SULLIVAN'S ISLAND

Sea Level Adaption & Resilience Plan

DRAFT

Table of Contents

Table List

Figure List

Introduction Letter

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I. Background and History

Sullivan's Island, South Carolina has a rich and layered history shaped by its geography, military history, and cultural significance.

Sullivan's Island is a low-lying barrier located along the Atlantic Ocean which is bordered to the west by the entrance to Charleston Harbor and to the east by Breach Inlet. The Ben Sawyer bridge connects Sullivan's Island to Mount Pleasant to the north. A bridge spanning Beach Inlet connects the Island to Isle of Palms to the east. Sullivan's Island is part of Charleston County and had a population of just under **2,000 people** in the 2020 census. The Island has about **4 miles** of oceanfront and a total area of **3.4 square miles**, of which about **1 square mile** is tidal salt marsh.

Figure 1: Breach

In the pre-colonial era, prior to the 1600s, the Island was originally inhabited by Native American Tribes who fished, hunted, and traded in the region. The Island was named for Captain Florence O'Sullivan who was stationed there as a lookout when English began settling the Island. Sullivan's Island was a key entry point of the Trans-Atlantic Slave Trade, serving as a quarantine station en route to the port of Charleston. Sullivan's military involvement in both the Revolutionary and Civil Wars led to its establishment as an important military base up until the conclusion of World War II, when the Fort was decommissioned. Fort Moultrie is now part of the Fort Sumter and Fort Moultrie National Historic Park which is managed by the National Park Service.

Following the decommissioning of Fort Moultrie, the Island began to transition to a residential beach community in the 1950s and 1980s. It now serves as a popular recreation spot for tourists and neighboring communities in Charleston County. Due to the process of sand-bar attachment from the sediment transport dynamics at Breach Inlet combined with hydromodifications to the Charleston harbor mouth with the installation of the harbor jetties in the 1890's, Sullivan's Island has a thriving broad beach and maritime forest that buffers the majority of beach front residences from the full effects of storm impacts. The Island suffered severe damage from Hurricane Hugo in 1989 with flood levels 5 feet deep in some locations. At that time, Town Council went through the process of securing the preservation of the dunes and maritime forest in perpetuity with the organization now known as the Lowcountry Land Trust. Since that time, the forest has developed into a 200 acre preserve of maritime forest, dune ridge trails, isolated wetlands, and grassland dune scrub vegetation of the beachfront dunes. Furthermore,

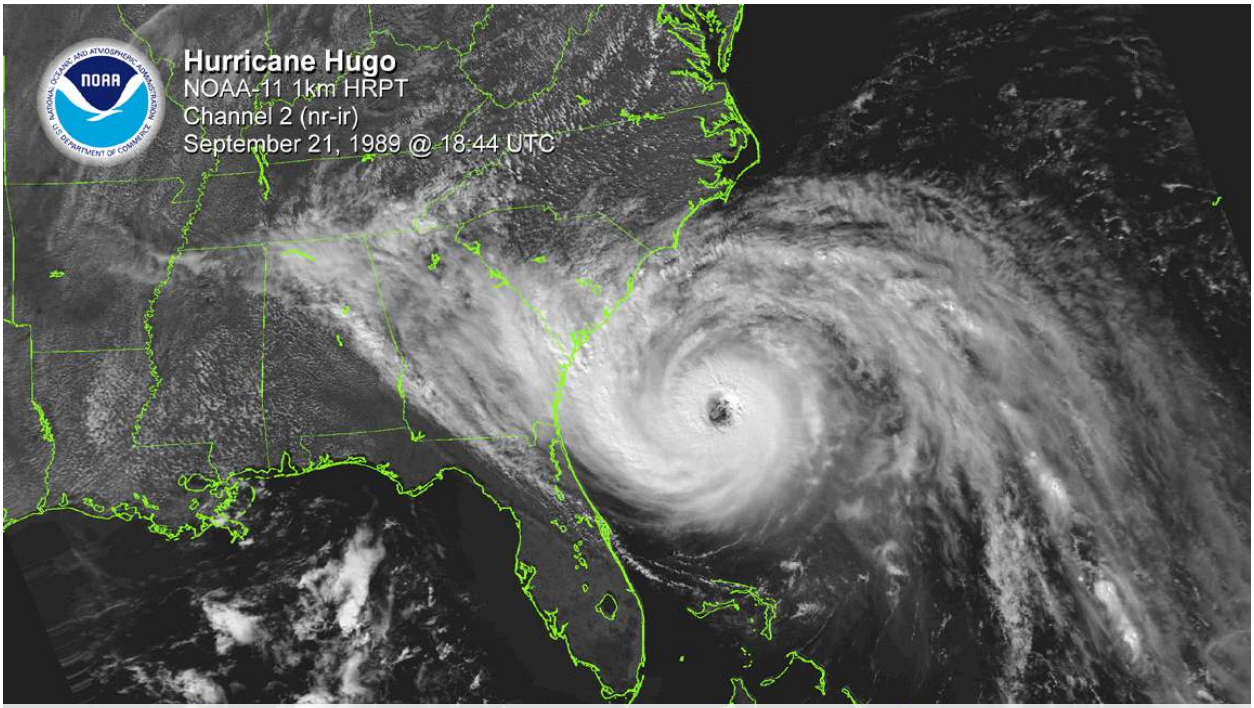


Figure 2: Hugo

Figure 3: Sunset

the causeway on marsh side of the island has caused siltation of the creeks to occur, building up marsh plateaus and creating thriving saltmarsh where open water used to exist . As a result, Sullivan's Island would be more resilient today to the effects of the storm surge felt in 1989. The buffering capacity of salt marsh and maritime forest to gale force winds and storm surge is a tremendous asset thanks to the foresight and wisdom of past Councilmembers and residents who advocated for natural resource.

Today the Island continues to face challenges from flood events such as hurricanes, extreme rainfall, and tidal events and is working to achieve long-term coastal resiliency. This resiliency process began with the creation of the Island-Wide Stormwater Master Plan and Infrastructure Improvement Strategy which was completed in February 2025. This report investigated drainage deficiencies to propose solutions to mitigate existing and future flooding. Building off the momentum of the solutions proposed in the Stormwater Master Plan and Federal Emergency Management Agency (FEMA), Building Resilient Infrastructure and Communities (BRIC) funding, which was received in 2023, the Town

Plan Vision

The Sullivan's Island Resilience & Sea Level Adaption Plan will provide **strategies on diverse scales**, ranging from community-wide to site level opportunities, that **honor the history** of the Island and learn from past applications, identify open areas for **storage and protection**, and further understand challenges to provide **adaptive solutions** through 2050.

acquired the team of Weston & Sampson, McCormick Taylor, and Elko Coastal Consulting to produce this Sullivan's Island Sea Level Adaptation and Resilience Plan.

This Plan was co-developed with the community and decision makers through robust engagement strategies including stakeholder interviews, community surveys, engagement sessions, and presentations to the Sullivan's Island Town Council and the Sullivan's Island Planning Commission. An initial planning analysis of other relevant plans concerning natural hazards was also conducted to ensure an understanding of current efforts in the County, region, and State. Both GIS analysis and Hydrologic and Hydraulic modeling informed the Plan's recommendations with a better understanding of existing and future conditions.

Plan Goals

Goal #1: Engage

Plan is co-developed with the community to increase buy-in and ensure a place-based approach where strategies for continued community involvement are established.

Goal #2: Protect

Protect natural and cultural resources through management and policy efforts.

Goal #3: Restore

Restore natural systems on the island using nature-based solutions that provide improved hydrology, ecological function, and enhanced aesthetics.

Goal #4: Adapt

Adapt on diverse scales that consider parcel-level strategies to community-wide approaches.

II. Plan Analysis

A review of relevant local, county, state, and regional plans, as listed below, was conducted to provide background information and identify opportunities for the Sullivan's Island Sea Level Adaptation & Resilience Plan.

1

Town of Sullivan's Island Comprehensive Plan:

The Comprehensive Plan consists of ten elements including elements that touch upon natural resources and resiliency and sea level rise. This plan is intended to serve as the guiding document for all land use decisions within the Town.

2

Charleston County Hazard Mitigation Plan:

Sullivan's Island is a participant in the county-wide Hazard Mitigation Plan. This plan includes a risk and vulnerability assessment as well as a list of mitigation action items that the Town plans to pursue.

3

Town of Sullivan's Island Accreted Land Management Plan:

A management plan that includes goals for the conservation and recreation zone created on the seaward edge of the Island through ordinance and deed restrictions.

4

Town of Sullivan's Island Comprehensive Beach Management Plan 2017:

This plan is required by the state of South Carolina for the Town to remain eligible for federally funded beach renourishment. The plan examines all policies that are in force in the beachfront area as well as the agencies responsible for implementing those policies.

5

Town of Sullivan's Island Protected Land Management Plan:

This plan provides management guidance for preserving the land placed under protection with the Lowcountry Open Land Trust as well as additional land owned by the Town.

6

Town of Sullivan's Island 2023 Beach Monitoring Report:

Conducted by Coastal Science and Engineering, the Annual Monitoring Report documents the condition of the beach by tracking changes in beach width, sand volumes, and other related factors that impact the shoreline.

7

Connected Land Conservation Plan of the East Cooper Region of SC:

This plan aims to map existing green infrastructure assets, inventory the region's recreational, historic, and cultural assets, assist municipalities with making informed decisions regarding natural assets, and begin a conservation project prioritization process.

8

South Carolina Statewide Resilience Plan:

This plan serves as a framework to guide state investment in flood mitigation projects and to guide adoption of programs and policies that will lessen the impact of natural disasters and protect the people and property of South Carolina.

9

Town of Sullivan's Island Historic Resources Survey:

This plan conducts a property-by-property survey of all historical assets on Sullivan's Island and provides recommendations for their management and preservation.

10

Charleston City Plan Land and Water Analysis:

This plan examines the interaction between aspects of land and water through watershed boundaries within the city. The results of this plan are to be used as underlying data to inform and improve the resiliency of future City decisions.

Methodology

The selected plans were evaluated based on the level of detail provided for the listed 13 factors in the table below. These selected topics relate to sea level and resilience and provide a lens to identify commonalities and gaps that may exist.

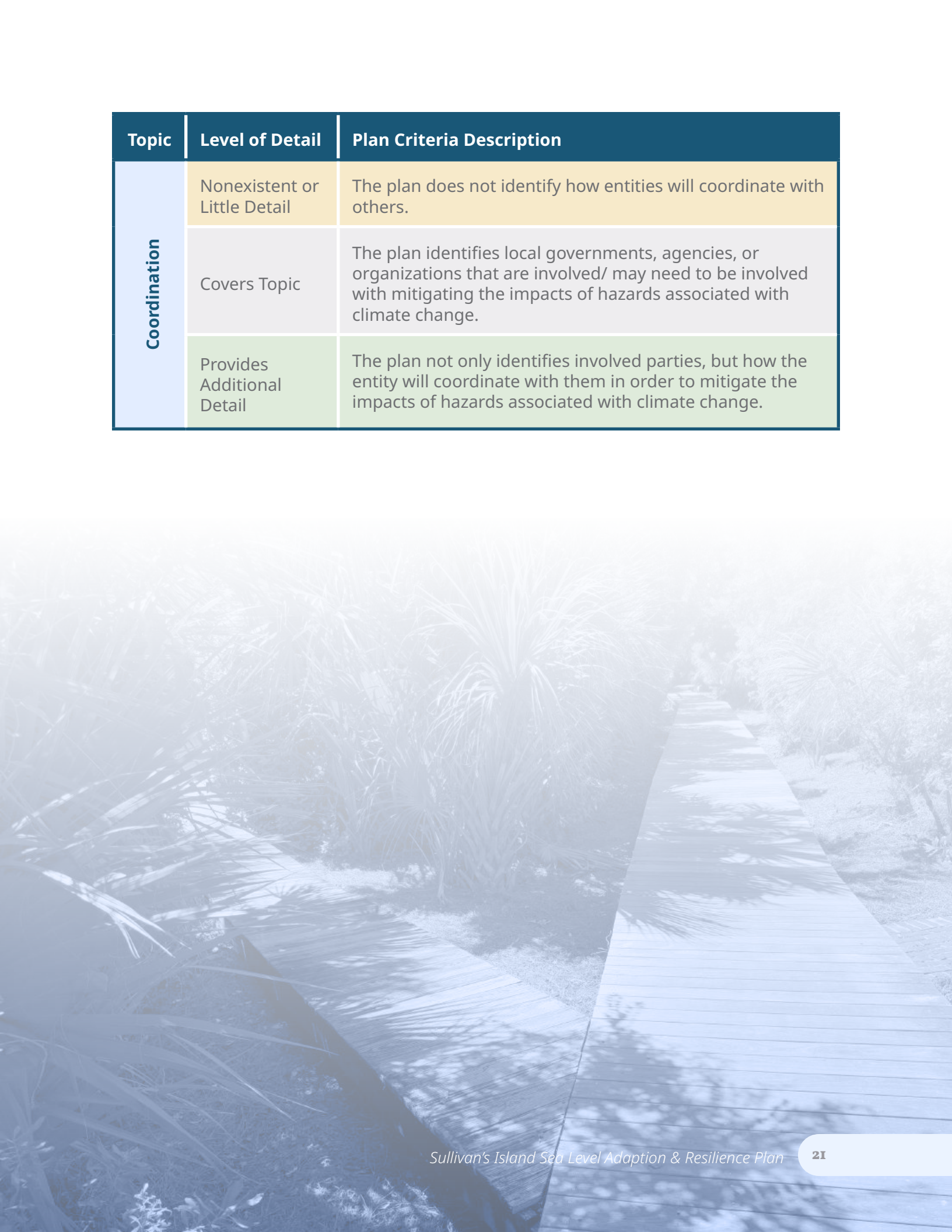
Table 1: Methodology

Topic	Level of Detail	Plan Criteria Description
Climate Change	Nonexistent or Little Detail	The plan does not mention climate change and associated concerns.
	Covers Topic	The plan addresses the topic of climate change and details associated concerns.
	Provides Additional Detail	The plan not only addresses climate change but offers a summary/description of climate change impacts.
Sea Level Rise / Hazard Assessment	Nonexistent or Little Detail	The plan does not contain a sea level rise/hazard assessment.
	Covers Topic	The plan mentions sea level rise and other hazards such as fire, earthquakes, and drought and/or others some level of sea level rise/hazard assessment mapping.
	Provides Additional Detail	The plan offers a detailed sea level rise and/or hazard assessment. This assessment includes a delineation of likely regional sea level rise and boundaries of the areas that will be impacted and a description on the impacts of sea level rise and impacts of previous flood events and/or frequency of flooding.
Risk and Vulnerability	Nonexistent or Little Detail	The plan does not address risk and vulnerability.
	Covers Topic	The plan addresses the vulnerabilities of environmental assets, floodplains, land use, coastal populations, private property, repetitive loss properties, or critical facilities.
	Provides Additional Detail	The plan not only addresses the vulnerabilities of assets and populations but provides further detail on the specific types and number.

Topic	Level of Detail	Plan Criteria Description
Goal Setting	Nonexistent or Little Detail	The plan does not mention goals.
	Covers Topic	The plan sets broad goals for mitigating flooding and/or the impacts of sea level rise.
	Provides Additional Detail	The plan sets broad goals and specific objectives or actions for mitigating flooding and/or the impacts of sea level rise.
Policies	Nonexistent or Little Detail	The plan does not provide specific policies to guide public and private land use decisions that mitigate the impacts of sea level rise and flooding.
	Covers Topic	The plan provides specific policies to guide public and private land use decisions that mitigate the impacts of sea level rise and flooding.
	Provides Additional Detail	The plan not only provides specific policies, but also describes how the Town supports development or updates to policies that are required or encouraged by federal programs/agencies such as FEMA, National Flood Insurance Program, and related.
Federal and State Funding	Nonexistent or Little Detail	Federal and state funding or programs are not mentioned.
	Covers Topic	Federal and state funding or programs are mentioned.
	Provides Additional Detail	The plan addresses federal or state programs that provide funding for actions or strategies that will mitigate flooding and the impacts of sea level rise.
Public Safety	Nonexistent or Little Detail	The plan does not address public safety issues that arise as a result of frequent flooding or sea level rise.
	Covers Topic	The plan addresses public safety issues that arise as a result of frequent flooding or sea level rise.
	Provides Additional Detail	Not only does the plan address these public safety issues but includes actions or steps that will be taken to improve public safety.

Topic	Level of Detail	Plan Criteria Description
Loss Reduction (Physical and Fiscal)	Nonexistent or Little Detail	The plan does not mention loss reduction.
	Covers Topic	The plan provides damage assessment information or history of damages.
	Provides Additional Detail	The plan seeks to reduce damages, both physical and fiscal by providing history and actions pertaining to loss reduction/prevention.
Policy Implementation	Nonexistent or Little Detail	The plan does not mention implementation policies.
	Covers Topic	The plan describes how policies that will mitigate sea level rise will be implemented.
	Provides Additional Detail	Not only does the plan describe how policies that mitigate sea level will be implemented, but the policies also identify a responsible entity, budget, staff, or technical assistance that will be needed to implement mitigation actions.
Obstacles and Barriers	Nonexistent or Little Detail	The plan does not identify obstacles to mitigation and adaptation planning and a systematic approach.
	Covers Topic	The plan identifies the obstacles to mitigation and adaptation planning.
	Provides Additional Detail	The plan not only identifies obstacles to mitigation and adaptation planning but provides a systematic approach to overcoming obstacles that inhibit the mitigation planning process.
Monitoring and Evaluation	Nonexistent or Little Detail	This plan does not provide monitoring and evaluation of implementation.
	Covers Topic	The plan provides some details on monitoring changes in sea level rise projections, hazard activity, or evaluating the implementation of mitigation policies or projects.
	Provides Additional Detail	The plan provides a comprehensive approach of monitoring changes in sea level rise projections, hazard activity, or evaluating the implementation of mitigation policies or projects.

Topic	Level of Detail	Plan Criteria Description
Coordination	Nonexistent or Little Detail	The plan does not identify how entities will coordinate with others.
	Covers Topic	The plan identifies local governments, agencies, or organizations that are involved/ may need to be involved with mitigating the impacts of hazards associated with climate change.
	Provides Additional Detail	The plan not only identifies involved parties, but how the entity will coordinate with them in order to mitigate the impacts of hazards associated with climate change.



Results

LEGEND
- Nonexistent or Little Detail
- Covers Topic
- Provides Additional Detail

Table 2: Results

	TOSI Comprehensive Plan	Charleston County HMP	TOSI Accreted Land Management Plan	TOSI Comprehensive Beach Management Plan	TOSI Protected Land Management Plan	TOSI 2023 Beach Monitoring Report	Connected Land Conservation Plan of the East Cooper Region of SC	SCOR Statewide Resilience Plan	TOSI Historic Resources Survey	City of Charleston Land & Water Analysis
Year Adopted/ Released	2019	2024	2010	2017	2011	2023	2017	2023	2024	2024
Climate Change	Climate change is mentioned once.	Climate change is mentioned multiple times throughout the report.	The plan does not go into any detail on climate change.	Climate change is not mentioned nor elaborated on.	Climate change is not mentioned nor elaborated on.	Climate change is not mentioned nor elaborated on.	Climate change is not mentioned nor elaborated on.	Climate change is not directly mentioned. Related topics are covered.	Climate change is not mentioned nor elaborated on.	Climate change is mentioned once in the report.
Sea Level Rise/Hazard Assessment	Contains a Resilience and Sea Level Rise chapter; mentions previous flooding events; mentions impacts to the island from sea level rise; contains projections from NOAA.	Identifies areas of frequent flooding and previous flooding occurrences; includes SLR projections from NOAA.	Need for fire control in the AL area; general sea level rise assessment and contains projections from IPCC; monitors annual average shoreline change; history of storms and flooding; discussion of FEMA flood maps.	History of storms and flooding that have impacted the greater Charleston area.	Sea level rise is not mentioned.	Projections from NOAA/ IPCC; discusses different scenarios under different emissions.	Sea level rise is not mentioned.	Sea level rise is addressed and metrics provided.	Sea level rise is not mentioned.	Contains SLR projections from NOAA, but Sullivan's Island is not included in the project area.
Risk & Vulnerability	Identifying stormwater collection deficiencies with an engineering firm, no risk and vulnerability assessment provided.	Identifies buildings vulnerable to flooding due to location and year of construction, provides valuation of these structures.	Identifies potential outcomes due to continued SLR, vulnerability of dune system; response of shoreline under a range of SLR scenarios; model to show the impact on flooding from changes to dunes/ vegetation; vulnerability of ocean front houses.	Beachfront structural inventory; threatened and endangered species.	Risk and vulnerability of protected lands depends on rates of erosion, sand deposition, hurricanes, and sea level rise.	Tracks changes in beach width, sand volumes; assesses properties and roads that could be underwater under different SLR scenarios.	Risk and vulnerability are not addressed.	Flood Risk and Vulnerability Assessment provided.	Risk and vulnerability are not addressed.	Identifies risk to properties based on elevation and year of construction; identifies risk to wetlands from sea level rise.

	TOSI Comprehensive Plan	Charleston County HMP	TOSI Accreted Land Management Plan	TOSI Comprehensive Beach Management Plan	TOSI Protected Land Management Plan	TOSI 2023 Beach Monitoring Report	Connected Land Conservation Plan of the East Cooper Region of SC	SCOR Statewide Resilience Plan	TOSI Historic Resources Survey	City of Charleston Land & Water Analysis
Goal Setting	4 goal actions (stormwater infrastructure improvements, drainage outfall improvements, regulatory compliance with TOSI floodplain ordinance, outreach and community engagement via CRS); goals and objectives in the appendix.	Goal setting in Chapter 2 (reduce potential flood damage, improve storm drainage, minimize future flood occurrence, improve resiliency of infrastructure, protect open space, higher regulatory standards, increase cooperation and coordination).	Manage the land for future generations by providing protection from storm and tidal impacts.	Aligns with goals of natural resources element in the Comprehensive Plan.	Enhance public safety, minimize fire hazard, encourage restoration of wetlands; strengthen dunes.	Goals are not mentioned.	Goals and strategies are mentioned in land conservation, connectivity of green spaces.	Broad goals are provided with specific actions and implementation details.	Goals are not mentioned.	Several goals for zones are identified, this includes those for Grow, Defend, Adapt, Reserve.
Policies	Mentions FEMA elevation requirements for new construction in the floodplain; TOSI Floodplain Ordinance; residential stormwater plans; non-conversion agreements; compliance with National Flood Insurance Program.	Reviews compliance with National Flood Insurance Program requirements; mentions flood damage prevention ordinance; lists TOSI's higher regulatory standards such as freeboard, enclosure limitations, V zone design standards, etc.	State and local development setbacks and control lines by DES; NFIP and local Town Flood Ordinance; deed restrictions established by the Town; Federal Endangered Species Act; Federal Clean Water Act; FEMA and NFIP regulations; FEMA construction standards in V Zones.	Drainage plan, post disaster plan, conventional zoning and land use plan for the area seaward of the setback line; flood prevention ordinance; zoning district recreation conservation along the beachfront accretional land to protect it from development; no drainage allowed toward the beachfront; reviews state and federal beachfront policies; conservation easements on beachfront properties.	Protected land under Deed Restriction with Lowcountry Open Land Trust and TOSI.	Specific principles are not mentioned.	Sullivan's Island has zoned protected lands as "Conservation."	Specific principles are not mentioned.	Specific principles are not mentioned.	Specific principles are not mentioned.

	TOSI Comprehensive Plan	Charleston County HMP	TOSI Accreted Land Management Plan	TOSI Comprehensive Beach Management Plan	TOSI Protected Land Management Plan	TOSI 2023 Beach Monitoring Report	Connected Land Conservation Plan of the East Cooper Region of SC	SCOR Statewide Resilience Plan	TOSI Historic Resources Survey	City of Charleston Land & Water Analysis
Federal and State Funding	FEMA grant obtained in 2017 to study the existent stormwater drainage deficiencies; additional FEMA grants being sought after.	The plan does not mention federal and state funding.	Identifies potential funding sources in Appendix 11.	The plan does not mention federal and state funding.	The plan does not mention federal and state funding.	Federal and state funding is not mentioned.	Federal and state funding is not mentioned.	Federal and state funding sources are mentioned.	Federal and state funding is not mentioned.	Federal and state funding is not mentioned.
Public Safety	Identifies emergency services notification systems, SIRENS systems, EOC operations, and participation in the CCEOP.	The HMP serves to improve the safety of citizens against natural and manmade hazards; specific actions aim to take steps towards safety.	Public safety addressed for each management alternative; considers emergency access to the beach .	Conservation zoning districts exist in the beach area to protect safety and welfare of residents and to buffer developed residential properties from floodwaters; retreat strategy so risks to private and public resources are minimized.	Enhance public safety, minimize fire hazard.	The plan does not address public safety issues directly.	The plan does not address public safety issues directly.	The plan does not address public safety issues directly.	The plan does not address public safety issues directly.	The plan does not address public safety issues directly.
Loss Reduction (Physical & Fiscal)	Performed damage assessment after previous flooding events that totaled 3 million dollars in property damages.	The HMP serves to improve loss reduction in the county. History and impacts relating to physical and fiscal losses are mentioned.	Calculated potential economic losses due to 10-year and 100-year storm events.	Identifies strategies that can be used to reduce damage to public infrastructure and private property that may be jeopardized due to erosion.	The plan does not address loss reduction.	The plan does not address loss reduction.	The plan does not address loss reduction.	The plan provides the history of loss and provides methods of reducing it.	The plan does not address loss reduction.	The plan seeks to reduce losses to the built environment.
Policy Implementation	Identifies that an increase in staffing may be needed in the coming years; identifies responsible staff for each goal in the appendix.	Identifies responsible party for mitigation action items.	Strategy and target vegetation mixes for four defined areas of Sullivan's Island are provided.	Identifies the responsible agency for implementation of beachfront policies.	The plan does not address implementation.	The plan does not address implementation.	The plan does not address implementation.	The plan does not address implementation.	The plan does not address implementation.	The plan does not address implementation.

	TOSI Comprehensive Plan	Charleston County HMP	TOSI Accreted Land Management Plan	TOSI Comprehensive Beach Management Plan	TOSI Protected Land Management Plan	TOSI 2023 Beach Monitoring Report	Connected Land Conservation Plan of the East Cooper Region of SC	SCOR Statewide Resilience Plan	TOSI Historic Resources Survey	City of Charleston Land & Water Analysis
Obstacles and Barriers	No obstacles or barriers are mentioned.	No obstacles or barriers are mentioned.	No obstacles or barriers are mentioned.	No obstacles or barriers are mentioned.	No obstacles or barriers are mentioned.	No obstacles or barriers are mentioned.	Recognizes that a non-governmental organization can plan but not implement.	Plan was developed in less than two years and during covid pandemic which limited public participation, some barriers are mentioned.	No obstacles or barriers are mentioned.	No obstacles or barriers are mentioned.
Monitoring and Evaluation	Monitoring is mentioned, but no overall comprehensive approach.	Maintenance plan of the HMP is that it is updated and reviewed annually and progress of mitigation actions must be noted annually.	Identifies criteria for success for each management strategy.	Monitors shoreline erosion rates/shoreline change analysis.	Monitoring is mentioned for specific invasive species, but no overall approach for sea level rise, hazards, or implementation of policies.	Monitors physical parameters of the beach and shoreline.	Monitoring is mentioned, but no overall comprehensive approach.	Development of resilience metrics.	Monitoring and evaluation are not mentioned.	Monitoring and evaluation are not mentioned.
Coordination	Identifies the need to coordinate with SCDOT and Charleston County to improve pipes, ditches, and outfall junction devices; coordinate with Charleston Resilience Network, DES, City, Sea Grant, NOAA and other public and private orgs to consider policies that encourage resiliency towards the impacts of flooding and high water.	Identifies coordinating agencies for some mitigation action items.	Coordination with other agencies is not mentioned.	Identifies all the regulatory agencies with authority over the beachfront.	Coordination with other agencies is not mentioned.	Coordination with other agencies is not mentioned.	Identifies the need for the Town and local land trusts to continue to work together to conserve land.	Identifies partners such as NOAA, First Street Foundation, SCEMD, FEMA, and SCDNR.	Coordination with other agencies is not mentioned.	Coordination with other agencies is not mentioned.

Discussion

Of the ten reviewed plans, many provided sea level rise and related hazard data for current and future projections extending to 2070 across a range of geographic scales. Another aspect that was heavily considered in the reviewed plans was risk and vulnerability assessments. Although only a few of the plans detailed the specific assets that are vulnerable to hazards such as sea level rise, most plans detailed deficiencies and general concerns with hazards. Some plans included building and property types that were at risk. Public safety was greatly considered in several plans, and a few plans identified actions relating to protecting people as well as physical and fiscal losses. Additionally, many plans at least outlined broad goals, while a few included action-oriented objectives, providing usable roadmap-style frameworks for consideration.

Several gaps were identified in the reviewed plans. Few reports explicitly mention the word "climate change" and even fewer identified the associated impacts of climate change. There was limited mention of obstacles and barriers to climate adaptation and resilience planning in the reviewed plans. Some plans mention available state and federal funding; however, many plans do not go into detail on the relevancy of programs or even program names. More information is needed on available state and federal funding sources and details on which specific programs are relevant to project types.

Sullivan's Island Sea Level Adaptation & Resilience Plan can address the resilience planning information gap by providing information on how Sullivan's Island is susceptible to climate change and the associated concerns. To create synergy with the established goals and strategies in existing plans, overlapping goals will be recognized where appropriate within the adaptation and resilience plan. Alongside improving access to state and federal funding, the Plan will identify obstacles and barriers specific to mitigation and adaptation for Sullivan's Island.

III. Stakeholder Engagement

The Sullivan's Island Sea Level Adaptation and Resilience Plan was co-developed with the community to create a place-based approach in identifying strategies to achieve greater Island resiliency.

Throughout the Plan development process, the community was engaged through diverse approaches including stakeholder interviews, a community survey, presentations, and engagement events. Stakeholder engagement is a critical component to any planning process and provides a deeper understanding of existing conditions.

Community Engagement Summary

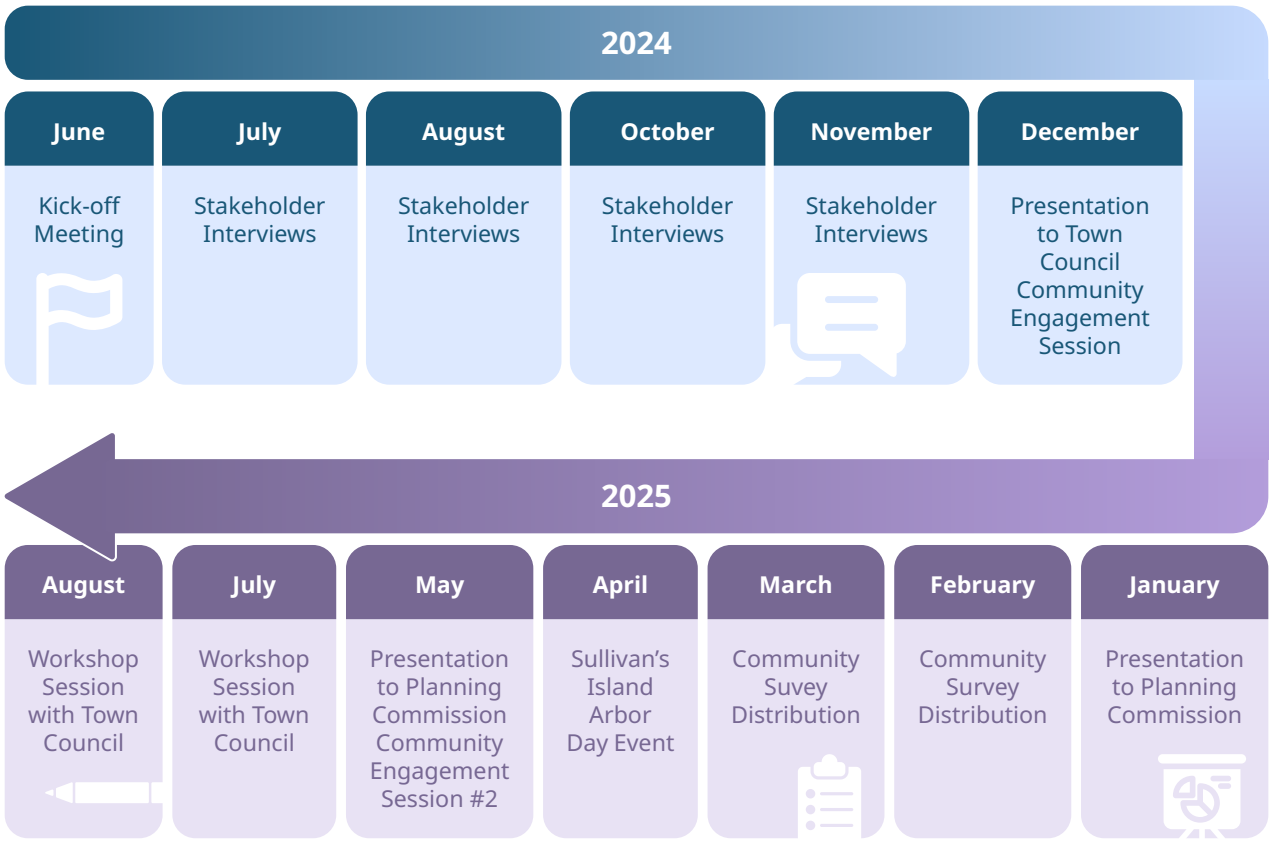


Figure 4: Presentation of model results to Sullivan's Island Planning Commission in May 2025

Stakeholder Interviews

In the early stages of this Plan's development, the consultant team conducted two rounds of stakeholder interviews. Stakeholders for interview were identified through collaboration with Town staff. Each interview asked open-ended questions and lasted approximately one hour. The first round of interviews took place from July to August, 2024 and the second round took place from October to November, 2024. The interviews included individuals who lived and/or worked on the Island including emergency first responders, Town staff, the Water & Sewer District Department, Island contractors, design professionals, business owners, community groups, and residents from different parts of the Island including the "back beach" and beachfront. The interviews also included individuals whose work relates to Sullivan's Island or has a similar focus including SC Department of Transportation, SC Sea Grant Consortium, SC Department of Environmental Services, Charleston County Stormwater Department, Sustainability Institute, Battery Gadsen Cultural Center, and Isle of Palms Town staff. In total, thirty-three individuals were interviewed, each of which provided valuable information that served as a foundation for the Plan's development.

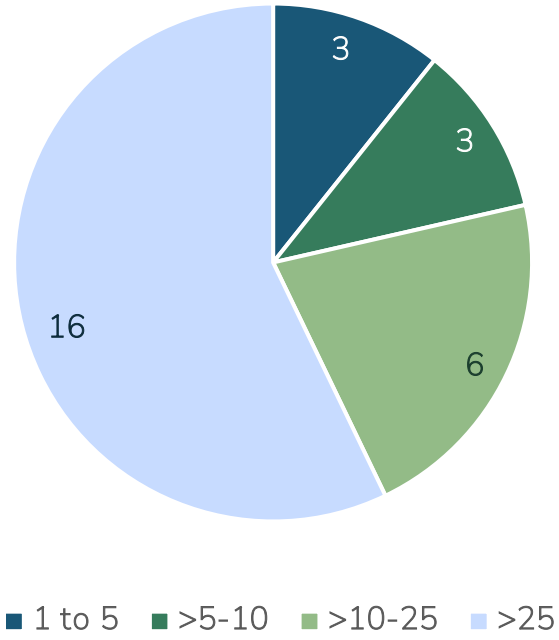
Figure 5: A local business owner showcases a sump pump used during high water events to reduce flooding in his place of business along Middle Street

Interview Results

In question one, participants were asked **how long they have lived or worked on Sullivan's Island or been involved with the community.** Results can be seen in Table 3.

Table 3: Interviewee Time Spent Working or Living on the Island

Most interview participants have lived and/or worked on Sullivan's Island for **over twenty-five years.**

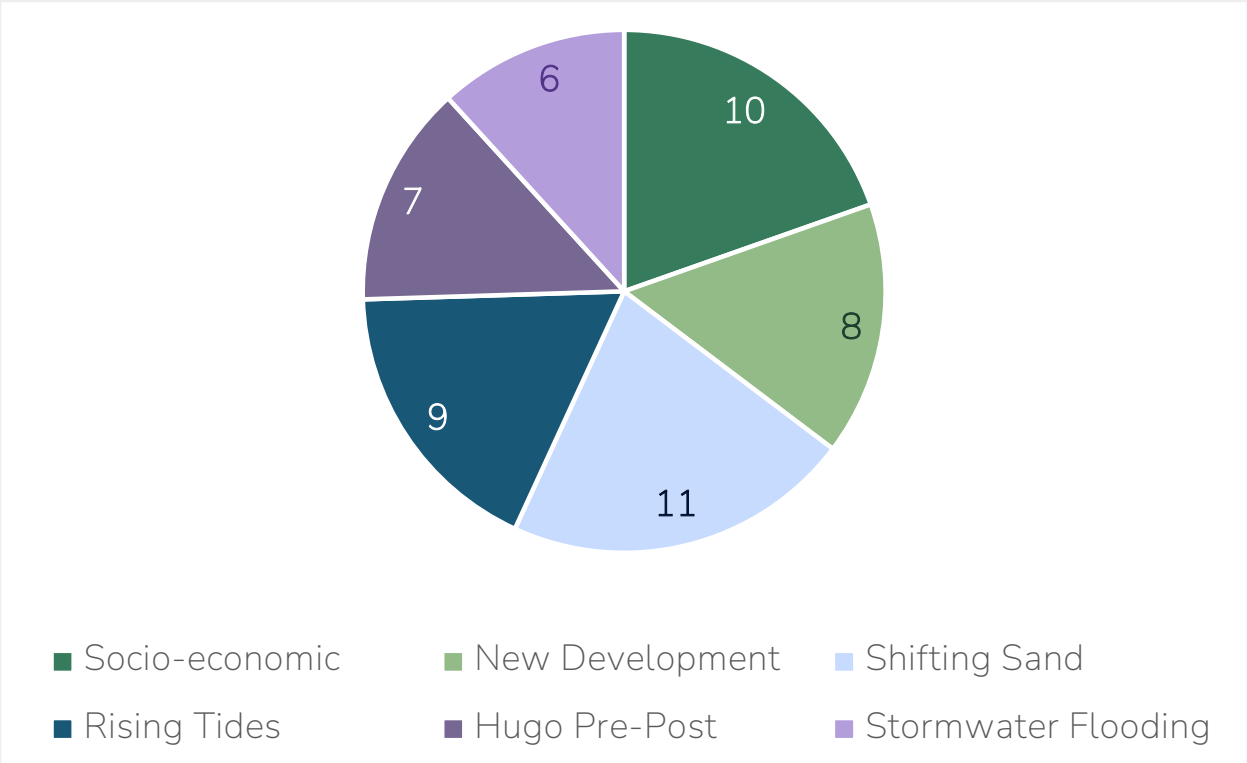


Interview participants were asked **"How have you witnessed Sullivan's Island change since your introduction to the Island?"** This question was open-ended, responses were recorded, coded and ranked into the following categories:

- Shifting Sand/Coastal Dynamics/Coastal Erosion: **11**
- Socio-economic/More Affluent Now/Larger Homes/More Second Homes: **10**
- Rising Tides/Tidal Flooding during King Tide Events: **9**
- New Construction/New Development: **8**
- Mention of Pre and Post Hugo: **7**
- Stormwater Flooding More Frequent & Intense: **6**
- Regulatory/Policy: **4**
- Frequency and Intensity of Coastal Storm Activity: **4**
- Incorporation of Site Level Flood Prevention Systems: **3**
- More Tourism/More Traffic: **3**
- More Landscaping: **1**
- More Focus on Resiliency: **1**
- More Town Staff: **1**

The top responses can be seen in Table 4:

Table 4: Perceived Changes on the Island

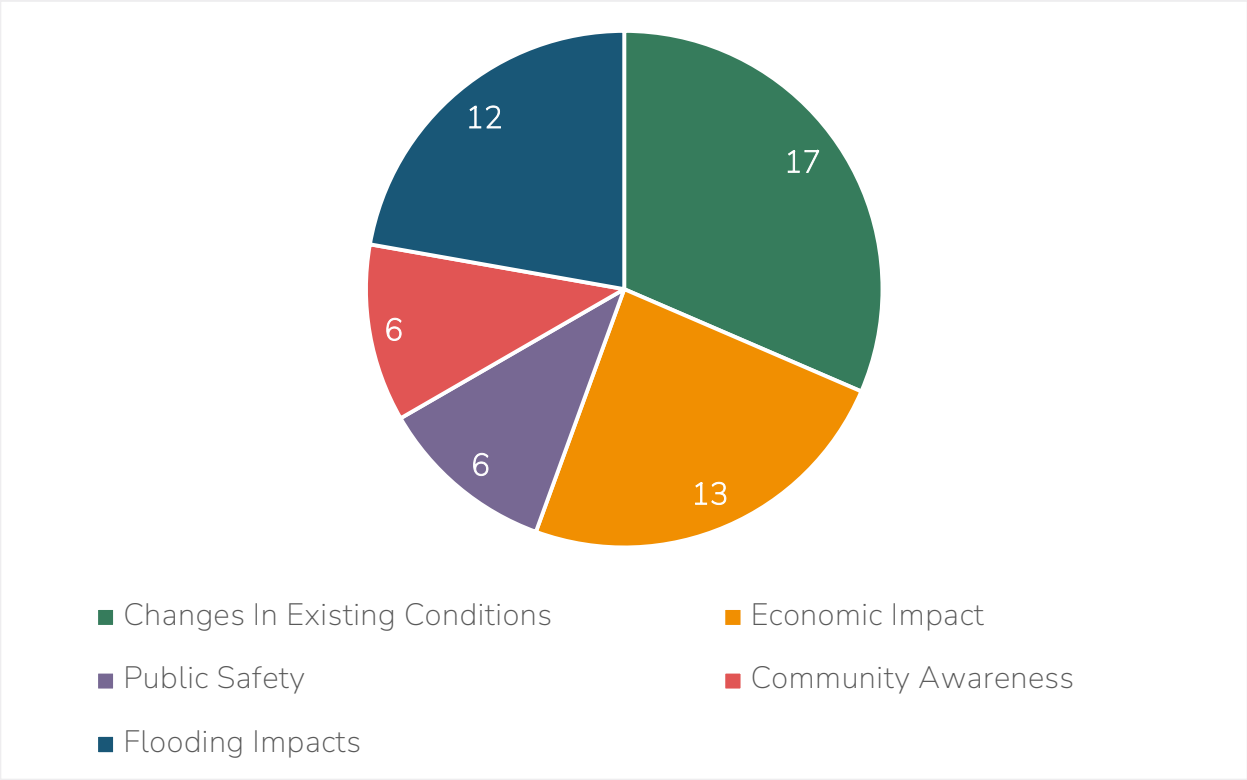


Next, interview participants were asked **"What concerns do you have about the impact of sea level rise, climate change, and flooding as they relate to your operations/ responsibilities/activities on the Island?"** This question was open-ended, responses were recorded, coded, ranked, and grouped into the following categories and represented in Table 5:

Flooding Impacts	• Severe Periodic Flooding: **5** • Rain Bombs: **4** • Flooding due to Ineffective Stormwater System: **3**
Changes in Existing Conditions	• Land Subsidence: **4** • Protection Measures to Address Changes in Shorelines: **3** • Loss of Natural Infrastructure (Trees and Space for Water to Infiltrate): **3** • Stabilization of Uplands on Back Beach: **3** • Dune Preservation: **2** • Damage to Maritime Forest: **1** • Water Quality Impacts: **1**

Public Safety	• Access to the Island: **2** • Public Safety Concerns: **2** • Residents Connecting Stormwater to Sewer Lines: **1** • Residents Pumping Stormwater Downstream Causing Flooding: **1**
Community Awareness	• Community Awareness/Managing Expectations: **4** • Not Concerned/Will Retreat When Time Comes: **2**
Economic Impact	• Damage to Private Property: **5** • Economic Impacts: **3** • Flood Insurance: **2** • Damage to Historical Assets: **2** • Impact on Business: **1**

Table 5: Concern Categories Related to Impacts of Sea Level Rise, Climate Change, & Flooding



Interview participants were asked **"How have you or your organization begun to plan for projects, strategies, or spending for future predictions of sea level rise and/or climate change?"**

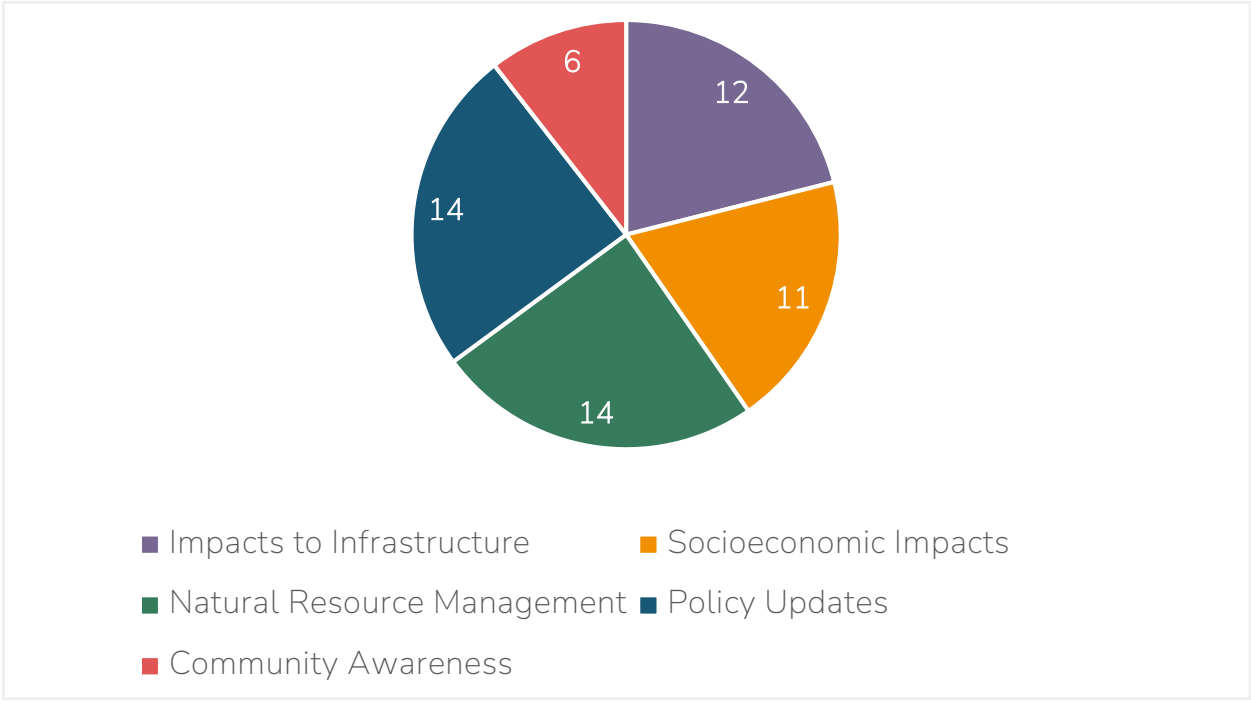
This question was open-ended; responses were recorded and coded into the following categories:

- Structural Adaptations (Pumps, Raising Equipment, Raise Lots, Raise Homes): **13**
- Landscape-level Adaptations (Rain Garden, Bioswale, Cistern, Sand Fencing): **8**
- Monitor Conditions/Mapping: **7**
- Community Education: **4**
- Planning Exercises/Documents: **4**
- Beach Renourishment: **4**
- High Water Vehicles: **2**
- Drainage Infrastructure Maintenance Ahead of Storm: **1**
- Ordinance Revisions: **1**
- Plan for Spending/Prepare Grant Applications: **1**

Next, interview participants were asked **"Are there any unique concerns that your organization has as we work toward developing a plan to address sea level rise and climate change on Sullivan's?"** This question was open-ended; responses were recorded, coded, ranked, and grouped into the following categories and represented in Table 6:

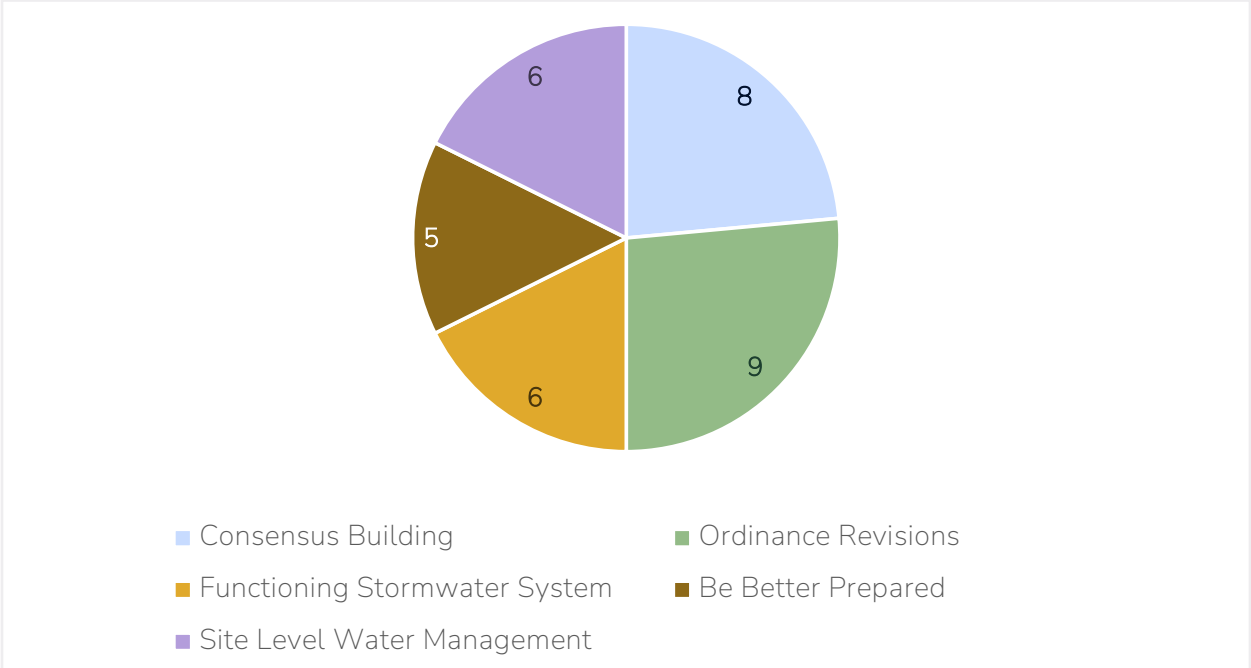
Policy Updates Management	• Sullivan's Island Ordinance Updates & Enforcement: **7** • Development Methods/Typology: **5** • USACE Beneficial Use: **2**
Natural Resource Management	• Protecting Existing Trees/Natural Infrastructure: **7** • Dune Management: **3** • Invasive Species Management: **2** • Groundwater Table: **2**
Impacts to Infrastructure	• Maintenance/Functionality of Drainage Infrastructure: **6** • Access & Impacts to Critical Infrastructure: **4** • Water on Roads/Causeway Cutting Off Access: **2**
Community Awareness	• Raising Community Awareness: **6**
Socioeconomic Impacts	• Inequity Associated with Cost of Living/Impacts to Real Estate Value/Build Out Analysis: **6** • Marginalized/ Most Impacted Populations: **3** • Human Safety as Relates to Heat Increases: **2**

Table 6: Unique Organizational Concerns Associated with SLR & Climate Change



Interview participants were also asked **"What does a successful project look like? How do you think this plan will make Sullivan's Island more resilient?"** The responses to this question were the most diverse. The top ranked coded responses are represented in Table 7.

Table 7: Successful Project Focus



Other responses included:

- Updated infrastructure with adaptative strategies (4)
- Staffing considerations (3)
- Consistent enforcement (3)
- Better communication with SC-DOT (3)
- Better communication between the Town and the community (3)
- Use of town owned properties and right-aways to manage water (3)
- Planning horizon is actionable (3)
- Consistency with other local resilience planning efforts (2)
- Marsh management to combat SLR (2)
- Use of accreted land for buffer (1)
- Recommendation to renew land trust for accreted land (1)
- Consideration for historical/cultural assets (1)
- Identify Island assets (1)
- Create maps that show future flooding (1)
- Protect natural areas (1)

Discussion

Over thirty hours of interview data was recorded and coded from conversations with key stakeholders including community leaders, emergency response personnel, state agencies, non-profit organizations, business owners, and residents. This data set provides a foundation for the vision and focus of the Plan.

Key takeaways from the interview discussions include:

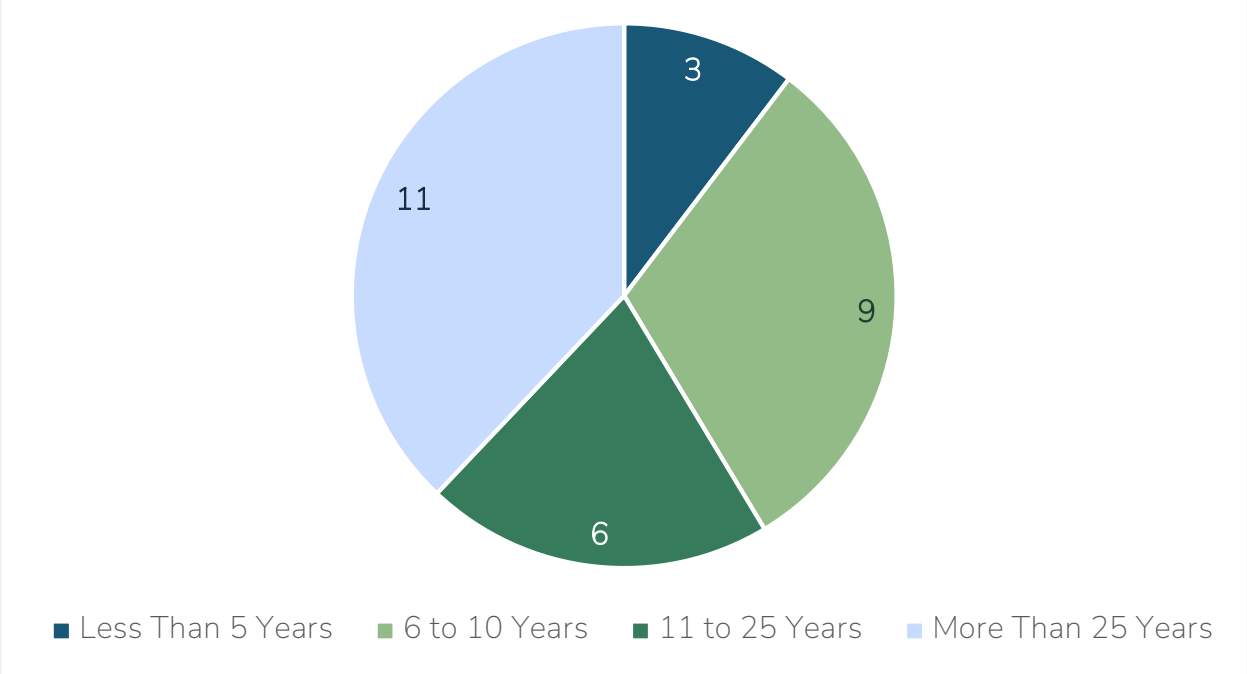
- **Effective communication and consensus building is necessary.** Involvement opportunities and information sharing with residents should include resiliency actions specific to Sullivan's Island.
- **Shifts in socio-economic conditions and an increase in construction** requires updates to local ordinances and policies to inform better site design as it relates to new and re-development. Enforcement should be consistent.
- **Recommended adaptation strategies** must include benefits to natural resource protection. Concerns of impacts to natural resources under future conditions are high.
- **Community safety and the health of natural resources** are outcomes of a more resilient Sullivan's Island.
- **A range of adaptation strategies** have been enacted on the Island to include structural improvements, landscape-level strategies, and monitoring/mapping exercises. These efforts provide ground truthing and momentum to inform future, broader implementation of resiliency practices.

Survey Results

Another component of the community engagement included a community survey aimed at gaining information on resident attitudes and perceptions as it relates to the effects of sea level rise and climate change on Sullivan's Island. The survey was largely closed-ended and the response options that were provided were informed by data collected during the interviews. The survey was distributed through the Town newsletter, featured in the Island Eye News, featured on the project page hosted on the Town website, provided at the Arbor Day event on April 25, 2025, and distributed at the in-person community engagement session on May 14, 2025. In total, twenty-nine surveys were completed.

In question one, participants were asked **"How long have you lived on Sullivan's Island?"** More than half of survey participants have lived on Sullivan's Island for eleven years or more. Results can be seen in Table 8.

Table 8: Survey Participant Time Spent Living on the Island



Survey participants were asked to rate the degree of change for certain conditions on the Island by marking "0 for No Change," "1 Somewhat Changed," and "2 Dramatic Change." The results of this closed-ended question as it relates to construction, traffic, flooding, storm intensity, coastal dynamics, socioeconomic, policy shifts, and local ecology are shown on the following page.

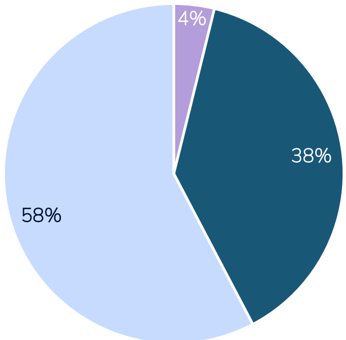


Table 9: Construction Change

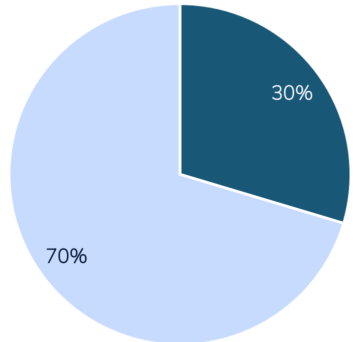


Table 10: Change in Beach Traffic

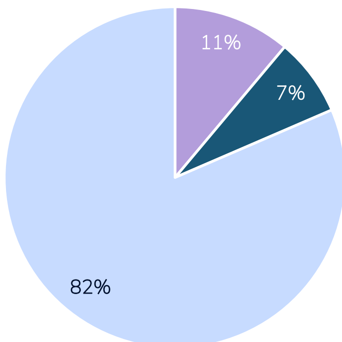


Table 11: Flooding / Higher Tides

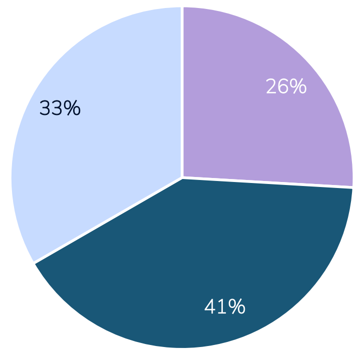


Table 12: Frequence / Intensity of Storms

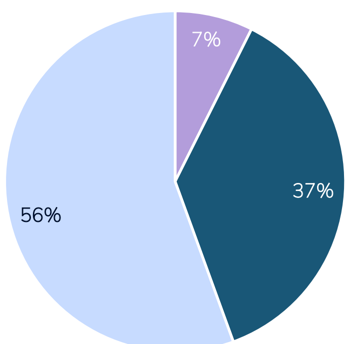


Table 13: Shifting Sand / Coastal Dynamics

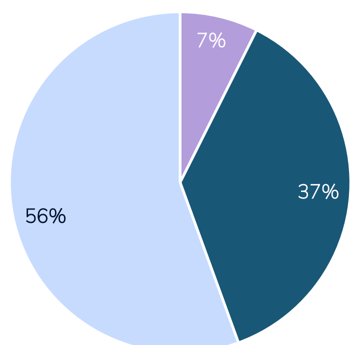


Table 14: Socioeconomic Demographics

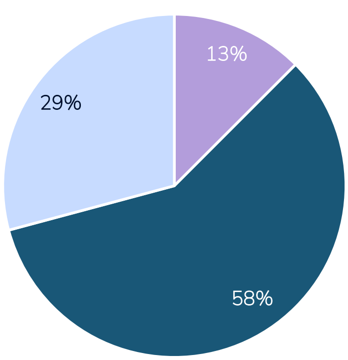


Table 15: Regulations Related to Development

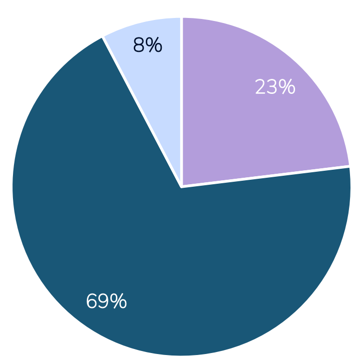
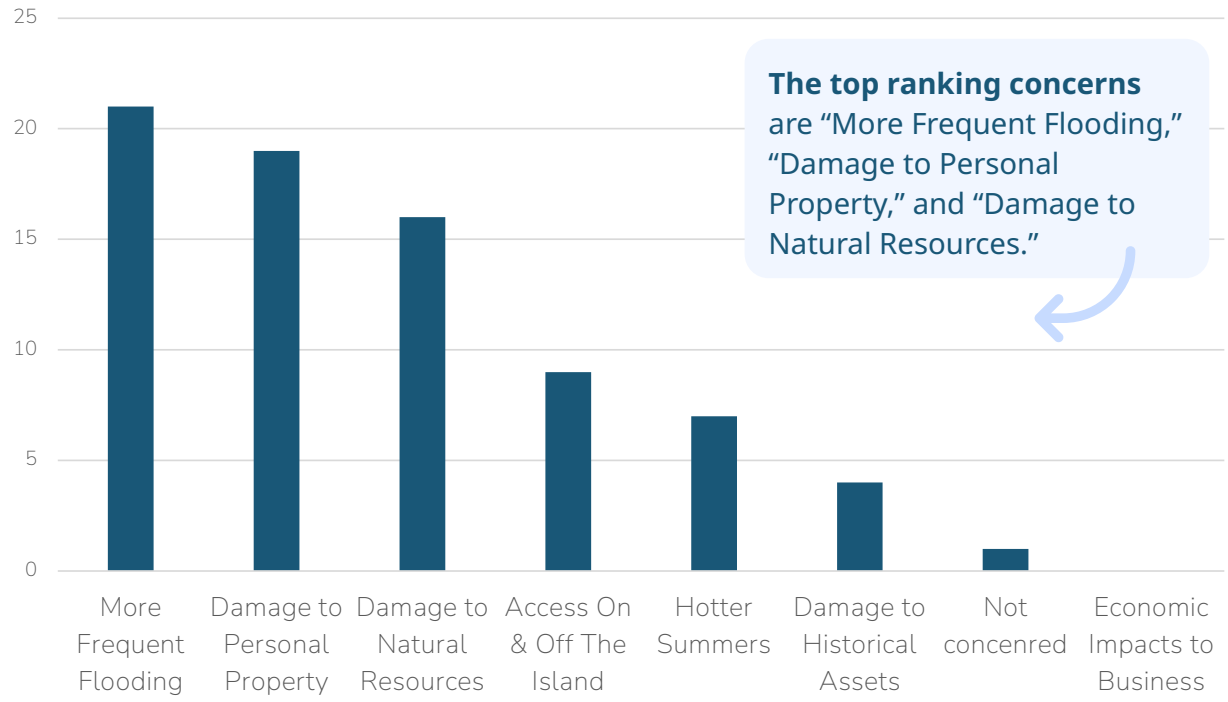


Table 16: Plants & Animals

No Change | Somewhat Changed | Dramatic Change

Survey participants were asked to indicate what concerns them most in the question **"What are your top three concerns about the impact of sea level rise and climate change as it relates to life on Sullivan's Island?"** Participants were able to select three answers, the totals for each response category are indicated in Table 17.

Table 17: Top Concerns for Residents Related to SLR & Climate Change on the Island

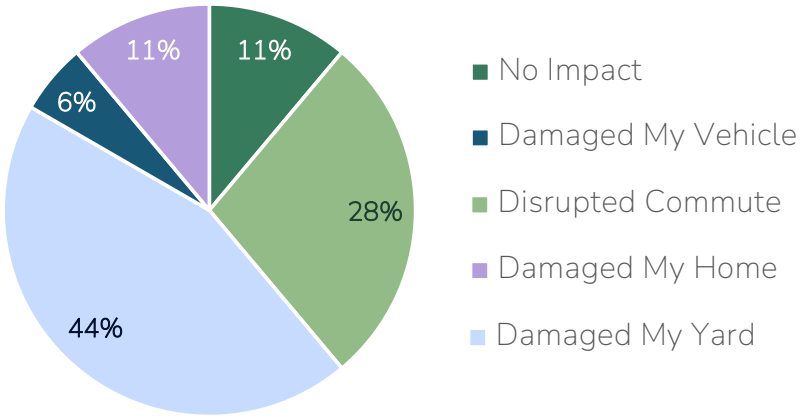


The top ranking concerns are "More Frequent Flooding," "Damage to Personal Property," and "Damage to Natural Resources."

In the next question, survey participants were asked **"How have you been impacted by tidal flooding in your community? Tidal flooding can be caused by King Tides or storm events."** Participants could select all responses that apply. Results are indicated in Table 18.

Table 18: Personal Experience of Impacts From Tidal Flooding

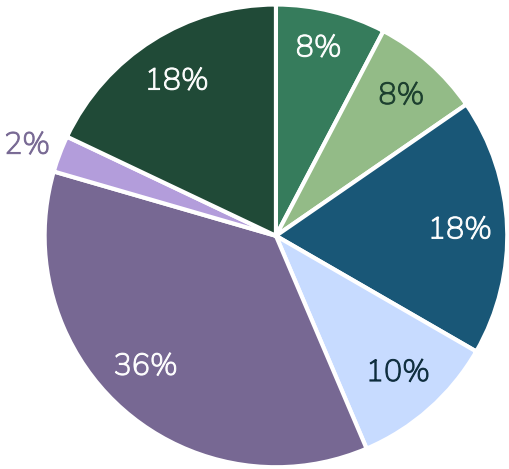
Damage to yard ranked highest and disruption of commute to work, school, and/or grocery shopping ranked second highest.



Participants were asked **"What have you done to prevent tidal flooding or flooding from storm events on your personal property?"** All responses that apply could be selected. Results can be viewed in Table 19.

Table 19: Personal Action to Combat Flooding

The provided response "I have landscaped to prevent flooding such as adding trees or other vegetation to soak up the water" **ranked highest.**



Both "I have used sandbags or another barrier to prevent water from entering my home/ garage/shed" and "I have elevated my home" **ranked second highest.**

Key takeaways from the community survey include:

Changes on the Island are being felt by community members; most notably an increase in construction and a shift in socioeconomic conditions, flooding intensity and frequency, more beach traffic, and the dynamics of a coastal barrier island.

Community members are concerned about localized impacts from climate change and sea level rise, including concerns related to an increase in flooding frequency, damage to personal property, and damage to natural resources.

Impacts from tidal flooding are being felt; most specifically, damage to home landscapes and disruptions in personal commutes.

Residents are motivated to take action to combat flooding including landscaping and the implementation of NBS on personal property.

Community Engagement Sessions

Two open-house style community engagement sessions were held during the development of this Plan. The first session, held in December 2024, was focused on gaining an understanding of existing conditions and specific Island needs, as well as information on the attitudes and perceptions related to sea level rise and climate change impacts. The project team set up stations around Town Hall where community members could talk with a member of the project team about various aspects of the Plan development. Flood maps of the Island were displayed to corroborate information on areas of tidal flooding and storm surge impacts. Participants provided feedback on feasibility and preferences regarding preliminary ideas for adaptation strategies.

Figure 6: Participant at the first Community Engagement Session provides feedback on preliminary adaptation strategies.

Key takeaways from the first engagement session include:

- Nature-based Solutions need to be site specific. Not all NBS will be effective Island-wide due to varying physical conditions on the Island.
- Residents are motivated and interested in taking action on personal property.
- The "back beach" area is the most impacted by tidal flooding.
- Proposed adaptation strategies should be diverse in nature ranging in scale and practice implementation to best serve the Island in achieving greater resiliency.

The second community engagement session was held in May 2025. Community members were informed of the event via a mailer that was included in the Town's water bill depicted in Figure 7. The second session focused on gaining feedback on proposed adaptation strategies typology and locations, as well as preferences to inform the strategy selection prioritization matrix.

Figure 7: Community members were notified about the second Community Engagement Session through a flyer distributed in the Town water bill.

Key takeaways from the second engagement session include:

- Marsh management strategies should consider approaches to shoreline stabilization, the dredging of Cove Creek, and mitigation of water quality impacts from stormwater runoff.
- Reduction of impervious surfaces Island-wide can be achieved in new and re-development requirements.
- On-site management of stormwater/floodwater is critical to limiting impacts to adjacent properties.
- Maintain integrity and natural beauty of dune system and maritime forest through invasive species management, restored plantings, and designated pathways.
- Benefits associated with flood reduction and ecological value ranked as most important considerations when selecting and implementing adaptation strategies.

Figure 8: The second Community Engagement Session provided community members an opportunity to provide feedback on adaptation strategy preferences.

Conclusion

The contributions that community members made to the development of this Plan are significant.

The information gathered during robust community engagement over the course of twelve months directly informed Plan recommendations. The initial interviews collected hours of interview data from over thirty stakeholders/decision-makers representing diverse sectors.

The key takeaways included considerations regarding consensus building, local ordinance updates, natural resource protection, and community safety. Interview data was coded and provided a foundation for the vision and focus of the Plan. The community survey and the community engagement sessions were open to the public and provided an opportunity for feedback. Community members indicated that changes on the Island are being felt, most notably with an increase in construction, a shift in socioeconomic conditions, flooding intensity and frequency, more traffic, and a more dynamic barrier island system. Community members are experiencing impacts from tidal flooding, most notably with damage to yards and disruptions in personal commutes.

On-site water management was favorable, including the reduction of impervious surfaces and the incorporation of NBS to help maintain the integrity and beauty of the Island. Flood reduction and natural resource management remain top priorities.

IV. Adaptation Strategies

Sullivan's Engage & Involve Strategy

Communications Plan

As the Island experiences the effects of sea level rise and other climate-related impacts, the development of a Communications Plan will establish a cohesive approach for a diverse array of **outreach strategies to communicate relevant information.** As indicated in both interview and survey data responses, the community seeks ways to stay informed and involved regarding climate information, emergency management, and environmental planning. The Communications Plan should have specific focus on delivering climate adaptation and hazards information and bolstering community support for a more resilient future. Guidance for the framework of a Communications Plan includes the following information:

Outreach Methodology:

Identify the preferred ways the community wishes to receive information. This will require research that may include a survey or focus group to understand effective means. Communication outlets that should be considered include established social media platforms, electronic newsletters, bill inserts, signage, community group meetings, non-profit organizations, and Town-led communications such as website, Town Council meetings, and events. By understanding the strengths and audience of each of these outlets, the Communications Plan can strategize how best to utilize these channels to effectively communicate, as well as determine if additional methods are needed.

Outreach Schedule:

Touch points and number of activities per communication style should be established. An example of this could be that two resilience-based informational one-pagers are included as water bill inserts per year. Modifications to the schedule should be anticipated with time.

Best Practices:

The Communications Plan will provide guidance on best practices for effective outreach. The best practices should consider the following:

- Establish a style guide (font style, font size, color palette) to brand the Island-wide resilience campaign
- Visualization guidance to include photography and icon-based graphics
- Strategies to increase social media engagement
- Determine metrics and a process for tracking the effectiveness of outreach efforts

Community Involvement

Meaningful community involvement builds trust, relationships, and consensus among stakeholders. Established resilience, nature-based programming would create consistent opportunities for an open line of communication with community members. The goal of community involvement is to further inform and engage the community to ultimately enable positive change and empower individual-scale adaptive action. The following activities are suggestions for ongoing implementation or future programmatic development:

Stewardship Activities:

Litter Removal: The abundant natural resources on the Island offer ample opportunities for environmental stewardship activities. The identification of litter hot spots, such as in the salt marsh adjacent to the Island Causeway, will aid in determining the frequency of litter removal efforts. Partnerships with local organizations, such as The Surfrider Foundation Charleston Chapter or Adopt-A-Highway program, may help support such litter removal initiatives.

Stormwater: As the Town has recently adopted a Stormwater Master Plan, stakeholders may assist with stormwater system maintenance to help keep debris and pollution out of stormwater conveyance. Volunteers can help to mark or label storm drains with “Don’t Pollute, Drains to The Sea” medallions in highly traveled areas. Clemson University Cooperative Extension and the Ashley Cooper Stormwater Education Consortium can provide storm drain marking materials to the Town of Sullivan’s Island as needed.

Alternatively, the Town may wish to create a unique easel that could be painted on curb or sidewalk adjacent to storm drains that reads “Don’t Pollute, Drains to Cove Creek.” In addition to storm drain marking, an “Adopt-A-Drain” program, like the City of Charleston’s, could be created to help protect the stormwater conveyance system and assure these systems are not clogged before major storm events.

Nature-based Solutions Implementation: The implementation of nature-based solutions on varying scales is an integral component to building resilience on Sullivan's Island. Volunteer opportunities exist in many of the recommended adaptation strategies outlined. Community members may help to install a rain garden in town-owned space, remove invasive species from the maritime forest, plant native plants as part of Town-led efforts, help to install a living shoreline along the "back beach," and more. Additional information can be found in these respective strategies writeups.

Figure 9: Community Rain Garden Workshop on Kiawah Island, SC

Yard Certification Program:

A yard recognition program specific to the Island could be a tool to help property owners take actionable steps to create a more resilient residential landscape. The suggested elements of a yard certification program are as follows:

- **Program Branding:** Develop a program that has name recognition with a branded icon and color scheme. The branding should resemble themes of Sullivan's Island.

- **Guidebook:** Develop a guidebook that provides considerations and high-level step-by-step information on actions that can be taken to create a more resilient home landscape. The Guidebook should be visually appealing and include photos of example implementation and graphics for better understanding. The Guidebook can provide information on where to learn more.
- **Scorecard:** Create a scorecard to help residents earn points. The points are earned based on the completion of actions on personal property. Actions may include installing a rain garden, incorporating pervious surfaces, removing an impervious surface, planting native plants, capturing rainwater, avoiding bare soil, and more.
- **Certified Yard:** Once an established number of points are received on the scorecard, the participant can achieve recognition as a Sullivan's Island certified resilient yard.
- **Recognition:** Residents who achieve certification can be recognized with a program-specific icon placed on their mailbox, a yard flag, or other similar items. These properties could also be highlighted on the Town website and an annual recognition lunch could be hosted in appreciation of their commitment to building resiliency.

Figure 10: Native plant landscaping on residential property, Sullivan's Island, SC

Established programs for reference include Clemson Extension's "Carolina Yards," the Town of Kiawah Island's "Kiawah Friendly Yards," Surfrider Foundation "Ocean Friendly Gardens," and the National Wildlife Federation "Certified Wildlife Habitat."

Roles & Responsibilities

Successful implementation of the Sullivan's Island Sea Level Adaptation & Resilience Plan will require the coordination and cooperation of many different stakeholder groups. The following concentrated task list helps to facilitate coordination and move the projects forward. Residents of the Island should be involved wherever possible. Roles & responsibilities will change with time and the following table will need to be adjusted.

Table 20: Roles & Responsibilities

Task	Lead Entity	Support Groups	Details
Review Site Plans	Town of Sullivan's Island Planning, Building, & Resiliency (PBR) Departments	Charleston County Government, Professional Engineers and Landscape Architects, Town Council Land Use & Natural Resource Committee	Review the submitted application and determine if suitable stormwater measures are incorporated
Review & Revise Residential Land Development Standards	Town of Sullivan's Island PBR	Town Council, Town of Sullivan's Island Planning Commission	Revise specific Town ordinances as they relate to single-lot development
Establish a Communications Plan for Resilience Based Efforts	Town of Sullivan's Island Administration Department; PBR	Focus Group of residents & other key stakeholders.; Land Use & Natural Resources Committee, or an established administration committee	A Communications Plan outlines effective engagement strategies to provide consistent messaging to achieve consensus building
Engage and Involve the Community	Town of Sullivan's Island	Non-profit organizations, neighboring local municipalities, Charleston County Government	Offer involvement opportunities that provide understanding and empowerment to act

Task	Lead Entity	Support Groups	Details
Maintain & Restore Town-owned Parcels	Town of Sullivan's Island	Non-profit organizations	Undeveloped parcels provide ecosystem services and should be maintained as needed. Enhancements may incorporate NBS at a parcel level if NBS do not encumber the properties in a way that affects the Town's bonding capacity.
Maintain Drainage Infrastructure	Town of Sullivan's Island, Charleston County Government; SCDOT	Property Owners, Volunteers	Both the centralized drainage infrastructure and NBS require maintenance to continue to function as designed
Pursue Funding Opportunities	Town of Sullivan's Island	University and State Agencies, Non-profit Organizations, Private sector partners	Funding from national, state, and local sources will help to implement identified adaptation strategies

Ordinance and Policy Review

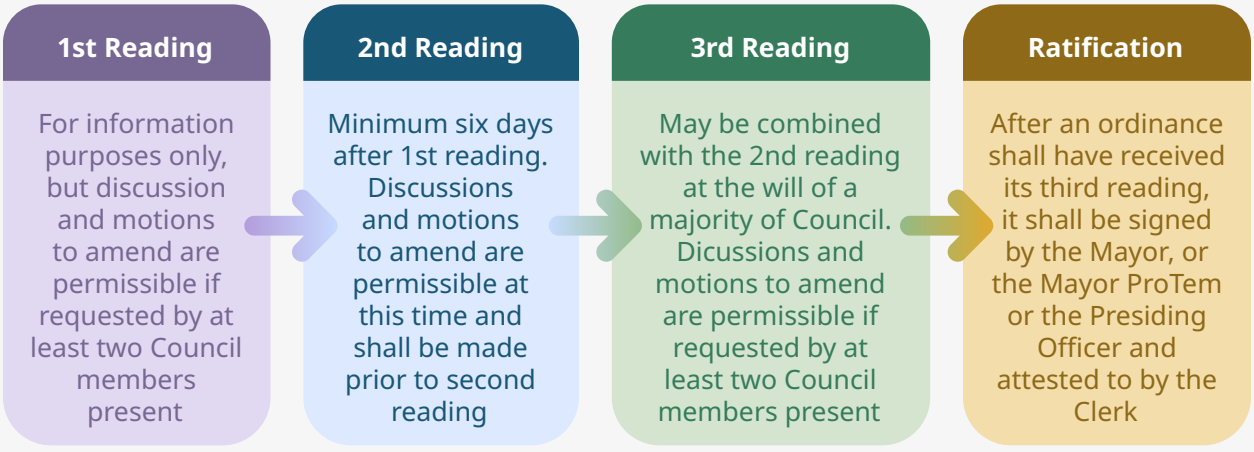
Description

Enacting new ordinances or updating the language in the Town of Sullivan's Island's current ordinances can significantly enhance the Town's long-term resilience by addressing various climate vulnerabilities (e.g., flooding and sea level rise) and allowing for greater protection of natural systems. South Carolina operates under Home Rule, in which county and local jurisdictions are granted the authority to enact their own, more restrictive ordinances to address their unique local environments, provided they do not conflict with state law. For example, baseline requirements for stormwater management during construction are implemented by the South Carolina Department of Environmental

Services (SCDES) through authority granted by the Clean Water Act and the South Carolina Stormwater Management and Sediment Reduction Act. However, local jurisdictions can enact more stringent standards, such as requiring a greater volume of stormwater to be treated for water quality, thus addressing any specific local needs. On Sullivan's Island, such standards could be tailored to protect nearby sensitive habitats, like the oyster reefs on the back side of the island.

The Town also participates in the National Flood Insurance Program's (NFIP) Community Rating System (CRS), which is a voluntary program that recognizes and encourages community flood management practices that exceed the minimum requirements. The communities that participate can receive discounted flood insurance premium rates through implementing activities that reduce flood damage, thus increasing resiliency. Ordinances can help improve a community's CRS rating by enacting more stringent floodplain management requirements, such as increasing freeboard requirements, updating building codes concerning floodproofing and venting, and retaining a larger volume of runoff through stormwater management design standards. Incorporating higher standards of floodplain management in the Town's ordinances will not only help reduce flood risk and potential storm damage, but also potentially improve the CRS rating, thus resulting in further discounted rates.

The Town's municipal ordinances were originally enacted in 1977 and since then have undergone several substantial revisions. Most recently in 2002, the Town retained Cooper Consulting, Inc. to review the existing zoning ordinances and propose amendments, which were ultimately adopted in Chapter 157 Appendix A: Zoning. Additionally, the Town regularly makes small ordinance amendments to address specific issues that have arisen or conditions that have evolved. All Town ordinances are deliberated and approved by Town Council in a multi-step process as detailed in Figure 11 below, which follows public input and study conducted through the Planning Commission.



All ordinances are introduced by the Mayor, Council member or a Council Committee member, in writing and in the form required for final adoption. Ordinance 2015-11 (PDF) outlines this procedure. Section 2-27, Town Code of Ordinances, provides full details of the ordinance approval process.

Figure 11: Ordinance Approval Process

Benefits

As a coastal barrier island, Sullivan's Island is extremely vulnerable to impacts from sea level rise, extreme storm events, and flooding; therefore, updating the Town's Municipal Code is one way to help increase the island's long-term resilience.

Protection and Enhancement of Natural Resources:

Requiring low-impact development and other green infrastructure practices will increase stormwater retention and filtering of pollutants, thus improving downstream water quality. Additionally, protecting resources, such as natural vegetated buffers, wetlands, and dune systems, will provide a number of benefits, like flood protection, shoreline stabilization, and diverse habitat for wildlife on the island.

Reduced Flood Risk/Damage, Increased Safety/Protection of Property:

Updating the Town's building codes or increasing stormwater management design requirements can help protect properties from flooding, thus ensuring vital infrastructure remains intact and potentially reducing post-storm damage and recovery costs.

Sustainable Land Use:

Ensuring development takes place in a way that is sustainable will help protect the character of the island and preserve the quality of life for residents.

Recommendations

To improve resilience through revised or newly adopted ordinances, recommendations are grouped into four key areas that were broadly considered before developing specific recommendations for updating the current language or adding new regulations, tailored to the unique barrier island environment and drawing from other local examples.

1. **Stormwater and Drainage Ordinances –** Recommendations focus on limiting the allowable amount of impervious area per parcel or mandating permeable surfaces, requiring on-site retention of stormwater for new development or redevelopment or requiring stormwater management plans that account for future precipitation intensity.
2. **Zoning and Land Use Ordinances –** Recommendations include limiting development in flood-prone or low-lying areas and encouraging more nature-based solutions across the island.
3. **Natural Resource Protection Ordinances –** Recommendations include expanding tree protection and replanting, strengthening wetland and marsh protections, creating vegetated buffer zones, and encouraging the rehabilitation of hardened shorelines with the incorporation of best management practices (BMP), thus limiting shoreline hardening.

4. **Building Code and Design Standards –** Recommendations focus on updating the building codes that specify flood resistant materials and flood proofing practices to reflect current Federal Emergency Management Agency (FEMA) guidance. For new structures, it is critical to update the minimum elevation requirements, such as freeboard above Base Flood Elevation.

Stormwater and Drainage Ordinances

1 **Consider redefining "Impervious Surface" (Sec 21-26A (2) and A (3)).**

a. Consider adopting language to include gravel as an impervious material along with other compactible material to promote the use of material that will allow for greater infiltration and to limit the total percentage of impervious cover. See definition for 'Impervious Surface' from the Town of Kiawah Island's Municipal Code[1] (See Appendix).

b. Alternatively, the Town could develop an exemption for gravel driveways, provided that the homeowner detains a specified amount of runoff or that a vegetated buffer is installed around the driveway.

2 **Consider revising language concerning impervious surface limits and exemptions.**

a. To further limit the total percentage of impervious cover, consider revising ordinance language so that a garage is not exempt from the impervious surface limits or add language that if the garage does not count towards the total impervious surface limit, that the homeowner must install a green roof or collect and detain runoff from the agreed upon design storm from the roof downspouts through other green infrastructure methods (Sec 21-26B (3)).

b. Consider adding language that any additional hard landscaping during redevelopment (more than what was there originally) must be built using pervious material, thus promoting low-impact development. For example, the City of Isle of Palms has language that requires any new hard landscaping (e.g., walkways, driveways, and pool surrounds) to be constructed using pervious materials[2] (See Appendix).

3 **Consider updating the ordinance on stormwater management with an emphasis on Low-Impact Development (LID).**

a. Stormwater management requirements for the Town are limited to the language in Sec 21-17A, which states "No lot shall be built upon, graded or filled without the Building Official's or Zoning Administrator's prior approval of a stormwater management plan. The stormwater management plan and construction specifications must be stamped and signed by a professional engineer or landscape architect actively licensed in the state. All stormwater plans must include a scaled site plan and survey illustrating all existing and

proposed topographical features of the lot, existing and proposed drainage flow patterns, with a site narrative describing the means and methods of preventing adverse impacts to adjacent and/or downstream properties". Therefore, we suggest that the Town:

i. Update the limits on when stormwater design criteria are required.

1. Consider following the Southern Lowcountry Stormwater Ordinance and Design Manual (SoLoCo) criteria[3] (See Appendix) when land disturbance exceeds 5,000 square feet (SF).

ii. Include Design Storms in the Standards.

1. Incorporate language into the ordinance that at a minimum the 25-year design storm must be used for calculations, with the 50-year design storm preferred, and that runoff volumes must be estimated using the TR-55 method (not the rational method).

2. For example, the SoLoCo manual uses the 2-, 10-, and 25-year, 24-hour storm event and the City of Beaufort requires stormwater quantity control based on the 25-year, 24-hour storm event.

iii. Encourage and Incentivize LID.

1. Consider referencing the SoLoCo manual's green infrastructure and LID recommendations.

2. The Town of Mount Pleasant implements "Environmental Guidelines for Land Development (LID)"- which is an initiative by the Town to create a more sustainable community using a point-based system with incentives[4] (See Appendix). While it is currently intended for commercial development, Mount Pleasant is in the process of creating a similar program for residential properties that could be tailored to Sullivan's Island. A similar resiliency quotient program can be found within the City of Norfolk, VA[5] (See Appendix).

4 Consider implementing special stormwater management overlay areas.

a. Consider implementing special stormwater management areas that require additional stormwater quality or quantity controls rather than the minimum design standards to protect sensitive waterbodies or flood prone areas.

i. For example, the SoLoCo manual has different requirements for post-construction stormwater management based upon the watershed it drains to, with projects draining to shellfish receiving waters or waters with Total Maximum Daily Loads (TMDL) having more stringent standards. Similarly, the City of Charleston has a Church Creek Special Stormwater

Management area, where all permanent stormwater management should detain the excess runoff volume up to the 100-year, 24-hour storms due to recurrent flooding.

Zoning and Land Use Ordinances

5 **Consider adding additional language promoting native landscaping.**

a. Consider revising the language from Sec 21-26 B (5), which states "At least 50% of the Lot Area shall remain naturally vegetated or landscaped with grass and/or other vegetation" to emphasize the preferred use of native vegetation.

i. Consider adding language that if grass is used, it can only account for a maximum 20% to encourage plantings that allow for greater infiltration and to help the Town reach their goal of ~30% canopy cover.

ii. Consider adding language that requires the preservation of existing natural buffers and native trees outside of the buildable area and mandating the removal of invasive species, much like the Town of Mount Pleasant.

b. Consider adding a table of preferred or recommended native vegetation for plantings within each soil type and zone on the island to Sec 21-41 B.

i. Consider redefining which of these native plants may be planted in the right-of-way that will not conflict with overhead or underground utilities, much like what the Mount Pleasant Water Works is currently considering.

Figure 12: A native meadow full of Gaillardia, Coreopsis, Tradescantia. (Source: INSERT SOURCE)

6 Consider altering fill material limits.

a. Currently, the Town only allows 1 foot of fill. The City of Isle of Palms similarly only allows 1 foot of fill provided that this requirement would not limit the elevation of a lot to an elevation lower than 7.4'. Consider implications for adopting similar language.

i. If language is adopted, fill slopes should be constructed at a 4:1 or flatter to maintain mow-ability, reduce erosion, encourage establishment of vegetation, and not impede pedestrian movements. If retaining walls are utilized, building codes should be considered that limit their height to not mandate the use of railings or be considered as sea-walls.

Natural Resource Protection Ordinances

I Consider establishing vegetated buffer requirements along the Critical area line, RC-2.

a. Consider implementing vegetated buffer requirements in addition to the Town's setback limits, similar to ordinances within the Town of Kiawah, City of Charleston, and Town of Mount Pleasant. Native plants should be selected, installed, and maintained within this buffer as an undeveloped vegetated area. Such language would prohibit grassed, manicured lawns within the buffer area and encourage greater filtration and uptake before stormwater reaches the marsh, thus providing a number of benefits, such as increased pollutant uptake, greater shoreline stabilization, and more diverse habitat for pollinators.

2 Consider adding a wetland ordinance for protection of isolated, non-jurisdictional wetlands.

a. The Sackett v. EPA decision removed federal protection from millions of acres of wetlands that may no longer qualify as federally jurisdictional. Consider adding an ordinance that protects local, isolated wetlands from development impacts. Such language would also protect the dune systems from any impacts due to un-permitted footpaths.

b. The Town of Bluffton recently passed an interim wetland protection ordinance that could be used as a template for the Town[6] (See Appendix).

Building Code and Design Standards

3 **Consider implementing higher freeboard requirements in Special Flood Hazard Areas.**

a. Consider revising the Town's Design Flood Elevation (DFE), which is currently, Base Flood Elevation (BFE) + 1 foot for new residential construction or substantial improvement (Sec 153.41 A; See Figure 14 for visualization) to provide greater protection from flooding and sea level rise.

i. For example, the Town of Mount Pleasant, Charleston County, and City of Charleston use BFE + 2 feet in special flood hazard areas, while the City of Myrtle Beach uses BFE + 3 feet.

b. Similarly, the ordinance states that in coastal high hazard areas, all buildings should be elevated so the bottom of the lowest supporting horizontal member is located no lower than the BFE level. Consider revising to the same standards as the special flood hazard areas in the above ordinance (BFE+1 foot) or BFE + 2 feet if the ordinance is updated (Sec 153.41F (2)).

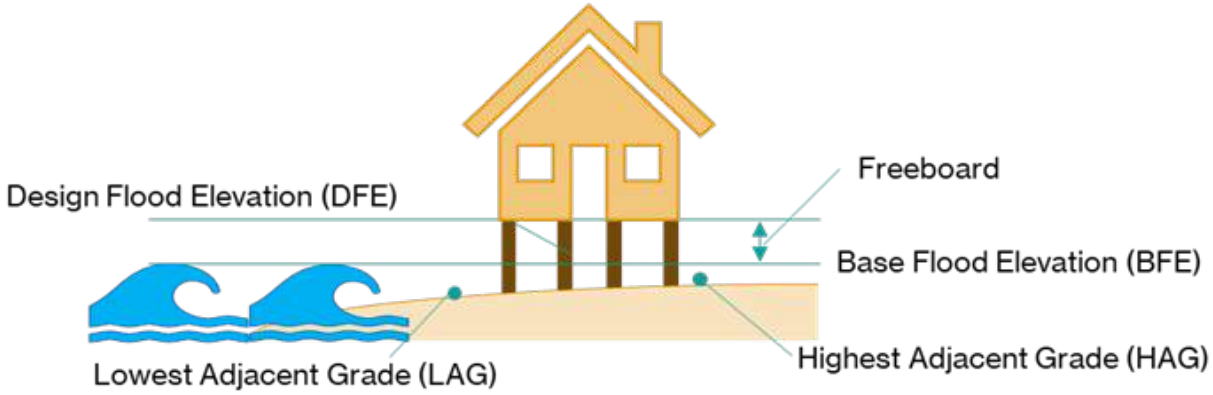


Figure 13: Visual representation of DFE, BFE, and Freeboard terminology

4 **Consider updating language on floodproofing and venting.**

a. Current regulations in Sec 21-32 B (1) state "A principal buildings foundation exceeding three (3) feet in height shall be enclosed by open lattice or slats having a min. of ½ inch between lattice or slats" (Flood hazard standards are also listed in Sec 153.41) and do not specify the amount of opening between slats or lattice. Similarly, the current ordinance does not specify that only flood-resistant materials should be used below DFE. Consider incorporating FEMA and ICB's guidelines on wet floodproofing/venting[7] into the ordinance language, similar to the Town of Mount Pleasant[8] (See Appendix).

Nature-based Solutions

Nature-based Solutions (NBS) refers to a suite of natural and engineered natural systems that help to manage water and protect ecosystems.

Many NBS practices are designed to assist in stormwater management by capturing, slowing, and filtering rainwater which reduces flooding, erosion, and pollution. NBS mimic pre-development hydrology by using landscape-level systems to capture water that runs off impervious surfaces associated with development. These practices often connect, protect, or create habitat for wildlife and pollinators which benefits habitat and biodiversity promoting a healthy local ecology. In turn the habitat and stormwater management benefits provide climate resilience by helping to buffer against climate impacts.

Nature-based Solutions offer a wide range of benefits including:

- **Water Quality –** Pollutants such as sediments and nutrients are filtered out of stormwater runoff.
- **Flood reduction –** Stormwater is slowed down, absorbed, and peak flows are reduced.
- **Erosion control –** Vegetation stabilizes shorelines and soils preventing erosion particularly along slopes.
- **Biodiversity –** Habitat is maintained or created for birds, pollinator, and other wildlife.
- **Temperature regulation –** Local temperatures are lowered from urban heat island effects due to presence of trees and green space.
- **Social –** Additional areas for recreation promote physical activity, reduce stress, and improve mental health.
- **Cultural –** Landscapes of historical or cultural significance are preserved or enhanced.
- **Economic –** Proximity to green space often increases property values. Local jobs are supported in the design, construction, and maintenance of these practices. These practices are often cheaper to install and maintain over their lifetime when compared to traditional grey infrastructure practices. These practices can also help to protect capital improvement projects by reducing the strain on the centralized system.

Figure 14: Tree

Three of the recommended strategies in this Plan incorporate NBS on diverse scales including open space/public right-of-ways, residential parcels, and in the commercial district.

Each strategy offers additional information regarding feasibility, considerations, and recommendations specific to the NBS application of focus. The following is a summary description of the types of NBS sited for use across the Island.

- **Bioretention –** a landscaped depression that uses engineered soils and native vegetation to store and manage stormwater runoff. A bioretention cell is designed to drain within 72 hours. Bioretention can be located within concrete walls or panels, or incorporated into the landscape using side slopes of the surrounding area to create a depression with ponding depth. Bioretention ranges in vegetation from turfed cells to a mix of native perennials and grasses.

- **Rain Garden –** a shallow landscaped depression planted with native vegetation that is sited to capture and filter stormwater runoff. Rain gardens have an amended soil that is a mix of sand and compost to provide infiltration capacity while also supporting healthy plant growth. Native plants are typically incorporated in rain gardens to withstand diverse conditions that range from dry to wet.
- **Rainwater Harvesting System –** a tank that is used to capture rainwater from a roof surface. Water is stored and used at a later time, typically for non-potable uses such as irrigation. Rainwater harvesting systems range in size from a rain barrel, considered less than 100 gallons, to larger cisterns that are 100 gallons or more in storage capacity. Pre-filtration devices should be cleaned regularly and include downspout filters, inlet screens, and first flush diverters. Water should be used often to maintain water quality and to allow the system to have storage capacity for the next rain event. Historic cisterns can still be seen on Sullivan's Island.
- **Green Roof –** a vegetated roof that insulates the home, reduces heat islands, and manages rainwater. Green roofs are part of the Sullivan's architectural vernacular.
- **Bioswale –** a vegetated channel that slows and treats stormwater runoff, often along driveways or property edges. Bioswales with engineered soils and the incorporation of native plant species will have the greatest water quality and quantity benefits.
- **Permeable Pavement –** driveways, walkways, or patios made from permeable materials such as pavers, gravel, or porous concrete that allows stormwater to infiltrate. The Town has defined a pervious surface in Sec 21-26 A (3) as, "Any material through which water can be easily absorbed or passed, at a minimum infiltration rate of 2.0 inches per hour, such as, but not limited to, grass and uncompacted gravel, shell, and crushed stone."
- **Living Shoreline –** natural elements such as oyster shells, coir logs, and plantings are used to protect coastal areas from erosion and storm surge while also supporting habitat and water quality. The living shoreline strategy is dependent upon existing site conditions including sediment firmness, wave energy, slope, erosional features, and more.
- **Conservation –** protecting natural areas to ensure they remain healthy and productive for future generations, as well as safeguarding the ecosystem from development.
- **Constructed Wetland -** a man-made system designed to mimic the natural functions of a wetland consisting of a shallow basin filled with soil or gravel substrate, wetland plants, and inflow and outflow structures to control water levels and flow.

Open Space Planning and Nature-based Solutions

Open space planning involves strategically managing land to preserve and enhance areas that provide various ecological, recreational, scenic, and cultural benefits.

The conservation of these natural resources protects water quality, wildlife habitat, and biodiversity. It also contributes to mitigating the impacts of climate change by managing stormwater and buffering against extreme weather. Protecting these open spaces helps maintain historic landscapes and cultural landmarks that define the Island's identity. Figure 15 depicts the open spaces that currently exist on the Island, the areas are color coded by property owner and the type of habitat (i.e. salt marsh or maritime forest) or land use (i.e. residential or commercial).

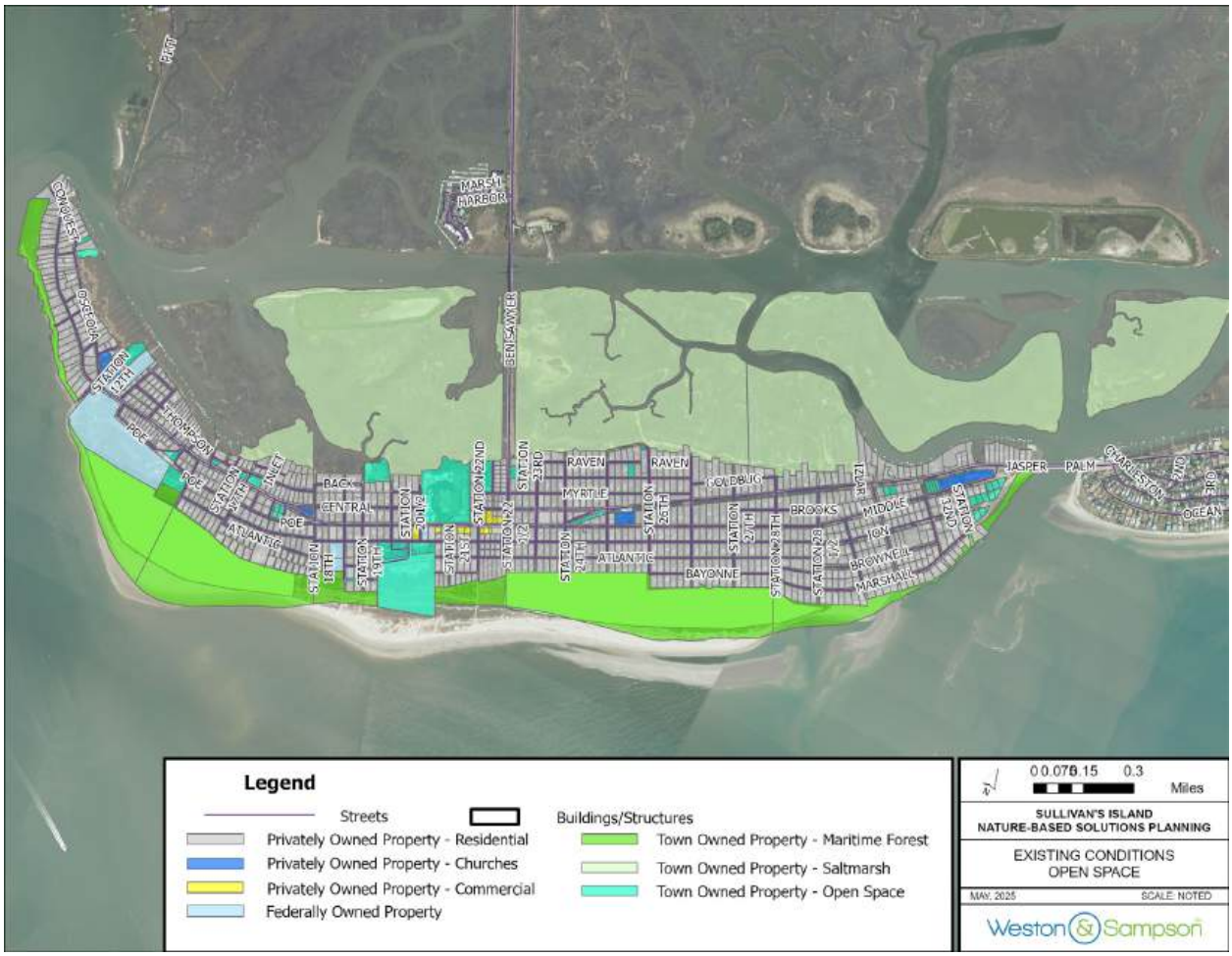


Figure 15: Open Space on Sullivan's Island Labeled by Owner and Land Use Type

Nature-based Solution screening was conducted using a GIS based-approach that analyzed several data layers associated with open space including surface flow paths on a 1-acre and 0.5-acre scale, elevation (DEM), soils (hydrologic soil group), and land ownership (parcel data). A prioritization analysis was completed to identify the NBS that are the most feasible and provide the most benefits to the community. The prioritization criteria included flood reduction, feasibility, and other co-benefits as shown in Table 21.

Each component of the matrix was scored on a scale of one to three, with one being the least beneficial/most difficult to implement and three being the most beneficial/easiest to implement. Additional details on the siting and prioritization of the NBS can be found in Appendix C as well as the scoring for the practices.

Table 21: Prioritization Criteria and Scoring for NBS

Indicator		Scoring			Data Reference
		3 (Best)	2	1 (Least)	
Flood Reduction	Function of Area of Practice and Runoff Reduction Rates*	Runoff Reduction Rate Significant: 75-100%	Runoff Reduction Rate Moderate: 50 -74%	Runoff Reduction Rate Minimal: 0-49%	SC Coastal Low Impact Development Manual
Feasibility	Soil Infiltration Rate	Soils are Suitable (Hydrologic Groups A and B)	Soils May be Suitable (Hydrologic Group C)	Soils are Unsuitable (Hydrologic Group D or Unknown)	USDA NRCS, Web Soil Survey
	Ease of Implementation - Land Ownership	Public Property: Town or County Owned	General-Right-of-Way and Private	Federal Ownership	Charleston County GIS Parcels
	Ease of Implementation - Permitting Level of Effort	State (DES) or Local Permit Only	SCDOT ROW Encroachment and State (DES) or Local Permit	Federal Permit or Local Building Permit	Charleston County GIS Parcels
	Ease of Implementation - Cost	Low Effort: Existing Practice or Unskilled/ Volunteer Labor	Moderate Effort: Skilled Labor to Install- Specialized Equipment Likely Necessary	High Effort: Engineered Designs and Construction Plans Required	Based on Level of Effort to Design and Install

Indicator		Scoring			Data Reference
		3 (Best)	2	1 (Least)	
Feasibility	Operations and Maintenance	Low Effort: Hand Tools and/or Quarterly Maintenance	Moderate Effort: Skilled Maintenance Crew and/or Bi-Monthly Maintenance	High Effort: Heavy Machinery Needed and/ or Monthly Maintenance	Based on Level of Effort to Maintain
	Professional Judgement	No Foreseen Hurdles to Acceptance	Some Foreseen Hurdles to Acceptance	Numerous Foreseen Hurdles to Acceptance	Based on Professional Judgement
Co-Benefits	Urban Heat Mitigation/ Pedestrian Improvements	Paved Surface Reduction and Increased Plantings	Paved Surface Reduction or Increased Plantings	Paved Surfaces are Not Increased Nor are Plantings Reduced	Based on Adding NBS and Removing Paved Surfaces
	Water Quality	95 – 100% of Total Suspended Solids Removed	80 – 94% of Total Suspended Solids Removed	0 – 79% of Total Suspended Solids Removed	SC Coastal Low Impact Development Manual
	Biodiversity/ Habitat	Increases forage, shelter, and freshwater source for pollinators	Either increases forage, shelter, or freshwater source for pollinators	Habitat impacts avoided during GSI project	NWF's Certified Habitat or Carolina Clear
Co-Benefits	Priority Populations Benefitted (Environmental Justice)	Entire Study Area Priority Population	Part of Study Area Contains Priority Population	No Priority Populations Present	EPA, EJSCREEN
	Cultural	Located at Nationally Registered Historic Place	Located Nearby Nationally Registered Historic Place (< 400 ft)	No Nationally Registered Historic Place (> 400 ft)	State Historic Preservation Office

The prioritization matrix went through several rounds of iteration, mainly adjusting weights, to ensure the benefits from all NBS practices were being captured. The GIS screening analysis combined with the prioritization analysis resulted in a ranking of **33 proposed NBS projects** as depicted in Figure 16 and listed in Table 22. The results are projects with the highest feasibility and maximum benefits to the community.

Table 22: Top NBS from Prioritization Scoring

Practice	Location	Rank
Conservation East*	Maritime Forest	1
Conservation West*	Maritime Forest	2
Rain Garden 1	Sullivan's Island Elementary	3
Rain Garden 2	Sullivan's Island Elementary	4
Rain Garden	Poe Ave. at Station 15	5
Constructed Wetland	Field behind Battery Logan	6
Green Roof*	Battery Logan	7
Pervious Paving 1	Sullivan's Island Elementary	8
Rain Garden	Stith Park Tennis Courts	9
Pervious Paving	Edgar Allan Poe Library	10
Pervious Paving 2	Sullivan's Island Elementary	11
Rain Garden	Beach Access at Marshall Blvd.	12
Green Roof	Edgar Allan Poe Library	13
Pervious Paving 1	Water Treatment Facility	14
Pervious Paving 1	Jasper Blvd.	15

**This practice already exists but the current condition should be evaluated and then properly maintained.*

Figure 16: Potential NBS Locations

Practice	Location	Rank
Pervious Paving	Battery Gadsden	16
Pervious Paving	Intersection of Middle St. and Osceola Ave.	17
Pervious Paving 2	Jasper Blvd.	18
Pervious Paving 2	Water Treatment Facility	19
Pervious Paving 3	Jasper Blvd.	20
Pervious Paving	Middle St. Between Station 13 and 14	21
Pervious Paving 4	Jasper Blvd.	22
Pervious Paving	Middle St. at Station 20 ½	23
Bioretention	Poe Ave. in front of Battery Jasper	24
Green Roof	Federal building across St. from Ft. Moultrie	25
Living Shoreline	Coastline of "Town Dump"	26
Living Shoreline	Coastline near Star of the West St.	27
Green Roof	Post Office	28
Living Shoreline	Boat ramp	29
Pervious Paving	In front of Ft. Moultrie	30
Bioswale	Stith Park	31
Bioswale	Water Treatment Facility	32
Bioretention	In front of Ft. Moultrie	33

Considerations for NBS in Open Space & Public Right-of-Ways

- **The identified projects are not meant to be an exhaustive list;** additional opportunities most certainly exist in other public locations on the Island. The identified projects were deemed the most feasible and can serve as demonstration projects to increase broad-scale adoption of NBS on the Island.
- **As indicated in the Residential NBS strategy, many of these same NBS are suitable for homeowners to implement in the home landscape.** The Island will achieve greater resiliency as more NBS are implemented on diverse scales and applications. For example, several living shoreline practices are sited on the marsh side of the Island with attention to public properties; however, a larger living shoreline spanning private properties could be undertaken as a more comprehensive project by the Town.
- **Maintenance of these NBS will be a key ingredient for long-term success.** A maintenance plan should be in place before construction begins, that identifies responsible parties, maintenance actions, and frequency.
- **On many of the Island's public properties, opportunities for increased tree plantings exist.** A healthy tree canopy offers abundant benefits including cooling effects, beautification, water management, aesthetic enhancements, pollution remediation, and more. The Sullivan's Island Tree Canopy Mapping conducted by the South Carolina Forestry Commission and Green Infrastructure Center offers guidance to increase tree plantings on public property and recommended strategies for long-term success. Figure 17 depicts areas of the Island in need of increased tree canopy cover.

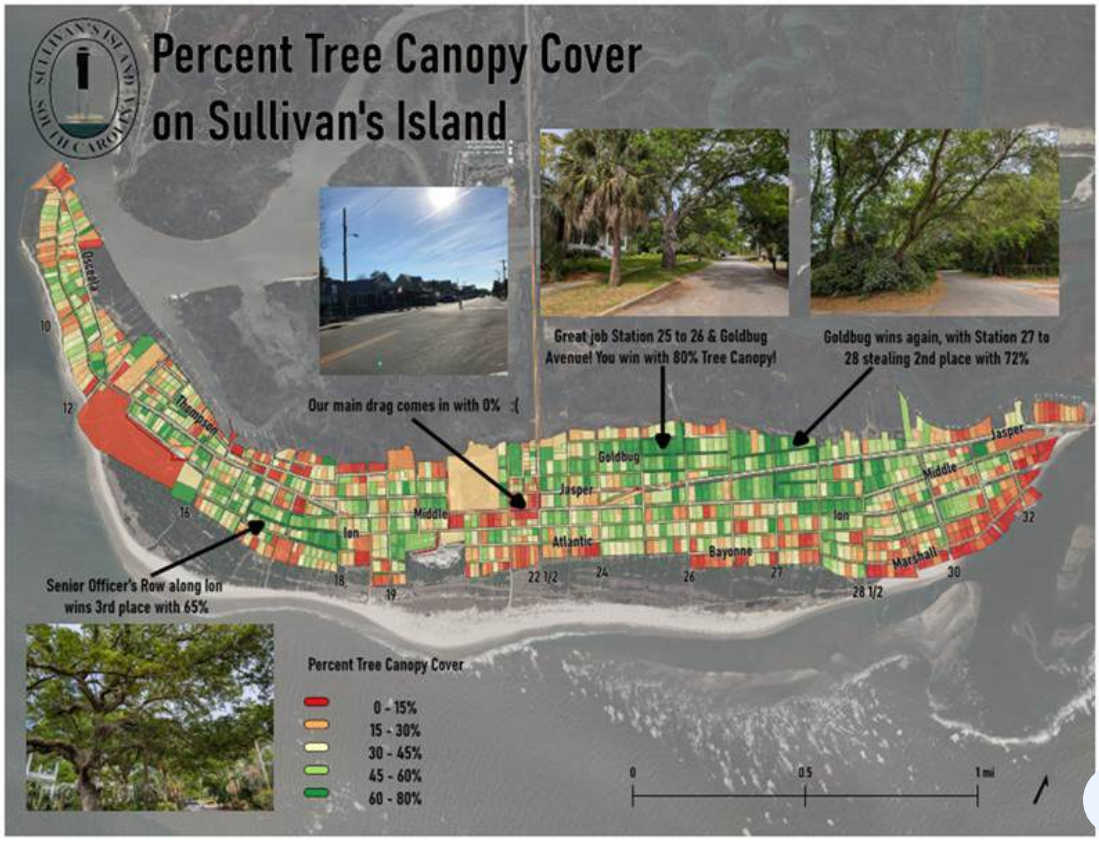


Figure 17: Sullivan's Island Percent Tree Canopy Cover

Figure 18: Sullivan's Island Marsh

Residential-scale Nature-based Solutions (NBS)

Residents can incorporate Nature-based Solutions into personal property to help slow down, capture, and filter stormwater, as well as stabilize shorelines and manage tidal flooding in some instances.

Residential-scale NBS can help to alleviate localized flooding on personal property as well as reduce the strain on the centralized drainage system. Properly designed and maintained NBS add aesthetic appeal and water quality benefits.

Nature-based Solutions are selected, designed, and implemented based on site-specific conditions. To help residents determine which NBS would be most effective on their property, GIS data on soil type, elevation, and tidal inundation was overlaid to create zones for recommended practices. For example, an area with low elevation and poorly draining soils will not be appropriate for an infiltration-based practice such as bioretention, but it may be possible to install a living shoreline along its edge to increase the filtration benefits of oyster reefs and spartina plantings.

The map of zones can be seen in Figure 19. This map should be used as an Island-wide, general recommendation. Parcel-level analysis is recommended. **Property owners can take the following simple measures to gain a better understanding of their property characteristics:**

- Conduct a percolation test to determine soil infiltration rates. This test will also help to determine if a high groundwater table is present.
- Use a jar test to determine the percent of sand, soil, and clay in the existing soil. The higher sand percentage the higher the infiltration capacity.
- Observe the property during storm and tidal events to document where pooling occurs.
- Identify signs of erosion in the yard, such as topsoil loss where bare earth is exposed and mulch or other ground cover has washed away. This will help to identify where NBS can be located to receive stormwater, dissipate energy, and remove common pollutants.

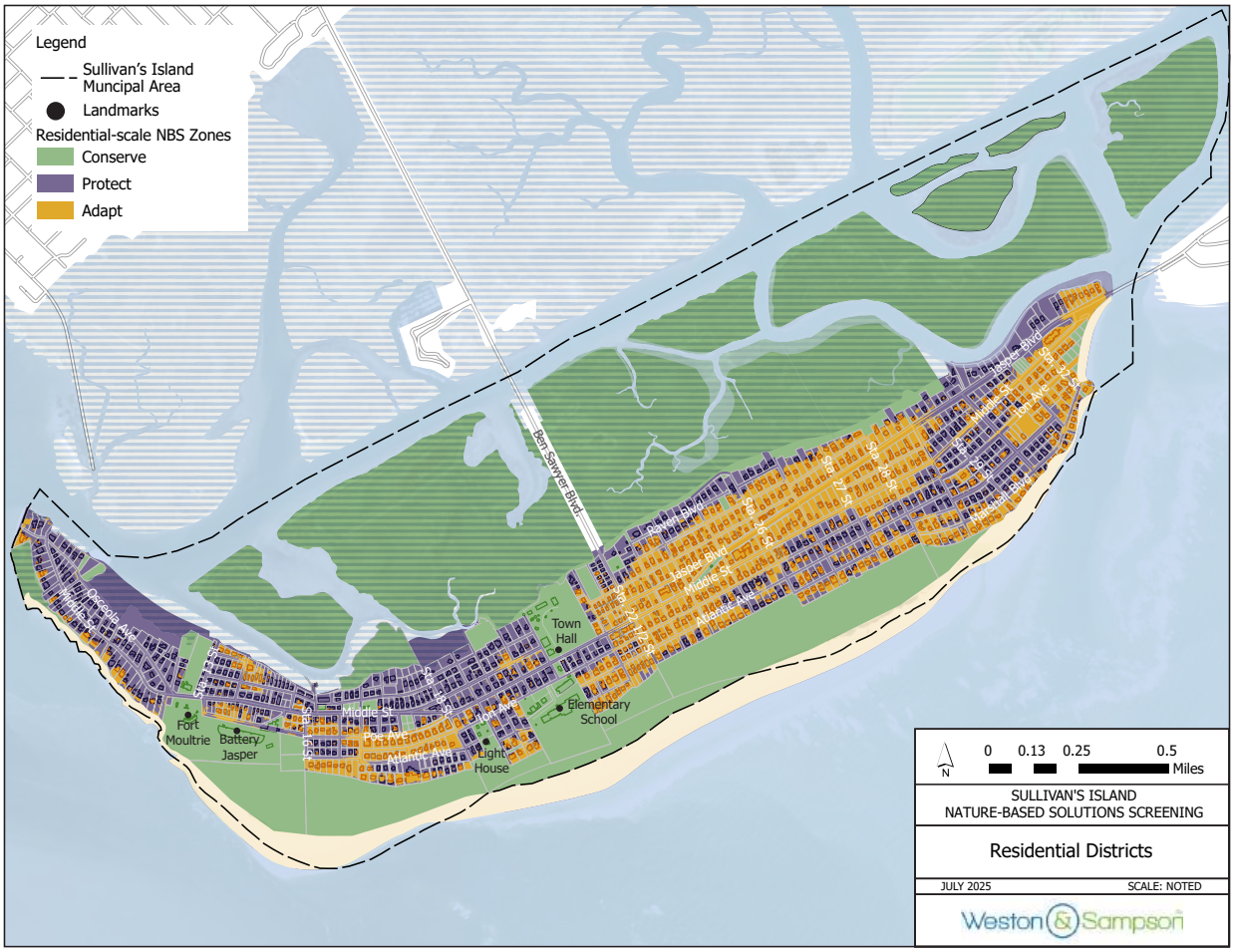


Figure 19: Residential Zones for NBS Implementation

Conserve Zone

The Conserve Zone incorporates areas with minimal development, typically along the perimeter of the Island. The Conserve Zone is largely made up of beachfront, salt marsh, and existing maritime forest. Areas in this Zone may be tidally influenced. Often areas within the Conserve Zone are public properties owned by the Town, State, or Federal Government. The Conserve Zone overlaps with the RC District Zoning.

Conservation of existing open space and natural resource management in the Conserve Zone will continue to allow the following benefits:

- Provide natural flood and storm protection by serving as a buffer for inland areas during storm surge and high tide events.
- Act as a sponge for the Island as natural areas absorb excess rainfall to slow overland flow and reduce flooding.
- Filter pollution protecting downstream water quality and recreational uses.

- Combat urban heat island effect and help to cool the Island. Trees provide shade and release moisture into the air through evapotranspiration. Impervious surfaces are limited, such as asphalt, which absorbs heat.
- Ecological benefits that support biodiversity on the Island include migratory and resident songbirds, shorebirds, wading birds, and birds of prey.

In the Conserve Zone, opportunities exist for the incorporation of NBS include tree planting, constructed wetlands, living shorelines, bioswales, vegetative buffers, and rain gardens. The Open Space, Maritime Forest, and Marsh Management Strategies provide additional information on the incorporation of NBS in the Conserve Zone. The Town may consider including added penalties for destructive activities in the Conserve Zone.

Protect Zone

The Protect Zone incorporates areas of the Island that are low lying and often C/D soils are present; these soil types are slow draining and may remain saturated. Parcels in the Protect Zone are typically residential and not publicly owned. Properties may experience occasional tidal flooding during King tide and storm events. The frequency of tidal flooding is expected to increase in the future.

Future Flooding

According to the Post & Courier, the City of Charleston and surrounding areas are predicted to see an **increase in tidal flooding to upwards of 70 to 90 days per year by 2050**, up from just 2 days of tidal flooding experienced in the 1970s.

The C/D soils on site, made up of fine particles, are slow draining and less effective at managing stormwater with infiltration-based practices. The most effective NBS in the Protect Zone are those that store the water and release water slowly or for future use; these practices have benefits for flood mitigation, erosion control, and water quality as water is slowed down and managed on site. NBS for consideration in the Protect Zone include bioswales, bog gardens, rainwater harvesting systems, tree plantings, green roofs, living shorelines, and vegetative buffers.

Properties in this zone may also consider home elevation or structural retrofits which serve as barriers to saltwater inundation.

Adapt Zone

In the Adapt Zone conditions are variable and often include moderately well-draining hydrologic soil group B soils with pockets of fast draining A soils that are underlain in places by a high-water table (A/D soils), which limits their otherwise quick draining capacities. The elevation in the Adapt Zone is greater than 7.5 feet. Infiltration based practices are likely suitable, as well as retention/detention-based practices. The Adapt Zone has a diverse array of NBS options including green roofs, rain gardens, rainwater harvesting, permeable pavement, and bioswales. A treatment train approach is encouraged, as practices can work in conjunction and increase water management effectiveness.

Considerations for Residential-scale NBS

Bioswales:

Place along property boundaries to assist with temporary storage and conveyance of stormwater. Bioswales, often included in individual stormwater management plans that the Town requires for development, can be helpful when neighboring lots differ in elevation to redirect stormwater runoff away from adjacent yards and towards the street or other conveyance area.

Bog Gardens:

Locate in an area of the property where the pooling of water has been observed. The bog garden will incorporate vegetation that thrives in wet conditions. The bog garden vegetation will improve infiltration with deep root systems and the uptake of water through evapotranspiration.

Green Roofs:

Locate on garage rooftops, awnings, and other surfaces with a gradual pitch. Have a structural engineer or architect assure the roof structure can support the added weight or consider for new builds.

Figure 20: Station 16 Beach

Living Shorelines:

Identify areas of shoreline erosion. Photographic monitoring will assist with understanding rate and severity of erosion. Determine if erosion is occurring at the marsh edge, near the low tide line, or if erosion is occurring adjacent to revetments and other hardened shoreline techniques. Note if an oyster-based practice is appropriate by determining if oysters are present along dock pilings and adjacent mud flats. If marsh edge protection is the goal, locate the living shoreline within ten feet of the erosional escarpment. If upland protection is the goal, locate the living shoreline at the base of the revetment as space allows. Over time, the living shoreline will capture sediment, raising the elevation of substrate adjacent to the revetment, which will help to prevent scouring, sinkholes, and slumping. Regardless of location, the incorporation of oysters and vegetation in living shorelines will function to filter contaminants out of the water column.

Permeable Pavement:

Permeable pavement is an infiltration-based practice. Permeable pavement options may include the removal of impervious areas, such as a concrete sidewalk, that is replaced with a more permeable surface such as a mulched pathway or stepping stones. Interlocking permeable paver systems are used in driveways and parking areas. Residents need to consider long-term maintenance of these systems. Interlocking pavers allow water to infiltrate between the pavers; the greater the space the more water will be able to infiltrate. If space between pavers becomes clogged the surface no longer functions as intended as it more closely resembles a traditional concrete driveway. Maintenance will include regular removal of debris using a leaf blower or other equipment; frequency is based on surrounding watershed such as overhanging trees and slope of land.

Rain Gardens:

Determine the source of rainwater runoff (ex. rooftop, roadway, driveway, etc.) and estimate the size in square feet. Identify where water flows during a rain event. Site the rain garden between the source (rooftop) and destination (ditch, neighboring yard, etc.). Determine infiltration rate of existing soils by conducting a percolation test. If the site is fast draining (“percs” within 6 hours) then a small rain garden roughly 20% of the impervious surface area will suffice. If the site is slow draining, a larger rain garden is needed.

Rainwater Harvesting:

Capture and temporarily store rainwater from porch, garage, and other roof surfaces for non-potable uses including irrigation. Site the rainwater harvesting system close to the area of intended use. Empty the tank in between rain events.

Vegetative Buffer:

Select native plants that can withstand salt spray and occasional saltwater inundation. Locate the vegetative buffer along the uplands adjacent to the shoreline. Limit irrigation, mowing, and fertilizer application in the buffer area. Not only do vegetated buffers filter contaminants before they enter the marsh, they build root structures that will hold uplands together in the event of a major storm surge event.

Table 23 depicts practices that are most appropriate per each designated zone. Note that tree plantings and vegetative buffers are appropriate in each of the Zones, as the increase of tree canopy cover and incorporation of native plant landscaping should be encouraged throughout the Island. The Sullivan's Island approved tree planting list provides tree species recommendations based on site conditions.

Table 23: Zone Recommendations:

Nature-based Solution	Conserve	Protect	Adapt
Rain Gardens	✿		✿
Bioswales	✿	✿	
Rainwater Harvesting		✿	✿
Permeable Pavement			✿
Green Roof		✿	✿
Bog Garden		✿	
Constructed Wetland	✿		
Living Shoreline	✿	✿	
Vegetative Buffer	✿	✿	✿
Tree Planting	✿	✿	✿

Business District Complete Street Adaptation Strategy

The Business District of Sullivan's Island is concentrated on Middle Street primarily between Station 22 ½ (Causeway) and the intersection of Station 20 ½ and Middle Street. This area is home to restaurants, shops, and business offices as well as Town Hall, the fire station, and Stith Park. As indicated in the Sullivan's Island Stormwater Master Plan, and observed in stakeholder interviews, this area of the Island is prone to stormwater flooding. Nature-based Solutions (NBS) can be incorporated along this popular corridor to assist with stormwater management, beautify the area, and reduce urban heat island effect. Opportunities to incorporate NBS are diverse and include permeable pavers, porous concrete, green roofs, tree plantings, bioswales, and bioretention cells. **Through desktop analysis and on-site investigation, paired with an understanding of local precedents, the green infrastructure opportunities are identified in Figure 22.**

Many of the opportunities for NBS along Middle Street are sited along the side or gutter area where water will travel first during a storm event. Infiltration-based practices such as bioretention, permeable pavers, and porous concrete can help to manage water close to the source and reduce community flooding.

Figure 21: Standing water on Middle Street hours after a rain event.

Details on design and maintenance when considering NBS along Middle Street are as follows:

Permeable Paver System

Driven by the Town of Sullivan's Island requirements, existing permeable parking areas are present in private parking areas. The pavers themselves are not permeable, however water is able to infiltrate through spaces between the pavers. The water drains into an aggregate base designed to manage water. Public parking areas, including parallel parking spots along the north side of Middle Street and the parking lot at the U.S. Post Office, can be retrofitted to incorporate a permeable paver system. Serving as a local precedent, the City of Folly Beach incorporated over 8,000 square feet of permeable pavers along the Center Street business district as part of a stormwater improvement project. Folly

Figure 22: Middle Street Nature Based Solutions Opportunities

Figure 23: Existing permeable parking at Obstinate Daughter

Figure 24: Concrete ribbon separates a permeable parking area from travel lanes, Mount Pleasant, SC.

Figure 25: Interlocking permeable paver system that does not require aggregate between pavers, James Island, SC.

Beach's Center Street, similar to Middle Street, is SC-DOT-owned. In the case of the Center Street retrofits, SC-DOT did not have issue with permeable pavers and rain gardens being incorporated, but SC-DOT did require a letter from the City of Folly Beach that states the City is responsible for maintenance of non-standard items in the right-away. Some of the areas identified in Figure 22 for permeable pavement are located on private business property. In this case, the Town will need to work with property owners in the business district to gain easements, or other mechanisms of cooperation to fulfill this vision.

Maintenance is a key consideration for long term success of permeable pavers. A routine maintenance plan that includes street sweeping/vacuum truck will help to ensure the system functions as intended. As permeable paver technology continues to evolve, selection of a system that does not include an aggregate (small stones) between pavers may be beneficial for long term success. In a beach community a high volume of sandy sediment is expected and the need for street sweeping which may dislodge aggregate over time. A concrete ribbon should be considered in design. Although one may not be necessary, the concrete ribbon provides stability for the system and separation from travel lanes, as well as aesthetic appeal. Furthermore, the surrounding area should be stabilized with vegetation, mulch, and other forms of ground cover to avoid sediment washing onto the paver area.

Porous Concrete

The south side of Middle Street does not include public parallel parking and space is available to incorporate porous concrete to

Figure 26: Stormcrete, a pre-cast pervious concrete system, is placed along road gutters in New York City, NY.

Figure 27: Bioswale installation using a product called "Bold & Gold" filtration media to assist with pollutant removal, Mount Pleasant, SC.

create a pervious gutter. New York City has incorporated porous gutters along miles of roadways to take advantage of available space that can be used for infiltration. In the case of Middle Street, the gutter would capture water flowing from the roadway surface and reduce the strain on drainage infrastructure. Similar to permeable paver systems, technologies surrounding porous concrete continue to evolve. Pre-cast systems create consistent drainage performance and ease of installation and maintenance. **Maintenance routines for porous concrete are consistent with that of permeable paver systems.**

Bioswale

Bioswales are depressed landscape features that temporarily store and treat stormwater. Bioswales are often long and linear in shape and are designed to convey water during larger storm events. Bioswales are located in areas that connect to existing stormwater infrastructure or located along the natural path of water. Bioswales can provide enhanced aesthetics for parking areas and provide ecological benefits through the incorporation of native plant species.

A potential area for a bioswale was identified along Station 21 where currently a traditional ditch exists. A bioswale retrofit could provide water quality and water quantity benefits with enhanced, engineered soils and native vegetation. Water would enter the bioswale through overland flow. Additional features, such as check dams, weirs, underdrains, and other engineered devices may be considered in the design to increase storage capacity or to filter out sediment to protect downstream water quality.

Maintenance of the bioswale is largely focused on areas where water enters and exits. If erosion is observed, the area should be stabilized with rock or vegetation to dissipate the energy of the water. Vegetation should be maintained according to the planted design. according to the intended design. In high energy bioswales, dense surface root structures are critical, but in the case of the Island, deep rooted plants that can withstand drought conditions between rain events and penetrate soil to allow the infiltration of water during floods are an important consideration. For this reason, bioswales should also be allowed to grow to full height each season. Mowing and trimming reduces root penetration and mass. The best species for the job in restoration and engineering projects are going to be native plants well adapted to the unique conditions of the site without irrigation or fertilizer. Sediment may accumulate in the bioswale and should be assessed on an annual basis or as needed.

Bioretention

Bioretention is a depression in the landscape that uses engineered soils and vegetation to store and manage stormwater runoff. Bioretention can be incorporated into urban settings by using concrete panels to separate the bioretention cell from travel lanes and sidewalks; this approach is also known as a "rain garden in a box." The surface of the planted area is lower than street level, and creates space, also known as ponding depth, for water to slow down and to infiltrate. Curb cuts allow water to flow off Middle Street and into the bioretention cell.

Figure 28: Example of a "Rain Garden in a Box," Burlington, VT

The engineered soil is high in sand content to assist with infiltration. Organic soil amendment is used to provide nutrients to aid in plant health as well as support microbes in the soil that help to break down pollution found in stormwater runoff. Plant species incorporated are typically native to coastal South Carolina. These plants are selected due to their ability to survive diverse conditions including heavy rainfall, periods of inundation, drought, and heat from the full sun and surrounding impervious surfaces.

Bioretention cells are designed to drain within 72 hours after a storm. To function as intended, bioretention cells must be at least six inches from the bottom of the bioretention cell to the seasonally high-water table. When designing the bioretention cell, plan for at least six inches of ponding depth (vertical difference between adjacent surface and surface of bioretention cell), three-inch layer of shredded hardwood mulch, and eighteen inches of engineered soil (filter media). Often an additional six to nine inches of stone is included at the bottom of the cell to assist with infiltration and to maintain the filter media; however, due to vertical space limitation with high groundwater table, this layer may be eliminated or incorporated into eighteen inches of engineered soil. The depth of each layer will be dependent upon the depth of the water table. Figure 29 depicts an example of the depths of each layer.

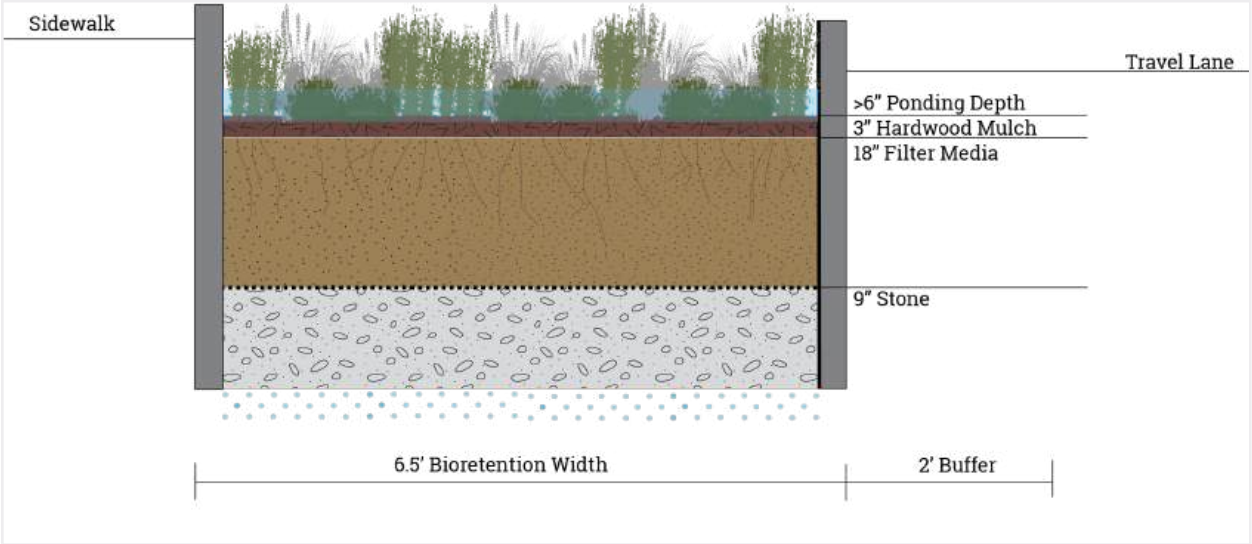


Figure 29: Bioretention depths

Green Roof

Green roof technologies take advantage of roof surfaces to reduce the volume of stormwater runoff, pollutant loading, and the peak runoff rate without consuming valuable land. Green roofs can help to cool buildings and provide added gathering spaces for businesses. As water falls on the roof area, rainfall is retained by plants and soaks into a soil media. A waterproof membrane separates water from the roof surface. As water infiltrates, it reaches the membrane and flows towards an outlet. Typically, green roofs

feature an extensive system, defined by the depth of the growing media which is three to six inches thick. Often, the extensive system is placed on the roof using modular tray units that can be oriented, moved, and replaced as needed. Some of the historic green roofs on the Island may feature an intensive system which has a growing media anywhere from six inches to four feet thick. It is assumed that any newly installed green roof on Sullivan's Island will use the extensive approach.

Figure 30: Sullivan's Island has a unique history with green roofs, some of which can still be seen today. Battery Gadsden, featured above, is the home of the beloved Edgar Allen Poe Library (foreground) and the Battery Gadsden Cultural Center (background).

Figure 31: Green roof located at the Clemson University Zucker Family Graduate Education Center, North Charleston SC.

Green roofs are typically placed on flat roofs, such as the roof on the U.S. Post Office located on Middle Street. In an area surrounded by pavement and concrete, green roofs offer an opportunity to soften the space with vegetation that absorbs both water and heat. The structural capacity of the roof must be accounted for when designing a green roof to ensure the roof can support the added weight (typically fifteen to thirty pounds per square foot is required to support an extensive green roof). Green roofs with established vegetative cover and root growth will perform best during a high wind event; therefore, green roofs should be installed in the spring at least three to four months before hurricane season. Roof access will be required for installation and for routine maintenance (Low Impact Development in Coastal South Carolina: A Planning and Design Guide).

Figure 32: Native plants and tree planting along Middle Street adds beauty, water absorption, and cooling benefits.

Tree and Native Plant Planting

Locations are identified for additional tree plantings focused on the south side of Middle Street due to existing overhead power lines on the north side of the Street. **In areas where space is limited, the Cabage Palmetto tree is an excellent option** for this barrier island community. The Palmetto Tree provides shade, habitat, and the trunk does not require extensive space nor does it have a spreading root system. The Palmetto Tree also has historical ties to the Island as it was once used in fortification.

In areas with more space, a Live Oak is recommended to provide even greater shade benefits and water management. Native plants and trees should be incorporated wherever possible to provide important cooling benefits which will add to the health, safety, and enjoyment of users of this popular space. When planting trees, conflict with underground utilities must be avoided. Trees and landscaping should be maintained for the health of the plants as well as the aesthetics of the space.

Marsh Management Protection

Description

South Carolina is home to over 350,000 acres of salt marsh which serves as an incredible resource for the local economy and way of life. The South Carolina salt marsh is flooded by the tides two times a day; Smooth cordgrass (*Spartina alterniflora or Sporobolus alterniflorus*) and black needlerush (*Juncus roemerianus*) are among the few plants that can thrive in these conditions.

Figure 33: Short-form Smooth Cordgrass with an enigmatic marker in the saltmarsh at Star of the West.

Figure 34: The saltmarsh at low tide. Smooth Cordgrass in coastal SC.

Critical Line

The boundary that separates uplands from coastal marsh is known as the **"critical line."**

Under the State's Coastal Zone Management Act, the South Carolina Department of Environmental Services (DES) Bureau of Coastal Management (BCM) is responsible for delineating the boundaries of critical areas, including tidally influenced wetlands. The jurisdiction of the SC DES-BCM extends to all tidally influenced wetlands that are located below this critical line.

Additionally, the Town of Sullivan's Island has implemented further regulations landward of the critical line through local ordinances, zoning laws, and setback requirements. **These regulations are designed to provide additional protection for marshfront ecosystems and to manage development.** Specifically, the Town has established a 30-foot setback from either the state critical line or the lot line—whichever is more landward.

The Town's zoning ordinance defines an RC-2 Area Zoning District that includes Sullivan's Island marshfront or "back beach" as it is referred to locally, and the Town's setback ordinance (Section 21-23) notes the purpose of the 30-foot setback is to create a buffer for the *"RC-2 Area Districts...that allows passive treatment of stormwater run-off before entering the waters surrounding Sullivan's Island and to provide a buffer zone from floodwater and erosion caused by storms, sea level rise and other natural conditions."*

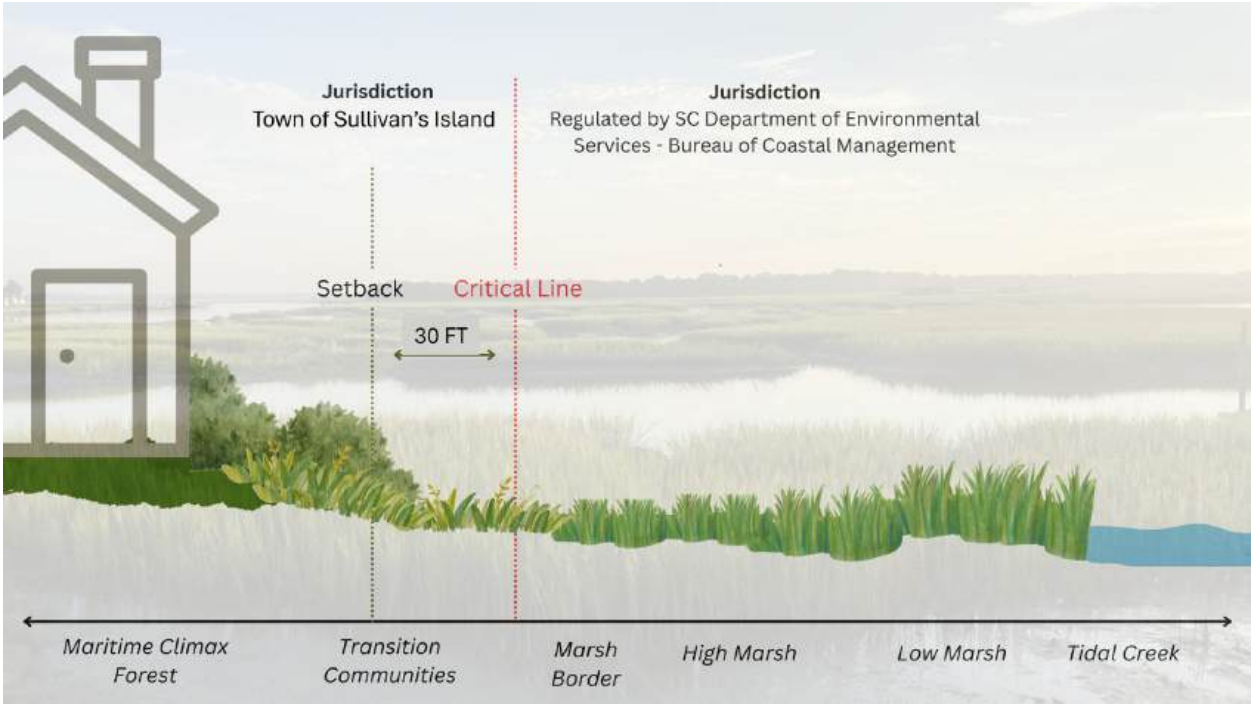


Figure 35: The critical line is a biophysical jurisdictional feature that will shift with the edge of the marsh as it migrates. Source: Elko Coastal Consulting, Inc.

Benefits

Sullivan's Island is home to approximately 1,100 acres of saltwater marsh, tidal creeks, and marsh islands. Marsh management is critical in protecting the vital functions and ecosystem services the salt marsh provides, including:

- **Coastal Protection –** The salt marsh acts like a sponge by absorbing excess rain and storm surge during hurricanes and high tides. The salt marsh also slows down water, which helps to protect inland areas and infrastructure. The abundant vegetation dissipates wave energy to decrease the impact of storm surge experienced inland.
- **Water Quality –** The salt marsh filters pollutants, including excess nutrients such as nitrogen and phosphorus, as well as sediments, debris, and heavy metals from adjacent stormwater runoff.
- **Biodiversity –** The salt marsh serves as essential habitat for wading birds, shorebirds, reptiles, and mammals, including several threatened and endangered species. It also acts as a nursery for various fish, shrimp, crabs, and oysters, all of which are crucial to the fishing industry.
- **Carbon Sequestration –** Salt marsh plants and sediments act as a carbon sink. The salt marsh captures and stores carbon dioxide by locking it into the existing biomass and soils, which can help combat climate change.
- **Economic and Cultural Value –** The salt marsh supports the coastal SC economy through commercial and recreational fishing. Recreational fishing is a significant industry in South Carolina, contributing approximately $2.74 billion annually and supporting nearly 32,000 jobs in 2023. In 2022, commercial fishermen landed 14 million pounds of finfish and shellfish, generating around $25 million in revenue.
    - **Sustainable management** is essential to preserve the area's economic stability and natural resources. Numerous eco-tourism opportunities are available in the salt marsh including kayaking, guiding fishing trips, bird watching, and nature tours. The salt marsh holds abundant cultural and historic value, from the many local traditions of the Gullah-Geechee communities to the shell rings left by the Sewee.
    - **Maintaining and protecting the salt marsh** also affords the Town a large allocation of points that contribute to the Town's excellent FEMA CRS (Community Rating System) rating of 5, which affords residents a 25% discount on National Flood Insurance Program rates and is the third best rating in the state, after Charleston County (2) and Folly Beach (3).

Considerations

Salt marshes are incredibly valuable ecosystems that face significant vulnerabilities from both human and natural sources including:

- **Sea Level Rise –** As sea levels rise, the salt marshes will drown if it is not able to build up sediment quickly enough, which could lead to the conversion of marsh to open water. This is considered one of the greatest threats to SC salt marshes.
- **Development –** As sea levels rise, marshes will migrate inland but migration pathways may be blocked by roads, seawalls, and buildings. This phenomenon is known as "coastal squeeze." Development also increases stormwater runoff and pollution entering the marsh, which can have detrimental impacts to marsh health. Development could also lead to salt marsh fragmentation as marshes are filled or degraded with roadways, bulkheads, and other forms of infrastructure.
- **Pollution –** An excess of nutrients, especially nitrogen, from sources such as fertilizers, pet waste, and septic systems can cause plant roots to decay and marsh die-off to occur.
- **Recreational and Commercial Impacts –** It is essential to avoid overharvesting species like oysters, as a single adult oyster can filter up to 50 gallons of water each day. Past overharvesting has greatly reduced stable substrate for oyster reef colonization, necessitating replacement to support healthy oyster populations. As the South Carolina coast attracts more vacationers and residents, increased boat traffic is rapidly eroding marsh banks.
- **Dredging inland waterways -** Dredging is often used to maintain navigable waterways; however, it can disrupt natural sediment flow, destabilize banks, release pollutants, and invite more boats and bigger wakes that could increase shoreline erosion. Nature-based erosion control is recommended along creek banks to stabilize shorelines.

Recommendations

In the last decade, marsh management has increasingly been used as an adaptation strategy for coastal communities. Lessons learned are drawn from beach and dune management, practiced since the 1980s in South Carolina. Marsh management relies on a variety of techniques used to protect, restore, or maintain the ecological health and function of salt marshes. Management plans often highlight collaboration, clear responsibility assignments, refined regulations, nature-based restoration projects, and educational initiatives.

Engage and Involve

1. Create and promote volunteer opportunities like marsh cleanups and educational events by leveraging training and volunteer opportunities offered by partner organizations:
    a. Clemson Extension Salt Marsh Short Course
    b. Clemson Extension Living Shoreline Contractor Training
    c. South Carolina Oyster Reef & Enhancement (SCORE) (Figure 3)
    d. South Carolina Sea Grant Consortium's From Seeds to Shoreline program
2. Install educational signage at high-use marshfront areas and develop visitor education campaigns.

Figure 36: SC DNR Oyster Recycling and Enhancement Program (SCORE) marsh restoration with volunteers at Mingo Point.

Monitor

This section recommends developing a companion marsh monitoring plan. Data and maps will inform future marshfront regulations for fill, berms, and citing nature-based protection features. Elements of this plan may include:

1. Utilize maps and data collected in this section in a feasibility analysis of appropriate elevation, slope, and distance tolerances from the critical line for nature-based systems along the marshfront.
2. Define the extent and characteristics of marsh areas:
    a. Map the critical line surrounding Sullivan's Island to establish a local regulatory

baseline for monitoring erosion rates. This boundary should be physically surveyed but can also be estimated by mapping a pre-defined contour (e.g., 7.5 ft MLLW).

   b. Map the marsh frontage within the Town (linear feet).

   c. Identify areas prone to marsh bank erosion, particularly creek bends, as well as areas of marsh accretion that may pose challenges to infrastructure maintenance. Assess the factors influencing marsh expansion or erosion.

   d. Calculate key indicators for marsh health to monitor vegetative cover and marsh die-off. The unvegetated-vegetated ratio (UVVR) is an indicator of marsh habitat health, calculated from the total areas that are unvegetated and vegetated.

3. Monitor variables that influence marsh health:

   a. Establish protocols for monitoring water quality, economic value, and wildlife populations.

   b. Define baseline sea level conditions, past storm and flood events, and future water level scenarios.

   c. Invest in water level sensor(s) to measure marshfront flooding and understand how marsh migration patterns are evolving.

4. Inventory and map marshfront structures:

   a. Habitable structures in the RC-2 Area District within and adjacent to the 30-ft setback.

   b. Structures that cross the critical line, including docks, causeways, and hardened shoreline stabilization.

   c. Public property, vacant/undeveloped lots, and conserved lands along the marshfront for potential demonstration sites.

   d. Pervious/imperious coverage within the jurisdictional limits of the Town

      i. Impervious surfaces can be estimated from aerial photography.

      ii. Pervious surfaces require on-the-ground quality checking to inventory and determine whether maintenance is needed to restore permeability.

Protect

1. Collaborate with stormwater drainage plan for infrastructure maintenance to minimize marsh impacts.

   a. Consider innovative stormwater delivery mechanisms like the Dune Infiltration System (see Dune System Management and Restoration Strategy) or perforated pipes, sprinkler or level spreader.

   b. Reference residential NBS section of this report.

   c. Ensure all new regulations include neighbor notification and determination of adjacent impacts/benefits to avoid new construction resulting in the diversion of flood waters to neighboring properties.

2. Refine allowable uses within the 30-ft setback to provide marshfront owners with nature-based options for enhancing their property.
    a. Permit eco-friendly erosion control measures, such as Envirolok (Figure 4) or similar nature-based stabilization .
    b. Permit solid 18” landscaping walls landward of the 30-ft setback.
    c. Properly define nature-based solutions appropriate for the marsh front, as distinct from erosion-control devices, and maintain current prohibition of sea walls, bulkheads, and other hardened and buried erosion control devices in the RC Districts.

Figure 37: Envirolok on Sullivan’s Island.

3. Refine property fill and new earthen berm allowances based on data from stormwater plan and the marsh monitoring plan recommended above.
    a. Property fill to exceed 1 ft in principal building footprint with property-specific stormwater plan that captures all runoff from a 50-yr 24-hr rainfall event.
    b. Consider allowing earthen berms landward of the 30-ft setback, in excess of 1 foot of fill, for lots with existing, low-lying buildings that would not be elevated unless damaged more than 50%.
    c. Require an adequate marshfront slope (e.g., 2:1) based on monitoring data to reduce property erosion.
4. Refine the 30-ft setback to function as a setback and a “native vegetation buffer” which helps reduce flood damage, pollution, and runoff; protect wildlife; and provide a transition between development and the marsh.

   a. Within the 30-foot setback, consider prohibiting grass lawns which require regular maintenance such as herbicides, pesticides, fertilizers, and frequent mowing.
   b. See Appendix C for examples of native marshfront vegetation.
5. Minimize the impacts of runoff into the marsh by:
   a. Manage impervious surfaces by enforcing Town ordinance 21-26, and
   b. Incentivize use of nature-based solutions to manage stormwater on private lands.
6. Extend no-wake zones into environmentally sensitive areas to reduce erosion of marsh habitat.

Restore

1. Collaborate with the US Army Corps of Engineers to locate appropriate beneficial use placement areas outside the Town's marsh limits for Intracoastal Waterway or Cove Creek dredged sediment. Sullivan's marshes are presently accreting, so in the short-term, Thin Layer Placement for marsh restoration would be better used elsewhere; however, large-scale marsh restoration may be a future consideration to manage rising water along the marshfront.
2. Assess the feasibility of pilot projects on public lands to provide hands-on demonstrations of best marshfront management practices (e.g., Figure 3).
3. Formulate a long-term funding strategy for future acquisition of distressed, undevelopable, and vulnerable marshfront property to protect for conservation and water absorption.
4. Explore creative funding opportunities:
   a. Offer mini grants to marshfront property owners to support the installation of green infrastructure and living shorelines.
   b. Incentivize private restoration efforts amongst adjacent marshfront property owners (e.g., rain barrel giveaways).
   c. Establish a marshfront preservation reserve for mitigation and acquisition.
   d. Track federal grant opportunities such as NOAA's National Coastal Resilience Fund and FEMA's pre-hazard mitigation grants.

Figure 38: Conceptual sketch of thin layer placement to rebuild marsh elevation.

Maritime Forest

A maritime forest is a coastal forest typically located behind dunes on the mainland or a barrier island.

Maritime forests survive in harsh conditions as they are exposed to high winds and salt spray from the ocean. The vegetation closer to the water is usually shorter in height and increases in height further inland.

The understory species are commonly comprised of Southern Waxmyrtle (*Myrica cerifera*), Yaupon Holly (*Illex vomitoria*), and Eastern Baccharis (*Baccharis halimifolia*). The canopy species are commonly comprised of Southern Live Oak (Quercus virginiana), Laurel Oak (*Quercus laurifolia*), Bull Pine (*Pinus elliottii*), Palmetto Tree (*Sabal palmetto*), Eastern Redcedar (*Juniperus virginiana*) and Southern Magnolia (*Magnolia grandiflora*). See Figure 39 which depicts some of these maritime forest species.

Benefits

The maritime forest on Sullivan's Island is an area to be celebrated and conserved as a vital community resource providing benefits to coastal resilience, ecosystem health, and human well-being. Ecosystem services of the maritime forest include the following:

- **Coastal Resilience –** Maritime forests act as natural windbreaks and storm surge barriers which protect inland areas from hurricanes and flooding. The maritime forest allows the ocean's dynamic coastline to move without damaging coastal human investments. Their root systems also stabilize soils and dunes, which reduces coastal erosion.
- **Biodiversity –** Maritime forests support a wide range of species – birds, mammals, and insects, some of which are rare or endangered. Migratory birds rely on these habitats as places for food and rest.
- **Water & Air Quality –** Maritime forests filter rainwater before it enters the ocean and adjacent communities by trapping pollutants and sediments. The forest also provides tremendous air quality control, scrubbing fine particulate matter and other contaminants.
- **Climate Regulation –** Maritime forests convert carbon dioxide into plant material which helps mitigate climate change. Canopy cover reduces the urban heat island effect by shading the ground and evapotranspiring water, creating a cooling effect.
- **Human-Well Being Value –** Maritime forests are often tied to indigenous and colonial history, which provides cultural value. They provide excellent value for hiking, birdwatching, and education for locals and visitors alike, which provides recreation value.

Figure 39: Maritime forest vegetation, Sullivan's Island, SC

Considerations

Globally, maritime forests are considered a rare ecosystem. They have been heavily impacted throughout the years due to human impact (about 10% of the world's population lives within 3 miles of an ocean) and natural events including the following:

- **Sea Level Rise –** Given the lower elevation of these maritime forests they are susceptible to rising sea levels and saltwater intrusion. Increased exposure to salt can kill some of the more freshwater-dependent species and result in stress or dying trees also known as "ghost forests or boneyard beaches."
- **Habitat Fragmentation –** When sections of maritime forest are broken up by roads, pathways, or subdivisions, wildlife corridors can be destroyed and reduce the functionality of the forest for pollinators, migratory birds, and amphibians. Fragmentation will also reduce the benefits of coastal protection by exposing further inland areas to impacts from ocean winds and storm surge.
- **Invasive Species –** As the name suggests, invasive species outcompete native plants, converting those spaces into food deserts for the larval stages of insects, which has ramifications all the way up the food chain. Below is a table of some of the common invasive species found specifically in the Sullivan's Island maritime forest.

Table 24: Common Invasive Species in Maritime Forest in Sullivan's Island, SC

Common Name	Photo	Scientific Name	Problems
Popcorn Tree		Triadica sebifera	Outcompetes native oaks and pines, can dry up isolated wetlands, and alters soil composition and reduces wildlife food sources.
Scarlet Sesbane		Sesbania punicea	Forms dense thickets, replacing native species and taking food resources from wildlife.
Privets		Ligustrum sinense, Ligustrum lucidum, Ligustrum japonicum	Dense shrub prevents growth of native seedlings.
Elaeagnus		Elaeagnus pungens, Elaeagnus umbellata	Forms in dense thickets, displace native species, and disrupt wildlife.
White Mulberry		Morus alba	Invasive root systems grow fast in thick patches so native vegetation cannot grow.
Wisteria		Wisteria sinensis	Woody vine that climbs and smothers native trees and shrubs.

Common Name	Photo	Scientific Name	Problems
Pampas Grass		Cortaderia selloana	Dense clumps outcompete native vegetation, wind-dispersed seeds spread quickly.
Japanese Honeysuckle		Lonicera japonica	Woody vine that climbs and smothers native trees and shrubs.
Common Reed		Phragmites australis	Forms dense thickets that block out native fauna. Has high above ground biomass which blocks light to other plants.
Beach Vitex		Vitex rotundifolia	Dominates dune ecosystems leading to a reduction in native species.
Tropical Milkweed		Asclepias curassavica	Present year-round in warmer climates, outcompetes native species.
Kusamaki		Podocarpus macrophyllus	Grows rapidly and forms thick patches that hinder the growth of native plants.

All photos from iNaturalist

Recommendations

The Town's current ordinance on Trimming and Pruning in the RC-1 District can be found at the following website: *codelibrary.amlegal.com/codes/sullivansislandsc/latest/sullivansisland_sc/0-0-0-5716*, relevant parts of the ordinance are copied below.

Sec. 21-71. Trimming and pruning in the RC-1 District.

> *C. (2) The trimming and pruning allowed herein shall only be permitted between November 1st and the following February 28th.*
>
> *C. (3) The only vegetation that may be trimmed and pruned in the RC-1, RC-1C or RC-1E Areas is limited to the following: Southern Waxmyrtle (Myrica cerifera), Eastern Baccharis (Baccharis halimifolia) and Popcorn trees (Tallowtree, Sapium sebiferum). This vegetation may be trimmed and pruned so as to have a maximum height of no less than five (5) feet above the ground…In the case of Popcorn trees, cutting can extend below five (5) feet if recommend by the consultant hired under this Ordinance and approved by the Tree Commission.*

Proposed updated to C. (2) includes the allowance for removal of invasives outside of the seasonal window specified. This update would make it easier to accurately identify certain invasive species while distinguishing foliage is present. Furthermore, landscaping companies would have more time to complete trimming and pruning work related to invasive species removal. Another proposed consideration should be to update the beginning and ending dates of the season to better reflect the dormant season for the 2 species of shrubs.

Clarity could be provided on the specific language in C. (3) as it relates to Popcorn tree cutting. Popcorn trees should be cut to ground level or physically uprooted where possible. Popcorn trees are incredibly fast growing and can invade rapidly. These invasive trees have been documented to grow ten feet high in as little as two years, and so it is especially important to target young trees before they begin producing seeds and become much more difficult to eradicate. Popcorn seedlings should be removed by mechanical means, including hand pulling and the use of weed wrenches.

To further modify the language in the C. (3) ordinance, proposed removal of language associated with the trimming of the Southern Waxmyrtle and Eastern Baccharis. Or as an option to removing the language considering limiting trimming to every other season. When the Southern Waxmyrtle is cut to five feet it does not produce berries to feed the myrtle warblers and other songbirds who overwinter on the Island. Southern Waxmyrtle and Baccharis are in most cases not the vegetation that blocks views of the ocean for beachfront homes; therefore, trimming is baseless and does more harm than good.

Further ordinance considerations could specify that only the Town or Town-appointed contractor is allowed to perform pruning or trimming activities within the maritime forest. In addition, the Town could expand the RC areas and list of species that are allowed to be pruned, trimmed, or removed to encompass more of the

invasive species. It is important to note that with the removal of invasive species-specific disposal protocols should be established and followed to ensure that roots or seeds left behind do not propagate. All these suggestions ultimately lead to the overarching goal for the creation of a resilience-based forest management plan. The creation of a forest management plan would effectively end the permitting trimming and pruning permits.

To assist with invasive species removal, an invasive species training course could be developed by the Town in partnership with other organizations such as Clemson Extension, SC Native Plant Society, or SC-Exotic Pest Plant Council. This training course is envisioned as a one-day field-based opportunity which would cover species identification, common similar-looking native species, the proper removal methods, and proper cataloging of removal efforts. Upon successful completion of the course, the individual would be provided with an invasive species removal license which could allow them to remove invasive species year-round. To further ensure the safe removal of the invasive species they should be smaller than a specified diameter stem diameter.

In some cases, removal of invasive species may necessitate restoration activities such as plantings or seed and sapling gathering. Native species that can be used for restoration include in the forest, Carolina Willow (*Salix caroliniana*), Yaupon Holly (*Ilex vomitoria*), Southern waxmyrtle (*Myrica cerifera*), Spotted Horse Mint (*Monarda punctata*), and American beautyberry (*Callicarpa americana*). Restoration activities are often a good opportunity to partner with other organizations such as Sullivan's Island Elementary School and Charleston Waterkeeper to obtain volunteers and provide education on the importance of these habitats.

INVASIVE SPECIES

All photos from iNaturalist

Carolina Willow (*Salix caroliniana*)

Yaupon Holly (*Ilex vomitoria*)

Spotted Horse Mint (*Monarda punctata*)

American beautyberry (*Callicarpa americana*)

Southern waxmyrtle (*Myrica cerifera*)

A balance of conservation and recreation is important when creating trails through the maritime forest. Recreation can have a negative impact by increasing soil compaction from foot traffic and disruption to wildlife that nest or forage in the area. The Town has already adopted several best practices to establish the minimally disruptive Nature Trail along a portion of the maritime forest. For the Nature Trail the Town utilizes the existing dune ridges within the maritime forest as the pathway, see Figure 2. The dune ridges are naturally void of most vegetation so there is minimal clearing required to establish the trail. The dune ridges can withstand the compaction from foot traffic and the dune ridges also run parallel to the shoreline so there are no gaps introduced which would compromise the natural coastal protection these areas provide. Eliminating the private beach paths that bifurcate the maritime forest should also be considered, and the Dune System Management and Restoration Strategy further details ways to minimize pedestrian pathways by having private access pathways join the Nature Trail or other public walkovers at Station accesses.

As time and funding become available the Town should seek to expand the extents of the Nature Trail, as shown in the dotted white line on Figure 3. The nature trail currently extends from Fort Moultrie, with access at Station 16, to the lighthouse past Station 18.

To further enhance the Nature Trail, interpretive signage can be added to educate visitors and highlight native species and ecosystem processes. Strategically locate birdwatching and wildlife observation locations outside of the maritime forest or along elevated beach access walkways for those that are unable to venture onto a Nature Trail.

Figure 40: Nature Trail at Station 16

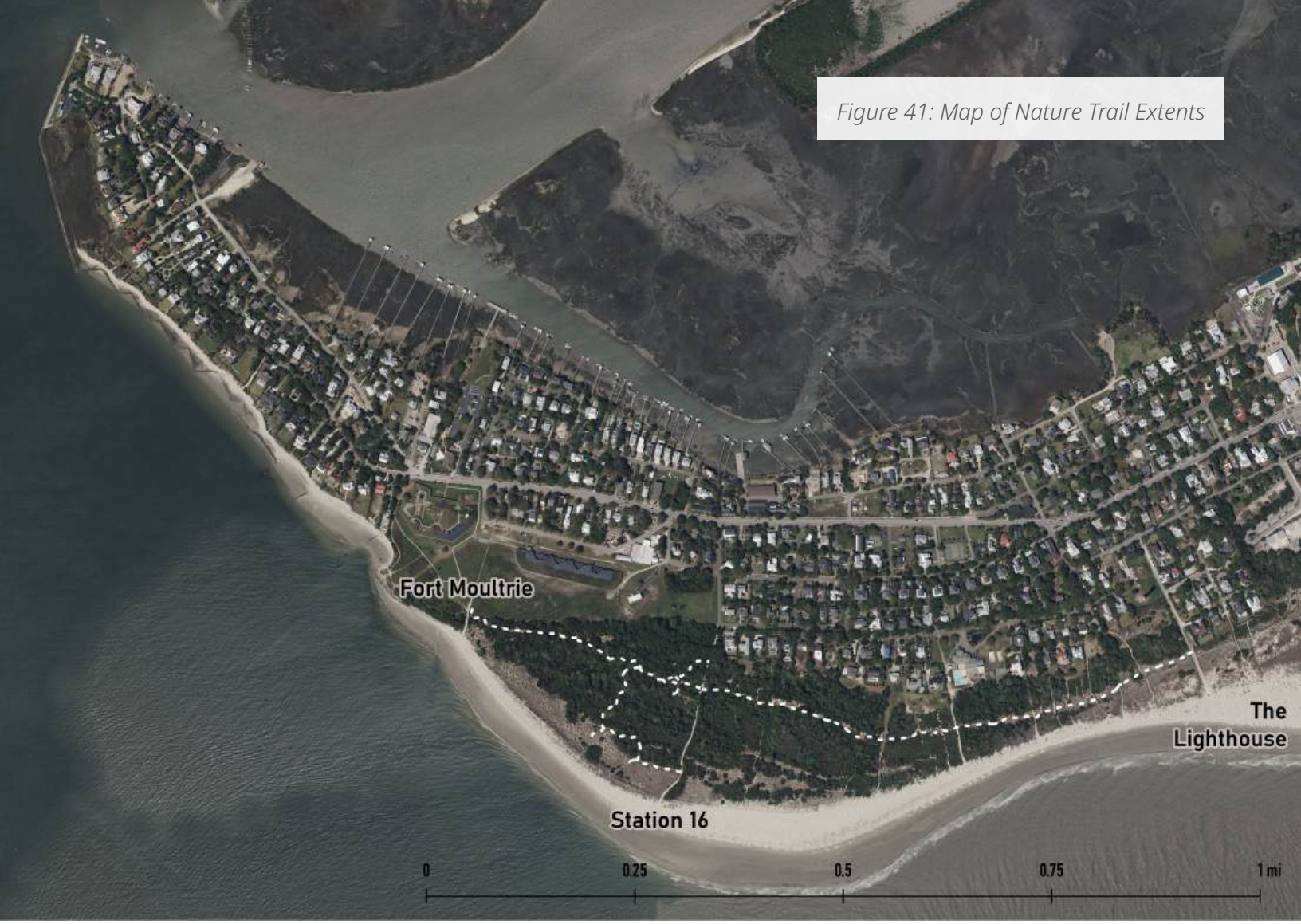


Figure 41: Map of Nature Trail Extents

Dune System Management & Restoration

Description

A beach dune is a mound or ridge of sand located between the inland and active beach (area affected by daily high tides). Dunes are the first line of defense between inland areas and the ocean and are an essential feature on many barrier islands and coastal landscapes. Dunes are a prominent coastal feature along South Carolina's coast (Hayes, 1979). Drumstick barrier islands like Sullivan's Island, Bull's Island, and Isle of Palms (Figure 42) are dominated by seaward-advancing beach ridges (prograding), which have developed in a dune-swale pattern. Swales are the low-lying areas between multiple dune crests.

The backshore becomes vegetated with dune grass soon after accreted lands (beach ridges) develop. Thanks to the combination of this system of prograding ridges and the

Figure 42: Drumstick barrier islands on the South Carolina coast, a) digital orthophoto (1994) of Bull's Island illustrating prograding beach ridges in a dune-swale pattern, and b) Isle of Palms (courtesy Coastal Science & Engineering).

island's location on the updrift side of the Charleston Harbor jetties, the beach and dunes on Sullivan's Island have generally been accretional (reference existing location map). Dune management strategies recommended in this section aim to replicate the benefits of natural dune formation. This allows for gradual dune growth to recruit native vegetation that will develop anchoring root systems.

The Town's Recreation & Conservation (RC) Area Zoning Districts include Sullivan's Island beach and dune system. The Town's zoning ordinances notes that the conserved land areas of the RC *"provide protection to adjoining landowners and their property from the hazards of high tides and floods caused by hurricanes, tropical storms and seasonal tides" and that "the Town of Sullivan's Island originated as a health resort for all the people of the State of South Carolina, and that the RC Areas are vital to the purpose, and useful for that purpose only so long as they remain in a natural, undeveloped condition subject to the changing tides."*

Annual monitoring of dune conditions is essential for understanding the evolving state of the coastline and implementing adaptive management strategies. Through consistent data collection, the Town ensures that dune systems remain healthy and stable, allowing for informed decision-making in response to environmental changes and human impacts. Annual beach and dune monitoring began by Elko Coastal Consulting on Sullivan's Island in 2016 to better understand the beach performance on the island. The profile data was used to measure shoreline position and beach and dune sand volumes.

Over the last decade, the central beach has shown stability to accretion, with some erosion at the northeast and southwest ends of the Island. In the central area, particularly between Stations 19 and 22.5, primary dunes are forming seaward of the secondary dune,

with increasing sand volume. The primary dune at the ends of the island is dynamic, as sediment shifts from sand bar attachment events, leading to management challenges due to narrow beach widths and limited storm protection. While additional dune and marsh progradation may occur in the central Island, reports indicate that more frequent king tides could hinder further dune advancement.

Sullivan's Island partnered with the U.S. Army Corps of Engineers (USACE) from November 2024 to March 2025 on an innovative and experimental project that beneficially placed sediment along the Breach Inlet shoreline. This initial project placed about 220,000 cubic yards (cy) of sediment along the low tide line and into the Breach Inlet Channel. The sand was not expected to immediately improve the beach; therefore, the Town separately contracted to transfer sand to the dune and beach berm. About 72,000 cy of sand was transferred, restoring dunes and building beach areas along the coast between Thomson Park and Station 28-1/2 (Figure 2). The project also placed sand at Station 12 and created a 1,500 cy stockpile at the north end of the island (CSE 2025).

Figure 43: Town contractor moving sand from USACE Beneficial Use of Dredged Material (BUDM) project along the Sullivan's Island Breach Inlet shoreline in late 2024. Photo by CSE.

Benefits

Dune management practices aim to protect and restore dunes so that the dunes will, in turn, protect the community. Dunes provide valuable ecosystem, as well as storm-protection, benefits (Wang et al., 2006). They also provide critical ecological, protective, and recreational benefits, including:

- **Coastal Protection -** The storm protection benefits of a healthy beach and dune system are well documented in scientific literature (Elko et al., 2016; 2021). Dunes absorb wave energy, which helps to protect inland areas, homes, and infrastructure during hurricanes and high tides. The elevation of dunes can also help slow or redirect water and serve as windbreaks.
- **Erosion Control –** Dune systems act as sand repositories to supply a beach with sand to recover after a storm. Sand dunes are a resilient coastal feature that, in the absence of long-term erosion, will build back beaches following an erosive storm event (Rogers & Nash, 2006).
- **Biodiversity –** Dunes support birds, small mammals, and nesting sea turtles by providing habitat in dune grasses and shrubs. Dunes are also host to unique plant communities that have adapted to harsh conditions (salt and wind), which help stabilize the dunes and trap windblown sand.
- **Cultural and Recreational Value –** Dunes are aesthetically pleasing and contribute to the natural beauty and sense of place along the South Carolina coast.

Considerations

Common threats to dunes include the following:

- **Storm Impacts –** Storm surge and wave action often associated with hurricanes can flatten or erode dunes, washing away large volumes of sand. Repeated storm events can prevent natural recovery, leading to long-term degradation.
- **Sea Level Rise –** Higher sea levels will lead to more frequent overwash and inundation of dune systems, which will increase erosion and weaken the vegetation that stabilizes dunes.
- **Development –** Construction near dunes can disturb natural sand movement and interfere with dune formation. Development can often lead to the removal of vegetation, which further reduces dune stability. Artificial lighting also disrupts sea turtle nesting.
- **Human Foot Traffic and Recreation –** Unregulated walking or climbing on dunes will crush vegetation, which will weaken root systems and increase dune erosion. Often, wooden structures are installed to direct foot traffic, protect the dune, and limit maintenance. These objectives sometimes have unintended consequences when sediment input overtakes the structure, as shown in Figure 44. Additionally, pieces of the structure destroyed during a storm can become projectiles, causing further damage and increasing cleanup efforts (Figure 45). Shared walkovers can

be effective at providing access, protecting the dune system, and limiting excessive structures. If sediment input is greater than pedestrian traffic, walkover structures may not be necessary, particularly if dune elevation is sufficiently higher than storm surge (Figure 46).

Recommendations

Considering challenges such as sea level rise, increased storm frequency, and Sullivan's updrift position from the Charleston Harbor jetties, this strategy highlights **the need for adaptive dune management.** Effective management of dunes can help create a continuous defense line along the beachfront. This minimizes pressure on primary dunes and limits low-lying areas that can funnel storm surge. Proactive dune management addresses the evolving challenges posed by climate change and sea-level rise, allowing the community to provide a resilient and sustainable coastline.

Engage and Involve

1. Create and promote volunteer opportunities such as beach cleanups, dune plantings, and educational events in collaboration with the State (i.e., DES Keep Off the Dunes Program) and Regional Programs (i.e., SC Aquarium conservation events).
2. Install educational signage in high-use areas such as the Town's Nature Trail and develop campaigns to raise awareness of issues affecting dunes.

Figure 44: Sand dunes overtaking wooden structures.

Figure 45: Photo of sand fencing and walkover materials that were destroyed during the passage of Hurricane Irma, increasing the post-storm clean-up effort (2017 Folly Beach).

Figure 46: An example of an effective access path through dunes where no dune walkover is needed.

3. Educate policy makers and managers that it is common for walkovers to be buried and exposed by natural processes over time. Recommendations in this section offer best management practices, but maintenance will be necessary due to the dynamic nature of beachfront dune systems.

Monitor

1. Annually inventory public and private infrastructure in, and immediately adjacent to, the RC-1 Area District, such as public dune walkovers, public access paths, foot paths, erosion control structures, sand fencing, pools, and habitable and accessory structures, to assess their condition and impact on dune stability, and track and eliminate non-compliance. This will help identify areas where maintenance or improvements are needed to ensure public safety and maintain the integrity of the dune system.
2. Annually survey beach and dune profiles via topographic and hydrographic methods. This detects physical changes in dune height and width to assess the outcome of restoration efforts, storms, sea-level rise, and human activity on the dune system. Utilize monitoring data and aerial photography to identify the seaward-most, historically stable dune line, and define restoration and conservation areas.

Protect

1. **Continued enforcement of existing local ordinances, including:**
   a. Sec. 21-72. Maintenance of footpaths in the RC-1 Area District. No new footpaths shall be created.
   b. Sec. 21-69. Erosion control structures in RC Area Districts. Allowing no rebuilding if damaged more than 50%.
2. **Develop new ordinances to help maintain a healthy dune system:**
   a. Consider a dune trampling ordinance to constrain foot traffic to designated areas within the dunes. Foot traffic should be discouraged on private pathways seaward of the inland dune ridge and directed to designated paths like the Town's Nature Trail. A local precedent for this was recently set in Folly Beach, § 151.02 SAND DUNES; PROTECTION AND PRESERVATION and § 151.03 DESTRUCTION OF SEA OATS PROHIBITED.
   b. Prohibit Beach Vitex (*Vitex rotundifolia*) as it is an invasive species prone to dune areas.
   c. Clearly define dunes in town regulations: The Town's definition of dunes should be consistent with the state's definition of primary oceanfront dunes as follows: *Sand dunes are elevated ridges adjacent to the Atlantic Ocean that typically exhibit the presence of stable, native vegetation. Dunes may extend landward to the most seaward road in the absence of beachfront development.*

3. **Enforce local, state, and federal laws and agreements** that prohibit permanent structures seaward of the baseline (including tents and commercial storage containers) unless permitted. A state permit is required for structures in the beach/dune system critical area.

Restore

1. **Manage walkovers and access paths.**
   - **a.** Maintain and strategically install and upgrade public paths, boardwalks, and walkovers to minimize pedestrian disruption to frontal dune systems and promote natural adaptation.
   - **b.** Build raised "dune walkovers" according to S.C. state guidance, R.30-13(O)(1), see Appendix C.
   - **c.** Ensure sufficient Americans with Disabilities Act access along the Island.
   - **d.** Maintain and improve beachfront emergency response via sand pathways wide enough for vehicular access.
   - **e.** Between Stations 16 and 28, reduce private beach access paths through the primary dune.
     - **i.** Identify volunteer property owners willing to terminate private access paths behind the secondary dune ridge. Terminate paths with sand fencing as a barrier to pedestrian access in the areas between Station access points, encouraging beachgoers to stay off the dunes.
     - **ii.** Continue extending the Nature Trail through the maritime forest along the secondary and tertiary dune ridges to funnel pedestrian traffic from the access paths leading from the private residences to public walkovers at Station accesses (Figure 47 and Figure 48). In the interim, encourage the informal use of Nature Trail's proposed pathway.

Figure 47: Example of offshoots of public dune walkover into secondary dune path to discourage use of numerous private footpaths through the dunes (Folly Beach 6th St. W.).

Figure 48: Concept to eliminate individual, private access paths and funnel pedestrian traffic to public access (Example between Stations 23 and 26, aerial imagery date: March 2025).

2. **In restoration areas defined by monitoring data,**
    a. Focus on increasing the elevation of dunes rather than adding additional rows of dunes.
    b. Leverage opportunities with USACE for beneficial use of dredged material, sediment from future Intracoastal Waterway dredging projects should be placed strategically to increase dune resilience.
3. **Restore dunes** by installing sand fencing and planting native vegetation in areas designated for restoration to promote gradual and natural dune growth (Figure 49 and Figure 50).
    a. Plant native vegetation such as sea oats (*Uniola paniculata*) and bitter panicum grass (*Panicum amarum*).
        i. Improper planting and irrigation are common causes of failed dune vegetation (Rogers and Nash, 2003). Sea oats and bitter panicum grass should be planted at least 6 inches deep, during the spring or early summer, which is the early part of their growing season. Seedlings may require hand watering once a week until they are established. Irrigation after establishment is not necessary. It can remove beneficial salt spray and encourage other plant species to invade the dune.
4. **Formulate a long-term funding strategy for future acquisition** of distressed, undevelopable, and vulnerable beachfront property to protect for conservation such as a beach preservation fund. A local precedent was set in 2014 in Folly Beach.

5. **Consider an innovative Dune Infiltration System** (Figure 51) that leverages drainage relief for native vegetation irrigation at public accesses.

Adapt

1. Implement a flexible, integrated, and adaptable plan to address evolving environmental and recreational needs by conducting the recommended assessments annually and updating this plan every five years.
2. Ensure consistency between this Plan and other environmental and resilience plans such as the Town's Comprehensive Plan and Local Comprehensive Beach Management Plan.

Underground Detention

Description

Underground detention is becoming an increasingly common practice on Sullivan's Island for managing stormwater runoff and can be highly effective if sited correctly, sized correctly, and properly maintained. Underground detention systems temporarily store stormwater runoff in a subsurface facility and allow for controlled release downstream or into the ground. More specifically, underground detention works by placing a storage tank or chamber underground and routing stormwater into it, either through a storm drainpipe or through an infiltration layer, such as pervious concrete. It can be as simple as

Figure 49: Example of using sand fencing and vegetation to restore dune system on Folly Beach.

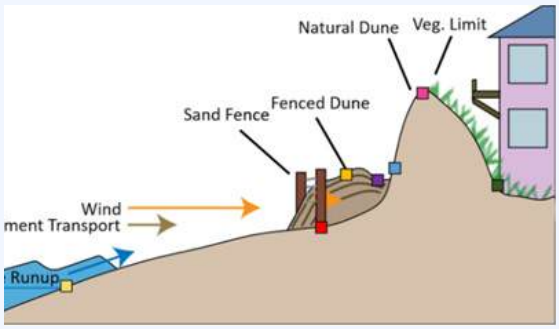


Figure 50: NOAA schematic of dune restoration with sand fencing in Bogue Banks, NC

Figure 51: Installation of the innovative Dune Infiltration System on Folly Beach, June 2025.

burying gravel to create space for water to fill and flow, or it can involve a 'treatment train' approach conveying, storing, and infiltrating water through a series of green stormwater infrastructure, such as a pervious paver system routed through a french drain to a storage tank underground. The captured stormwater is then slowly released over time, either through an outfall pipe or back into the soil through infiltration.

Below is a profile of an R-tank, which is a modular underground detention system, installed within a rain garden. A rain garden is a depressed area with plants that collects water during a storm, allowing both infiltration into the surrounding media and direct uptake by plants. In this example, as rain and stormwater enter and move through the rain garden cell, it collects within the R-tank storage chambers. The chambers create space beneath the rain garden where the runoff has the opportunity to slow down and infiltrate, decreasing downstream flow, strain on the centralized drainage system, and filtering the water, thus decreasing pollutants.

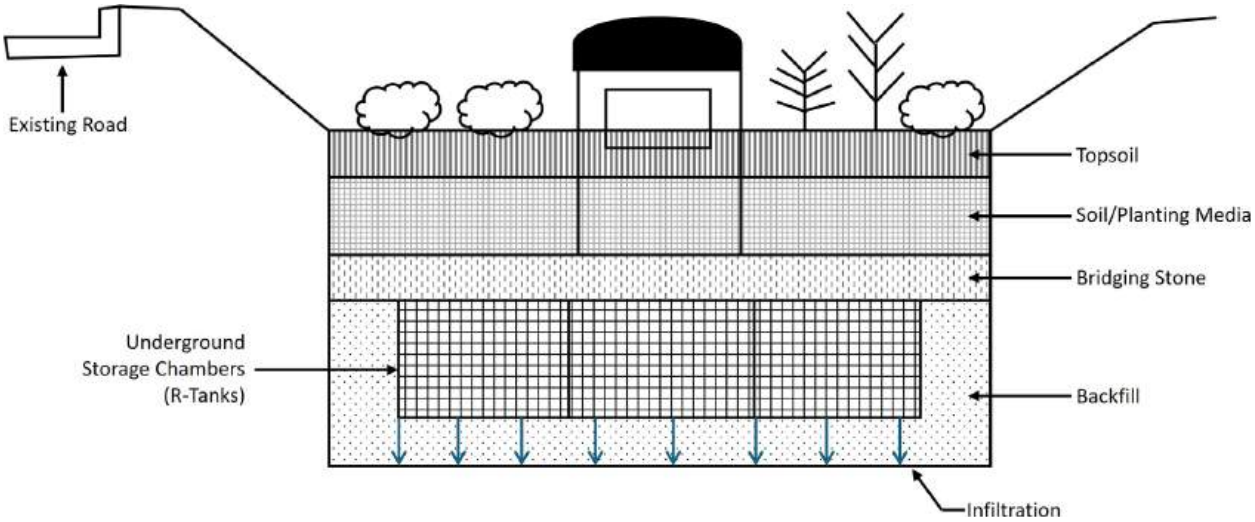


Figure 52: Profile of R-Tank Rain Garden Infiltration System (Source: McCormick Taylor)

With most underground storage designs, you would never know there is a flood control infrastructure right under your feet. Another example of an underground detention system can be seen below. This design uses an attractive rain chain to funnel water into a pipe hidden by a decorative vase, as well as pervious pavers in a herringbone pattern to infiltrate water to storage tanks below. In a traditional driveway and gutter design, all the rainfall hitting the pavement and leaving the gutter downspout would be headed straight to the roadway to find a storm drain and tidal creek at the outfall that may already be flooded in a big rain event. With nowhere to go, that extra water would exacerbate flooding for neighbors downstream.

At the end of the day, underground storage is designed to replicate the way the water cycle worked before the lot was developed, with most of the water going back into the ground instead of into a pipe that discharges into a creek that may already be at capacity.

Figure 53: Example of an underground detention treatment train. (Source: Town of Sullivan's Island)

As water is allowed to infiltrate gradually by underground detention practices, potentially being taken up by plants or trees or filtered through sand, water quality benefits are a major bonus of this stormwater best management practice as well. The table below shows estimates of how pervious systems with infiltration chambers can reduce some of the major pollutants affecting water quality in the region.

Table 25: Pollutant removal rates from permeable materials

Surface Type	Total Suspended Solids	Metals	Nutrients
Porous asphalt	94-99%	76-97%	42-43%
Pervious concrete	91%	75-92%	N/A
PICP	67-81%	13-88%	34-72%

Source: epa.gov/system/files/documents/2021-11/bmp-permeable-pavements.pdf

Benefits

Underground detention is well suited for Sullivan's Island, where there is not necessarily a lot of space in between houses to keep stormwater runoff from impacting neighboring properties (which is a requirement of all land disturbance activities that impact more than 625 square feet). Below are just a few of the co-benefits underground detention provides.

- **Land Use –** In tight areas between houses and driveways, this practice allows for a creative use of space, with the land above the tanks remaining available for either buildings, parking, or green space. The tanks are hidden, which helps maintain aesthetics as well.
- **Stormwater Management –** Underground storage helps reduce pressure on storm drain systems. By slowing down the flow of stormwater runoff, underground tanks leverage the passage of time to allow drainage pipes to regain capacity to handle even more water. When it is actively raining at high tide, a few hours' delay can make a big difference for the capacity of drainage infrastructure to work effectively. In cases where the water is not stored and then routed through the Town's stormwater infrastructure but allowed to slowly infiltrate into the ground, the stormwater benefits become shared across the whole stormwater basin.
- **Pollutant Removal –** In some cases, pre-treatment can also be added to the underground detention systems with filters or separators to remove trash and sediments, thus providing stormwater management and improving water quality.
- **Design and Maintenance –** The tanks are made of durable materials, such as concrete, heavy-duty plastic, or metal, which can oftentimes withstand traffic loads and the test of time. Given the modular nature of the units, the systems can be scaled to specific sites and various project sizes, reducing the pollutant load and increasing its drainage efficiency over time. With proper design, the system can incorporate manholes to allow for easy cleanouts, inspection, and debris removal.

Considerations

Underground detention in coastal communities may have limitations due to the high-water table and low ground elevation. On Sullivan's Island, it is likely not feasible to connect an underground storage tank, located 3 to 4 feet below the ground, to the storm drain system that is located approximately 2 to 3 feet below the ground without the use of a pumping system. Under roadway storage is another option but may not be suitable for the island as the storage chambers would have to be placed deep under the paved surface and would likely encounter the water table. Additionally, the South Carolina Department of Transportation (SCDOT) does not currently allow for under roadway storage, which would present a challenge to implement this measure, as almost all the roads on the island are maintained by the SCDOT.

Directing stormwater runoff to an underground storage tank and allowing the tank to slowly drain as an infiltration-based practice is a viable option, as mentioned earlier, and brings the added benefit of relieving the public stormwater conveyance system of the burden to manage that water. Many underground detention systems are placed under driveways or parking areas as the storage chambers are designed to withstand vehicular weight. This option would be most affordable to consider during new or redevelopment of homes or businesses; however, there are easy retrofits for smaller renovation projects to be considered on their own too. Gravel of a certain size (the industry calls it #57 stone) can be laid below a new driveway or garden path and create a 40% void in the ground where water can seep in. In the case of a small two-car driveway, set back 100 feet from the road, laid with 4 inches of #57 stone, you are looking at 2,000 gallons of storage.

Recommendations

For the Town of Sullivan's Island to embrace underground detention to the greatest benefit to the community, residents should consider adopting underground storage practices as suitable renovation strategies for driveways, decks, or new construction, and the Town should look to add infiltration practices in right-of-ways where sidewalk infrastructure or open space could be retrofitted for additional drainage capacity. This approach will work best in areas of the island with well-draining soils.

If you have standing water in your yard, there is a good chance the water table is close to the surface, and any underground storage tank would need to be discharged to a storm drain, rather than being left to infiltrate into the soil. If, however, your yard dries out well in between rain events, creating rain gardens or replacing sidewalks with permeable paver systems with underground storage chambers beneath is ideal. This treatment train approach would not disrupt existing developments and could provide aesthetic improvements.

Modular underground storage systems, such as the R-tanks mentioned above, can provide stormwater storage without requiring a lot of valuable land space and can be pieced together in such a way as to avoid tree roots and other underground utilities. They are also relatively inexpensive. The two main roads that run the length of the island, Middle Street and Jasper Boulevard, sit on a higher elevation compared to most of the island and have sidewalks along either side for a significant portion of the roadway. These roadways also have well-draining soils, and if the water table is far enough below the surface, sidewalks along these streets could be replaced with permeable pavers with the R-tanks placed beneath. With this proposed system, the stormwater runoff would infiltrate into the underground detention system through the gaps in the pavers and eventually infiltrate out of the chambers directly into the existing soil underneath. This overall system could be effective at alleviating flooding along these main roadways and reducing capacity issues for the stormwater drainage pipes they feed. However, if located within the SCDOT right-of-ways, the Town would need to acquire the right-of-way or obtain a memorandum of understanding (MOU) with the SCDOT to proceed with this adaptation measure.

Similarly, a rain garden with an underground detention system may be feasible along Jasper Boulevard, between Station 27 and Station 28 ½, where there is a section of greenspace outside of residential parcels between the road and the existing stormwater ditch-culvert system (Figure 54). This space was identified in the Town's Island Wide Stormwater Master Plan and Infrastructure Improvement Strategy. Figure 55 shows this practice in use for a residential area in Maryland, which was also intended to address frequent flooding issues. To site additional locations for underground detention systems, ground water wells should be installed at various points across the island to determine the depth to the seasonally high-water table.

Figure 54: Potential location for a rain garden with an underground detention system. (Source: McCormick Taylor).

Figure 55: Example of an R-Tank rain garden system in a neighborhood in Dundalk, MD. (Source: McCormick Taylor).

Causeway Adaptation

Description

Causeways are raised roads that are built to connect areas separated by water or marsh and are common in coastal or barrier island communities. These roads provide critical access to isolated areas, improve emergency response time, support local economies, and can leverage erosion and flood control benefits.

Ben Sawyer Boulevard currently serves as one of two access routes to Sullivan's Island and is the only route that directly connects the island to the mainland (Figure 56). The existing roadway is comprised of a drawbridge over the Intercoastal Waterway (ICW) with leveed roadways across the marshlands on either side. The other route onto Sullivan's Island is via Jasper Boulevard, which turns into Palm Boulevard as it enters the neighboring barrier island, Isle of Palms.

Figure 56: Ben Sawyer Blvd Bridge over Intracoastal Waterway

To combat sea level rise, some coastal communities have turned to raising their existing causeway profiles above anticipated flood levels, as well as implementing other strategies to increase causeway resilience. The Sanibel Island Causeway, which was washed out in 2022 from Hurricane Ian, has raised their profile

Figure 57: Video still from aftermath of Hugo showing Breach Inlet bridge to Isle of Palms washed out. A good reminder we need those multiple points of ingress and egress in the event one fails. In the case of Hugo, both bridges did.

and added armor stone, gabion marine mattress, and coastal riprap to strengthen the structural integrity of the roadway and prevent scour. In Mount Pleasant, upgrades to the Pitt Street Bridge, which were completed in July 2025, included using oysters to stabilize the sides of the bridge. Practices like living shorelines, including establishing oyster beds along the banks may be a valuable inclusion to the Ben Sawyer Causeway to increase its resilience to rising sea levels.

Benefits

Since Ben Sawyer Boulevard is a critical path for hurricane evacuations and emergency vehicles, protecting it from flood waters is critical to the safety of the island. Raising the elevation of the causeway will provide resilience and safety benefits, including the following.

- **Reliability –** Raising the causeway will reduce washout and closures from heavy rainfall in the event increased sea levels cause this to become a frequent occurrence. This will ensure year-round access for emergency vehicles and evacuation routes.
- **Reduce Flood Risk –** As sea levels rise and there is an increase in tidal flooding and storm surge events, an elevated roadway should be designed to remain unsubmerged during these high-water events.
- **Design Standards –** Agencies are increasing requirements for causeways to meet higher base flood elevations, such as the 100- or 500-year storm events. Federal or state funds may be available to incorporate climate adaptation methods, such as elevation increases.
- **Environmental –** Levees like the Ben Sawyer Causeway slow the flow of tidal waters, allowing them to drop out fine silt particles at high tide, and leading to accelerated accretion of adjacent marsh systems. With sea level rise predicted to drown out much of the South Carolina Lowcountry's saltmarsh, this accelerated siltation provides a tremendous benefit to marshfront properties, increasing the resilience of these natural erosion control and floodwater absorbing saltmarsh ecosystems. This provides the island with additional and natural safety protection from flooding and other extreme weather events.

Additionally, as sea levels rise, the water table also rises. A higher water table decreases the amount of space between the ground surface and water table, where stormwater would otherwise infiltrate during a rainfall event. As a result, more water is expected to sit above the ground, which would lead to an even greater increase in flooding, further supporting the idea of adaptation measures to be taken, such as raising road profiles. Utilities that may run along the causeway may also be able to rise if the roadway rises, which would result in less likelihood of damage during storm or flooding events impacting the causeway.

Recommendations

Most of the roadway elevation on Ben Sawyer Boulevard is currently around 9 feet over the embankments using the NAVD88 datum. To meet South Carolina Department of Transportation (SCDOT) design criteria, there must be 2 feet of freeboard over the highest water surface elevation for the 50-year return period storm event. Using the highest stillwater elevation in the vicinity of the bridge, with significant wave height tabulated by the Federal Emergency Management Agency (FEMA), this would require the roadway section of the bridge to be raised to at least an elevation of 13.2 feet NAVD88 (including the 2 ft of freeboard). This elevation would only apply if the entire causeway was turned into a bridge and no longer had the embankments.

Figure 58: Location of Proposed Project Area

When evaluating options for raising this crucial causeway, there are two alternatives that could be taken. A raised embankment alternative, which would keep the design of the causeway similar to how it is currently and only elevate the roadway over the embankments, which would also require some adjustments of the approaches for the bridge over the ICW to occur (Figure 60). This alternative would require additional fill to be placed in the wetlands to account for the wider, more elevated roadway. By widening the road through raising the embankments, there may be an opportunity to introduce bioswales into the medians or along the perimeter of the road, as it would have an earthen embankment (Figure 59). Bioswales are engineered drainage ditches that harness the power of plants to bioremediate common roadway contaminants, and the power of sandy soils to infiltrate water into the ground. They also convey and store stormwater,

which would alleviate some flooding in tidal creeks that have a limited capacity in carrying stormwater.

The addition of a bioswale along the causeway presents an excellent opportunity to capture the region's number 1 microplastic – tire particles. Runoff from roadways where small oil leaks occur from cars traveling along it is especially well adapted to remediation through plants, as most hydrocarbons can easily be broken down by plants into non-toxic plant materials. While tire particles are not so easily broken down, bioswales become a 'sink' for pollutants, keeping those contaminants from damaging the marsh system and entering the Atlantic Ocean. Implementing this measure would allow for the elevation raise of Ben Sawyer Boulevard to open the door for ensuring accessibility to the island while offering additional environmental benefits to the surrounding area.

Another alternative would be to build an entirely new road at a higher elevation that acts as a fixed-span bridge along most of the current causeway (Figure 60). This would increase tidal flow between the two sides of the saltmarsh, allowing the safer passage of marine life; however, it would potentially cause a massive release of sediment from the northeastern side of the causeway, leading to erosion of the saltmarsh and potential loss of it to sea level rise. The severity of these environmental impacts may make this option infeasible to implement.

Figure 59: Example of median bioswale.

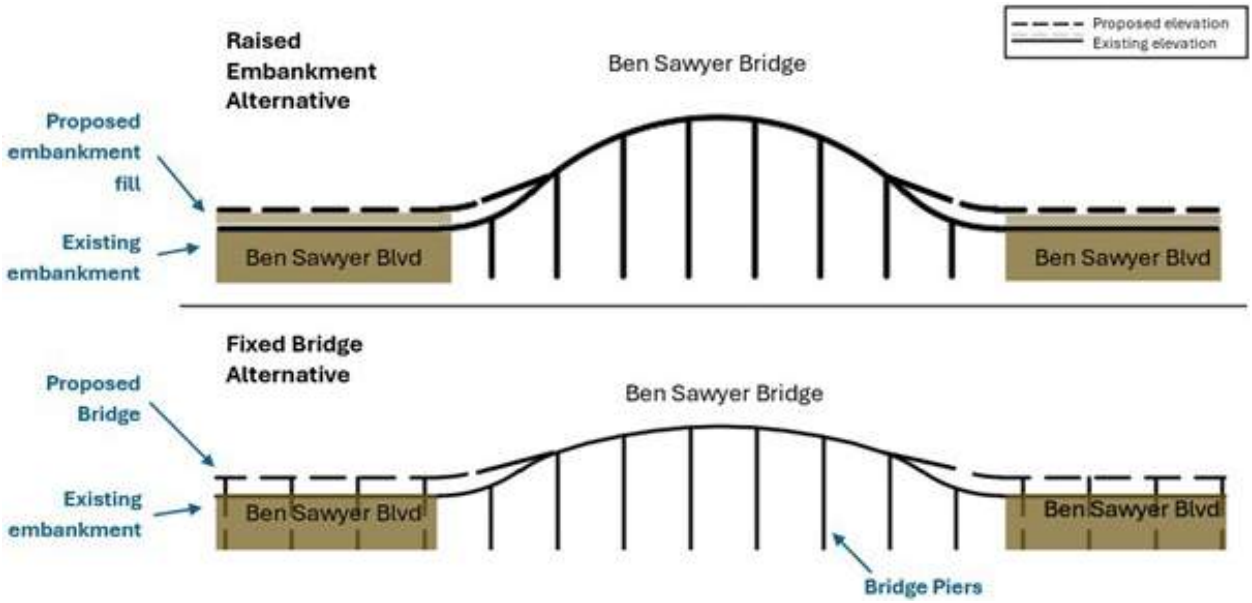


Figure 60: Sketch of adaptation measure approaches.

Considerations

The existing design of the bridge and embankments encourages marsh accretion along Sullivan's Island. Flow is restricted by the causeway, which causes sediment to settle out of the water column, supports the growth of Spartina, and ultimately elevates the marsh platform. Marshes help with flood protection, water quality, and preventing erosion along shorelines. By extending the bridge and opening more flow to the marshes along the northern side of Sullivan's Island, sedimentation might be reduced along the existing marshes and expose the island to more adverse effects.

As both approaches to raise the causeway would result in a need to widen the roadway footprint, impacts to the current marshlands are likely to occur; however, impacts would be more drastic with the fixed bridge alternative. Adding a fixed bridge on piers and removing the current embankment would result in a more extreme increase in flow altering sedimentation patterns and causing erosion along some of the marshes. However, improving the natural hydrology for better tidal flow would also help wildlife move through the adjacent tidal wetlands. Keeping waterways accessible by dredging would be made easier with the fixed bridge alternative, though, the protection provided to the island from the marsh would likely be drastically reduced.

Another factor that would need to be considered with either approach is where the road would "tie-out" onto the island. Most of the existing causeway elevation is around 9 feet NAVD88, which is about 1 foot above the road elevation once it reaches the island. While properly tying out the causeway to the island may result in the causeway elevation being much higher than the roadway elevations on the island and will not reduce island flooding, maintaining this point of access to the island is critical for the safety of the residents.

Cost Estimate

The strategies proposed are intended to manage stormwater, reduce flood risk, enhance ecological resilience, and support the community of Sullivan's Island in adapting to sea level changes.

To assist in a comparative evaluation of strategies and individual project prioritization, an approximation of cost for implementation was developed. The following Table presents preliminary cost estimates for the recommendations found in each of the ten adaptation strategies discussed in this section. Design and permitting fees are not reflected in these estimates. Where applicable estimates note whether installation cost is included. Actual cost may vary based on site-specific conditions, regulatory requirements, and market rates at the time of implementation.

Table 26: Strategy Development Cost Analysis

Engage and Involve			
Item	**Unit Cost**	**Unit**	**Description**
Guidebook Development	$12,000	1	Variable as there are free versions online, cost is based on a mid level guidebook.
Program Branding (Marketing)	$7,500 - $25,000		Variable based on the content desired.
New/Re-Development Policy Review			
Item	**Unit Cost**	**Unit**	**Description**
Consulting	$210	HR	
Open Space Planning and Nature-based Solutions			
Item	**Unit Cost**	**Unit**	**Description**
Bioretention Cells	$35	SF	Assumes no need for additional control structures.
Bioswale	$60	LF	For bioswales 9-16' wide, per Terrascope.
Extensive Green Roof	$40	SF	Variable cost based on size, slope, complexity of the roof. Intensive Green Roofs are up to $200 to $400 a square foot.
Living Shoreline	$2,500	LF	Price from NOAA.
PowerBlock Permeable Pavers w/o install	$44	SF	Includes fabric, delivery, pallet fees. Does not include installation.

PowerBlock Permeable Pavers w/ install	$155	SF	Includes material, gravel subbase, excavation, and installation
Stormcrete w/o install	$35	SF	Includes panels, placement of panels, stone cost, and stone placement. Does not include installation.
Stormcrete w/ install	$145	SF	Includes material, gravel subbase, excavation, and installation.
Tree Plantings	$600	EA	7 ft tall tree on average.
Urban Rain Garden	$15,000	EA	Includes URG T-walls, rain guardian fortress (pretreatment), beehive overflow, bold and gold media. Does not include stone, riprap, liner, mulch, and topsoil.

Residential-scale Nature-based Solutions			
Item	**Unit Cost**	**Unit**	**Description**
Bioretention Cells	$35	SF	Assumes no need for additional control structures.
Bioswale	$60	LF	For bioswales 9-16' wide, per Terrascope.
Bog Gardens	$50	SF	
Green Roof	$25	SF	Variable cost based on size, slope, complexity of the roof.
Living Shoreline	$1,500	LF	Price from NOAA.

PowerBlock Permeable Pavers w/o install	$44	SF	Includes fabric, delivery, pallet fees. Does not include installation.
PowerBlock Permeable Pavers w/ install	$155	SF	Includes material, gravel subbase, excavation, and installation
Rainwater Harvesting System	$2,500	EA	Dependent on size, use, etc.
Stormcrete w/o install	$35	SF	Includes panels, placement of panels, stone cost, and stone placement. Does not include installation.
Stormcrete w/ install	$145	SF	Includes material, gravel subbase, excavation, and installation.
Tree Plantings	$150	EA	
Vegetative Buffer Planting	$22,000	Acre	Variable if seed is utilized over plants, plants provide higher success rate, price here reflects plants.

Business District Complete Street			
Item	**Unit Cost**	**Unit**	**Description**
Bioretention Cells	$35	SF	Includes potential need for control structures, curbing, storm drains and underdrains, extensive plantings
Bioswale	$60	LF	For bioswales 9-16' wide, per Terrascope.

Extensive Green Roof	$40	SF	Variable cost based on size, slope, complexity of the roof. Intensive Green Roofs are up to $200 to $400 a square foot.
PowerBlock Permeable Pavers w/o install	$44	SF	Includes fabric, delivery, pallet fees. Does not include installation.
PowerBlock Permeable Pavers w/ install	$155	SF	Includes material, gravel subbase, excavation, and installation
Stormcrete w/o install	$35	SF	Includes panels, placement of panels, stone cost, and placement. Does not include installation.
Stormcrete w/ install	$145	SF	Includes material, gravel subbase, excavation, and installation.
Tree Plantings	$600	EA	7 ft tall tree on average.
Urban Rain Garden	$15,000	EA	Includes URG T-walls, rain guardian fortress (pretreatment), beehive overflow, bold and gold media. Does not include stone, riprap, liner, mulch, and topsoil.

Marsh Management Protection			
Item	**Unit Cost**	**Unit**	**Description**
Envirolok	$60	SF	JMH received email from company for guidance. SF refers to the proposed slopes surface area square footage.

Oyster Reefs	$75	LF	Includes bags of recycled oyster shells intended for living shoreline applications.

Maritime Forest			
Item	**Unit Cost**	**Unit**	**Description**
Invasive Plant Management	$1,100	Acre	Dependent on type of invasive and density. Price reflects primarily hand work and limits use of chemicals and machinery

Dune System Management and Restoration			
Item	**Unit Cost**	**Unit**	**Description**
Beach Nourishment	$15	CY	Price from 2024 Folly Beach project, cost includes all steps of beach nourishment.
Dune Walkover	$15,000 - $75,000	EA	Variable and dependent on ADA compatibility requirements and ramping.
Educational Signage w/o install	$1,500	EA	Includes material.
Educational Signage w/ install	$2,500	EA	Includes material and installation.
Sand Fencing	$25	LF	From Delaware DNREC, includes materials and construction.

Underground Detention			
Item	**Unit Cost**	**Unit**	**Description**
ADS StormTech Chambers	$25	CF	Includes installation, materials, etc
R-Tank Underground Stormwater Storage	$17	CF	Includes installation, materials, and Ferguson markup. Pulled from Kings Manor.
Causeway Adaptation			
Item	**Unit Cost**	**Unit**	**Description**
Bridge Replacement	$55,000,000	EA	Cost of replacing US 21 bridge in Beaufort County (2021).
Bioswale	$60	LF	For bioswales 9-16' wide, per Terrascope.

**Prices do not reflect design fees nor permitting fees that may be required to construct any of these projects.*

V. Hydrologic & Hydraulic Analysis

Methodology

The Town worked with another consulting firm to conduct a *Stormwater Master Plan and Infrastructure Improvement Strategy*, this final report was published in February 2025 (Seamon Whiteside & Associates). This prior work consisted of an extensive effort to create a hydrologic and hydraulic model for the Island, therefore this model served as the starting point for this resilience focused hydrologic and hydraulic analysis. Several modifications were made to the provided stormwater infrastructure model which will be discussed in this section.

First it is important to acknowledge that the hydrologic and hydraulic model has inherent limitations and may not accurately predict observed conditions due to uncertainties in input data, assumptions in model parameters and structure, and the complexity of natural and engineered systems. The modeling was completed using Computation Hydraulics Incorporated's (CHI's) Personal Computer Storm Water Management Model (PCSWMM) software. This software uses version 5 of the Environmental Protection Agency stormwater management model (EPA SWMM). PCSWMM is considered a link-node model where inlets and junctions are represented as 1D nodes, pipes and channels are represented as 1D link, and overland flow is represented as a series of 2D nodes and links in the model domain. This allows the model to simulate both 1D/2D to capture the hydraulics (1D) in the drainage system and the hydrology (2D) in the extent, depth, and duration of flooding overland.

Hydraulics

The 1D domain which represents the drainage infrastructure was not modified from the provided stormwater infrastructure model. Inlets, junction, pipes, channels, and outfalls and their physical attributes such as invert and rim elevations, geometry (i.e. size, cross section), material (i.e. concrete, brick), and back flow prevention (i.e. tide gates, check values) were all maintained in the model to represent existing conditions.

For proposed conditions modeling, the **18 proposed stormwater infrastructure improvements** including, upgrading existing infrastructure, installation of new infrastructure, raising roadways, and leveraging pump stations were included in these modeling scenarios.

Hydrology

As mentioned, the provided model was focused on stormwater improvements which inhabit the interior developed portion of the island and did not examine watersheds with flow to areas outside of the developed portion of the island (i.e. Accreted land, marsh, etc.). **For this resilience plan it is important to incorporate the hydrologic processes such as rainfall, runoff, and infiltration, that are occurring in these areas so that proposed adaptation strategies can be more effectively implemented in these areas.**

The watershed boundaries were delineated using digital elevation model (DEM) topographic data. The original stormwater model had 812 and during this process 132 additional watersheds were added to the undeveloped portions of the island for **a total of 944 watersheds** (Figure 61). Watershed physical properties such as area, flow length, and slope were calculated using geospatial analysis.

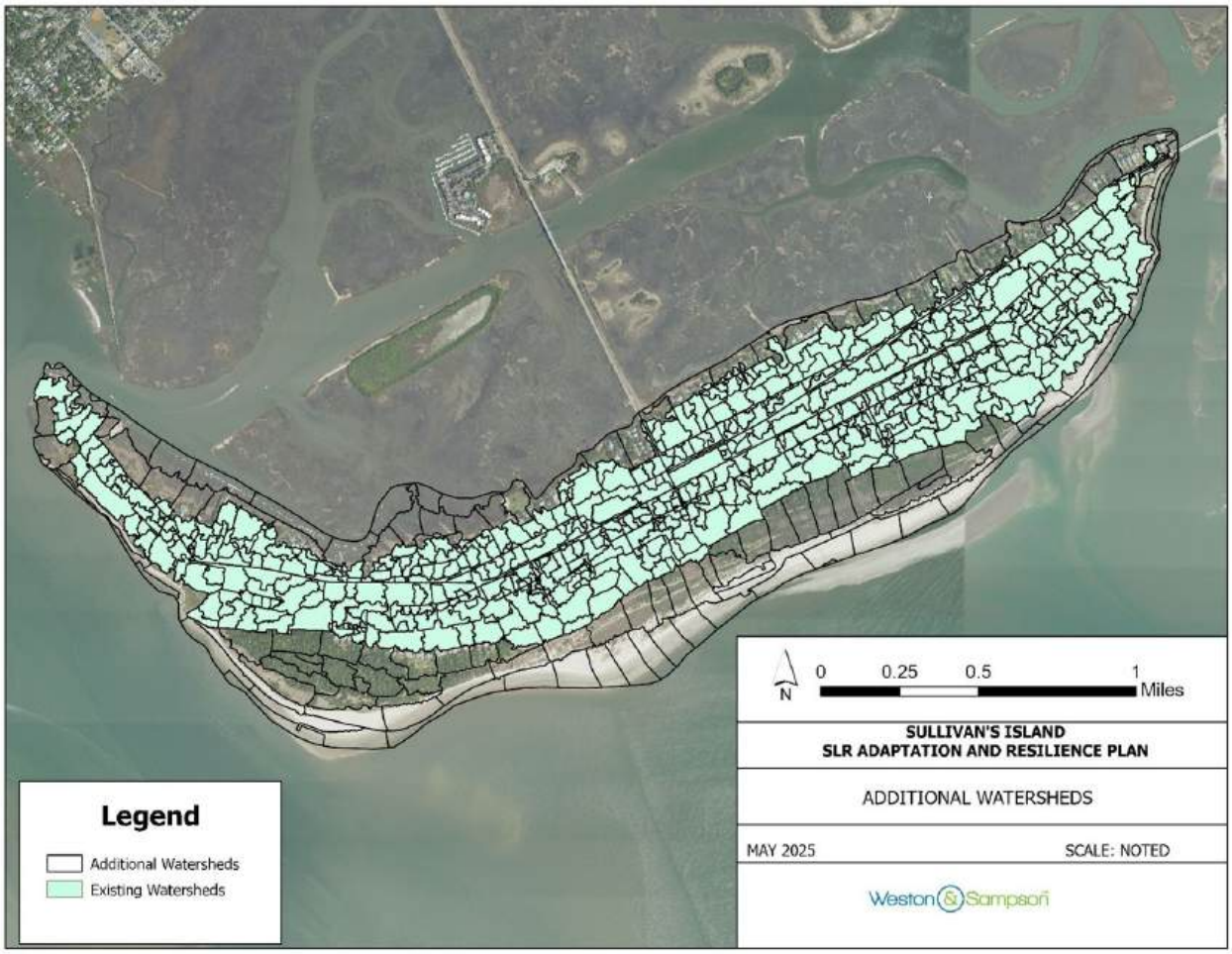


Figure 61: Additional Watersheds

The provided stormwater infrastructure model used an empirical method known as **the Curve Number method (CN).** The CN method is a widely used hydrologic technique developed by the USDA Natural Resources Conservation Service (NRCS) (formerly the Soil Conservation Service, SCS) to estimate direct runoff from a rainfall event in small to medium-sized watersheds. The CN ranges from 30 (low runoff potential) to 98 (high runoff potential) by considering a variety of factors such as:

- **Soil Hydrologic Group** (A, B, C, D: A = high infiltration, D = low),
- **Land use/cover** (e.g., forest, urban, agriculture), and
- **Antecedent Moisture Condition** (AMC I: dry, AMC II: average, AMC III: wet).

The CN method was well-suited for the stormwater design and management focus of the previous work; however, for the current resilience analysis—where nature-based solutions (NBS) are proposed rather than traditional gray infrastructure—alternative infiltration methods may offer greater accuracy.

To account for changing infiltration rates during an event the physically based infiltration method known as **the Green-Ampt method** was used to update the model's hydrologic parameters. The Green-Ampt method considers several soil properties such as:

- **Initial Moisture Deficit**, fraction of soil that is initially wet (closer to saturation less infiltration, and more runoff),
- **Hydraulic Conductivity**, the ease of water moving through saturated soil (high for sands and low for clays), and
- **Suction Head**, the capillary forces that draw water into unsaturated soil (high for clays and low for sands).

Table 27 shows a summary of the Green-Ampt parameters that were used in the model based on soil texture class. If watersheds had multiple soil texture classes present, then an area-weighted (or composited) approach was used to develop the Green-Ampt parameters.

Table 27: Summary of Green-Ampt parameters assigned to soil texture classes

Soil Texture Class	Initial Moisture Deficit (fraction)	Hydraulic Conductivity (in/hr)	Suction Head (in)
Sand	0.413	4.74	1.93
Sandy Loam	0.368	0.43	4.33
Fine Sand	0.262	0.06	8.66
Silty Clay Loam	0.261	0.04	10.63

To supplement the infiltration parameters determined by the Green-Ampt method, a percent impervious was also calculated to help determine a watershed's ability to produce runoff during a rainfall event. Using the land cover data from 2021 published by USGS the percent impervious was developed and assigned for each watershed.

While some hydrologic parameters such as additional watersheds, infiltration method, and percent impervious were modified, the model's 2D domain remained the same. The 2D mesh that was previously developed was used to represent overland flow if stormwater were to surcharge from the existing system.

Calibration

To calibrate the model rainfall and tide data from Hurricane Debby which affected the study area in August of 2024 were used. Rainfall data measured in five (5) minute intervals were taken from USGS station near Summerville, SC from August 4, 2024 to August 7, 2024, the cumulative rainfall distribution curve over the 72-hour period is shown in Figure 62. The observed tidal data from the Charleston Harbor (NOAA Station 8665530) from the same storm period was used for tidal conditions.

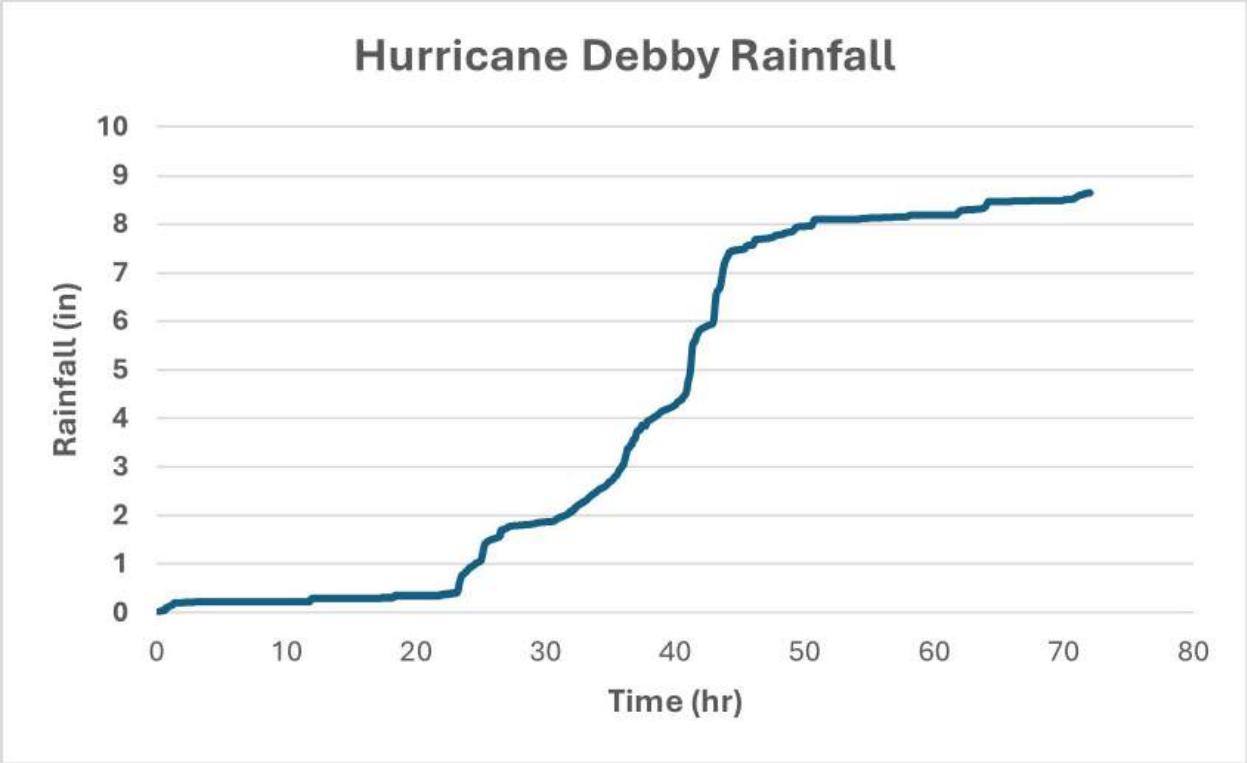


Figure 62: Hurricane Debby Rainfall Aug 4 - 7 from Summerville, SC USGS

The model results were calibrated against data from *MyCoast* which were collected by the Town on the afternoon August 7, 2024. Data from the MyCoast Storm Witness Report, shown in Figure 63 provides a photo of the flooding with a measuring rod and person for depth reference, the location of flooding, and the time of report which is correlated to the position in the tidal cycle.

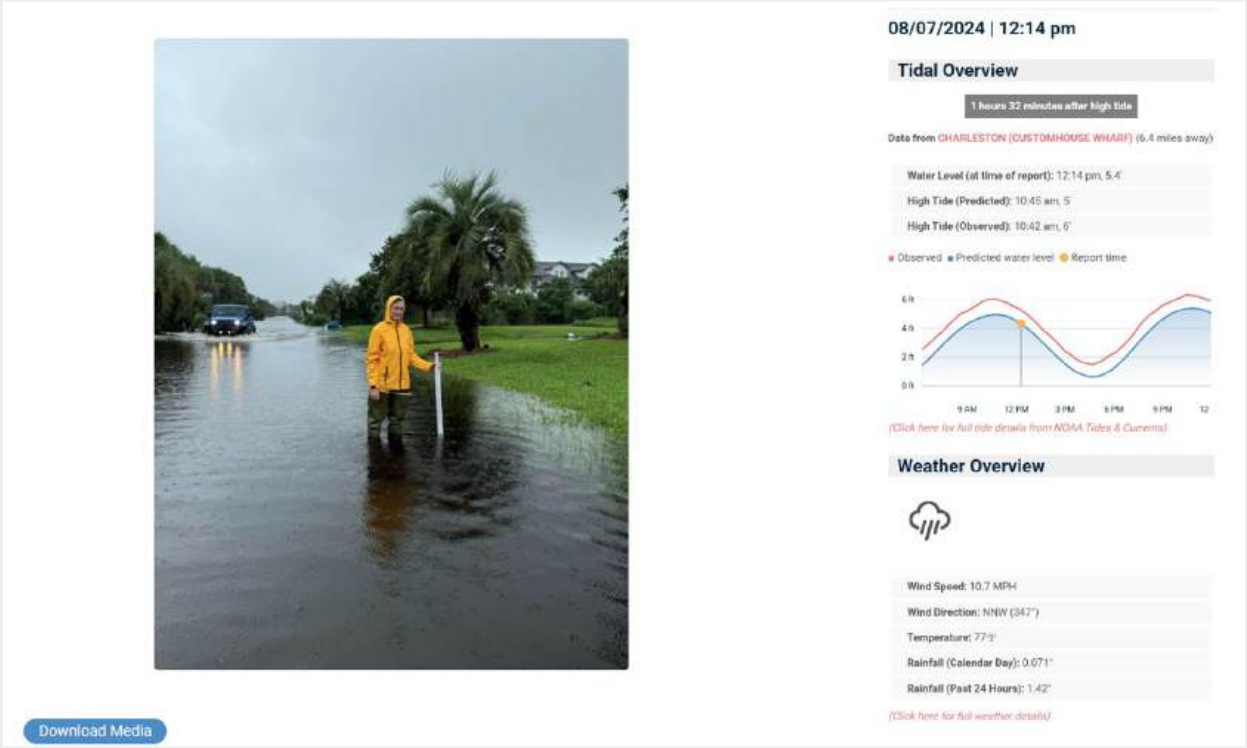


Figure 63: Sample of MyCoast Calibration data for Hurricane Debby

Scenarios

A variety of rainfall and tidal conditions were analyzed as part of this study to assess existing conditions and analyze the effectiveness of recommendations for NBS practices to help mitigate current and future flood risk. Table 28 shows the rainfall and tide scenarios that were run for existing and proposed conditions.

The existing rainfall and existing tide conditions were the same ones developed from the previous stormwater infrastructure study, refer to that report for details on the development of the SC Long rainfall distributions. Some of the larger rainfall events from that report, 25-year and 100-year, were not modeled as those events are considered too large for nature-based solutions to effectively mitigate.

Table 28: Scenarios Investigated for Sea Level Rise and Resilience

Scenario	Existing or Proposed Infrastructure	Current or Future Climate	Tidal Boundary Conditions	Annual Exceedance Probability (Recurrence Interval)	Precipitation Depth (inches)
0	Existing	Hurricane Debby August 4-7, 2024			
1	Existing	Current	Typical Tide (3.31 ft NAVD88)	50% (2-Year)	4.34
2				10% (10-Year)	6.60
3	Proposed Stormwater	Future	2050 Typical Tide (4.38 ft NAVD88)	50% (2-Year)	4.77
4				10% (10-Year)	7.26
5	Existing w/ NBS	Current	Typical Tide (3.31 ft NAVD88)	50% (2-Year)	4.34
6				10% (10-Year)	6.60
7	Proposed Stormwater w/NBS	Future	2050 Typical Tide (4.38 ft NAVD88)	50% (2-Year)	4.77
8				10% (10-Year)	7.26

However, one additional rainfall event, the 2-year, was added, this smaller rainfall event will help demonstrate the impact the nature-based solutions would have. The precipitation depth for this 2-year storm was obtained from the National Oceanic and Atmospheric Administration (NOAA) precipitation frequency data server, specifically the estimates for the Town of Sullivan's Island. This precipitation depth for the 2-year 24-hour duration was combined with the dimensionless SC Long rainfall distribution to generate the rainfall curve. Also, in alignment with the previous study, the rainfall depth for the future 2-year 24-hour duration was calculated by increasing the depth by 10% based off the SC Office of Resilience's Strategic Statewide Resilience and Risk Reduction Plan recommended prediction.

To examine the impacts of sea level rise, future tidal boundary conditions were developed based on established projections from the Sea Level Rise and Coastal Flood Hazard Scenarios and Tools Interagency Task Force. The projections and scenarios presented by this task force represent the most comprehensive and current (last updated 2022) when investigating the impact of sea level rise along the Charleston coastline. For this sea level rise and resilience plan the projection year of 2050 was selected for several reasons including this future year would represent the typical lifespan of proposed nature-based solutions (approximately 25 years), this is roughly the span of a typical mortgage, so it is easy for stakeholders to understand this planning horizon.

Vertical Land Subsidence

In addition to sea level rise coastal communities are also facing the hazard of **vertical land subsidence**, or the rate at which the surrounding landscape is sinking.

It is important to note that sea level rise projections from the interagency task force do account for some level of vertical land subsidence, those estimates are not based on localized, higher-resolution data. The previous stormwater and infrastructure study quantified a localized rate of vertical land subsidence for the Town of Sullivan's Island, at a rate of 0.15 inches/year. This data came from 2007 to 2020 vertical land motion data published by United States Geological Survey (Ohenhen et. Al., 2024).

Combining the localized vertical land motion rates with the 2050 intermediate sea level rise projection results in a projected increase in sea level rise of approximately 1.07 feet over the next 25 years. Future tidal boundary conditions for this analysis were then developed by vertically shifting the typical tide boundary conditions by 1.07 feet.

To model future conditions consistent with the proposed stormwater model, the same future land cover assumptions were applied to this resilience focused model. To account for an increase in impervious coverage from larger houses and continued redevelopment, the impervious coverage was increased by 14 percent for all the subcatchments within the study area. Areas with existing zero percent impervious coverage remained that way under the future conditions to maintain the integrity of protected areas on the island such as the beach, marsh, and maritime forest.

For scenarios 5-8 shown in Table 28 the 33 NBS that were cited across the Island as discussed in the Open Space Planning and Nature-based Solutions strategy were incorporated into the model **to demonstrate the flooding reduction benefit that could be observed by having these practices in place.** Scenarios 5-8 are the same conditions as scenarios 1-4, the only difference being the incorporation of the NBS, this

will allow for a comparison of the percentage of runoff reduction that could be observed by implementing NBS. The maximum flooding depth and extent of flood reduced would be hard to observe on an Island wide model scale which is why the percentage of runoff reduction was compared.

Of the 33 practices identified a few were not considered in the modeling effort as they were determined to have no perceived runoff reduction benefit, this includes the living shorelines, the existing conservation areas in the maritime forest, and the existing green roof at the Battery Logan. This resulted in a total of 27 NBS that were modeled.

For the remaining NBS types that were modeled for each practice a storage depth and impervious reduction was determined as shown in Table 29 by reviewing the SCLID manual. These impervious reductions and storage depths were applied to the specific area of the practice and used to modify three subcatchment parameters of percent impervious (Imperv %), pervious storage (dstore perv in.), and impervious storage (dstore imperv in.).

Table 29: NBS Impervious reduction and Storage Values for Modeling

NBS Type	Impervious Reduction	Storage Depth
Rain Garden	100%	1 ft plus 1.25 ft with 40% voids
Bioretention	100%	0.75 ft plus 2 ft with 40% voids
Bioswale	100%	1.25 ft plus 1.75 ft with 40% voids
Pervious Paving	100%	0.5 ft with 20% voids plus 1.5 ft with 35% voids
Constructed Wetland	100%	0.5 ft
Green Roof	100%	0.5 ft at 30% voids

In some cases, multiple NBS practices were in one subcatchment so their storage effects were combined. Sometimes, when these NBS were contained within one subcatchment their combined effects would reduce the percent impervious beyond the amount of impervious area that was already present in the subcatchment. In these scenarios, instead of reporting a negative impervious percentage, which the model would not accept, a value of zero was used. This was considered a conservative approach instead of choosing to redistribute that impervious reduction effects to adjacent subcatchments when that may or may not be the case of how that NBS benefit would translate in the real world. In other cases, NBS practices appeared in multiple adjacent subcatchments so their effects were distributed over several subcatchments based on the area of NBS within the subcatchment.

Results

The flooding extent and maximum water depth result maps for the calibration scenario and the first four scenarios in Table 28 can be found in Appendix D. An example of this maximum flood depth map from scenario 2 is shown in Figure 65.

As noted earlier, it would be difficult to compare the flood depth and extents of scenario 2 with scenario 6 (with NBS) so instead **percentage of runoff reduction was calculated by subtracting the runoff volumes between scenario 2 and scenario 6** as shown in Figure 64 below. The remaining comparison figures for scenarios 5-8 can also be found in Appendix D.

It is encouraging to see that for all the scenarios with NBS incorporated in the model there were runoff reductions observed in the subcatchments containing or adjacent to the practices. As stated earlier there is always some error expected in modeling, but these results are a good indication that some benefit would be achieved.

Figure 64: Percentage of Runoff Reduction from NBS for Existing Current Conditions 10 yr Rainfall

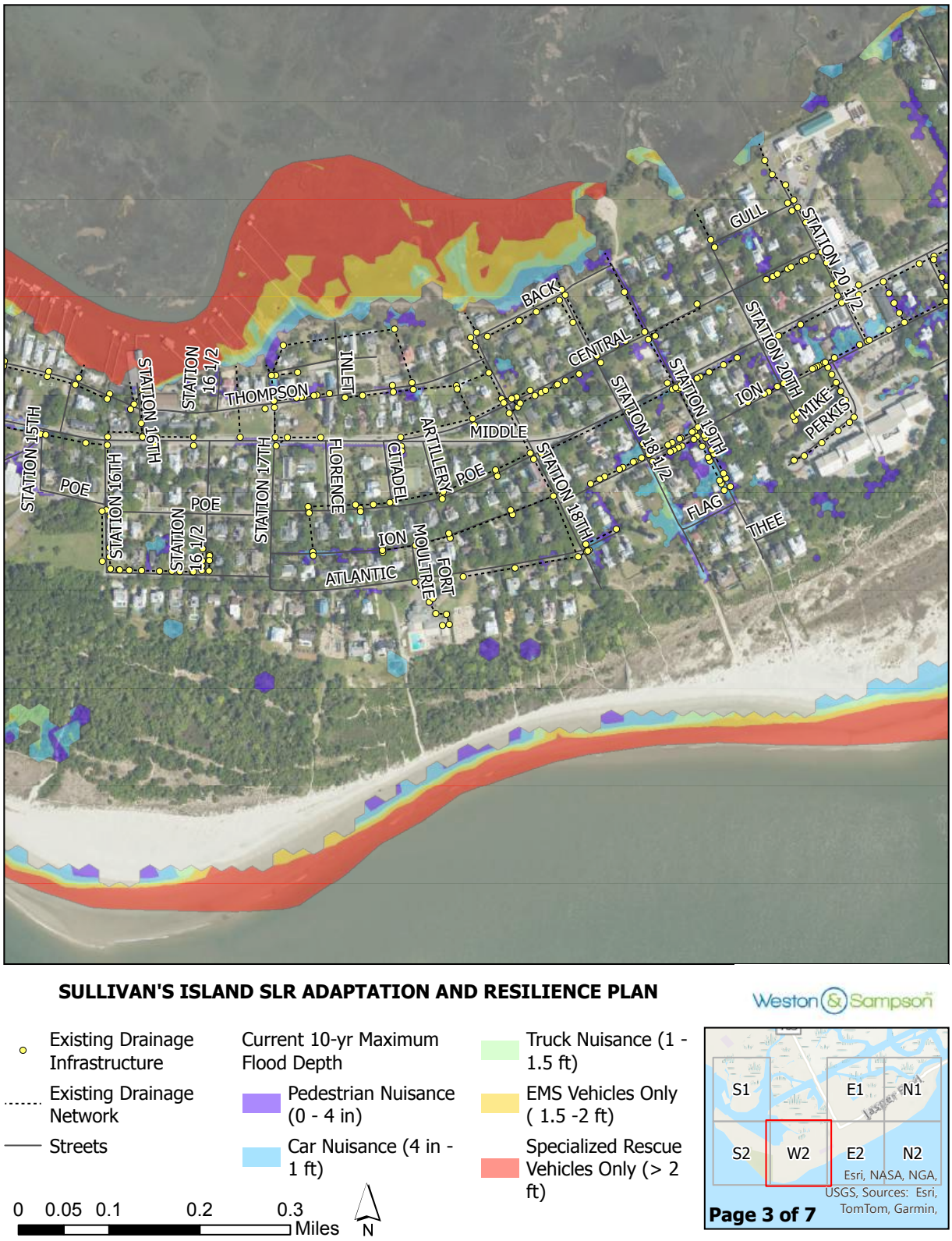


Figure 65: Maximum Flood Depth Example Map

VI. Conclusion

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VII. References

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Appendix A

Policy Appendix

Appendix B

Stakeholder Engagement

Appendix C

Open Space Planning and NBS

Appendix D

Hydrologic and Hydraulic Analysis