbee-Bibb complex, frequently flooded

Map Unit Setting

National map unit symbol: c4w4
Elevation: 50 to 450 feet
Mean annual precipitation: 60 to 75 inches
Mean annual air temperature: 64 to 70 degrees F
Frost-free period: 270 to 335 days
Farmland classification: Not prime farmland

Map Unit Composition

Bigbee and similar soils: 45 percent
Bibb and similar soils: 40 percent
Minor components: 9 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Bigbee

Setting

Landform: Terraces
Landform position (three-dimensional): Tread
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Sandy alluvium deposits

Typical profile

H1 - 0 to 38 inches: loamy sand
H2 - 38 to 60 inches: sand

Properties and qualities

Slope: 0 to 2 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Excessively drained
Runoff class: Very low
Capacity of the most limiting layer to transmit water (Ksat): High to very high (6.00 to 20.00 in/hr)
Depth to water table: About 42 to 72 inches
Frequency of flooding: Frequent
Frequency of ponding: None
Available water storage in profile: Low (about 4.6 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 5w
Hydrologic Soil Group: A

Description of Bibb

Setting

Landform: Flood plains

Landform position (three-dimensional): Tread
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Sandy and loamy alluvium deposits

Typical profile
H1 - 0 to 60 inches: silt loam

Properties and qualities
Slope: 0 to 2 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Poorly drained
Runoff class: Very high
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (0.60 to 2.00 in/hr)
Depth to water table: About 6 to 12 inches
Frequency of flooding: Frequent
Frequency of ponding: None
Available water storage in profile: High (about 10.8 inches)

Interpretive groups
Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 5w
Hydrologic Soil Group: D

Minor Components

Harleston
Percent of map unit: 9 percent
Landform: Stream terraces
Landform position (two-dimensional): Shoulder
Landform position (three-dimensional): Tread
Down-slope shape: Linear
Across-slope shape: Linear

EsA—Escambia loam, 0 to 2 percent slopes

Map Unit Setting
National map unit symbol: c4w6
Elevation: 20 to 200 feet
Mean annual precipitation: 42 to 75 inches
Mean annual air temperature: 61 to 70 degrees F
Frost-free period: 220 to 350 days
Farmland classification: All areas are prime farmland

Map Unit Composition
Escambia and similar soils: 85 percent
Minor components: 14 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Escambia

Setting

Landform: Coastal plains
Landform position (two-dimensional): Shoulder
Landform position (three-dimensional): Crest
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Sandy and loamy marine deposits

Typical profile

H1 - 0 to 14 inches: loam
H2 - 14 to 33 inches: fine sandy loam
H3 - 33 to 60 inches: loam

Properties and qualities

Slope: 0 to 2 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Somewhat poorly drained
Runoff class: Low
Capacity of the most limiting layer to transmit water (Ksat): Moderately low to moderately high (0.06 to 0.60 in/hr)
Depth to water table: About 18 to 30 inches
Frequency of flooding: None
Frequency of ponding: None
Available water storage in profile: Moderate (about 9.0 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 2w
Hydrologic Soil Group: C

Minor Components

Atmore

Percent of map unit: 3 percent
Landform: Depressions
Landform position (three-dimensional): Dip
Down-slope shape: Linear
Across-slope shape: Linear

Harleston

Percent of map unit: 3 percent
Landform: Stream terraces
Landform position (two-dimensional): Shoulder
Landform position (three-dimensional): Tread
Down-slope shape: Linear
Across-slope shape: Linear

Guyton

Percent of map unit: 3 percent
Landform: Terraces
Landform position (three-dimensional): Tread
Down-slope shape: Linear
Across-slope shape: Linear

Saucier

Percent of map unit: 3 percent
Landform: Coastal plains
Landform position (two-dimensional): Shoulder
Landform position (three-dimensional): Crest
Down-slope shape: Linear
Across-slope shape: Linear

Poarch

Percent of map unit: 2 percent
Landform: Ridges
Landform position (two-dimensional): Shoulder
Landform position (three-dimensional): Crest
Down-slope shape: Linear
Across-slope shape: Linear

EsB—Escambia loam, 2 to 5 percent slopes

Map Unit Setting

National map unit symbol: c4w7
Elevation: 20 to 200 feet
Mean annual precipitation: 42 to 75 inches
Mean annual air temperature: 61 to 70 degrees F
Frost-free period: 220 to 350 days
Farmland classification: All areas are prime farmland

Map Unit Composition

Escambia and similar soils: 85 percent
Minor components: 13 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Escambia

Setting

Landform: Coastal plains
Landform position (two-dimensional): Shoulder
Landform position (three-dimensional): Crest
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Sandy and loamy marine deposits

Typical profile

H1 - 0 to 14 inches: loam
H2 - 14 to 33 inches: fine sandy loam
H3 - 33 to 60 inches: loam

Properties and qualities

Slope: 2 to 5 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Somewhat poorly drained

Runoff class: Low
Capacity of the most limiting layer to transmit water (Ksat): Moderately low to moderately high (0.06 to 0.60 in/hr)
Depth to water table: About 18 to 30 inches
Frequency of flooding: None
Frequency of ponding: None
Available water storage in profile: Moderate (about 9.0 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 2e
Hydrologic Soil Group: C

Minor Components

Atmore

Percent of map unit: 3 percent
Landform: Depressions
Landform position (three-dimensional): Dip
Down-slope shape: Linear
Across-slope shape: Linear

Harleston

Percent of map unit: 3 percent
Landform: Stream terraces
Landform position (two-dimensional): Shoulder
Landform position (three-dimensional): Tread
Down-slope shape: Linear
Across-slope shape: Linear

Guyton

Percent of map unit: 3 percent
Landform: Terraces
Landform position (three-dimensional): Tread
Down-slope shape: Linear
Across-slope shape: Linear

Poarch

Percent of map unit: 2 percent
Landform: Ridges
Landform position (two-dimensional): Shoulder
Landform position (three-dimensional): Crest
Down-slope shape: Linear
Across-slope shape: Linear

Saucier

Percent of map unit: 2 percent
Landform: Coastal plains
Landform position (two-dimensional): Shoulder
Landform position (three-dimensional): Crest
Down-slope shape: Linear
Across-slope shape: Linear

EuB—Eustis loamy fine sand, 2 to 5 percent slopes

Map Unit Setting

National map unit symbol: c4w8
Mean annual precipitation: 60 to 75 inches
Mean annual air temperature: 64 to 70 degrees F
Frost-free period: 270 to 335 days
Farmland classification: Farmland of statewide importance

Map Unit Composition

Eustis and similar soils: 85 percent
Minor components: 12 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Eustis

Setting

Landform: Hillslopes
Landform position (two-dimensional): Shoulder
Landform position (three-dimensional): Crest
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Sandy marine deposits

Typical profile

H1 - 0 to 6 inches: loamy fine sand
H2 - 6 to 24 inches: sand
H3 - 24 to 76 inches: loamy sand
H4 - 76 to 98 inches: sand

Properties and qualities

Slope: 2 to 5 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Somewhat excessively drained
Runoff class: Very low
Capacity of the most limiting layer to transmit water (Ksat): High to very high (6.00 to 20.00 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Available water storage in profile: Low (about 5.0 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 3s
Hydrologic Soil Group: A

Minor Components

Escambia

Percent of map unit: 4 percent
Landform: Coastal plains
Landform position (two-dimensional): Shoulder
Landform position (three-dimensional): Crest
Down-slope shape: Linear
Across-slope shape: Linear

Harleston

Percent of map unit: 4 percent
Landform: Stream terraces
Landform position (two-dimensional): Shoulder
Landform position (three-dimensional): Tread
Down-slope shape: Linear
Across-slope shape: Linear

Poarch

Percent of map unit: 4 percent
Landform: Ridges
Landform position (two-dimensional): Shoulder
Landform position (three-dimensional): Crest
Down-slope shape: Linear
Across-slope shape: Linear

HA—Handsboro association

Map Unit Setting

National map unit symbol: c4wb
Elevation: 0 feet
Mean annual precipitation: 38 to 75 inches
Mean annual air temperature: 59 to 70 degrees F
Frost-free period: 220 to 335 days
Farmland classification: Not prime farmland

Map Unit Composition

Handsboro and similar soils: 85 percent
Minor components: 10 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Handsboro

Setting

Landform: Tidal flats
Landform position (three-dimensional): Dip
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Decomposed herbaceous plant remains and alluvium deposits

Typical profile

H1 - 0 to 2 inches: mucky silt loam
Oa - 2 to 46 inches: muck
H3 - 46 to 61 inches: stratified muck to loam

Properties and qualities

Slope: 0 to 1 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Very poorly drained
Runoff class: Negligible
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (0.60 to 2.00 in/hr)
Depth to water table: About 0 inches
Frequency of flooding: Frequent
Frequency of ponding: Frequent
Salinity, maximum in profile: Moderately saline (16.0 mmhos/cm)
Sodium adsorption ratio, maximum in profile: 4.0
Available water storage in profile: Very high (about 14.1 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 8w
Hydrologic Soil Group: D

Minor Components

Bohicket

Percent of map unit: 10 percent
Landform: Tidal flats
Down-slope shape: Linear
Across-slope shape: Linear

HIA—Harleston fine sandy loam, 0 to 2 percent slopes

Map Unit Setting

National map unit symbol: c4wc
Mean annual precipitation: 60 to 75 inches
Mean annual air temperature: 64 to 70 degrees F
Frost-free period: 270 to 335 days
Farmland classification: All areas are prime farmland

Map Unit Composition

Harleston and similar soils: 90 percent
Minor components: 2 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Harleston

Setting

Landform: Stream terraces

Landform position (two-dimensional): Shoulder
Landform position (three-dimensional): Tread
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Loamy alluvium

Typical profile
H1 - 0 to 9 inches: fine sandy loam
H2 - 9 to 60 inches: sandy loam
H3 - 60 to 72 inches: sandy loam

Properties and qualities
Slope: 0 to 2 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Moderately well drained
Runoff class: Low
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (0.60 to 2.00 in/hr)
Depth to water table: About 24 to 36 inches
Frequency of flooding: None
Frequency of ponding: None
Available water storage in profile: Moderate (about 8.7 inches)

Interpretive groups
Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 2w
Hydrologic Soil Group: C

Minor Components

Unnamed hydric soils (133de)
Percent of map unit: 2 percent
Landform: Depressions
Landform position (three-dimensional): Dip
Down-slope shape: Concave
Across-slope shape: Concave

HIB—Harleston fine sandy loam, 2 to 5 percent slopes

Map Unit Setting
National map unit symbol: c4wd
Elevation: 100 to 300 feet
Mean annual precipitation: 48 to 75 inches
Mean annual air temperature: 63 to 70 degrees F
Frost-free period: 200 to 335 days
Farmland classification: All areas are prime farmland

Map Unit Composition
Harleston and similar soils: 85 percent
Minor components: 12 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Harleston

Setting

Landform: Stream terraces
Landform position (two-dimensional): Shoulder
Landform position (three-dimensional): Tread
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Loamy alluvium

Typical profile

H1 - 0 to 8 inches: fine sandy loam
H2 - 8 to 30 inches: sandy loam
H3 - 30 to 60 inches: sandy loam

Properties and qualities

Slope: 2 to 5 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Moderately well drained
Runoff class: Low
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (0.60 to 2.00 in/hr)
Depth to water table: About 24 to 36 inches
Frequency of flooding: None
Frequency of ponding: None
Available water storage in profile: Moderate (about 8.7 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 2e
Hydrologic Soil Group: C

Minor Components

Saucier

Percent of map unit: 3 percent
Landform: Coastal plains
Landform position (two-dimensional): Shoulder
Landform position (three-dimensional): Crest
Down-slope shape: Linear
Across-slope shape: Linear

Smithton

Percent of map unit: 3 percent
Landform: Terraces
Landform position (three-dimensional): Tread, dip
Down-slope shape: Linear
Across-slope shape: Linear

Escambia

Percent of map unit: 3 percent
Landform: Coastal plains
Landform position (two-dimensional): Shoulder
Landform position (three-dimensional): Crest
Down-slope shape: Linear
Across-slope shape: Linear

Poarch

Percent of map unit: 3 percent
Landform: Ridges
Landform position (two-dimensional): Shoulder
Landform position (three-dimensional): Crest
Down-slope shape: Linear
Across-slope shape: Linear

MaB—Malbis fine sandy loam, 2 to 5 percent slopes

Map Unit Setting

National map unit symbol: c4wh
Mean annual precipitation: 60 to 75 inches
Mean annual air temperature: 64 to 70 degrees F
Frost-free period: 270 to 335 days
Farmland classification: All areas are prime farmland

Map Unit Composition

Malbis and similar soils: 90 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Malbis

Setting

Landform: Coastal plains
Landform position (two-dimensional): Shoulder
Landform position (three-dimensional): Crest
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Loamy marine deposits

Typical profile

H1 - 0 to 7 inches: fine sandy loam
H2 - 7 to 20 inches: loam
H3 - 20 to 32 inches: sandy clay loam
H4 - 32 to 60 inches: sandy clay loam

Properties and qualities

Slope: 2 to 5 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Moderately well drained
Runoff class: Low
Capacity of the most limiting layer to transmit water (Ksat): Moderately high (0.20 to 0.60 in/hr)
Depth to water table: About 30 to 42 inches
Frequency of flooding: None
Frequency of ponding: None
Available water storage in profile: Moderate (about 7.3 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 2e
Hydrologic Soil Group: B

MaC—Malbis fine sandy loam, 5 to 8 percent slopes

Map Unit Setting

National map unit symbol: c4wj
Mean annual precipitation: 60 to 75 inches
Mean annual air temperature: 64 to 70 degrees F
Frost-free period: 270 to 335 days
Farmland classification: All areas are prime farmland

Map Unit Composition

Malbis and similar soils: 90 percent
Minor components: 2 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Malbis

Setting

Landform: Coastal plains
Landform position (two-dimensional): Shoulder
Landform position (three-dimensional): Crest
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Loamy marine deposits

Typical profile

H1 - 0 to 7 inches: fine sandy loam
H2 - 7 to 20 inches: loam
H3 - 20 to 32 inches: sandy clay loam
H4 - 32 to 60 inches: sandy clay loam

Properties and qualities

Slope: 2 to 5 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Moderately well drained
Runoff class: Low
Capacity of the most limiting layer to transmit water (Ksat): Moderately high (0.20 to 0.60 in/hr)
Depth to water table: About 30 to 42 inches
Frequency of flooding: None
Frequency of ponding: None
Available water storage in profile: Moderate (about 7.3 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 3e
Hydrologic Soil Group: B

Minor Components

Unnamed hydric soils (133dr)

Percent of map unit: 2 percent
Landform: Drainageways
Landform position (three-dimensional): Dip
Down-slope shape: Linear
Across-slope shape: Linear

McB—McLaurin fine sandy loam, 2 to 5 percent slopes

Map Unit Setting

National map unit symbol: c4wk
Mean annual precipitation: 60 to 75 inches
Mean annual air temperature: 64 to 70 degrees F
Frost-free period: 270 to 335 days
Farmland classification: All areas are prime farmland

Map Unit Composition

Mclaurin and similar soils: 90 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Mclaurin

Setting

Landform: Coastal plains
Landform position (two-dimensional): Shoulder
Landform position (three-dimensional): Crest
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Loamy fluviomarine deposits

Typical profile

H1 - 0 to 10 inches: fine sandy loam
H2 - 10 to 38 inches: sandy loam
H3 - 38 to 49 inches: loamy sand
H4 - 49 to 60 inches: sandy loam

Properties and qualities

Slope: 2 to 5 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Well drained
Runoff class: Low
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (0.60 to 2.00 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Available water storage in profile: Moderate (about 7.3 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 2e
Hydrologic Soil Group: B

McC—McLaurin fine sandy loam, 5 to 8 percent slopes

Map Unit Setting

National map unit symbol: c4wl
Mean annual precipitation: 60 to 75 inches
Mean annual air temperature: 64 to 70 degrees F
Frost-free period: 270 to 335 days
Farmland classification: Farmland of statewide importance

Map Unit Composition

Mclaurin and similar soils: 90 percent
Minor components: 3 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Mclaurin

Setting

Landform: Coastal plains
Landform position (two-dimensional): Shoulder
Landform position (three-dimensional): Side slope
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Loamy fluviomarine deposits

Typical profile

H1 - 0 to 10 inches: fine sandy loam
H2 - 10 to 38 inches: sandy loam
H3 - 38 to 49 inches: loamy sand
H4 - 49 to 60 inches: sandy loam

Properties and qualities

Slope: 5 to 8 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Well drained
Runoff class: Medium
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (0.60 to 2.00 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Available water storage in profile: Moderate (about 7.3 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 3e
Hydrologic Soil Group: B

Minor Components

Unnamed hydric soils (133dr)

Percent of map unit: 3 percent
Landform: Drainageways
Landform position (two-dimensional): Shoulder
Landform position (three-dimensional): Dip
Down-slope shape: Linear
Across-slope shape: Linear

PoA—Poarch fine sandy loam, 0 to 2 percent slopes

Map Unit Setting

National map unit symbol: c4wp
Mean annual precipitation: 60 to 75 inches
Mean annual air temperature: 64 to 70 degrees F
Frost-free period: 270 to 335 days
Farmland classification: All areas are prime farmland

Map Unit Composition

Poarch and similar soils: 85 percent
Minor components: 14 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Poarch

Setting

Landform: Ridges
Landform position (two-dimensional): Shoulder
Landform position (three-dimensional): Crest
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Sandy and loamy marine deposits

Typical profile

H1 - 0 to 7 inches: fine sandy loam
H2 - 7 to 35 inches: loam
H3 - 35 to 60 inches: loam

Properties and qualities

Slope: 0 to 2 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Well drained
Runoff class: Low
Capacity of the most limiting layer to transmit water (Ksat): Moderately high (0.20 to 0.60 in/hr)
Depth to water table: About 30 to 60 inches
Frequency of flooding: None
Frequency of ponding: None
Available water storage in profile: Moderate (about 8.8 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 1
Hydrologic Soil Group: B

Minor Components

Escambia

Percent of map unit: 4 percent
Landform: Coastal plains
Landform position (two-dimensional): Shoulder
Landform position (three-dimensional): Crest
Down-slope shape: Linear
Across-slope shape: Linear

Harleston

Percent of map unit: 4 percent
Landform: Stream terraces
Landform position (two-dimensional): Shoulder
Landform position (three-dimensional): Tread
Down-slope shape: Linear
Across-slope shape: Linear

Eustis

Percent of map unit: 4 percent
Landform: Hillslopes
Landform position (two-dimensional): Shoulder
Landform position (three-dimensional): Crest
Down-slope shape: Linear
Across-slope shape: Linear

Unnamed hydric soils (133de)

Percent of map unit: 2 percent
Landform: Depressions
Landform position (three-dimensional): Dip
Down-slope shape: Concave
Across-slope shape: Concave

PoB—Poarch fine sandy loam, 2 to 5 percent slopes

Map Unit Setting

National map unit symbol: c4wq
Mean annual precipitation: 60 to 75 inches
Mean annual air temperature: 64 to 70 degrees F
Frost-free period: 270 to 335 days
Farmland classification: All areas are prime farmland

Map Unit Composition

Poarch and similar soils: 90 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Poarch

Setting

Landform: Ridges
Landform position (two-dimensional): Shoulder
Landform position (three-dimensional): Crest
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Sandy and loamy marine deposits

Typical profile

H1 - 0 to 10 inches: fine sandy loam
H2 - 10 to 73 inches: loam
H3 - 73 to 81 inches: loam

Properties and qualities

Slope: 2 to 5 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Well drained
Runoff class: Low
Capacity of the most limiting layer to transmit water (Ksat): Moderately high (0.20 to 0.60 in/hr)
Depth to water table: About 30 to 60 inches
Frequency of flooding: None
Frequency of ponding: None
Available water storage in profile: Moderate (about 8.8 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 2e
Hydrologic Soil Group: B

PoC—Poarch fine sandy loam, 5 to 8 percent slopes

Map Unit Setting

National map unit symbol: c4wr
Elevation: 100 to 300 feet
Mean annual precipitation: 48 to 75 inches
Mean annual air temperature: 63 to 70 degrees F
Frost-free period: 200 to 335 days
Farmland classification: Farmland of statewide importance

Map Unit Composition

Poarch and similar soils: 85 percent
Minor components: 12 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Poarch

Setting

Landform: Hillslopes
Landform position (two-dimensional): Shoulder

Landform position (three-dimensional): Side slope
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Sandy and loamy marine deposits

Typical profile
H1 - 0 to 7 inches: fine sandy loam
H2 - 7 to 35 inches: loam
H3 - 35 to 60 inches: loam

Properties and qualities
Slope: 5 to 8 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Well drained
Runoff class: Medium
Capacity of the most limiting layer to transmit water (Ksat): Moderately high (0.20 to 0.60 in/hr)
Depth to water table: About 30 to 60 inches
Frequency of flooding: None
Frequency of ponding: None
Available water storage in profile: Moderate (about 8.8 inches)

Interpretive groups
Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 3e
Hydrologic Soil Group: B

Minor Components

Escambia
Percent of map unit: 4 percent
Landform: Coastal plains
Landform position (two-dimensional): Shoulder
Landform position (three-dimensional): Crest
Down-slope shape: Linear
Across-slope shape: Linear

Harleston
Percent of map unit: 4 percent
Landform: Stream terraces
Landform position (two-dimensional): Shoulder
Landform position (three-dimensional): Tread
Down-slope shape: Linear
Across-slope shape: Linear

Smithton
Percent of map unit: 4 percent
Landform: Terraces
Landform position (three-dimensional): Tread, dip
Down-slope shape: Linear
Across-slope shape: Linear

PoD—Poarch fine sandy loam, 8 to 12 percent slopes

Map Unit Setting

National map unit symbol: c4ws
Elevation: 100 to 300 feet
Mean annual precipitation: 48 to 75 inches
Mean annual air temperature: 63 to 70 degrees F
Frost-free period: 200 to 335 days
Farmland classification: Farmland of statewide importance

Map Unit Composition

Poarch and similar soils: 85 percent
Minor components: 12 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Poarch

Setting

Landform: Hillslopes
Landform position (two-dimensional): Shoulder
Landform position (three-dimensional): Side slope
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Sandy and loamy marine deposits

Typical profile

H1 - 0 to 7 inches: fine sandy loam
H2 - 7 to 35 inches: loam
H3 - 35 to 60 inches: loam

Properties and qualities

Slope: 8 to 12 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Well drained
Runoff class: Medium
Capacity of the most limiting layer to transmit water (Ksat): Moderately high (0.20 to 0.60 in/hr)
Depth to water table: About 30 to 60 inches
Frequency of flooding: None
Frequency of ponding: None
Available water storage in profile: Moderate (about 8.8 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 4e
Hydrologic Soil Group: B

Minor Components

Smithton

Percent of map unit: 4 percent
Landform: Terraces
Landform position (three-dimensional): Tread, dip
Down-slope shape: Linear
Across-slope shape: Linear

Eustis

Percent of map unit: 4 percent
Landform: Hillslopes
Landform position (two-dimensional): Shoulder
Landform position (three-dimensional): Side slope
Down-slope shape: Linear
Across-slope shape: Linear

Saucier

Percent of map unit: 4 percent
Landform: Coastal plains
Landform position (two-dimensional): Shoulder
Landform position (three-dimensional): Side slope
Down-slope shape: Linear
Across-slope shape: Linear

RuB—Ruston fine sandy loam, 2 to 5 percent slopes

Map Unit Setting

National map unit symbol: c4wv
Elevation: 100 to 550 feet
Mean annual precipitation: 60 to 75 inches
Mean annual air temperature: 64 to 70 degrees F
Frost-free period: 270 to 335 days
Farmland classification: All areas are prime farmland

Map Unit Composition

Ruston and similar soils: 95 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Ruston

Setting

Landform: Coastal plains
Landform position (two-dimensional): Shoulder
Landform position (three-dimensional): Side slope
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Loamy fluviomarine deposits

Typical profile

H1 - 0 to 7 inches: fine sandy loam
H2 - 7 to 18 inches: sandy clay loam
H3 - 18 to 39 inches: sandy loam
H4 - 39 to 85 inches: sandy clay loam

Properties and qualities

Slope: 2 to 5 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Well drained
Runoff class: Low
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (0.60 to 2.00 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Available water storage in profile: Moderate (about 8.6 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 3e
Hydrologic Soil Group: B

RuC—Ruston fine sandy loam, 5 to 8 percent slopes

Map Unit Setting

National map unit symbol: c4ww
Elevation: 100 to 550 feet
Mean annual precipitation: 60 to 75 inches
Mean annual air temperature: 64 to 70 degrees F
Frost-free period: 270 to 335 days
Farmland classification: All areas are prime farmland

Map Unit Composition

Ruston and similar soils: 95 percent
Minor components: 2 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Ruston

Setting

Landform: Coastal plains
Landform position (two-dimensional): Shoulder
Landform position (three-dimensional): Side slope
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Loamy fluviomarine deposits

Typical profile

H1 - 0 to 7 inches: fine sandy loam
H2 - 7 to 18 inches: sandy clay loam
H3 - 18 to 39 inches: sandy loam

H4 - 39 to 85 inches: loam

Properties and qualities

Slope: 5 to 8 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Well drained
Runoff class: Medium
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (0.60 to 2.00 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Available water storage in profile: Moderate (about 8.6 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 3e
Hydrologic Soil Group: B

Minor Components

Unnamed hydric soils (133dr)

Percent of map unit: 2 percent
Landform: Drainageways
Landform position (two-dimensional): Shoulder
Landform position (three-dimensional): Dip
Down-slope shape: Linear
Across-slope shape: Linear

SaA—Saucier fine sandy loam, 0 to 2 percent slopes

Map Unit Setting

National map unit symbol: c4wy
Mean annual precipitation: 60 to 75 inches
Mean annual air temperature: 64 to 70 degrees F
Frost-free period: 270 to 335 days
Farmland classification: All areas are prime farmland

Map Unit Composition

Saucier and similar soils: 85 percent
Minor components: 14 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Saucier

Setting

Landform: Coastal plains
Landform position (two-dimensional): Shoulder
Landform position (three-dimensional): Crest
Down-slope shape: Linear
Across-slope shape: Linear

Parent material: Loamy over clayey marine deposits

Typical profile

H1 - 0 to 9 inches: fine sandy loam
H2 - 9 to 40 inches: loam
H3 - 40 to 47 inches: silty clay loam
H4 - 47 to 60 inches: clay

Properties and qualities

Slope: 0 to 2 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Moderately well drained
Runoff class: Low
Capacity of the most limiting layer to transmit water (Ksat): Moderately low to moderately high (0.06 to 0.20 in/hr)
Depth to water table: About 30 to 48 inches
Frequency of flooding: None
Frequency of ponding: None
Available water storage in profile: High (about 10.4 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 2w
Hydrologic Soil Group: C

Minor Components

Poarch

Percent of map unit: 4 percent
Landform: Ridges
Landform position (two-dimensional): Shoulder
Landform position (three-dimensional): Crest
Down-slope shape: Linear
Across-slope shape: Linear

Escambia

Percent of map unit: 4 percent
Landform: Coastal plains
Landform position (two-dimensional): Shoulder
Landform position (three-dimensional): Crest
Down-slope shape: Linear
Across-slope shape: Linear

Harleston

Percent of map unit: 4 percent
Landform: Stream terraces
Landform position (two-dimensional): Shoulder
Landform position (three-dimensional): Tread
Down-slope shape: Linear
Across-slope shape: Linear

Unnamed hydric soils (133de)

Percent of map unit: 2 percent
Landform: Depressions
Landform position (three-dimensional): Dip
Down-slope shape: Concave
Across-slope shape: Concave

SaB—Saucier fine sandy loam, 2 to 5 percent slopes

Map Unit Setting

National map unit symbol: c4wz
Mean annual precipitation: 60 to 75 inches
Mean annual air temperature: 64 to 70 degrees F
Frost-free period: 270 to 335 days
Farmland classification: All areas are prime farmland

Map Unit Composition

Saucier and similar soils: 85 percent
Minor components: 12 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Saucier

Setting

Landform: Coastal plains
Landform position (two-dimensional): Shoulder
Landform position (three-dimensional): Crest
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Loamy over clayey marine deposits

Typical profile

H1 - 0 to 9 inches: fine sandy loam
H2 - 9 to 40 inches: loam
H3 - 40 to 47 inches: silty clay loam
H4 - 47 to 60 inches: clay

Properties and qualities

Slope: 2 to 5 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Moderately well drained
Runoff class: Low
Capacity of the most limiting layer to transmit water (Ksat): Moderately low to moderately high (0.06 to 0.20 in/hr)
Depth to water table: About 30 to 48 inches
Frequency of flooding: None
Frequency of ponding: None
Available water storage in profile: High (about 10.4 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 2e
Hydrologic Soil Group: C

Minor Components

Poarch

Percent of map unit: 4 percent
Landform: Ridges
Landform position (two-dimensional): Shoulder
Landform position (three-dimensional): Crest
Down-slope shape: Linear
Across-slope shape: Linear

Escambia

Percent of map unit: 4 percent
Landform: Coastal plains
Landform position (two-dimensional): Shoulder
Landform position (three-dimensional): Crest
Down-slope shape: Linear
Across-slope shape: Linear

Harleston

Percent of map unit: 4 percent
Landform: Stream terraces
Landform position (two-dimensional): Shoulder
Landform position (three-dimensional): Tread
Down-slope shape: Linear
Across-slope shape: Linear

SaC—Saucier fine sandy loam, 5 to 8 percent slopes

Map Unit Setting

National map unit symbol: c4x0
Elevation: 100 to 300 feet
Mean annual precipitation: 48 to 75 inches
Mean annual air temperature: 63 to 70 degrees F
Frost-free period: 200 to 335 days
Farmland classification: Farmland of statewide importance

Map Unit Composition

Saucier and similar soils: 85 percent
Minor components: 12 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Saucier

Setting

Landform: Coastal plains
Landform position (two-dimensional): Shoulder
Landform position (three-dimensional): Side slope
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Loamy over clayey marine deposits

Typical profile

H1 - 0 to 9 inches: fine sandy loam
H2 - 9 to 40 inches: loam
H3 - 40 to 47 inches: silty clay loam
H4 - 47 to 60 inches: clay

Properties and qualities

Slope: 5 to 8 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Moderately well drained
Runoff class: Medium
Capacity of the most limiting layer to transmit water (Ksat): Moderately low to moderately high (0.06 to 0.20 in/hr)
Depth to water table: About 30 to 48 inches
Frequency of flooding: None
Frequency of ponding: None
Available water storage in profile: High (about 10.4 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 3e
Hydrologic Soil Group: C

Minor Components

Poarch

Percent of map unit: 4 percent
Landform: Hillslopes
Landform position (two-dimensional): Shoulder
Landform position (three-dimensional): Side slope
Down-slope shape: Linear
Across-slope shape: Linear

Harleston

Percent of map unit: 4 percent
Landform: Stream terraces
Landform position (two-dimensional): Shoulder
Landform position (three-dimensional): Tread
Down-slope shape: Linear
Across-slope shape: Linear

Smithton

Percent of map unit: 4 percent
Landform: Terraces
Landform position (three-dimensional): Tread, dip
Down-slope shape: Linear
Across-slope shape: Linear

SaD—Saucier fine sandy loam, 8 to 12 percent slopes

Map Unit Setting

National map unit symbol: c4x1
Elevation: 100 to 300 feet
Mean annual precipitation: 48 to 75 inches
Mean annual air temperature: 63 to 70 degrees F
Frost-free period: 200 to 335 days
Farmland classification: Farmland of statewide importance

Map Unit Composition

Saucier and similar soils: 85 percent
Minor components: 12 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Saucier

Setting

Landform: Coastal plains
Landform position (two-dimensional): Shoulder
Landform position (three-dimensional): Side slope
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Loamy over clayey marine deposits

Typical profile

H1 - 0 to 9 inches: fine sandy loam
H2 - 9 to 40 inches: loam
H3 - 40 to 47 inches: silty clay loam
H4 - 47 to 60 inches: clay

Properties and qualities

Slope: 8 to 12 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Moderately well drained
Runoff class: Medium
Capacity of the most limiting layer to transmit water (Ksat): Moderately low to moderately high (0.06 to 0.20 in/hr)
Depth to water table: About 30 to 48 inches
Frequency of flooding: None
Frequency of ponding: None
Available water storage in profile: High (about 10.4 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 4e
Hydrologic Soil Group: C

Minor Components

Poarch

Percent of map unit: 3 percent
Landform: Hillslopes
Landform position (two-dimensional): Shoulder
Landform position (three-dimensional): Side slope
Down-slope shape: Linear
Across-slope shape: Linear

Harleston

Percent of map unit: 3 percent
Landform: Stream terraces
Landform position (two-dimensional): Shoulder
Landform position (three-dimensional): Riser
Down-slope shape: Linear
Across-slope shape: Linear

Smithton

Percent of map unit: 3 percent
Landform: Terraces
Landform position (three-dimensional): Tread, dip
Down-slope shape: Linear
Across-slope shape: Linear

Malbis

Percent of map unit: 3 percent
Landform: Coastal plains
Landform position (two-dimensional): Shoulder
Landform position (three-dimensional): Side slope
Down-slope shape: Linear
Across-slope shape: Linear

ScB—Saucier-Susquehanna complex, 2 to 5 percent slopes

Map Unit Setting

National map unit symbol: c4x2
Elevation: 100 to 300 feet
Mean annual precipitation: 48 to 75 inches
Mean annual air temperature: 63 to 70 degrees F
Frost-free period: 200 to 335 days
Farmland classification: Not prime farmland

Map Unit Composition

Saucier and similar soils: 50 percent
Susquehanna and similar soils: 35 percent
Minor components: 12 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Saucier

Setting

Landform: Coastal plains
Landform position (two-dimensional): Shoulder
Landform position (three-dimensional): Crest
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Loamy over clayey marine deposits

Typical profile

H1 - 0 to 9 inches: fine sandy loam
H2 - 9 to 40 inches: loam
H3 - 40 to 47 inches: silty clay loam
H4 - 47 to 60 inches: clay

Properties and qualities

Slope: 2 to 5 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Moderately well drained
Runoff class: Low
Capacity of the most limiting layer to transmit water (Ksat): Moderately low to moderately high (0.06 to 0.20 in/hr)
Depth to water table: About 30 to 48 inches
Frequency of flooding: None
Frequency of ponding: None
Available water storage in profile: High (about 10.4 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 2e
Hydrologic Soil Group: C

Description of Susquehanna

Setting

Landform: Coastal plains
Landform position (two-dimensional): Shoulder
Landform position (three-dimensional): Crest
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Clayey marine deposits

Typical profile

H1 - 0 to 7 inches: fine sandy loam
H2 - 7 to 60 inches: clay

Properties and qualities

Slope: 2 to 5 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Somewhat poorly drained
Runoff class: Medium
Capacity of the most limiting layer to transmit water (Ksat): Very low to moderately low (0.00 to 0.06 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None

Available water storage in profile: High (about 10.4 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 4e
Hydrologic Soil Group: D

Minor Components

Harleston

Percent of map unit: 3 percent
Landform: Stream terraces
Landform position (two-dimensional): Shoulder
Landform position (three-dimensional): Tread
Down-slope shape: Linear
Across-slope shape: Linear

Poarch

Percent of map unit: 3 percent
Landform: Ridges
Landform position (two-dimensional): Shoulder
Landform position (three-dimensional): Crest
Down-slope shape: Linear
Across-slope shape: Linear

Smithton

Percent of map unit: 3 percent
Landform: Terraces
Landform position (three-dimensional): Tread, dip
Down-slope shape: Linear
Across-slope shape: Linear

Malbis

Percent of map unit: 3 percent
Landform: Coastal plains
Landform position (two-dimensional): Shoulder
Landform position (three-dimensional): Crest
Down-slope shape: Linear
Across-slope shape: Linear

ScD—Saucier-Susquehanna complex, 5 to 12 percent slopes

Map Unit Setting

National map unit symbol: c4x3
Elevation: 100 to 550 feet
Mean annual precipitation: 45 to 75 inches
Mean annual air temperature: 61 to 70 degrees F
Frost-free period: 200 to 335 days
Farmland classification: Not prime farmland

Map Unit Composition

Saucier and similar soils: 45 percent
Susquehanna and similar soils: 30 percent
Minor components: 12 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Saucier

Setting

Landform: Coastal plains
Landform position (two-dimensional): Shoulder
Landform position (three-dimensional): Side slope
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Loamy over clayey marine deposits

Typical profile

H1 - 0 to 9 inches: fine sandy loam
H2 - 9 to 40 inches: loam
H3 - 40 to 47 inches: silty clay loam
H4 - 47 to 60 inches: clay

Properties and qualities

Slope: 5 to 12 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Moderately well drained
Runoff class: Medium
Capacity of the most limiting layer to transmit water (Ksat): Moderately low to moderately high (0.06 to 0.20 in/hr)
Depth to water table: About 30 to 48 inches
Frequency of flooding: None
Frequency of ponding: None
Available water storage in profile: High (about 10.4 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 4e
Hydrologic Soil Group: C

Description of Susquehanna

Setting

Landform: Coastal plains
Landform position (two-dimensional): Shoulder
Landform position (three-dimensional): Side slope
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Clayey marine deposits

Typical profile

H1 - 0 to 7 inches: fine sandy loam
H2 - 7 to 60 inches: clay

Properties and qualities

Slope: 5 to 12 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Somewhat poorly drained

Runoff class: High
Capacity of the most limiting layer to transmit water (Ksat): Very low to moderately low (0.00 to 0.06 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Available water storage in profile: High (about 10.4 inches)

Interpretive groups
Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 6e
Hydrologic Soil Group: D

Minor Components

Poarch
Percent of map unit: 3 percent
Landform: Hillslopes
Landform position (two-dimensional): Shoulder
Landform position (three-dimensional): Side slope
Down-slope shape: Linear
Across-slope shape: Linear

Smithton
Percent of map unit: 3 percent
Landform: Terraces
Landform position (three-dimensional): Tread, dip
Down-slope shape: Linear
Across-slope shape: Linear

Escambia
Percent of map unit: 3 percent
Landform: Coastal plains
Landform position (two-dimensional): Shoulder
Landform position (three-dimensional): Crest
Down-slope shape: Linear
Across-slope shape: Linear

Ruston
Percent of map unit: 3 percent
Landform: Coastal plains
Landform position (two-dimensional): Shoulder
Landform position (three-dimensional): Side slope
Down-slope shape: Linear
Across-slope shape: Linear

SmD—Smithdale fine sandy loam, 8 to 12 percent slopes

Map Unit Setting
National map unit symbol: c4x4

Mean annual precipitation: 60 to 75 inches
Mean annual air temperature: 64 to 70 degrees F
Frost-free period: 270 to 335 days
Farmland classification: Not prime farmland

Map Unit Composition

Smithdale and similar soils: 90 percent
Minor components: 2 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Smithdale

Setting

Landform: Hillslopes
Landform position (two-dimensional): Backslope
Landform position (three-dimensional): Side slope
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Loamy fluviomarine deposits

Typical profile

H1 - 0 to 14 inches: fine sandy loam
H2 - 14 to 40 inches: sandy clay loam
H3 - 40 to 80 inches: sandy loam

Properties and qualities

Slope: 8 to 12 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Well drained
Runoff class: Medium
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (0.60 to 2.00 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Available water storage in profile: High (about 9.2 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 4e
Hydrologic Soil Group: B

Minor Components

Unnamed hydric soils (133dr)

Percent of map unit: 2 percent
Landform: Drainageways
Landform position (three-dimensional): Dip
Down-slope shape: Linear
Across-slope shape: Linear

Su—Smithton fine sandy loam, frequently flooded

Map Unit Setting

National map unit symbol: c4x7
Elevation: 20 to 400 feet
Mean annual precipitation: 40 to 75 inches
Mean annual air temperature: 61 to 72 degrees F
Frost-free period: 220 to 350 days
Farmland classification: Not prime farmland

Map Unit Composition

Smithton and similar soils: 85 percent
Minor components: 12 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Smithton

Setting

Landform: Terraces
Landform position (three-dimensional): Tread, dip
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Loamy alluvium

Typical profile

H1 - 0 to 8 inches: fine sandy loam
H2 - 8 to 38 inches: sandy loam
H3 - 38 to 49 inches: loam
H4 - 49 to 60 inches: loam

Properties and qualities

Slope: 0 to 2 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Poorly drained
Runoff class: Very high
Capacity of the most limiting layer to transmit water (Ksat): Moderately high (0.20 to 0.60 in/hr)
Depth to water table: About 0 to 12 inches
Frequency of flooding: Frequent
Frequency of ponding: None
Available water storage in profile: High (about 9.0 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 5w
Hydrologic Soil Group: D

Minor Components

Atmore

Percent of map unit: 3 percent
Landform: Depressions
Landform position (three-dimensional): Dip
Down-slope shape: Linear
Across-slope shape: Linear

Guyton

Percent of map unit: 3 percent
Landform: Terraces
Landform position (three-dimensional): Tread
Down-slope shape: Linear
Across-slope shape: Linear

Harleston

Percent of map unit: 3 percent
Landform: Stream terraces
Landform position (two-dimensional): Shoulder
Landform position (three-dimensional): Tread
Down-slope shape: Linear
Across-slope shape: Linear

Plummer

Percent of map unit: 3 percent
Landform: Flats
Landform position (three-dimensional): Dip
Down-slope shape: Convex
Across-slope shape: Convex

W—Water

Map Unit Composition

Water: 100 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Harrison County, Mississippi

At—Atmore silt loam

Map Unit Setting

National map unit symbol: c4xc
Elevation: 20 to 400 feet
Mean annual precipitation: 40 to 75 inches
Mean annual air temperature: 61 to 72 degrees F
Frost-free period: 200 to 335 days
Farmland classification: Not prime farmland

Map Unit Composition

Atmore and similar soils: 85 percent
Minor components: 14 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Atmore

Setting

Landform: Depressions
Landform position (three-dimensional): Dip
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Loamy marine deposits

Typical profile

H1 - 0 to 13 inches: silt loam
H2 - 13 to 48 inches: loam
H3 - 48 to 70 inches: clay loam

Properties and qualities

Slope: 0 to 2 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Poorly drained
Runoff class: Very high
Capacity of the most limiting layer to transmit water (Ksat): Moderately high (0.20 to 0.60 in/hr)
Depth to water table: About 0 to 12 inches
Frequency of flooding: None
Frequency of ponding: None
Available water storage in profile: High (about 12.0 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 4w
Hydrologic Soil Group: B/D

Minor Components

Escambia

Percent of map unit: 3 percent
Landform: Coastal plains
Landform position (two-dimensional): Shoulder
Landform position (three-dimensional): Crest
Down-slope shape: Linear

Across-slope shape: Linear

Harleston

Percent of map unit: 3 percent
Landform: Stream terraces
Landform position (two-dimensional): Shoulder
Landform position (three-dimensional): Tread
Down-slope shape: Linear
Across-slope shape: Linear

Hyde

Percent of map unit: 2 percent
Landform: Terraces
Landform position (three-dimensional): Tread
Down-slope shape: Linear
Across-slope shape: Linear

Ocilla

Percent of map unit: 2 percent
Landform: Stream terraces
Landform position (two-dimensional): Shoulder
Landform position (three-dimensional): Tread
Down-slope shape: Convex
Across-slope shape: Convex

Plummer

Percent of map unit: 2 percent
Landform: Flats
Landform position (three-dimensional): Dip
Down-slope shape: Convex
Across-slope shape: Convex

Smithton

Percent of map unit: 2 percent
Landform: Terraces
Landform position (three-dimensional): Tread, dip
Down-slope shape: Linear
Across-slope shape: Linear

Es—Escambia silt loam

Map Unit Setting

National map unit symbol: c4xf
Elevation: 100 to 300 feet
Mean annual precipitation: 48 to 75 inches
Mean annual air temperature: 63 to 70 degrees F
Frost-free period: 200 to 335 days
Farmland classification: All areas are prime farmland

Map Unit Composition

Escambia and similar soils: 85 percent

Minor components: 14 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Escambia

Setting

Landform: Coastal plains
Landform position (two-dimensional): Shoulder
Landform position (three-dimensional): Crest
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Sandy and loamy marine deposits

Typical profile

H1 - 0 to 13 inches: silt loam
H2 - 13 to 35 inches: fine sandy loam
H3 - 35 to 72 inches: fine sandy loam

Properties and qualities

Slope: 0 to 2 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Somewhat poorly drained
Runoff class: Low
Capacity of the most limiting layer to transmit water (Ksat): Moderately low to moderately high (0.06 to 0.60 in/hr)
Depth to water table: About 18 to 30 inches
Frequency of flooding: None
Frequency of ponding: None
Available water storage in profile: High (about 9.1 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 2w
Hydrologic Soil Group: C

Minor Components

Atmore

Percent of map unit: 3 percent
Landform: Depressions
Landform position (three-dimensional): Dip
Down-slope shape: Linear
Across-slope shape: Linear

Smithton

Percent of map unit: 3 percent
Landform: Terraces
Landform position (three-dimensional): Tread, dip
Down-slope shape: Linear
Across-slope shape: Linear

Harleston

Percent of map unit: 3 percent
Landform: Stream terraces
Landform position (two-dimensional): Shoulder
Landform position (three-dimensional): Tread
Down-slope shape: Linear
Across-slope shape: Linear

Poarch

Percent of map unit: 3 percent
Landform: Ridges
Landform position (two-dimensional): Shoulder
Landform position (three-dimensional): Crest
Down-slope shape: Linear
Across-slope shape: Linear

Saucier

Percent of map unit: 2 percent
Landform: Coastal plains
Landform position (two-dimensional): Shoulder
Landform position (three-dimensional): Crest
Down-slope shape: Linear
Across-slope shape: Linear

EtB—Eustis loamy sand, 0 to 5 percent slopes

Map Unit Setting

National map unit symbol: c4xg
Mean annual precipitation: 60 to 75 inches
Mean annual air temperature: 64 to 70 degrees F
Frost-free period: 270 to 335 days
Farmland classification: Farmland of statewide importance

Map Unit Composition

Eustis and similar soils: 85 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Eustis

Setting

Landform: Hillslopes
Landform position (two-dimensional): Shoulder
Landform position (three-dimensional): Crest
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Sandy marine deposits

Typical profile

H1 - 0 to 6 inches: loamy sand
H2 - 6 to 24 inches: sand
H3 - 24 to 76 inches: loamy sand
H4 - 76 to 98 inches: sand

Properties and qualities

Slope: 0 to 5 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Somewhat excessively drained
Runoff class: Very low

Capacity of the most limiting layer to transmit water (Ksat): High to very high (6.00 to 20.00 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Available water storage in profile: Low (about 5.0 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 3s
Hydrologic Soil Group: A

EuE—Eustis and Poarch soils, 8 to 17 percent slopes

Map Unit Setting

National map unit symbol: c4xh
Elevation: 20 to 400 feet
Mean annual precipitation: 40 to 75 inches
Mean annual air temperature: 61 to 72 degrees F
Frost-free period: 200 to 335 days
Farmland classification: Not prime farmland

Map Unit Composition

Eustis and similar soils: 42 percent
Poarch and similar soils: 33 percent
Minor components: 23 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Eustis

Setting

Landform: Hillslopes
Landform position (two-dimensional): Shoulder
Landform position (three-dimensional): Side slope
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Sandy marine deposits

Typical profile

H1 - 0 to 6 inches: loamy fine sand
H2 - 6 to 24 inches: sand
H3 - 24 to 76 inches: loamy sand
H4 - 76 to 98 inches: sand

Properties and qualities

Slope: 8 to 17 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Somewhat excessively drained
Runoff class: Low
Capacity of the most limiting layer to transmit water (Ksat): High to very high (6.00 to 20.00 in/hr)
Depth to water table: More than 80 inches

Frequency of flooding: None
Frequency of ponding: None
Available water storage in profile: Low (about 5.0 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 7s
Hydrologic Soil Group: A

Description of Poarch

Setting

Landform: Hillslopes
Landform position (two-dimensional): Shoulder
Landform position (three-dimensional): Side slope
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Sandy and loamy marine deposits

Typical profile

H1 - 0 to 7 inches: fine sandy loam
H2 - 7 to 32 inches: loam
H3 - 32 to 66 inches: loam

Properties and qualities

Slope: 8 to 12 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Well drained
Runoff class: Medium
Capacity of the most limiting layer to transmit water (Ksat): Moderately high (0.20 to 0.60 in/hr)
Depth to water table: About 30 to 60 inches
Frequency of flooding: None
Frequency of ponding: None
Available water storage in profile: Moderate (about 8.8 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 4e
Hydrologic Soil Group: B

Minor Components

Plummer

Percent of map unit: 5 percent
Landform: Flats
Landform position (three-dimensional): Dip
Down-slope shape: Convex
Across-slope shape: Convex

Lakeland

Percent of map unit: 5 percent
Landform: Coastal plains
Landform position (two-dimensional): Shoulder
Landform position (three-dimensional): Side slope
Down-slope shape: Linear
Across-slope shape: Linear

Latonia

Percent of map unit: 5 percent
Landform: Terraces
Landform position (two-dimensional): Shoulder
Landform position (three-dimensional): Tread
Down-slope shape: Linear
Across-slope shape: Linear

Smithton

Percent of map unit: 4 percent
Landform: Terraces
Landform position (three-dimensional): Tread, dip
Down-slope shape: Linear
Across-slope shape: Linear

Smithdale

Percent of map unit: 4 percent
Landform: Hillslopes
Landform position (two-dimensional): Backslope
Landform position (three-dimensional): Side slope
Down-slope shape: Linear
Across-slope shape: Linear

HIA—Harleston fine sandy loam, 0 to 2 percent slopes

Map Unit Setting

National map unit symbol: c4xk
Mean annual precipitation: 60 to 75 inches
Mean annual air temperature: 64 to 70 degrees F
Frost-free period: 270 to 335 days
Farmland classification: All areas are prime farmland

Map Unit Composition

Harleston and similar soils: 90 percent
Minor components: 2 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Harleston

Setting

Landform: Stream terraces
Landform position (two-dimensional): Shoulder
Landform position (three-dimensional): Tread
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Loamy alluvium

Typical profile

H1 - 0 to 9 inches: fine sandy loam

H2 - 9 to 60 inches: sandy loam
H3 - 60 to 72 inches: sandy loam

Properties and qualities

Slope: 0 to 2 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Moderately well drained
Runoff class: Low
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (0.60 to 2.00 in/hr)
Depth to water table: About 24 to 36 inches
Frequency of flooding: None
Frequency of ponding: None
Available water storage in profile: Moderate (about 8.7 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 2w
Hydrologic Soil Group: C

Minor Components

Unnamed hydric soils (133de)

Percent of map unit: 2 percent
Landform: Depressions
Landform position (three-dimensional): Dip
Down-slope shape: Concave
Across-slope shape: Concave

HIB—Harleston fine sandy loam, 2 to 5 percent slopes

Map Unit Setting

National map unit symbol: c4xl
Mean annual precipitation: 60 to 75 inches
Mean annual air temperature: 64 to 70 degrees F
Frost-free period: 270 to 335 days
Farmland classification: All areas are prime farmland

Map Unit Composition

Harleston and similar soils: 85 percent
Minor components: 13 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Harleston

Setting

Landform: Stream terraces
Landform position (two-dimensional): Shoulder
Landform position (three-dimensional): Tread
Down-slope shape: Linear
Across-slope shape: Linear

Parent material: Loamy alluvium

Typical profile

H1 - 0 to 9 inches: fine sandy loam
H2 - 9 to 60 inches: sandy loam
H3 - 60 to 72 inches: sandy loam

Properties and qualities

Slope: 2 to 5 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Moderately well drained
Runoff class: Low
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (0.60 to 2.00 in/hr)
Depth to water table: About 24 to 36 inches
Frequency of flooding: None
Frequency of ponding: None
Available water storage in profile: Moderate (about 8.7 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 2e
Hydrologic Soil Group: C

Minor Components

Escambia

Percent of map unit: 5 percent
Landform: Coastal plains
Landform position (two-dimensional): Shoulder
Landform position (three-dimensional): Crest
Down-slope shape: Linear
Across-slope shape: Linear

Latonia

Percent of map unit: 4 percent
Landform: Terraces
Landform position (two-dimensional): Shoulder
Landform position (three-dimensional): Tread
Down-slope shape: Linear
Across-slope shape: Linear

Poarch

Percent of map unit: 4 percent
Landform: Ridges
Landform position (two-dimensional): Shoulder
Landform position (three-dimensional): Crest
Down-slope shape: Linear
Across-slope shape: Linear

Lr—Lakeland fine sand

Map Unit Setting

National map unit symbol: c4xn
Elevation: 40 to 300 feet
Mean annual precipitation: 60 to 75 inches
Mean annual air temperature: 64 to 70 degrees F
Frost-free period: 270 to 335 days
Farmland classification: Farmland of statewide importance

Map Unit Composition

Lakeland and similar soils: 85 percent
Minor components: 13 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Lakeland

Setting

Landform: Coastal plains
Landform position (two-dimensional): Shoulder
Landform position (three-dimensional): Crest
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Sandy marine deposits

Typical profile

H1 - 0 to 43 inches: fine sand
H2 - 43 to 80 inches: sand

Properties and qualities

Slope: 0 to 2 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Excessively drained
Runoff class: Very low
Capacity of the most limiting layer to transmit water (Ksat): High to very high (6.00 to 20.00 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Salinity, maximum in profile: Nonsaline (0.0 to 2.0 mmhos/cm)
Available water storage in profile: Low (about 3.9 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 4s
Hydrologic Soil Group: A

Minor Components

Eustis

Percent of map unit: 5 percent
Landform: Hillslopes
Landform position (two-dimensional): Shoulder
Landform position (three-dimensional): Side slope
Down-slope shape: Linear
Across-slope shape: Linear

Poarch

Percent of map unit: 4 percent
Landform: Hillslopes
Landform position (two-dimensional): Shoulder
Landform position (three-dimensional): Side slope
Down-slope shape: Linear
Across-slope shape: Linear

Latonia

Percent of map unit: 4 percent
Landform: Terraces
Landform position (two-dimensional): Shoulder
Landform position (three-dimensional): Tread
Down-slope shape: Linear
Across-slope shape: Linear

Nh—Nahunta silt loam

Map Unit Setting

National map unit symbol: c4xs
Elevation: 100 to 300 feet
Mean annual precipitation: 48 to 75 inches
Mean annual air temperature: 63 to 70 degrees F
Frost-free period: 200 to 335 days
Farmland classification: Prime farmland if drained

Map Unit Composition

Nahunta and similar soils: 85 percent
Minor components: 13 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Nahunta

Setting

Landform: Terraces
Landform position (three-dimensional): Tread
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Loamy and silty alluvium deposits

Typical profile

H1 - 0 to 8 inches: silt loam
H2 - 8 to 24 inches: silt loam
H3 - 24 to 34 inches: sandy clay loam
H4 - 34 to 58 inches: silt loam
H5 - 58 to 70 inches: loam

Properties and qualities

Slope: 0 to 2 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Somewhat poorly drained
Runoff class: Very high
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (0.60 to 2.00 in/hr)
Depth to water table: About 6 to 18 inches
Frequency of flooding: None
Frequency of ponding: None
Available water storage in profile: High (about 11.6 inches)

Minor Components

Nugent

Percent of map unit: 5 percent
Landform: Natural levees
Landform position (two-dimensional): Shoulder
Landform position (three-dimensional): Rise
Down-slope shape: Linear
Across-slope shape: Linear

Saucier

Percent of map unit: 5 percent
Landform: Coastal plains
Landform position (two-dimensional): Shoulder
Landform position (three-dimensional): Crest
Down-slope shape: Linear
Across-slope shape: Linear

Smithton

Percent of map unit: 3 percent
Landform: Terraces
Landform position (three-dimensional): Tread, dip
Down-slope shape: Linear
Across-slope shape: Linear

Pm—Plummer loamy sand

Map Unit Setting

National map unit symbol: c4xw
Elevation: 20 to 400 feet
Mean annual precipitation: 40 to 75 inches

Mean annual air temperature: 63 to 72 degrees F
Frost-free period: 240 to 335 days
Farmland classification: Not prime farmland

Map Unit Composition

Plummer and similar soils: 85 percent
Minor components: 13 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Plummer

Setting

Landform: Flats
Landform position (three-dimensional): Dip
Down-slope shape: Convex
Across-slope shape: Convex
Parent material: Sandy marine deposits

Typical profile

H1 - 0 to 50 inches: loamy sand
H2 - 50 to 72 inches: sandy clay loam

Properties and qualities

Slope: 0 to 2 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Poorly drained
Runoff class: Very high
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (0.20 to 2.00 in/hr)
Depth to water table: About 0 to 12 inches
Frequency of flooding: Rare
Frequency of ponding: None
Available water storage in profile: Low (about 4.6 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 4w
Hydrologic Soil Group: B/D

Minor Components

Atmore

Percent of map unit: 5 percent
Landform: Depressions
Landform position (three-dimensional): Dip
Down-slope shape: Linear
Across-slope shape: Linear

Ocilla

Percent of map unit: 4 percent
Landform: Stream terraces
Landform position (two-dimensional): Shoulder
Landform position (three-dimensional): Tread
Down-slope shape: Convex
Across-slope shape: Convex

Nugent

Percent of map unit: 4 percent

Landform: Natural levees
Landform position (two-dimensional): Shoulder
Landform position (three-dimensional): Rise
Down-slope shape: Linear
Across-slope shape: Linear

PoA—Poarch fine sandy loam, 0 to 2 percent slopes

Map Unit Setting

National map unit symbol: c4xx
Elevation: 100 to 550 feet
Mean annual precipitation: 45 to 75 inches
Mean annual air temperature: 61 to 70 degrees F
Frost-free period: 200 to 335 days
Farmland classification: All areas are prime farmland

Map Unit Composition

Poarch and similar soils: 85 percent
Minor components: 13 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Poarch

Setting

Landform: Ridges
Landform position (two-dimensional): Shoulder
Landform position (three-dimensional): Crest
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Sandy and loamy marine deposits

Typical profile

H1 - 0 to 7 inches: fine sandy loam
H2 - 7 to 32 inches: loam
H3 - 32 to 66 inches: loam

Properties and qualities

Slope: 0 to 2 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Well drained
Runoff class: Low
Capacity of the most limiting layer to transmit water (Ksat): Moderately high (0.20 to 0.60 in/hr)
Depth to water table: About 30 to 60 inches
Frequency of flooding: None
Frequency of ponding: None
Available water storage in profile: Moderate (about 8.8 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 1

Hydrologic Soil Group: B

Minor Components

Harleston

Percent of map unit: 5 percent
Landform: Stream terraces
Landform position (two-dimensional): Shoulder
Landform position (three-dimensional): Tread
Down-slope shape: Linear
Across-slope shape: Linear

Ruston

Percent of map unit: 5 percent
Landform: Coastal plains
Landform position (two-dimensional): Shoulder
Landform position (three-dimensional): Side slope
Down-slope shape: Linear
Across-slope shape: Linear

Smithton

Percent of map unit: 3 percent
Landform: Terraces
Landform position (three-dimensional): Tread, dip
Down-slope shape: Linear
Across-slope shape: Linear

PoB—Poarch fine sandy loam, 2 to 5 percent slopes

Map Unit Setting

National map unit symbol: c4xy
Mean annual precipitation: 60 to 75 inches
Mean annual air temperature: 64 to 70 degrees F
Frost-free period: 270 to 335 days
Farmland classification: All areas are prime farmland

Map Unit Composition

Poarch and similar soils: 90 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Poarch

Setting

Landform: Ridges
Landform position (two-dimensional): Shoulder
Landform position (three-dimensional): Crest
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Sandy and loamy marine deposits

Typical profile

H1 - 0 to 10 inches: fine sandy loam
H2 - 10 to 73 inches: loam
H3 - 73 to 81 inches: loam

Properties and qualities

Slope: 2 to 5 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Well drained
Runoff class: Low
Capacity of the most limiting layer to transmit water (Ksat): Moderately high (0.20 to 0.60 in/hr)
Depth to water table: About 30 to 60 inches
Frequency of flooding: None
Frequency of ponding: None
Available water storage in profile: Moderate (about 8.8 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 2e
Hydrologic Soil Group: B

PoC—Poarch fine sandy loam, 5 to 12 percent slopes

Map Unit Setting

National map unit symbol: c4xz
Elevation: 100 to 300 feet
Mean annual precipitation: 48 to 75 inches
Mean annual air temperature: 63 to 70 degrees F
Frost-free period: 200 to 335 days
Farmland classification: Farmland of statewide importance

Map Unit Composition

Poarch and similar soils: 85 percent
Minor components: 12 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Poarch

Setting

Landform: Hillslopes
Landform position (two-dimensional): Shoulder
Landform position (three-dimensional): Side slope
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Sandy and loamy marine deposits

Typical profile

H1 - 0 to 7 inches: fine sandy loam
H2 - 7 to 32 inches: loam
H3 - 32 to 66 inches: loam

Properties and qualities

Slope: 5 to 12 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Well drained
Runoff class: Medium
Capacity of the most limiting layer to transmit water (Ksat): Moderately high (0.20 to 0.60 in/hr)
Depth to water table: About 30 to 60 inches
Frequency of flooding: None
Frequency of ponding: None
Available water storage in profile: Moderate (about 8.8 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 4e
Hydrologic Soil Group: B

Minor Components

Smithton

Percent of map unit: 4 percent
Landform: Terraces
Landform position (three-dimensional): Tread, dip
Down-slope shape: Linear
Across-slope shape: Linear

Harleston

Percent of map unit: 4 percent
Landform: Stream terraces
Landform position (two-dimensional): Shoulder
Landform position (three-dimensional): Tread
Down-slope shape: Linear
Across-slope shape: Linear

Smithdale

Percent of map unit: 4 percent
Landform: Hillslopes
Landform position (two-dimensional): Backslope
Landform position (three-dimensional): Side slope
Down-slope shape: Linear
Across-slope shape: Linear

Ps—Ponzer and Smithton soils

Map Unit Setting

National map unit symbol: c4y0
Elevation: 100 to 300 feet
Mean annual precipitation: 60 to 75 inches
Mean annual air temperature: 64 to 70 degrees F
Frost-free period: 270 to 335 days

Farmland classification: Not prime farmland

Map Unit Composition

Ponzer and similar soils: 59 percent
Smithton and similar soils: 18 percent
Minor components: 22 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Ponzer

Setting

Landform: Drainageways
Landform position (three-dimensional): Dip
Down-slope shape: Convex
Across-slope shape: Convex
Parent material: Decomposed organic material over loamy alluvium

Typical profile

Oa - 0 to 24 inches: muck
H2 - 24 to 52 inches: loam
H3 - 52 to 72 inches: loam

Properties and qualities

Slope: 0 to 1 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Very poorly drained
Runoff class: Very high
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (0.20 to 2.00 in/hr)
Depth to water table: About 0 to 12 inches
Frequency of flooding: Frequent
Frequency of ponding: None
Salinity, maximum in profile: Nonsaline (0.0 to 2.0 mmhos/cm)
Sodium adsorption ratio, maximum in profile: 4.0
Available water storage in profile: High (about 11.6 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 7w
Hydrologic Soil Group: D

Description of Smithton

Setting

Landform: Terraces
Landform position (three-dimensional): Tread, dip
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Loamy alluvium

Typical profile

H1 - 0 to 1 inches: fine sandy loam
H2 - 1 to 10 inches: fine sandy loam
H3 - 10 to 38 inches: fine sandy loam
H4 - 38 to 72 inches: fine sandy loam

Properties and qualities

Slope: 0 to 2 percent

Depth to restrictive feature: More than 80 inches
Natural drainage class: Poorly drained
Runoff class: Very high
Capacity of the most limiting layer to transmit water (Ksat): Moderately high (0.20 to 0.60 in/hr)
Depth to water table: About 0 to 12 inches
Frequency of flooding: Frequent
Frequency of ponding: None
Available water storage in profile: High (about 9.5 inches)

Interpretive groups
Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 5w
Hydrologic Soil Group: D

Minor Components

Hyde
Percent of map unit: 8 percent
Landform: Terraces
Landform position (three-dimensional): Tread
Down-slope shape: Linear
Across-slope shape: Linear

Handsboro
Percent of map unit: 7 percent
Landform: Tidal flats
Landform position (three-dimensional): Dip
Down-slope shape: Linear
Across-slope shape: Linear

St. lucie
Percent of map unit: 7 percent
Landform position (two-dimensional): Shoulder
Landform position (three-dimensional): Crest
Down-slope shape: Linear
Across-slope shape: Linear

RuB—Ruston fine sandy loam, 2 to 5 percent slopes

Map Unit Setting
National map unit symbol: c4y2
Elevation: 100 to 550 feet
Mean annual precipitation: 60 to 75 inches
Mean annual air temperature: 64 to 70 degrees F
Frost-free period: 270 to 335 days
Farmland classification: All areas are prime farmland

Map Unit Composition
Ruston and similar soils: 95 percent

Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Ruston

Setting

Landform: Coastal plains
Landform position (two-dimensional): Shoulder
Landform position (three-dimensional): Side slope
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Loamy fluviomarine deposits

Typical profile

H1 - 0 to 7 inches: fine sandy loam
H2 - 7 to 18 inches: sandy clay loam
H3 - 18 to 39 inches: sandy loam
H4 - 39 to 85 inches: sandy clay loam

Properties and qualities

Slope: 2 to 5 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Well drained
Runoff class: Low
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (0.60 to 2.00 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Available water storage in profile: Moderate (about 8.6 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 3e
Hydrologic Soil Group: B

RuC—Ruston fine sandy loam, 5 to 8 percent slopes

Map Unit Setting

National map unit symbol: c4y3
Elevation: 100 to 550 feet
Mean annual precipitation: 60 to 75 inches
Mean annual air temperature: 64 to 70 degrees F
Frost-free period: 270 to 335 days
Farmland classification: All areas are prime farmland

Map Unit Composition

Ruston and similar soils: 95 percent
Minor components: 2 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Ruston

Setting

Landform: Coastal plains
Landform position (two-dimensional): Shoulder
Landform position (three-dimensional): Side slope
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Loamy fluviomarine deposits

Typical profile

H1 - 0 to 7 inches: fine sandy loam
H2 - 7 to 18 inches: sandy clay loam
H3 - 18 to 39 inches: sandy loam
H4 - 39 to 85 inches: loam

Properties and qualities

Slope: 5 to 8 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Well drained
Runoff class: Medium
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (0.60 to 2.00 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Available water storage in profile: Moderate (about 8.6 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 3e
Hydrologic Soil Group: B

Minor Components

Unnamed hydric soils (133dr)

Percent of map unit: 2 percent
Landform: Drainageways
Landform position (two-dimensional): Shoulder
Landform position (three-dimensional): Dip
Down-slope shape: Linear
Across-slope shape: Linear

RuD—Ruston fine sandy loam, 8 to 12 percent slopes (smithdale)

Map Unit Setting

National map unit symbol: c4y4
Elevation: 100 to 300 feet
Mean annual precipitation: 48 to 75 inches
Mean annual air temperature: 63 to 70 degrees F

Frost-free period: 200 to 335 days
Farmland classification: Farmland of statewide importance

Map Unit Composition

Smithdale and similar soils: 90 percent
Minor components: 5 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Smithdale

Setting

Landform: Hillslopes
Landform position (two-dimensional): Backslope
Landform position (three-dimensional): Side slope
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Loamy fluviomarine deposits

Typical profile

H1 - 0 to 11 inches: fine sandy loam
H2 - 11 to 38 inches: loam
H3 - 38 to 80 inches: loam

Properties and qualities

Slope: 8 to 12 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Well drained
Runoff class: Medium
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (0.60 to 2.00 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Available water storage in profile: High (about 9.2 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 4e
Hydrologic Soil Group: B

Minor Components

Smithton

Percent of map unit: 5 percent
Landform: Terraces
Landform position (three-dimensional): Tread, dip
Down-slope shape: Linear
Across-slope shape: Linear

SfB—Saucier fine sandy loam, 2 to 5 percent slopes

Map Unit Setting

National map unit symbol: c4y6
Elevation: 100 to 550 feet
Mean annual precipitation: 45 to 75 inches
Mean annual air temperature: 61 to 70 degrees F
Frost-free period: 200 to 335 days
Farmland classification: All areas are prime farmland

Map Unit Composition

Saucier and similar soils: 85 percent
Minor components: 14 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Saucier

Setting

Landform: Coastal plains
Landform position (two-dimensional): Shoulder
Landform position (three-dimensional): Crest
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Loamy over clayey marine deposits

Typical profile

H1 - 0 to 12 inches: fine sandy loam
H2 - 12 to 48 inches: loam
H3 - 48 to 60 inches: silty clay loam
H4 - 60 to 72 inches: clay

Properties and qualities

Slope: 2 to 5 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Moderately well drained
Runoff class: Low
Capacity of the most limiting layer to transmit water (Ksat): Moderately low to moderately high (0.06 to 0.20 in/hr)
Depth to water table: About 30 to 48 inches
Frequency of flooding: None
Frequency of ponding: None
Available water storage in profile: High (about 10.3 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 2e
Hydrologic Soil Group: C

Minor Components

Ruston

Percent of map unit: 4 percent
Landform: Coastal plains
Landform position (two-dimensional): Shoulder
Landform position (three-dimensional): Crest
Down-slope shape: Linear
Across-slope shape: Linear

Poarch

Percent of map unit: 4 percent
Landform: Ridges
Landform position (two-dimensional): Shoulder
Landform position (three-dimensional): Crest
Down-slope shape: Linear
Across-slope shape: Linear

Harleston

Percent of map unit: 4 percent
Landform: Stream terraces
Landform position (two-dimensional): Shoulder
Landform position (three-dimensional): Tread
Down-slope shape: Linear
Across-slope shape: Linear

Smithton

Percent of map unit: 2 percent
Landform: Terraces
Landform position (three-dimensional): Tread, dip
Down-slope shape: Linear
Across-slope shape: Linear

SfC—Saucier fine sandy loam, 5 to 8 percent slopes

Map Unit Setting

National map unit symbol: c4y7
Elevation: 100 to 550 feet
Mean annual precipitation: 45 to 75 inches
Mean annual air temperature: 61 to 70 degrees F
Frost-free period: 200 to 335 days
Farmland classification: Farmland of statewide importance

Map Unit Composition

Saucier and similar soils: 85 percent
Minor components: 14 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Saucier

Setting

Landform: Coastal plains
Landform position (two-dimensional): Shoulder
Landform position (three-dimensional): Side slope
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Loamy over clayey marine deposits

Typical profile

H1 - 0 to 12 inches: fine sandy loam
H2 - 12 to 48 inches: loam
H3 - 48 to 60 inches: silty clay loam
H4 - 60 to 72 inches: clay

Properties and qualities

Slope: 5 to 8 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Moderately well drained
Runoff class: Medium
Capacity of the most limiting layer to transmit water (Ksat): Moderately low to moderately high (0.06 to 0.20 in/hr)
Depth to water table: About 30 to 48 inches
Frequency of flooding: None
Frequency of ponding: None
Available water storage in profile: High (about 10.3 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 3e
Hydrologic Soil Group: C

Minor Components

Harleston

Percent of map unit: 4 percent
Landform: Stream terraces
Landform position (two-dimensional): Shoulder
Landform position (three-dimensional): Riser
Down-slope shape: Linear
Across-slope shape: Linear

Poarch

Percent of map unit: 4 percent
Landform: Hillslopes
Landform position (two-dimensional): Shoulder
Landform position (three-dimensional): Side slope
Down-slope shape: Linear
Across-slope shape: Linear

Ruston

Percent of map unit: 4 percent
Landform: Coastal plains
Landform position (two-dimensional): Shoulder
Landform position (three-dimensional): Side slope
Down-slope shape: Linear

Across-slope shape: Linear

Smithton

Percent of map unit: 2 percent
Landform: Terraces
Landform position (three-dimensional): Tread, dip
Down-slope shape: Linear
Across-slope shape: Linear

ShC—Saucier, Smithton, and Susquehanna soils, rolling

Map Unit Setting

National map unit symbol: c4y8
Elevation: 100 to 300 feet
Mean annual precipitation: 60 to 75 inches
Mean annual air temperature: 64 to 70 degrees F
Frost-free period: 270 to 335 days
Farmland classification: Not prime farmland

Map Unit Composition

Saucier and similar soils: 45 percent
Smithton and similar soils: 20 percent
Susquehanna and similar soils: 10 percent
Minor components: 24 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Saucier

Setting

Landform: Coastal plains
Landform position (two-dimensional): Shoulder
Landform position (three-dimensional): Side slope
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Loamy over clayey marine deposits

Typical profile

H1 - 0 to 12 inches: fine sandy loam
H2 - 12 to 48 inches: loam
H3 - 48 to 60 inches: silty clay loam
H4 - 60 to 72 inches: clay

Properties and qualities

Slope: 5 to 12 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Moderately well drained
Runoff class: Medium
Capacity of the most limiting layer to transmit water (Ksat): Moderately low to moderately high (0.06 to 0.20 in/hr)
Depth to water table: About 30 to 48 inches
Frequency of flooding: None

Frequency of ponding: None
Available water storage in profile: High (about 10.3 inches)

Interpretive groups
Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 4e
Hydrologic Soil Group: C

Description of Smithton

Setting
Landform: Terraces
Landform position (three-dimensional): Tread, dip
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Loamy alluvium

Typical profile
H1 - 0 to 1 inches: fine sandy loam
H2 - 1 to 10 inches: fine sandy loam
H3 - 10 to 38 inches: fine sandy loam
H4 - 38 to 72 inches: fine sandy loam

Properties and qualities
Slope: 0 to 2 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Poorly drained
Runoff class: Very high
Capacity of the most limiting layer to transmit water (Ksat): Moderately high (0.20 to 0.60 in/hr)
Depth to water table: About 0 to 12 inches
Frequency of flooding: None
Frequency of ponding: None
Available water storage in profile: High (about 9.5 inches)

Interpretive groups
Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 3w
Hydrologic Soil Group: D

Description of Susquehanna

Setting
Landform: Coastal plains
Landform position (two-dimensional): Shoulder
Landform position (three-dimensional): Side slope
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Clayey marine deposits

Typical profile
H1 - 0 to 5 inches: fine sandy loam
H2 - 5 to 77 inches: clay

Properties and qualities
Slope: 5 to 12 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Somewhat poorly drained

Runoff class: High
Capacity of the most limiting layer to transmit water (Ksat): Very low to moderately low (0.00 to 0.06 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Available water storage in profile: High (about 10.5 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 6e
Hydrologic Soil Group: D

Minor Components

Harleston

Percent of map unit: 8 percent
Landform: Stream terraces
Landform position (two-dimensional): Shoulder
Landform position (three-dimensional): Riser
Down-slope shape: Linear
Across-slope shape: Linear

Poarch

Percent of map unit: 8 percent
Landform: Hillslopes
Landform position (two-dimensional): Shoulder
Landform position (three-dimensional): Side slope
Down-slope shape: Linear
Across-slope shape: Linear

Atmore

Percent of map unit: 8 percent
Landform: Depressions
Landform position (three-dimensional): Dip
Down-slope shape: Linear
Across-slope shape: Linear

SnB—Saucier-Susquehanna complex, 2 to 5 percent slopes

Map Unit Setting

National map unit symbol: c4y9
Elevation: 100 to 300 feet
Mean annual precipitation: 48 to 75 inches
Mean annual air temperature: 63 to 70 degrees F
Frost-free period: 200 to 335 days
Farmland classification: Not prime farmland

Map Unit Composition

Saucier and similar soils: 50 percent
Susquehanna and similar soils: 25 percent
Minor components: 23 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Saucier

Setting

Landform: Coastal plains
Landform position (two-dimensional): Shoulder
Landform position (three-dimensional): Crest
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Loamy over clayey marine deposits

Typical profile

H1 - 0 to 12 inches: fine sandy loam
H2 - 12 to 48 inches: loam
H3 - 48 to 60 inches: silty clay loam
H4 - 60 to 72 inches: clay

Properties and qualities

Slope: 2 to 5 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Moderately well drained
Runoff class: Low
Capacity of the most limiting layer to transmit water (Ksat): Moderately low to moderately high (0.06 to 0.20 in/hr)
Depth to water table: About 30 to 48 inches
Frequency of flooding: None
Frequency of ponding: None
Available water storage in profile: High (about 10.3 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 2e
Hydrologic Soil Group: C

Description of Susquehanna

Setting

Landform: Coastal plains
Landform position (two-dimensional): Shoulder
Landform position (three-dimensional): Crest
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Clayey marine deposits

Typical profile

H1 - 0 to 5 inches: fine sandy loam
H2 - 5 to 77 inches: clay

Properties and qualities

Slope: 2 to 5 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Somewhat poorly drained

Runoff class: Medium
Capacity of the most limiting layer to transmit water (Ksat): Very low to moderately low (0.00 to 0.06 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Available water storage in profile: High (about 10.5 inches)

Interpretive groups
Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 4e
Hydrologic Soil Group: D

Minor Components

Harleston
Percent of map unit: 9 percent
Landform: Stream terraces
Landform position (two-dimensional): Shoulder
Landform position (three-dimensional): Riser
Down-slope shape: Linear
Across-slope shape: Linear

Poarch
Percent of map unit: 9 percent
Landform: Hillslopes
Landform position (two-dimensional): Shoulder
Landform position (three-dimensional): Side slope
Down-slope shape: Linear
Across-slope shape: Linear

Smithton
Percent of map unit: 5 percent
Landform: Terraces
Landform position (three-dimensional): Tread, dip
Down-slope shape: Linear
Across-slope shape: Linear

SsE—Smithdale fine sandy loam, 12 to 17 percent slopes

Map Unit Setting
National map unit symbol: c4yb
Elevation: 100 to 550 feet
Mean annual precipitation: 45 to 75 inches
Mean annual air temperature: 61 to 70 degrees F
Frost-free period: 200 to 335 days
Farmland classification: Not prime farmland

Map Unit Composition
Smithdale and similar soils: 85 percent

Minor components: 14 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Smithdale

Setting

Landform: Hillslopes
Landform position (two-dimensional): Backslope
Landform position (three-dimensional): Side slope
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Loamy fluviomarine deposits

Typical profile

H1 - 0 to 11 inches: fine sandy loam
H2 - 11 to 38 inches: loam
H3 - 38 to 80 inches: loam

Properties and qualities

Slope: 12 to 17 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Well drained
Runoff class: Medium
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (0.60 to 2.00 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Available water storage in profile: High (about 9.2 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 6e
Hydrologic Soil Group: B

Minor Components

Ruston

Percent of map unit: 4 percent
Landform: Coastal plains
Landform position (two-dimensional): Shoulder
Landform position (three-dimensional): Side slope
Down-slope shape: Linear
Across-slope shape: Linear

Mclaurin

Percent of map unit: 4 percent
Landform: Coastal plains
Landform position (two-dimensional): Shoulder
Landform position (three-dimensional): Side slope
Down-slope shape: Linear
Across-slope shape: Linear

Poarch

Percent of map unit: 4 percent
Landform: Hillslopes
Landform position (two-dimensional): Shoulder
Landform position (three-dimensional): Side slope

Down-slope shape: Linear
Across-slope shape: Linear

Smithton
Percent of map unit: 2 percent
Landform: Terraces
Landform position (three-dimensional): Tread, dip
Down-slope shape: Linear
Across-slope shape: Linear

St—Smithton fine sandy loam

Map Unit Setting
National map unit symbol: c4yc
Elevation: 100 to 300 feet
Mean annual precipitation: 60 to 75 inches
Mean annual air temperature: 64 to 70 degrees F
Frost-free period: 270 to 335 days
Farmland classification: Prime farmland if drained

Map Unit Composition
Smithton and similar soils: 85 percent
Minor components: 12 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Smithton

Setting
Landform: Terraces
Landform position (three-dimensional): Tread, dip
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Loamy alluvium

Typical profile
H1 - 0 to 1 inches: fine sandy loam
H2 - 1 to 10 inches: fine sandy loam
H3 - 10 to 38 inches: fine sandy loam
H4 - 38 to 72 inches: fine sandy loam

Properties and qualities
Slope: 0 to 2 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Poorly drained
Runoff class: Very high
Capacity of the most limiting layer to transmit water (Ksat): Moderately high (0.20 to 0.60 in/hr)
Depth to water table: About 0 to 12 inches
Frequency of flooding: Occasional
Frequency of ponding: None
Available water storage in profile: High (about 9.5 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 4w
Hydrologic Soil Group: D

Minor Components

Escambia

Percent of map unit: 4 percent
Landform: Coastal plains
Landform position (two-dimensional): Shoulder
Landform position (three-dimensional): Crest
Down-slope shape: Linear
Across-slope shape: Linear

Saucier

Percent of map unit: 4 percent
Landform: Coastal plains
Landform position (two-dimensional): Shoulder
Landform position (three-dimensional): Crest
Down-slope shape: Linear
Across-slope shape: Linear

Ponzer

Percent of map unit: 4 percent
Landform: Drainageways
Landform position (two-dimensional): Shoulder
Landform position (three-dimensional): Dip
Down-slope shape: Linear
Across-slope shape: Linear

W—Water

Map Unit Composition

Water: 100 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

References

American Association of State Highway and Transportation Officials (AASHTO). 2004. Standard specifications for transportation materials and methods of sampling and testing. 24th edition.

American Society for Testing and Materials (ASTM). 2005. Standard classification of soils for engineering purposes. ASTM Standard D2487-00.

Cowardin, L.M., V. Carter, F.C. Golet, and E.T. LaRoe. 1979. Classification of wetlands and deep-water habitats of the United States. U.S. Fish and Wildlife Service FWS/OBS-79/31.

Federal Register. July 13, 1994. Changes in hydric soils of the United States.

Federal Register. September 18, 2002. Hydric soils of the United States.

Hurt, G.W., and L.M. Vasilas, editors. Version 6.0, 2006. Field indicators of hydric soils in the United States.

National Research Council. 1995. Wetlands: Characteristics and boundaries.

Soil Survey Division Staff. 1993. Soil survey manual. Soil Conservation Service. U.S. Department of Agriculture Handbook 18. http://www.nrcs.usda.gov/wps/portal/nrcs/detail/national/soils/?cid=nrcs142p2_054262

Soil Survey Staff. 1999. Soil taxonomy: A basic system of soil classification for making and interpreting soil surveys. 2nd edition. Natural Resources Conservation Service, U.S. Department of Agriculture Handbook 436. http://www.nrcs.usda.gov/wps/portal/nrcs/detail/national/soils/?cid=nrcs142p2_053577

Soil Survey Staff. 2010. Keys to soil taxonomy. 11th edition. U.S. Department of Agriculture, Natural Resources Conservation Service. http://www.nrcs.usda.gov/wps/portal/nrcs/detail/national/soils/?cid=nrcs142p2_053580

Tiner, R.W., Jr. 1985. Wetlands of Delaware. U.S. Fish and Wildlife Service and Delaware Department of Natural Resources and Environmental Control, Wetlands Section.

United States Army Corps of Engineers, Environmental Laboratory. 1987. Corps of Engineers wetlands delineation manual. Waterways Experiment Station Technical Report Y-87-1.

United States Department of Agriculture, Natural Resources Conservation Service. National forestry manual. http://www.nrcs.usda.gov/wps/portal/nrcs/detail/soils/home/?cid=nrcs142p2_053374

United States Department of Agriculture, Natural Resources Conservation Service. National range and pasture handbook. http://www.nrcs.usda.gov/wps/portal/nrcs/detail/national/landuse/rangepasture/?cid=stelprdb1043084

United States Department of Agriculture, Natural Resources Conservation Service. National soil survey handbook, title 430-VI. http://www.nrcs.usda.gov/wps/portal/nrcs/detail/soils/scientists/?cid=nrcs142p2_054242

United States Department of Agriculture, Natural Resources Conservation Service. 2006. Land resource regions and major land resource areas of the United States, the Caribbean, and the Pacific Basin. U.S. Department of Agriculture Handbook 296. http://www.nrcs.usda.gov/wps/portal/nrcs/detail/national/soils/?cid=nrcs142p2_053624

United States Department of Agriculture, Soil Conservation Service. 1961. Land capability classification. U.S. Department of Agriculture Handbook 210. http://www.nrcs.usda.gov/Internet/FSE_DOCUMENTS/nrcs142p2_052290.pdf

Glossary

Many of the terms relating to landforms, geology, and geomorphology are defined in more detail in the "National Soil Survey Handbook."

ABC soil

A soil having an A, a B, and a C horizon.

Ablation till

Loose, relatively permeable earthy material deposited during the downwasting of nearly static glacial ice, either contained within or accumulated on the surface of the glacier.

AC soil

A soil having only an A and a C horizon. Commonly, such soil formed in recent alluvium or on steep, rocky slopes.

Aeration, soil

The exchange of air in soil with air from the atmosphere. The air in a well aerated soil is similar to that in the atmosphere; the air in a poorly aerated soil is considerably higher in carbon dioxide and lower in oxygen.

Aggregate, soil

Many fine particles held in a single mass or cluster. Natural soil aggregates, such as granules, blocks, or prisms, are called peds. Clods are aggregates produced by tillage or logging.

Alkali (sodic) soil

A soil having so high a degree of alkalinity (pH 8.5 or higher) or so high a percentage of exchangeable sodium (15 percent or more of the total exchangeable bases), or both, that plant growth is restricted.

Alluvial cone

A semiconical type of alluvial fan having very steep slopes. It is higher, narrower, and steeper than a fan and is composed of coarser and thicker layers of material deposited by a combination of alluvial episodes and (to a much lesser degree) landslides (debris flow). The coarsest materials tend to be concentrated at the apex of the cone.

Alluvial fan

A low, outspread mass of loose materials and/or rock material, commonly with gentle slopes. It is shaped like an open fan or a segment of a cone. The material was deposited by a stream at the place where it issues from a narrow mountain valley or upland valley or where a tributary stream is near or at its junction with the main stream. The fan is steepest near its apex, which points upstream, and slopes gently and convexly outward (downstream) with a gradual decrease in gradient.

Alluvium

Unconsolidated material, such as gravel, sand, silt, clay, and various mixtures of these, deposited on land by running water.

Alpha,alpha-dipyridyl

A compound that when dissolved in ammonium acetate is used to detect the presence of reduced iron (Fe II) in the soil. A positive reaction implies reducing conditions and the likely presence of redoximorphic features.

Animal unit month (AUM)

The amount of forage required by one mature cow of approximately 1,000 pounds weight, with or without a calf, for 1 month.

Aquic conditions

Current soil wetness characterized by saturation, reduction, and redoximorphic features.

Argillic horizon

A subsoil horizon characterized by an accumulation of illuvial clay.

Arroyo

The flat-floored channel of an ephemeral stream, commonly with very steep to vertical banks cut in unconsolidated material. It is usually dry but can be transformed into a temporary watercourse or short-lived torrent after heavy rain within the watershed.

Aspect

The direction toward which a slope faces. Also called slope aspect.

Association, soil

A group of soils or miscellaneous areas geographically associated in a characteristic repeating pattern and defined and delineated as a single map unit.

Available water capacity (available moisture capacity)

The capacity of soils to hold water available for use by most plants. It is commonly defined as the difference between the amount of soil water at field moisture capacity and the amount at wilting point. It is commonly expressed as inches of water per inch of soil. The capacity, in inches, in a 60-inch profile or to a limiting layer is expressed as:

Very low: 0 to 3
Low: 3 to 6
Moderate: 6 to 9
High: 9 to 12
Very high: More than 12

Backslope

The position that forms the steepest and generally linear, middle portion of a hillslope. In profile, backslopes are commonly bounded by a convex shoulder above and a concave footslope below.

Backswamp

A flood-plain landform. Extensive, marshy or swampy, depressed areas of flood plains between natural levees and valley sides or terraces.

Badland

A landscape that is intricately dissected and characterized by a very fine drainage network with high drainage densities and short, steep slopes and narrow interfluves. Badlands develop on surfaces that have little or no vegetative cover overlying unconsolidated or poorly cemented materials (clays, silts, or sandstones) with, in some cases, soluble minerals, such as gypsum or halite.

Bajada

A broad, gently inclined alluvial piedmont slope extending from the base of a mountain range out into a basin and formed by the lateral coalescence of a series of alluvial fans. Typically, it has a broadly undulating transverse profile, parallel to the mountain front, resulting from the convexities of component fans. The term is generally restricted to constructional slopes of intermontane basins.

Basal area

The area of a cross section of a tree, generally referring to the section at breast height and measured outside the bark. It is a measure of stand density, commonly expressed in square feet.

Base saturation

The degree to which material having cation-exchange properties is saturated with exchangeable bases (sum of Ca, Mg, Na, and K), expressed as a percentage of the total cation-exchange capacity.

Base slope (geomorphology)

A geomorphic component of hills consisting of the concave to linear (perpendicular to the contour) slope that, regardless of the lateral shape, forms an apron or wedge at the bottom of a hillside dominated by colluvium and slope-wash sediments (for example, slope alluvium).

Bedding plane

A planar or nearly planar bedding surface that visibly separates each successive layer of stratified sediment or rock (of the same or different lithology) from the preceding or following layer; a plane of deposition. It commonly marks a change in the circumstances of deposition and may show a parting, a color difference, a change in particle size, or various combinations of these. The term is commonly applied to any bedding surface, even one that is conspicuously bent or deformed by folding.

Bedding system

A drainage system made by plowing, grading, or otherwise shaping the surface of a flat field. It consists of a series of low ridges separated by shallow, parallel dead furrows.

Bedrock

The solid rock that underlies the soil and other unconsolidated material or that is exposed at the surface.

Bedrock-controlled topography

A landscape where the configuration and relief of the landforms are determined or strongly influenced by the underlying bedrock.

Bench terrace

A raised, level or nearly level strip of earth constructed on or nearly on a contour, supported by a barrier of rocks or similar material, and designed to make the soil suitable for tillage and to prevent accelerated erosion.

Bisequum

Two sequences of soil horizons, each of which consists of an illuvial horizon and the overlying eluvial horizons.

Blowout (map symbol)

A saucer-, cup-, or trough-shaped depression formed by wind erosion on a preexisting dune or other sand deposit, especially in an area of shifting sand or loose soil or where protective vegetation is disturbed or destroyed. The adjoining accumulation of sand derived from the depression, where recognizable, is commonly included. Blowouts are commonly small.

Borrow pit (map symbol)

An open excavation from which soil and underlying material have been removed, usually for construction purposes.

Bottom land

An informal term loosely applied to various portions of a flood plain.

Boulders

Rock fragments larger than 2 feet (60 centimeters) in diameter.

Breaks

A landscape or tract of steep, rough or broken land dissected by ravines and gullies and marking a sudden change in topography.

Breast height

An average height of 4.5 feet above the ground surface; the point on a tree where diameter measurements are ordinarily taken.

Brush management

Use of mechanical, chemical, or biological methods to make conditions favorable for reseeding or to reduce or eliminate competition from woody vegetation and thus allow understory grasses and forbs to recover. Brush management increases forage production and thus reduces the hazard of erosion. It can improve the habitat for some species of wildlife.

Butte

An isolated, generally flat-topped hill or mountain with relatively steep slopes and talus or precipitous cliffs and characterized by summit width that is less than the height of bounding escarpments; commonly topped by a caprock of resistant material and representing an erosion remnant carved from flat-lying rocks.

Cable yarding

A method of moving felled trees to a nearby central area for transport to a processing facility. Most cable yarding systems involve use of a drum, a pole, and wire cables in an arrangement similar to that of a rod and reel used for fishing. To reduce friction and soil disturbance, felled trees generally are reeled in while one end is lifted or the entire log is suspended.

Calcareous soil

A soil containing enough calcium carbonate (commonly combined with magnesium carbonate) to effervesce visibly when treated with cold, dilute hydrochloric acid.

Caliche

A general term for a prominent zone of secondary carbonate accumulation in surficial materials in warm, subhumid to arid areas. Caliche is formed by both geologic and pedologic processes. Finely crystalline calcium carbonate forms a nearly continuous surface-coating and void-filling medium in geologic (parent) materials. Cementation ranges from weak in nonindurated forms to very strong in indurated forms. Other minerals (e.g., carbonates, silicate, and sulfate) may occur as accessory cements. Most petrocalcic horizons and some calcic horizons are caliche.

California bearing ratio (CBR)

The load-supporting capacity of a soil as compared to that of standard crushed limestone, expressed as a ratio. First standardized in California. A soil having a CBR of 16 supports 16 percent of the load that would be supported by standard crushed limestone, per unit area, with the same degree of distortion.

Canopy

The leafy crown of trees or shrubs. (See Crown.)

Canyon

A long, deep, narrow valley with high, precipitous walls in an area of high local relief.

Capillary water

Water held as a film around soil particles and in tiny spaces between particles. Surface tension is the adhesive force that holds capillary water in the soil.

Catena

A sequence, or “chain,” of soils on a landscape that formed in similar kinds of parent material and under similar climatic conditions but that have different characteristics as a result of differences in relief and drainage.

Cation

An ion carrying a positive charge of electricity. The common soil cations are calcium, potassium, magnesium, sodium, and hydrogen.

Cation-exchange capacity

The total amount of exchangeable cations that can be held by the soil, expressed in terms of milliequivalents per 100 grams of soil at neutrality (pH 7.0) or at some other stated pH value. The term, as applied to soils, is synonymous with base-exchange capacity but is more precise in meaning.

Catsteps

See Terracettes.

Cement rock

Shaly limestone used in the manufacture of cement.

Channery soil material

Soil material that has, by volume, 15 to 35 percent thin, flat fragments of sandstone, shale, slate, limestone, or schist as much as 6 inches (15 centimeters) along the longest axis. A single piece is called a channer.

Chemical treatment

Control of unwanted vegetation through the use of chemicals.

Chiseling

Tillage with an implement having one or more soil-penetrating points that shatter or loosen hard, compacted layers to a depth below normal plow depth.

Cirque

A steep-walled, semicircular or crescent-shaped, half-bowl-like recess or hollow, commonly situated at the head of a glaciated mountain valley or high on the side of a mountain. It was produced by the erosive activity of a mountain glacier. It commonly contains a small round lake (tarn).

Clay

As a soil separate, the mineral soil particles less than 0.002 millimeter in diameter. As a soil textural class, soil material that is 40 percent or more clay, less than 45 percent sand, and less than 40 percent silt.

Clay depletions

See Redoximorphic features.

Clay film

A thin coating of oriented clay on the surface of a soil aggregate or lining pores or root channels. Synonyms: clay coating, clay skin.

Clay spot (map symbol)

A spot where the surface texture is silty clay or clay in areas where the surface layer of the soils in the surrounding map unit is sandy loam, loam, silt loam, or coarser.

Claypan

A dense, compact subsoil layer that contains much more clay than the overlying materials, from which it is separated by a sharply defined boundary. The layer restricts the downward movement of water through the soil. A claypan is commonly hard when dry and plastic and sticky when wet.

Climax plant community

The stabilized plant community on a particular site. The plant cover reproduces itself and does not change so long as the environment remains the same.

Coarse textured soil

Sand or loamy sand.

Cobble (or cobblestone)

A rounded or partly rounded fragment of rock 3 to 10 inches (7.6 to 25 centimeters) in diameter.

Cobbly soil material

Material that has 15 to 35 percent, by volume, rounded or partially rounded rock fragments 3 to 10 inches (7.6 to 25 centimeters) in diameter. Very cobbly soil material has 35 to 60 percent of these rock fragments, and extremely cobbly soil material has more than 60 percent.

COLE (coefficient of linear extensibility)

See Linear extensibility.

Colluvium

Unconsolidated, unsorted earth material being transported or deposited on side slopes and/or at the base of slopes by mass movement (e.g., direct gravitational action) and by local, unconcentrated runoff.

Complex slope

Irregular or variable slope. Planning or establishing terraces, diversions, and other water-control structures on a complex slope is difficult.

Complex, soil

A map unit of two or more kinds of soil or miscellaneous areas in such an intricate pattern or so small in area that it is not practical to map them separately at the selected scale of mapping. The pattern and proportion of the soils or miscellaneous areas are somewhat similar in all areas.

Concretions

See Redoximorphic features.

Conglomerate

A coarse grained, clastic sedimentary rock composed of rounded or subangular rock fragments more than 2 millimeters in diameter. It commonly has a matrix of sand and finer textured material. Conglomerate is the consolidated equivalent of gravel.

Conservation cropping system

Growing crops in combination with needed cultural and management practices. In a good conservation cropping system, the soil-improving crops and practices more than offset the effects of the soil-depleting crops and practices. Cropping systems are needed on all tilled soils. Soil-improving practices in a conservation cropping system include the use of rotations that contain grasses and legumes and the return of crop residue to the soil. Other practices include the use of green manure crops of grasses and legumes, proper tillage, adequate fertilization, and weed and pest control.

Conservation tillage

A tillage system that does not invert the soil and that leaves a protective amount of crop residue on the surface throughout the year.

Consistence, soil

Refers to the degree of cohesion and adhesion of soil material and its resistance to deformation when ruptured. Consistence includes resistance of soil material to rupture and to penetration; plasticity, toughness, and stickiness of puddled soil material; and the manner in which the soil material behaves when subject to compression. Terms describing consistence are defined in the “Soil Survey Manual.”

Contour stripcropping

Growing crops in strips that follow the contour. Strips of grass or close-growing crops are alternated with strips of clean-tilled crops or summer fallow.

Control section

The part of the soil on which classification is based. The thickness varies among different kinds of soil, but for many it is that part of the soil profile between depths of 10 inches and 40 or 80 inches.

Coprogenous earth (sedimentary peat)

A type of limnic layer composed predominantly of fecal material derived from aquatic animals.

Corrosion (geomorphology)

A process of erosion whereby rocks and soil are removed or worn away by natural chemical processes, especially by the solvent action of running water, but also by other reactions, such as hydrolysis, hydration, carbonation, and oxidation.

Corrosion (soil survey interpretations)

Soil-induced electrochemical or chemical action that dissolves or weakens concrete or uncoated steel.

Cover crop

A close-growing crop grown primarily to improve and protect the soil between periods of regular crop production, or a crop grown between trees and vines in orchards and vineyards.

Crop residue management

Returning crop residue to the soil, which helps to maintain soil structure, organic matter content, and fertility and helps to control erosion.

Cropping system

Growing crops according to a planned system of rotation and management practices.

Cross-slope farming

Deliberately conducting farming operations on sloping farmland in such a way that tillage is across the general slope.

Crown

The upper part of a tree or shrub, including the living branches and their foliage.

Cryoturbate

A mass of soil or other unconsolidated earthy material moved or disturbed by frost action. It is typically coarser than the underlying material.

Cuesta

An asymmetric ridge capped by resistant rock layers of slight or moderate dip (commonly less than 15 percent slopes); a type of homocline produced by differential erosion of interbedded resistant and weak rocks. A cuesta has a long, gentle slope on one side (dip slope) that roughly parallels the inclined beds; on the other side, it has a relatively short and steep or clifflike slope (scarp) that cuts through the tilted rocks.

Culmination of the mean annual increment (CMAI)

The average annual increase per acre in the volume of a stand. Computed by dividing the total volume of the stand by its age. As the stand increases in age, the mean annual increment continues to increase until mortality begins to reduce the rate of increase. The point where the stand reaches its maximum annual rate of growth is called the culmination of the mean annual increment.

Cutbanks cave

The walls of excavations tend to cave in or slough.

Decreasers

The most heavily grazed climax range plants. Because they are the most palatable, they are the first to be destroyed by overgrazing.

Deferred grazing

Postponing grazing or resting grazing land for a prescribed period.

Delta

A body of alluvium having a surface that is fan shaped and nearly flat; deposited at or near the mouth of a river or stream where it enters a body of relatively quiet water, generally a sea or lake.

Dense layer

A very firm, massive layer that has a bulk density of more than 1.8 grams per cubic centimeter. Such a layer affects the ease of digging and can affect filling and compacting.

Depression, closed (map symbol)

A shallow, saucer-shaped area that is slightly lower on the landscape than the surrounding area and that does not have a natural outlet for surface drainage.

Depth, soil

Generally, the thickness of the soil over bedrock. Very deep soils are more than 60 inches deep over bedrock; deep soils, 40 to 60 inches; moderately deep, 20 to 40 inches; shallow, 10 to 20 inches; and very shallow, less than 10 inches.

Desert pavement

A natural, residual concentration or layer of wind-polished, closely packed gravel, boulders, and other rock fragments mantling a desert surface. It forms where wind action and sheetwash have removed all smaller particles or where rock fragments have migrated upward through sediments to the surface. It typically protects the finer grained underlying material from further erosion.

Diatomaceous earth

A geologic deposit of fine, grayish siliceous material composed chiefly or entirely of the remains of diatoms.

Dip slope

A slope of the land surface, roughly determined by and approximately conforming to the dip of the underlying bedrock.

Diversion (or diversion terrace)

A ridge of earth, generally a terrace, built to protect downslope areas by diverting runoff from its natural course.

Divided-slope farming

A form of field stripcropping in which crops are grown in a systematic arrangement of two strips, or bands, across the slope to reduce the hazard of water erosion. One strip is in a close-growing crop that provides protection from erosion, and the other strip is in a crop that provides less protection from erosion. This practice is used where slopes are not long enough to permit a full stripcropping pattern to be used.

Drainage class (natural)

Refers to the frequency and duration of wet periods under conditions similar to those under which the soil formed. Alterations of the water regime by human activities, either through drainage or irrigation, are not a consideration unless they have significantly changed the morphology of the soil. Seven classes of natural soil drainage are recognized—*excessively drained, somewhat excessively drained, well drained, moderately well drained, somewhat poorly drained, poorly drained,* and *very poorly drained*. These classes are defined in the “Soil Survey Manual.”

Drainage, surface

Runoff, or surface flow of water, from an area.

Drainageway

A general term for a course or channel along which water moves in draining an area. A term restricted to relatively small, linear depressions that at some time move concentrated water and either do not have a defined channel or have only a small defined channel.

Draw

A small stream valley that generally is shallower and more open than a ravine or gulch and that has a broader bottom. The present stream channel may appear inadequate to have cut the drainageway that it occupies.

Drift

A general term applied to all mineral material (clay, silt, sand, gravel, and boulders) transported by a glacier and deposited directly by or from the ice or transported by running water emanating from a glacier. Drift includes unstratified material (till) that forms moraines and stratified deposits that form outwash plains, eskers, kames, varves, and glaciofluvial sediments. The term is generally applied to Pleistocene glacial deposits in areas that no longer contain glaciers.

Drumlin

A low, smooth, elongated oval hill, mound, or ridge of compact till that has a core of bedrock or drift. It commonly has a blunt nose facing the direction from which the ice approached and a gentler slope tapering in the other direction. The longer axis is parallel to the general direction of glacier flow. Drumlins are products of streamline (laminar) flow of glaciers, which molded the subglacial floor through a combination of erosion and deposition.

Duff

A generally firm organic layer on the surface of mineral soils. It consists of fallen plant material that is in the process of decomposition and includes everything from the litter on the surface to underlying pure humus.

Dune

A low mound, ridge, bank, or hill of loose, windblown granular material (generally sand), either barren and capable of movement from place to place or covered and stabilized with vegetation but retaining its characteristic shape.

Earthy fill

See Mine spoil.

Ecological site

An area where climate, soil, and relief are sufficiently uniform to produce a distinct natural plant community. An ecological site is the product of all the environmental factors responsible for its development. It is typified by an association of species that differ from those on other ecological sites in kind and/or proportion of species or in total production.

Eluviation

The movement of material in true solution or colloidal suspension from one place to another within the soil. Soil horizons that have lost material through eluviation are eluvial; those that have received material are illuvial.

Endosaturation

A type of saturation of the soil in which all horizons between the upper boundary of saturation and a depth of 2 meters are saturated.

Eolian deposit

Sand-, silt-, or clay-sized clastic material transported and deposited primarily by wind, commonly in the form of a dune or a sheet of sand or loess.

Ephemeral stream

A stream, or reach of a stream, that flows only in direct response to precipitation. It receives no long-continued supply from melting snow or other source, and its channel is above the water table at all times.

Episaturation

A type of saturation indicating a perched water table in a soil in which saturated layers are underlain by one or more unsaturated layers within 2 meters of the surface.

Erosion

The wearing away of the land surface by water, wind, ice, or other geologic agents and by such processes as gravitational creep.

Erosion (accelerated)

Erosion much more rapid than geologic erosion, mainly as a result of human or animal activities or of a catastrophe in nature, such as a fire, that exposes the surface.

Erosion (geologic)

Erosion caused by geologic processes acting over long geologic periods and resulting in the wearing away of mountains and the building up of such landscape features as flood plains and coastal plains. Synonym: natural erosion.

Erosion pavement

A surficial lag concentration or layer of gravel and other rock fragments that remains on the soil surface after sheet or rill erosion or wind has removed the finer soil particles and that tends to protect the underlying soil from further erosion.

Erosion surface

A land surface shaped by the action of erosion, especially by running water.

Escarpment

A relatively continuous and steep slope or cliff breaking the general continuity of more gently sloping land surfaces and resulting from erosion or faulting. Most commonly applied to cliffs produced by differential erosion. Synonym: scarp.

Escarpment, bedrock (map symbol)

A relatively continuous and steep slope or cliff, produced by erosion or faulting, that breaks the general continuity of more gently sloping land surfaces. Exposed material is hard or soft bedrock.

Escarpment, nonbedrock (map symbol)

A relatively continuous and steep slope or cliff, generally produced by erosion but in some places produced by faulting, that breaks the continuity of more gently sloping land surfaces. Exposed earthy material is nonsoil or very shallow soil.

Esker

A long, narrow, sinuous, steep-sided ridge of stratified sand and gravel deposited as the bed of a stream flowing in an ice tunnel within or below the ice (subglacial) or between ice walls on top of the ice of a wasting glacier and left behind as high ground when the ice melted. Eskers range in length from less than a kilometer to more than 160 kilometers and in height from 3 to 30 meters.

Extrusive rock

Igneous rock derived from deep-seated molten matter (magma) deposited and cooled on the earth's surface.

Fallow

Cropland left idle in order to restore productivity through accumulation of moisture. Summer fallow is common in regions of limited rainfall where cereal grain is grown.

The soil is tilled for at least one growing season for weed control and decomposition of plant residue.

Fan remnant

A general term for landforms that are the remaining parts of older fan landforms, such as alluvial fans, that have been either dissected or partially buried.

Fertility, soil

The quality that enables a soil to provide plant nutrients, in adequate amounts and in proper balance, for the growth of specified plants when light, moisture, temperature, tilth, and other growth factors are favorable.

Fibric soil material (peat)

The least decomposed of all organic soil material. Peat contains a large amount of well preserved fiber that is readily identifiable according to botanical origin. Peat has the lowest bulk density and the highest water content at saturation of all organic soil material.

Field moisture capacity

The moisture content of a soil, expressed as a percentage of the ovendry weight, after the gravitational, or free, water has drained away; the field moisture content 2 or 3 days after a soaking rain; also called *normal field capacity, normal moisture capacity,* or *capillary capacity*.

Fill slope

A sloping surface consisting of excavated soil material from a road cut. It commonly is on the downhill side of the road.

Fine textured soil

Sandy clay, silty clay, or clay.

Firebreak

An area cleared of flammable material to stop or help control creeping or running fires. It also serves as a line from which to work and to facilitate the movement of firefighters and equipment. Designated roads also serve as firebreaks.

First bottom

An obsolete, informal term loosely applied to the lowest flood-plain steps that are subject to regular flooding.

Flaggy soil material

Material that has, by volume, 15 to 35 percent flagstones. Very flaggy soil material has 35 to 60 percent flagstones, and extremely flaggy soil material has more than 60 percent flagstones.

Flagstone

A thin fragment of sandstone, limestone, slate, shale, or (rarely) schist 6 to 15 inches (15 to 38 centimeters) long.

Flood plain

The nearly level plain that borders a stream and is subject to flooding unless protected artificially.

Flood-plain landforms

A variety of constructional and erosional features produced by stream channel migration and flooding. Examples include backswamps, flood-plain splays, meanders, meander belts, meander scrolls, oxbow lakes, and natural levees.

Flood-plain splay

A fan-shaped deposit or other outspread deposit formed where an overloaded stream breaks through a levee (natural or artificial) and deposits its material (commonly coarse grained) on the flood plain.

Flood-plain step

An essentially flat, terrace-like alluvial surface within a valley that is frequently covered by floodwater from the present stream; any approximately horizontal surface still actively modified by fluvial scour and/or deposition. May occur individually or as a series of steps.

Fluvial

Of or pertaining to rivers or streams; produced by stream or river action.

Foothills

A region of steeply sloping hills that fringes a mountain range or high-plateau escarpment. The hills have relief of as much as 1,000 feet (300 meters).

Footslope

The concave surface at the base of a hillslope. A footslope is a transition zone between upslope sites of erosion and transport (shoulders and backslopes) and downslope sites of deposition (toeslopes).

Forb

Any herbaceous plant not a grass or a sedge.

Forest cover

All trees and other woody plants (underbrush) covering the ground in a forest.

Forest type

A stand of trees similar in composition and development because of given physical and biological factors by which it may be differentiated from other stands.

Fragipan

A loamy, brittle subsurface horizon low in porosity and content of organic matter and low or moderate in clay but high in silt or very fine sand. A fragipan appears cemented and restricts roots. When dry, it is hard or very hard and has a higher bulk density than the horizon or horizons above. When moist, it tends to rupture suddenly under pressure rather than to deform slowly.

Genesis, soil

The mode of origin of the soil. Refers especially to the processes or soil-forming factors responsible for the formation of the solum, or true soil, from the unconsolidated parent material.

Gilgai

Commonly, a succession of microbasins and microknolls in nearly level areas or of microvalleys and microridges parallel with the slope. Typically, the microrelief of clayey soils that shrink and swell considerably with changes in moisture content.

Glaciofluvial deposits

Material moved by glaciers and subsequently sorted and deposited by streams flowing from the melting ice. The deposits are stratified and occur in the form of outwash plains, valley trains, deltas, kames, eskers, and kame terraces.

Glaciolacustrine deposits

Material ranging from fine clay to sand derived from glaciers and deposited in glacial lakes mainly by glacial meltwater. Many deposits are bedded or laminated.

Gleyed soil

Soil that formed under poor drainage, resulting in the reduction of iron and other elements in the profile and in gray colors.

Graded stripcropping

Growing crops in strips that grade toward a protected waterway.

Grassed waterway

A natural or constructed waterway, typically broad and shallow, seeded to grass as protection against erosion. Conducts surface water away from cropland.

Gravel

Rounded or angular fragments of rock as much as 3 inches (2 millimeters to 7.6 centimeters) in diameter. An individual piece is a pebble.

Gravel pit (map symbol)

An open excavation from which soil and underlying material have been removed and used, without crushing, as a source of sand or gravel.

Gravelly soil material

Material that has 15 to 35 percent, by volume, rounded or angular rock fragments, not prominently flattened, as much as 3 inches (7.6 centimeters) in diameter.

Gravelly spot (map symbol)

A spot where the surface layer has more than 35 percent, by volume, rock fragments that are mostly less than 3 inches in diameter in an area that has less than 15 percent rock fragments.

Green manure crop (agronomy)

A soil-improving crop grown to be plowed under in an early stage of maturity or soon after maturity.

Ground water

Water filling all the unblocked pores of the material below the water table.

Gully (map symbol)

A small, steep-sided channel caused by erosion and cut in unconsolidated materials by concentrated but intermittent flow of water. The distinction between a gully and a rill is one of depth. A gully generally is an obstacle to farm machinery and is too deep to be obliterated by ordinary tillage whereas a rill is of lesser depth and can be smoothed over by ordinary tillage.

Hard bedrock

Bedrock that cannot be excavated except by blasting or by the use of special equipment that is not commonly used in construction.

Hard to reclaim

Reclamation is difficult after the removal of soil for construction and other uses. Revegetation and erosion control are extremely difficult.

Hardpan

A hardened or cemented soil horizon, or layer. The soil material is sandy, loamy, or clayey and is cemented by iron oxide, silica, calcium carbonate, or other substance.

Head slope (geomorphology)

A geomorphic component of hills consisting of a laterally concave area of a hillside, especially at the head of a drainageway. The overland waterflow is converging.

Hemic soil material (mucky peat)

Organic soil material intermediate in degree of decomposition between the less decomposed fibric material and the more decomposed sapric material.

High-residue crops

Such crops as small grain and corn used for grain. If properly managed, residue from these crops can be used to control erosion until the next crop in the rotation is established. These crops return large amounts of organic matter to the soil.

Hill

A generic term for an elevated area of the land surface, rising as much as 1,000 feet above surrounding lowlands, commonly of limited summit area and having a well defined outline. Slopes are generally more than 15 percent. The distinction between a hill and a mountain is arbitrary and may depend on local usage.

Hillslope

A generic term for the steeper part of a hill between its summit and the drainage line, valley flat, or depression floor at the base of a hill.

Horizon, soil

A layer of soil, approximately parallel to the surface, having distinct characteristics produced by soil-forming processes. In the identification of soil horizons, an uppercase letter represents the major horizons. Numbers or lowercase letters that follow represent subdivisions of the major horizons. An explanation of the subdivisions is given in the “Soil Survey Manual.” The major horizons of mineral soil are as follows:

O horizon: An organic layer of fresh and decaying plant residue.

L horizon: A layer of organic and mineral limnic materials, including coprogenous earth (sedimentary peat), diatomaceous earth, and marl.

A horizon: The mineral horizon at or near the surface in which an accumulation of humified organic matter is mixed with the mineral material. Also, a plowed surface horizon, most of which was originally part of a B horizon.

E horizon: The mineral horizon in which the main feature is loss of silicate clay, iron, aluminum, or some combination of these.

B horizon: The mineral horizon below an A horizon. The B horizon is in part a layer of transition from the overlying A to the underlying C horizon. The B horizon also has distinctive characteristics, such as (1) accumulation of clay, sesquioxides, humus, or a combination of these; (2) prismatic or blocky structure; (3) redder or browner colors than those in the A horizon; or (4) a combination of these.

C horizon: The mineral horizon or layer, excluding indurated bedrock, that is little affected by soil-forming processes and does not have the properties typical of the overlying soil material. The material of a C horizon may be either like or unlike that in which the solum formed. If the material is known to differ from that in the solum, an Arabic numeral, commonly a 2, precedes the letter C.

Cr horizon: Soft, consolidated bedrock beneath the soil.

R layer: Consolidated bedrock beneath the soil. The bedrock commonly underlies a C horizon, but it can be directly below an A or a B horizon.

M layer: A root-limiting subsoil layer consisting of nearly continuous, horizontally oriented, human-manufactured materials.

W layer: A layer of water within or beneath the soil.

Humus

The well decomposed, more or less stable part of the organic matter in mineral soils.

Hydrologic soil groups

Refers to soils grouped according to their runoff potential. The soil properties that influence this potential are those that affect the minimum rate of water infiltration on a bare soil during periods after prolonged wetting when the soil is not frozen. These properties include depth to a seasonal high water table, the infiltration rate, and depth to a layer that significantly restricts the downward movement of water. The slope and the kind of plant cover are not considered but are separate factors in predicting runoff.

Igneous rock

Rock that was formed by cooling and solidification of magma and that has not been changed appreciably by weathering since its formation. Major varieties include plutonic and volcanic rock (e.g., andesite, basalt, and granite).

Illuviation

The movement of soil material from one horizon to another in the soil profile. Generally, material is removed from an upper horizon and deposited in a lower horizon.

Impervious soil

A soil through which water, air, or roots penetrate slowly or not at all. No soil is absolutely impervious to air and water all the time.

Increasers

Species in the climax vegetation that increase in amount as the more desirable plants are reduced by close grazing. Increasers commonly are the shorter plants and the less palatable to livestock.

Infiltration

The downward entry of water into the immediate surface of soil or other material, as contrasted with percolation, which is movement of water through soil layers or material.

Infiltration capacity

The maximum rate at which water can infiltrate into a soil under a given set of conditions.

Infiltration rate

The rate at which water penetrates the surface of the soil at any given instant, usually expressed in inches per hour. The rate can be limited by the infiltration capacity of the soil or the rate at which water is applied at the surface.

Intake rate

The average rate of water entering the soil under irrigation. Most soils have a fast initial rate; the rate decreases with application time. Therefore, intake rate for design purposes is not a constant but is a variable depending on the net irrigation application. The rate of water intake, in inches per hour, is expressed as follows:

Very low: Less than 0.2
Low: 0.2 to 0.4
Moderately low: 0.4 to 0.75
Moderate: 0.75 to 1.25
Moderately high: 1.25 to 1.75
High: 1.75 to 2.5
Very high: More than 2.5

Interfluve

A landform composed of the relatively undissected upland or ridge between two adjacent valleys containing streams flowing in the same general direction. An elevated area between two drainageways that sheds water to those drainageways.

Interfluve (geomorphology)

A geomorphic component of hills consisting of the uppermost, comparatively level or gently sloping area of a hill; shoulders of backwearing hillslopes can narrow the upland or can merge, resulting in a strongly convex shape.

Intermittent stream

A stream, or reach of a stream, that does not flow year-round but that is commonly dry for 3 or more months out of 12 and whose channel is generally below the local water table. It flows only during wet periods or when it receives ground-water discharge or long, continued contributions from melting snow or other surface and shallow subsurface sources.

Invaders

On range, plants that encroach into an area and grow after the climax vegetation has been reduced by grazing. Generally, plants invade following disturbance of the surface.

Iron depletions

See Redoximorphic features.

Irrigation

Application of water to soils to assist in production of crops. Methods of irrigation are:

Basin: Water is applied rapidly to nearly level plains surrounded by levees or dikes.

Border: Water is applied at the upper end of a strip in which the lateral flow of water is controlled by small earth ridges called border dikes, or borders.

Controlled flooding: Water is released at intervals from closely spaced field ditches and distributed uniformly over the field.

Corrugation: Water is applied to small, closely spaced furrows or ditches in fields of close-growing crops or in orchards so that it flows in only one direction.

Drip (or trickle): Water is applied slowly and under low pressure to the surface of the soil or into the soil through such applicators as emitters, porous tubing, or perforated pipe.

Furrow: Water is applied in small ditches made by cultivation implements. Furrows are used for tree and row crops.

Sprinkler: Water is sprayed over the soil surface through pipes or nozzles from a pressure system.

Subirrigation: Water is applied in open ditches or tile lines until the water table is raised enough to wet the soil.

Wild flooding: Water, released at high points, is allowed to flow onto an area without controlled distribution.

Kame

A low mound, knob, hummock, or short irregular ridge composed of stratified sand and gravel deposited by a subglacial stream as a fan or delta at the margin of a melting glacier; by a supraglacial stream in a low place or hole on the surface of the glacier; or as a ponded deposit on the surface or at the margin of stagnant ice.

Karst (topography)

A kind of topography that formed in limestone, gypsum, or other soluble rocks by dissolution and that is characterized by closed depressions, sinkholes, caves, and underground drainage.

Knoll

A small, low, rounded hill rising above adjacent landforms.

Ksat

See Saturated hydraulic conductivity.

Lacustrine deposit

Material deposited in lake water and exposed when the water level is lowered or the elevation of the land is raised.

Lake plain

A nearly level surface marking the floor of an extinct lake filled by well sorted, generally fine textured, stratified deposits, commonly containing varves.

Lake terrace

A narrow shelf, partly cut and partly built, produced along a lakeshore in front of a scarp line of low cliffs and later exposed when the water level falls.

Landfill (map symbol)

An area of accumulated waste products of human habitation, either above or below natural ground level.

Landslide

A general, encompassing term for most types of mass movement landforms and processes involving the downslope transport and outward deposition of soil and rock materials caused by gravitational forces; the movement may or may not involve saturated materials. The speed and distance of movement, as well as the amount of soil and rock material, vary greatly.

Large stones

Rock fragments 3 inches (7.6 centimeters) or more across. Large stones adversely affect the specified use of the soil.

Lava flow (map symbol)

A solidified, commonly lobate body of rock formed through lateral, surface outpouring of molten lava from a vent or fissure.

Leaching

The removal of soluble material from soil or other material by percolating water.

Levee (map symbol)

An embankment that confines or controls water, especially one built along the banks of a river to prevent overflow onto lowlands.

Linear extensibility

Refers to the change in length of an unconfined clod as moisture content is decreased from a moist to a dry state. Linear extensibility is used to determine the shrink-swell potential of soils. It is an expression of the volume change between the water content of the clod at $^{1}/_{3}$- or $^{1}/_{10}$-bar tension (33kPa or 10kPa tension) and oven dryness. Volume change is influenced by the amount and type of clay minerals in the soil. The volume change is the percent change for the whole soil. If it is expressed as a fraction, the resulting value is COLE, coefficient of linear extensibility.

Liquid limit

The moisture content at which the soil passes from a plastic to a liquid state.

Loam

Soil material that is 7 to 27 percent clay particles, 28 to 50 percent silt particles, and less than 52 percent sand particles.

Loess

Material transported and deposited by wind and consisting dominantly of silt-sized particles.

Low strength

The soil is not strong enough to support loads.

Low-residue crops

Such crops as corn used for silage, peas, beans, and potatoes. Residue from these crops is not adequate to control erosion until the next crop in the rotation is established. These crops return little organic matter to the soil.

Marl

An earthy, unconsolidated deposit consisting chiefly of calcium carbonate mixed with clay in approximately equal proportions; formed primarily under freshwater lacustrine conditions but also formed in more saline environments.

Marsh or swamp (map symbol)

A water-saturated, very poorly drained area that is intermittently or permanently covered by water. Sedges, cattails, and rushes are the dominant vegetation in marshes, and trees or shrubs are the dominant vegetation in swamps. Not used in map units where the named soils are poorly drained or very poorly drained.

Mass movement

A generic term for the dislodgment and downslope transport of soil and rock material as a unit under direct gravitational stress.

Masses

See Redoximorphic features.

Meander belt

The zone within which migration of a meandering channel occurs; the flood-plain area included between two imaginary lines drawn tangential to the outer bends of active channel loops.

Meander scar

A crescent-shaped, concave or linear mark on the face of a bluff or valley wall, produced by the lateral erosion of a meandering stream that impinged upon and undercut the bluff.

Meander scroll

One of a series of long, parallel, close-fitting, crescent-shaped ridges and troughs formed along the inner bank of a stream meander as the channel migrated laterally down-valley and toward the outer bank.

Mechanical treatment

Use of mechanical equipment for seeding, brush management, and other management practices.

Medium textured soil

Very fine sandy loam, loam, silt loam, or silt.

Mesa

A broad, nearly flat topped and commonly isolated landmass bounded by steep slopes or precipitous cliffs and capped by layers of resistant, nearly horizontal rocky material. The summit width is characteristically greater than the height of the bounding escarpments.

Metamorphic rock

Rock of any origin altered in mineralogical composition, chemical composition, or structure by heat, pressure, and movement at depth in the earth’s crust. Nearly all such rocks are crystalline.

Mine or quarry (map symbol)

An open excavation from which soil and underlying material have been removed and in which bedrock is exposed. Also denotes surface openings to underground mines.

Mine spoil

An accumulation of displaced earthy material, rock, or other waste material removed during mining or excavation. Also called earthy fill.

Mineral soil

Soil that is mainly mineral material and low in organic material. Its bulk density is more than that of organic soil.

Minimum tillage

Only the tillage essential to crop production and prevention of soil damage.

Miscellaneous area

A kind of map unit that has little or no natural soil and supports little or no vegetation.

Miscellaneous water (map symbol)

Small, constructed bodies of water that are used for industrial, sanitary, or mining applications and that contain water most of the year.

Moderately coarse textured soil

Coarse sandy loam, sandy loam, or fine sandy loam.

Moderately fine textured soil

Clay loam, sandy clay loam, or silty clay loam.

Mollic epipedon

A thick, dark, humus-rich surface horizon (or horizons) that has high base saturation and pedogenic soil structure. It may include the upper part of the subsoil.

Moraine

In terms of glacial geology, a mound, ridge, or other topographically distinct accumulation of unsorted, unstratified drift, predominantly till, deposited primarily by the direct action of glacial ice in a variety of landforms. Also, a general term for a landform composed mainly of till (except for kame moraines, which are composed mainly of stratified outwash) that has been deposited by a glacier. Some types of moraines are disintegration, end, ground, kame, lateral, recessional, and terminal.

Morphology, soil

The physical makeup of the soil, including the texture, structure, porosity, consistence, color, and other physical, mineral, and biological properties of the various horizons, and the thickness and arrangement of those horizons in the soil profile.

Mottling, soil

Irregular spots of different colors that vary in number and size. Descriptive terms are as follows: abundance—*few, common,* and *many;* size—*fine, medium,* and *coarse;* and contrast—*faint, distinct,* and *prominent*. The size measurements are of the diameter along the greatest dimension. *Fine* indicates less than 5 millimeters (about 0.2 inch); *medium,* from 5 to 15 millimeters (about 0.2 to 0.6 inch); and *coarse,* more than 15 millimeters (about 0.6 inch).

Mountain

A generic term for an elevated area of the land surface, rising more than 1,000 feet (300 meters) above surrounding lowlands, commonly of restricted summit area (relative to a plateau) and generally having steep sides. A mountain can occur as a single, isolated mass or in a group forming a chain or range. Mountains are formed primarily by tectonic activity and/or volcanic action but can also be formed by differential erosion.

Muck

Dark, finely divided, well decomposed organic soil material. (See Sapric soil material.)

Mucky peat

See Hemic soil material.

Mudstone

A blocky or massive, fine grained sedimentary rock in which the proportions of clay and silt are approximately equal. Also, a general term for such material as clay, silt, claystone, siltstone, shale, and argillite and that should be used only when the amounts of clay and silt are not known or cannot be precisely identified.

Munsell notation

A designation of color by degrees of three simple variables—hue, value, and chroma. For example, a notation of 10YR 6/4 is a color with hue of 10YR, value of 6, and chroma of 4.

Natric horizon

A special kind of argillic horizon that contains enough exchangeable sodium to have an adverse effect on the physical condition of the subsoil.

Neutral soil

A soil having a pH value of 6.6 to 7.3. (See Reaction, soil.)

Nodules

See Redoximorphic features.

Nose slope (geomorphology)

A geomorphic component of hills consisting of the projecting end (laterally convex area) of a hillside. The overland waterflow is predominantly divergent. Nose slopes consist dominantly of colluvium and slope-wash sediments (for example, slope alluvium).

Nutrient, plant

Any element taken in by a plant essential to its growth. Plant nutrients are mainly nitrogen, phosphorus, potassium, calcium, magnesium, sulfur, iron, manganese, copper, boron, and zinc obtained from the soil and carbon, hydrogen, and oxygen obtained from the air and water.

Organic matter

Plant and animal residue in the soil in various stages of decomposition. The content of organic matter in the surface layer is described as follows:

Very low: Less than 0.5 percent
Low: 0.5 to 1.0 percent
Moderately low: 1.0 to 2.0 percent
Moderate: 2.0 to 4.0 percent
High: 4.0 to 8.0 percent
Very high: More than 8.0 percent

Outwash

Stratified and sorted sediments (chiefly sand and gravel) removed or “washed out” from a glacier by meltwater streams and deposited in front of or beyond the end moraine or the margin of a glacier. The coarser material is deposited nearer to the ice.

Outwash plain

An extensive lowland area of coarse textured glaciofluvial material. An outwash plain is commonly smooth; where pitted, it generally is low in relief.

Paleoterrace

An erosional remnant of a terrace that retains the surface form and alluvial deposits of its origin but was not emplaced by, and commonly does not grade to, a present-day stream or drainage network.

Pan

A compact, dense layer in a soil that impedes the movement of water and the growth of roots. For example, *hardpan, fragipan, claypan, plowpan,* and *traffic pan*.

Parent material

The unconsolidated organic and mineral material in which soil forms.

Peat

Unconsolidated material, largely undecomposed organic matter, that has accumulated under excess moisture. (See Fibric soil material.)

Ped

An individual natural soil aggregate, such as a granule, a prism, or a block.

Pedisediment

A layer of sediment, eroded from the shoulder and backslope of an erosional slope, that lies on and is being (or was) transported across a gently sloping erosional surface at the foot of a receding hill or mountain slope.

Pedon

The smallest volume that can be called “a soil.” A pedon is three dimensional and large enough to permit study of all horizons. Its area ranges from about 10 to 100 square feet (1 square meter to 10 square meters), depending on the variability of the soil.

Percolation

The movement of water through the soil.

Perennial water (map symbol)

Small, natural or constructed lakes, ponds, or pits that contain water most of the year.

Permafrost

Ground, soil, or rock that remains at or below 0 degrees C for at least 2 years. It is defined on the basis of temperature and is not necessarily frozen.

pH value

A numerical designation of acidity and alkalinity in soil. (See Reaction, soil.)

Phase, soil

A subdivision of a soil series based on features that affect its use and management, such as slope, stoniness, and flooding.

Piping

Formation of subsurface tunnels or pipelike cavities by water moving through the soil.

Pitting

Pits caused by melting around ice. They form on the soil after plant cover is removed.

Plastic limit

The moisture content at which a soil changes from semisolid to plastic.

Plasticity index

The numerical difference between the liquid limit and the plastic limit; the range of moisture content within which the soil remains plastic.

Plateau (geomorphology)

A comparatively flat area of great extent and elevation; specifically, an extensive land region that is considerably elevated (more than 100 meters) above the adjacent lower lying terrain, is commonly limited on at least one side by an abrupt descent, and has a flat or nearly level surface. A comparatively large part of a plateau surface is near summit level.

Playa

The generally dry and nearly level lake plain that occupies the lowest parts of closed depressions, such as those on intermontane basin floors. Temporary flooding occurs primarily in response to precipitation and runoff. Playa deposits are fine grained and may or may not have a high water table and saline conditions.

Plinthite

The sesquioxide-rich, humus-poor, highly weathered mixture of clay with quartz and other diluents. It commonly appears as red mottles, usually in platy, polygonal, or reticulate patterns. Plinthite changes irreversibly to an ironstone hardpan or to irregular aggregates on repeated wetting and drying, especially if it is exposed also to heat from the sun. In a moist soil, plinthite can be cut with a spade. It is a form of laterite.

Plowpan

A compacted layer formed in the soil directly below the plowed layer.

Ponding

Standing water on soils in closed depressions. Unless the soils are artificially drained, the water can be removed only by percolation or evapotranspiration.

Poorly graded

Refers to a coarse grained soil or soil material consisting mainly of particles of nearly the same size. Because there is little difference in size of the particles, density can be increased only slightly by compaction.

Pore linings

See Redoximorphic features.

Potential native plant community

See Climax plant community.

Potential rooting depth (effective rooting depth)

Depth to which roots could penetrate if the content of moisture in the soil were adequate. The soil has no properties restricting the penetration of roots to this depth.

Prescribed burning

Deliberately burning an area for specific management purposes, under the appropriate conditions of weather and soil moisture and at the proper time of day.

Productivity, soil

The capability of a soil for producing a specified plant or sequence of plants under specific management.

Profile, soil

A vertical section of the soil extending through all its horizons and into the parent material.

Proper grazing use

Grazing at an intensity that maintains enough cover to protect the soil and maintain or improve the quantity and quality of the desirable vegetation. This practice increases the vigor and reproduction capacity of the key plants and promotes the accumulation of litter and mulch necessary to conserve soil and water.

Rangeland

Land on which the potential natural vegetation is predominantly grasses, grasslike plants, forbs, or shrubs suitable for grazing or browsing. It includes natural grasslands, savannas, many wetlands, some deserts, tundras, and areas that support certain forb and shrub communities.

Reaction, soil

A measure of acidity or alkalinity of a soil, expressed as pH values. A soil that tests to pH 7.0 is described as precisely neutral in reaction because it is neither acid nor alkaline. The degrees of acidity or alkalinity, expressed as pH values, are:

Ultra acid: Less than 3.5
Extremely acid: 3.5 to 4.4
Very strongly acid: 4.5 to 5.0
Strongly acid: 5.1 to 5.5
Moderately acid: 5.6 to 6.0
Slightly acid: 6.1 to 6.5
Neutral: 6.6 to 7.3
Slightly alkaline: 7.4 to 7.8
Moderately alkaline: 7.9 to 8.4
Strongly alkaline: 8.5 to 9.0
Very strongly alkaline: 9.1 and higher

Red beds

Sedimentary strata that are mainly red and are made up largely of sandstone and shale.

Redoximorphic concentrations

See Redoximorphic features.

Redoximorphic depletions

See Redoximorphic features.

Redoximorphic features

Redoximorphic features are associated with wetness and result from alternating periods of reduction and oxidation of iron and manganese compounds in the soil. Reduction occurs during saturation with water, and oxidation occurs when the soil is not saturated. Characteristic color patterns are created by these processes. The reduced iron and manganese ions may be removed from a soil if vertical or lateral fluxes of water occur, in which case there is no iron or manganese precipitation in that soil. Wherever the iron and manganese are oxidized and precipitated, they form either soft masses or hard concretions or nodules. Movement of iron and manganese as a result of redoximorphic processes in a soil may result in redoximorphic features that are defined as follows:

1. Redoximorphic concentrations.—These are zones of apparent accumulation of iron-manganese oxides, including:
   A. Nodules and concretions, which are cemented bodies that can be removed from the soil intact. Concretions are distinguished from nodules on the basis of internal organization. A concretion typically has concentric layers that are visible to the naked eye. Nodules do not have visible organized internal structure; *and*
   B. Masses, which are noncemented concentrations of substances within the soil matrix; *and*
   C. Pore linings, i.e., zones of accumulation along pores that may be either coatings on pore surfaces or impregnations from the matrix adjacent to the pores.
2. Redoximorphic depletions.—These are zones of low chroma (chromas less than those in the matrix) where either iron-manganese oxides alone or both iron-manganese oxides and clay have been stripped out, including:
   A. Iron depletions, i.e., zones that contain low amounts of iron and manganese oxides but have a clay content similar to that of the adjacent matrix; *and*
   B. Clay depletions, i.e., zones that contain low amounts of iron, manganese, and clay (often referred to as silt coatings or skeletans).
3. Reduced matrix.—This is a soil matrix that has low chroma *in situ* but undergoes a change in hue or chroma within 30 minutes after the soil material has been exposed to air.

Reduced matrix

See Redoximorphic features.

Regolith

All unconsolidated earth materials above the solid bedrock. It includes material weathered in place from all kinds of bedrock and alluvial, glacial, eolian, lacustrine, and pyroclastic deposits.

Relief

The relative difference in elevation between the upland summits and the lowlands or valleys of a given region.

Residuum (residual soil material)

Unconsolidated, weathered or partly weathered mineral material that accumulated as bedrock disintegrated in place.

Rill

A very small, steep-sided channel resulting from erosion and cut in unconsolidated materials by concentrated but intermittent flow of water. A rill generally is not an obstacle to wheeled vehicles and is shallow enough to be smoothed over by ordinary tillage.

Riser

The vertical or steep side slope (e.g., escarpment) of terraces, flood-plain steps, or other stepped landforms; commonly a recurring part of a series of natural, steplike landforms, such as successive stream terraces.

Road cut

A sloping surface produced by mechanical means during road construction. It is commonly on the uphill side of the road.

Rock fragments

Rock or mineral fragments having a diameter of 2 millimeters or more; for example, pebbles, cobbles, stones, and boulders.

Rock outcrop (map symbol)

An exposure of bedrock at the surface of the earth. Not used where the named soils of the surrounding map unit are shallow over bedrock or where “Rock outcrop” is a named component of the map unit.

Root zone

The part of the soil that can be penetrated by plant roots.

Runoff

The precipitation discharged into stream channels from an area. The water that flows off the surface of the land without sinking into the soil is called surface runoff. Water that enters the soil before reaching surface streams is called ground-water runoff or seepage flow from ground water.

Saline soil

A soil containing soluble salts in an amount that impairs growth of plants. A saline soil does not contain excess exchangeable sodium.

Saline spot (map symbol)

An area where the surface layer has an electrical conductivity of 8 mmhos/cm more than the surface layer of the named soils in the surrounding map unit. The surface layer of the surrounding soils has an electrical conductivity of 2 mmhos/cm or less.

Sand

As a soil separate, individual rock or mineral fragments from 0.05 millimeter to 2.0 millimeters in diameter. Most sand grains consist of quartz. As a soil textural class, a soil that is 85 percent or more sand and not more than 10 percent clay.

Sandstone

Sedimentary rock containing dominantly sand-sized particles.

Sandy spot (map symbol)

A spot where the surface layer is loamy fine sand or coarser in areas where the surface layer of the named soils in the surrounding map unit is very fine sandy loam or finer.

Sapric soil material (muck)

The most highly decomposed of all organic soil material. Muck has the least amount of plant fiber, the highest bulk density, and the lowest water content at saturation of all organic soil material.

Saturated hydraulic conductivity (Ksat)

The ease with which pores of a saturated soil transmit water. Formally, the proportionality coefficient that expresses the relationship of the rate of water movement to hydraulic gradient in Darcy's Law, a law that describes the rate of water movement through porous media. Commonly abbreviated as "Ksat." Terms describing saturated hydraulic conductivity are:

Very high: 100 or more micrometers per second (14.17 or more inches per hour)

High: 10 to 100 micrometers per second (1.417 to 14.17 inches per hour)

Moderately high: 1 to 10 micrometers per second (0.1417 inch to 1.417 inches per hour)

Moderately low: 0.1 to 1 micrometer per second (0.01417 to 0.1417 inch per hour)

Low: 0.01 to 0.1 micrometer per second (0.001417 to 0.01417 inch per hour)

Very low: Less than 0.01 micrometer per second (less than 0.001417 inch per hour).

To convert inches per hour to micrometers per second, multiply inches per hour by 7.0572. To convert micrometers per second to inches per hour, multiply micrometers per second by 0.1417.

Saturation

Wetness characterized by zero or positive pressure of the soil water. Under conditions of saturation, the water will flow from the soil matrix into an unlined auger hole.

Scarification

The act of abrading, scratching, loosening, crushing, or modifying the surface to increase water absorption or to provide a more tillable soil.

Sedimentary rock

A consolidated deposit of clastic particles, chemical precipitates, or organic remains accumulated at or near the surface of the earth under normal low temperature and pressure conditions. Sedimentary rocks include consolidated equivalents of alluvium, colluvium, drift, and eolian, lacustrine, and marine deposits. Examples are sandstone, siltstone, mudstone, claystone, shale, conglomerate, limestone, dolomite, and coal.

Sequum

A sequence consisting of an illuvial horizon and the overlying eluvial horizon. (See Eluviation.)

Series, soil

A group of soils that have profiles that are almost alike, except for differences in texture of the surface layer. All the soils of a series have horizons that are similar in composition, thickness, and arrangement.

Severely eroded spot (map symbol)

An area where, on the average, 75 percent or more of the original surface layer has been lost because of accelerated erosion. Not used in map units in which “severely eroded,” “very severely eroded,” or “gullied” is part of the map unit name.

Shale

Sedimentary rock that formed by the hardening of a deposit of clay, silty clay, or silty clay loam and that has a tendency to split into thin layers.

Sheet erosion

The removal of a fairly uniform layer of soil material from the land surface by the action of rainfall and surface runoff.

Short, steep slope (map symbol)

A narrow area of soil having slopes that are at least two slope classes steeper than the slope class of the surrounding map unit.

Shoulder

The convex, erosional surface near the top of a hillslope. A shoulder is a transition from summit to backslope.

Shrink-swell

The shrinking of soil when dry and the swelling when wet. Shrinking and swelling can damage roads, dams, building foundations, and other structures. It can also damage plant roots.

Shrub-coppice dune

A small, streamlined dune that forms around brush and clump vegetation.

Side slope (geomorphology)

A geomorphic component of hills consisting of a laterally planar area of a hillside. The overland waterflow is predominantly parallel. Side slopes are dominantly colluvium and slope-wash sediments.

Silica

A combination of silicon and oxygen. The mineral form is called quartz.

Silica-sesquioxide ratio

The ratio of the number of molecules of silica to the number of molecules of alumina and iron oxide. The more highly weathered soils or their clay fractions in warm-temperate, humid regions, and especially those in the tropics, generally have a low ratio.

Silt

As a soil separate, individual mineral particles that range in diameter from the upper limit of clay (0.002 millimeter) to the lower limit of very fine sand (0.05 millimeter). As a soil textural class, soil that is 80 percent or more silt and less than 12 percent clay.

Siltstone

An indurated silt having the texture and composition of shale but lacking its fine lamination or fissility; a massive mudstone in which silt predominates over clay.

Similar soils

Soils that share limits of diagnostic criteria, behave and perform in a similar manner, and have similar conservation needs or management requirements for the major land uses in the survey area.

Sinkhole (map symbol)

A closed, circular or elliptical depression, commonly funnel shaped, characterized by subsurface drainage and formed either by dissolution of the surface of underlying bedrock (e.g., limestone, gypsum, or salt) or by collapse of underlying caves within bedrock. Complexes of sinkholes in carbonate-rock terrain are the main components of karst topography.

Site index

A designation of the quality of a forest site based on the height of the dominant stand at an arbitrarily chosen age. For example, if the average height attained by dominant and codominant trees in a fully stocked stand at the age of 50 years is 75 feet, the site index is 75.

Slickensides (pedogenic)

Grooved, striated, and/or glossy (shiny) slip faces on structural peds, such as wedges; produced by shrink-swell processes, most commonly in soils that have a high content of expansive clays.

Slide or slip (map symbol)

A prominent landform scar or ridge caused by fairly recent mass movement or descent of earthy material resulting from failure of earth or rock under shear stress along one or several surfaces.

Slope

The inclination of the land surface from the horizontal. Percentage of slope is the vertical distance divided by horizontal distance, then multiplied by 100. Thus, a slope of 20 percent is a drop of 20 feet in 100 feet of horizontal distance.

Slope alluvium

Sediment gradually transported down the slopes of mountains or hills primarily by nonchannel alluvial processes (i.e., slope-wash processes) and characterized by particle sorting. Lateral particle sorting is evident on long slopes. In a profile sequence, sediments may be distinguished by differences in size and/or specific gravity of rock fragments and may be separated by stone lines. Burnished peds and sorting of rounded or subrounded pebbles or cobbles distinguish these materials from unsorted colluvial deposits.

Slow refill

The slow filling of ponds, resulting from restricted water transmission in the soil.

Slow water movement

Restricted downward movement of water through the soil. See Saturated hydraulic conductivity.

Sodic (alkali) soil

A soil having so high a degree of alkalinity (pH 8.5 or higher) or so high a percentage of exchangeable sodium (15 percent or more of the total exchangeable bases), or both, that plant growth is restricted.

Sodic spot (map symbol)

An area where the surface layer has a sodium adsorption ratio that is at least 10 more than that of the surface layer of the named soils in the surrounding map unit. The surface layer of the surrounding soils has a sodium adsorption ratio of 5 or less.

Sodicity

The degree to which a soil is affected by exchangeable sodium. Sodicity is expressed as a sodium adsorption ratio (SAR) of a saturation extract, or the ratio of Na^{+} to Ca^{++} + Mg^{++}. The degrees of sodicity and their respective ratios are:

Slight: Less than 13:1

Moderate: 13-30:1

Strong: More than 30:1

Sodium adsorption ratio (SAR)

A measure of the amount of sodium (Na) relative to calcium (Ca) and magnesium (Mg) in the water extract from saturated soil paste. It is the ratio of the Na concentration divided by the square root of one-half of the Ca + Mg concentration.

Soft bedrock

Bedrock that can be excavated with trenching machines, backhoes, small rippers, and other equipment commonly used in construction.

Soil

A natural, three-dimensional body at the earth's surface. It is capable of supporting plants and has properties resulting from the integrated effect of climate and living matter acting on earthy parent material, as conditioned by relief and by the passage of time.

Soil separates

Mineral particles less than 2 millimeters in equivalent diameter and ranging between specified size limits. The names and sizes, in millimeters, of separates recognized in the United States are as follows:

Very coarse sand: 2.0 to 1.0
Coarse sand: 1.0 to 0.5
Medium sand: 0.5 to 0.25
Fine sand: 0.25 to 0.10
Very fine sand: 0.10 to 0.05
Silt: 0.05 to 0.002
Clay: Less than 0.002

Solum

The upper part of a soil profile, above the C horizon, in which the processes of soil formation are active. The solum in soil consists of the A, E, and B horizons. Generally, the characteristics of the material in these horizons are unlike those of the material below the solum. The living roots and plant and animal activities are largely confined to the solum.

Spoil area (map symbol)

A pile of earthy materials, either smoothed or uneven, resulting from human activity.

Stone line

In a vertical cross section, a line formed by scattered fragments or a discrete layer of angular and subangular rock fragments (commonly a gravel- or cobble-sized lag concentration) that formerly was draped across a topographic surface and was later buried by additional sediments. A stone line generally caps material that was subject to weathering, soil formation, and erosion before burial. Many stone lines seem to be buried erosion pavements, originally formed by sheet and rill erosion across the land surface.

Stones

Rock fragments 10 to 24 inches (25 to 60 centimeters) in diameter if rounded or 15 to 24 inches (38 to 60 centimeters) in length if flat.

Stony

Refers to a soil containing stones in numbers that interfere with or prevent tillage.

Stony spot (map symbol)

A spot where 0.01 to 0.1 percent of the soil surface is covered by rock fragments that are more than 10 inches in diameter in areas where the surrounding soil has no surface stones.

Strath terrace

A type of stream terrace; formed as an erosional surface cut on bedrock and thinly mantled with stream deposits (alluvium).

Stream terrace

One of a series of platforms in a stream valley, flanking and more or less parallel to the stream channel, originally formed near the level of the stream; represents the remnants of an abandoned flood plain, stream bed, or valley floor produced during a former state of fluvial erosion or deposition.

Stripcropping

Growing crops in a systematic arrangement of strips or bands that provide vegetative barriers to wind erosion and water erosion.

Structure, soil

The arrangement of primary soil particles into compound particles or aggregates. The principal forms of soil structure are:

Platy: Flat and laminated
Prismatic: Vertically elongated and having flat tops
Columnar: Vertically elongated and having rounded tops
Angular blocky: Having faces that intersect at sharp angles (planes)
Subangular blocky: Having subrounded and planar faces (no sharp angles)
Granular: Small structural units with curved or very irregular faces

Structureless soil horizons are defined as follows:

Single grained: Entirely noncoherent (each grain by itself), as in loose sand
Massive: Occurring as a coherent mass

Stubble mulch

Stubble or other crop residue left on the soil or partly worked into the soil. It protects the soil from wind erosion and water erosion after harvest, during preparation of a seedbed for the next crop, and during the early growing period of the new crop.

Subsoil

Technically, the B horizon; roughly, the part of the solum below plow depth.

Subsoiling

Tilling a soil below normal plow depth, ordinarily to shatter a hardpan or claypan.

Substratum

The part of the soil below the solum.

Subsurface layer

Any surface soil horizon (A, E, AB, or EB) below the surface layer.

Summer fallow

The tillage of uncropped land during the summer to control weeds and allow storage of moisture in the soil for the growth of a later crop. A practice common in semiarid regions, where annual precipitation is not enough to produce a crop every year. Summer fallow is frequently practiced before planting winter grain.

Summit

The topographically highest position of a hillslope. It has a nearly level (planar or only slightly convex) surface.

Surface layer

The soil ordinarily moved in tillage, or its equivalent in uncultivated soil, ranging in depth from 4 to 10 inches (10 to 25 centimeters). Frequently designated as the "plow layer," or the "Ap horizon."

Surface soil

The A, E, AB, and EB horizons, considered collectively. It includes all subdivisions of these horizons.

Talus

Rock fragments of any size or shape (commonly coarse and angular) derived from and lying at the base of a cliff or very steep rock slope. The accumulated mass of such loose broken rock formed chiefly by falling, rolling, or sliding.

Taxadjuncts

Soils that cannot be classified in a series recognized in the classification system. Such soils are named for a series they strongly resemble and are designated as taxadjuncts to that series because they differ in ways too small to be of consequence in interpreting their use and behavior. Soils are recognized as taxadjuncts only when one or more of their characteristics are slightly outside the range defined for the family of the series for which the soils are named.

Terminal moraine

An end moraine that marks the farthest advance of a glacier. It typically has the form of a massive arcuate or concentric ridge, or complex of ridges, and is underlain by till and other types of drift.

Terrace (conservation)

An embankment, or ridge, constructed across sloping soils on the contour or at a slight angle to the contour. The terrace intercepts surface runoff so that water soaks into the soil or flows slowly to a prepared outlet. A terrace in a field generally is built so that the field can be farmed. A terrace intended mainly for drainage has a deep channel that is maintained in permanent sod.

Terrace (geomorphology)

A steplike surface, bordering a valley floor or shoreline, that represents the former position of a flood plain, lake, or seashore. The term is usually applied both to the relatively flat summit surface (tread) that was cut or built by stream or wave action and to the steeper descending slope (scarp or riser) that has graded to a lower base level of erosion.

Terracettes

Small, irregular steplike forms on steep hillslopes, especially in pasture, formed by creep or erosion of surficial materials that may be induced or enhanced by trampling of livestock, such as sheep or cattle.

Texture, soil

The relative proportions of sand, silt, and clay particles in a mass of soil. The basic textural classes, in order of increasing proportion of fine particles, are *sand, loamy sand, sandy loam, loam, silt loam, silt, sandy clay loam, clay loam, silty clay loam, sandy clay, silty clay,* and *clay*. The sand, loamy sand, and sandy loam classes may be further divided by specifying “coarse,” “fine,” or “very fine.”

Thin layer

Otherwise suitable soil material that is too thin for the specified use.

Till

Dominantly unsorted and nonstratified drift, generally unconsolidated and deposited directly by a glacier without subsequent reworking by meltwater, and consisting of a heterogeneous mixture of clay, silt, sand, gravel, stones, and boulders; rock fragments of various lithologies are embedded within a finer matrix that can range from clay to sandy loam.

Till plain

An extensive area of level to gently undulating soils underlain predominantly by till and bounded at the distal end by subordinate recessional or end moraines.

Tilth, soil

The physical condition of the soil as related to tillage, seedbed preparation, seedling emergence, and root penetration.

Toeslope

The gently inclined surface at the base of a hillslope. Toeslopes in profile are commonly gentle and linear and are constructional surfaces forming the lower part of a hillslope continuum that grades to valley or closed-depression floors.

Topsoil

The upper part of the soil, which is the most favorable material for plant growth. It is ordinarily rich in organic matter and is used to topdress roadbanks, lawns, and land affected by mining.

Trace elements

Chemical elements, for example, zinc, cobalt, manganese, copper, and iron, in soils in extremely small amounts. They are essential to plant growth.

Tread

The flat to gently sloping, topmost, laterally extensive slope of terraces, flood-plain steps, or other stepped landforms; commonly a recurring part of a series of natural steplike landforms, such as successive stream terraces.

Tuff

A generic term for any consolidated or cemented deposit that is 50 percent or more volcanic ash.

Upland

An informal, general term for the higher ground of a region, in contrast with a low-lying adjacent area, such as a valley or plain, or for land at a higher elevation than the flood plain or low stream terrace; land above the footslope zone of the hillslope continuum.

Valley fill

The unconsolidated sediment deposited by any agent (water, wind, ice, or mass wasting) so as to fill or partly fill a valley.

Variegation

Refers to patterns of contrasting colors assumed to be inherited from the parent material rather than to be the result of poor drainage.

Varve

A sedimentary layer or a lamina or sequence of laminae deposited in a body of still water within a year. Specifically, a thin pair of graded glaciolacustrine layers seasonally deposited, usually by meltwater streams, in a glacial lake or other body of still water in front of a glacier.

Very stony spot (map symbol)

A spot where 0.1 to 3.0 percent of the soil surface is covered by rock fragments that are more than 10 inches in diameter in areas where the surface of the surrounding soil is covered by less than 0.01 percent stones.

Water bars

Smooth, shallow ditches or depressional areas that are excavated at an angle across a sloping road. They are used to reduce the downward velocity of water and divert it off and away from the road surface. Water bars can easily be driven over if constructed properly.

Weathering

All physical disintegration, chemical decomposition, and biologically induced changes in rocks or other deposits at or near the earth's surface by atmospheric or biologic agents or by circulating surface waters but involving essentially no transport of the altered material.

Well graded

Refers to soil material consisting of coarse grained particles that are well distributed over a wide range in size or diameter. Such soil normally can be easily increased in density and bearing properties by compaction. Contrasts with poorly graded soil.

Wet spot (map symbol)

A somewhat poorly drained to very poorly drained area that is at least two drainage classes wetter than the named soils in the surrounding map unit.

Wilting point (or permanent wilting point)

The moisture content of soil, on an ovendry basis, at which a plant (specifically a sunflower) wilts so much that it does not recover when placed in a humid, dark chamber.

Windthrow

The uprooting and tipping over of trees by the wind.

Appendix B: Mississippi National Heritage Inventory

Mississippi National Heritage Inventory

www.mdwfp.com

Accessed 8/15/14

This list is not meant as a comprehensive listing of all plant and animal species. Rather the plants and animals listed below are recognized as species of "special concern".

GREEN text indicates threatened federal status

Plants – Hancock County

County	Scientific Name	Common Name	Global Rank	State Rank	Type
Hancock	Agalinis aphylla	Coastal Plain False-foxglove	G3G4	S2S3	Plant
Hancock	Agalinis filicaulis	Thin Stemmed False-foxglove	G3G4	S2?	Plant
Hancock	Amsonia ludoviciana	Creole Phlox	G3	SX	Plant
Hancock	Calopogon barbatus	Bearded Grass-pink	G4?	S2S3	Plant
Hancock	Calopogon multiflorus	Many-flower Grass-pink	G2G3	S1	Plant
Hancock	Carex exilis	Coast Sedge	G5	S2	Plant
Hancock	Chamaecyparis thyoides	Atlantic White Cedar	G4	S2	Plant
Hancock	Cleistes bifaria	Spreading Pogonia	G4?	S3	Plant
Hancock	Dalea carnea var. gracilis	Pine Barrens Prairie Clover	G5T3T4	S2S3	Plant
Hancock	Desmodium tenuifolium	Slim-leaf Tick-trefoil	G4	S2	Plant
Hancock	Dichanthelium wrightianum	Wright's Witchgrass	G4	S1S2	Plant
Hancock	Eleocharis elongata	Slim Spike-rush	G5?	S1	Plant
Hancock	Eriocaulon texense	Texas Pipewort	G4	S2S3	Plant
Hancock	Eryngium aquaticum	Marsh Eryngo	G4	S1	Plant
Hancock	Eupatorium ivifolium	Ivy-leaf Throughwort	G5	S3S4	Plant
Hancock	Hibiscus coccineus	Brillant Hibiscus	G4?	S2	Plant
Hancock	Ilex amelanchier	Juneberry Holly	G4	S3	Plant
Hancock	Ilex myrtifolia	Myrtle Holly	G5?	S3S4	Plant
Hancock	Isoetes louisianensis	Louisiana Quillwort	G2	S2	Plant
Hancock	Juniperus virginiana var. silicicola	Southern Red Cedar	G5T4T5	S2	Plant
Hancock	Lachnocaulon digynum	Pineland Bogbutton	G3	S2	Plant
Hancock	Lilaeopsis carolinensis	Carolina Lilaeopsis	G3G5	S2S3	Plant
Hancock	Macranthera flammea	Flame Flower	G3	S3?	Plant
Hancock	Panicum nudicaule	Naked-stemmed Panic Grass	G3Q	S2	Plant
Hancock	Pinguicula planifolia	Chapman's Butterwort	G3?	S2	Plant
Hancock	Pinguicula primuliflora	Southern Butterwort	G3G4	S3	Plant
Hancock	Platanthera integra	Yellow Fringeless Orchid	G3G4	S3	Plant

Appendix B: Mississippi National Heritage Inventory

Hancock	Polygala leptostachys	Georgia Milkwort	G3G4	S1	Plant
Hancock	Quadrula quadrula	Mapleleaf	G5	S5	Plant
Hancock	Rhynchospora curtissii	Curtiss's Beakrush	G4	S1	Plant
Hancock	Rhynchospora macra	Large Beakrush	G3	S3	Plant
Hancock	Rhynchospora stenophylla	Chapman Beakrush	G4	S2S3	Plant
Hancock	Ruellia noctiflora	Night-flowering Ruellia	G2	S2	Plant
Hancock	Ruellia pedunculata ssp. pinetorum	Pine Barren Ruellia	G5T3T4	S3	Plant
Hancock	Sageretia minutiflora	Tiny-leaved Buckthorn	G4	S2	Plant
Hancock	Shell midden shrub/woodland	Southern Redcedar - False Buckthorn	GNR	S1	Plant
Hancock	Syngonanthus flavidulus	Yellow Pipewort	G5	S2?	Plant
Hancock	Utricularia purpurea	Purple Bladderwort	G5	S2S3	Plant
Hancock	Xyris drummondii	Drummond's Yellow-eyed Grass	G3	S2	Plant

Plants – Harrison County

County	Scientific Name	Common Name	Global Rank	State Rank	Type
Harrison	Agalinis aphylla	Coastal Plain False-foxglove	G3G4	S2S3	Plant
Harrison	Agalinis filicaulis	Thin Stemmed False-foxglove	G3G4	S2?	Plant
Harrison	Agrimonia incisa	Incised Groovebur	G3	S3	Plant
Harrison	Andropogon gyrans var. stenophyllus	Elliott's Bluestem (Var.2)	G5T4	S1S2	Plant
Harrison	Calopogon barbatus	Bearded Grass-pink	G4?	S2S3	Plant
Harrison	Carex exilis	Coast Sedge	G5	S2	Plant
Harrison	Cleistes bifaria	Spreading Pogonia	G4?	S3	Plant
Harrison	Dalea carnea var. gracilis	Pine Barrens Prairie Clover	G5T3T4	S2S3	Plant
Harrison	Desmodium tenuifolium	Slim-leaf Tick-trefoil	G4	S2	Plant
Harrison	Dichanthelium erectifolium	Erect-leaf Witchgrass	G4	S3S4	Plant
Harrison	Dichanthelium wrightianum	Wright's Witchgrass	G4	S1S2	Plant
Harrison	Elyonurus tripsacoides	Pan American Balsamscale	G5?	SH	Plant
Harrison	Enallagma pollutum	Florida Bluet	G5	S2	Plant
Harrison	Epidendrum conopseum	Green-fly Orchid	G4	S2	Plant
Harrison	Eriocaulon texense	Texas Pipewort	G4	S2S3	Plant
Harrison	Eupatorium ivifolium	Ivy-leaf Throughwort	G5	S3S4	Plant
Harrison	Gaylussacia nana	Dangleberry	G4	S2S3	Plant
Harrison	Gordonia lasianthus	Loblolly Bay	G5	S3	Plant
Harrison	Helianthemum arenicola	Gulf Rockrose	G3	S1S2	Plant
Harrison	Ilex amelanchier	Juneberry Holly	G4	S3	Plant
Harrison	Ilex cassine	Dahoon Holly	G5	S2	Plant

Appendix B: Mississippi National Heritage Inventory

Harrison	Ilex myrtifolia	Myrtle Holly	G5?	S3S4	Plant
Harrison	Isoetes louisianensis	Louisiana Quillwort	G2	S2	Plant
Harrison	Lachnocaulon digynum	Pineland Bogbutton	G3	S2	Plant
Harrison	Lilaeopsis carolinensis	Carolina Lilaeopsis	G3G5	S2S3	Plant
Harrison	Lindera subcoriacea	Bog Spice Bush	G2G3	S2	Plant
Harrison	Linum macrocarpum	Large Fruited Flax	G2	S2S3	Plant
Harrison	Lycopodiella cernua	Nodding Clubmoss	G5	S2	Plant
Harrison	Macranthera flammea	Flame Flower	G3	S3?	Plant
Harrison	Melanthium virginicum	Virginia Bunchflower	G5	S2S3	Plant
Harrison	Panicum nudicaule	Naked-stemmed Panic Grass	G3Q	S2	Plant
Harrison	Paronychia erecta	Beach Sand-squares	G3G4	S1S2	Plant
Harrison	Paspalum monostachyum	Gulfdune Paspalum	G4?	SU	Plant
Harrison	Peltandra sagittifolia	White Arum	G3G4	S3	Plant
Harrison	Physalis angustifolia	Coast Ground-cherry	G3G4	S3S4	Plant
Harrison	Pinguicula planifolia	Chapman's Butterwort	G3?	S2	Plant
Harrison	Pinguicula primuliflora	Southern Butterwort	G3G4	S3	Plant
Harrison	Platanthera blephariglottis	Large White Fringed Orchid	G4G5	S2	Plant
Harrison	Platanthera cristata	Crested Fringed Orchid	G5	S3	Plant
Harrison	Platanthera integra	Yellow Fringeless Orchid	G3G4	S3	Plant
Harrison	Polygala crenata	Crenate Milkwort	G4?	S1S2	Plant
Harrison	Polygala hookeri	Hooker's Milkwort	G3	S1S2	Plant
Harrison	Polygala leptostachys	Georgia Milkwort	G3G4	S1	Plant
Harrison	Quercus minima	Dwarf Live Oak	G5	S1	Plant
Harrison	Quercus myrtifolia	Myrtle-leaf Oak	G5	S2	Plant
Harrison	Rhynchospora macra	Large Beakrush	G3	S3	Plant
Harrison	Rhynchospora stenophylla	Chapman Beakrush	G4	S2S3	Plant
Harrison	Ruellia noctiflora	Night-flowering Ruellia	G2	S2	Plant
Harrison	Ruellia pedunculata ssp. pinetorum	Pine Barren Ruellia	G5T3T4	S3	Plant
Harrison	Schizachyrium maritimum	Gulf Bluestem	G3G4Q	S3?	Plant
Harrison	Scleria reticularis	Reticulated Nutrush	G4	S1	Plant
Harrison	Setaria corrugata	Coastal Fox-tail	G5?	SU	Plant
Harrison	Sorghastrum apalachicolense	Open Indian Grass	G3G4Q	S3S4	Plant
Harrison	Spiranthes brevilabris var. floridana	Florida Ladies'-tresses	G3G4T1	S1	Plant
Harrison	Spiranthes longilabris	Giant Spiral Ladies'-tresses	G3	S2	Plant
Harrison	Stylisma aquatica	Water Southern Morning-glory	G4	S1	Plant
Harrison	Syngonanthus flavidulus	Yellow Pipewort	G5	S2?	Plant
Harrison	Utricularia purpurea	Purple Bladderwort	G5	S2S3	Plant
Harrison	Xyris drummondii	Drummond's Yellow-eyed Grass	G3	S2	Plant
Harrison	Xyris scabrifolia	Harper's Yellow-eyed Grass	G3	S2S3	Plant

Appendix B: Mississippi National Heritage Inventory

Animals – Hancock County

County	Scientific Name	Common Name	Global Rank	State Rank	Type
Hancock	Acipenser oxyrinchus desotoi	Gulf Sturgeon	G3T2	S1	Animal
Hancock	Aimophila aestivalis	Bachman's Sparrow	G3	S3B,S3S4N	Animal
Hancock	Anas fulvigula	Mottled Duck	G4	S2B,S4N	Animal
Hancock	Bufo nebulifer	Gulf Coast Toad	G5	S3	Animal
Hancock	Celithemis amanda	Amanda's Pennant	G5	S2	Animal
Hancock	Charadrius melodus	Piping Plover	G3	S2N	Animal
Hancock	Circus cyaneus	Northern Harrier	G5	S4N	Animal
Hancock	Cirsium lecontei	Leconte's Thistle	G2G3	S1S2	Animal
Hancock	Corynorhinus rafinesquii	Rafinesque's Big-eared Bat	G3G4	S2	Animal
Hancock	Crystallaria asprella	Crystal Darter	G3	S1	Animal
Hancock	Deirochelys reticularia	Chicken Turtle	G5	S4	Animal
Hancock	Drymarchon couperi	Eastern Indigo Snake	G3	S1	Animal
Hancock	Enallagma pallidum	Pale Bluet	G4	S2	Animal
Hancock	Enneacanthus gloriosus	Bluespotted Sunfish	G5	S3	Animal
Hancock	Euphyes bayensis	Bay St. Louis Skipper	G1G3	S1	Animal
Hancock	Falco sparverius	American Kestrel	G5	S3B,S4S5N	Animal
Hancock	Fundulus jenkinsi	Saltmarsh Topminnow	G3	S3	Animal
Hancock	Gomphus hodgesi	Hodges' Clubtail	G3	S2	Animal
Hancock	Gomphus hybridus	Cocoa Clubtail	G4	S3	Animal
Hancock	Gomphus modestus	Gulf Coast Clubtail	G3	S3	Animal
Hancock	Gopherus polyphemus	Gopher Tortoise	G3	S2	Animal
Hancock	Haliaeetus leucocephalus	Bald Eagle	G5	S2B,S2N	Animal
Hancock	Heterandria formosa	Least Killifish	G5	S3	Animal
Hancock	Heterodon simus	Southern Hognose Snake	G2	SX	Animal
Hancock	Ictiobus niger	Black Buffalo	G5	S3	Animal
Hancock	Lampsilis straminea claibornensis	Southern Fatmucket	G5T5	S5	Animal
Hancock	Lampsilis teres	Yellow Sandshell	G5	S5	Animal
Hancock	Macrodiplax balteata	Marl Pennant	G5	S2	Animal
Hancock	Malaclemys terrapin pileata	Mississippi Diamondback Terrapin	G4T3Q	S2	Animal
Hancock	Micrurus fulvius	Eastern Coral Snake	G5	S3S4	Animal
Hancock	Notropis chalybaeus	Ironcolor Shiner	G4	S2	Animal
Hancock	Notropis petersoni	Coastal Shiner	G5	S4	Animal
Hancock	Ophioglossum petiolatum	Stalked Adders-tongue	G5	S4	Animal
Hancock	Polyodon spathula	Paddlefish	G4	S3	Animal

Appendix B: Mississippi National Heritage Inventory

Hancock	Potamilus purpuratus	Bleufer	G5	S5	Animal
Hancock	Pseudotriton montanus	Mud Salamander	G5	S2S3	Animal
Hancock	Pteronotropis welaka	Bluenose Shiner	G3G4	S3	Animal
Hancock	Puma concolor coryi	Florida Panther	G5T1	SX	Animal
Hancock	Quadrula refulgens	Purple Pimpleback	G3G4	S3S4	Animal
Hancock	Rana heckscheri	River Frog	G5	S1	Animal
Hancock	Regina rigida sinicola	Gulf Crayfish Snake	G5T5	S3?	Animal
Hancock	Rhadinaea flavilata	Pine Woods Snake	G4	S3?	Animal
Hancock	Somatochlora provocans	Treetop Emerald	G4	S2	Animal
Hancock	Tritogonia verrucosa	Pistolgrip	G4G5	S4	Animal
Hancock	Ursus americanus	Black Bear	G5	S1	Animal

Animals – Harrison County

County	Scientific Name	Common Name	Global Rank	State Rank	Type
Harrison	Acipenser oxyrinchus desotoi	Gulf Sturgeon	G3T2	S1	Animal
Harrison	Aimophila aestivalis	Bachman's Sparrow	G3	S3B,S3S4N	Animal
Harrison	Alligator mississippiensis	American Alligator	G5	S4	Animal
Harrison	Ammodramus nelsoni	Nelson's Sharp-tailed Sparrow	G5	S3N	Animal
Harrison	Anas acuta	Northern Pintail	G5	S4N	Animal
Harrison	Anas fulvigula	Mottled Duck	G4	S2B,S4N	Animal
Harrison	Aythya affinis	Lesser Scaup	G5	S4N	Animal
Harrison	Celithemis amanda	Amanda's Pennant	G5	S2	Animal
Harrison	Cemophora coccinea	Scarlet Snake	G5	S4	Animal
Harrison	Charadrius alexandrinus	Snowy Plover	G4	S2	Animal
Harrison	Charadrius alexandrinus tenuirostris	Southeastern Snowy Plover	G4T3Q	S2	Animal
Harrison	Charadrius melodus	Piping Plover	G3	S2N	Animal
Harrison	Charadrius wilsonia	Wilson's Plover	G5	S1	Animal
Harrison	Circus cyaneus	Northern Harrier	G5	S4N	Animal
Harrison	Cirsium lecontei	Leconte's Thistle	G2G3	S1S2	Animal
Harrison	Colinus virginianus	Northern Bobwhite	G5	S3S4	Animal
Harrison	Crotalus adamanteus	Eastern Diamondback Rattlesnake	G4	S3S4	Animal
Harrison	Deirochelys reticularia	Chicken Turtle	G5	S4	Animal
Harrison	Dromogomphus armatus	Southeastern Spinyleg	G4	S3	Animal
Harrison	Egretta rufescens	Reddish Egret	G4	S2N	Animal
Harrison	Enallagma concisum	Cherry Bluet	G4	S2	Animal
Harrison	Enallagma pallidum	Pale Bluet	G4	S2	Animal
Harrison	Enneacanthus gloriosus	Bluespotted Sunfish	G5	S3	Animal

Appendix B: Mississippi National Heritage Inventory

Harrison	Eumeces anthracinus	Coal Skink	G5	S3S4	Animal
Harrison	Falco sparverius	American Kestrel	G5	S3B,S4S5N	Animal
Harrison	Falco sparverius paulus	Southeastern American Kestrel	G5T4	S3	Animal
Harrison	Fallicambarus byersi	Lavender Burrowing Crayfish	G4	S3	Animal
Harrison	Fundulus jenkinsi	Saltmarsh Topminnow	G3	S3	Animal
Harrison	Gomphus modestus	Gulf Coast Clubtail	G3	S3	Animal
Harrison	Gopherus polyphemus	Gopher Tortoise	G3	S2	Animal
Harrison	Haematopus palliatus	American Oystercatcher	G5	S1	Animal
Harrison	Haliaeetus leucocephalus	Bald Eagle	G5	S2B,S2N	Animal
Harrison	Heterandria formosa	Least Killifish	G5	S3	Animal
Harrison	Heterodon simus	Southern Hognose Snake	G2	SX	Animal
Harrison	Lampropeltis triangulum elapsoides	Scarlet Kingsnake	G5T5	S4	Animal
Harrison	Lampsilis straminea claibornensis	Southern Fatmucket	G5T5	S5	Animal
Harrison	Laterallus jamaicensis	Black Rail	G4	S2N	Animal
Harrison	Macrochelys temminckii	Alligator Snapping Turtle	G3G4	S3	Animal
Harrison	Malaclemys terrapin pileata	Mississippi Diamondback Terrapin	G4T3Q	S2	Animal
Harrison	Masticophis flagellum	Coachwhip	G5	S3S4	Animal
Harrison	Melanerpes erythrocephalus	Red-headed Woodpecker	G5	S4S5	Animal
Harrison	Morone saxatilis	Striped Bass	G5	SH	Animal
Harrison	Nerodia clarkii clarkii	Gulf Salt Marsh Snake	G4T4	S2?	Animal
Harrison	Notropis chalybaeus	Ironcolor Shiner	G4	S2	Animal
Harrison	Notropis petersoni	Coastal Shiner	G5	S4	Animal
Harrison	Ophioglossum petiolatum	Stalked Adders-tongue	G5	S4	Animal
Harrison	Pandion haliaetus	Osprey	G5	S3B,S1S2N	Animal
Harrison	Pelecanus occidentalis	Brown Pelican	G4	S1N	Animal
Harrison	Pelecanus occidentalis carolinensis	Eastern Brown Pelican	G4TU	S1N	Animal
Harrison	Picoides borealis	Red-cockaded Woodpecker	G3	S1	Animal
Harrison	Pituophis melanoleucus lodingi	Black Pine Snake	G4T2T3	S2	Animal
Harrison	Procambarus fitzpatricki	Spiny-tailed Crayfish	G2	S2	Animal
Harrison	Pseudemys alabamensis	Alabama Redbelly Turtle	G1	S1	Animal
Harrison	Pseudotriton montanus	Mud Salamander	G5	S2S3	Animal
Harrison	Rallus elegans	King Rail	G4	S3B,S3N	Animal
Harrison	Rana heckscheri	River Frog	G5	S1	Animal
Harrison	Rana sevosa	Dark Gopher Frog	G1	S1	Animal
Harrison	Regina rigida sinicola	Gulf Crayfish Snake	G5T5	S3?	Animal
Harrison	Rhadinaea flavilata	Pine Woods Snake	G4	S3?	Animal
Harrison	Rynchops niger	Black Skimmer	G5	S3B,S3N	Animal

Appendix B: Mississippi National Heritage Inventory

Harrison	Sitta pusilla	Brown-headed Nuthatch	G5	S4B	Animal
Harrison	Sorex longirostris	Southeastern Shrew	G5	S4	Animal
Harrison	Sternula antillarum	Least Tern	G4	S3B	Animal
Harrison	Thalasseus maximus	Royal Tern	G5	S1B,S4N	Animal
Harrison	Thryomanes bewickii	Bewick's Wren	G5	S2B,S3N	Animal
Harrison	Ursus americanus	Black Bear	G5	S1	Animal
Harrison	Villosa lienosa	Little Spectaclecase	G5	S5	Animal
Harrison	Villosa vibex	Southern Rainbow	G5Q	S4?	Animal

Appendix B: Mississippi National Heritage Inventory

MISSISSIPPI NATURAL HERITAGE PROGRAM
LISTED SPECIES OF MISSISSIPPI
2011

SCIENTIFIC NAME	COMMON NAME	GLOBAL RANK	FEDERAL STATUS	STATE STATUS	STATE RANK
ANIMALS					
BIVALVIA					
Actinonaias ligamentina	Mucket	G5		LE	S1
Cyclonaias tuberculata	Purple Wartyback	G5		LE	S1
Elliptio arctata	Delicate Spike	G3Q		LE	S1
Elliptio dilatata	Spike	G5		LE	S1
Epioblasma brevidens	Cumberlandian Combshell	G1	LE, XN	LE	S1
Epioblasma penita	Southern Combshell	G1	LE	LE	S1
Epioblasma triquetra	Snuffbox	G3		LE	S1
Hamiota perovalis	Orangenacre Mucket	G2	LT	LE	S1
Lexingtonia dolabelloides	Slabside Pearlymussel	G2	C	LE	S1
Medionidus acutissimus	Alabama Moccasinshell	G2	LT	LE	S1
Plethobasus cyphyus	Sheepnose	G3	C	LE	S1
Pleurobema curtum	Black Clubshell	G1	LE	LE	SH
Pleurobema decisum	Southern Clubshell	G2	LE	LE	S1S2
Pleurobema marshalli	Flat Pigtoe	GH	LE	LE	SX
Pleurobema perovatum	Ovate Clubshell	G1	LE	LE	S1
Pleurobema rubrum	Pyramid Pigtoe	G2		LE	S1
Pleurobema taitianum	Heavy Pigtoe	G1	LE	LE	SX
Potamilus capax	Fat Pocketbook	G1	LE	LE	S1
Potamilus inflatus	Inflated Heelsplitter	G1G2	LT	LE	S1
Ptychobranchus fasciolaris	Kidneyshell	G4G5		LE	S1
Quadrula cylindrica cylindrica	Rabbitsfoot	G3T3		LE	S1
Quadrula metanevra	Monkeyface	G4		LE	SX
Quadrula stapes	Stirrupshell	GH	LE	LE	SX
MALACOSTRACA					
Fallicambarus gordoni	Camp Shelby Burrowing Crayfish	G1		LE	S1
INSECTA					
Neonympha mitchellii mitchellii	Mitchell's Satyr	G2T2	LE		S1
Nicrophorus americanus	American Burying Beetle	G2G3	LE	LE	SX
OSTEICHTHYES					
Acipenser oxyrinchus desotoi	Gulf Sturgeon	G3T2	LT	LE	S1
Crystallaria asprella	Crystal Darter	G3		LE	S1
Etheostoma blennioides	Greenside Darter	G5		LE	S1

MISSISSIPPI NATURAL HERITAGE PROGRAM
LISTED SPECIES OF MISSISSIPPI
2011

SCIENTIFIC NAME	COMMON NAME	GLOBAL RANK	FEDERAL STATUS	STATE STATUS	STATE RANK
OSTEICHTHYES					
Etheostoma rubrum	Bayou Darter	G1	LT	LE	S1
Notropis boops	Bigeye Shiner	G5		LE	S1
Notropis chalybaeus	Ironcolor Shiner	G4		LE	S2
Noturus exilis	Slender Madtom	G5		LE	S1
Noturus gladiator	Piebald Madtom	G3		LE	S1
Noturus munitus	Frecklebelly Madtom	G3		LE	S2
Percina aurora	Pearl Darter	G1	C	LE	S1
Percina phoxocephala	Slenderhead Darter	G5		LE	S1
Phenacobius mirabilis	Suckermouth Minnow	G5		LE	S1
Phoxinus erythrogaster	Southern Redbelly Dace [2]	G5		LE	S2
Scaphirhynchus albus	Pallid Sturgeon	G1	LE	LE	S1
Scaphirhynchus platorynchus	Shovelnose Sturgeon	G4	T/SA		S3?
Scaphirhynchus suttkusi	Alabama Sturgeon	G1	LE	LE	S1
AMPHIBIA					
Amphiuma pholeter	One-toed Amphiuma	G3		LE	S1
Aneides aeneus	Green Salamander	G3G4		LE	S1
Eurycea lucifuga	Cave Salamander	G5		LE	S1
Gyrinophilus porphyriticus	Spring Salamander	G5		LE	S1
Rana sevosa	Dusky Gopher Frog	G1	LE	LE	S1
REPTILIA					
Caretta caretta	Loggerhead	G3	LT	LE	S1B
Chelonia mydas	Green Turtle	G3	LE, LT	LE	SNA
Dermochelys coriacea	Leatherback	G2	LE	LE	SNA
Drymarchon couperi	Eastern Indigo Snake	G3	LT	LE	SH
Eretmochelys imbricata	Hawksbill	G3	LE	LE	SNA
Farancia erytrogramma	Rainbow Snake	G5		LE	S2
Gopherus polyphemus	Gopher Tortoise	G3	PS:LT	LE	S2
Graptemys flavimaculata	Yellow-blotched Map Turtle	G2	LT	LE	S2
Graptemys nigrinoda	Black-knobbed Map Turtle	G3		LE	S2
Graptemys oculifera	Ringed Map Turtle	G2	LT	LE	S2
Heterodon simus	Southern Hognose Snake	G2		LE	SX
Lepidochelys kempii	Kemp's or Atlantic Ridley	G1	LE	LE	S1N
Pituophis melanoleucus lodingi	Black Pine Snake	G4T3	C	LE	S2
Pseudemys alabamensis	Alabama Redbelly Turtle	G1	LE	LE	S1
AVES					
Campephilus principalis	Ivory-billed Woodpecker	G1	LE	LE	SX

MISSISSIPPI NATURAL HERITAGE PROGRAM
LISTED SPECIES OF MISSISSIPPI
2011

SCIENTIFIC NAME	COMMON NAME	GLOBAL RANK	FEDERAL STATUS	STATE STATUS	STATE RANK
AVES					
Charadrius alexandrinus tenuirostris	Southeastern Snowy Plover	G4T3Q		LE	S1B,S1N
Charadrius melodus	Piping Plover	G3	LE, LT	LE	S1N
Falco peregrinus	Peregrine Falcon	G4		LE	SNA
Grus canadensis pulla	Mississippi Sandhill Crane	G5T1	LE	LE	S1
Haliaeetus leucocephalus	Bald Eagle	G5		LE	S1B,S2N
Mycteria americana	Wood Stork	G4	PS:LE	LE	S1N
Pelecanus occidentalis	Brown Pelican	G4		LE	S1N
Picoides borealis	Red-cockaded Woodpecker	G3	LE	LE	S1
Sterna antillarum athalassos	Interior Least Tern [3]	G4T2Q	PS:LE	LE	S3?B
Thryomanes bewickii	Bewick's Wren	G5		LE	S2S3B
Vermivora bachmanii	Bachman's Warbler	GH	LE	LE	SXB
MAMMALIA					
Myotis grisescens	Gray Myotis	G3	LE	LE	SNA
Myotis sodalis	Indiana Bat	G2	LE	LE	SNA
Puma concolor coryi	Florida Panther	G5T1	LE	LE	SX
Trichechus manatus	West Indian Manatee	G2	LE	LE	SNA
Ursus americanus	American Black Bear	G5	PS	LE	S1
Ursus americanus luteolus	Louisiana Black Bear	G5T2	LT	LE	S1
PLANTS [1]					
DICOTYLEDONEAE					
Apios priceana	Price’s Potato Bean	G2	LT		S1
Lindera melissifolia	Pondberry	G2	LE		S2
Schwalbea Americana	Chaffseed	G2	LE		SH
ISOETOPSIDA					
Isoetes louisianensis	Louisiana quillwort	G3	LE		S2

[1] *Mississippi has no status concerning endangered plants.*

[2] *West Mississippi disjunct populations*

[3] *Interior populations nesting along the Mississippi River*

Cite the list as:
Mississippi Natural Heritage Program, 2011. Listed Species of Mississippi. Museum of Natural Science, Mississippi Dept. of Wildlife, Fisheries, and Parks, Jackson, MS. 3pp.

ROTTEN BAYOU WATER QUALITY ASSESSMENT

Prepared for

Land Trust for the Mississippi Coastal Plain

P.O. Box 245

Biloxi, Mississippi 39533

Prepared by

Anchor QEA, LLC

901 S. Mopac Expressway

Barton Oaks Plaza V, Suite 150

Austin, Texas 78746

December 2014

TABLE OF CONTENTS

List of Tables

List of Figures

LIST OF ACRONYMS AND ABBREVIATIONS

Abbreviation	Definition
BMP	best management practice
DO	dissolved oxygen
GOMA	Gulf of Mexico Alliance
lbs/day	pounds per day
MDEQ	Mississippi Department of Environmental Quality
mg/l	milligrams per liter
NLCD	National Land Cover Database
TBODu	total biochemical oxygen demand, ultimate
TMDL	total maximum daily load
TN	total nitrogen
TP	total phosphorus
USEPA	U.S. Environmental Protection Agency
USGS	U.S. Geological Survey

1 INTRODUCTION

Rotten Bayou, a tributary to St. Louis Bay, is located on the Mississippi Gulf Coast and is listed on Mississippi's 2004 303(d) List of Water Bodies as impaired for organic enrichment/low dissolved oxygen (DO) and nutrients (MDEQ 2007). Rotten Bayou's beneficial use is designated as "Aquatic Life Support." Applicable water quality standards included DO concentrations maintained at a daily average of not less than 5.0 milligrams per liter (mg/l) with an instantaneous minimum of not less than 4.0 mg/l. For tributaries to St. Louis Bay, the MDEQ 2007 water quality standard for nutrients states:

> Waters shall be free from materials attributable to municipal, industrial, agricultural or other discharges producing color, odor, taste, total suspended or dissolved solids, sediment, turbidity, or other conditions in such degree as to create a nuisance, render the waters injurious to public health, recreation or to aquatic life and wildlife or adversely affect the palatability of fish, aesthetic quality, or impair the water for any designated use. (p. 5)

The purpose of this water quality assessment was to investigate watershed nutrient inputs to Rotten Bayou and look for signatures of significant nonpoint source loads by understanding current nutrient levels using existing watershed data and reviewing land use information. Results of the evaluation were used in recommending management steps for controlling nutrients from the watershed to Rotten Bayou. The nutrients considered were total nitrogen (TN) and total phosphorus (TP).

The first step in this water quality assessment was to determine if current monitoring data being collected by the U.S. Geological Survey (USGS) within the Rotten Bayou watershed exceed applicable thresholds: total maximum daily load (TMDL) thresholds, draft thresholds for non-tidal rivers and streams in southeast Mississippi, or threshold recommendations in the tidally influenced St. Louis Bay. The next step involved evaluating if adequate data exist to determine sub-watershed inputs and loads and to discern patterns based on land use and water quality data so that management steps for controlling nutrients from the Rotten Bayou watershed could be recommended.

1.1 Applicable Nutrient Thresholds

A TMDL was developed for Rotten Bayou (along with four other tributaries to St. Louis Bay) in 2007 based on monitoring data and modeling of the system (MDEQ 2007). Model calibration and verification were based on water quality studies conducted in 1998, 1999, and 2001. The TMDL for organic enrichment was quantified in terms of total biochemical oxygen demand, ultimate (TBODu); since TBODu did not exceed the assimilative capacity of Rotten Bayou, no reductions in permitted loads of organic material were specified in the TMDL in order to meet water quality limits. The TMDL set a threshold concentration of 1.5 mg/l as the target for TN and 0.1 mg/l for TP for waterbodies located in the St. Louis Bay watershed. Mississippi Department of Environmental Quality (MDEQ) presented these concentrations as preliminary target values for TMDL development but noted that the values are subject to revision after the development of numeric nutrient criteria. Based on these target concentrations and estimated flows, the TMDL established nonpoint source load allocations for Rotten Bayou (inclusive of the nearby Jourdan River) of 5,810 pounds per day (lbs/day) for TN and 387 lbs/day for TP.

The State of Mississippi has not yet adopted numeric water quality standards for allowable nutrient concentrations; however, draft stream nutrient thresholds have been developed for non-tidal streams and rivers to protect aquatic life uses in Mississippi (MDEQ 2011). The draft standards were based on reference approaches, stressor response approaches, and relevant literature values. For TN in southeast Mississippi rivers and streams, the recommended thresholds range from 0.31 to 0.68 mg/l, depending on the approach; for TP, the proposed criteria range from 0.01 to 0.05 mg/l, depending on the approach (MDEQ 2011). Literature values and criteria from other states range from 0.18 to 2.0 mg/l for TN and 0.02 to 0.2 mg/l for TP.

In 2013, the Gulf of Mexico Alliance (GOMA), under the direction of MDEQ, completed a study of sources, fate, transport, and effects of nutrients as a basis for protection in estuarine and near-coastal waters for St. Louis Bay (GOMA 2013). The intent of this study was to provide the technical foundation for pilot nutrient thresholds for St. Louis Bay, a tidally influenced coastal bay. Based on empirical and mechanistic modeling results, the preliminary annual geometric mean threshold recommendations are 0.6 to 0.8 mg/l for TN and 0.06 to 0.08 mg/l for TP.

Table 1 summarizes the TN and TP targets and thresholds from the three reports.

Table 1
Various Targets and Thresholds for Tributaries to St. Louis Bay and for St. Louis Bay

	TMDL Targets and Thresholds for Tributaries to St. Louis Bay (MDEQ 2007)		Draft Revised Stream Nutrient Thresholds for Southeast Mississippi Rivers and Streams (MDEQ 2011)	Threshold Recommendations for St. Louis Bay Based on Modeling Results (GOMA 2013)
Parameter	Target* (lbs/day)	Threshold (mg/l)	Threshold (mg/l)	Threshold (mg/l)
Total Nitrogen	5,810	1.5	0.31 – 0.68	0.6 – 0.8
Total Phosphorus	387	0.1	0.01 – 0.05	0.06 – 0.08

Notes:
*Includes Jourdan River loads
lbs/day = pounds per day
mg/l = milligrams per liter
TMDL = total maximum daily load

2 DATA SOURCES

2.1 Water Quality

Locations of monitoring gages within the Rotten Bayou watershed from the USGS National Water Information System website were reviewed. Three freshwater (i.e., non-tidal) gages and one tidally-influenced gage were identified due to their proximity to Rotten Bayou (Figure 1):

- 02481661 – Tributary to Bayou LaSalle near Vidalia, Mississippi
- 02481663 – Rotten Bayou near Fenton, Mississippi
- 0248166310 – Mill Creek at Fenton, Mississippi
- 0248166590 – Rotten Bayou Tributary No. 1 at Diamondhead, Mississippi

The gage at Diamondhead, located downstream of the bayou, is tidally-influenced. Because of this, it is impossible to discern the influence of the Rotten Bayou watershed from the influence of St. Louis Bay to nutrient concentrations and loads at this gage due to reversal of flow. Therefore, while the data from this gage were reviewed and compared to appropriate thresholds, they were not considered in evaluations of sub-watershed contributions of nutrients. In addition, point sources contribute nutrients into the tidally-influenced area (Liu et al. 2008) and, therefore, separating nonpoint source contributions at this gage would be further complicated.

Flow and TN and TP concentration data from the three freshwater gages and one tidally influenced gage were downloaded from the website (USGS); data were collected monthly or every other month from 2012 to 2014, with some days having multiple measurements (Table 2). It should be noted that the USGS data are considered draft and provisional and that the USGS is anticipated to complete their monitoring of these gages in 2014. Analyses of the data by USGS are projected to occur by 2016.

Table 2
Counts of Available USGS Data

Gage	Year	Total Nitrogen Concentration	Total Phosphorus Concentration	Flow Measurements	Paired Concentration and Flow Measurements
02481661 – Tributary to Bayou LaSalle near Vidalia	2012	43	43	7	7
	2013	6	6	6	6
	2014*	29	29	5	5
02481663 – Rotten Bayou near Fenton	2012	9	9	9	9
	2013	6	6	6	6
	2014*	5	5	5	5
0248166310 – Mill Creek at Fenton	2012	51	51	9	9
	2013	6	6	6	6
	2014*	17	17	5	5
0248166590 – Rotten Bayou Tributary No. 1 at Diamondhead	2012	37	37	9	8
	2013	22	22	6	6
	2014*	37	37	5	5

Note:
*Per the project's schedule, data assessments were performed prior to the availability of all 2014 data. Data from the freshwater gages were downloaded on September 14, 2014, and from the tidal gage at Diamondhead on October 2, 2014.

Data collected within Rotten Bayou during a special water quality study in August 2012 (USEPA 2014) were also reviewed. The monitoring stations located within the bayou were tidally-influenced and therefore not used herein for comparison to nutrient thresholds.

2.2 Land Use

Land use information was downloaded from the internet (Multi-Resolution Land Characteristics Consortium). The coverage was based on the 2006 National Land Cover Database (NLCD), which employs a 16-class land cover classification scheme at a spatial resolution of 30 meters (Fry et al. 2011). As of this assessment, the NLCD 2011 coverage was not available online, only a coverage depicting changes in land use since 2006 was available.

3 ASSESSMENT METHODOLOGY

The water quality assessment methodology consisted of two steps: 1) comparison of TN and TP concentrations to TMDL thresholds (MDEQ 2007), draft stream nutrient thresholds (MDEQ 2011), and St. Louis Bay threshold recommendations (GOMA 2013); and 2) assessment of major land use types upstream of each gage. Thresholds are summarized in Table 1.

Nutrient loads, which are calculated by multiplying stream flow by nutrient concentrations, were not computed due to the paucity of paired concentration and flow data (Table 2). The evaluation of export coefficients (e.g., loads per unit area of watershed) likewise could not be performed due to the limited dataset. As a result, only concentrations and land use variations in sub-watersheds were considered in qualitatively assessing potential sources and management options for reducing nonpoint source nutrients reaching Rotten Bayou.

4 FINDINGS

4.1 Comparison of Concentrations to Appropriate Thresholds

Figures 2 and 3 show temporals of TN and TP concentrations, respectively, at the three freshwater gages. Figures 4 and 5 show TN and TP concentration temporals for the tidally influenced gage at Diamondhead. Measurements were taken on a routine basis as well as a sub-daily basis during storm events (Hicks 2014).

4.1.1 Nutrient TMDL Thresholds

Few TN and TP measurements from 2012 to 2014 exceeded the nutrient TMDL thresholds at the freshwater gages (Figures 2 and 3). For TN, none of the measurements exceeded the nutrient TMDL threshold with the exception of one measurement on July 18, 2012, at 4:15 pm at 0248166310 Mill Creek at Fenton. For TP, 8% and 4% of samples at 02481661 Tributary to Bayou LaSalle near Vidalia and at 0248166310 Mill Creek at Fenton, respectively, exceeded the TMDL threshold; these exceedances appear to have been during storm events. Only one sample taken at 02481663 Rotten Bayou near Fenton exceeded the TP TMDL threshold; this sample was collected on July 12, 2012.

4.1.2 Draft Revised Stream Nutrient Thresholds

For the freshwater gages, some TN and TP concentrations from 2012 to 2014 were higher than the draft revised stream nutrient thresholds for southeast Mississippi (Figures 2 and 3). For TN, 13% and 7% of samples exceeded the threshold at 02481661 Tributary to Bayou LaSalle near Vidalia and at 0248166310 Mill Creek at Fenton, respectively; these appear to have been taken during storm events as multiple samples were taken on a single day (Hicks 2014). In addition, detection limits reported for several samples were higher than the threshold (Figure 2). No TN measurement at 02481663 Rotten Bayou near Fenton exceeded the threshold. A similar pattern of exceedances is observed for TP data (Figure 3).

4.1.3 St. Louis Bay Thresholds

The St. Louis Bay thresholds were developed based on tidally influenced monitoring data in St. Louis Bay. Table 3 summarizes annual geometric means of TN and TP for the tidal gage near Rotten Bayou from 2012 to 2014. At this gage, the annual geometric means exceeded the St. Louis Bay thresholds for both TN and TP in 2013 and 2014.

Table 3
Annual Geometric Means at the Tidal Gage at Diamondhead

Nutrient	Annual Geometric Mean (mg/l)		
	2012	**2013**	**2014**
Total Nitrogen	0.68	1.15	1.02
Total Phosphorus	0.060	0.106	0.090

Notes:
- Recommended thresholds for St. Louis Bay based on modeling (GOMA 2013): Total Nitrogen 0.6 to 0.8 mg/l, Total Phosphorus 0.06 to 0.08 mg/l
- The tidal gage is 0248166590 – Rotten Bayou Tributary No. 1 at Diamondhead.
- Non-detect values were set to the detection limit prior to calculation.

mg/l = milligrams per liter

4.2 Incorporation of Land Use Information

Figure 6 shows land cover classification within sub-watersheds upstream of each of the three freshwater USGS gages. The sub-watersheds were delineated in ArcMap using topography and the gage locations.

Figure 7 shows the proportions of each land cover classification within each sub-watershed. Land cover is similar among the three sub-watersheds, with shrub/scrub, evergreen forest, and woody wetlands being dominant. From the station furthest upland to downstream, the proportions of developed open space and woody wetlands increase while shrub/scrub and grassland/herbaceous proportions decrease.

5 LIMITATIONS OF DATA ASSESSMENT

Limitations of this data assessment are as follows:

- Few paired measurements of TN and TP concentration and flow exist for three freshwater gages near Rotten Bayou (Table 2) and therefore, nutrient loads (i.e., concentration multiplied by flow) cannot be adequately assessed. The calculation of nutrient loads would provide an indication of the amount of nutrients passing each gage during the time of measurement.
- Measurements of TN, TP, and flow during storm events are limited.

- Three years of data are not a long enough record to assess long-term or seasonal trends or fluctuations in TN and TP concentrations due to precipitation (e.g., dry year versus wet year).
- Data downloaded from USGS are draft and provisional. Per the project's schedule, data from 2014 were downloaded in September and October 2014; therefore, an assessment of all 2014 data was not performed. Data are being collected by USGS through 2014.
- The reported detection limits for TN data from USGS are sometimes above the threshold recommendations or are high compared to detected data (see open symbols on Figures 2 and 4). These detection limits should be investigated further.
- Tidally influenced data include both watershed and bay sources of nutrients and therefore, cannot be used to identify sources of nutrients from the watershed.

6 RECOMMENDATIONS FOR FURTHER STUDY

Based on the findings, TN and TP concentrations measured at three freshwater gages located in the Rotten Bayou watershed are generally below or near various Mississippi nutrient threshold concentrations with the exception of data collected during a few storm events in 2012 and 2014 (Darby 2014). The TN and TP data collected at a tidal gage just downstream of Rotten Bayou exceeded applicable criteria in 2 of the last 3 years. Based on an evaluation of land cover within the sub-watershed above each gage, streamside management is recommended to control nutrient run-off during timber harvesting and re-vegetation. In addition, landside best management practices (BMPs) to control runoff and stormwater are recommended, particularly upland of the Diamondhead and Mill Creek gages.

The following next steps are recommended for further study:

- Continue review of the USGS data, which are being collected through 2014.
- Evaluate land use types near streams for appropriate watershed BMP selection and implementation.
- Verify if data with TN and TP threshold exceedances were collected during storm events. Design a stormwater sampling program in areas expected to be contributing higher TN and TP loads.

- Determine if chlorophyll-a (algal bloom) is a concern in the tidal portion of the bayou.
- Evaluate bacteria data in Rotten Bayou and its tributaries, as available.

7 REFERENCES

Darby, E., 2014. Water Quality Update – Rotten Bayou Watershed. PowerPoint presented at Stakeholder meeting. Diamondhead, Mississippi. October 2014.

Fry, J., G. Xian, S. Jin, J. Dewitz, C. Homer, L. Yang, C. Barnes, N. Herold, and J. Wickham, 2011. Completion of the 2006 National Land Cover Database for the Conterminous United States. *Photogrammetric Engineering & Remote Sensing* 77(9):858-864.

GOMA (Gulf of Mexico Alliance), 2013. *Sources, Fate, Transport, and Effects (SFTE) of Nutrients as a Basis for Protective Criteria in Estuarine and Near-Coastal Waters: Saint Louis Bay, Mississippi Pilot Study*. Prepared by Tetra Tech, Inc. December 2013.

Hicks, M., 2014. Regarding: USGS Water Quality Study. Email to: Elaine Darby, Anchor QEA. October 8, 2014.

Liu, Z., W.L. Kingery, D.H. Huddleston, F. Hossain, W. Chen, N.B. Hashim, and J.M. Kieffer, 2008. Modeling Nutrient Dynamics Under Critical Flow Conditions in Three Tributaries of St. Louis Bay. *Journal of Environmental Science and Health, Part A: Toxic/Hazardous Substances and Environmental Engineering* 43:6, 633-645, DOI: 10.1080/10934520801893725

MDEQ (Mississippi Department of Environmental Quality), 2007. *Total Maximum Daily Load for Nutrients and Organic Enrichment/Low DO in Listed Tributaries to St. Louis Bay Coastal Streams Basin*. Prepared by MDEQ Office of Pollution Control Standards, Modeling and TMDL Branch. June 2007.

MDEQ, 2011. *Revised Draft Nutrient Thresholds to Protect Aquatic Life Uses in Mississippi Non-Tidal Streams and Rivers*. Prepared by Tetra Tech, Inc. Prepared for MDEQ Office of Pollution Control. June 2011.

Multi-Resolution Land Characteristics Consortium. National Land Cover Database 2006. Cited: March 2011. Available from: www.mrlc.gov.

USEPA (U.S. Environmental Protection Agency), 2014. *Rotten Bayou Water Quality Study Final Report*. Prepared by USEPA Region 4 Science and Ecosystem Support Division. March 2014.

USGS (U.S. Geological Survey). National Water Information System. Cited: June 9, 2014, September 14, 2014, and October 2, 2014. Available from: water.usgs.gov/data/.

FIGURES

Basemap Source: USGS

\\austin2\austin\D_drive\Projects\LandTrust_MS_CoastalPlain\Rotten_Bayou\Deliverables\141205_report\figures\Fig1__usgs_gauges.docx

Figure 1
Locations of USGS Gages Near Rotten Bayou
Rotten Bayou Water Quality Assessment

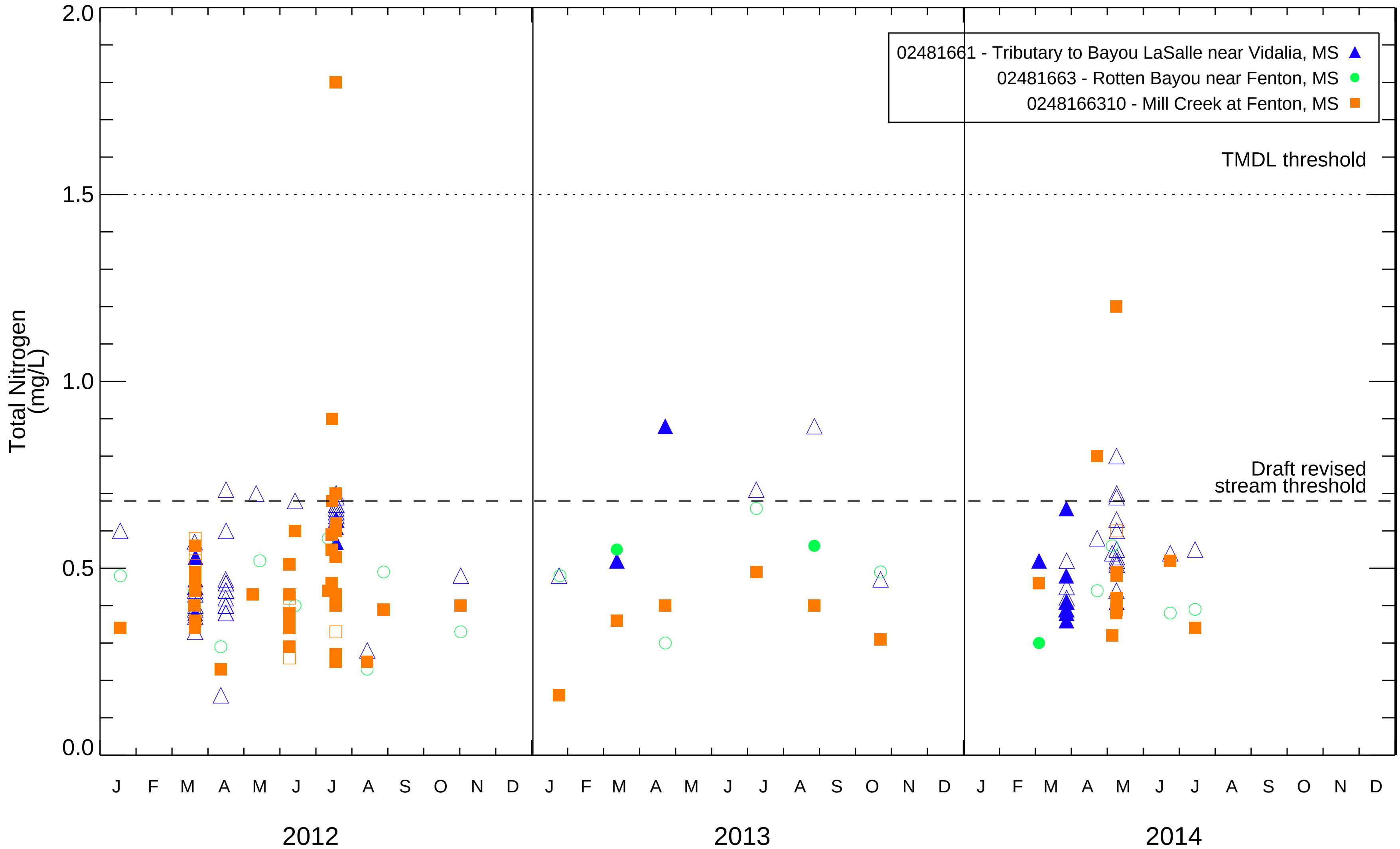


Figure 2

Temporal of Total Nitrogen Concentration at Three Freshwater USGS Gages near Rotten Bayou

Non-detects are shown as open symbols at the detection limit.
Dotted line is TMDL threshold for tributaries to St. Louis Bay (MDEQ 2007).
Dashed line is the top of range of draft revised stream nutrient threshold for southeast MS (MDEQ 2011).

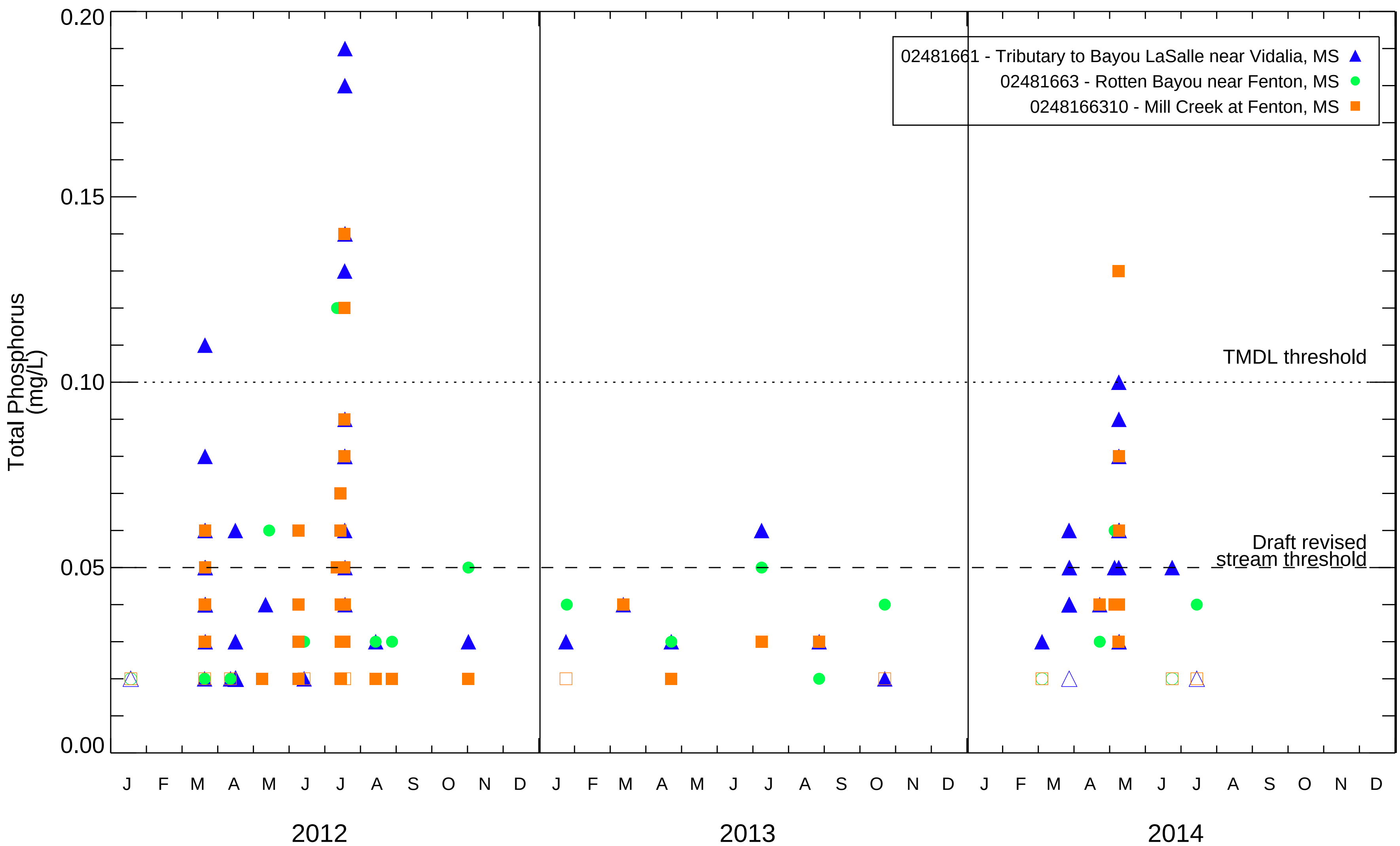


Figure 3

Temporal of Total Phosphorus Concentration at Three Freshwater USGS Gages near Rotten Bayou

Non-detects are shown as open symbols at the detection limit.
Dotted line is TMDL threshold for tributaries to St. Louis Bay (MDEQ 2007).
Dashed line is the top of range of draft revised stream nutrient threshold for southeast MS (MDEQ 2011).

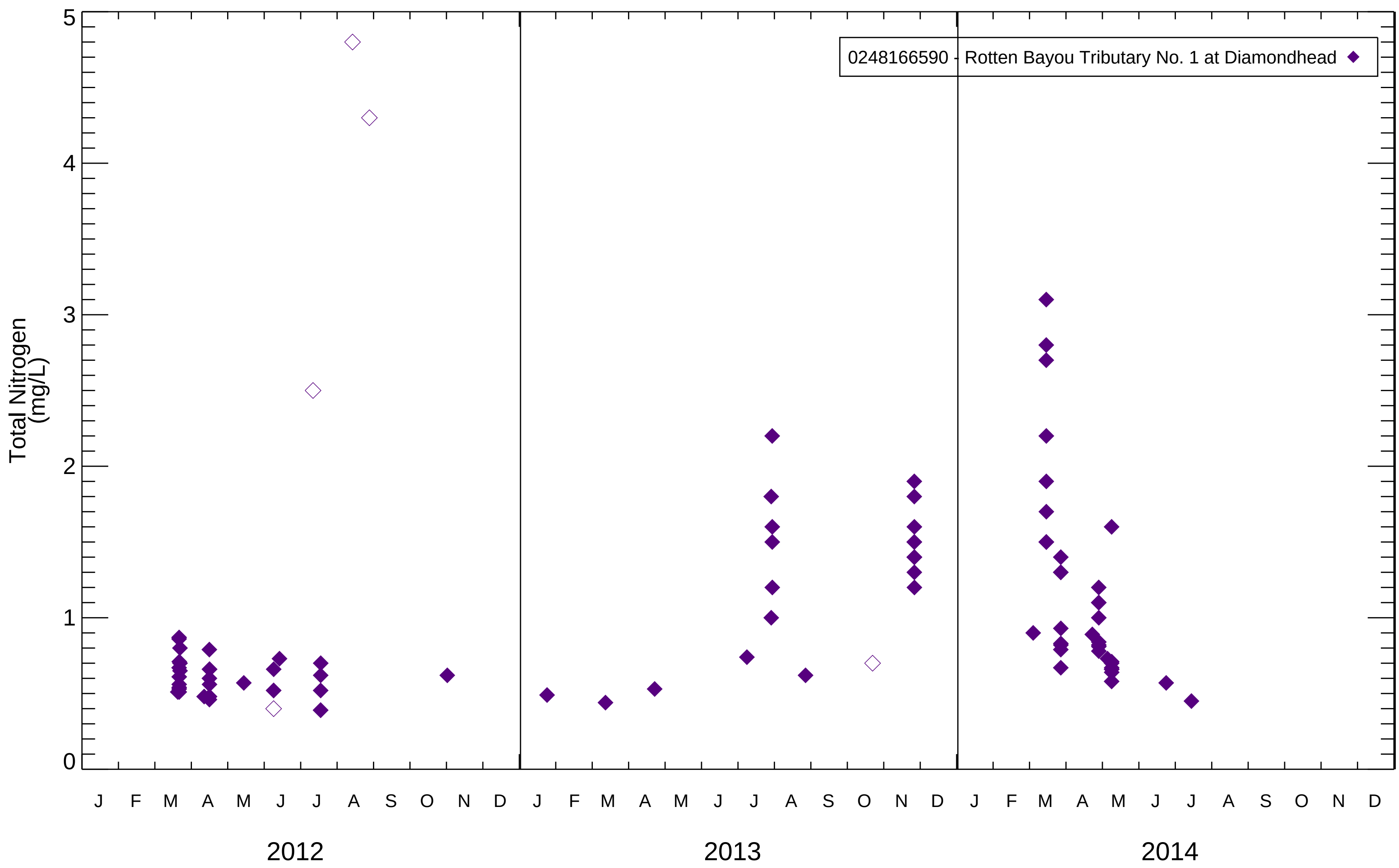


Figure 4

Temporal of Total Nitrogen Concentration at One Tidal USGS Gage near Rotten Bayou

Non-detects are shown as open symbols at the detection limit.

Rotten Bayou Water Quality Assessment

ANCHOR QEA

EC - \\austin2\austin\D_drive\Projects\LandTrust_MS_CoastalPlain\Rotten_Bayou\Analysis\nutrient\TN_TP_temporals.pro Fri Dec 05 11:25:11 2014

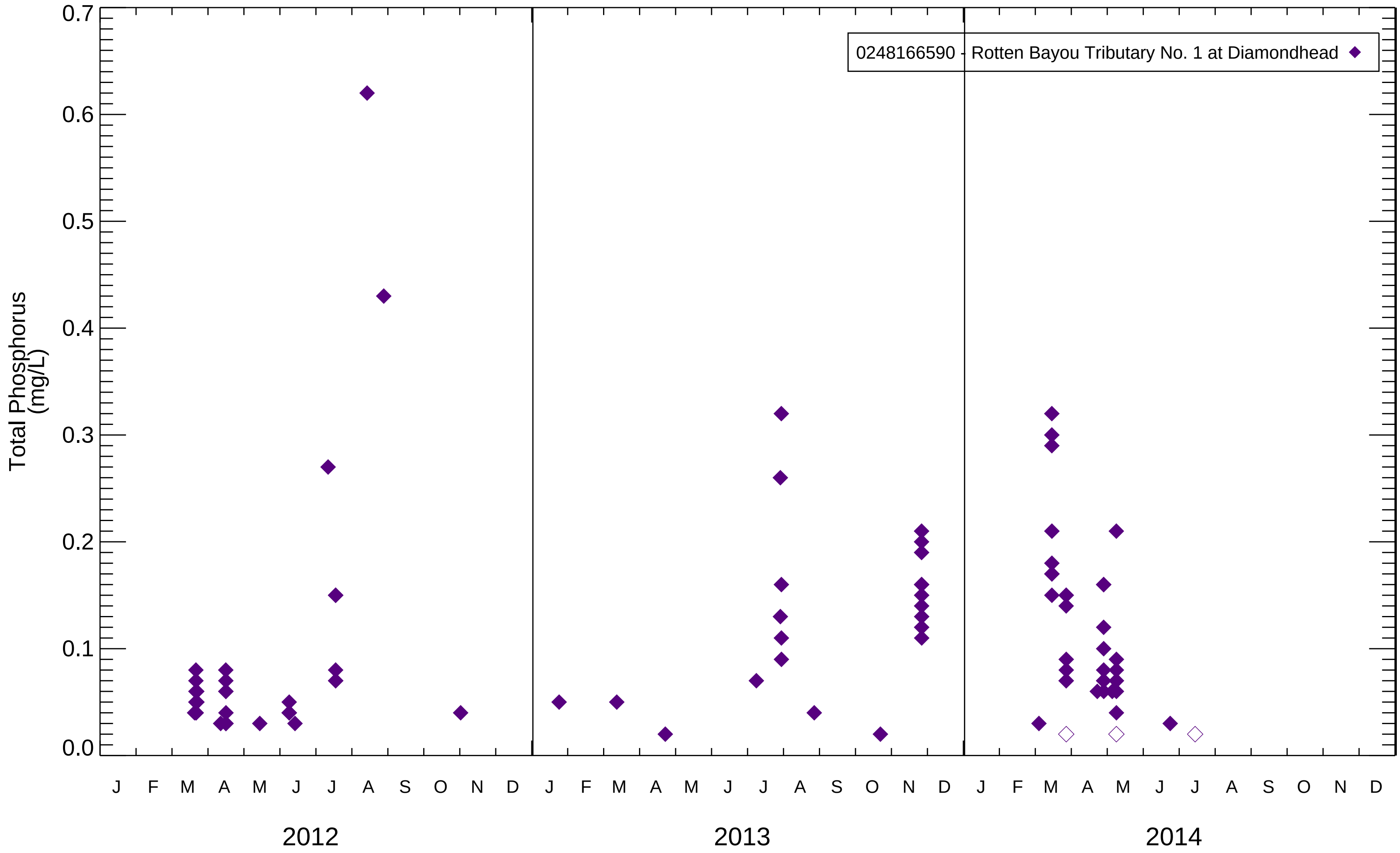


Figure 5

Temporal of Total Phosphorus Concentration at One Tidal USGS Gage near Rotten Bayou

Non-detects are shown as open symbols at the detection limit.

Rotten Bayou Water Quality Assessment

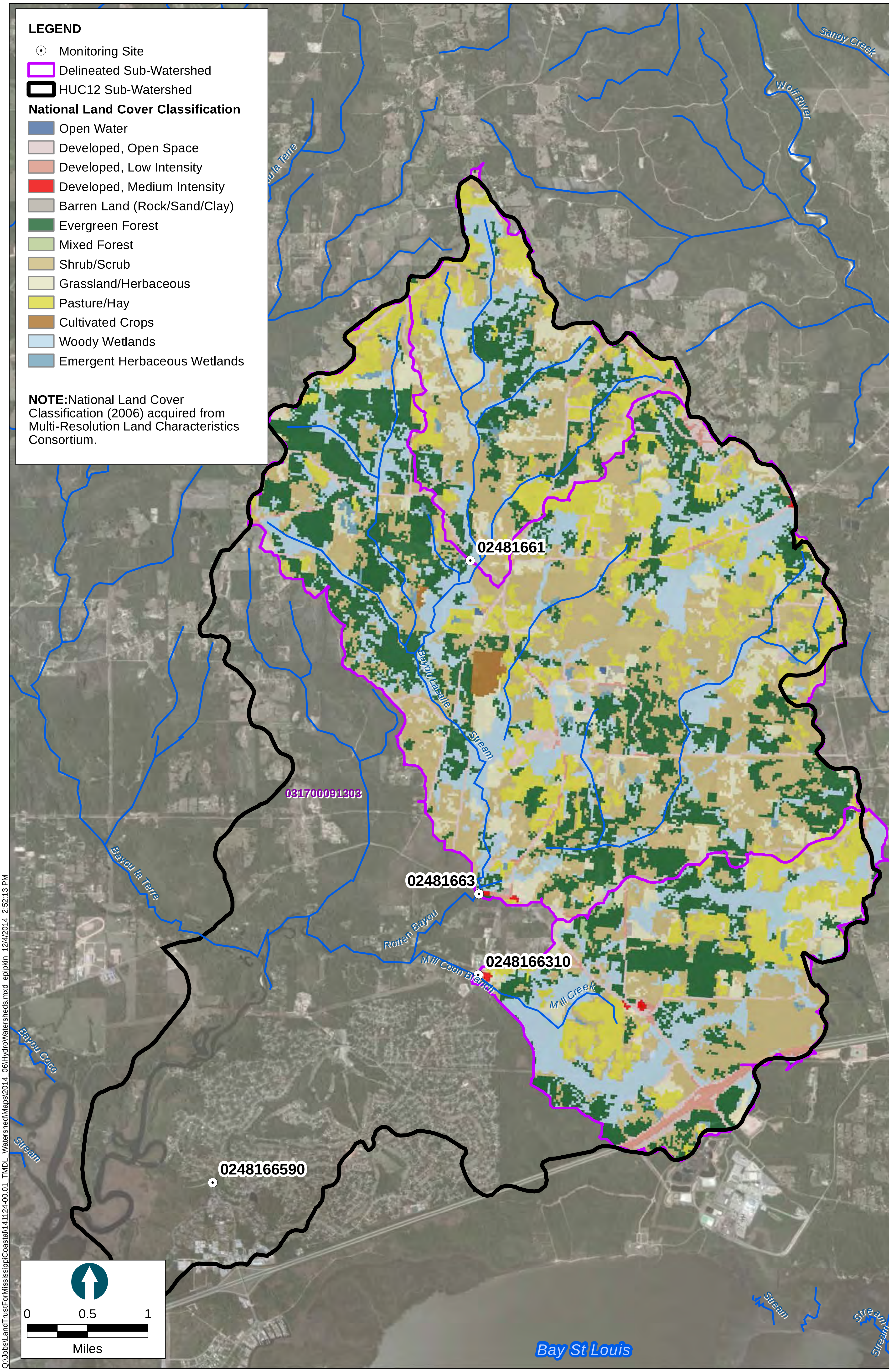
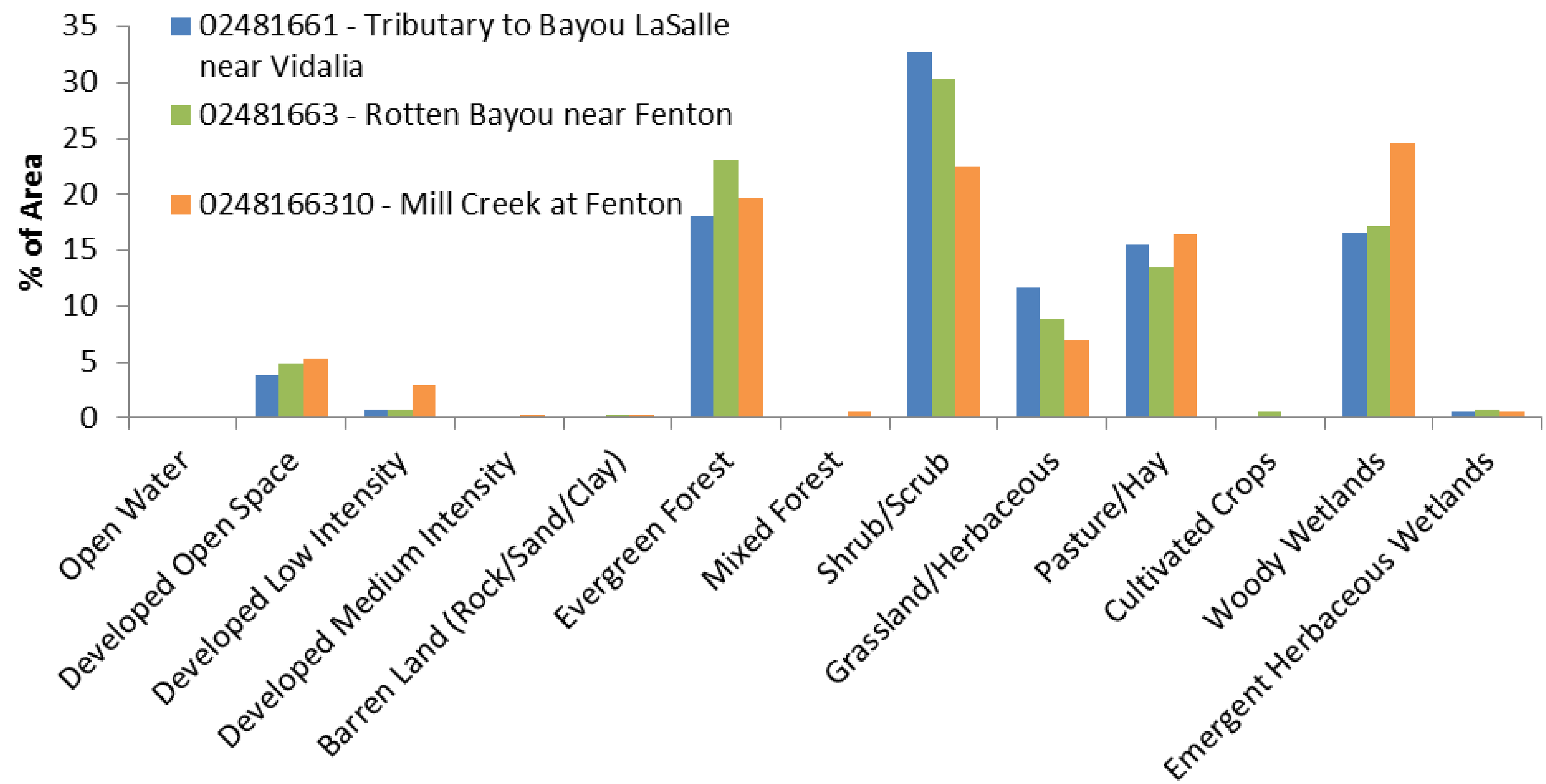


Figure 6
National Land Cover Classification within Sub-Watersheds
Rotten Bayou Water Quality Assessment

\\austin2\austin\D_drive\Projects\LandTrust_MS_CoastalPlain\Rotten_Bayou\Deliverables\141205_report\figures\Fig7_land_use_bar_plot.docx



ANCHOR QEA

Figure 7
Proportion of Land Cover Classifications in Watershed of Three Freshwater USGS Gages
Rotten Bayou Water Quality Assessment

Rotten Bayou Watershed

Final Report

MDEQ Agreement Number
12-00011

September 21, 2011-September 30, 2014

Mississippi Soil and Water Conservation Commission

ROTTEN BAYOU WATERSHED AGRICULTURAL NONPOINT SOURCE POLLUTION PROJECT

Table of Contents

SECTION 319 (H) NONPOINT SOURCE GRANT MILESTONES AND STATUS FORM

QUARTER: September 30, 2014 WORK ORDER NO: 12-00011 STATE: Mississippi
PROJECT NAME: Rotten Bayou Watershed 319 Project
SUBGRANTEE/CONTRACTOR AND OTHER COOPERATORS:
BUDGET PERIOD START DATE: 09/21/11
BUDGET PERIOD END DATE: 09/30/2014
TOTAL PROJECT COST: $550,001
EXPENDED THIS PERIOD:
TOTAL EXPENDITURES TO DATE:
WATERBODY/WATERSHED IDENTIFICATION: Rotten Bayou
NPS CATEGORY: Agriculture
PURPOSE STATEMENT: The purpose of this project will be to implement Best Management Practices (BMPs) on targeted areas in the Rotten Bayou Watershed that will reduce pollutant loadings from agricultural nonpoint sources.

SPECIFIC MILESTONES/OUTPUTS:	EXPECTED COMPLETION DATE	ACTUAL COMPLETION DATE
1. Coordinate with the Mississippi Department of Environmental Quality (MDEQ), Natural Resources Conservation Service (NRCS), United States Geological Survey (USGS) and the Hancock and Harrison County Soil and Water Conservation Districts (SWCD) to determine priority areas that are contributing significant pollutant loads in the watershed.	Month 1-2	November 2011
2. Develop a Watershed Implementation Plan (WIP) consistent with MDEQ guidance with assistance from the WIT	Month 1-3	
3. Assist in the development and implementation of a watershed monitoring plan for the project	Month 1-36	September 2014
4. Present a draft WIP to MDEQ and Rotten Bayou WIT for review and comments.	Month 1-6	
5. Determine through intensive surveys priority areas that are contributing significant pollutant loads in the watershed.	Month 1-6	February 2012
6. Inform the landowners and operators within the project area about the project and shall work to secure commitments from priority-area landowners and others willing to participate in the project.	Month 1-6	April 2012

7. Notify MDEQ project officer, in a timely manner, of all project site locations/ inspections/public meetings so that the project officer may have an opportunity to attend.	Month 1-36	September 2014
8. Develop plans for Best Management Practices (BMPs) in accordance with the previously submitted and approved WIP.	Month 1-10	September 2014
9. Assist participants in installing BMPs, in accordance with the guidelines developed in the latest edition of the NRCS Technical Field Manual, or other approved guidelines.	Month 1-36	September 2014
10. Submit blank copies of standard maintenance agreements to MDEQ.	Month 10-36	September 2014
11. Assist the MDEQ project officer in conducting inspections during construction.	Month 3-36	September 2014
12. Collect relevant GPS coordinates of all installed BMPs and incorporate into GIS format. All Geospatial data shall be collected in a manner consistent with the Federal Geographic Data Committee endorsed standards.	Month 3-36	September 2014
13. Submit bi-annual reports not later than September 25th and March 25th of each year showing status of tasks and start/completion dates of each task.	Month 1-36	September 2014
14. Develop and implement an education plan in order to achieve WIP goals with assistance from MDEQ and the WIT.	Month 1-36	September 2014
15. Take adequate photo documentation before, during, and after installation of the approved BMPs.	Month 1-36	September 2014
16. Make project presentations as requested by MDEQ.	Month 6-36	September 2014
17. Submit a final report to MDEQ to include measured, or estimated, non-point-source, pollutant-load reductions or water-quality improvements, measured improvements in fisheries and wildlife habitat, acreage offered, pre- and post-site conditions and GIS data.	Month 36	September 2014

STATUS OF MILESTONES:

1. Completed. MSWCC coordinated with MDEQ, NRCS, USGS and the Hancock and Harrison County SWCDs to identify priority areas that were contributing significant pollutant loads in the watershed.

2. This milestone is being completed by the Mississippi Land Trust.

3. Completed. MSWCC assisted in the development and implementation of a watershed monitoring plan for the Rotten Bayou project.
4. This milestone is being completed by the Mississippi Land Trust.

5. Completed. Through intensive site surveys, the priority areas that were contributing significant pollutant loads were identified.

6. Completed. A landowner meeting was held on April 9, 2012 to inform the local landowners in the watershed about the project and invite them to participate. There were 37 people in attendance.

7. Completed. The DEQ project officer was notified, in a timely manner, of all project site locations/inspections/public meetings so they would have the opportunity to attend.

8. Completed. Plans were developed for BMPs in accordance to the locations identified by the group. The Land Trust had not completed the WIP at the time these BMPs were installed.

9. Completed. Participants in the project received assistance with the installation of their BMPs to ensure that they met the specifications of the latest edition of the NRCS Technical Field Manual.

10. Completed. Blank copies of the standard maintenance agreement were provided to MDEQ.

11. Completed. The MDEQ officer was assisted on ding inspections during construction.

12. Completed. GPS coordinates were collected on all BMPs that were installed in the project.

13. Completed. Bi-annual reports were submitted to MDEQ on or before the 25th of March and September each year during the project.

14. Completed. An educational plan was developed for this project that consisted of field days to showcase installed practices and allow them to see what improvements could be made on their farms. Signs were installed on practices that were visible form the road to raise awareness about the project, and news articles were written to show the highlights of the project and invite others to participate.

15. Completed. Before and after photo documentation was taken on all installed BMPs.

16. Completed. Project presentations were made at the request of MDEQ.

17. Completed. A final report has been submitted to MDEQ and include in this report are as follows: measured or estimated nonpoint source pollution reductions or improvements, improvements to fisheries and wildlife habitat, acres affected, pre and post site conditions, ad GIS data.

SECTION 319(H) NONPOINT SOURCE GRANT REPORT FOR ROTTEN BAYOU AGRICULTURAL NONPOINT SOURCE POLLUTION PROJECT

MDEQ Agreement No. 12-00011

FINAL REPORT

Project Summary

The Rotten Bayou Watershed is approximately 22,446 acres and is located in Eastern Hancock and Western Harrison Counties in South Mississippi. The Rotten Bayou Watershed is comprised of approximately 25% pastureland, 50% timberland, and 25% wetlands, urban, and other. Primarily all the BMP work in this watershed has occurred on the pastureland located within the watershed.

Because of the high level of stakeholder interest and being listed on Mississippi's 303(d) list of impaired waters, the Rotten Bayou Watershed was selected as a priority watershed by the Mississippi Department of Environmental Quality in the Coastal Streams/Pascagoula River Basin for restoration activities. Therefore, a joint effort by the Mississippi Soil and Water Conservation Commission (MSWCC), the Mississippi Department of Environmental Quality (MDEQ), Environmental Protection Agency (EPA), the Natural Resources Conservation Service (NRCS), and the Hancock County Soil and Water Conservation District (SWCD) resulted in a proposal and subsequent implementation of a project to significantly reduce the amount of nutrients and sediment entering Rotten Bayou by implementing selected Best Management Practices (BMPs).

The primary goals of the project have been:

1. To improve water quality and protect high quality waters by demonstrating the economic benefits and effectiveness of selected BMPs in targeted areas,

2. To apply BMPs to agricultural land in the project area as to reach the desired outcome of reduced runoff, cattle access/nutrients to the stream and sedimentation, and

3. To inform and educate the public about BMPs that benefit water quality.

Information/education activities carried out under this project have included the following:

A. Demonstration farms were established on the following farms: Mark Ladner and Charles DesAngles

B. The first Educational Field Day was conducted on November 7, 2013. The second Educational Field Day was conducted on August 26, 2014.

C. News articles were published to make the public aware of the project.

D. 1,000 fact sheets were distributed to make the public aware of the practices installed and the soil savings from those practices.

Attached below is a summary of the tons of soil saved through the installation of BMPs in the Rotten Bayou Watershed.

SUMMARY OF BEST MANAGEMENT PRACTICES INSTALLED

Practice Name	Number of Practices	Number of Acres Affected	Total Tons of Soil Saved Per Year
342- Critical Area Planting	6	10	51
382- Fencing	19	24,563 feet	
590-Nutrient Management	12	250.5	762.7
512-1-Pasture and Hayland Planting	2	38	144
561- Heavy Use Area Protection	3		
614-Tank/Trough	6		
378- Pond (Alternative Water Source)	14		
638-Water & Sediment Control Basin	4	4	118.2
Totals	**66**	**302.5**	**1,075.9**

Outputs

The outputs required under this project were:

1. Completed. MSWCC coordinated with MDEQ, NRCS, USGS and the Hancock and Harrison County SWCDs to identify priority areas that were contributing significant pollutant loads in the watershed.

2. This milestone is being completed by the Mississippi Land Trust.

3. Completed. MSWCC assisted in the development and implementation of a watershed monitoring plan for the Rotten Bayou project.

4. This milestone is being completed by the Mississippi Land Trust.

5. Completed. Through intensive site surveys, the priority areas that were contributing significant pollutant loads were identified.

6. Completed. A landowner meeting was held on April 9, 2012 to inform the local landowners in the watershed about the project and invite them to participate. There were 37 people in attendance.

7. Completed. The DEQ project officer was notified, in a timely manner, of all project site locations/inspections/public meetings so they would have the opportunity to attend.

8. Completed. Plans were developed for BMPs in accordance to the locations identified by the group. The Land Trust had not completed the WIP at the time these BMPs were installed.

9. Completed. Participants in the project received assistance with the installation of their BMPs to ensure that they met the specifications of the latest edition of the NRCS Technical Field Manual.

10. Completed. Blank copies of the standard maintenance agreement were provided to MDEQ.

11. Completed. The MDEQ officer was assisted on ding inspections during construction.
12. Completed. GPS coordinates were collected on all BMPs that were installed in the project.

13. Completed. Bi-annual reports were submitted to MDEQ on or before the 25th of March and September each year during the project.

14. Completed. An educational plan was developed for this project that consisted of field days to showcase installed practices and allow them to see what improvements could be made on their farms. Signs were installed on practices that were visible form the road to

raise awareness about the project, and news articles were written to show the highlights of the project and invite others to participate.

15. Completed. Before and after photo documentation was taken on all installed BMPs.

16. Completed. Project presentations were made at the request of MDEQ.

17. Completed. A final report has been submitted to MDEQ and include in this report are as follows: measured or estimated nonpoint source pollution reductions or improvements, improvements to fisheries and wildlife habitat, acres affected, pre and post site conditions, and GIS data.

All of these outputs that were the responsibility of MSWCC have been completed.

raise awareness about the project, and news articles were written to show the highlights of the project and invite others to participate.

15. Completed. Before and after photo documentation was taken on all installed BMPs.

16. Completed. Project presentations were made at the request of MDEQ.

17. Completed. A final report has been submitted to MDEQ and include in this report are as follows: measured or estimated nonpoint source pollution reductions or improvements, improvements to fisheries and wildlife habitat, acres affected, pre and post site conditions, and GIS data.

All of these outputs have been completed.

Equipment

No equipment has been purchased with 319 funds under this project.

Match Documentation

State and local sources provided the match for this project with the majority of match coming from local sources. The budget table for this project is given on the following page and lists the total expenditures by budget category, the 319 funds used, and the amount of the total expenditures supplied as state and local match.

Local match for this project was received several ways. They are listed as follows:

1. the 40% out of pocket expense to the participants for the installation of BMPS.
2. the expense to participants for installing additional practices to support the water quality benefits of cost-shared BMPs.
3. Soil and Water Conservation District commissioners' time spent on the project.

Examples of local match documentation are included in this report as an attachment.

Project Budget

BUDGET EXPENDITURES	319 FUNDS	STATE/LOCAL MATCH	TOTAL
Technical Assistance	$14,386.45	$9,591.00	$23,977.45
Information and Education	$6,620.20	$4,414.00	$11,034.20
Cost Share/ BMP Implementation	$268,993.35	$192,809.01	$461,802.36
Total	**$290,000.00**	**$206,814.01**	**$496,814.01**

Total Federal Funds	$ 290,000.00
Total Match	$ 206,814.01
Total Project Cost	**$ 496,814.01**

Index of Attachments

Appendix E: Diamondhead Cardinal Golf Course BMPs

Project Name:	Partnership:
Cardinal Improvements: Best Management Practices on Diamondhead's Cardinal Golf Course	Land Trust for the Mississippi Coastal Plain MSU's Gulf Coast Community Design Studio Diamondhead Country Club & Property Owners Assn Mississippi Water Resources Research Institute

Project Address/Location:	City	County	State
7600 Country Club Drive Diamondhead, MS 39525	Diamondhead	Hancock County	Mississippi

Watershed Name:	Watershed Number (12-digit HUC):	Name of Improved Waterbody:
Rotten Bayou Watershed	031700109-002	Rotten Bayou

Drainage Area (acres):	% Impervious Cover in Drainage Area:	Project Square Footage/Footprint:
22,446 Acres	30%	36,640 sq. ft. for all 3 BMPs

Run-off volume treated by the BMPs (cubic feet): 19,125 cu. ft. for the 90th percentile rain event

*Costs of Land:	*Costs of Design/Planning:	*Construction Costs:	*Legal costs:	*Costs of maintenance (If maintenance has not occurred yet, planned costs should be included):
N/A	$1,800	$5,900	N/A	$550-$600/month during the growing season (8-9 months of the year). Costs will go down once vegetation is established.

Brief Project Description (2-4 Sentences Maximum):

In coordination with the development of a Watershed Implementation Plan to address water quality in Rotten Bayou Watershed, three Best Management Practices (BMPs) were installed on Diamondhead's Cardinal Golf Course along with educational signage. BMPs included a dry swale on hole one, a restored stream segment on hole two, and a native planting area on hole three. The BMPs installed on Diamondhead's Cardinal Golf Course are not only reducing stormwater runoff and improving water quality in a critical area in Rotten Bayou Watershed, but are serving as a great outreach tool to education the public.

Appendix E: Diamondhead Cardinal Golf Course BMPs

Project Narrative

Since early 2010 the Land Trust for the Mississippi Coastal Plain (LTMCP) and Mississippi State University's Gulf Coast Community Design Studio (GCCDS) have been facilitating the development of a Watershed Implementation Plan for Rotten Bayou Watershed in Hancock and Harrison Counties, Mississippi. Funding was provided in part by a grant from the US EPA to the Mississippi Department of Environmental Quality, Nonpoint Source Branch under provisions of Section 319(h) of the Clean Water Act along with state and local match.

Developing a watershed plan for Rotten Bayou Watershed is a key step in implementing the Coastal Nutrient Reduction Strategy and improving water quality in the watershed. Rotten Bayou is a tributary of the Bay of St. Louis and is listed on the EPA's Section 303(d) list of impaired waterbodies for organic enrichment, low dissolved oxygen, turbidity, and nutrient levels that do not meet water quality standards. Many community and agency stakeholders have been involved in the planning process and significant outreach, education and training has and is being conducted as part of the project. LTMCP and GCCDS were also tasked with planning and implementing best management practices (BMP) within the watershed.

The US Geological Survey has been monitoring water quality at four different stations within the watershed. Preliminary data showed that more of the nutrients common to fertilizers, etc., were coming from the subwatershed that included the city of Diamondhead. Diamondhead was built as a planned retirement community and is mainly comprised of single family residential and some recreational areas including two, eighteen-hole golf courses. The golf courses are owned and managed by the Diamondhead County Club and Property Owners Association (DPOA) and the golf course superintendent, Brook Sentell, has been an active participant on the steering committee for the Rotten Bayou Watershed Project. Sentell has long been employing best management practices such as soil testing and applying minimal amounts of slow release fertilizer when necessary, but was interested in doing more.

Landscape architects with the Golf Coast Community Design Studio and the Mississippi Water Resources Research Institute worked with Sentell to identify areas on Diamondhead's Cardinal golf course that had existing drainage problems and provided opportunities for slowing and filtering runoff from a larger area. Holes one, two and six were selected. Initially Sentell was planning on piping, filling and sodding these areas to address the drainage challenges as part of ongoing renovation work on the course. When alternative designs were discussed that would not only address the drainage problems, but would reduce maintenance costs and add visual interest to the course, the DPOA agreed to put some of the renovation funding toward installing the suggested BMPs.

Between June 2014 and December 2014 Sentell and the partnership worked to install a dry swale on hole one (See Image 1), a naturalized stream segment on hole two (See Image 2), and a native planting area on hole six (See Image 3). Cory Gallo, Associate Professor of Landscape Architecture at Mississippi State University, working through the Mississippi Water Resources Research Institute, designed the dry swale at hole two and suggested plantings for the native planting area on hole six. Sentell and his team were able to implement both of these BMPs on their own.

The stream naturalization at hole two was a more involved project and GCCDS worked closely with Sentell and his team on this project. In December 2015, GCCDS staff worked alongside Sentell and his staff to not only do the stream restoration, but to train the DPOA staff in techniques including terracing the streambank, installing erosion control, and planting and maintaining the native vegetation. The DPOA has received considerable positive feedback on the work on all three holes and, as a result of the training, Sentell and his team are now able to replicate the BMPs at other similar sites on both courses.

While BMP's of this nature are becoming more common on golf courses around the country, they are still relatively new to Mississippi. The partners wanted to be able to educate the public on the work done. To accomplish this, GCCDS designed signage to go at the tee box of each hole where a BMP was installed (See Image 4), sent out a press release that was picked up by several newspapers in Hancock and Harrison Counties (See Supporting Materials); and kept people informed through the Rotten Bayou Watershed Partnership's Facebook page. In addition, GCCDS coordinated a workshop in July 2015 for local leadership, landscaping and lawncare professionals, nursery owners and engineers who do work in Rotten Bayou Watershed. Participants were able to see the work done on holes one and two and learn how they can apply or encourage BMPs in their own professional or leadership roles.

The Coastal Project Coordinator with REACH (Research and Education to Advance Conservation and Habitat) has also been serving on the steering committee for the Rotten Bayou Watershed Partnership. REACH has been working primarily in the central and northern parts of the state with a focus on agriculture. Within the past couple of years REACH has been looking for opportunities to expand their work in South Mississippi. REACH was able to do some water quality monitoring before the BMPs were installed on the golf course and, as the vegetation becomes more established, is continuing to monitor the water quality at the sites. While conclusion data is not yet available from their monitoring efforts, it will be a valuable part of evaluating the effectiveness of the BMPs and may encourage more work to be done in other areas along the coast.

This project has been such a success due to the partnership between the Land Trust for the Mississippi Coastal Plain, the Gulf Coast Community Design Studio and the Diamondhead Country Club and Property Owners Association with assistance from the Water Resources Research Institute and monitoring through REACH. All three BMPs were accomplished with $1,800 in planning and design work and $5,900 in construction labor and materials. Educational signage for all three holes cost $900, bringing the total project budget to $8,600. Of the total project budget, $4,200 was grant funded and $4,400 was funded by the DPOA.

Appendix E: Diamondhead Cardinal Golf Course BMPs

Appendix E: Diamondhead Cardinal Golf Course BMPs

Example of educational signage at tee box

Cardinal cutouts mark location of each BMP

Diamondhead News

FEBRUARY 2015 www.diamondheadms.org VOL. 32, NO. 2

Diamondhead golf courses start off the new year green

Golfers will see new signage at the tee boxes of holes one, two and six of Diamondhead's Cardinal Golf Course as they get back to playing in the new year. The signage describes best management practices incorporated on these holes to improve drainage and water quality as stormwater flows over the golf course and eventually into Rotten Bayou. Changes include adding a dry swale, restoring a stream bed, and adding a field of native plantings in place of grass turf. In addition to the signs at the tee boxes, subtle cardinal silhouettes are located at each of the best management practices to direct golfers to the specific changes.

Since becoming Diamondhead Country Club's Golf Superintendent in September 2011, Brook Sentell, has been employing best management practices on Diamondhead's golf courses including applying slow-release fertilizer only when and where necessary and regularly having the soil tested through Mississippi State University's Extension Service. Since joining the Steering Committee of the Rotten Bayou Watershed Partnership, Sentell has also incorporated drainage improvements and native plantings into his renovation plan as recommended by the Partnership. "Not only will the modifications improve drainage and water quality," commented Sentell, "they will add interest to the golf course and reduce our maintenance costs."

Most of the work on the course has been done by Sentell and staff of the Diamondhead Country Club and Property Owners Association (DPOA), but on December 16th landscape architects and planners from Mississippi State University's Gulf Coast Community Design Studio worked with DPOA staff to restore the stream at hole two and provided training on stream restoration techniques. Work included terracing the stream bank, installing erosion control and rock weirs, and planting native grasses and irises. "I've received a lot of positive feedback on the work done and I hope to be able to make similar improvements to the Pine Course in the next year or so," commented Sentell.

The Land Trust for the Mississippi Coastal Plain and Mississippi State University's Gulf Coast Community Design Studio are facilitating the development of a watershed implementation plan for Rotten Bayou Watershed with the help of community leaders and residents. "The Land Trust for the Mississippi Coastal Plain has enjoyed working with the Rotten Bayou Watershed Implementation Team in helping to bring into reality the vision that the Rotten Bayou watershed residents hold for their community," says Judy Steckler, Executive Director of the Land Trust.

The watershed plan is to address water quality issues in Rotten Bayou and a large part of the work involves outreach and education including demonstration projects and signage such as those implemented on the golf course. The project is partially funded by a grant from the US Environmental Protection Agency to the Mississippi Department of Environmental Quality, Nonpoint Source (NPS) Branch under the provisions of Section 319(h) of the Clean Water Act along with State and local match. Planning, outreach and education activities will continue through the summer of 2015. Follow the progress of the Rotten Bayou Watershed Partnership on facebook at facebook.com/rottenbayou.

DIAMONDHEAD POA ANNUAL YOUTH FISHING RODEO

Saturday, March 7
at Twin Lakes Pavilion

Registration begins at 8 a.m.

DIAMONDHEAD MARDI GRAS PARADE

Krewe of Diamondhead's annual Mardi Gras parade rolls on Saturday, February 14th at 12noon. Parade route begins at the Community Center, goes down Gex Dr., turns left to the shopping area up to the fire station and then on to Golf Club Dr. to its destination at the Country Club.

NOTE: Items for the next issue of The Diamondhead News must be in the POA office no later than 3 p.m. on February 13

THE SEA COAST ECHO SATURDAY, JANUARY 10, 2015 • 7A

Sports

Diamondhead Country Club, Diamondhead Property Owners Assoc. and Rotten Bayou Watershed Partnership have partnered to improve drainage and water quality as stormwater flows over the golf course and eventually into Rotten Bayou.

Diamondhead golf courses start off the New Year 'green'

SEA COAST ECHO

Golfers will see new signage at the tee boxes of holes one, two and six of Diamondhead's Cardinal Golf Course as they get back to playing in the new year.

The signage describes best management practices incorporated on these holes to improve drainage and water quality as stormwater flows over the golf course and eventually into Rotten Bayou.

Changes include adding a dry swale, restoring a stream bed, and adding a field of native plantings in place of grass turf.

In addition to the signs at the tee boxes, subtle cardinal silhouettes are located at each of the best management practices to direct golfers to the specific changes.

Signs at the tee boxes and subtle cardinal silhouettes are located at each of the best management practices to direct golfers to the specific changes.

Since becoming Diamondhead Country Club's Golf Superintendent in September 2011, Brook Sentell has been employing best management practices on Diamondhead's golf courses including applying slow-release fertilizer only when and where necessary and regularly having the soil tested through Mississippi State University's Extension Service.

Since joining the Steering Committee of the Rotten Bayou Watershed Partnership, Sentell has also incorporated drainage improvements and native plantings into his renovation plan as recommended by the Partnership.

"Not only will the modifications improve drainage and water quality," commented Sentell, "they will add interest to the golf course and reduce our maintenance costs."

Most of the work on the course has been done by Sentell and staff of the Diamondhead Country Club and Property Owners Association (DPOA), but on Dec.16, landscape architects and planners from Mississippi State University's Gulf Coast Community Design Studio worked with DPOA staff to restore the stream at hole two and provided training on stream restoration techniques.

Work included terracing the stream bank, installing erosion control and rock weirs, and planting native grasses and irises.

"I've received a lot of positive feedback on the work done and I hope to be able to make similar improvements to the Pine Course in the next year or so," commented Sentell.

The Land Trust for the Mississippi Coastal Plain and Mississippi State University's Gulf Coast Community Design Studio are facilitating the development of a watershed implementation plan for Rotten Bayou Watershed with the help of community leaders and residents.

"The Land Trust for the Mississippi Coastal Plain has enjoyed working with the Rotten Bayou Watershed Implementation Team in helping to bring into reality the vision that the Rotten Bayou watershed residents hold for their community," says Judy Steckler, executive director of the Land Trust.

The watershed plan is to address water quality issues in Rotten Bayou and a large part of the work involves outreach and education including demonstration projects and signage such as those implemented on the golf course.

The project is partially funded by a grant from the US Environmental Protection Agency to the Mississippi Department of Environmental Quality, Nonpoint Source (NPS) Branch. Work will continue through summer of 2015.

the Keep Diamondhead Beautiful Committee, please contact the Diamondhead City Hall.

ROTTEN BAYOU WATERSHED PARTNERSHIP

Local leaders and professionals learn how to improve water quality from example set by Diamondhead Golf Superintendent

Local leaders, engineers, and landscaping and lawn care professionals from Diamondhead and Hancock and Harrison Counties met Tuesday, July 15th at the Diamondhead Country Club to see projects installed on the Cardinal golf course designed to improve drainage and water quality. The Rotten Bayou Watershed Partnership, led by the Land Trust for the Mississippi Coast Plain and Mississippi State University's Gulf Coast Community Design Studio, hosted the workshop as part of efforts to improve water quality and awareness in Rotten Bayou Watershed. As part of the workshop, participants learned how to apply techniques such as those used on the golf course, at home and through their work to help improve water quality in Rotten Bayou.

Diamondhead Golf Superintendent, Brook Sentell, has been employing best management practices on Diamondhead's golf courses such as applying slow-release fertilizer only when and where necessary and regularly having the soil tested through Mississippi State University's Extension Service. Since joining the Steering Committee of the Rotten Bayou Watershed Partnership, Sentell has also incorporated drainage improvements and native plantings into his renovation plan as recommended by the Partnership. "Not only will the modifications improve drainage and water quality," commented Sentell, "they will add interest to the golf course and reduce our maintenance costs." Designs for the projects were done by Cory Gallo of Mississippi State University Department of Landscape Architecture.

The Rotten Bayou Watershed (HUC 031700109-002) is 22,446 acres and lies in Hancock and Harrison Counties. Rotten Bayou itself is a tributary of the Bay of St. Louis and was listed on the EPA's 2006 Section 303(d) list of impaired waterbodies for organic enrichment, low dissolved oxygen, turbidity, and nutrient levels that did not meet water quality standards. The main contributors to these environmental stressors do not come from a single source and so require a holistic approach to developing solutions. Nonpoint source pollution can come from excess fertilizers, herbicides and insecticides from agricultural lands and residential areas; oil, grease and toxic chemicals from urban runoff; sediment from improperly managed construction sites, crop and forest lands, and eroding streambanks; and bacteria and nutrients from livestock, pet wastes and faulty septic systems.

The Land Trust for the Mississippi Coastal Plain and Mississippi State University's Gulf Coast Community Design Studio are facilitating the development of a watershed implementation plan for Rotten Bayou Watershed with the help of community leaders and residents. This project was partially funded by a grant from the US Environmental Protection Agency to the Mississippi Department of Environmental Quality, Nonpoint Source (NPS) Branch under the provisions of Section 319(h) of the Clean Water Act along with State and local match. Planning, outreach and education activities will continue through the summer of 2015. Follow the progress of the Rotten Bayou Watershed Partnership on facebook at facebook.com/rottenbayou.

DIAMONDHEAD VFW WILL HONOR VIET NAM VETERANS

Jerry L. Peppenger, Senior Vice Commander, VFW Post 2880, jpeppenger@cableone.net or 228-343-6221

The city of Diamondhead, MS has a number of veterans that exceeds 25

Continued on page 12

Appendix F: Diamondhead Duck Pond Demonstration Project

Diamondhead Duck Pond

Demonstration Project

Diamondhead, MS

Improve Water Quality and decrease sedimentation down stream

Create a welcoming aesthetic for the community

Provide a park atmosphere for community to enjoy

Decrease stormwater velocity and erosion of stream

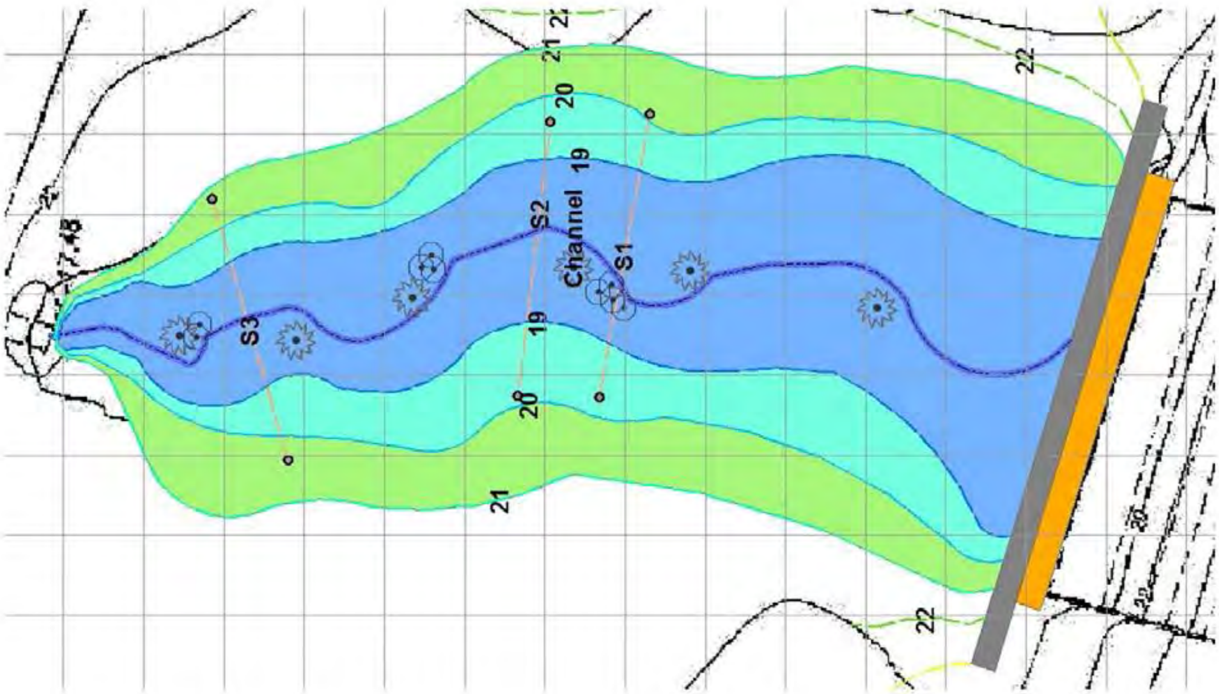
Provide education about native vegetation to use at home

Provide habitat for butterflies and songbirds

Components:

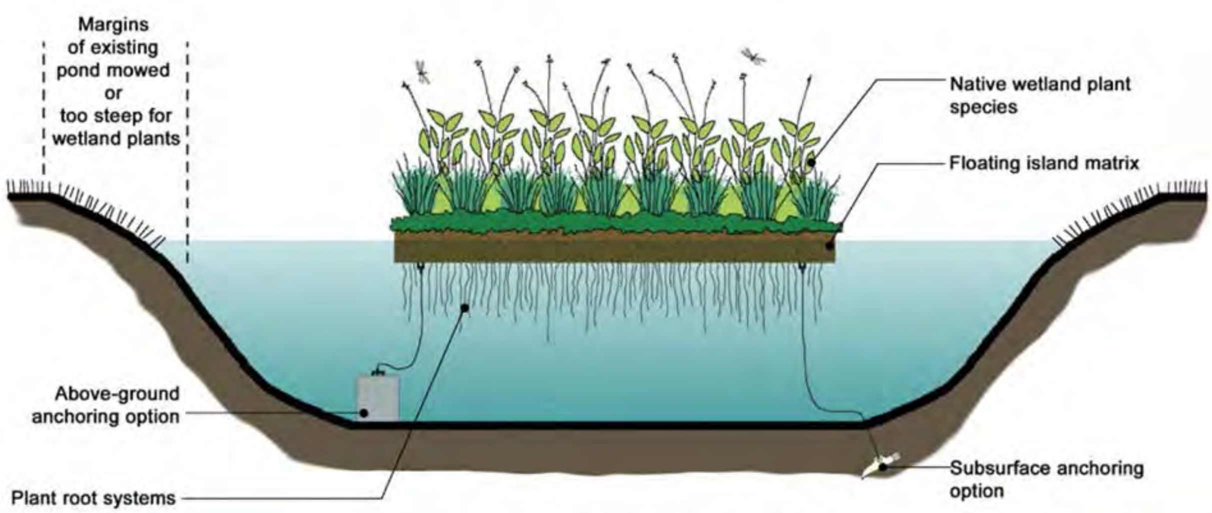
- Grading
- Floating Island
- Gabion Structure and Stepping Stones
- Mix of Native Vegetation and Trees
- Educational Signage at Deck Overlook

Appendix F: Diamondhead Duck Pond Demonstration Project



Floodplain image provided by Cypress Engineering

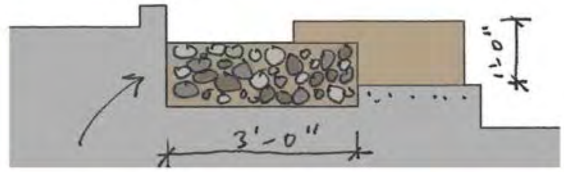
Grading



Floating Island

Appendix F: Diamondhead Duck Pond Demonstration Project

Gabion Structure and Stepping Stones



Native Vegetation and Trees

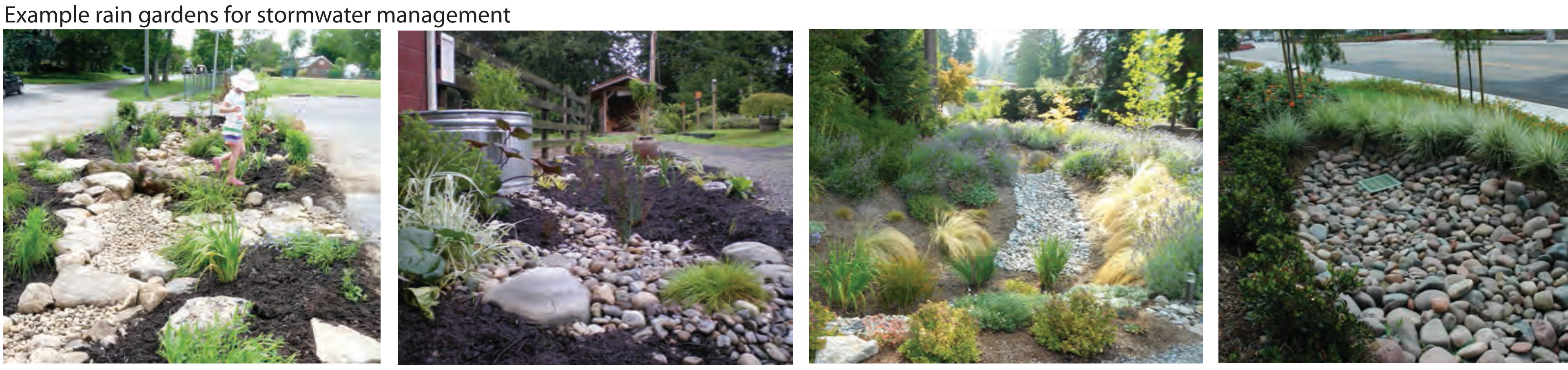
Scientific Name	Common Name
Acer barbatum	SOUTHERN SUGAR MAPLE
Cliftonia monophylla (Buddy Lee pink seedling)	BUCKWHEAT TREE
Cephalanthus occidentalis	COMMON BUTTONBUSH
Cyrilla racemiflora	SWAMP TITI
Itea virginica	VIRGINIA-WILLOW
Magnolia virginiana var. australis	SWEETBAY MAGNOLIA
Nyssa aquatica	WATER TUPELO
Oxydendrum aboreum	SOURWOOD
Styrax americanus	AMERICAN SNOWBELL
Taxodium distichum	COMMON BALDCYPRESS
Sagittaria lancifolia	BULLTONGUE
Pontederia cordata	PICKERELWEED
Iris x species	LOUISIANA IRIS
Hibiscus moscheutos	CRIMSON-EYED ROSEMALLOW
Crinum americanum	SWAMP LILY
Crinum americanum	SWAMP LILY
Rhynchospora colorata	STARRUSH SEDGE
Muhlenbergia capillaris	HAIRAWN MUHLY GRASS
Hymenocallis liriosme	SPIDER LILY
Pontederia cordata	PICKERELWEED

Appendix F: Diamondhead Duck Pond Demonstration Project

Rain Garden Plan view

Rain Garden Section View

Example rain gardens for stormwater management



South Mississippi plants for stormwater management

GCCDS Gulf Coast Community Design Studio Mississippi State University College of Architecture Art + Design

SACRED HEART CATHOLIC CHURCH - Stormwater Management Planning Rain Garden

Opportunity for Restoration & Recreation on Diamondhead Utility Easement

Problem *and* Opportunity: Significant erosion is occurring on the utility easement adjacent to Rotten Bayou primarily caused by lack of vegetation and regular ATV use. Utility easements are more frequently being utilized as habitat and nature/recreation trails to the benefit of communities and wildlife. The Utility easement in Diamondhead between Rotten Bayou and Twin Lakes presents an excellent opportunity for both restoration and recreation.

PHASE 1

Re-grade steep slopes to prepare soil for planting and stabilization.

Re-plant native plants for stabilize soil, reduce runoff, create habitat and beautify the area.

Place educational signage and work with law enforcement and property owner to eliminate ATV use on easement.

PHASE 2

Create trails appropriate for pedestrians and bicycles. This walkway and restoration project were designed and implemented by Anchor QEA. Salvaged telephone poles were diverted from a landfill to make this path to the beach. *Photograph by Sea Turtle.*

Introduce signage acknowledging partnerships and educating trail users about the environment.

Existing infrastructure at Twin Lakes provides space for parking and could be a gateway to the nature/recreation trail.

Potential Diamondhead City Hall Restoration and Demonstration Projects

Background: The City of Diamondhead currently has plans to address drainage issues on the north end of City Hall property (A). Unfortunately, due to the proximity to existing housing, this drainage area will have to be piped. The drainage area is part of a creek that feeds directly to Rotten Bayou and there are opportunities beyond that area that needs to be piped for creek restoration (B). In addition, there are remnants of an existing trail that could be enhanced for public use. In addition, the City has plans to install an additional parking lot on the north side of the building (C). This would be an excellent opportunity to demonstrate permeable paving. Finally, the area east of the building consistently floods during rain events and lack of vegetation has made the land susceptible to erosion (D). The space is currently not utilized, but has the potential to be a beautiful public area that can accommodate both stormwater and passive recreation.

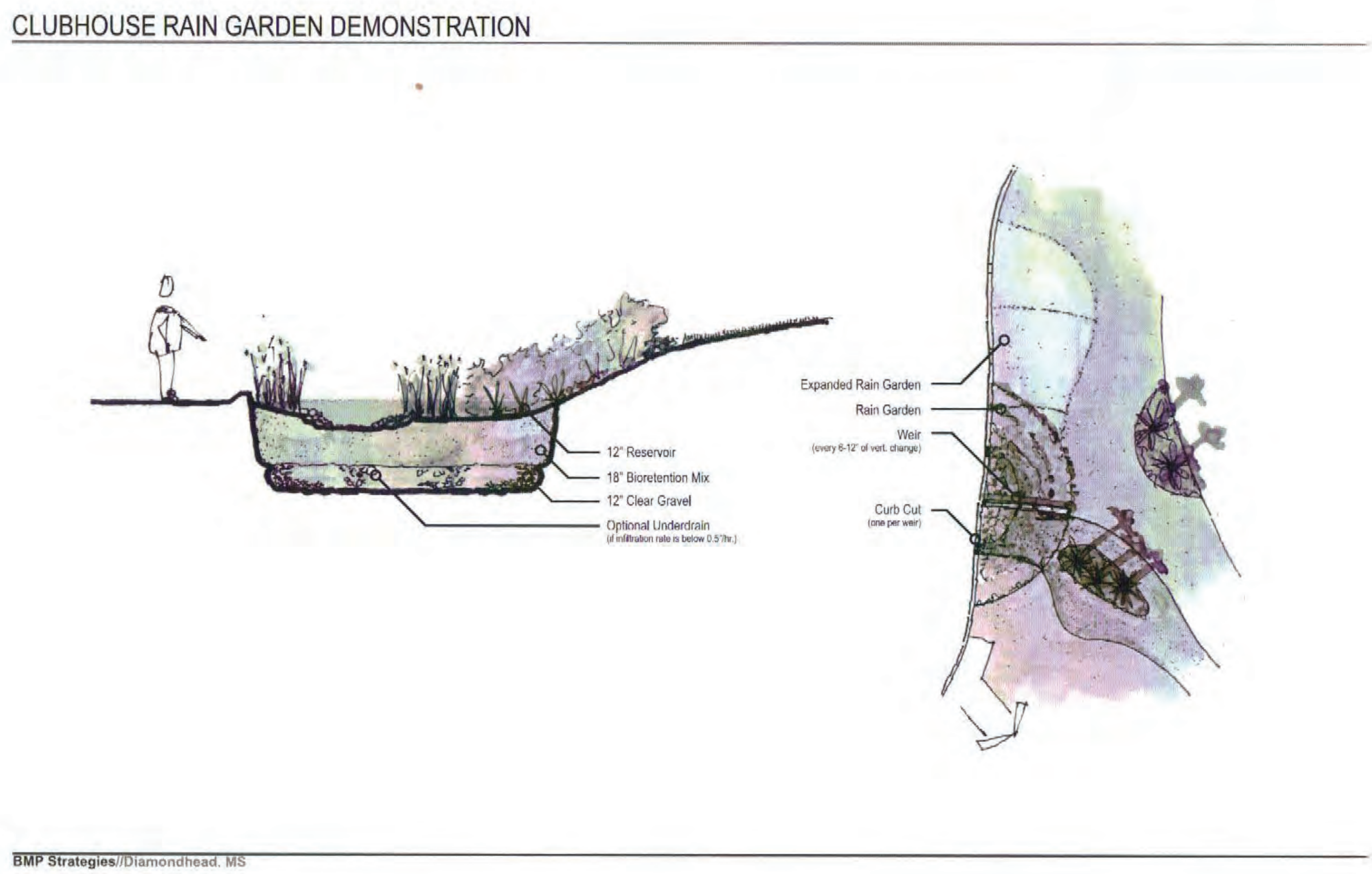
Plan Components:

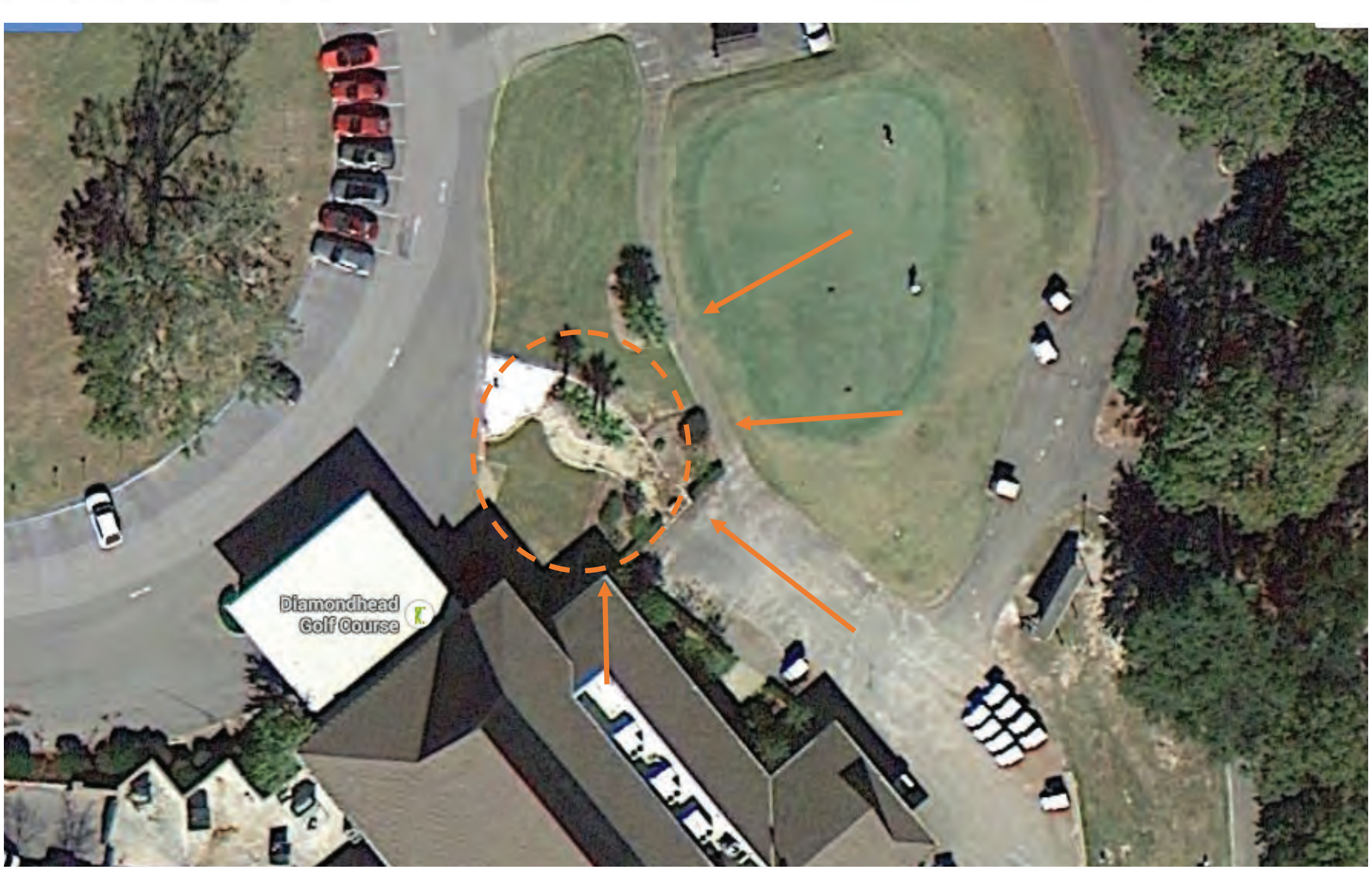
- Creek Restoration and Nature Trail
- Permeable Parking Lot
- Rain Lawn and Civic Space
- Educational Signage

Examples of Rain Gardens and Detention Lawns that serve as civic space:

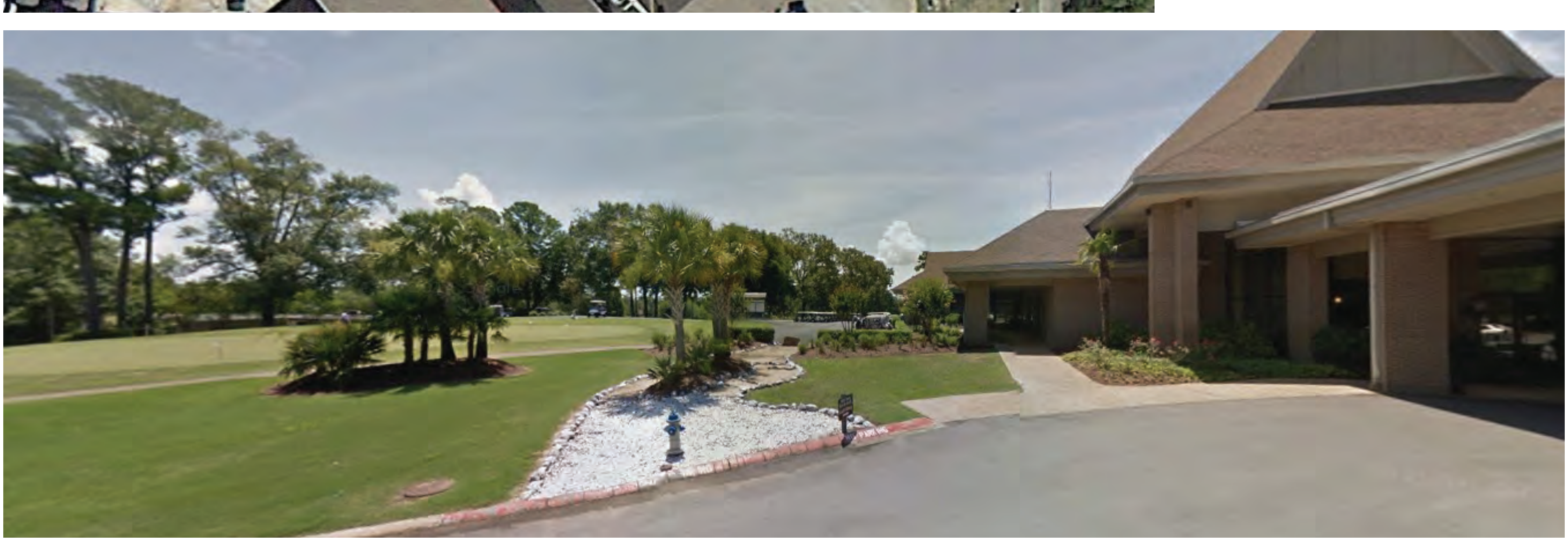
Potential Rain Garden and Kiosk at Diamondhead Country Club

The proposed rain garden, if expanded, would filter water off the cart parking lot, putting green and section of the club roof. An educational kiosk could compliment the design and serve to educate the public on the function of the rain garden and the additional BMPs installed on the golf course.





The initial design proposed by the Water Resources Research Institute would be expanded to capture drainage off the club roof and include an educational kiosk.



Appendix H: Management Actions

No.	Management Action	Watershed Management Category	Goals and Objectives	Cost Estimate*	Implementer and Potential Partners	Potential Funders	Milestones	Proposed Implementation Schedule (S < 5 Years, L > 5 Years)
1	Coordination of Rotten Bayou Watershed Partnership	Rotten Bayou Watershed Partnership	5a	$15,000 per year (includes salary and minimal cost of supplies)	Potentially GCCDS or LTMCP staff or intern	Grant and/or local business and municipal partners	Designate volunteer coordinator for Rotten Bayou Watershed Partnership	S
							Secure long-term funding source for coordinator of Rotten Bayou Watershed Partnership	L
2	Visual Survey	Data Gaps	1a, 1b	n/a or TBD at time services requested	Boy Scouts or other volunteer group. Gulf Coast Restore Corps or other semi-professional or professional group. Third party may be needed to help synthesis the data.	If funds are needed, most likely will need to be covered by a private sponsor.	Conduct survey before or at time of 5 year watershed assessment and plan revision	S
3	Study: Erosion and Sediment Delivery Rates	Data Gaps	1a	TBD at time services requested	Subcontractor with assistance from MDEQ	MDEQ with potential grant funding	Rotten Bayou Watershed Partnership to determine if this is feasible and a priority	S
4	Study: Primary Source(s) of Pathogens	Data Gaps	2b	TBD at time services requested	Subcontractor with assistance from MDEQ	MDEQ with potential grant funding	Rotten Bayou Watershed Partnership to determine if this is feasible and a priority	S

Appendix H: Management Actions

5	Utility Easement Habitat Restoration and Bayou Access	Priority Projects	1b, 1c, 4a, 4b, 5c	3 signs at $200 per sign	RBWP in partnership with Purcell Corporation, Diamondhead POA and Mississippi Power.	Mississippi Power or other interested party	Signage to stop ATV use on easement	S
				$10,000-$20,000/acres for regrading. $100-$250/acre for grassland restoration.	Will depend on who retains ownership. Regardless, should be in collaboration with the DPOA, City of Diamondhead and Mississippi Power. Design/environmental engineering services will need to be contracted.	Land donation or funding for land acquisition may be necessary to proceed. Certain grants (i.e. Tidelands Trust Fund Program) will pay for land acquisition and restoration activities. Other grants may pay for recreational trails including Five Star grants through National Fish and Wildlife	Regrading and habitat restoration	L
				$2,500/quarter mile of trail. $50,000-$60,000 for ADA accessible kayak launch including site prep and installation (ex. launch at Bayou Bogue Homa in Hancock County)			Trail development and kayak/canoe launch	L
6	City Hall Rain Lawn and Creek Restoration	Priority Projects	3c	$15/sq ft	City of Diamondhead in collaboration with Keep Diamondhead Beautiful. Design/environment al engineering	Some grants through Keep America Beautiful may apply along with funding sources listed in Management Action	Rain lawn and civic space	S
				$50/ft			Creek restoration	L
				$2,500/quarter mile of trail. $200 for signage			Trail development and signage	L
7	Country Club Rain Garden	Priority Projects	2a	$10/sq ft for the rain garden and $200 for signage	DPOA. Design/environmental engineering services will need to be contracted.	DPOA and/or possible grant funding.	Install rain garden and educational signage	S

Appendix H: Management Actions

8	Conservation	Conservation and Restoration	3b	Dependent on the property, donation or sales agreement, and extent of restoration needed.	LTMCP in coordination with the City of Diamondhead and DPOA.	Land donations and/or possible grant funding when tied to restoration. RESTORE funds may apply.	At least 1 property along Rotten Bayou put into conservation and providing bayou access	S
9	Living Shorelines	Conservation and Restoration	1b	n/a or TBD at time services requested	Management Action 2	If funds are needed, most likely will need to be covered by a private sponsor.	Determine priority areas through visual survey	S
				$3/plant/LF to $200/LF depending on wave energy and amount of hard stabalization needed	Private land owners	Property owner with possible grant funding or cost-share.	One high priority project implemented	L
10	Streamside Buffers	Conservation and Restoration	1b	n/a or TBD at time services requested	Management Action 2	If funds are needed, most likely will need to be covered by a private sponsor.	Determine priority areas through visual survey	S
				Forest Buffer: $200-700/acre to plant and maintain. Grass Buffer: $100-400/acres to plant and maintain.	Private land owners	Property owner, cost-share program through USDA or Mississippi Reforestation Tax Credit.	One high priority project implemented	L
11	Dredging and Beneficial Use	Conservation and Restoration	1c	Dependent on project	Will depend on project or property owner	DPOA, City of Diamondhead, Possible grant funding when connected to restoration	n/a	Ongoing

Appendix H: Management Actions

12	Bayou Access	Recreation and Ecotourism	4a	Dependent on the property and donation or sales agreement	City of Diamondhead and DPOA with possible support from LTMCP. Design/engineering services will need to be contracted before installing any supporting infrastructure.	Land donations and/or possible grant funding when tied to restoration. RESTORE funds maY apply.	Secure property for public access	S
				Overall cost may vary greatly depending on the property.		Grants available through National Fish and Wildlife Foundation, Mississippi Department of Wildlife, Fisheries and Parks, etc.	Install infrastructure and signage needed for access point	L
13	Blueway	Recreation and Ecotourism	4c	n/a	RBWP with support from LTMCP	Hancock County Chamber of Commerce, City of Diamondhead, DPOA. Five Star grant may apply.	Obtain political and community support	S
				Management Action 12	City of Diamondhead and DPOA with possible support from LTMCP.		Secure additional bayou access point (Management Action 12)	L
				$95/sign including post and installation. Signs are typically installed at every stream mile and points of interest.	LTMCP in coordination with the City of Diamondhead and Hancock County.		Implement signage along blueway	L
14	Effluent for Irrigation	Waste and Wastewater	2b	Minimal administrative expenses	DWSD, City of Diamondhead and DPOA with support from MDEQ	DWSD, City of Diamondhead, DPOA and possible grant opportunities	Identify infrastructure needed, costs and funding source(s) to use effluent to irrigate golf courses and other potential sites	L
				TBD			If feasible, implement plan to use effluent to irrigate golf courses	L

Appendix H: Management Actions

15	Curbside Recycling	Litter	2c, 5c	$3/month/resident	Hancock County, the City of Diamondhead and Hancock County Solid Waste Authority with support from the Mississippi Recycling Coalition	Residents and Jurisdictions	Curbside recycling reinstated in Hancock County	L
16	Trash Catches	Litter	2c, 5c	n/a	Keep Diamondhead Beautiful	City of Diamondhead and/or potential grant funding through Keep America Beautiful	Inventory and prioritize sites to install catches	S
				$50-$150 /stormdrain	City of Diamondhead and/or Keep Diamondhead Beautiful		Install 3 trash catches in high priority locations	S
17	Street Sweeping	Litter	2c, 5c	n/a	Keep Diamondhead Beautiful	n/a	Identify high priority roadways in watershed	S
				$105/curb mile if already own machine	Jurisdictions, MDOT and Keep Diamondhead Beautiful	Jurisdictions, MDOT	Petition jurisdiction to increase frequency and miles swept	S
18	Keep Diamondhead Beautiful Extension	Litter	2c, 5c	n/a	Keep Diamondhead Beautiful	n/a	Amended mission and scope of work	S

Appendix H: Management Actions

19	Adopt-a-Roadway	Litter	2c, 5c	n/a	Keep Diamondhead Beautiful	n/a	Identify high priority roadways in watershed	S
				One-time costs: $200/sign and est. $35/person for resusable supplies including a trash grabber, gloves and safety vest. Annual costs include $20/adopted roadway segment for trash bags. Jurisdictions will also need to pick up grarbage bags on the roadways after clean-up and may incure some minimal additional expenses.	Keep Diamondhead Beautiful and/or Jurisdictions	Jurisdictions and/or grant through Keep America Beautiful	Implement program with a goal of having 5 roadway segments adopted	S
20	Zoning Ordinance Amendment: Permeable Paving	Urban - Nonstructural	2a, 2c	Minimal administrative and/or legal expenses	City of Diamondhead	City of Diamondhead	Ordinance amendment	S
21	Stormwater Ordinance Amendments	Urban - Nonstructural	2a, 2b, 3a, 3c	Minimal administrative and/or legal expenses	City of Diamondhead	City of Diamondhead	Ordinance amendment	S
22	Building Code Amendment	Urban - Nonstructural	2c	Minimal administrative and/or legal expenses	City of Diamondhead	City of Diamondhead	Code amendment	S
23	Fertilizer Ordinance	Urban - Nonstructural	2a	Minimal administrative and/or legal expenses	City of Diamondhead	City of Diamondhead	Ordinance adoption	L

24	Coastal Technical Manual	Urban - Nonstructural	2a, 3a, 3c	Funding needed dependent on creation of new manual or adoption of existing manual.	MDEQ, MASGC, DMR	MDEQ, MASGC, DMR	Review current technical documents compared to newly revised Georgia Coastal Supplement	S
							Take action to revise existing or adopt Georgia Coastal Supplement	L
25	Urban Wildlife Population Control	Urban - Nonstructural	2b	n/a or TBD at time services requested	City of Diamondhead, MS Department of Wildlife, Fisheries and Parks, MSU Extensions	City of Diamondhead and/or MS Department of Wildlife, Fisheries and Parks	Determine need and cost	S
				$1,000 -$10,000 depending on extend of program			If significant need exist, pursue agreed upon course of action	L
26	Enforcement of Stormwater Pollution Prevention Plans	Urban - Structural	1a	Administrative Expenses. Potential need for additional staff or staff hours.	Jurisdictions, MDEQ	Jurisdictions, MDEQ	Increase monitoring and enforcement of SWPPPs	S
27	Drainage Swale Maintenance	Urban - Structural	1a, 2a, 3c	$1/foot annually	Jurisdictions with guidance from MDEQ/EPA	Jurisdictions	Jurisdictions to stop scouring ditches as part of regular maintenance	S
28	Rain Barrels	Urban - Structural	3c, 5b, 5c	$50-$150	Property owners	Property owners	Implemented on private property	Ongoing
29	Rain Gardens	Urban - Structural	3c, 5b, 5c	$3-$5/square foot	Property owners	Property owners	Implemented on private property	Ongoing
30	Logging and Forestry Ordinance	Rural - Nonstructural	1a, 3c	Minimal administrative and/or legal expenses	Hancock/Harrison County	Hancock/Harrison County	Adopt ordinance	L
31	Water and Sediment Control Basin	Rural - Structural	2a, 2b	$2,500-$7,000/each	Property owners	Property owner or cost-share program through USDA.	Implemented on private property	Ongoing

32	Heavy Use Area Protection	Rural - Structural	2a, 2b	$1,000-$5,000/each	Property owners	Property owner or cost-share program through USDA.	Implemented on private property	Ongoing
33	Fencing	Rural - Structural	2a, 2b	$1.50-$5.00/foot	Property owners	Property owner or cost-share program through USDA.	Implemented on private property	Ongoing
34	Pond (Alternative Water Source)	Rural - Structural	2a, 2b	$2,500-$7,000/each	Property owners	Property owner or cost-share program through USDA.	Implemented on private property	Ongoing
35	Critical Planting Area	Rural - Structural	2a, 2b	$250-$400/acre	Property owners	Property owner or cost-share program through USDA.	Implemented on private property	Ongoing
36	Tank/Trough	Rural - Structural	2a, 2b	$200-$700/each	Property owners	Property owner or cost-share program through USDA.	Implemented on private property	Ongoing
37	Facebook Page	Education and Outreach	5b, 5c	n/a	Rotten Bayou Watershed Partnership	n/a	Page maintained and number of likes increased	Ongoing
38	MS Coastal Cleanup	Education and Outreach	2c, 5c	n/a	Hancock County coordinator for MS Coastal Cleanup and Rotten Bayou Watershed Partnership	Funding provided by MDMR and other sponsors	Increased participation and stream miles cleaned	Ongoing
39	Projects for Scout Troops	Education and Outreach	1a, 1b, 5a, 5c	n/a	Boy Scout Troops	n/a	At least 2 local scouts achieving their Soil and Water Conservation Badge through projects that apply to Rotten Bayou Watershed	S

40	Septic System Maintenance Education	Education and Outreach	2b, 5b, 5c	Only the cost of printing if tied in with a regular mailing through the county or other agency or utility company.	Harrison County, MS Department of Health and Human Services, other agency or utility company who may include information in regular newsletter or mailer.	Harrison County and/or Department of Heath and Human Services	Annual mailing	S
41	Pet Waste Education	Education and Outreach	2b, 5b, 5c	$0 or cost of printing if included in regular mailing or newsletter or distributed at local pet-related businesses such as veterinary clinics	DPOA, Jurisdictions, Keep Diamondhead Beautiful and local pet-related businesses	Possible grant funding available through Keep America Beautiful	1 educational ad, mailer or flier distributed in each jurisdiction	S
42	Pet Waste Signage and Receptacles	Education and Outreach	2b	n/a	RBWP and/or Keep Diamondhead Beautiful	DPOA and Jurisdictions. Possible grant funding available through Keep America Beautiful	Identify high priority locations within the watershed.	S
				$200-$600 per receptacle/sign combination	DPOA, Jurisdictions, Keep Diamondhead Beautiful		Install at least 5 receptacles with signage	S

Appendix H: Management Actions

43	Education in Schools	Education and Outreach	5b, Indirectly accomplishes other water quality goals 1-3	$160 per field trip for water quality monitoring at East Hancock Elementary.	East Hancock Elementary School	East Hancock Elementary School	B-Wet program implemented at East Hancock Elementary annually with at least 1 field trip.	S
				$1,000 per Bayou Town Production Show. MDOT anti-litter education program provided at no cost.	Schools in partnership with Bayou Town Productions, MDOT or other watershed/anti-litter education groups	Schools, MDEQ and/or possible grant through Keep America Beautiful.	2 general watershed education and anti-litter education programs brought to East Hancock Elementary and Delisle Elementary	S
				Approx. $30K to bring B-Wet program to Delisle Elementary.	GCCDS	DMR education grants may apply	B-Wet program brought to Delisle Elementary	L
44	Promote Use of Native Plants	Education and Outreach	5b, Indirectly accomplishes other water quality goals 1-3	n/a	Diamondhead Garden Club, Pine Hills Nursery, Keep Diamondhead Beautiful and other civic organizations or business with an interest in landscape	n/a	Promote use of native plants through social media, member meetings and community projects	Ongoing

45	Establish More Connections with County Residents	Education and Outreach	5a, 5b	n/a	RBWP	n/a	Recruit at least 2 new members to the Rotten Bayou Watershed Partnership who represent county community or civic organizations	S
				Cost depends on project chosen. $50-$150 per rain barrel. $10 per sq ft for rain garden.	Potential partners include Sacred Heart Catholic Church and Knights of Columbus	county partner, private sponsor and/or grant funding may be available.	Work with county partner to implement 1 residential-focused demonstration project	L
46	Workshops with Local Leadership	Education and Outreach	5b, Indirectly accomplishes other water quality goals 1-3	$1,500-$5,000 depending on cost of venue and number of attendees	MDEQ, MASGC, DMR	MDEQ, MASGC, DMR	1 workshop on swale maintenance and 2 workshops on adopting and enforcing ordinances	S

*All prices will vary depending upon the site preparation needed, contractor pricing, and the market for the products that will be needed to install the Best Management

January 7, 2015

Proposed Zoning Code Amendment Regarding Allowance of Permeable Paving Options

I. **Initiator of Amendment:** Gulf Coast Community Design Studio, as part of the Rotten Bayou Watershed Partnership

II. **Intent of Ordinance Amendment:** To update the standards related to parking and driveway surfacing requirements to better align with the City's goals, objectives and policies.

III. **Appropriate Sections of Zoning Code:**

Article 8.4 DESIGN STANDARDS FOR OFF-STREET PARKING FACILITIES
Article 8.5 OFF STREET LOADING FACILITIES

IV. **Background:**

The Land Trust for the Mississippi Coastal Plain and Mississippi State University's Gulf Coast Community Design Studio are facilitating the development of a watershed implementation plan for Rotten Bayou Watershed with the help of community leaders and residents. Rotten Bayou is a tributary of the Bay of St. Louis and a significant asset to the City of Diamondhead. As a result of concerns regarding organic enrichment, low dissolved oxygen, turbidity, and nutrient levels that did not meet water quality standards, Rotten Bayou was listed on the EPA's 2006 Section 303(d) list of impaired waterways. This designation triggered the need for a watershed implementation plan to outline steps to improve water quality.

A preliminary review of US Geological Survey (USGS) water quality data by environmental and engineering consulting firm, Anchor QEA, suggests that current nutrient levels are not exceedingly high, but do increase during storm events especially coming from the parts of Diamondhead within the watershed (most of the area north of I-10). These findings imply that the area actually has a relatively good standing in terms of water quality, but that any new development has the potential of pushing those nutrient levels higher. The prevalence of impervious surfaces associated with development increases stormwater runoff and the potential for flooding, erosion and pollutants entering the waterways.

Currently, the City's zoning ordinance does not allow for pervious paving options in commercial parking areas, loading facilities or access drives. By allowing and even encouraging the use of pervious paving options the City would be furthering the environmental goals established in the 25 Year Comprehensive Plan and taking necessary steps to protect water quality in Rotten Bayou and the watershed. The following proposed amendment seeks to allow for pervious paving while addressing the City's concerns about ADA compliance and long-term maintenance.

Because the proposed changed would allow for, but not require, permeable paving, the change would not cost the city or deter future development.

V. **Relationship to Comprehensive Plan:**

Goal 2: Guide and direct development in a manner which is sensitive and responsible with respect to the natural environment and natural resources.

Objective 2.1: Provide an incentive for developers and land owners to preserve environmentally sensitive areas and to employ development techniques which result in the conservation of natural resources or otherwise benefit the natural environment.

Goal 18: Develop or encourage building practices, services or procedures within Diamondhead that serve to enhance the natural environment by conserving energy and natural resources.

Policy 18.4.1: Diamondhead will encourage the use of rain barrels, solar panel systems, pervious paving systems, swales and other similar practices as a means to conserve resources.

Objective 18.5: Implement city programs designed to enhance environmental quality.

VI. **Proposed Amendment:** *Underlined text represents additions to existing ordinance.*

8.4 DESIGN STANDARDS FOR OFF-STREET PARKING FACILITIES
8.4.1 General Requirements

A. Surfacing of all parking facilities shall be concrete, asphaltic concrete, or asphalt and all parking facilities shall be properly graded for drainage and maintained in a good condition, free of weeds, dust, trash and debris, potholes or other surface failures. Pervious pavement or pervious pavement systems are allowed subject to the provisions of Article 8.4.9.

. . .

8.4.9 Pervious pavement or pervious pavement systems. Pervious pavement or pervious pavement systems, capable of carrying a wheel load of four thousand (4,000) pounds, including pervious asphalt, pervious concrete, modular pavers designed to funnel water between blocks, lattice or honeycomb shaped concrete grids with turf grass or gravel filled voids to funnel water, plastic geocells with turf grass or gravel, reinforced turf grass or gravel with overlaid or embedded meshes, or similar structured and durable systems are permitted. Gravel, turf, or other materials that are not part of a structured system designed to manage stormwater shall not be considered pervious pavement or a pervious pavement system. Pervious pavement and pervious pavement systems shall meet the following conditions:

A. All materials shall be installed per industry standards. Appropriate soils and site conditions shall exist for the pervious pavement or pervious pavement system to function. Documentation that verifies appropriate soils and site conditions shall be provided. For further guidance and technical assistance, please refer to the following source: Georgia Stormwater Management Manual: Volume 2 Technical Handbook.

B. All materials shall be maintained per industry and city standards. Damaged areas shall be promptly repaired. Gravel that has migrated from the pervious pavement systems onto adjacent areas shall be swept and removed regularly.

C. Pervious pavement or pervious pavement systems, except for pervious asphalt or pervious concrete, shall not be used for accessible parking spaces or the accessible route from the accessible space to the principal structure or use served.

D. Pervious pavement or pervious pavement systems shall be prohibited in areas used for the dispensing of gasoline or other engine fuels or where hazardous liquids could be absorbed into the soil through the pervious pavement or pervious pavement system.

E. Pervious pavement or pervious pavement systems that utilize turf grass shall be limited to overflow parking spaces that are not utilized for required parking and that are not occupied on a daily or regular basis.

F. Pervious pavement or pervious pavement systems used for parking or associated drive aisles or driveways shall count as impervious surface for the purposes of impervious surface coverage in any zoning district that has a maximum impervious surface limit or percentage, except where a pervious pavement system utilizing turf grass is provided for a fire access lane that is independent of a parking lot.

G. Pervious pavement or pervious pavement systems shall not allow parking spaces, drives aisles, or driveways to be located anywhere not otherwise permitted by the regulations of this zoning ordinance and the district in which it is located.

H. Parking areas shall have the parking spaces marked as required by this article except that pervious pavement systems that utilize gravel or turf may use alternative marking to indicate the location of the parking space, including, but not limited to, markings at the end of spaces on the drive aisle or curbing, wheel stops, or concrete or paver strips in lieu of painted lines.

. . .

8.4.2 Parking Space Geometry.

E. Pedestrian walks shall be located between every other (alternating) parking bay, a parking bay being the vehicular access aisle and parking spaces on one or both side served by it. If parking bays exceed three hundred (300) feet in length without vehicular access to adjacent bays or to another drive or street, a pedestrian walk shall be provided between each parking bay. Required pedestrian walks shall have a four foot (4’) clear width and such width shall be protected and maintained by curbs or wheel guards. All pedestrian walks shall be paved and maintained free of standing water. Pervious asphalt or pervious concrete may be used as an alternative to concrete, asphaltic concrete, or asphalt subject to the provisions of Article 8.4.9.

. . .

8.5.2 Construction and Maintenance

B. They shall be graded for drainage, surfaced with concrete, asphaltic concrete, or asphalt and maintained in good condition free of weeds, dust, trash and debris and be free from potholes or other signs of surface failure. Pervious pavement or pervious pavement systems are allowed subject to the provisions of Article 8.4.9.

VII. Examples of Pervious Paving

Pervious Concrete


Photo: Bank at the corner of Porter Ave. and Robertson St. in Biloxi

Modular Pavers


Photo: Behind the Biloxi Civic Center and Library (580 Howard Ave.). Modular pavers are currently being installed by the City of Biloxi at Lighthouse Park at Hwy 90 and Porter Ave.)

Lattice or Honeycomb Concrete Grids


Photo: Ohr O'Keefe Museum of Art (386 Beach Blvd., Biloxi). Also installed at the Biloxi Yacht Club (408 Beach Blvd., Biloxi).

Reinforced Turf Grass

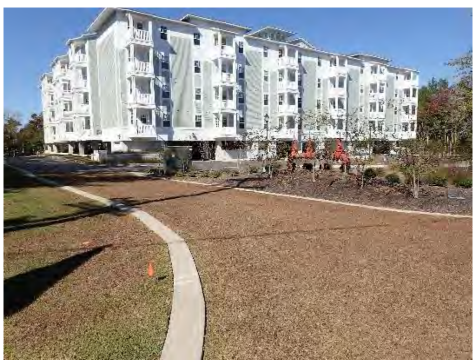
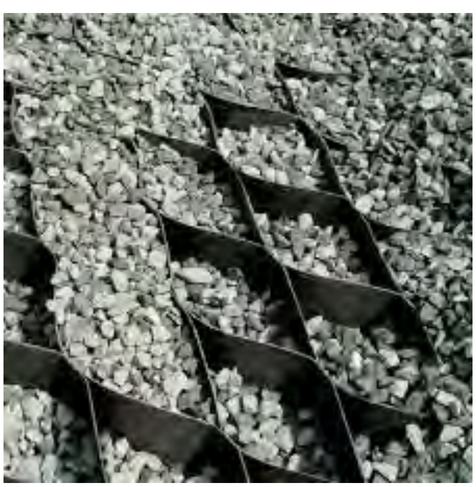



Photo: Riverside (12420 Lamey Bridge Rd., Diberville)

Plastic Geocells




City of Diamondhead

Recommended Changes to the Stormwater Ordinance

January, 6 2015

Prepared by the Mississippi Water Resources Research Institute for the Rotten Bayou Watershed Plan

Recommendation 1

Make the following addition to the building code.

Reference: Mandeville, LA

Reason: Would not allow complete filling of a residential lot, which reduces the area water can be stored within the watershed and may increase flood risk downstream.

Grading Supplement

No fill shall be placed outside the roof line and or soffit area of the principal building or accessory structure(s) including parking lots except as provided herein. A maximum of two (2) feet of fill material is allowed under the roof line and or soffit area of the principle building without retainer methods of construction. If more than two (2) feet of fill are used, retainer methods of construction shall be required beyond the initial twenty four (24) inches allowed. When fill material is proposed for an attached garage, which is attached to the principle building by common wall and the roof, the finished floor elevation shall be no greater than thirty two (32) inches above existing grade. Fill for all structures (foundations, improvements that require fill material shall taper from the edge of the improvement at a slope of three horizontal feet for every one vertical foot (3:1). In any case, this fill shall not extend out from any improvement or foundation more than six (6) feet. No fill shall be placed within three (3) feet of the property line. No fill shall be allowed around existing trees which are required to remain and no fill shall be allowed around existing trees which are required to remain and no fill shall be allowed in any vegetative protection zone. Driveways, parking lots, and detached accessory structures shall be arranged on the site in a manner that minimizes the alteration or disturbance to existing grades and natural drainage patterns. At completion, a final certificate from a Mississippi Licensed Civil Engineer shall be furnished by the owner stating that the lot was graded accordingly before occupancy is granted.

Beginning at the property line, the lot shall slope upwards not less than 1 inch in 20' away from the receiving drainage facility unless an alternate slope is approved by the Building Inspector. Such drainage to be submitted by a Mississippi Licensed Land Surveyor or Civil Engineer that states the drainage meets all state and local codes not to inundate adjacent property.

Recommendation 2

Add the following definition to the stormwater ordinance.

Reference: Center for Watershed Protection

Reason: The term "redevelopment" is used in proposed Article 7.0 Section B, Part A) of the stormwater ordinance.

<u>Redevelopment</u>. A change to previously existing, improved property, including but not limited to the demolition or building of structures, filling, grading, paving, or excavating, but excluding ordinary maintenance activities, remodeling of buildings on the existing footprint, resurfacing of paved areas and exterior changes or improvements that do not materially increase or concentrate stormwater runoff or cause additional nonpoint source pollution.

Recommendation 3

Make the following changes to Article 6.0 Section A, first and second bullets, of the stormwater ordinance.

Reference: Ocean Springs, MS

Reason: This change would align with MDEQ permit language and be consistent with other communities in the area.

Existing:

- 0 < 10,000 square feet of land disturbed: No permit or SWPPP currently required unless the disturbance is part of a Larger Common Plan of Development or Sale. A SWPP may be requested or required if there are complaints or nuisance conditions.
- 10,000 square feet of land disturbed: Permit required from City of Diamondhead Code Enforcement Office (See Appendix). A Small Construction Notice of Intent (NOI) and SWPPP must be submitted to the Planning Department (See Appendix B and C for examples).

Proposed:

- 0 < 1 ac. of land disturbed: No permit or SWPPP required unless the disturbance is part of a Larger Common Plan of Development or Sale. However, stormwater pollution prevention should be considered during any land disturbance activity, and a SWPPP may be requested or required if there are complaints or nuisance conditions.
- 1 ac. < 5ac. of land disturbed: Permit required from City of Diamondhead Code Enforcement Office (See Appendix). A Small Construction Notice of Intent (NOI) and SWPPP must be submitted to the Planning Department (See Appendix B and C for examples).

Recommendation 4

Remove the first sentence of Article 9.0 of the stormwater ordinance.

Reason: The sentence states that the agency (city) will adopt BMPs for water quality. By keeping the rest of the section, the ordinance protects the city but doesn't require it to say how it's met thereby putting the responsibility on the developer.

~~The Board or their authorized enforcement agency will adopt requirements identifying Best Management Practices for any activity, operation, or facility which may cause or contribute to pollution or contamination of stormwater, the storm drainage system, or waters of the U.S.~~ The owner or operator of a commercial or industrial establishment shall provide, at their own expense, reasonable protection from accidental discharge of prohibited materials or other wastes into the municipal storm drainage system or watercourses through the use of these structural and non-structural BMPs. Further, any person responsible for a property or premise, which is, or may be, the source of an illicit discharge, may be required to implement, at said person's expense, additional structural and non-structural BMP's to prevent the further discharge of pollutants to the municipal separate storm sewer system. Compliance with all terms and conditions of a valid NPDES permit authorizing the discharge of stormwater associated with industrial activity shall be deemed compliant with the provisions of this section. These BMPs shall be part of a Stormwater Pollution Prevention Plan (SWPPP) as necessary for compliance with requirements of the NPDES permit.

All post-construction BMPs and landscaping designed for the control or management of stormwater runoff and the control of erosion or sediment shall be maintained and cannot be developed for any other use which would limit or cause to limit the use of the improvements. Responsibility and maintenance of these improvements shall follow the Ownership of the property. Each property owner shall be liable within the contents of his deed for the maintenance of the improvements and must sign a Post-Construction Maintenance Agreement with the City. A special note to this effect shall appear on any final plat of subdivision. Before granting final approval for the project, the Board of Alderman must place the Post-Construction Maintenance Agreement on the agenda of a regular meeting of the Board for approval.

Post-construction BMPs in place and operational prior to the adoption of this ordinance shall be subject to execution of a maintenance agreement between the property owner and the city. In these instances, adoption and approval of the maintenance agreement shall follow the same procedures established herein for new construction or development.

Recommendation 5

Make the following changes to Article 7.0 Section B, Part A) of the stormwater ordinance.

Reason: The existing language places the responsibility on the city to ensure that a downstream analysis is completed and would require a potentially costly analysis of the downstream watershed. The proposed language creates three levels of compliance and requires specific and reasonable levels of flood protection.

Existing:

A. It is prohibited to place fill material or construct impervious cover or construct or place any other structure on such person's property or perform any excavation or grading in a manner, which alters the flow of surface water across said property in a manner which damages any adjacent property.

1. No final subdivision plat, subdivision construction plan, site plan or building permit shall be approved by the City unless it can be demonstrated by the owner or developer of such property that the proposed development will not result in damage to any adjacent or downstream property. This will be certified by a professional engineer's submittal of sufficient data and calculations based upon the 2-year, 5-year, 10-year, 25-year and 50-year 24-hour storm events.

Proposed:

A. It is prohibited to place fill material or construct impervious cover or construct or place any other structure on such person's property or perform any excavation or grading in a manner, which alters the flow of surface water across said property in a manner which damages any adjacent property.

1. Sites with 20,000 square feet or more of impervious cover created, added, or replaced for redevelopment must protect downstream overbank flood and property protection by controlling the post-development peak discharge rate to the pre-development rate for the 2-year, 24-hour storm events.
2. Site greater than 1 acre in size with 20,000 square feet or more of impervious cover created, added, or replaced for redevelopment must provide downstream overbank flood and property protection by controlling the post-development peak discharge rate to the pre-development rate for the 2- and 5-year, 24-hour storm events, and demonstrate that the 100-year storm can safely pass through the site without creating damaging conditions downstream.
3. Site greater than 5 acres in size with 40,000 square feet or more of impervious cover created, added, or replaced for redevelopment must provide downstream overbank flood and property protection by controlling the post-development peak discharge rate to the pre-development rate for the 2-, 5-, 10-, 25-year, 24-hour storm events, and demonstrate that the 100-year storm can safely pass through the site without creating damaging conditions downstream.

Recommendation 6

Make the following changes to Article 7.0 Section B, Part B) of the stormwater ordinance.

Reason: The proposed section gives specific references for standards for the various types of BMPs that could be used and also encourages better site design and green infrastructure solutions, which are better for the environment and the watershed. The list of references should be reviewed and added to as necessary.

Existing:

B. The above requirement shall be accomplished through one or more of the following options:

1. Design and construction of an on-site stormwater detention facility, or facilities, by the landowner or developer which limits the peak flood flows from the proposed development to the existing peak flood flows from the subject tract.

2. Construction of, or participation in the construction of, off-site drainage improvements, such as storm inlets, storm sewers, culverts, channel modifications, land filling, and/or other drainage facilities such that the peak flood flows for fully-developed watershed conditions from the watershed area in which the proposed development is located will be sufficiently and safely passed without flooding of adjacent and downstream property and roadways. Because this option alone does not assist the City with maintaining pre-development run-off conditions, it must be used in conjunction with the first or third option outlined in this section.

3. Design and construction of the development by certified engineering data and calculations utilizing limited impervious cover, infiltration of runoff from impervious cover via flow through pervious areas, and/or grass-lined swales or channels such that these measures result in a minimal increase in peak flood flows from the development.

4. All on-site stormwater detention facilities shall be designed to adequately and safely pass all stormwater inflows, including flood flows and runoff from upstream and adjacent properties that have natural and/or existing overland flows toward and onto the subject tract. The on-site stormwater detention facilities should not impound stormwater onto or cause backwater to inundate any upstream or adjacent properties in excess of existing conditions.

Proposed:

B. The above requirement shall be accomplished through one or more of the following options:

1. Better Site Planning and Design which involves using site design techniques during the site planning and design process that help to minimize land disturbance and reduce the creation of new impervious and disturbed land cover. Techniques include reducing clearing and grading limits, reducing roadway lengths and widths, and reducing parking lot and building footprints. It also aims to protect valuable aquatic and terrestrial resources from impacts of the land development process. This should protect primary and secondary conservation areas.

For further guidance and technical assistance, please refer to the following source:

Georgia Coastal Stormwater Supplement

Section 4.3- Site Planning and Design Criteria

2. Green Infrastructure Practices which used to protect valuable terrestrial and aquatic resources from the direct impacts of the land development process, maintain pre-development site hydrology and reduce post- construction stormwater runoff rates, volumes, and pollutant loads.

For further guidance and technical assistance, please refer to the following source:

Georgia Coastal Stormwater Supplement

Section 7.8- Low Impact Development Practices Profile Sheets

3. Detention which is the temporary storage of storm runoff in a stormwater BMP with the goals of controlling peak discharge rates and providing gravity settling of pollutants.

For further guidance and technical assistance, please refer to the following sources:

Georgia Coastal Stormwater Supplement

Section 8.6.1- Stormwater Pond

Section 8.6.2- Stormwater Wetlands

Section 8.6.3- Bioretention Areas

Georgia Stormwater Management Manual: Volume 2 Technical Handbook

Section 3.4.1- Dry Detention/ Dry Extended Detention Basins

Section 3.4.2- Multi-Purpose Detention Areas

Section 3.4.3- Underground Detention

Mississippi Department of Environmental Quality Handbook for Erosion Control, Stormwater Control, and Stormwater Management on Construction Sites and Urban Areas: Volume 2 Stormwater Management

Chapter 3: Retention/Detention

Recommendation 7

Add the following section as Article 7.0 Section B, Part C) of the stormwater ordinance.

Reason: If a site discharges directly into a reviving water detention is not necessary and should be waived. This language should be modified for the specific conditions in Diamondhead.

Proposed:

C. Detention requirements may be waived on any site that discharges directly to a flood plain, Gulf, or major river or waterbody, and the City of Diamondhead determines that waiving the flooding criteria will not harm public health and safety. The applicant shall secure drainage easements from any downstream property owners across whose property the runoff must flow to reach the flood plain, Gulf, major river, or waterbody. The applicant shall also demonstrate that any piped or open-channel system in which the runoff will flow has adequate capacity and stability to receive the project's runoff plus any off-site runoff also passing through the system.

Recommendation 8

Remove Article 7.0 Section C, Part (c) 6 of the stormwater ordinance.

Reference: Ocean Springs, MS

Reason: The section relies on MS4 language which Diamondhead is not a part of.

Proposed:

~~This permit authorizes the following non-storm water discharges provided: (1) they do no cause or contribute to a violation of water quality standards, (2) the Executive Director of the Mississippi Department of Environmental Quality (MDEQ) has determined these sources entering the MS4 are not a substantial cause or contributor of pollutants entering the Municipal Separate Storm Sewer System (MS4) that may violate applicable state or federal laws, regulations, or criteria, (3) the regulated entity has determined these sources entering the MS4 are not a substantial contributor of pollutants entering the MS4 that may violate applicable state or federal laws, regulations, or criteria, and (4) the regulated entity is implementing the Storm Water Management Program as set forth in ACT5 as set forth in the MS4 General Permit.~~

Florida Department of Environmental Protection

MODEL ORDINANCE FOR FLORIDA-FRIENDLY FERTILIZER USE ON URBAN LANDSCAPES

[alternate title: **MODEL ORDINANCE FOR FLORIDA-FRIENDLY USE OF FERTILIZER ON URBAN LANDSCAPES]**

2015

[Note: Title revision for clarity. There is no defined Florida-Friendly fertilizer product, as timing, chemistry, grade, amount, site-specific conditions and application practices all affect "Florida-friendliness".]

INTRODUCTION

This attached Model Fertilizer Use Ordinance is another tool to reduce sources of nutrients coming from urban landscapes to reduce the impact of nutrients on Florida's surface and ground waters. Limiting the amount of fertilizer applied to the landscape will reduce the risk of nutrient enrichment of surface and ground waters, but effective nutrient management requires more comprehensive control measures. Such a comprehensive approach is needed that may include, but is not limited to, land planning and low-impact development, site plan design, landscape design, irrigation system design and maintenance, fertilizer application, landscape maintenance, and waste disposal. To assist local governments in improving their existing land development regulations, several "model" ordinances have been developed. These include:

- "Low Impact Design" ordinances which seek to reduce the impact of urbanization on our natural resources by stressing "source controls" that either minimize the generation of stormwater or minimize the pollutants that can get into stormwater. For example, promoting development designs that minimizes clearing of natural vegetation and the compaction of urban soils. A Model Springs Protection Code was developed by DCA, DEP, and other stakeholders that includes specific Land Development Regulation recommendations that promote Low Impact Design. This Model Code is available as Chapter 5 in Protecting Florida's Springs: An Implementation Guidebook. It is available at http://www.dca.state.fl.us/fdcp/DCP/springs/index.cfm.

- "Landscape Ordinances" because design, construction, and maintenance are major determinants in the amount of fertilizer and irrigation that is needed to maintain healthy urban landscapes and minimize adverse impacts on water resources. A model Landscape Ordinance entitled "Guidelines for Model Ordinance Language for Protection of Water Quality and Quantity Using Florida-Friendly Lawns and Landscapes" was developed by a group of agencies, industries, and interest groups over a two year period and published in 2003. It was fundamentally an adaptation of earlier water conservation ordinances revised to include water quality protections for compliance with Total Maximum Daily Load (TMDL) or stormwater NPDES permit requirements. The language focused on continuing education of lawn care and landscape professionals, proper planning and supervision during development and construction, and the use of best management practices, including the Florida-

Friendly Landscape Program. This model ordinance has been renamed "Florida-Friendly Landscaping™ Model Guidelines for Ordinance Language for Protection of Water Quality and Quantity," updated in 2008 and 2010 and may be downloaded from: http://www.dep.state.fl.us/water/nonpoint/pubs.htm.

- Finally, the 2004 Florida Legislature directed Florida's water management districts to work with interested parties to develop landscape irrigation and Florida-Friendly design standards for new construction (section 373.228, F.S.). Local governments are to use the standards and guidelines when developing landscape irrigation and Florida-Friendly ordinances. The Committee on Landscape Irrigation and Florida-Friendly Design Standards convened and developed the standards. They are published in a booklet called Landscape Irrigation and Florida-Friendly Design Standards (December 2006). The 2009 Legislature has directed that it be revised in 2011. The current version of this document can be downloaded from: http://www.dep.state.fl.us/water/waterpolicy/land_irr.htm

MODEL ORDINANCE FOR FLORIDA-FRIENDLY USE OF FERTILIZER ON URBAN LANDSCAPES (FEBRUARY 2015)

1. FINDINGS

As a result of impairment to (MUNICIPALITY / COUNTY)'S surface waters caused by excessive nutrients, or, as a result of increasing levels of nitrogen in the surface and/or ground water within the aquifers or springs within the boundaries of (municipality/county), the governing body of (municipality / county) has determined that the use of fertilizers on lands within (municipality / county) creates a risk to contributing to adverse effects on surface and/or ground water. Accordingly, the governing board of (municipality/county) finds that management measures [Guidance: optional "additional management measures than are otherwise"] contained in the most recent edition of the "*Florida-Friendly Best Management Practices for Protection of Water Resources by the Green Industries*, 2008," may be required by this ordinance.

2. PURPOSE AND INTENT

This Ordinance regulates the proper use of fertilizers by any applicator; requires proper training of Commercial and Institutional Fertilizer Applicators; establishes training and licensing requirements; establishes a Prohibited Application Period; specifies allowable fertilizer application rates and methods, fertilizer-free zones, low maintenance zones, and exemptions. The Ordinance requires the use of Best Management Practices which provide specific management guidelines to minimize negative secondary and cumulative environmental effects associated with the misuse of fertilizers. These secondary and cumulative effects have been observed in and on (MUNICIPALITY / COUNTY)'s natural and constructed stormwater conveyances, rivers, creeks, canals, springs, lakes, estuaries and other water bodies. [Guidance: as appropriate] Collectively, these water bodies are an asset critical to the environmental, recreational, cultural and economic well-being of (MUNICIPALITY / COUNTY) residents and the health of the public. Overgrowth of algae and vegetation hinder the effectiveness of flood attenuation provided by natural and constructed stormwater conveyances. Regulation of nutrients, including both phosphorus and nitrogen contained in fertilizer, will help improve and maintain water and habitat quality.

3. DEFINITIONS

For this Article, the following terms shall have the meanings set forth in this section unless the context clearly indicates otherwise.

"Administrator" means the (MUNICIPALITY / COUNTY) Administrator, or an administrative official of (MUNICIPALITY / COUNTY) government designated by the City/County Administrator to administer and enforce the provisions of this Article.

"Application" or "Apply" means the actual physical deposit of fertilizer to turf or landscape plants.

"Applicator" means any Person who applies fertilizer on turf and/or landscape plants in (MUNICIPALITY / COUNTY).

"Board or Governing Board" means the Board of City/County Commissioners of (MUNICIPALITY / COUNTY), Florida.

"Best Management Practices" means turf and landscape practices or combination of practices based on research, field-testing, and expert review, determined to be the most effective and practicable on-location means, including economic and technological considerations, for improving water quality, conserving water supplies and protecting natural resources.

"Code Enforcement Officer, Official, or Inspector" means any designated employee or agent of (MUNICIPALITY / COUNTY) whose duty it is to enforce codes and ordinances enacted by (MUNICIPALITY / COUNTY).

"Commercial Fertilizer Applicator", except as provided in 482.1562(9) F.S., means any person who applies fertilizer for payment or other consideration to property not owned by the person or firm applying the fertilizer or the employer of the applicator.

"Fertilize," "Fertilizing," or "Fertilization" means the act of applying fertilizer to turf, specialized turf, or landscape plants.

"Fertilizer" means any substance or mixture of substances that contains one or more recognized plant nutrients and promotes plant growth, or controls soil acidity or alkalinity, or provides other soil enrichment, or provides other corrective measures to the soil.

"Guaranteed Analysis" means the percentage of plant nutrients or measures of neutralizing capability claimed to be present in a fertilizer.

"Institutional Applicator" means any person, other than a private, non-commercial or a Commercial Applicator (unless such definitions also apply under the circumstances), that applies fertilizer for the purpose of maintaining turf and/or landscape plants. Institutional Applicators shall include, but shall not be limited to, owners, managers or employees of public lands, schools, parks, religious institutions, utilities, industrial or business sites and any residential properties maintained in condominium and/or common ownership.

"Landscape Plant" means any native or exotic tree, shrub, or groundcover (excluding turf).

"Low Maintenance Zone" means an area a minimum of ten (10) feet wide adjacent to water courses which is planted and managed in order to minimize the need for fertilization, watering, mowing, etc.

"Person" means any natural person, business, corporation, limited liability company, partnership, limited partnership, association, club, organization, and/or any group of people acting as an organized entity.

"Prohibited Application Period" means the time period during which a Flood Watch or Warning, or a Tropical Storm Watch or Warning, or a Hurricane Watch or Warning is in effect for any portion of (CITY/COUNTY), issued by the National Weather Service, or if heavy rain[1] is likely.

"(MUNICIPALITY / COUNTY) Approved Best Management Practices Training Program" means a training program approved per 403.9338 F.S., or any more stringent requirements set forth in this Article that includes the most current version of the Florida Department of Environmental Protection's "*Florida-Friendly Best Management Practices for Protection of Water Resources by the Green Industries*, 2008," as revised, and approved by the (MUNICIPALITY / COUNTY) Administrator.

"Saturated soil" means a soil in which the voids are filled with water. Saturation does not require flow. For the purposes of this ordinance, soils shall be considered saturated if standing water is present or the pressure of a person standing on the soil causes the release of free water. [Guidance: Some have questioned the enforceability of practical field definitions which should be considered before adoption.]

"Slow Release," "Controlled Release," "Timed Release," "Slowly Available," or "Water Insoluble Nitrogen" means nitrogen in a form which delays its availability for plant uptake and use after application, or which extends its availability to the plant longer than a reference rapid or quick release product.

"Turf," "Sod," or "Lawn" means a piece of grass-covered soil held together by the roots of the grass.

"Urban landscape" means pervious areas on residential, commercial, industrial, institutional, highway rights-of-way, or other nonagricultural lands that are planted with turf or horticultural plants. For the purposes of this section, agriculture has the same meaning as in s. 570.02.

4. APPLICABILITY

This Ordinance shall be applicable to and shall regulate any and all applicators of fertilizer and areas of application of fertilizer within the area of (MUNICIPALITY / COUNTY), unless such applicator is specifically exempted by the terms of this Ordinance from the regulatory provisions of this Ordinance. This Ordinance shall be prospective only, and shall not impair any existing contracts.

[Guidance: In 403.9336, the Legislature further finds that local conditions, including variations in the types and quality of water bodies, site-specific soils and geology, and urban or rural densities and characteristics, may necessitate the implementation of additional or more stringent fertilizer

[1] World Meteorological Organization definition of heavy rain: Rainfall greater than or equal to 50 mm (2 inches) in a 24 hour period. http://severe.worldweather.org/rain/, and forecast keyword "likely", http://www.wrh.noaa.gov/sew/MediaGuide/TermsOutlooks_Watches_Warnings.pdf.

management practices at the local government level. Local government may adopt additional or more stringent provisions to the model ordinance as provided in 403.9337(2). However, the local government should consider the disadvantages of confusing jurisdictional differences and should clearly demonstrate they meet the required criteria:

(2) Each county and municipal government located within the watershed of a water body or water segment that is listed as impaired by nutrients pursuant to s. 403.067, shall, at a minimum, adopt the department's Model Ordinance for Florida-Friendly Fertilizer Use on Urban Landscapes. A local government may adopt additional or more stringent standards than the model ordinance if the following criteria are met:

- (a) The local government has demonstrated, as part of a comprehensive program to address nonpoint sources of nutrient pollution which is science based, and economically and technically feasible, that additional or more stringent standards than the model ordinance are necessary in order to adequately address urban fertilizer contributions to nonpoint source nutrient loading to a water body.
- (b) The local government documents that it has considered all relevant scientific information, including input from the department, the institute, the Department of Agriculture and Consumer Services, and the University of Florida Institute of Food and Agricultural Sciences, if provided, on the need for additional or more stringent provisions to address fertilizer use as a contributor to water quality degradation. All documentation must become part of the public record before adoption of the additional or more stringent criteria.]

[Guidance: Florida Statues 125.568(3), 166.048(3), 373.185(3), 720.3075(4), and others provide that a local ordinance, deed restriction or covenant may not prohibit or be enforced so as to prohibit any property owner from implementing Florida-friendly landscaping on his or her land or create any requirement or limitation in conflict with any provision of part II of this chapter {373} or a water shortage order, other order, consumptive use permit, or rule adopted or issued pursuant to Chapter 373 part II.]

[Guidance: Florida Statues 482.156 and 482.1562. Neither the Limited Commercial Landscape Maintenance Certification Program nor the Limited Certification for Urban Landscape Commercial Fertilizer Application allows landscape maintenance workers to make any kind of pesticide applications (including weed control and/or weed and feed products) to any turf areas.]

[Guidance: Florida Statues 482.242, and 487.051 (2), F.S. Regulation of pest control businesses and applicators, and of pesticide use, is preempted to the Florida Department of Agriculture and Consumer Services (FDACS and suspected pesticide misuse should be reported to FDACS.

5. TIMING OF FERTILIZER APPLICATION

No applicator shall apply fertilizers containing nitrogen and/or phosphorus to turf and/or landscape plants during the Prohibited Application Period, or to saturated soils.

[Guidance: One of the most controversial issues associated with recent fertilizer ordinances enacted by local governments is the definition of the Prohibited Application Period. Some ordinances have prohibited the application of fertilizer, even slow release formulations, during the summer rainy season, typically June 1 to September 30. The reasoning is that rain occurs frequently, saturating the soil, leading to more runoff. Saturated soils are prone to runoff or leaching with little or no additional water, and pose a higher than normal risk until soil moisture capacity is restored. Fertilizer management is largely about keeping the nitrogen and/or phosphorus in the root zone where it can be used by plants. Periods of heavy rainfall contribute to leaching, which is washing nutrients out of the root zone, and to runoff, especially in areas with compacted or bare soils and significant slope. Vegetative ground cover is important to minimizing erosion, filtering particulates, and incorporating or promoting the biological transformation of potential pollutants. Many variables influence the relationship between fertilizer rates, vegetation health and nutrient enrichment of surface and ground waters. Accordingly, sound science and carefully reasoned judgment are recommended in determining how to define the Prohibited Application Period.]

6. FERTILIZER FREE ZONES

Fertilizer shall not be applied within ten (10) feet of any pond, stream, watercourse, lake, canal, or wetland as defined by the Florida Department of Environmental Protection (Chapter 62-340, Florida Administrative Code) or from the top of a seawall, unless a deflector shield, drop spreader, or liquid applicator with a visible and sharply defined edge, is used, in which case a minimum of 3 feet shall be maintained. If more stringent (MUNICIPALITY / COUNTY) Code regulations apply, this provision does not relieve the requirement to adhere to the more stringent regulations. Newly planted turf and/or landscape plants may be fertilized in this Zone only for a sixty (60) day period beginning 30 days after planting if need to allow the plants to become well established. Caution shall be used to prevent direct deposition of nutrients into the water. [Guidance: This zone is a setback to prevent the applicator from inadvertently depositing fertilizer in the water while performing the application. It is not designed as a treatment buffer, and is to be adhered to as a fundamental environmental safety aspect of the applicator's job, regardless of the owner's desires. Some communities have existing residential setbacks of as little as 10 feet from water or seawall. Low maintenance zones, vegetated filter strips, and riparian buffers are strongly encouraged, but such activities are rightly a part of land use planning. Local governments are encouraged to implement these low-impact development practices where feasible.]

7. LOW MAINTENANCE ZONES

A voluntary ten (10) foot low maintenance zone is strongly recommended, but not mandated, from any pond, stream, water course, lake, wetland or from the top of a seawall. A swale/berm system is recommended for installation at the landward edge of this low maintenance zone to capture and filter runoff. If more stringent (MUNICIPALITY / COUNTY) Code regulations apply, this provision does not relieve the requirement to adhere to the more stringent regulations. No mowed or cut vegetative material may be deposited or left remaining in this zone or deposited in the water. Care should be taken to prevent the over-spray of aquatic weed products in this zone. [Guidance: Care must be taken to ensure erosion of the surface soil does not occur. Excessive erosion may be a greater pollution hazard than occasional proper applications of fertilizer.]

8. FERTILIZER CONTENT AND APPLICATION RATES

[Guidance: RULE 5E-1.003, F.A.C contains the following provisions for <u>golf courses, parks and athletic fields</u>. As such, no additional specific requirements are included for these types of urban turf. The appropriate Best Management Practices listed below must be followed on such sites for nutrient management activities:

These include not to exceed rates recommended in the document titled SL191 "*Recommendations for N, P, K and Mg for Golf Course and Athletic Field Fertilization Based on Mehlich I Extractant*", and to comply with the recommendations in "*BMP's for the Enhancement of Environmental Quality on Florida Golf Courses*", published by the Florida Department of Environmental Protection, dated 2012.

Note that this does not exempt applicators at these sites from the required basic Green Industry BMP training.

(a) Fertilizers applied to turf within (MUNICIPALITY / COUNTY) shall be applied in accordance with requirements and directions provided by Rule 5E-1.003, Florida Administrative Code.

(b) Fertilizer containing nitrogen shall not be applied before seeding or sodding a site, and shall not be applied for the first 30 days after seeding or sodding, except when hydro-seeding for temporary or permanent erosion control in an emergency situation (wildfire, etc.), or in accordance with the Stormwater Pollution Prevention Plan for that site.

(c) Nitrogen or phosphorus fertilizer shall not be applied to turf or landscape plants except as provided in (a) above for turf, or in UF/IFAS recommendations for landscape plants, vegetable gardens, and fruit trees and shrubs, unless a soil or tissue deficiency has been verified by an approved test. [Guidance: Soil and tissue tests for phosphorus are normally done by UF/IFAS or another accredited laboratory. IFAS recommendations are available from the County Extension service or http://solutionsforyourlife.ufl.edu/lawn_and_garden/]

9. APPLICATION PRACTICES

a. Spreader deflector shields are required when fertilizing via rotary (broadcast) spreaders. Deflectors must be positioned such that fertilizer granules are deflected away from all impervious surfaces, fertilizer-free zones and water bodies, including wetlands.
b. Fertilizer shall not be applied, spilled, or otherwise deposited on any impervious surfaces.
c. Any fertilizer applied, spilled, or deposited, either intentionally or accidentally, on any impervious surface shall be immediately and completely removed to the greatest extent practicable.
d. Fertilizer released on an impervious surface must be immediately contained and either legally applied to turf or any other legal site, or returned to the original or other appropriate container.
e. In no case shall fertilizer be washed, swept, or blown off impervious surfaces into stormwater drains, ditches, conveyances, or water bodies.

10. MANAGEMENT OF GRASS CLIPPINGS AND VEGETATIVE MATTER

In no case shall grass clippings, vegetative material, and/or vegetative debris be washed, swept, or blown off into stormwater drains, ditches, conveyances, water bodies, wetlands, or sidewalks or roadways. Any material that is accidentally so deposited shall be immediately removed to the maximum extent practicable.

11. EXEMPTIONS

The provisions set forth above in this Ordinance shall not apply to:

(a) bona fide farm operations as defined in the Florida Right to Farm Act, Section 823.14 Florida Statutes;

(b) other properties not subject to or covered under the Florida Right to Farm Act that have pastures used for grazing livestock;

(c) any lands used for bona fide scientific research, including, but not limited to, research on the effects of fertilizer use on urban stormwater, water quality, agronomics, or horticulture.
[Guidance: Limited waivers for special cases such as botanical gardens, etc. should not be considered as less stringent for the purposes of the model as a minimum requirement.]

12. TRAINING

(a) All commercial and institutional applicators of fertilizer within the (un)incorporated area of (MUNICIPALITY / COUNTY), shall abide by and successfully complete the six-hour training program in the "*Florida Friendly Best Management Practices for Protection of Water Resources by the Green Industries*" offered by the Florida Department of Environmental Protection through the University of Florida Extension "*Florida-Friendly Landscaping*™" program, or an approved equivalent.

(b) Private, non-commercial applicators are encouraged to follow the recommendations of the University of Florida IFAS *Florida Yards and Neighborhoods* program when applying fertilizers.

[Guidance: A local government may establish a certification/education program for the institutional or private application of fertilizers indicating the completion of an education program for special local requirements not covered in the above programs. It is up to the local government to set a continuing education or renewal provision for these applicators. Persons with statewide FDACS commercial fertilizer certification cannot be required to submit to additional local testing after obtaining the FDACS certificate.]

13. LICENSING OF COMMERCIAL APPLICATORS

All commercial applicators of fertilizer within the (un)incorporated area of (MUNICIPALITY / COUNTY), shall have and carry in their possession at all times when applying fertilizer, evidence of certification by the Florida Department of Agriculture and Consumer Services as a Commercial Fertilizer Applicator per 5E-14.117(18) F.A.C.

All businesses applying fertilizer to turf and/or landscape plants (including but not limited to residential lawns, golf courses, commercial properties, and multi-family and condominium properties) must ensure that at least one employee has a "*Florida-Friendly Best Management Practices for Protection of Water Resources by the Green Industries*" training certificate prior to the business owner obtaining a Local Business Tax Certificate. Owners for any category of occupation which may apply any fertilizer to Turf and/or Landscape Plants shall provide proof of completion of the program to the (Municipality/ County) Tax Collector's Office.
[Guidance: This is an example of an administrative enforcement mechanism. It may be modified to use other local mechanisms as appropriate].

14. ENFORCEMENT

[Guidance: Local governments should consider making penalties consistent with their other fines and penalties.]

Funds generated by penalties imposed under this section shall be used by (Municipality/ County) for the administration and enforcement of section 403.9337, Florida Statutes, and the corresponding sections of this ordinance, and to further water conservation and nonpoint pollution prevention activities.

Appendix K: Sample Boy Scout Projects for Rotten Bayou Watershed

Appendix L: Sample Boy Scout Projects for Rotten Bayou Watershed

Highlighted below are activities that can be used to satisfy the **Soil and Water Conservation Merit Badge** that are particularly relevant to and would benefit Rotten Bayou Watershed.

- Plant 100 trees, bushes and/or vines for a good purpose.
- Seed an area of at least one-fifth acre for some worthwhile conservation purpose, using suitable grasses or legumes alone or in a mixture.
- Make a list of places in your neighborhood, camps, school ground, or park having erosion, sedimentation, or pollution problems. Describe how these could be corrected through individual or group action.

More information can be found at http://www.boyscouttrail.com/boy-scouts/meritbadges/soil-and-water-conservation-merit-badge.asp

Soil and Water Conservation

Merit Badge Workbook

This workbook can help you but you still need to read the merit badge pamphlet.

The work space provided for each requirement should be used by the Scout to make notes for discussing the item with his counselor, not for providing the full and complete answers. Each Scout must do each requirement.

No one may add or subtract from the official requirements found in ***Boy Scout Requirements*** (Pub. 33216 – SKU 34765).

The requirements were last issued or revised in 2005 • This workbook was updated in January 2014.

Scout's Name:________________________________ Unit: ________________________________

Counselor's Name: ____________________________ Counselor's Phone No.: __________________

http://www.USScouts.Org • http://www.MeritBadge.Org

Please submit errors, omissions, comments or suggestions about this **workbook** to: Workbooks@USScouts.Org
Comments or suggestions for changes to the **requirements** for the **merit badge** should be sent to: Merit.Badge@Scouting.Org

---

1. Do the following:
   a. Tell what soil is.

   Tell how it is formed.

   b. Describe three kinds of soil. Tell how they are different.

   1.

Workbook © Copyright 2014 - U.S. Scouting Service Project, Inc. - All Rights Reserved
Requirements © Copyright, Boy Scouts of America (Used with permission.)

2.

3.

c. Describe the three main plant nutrients in fertile soil.

1.

2.

3.

Tell how they can be put back when used up.

2. Do the following:

a. Define soil erosion.

Soil and Water Conservation — Scout's Name: ______________________

b. Tell why it is important.

Tell how it affects you.

c. Name three kinds of soil erosion. Describe each.

1.		
2.		
3.		

Soil and Water Conservation Scout's Name: ______________________

d. Take pictures or draw two kinds of soil erosion.

3. Do the following:

a. Tell what is meant by conservation practices.

b. Describe the effect of three kinds of erosion-control practices.

1.		
2.		
3.		

Soil and Water Conservation Scout's Name: ________________________

c. Take pictures or draw three kinds of erosion-control practices.

4. Do the following:

a. Explain what a watershed is.

Soil and Water Conservation   Scout's Name: ________________________

☐ b. Outline the smallest watershed that you can find on a contour map.

☐ c. Then outline on your map, as far as possible, the next larger watershed which also has the smallest in it.

d. Explain what a river basin is.

Tell why all people living in it should be concerned about land and water use in it.

5. Do the following:

a. Make a drawing to show the hydrologic cycle.

☐ b. Show by demonstration at least two of the following actions of water in relation to soil: percolation, capillary action, precipitation, evaporation, and transpiration.

c. Explain how removal of vegetation will affect the way water runs off a watershed.

d. Tell how uses of forest, range, and farm land affect usable water supply.

e. Explain how industrial use affects water supply.

6. Do the following:

a. Tell what is meant by water pollution.

Soil and Water Conservation Scout's Name: ______________________

b. Describe common sources of water pollution and explain the effects.

Water Pollution Source	Effects

c. Tell what is meant by "primary water treatment," "secondary waste treatment," and "biochemical oxygen demand."

Primary water treatment	

secondary waste treatment	
biochemical oxygen demand	

d. Make a drawing showing the principles of complete waste treatment.

Soil and Water Conservation Scout's Name: ________________________

7. Do TWO of the following:
   - ☐ a. Make a trip to two of the following places. Write a report of more than 500 words about the soil and water and energy conservation practices you saw.
     - ☐ 1. An agricultural experiment.
     - ☐ 2. A managed forest or woodlot, range, or pasture.
     - ☐ 3. A wildlife refuge or a fish or game management area.
     - ☐ 4. A conservation-managed farm or ranch.
     - ☐ 5. A managed watershed.
     - ☐ 6. A waste-treatment plant.
     - ☐ 7. A public drinking water treatment plant.
     - ☐. 8. Industry water use installation.
     - ☐ 9. Desalinization plant
   - ☐ b. Plant 100 trees, bushes and/or vines for a good purpose.
   - ☐ c. Seed an area of at least 1/5 acre for some worthwhile conservation purpose, using suitable grasses or legumes alone or in a mixture.
   - ☐ d. Study a soil survey report. Describe the things in it. On tracing paper over any of the soil maps, outline an area with three or more different kinds of soil. List each kind of soil by full name and map symbol.

   - ☐ e. Make a list of places in your neighborhood, camps, school ground, or park that have erosion, sedimentation, or pollution problems. Describe how these could be corrected through individual or group action.

   - ☐ f. Carry out any other soil and water conservation project approved by your merit badge counselor.

Requirement resources can be found here:
http://www.meritbadge.org/wiki/index.php/Soil and Water Conservation#Requirement resources

Important excerpts from the *Guide To Advancement - 2013*, No. 33088 (SKU-618673)

[1.0.0.0] — Introduction
The current edition of the *Guide to Advancement* is the official source for administering advancement in all Boy Scouts of America programs: Cub Scouting, Boy Scouting, Varsity Scouting, Venturing, and Sea Scouts. It replaces any previous BSA advancement manuals, including *Advancement Committee Policies and Procedures*, *Advancement and Recognition Policies and Procedures*, and previous editions of the *Guide to Advancement*.

[Page 2, and 5.0.1.4] — Policy on Unauthorized Changes to Advancement Program
No council, committee, district, unit, or individual has the authority to add to, or subtract from, advancement requirements. There are limited exceptions relating only to youth members with special needs. For details see section 10, "Advancement for Members With Special Needs".

[Page 2] — The "Guide to Safe Scouting" Applies
Policies and procedures outlined in the ***Guide to Safe Scouting**,* No. 34416, apply to all BSA activities, including those related to advancement and Eagle Scout service projects.

[7.0.3.1] — The Buddy System and Certifying Completion
A youth member must not meet one-on-one with an adult. Sessions with counselors must take place where others can view the interaction, or the Scout must have a buddy: a friend, parent, guardian, brother, sister, or other relative—or better yet, another Scout working on the same badge—along with him attending the session.
When the Scout meets with the counselor, he should bring any required projects. If these cannot be transported, he should present evidence, such as photographs or adult verification. His unit leader, for example, might state that a satisfactory bridge or tower has been built for the Pioneering merit badge, or that meals were prepared for Cooking. If there are questions that requirements were met, a counselor may confirm with adults involved. Once satisfied, the counselor signs the blue card using the date upon which the Scout completed the requirements, or in the case of partials, initials the individual requirements passed.
Note that from time to time, it may be appropriate for a requirement that has been met for one badge to also count for another. See "Fulfilling More Than One Requirement With a Single Activity," 4.2.3.6.

[7.0.3.2] — Group Instruction
It is acceptable—and sometimes desirable—for merit badges to be taught in group settings. This often occurs at camp and merit badge midways or similar events. Interactive group discussions can support learning. The method can also be attractive to "guest experts" assisting registered and approved counselors. Slide shows, skits, demonstrations, panels, and various other techniques can also be employed, but as any teacher can attest, not everyone will learn all the material.
There must be attention to each individual's projects and his fulfillment of *all* requirements. We must know that every Scout —actually and *personally*— completed them. If, for example, a requirement uses words like "show," "demonstrate," or "discuss," then every Scout must do that. It is unacceptable to award badges on the basis of sitting in classrooms *watching* demonstrations, or remaining silent during discussions.
It is sometimes reported that Scouts who have received merit badges through group instructional settings have not fulfilled all the requirements. To offer a quality merit badge program, council and district advancement committees should ensure the following are in place for all group instructional events.

- Merit badge counselors are known to be registered and approved.
- Any guest experts or guest speakers, or others assisting who are not registered and approved as merit badge counselors, do not accept the responsibilities of, or behave as, merit badge counselors, either at a group instructional event or at any other time. Their service is temporary, not ongoing.
- Counselors agree not to assume prerequisites have been completed without some level of evidence that the work has been done. Pictures and letters from other merit badge counselors or unit leaders are the best form of prerequisite documentation when the actual work done cannot be brought to the camp or site of the merit badge event.
- There is a mechanism for unit leaders or others to report concerns to a council advancement committee on summer camp merit badge programs, group instructional events, and any other merit badge counseling issues—especially in instances where it is believed BSA procedures are not followed. See "Reporting Merit Badge Counseling Concerns," 11.1.0.0.
- There must be attention to each individual's projects and his fulfillment of all requirements. We must know that every Scout—actually and personally—completed them.

[7.0.3.3] — Partial Completions
A Scout need not pass all the requirements of one merit badge with the same counselor. It may be that due to timing or location issues, etc., he must meet with a different counselor to finish the badge. The Application for Merit Badge has a place to record what has been finished—a "partial." In the center section on the reverse of the blue card, the counselor initials for each requirement passed. In the case of a partial completion, the counselor does not retain his or her portion of the card. A subsequent counselor may choose not to accept partial work, but this should be rare. A Scout, if he believes he is being treated unfairly, may work with his unit leader to find another counselor. An example for the use of a signed partial would be to take it to camp as proof of prerequisites. Partials have no expiration except the Scout's 18th birthday. Units, districts, or councils shall not establish other expiration dates for partial merit badges.

[7.0.4.8] — Unofficial Worksheets and Learning Aids
Worksheets and other materials that may be of assistance in earning merit badges are available from a variety of places including unofficial sources on the Internet and even troop libraries. Use of these aids is permissible as long as the materials can be correlated with the current requirements that Scouts must fulfill. Completing "worksheets" may suffice where a requirement calls for something in writing, but this would not work for a requirement where the Scout must discuss, tell, show, or demonstrate, etc. Note that Scouts shall not be required to use these learning aids in order to complete a merit badge.

Appendix L: Elementary Education for Rotten Bayou Watershed

Project Summary

Project Title: Elementary Education for Rotten Bayou Watershed

Organization Title: Gulf Coast Community Design Studio, Mississippi State University

Principle Investigator: David Perkes, AIA, Director
Gulf Coast Community Design Studio
769 Howard Avenue
Biloxi, MS 39530

Office Phone: 228.436.4661
Email: dperkes@gccds.msstate.edu

Scope of Work: Mississippi State University's Gulf Coast Community Design Studio, in partnership with East Hancock Elementary School, Mississippi Wildlife Federation's (MWF) Adopt-a-Stream Program, NOAA's sNational Coastal Data Development Center (NCCDC), and Land Trust for the Mississippi Coastal Plain (LTMCP) proposes to work with the fifth grade students at East Hancock Elementary during the 2014-2015 academic year. There will be approximately 150 fifth grade students enrolled during the 2014-2015 academic year under the guidance of five teachers, the majority of whom live in the Rotten Bayou Watershed (Hydrologic Unit Code 031700109-002). Programming will include a four-day, in-class workshop with the students based on curriculum developed by the Gulf Coast Community Design Studio in 2012 for sixth graders at Biloxi Junior High School (See Appendix D: NEA Environmental Education with Biloxi Junior High School) and will focus on how the built environment, human activity and stormwater runoff affect the health of their waterways and watershed. Students will also go on two field trips – one to collect water quality data with assistance from the MWF Adopt-a-Stream Program and another to collect geospatial data with assistance from NCCDC. Students will work with GCCDS and partnering organization to analyze, present and share their data both within the school and larger community (See Data Share Plan). This project will enhance the current science curriculum at East Hancock Elementary; assist with the transition to Common Core standards by encouraging critical thinking, subject integration and information sharing; and support the efforts of the Rotten Bayou Watershed Implementation Planning Effort funded by the Mississippi Department of Environmental Quality (MDEQ).

Priorities Addressed: This project will address the following priorities defined by the Gulf B-WET Program.

I. Meaningful Watershed Educational Experiences for Students: Students will be engaged both in and out of the classroom through an interactive workshop and data collection and observation in the field. Students will learn to use new equipment and technology including World Water Monitoring Challenge chemical kits, aquatic nets, forceps, jeweler's loupes and digital cameras with GPS. Through the proposed program students will receive base knowledge, interact with the natural environmental and reflect on their findings by making connections to other watershed-wide initiatives.

II. GOMA Priorities addressed: Water quality for healthy beaches and shellfish beds; environmental education; and reducing nutrient inputs to coastal ecosystems. To a lesser extent wetland and coastal conservation and restoration; identification and characterization of gulf habitats; and coastal community resiliency will be addressed.

Total Federal Funding Requested: $44,236.88.

Cost per student: $294.91

Appendix L: Elementary Education for Rotten Bayou Watershed

Project Description

Organization and Partners:

The Gulf Coast Community Design Studio (GCCDS), an outreach program of Mississippi State University's College of Architecture, Art + Design, provides professional design and planning services to local communities and organizations to assistance in increasing their capacity to address issues of housing, public space, neighborhood development and the environment. The GCCDS staff that will manage and implement the project include David Perkes, Architect, Associate Professor and founding Director of the studio, Britton Jones, Landscape Architect, and Kelsey Johnson, Community Planner (*See Appendix B: Resumes*)

Partners include East Hancock Elementary School, Land Trust for the Mississippi Coastal Plain (LTMCP), Mississippi Wildlife Federation's (MWF) Adopt-a-Stream Program, and NOAA's National Coastal Data Development Center (NCDDC) (*See Appendix C: Letters of Support*).

Objectives:

The educational program for fifth graders at East Hancock Elementary strives to:

- Enhance the current fifth grade science curriculum around issues of stormwater runoff, water quality, and the effects of land use, development and human activity on the health of the watershed.
- Utilize creative, innovative and multidisciplinary educational methodologies to inspire learning and assist with the transition to Common Core.
- Introduce students to water quality and geospatial data collection techniques and technology.
- Connect students to professionals in the science and design fields to encourage interest in science, technology, engineering, and math (STEM) and higher education.
- Connect students and their families with Rotten Bayou watershed to foster increased stewardship and efforts of the Rotten Bayou Watershed Implementation Plan.

Summary and Project Justification:

The Rotten Bayou Watershed (HUC 031700109-002) is 22,446 acres and lies in Harrison and Hancock Counties in Mississippi. Rotten Bayou is a tributary of St. Louis Bay and has a TMDL for organic enrichment, low dissolved oxygen, and nutrients. The Mississippi Natural Resource Conservation Service (NRCS) has partnered with the Mississippi Department of Environmental Quality (MDEQ) to implement a Coastal Nutrient Reduction Strategy in Rotten Bayou Watershed. As part of the initiative, MDEQ is funding the Land Trust for Mississippi Coastal Plain and the Gulf Coast Community Design Studio to complete a Watershed Implementation Plan (WIP) for Rotten Bayou. A key part of a WIP is education and outreach. While the WIP partnership is specifically tasked with doing outreach to local officials and professionals, GCCDS is proposing to expand this outreach to local teachers, children and their families by leveraging funding through the Gulf B-WET Program.

GCCDS is proposing to engage fifth grade students and teachers in an innovative and interactive educational program focused on water quality, stormwater runoff and watershed dynamics that would lead to an overall meaningful watershed educational experience as defined by the Gulf B-WET Program. The fifth grade at East Hancock Elementary located at 4221 Kiln Delisle Road in Kiln, Mississippi was chosen for this outreach effort because the vast majority if not all of the students live in Rotten Bayou Watershed and key water quality and watershed concepts are introduced to students in the fifth grade based on Mississippi's science curriculum. While the program curriculum is relevant to many coastal watersheds and in line with the Mississippi science curriculum, materials will be modified to highlight the specific characteristics of Rotten Bayou Watershed. Students will be further connected to their watershed through participation in two field trips throughout the year.

The proposed educational program is innovative on several fronts. First, the program is uniquely tailored to the local community and watershed. The four-day workshop held at the beginning of the program, though science-based, has a strong tie to the planning and design fields further enhancing the multidisciplinary nature of the program. After the students receive some base knowledge from the workshop and are prepared to go into the field, they will be guided by science and technical professionals who will help put the students work into context. Finally, with assistance from GCCDS and the other partners, students will be guided through a process of analyzing, displaying and sharing their findings with each other, the school and larger community.

In addition to forwarding the Gulf B-WET Programs goal of providing meaningful watershed educational experiences for students, this project directly supports several of the GOMA priorities including water quality for healthy beaches and shellfish beds; environmental education; and reducing nutrient inputs to coastal ecosystems. To a lesser extent the program also supports and coastal conservation and restoration; identification and characterization of gulf habitats; and coastal community resiliency will be addressed. Many of these goals are directly in line with those of the Coastal Nutrient Reduction Strategy for Rotten Bayou Watershed and the Rotten Bayou Watershed Implementation Plan that GCCDS is concurrently developing with funding from MDEQ through the Land Trust for the Mississippi Coastal Plain.

Methodology and Deliverables:

Preparation Phase and Classroom Work:

Four In-Class lesson plans, lectures, experiment models, and digital presentations: GCCDS developed a four day science and arts based curriculum on the role people and materials play in the quality and quantity of stormwater runoff (See Appendix D: NEA Environmental Education with Biloxi Junior High School).

Day 1 *Then & Now* discusses the important role water plays in our everyday lives, what our waterways (bays, rivers, bayous & gulf) were like before people inhabited the land around them versus, and what the condition they are in now.

Day 2 *Materials* discusses how the materials of our build environment (houses/roofs, roads, lawns & etc.) affect the quantity of stormwater runoff.

Day 3 *Behaviors* discussed how our actions and pollution (littering, disposing of paint/oil/chemicals, composting, water harvesting & etc.) can affect the quality of stormwater runoff.

Day 4 *Improving Stormwater* discusses ways that we can make design decisions that positively affect stormwater runoff and ways architects and landscape architects design buildings and spaces to improve stormwater runoff.

GCCDS designed an experiment to go along with the lesson plans to demonstrate the issues affecting stormwater runoff quality and quantity. Each teacher will receive a model that consists of four gutters to represent different materials. Water with materials added to represent pollutants will be poured into the four gutters so the students can compare the quantity and quality of water going in versus that coming out. Each lesson includes an interactive presentation created in PREZI. This digital tool takes students and teachers through the entire lesson plan and experiments in a fun and thorough manner. These are designed to teach students about local issues affecting the world around them and the tools created during the project can be used by teachers in future years.

One take-home brochure about stormwater lesson: GCCDS produced a brochure for students and science teachers to take home and share with their family and friends. The brochure titled *What You Can Do to Be a Stormwater Super Hero* discusses what stormwater runoff is, how it can be a problem, why we should care and what we can do about it. The brochure provides information for local resources that can help improve stormwater runoff at your own home. This brochure is designed to help reach a broader audience and to bring the lessons taught in class back to the student's home.

Artworks created: During the last three in-class lessons students will be asked to create a piece of art that is representative of their own home (materials, site, behaviors and stormwater conditions). Based on what they learned through the four days of lessons, the students will use paper collage and drawing to design improvements for their home that will have a positive impact on stormwater runoff. By applying what they were taught to their design the knowledge gained from the classes will become integrated into their everyday lives.

Field work and data collection: GCCDS will work in partnership with MWF's Adopt-a-Stream Program and NCDDC to guide the students in field work and data collection around water quality and land use/habitat change. The Adopt-a-Stream program staff will facilitate the use of World Water Monitoring Challenge chemical kits to test various parameters in streams to help determine water quality. In addition, students will learn about the importance of macroinvertebrates in the water system and how to identify common aquatic organisms. Testing kits and other equipment will be purchased through the grant and given to the teachers to use with future classes.

Students will choose two sites currently being monitored by USGS for the Rotten Bayou Watershed Project. One to Two classes will go out at various times during the academic year (Fall, Winter and Spring) to collect data at the chosen locations. Students will be able to compare their data to data collected by USGS and will also be tasked with reporting their findings to the other fifth grade classes not present on that given field trip. Dividing up the classes and spreading out the trips over the year will give students the opportunity to see variations in water conditions and challenge them to communicate those findings to their peers. Water quality data will be used in the Rotten Bayou Watershed Implementation Plan and made publically available on the MWF Adopt-a-Stream program website and the Rotten Bayou Watershed webpage hosted on the website of the Land Trust for the Mississippi Coastal Plain (See Appendix E: Data Share Plan).

NOAA's National Coastal Data Development Center staff will assist the students with collecting digital photographs, GPS coordinates and descriptions about surrounding land uses around the streams that are being sampled for water quality. NCDDC will also provide USGS LANDSAT satellite imagery characterizing land usage and habitat change over a period of time for Rotten Bayou Watershed. NCCDC will use the students' data for ground truthing and validation of the NOAA imagery analyses and will work with the students and teachers to make all data accessible online through ESRI's ArcGIS Online (See Appendix E: Data Share Plan).

One school-wide and one community exhibit: GCCDS will work with students at the end of the academic year to design and install an exhibit of their work. Displaying in the school will the program to reach more of the student and teacher population along with the issues they were addressing to extend the knowledge and conversation beyond the fifth grade. Following the school-wide exhibit, the installation will be moved to a location in the community that is publically accessible so that the larger community and Rotten Bayou Watershed Implementation Planning Effort can also benefit from the students knowledge and work.

Appendix L: Elementary Education for Rotten Bayou Watershed

Timeline:

Task	Description/Deliverable	Responsible Party	Jul-14	Aug-14	Sep-14	Oct-14	Nov-14	Dec-14	Jan-15	Feb-15	Mar-15	Apr-15	May-15	Jun-15
Workshop Preparation	Modified lesson plans specific to Rotten Bayou Watershed based on GCCDS work with Biloxi Junior High School in 2012 and assembly of stormwater runoff models (1 per class) to be left with the teachers.	GCCDS												
Pre-Program Survey	Survey will gage students base knowledge and awareness of issues in their watershed.	GCCDS												
Field Trip Preparation	Field trips will be planned in collaboration with technical partners. Materials and equipment for field trips will be purchased and organized.	GCCDS, MWF Adopt-a-Stream, NCDDC, East Hancock Elementary												
4-Day, In-Class Workshop	Detailed lesson plans, in-class and take-home materials and models to be left with the teachers for future use. Student work will be utilized in a post-workshop exhibition.	GCCDS												
Water Quality Field Trips (1-2 classes/day)	1-2 Classes will go out at a time and collect water quality data at 2 site in the watershed currently being monitored by USGS.	GCCDS, MWF Adopt-a-Stream, East Hancock Elementary												
Post-Field Trip Evaluations	Evaluations will gage suscess of field trip to improve subsequent trips.	GCCDS												
Geospatial Field Trip	All 5 classes will go to a site to be determined by NOAA's NCDDC and collect digital imagery, GPS coordinates and other land use data.	GCCDS, NCDDC, East Hancock Elementary												
Data Compilation & Sharing	As data is collected students will analyze their data, present water quality data to the other fifth grade classes and post data on LTMCP and MWF's websites and ArcGIS online.	GCCDS, LTMCP, MWF Adopt-a-Stream, NCCDS, East Hancock Elementary												
Exhibition Installation & Exhibition	GCCDS will work with students to compile their work in a school-wide exhibition. The installation will then be moved to a publically accessible site in Diamondhead to use as outreach and education for the Rotten Bayou Watershed Implementation Planning Effort.	GCCDS, LTMCP, East Hancock Elementary												
Post-Program Evaluation	Students and teachers will be surveyed at the culmination of the program and program partners will work together to summarize the findings from all surveys and evaluations conducted during the grant period.	GCCDS												

GCCDS understands that there may be a need to change the start date of the project. All partners involved in this proposal are anticipating the need to be flexible with the start date of the work and detailed schedules of the proposed activities.

Expected Outcomes:

- 150 fifth grade students and 5 teachers will be directly involved with the program during the 2014-2015 academic year. The materials, equipment and lesson plans, however, will remain with the teachers and benefit countless future students.

- Student work and outreach materials will be made available to the rest of the school and the students' families further extending the impact of their work.

- Students will develop a stronger connection to their waterways and watershed developing and increased sense of stewardship.

- Interaction with science and design professionals will increase student interest in STEM, thus contributing to NOAA's obligations under the America Competes Act (33 USC 893a(a)) and encouraging the importance of higher education.

- Student work and data collected will be utilized by partnering organizations and made available to the larger community which will have the twofold effect of helping the students realize the importance of their work and increasing the communities' awareness of issues and opportunities in their watershed.

Project Evaluation:

GCCDS is committed to collecting information before, during and after the completion of the proposed education program in order to improve the program's effectiveness. At the start of the grant, GCCDS will conduct a survey of the participating students to determine their prior knowledge and attitudes about the topics they will study. Questions will attempt to gain information about the following:

- Student knowledge around issues of stormwater runoff, water quality, and the effects of land use, development and human activity on the health of the watershed;

- Student understanding about their connection to Rotten Bayou Watershed;

- Student interest in higher education and science, technology, engineering, and math (STEM)

- Students' inclinations towards environmental stewardship.

Results from this survey will be compared to the results of a survey to be conducted at the end of the academic year to determine how the students understanding and interests have changed as a result of the program.

GCCDS will also conduct a survey of students and teachers following each field trip. This information will be used by GCCDS and partners to improve subsequent field trips. At the end of the academic year, GCCDS will survey the students and teachers. Students will be asked to complete the same survey they completed at the beginning of the year so that changes in their knowledge and interests can be evaluated. Teachers will be consulted to determine their level of satisfaction with the program in terms of student development, teacher capacity building, enhancement of Mississippi science curriculum, and promotion of Common Core standards. At the end of the grant, partners will evaluate and summarize the findings of surveys and provide recommendations for potential program and funding modification.

GCCDS is also aware that grantees may be asked to participate in data collection for the national B-WET evaluation and is willing to assist in any way possible.

Appendix L: Elementary Education for Rotten Bayou Watershed

Appendix A: Letter of Support

Appendix L: Elementary Education for Rotten Bayou Watershed

East Hancock Elementary School

4221 Kiln-Delisle Road Kiln Mississippi 39556 Phone (228)255-6637

November 6, 2013

Amy Clark
Gulf of Mexico B-WET Program Manager
NOAA Fisheries Southeast Regional Office
Building 1100
Room 202D
Stennis Space Center, MS 39529

Dear Grant Review Committee,

On behalf of East Hancock Elementary school, we are pleased to support the Gulf Coast Community Design Studio's proposal to work with our 5th graders. Through the acquisition of this grant, our Mississippi science curriculum will be greatly enhanced. Not only will this project correlate with our science standards, but it will be a great tool for subject integration as we transition into Common Core. In addition, as the students interact with professionals from Adopt-a-Stream, NOAA, and USGS to collect, analyze and share data, their interest in various areas of STEM and post high school education will likely increase.

The 5th grade teachers and administration at East Hancock are in full support of devoting class time to the proposed workshops on stormwater runoff, waters quality and their relationship to the health of the larger watershed. We are also excited for our students to have the opportunity to collect, analyze and share waters quality, macroinvertebrate and geospatial data from their own watershed. The equipment and materials provided through this grant will be a great addition to our classroom resources and will benefit many students that will come through our program in the future. In addition, as most of our kids live in Rotten Bayou Watershed, it is exciting to know that the work they do and information they take home will benefit the larger efforts to improve the ecological health of Rotten Bayou Watershed lead by the Land Trust for the Mississippi Coastal Plain. Thank you again for your consideration.

Sincerely,

Tammy Estapa

Tammy Estapa

District and School Science Liaison

UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
NATIONAL ENVIRONMENTAL SATELLITE, DATA, AND INFORMATION SERVICE

Russell H. Beard
Director, NOAA's National Coastal Data Development Center (NCDDC)
NOAA Gulf of Mexico Regional Collaboration Team Lead

6 November 2013

David Perkes, Director (AIA)
769 Howard Avenue, Biloxi, MS 39530

Dear David:

The NCDDC strongly endorses your proposal submitted by the Gulf Coast Community Design Studio for educational training of students to enhance their understanding of the impacts of development and human activity on storm water runoff and water quality as it relates to the Rotten Bayou watershed (Figure 1.) The in-kind technical support we will offer is an excellent companion piece to the Adopt-A-Stream program that will provide training and assistance to the students in water quality testing on streams in Rotten Bayou watershed.

The NCDDC will provide USGS LANDSAT satellite imagery characterizing land usage and habitat change over a period of time (e.g., 1970-2012), for the Rotten Bayou watershed. For those streams sampled by the students, we would task the students to undergo field observations for the collection of digital photographs, GPS coordinates, develop a brief narrative on the stream characteristics (e.g., estimated width/depth, free flowing, stagnant, and/or intermittent flow, presence of algae) and describe the surrounding land usage, e.g., housing, rural, forest, wetland, agricultural, recreational, industrial etc. The students will submit their in situ observations to NCDDC be used for ground truthing and validation of the NOAA imagery analyses. The NCDDC staff working with the teachers and students will make all data accessible immediately upon validation via the Internet (Figure 2. ESRI's ArcGIS Online). The data management plan will incorporate NOAA regulations (Appendix A) and NCDDC will assist the PI in preparation.

This proposal addresses 5 of the 6 established regional priorities of the Gulf of Mexico Alliance including: water quality; environmental education; identification and characterization of Gulf habitats; reducing nutrients to coastal ecosystems; and, coastal community resilience. The project will greatly enhance the student's knowledge on the need to monitor environmental conditions, and the impact of development/change on the watershed's health. We encourage the NOAA B-WET to fund this worthwhile proposal.

Respectfully

Russell H Beard

Appendix L: Elementary Education for Rotten Bayou Watershed

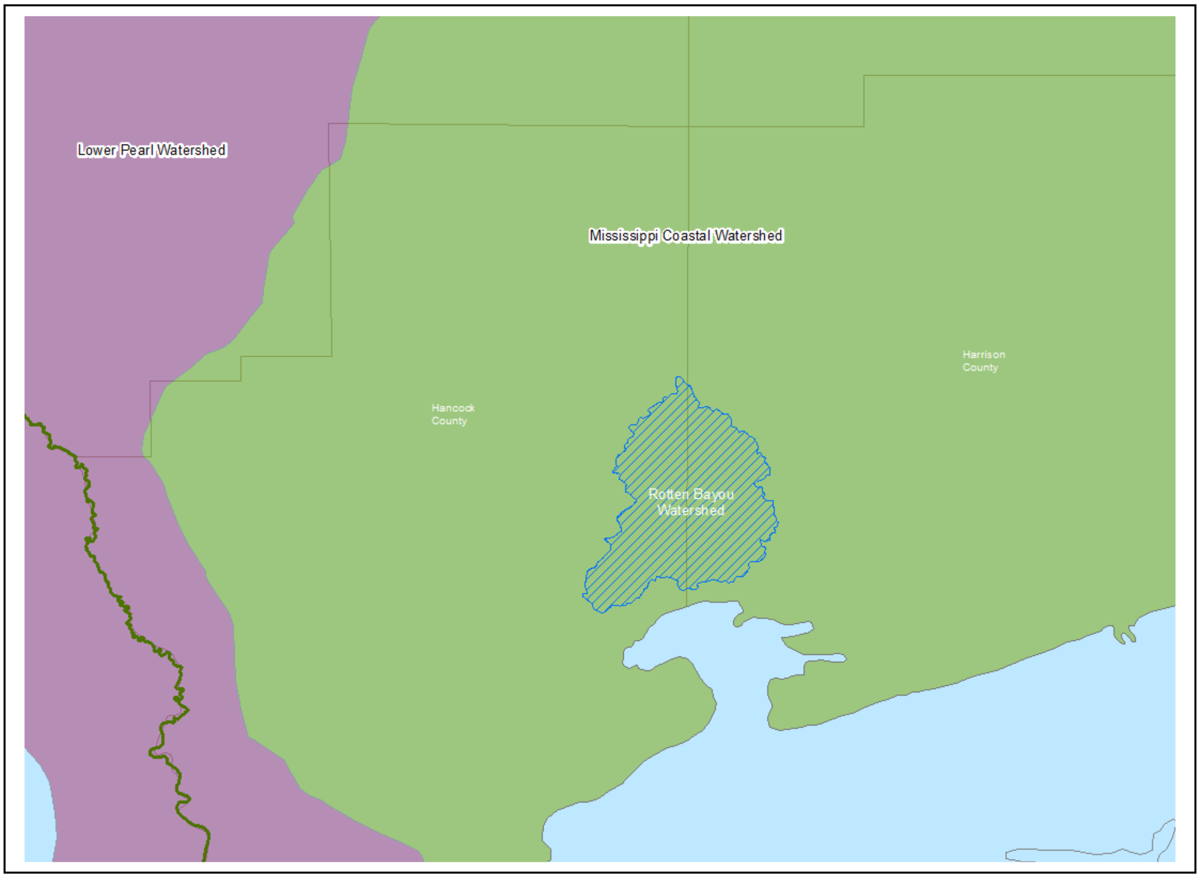


Figure 1. Rotten Bayou Watershed

A story map is built on intelligent maps (also called web maps) hosted on ESRI's ArcGIS Online or on your own web server. In addition, a story map provides a way to combine other elements such descriptive text, clickable icons, and multi-media content (photos, videos, etc.) into a seamless picture that students can interact with. There are various story map templates available for use. Below is a version called "Map Tour" that combines photos with locations on an interactive map.

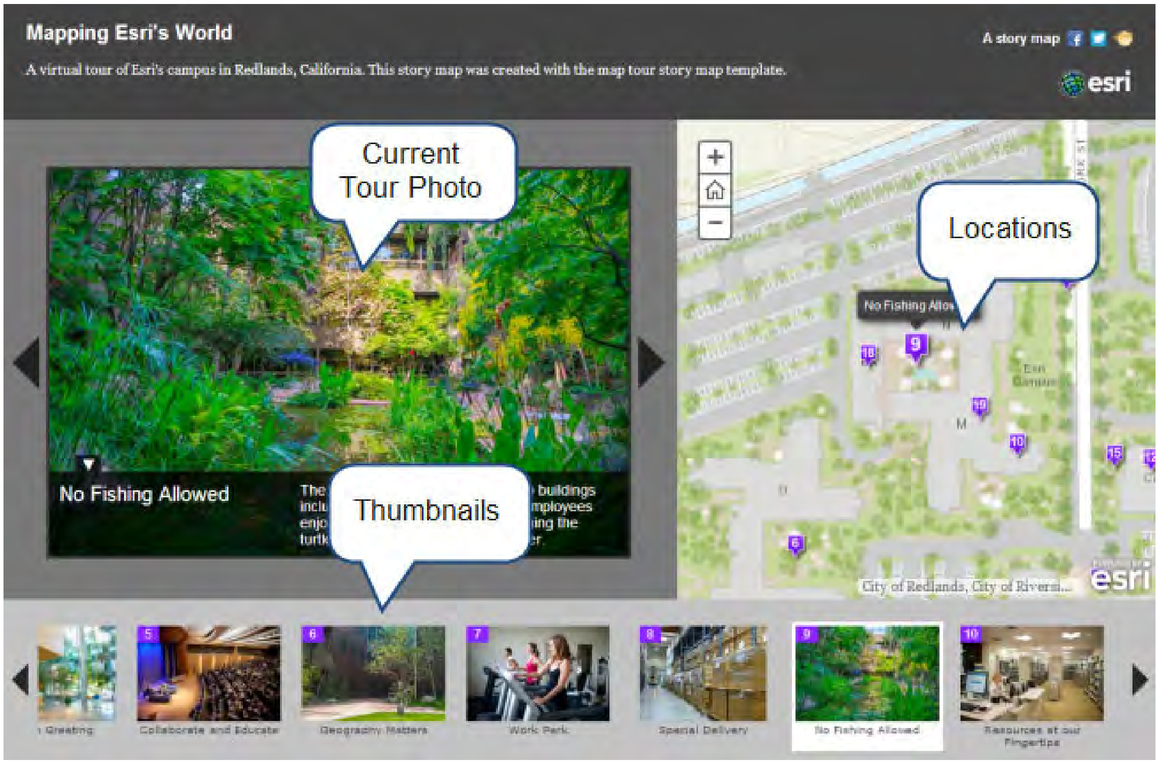


Figure 2. Example of Story Map

Data Management Plan (Data and Information Sharing)

A typical plan should include descriptions of the types of environmental data and information that will be collected/created during the course of the project; the tentative date by which data will be shared and documentation of any proposed exceptions (e.g. data anticipated to have homeland/national security, cultural heritage, or protected resources value); the standards to be used for data/metadata format and content; policies addressing data stewardship and preservation; procedures for providing access, sharing, and security; and prior experience in publishing such data.

Spatial data are considered a national capital asset, and to that end, the National Spatial Data Infrastructure described in Office of Management and Budget (OMB) Circular No. A-16 facilitates efficient collection, integration, sharing, and dissemination of spatial data among all levels of government institutions, academia, and the private sector. The White House Office of Science and Technology Policy (OSTP) consistently reaffirm requirements for open government and transparent access to digital data through a series of Memorandums and Policy Directives. The OSTP Memorandum Open Data Policy – Managing Data as an Asset issued May 9, 2013 directs that data and information collected or created with public funds should be managed "… in a way that supports downstream information processing and dissemination activities."

On behalf of the NOAA Observing System Council (NOSC) and the NOAA CIO Council, the Environmental Data Management Committee (EDMC) coordinates the development of NOAA's environmental data management strategy and policy in compliance with National Policy. NOAA Administrative Order (NAO) 212-15 Management of Environmental Data and Information provides high-level direction to guide consistent implementation of procedures, decisions and actions regarding environmental data and information management. Approved Procedural Directives provide detailed guidance on environmental data management lifecycle components.

The NAO applies to all NOAA environmental data and to the personnel and organizations that manage these data, unless exempted by statutory or regulatory authority. The NOAA Procedural Directive for Data Sharing Policy for Grants and Cooperative Agreements states in part

All NOAA Grantees must share data produced under NOAA grants and cooperative agreements in a timely fashion, except where limited by law, regulation, and policy or security requirements. Grantees must address this requirement formally by preparing a Data Sharing Plan as part of their grant project narrative.

Debra Veeder
Mississippi Wildlife Federation
Adopt-A-Stream Coordinator
517 Cobblestone Court, Suite 2
Madison, MS 39110

November 4, 2013

To Whom It May Concern:

On behalf of the MS Wildlife Federation Adopt-A-Stream Program we support the funding of a grant proposal submitted by the Gulf Coast Community Design Studio for educational training of students to enhance their understanding of the impacts of development and human activity on stormwater runoff and water quality as it relates to their watershed. The Adopt-A-Stream program would be very interested in working with the Gulf Coast Community Design Studio on this proposed project. The Adopt-A-Stream program will assist the program by providing training and assistance to the students so that they can do water quality testing on streams in their watershed area. Adopt-A-Stream can also provide a venue to store and track data that they obtain through their water quality testing. Adopt-A-Stream is a program that is administered through the Mississippi Wildlife Federation from a grant with the Mississippi Department of Environmental Quality.

Projects like these that can educate and involve the community help the water resources that we all depend on both economically and aesthetically. We are pleased to promote this project and collaborate with the Gulf Coast Community Design Studio to make this project a success.

Please do not hesitate to contact me if you need additional information.

Sincerely,

Debra Veeder

Debra Veeder
Adopt-A-Stream Coordinator
(601)605-1790
dveeder@mswf.org

Adopt-A-Stream Mississippi MISSISSIPPI Wildlife FEDERATION MISSISSIPPI DEPARTMENT OF ENVIRONMENTAL QUALITY

LAND TRUST FOR THE MISSISSIPPI COASTAL PLAIN

OFFICERS

Jon Bond
President

Melanie Allen
Vice President

Flowers White
Treasurer

Alice Duckett
Secretary

BOARD OF DIRECTORS

Melanie Allen

Beth Ashley

Jennifer Tyler Baker

Jon Bond

Russell Evans

Lisa Eveleigh

Peggy Hoover

Steve Lawler

Johnny Marquez

Allen Reed

Flowers White

November 5, 2013

Amy Clark
Gulf of Mexico B-WET Program Manager
NOAA Fisheries Southeast Regional Office
Building 1100
Room 202D
Stennis Space Center, MS 39529

Dear Grant Review Committee,

The Land Trust for the Mississippi Coastal Plain (LTMCP) is enthusiastic about the Gulf Coast Community Design Studio's proposal to work with the 5th graders at East Hancock Elementary to supplement their science curriculum around the impacts of the built environment and human activity on watersheds and Rotten Bayou Watershed, in particular. LTMCP recently received funding from the Mississippi Department of Environmental Quality to develop a Watershed Implementation Plan for Rotten Bayou Watershed. In addition to developing a Watershed Implementation Plan, LTMCP is tasked with conducting field assessments, planning and implementing restoration actions and best management practices, and conducting meetings to education landowners and stakeholders. The Land Trust has contracted with the Gulf Coast Community Design Studio to facilitate these planning efforts in the Rotten Bayou Watershed and is fully supportive of the Design Studio's initiative to apply for additional funding to bring watershed-related education to the students at East Hancock and to assist the students with water quality and geospatial data collection that will benefit the larger watershed planning work.

Wherever possible the Land Trust will assist with these educational and data collection efforts as they so directly tie in with the goals of the Rotten Bayou Watershed Implementation Plan and Coastal Nutrient Reduction Strategy. As an accredited land trust, LTMCP has valuable knowledge and experience in restoring and maintaining coastal lands and will be a valuable asset to this partnership. Our broad base of experienced volunteers will also prove valuable in assisting the partnership in outreach, education and data collection activities. Thank you for your consideration of this proposal.

Respectfully,

Judy Steckler
Executive Director

/det

P.O. BOX 245 BILOXI, MISSISSIPPI 39533 PH: 228-435-9191 WWW.LTMCP.ORG
JUDY STECKLER, EXECUTIVE DIRECTOR

Appendix L: Elementary Education for Rotten Bayou Watershed

Appendix B: Budget and Budget Justification

Total Project Costs & Justification	REQUEST YEAR 1	MATCH YEAR 1	TOTAL YEAR 1	REQUEST YEAR 2	MATCH YEAR 2	TOTAL YEAR 2	*TOTAL REQUEST*	*TOTAL MATCH*	*TOTAL PROJECT COSTS*
A. Personnel/Salaries:									
Key Staff: David Perkes, Britton Jones, Kelsey Johnson	$14,548.71								*$14,549*
David Perkes is an architect, director of GCCDS, and the Principle Investigator for the grant. Britton Jones is a landscape architect and Kelsey Johnson is a planner at GCCDS. Both have significant experience with environmental education.									
Support Staff: Public Design Intern	$3,600.00								*$3,600*
Salary for a Public Design Intern has been included in the project budget. The intern will dedicate about 200 total hours to the project and assist with all aspects of the work. Public Design Interns with GCCDS hold a minimum of a bachelors degree and work at GCCDS while receiving credit to complete independent study through MSU.									
	$18,148.71	**$0.00**	**$0.00**	**$0.00**	**$0.00**	**$0.00**	***$0.00***	***$0.00***	***$18,149***
B. Fringe Benefits:	$6,540.80								
Fringe benefits at MSU are currently set at 36.04%	**$6,540.80**	**$0.00**	**$0.00**	**$0.00**	**$0.00**	**$0.00**	***$0.00***	***$0.00***	***$6,541***
C. Travel:									
Travel Directly Related to Program Implementation	$1,400.00								
Includes 13 round trips from Biloxi to the Diamondhead area for two staff cars. Trips are for classroom time, field trips and pre-paratory meetings. Distance is approximately 80 miles round trip and the reimbursement rate is $0.565/mile.									
Travel Indirectly Related to Program Implementation	$1,500.00								
Includes flight, hotel and rental car for a two-day Regional B-WET conference to be held in one of the Gulf States or a Na-tional B-WET conference during the award period for one of the key staff.									
	$2,900.00	**$0.00**	**$0.00**	**$0.00**	**$0.00**	**$0.00**	***$0.00***	***$0.00***	***$2,900***
D. Equipment:	**$0.00**	**$0.00**	**$0.00**	**$0.00**	**$0.00**	**$0.00**	***$0.00***	***$0.00***	***$0***
E. Supplies	$7,800.00								
Expenses are for 50 World Water Monitoring Challenge chemical kits, 25 larval trays, 25 heavy duty D-frame aquatic nets, 25 for-ceps, 36 jeweler's loupes, 5 digital cameras with GPS, materials to build 5 stormwater demonstration models, and paper, mark-ers, etc. for the 4-day classroom workshop. All equipment and models will be left with the teachers at East Hancock Elementary for use with future classes.									
	$7,800.00	**$0.00**	**$0.00**	**$0.00**	**$0.00**	**$0.00**	***$0.00***	***$0.00***	***$7,800***
F. Contractual	**$0.00**	**$0.00**	**$0.00**	**$0.00**	**$0.00**	**$0.00**	***$0.00***	***$0.00***	***$0***
G. Construction: Construction is not allowed through the B-WET Program	XXXXX	XXXXX	XXXXX	XXXXX	XXXXX	XXXXX	*XXXXX*	*XXXXX*	*XXXXX*
H. Other:	**$0.00**	**$0.00**	**$0.00**	**$0.00**	**$0.00**	**$0.00**	***$0.00***	***$0.00***	***$0***
I. Total Direct Charges:	**$35,389.51**	**$0.00**	**$0.00**	**$0.00**	**$0.00**	**$0.00**	***$0.00***	***$0.00***	***$35,390***
J. Indirect Charges:	$8,847.38						***$0.00***	***$0.00***	***$8,847***
K: Totals:	**$44,236.89**	**$0.00**	**$0.00**	**$0.00**	**$0.00**	**$0.00**	***$0.00***	***$0.00***	***$44,237***

Appendix C: Resumes

GCCDS
Gulf Coast Community Design Studio
Mississippi State University College of Architecture Art + Design
425 Division Street, Biloxi, MS 39530 phone: 228-436-4661

DAVID PERKES, AIA

BIO

David Perkes is a licensed architect and Professor for Mississippi State University. He is the founding director of the Gulf Coast Community Design Studio, a professional outreach program of the College of Architecture, Art + Design. The design studio was established in Biloxi following Hurricane Katrina and has evolved into a multi-disciplinary, non-profit design firm with planners, landscape architects, architects and interns working on projects that range from regional planning to individual houses.

David has a national role in leading the effort for design organizations to better serve the needs of communities. He has lectured and written on community design for many years and is an active participant in several national social-impact design organizations such as the Association for Community Design, Structures for Inclusion, Better World by Design, and SEED Network. David is part of a four person national team to receive the 2011 Latrobe Prize from the American Institute of Architects. The prize is supporting research in Public Interest Practices in Architecture. In 2011 David was selected by the White House as a “Champion of Change” for his work on the Gulf Coast.

David works to build and strengthen partnerships in the work of the Gulf Coast Community Design Studio. Under his leadership the design studio has assisted in the renovation of hundreds of damaged homes and over two hundred new house projects in Biloxi and other communities. The Biloxi house projects were awarded an Honor Citation from the Gulf States Region AIA in 2007, a Terner Award for Innovative Housing, and a Mississippi AIA Honor Citation in 2009. Before creating the Gulf Coast Community Design Studio, David was the director of the Jackson Community Design Center and taught in the School of Architecture’s fifth year program in Jackson, Mississippi.

EDUCATION AND REGISTRATION

Loeb Fellow, Harvard Graduate School of Design, 2004
Master of Environmental Design, Yale School of Architecture, 1993
Master of Architecture, University of Utah, 1985
Ecole d’ Art Americaines, Fountainbleau, France, Summer 1984.
Bachelor of Science in Civil and Environmental Engineering, Utah State University, 1982.
AIA, Mississippi & Pennsylvania

PROFESSIONAL AFFILIATIONS

American Institute of Architects, Latrobe Prize Research Team 2011
Association for Community Design, Board Member, 2008 to present
SEED Network, Member 2010 to present
Public Interest Design Institute, Instructor 2011 to present

COMMUNITY INVOLVEMENT

Moore Community House, Board Member
Gulf Coast Renaissance Corporation, Advisory Board Member

PROJECTS

Community Education
- East Lawn Elementary School Playground
- Moss Point Community Exhibits

Non-profit organizations
- Camp John I Hay Pavilion, Boys and Girls Club
- Farish Street Baptist Church Site Improvements
- Mississippi 4-H Museum

Historic, Adaptive Reuse, or Renovation
- Shaw Homestead
- Bratton Street House Projects

Research
- Temporary Disaster Housing Research, Depart ment of Homeland Security
- Flood-proof Commercial Construction, Depart ment of Homeland Security
- Energy Efficient Design Tools, Department of Energy
- Housing Systems Educational Program, Small Business Administration
- Renaissance Development Standards Housing
- Long Term Work Force Housing Design Services
- Bethel Estates
- Sustainable Habitat for Humanity House

Urban Planning
- Gulf Coast Sustainable Communities Regional Plan
- Downtown Biloxi Planning
- East Biloxi Redevelopment Planning
- Soria City Neighborhood Planning
- Mississippi Renewal Forum
- Jackson Metro Parkway Open Space Program ming and Pre-planning

Environmental
- Bayou Auguste Restoration
- Eco Village Bridge
- Earth Lab Demonstration House

GCCDS
Gulf Coast Community Design Studio
Mississippi State University College of Architecture Art + Design
425 Division Street, Biloxi, MS 39530 phone: 228-436-4661

BRITTON JONES, RLA

BIO

Britton Jones is a Landscape Architect at the Gulf Coast Community Design Studio (GCCDS), a non-profit professional office that offers sustainable design services in architecture, planning and landscape to the communities of the Mississippi Gulf Coast. Britton's work and interest are in the challenges of creating places that successfully merge ecological and social systems. He is involved in projects that range from large scale planning to small scale design. His work has also been to help organize and lead design charrettes, public exhibits and workshops, and lead educational activities in the public schools.

Britton has over eight years of experience in landscape architectural practice. Prior to his work at the GCCDS Britton was a landscape designer at OLIN Landscape Studio in Philadelphia, PA where he worked on and managed projects of varying scales and scopes in many areas of the United States. His work in the field has allowed him to work on award winning projects that pride themselves on socially and ecologically sustainable designs.

EDUCATION AND REGISTRATION

Master of Landscape Architecture, Auburn University, 2004 cum laude
Bachelor of Science in Environmental Design, Auburn University, 2002
RLA, Mississippi

TEACHING/VISITING CRITIC

Spring 2013 Biloxi Jr. High School 6th grade science - Developed and taught lessons on stormwater and our built environment

Spring 2012 Louisiana State University MLA Studio – Rethinking Biloxi Waterfronts

Spring 2010 GCCDS & University of Minnesota MArch Studio – Gulfport/Soria City Community Planning Project

Summer 2004 Auburn University (prospective MLA students) – Drawing by Hand

PROFESSIONAL ACTIVITIES

November 2012 Bays & Bayous Symposium – Presenter of 'Community Based Restoration'

March 2012 Structures for Inclusion 12 – Presenter of 'The Bayou by You'

May 2011 Gulf Coast Sustainable Economies Leadership Academy – Presenter of 'Bayou Auguste Urban Restoration Project'

May 2011 Coastal Development Strategies Conference – Presenter of 'The Bayou by You: A Community Partnership for Urban Wetland Restoration in East Biloxi'

SELECTED PROJECTS

Community Education
- Biloxi Public Schools Bayou Ecology Lessons
- Moss Point Community Exhibits

Non-profit organizations
- Blossman Family YMCA
- Community Design Collaborative*

Historic, Adaptive Reuse, or Renovation
- Shaw Homestead
- Old Brick House
- Moss Point Parks

Research
- Sustainable Office Practices*
- Renaissance Development Standards

Campus
- ABC/Disney Studios at Golden Oak Ranch *
- Harbor Plaza*

Parks & Gardens
- Getty Stark Sculpture Garden*
- Philadelphia Museum of Art Sculpture Garden*
- Director's Park*

Urban Planning
- Baltimore Pratt Street Master Plan*
- Downtown Biloxi Planning
- Soria City Neighborhood Planning
- I-110 Loop & Underpass

Environmental
- Bayou Auguste Restoration
- Mill River Restoration*

Residential
- Cottages at Oak Park
- Cottages at 2nd Street
- Lamey Bridge Senior Center

*OLIN project

GCCDS
Gulf Coast Community Design Studio
Mississippi State University College of Architecture Art + Design
425 Division Street, Biloxi, MS 39530 phone: 228-436-4661

KELSEY JOHNSON, COMMUNITY PLANNER

BIO

Kelsey Johnson is a Community Planner with the Gulf Coast Community Design Studio in (GCCDS), a non-profit professional office that offers sustainable design services in architecture, planning and landscape to the communities of the Mississippi Gulf Coast. Her work has focused on assessing housing priorities on the Mississippi Gulf Coast and developing recommendations as part of a three-year regional sustainability plan. She also works with various communities and organizations along the coast on planning and public engagement.

Prior to joining the studio she worked as an Environmental Planner II at the Metropolitan Washington Council of Governments. There she worked with various governmental partners as part of the Anacostia Watershed Restoration Partnership, as well as with schools and community groups to educate students and residents about restoration efforts and stewardship. Kelsey holds a Masters of Urban and Regional Planning from the University of Michigan, focusing on environmental and land use policy and planning. The majority of her studies concentrated on planning issues and policy in coastal towns. While earning her masters she served as an AmeriCorps member in the Community and Economic Development Department at Focus: HOPE in Detroit, Michigan. There she worked closely with community groups on neighborhood revitalization and capacity building.

EDUCATION AND REGISTRATION

Master of Urban & Regional Planning, University of Michigan, 2007
Bachelor of Science in Environmental Studies, Bucknell University, 2005

PROFESSIONAL ACTIVITIES

Gulf Coast Sustainable Economies Leadership Academy 2011 – Team Leader

MS APA Annual Conference 2012 – Conference Committee

Leadership Hancock County - Class of 2013

COMMUNITY INVOLVEMENT

Community of Choice Workgroup for Hancock County's Economic Development Strategy - 2011 to Present

SELECTED PROJECTS

Regional Planning
- Sustainable Communities Regional Plan for the Mississippi Gulf Coast

Environmental Planning
- Rotten Bayou Watershed Implementation Plan

Mapping
- Gulf Coast Renaissance Corporation - New Market Tax Credit Eligibility
- Gulf Coast Renaissance Corporation - CDFI Fund Eligibility
- Moss Point City Ordinances

Community Education
- Biloxi Junior High School Stormwater Lessons

Research
- East Biloxi Vacant Land Study
- Planning for a Mixed-Use Community in Kiln, Mississippi
- Southside Economic & Mixed-Use Development A Planning and Design Exercise for Diamondhead, MS

Appendix D: Data Share Plan

Environmental Data Created:

Through the course of the proposed project the following data sets with be collected:

- Water quality data including pH, dissolved oxygen, temperature, and turbidity
- Presence of macroinvertebrates
- Stream Characteristics (e.g., estimated width/depth; free flowing, stagnant and/or intermittent flow; presence of algae)
- Land Usage Characteristics (e.g., residential, rural, forest, wetland, agricultural, recreational, commercial)
- GPS Coordinates
- Digital Photographs

Temporal and Spatial Data Coverage:

Data will be collect during the 2014-2015 academic year between September and April. All data will be collected within the Rotten Bayou Watershed (Hydrologic Unit Code 031700109-002).

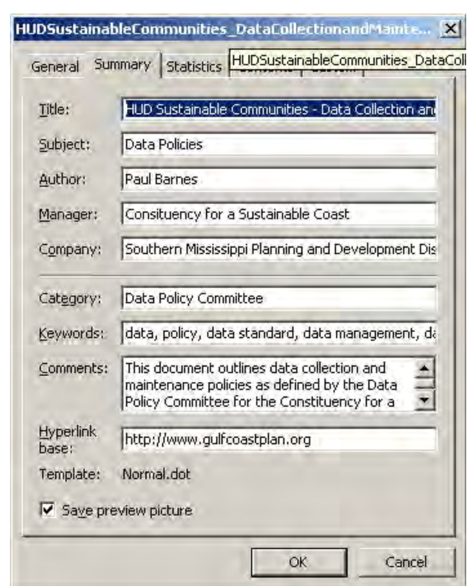
Timeline for Data Sharing:

Data collected will be shared immediately upon validation and during the course of the 2014-2015 academic year.

Standards for Data/MetaData Format and Content:

Metadata will be entered for all shared files Including Word docs, PDFs, Powerpoint, etc. (File>Properties). Information will include Title, Subject, Author, Manager, Company, Category, Keywords, Comments and Hyperlink as shown in Figure 1.

Figure 1



GCCDS will adhere to the following website data formats and website accessibility standards Under Title II of the ADA (http://www.ada.gov/pcatoolkit/chap5toolkit.htm) when posting all data.

- Images should have alternate text when uploaded.
- All graphics such as charts and graphs should have an excel table copy linked to in the alternate text for the image.
- All headings should be marked as <h2> elements.
- Standard HTML elements of <b>, <i>, and <u> should be used where needed.

- All featured news posts should have an image associated.

Data Stewardship and Preservation:

able and reliable infrastructure to support long-term access and preservation, preserving data access and archive integrity during media migration and software evolution, providing effective data support services and tools for users, and enhancing data and metadata by adding information that is established throughout the data life cycle.

Since environmental data is not static, stewardship is ongoing that relies on the stability of the servers, storage systems, software, etc. Inclusion of consistent and complete metadata is another important component of data stewardship and preservation. GCCDS and partnering organizations are committed to maintaining and preserving all data collected during the project period.

Access, Sharing and Security:

All data collected during the project period will be publically available upon validation with no access limitation.

Appendix E: NEA Environmental Education with Biloxi Junior High School:

The Gulf Coast Community Design Studio developed and implemented an educational outreach program with the Biloxi Public School District's sixth grade class of Biloxi Junior High School. The program, which was developed and taught in cooperation with the sixth grade science teachers, focused on the role people, the built environment, and stormwater play in protecting local waters, one of our most valued resources. During four in-class sessions students learned the importance of healthy water and how stormwater runoff from their neighborhoods affects the waters quality and quantity. In-class exhibits, interactive presentations, and experiments explained how the materials chosen to build our neighborhoods and the activities done around them can reduce or increase runoff and can contribute or mitigate pollution. With this new knowledge, students created site plans of their homes including the materials that make them and the activities that take place around the home. They were then asked to identify problems and opportunities for dealing with stormwater runoff and develop creative solutions to make improvements to the stormwater runoff leaving their homes. At the end of the program selected artworks were displayed in a school-wide exhibit for the entire student body and teachers to observe. Students were also given brochures and handouts to take home and share with their families on the stormwater issues they learned in class. With this program GCCDS was able to reach students and their families on an important local issue to the community and offer information, resources, and creative and practical solutions to help keep their waters clean.

Four In-Class lesson plans, lectures, experiment models, and digital presentations. The Gulf Coast Community Design Studio (GCCDS) developed a four day science and arts based curriculum on the role people and materials play in the quality and quantity of stormwater runoff. Day 1 *Then & Now* discussed the important role water plays in our everyday lives, what our waterways (bays, rivers, bayous & gulf) were like before people inhabited the land around them versus, and what the condition they are in now. Day 2 *Materials* discussed how the materials of our build environment (houses/roofs, roads, lawns & etc.) affect the quantity of stormwater runoff. Day 3 *Behaviors* discussed how our actions and pollution (littering, disposing of paint/oil/chemicals, composting, water harvesting & etc.) can affect the quality of stormwater runoff. Day 4 *Improving Stormwater* discussed ways that we can make design decisions that positively affect stormwater runoff and ways architects and landscape architects design buildings and spaces to improve stormwater runoff.

GCCDS designed and built an experiment to go along with the lesson plans to demonstrate the issues affecting stormwater runoff quality and quantity. Each teacher received a model that consisted of four gutters to represent different materials. Water with materials added to represent pollutants were poured into the four gutters so the students could compare the quantity and quality of water going in versus that coming out.

Each lesson included an interactive presentation created in PREZI. This digital tool takes students and teachers through the entire lesson plan and experiments in a fun and thorough manner. These lessons were successful in teaching students about local issues affecting the world around them and the tools created during the project can be used by teachers in future years.

One take home brochure about stormwater lessons. GCCDS produced a brochure for all 6th grade students and science teachers to take home and share with their family and friends. The brochure titled *What You Can Do to Be a Stormwater Super Hero* discusses what stormwater runoff is, how it can be a problem, why we should care and what we can do about it. The brochure provided information for local resources that can help improve stormwater runoff at your own home. This brochure was used to help reach a broader audience and to bring the lessons taught in class back to the students home.

736 artworks created. During the last three in-class lessons students were asked to create a piece of art that was representative of their own home (materials, site, behaviors and stormwater conditions). Based on what they learned through the four days of lessons, the students used paper collage and drawing to design improvements for their home that would have a positive impact on stormwater runoff. By applying what they were taught to their design the knowledge gained from the classes became integrated into their everyday lives.

Four in-class exhibits and one school wide exhibit. GCCDS created four in-class exhibits, one for each classroom. This included work created during the lessons and aerial map of Biloxi. Each student wrote or drew their favorite water related activity (fishing, swimming or etc.) on a sticky note and placed it on the map at the location of where they like to do that activity. Each student also placed a sticker indicating approximately where they live. This process illustrated the physical relationship between where people live, where they recreate and why they should care about their local waterways. At the end of the program GCCDS installed an exhibit of the students' work located in one of the most visible spaces in the school for 1,200 students and teachers to observe. The exhibit introduced the program and its purpose and displayed 80 representative works of art created by the students. Displaying in the school allowed the program to reach more of the student and teacher population along with the issues they were addressing to extend the knowledge and conversation beyond the sixth grade.

All project activities were carried out with the exception of a change in the number of organizational partners working together on the project as well as the total number of individuals who benefited. When the scope and location of our project changed from Moss Point schools to Biloxi Junior High we neglected to update the number of partnering organizations with whom we would be working which affected the number of people exposed to the project. Instead of working with seven organizational partners, which included several schools in Moss Point, three organizations worked together on this project including GCCDS, Biloxi Junior High, and the City of Biloxi. With the reduction in schools involved the number of students, teachers, and family members who benefited was also reduced from 17,000 to 4200.

The Gulf Coast Community Design Studio, the grant recipient, initiated and developed project activities along with five teachers from Biloxi Junior High School. The former Biloxi School's science curriculum coordinator and current teacher at Biloxi Junior High helped us define our program and determine the most appropriate teachers, class, and age group for conducting the program. This teacher connected GCCDS with four enthusiastic sixth grade science teachers who worked to fit the program into their existing strand of earth science curriculum. As GCCDS develop the program content and activities the teachers reviewed and suggested ways to make the materials age appropriate and relevant to their curriculum. Once the program content was complete GCCDS staff taught twenty-five sixth grade classes per day with the teachers' assistance. Project materials have been passed onto the teachers and they will be prepared to continue the curriculum in future years due to their help in the development and assistance through the entire program.

The City of Biloxi was a key partner in providing support and information on the specific local conditions of stormwater infrastructure throughout the city. The information provided included the function and types of infrastructure present in the city, as well as mapping information to find the location of different systems. This information was used to create accurate and relevant content to develop a program specific to Biloxi.

The Arts Endowment outcome of learning was addressed very specifically in this project through the direct contact with 368 Junior High students inside their classroom. GCCDS along with the support and assistance of the sixth grade science teachers taught twenty-five classes per day over a four day period. The program was rooted in existing curriculum and used several methods for teaching the program including interactive presentations and experiments. It also brought an alternative approach to learning in the sciences by introducing a design approach method to their inquiries. The level of understanding and learning by the students was evaluated by the quality and content of the artwork created by the students during the project lessons. The content of the artworks reflected what information each student learned during class as well as how they could develop solutions that creatively addressed relevant issues raised during the course. Based on these measures the outcome of learning was achieved by the students.

This project benefitted GCCDS by built capacity for developing curriculum and teaching school age students about design related issues and methodology. It also expanded the quality and quantity of outreach materials available and created new teaching tools for future community engagement.

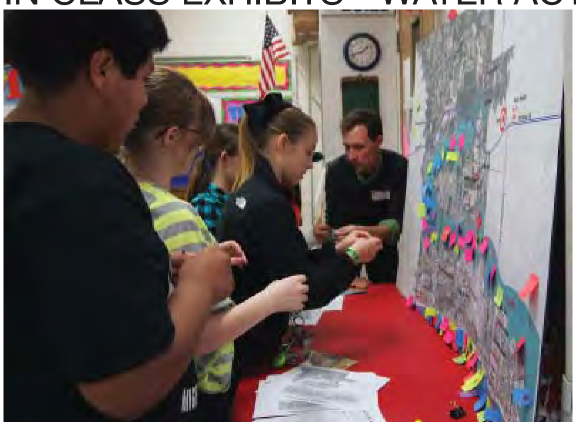
These materials will be of special interest and benefit to other community design educators as a successful model and program for those teaching similar issues around the country. We predict the program will become known through the various national conversations we engage in with others in our field as well as from our website.

The principal and educators of Biloxi Junior High were very grateful and supportive of the contribution made by this program and our organization during our work together. The impact of this NEA program has led to further conversations with the school principal on ways to continue working with the school and students through a variety of new programs.

Appendix L: Elementary Education for Rotten Bayou Watershed

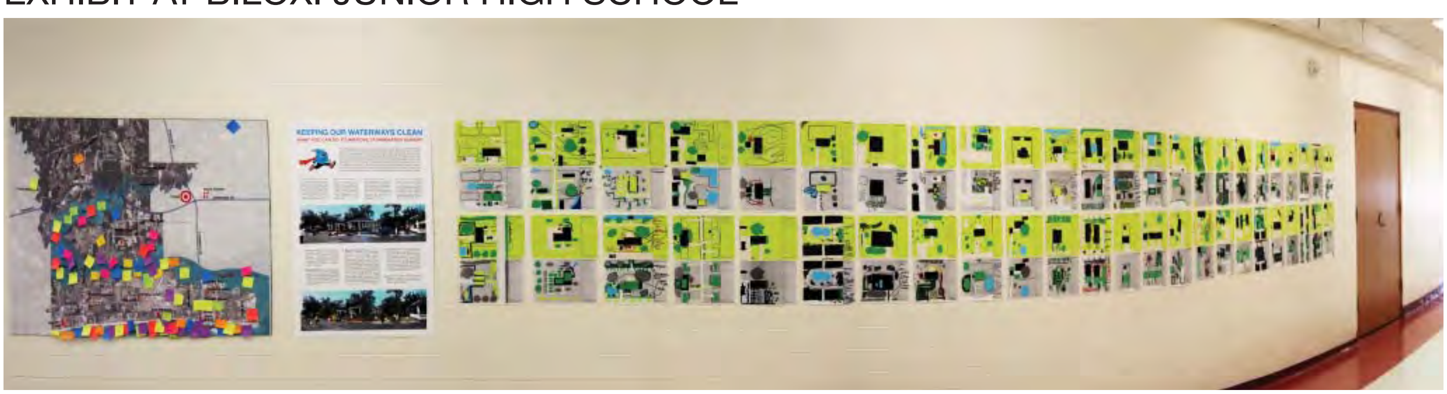
EXPERIMENTS WITH STORMWATER

IN CLASS EXHIBITS - WATER ACTIVITIES AND RELATING IT TO WHERE WE LIVE



MAKING ARTFUL COLLAGES OF OUR HOMES

EXHIBIT AT BILOXI JUNIOR HIGH SCHOOL



Appendix L: Elementary Education for Rotten Bayou Watershed

DAY 1 CONNECTING TO AND CARING FOR OUR LOCAL WATERWAYS

Introductions (3 min)

1. Introduction (Self and studio, where we are located, what we do)
   GCCDS – Architects, Landscape Architects and Planners (ask what are these things?)
   Stormwater runoff, or what happens to rainwater when it hits the ground, is a really important part of our work because it affects everything from someone's roof to their yard to the parks in their neighborhood to streets all around the city and the beach.
2. Run through the four days (Introduction, Materials, Behaviors, Designs)
   a. Today
      i. Map activity
      ii. Presentation about how stormwater moves through the city.
   b. Wednesday - Materials
      i. Hands on experiment.
      ii. Learn how to make a site plan, which we use in our design studio.
   c. Friday – Behaviors
      i. Another hands on experiment.
      ii. Class game
      iii. Continue to work on site plan.
   d. Monday – Creative designs
      i. Presentation on creative designs
      ii. Finish up site plan with your own designs.

Map Activity (15 min)

3. Introduce Map
   a. Point out major waterways (Gulf, Back Bay, Biloxi river, bayous)
   b. Point out major landmarks (Roads, schools, air force base, shopping)
4. Demo Activity (Explain handout)
   a. Find our office and put up favorite water activity.
5. Pass out handouts for each student, post-it note and marker.
6. Students should line up when they are ready. Might not get through everybody.
7. Sum up activity – It is really important for us to understand how what we do at home affects the waterways all around us. These four classes we'll be learning about how to keep our water from getting polluted, how to prevent harm to habitat for animals and plants, and how to keep being able to enjoy our favorite water activities.
8. If there is extra time, go through the different waterways and ask kids about their activities there.

<u>**PREZI BILOXI THEN & NOW**</u> (25 min – 5 minutes per section)

A. What is Stormwater Runoff

1. Definition**:** Stormwater runoff occurs when rain or other precipitation flows over the ground. Whenever it rains, water flows into different systems that might include ditches, drains and pipes, but eventually the water in Biloxi that doesn't soak into the ground comes out at the Gulf of Mexico. Paved surfaces like driveways, sidewalks and streets prevent stormwater from naturally soaking into the ground. Stormwater runoff is important because it affects how much water we have and how clean that water is. Stormwater runoff affects all the water activities we love!
2. Video: Introduction to Runoff (stop after approx. 2 min)
3. Introduce the four areas on the map: Beach, Bayou, River and Inland. Have the students raise their hand if they live in one of these areas. We will be looking at what these areas are like now, and what they were like before Biloxi was a city.

B. Beach

1. Now

a. Today, Biloxi has a nice long sandy beach along the water.
   What are some of your favorite beach activities on the map?
   i. The sand is raked and fluffed and groomed for beach activities.
   ii. Highway 90 runs beside the beach and is separated from it by a sidewalk and a concrete sea wall. The concrete wall is used to keep sand off the highway and protect the beach.
   iii. Some buildings are right along the water, like the Beau Rivage.
b. Stormwater diagram

2. Then
   a. There used to be a very narrow beach by the water but most of the sand in today's beach has been brought in from other places.
      Oak and cypress trees and grasses grew close to the water. It probably looked a lot more like Deer Island.
      Rain and wind transformed the water's edge, it was constantly changing.
   b. Stormwater diagram

3. Problems
   a. While the beach allows for lots of fun activities, there are some problems with how stormwater flows to the beach.
      i. Pollution comes through pipes and dumps onto the beach or directly into the water. The water is sometimes so polluted that the beach has to close for a couple days.
      ii. Litter from people's houses can wash onto the beach, affecting animals like this Spork Crab.
      iii. Have you found any garbage down at the beach?
      iv. How might litter affect some of your favorite activities?
4. Solutions
   a. The stormwater runoff used to get cleaned by plants and grasses that flowed into small streams and then into the Gulf. Planting new vegetation near the water helps to filter and clean water that runs off.
   b. We can participate in beach clean up days to pick up litter.
   c. Throw garbage and recycling into containers instead of onto the street or anywhere else where it can wash down to the beach.

C. Bayou
1. Now
   a. What are some of your favorite beach activities on the map?
   b. Even if you live right near a bayou, you might not know it. A lot of the waterways in Biloxi have been piped underground.
   c. Why put the bayou in a pipe and pave over it? (i.e. to build houses, roads, sidewalks, shops)
   d. There may be a storm drain near your house that runs under the street and comes out of a pipe (also called a culvert) into a waterway.
   e. Stormwater diagram

2. Then
   a. Before Biloxi was a city, the bayous were lined with marsh grasses and many other plants. Many more animals lived both in the water and along the banks. There were no pipes, houses or pavement, and there was a lot more water.
   b. Stormwater diagram

3. Problems
   a. In order to build houses and roads, the banks of the bayou were all filled in. Lots of vegetation and animal habitat was lost when this happened.

b. When water comes out of pipes (or culverts) it can be polluted. It is also difficult for animals like fish to survive in the pipes, or moving from the pipe to the stream. This makes for very unhappy fish.

c. How might water from drainage pipes affect some of your favorite activities?

4. Solutions

a. There is a project our studio did in Bayou Auguste. The Bayou used to be in a pipe, but it was opened up and the banks were rebuilt and planted with vegetation. The wall you see is made of oyster shells and helps prevent the banks from caving in (called erosion). Before it was just a pipe, but now it is like a community park, where you can go and enjoy the open stream. It is also very good for animal habitat both in the bayou and along the banks.

D. Biloxi River

1. Now

a. What are some of your favorite river activities on the map?

b. This Home Depot is very close to the Biloxi River near Popps Ferry Road. While some parts of the river are still natural, there are many roads, stores and houses that have been built up very close to it.

c. Stormwater diagram

2. Then

a. The river had soft planted edges. Many grasses and plants grew right up to the banks.

The river meandered and changed course over time (wind, storms, soil moving around)

The river was much wider and was surrounded by larger forests.

b. Stormwater diagram

3. Problems

a. There are many more paved surfaces like parking lots, roofs and roads. Large amounts of stormwater collect and flow into the river above the land or in pipes. There is so much water and it comes so fast that it causes erosion when it hits the river. Erosion is when part of the soil bank is washed away into the water.

b. How might erosion affect some of your favorite activities?

4. Solutions

a. Stormwater moves more slowly when there are more plants and soil because part of the water can soak into the ground.

b. Parking lots are large paved surfaces, and we can design them in creative ways to help with stormwater issues. Planted areas help soak up some of the stormwater.

c. Some hard materials like these parking pavers also allow some water to soak through the ground instead of running off into the river.

E. Inland

1. Now

a. There are many areas of Biloxi that aren't close to a waterway. In this part of Biloxi, there are many neighborhoods that have houses with yards and streets.

b. Stormwater diagram

2. Then

a. This is an example of a pine forest, which would have been growing in some parts of Biloxi, away from the water. There were many species of plants and animals that lived in this type of forest.

b. Stormwater diagram

3. Problems

a. Even if we don't live anywhere near the water, many of the things we do at our house or apartment affect the quality of the water, and how many pollutants it carries with it on its journey to a waterway, like the Back Bay or the Gulf of Mexico.

b. There are a lot of chemicals we use at home, like fertilizer for the grass, paint, motor oil, and all these things can end up in a waterway somewhere if we're not careful.
c. One example would be working on a car in the driveway. If some motor oil or gas leaks out, it can go down a drain and dump out into a waterway.
d. When pets go to the bathroom outside and their waste isn't picked up, there might be bacteria and other harmful chemicals that can end up in the water.
e. How might what you do at home affect some of your favorite water activities?

4. Solutions
    a. We can dispose of harmful chemicals properly.
    b. Some creative designs can help filter some chemicals out of the water and slow down water as it runs off yards. This example is a rain garden, where a ditch is planted with grasses that don't mind sitting in water some of the time.
    c. Another way to prevent all the water from the roof flowing over chemicals you might have in the yard or on the driveway is to collect and recycle the rainwater with a barrel. This recycled water can be used to water plants in the yard.

F. Conclusion

The end! Today we talked about four areas of Biloxi: the beach, the bayou, the river and the inland areas. Even if rain falls far away from a waterway, it still has a great affect on the water and on all our favorite activities. Tomorrow, we'll learn about how stormwater runoff moves around at your home through an experiment and activity. We'll learn all about different materials.

Questionnaire (3-5 min)
We have a scavenger hunt for you to complete about your own house or apartment. What I want you to do is investigate your home and the land around it for these different things. Some are about where certain things are, like your driveway, and others are about what materials you have at home. We will use this on Wednesday to work on a site plan. A site plan is a drawing from above, like a close up of an aerial map. We will teach you all about the site plan on Wednesday, but the scavenger hunt is to get you ready.

DAY 2 PAYING ATTENTION TO WHAT HAPPENS TO STORMWATER RUNOFF WHERE YOU LIVE- MATERIALS

GREETING/RECAP OF LAST LESSON: (5 min.)

A. When it rains, the water that falls around your home either absorbs into the ground or flows across the land and ends up in the Gulf of Mexico. This flowing water is called runoff.
B. The other day we talked about some of the effects runoff can have on the water we use for different activities. Lots of runoff can: (put in main points from Day 1)
    1. Cause flooding
    2. Erosion
    3. Pollution
    4. Litter

INTRODUCE TODAY'S LESSON AND GOALS: (2 min.)

A. Today we will learn how different materials around your home and neighborhood affect the amount of runoff that leaves your home and makes its way to the Gulf.
B. Then we will use our memory, questionnaire, and imagination to make a picture/plan of all the materials that are around our homes

PREZI & EXPERIMENT: HOW MATERIALS AFFECT STORMWATER RUNOFF (15 min.)

A. Objects and materials that make up the place you live absorb different amounts of water or none at all. Materials that are able to absorb fluids are called porous. Materials that can't absorb fluids are called non porous.
    1. Ask for three volunteers to do a demonstration on what it means to be porous.
    2. Two students stand with arms and legs out with their fingers and feet touching representing small pieces of dirt that are porous.
    3. A third student representing water tries to get through the rocks. It's pretty easy.
       Name some porous materials: dirt, sand, gravel, grass, oyster shells, fabric
    4. Now the two students stand right next to each other shoulder to shoulder representing a non porous material like concrete.
    5. The third student representing water can't get through.
       Name non porous materials: concrete, plastic, asphalt, bricks,
B. These 4 gutters represent different materials you can find around your home and neighborhood. (Show pictures of the materials and places in presentation while talking about them)
    1. Concrete- Driveways, sidewalks, roads, asphalt, tile roof, pipes, storm vault
        a. See what happens when rain falls on these surfaces
        b. Same amount of water runoff in same amount out
        c. This is a non porous material
    2. Soil- open ditches, bare ground, beach
        a. See what happens when rain falls on a surface like this
        b. Amount of water runoff is less
        c. This is a porous material
        d. There is some dirt in the water-Erosion
           The amount depends on how hard and fast it rains.
        e. Dirt, sand particle are so small and are easily carried away by water
            i. Dirt in water can make it hard for wildlife and plant to live in it.
            ii. Makes land less stable
    3. Rock over dirt- gravel driveways, oysters, pavers, rip-wrap, rock ditches
        a. See what happens when rain falls on rock that is covering bare ground
        b. Amount of water runoff is a little less
        c. This is a porous material
        d. There is some dirt in the water-Erosion rocks stop it a little

4. Plants- Trees, Gardens, rain gardens, wetlands, plant beds
    a. See what happens when rain falls on a planted surface like this
    b. Amount of water runoff is much less
    c. This is a porous material
        i. Plant roots grow far down into the soil and let water infiltrate it easier.
        ii. Plants also absorb water so there is less runoff
        iii. Plants stabilize soil and prevent erosion

EXERCISE- MAKING A SITE PLAN OF YOUR HOME. WHAT OBJECTS AND MATERIALS MAKE UP THE PLACE WHERE YOU LIVE? (15+ min.)

Now with all of this new knowledge about materials around our homes you are going to use your memory, questionnaire, and imagination to make a picture/plan of all the objects and materials that are around your home.

A. Let me walk you through an example sight plan of a friend's house and another friend's apartment
    1. This is a picture of my friend Rachel's house.
        The house is close to the street
        It has a driveway on the right and a sidewalk to the front door
        There are planter boxes and trees in the front yard
        There is a shed and a little apartment in the back yard
        There isn't much grass in the back yard but there is another tree
    2. Here is the example site plan we put together or this house
    3. There are a lot of hard surfaces around Sarah's house so there is a lot of runoff here.
    4. This is a picture of my friend Matt's apartment.
        Matt lives in this building here on the bottom floor.
        He parks his car here in the long parking lot.
        There is a sidewalk that leads from the parking lot to his building and the other building across from his apartment.
        The yard is shared with neighbors. There are a couple of plants and trees.
    5. Here is the example site plan we put together or this apartment
    6. There is a lot of paving around the apartment so there is a lot of runoff.
    7. Estimate whether the site plan creates little or a lot of stormwater runoff.

B. Each student will make a generic model of home property using colored paper.
    1. GCCDS will prepare standard size elements (sidewalks, driveway, house, garage, trees, garden, gutters, etc.)
    2. Students will take note of the different materials in their site plan, which ones are porous, or non porous, and estimate if their home creates a lot or a little stormwater runoff.

DAY 3 POLLUTION AND YOU- ACTIVITIES AND BEHAVIORS THAT AFFECT STORMWATER RUNOFF

Intro (5 Minutes)

A. Recap from Day 2
    1. Reintroduce the ideas of how different materials around your home and neighborhood affect the amount of runoff that leaves your home and makes its way to the Gulf.
    2. Go over what each type of gutter represents-ask students if they can remember the different types of drainage and ask students to define porosity or other key words.

Pollution and the world around you (15 minutes)

A. When rain runs off our yards, streets, and roofs it absorbs pollutants and brings them into stormwater system, which results in high concentrations of pollutants in our Bayous and in the Gulf.
B. In this experiment we will show how pollutants mix with water and how they impact the environment. There are four categories of pollutants and each impacts the environment differently. Begin to mix the pollutions into the water for drainage test-as mixing tell students what each thing represents and ask them for examples of things around them and discuss how they impact the water.
    1. The first type of pollutants are contaminates that dissolve into the water
        a. We will use Sprinkles to represent these
        b. Can you think of any contaminants that dissolve in water? (Fertilizer, dog poop, detergents, etc.)
        c. This type of contaminant reduces the water quality which limits the amount of species that can survive. In particular, the overuse of fertilizers is a widespread problem, and can drastically affect ecosystems by overloading them with nutrients. Have you heard of The Dead Zone in the Gulf?
    2. The second type of pollutants are large amounts of organic matter
        a. We will use Parsley Flakes to represent this
        b. Can you think of an example of this? (Yard trash, leaves, bush or tree trimmings).
        c. While organic material in small amounts is fine for a water system, large amounts clog up water movement and change the nutrient balance of the water.
    3. The third type of pollutants is manmade trash
        a. We will use Red Pepper Flakes to represent this
        b. Examples of this include? (Plastic bottles and bags, newspapers, cans, tires etc.)
        c. Ingested trash can kill wildlife and large amounts of trash can smother a habitat. Also, as trash breaks down it can release harmful chemicals.
    4. The fourth type is the chemicals that don't mix with water (hydrophobic)
        a. We will use Sesame Oil to represent this
        b. Examples of this include? (car oil, gasoline, a lot of industrial waste)
        c. These types of pollutants poison wildlife and persist in the environment for a very long time.

Eye-Spy/ Behavioral Analysis (10 Minutes)

A. In each of the following images there are examples of good and bad behavior that affect runoff. Can you pick out some of these? How do you think they affect the environment? If the behavior is negative, how would you improve it? What kind of pollutant/sprinkle is each of these?
B. Eye-Spy 1: The House (from left to right)
    - Littering
    - Leaving out large piles of organic matter
    - Leaving trash in loose bags on the street, not sorting out recyclables.
    - Animal Waste
    - Rainwater Barrel

- Car Washing
- Permeable Paving
- Use/overuse of fertilizers

C. Eye-Spy 2: The Bayou
- Animal Waste
- People Fishing
- Bulkhead
- Lawn up to water edge
- Rain Garden
- Riparian Edge/Native Plants
- Green Roof

D. Eye-Spy 3: The Apartment
- Littering
- Mardi Gras Litter
- Washing paint down drain
- Recycling
- Water sprinklers on pavement
- Gutter connected to planter
- Not disposing of oil properly
- Native Plants
- Planters

Site Plan, Part Two: (15 Minutes)

A. We are now going to think about our own homes and what kinds of behaviors we see that affect the rainwater runoff.
B. Using your site plan, mark places around your home where you notice a behavior that will affect the runoff. Think about where your trash is located, is it stored tightly or can it get into the stormwater system? Do you have a planter or garden at your home that absorbs rainwater? Do you have a rain barrel?
C. Using our example home, we might note the planters in the front yard, the semi permeable driveway, the water sprinklers that spray the road, the uncollected animal waste…
D. For this next part, think about:
   1. How does water move from your home into the bay? Using a marker/pencil draw how the water moves off of your roof and into the ground or drain. Where does runoff from your driveway go? And how about your sidewalk?
   2. Continue to note objects/behaviors that affect runoff. Here are some ideas to keep you going:
      a. What kinds of materials are around your house? Thinking back to our experiment on porosity, what materials absorb water and which ones shed it?
      b. What about the gutter or if you don’t have gutters, where does the runoff from the roof collect?
      c. Where is the nearest drain?
      d. Is there a pile of organic waste?
      e. Do you live near a stream or bayou? Does the water from your house flow into it?

DAY 4: What You Can Do to Improve Stormwater

Introduction/Recap (3 mins)
Last week we learned what stormwater runoff is, how materials (or our built world) affect runoff, and we learned how our behaviors affect runoff.

A. Questions to engage the class:
   - Who can tell me what runoff is?
   - Who can give me an example of a porous surface and how that surface affects runoff?
   - Who can give me an example of a non-porous surface and how that surface affects runoff?
   - What is an example of a behavior that negatively affects runoff/water quality?
   - What is an example of a behavior that positively affects runoff/water quality?

PREZI: IMPROVING STORMWATER AT YOUR HOME (12 MINS)
Today we are going to learn about ways we can positively affect (or improve) runoff and water quality!
In today's PREZI you will see how people change their actions to improve water quality and how people / designers create fun and interesting ways to use runoff and improve water quality. After the PREZI you will use these ideas and some of your own ideas to illustrate on your site plan how you can have a positive effect on stormwater runoff from your own home.

Slide:
1. Intro – How will you improve stormwater runoff?
2. Compare bad and good behaviors
3. Example of a bad place for stormwater runoff (all non-porous)
4. Example of buildings that absorb, filter or reuse stormwater
5. Example of a house that does not improve or help stormwater runoff
6. Example of houses that improve and/or use stormwater
7. Examples of yards that use, filter and decrease stormwater runoff
8. Example of a detention pond that is bad due to grass mown to edge, perhaps fertilizer = algae
9. Example of a detention pond that has clean water with lots of plants at the edge acting as a filter
10. Example of a seawall/bulkhead failing and not helping to filter stormwater or provide habitat
11. Example of a living shoreline that stabilizes the shore, filters water and provides habitat
12. Example of a culvert emptying into the Gulf, where stormwater carries all the pollutant with it
13. Ways to filter water before it goes into culverts, at the end of the culvert and beach plantings
14. Explain and compare the example site plans and their improvements

EXERCISE- MAKING IMPROVEMENTS ON YOUR SITE PLAN (20 mins)
Give students the Xerox copy of their plans and hand out colored construction paper, markers, glue and scissors. Have them illustrate through collage, drawings and words ways they can improve stormwater runoff on their site.

A. **(10 mins)** Allow for time at the end of class for some of the students to present their ideas to the class.