FINAL

Three Mile Creek Watershed Management Plan

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Three Mile Creek Watershed Management Plan

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ACRONYMS

A, Ad – Alluvial-Deltaic Plain

ACS – American Community Survey

ADA – Americans with Disabilities Act

ADCNR – Alabama Department of Conservation and Natural Resources

ADEM – Alabama Department of Environmental Management

ADWFF - Alabama Division of Wildlife and Freashwater Fisheries

ALNHP – Alabama Natural Heritage Program

AR4 – Intergovernmental Panel on Climate Change Working Group I Fourth Assessment Report

ASWP - Alabama State Water Program

BMP – Best Management Practice

BOD – Biochemical Oxygen Demand

BOD5 – Measured 5-day Biochemical Oxygen Demand

CBOD – Carbonaceous Biochemical Oxygen Demand

C-CAP – Coastal Change Analysis Program

CCMP – Comprehensive Conservation and Management Plan

CDBG – Community Development Block Grants

CEN – Central unnamed tributary to Three Mile Crek (see UTTM)

CIP – Capital Improvement Projects

COD – Chemical Oxygen Demand

Col/100 mi – Colony per 100 milliliter

CL- Coastal Lowland

CPS – Coastal Political Subdivision

CWA – Clean Water Act

CY – Cubic Yard

DO – Dissolved Oxygen

EPA – U.S. Environmental Protection Agency

EPT – Ephemeroptera, Plecoptera, Tricopera

FEMA – Federal Emergency Management Agency

GIS – Geographic information System

GOM – Gulf of Mexico

GOMESA – Gulf Environmental Benefit Fund, and the Gulf of Mexico Energy Security Act

GPRS – Gross Pollutant Removal Structure

GPS – Global Positioning System

I & I – Infltration & Inflow

IDW - Inverse Distance Weighting

INCM – Industrial Canal

l – Liter

LiDAR – Light Detection and Ranging

lf – Linear Foot

LWCF – Land and Water Conservation Fund

m – Meter

MAWSS – Mobile Area Water and Sewer System

MBNEP – Mobile Bay National Estuary Program

MEOW - Maximum Envelopes of Water

MEP – Maximum Extent Practical

mg – Milligram

mg/L – Milligrams per liter

MOM - Maximum of MEOWs

MS4 – Municipal Separate Storm Sewer System

MTL – Mean Tide Level

N – Nitrogen

NASA – National Aeronautics and Space Administration

NAVD88 – North American Vertical Datum of 1988

NBOD – Nitrogenous Biochemical Oxygen Demand

NGVD – National Geodetic Vertical Datum of 1929

NH3 – Ammonia

NHC – National Hurricane Center

NOAA - Nation Oceanic and Atmospheric Administration

NOx - Nitrous oxide

NPDES – National Pollutant Discharge Elimination Systerm

NPS – Non-point Source Pollution

NWI - National Wetlands Inventory

O&M – Operation and Maintenance

OCS – Outer Continental Shelf

ORP – Oxidation Reduction Potential

OSDS – Onsite Sewage Disposal System

P - Phosphorus

RCRA – Resource Conservation and Recovery Act

RESTORE – Resources and Ecosystems Sustainability, Tourist Opportunities and Revived Economies

SAV – Submerged Aquatic Vegetation

SLAMM – Sea-Level Affecting Marshes Model

SLOSH – The Sea, Lake, and Overland Surges from Hurricanes Model

SLR – Sea level rise

SOD – Sediment Oxygen Demand

SPH – Southern Pine Hills

SRF – State Revolving Funds

SRP – Soluble Reactive Phospshorus

SS – Sanitary Sewer

SSO – Sanitary Sewer Overflow

SWAT – Severe Weather Attenuation Tank

TKN - Total Kjehldahl Nitrogen

TMCP – Threemile Creek Partnership

TMDL – T otal Maximum Daily Load

TN – Total Nitrogen

TP – Total Phosphorus

TSB – Toulmins Spring Branch

TWEM – Central Northern Tributary to Three Mile Creek

USA – University of South Alabama

USACE – U.S. Army Corps of Engineers

USCB – U.S. Census Bureau

USDA – U.S. Department of Agriculture

USDHHS – U.S. Department of Health and Human Services

USDOT – U.S. Department of Transportation

USFWS – U.S. Fish and Wildlife Service

USGS – U.S. Geological Survey

UTTM – Unnamed Tributary to Three Mile Creek (see CEN)

WMP – Watershed Management Plan

WQ – Water Quality

WWTF - Wastewater Treatment Facility

EXECUTIVE SUMMARY

Purpose. Three Mile Creek and its surrounding watershed present an extraordinary opportunity for the Cities of Mobile and Prichard to turn what is now a community liability, due to its degraded condition, into a community amenity and a waterway destination. Throughout the process of developing this Watershed Management Plan (WMP), public input regarding the restoration of Three Mile Creek was incredibly supportive, particularly to make Three Mile Creek an accessible recreational destination (see Section 1.6.4). Three Mile Creek suffers from the negative effects of stormwater runoff in a highly urbanized area. Major pollutants contributing to the degradation of Three Mile Creek include trash/litter; bacteria from sewage (i.e., pathogens); excessive amounts of nitrogen and phosphorus from fertilizers (i.e., nutrients); and small particles broken down through weathering and erosion (i.e., sediments). The purpose of this Watershed Management Plan (WMP) is to document the current state of water quality and ecological impairment in the Three Mile Creek watershed; evaluate improvement measures and practices that could be implemented; and recommend a prioritized list of actions (including costs) needed to improve water quality and improve access for recreation, and by extension, the quality of life in the watershed. Where the above recommendations require the introduction of new impervious surface to the watershed the added goal of incorporating Low Impact Development (LID) and Green Infrastructure (GI) practices, such as permeable pavement, stormwater capture and minimization of impervious surfaces, to mimic the predevelopment environment of these areas and lessen stormwater impacts to watershed should also be considered. Suggested actions (see more detail in Section 6) include:

1) Develop trails along Three Mile Creek and integrate existing trails to increase public recreational space for hiking, walking, and picnicking. Include crossovers for recreation on both sides of the creek and utilize multi-use opportunities where education and LID/GI measures can also be incorporated such as stormwater parks.
2) Install best management practices (BMPs) such as upstream LID/GI, downstream sediment basins or manual collection to reduce trash/litter and sediments from entering Three Mile Creek.
3) Develop K-12 environmental education plans on preservation and restoration of Three Mile Creek.
4) Enhance and build canoe and kayak launch areas and portages to promote water sport activities.
5) Launch marketing program on Three Mile Creek as a natural resource available to residents for recreation.
6) Explore retrofitting opportunities for water retention ponds (e.g., Spring Hill Lake and USA wetlands) for enhanced water quality downstream and utilize multi-use opportunities where education and LID/GI measure can also be incorporated into existing parks.

7) Fund additional field sampling, analysis and studies to close data gaps.

Period Addressed by Watershed Management Plan. The scope and breadth of the recommended improvements from this WMP to restore water quality and habitat in Three Mile Creek will require significant time to implement. This WMP provides a 10-year framework to begin the implementation of recommended actions. This time frame is subject to change depending on the availability of funds, success of recommended projects, and watershed response. As part of the recommended adaptive management approach, a review of the WMP recommendations should be performed every year, with an in-depth assessment every 3 to 5 years. This review should consider monitoring results from implemented projects and whether changes are warranted to the project type, scope or area of implementation to achieve the stated goals and objectives of the WMP.

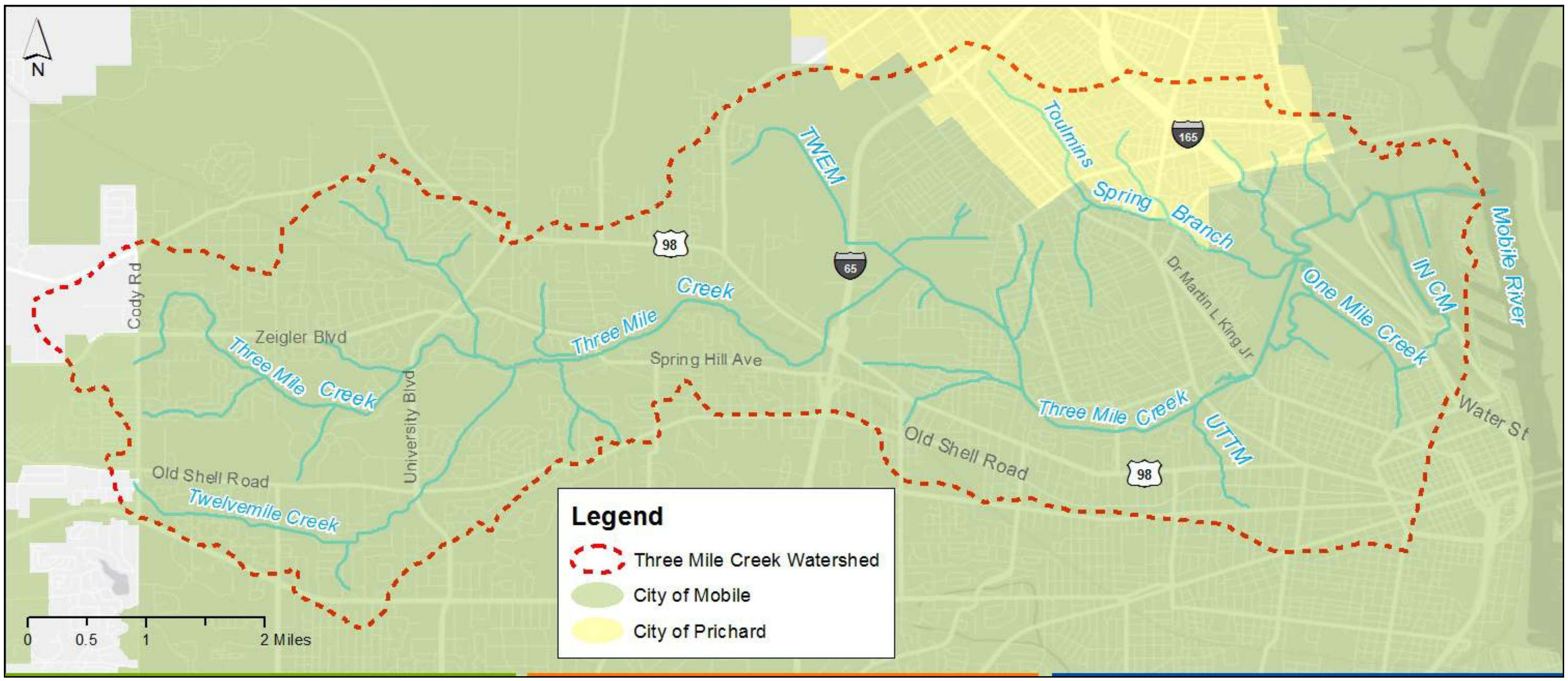
Section 2: Watershed Description. The Three Mile Creek watershed is located on the northern edge of the City of Mobile, Alabama (See Figure 1-1). Three Mile Creek drains a total area of approximately 30 square miles within the City of Mobile, which represents nearly 20% of the total city land area. The watershed's location immediately north of the urban core of the city made it one of the very earliest areas impacted by growth, as the population in the early 1700s spread from the French settlements of Old Mobile and Fort Conde that had been established on the shores of the Mobile River. The watershed's tidal bays and freshwater streams provided a source of food for settlers, and the varied terrain served as convenient homesteading lands. It served as Mobile's source of drinking water until the 1940s, when urbanization throughout the watershed resulted in the degradation of its water quality, forcing the city to look farther west to Big Creek for its drinking water supply. From 1974 to 2008, the Three Mile Creek watershed experienced an increase in urbanization from 49% to 70%, accompanied by a decrease in upland forest from 30% to 12%. (MBNEP 2, 2012)

Three Mile Creek stretches approximately 14 miles from west of the University of South Alabama (USA) east to its confluence with the Mobile River, which then drains to Mobile Bay. The Three Mile Creek watershed flows through residential sections of the city, habitat-rich wooded wetlands supporting a broad diversity of both marine and freshwater species, as well as areas that have since become urbanized. The land use distribution in the Three Mile Creek watershed is 42% residential; 26% commercial/industrial; 17% transportation; 6% industrial and 9% undeveloped/wetlands.

In 2010, the population within the Three Mile Creek watershed was 99,039 people and comprised 25% of the total population of Mobile County (U.S. Census Bureau (USCB), 2010). In a survey conducted from 2007 to 2011, nearly 25% of the household incomes within the Three Mile Creek watershed were below the national poverty line of $22,350 for a family of four. The median income within the watershed was $41,665 during this same period.

Three Mile Creek courses through: five of the City's seven Council Districts (Districts 1, 2 5, 6, and 7); all three Mobile County Commission Districts; and a small section of the City of Prichard along the Toulmins Spring Branch (TSB) tributary. The Creek banks also abut five public housing developments, the USA, the USA Medical Center, Mobile Infirmary, USA Children's and Women's Hospital, Mobile Gas/Sempra, Scotch Gulf Lumber and the Alabama Port. The geography of Three Mile Creek is what makes it unique – it can serve as a natural resource for many people within the community – but its geography also provides restoration challenges, such as addressing an array of pollutants and their sources, collaboration challenges among various stakeholders and funding needs for multiple implementation recommendations.

Figure ES-1 Map of Three Mile Creek Watershed



Section 3: Watershed Conditions

The major challenges facing Three Mile Creek watershed include:

1. Stormwater
    - **Effects of stormwater runoff** – significant impervious land cover generating excess stormwater runoff which is the primary source of trash/litter, nutrients, oxygen demanding substances, and pathogens to the creek during wet weather.
2. Wastewater
    - **Illicit connections and sanitary sewer outfalls (SSOs) -** primarily in tributaries and the creek below Martin Luther King Jr. Blvd. from groundwater seepage and direct sanitary discharges.
    - **Excessive water quality pollutants** –particularly pathogens
    - **Potential groundwater contamination** – potential contributions to Three Mile Creek from the Hickory Street Landfill and Mobile Gas/Sempra remediation site.
3. Ecology
    - **Abundance of invasive species** – Infestation of island apple snails, Chinese tallow (popcorn) trees, and wild taro, among others.
    - **Abundance of aquatic vegetation** – densely-matted nuisance vegetation related to nutrient over – enrichment, particularly in the downstream segment of the creek, contributing to low dissolved oxygen (DO).
    - **Altered watershed hydrology -** loss of floodplain connectivity; loss of connected wetland areas; reduced length of creek flow path; and loss of connectivity with historic streamway.
    - **Altered creek geomorphology** – loss of riparian buffers; construction of engineered channels and bank stabilization; stream bank erosion and sedimentation.
4. Access
    - **Lack of recreational access to the creek** – public access to the Creek is currently limited to only a few locations, and over a significant length the U.S. Army Corps of Engineers' (USACE) engineered channel, sheet pile weirs and riprap and gabion bank stabilization make use of the creek for water sports difficult.
5. Climate Adaptation
    - **Sea Level Rise (SLR) -** identified needs for BMPs to address long-term sustainability. Changing sea levels can alter the balance and distribution of native habitats in the watershed by negatively affecting some and

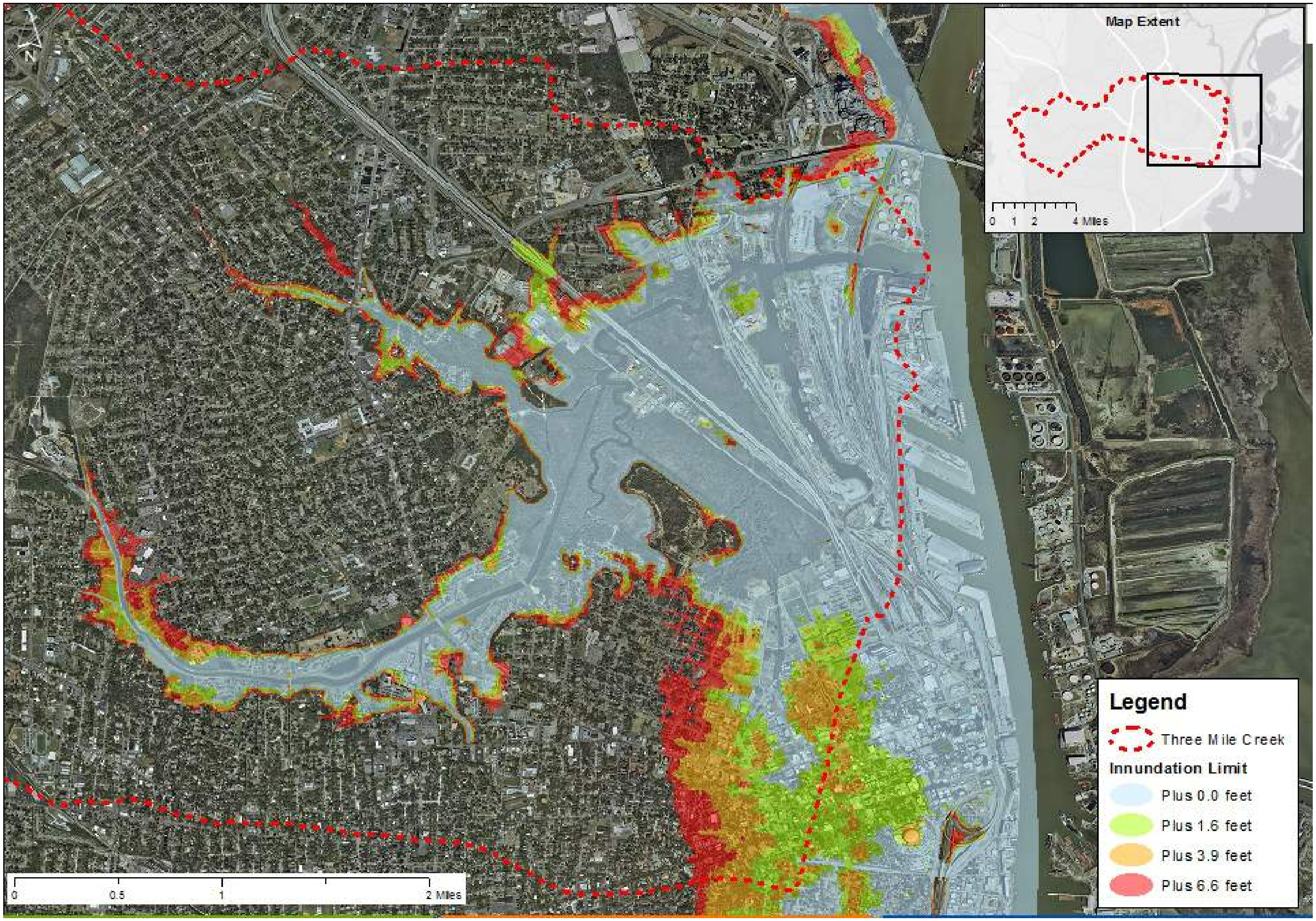
expanding or creating others.

- **Increased Incidents of Storm Events** – an increased incidence and intensity of storm events will result in higher tidal surges impacting infrastructure.

Section 4: New Data Collection

The information collected through existing reports and studies provided a great amount of detail of the major challenges facing the Three Mile Creek watershed. However, certain data must still be gathered to complete a full assessment. Three of the most significant data gaps uncovered through the development of the WMP relate to pollutant loadings, and specifically, whether the portion of the pollutant loads entering the creek is from groundwater seepage, creek bottom sediments, or Brownfield sites (previously developed sites with known groundwater and/or soil contamination). During the development of this WMP, the Dewberry Team collected additional data through water quality field sampling and modeling potential impacts to Three Mile Creek from SLR and potential storm surge events.

Figure ES-2 Inundation of each SLR scenario performed Note: inundation in feet, zero = current 1% flood zone.



Section 5: Watershed Management Goals and Objectives

<u>Goals for Three Mile Creek</u>

1) Improve water quality
2) Provide access to resources
3) Protect and improve the health of residents, fish and wildlife
4) Restore the heritage and cultural connection between the watershed and the community
5) Plan and prepare for climate resiliency

<u>Objectives of Three Mile Creek WMP</u>

1) Develop 12.3 miles of continuous greenway and restore natural channels and riparian buffer where feasible (Goal 2)
2) Develop a strategy for implementing Total Maximum Daily Loads (TMDLs) in coordination with the Alabama Department of Emergency Management (ADEM) (Goal 1 & 3)
3) Achieve State water quality standards for warm water fisheries (Goal 1 & 3)
4) Eliminate all known illicit connections/sanitary inputs (Goal 1 & 3)
5) Reduce amount of trash in waterways by 75% (Goals 1,3 & 4)
6) Maintain design level of service for flood protection from USACE dams (Goal 5)
7) Install environmental education signage in six existing or proposed parks (Goals 1-5)

Table ES-1 Provides a quick reference where each of EPA's 9 Elements of a Watershed Plans are addressed in this WMP.

EPA's 9 Elements of a Watershed Plans	Three Mile Creek WMP Reference Site	Page No. (s)
A. Identification of causes of impairment and pollutant sources or groups of similar sources that need to be controlled to achieve needed load reductions, and any other goals identified in the watershed plan.	**Section 3** discusses existing water quality impairments and potential sources of impairment for the Three Mile Creek watershed. **Table 3-50b** lists all current TMDLs and Delistings.	Pg. 119
B. An estimate of the load reductions expected from management measures	Structural BMP removal efficiencies ranges are shown in **Appendix H** for TSS, TN and TP. Other targeted removal efficiencies such as those for pathogens are either sources dependent or design specific and therefore will be determined in the Implementation phase of the WMP when load allocation modeling is completed.	Appendix H

C. A description of the nonpoint source management measures that will need to be implemented to achieve load reductions in paragraph 2, and a description of the critical areas in which those measures will be needed to implement this plan.	**Section 6** addresses non-structural and structural BMPs recommended for implementation in the watershed. These include NPS management measures to control stormwater runoff and improve water quality.	Pg. 190
D. Estimate of the amounts of technical and financial assistance needed associated costs, and/or the sources and authorities that will be relied upon to implement this plan.	The tables included in **Section 6 and 7** address the costs of implementing the recommendatins of the WMP.	Pg.177 Pg.299
E. An information and education component used to enhance public understanding of the project and encourage their early and continued participation in selecting, designing, and implementing the nonpoint source management measures that will be implemented.	Recommended non-structural BMPs (4NS, 5 NS, 7NS, 11NS and 12 NS) in **Section 6** specifically target public education and public involvement. These are included as part of the 1st priority project listed in **Table 6-12**. In addition, **Section 8** provides a detailed Public Engagement Plan for the implementation of the WMP.	Pg.194 Pg.223 Pg.244
F. Schedule for implementing the nonpoint source management measures identified in this plan that is reasonably expeditious.	**Table 6-12** includes a specific implementation schedule for the priority projects. Phase II projects and future project prioritization for the 10 year implementation period are discussed in **Appendix H**.	Pg.223
G. A description of interim measurable milestones for determining whether nonpoint source management measures or other control actions are being implemented	**Table 6-12** includes a specific milestone, where appropriate, for implementation of the priority projects. The role of Adaptive Management in determining future milestones is discussed in **Appendix H** and **Section 9** discusses Adaptive Management principles.	Pg.223 Pg.254
H. A set of criteria that can be used to determine whether loading reductions are being achieved over time and substantial progress is being made toward attaining water quality standards	The TMDL load allocations and percent reduction requirements are shown in **Table 3-50b**. More specific discretized targets will be developed when load allocation modeling is completed.	Pg.119
I. A monitoring component to evaluate the effectiveness of the implementation efforts over time, measured against the criteria established under item h immediately above	Monitoring is discussed **Section 6, Appendix H** and as part of Adaptive Management in **Section 9.**	Pg.177 Pg.253

Section 6: Management Measures and Cost Estimates

The Dewberry Team developed a list of recommended structural and non-structural BMPs to achieve the goals established for Three Mile Creek (discussed in detail in Section 6) which target the primary causes of degradation. There are three types of recommended management measures:

- Non-structural BMPs (including educational signs)
  - Field studies to identify non-stormwater pollutant sources such as groundwater contamination
  - Mapping of creek and tributary bathymetry to determine the depth of residual sediments on the creek bed
  - Researching potential partnership funding for BMP implementation by private land owners
  - Enhanced management (removal) of non-native invasive species along with general street and land management practices (trash collection)
  - Field observations to locate and address other pollutant sources such as illicit wastewater discharges or sediment discharges from construction sites
  - Placement of watershed awareness signage, educational signs, and placards (See Section 5.3.3.4 for further details on signage)
  - Additional environmental education and public outreach
  - Additional field monitoring and laboratory analyses of groundwater and surface water quality
- Structural BMPs (including green infrastructure solutions)
  - Install Gross Pollutant Removal Structure (GPRS) on pipe outfalls and/or LID/GI practices upstream
  - Install GPRS on channel outfalls and/or LID/GI practices upstream
  - Install green infrastructure retrofits on developed public access (below Langan Park)
  - Remove sediment and increase normal water depth/volume at USA wet ponds
  - Remove sediment and increase normal water depth/volume at Langan Park ponds
  - Add trash capture at Langan Park pond inflow points
  - Streambank restoration upstream of USACE segment and within
  - Riparian buffer restoration upstream of USACE segment and within
  - Remove bottom sediment at select locations

- Removed designated submerged nuisance vegetation
    - Remove channel plug and restore historic creek stream channel
    - Restore and enhance wetland areas adjacent to historic channel and create living shorelines.
    - Repair erosion and construct energy disappater on Twelve Mile Creek at certain locations
- Long-range sustainability project solutions
    - Monitoring plan
    - Tidal marsh restoration
    - Beneficial use of dredged material
    - Vegetative planting and marsh nourishment
    - Land acquisition to secure long term project protection
    - Rolling easements
    - Freshwater introduction in select areas to improve DO

These recommendations also include enhancing and developing greenways and blueways (see Section 5) for public recreation.

Costs estimates:

- The total estimated planning level cost for the priority BMPs for all four watershed segments ranges from $12 million to $34 million.
- The total estimated planning level cost for implementing structural BMPs in the Three Mile Creek watershed is $38 million to $130.5 million over 10 years.
- The total estimated planning level cost for the recreation facilities for the Three Mile Creek Watershed ranges from $15 million to $23 million.
- The total estimated planning costs for long-range sustainability project solutions is anticipated to be $90,000 to $125,000.

This section concludes with a summary table of the top projects to be implemented in the Three Mile Creek Watershed.

Table ES-2, Projects identified as providing early significant benefits to reaching the WMP goals for Three Mile Creek(*indicates which of the implementation strategies, if implemented in a section of the watershed contributing to an impacted stream segment, could improve the effected water quality parameter(s), See Tables 6-4 and 6-5).

TMC Watershed Challenge to be Addressed and CCMP Value	Priority Projects	Summary Description	Cost	Proposed Implementation Schedule
Stormwater Resiliency Water	Reduce the amount of trash in and entering the creek and tributaries with a focus on One Mile Creek, Toulmins Spring Branch, USA, and Langan Park	1. Utilize utility/trash boat/weed harvester/engage Navy Seabees (6NS) 2. Identify the outfalls that contribute the most trash (8NS, 10NS, 14NS*) 3. Install GPRS and/or Green Infrastructure in strategic locations (1S*, 2S*, 3S*) 4. Citizen involvement and education campaign (7NS, 11NS, 12NS) 5. Add trash capture at USA pond inflow points (6S*) 6. Add trash capture at Langan Park pond inflow points (7S*) *(* If purchase of utility/trash boat/weed harvester is required then add $800,000 to this Project (15NS, 16NS))*	$2.94M to $5.34M*	1. Initiate immediately 2. Initiate immediately 3. Following completion of 2 4. Continue throughout 10-year implementation period of WMP 5. Initiate immediately 6. Initiate immediately
Stormwater, Ecology Fish Resiliency Water	Remove sediment to increase storage capacity and conveyance of stormwater runoff while improving ecological conditions	1. Identify locations of excessive sediment (3NS, 11NS, 12 NS) 2. Remove sediment at strategic locations (4S*, 5S*, 12S*)	$18.2M to $72.7M	1. Initiate immediately 2. Within second year of adoption of WMP (Continue additional segments throughout 10-year implementation period of WMP)

TMC Watershed Challenge to be Addressed and CCMP Value	Priority Projects	Summary Description	Cost	Proposed Implementation Schedule
Wastewater Fish Resiliency Water	Remove Sanitary System Leaks, SSO, and Illicit Discharges in Toulmins Spring Branch and Unnamed Tributary to Three Mile Creek	1. Identify and remove sanitary system and septic system leakage/overflows into groundwater, creeks and tributaries (1NS*) 2. Identify and remove illicit discharges to stormwater and surface water system in watershed (2NS*) (Focus on Toulmins Spring Branch and UTTM sub-basins and lower portion of watershed (1NS* and 2 NS*))	$1.06M to $7.2M	1. Initiate immediately 2. Initiate immediately
Ecology Coastlines Fish Resiliency	Reduce the occurrence of nuisance and/or exotic species with a focus on One Mile Creek	1. Map SAV in watershed and Improve management of exotic/nuisance vegetation in wetland and upland riparian areas adjacent to creek and tributaries (6NS) 2. Develop plan for long term management. (6NS) 3. Utilize previously purchased utility/trash boat/weed harvester (6NS) *(* If purchase of utility/trash boat/weed harvester is required then add $800,000 to this Project (15NS, 16NS))*	$154,000 to $285,000 *	1. Within first year of adoption of WMP 2. Within second year of adoption of WMP 3. Perform within the WMP 10-year period (Implement Management Plan throughout 10-year implementation period of WMP)
Access Access Heritage	Initiate Construction of Greenway & Blueway Development	1. Establish a greenway along the existing USACE maintenance corridor utilizing the existing bridge at Martin Luther King Jr. Ave. to cross Three Mile Creek (1GW) 2. Anchor the Three Mile Creek blueway and greenway systems at Martin Luther King, Jr. Ave. and Tricentennial Park (1GW) 3. Construct two blueway access points at Tricentennial Park and Martin Luther King, Jr. Ave. (1BW)	$255,000 to $382,000	1. Initiate immediately 2. Initiate immediately 3. Initiate immediately (Continue additional segments throughout 10-year implementation period of WMP)

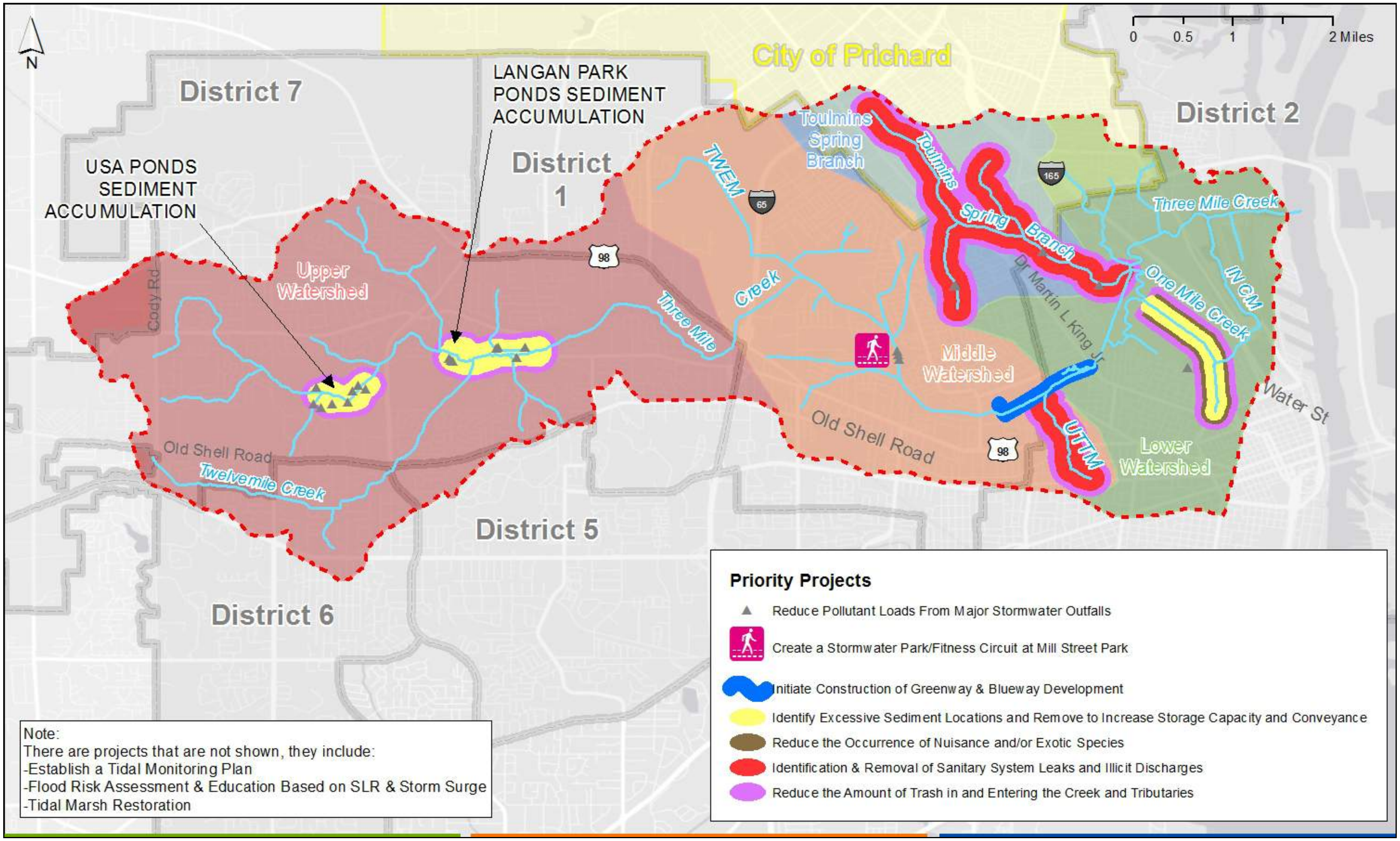
TMC Watershed Challenge to be Addressed and CCMP Value	Priority Projects	Summary Description	Cost	Proposed Implementation Schedule
Stormwater, Access Water Access Heritage	Create a stormwater park/fitness circuit at Mill Street Park	1. Install structural BMPs as part of stormwater park (1S*, 2S*, 3S*) 2. Integrate park access with blueway and greenway trail systems (1BW, 1GW) *(* Costs for easement purchase TBD)*	$546,000 to $966,000 *	1. Initiate immediately 2. Initiate immediately (Continue additional segments throughout 10-year implementation period of WMP)
Stormwater, Access Water Access Heritage Water	Establish a Stormwater and Tidal Monitoring System	1. Complete water quality monitoring identified in Data Gaps; identify major hydrologic and pollutant inputs (14NS*) 2. Identify or establish local tidal level monitoring sites and vegetation plots; monitor and record data in a database yearly (1CA) 3. At three-year intervals, evaluate changes in tidal range over time, vegetation survival/conversion and predictive modeling results to develop implementation plans for other projects (1CA)	$90,000 to $125,000	1. Initiate immediately 2. Conduct baseline monitoring during 2015 3. Continue throughout 10-year implementation period of WMP
Climate Adaptation Coastlines Resiliency	Flood Risk Assessment and Education based on SLR and storm surge	Incorporate flood risk management and storm surge information in educational outreach program (7NS)	Partnering Funds TBD	First quarter of 2015

TMC Watershed Challenge to be Addressed and CCMP Value	Priority Projects	Summary Description	Cost	Proposed Implementation Schedule
Climate Adaptation Access Heritage Coastlines Resiliency	Tidal Marsh Restoration	Utilize SLR, Tidal Monitoring data and Surge study results to identify opportunities (areas at risk) for land acquisition and tidal marsh restoration (2CA, 4CA, 5CA)	TBD	Within one year of adoption of WMP
		Total	$23.2M to $87.1M	

*Comprehensive Conservation and Management Plan

Three Mile Creek Watershed Management Plan

Figure ES-3, Top Priority Projects cover all subsegments of the watershed.



Section 7: Financing Alternatives

The path forward to successful implementation of this WMP will rely heavily on achieving a successful collaborative financing portfolio supported by Three Mile Creek watershed's three primary support sectors: government, business & industry, and the civic & non-profit. Dewberry conducted an assessment of the leading finance authorities and/or market instruments (i.e., grants, cooperative agreements, loans, taxes and fees) that currently have the greatest potential to help underwrite this WMP's projects implementation. This section identifies, and catalogs, over 80 separate authorities and instruments that could be pursued immediately to help successfully implement the WMP projects.

Table ES-3, Recommended funding sources for Top Priority Projects, first five year implementation cycle (2015 – 2019)

<table>
<tr><th rowspan="2">Priority Projects</th><th rowspan="2">Est. Cost (range)</th><th colspan="3">Recommended Support Targets/Authorities:</th></tr>
<tr><th>Federal/State Grants (65%)</th><th>Local Cost Share (15%)</th><th>Private Partnership Support (20%)</th></tr>
<tr><td>Reduce the amount of trash in and entering the creek and tributaries with a focus on One Mile Creek, Toulmins Spring Branch, USA, and Langan Park</td><td>$2.94M to $5.34M*</td><td>EPA
NOAA
USDA (GOMI)
DOD (NAVY Seabees)
ADEM
RESTORE</td><td rowspan="4">General Fund Commitments (County & Municipal)
Municipal Bonds
Clean Water SRF
Stormwater Utility Fee Program Implementation (w/TMC Set-aside)
AL RESTORE</td><td rowspan="4">Private Contributions and Grants Portfolio Development and Management
NFWF</td></tr>
<tr><td>Remove sediment to increase storage capacity and conveyance of stormwater runoff while improving ecological conditions</td><td>$18.2M to $72.7M</td><td>ACOE
NOAA
FEMA (HMGP)
USDA (GOMI)
ADEM
RESTORE</td></tr>
<tr><td>Remove Sanitary System Leaks, SSO, and Illicit Discharges in Toulmins Spring Branch and Unnamed Tributary to Three Mile Creek</td><td>$1.06M to $7.2M</td><td>EPA
ADEM</td></tr>
<tr><td>Reduce the occurrence of nuisance and/or exotic species with a focus on One Mile Creek</td><td>$154,000 to $285,000*</td><td>NOAA
USFWS
EPA
ACOE
RESTORE</td></tr>
</table>

<table>
<tr><th rowspan="2">Priority Projects</th><th rowspan="2">Est. Cost (range)</th><th colspan="3">Recommended Support Targets/Authorities:</th></tr>
<tr><th>Federal/State Grants (65%)</th><th>Local Cost Share (15%)</th><th>Private Partnership Support (20%)</th></tr>
<tr><td>Initiate Construction of Greenway & Blueway Development</td><td>$255,000 to $382,000</td><td>ALDOT
HUD/CDBG
USDA
RESTORE NOAA
DOI</td><td rowspan="5">General Fund Commitments (County & Municipal)
Municipal Bonds
Clean Water SRF
Stormwater Utility Fee Program Implementation (w/TMC Set-aside)
AL RESTORE
ADCNR
ADECA</td><td rowspan="5">Private Contributions and Grants Portfolio Development and Management
NFWF</td></tr>
<tr><td>Create a stormwater park/fitness circuit at Mill Street Park</td><td>$546,000 to $966,000*</td><td>Funded under Private Partnership Support</td></tr>
<tr><td>Establish a Stormwater and Tidal Monitoring System</td><td>$90,000 to $125,000</td><td>RESTORE
NFWF
EPA
NOAA
USGS
ADEM</td></tr>
<tr><td>Flood Risk Assessment and Education based on SLR and storm surge</td><td>Partnering, TBD</td><td>FEMA
AEMA</td></tr>
<tr><td>Tidal Marsh Restoration</td><td>TBD</td><td>RESTORE
EPA
NOAA
USFWS
ACOE</td></tr>
<tr><td>Total</td><td>$23.2M to $87.1M</td><td></td><td></td><td></td></tr>
</table>

Section 8: Partnering Together

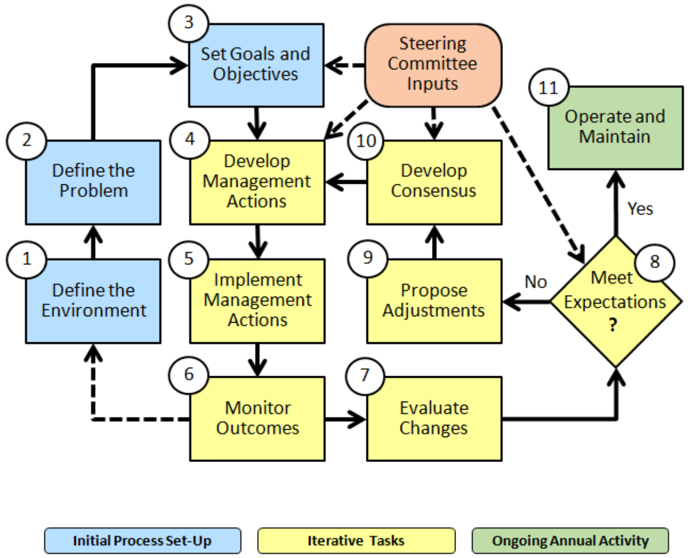
Public input was a critical component to the development of this WMP since successful restoration of Three Mile Creek relies on the vision of the surrounding community. Three Mile Creek is a public resource and the citizens of Mobile should define what restoration should look like. Public meetings, clean up events and social media alerts were among the many outreach mechanisms utilized to gain insight for Three Mile Creek's restoration. The Mobile Bay National Estuary Program (MBNEP) and the Dewberry Team directly learned from Mobilians what they would like to see, such as additional public access points, connecting walking and bicycling paths, and additional kayaking opportunities.

Moving forward, an independent leadership organization is needed to coordinate WMP implementation in close collaboration with MBNEP with the ultimate goal of spearheading Three Mile Creek's long-term restoration.

Section 9: Tracking Progress through Adaptive Management

Effective Three Mile Creek watershed management, including the implementation of BMPs, will involve making decisions based on multiple objectives constrained by available resources, implementation capabilities, regulations and uncertain responses to decisions. Adaptive management is a systematic approach for improving management decisions by accruing information, learning from initial outcomes, and utilizing this information. The adaptive management process proposed by the Dewberry Team for Three Mile Creek includes steps to monitor outcomes, evaluate changes, determine if goals and objectives are being met, propose adjustments, develop consensus and implement revised actions. (Figure ES-4)

Figure ES-4, the adaptive management process being proposed by the Dewberry Team consists of 11 steps with linked interactions.



1 INTRODUCTION

1.1 Purpose, Goals and Objectives

Three Mile Creek and its surrounding watershed present an extraordinary opportunity for the Cities of Mobile and Prichard to turn what is now a community liability, due to its degraded condition, into a community amenity and a waterway destination. The major challenges facing this watershed can be categorized into these five major issues: Stormwater, Wastewater, Ecological, Access, and SLR. Three Mile Creek suffers from the negative effects of stormwater runoff in a highly urbanized area. According to the U.S. Environmental Protection Agency's (EPA) National Summary of Impaired Waters and TMDL Information database, the pollutants causing the greatest number of surface water impairments across the U.S. include pathogens, nutrients and sediments (EPA, 2013). Three Mile Creek is no exception. Major pollutants contributing to the degradation of Three Mile Creek include trash/litter; bacteria from sewage (i.e., pathogens); excessive amounts of nitrogen (N) and phosphorus (P) (i.e., nutrients); and small particles broken down through weathering and erosion (i.e., sediments).

The purpose of this WMP is to document the current state of water quality and ecology in the Three Mile Creek watershed; evaluate improvement measures and practices that could be implemented; and recommend a prioritized list of actions needed to improve water quality, ecological integrity, and by extension, the quality of life in the watershed. The Watershed Management Team (see Section 1.3) developed the following goals and objectives for Three Mile Creek:

<u>Goals for Three Mile Creek</u>

1) Improve water quality
2) Provide access to resources
3) Protect and improve the health of fish and wildlife
4) Restore the heritage and cultural connection between the watershed and the community
5) Plan and prepare for climate resiliency

<u>Objectives of Three Mile Creek WMP</u>

1) Develop 12.3 miles of continuous greenway (Goal 2)
2) Develop a strategy for implementing TMDLs in coordination with ADEM (Goal 1 & 3)
3) Achieve State water quality standards for warm water fisheries (Goal 1 & 3)

4) Eliminate all known illicit connections/sanitary inputs (Goal 1 & 3)
5) Reduce amount of trash in waterways by 75% (Goals 1,3 & 4)
6) Maintain design level of service for flood protection from USACE dams (Goal 5)
7) Install environmental education signage in six existing or proposed parks (Goals 1-5)

1.2 Previous Studies

The Dewberry Team performed a detailed review of data available on the Three Mile Creek watershed. As a result, 88 reports, tables, spreadsheets and maps have been collected on various aspects of the Three Mile Creek watershed. Data has been collected from multiple agencies, including the ADEM, USACE, the City of Mobile (Mobile), the Mobile Area Water and Sewer System (MAWSS), and the MBNEP. The files have been grouped into the following categories based upon the type of file: Data Source Reports, Email, Environmental Reports, Maps, Modeling Reports, Outreach and Engagement, Photos, Sample Projects, Software, Spreadsheets, and Water Quality Reports (see Appendix A).

In the 1980s, the Mobile District of the USACE prepared preliminary design documents and an environmental assessment report for Three Mile Creek that recommended channel improvements to reduce flooding. These documents provided valuable information related to the design of the improvements, including channel straightening, channel widening and the installation of numerous weirs/water control structures.

Several items obtained during the data collection efforts revealed key information that forms the basis of this study and informs the required steps ahead. In 2004, the U.S. Geological Survey (USGS) published the report titled "Assessment of Water Quality, Benthic Invertebrates, and Periphyton in the Three Mile Creek Basin, Mobile, Alabama, 1999-2003." This report summarizes the results of extensive water quality and biological monitoring performed between 1999 and 2003 in the creek and two tributaries. Surface water flow monitoring was performed in conjunction with sample collection and laboratory analysis for a wide range of parameters, including nutrients, oxygen demand parameters, pathogens, benthic invertebrates, periphyton and even potential wastewater compounds. This report documented the water quality and biological conditions within Three Mile Creek at the time and identified key stressors (e.g., pathogens and nutrients, biochemical oxygen demand) to the surface water system.

In 2006, ADEM published the Final TMDL report for Organic Enrichment/DO for all three segments of Three Mile Creek. TMDL reports determine the amount of a pollutant that a body of water can receive while still meeting the regulatory numeric pollutant concentrations that protect the use of the waterbody (i.e., water quality standards). ADEM's report included the maximum pollutant load/contributions that can enter the creek while still maintaining healthy DO levels. ADEM also produced TMDLs for nitrogenous biochemical oxygen demand (NBOD) and carbonaceous biological oxygen demand (CBOD), which are tests of the amount of oxygen utilized by nitrogen and carbon-based bacteria to determine if the body of water needs more oxygen to thrive. ADEM performed model simulations in conjunction with field monitoring to develop these TMDLs for both point source pollution (areas of concentrated discharge such as a pipe discharging treated wastewater) and non-point pollution sources (i.e., general runoff of street rainfall into a nearby body of water). These TMDLs established and required NBOD and CBOD load reductions to improve water quality and gradually increase ambient dissolved oxygen concentrations throughout the creek, specifically improving dissolved oxygen conditions and conditions for biological life.

In 2009, ADEM developed final TMDLs for pathogens in TSB and the UTTM. In 2013 ADEM developed final TMDLs for pathogens in the lower two segments of Three Mile Creek. A draft delisting for ammonia was also issued in 2013. A TMDL is still pending for for nutrients in the UTTM. Once the TMDL is completed, the required load reductions will be specified for all primary pollutants of concern in the Three Mile Creek basin. The primary pollutants of concern include NBOD/CBOD (impacting ambient dissolved oxygen concentrations), nutrients and pathogens. A secondary concern is related to industrial and wastewater compounds in specific areas.

1.3 Period Addressed by the WMP

It will take significant time to implement the scope and breadth of the recommended improvements to stem the continued degradation of water quality in Three Mile Creek. This WMP provides a 10-year framework to begin the implementation of recommended actions to improve management of stormwater and wastewater, reduce the incidence of invasive species, restore hydrologic connectivity and provide recreational access to the Creek. This time frame is subject to change depending on the availability of funds, success of recommended projects and watershed response. As part of the recommended adaptive management approach, a review of WMP recommendations should be performed every year, and an in depth assessment every 3 to 5 years. This review should consider monitoring results from implemented projects and whether changes are warranted to the project type, scope or area of implementation to achieve the stated goals and objectives of the WMP.

1.4 Watershed Management Team

From the conception of this project, the MBNEP recognized the need for guidance from certain local leaders on the overall project direction, technical work and public outreach for the WMP. MBNEP staff provided the Dewberry Team with lists of contacts whose knowledge of and expertise on the issues would, the staff believed, provide valuable input to each area of the WMP. These contact groups included a conglomeration of local leaders in Mobile and Prichard who could provide overall input on project direction (Three Mile Creek Steering Committee); technical experts to guide and assist the Dewberry Team with scientific and geographical input (Three Mile Creek Technical Committee); and members of the community to help identify organizations and champions to disseminate project information to the public (Three Mile Creek Engagement Committee).

Each identified member for all the Committees (82 in total) was contacted by the Dewberry Team to be a part of the inaugural meeting on January 11, 2012. This inaugural meeting was the first assembly of all 82 members of the Three Mile Creek Steering Committee, Three Mile Creek Technical Committee and Three Mile Creek Engagement Committee to explain project goals and outline their potential involvement in the project. After the January meeting, the Dewberry Team met with a large representation (19) of the three committees on a one-on-one basis to learn about their knowledge and experience with Three Mile Creek, their vision for its restoration and their input for successful development of the WMP. Over the course of the year, these Committees assembled multiple times to provide their professional input and guidance, and many gave additional time and effort to execute this WMP. The details in this report would not have been possible without the many efforts of all Committee members.

1.5 Document Overview

This WMP is organized into the following sections:

- Section 2 provides background on Three Mile Creek watershed's characteristics and current conditions – its geography, hydrology, wetlands, soils, biological life, demographics and land use - to provide an understanding of current conditions.
- Section 3 includes an assessment of the challenges in the Three Mile Creek watershed such as stormwater and wastewater management, ecological modifications and lack of recreational access based on previously conducted studies.
- Section 4 identifies additional data to acquire, presents ideas for obtaining this information, and provides results from

new data collected or analyzed including field groundwater and sediment sampling by USA, SLR and storm surge modeling, and an inventory of stormwater outfall locations conducted by Dewberry.

- Section 5 discusses the goals and objectives and examines regulatory drivers and constraints to restoration.
- Section 6 provides an implementation strategy to address these challenges. This section also provides detailed information on restoration planning, associated costs and project recommendations for cost-efficient and effective restoration (in two phases).
- Section 7 presents a financial strategy, including available sources of funding (i.e., grants, partnerships, etc.) for restoration projects, and examines innovative mechanisms and alternatives for leveraging funding sources.
- Section 8 details the past public outreach efforts for this WMP including information on past Three Mile Creek Engagement Committee initiatives, suggested future public message campaigns, cleanup events, and strategies for key stakeholder involvement.
- Section 9 explores mechanisms for tracking progress including the use of visualization maps, how to adaptively manage as implementation efforts commence, ways to monitor the effects of efforts, recommendations for reporting and tools for measuring success.

1.6 Outreach Planning and Activities during WMP Development

1.6.1 Three Mile Creek Watershed Engagement Committee

Since the beginning of Three Mile Creek restoration planning, it was understood that interacting with and engaging with the public will be critical to the project's success. Information gleaned from earlier reports and articles, such as the City of Mobile Tricentennial Green Space Master Plan (2002) and the New Plan for Mobile (2009) demonstrated a strong public will to make Three Mile Creek an accessible recreational destination. Dewberry and the MBNEP made public engagement an equal priority to understanding the scientific and technical aspects of creek restoration. Therefore, the Three Mile Creek Engagement Committee (see Acknowledgements for a full list of committee members) was assembled to ensure that the WMP process was clear and transparent to the public and that all sources of input were incorporated into planning. Committee members, including concerned citizens, non-governmental organization members, academic and industry representatives, and local and state officials, contributed diverse expertise and knowledge regarding Three Mile Creek and its watershed communities. A primary purpose of restoring Three Mile Creek is to provide the public a value-added resource – an attractive venue to go for a walk, jog, or bike ride, have a family picnic, or paddle through the unique wilderness directly adjacent to downtown Mobile. A committee focused on public needs and desires was considered essential to comprehensive planning.

1.6.2 Engagement Committees Activites

The Engagement Committee convened on February 28, 2012, and received copies of a Three Mile Creek Public Engagement Plan prepared in advance by the Dewberry Team. This plan included the committee's purpose and goals, a list of targeted audiences and associated messages, and a list of potential engagement activities. This document was used to guide discussion and identify necessary tasks for committee members. MBNEP, Mobile Gas, Mobile Baykeeper, Partners for Environmental Progress, Mobile Area Chamber of Commerce, Mobile Housing Board, Auburn Marine Extension & Research Center, the City of Mobile, and the Mobile community were represented at this meeting.

Members also recommended additional organizations for participation in the Three Mile Creek engagement effort, including Keep Mobile Beautiful, the USA, and MAWSS. The group also agreed to focus on two specific engagement activities – a cleanup project and a series of public meetings – and created two subcommittees to guide these activities. Committee members volunteered to participate on one or both. The Engagement Committee and its Subcommittees met multiple times over the course of the year to coordinate efforts and provide input to the Dewberry Team and the MBNEP. Activities and accomplishments of the Engagement Committee and its subcommittees were communicated by the Dewberry Team several times throughout the year to the Three Mile Creek Steering Committee to seek guidance and direction.

1.6.3 Cleanup Subcommittee

The Three Mile Creek Cleanup Subcommittee focused on organizing cleanup events within the watershed, identifying similar events hosted by others, and bolstering participation. Hosting a series of cleanup events was considered, but due to the intense resource needs of executing these events, the Subcommittee agreed to concentrate on a single cleanup for the fall of 2013 and to support partner organizations leading other cleanup events. Mobile Baykeeper and the Mobile Housing Board co-hosted a Three Mile Creek cleanup on Saturday, March 23, 2013, at the Renaissance Corridor, and several Dewberry Team and MBNEP staff members assisted in both planning and cleanup efforts. The Dewberry Team and the MBNEP also supported the Great American Cleanup on April 27, 2013, and the 26th Annual Alabama Coastal Cleanup on September 21, 2013.

On November 23, 2013, the MBNEP organized and hosted "Take Pride in Toulminville,"where over 350 volunteers collected over 600 bags of trash, discarded tires, furniture, and other items from along Three Mile Creek and the streets of this neighborhood. The success of the event extended beyond the trash collection and helped residents connect with and appreciate the value of this local natural resource.

1.6.4 Public Meetings and Campaigning Subcommittee

The Engagement Committee also recognized the need for a subcommittee to guide a campaign to inform the general public and stakeholders about the issues facing Three Mile Creek and to gather their input to assist in developing the WMP. The role of the Public Meeting and Campaign Subcommittee was to develop messaging for the project, identify messaging vehicles, and coordinate public meetings to share information and gather public input.

Public Meetings

Dewberry and the MBNEP scheduled and conducted 13 public meetings throughout the watershed at schools, boys and girls clubs, senior centers, and churches (see Table 8-1). The meetings were held between April and May, 2013 during evening hours to allow working people to participate. The meetings were established to:

- Provide an overview of the challenges facing Three Mile Creek (i.e., litter and trash, poor water quality, invasive species, lack of recreational access points);
- Explain the watershed management planning process; and
- Obtain insight from attendees on their future vision of "an ideal" Three Mile Creek.

In addition, Dewberry and the MBNEP challenged attendees to organize their own neighborhood cleanups or collect trash littering the watershed near their homes. Materials such as trash pickers, gloves, and trash bags were provided.

Table 1-1 List of public meetings held throughout the Three Mile Creek watershed planning process

Date	Time	Place	Address
Tuesday, April 16, 2014	6:30 to 8 pm	Whitley Elementary School	528 Sipsey St. Prichard, AL
Thursday, April 18, 2014	6:30 to 8 pm	Roger Williams Boys and Girls Club	308 Simington Dr. Mobile, AL
Thursday, April 25, 2014	6:30 to 8 pm	Corpus Christi Catholic School	6300 McKenna Dr. Mobile, AL
Tuesday, April 30, 2014	6:30 to 8 pm	VIA (Mary Abbie Berg) Senior Center	1717 Dauphin St. Mobile, AL

Date	Time	Place	Address
Wednesday, May 1, 2014	4:30 to 6 pm	Ariel Holloway Elementary School	625 Stanton Rd. Mobile, AL
Thursday, May 2, 2014	6:30 to 8 pm	Mary B. Austin Elementary School	150 Provident Ln. Mobile, AL
Tuesday, May 7, 2014	6:30 to 8 pm	Florence Howard Elementary School	957 Dr. ML King Jr. Ave. Mobile, AL
Thursday, May 9, 2014	6:30 to 8 pm	Phillips Preparatory Middle School	3255 Old Shell Rd. Mobile, AL
Tuesday, May 14, 2014	6:30 to 8 pm	Clark Shaw Magnet School	5960 Arlberg St. Mobile, AL
Thursday, May 16, 2014	6:30 to 8 pm	Mobile Botanical Gardens	5151 Museum Dr. Mobile, AL
Tuesday, May 21, 2014	6:30 to 8 pm	Hillsdale Community Center	558 East Felhorn Rd. Mobile, AL
Thursday, May 23, 2014	6:30 to 8 pm	Forest Hill Elementary School	4501 Moffett Rd. Mobile, AL
Thursday, May 23, 2014	6:30 to 8 pm	St. Ignatius Catholic School	3650 Springhill Ave. Mobile, AL
Wednesday, June 5, 2014	6:30 to 8 pm	Ella Grant Elementary School	535 Easterling St. Prichard, AL

During these public meetings, the Dewberry Team and the MBNEP learned the following:

1. Public-Envisioned Strengths of Three Mile Creek Restoration Planning:
    - Overwhelming support for a connected corridor for biking, kayaking, walking, and running
    - Three Mile Creek could be a form of transportation for commuters and would reduce traffic.
    - Three Mile Creek restoration would encourage movement of people – families out having picnics, taking walks, and exercising.
    - Mobile could become a more bike-friendly community.
    - Three Mile Creek could be a symbol of Mobile – its own Central Park – an escape to nature from urban life next door.
    - The area around the historic streamway is a beautiful wilderness hidden within the city.
    - Three Mile Creek restoration would improve local home values, the economy, and the environment.
    - As trails connect Creek sections, public investment will grow and build momentum that will foster future planning efforts.
    - Current MAWSS project of relocating water treatment outfalls out of Three Mile Creek will improve water quality.
    - Three Mile Creek restoration would be a positive resource for children, encouraging them to spend time enjoying the outdoors.

2. Public Concerns re: Three Mile Creek Restoration Planning:
    - The Creek smells and is an eyesore. Huge amounts of trash and litter burden its banks.

- Three Mile Creek has been degraded over time, and much of its natural character is already lost.
- Potential health issues related to people eating fish caught in the creek.
- Lack of awareness about the Creek, making it difficult to generate public support.
- Existing bike paths are not maintained.

3. Opportunities and Ideas for Three Mile Creek Restoration:
    - Raising public awareness is critical to restoring the Creek. We need a public awareness campaign.
    - Any trails built need to be safe and efficiently designed; using eco-friendly ideas, methods, and materials, as well as implementing sustainable-use planning.
    - Trails should be large enough to provide space for potential walking/running races.
    - Trails on both sides of Three Mile Creek would be ideal.
    - Create additional locations for launching kayaks and canoes.
    - Consider a river walk shopping center with restaurants as a future goal.
    - Community development block grants (CDBGs) are a great way to secure future funding.
    - Three Mile Creek needs a new name, as the current one implies it is only three miles long and bears similarities to Three Mile Island. What about returning Three Mile Creek to its original name of Bayou Chatogue?
    - Churches can be a great vehicle to advertise public meetings and the restorative work being performed.
    - Engage community action groups in the restoration of Three Mile Creek.
    - Involve churches, sororities/fraternities, schools, and civic clubs.
    - Tricentennial Park is great, but packed –more access areas along Three Mile Creek are needed.
    - Restoration planners will need to work on this project one section at a time to build public trust and overcome negativity.
    - Planners need to think of groups that would use future parks, as well as the businesses that could sponsor park creation, beautification, improvement, or maintenance.
    - Use existing plans rather than trying to "reinvent the wheel."
    - "Piggyback" on existing efforts (i.e., look for opportunities to include the Three Mile Creek restoration on the agendas of existing meetings).
    - Need public/private partnerships.
    - Make it a priority to focus initial WMP restoration efforts on the Creek's eastern reaches to build the confidence of the neighborhoods in those areas and demonstrate that transformation will occur throughout the watershed. More

parks in the eastern reaches like Tricentennial Park.
- First step should be to put in trails before tackling water quality improvement - having visual improvement will help gain the support of the community.
- Ensure sufficient lighting along any built paths.

4. Threats to Success of Three Mile Creek Restoration
    - Safety is a priority, and we need to make sure people feel secure visiting Three Mile Creek.
    - A major challenge will be changing the littering culture in this area.
    - Potential for increased crime is a fear expressed in some neighborhoods.
    - Physical obstructions in Three Mile Creek will limit use by paddlers.
    - Different perceptions in populations east vs. west of I-65.
    - Industrial sites will be problematic.

Figure 1-1 Members of the public reviewing maps of the Three Mile Creek watershed during the April 30, 2013, public meeting at the Via Senior Center in Mobile

Figure 1-2 Presentation during the April 16, 2013, Three Mile Creek public meeting held at Whitley Elementary School in Prichard

1.6.5 Media Outreach

Through the course of WMP development, developments were shared through social media, websites, newspaper, radio, and other media.

- The Three Mile Creek webpage on the MBNEP's website was revamped to improve user experience and interactivity and to highlight history, culture, and current events in the watershed. Links added to the site include: event announcements; latest developments about the project; a portal for users to submit questions, comments, or ideas; videos; and photographs.
- MBNEP and Dewberry created and frequently updated a Three Mile Creek Facebook page, as well as a Three Mile Creek Twitter feed to share information on public meetings, cleanup events, and other notifications.
- The Mobile Press-Register covered the March 23, 2013 cleanup event. (http://blog.al.com/live/2013/03/three_mile_creek_cleanup_yield.html)
- The April 18, 2013, issue of the *Mobile Lagniappe* featured an article on Three Mile Creek and the public meeting

initiative (http://classic.lagniappemobile.com/article.asp?articleID=6350&sid=1).

- On May 2, 2013, the MBNEP also conducted an interview with DJ Felicia Allbritton on Mobile's WGOK Gospel 900 FM station to share Three Mile Creek developments and the public meeting schedule.
- The *Mobile Press-Register* also covered the November 23, 2013 cleanup event (http://blog.al.com/pr-community-news/2013/11/take_pride_in_toulminville_eve.html).
- *Mobile Lagniappe* featured planning efforts in its May 22, 2014 edition (agniappemobile.com/three-mile-creek-plans-aim-support-thriving-waterfront/)

1.7 Public Participation for Plan Adoption

Note to reader of Draft TMC WMP: this section will be completed after the comment period is completed.

The Draft WMP was released to the public for their review at a public meeting on xxxxxx held at the xxxx. It was provided electronically on the MBNEP website as well as many Committee member websites. The public had access to hard copies of the Draft WMP at the following libraries located within the Three Mile Creek watershed: xxxxx. The public was provided a 30-day review time that ended on xxxx. A summary of the information collected in written comments, emails and notes from the public meeting held on XXXX and the comments received can be found Appendix B.

2 LEARNING ABOUT THE WATERSHED

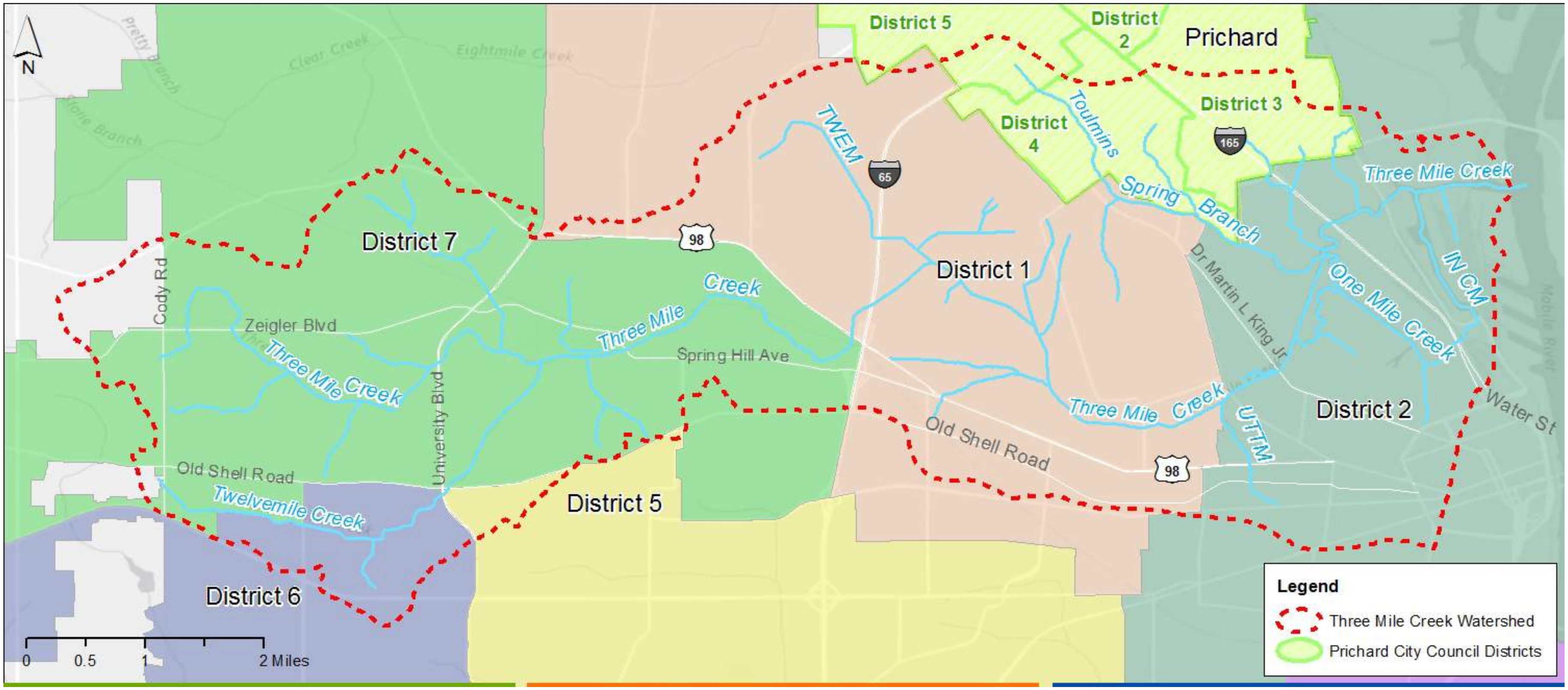
2.1 Watershed Description

The Three Mile Creek watershed (HUC 031602040504) drains a total area of 30.1 square miles within the cities of Mobile and Prichard (See Figure 2-1). The main channel in the watershed flows in an east-west direction into the Mobile River. The portion of the watershed within Mobile represents nearly 20% of the total city land area. The watershed's location immediately north of the urban core of the city made it one of the very earliest areas impacted by growth, as the population in the early 1700s spread from the French settlements of Old Mobile and Fort Conde that had been established on the shores of the Mobile River. The watershed's tidal bays and freshwater streams provided a source of food for settlers, and the varied terrain served as convenient homesteading lands. It served as Mobile's source of drinking water until the 1940s, when urbanization throughout the watershed resulted in the degradation of its water quality, forcing the city to look farther west to Big Creek for its drinking water supply. From 1974 to 2008, the Three Mile Creek watershed showed an increase in urbanization from 49.2% to 70.1%, accompanied by a decrease in upland forest from 30.3% to 12.2%. (MBNEP 2, 2012)

Three Mile Creek stretches 14 miles from west of the USA, east to its confluence with the Mobile River, which then drains to the Mobile Bay. The Three Mile Creek watershed flows through residential sections of the city, habitat-rich wooded wetlands supporting a broad diversity of both marine and freshwater species, as well as areas that have since become urbanized.

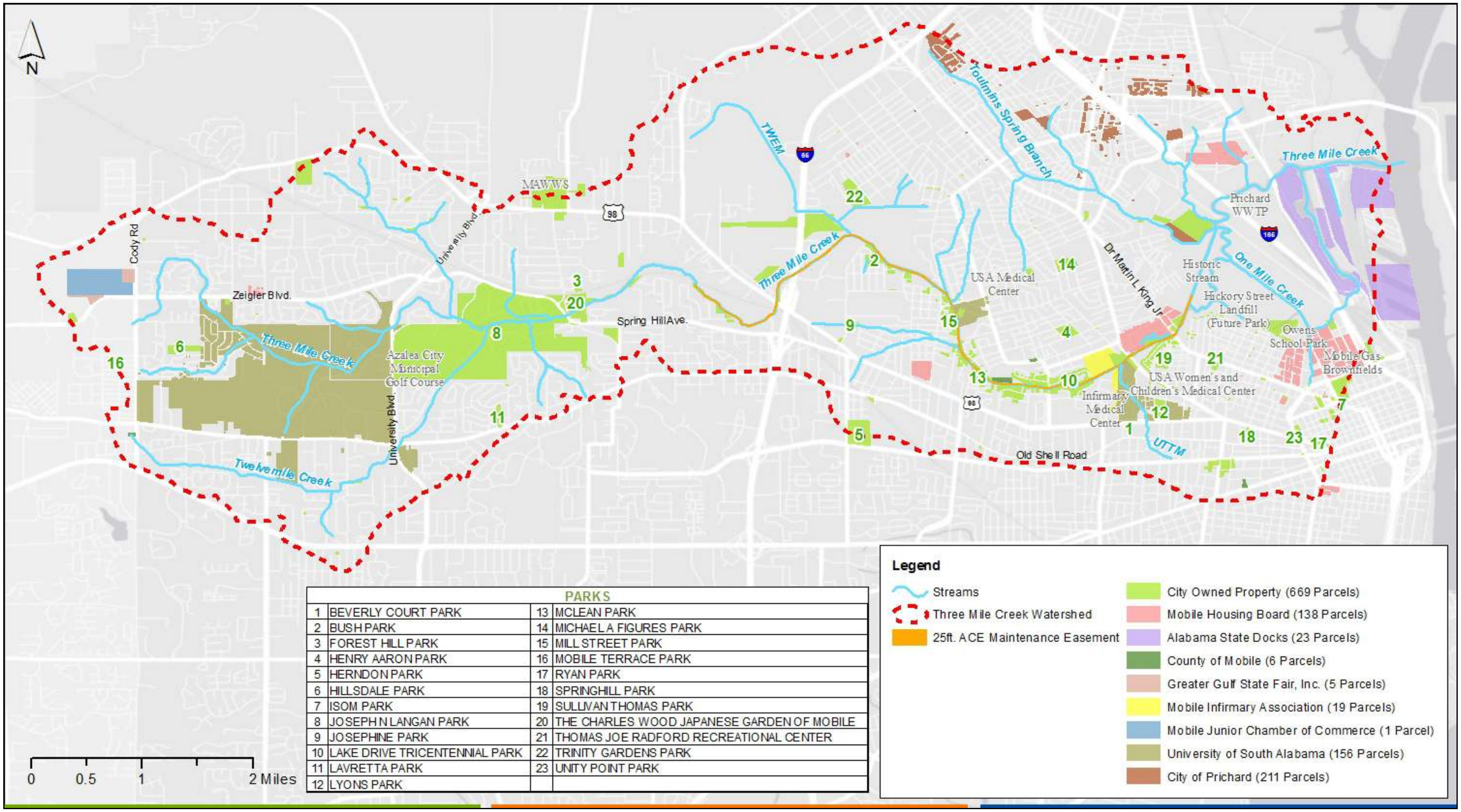
Three Mile Creek courses through five of the City's seven Council Districts (Districts 1, 2 5, 6, 7), all three Mobile County Commission Districts, and a small section of the City of Prichard along the TSB tributary (See Figure 2-1).

Figure 2-1 Five City Council-Districts and a portion of the City of Prichard Lie within the Three Mile Creek watershed



The watershed is home to major public and nonprofit landowners, including the USA; USA Medical Center; Mobile Infirmary; USA Children's and Women's Hospital; Mobile Gas/Sempra remediation site; Scotch Gulf Lumber; the Alabama State Port Authority; and the Mobile Housing Board, including five public housing developments (See Figure 2-2).

Figure 2-2 Significant Land Area along Three Mile Creek is Owned by Public & Non-profit Land Owners (Source: City of Mobile GIS, Mobile County Revenue Commission)



PARKS

1	BEVERLY COURT PARK	13	MCLEAN PARK
2	BUSH PARK	14	MICHAEL A FIGURES PARK
3	FOREST HILL PARK	15	MILL STREET PARK
4	HENRY AARON PARK	16	MOBILE TERRACE PARK
5	HERNDON PARK	17	RYAN PARK
6	HILLSDALE PARK	18	SPRINGHILL PARK
7	ISOM PARK	19	SULLIVAN THOMAS PARK
8	JOSEPH N LANGAN PARK	20	THE CHARLES WOOD JAPANESE GARDEN OF MOBILE
9	JOSEPHINE PARK	21	THOMAS JOE RADFORD RECREATIONAL CENTER
10	LAKE DRIVE TRICENTENNIAL PARK	22	TRINITY GARDENS PARK
11	LAVRETTA PARK	23	UNITY POINT PARK
12	LYONS PARK		

Three Mile Creek is physically, spiritually and historically deeply ingrained in the fabric of the Mobile community. After the Civil War, the economy in Mobile thrived from riverboat trade along the Mobile River and from a growing lumber trade industry that caused new development throughout the area, including a growing African-American community. In the early 1900s, the number of African-American churches increased, particularly in areas along Three Mile Creek. During this time, baptisms were held in Three Mile Creek for congregation members to "have their sins washed away" (Alabama Current Connection, 2013). In addition, historical paintings depict horse races and hotels along the Creek's banks. During interviews held with members of the Three Mile Creek Committees in January 2012, the Dewberry Team listened to individual stories of members swimming in Three Mile Creek during their childhood.

Currently, many residents frequent parks adjacent to the banks of Three Mile Creek – particularly Tricentennial Park – and a group of avid kayakers and canoers explores sections of Three Mile Creek. During our field trips, we also noted subsistence fishing occurring most frequently downstream in the lower watershed near Dr. Martin Luther King Blvd.

2.2 Watershed Characteristics

2.2.1 Hydrology

Located near the Gulf of Mexico, the Three Mile Creek watershed is subject to an abundance of rainfall and frequent tropical storms. Significant portions of the watershed have been altered to accommodate development and reduce flooding. Much of the development pre-dates current regulations, so stormwater BMPs were not used, resulting in water quality impairment and impacts to wildlife habitat.

2.2.1.1 Surface Water

Three Mile Creek drains a total area of 30.1 square miles – 27 square miles within the City of Mobile representing nearly 20% of the total city land area and 2.6 square miles within the City of Prichard. The unincorporated area of Mobile County contains the remaining 0.5 square miles. Three Mile Creek stretches 14 miles from west of USA, east to its confluence with the Mobile River, which then drains to Mobile Bay. From its origin to its confluence with the Mobile River, (the creek bottom profile of) Three Mile Creek falls less than 50 feet. This represents a vertical fall of approximately 2.5 feet every mile (Woods, 2004). It is notable that the majority of this fall occurs in the upper, less altered portion of the watershed above I-65. The Three Mile Creek watershed flows through residential sections of the city, habitat-rich wooded wetlands supporting a broad diversity of both marine and freshwater species, as well as highly urbanized areas.

As shown in Figure 2-1, the watershed contains six significant tributaries. Listed in order from downstream to upstream, these include (ADEM, 2013):

- Industrial Canal (INCM), length approximately 1 mile
- TSB, length approximately 2.5 miles
- One Mile Creek, length approximately 2 miles
- UTTM, length approximately 1 mile
- Central Northern Tributary (TWEM), length approximately 2 miles
- Twelve Mile Creek, length approximately 3 miles

The upper watershed also contains two notable impoundments, the 61.5-acre Spring Hill Lake in Langan Park and a 93-acre wetland/lake system on the USA campus (USGS, 2013). Both of these impoundments were created through the construction of dams. In addition five sets of man-made dams or weirs were installed in the middle portion of the watershed as part of the USACE Flood Control Project.

2.2.1.2 Climate

The City of Mobile is located on the western shore of Mobile Bay in proximity to the Gulf of Mexico. The Three Mile Creek watershed, located in northern Mobile, experiences a mild, subtropical climate, with hot, humid summers and mild, rainy winters.

The average maximum and minimum temperatures in Mobile during January (one of the area's colder months) are 61° F and 43.5°F, respectively. During July (one of the area's warmer months), average maximum and minimum temperatures are estimated at 90°F and 74° (SRCC, 2013). Record temperatures are a high of 105°F in August 2000 and a low of -1°F in February 1899 (Weather, 2014).

This area is also subject to frequent severe weather, including hurricanes. Coastal Alabama, including the Cities of Mobile and Prichard, has experienced hurricanes, tropical storms and other major wet weather events for decades. During the last century, the City of Mobile suffered from the impacts of many hurricanes, most notably the following 13 major hurricanes (Sealls, 2013):

- Category 3 - Unnamed hurricane in July 1916;
- Category 3 - Unnamed hurricane in October 1916;
- Category 3 - Unnamed hurricane in September 1926;
- Category 5 - Hurricane Camille in August 1969;
- Category 3 - Hurricane Frederic in September 1979;
- Category 3 - Hurricane Elena in 1985;
- Category 2 - Hurricane Erin in August 1995;
- Category 3 - Hurricane Opal in October 1995;
- Category 1 - Hurricane Danny in July 1997;
- Category 2 - Hurricane George in 1998;
- Category 3 - Hurricane Ivan in September 2004;
- Category 3 - Hurricane Dennis in July 2005;
- Category 3 - Hurricane Katrina in August 2005

2.2.1.3 Rainfall & Flooding

Rain occurs year round, with the heaviest rainfall occurring between April and September. Typical average rainfall for this region ranges from a monthly low of 3.69 inches in October to a monthly high of 7.25 inches in July. Mobile has been noted as the wettest city in the contiguous 48 States, with 66.3 inches of average annual rainfall (WeatherBill, 2007).

Historically, flooding has been a major concern within the watershed, particularly in the lower reaches of Three Mile Creek, also known as “The Bottom” (see Figure 2-4). This has led to federal projects to reduce the rate of flooding within the watershed. One of the most severe weather events to impact the City of Mobile was Hurricane Frederic in 1979. This storm caused widespread damage from flooding throughout the City. After Hurricane Frederic and subsequent smaller events, the USACE and the City undertook flood mitigation actions. These events prompted significant hydraulic modifications by the USACE to the creek that are now dominant features in the watershed. The flood control project developed and installed by the USACE in the early 1980s included hydraulic modifications such as creek widening, channelization, installation of weirs and profile changes. It began in 1982 when the USACE provided an Interim Survey Report to the City of Mobile (USACE, 1982). In 1984, USACE provided the City design plans based upon recommendations provided in the Interim Survey Report and a cost-share contract to provide flood relief to residents of the watershed. To protect against future flooding, the design plans included widening and straightening the lower third section of Three Mile Creek and adding five sets of water control weirs (occurring in pairs) between Brawood Drive and Tricentennial Park (USACE, 1984). This $18.5 M project reduced the area affected by flooding in the watershed by nearly 25% and, along with significant land buyout programs throughout the lower reaches of Three Mile Creek.

2.2.2 Topography and Floodplains

Progressing inland from the mouth of Three Mile Creek the terrain is mainly low coastal plain and tidal marsh. This includes tributary outfalls from the INCM, TSB, and One Mile Creek. This area also includes a section of historic wetlands. The upstream portion of the historic streamway that once connected these wetlands to Three Mile Creek is now interrupted by a sediment and vegetation channel plug. However, the historic channel is still confluent with the bypass channel just south of Conception Street Road. This area east of Martin Luther King Boulevard is most affected by tidal surge flooding, with elevations generally below 20 feet (referenced to the National Geodetic Vertical Datum of 1929 (NGVD)). Upstream from this point are the UTTM and TWEM tributaries before reaching I-65 which follows a natural ridge at 50 feet NGVD across the Three Mile Creek watershed. This ridge is also the general limit of upland riverine flooding experienced in the watershed (See Figures 2-3 and 2-4). From this point to its upper limit the watershed has a gently rolling terrain characteristic of pinewoods uplands and the land surface rises to a maximum elevation of 256 feet NGVD. Twelve Mile Creek, the last major tributary, enters Spring Hill Lake (part of Three Mile Creek) in Langan Park.

Figure 2-3 Flooding is Mainly Confined to Channel and Wetland areas in Three Mile Creek Watershed (source: Federal Emergency Management Agency (FEMA), Digital Flood Insurance Rate Map Database, Mobile County AL, March 2010)

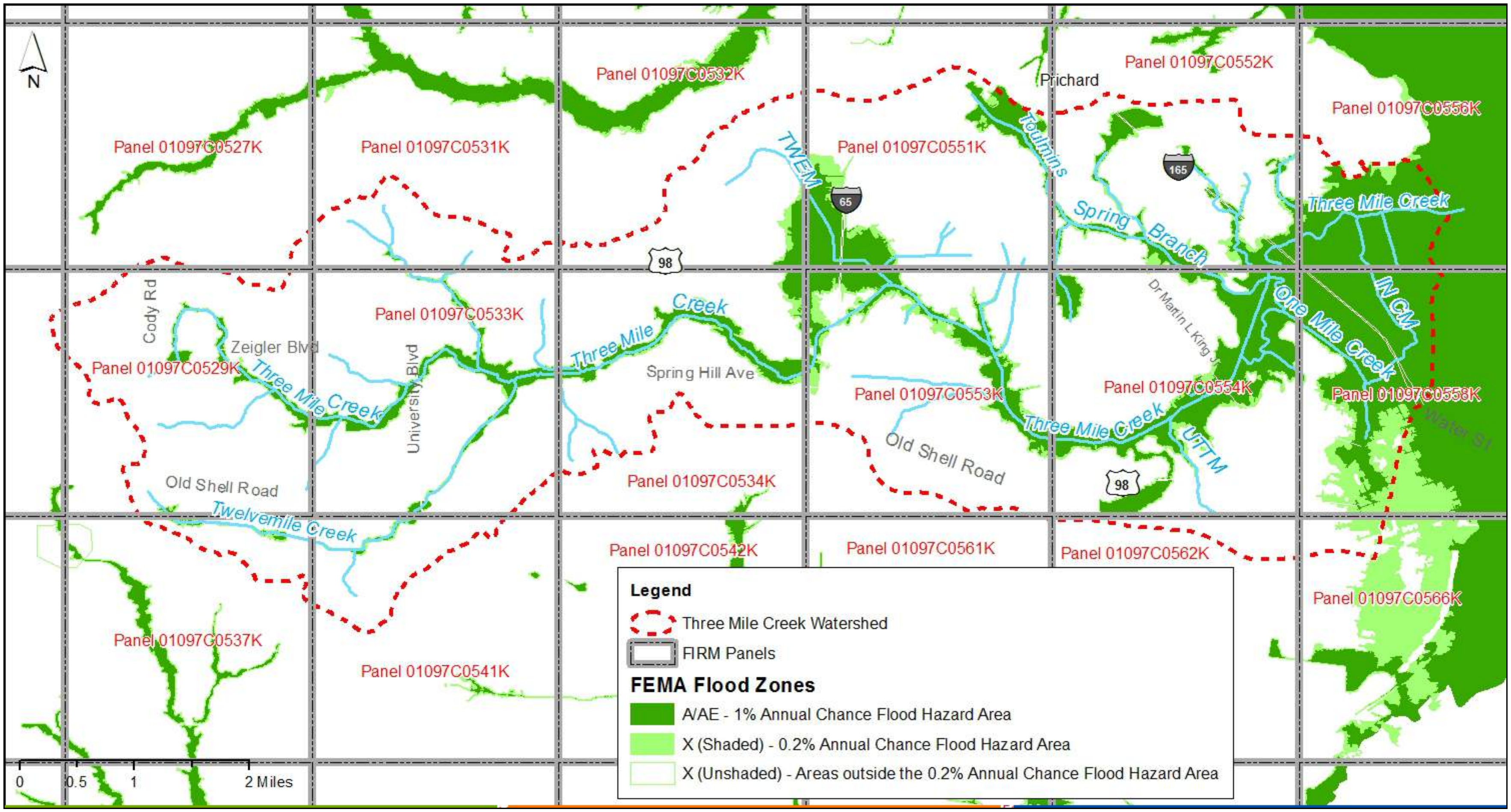
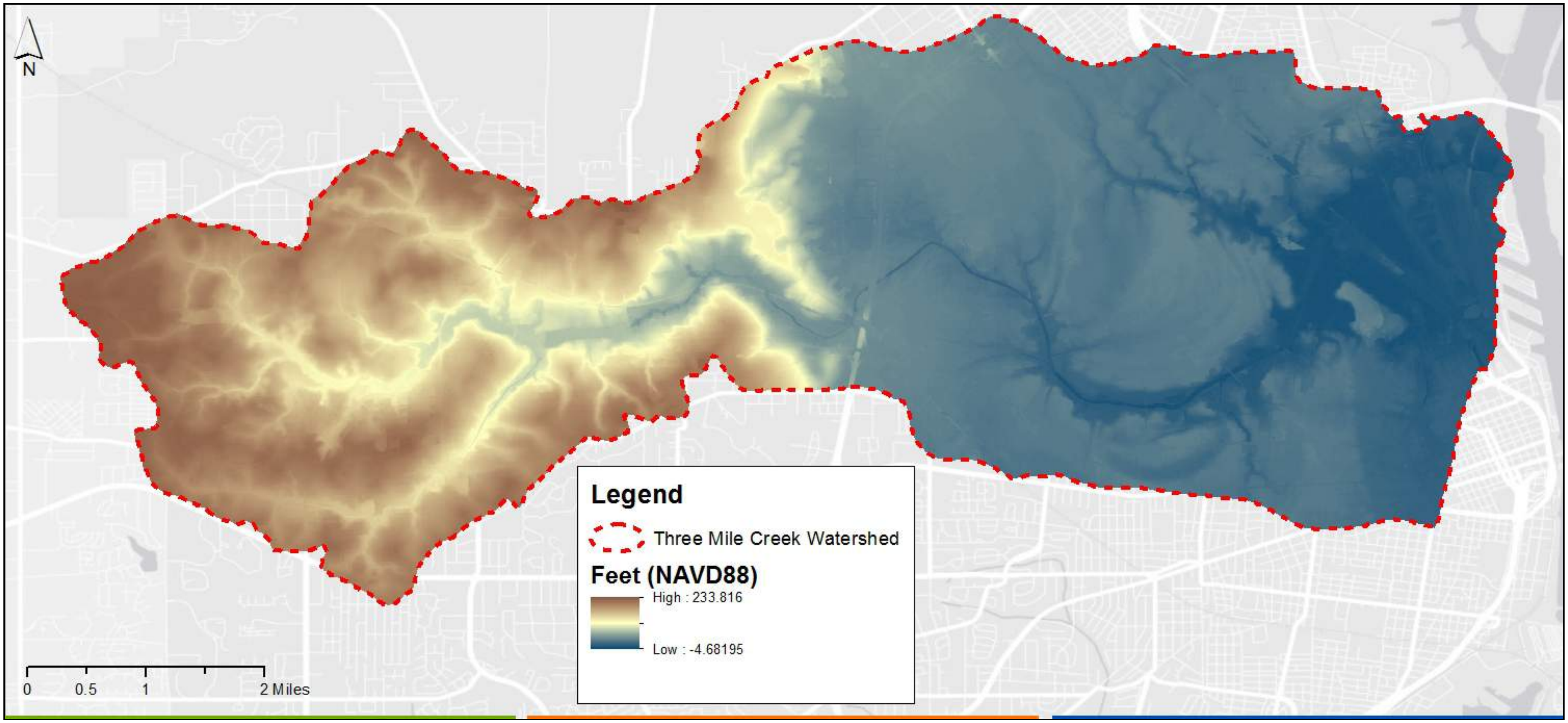


Figure 2-4 The Topography in the Three Mile Creek Watershed has an Abrupt Elevation Change Near I-65 (Source: Mobile County LiDAR, 2002)



2.2.3 Geology

The physiographic regions represented in the Three Mile Creek watershed are the Southern Pine Hills (SPH), the Coastal Lowlands (CL) and the Alluvial-Deltaic Plain (A, Ad). The SPH is underlain by terrigenous sediments, or sediments derived directly from the neighboring land, and make up the westernmost portion of the watershed. In the central portion of the watershed, the CLs are the principal physiographic region and are characterized by flat to gently undulating, locally swampy plains underlain by terrigenous deposits of the Holocene and late Pleistocene age. The A, Ad present at the easternmost reaches of the watershed exhibits very little topographic relief and consists of alluvial and terrace deposits from rivers (Woods, 2004).

2.2.4 Wetlands and Habitats

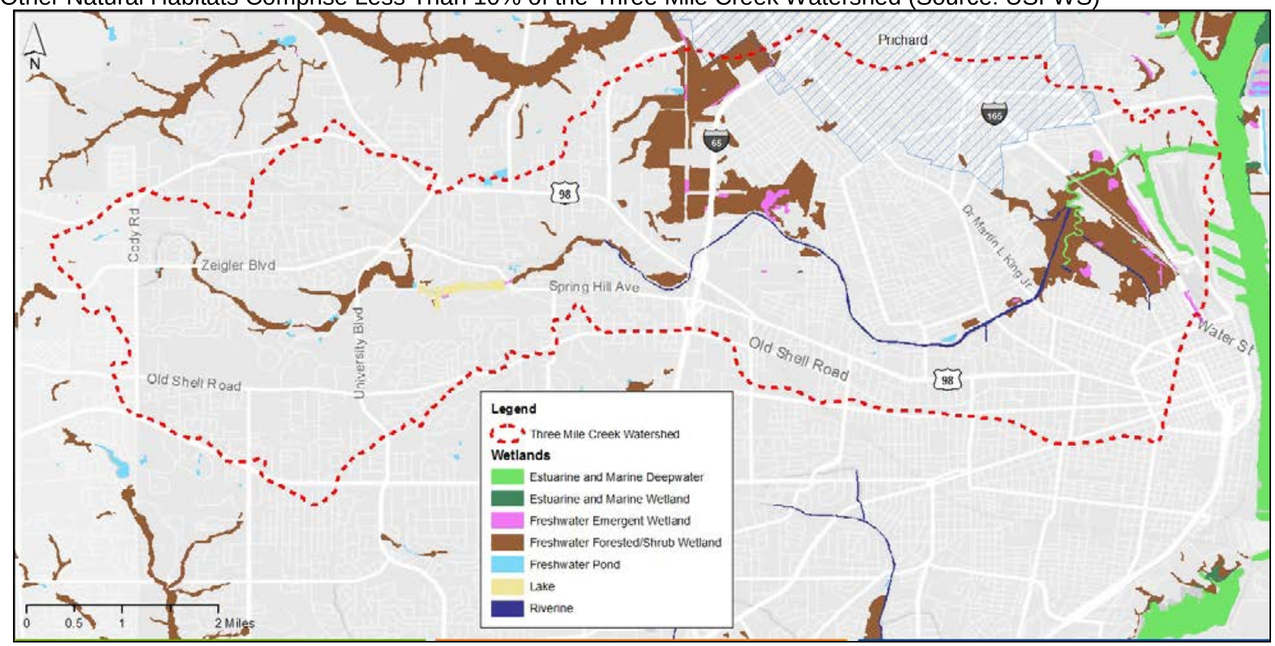
Wetlands and open water areas comprise less than 10% of the total area of the Three Mile Creek watershed. Of this, more than 8% is either Freshwater Emergent Wetland or Freshwater Forested/Shrub Wetland. These wetlands are primarily clustered around TWEM, a central northern tributary to Three Mile Creek near I-65. The wetlands associated with a historic stream channel are located within the vicinity of One Mile Creek near I-165 (See Figure 2-5). The watershed also contains Freshwater Pond and Lake habitats in the upland areas (USFWS, 2009). These wetland ecosystems provide vital functions and values that include groundwater recharge and discharge (seepage flow); flood flow alteration; fish and shellfish habitat; sediment, toxicant and pathogen retention; nutrient removal, retention and transformation (processing nutrients from one form to another); nutrient production export (effectiveness to produce food for living organisms); sediment and shoreline stabilization; wildlife habitat; recreation; educational/scientific value; uniqueness/heritage; visual quality and aesthetics; and threatened or endangered species habitat. Factors that decrease wetland function and value specifically for fish and wildlife habitat include degradation and fragmentation of wetland areas, disconnection and loss of greenway corridors. Typically a wetland will have a higher function and value for providing wildlife habitat if it is in close proximity to a continuous watercourse such as Three Mile Creek, and includes habitat features such as food sources, available cover, and breeding areas.

The wetlands in the Three Mile Creek watershed, specifically the diverse historic wetland area located in the vicinity of One Mile Creek, exhibits not only scientific, measurable qualities of wetland complexes such as ecological richness, but a unique visual and cultural presence as well. The American alligator (*Alligator mississippiensis*) and many species of wading birds are common finds in this tucked-away wetland complex of the Three Mile Creek watershed. A complete breakdown of habitat types and percentage, including wetland areas in the Three Mile Creek watershed, is presented below in Table 2-1.

Table 2-1 Three Mile Creek Wetlands and Habitats according to the National Wetland Inventory (NWI)

Type	Acres	%
Upland	17,389.5	90.40%
Estuarine and Marine Deepwater	116.2	0.60%
Freshwater Emergent Wetland	88.7	0.46%
Freshwater Forested/Shrub Wetland	1,476.8	7.68%
Freshwater Pond	26.6	0.14%
Lake	42.8	0.22%
Riverine	96.5	0.50%
TOTAL	**19,237.1**	**100%**

Figure 2-5 Wetlands and Other Natural Habitats Comprise Less Than 10% of the Three Mile Creek Watershed (Source: USFWS)



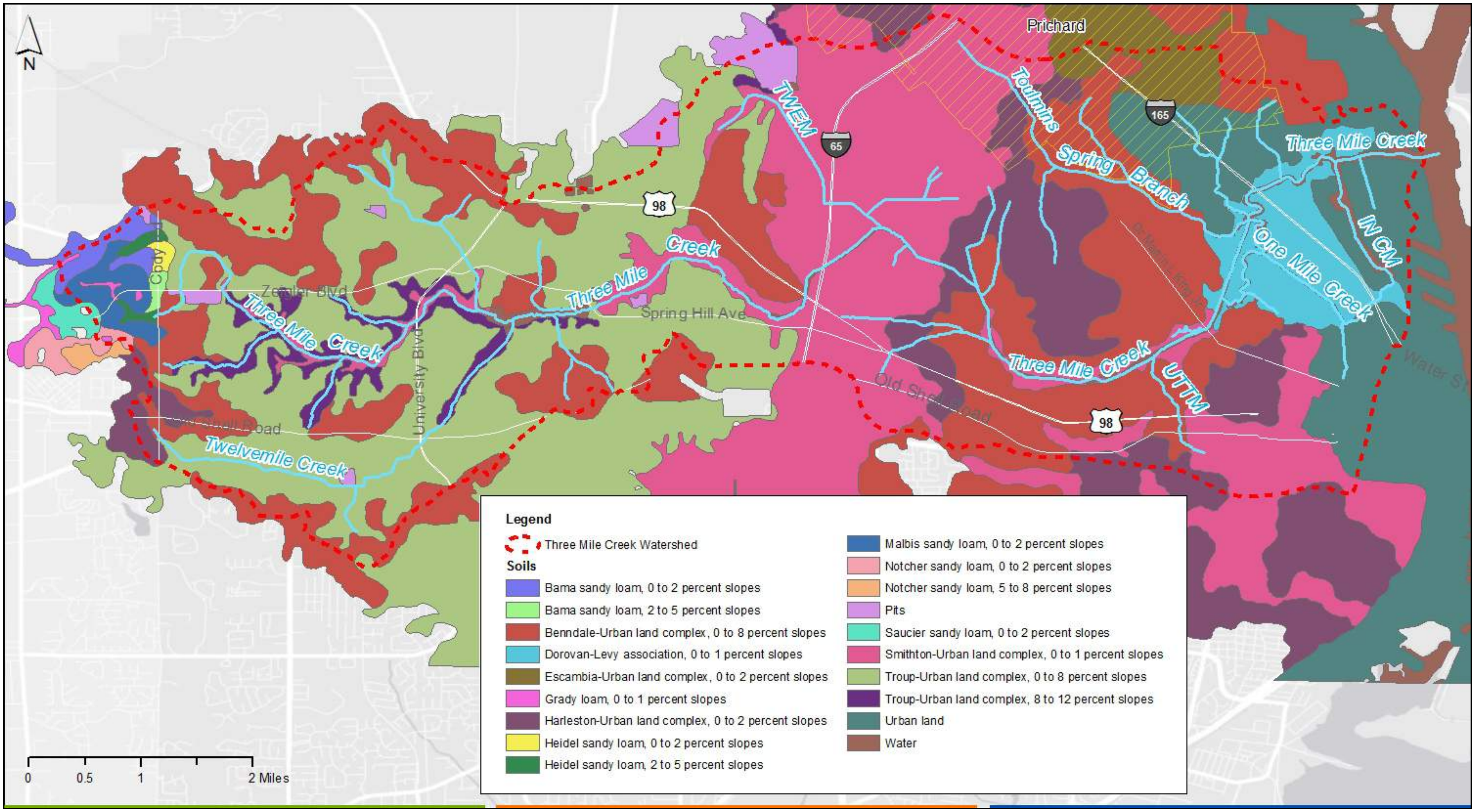
2.2.5 Soils

The watershed has two predominant soils - Troup-Urban land complex and Benndale-Urban land complex - that comprise nearly 50% of the total area. These sandy loam soils are generally well drained. The remaining predominant soil, comprising 25% of the area, is Smithton-Urban land complex, which is a poorly-drained loamy alluvial soil (See Figure 2-6). A complete breakdown of the U.S. Department of Agriculture (USDA), Natural Resources Conservation Service classified soils in the watershed is provided in Table 2-2 (USDA, 2006).

Table 2-2 Three Mile Creek Soils

Soil Map Unit Names	Acres	%
Bama sandy loam, 0 to 2 percent slopes	107.5	0.56%
Bama sandy loam, 2 to 5 percent slopes	25.1	0.13%
Benndale-Urban land complex, 0 to 8 percent slopes	4,729.7	24.59%
Dorovan-Levy association, 0 to 1 percent slopes	825.4	4.29%
Escambia-Urban land complex, 0 to 2 percent slopes	279.8	1.45%
Grady loam, 0 to 1 percent slopes	16.8	0.09%
Harleston-Urban land complex, 0 to 2 percent slopes	1,626.5	8.46%
Heidel sandy loam, 0 to 2 percent slopes	26.1	0.14%
Heidel sandy loam, 2 to 5 percent slopes	42.7	0.22%
Malbis sandy loam, 0 to 2 percent slopes	190.5	0.99%
Notcher sandy loam, 0 to 2 percent slopes	16.6	0.09%
Notcher sandy loam, 5 to 8 percent slopes	0.0	0.00%
Pits	167.2	0.87%
Saucier sandy loam, 0 to 2 percent slopes	8.8	0.05%
Smithton-Urban land complex, 0 to 1 percent slopes	4,172.0	21.69%
Troup-Urban land complex, 0 to 8 percent slopes	4,652.3	24.18%
Troup-Urban land complex, 8 to 12 percent slopes	487.8	2.54%
Urban land	1,553.1	8.07%
Water	318.1	1.65%
TOTAL	**19,246.1**	**100%**

Figure 2-6 Over 82% of the Soils in Three Mile Creek Watershed are Urban Land Complex (Source: USDA)



2.2.6 Flora and Fauna

The Three Mile Creek watershed exhibits a diverse and prolific array of flora and fauna. However, the signs of impacts to habitat are evident from anthropogenic activities and population pressures. Wading birds and various hawk species, which are indicators of ample food supply and acceptable habitat (Woods, 2004) are present in Three Mile Creek. Bird species observed in the Three Mile Creek include wading birds and other water-dependant birds, as well as resident raptor and song bird species. Table 2-3 lists some of the local breeding birds observed in the Three Mile Creek watershed (ADWFF, 2011):

Table 2-3 Three Mile Creek Breeding Birds

Genus/species	Common Name
Ardea alba	great egret
Ardea herodias	great blue heron
Egretta caerulea	little blue heron
Nyctanassa violacea	yellow-crowned night heron
Eudocimus albus	white ibis
Anhinga anhinga	anhinga
Egretta thula	snowy egret
Bubulcus ibis	cattle egret
Aix sponsa	wood duck
Pandion haliaetus	osprey
Buteo lineatus	red-shouldered hawk
Elanoides forficatus	swallow-tailed kite
Strix varia	barred owl
Bubo virginianus	great horned owl
Melanerpes carolinus	red-bellied woodpecker
Dryocopus pileatus	pileated woodpecker
Sphyrapicus varius	yellow-bellied sapsucker
Megaceryle alcyon	belted kingfisher

Genus/species	Common Name
Vireo griseus	white-eyed vireo
Vireo olivaceus	red-eyed vireo
Polioptila caerulea	blue-gray gnatcatcher
Protonotaria citrea	prothonotary warbler
Geothlypis trichas	common yellowthroat
Passerina ciris	painted bunting

The Alabama Natural Heritage Program (ALNHP) is an ongoing ecological inventory administered through the Auburn University Environmental Institute that exists to clearly identify significant natural elements (rare and endangered species and communities of species) in order to establish conservation priorities in Alabama. The Dewberry Team contacted the ALNHP for the latest data for the Three Mile Creek watershed and the results (dated January 15, 2014) indicated that three (3) rare plant species are known to exist within the Three Mile Creek watershed: the critically imperiled loblolly bay (*Gordonia lasianthus*), a small to medium-sized evergreen tree found in acid, swampy soils; capitate spikerush (*Eleocharis olivacea*), a sedge found in wetlands; and incised groovebur (*Agrimona incisa*), a small flowering plant in the rose family. The loblolly bay and capitate spikerush are state ranked as critically imperiled which is defined as extremely rare, with very few remaining individuals or acres. Incised groovebur is state ranked as imperiled, which is defined as rare due to few individuals or acres.

The ALNHP provides a list of species and natural communities for Mobile County categorized as follows: caddisflies, crayfish, ferns and relatives, fishes, flowering plants, freshwater mussels, freshwater snails, mammals, reptiles, turtles, and natural communities (Appendix C). This list identifies which of those species are rare, threatened or endangered. The ALNHP stated that for most of the listed species, the probability of their occurrence in the Three Mile Creek watershed is low given the highly developed nature of the watershed, however, there is a possibility that some of the listed species could be found in the watershed if suitable habitat exists.

The lower reaches of Three Mile Creek provide a unique ecological niche for a population of North America's largest reptile, the American alligator (*Alligator mississippiensis*). Alligators are apex predators (not preyed upon), and also opportunistic feeders, eating what is readily available to them. Adult alligators eat large fish such as gar, snakes, turtles, and mammals such as nutria, muskrats and raccoons. Young alligators eat fish, insects, snails and worms. Alligators are a keystone species, a vital part of their ecosystem, controlling the long-term vegetation dynamics in wetlands by reducing the population of small mammals, particularly nutria, which overgraze marsh vegetation. A unique relationship exists between nesting water birds in freshwater wetlands and the alligator - the alligator prevents predatory mammals from reaching rookeries and in return eats the spilled food and birds that fall from the nests.

Another unique contribution by the alligator to the surrounding ecosystem is the construction and maintenance of small ponds in or near the water, often in wetlands, known as alligator holes. These holes serve as the nest for alligator egg lying, but also serve as a refuge to aquatic organisms during the dry season, as well as serving as an important foraging area for birds and mammals. The alligators residing in Three Mile Creek are not only a local interest for paddlers and other stakeholders, but an important resource to the watershed.

The Alabama Division of Wildlife and Freshwater Fisheries (ADWFF), conducts periodic diversity sampling on the state's reservoirs and waterways to keep an inventory of, and manage the fish species residing in Alabama's waters. A sampling effort in the fall of 2009 recorded 19 species representing 10 families of fish (ADWFF, 2009).

Table 2-4 Three Mile Creek Fish

Family	Genus/species	Common Name
Amiidae	*Amia calva*	bowfin
Anguillidae	*Anguilla rostrata*	American eel
Centrarchidae	*Lepomis gulosus*	warmouth
	Lepomis macrochirus	bluegill
	Lepomis megalotis	longear sunfish
	Lepomis microlophus	redear sunfish
	Lepomis miniatus	redspotted sunfish
	Micropterus salmoides	largemouth bass
	Pomoxis nigromaculatus	black crappie
Cichlidae	*Oreochremis niloticus*	Nile tilapia[1]
Clupeidae	*Brevoortia patronus*	menhaden[2]
Cyprinidae	*Notemigonus crysoleucas*	golden shiner

Family	Genus/species	Common Name
	Notropis texanus	weed shiner
Elassomatidae	*Elassoma zonatum*	banded pygmy sunfish
Esocidae	*Esox niger*	chain pickerel
Fundulidae	*Fundulus notti*	southern starhead topminnow
Ictaluridae	*Ameiurus nebulosis*	brown bullhead
Lepisosteidae	*Lepisosteus oculatus*	spotted gar
	Atractosteus spatula	alligator gar[3]
Mugilidae	*Mugil cephalus*	striped mullet
Sciaenidae	*Aplodinotus grunniens*	freshwater drum

[1] Non-native species
[2] Not included in ADWFF 2009 sampling, but observed in TMC lower reaches
[3] Not included in ADWFF 2009 sampling, but verified by ADWFF to exist in TMC

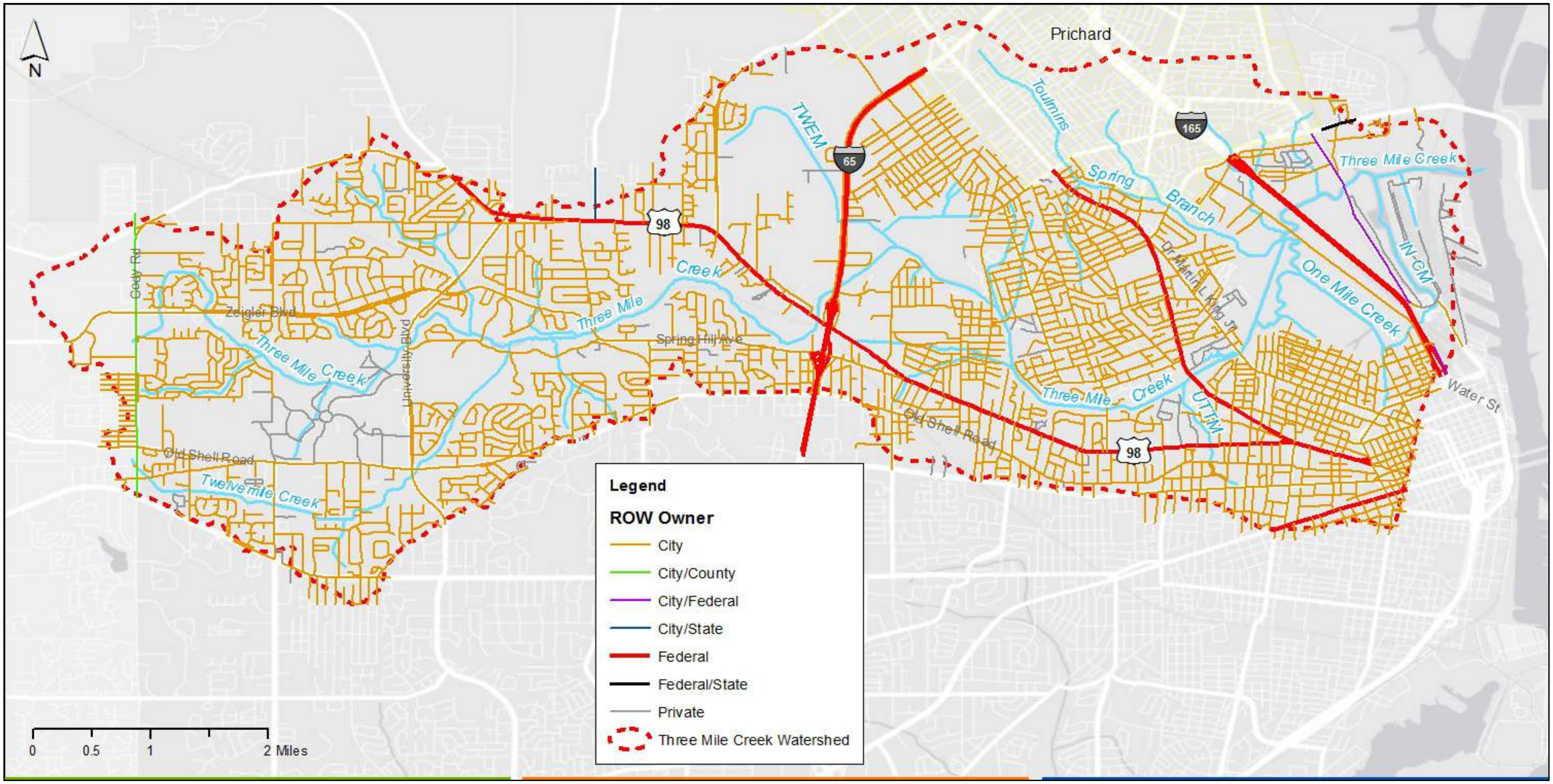
According to ADWFF Three Mile Creek is the primary location for collecting adult alligator gar for brood fish in ADWFF's stock enhancement project. The alligator gar are far less numerous than the spotted gar, and are rarely caught using electrofishing methods during the sampling efforts (D. Armstrong, personal communication, February 19, 2014).

2.2.7 Political Institutions

Approximately 90 percent of the watershed is controlled by the City of Mobile with the City of Prichard controlling approximately 8.5 percent and the remaining area in unincorporated Mobile County (See Figure 2-1). Interstates 65 and 165 and State Roads 98 and 45 and Telegraph Road and their associated rights of way are the only state and federal holdings in the watershed. The remaining roads are controlled by the Cities except Cody Road which has shared jurisdiction by the County and City of Mobile (See Figure 2-7). All of the drainage from the watershed within the City of Prichard discharges to the City of Mobile, mostly via the Toulmins Spring Branch. All of Three Mile Creek lies within the control of the City of Mobile. The City also controls the maintenance easements along the lower portion of the creek obtained during the construction of the USACE Flood Control Project. In addition to these political institutions, there are significant holdings along the creek that are under the ownership of other governmental and non-profit entities including: the USA Medical Center; Mobile Infirmary; USA Children's and Women's Hospital; Mobile Gas/Sempra historic coal gasification remediation site; the Alabama State Port Authority; and the Mobile

Housing Board (including five of their public housing developments) (See Figure 2-2).

Figure 2-7 The Road network in the Three Mile Creek Watershed is Predominantly Maintained by the City

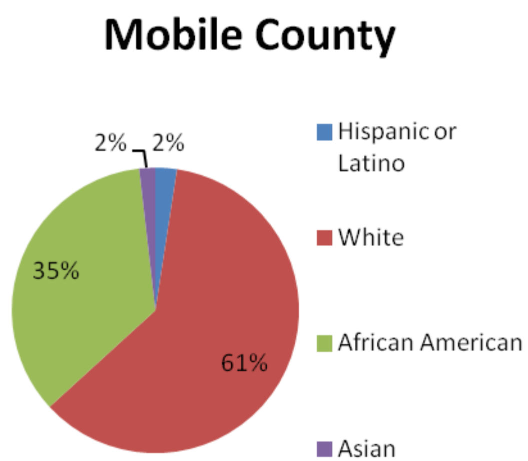


2.2.8 Three Mile Creek Watershed Demographics

The total population within the Census Block Groups that intersect the Three Mile Creek watershed in 2010 was 99,039 people - nearly 25% of the total Mobile County population (USCB, 2010). In 2010, the population within the Three Mile Creek watershed was 99,039, encompassing 25% of the total population of Mobile County (USCB, 2010). The population of the City of Mobile in 2010 was 195,111, of which approximately 88,784 (45.5%) people lived within the Census Block Groups that intersect the watershed. The population of Prichard in 2010 was 22,659, of which approximately 10,255 (45%) people lived within the Census Block Groups that intersect the watershed. This section provides more detail on the population of the area and information on resident incomes.

Mobile County and the Cities of Mobile and Prichard have multi-ethnic populations. According to the 2010 Census (USCB, 2010; GeoLytics, 2013), the ethnic distribution of Mobile County's population of 412,992 people is 61% White; 35% African American; 2% Asian; and 2% Hispanic or Latino (See Figure 2-8).

Figure 2-8 Mobile County's Dominant Ethnic Groups are White (61%) and African American (37%).



Within the Cities of Mobile and Prichard the ethnic distribution shifts dramatically compared to Mobile County. The City of Mobile has a total population of 195,111. The ethnic distribution in the City of Mobile is 51% African American, 45% White, and 1% Hispanic or Latino (see Figure 2-9). The City of Prichard's total population is 22,659 and its ethnic distribution is 86%

African American, 13% White, and 1% Hispanic or Latino (see Figure 2-10).

Figure 2-9 The City of Mobile's Dominant Ethnic Groups are African American (51%) and White (45%)

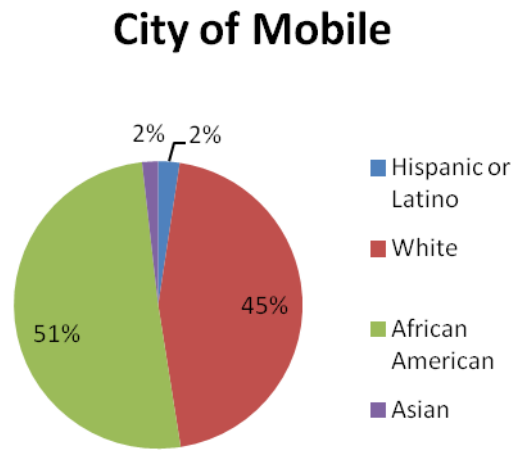
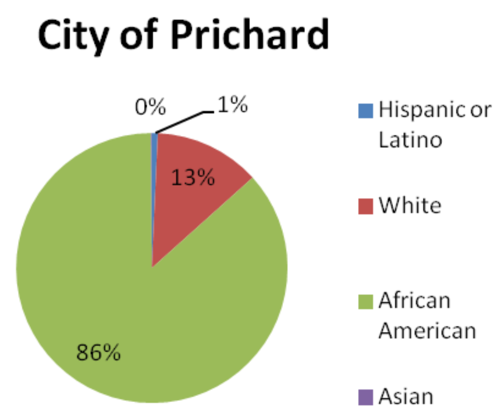
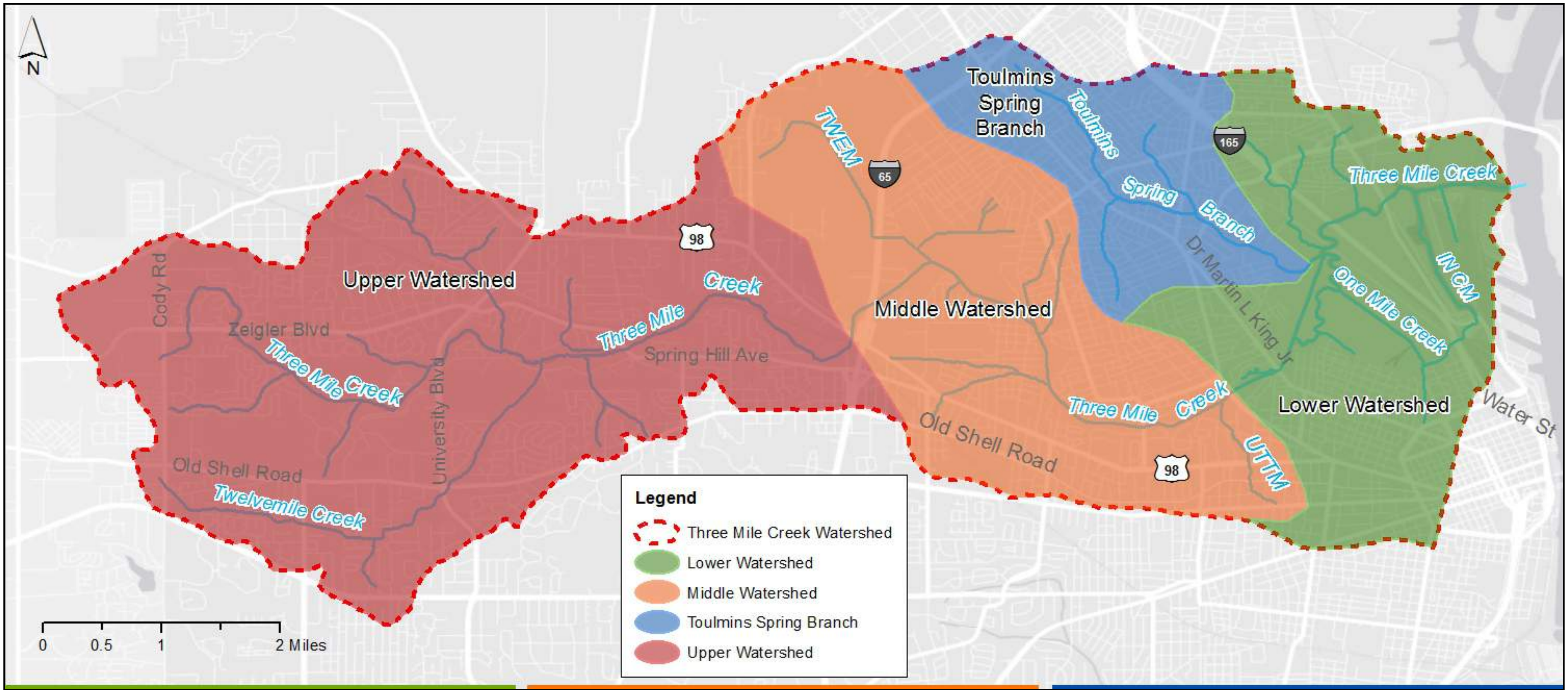


Figure 2-10 The City of Prichard's Dominant Ethnic Groups are African American (86%) and White (13%)



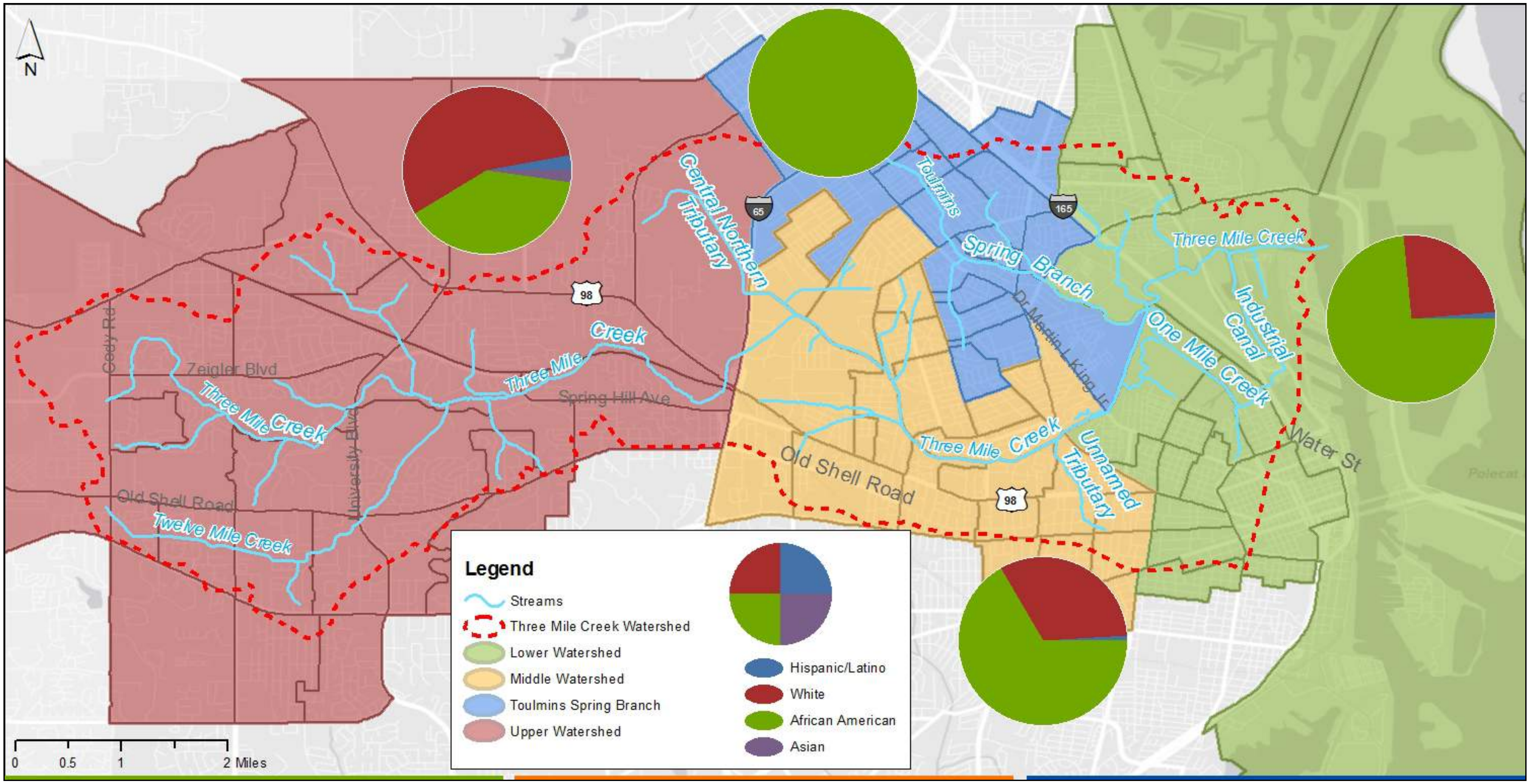
For the purposes of this WMP, we have organized the watershed into areas of concern (See Figure 2-11) to assist our recommended project prioritization based on geographic location. These areas of concern are named: Upper Watershed, Middle Watershed, Toulmins Spring Branch, and Lower Watershed.

Figure 2-11 Areas of Concern in Three Mile Creek Watershed Based on Geographic Location and Types of Hydrologic Challenges



The ethnic distribution of the Three Mile Creek watershed was determined by overlaying the watershed boundary on the 85 Census Block Groups that cover the same geographic area. Census Block Groups are the geographical unit used by the USCB; intermediate in size between the Census Tract and the Census Block. It is the smallest geographical unit for which the USCB publishes sample data. Therefore, each watershed area contained several Census Block Groups. The overall ethnic distribution in each watershed area was derived from the weighted average of the combined Census Block Groups in that area. (Figure 2-12)

Figure 2-12 Census Block Group Overlay with Areas of Concern and Ethnicity in Three Mile Creek Watershed



Within the Three Mile Creek watershed, the ethnic distribution is similar to the City of Mobile: 59% African American and 37% White and 2% Hispanic or Latino (See Table 2-5).

Table 2-5 Ethnicity for All Census Block Groups Intersecting Three Mile Creek HUC12 Sub-Basin

Census 2010 Population	Hispanic	White	African American	American Indian or Alaska Native	Asian	Native Hawaiian or Other Pacific Islander	Some Other Race	Two or More Races
99,039	1,830	36,585	57,992	259	1,224	13	92	1,044
	2%	37%	59%	0.3%	1%	0.01%	0.1%	1%

The demographic results for each area of concern are shown in Tables 2-6 and 2-7. The ethnic distribution clearly shifts along the areas of concern within the Three Mile Creek Watershed, particularly moving up the watershed to the headwaters near USA. For instance, the percentage of African Americans within the areas of concern shifts from 72% in the Lower Watershed to 97% in Toulmins Springs Branch to 66% in the Middle Watershed and to 39% in the Upper Watershed.

Table 2-6 Census Block Groups Intersecting Three Mile Creek Areas of Concern

	Census 2010 Population	Hispanic	White	African American	American Indian or Alaska Native	Asian	Native Hawaiian or Other Pacific Islander	Other	Two or More Races
Lower Watershed	15,247	195	3,742	11,042	47	79	1	15	126
		1.3%	25%	72%	0.3%	0.5%	0.01%	0.10%	0.8%
Middle Watershed	22,181	231	7,027	14,623	45	69	3	7	176
		1.0%	32%	66%	0.2%	0.3%	0.01%	0.03%	0.8%
Toulmins Spring Branch	14,401	94	128	14,060	29	2	0	2	86
		0.7%	0.9%	98%	0.2%	0.0%	0.00%	0.01%	0.6%
Upper Watershed	47,210	1,310	25,688	18,267	138	1,074	9	68	656
		3%	54%	39%	0.3%	2.3%	0.02%	0.14%	1.4%

Table 2-7 Census Block Groups Intersecting Three Mile Creek Areas of Concern (Median Houdsehold Income is average median household income in the past 12 months (in 2011 inflation-adjusted dollars))

	Number of Households	Median Household Income	Number of Households with Income Below Poverty Line	Number of Households with Income at or Above Poverty Line	Percent Households Below Poverty Line
Lower Watershed	5,672	$26,512	1,840	3,832	32%
Middle Watershed	9,563	$34,154	2,473	7,090	26%
Toulmins Spring Branch	5,788	$19,741	2,683	3,150	46%
Upper Watershed	18,036	$57,190	2,757	15,279	15%

2.2.8.1 Income Data

Information was obtained on the household income diversity within the watershed from the American Community Survey (ACS) 2007 – 2011 (ACS, 2011). During the time period of this survey, the median income within the Three Mile Creek watershed was $41,665. In addition, 25% of the household incomes in Three Mile Creek were below the 2009 federal poverty line of $22,050 for a family of four (see Table 2-8).

Table 2-8 Income Statistics for All Census Block Groups Intersecting Three Mile Creek HUC12 Sub-basin (Median Houdsehold Income is average median household income in the past 12 months (in 2011 inflation-adjusted dollars))

Number of Households	Median household income	Number of Household Incomes below poverty level:	Number of Household Incomes at or above poverty level:	Percent of Households Below Poverty Line
39,059	$41,665.29	9,708	29,351	24.9%

Within Three Mile Creek's areas of concern, median household incomes range from a low of $19,741 in TSB to $57,190 in the Upper Watershed. The percentage of household incomes below the national poverty line (household income of $22,350 for a family of four) is 43% in the TSB and 36% in the Lower Watershed; these are much higher percentages compared to the percentage of household incomes below the national poverty line for the whole watershed (25%). The higher rates of poverty are found in areas where the ethnic distribution is predominantly African-American (See Table 2-6 and 2-7).

2.2.9 Land use and land cover

2.2.9.1 Historic land use

The Three Mile Creek watershed was one of the first areas to be settled as the City of Mobile developed. The Creek served as the City's drinking water source until the 1940s when urbanization degraded water quality and forced the City to look toward Big Creek Lake as a water supply. After the Civil War, the economy in Mobile thrived from the riverboat trade along the Mobile River and from a growing lumber trade industry (ACC, 2013). From 1974 to 2008, the Three Mile Creek watershed experienced an increase in urbanization from 49.2% to 70.1%, accompanied by a decrease in upland forest from 30.3% to 12.2%. (NASA, 2008)

Figure 2-13 Historical Land Use in 1974 with 49% Urban areas

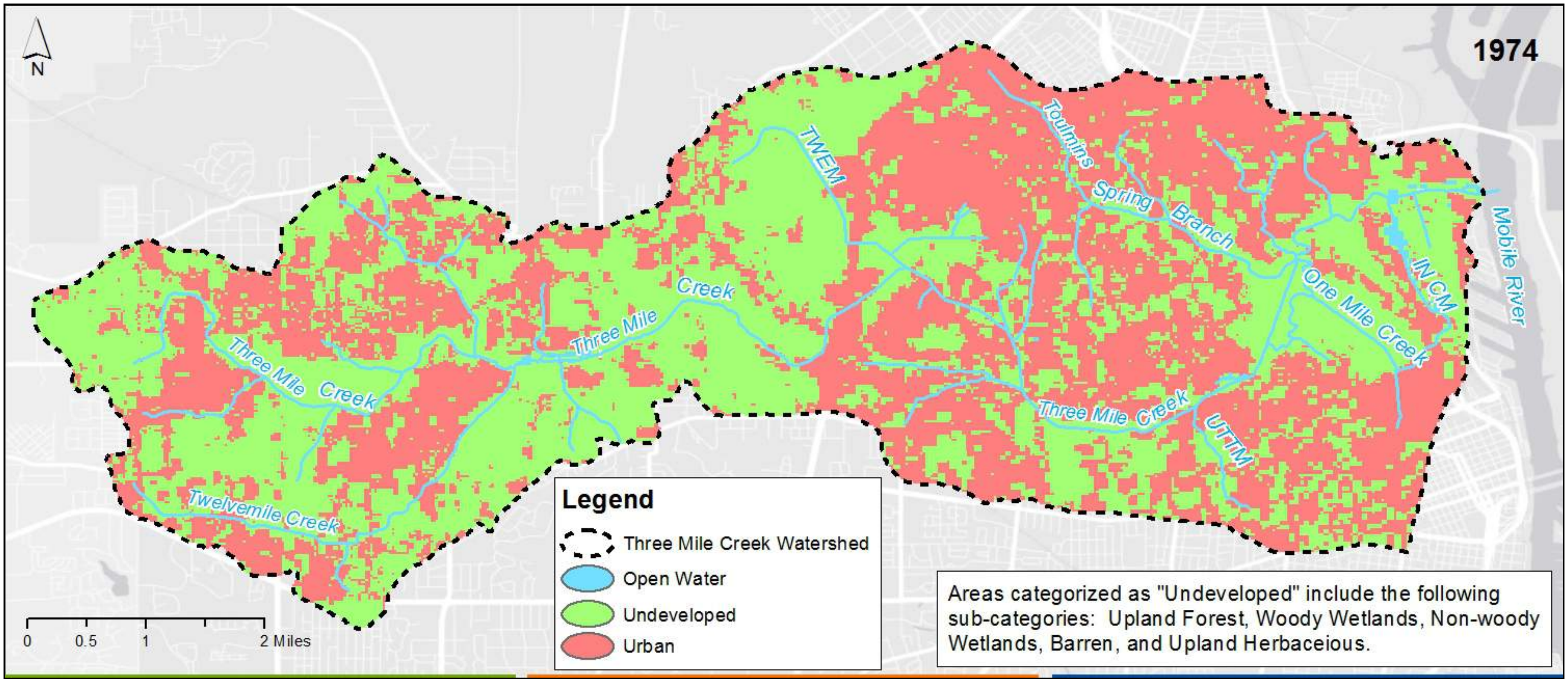
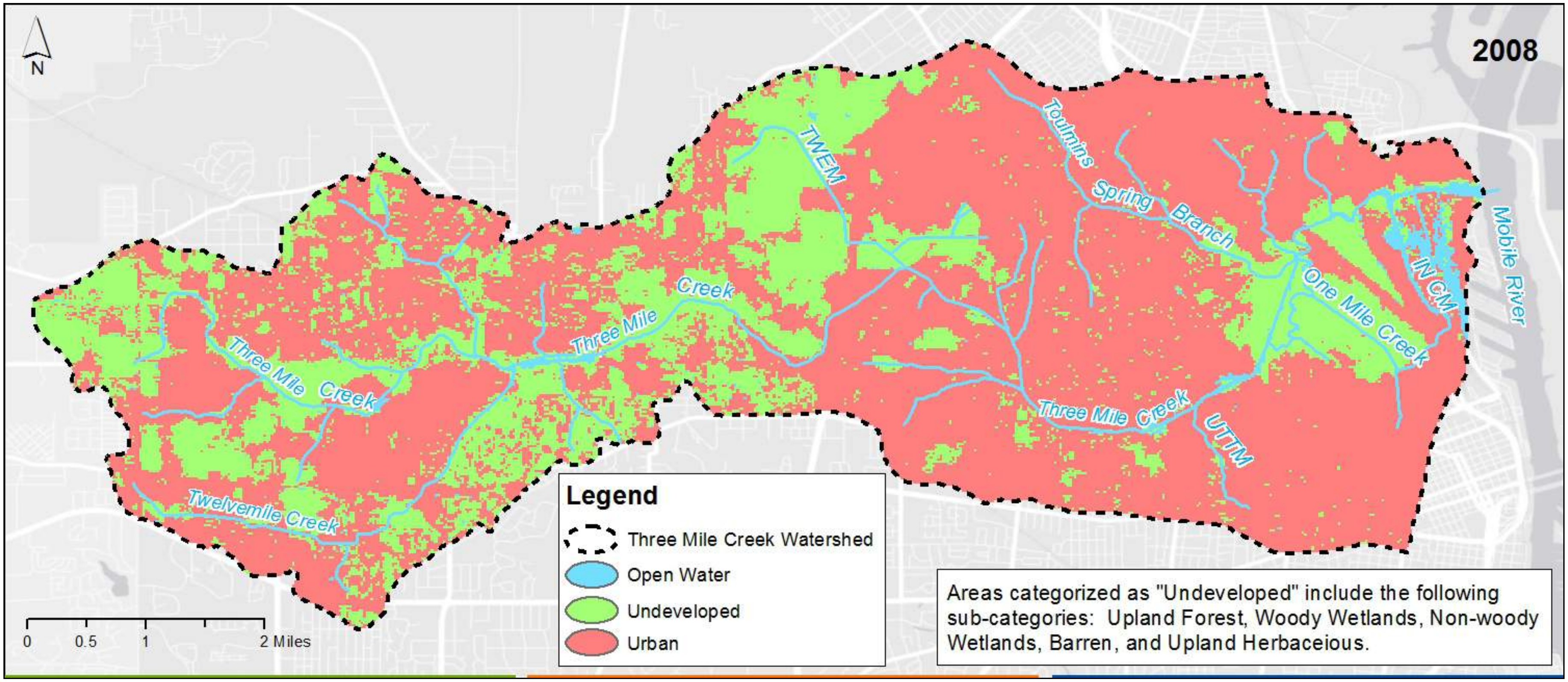


Figure 2-14 Historical Land Use in 2008 with 70% Urban areas



2.2.9.2 Current land use

Table 2-9 below shows that the dominant land use in the Three Mile Creek watershed is residential, comprising almost 42% of the total area, followed by commercial at 26% and transportation at 17%. The remaining portions of the watershed are Industrial at 6% and undeveloped at 9% (predominantly wetlands) (MCRC, 2013). The commercial land use areas are clustered mainly in the lower watershed, along I-65 and the USA campus (See Figure 2-13). Future growth is not expected to be a significant factor in the recovery of this watershed. As part of the earliest settlement areas in Mobile, Three Mile Creek is well established with 37% impervious cover (GSA, 2003). The watershed is predominantly developed (>90%) in all reaches.

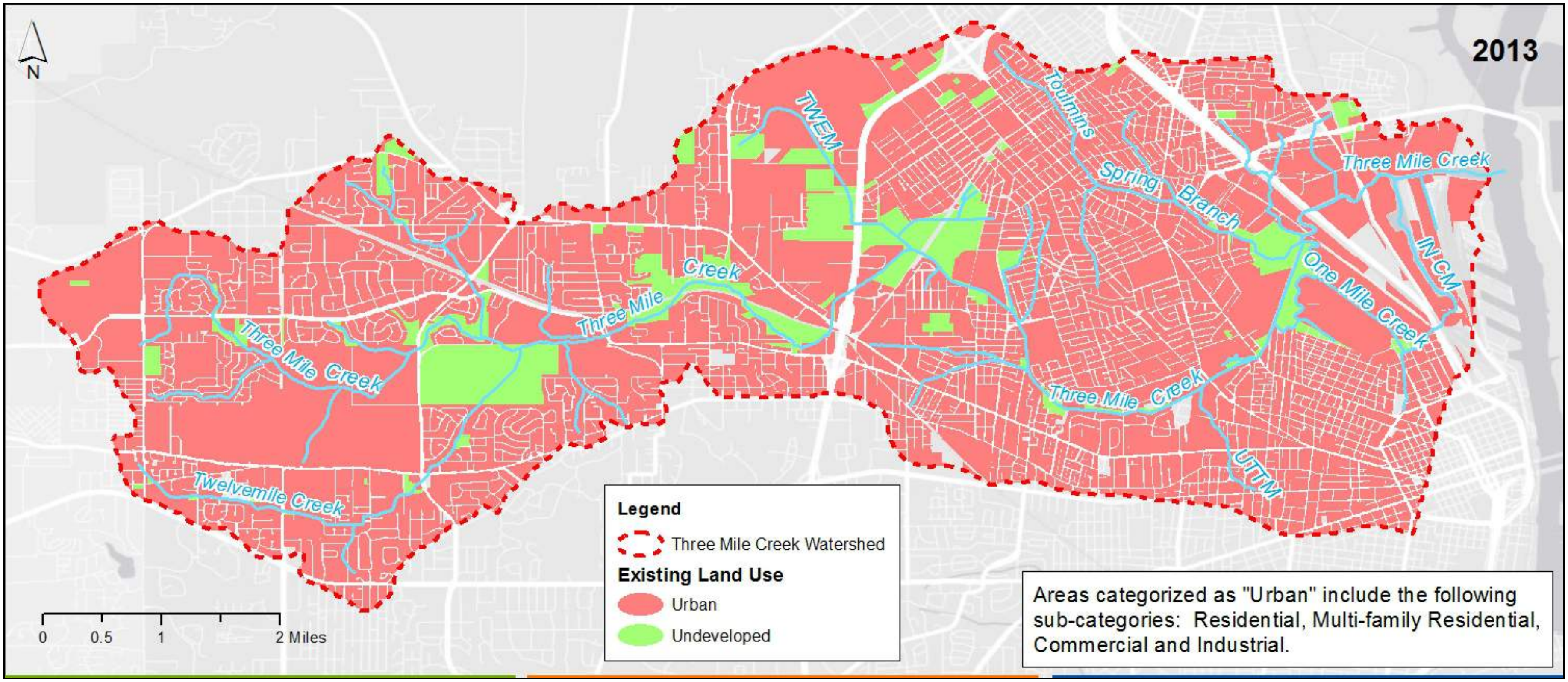
Most of the development within the watershed was completed without the installation of post-construction stormwater treatment controls. Therefore, untreated stormwater runoff and associated pollutant load from most developed areas discharge directly to Three Mile Creek and its tributaries. The discharge of untreated stormwater runoff to Three Mile Creek is the primary source of surface water quality degradation.

Table 2-9 Three Mile Creek Land Use

Existing Land Use Type	Acres	%
Apt/Condo	240.8	1.25%
Apt Site	223.3	1.16%
Commercial	5,071.7	26.36%
Industrial	1,068.8	5.56%
Residential	7,673.6	39.89%
Transportation	3,234.3	16.81%
Undeveloped	1,724.6	8.96%
Total	**19,237.1**	**100%**

The land use distribution in the Three Mile Creek watershed is 42% residential; 26% commercial/industrial; 17% transportation; 6% industrial and 9% undeveloped/wetlands (see Figure 2-15).

Figure 2-15 Three Mile Creek Watershed is a Highly Urbanized Area with 42% Residential Landuse



3 WATERSHED CONDITIONS

Upon project start, the Dewberry Team requested that all members of the Steering and Technical Committees provide any available information on Three Mile Creek watershed conditions. All data, reports, and additional information the Dewberry Team obtained were organized and reviewed. The data collection effort for Three Mile Creek revealed that a significant amount of data exists for this watershed. In addition, the Dewberry Team visited the watershed on three separate occasions to observe conditions as part of an on-the-ground watershed assessment.

The following section details and analyzes the information collected during the data collection review, as well as field sampling results gathered by the Dewberry Team and others. The focus of the team's efforts was:

1. Review and analyze all existing data (Section 3);
2. Collect additional data and identify the remaining data gaps for future collection efforts (Section 4); and
3. Identify and prioritize actions that can be taken now to improve water quality in Three Mile Creek (see Section 5).

3.1 Current Challenges

The major challenges facing Three Mile Creek watershed include:

1. Stormwater
    - **Effects of stormwater runoff** – significant impervious land cover generating excess stormwater runoff which is the primary source of trash/litter, nutrients, oxygen demanding substances, and pathogens to the creek during wet weather.
2. Wastewater
    - **Illicit connections SSOs -** primarily in tributaries and the creek below Martin Luther King Jr. Blvd. from groundwater seepage and direct sanitary discharges.
    - **Excessive water quality pollutants** –particularly pathogens
    - **Potential groundwater contamination** – potential contributions to Three Mile Creek from the Hickory Street Landfill and Mobile Gas/Sempra remediation site.
3. Ecology
    - **Abundance of invasive species** – Infestation of island apple snails, Chinese tallow (popcorn) trees, and wild

taro, among others.

- **Abundance of aquatic vegetation** – densely-matted nuisance vegetation related to nutrient over – enrichment, particularly in the downstream segment of the creek, contributing to low DO.
- **Altered watershed hydrology -** loss of floodplain connectivity; loss of connected wetland areas; reduced length of creek flow path; and loss of connectivity with historic streamway.
- **Altered creek geomorphology** – loss of riparian buffers; construction of engineered channels and bank stabilization; stream bank erosion and sedimentation.

4. Access
    - **Lack of recreational access to the creek** – public access to the Creek is currently limited to only a few locations, and over a significant length the USACE engineered channel, sheet pile weirs and riprap and gabion bank stabilization make use of the creek for water sports difficult.

5. Climate Adaptation
    - **Sea Level Rise -** identified needs for BMPs to address long-term sustainability. Changing sea levels can alter the balance and distribution of native habitats in the watershed by negatively affecting some and expanding or creating others.
    - **Increased Incidents of Storm Events** – an increased incidence and intensity of storm events will result in higher tidal surges impacting infrastructure.

3.1.1 Water Quality Pollutants

Excess water quality pollutants discharging to Three Mile Creek produce elevated nutrient and pathogen levels and low dissolved oxygen concentrations. These reduce the abundance and health of all aquatic organisms in the creek and tributaries, from benthos to fish. Elevated nutrients and pathogens in the creek can also affect human health and welfare by making the water unsafe for human contact and producing algal blooms that limit recreation.

Progress towards improving water quality in the Three Mile Creek watershed started in the mid-1990s with the EPA and ADEM's local enforcement of the 1972 Clean Water Act (CWA). Multiple localized improvements to the sanitary sewer collection system were implemented during this period to address system overflows and leaky pipes (See Figures 3-1 & 3-2, Information provided by MAWSS).

Three Mile Creek Watershed Management Plan

Figure 3-1 Major Improvements (sewer rehab and upgrades) were implemented in Three Mile Creek Watershed in the 1990's, Eastern portion of the watershed. (MAWSS). Note: SS= sanitary sewer and SWAT = Severe Weather Attenuation Tank

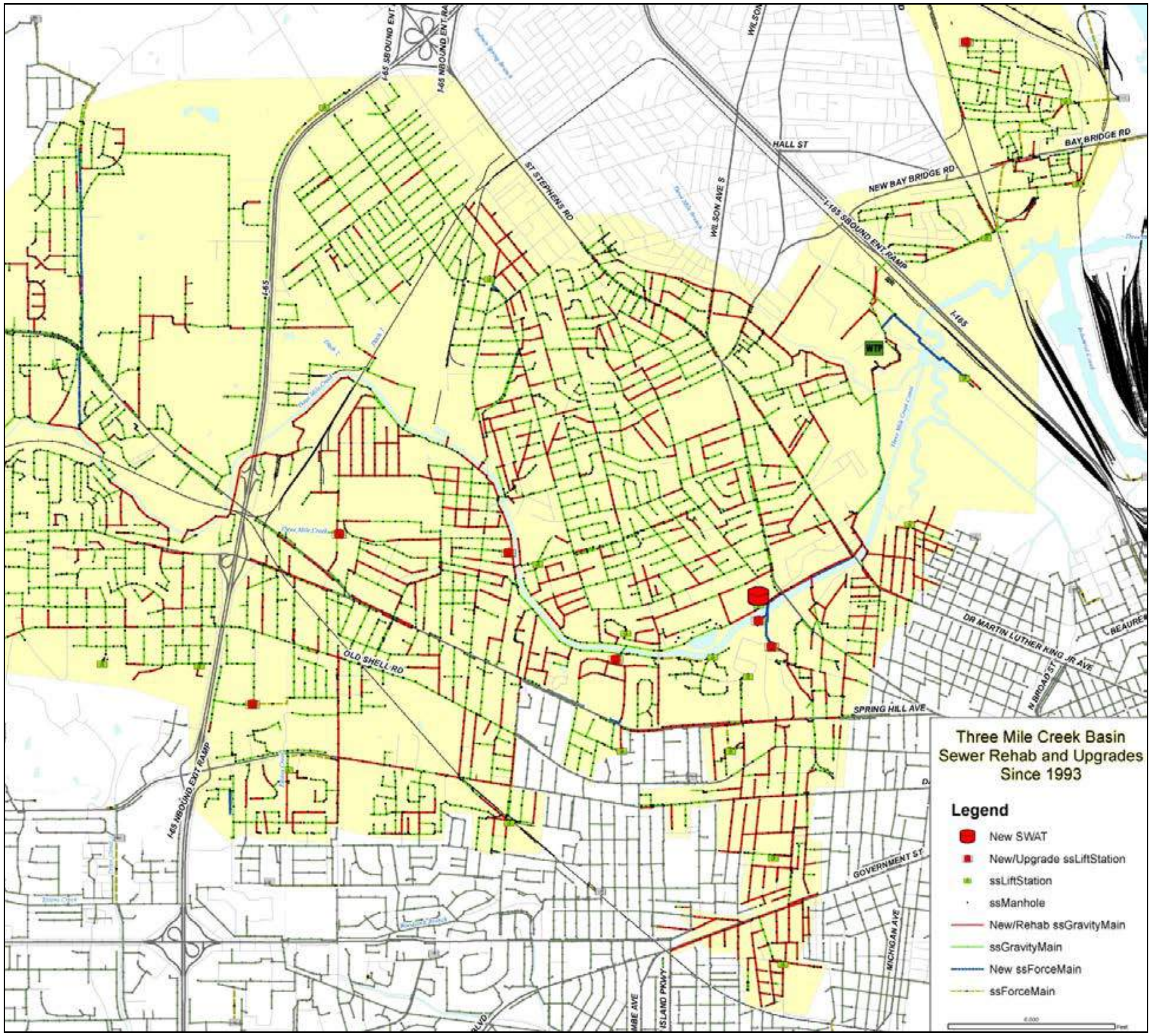
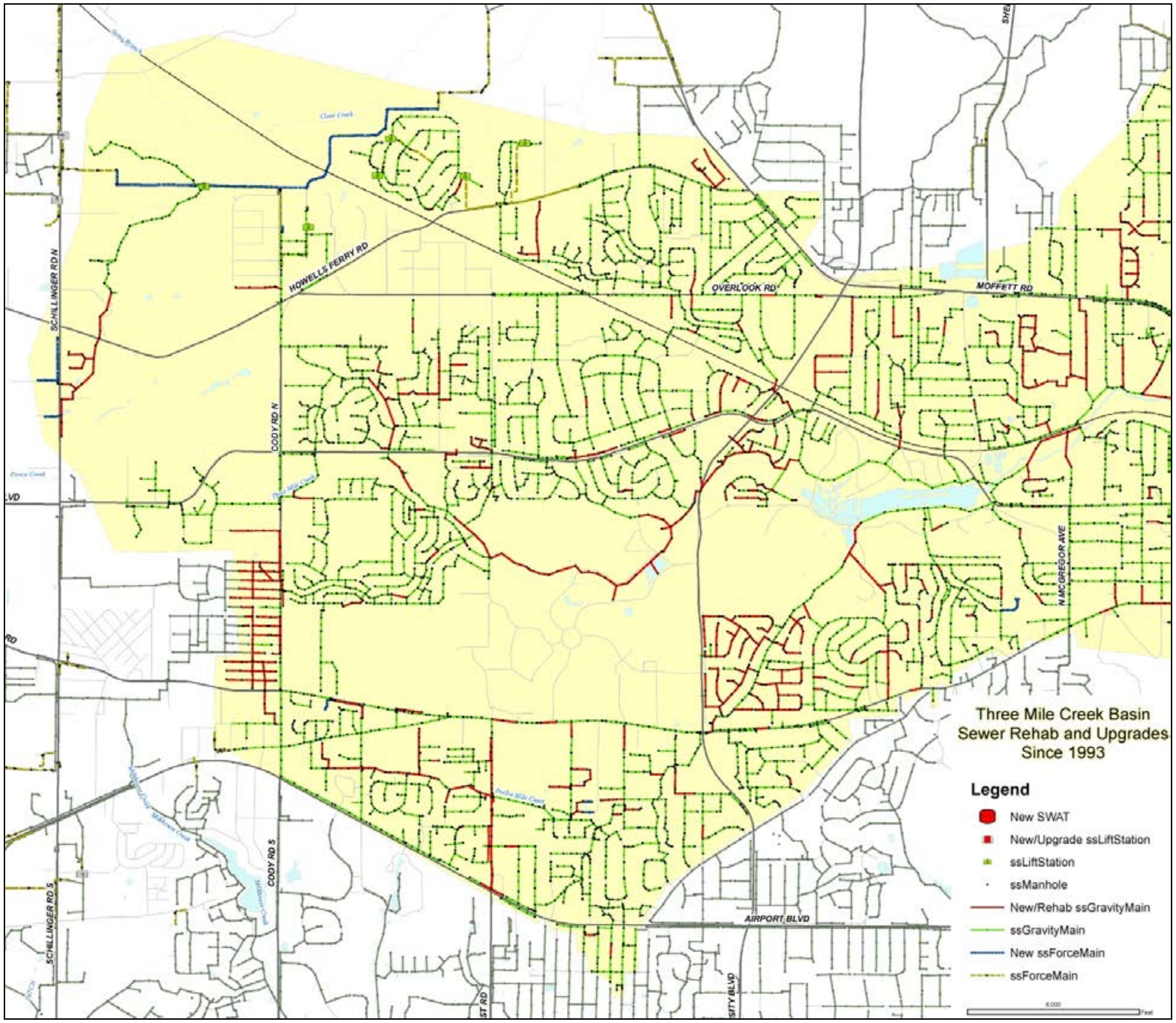


Figure 3-2 Major Improvements (sewer rehab and upgrades) were implemented in Three Mile Creek Watershed in the 1990's, Western portion of the watershed. (MAWSS). Note: SS= sanitary sewer and SWAT = Severe Weather Attenuation Tank



A common problem among older urban sanitary sewer systems is SSO. This condition occurs during intense rain events when sewage escapes the sanitary system and becomes a direct pollution source for creeks and streams. This most often occurs through a process referred to as "Infiltration and Inflow" or I & I. I & I is stormwater runoff and/or groundwater that enters the sanitary sewer system through cracked pipes, leaky manholes, or improperly connected storm drains, down spouts, and sump pumps. The stormwater and groundwater combine with raw sewage, exceeding the design capacity of the sanitary sewer system and causeing overflows. Overflows can increase pollutant loads including oxygen demand, nutrients, and pathogens to surface waters. In 2003, following a legally mandated consent decree, the MAWSS implemented a 1 million gallon side-stream diversion and re-lining of the main sanitary sewer collection system in Three Mile Creek watershed. The side-stream diversion provides temporary storage for sewage during high flow periods to prevent overflows, and the re-lining sealed the older pipe system to prevent sewage leaks and groundwater infiltration.

Around this same time, ADEM's enforcement required that MAWSS begin welding sanitary sewer lids shut in certain areas of Three Mile Creek that experience persistent overflow problems. Similar to the side-stream diversion, this effort was intended to prevent SSOs by preventing internal pressure buildup in the sewer system that lifts manhole lids during high flows and allows sewage to escape to the surface.

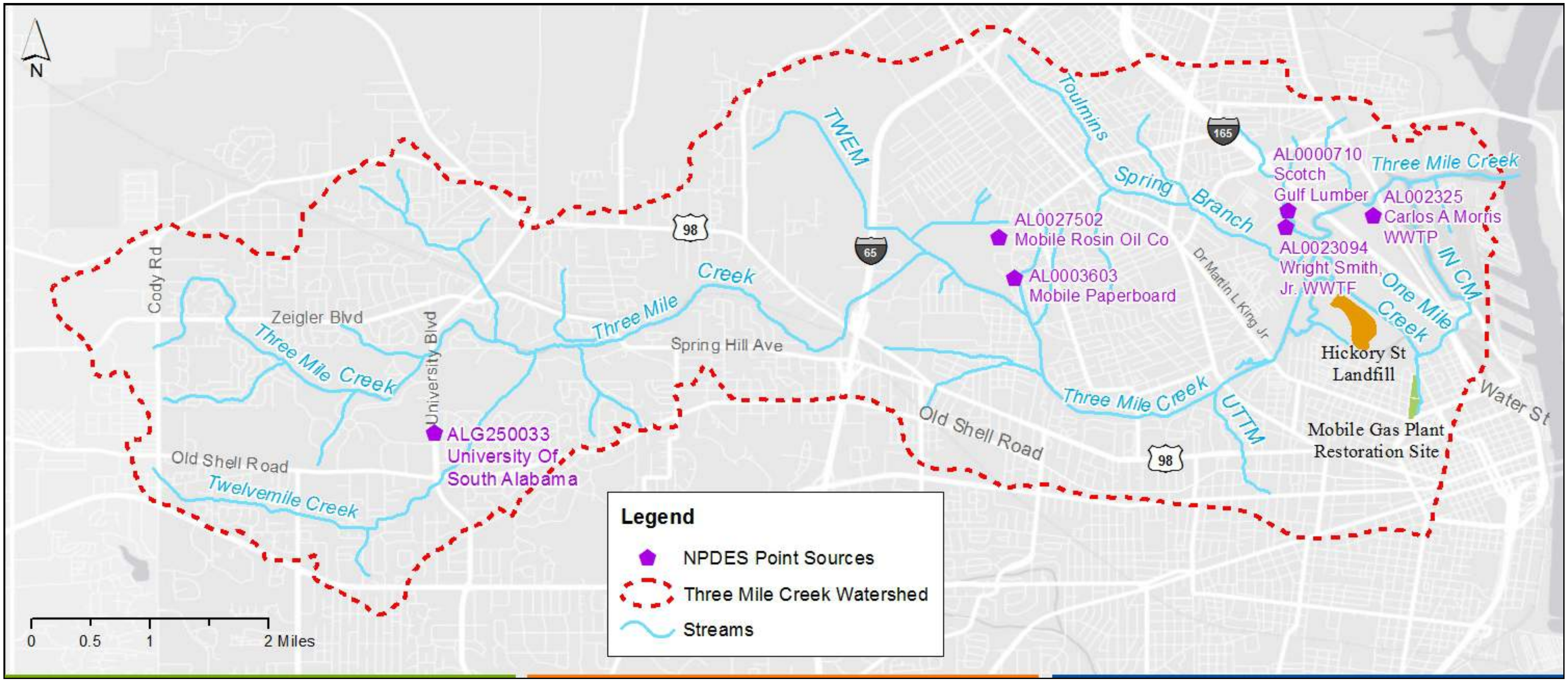
While much of Three Mile Creek's systematic SSO issues have been resolved, the problem remains a sewer maintenance challenge today. As reported in the *Press Register*, "a grease stoppage caused about 600 gallons of wastewater to flow from a manhole in the woods near Carondolet Court into Three Mile Creek" (Kent, 2011). Continued vigilance of sewer system maintenance and enforcement of grease trap installation and inspections remains necessary.

3.1.2 Illicit Discharges

Just as storm flows can be improperly plumbed to the sanitary sewer system, sanitary sewer pipes can be improperly connected to the stormwater system. This is typically called an "illicit discharge." In 2009, MAWSS undertook an illicit discharge study of the Three Mile Creek stormwater system. They performed an inventory of 286 outfall locations during an extended period of dry weather to identify potential illicit connections. Several potential sewer discharge locations were traced and sampled. The study ultimately identified and removed two verified sanitary sewer discharges to stormwater outfalls.

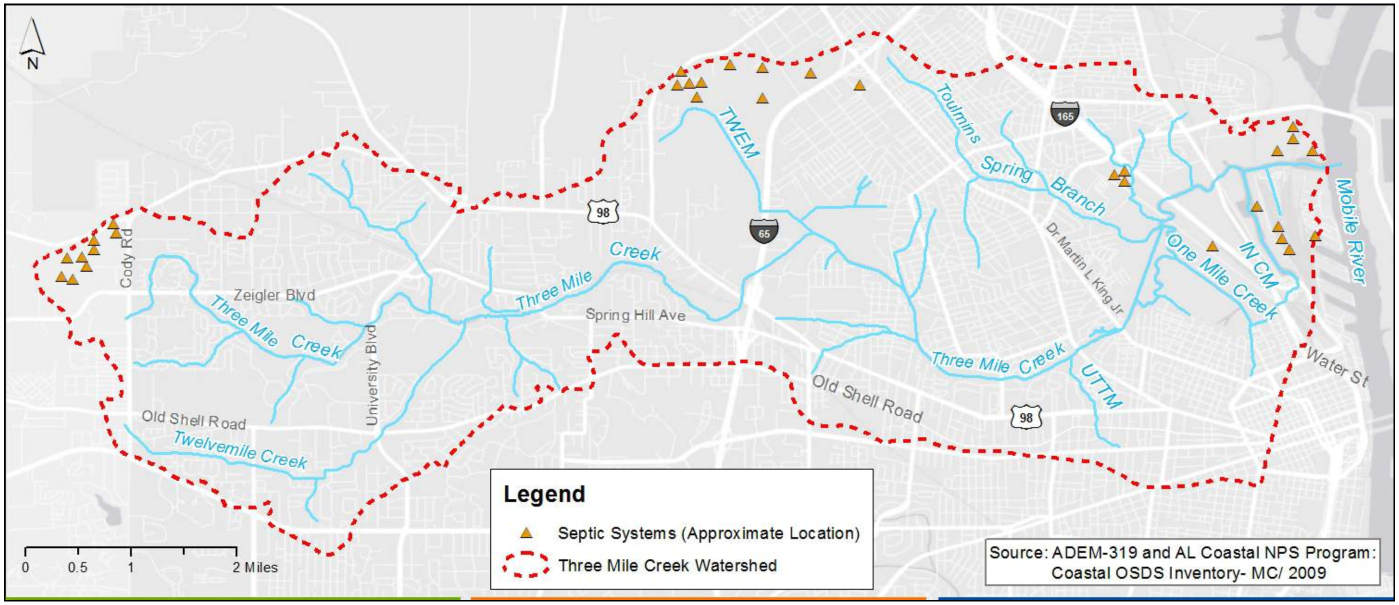
The two major permitted outfalls contributing biochemical oxygen demand (BOD) and nutrient loads to Three Mile Creek include the MAWSS Wright Smith, Jr. Wastewater Treatment Facility (WWTF) and the City of Prichard's Carlos A. Morris WWTF. The point source discharges from these two facilities are scheduled to be removed from Three Mile Creek watershed in 2014. This will represent a major BOD and nutrient load reduction to Three Mile Creek (See Figure 3-3). However, the reduced flow in the creek may result in a seasonal increase in salinity in the lower reaches of the watershed, further contributing to lower DO.

Figure 3-3 Major Permitted Outfalls (MAWSS WWTF and Prichard WWTF) are Scheduled to be Removed From Three Mile Creek Watershed in 2014



There were 32 tank systems identified in the 2009 Coastal Alabama Onsite Sewage Disposal System (OSDS) Inventory: Mobile County, AL (See Figure 3-4, courtesy of ADEM-319 and AL Coastal Non-point Source Pollution (NPS) Program: Coastal OSDS Inventory - MC/ 2009). Septic systems are indicated in the eastern section of the watershed near Conception Street and I-165; in the north central section of the watershed near Wolf Ridge Road and Dickinson Road and in the extreme western area of the watershed near Howells Ferry Road and Cody Road. The septic systems indicated are based upon geographic information system (GIS) statistical modeling and may be in error (+/- 5% of the total study). No information was available about the condition of these septic tanks. However, based on the age of development in the watershed it is likely that many septic systems may exceed the typical 20-year design life and may be contributing to locally diminished water quality in these areas. Even newer septic systems produce elevated nutrient and pathogen concentrations and BOD in groundwater when located or operated inappropriately contributing to poorer Creek water quality. Unfortunately, the detailed water quality studies discussed in Section 4 for Three Mile Creek do not provide data for these areas of the watershed, so a direct link cannot be established between septic systems and elevated nutrients and pathogen levels and low DO concentrations noted elsewhere in Three Mile Creek.

Figure 3-4 Septic Tank systems identified in the watershed, likely exceed the typical 20-year design life and could be contributing to locally diminished water quality.



3.1.3 Stormwater Runoff

While the aforementioned measures helped isolate and control leaks from the sanitary sewer system, surface water quality continues to be a problem in Three Mile Creek. One of the primary reasons for continued surface water quality degradation is stormwater runoff discharges from the developed watershed. Impervious surfaces (streets, parking lots, rooftops, etc.) cover at least 37% of Three Mile Creek watershed (GSA, 2003). This is notable because a host of surface water-related problems stem from a high percentage of impervious cover in a watershed. Typically, when a watershed's impervious cover exceeds 20-25%, its receiving streams will be impaired (Hammock and Leo, 2013). This impairment can be caused by many different factors, including increased stormwater runoff volume; increases in the ambient stream flow temperature caused by runoff entering streams; increased channel velocities causing stream bank erosion; and pollutant loadings from trash, sediment, grass clippings, fertilizer, pet waste, and heavy metals and petrochemicals from road surfaces.

Currently, Three Mile Creek is rated as Agricultural and Industrial Water Supply Use, the lowest of ADEM's seven use classification tiers. The Agricultural and Industrial Water Supply use designation carries the lowest State DO requirement, 3 milligrams per liter (mg/L). The State is required to categorize its surface waters based on their suitable uses (e.g., drinking water, irrigation, fishing, etc.) and current health, which includes factors such as biodiversity and pollutant concentrations in the surface water and groundwater. The DO concentrations are commonly below 3 mg/L in all segments of the Three Mile Creek surface water system, making it unsuitable to support a healthy aquatic ecosystem and fishery. However, there are many estuarine fish that have adapted to this lower water quality environment. The typical minimum DO requirement to sustain fisheries is 5 mg/L. In addition to low DO, ADEM also requires an existing TMDL for pathogens in the lower two segments of Three Mile Creek, which was included on the 303d list for "Collection system failure, Municipal Urban runoff/storm sewers." High concentrations of pathogens in Three Mile Creek make it unsuitable for human contact activities, such as bathing or swimming.

3.1.4 Altered Watershed Hydrology

The Three Mile Creek Flood Control Project completed by the USACE in the late 1980s substantially altered the hydrology of Three Mile Creek. A 5.5-mile section of Three Mile Creek was straightened and widened from Conception Street Road upstream 5.6 miles to just past I-65. The USACE implemented a series of measures to control flooding. Five sets of water control weirs were installed, and the channel slope was lowered to prevent flooding (see weir depiction in Figures 3-5 and 3-6). These metal sheet pile weirs were installed across Three Mile Creek to create in-stream pools that provide storage and better convey flows through the channel. Normal creek surface water level drops close to four feet over each set of weirs. The weirs also reduced the extent of tidal influence on the freshwater portion of the creek. Berms were constructed adjacent to the creek on one or both sides in certain locations, which isolated the creek from its historic floodplain. In addition, many of the road bridges within the project area were modified to accommodate the wider channel. The USACE considered bioengineering elements such as matted and vegetated channel side slopes, but instead chose to install large rock (i.e., riprap) on the creek side slopes. Gabions, wire baskets containing large rocks, were also used to create vertical channel banks in areas with limited property width. Near the downstream end of the project (directly upstream of Conception Street Road), a straight channel with a lower bottom elevation was constructed adjacent to the historic meandering channel. Low channel velocities in the historic channel resulted in sedimentation and plant growth that formed a plug near the junction with the bypass channel, as depicted in Figure 3-7. This plug isolates the creek from the historic channel and adjacent tidal wetland area.

Figure 3-5 USACE channel widening and straightening, and installation of weir structures and gabion walls substantially changed the hydrology, hydraulics, water quality, and habitat of Three Mile Creek (Location: Three Mile Creek downstream of I-65)

Figure 3-6 Deepening of the channel from the USACE project disconnected Three Mile Creek from its floodplain (Location: Three Mile Creek most upstream USACE weir upstream of I-65).

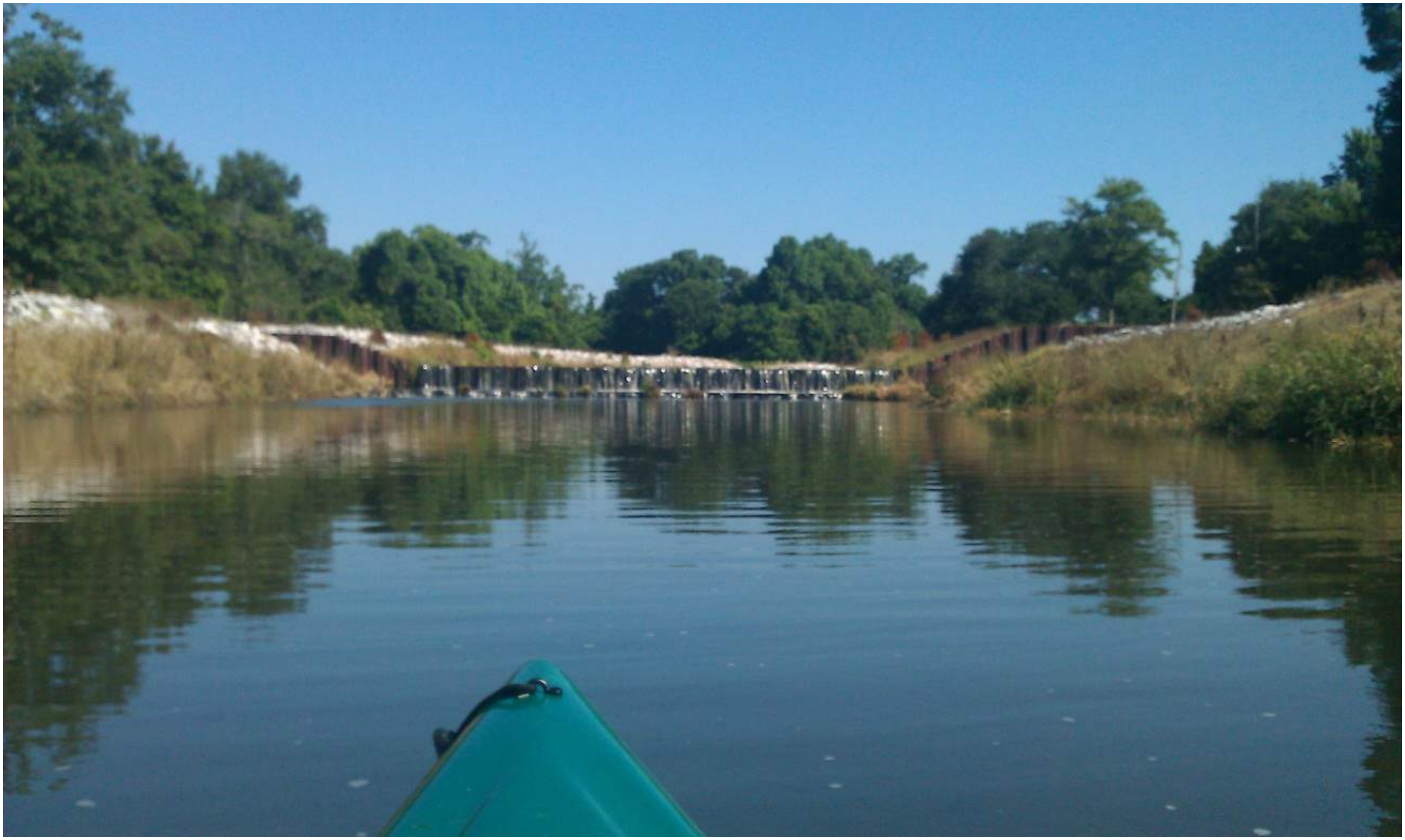


Figure 3-7 Dense vegetation shows the location of accumulated sediments at the upstream entrance to the historic channel of Three Mile Creek substantially changing the hydrology, hydraulics, water quality, connectivity and habitat of Three Mile Creek and adjacent wetland areas

3.1.5 Altered Creek Geomorphology

In many upstream areas of Three Mile Creek and its tributaries, vegetated stream banks have been replaced by concrete-lined channels, as shown in Figures 3-8 through 3-10. While this concrete lining provides better conveyance for stormwater and reduces flooding, it also prohibits infiltration, thereby increasing stormwater runoff volumes and pollutant loads, and eliminates natural habitat from the bed and banks of the stream, thereby inhibiting the natural cleansing processes of the stream. In many of these areas riparian buffer vegetation has been replaced by mowed lawns up to the stream bank, completely eliminating the natural environment for significant lengths of the stream.

In other areas such as the northwestern tributaries and near the USACE weirs, gabions have been installed to create almost vertical banks, as shown in Figure 3-11. Gabions are also used to enhance stormwater conveyance, typically deepening the stream to form a channel and confine stormwater flow, allowing development of the adjacent natural floodplain area or retrofitting a wdier channel into existing development as in the case of the USACE weirs. , These gabioned areas often accumulate sediment as a result of the entrained solids dropping out of the water column to the stream bed during frequent reduced flows in the enlarged channel, requiring costly maintenance to correct. In the northwestern tributary areas, poor maintenance has lead to dense vegetation growing inside the channel causing sediment deposition to increase, which restricts flow and can lead to flooding. Fortunately, gabions are present in a fairly small area of the overall watershed. A more prevelant issue is the loss of a natural riparian buffer. In many areas where a natural channel still exists in the watershed, the vegetation in the riparian buffer has been cut back from the creek, only allowing low growing grass and weeds or riprap adjacent to the stream. This is most evident along the entire length of the USACE flood control project where there is minimal natural riparian buffer adjacent to Three Mile Creek as a result of the maintenance paths on either side. An estimated 50% of the length of Three Mile Creek and its tributaries are without a naturally vegetated riparian buffer.

Trees within the riparian buffer provide shade, helping to reduce high water temperatures during warmer months and also providing cover, resting and nesting areas for birds and other wildlife species. Loss of shade as shown on Figures 3-12 and 3-13 results in higher water temperatures which, in turn, produce lower water DO concentrations, due to the fact that since the solubility of oxygen in water decreases with increasing temperature. Tree roots also provide natural bank stabilization benefits and potential fish and herptile habitat structure.

Another issue observed during field visits was severe stream bank erosion in certain locations. A photograph taken just downstream of University Boulevard on the Twelve Mile Creek tributary is included as Figure 3-14 along with one taken downstream of East Drive as Figure 3-15. Stream bank erosion has progressed to the point of exposing a sanitary sewer line that extends along the south streambank. Exposed piping is particularly vulnerable to leaks and failure, which have significant impacts on ambient water quality. Sediment from eroding streambanks is carried downstream to locations where water velocities slow enough that the fine sediment falls out of suspension in the water and settles to the bottom of the creek. Ponds, including those at the USA campus and Langan Park, are common sinks for sediment accumulation. The accumulated sediment can reduce creek water depth and cross-sectional flow area and therefore increase water flow velocities during storm events. This can lead to further channel erosion and sediment transport. The sediment particles can contain pollutants that impact water quality, including oxygen-demanding substances and nutrients.

Figure 3-8 Concrete lined channel prohibits infiltration increasing stormwater runoff volumes and pollutant loads to Three Mile Creek, degrading water quality and habitat (Location: Three Mile Creek downstream of Cody Road, uppermost segment of the stream).

Figure 3-9 Concrete lined channel with mowed maintenance path on one side interrupting riparian corridor (Location: Twelve Mile Creek downstream of Hillcrest Road)

Figure 3-10 Concrete lined channel on Toulmins Spring Branch prohibits infiltration increasing stormwater runoff volumes and pollutant loads to Three Mile Creek, degrading water quality and habitat (Location: Toulmins Spring Branch downstream of Prichard Avenue)

Figure 3-11 Gabion lined channel filled with sediment and vegetation reduces system drainage capacity and can result in localized flooding in the watershed (Location: TWEM downstream of Renn Street)

Figure 3-12 Disturbed riparian buffers where trees and natural vegetation are maintained away from the stream bank reduces system resiliency and removes tree roots that provide natural bank stabilization benefits and potential fish habitat structure. (Location: Three Mile Creek downstream of Zeigler Boulevard).

Figure 3-13 Loss of shade and riparian buffer results in higher water temperatures which in turn, produce lower water DO concentrations since the solubility of oxygen in water decreases with increasing temperature. (Location: Three Mile Creek downstream of Moffett Road)

Figure 3-14 Erosion downstream of University Blvd in Twelve Mile Creek which flows into Three Mile Creek.

Figure 3-15 Exposed sanitary sewer pipe in Twelve Mile Creek from side stream erosion increasing the risk of a sanitary sewer leak into Three Mile Creek.

3.1.6 Submerged Aquatic Vegetation

In the lower portion of Three Mile Creek, dense aquatic vegetation was observed (see Figures 3-16 and 3-17). The vegetation includes submerged, emergent and floating species of vegetation (ADCNR, 2007). Throughout the water column, the submerged species in Three Mile Creek are primarily dominated by Eurasian watermilfoil (*Myriophyllum spicatum*) and parrot's feather (*Myriophyllum aquaticum*) (Figure 3-16). Other submerged species observed in Three Mile Creek include bladderwort (*Utricularia* spp.), variable-leaf pondweed (*Potamogeton diversifolius*), and fanwort (*Cabomba caroliniana*) (D. Armstrong, ADWFF, personal communication, February 19, 2014). Emergent vegetation including pickerelweed (*Pontederia cordata*) blooms bright purple along the water's edge in the early summer months competing with stands of wild taro (*Colocasia esculenta*). In the wooded wetlands of the headwater area, duckweed (*Lemna* spp.) and giant duckweed (*Spirodela polyrhiza*), both floating species, dominate the water's surface, while alligator weed (*Alternanthera philoxeroides*) dominates the emergent bank areas. The thick aquatic vegetation growing along the creeks margins including Hygrophila (*Hygrophila* sp.), an emergent species, most likely discourages recreational activities (Figure 3-17). The density of the submerged and emergent vegetation made it difficult to kayak through the area during our field trip. While vegetation can assimilate nutrients during growth periods, decaying vegetation releases excess nutrients and exerts a substantial oxygen demand, contributing to low water DO concentrations consistent with eutrophic condition. Heavy growth of floating species, such as duckweed, can also shade the sunlight required for oxygen synthesis and fish productivity during daylight hours.

Figure 3-16 An abundance of submergent aquatic vegetation *(Hygrophila* sp.) in Three Mile Creek increases oxygen demand and nutrient load during die-off resulting in low DO which affects the ability of the creek to sustain wildlife. (Location: Three Mile Creek downstream of Summerville Street).

Figure 3-17 Dense emersed vegetation along the creeks margins (*Hygrophila* sp.) inhibits recreation (Location: Three Mile Creek downstream of Summerville Street).

3.1.7 Potential groundwater contamination – Hickory Landfill and Mobile Gas Site

3.1.7.1 Hickory Street Landfill

The 57-acre Hickory Street Landfill site (adjacent to One Mile Creek) was an open, active dump from roughly 1940 to 1970 used for dumping a wide variety of wastes and chemicals, including heavy metals, inorganics, solvents and cyanide (USDHHS, 2006). Based on a Health Consultation report prepared by the U.S. Department of Health and Human Services (USDHHS) in March 2006, 55-gallon drums of hazardous chemicals were buried on the site several years ago. In 1970, the landfill reverted to a permitted sanitary landfill (USDHHS, 2006).

The Hickory Street Landfill is estimated to be 50 feet higher than the existing grade with approximately 130,680,000 cubic feet of industrial and commercial waste buried under the capped portion (USDHHS, 2006). The landfill was covered with a two-foot clay cap in the early 1980s. The USDHHS noted that some areas of the cap have been compromised by erosion. Currently, there is no known removal action or cleanup of materials placed in the landfill. This property has been abandoned for approximately 20 years.

Monitoring wells on the landfill site have confirmed the presence of volatile organics such as tetrahydrofuran, toluene, methyl ethyl ketone, and metals such as lead, cadmium, copper and zinc and the pesticide chlordane (USDHHS, 2006). Methane gas has been known to build up in the monitoring wells and pop the tops off the wells.

The ADEM conducted an initial site assessment and sampling of the soils and groundwater on the perimeter of the landfill site (ADEM 1, 2002). The preliminary findings have shown that there are slightly elevated levels of volatile organics and heavy metals in the soil and groundwater. However, this assessment found that humans were not exposed to any contaminants since they are located at depths below the surface with which the public would not come into contact. The consultation stated the site is fenced and the home located nearest to the site is approximately one half mile away. In the absence of a human exposure, it concluded there are no completed exposure pathways (documented direct links between the source and the public) which could lead to human health problems within the community, and therefore, no public health hazard exists.

A Phase 2 site assessment was completed by ADEM in 2005 for the Hickory Street Landfill. Surface water, sediment, surface soils, subsurface soils and groundwater samples were collected during April 2003. Samples were analyzed for a variety of metals, volatile organic compounds, and semi-volatile organic compounds. Concentrations above the appropriate screening values for a small number of the constituents were measured in all sample matrices. However, the report concludes that it is not possible to confirm the source of the values above the screening levels. The report recommends further assessment and monitoring before making a final decision on the surface water, sediment, surface soils, subsurface soils and groundwater conditions or any future use of the properties (ADEM, 2005).

Additional sampling above and below the Hickory St. Landfill was performed by ADEM in 2014. There were no discernible differences between the upstream and downstream data or exceedances of water quality criteria. Based on this it does not appear that the site contributes to water quality and/or habitat degradation in One Mile Creek/Three Mile Creek. Additional groundwater and sediment monitoring in the vicinity of the landfill in the surface water system may be warranted to determine if the site may still act as a legacy source of pollutnats that could is adversely impacting Three Mile Creek in the future.

3.1.7.2 Mobile Gas/Sempra Remediation Site

The Mobile Gas/Sempra Remediation Site includes approximately eight acres of fenced land located adjacent to and west of the upstream end of One Mile Creek. The site was used from the early 1800s until the early 1970s first to manufacture gas from coal, which created several potential contaminants including tars, and later as an office and storage facility.

In 2002, ADEM completed an EPA Phase I Targeted Brownfield Assessment including an initial investigation related to possible groundwater and/or soil contamination at the site (ADEM 2, 2002). During a March 7, 2002 site inspection, six drums filled with a solidified tar-like substance were observed on the property along with six empty drums. There are currently four groundwater monitoring wells on the site. At the time of the preparation of this WMP, data from these monitoring wells was not available.

A Phase 2 site assessment was completed by ADEM in 2004. Surface water, sediment, surface soils, subsurface soils and groundwater samples were collected during March 2003. Samples were analyzed for a variety of metals, volatile organic compounds, and semi-volatile organic compounds. Concentrations above the appropriate screening values for a small number of the constituents were measured in all sample matrices. However, the report concludes that it is not possible to confirm the source of the values above the screening levels. The report recommends further assessment and monitoring before making a final decision on the surface water, sediment, surface soils, subsurface soils and groundwater conditions or any future use of the properties (ADEM, 2004).

At this time, it is unknown if the site contributes to water quality and/or habitat degradation in One Mile Creek/Three Mile Creek. Additional groundwater and sediment monitoring in the vicinity of the site in the surface water system is warranted to determine if the site is adversely impacting Three Mile Creek.

3.1.8 Invasive Species

Numerous species of non-native plants and animals were also observed in Three Mile Creek. The eggs of the invasive nuisance island apple snails (*Pomacea insularum*) were observed along the creek attached to woody material, vegetation, and concrete pilings throughout the lower portion of the watershed, as shown on Figure 3-18 and 3-19. Since the South American snails were discovered in Alabama — first in the pond at Langan Park in 2008, then downstream in Three Mile Creek — the state's prime directive has been to keep the creatures out of the Delta (Personal communication with D. Armstrong, 2013). Like all invasive species, apple snails have the potential to compete with native species for limited resources, and the non-native snails have been shown to eat 95 percent of the aquatic vegetation in some natural systems, leaving behind murky, algae-filled water. The snails' preferred food items include some of Alabama's most common and important aquatic plants: coontail (*Ceratophyllum demersum*), spiderlillies (*Hymenocallis* spp.), pickerelweed (*Pontederia cordata*) and bulltongue arrowhead (*Sagittaria lancifolia*). The apple snail prefers to lay its eggs on heavy-stemmed, emergent aquatic plants that grow over surface water including giant cutgrass (*Zizaniopsis miliacea*), cattails (*Typha* spp.) and arrow arum (*Peltandra virginica*), all native plants to the TMC watershed.

Stands of Chinese tallow trees (*Triadica sebifera*), locally known as popcorn trees, dominate in the lower reaches of the Three Mile Creek. Popcorn trees can grow to a height of 50 feet, and are especially invasive in wet areas including stream bottoms. The fruit is a waxy cluster that resembles a popped kernel of corn and is readily eaten by some birds, which is a major factor in seed dispersal. Flood waters move and spread seeds in stream bottoms. Three-year-old tallow tree seedlings will bear fruit which also contributes to the rapid spread of this species. Herbicide application to foliage, stems, or cut stumps is needed to control stands of tallow trees.

Many of the aquatic vegetation species in Three Mile Creek are introduced, non-native species. Wild taro, locally know also as elephant's ear, or coco yam, is another invasive species that forms dense stands that displace native vegetation, such as pickerelweed along the banks of Three Mile Creek. Wild taro is a large, emergent nuisance plant, crowding out native plants that are important sources of wildlife food. Wild taro is quick to re-sprout even after repeat herbicide application or hand pulling efforts, if the entire rhizome is not removed.

Figure 3-18 Apple snail eggs are prevalent throughout the downstream segments of Three Mile Creek (Location: Three Mile Creek downstream of Pope Street).

Figure 3-19 Alabama Department of Conservation and Natural Resources (ADCNR) Wildlife and Freshwater Fisheries Division's apple snail eradication program is facing difficulty in trying to keep these non-native snails out of Mobile Bay. (Location: Three Mile Creek downstream of under US 45).

3.1.9 Pollutant Sources

3.1.9.1. Gross Pollutants

“Gross pollutant” is a general term used to describe trash and organic debris like decaying branches, leaves, vegetation and grass clippings, as well as larger particle-sized sediment. During field visits and the outfall inventory (discussed in Section 3.1.10), gross pollutants were commonly observed throughout the watershed. Gross pollutants can block a drainage system, resulting in decreased flows and localized flooding.

Gross pollutants are a primary concern in the Three Mile Creek watershed. Gross pollutants include nutrients (nitrogen and phosphorus) and pathogens (e.g. from improperly disposed diapers or animal waste) within the watershed. Removing gross pollutants from the watershed and surface water system will be an essential element of watershed and creek restoration efforts, improving the water quality and aesthetics of the area (Figures 3-20 to 3-23).

Figure 3-20 Gross Pollutants (trash, organic debris, sediment) are a primary source of oxygen demand, nutrients, and pathogens in the Three Mile Creek watershed, degrading surface water quality and habitat.

Figure 3-21 Unmaintained channels accumulate organic debris that rots placing an additional oxygen demand on the creek and degrading surface water quality and habitat (Location Twelve Mile Creek at Fontaine Drive).

Figure 3-22 Improperly disposed trash, prevalent throughout the lower portion of Three Mile Creek and its tributaries, is a primary source of pollutants, degrading surface water quality and habitat..

Figure 3-23 Gross Pollutants discharging from a dumpster pad via a concrete flume to a tributary to Three Mile Creek, degrading surface water quality and habitat (Location: Dollar General on Spring Hill Road)

3.1.9.2. Erosion and Sediment Transport from Construction Sites

The State of Alabama's National Pollutant Discharge Elimination System (NPDES) Construction General Permit requires developers/contractors to install and maintain BMPs on construction sites (one acre and larger) to minimize the discharge of sediment and turbid water. During field visits and the outfall inventory, sites were observed without BMPs (i.e., erosion control fencing) or with poorly maintained BMPs (fallen fencing or accumulated sediment that has not been removed) (See Figures 3-24 to 3-27). During each rainfall event, turbid water and sediment from these sites may be transported to Three Mile Creek and carry gross pollutants, sediment, and other pollutants into the surface water system. It is important that construction site requirements are enforced to prevent sediment accumulation in Three Mile Creek. Sediment from the watershed accumulates throughout Three Mile Creek, reducing conveyance capacity and adding pollutant load. Once sediment accumulates, its removal is expensive and time consuming. In some cases, as creek water depth decreases from accumulated sediment, opportunistic, invasive vegetation can establish itself. Invasive/nuisance vegetation can be highly adaptable and aggressive, and can suppress or completely out-compete local, native vegetation. Managing nuisance species, or completely eradicating established populations, is also expensive and time consuming.

Figure 3-24 Undeveloped, exposed site near Cody Road and Zeigler Road with no construction site BMPs releases sediment and turbidity to Three Mile Creek, degrading surface water quality and habitat

Figure 3-25 Turbidity of water in Three Mile Creek after recent rainfall shows impact of sediment discharged from the adjacent construction site with no erosion controls.

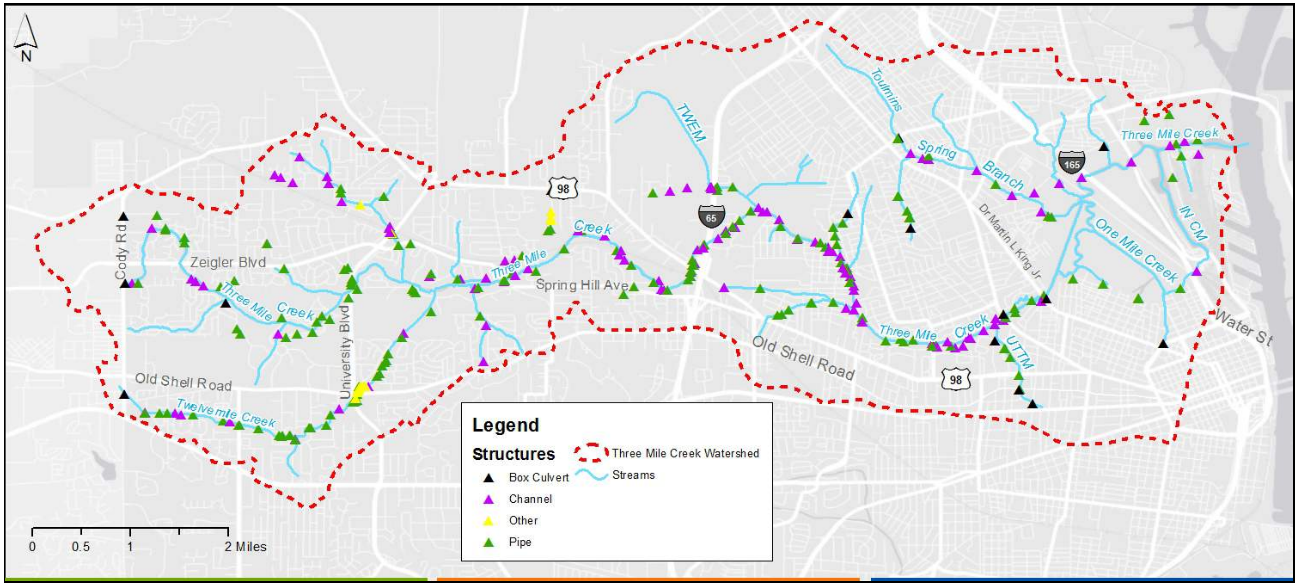
Figure 3-26 Active erosion at a recently cleared area upstream of Cody Road (headwaters of Three Mile Creek), degrading surface water quality and habitat.

Figure 3-27 Eroded sediments from active utility construction site without erosion control entering roadway stormwater system connecting to Three Mile Creek, orange fence is for construction site safety, not erosion control (Location: USA Campus)

3.1.10 Field Data Collection

The scope of work for the Three Mile Creek WMP included a limited field data collection effort. Among the most basic and important data elements necessary for developing a WMP are the location, contributing drainage area and land use mix, and size of significant stormwater discharges into the surface water system. The City of Mobile provided the Dewberry Team with GIS data of known stormwater outfall locations. However, the data set lacked the outfall size, an attribute that is critical to the development of a complete understanding of the geographic location of the primary pollutant loading sources, which is commonly called a loading assessment. To obtain this data, the Dewberry Team's subconsultant Aerostar walked and conducted an inventory of the surface water system throughout the entire watershed. The location of all 286 stormwater outfalls (pipes and open channels) discharging into Three Mile Creek and the tributaries to Three Mile Creek were determined and recorded using handheld Global Positioning System (GPS) equipment. At the same time, the type, size, material and general condition of each outfall was recorded and placed into a project geospatial database. The database provides easy reference between the geographic position of an outfall and its physical features. A map of the stormwater outfalls preliminarily identified during the field inventory is provided in Figure 3-28.

Figure 3-28 Geospatial location of the 286 stormwater outfalls preliminarily identified during the inventory of the Three Mile Creek Watershed



A further evaluation of the inventory data was performed. The 286 outfalls were then broken into two groups: 123 'significant' and 163 'not significant' or not of 'significant' size, due to the fact that the outfall diameter was less than 24 inches. The 'not significant' outfalls include 122 stormwater pipe discharges and 41 open channel/flume discharges to Three Mile Creek and tributaries. This is important because it serves as a defining point for the basin size limit in a pollutant loading assessment model. When performing a pollutant loading assessment a watershed is divided into contributing areas, or basins, using topography and the known channel and pipe network. The smaller basins flow via pipe or channel into larger basins eventually outfalling into the main channels such as Three Mile Creek and tributaries. A typical industry standard was developed in the 1990's as part of the NPDES program that identifies a 30 or 36-inch diameter pipe as the minimum pipe size used to define an outfall from a municipal urban basin. Smaller pipes and basin areas are combined until reaching the minimum pipe size or equivalent channel. A summary of the outfall data and field observations is provided in Table 3-1, with more detailed information and photos provided in Appendix D. These stormwater outfalls to Three Mile Creek and its tributaries account for the vast majority of stormwater runoff volume and pollutant loads discharged to the surface water system (See Figure 3-29). Other key observations that were made and recorded during the field inventory of the surface water system include the location of stream bank erosion, streambank buffer encroachment, excessive trash, water turbidity and accumulation of sediment.

Overland flows generated in the areas immediately adjacent to Three Mile Creek that also discharge directly to the creek and tributaries contribute a much smaller fraction of stormwater runoff volumes and pollutant loads. Additionally, non-gauged groundwater baseflows enter Three Mile Creek and degrade its ambient water quality. The stormwater runoff discharges, in combination with groundwater discharges, are the primary cause of degraded water quality in Three Mile Creek.

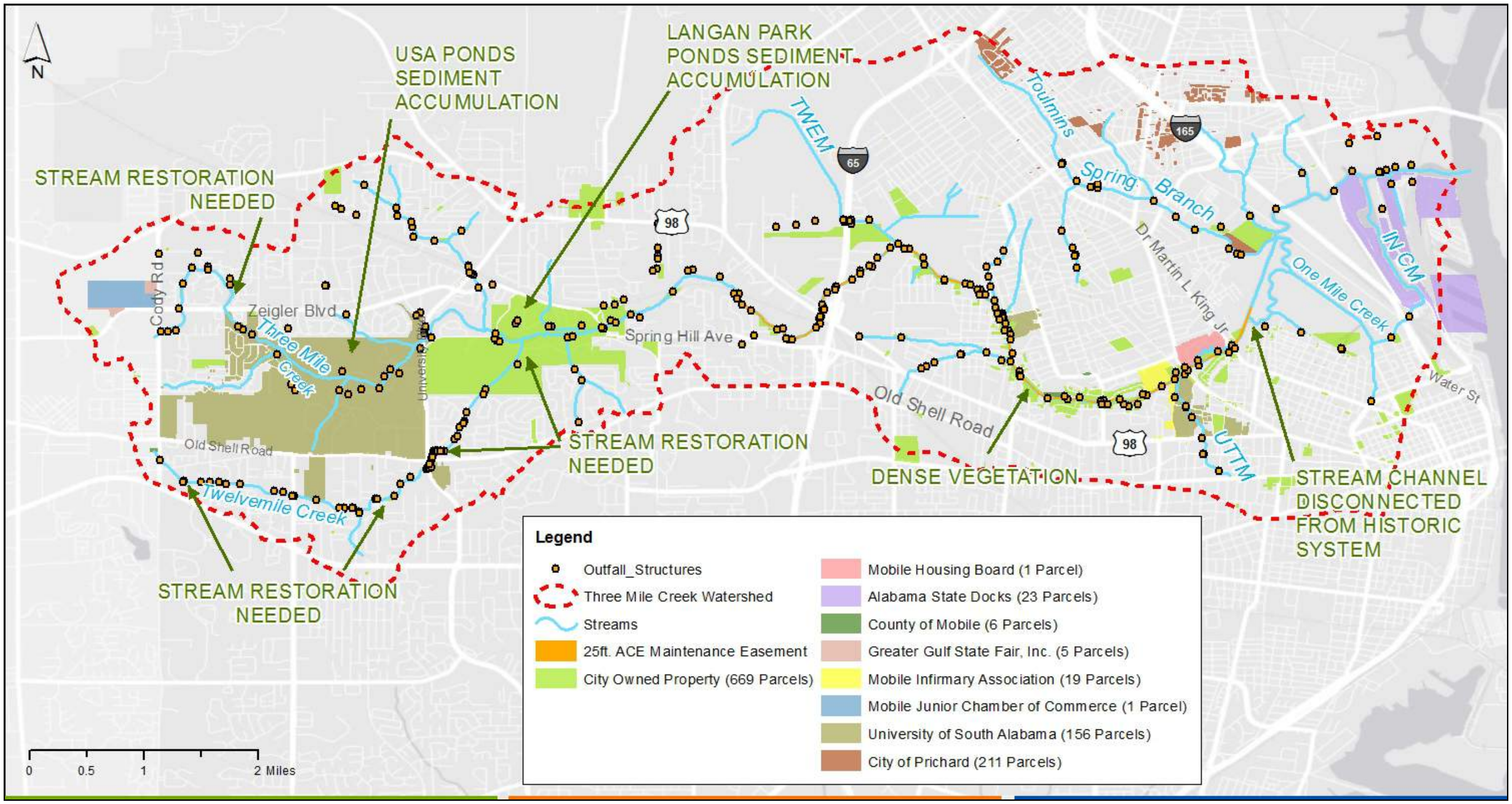
Table 3-1 Field Data Summary by Reach

Reach ID	Date	Photos	WQ Issues	Additional Comments	Outfalls
Three Mile Creek - Cody Road to University Boulevard	6/11/2013	1-28	Sedimentation from roadwork and developments; Trash.	Privet and Kudzu infestation	71, 202, 1001, 169, 70, 164, 165, 205, 100, 204, 256, 257, 220, 166, 242, 244
Three Mile Creek - Ziegler Blvd to Bristol Court	6/12/2013	29-62	Sedimentation along University; Bank erosion near new developments (Bristol Court Area); trash.	Apple Snails in municipal park	66, 182, 184, 183, 107, 108, 109, 111, 69, 181, 192, 1005, 1006, 148, 1008, 137, 139, 195, 196, 56, 50, 1009

Reach ID	Date	Photos	WQ Issues	Additional Comments	Outfalls
Three Mile Creek - Bristol Court to Mobile Street	6/13/2013	63-104	Reduced buffer at major intersections (US98, I65, and North Bank at Mobile St.); sediment and turbidity observed at these locations.	Industrial/commercial properties located near Mobile St.	15, 106, 26, 27, 140, 258, 254, 49, 48, 1010, 252, 142, 143, 1011, 1012, 1013, 222, 253, 1014, 47, 251, 1015, 1016, 38, 1017, 214, 216, 213, 4, 5, 14, 286, 79, 13, 282, 271, 80, 272
Three Mile Creek - Mobile Street to Martin Luther King	6/14/2013	105-151	Large areas have no buffer around Mobile Paperboard, USA Medical, and Mobile Infirmary. Some turbidity and sedimentation from roadways and parking lots. Significant trash.	Lake Clark (located off of Stanton Road) appears to be beneficial to Three Mile Creek by providing retention/detention of runoff	129, 17, 10, 9, 11, 6, 273, 274, 20, 24, 19, 18, 194, 21, 22, 23, 187, 189, 186, 206, 200, 255, 277, 1018, 1019, 1020, 279, 81, 209, 1021, 87, 88, 1022, 219, 61, 278, 270, 52, 250, 3, 191, 144, 54, 53, 45, 128, 89, 51
Three Mile Creek - W of I65 to Mobile River Discharge	6/17/2013	152-164	Industrial facilities at the low end with nonpoint runoff. Railroad yard sediment in channels.		41, 44, 120, 123, 122, 117
One Mile Creek	6/17/2013	165-168	Trash in residential areas; sediment impacts at south end and some industry discharges at south end. Potential from Hickory St. Landfill	HSL or Mobile Gas Plant Restoration	233, 239, 114, 210, 112
Toulmins Spring Branch - Clinton St to Treatment Plant	6/17/2013 - 6/18/2013	169-189	Trash in residential areas and roadway stormwater drainage in upper portions of Branch.	SW Reach is concrete lined and main channel is concrete lined to S Wilson Ave.	185, 197, 199, 193, 127, 43
Twelve Mile Creek - Scottsdale Drive to University Blvd.	6/18/2013	190-204	Scottsdale Dr. to Sandra Dr. buffer in poor condition. Nonpoint source (roadway) runoff.	Concrete lined from Scottsdale to Carlyle Dr E	179, 178, 180, 60, 59, 58, 285, 75, 176, 68, 177, 283, 105, 104, 284
Twelve Mile Creek - Cody Road to Museum	6/19/2013 - 6/20/2013	205-258	Banks unstable from East Dr. E to University and University to Vanderbilt Dr.; some nonpoint source pollution from residential developments in this area.	Concrete lined from Foreman Rd to East Drive	102, 223, 224, 225, 1023, 1024, 217, 232, 221, 72, 215, 208, 1026, 266, 33, 94, 1027, 55
INCM - N Cath to WSA Medical	6/20/2013	259-267	Some roadway runoff; iron reducing bacteria on north end.	Concrete lined from N Cath to Old Shell and Springhill to Center St.	36, 238

Reach ID	Date	Photos	WQ Issues	Additional Comments	Outfalls
UTTM Entire Reach	6/20/2013	268-279	Banks unstable from Frederick St to Bayshore; excessive sediment from roadway at Moffett Road; significant trash from Frederick to Bayshore; potential point source pollution from shopping center on Springhill (photo 269).		90, 237, 91, 130

Figure 3-29 Primary sources of stormwater runoff and areas of concern in the Three Mile Creek Watershed



3.1.11 Lack of Recreational Access

It is possible to restore the unique relationship that Three Mile Creek once shared with the people of Mobile and Prichard. Through environmental restoration and project implementation, Three Mile Creek will boost the amount of public access to green space and allow for more recreational opportunities. Where trails are discussed below, this WMP acknowledges that there are other plans for trails in existence. This plan will strive to create trails that can easily be incorporated into these existing plans while suggesting implementation using low impact design techniques.

3.1.11.1 Previous Studies

In addition to the regulatory and water quality data discussed earlier, the Dewberry Team also identified several sources of information that outlined recreational goals for Three Mile Creek:

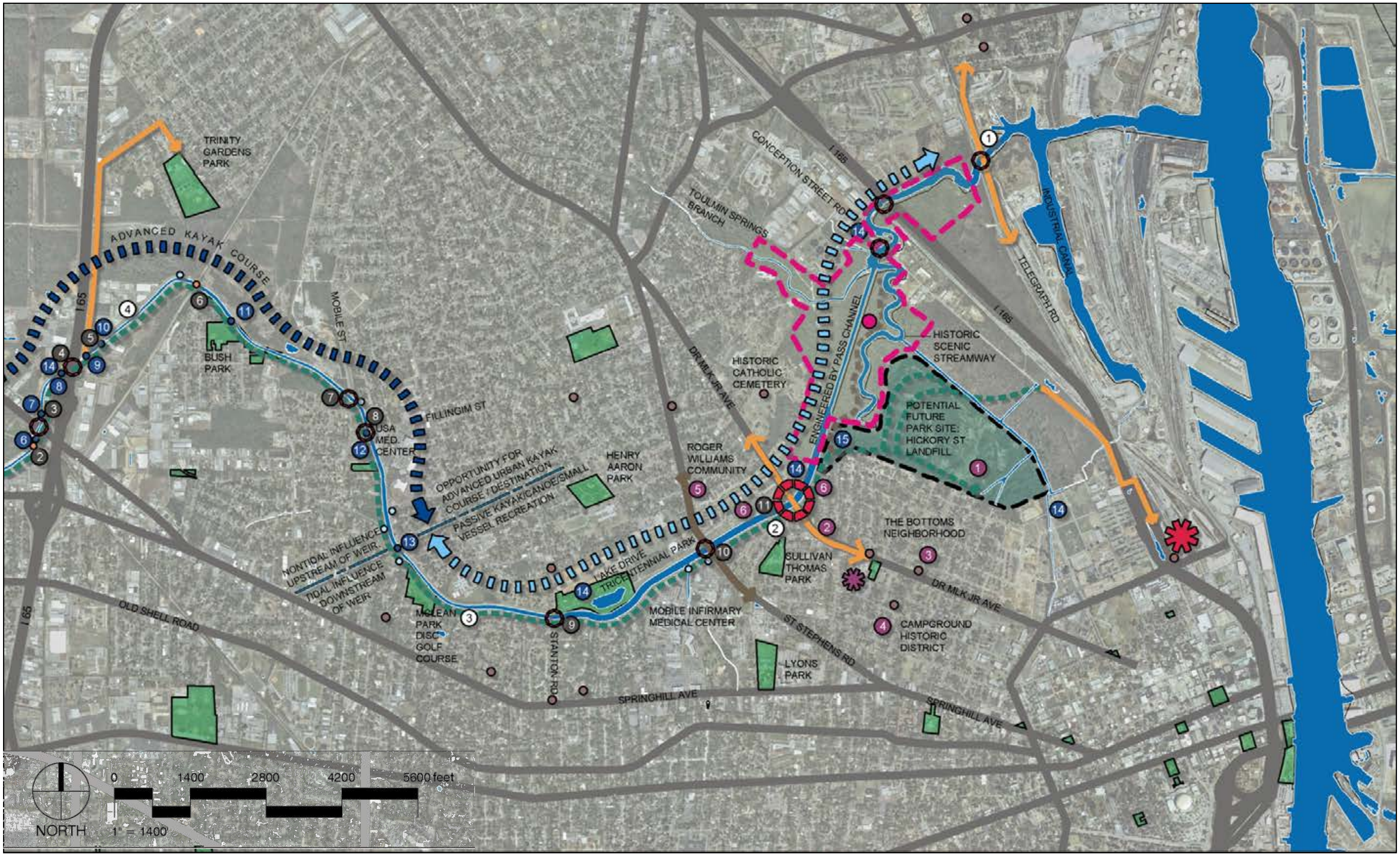
- USACE Survey/Environmental Impact Statement (USACE, 1982). This flood reduction study included a recreation component within the maintenance easement that was never constructed. The planned facility included an asphalt, multi-use trail along Three Mile Creek with supplemental tree and shrub plantings.
- City of Mobile Tricentennial Green Space Master Plan (Adams & Johnson, 2002). This framework for a city green space master plan suggests linear parks for Three Mile Creek and Twelve Mile Creek with bike, running, and walking trails. The plan envisioned connections to trail and park systems along Eight Mile Creek, along the I-65 corridor and into downtown.
- New Plan for Mobile (EDSA, 2009). This plan included initiatives that would "improve, enhance and revitalize" midtown and downtown areas. Among the midtown north revitalization initiatives were the Dr. Martin Luther King Jr. Avenue neighborhood (including the historic Camp Grounds area, now known as the Fisher neighborhood) and a park in the location of the Hickory Street Landfill.
- County of Mobile Bicentennial Bicycle and Pedestrian Comprehensive Plan (Neel-Schaffer & Slade, 2011). This document provides guidance for future development of bicycle and pedestrian paths and maps out multiple on-road bicycle paths for Three Mile Creek, interconnected with the linear park in the Tricentennial Green Space Master Plan.

3.1.11.2 Recreational Assessment and Constraints

The Dewberry Team prepared an Opportunities and Constraints Map evaluating public access, recreation, and ecotourism opportunities along the Three Mile Creek corridor (See Figures 3-30a through 3-30d). The Dewberry Team evaluated and considered the area's history, natural amenities, existing parks, and urban density in the plan's development. This map provides an initial inventory of relevant information for use when evaluating public access, recreation, and ecotourism opportunities along the corridor. Notable elements included on the Opportunities and Constraints map include (with associated information sources in parentheses when necessary):

- Historic sites (City of Mobile GIS data)
- Parks (City of Mobile GIS data)
- Major roads (City of Mobile GIS data)
- Universities and colleges
- USA Medical Center
- Mobile Infirmary Medical Center
- Adjacent neighborhoods and Historic District designations
- African American Heritage Trail
- Potential on-road and off-road bicycle connections (Mobile County Bicentennial Bicycle and Pedestrian Master Plan and City of Mobile Park and Recreation Master Plan)
- "New Plan for Mobile" Urban Design Implementation Initiatives
- Creek observations (Woods, 2004)
- Kayak observations (Paddle Trip Advisor notes from April 3, 2012).
- Three Mile Creek historic scenic streamway
- Potential advanced urban kayak route
- Passive kayak/canoe/small vessel recreation route
- Tidal vs. non-tidal Three Mile Creek zones
- Major transit hubs
- Field observations
- Noted drainage ditches
- Vehicular crossing locations

Figure 3-30a Recreation Opportunities and Constraints Map provides an initial inventory of relevant information to evaluate public access, recreations and ecotourism opportunities along Three Mile Creek. (Eastern Portion of Watershed)



Three Mile Creek Watershed Management Plan

Figure 3-30b Recreation Opportunities and Constraints Map provides an initial inventory of relevant information to evaluate public access, recreations and ecotourism opportunities along Three Mile Creek. (Western Portion of Watershed)

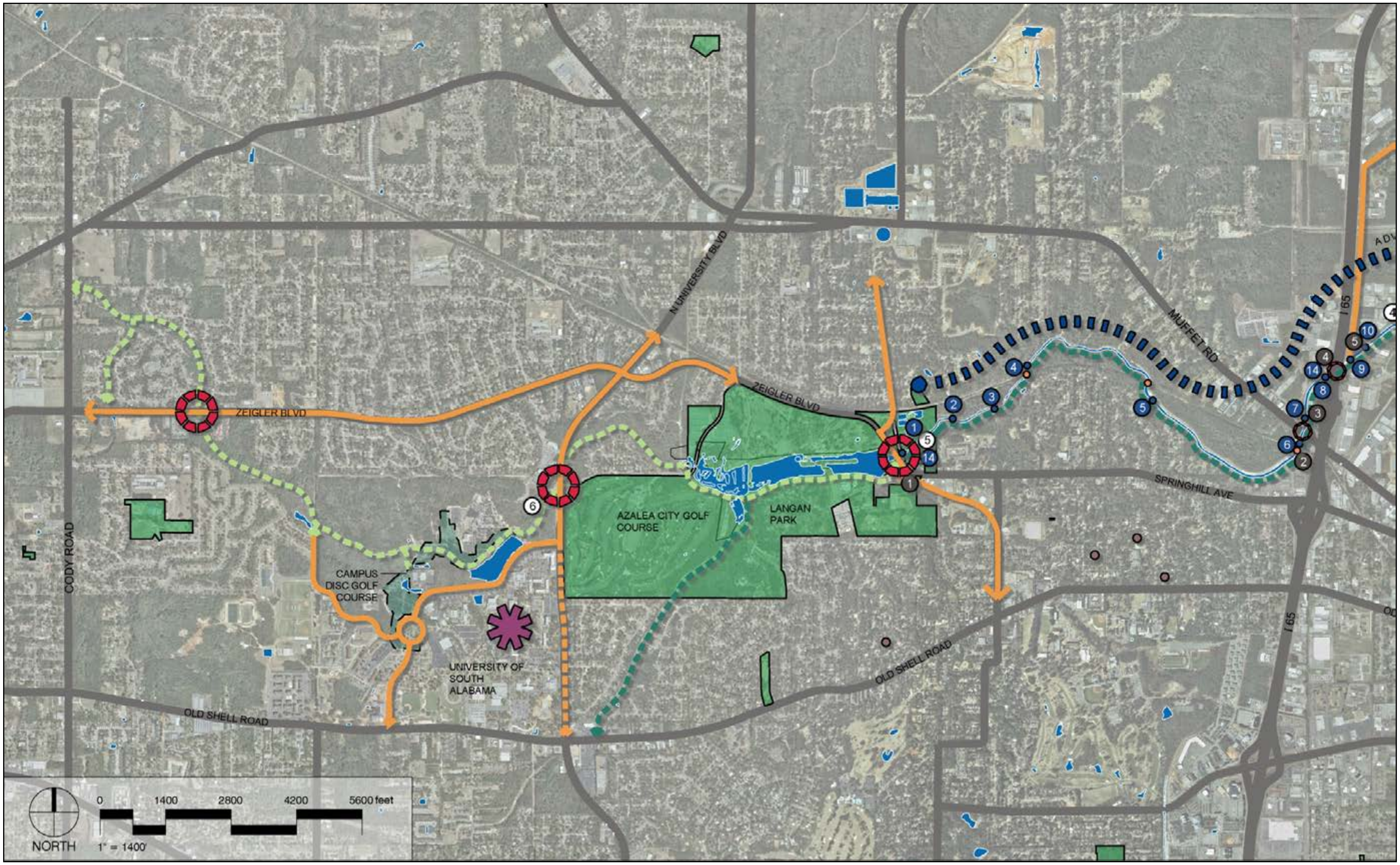


Figure 3-30c Legend for Figures 3-30 a, b

LEGEND

- EXISTING PARKS
- HABITAT RICH, FORESTED WETLAND. BROAD DIVERSITY OF MARINE AND FRESHWATER SPECIES. OPPORTUNITY TO ENHANCE PUBLIC ACCESS FOR ECOTOURISM DESTINATION IN THE HEART OF MOBILE.
- HISTORIC SITE
- EXISTING WEIR / DAM CONSTRAINT - KAYAK PORTAGE OPPORTUNITY
- EXISTING RAILROAD CROSSING CONSTRAINT - SAFE PEDESTRIAN CROSSING REQUIRED FOR GREENWAY TRAIL
- EXISTING DRAINAGE DITCH CONSTRAINT - PEDESTRIAN CROSSING REQUIRED
- AFRICAN AMERICAN HERITAGE TRAIL. OPPORTUNITY TO LINK WITH THREE MILE CREEK TRAIL SYSTEM.
- PROPOSED ON-ROAD BIKEWAY PER MOBILE COUNTY BICENTENNIAL BICYCLE AND PEDESTRIAN MASTER PLAN AND CITY OF MOBILE PARK & REC. MASTER PLAN
- PROPOSED OFF-ROAD BIKEWAY PER CITY OF MOBILE PARK AND RECREATION MASTER PLAN
- EXISTING OFF-ROAD BIKEWAY
- OPPORTUNITY FOR EXTENSION OF PROPOSED SHARED USE TRAIL
- OPPORTUNITY FOR BOARDWALK IN FORESTED WETLAND
- OPPORTUNITY FOR ADVANCED URBAN KAYAK COURSE. POTENTIAL URBAN ECOTOURISM DESTINATION.
- OPPORTUNITY FOR ENHANCED KAYAK/CANOE/SMALL VESSEL EXPERIENCE. UNIQUE TIDAL HABITAT RICH ENVIRONMENT.
- OPPORTUNITY TO CONNECT THREE MILE CREEK SHARED USE TRAIL WITH PROPOSED CITY OF MOBILE ON-ROAD BIKEWAY. EXISTING VEHICULAR CROSSING LOCATION WITH PLANNED ON-ROAD BIKEWAY.
- OPPORTUNITY FOR OBSERVATION TOWER IN FORESTED WETLAND
- EXISTING VEHICULAR CROSSING OVER THREE MILE CREEK
- COLLEGE AND UNIVERSITY
- THE WAVE MASS TRANSIT HUB

THREE MILE CREEK SUB-AREAS:

- UPPER WATERSHED
- MIDDLE WATERSHED
- TOULMINS SPRING BRANCH
- LOWER WATERSHED

THREE MILE CREEK OBSERVATIONS PER "AN IMPERVIOUS SURFACE STUDY OVER THREE REGIMES: THREE MILE CREEK, FLY CREEK, AND BAY MINETTE CREEK SUBWATERSHEDS" (MARCH 2004).

1. UPSTREAM OF INDUSTRIAL CANAL: STREAM WIDTH APPROXIMATELY 60 FEET. INDUSTRIAL LAND USE. ESTIMATED IMPERVIOUS SURFACE GREATER THAN 50 PERCENT. RIPARIAN ZONE DISTURBANCES ON BOTH BANKS. NO NATURAL CANOPY NOTED. AQUATIC VEGETATION OBSERVED ALONG BOTH BANKS.
2. DR. MLK JR. AVE: STREAM WIDTH APPROXIMATELY 100 FEET. URBAN LAND USE. ESTIMATED IMPERVIOUS SURFACE 20 PERCENT. RIPARIAN ZONE DISTURBANCES ON BOTH BANKS. NO CANOPY COVER NOTED. AQUATIC VEGETATION OBSERVED ALONG BOTH BANKS.
3. LEVERT DRIVE: STREAM WIDTH APPROXIMATELY 60 FEET. RESIDENTIAL LAND USE. ESTIMATED IMPERVIOUS SURFACE LESS THAN 10 PERCENT. RIPARIAN ZONE DISTURBANCES ON BOTH BANKS. NO CANOPY COVER NOTED. AQUATIC VEGETATION OBSERVED ALONG BOTH BANKS.
4. ARMOUR AVENUE: CHANNELIZED STREAM WIDTH APPROXIMATELY 50 FEET. COMMERCIAL LAND USE. ESTIMATED IMPERVIOUS SURFACE 10 PERCENT. RIPARIAN ZONE DISTURBANCES ON BOTH BANKS. NO CANOPY COVER NOTED. AQUATIC VEGETATION OBSERVED IN PATCHES.
5. DOWNSTREAM OF ZIEGLER BLVD: STREAM WIDTH APPROXIMATELY 20 FEET. URBAN FOREST LAND USE. ESTIMATED IMPERVIOUS SURFACE LESS THAN 10 PERCENT. NO RIPARIAN ZONE DISTURBANCES NOTED ON BOTH BANKS. 10 PERCENT CANOPY COVER. AQUATIC VEGETATION OBSERVED IN PATCHES. SUBSTANTIAL EROSION OBSERVED. DRAMATIC VARIANCE IN WATER LEVEL DURING PERIODS OF HEAVY RAINFALL.
6. UPSTREAM OF UNIVERSITY BLVD: STREAM WIDTH APPROXIMATELY 7 FEET. URBAN FOREST LAND USE ON BOTH BANKS. ESTIMATED IMPERVIOUS SURFACE LESS THAN 10 PERCENT. NO RIPARIAN ZONE DISTURBANCES NOTED ON BOTH BANKS. 70 PERCENT CANOPY COVER ESTIMATED. AQUATIC VEGETATION OBSERVED IN PATCHES.

"NEW PLAN FOR MOBILE": IMPLEMENTATION INITIATIVES (2009)

1. HICKORY STREET SPORTS ACADEMY AND COMMUNITY PARK - LANDFILL REDEVELOPMENT AND REUSE
2. MLK JR. AVE WEST MIXED-USE - COMMERCIAL NEIGHBORHOOD CENTER
3. THE BOTTOMS NEIGHBORHOOD REVITALIZATION
4. CAMPGROUND NEIGHBORHOOD REVITALIZATION
5. ST STEPHENS ROAD WEST GATEWAY COMMERCIAL RELOCATION AND MIDTOWN CENTER REDEVELOPMENT
6. THREE MILE CREEK GREENWAY INITIATIVE AND NEW TERRACE RESIDENTIAL COMMUNITY.

Figure 3-30d Key to Opportunities identified on map in Figures 3-30 a, b

KAYAKING OPPORTUNITIES AND CONSTRAINTS PER UPPER THREE MILE CREEK "PADDLE TRIP ADVISOR." CONDITIONS NOTED ON APRIL 3, 2012. CONDITIONS VARIABLE.

1. OPPORTUNITY FOR DESIGNATED PARKING AND ENHANCED KAYAK PUT-IN AT LANGAN PARK'S JAPANESE GARDEN
2. ROCK RAPIDS. REQUIRES PORTAGE. OPPORTUNITY TO PROVIDE ENHANCED PORTAGE.
3. ROCK RAPIDS. NO PORTAGE REQUIRED.
4. ROCK RAPIDS. NO PORTAGE REQUIRED.
5. SPILLWAY CHUTE, TWO WEIRS, AND ROCK RAPIDS. PORTAGE REQUIRED. OPPORTUNITY TO PROVIDE ENHANCED PORTAGE.
6. ROCK RAPIDS. NO PORTAGE REQUIRED.
7. TWO WEIRS. PORTAGE REQUIRED. OPPORTUNITY TO PROVIDE ENHANCED PORTAGE.
8. BOX CULVERT UNDER I-65. FAST CURRENT.
9. NAVIGABLE BUT DANGEROUS SPILLWAY CHUTE DROP AT END OF CULVERT.
10. TWO WEIRS FOLLOWED BY NAVIGABLE BUT DANGEROUS ROCK RAPIDS. DANGEROUS PORTAGE ALONG STEEP GABION ROCK-STEPPED WALL. PUT-IN PAST ROCK RAPIDS IS RECOMMENDED. OPPORTUNITY TO PROVIDE ENHANCED PORTAGE.
11. TWO WEIRS WITH ROCK RAPIDS. OPPORTUNITY TO PROVIDE ENHANCED PORTAGE.
12. TWO WEIRS UNDER FILLINGIM STREET BRIDGE. OPPORTUNITY TO PROVIDE ENHANCED PORTAGE.
13. TWO WEIRS WITH ROCK RAPIDS. OPPORTUNITY TO PROVIDE ENHANCED PORTAGE. TIDAL INFLUENCE DOWNSTREAM.
14. OPPORTUNITY TO PROVIDE KAYAK/CANOE/SMALL VESSEL LAUNCH AND PARKING FOR RECREATIONAL ACCESS. SMALL OUTFITTER/RENTAL OPPORTUNITY.
15. SILTATION PREVENTS NAVIGATION AT THE "PLUG." OPPORTUNITY FOR PADDLE LOOP.

Figures 3-30d 1-11 relate to the numbered locations shown in gray in Figures 3-30a, 3-30b.

Figure 3-30d 1

1 View from Springhill Ave. Significant grade change. Greenway trail constraint.

Figure 3-30d 2

2 Railroad crossing west of I-65. Greenway trail constraint.

Figure 3-30d 3

3 View towards Moffet Road. Significant greenway trail constraint.

Figure 3-30d 4

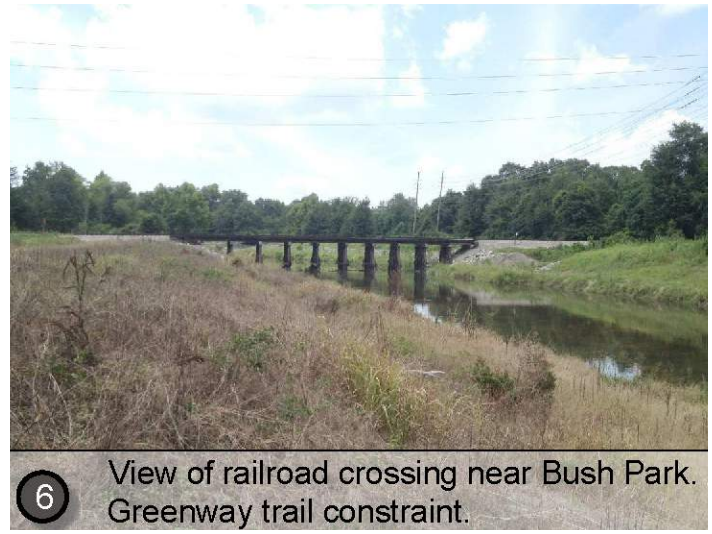
4 View towards I-65. Major transportation route and significant trail constraint.

Figures 3-30d 1-11 relate to the numbered locations shown in gray in Figures 3-30a, 3-30b.

Figure 3-30d 5

5 View towards I-65. Major transportation route and significant trail constraint.

Figure 3-30d 6



6 View of railroad crossing near Bush Park. Greenway trail constraint.

Figure 3-30d 7

7 View of Mobile St. Minor greenway trail constraint.

Figure 3-30d 8

8 View of Fillingim St. Minor greenway trail constraint.

Figures 3-30d 1-11 relate to the numbered locations shown in gray in Figures 3-30a, 3-30b.

Figure 3-30d 9

9 View of Stanton Rd. Minor greenway trail constraint.

Figure 3-30d 10

10 View of St. Stephens Rd. Minor greenway trail constraint.

Figure 3-30d 11

11 View of Dr. Martin Luther King Jr. Ave. Minor greenway trail constraint.

3.1.11.3 Greenway and Blueway Constraints

During our review of information on and field visits to Three Mile Creek, we noted several constraints to the development of greenways such as crossings at major roads, railroads and, drainage ditches. For blueways, the Dewberry Team identified watercourse obstructions such as culverts, weirs, spillways, gabion baskets and riprap. In addition to physical developments, another overarching constraint to recreation projects is private and public land ownership for property adjacent to Three Mile Creek. All of these are discussed in this section. See Figure 3-31 as an example at I-65.

Figure 3-31: I-65 is a major transportation route that will be a significant greenway trail constraint.

3.1.11.3.1 Road Crossings

A creek-side trail would encounter 10 crossings between Cody Road and a potential park site at the Hickory Street Landfill. Each road crossing will require a detailed design study to understand the optimal way to provide safe crossing for pedestrians and cyclists. Each crossing will be unique, and the cost for the crossings can vary depending on the extent of required grade changes and modifications. These crossing would need to be addressed with a combination of over- and under-road structures. Ten road crossings that were identified as intersecting a potential shared-use trail are listed below

1. Zeigler Boulevard
2. N. University Boulevard
3. Springhill Avenue at Langan Park
4. Moffet Road
5. I-65
6. Mobile Street
7. Fillingim Street
8. Stanton Road
9. St. Stephens Road
10. Dr. Martin Luther King Jr. Avenue

3.1.11.3.2 Railroad Crossings

A number of railroad crossings along the proposed trail will require unique design solutions (see Figure 3-32). At-grade crossings are typically infeasible unless they are integrated with existing road crossings that are already signalized. It is likely pedestrian bridges will be required to provide safe crossings.

Figure 3-32 Three railroad crossings are located West of I-65 and one East of I- 65

3.1.11.3.3 Drainage Channels and Ditches

A number of drainage ditches, channels and tributaries interrupt the potential trail corridor. The options and costs for crossings in these locations vary widely depending on the span of the crossing. In many cases, a short culvert (structure to allow water or pedestrians through – in this case, pedestrians) or a boardwalk will provide the required access. In other locations, trail extensions to the nearest existing crossing may be more cost-effective than providing dedicated bridges.

3.1.11.3.4 Culverts

Culverts provide both a constraint and an opportunity for the proposed trail system. Many culverts are too small or too long for a kayaker or canoeist to navigate as part of the blueway and will require portaging watercraft via the greenway trail crossings. In some locations such as I-65, the culverts are tall enough to allow safe access via watercraft and have a lower channel invert in one cell that maintains water flow (See Figure 3-33). This arrangement can also provide an opportunity for the greenway trail system. A dry cell is a type of a culvert which is higher in profile and would stay dry under normal flow conditions. A dry cell could be used as part of the greenway trail for pedestrians to pass under I-65, similar to the Alligator Alley Pass under I-10 in Baldwin County, Alabama (See Figure 3-34). This would require ramps from the stream bank into the channel to access the culverts and would require that the culverts provide the required minimum eight-foot clearance for pedestrian and bicycle traffic. As part of the design process, hydraulic modeling and permitting through the FEMA would be necessary to show that the permanent encroachment of ramps and railings into the channel do not significantly change the water elevations in Three Mile Creek. These alternatives would also require consideration of waterproof lighting and signage plus temporary barricades to restrict their use during rain events.

Figure 3-33 Gabion baskets create nearly vertical walls downstream of I-65; these prevent access to the creek and are a significant challenge during portage.

Figure 3-34 Culvert under I-65, a dry cell, may provide an opportunity for pedestrian access in the proposed greenway trail system.

3.1.11.3.5 Weirs & RipRap

The five sets of weirs and associated riprap along Three Mile Creek present another constraint for the proposed blueway. It is difficult for people using canoes and kayaks to maneuver over these weirs because of the weir height (see Figure 3-35). Boaters have to take their vessels out of the water, walk along the greenway past the weirs with their vessels and then re-enter the waterway. Riprap along the banks of the creek creates a challenging surface to walk over while carrying a vessel.

Figure 3-35 Weirs near Moffet Road will require a portage solution that also addresses riprap on the banks

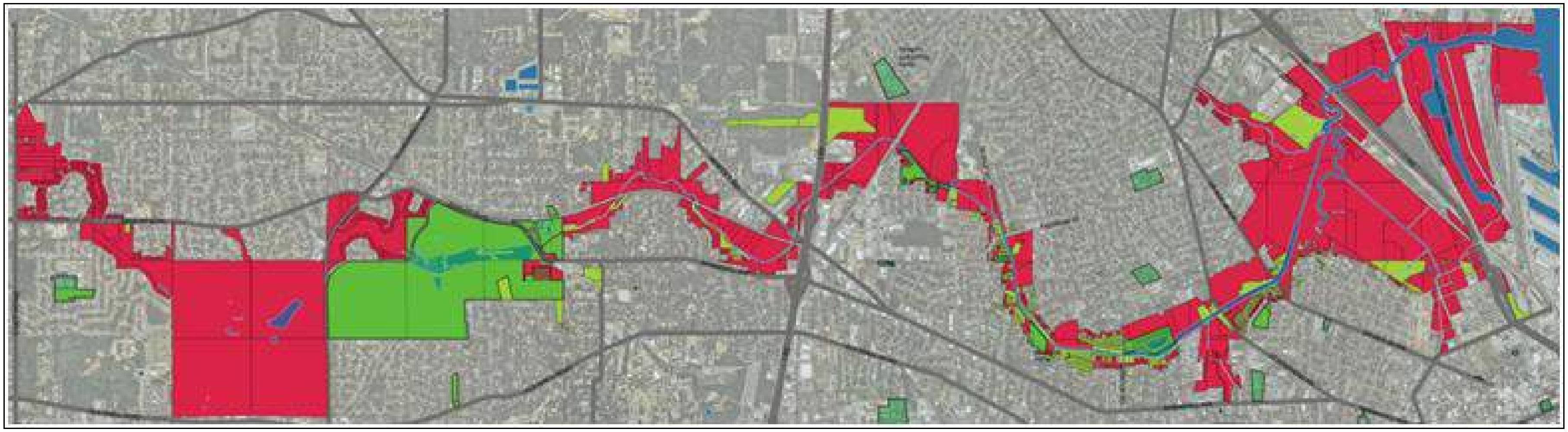
3.1.11.3.6 Property Ownership

Property ownership presents the single biggest resource challenge to realizing the greenway/blueway trail system along Three Mile Creek. Significant tracts of land along Three Mile Creek are already controlled by public, nonprofit and private owners. Access to certain lands would require an easement – a right given by the property owner to allow others access to the land. The total potential trail length from Cody Road to Hickory Street Landfill is 12.7 miles. Portions of the trail alignment are already in City ownership (USACE maintenance corridors along Three Mile Creek) while other portions, owned by non-profit companies, will require easements, but could be obtained at no cost. The remaining 8.1 miles of this route (almost 75%) are currently under private ownership where easement acquisition may require compensation (See Figure 3-36). Easements would be required for:

- Available lands under the ownership of the Mobile Housing Authority near the former Roger Williams and Orange Grove housing developments;
- Alabama Port Authority-owned lands connecting to existing City parks and USA campus trail systems;
- Privately owned properties.

The use of certain City and Housing Authority-owned lands may also come with certain limitations. Construction on land purchased with FEMA flood relief funds, such as the land near the Roger Williams and Orange Grove developments will require permit coordination with FEMA and will be limited to at-grade construction with minimal changes to the stream banks. In addition, no structures or dense vegetation may be installed that would impede the flow of water in these areas. These restrictions would also apply to USACE maintenance corridors.

Figure 3-36 The total trail length from Cody Road to Hickory Street Landfill is 12.7 miles. Nearly 8.1 miles of this route would potentially require private easements. (Areas shown in red are private lands).

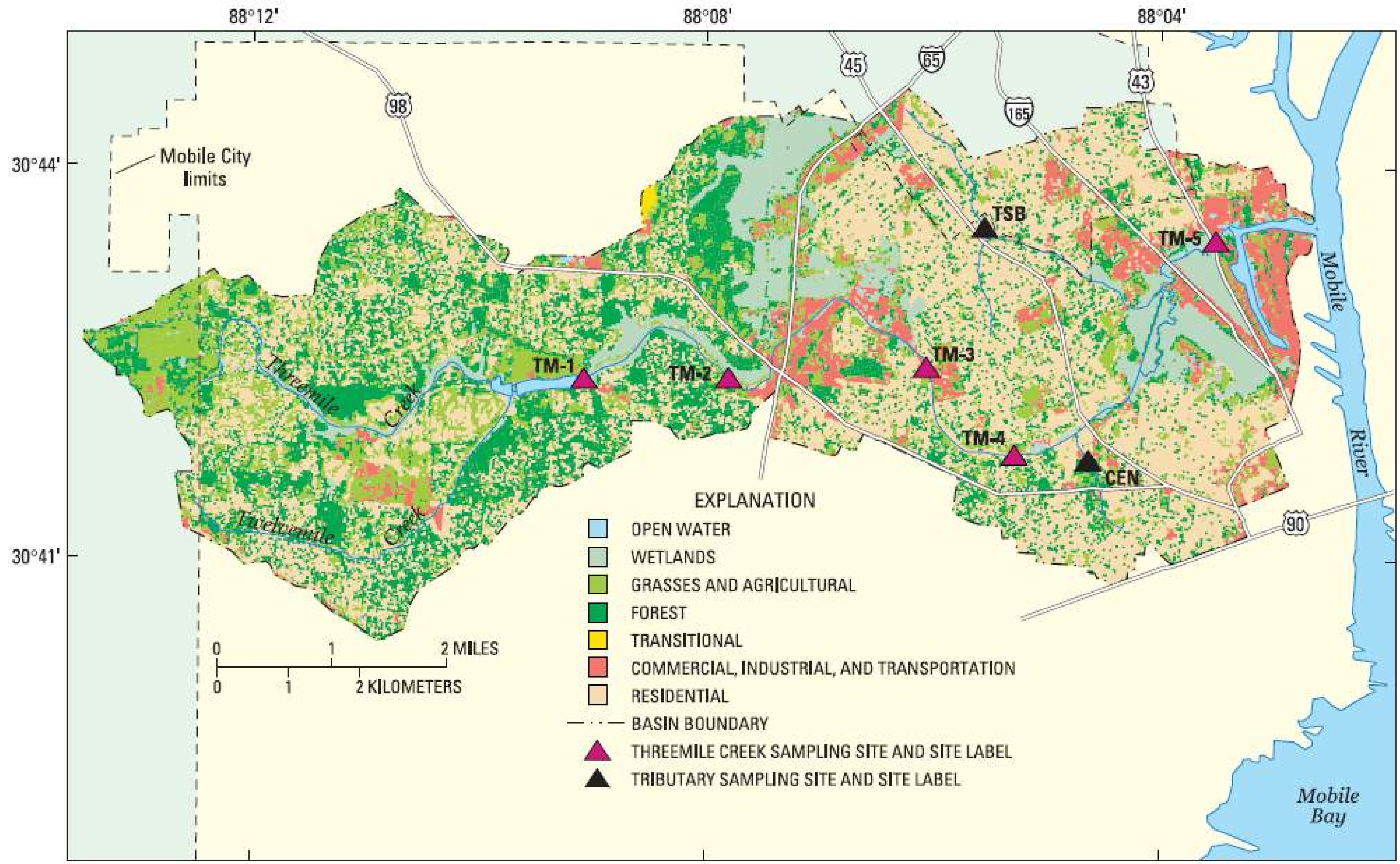


3.2 Watershed Assessment

3.2.1 Water Quality and Biological Monitoring Data from USGS/MAWSS Study on Three Mile Creek from 1999 to 2003 (2004)

From 1999 to 2003, the USGS and MAWSS conducted extensive monitoring in Three Mile Creek to evaluate water quality and biological conditions. A map with surface water monitoring locations is shown in Figure 3-37. Five surface water monitoring sites (TM-1 through TM-5) were established in Three Mile Creek, along with sites in TSB and UTTM. This section describes the findings from this monitoring effort.

Figure 3-37 USGS/MAWSS Surface Water Monitoring Sites in Three Mile Creek. (Source: USGS/MAWSS, 2004)



Base from U.S. Environmental Protection Agency
National Land Cover Data, from Landsat-5 Thematic Mapper images
30-meter resolution, 1992

3.2.1.1. Dissolved Oxygen

As noted earlier, DO is the measurement of the amount of oxygen in a water body. The lower the level of oxygen in the water, the less biological life can be supported. ADEM applied the “agricultural and industrial water supply” designated use (the State’s lowest water quality use designation) to Three Mile Creek. The State of Alabama’s water quality standard for DO for the agricultural and industrial water supply use is 3.0 mg/L. During the USGS/MAWSS monitoring, the number of days in 1999-2003 with measured DO values below 3.0 mg/L is shown in Figure 3-38. At the most downstream site (TM-5), the measured DO in the creek was below the State standard for at least 180 days per year. In 1999, the DO standard was met on only approximately 75 days. Two of the factors contributing to low DO values are the shallow water depths and higher temperatures in the warmer months. The DO standard was not met on as many as 100 days per year at site TM-4, and 45 days per year at the most upstream monitoring site, TM-1. The downstream segments of Three Mile Creek had more days with DO values below the State standard; the upstream segments of Three Mile Creek had more days with DO values above the State standard. Measured five-day BOD (BOD5) concentrations ranged from 0.1 mg/L at TM-1 to 8.8 mg/L at site UTTM. Higher BOD concentrations impact water quality by reducing available oxygen in the water to support aquatic organisms. BOD5 concentrations at UTTM and TM-5 were significantly higher than at TM-1. Most moderately contaminated streams have BOD5 concentrations ranging from 1 to 8 mg/L. Discharges containing BOD exert an oxygen demand on the surface water system. This produces lower DO concentrations in the surface water system, resulting in a degraded aquatic ecosystem.

3.2.1.2. Nutrients

Nutrient pollution is caused by excess nitrogen and phosphorus in water, typically stemming from gross pollutants, SSO’s and fertilizer-laden runoff. Phosphorus and nitrogen are essential nutrients, but in excessive concentrations, they degrade water quality by encouraging the growth of algae (algal blooms) at a rapid rate, which in turn reduces DO. The State of Alabama does not have a specific water quality standard for nutrients. The EPA-recommended value for total phosphorus (TP) concentration for this ecological region of the United States is 0.04 mg/L. Concentrations of both suspended and dissolved P were measured by USGS/MAWSS in Three Mile Creek during 1999-2003. The sum of these values is the TP concentration. Phosphorus is an essential nutrient, but in high concentrations it can degrade water quality by encouraging algal blooms, which, in turn, reduce DO. A summary of the measured median TP values is shown in Figure 3-39. Elevated TP concentrations were measured in both tributaries (UTTM and TSB) and at the most downstream creek monitoring site (TM-5). The median TP concentrations measured in both tributaries and at siteTM-5 were more than an order of magnitude higher than the TP concentrations measured at the other sites. The EPA-recommended value for TP concentration for this ecoregion is 0.04 mg/L. The measured median values at both tributaries and at site TM-5 ranged from 0.14 to 0.35 mg/L, well above the recommended value. The measured median values at the other monitoring sites were below the recommended TP concentration.

Figure 3-38 Number of days with measured DO concentrations less than 3.0 mg/L in Three Mile Creek during 1999 to 2003; Downstream station (TM-5) has poorest water quality. (Source: USGS/MAWSS, 2004)

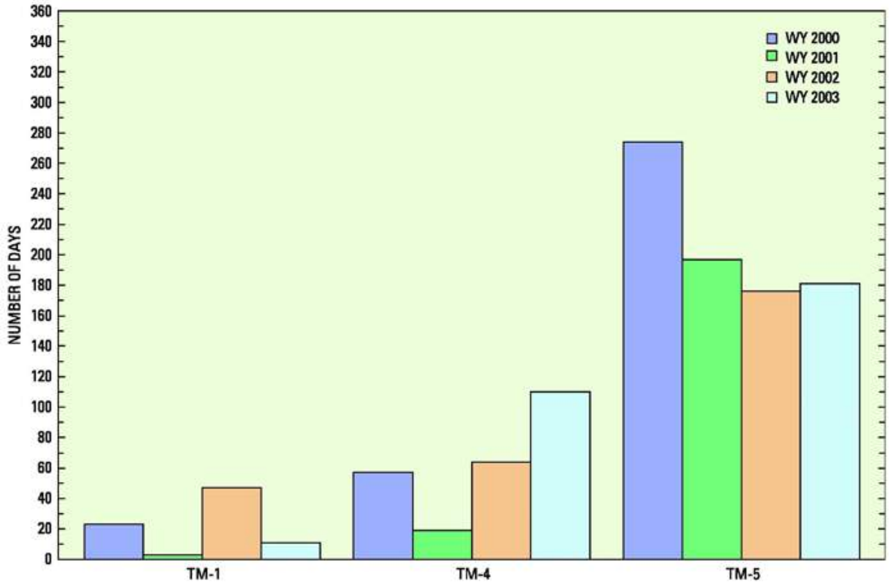
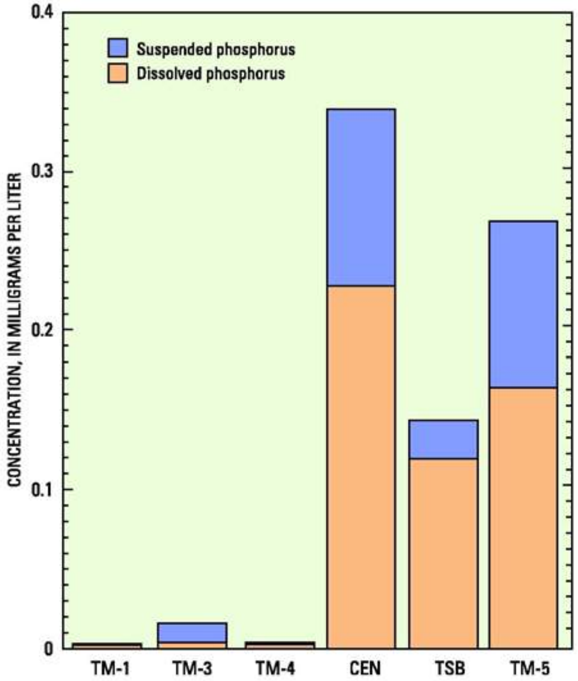
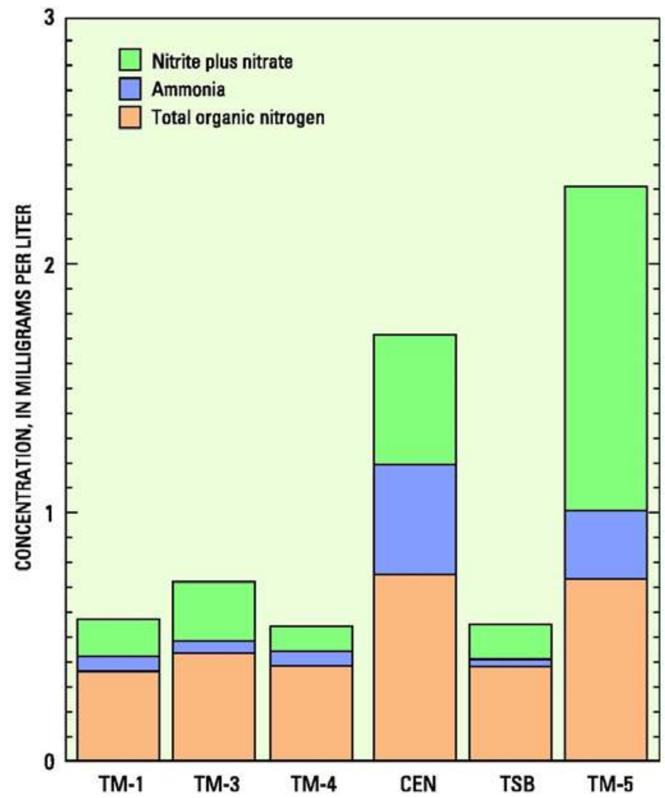


Figure 3-39 M easured median suspended and dissolved phosphorus concentrations in Three Mile Creek during 1999 to 2003; Highest phosphorus concentrations in UTTM, TSB, and TM-5. (Source: USGS/MAWSS, 2004)



Measured median values for nitrate plus nitrite, ammonia, and total organic nitrogen are shown in Figure 3-40. The sum of these values is the total nitrogen (TN) concentration. Elevated TN values were measured at the UTTM and at site TM-5. The median TN values at the UTTM and at site TM-5 were more than double the measured TN values at the other monitoring sites. The EPA-recommended value for TN concentration for this ecological region of the US is 0.90 mg/L. The measured median values at the UTTM and at site TM-5 ranged from 1.7 to 2.4 mg/L, well above the EPA-recommended value. The measured median values at the other monitoring sites were below the EPA-recommended TN concentration.

Figure 3-40 Measured median nitrate plus nitrite, ammonia, and total organic nitrogen concentrations in Three Mile Creek during 1999 to 2003; Highest concentrations of nitrogen species at UTTM and TM-5. (Source: USGS/MAWSS, 2004)



The presence of elevated concentrations of pathogens (i.e., bacterial indicator organisms) in surface waters is a serious threat to human health and safety, because they indicate the presence of disease-causing micro-organisms. These bacterial indicator organisms are enterococci, *Escherichia coli* (E. coli), and fecal coliform. The EPA-recommended maximum concentrations for fecal indicators in recreational waters are 151 colonies per 100 milliliters (col/100 ml) for enterococci, and 576 col/100 ml for E. coli (see Figure 3-41a through3-41c). ADEM's State surface water quality standard for fecal coliform for an agricultural and industrial water use is 4,000 col/100 ml. A summary of the measured concentrations for fecal indicators in Three Mile Creek during 1999 to 2003 is provided in Table 3-2. Values measured during wet weather are shown with a red triangle. Dry weather values are identified with a white triangle. Elevated concentrations of all three fecal indicator organisms were measured at all monitoring sites during wet weather. Measured values were greater than two orders of magnitude higher than the recommended State standards. As listed in Table 3-2, the sites with the highest frequency of water quality standard exceedances include UTTM, Toulmins Spring Branch, and TM-5. The sites with the lowest exceedance frequencies were TM-1 and TM-4. Anthropogenic sources of bacteria indicator organisms are also likely sources of BOD and nutrients to Three Mile Creek and are at least partially responsible for the periodic low DO conditions in the creek.

Of particular interest is the measurement of elevated fecal indicator organism concentrations well above the water quality standards during dry weather. At sites TSB, UTTM, and TM-5, the measured dry weather concentrations were as high or almost as high as those measured during wet weather. Fecal indicator organisms are typically seen in higher numbers after a wet weather event as a result of runoff laden with gross pollutants. The measurement of elevated bacteria indicator organisms during dry weather indicates bacteria contributions from other sources such as groundwater seepage into the surface water system or direct inputs of bacteria into the surface water system through illicit connections and/or sanitary discharges. Measured concentrations are displayed below in Figure 3-41 (a-c) below.

Figure 3-41 (a-c) Measured concentrations of enterococci, Escherichia coli, and fecal coliform in Three Mile Creek during 1999 to 2003; Elevated pathogen concentrations observed from dry weather at UTTM, TSB, and TM-5. (Source: USGS/MAWSS, 2004)

Figure 3-41a

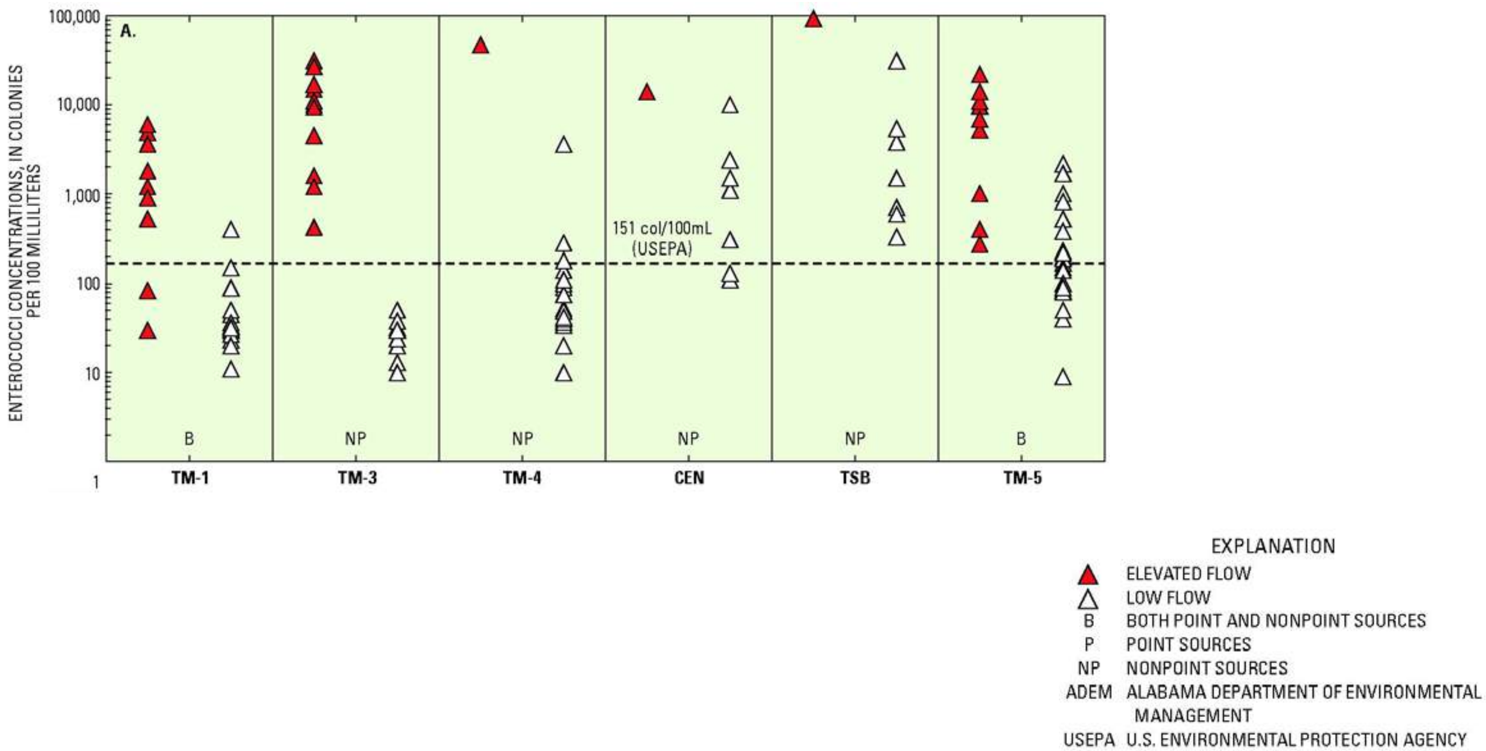


Figure 3-41b

Figure 3-41c

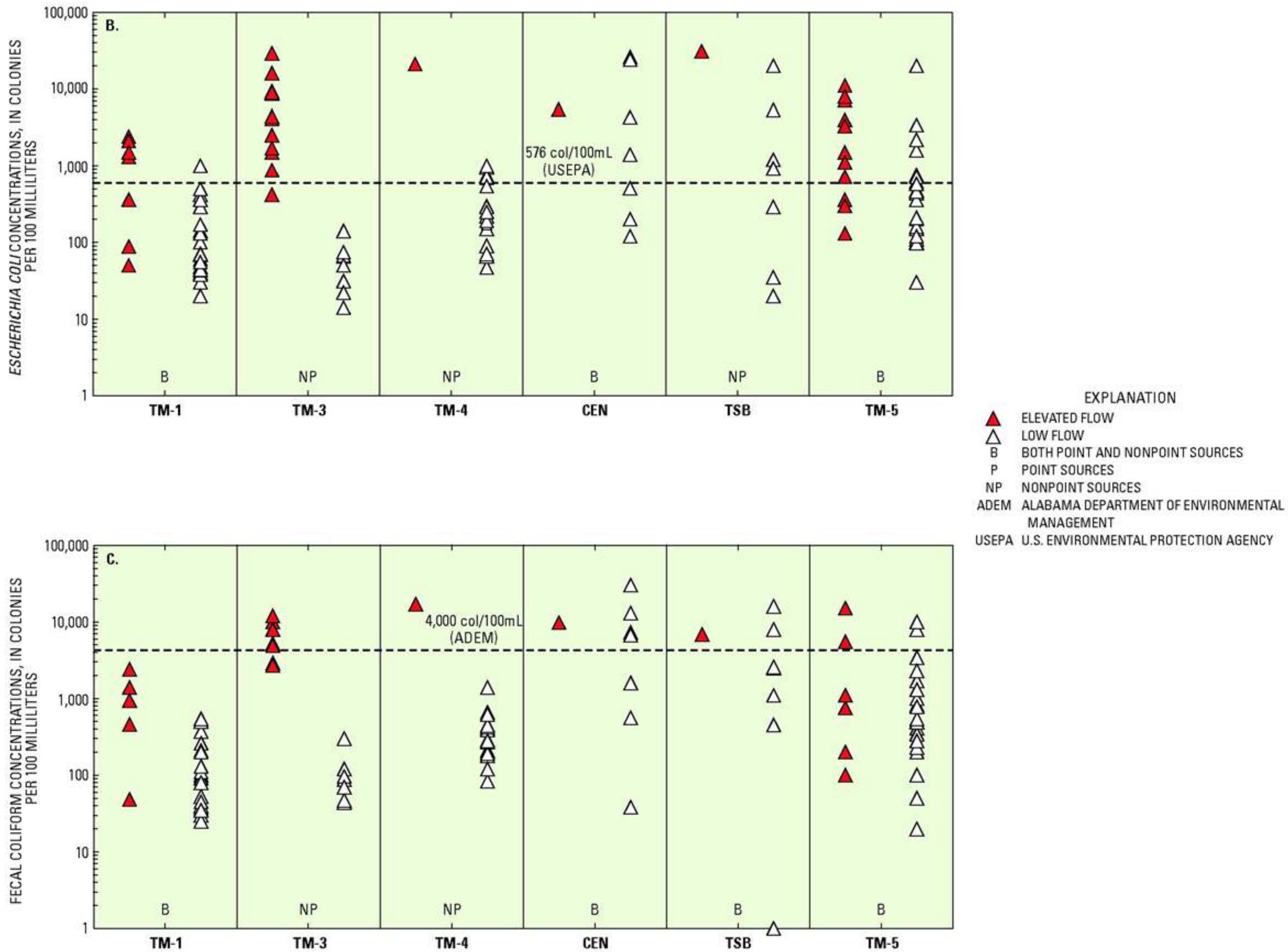


Table 3-2 Summary of exceedance frequency for enterococci, Escherichia coli, and fecal coliform measured in Three Mile Creek **from** 1999 to 2003; Highest exceedance frequency at UTTM, TSB, and TM-5. (Source: USGS/MAWSS, 2004)

[USEPA, U.S. Environmental Protection Agency; col/100 mL, colonies per 100 milliliters; ADEM, Alabama Department of Environmental Management]

Site label (fig. 1)	Enterococci			*Escherichia coli*			Fecal coliform		
	Total number of samples	Samples exceeding USEPA criterion[a] (151 col/ 100 mL)	Exceedance frequency (percent)	Total number of samples	Samples exceeding USEPA criterion[a] (576 col/ 100 mL)	Exceedance frequency (percent)	Total number of samples	Samples exceeding ADEM criterion[b] (4,000 col/ 100 mL)	Exceedance frequency (percent)
TM-1	26	8	31	35	7	20	31	0	0
TM-3	19	11	58	21	12	57	15	5	33
TM-4	20	5	25	19	6	32	20	1	5
CEN	8	6	75	8	5	63	8	5	63
TSB	8	8	100	8	5	63	8	3	38
TM-5	34	22	65	36	17	47	31	4	13
TOTALS	115	60	52	127	52	41	111	18	16

[a] U.S. Environmental Protection Agency (1986a).

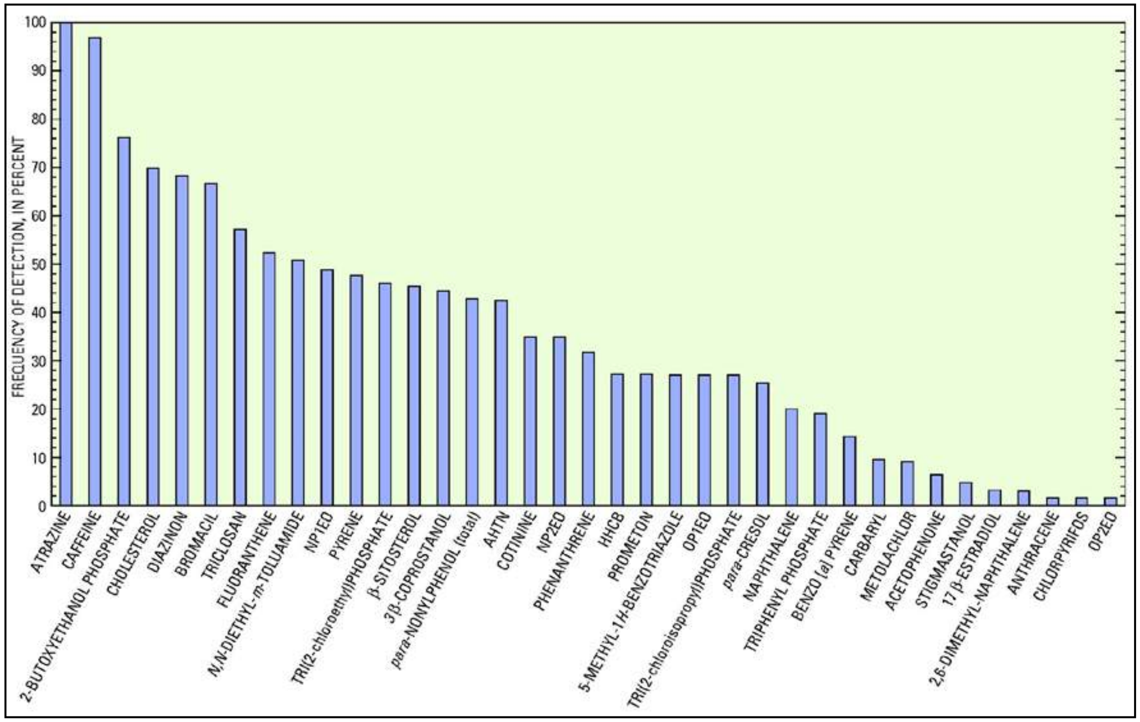
[b] Alabama Department of Environmental Management (2000c, 2004).

3.2.1.3. Organic Compounds

The USGS/MAWSS also collected and analyzed 63 surface water samples in Three Mile Creek and its tributaries for a wide variety of organic wastewater compounds. A summary of the frequency of detection for these compounds is illustrated in Figure 3-42. Atrazine (herbicide) and caffeine were detected in almost all of the samples. A variety of other compounds including plasticizers, antimicrobials, insecticides, and steroids were observed in at least 50 percent of the samples. In high enough concentrations, these man-made substances can be toxic to wildlife and humans, causing a variety of health issues such as reproductive problems and reduced ability to fight disease and infection. A summary of the detection frequency of organic wastewater compounds at each site is provided in Table 3-3.

The highest detection frequency was observed at the UTTM, followed by TSB and the farthest downstream creek monitoring site (TM-5). Every sample collected at site UTTM contained caffeine; cholesterol and B-sitosterol (steroids); AHTN (fragrance); and three detergent metabolites. Similar compounds were detected at sites and TM-5. TM-1 had the lowest observed detection frequency followed by TM-3 and TM-4. As shown on Figure 3-43, the total concentration of organic wastewater compounds was generally higher during dry weather than during wet weather. Exceptions to this were observed at site TM-1 and TM-3; this is likely due to the very low concentrations of wastewater compounds measured during dry weather at these sites.

Figure 3-42 Frequency of detection for organic wastewater compounds in Three Mile Creek during 1999 to 2003; Many different compounds are present in the watershed. (Source: USGS/MAWSS, 2004)



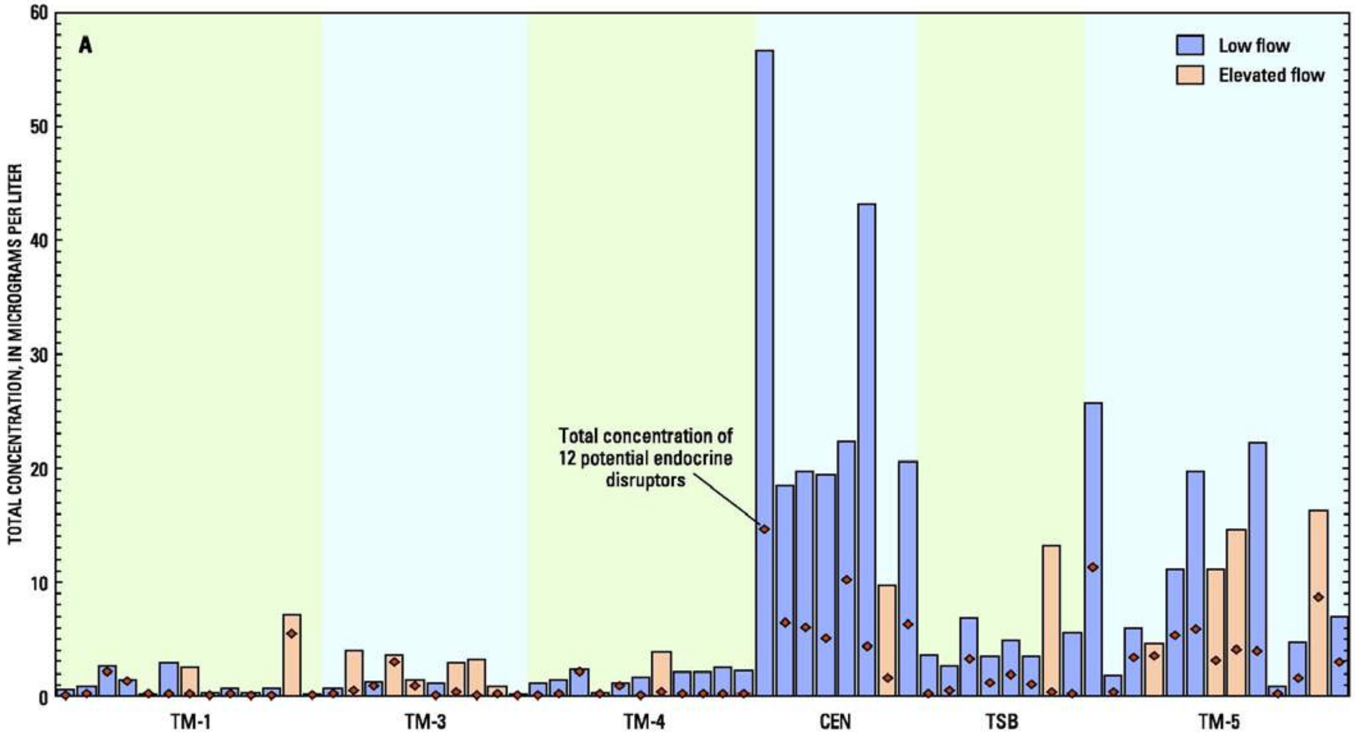
The detection of a variety of organic wastewater compounds in samples collected at sites UTTM, TSB and TM-5 is further evidence of sanitary contributions from groundwater seepage into the surface water system from septic systems or direct inputs into the surface water system through illicit connections, overflows or leaks. This applies to TSB, the UTTM, and Three Mile Creek below the discharge from the UTTM. Conversely, there appears to be minimal influence from wastewater compounds on surface water quality in the creek in the upper and middle segments (from site TM-1 to site TM-4), which are upstream of the UTTM discharge to Three Mile Creek. Similar to pathogens, the presence of organic wastewater compounds in the lower portion of the creek is a serious concern for water designated for recreational use and is a threat to public health and safety.

Table 3-3 Summary of organic wastewater compounds detected in Three Mile Creek from 1999 to 2003; highest detection frequency at UTTM, TSB, and TM-5. (Source: USGS/MAWSS, 2004)

[µg/L, micrograms per liter; BHA, butylated hydroxyanisole; BHT, butylated hydroxytoluene; E, estimated; AHTN, 6-acetyl-1,1,2,4,4,7-hexamethyltetraline; HHCB, 1,3,4,6,7,8-hexahydro-4,6,6,7,8,8-hexamethyl-cyclopenta(*g*)-2-benzopyran; NP1EO, monoethoxylate nonylphenol; NP2EO, diethoxylate nonylphenol; OP1EO, monoethoxylate octylphenol; OP2EO, diethoxylate octylphenol; OWCs, organic wastewater compounds; Compounds that are potential endocrine disruptors are in **bold**; Percent detections in **bold** indicate which site had the maximum concentration measured for a chemical]

Compound	Maximum concentration (µg/L)	Number of detections	Sample size	Detection frequency (percent)						
				All sites	TM-1	TM-3	TM-4	CEN	TSB	TM-5
Antioxidants										
2,6-di-*tert*-butylphenol		0	30	0	0	0	0	0	0	0
2,6-di-*tert*-*p*-benzoquinone		0	30	0	0	0	0	0	0	0
5-methyl-1*H*-benzotriazole	21.4	17	63	27	8	20	18	**88**	25	23
BHA		0	63	0	0	0	0	0	0	0
BHT		0	30	0	0	0	0	0	0	0
para-cresol	1.4	16	63	25	0	10	0	**75**	75	23
Prescription and nonprescription drugs										
17β-estradiol	E 0.636	2	63	3	0	**10**	0	0	13	0
Caffeine	9.8	61	63	97	92	100	100	**100**	100	92
Cotinine	E 0.469	22	63	35	23	0	18	**88**	63	38
Steroids (stanols and sterols)										
Cholesterol	E 7.0	44	63	70	43	50	64	**100**	88	85
3β-coprostanol	E 5.86	28	63	44	8	10	9	88	88	**85**
β-sitosterol	E 3.80	15	33	45	13	40	50	100	67	**50**
Stigmastanol	E 1.1	3	63	5	0	0	0	13	0	**15**
Fragrances										
Acetophenone	0.236	4	63	6	0	0	0	**13**	13	15
AHTN	E 0.42	14	33	42	25	0	0	100	67	**88**
HHCB	E 0.19	9	33	27	0	0	0	67	33	**75**
Detergent metabolites										
NP1EO	E 4.91	21	43	49	30	33	22	**100**	60	67
NP2EO	E 5.97	22	63	35	8	0	0	**100**	25	85
OP1EO	E 0.76	17	63	27	23	20	18	38	38	**31**
OP2EO	E 0.13	1	63	2	0	0	0	0	0	**8**
***para*-nonylphenol (total)**	E 3.33	27	63	43	8	30	18	**100**	38	77

Figure 3-43 Total concentration of organic wastewater compounds measured in Three Mile Creek and tributaries during dry and wet weather from 1999 to 2003; much higher concentrations observed at UTTM, TSB, and TM-5. (Source: USGS/MAWSS, 2004)

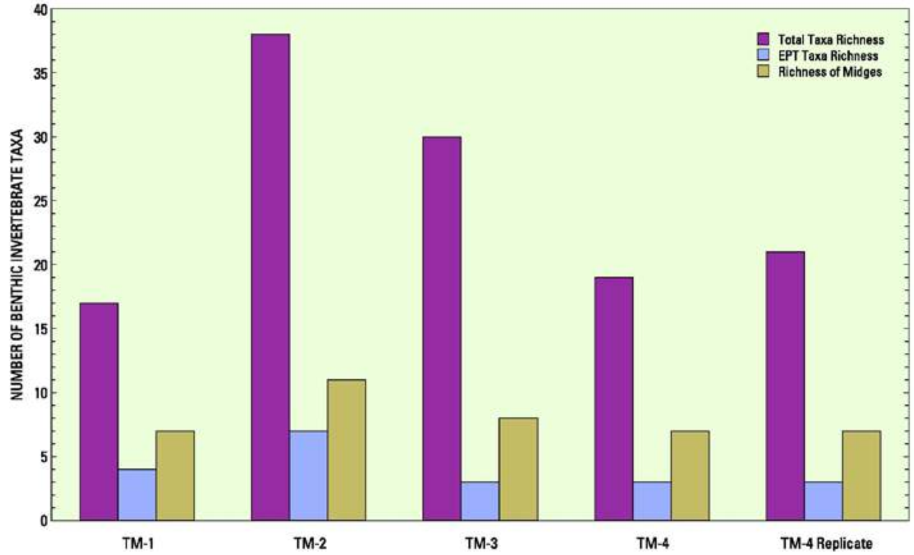


3.2.1.4. Biological Monitoring

The USGS/MAWSS collected and analyzed benthic invertebrate samples at four locations in Three Mile Creek (see Figure 3-44). The total number of taxa was highest at site TM-2, followed by site TM-3. Lower taxa numbers were observed at sites TM-1, and TM-4. The low score at site TM-1 was likely impacted by the water impoundment immediately upstream of the monitoring site. It is generally thought that overall taxa richness declines from upstream to downstream in the creek.

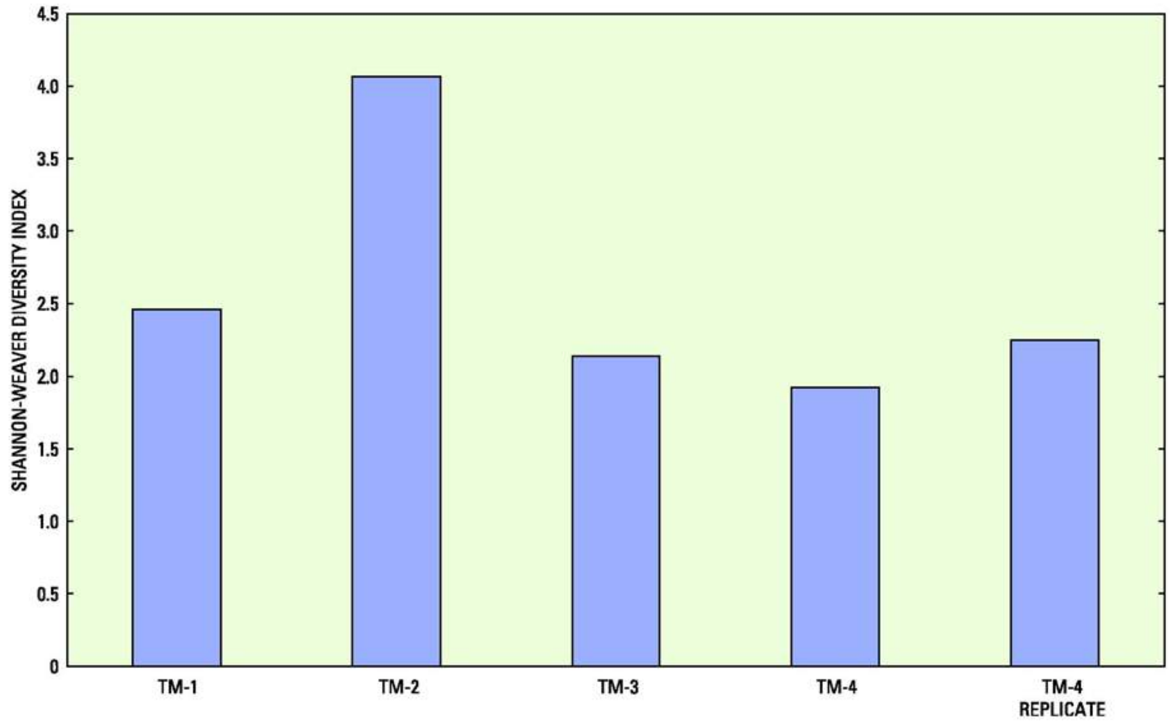
Macroinvertebrates are organisms that have no backbone and can be seen with the naked eye, generally including insects, crustaceans, mollusks, arachnids and annelids. Aquatic macroinvertebrates live in the water for all or part of their lives, so their survival is related to the water quality. They are significant within the food chain, because larger animals such as fish and birds rely on them as a food source. Macroinvertebrates are sensitive to different chemical and physical conditions. If there is a change in water quality, perhaps because of a pollutant entering the water, or a change in the flow downstream of a dam, then the macroinvertebrate community may also change. Therefore, the richness of macroinvertebrate community composition in a water body can be used to provide an estimate of water body health. Taxa richness is a tally of how many different kinds of organisms are present. This metric broadly compares community diversity and structure. However, it lacks the capacity to describe the composition of the community, such as pollutant tolerant versus intolerant. Some diversity reduction is generally seen from upstream to downstream due to degrees of "urban-effect" (the amount of impervious area that has replaced natural environment). Ephemeroptera, Plecoptera and Trichopera (EPT) represent orders of invertebrates that are environmentally sensitive; they are most diverse in natural streams and decline with increased watershed disturbances. EPT taxa richness represents the number of Ephemeroptera (mayflys), Plecoptera (stoneflys) and Trichopera (caddisflys) found at sampling locations. The EPT measure provides a better understanding of the community composition at each site. The EPT taxa richness findings appear to follow this same pattern, with TM-2 exhibiting the highest numbers of EPT.

Figure 3-44 Number of benthic invertebrate taxa measured in Three Mile Creek from 1999 to 2003; number generally declines from upstream to downstream indicating poorer water quality and habitat conditions. (Source: USGS/MAWSS, 2004)



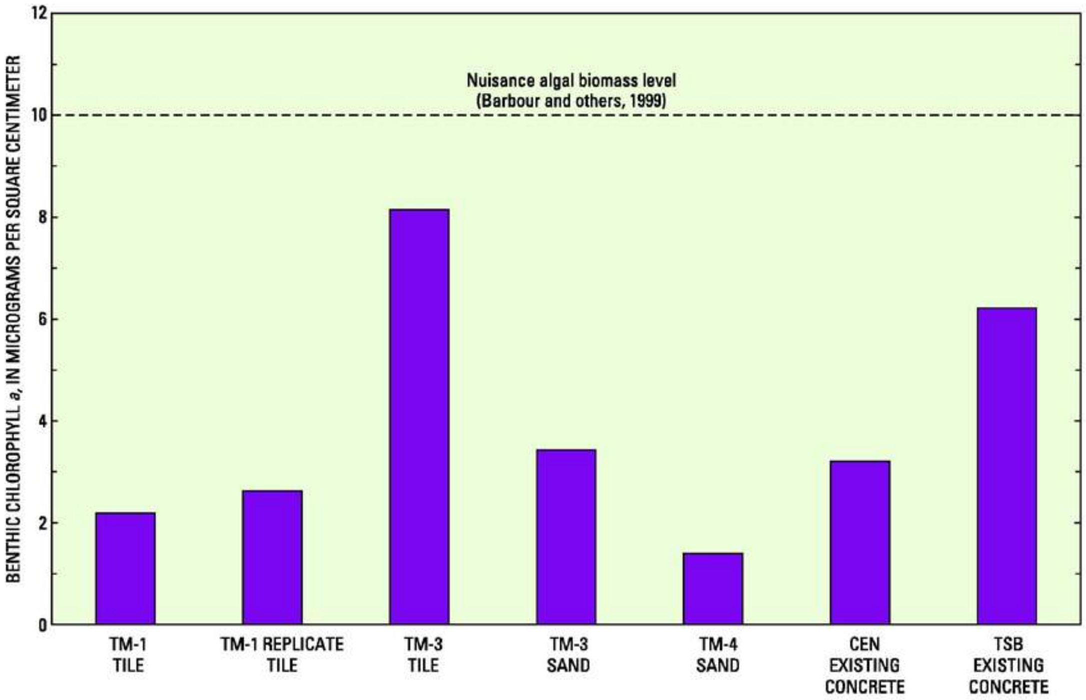
The Shannon-Weaver Diversity Index indicates the diversity of a biological community. The calculated Shannon-Weaver Diversity Index for the four USGS/MAWSS biological monitoring sites in Three Mile Creek is shown on Figure 3-45. Scores between 3 and 4 can indicate a healthy stream. Scores below 1 indicate impairment. Site TM-2 had a score of 4.1, indicating high diversity and a healthy stream. The downstream sites had a score of between 1.9 to 2.5, indicating moderate diversity and marginally impaired water quality. Similar to taxa richness and EPT taxa richness, the water impoundment immediately upstream of monitoring site TM-1 is thought to have lowered the diversity index score at site TM-1.

Figure 3-45 Calculated Shannon-Weaver Diversity Index for the four biological monitoring sites in Three Mile Creek from 1999 to 2003; only site TM-2 had higher diversity indicative of a healthy stream; most of Three Mile Creek has low diversity and poor health. (Source: USGS/MAWSS, 2004)



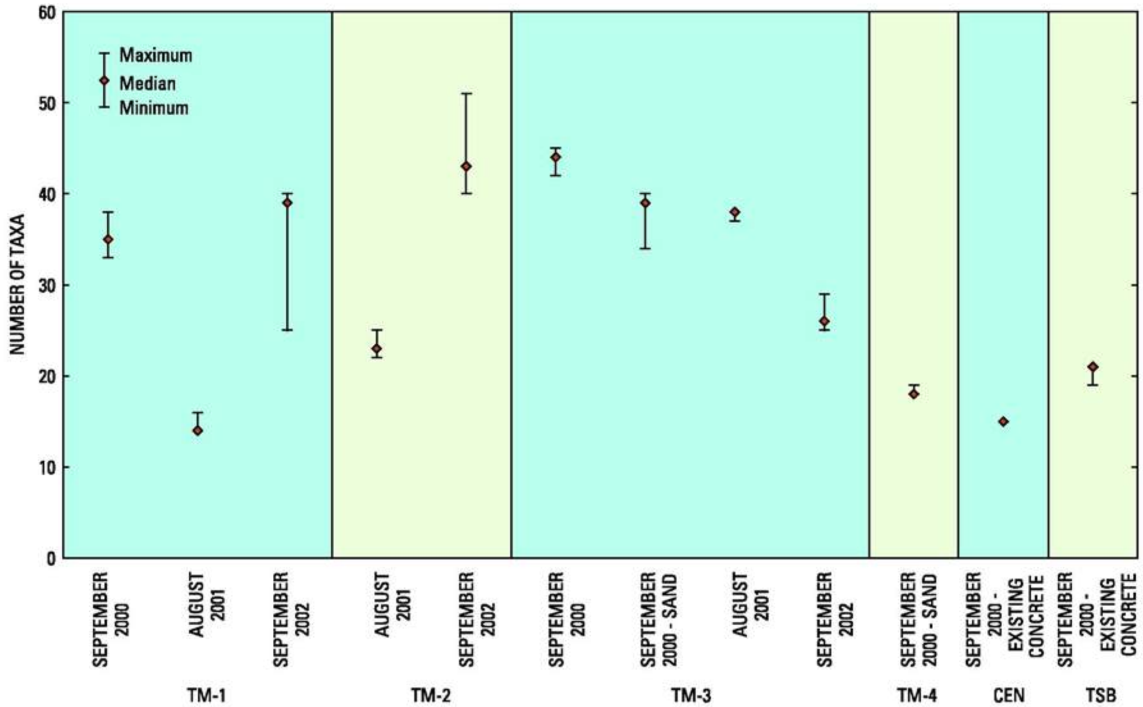
The USGS/MAWSS estimated periphyton biomass based on measured benthic chlorophyll-aconcentrations is shown in Figure 3-46. All measured benthic chlorophyll-aconcentrations were below the suggested nuisance algal growth level of 10 micrograms per square centimeter. The greatest benthic chlorophyll-a concentrations were measured at site TM-3, followed by Toulmins Spring Branch, but the benthic chlorophyll-a concentrations measured at site TM-3 in sand versus tile substrates were very different. The variability is likely due to the sampling methods but both samples remain well below the nuisance threshold.

Figure 3-46 Benthic chlorophyll-a concentrations measured in Three Mile Creek from 1999 to 2003; highest concentrations measured at TM-3, UTTM, and TSB. (Source: USGS/MAWSS, 2004)



Periphyton taxa richness was analyzed in samples collected in the creek and tributaries (see Figure 3-47). In 2000, periphyton taxa richness was greatest at site TM-3, followed by site TM-1. In 2001, periphyton taxa richness was greatest at site TM-3, followed by site TM-2. In 2002, periphyton taxa richness was greatest at site TM-2, followed by site TM-1. Further analysis of the types and densities of algae present at the monitoring sites supported the overall water quality observations. Conditions including lower DO, higher BOD, and nutrient enrichment are most prevalent in TSB, the UTTM, and the downstream end of Three Mile Creek below the UTTM discharge into Three Mile Creek.

Figure 3-47 Periphyton taxa richness measured in Three Mile Creek from 1999 to 2003; Taxa richness generally declines from upstream to downstream indicating declining water quality and habitat. (Source: USGS/MAWSS, 2004)



The in-line wet ponds located on the USA campus and at Langan Park, as shown in Figure 3-48, provide valuable wet detention treatment for NPS discharges entering the upstream portion of Three Mile Creek. The permanent pool volume provided in these ponds results in reduced concentrations of nutrients, BOD and other pollutants by providing attenuation, which in turn promotes the settling of sediments and biological uptake of nutrients. These ponds are a likely reason for the lower nutrient, BOD and other pollutant concentrations in Three Mile Creek at sites TM-1 through TM-4. Three Mile Creek downstream of the USA pond is in very good condition, as shown on Figure 3-49.

Figure 3-48 Wet detention ponds at the USA Campus and Langan Park provide flood storage, trap sediments, reduce nutrients and assimilate pollutants in this extensively modified watershed.

Figure 3-49 Stable section of Three Mile Creek downstream of USA campus wet detention treatment.

3.2.1.5. Biological Monitoring Conclusion, USGS Study

The results of the USGS study indicate the poorest water quality and habitat conditions in the Three Mile Creek watershed are in the downstream segment of the creek and in two of the primary tributaries, TSB and the UTTM. This area of the watershed had the longest periods of low DO conditions, the highest concentration of pollutants and the lowest biological indices.

3.2.1.6. ADEM Three Mile Creek Total Maximum Daily Loads

TMDLs are an assessment of a water body to determine the maximum daily loading of pollutants that can be assimilated by the water body and still sustain the minimum water quality required for its identified use. ADEM is responsible for developing TMDLs. ADEM finalized a TMDL for organic enrichment/dissolved oxygen for the entire length of Three Mile Creek in December 2006. Low DO measurements in the creek, below the 3 mg/L standard, are attributed to salinity intrusions during low flows; stratification of DO, temperature, salinity during neap tides; and oxygen consuming waste in point and non-point source discharges to the tributaries and creek. Primary sources of oxygen-consuming waste include trash, organic debris (i.e., decaying vegetation, leaves, etc.), and stormwater runoff. Other expected sources based on the results of the USGS/MAWSS study include sanitary contributions from groundwater seepage into the surface water system or direct inputs into the surface water system through illicit connections and/or discharges. A final TMDL was developed for pathogens in the lower two segments of Three Mile Creek. A draft delisting for ammonia in TSB was issued and a TMDL is still pending from ADEM for for nutrients for UTTM. A map of Three Mile Creek and a summary of existing and pending ADEM TMDLs in the Three Mile Creek watershed are provided in Figures 3-50 (a-b).

Figure 3-50a Three Mile Creek watershed map and TMDL summary; TMDLs cover the entire main stem creek, UTTM and TSB. (Source: ADEM, 2013)

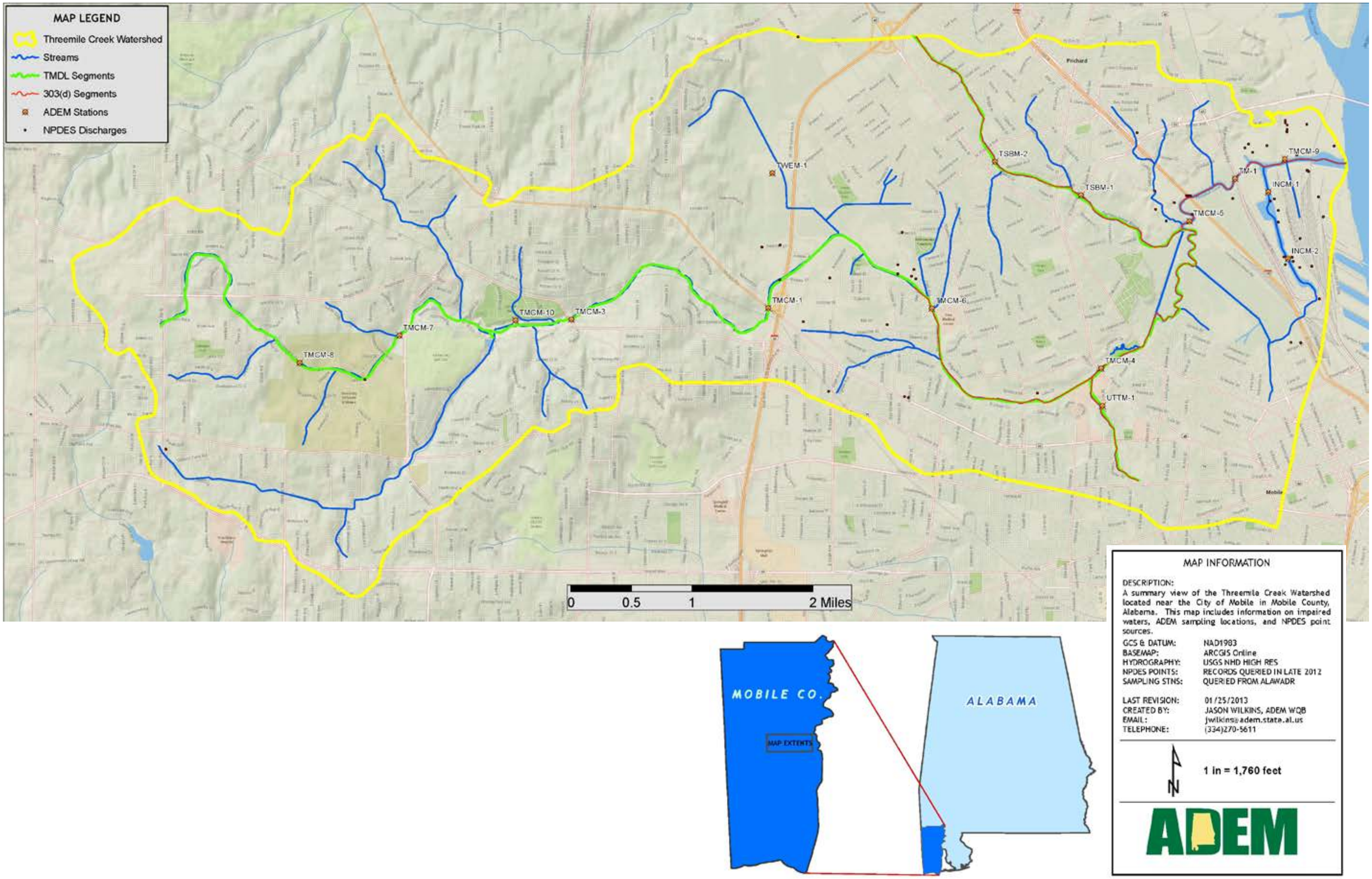


Figure 3-50b TMDL Summary (Details on Load Reduction requirements are provided in the tables following this table)

Table 1: 303(d) Listed Segments in the Three Mile Creek Watershed				
Assessment ID	**Waterbody**	**Use Classification(s)**	**Cause(s)**	**Scheduled TMDL Date**
AL03160205-0504-101	Three Mile Creek	Agricultural & Industrial (A&I)	Pathogens	2013
AL03160205-0504-102	Three Mile Creek	Agricultural & Industrial (A&I)	Pathogens	2013
AL03160205-0504-300	Toulmins Spring Branch	Fish & Wildlife (F&W)	Ammonia & Nutrients	2013
AL03160205-0504-500	UT to Three Mile Creek	Fish & Wildlife (F&W)	Nutrients	2013

Table 2: EPA Approved TMDLs in the Three Mile Creek Watershed					
Assessment ID	**Waterbody**	**Use Classification(s)**	**Cause(s)**	**TMDL Approval Date**	**Required Load Allocation Reduction**
AL03160205-0504-101	Three Mile Creek	Agricultural & Industrial (A&I)	Organic Enrichment Dissolved Oxygen	1/18/2007	21% NBOD 22% CBOD (Note: LAR is seasonally dependent)
AL03160205-0504-102	Three Mile Creek	Agricultural & Industrial (A&I)	Organic Enrichment Dissolved Oxygen	1/18/2007	21% NBOD 22% CBOD (Note: LAR is seasonally dependent)
AL03160205-0504-103	Three Mile Creek	Agricultural & Industrial (A&I)	Organic Enrichment Dissolved Oxygen	1/18/2007	21% NBOD 22% CBOD (Note: LAR is seasonally dependent)
AL03160205-0504-300	Toulmins Spring Branch	Fish & Wildlife (F&W)	Pathogens	9/23/2009	96% Non-Point Source Fecal Coliform
AL03160205-0504-500	UT to Three Mile Creek	Fish & Wildlife (F&W)	Pathogens	9/23/2009	97% Non-Point Source Fecal Coliform
AL03160205-0504-101	Three Mile Creek	Agricultural & Industrial (A&I)	Pathogens	8/26/2013	97% Non-Point Source Fecal Coliform
AL03160205-0504-102	Three Mile Creek	Agricultural & Industrial (A&I)	Pathogens	8/26/2013	97% Non-Point Source Fecal Coliform

Delisting Decisions in Three Mile Creek Watershed				
Assessment ID	**Waterbody**	**Use Classification(s)**	**Cause(s)**	**Delisting Date**
AL03160205-0504-101	Three Mile Creek	Agricultural & Industrial (A&I)	Chlordane	8/12/2010
AL03160205-0504-300	Toulmins Spring Branch	Fish & Wildlife (F&W)	Ammonia	10/2013 (Draft)

A summary of the TMDL organic enrichment load reduction requirements for the entire length of Three Mile Creek is given in Table 3-4. These load reduction requirements include the complete elimination of both primary municipal wastewater treatment facility discharges (MAWSS and City of Prichard) in the watershed. These point source outfall relocations are scheduled to be completed in 2014 (neither have been completed as of the date of printing of this WMP). The TMDL for Three Mile Creek organic enrichment includes a nitrogenous BOD component and a carbonaceous BOD component. Nitrogenous BOD includes ammonia and organic nitrogen, and carbonaceous BOD includes organic and inorganic carbon forms. From December to April, a 21% to 22% reduction in non-point source BOD load is required, and from May through November, a 49% to 55% reduction is required. This percentage reduction equates to a BOD load reduction of approximately 73 pounds per day from December through April and 161 pounds per day from May through November.

Table 3-4 Summary of Three Mile Creek Organic Enrichment TMDL; non-point sources of BOD must be reduced. (Source: ADEM, 2006)

Constituent	Existing WLA (lb/day) MS4	Existing LA (lb/day)	TMDL WLA (lb/day) MS4	TMDL LA (lb/day)	TMDL (lb/day)	WLA Reduction MS4	LA Reduction
$NBOD_U$	65	65.4	51	51.6	51.6	21%	21%
$CBOD_U$	262.5	274.9	203.5	215.9	215.9	22%	22%

A summary of required load reductions for existing ADEM TMDLs for pathogens for lower two segment of Three Mile Creek are provided in Tables 3-5, 3-6 and 3-7, respectively. A 97% reduction in non-point source fecal coliform loads is required in lower two segments of Three Mile Creek. The dominant sources of fecal coliform in urban watersheds include SSOs; sanitary contributions from groundwater seepage into the surface water system or direct inputs into the surface water system through illicit connections and/or discharges. Less common sources of fecal coliform in urban watersheds include birds, wildlife and pets.

Table 3-5: Enterococci Load Reduction Requirements 97% fecal coliform reduction from NPSs (Source: ADEM 1, 2013)				
Source	**Existing Load a (colonies/day)**	**Allowable Load b (colonies/day)**	**Required Reduction (colonies/day)**	**% Reduction**
Nonpoint Source Load (LA)	7.13 E+13	2.36 E+12	6.89 E+13	97%
Point Source Load (WLA)	6.91 E+10	3.19 E+11	0	0%

a. Existing WLA loads were based on facility DMR data at the time the highest instream exceedance was observed.

b. Allowable WLA loads were based on design flow & NPDES-permitted limits for *Enterococci* (500 colonies /100 ml).

Table 3-6: Individual NPDES Point Source Reductions 0% reduction from Point Sources (Source: ADEM 1, 2013)				
Source	**Existing Load a (colonies/day)**	**Allowable Load b (colonies/day)**	**Required Reduction (colonies/day)**	**% Reduction**
Wright Smith WWTP (AL0023094)	1.50 E+10	2.42 E+11	0	0%
Carlos Morris WWTP (AL0023205)	5.40 E+10	7.72 E+10	0	0%
Total WWTPs (WLA)	6.91 E+10	3.19 E+11	0	0%

a**. Existing WLA loads were based on facility DMR data at the time the highest instream exceedance was observed**

b. Allowable WLA loads were based on design flow & NPDES-permitted limits for *Enterococci* (500 colonies /100 ml)

Table 3-7: Enterococci Pathogen TMDL Summary for Threemile Creek 97% fecal coliform reduction from NPSs (Source: ADEM 1, 2013)						
TMDL a	**Margin of Safety (MOS)**	**Waste Load Allocation (WLA)**			**Load Allocation (LA)**	
		WWTPs b	**MS4s c**	**Leaking Collection Systems d**		
(col/day)	**(col/day)**	**(col/day)**	**Reduction**	**(col/day)**	**(col/day)**	**Reduction**
2.97 E+12	2.97 E+11	3.19 E+11	97%	0	2.36 E+12	97%

a. TMDL was established using the single-sample *Enterococci* criterion for the *A&I* use classification (500 colonies/100 ml)

b. WLAs for WWTPs are expressed as a daily maximum. Any future WWTPs (and expansions of existing facilities) must meet the applicable instream water quality criteria for *Enterococci* at the point of discharge.

c. Future MS4 areas would be required to demonstrate consistency with the assumptions and requirements of this TMDL.

d. The WLA target for leaking collection systems is zero. It is recognized, however, that a WLA of 0 col/day may not be practical. For these sources, the WLA is interpreted to mean a reduction in *Enterococci* loading to the maximum extent practicable, consistent with the requirement that these sources not contribute to a violation of the water quality criteria for *Enterococci*.

A summary of required load reductions for existing ADEM TMDLs for pathogens for Toulmins Spring Branch and the UTTM are provided in Tables 3-8 and 3-9, respectively. A 96% reduction in non-point source fecal coliform loads is required in TSB and a 97% reduction in non-point source fecal coliform loads is required in the UTTM. The dominant sources of fecal coliform in urban watersheds include SSOs; sanitary contributions from groundwater seepage into the surface water system or direct inputs into the surface water system through illicit connections and/or discharges. Less common sources of fecal coliform in urban watersheds include birds, wildlife and pets.

Table 3-8 Summary of TSB Pathogen TMDL; 96% fecal coliform reduction from NPSs. (Source: ADEM 1, 2009)

TMDL	Margin of Safety (MOS)	Waste Load Allocation (WLA)[a]			Load Allocation (LA)	
		WWTPs[b]	MS4s[c]	Leaking Collection Systems[d]		
(col/100 mL)	(col/100 mL)	(col/100 mL)	(% reduction)	(col/100 mL)	(col/100 mL)	(% reduction)
2,000	200	NA	96%	0	1,800	96%

Table 3-9 Summary of UTTM Pathogen TMDL; 97% fecal coliform reduction from NPSs. (Source: ADEM 2, 2009)

TMDL	Margin of Safety (MOS)	Waste Load Allocation (WLA)[a]			Load Allocation(LA)	
		WWTPs[b]	MS4s[c]	Leaking Collection Systems[d]		
(colonies/day)	(colonies/day)	(colonies/day)	(% reduction)	(colonies/day)	(colonies/day)	(% reduction)
2.45E+11	2.45E+10	NA	97%	0	2.20E+11	97%

3.2.1.7. Impacts of Climate Change and Variability

A series of reports on the Impacts of Climate Change and Variability in the Gulf Coast area were published over the past five years through a cooperative agreement between the U.S. Department of Transportation (USDOT), Texas Tech University and the USGS. The study findings are summarized in “The Gulf Coast Study, Phase 2, Task 2, Climate Variability and Change in Mobile, Alabama" (USDOT, FHWA-HEP-12-053, September 2012 (updated June 2013). The Gulf Coast Study has two distinct study periods: Phase 1 (2003 to 2008) examined the impacts of climate change on transportation infrastructure at a regional scale from Houston, TX to Mobile, AL, while Phase 2 (still underway) is focusing on a single Metropolitan Planning Organization region around Mobile, AL. The Phase 1 study results indicate that the Gulf Coast region is particularly susceptible to climate change over the 21st century. Some of the changes projected for the region include the following:

- Sea level is likely to rise in the region by at least 1 foot (0.3 meters), and by as much as 6 to 7 feet (2 meters) in some parts of the study area.
- Major storms could increase in intensity by at least 10%.
- Storms of at least Category 3 intensity (sustained winds of 111+ miles per hour (179 kilometers per hour) & storm surge of 9+ feet (about 3 meters)) are projected to increase in frequency.
- Annual average precipitation could either increase or decrease (varying by climate model), but precipitation event intensity is likely to increase over the next century.
- The average annual temperature is likely to increase by at least 2.7°F (+/- 1.8°F) (1.5°C +/- 1°C) over the next 50 years.
- The numbers of days above 90°F (32°C) and 100°F (38°C) are both projected to increase; days over 90°F (32°C) could increase by 50%.

As these studies are focused on impacts on the transporation system, the conclusions were limited to the implications of projected changes in climate for regional transportation systems. These changes, characterized as significant by the authors included:

- Increasing temperatures are likely to require modifications to system materials and maintenance.
- Increased severity of precipitation events could exacerbate incidents of flash flooding, threatening the stability of soils and foundational materials.
- The combined effects of land subsidence and absolute SLR could permanently inundate existing infrastructure.
- An increase in severity of tropical storms could have significant impacts on coastal infrastructure. Damages due to storm surge, winds, and flying debris can be catastrophic, as has been seen with previous hurricanes.

The environmental affects within the Three Mile Creek watershed brought about by these projected climate changes may be reasonably inferred to also be significant. Some of these may include:

- Longer periods of warmer temperatures will generally increase the length of the growing season making control and removal of invasive vegetation more costly.
- Increasing temperatures will cause an increase in evaporation and a reduction in near surface soil saturation levels in areas of less dense vegetation. This combined with reduced stream flows in the summer months will likely cause stress to some areas of native riparian vegetation making it more difficult to resist intrusion by more resilient invasive species.
- Increasing temperatures combined with reduced stream flows in the summer months will also lead to higher ambient stream temperatures and reduced DO concentrations. Less oxygen entrainment from reduce water turbulence, higher water temperatures and reduced DO concentrations will impact fish health and reproduction.
- Increased severity of precipitation events could exacerbate incidents of flash flooding, threatening the stability of soils and foundational materials. This would increase the sediment loads to Three Mile Creek increasing associated pollutant loadings such as heavy metals that are delivered with sediment and increased nutrients and BOD from increased organic debris.
- Increased severity of precipitation events leading to more frequent incidents of flash flooding would also increase the frequency of SSO leading to higher pathogen loads entering Three Mile Creek.

4 DATA GAPS & NEW DATA

In Section 3, we discussed the findings from data collection review and field studies. Section 4 provides a summary of the identified data gaps and recommendations for future data collection. During the development of the WMP, the Dewberry Team focused on collecting as much information as possible based on available labor and funding. In this Section, we also summarize data we collected through water quality field sampling. Finally, the Dewberry Team ran models on potential impacts to Three Mile Creek from SLR and potential storm surge events.

4.1 Identified Data Gaps

The Three Mile Creek basin study completed by USGS/MAWSS and the TMDLs developed by ADEM provide a relatively good understanding of the general water quality conditions within the Creek and the overall pollutant load reductions needed to achieve the ADEM TMDLs and State surface water quality standards. Three of the most significant data gaps the Dewberry Team uncovered relate to pollutant loadings, and specifically, whether the portion of the pollutant loads entering the creek is from groundwater seepage, creek bottom sediments, or Brownfield sites (previously developed sites with known groundwater and/or soil contamination). The primary unknowns (data gaps) are:

- Drainage area, land use mix and measured pollutant loads associated with each major storm sewer outfall (>/= 36-inch)
- Water quality associated with individual stormwater outfalls and ambient creek water quality during wet weather conditions
- Current bathymetry of Three Mile Creek and the tributaries
- Current physical and chemical characteristics of the creek's bottom sediments for each creek segment
- Understanding of how the creek's bottom sediments affect ambient and event-based water quality conditions in each creek segment
- Volume and quality of groundwater seepage flows discharged to each segment of the creek (to facilitate assessment of the surface water ambient water quality)
- Identification of remaining sources of pathogens and wastewater compounds in the watershed
- Impacts on surface water quality from identified Brownfield sites (Mobile Gas site and Hickory Street landfill site)
- Current mapping of submerged/emergent vegetation in the creek and tributaries

- Estimated effects on flood elevations and water quality conditions attributable to any additions, modifications or removal of in-creek structures
- Impacts of SLR on Three Mile Creek's existing land use and habitat types
- Impacts of SLR on Three Mile Creek's Critical Infrastructure

4.1.1 Drainage area and pollutant loads for each major storm sewer outfall (>/= 36-inch)

The size, material composition and condition of each stormwater outfall connection to the creek system are known, but the specific drainage area, land use mix and pollutant loads for each outfall are not. Knowing the pollutant loads for each outfall would enable the targeting and prioritization of capital improvement projects (CIP) based on the principle of retrofitting and treating the outfalls with the largest pollutant loads first.

Recommendation: A map of the entire stormwater system with the location and elevation of all inlets and pipes/channels is needed to determine the contributing drainage area for each outfall. Once the drainage areas are delineated, the annual runoff volumes can be estimated using a hydrologic/hydraulic model. Both the annual water volume discharging from each outfall and the typical pollutant concentrations during both wet and dry weather are needed to calculate pollutant loads for each outfall. Pollutant loads can be estimated based on land uses in the contributing drainage areas. Alternately, actual runoff concentrations can be developed using water quality sampling/monitoring results. Ideally, outfall pollutant concentrations from different land uses would be measured for a number of rainfall/runoff events and then applied to other similar land uses in the basin. In the absence of measured pollutant concentrations, scientific literature values are commonly used to estimate pollutant loads. Because specific outfall pollutant loads are not known at this time, outfall size will be used as a surrogate for prioritizing the outfalls to be retrofitted. As additional information is collected, the retrofit prioritization should be modified to address the outfalls with the largest pollutant loads earlier, if possible.

4.1.2 Stormwater and wet weather creek surface water quality;

The extensive Three Mile Creek study completed by USGS/MAWSS and the TMDL analyses completed by ADEM did not include the measurement of outfall stormwater quality or creek surface water quality during and immediately following rainfall events (wet weather conditions). Measured outfall stormwater quality for different land uses is very valuable in calculating pollutant loads for each outfall, as described in Section 3. Since the completion of the USGS/MAWSS study, MAWSS has taken additional steps to identify and complete repairs in the watershed on stormwater system illicit connections and sources of sanitary sewer system infiltration and inflow (Vittor, 2009). Surface water quality monitoring can be used to identify any additional needs related to eliminating these pollutant sources.

Recommendation: Ideally, automatic stormwater samplers with integral flow meters would be installed on a number of primary outfalls. For each outfall, it is preferable to have a single predominant land use so typical pollutant concentrations can be developed for that land use. Outfalls with different land uses should be selected for monitoring. Flow composite samples (samples obtained at several discrete times during a rainfall event intended to capture the full range of potential event pollutant loading) would be collected using the automatic samplers and analyzed for pollutants of concern including NBOD/CBOD, nutrients, and pathogens. Depending on the sample location (e.g., in close vicinity to a potential contamination source, such as the landfill), additional parameters may be added. It may also be worthwhile to monitor for a select group of wastewater compounds in areas shown in previous studies to have elevated values (TSB, UTTM, and downstream end of watershed). It would also be beneficial to monitor ambient DO levels at these same locations to establish baseline conditions during non-storm events and DO variability/impacts during storm events. These data would provide valuable DO information for assessing storm effects and eventual calibration of a water quality simulation model. A detailed water quality simulation model that is calibrated to local conditions is a useful tool to better understand the dominant factors affecting water quality, assess the sensitivity of the watershed response to proposed mitigation measures and to focus funding on the most productive measures as predicted by the model. It may also serve as the basis to reduce the allocated pollutant load reduction generated by the ADEM TMDL assessments.

4.1.3 Current creek and tributaries bathymetry

No information on the bottom surface elevation of the creek and tributaries or the corresponding water depth is currently available. Shallow water depths can contribute to a number of water quality concerns including higher water temperatures; lower DO concentrations; low DO conditions resulting in pollutant recycling from bottom sediments to the water column; and the excessive growth of nuisance aquatic vegetation. In shallow channels, pulsed stormwater flows are more likely to scour bottom sediments and re-entrain settled sediments and pollutants during wet weather conditions. Shallow water depths may also hinder recreational activities in the creek.

Recommendation: A bathymetric map of the creek and tributaries is recommended to provide 1-foot contours of the bottom elevations. While completing the bathymetric map it would also be advisable to concurrently determine the depth of soft/fine/organic sediment in the creek system, as well as the type and coverage of aquatic vegetation. There may be locations where bottom sediment removal is warranted based on the shallow water depth.

4.1.4 Current creek bottom sediment physical and chemical characteristics/contribution to water quality

No known studies have been performed on the physical and/or chemical characteristics of the creek and tributary bottom sediments. Bottom sediments were not considered in the TMDLs. These sediments can represent a major pool of pollutants that, under certain conditions (e.g., low DO, changes in pH, or mixing due to wind), can release pollutants into the overlying water column. Sediments can also create an oxygen demand which can reduce the water column DO concentration.

Recommendation: The physical and chemical characteristics of the creek system bottom sediments should be determined when assessing water quality. As mentioned above, the depth of soft sediment can be measured during preparation of the bathymetric map. Measurements of soft sediment thickness could also be performed independent of the bathymetry. Sediment core samples would be collected using a split-spoon coring device at multiple locations throughout the creek system. Sediment cores would be visually classified and samples collected for laboratory analysis. Suggested lab parameters for sediments include moisture content, organic content, TP, TN, density, eight Resource Conservation and Recovery Act (RCRA) metals (in proximity to the landfill), BOD, chemical oxygen demand (COD), fecal coliform (in freshwater reaches), and Enterococcus (in brackish water reaches). In some cases other parameters (i.e., sediment oxygen demand (SOD), metals, or toxic compounds) may warrant measurement. Sample assessment must be done carefully, considering the sediment scour, transport and deposition behavior of the channel to accurately identify sediment origins and to avoid incorrect characterization of hotspots in downstream segments based on SOD and other pollutant concentrations.

4.1.5 Groundwater seepage quality and quantity reaching the surface water system/contribution to water quality;

Similar to bottom sediments, groundwater seepage discharging to a surface water system can carry pollutants. This is especially true in low-lying, high-groundwater areas such as the lower portion of the watershed. Agricultural areas and those subject to significant long-term fertilization practices prior to the 1980s would be of specific interest. There are no known studies related to groundwater quantity or quality in the Three Mile Creek watershed.

Recommendation: Evaluating the significance of groundwater seepage on surface water quality would involve estimating groundwater seepage flow rates and volumes, which can be accomplished using a series of groundwater wells or other specialized equipment. Suggested laboratory parameters include eight RCRA metals (in proximity to the landfill), Total Kjeldahl Nitrogen (TKN), gaseous ammonia (NH3), nitrous oxide (NOx), sediment reduction potential (SRP), TP, BOD, COD, fecal coliform (in freshwater reaches), Enterococcus (in brackish water reaches), field pH, conductivity, DO, temperature, oxidation reduction potential (ORP), and/or salinity. Pollutant loads would be developed by multiplying groundwater volume by a mean pollutant concentration. This load can then be compared to other sources to determine the importance. Depending on the severity, geographic distribution and parameters of concern present, a variety of potential management measures can be developed to address those sources. In highly concentrated and localized occurrences, such as septic tanks, removal and connection of the residence to a sanitary sewer system is typical. Larger geographic sources from areas like the Hickory Street Landfill or Mobile Gas/Sempra Remediation Site may require additional on-site containment or removal measures. Legacy sources such as residual soil contamination from leaking sewers tend to be the most difficult to treat due to the difficulty in identifying the locations of broadly-distributed, low-concentration contamination.

4.1.6 Primary sources of pathogens and wastewater compounds in the watershed;

Elevated pathogen concentrations have been measured in the lower two segments of Three Mile Creek and its tributaries. Pathogen TMDLs have been developed for these streams that require very high removal efficiencies. The primary sources of pathogens are largely unknown at this time. Many different wastewater compounds were also detected in Three Mile Creek with increasing prevalence in TSB, UTTM, and the downstream end of the watershed. These compounds are typically from a wastewater source such as a failed septic system, sanitary sewer leak, periodic sanitary pump station overflow, illicit discharges, illicit connections or pets and wildlife. Groundwater seepage and sediment recycling are also two potential sources.

Recommendation: Additional studies are needed to determine the primary sources of pathogens and wastewater compounds and will likely involve developing a focused field monitoring program to collect and analyze surface water, stormwater and groundwater samples at specific locations to establish reduction program performance and trends.

4.1.7 Impacts on surface water quality from Brownfield sites

The Hickory Street Landfill Site and the Mobile Gas Site are both potential pollutant sources for the surface water system. Minimal assessment of these sites has been completed (ADEM 1 and ADEM 2, 2002). The primary concern is groundwater contamination.

Recommendation: An assessment of groundwater flow and chemical characteristics is needed to determine if these sites are an important pollutant source. Two pairs of relatively shallow groundwater wells would be installed up gradient and down gradient of the sites. Groundwater flow rate and volume can be estimated based on soil characteristics and the hydraulic gradient of the groundwater surface. Pollutant loads can then be estimated by multiplying water volume by pollutant concentration. Suggested laboratory parameters include 126 Priority Pollutants; TKN, NH3, and NOx; SRP and TP; BOD; COD; fecal coliform (in freshwater reaches); Enterococcus (in brackish water reaches); field pH; conductivity; DO; temperature; and ORP.

4.1.8 Current mapping of creek and tributary submerged/emergent vegetation

There are segments of Three Mile Creek with dense areas of nuisance/exotic vegetation, while other areas contain a more desirable amount of submerged/emergent vegetation. However, to date the vegetation in the creek system has not been characterized nor quantified. It is advantageous to determine this quantity because the presence of desirable vegetation helps us to understand the conditions that sustain its growth. This information can be used to grow desirable vegetation in other areas. Assessing nuisance/exotic vegetation locations provides information on the areas where it thrives.

Recommendation: The areal extent of different types of vegetation can be developed in the field using handheld GPS equipment. The vegetation density and soil conditions can be determined at the same time and added to the geospatial database. A strategy to manage vegetation and reduce the coverage of nuisance plants, while encouraging and expanding the growth of desirable plants, is recommended.

4.1.9 Potential effect of in-creek structure changes on flood elevations and water quality

Preliminary design documents and an Environmental Assessment for the 1980s Three Mile Creek channel improvements were obtained from the USACE. Some channel hydrologic/hydraulic modeling information was also received. The potential changes in flood elevations and creek water quality resulting additions, modifications or removal of in-creek structures are unknown at this time.

Recommendation: The evaluation of potential flood elevation changes would require the development of an updated hydrologic/hydraulic model for the creek and tributaries. Development of an updated hydrodynamic and water quality model would be necessary to evaluate potential changes in creek water quantity and quality. Both of these modeling efforts would require a substantial labor commitment. Possible added values of these models would be to "clarify" the pollutant sources and loadings and transport mechanisms and "update" the accuracy and basis of the ADEM TMDLs and allocations. This could result in a potential savings in long-term CIP and operation and maintenance (O&M) costs by focusing on measures where load reductions will be most effective.

4.1.10 Impacts of sea level rise on Three Mile Creek's existing land use and habitat types

Existing studies addressing SLR and climate change are underway by the National Oceanic and Atmospheric Administration (NOAA) and USDOT, respectively. These projects address the affects resulting from the broader region and areas local to Mobile, AL. While the climate change affects on water quality can be easily inferred to Three Mile Creek the direct impacts of SLR on habitat cannot be.

Recommendation: Perform a Sea-Level Affecting Marshes Model (SLAMM) analysis to simulate the impacts of sea level rise on Three Mile Creek's existing land use and habitat types to determine best management practices for addressing habitat changes or loss that work cooperatively with measures envisioned to improve creek water quality.

4.1.11 Impacts of sea level rise on Three Mile Creek's Critical Infrastructure

Existing studies addressing SLR and climate change are underway by NOAA and USDOT, respectively. The scope of these studies is directed at a broad geographic region, although the USDOT studies may include some information specific to Three Mile Creek.

Recommendation: Perform an inventory to document elevations relative to level of service and occupied finished floor for critical structures in the Three Mile Creek watershed. Relate these elevations to SLR predictions and establish mitigative and management actions to offset impacts to medical facilitiers, transporation and evacuation routes and residential structures.

4.2 Acquisition and Development of New Data

During this study, the Dewberry Team developed new data and also partnered with others to acquire new data. This included collecting surface, groundwater and sediment data; modeling the effects of sea level rise; and modeling the combined effects of storm surge and sea level rise. The next three sections discuss data acquisition and analytical results.

Dr. Jim Connors from the Department of Earth Sciences at USA created an opportunity for the university to partner with MBNEP in filling some of the data gaps identified during the development of the Three Mile Creek WMP. Graduate students performed field groundwater and sediment sampling and submitted the samples to a local laboratory for analysis. The Dewberry Team contracted Test America to complete the analysis. The one-time sampling and laboratory analysis was completed during September and October 2013 at sites specified in Figures 4-1 and 4-2. The sampling and testing plan along with a complete summary of groundwater and sediment laboratory results is provided in Appendix E.

It is important to recognize that at this time only single grab samples have been collected and analyzed at various locations in the watershed. While it is informative, a single sample is not sufficient to reach conclusions regarding the monitoring results or trends. At the Hickory Street landfill site (see Figure 4-1), there was a mild trend in the groundwater data generally reflecting higher nutrient concentrations closer to Three Mile Creek, and downstream of the landfill. Higher BOD values were also observed downstream of the landfill, while the highest COD value was measured upstream of the landfill. Most other measured values, including metals and a wide range of synthetic organics, were near or below laboratory method detection limits. Specific results include elevated levels of COD, BOD, TN, TP, and orthophosphate observed in groundwater (See Table 4-1). States do not usually establish COD or BOD concentration criteria for waterbodies and streams. In the case of Three Mile Creek, ADEM has established wasteload reduction targets (in pounds/year) for certains segments and tributaries. The water DO concentration is the main concern and elevated COD or BOD concentrations will depress DO concentrations impacting fish. Nutrients such as Nitrogen (N) and P are water body dependent. ADEM has established wasteload reduction targets (in pounds/year) for UTTM and TSB tributaries. However, we have not done detailed modeling to determine the acceptable N and P concentrations in TMC. For reference the “Desired Value” for these constituents has also been shown in the table. These are values that are generally indicative of unpolluted waters. For reference the “Desired Value” has also been shown in the table. These are values that are generally indicative of unpolluted waters (See Table 4-1).

Table 4-1 Summary of USA Field Samples (Hickory Street Landfill Sites 1-4)

Parameter	Low Value/Location	High Value/Location	Desired Value
COD	13 mg/L at site 2	45 mg/L at site 1	< 20 mg/L
BOD	<2.0 mg/L at site 2	6.9 mg/L at site 4	< 2 mg/L
TN	1.4 mg/L at site 4	2.8 mg/L at both sites 1 and 3	< 0.9 mg/L
TP	0.27 mg/L at site 3	1.3 mg/L at both sites 1 and 2	< 0.04 mg/L
OP	0.11 mg/L at site 2	0.33 mg/L at site 4	< 0.04 mg/L

Groundwater quality was better upstream of site 6 (see Figure 4-1). Based on the measured elevated BOD, COD and nutrient values, groundwater seeping into the Three Mile Creek surface water system will exert an oxygen demand which will depress surface water DO concentrations, especially in the lower half of the watershed. Specifically, elevated COD, BOD and nutrient values (TN and TP) were measured in groundwater samples collected farther away from the landfill (see Figure 4-2) at sites 1, 3, 4, and 6. No COD or TN results were available for sites 2, 5, 9 and 10. For reference the "Desired Value" has also been shown in the table. These are values that are generally indicative of unpolluted waters (See Table 4-2).

Table 4-2 Summary of USA Field Samples (Three Mile Creek Sites 1-10)

Parameter	Low Value/Location	High Value/Location	Desired Values
COD	23 mg/L at site 8	220 mg/L at site 6	< 20 mg/L
BOD	3.0 mg/L at site 1	18 mg/L at site 3	< 2 mg/L
TN	1.4 mg/L at site 4	5.9 mg/L at site 3	< 0.9 mg/L
TP	< 0.1 mg/L at sites 9 & 10	1.2 mg/L at site 3	< 0.04 mg/L

In general, sediment quality deteriorates from upstream to downstream in Three Mile Creek (See Figure 4-1). Elevated COD and nutrient values measured at sites 1, 3 and 4 are likely having a minor impact on oxygen demand and creek water quality. Therefore, it appears that groundwater quality affects creek surface water quality more than sediment quality. The limited data supporting this includes elevated COD, TN and TP concentrations found in the sediment sample collected at site 3. Elevated TN concentrations were found in the sediment samples collected from sites 1 and 4. The COD, TN and TP concentrations measured for sites 5-10 were substantially lower than the results at sites 1, 3 and 4. No sediment sample data was available for site 2 and TN values were not available for sites 7 and 8.

It is important to recognize that these groundwater and sediment results and observations are based on a single monitoring event. Additional samples should be collected and analyzed in the future. Monitoring results can vary substantially from one location to another (even a few feet away) and additional analyses will reduce the uncertainty associated with these very limited results.

Figure 4-1 Map of Proposed Three Mile Creek Groundwater and Sediment Monitoring Locations

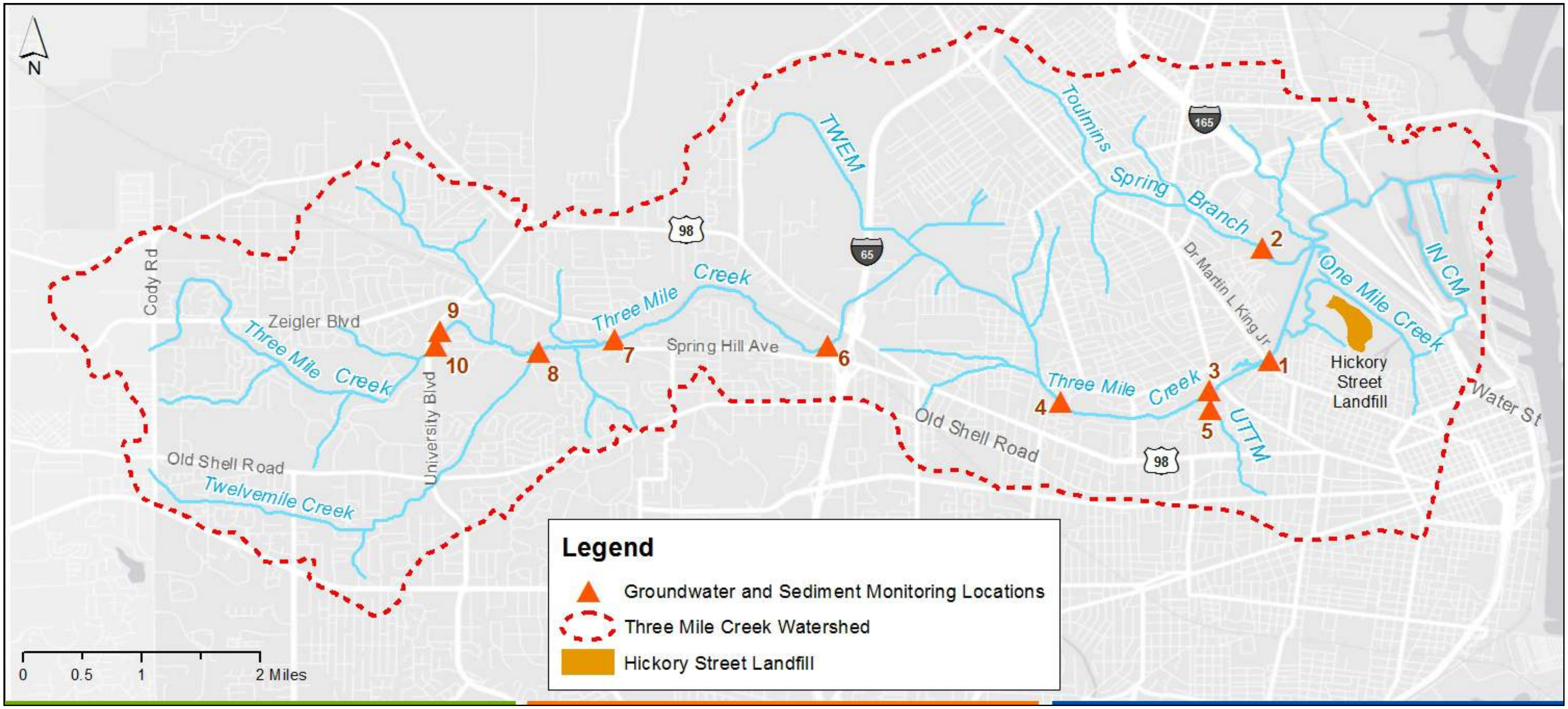
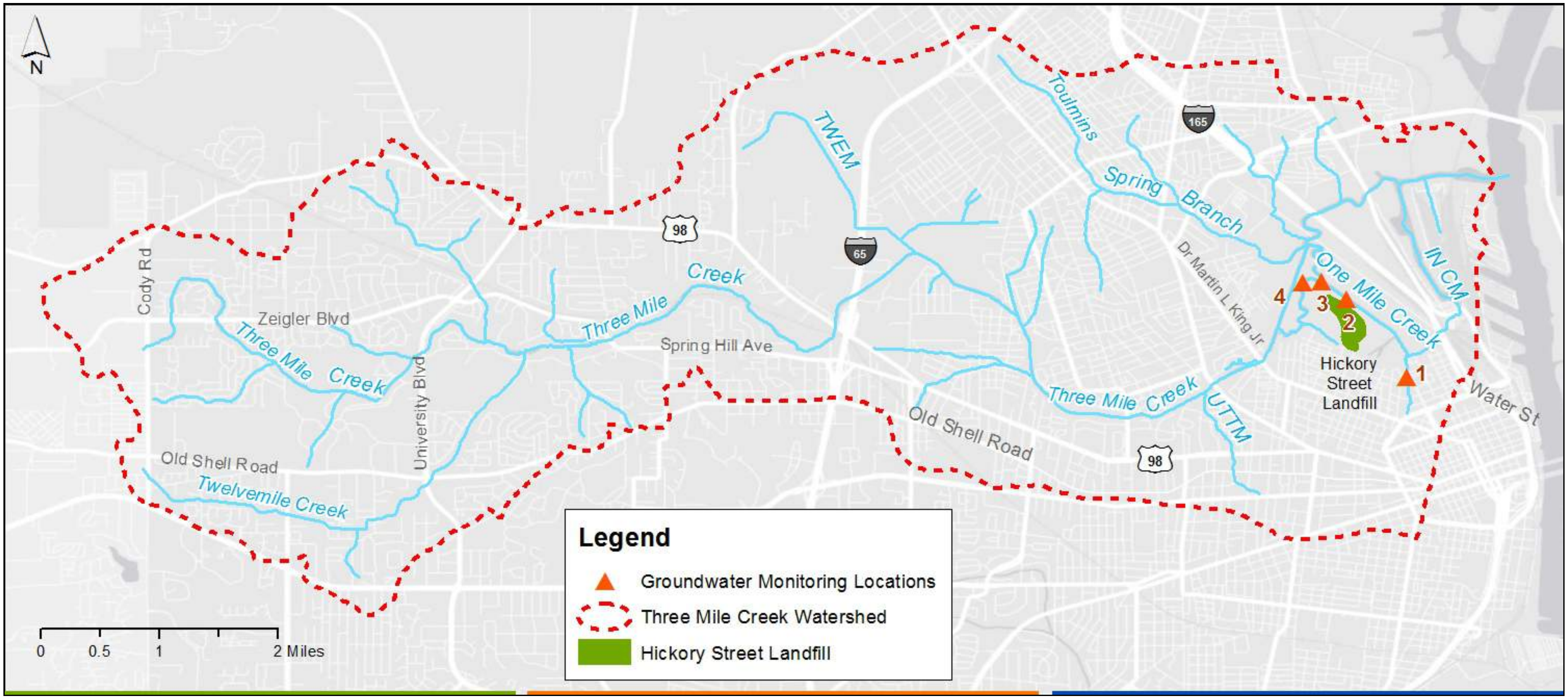


Figure 4-2 Map of Proposed Hickory Street Landfill Groundwater Monitoring Locations



4.3 Sea Level Rise Modeling Results

The SLAMM analysis was performed to simulate the impacts of SLR on Three Mile Creek's existing land use and habitat types to determine best management practices for addressing habitat changes or loss that work cooperatively with measures envisioned to improve creek water quality.

4.3.1 Overview of Tidal Marsh Vulnerability to Climate Change

The State of Alabama has an expanse of shallow tidal water along its shoreline that serves as essential habitat for estuarine flora and fauna. Shallow water environments are vital to the coastal community, providing an enormous mix of ecological services. Managing coastal habitats for sustained ecosystem functioning, while accommodating increasing developmental pressures, has never been simple. The challenge is multiplied by the fact that the entire system is changing, driven by both human uses and climate change. Effective management requires some understanding of not only current conditions, but also potential future conditions. The state of scientific understanding does not yet support precise forecasting, but there is a sufficient array of information to begin assessing potentials for change in some key components of the system.

The principal objective of this study was to develop a characterization of current shallow-water habitat components in Alabama tidal waters and predict climate driven changes to these habitats. Projected changes in tidal marsh area and habitat type in response to current and future SLR were modeled using SLAMM v6.0.1. SLAMM accounts for the dominant processes involved in wetland conversion and shoreline modification during long-term SLR (Park et al. 1993). To project broad-scale climate change effects on the abundance and distribution of coastal habitats, an inundation model based on anticipated relative SLR and coastal development was integrated into SLAMM. Using this framework, simple models were constructed that forecast the distribution of key coastal habitat parameters within the next 50 years, including shallow-water areas, tidal wetlands, submerged aquatic vegetation, estuarine beaches, freshwater marsh and uplands.

The purpose of this analysis is to inform management and planning efforts by identifying areas at significant risk for changes to habitat components, and areas with significant potential to support critical habitat components in the future. These projected changes will enable managers to make proactive decisions to mitigate impacts and preserve opportunities for sustained habitat services as the estuarine system evolves. From a practical perspective, understanding potential future scenarios can help target limited management resources to the areas at greatest risk and/or areas with the greatest probability for successful outcomes.

4.3.2 Model Summary

Successive versions of the SLAMM model have been used to estimate the impacts of SLR along the U.S. coast. (Titus et al. 1991; Lee et al. 1992; Park et al. 1993; Galbraith et al. 2002; National Wildlife Federation & Florida Wildlife Federation 2006; Glick et al. 2007; Craft et al. 2009).

SLAMM simulates the dominant processes involved in wetland conversions and shoreline modifications during long-term SLR. Tidal marshes can be among the most susceptible ecosystems to climate change, especially accelerated SLR. Within SLAMM there are five primary processes that affect wetland sustainability under SLR:

- **Inundation:** The rise of water levels and the salt boundary is tracked by reducing elevations as sea levels rise, thus keeping mean tide level (MTL) constant at zero. The effects are calculated based on the minimum elevation and slope.

Erosion: Erosion is triggered based on a threshold of maximum fetch (the length of an area where open water waves are being generated by the wind) and the proximity of the wetland to estuarine water or open ocean. When these conditions are met, horizontal erosion occurs at a rate based on site specific parameters.

- **Overwash:** Barrier islands under 500 meters wide are assumed to undergo overwash during each 25-year time-step as a result of storms. Beach migration and transport of sediments are calculated.
- **Saturation:** Coastal swamps and fresh marshes can migrate onto adjacent uplands as a response of the water table reacting to SLR close to the coast.
- **Accretion** Upward movement of marshes is due to sequestration of sediments and biogenic production. This process may be simulated on a spatially variable basis or accretion may be specified as a function of elevation, salinity, and/or distance to channel.

SLAMM Version 6.0 was developed in 2008/2009 and is based on SLAMM 5. SLAMM 6 provides “backwards compatibility” to SLAMM 5, meaning SLAMM 5 results can be replicated in SLAMM 6. However, SLAMM 6 also provides several optional capabilities.

- **Accretion Feedback Component**: Feedback based on wetland elevation, distance to channel, and salinity may be specified. This feedback will be used in U.S. Fish and Wildlife Service (USFWS) simulations, but only where adequate data exist for parameterization.

- **Salinity Model**: Multiple time-variable freshwater flows may be specified. Salinity is estimated and mapped at Mean Lower Low Water, Mean Higher High Water, and MTL. Habitat switching is a shift in habitat type caused by changes in the local environment such as increased sea level or salinity, etc. This optional sub-model is not utilized in USFWS simulations.
- **Integrated Elevation Analysis**: SLAMM will summarize site-specific, categorized elevation ranges for wetlands as derived from Light Detection and Ranging (LiDAR) data or other high-resolution data sets. This functionality is used in USFWS simulations to test the SLAMM conceptual model at each site. The causes of any discrepancies are then identified andelucidated and reported within the model application report.
- **Flexible Elevation Ranges for land categories**: If site-specific data indicate that wetland elevation ranges are outside of SLAMM defaults, a different range may be specified within the interface. In USFWS simulations, values outside of SLAMM defaults are rarely used. If such a change is made, the change and the reason for it are fully documented within the model application reports.
- **New Version Upgrades**: Many other graphical user interface and memory management improvements are also part of the new version, including updated Technical Documentation and context-sensitive help files.

For a thorough accounting of SLAMM model processes and the underlying assumptions and equations, please see the SLAMM 6.0 Technical Documentation (Clough et al. 2010). This document is available at http://warrenpinnacle.com/prof/SLAMM. All model results are subject to uncertainty due to limitations in input data, incomplete knowledge about factors that control the behavior of the system being modeled and simplifications of the system (CREM, 2008). Site-specific factors that increase or decrease model uncertainty are addressed in subsequent sections of this report.

4.3.3 SLR Scenarios

Sea level rise scenarios were based on the latest findings of the ongoing NOAA-funded *Ecological Effects of Sea Level Rise in the Gulf of Mexico* (study led by Scott Hagen). The Dewberry Team used the Global SLR Scenarios for the United States National Climate Assessment published December 2012. Three forecast simulation scenarios were modeled: low, intermediate-high, and highest. In these simulations, we used scenario A1B from the Special Report on Emissions Scenarios – mean and maximum estimates. The A1 family of scenarios assumes that the future world includes rapid economic growth and global population peaks in mid-century and declines thereafter. There will also be a rapid introduction of new and more efficient technologies. In particular, the A1B scenario assumes that energy sources will be balanced. Under the A1B scenario, the Intergovernmental Panel on Climate Change (IPCC) Working Group I Fourth Assessment Report (AR4) (IPCC 2007) suggests a likely range of 0.21 to 0.48 meters of SLR by 2090-2099, "excluding future rapid dynamical changes in ice flow." The A1B-mean scenario that was run as part of this project falls near the middle of this estimated range, predicting 0.39 meters of global SLR by 2050. A1B-maximum predicts 0.69 meters of global SLR by 2050.

The latest literature (Chen et al. 2006; Monaghan et al. 2006) indicates that the eustatic, or global (as opposed to local), rise in sea levels is progressing more rapidly than was previously assumed, perhaps attributed to the dynamic changes in ice flow omitted within the IPCC report's calculations. The term "eustatic" refers to any uniformly global change of sea level that may reflect a change in the quantity of water in the ocean, or a change in the shape and capacity of the ocean basins. A recent paper in the journal Science (Rahmstorf 2007) suggests, taking into account possible model error, a feasible range of 50 to 140 cm of SLR by 2050. This work was recently updated and the ranges were increased to 75 to 190 cm (Vermeer and Rahmstorf 2009). Pfeffer et al. (2008) suggests that two meters SLR by 2050 is at the upper end of plausible scenarios because of physical limitations on glaciological conditions. A recent U.S. intergovernmental report states "Although no ice-sheet model is currently capable of capturing the glacier melt speedups in Antarctica or Greenland that have been observed over the last decade, including these processes in models will very likely show that IPCC AR4 projected SLRs for the end of the 21st century are too low" (Clark 2009). A recent paper by Grinsted et al. (2009) states that "sea level 2090-2099 is projected to be 0.9 to 1.3 m for the A1B scenario…" Grinsted also states that there is a "low probability" that SLR will match the lower IPCC estimates.

To allow for flexibility when interpreting the results, SLAMM was also run assuming 1 meter, 1½ meters, and 2 meters of eustatic SLR by the year 2050. The A1B- maximum scenario was scaled up to produce these bounding scenarios. We modeled three scenarios: intermediate-low, intermediate-high, and highest (See Table 4-3).

Table 4-3 Global SLR scenarios from Parris et al., 2012.

Scenario	SLR by 2100 (m/ft)
Highest	2.0/6.6
Intermediate-High	1.2/3.9
Intermediate-Low	0.5/1.6

4.3.4 Methods and Data Sources

The main data input for the SLAMM model consists of elevation and habitat. The SLAMM model accounts for the context of the surrounding lands or open water when calculating effects. For example, erosion rates can be calculated based on the maximum fetch (wave action), which is estimated by comparing contiguous open water to a given marsh area. Another example is that inundated dry lands will convert to marshes or ocean beach depending on their proximity to open ocean.

4.3.4.1. Digital Elevation Model

The digital elevation model used in this simulation was derived from LiDAR captured in 2002. The vertical-resolution of elevation is one of the most important SLAMM data requirements. Elevation data determines where salt water is forecast to penetrate and, when combined with tidal data, the frequency of inundation for wetlands and marshes. Gesch (2009) demonstrated that bare-earth LiDAR should be utilized to run the SLAMM model to reduce uncertainty. The elevation data must be corrected so that MTL is set to zero. The elevation correction is determined using NOAA Tides and Currents Stations: Mobile State Docks, AL 8737048. We subtracted elevation minus 0.104 to get the correct elevation.

Elevation data sets were based on high-vertical-resolution LiDAR data for the entire area to reduce model uncertainty. The anticipated maximum SLR rates are lower than the elevations of USACE water control structures that currently exist in the creek. Therefore, the SLR study area was limited to the portion of Three Mile Creek downstream of Stanton Road (near Tricentennial Park). Developed and undeveloped dry land account for most of the Three Mile Creek study area. Non-tidal/cypress swamp represents approximately one-third of the study area. A fourth significant constituent would be inland fresh marsh comprising approximately one-eighth (12.5%) of the study area. Of those four constituents, the latter two are most heavily impacted by SLR, even at the lowest projected/considered rate. Regularly flooded marsh and estuarine open water also exhibit notable results under the various SLR change scenarios in that they increase as other land types are submerged due to the rise in water levels. Table 4-4 provides guidance on how habitat type changes based on SLR as a result of inundation or erosion.

Table 4-4 SLAMM Assumed Effects of Inundation and Erosion

	Inundation: Non-adjacent to open water or Fetch < 9km (non tropical systems)	Erosion: Adjacent to Open Water and Fetch > 9km (erosion)
Converting From	**Converts To**	**Converts To**
Dry Land	Transitional salt marsh, ocean beach, or estuarine beach, depending on context (see below)	Erosion of dry land is ignored.
Swamp	Transitional salt marsh	Erosion to Tidal Flat
Nontidal/Cypress Swamp	Open Water	Erosion to Tidal Flat
Inland Fresh Marsh	Transitional salt marsh	Erosion to Tidal Flat
Tidal Swamp	Tidal Fresh Marsh	Erosion to Tidal Flat
Tidal Marsh	Irregularly Flooded Marsh	Erosion to Tidal Flat
Scrub-Shrub, Irregularly Flooded Marsh	to Regularly Flooded Marsh	Erosion to Tidal Flat
Regularly Flooded Marsh	to Tidal Flat	Erosion to Tidal Flat
Mangrove	to Estuarine Water	Erosion & Inundation to Estuarine Water
Ocean Flat	to Open Ocean	Erosion to Open Ocean
Tidal Flat	Erosion, Inundation to Estuarine Water	Erosion to Estuarine Water
Estuarine Beach, Ocean Beach	open water	Erosion to open water

4.3.4.2. National Wetlands Inventory

The wetlands layer for the study area was produced from the best available data which was the National Wetlands Inventory (NWI) based on a 2002 photo date. NWI data were downloaded and converted to SLAMM codes based on the provided conversion codes. Where classifications were not provided (approx 15 classifications), appropriate SLAMM codes were determined from looking up the NWI descriptions (source NWI Lookup) and coordinated using the SLAMM technical manual. The NWI data does not provide for developed or undeveloped dry land; these gaps were identified and filled using 2006 Coastal Change Analysis Program (C-CAP) data provided from NOAA. C-CAP data were converted to a SLAMM classification using the conversions in Table 4-5.

Table 4-5 C-CAP conversion to SLAMM classification for gaps where NWI data does not exist.

C-CAP	Description	SLAMM
2-5	Developed	1
6-12, 20	Natural areas, bare land	2
13-14	Palustrine scrub/shrub/emergent wetlands	3
15	Palustrine emergent wetland	5
17	Estuarine scrub/shrub wetland	7
18	Estuarine emergent wetland	8
19	Unconsolidated shore	11
21	Open Water	17
23	Estuarine Aquatic Bed	17

4.3.5 Additional Parameters

An example of the model parameters used to execute a virtual simulation of SLR can be found in Table 4-6 below. Three NOAA tide and current stations were available in proximity to the study area allowing for accurate projection of those two parameters.

NOAA Tides and Currents Stations:

1. Mobile State Docks, AL 8737048 (does have NAVD88)
2. Coast Guard Sector Mobile, AL 8736897 (no NAVD88)
3. Chickasaw Creek, AL 8737138 (no NAVD88)

Table 4-6 Example SLAMM Model Parameters

Parameter	Global
Description	2100_2m
NWI Photo Date (YYYY)	2002
DEM Date (YYYY)	2010
Direction Offshore [n,s,e,w]	South
Historic Trend (mm/yr)	2.98
MTL-NAVD88 (m)	0.104
GT Great Diurnal Tide Range (m)	0.494
Salt Elev. (m above MTL)	0.401
Marsh Erosion (horz. m /yr)	1.8
Swamp Erosion (horz. m /yr)	1
T.Flat Erosion (horz. m /yr)	0.5
Reg. Flood Marsh Accr (mm/yr)	6.8
Irreg. Flood Marsh Accr (mm/yr)	5
Tidal Fresh Marsh Accr (mm/yr)	5.9
Beach Sed. Rate (mm/yr)	0.5
Freq. Overwash (years)	25
Use Elev Pre-processor [True,False]	False

4.3.6 SLAMM Model Results

SLAMM results for the Three Mile Creek study area indicate that, as a whole, the watershed is only moderately vulnerable to SLR under the most extreme SLR scenarios (2 meters and greater). When evaluating the initial condition (i.e., existing habitat regimes) against years 2025 and 2050 more significant habitat conversions are exhibited in proximity of the eastern edge of the study area nearest Mobile Bay, which comprises mostly non-tidal swamp and inland fresh marsh. This area trends mostly towards transitional marsh/scrub shrub and regularly flooded marsh (saltmarsh) at year 2025 and further trends towards tidal flats with a slight trend towards estuarine open water habitats at year 2050, in both the 1.2M and 2M scenarios. Moreover, these areas transition from stable, more upland elevations down to lower elevations (i.e., trending towards open water) under the higher SLR scenarios, with the most drastic conversions observed during the 2M SLR scenario at year 2050. The major difference between the 1.2M and 2M SLR scenarios is the amount of conversion to estuarine open water. It is worth noting that the amount of change is quite similar for the higher SLR scenarios at year 2050, while under the 0.5M scenario, the area only exhibits conversion mostly towards inland fresh marsh for the same targeted study year. In reviewing a the results of another SLAMM study displayed on The Nature Conservancy Website (maps.coastalresilience.org/gulfmex) similar trends toward Regularly Flooded Marsh and Tidal Fresh Marsh were apparent in the upper Mobile Bay areas.

When rates of SLR exceed measured accretion rates for irregularly-flooded marsh in this region, marshes are predicted to sustain moderate losses. The SLAMM model simulations were run without inputting the USACE weirs located in the creek because neither of the SLR scenarios is greater than 2M. Therefore, they would not overtop the USACE weirs, which would be modeled as dikes in SLAMM. Given this fact and the knowledge that the first water control structure is located more inland of the transitional areas, it may be safe to assume that even with the dike files included there would be similar impacts associated to the study area under the modeled SLR rates.

The following tables and diagrams were produced from the SLAMM model runs. The information contained within them guides the preliminary results and discussion presented herein. Table 4-7 presents the SLAMM code and the associated habitat types input in the model. Tables 4-8 through 4-10 depict the various SLR scenarios and the preliminary change results from the existing conditions to the habitat status at years 2025 and 2050, based on SLR rises of 0.5, 1.2, and 2 meters. Figures 4-3 through 4-11 provide a graphical depiction of habitat conversion based on the same SLR rates and target years.

Table 4-7 SLAMM Code and Habitat Types

SLAMM Code	Name
1	Developed Dry Land (upland)
2	Undeveloped Dry Land (upland)
3	Nontidal Swamp
4	Cypress Swamp
5	Inland Fresh Marsh
6	Tidal Marsh
7	Transitional Marsh/ Scrub Shrub
8	Regularly Flooded Marsh
10	Estuarine Beach
11	Tidal Flat
12	Ocean Beach
13	Ocean Flat
14	Rocky Intertidal
15	Inland Open Water
16	Riverine Tidal Open Water
17	Estuarine Open Water
18	Tidal Creek
19	Open Ocean
20	Irregularly Flooded Marsh
22	Inland Shore
23	Tidal Swamp

Table 4-8 SLR Scenario 0.5M Habitat Change

SLR Scenario 0.5M	Initial (acres)	2025 (acres)	2050 (acres)	Change (Acres, Initial minus 2050 Projection)
Developed Dry Land (upland)	8,360.17	8,360.17	8,360.17	0
Undeveloped Dry Land (upland)	2,406.79	2,406.64	2,406.40	0.39
Nontidal/Cypress Swamp	1,790.04	1,675.16	1,644.58	**145.46**
Inland Fresh Marsh	71.48	65.23	65.12	6.36
Transitional Marsh/ Scrub Shrub	0.24	110.57	138.52	**-138.28**
Regularly Flooded Marsh (Saltmarsh)	6.42	17.44	19.11	**-12.69**
Estuarine Beach	0.80	0.80	0.80	0
Tidal Flat	1.76	1.44	2.39	-0.63
Inland Open Water	80.22	78.79	77.82	2.4
Riverine Tidal Open Water	7.82	4.85	3.92	3.9
Estuarine Open Water	148.10	152.89	155.18	-7.08
Irregularly Flooded Marsh	1.16	1.47	1.65	-0.49
Inland Shore	2.92	2.92	2.92	0
Tidal Swamp	2.41	1.95	1.75	0.66
Total	**12,880.33**	**12,880.33**	**12,880.33**	

Table 4-9 SLR Scenario 1.2M Habitat Change

SLR SCENARIO 1.2M	Initial (acres)	2025 (acres)	2050 (acres)	Change (Acres, Initial minus 2050 Projection)
Developed Dry Land (upland)	8360.17	8360.17	8360.17	0
Undeveloped Dry Land (upland)	2406.79	2406.53	2405.54	1.25
Nontidal/Cypress Swamp	1790.04	1654.39	1611.63	**178.41**
Inland Fresh Marsh	71.48	63.86	60.28	11.2
Transitional Marsh/ Scrub Shrub	0.24	112.99	48.44	**-48.2**
Regularly Flooded Marsh (Saltmarsh)	6.42	37.32	141.03	**-134.61**
Estuarine Beach	0.80	0.80	0.80	0
Tidal Flat	1.76	1.44	8.84	-7.08
Inland Open Water	80.22	78.31	75.21	5.01
Riverine Tidal Open Water	7.82	4.45	3.25	4.57
Estuarine Open Water	148.10	153.79	159.08	-10.98
Irregularly Flooded Marsh	1.16	1.55	1.90	-0.74
Inland Shore	2.92	2.92	2.92	0
Tidal Swamp	2.41	1.81	1.24	1.17
Total	12880.33	12880.33	12880.33	

Table 4-10 SLR Scenario 2.0M Habitat Change

SLR SCENARIO 2.0M	Initial (acres)	2025 (acres)	2050 (acres)	Change (Acres, Initial minus 2050 Projection)
Developed Dry Land (upland)	8360.17	8360.17	8360.17	0
Undeveloped Dry Land (upland)	2406.79	2406.31	2402.80	3.99
Nontidal/Cypress Swamp	1790.04	1636.88	1590.30	**199.74**
Inland Fresh Marsh	71.48	61.36	56.57	14.91
Transitional Marsh/ Scrub Shrub	0.24	81.61	55.17	-54.93
Regularly Flooded Marsh (Saltmarsh)	6.44	89.01	88.14	**-81.7**
Estuarine Beach	0.80	0.80	0.80	0
Tidal Flat	1.76	1.44	81.18	**-79.42**
Inland Open Water	80.22	77.69	73.43	6.79
Riverine Tidal Open Water	7.82	4.18	2.98	4.84
Estuarine Open Water	148.14	154.73	163.25	-15.11
Irregularly Flooded Marsh	1.16	1.61	1.75	-0.59
Inland Shore	2.92	2.92	2.92	0
Tidal Swamp	2.41	1.63	0.87	1.54
Total	**12880.39**	**12880.33**	**12880.33**	

Figure 4-3 Change in habitat types based on an 0.5 M increase in SLR in the year 2013 (see Table 4-8)

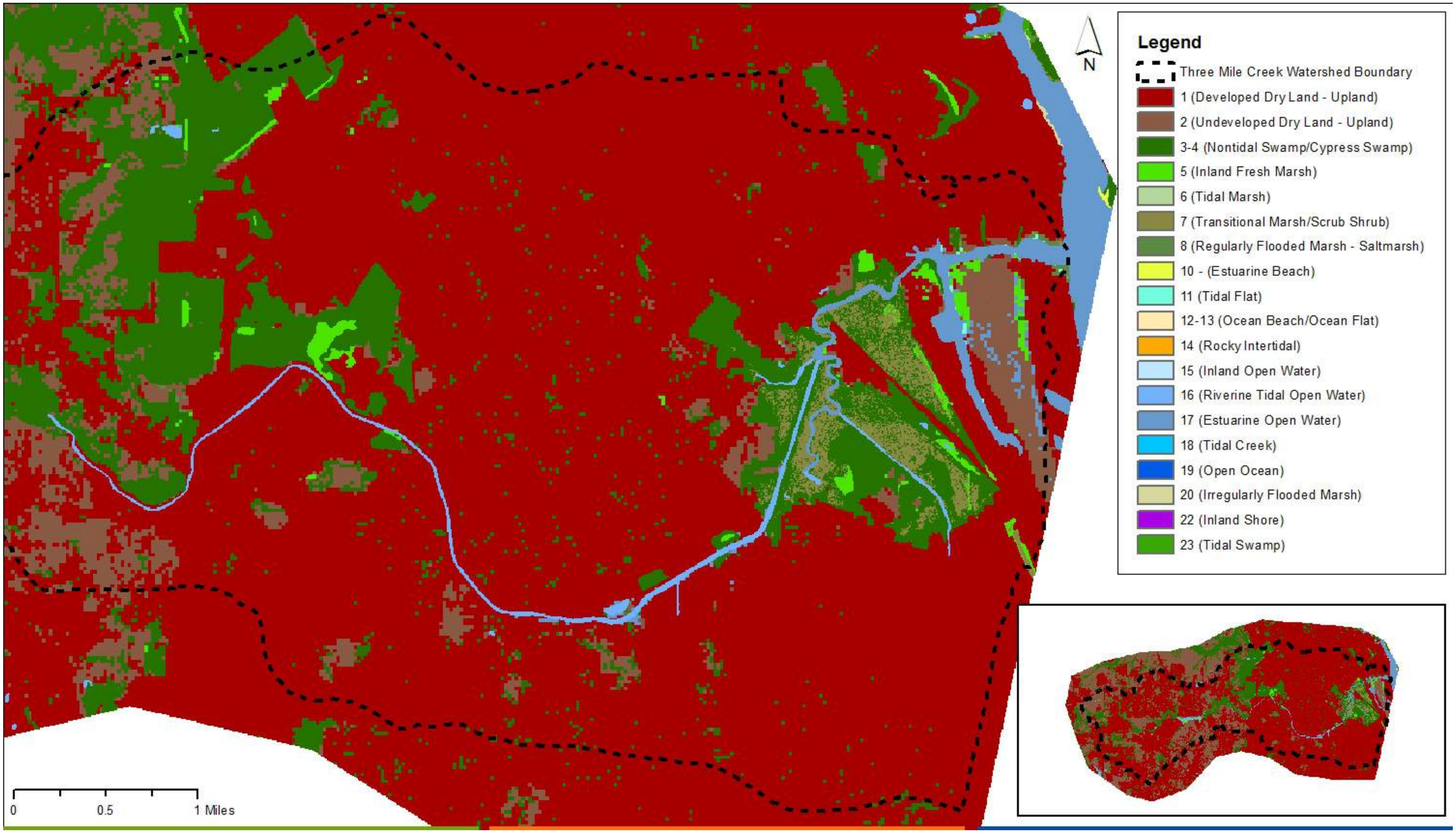


Figure 4-4 Change in habitat types based on an 0.5 M increase in SLR in the year 2025 (see Table 4-8)

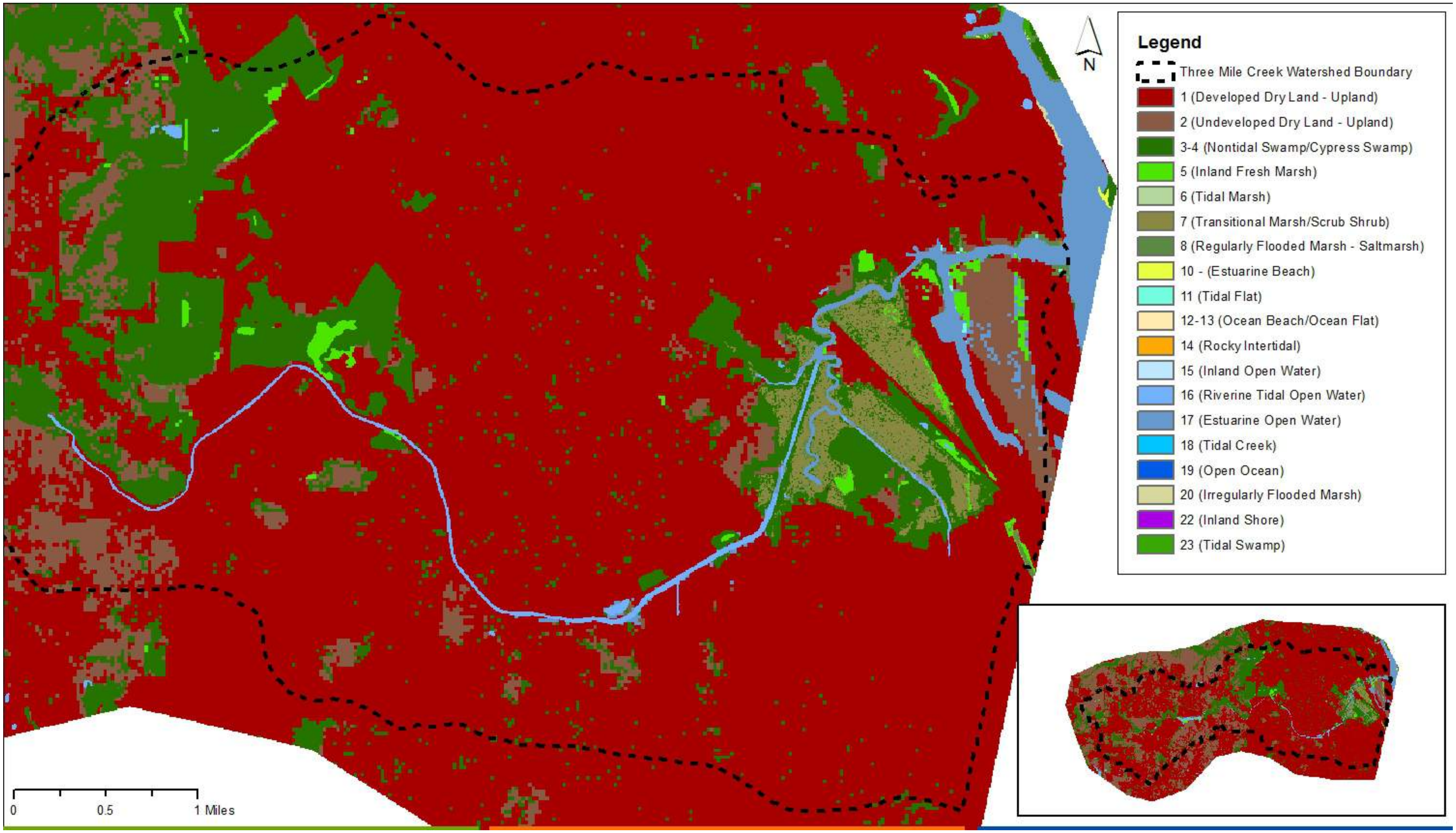


Figure 4-5 Change in habitat types based on an 0.5 M increase in SLR in the year 2050 (see Table 4-8)

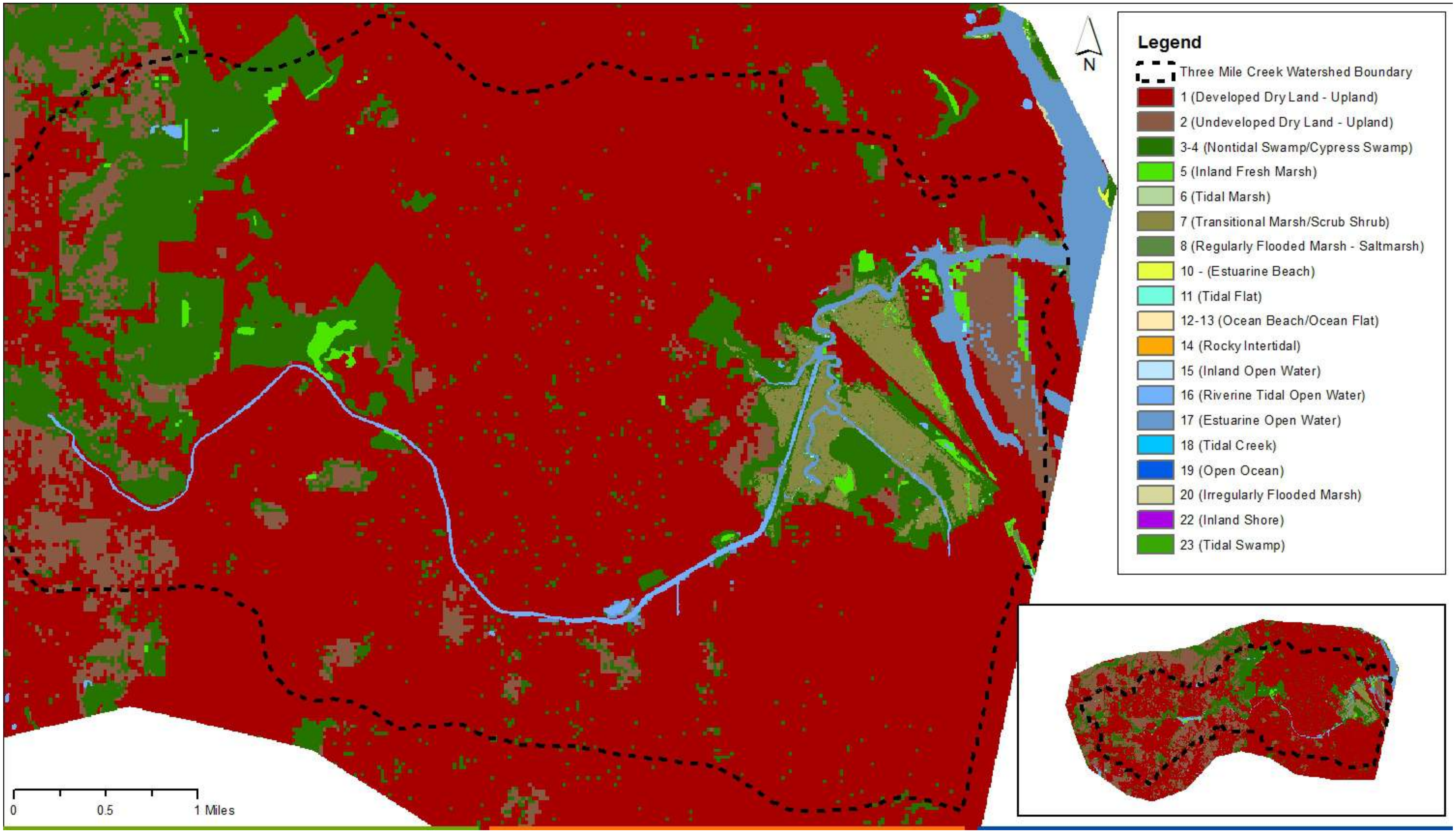


Figure 4-6 Change in habitat types based on an 1.2 M increase in SLR in the year 2013 (see Table 4-9)

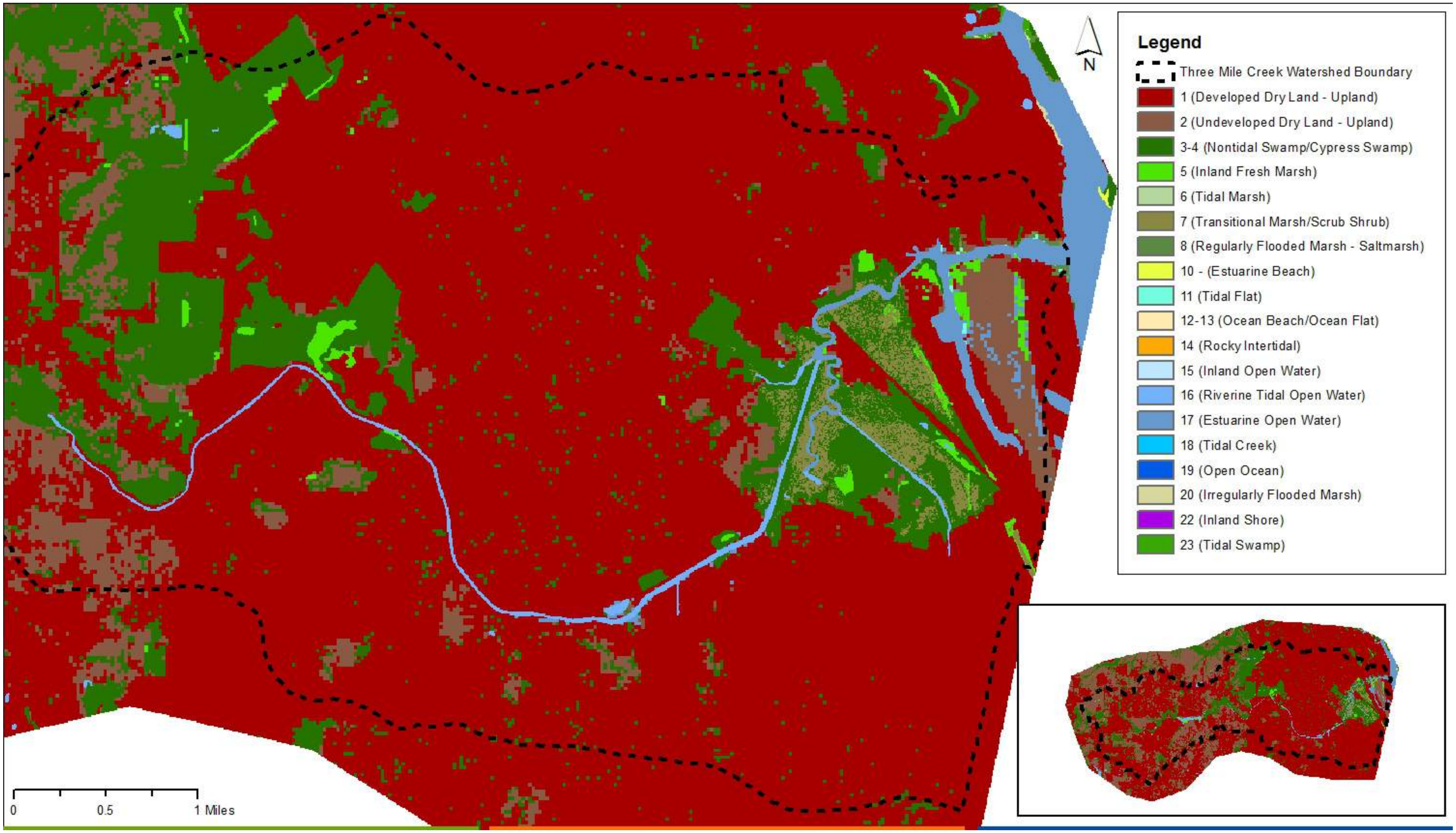


Figure 4-7 Change in habitat types based on an 1.2 M increase in SLR in the year 2025 (see Table 4-9)

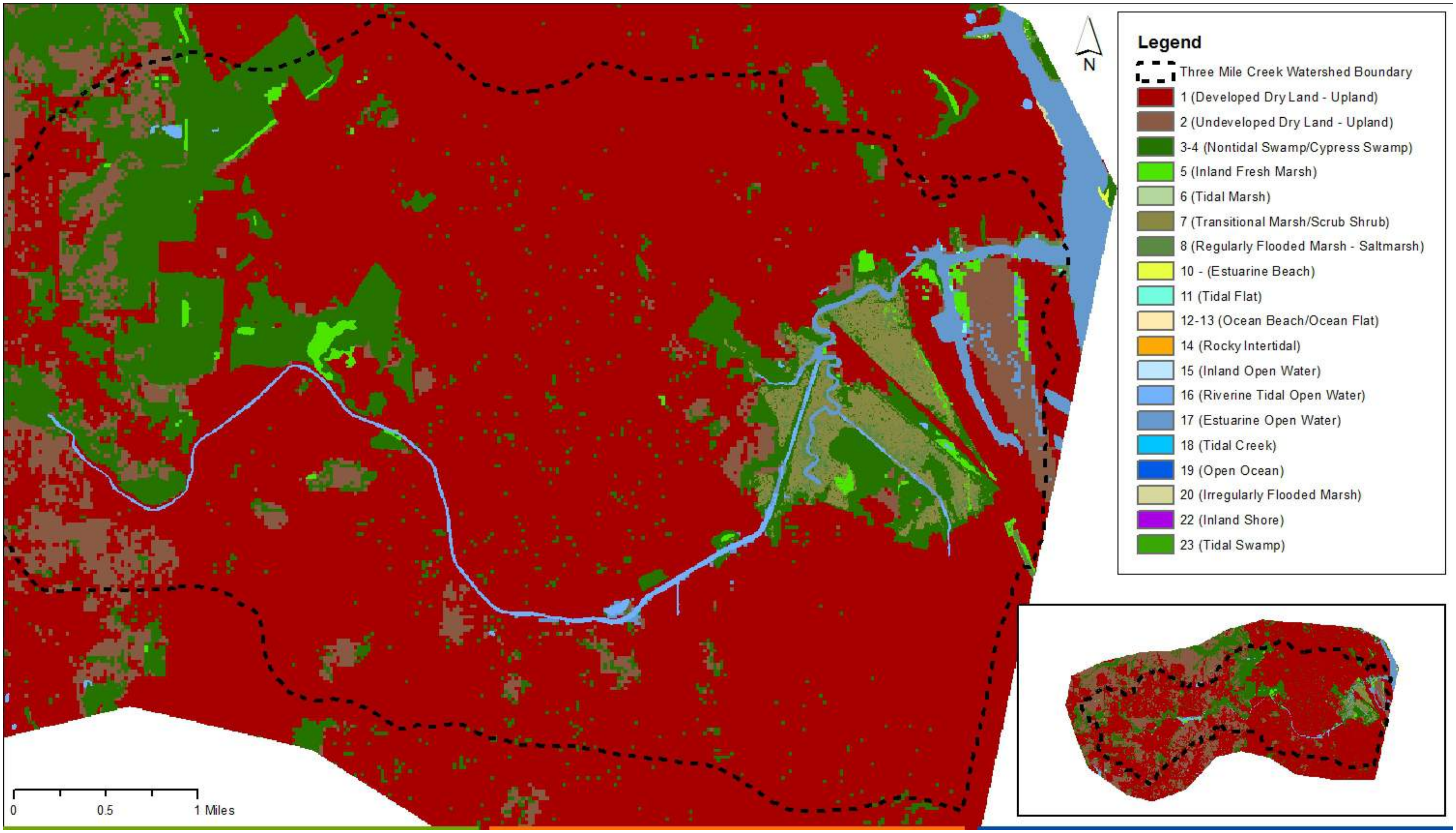


Figure 4-8 Change in habitat types based on an 1.2 M increase in SLR in the year 2050 (see Table 4-9)

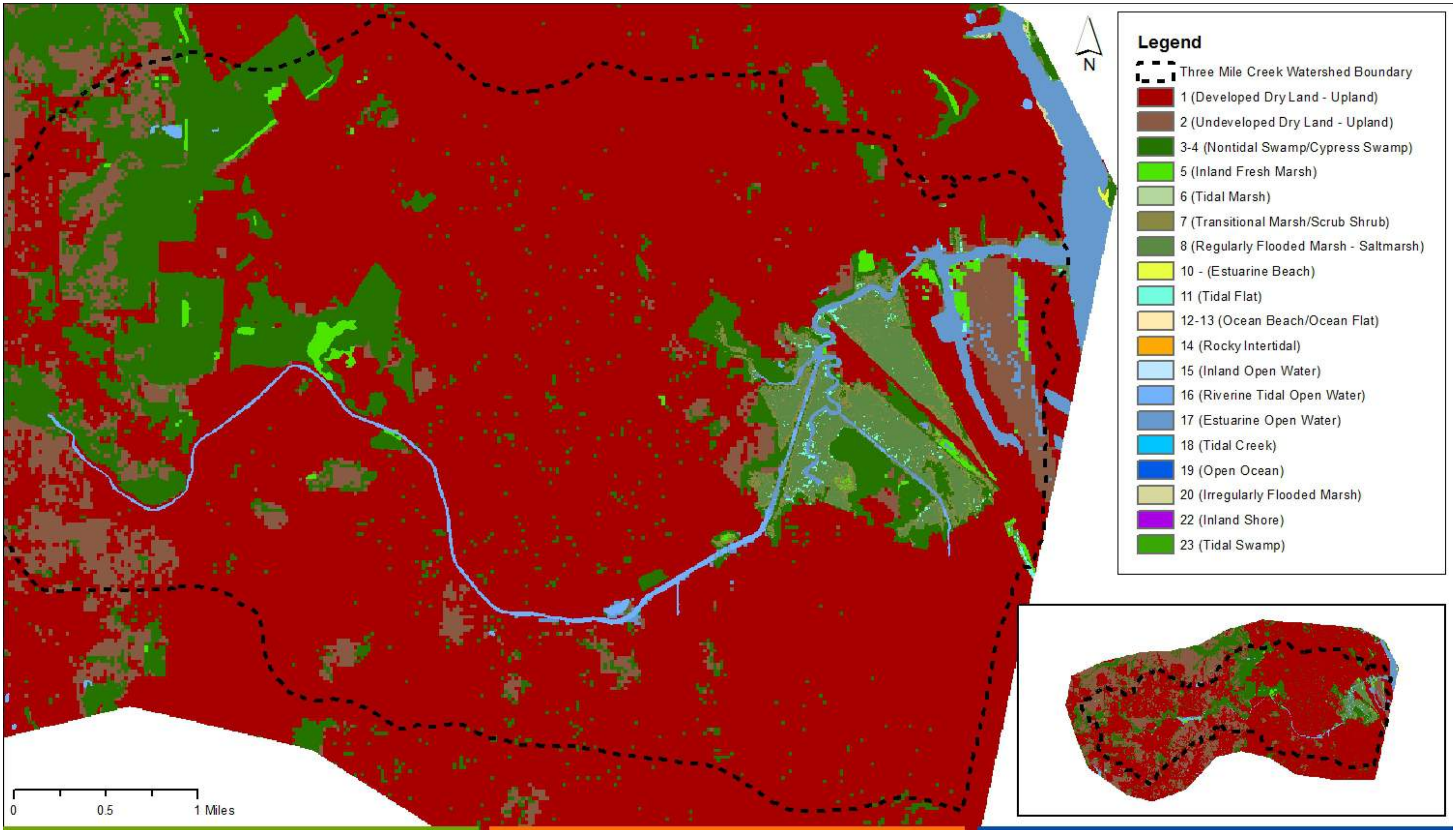


Figure 4-9 Change in habitat types based on an 2.0 M increase in SLR in the year 2013 (see Table 4-10)

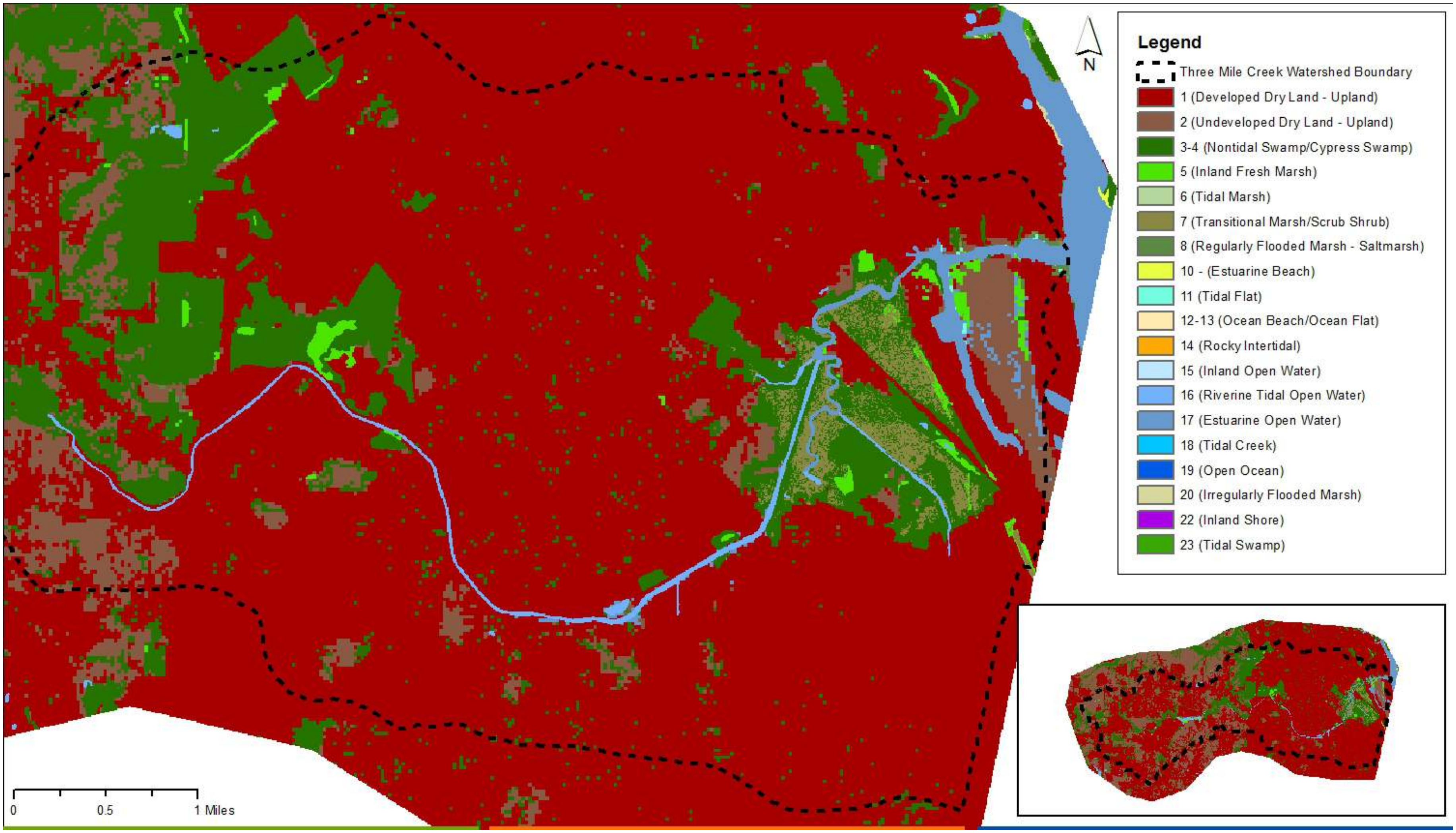


Figure 4-10 Change in habitat types based on an 2.0 M increase in SLR in the year 2025 (see Table 4-10)

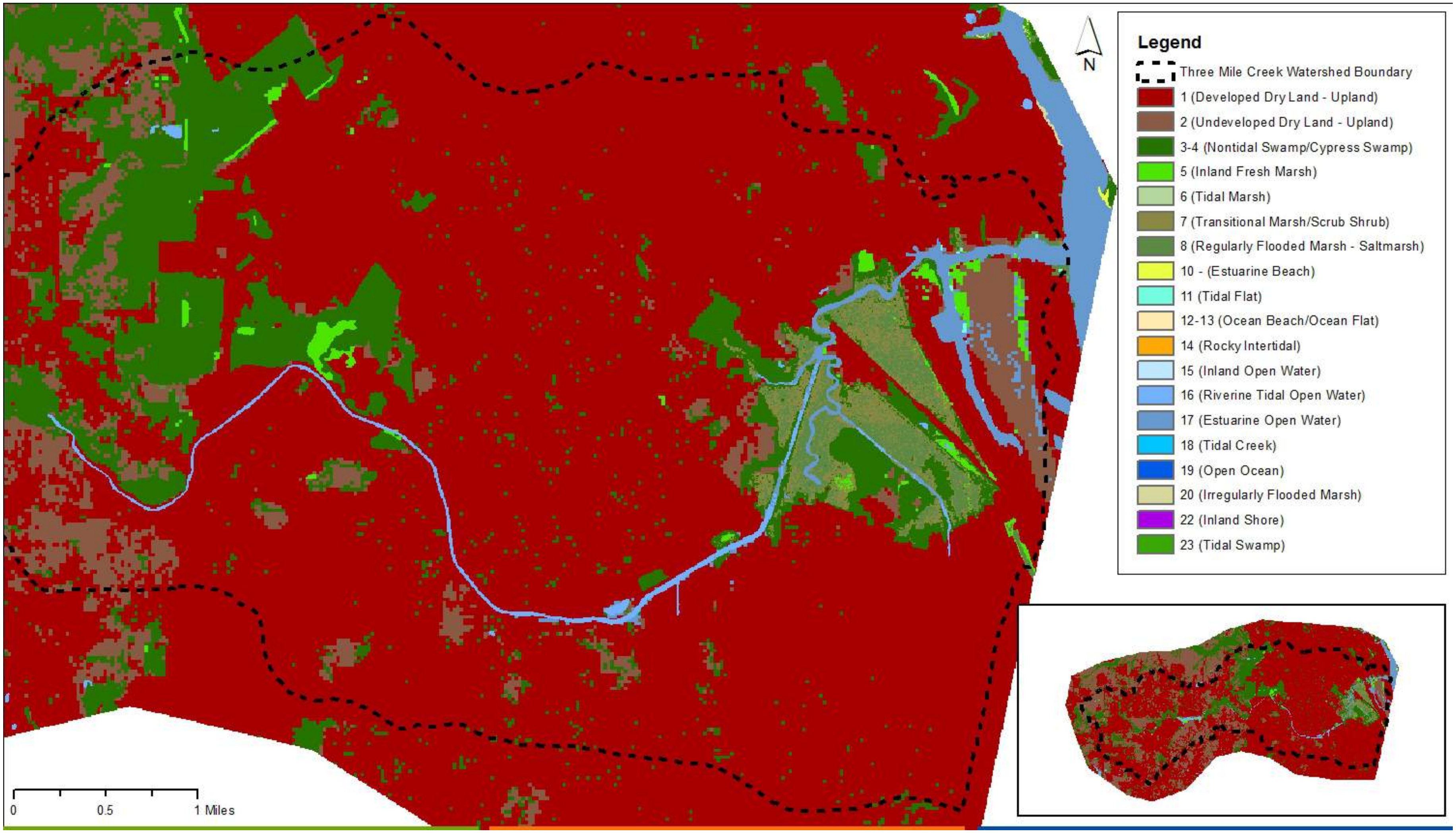
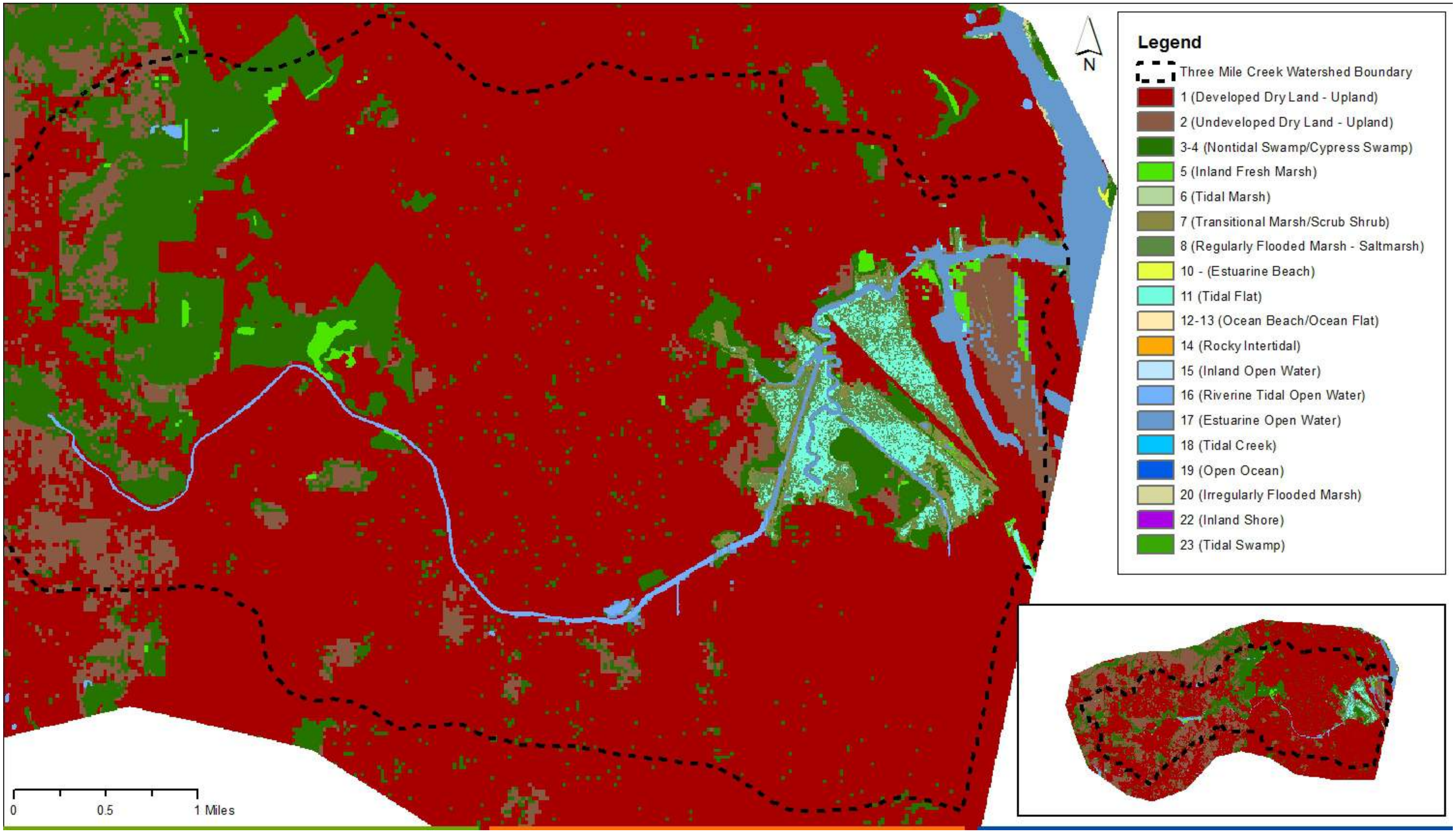


Figure 4-11 Change in habitat types based on an 2.0 M increase in SLR in the year 2050 (see Table 4-10)



4.3.7 Potential Benefits/Impacts of Habitat Shift from SLR Inundation

4.3.7.1. Changes in Habitat and Wildlife Diversity

Depending on how drastic the inundation and the duration, as areas convert from one habitat type to another, new ecosystem components will be introduced to the watershed. This will mean an overall decrease in habitats and associated vegetation types such as Nontidal/Cypress Swamp and an increase in habitats and associated vegetation types such as Regularly Flooded Marsh (Saltmarsh) and Tidal Flats. This change can be seen as a benefit or a disadvantage in that some species will certainly benefit from this change and others will be displaced. In Three Mile Creek the introduction of more salt water and brackish habitat will likely increase the diversity of plant and animal species in the watershed. This will occur at the cost of less habitat availability for upland and freshwater species.

4.3.7.2. Loss of Preferred Habitat And Ecosystem Niche

A negative impact of increasing SLR would be the loss of preferred habitats and ecosystems should areas transition over shorter durations, potentially affecting recreational fishing by changes to habitat and spawning areas.

4.3.7.3. Increased SLR Could Exacerbate Existing Flood Issues

The study area has historically had issues with flooding. SLR rates modeled are lower than the elevations of water control structures that currently exist in the creek, but sustained inundation attributable to projected SLR could slow drainage rates in the lower reaches of the watershed, thus increasing retention periods of stormwater runoff. Localized inundation could create backwater conditions that reduce stormwater discharge.

4.4 SLR + SLOSH Model

4.4.1 Model Summary

The Sea, Lake, and Overland Surges from Hurricanes (SLOSH) model is a two-dimensional numerical model developed by the National Weather Service to estimate storm surge heights from historical, hypothetical, or predicted hurricanes. The model is subdivided into 37 basins covering the entire Atlantic and Gulf of Mexico shorelines, as well as Hawaii, Puerto Rico, the Virgin Islands, and the Bahamas.

For each basin, the National Hurricane Center (NHC) runs thousands of hypothetical hurricanes under different storm conditions. These runs are used to generate Maximum Envelopes of Water (MEOWs) and Maximum of MEOWs (MOMs). MEOWs provide a worst case scenario for each category of storm, forward speed, radius of maximum wind, landfall location, and tidal levels. MOMs are considered to be the worst case scenario for each category of storm.

For Three Mile Creek, the SLOSH model used is the Mobile Bay Version 3 (EMO2), developed by the NHC in 2008. The Category 3 MOM with an initial tidal level of 1.4 feet was used for this scenario. Storm surge elevations are in the North American Vertical Datum of 1988 (NAVD88).

4.4.2 SLR Scenarios

The Three Mile Creek SLR scenarios are based on the ongoing NOAA-funded and aforementioned research *Ecological Effects of SLR in the Gulf of Mexico*. For this study, Global SLR Scenarios for the United States National Climate Assessment were used, published December 2012 (See Table 4-3). Three scenarios were modeled including intermediate-low, intermediate-high, and highest.

4.4.3 Digital Elevation Model

A digital elevation model was developed from 2-foot contours and spot elevations provided by the City of Mobile. The source of these data is from the 2010 planimetric update. No vertical or horizontal accuracy is stated, but it is determined to be the best available topographic data for the study area. The latest LiDAR data available for the entire study area is the 2002 LiDAR data.

4.4.4 SLOSH Model

Storm surge data from the EMO2 basin were exported from the SLOSH display program and imported into ArcGIS. Centroids of the SLOSH grids were exported to an ESRI point shapefile. Points lying outside of the Three Mile Creek HUC 12 basin were removed from the data set. A water surface was created from the centroids using the Inverse Distance Weighting (IDW) tool within ArcGIS. The methodology of using IDW for water surface creation from SLOSH is common practice and documented by FEMA.

In order to model the anticipated SLR scenarios described in Tables 4-8 through 4-10, the increased sea levels from the highest (6.6 feet), intermediate-high (3.9 feet) and intermediate-low (1.6 feet) scenarios were added to the storm surge heights and water surfaces were created from these. To determine the inland extent of flooding, the water depth was determined by subtracting the ground elevation from the water surfaces.

4.4.5 Results

A category 3 hurricane storm surge affects 2,255 buildings within the study area including residential, commercial and retail properties and areas within environmental justice communities such as those along TSB. Figure 4-12 depicts the extent of combined SLOSH and SLR inundation at high tide. The intermediate-low scenario inundates an additional 1,156 buildings. The intermediate-high scenario inundates an additional 1,197 buildings. The highest scenario inundates an additional 876 buildings. Figures 4-13 through 4-15 depict the various combined SLOSH and SLR scenarios for the intermediate-low, intermediate-high and highest scenarios, respectively, as summarized in Table 4-13. Figure 4-16 depicts the progressive inundation limits of each combined SLOSH and SLR scenario.

Summarizing the combined impacts of the SLOSH and SLR simulations, major road corridors within Three Mile Creek affected by storm surge include:

- Martin Luther King, Jr. Boulevard,
- St. Stephens Road,
- Government Street, and
- Water Street.

While the determination of exact depths of flooding is not available, GIS topographic information suggests these roads will be impacted by flooding. Having these roads impassable during storm events is a major concern, as these thoroughfares serve as evacuation routes and are connections to local emergency facilities. Of a greater concern are the emergency facilities themselves. Those projected to be impacted by flooding or restricted access from storm surge include:

- Mobile Infirmary.
- USA Children and Women's Hospital.

Other important sites that may be affected by flooding include:

- Historic Mobile Gas/Sempra Remediation Site.
- Alabama Port Authority.

The habitat and water quality changes that may occur due to the increased inundation depths from a Categroy 3 hurricane include:

- Increased depth of flooding from extreme events will put more land areas at risk further threatening the stability of soils and foundational materials. This would increase the sediment loads to Three Mile Creek increasing associated pollutant loadings such as heavy metals that are delivered with sediment and increased nutrients and BOD from increased organic debris.
- Increased depth of flooding from extreme events will put new land areas at risk increasing the frequency of SSO leading to higher pathogen loads entering Three Mile Creek.

Figure 4-12 Depth grid showing depth of water from a Category 3 storm surge at high tide in 2013 with no SLR

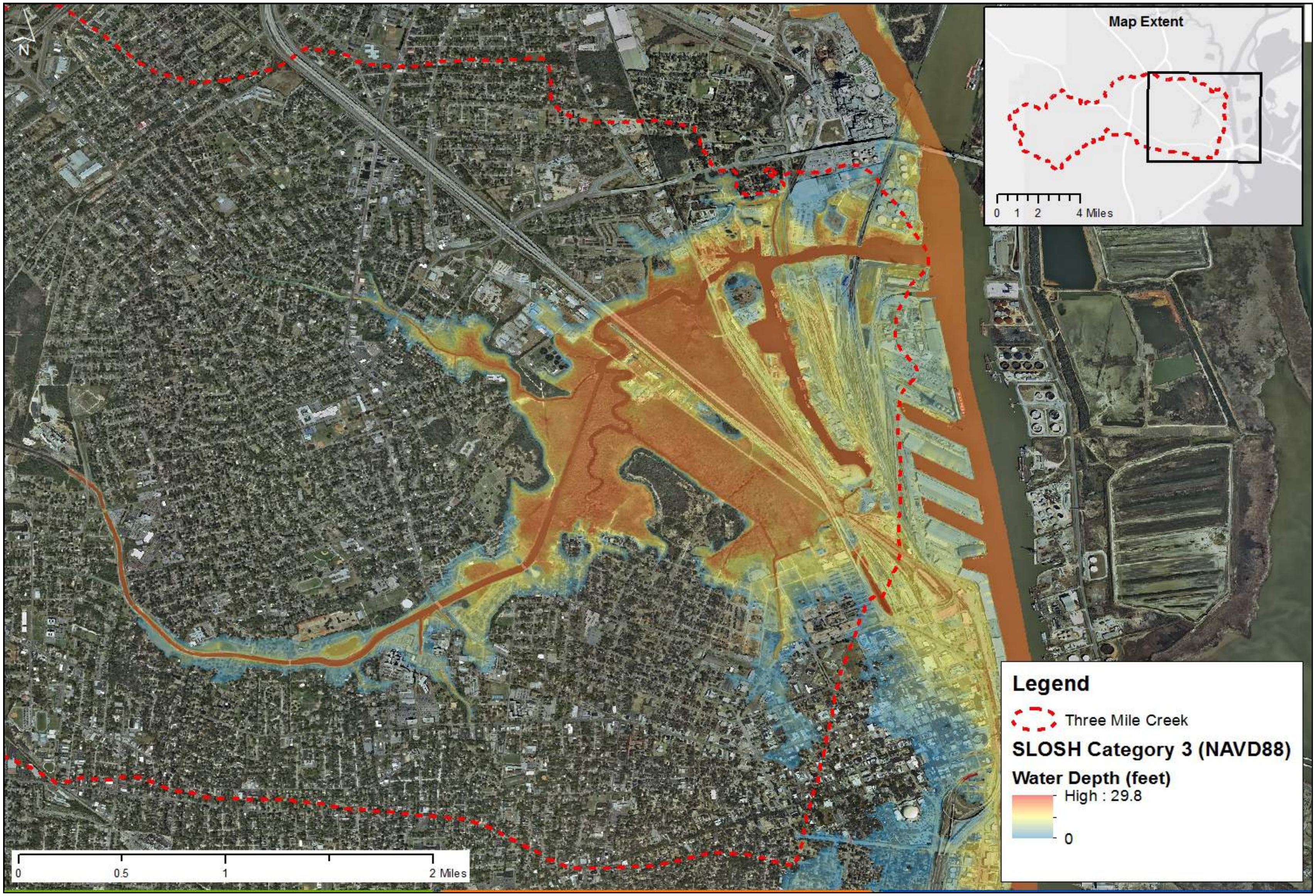


Figure 4-13 Depth grid showing the Intermediate-low (1.6 feet) SLR result and Category 3 storm surge

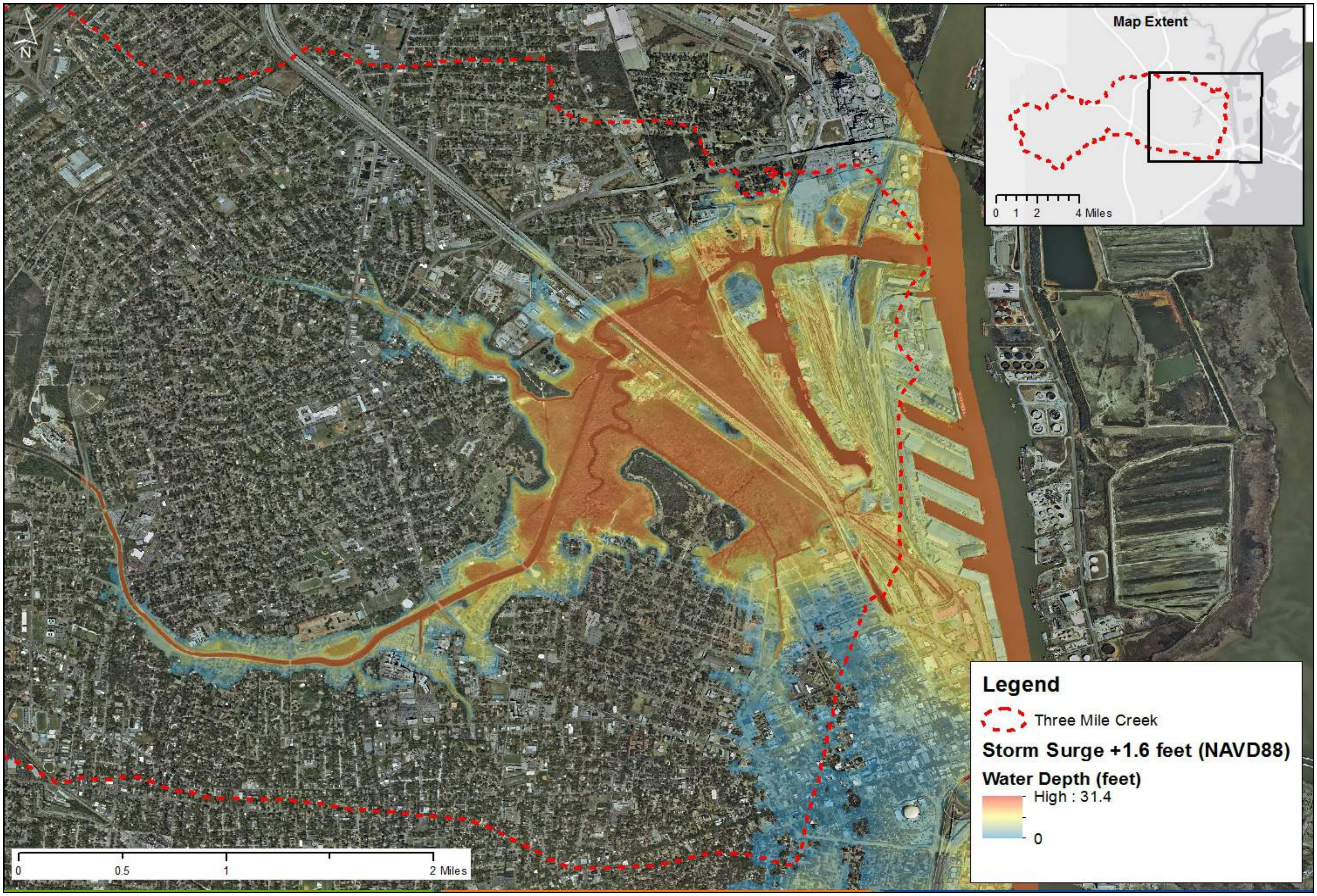


Figure 4-14 Depth grid showing the Intermediate-high (3.9 feet) SLR result and Category 3 storm surge

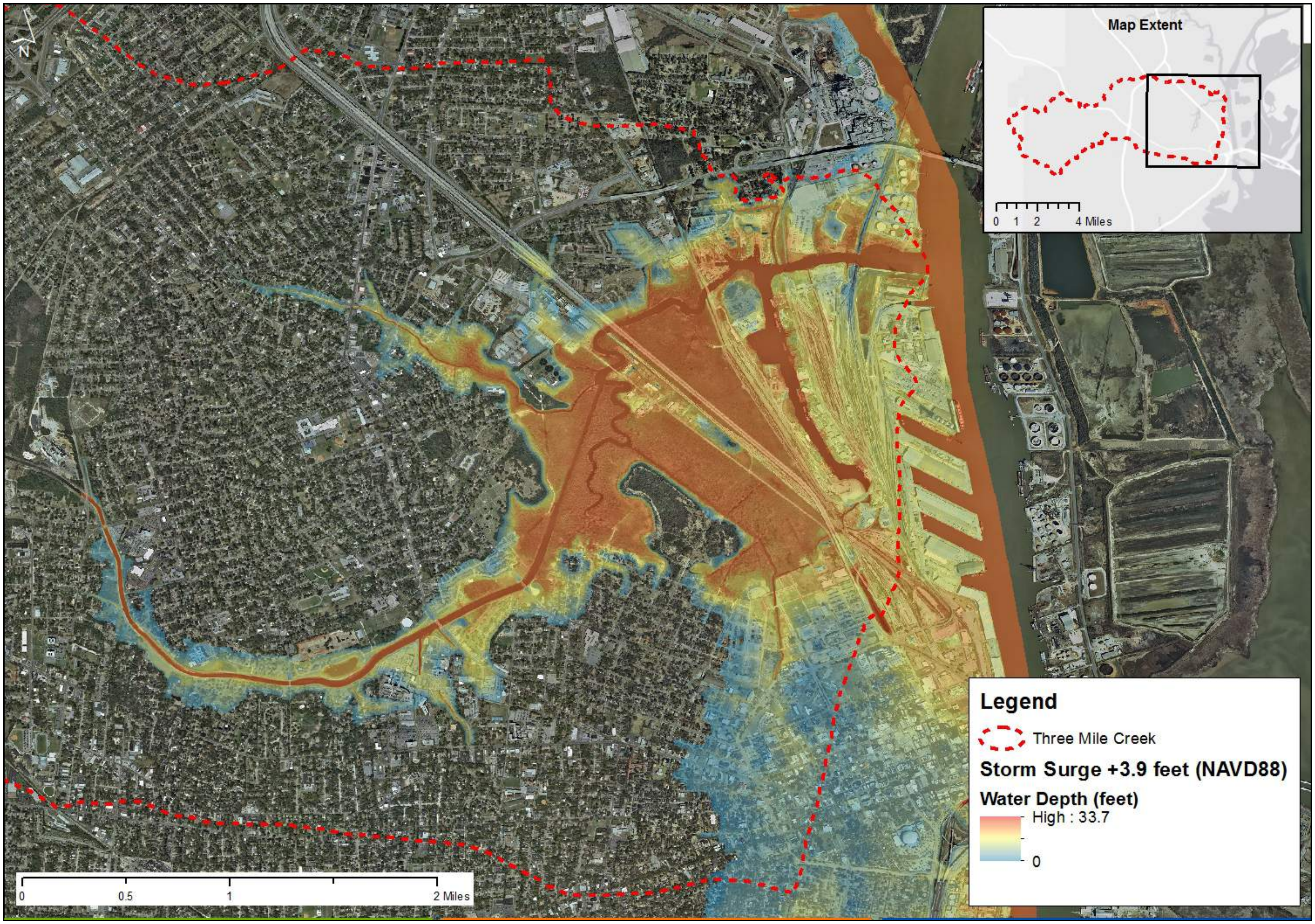


Figure 4-15 Depth grid showing the highest result (6.6 feet) SLR result and Category 3 storm surge

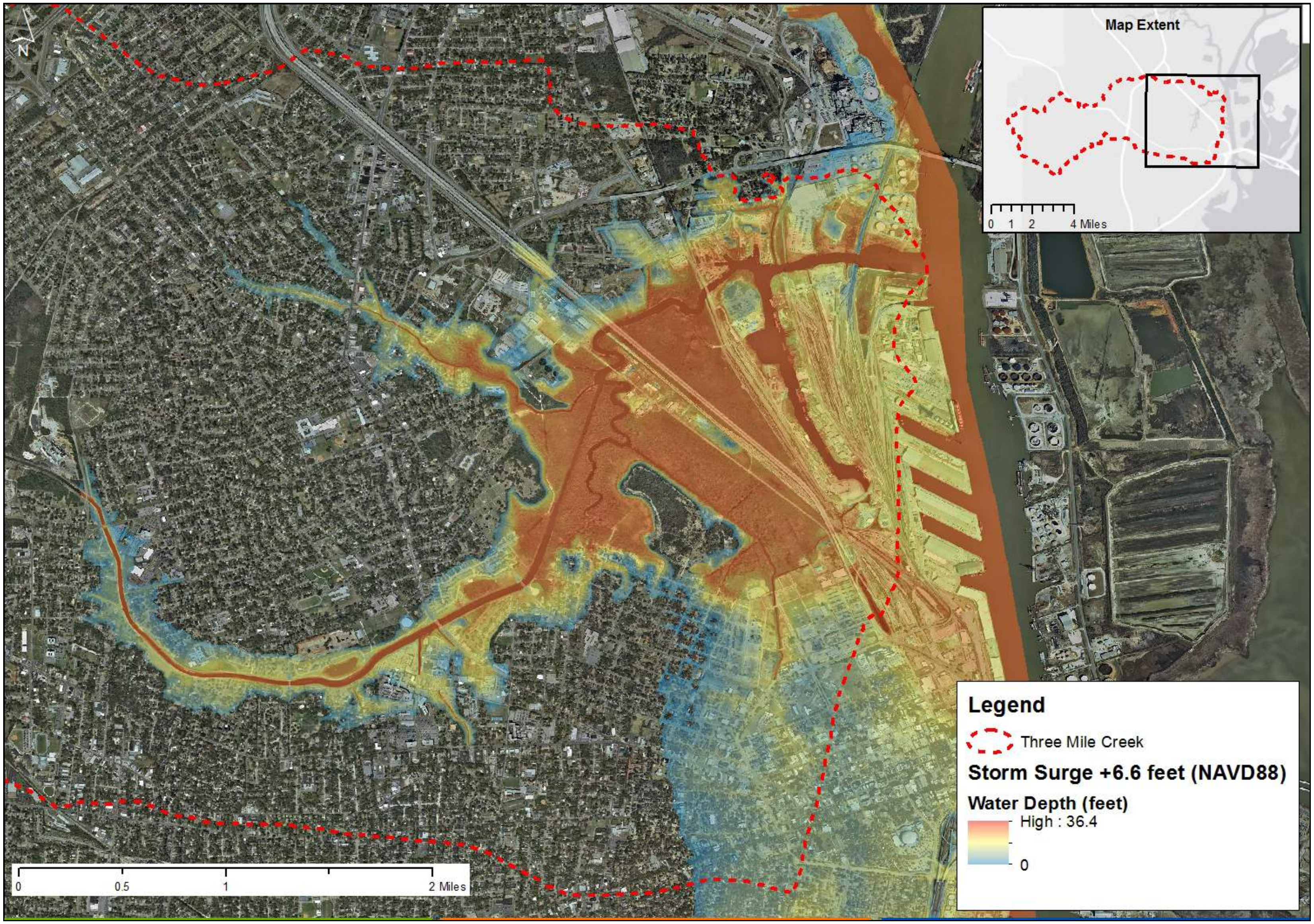
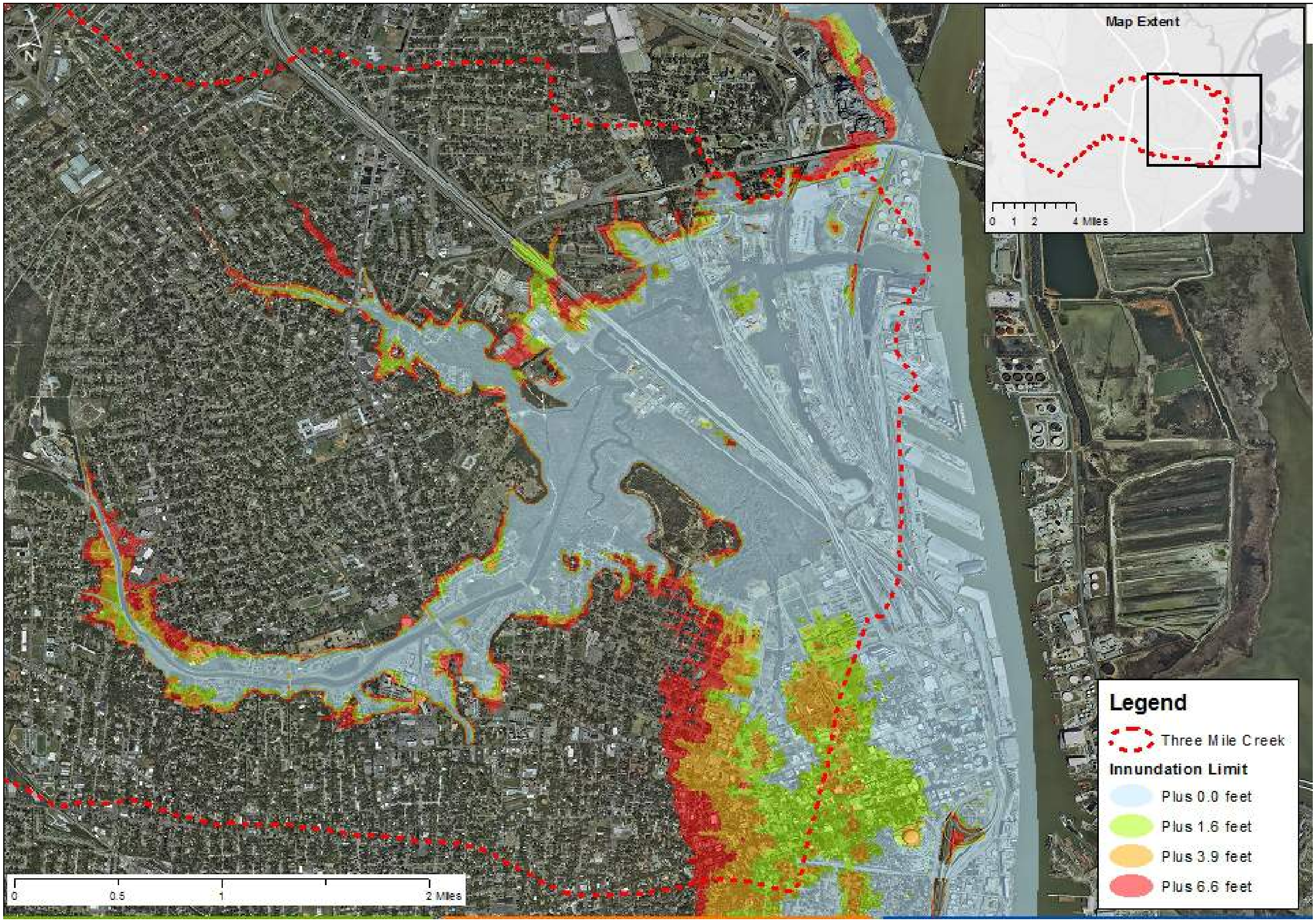


Figure 4-16 Inundation of each SLR scenario performed and shown above in Figures 4-12 through 4-15 Note: inundation in feet, zero = current 1% flood zone



5 CONSIDERING THE OPTIONS-WATERSHED MANAGEMENT GOALS AND OBJECTIVES

5.1 The Vision: Catalyst for Connecting Communities and Celebrating Place, History, Nature, and Culture

Public access to Three Mile Creek for recreational purposes is currently limited, but recreation could serve as an interconnecting element linking a number of man-made and natural destinations within the Cities of Mobile and Prichard. Thoughtful planning could turn this degraded resource into a restored urban amenity that celebrates its people, area, history, nature, and community. It could also reconnect the communities to Three Mile Creek by providing them access to extraordinary green space in the middle of an existing urban community. Providing public access along a restored landscape would allow residents and visitors to celebrate, relax, walk, run, paddle, fish, enjoy a historic environment, and enjoy nature.

Three Mile Creek could once again be a unique amenity for the Cities of Mobile and Prichard and could provide an authentic sense of place for both tourists and residents. It offers an opportunity for this community to have a distinct ecotourism destination.

5.2 Decision Framework

5.2.1 Goals and Objectives

Input gathered from numerous sources including residents, stakeholders, and the results of earlier studies were used to shape the following goals and objectives.

Water Quality Issues Observed During Dewberry Team Research and Field Trips

- Low oxygen levels
- Excessive nutrients levels
- Excessive pathogens present
- Trash
- Subsistence fishing in areas of poor water quality

Safety Concerns Noted at Public Meetings

- Water quality concerns due to pollution
- Lack of access to creek
- Structural challenges for non-motorized boating
- Safety of fish caught and consumed
- Lack of boat launches
- Lack of fishing piers
- Poor lighting
- Safety

Three Mile Creek Steering, Technical and Engagement Committees

- Water quality
- Restoration needs
- Lack of access

Proposed recreation ideas in other studies (See Section 3.1.11.1)

- Picnic areas
- Rest areas
- Water fountains
- Bike racks
- Greenway

Climate Adaptation ideas

- Areas of protection
- Areas of conservation
- Areas of relocation
- Evacuation and other adaptation planning

All of the above input was considered to create the goals below.

Goals of Three Mile Creek WMP

1) Improve water quality
2) Provide access to resources
3) Protect and improve the health of residents, fish and wildlife
4) Restore heritage and cultural connection between the watershed and the community
5) Plan and prepare for climate resiliency

To reach these goals, the following objectives were developed:

Objectives of Three Mile Creek (matched with associated Goals):

1) Develop 12.3 miles of continuous greenway and restore natural channels and riparian buffer where feasible (Goal 2)
2) Develop a strategy for implementing TMDLs in coordination with ADEM (Goal 1 & 3)
3) Achieve state water quality standards for warm water fisheries (Goal 1 & 3)
4) Eliminate all known illicit connections/sanitary inputs (Goal 1 & 3)
5) Reduce amount of trash in waterways by 75% (Goals 1,3 & 4)
6) Maintain design level of service for flood protection from USACE dams (Goal 5)
7) Install environmental education signage in six existing or proposed parks (Goals 1-5)

5.2.2 Prioritization Process of Management Measures and Recreation Projects

The Dewberry Team developed a list of recommended structural and non-structural BMPs and recreation projects to satisfy the management plan objectives and address EPA's 9 Elements of a Watershed Plans. The BMPs were selected to address the primary causes of degradation in the watershed identified during the Dewberry Team field visits; in the TMDLs; and in other previous studies on Three Mile Creek.

The recreation projects were selected to enhance access to the Creek and raise the overall awareness of water quality in the watershed. Therefore, where feasible, the recreation projects are combined with BMP activities and include public education components. As BMPs are successfully implemented in the various segments of the watershed and water quality improves the opportunity exists to remove the plug separating the Three Mile Creek channel and the historic stream near One Mile Creek creating a kayak circuit on the blueway in the lower watershed.

The list of recommended BMPs was then provided in a ranking matrix layout to the Technical Committee at the September 2013 meeting. The matrix included general information on the intended water quality target of each BMP and whether the BMP would likely contribute to the City's ability to meet NPDES or TMDL goals. The Technical Committee members were each asked to rank all projects from high to low priority. To gather a robust response to present to the Steering Committee the next month, the MBNEP and Dewberry Team created and disseminated an online survey similar to the matrix. This survey consolidated the original project information and limited the response to identify and rank only the top five projects. The survey also provided a vision statement and a definition of success along with instruction for responding. The survey and its results are included in Appendix F. A discussion of how the results were used in the final recommended project implementation is provided in Section 6.

5.2.3 EPA's Nine Elements Of A Watershed Management Plan Cross Walk (319)

Table 5-1 Provides a quick reference where each of EPA's 9 Elements of a Watershed Plans are addressed in this WMP.

EPA's 9 Elements of a Watershed Plans	Three Mile Creek WMP Reference Site	Page No. (s)
A. Identification of causes of impairment and pollutant sources or groups of similar sources that need to be controlled to achieve needed load reductions, and any other goals identified in the watershed plan.	**Section 3** discusses existing water quality impairments and potential sources of impairment for the Three Mile Creek watershed. **Table 3-50b** lists all current TMDLs and Delistings.	Pg. 119
B. An estimate of the load reductions expected from management measures	Structural BMP removal efficiencies ranges are shown in **Appendix H** for TSS, TN and TP. Other targeted removal efficiencies such as those for pathogens are either sources dependent or design specific and therefore will be determined in the Implementation phase of the WMP when load allocation modeling is completed.	Appendix H

EPA's 9 Elements of a Watershed Plans	Three Mile Creek WMP Reference Site	Page No. (s)
C. A description of the nonpoint source management measures that will need to be implemented to achieve load reductions in paragraph 2, and a description of the critical areas in which those measures will be needed to implement this plan.	**Section 6** addresses non-structural and structural BMPs recommended for implementation in the watershed. These include NPS management measures to control stormwater runoff and improve water quality.	Pg. 190
D. Estimate of the amounts of technical and financial assistance needed, associated costs, and/or the sources and authorities that will be relied upon to implement this plan.	The tables included in **Section 6 and 7** address the costs of implementing the recommendatins of the WMP.	Pg.177 Pg.299
E. An information and education component used to enhance public understanding of the project and encourage their early and continued participation in selecting, designing, and implementing the nonpoint source management measures that will be implemented.	Recommended non-structural BMPs (4NS, 5 NS, 7NS, 11NS and 12 NS) in **Section 6** specifically target public education and public involvement. These are included as part of the 1st priority project listed in **Table 6-12**. In addition, **Section 8** provides a detailed Public Engagement Plan for the implementation of the WMP.	Pg.194 Pg.223 Pg.244
F. Schedule for implementing the nonpoint source management measures identified in this plan that is reasonably expeditious.	**Table 6-12** includes a specific implementation schedule for the priority projects. Phase II projects and future project prioritization for the 10 year implementation period are discussed in **Appendix H**.	Pg.223
G. A description of interim measurable milestones for determining whether nonpoint source management measures or other control actions are being implemented	**Table 6-12** includes a specific milestone, where appropriate, for implementation of the priority projects. The role of Adaptive Management in determining future milestones is discussed in **Appendix H** and **Section 9** discusses Adaptive Management principles.	Pg.223 Pg.254
H. A set of criteria that can be used to determine whether loading reductions are being achieved over time and substantial progress is being made toward attaining water quality standards	The TMDL load allocations and percent reduction requirements are shown in **Table 3-50b**. More specific discretized targets will be developed when load allocation modeling is completed.	Pg.119
I. A monitoring component to evaluate the effectiveness of the implementation efforts over time, measured against the criteria established under item h immediately above	Monitoring is discussed **Section 6, Appendix H** and as part of Adaptive Management in **Section 9.**	Pg.177 Pg.253

5.3 Convergence of this WMP and MBNEP's Comprehensive Conservation and Management Plan (CCMP)

Section 320 of the CWA calls for each EPA national estuary program to develop and implement a CCMP. A CCMP is a long-term plan that spells out specific targeted actions designed to address water quality, habitat, and living resource challenges in an estuarine watershed.

The *2013 to 2018 CCMP for Mobile and Baldwin Counties* incorporates scientific assessments of the greatest stressors occurring on marine and wildlife habitats in the estuary and is based on what residents in coastal Alabama value most: Water, Coastlines, Access, Fish, Heritage, and Resiliency.

Figure 5-1 CCMP Values

The Three Mile Creek watershed is located within the larger Mobile Bay watershed. Many of the values and objectives outlined in the Three Mile Creek WMP align with the values and objectives of the CCMP. For example, a significant number of the recommended projects in Section 6 of the WMP are focused on improving water quality and providing increased access to the creek. Improved water quality will benefit biological life, including fish. Three Mile Creek also experiences stressors similar to those the Mobile Bay estuary faces – invasive species, stormwater runoff carrying pollutants such as nutrients and pathogens, and increased intensity of storms causing erosion – particularly along creek banks.

The 2013 to 2018 CCMP should be consulted frequently during implementation of the Three Mile Creek WMP to ensure consistent and continual alignment of both plans' values and objectives.

The CCMP can be found online at http://www.mobilebaynep.com/what_we_do/ccmp/.

5.4 Regulatory Environment

5.4.1 Regulatory Drivers and Constraints

The regulatory framework that applies to Three Mile Creek includes several layers of requirements from local, state and federal agencies. These regulations can be grouped into two primary types: 1) those that govern the current activities in the watershed (i.e., compliance with NPDES permitting) and drive the restoration effort (i.e., meeting state water quality standards); and 2) those that govern specific project implementation such as stream restoration and stormwater retrofits (i.e., compliance with ADEM and City construction requirements for BMP projects). These are explained in greater detail below.

5.4.1.1 Watershed Restoration Drivers

The primary regulatory requirements governing the current activities in the watershed and driving the restoration effort include:

- USFWS regulatory requirements;
- FEMA floodplain development standards;
- Compliance with USACE flood management and environmental requirements as necessary;
- ADEM NPDES municipal separate storm sewer system (MS4) permits which regulate stormwater discharges for the entire watershed (286 outfalls discharge to surface waters in this watershed) and upcoming changes to the EPA NPDES MS4 program expected to be final in 2014;
- ADEM NPDES Municipal and Industrial Permits (See table 5-2)
- ADEM state groundwater and surface water quality standards;
- TMDLs for Three Mile Creek, TSB, and UTTM;
- ADCNR/ADEM coastal management concurrence; and
- County of Mobile, City of Mobile and City of Prichard permitting and zoning issues.

There are two additional minor regulatory drivers: NPDES Industrial General Permits for specific facilities and NPDES Construction General Permits for active construction sites. These permits require industrial and construction sites to capture pollutants, such as sediments, to water bodies which would otherwise leave the sites via storm runoff and pollute local waters.

Although listed as minor drivers, it is critical for ADEM and the City of Mobile to enforce the requirements of these NPDES permits to prevent pollutants from entering the creek. The City of Mobile is the local issuing authority for land-disturbing permits and is therefore responsible for ensuring construction erosion and sediment controls are properly implemented and maintained.

Table 5-2 Active NPDES Permits in TMC Watershed (individual permits, general permits or construction permits listed in EPA's Envirofacts PCS system

Permit #	Facility Name	Address	City	Latitude	Longitude
AL0047651	BULK MATERIAL HANDLING PLANT	2010 ALABAMA STATE DOCKS BLVD	MOBILE	30.67633	-88.0671
AL0001104	CAVENHAM FOREST INDUSTRIES, LLC	SOUTH END HERBERT STREET	MOBILE	30.73044	-88.0492
AL0002801*	MOBILE MILL	200 BAY BRIDGE ROAD	MOBILE	30.73433	-88.0482
AL0003603	MOBILE PAPERBOARD CORP	701 MOBILE ST	MOBILE	30.71381	-88.1032
AL0027502	MOBILE ROSIN OIL CO INC	2469 BRAGDON AVE	MOBILE	30.71875	-88.105
AL0056316	NEXEO SOLUTIONS LLC	701 WESTERN DRIVE	MOBILE	30.71147	-88.1148
AL0000710	SCOTCH AND GULF LUMBER LLC	1850 CONCEPTION STREET	MOBILE	30.722	-88.0698
AL0023205*	CARLOS A MORRIS WWTP	54 GROVER STREET	PRICHARD		
AL0023094*	WRIGHT SMITH, JR. WASTEWATER TREATMENT FACILITY	1879 CONCEPTION STREET ROAD	MOBILE		
ALG180014	ASM RECYCLING INC	2751 MCKINNEY STREET	MOBILE	30.70722	-88.1061
ALG140089	CSX TRANSPORTATION	INDUSTRIAL CANAL ROAD	MOBILE	30.72547	-88.0494
ALG140433	INDUSTRIAL CHEMICALS INC.	3212 CRICHTON STREET	MOBILE	30.70806	-88.1181
ALG340539	JOHNS MINI MART	HERNDON OIL JOHNS MINI MART	MOBILE	30.6975	-88.1042
ALG030027	MOBILE SHIPBUILDING & REPAIR	1920 BAY BRIDGE CUTOFF ROAD	MOBILE	30.72806	-88.0604
ALG340278	PLAINS MARKETING LP	MAGAZINE POINT	MOBILE	30.73105	-88.0559
ALG250033	UNIVERSITY OF SOUTH ALABAMA SPRINGHILL	307 N UNIVERSITY BLVD	MOBILE	30.69595	-88.1737

Historically, the ADEM NPDES Wastewater Permits for two municipal wastewater treatment facilities (Wright Smith Jr. WWTF (12.8 MGD) and City of Prichard Carlos Morris WWTF (4.1 MGD)) were the primary water quality drivers in the Three Mile Creek watershed. Now that both of these point source discharges are scheduled to be diverted to a different watershed, their discharges should no longer impact Three Mile Creek water quality. While this reduces pollutant loads to Three Mile Creek, there is a concern about the reduction in freshwater flow to the creek from the two facilities and how it will affect water quality in the lower, brackish portion of the creek.

The MBNEP's Draft *2013 to 2018 Comprehensive Conservation and Management Plan* has established a multitude of actions to protect Coastal Alabama and should be consulted consistently during implementation of the WMP to ensure alignment of goals. The CCMP was structured around six community values: access; coastlines; fish; heritage; resilience; and water quality.

Finally, groundwater concerns associated with the Hickory Street Landfill and Mobile Coal Gasification Plant need to be explored further through testing and analysis to determine if any groundwater remediation might be require.

5.4.1.2 Project Implementation Drivers

The second component of the regulatory framework relates to the permits required to construct potential stormwater BMPs or ecological restoration projects proposed in the WMP. It will be very important with each and every restoration project to meet with local, state and federal permitting entities early in the planning process to identify all required permits and project permit application requirements. A more detailed discussion is presented in Appendix G.

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6 WATERSHED RESTORATION MANAGEMENT MEASURES

6.1 Challenges in the Three Mile Creek Watershed

In previous sections, we have defined the challenges facing Three Mile Creek and identified the goals and objectives for restoring the watershed. This section not only explores the range of project options and costs for consideration in restoring Three Mile Creek, identified earlier as BMPs, but it also provides the Dewberry Team's strategically selected, phased approach for restoration.

In this Section we will discuss each of the challenges facing Three Mile Creek and identify what BMPs can be implemented to address the issue and achieve the goals and objectives set forth in Section 5. The Dewberry Team developed a list of recommended management measures which are grouped based on the challenge they address. Challenges 1-3 which are focused on water quality are addressed by non-structural measures (e.g., education, outreach, code enforcement, street sweeping, planning and field investigations) and structural measures (e.g., swales, treatment ponds, LID/GI practices, channel bank stabilization and dredging); challenge 4, recreation, is addressed by providing blueways and greenways and improving access opportunities to the Creek; and challenge 5, climate adaptation, is addressed by long-range sustainability projects (e.g., tidal monitoring, tidal marsh restoration and beneficial use of dredged material). A full listing of potential BMPs recommended for the Three Mile Creek watershed is included in Appendix H along with planning level costs.

6.1.1 Stormwater

The **effects of stormwater runoff** in Three Mile Creek include excessive loadings of trash/litter, nutrients, Oxygen-demanding substances, and pathogens to the creek during wet weather. Stormwater runoff collects these contaminants while draining across paved areas and directly discharging into stormwater pipes, channels or streams. Once these pollutants are in Three Mile Creek they produce elevated nutrient and pathogen levels and low DO concentrations. Low DO concentrations reduce the abundance and health of all aquatic organisms in the creek and tributaries, from benthos to fish. Elevated nutrients and pathogens in the creek can also affect human health and welfare by making the water unsafe for human contact and producing algal blooms that limit recreation.

6.1.2 Wastewater

Wastewater related issues in Three Mile Creek include **Illicit connections and SSOs**, primarily in tributaries and near the downstream end of the Creek from groundwater seepage and direct sanitary discharges; **excessive water quality pollutants**, particularly pathogens, and **potential groundwater contamination** from the Hickory Street Landfill and the Mobile Gas/Sempra remediation site. Wastewater and contaminated groundwater pollutants discharging to Three Mile Creek produce elevated pathogen levels. These pathogens can have negative impacts on the health of aquatic organisms in the creek and tributaries and can also affect human health and welfare by making the water unsafe for human contact.

6.1.3 Ecology

Shallow water environments are vital to the coastal community, providing an enormous mix of ecological value. In Three Mile Creek the tidal and brackish habtitats exist below the first USACE weir near Dr. Martin Luther King Jr. Avenue where channel widening and straightening substantially **altered the creek geomorphology and watershed hydrology**. A blockage at the top end of the historical channel has lead to an **abundance of invasive species and aquatic vegetation** concentrated in this area of the Creek. This loss of connection for the historical channel removed the cleansing and nutrient assimilation potential of the woody wetland habitat that would othewrwise benefit water quality in Three Mile Creek. Through the length of the USACE weir system channel deepening disconnected the Creek from its floodplain. In the upstream areas of the watershed the intrusion of urban landuse has reduced or eliminated the riparian buffer vegetation with mowed lawns up to the stream bank thereby removing the natural cleansing of runoff flowing through vegetation. These conditions contribute the reduced water quality, impact the the abundance and health of all aquatic organisms in the creek and tributaries and eliminate potential nusery habitats throughout the watershed.

6.1.4 Access

Lack of recreational access to the creek limits human interaction with the environment and reduces the awareness of the water quality and habitat issues that persist with Three Mile Creek. Physical constraints such as weirs and gabion walls are a deterent to water sports such as fishing and kayaking establishing further barriers to access.

6.1.5 Climate Adaptation

Three Mile Creek includes coastal and upland habitats that are being impacted by increasing developmental pressures. These natural and human uses of the watershed are challenged by climate change. **Changing sea levels** will alter the balance and distribution of native habitats in the watershed and an **increase in the frequency and intensity of storm events** will result in higher the tidal surges impacting infrastructure. Longer periods of warmer temperatures will generally increase the length of the growing season making control and removal of invasive vegetation more costly. This combined with reduced stream flows in the summer months will also lead to higher ambient stream temperatures and reduced DO concentrations impacting fish health and reproduction.

6.2 Solutions to Address Challenges

In previous sections, we have addressed the challenges facing Three Mile Creek and identified the goals and objectives for restoring the watershed. This section not only explores the range of project options and costs for consideration in restoring Three Mile Creek, identified earlier as BMPs, but it also provides the Dewberry Team's strategically selected, phased approach for restoration.

Section 5 began with a brief summary of the established goals and objectives. Section 6 will now discuss the types of solutions and associated costs in the following order:

- Non-structural BMPs (including educational signs)
- Structural BMPs (including LID/GI solutions)
- Long-range sustainability project solutions
- Recreation Opportunities

A short sub-section discusses the correlation between the presented structural and non-structural BMPs to the management measures currently listed in the City of Mobile's stormwater permit, and the TMDLs issued for the watershed.

The solutions are presented in three different ways:

- We first establish the requirements associated with different solutions for the different geographic segments in the watershed. Many of the solutions are geographically specific and do not apply watershed-wide.
- The recommendations from the Dewberry Team, in concert with the priority BMPs selected by the Technical Committee, are then presented.
- Lastly, the Dewberry Team's recommended approach for achieving the WMP goals and objectives from Section 5 is revealed, with recommendations for priotity projects. This approach is based on the total information provided to us since the inception of this project and provided in this WMP thus far.

All BMPs and solutions focus on the improvement of water quality, biological habitat, access and climate adaptation.

6.2.1 Goals and Objectives Summary

Many of the goals and objectives identified in Section 5 are interrelated, particularly the goals and objectives focused on improving water quality.

Achieving state water quality standards for warm-water fisheries (Objective 3) is dependent on eliminating illicit connections/sanitary inputs and reducing the amount of trash in waterways (Objectives 4 and 5). It is also dependent on reducing non-point source pollutant loads (Objective 2) to the surface water system. Non-point source pollutant loads are specifically identified in watershed TMDLs as one the primary remaining pollutant sources (once the two wastewater facility discharges are removed from entering the creek) for oxygen-demanding substances, nutrients, and pathogens. Restoring the natural hydrology of the watershed, restoring riparian buffers, and eliminating exotic species will also benefit both surface water quality and habitat.

During the implementation of the recommended BMPs, another essential objective is to eliminate flooding in the watershed by maintaining the drainage and surface water system design level of service for flood protection (Objective 6). If achieved, this will also benefit public safety and protect property.

Another primary objective of this WMP is developing a continuous greenway (Objective 1) adjacent to Three Mile Creek. The idea of a continuous greenway and the associated recreational opportunities it provides was one of the public's most requested watershed plan elements. We believe the construction of a greenway will also improve water quality. The construction of a greenway trail will draw people to the area. The exposure of more residents and visitors to the watershed may increase the public's appreciation for Three Mile Creek and create additional support for its restoration. As public awareness rises, particularly through the development of greenway space, so does the opportunity to further educate the public on the threats to Three Mile Creek's health and the importance of supporting long-term restoration efforts. A greenway will provide an array of opportunities for environmental education, including posting of educational signs along the trail (Objective 7).

6.2.2 Types of Solutions for Restoration Success

To begin preparation of the implementation strategy, the Dewberry Team developed a list of recommended structural and non-structural BMPs to achieve the WMP goals and objectives for Three Mile Creek (see Tables 6-1 and 6-2). This list of solutions specifically targets the primary causes of degradation identified in the Three Mile Creek Watershed Assessment discussed in Section 3.

The Dewberry Team also requested the input of the Three Mile Creek Technical Committee members on BMP projects. In September 2013, the Dewberry Team presented the findings of the Watershed Assessment and BMP recommendations and requested that the Technical Committee provide their input on prioritizing the list of structural and non-structural BMPs. The Dewberry Team and MBNEP prepared and disseminated a web survey to solicit input from the Technical Committee. The Technical Committee's final prioritized list of the top six BMPs was approved by the larger Steering Committee in October 2013. The final list of BMPs is presented in the sections below.

As noted in Section 1, it is anticipated the MBNEP will implement the WMP over a 10-year period and will likely rely on a variety of funding sources and partnerships. Therefore, the Dewberry Team recommends a phased implementation of the suggested BMPs. This not only allows for flexibility in responding to available funding, but it also supports an adaptive management approach where assessment of successes and failures of completed phases informs implementation of future phases. As discussed both earlier and later in this section, the Dewberry Team worked with MBNEP to determine the areas best suited to implementation of the priority projects. These priority projects will be the first to be completed and monitored to evaluate the benefits and start the adaptive management process that will take place throughout the WMP implementation.

The priority projects are intended to serve as exhibitions for initial restoration efforts in Three Mile Creek. The priority projects were selected based on the severity of water quality degradation; the potential for water quality and habitat improvement close to downtown; and the ease of greenway connectivity and to have each segment of the watershed represented. Once the priority projects are completed, monitoring will be needed to assess the success of the restoration activities and greenway and blueway segments before additional restoration phases are finalized. Structural BMP operation and maintenance requirements and costs can also be refined during this time. The success of the greenway and blueway segments will be determined by public acceptance and use. Lessons learned can be applied to the implementation of future restoration phases using an adaptive management approach as dicussed in Section 9. Recommendations for future projects that further address the goals and objectives of the WMP are presented in Appendix H.

6.2.3 Recreation Opportunities

6.2.3.1 Improved Connectivity and Circulation (A Connected Greenway and Blueway Network)

Three Mile Creek offers a unique opportunity to create a more interconnected area along its banks with longer stretches of trails for walking, running, picnicking, and cycling, while also providing additional access for recreational water sports. It could serve as the setting for an extensive blueway and greenway system connecting many different destinations and attractions within the cities of Mobile and Prichard. The blueway, a habitat-rich historic and scenic stream corridor and greenway systems could initially be anchored by the existing facilities at USA and Langan Park to the west and potential reuse of the Hickory Street Landfill site for a park, to the east. The total potential greenway trail length from Cody Road to Hickory Street Landfill is 12.7 miles (see Figure 6-1). However, nearly 75% of the land on this route would potentially require easements. The corridor and immediate surroundings are rich in history, culture, and environmental amenities.

6.2.3.2 Shared-Use Trail

The Mobile County Bicentennial Bicycle & Pedestrian Comprehensive Plan provides a typical section design that is appropriate for this WMP. The Plan envisioned a shared-use greenway trail along Three Mile Creek (see Figure 6-2) that captures common trail design parameters, including a trail to provide access to those with disabilities in accordance with the Americans with Disabilities Act (ADA). The recommended trail width is 10 feet (12 to 14 feet is recommended if heavy bicycle use or maintenance vehicle use is anticipated) and a 2-foot graded shoulder (1' vertical: 6' horizontal maximum slope). Where improved connectivity and circulation opportunities require the introduction of new impervious surface to the watershed consideration should also be given to incorporation Low Impact Development (LID) and Green Infrastructure (GI) practices, such as permeable pavement, stormwater capture and minimization of impervious surfaces, to mimic the predevelopment environment of these areas and lessen stormwater impacts to watershed should also be considered. This also provides opportunities to tie together different WMP goals such as improving water quality, providing public education and improving public access. Stormwater Parks provide a unique setting where measures being taken to improve water quality are incorporated into a publicly accessible area where visiting residents can be engaged through educational signage on technical or historical information. Stormwater parks have been successfully utilized in many locations such as Florida's Indian River Lagoon and Charlotte Harbor areas.

Figure 6-1 Proposed trail from the City's Tricentennial Green Space master Plan that would run wesward from Conception Street and end at Langan Park.

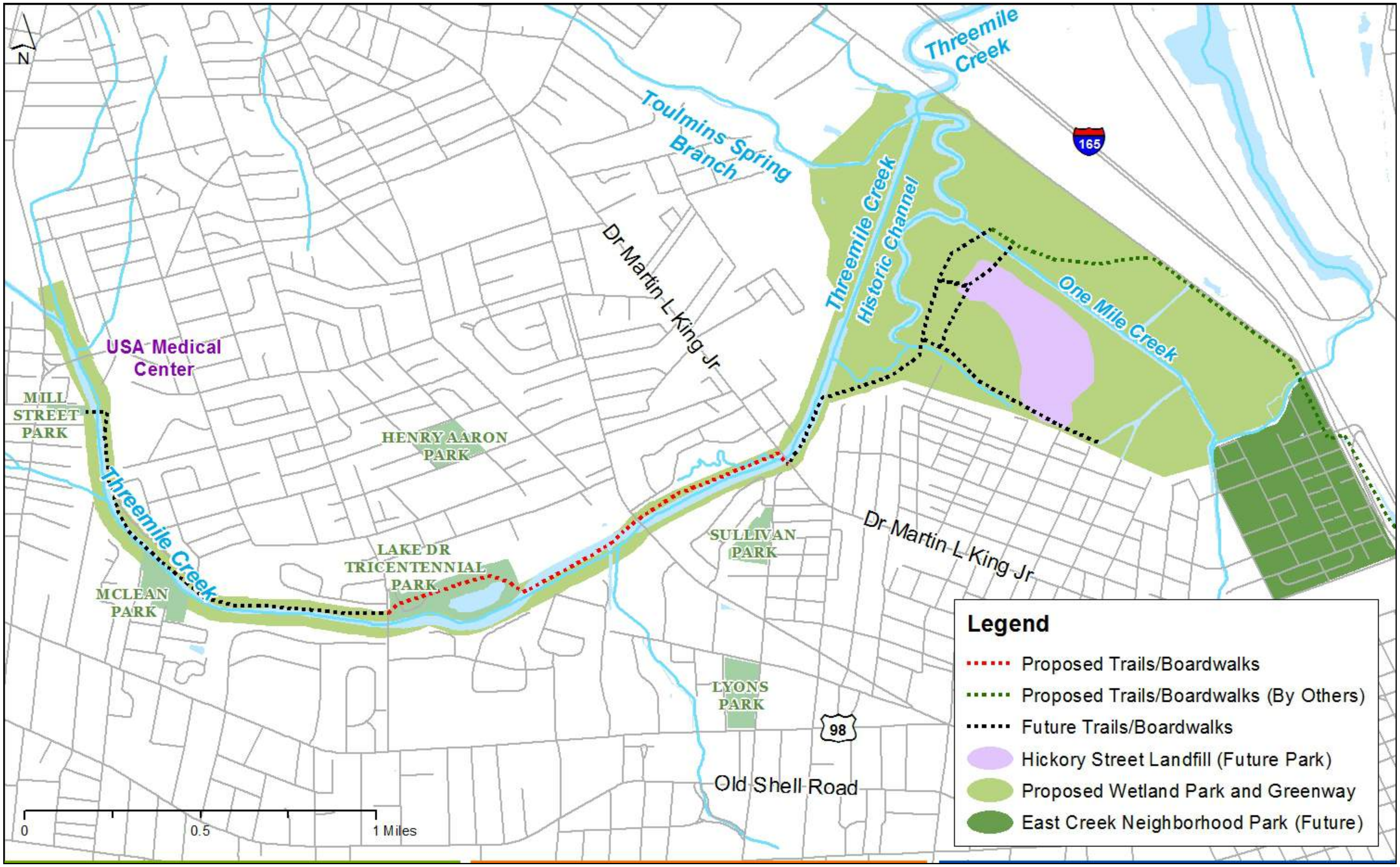
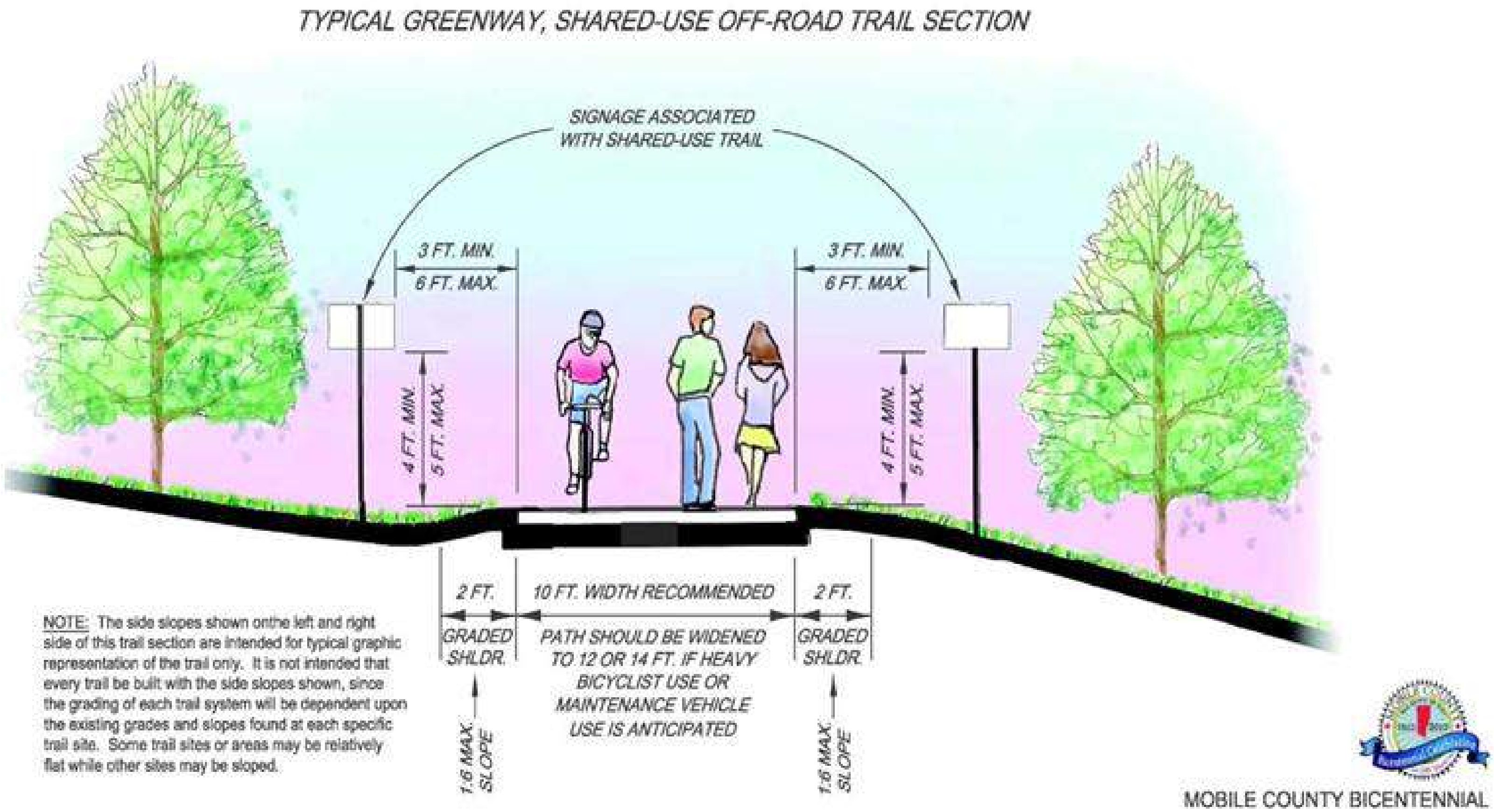


Figure 6-2 Typical greenway, shared use off road section for a trail along Three Mile Creek, from the Mobile County Bicentennial Bicycle & Pedestrian Comprehensive Plan.



Signage should be kept a minimum of 3 feet from the paved path and a maximum of 6 feet away. The City of Mobile's Parks and Recreation Department, per the City's Tricentennial Green Space Master Plan (2002), proposed a trail that would run westward from Conception Street and end at Langan Park. This trail could accommodate walking, running and cycling (see Figure 6-1). Much of this trail alignment is appropriate for this WMP.

Trail furnishings and amenities could include:

- Environmentally appropriate trail surface
- Benches
- Trash receptacles
- Boardwalk fishing areas
- Bicycle racks
- Lighting
- Signage – (historical markers, descriptions of habitat and wildlife, directions)
- Mile markers
- Shade trees and enhancement plantings

6.2.3.3 Blueway Trails

Three Mile Creek offers a unique ecotourism opportunity for kayaking, canoeing, and other use by small, non-motorized water vessels. As noted in Figure 6-1, there are two potential zones for water-based recreation. The zones are separated by the last downstream weir located near McLean Park. In the lower reaches of Three Mile Creek, the tidal influence downstream (east) of this weir provide enough water volume and low velocity for less skilled boaters.

An advanced urban kayak course in the upper reaches of the creek would provide another unique ecotourism destination. This course could start at Langan Park's Japanese Garden and end close to the last weir near McLean Park. For advanced kayakers, spillway chutes, riprap, rock rapids and multiple weirs provide elevation change and potential hazard challenges within the western segment of Three Mile Creek. Some local kayakers have already successfully navigated this segment, albeit with the challenge of a few portages. A successful course would require some modifications to the existing control structures to create easier portages.

Other portions of Three Mile Creek offer some excellent opportunities for canoes, kayaks and small vessels, especially at the historic scenic streamway just west of I-165 (see Figures 3-30a through 3-30d). The streamway is a habitat-rich, forested wetland with a broad diversity of marine and freshwater species. This area could be better utilized for water recreation. When Three Mile Creek was channelized as a result of flooding concerns, accumulation of silt left the streamway isolated from southern access. This siltation barrier, known as the "plug," impacts about 1,800 feet of productive stream habitat running through forested wetlands. However, restoration of this segment through sediment removal could provide a continuous two-mile circuit for paddlers (See Figure 6-1).

There are a number of potential locations for non-motorized boat launches. Each of these locations will need to be more closely evaluated to ensure they can be developed in compliance with USACE, FEMA and municipal regulations. The suggested locations for non-motorized boat launches (identified on the Opportunities and Constraints Map - See Figures 3-30a through 3-30d for exact location) are:

- Conception Street (private land, this site is currently being used by the public to launch kayaks)
- North end of Lawrence Street (private land)
- Dr. Martin Luther King Jr. Avenue (public land)
- Lake Drive at Tricentenial Park (public land)
- Near I-65 (private land, advanced kayak access only)
- Springhill Avenue near Langan Park (public land, advanced kayak access only)

Figure 6-3 Development of Blueway and Greenway Systems along Three Mile Creek would offer opportunities to connect people with watershed restoration achievements

A site near Dr. Martin Luther King Jr. Avenue might be a preferred alternative due to the ease of access. A plan to include an on-road bikeway on this street is being considered by the City of Mobile in its Tricentennial Green Space Master Plan.

6.2.4 Ecotourism Opportunities

Three Mile Creek is rich in history and has many interesting stories to tell. The history of Three Mile Creek and the City of Mobile's relationship with this natural resource could be further catalogued for preservation and celebrated along the corridor in an assortment of ways beyond informational signs throughout the area. A welcome kiosk providing maps, signs (including braille as well as language translations), historical information and first aid resources could greatly benefit to Three Mile Creek. Locating this welcome kiosk near Dr. Martin Luther King Jr. Avenue could provide good visibility for the Three Mile Creek, close access to a number of historical sites and easy access to the historic and scenic streamway. Another potential location for a welcome kiosk would be next to a potential future park near the former Hickory Street Landfill. Through the development of this WMP, the Dewberry Team identified additional information regarding Three Mile Creek's environment, heritage and history, all which should be utilized to promote its visibility. Below is a list of additional potential amenities.

- Cultural Themes for Eco-heritage Tourism:
- Baptisms in Three Mile Creek
- Horse races along the banks
- Local waterways serving as social gathering sites
- Hotels along the banks
- African-American Heritage Trail Connection
- Historical Themes for Eco-heritage Tourism
- History of drinking water in the City of Mobile
- Three Mile Creek: From natural to sewer/storm conveyance to restoring natural function
- History of the area known as "the plug" and restoration efforts
- Historic sites near Three Mile Creek

"Timeline" trail theme that tells the history of man's connection with Three Mile Creek. The sequence could begin on the west end and go back in time as one travels east on the trail toward downtown and the forested wetlands near the bay
Bicycle, kayak and canoe rental shops could provide recreational vehicles for those who do not own them and could be a potential source of funding for the City. This money could be reinvested into the area for Creek trail and park maintenance. A renewed and enhanced Three Mile Creek would improve the quality of life of residents, benefit the local tourism industry and stimulate

economic growth. Each of these facilities will need to be more closely evaluated to ensure they can be developed in compliance with USACE, FEMA and municipal regulations.

- Picnic areas
- Fishing piers
- Boat launch for increased public access
- Drinking fountains
- Benches in shaded areas
- Advanced kayak shuttle (at Langan Park)
- Restrooms
- Parking lots
- Interpretive signage

6.2.5 Best Management Practices (BMPs) and Costs

A list of all recommended BMPs to achieve the watershed plan objectives was developed based on the specific needs identified in the previous sections and is presented in the sections below. These recommendations included both structural BMPs and non-structural BMPs. Structural BMPs are engineering solutions for managing stormwater, such as sediment boxes to improve water quality by preventing litter and sediments from entering a water body. Non-structural BMPs do not have physical structures, but instead are actions or activities that improve watershed conditions, such as enforcement of regulations, additional field studies, or education efforts.

6.2.6 Non-Structural BMPs & Signs

Non-structural BMPs considered for this watershed include:

- Field studies to identify non-stormwater pollutant sources such as groundwater contamination
- Mapping of creek and tributary bathymetry to determine the depth of residual sediments on the creek bed
- Researching potential partnership funding for BMP implementation by private land owners
- Enhanced management (removal) of non-native invasive species along with general street and land management practices

(trash collection)

- Field observations to locate and address other pollutant sources such as illicit wastewater discharges or sediment discharges from construction sites
- Placement of watershed awareness signage, educational signs, and placards
- Additional environmental education and public outreach
- Additional field monitoring and laboratory analyses of groundwater and surface water quality

During the development of this WMP, the Dewberry Team and members of the Technical and Steering Committees had the opportunity to observe a field test of a water craft specially fabricated to address a number of water quality challenges faced by Three Mile Creek, including vegetation management, dredging, and floatable debris removal. John Farrell with Florida Aquatic Lake Management presented the pontoon-based Truxor Amphibian Toolcarrier (See Figure 6-4) and gave a video presentation of a similar boat-mounted unit called the Conver (See Figure 6-5). The supporting equipment such as trailer and additional tools are optional for these units. The MBNEP is pursuing a cost share for purchasing and operating a combination of these units with the Alabama Port Authority. Therefore, the purchase and use of boats and/or amphibious vehicles for collection of trash, sediment, and excessive vegetation is also included as a non-structural BMP.

Figure 6-4 Truxor Amphibian Toolcarrier facilitates shoreline vegetation management and floating debris removal (http://flaqlm.com/harvester_boats.html)

Figure 6-5 The Conver boat is well suited for shallow water vegetation removal and dredging (http://flaqim.com/harvester_boats.html)

Another non-structural BMP is the design and placement of watershed signs. Signs can be used in a variety of ways in the Three Mile Creek restoration effort to engage and educate the public with the goal of encouraging a feeling of ownership of its restoration. In August 2013, the MBNEP and Mobile County worked together to create, manufacture, and post 12 signs along prominent transportation corridors around the perimeter of the TMC watershed (see Figure 6-6 for sign design and Figure 6-7 for locations) to inform people they were entering the Three Mile Creek Watershed. Installation of environmental education signage is a specific objective listed in Section 1.

Figure 6-6 The design of the sign was intended to raise awareness of Three Mile Creek Watershed and water quality issues.

Figure 6-7 Educational signage was installed on prominent transportation corridors around the perimeter of the TMC watershed.

Because non-structural BMPs do not require construction, the cost to implement them is typically much lower than structural BMPs. **The total estimated planning level cost for implementing non-structural BMPs in the Three Mile Creek watershed is $5M to $14.5M over 10 years (see Table 6-1).**

Although the non-structural costs are distributed over 10 years, it is possible to accelerate BMP implementation if additional funding can be secured. In addition, costs are projected for only the first 10 years. There will be recurring costs beyond the 10-year time frame, including maintenance and equipment replacement.

Table 6-1 Dewberry Team Recommended Non-Structural BMPs and Planning Level Costs for the Three Mile Creek watershed

Measure Identification Number	Non-Structural BMP Activity Description	Quantity	Unit Cost ($)	Total Cost ($)
1NS	Field studies and inspection: Identify and remove sanitary system and septic system leakage/overflows into groundwater, creeks and tributaries. Focus on TSB and CEN sub-basins and lower portion of watershed.	Study only; estimate 133 miles along the sewer system (mi)	$5,000-$50,000/mi	$665,000-$6,650,000
2NS	Field studies and inspection: Identify and remove illicit discharges to stormwater and surface water system in watershed. Focus on TSB and CEN and lower portion of watershed.	Study only; estimate 11.2 sq. mi.	$35,000-$50,000/sq.mi.	$390,000-$560,000
3NS	Develop map of current creek and tributary bathymetry and determine physical and chemical characteristics identified in Data Gaps; assess normal water depths; select locations for sediment removal.	30pts/mi. @ 46 mi. of stream	$1,600-$2,500/mi	$74,000-$115,000
4NS	Partner with private land owners to disconnect impervious areas/ install Green Infrastructure projects; provide grants for installation of green infrastructure BMPs on private property.	Assume 1% of pop. or 100 projects	$5,000-$20,000/project @ 50% cost share	$500,000-$2,000,000
5NS	Partner with private land owners to revegetate or stabilize upland areas in watershed to reduce erosion and loss of other materials; provide grants/incentives for revegetation of disturbed eroding areas on private upland land.	Assume 5% of area or 1,000 acres (ac)	$1,000-$2,500/ac @ 50% cost share	$1,000,000-$2,500,000

Measure Identification Number	Non-Structural BMP Activity Description	Quantity	Unit Cost ($)	Total Cost ($)
6NS	Map SAV in watershed and Improve management of exotic/nuisance vegetation in wetland and upland riparian areas adjacent to creek and tributaries; develop plan for long term management.	Assume 10 mi. of stream @ avg 30 ft wide = 36 acres	$3,500-$7,000/ac	$126,000 – $252,000
7NS	Continue intense education and outreach program; partner with schools, churches and community groups.	10 years	$20,000/yr allocation	$200,000
8NS	Routine collection of trash/organic debris; conduct intensive street cleaning; clean-up of private parcels.	NA	NA	NA
9NS	Construction related observation and enforcement of NPDES Construction General Permit Requirements (>1 acre disturbance).	NA	NA	NA
10NS	Field observation/inspection and identification of litter and pollution sources. Code enforcement/fines.	NA	NA	NA
11NS	Install road signage (Anti-littering – Drains to Three Mile Creek).	10 years	$5,000/yr allocation	$50,000
12NS	Install placards on storm structures (Anti-littering – Drains to Three Mile Creek)	10 years	$1,000/yr allocation	$10,000
13NS	Remove Island Apple Snails and eggs	6 treatments	$150,000/ treatment	$900,000
14NS	Complete Stormwater and wet weather creek surface water quality monitoring identified and Drainage area and pollutant loads for each major storm sewer outfall identified in Data Gaps.	10 years	$25,000/yr	$250,000
15NS	Purchase Conver w/ attachments and trailer and smaller utility boat	One time	$300,000	$300,000
16NS	Maintain & operate Conver and associated equipment	10 years	$50,000/yr	$500,000
Total		**$5,165,000- $14,487,000**		
Note: Cost does not include the costs associated with completing potential system improvements identified during the recommended field studies of the sanitary sewer system, septic systems, and drainage system illicit discharges.				

6.2.6.1 Structural BMPs & Green Infrastructure

A summary of recommended structural BMPs for restoration of the entire watershed and the ranges of their implementation costs are listed in Table 6-2. A more detailed explanation of structural BMPs, including various examples, is provided in Appendix H. As mentioned earlier, structural BMPs involve constructed restoration efforts, such as sediment boxes, wet detention facilities, and riparian buffer improvements that may require land acquisition and/or easements. For this reason, the cost to implement structural BMPs is typically more expensive than non-structural BMPs. These structural BMPs include stormwater retrofit projects such as LID/GI and GPRS..

Another structural BMP that will improve water quality and aquatic life is the removal of submerged aquatic vegetation in select locations (see Table 6-2) and reconnecting the historic creek channel and adjacent wetlands in the lower portion of the watershed by removing the plug (see Section 6.3.2.1.3). **The total estimated planning level cost for implementing structural BMPs in the Three Mile Creek watershed is $38 million to $130.5 million over 10 years.**

LID/GIis type of structural BMP that assists in improving water quality and supports sustainability by capturing pollutants and infiltrating runoff near its source. LID/GI typically involves the development of small-scale BMPs such as rain gardens and curb diversions that collect, filter, and treat rainwater before it reaches the stormwater collection system. These small-scale BMPs can be less effective if not sized specific to the contributing area or poorly maintained. When implemented throughout a watershed, green infrastructure can significantly contribute to reductions in the pollutant load from stormwater runoff.

GPRSs or sediment boxes, which are effective for removing trash, organic debris, and larger sediment in stormwater prior to them entering the creek and tributaries. These are devices which are typically intrdoduced at the pipe or channel outfall and therefore are designed to handle larger flows than LID/GI devices. As retrofit options GPRSs are sometime easier to install due to a small footprint which may fit within existing rights-of-way as some of these devices can be located underground. The downside is that GPRSs require frequent maintenance which if not performed regularly can be more problematic than poorly maintained LID/GI due to the higher flows.

Restoration of degraded stream banks and riparian buffers is also included in the list of structural BMPs. The existing wet ponds at the USA campus and at Langan Park provide an opportunity to substantially improve pollutant removal efficiencies within the current BMP footprint by removing accumulated sediment and increasing both permanent pool volume and temporary detention storage. This additional volume will increase pollutant load reduction and also reduce peak stormwater discharges in the creek downstream of the discharge. The capacity to store and naturally treat stormwater runoff decreases pollutants, but also reduces the volume of stormwater discharges to the creek during peak wet weather events.

Each of the structural BMPs noted have a range of expected pollutant removal efficiencies. These ranges are addressed in Appendix H along with examples pictures and detailed descriptions and implementation limitations. Due to the wide range of problems in the watershed and the varied geographic regions of each TMDL it is not practical to identify specific contributions from each recommended BMP to achieving the TMDL reduction goals at this time. During the first stage of implementation of the WMP more specifics will be known on the sources and proportional contribution of targeted pollutants from each area of the watershed which will allow the prediction of percent contribution during the preliminary design of the BMPs.

Table 6-2 Dewberry Team Recommended Structural BMPs for the Three Mile Creek Watershed

Measure Identification Number	Structural BMP Activity Description	Quantity	Unit Cost ($)	Total Cost ($)
1S	Install Gross Pollutant Removal Structure (GPRS) on pipe outfalls or implement upstream LID/GI in the contributing watersheds.	97 ea	$75,000-$150,000	$7,275,000-$14,550,000
2S	Install GPRS on channel outfalls or implement upstream LID/GI in the contributing watersheds.	40 ea	$37,500-$75,000	$1,500,000-$3,000,000
3S	Install green infrastructure retrofits on developed public areas (below Langan Park).	10 ea	$100,000-$200,000	$1,000,000-$2,000,000
4S	Remove sediment and increase normal water depth/volume at USA wet ponds	120,000-240,000 cubic yards (cy)	$60-$120	$7,200,000-$28,800,000
5S	Remove sediment and increase normal water depth/volume at Langan Park ponds (assumes 3-foot sediment depth).	180,000-360,000 cy	$60-$120	$10,800,000-$43,200,000
6S	Add trash capture at USA pond inflow points or implement upstream LID/GI in the contributing watersheds.(stormwater park)	6 ea	$75,000-$150,000	$450,000-$900,000
7S	Add trash capture at Langan Park pond inflow points or implement upstream LID/GI in the contributing watersheds.(stormwater park)	6 ea	$75,000-$150,000	$450,000-$900,000
8S	Survey of natural/armored and streambank restoration upstream of USACE segment.	2,000-4,000 linear feet (lf)	$500-$1,000	$1,000,000-$4,000,000
9S	Survey of natural/armored and streambank restoration within USACE segment.	1,500-3,000 lf	$600-$1,200	$900,000-$3,600,000
10S	Survey of urban forest coverage and riparian buffer restoration upstream of USACE segment.	1,800-3,600 lf	$250-$500	$450,000-$1,800,000
11S	Survey of urban forest coverage and riparian buffer restorations within USACE segment/create depressional runoff storage.	4,000-8,000 lf	$350-$700	$1,400,000-$5,600,000
12S	Remove bottom sediment at select locations in creek.	75,000-150,000 cy	$60-$120	$4,500,000-$18,000,000
13S	Remove submerged nuisance vegetation in creek.	15-30 ac	$7,500-$15,000	$112,500-$450,000
14S	Remove channel plug and restore historic creek stream channel.	1,200-1,800 lf	$750-$1,500	$900,000-$2,700,000

Measure Identification Number	Structural BMP Activity Description	Quantity	Unit Cost ($)	Total Cost ($)
15S	Restore/enhance wetland areas adjacent to historic channel/create living shorelines.	75-125 ac	$2,500-$5,000	$187,500-$625,000
16S	Repair erosion; construct energy dissipater on Twelve Mile Creek downstream of East Drive.	1 ea	$75,000-$150,000	$75,000-$150,000
17S	Repair erosion; construct energy dissipater on Twelve Mile Creek downstream of University Blvd.	1 ea	$75,000-$150,000	$75,000-$150,000
Total		**$38,275,000- $130,425,000**		

Note: The variable cost range shown is intended to address the cost of obtaining land or easements, if required; surveying and engineering costs. A 15-20% annual maintenance fee should be added for all structural measures to provide for on-going maintenance.

6.2.6.2 Long-Range Climate Adaptation and Sustainability Project Solutions

In addition to the BMPs that are focused specifically on water quality improvements for Three Mile Creek, the SLR and tidal surge predictions for Three Mile Creek discussed in Section 4 also identify the need for BMPs to address long-term sustainability. Changing sea levels and tidal surge can alter infrastructure and the balance and distribution of native habitats in the watershed by negatively affecting some and expanding or creating others. An example of a BMP for responding to SLR and tidal surge would be to acquire properties identified to be subject to future inundation and maintain them as open space in perpetuity. By following this strategy these properties can both be removed from the real estate market and open space can be added for conservation, recreation, or other public purposes. The acquisition of floodprone properties can translate into other environmental benefits such as marshland migration and reducing non-point source pollution through the creation of vegetated buffers. This approach is based on working in conjunction with predicted land use conversion. Land use conversion is the change in the type of land cover, such as the conversion of saltwater marsh to tidal flats due to plant die-off from increased salinity or the frequency and depth of water inundation. The area where land use conversions are expected to have the most significant effect is downstream of the Dr. Martin Luther King Jr. Avenue Bridge, near the historic channel and One Mile Creek (see Section 4). Conversions from non-tidal swamp and inland fresh marsh to marsh/scrub shrub and regularly flooded marsh (saltmarsh) are predicted to occur at year 2025, with further conversion to tidal flats habitats occurring at year 2050.

The long-term SLR mitigation measures in the Three Mile Creek watershed are presented in Table 6-3. A more in-depth description for certain strategies is provided in Appendix H. Existing water quality challenges are easily quantified and have defined scalable solutions with predictable costs, unlike solutions for SLR and storm surge, which vary over longer durations and are less predictable. For this reason, we only recommend implementation of monitoring at this time. A monitoring plan would provide communities the opportunity to collect data over time to gauge the local impacts of SLR and inform appropriate responses through future BMPs. The plan would identify and establish tidal level monitoring sites and vegetation plots; record this information in a database; evaluate changes in tidal range and vegetation survival/conversion over time; and compare actual results to the predictive modeling results to develop an implementation plan for future projects. We anticipate that a plan of this detail would require an initial $30,000-$40,000 effort to establish; $3,000 - $5,000 annually for data acquisition; and $15,000 - $20,000 every 3 years to perform the evaluations for changes in tidal ranges. **The total 10-year cost is anticipated to be $90,000 to $125,000.**

Table 6-3 Dewberry Team Recommended Long Term SLR Mitigation Measures for the Three Mile Creek Watershed

Measure Identification Number	Activity Description
1CA	**Monitoring Plan** – Identify or establish local tidal level monitoring sites and vegetation plots; monitor and record data in a database yearly. At 3 year intervals, evaluate changes in tidal range over time, vegetation survival/conversion and predictive modeling results to develop implementation plans for other projects.
Natural Environment Strategies	
2CA	**Tidal Marsh Restoration -** This is a method to protect areas from inundation by use of a levee and tidal marsh system. The innovation lies in the addition of an upland ecotone slope (a gradual transition area between two adjacent but different communities) of moist grasslands and brackish marshes landward of the existing tidal marsh. The upland ecotone slope would provide both elevation and salinity gradients that would allow the tidal marsh to both move landward and accelerate vertical accretion in order to keep pace with SLR (Lowe, Jeremy).
3CA	**Beneficial use of dredged material** (i.e., sediment placement and introduction) - Assuming the creek or surrounding water bodies are dredged to maintain navigatin or for other reasons, the material could be strategically placed in fractured marsh areas as nourishment. Depending on the quantity and size of the material, there may even be opportunities to directly create marsh, terraces, or berms, all of which have storm and tidal attenuation potential. Beneficially-used dredge material is also a component of the Tidal Marsh Restoration mentioned above.
4CA	**Vegetative planting and marsh nourishment** – As areas transition because of SLR, they could be stabilized by vegetative planting projects that are conducive to the salinity regimes of the newly converted areas. Additionally, if material is available from maintenance dredging, the areas could be equally nourished and stabilized with plantings.

Measure Identification Number	Activity Description
5CA	**Land Acquisition** - States and other government entities can play a critical role in acquiring property that is vulnerable to flooding and adaptively reusing such properties to advance additional complementary goals.
6CA	**Rolling Easements** - An option to address the natural dynamism of coastal environments, including the migration of coastal wetlands, is to utilize rolling easements (easements with changing boundaries based on based on a natural demarcation such as the high tide line). The application of rolling easements has the additional benefit of maintaining public access along the State's shores, which also enhances important tourism and recreation-based economies (Titus, James G., "Rolling Easements Primer").
7CA	**Freshwater introduction** (could design stormwater BMP discharge to targeted locations) - If water quality is improved at the sources of contamination, it is logical to think those inflows could be beneficially used to flush marsh areas during periods of higher salinity or extended durations of inundation.
Infrastructure Strategies	
8CA	**Raise Road Levels** – to provide more resilience for emergency access and evacuation, certain key arterial roads could be elevated above the predicted tide and/or surge elevations.
9CA	**Flood Proof Structures** –Flood control measures that are specific structures include: **Residential Structures** –to flood proof residential structures they either must be elevated or removed. **Non- Residential Structures** –In addition to the measures available for residential structures, both wet and dry floodproofing can be undertaken for non-residential structures. Wet floodproofing allows the building to flood on the interior and provides protection for utilities and vents to evacuate water after the flood. This can be used for warehouses and other storage facilities where materials can be elevated or otherwise protected from flooding. Dry flood proofing uses manual or automatic gates to prevent flood waters from entering a building. It is limited to 3 feet or less and requires a warning and response plan for deployment. This can be used for office buildings and commercial businesses that require protection of interior materials and merchandise.
10CA	**Backwater Control Valves** – As sea levels rise, areas that are currently subject to flooding or are close to these elevations may see more severe or frequent flooding. One-way valves can be installed on these stormwater outfalls to prevent tidal inundation of existing BMPs and collection systems and allow discharge of rainfall runoff during low tide levels.
11CA	**Levees and Floodwalls**- A variety of structural measures protect against flooding, including impoundments to reduce water levels and levees and flood walls that provide a protective barrier between the flooding source (river) and the floodprone area. Typically, the protected floodprone area will also require provisions for internal drainage (e.g., conveyance and storage or pumping of rainfall runoff behind the levee or floodwall).

6.2.6.3 Correlation of Implementation Strategies with City of Mobile NPDES Permit and TMDLs

The City of Mobile holds an EPA permit to operate a MS4s to collect and convey stormwater, including storm drains, pipes, and ditches. This permit requires implementation of six stormwater management measures, including (EPA, 2007):

1. Public education and outreach on stormwater impacts
2. Public involvement/participation
3. Illicit discharge detection and elimination
4. Construction site stormwater runoff control
5. Post-construction stormwater management in new development and redevelopment
6. Pollution prevention/good housekeeping for municipal operations

Communities such as Mobile typically also have requirements to perform certain activities to the Maximum Extent Practical (MEP). The Dewberry Team assessed the recommended structural and non-structural BMPs to determine if any of these implementation strategies would assist the City of Mobile in meeting its NPDES MS4 permit and MEP implementation requirements. The TMDL notation indicates which of the implementation strategies, if implemented in a section of the watershed contributing to an impacted stream segment, could improve the effected water quality parameter(s). This assessment is provided in Table 6-4 and Table 6-5.

Table 6-4 NPDES Compliance of Recommended Non-Structural BMPs for the Three Mile Creek Watershed

Measure Identification Number	Non - Structural BMP Description	NPDES	Management Measure
1NS	Field studies and inspection: Identify and remove sanitary system and septic system leakage/overflows into groundwater, creek, and tributaries. Focus on TSB and UTTM sub-basins and lower portion of watershed.	Y	Measure 3 /TMDL
2NS	Field studies and inspection: Identify and remove illicit discharges to stormwater and surface water system in watershed. Focus on TSB and UTTM and lower portion of watershed.	Y	Measure 3 /TMDL
3NS	Develop map of current creek and tributary bathymetry; assess normal water depths; select locations for sediment removal.	N	N/A

Measure Identification Number	Non - Structural BMP Description	NPDES	Management Measure
4NS	Partner with private land owners to disconnect impervious areas/ install Green Infrastructure projects; provide grants for installation of green infrastructure BMPs on private property.	Y	Measure 5
5NS	Partner with private land owners to revegetate or stabilize upland areas in watershed to reduce erosion and loss of other materials; provide grants/incentives for revegetation of disturbed eroding areas on private upland land.	Y	Measure 5
6NS	Improve management of exotic/nuisance vegetation in wetland and upland riparian areas adjacent to creek and tributaries; develop plan for long-term management.	N	N/A
7NS	Continue intense education and outreach program; partner with schools, churches and community groups.	Y	Measure 1
8NS	Routine collection of trash/organic debris; conduct intensive street cleaning; clean-up of private parcels.	Y	MEP
9NS	Construction, observation and enforcement of NPDES Construction General Permit Requirements (>1 acre disturbance).	Y	Measure 4
10NS	Field observation/inspection and identification of litter and pollution sources. Code enforcement/fines.	Y	MEP
11NS	Install road signage (Anti-littering – Drains to Three Mile Creek).	Y	Measure 4
12NS	Install placards on storm structures (Anti-littering – Drains to Three Mile Creek)	Y	Measure 4
13NS	Remove Island Apple Snails and eggs	N	N/A
14NS	Complete water quality monitoring identified in Data Gaps; identify major hydrologic and pollutant inputs.	Y	MEP/TMDL
15NS	Purchase Conver and Truxor with attachments and trailers	N	N/A
16NS	Maintain & operate Conver and associated equipment	N	N/A

Table 6-5 NPDES Compliance of Recommended Structural BMPs for the Three Mile Creek Watershed (continued)

Measure Identification Number	Structural Activity Description	NPDES	Management Measure
1S	Install GPRS on pipe outfalls or implement upstream LID/GI in the contributing watersheds.	Y	Measure 5 /TMDL

Measure Identification Number	Structural Activity Description	NPDES	Management Measure
2S	Install GPRS on channel outfalls or implement upstream LID/GI in the contributing watersheds.	Y	Measure 5 /TMDL
3S	Install green infrastructure retrofits on public developed areas (below Langan Park).	Y	Measure 5 /TMDL
4S	Remove sediment and increase normal water depth/volume at USA wet ponds	Y	Measure 5 /TMDL
5S	Remove sediment and increase normal water depth/volume at Langan Park ponds (assumes 3-ft sediment depth).	Y	Measure 5 /TMDL
6S	Add trash capture at USA pond inflow points or implement upstream LID/GI in the contributing watersheds..	Y	Measure 5 /TMDL
7S	Add trash capture at Langan Park pond inflow points or implement upstream LID/GI in the contributing watersheds..	Y	Measure 5 /TMDL
8S	Streambank restoration upstream of USACE segment.	Y	MEP/TMDL
9S	Streambank restoration within USACE segment.	Y	MEP/TMDL
10S	Riparian buffer restoration upstream of USACE segment.	N	TMDL
11S	Riparian buffer restorations within USACE segment/create depressional runoff storage.	N	TMDL
12S	Remove bottom sediment at select locations in creek.	N	TMDL
13S	Remove submerged nuisance vegetation in creek.	N	TMDL
14S	Remove channel plug and restore historic creek stream channel.	N	N/A
15S	Restore/enhance wetland areas adjacent to historic channel; create living shorelines.	N	N/A
16S	Repair erosion; construct energy dissipater on Twelve Mile Creek downstream of East Drive.	N	N/A
17S	Repair erosion; construct energy dissipater on Twelve Mile Creek downstream of University Blvd.	N	N/A

6.2.7 Technical Committee Ranking of Projects

The Technical Committee was asked to provide its input on prioritizing the list of both structural and non-structural BMPs presented above. The Dewberry Team and MBNEP prepared and disseminated a web survey to solicit input from the Technical Committee in fall 2013. The full survey is provided in Appendix F. The survey asked each committee member to rank the suggested BMPs from 0 to 5, with 5 being the most important BMP to implement. A summary of the top six responses is provided in Table 6-6. These BMPs scored a minimum of 4.0 out of 5.0 total possible points. The highest ranked BMP is "Identify and remove sanitary sewer system and septic system leakage/overflows into groundwater, creek, and tributaries in the Three Mile Creek watershed." The Technical Committee members believe that eliminating these sources of leaks and discharges and removing overflows will provide the most benefit to the water quality of Three Mile Creek. The second highest ranked BMP is "Identify and remove illicit discharges to stormwater and surface water system." These are the discharges discussed in Section 4.1.4 and are typically older or unaccounted for sources discharging pollutants into the watershed. Other highly ranked BMPs included restoring, repairing, fortifying stream banks and riparian buffers, and installing outfall end-of-pipe BMPs. The alternative response "Other" ranked third highest and includes the items listed at the bottom of Table 6-6.

Table 6-6 Technical Committee Ranking of Recommended BMPs for the Three Mile Creek Watershed

Top 6 Responses (12 responders)	Response Count	Average Response
Water Quality (WQ): Identify and remove sanitary sewer system and septic system leakage/overflows into groundwater, creek, and tributaries (provides reduction in nutrients, oxygen demand, pathogens and wastewater compounds).	11	4.818
WQ: Identify and remove illicit discharges to stormwater and surface water system (provides reduction in nutrients, oxygen demand, pathogens, and wastewater compounds).	11	4.545
Other (see below)	5	4.400
Habitat Assessment HA: Stabilize/Restore streambanks and riparian buffers in degraded areas to reduce in-stream erosion and improve habitat condition (provides reduction in nutrients and oxygen demand, improves habitat).	12	4.333
WQ: Repair/Protect/Fortify streambanks where utility infrastructure is located to reduce potential illicit discharges and reduce in-stream erosion (provides reduction in nutrients and oxygen demand and improves habitat).	12	4.167
WQ: Install Stormwater Outfall End-of-Pipe BMPs to remove non-point sources (also provides reduction in nutrients, oxygen demand and pathogens).	11	4.000

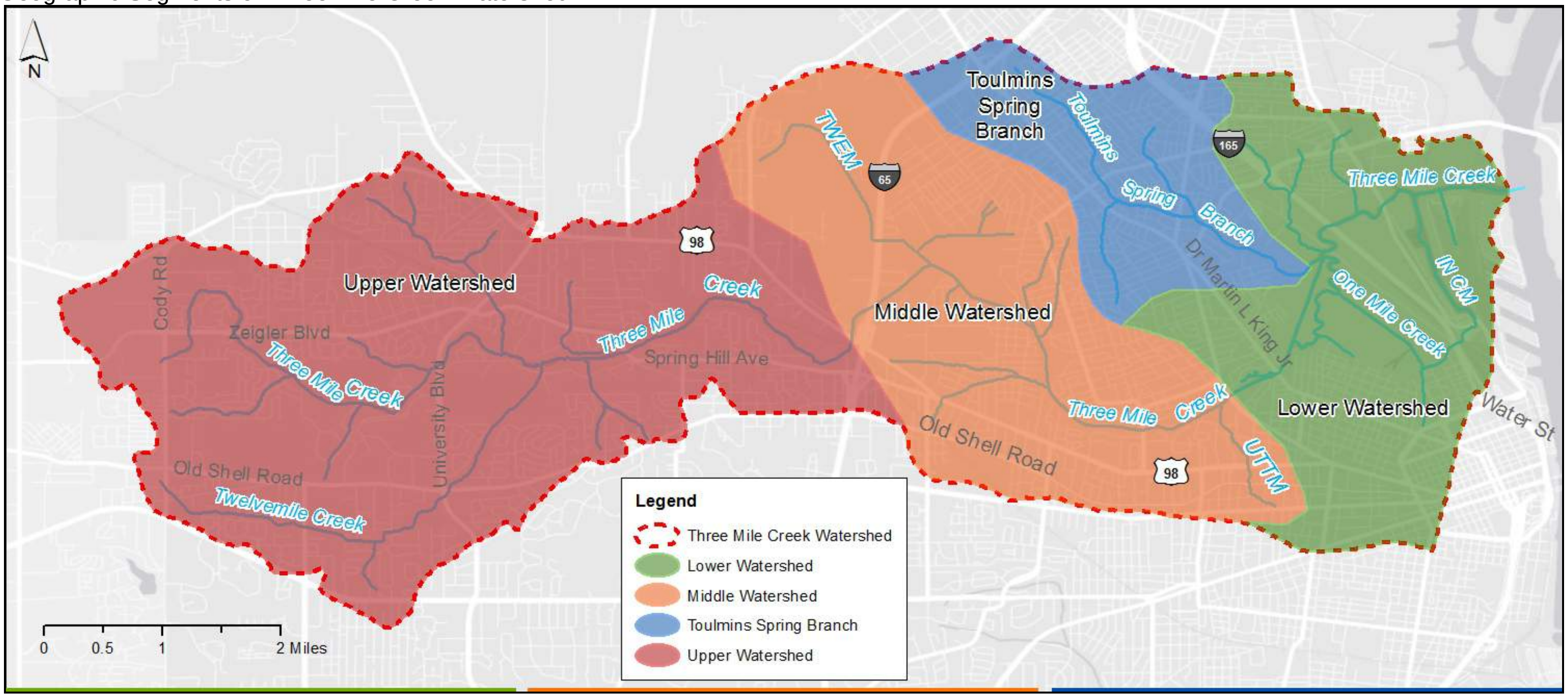
Top 6 Responses (12 responders)	Response Count	Average Response
Write-in responses for "Other" included: 1. The lower ranked priorities are VERY important, but not the immediate items that need to be addressed. 2. City of Mobile needs a better plan to get trash out of system "before the end of pipe." 3. Need better code enforcement and a new contractor w/ sewerage/outfall management concerns. 4. Include incremental flow mapping to study hydrology inputs. Another item to map/assess is the current condition of riparian buffers for the entire watershed 5. Ordinance and fines against litter		

6.2.8 Location of Solutions for Restoration Success

6.2.8.1 Watershed Segments

As mentioned in Section 3, the Dewberry Team divided and prioritized the Three Mile Creek watershed into four geographical segments based on the unique conditions within each geographic area; the severity of existing water quality problems/impairments; the severity of habitat degradation; and the potential for improvement to identify the specific types of BMPs required to address each area's unique combination of problems. A map with the four watershed plan implementation segments is shown in Figure 6-8. The priority watershed segments listed from highest to lowest are 1) "Middle" segment; 2) "Toulmins Spring Branch;" 3) "Lower" segment; and 4) "Upper" segment.

Figure 6-8 Geographic Segments of Three Mile Creek Watershed

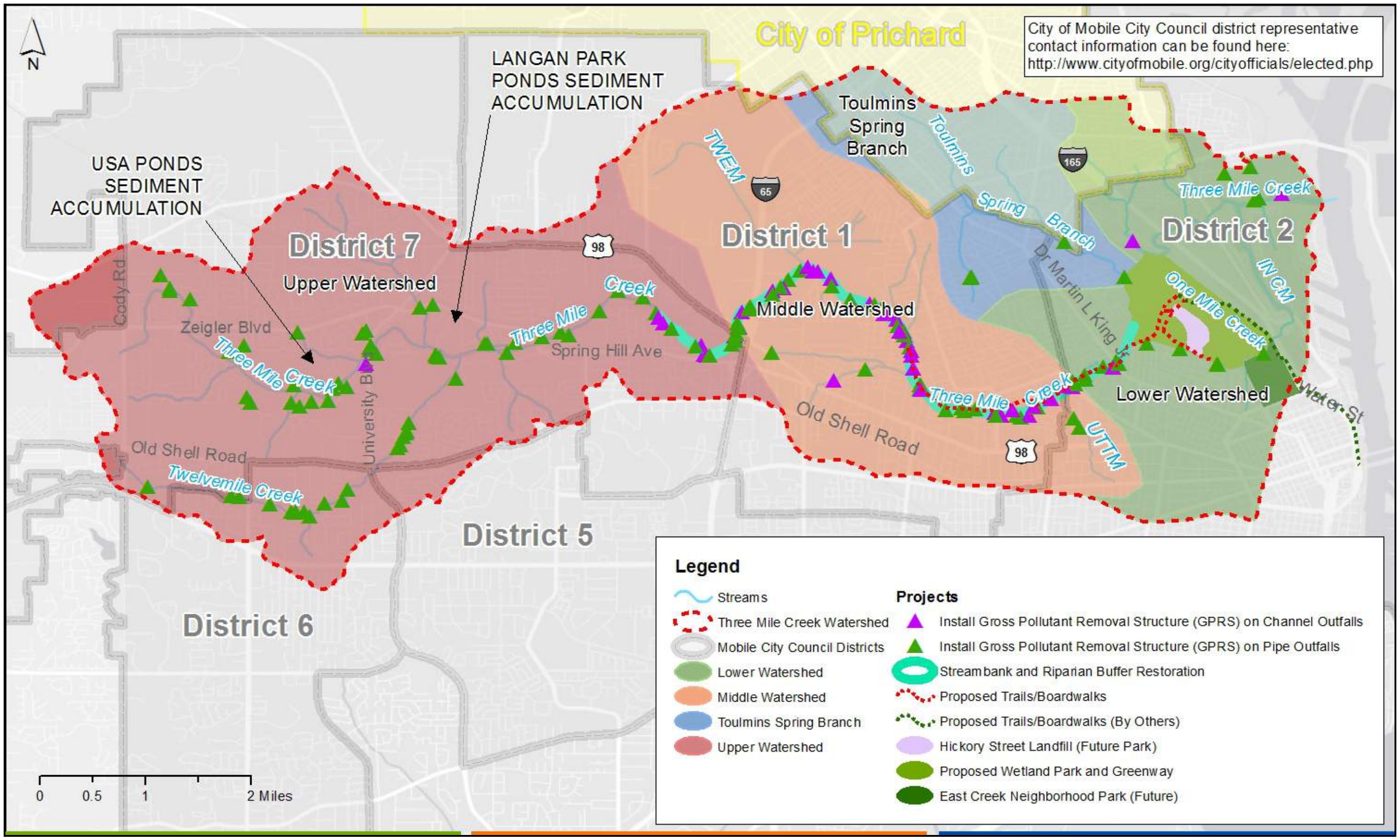


The highest concentrations of the pollutants of concern were measured in the Middle segment, particularly in the UTTM (Unnamed Tributary to Three Mile Creek aka Central tributary or CEN), followed closely by the TSB segment as noted in Section 3.2 as the second priority. The UTTM is located in the Middle segment. The Middle segment also includes the five-mile section of Three Mile Creek modified by the USACE, including the constructed bypass channel and the plugged historic creek channel.

The third priority segment is the Lower segment that includes One Mile Creek. The fourth priority segment is the Upper segment, which includes the headwaters of Three Mile Creek and has the best water quality of all four segments. The Upper segment has newr and less dense development and therefore has more green space than other segments within the watershed. The Upper segment also includes the existing wetland and wet detention ponds system at the USA campus and the wet detention pond at Langan Park (both on the main stem of Three Mile Creek). These facilities act as on-line stormwater treatment for all flows eminating from the Upper segmen, including discharges from Twelve Mile Creek, providing sedimentation and nutrient uptake. However, as they do not have sufficient volume and skimming devices they only provide partial treatment of stormwater.

An overall map of BMP locations is provided in Figure 6-9; enlarged versions of the map are available for each of the four sub sections in Figures 6-10, 6-11, 6-12, and 6-13.

Figure 6-9 Location of Recommended BMPs for Three Mile Creek watershed



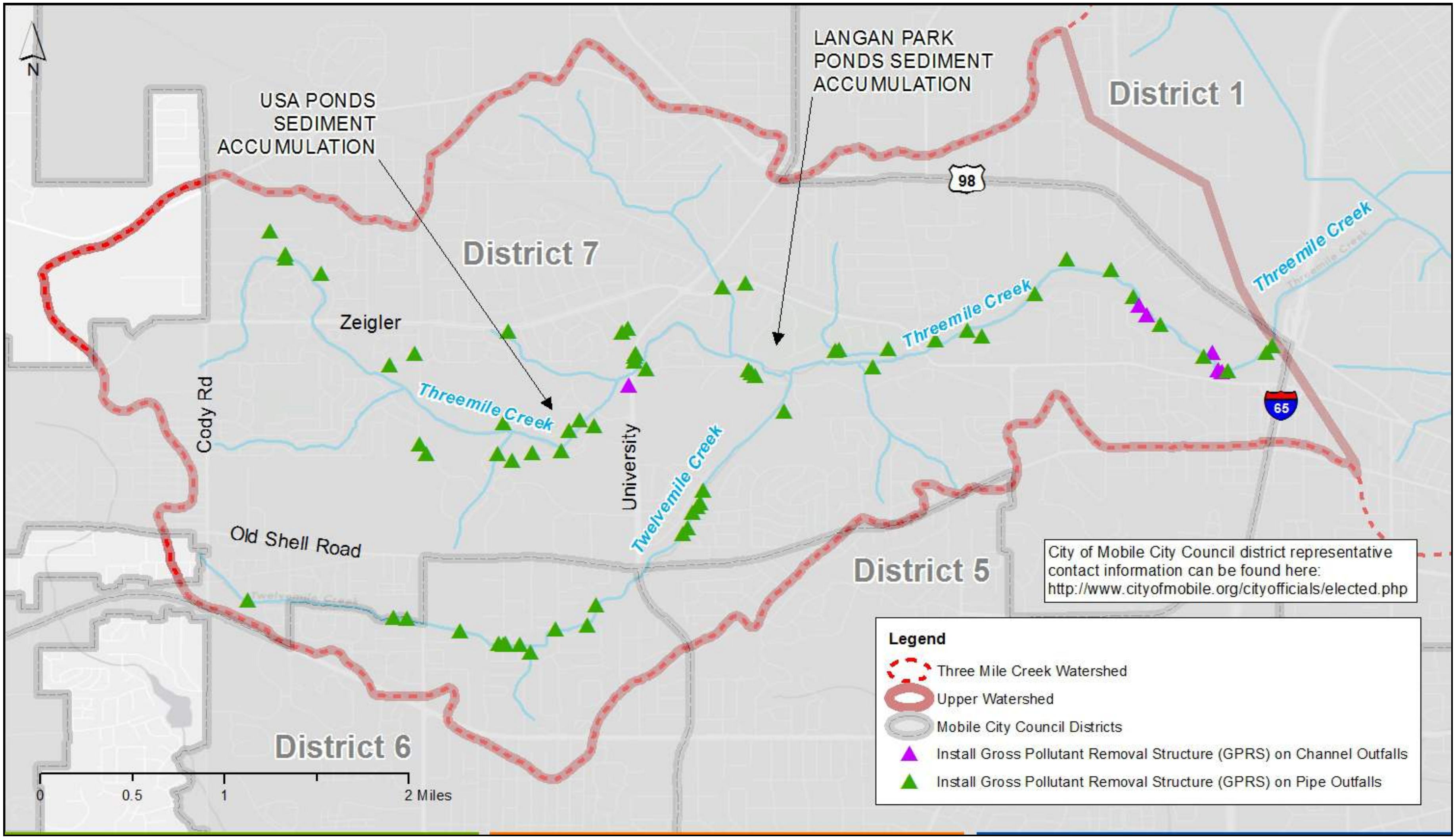
6.2.8.2 Upper Watershed Segment Recommended BMPs

Once the watershed segments were prioritized, the Dewberry Team took the Technical Committee's list of top-ranked non-structural and structural BMPs and applied them to each of the four priority segments. The following tables provide the BMPs for each of the four watershed segments, as well as their associated range of costs (see Tables 6-7 through 6-10.). The color of each table heading corresponds to the color of the sections in Figures 6-8 through 6-11. **The total estimated planning level cost for the priority BMPs for all four watershed segments ranges from $12 million to $34 million**.

Table 6-7 Summary of Recommended BMPs and Planning Level costs for the Upper Watershed Segment

Upper Watershed Non-Structural BMPs				
Project Identification Number	Description	Quantity	Unit Cost ($)	Total Cost ($)
10NS	Continue field observation/inspection and identification of litter and pollution sources. Code enforcement/fines.	N/A	N/A	N/A
Upper Watershed Structural BMPs				
Project Identificaiton Number	Description	Quantity	Unit Cost ($)	Total Cost ($)
1S	Install GPRS on pipe outfalls or implement upstream LID/GI in the contributing watersheds.	42	$75,000-$150,000	$3,150,000-$6,300,000
2S	Install GPRS on channel outfalls or implement upstream LID/GI in the contributing watersheds.	15	$37,500-$75,000	$562,500-$1,125,000
Upper Watershed Priority BMP Planning Level Cost		$3,712,500 - $7,425,000		
Note: Cost range does not include the cost of obtaining land or easements if required; surveying and engineering costs; and annual costs associated with operation and maintenance of the completed structural improvements.				

Figure 6-10 Location of Recommended BMPs for the Upper Watershed Segment

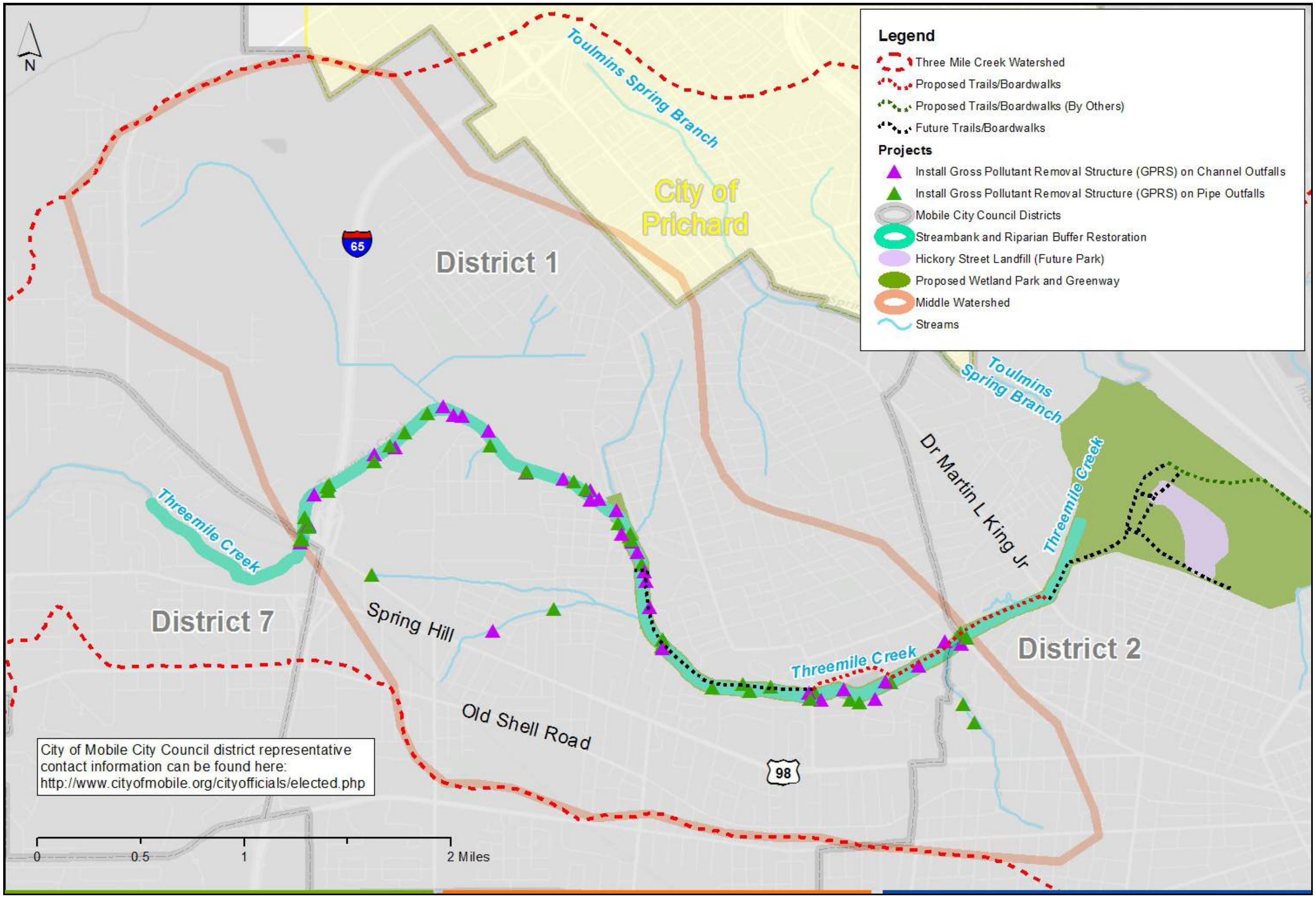


6.2.8.3 Middle Watershed Segment Recommended BMPs

Table 6-8 Summary of Recommended BMPs and Planning Level Costs for the Middle Watershed Segment

Middle Watershed Non-Structural BMPs				
Project Identification Number	Description	Quantity	Unit Cost ($)	Total Cost ($)
1NS	Field studies and inspection: Identify and remove sanitary system and septic system leakage/overflows into groundwater, creek and tributaries.	I/I study (est. 95 mi of stream)	$5,000-$50,000/mi	$475,000-$4,750,000
2NS	Field studies and inspection: Identify and remove illicit discharges to stormwater and surface water system in watershed.	Determine by storm inventory $/sq.mi. (7.9 sq.mi.)	$35,000-$50,000/sq.mi.	$277,200-$396,000
10NS	Continue field observation/inspection and identification of litter and pollution sources. Code enforcement/fines.	N/A	N/A	N/A
Middle Watershed Structural BMPs				
	Description	Quantity	Unit Cost ($)	Total Cost ($)
1S	Install GPRS on pipe outfalls or implement upstream LID/GI in the contributing watersheds.	43	$75,000-$150,000	$3,225,000-$6,450,000
2S	Install GPRS on channel outfalls or implement upstream LID/GI in the contributing watersheds.	23	$37,500-$75,000	$862,500-$1,725,000
8S	Streambank restoration within USACE segment.	1,500-3,000 lf	$600-$1,200	$900,000-$3,600,000
10S	Riparian buffer restorations within USACE segment/create depressional runoff storage.	4,000-8,000 lf	$350-$700	$1,400,000-$5,600,000
Middle Watershed Priority BMP Planning Level Cost		$7,139,700 - $22,521,000		
Note: Cost range does not include the cost of obtaining land or easements if required; surveying and engineering costs; and annual costs associated with operation and maintenance of the completed structural improvements.				

Figure 6-11 Location of Recommended BMPs and Recreational Projects for the Middle Watershed Segment

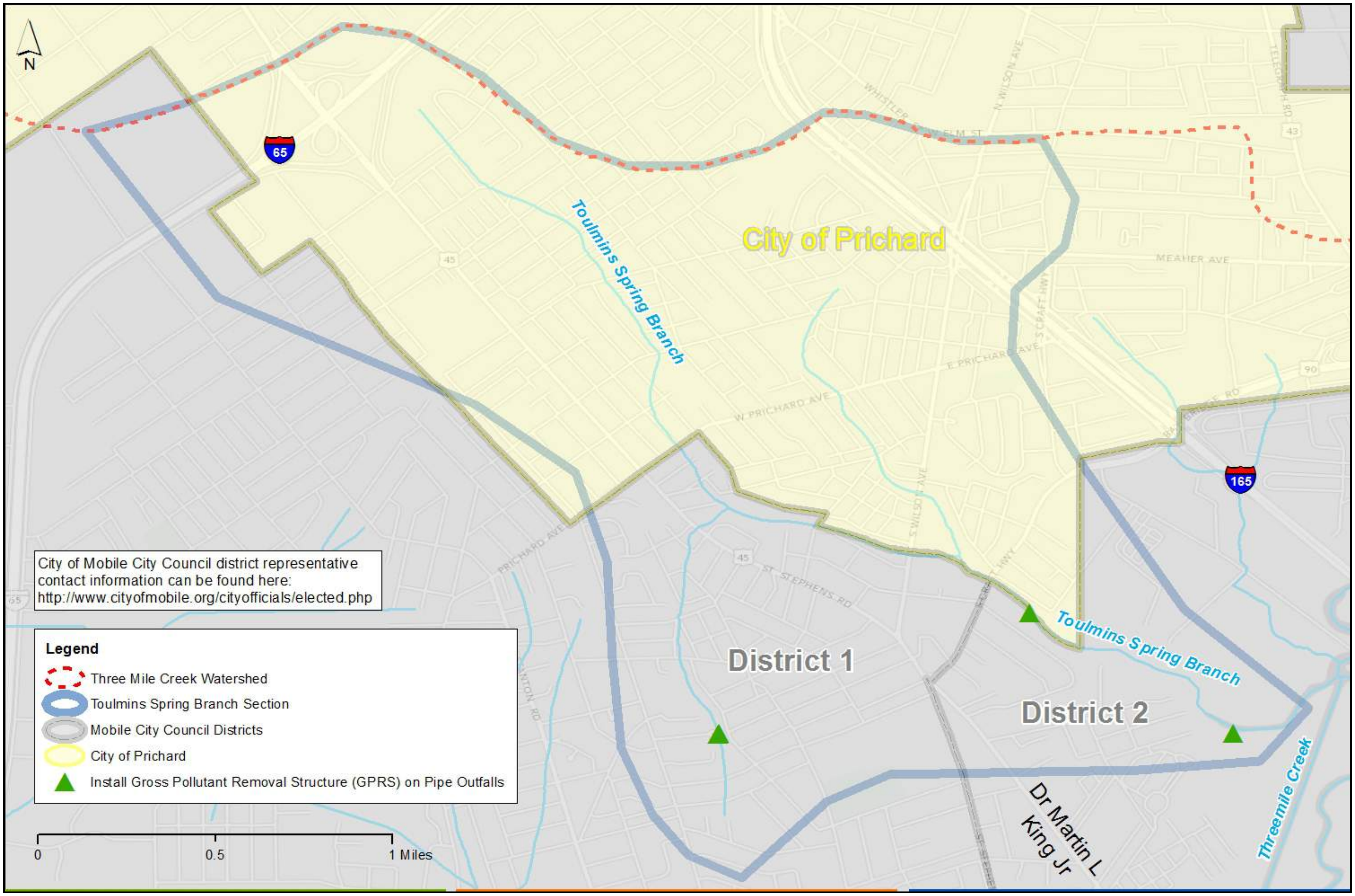


6.2.8.4 Toulmins Spring Branch Watershed Segment Recommended BMPs

Table 6-9 Summary of Recommended BMPs and Planning Level Costs for Toulmins Spring Branch Watershed Segment

Toulmins Spring Branch Non-Structural BMPs				
Project Identification Number	Description	Quantity	Unit Cost ($)	Total Cost ($)
1NS	Field studies and inspection: Identify and remove sanitary system and septic system leakage/overflows into groundwater, creek and tributaries.	I/I study (est. 38 mi of stream)	$5,000-$50,000/mi	$190,000-$1,900,000
2NS	Field studies and inspection: Identify and remove illicit discharges to stormwater and surface water system in watershed.	Determine by storm inventory $/sq.mi. (3.3 sq.mi.)	$35,000-$50,000/sq.mi.	$115,500-$165,000
10NS	Continue field observation/inspection and identification of litter and pollution sources. Code enforcement/fines.	N/A	N/A	N/A
Toulmins Spring Branch Structural BMPs				
Project Identification Number	Description	Quantity	Unit Cost ($)	Total Cost ($)
1S	Install Gross Pollutant Removal Structure (GPRS) on pipe outfalls or implement upstream LID/GI in the contributing watersheds.	5	$75,000-$150,000	$375,000-$750,000
Toulmins Springs Branch Watershed Priority BMP Planning Level Cost		$680,500 - $2,815,000		
Note: Cost range does not include the cost of obtaining land or easements if required; surveying and engineering costs; and annual costs associated with operation and maintenance of the completed structural improvements.				

Figure 6-12 Location of Recommended BMPs for the Toulmins Spring Branch Watershed Segment

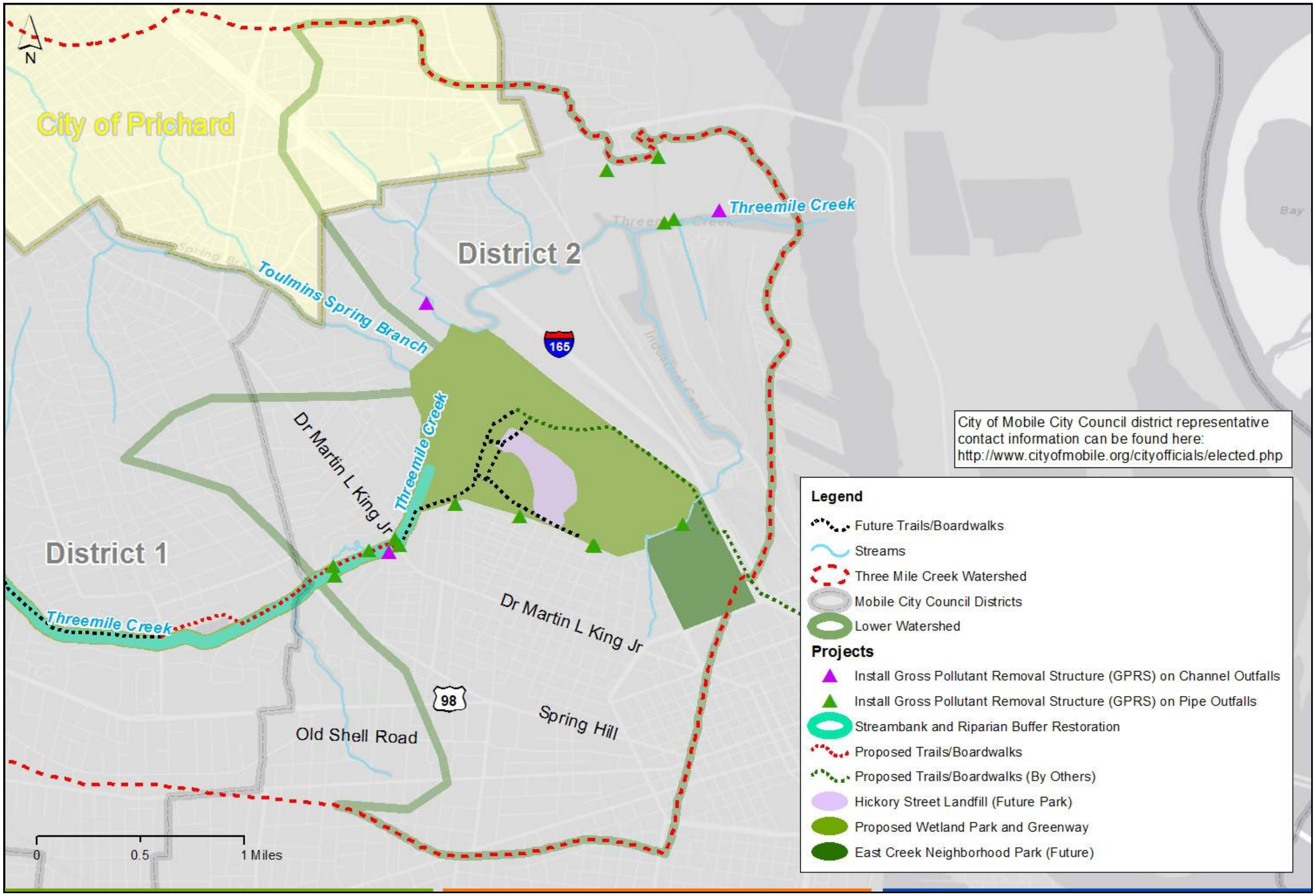


6.2.8.5 Lower Watershed Segment Recommended BMPs

Table 6-10 Summary of Recommended BMPs and Planning Level Costs for the Lower Watershed Segment

Lower Watershed Non-Structural BMPs				
Project Identification number	Description	Quantity	Unit Cost ($)	Total Cost ($)
10NS	Continue field observation/inspection and identification of litter and pollution sources. Code enforcement/fines.	N/A	N/A	N/A
Lower Watershed Structural BMPs				
Project Identification number	Description	Quantity	Unit Cost ($)	Total Cost ($)
1S	Install GPRS on pipe outfalls or implement upstream LID/GI in the contributing watersheds.	7	$75,000-$150,000	$525,000-$1,050,000
2S	Install GPRS on channel outfalls or implement upstream LID/GI in the contributing watersheds.	2	$37,500-$75,000	$75,000-$150,000
Lower Watershed Priority BMP Planning Level Cost		$600,000 - $1,200,000		
Note: Cost range does not include the cost of obtaining land or easements if required; surveying and engineering costs; and annual costs associated with operation and maintenance of the completed structural improvements.				

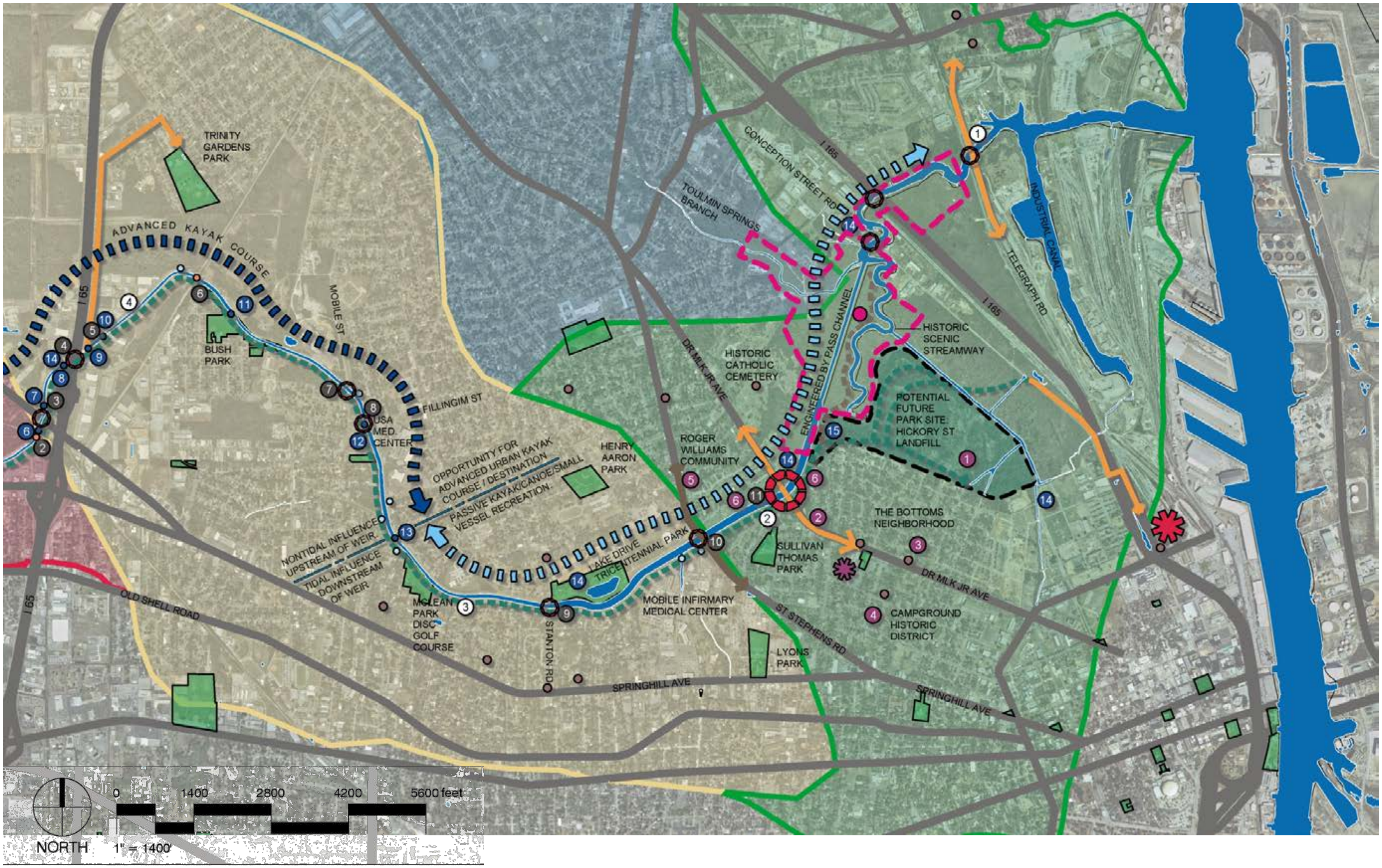
Figure 6-13 Location of Recommended BMPs and Recreational Projects for the Lower Watershed Segment



6.2.9 Recreation Improvements and Costs

Recreational spaces can serve as interconnecting elements linking a number of man-made and natural destinations within the cities of Mobile and Prichard, as well as linking people to their community's natural spaces. Section 6.2.3.1 envisions the Three Mile Creek community connected to a restored, natural amenity that celebrates its people, places, history, nature, and community. These recreation improvements present opportunities provided by the creek and its surrounding environment through the development of a greenway and blueway system, as shown in Figure 6-14a-c. Where improved connectivity and circulation opportunities require the introduction of new impervious surface to the watershed consideration has also be given to incorporation Low Impact Development (LID) and Green Infrastructure (GI) practices, such as permeable pavement, stormwater capture and minimization of impervious surfaces, to mimic the predevelopment environment of these areas and lessen stormwater impacts to watershed should also be considered. The following subsection describes the costs involved for making greenway and blueway systems a reality in the Three Mile Creek Watershed.

Figure 6-14a Recreation Opportunities and Constraints Map evaluates public access, recreation, and ecotourism opportunities along Three Mile Creek, east



Three Mile Creek Watershed Management Plan

Figure 6-15b Recreation Opportunities and Constraints Map evaluates public access, recreation, and ecotourism opportunities along Three Mile Creek, west

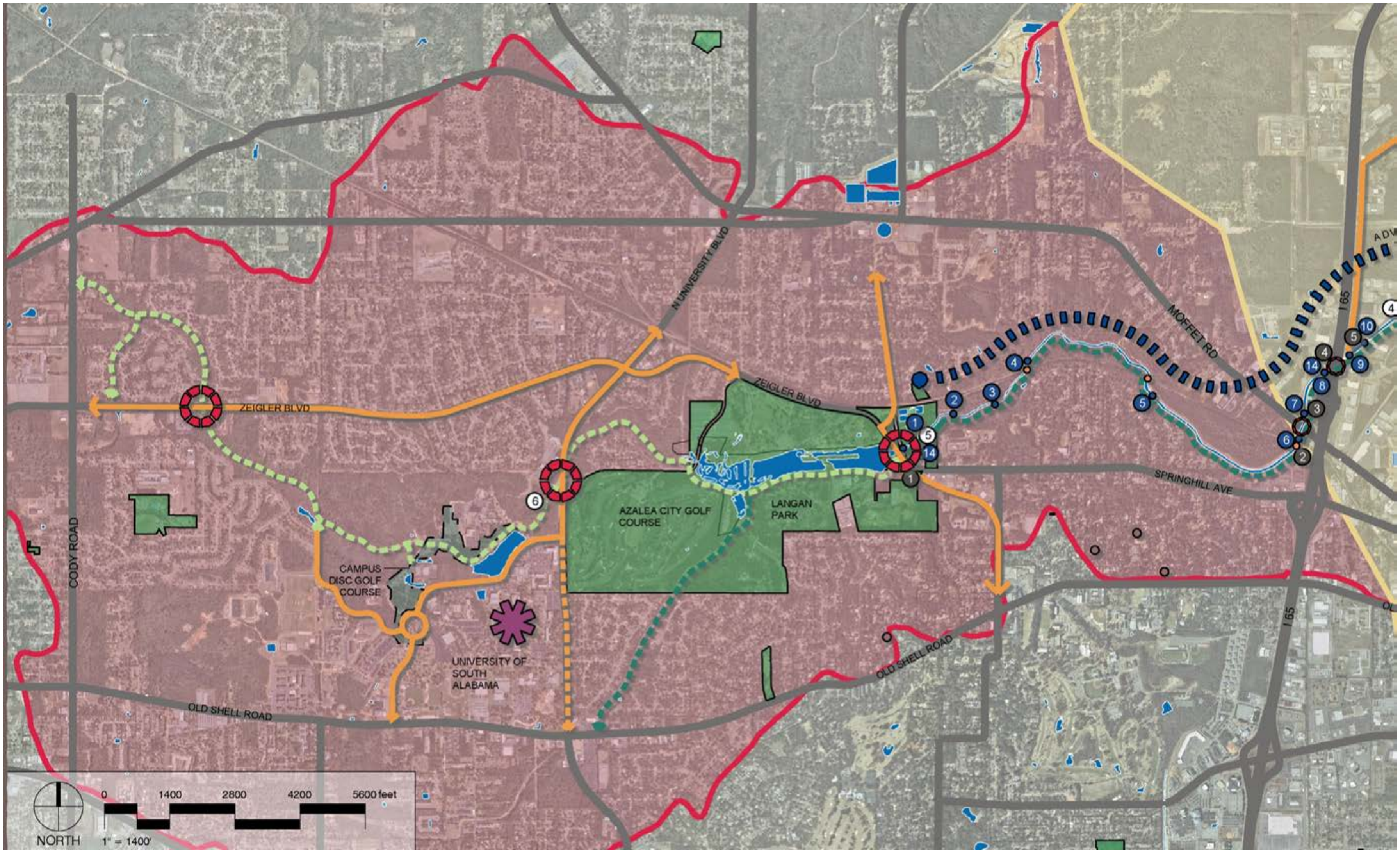


Figure 6-16c Legend for Figures 6-14a and 6-14b

LEGEND

- EXISTING PARKS
- HABITAT RICH, FORESTED WETLAND. BROAD DIVERSITY OF MARINE AND FRESHWATER SPECIES. OPPORTUNITY TO ENHANCE PUBLIC ACCESS FOR ECOTOURISM DESTINATION IN THE HEART OF MOBILE.
- HISTORIC SITE
- EXISTING WEIR / DAM CONSTRAINT - KAYAK PORTAGE OPPORTUNITY
- EXISTING RAILROAD CROSSING CONSTRAINT - SAFE PEDESTRIAN CROSSING REQUIRED FOR GREENWAY TRAIL
- EXISTING DRAINAGE DITCH CONSTRAINT - PEDESTRIAN CROSSING REQUIRED
- AFRICAN AMERICAN HERITAGE TRAIL. OPPORTUNITY TO LINK WITH THREE MILE CREEK TRAIL SYSTEM.
- PROPOSED ON-ROAD BIKEWAY PER MOBILE COUNTY BICENTENNIAL BICYCLE AND PEDESTRIAN MASTER PLAN AND CITY OF MOBILE PARK & REC. MASTER PLAN
- PROPOSED OFF-ROAD BIKEWAY PER CITY OF MOBILE PARK AND RECREATION MASTER PLAN
- EXISTING OFF-ROAD BIKEWAY
- OPPORTUNITY FOR EXTENSION OF PROPOSED SHARED USE TRAIL
- OPPORTUNITY FOR BOARDWALK IN FORESTED WETLAND
- OPPORTUNITY FOR ADVANCED URBAN KAYAK COURSE. POTENTIAL URBAN ECOTOURISM DESTINATION.
- OPPORTUNITY FOR ENHANCED KAYAK/CANOE/SMALL VESSEL EXPERIENCE. UNIQUE TIDAL HABITAT RICH ENVIRONMENT.
- OPPORTUNITY TO CONNECT THREE MILE CREEK SHARED USE TRAIL WITH PROPOSED CITY OF MOBILE ON-ROAD BIKEWAY. EXISTING VEHICULAR CROSSING LOCATION WITH PLANNED ON-ROAD BIKEWAY.
- OPPORTUNITY FOR OBSERVATION TOWER IN FORESTED WETLAND
- EXISTING VEHICULAR CROSSING OVER THREE MILE CREEK
- COLLEGE AND UNIVERSITY
- THE WAVE MASS TRANSIT HUB

THREE MILE CREEK SUB-AREAS:

- UPPER WATERSHED
- MIDDLE WATERSHED
- TOULMINS SPRING BRANCH
- LOWER WATERSHED

THREE MILE CREEK OBSERVATIONS PER "AN IMPERVIOUS SURFACE STUDY OVER THREE REGIMES: THREE MILE CREEK, FLY CREEK, AND BAY MINETTE CREEK SUBWATERSHEDS" (MARCH 2004).

1. UPSTREAM OF INDUSTRIAL CANAL: STREAM WIDTH APPROXIMATELY 60 FEET. INDUSTRIAL LAND USE. ESTIMATED IMPERVIOUS SURFACE GREATER THAN 50 PERCENT. RIPARIAN ZONE DISTURBANCES ON BOTH BANKS. NO NATURAL CANOPY NOTED. AQUATIC VEGETATION OBSERVED ALONG BOTH BANKS.
2. DR. MLK JR. AVE: STREAM WIDTH APPROXIMATELY 100 FEET. URBAN LAND USE. ESTIMATED IMPERVIOUS SURFACE 20 PERCENT. RIPARIAN ZONE DISTURBANCES ON BOTH BANKS. NO CANOPY COVER NOTED. AQUATIC VEGETATION OBSERVED ALONG BOTH BANKS.
3. LEVERT DRIVE: STREAM WIDTH APPROXIMATELY 60 FEET. RESIDENTIAL LAND USE. ESTIMATED IMPERVIOUS SURFACE LESS THAN 10 PERCENT. RIPARIAN ZONE DISTURBANCES ON BOTH BANKS. NO CANOPY COVER NOTED. AQUATIC VEGETATION OBSERVED ALONG BOTH BANKS.
4. ARMOUR AVENUE: CHANNELIZED STREAM WIDTH APPROXIMATELY 50 FEET. COMMERCIAL LAND USE. ESTIMATED IMPERVIOUS SURFACE 10 PERCENT. RIPARIAN ZONE DISTURBANCES ON BOTH BANKS. NO CANOPY COVER NOTED. AQUATIC VEGETATION OBSERVED IN PATCHES.
5. DOWNSTREAM OF ZIEGLER BLVD: STREAM WIDTH APPROXIMATELY 20 FEET. URBAN FOREST LAND USE. ESTIMATED IMPERVIOUS SURFACE LESS THAN 10 PERCENT. NO RIPARIAN ZONE DISTURBANCES NOTED ON BOTH BANKS. 10 PERCENT CANOPY COVER. AQUATIC VEGETATION OBSERVED IN PATCHES. SUBSTANTIAL EROSION OBSERVED. DRAMATIC VARIANCE IN WATER LEVEL DURING PERIODS OF HEAVY RAINFALL.
6. UPSTREAM OF UNIVERSITY BLVD: STREAM WIDTH APPROXIMATELY 7 FEET. URBAN FOREST LAND USE ON BOTH BANKS. ESTIMATED IMPERVIOUS SURFACE LESS THAN 10 PERCENT. NO RIPARIAN ZONE DISTURBANCES NOTED ON BOTH BANKS. 70 PERCENT CANOPY COVER ESTIMATED. AQUATIC VEGETATION OBSERVED IN PATCHES.

"NEW PLAN FOR MOBILE": IMPLEMENTATION INITIATIVES (2009)

1. HICKORY STREET SPORTS ACADEMY AND COMMUNITY PARK - LANDFILL REDEVELOPMENT AND REUSE
2. MLK JR. AVE WEST MIXED-USE - COMMERCIAL NEIGHBORHOOD CENTER
3. THE BOTTOMS NEIGHBORHOOD REVITALIZATION
4. CAMPGROUND NEIGHBORHOOD REVITALIZATION
5. ST STEPHENS ROAD WEST GATEWAY COMMERCIAL RELOCATION AND MIDTOWN CENTER REDEVELOPMENT
6. THREE MILE CREEK GREENWAY INITIATIVE AND NEW TERRACE RESIDENTIAL COMMUNITY.

The total potential greenway trail length from Cody Road to Hickory Street Landfill is 12.7 miles (See Figures 6-16 a and b). However, nearly 75% of the land along this route may require land purchase or easements. Easements establish legal rights for a party, other than the owner, to utilize land for a specific purpose, such as the installation of power lines or a greenway trail, without actually purchasing the land. Typically, the easement is donated or purchased at a fraction of the cost of a fee simple purchase. The City of Mobile's recent experience with the purchase of utility and recreation easements indicates an average cost of $2/sq.ft. These costs are noted in the project costs provided in Table 6-11.

Three Mile Creek offers unique ecotourism opportunities for kayaking, canoeing, and use by other small, non-motorized water vessels. As noted in Figure 6-16 a and c, there are two potential zones for water-based recreation. Above the weir located near McLean Park is an advanced urban kayak course, while below the weir provides enough water volume and low velocity for less skilled boaters. Five suggested creek access locations identified on Figure 6-16 a-c:

- Conception Street (this site is currently being used by the public to launch kayaks)
- North end of Lawrence Street
- Dr. Martin Luther King, Jr. Avenue
- Lake Drive at Tricentennial Park
- Near I-65 (advanced kayak access only)
- Springhill Avenue near Langan Park (advanced kayak access only)

The breakdown of anticipated costs to implement the proposed greenway and blueway system in Three Mile Creek are provided by watershed segment in Table 6-11. An allowance for enhancements to facilitate portage over existing USACE weirs is included in the costs. Costs for design and construction of separated grade crossings at highways and railroads, as well as park amenities, require further detailed evaluation and therefore are not included at this time.

The total estimated planning level cost for the recreation facilities for the Three Mile Creek watershed ranges from $15 million to $23 million. The greenway costs are based on the section design from the Mobile County Bicentennial Bicycle & Pedestrian Comprehensive Plan provided in Figure 6-2. This design was used to develop the anticipated costs for the shared-use greenway trail along Three Mile Creek. It includes a paved trail to provide access to those with disabilities in accordance with the ADA, a recommended trail width of 10 feet, and a 2-foot graded shoulder (6:1 (H:V) maximum slope).

Table 6-11 Greenway and Blueway Costs

Project Identification Numbers	Recreation Projects	Costs ($)
1GW, 1BW	Lower Watershed: Greenway - 1.7 miles (50% public or non-profit ownership, 50% private easements) Blueway – (3 accesses, 0 portage enhancements)	$2,160,000 - $3,230,000 $21,500 - $32,400
	Subtotal	$2,181,500 - $3,262,400
1GW, 1BW	Middle Watershed: Greenway – 4.2 miles (100% public or non-profit ownership, 0% private easements) Blueway – (2 accesses, 4 portage enhancements)	$4,880,000-$7,320,000 $72,000-$108,500
	Subtotal	$4,952,000-$7,428,500
1GW, 1BW	Upper Watershed: Greenway – 6.8 miles (62% public or non-profit ownership, 48% private easements) Blueway – (1 accesses, 1 portage enhancements)	$8,590,000-$12,890,000 $16,800-$25,200
	Subtotal	$8,606,800-$12,915,200
1GW, 1BW	Grand Total	$15,740,300-$23,606,100

Note: Cost does not include surveying and engineering costs or annual costs associated with operation and maintenance of the completed structural improvements.

6.3 Top Projects Recommended for Implementation to Address Water Quality in the Three Mile Creek Watershed

In previous sections, we have addressed the challenges facing Three Mile Creek and identified the goals and objectives for restoring the watershed. The following projects (Table 6-12 and Figure 6-17) have been identified as having the greatest potential to provide significant early benefits to reaching the WMP goals. These projects are made up of one or more BMPs, or measures, and are described in more detail later in this section. Also as noted later in this section a 15-20% annual maintenance fee should be added for all structural measures to provide for on-going maintenance.

Table 6-12 Projects identified as providing early significant benefits to reaching the WMP goals for Three Mile Creek(* indicates which of the implementation strategies, if implemented in a section of the watershed contributing to an impacted stream segment, could improve the effected water quality parameter(s), See Tables 6-4 and 6-5).

Three Mile Creek Watershed Challenge to be Addressed and CCMP Value	Priority Projects	Summary Description	Cost	Proposed Implementation Schedule
Stormwater Resiliency Water	Reduce the amount of trash in and entering the creek and tributaries with a focus on One Mile Creek, Toulmins Spring Branch, USA, and Langan Park	1. Utilize utility/trash boat/weed harvester/engage Navy Seabees (6NS) 2. Identify the outfalls that contribute the most trash (8NS, 10NS, 14NS*) 3. Install GPRS or implement upstream LID/GI in the contributing watersheds, and/or Green Infrastructure in strategic locations (1S*, 2S*, 3S*) 4. Citizen involvement and education campaign (7NS, 11NS, 12NS) 5. Add trash capture at USA pond inflow points or implement upstream LID/GI in the contributing watersheds.(stormwater park) (6S*) 6. Add trash capture at Langan Park pond inflow points or implement upstream LID/GI in the contributing watersheds.(stormwater park) (7S*) *(* If purchase of utility/trash boat/weed harvester is required then add $800,000 to this Project (15NS, 16NS))*	$2.94M to $5.34M*	1. Initiate immediately 2. Initiate immediately 3. Following completion of 2 4. Continue throughout 10-year implementation period of WMP 5. Initiate immediately 6. Initiate immediately

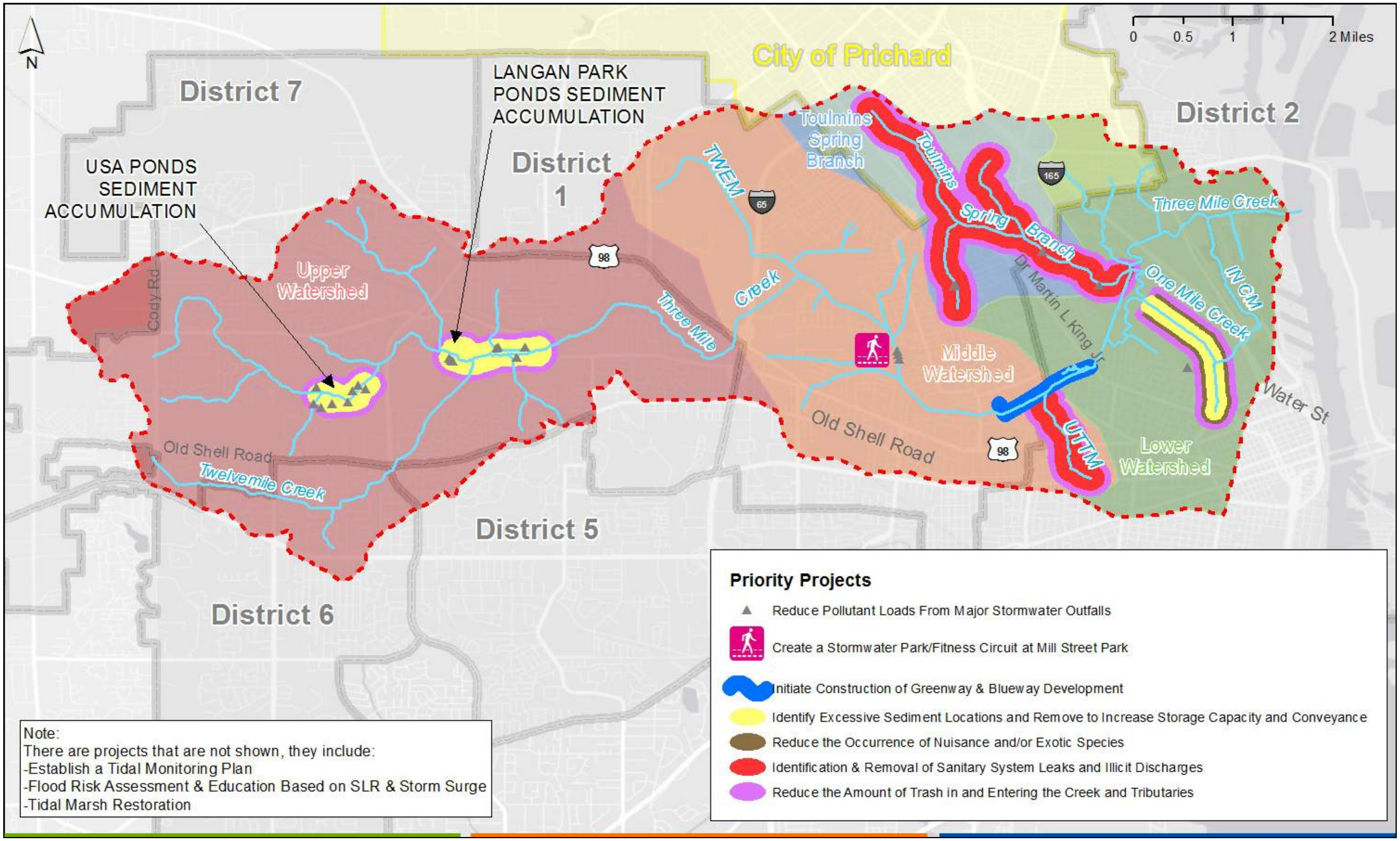
Three Mile Creek Watershed Challenge to be Addressed and CCMP Value	Priority Projects	Summary Description	Cost	Proposed Implementation Schedule
Stormwater, Ecology Fish Resiliency Water	Remove sediment to increase storage capacity and conveyance of stormwater runoff while improving ecological conditions	1. Identify locations of excessive sediment (3NS, 11NS, 12 NS) 2. Remove sediment at strategic locations (4S*, 5S*, 12S*)	$18.2M to $72.7M	1. Initiate immediately 2. Within second year of adoption of WMP (Continue additional segments throughout 10-year implementation period of WMP)
Wastewater Fish Resiliency Water	Remove Sanitary System Leaks, SSO, and Illicit Discharges in Toulmins Spring Branch and Unnamed Tributary to Three Mile Creek	1. Identify and remove sanitary system and septic system leakage/overflows into groundwater, creeks and tributaries (1NS*) 2. Identify and remove illicit discharges to stormwater and surface water system in watershed (2NS*) (Focus on Toulmins Spring Branch and UTTM sub-basins and lower portion of watershed (1NS* and 2 NS*)	$1.06M to $7.2M	1. Initiate immediately 2. Initiate immediately
Ecology Coastlines Fish Resiliency	Reduce the occurrence of nuisance and/or exotic species with a focus on One Mile Creek	1. Map SAV in watershed and Improve management of exotic/nuisance vegetation in wetland and upland riparian areas adjacent to creek and tributaries (6NS) 2. Develop plan for long term management. (6NS) 3. Utilize previously purchased utility/trash boat/weed harvester (6NS) *(* If purchase of utility/trash boat/weed harvester is required then add $800,000 to this Project (15NS, 16NS)*	$154,000 to $285,000 *	1. Within first year of adoption of WMP 2. Within second year of adoption of WMP 3. Perform within the WMP 10-year period (Implement Management Plan throughout 10-year implementation period of WMP)

Three Mile Creek Watershed Challenge to be Addressed and CCMP Value	Priority Projects	Summary Description	Cost	Proposed Implementation Schedule
Access Access Heritage	Initiate Construction of Greenway & Blueway Development	1. Establish a greenway along the existing USACE maintenance corridor utilizing the existing bridge at Martin Luther King Jr. Ave. to cross Three Mile Creek (1GW) 2. Anchor the Three Mile Creek blueway and greenway systems at Martin Luther King, Jr. Ave. and Tricentennial Park (1GW) 3. Construct two blueway access points at Tricentennial Park and Martin Luther King, Jr. Ave. (1BW)	$255,000 to $382,000	1. Initiate immediately 2. Initiate immediately 3. Initiate immediately (Continue additional segments throughout 10-year implementation period of WMP)
Stormwater, Access Water Access Heritage	Create a stormwater park/fitness circuit at Mill Street Park	1. Install structural BMPs as part of stormwater park or implement upstream LID/GI in the contributing watersheds. (1S*, 2S*, 3S*) 2. Integrate park access with blueway and greenway trail systems (1BW, 1GW) *(* Costs for easement purchase TBD)*	$546,000 to $966,000 *	1. Initiate immediately 2. Initiate immediately (Continue additional segments throughout 10-year implementation period of WMP)
Stormwater, Access Water Access Heritage Water	Establish a Stormwater and Tidal Monitoring System	1. Complete water quality monitoring identified in Data Gaps; identify major hydrologic and pollutant inputs (14NS*) 2. Identify or establish local tidal level monitoring sites and vegetation plots; monitor and record data in a database yearly (1CA) 3. At three-year intervals, evaluate changes in tidal range over time, vegetation survival/conversion and predictive modeling results to develop implementation plans for other projects (1CA)	$90,000 to $125,000	1. Initiate immediately 2. Conduct baseline monitoring during 2015 3. Continue throughout 10-year implementation period of WMP

Three Mile Creek Watershed Challenge to be Addressed and CCMP Value	Priority Projects	Summary Description	Cost	Proposed Implementation Schedule
Climate Adaptation Coastlines Resiliency	Flood Risk Assessment and Education based on SLR and storm surge	Incorporate flood risk management and storm surge information in educational outreach program (7NS)	Partnering Funds TBD	First quarter of 2015
Climate Adaptation Access Heritage Coastlines Resiliency	Tidal Marsh Restoration	Utilize SLR, Tidal Monitoring data and Surge study results to identify opportunities (areas at risk) for land acquisition and tidal marsh restoration (2CA, 4CA, 5CA)	TBD	Within one year of adoption of WMP
		Total	$23.2M to $87.1M	

*Comprehensive Conservation and Management Plan

Figure 6-17 Top Priority Projects cover all subsegments of the watershed.



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7 FINANCE STRATEGY & SUPPORTING FRAMEWORK

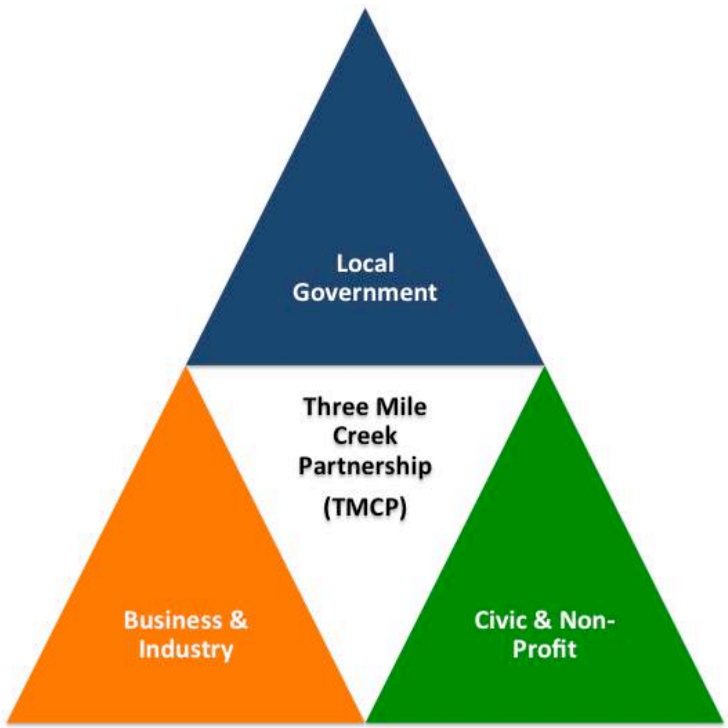
7.1 Recommended Supporting Management Framework

Successful implementation of the 44 management measures recommended in this WMP will require the long-term commitment of significant financial resources and community support. Many financial assistance opportunities, primarily in the form of Federal grants and cooperative agreements, are available readily exist to help restore, enhance, and reconnect Three Mile Creek to its surrounding communities.

In recent years, increases in watershed recovery efforts by communities around the nation have substantially increased the competition for these assistive resources. In order for the projects included in this plan to move forward effectively in this environment, Dewberry recommends the establishment of a model Three Mile Creek Partnership (TMCP) representing three primary support sectors (See Figure 7-1):

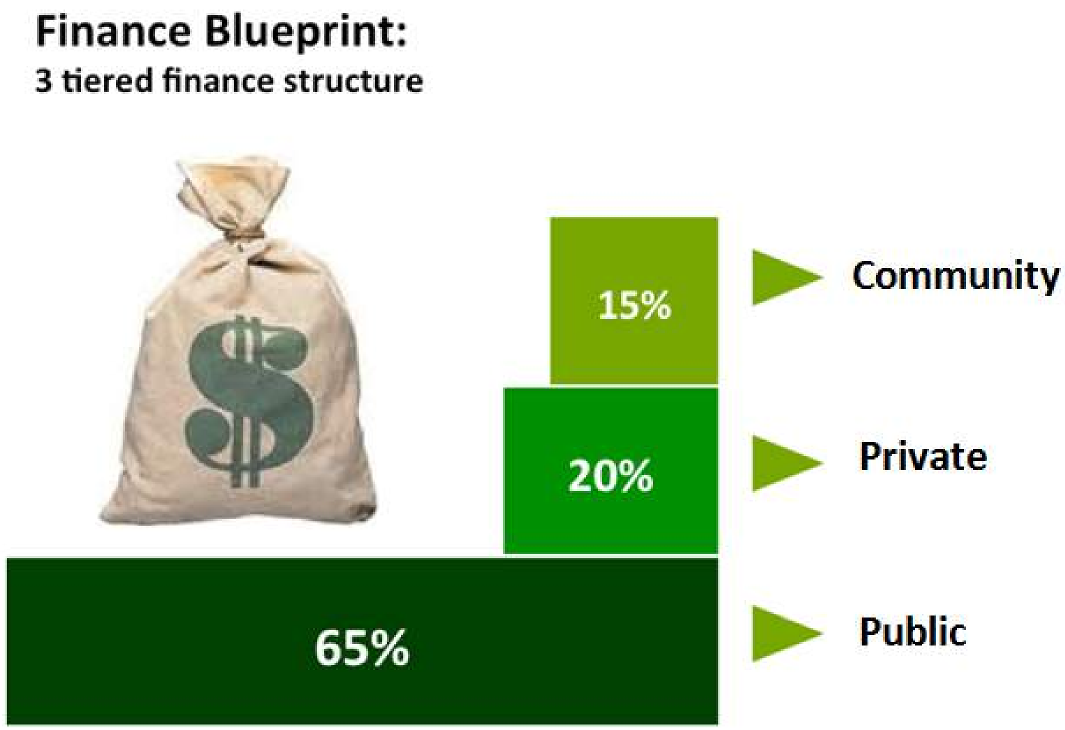
- Public (local government)
- Private (business & industry)
- Community (civic & non-profit)

Figure 7-1 Recommended Multi-Sector Partnership



Dewberry's recommended approach involves the pursuit of a 65% local government, 20% business & industry, and 15% community & civic organizational financing support partnership (Figure 7-2). This organizational model, effectively implemented, would set the Three Mile Creek WMP apart in the competitive grants market. Our experience working with each of these critical sectors of interest while we developed this WMP confirms that more than ample interest and capacity exists within the watershed to establish a multi-sector partnership on the scale required for full implementation of this plan. However, effectively tapping into this capacity will require organization and facilitative leadership commitment from each sector.

Figure 7-2 Leveraged Financing Goals



7.1.1 Local Government

Dewberry recommends that the local government sector of the TMCP include: the Cities of Mobile and Prichard, Mobile County, and MAWSS. Of these four governmental entities, we believe the City of Mobile possesses both the greatest opportunity and best coordination capacity among authorities to successfully guide this intergovernmental cooperative within the landscape involved.

7.1.2 Business and Industry

The Three Mile Creek watershed encompasses a highly diverse business and industry community spanning manufacturing, retail, wholesale, light and heavy industrial operations, technology, medicine, utilities, maritime industries, and residential and commercial development. Each and every one of these commercial interests has an economic stake in the health of the Three Mile Creek watershed and will directly benefit from its recovery or suffer from its decline. To help lead the involvement of this expansive community of stakeholders, Dewberry recommends leveraging the organization and leadership capacity of the Mobile Area Chamber of Commerce. The Chamber has a long and impressive record of success in facilitating the business partnerships needed to help Mobile's growth and competitiveness, which it has achieved through the continued innovation and focus of its membership.

7.1.3 Civic & Non-Profit

Well over 100 civic and non-profit organizations are either headquartered or operate in the Three Mile Creek watershed. As diverse as the business community, these organizations include a wide range of environmental, academic, social, educational, religious, medical, and philanthropic institutions focused on achieving continued improvement in the quality of life for the residents of the Three Mile Creek watershed. While not all of these organizations have either the focus or capacity of watershed recovery in their missions, we believe that many of these organizations would actively participate and contribute if simply given the opportunity.

As a start-up, we would recommend the targeted inclusion of the organizations listed below in this sector of the TMCP:

Alabama Coastal Foundation

Bishop State Community College

Coalition of Alabama Students for the Environment

Concerned Citizens of Prichard

Discovering Alabama

Hands on Mobile

J.L. Bedsole Foundation

Keep Mobile Beautiful

Mobile Baykeeper

Mobile Bay Sierra Club

Mobilians on Bikes

Mobile United

National Audubon Society

The Nature Conservancy

Partners for Environmental Progress

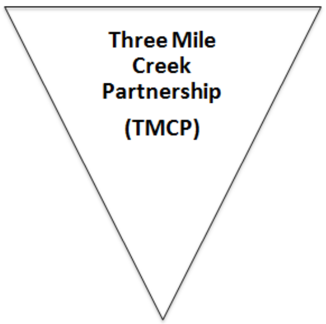
Prichard Environmental

Restoration Keepers

University of South Alabama

Dewberry recommends that the MBNEP work with these organizations to help identify and secure a facilitating lead organization based on capacity and experience with developing and administering multi-organizational partnerships development and administration. Several of these organizations, such as the Alabama Coastal Foundation, Mobile Baykeeper, or The Nature Conservancy, have established track records in this type of organizational facilitation, and each would be an excellent candidate for leading the civic and nonprofit sector's participation in the TMCP.

7.1.4 Three Mile Creek Partnership



Our recommendation, as noted earlier, is the establishment of a TMCP. This initiative can be created as a public-private partnership among the other three entities discussed above, or it could be a grassroots effort such as a 501(c)(3) organization. The TMCP would be a coordinating body for all initiatives to be implemented in this WMP. Elements in the creation of a TMCP may include:

- A small staff started by an entity with similar partnership-type experience and assisted by volunteers (e.g., AmeriCorps, Gulf Coast Restoration Corps, interested stakeholders);
- Initial funding from local foundations and private citizens with aligned goals of Three Mile Creek restoration – improvement of Mobile's environment, economy, public health, and quality of life;
- The participation of the established Three Mile Creek Steering, Technical, and Engagement Committees; and
- MBNEP in the role of the interim leader until the transfer of responsibilities is complete.

7.1.5 "One Mobile" in Action

In November 2013, Mobile seated a new city administration. This new leadership structure has issued a challenge for Mobilians — help create a progressive and business-friendly environment with a parallel goal of promoting safety and improved quality of life for all its citizens—a goal that is referred to as "One Mobile." The City's active support of the TMCP could provide a unique and timely laboratory for advancing the vision of "One Mobile" to measurable practice.

7.2 Public Funding Sources

Newly established, the Resources and Ecosystems Sustainability, Tourist Opportunities and Revived Economies (RESTORE)

Act, National Fish and Wildlife Foundation's (NFWF) Gulf Environmental Benefit Fund, and the Gulf of Mexico Energy Security Act (GOMESA) represent some of the most promising and challenging of these opportunities for this watershed.

7.2.1 Resources and Ecosystem Sustainability, Tourist Opportunities, and Revived Economies of the Gulf Coast States Act (RESTORE Act)

The federal RESTORE Act was signed into law on July 6th, 2012, as part of the Moving Ahead for Progress in the 21st Century Act (Public Law 112-141). The legislation established a mechanism for providing funding to the Gulf region to restore ecosystems and rebuild local economies damaged by the Deepwater Horizon oil spill. The RESTORE Act established in the Treasury of the United States the Gulf Coast Restoration Trust Fund (Trust Fund) consisting of 80% of an amount equal to any administrative and civil penalties paid after the date of the RESTORE Act by the responsible parties in connection with the Deepwater Horizon oil spill to the United States pursuant to a court order, negotiated settlement, or other instrument in accordance with section 311 of the Federal Water Pollution Control Act (FWPCA, 33 U.S.C. 1321).

Even though funding opportunities related to the Deepwater Horizon incident have clear potential to significantly "jump start" implementation activities, ***full and sustained restoration will require a long-term commitment from local government, citizens, and the private sector.***

As shown in Figure 7.3, the RESTORE Act divides the funds into five separate allocations and sets the parameters for how the funds are to be spent in each:

- 35% of the funds are divided equally among the five Gulf Coast states for ecological and economic restoration. Eligible activities include: restoration and protection of natural resources; mitigation of damage to natural resources; work force development and job creation; improvements to state parks; infrastructure projects, including ports; coastal flood protection; and promotion of tourism and Gulf seafood.
- 30% of the funds will be administered for restoration and protection according to the Comprehensive Plan developed by the Gulf Coast Ecosystem Restoration Council.
- 30% of the funds are dedicated to the Gulf Coast states based on a formula. This formula will be based on the number of miles of shoreline that experienced oiling, the distance from the Deepwater Horizon mobile drilling unit at the time of the

explosion, and the average population as of the 2010 Census. Each state is required to have a Council-approved plan in place for use of these funds.

- Two and a half percent of the funds are dedicated to the Gulf Coast Ecosystem Restoration Science, Observation, Monitoring and Technology Program, which will be established by NOAA for marine and estuarine research, ecosystem monitoring and ocean observation, data collection and stock assessments, and cooperative research.
- Two and a half percent of the funds are dedicated to the Centers of Excellence Research Grants Program. The funding is distributed through the states to nongovernmental entities to establish Centers of Excellence that will focus on the following disciplines: coastal and deltaic sustainability; restoration and protection; fisheries and wildlife ecosystem research and monitoring; offshore energy development; sustainable and resilient growth; and comprehensive observation, monitoring, and mapping in the Gulf.

Figure 7-3, RESTORE Act Allocation Structure

Note: At the time of this report, it is anticipated that the Deepwater Horizon litigation process will conclude in early 2015, which should result in a final settlement that will drive the ultimate distribution of the formulas described above.

7.2.2 – National Fish and Wildlife Foundation Gulf Environmental Benefit Fund

In early 2013, a U.S. District Court approved two plea agreements resolving certain criminal cases against British Petroleum and Transocean that arose from the 2010 Deepwater Horizon explosion and oil spill. The agreements directed a total of $2.544 billion to the NFWF to fund projects benefiting the natural resources of the Gulf Coast that were affected by the spill. Over the next five years, NFWF's newly established Gulf Environmental Benefit Fund will receive a total of $1.272 billion for barrier island and river diversion projects in Louisiana; $356 million each for natural resource projects in Alabama, Florida, and Mississippi; and $203 million for similar projects in Texas.

7.2.3 – Gulf of Mexico Energy Security Act of 2006 (GOMESA)

On December 20, 2006, the President signed into law the Gulf of Mexico Energy Security Act of 2006 (Pub. Law 109-432). The Act significantly enhances outer continental shelf (OCS) oil and gas leasing activities and revenue sharing in the Gulf of Mexico (GOM). The Act shares leasing revenues with Gulf oil and gas-producing states and the Land & Water Conservation Fund for coastal restoration projects; bans oil and gas leasing within 125 miles of the Florida coastline in the Eastern Planning Area, and a portion of the Central Planning Area, until 2022; and, allows companies to exchange certain existing leases in moratorium areas for bonus and royalty credits to be used on other GOM leases.

The Act created revenue-sharing provisions for the four Gulf oil- and gas- producing states of Alabama, Louisiana, Mississippi, and Texas, and their coastal political subdivisions (CPSs). GOMESA funds are to be used for coastal conservation, restoration, and hurricane protection. There are two phases of GOMESA revenue sharing:

Phase I: Beginning in Fiscal Year 2007 (FY07), 37.5%of all qualified OCS revenues, including bonus bids, rentals, and production royalties, were shared among the four states and their coastal political subdivisions from those new leases issued in the 181 Area in the Eastern planning area (also known as the 224 Sale Area) and the 181 South Area. Additionally, 12.5% of revenues are allocated to the Land and Water Conservation Fund (LWCF).

Phase II: The second phase of GOMESA revenue sharing begins in Fiscal Year 2017 (FY17).. It expands the definition of qualified OCS revenues to include receipts from GOM leases issued either after December 20, 2006, in the 181 Call Area, or, in 2002–2007, GOM Planning Areas subject to withdrawal or moratoria restrictions. A revenue-sharing cap of $500 million per year for the four Gulf oil- and gas-producing states, their CPSs, and the LWCF applies from Fiscal Years 2016 through 2055. The $500 million cap does not apply to qualified revenues generated in those areas associated with Phase I of the GOMESA program. The Bureau will address the second phase of GOMESA revenue sharing in a subsequent rulemaking.

7.2.4 – Other Public Funding Sources

Other public sources of funding include the following:

- EPA 604(b) grands
- EPA 319 grands
- EPA Brownfield grants
- EPA Urban Waters grants

7.3 Recommended Path Forward

These highly unique new authorities are arguably the most adaptive restoration funding-support programs in the market at this time. Collectively these authorities give local governments the flexibility to increase these funds by allowing their use as a “non-federal match” to further leverage other federal program authorities at ratios as high as 3:1. The RESTORE Act and the Gulf Environmental Benefit Fund implementation structures are still evolving, and currently many unknowns exist regarding their actual value to and eligibility for implementation of this WMP. Currently, there are four dominant financial program categories that have the greatest potential to significantly fund implementation of these projects in partnership with the championing county and municipal authorities that govern the watershed. Cataloged as an ongoing resource guide, composite lists of these funding opportunities are included in: Appendix I – Composite List of Federal Funding Opportunities; and, Appendix H – Selected Non-Government Organization and Other Private Funding Opportunities. The name of the funding program, contact information (including a web site), and a description of the program, are included in these appendices. Table 7-1 below summarizes available opportunities.

Table 7-1 Available Funding Sources

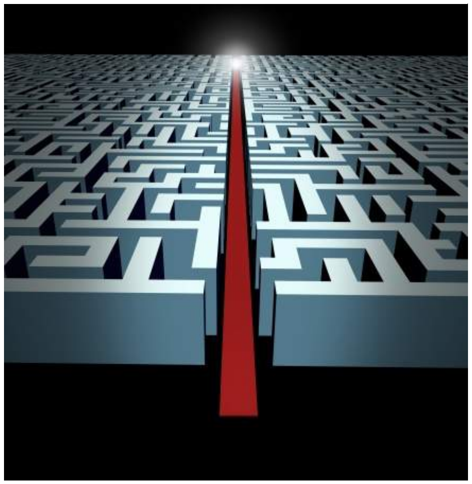
Acronym	Agency Name	No. of Programs
EPA	Environmental Protection Agency	11
FEMA	Federal Emergency Management Agency	2
NOAA	National Oceanic and Atmospheric Administration	7
USACE	U.S. Army Corps of Engineers	9
USDA	U.S. Department of Agriculture	8
USDOI	U.S. Department of the Interior	2
USDOT	U.S. Department of Transportation	2
USFWS	U.S. Fish and Wildlife Service	15
USHUD	U.S. Housing and Urban Development	2
EDA	Economic Development Administration	1
	Total of Federal Grants applicable to Three Mile Creek WMP Implementation	59
AEMA	Alabama Emergency Management Agency	11
ALWCF	Alabama Land & Water Conservation Fund	2
GOMESA	Gulf of Mexico Energy Security Act	7
CIAP	Coastal Impact Assistance Program	9
	Total State and Local funding sources applicable to Three Mile Creek WMP Implementation	4
TCOP	The Chronicle of Philanthropy	1
COS	Community of Science Database	1
FC	The Foundation Center	1
KAGP	Kodak American Greenways Program	1
RBC	RBC Blue Water Project	1
SFSE	Surdna Foundation Sustainable Environments Grants	1
WERF	Water Environmental Research Foundation	1
KF	The Kellogg Foundation	1
KB	KaBoom (recreational facilities)	1
	Total Private funding sources applicable to Three Mile Creek WMP Implementation	9

Organizational and O&M Support Financing Programs applicable to Three Mile Creek WMP Implementation include:

Figure 7-4 A Rich But Complex Market

- Two (2) Loan Instruments
    - Municpal bonds
    - Clean Water State Revolving Funds (SRF)
    - Other
- Eight (8) Taxes/Fees
    - Local Taxes
    - Stormwater District Utility Fees
    - Special Assessments
    - Impact Fees
    - Capital Improvement Cooperative Districts
    - Tax Increment Financing Districts
    - Alabama Improvement Districts
    - Environmental Tax Shift
- One (1) Natural Resource Credit
    - Wetlands Mitigation Banks
- Others as necessary

Figure 7-5 Solving the complexity through well-structured management and planning.



Virtually all of these financial authorities and/or market instruments can be coupled with one or more additional authorities for maximum leveraged value and benefit to the Three Mile Creek communities. The leveraging technique used by many of the nation's most successful WMP implementors involves breaking out the project scope so that discrete elements can be allocated among different funding sources. By way of example, many grant funding authorities do not allow for the award of funds for every element of a candidate project's implementation scope (i.e., planning, design, engineering, construction, performance monitoring, and operations and maintenance). Consequently, WMP implementors find that they have to align the elements of their projects with those authorities for which they are eligible.

To help ensure success going forward in navigating and competing in this complex funding framework going forward, we recommend the adoption of a renewable five-year adaptive implementation planning cycle to be administered under a bi-annual work plan and supporting budget framework. Most of the funding assistance programs identified here require pre-commitment of matching funds for application eligibility. Consequently, utilizing a two-year (planning in year one and budget in year two) structure will prove critical in meeting these eligibility requirements, and will greatly strengthen TMCP's competitiveness in these targeted assistance programs. Additionally, this approach will help establish the metrics needed to guide the focus of the remaining non-grant (local and public partnership) components of the supporting budget plan.

7.4 Funding for Top Priority Projects

The expansive and diverse pool of flexible financing-support structures identified in this assessment illustrates that significant tools and capacities readily exist to help support Three Mile Creek WMP implementation at whatever speed the supporting governance and community are prepared and commited to undertake to reclaim this invaluable resource. In anticipation that this WMP will be adopted for implementation, we conducted an initial assessment of which of these entities might offer the best inital underwriting assistance for the nine initial priority projects. The results of that assessment are provided as a "jump- start" blueprint in Table 7-2.

Table 7 -2 Recommended funding sources for Top Priority Projects, first year implementation cycle (2015 – 2019)

<table>
<tr><th rowspan="2">Priority Projects</th><th rowspan="2">Est. Cost (range)</th><th colspan="3">Recommended Support Targets/Authorities:</th></tr>
<tr><th>Federal/State Grants (65%)</th><th>Local Cost Share (15%)</th><th>Private Partnership Support (20%)</th></tr>
<tr><td>Reduce the amount of trash in and entering the creek and tributaries with a focus on One Mile Creek, Toulmins Spring Branch, USA, and Langan Park</td><td>$2.94M to $5.34M*</td><td>EPA
NOAA
USDA (GOMI)
DOD (NAVY Seabees)
ADEM
RESTORE</td><td rowspan="6">General Fund Commitments (County & Municipal)
Municipal Bonds
Clean Water
SRF
Stormwater Utility Fee
Program Implementation (w/TMC Set-aside)
AL RESTORE
ADCNR
ADECA</td><td rowspan="6">Private Contributions and Grants Portfolio Development and Management
NFWF</td></tr>
<tr><td>Remove sediment to increase storage capacity and conveyance of stormwater runoff while improving ecological conditions</td><td>$18.2M to $72.7M</td><td>ACOE
NOAA
FEMA (HMGP)
USDA (GOMI)
ADEM
RESTORE</td></tr>
<tr><td>Remove Sanitary System Leaks, SSO, and Illicit Discharges in Toulmins Spring Branch and Unnamed Tributary to Three Mile Creek</td><td>$1.06M to $7.2M</td><td>EPA
ADEM</td></tr>
<tr><td>Reduce the occurrence of nuisance and/or exotic species with a focus on One Mile Creek</td><td>$154,000 to $285,000*</td><td>NOAA
USFWS
EPA
ACOE
RESTORE</td></tr>
<tr><td>Initiate Construction of Greenway & Blueway Development</td><td>$255,000 to $382,000</td><td>ALDOT
HUD/CDBG
USDA
Restore (R)
NOAA
DOI</td></tr>
<tr><td>Create a stormwater park/fitness circuit at Mill Street Park</td><td>$546,000 to $966,000*</td><td>Funded under Private Partnership Support</td></tr>
</table>

<table>
<tr><th rowspan="2">Priority Projects</th><th rowspan="2">Est. Cost (range)</th><th colspan="3">Recommended Support Targets/Authorities:</th></tr>
<tr><th>Federal/State Grants (65%)</th><th>Local Cost Share (15%)</th><th>Private Partnership Support (20%)</th></tr>
<tr><td>Establish a Stormwater and Tidal Monitoring System</td><td>$90,000 to $125,000</td><td>RESTORE
NFWF
EPA
NOAA
USGS
ADEM</td><td rowspan="3">General Fund Commitments (County & Municipal)
Municipal Bonds
Clean Water SRF
Stormwater Utility Fee Program Implementation (w/TMC Set-aside)
AL RESTORE
ADCNR
ADECA</td><td rowspan="3">Private Contributions and Grants Portfolio Development and Management
NFWF</td></tr>
<tr><td>Flood Risk Assessment and Education based on SLR and storm surge</td><td>Partnering, TBD</td><td>FEMA
AEMA</td></tr>
<tr><td>Tidal Marsh Restoration</td><td>TBD</td><td>RESTORE
EPA
NOAA
USFWS
ACOE</td></tr>
<tr><td>Total</td><td>$23.2M to $87.1M</td><td></td><td></td><td></td></tr>
</table>

In summary, there are considerable and almost-boundless financial support options available to help support and ensure the Three Mile Creek WMP's success in reclaiming and revitalizing this resource. Establishment of a TMCP would clearly illustrate to the grants market the communities' active resolve to serve as vested and committed partners in the Three Mile Creek watershed recovery process. This endeavor would significantly enhance the TMCP's competitiveness and position going forward as it pursues available federal, state, local, and private grant assistance needed for implementation.

Dewberry is confident that the combination of an effectively-engineered and supported TMCP, coupled with aggressive, deliberate, and appropriately-celebrated implementation of the initial nine priority pilot projects over the next five years, will help secure long-term local commitment. These efforts will also establish the knowledge and experience needed to apply for the full range of funding sources needed for complete and successful implementation of this WMP.

8 PARTNERING TOGETHER

8.1 Introduction and Purpose

This section of the WMP outlines the efforts completed in the Mobile area to create and execute a robust community outreach plan that informs, educates, and engages citizens within the Three Mile Creek watershed. The plan will increase awareness of the benefits provided by the Creek, as well as the problems that impact it. The WMP also provides outreach recommendations to be considered during implementation of the plan. Successful implementation of the WMP will be achieved through a partnership between the MBNEP, members of the Three Mile Creek committees (see Acknowledgements), and the public. Consistent input from public stakeholders during the planning process identified ideas for addressing the environmental challenges facing Three Mile Creek. Through public meetings, messaging, and clean-up events, local residents have become more invested in the restoration of the Creek. With input from the MBNEP, Dewberry developed a Public Outreach Plan to establish a healthy dialogue between stakeholders in the watershed and create and encourage investment in the restoration of this valuable natural resource.

8.2 Goals

The goals of the Public Outreach Plan are to:

- Inform, educate, and engage key stakeholders in an effort to increase the public's awareness of the benefits provided by Three Mile Creek, as well as the problems impacting the Creek and its watershed.
- Develop the public's sense of ownership of Three Mile Creek along with an understanding of the value of watershed resources to the community.
- Provide avenues for the public to contribute to the watershed restoration process, such as offering their visions for the watershed that involve aesthetic enhancement, recreational access, and improved water quality.
- Reduce the volume of trash in Three Mile Creek through a cultural shift – where the community increasingly values Three Mile Creek as a natural resource that deserves protection and actively prevents trash from entering the creek.
- Explore additional techniques and opportunities for public involvement.

8.3 General Messaging

To achieve the goals outlined in Section 8.2, Dewberry and the MBNEP, with input from the Three Mile Creek Steering and Engagement Committees (see Section 8.4.1), developed the following statements to use as cohesive messages for all types of stakeholders. For instance, project handouts or talking points include the project vision statement, the definition of success, or the tag line. The benefit of this approach is delivery of a consistent message to the public. In addition, certain questions such as "what are the problems with Three Mile Creek?" or "what are the benefits of restoring the creek?" were asked frequently by many members of the public. The information below equipped the Dewberry Team, MBNEP, and members of all three committees with common messages for dissemination.

- **Vision Statement**: Three Mile Creek and its surrounding watershed present an extraordinary opportunity to the cities of Mobile and Prichard to turn what is now a community liability, as a result of its degraded condition, into a community amenity and a waterway destination.

- **Success**: The definition of success would be transformation of Three Mile Creek into a valuable artery through the City of Mobile, with improved water quality, habitats that support its living resources, accessible park areas connected by paths for walking and biking that also connect neighborhoods, and opportunities for paddling.

Challenges to Three Mile Creek Restoration

- Negative effects of stormwater runoff – including abundance of trash/litter and limited removal capacity
- The public's lack of knowledge about Three Mile Creek – its existence, history, and value
- Abundance of invasive species – e.g., apple snails and popcorn trees
- Limited public access
- Proportion of underserved residents living in the more vulnerable areas of the watershed
- Negative impacts to water quality, particularly from pathogens and nutrients

Beneficial Impacts of Three Mile Creek Restoration

- Monetary:
  - Increased surrounding property values
  - Increased economic opportunites related to development of Three Mile Creek as a tourist destination
  - Restoration of a cultural destination that celebrates a unique history
- Health:
  - Improved water quality
  - Improved fish and wildlife health, resulting in improved community health and increased civic pride
  - Reduced trash and litter as well as improved stormwater management in a smaller watershed (this can be used as a model for addressing similar challenges in larger drainage basins, such as Dog River)
  - Creation of over 12 miles of trails to serve recreational and commuter bicyclists, runners and joggers, and walkers along a scenic waterway.

8.4 Partnering Together During Implementation

Engagement is an essential component of ongoing restoration activities and should not end after the publication of the WMP. This planning effort represents an opportunity for intertwining environmental protection with community development. Moving forward, Three Mile Creek restoration engagement should center on the following principles:

- Involve
- Engage
- Educate
- Own

Involve

Momentum has been building over the years for restoration of Three Mile Creek, and as a result of the current efforts towards developing a WMP (i.e., public meetings, committee meetings), the timing is right to build upon the involvement of current audiences and invite more to participate in this work. The existing leadership structure – Steering, Technical, and Engagement committees – provides a wide array of local leaders who have been actively involved throughout this planning process, and their continued involvement will be extremely beneficial. New organizations and businesses should be identified and recruited to share in the Three Mile Creek restoration activities.

Engage

The WMP provides ideas and opportunities for stakeholders to become more actively engaged in restoration efforts and allows stakeholders to see where they might fit in with restoration. The MBNEP has made a great effort to get stakeholders out on the waters of Three Mile Creek in canoes and kayaks to experience the natural resource. These trips have inspired community leaders and organizations and built excitement for what Three Mile Creek offers and can become.

Educate

Education is critical to continue building the current momentum of Three Mile Creek restoration. Education extends beyond school curriculum opportunities and involvement of colleges and universities in research planning. It involves educating all stakeholders (i.e., local officials, private industry, grassroots organizations, and citizens) to increase awareness about Three Mile Creek's challenges and solutions, and to foster new attitudes, motivations, and stakeholder commitments.

Evaluating your outreach efforts, particularly education, provides a feedback mechanism for continuous improvement. As part of any future education endeavors, building in an evaluation component from the beginning will ensure some feedback on the impact of the outreach program.

Own

To acheive success, Three Mile Creek restoration must become an initiative rooted within the community. The MBNEP has led by initiating and driving the development of Three Mile Creek WMP, engaging a wide variety of stakeholders, and working to make the community vision of the Creek a reality. The MBNEP must pass the Three Mile Creek restoration "torch" to an independent organization solely focused on this effort (see Section 8.5.3.9).

8.4.1 Target Audiences During WMP Implementation

Dewberry and the MBNEP have targeted specific community stakeholders to become leaders in Three Mile Creek restoration. This section identifies these target audiences, describes how WMP implementation will address different values that are important to each, and identifies appropriate initiatives for each target audience to lead.

Our targeted primary audience includes those stakeholders who have the ability to make changes, whether through regulation or policy, participation in restoration activities, management of stormwater runoff, or communication of the Three Mile Creek restoration message. This audience includes:

- Local government officials (e.g., Mobile County Commissioners, Mayors, City Council members, and city and county administrators)
- Private industry
- Academia
- Local resource managers (e.g., utilities, and particularly the Mobile Area Water and Sewer System)
- Media (newspaper, radio, TV, and online)
- Community leaders

8.4.2 Targeted Audiences - Messaging & Tailored Implementation Initiatives

This section includes particular messages we want to communicate to important audiences within the watershed and suggested initiatives to encourage action by these targeted audiences:

Local Government Officials - Local elected officials and their staffs are responsible for establishing priorities for local programs, developing policy, and setting annual budgets. These roles can influence the scale and direction of Three Mile Creek restoration. The targeted value message for this stakeholder group is:

> *The WMP will provide local government officials with a vision to unify the City of Mobile around a concept – restoring Three Mile Creek will revitalize the local community and provide access to a historical and productive waterway. The WMP also provides the necessary information to guide wise decisions related to recreational access and economic development while ensuring protection of environmental resources.*

<u>Local Government Officials can</u>:

- Review and adopt the Three Mile Creek WMP Plan (Mobile City Council).
- Make implementation of WMP recommendations priorities for City planning.

* Ensure stricter enforcement of regulations related to littering and policing of frontage areas
* Implement innovative approaches to stormwater management as suggested in Section 6.
* Facilitate the review and approval of permits associated with the proposed WMP BMPs in a timely manner.
* Consider the establishment of an overlay district within the watershed area to channel a portion of taxes generated by local industry to Three Mile Creek restoration.
* Work with state and federal agencies to align projects and priorities.
* Explore a local disposable bag fee. This would entail passing legislation requiring all businesses selling food and/or alcohol to charge customers five cents for each disposable plastic bag. The businesses would retain one cent per bag and the remaining four cents would be put in a fund for Three Mile Creek restoration and maintenance, implementation of watershed education programs, trash collection and retention projects, and distribution of reusable bags. Several cities have implemented this policy (e.g., Washington, DC's Anacostia River Cleanup and Protection Act initiative - "Skip a Bag, Save the Creek"). The initiative would incentivise the use of reusable bags and aid in litter removal and education.
* Investigate opportunities to foster watershed community pride. Challenge City Council Districts to host trash collection competitions.
* Examine funding additional watershed signage (in addition to current watershed boundary signs):
    * Historical and cultural signage – post signs documenting specific moments in history and the role Three Mile Creek played (i.e., Civil War activities , biographies of local historical figures, baptismal sites, or other uses).
    * "Positive" ownership signs – positively connect residents with the Three Mile Creek watershed (e.g., "Keep Our Creek Clean" or "Creating a Clean Water Future") rather than "Don't Litter."
    * Visual ways to explain the benefits of Three Mile Creek and share the biological richness of the Creek with people.
* Host events (e.g., 5k races, public health fairs) at locations in Three Mile Creek to celebrate the venue while promoting fitness, health, and community among residents of Mobile and Prichard.

Private Industry – Success is more likely with a broad range of financial supporters. Thinking innovatively and demonstrating support from an active and diverse group of private stakeholders will attract and match sources of federal, state, and local funding.

Major institutions along the Three Mile Creek should be motivated to support its restoration because:

* All businesses near Three Mile Creek will benefit from its restoration.

- More foot traffic will benefit small businesses.
- Patients at local hospitals and students at local colleges – such as USA or Bishop State – will enjoy improved surroundings that will create a better living environment and increase satisfaction and pride in their community.
- Businesses can enhance their public image by demonstrating their support for restoring a local resource.

The targeted value message for this stakeholder group is:

The WMP recommends engagement opportunities for private industry in the implementation of projects to support their surrounding community, local workforce, and economy, while promoting their company image and goodwill.

Private industry can:

- Seize opportunities to become involved in recommended projects (see Section 6) near their businesses. For example, USA Hospital is exploring stormwater retention ponds and beautification along Three Mile Creek near their facilities. This benefits not only water quality, but patient and staff experiences.
- Fund components of other recommended BMPs throughout the watershed. Sponsorship information can be highlighted on signs or plaques.
- Donate materials for trail development (e.g., local nurseries, landscapers, boat launches, and landscape architects donating materials and planting flower beds along the trail).
- Provide construction services and equipment for project implementation.
- Build partnerships with the MBNEP and non-government organizations to become more engaged and learn about other ways they can participate in Three Mile Creek restoration.

Academia – Local schools and institutions of higher education provide opportunities to inform students about issues in their own backyards. Teachers and instructors can introduce their students to WMP concepts (e.g., dynamics and impacts of littering, stormwater management benefits, and water quality impairments). The targeted value message for this stakeholder group is:

The WMP presents extensive scientific and technical data regarding the current status of Three Mile Creek and measures to improve condition that can be utilized as educational tools for all levels of curriculum. The WMP also identifies data gaps which can provide opportunities for academic field work that benefits local resources.

Academic institutions can:

- Develop multiple curriculums for grades K-12 and beyond.
- Create grade school field trip opportunities to Three Mile Creek.
- Identify research and implementation opportunities, including field work/data collection with relevant departments at local colleges and universities. Include restoration initiatives in their curriculum when possible.

Local Resource Managers – Local resource managers provide services to Mobile residents, including water supply and wastewater treatment. These managers can assist in guiding water quantity and quality management within the watershed. The targeted value message for this stakeholder group is:

The WMP recommends actions that can be taken to improve water quantity and quality for Three Mile Creek, such as reducing stormwater pollutants, eliminating illicit sewer connections, reducing the amount of trash in waterways, and increasing the public's understanding of human impact on water resources.

Local resource managers can:

- Continue efforts to eliminate illicit wastewater connections and sanitary sewer overflows into groundwater, creeks, and tributaries within the Three Mile Creek watershed.
- Maintain their involvement in Three Mile Creek restoration efforts.

Media – Newspapers, television news programs, online news sources, and radio stations are significant sources of information for the public. The targeted value message for this stakeholder group is:

The WMP provides the background to a story of possibility for Mobile, and a vision supported by the public to revitalize the area and provide access for all residents to a beautiful natural resource within the City.

Local media can:

- Publish stories that highlight the WMP and its recommended actions.
- Create a news series describing developments of Three Mile Creek restoration post-WMP.
- Advertise any cleanup or anti-littering events and/or campaigns.
- Relate involvement of local leaders in Three Mile Creek restoration.

Community Leaders (neighborhood associations, community action groups, faith-based organizations, residents, etc.) – Community leaders play a vital role in improving Three Mile Creek conditions through actions such as litter reduction campaigns, sharing restoration ideas, and demanding that elected officials prioritize Three Mile Creek restoration. The targeted value message for this stakeholder group is:

> *The WMP represents a community-based approach to protect water quality, habitat, and living resources of the Three Mile Creek watershed with the goals of improving recreational opportunities, beautifying the area, and highlighting historical and cultural aspects of the watershed.*

Community leaders can:

- Host/co-host cleanup events that could be held in moving upstream from the Bottom.
- Work to create and launch neighborhood anti-littering campaigns.
- Promote Three Mile Creek as a neighborhood location for recreational activities (e.g., walks/runs for charity, kayak/canoe clean-up events).
- Educate residents on the benefits of restoration to their properties.
- Demand that elected officials prioritize Three Mile Creek restoration.

8.4.3 Future Leadership Structure – Three Mile Creek Partnership

The MBNEP and the Dewberry Team have already identified and involved many key Mobile leaders in this project; therefore, the concept is not to identify additional leaders to engage, but rather, how to structure the existing group moving forward. While the MBNEP has led the effort to initiate the restoration of Three Mile Creek, future efforts and project implementation must be rooted within the community.

The mission of the MBNEP is to promote wise stewardship of water quality and living resources of the Mobile Bay and the Mobile-Tensaw Delta. Three Mile Creek watershed is a part of this area. In order to support its mission and its role in the community, the MBNEP chooses to promote watershed planning, hence the development of this WMP. The MBNEP recognizes the crtical importance of restoring Three Mile Creek, but an independent leadership organization is needed to coordinate WMP implementation in close collaboration with the MBNEP.

Suggestions for Three Mile Creek Partnership initiatives:

- Develop a vision, mission, bylaws, and leadership structure based on current Three Mile Creek restoration involvement.
- Work with local governmental officials and regulators to implement the recommended WMP projects.
- Provide opportunities for public involvement and membership. The MBNEP and other partner organizations should continue to host/co-host a series of additional cleanup events that could be held in consecutive order upstream from the Bottom.
- Organize and coordinate the training of volunteer Estuary Coordinators on a wide variety of environmental topics (e.g., water quality monitoring and data collection, HAZWOPPER training) and utilize their skills for various watershed efforts.
- Host meetings with Community Action Groups and other neighborhood associations to equip them with knowledge and materials for creating anti-littering campaigns and for hosting their own cleanup events. The MBNEP should advertise itself as a resource for planning purposes and materials.
- Collaborate with citizen groups to promote stewardship efforts in restoring Three Mile Creek such as working with the Alabama Water Watch, a citizen volunteer water quality monitoring program that addresses water quality issues for both urban and rural watersheds throughout Alabama through citizen-based water quality monitoring and action enabling people to gather their own environmental data to address local issues.
- Promote Three Mile Creek as a location for recreational activities (e.g., walks/runs for charity, kayak/canoe cleanup events).
- Hold reoccurring meetings with area media professionals (e.g., The Mobile Press-Register, Lagniappe, other publications and local television news programs) to educate them about watershed management; provide information on events, pictures, and other descriptive materials; and update them on new developments and opportunities for public engagement.
- Generate media releases once a month on Three Mile Creek watershed activity.

9 ADAPTIVE MANAGEMENT

9.1 Introduction and Purpose

Watersheds are dynamic ecological and physical systems that are impacted by natural and anthropogenic events. Effectively managing them involves making decisions based on multiple, frequently-competing objectives that may be constrained by regulations, implementation capabilities, available resources, and uncertain responses to management actions.

Adaptive management is a systematic approach to improving management decisions by gathering information and learning from outcomes to guide future management decisions. This approach focuses on partnerships of stakeholders who together learn how to create and maintain sustainable resource systems.

9.2 The Role of Stakeholders

Stakeholder engagement and input are essential to success in virtually every stage of the adaptive management process; methods to encourage this continued involvement are detailed in Section 8. These stakeholders include the previously identified Steering, Engagement and Technical Committees, as well as interested members of the public, who should continue to serve in collaborative and advisory roles during implementation. The adaptive management process proposed for the Three Mile Creek watershed promotes stakeholder and project implementation team collaboration by:

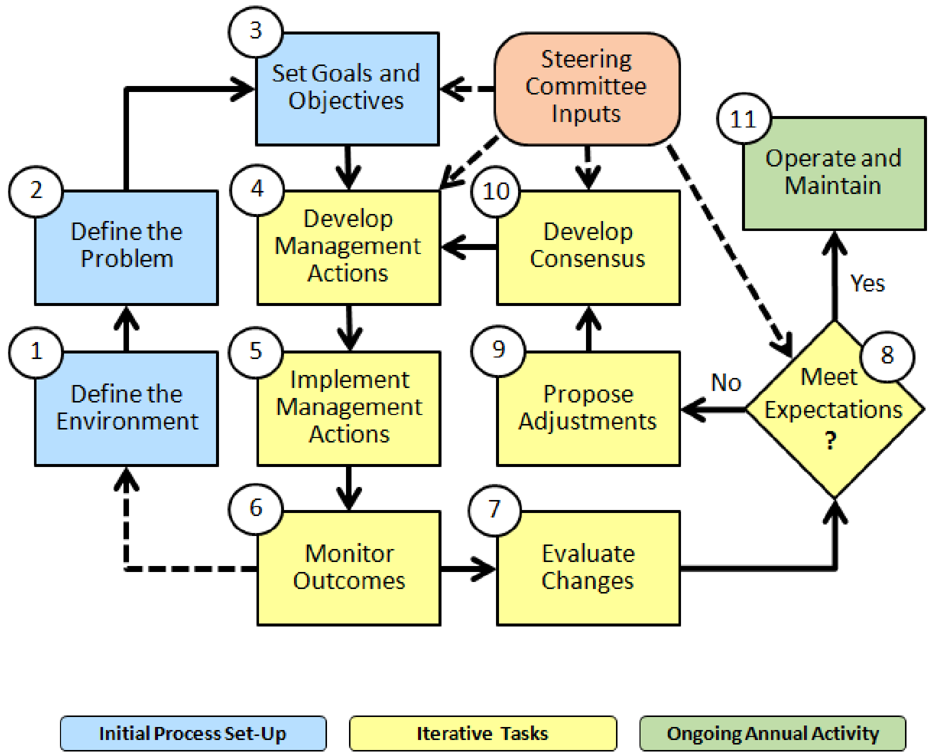
- Bolstering the level of stakeholder knowledge and science in the watershed,
- Setting programmatic goals and resource management objectives,
- Guiding the selection and development of the management actions that will be incorporated in individual projects,
- Tracking the implementation of management actions in the watershed,
- Guiding the development of adjustments to the implemented management actions to improve watershed outcomes,
- Assisting in the management and supervision of long-term O&M activities, and
- Garnering stakeholder support for the goals, strategies and objectives throughout the implementation process if adaptive management strategies are to work in practice.

Adaptive management requires the commitment of time and resources and the active engagement of stakeholders working to produce balanced, resilient and sustainable outcomes in the watershed. All phases of the adaptive management process must be open and transparent to stakeholders.

9.3 Adaptive Management Process

To implement the adaptive management process for Three Mile Creek, certain elements must be put in place, and then used in a cycle arriving at decisions by repeating rounds of discovery analyses to achieve the most desired result (See Figure 9-1). This section discusses each step in this process and the key activities to be undertaken.

Figure 9-1 The adaptive management process being proposed by the Dewberry Team consists of 11 steps with linked interactions.



9.3.1 Step 1: Define the Environment

The multiple aspects of a natural system include its physical, environmental, regulatory, community, financial, cultural and political environments. These environments can be represented as temporal and spatial datasets that are frequently organized in GIS data platforms to facilitate data use and reduce analytical costs. Taken collectively, they provide the basis for identifying and solving problems and developing management solutions. Existing watershed data collected for the development of this WMP includes a GIS database (see Appendix A and Sections 2 and 3 of this document).

Key activities in the initial implementation cycle include:

- Acquire available and relevant information to provide a sound basis for managing the watershed, and
- Identify any data adjustments needed to effectively use the acquired data.

Key activities in successive iteration cycles include:

- Continuously update the environment with new data, and
- Maintain data to ensure that acquired data is readily accessible.

9.3.2 Step 2: Define the Problem

This plan identifies the problems and associated consequences in the watershed and prioritizes the problems to be addressed in management actions (see Section 6). Implementation of this plan will require initiation of measures, projects and further studies. In each case, a more in-depth evaluation of the specific problems being addressed will be necessary.

Key activities in the initial implementation cycle include:

- Collaborate with stakeholders to develop a consensus regarding the significance of the identified problems; identify additional problems that should be addressed and decide which problems can be potentially eliminated from consideration, and
- Identify additional data gaps that adversely impact the knowledge basis for the management effort.

Key activities in successive iteration cycles include:

- Revise the problem definition(s) as appropriate based on new data resulting from implemented management activities

9.3.3 Step 3: Set Goals and Objectives

Adaptive management requires clear and agreed-upon goals and objectives that are specific, measurable, achievable, results-oriented and time-fixed. These goals and objectives will be used to inform and guide decision-making for taking actions, developing assumptions, formulating expected outcomes, modifying implemented actions, ensuring overall value being received and success.

Objectives should not be “broad-brush” statements. Adaptive management itself is not designed to resolve conflicts about objectives. If the objectives are not clear and measurable, the adaptive framework is undermined. Examples of objectives within the Three Mile Creek watershed might include:

Table 9-1 Example Resource Management Objectives for Identified Watershed Management Components

Component	Resource Management Objective
Wastewater	Reduction in pathogens entering water bodies from sanitary sewer overflows
Stormwater	Reduction of annual pollutant loads entering water bodies from sediments, organic matter and trash
Ecology	Decreased areas of non-native species
Climate Adaption	Maintain public access along the Three Mile Creek blueway or reduce impacts of flooding on economically underserved communities
Access	Improved public recreation opportunities

Key activities in the initial implementation cycle include:

- Define goals and objectives in detail, using clear language, so that they are useful as guides for decision making and evaluation;
- Confirm that regulatory requirements, standards and design criteria are being addressed in the new restoration projects;
- Recognize that multiple objectives often exist and work to balance stakeholder interests in the selection of strategies and actions;

- Identify and prioritize critical uncertainties;
- Define the collective vision of stakeholders for the watershed after the identified problems have been addressed;
- Incorporate the social, economic and/or ecological values of stakeholders in the framing of objectives;
- Reach agreement on the definition of and criteria for a successful restoration;
- Ensure that objectives are measurable with appropriate field data, achievable, results-oriented and applicable over the timeframe of the project; and
- Modify goals, objectives and desired endpoints based on input from the stakeholders.

Key activities in successive iteration cycles include:

- Review the initial stakeholder vision to better reflect the insights derived from the implemented management practices,
- Adjust and/or further refine goals and objectives where necessary based on new data and information derived from the monitoring of outcomes, and
- Consider the current criteria being used to identify successful restoration outcomes and make adjustments where required.

9.3.4 Step 4: Develop Management Actions

Decision-making in adaptive management involves the selection of appropriate actions for each point in time guided by evolving knowledge and science. Managers have the responsibility of identifying the set of potential management actions from which strategies and implementation plans are developed. If these actions fail to produce intended results, adaptive management will be unable to produce informative strategies. It is often beneficial to consider and include alternatives that will produce different system responses that can be measured and evaluated.

There are many ways to design the process for selecting alternatives. Formal methods can be used to select options that best account for current and future consequences. Stakeholders and managers can sometimes rely on less-structured approaches or common sense to identify acceptable strategies. Decision making should be driven by the objectives and informed by resource status and process uncertainties.

Key activities in the implementation cycle of initial resource management strategies include:

- Determine alternative restoration strategies and approaches that meet goals and objectives,
- Develop appropriate performance measures,
- Bring stakeholders together during the development of management strategies, and encourage long-term collaboration,
- Compare and rank projected outcomes for management alternatives in selection of actions, and
- Predict expected outcomes based on the current state of knowledge.

Key activities in successive iteration cycles for project alternatives include:

- Define alternative strategies for new projects based on initial project outcomes measured relative to goals and objectives,
- Continue to bring stakeholders together during the development of management strategies and decision making practices, and
- Review predicted performance characteristics from prior iteration, and revise as appropriate.

9.3.5 Step 5: Implement Management Actions

When all relevant factors have been considered and a strategy developed to consensus, one or more alternatives can be implemented. Examples of management actions that might be implemented for this plan are summarized in Table 9-2.

Table 9-2 Example Management Actions for Objectives

Component	Objective	Management Action
Wastewater	Reduction of pathogens entering water bodies from SSO	Decrease stormwater inflows to the wastewater system and/or increase equalization tank storage volume
Stormwater	Reduction of annual pollutant loads entering water bodies from sediments, organic matter and trash	Install green infrastructure and/or gross pollutant removal systems
Ecology	Decreased areas of non-native species	Remove invasive species
Climate Adaption	Maintain public access along the Three Mile Creek blueway or reduce impacts of flooding on economically-underserved communities	Identify and purchase easements over riparian lands most susceptible to conversion, or purchase flood-prone properties
Access	Improved public recreation opportunity	Develop of trails, kayak launches and parking facilities

Each management activity needs to be defined in terms of what will be done, when it will be done, capital investment needed, anticipated annual operation and management costs, and predicted outcomes/benefits.

Key activities in the initial implementation cycle include:

- Develop consensus with stakeholders early on regarding who will be responsible for the different aspects of implementing the selected management activities;
- Secure funding for initial construction and annual operating activities;
- Solicit proposals for implementing the selected management actions, select contractors and award contracts; and
- Adjust project plans as needed.

Key activities in successive iteration cycles, in addition to the work required in the initial iteration, include:

- Confirm that regulatory requirements, standards and design criteria are being addressed in the new restoration projects;
- Update the WMP to reflect successes and conclusion of the initial projects, and add any new implementation plans; and
- Adjust project plans as needed.

9.3.6 Step 6: Monitor Outcomes

Adaptive management is not possible without effective monitoring. Monitoring assesses watershed responses to management actions to inform better decisions and increase likelihood of success. By tracking implementation of management measures, monitoring programs enable project evaluation in adaptive management. Outcomes of management programs need to be measured for two distinct purposes:

- To establish performance points (baseline conditions) that can be used to measure progress and establish trends.
- To trigger change in management direction if performance does not meet objectives.

Monitoring provides the data from which to test alternatives and measure progress towards accomplishing objectives. Improved decision making justifies the cost of monitoring and assessment in adaptive management.

Examples of potential monitoring measures that might be adopted in the Three Mile Creek WMP for assessing the effectiveness of project implementation are shown in Table 9-3.

Table 9-3 Example Monitoring Issues

Component	Resource Management Objective	Management Action	Performance Measure
Wastewater	Reduction of pathogens entering water bodies from SSOs	Decrease stormwater inflows to the wastewater system and/or increase equalization tankstorage volume	Annual reduction in gallons of wastewater discharges via SSOs
Stormwater	Reduction of annual pollutant loads entering water bodies from sediments, organic matter and trash	Installation of green infrastructure and/or gross pollutant removal systems	Tons of accumulated sediment, organic matter and trash removed from drainage channels
Ecology	Decreased areas of non-native species	Remove invasive species	Lack of invasive species present
Climate Adaption	Maintain public access along the Three Mile Creek blueway or reduce impacts of flooding on economically underserved communities	Identify and purchase easements over riparian lands most susceptible to conversion, or purchase floodprone properties	Miles of Three Mile Creek open to public access or number of households no longer impacted by flooding
Access	Improved public recreation opportunity	Development of trails, kayak launches and parking facilities for the linear creek park	Inventory of constructed trails, kayak launches and parking spaces serving the public

Key activities in the initial implementation cycle include:

- Develop and implement monitoring plans to assess progress toward goals and objectives,
- Align monitoring activities with any current stakeholder monitoring programs to the maximum extent possible, and
- Establish current baseline reference conditions in the watershed to compare to responses after project implementation.

Key activities in successive iteration cycles include:

- Continue targeted monitoring activities from the prior iterative cycle with approved adjustments, and
- Review and modify the implemented monitoring plans as necessary.

9.3.7 Step 7: Evaluate Changes

Evaluation of system changes improves understanding of resource dynamics. Assessing desired outcomes against actual outcomes can be used to evaluate the effectiveness of decisions and to measure success in attaining objectives. Ideally, the response to previous management actions can be assessed before a decision about the next management action is made. For example, the response of water quality to implementation of water quality BMPs in one year can be assessed in time to inform the selection of the next cycle of BMPs.

Key activities in the initial implementation cycle include:

- Review monitoring data and compare expected outcomes against actual outcomes,
- Evaluate progress of improvements related to the implemented management actions,
- Identify approaches for reducing uncertainty and improving choices of management activities through time, and
- Develop processes for evaluating alternative management approaches.

Key activities in successive iteration cycles include:

- Continue assessment activities from the prior iterative cycle with approved adjustments,
- Identify which management practices had unrealistic or unobtainable initial performance predictions, and
- Evaluate the BMP priorities in future management projects going forward.

9.3.8 Step 8: Determine if Meeting Expectations

Adaptive management allows managers to determine systematically whether implemented projects are succeeding or failing to achieve objectives. Consequently, it is important to determine how the actual outcomes measured in the field compare to predicted outcomes. Metrics and the criteria for success in meeting implemented resource management objectives are commonly established by one of two methods:

- Compliance with regulatory criteria and standards
- Consensus of the stakeholders participating in and/or funding the process.

If performance meets or exceeds expectations:

- Determine the management practice to be a success.
- Document the final configuration of components and practices for use in upcoming opportunities.
- Transition the practice status from "adjustment and testing" to "operating and maintaining."

If performance fails to meet expectations:

- Make adjustments based on assessments and best available data.
- Continue monitoring performance/outcomes.
- Re-evaluate changes in performance/outcomes.

Key activities in the initial implementation cycle include:

- Determine if data is sufficient to decide whether success was achieved;
- If inadequate information exists, examine the data and estimate how much more is needed to decide if success can be achieved; and
- If adequate information exists, share the information with the Steering Committee, schedule a meeting, and collectively decide whether success has been achieved.

9.3.9 Step 9: Propose Adjustments

Management decisions can be revisited and adjusted over time. Decision making needs to be fact-based; otherwise, understanding of systems' behaviors cannot advance and learning cannot be applied to other opportunities.

At each decision point during implementation, actions can be adjusted. Appropriate actions are likely to change through time, as understanding evolves and the resource system responds to environmental conditions and management actions. It is the influence of reduced uncertainty on decision making that makes the decision process adaptive.

Key activities in the initial implementation cycle include:

- Use the monitoring results to identify which aspect(s) of the action is causing it to not meet its objective(s),
- Determine which aspect(s) of the action can be adjusted to best improve its performance during the next iterative cycle,
- Recommend one or more potential adjustments expected to improve the future performance of the action, and
- Develop consensus for the recommended adjustments and proceed with implementing those adjustments.

Key work activities in successive iteration cycles include:

- Evaluate the cost effectiveness of the action in terms of the cost per unit of benefit (e.g., $/pound of annual pollutant removal, $/acre of new public creek access, etc.) based on the use of monitoring data, and
- Adjust management actions over time as resource conditions change and understanding of the processes driving the system's responses increases.

9.3.10 Step 10: Develop Consensus

Although technical information and scientific understanding are required to assess tradeoffs and levels of risk associated with different management actions, the selection of an appropriate strategy requires building consensus. Stakeholder support of the programmatic goals and objectives helps to ensure that a management strategy works in practice. Consensus on goals and objectives at the beginning of an adaptive management project sets the stage for iterative, adaptive management cycles. However, consensus should continue through the life of the project.

Consensus is sustained by ongoing collaboration, through which any potential conflicts can be resolved. Consensus is promoted by collaboration and relationship building.

Key activities in the initial implementation cycle include:

- Develop a document that carefully defines the proposed changes in the management practice, and provide it to the Steering Committee so that all decision makers will be working from the same information;
- Conduct a collaborative workshop to develop consensus on the adjustments and timing of management activities based on resource status and ongoing information gathering.

Key activities in successive iteration cycles include:

- Strengthen working relationships with stakeholders to facilitate the best outcomes for the Three Mile Creek watershed and receiving water bodies, and

- Continue to encourage stakeholders to commit time and energy to adaptively manage the resource.

9.3.11 Step 11: Operate and Maintain

The last step in successful adaptive management processes is the conversion from the experimental "what if we…" phase to the sustained operations phase. In some cases, particularly where water quality treatment infrastructure has continued operations, maintenance activities are required to maintain permitting compliance.

Key activities include:

- Continue operating the management practice under the "success" conditions,
- Provide ongoing maintenance as required to sustain performance levels,
- Continue to measure and document performance,
- Look for ways to reduce annual O&M costs (e.g., labor, electricity, fuels, chemicals), and
- Update the cost per unit benefit estimates.

9.4 Indications of Programmatic Success in Adaptive Management Processes

Although "success" means different things to different people, indications of programmatic success in using the adaptive management process are likely to include:

- Stakeholders are actively involved and committed to the process.
- Progress is made toward achieving resource management objectives.
- Results from monitoring and assessment are used to adjust and improve management decisions.
- Implementation is consistent with applicable laws.

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APPENDICES