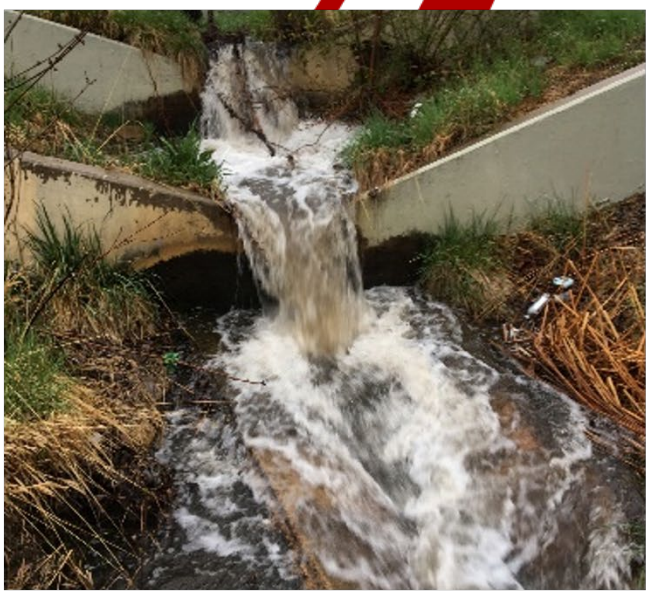
LONG-TERM SOLUTIONS FOR

Stormwater Management

Hattiesburg, Mississippi

Incorporating Stormwater Management into Broader Community Goals



October 2021

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Executive Summary

EXECUTIVE SUMMARY

Hattiesburg, Mississippi is one of four communities that participated in a U.S. Environmental Protection Agency (EPA) technical assistance effort to begin planning for stormwater management on a more long-term basis. These communities worked with EPA to synchronize planned and future activities and community goals with long-term stormwater planning.

Through a technical assistance effort, the city and EPA worked together to identify several of the city's long-term stormwater goals and develop a framework to implement them and engage stakeholders throughout the process. The city and EPA collaborated during a two-day onsite meeting in Hattiesburg and held numerous calls and working sessions throughout the technical assistance effort to identify goals, gather information, discuss ideas, establish strategies to achieve each goal, and document the strategies in a long-term plan. Hattiesburg participants included staff from the Engineering, Urban Development, and Public Works Departments, and the Mayor's Office.

The effort resulted in this plan, which identifies and describes the following goals to help guide Hattiesburg's stormwater management approach over the next 20 to 30 years:

- **Engage stakeholders**. Elicit community members' ideas, increase collaboration in the watershed, and gain support to help achieve the city's long-term stormwater vision.
- **Ensure adequate funding for the stormwater program**. Identify viable long-term funding options available to support a successful stormwater program that provides a desired level of service and meets regulatory requirements.
- **Achieve efficient, proactive, and cost-effective operation and maintenance of the city's stormwater infrastructure through asset management**. Establish a central data management and recordkeeping system that emphasizes data-driven actions, proactive maintenance procedures, stormwater asset inventory data, and financial planning to improve the quality, efficiency, and cost-effectiveness of services.
- **Improve the city's resilience to flooding**. Evaluate options for improved stormwater management practices to reduce vulnerability to flooding and support long-term recovery after a flood.
- **Incorporate green infrastructure into public project planning**. Explore ways to include green infrastructure approaches in public projects to increase resilience to extreme weather events and capture valuable co-benefits that gray infrastructure practices do not offer.

These goals align with a variety of other community master planning, development, recreation, and transportation goals that the city already has or is planning to pursue. By taking a comprehensive approach to stormwater management, the city can prioritize capital investments in stormwater infrastructure to protect human health and the environment, while minimizing costs and meeting bigger-picture goals.

By working with stakeholders to pursue the long-term stormwater plan's goals, the city can:

- Save money by aligning stormwater upgrades with other infrastructure and development projects.
- Engage with community members to continuously convey priorities and hear directly from those who will benefit from the city's goals.
- Improve drainage and reduce pollution with reliable infrastructure, which will attract and sustain residents and businesses in the community.
- Build an attractive community where residents can eat, live, work, play, fish, and canoe in their own backyards.
- Provide certainty and predictability to developers.
- Identify and pursue new opportunities for financing.

This plan outlines multiple "key actions" to achieve incremental progress toward each goal over time. The plan focuses on community-based solutions for stormwater management that city department supervisors, decision-makers, and key stakeholders may use to demonstrate the value of stormwater management in improving public infrastructure, the environment, and the overall quality of life for residents of Hattiesburg.

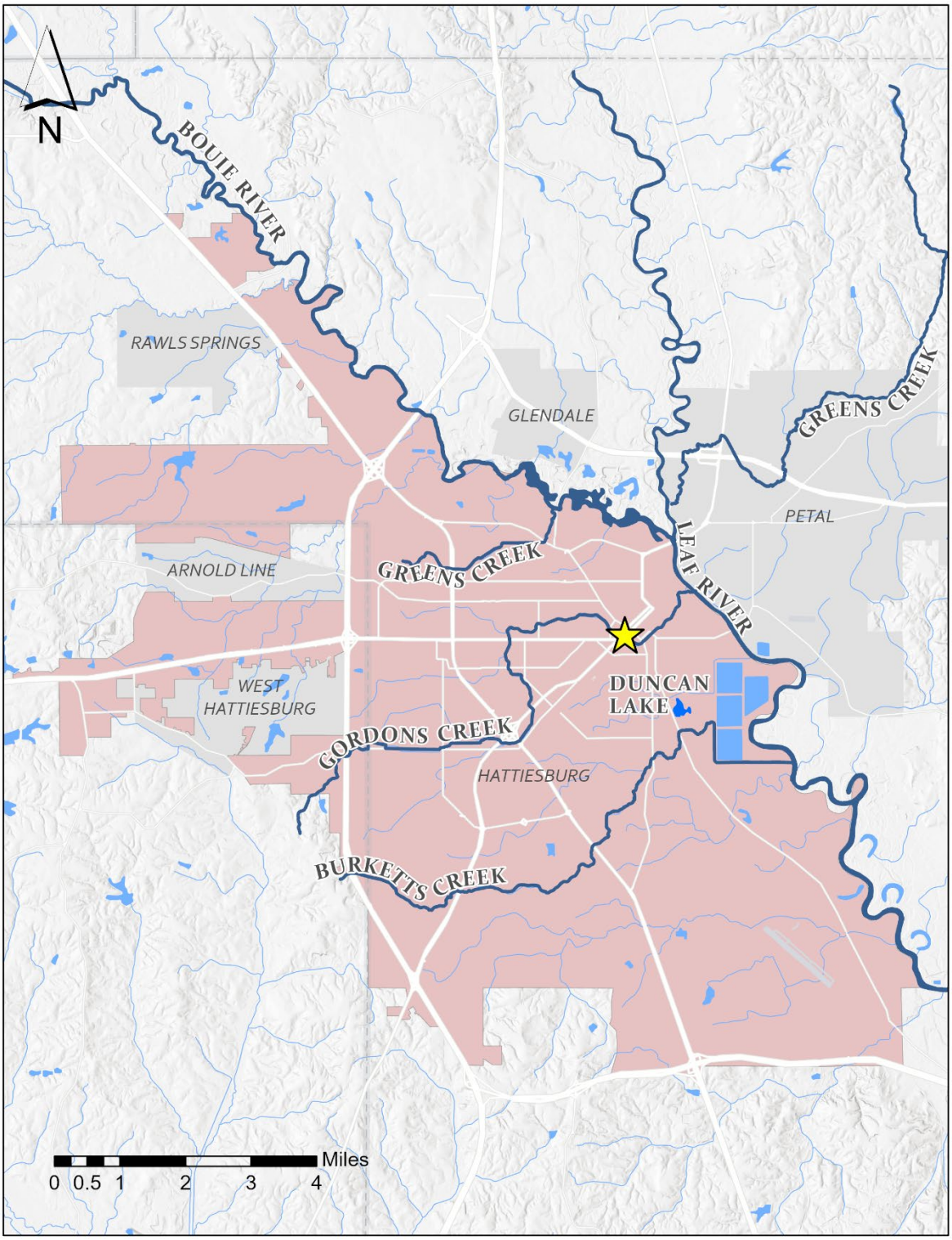

Figure ES-1. Map Showing the Hattiesburg City Limits and Primary Waterbodies.

OVERVIEW OF HATTIESBURG, MISSISSIPPI	
AT A GLANCE	**DETAILS**
Location • Southern Mississippi • Forrest County and Lamar County	Hattiesburg is known as the "Hub City" because it is located at the ***intersections of several major roadways and rail lines***. The city was established in the year 1884.
Size & Population • City pop.: 48,730 people • Metro area pop.: 172,231 people (U.S. Census Bureau 2020)	The city covers an area of approximately 54 square miles. The city's population is 53% Black, 43% White, 3% Hispanic, and 1% Asian.
Economy • $34,735 median household income (U.S. Census Bureau 2020) • Moody's Bond Rating of Aa3	Hattiesburg's economy was historically based on the railroad and lumber industries but has since transitioned primarily to health care and education. Some challenges include low property values, high unemployment rates, and multiple brownfield sites and vacant lots.
Climate • Average 62 inches of rainfall per year (U.S. Climate Data)	Due to Hattiesburg's geographic location and climate, the city experiences ***hurricanes, tornadoes, and heavy rainfall***, which often result in localized flooding.
Natural Disasters • 2005: Hurricane Katrina • 2013: Tornado • 2017: Tornado • 2018: Flood	Natural disasters have caused significant damage to Hattiesburg, forcing the city to prioritize rebuilding in their aftermath.
Flooding Primary causes: • River overflow from the Leaf River and its tributary creeks • Lack of capacity in the drainage system	***Flooding occurs in Hattiesburg virtually every year***. After an intense rainfall, floodwaters can rise at a rate of 2 to 3 feet per hour, reaching maximum stage in two hours (or less). A 1983 flood with a river stage of 29.19 feet resulted in over $32 million (approximately $81 million in 2019 USD) in damage. Two flash floods in the Mixon Creek basin area in 1999 had rainfall characteristics in the range of 100- and 500-year frequencies.[1]
Surface Waters • Bouie River • Leaf River • Gordon's Creek • Burketts Creek • Greens Creek	Located within the Pascagoula River Basin, Hattiesburg offers recreational activities near many of its local waterways. However, this ***proximity to water can present management challenges***. For example, the "Twin Forks Rising District," located at the intersection of the Bouie and Leaf Rivers, experiences regular flooding.

[1] http://www.hattiesburgms.com/government/departments/urban-development/floodplain-management/

OVERVIEW OF HATTIESBURG, MISSISSIPPI	
AT A GLANCE	**DETAILS**
Drinking Water Supplies • Supplied by 14 groundwater wells • Treated by two drinking water facilities	Hattiesburg's ***drinking water is supplied by more than a dozen groundwater wells*** throughout the local Miocene aquifer system. The water is treated by the city's drinking water treatment plants before distribution to customers.[2]
Wastewater Management • 400-acre South Lagoon Wastewater Treatment Facility (WWTF) • 18-acre North Lagoon WWTF	A dedicated system of pipes collect wastewater from homes and businesses and transport it to a city facility for processing. Two sewer lagoons treat the wastewater, which is then discharged to the Bouie River and the Leaf River.[3]
Stormwater Management • Discharges are permitted under the city's Small MS4 General Permit (No. MSRMS4) issued by the Mississippi Department of Environmental Quality	The city has separate systems for stormwater and wastewater. During rain events, a system of pipes, streets, and ditches (called the municipal separate storm sewer system or "MS4") collects and conveys stormwater runoff to nearby water bodies, primarily the Leaf River. Because of its location and the age/condition of its existing infrastructure, ***Hattiesburg experiences drainage issues, which can cause localized flooding*** and possible water quality problems.
Overall Water Infrastructure Condition (Drinking Water, Wastewater, and Stormwater) • Many assets are more than 80 years old	Being a historic city, **a significant portion of Hattiesburg's water infrastructure (stormwater, drinking water, and wastewater) needs repair or replacement**. The city's stormwater infrastructure requires resources to provide adequate levels of services and reduce flooding hazards, while its wastewater and drinking water infrastructure requires resources to ensure proper operation and maintenance, as well as treatment to protect health and receiving water quality.

This document was created collaboratively between the City of Hattiesburg and EPA. It does not impose any legally binding requirements on EPA, states, or the regulated community and does not confer legal rights or impose legal obligations upon any member of the public. EPA made every attempt to ensure the accuracy of the examples included in this document. In the event of a conflict or inconsistency between this document and any statute, regulation, or permit, it is the statute, regulation, or permit that governs, not this document.

[2] Hattiesburg 2014

[3] Hattiesburg n.d.

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Abbreviations and Acronyms

ABREVIATIONS AND ACRONYMS

BMP	Best Management Practice
CRS	Community Rating System
CSO	combined sewer overflow
DOT	U.S. Department of Transportation
EPA	U.S. Environmental Protection Agency
FEMA	U.S. Federal Emergency Management Agency
FMA	Flood Mitigation Assistance (Grant Program)
GIS	geographic information system
HMGP	Hazard Mitigation Grant Program
LOS	level of service
MDEQ	Mississippi Department of Environmental Quality
MDOT	Mississippi Department of Transportation
MEMA	Mississippi Emergency Management Agency
MS4	Municipal Separate Storm Sewer System
NFIP	National Flood Insurance Program
NRCS	Natural Resources Conservation Service
O&M	operation and maintenance
PDM	Pre-Disaster Mitigation (Grant Program)

Introduction

To help improve its flood resilience, infrastructure investments, environmental compliance, economic opportunities, and overall quality of life, the City of Hattiesburg, Mississippi, developed this Long-term Stormwater Plan in collaboration with the U.S. Environmental Protection Agency (EPA) as part of a voluntary technical assistance effort. The city also designed this plan to help it access funding sources by identifying long-term community goals and strategically aligning activities with a comprehensive water resource management focus.

View of a person kayaking on the Leaf River.

Through a collaborative process with various city departments and stakeholders, Hattiesburg aims to improve its stormwater services so that its program reflects and promotes the vision outlined below.

A VISION FOR THE CITY'S STORMWATER MANAGEMENT APPROACH:

- ✓ *Citizens are aware of and value the stormwater services that the city provides.*
- ✓ *The city has adequate funding for the program and a process for identifying and prioritizing needs.*
- ✓ *The city efficiently and proactively performs operation and maintenance activities using its asset management system.*
- ✓ *All city projects consider stormwater management as a component.*
- ✓ *Citizens can enjoy the multiple benefits of green infrastructure approaches.*
- ✓ *The city's program coordinates and leverages opportunities with other local programs and entities (e.g., City of Petal, Lamar County, Forrest County, University of Southern Mississippi).*
- ✓ *The city minimizes flooding impacts to citizens and businesses.*
- ✓ *The city effectively coordinates stormwater, drinking water, and sewer service management with a holistic view of overall water resource management.*

Acknowledging that program implementation can take considerable time, this plan conveys the city's overall vision for stormwater management and identifies several goals to help achieve that vision over the next 10 to 20 years. To help overcome challenges and realize the community benefits of improved stormwater services, the city is focusing on the following goals:

- **Goal 1:** Engage stakeholders.
- **Goal 2:** Ensure adequate funding for the stormwater program.
- **Goal 3:** Achieve efficient, proactive, and cost-effective operation and maintenance (O&M) of the city's stormwater infrastructure through asset management.
- **Goal 4:** Improve the city's resilience to flooding.
- **Goal 5:** Identify opportunities for improved stormwater management and green infrastructure in public projects.

The city anticipates continuing to pursue long-term stormwater planning and implementation well into the future. To make incremental progress, the city has identified "key actions" within each goal to accomplish over time. The sections within this plan fully describe these goals and key actions the city may take in the short (zero to five years), mid (five to 15 years), and long (15+ years) term. Due to the potential for changes over time that may be caused by a variety of forces (e.g., funding needs, political support, natural disasters), *these key actions and associated timelines are intended to be an adaptable framework* for the city that can ultimately lead to community and environmental benefits.

Although the goals in this plan are stormwater focused, they are also closely linked to broader community goals that promote smart development and economic growth, revitalize the city's downtown corridor, assist with permit compliance, improve public health and wellbeing, and are aligned with and support the objectives of some other community plans.

View of the confluence of the Leaf River and the Bouie River.

EXAMPLES OF EXISTING COMMUNITY PLANS

Hattiesburg Comprehensive Plan 2008–2028: Identifies long-range goals and policies that will be used to guide public and private decision-making related to Hattiesburg's future growth and community development and addresses the enlarged corporate limits and major advances in technology that the previous plan did not.

Little Gordy Lake: A conceptual project that focuses on relieving a flood prone area and providing a scenic linkage between the University of Southern Mississippi, Midtown, and Forrest General Hospital with a 1.8-acre lake project and associated walking trails, benches, lighting, and bridges.

Midtown in Motion – A Master Plan for Midtown Hattiesburg: A community development plan for the Midtown area focuses on using stormwater as an amenity/resource, while also mitigating flooding issues.

Pathways Master Plan: Provides a clear framework for the development of new facilities, programs, and policies that will support safe and convenient walking and hiking conditions for transportation and recreation.

Twin Forks Rising Master Plan: Lays out the framework for creating a series of water features to address both the real and the perceived threat of flooding in the Twin Forks area. These features incorporate two important redevelopment catalysts: to serve as a basis of flood zone revisions and to provide redevelopment opportunities based on a public amenity.

Vision 2020 Strategic Plan: Focuses on four specific core values, with each core value specifying goals and outlining tactics to achieve those goals. The goals are: Grow tourism's economic impact in Hattiesburg; Communicate and amplify the Hattiesburg story; Strengthen partner network and collaboration; and Prioritize placemaking and enhance the Hattiesburg experience.

Lamar County Comprehensive Plan: Serves as a policy guide to the decision-making process in the Lamar County government and is the result of an extensive study into existing development patterns, as well as population and economic trends.

Gordon's Creek Park Conceptual Development Plan: Features the addition of pathways, bank stabilization (including loose riprap, concrete, riprap, gabions, loose concrete and formed concrete banks) to the Gordon's Creek Park. The goal of the project is to restore some of the banks to a more natural state while protecting the banks from further erosion.

2045 Metropolitan Transportation Plan: Lays out a vision and course of action for addressing the transportation needs of Hattiesburg over the next twenty-five years. Its recommendations are the result of public input, technical analysis, and close coordination between local municipalities and counties, public transportation providers, the Mississippi Department of Transportation (MDOT), and other members of the Hattiesburg-Petal-Forrest-Lamar Metropolitan Planning Organization (MPO).

Leaf River Watershed Plan (to be developed): Will be a multi-jurisdiction plan created with significant stakeholder input. The plan is intended to identify and better understand the sources and impacts of water volume and potential pollution, as well as possible solutions to capacity challenges and mitigation options to help prevent flooding and to protect and restore waterbodies within area watersheds.

Goal 1: Engage Stakeholders

Hattiesburg will engage a robust group of stakeholders to elicit ideas, increase collaboration in the watershed, and engender community support to help achieve the city's long-term stormwater vision. This involves opening channels of communication to fully consider the views of the public and decision makers alike. Community members are more likely to embrace the Long-term Stormwater Plan, remain engaged, and be part of its success if they can discuss options and issues before decisions are made. Having local support from the community, including high-profile business owners, political activists, educators, citizen group activists, religious leaders, and outside experts helps spread the message about the need for a strong stormwater plan and adequate funding. Furthermore, incorporating this local knowledge and expertise will allow the city to be more responsive to locally identified issues.

The city will identify target stakeholder groups and audiences who are interested in, affected by, or could help implement activities related to the Long-term Stormwater Plan as well as create a stakeholder engagement strategy. Stakeholders will have multiple opportunities to help establish the plan vision and goals and to identify and prioritize project alternatives. Ideally, this process will yield community consensus and help reduce the number of challenges that remain when officials must determine whether to fund plan components.

Overall, Hattiesburg has identified three main key actions under this goal that will be essential to the long-term success of its stormwater management efforts. Table 1 lists these key actions, and the following sections describe them in more detail.

Hattiesburg hosted a three-day charrette with EPA and various stakeholders in May 2018 to **elicit input on sustainable community design options** for several areas in the community. The design team facilitated a public meeting and three focus groups on economic development, green infrastructure, and multimodal transportation. Participants included the following:

- ✓ Twin Forks Rising group and residents of the Edwards Street area.
- ✓ City Council members.
- ✓ Area Development Partnership.
- ✓ William Carey University staff.
- ✓ Members of the Hattiesburg Police and Fire Departments.
- ✓ City employees from the planning, public works, and parks and recreation departments.
- ✓ Local business owners.

The city refined the designs based on the expressed comments, preferences, and concerns. The city continues to engage in project planning efforts stemming from the collaborative design process.

Table 1. Key Actions to Engage Stakeholders (Goal 1)

Key Actions	
1.1	Identify stakeholders, target audiences, and potential partners.
1.2	Write a stakeholder engagement strategy.
1.3	Conduct ongoing stakeholder outreach and engagement.

1.1 Key Action: Identify Stakeholders, Target Audiences, and Potential Partners

As a preliminary step, the city has outlined several key groups, including community members and organizations, local institutions, and government agencies that it may engage to some degree in the long-term stormwater planning effort (see Table 1 below). To better understand stakeholders, target audiences, and potential partners, the city will:

- **Identify key city team members** for developing and implementing the stakeholder engagement strategy under Key Action 1.2.
- **Identify additional partners** interested in supporting strategy development and outreach.
- **Outline the roles, responsibilities, and level of involvement** of stakeholder engagement team members as well as stakeholders who will help implement aspects of the Long-term Stormwater Plan.
- **Identify target stakeholder groups and audiences** who are interested in, affected by, or could help implement activities related to the Long-term Stormwater Plan and identify the relevant goals and steps in planning and implementation for each group. The city will need to identify a team member responsible for communicating with each stakeholder group, as well as the frequency and means of communication.

City staff should continue to engage the **city's elected officials** to update them on steps to improve stormwater services and, in turn, reduce flooding and improve local water quality.

Hattiesburg could further engage with the **City of Petal, Forrest County, Lamar County, and other local communities** to pool resources for stormwater-related educational materials, green infrastructure demonstration projects, and other commitments under the MS4 Permit.

Table 2. List of Potential Stakeholders

- **Elected Officials:**
  - City mayor
  - City manager
  - City council
- **City Departments:**
  - Engineering
  - Public Works
  - Finance
  - Urban Development and Federal and State Programs
  - Planning
  - Schools
- **Local Stakeholders:**
  - University of Southern Mississippi
  - The Lake Thoreau Environmental Center
  - William Carey College
  - Longleaf Trace (Pearl and Leaf Rivers Rails to Trails Recreation District)
  - Hospitals
  - Pascagoula River Basin Alliance
  - Blueways Group
  - Gordon's Creek Yacht Club
  - Engineering and architecture firms
- **Community Partnerships:**
  - City of Petal
  - Lamar and Forrest Counties
- **State Agencies:**
  - Mississippi Department of Environmental Quality
  - Mississippi Department of Wildlife, Fisheries, and Parks
  - Mississippi Department of Transportation
  - Mississippi Development Authority
- **Regional Entities:**
  - Metropolitan Planning Organization
- **Federal Agencies:**
  - U.S. Environmental Protection Agency
  - U.S. Department of Agriculture
  - Natural Resources Conservation Service
  - Federal Emergency Management Agency
  - U.S. Army Corps of Engineers
  - U.S. Department of Housing and Urban Development
  - U.S. Department of Transportation (Federal Highway Administration)
  - U.S. National Park Service
  - U.S. Forest Service
- **Foundations:**
  - National Fish and Wildlife Foundation

1.2 Key Action: Write a Stakeholder Engagement Strategy

The city will write an engagement strategy that includes information about target stakeholders and audiences (identified through Key Action 1.1), key messages, and means of reaching each audience. To develop the strategy, the city will:

- **Identify key messages** that resonate with each target audience and stakeholder group. The messages should express the science behind the problem without jargon and confusing acronyms, so they are more understandable to a wider audience.
- When developing key messages, it is important to think about the aspects of the Long-term Stormwater Plan that will resonate with each of the identified target audiences. For example, homeowners may be interested in the impact on property values, neighborhood aesthetics, and

recreational opportunities, while city departments may be more focused on the plan's financial impacts or changes in local flooding. Best practices to consider when developing key messages include:

- Keep the main message simple and focus on how these actions can help improve areas where people live, work, or play.
- Try to create an emotional connection with the audience.
- Sell the benefits of your program rather than the features.
- Identify facts that can support your main message.

- Determine **methods for engaging** with target audiences and stakeholders. For example:
  - City stormwater staff should engage with city communications staff to understand the best methods for engaging with the public and soliciting their input on public matters.
  - The best way to reach out to residents might be at a community event or public meeting, as well as via the city's website or social media accounts.
  - Traditional media (e.g., newspapers, radio) and printed materials might be best suited for reaching some audiences.
  - Face-to-face meetings might be best for discussing the plan with the mayor, city council, city departments, and local and regional stakeholder organizations.

As needed, the team will explore existing documents and resources on effective stakeholder engagement. Several links to resources are provided at the end of this Key Action section.

EXAMPLES OF KEY MESSAGES

- ✓ While costs are associated with implementing the Long-term Stormwater Plan, paying for these projects now will improve our community.
- ✓ Implementing the Long-term Stormwater Plan will result in a cleaner, more livable community with enhanced aesthetics and recreational opportunities.

- Outline **methods for measuring engagement and success** as part of the engagement strategy to evaluate public awareness or the effect of media outreach. Using a combination of metrics will ensure the city reaches a broader range of the public in varying socioeconomic classes. It will also help the city assess public engagement and whether it needs to take a different approach or make a mid-course correction. Metrics to consider for engagement methods (if applicable) include:
  - **Survey responses:** the number and percentage of positive/negative responses, or an indication of understanding of key stormwater concepts (e.g., watershed, green infrastructure).
  - **Media tracking and social media impressions:** number of articles in local and regional media; social media posts (Twitter, Facebook).
  - **Document downloads:** number of document views/downloads from a website.
  - **Meeting attendance and contact information:** number of attendees at public meetings and contact information of participants willing to share.
  - **Public comment tracking:** number of comments broken down by positive/negative.

- The following publications provide additional resources for tactics and strategies to engage the public:

- Public Outreach for Integrated Wastewater and Stormwater Planning
- Prioritizing Wastewater and Stormwater Projects Using Stakeholder Input
- University of Pennsylvania: Your Quick Guide to Community-Based Social Marketing

1.3 Key Action: Conduct Ongoing Stakeholder Outreach and Engagement

The city will use the stakeholder engagement strategy to conduct outreach when implementing the Long-term Stormwater Plan and updating it over time. Outreach activities can build awareness about stormwater services, inform the public about the city's activities, communicate the value and benefits of the plan, access local knowledge and experience, create buy-in for infrastructure investment expenditures, and identify potentially contentious issues or deal breakers. Hattiesburg should scale efforts according to local conditions and program goals. Table 3 summarizes some key factors to consider.

Table 3. Key Factors to Consider During Outreach and Engagement

More Intensive Effort Needed for Outreach and Engagement if...	Less Intensive Efforts Needed for Outreach and Engagement if...
Stormwater issues are complex, and solutions are unclear.	Program drivers and solutions are relatively simple and straightforward.
The city needs substantial new funding compared to current funding.	The city needs modest or minimal additional funding.
Decision makers are unfamiliar with stormwater services and needs.	Decision makers understand stormwater is a priority.
The community has little awareness of water issues and opportunities.	The community highly values clean water and the need for stormwater services.

The city will adjust outreach activities based on the observed or measured effectiveness of the chosen approaches.

View of citizens enjoying a summertime "Live at Five" event along Gordon's Creek.

Goal 2: Ensure Adequate Funding to Meet Stormwater Program Objectives

Effective stormwater management approaches support Hattiesburg's overarching goals for economic growth, community vibrancy, and resilience. Accomplishing each of the goals in the city's Long-Term Stormwater Plan will require a sustainable municipal stormwater funding strategy. To develop this strategy, the city will evaluate existing stormwater management activities and responsibilities, including the current level and cost of services it provides to citizens.

View of Duncan Lake.

In Hattiesburg, the engineering department is primarily responsible for providing stormwater-related services, with the city's public works, urban development, and other departments providing some services. These departments bear the costs of stormwater activities in their budgets, which are funded through the city's general fund (not through a separate stormwater utility fee or similar). The city has obtained some grant funding for stormwater-related activities (e.g., bank stabilization through the Natural Resources Conservation Service [NRCS]). To date, the city has not obtained funds for stormwater activities or improvements through the Mississippi Water Pollution Control (Clean Water) Revolving Loan Fund.

Many communities across the country struggle to identify the true costs associated with specific program activities. This is particularly true for stormwater services, which are often integrated with or combined with services provided through multiple municipal departments and programs, such as public works, engineering, planning, wastewater, transportation, waste management, and more.

Without an accurate picture of the costs of a stormwater program's activities and their associated financial, environmental, and social benefits, stormwater managers will face a steep challenge making the case for stormwater investments to the public and elected officials. In addition, many stormwater programs are implemented based on the funding they can get, not on the funding they need. This approach may seem the most realistic based on what the community can afford and competing needs. However, it can institutionalize subpar program design and implementation that limits the city's ability to improve incrementally and eventually achieve important long-term goals.

Hattiesburg is developing a vision for enhanced stormwater services in the community (further outlined in Goal 3) and must therefore estimate the cost of delivering these services to determine funding needs. Additional funding will likely be necessary to realize these enhancements, thus a detailed analysis will help the city identify resource gaps, articulate the anticipated benefits and outcomes of stormwater improvements, and develop a plan for acquiring necessary resources for the community.

The strategy outlined below identifies key actions that Hattiesburg can undertake to better define the scope of stormwater services and continue efforts to evaluate the appropriateness of its current program funding. Overall, the city has identified two key actions under this goal that will be essential to the long-term success of the city's stormwater management efforts. Table 4 lists these key actions, and the following sections describe them in more detail.

Table 4. Key Actions to Ensure Adequate Funding to Meet Stormwater Program Objectives (Goal 2)

	Key Actions
2.1	Identify and evaluate stormwater activities, revenues, and expenditures relative to program objectives. • Catalog existing stormwater activities. • Identify responsible department and estimated annual cost and personnel associated with each activity. • Use summary of stormwater activities and collect additional budget information as needed to determine the current and last five years of stormwater budget, revenue sources, and actual expenditures. • Estimate stormwater program costs for the next five to 15 years.
2.2	Develop and work toward implementing a future program funding strategy. • Consider the estimates of annual costs relative to revenue and program goals. • Determine how to integrate life cycle costing concepts into stormwater budgeting. • Outline all available funding and financing resources. • Evaluate additional options for establishing and/or blending revenue streams. • Develop a written strategy for stormwater program funding and obtain buy-in from city decision makers.

2.1 Key Action: Identify and Evaluate Stormwater Activities, Revenues, and Expenditures

Program costs vary with the size and complexity of a program but typically include labor, O&M, capital costs, and various miscellaneous costs (e.g., equipment, materials) for infrastructure and program implementation. As part of the long-term planning effort, Hattiesburg worked with EPA to identify the activities that comprise the city's current stormwater services and envision future activities the city may need to improve stormwater services over time to meet the city's long-term goals.

Figure 1 below summarizes the division of responsibilities across city departments for current stormwater services as well as possible service enhancements that the city envisions for the future. Over time, the city may identify opportunities to consolidate and streamline services and/or improve coordination across departments or divisions, which could change the distribution of responsibilities.

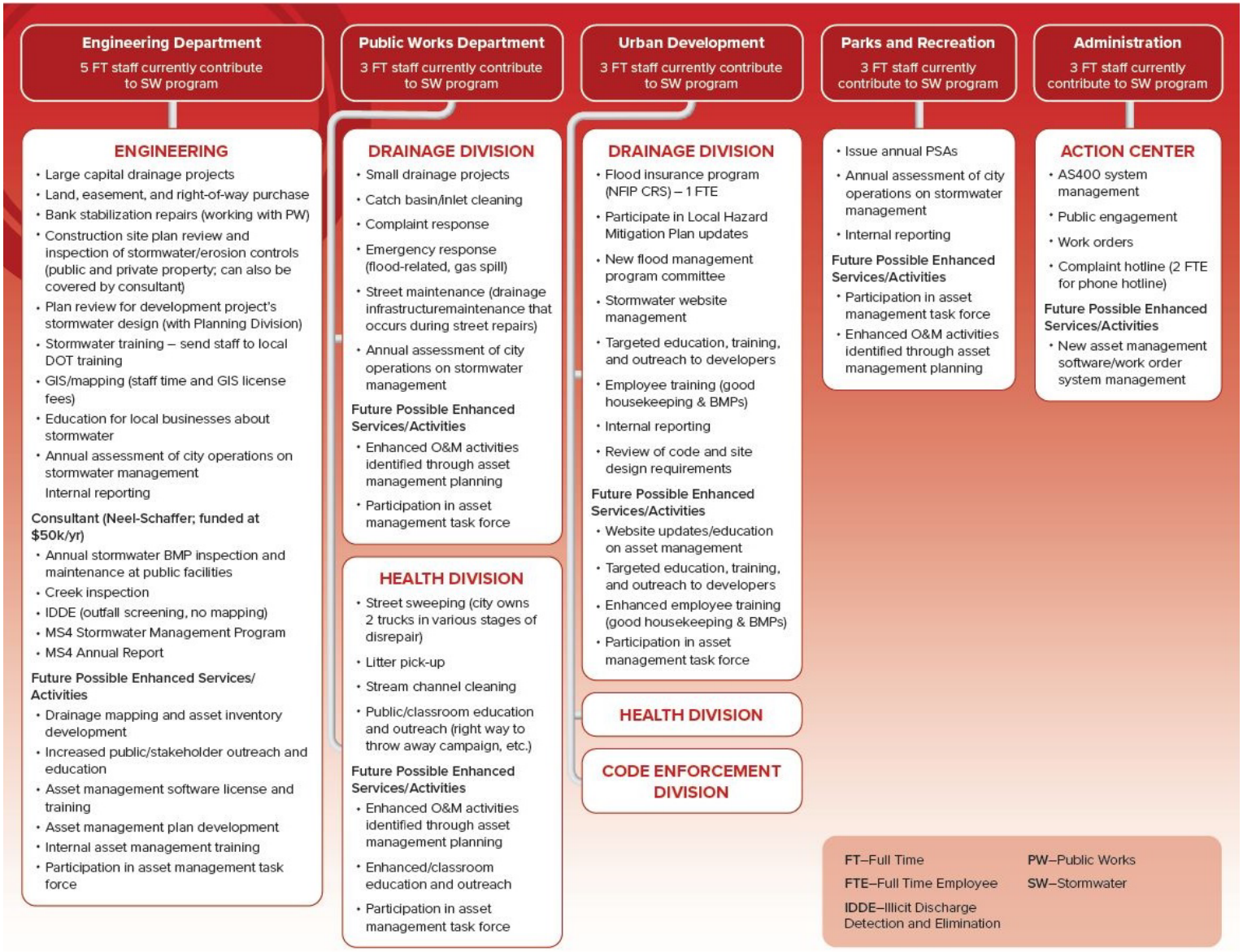


Figure 1. Main Departments Responsible for Stormwater-related Services and Possible Future Service Enhancements

The city performed an initial exercise to identify funding estimates related to the city's stormwater services. Appendix A includes an example table that the city used to compile its initial funding estimates and could use to update its estimates in the future.

Following are some characteristics of the city's current funding approach for stormwater-related activities:

- The city's general fund within various departments funds all stormwater operating costs.
- While the engineering department is responsible for core stormwater services, other stormwater activities are distributed across multiple departments and divisions.
- Each department—and in some cases, an individual division within a department—establishes annual budgets.
- Every year, each department director identifies their capital needs and submits a list to the city administration for possible inclusion in the upcoming budget. Inclusion in the budget depends on priority and available funding.
- If unplanned needs arise during the fiscal year, the departments will re-prioritize or seek additional funding if possible.
- The general fund, federal grants or loans, state grants, or bonds, among other sources, are used to fund capital projects.
- Due to various city departments being involved in stormwater-related tasks and funding coming from the general fund, it is difficult to determine an overall budget estimate for all costs related to stormwater management.

To support a successful stormwater program, it is important for the city to understand the investment necessary to provide the desired level of service (LOS) to its citizens and meet regulatory requirements. This will allow Hattiesburg to align stormwater-related revenue with stormwater-related expenses more closely while also weighing the costs and benefits of potential activities more easily.

Building a sustainable stormwater program requires staff, financial resources, and an in-depth understanding of the true costs of providing stormwater services. Funding for these services can include resources from a variety of sources, including tax dollars from the general fund, dedicated revenue sources, grants, and financing options.

Next Steps to Identify and Evaluate Stormwater Activities, Revenues, and Expenditures

To attain greater clarity about historical expenditures and future budget needs, the city will need to gather and assess additional information to determine the true operating costs of its stormwater services. In some cases, enough financial information may not be available to identify stormwater-specific costs. It is recommended that the city take the following steps to help move through this process:

- **Summarize historical (e.g., the last five years) revenue and expenditures** attributable to stormwater services (distinctly separate from sanitary sewer services).

- **Compare the current budget and revenue** against historical expenditures—as well as anticipated short-, mid-, and long-term costs—to evaluate (1) the extent to which expenditures are exceeding revenue/budget, and (2) whether the program captures the full suite of costs associated with stormwater in its budget and appropriately passes them on to customers.
- **Determine if accounting processes must be changed** to ensure the city can identify and evaluate stormwater activity budgets and expenditures.
- **Consider the extent to which the city's stormwater LOS targets** have an implication on the cost of stormwater services (done as part of stormwater asset management efforts under Long-term Stormwater Plan Goal 3).

Stormwater programs that are funded through general funds or other non-dedicated revenue sources are competing for funds with other local programs. Therefore, funding is often unreliable from year to year. Across the United States, unlike drinking water or wastewater services, stormwater services typically do not have a dedicated revenue source—although this appears to be changing as an increasing number of communities have established a local or regional stormwater utility to address this problem.

Like drinking water or wastewater utilities, stormwater utilities are organizational entities that manage stormwater programs for which the community can set a user fee and establish a dedicated revenue source. In 2008, an annual survey of stormwater utilities identified 923 stormwater utilities in 38 states and Washington, D.C. In 2020, the same survey identified 1,807 stormwater utilities across 41 states and Washington, D.C. To date, the survey has not identified any stormwater utilities in Mississippi.

2.2 Key Action: Develop and Work Toward Implementing a Future Program Funding Strategy

Using the results and information from Key Action 2.1 ("Identify and Evaluate Stormwater Activities, Revenues, and Expenditures"), Hattiesburg should develop a future program funding strategy and work toward implementing it in coming years. To help develop a funding strategy, the city plans to:

- **Consider the estimates of annual costs** of stormwater services relative to revenue and the city's asset management planning process and LOS goals (described below under Goal 3). The city will use this information to identify funding gaps and develop a coherent vision for how it wants its stormwater system to operate 10 to 15 years from now.
- **Determine how to integrate life cycle costing concepts** introduced through the asset management key actions (Goal 3) into the city's stormwater program budgeting process. Life cycle costing aims to identify the necessary level of maintenance required to achieve the maximum useful life of each asset and replace most critical assets before failure. While robust life cycle costing may be a mid- to long-term goal for the city, Hattiesburg should fully integrate the outcomes of the ongoing asset management process into the city's budgeting and capital improvement planning exercises for stormwater and other water infrastructure (sanitary sewer and drinking water). As described in Goal 3, life cycle costing is a key component of any asset management program and involves evaluating how to provide sustainable services and meet the established LOS at the lowest cost.

- **Outline all available funding and financing resources** that can apply toward stormwater projects and establish a plan for expanding stormwater funding beyond general funds. General funds can vary year to year and are not dedicated specifically to a single service. These funds are not considered stable revenue sources and can preclude the community from qualifying for longer-term financing from organizations that issue bonds or loans. The city worked with EPA to identify relevant funding sources, which are described below.

- **Evaluate additional options for establishing and/or blending revenue streams** or approaches to collecting revenue. A variety of funding options can support the budget of a successful stormwater program. In addition to the general fund (supported by tax dollars), other funding options include stormwater utilities, grants, bonds, low-interest loans, system development charges, public-private partnerships, market-based approaches, and regional approaches. Developing a dedicated local funding source can help the city leverage access to other funding and financing vehicles. During this process, the city should identify any potential legal or political challenges to successful implementation and the corresponding solutions. The city should also look for cost-sharing opportunities across city departments, as well as options for multi-jurisdictional, organizational, and financial solutions for revenue generation/resource acquisition.

For some grant and loan programs, stormwater management by itself may not be the central focus nor meet all the qualifying criteria. However, applicants can often still qualify for funding by strategically **incorporating stormwater components into the scope of broader projects,** such as transportation and safety improvements, hazard mitigation, or community and quality-of-life enhancements.

A list of stormwater-related funding sources in Appendix B includes examples of how states and communities have addressed cross-sector needs through a single funding source.

- **Develop a written strategy** for stormwater program funding and obtain buy-in from city decision makers and stakeholders through significant outreach and communication efforts.

View of a portion of downtown Hattiesburg.

Government Funding Programs That May Support Stormwater Projects

In addition to locally available funds, the State of Mississippi and the federal government offer a wide variety of funding resources that Hattiesburg can use for stormwater-related efforts. Many government funding programs also include requirements for a local match or other financial contingencies, so Hattiesburg would need to be able to accommodate these requirements as opportunities become available.

Each funding source may dictate how the city can use resources, as different types of funding may be allocated to pay for different types of activities (e.g., a one-time capital project versus ongoing O&M costs). In the case of government grant and loan programs, funding should be treated as *supplementary* to a well-structured and sustainable funding approach.

Being aware of available funding options and funding cycles and engaging in long-term planning to identify specific projects can provide many benefits. Not only can this awareness contribute to a cohesive community vision, but it can also increase the ability for the city to identify applicable projects and receive funding.

Table 5 describes examples of federal funding opportunities that may be available to the city. Additional information on these and other relevant federal funding programs is available in Appendix B and at EPA's green infrastructure funding opportunities webpage.

Some opportunities present a clear path for incorporating stormwater management (e.g., the Clean Water State Revolving Fund), whereas others may require more coordination.

EPA's websites for Green Infrastructure Funding Opportunities and the Water Finance Clearinghouse can help with navigating the various funding options. The Clearinghouse is a searchable database for stormwater, sanitary sewer, drinking water, and other relevant funding sources from federal, state, local, and other programs. EPA regularly updates resources and information on available funding sources, including state-specific contact information.

Table 5. Potential Federal Funding Sources

Source	Description	Administered by
Clean Water State Revolving Fund (CWSRF)	EPA federal-state partnership that provides low-cost financing to communities for a wide range of water quality infrastructure projects, including to construct municipal wastewater facilities, mitigate stormwater runoff, control nonpoint sources of pollution, build decentralized wastewater treatment systems, create green infrastructure projects, protect estuaries, and fund other water quality projects.	**Mississippi Department of Environmental Quality (MDEQ)**
Section 319 Nonpoint Source Grant Program	EPA program to reduce nonpoint source pollution (i.e., pollution caused by rainfall running over the ground and carrying pollutants, including trash, oil and grease, and fertilizers, into nearby waterways). EPA has recognized the value of using the 319 program funds for green infrastructure, and other stormwater management efforts.	**MDEQ**

Source	Description	Administered by
Urban Waters Small Grants Program (UWSG)	EPA program that funds communities seeking to improve the quality of urban waters while stimulating neighborhood revitalization. UWSG focuses on underserved communities, defined as "communities with environmental justice concerns and/or susceptible populations."	**EPA**
Community Development Block Grants	U.S. Department of Housing and Urban Development (HUD) funded program that supports development of viable communities by providing decent housing and suitable living environments and expanding economic opportunities (including through improved sewer and stormwater services and green infrastructure installation), principally for persons of low and moderate incomes. Hattiesburg is a HUD entitlement community and the city's Community Development Division administers this program within the city.	**Mississippi Development Authority and City of Hattiesburg**
Hazard Mitigation Grants Program and Pre-Disaster Mitigation Grant Program	Federal Emergency Management Agency program that supports implementation of hazard mitigation measures (e.g., acquiring and relocating flood-prone properties and soil stabilization efforts), including mitigation planning.	**Mississippi Emergency Management Agency**
Better Utilizing Investments to Leverage Development (BUILD) Grant Program	U.S. Department of Transportation (DOT) program that funds surface transportation projects with a significant regional or local impact; past projects funded have included those with green infrastructure/stormwater management components.	**U.S. DOT**

Goal 3: Achieve Efficient, Proactive, and Cost-Effective Operation and Maintenance of the City's Stormwater Infrastructure through Asset Management

To improve the quality, efficiency, and cost-effectiveness of services to its citizens, the City of Hattiesburg is exploring opportunities to strengthen the O&M of its stormwater infrastructure by establishing a comprehensive asset management program. Asset management emphasizes a proactive, long-term focus on maintaining and sustaining assets, rather than a short-term, reactive approach. At present, the city does not have a comprehensive understanding of the location, appropriate sizing, and condition of its stormwater assets, so it primarily conducts most of its stormwater-related activities in response to flooding issues. The city is interested in adopting and integrating an asset management program across its water services, including stormwater, wastewater, and drinking water systems.

Asset management refers to a strategic, comprehensive approach to managing the long-term sustainability of assets and achieving desired LOS and regulatory requirements in the most cost-effective way possible.

An **asset management program** refers to the full suite of data-driven, organization-wide actions and procedures to successfully manage assets.

An asset management program that emphasizes data-driven actions informed by a central data management and recordkeeping system, proactive maintenance procedures, stormwater asset inventory data, and financial planning will allow the city to realize economic, environmental, and social benefits from sustainable infrastructure. These benefits will include:

- **Reducing instances of flooding** in the city in the near term through proactive O&M activities and long-term actions to improve drainage capacity.
- Providing a method to **prioritize the city's most critical projects.**
- **Better forecasting the timing** of when the city will need to replace system assets.
- **Reducing the need for emergency asset replacement costs**, which can often be much higher than planned costs.
- **Protecting assets from premature failure** through proper O&M.
- **Understanding the cost** of stormwater assets over the course of their useful life.
- **Gathering data to inform adequate budgets** for operations, capital projects, and user rates (if established in the city).
- **Improving business management** by establishing a robust approach to planning and investment, driven by comprehensive and current data.
- **Increasing collaboration and coordination** across the city's water, wastewater, and stormwater programs and with other public departments (transportation, parks and recreation).

More broadly, comprehensive stormwater asset management—particularly when coupled with parallel efforts across water sector and other public services—can provide community-wide economic, environmental, and social benefits that include:

- **Enhancing long-term economic sustainability and growth** by providing reliable, cost-effective public services and reduced flooding.
- **Potentially providing significant long-term cost savings** through proactive maintenance, data-driven decision making on the timing and type of infrastructure investments and avoided costs.
- **Improving and sustaining the integrity and quality** of the city's natural environment and infrastructure, positively contributing to quality of life.
- **Meeting or exceeding the expectations of Hattiesburg residents and businesses** for high-quality public services.

STORMWATER ASSET MANAGEMENT RESOURCES

Additional information can be found in a white paper titled, *Asset Management Programs for Stormwater and Wastewater Systems: Overcoming Barriers to Development and Implementation* (March 2017). This document presents examples of communities engaging in asset management and identifies various asset management resources and software.

Asset management programs (and their associated plans) are scalable and can be relatively simple or very complex depending on the size, sophistication, and resources of the entity developing and implementing the program. Overall, the city has identified 11 main key actions under this goal that will be essential to the long-term success of its stormwater management efforts. Table 6 lists these key actions, and the following sections describe them in more detail.

Though Hattiesburg has no existing asset management program across utility services and no dedicated resources for establishing one at this time, the city could soon take some initial steps to begin development of an asset management program and expand it iteratively over time. Appendix C presents additional detail about an approach the city could take to develop an asset management program. This appendix can serve as a standalone resource the city can use when it is ready to start its asset management efforts.

Table 6. Key Actions for Building an Asset Management Program (Goal 3)

	Key Actions
3.1	Develop program scope, goals and objectives, and timeline and establish asset management task force.
3.2	Develop an asset inventory.
3.3	Evaluate asset condition and performance.
3.4	Estimate asset value, remaining useful life, and replacement cost.
3.5	Establish LOS and associated performance measures.
3.6	Assess asset criticality and risk.
3.7	Optimize capital and O&M costs and prioritize investments (life cycle costing).
3.8	Develop a funding strategy.
3.9	Document asset management activities in a written plan.
3.10	Conduct training, education, and outreach.
3.11	Pursue continuous evaluation and improvement.

3.1 Key Action: Develop Program Scope, Goals and Objectives, and Timeline and Establish Asset Management Task Force

The city should consider intended improvements in infrastructure, operational and managerial processes, and financial management, as well environmental, economic, and other outcomes while developing its asset management program goals and objectives. These goals and objectives will drive and inform all asset management activities, and the city should revisit and modify them as needed as the program evolves over time.

- **Develop cross-sector asset management task force** and determine the scope of the O&M program and overall asset management approach. Coordination on asset management across interrelated municipal sectors (e.g., wastewater, drinking water, stormwater, transportation, purchasing) enhances the commitment to and buy-in for asset management activities. Furthermore, this coordination offers efficiencies and cost savings as activities and tools may be shared across sectors while avoiding redundancy. It can also result in a more comprehensive understanding of citywide capital investment needs, including identification of investments that may have significant co-benefits across sectors. Designating asset management "champions" and assigning responsibility for execution at the outset of the effort will allow for more streamlined and efficient decision making and program rollout over time.
- Key representatives to include in this effort are as follows:
  - Engineering department representative(s)
  - Public works representative(s) (leadership and maintenance staff)
  - Drinking water representative(s)
  - Wastewater representative(s)
- Optional participants may include the following:
  - Parks and recreation, urban development, and Mayor's office representative(s)
  - Urban development representative(s)
  - Mayor's office representative(s)

  In addition to determining the focus and phased implementation of an asset management effort, this task force will communicate the concepts and benefits of asset management to staff responsible for implementing asset management-related actions, customers, and municipal leaders and other elected officials responsible for city governance. Establishing regular asset management-focused meetings to sustain momentum, evaluate progress, and demonstrate commitment is critical.

- **Identify short-, mid-, and long-term goals** for stormwater asset management. Acknowledging that Hattiesburg is in the initial stages of developing an asset management program and does not currently have resources set aside for this effort, the city has established draft overall asset management goals and phased timelines to provide a platform for long-term success. Figure 2 on the following page presents the city's overall draft asset management goals. Appendix C provides additional details about draft goals and timelines for asset management program development.

Figure 2. Hattiesburg's Overall Draft Asset Management Goals

3.2 Key Action: Develop an Asset Inventory

Building an asset inventory is the first step in understanding the current condition, sizing, status, and scope of stormwater assets across the city and prioritizing maintenance and capital needs going forward. Hattiesburg can build out an asset inventory iteratively over time, beginning with the most critical needs and expanding to cover the entire system as resources allow. The city should capture the types of stormwater assets in Table 7 when creating its inventory.

Table 7. Stormwater Asset Types for Hattiesburg's Inventory

Stormwater Asset Type	Estimated Quantity	Stormwater Asset Type	Estimated Quantity
Drainage pipes	X miles	**Infiltration basins**	X
Open ditches	X miles	**Retention ponds**	X
Storm sewer outfalls	X	**Detention ponds**	X
Drain inlets	X	**Rain gardens**	X
Catch basins	X	**Bioswales**	X
Culverts	X	**Permeable pavement**	X
Pumps	X	**Other stormwater treatment controls**	X

The city may identify other types of stormwater-related assets to include in the inventory and should periodically consider what types of assets it may need to incorporate in the future.

- Before collecting data, the city should clearly **identify what data to collect and why**. Drivers and intended uses for the data should align with the stated goals and objectives for the asset management program identified under Key Action 3.1. The types of information (or attributes) the city should aim to collect in its stormwater asset inventory include the following:

  - Coordinate/location
  - Size
  - Length
  - Installation date
  - Material
  - Condition

  The city should customize this list based on its drivers and intended uses for the data. Some of these attributes may not pertain to each asset type and the city may want to record additional attributes.

- **Identify sources and format of existing data**. Currently, the city has limited information available on number, location, sizing, and condition of stormwater assets. The city should compile and use any existing data, regardless of format (e.g., existing inventories or asset identification systems, as-built drawings or maps, system records, photos, interviews with current and former staff if possible), as the starting point for additional data collection efforts.

- **Select a data tracking tool**. Successful asset management requires significant data of sufficient quality on which to base management decisions. Data tracking products can range from a relatively simple spreadsheet developed in house to a more sophisticated database or proprietary

asset management software; costs can scale from hundreds of dollars to hundreds of thousands of dollars.

The city should select a product by considering resource availability, staff skill and capacity to appropriately use and manage the system (including quality assurance and quality control), and what the city would like to do with the system (which can range from maintaining a simple inventory to generating work orders, ordering parts, and billing customers). Hattiesburg has an expressed interest in pursuing asset management approaches for stormwater, wastewater, and drinking water and should consider how these efforts integrate during data collection efforts. However, the city should initiate a realistic near-term approach to starting its stormwater asset inventory rather than waiting until it determines the full path for asset management for all three city services.

- **Collect data using a prioritized approach** and compile inventory. Developing a system-wide asset inventory can require significant staff time and/or consultant resources. Because the city does not currently have resources set aside for this activity, it has identified a stepwise, prioritized approach to start collecting asset data that will enable it to build its processes and capacity over time. High-level activities include:
  - Leveraging existing information and identifying priority drainage areas.
  - Preparing and securing staff resources.
  - Collecting and compiling field data.
  - Reassessing data management approaches and goals.

Corresponding steps with more detail for each activity are outlined in Appendix C.

3.3 Key Action: Evaluate Asset Condition and Performance

A condition assessment identifies and ranks the physical condition of assets. Like the asset inventory, the city can conduct the condition assessment iteratively, focusing first on the highest-priority assets (i.e., those targeted for the initial asset inventory development) and those for which the city has existing information.

- **Select which assets to include** in the condition assessment. For example, the city may initially focus on assets above a certain replacement value threshold; alternatively, it may determine that assets in certain areas (e.g., those more prone to flooding) should be the priority. Field surveys of visible assets may help the city make an initial determination as to which ones appear more likely to need repair or replacement in the near term.
- Once the city has determined the scope of the initial condition assessment and rating, it should **document this decision and develop a general timeline** for expanding the initial condition

Examples of stormwater conveyance assets.

assessment (in alignment with that for an expanded asset inventory under Key Action 3.2).

- **Rate and rank the condition of assets** identified under Key Action 3.2 using an established scale. In addition to visual appearance, additional considerations for condition rating should include:
  - Asset history (e.g., known history of pipe leaks, repairs, failures).
  - Asset location (e.g., within a drainage basin with known flooding problems).
  - Visible signs of deterioration/structural or mechanical problems.

  Note that the city should assess asset condition relative to that of other assets within the same class, not broadly across all stormwater assets.

- **Compile condition data electronically** and merge/integrate them with previously compiled asset inventory data and other data collected and compiled under Key Actions 3.4 and 3.6.

Appendix C includes additional information about this key action.

3.4 Key Action: Estimate Asset Value, Remaining Useful Life, and Replacement Cost

As assets age, their value declines, while the cost associated with operating, maintaining, and repairing the asset increase. Estimating asset value, remaining useful life, and replacement costs, together with the information compiled under Key Actions 3.3 (Asset Condition), 3.5 (level of Service), and 3.6 (Criticality and Risk), will help the city optimize and prioritize capital and O&M investments as described in more detail under Key Action 3.7 (Lifecycle Costing). Appendix C includes additional information about this key action.

3.5 Key Action: Establish LOS and Associated Performance Measures

LOS is an articulation of the service you want to be able to provide using your assets and how you want them to perform. It should capture considerations such as regulatory requirements for permit compliance; water quality, capture, and conservation; flood mitigation; customer service and social considerations; and cost-effectiveness.

Hattiesburg can evaluate its performance against LOS using quantitative performance measures. Because LOS goals and the city's ability to meet them can have a significant resource dimension, it is important to consider what is achievable with the city's current level of staffing and what O&M approaches it would need to change or introduce to meet LOS targets.

Table 8. Sample Overall LOS Goals

Sample LOS Goal	Sample Performance Measure	Sample Target
LOS Goal 1: Meet customer and municipal decision maker expectations for public services	Count number of customer complaints	Number of complaints reduced by X% over the previous year
	Educate decision makers and public on environmental value of stormwater services	Annual communication and outreach provided on stormwater

Sample LOS Goal	Sample Performance Measure	Sample Target
		accomplishments and investments
LOS Goal 2: Ensure sound financial management	Budget for full cost of stormwater services	Annual budget that is adequate to fund stormwater services provided across city departments
	Control increases in O&M costs	O&M costs not to exceed X% over the previous year
LOS Goal 3: Maintain integrity of key infrastructure assets (as established in Key Action 3.2)	Address deficiencies in the most critical assets each year	*See several examples in* Table 9
	Limit structural failures	
	Reduce flooding	
	Implement a proactive asset maintenance approach	
LOS Goal 4: Support an engaged and knowledgeable workforce	Promote understanding across employees of the principles of asset management	X hours of training per person, per year
	Provide technical capacity to conduct comprehensive system mapping and inventory	X staff trained in GIS/data collection

Table 9. Examples of Asset-Specific LOS Targets

Level of Service				
Asset	**Inspection Activities**	**Corrective Repair and Maintenance**	**Preventive Maintenance**	**Complete Replacement/Renewal**
Drainage pipes	Use closed circuit television to inspect and assign condition ratings to the complete system over an X year period.	Clean in response to customer complaints. Repair or replace X% of highest criticality annually.	Coordinate root control for sewer and storm.	Replace X% of pipe that is at or has exceeded useful life and/or has a condition rating of X of worse over an X year period. Replace drainage pipes every X years.

Level of Service				
Asset	**Inspection Activities**	**Corrective Repair and Maintenance**	**Preventive Maintenance**	**Complete Replacement/Renewal**
Open ditches	Walking survey of X%/miles every X years.	Clean in response to customer complaints.	Annual application of herbicide in appropriate ditch areas. Cleaning of X% of ditches annually.	Clean all open ditches every X years.

Appendix C provides a significant amount of additional information about this key action.

3.6 Key Action: Assess Asset Criticality and Risk

Assessing asset criticality and risk means building on the knowledge collected through the asset inventory, condition assessment, and remaining useful life processes to evaluate each asset in terms of the likelihood or probability of failure and the consequence of failure. This will allow the city to prioritize assets more easily for repair and replacement, further enhancing its ability to target resources most cost-effectively. As asset criticality will change over time, the city should routinely re-evaluate its findings. Additional information about this Key Action is included in Appendix C.

3.7 Key Action: Optimize Capital And O&M Costs and Prioritize Investments (Life Cycle Costing)

Life cycle costing considers the costs of each asset throughout its full life cycle, including installation; O&M; repair; rehabilitation; disposal; and environmental, financial, and social costs. The exercise requires the city to evaluate how to provide sustainable stormwater services and meet the established LOS at the lowest cost. The goal is to conduct only as much maintenance as is needed to reach the maximum useful life of the asset and replace most critical assets before failure. Appendix C includes additional information about this key action.

3.8 Key Action: Develop a Funding Strategy

In addition to any incremental funding required to accomplish the asset management actions described previously, the city needs to identify funding (e.g., community and supplemental/external funding) for necessary O&M and capital improvement activities. Goal 2 of the city's Long-term Stormwater Plan discusses funding strategies in greater detail—asset management should be included in considerations for program funding.

3.9 Key Action: Document Asset Management Activities in a Written Plan

A written asset management plan documents the information and procedures guiding implementation. The city should write a plan that identifies its approach to building an asset management program according to the key actions outlined and revisit/revise the plan over time, as needed. An example written stormwater asset management program plan can be seen in the City of Grand Rapids Stormwater Asset Management Program.

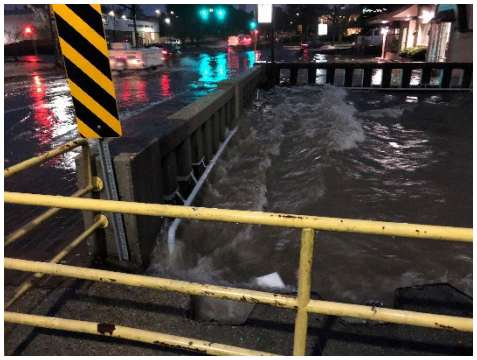
3.10 Key Action: Conduct Training, Education, and Outreach

Relevant staff should receive regular training on the process and importance of asset management, as well as key messages to communicate the benefits to the community, managers, stakeholders, customers, and decision makers. The city should actively conduct broader education and outreach with local stakeholders to generate awareness and buy-in.

3.11 Key Action: Pursue Continuous Evaluation and Improvement

Asset management is a continuous process. The city should routinely revisit, evaluate, and revise the asset management approaches as needed over time to accommodate new data, new technologies, regulatory changes, and other developments.

Goal 4: Improve the City's Resilience to Flooding



View of flooding in Gordon's Creek.

One of Hattiesburg's priority goals is to increase the city's resilience and ability to recover quickly from flooding events. Furthermore, by identifying and implementing long-term solutions, Hattiesburg may be able to prevent some flooding occurrences. With approximately 62 inches of annual rainfall, the city experiences flooding and associated negative economic impacts almost every year. Since 1993, the city has experienced 46 distinct flooding events with reported impacts amounting to over $38.6M in property damages.[4]

River overflow is a common source of flooding, primarily from the Leaf River's tributary creeks. In the main section of the city, flooding is largely due to insufficient or reduced capacity of the drainage infrastructure as the urban landscape expands. With uncertain future changes in rainfall patterns, the city could experience increased rainfall amounts and/or intensity, which would exacerbate these existing flooding issues.

After an intense rainfall, floodwaters in Hattiesburg can rise at a rate of 2 to 3 feet per hour, reaching maximum stage in two hours (or less). **In 1983, the city experienced a river stage of 29.19 feet and over $32 million in damage**. In January and March 1999, the Mixon Creek basin area experienced flash floods from rainfall that may have been in the range of the 500-year and 100-year frequencies, respectively.[5]

Hattiesburg has already taken several measures to strengthen its resilience to flooding, including the following:

- The city engages in ongoing drainage enhancement projects as funding becomes available to help mitigate flooding issues. Since 2002, the city—in conjunction with state and federal agencies—has completed over $19.5 million in drainage enhancement projects, resulting in some drainage improvements and reduced flood hazards.[5]
- The city implemented a policy for the parks and recreation department to move a trailer-mounted public restroom to higher ground when the city expects a flooding event and when the river reaches a certain level.
- The city clears some storm drain inlets, culverts, and ditches in problem areas when it expects a storm.
- Hattiesburg collaborated with multiple jurisdictions to complete the *2020 Mississippi Emergency Management Agency (MEMA) District 8 Hazard Mitigation Plan* to help identify improvements and to satisfy requirements for requesting funds. Securing funds from MEMA for pre- and post-disaster mitigation remains a critically important funding source for further exploration, as the city still needs significant improvements to strengthen its resilience against flooding.

Furthermore, after undertaking this overall long-term stormwater planning effort, the city is also:

[4] 2020 MEMA District 8 Hazard Mitigation Plan

[5] Forrest County Local Hazard Mitigation Plan 2013

- Identifying policies and funding sources to improve resilience to flooding in Hattiesburg.
- Evaluating ways to better coordinate stormwater projects with state and local hazard mitigation plans.
- Assessing the potential for incorporating green infrastructure into public spaces through GIS modeling (as described in Goal 5). This work will help mitigate flooding and offer additional benefits to the community.
- Exploring the use of green infrastructure in work funded by the NRCS and Federal Emergency Management Agency (FEMA) on Gordon's Creek.

Overall, the city has identified four key actions under this goal that will be essential to the long-term success of its stormwater management efforts. Table 10 lists these key actions, and the following sections describe them in more detail.

Green infrastructure can be a cost-effective, resilient approach to managing wet weather impacts that provides many community benefits. While single-purpose gray stormwater infrastructure—conventional piped drainage and water treatment systems—is designed to move urban stormwater away from the built environment, green infrastructure reduces and treats stormwater at its source while delivering environmental, social, and economic benefits.[6]

Table 10. Key Actions to Improve the City's Resilience to Flooding

	Key Action
4.1	Leverage FEMA's programs for pre- and post-disaster mitigation to obtain project funding.
4.2	Explore alternative bank stabilization approaches to reduce flashiness* of flows in Gordon's Creek and create a greater community connection to the creek.
4.3	Evaluate the city's current practices for flood resilience using EPA's Flood Resilience Checklist.
4.4	Improve the city's rating for flood insurance rate reduction.

** Flashiness reflects the frequency and rapidity of short-term changes in stream flow in response to storm events. Streams that rise and fall quickly are considered "flashy."[7]*

[6] https://www.epa.gov/green-infrastructure/what-green-infrastructure

[7] https://oehha.ca.gov/media/downloads/ecotoxicology/document/flashiness2015.pdf

4.1 Key Action: Leverage FEMA's Programs for Pre- and Post-Disaster Mitigation to Obtain Project Funding

FEMA—part of the U.S. Department of Homeland Security—coordinates the response to U.S.-based disasters that can overwhelm the resources of local and state authorities. The agency also has different types of grant funding for non-disaster hazard mitigation available to states, tribes, and local communities. Hattiesburg may be able to leverage the following FEMA programs for pre- and post-disaster mitigation project funding to alleviate flooding issues:

- The **Hazard Mitigation Grant Program** (HMGP) helps funding recipients implement long-term hazard mitigation measures following presidential disaster declarations[8]. For 2017, MEMA received funding from the HMGP to use throughout the state.[9] In 2017, after severe storms and tornadoes struck the Hattiesburg area, HMGP funds were used to construct storm shelters, generators, and warning sirens.
- The **Pre-Disaster Mitigation (PDM) Grant Program** provides funds every year for hazard mitigation planning and mitigation project implementation before a disaster.
- The **Flood Mitigation Assistance (FMA) Grant Program** provides funds every year so communities can take measures to reduce or eliminate the risk of flood damage to buildings insured under the National Flood Insurance Program (NFIP).

To be eligible for pre-disaster funding (i.e., PDM and FMA grants), the community must have (1) **shovel-ready projects** that are consistent with a **local hazard mitigation plan** and (2) an **NFIP in good standing**. Communities must compete nationally for these funds during a 60-day application period. Interested parties should contact MEMA with a notice of intent that they want to submit projects for funding.

"Shovel-ready" means a project is at the stage where workers can be employed and construction can begin.

To better position itself for obtaining FEMA funding, the city should:

- **Document all known flooding areas** and the causes, anticipated fixes, and associated timelines. City discussions during the long-term effort produced a preliminary list of flood-prone areas, described under Goal 5.
- **Identify city projects that are eligible for FEMA funding**. Projects need to conform to state and local hazard mitigation plans, floodplain management ordinances, and wetlands and environmental regulations; meet all applicable codes and standards; provide a long-term solution; and be cost-effective. Examples of projects eligible for FEMA funding include drainage and bank stabilization projects and culvert replacements.
- **Include specific projects in the local hazard mitigation plan**. Hattiesburg is included in the multi-jurisdictional MEMA District 8 Hazard Mitigation Plan. The plan identifies the potential

[8] This website contains additional information about Mississippi's HMDP program and application process.

[9] Personal communication with MEMA official, George Humphrey, March 21, 2018.

hazards and natural disasters the communities might experience as well as the actions they can take to reduce or mitigate those threats.

Incorporating Green Infrastructure into Local Hazard Mitigation Plans

As the city further evaluates the use of green infrastructure practices in its stormwater management approaches (additional information contained under Goal 5), it could consider how green infrastructure may be incorporated into projects in its local hazard mitigation plan. Appendix D contains additional information about this process. Furthermore, EPA's *Storm Smart Cities—Integrating Green Infrastructure into Local Hazard Mitigation Plans* provides many examples of infrastructure improvements at both the residential and municipal levels to incorporate green infrastructure approaches into a hazard mitigation plan. Improvements include replacing large paved lots with permeable pavement that allows precipitation to soak into the ground instead of flowing into stormwater systems, adding bioswales to landscaped areas, planting trees in urban areas, and adding rain gardens to collect runoff and absorb it back into the ground.

Examples of green infrastructure.

The following page provides examples of flooding-related projects that were funded through FEMA programs, and the following publications provide additional resources for hazard mitigation planning and funding:

- Hazard Mitigation Planning Process
- State Mitigation Plan Review Guide
- State Mitigation Plan Review Guide Policy

Hazard Mitigation Spotlight

The City of Lake Forest Park in the suburbs of Seattle, Washington, experienced frequent flooding in Lyon Creek that damaged residences and a large commercial center and disrupted emergency responders, forcing the city to act. The city considered a gray infrastructure solution involving an underground high-flow diversion pipe system before seeing the benefits that a green infrastructure system would bring. The city partnered with many levels of government to fund the project—which featured flood reduction, environmental restoration, and transportation enhancements—and received over $6.9 million in funding, including $3 million from FEMA.[10]

Lyon Creek after restoration efforts.

Hazard Mitigation Spotlight

Johnson Creek in southeast Portland, Oregon, experienced record-breaking rain in December 2015. However, the creek avoided significant damage due to previous investments in floodplain restoration and creek improvements. The creek frequently floods—experiencing at least eight floods that induced major damage in the past 50 years. Portland repaired the creek by bringing back a natural floodplain to mitigate flooding damage. The total project cost was approximately $4.6 million, and Portland received $2.7 million from the FEMA HMGP.[11]

Stream improvements and floodplain repairs in Johnson Creek.

[10] APWA Project of the Year—Lyon Creek Flood Mitigation: http://washington.apwa.net/Content/Chapters/washington.apwa.net/File/Project%20of%20the%20Year%2F2016%2FAPWA_POY2016_LyonCreekFloodMitigationProject_CityLakeForestPark.pdf

[11] https://www.portlandoregon.gov/bes/article/286175

4.2 Key Action: Explore Alternative Bank Stabilization Approaches to Reduce Flashiness of Flows in Gordon's Creek and Create a Greater Community Connection to the Creek

Gordon's Creek flows through downtown Hattiesburg and is a prominent feature throughout the city. Historically, children would routinely play in and around the creek, and the community had a much more significant connection to the water body than it does today. Through the years, commercial and residential development to the west of Hattiesburg has contributed to higher peak flow volumes and bank erosion along Gordon's Creek. To help protect the creek during times of heavy rainfall, the city has lined many of the banks along Gordon's Creek with rock rip rap and/or concrete for stabilization. This has significantly increased the flow rate in the system in response to rain events.

Ceremony in Gordon's Creek (date unknown).

When stabilized areas require restoration, the city typically applies rock rip rap or gabions, or it repairs the existing concrete structures. This work is primarily funded through the U.S. Department of Agriculture's NRCS. NRCS has provided approximately $200,000 for gabion bank stabilization in areas along Lincoln Road in Hattiesburg. Nationwide, NRCS funds up to 75 percent of erosion control projects, including design and construction.

However, city leaders and residents have expressed their desire to explore more attractive solutions that return the creek to a more natural state. The city is interested in green infrastructure options for bank stabilization, such as stepped terraces, which can be funded through federal programs (examples of stabilization practices are provided on the following page). The city will continue to evaluate and consider various techniques for stream bank stabilization when planning improvements and repairs to Gordon's Creek.

Left and middle images show rip rap and concrete armoring along Gordon's Creek.
Right image shows a portion of Gordon's Creek without armoring.

Examples of Green Infrastructure and Bioengineering Approaches to Stabilize Banks

Several alternatives exist for stabilizing rivers, designed to mimic nature. FEMA's *Engineering with Nature: Alternative Techniques to Riprap Bank Stabilization* describes approaches to repair creek and river banks using natural materials such as anchored logs, wood stakes, brush, vegetation, and coir fabric. These materials create a natural looking bank improvement that slows water down and protects the bank from washing away during high waters. Importantly, nature-based solutions typically offer co-benefits such as increased aesthetics, greater community connection with water bodies, recreational opportunities, new wildlife habitat, and greater biodiversity.

The FEMA document referenced above and the following table present a range of approaches that other communities have successfully adopted in lieu of rock rip rap or concrete lining of stream channels and banks. These approaches are not suitable for all applications and should be evaluated by engineers to help determine the appropriate solution(s) for a given project.

Stabilization Practice	Description	Potential Advantages
Brush layering 	Revegetation process where live branches are planted horizontally in rows along a bank.	• Traps sediment before it enters the waterway • Can be used to restore eroded banks
Brush mattress 	A thick layer of branches affixed to a stream bank with wire/twine and stakes to stabilize existing soils	• Serves as habitat for local wildlife • Fosters colonization by native plants
Coir logs 	Natural fiber rolls used to hold loose soil in place while vegetation becomes established. *Not recommended for high-velocity areas.*	• Completely biodegradable • Provides a stable substrate for new plant growth

Stabilization Practice	Description	Potential Advantages
Engineered logjams 	The strategic placement of rock and woody debris within a waterway to slow and direct flow.	• Traps sediment within the waterway • Provides fish habitat for spawning and migration
Hydro-seeding 	The hydraulic application of seeds with strong root structures to establish natural erosion control. *Often used in combination with other stabilization measures (e.g., coir logs).*	• Cost-effective • Suitable for steep embankments
Wattle fences 	Rows of branch bundles installed in shallow trenches along a waterway to reinforce the banks.	• Immediate surface and rill erosion control • Suitable for steep slopes

Funding Source Examples for Bank Stabilization and Erosion Control

Federal programs can help offset the cost of stream bank restoration for erosion control. As noted above, NRCS funds 75 percent of erosion control projects, including design and construction; the city has used this funding source in the past. In addition, FEMA funding has also supported related projects in Hattiesburg, including repair of concrete slabs at Camper Zoo at a total estimated cost of $500,000.

The U.S. Environmental Protection Agency's Water Finance Clearinghouse is a web-based portal that includes information about funding opportunities. Example results from a search for bank stabilization and flood control funding sources follow.

Source	Program Name	Description	Current Funding Level
U.S. Army Corps of Engineers (USACE)	Emergency Streambank and Shoreline Protection	USACE is authorized to construct bank protection works to protect endangered highways; highway bridge approaches; and other essential, important public works, such as municipal water supply systems and sewage disposal plants, churches, hospitals, schools, and nonprofit public services and known cultural sites that are endangered by flood-caused bank or shoreline erosion. (The website provided is an example from one USACE district.)	The first $100,000 of the planning design analysis (PDA) phase (normally limited to 12 months) is a federal expense. All PDA costs after the first $100,000 are cost-shared 50/50. All construction costs are cost-shared 65 percent federal and 35 percent non-federal. Each project is limited to a total federal cost of $5 million.
USACE	Small Flood Damage Reduction Projects	Section 205 of the 1948 Flood Control Act authorizes USACE to study, design, and construct small flood control projects in partnership with non-federal government agencies, such as cities, counties, special authorities, or units of state government. (The website provided is an example from one USACE district.)	The feasibility study is 100 percent federally funded up to $100,000. Costs over $100,000 are shared equally with the non-federal sponsor. Up to one-half of the non-federal share can be in the form of in-kind services. Costs for preparing plans and specifications and construction are shared at 65 percent federal/35 percent non-federal.
FEMA	Flood Mitigation Assistance Grant Program (FMA)	The FMA program is authorized by Section 1366 of the National Flood Insurance Act of 1968, with the goal of reducing or eliminating claims under the National Flood Insurance Program (NFIP). FMA provides funding to states, territories, federally recognized tribes, and local communities for projects and planning that reduce or eliminate long-term risk of flood damage to structures insured under the NFIP. FMA funding is also available for management costs.	The total amount of funds available under the fiscal year 2018 FMA grant program is $160 million. Of this, a total of $70 million has been prioritized for community flood mitigation proposals, leaving an estimated $90 million available for other FMA priorities. FEMA will select remaining eligible applications once all priorities are met based on benefits to the NFIP.

4.3 Key Action: Evaluate the City's Current Practices for Flood Resilience Using EPA's Flood Resilience Checklist

Maintaining policies that encourage resilience is vital to the city's long-term economic health and ability to avoid repeated losses due to flooding. Hattiesburg has enacted some of these policies over

the years and recognizes there are other areas for improvement. To help evaluate the city's current practices and potential improvements, Hattiesburg and EPA used a Flood Resilience Checklist[12] while reviewing components of the Hattiesburg Comprehensive Plan, local hazard mitigation plan (2013 version), and some other available sources. The following are some key recommendations and considerations from this effort. Appendix E includes the completed checklist with supporting details and notes.

Overall Strategies to Enhance Resilience

- **Involvement.** Involve the city's emergency response personnel, floodplain manager, and department of public works in the development of future iterations of the city's Comprehensive Plan and local hazard mitigation plan.
- **Green infrastructure.** Educate city staff and developers on green infrastructure approaches. Encourage them to use the city's green infrastructure opportunities analysis as a resource to identify where green infrastructure practices may be most suitable for implementation. This is discussed in more detail under Goal 5.
- **Local hazard mitigation plan.** Evaluate the projects listed in the local hazard mitigation plan to determine whether the list is still accurate and add stormwater-related projects that could be potentially funded in the future. Identify steps needed to complete the application process and/or have the application process started before a disaster occurs for the flood resilience projects included in the plan. Considerations for incorporating green infrastructure into the local hazard mitigation plan is discussed more above under Key Action 4.1.

Hattiesburg's **Floodplain Management Committee** (comprised of the CRS Committee whose membership is based upon CRS requirements) identifies strategies to reduce flood insurance costs for citizens and participates in policy discussions to enhance the city's resilience to flooding.

Protect People, Buildings, and Facilities in Vulnerable Areas

- **Base-flood elevation.** Evaluate increasing the base-flood elevation requirement in Chapter 10 of the Hattiesburg Code of Ordinances for new construction and substantial improvement of any building inside a Special Flood Hazard Area from 1 foot to 2 feet. Also propose raising the requirement for the elevation of heating, ventilation, and air conditioning and other equipment consistent with the revised base-flood elevation.

Plan for and Encourage New Development in Safer Areas

- **Safer growth areas.** Distinguish areas planned for development outside of permanent open space lands and outside of floodways (as identified in the city's Future Land Use Plan) as "safer growth areas."

4.4 Key Action: Improve the City's Rating for Flood Insurance Rate Reduction

To offer reduced flood insurance rates to its citizens, Hattiesburg participates in FEMA's NFIP. In the past, the city has taken advantage of NFIP's Community Rating System (CRS) program to gain further

[12] This checklist was developed collaboratively by EPA and several communities in 2014.

discounts on flood insurance rates. Until December 2014, the city maintained a CRS "Class 6" rating,[13] which allowed for up to a 20 percent discount on flood insurance rates to citizens (depending on whether citizens lived in a Special Flood Hazard Area). However, due to point allocation adjustments, staff turnover, and a lapse in reporting under the flood insurance program, Hattiesburg's rating dropped to Class 8 in 2015. This resulted in increased flood insurance rates for the community.

To maintain the CRS discounts, the city must maintain and report on stormwater management policies and perform preparedness activities under four categories: (1) public information, (2) flood damage reduction, (3) flood preparedness, and (4) mapping and regulations.

Appendix F provides additional details about the CRS rating program, the city's participation, and the types of stormwater-related efforts the city can undertake to gain points for its CRS rating.

FEMA established and oversees **NFIP** to encourage the adoption of floodplain management ordinances that reduce future damage. Residents of participating communities are eligible to purchase flood insurance through the program. Today, NFIP insures an estimated 5 million homes in 23,000 communities across the United States.[14]

Communities that exceed the minimum NFIP standards can apply for the **CRS**, an incentive program established in 1990 that offers discounted flood insurance premiums. Depending upon the level of participation, flood insurance premium rates for policyholders can be reduced up to 45 percent. Participating in the CRS provides an incentive to maintaining and improving a community's floodplain management program over the years. Activities that communities can pursue to gain credit points to earn CRS "class" ratings include:

- Open space preservation
- Low impact development (or green infrastructure approaches)
- Stormwater runoff volume control
- Stormwater runoff quality control
- Watershed master planning
- Erosion and sediment control

Beginning in 2018, the city reinvigorated efforts to regain its CRS rating and associated insurance discount. The city is continuing to work on efforts to improve its rating and reduce insurance costs for its citizens.

[13] FEMA conducts a site visit to verify the CRS rating, which ranges from Class 9 (lowest discount) to Class 1 (highest discount). The program awards insurance discounts based on performance. For residents living in a Special Flood Hazard.

[14] https://www.fema.gov/flood-insurance

Goal 5: Identify Opportunities for Improved Stormwater Management and Green Infrastructure in Public Projects

As outlined in the introduction of this plan, Hattiesburg is working to integrate green infrastructure practices into the landscape throughout the city to meet broader community goals, while improving environmental outcomes via increased green space, better stormwater management, better water quality, and a variety of benefits that gray infrastructure practices do not offer. Using green infrastructure can help the city meet its MS4 permit requirements and protect and improve the health of its existing waters. Green infrastructure can provide welcoming environments in downtown central areas with tree-lined streets, traffic-calming via curb bump-outs, pervious pavements, green linkages to neighboring areas, dual-purpose open spaces for special events, and beautiful plants and scenery for all to enjoy.

Aerial view of Hattiesburg. Photo from the Area Development Partnership.

What is green infrastructure?

"Green infrastructure" is the range of measures that use plant or soil systems, permeable pavement or other permeable surfaces or substrates, stormwater harvest or reuse, or landscaping to store, infiltrate, or evapotranspirate stormwater and reduce flows to sewer systems or to surface waters (33 U.S.C. § 1362(27))." These practices mimic natural conditions of a site to reduce the negative impacts that challenge urban areas.

With such a wide variety of green infrastructure practices to choose from, there is a practice for every setting, from a small sidewalk or right-of-way in the urban downtown area to an existing public park or parking lot. However, the most cost-effective and technically effective green infrastructure practices for the city will be those that are best suited to the physical site characteristics of a property, avoid existing site constraints, and are integrated into an existing public parcel (e.g., a park, parking lot, or streetscape) or planned public project. For example, the city could incorporate stormwater management into the types of public projects that it currently performs, such as: road safety improvements, the creation of public works facilities, roundabouts, sewer projects, and street area improvements.

As a starting point, the city plans to integrate consideration of green infrastructure into a public project design process and identify areas that are most suitable for green infrastructure. As its approach evolves, the city could consider developing and adopting green infrastructure design specifications or guidance.

Green infrastructure may directly support many of the goals and community visions outlined in the following city plans:

POTENTIAL BENEFITS OF GREEN INFRASTRUCTURE

- ✓ Reduce localized minor flooding
- ✓ Improve aesthetics
- ✓ Preserve and create public green space
- ✓ Create and enhance habitat
- ✓ Improve air quality
- ✓ Reduce heat island effect
- ✓ Recharge groundwater

Document Name	Description
Hattiesburg Comprehensive Plan (2008–2028)	Lays out policies and goals to ensure that the City of Hattiesburg sets a good example of stewardship of the natural environment by employing current best management practices to address stormwater management, tree planting and maintenance, chemical usage, recycling, energy usage, and other areas of environmental protection and natural resource management.
Little Gordy Lake	A conceptual project that is intended to reduce flooding and has opportunities to install many green infrastructure elements including planters, permeable landscapes, and greenways.
Midtown in Motion – A Master Plan for Midtown Hattiesburg	Focuses on creating a more sustainable Midtown and could expand the use of green infrastructure through planting of trees along streets and within parking areas.
Pathways Master Plan	Centers its green infrastructure focus on the use of a greenway system within the city while developing additional pathways for walking and hiking. A greenway is undeveloped land near an urban area that is prioritized for recreational use or environmental protection.
Twin Forks Rising Master Plan	It is envisioned that the Twin Forks Rising plan will include a combination of water body and a green area that would serve as spillway for increased water retention capacity as needed.
Lamar County Comprehensive Plan	Identifies opportunities to install urban greenspace and includes areas provided mainly for their aesthetic and/or environmental enhancement qualities. The identified urban greenspace areas include natural wooded or open lands, floodplains, river corridors, streambanks, parkways, street medians and shoulder ways, areas around public buildings and town squares.
Gordon's Creek Park Conceptual Development Plan	Identifies green infrastructure to be utilized for the restoration of the creek and includes detention ponds, swales, and other practices.

Leading by Example with the Public Project Design Process. Not only can publicly installed green infrastructure projects improve stormwater management and provide a multitude of benefits, but they also can serve as examples to others. Public projects, regardless of size, can be great opportunities for the city to demonstrate the process and benefits of using green infrastructure. All publicly installed green infrastructure can serve as pilot projects, providing learning opportunities for the city, the business community, and residents while also improving the community. Integrating green infrastructure into the design of planned public projects will increase green infrastructure's visibility in Hattiesburg, which will help encourage private developers and property owners to use green infrastructure in their own projects.

Identifying Areas with the Most Suitable Conditions. Looking across an entire community to determine where green infrastructure will work best can be daunting, but a targeted search for existing areas with conditions suitable for green infrastructure practices can be immensely helpful. With a baseline understanding of where different types of green infrastructure may be suitable,

Hattiesburg can make more informed and timely decisions, which will increase the likelihood that green infrastructure practices are successfully installed as part of public projects.

Most communities implement green infrastructure as standalone projects. Institutionalizing procedures to look for and prioritize opportunities within existing and future planned projects is key to saving money and reaping multiple benefits from projects. Preemptively identifying areas that are most suitable for green infrastructure can help determine where green infrastructure can make the biggest difference. Once the city identifies a refined list of areas, it can further investigate and develop design concepts for selected sites.

Table 11 below presents a stepwise list of key actions to integrate green infrastructure into public projects and identify suitable areas for implementation. The city should repeat these key actions regularly to continually evaluate priorities and identify opportunities as landscapes, city agendas, regulatory requirements, and development evolve.

Table 11. Key Actions to Integrate Green Infrastructure into Public Projects (Goal 5)

Key Action	
5.1	Identify public parcels and projects.
5.2	Assess areas that are potentially suitable for green infrastructure.
5.3	Perform site investigations and develop design concepts.
5.4	Develop and update procedures to implement green infrastructure.
5.5	Develop an O&M plan for public green infrastructure.




GREEN INFRASTRUCTURE PRACTICE EXAMPLES

Clockwise from top left:

(1) tree box,
(2) bioswale,
(3) tree trench,
(4) constructed wetland,
(5) permeable pavement,
(6) infiltration Basin,
(7) bioretention System.



Figure 3. Green Infrastructure Practice Examples

5.1 Key Action: Identify Public Parcels and Projects

Public Parcel Identification

As noted above, green infrastructure can be applied in a variety of settings, including public parcels. Incorporating green infrastructure into these public areas not only improves stormwater management in the community, but it can also complement the architecture in the downtown area and bring a more natural appearance to some public spaces.

Figure 4 shows the array of city-owned parcels and identifies the regulated MS4 area as a point of reference.

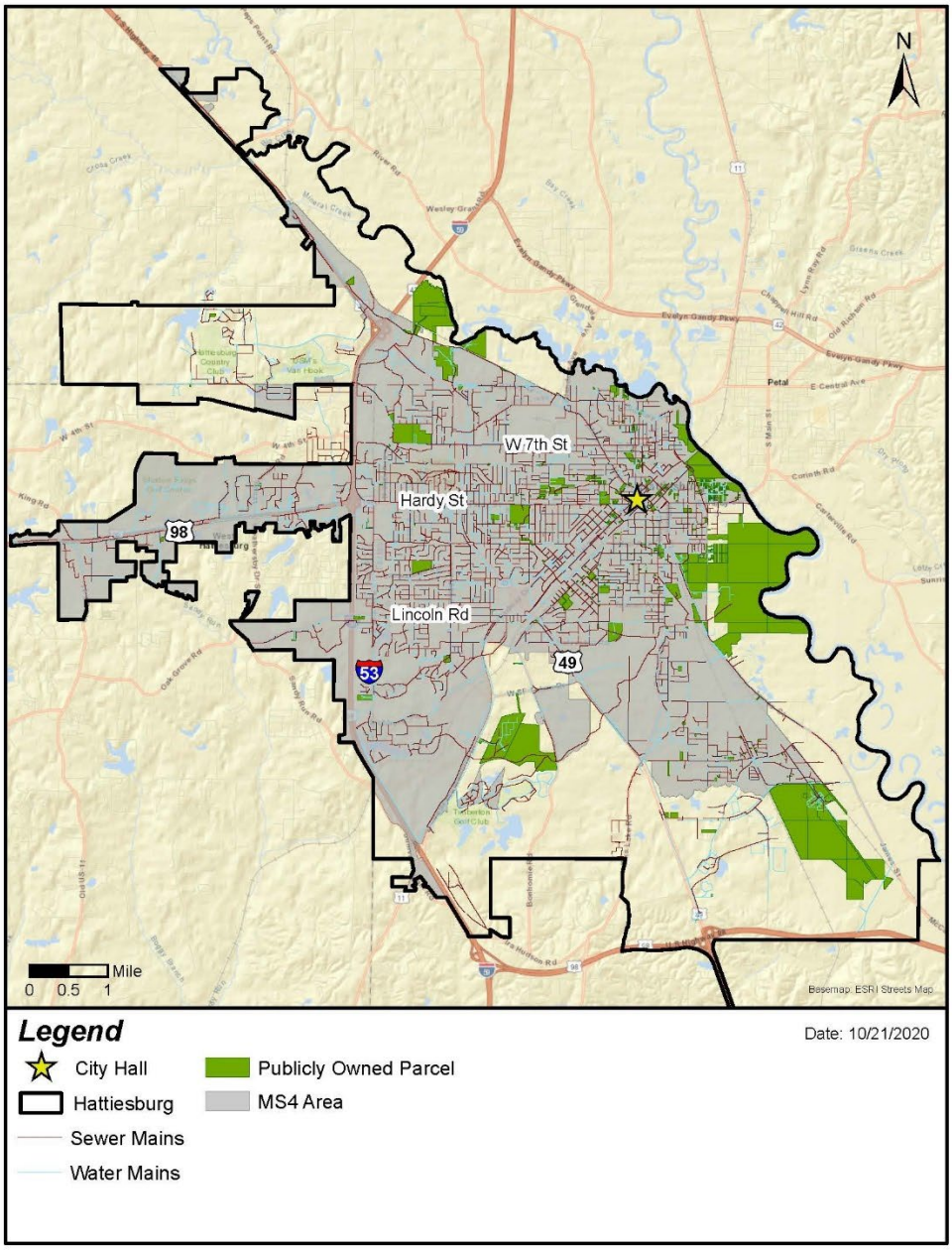


Figure 4. City-owned Parcels and Regulated MS4 Area Map

Public Project Identification

Green infrastructure is an integral part of site design, rather than an afterthought to be tacked on at the end of the core project design. An important step in being prepared for green infrastructure implementation opportunities is to be actively aware of upcoming public projects and to consider whether those project sites, or portions thereof, might be suitable for green infrastructure. In this way, the city can integrate green infrastructure into the early stages of project planning, when site layout is being contemplated. The city should look across departments to gain a more complete view of

upcoming projects to determine if opportunities exist to incorporate stormwater management practices.

At the initiation of this stormwater planning process, Hattiesburg staff identified a list of potential upcoming public projects to focus on in the next several years based on the city's current priorities. These include streetscape and drainage improvements and improvements to public lands for public parks and open space access. Table 12 below highlights the potential public projects and the associated potential community-related benefits for each of them. Figure 5 presents the locations of these public projects[15].

Table 12. Potential Public Projects and Examples of Community-Related Benefits

Project Name	Example Community-Related Benefits			
	Street Improvement	Waterway Improvement	Flooding Reduction	Park Improvement
#1 Little Gordy Lake Project Watershed			✓	
#2 Little Gordy Lake Project			✓	
#3 Neighborhoods Contributing to Gordon's Creek Improvements along Lincoln Road		✓	✓	
#4 Hardy Street Improvements	✓		✓	
#5 Gordon's Creek Improvement in the Cultural District		✓		✓
#6 Twin Forks Rising Area of Flooding Concern			✓	
#7 Neighborhood Contributing to Chain Park			✓	✓
#8 Gordon's Creek Improvement Connecting the Downtown and Depot District				✓
#9 East Hardy Park				✓
#10 Edwards Street Improvements	✓		✓	

[15] Note that these areas delineated on the map may not encompass the full extent of a potential project or impacted area. This information can be refined through further discussions among stormwater stakeholders and site investigations.

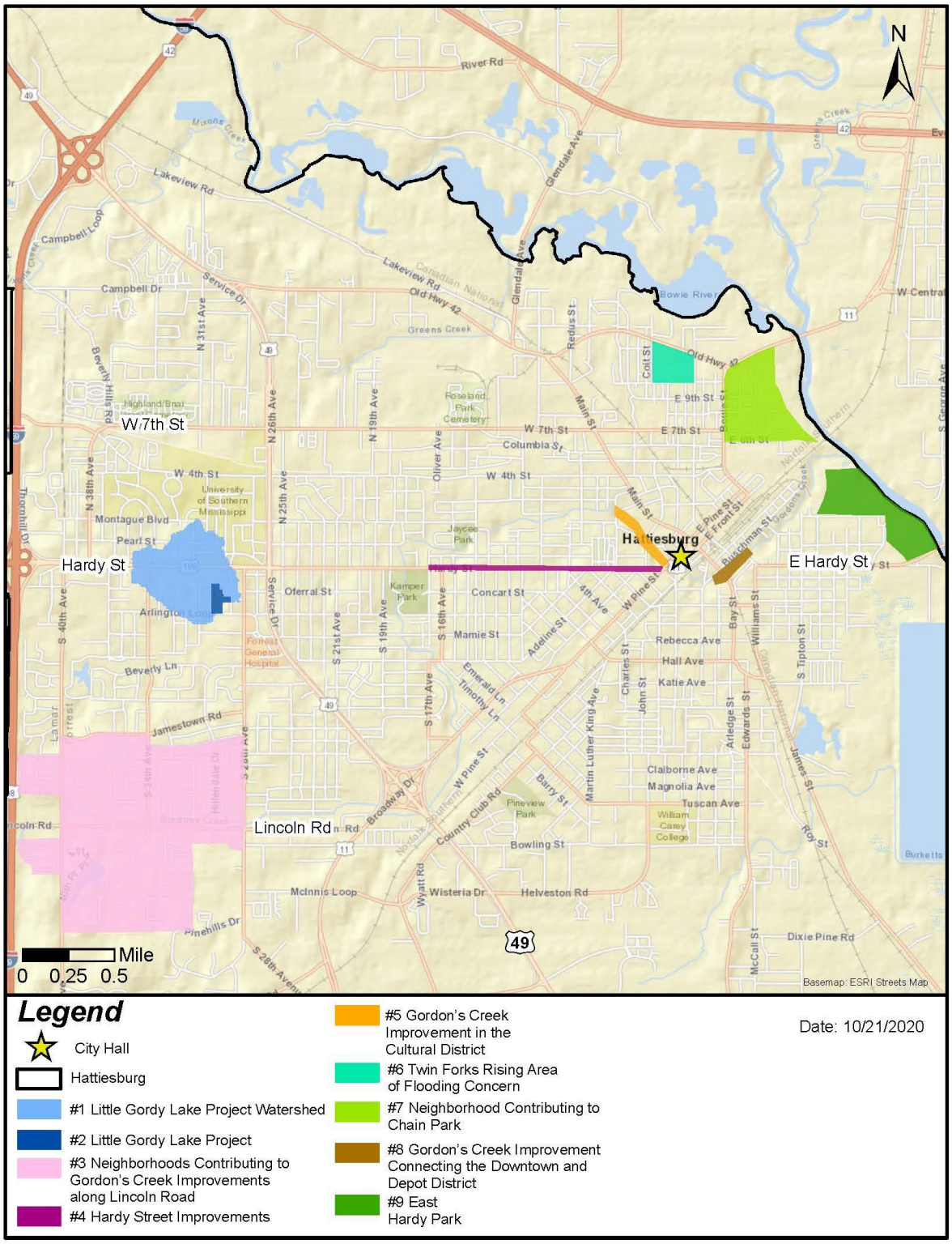


Figure 5. Potential Upcoming Public Project Site Locations Map

An annual review and update of the projects list is recommended. Multiple city departments should update and contribute to this list, such as public works, parks and recreation, urban development, building, planning, and engineering, since those departments all undertake projects on public property. The project list should also include planned city projects from the most current versions of city capital improvement and master planning initiatives.

A GIS map or other list that identifies upcoming planned public projects in the queue, as well as the responsible city departments, should be kept current and readily available to the various city departments. This will help to facilitate coordination and communication among departments so the city can readily identify and seize green infrastructure opportunities when they arise. The next key action describes how the city can identify and assess the potential suitability of parcels and proposed public project sites for different types of green infrastructure. This type of assessment will help the city more efficiently target its site investigation efforts for green infrastructure implementation.

INCLUDING GREEN INFRASTRUCTURE: IT MAY BE EASIER THAN YOU THINK!

Identifying projects with green infrastructure opportunities may be easier than you think! The flexibility of green infrastructure design means that it can be a part of most projects. The site suitability assessment maps discussed in the next key action can be referenced to quickly identify locations for green infrastructure opportunities that overlap with capital improvement and master planning project sites.

5.2 Key Action: Assess Potential Site Suitability for Green Infrastructure

Not only can geographic information help the city understand where upcoming and potential city project sites are located, it can also help the city assess how suitable a site's physical characteristics are for green infrastructure. This type of assessment is a useful planning exercise because it allows the city to prioritize locations with greater suitability potential.

Hattiesburg's Assessment Results

EPA conducted a desktop GIS-based site suitability assessment across the entire city. Appendix G provides the methodology to perform the assessment and additional details on the results. The assessment looked at the suitability of sites for two different categories of green infrastructure—infiltrating and non-infiltrating practices—each of which relies on a slightly different set of site characteristics to function most effectively.

The site characteristics considered in an assessment depend on the data availability, reliability, and accuracy for a given location, and generally include:

- Slope
- Hydrologic soil group
- Depth to groundwater and bedrock[16]
- Location within a buffer to a water body
- Flood zone or drinking water supply protection area

[16] For Hattiesburg, data were not available for depth to groundwater and bedrock and soil contamination, but these data can be integrated into the assessment if and when they become available.

- Soil contamination
- Location relative to an impaired water body
- Existence of paved or pervious area

Infiltrating practices must be installed where underlying native or amended soil allows site stormwater runoff to soak into the ground. Many green infrastructure practices, such as bioretention areas, bioswales, and tree trenches, can be designed as either infiltrating or non-infiltrating practices to accommodate the specific site conditions where they are being installed (e.g., whether an underdrain system and/or liner is needed).

INFILTRATING PRACTICES

These practices store stormwater and allow it to infiltrate into the underlying soil and groundwater. They help reduce the volume and flow rate of stormwater runoff and remove pollutants. They may also provide aquifer recharge and flood mitigation.

NON-INFILTRATING PRACTICES

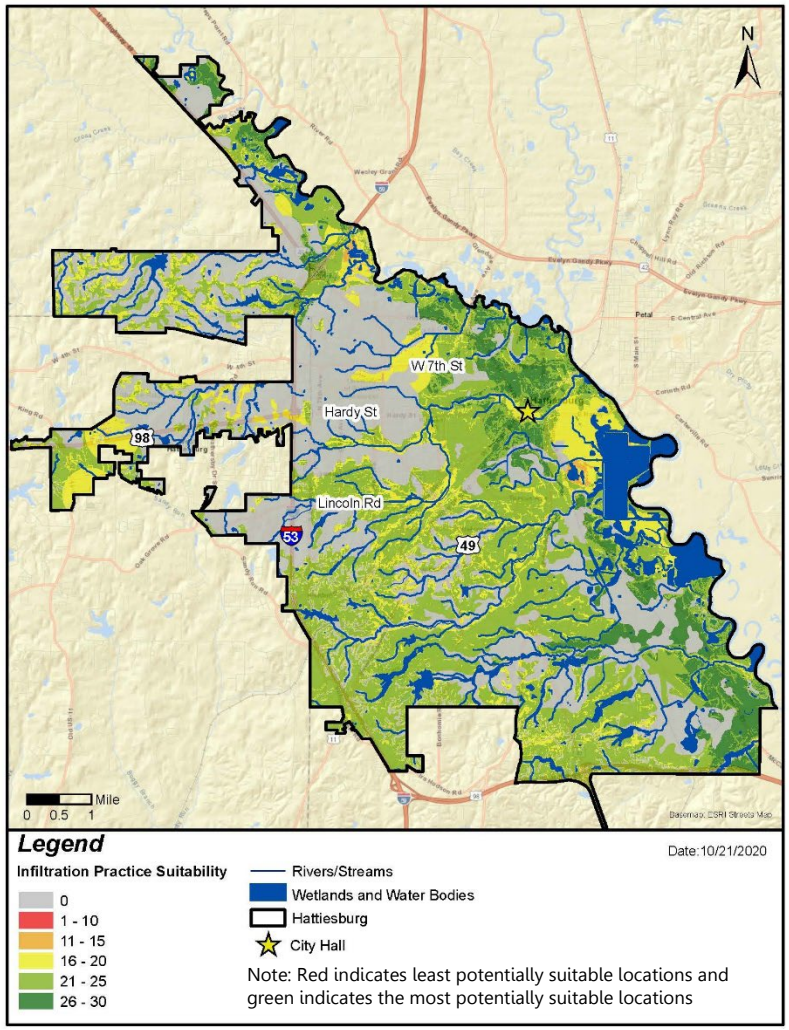
These practices store stormwater but do not allow it to infiltrate into the underlying soil and groundwater. Like infiltrating practices, they help reduce the flow rate of stormwater runoff and remove pollutants.

The assessment results are presented as maps, one for each category of green infrastructure, in which each pixel in the map grid is color-coded according to its calculated site suitability score. The assessment results are presented on a scale from least potentially suitable (red) to most potentially suitable (green) for the targeted category of green infrastructure practices. It should be noted that a red color-coding does not preclude the successful installation of green infrastructure; it indicates the location may be less suitable based on the chosen criteria and desktop-screening compared to a location with green coloring. The site suitability score is a way for city staff to prioritize which projects and project locations to pursue further.

Figure 6 presents the mapped results of the assessment in Hattiesburg. A GIS map has also been provided to the city. Areas in the west in the higher elevations of Hattiesburg are likely less suitable for infiltrating practices, primarily due to less permeable soils (hydrologic soil group D soil) and steeper slopes. Therefore, non-infiltrating green infrastructure may be better suited to those locations. There is substantial potential opportunity for infiltrating practices in Hattiesburg, particularly in the eastern portions of the city.

Hattiesburg experiences localized flooding due to drainage constraints and is particularly interested in determining where green infrastructure might be suitable to help mitigate that flooding. The city has clay soils in many areas and this assessment evaluates hydrologic soil type as a criterion for green infrastructure suitability. It also evaluates suitability for non-infiltrating green infrastructure practices that do not rely on soil type as a criterion. Figure 7 shows the green infrastructure site suitability assessment results for the drainage areas that contribute to flood-prone locations. In many cases, the drainage areas are suitable for both infiltrating and non-infiltrating practices, but in general, a broader area is suitable for non-infiltrating practices. This makes sense because the site characteristic criteria for infiltrating practices are slightly more constraining than those for non-filtrating practices. Ultimately, site visits and site investigations will further clarify these results when the city pursues a specific project location.

Infiltrating Suitability



Non-Infiltrating Suitability

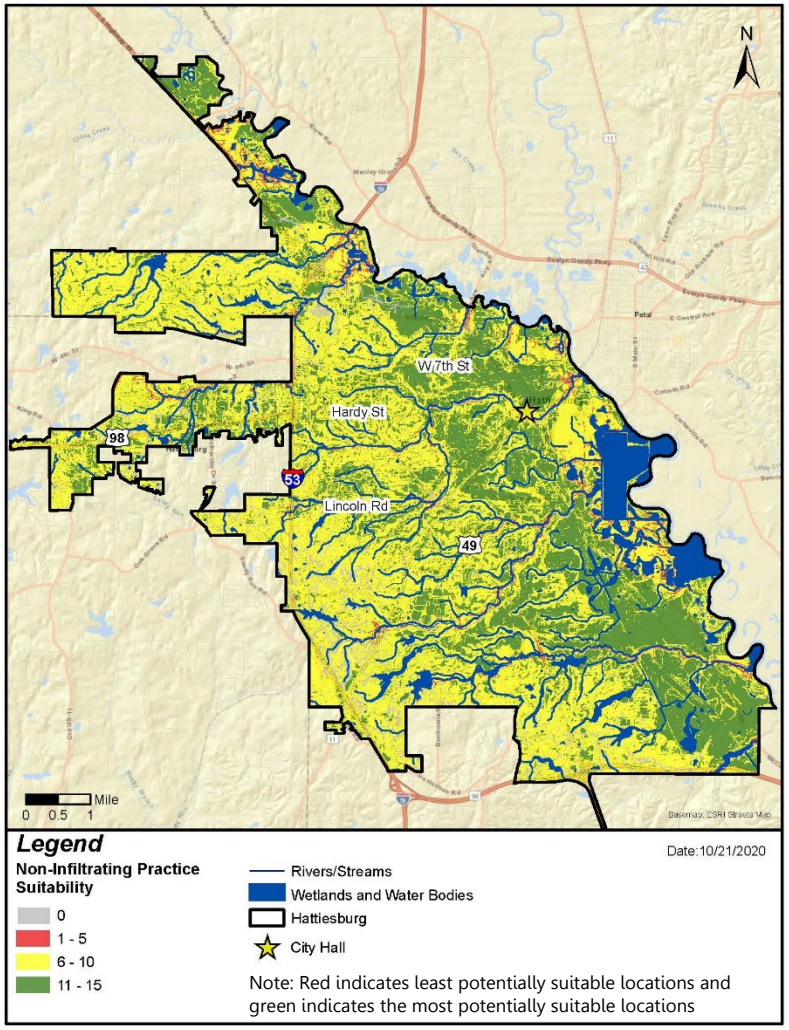
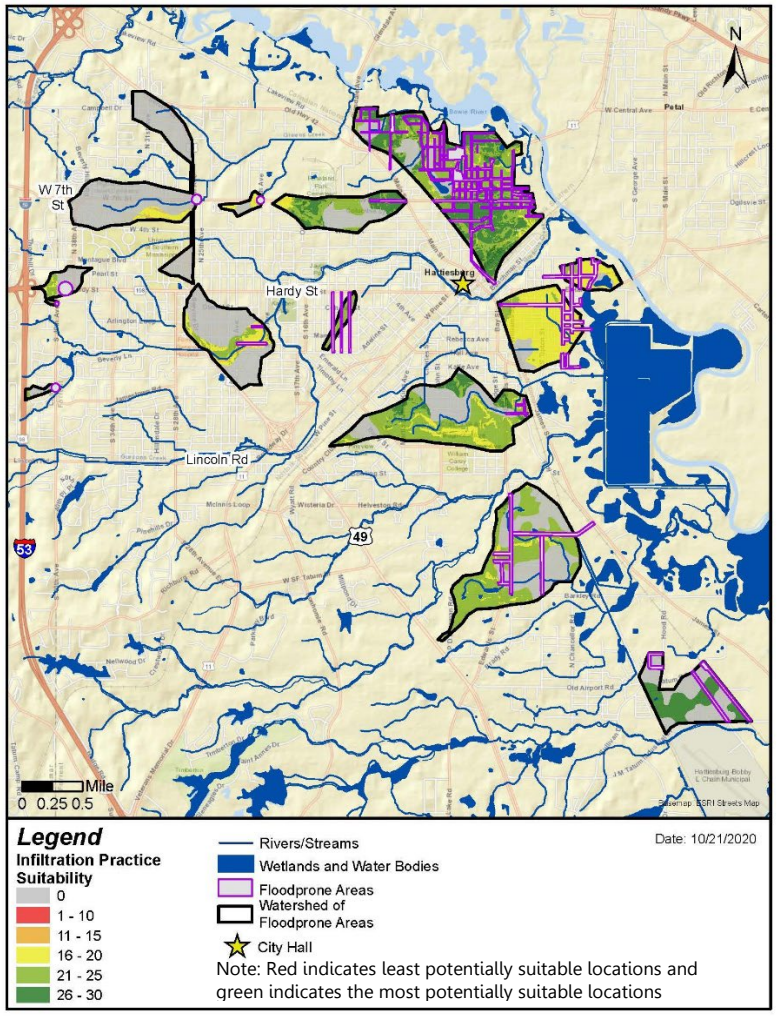


Figure 6. Infiltrating and Non-infiltrating Practice Suitability Maps

Infiltrating Suitability



Non-Infiltrating Suitability

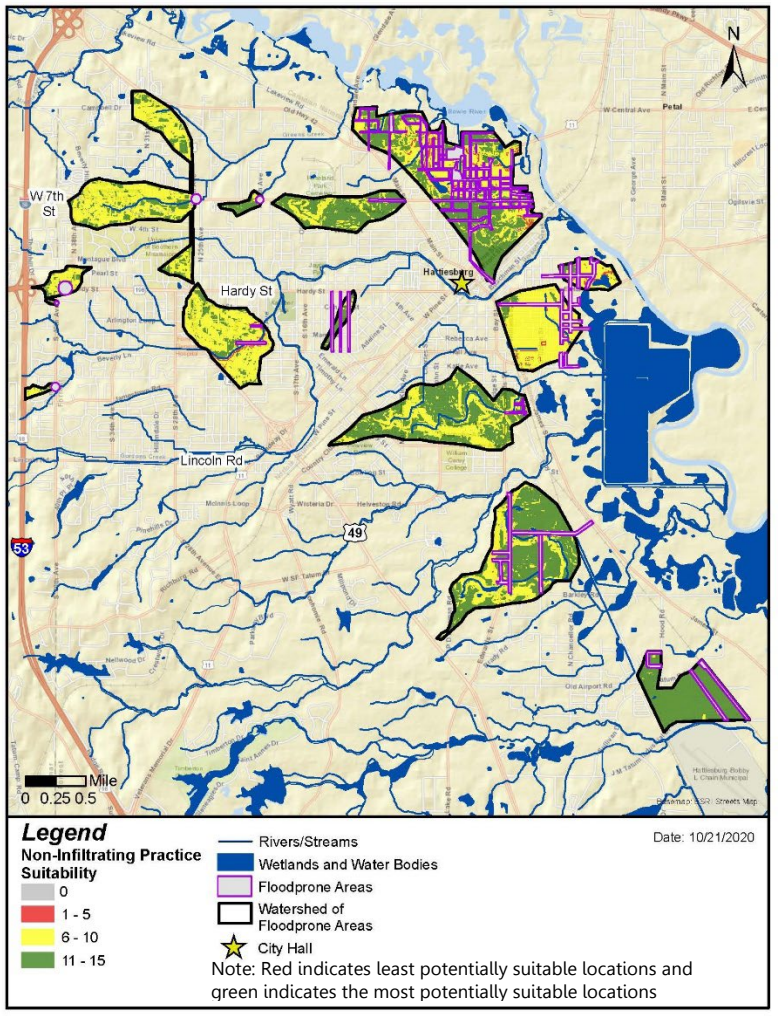


Figure 7. Infiltrating and Non-infiltrating Practice Suitability Maps for Drainage Areas to Flood-prone Locations

Continuing to Reference and Revise Assessment Results

As stated earlier, many municipal green infrastructure projects are undertaken opportunistically. For those cases, site suitability maps can provide a basic assessment of the project site, identify which category of green infrastructure practices may be best suited for the location, and identify where at the site to focus those efforts. The site suitability maps also indicate areas where the city could pursue retrofit projects or standalone green infrastructure demonstration projects due to the benefits and likelihood of successful installation.

Example of permeable pavers.

The methodology may be used to assess both private and public parcels for potential site suitability for green infrastructure. The site suitability map can be a useful reference for private developers considering which types of green infrastructure practices might be suitable for their sites. The city can use these suitability maps to encourage private developers to consider green infrastructure practices in their designs and to help project designers develop concepts for stormwater management.

When designers and planners consider green infrastructure practice selection at an early stage in the design, it can be effectively integrated into the site layout. This helps to ensure that the design preserves, takes advantage of, and places buildings outside of suitable areas to the extent possible. Though the city does not currently have green infrastructure design specifications or guidance, the city could consider developing and adopting them as its program evolves.

ALIGNING WITH OTHER OBJECTIVES

- ✓ Using the methodology presented in Appendix G to assess the potential suitability of sites for green infrastructure can directly help the city prioritize opportunities for stormwater improvements on public properties.
- ✓ Installing green infrastructure in public projects aligns with priorities in the city's stormwater management plan.
- ✓ A well-placed green infrastructure retrofit project serves as great public education resource.

To advise both private and public projects, it is recommended that Hattiesburg continue to use this methodology and refine the data inputs as new data become available or community priorities change. For example, in Hattiesburg, accurate depth to groundwater data were not available for the assessment. Such data can provide a useful additional criterion to evaluate site suitability for infiltrating green infrastructure practices, which often require a minimum clearance of 2 to 4 feet from the bottom of the practice to the seasonal high groundwater. If such data become available, the assessment could be redone to provide more accurate results. The maps do not need to be recreated for every project, but rather they can serve as a standing reference until new data are available, or site conditions change considerably.

Many additional desktop tools and methodologies are available to help communities assess and plan for green infrastructure implementation. These tools require varied levels of technical knowledge and

data input, and are targeted to a variety of specific goals, mostly related to calculating the pollutant removal anticipated from a set of stormwater management practices.

GREEN INFRASTRUCTURE PLANNING & ANALYSIS TOOLS

Green Infrastructure Screening and Selection

The **EPA Green Infrastructure Modeling Toolkit** includes many tools and models to help communities identify and evaluate which green infrastructure practices and combinations could be effective.

The **Green Infrastructure Wizard** is a web application that provides communities with information about EPA green infrastructure tools and resources.

The **Watershed Management Optimization Support Tool** is a software application that allows users to screen a wide range of management practices for cost-effectiveness and economic sustainability.

Performance Simulation and Modeling

Visualizing Ecosystem Land Management Assessments is a computer software model to help regional planners and land managers determine which green infrastructure practice would be most effective for improving water quality in streams, estuaries, and groundwater.

The **Storm Water Management Model** is a simulation model that communities can use for stormwater runoff reduction planning, analysis, and the design of stormwater systems, combined sewers, and other drainage systems.

The **National Stormwater Calculator** is a desktop application that estimates the annual amount of rainwater and frequency of runoff from a specific site anywhere in the United States (including Puerto Rico). SWC allows users to learn about the ways that green infrastructure practices, like rain gardens, can prevent water pollution in their neighborhoods.

The **Green Infrastructure Flexible Model** is a computer program that evaluates the performance of urban stormwater and agricultural green infrastructure practices. Users can build conceptual models of green infrastructure practices to predict hydraulic and water quality performance under given weather scenarios.

EPA Region 1's **Stormwater Optimization Tool** is a desktop application combining GIS and spreadsheet analysis that allows users to evaluate options and determine the best mix of structural stormwater practices, including green infrastructure, to achieve quantitative water resource goals.

5.3 Key Action: Perform Site Investigations and Develop Design Concepts

Once potentially suitable sites are identified through the desktop GIS-based site suitability assessment, the next step is to investigate the sites to identify additional constraints and opportunities that may not be visible using GIS data alone. For example, data on the location of utilities may not be available in GIS but can often be readily observed at the site and may determine whether a green infrastructure practice is feasible at a specific location. In addition, a site visit may reveal a change in land use or slope that is not reflected in the latest GIS data or a stormwater-related impact, such as sediment buildup or erosion, that may influence the design or selection of green infrastructure practices. This site investigation is also an opportunity to begin sketching out conceptual designs for potential green infrastructure practices at the site, particularly if the project is a retrofit or renovation of an existing site.

A conceptual design of a green infrastructure practice can range from a handwritten sketch using a marker to an aerial photo or a sketch on a tablet with mobile GIS and sketch capabilities. The design should identify (1) a location that is the appropriate size for the proposed practice, (2) a feasible way to direct water into the practice, and (3) a feasible mechanism for discharging water from the practice via infiltration, underdrain connection to existing infrastructure, or overflow. The concept design should consider the estimated size of the contributing drainage area to the site and the basic treatment and/or detention volume. Even though the assumptions made in the concept sketch are estimates, a designer or engineer with stormwater management experience should make and document the assumptions.

To help lead by example, the city could also consider establishing a policy that requires its relevant departments and programs to consider integrating green infrastructure at the conceptual design phase for all projects on public property. The policy or regulation could include a mechanism to release some projects from this requirement if it is demonstrated that green infrastructure would not be feasible or effective for that project. These projects—whether they are streetscape projects, park renovations, or new facilities—should strive to meet or exceed the stormwater management design standards required under the Land Development Code for private projects.

EDWARDS STREET PROJECT

The city of Hattiesburg requested assistance from the EPA's Greening America's Communities Program to transform their streets and public spaces into green and complete streets and spaces. The city focused on Edwards Street, between James Street and Milton Barnes Avenue, located in a portion of Hattiesburg that was hardest hit by a devastating January 2017 tornado. Project goals include improving pedestrian, bicycle, and vehicular routes; incorporating green infrastructure elements and other stormwater management practices; and enhancing neighborhood identity to attract investment and spur ongoing redevelopment and renovation of the neighborhood.

Figure 8. (Left): Current condition of Edwards Street just north of Milton Barnes Avenue, facing south.

Figure 9. (Right): Design concept for Edwards Street.

The perspective shows two lanes of traffic with a stormwater median; street trees; a designated bike lane; sidewalks with decorative permeable paving; pedestrian crosswalks; and additional lighting.

5.4 Key Action: Develop and Update Procedures to Implement Green Infrastructure

The city can convert the green infrastructure site suitability assessment, site visit, and concept plan into action by developing procedures for implementing green infrastructure into public projects. Implementing green infrastructure requires funding, creativity, an understanding of municipal processes, and the ability to take advantage of opportunities when they arise. The city should revisit and update these procedures often—annually if possible, but at least every few years. These procedures will enable the city not only to be opportunistic with green infrastructure implementation as capital projects come along, but also to make standalone projects feasible.

The green infrastructure site suitability assessment process described above and in Appendix G will produce a mapped list of potential green infrastructure implementation locations with recommended practice types and concept design sketches. This master list of green infrastructure projects within the city, a specific watershed, or neighborhood can serve as the basis for an implementation plan. Table 12 presents the city's list of public projects to demonstrate what the initial stages of the implementation plan might look like. Recommended green infrastructure practices were identified based on the area-weighted average suitability scores for each project site (see Appendix G) and a review of the geographic distribution of suitability scores across each project site. An implementation plan following a more robust planning process could contain more detail, including implementation status tracking.

Multiple city departments should help develop the implementation timeline, such as public works, parks and recreation, urban development, building, planning, and engineering, since these departments all undertake projects on public property. The city can assign timeframes or actual implementation deadlines to these sites, based on how they align with known public project schedules or other development timelines. This implementation plan can also serve as a basis for grant applications, so the city is prepared for funding opportunities when they arise. The implementation timeline will be an estimate, but having a basic schedule helps keep the projects on the city's radar.

The implementation timeline should be updated on an annual to five-year basis to note projects that have been implemented and add new projects to the list. New projects could be added by revisiting the desktop green infrastructure suitability assessment as needed, developing an updated list of public projects where green infrastructure might be incorporated, performing site visits, developing concept sketches, and assigning a timeline for implementation.

Table 13. Example Implementation Plan Template for Green Infrastructure in Hattiesburg Public Projects

Project Name	Brief Description	Recommended Practice [1]	Responsible Department	Timeframe
#1 Little Gordy Lake Project Watershed	This is the area of land contributing drainage to the Little Gordy Lake Project, which is a flood mitigation project described below in #2. Controlling drainage from this area is understood to help achieve the flood mitigation goals of the Little Gordy Lake Project (#2 below).	This area is suitable for non-infiltrating practices and could potentially benefit from a series of lined bioswales and bioretention systems, a constructed wetland system, and lined tree trenches to help slow and detain the flow of stormwater and reduce peak flows that are contributing to flooding. The proposed project could be augmented by a series of green infrastructure practices that would also serve as landscaping elements and could reduce the size of the proposed "lake."	Engineering	TBD
#2 Little Gordy Lake Project	This is a flood mitigation project targeted at relieving the Hardy Street neighborhood from flooding associated with a lack of drainage capacity through the neighborhood. The project is part of the Midtown in Motion master Plan and envisions the creation of a detention pond or "lake" as a type of amenity or water feature.		Engineering	TBD
#3 Neighborhoods Contributing to Gordon's Creek Improvements along Lincoln Road	This is a flood mitigation project to alleviate overbank flooding into the neighborhood along Gordon's Creek and Lincoln Road. The city is contemplating surface detention of water in ponds on vacant lots as a means of reducing flooding for the betterment of the neighborhood.	Further improve the flow capacity in the creek by potentially using infiltration practices such as tree trenches, permeable pavement and bioretention areas in the northern portion of the project area, which is suitable for infiltration. In the southern portion of the project area, which is less suitable for infiltration practices, the city could consider incorporating constructed wetlands and lined bioretention systems to further slow the flow of stormwater. Together, these approaches could reduce the flow volume and help alleviate flooding	Engineering	Medium (4-6 years)

Project Name	Brief Description	Recommended Practice [1]	Responsible Department	Timeframe
		originating from neighborhoods to the north and south.		
#4 Hardy Street Improvements	This project involves beautification of a long, major street through the city.	Practices might include tree boxes or bioretention systems within the street scape to slow the stormwater runoff and provide stormwater treatment.	Engineering	Short (1-3 years)
#5 Gordon's Creek Improvement in the Cultural District	A multi-use path is being developed along the entire length of Gordon's Creek. Some parts of the Downtown, Depot and San Antonio Districts are already complete. This project focuses on the Cultural District.	The project area includes potential green infrastructure opportunities, such as bioretention, tree filters, or permeable pavement.	Engineering, Parks and Recreation Department, Planning	Medium (4-6 years)
#6 Twin Forks Rising Area of Flooding Concern	This is part of the Master Plan for Urban Revitalization in Ward 2, known as Twin Forks Rising. This project could more actively include integration of stormwater management and natural elements to help address flooding from drainage issues.	Practices could include bioretention systems and tree trenches throughout.	Engineering, Planning	TBD
#7 Neighborhood Contributing to Chain Park	The neighborhood to the west of Chain Park experiences flooding/drainage problems. The city could possibly retrofit drainage in that neighborhood or use portions of the park to alleviate flooding.	Practices could include bioretention systems and tree trenches throughout the neighborhood.	Engineering, Planning	Long (7-10 years)

Project Name	Brief Description	Recommended Practice [1]	Responsible Department	Timeframe
#8 Gordon's Creek Improvement Connecting the Downtown and Depot District	This project is similar to #5 above, but with a longer time horizon. A multi-use path is being developed along the entire length of Gordon's Creek and portions of the Downtown, Depot and San Antonio Districts already complete. This project focuses on connecting the Downtown and Depot District.	There may be some opportunities for non-infiltrating green infrastructure within future sections of this project. Practices might include bioretention systems, tree boxes, or tree trenches along the path, as well as potentially permeable pavement with storage and connection to the drainage system.	Engineering, Planning	Long (7-10 years)
#9 East Hardy Park	Potential future plan for park, including golf holes, a baseball field, soccer field, hiking trails, outdoor park space, and more.	This park might include constructed wetlands, permeable pavement with storage and connection to the drainage system, and tree trenches throughout to slow and treat runoff.	Engineering, Parks and Recreation	Long (7-10 years)
#10 Edwards Street Improvements	This project aims to revitalize a heavily traveled road, incorporating green infrastructure elements and other stormwater management practices to improve water quality and help reduce localized flooding by capturing and slowing down rainfall before it reaches and inundates the sewer system. This project was part of EPA's Green America's Communities design efforts.	Practices might include tree boxes, permeable pavement, or bioretention systems within the street scape to slow the stormwater runoff and provide stormwater treatment. See the inset box above in **Section 5.3** for more details.	Engineering, Planning	Long (7-10 years)

Table Notes:

[1] *Recommended practices are advisory in nature. The ultimate recommendations would include specific practices following deliberations by the city.*

5.5 Key Action: Develop and Integrate an O&M Process for Public Green Infrastructure

Green infrastructure, like all infrastructure, must be maintained to function properly over time and provide the planned services and benefits. When the implementation plan (described above) identifies green infrastructure, the city should begin to consider who will be responsible for regular maintenance of the green infrastructure practice.

Example of bioretention system.

It can be difficult to centralize green infrastructure maintenance. Green infrastructure can cross the somewhat traditional boundaries between landscaping and drainage or highway infrastructure. Therefore, it can potentially fail to receive required maintenance because it does not completely fall within a specific category of operations. In addition, it can be challenging to designate one department responsible for maintenance because various green infrastructure may be dispersed throughout properties traditionally maintained or operated by different municipal departments. Some communities allocate green infrastructure maintenance responsibilities based on which department manages a parcel, and other communities allocate citywide maintenance responsibilities to one department, such as public works.

Regardless of who is responsible for maintenance, it is important to ensure that staff are adequately trained and that the city keeps records of green infrastructure, just as for traditional infrastructure like streets and bridges. As part of that record, each green infrastructure practice should have a documented O&M procedure that identifies and records long-term responsibilities and activities. The O&M procedures should clearly define what the maintenance processes are, what equipment is required, and who is responsible for the maintenance. It is also helpful to include an estimate of the annual budget needed to perform the maintenance, so that the budget can be incorporated into the annual operating budget of the department and the city. This type of information is a key part of asset management (see Goal 3). In addition, the city could develop a condition index and rating scale to document the condition of green infrastructure practices over time to help plan for repairs and replacement.

GREEN INFRASTRUCTURE MAINTENANCE

Green infrastructure maintenance often includes removal of sediment and debris, vegetation replacement, weeding, and other periodic maintenance of structural aspects such as pavers, inspection ports or cleanouts.

Plan Implementation and Next Steps

The city's long-term stormwater plan identifies five primary long-term goals and an overall vision the city aims to achieve related to stormwater management over time. The plan provides context about the city's current stormwater management approaches as well as information and tools the city may use to help make progress towards its goals. Successful implementation will require collaboration across city departments and with other stakeholders, and an adaptive management approach.

View of family canoeing in Hattiesburg.

This plan is a flexible framework for action that the city can use to ensure progress over the long-term and balance stormwater management objectives with other city priorities. Several of the city's focus areas relate directly to this effort, including reduction of flood insurance costs for citizens, minimizing impacts from flooding, and ensuring adequate funding for its programs. During the creation of this plan, response to the coronavirus pandemic has impacted staff and budget resource allocations for the city. However, the city has reevaluated this plan to identify priorities and feasibility and intends to pursue the key actions listed below in the near term.

Table 14. Key Actions to Pursue in the Near Term

Goal 1 – Engage Stakeholders	
Key Action 1.1: Identify stakeholders, target audiences, and potential partners to engage in planning efforts related to long-term stormwater management.	***Notes:*** *Complete within 2 to 3 months of long-term stormwater plan adoption; coordinate with pursuit of developing the Leaf River Watershed Plan.*
Key Action 1.2: Write a stakeholder engagement strategy.	***Notes:*** *Complete by the end of 2021; coordinate with pursuit of developing the Leaf River Watershed Plan.*
Key Action 1.3: Conduct ongoing stakeholder outreach and engagement.	***Notes:*** *Continue current ongoing engagement efforts related to stormwater. Align efforts with the stakeholder engagement strategy (Key Action 1.2) upon its completion and into 2022.*
Goal 2 – Ensure Adequate Funding to Meet Stormwater Program Objectives	
Key Action 2.1: Identify and evaluate stormwater activities, revenues, and expenditures.	***Notes:*** *Effort initiated. Plan to update estimates for current stormwater activities by the end of 2021.*
Goal 3 – Achieve Efficient, Practice, and Cost-Effective Operation and Maintenance of the City's Stormwater Infrastructure through Asset Management	

Key Action 3.1: Develop program scope, goals and objectives, and timeline and establish asset management task force.	***Notes:*** *To complete by end of 2021.*
Key Action 3.2: Start to develop an asset inventory.	***Notes:*** *Start by the end of 2021. This key action is a critical starting point and other relevant key actions such as 3.3 to 3.6 will be considered when embarking on this effort.*
Goal 4 – Improve the City's Resilience to Flooding	
Key Action 4.1: Continue to leverage FEMA's programs for pre- and post-disaster mitigation to obtain project funding.	***Notes:*** *Pursue when project opportunities arise.*
Key Action 4.2: Explore alternative bank stabilization approaches to reduce flashiness of flows in Gordon's Creek and create a greater community connection to the creek.	***Notes:*** *Pursue when project opportunities arise.*
Key Action 4.3: Evaluate the city's current practices for flood resilience using EPA's Flood Resilience Checklist.	***Notes:*** *Initial evaluation complete. City to consider recommendations and evaluate next steps by the end of 2021.*
Key Action 4.4: Improve the city's rating for flood insurance rate reduction.	***Notes:*** *Complete by July 1, 2021.*
Goal 5 – Identify Opportunities for Improved Stormwater Management and Green Infrastructure in Public Projects	
Key Action 5.1: Identify public parcels and projects.	***Notes:*** *Completed. Update information at end of 2021.*
Key Action 5.2: Assess areas that are potentially suitable for green infrastructure.	***Notes:*** *Completed. Reevaluate analysis during project planning. Update analysis at end of 2021.*
Key Action 5.3: Perform site investigations and develop design concepts.	***Notes:*** *Pursue when project opportunities arise.*

Other key actions listed under the various goals of this plan may be mid- or long-term tasks. The timing and approach for these activities will be determined later. Appendix H provides a simple tool for key action implementation planning and progress evaluation.

The city will reassess its progress at least annually to ensure that implementation of this plan continues in a manageable and effective way. Based on progress, challenges, and city priorities, the city may update this plan over time to help achieve its stormwater management goals and provide valuable services for the community.

APPENDIX A:
EXAMPLE TABLE FOR IDENTIFYING AND EVALUATING STORMWATER ACTIVITIES AND BUDGET ESTIMATES

Example Table for Identifying and Evaluating Stormwater Activities and Budget Estimates

The table below provides a simple tool for creating a snapshot of a community's current and/or anticipated stormwater management activities and budget estimates. The list of stormwater-related activities is not necessarily exhaustive and can be updated to reflect a community's actual activities. Information on the activities and corresponding budgets may come from various sources including budgeting documents, stormwater program records, individual staff knowledge, among others. This information can be updated over time as additional data becomes available.

Item No.	Stormwater-Related Activity	Department Responsible	Annual Budget Estimate	Source of Budget Estimate	Other Notes
Administration and Finance					
1	Budgeting and accounting (for general fund allocation to the engineering department for stormwater activities)				
2	Customer service (e.g., complaint hotline related to stormwater)				
3	Documentation and recordkeeping (e.g., work orders, hard copy maps)				
4	Stormwater consultant fees to support MS4 Program				
Operation and Maintenance					
5	Street sweeping				
6	Catch basin/inlet cleaning				
7	Stream channel cleaning				
8	Storm sewer cleaning and televising				
9	Complaint response				
10	Emergency response				
11	Street maintenance (drainage infrastructure maintenance that occurs during street repairs)				

Item No.	Stormwater-Related Activity	Department Responsible	Annual Budget Estimate	Source of Budget Estimate	Other Notes
12	Bank stabilization repairs				
13	Inspections of structural and non-structural Best Management Practices (BMPs) on public property				
14	Maintenance for structural and non-structural BMPs on public property				
15	Major capital storm sewer system improvements				
16	Minor capital storm sewer system improvements				
17	Land, easement, and right-of-way purchase				
18	Construction management for drainage improvements				
Regulatory Compliance and Enforcement					
19	MS4 Program—Public education and outreach (educational materials development and distribution)				
20	MS4 Program—Public involvement (household hazardous waste events, community hotline)				
21	MS4 Program—Illicit discharge detection and elimination (outfall screening, mapping)				
22	MS4 Program—Construction site runoff control (erosion and sediment control inspections)				

Item No.	Stormwater-Related Activity	Department Responsible	Annual Budget Estimate	Source of Budget Estimate	Other Notes
23	MS4 Program—Post-construction runoff control (BMP inspections and maintenance)				
24	MS4 Program—Municipal facility pollution prevention/good housekeeping (facility inspections)				
25	MS4 Program—Surface water quality (e.g., rivers and streams) monitoring program				
26	MS4 Program—Reports (stormwater management plan, annual report)				
27	Inspections of industrial and commercial facilities				
28	Fertilizer management program expenditures				
29	General watershed management activities				
30	Other MS4 Program expenditures				
Engineering and Planning					
31	Design of structural and non-structural BMPs (public projects)				
32	Stream restoration (e.g., bank stabilization efforts)				
33	Asset management—Inventory				
34	Asset management—Condition assessment				

Item No.	Stormwater-Related Activity	Department Responsible	Annual Budget Estimate	Source of Budget Estimate	Other Notes
Development Support Services					
35	Plan review to ensure projects meet stormwater design criteria and standards (private projects)				
36	Erosion and sediment control inspection services for construction projects (private projects)				
37	Field acceptance inspections to ensure construction meets city standards (private projects)				
38	Stormwater code enforcement				
Flood Management					
39	Flood insurance program support				
40	Flooding hazard mitigation				
Geographic Information System (GIS) and Technology Support					
41	GIS licenses				
42	GIS staff time for stormwater program assistance				
43	System mapping				
44	Database management				
45	Stormwater website design and support				
46	Asset management—Software licenses				
Staff Training/Certification					
47	Specific technical training/certification				

APPENDIX B:
SUMMARY OF POTENTIAL FEDERAL FUNDING OPPORTUNITIES

Summary of Potential Federal Funding Opportunities

The following tables summarize federal funding programs across various agencies that may offer opportunities for stormwater-related project funding.

U.S. Environmental Protection Agency (EPA)

PROGRAM	PROGRAM DESCRIPTION	EXAMPLES OF FUNDED PROJECTS
Clean Water State Revolving Fund (CWSRF)	Using a combination of federal and state funds, the program provides loans to construct municipal wastewater facilities, control nonpoint sources of pollution, build decentralized wastewater treatment systems, create green infrastructure projects, protect estuaries, and fund other water quality projects. *Financing Green Infrastructure: A Best Practices Guide for the Clean Water State Revolving Fund* (2015) highlights successful case studies and examples of ways CWSRF programs can prioritize green infrastructure projects for funding by implementing priority point systems, program set-asides, and marketing strategies for state programs. For more information, see the *Green Infrastructure Approaches to Managing Wet Weather with Clean Water State Revolving Funds* fact sheet (2008). *Additional details about this funding program are provided after this table.*	• Hoboken, New Jersey received $4.2 million in low-interest CWSRF financing from the New Jersey Environmental Infrastructure Financing Program to establish a citywide stormwater management campaign and green infrastructure initiative. The funding established two parks to better handle stormwater flows, which include underground detention systems, permeable paving, rain gardens, and bioswales. The 1-acre and 6-acre parks provide green space while also filtering and diverting up to 1.2 million gallons of stormwater runoff to the city's sewer system for treatment. • Prineville, Oregon needed to increase its wastewater treatment capacity. After receiving a grant to study a pilot wetland for wastewater treatment, the city designed the 120-acre Crooked River Wetlands Complex to reduce instream water temperature and augment stream flow to meet the effluent limits in its NPDES wastewater permit. The project included over 2 miles of riparian improvements and 5.4 miles of new recreational trails. It also serves as an outdoor classroom. In addition, the wetland wastewater treatment system cost $54 million less than the projected cost of a new treatment facility.
Water Infrastructure Finance and Innovation Act (WIFIA)	WIFIA is a federal credit program administered by EPA for eligible water and wastewater infrastructure projects, including stormwater and green infrastructure projects.	In 2018, the WIFIA program invited 39 entities with projects in 16 states and Washington, DC to apply for more than $5 billion in WIFIA loans. Several of the selected projects include stormwater: • The Coachella Valley, California Stormwater Channel Improvement Project was invited to apply for $22 million in funding to improve stormwater channels to increase their capacity to capture and convey stormwater, reduce stormwater runoff to the surrounding areas, and help the district meet design standards. • The City of Indio, California and parts of the unincorporated county were invited to apply for $29 million in funding for a 3.3-mile regional

PROGRAM	PROGRAM DESCRIPTION	EXAMPLES OF FUNDED PROJECTS
		stormwater channel conveyance facility to manage and capture stormwater and reduce reoccurring runoff and debris. • DeKalb County, Georgia was invited to apply for $251 million in funding to rehabilitate and repair an aging wastewater collection and treatment system to comply with its December 2011 Sanitary Sewer Overflow Consent Decree.
Brownfields Grants	The Brownfields Program provides direct funding for brownfields assessment, cleanup, revolving loans, environmental job training, technical assistance, training, and research.	Cincinnati's South Fairmount/Lick Run Project used the Brownfields and Land Revitalization Programs to fund the Lick Run Watershed Strategic Integration Plan. The plan provides an "implementation road map" that outlines opportunities associated with a green infrastructure approach. EPA is working with other federal partners to leverage investments in the South Fairmount community (e.g., housing development, floodplain management, transportation improvements).
Section 319 Nonpoint Source Grant Program	A grant program that can be used to support federally unregulated stormwater management planning and implementation. EPA's most recent program guidance recognized the "importance of green infrastructure… in managing stormwater" and supported awarding funding to green infrastructure projects. *Additional details about this funding program are provided after this table. Additional guidance available on Nonpoint Source Grant website*	The District of Columbia Department of Energy and Environment used Section 319 funding to partially fund remediation of the Watts Branch watershed in northeast DC The Watts Branch suffered from severe erosion and sediment pollution due to frequent flooding. The department led a project to restore the stream bed and control flooding through tree and shrub plantings, regrading of the stream bed, and upstream low impact development practices to manage impervious surface runoff.
Urban Waters Small Grants Program (UWSG)	Program funding goes to communities to improve the quality of urban waters while simultaneously stimulating neighborhood revitalization. The Urban Waters Small Grants Program has a focus on underserved communities, defined as "communities with environmental justice concerns and/or susceptible populations." The program funding can be used specifically for innovative or new green infrastructure practices that improve water quality. State, local, and tribal governments; universities; and nonprofit organizations are eligible to apply.	• The Constitutional Rights Foundation, in partnership with Los Angeles Waterkeeper and the University of California, Los Angeles, was awarded more than $59,000 to work with four high schools in Los Angeles County. College-aspiring students were taught how to collect data related to trash and industrial stormwater pollution. Seniors from the University of California, Los Angeles's environmental sciences bachelor's program served as peer mentors and role models for participants. At the end, students presented their findings. • Heal the Bay was awarded $60,000 to monitor bacterial water pollution at two recreational zones in the Los Angeles River. Water quality findings are made available to the public in an annual River

PROGRAM	PROGRAM DESCRIPTION	EXAMPLES OF FUNDED PROJECTS
		Report Card. Results of the study will be used to make recommendations to agencies and watershed stakeholders for improving water quality and protecting public health.
Drinking Water State Revolving Loan Fund (DWSRF)	The Drinking Water State Revolving Fund is a low-interest revolving loan program to help water systems and states achieve the health protection objectives of the Safe Drinking Water Act.	Baltimore, Maryland used Drinking Water State Revolving Fund funding to replace an existing open finished reservoir with a new enclosed 35-million-gallon reservoir, which was covered with a green roof to improve runoff water quality and reduce runoff volume.
Superfund Program	Superfund sites placed on the National Priorities List are eligible for federal funding for site cleanup, resilience, and green remediation.	The Butterworth #2 Landfill Superfund site is in Grand Rapids, Michigan where landfill operations contaminated groundwater and soil. After cleanup was done, the city held public meetings to work with community and recreation organizations on reuse planning. In 2009, the city extended a bike trail across the site. EPA has also worked with the city to evaluate the site's capacity to support a solar energy facility. The solar redevelopment is currently on hold, as the city is reevaluating power needs for its wastewater treatment plant.

EPA Clean Water State Revolving Fund Program

Background

The CWSRF is a critical source of federal funding for community stormwater programs. Mississippi administers its CWSRF funding through the state Water Pollution Control Revolving Loan Fund (WPCRLF) program within the Mississippi Department of Environmental Quality (MDEQ) Office of Pollution Control. In FY 2018, over $80 million was available through the WPCRLF, and the state recently began offering 30-year loans.[1] As of the writing of this plan, however, Mississippi has not funded a stormwater-oriented project through the CWSRF program.

The CWSRF provides at or below market-based interest rate loans, refinancing assistance, and loan guarantees to publicly and privately owned, permitted and unpermitted projects that manage, reduce, treat, or recapture stormwater or subsurface drainage water. Types of projects that can receive funding include:

- Projects designed to manage, reduce, treat, reuse, or recapture stormwater or subsurface drainage water, including:

[1] https://www.mdeq.ms.gov/wp-content/uploads/2019/09/FY19IUPfinal.pdf

  - Gray infrastructure, such as traditional pipe, storage, and treatment systems; real-time combined sewer overflow management control systems; and sediment control features (e.g., filter fences, street sweepers, and vacuum trucks).
  - Green infrastructure, such as green roofs, rain gardens, roadside plantings, permeable pavement, bioretention ponds, bioswales, and rainwater harvesting.
- Stormwater Best Management Practice (BMP) projects that use cost-effective controls and innovative technologies.
- Projects that develop and implement a municipality-wide stormwater management plan.
- Projects that develop and implement watershed partnerships between municipalities and property owners to address nonpoint sources of pollution.
- Projects to manage municipal wet weather discharges on an integrated watershed or sub-watershed basis, demonstrating the effectiveness of a unified wet weather approach.

The state maintains three priority ranking lists for eligible projects, including a small/low-income communities priority list, a green project reserve (GPR) priority list, and a regular WPCRLF priority list. Projects in eligible categories are ranked on these lists based on established criteria and project readiness to proceed. Stormwater pollution correction projects are an eligible project category. However, as noted above, the state has not funded stormwater-related projects to date and does not fund flood control projects. *To obtain WPCRLF funding for an eligible stormwater project (including green infrastructure), Hattiesburg will need to demonstrate and clearly articulate during the loan application process the anticipated water quality benefits associated with the project, such as reductions in sediment, nutrients, or bacterial discharges.*

Green Project Reserve

The CWSRF is also "ideally suited to serve as sources of low or no cost financial assistance to a broad and diverse range of publicly and privately-owned green infrastructure projects"[2]. The CWSRF GPR, established in 2009, is specifically designed to support green infrastructure, water and energy efficiency improvements, and other innovative activities[3]. Since 2009, the CWSRF program has awarded $1.1 billion toward green infrastructure projects nationwide, and EPA encourages state CWSRF programs to offer financial incentives and priority ranking criteria/bonus points for green infrastructure projects[4]. In FY 2018, Mississippi did not award any GPR funding, as "the Department did not receive sufficient eligible applications for green infrastructure, water or energy efficiency improvements, or other environmentally innovative activities to be able to obligate ten percent (10%) of the FY-18 allotment to 'green projects.'"[5]

[2] https://www.epa.gov/sites/production/files/2016-01/documents/cwsrf_green_infrastructure_policy_final.pdf

[3] https://www.epa.gov/sites/production/files/2019-05/documents/gpr_guidance_change_memo_2-21-17.pdf

[4] https://www.epa.gov/sites/production/files/2015-04/documents/arra_green_project_reserve_report.pdf

[5] https://www.mdeq.ms.gov/wp-content/uploads/2018/10/FY18IUPFinal.pdf

CWSRF and Asset Management

The CWSRF may fund asset management and similar planning if there is a reasonable expectation that the planning activity will result in a construction project. Moreover, asset management concepts are now integrated into the broader CWSRF application process. Following passage of the 2014 Water Resources Reform and Development Act, CWSRF assistance recipients are required to develop fiscal sustainability plans (FSPs), which contain many components of a typical asset management plan and also require evaluation of approaches to improve water and energy efficiency. Therefore, implementing the key actions described under Goal 3 can help Hattiesburg meet this new requirement for receiving CWSRF assistance. Specific FSP requirements vary by state.

Next Steps for Evaluating the CWSRF Funding Program as a Source for Stormwater-Related Projects

Based on the evaluation of funding needs and associated revenue available as well as the established funding strategy, Hattiesburg should coordinate with the Mississippi WPCRLF program to:

- Identify Hattiesburg's most critical infrastructure needs that best align with the goals and scope of the WPCRLF, including projects that may qualify for the GPR. As part of this, the city should identify the specific quantitative and qualitative water quality improvements it can realize through implementation of these projects.
- Establish a plan and timeline for obtaining WPCRLF funding.

EPA Section 319 Grant Program

Background

EPA's Clean Water Act Section 319 program[6] allocates funding to states via an established formula to support nonpoint source pollution reduction efforts. MDEQ's Office of Pollution Control administers Mississippi's Section 319 funds. Each year, Mississippi has approximately $4.5 million in funding available. Projects must provide a 60:40 dollar match,[7] and MDEQ prioritizes projects based on the five-year cycle implemented under Mississippi's rotating basin approach to water quality management.

Funding Stormwater Improvements with Section 319 Grants

EPA's Section 319 program guidance specifically recognizes the "importance of green infrastructure … in managing stormwater" and supports awarding funding to green infrastructure projects.[8] Urban stormwater runoff activities are eligible for Section 319 funding if those activities are not required by or do not directly implement a draft or final National Pollutant Discharge Elimination System permit. Eligible activities may include:

- Technical assistance.

[6] https://www.epa.gov/green-infrastructure/green-infrastructure-funding-opportunities

[7] https://www.mdeq.ms.gov/about-mdeq/grants-loans-and-trust-funds-available-through-mdeq/nonpoint-source-pollution-control-grants/

[8] https://www.epa.gov/sites/production/files/2015-10/documents/319-guidelines-fy14.pdf

- Monitoring activities related to designing and evaluating urban runoff management strategies.
- Outreach and education.
- Regulatory, policy, or local ordinance development.
- BMPs.
- Technology transfer and training.

The state's 2014 updated nonpoint source management plan notes that "[b]ecause of the frequent and intense storms in the State, stormwater runoff that carries sediment-carrying pollutants and nutrients is a big issue in Mississippi and is addressed both as a statewide issue and an issue in individual watersheds."[9] The plan also has specific actions and goals related to urban stormwater and construction, including the following:

> Increase protection for waters in urban and construction areas; promote stormwater management on the local level; encourage and assist municipalities and county government in obtaining loans to address local nonpoint source pollution control issues; Continue to work with MDEQ's ECED to increase compliance and enforcement activities for construction projects; Continue outreach and education on stormwater management; Establish Urban BMP demonstration sties at different regions in the state; Continue to support Nutrient Reduction, BMP Demonstration and [Low Impact Development] Demonstration in the state.[10]

EPA guidelines specify that recipients should use Section 319 grants to restore impaired waters and protect unimpaired or high-quality waters, with an emphasis on using a watershed-based approach to restore nonpoint source-impaired waters. EPA generally requires development of watershed-based plans that include specific elements before implementing Section 319-funded projects, though existing local or other watershed plans may be able to serve as the foundation for these required plans.

Next Steps for Evaluating This Funding Program as a Source for Stormwater-Related Projects

Based on the evaluation of funding needs and associated revenue available as well as the established funding strategy, Hattiesburg should:

- *Consider Section 319 grant funding as one of several supplemental funding sources that may apply to the city's stormwater-related projects in the longer term.*
- *In anticipation of expanding funding options, evaluate water quality in Gordon's Creek and identify existing or opportunities for new watershed-based planning efforts to improve water quality.*

[9] https://www.mdeq.ms.gov/wp-content/uploads/2017/05/FINAL_NPS_Management_Plan_Update_2014.pdf

[10] https://www.mdeq.ms.gov/wp-content/uploads/2017/05/FINAL_NPS_Management_Plan_Update_2014.pdf

U.S. Department of Housing and Urban Development (HUD)

PROGRAM	PROGRAM DESCRIPTION	EXAMPLES OF FUNDED PROJECTS
Community Development Block Grant (CDBG)	The Community Development Block Grant Program is designed to create jobs, increase economic activity, and increase property values. Green infrastructure and stormwater projects with into this scope because urban tree planting can increase economic activity in a commercial district and green infrastructure can increase property values by mitigating flooding and improving neighborhood aesthetics.	• Detroit, Michigan used $8.9 million in CDBG funds in 2014 to create a major flood prevention and economic development program. The program demolishes blighted properties, landscapes and installs trees on 200 vacant lots to improve stormwater management and neighborhood aesthetics, and installs infrastructure that directs stormwater to new bioretention basins. • Chicago, Illinois used CDBG funding to put a new green roof on its historic cultural center.
Section 108 Loan Guarantee Program	This program allows future CDBG allocations to be used to guarantee loans for neighborhood revitalization projects, including construction and installation of public facilities and infrastructure. Section 108-guaranteed projects can incorporate green infrastructure into their designs and construction.	Through a CDBG loan, the City of Indio, California has been able to allocate funding to the design, engineering, and construction of public infrastructure improvements in its low- and moderate-income neighborhoods. Residents help prioritize the improvements. Activities have included tree planting and street, sidewalk, and park improvements.
Community Development Block Grant Disaster Recovery Program (CDBG-DR)	This program provides federal aid to states post-disaster. Funds can be used for a variety of community development activities that benefit low- and moderate-income people, reduce blight, or address an urgent community need. In rehabilitating housing and constructing public amenities, cities may be able to incorporate green infrastructure techniques (like street trees and permeable pavements) in street design.	Columbia, South Carolina received a $19.99 million grant from CDBG-DR following a 1,000-year flood in October 2015. The grant helped the city of Columbia recover and build resiliency. Among other projects, the CDBG-DR funds were used to promote green infrastructure, such as swales and rain gardens; plant buffer areas around water courses; promote pervious parking surfaces; and encourage preservation of sensitive environmental areas.
Sustainable Communities Regional Planning Grants	These grants support metropolitan and multijurisdictional planning efforts to integrate housing, land use, economic and workforce development, transportation, and infrastructure investments. They are designed to empower jurisdictions to consider the interdependent challenges of economic competitiveness and revitalization, social equity, inclusion, and access to opportunity, energy use and climate change, and public health and environmental impacts.	The *Green Infrastructure and the Sustainable Communities Initiative* report provides case studies of 30 local governments that have used HUD Sustainable Communities Regional Planning Grants or Community Challenge Planning Grants to fund green infrastructure programs. Generally, grantees have planned for climate resilience by identifying strategic areas to implement stormwater practices, with a dual approach to stormwater management that uses both traditional

PROGRAM	PROGRAM DESCRIPTION	EXAMPLES OF FUNDED PROJECTS
		gray infrastructure and green infrastructure. Although the HUD Sustainable Communities Initiative grant programs have not received appropriations since 2011, the case studies provide excellent examples of how local governments can combine various funding streams to pay for green infrastructure programs.
Community Challenge Planning Grants	These grants foster reform and reduce barriers to achieving affordable, economically vital, and sustainable communities. Such efforts may include amending or replacing local master plans, zoning codes, and building codes, either on a jurisdiction-wide basis or in a specific neighborhood, to promote mixed-use development, affordable housing, the reuse of older buildings for new purposes, and similar activities with the goal of promoting sustainability at the local or neighborhood level.	The City of Pittsburgh, Pennsylvania combined a HUD Community Challenge Planning Grant with a U.S. Department of Transportation Investment Generating Economic Recovery II grant to fund the planning of the Allegheny Riverfront Green Boulevard project.

U.S. Department of Homeland Security, Federal Emergency Management Administration (FEMA)

PROGRAM	PROGRAM DESCRIPTION	EXAMPLES OF FUNDED PROJECTS
Hazard Mitigation Grant Program	The Hazard Mitigation Grant Program provides post-disaster federal aid to states to mitigate the risks of future disasters and fund flood mitigation projects, including the acquisition and relocation of flood-prone properties and soil stabilization projects, like the installation of vegetative buffer strips. Accounting for the full benefits of green infrastructure projects under the Hazard Mitigation Grant Program has been much easier since FEMA amended its policy to include "ecosystem services" benefits for green open space, riparian areas, and other land use types.	New Orleans, Louisiana used Hazard Mitigation Grant Program funding for its post-Katrina rebuilding process, including the reconstruction of the city's stormwater infrastructure. Although the New Orleans stormwater plan calls for a significant expansion of green infrastructure to manage the city's chronic flooding, the city initially had difficulty demonstrating the benefits of green infrastructure under FEMA's required cost-benefit analysis because it 1) lacked the data to demonstrate potential flood losses avoided, and 2) could not count many of green infrastructure's environmental benefits.
Pre-Disaster Mitigation (PDM) Grant Program	Mitigation planning is a key process used to break the cycle of disaster damage, reconstruction, and repeated damage. PDM grants offer funding for sustained pre-disaster natural hazard mitigation	Spokane County, Washington often has heavy rainstorms, and post-storm flash flooding is common. In 2016, the county was awarded PDM funding to improve road drainage to Hazard Road, northwest

PROGRAM	PROGRAM DESCRIPTION	EXAMPLES OF FUNDED PROJECTS
	programs. The goal is to reduce overall risk to the population and structures from future hazard events, while also reducing reliance on federal funding in future disasters. This program awards planning and project grants. It provides opportunities for raising public awareness about reducing future losses before disaster strikes. PDM grants are funded annually by congressional appropriations and are awarded on a nationally competitive basis.	of the city of Spokane, after a flash flood washed out a section of the roadway the year before. The flood damaged a section of the road with 14 culverts. Instead of simply repairing or replacing the culverts, the county applied for funding to implement a combination of "gray" and "green" techniques, including adding vegetation to stabilize the soil against erosion and to improve the health of the stream. By incorporating green approaches, the project cost less than simply replacing the culverts would have, stabilized the soil against erosion, and improved the health of the stream. The county's decision to include green infrastructure mitigation elements is ultimately what allowed FEMA to fund the project.
Flood Mitigation Assistance (FMA) Grant Program	The FMA Grant Program aims to reduce or eliminate claims under the National Flood Insurance Program. FMA grants provide funding to states, territories, federally recognized tribes, and local communities for projects and planning that reduce or eliminate the long-term risk of flood damage to structures insured under the National Flood Insurance Program. FMA funding is also available for management costs. Congress appropriates funding annually. FMA grants require state, tribal, and local governments to develop and adopt hazard mitigation plans as a condition for receiving certain types of non-emergency disaster assistance, including funding for hazard mitigation assistance projects. Generally, local communities will sponsor applications on behalf of homeowners and then submit the applications to their states. All FMA grant applications must be submitted to FEMA by a state, U.S. territory, or federally recognized tribe. Refer to the current hazard mitigation assistance guidance for detailed information on the FMA program and on the mitigation plan requirement.	In fiscal year 2018, $160 million in FMA funding was available to help state, tribal, territorial, and local governments reduce or eliminate claims under the National Flood Insurance Program. Eligible project activities include: • Infrastructure protective measures. • Floodwater storage and diversion. • Utility protective measures. • Stormwater management. • Wetland restoration/creation. • Aquifer storage and recovery. • Localized flood control to protect critical facilities. • Floodplain and stream restoration. • Water and sanitary sewer system protective measures.

U.S. Department of Defense, Army Corps of Engineers (USACE)

PROGRAM	PROGRAM DESCRIPTION	EXAMPLES OF FUNDED PROJECTS
Planning Assistance to States	The Corps of Engineers can help states, local governments, other non-federal entities, and eligible tribes prepare comprehensive plans for the development, utilization, and conservation of water and related land resources. Typical studies are only at the planning level of detail; they do not include detailed design for project construction. The program can encompass many types of studies dealing with water resource issues. Types of studies in recent years under the program include water supply/demand, water conservation, water quality, environmental/conservation, wetlands evaluation/restoration, dam safety/failure, flood damage reduction, coastal zone protection, and harbor planning. Efforts under this program are cost-shared on a 50 percent federal/50 percent non-federal basis. The study sponsor has the option of providing in-kind services for its share of the study cost.	In 1999, the Corps of Engineers was authorized to study the Boston, Massachusetts Muddy River to determine if flood risk management and environmental restoration improvements were in the federal interest. Following the corps' 2001 draft evaluation report, environmental dredging of sediment, preservation and restoration of historic park shorelines, and preservation of vegetation in construction areas were recommended.

U.S. Department of Transportation (USDOT)

PROGRAM	PROGRAM DESCRIPTION	EXAMPLE OF FUNDED PROJECTS
Rebuilding American Infrastructure with Sustainability and Equity (RAISE) Grant Program	Rebuilding American Infrastructure with Sustainability and Equity (RAISE) grants fund investments in road, rail, transit, and port projects. These grants have been awarded to projects that included green infrastructure components. These grants were previously known as Transportation Investment Generating Economic Recovery (TIGER) and Better Utilizing Investments to Leverage Development (BUILD) transportation grants.	In 2018, the Siouxland Regional Transit System in Sioux City, Iowa was awarded $7 million to construct a new facility for bus maintenance and storage. The facility also includes green building materials and techniques such as stormwater retention, reuse of natural rainwater for irrigation, and water recycling for restrooms and bus washing.
Federal Highway Administration Surface Transportation Block Grant (STBG) Transportation	STBG provides funding for "transportation alternatives," including "off-road trail facilities for pedestrians, bicyclists, and other non-motorized forms of transportation." STBG funding can be used to pay for green infrastructure	The Southeast Michigan Council of Governments used the transportation alternatives set-aside in STBG funding (in 2015 from the State of Michigan) to fund the Detroit–Inner Circle Greenway Railroad Acquisition, which included 1)

PROGRAM	PROGRAM DESCRIPTION	EXAMPLE OF FUNDED PROJECTS
Alternatives Set-Aside	components of trails and sidewalks, such as permeable pavements.	installing green infrastructure such as green streets and bioretention, and 2) repurposing 8.3 miles of abandoned railway near Detroit.
Federal Highway Administration Congestion Mitigation and Air Quality (CMAQ) Program	The CMAQ Program allocates federal funding for infrastructure projects that reduce congestion and improve air quality. Bicycle transportation and pedestrian walkways are eligible uses of the money; they can be designed to include green infrastructure features (such as permeable surfaces for trails, and bioswales and bioretention for areas adjacent to trail surfaces).	The City of Santa Fe's Acequia Trail Underpass project used CMAQ funding in 2017 2018 via the New Mexico Department of Transportation to construct a bicycle underpass under federal highway U.S. 284/85 to improve the safety of pedestrians and bicyclists crossing one of the city's busiest and most congested intersections. The project installed low impact development drainage basins that capture and infiltrate 100 percent of the onsite stormwater up to the 100-year storm, as well as other green infrastructure elements such as soil-enhanced swales and landscaping to improve site permeability.
Federal Highway Administration National Highway Performance Program	The National Highway Performance Program supports the national highway system in constructing new facilities and ensuring that investments of federal aid funds in highway construction support progress toward the performance targets in a state's asset management plan. States may transfer up to 50 percent of National Highway Performance Program funds to the STBG, Highway Safety Improvement Program, and CMAQ Program (see above for more details).	

U.S. Department of Agriculture (USDA)

PROGRAM	PROGRAM DESCRIPTION	EXAMPLES OF FUNDED PROJECTS
Rural Development Water and Environmental Programs	Water and Environmental Programs are exclusively focused on the water and waste infrastructure needs of rural communities with populations of 10,000 or fewer. The programs provide technical assistance and financing for development of drinking water, waste disposal, and stormwater systems in rural areas.	In 2016, the Pine Ridge Indian Reservation, South Dakota was awarded $1.97 million for a new community center, which is the first phase of a three-part solution to improve environmental and human health, increase jobs, and make housing more affordable. The master plan includes using potable water more productively by embedding strategies in streets and buildings to collect rainwater for use. Additionally, the plan will implement roadside bioswales, culverts, rain gardens, and storm drain inlets.
Rural Development Water and Waste Disposal Loan and Grant Program	This program provides funding for clean and reliable drinking water systems, sanitary sewage disposal, sanitary solid waste disposal, and stormwater drainage to households and businesses in eligible rural areas.	The City of Bowdle, South Dakota received a $1.172 million loan and a $400,000 grant for improvements to the water and sewer collection system. The city will replace outdated water and sewer lines along Main Street. This will help address inflow and infiltration caused by deficiencies in the sewer system and replace outdated waterlines. Local funds will also be used.
U.S. Forest Service Urban and Community Forestry Program	The Urban and Community Forestry Program is a cooperative program that focuses on the stewardship of urban natural resources, providing grants for urban forestry projects.	Campbell Creek, which flows from the Chugach Mountains to Cook Inlet through the heart of Anchorage, Alaska, creates a 70-square-mile watershed that is home to five species of salmon, rainbow trout, moose, bears, and beavers. The loss of vegetation and pervious surfaces, as well as polluted runoff, degrade aquatic and wildlife habitat and increase flooding risks. Anchorage is reconstructing the trail with help from the Urban and Community Forestry Program. This presents a perfect opportunity to share resources to restore the riparian area and create low-impact access.

U.S. Department of the Treasury

PROGRAM	PROGRAM DESCRIPTION	EXAMPLES OF FUNDED PROJECTS
New Markets Tax Credit Program	This program encourages private investment in a range of project types in distressed areas (e.g., real estate or business development projects). Awards are allocated to nonprofit and private entities based on their proposals for distributing the tax benefits.	In 2013, a nonprofit investor partnered with The Freshwater Trust to finance a project that restored 30 miles of streamside vegetation in Oregon. This green infrastructure solution created shade and offset the increasingly warm temperature of the river, which was negatively affecting native fish populations.

U.S. Department of Energy

PROGRAM	PROGRAM DESCRIPTION	EXAMPLE OF FUNDED PROJECTS
Energy Efficiency Savings—Tax Incentives and Rebates	Green infrastructure can be integrated into project design to claim tax incentives and rebates.	Eugene, Oregon built a new biofuel station on an abandoned gas station site that included a green roof, bioswales, and rain gardens. Nearly $250,000 worth of tax credits reduced income and sales tax for the private company that built and operated the project.
Weatherization and Intergovernmental Program	The Weatherization and Intergovernmental Program provides grants, technical assistance, and information tools to states, local governments, community action agencies, utilities, tribes, and U.S. territories for their energy programs. The funding can be used to encourage installation of green infrastructure—such as green roofs—as part of the weatherization process.	Through the Better Buildings Challenge, a Silver Spring, Maryland multifamily residential building, The Pearl, has been designed to include 1,250 square feet of vegetated green roof with a uniquely integrated solar photovoltaic array. This design is projected to save more than $150,000 annually in energy costs.

U.S. Department of the Interior, National Park Service

PROGRAM	PROGRAM DESCRIPTION	EXAMPLE OF FUNDED PROJECTS
Rivers, Trails and Conservation Assistance Program	The Rivers, Trails, and Conservation Assistance Program assists community-led natural resource conservation and outdoor recreation initiatives. Program staff provide guidance to communities on conserving waterways, preserving open space, and developing trails and greenways.	The communities of Midlothian, Oak Forest, and Crestwood, Illinois received funding to prepare the Natalie Creek Trail from Oak Forest to Blue Island. The trail proposal came out of Midlothian's planning to alleviate flooding through a Metropolitan Water Reclamation District project (now underway). This regional trail will have both on-road and off-road sections connecting five Illinois communities.

U.S. Department of Commerce

PROGRAM	PROGRAM DESCRIPTION	EXAMPLE OF FUNDED PROJECTS
Economic Development Administration: Public Works and Economic Adjustment Assistance Programs	These programs support a range of business and industrial development activities—including infrastructure development—that create or retain jobs. Economic Development Administration-capitalized revolving loan funds encourage new business development in economically distressed communities.	In September 2019, the Economic Development Administration awarded a $1.8 million grant to the city of West Plains, Missouri to make critical infrastructure improvements, including constructing stormwater detention basins to help protect the local business community from flooding.
National Oceanic and Atmospheric Administration: Community-Based Restoration Program	This program, which began in 1996, seeks to inspire and sustain local efforts to restore coastal habitat. It has funded more than 2,000 projects in the United States, Canada, the Caribbean, and the Pacific Islands. These projects have restored more than 86,000 acres of habitat and opened more than 3,800 stream miles for fish passage.	Ducks Unlimited was awarded $825,000 to restore estuarine and coastal dune habitat in California. The project will restore more than 800 acres of Eel River estuary habitat to help recover Endangered Species Act-listed salmon. The project will also increase resilience to storm events and sea level rise, reestablish a healthy ecosystem, and provide habitat for juvenile migratory fish to grow.
National Oceanic and Atmospheric Administration: Coastal Resilience Grants Program	This competitive grant program funds projects that are helping coastal communities and ecosystems prepare for and recover from extreme weather events, climate hazards, and changing ocean conditions. All project proposals undergo a rigorous merit review and selection process by a panel of subject matter experts from across the United States that include representatives from government, academia, and private industry.	The Northeast Regional Association of Coastal and Ocean Observing Systems was awarded $456,257 in match grants to document and predict coastal storm impacts and increase the implementation of sustainable, nature-based infrastructure approaches (living shorelines). The project also fills high-priority data and capacity gaps, develops tools for decision-making, and improves communications and outreach.

Additional Sources:

U.S. EPA. 2021. Green Infrastructure Funding Opportunities. Available at https://www.epa.gov/green-infrastructure/green-infrastructure-funding-opportunities.

Georgetown Climate Center. n.d. Federal Funding. Available at http://www.georgetownclimate.org/adaptation/toolkits/green-infrastructure-toolkit/federal-funding.html.

APPENDIX C:
ASSET MANAGEMENT PROGRAM DEVELOPMENT STEPS AND RESOURCES

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Asset Management Program Development Steps and Resources

The City of Hattiesburg currently has no existing asset management program across its utility services and no dedicated resources for establishing one. This appendix is therefore intended to be a standalone guide Hattiesburg can use to develop an asset management program when the city is ready. It expands on information provided under Goal 3 of the city's Long-term Stormwater Plan.

Background

To improve the quality, efficiency, and cost-effectiveness of services to its citizens, the City of Hattiesburg is exploring opportunities to improve the operation and maintenance (O&M) of its stormwater infrastructure by establishing a comprehensive asset management program. Asset management emphasizes a proactive, long-term focus on maintaining and sustaining assets, rather than a short-term, reactive approach. At present, the city does not have a comprehensive understanding of the location, appropriate sizing, and condition of its stormwater assets, so it conducts most of its stormwater-related activities in response to flooding issues. The city is interested in adopting and integrating an asset management program across its water services, including stormwater, wastewater, and drinking water systems.

Asset management refers to a strategic, comprehensive approach to managing the long-term sustainability of assets and achieving desired level of service and regulatory requirements in the most cost-effective way possible.

An asset management program refers to the full suite of data-driven, organization-wide actions and procedures to successfully manage assets.

An asset management program that emphasizes data-driven actions informed by a central data management and recordkeeping system, proactive maintenance procedures, stormwater asset inventory data, and financial planning will allow the city to realize the economic, environmental, and social benefits from sustainable infrastructure.

The multiple benefits to stormwater services include:

- **Reducing instances of flooding** in the city in the near term through proactive O&M activities and long-term actions to improve drainage capacity.
- **Knowing the location, appropriate sizing, and condition** of the city's stormwater assets.
- Providing a method to **prioritize the city's most critical projects**.
- **Better forecasting the timing** of when the city will need to replace system assets.
- **Reducing the need for emergency asset replacement costs**, which can often be much higher than planned costs.
- **Protecting assets** from premature failure through proper O&M.
- **Understanding the cost** of stormwater assets over the course of their useful life.
- **Gathering data to inform adequate budgets** for operations, capital projects, and user rates (if established in the city).
- **Improving business management** by establishing a robust approach to planning and investment, driven by comprehensive and current data.

- **Increasing collaboration and coordination** across the city's water, wastewater, and stormwater programs and with other public departments (transportation, parks and recreation).

More broadly, comprehensive stormwater asset management—particularly when coupled with parallel efforts across water sector and other public services—can provide community-wide economic, environmental, and social benefits that include:

- **Enhancing long-term economic sustainability and growth** by providing reliable, cost-effective public services and reduced flooding.
- **Potentially providing significant long-term cost savings** through proactive maintenance, data-driven decision making on the timing and type of infrastructure investments and avoided costs.
- **Improving and sustaining the integrity and quality** of the city's natural environment and infrastructure, positively contributing to quality of life.
- **Meeting or exceeding the expectations of Hattiesburg residents and businesses** for high-quality public services.

Key Actions to Build a Successful Asset Management Program

Asset management programs (and their associated plans) are scalable and can be relatively simple or very complex, depending on the size, sophistication, and resources of the entity developing and implementing the program. This appendix outlines the key actions the city can take to begin developing an asset management program today and expand the program iteratively over time. The city can undertake many of these actions in parallel.

Table C-1. Key Actions for Building an Asset Management Program

Key Action		Summary
1	**Develop program scope, goals and objectives, and timeline and establish asset management task force.**	Identify goals and objectives upfront to guide program development. Engage cross-sector representatives to serve as leaders and champions for program development and implementation.
2	**Develop an asset inventory.**	Compile key data on all assets to begin evaluating the current condition, sizing, status, and scope of relevant assets across the city.
3	**Evaluate asset condition and performance.**	Document and/or inspect each asset to the extent possible to assess and rate its current condition.
4	**Estimate asset value, remaining useful life, and replacement cost.**	Evaluate current condition and maintenance history of assets and estimate cost of replacing the asset.
5	**Establish level of service and associated performance measures.**	Articulate the service the city wants to provide using its assets and how the city wants the assets to perform. Establish performance measures to track progress against goals over time.
6	**Assess asset criticality and risk.**	Evaluate assets in terms of their likelihood/probability of failure and their consequence of failure to prioritize the most critical assets.

Key Action		Summary
7	**Optimize capital and O&M costs and prioritize investments (life cycle costing).**	Evaluate how to provide sustainable service and meet the established level of service at the lowest cost.
8	**Develop a funding strategy.**	Identify funding (e.g., community and supplemental/external funding) for necessary O&M and capital improvement activities.
9	**Document activities in a written plan.**	Document the information and procedures guiding asset management approach and implementation over time.
10	**Conduct training, education, and outreach.**	Conduct continuous internal and external education and outreach to engage relevant staff and demonstrate the value of asset management to decision makers and the community.
11	**Pursue continuous evaluation and improvement**	Revisit, evaluate, and revise the asset management approaches as needed over time.

Key Action 1: Develop program scope, goals and objectives, and timeline and establish asset management task force

The city should consider intended improvements in infrastructure, operational and managerial processes, and financial management, as well environmental, economic, and other outcomes while developing its asset management program goals and objectives. These goals and objectives will drive and inform all asset management activities, and the city should revisit and modify them as needed as the program evolves over time.

1.A. Develop cross-sector asset management task force and determine the program scope

Coordination on asset management across interrelated municipal sectors (e.g., wastewater, drinking water, stormwater, transportation, purchasing) enhances the commitment to and buy-in for asset management activities. Furthermore, this coordination offers efficiencies and cost savings as city sectors and departments can share tools and combine activities while avoiding redundancy. It can also result in a more comprehensive understanding of citywide capital investment needs, including identification of investments that may have significant co-benefits across sectors. Finally, improved coordination can help the city build a more robust, consistent story about the purpose, condition, and needs of stormwater assets to share with community members, city staff, and elected officials.

The city has prioritized the development of a stormwater asset inventory and condition assessment as well as mapping of drainage infrastructure in areas prone to flooding. These priorities are the focus of the scope and specific actions laid out in the first portion of this document. Once the city addresses these early priorities, it can broaden the program scope to include other areas and priorities.

The city's wastewater program is also evaluating the adoption of an asset management approach to ensure it can meet obligations for sewer system O&M. The city's shared goal of asset management for

water-related services presents a natural starting point for coordination in developing the city's overall asset management approach, tools, and capabilities.

A successful asset management program requires commitment and buy-in from all levels of staff and leadership involved in providing stormwater services, other related municipal services, and city management in general. Designating asset management "champions"—who act as the team motivators and can come from various departments within the program—and assigning responsibility for execution at the outset of the effort will allow for more streamlined and efficient decision making and program rollout over time. The champions are the motivating force behind the team, which can consist of operators, managers, elected officials, and stakeholders.

Key representatives to include in this effort are as follows:

- Engineering department representative(s)
- Public works representative(s) (leadership and maintenance staff)
- Drinking water representative(s)
- Wastewater representative(s)

Optional participants may include the following:

- Parks and recreation representative(s)
- Urban development representative(s)
- Transportation representative(s)
- Mayor's office representative(s)

Table C-2. Hattiesburg Asset Management Task Force
[to be completed by the city at a future date]

Name	Department	Role

In addition to determining the focus and phased implementation of an asset management effort, this task force will communicate the concepts and benefits of asset management to staff responsible for implementing asset management-related actions, customers, and municipal leaders and other elected officials responsible for city governance. The city should establish regular asset management-focused meetings to sustain momentum, evaluate progress, and demonstrate commitment.

Potential Opportunities for City Task Force Coordination
• Adapt and/or use previously applied approaches, vendors, software, etc., for stormwater asset condition assessments and inventory. • If using different software systems across sectors (e.g., drinking water, wastewater, stormwater), consider how to share information across systems as needed. • Obtain key lessons learned from similar processes other departments have conducted and take advantage of opportunities for knowledge transfers among staff.

Additional Resources

Building an Asset Management Team

1.B. Identify Short-, Mid-, and Long-Term Goals for Stormwater Asset Management

Acknowledging that it is in the initial stages of developing an asset management program and does not currently have resources set aside for this effort, the city has established draft overall asset management goals and phased timelines to provide a platform for long-term success.

Figure C-1 on the following page presents the city's overall draft asset management goals.

Figure C-1. Hattiesburg's Overall Draft Asset Management Goals

To further illustrate how the city will make progress toward its stormwater asset management goals, Hattiesburg has developed the following draft timeframes. Note that some of these goals correspond directly to key actions described in more detail later in this appendix, and some key actions will appear multiple times as the city builds the program iteratively over time.

Table C-3. Draft Timeline for Accomplishing Stormwater Asset Management Goals

Timeframe	Draft Goals
Year 1	• Identify the scope of initial asset management program development and form a cross-sector task force to oversee program development and implementation. (Key Action 1)
Years 2 to 5	• Using a prioritized approach, start to build and sustain a comprehensive understanding of the location, characteristics, and condition of stormwater infrastructure assets in flood-prone areas of the city to help facilitate proactive asset maintenance, repair, and replacement. Part of this effort will include selecting a data management system (either an interim system for initial data gathering or a permanent system for long-term implantation of the program). (Key Actions 2, 3, 4, and 6) • Define desired service goals and associated performance metrics and begin routine performance tracking. (Key Action 5) • Establish sustainable and efficient procedures and schedules for routine, preventive maintenance for stormwater infrastructure assets. (Key Action 7)
Years 6 to 10	• Continue to develop and maintain a robust, comprehensive data management system that facilitates asset inventory management, asset mapping, maintenance scheduling, generation of work orders, billing, financial forecasting, and integration of asset management activities across city services. (Key Action 2) • Build the financial capacity necessary to establish and implement a robust, long-term asset management program. (Key Actions 7 and 8) • Identify comprehensive long-term financial needs for sustaining stormwater services into the future. (Key Actions 4, 7, and 8) • Evaluate whether hydrology and hydraulics modeling is necessary to determine the sizing of drainage infrastructure needed to inform capital improvements.
Years 11 to 20	• Build a robust life cycle cost assessment of short- and long-term stormwater needs to inform municipal decision making. (Key Action 7)
Ongoing into Perpetuity	• Sustain the city's comprehensive understanding of location, characteristics, and condition of stormwater infrastructure assets across the city, and perform proactive asset maintenance, repair, and replacement to satisfy the city's level of service goals.

Key Action 2: Develop an asset inventory

Building an asset inventory is the first step in understanding the current condition, sizing, status, and scope of stormwater assets across the city, as well as prioritizing maintenance and capital needs going forward. An asset inventory can be built out iteratively over time, beginning with the most critical needs and expanding to cover the entire system as resources allow. The city should capture the types of public stormwater assets in Table C-4 when creating its inventory and update the table with known quantities.

Table C-4. Stormwater Asset Types for Hattiesburg's Inventory

Stormwater Asset Type	Estimated Quantity	Stormwater Asset Type	Estimated Quantity
Drainage pipes	X miles	**Infiltration basins**	X
Open ditches	X miles	**Retention ponds**	X
Storm sewer outfalls	X	**Detention ponds**	X
Drain inlets	X	**Rain gardens**	X
Catch basins	X	**Bioswales**	X
Culverts	X	**Permeable pavement**	X
Pumps	X	**Other stormwater treatment controls**	X

The city may identify other types of stormwater-related assets to include in the inventory and should periodically consider what types of assets it may want to incorporate in the future.

2.A. Identify data to collect and intended use of data

Before collecting data, the city should clearly identify what data to collect and the purpose of collecting these data. Data drivers and intended uses should align with the stated goals and objectives for the asset management program identified under Key Action 1.

The city has initially identified its data drivers and intended uses to include:

- ✓ Building its basic stormwater asset inventory.
- ✓ Satisfying municipal separate storm sewer (MS4) permit mapping requirements.
- ✓ Tracking flows in the system.
- ✓ Conducting future modeling efforts.

The city has acknowledged resource limitations for asset inventory development, so these will likely need to be prioritized.

Table C-5 identifies the types of information (or attributes) the city should aim to collect in its stormwater asset inventory, though this is subject to change based on the city's drivers and intended uses for the data. Some of the attributes listed below may not pertain to each asset type; the city should customize this list for staff tasked with collecting data. Furthermore, the city may identify and add more asset attributes for data collection to this table, including age, estimated remaining life, estimated replacement cost, maintenance activity required based on inspection, date, maintenance completion date, parts required, and estimated costs.

Table C-5. Types of Data to Collect in the Stormwater Asset Inventory

Asset	Asset ID	X, Y, Z Coordinate/Location	Size	Length	Installation Date	Material	Condition
Drainage pipes							
Open ditches							
Storm sewer outfalls							
Drain inlets							
Catch basins							
Culverts							
Pumps							
Infiltration basins							
Retention ponds							
Detention ponds							
Rain gardens							
Bioswales							
Permeable pavement							
Other stormwater treatment controls							

2.B. Identify sources and format of existing data

Currently, the city has limited information available on number, location, sizing, and condition of stormwater assets. As the city embarks on developing its stormwater asset inventory and identifies key data to collect, it should identify and evaluate existing data sources and formats. The city should compile any existing data, regardless of format (e.g., existing inventories or asset identification systems, as-built drawings or maps, system records, photos, interviews with current and former staff), and use the data as the starting point for additional data collection efforts.

Maps

The city maintains some hard copy maps of storm sewers and unsewered areas (generated primarily in the 1970s and 1980s and estimated to capture approximately 30 percent of the city) but has not digitized these maps. The city stores hard copy maps in a map room, using an established filing system, but rarely accesses or refers to them for supporting maintenance tasks. There is additional concern that the hard copy storm sewer maps may be inaccurate and unreliable; therefore, it may be more cost-effective to conduct a new surveying effort, rather than digitizing existing maps. For its wastewater and drinking water systems, the city's consultants developed a geographic information system (GIS)-based map of its assets. Individual city staff (past and present) may also retain additional information systems as institutional knowledge regarding location and condition of assets in the storm sewer system.

In addition to limited mapping of the storm sewer system, the city has not systematically assessed the current condition of and maintenance needs for storm sewer infrastructure. Hattiesburg is currently mapping and conducting closed circuit television (CCTV) inspections and root control activities in the sewer lines, as well as cleaning the sewer system. However, the city has not expanded this effort to the storm sewer system.

Citizen Complaints and Work Orders

City staff operate an "Action Center" for receiving citizen complaints 24 hours a day/7 days a week. For example, residents may observe a clogged ditch and alert the city to the need for cleaning or other problems (e.g., flooding). The system and the city identify assets by street addresses, not with unique asset identification numbers. Staff enter complaint calls into the city's AS400 system, which generates a ticket. Staff close the ticket once the city resolves the issue. The city does not, however, use the system to proactively address anticipated maintenance needs. While the city can export and manipulate the data for use in GIS (to identify hot spots), this process can be cumbersome due to quality issues with the data entry. City information technology staff maintain and operate the system.

The city may have other sources of storm sewer system data that could help it develop the asset inventory. The city should evaluate whether other sources exist and consider how to use them in the data collection process.

2.C. Select a Data Tracking Tool

Successful asset management requires significant data of sufficient quality on which to base management decisions. Before collecting data, the city should decide which data it would like to track and use that knowledge to select an appropriate data tracking mechanism. Data tracking products can range from a relatively simple spreadsheet developed in house to a more sophisticated database or proprietary asset management software; costs can scale from hundreds of dollars to hundreds of thousands of dollars.

The city should select a product by considering resource availability, staff skill and capacity to appropriately use and manage the system (including quality assurance and quality control), and what the city would like to do with the system (which can range from maintaining a simple inventory to generating work orders, ordering parts, and billing customers). As data quality is currently a concern with the city's AS400 system and existing hard copy storm sewer system maps, the city would need to

develop and implement a robust approach for staff training and regular quality reviews for whichever type of data tracking system it pursues.

As described below, there are benefits to beginning the data collection process with a simpler, affordable spreadsheet or database tool (e.g., MS Access) and then evaluating the needed scope and functionality of a more robust computerized maintenance management system (CMMS) as the asset management program expands over time. Based on short-, mid-, and long-term goals and objectives established under Key Action 1, the sophistication of the tracking mechanism may increase over time. The city should periodically evaluate data management procedures and systems.

STORMWATER ASSET MANAGEMENT RESOURCES

Additional information can be found in a white paper, *Asset Management Programs for Stormwater and Wastewater Systems: Overcoming Barriers to Development and Implementation* (EPA, March 2017). This document presents examples of communities engaging in asset management and identifies various free and proprietary asset management resources and software.

The city has an expressed interest in pursuing asset management approaches for stormwater, wastewater, and drinking water and should consider how these efforts integrate during data collection efforts. However, the city should initiate a realistic near-term approach to starting its stormwater asset inventory rather than waiting until it determines the full path for asset management for all three city services.

2.D. Collect Data Using a Prioritized Approach and Compile Inventory

Developing a system-wide asset inventory can require significant staff time and/or consultant resources. Because the city does not currently have resources set aside for this activity, it has identified a stepwise, prioritized approach to start collecting asset data that will enable it to build its processes and capacity over time. This prioritized approach first distinguishes between areas with surface drainage and areas with underground piped drainage, then prioritizes surveys and mapping of larger surface drainage areas such as Gordon's Creek. The city plans to identify choke points that lead to flooding issues in the larger system before mapping smaller neighborhood systems (based on pipe size and/or known flooding issues).

Below is an outline of a prioritized approach for collecting data and compiling the city's stormwater asset inventory. This outline also depicts the general steps to initiate development of the asset inventory.

Year 1: Leverage Existing Information and Identify Priority Drainage Areas

1. Identify preliminary data collection priorities.
2. Compile existing hard copy maps. Interview current and former staff (if possible) to obtain information on known asset location, condition, and problem areas; mark up hard copy maps as appropriate to reflect information collected during interviews.
3. Begin developing a basic GIS-based city map that is divided into major drainage areas based on national hydrography dataset or other available information.
4. Use a basic spreadsheet to begin compiling stormwater asset information available through the existing maps and interviews.
5. Identify on a map the areas of the city with underground stormwater drainage versus open ditch drainage. Also identify areas with known flooding issues. This will be used to prioritize areas with underground drainage and/or flooding issues for initial data collection (this could include areas with ditch drainage).
    a. The city can identify these areas using existing maps, staff knowledge, and complaint records, supplemented with aerial imagery from a service such as Google Earth.
    b. Adding this data to a GIS map would be advantageous but is not necessary for accomplishing the task at this stage.
6. Rank drainage areas in order of priority for initial data collection.

Year 2: Prepare and Secure Staff Resources

1. Purchase/rent/borrow GPS units to use for data collection.
    a. Appendix D includes additional information regarding possible GPS units or other tools that the city could use for data collection and associated preliminary equipment costs.
2. Identify city staff to participate in data collection.
    a. Consider summer internship opportunities for data collection support.
3. Identify potential collaborative partners (e.g., University of Southern Mississippi or other local entities).
    a. Data collection support.
    b. GIS support.
    c. Technical insight and support on stormwater management and asset management issues.
4. Develop methodology and processes for data collection and quality assurance.
5. Train involved staff (and volunteers, if applicable) and institute quality assurance/quality control measures to ensure the quality and consistency of data collected.

Year 2 to 7: Collect and Compile Field Data

1. Conduct a walking field survey along stream/drainage channels of the highest-priority drainage area. Identify outfall locations; measure outfall diameter; use GPS to record X, Y, Z coordinates for outfalls; and record visible condition.
    a. Field staff should be mindful of known flooding areas in this drainage area.
2. Incorporate outfall information collected into asset inventory spreadsheet and assign unique identifiers.
3. Work with city maintenance staff to enhance the marked-up hard copy maps (or GIS map if available) with additional outfall information collected during the field survey and review available GIS topographic information to identify and understand subsurface system tributaries to the outfalls.
    a. Where possible, identify on the maps the approximate or actual locations of subsurface drainage pipes. The city could survey all pipes or focus on pipes 18 inches in diameter or greater.
4. As resources allow, for areas with known flooding issues within the priority drainage areas, conduct a focused field survey from the outfall to the problem area to gain more information on the drainage pathway and possible root causes of the flooding issue. During this focused field survey, the city should collect additional location and condition information about assets such as pipes, inlets, catch basins, and culverts. This activity can be performed initially and then on an as needed basis.
    a. The city could consider the following techniques:
        i. Simple visual observation of accessible pipe segments
        ii. Shining a light at the end of a culvert to identify whether it is open or clogged
        iii. Dye testing
        iv. Pole camera inspection
        v. CCTV inspection
    b. Based on the severity of the flooding issue and on-site observations, the city may elect to conduct a more detailed survey to record information needed for hydraulic modeling.
5. Continue building out GIS map with known asset locations collected during stream walks and focused field surveys.
    a. Include outfalls and information on subsurface or aboveground flow pathways.
    b. Include other stormwater asset location and condition information as available (e.g., inlets, catch basins, culverts, pump stations).
6. Expand data collection and mapping efforts across remaining selected drainage areas.
7. Throughout data collection efforts, create an ongoing list of significant upgrades or maintenance needed in the storm sewer system to address flooding issues.

Figure C-2 on the next page visualizes the above steps for collecting data and compiling the city's stormwater assets, flowing from left to right in chronological order.

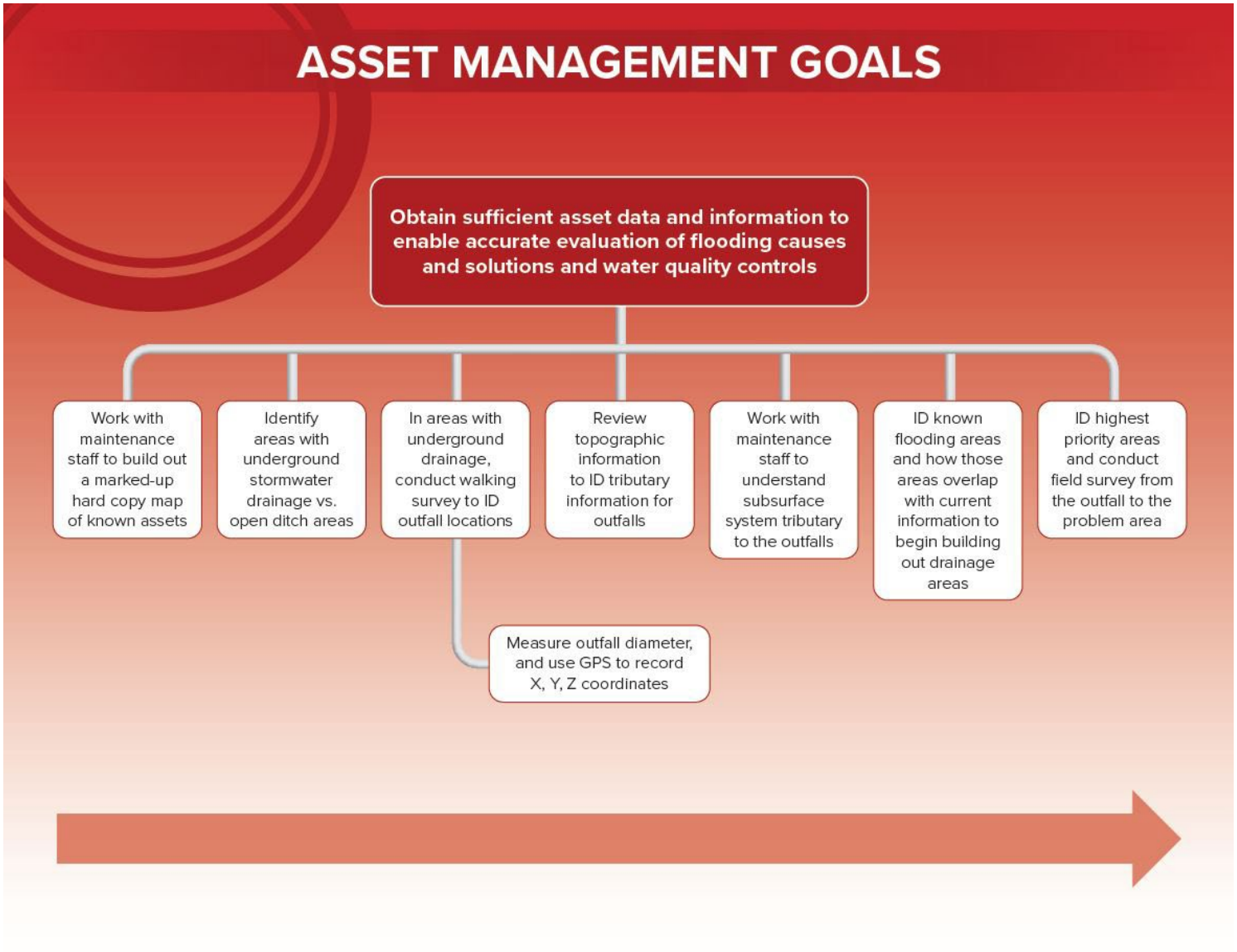

Figure C-2. Example Steps to Collect and Compile Asset Management Data

After collecting the initial field survey data and assessing the maintenance and upgrades the system needs, the city should reassess its data management approaches and goals.

1. **Connect with another utility in Mississippi** with asset management experience (e.g., Biloxi, Mississippi) to gain technical insight and support on data management approaches and systems and other stormwater management issues.
2. **Re-evaluate possible data management options** (e.g., spreadsheet, database, proprietary asset management software).
    - Identify cross-sector data management needs (drinking water, sewer, transportation) to determine opportunities for cost-sharing and further data centralization.
    - Prioritize key functions (e.g., maintain inventory data, billing, generate work orders) for any data management system.
    - Determine available budget for data management into the future.
    - Consider startup costs and future costs, including costs for obtaining a CMMS, performing system maintenance and upgrades, training internal staff, and maintaining records.
3. **Consider whether data collection efforts align with modeling needs** (e.g., hydrology and hydraulics) to inform necessary sizing of drainage infrastructure capital improvements.
    - Determine if the city needs to adjust data collection processes to support modeling efforts.

Key Action 3: Evaluate asset condition and performance

A condition assessment identifies and ranks the physical condition of assets. Like the asset inventory, the city can conduct a condition assessment iteratively, focusing first on the highest-priority assets (i.e., those targeted for the initial asset inventory development) and those for which the city has existing information.

First, the city should consider which assets to include in the condition assessment. For example, the city could prioritize its assets based on:

Replacement value threshold. The city may determine that only assets above a certain replacement value threshold are worth considering at this juncture.

Particular areas of the city. Based on the initial asset inventory evaluation, the city may determine that assets in certain areas (e.g., those prone to flooding) should be the sole focus of the initial condition assessment, expanding to other areas as time and resources permit.

Likelihood of repair or replacement need. The initial field surveys of visible assets may help the city make an initial determination as to which assets appear more likely to need repair or replacement in the near term.

The city should document the initial condition assessment and rating, then develop a general timeline for expanding the initial condition assessment to other assets (in alignment with the timeline for an expanded asset inventory under Key Action 3).

Through the field data collection and compilation steps of Key Action 2 (outlined above), the city will compile basic condition information. The city should use the inspection results to rate and rank the condition of assets on an established scale. In addition to visual appearance, additional considerations for condition rating should include, but are not limited to:

- Asset history (e.g., known history of pipe leaks, repairs, failures).
- Asset location (e.g., within a drainage basin with known flooding problems).
- Visible signs of deterioration/structural or mechanical problems.

Note that the city should assess asset condition relative to that of other assets within the same class, not broadly across all stormwater assets.

There is no single, established scale or set of criteria for assigning condition ratings. The city may choose to use a very simple rating scale at first (e.g., A–F grade, excellent to very poor scale) if it has limited asset condition data and expand the detail and complexity of the rating scale as better data become available over time. Similarly, the city may choose to use the same scale and rating criteria for all assets at first and develop specific criteria for evaluating individual classes of assets over time. An example of this approach can be found in the work Grand Rapids, Michigan, did when developing an asset management plan.

The city should compile condition data electronically and merge/integrate them with previously compiled asset inventory data and data collected and compiled under Key Actions 4 and 6

Potential Opportunities for Task Force Coordination

- Adapt and use previously applied rating, ranking, and prioritization approaches for stormwater asset condition assessments and inventory.
- Evaluate options for prioritizing projects to undertake simultaneously with other planned capital improvements to maximize efficiency and resources and minimize disruption to the public.
- Obtain key lessons learned from similar processes other departments have conducted and take advantage of opportunities for knowledge transfers among staff.

Additional Resources

- Condition Assessment Protocols for Stormwater Infrastructure
- Condition Assessment of Underground Pipes
- Condition Assessment for Stormwater Drainage Assets
- Risk-Based Stormwater Asset Management
- Introduction to Asset Management

Key Action 4: Estimate asset value, remaining useful life, and replacement costs

As assets age, their value declines, while the cost associated with operating, maintaining, and repairing the asset increases. Estimating asset value, remaining useful life, and replacement costs—together with the information compiled under Key Actions 3, 5, and 6—will help the city optimize and prioritize capital and O&M investments (described in more detail under Key Action 7).

As with the previous key actions, the city can iteratively estimate asset value, remaining useful life, and replacement cost for those assets that the city prioritizes first, gradually expanding to other assets as resources and time allow.

For each asset cataloged under the asset inventory, the city can estimate the following:

- **Estimated value** if the city depreciates the costs of assets over time for accounting purposes. If the estimated value is unknown, the city may choose not to calculate it, as it will not significantly impact decision making. (For assistance, refer to the additional resources at the end of this key action.)
- **Remaining useful life**, which the city can estimate by considering:
  - Expected useful life, all other factors being equal (i.e., standard useful life estimate given asset material, manufacturer guidelines, etc., minus number of years installed).
  - Current condition (as determined under Key Action 3).
  - Use history (i.e., has the asset been over- or under-used relative to design capacity).
  - Maintenance history (the city can reasonably expect a well-maintained asset with limited history of repair needs to last beyond standard useful life estimates, while a poorly maintained asset—particularly if use history exceeds expected capacity—may last for less time than the standard estimate would presume).
- **Replacement cost**, which is an estimate of the cost to replace the asset with whatever technology or item the city would use in place of the current asset (even if different than the currently installed practice). Sources of replacement cost information may include:
  - Comparable city investments in previous years (potentially from other sectors).
  - Manufacturers.
  - State agencies.
  - Neighboring communities.

Additional Resources

- A.M. KAN Work! An Asset Management and Energy Efficiency Manual

Key Action 5: Establish level of service and associated performance measures

Level of service (LOS) is an articulation of the service you want to be able to provide using your assets and how you want them to perform. LOS should capture considerations including but not

limited to regulatory requirements for permit compliance; water quality, capture, and conservation; flood mitigation; customer service and social considerations; and cost-effectiveness. The city can evaluate performance against LOS using quantitative performance measures, as shown in the examples below.

LOS goals will be one important determinant for how the city spends its money. It is important to remember that the city can change LOS goals, and they are not mandatory. The city can revise, add, or remove goals as conditions warrant.

LOS goals can also become more ambitious as the city's asset management program evolves over time, and the city realizes the financial and operational benefits of the program. This is particularly important given that higher LOSs will generally mean higher stormwater management costs for the city (although higher LOSs should also result in greater financial, environmental, and social benefits). LOS goals and the city's ability to meet them can have a significant resource dimension. Therefore, when establishing LOS goals, it is important to consider 1) what the city can achieve with its current level of staffing (in particular, staff who are responsible for routine O&M), and 2) what O&M approaches the city would need to change or introduce to meet LOS targets.

The city should document LOS goals, the measures it will use to evaluate performance against those goals, and the frequency of evaluation.

The overall and specific LOS goals outlined in the remainder of this section are intended as examples. They illustrate how the city can transform priorities around stormwater services and asset management into measurable goals and targets that can be enhanced over time. Table C-6 below outlines four high-level goals, providing examples of associated performance measures to track progress against those goals, as well as targets or benchmarks to strive toward.

Table C-6. Sample Overall Level of Service Goals

Sample Level of Service Goal	Sample Performance Measure	Sample Target
LOS Goal 1: Meet customer and municipal decision maker expectations for public services	Number of customer complaints	Number of complaints reduced by X% over the previous year
	Educate decision makers and public on environmental value of stormwater services.	Annual communication and outreach provided on stormwater accomplishments and investments
LOS Goal 2: Ensure sound financial management	Budget for full cost of stormwater services	Annual budget that is adequate to fund stormwater services provided across city departments
	Control increases in O&M costs	O&M costs not to exceed X% over the previous year

Sample Level of Service Goal	Sample Performance Measure	Sample Target
LOS Goal 3: Maintain integrity of key infrastructure assets (as established in Key Action 2)	Address deficiencies in the most critical assets each year	*See expanded tables below.*
	Limit structural failures	
	Reduce flooding	
	Implement a proactive asset maintenance approach	
LOS Goal 4: Support an engaged and knowledgeable workforce	Promote understanding across employees of the principles of asset management	X hours of training per person, per year
	Provide technical capacity to conduct comprehensive system mapping and inventory	X staff trained in GIS/data collection

Expanded Example of LOS Goal 3: Maintain Integrity of Key Infrastructure Assets

To meet each of these high-level goals, the city will have to identify an expanded set of concrete actions and targets with associated metrics and benchmarks. Additionally, the city can set multiple LOS "tiers" to build out a short-, mid-, and long-term vision for how stormwater services will improve over time as the city accumulates the technical and financial resources needed to enhance service through asset management. As an example, Table 1-3 illustrate the process of expanding LOS Goal 3 into three tiers.

In this example, LOS initially targets the highest-priority assets (determined in part through existing knowledge of the stormwater system and Key Action 6). Over time, LOS is based on broader O&M objectives and other activities that seek to maintain the integrity of all assets within the system. Tier 1 represents baseline conditions (i.e., asset maintenance activities the city currently undertakes), Tier 2 represents enhanced maintenance activities in areas prioritized through the city's asset inventory process, and Tier 3 represents full expansion of enhanced maintenance activities across the entire system. Tier 3 would be the long-term target.

As shown in the tables, the city can enhance its LOS among tiers (1–3) as the asset management program becomes more robust over time and the city acquires more data, experience, and resources to improve overall service. The breakdown of the tiers is as follows:

- **Tier 1—Baseline/Existing LOS:** Identifies the city's current LOS.
- **Tier 2—Enhanced LOS:** Identifies increased LOS goals beyond Tier 1 that the city can implement once it has enhanced its technical and financial capacity and data management capabilities through asset management. This would be done in priority areas identified during the city's asset inventory process under Key Action 2. The City will review the frequencies currently denoted with the letter "X" and update them throughout the inventory process.
- **Tier 3—Robust LOS:** Identifies increased LOS goals beyond Tier 2 that the city can implement once it has significantly enhanced its technical and financial capacity and data

management capabilities through asset management. This would be done across the city's entire system.

These examples are generally based on the stormwater asset management plan for the City of Grand Rapids, Michigan, and its approach to LOS, which is one example Hattiesburg may wish to consider when developing its LOS goals. The activities are outlined under four categories:

- **Inspection:** Conducting on-site visual inspections to assess asset condition or related issues.
- **Corrective repair and maintenance**: Repairing, rehabilitating, or replacing assets that have failed or are anticipated to fail in the near future.
- **Preventative maintenance:** Performing maintenance activities that can help prevent flooding, service disruptions, or failure of assets in any condition.
- **Complete replacement/renewal**: Based on the rate of corrective repair and maintenance, the timescale over which the city will completely replace or renew a specific class of assets.

In the tables below, the "X" notations in some cells denote items that the city can consider and replace with appropriate figures.

Tier 1—Baseline/Existing LOS

This tier represents the city's current key infrastructure asset maintenance and is characterized by:

- Limited O&M and capital funding.
- Intermittent corrective cleaning and maintenance of critical infrastructure in response to customer complaints.
- Proactive cleaning of select outfalls before forecasted storms.
- Data limited to hard copy maps and customer complaints entered in the AS400 system.

Table C-7. Activities to Consider for Tier 1—Baseline/Existing LOS

Tier 1—Baseline/Existing LOS				
Asset	**Inspection Activities**	**Corrective Repair and Maintenance**	**Preventive Maintenance**	**Complete Replacement/Renewal**
Drainage pipes		Clean in response to customer complaints.		
Open ditches		Clean in response to customer complaints.	Annual application of herbicide in appropriate ditch areas.	

Tier 1—Baseline/Existing LOS				
Asset	**Inspection Activities**	**Corrective Repair and Maintenance**	**Preventive Maintenance**	**Complete Replacement/Renewal**
			Clean predetermined areas.	
Storm sewer outfalls	Annual dry weather inspections.	Clean in response to customer complaints.	Clean select outfalls before forecasted storms.	
Drain inlets	Inspect before and after rain events.	Clean in response to customer complaints.		
Catch basins		Clean in response to customer complaints.		
Culverts		Clean in response to customer complaints.		
Pumps				
Infiltration basins	*The city does not currently have this asset type but may in the future.*			
Retention ponds				
Detention ponds				
Rain gardens	*The city does not currently have this asset type but may in the future.*			
Bioswales	*The city does not currently have this asset type but may in the future.*			
Permeable pavement	*The city does not currently have this asset type but may in the future.*			
Other stormwater treatment controls				

** Empty cells indicate the city does not perform this activity.*

Tier 2—Enhanced LOS

This tier represents an enhanced level of key infrastructure asset maintenance in priority areas and is characterized by:

- Resources increased for inspections, proactive maintenance, and capital projects.
- Consistent inspection and maintenance routine for critical infrastructure in place.
- Initial inventory and condition assessment of critical infrastructure completed (see Key Actions 2–4); GIS data and mapping completed for critical infrastructure.
- Green infrastructure opportunities and needed resources identified.

Table C-8. Activities to Consider for Tier 2—Enhanced LOS

Tier 2—Enhanced LOS				
Asset	**Inspection Activities**	**Corrective Repair and Maintenance**	**Preventive Maintenance**	**Complete Replacement/Renewal**
Drainage pipes	CCTV and assign condition ratings to the complete system over an X-year period.	Clean in response to customer complaints. Repair or replace X% of highest criticality annually.	Coordinate root control for sewer and storm.	Replace X% of pipe that is at or has exceeded useful life and/or has a condition rating of X of worse over an X year period. Replace drainage pipes every X years.
Open ditches	Walking survey of X%/miles every X years.	Clean in response to customer complaints.	Annual application of herbicide in appropriate ditch areas. Cleaning of X% of ditches annually.	Clean all open ditches every X years.
Storm sewer outfalls	Annual dry weather inspections.	Clean in response to customer complaints. Repair or replace X% of highest criticality annually.	Clean before forecasted storms. Perform preventive maintenance on X% of inspected outfalls annually.	Replace outfalls every X years.
Drain inlets	Inspection at least X times annually and before and after rain events.	Clean in response to customer complaints.	Clean before forecasted storms.	Replace drain inlets every X years.
Catch basins	Inspection X times annually.	Clean in response to customer complaints. Replace X% of catch basins that are at or have exceeded useful life over X years.	Perform rehabilitation when X% of catch basins are at or have exceeded useful life over X years.	Replace catch basins every X years.
Culverts	Inspect X% annually.	Clean in response to customer complaints. Repair or replace X% of highest criticality annually.		Replace culverts every X years.

Tier 2—Enhanced LOS				
Asset	**Inspection Activities**	**Corrective Repair and Maintenance**	**Preventive Maintenance**	**Complete Replacement/Renewal**
Pumps	Inspect annually.	Repair or replace X% of highest criticality annually.	Clean / maintain annually.	Replace pumps every X years.
Infiltration basins	*The city does not currently have this asset type but may in the future.*			
Retention ponds				
Detention ponds	Inspect X times annually.			Renovate every X years.
Rain gardens	*The city does not currently have this asset type but may in the future.*			
Bioswales	*The city does not currently have this asset type but may in the future.*			
Permeable pavement	*The city does not currently have this asset type but may in the future.*			
Other SW treatment controls				

** Empty cells indicate the city does not perform this activity.*

Tier 3—Robust LOS

This tier represents an enhanced level of key infrastructure asset maintenance throughout the city's entire system and is characterized by:

- Resources sufficient for enhanced O&M and capital spending that allows for complete system renewal every X years.
- Resources dedicated to design and installation of green infrastructure.
- Consistent inspection and maintenance routine for all infrastructure in place.
- Inventory and condition assessment of all assets in place; GIS data and maps available for all assets.
- Work order system integrated into system map and O&M activities.

Table C-9. Activities to Consider for Tier 3—Robust LOS

Tier 3—Robust LOS				
Asset	**Inspection Activities**	**Corrective Repair and Maintenance**	**Preventive Maintenance**	**Complete Replacement/Renewal**
Drainage pipes	CCTV and assign condition ratings to the	Clean in response to customer complaints.	Coordinate root control for sewer and storm; perform	Replace drainage pipes every X years.

Tier 3—Robust LOS				
Asset	**Inspection Activities**	**Corrective Repair and Maintenance**	**Preventive Maintenance**	**Complete Replacement/Renewal**
	complete system over an X-year period.	Repair or replace X% of highest criticality annually.	rehabilitation for X% of pipe that is at or has exceeded useful life over X years.	
Open ditches	Walking survey of X%/miles every X years.	Clean in response to customer complaints.	Annual application of herbicide in appropriate ditch areas. Cleaning of X% of ditches annually.	Clean all open ditches every X years.
Storm sewer outfalls	Annual dry weather inspections.	Clean in response to customer complaints. Repair or replace X% of highest criticality annually.	Clean before forecasted storms; perform preventive maintenance on X% of inspected outfalls annually.	Replace outfalls every X years.
Drain inlets	Inspection at least X times annually and before and after rain events.	Clean in response to customer complaints.	Clean before forecasted storms.	Replace drain inlets every X years.
Catch basins	Inspection X times annually.	Clean in response to customer complaints. Replace X% of catch basins that are at or have exceeded useful life over X years.	Perform rehabilitation when X% of catch basins are at or have exceeded useful life over X years.	Replace catch basins every X years.
Culverts	Inspect X% annually.	Clean in response to customer complaints. Repair or replace X% of highest criticality annually.		Replace culverts every X years.
Pumps	Inspect two times per year.	Repair or replace X% of highest criticality annually.	Clean/maintain annually.	Replace pumps every X years.
Infiltration basins	*The city does not currently have this asset type but may in the future.*			

Tier 3—Robust LOS				
Asset	**Inspection Activities**	**Corrective Repair and Maintenance**	**Preventive Maintenance**	**Complete Replacement/Renewal**
Retention ponds	Inspect X times annually.	Repair or replace X% of highest criticality annually.	Clean/maintain annually.	Renovate retention ponds every X years.
Detention ponds	Inspect X times annually.	Repair or replace X% of highest criticality annually.	Clean/maintain annually.	Renovate detention ponds every X years.
Rain gardens	*The city does not currently have this asset type but may in the future.*			
Bioswales	*The city does not currently have this asset type but may in the future.*			
Permeable pavement	*The city does not currently have this asset type but may in the future.*			
Other stormwater treatment controls				

** Empty cells indicate the city does not perform this activity.*

Potential Opportunities for Coordination with Drinking Water, Wastewater, Roads, and Parks and Recreation Sectors

- Coordinate on LOS goals to avoid conflicting goals or redundancy and identify opportunities for cross-department collaboration on tracking and meeting goals.
- Obtain key lessons learned from similar processes other departments have conducted and take advantage of opportunities for knowledge transfers among staff.

Key Action 6: Assess criticality and risk

Condition assessments and estimates of remaining useful life will provide an initial picture of which assets are more significant concerns in terms of timing and extent of repair or replacement needs. These assessments are critical steps in applying the asset management framework to stormwater services. Evaluating asset criticality and risk will allow the city to prioritize assets more easily for repair and replacement, further enhancing the city's ability to target resources most cost-effectively.

To assess asset criticality and risk, Hattiesburg will have to build on the knowledge it collected through the asset inventory, condition assessment, and remaining useful life processes and evaluate each asset in terms of its likelihood or probability of failure (POF) and consequence of failure (COF). "Failure" can include physical failure, physical capacity issues (too much, too little), failure to meet LOS/customer service goals, and financial inefficiencies (increasingly and prohibitively expensive to maintain over time).

The city can choose parameters for evaluating POF or COF that most closely align with its stormwater management and LOS goals. For example, to consider POF, the city may consider the following:

- Age
- Estimated remaining useful life
- Condition
- Reliability history
- Regularity of O&M activities related to the asset

To determine COF, the city may consider the following (note that these criteria include social, environmental, *and* financial consequences):

- Time and cost associated with asset repair/replacement.
- Percentage of residents impacted by asset failure (e.g., through flooding, road closures).
- Likelihood that asset failure would release pollutants into waterways and result in a regulatory/permit violation.
- Likelihood that asset failure would result in a significant environmental or public health concern.
- Likelihood/percentage of businesses impacted by asset failure.
- Likelihood that asset failure would create long-term disruptions to essential stormwater management services.

The city can determine asset criticality by visually plotting COF and POF on a matrix (see Figure C-3) and/or assigning quantitative values for COF and POF and multiplying them. The result should rank assets by criticality to inform subsequent decision making on how to spend limited resources.

As asset criticality changes over time, the city should routinely re-evaluate the findings (e.g., every one to three years).

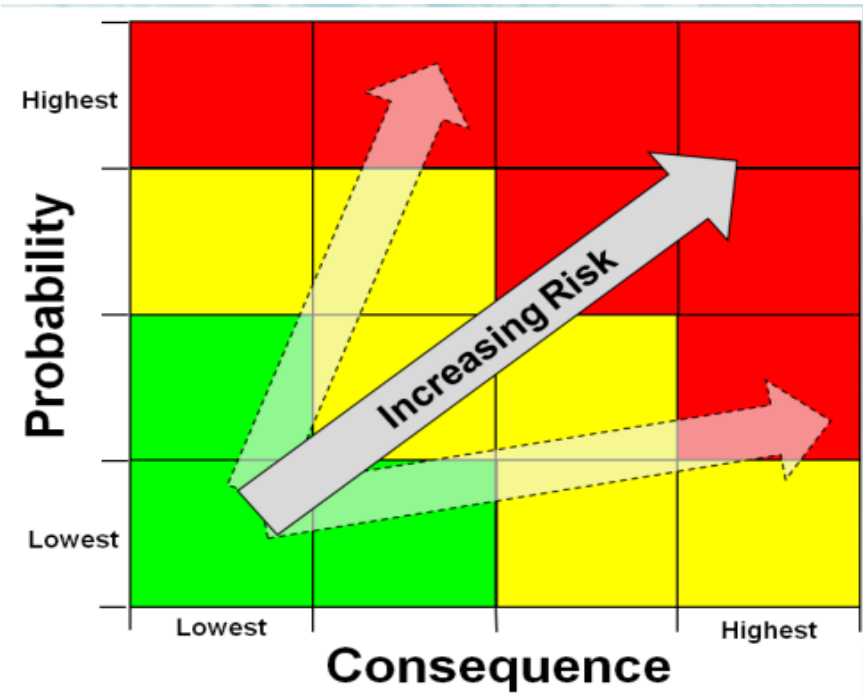

Figure C-3. Matrix Depicting Risk Associated with POF and COF[1]

Potential Opportunities for Task Force Coordination
• Use previously applied approaches to quantify and plot risk and consequence. • Consider criticality of stormwater assets in the context of other public infrastructure in the community. • Obtain key lessons learned from similar processes other departments have conducted and take advantage of opportunities for knowledge transfers among staff.

Key Action 7: Optimize capital and O&M costs and prioritize investments (life cycle costing)

Life cycle costing considers the costs of each asset throughout its full life cycle, including installation; O&M; repair; rehabilitation; disposal; and environmental, financial, and social costs. Life cycle costing requires the city to evaluate how to provide sustainable stormwater services and meet the established LOS at the lowest cost. The city should aim to conduct only as much maintenance as is needed to reach the maximum useful life of the asset and should replace most critical assets before failure.

[1] Source: Developing a Comprehensive Asset Management Plan by Consistently Assessing Asset Condition, Consequence of Failure, and Risk, Presentation at the 2015 One Water Utility Workshop, K. Slaven.

The level of detail the city collects on costs per asset type and the accuracy of criticality assessments will enhance Hattiesburg's decision-making capabilities on where and when to invest in infrastructure. Therefore, the city's ability to conduct life cycle costing may improve over time as the scope and depth of asset data improves. The city should consider integrating investment decisions into capital improvement planning efforts.

With respect to O&M activities, investments in low-risk assets would generally be limited to routine maintenance only. Moderate-risk assets may see investments for routine and limited preventive maintenance. Highest-risk assets would see investments for routine, preventive, and possibly predictive maintenance. Key considerations related to O&M investments should include:

- What ongoing maintenance activities the city should continue and discontinue.
- What maintenance activities the city should perform but does not.
- How the city can achieve a target balance of roughly 80 percent proactive maintenance and 20 percent reactive maintenance (with proactive maintenance focused on high criticality assets).

In terms of capital investment, low-risk assets would receive investments for basic repair and replacement at the end of useful life. Moderate-risk assets may see investments for repair and rehabilitation, which could extend useful life, and highest-risk assets would see investments for repair, rehabilitation, and replacement.

The city should schedule O&M and capital investments based on risk, funding availability, and available technology. Additionally, to the extent possible, the city should align stormwater capital investments and projects with other infrastructure investments (e.g., timing pipe replacement to coincide with planned street repairs) to maximize cost-effectiveness and limit disruption to the community.

Potential Opportunities for Task Force Coordination
• Coordinate on existing capital improvement planning processes and integrate stormwater needs into the existing and subsequent capital improvement plans if relevant. • Identify opportunities to coordinate timing of capital projects with other planned public infrastructure projects. • Identify ongoing O&M activities in other sectors that the city could integrate with stormwater activities, or that could serve as a model for improved, routine stormwater O&M activities. • Obtain key lessons learned from similar processes other departments have conducted and take advantage of opportunities for knowledge transfers among staff.

Key Action 8: Develop a funding strategy

In addition to any incremental funding required to accomplish the asset management actions described previously, the city needs to identify funding (e.g., community and

supplemental/external funding) for necessary O&M and capital improvement activities. Goal 2 of the city's Long-term Stormwater Plan discusses funding strategies in greater detail.

Potential Opportunities for Task Force Coordination
• Evaluate highest-priority funding needs across sectors and identify projects to conduct simultaneously to maximize efficiency (this would also require coordination on funding). • Identify funding sources that could cover projects across multiple sectors at the same time. • Establish agreed-upon priorities for funding across the municipality based on asset criticality evaluations.

Key Action 9: Document asset management activities in a written plan

A written asset management plan serves as a resource for implementing the asset management program and documents the information and procedures guiding implementation over time. The written plan should identify the city's approach to building an asset management program according to the key actions outlined above, and the city should revisit/revise the plan over time as needed. The city should make the plan publicly available to demonstrate its commitment to providing data-driven, sustainable, cost-effective public services. An example written stormwater asset management program plan can be seen in the City of Grand Rapids Stormwater Asset Management Program.

The following actions should occur in tandem with Key Actions 1–9, as appropriate, and should include coordination across public works sectors to identify opportunities for resource and knowledge sharing, streamline asset management processes, approaches, and tools, and avoid redundancy.

Key Action 10: Conduct training, education, and outreach

Relevant staff should receive training on the process and importance of asset management, as well as key messages for communicating the benefits of asset management to the community, managers, stakeholders, customers, and decision makers. The city should also provide training when introducing any new procedures or tools (e.g., data systems) as part of the asset management program.

The city should conduct broader education and outreach with local decision makers and community members to generate awareness of and buy-in for asset management activities, as well as associated investments in infrastructure maintenance and management.

Key Action 11: Pursue continuous evaluation and improvement

Asset management is a continuous process. The city should routinely revisit, re-evaluate, and expand or refine its asset management program to accommodate new data, new technologies, regulatory changes, and other developments. Municipal sectors should also continue to evaluate opportunities to collaborate on and integrate asset management activities.

The city should routinely track progress against established performance measures and associated targets to determine whether it is meeting the LOS. It should then revise LOS targets and expectations as needed.

APPENDIX D:
CONSIDERATIONS FOR INCORPORATING GREEN INFRASTRUCTURE INTO LOCAL HAZARD MITIGATION PLANS

Considerations for Incorporating Green Infrastructure into Local Hazard Mitigation Plans

To compete for the Federal Emergency Management Agency's (FEMA's) Pre-Disaster Mitigation and Flood Mitigation Assistance grant programs, communities are required to develop a Local Hazard Mitigation Plan and update it every five years.

Federal guidelines outlining mitigation plan requirements strongly advocate that communities include projects beyond those traditionally funded by FEMA to address vulnerabilities. Hattiesburg should therefore advocate for green infrastructure approaches in the updated Forrest County Local Hazard Mitigation Plan. An overview of plan requirements is included below, along with strategies for incorporating green infrastructure.

Hazard Identification and Risk Assessment

Local Hazard Mitigation Plans must include a hazard identification and risk assessment (HIRA). The HIRA provides the building blocks and context for specific projects that are later described in the action plan. It is important for the plan to clearly connect identified hazards with recommended mitigation strategies and actions. Because the HIRA is used to identify hazards and justify the need for future actions, planners should be familiar with potential mitigation strategies early in the HIRA phase. Therefore, to fully integrate green infrastructure into the plan, the core planning team must be aware of the types and benefits of green infrastructure projects as it develops the HIRA. The team should begin the planning process with a shared understanding of the opportunities that green infrastructure can provide. This may mean that the planning team will require training on green infrastructure before it starts the planning process.

During the HIRA phase, planners "profile" the hazards that could impact their communities. These profiles provide a well-rounded overview of the hazard, ranging from dictionary-style definitions to detailed discussions on the extent of the hazard and the specific negative impacts the hazard could create in the community. The profiles typically list historical occurrences, contain graphic risk maps, and often include loss estimates. In the context of green infrastructure, when HIRA planners establish a flooding profile, they should acknowledge stormwater-related flooding issues. This includes describing the connections between impervious surfaces, increases in stormwater runoff, and local flooding. Identifying areas with high concentrations of impervious surfaces in the HIRA phase, as well as identifying how and where green infrastructure might be effective in the community, creates the foundation for including green infrastructure projects later in the mitigation strategy phase.

Mitigation Strategy

Local Hazard Mitigation Plans must also outline a mitigation strategy. This phase of the planning process requires communities to set goals related to risk reduction and then further outline actions that work toward achieving those goals. It is important to understand that goals may be very broad and could be aspirational, such as "completely eliminating flood-related losses." Actions, in this sense, identify specific mitigation projects.

- Goals and actions should be based on the findings of the HIRA. As such, it is important to:
- Acknowledge specific flood impact areas.

- Prioritize green infrastructure-related actions and goals.
- Describe the implementation of green infrastructure-related projects in the action plan.

This approach considers the costs and benefits of specific projects and helps to frame the thinking with respect to determining where green infrastructure projects should be located.

Other Requirements

Regulations guiding the hazard mitigation planning process require two-way alignment of mitigation with other planning efforts to help support resiliency. Communities should integrate mitigation considerations into other plans and include measures the other plans suggest in the hazard mitigation document. For example, a community's comprehensive development, economic development, and land use plans are applicable for integration. Other documents that focus on watershed protection and stormwater management plans may also apply.

It is important to look for points of integration across regional-level plans as well as local-level plans. Regional plans allow for an examination of hazard impacts that cross jurisdictional lines, both from a mitigation perspective and a green infrastructure perspective. Local-level plans may provide more detail about local flood hazards or identify local projects that could incorporate green infrastructure. Aligning plans at both the regional and local levels increases the likelihood that plan goals will be realized. A joint stormwater management/hazard mitigation focus can highlight green infrastructure options that benefit both water quality and flood mitigation.

APPENDIX E:
FLOOD RESILIENCE CHECKLIST

Flood Resilience Checklist

The following checklist was created by EPA through collaboration with various communities during a Smart Growth Implementation Assistance Project[1]. The checklist is intended to help communities evaluate their preparedness for a possible flood.

During the long-term stormwater planning process with the City of Hattiesburg, the city worked with EPA to fill out the flood resilience checklist. Note that it was completed using the city's previous local hazard mitigation plan as the evaluation was done prior to development of the 2020 Mississippi Emergency Management Agency (MEMA) District 8 Hazard Mitigation Plan, of which Hattiesburg is a part. The city plans to reevaluate this checklist in the future to consider the most up-to-date information, complete any unanswered questions, and determine if there steps the city will take to further increase flood resilience.

Overall Strategies to Enhance Flood Resilience		
1. Does the community's Comprehensive Plan have a hazard element or flood planning section? **Notes** • Page 83 of the City of Hattiesburg's 2008–2028 Comprehensive Plan (p. 14 of the "Natural Environment" section) includes a "Hazard Mitigation" section, which references the Multi-Jurisdictional Hazard Mitigation Plan (created in partnership with Forrest County and the City of Petal). • The Comprehensive Plan identifies hurricanes and coastal storms, thunderstorms and tornadoes, flooding and potential flood events, wildfires, and manmade hazards such as material spills as the primary types of hazards that could potentially impact Hattiesburg.	☒ Yes	☐ No
a. Does the Comprehensive Plan cross-reference the Local Hazard Mitigation Plan and any disaster recovery plans? **Notes** • Page 83 (p. 14 of the "Natural Environment" section) references the Multi-Jurisdictional Hazard Mitigation Plan created by the City of Hattiesburg, the City of Petal, and Forrest County.	☒ Yes	☐ No

[1] Additional information on the flood resilience checklist can be found online at the following website: https://www.epa.gov/sites/production/files/2014-07/documents/flood-resilience-checklist.pdf

Overall Strategies to Enhance Flood Resilience		
b. Does the Comprehensive Plan identify flood- and erosion-prone areas, including river corridor and fluvial erosion hazard areas, if applicable? **Notes** • Page 73 (pg. 4 of "Natural Environment" section) includes a "Floodplain Management" section, which describes the need for bank stabilization along Gordon's Creek from East Hardy Street to Interstate 59 and sections of Mixon's Creek as priority projects.	▣ Yes	☐ No
c. Did the local government emergency response personnel, floodplain manager, and department of public works participate in developing/updating the Comprehensive Plan? **Notes** • As part of the planning process for the Hattiesburg Comprehensive Plan, the Visionary Advisory Team participated in 19 meetings, during which guest speakers with expertise in aspects of Hattiesburg's physical, social, and economic conditions gave presentations. The topic of meeting #4 of the planning process (as outlined in Figure 4 on p. 18 of the Comprehensive Plan) was storm drainage, environmental protection, and floodplains.	▣ Yes	☐ No
2. Does the community have a Local Hazard Mitigation Plan approved by the Federal Emergency Management Agency (FEMA) and the state emergency management agency? **Notes** • The Hazard Mitigation Plan developed by the City of Hattiesburg, the City of Petal, and Forrest County was submitted for FEMA approval in August 2013. The plan is up for renewal in 2018.	▣ Yes	☐ No
a. Does the Hazard Mitigation Plan cross-reference the local Comprehensive Plan? **Notes** • Page 2-5 of the Hazard Mitigation Plan references the City of Hattiesburg Comprehensive Plan as a document that was reviewed during the drafting process.	▣ Yes	☐ No
Overall Recommendation: *In future comprehensive planning efforts, the city should ensure that key city staff and stakeholders (e.g., emergency response personnel, floodplain manager, public works staff) participate in the discussions.*		
b. Was the local government planner or zoning administrator involved in developing/updating the Hazard Mitigation Plan? **Notes** • Page 2-2 of the Hazard Mitigation Plan indicates that Hattiesburg's urban development department is a local agency that helped develop the plan.	☐ Yes	☐ No

Overall Strategies to Enhance Flood Resilience		
• Recommendation: *Current staff, including the local government planner or zoning administrator, should be involved in updating the Hazard Mitigation Plan. The city should identify responsible staff before the planning process begins.*		
c. Were groups such as local businesses, schools, hospitals/medical facilities, agricultural landowners, and others who could be affected by floods involved in the Hazard Mitigation Plan drafting process? **Notes** • Page 2-2 of the Hazard Mitigation Plan lists multiple local agencies from Hattiesburg that helped develop the plan, including the school district, urban development, mass transit, home association, police department, and fire department. • Recommendation: *Identify local agencies within Hattiesburg that should be involved in developing future Hazard Mitigation Plans/renewals. Ensure the local agencies represent those most affected by floods and other natural disaster risks.*	▣ Yes	☐ No
d. Were other local governments in the watershed involved to coordinate responses and strategies? **Notes** • The Hazard Mitigation Plan is a multi-jurisdictional plan developed by the City of Hattiesburg, the City of Petal, and Forrest County.	▣ Yes	☐ No
e. Does the Hazard Mitigation Plan emphasize non-structural pre-disaster mitigation measures such as acquiring flood-prone lands and adopting No Adverse Impact floodplain regulations? **Notes** • Goal 1 on page 5-2 of the Hazard Mitigation Plan lists re-establishing corridors along rivers and streambeds in Forrest County, as well as actively pursuing buyouts of properties that are considered repetitive loss properties, as actions for encouraging development and maintenance of facilities and infrastructure that will mitigate hazards.	▣ Yes	☐ No
f. Does the Hazard Mitigation Plan encourage using green infrastructure techniques to help prevent flooding? **Notes** • The Hazard Mitigation Plan does not explicitly encourage the use of green infrastructure techniques to help prevent flooding. However, the Land Development Code includes a requirement. • Recommendation: *Improve education for city staff and developers on green infrastructure approaches and use the city's green infrastructure opportunities analysis as a tool to identify where green infrastructure practices may be most effective. Consider how the city*	☐ Yes	▣ No

Overall Strategies to Enhance Flood Resilience		
can incorporate green infrastructure approaches when updating the plan.		
g. Does the Hazard Mitigation Plan identify projects that could be included in pre-disaster grant applications and does it expedite the application process for post-disaster Hazard Mitigation Grant Program acquisitions? **Notes** • Section 5 of the Hazard Mitigation Plan identifies project goals related to stormwater and flooding mitigations, including the following: ○ Residential property elevation: Elevate existing properties located within flood zones, specifically, flood-prone structures in zone AE, zone A, and the floodway. ○ Flood insurance education program: Educate the general public and financial and real estate professionals on the benefits of flood insurance. ○ Equipment purchase: Improve the city's ability to remove debris from flooding and wind events by purchasing additional chipper/shredders, a chip truck, knuckle boom equipment, and other types of equipment for debris removal and disposal. ○ Hazard-related public information: Inform the public about Special Flood Hazard Areas (SFHAs), stormwater management, the National Flood Insurance Program, and storm preparedness. ○ Critical facility relocation: Pursue funding to relocate, retrofit, or raise county-owned critical facilities located within SFHAs. ○ Stream corridor reforestation: Work with local Soil and Water Conservation District, Natural Resources Conservation Service, and Forest Service to establish reforested corridors along river and stream beds. ○ Acquisition/relocation: Actively pursue and buy repetitive loss properties. Develop a prioritized list of properties within SFHAs to acquire (buy out) if state or federal monies are available. • Funding sources for these stormwater and flooding mitigation projects are vague (e.g., "federal and/or state grants," "unknown," "general budgets"). • EPA's smart growth document[2] recommends approaches for disaster-resilient communities, including how communities can expedite the application process for post-disaster Hazard Mitigation Grant Program acquisitions by "*identifying potential hazard mitigation projects*" and beginning to *"complet[e] hazard mitigation grant applications before a disaster occurs, instead of having to quickly develop such lists or projects in the aftermath of a disaster.*"	▣ Yes	☐ No

[2] https://www.epa.gov/sites/production/files/2014-07/documents/vermont-sgia-final-report.pdf

Overall Strategies to Enhance Flood Resilience		
Communities that take these steps are better positioned to apply for federal funding for disaster recovery and can speed up the recovery process. • Recommendation: *Identify steps to complete the application process/start the application process before a disaster occurs for the projects included in the Hazard Mitigation Plan. Evaluate the list of projects to determine whether it is still accurate or determine whether the city should add or remove projects based on current needs. Contact the Mississippi Emergency Management Agency for more information/guidance.*		
3. Do other community plans (e.g., open space or parks plans) require or encourage green infrastructure techniques? **Notes** • Hattiesburg's parks and recreation website has a July 2011 Gordon's Creek Park Conceptual Development Plan, which includes bioretention swales as a landscape improvement technique. • Currently, there are no incentives for green infrastructure in the private sector; the city is revisiting this policy for public development.	☐ Yes	▣ No
4. Do all community plans consider possible impacts of climate change on areas that are likely to be flooded? **Notes** • The Hazard Mitigation Plan does not specifically reference impacts of climate change, but did use a level of risk formula, which factored into the probability of future occurrence.	☐ Yes	▣ No
5. Does the budget prioritize structural flood mitigation approaches (such as repairing bridges, culverts, and levees) and non-structural approaches (such as green infrastructure) that require significant investment of resources coordinated with local capital improvement plans?	☐ Yes	▣ No
6. Does the community participate in the National Flood Insurance Program Community Rating System? **Notes** • The City of Hattiesburg participates in the Community Rating System and currently maintains a Class 8 rating. The city has submitted a request for a revised class rating.	▣ Yes	☐ No

Conserve Land and Discourage Development in River Corridors		
1. Has the community implemented non-regulatory strategies to conserve land in river corridors, such as:		
a. Acquisition of land (or conservation easements on land) to allow for stormwater absorption, river channel adjustment, or other flood resilience benefits? b. Buyouts of properties that are frequently flooded? **Notes** • A proposed project on page 5-3 of the Hazard Mitigation Plan is to elevate existing properties that are within flood zones; however, in the absence of elevation, the proposed alternative is either acquisition or demolition. • The city has been considering locations for off-site detention to help alleviate some flooding issues along Lincoln Road (near S. 34th Avenue). • An action item for Goal #1 on page 5-2 of the Hazard Mitigation Plan is to actively pursue and buy repetitive loss properties. • A proposed mitigation project on page 5-12 of the Hazard Mitigation Plan is to develop a prioritized list of properties that are within the SFHA and acquire (buyout) those properties if state or federal monies are available. • The city has purchased some properties that are prone to flooding to allow for stormwater absorption and avoid property impacts. The land secured for the potential future East Hardy Park is an example of an acquisition.	▣ Yes	☐ No
c. Transfer of development rights (TDR) program that targets flood-prone areas as sending areas and safer areas as receiving areas? **Notes** • A TDR program involves zoning of sensitive, vulnerable lands to restrict development. These areas are called "sending areas." Communities then designate "receiving areas" where they wish to see additional development, which are zoned to allow additional density. • State law must allow TDR programs for municipalities to implement them. • The city has purchased flood-prone land to prevent future development.	☐ Yes	▣ No
d. Tax incentives for conserving vulnerable land? **Notes** • EPA's smart growth document includes land use policy options and strategies to improve flood resilience. Various examples are provided. including one related to communities providing tax incentives to protect important land. One example provided is a riparian buffer tax	☐ Yes	▣ No

Conserve Land and Discourage Development in River Corridors		
credit Virginia implemented in 2000, which granted tax credits equal to 25 percent of the value of timber retained in a buffer up to $17,500.		
e. Incentives for restoring riparian and wetland vegetation in areas subject to erosion and flooding? **Notes** • Page 5-11 of the Hazard Mitigation Plan lists reforestation of river corridors as a mitigation project during which the city will work with the local Soil and Water Conservation District, Natural Resources Conservation Service, and the Forest Service to establish reforested corridors along river and stream beds. • EPA's smart growth document identifies the U.S. Department of Agriculture's Conservation Reserve Enhancement Program as a federal program that can help restore agricultural land along streams.	☐ Yes	▣ No
2. Has the community encouraged agricultural and other landowners to implement pre-disaster mitigation measures, such as: **Overall Notes** • Page 3-2 and Map 3-14 in the Hazard Mitigation Plan indicate that most of the agricultural land use within the City of Hattiesburg is located along the floodplain (Leaf River) properties on the east part of the city. The Hazard Mitigation Plan does not identify specific strategies for agricultural landowners to implement pre-disaster mitigation measures. • Recommendation: *Encourage/implement the pre-disaster mitigation strategies listed in items a–d below among the agricultural properties located within the floodplain of the Leaf River. The city could incorporate these recommendations in future updates to the Comprehensive Plan or Hazard Mitigation Plan.*		
a. Storing hay bales and equipment in areas less likely to be flooded? **Notes** • See above notes. Recommend implementing this strategy among agricultural lands within the Leaf River floodplain.	☐ Yes	▣ No
b. Installing ponds or swales to capture stormwater? **Notes** • See above notes. Recommend implementing this strategy among agricultural lands within the Leaf River floodplain.	☐ Yes	▣ No
c. Planting vegetation that can tolerate inundation? **Notes** • See above notes. Recommend implementing this strategy among agricultural lands within the Leaf River floodplain.	☐ Yes	▣ No
d. Using land management practices to improve the capability of the soil on their lands to retain water? **Notes**	☐ Yes	▣ No

Conserve Land and Discourage Development in River Corridors		
• See above notes. Recommend implementing this strategy among agricultural lands within the Leaf River floodplain.		
3. Has the community adopted floodplain development limits that go beyond FEMA's minimum standards for SHFAs and prohibit or reduce any new encroachment and fill in river corridors and fluvial erosion hazard areas? **Notes** • The Hazard Mitigation Plan only considers mitigation of facilities located in SFHAs. • EPA's smart growth document includes example prohibits all new development in floodplains or floodways. • The City of Hattiesburg's Land Development Code identifies Floodplain Overlay Districts and implements the requirements of Chapter 10 of the City's Code of Ordinances, as amended: http://www.hattiesburgms.com/wp-content/uploads/Ordinance-Chapter-10-2015-Flood-Ordinance-8-4-2015-legal-1.pdf. • Chapter 10 (link above) recognizes that flood losses are caused by the cumulative effect of obstructions—both inside and outside the identified SFHAs. However, Section A of the General Provisions (p. 13) indicates that the ordinance only applies to SFHAs within the jurisdiction of the City of Hattiesburg. • *Fluvial erosion* is caused by streams and rivers and can range from gradual bank erosion to catastrophic changes in river channel location and size during floods. Development in river corridors can cause erosion and changes to the river channel. Fluvial erosion is prevalent in streams that have been altered or channelized and can destroy bridges, culverts, roads, and houses. • The city currently includes a buffer for development around water bodies, including creeks/rivers. A landfill along the Lear River is at a greater risk for erosion due to its proximity to the river.	☐ Yes	▣ No
4. Has the community implemented development regulations that incorporate approaches and standards to protect land in vulnerable areas, including:		
a. Fluvial erosion hazard zoning? **Notes** • The city's Land Development Code does not reference fluvial erosion zoning or regulations. • There is a buffer for development around water bodies regardless of whether there are known erosion issues.	☐ Yes	▣ No
b. Agricultural or open space zoning? **Notes** • Page 21 of the city's Land Development Code identifies A-1 and A-2 Agricultural Districts, which are intended to encourage and protect	▣ Yes	☐ No

Conserve Land and Discourage Development in River Corridors		
rural uses from urbanization, as well as to encourage and protect large lots, open space, and low-density population, respectively.		
c. Conservation or cluster subdivision ordinances, where appropriate? **Notes** • *Conservation or cluster subdivision ordinances* encourage or require new development to protect tracts of intact open space (including sensitive natural areas like river and stream corridors) while clustering development into a small section of the parcel. This requires designating specific areas for growth. • The city has unique development plans for mid-town, which includes its own set of codes for developing high-density population areas.	▣ Yes	☐ No

d. Other zoning or regulatory tools that limit development in areas subject to flooding, including river corridors and SFHAs?
Notes
• The city's Land Development Code designates special Floodplain Overlay Districts, which are subject to the requirements of Chapter 10 of the City's Code of Ordinances.
• Chapter 10 identifies the following methods for reducing flood loss:
  ○ Restricting or prohibiting uses that are dangerous to health, safety, and property due to water or erosion hazards.
  ○ Requiring that uses vulnerable to floods be protected against flood damage at the time of initial construction.
  ○ Controlling the alteration of natural floodplains, stream channels, and natural protective barriers.
  ○ Controlling filling, grading, dredging, and other development that may increase flood damage.
  ○ Preventing or regulating the construction of flood barriers that will unnaturally divert floodwaters or may increase flood hazards in other areas.
• Chapter 10 of the City's Code of Ordinances (link above) requires development permits before commencing any development activities in identified SFHAs.
	▣ Yes	☐ No

Protect People, Buildings, and Facilities in Vulnerable Settlements		
1. Do the local Comprehensive Plan and Hazard Mitigation Plan identify developed areas that have been or are likely to be flooded? **Notes** • Map 3-8 of the Hazard Mitigation Plan identifies repetitive loss properties within Hattiesburg city limits.	▣ Yes	☐ No

Protect People, Buildings, and Facilities in Vulnerable Settlements		
a. If so, does the Comprehensive Plan discourage development in those areas or require strategies to reduce damage to buildings during floods (such as elevating heating, ventilation, and air conditioning [HVAC] systems and flood-proofing basements)? **Notes** • The city's Comprehensive Plan does not specifically address development in flood-prone areas but does reference the Hazard Mitigation Plan. • Chapter 10 of the City's Code of Ordinances (link above) requires all HVAC, including ductwork, be elevated to the regulatory base flood elevation. • Recommendation: *Propose raising HVAC and other equipment elevations to elevations consistent with those recommended in section 2.a below.*	▣ Yes	☐ No
b. Does the Hazard Mitigation Plan identify critical facilities and infrastructure that are located in vulnerable areas and should be protected, repaired, or relocated (e.g., town facilities, bridges, roads, and wastewater facilities)? **Notes** • A proposed project in the Hazard Mitigation Plan (page 5-11) is to actively pursue funding to relocate, retrofit, or raise county-owned critical facilities located within SFHAs. The project description is general and does not specifically identify assets and facilities. The funding source is listed as "federal and state grants."	☐ Yes	☐ No
2. Do land development regulations and building codes promote safer building and rebuilding in flood-prone areas? Specifically:		
a. Do zoning or floodplain regulations require elevation of 2 or more feet above base flood elevation? **Notes** • Chapter 10 of the City's Code of Ordinances (link above) requires new construction and substantial improvement of any building inside an SFHA to have the lowest floor (including basement) at least 1 foot above the base flood elevation or at least 1 foot above the centerline of the designated street, whichever is greater. • Recommendation: *Propose increasing this requirement to 2 feet or more above the base flood elevation to provide an extra margin of safety.*	☐ Yes	▣ No
b. Does the community have the ability to establish a temporary post-disaster building moratorium on all new development? **Notes**	☐ Yes	▣ No

Protect People, Buildings, and Facilities in Vulnerable Settlements		
• This item involves preventing new development in the floodplain after a flood occurs. • The city re-evaluates the baseline flood level after a flooding event.		
c. Have non-conforming use and structure standards been revised to encourage safer rebuilding in flood-prone areas? **Notes** • Chapter 10 of the City's Code of Ordinances, Article 5, Section A, establishes a general standard for new construction and alterations or repairs for existing structures within SFHAs.	▣ Yes	☐ No
d. Has the community adopted the International Building Code or American Society of Civil Engineers (ASCE) standards that promote flood-resistant buildings? **Notes** • The city has adopted the 2018 International Building Code.	▣ Yes	☐ No
e. Does the community plan for costs associated with follow-up inspection and enforcement of land development regulations and building codes? **Notes** • The Hattiesburg Code Enforcement Division in the Department of Urban Development is responsible for inspections and enforcement. Permitting fees and money from fines are used for inspections and personnel salaries.	▣ Yes	☐ No
3. Does the community require developers who are rebuilding in flood-prone locations to add additional flood storage capacity in any new redevelopment projects, such as adding new parks and open space and allowing space along the river's edge for the river to move during high-water events? **Notes** • Section 9.4.1 of the city's Land Development Code requires a minimum of a 25-foot undisturbed vegetated buffer along all perennial streams and around all other water bodies including wetlands. A minimum of a 10-foot undisturbed vegetated buffer is required along all intermittent streams. • Section 9.4.3 of the city's Land Development Code lists permitted uses and activities within all riparian buffers. • Projects that are located within the flood zone must prove that they create no greater flooding risk or impact.	☐ Yes	▣ No
4. Is the community planning for development (e.g., parks, river-based recreation) along the river's edge that will help connect people to the river AND accommodate water during floods? **Notes**	▣ Yes	☐ No

Protect People, Buildings, and Facilities in Vulnerable Settlements		
• The city has developed a Gordon's Creek improvement plan that has various aspects to connect the community with the waterway. • The city has developed a conceptual master plan for East Hardy Park along the Leaf River: http://www.hattiesburgms.com/wp-content/uploads/11827_final-document_2-27-14-1.pdf. • The city has a series of lakes that accommodate fishing and boating activities and other daily uses while also serving as retention ponds. The lakes will store stormwater and slowly release it after a rain event. Lakes are projected to temporarily store over 2.2 million cubic feet of water. • The city has some additional ideas to create a greater connection between the people and the Leaf River in Chain Park, but this likely would not be possible during flood stage events.		

5. Does the Comprehensive Plan or Hazard Mitigation Plan discuss strategies to determine whether to relocate structures that have repeatedly flooded, including identifying an equitable approach for community involvement in relocation decisions and potential funding sources (e.g., funds from FEMA, stormwater utility, or special assessment district)?
Notes
• The city's Hazard Mitigation Plan identifies developing a prioritized list of properties that are in SFHAs and acquiring (buyout) these properties if state or federal monies are available (acquisition/relocation project, pp. 5–12). The funding source for the acquisition and relocation project is generally listed as "federal and state grants."
• EPA's smart growth document includes lists multiple examples of funding mechanisms to buy properties that are susceptible to future floods:
  ○ Sales tax: to pay the local share of a federal flood control project that acquires flood-prone properties.
  ○ Stormwater utility fees: fee per residential unit to generate revenue to purchase flood-prone properties.
  ○ Pre-disaster anticipatory relocation fund: when such a program is cost-effective (cost-benefit analysis may be required).
• The city currently does not have a clear process for determining how to deal with structures that have repeatedly flooded.
	☐ Yes	▣ No

Plan for and Encourage New Development in Safer Areas		
1. Does the local Comprehensive Plan or Hazard Mitigation Plan clearly identify safer growth areas in the community? **Notes** • The city's Comprehensive Plan and Future Land Use Plan (Map 2 on p. 104 of the Comprehensive Plan) identifies residential and permanent open space lands but does not specifically identify "safer growth areas." • Recommendation: *Distinguish that areas planned for development outside of the permanent open space lands within the floodway can be considered "safer growth areas."*	☐ Yes	☐ No
2. Has the community adopted policies to encourage development in these areas? **Notes** • The city currently does not have specific policies to implement the future land use goals identified in the Comprehensive Plan.	☐ Yes	▣ No
3. Has the community planned for new development in safer areas to ensure that it is compact, walkable, and has a variety of uses? **Notes** • Hattiesburg has identified "mixed use" areas as part of its Future Land Use Plan, which include "Planned Mixed-Use Districts" as well as "Neighborhood Center Mixed-Use Districts."	▣ Yes	☐ No
4. Has the community changed its land use codes and regulations to allow for this type of development? **Notes** • The Future Land Use Plan lists amendments to the city's Land Development Code as an implementation strategy. • Page 93 of the city's Comprehensive Plan indicates, "*The first step toward implementing the future land use plan should be to create new development standards to ensure that any requested re-zonings are in conformity to the Future Land Use Map.*"	▣ Yes	☐ No
5. Have land development regulations been audited to ensure that development in safer areas meets the community's needs for off-street parking requirements, building height and density, and front-yard setbacks and that these regulations do not unintentionally inhibit development in these areas? **Notes** • According to pages 93–94 of the city's Comprehensive Plan, Hattiesburg should use the future land use classifications as a guide in creating new zoning districts and for re-zoning land to avoid unintentionally inhibiting development in areas designated for safe growth. One future land use classification may incorporate multiple zone districts, as described in the current Land Development Code.	▣ Yes	☐ No

Plan for and Encourage New Development in Safer Areas		
• For example, Neighborhood Conservation District #1 incorporates single-family residential land uses, certain types of two-family and multi-family residences, public and quasi-public uses, and small offices and retail uses. • The city should address the specific uses, design of buildings, size of buildings and parcels, and pedestrian accessibility to ensure offices and retail uses do not negatively impact neighborhoods. Additionally, the city should write the revised zoning district description to specify that vehicular access to offices and retail uses must protect residential streets from non-local traffic.		
6. Do capital improvement plans and budgets support development in preferred safer growth areas (e.g., through investment in wastewater treatment facilities and roads)? **Notes** • Currently, the city does not prioritize development based on location and supports development wherever it is proposed.	☐ Yes	☐ No
7. Have building codes been upgraded to promote more flood-resistant buildings in safer locations? **Notes** • Flood-resistant building codes only seem to be addressed in Chapter 10 of the city's Code of Ordinances, which only applies to new development in SFHAs. • The city has adopted the 2018 International Building Code.	☐ Yes	☐ No

Implement Stormwater Management Techniques Throughout the Whole Watershed		
1. Has the community coordinated with neighboring jurisdictions to explore a watershed-wide approach to stormwater management? **Notes** • There is a comprehensive Forrest County Stormwater Ordinance; however, according to the Hazard Mitigation Plan, the City of Hattiesburg adopted its own stormwater ordinance on February 20, 2007, to comply with Mississippi Department of Environmental Quality Stormwater Phase II requirements. • The regional communities used to have a stormwater task force that met to coordinate on stormwater and water quality issues. This group has not met for at least four years. • Recommendation: *Reinvigorate collaboration with neighboring jurisdictions on water quality issues and stormwater management.*	☐ Yes	☑ No

Implement Stormwater Management Techniques Throughout the Whole Watershed		
2. Has the community developed a stormwater utility to serve as a funding source for stormwater management activities? **Notes** • The city does not have a dedicated funding source for stormwater management activities. • Recommendation: *Consider whether a dedicated funding source is a feasible component of the city's stormwater program funding portfolio.*	☐ Yes	▣ No
3. Has the community implemented strategies to reduce stormwater runoff from roads, driveways, and parking lots? **Notes** • Section 9.1.6 of the Land Development Code encourages low impact design for all non-residential projects. • Section 9.1.7.4 includes specific design requirements relating to streets, curbs, gutters, inlets, and parking lots.	▣ Yes	☐ No
4. Do stormwater management regulations apply to areas beyond those that are regulated by federal or state stormwater regulations? **Notes** • The city does not have stormwater management or erosion sediment control requirements for projects with less than 1 acre of disturbance.	☐ Yes	▣ No
5. Do stormwater management regulations encourage the use of green infrastructure techniques? **Notes** • Section 9.1.7.2 of the city's Land Development Code encourages natural and vegetated stormwater management systems, such as swales, constructed, wetlands, and bioretention cells. • Recommendation: *The city does not have green infrastructure practices installed within the city. Continue outreach and consider requirements for green infrastructure approaches*.	▣ Yes	☐ No
6. Has the community adopted tree protection measures? **Notes** • Section 9.1.6 of the Land Development Code encourages low impact design to preserve trees and natural vegetation.	▣ Yes	☐ No
7. Has the community adopted steep slope development regulations? **Notes** • The stormwater section of the city's Land Development Code does not appear to include steep slope development regulations. • Recommendation: Consider *whether development on steep slopes is a concern in the city and proceed accordingly.*	☐ Yes	▣ No

Implement Stormwater Management Techniques Throughout the Whole Watershed		
8. Has the community adopted riparian and wetland buffer requirements? **Notes** • Section 9.4.1 of the city's Land Development Code requires a minimum of a 25-foot undisturbed vegetated buffer along all perennial streams and around all other water bodies including wetlands. A minimum of a 10-foot undisturbed vegetated buffer is required along all intermittent streams.	▣ Yes	☐ No

APPENDIX F:
COMMUNITY RATING SYSTEM
SUMMARY INFORMATION

Community Rating System (CRS) Summary Information

The information in this appendix provides an overview of the Community Rating System (CRS) under FEMA's National Flood Insurance Program (NFIP), particularly as it relates to stormwater management approaches. Additional information, including any of the latest updates, and the Community Rating System Coordinator's Manual can be found within FEMA's online resources.

The Federal Emergency Management Agency (FEMA) oversees the **National Flood Insurance Program** (NFIP), which was established in 1968 to encourage the adoption of floodplain management ordinances designed to reduce future damage. Residents of participating communities are eligible to purchase flood insurance through the program. Today, NFIP insures an estimated 5 million homes in 22,000 communities across the United States[1]. Communities that exceed the minimum NFIP standards can apply for the **Community Rating System** (CRS), an incentive program established in 1990 that offers discounted flood insurance premiums. To date, just 5 percent of communities participate, representing 3.6 million policyholders[2].

To qualify for CRS, FEMA assesses communities for stormwater management and preparedness activities under four categories[3]:

Public Information

- Elevation certificates
- Map information service
- Outreach projects
- Hazard disclosure
- Flood protection information
- Flood protection assistance
- Flood insurance promotion

Mapping and Regulations

- Floodplain mapping
- Open space preservation
- Higher regulatory standards
- Flood data maintenance
- Stormwater management

Flood Damage Reduction

- Floodplain management planning
- Acquisition and relocation
- Flood protection
- Drainage system maintenance

Flood Preparedness

- Flood warning and response
- Levee safety
- Dam safety

[1] https://www.fema.gov/media-library-data/1464695949383-abdada4ea913e679e2b7e57484dcb1e4/National-Flood-Insurance-Program-Fact-Sheet-May-2016r.pdf

[2] https://www.fema.gov/media-library-data/1507029324530-082938e6607d4d9eba4004890dbad39c/NFIP_CRS_Fact_Sheet_2017_508OK.pdf

[3] https://www.fema.gov/media-library-data/1493905477815-d794671adeed5beab6a6304d8ba0b207/633300_2017_CRS_Coordinators_Manual_508.pdf

FEMA conducts a site visit to verify the rating, which ranges from Class 9 (lowest) to Class 1 (highest), and then awards insurance discounts based on performance. For residents living in Special Flood Hazard Areas (SFHA), each class improvement results in a 5 percent greater discount on residents' flood insurance premiums (up to 45 percent); residents in non-SFHA zones can receive up to a 10 percent discount.

Hattiesburg CRS Participation

As of June 2017, there were more than 1,400 communities enrolled in CRS[4]. Each CRS community must undergo an annual recertification process. A rating may be adjusted up or down based on documented activities and performance. Hattiesburg previously attained a Class 6 rating but dropped to Class 8 in December 2014 due to point allocation adjustments and local staffing changes[5].

The city is committed to increasing its rating under the program. To return to Class 6, Hattiesburg needed to add 500 to 1,000 credit points. Beginning in 2018, the city reinvigorated efforts to regain its CRS rating and associated insurance discount. The city is continuing to work on efforts to improve its rating and reduce insurance costs for citizens.

How much discount property owners in your community can get

Rate Class	Discount SFHA*	Discount Non-SFHA**	Credit Points Required
1	45%	10%	4,500 +
2	40%	10%	4,000 - 4,499
3	35%	10%	3,500 - 3,999
4	30%	10%	3,000 - 3,499
5	25%	10%	2,500 - 2,999
6	20%	10%	2,000 - 2,499
7	15%	5%	1,500 - 1,999
8	10%	5%	1,000 - 1,499
9	5%	5%	500 - 999
10	0%	0%	0 - 499

* Special Flood Hazard Area

** Preferred Risk Policies are available only in B,C, and X Zones for properties that are shown to have a minimal risk of flood damage. The Preferred Risk Policy does not receive premium rate credits under the CRS because it already has a lower premium than other policies. Although they are in SFHAs, Zones AR and A99 are limited to a 5% discount. Premium reductions are subject to change.

Figure F-1. CRS insurance premium discounts by class[6]

Examples of Creditable Stormwater-Related Activities

Hattiesburg has indicated that it would like to invest in green infrastructure approaches to strengthen its resilience. Though the CRS program does not currently use the term "green infrastructure" in its specific rating criteria, it does provide credit for similar practices, including those commonly called "low impact development" or "LID."

The following are examples of creditable activities the city could pursue to improve its rating if it has not yet accomplished them. The examples indicate the potential number of points associated with each activity, along with where this information can be found in the *CRS Coordinator's Manual*[7].

[4] https://www.fema.gov/media-library-data/1507029324530-082938e6607d4d9eba4004890dbad39c/NFIP_CRS_Fact_Sheet_2017_508OK.pdf

[5] https://www.clarionledger.com/story/news/2016/11/25/hattiesburg-look-flood-rating/94444290/

[6] https://www.fema.gov/media-library-data/1493905477815-d794671adeed5beab6a6304d8ba0b207/633300_2017_CRS_Coordinators_Manual_508.pdf

[7] https://www.fema.gov/media-library-data/1493905477815-d794671adeed5beab6a6304d8ba0b207/633300_2017_CRS_Coordinators_Manual_508.pdf

Open Space Preservation (2,870-point maximum; p. 420-1)

- Open space preservation (OSP): Up to 1,450 points for keeping land vacant through ownership or regulations.
- Deed restrictions: Up to 50 points extra credit for legal restrictions that ensure that parcels credited for OSP will never be developed.
- Natural functions open space: Up to 350 points extra credit for OSP-credited parcels that are preserved in or restored to their natural state.
- Special flood-related hazards open space: Up to 150 points if the OSP-credited parcels are subject to one of the special flood-related hazards or if areas of special flood-related hazard are covered by low-density zoning regulations.
- Coastal erosion open space: Up to 750 points if the OSP-credited parcels are subject to coastal erosion.
- Open space incentives: Up to 250 points for local requirements and incentives that keep flood-prone portions of new development open.
- Low-density zoning: Up to 600 points for zoning districts that require lot sizes of 5 acres or larger.
- Natural shoreline protection: Up to 120 points for programs that protect natural channels and shorelines.

Stormwater Management (755-point maximum; p. 450-1)

- Stormwater management regulations: Up to 380 points for regulating development to ensure that the peak flow and volume of stormwater runoff from each site will be no greater than the runoff from the site before it was developed or redeveloped. Low impact development (LID) or green infrastructure approaches may be included in these regulations as well as requirements for maintenance of stormwater management facilities.
- Watershed master planning: Up to 315 points for developing and implementing a watershed management master plan that analyzes the combined effects of existing and expected development and redevelopment on drainage throughout the watershed and also includes a plan of action to address current and expected problems.
- Erosion and sediment control: Up to 40 points for regulating activities throughout the watershed to minimize erosion on construction sites that result could in sedimentation and water pollution.
- Water quality: Up to 20 points for requiring new developments' stormwater management facilities to improve the quality of stormwater runoff.

APPENDIX G:
SITE SUITABILITY ASSESSMENT FOR GREEN INFRASTRUCTURE

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Summary

This document is intended to guide planners, engineers, and technical staff through a geographic information system (GIS) based analysis to help identify opportunities to improve stormwater management by implementing green infrastructure. This document serves two purposes:

- It **provides a methodology** for using GIS to assess the suitability of sites in Hattiesburg, Mississippi, for green infrastructure. Hattiesburg's planners, engineers, and technical staff can use this methodology to find opportunities to improve stormwater management across the city. Other cities may find the methodology useful in their own communities.
- It **demonstrates the use** of this methodology, providing results based on currently available information for Hattiesburg, Mississippi.

Installing green infrastructure can enhance infiltration, reduce localized flooding, improve water quality, recharge groundwater, improve site aesthetics, and increase the resiliency of the city's landscape.[1] With targeted and proactive planning that leverages goals across city departments, the implementation of green infrastructure is an effective way to use often limited community resources to gain a broader range of benefits to support Hattiesburg's larger community goals.

Green infrastructure has the design flexibility to be installed at almost any site. This methodology provides a set of criteria that will help Hattiesburg further investigate and prioritize each site's (specifically, public parcels) potential for implementing green infrastructure practices that provide a range of benefits.

This document's GIS-based methodology groups green infrastructure into two categories, based on function and site requirements:

- Infiltrating practices
- Non-infiltrating practices

Each category provides a different set of water quality and quantity benefits and requires a unique combination of physical site conditions to work properly. Green infrastructure practices can be designed, sized, and adapted to almost any location. Assessment results will change depending on what data are available, what criteria Hattiesburg uses, and how the city prioritizes those criteria within the methodology.

By carrying out an assessment using this document's framework, communities can identify sites where beneficial conditions for a category of green infrastructure align with the city's needs for the areas around those sites. This will give the city screening-level results—key information to inform the city's decision-making and planning. This framework is flexible and adjustable if the city revisits its priorities. It does not identify all potential sites where practices can be implemented across the city. Rather, it can help Hattiesburg prioritize sites with the best potential to investigate further.

[1] https://www.epa.gov/green-infrastructure/performance-green-infrastructure and https://www.epa.gov/green-infrastructure/benefits-green-infrastructure

To illustrate the use of this document's methodology, a site suitability assessment has been carried out for Hattiesburg, using available data and criteria established by the city. Hattiesburg's assessment results are shown via heat maps with planning-level information about where green infrastructure may be suitable. The maps demonstrate that many areas of the city are suitable for both infiltrating and non-infiltrating green infrastructure. However, non-infiltrating practices are suitable in a slightly broader range of locations because they are not restricted by soil permeability.

1. Introduction

The city of Hattiesburg, Mississippi, is actively working to improve stormwater management and reduce instances of flooding throughout the city. This document presents a methodology to help the city screen sites for their potential suitability for different categories of green infrastructure. Installing green infrastructure on public and private property can help improve water quality, increase groundwater recharge, and reduce flooding.

This assessment considers the physical conditions of a site, based on available geospatial data such as slope, depth to bedrock, hydrologic soil group (HSG), and other characteristics, and provides screening-level information that can help the city prioritize its efforts.

Different green infrastructure practices have different functions and require specific site characteristics for successful implementation. Using this methodology, site suitability assessments are performed separately for infiltrating and non-infiltrating green infrastructure.

Infiltrating: These practices store stormwater and allow it to infiltrate into the underlying soil and groundwater. They help reduce the volume and flow rate of stormwater runoff and remove pollutants. They may also provide aquifer recharge and flood mitigation.

Non-infiltrating: These practices store stormwater but do not allow it to infiltrate into the underlying soil and groundwater. Like infiltrating practices, they help reduce the flow rate of stormwater runoff and remove pollutants.

Infiltrating and non-infiltrating green infrastructure practices also have different benefits, depending on designed functionality, specified materials, and physical location. For example, practices that infiltrate water into the ground provide the added benefits of groundwater recharge and, in many cases, flood mitigation. Many green infrastructure practices, such as bioretention areas, bioswales, and tree trenches, can be designed as either infiltrating or non-infiltrating practices to accommodate the site conditions (e.g., requiring an underdrain system and/or liner) where they are installed.

Green Infrastructure

"Green infrastructure" (as defined by the Clean Water Act) is the range of measures that use plant or soil systems, permeable pavement or other permeable surfaces or substrates, stormwater harvest or reuse, or landscaping to store, infiltrate, or evapotranspirate stormwater and reduce flows to sewer systems or to surface waters. These practices mimic natural conditions of a site to reduce the negative impacts that challenge urbanized areas. Green infrastructure, such as bioretention, tree boxes, and permeable pavements, is included in the assessment categories of infiltrating and non-infiltrating stormwater management practices. These practices can be attractive elements of the landscape. Figure G-1on Page G-7 shows a variety of installed green infrastructure.

Figure G-1. Green Infrastructure Examples

Table G-1 lists examples of infiltrating and non-infiltrating green infrastructure and its associated benefits.

Table G-1. Benefits of Infiltrating and Non-Infiltrating Green Infrastructure

Green Infrastructure Practices	Category		Potential Benefits							
	Infiltrating	Non-Infiltrating	Aquifer Recharge	Flood Mitigation	Water Quality Treatment	Habitat Creation and/or Preservation	Cooling/ Reduced Heat Island Effect	Reduced Need for Deicers	Reduced Roadway Spray and Noise	Air Quality Improvement
Bioretention/bioswale *(no underdrain/liner)*	✓		✓	✓	✓	✓	✓			✓
Bioretention/bioswale *(with underdrain/liner)*		✓		✓	✓	✓	✓			✓
Tree trench *(no underdrain/liner)*	✓		✓	✓	✓	✓	✓			✓
Tree trench *(with underdrain/liner)*		✓			✓	✓	✓			✓
Tree box *(no underdrain/liner)*	✓		✓	✓	✓	✓	✓			✓
Tree box *(with underdrain/liner)*		✓			✓	✓	✓			✓
Permeable pavement/pavers *(no underdrain)*	✓		✓	✓	✓		✓	✓	✓	
Permeable pavement/pavers *(with underdrain)*		✓		✓	✓		✓	✓	✓	
Sand or media filter *(no underdrain/liner)*	✓		✓	✓	✓		✓			
Sand or media filter *(with underdrain/liner)*		✓		✓	✓		✓			
Infiltration chamber	✓		✓	✓	✓		✓			
Infiltration basin	✓		✓	✓	✓	✓	✓			
Infiltration trench	✓		✓	✓	✓		✓			
Constructed wetland		✓		✓	✓	✓	✓			✓

2. Methodology

This screening-level site suitability assessment is a desktop geographic information system (GIS) analysis that uses a set of physical criteria to assess the potential suitability of sites for green infrastructure to enhance infiltration, reduce localized flooding, improve water quality, recharge groundwater, improve site aesthetics, and increase the resiliency of the landscape in ways that not only meet stormwater management needs but also support Hattiesburg's broader community vision. This analysis evaluates site suitability for two categories of green infrastructure, based on the primary physical processes and site conditions that define them:

- Infiltrating practices
- Non-infiltrating practices

These green infrastructure categories were chosen to reflect the interests of Hattiesburg but could be adjusted for other communities along with the methodology framework.

Five site suitability assessment steps are outlined below.

- **Step 1** identifies the physical characteristics that will be used as criteria to assess the most suitable sites for each green infrastructure category.
- **Step 2** describes how the criteria established in Step 1 are either excluded or rated for the analysis.
- **Step 3** describes the mechanics of the suitability analysis, which uses a simple equation to compute a suitability score in GIS for each pixel in the data grid across the city.
- **Step 4** describes the development of heat maps to visually display site suitability scores.
- **Step 5** discusses how to use the maps generated in Step 4 to identify potentially suitable green infrastructure practices for chosen locations.

Once the assessment results are produced, lenses such as land ownership (public versus private lands), location in relationship to the regulated municipal separate storm sewer system (MS4) area, location within drainage areas contributing to areas prone to flooding, or locations of planned city projects can be added to the output maps to further prioritize future investigation efforts. The developed maps can be used as a screening and decision support tool to distinguish which sites in the city may be better suited for each category of green infrastructure.

Step 1: Identify Site Characteristics for Site Suitability Assessment

The first step of the site suitability assessment is to compile a list of physical site characteristic data. The feasibility of implementing green infrastructure depends in part on a location's physical site characteristics such as soil permeability, slope, and flood zone locations. A community can map these physical site characteristics in GIS using data that are publicly available or generated by the community. Table G-2 and Table G-3 contain the full set of physical site characteristics data that were sought for use as criteria in the Hattiesburg screening assessments. The names of the GIS layers in the

tables are specific to the Hattiesburg data source and naming conventions will vary in each community.

Table G-2 lists the available data for Hattiesburg at the time of this analysis. Table G-3 lists additional data that were not available at the time of this analysis, but that the city could use if they become available. For each characteristic used in the assessment, the tables provide the data file name and source, as well describing of how it is relevant to site suitability for green infrastructure implementation. For several characteristics, the tables provide additional technical references to support and expand upon this information.

Table G-2. Hattiesburg Site Characteristics Used in Site Suitability Assessment

Physical Site Characteristic	GIS Data Layer	Source	Considerations for Green Infrastructure Implementation
Soil permeability	SSURGO-certified soils Surficial geology 1:24,000	U.S. Natural Conservation Service https://websoilsurvey.sc.egov.usda.gov/app/WebSoilSurvey.aspx	More permeable soils such as sand and gravel, categorized as hydrologic soil group (HSG) A soils, have a higher capacity for infiltration. Sites with less permeable soils (HSG C and D) may also achieve some runoff volume and pollutant load reduction and provide replenishment to groundwater storage reservoirs. In less permeable soils, smaller capacity green infrastructure practices, including biofiltration and shallow filtration, may be considered. Non-infiltrating green infrastructure practices may be suitable in any HSG. **Additional Technical References:** Mississippi Handbook for Erosion Control, Sediment Control and Stormwater Management on Construction Sites and Urban Areas, Volume 2, p. 4-74
Water bodies and associated buffers	NHDWaterbody NHDFlowline NWI_MSWetlands	National Hydrography Database (2018), National Wetland Inventory (2018)	Wetlands, streams, rivers, and their associated buffers are protected by local wetland protection regulations. Avoiding these regulated areas and buffer zones will reduce risk of damaging existing waterbodies and avoid administrative burden during planning and construction. **Additional Technical References:** The Hattiesburg, Mississippi, Land Development Code states that it is desirable to leave a 25-foot buffer along streams, lake shores, rivers, and bodies of water. The Hattiesburg analysis used this buffer, as it is in place to protect downstream drainage channels and water bodies from impairment and to impose stricter guidelines for the construction site. EPA, 1996, Protecting Natural Wetlands, A Guide to Stormwater Best Management Practices

Physical Site Characteristic	GIS Data Layer	Source	Considerations for Green Infrastructure Implementation
Flood hazard zones	FEMA National Flood Hazard Layer (eff. 3/2/2010)	Federal Emergency Management Agency (FEMA) https://msc.fema.gov/portal/advanceSearch	Green infrastructure infiltrating practices should generally be constructed in areas outside mapped flood hazard zones (Zones A, AE, or AH) so that floods will not damage them. In addition, wet, poorly drained soils and shallow groundwater depths within those flood zones may render the site unsuitable for green infrastructure infiltrating practices. If water quality practices are desired, biofiltration or shallow filtration green infrastructure practices are flexible in design and may be considered within flood zones, but areas outside the flood zone are more desirable sites for all practices. Preservation of natural lands, which is a green infrastructure approach, can be highly prioritized within flood zones to protect flood capacity and protect habitat. **Additional Technical References:** Forrest County, Mississippi, Floodplain Damage Prevention Ordinance
Source water protection areas	Source water protection areas (2009)	MARIS http://www.maris.state.ms.us/HTM/DownloadData/Statewide.html	The term "source water" means drinking water, either as surface water (rivers, streams, reservoirs, lakes) or as groundwater (aquifers). Source water protection thus includes both groundwater (wellhead) protection and surface water protection. The Mississippi Department for Environmental Quality has delineated source water capture areas for each community. In Mississippi, most of the drinking water systems use groundwater. The data source delineates buffers (ranging from 1,285 feet to 4,040 feet) around each wellhead, based on the pumping rate of the well. For this assessment, sites outside these areas should be prioritized over sites inside them for infiltrating practices to protect the quality of the drinking water source from potential contamination.

Physical Site Characteristic	GIS Data Layer	Source	Considerations for Green Infrastructure Implementation
Slope	USGS NED 1/3 arc-second n32w090 1 x 1-degree ArcGrid 2018	U.S. Geological Survey (USGS) https://viewer.nationalmap.gov/basic/?basemap=b1&category=ned,nedsrc&title=3DEP%20View#productSearch	For this analysis, and in accordance with the screening process described in the *Mississippi Handbook for Erosion Control, Sediment Control and Stormwater Management on Construction Sites and Urban Areas, Volume 2* (2011), sites with greater than 15 percent slopes were not considered suitable for green infrastructure implementation. Sites with a shallow slope (less than 15 percent) are better able to capture rainfall on site and slow stormwater runoff to provide more opportunities for treatment and infiltration. Certain green infrastructure practices, such as shallow filtration types, can be considered for use at sites with greater slopes with certain adjustments to manage high flows and erosion. For this assessment, any sites above a 15 percent slope were assumed to be sufficiently challenging to exclude from consideration. **Additional Technical References:** EPA helped Pittsburgh consider how to implement green infrastructure in settings with steep slopes. Through this effort, EPA produced the document *Addressing Green infrastructure Design Challenges in the Pittsburgh Region Steep Slopes* (2012) to illustrate innovative design adaptations, such as step pools, terraced infiltration, and others.
Parcel boundaries	Parcels	City of Hattiesburg	Parcels provide a unit of assessment for the site assessment.
Impaired water bodies	TMDLs on impaired waters Catchments	EPA https://epa.maps.arcgis.com/apps/webappviewer/index.html?id=ada349b90c26496ea52aab66a092593b	Implementing green infrastructure in watersheds with water quality impairments will provide more water quality benefits. This assessment prioritized areas within every catchment that contributes water to a river or water body that has a relevant stormwater-related total maximum daily load (TMDL). For example, relevant TMDLs for pathogens include nutrients or biological impairment. These were selected because implementation of green infrastructure practices could help mitigate these types of impairments.

Physical Site Characteristic	GIS Data Layer	Source	Considerations for Green Infrastructure Implementation
Impervious cover	National Agriculture Imagery Program (NAIP) Geotiff – 2016	USGS https://earthexplorer.usgs.gov/	Impervious cover generates runoff and prevents rainwater from infiltrating into the ground. Impervious cover includes paved areas as well as buildings. The amount of impervious area on a parcel can limit the area available for the implementation of surface green infrastructure practices. However, impervious areas can also be retrofitted with facilities for underground infiltration or detention of stormwater. These areas most commonly include parking lots but could also include sidewalks and paths in some cases. In addition, reducing impervious area can help to manage stormwater in urban areas because it reduces the volume of stormwater runoff generated at a site. Impervious cover for this analysis was extracted from the National Agriculture Imagery Program data set. If Hattiesburg develops its own impervious cover data with increased precision, this data set could be incorporated into a future assessment. **Additional Technical References:** The Federal Highway Administration developed *Stormwater Best Management Practices in an Ultra-Urban Setting: Selection and Monitoring*, which includes some helpful ideas about practice selection and site considerations in highly impervious areas. EPA's *Managing Wet Weather with Green Infrastructure, Municipal Handbook: Green Streets* (2008) provides useful considerations for reducing stormwater generation on streets and improving infiltration and water quality treatment.

Physical Site Characteristic	GIS Data Layer	Source	Considerations for Green Infrastructure Implementation
Land use	USDA NLCD 2001 For Gulf Coast Region	U.S. Department of Agriculture http://www.gis.ms.gov/Portal/detail.aspx?aspect=Environmental&realm=All&dom=	Land use data are used in this analysis to estimate parking lot size per parcel. "Parking areas" in this analysis are estimated as impervious area that is neither a building nor a road. This category, therefore, primarily includes parking areas but also default driveways or other large, flat impervious areas. This analysis approximated "parking area" by classifying a specific percentage of impervious area per parcel (based on land use) as parking area (i.e., 50 percent of impervious area for high and medium density development, and 20 percent of impervious area for low density and open land development). The percentages were estimated based on observations of an informal sample of parcels using aerial photography and NAIP aerial imagery, which was also the basis for the classification of impervious area (described above). Furthermore, land use in combination with soils and geology can be used in future analysis steps to estimate runoff generation and pollutant loading.

Table G-3. Additional Site Characteristics to Consider in Site Suitability Assessment When Data Are Available

Physical Site Characteristic	GIS Data Layer	Potential Data Source	Considerations for Green Infrastructure Implementation
Contaminated sites	Superfund Sites in Mississippi	EPA https://www.epa.gov/superfund-redevelopment-initiative/superfund-sites-reuse-mississippi	Infiltration should be avoided at sites with contaminated soils, because the increased movement of water through the soils can mobilize contaminants. A single database containing the locations and status of contaminated sites is not available for Hattiesburg, Mississippi. Further investigation identified one Superfund site[a] that was sufficiently set back from the city boundary to be disregarded as a risk in this assessment. **Additional Technical References:** The EPA Brownfields Program developed Design Principles for Stormwater Management on Compacted, Contaminated Soils in Dense Urban Areas, which explains how to integrate green infrastructure into brownfields redevelopment projects when these larger opportunities arise.
Depth to groundwater and bedrock	NRCS SSURGO-Certified Soils – Federal Source	U.S. Natural Conservation Service https://websoilsurvey.sc.egov.usda.gov/app/WebSoilSurvey.aspx	The depth to groundwater and depth to bedrock are constraints that define the ability of many green infrastructure practices to function effectively. Infiltrating practices require minimum depths to groundwater and bedrock usually in the range of 3 to 4 feet. Depth to bedrock can also restrict the ability to construct practices, because construction in bedrock can be very expensive or cost-prohibitive. Areas with certain minimum depths to bedrock and/or groundwater can be excluded from consideration for some green infrastructure practices, other than surface biofiltration practices. Depth to groundwater and bedrock can also be used to prioritize sites, as a greater depth ensures the green infrastructure can better function and is easier to construct. The data set for Hattiesburg was significantly lacking, exhibited considerable uncertainty and inaccuracy, and was therefore excluded from the analysis.

Physical Site Characteristic	GIS Data Layer	Potential Data Source	Considerations for Green Infrastructure Implementation
Surficial geology	Not available	Not available	Surficial geology typically provides additional understanding of the potential for infiltration, especially in areas where soils are characterized as urban land. These data were not available for Hattiesburg and were not included in the analysis.
Existing stormwater infrastructure (pipes and stormwater management practices)	Not available	Not available	Mapping of existing drainage infrastructure and stormwater management practices can help inform the site suitability analysis. Areas where existing drainage can be diverted to a suitable green infrastructure practice are often better for construction than sites where drainage is more difficult to collect. Existing stormwater practices such as large detention basins can sometimes be easy candidates for green infrastructure practice retrofits. Hattiesburg does not have available mapping data for its existing stormwater infrastructure; therefore, this dataset was unable to be included in the analysis.

[a] At the David Timber Company site, 79 Jackson Rd., Hattiesburg, MS.

Step 2: Establish Exclusion Criteria, Rated Criteria, and a Rating System

Once the physical site characteristic data is gathered, the community should establish which criteria will be excluded versus rated. For rated criteria, a range of ratings specific to each category of green infrastructure (infiltrating and non-infiltrating) should be set up. The community will use this rating system to calculate a location-specific site suitability score in GIS (Step 3). The sections below describe the exclusion criteria and rated criteria, which are also identified in Table G-4 and Table G-5. The following sections describe the exclusion and rating processes.

Exclusion Criteria

These criteria are used to exclude sites with certain characteristics from the assessment. Some conditions render a site ineffective or overly challenging for green infrastructure. For example, sites within water bodies or on steep slopes and sites that are in HSG D are excluded in the Hattiesburg assessment (refer to Table G-2 for further explanation). Exclusion criteria are applied by assigning a rating of 0 to excluded areas. Some exclusions remove areas that the city does not want to target. For example, infiltration within areas of contaminated soils and/or groundwater poses an unacceptable risk to pollution migration. Hattiesburg could exclude those areas when those data become available by assigning a rating of 0 to areas with contamination and a rating of 1 to all other areas. In the equation used to compute the suitability score in Step 3, exclusion criteria are applied as multipliers (i.e., a 0 rating will result in a 0 overall suitability score). General types of exclusion criteria for each category of green infrastructure are shown with check marks in Table G-4 below. Specific exclusion criteria parameters are provided in Table G-6 and Table G-7.

Table G-4. Exclusion Criteria for Each Green Infrastructure Category

Exclusion Criteria	Infiltrating	Non-Infiltrating
Areas within water bodies	✓	✓
Steep slopes	✓	✓
HSG D	✓	

Rated Criteria

Criteria that are not exclusions receive ratings between 1 and 5. Higher ratings indicate more suitability for the green infrastructure category under assessment. In cases where a data set includes "no data" for some areas, the "no data" entries receive ratings of 3 so that they do not unduly influence the overall scoring. Rated criteria are added and contribute cumulatively to the suitability score (Step 3).

In many cases, a rating of 1 does not prevent the successful installation of green infrastructure, but it does indicate that further investigation into site suitability should be pursued. The city may adjust or weight the ratings as needed in the future to reflect a different emphasis on certain criteria, or to ensure that the resulting suitability scores are meaningfully distributed. This process is intended to be iterative and repeatable.

General types of rated criteria for each category of stormwater management practice are shown with check marks in Table G-5 below. Rated criteria are given a rating between 1 and 5 depending on criteria parameters outlined in Table G-6 and Table G-7.

Table G-5. Rated Criteria for Each Green Infrastructure Category

Rated Criteria	Infiltrating	Non-Infiltrating
HSG A, B, C	✓	
Buffer to water bodies	✓	
FEMA flood zone	✓	✓
Water supply protection zone	✓	
Drainage area to impaired water bodies	✓	✓
Slope	✓	✓

Different Exclusions and Ratings for Green Infrastructure Categories

The key exclusion and rated criteria for each green infrastructure category are summarized below and presented in Table G-6 and Table G-7.

Each physical site characteristic is assigned either an exclusion score of 0 or 1 (with 0 being excluded and 1 being included) or a rating score between 0 and 5 (with 5 being assigned to the most desirable characteristic and 1 being the least desirable, yet still feasible). Hattiesburg may adjust or weight the criteria ratings as needed in the future to reflect a different emphasis on certain criteria, or to ensure that the resulting suitability scores are meaningfully distributed. This process is intended to be customizable, iterative, and repeatable.

Infiltrating Practices

Infiltrating practices (Table G-6) use temporary surface or underground storage to allow captured stormwater to exfiltrate into underlying soils. Higher ratings are applied to areas with the following criteria:

- Greater buffer distance from water bodies and wetlands
- Location outside versus inside flood zones
- Location outside versus inside water supply protection zones
- Location inside versus outside the drainage area of an impaired waterbody
- Lower slope

Areas with the following characteristics are excluded from this assessment for infiltrating practices:

- Water bodies
- Slopes greater than 15 percent
- Low-permeability soils (indicated by HSG D)

Non-Infiltrating Practices

Non-infiltrating practices (Table G-7) use temporary surface or underground storage to allow captured stormwater to exfiltrate into an underdrain that ties into storm sewer infrastructure. Higher ratings are applied to the remaining areas with the following criteria:

- Location outside versus inside flood zones
- Location inside versus outside the drainage area of an impaired waterbody
- Lower slope

Areas with the following characteristics are excluded from this assessment for non-infiltrating practices:

- Water bodies
- Slopes greater than 15 percent

Table G-6. Criteria Ratings for Infiltrating Practice Site Suitability Assessment

Rating[a]	Infiltrating Practice Exclusion Criteria			Infiltrating Practice Rated Criteria					
	Water Bodies	**Steep Slope[b]**	**Soils HSG[c]**	**Soils HSG[d]**	**Buffer to Water Body[e]**	**FEMA Flood Zone[f]**	**Water Supply Protection Zone[g]**	**Impaired Water Bodies[h]**	**Slope**
0 (exclusion)	Inside wetland, lake, or river	>15%	Water, HSG D (+A/D, B/D, C/D)						
1	Outside wetland, lake, or river	≤15%		HSG C	Within 25 ft of rivers and wetlands	Zones A and AE	Inside water supply protection zone	Outside drainage area of impaired water body	>12% to 15%
2									>8% to 12%
3				HSG B (+ no data)					>4% to 8%
4									>2% to 4%
5				HSG A	Beyond 25 ft from wetlands or rivers	All other zones	Outside water supply protection zone	Within drainage area of impaired water body	0% to 2%

[a] The ratings apply to each criterion individually, not to all the criteria for a given site. For example, a site can have a rating of 2 for one criterion and a rating of 5 for another.

[b] Based on *Mississippi Handbook for Erosion Control, Sediment Control and Stormwater Management on Construction Sites and Urban Areas, Volume 2*, p. 4-73

[c] Based on *Mississippi Handbook for Erosion Control, Sediment Control and Stormwater Management on Construction Sites and Urban Areas, Volume 2*, p. 4-74.

[d] Based on *Mississippi Handbook for Erosion Control, Sediment Control and Stormwater Management on Construction Sites and Urban Areas, Volume 2*, p. 4-74.

[e] Based on the Hattiesburg, Mississippi, Land Development Code, p.112.

[f] Based on Forrest County, MS Floodplain Damage Prevention Ordinance.

[g] Based on buffers around drinking water wells established by the Mississippi Department of Environmental Quality.

[h] Based on EPA's impaired catchment delineation.

Table G-7. Criteria Ratings for Non-Infiltrating Practice Site Suitability Assessment

Rating[a]	Non-Infiltrating Practice Exclusion Criteria		Non-Infiltrating Practice Rated Criteria		
	Water Bodies	Steep Slope[b]	FEMA Flood Zone[c]	Impaired Water Bodies[d]	Slope
0 (exclusion)	Inside wetland, lake, or river	>15%			
1	Outside wetland, lake, or river	≤15%	Zones A and AE	Outside drainage area of impaired water body	>12% to 15%
2					>8% to 12%
3					>4% to 8%
4					>2% to 4%
5			All other zones	Within drainage area of impaired water body	0% to 2%

[a] The ratings apply to each criterion individually, not to all the criteria for a given site. For example, site can have a rating of 2 for one criterion and a rating of 5 for another.

[b] Based on *Mississippi Handbook for Erosion Control, Sediment Control and Stormwater Management on Construction Sites and Urban Areas, Volume 2,* p. 4-73

[c] Based on Forrest County, Mississippi, Floodplain Damage Prevention Ordinance.

[d] Based on EPA's impaired catchment delineation.

Step 3: Perform Site Suitability Scoring

Site suitability scores are computed in GIS at every assessed location based on the criteria ratings established in Step 2 for both green infrastructure categories (infiltrating and non-infiltrating). The site suitability scores incorporate the exclusion criteria and the rated criteria according to the scoring equations below. Exclusion criteria scores are multiplied together and then multiplied by the sum of the rated criteria scores.

> **The User Can Adjust These Scores and Scoring Equations**
>
> These scores and equations were developed by EPA in conjunction with the city of Hattiesburg. The data and scores used in this assessment can be updated as needed in future iterations of the analysis, using the same methodology framework.

The overall format of each of the scoring equations is as follows:

suitability score = product of exclusion criteria × sum of rating criteria

Scoring Equation: Infiltrating Green Infrastructure

infiltrating suitability score = water bodies x steep slope x HSG D soils × HSG soils + buffer to water bodies + FEMA flood zone + water supply protection zone + drainage area to impaired water bodies + slope

total possible infiltrating suitability score = 30

Scoring Equation: Non-Infiltrating Green Infrastructure

non-infiltrating suitability score = water bodies x steep slope × FEMA flood zone + drainage area to impaired water bodies + slope

total possible non-infiltrating suitability score = 15

Step 4: Map Site Suitability

Once calculated, the site suitability scores can be presented on a map. Scores can be grouped into ranges to create a "heat map," with colors showing suitability for each green infrastructure category. The GIS processes required to calculate the site suitability scores across the study area for infiltrating and non-infiltrating practices are presented in Figure G-2 and Figure G-3 below. The GIS data are transformed to apply the ratings and then compute the rating scores to develop the final assessment heat maps. The common methods of GIS data transformation used in this process are:

- **Buffer.** Create a zone around a set of map elements using a set distance.
- **Clip.** Overlay map layers on top of one another, then extract only that area of a map that is within the polygon or polygons defined by one of the data layers.
- **Exclude.** Overlay map layers on top of one another, then exclude only that area of the map that is outside a polygon or polygons defined by one of the data layers.
- **Rate.** Assign a rating score to individual pixels or polygons based on a given characteristic.
- **Union.** Overlay one map layer on top of another and combine two types of map features into one feature to create a new map layer.
- **Dissolve.** Merge different features of a map into one feature to create a new map layer.

The flow charts in the figures below serve as a guide for a GIS analyst to recreate this assessment process and revise it in the future as needed, so that the city can employ this methodology as data and priorities evolve. The output from this process is a map in which each pixel in the map grid is assigned a final suitability score. Those scores are grouped into categories and color coded to define differing levels of suitability.

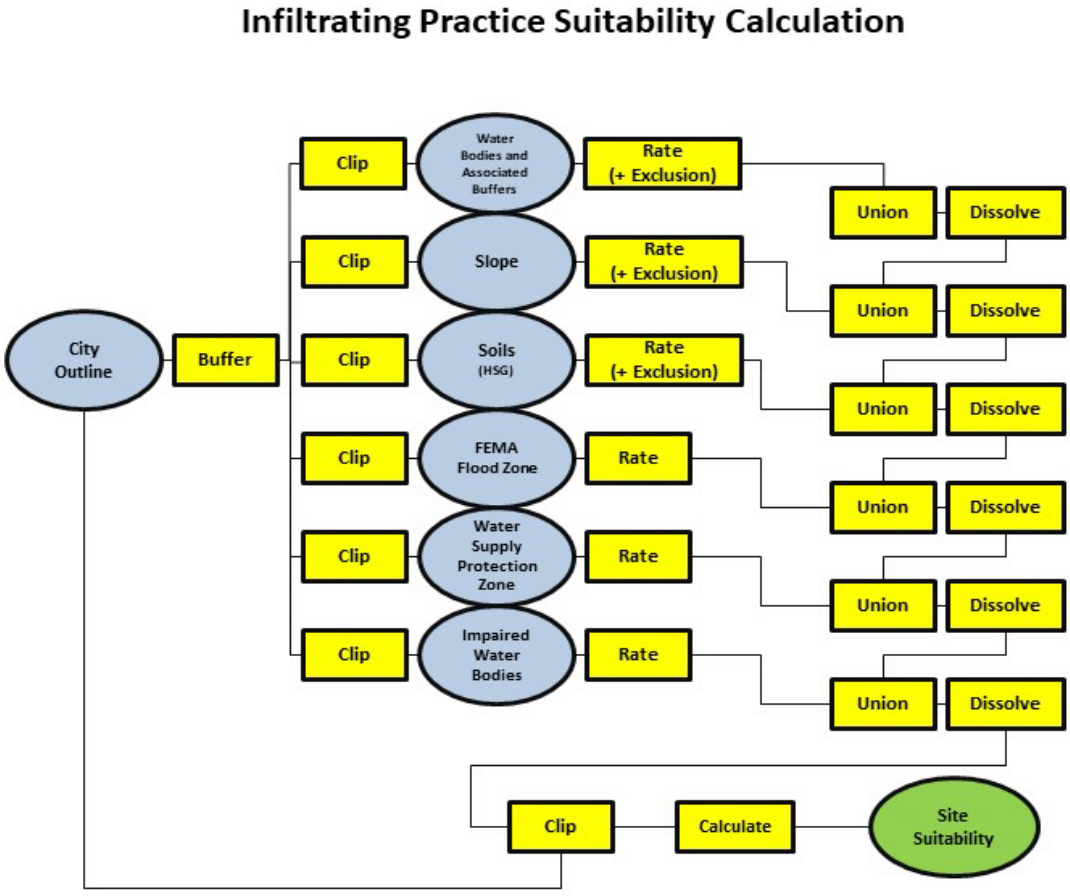


Figure G-2. Flow Chart: GIS Suitability Assessment Process for Infiltrating Green Infrastructure

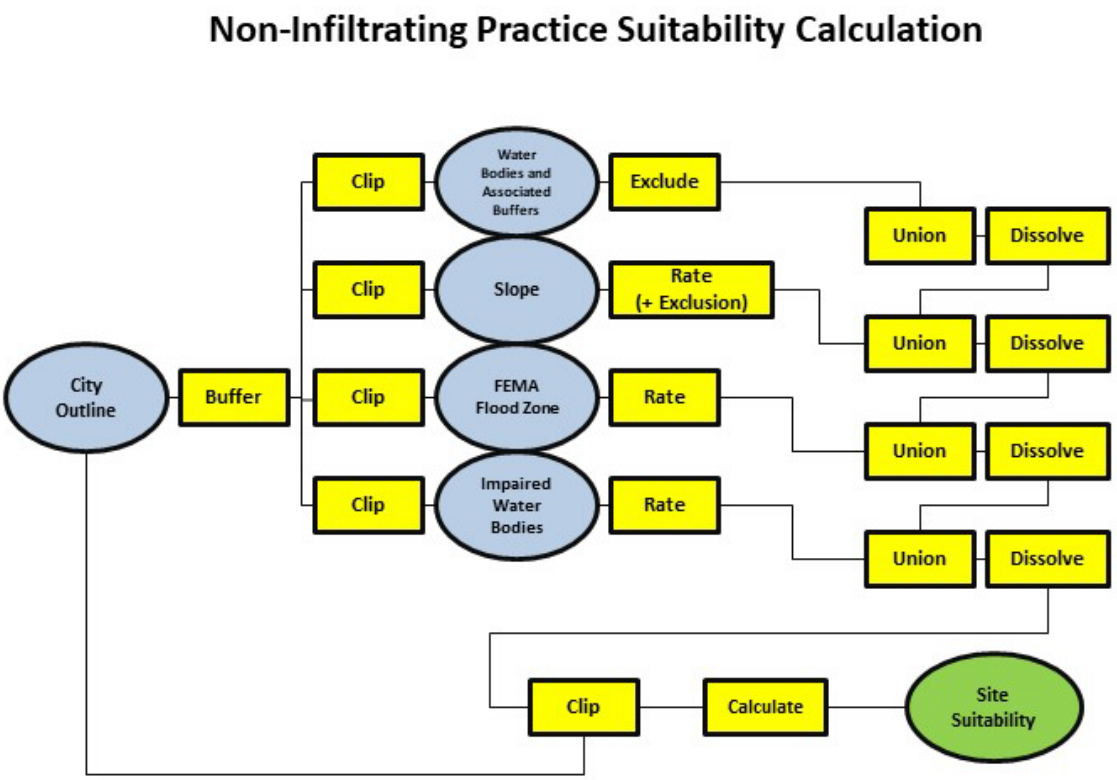


Figure G-3. Flow Chart: GIS Suitability Assessment Process for Non-Infiltrating Green Infrastructure

Step 5: Evaluate Site Suitability Assessment Results

The maps generated in Step 4 can be used to evaluate the suitability of parcels or sites for the implementation of infiltrating and non-infiltrating green infrastructure.

Lenses

Several additional data layers representing geographic, physical, or regulatory characteristics can be applied to the assessment maps as "lenses" through which the user can further evaluate the results. Lenses are not rated or included in the computation of the suitability score, but they add context to help the user evaluate the site suitability results. Lenses are typically boundaries for a targeted suitability assessment. For example, Hattiesburg established the lenses in Table G-8 to enhance the assessment. Additional lenses could be established depending on Hattiesburg's desired goals and priorities.

Table G-8. Hattiesburg Lenses for Interpreting Targeted Results

Lens	GIS Data Layer	Source	Considerations for Assessment
MS4 regulated area	2010 Census urbanized areas	U.S. Census https://www2.census.gov/geo/tiger/TIGER2010/UA/2010/	The city may be interested in evaluating whether a site is located within the regulated MS4 area because green infrastructure practices may help the community meet MS4 permit requirements. This boundary is used as a lens to evaluate the green infrastructure site assessment results but is not used as an assessment criterion within the site assessment analysis.
Public parcel ownership	Parcels	City of Hattiesburg	Public parcels may be easier or less costly than private parcels to retrofit with green infrastructure practices or to conserve as open space when the municipality is undertaking the project or retrofit. Parcel ownership is used as a lens when considering the site assessment results but is not used as an assessment criterion within the site assessment analysis.
Drainage areas to locations prone to flooding	Areas contributing to locations prone to flooding	City of Hattiesburg	City of Hattiesburg staff developed a map of eight areas that experience frequent flooding. The approximate boundaries of these areas were digitized into a GIS data layer, which includes parcels as well as public road rights-of-way. The drainage areas to these sites were also delineated based on surface topography data. The site screening assessment results can be evaluated through this lens to inform project planning and facilitate the incorporation of green infrastructure to potentially help mitigate flooding and improve stormwater management.
Planned public project sites	Public project sites	City of Hattiesburg	This information was generated through discussions with city staff members who are knowledgeable about the city's capital improvement plan, as well as upcoming roadway, parks, and other maintenance efforts. As project plans change over time, this data layer should be updated as needed.

Mapped results can be evaluated within GIS (recommended for parcel-specific investigations) or by printing suitability maps for each green infrastructure category, with or without lenses. Printed maps from Hattiesburg's assessment are included in Section 3 below to provide a visual example of the methodology outputs and how they were used to evaluate site suitability results.

3. Next Steps: Building on the Site Suitability Assessment

The site suitability assessment methodology described in this document can be used to guide the city toward targeted and informed green infrastructure implementation. This methodology helps the city narrow in on where to further investigate and pursue green infrastructure opportunities. It also provides a process that the city can repeat to assess suitability under different criteria ratings as desired or as additional data become available (e.g., depth to groundwater or bedrock, or surficial geology data in Hattiesburg).

The results of this assessment are screening-level only and should not be interpreted as prohibiting certain types of green infrastructure in areas that score low in the suitability assessment. Rather, the mapping outputs and site scores relative to each other help to focus limited city funds and efforts on areas that appear to be more suitable based on the chosen criteria, scoring, and city priorities. Using this methodology to perform assessments provides a logical pathway forward when the city desires green infrastructure implementation.

4. Evaluating Site Suitability Assessment Results for Hattiesburg

The site suitability maps can be evaluated and analyzed individually and through a variety of lenses to answer specific questions of interest to the community. In Hattiesburg, the city was interested in evaluating the suitability of sites within the MS4 regulated area, publicly owned parcels, and areas that drain to locations prone to flooding, which were added as lenses and are described in Sections 3.2, 3.3, and 3.4, respectively. Hattiesburg was also interested in assessing the locations of anticipated public projects, which are discussed in Section 3.5. City staff can continually update this information and use it as an ongoing point of reference when projects develop on city property or when the city wants to implement additional green infrastructure.

4-1. Site Suitability Across Hattiesburg

Citywide maps (Figure G-4 and Figure G-5) showing site suitability for the two green infrastructure categories were prepared for Hattiesburg using the methodology described in Section 2. Rating scores were assigned to each pixel across the maps and then color coded. The higher the rating score the higher the potential suitability. In each figure, the assessment results are presented on a scale from least potential suitability (red) to most potential suitability (green) for the targeted category of green infrastructure. A red color coding does not preclude the successful installation of green infrastructure; it simply indicates that the location may be less suitable than a green location based on the chosen criteria and desktop screening.

Challenges with Suitability Scoring on Public Roadways

This analysis treats all streets within the city of Hattiesburg as one public parcel due to the nature of the GIS data layer for parcels. This results in one suitability score for the entire street network. Although this medium-level score likely approximates a realistic score for most streets within the city, a more in-depth analysis is necessary to properly rank individual streets or sections of streets against other public parcels. This can be done by dividing the streets into individual polygons (or parcels) for analysis.

The city can use each map to evaluate which category of green infrastructure may be the most suitable for implementation at a given site. The Hattiesburg figures demonstrate that some areas of the city are suitable for both infiltrating and non-infiltrating green infrastructure. However, non-infiltrating green infrastructure is suitable in a broader range of locations because they are not restricted by HSG D soils. Figures showing the individual criteria used in the site suitability assessments, color coded according to the assigned rating values, are included for reference at the end of this document.

4-2. Site Suitability Within the MS4 Area

The assessment results indicate that there are many potential opportunities within the MS4 area for both infiltrating and non-infiltrating practices to improve water quality, reduce stormwater volumes and velocities, and reduce erosion. The city can use the assessment results presented in Figure G-4 and Figure G-5 to consider where to pursue implementation of green infrastructure within the MS4 regulated area. Figure G-6 presents the boundary of the MS4 regulated area.

4-3. Site Suitability Within Publicly Owned Parcels

Figure G-6 also shows the location of publicly owned parcels. These sites can be visually cross-referenced with Figure G-4 and Figure G-5 when reviewing results on paper, or overlaid on the output maps in desktop GIS at an appropriate scale, to see whether a parcel or portion of a parcel may be potentially suitable for green infrastructure implementation.

4-4. Site Suitability Within Areas that Drain to Flooding-Prone Locations

Figure G-7 shows locations that the city has identified as being regularly prone to flooding, and Figure G-8 presents an estimate of the areas (based on topography) that drain to those locations. Figure G-9 and Figure G-10 present the suitability assessment results within the drainage areas to locations prone to flooding.

These drainage areas may be targeted for green infrastructure to slow the flow of runoff or reduce the flow through infiltration. Both infiltrating and non-infiltrating green infrastructure can potentially help mitigate flooding in these areas. The drainage areas can be overlaid on the output maps at an appropriate scale to examine each and determine if the drainage area is suitable for either green infrastructure category.

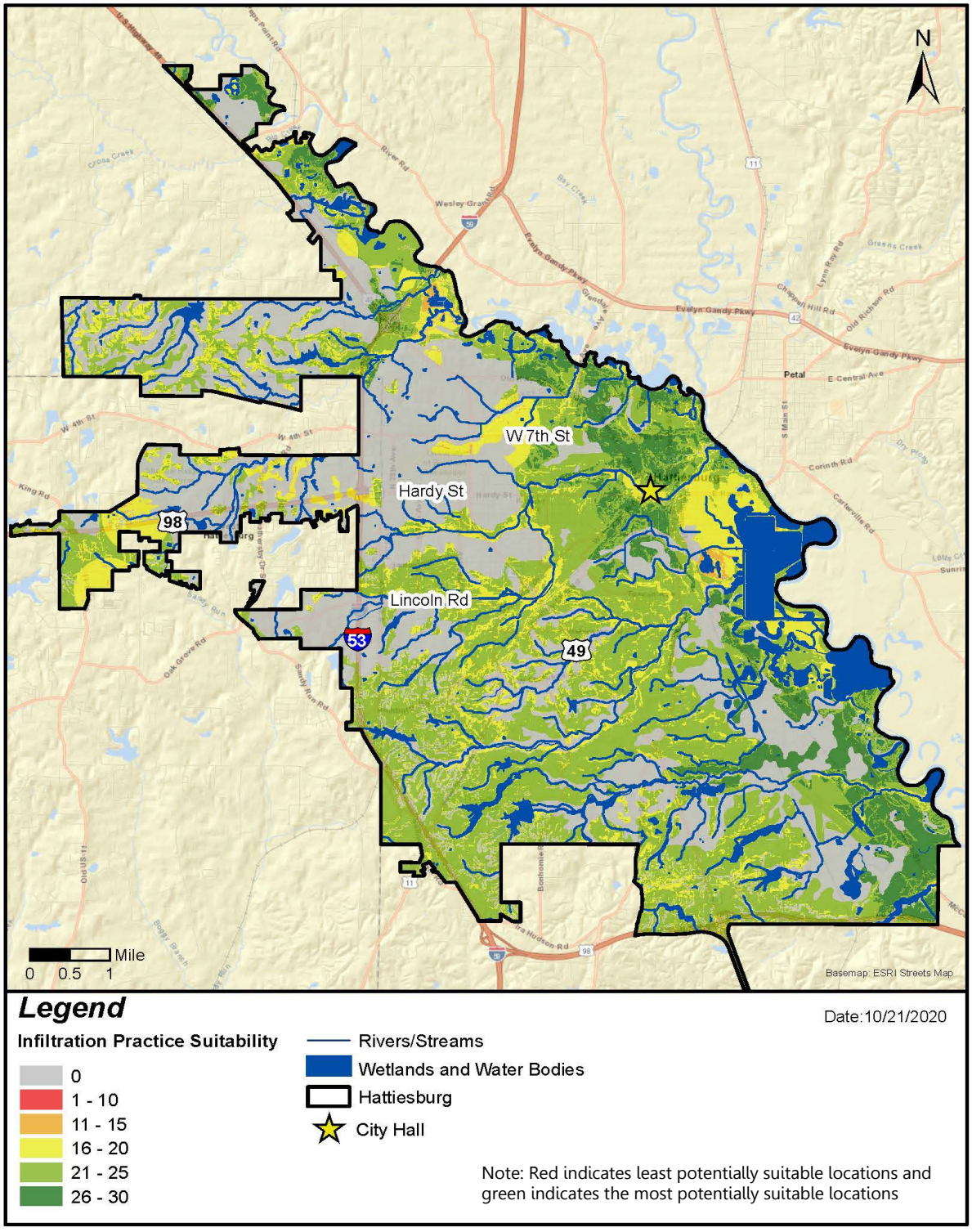


Figure G-4. Infiltrating Practice Suitability

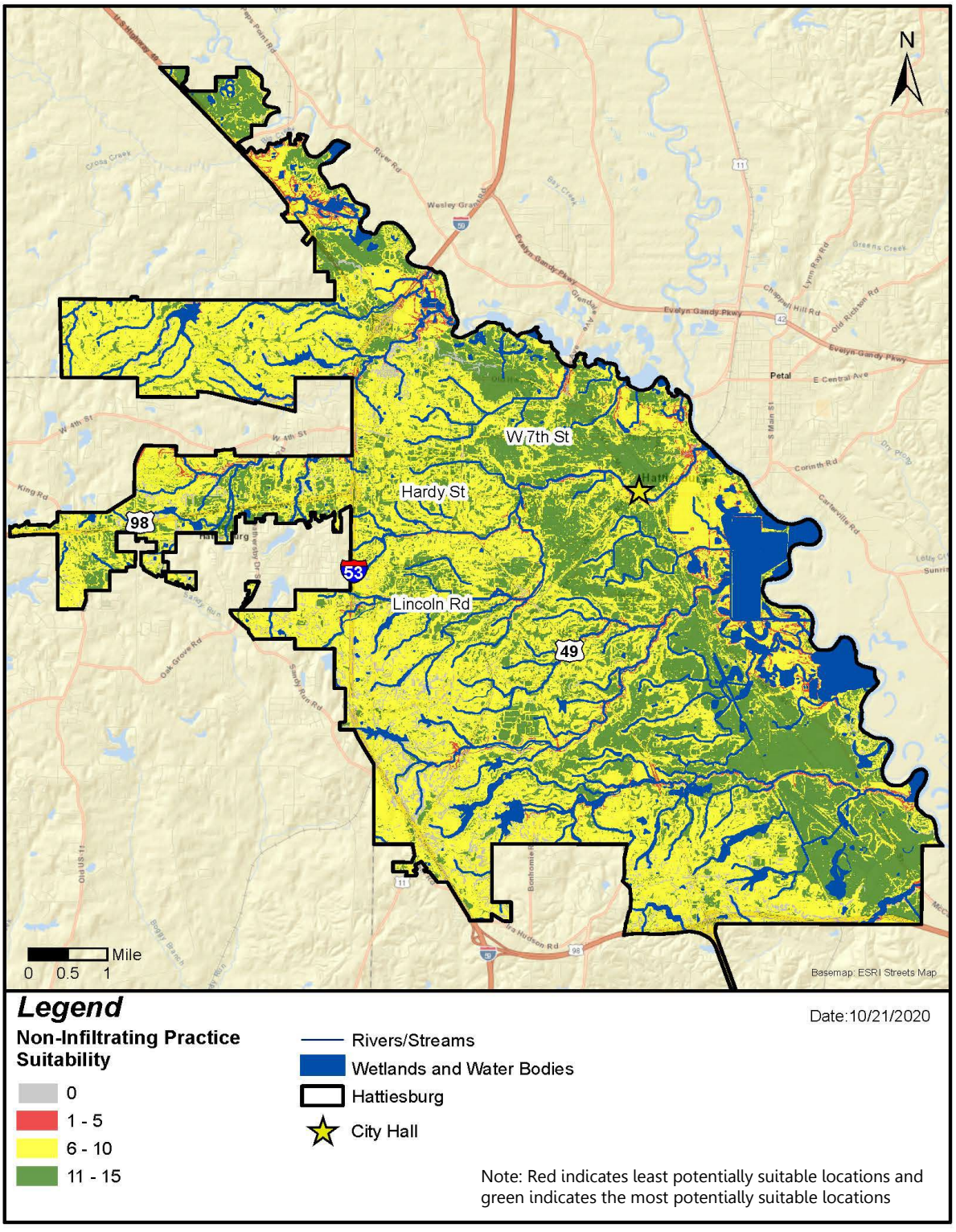


Figure G-5. Non-Infiltrating Practice Suitability

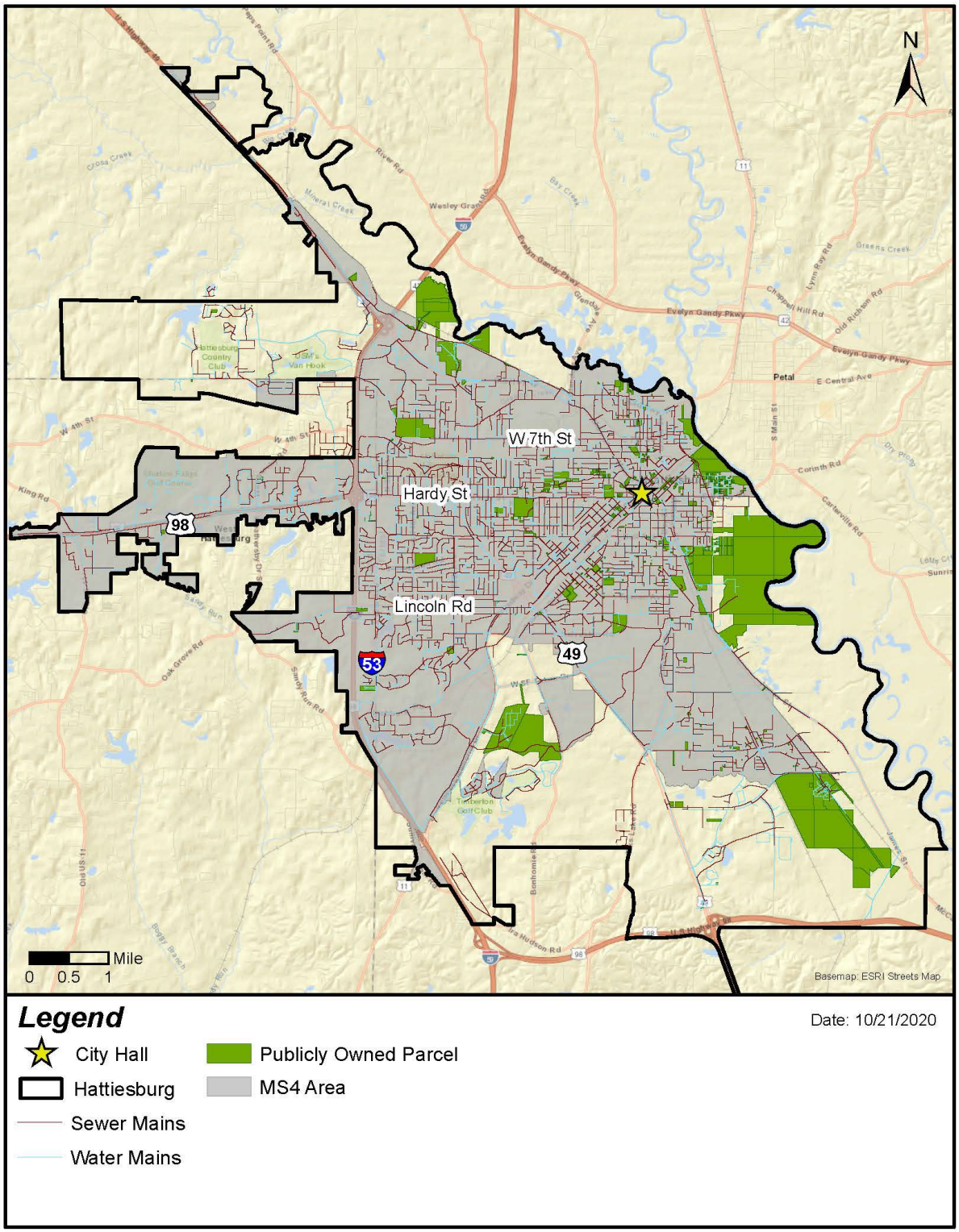


Figure G-6. Boundary of the MS4 Regulated Area and Publicly Owned Parcels

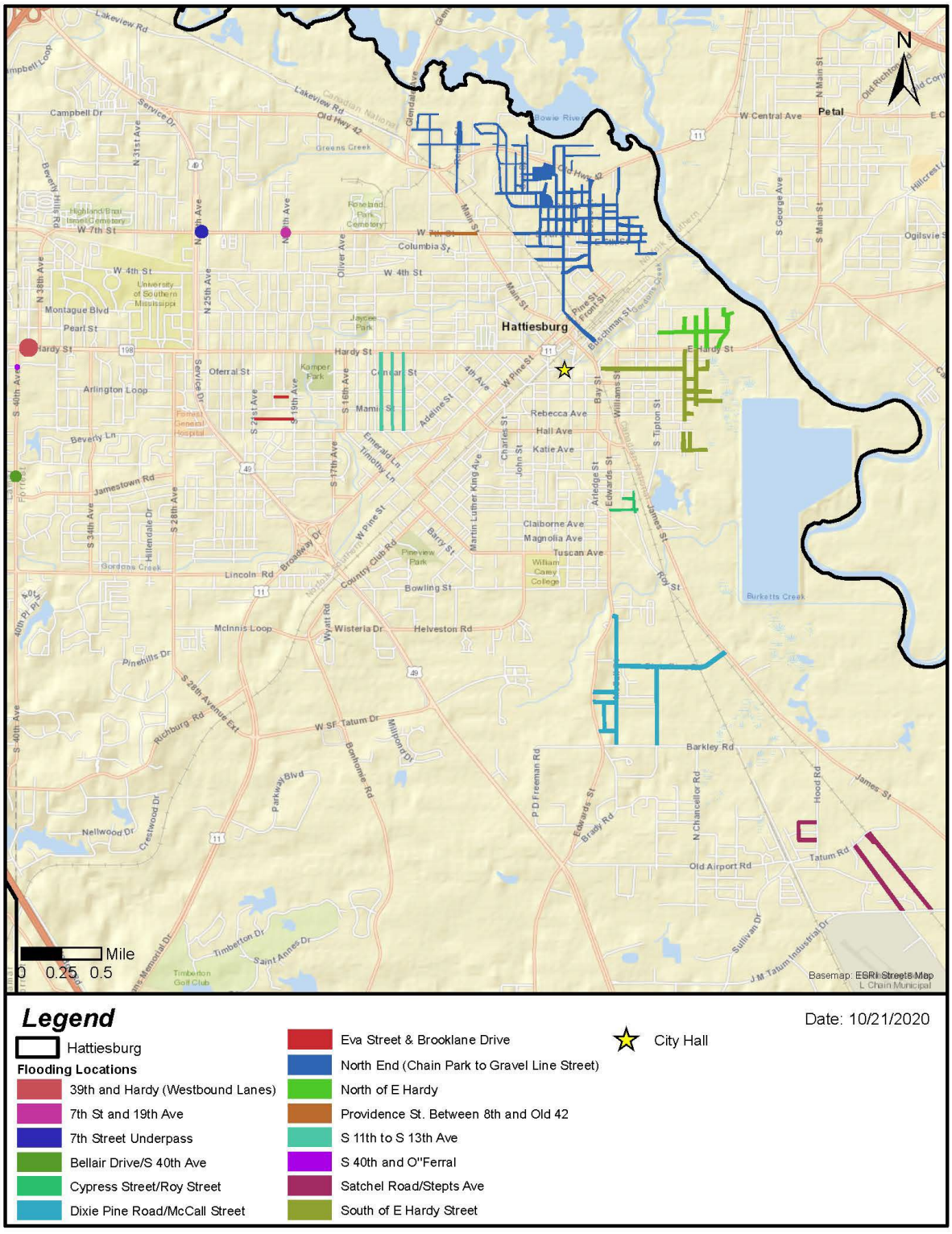


Figure G-7. Locations Prone to Flooding

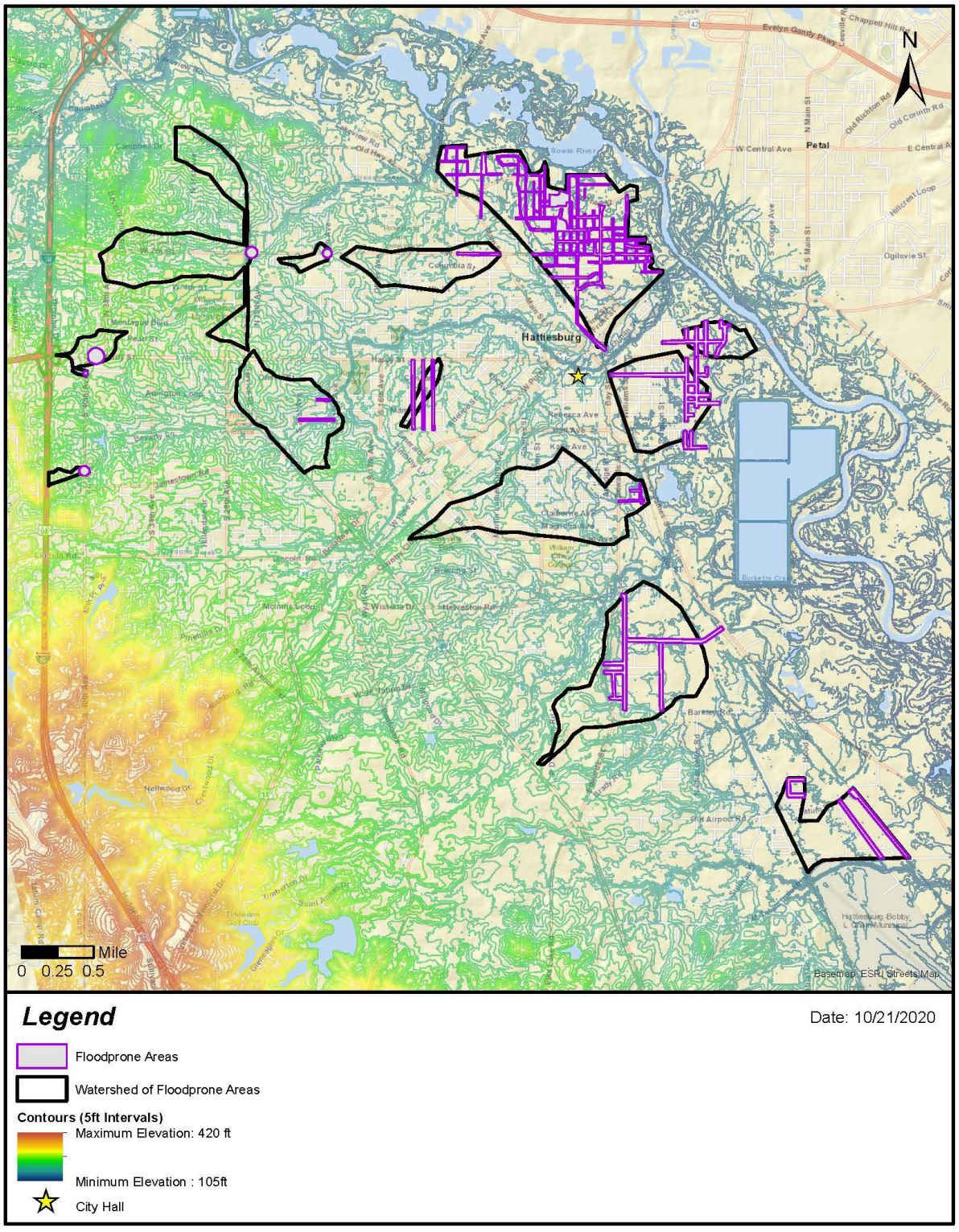


Figure G-8. Areas That Drain to Locations Prone to Flooding

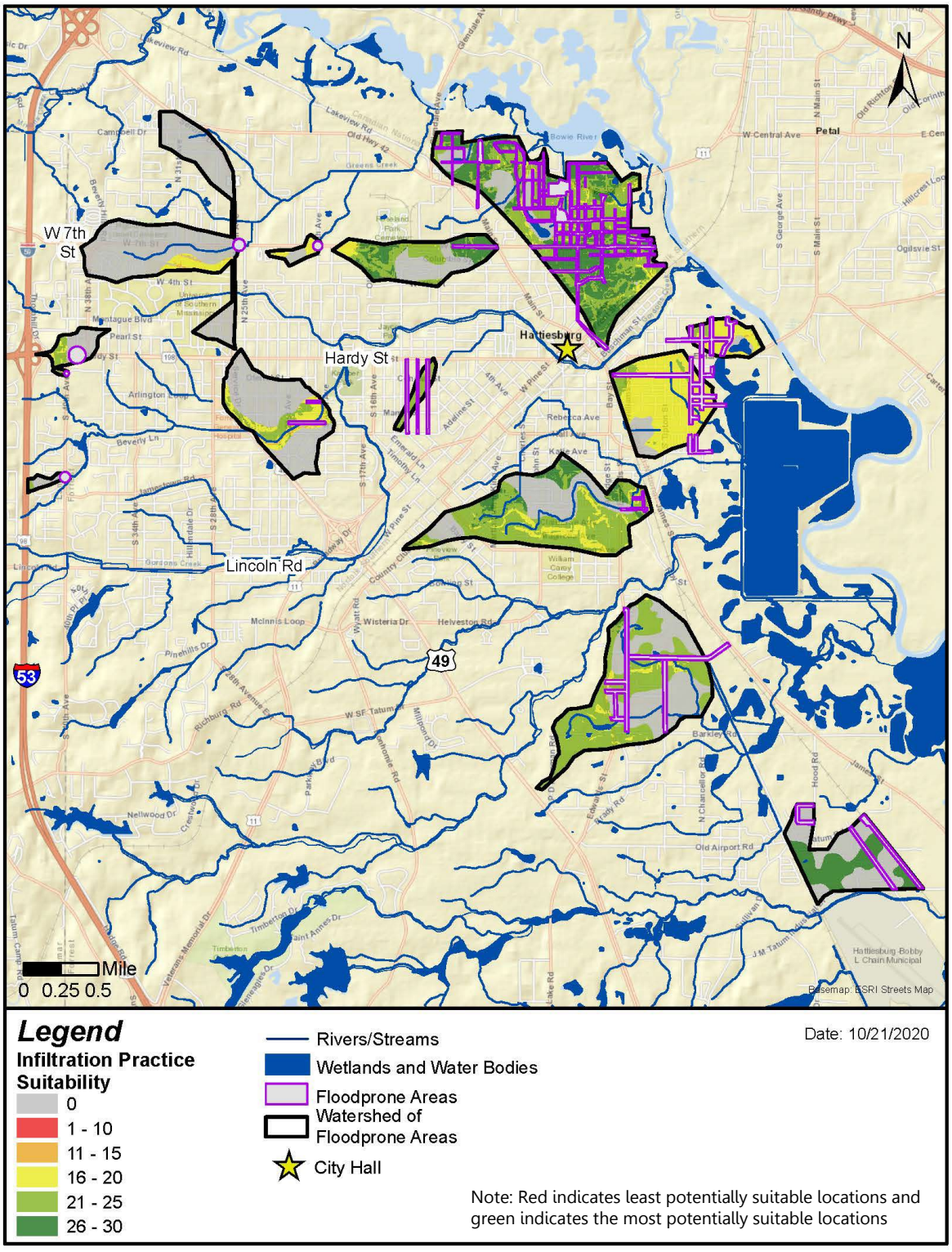


Figure G-9. Infiltrating Practice Suitability for Locations Prone to Flooding

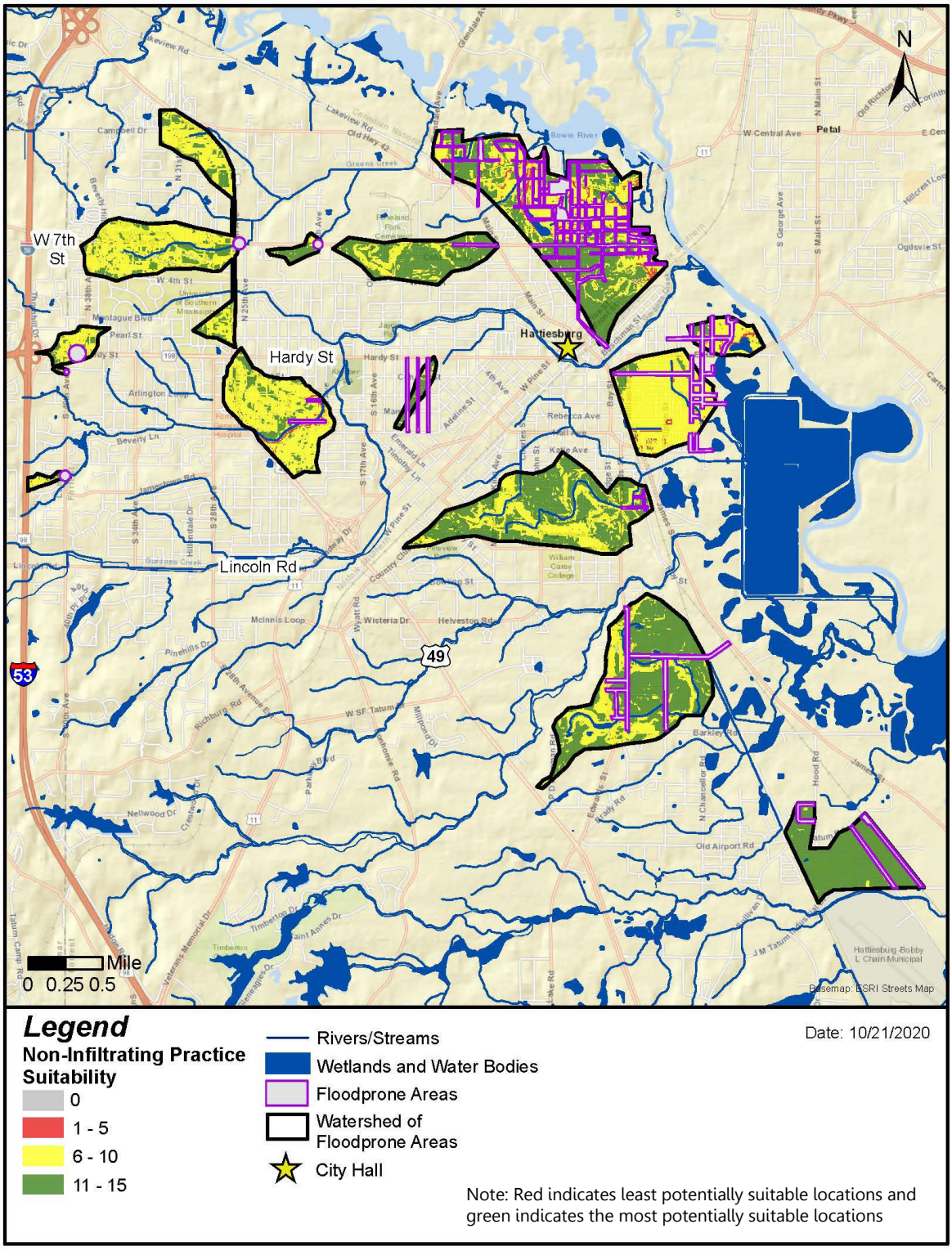


Figure G-10. Non-Infiltrating Practice Suitability for Locations Prone to Flooding

4-5. Overall Suitability Ranking of Public Project Sites

The city of Hattiesburg identified the locations of nine anticipated public project sites and delineated these locations in a GIS shape file for analysis. The proposed public project sites are:

- Little Gordy Lake project watershed
- Little Gordy Lake project
- Neighborhoods contributing to Gordon's Creek improvements along Lincoln Road
- Hardy Street improvements
- Gordon's Creek improvement in the Cultural District
- Twin Forks rising area of flooding concern
- Neighborhood contributing to Chain Park
- Gordon's Creek improvement connecting the Downtown and Depot District
- East Hardy Park

Figure G-11 show the locations of the public project sites. Public project sites differ from parcel boundaries because they include the specific portions of parcels and roads where disturbance is anticipated during project implementation. This is important because street projects need a defined outline to receive an accurate suitability score. An area-weighted average suitability score was generated for each green infrastructure category for the public project sites. These scores are summarized in Table G-9.

Table G-9. Site Suitability Scores for Selected Public Projects

Project Name	Infiltrating Practice Score (weighted average score and % of total possible score)	Non-Infiltrating Practice Score (weighted average score and % of total possible score)
Little Gordy Lake project watershed	0.1 (0%)	9.7 (65%)
Little Gordy Lake project	0.0 (0%)	9.1 (61%)
Neighborhoods contributing to Gordon's Creek improvements along Lincoln Road	11.2 (37%)	8.8 (59%)
Hardy Street improvements	22.1 (74%)	10.1 (67%)
Gordon's Creek improvement in the Cultural District	10.2 (34%)	4.0 (27%)
Twin Forks rising area of flooding concern	21.6 (72%)	7.0 (47%)
Neighborhood contributing to Chain Park	22.7 (76%)	8.1 (54%)

Project Name	Infiltrating Practice Score (weighted average score and % of total possible score)	Non-Infiltrating Practice Score (weighted average score and % of total possible score)
Gordon's Creek improvement connecting the Downtown and Depot District	13.6 (45%)	4.8 (32%)
East Hardy Park	19.1 (64%)	8.2 (55%)
TOTAL POSSIBLE SCORE	**30**	**15**

Figure G-12 and Figure G-13 present the suitability assessment results within the planned public project locations. Figure G-14 and Figure G-15 show the locations of the public project sites, with both the weighted average scores as well as the spatial distribution of the total suitability scores across the sites for each green infrastructure category. These figures can help the city assess which categories of green infrastructure may be appropriate for specific areas within the public project boundaries, inform the site layout and stormwater management concepts developed for these projects, and guide the city in further integrating green infrastructure into the public project designs as they progress.

The assessment results show varying levels of suitability between the two categories of green infrastructure for each public project site. While most public project sites appear to be reasonably well suited for non-infiltrating green infrastructure practices, they vary significantly (range from 0% to 76%) in their suitability for infiltrating practices. In addition, a closer examination of the distribution of the suitability scores within the public project boundaries also demonstrate that some internal portions of sites show a high suitability score for infiltrating practices while others show a low score. Section 4 provides more information on using this methodology to narrow in on where to further investigate and pursue green infrastructure opportunities.

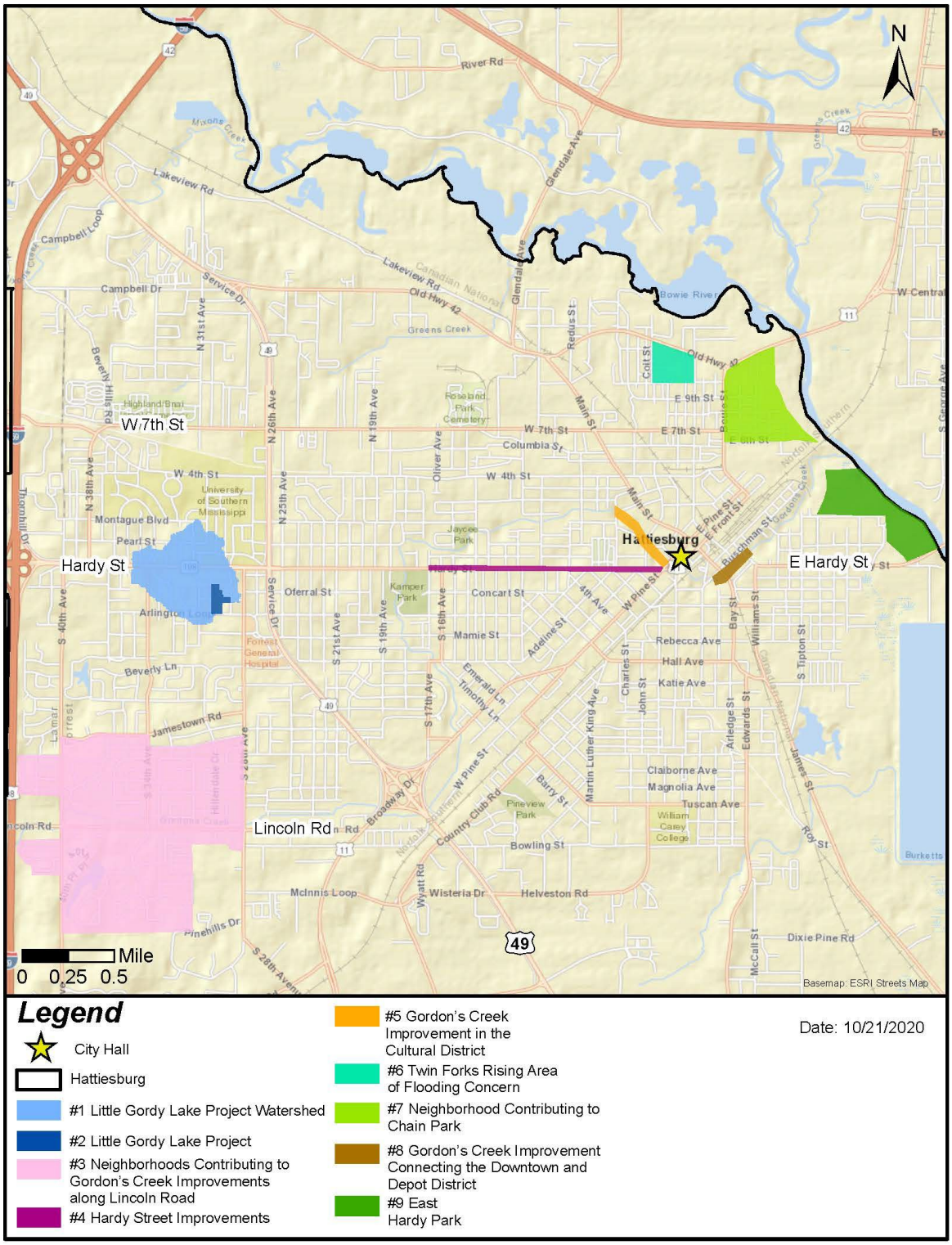


Figure G-11. Planned Public Project Locations

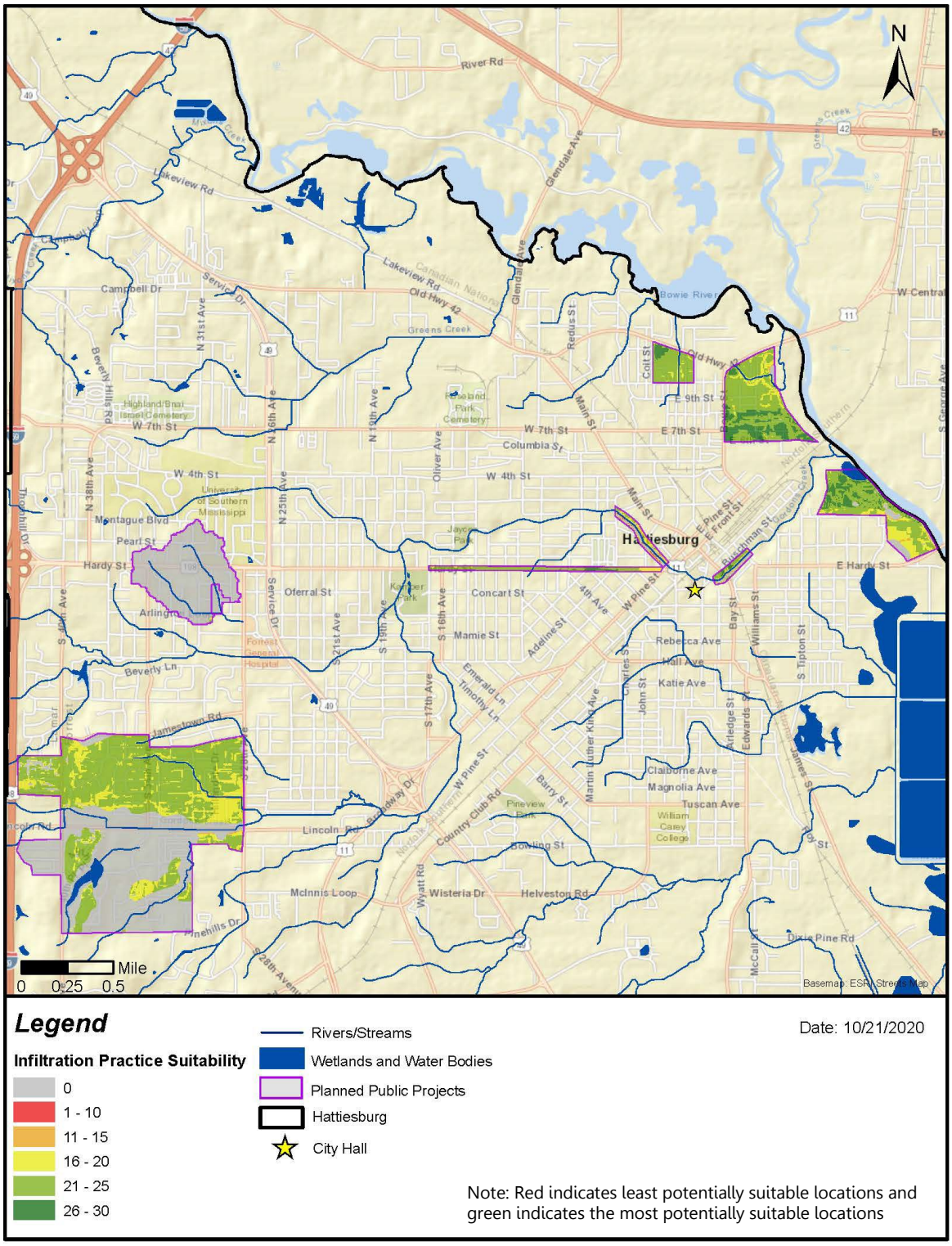


Figure G-12. Planned Public Projects Infiltrating Practice Suitability

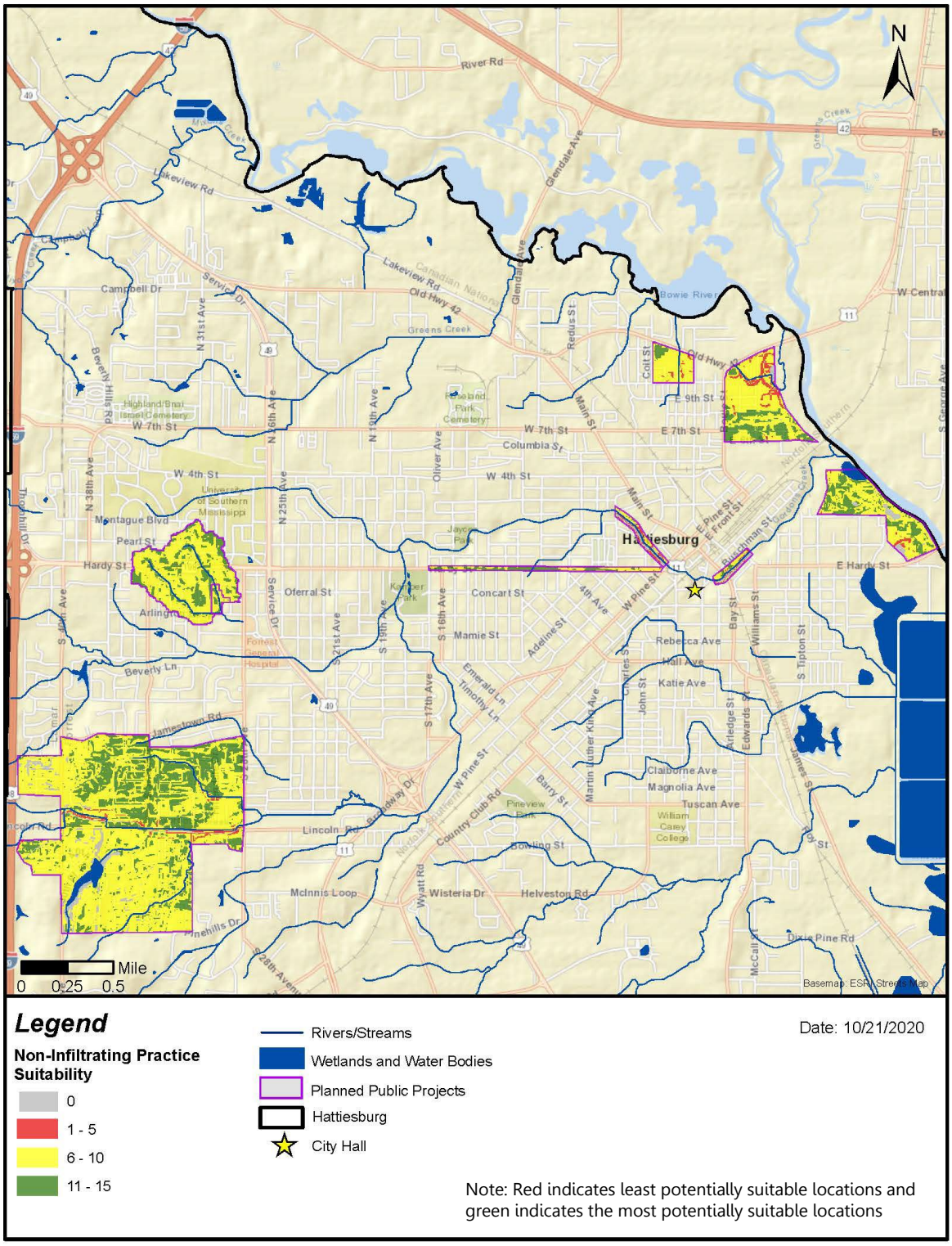


Figure G-13. Planned Public Projects Non-Infiltrating Practice Suitability

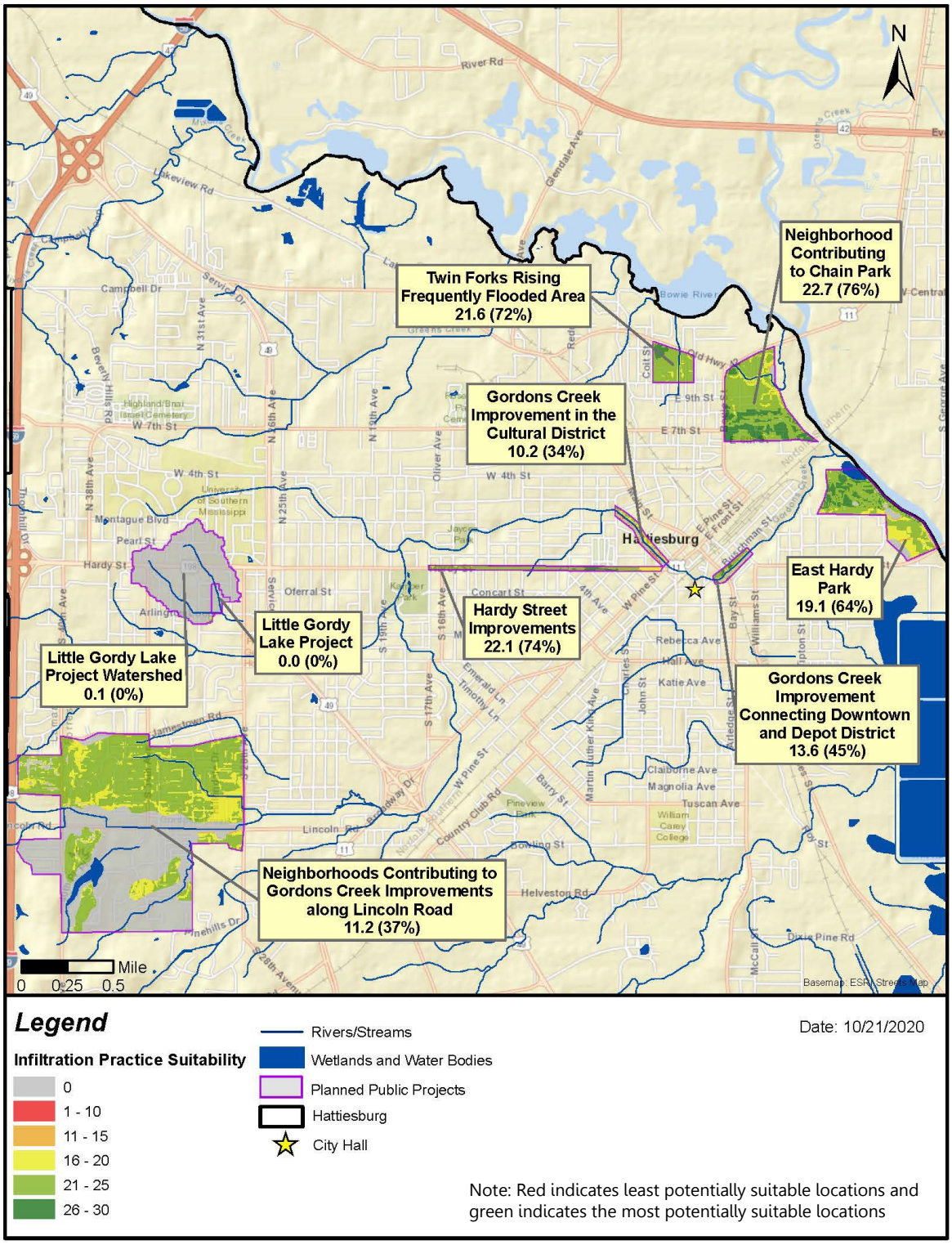


Figure G-14. Planned Public Projects Weighted Average of Infiltrating Practice Suitability

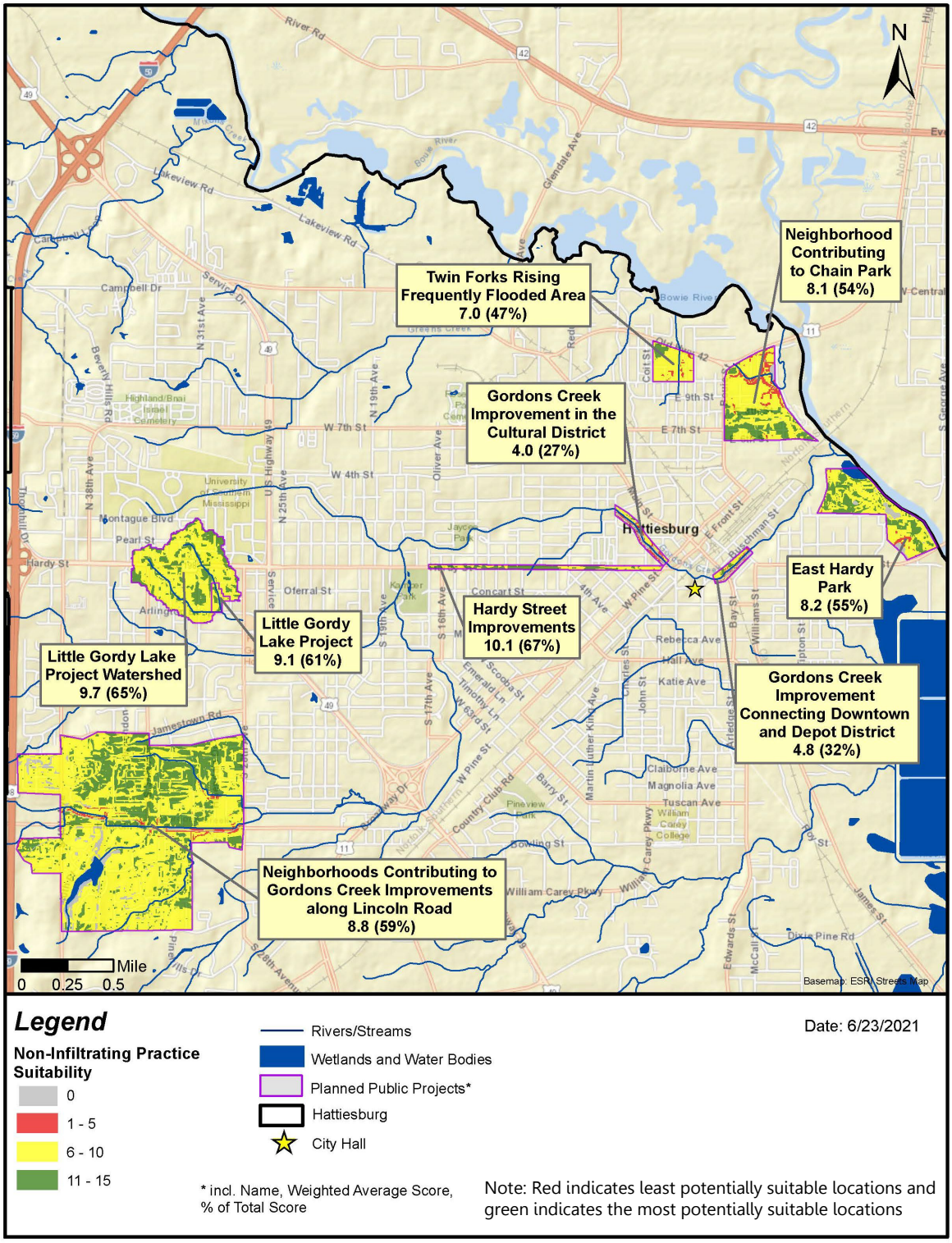


Figure G-15. Weighted Average of Non-Infiltrating Practice Suitability for Planned Public Projects

4-6. Targeted Desktop Analysis

The site suitability assessment and evaluation lenses can identify a variety of potential sites where green infrastructure might be suitable. There may also be locations that surprisingly did not appear on the heat maps as good spots for green infrastructure. A more detailed review of each data layer that went into the assessment can provide important insight into the assessment results for a given parcel. An aerial photo can also provide context and help to clarify what land use and site conditions exist at the site. Other available GIS data layers can also be incorporated. For example, the city might choose to include GIS mapping of the sanitary and storm sewer mains to augment the site suitability assessment data.

4-7. Field Investigation and Concept Design

Once potentially suitable green infrastructure sites are identified through the GIS-based site suitability assessment and targeted desktop analysis, the next step is to investigate these sites in person to identify additional constraints and opportunities that may not be visible using GIS data alone. For example, a site visit may reveal:

- Information on utilities for which the GIS has no data.
- A change in land use that is not reflected in the latest GIS data.
- An impact, such as sediment buildup, erosion, or prevalence of an invasive species, that may influence the design or selection of green infrastructure.

Site investigations are also an opportunity to begin sketching out conceptual designs for potential green infrastructure at the site, particularly if the project is a retrofit or renovation of an existing site. A conceptual design can be a sketch using a marker on an aerial photo, or a sketch on a tablet computer that may have mobile GIS capabilities. The idea is to identify:

- A location that is the appropriate size for the proposed green infrastructure.
- A feasible mechanism for draining water into the practice.
- A feasible mechanism for discharging water from the practice via infiltration, underdrain connection to existing infrastructure, or overflow.

The concept design should take into consideration an estimate of the size of the site's contributing drainage area and the basic treatment and/or detention volume. All the assumptions made in the concept sketch are estimates but should be made by a designer or engineer with stormwater management experience. An organized site visit effort following the site assessment phase can result in a well-documented plan of green infrastructure implementation opportunities throughout a neighborhood, basin, or city boundary.

Stormwater Management Opportunities Come in Many Functions, Shapes, and Sizes

Innovative approaches are used in locations throughout the country to integrate green infrastructure into developed landscapes. The restoration work in the Berry Brook watershed in Dover, New Hampshire, and the Mystic River and Buzzards Bay Watersheds in Massachusetts are examples of the effectiveness of smaller-capacity stormwater control systems that provide water quality and other benefits. These case studies also demonstrate the process of evaluating pollutant load reduction and cost effectiveness of green infrastructure on the ground.

(For more information on the restoration projects mentioned above, visit https://www.unh.edu/unhsc/berry-brook-project and https://www3.epa.gov/region1/npdes/stormwater/ma/opti-tool-case-study-demo-buzzards-bay-watershed.pdf.)

4-8. Estimating Benefits

This type of site suitability assessment lays the groundwork for a community to consider the combined water quality benefits of implementing stormwater management practices at scale across a neighborhood, a basin, or the community. Once the suitability assessment identifies potential sites and basic concepts are developed, the community can begin to estimate the potential stormwater water quality treatment, flood mitigation, infiltration, and detention improvements at each site. These estimates can be combined and evaluated to see which combinations of practices in which locations might be most effective. A host of modeling tools can be employed for this purpose, ranging in complexity and data intensity. An overview of green infrastructure modeling tools for planning and design can be found at https://www.epa.gov/green-infrastructure/green-infrastructure-modeling-tools. Links to more detailed information about specific tools and models are summarized in the call-out boxes below.

Green Infrastructure Screening and Selection

The **EPA Green Infrastructure Modeling Toolkit** includes many tools and models to help communities identify and evaluate which green infrastructure and combinations could be effective.

The **Green Infrastructure Wizard** is a web application that provides communities with information about EPA green infrastructure tools and resources.

The **Watershed Management Optimization Support Tool** is a software application that allows users to screen a wide range of management practices for cost-effectiveness and economic sustainability.

Performance Simulation and Modeling

Visualizing Ecosystem Land Management Assessments is a computer software model to help regional planners and land managers determine which green infrastructure practice would be most effective for improving water quality in streams, estuaries, and groundwater.

The **Storm Water Management Model** is a simulation model that communities can use for stormwater runoff reduction planning, analysis, and the design of combined sewers and other drainage systems.

The **National Stormwater Calculator** is a desktop application that estimates the annual amount of rainwater and frequency of runoff from a specific site anywhere in the United States (including Puerto Rico). SWC allows users to learn about the ways that green infrastructure, like rain gardens, can prevent water pollution in their neighborhoods.

The **Green Infrastructure Flexible Model** is a computer program that evaluates the performance of urban stormwater and agricultural green infrastructure practices. Users can build conceptual models of green infrastructure to predict hydraulic and water quality performance under given weather scenarios.

EPA Region 1's **Stormwater Optimization Tool** is a desktop application combining GIS and spreadsheet analysis that allows users to evaluate options and determine the best mix of structural stormwater management practices, including green infrastructure, to achieve quantitative water resource goals.

EPA Region 1's **Stormwater Optimization Tool** is a desktop application combining GIS and spreadsheet analysis that allows users to evaluate options and determine the best mix of structural stormwater management practices, including green infrastructure, to achieve quantitative water resource goals.

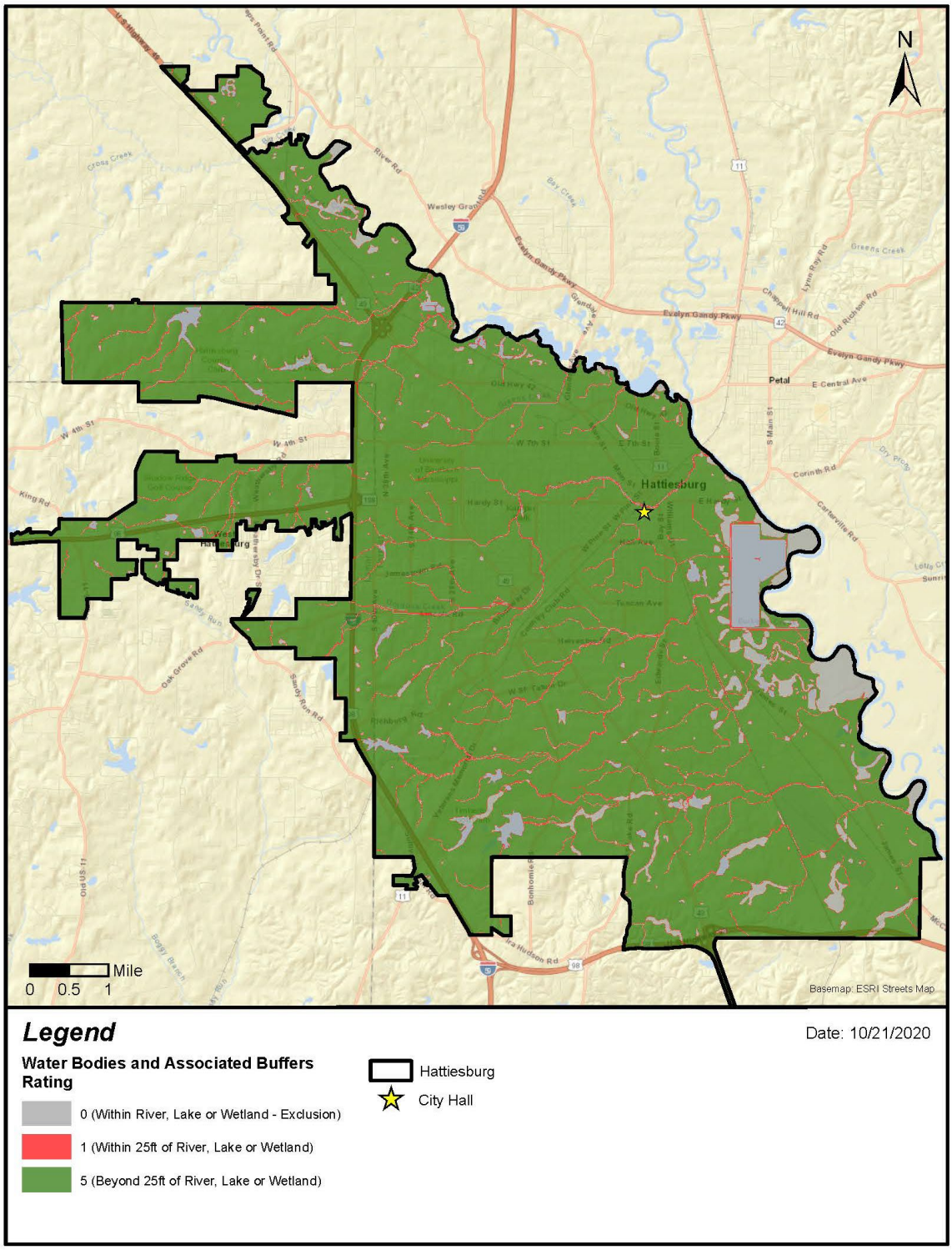
4-9. Leveraging Analysis Results

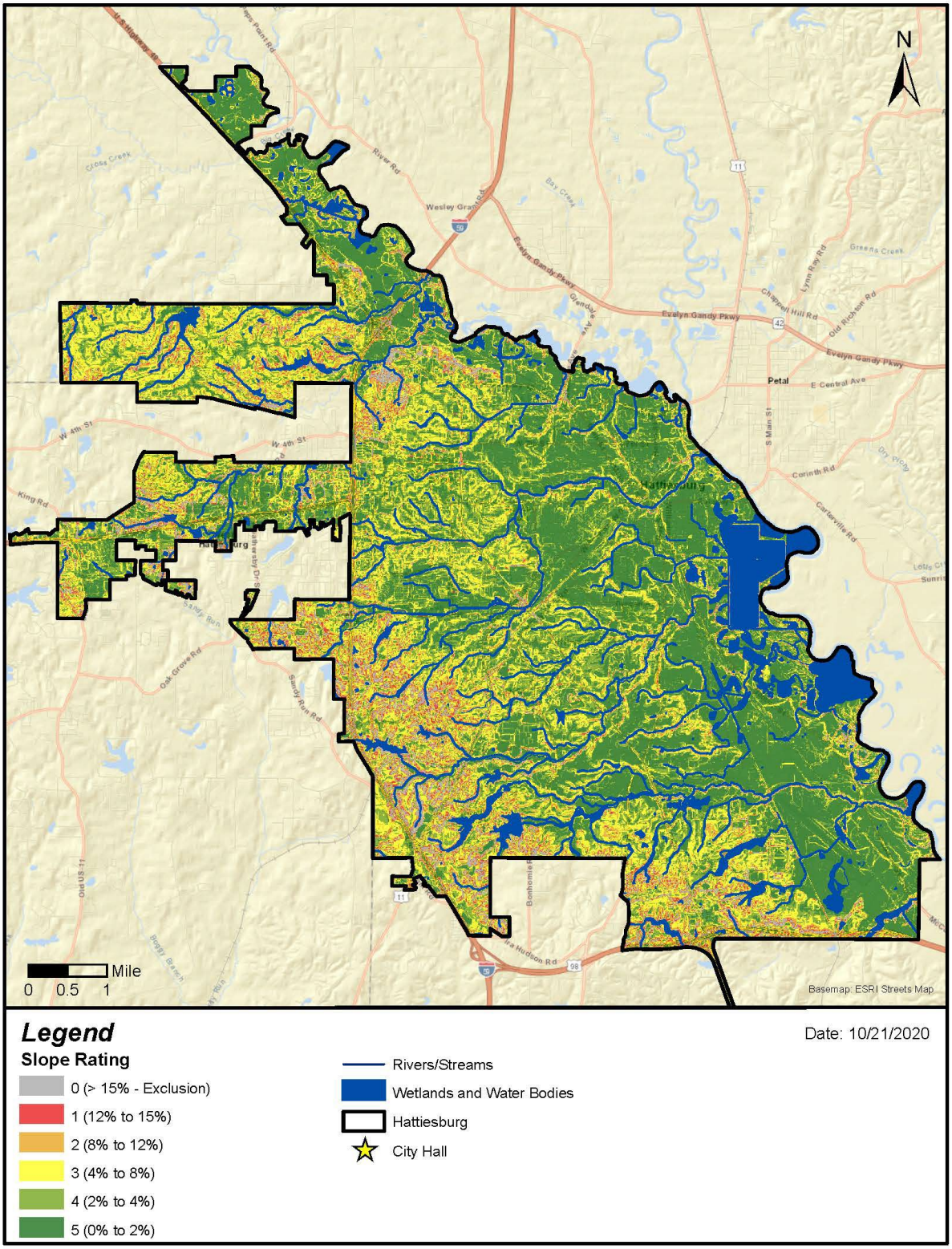
This type of preliminary green infrastructure opportunity assessment positions the city to pursue and take advantage of available grants and other funding mechanisms to design and install green infrastructure. Communities are encouraged to think broadly about where they search for implementation funding sources, including sources geared toward water quality improvements, stormwater management, parks improvement, public-private partnerships, climate change resilience, urban revitalization, transportation projects (including green streets and "road diets"), and even historic restoration.

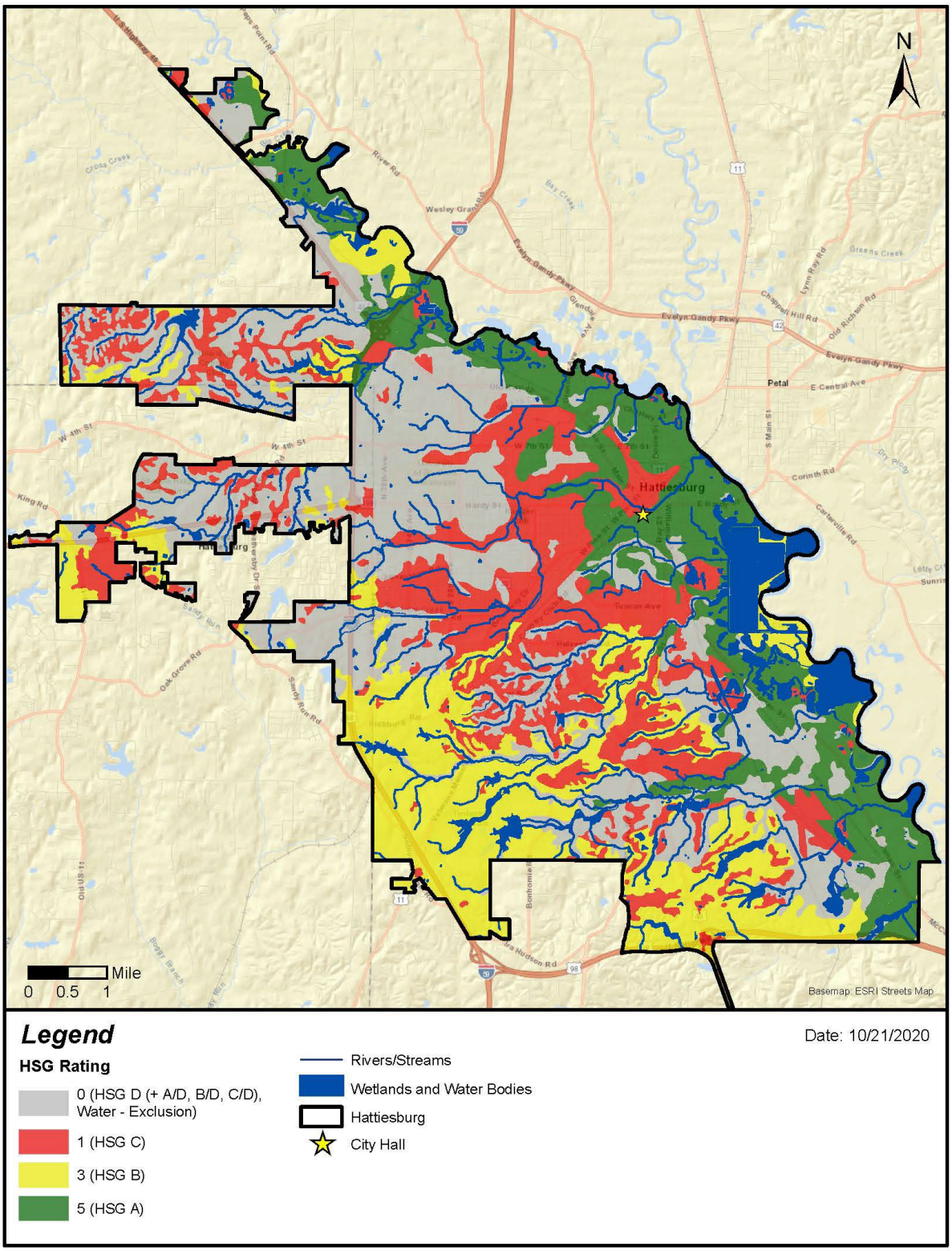
This type of analysis identifies multiple stormwater management and green infrastructure opportunities that could be 'bundled' together to pursue funding for more than one project at a time. For example, communities could apply for funding from the Clean Water State Revolving Fund (CWSRF) to implement multiple opportunities within a given neighborhood or watershed, or multiple opportunities that include a uniform set of stormwater management practices or a uniform set of property types (public parks, residential sites, schools, municipal facilities, historic properties, etc.). For more information about stormwater funding resources and opportunities, visit: https://www.epa.gov/waterdata/water-finance-clearinghouse and https://www.epa.gov/green-infrastructure/green-infrastructure-funding-opportunities.

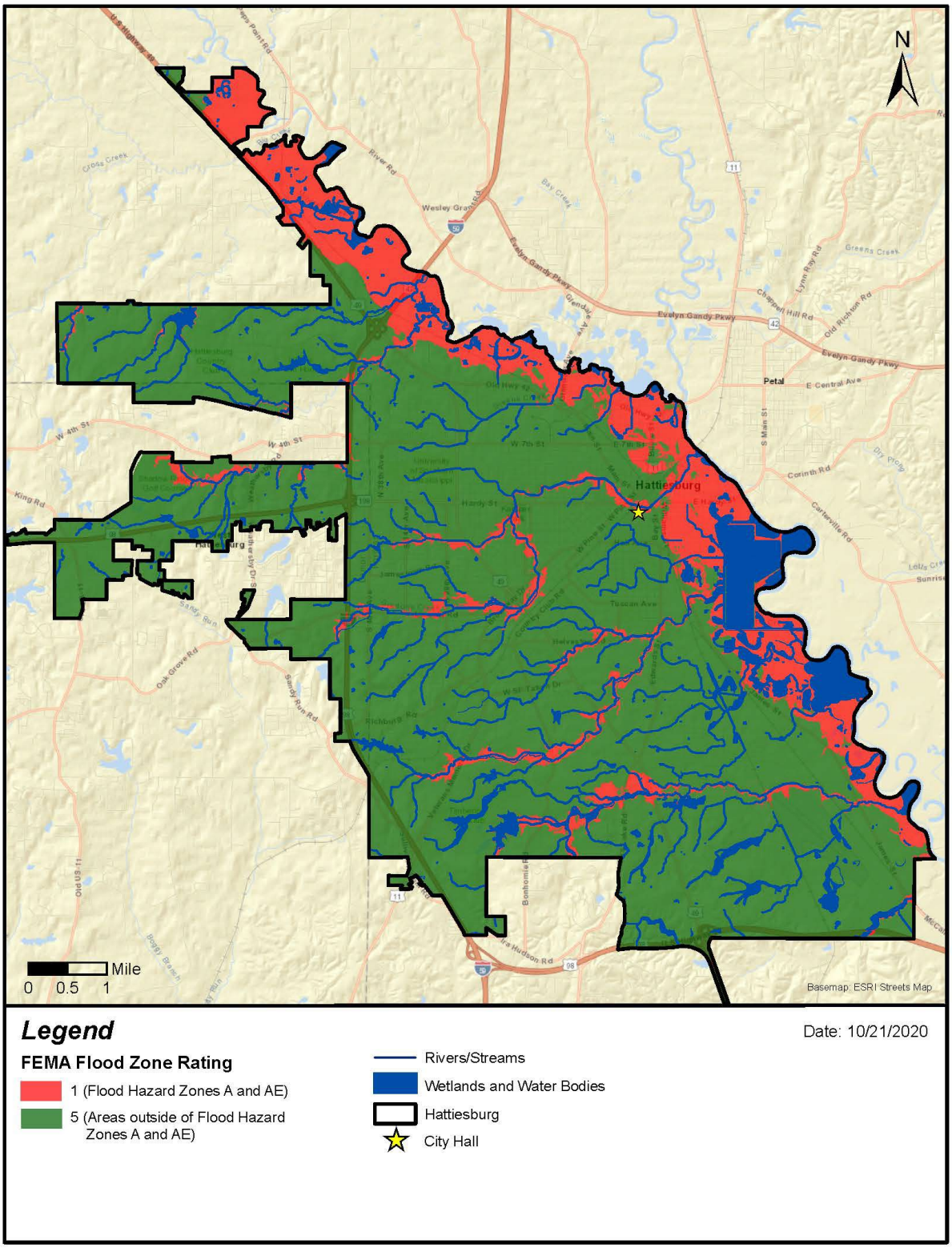
Thanks to their multiple benefits, green infrastructure can be integrated into projects to support goals such as revitalization, historic preservation and restoration, habitat creation, localized flooding reduction, or park improvement. The benefits are often experienced by adjacent landowners as well as residents throughout the community, making the value of these projects even greater. In some cases, stakeholders may be interested in supporting a project through a public-private partnership in which the private entity helps fund, finance, or provide space for a project.

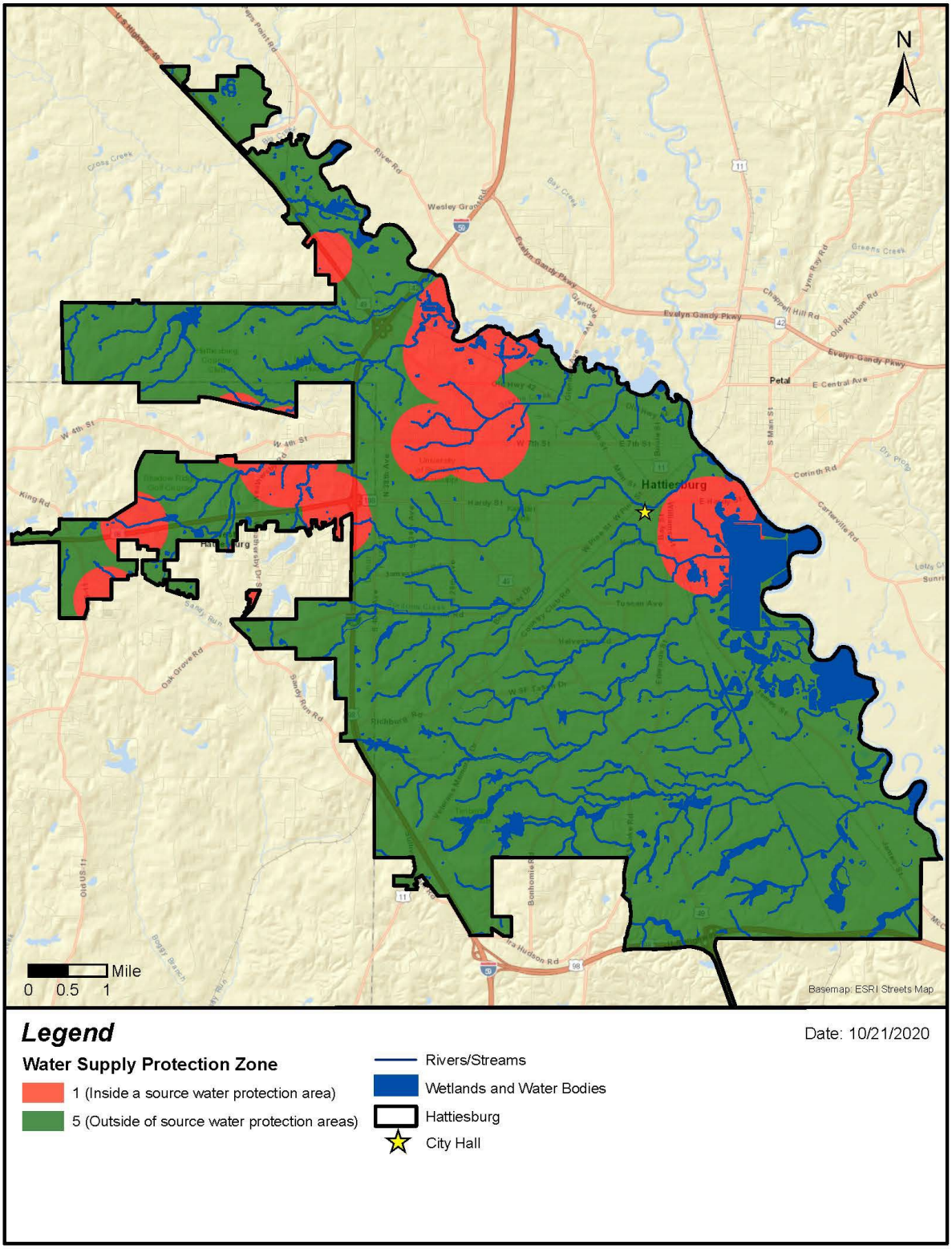
4-10. Additional Rating and Exclusion Maps for Each Assessment Criterion

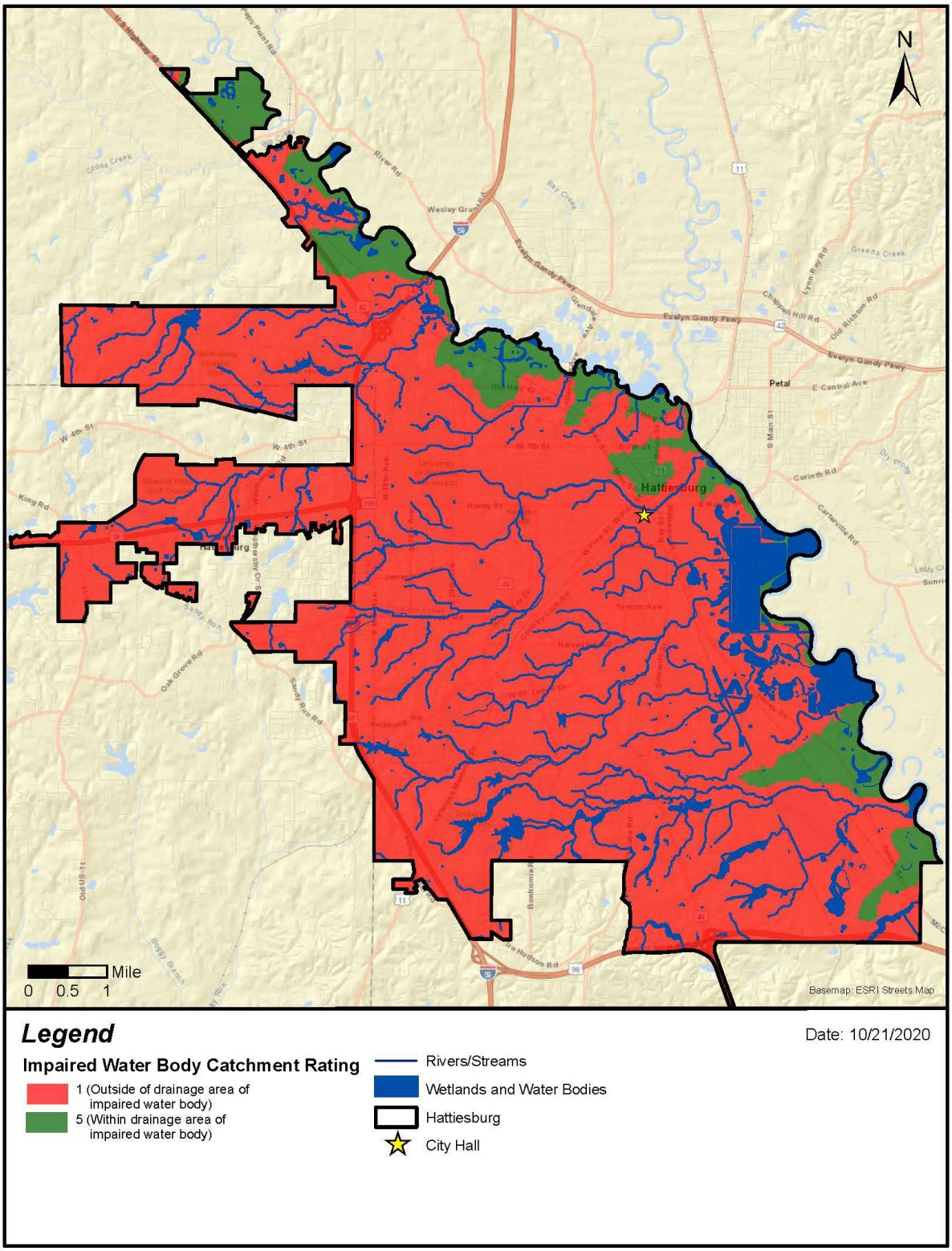



N
Mile
0 0.5 1
Basemap: ESRI Streets Map
Legend
Slope Rating
0 (> 15% - Exclusion)
1 (12% to 15%)
2 (8% to 12%)
3 (4% to 8%)
4 (2% to 4%)
5 (0% to 2%)
Rivers/Streams
Wetlands and Water Bodies
Hattiesburg
City Hall
Date: 10/21/2020


N
Hattiesburg
Petal
Mile
0 0.5 1
Basemap: ESRI Streets Map
Legend
Date: 10/21/2020
HSG Rating
0 (HSG D (+ A/D, B/D, C/D), Water - Exclusion)
1 (HSG C)
3 (HSG B)
5 (HSG A)
Rivers/Streams
Wetlands and Water Bodies
Hattiesburg
City Hall


N
Hattiesburg
Petal
Evelyn Gandy Pkwy
Wesley Grant Rd
River Rd
Corinth Rd
Carterville Rd
Sandy Run Rd
Oak Grove Rd
King Rd
Mile
0 0.5 1
Basemap: ESRI Streets Map
Legend
Date: 10/21/2020
FEMA Flood Zone Rating
1 (Flood Hazard Zones A and AE)
5 (Areas outside of Flood Hazard Zones A and AE)
Rivers/Streams
Wetlands and Water Bodies
Hattiesburg
City Hall


N
Hattiesburg
Petal
Mile
0 0.5 1
Basemap: ESRI Streets Map
Legend
Date: 10/21/2020
Water Supply Protection Zone
1 (Inside a source water protection area)
5 (Outside of source water protection areas)
Rivers/Streams
Wetlands and Water Bodies
Hattiesburg
City Hall


N
Mile
0 0.5 1
Basemap: ESRI Streets Map
Legend
Date: 10/21/2020
Impaired Water Body Catchment Rating
1 (Outside of drainage area of impaired water body)
5 (Within drainage area of impaired water body)
Rivers/Streams
Wetlands and Water Bodies
Hattiesburg
City Hall

APPENDIX H:
IMPLEMENTATION PLANNING AND PROGRESS EVALUATION TOOL

Implementation Planning and Progress Evaluation Tool

The following tables summarize the key actions from each chapter (or goal) of the city's Long-term Stormwater Plan. The tables are intended to be used by the city to establish timelines for starting and completing key actions and to evaluate progress. The city intends to revisit this information yearly to check on progress and adjust the timeline and actions based on progress from the prior year, challenges encountered, and community priorities.

Symbol Definitions:

- The "✓" symbol indicates anticipated activity or completion for a key action in a particular year (or period of years).
- The "↺" symbol indicates anticipated repetition of a key action at times throughout program implementation.
- The "-" symbol indicates no anticipated activity for a key action in a particular year (or period of years).

Goal 1 - Engage Stakeholders

Key Action	Status	*2021*	*2022*	*2023*	*2024 to 2028*	*2029 to 2033*	*2034 to 2038*
Key Action 1.1: Identify stakeholders, target audiences, and potential partners.	Initiated during LTSW planning process. Plan to complete by end of 2021.	✓	-	↺	-	↺	-
Key Action 1.2: Write a stakeholder engagement strategy.	Not started. Plan to complete by end of 2021.	✓	-	-	↺	-	↺
Key Action 1.3: Conduct ongoing stakeholder outreach and engagement.	Will continue existing outreach and align efforts with the stakeholder engagement strategy upon its completion and into 2022.	✓	↺	↺	↺	↺	↺

Goal 2 - Ensure Adequate Funding to Meet Stormwater Program Objectives

Key Action	Status	*2021*	*2022*	*2023*	*2024 to 2028*	*2029 to 2033*	*2034 to 2038*
Key Action 2.1: Identify and evaluate all stormwater activities, revenues, and expenditures.	Initiated during LTSW planning process. Plan to update estimates for current stormwater activities by the end of 2021.	✓	-	↺	↺	↺	↺
Key Action 2.2: Develop and work toward implementing a future program funding strategy.	Not started.	-	✓	✓	↺	↺	↺

Goal 3 - Achieve Efficient, Proactive, and Cost-Effective Operation and Maintenance of the City's Stormwater Infrastructure Through Asset Management

Key Action	Status	*2021*	*2022*	*2023*	*2024 to 2028*	*2029 to 2033*	*2034 to 2038*
Key Action 3.1: Develop program scope, goals and objectives, and timeline and establish asset management task force.	Initiated during LTSW planning process. Plan to coordinate across departments and complete by end of 2021.	✓	-	-	↺	↺	↺
Key Action 3.2: Develop an asset inventory.	Start by end of 2021. This key action is a critical starting point and other relevant key actions such as 3.3 to 3.6 will be considered when embarking on this effort.	✓	✓	✓	✓	✓	↺
Key Action 3.3: Evaluate asset condition and performance.	Not started.	-	✓	✓	✓	✓	↺
Key Action 3.4: Estimate asset value, remaining useful life, and replacement cost.	Not started.	-	-	✓	✓	✓	↺

Key Action	Status	*2021*	*2022*	*2023*	*2024 to 2028*	*2029 to 2033*	*2034 to 2038*
Key Action 3.5: Establish LOS and associated performance measures.	Not started.	-	-	✓	↺	↺	↺
Key Action 3.6: Assess asset criticality and risk.	Not started.	-	-	✓	✓	↺	↺
Key Action 3.7: Optimize capital and O&M costs and prioritize investments (life cycle costing).	Not started.	-	-	-	✓	✓	↺
Key Action 3.8: Develop a funding strategy.	Not started.	-	✓	✓	✓	↺	↺
Key Action 3.9: Document asset management activities in a written plan.	Not started.	-	-	✓	↺	↺	↺
Key Action 3.10: Conduct training, education, and outreach.	Not started.	-	✓	✓	↺	↺	↺
Key Action 3.11: Pursue continuous evaluation and improvement.	Not started.	-	✓	✓	↺	↺	↺

Goal 4 - Improve the City's Resilience to Flooding

Key Action	Status	*2021*	*2022*	*2023*	*2024 to 2028*	*2029 to 2033*	*2034 to 2038*
Key Action 4.1: Leverage FEMA's programs for pre- and post-disaster mitigation to obtain project funding.	Pursue when project opportunities arise.	✓	✓	✓	↺	↺	↺
Key Action 4.2: Explore alternative bank stabilization approaches to reduce flashiness of flows in Gordon's Creek and create a greater community connection to the creek.	Pursue when project opportunities arise.	✓	✓	✓	↺	↺	↺
Key Action 4.3: Evaluate the city's current practices for flood resiliency using EPA's Flood Resilience Checklist.	Initial evaluation complete. City to consider recommendations and evaluate next steps by the end of 2021.	✓	-	✓	↺	↺	↺
Key Action 4.4: Improve the city's rating for flood insurance rate reduction.	Complete by July 1, 2021.	✓	-	-	↺	↺	↺

Goal 5 - Identify Opportunities for Improved Stormwater Management and Green Infrastructure in Public Projects

Key Action	Status	*2021*	*2022*	*2023*	*2024 to 2028*	*2029 to 2033*	*2034 to 2038*
Key Action 5.1: Identify public parcels and projects.	Completed. Update information at end of 2021.	✓	✓	✓	↺	↺	↺
Key Action 5.2: Assess areas that are potentially suitable for green infrastructure.	Completed. Reevaluate analysis during project planning. Update analysis at end of 2021.	✓	-	✓	↺	↺	↺
Key Action 5.3: Perform site investigations and develop design concepts.	Pursue when project opportunities arise.	✓	✓	✓	↺	↺	↺
Key Action 5.4: Develop and update procedures to implement green infrastructure.	Not started. The city has not yet installed green infrastructure practices.	-	-	✓	↺	↺	↺
Key Action 5.5: Develop an O&M plan for public green infrastructure.	Not started. The city has not yet installed green infrastructure practices.	-	-	✓	↺	↺	↺