2025

SULLIVAN'S ISLAND

Sea Level Adaption & Resilience Plan

ELKO COASTAL CONSULTING INC.

Weston & Sampson

McCORMICK TAYLOR

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November 14, 2025

Sullivan's Island is a place where land, marsh, and sea meet in a delicate balance. We live close with nature, surrounded by salt air, live oaks, and the tides that shape our days. The plan presented in the following pages is like a seed in the sand. Given the right conditions, it will take root and grow into something lasting, a guide to help our community adapt, endure, and thrive in the years ahead. Our future depends on how well we safeguard the natural systems that protect us and give us definition as a uniquely beautiful barrier island.

Perseverance is nothing new to the Sullivan's Island community. When Hurricane Hugo swept through, the Town joined together to recover and build back stronger, putting measures in place to preserve natural buffers that defend our shores against the powerful forces of inevitable wind and waves. Our accreting shores were placed in a deed restriction, never to be subdivided, sold off, and built upon. Some thirty-six years later, we now boast two hundred acres of rolling dunes and maritime forest that will dampen the effects of future storms and render us better prepared to face them than ever before.

The Sea Level Rise Adaptation and Resilience Plan represents our first coordinated effort to face the challenges of flooding, erosion, and rising seas head-on. It lays out strategies for resilience from protecting our dunes and marshes to improving stormwater management, while respecting the history and character of our island. This science-based plan is the result of more than a year's worth of thoughtful work by planners, engineers, environmental scientists, and residents. But most importantly, it is the beginning of a conversation, not the end of one. In the pages ahead, you will find a plan written in pencil waiting for all of us to review, improve, and eventually draw in ink. But the act of planning together is what builds resilience, both for our island and for community ties to this lowcountry landscape we all call home.

Looking back, the Town of Sullivan's Island has long exemplified endurance and taken great care to protect this precious place. Looking forward, it's our turn to cultivate what future generations will inherit. As the old adage goes, the best time to plant a tree was thirty-six years ago, but the second best time is now.

Sincerely,

Councilmember Gary Visser
Chair of the Land Use & Natural Resources Committee

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- Laura Schroeder

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- Adam Bode, SC Department of Environmental Services
- Adam & Pat Ilderton, Business Owners
- Bunky Wichmann, Sullivan's Island Design Review Boardmember & Madeleine McGee, Tree Commissioner
- Chief Anthony Stith, Sullivan's Island Fire Department
- Chief Glenn Meadows, Sullivan's Island Police Department
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- Debra Lofton, Resident
- Derek Wade, Tree Commissioner
- Douglas Kerr & Matt Simms, Town of Isle of Palms Staff
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- Eric Brooks, Business Owner
- Greg Atkins, Resident
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- Landon Knapp, SC Sea Grant Consortium
- Max Wurthmann, Town of Sullivan's Island Building Inspector
- Mike Cartner, Business Owner
- Rob Bedenbaugh & Roberto Tuiz, SC-Department of Transportation
- Steve Herlong, Business Owner
- Susan Middaugh, Resident

Thank you to all the **community members** who participated and provided feedback during the project's public engagement sessions, community survey, and presentations to Town Council and the Planning Commission.

The Town of Sullivan's Island selected a team of consultants including **Weston & Sampson**, **Elko Coastal Consulting**, and **McCormick Taylor** to lead the development of the Sullivan's Island Sea Level Adaptation & Resilience Plan. The multi-discipline consultant team enjoyed a collaborative approach in the development of this Plan. Thank you to Seamon Whiteside for model coordination and sharing from the Sullivan's Island Stormwater Master Plan development.

** All photos are provided by Weston & Sampson unless otherwise noted.*

I. Background and History

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

Sullivan's Island is a low-lying barrier island 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** based on the 2020 census. The Island has approximately **4 miles** of beach front and encompasses a total of over **2,100 acres** with about **600 acres** of tidal salt marsh.

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

Figure 1: Aerial view of Sullivan's Island from Breach Inlet

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. The Island benefits from a thriving broad beach and maritime forest that buffer most beachfront residences from the full force of coastal storms. These natural features developed in part because of sand transport processes at Breach Inlet and the construction of the Charleston Harbor jetties in the 1890s, which reshaped the shoreline and encouraged sand-bar attachment to the Island.

The community was forever changed after Sullivan's Island suffered severe damage from Hurricane Hugo in 1989. At that time, Town Council went through the process of securing the preservation of the dunes and maritime forest in perpetuity with the organization

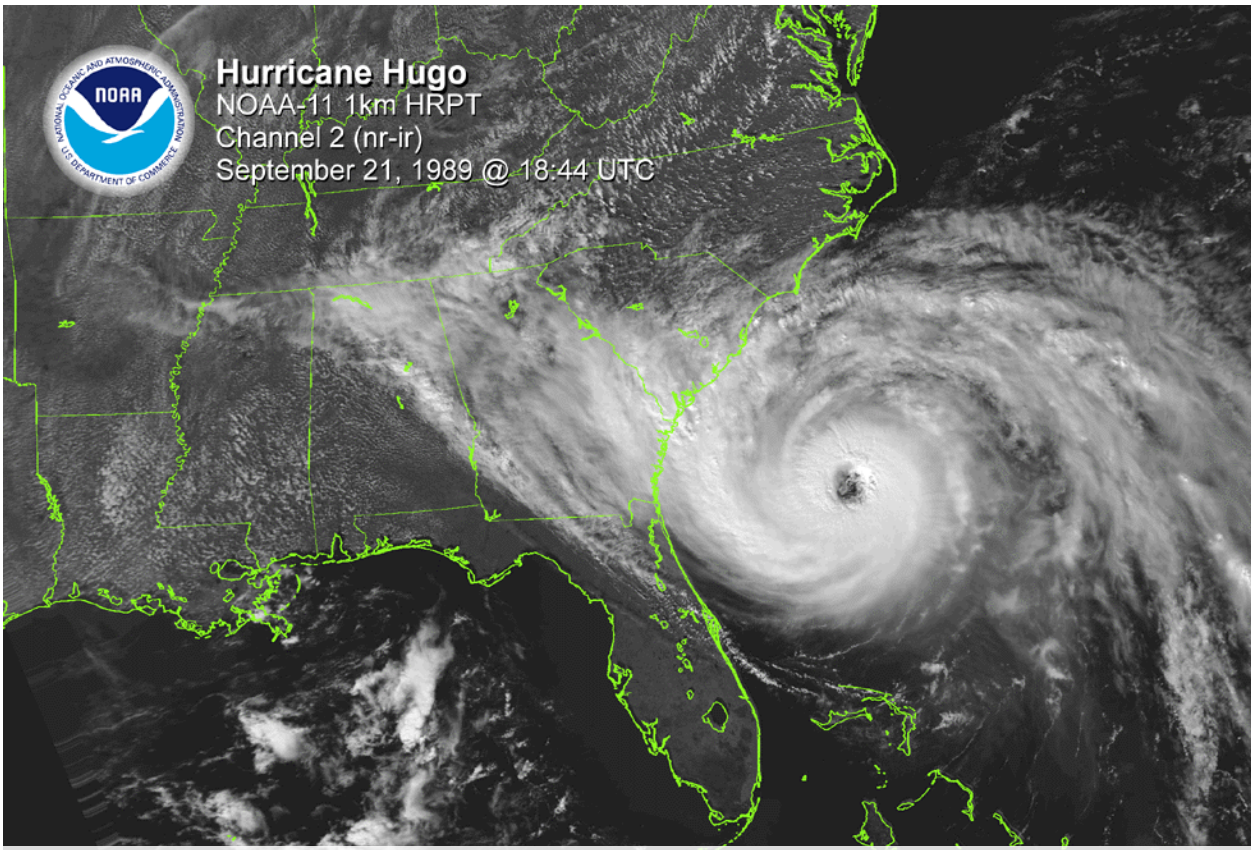


Figure 2: Hurricane Hugo approaching SC on September 21, 1989

Figure 3: Sullivan's Island lighthouse at sunset. Image Source: Town of Sullivan's Island.

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, the causeway on the 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 resources.

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

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.

and future flooding. In 2023, the Town received funding from the Federal Emergency Management Agency (FEMA) Building Resilient Infrastructure and Communities (BRIC) program and acquired a team of consultants including Weston & Sampson, Elko Coastal Consulting, and McCormick Taylor to produce the Town's first ever Sea Level Adaptation & Resilience Plan (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.

Hydrologic and Hydraulic Modeling

The Town worked with Seamon Whiteside & Associates to conduct a *Stormwater Master Plan and Infrastructure Improvement Strategy*, this final report was published in February 2025. The Stormwater Master Plan consisted of an extensive effort to create a hydrologic and hydraulic (H&H) model for Sullivan's Island which served as the starting point for this resilience focused hydrologic and hydraulic analysis. Several modifications were made to the provided stormwater infrastructure model including:

The addition of 132 watersheds to model rainfall, runoff, and infiltration in the undeveloped portions of the island (ie. beach and marsh). See Figure 4.

Infiltration method was converted from Curve Number method to Green-Ampt method to better account for changing infiltration rates during storm events.

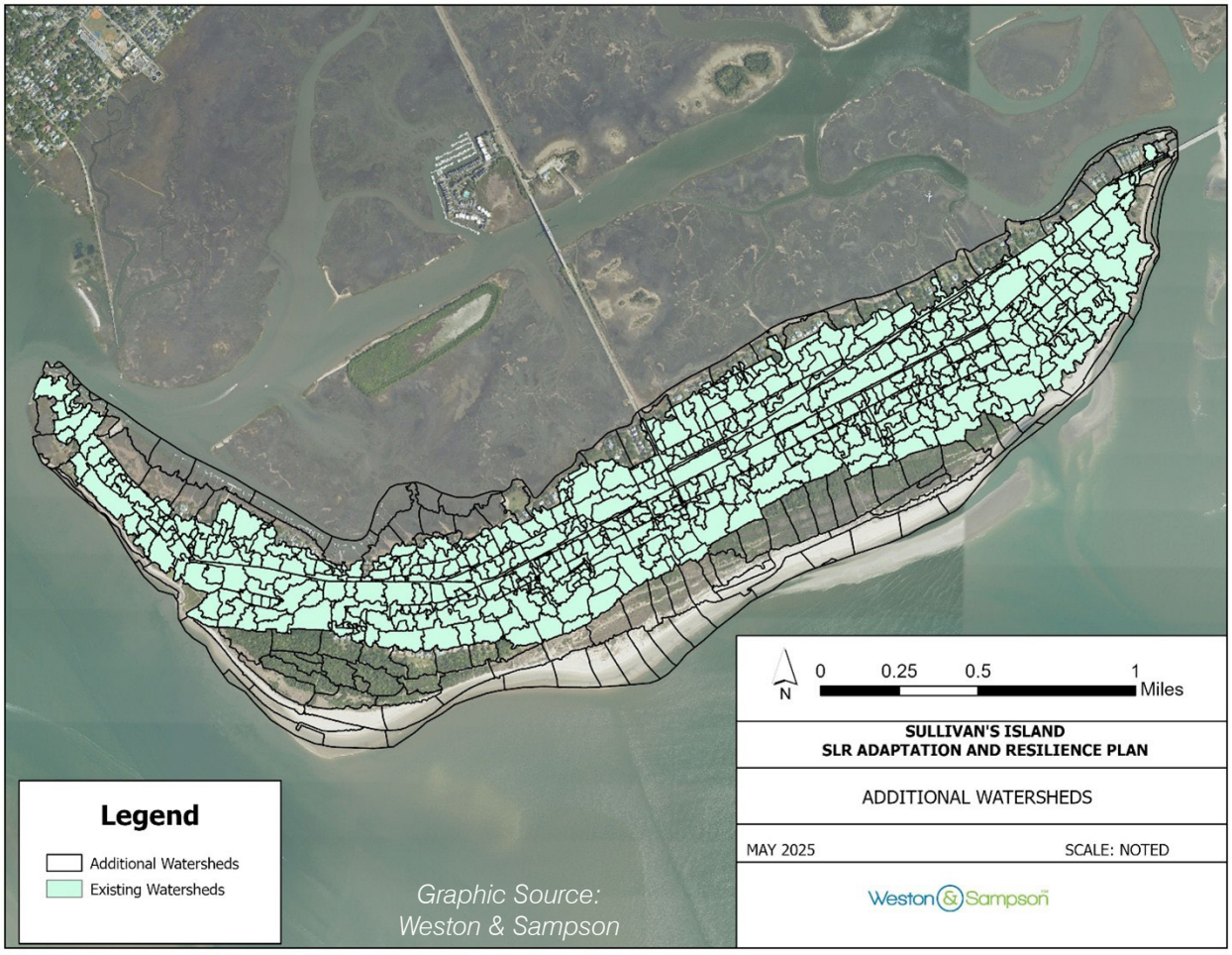


Figure 4: Additional Watersheds

Calibration

To calibrate the model, rainfall and tide data from Hurricane Debby were used. Hurricane Debby affected the Island from August 4-7, 2024. Rainfall data from the USGS station near Summerville, SC along with tidal data from the NOAA Charleston Harbor station were downloaded to replicate Hurricane Debby conditions.

These Hurricane Debby 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 5, 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.

A full discussion of methodology for the H&H analysis can be found in Appendix A.

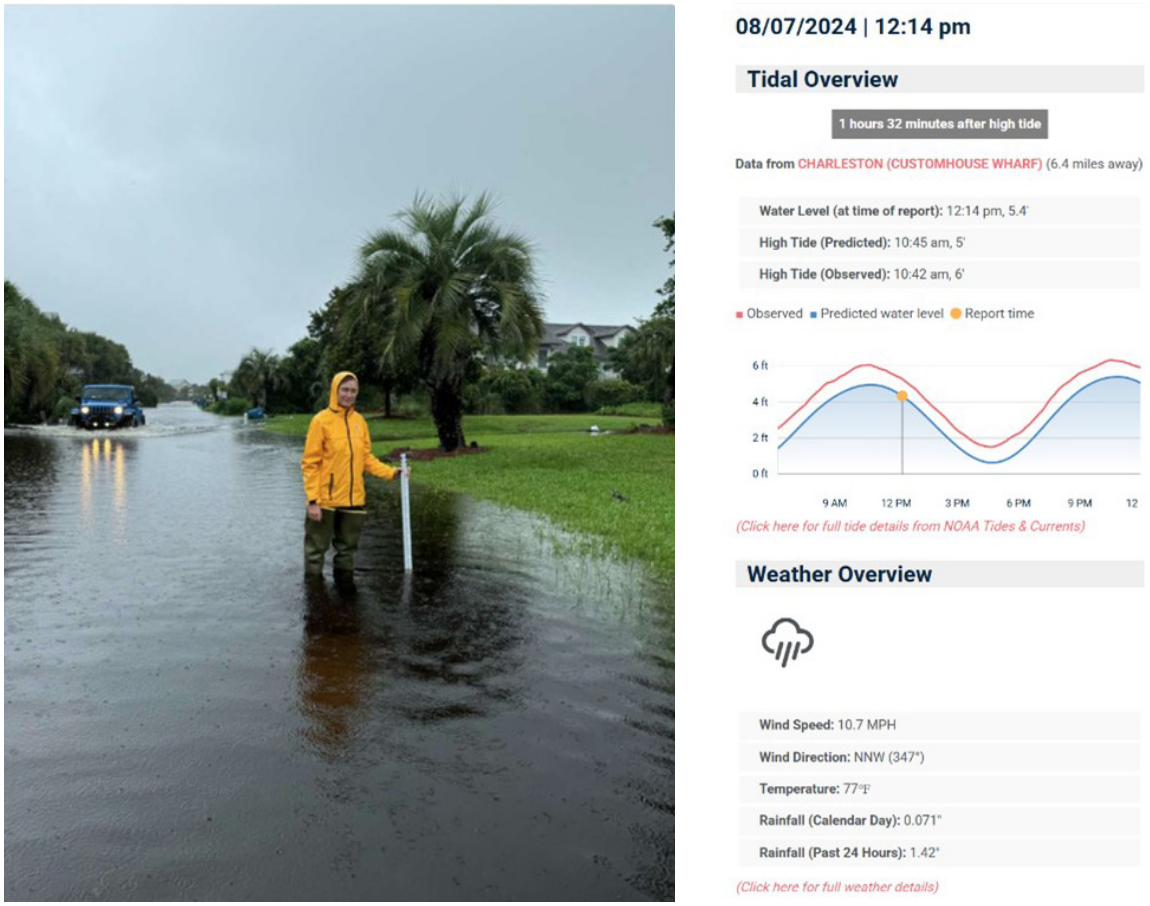


Figure 5: Sample of MyCoast Calibration data for Hurricane Debby

Planning Horizon

The planning horizon for the Sullivan's Island Sea Level Adaptation and Resilience Plan is the year 2050. This timeframe aligns with the expected lifespan of many proposed nature-based solutions (approximately 25 years) and corresponds to the length of a typical mortgage, making it a practical and relatable planning period for stakeholders. Combining the localized vertical land motion rates with the 2050 intermediate sea level rise projection results in an **estimated increase in sea level rise of approximately 1.07 feet over the next 25 years.** More details on how this sea level rise was derived can be found in the Appendix A "Hydrologic and Hydraulic Analysis." This sea level rise scenario is shown in Figure 6.

The elevation of mean high water, or a typical high tide, was projected to be 4.38 ft NAVD88 in 2050 which accounts for sea level rise. **The map depicts this projected typical high tide in 2050 during a no rainfall event.** Under these conditions, some "sunny day flooding" may be experienced along roadways and in yards. Furthermore, the tidal waters will significantly reduce the function of the gravity-fed stormwater system to move water downstream.

Figure 6: Projected sea level rise in 2050

Graphic Source: Weston & Sampson

This map depicts a 100-year storm event in the year 2050. This map illustrates both a tidal waters and rainfall event and the compound flooding that would occur if no action is taken, including stormwater infrastructure improvements proposed in the Sullivan's Island Stormwater Master Plan.

As defined by the South Carolina Office of Resilience, resilience is "the ability of communities, economies, and ecosystems to anticipate, absorb, recover, and thrive in the face of environmental change and natural hazards." As the community of Sullivan's Island increasingly feels the impacts of sea level rise and climate change; **this Sullivan's Island Sea Level Adaptation & Resilience Plan is an integral guidance document in providing recommendations to build a more resilient Sullivan's Island.**

Figure 7: A 100-year storm event in 2050

Graphic Source: Weston & Sampson

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 maps 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 topics listed in Table 1. These selected topics provide a lens to identify commonalities, gaps, and opportunities in addressing sea level adaptation and resiliency.

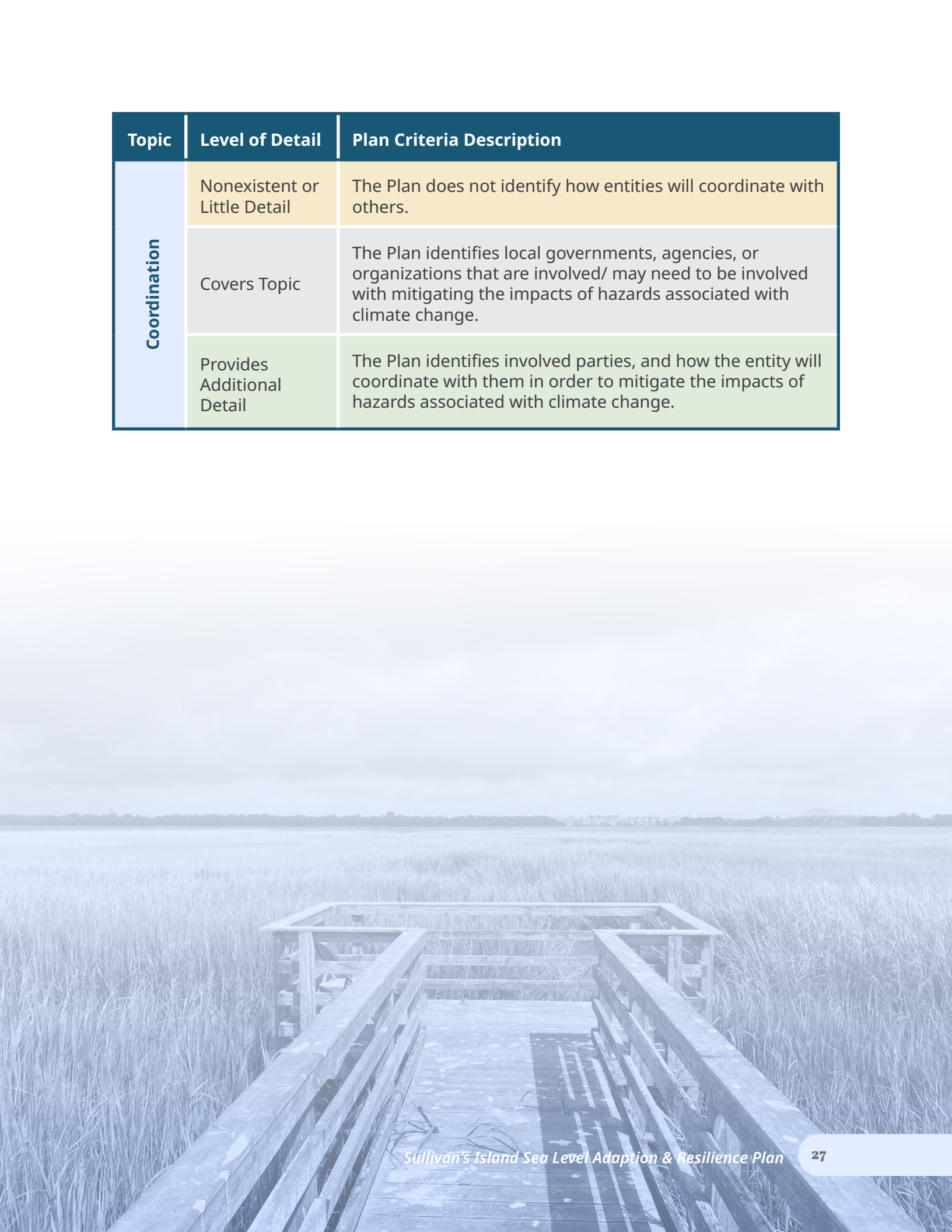
Table 1: Methodology to Evaluate Plans

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, earthquake, and drought and/or other hazards to 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	The Plan addresses public safety issues and 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	The Plan describes how policies that mitigate sea level rise will be implemented and 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 identifies obstacles to mitigation and adaptation planning and 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 identifies involved parties, and 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 of Plan Analysis

	TOSI Comprehensive Plan	Charleston County HMP	Accreted Land Management Plan	Comprehensive Beach Management Plan	Protected Land Management Plan	2023 Beach Monitoring Report	Connected Land Conservation Plan of the East Cooper Region of SC	SCOR Statewide Resilience Plan	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.	Environmental change is mentioned in the context of climate change multiple times throughout the report.	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.	Discussion of sea level rise effects on ground water and septic systems. Uses projections from NOAA. Discusses impacts on coastal flooding while showing areas and amount of people affected.	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	Accreted Land Management Plan	Comprehensive Beach Management Plan	Protected Land Management Plan	2023 Beach Monitoring Report	Connected Land Conservation Plan of the East Cooper Region of SC	SCOR Statewide Resilience Plan	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	Accreted Land Management Plan	Comprehensive Beach Management Plan	Protected Land Management Plan	2023 Beach Monitoring Report	Connected Land Conservation Plan of the East Cooper Region of SC	SCOR Statewide Resilience Plan	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.	Action items are included in tables with specific funding sources identified.	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.	Identifies multiple public safety impacts due to flooding. State dam safety programs.	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.	This 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.
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	Accreted Land Management Plan	Comprehensive Beach Management Plan	Protected Land Management Plan	2023 Beach Monitoring Report	Connected Land Conservation Plan of the East Cooper Region of SC	SCOR Statewide Resilience Plan	Historic Resources Survey	City of Charleston Land & Water Analysis
Obstacles & 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.	Identified local barriers to mitigation and adaptation planning.	No obstacles or barriers are mentioned.	No obstacles or barriers are mentioned.
Monitoring & Evaluation	Monitoring is mentioned, but no overall comprehensive approach is provided.	HMP 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 is provided.	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 provide 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 specific to the needs and existing conditions of Sullivan's Island as it relates to climate change and the associated concerns. To create synergy with existing plans, overlapping goals and strategies will be incorporated where appropriate. This Plan will identify strategies, policy recommendations, and cost estimations for consideration in future decision making.

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

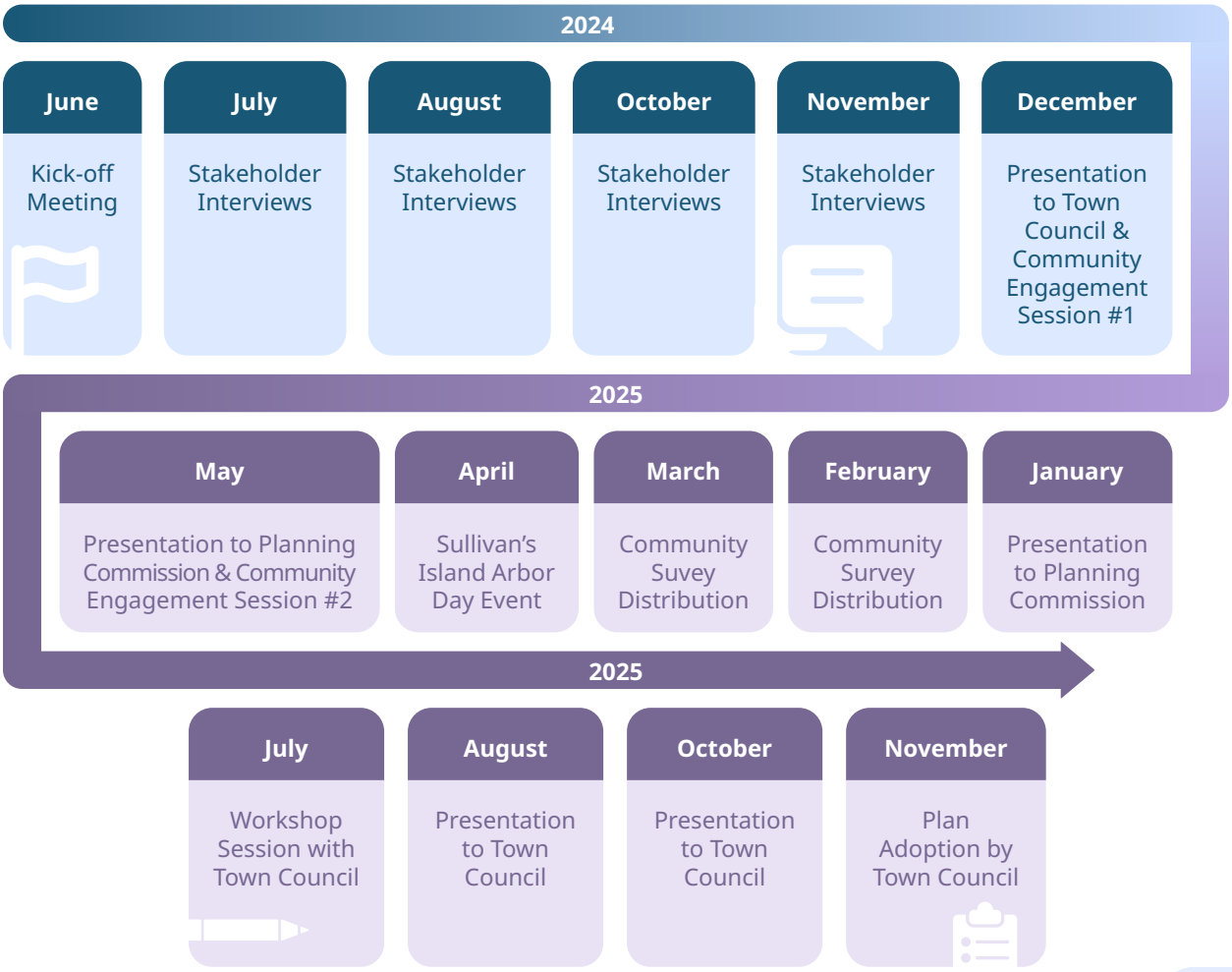


Figure 8: Presentation of model results to Sullivan's Island Planning Commission in May 2025

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 9: 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 Figure 10.

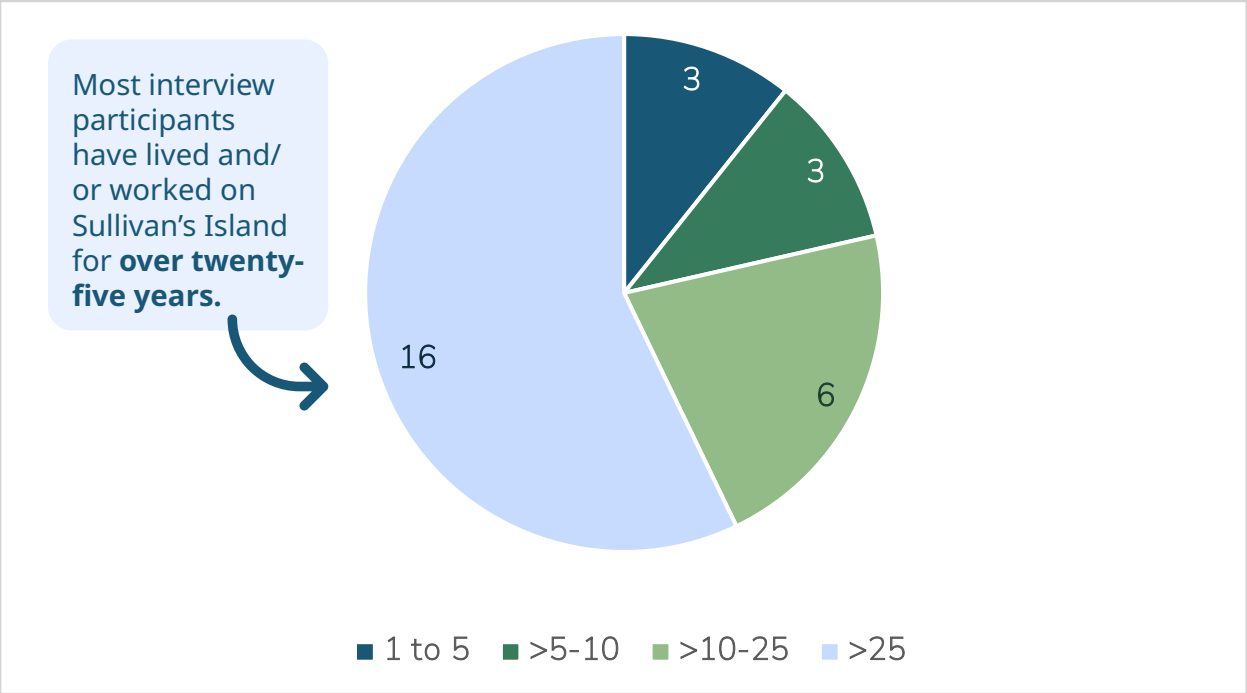


Figure 10: Interviewee Time Spent Working or Living on the Island

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 Figure 11:

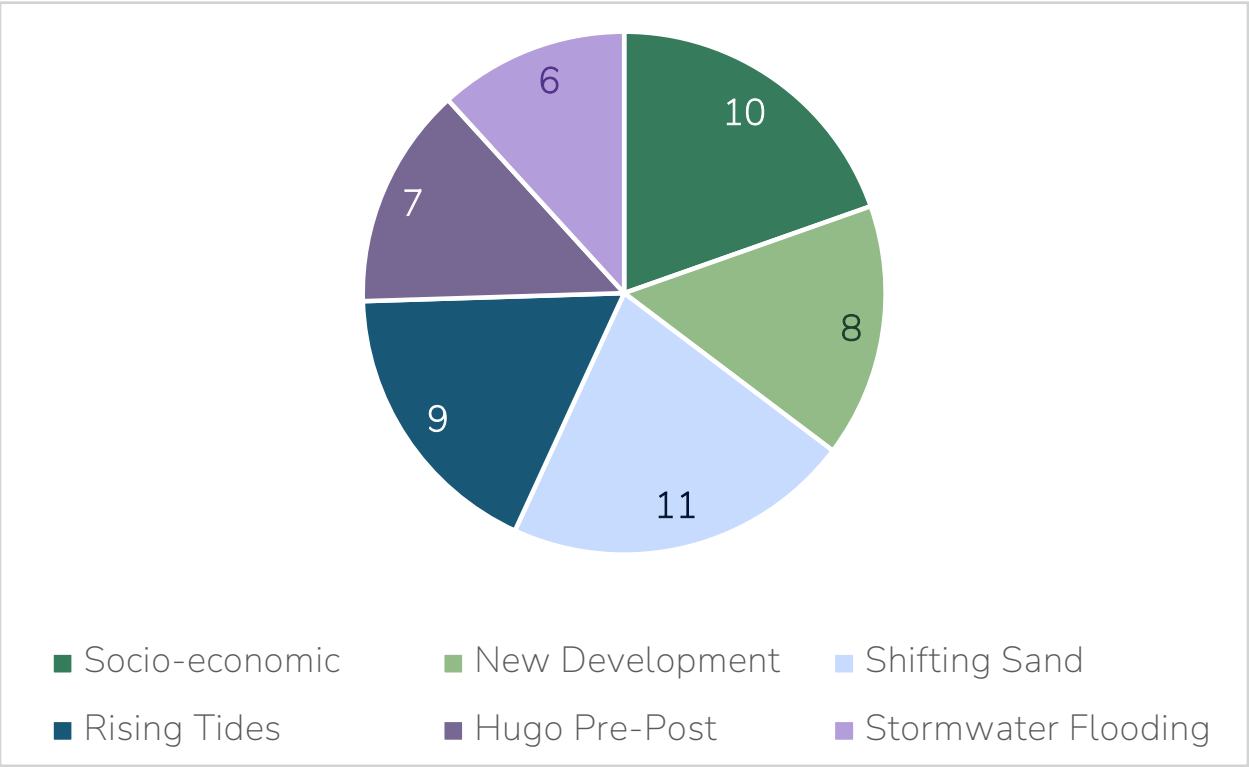


Figure 11: Perceived Changes on the Island

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 Figure 12:

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**

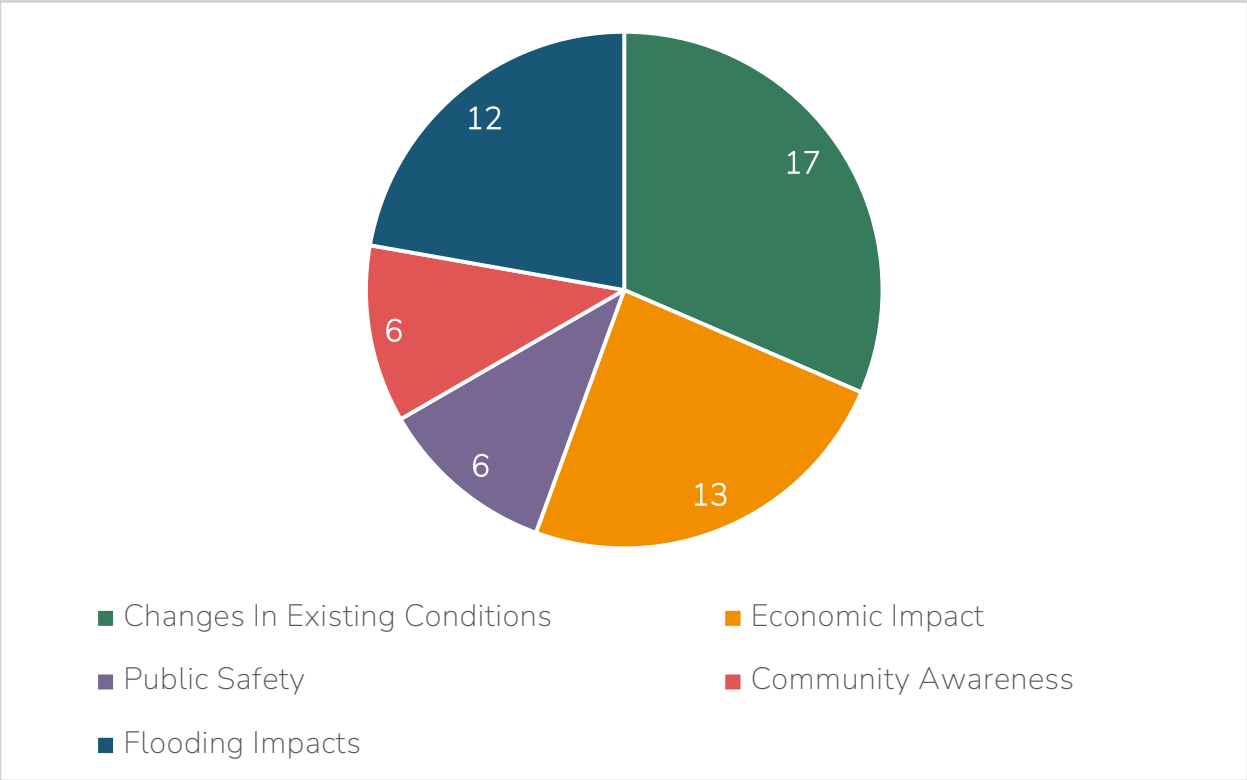


Figure 12: Concern Categories Related to Impacts of Sea Level Rise, Climate Change, & Flooding

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 Figure 13:

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**

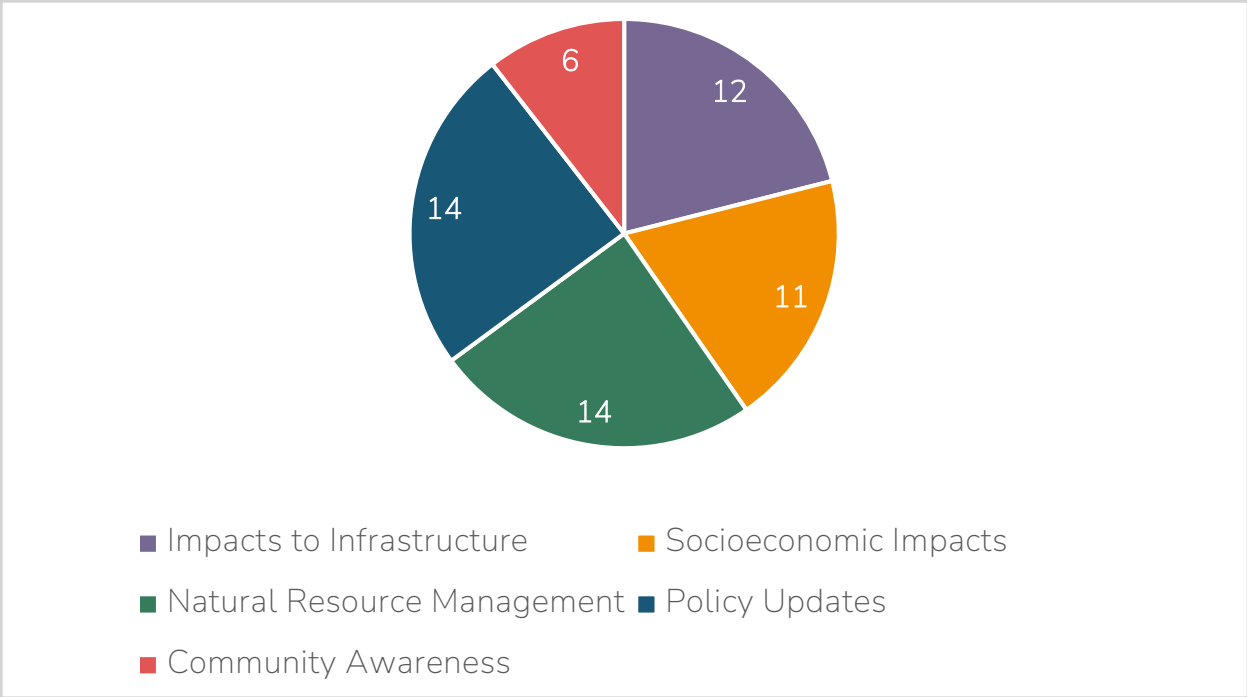


Figure 13: Unique Organizational Concerns Associated with SLR & Climate Change

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 Figure 14.

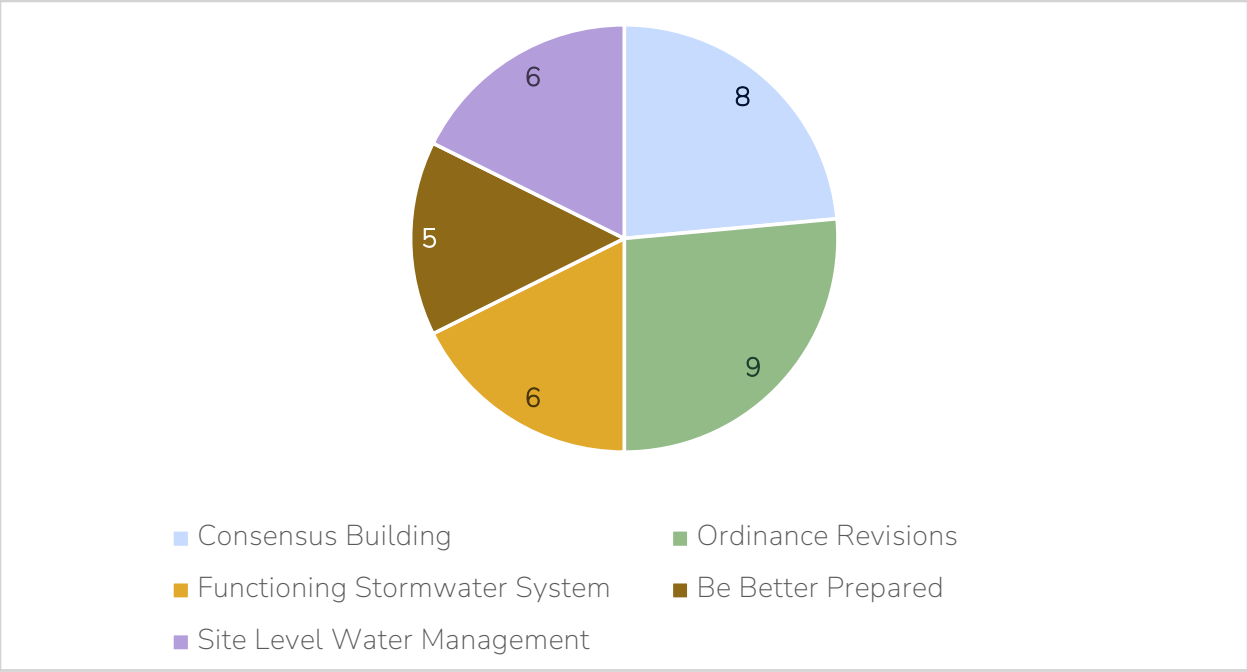


Figure 14: Successful Project Focus

Other responses included:

- Updated infrastructure with adaptative strategies (**4**)
- Staffing considerations (**3**)
- Consistent enforcement (**3**)
- Better communication with SCDOT (**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 community engagement included a community survey to gain 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 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 Figure 15.

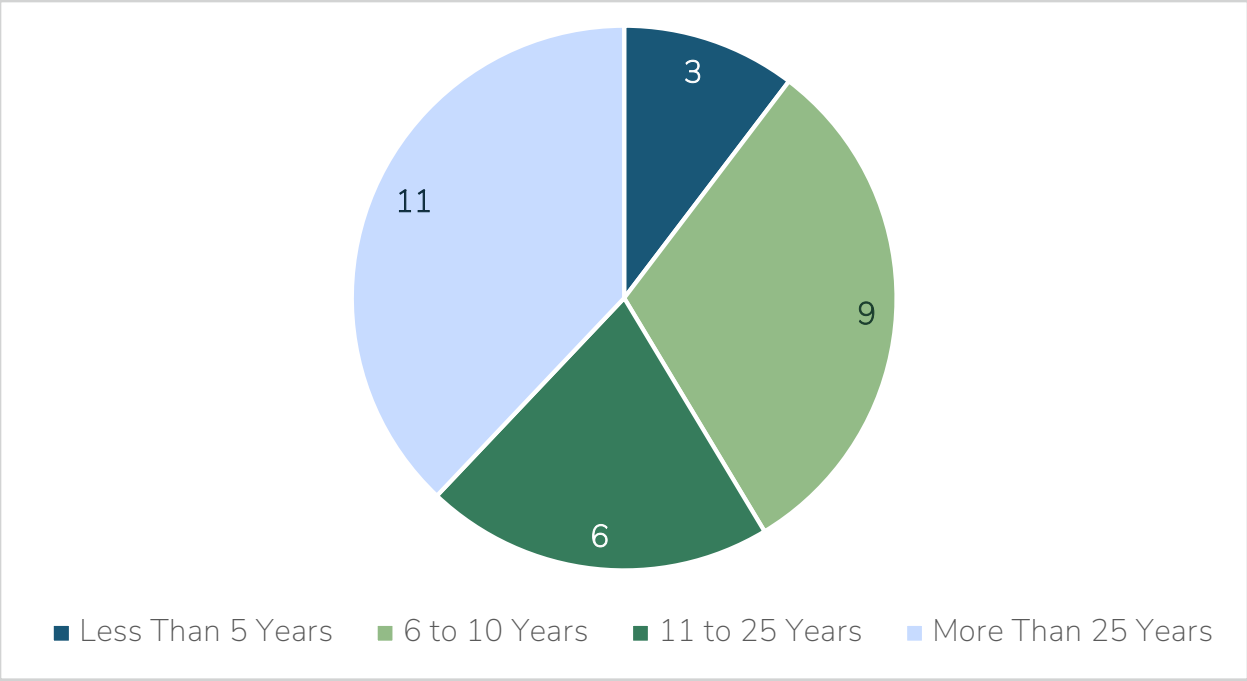


Figure 15: Survey Participant Time Spent Living on the Island

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.

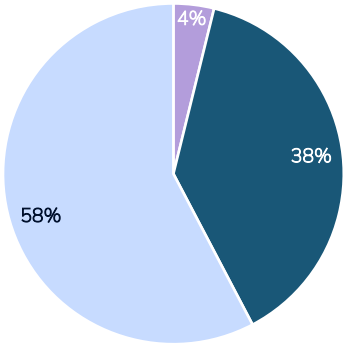


Figure 16: Construction Change

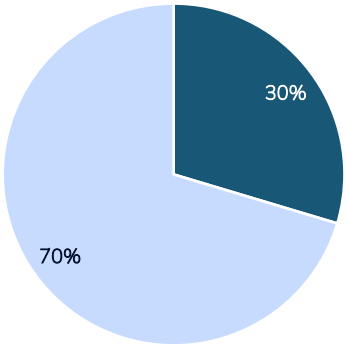


Figure 17: Change in Beach Traffic

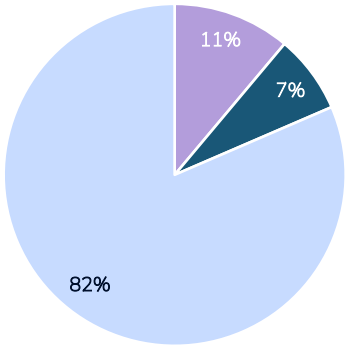


Figure 18: Flooding / Higher Tides

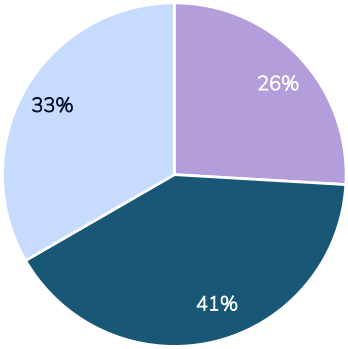


Figure 19: Frequence / Intensity of Storms

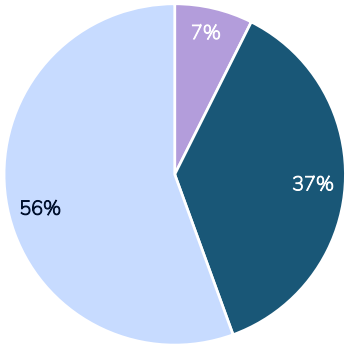


Figure 20: Shifting Sand / Coastal Dynamics

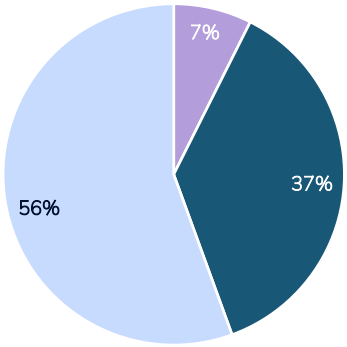


Figure 21: Socioeconomic Demographics

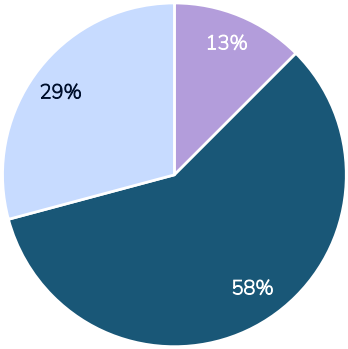


Figure 22: Regulations Related to Development

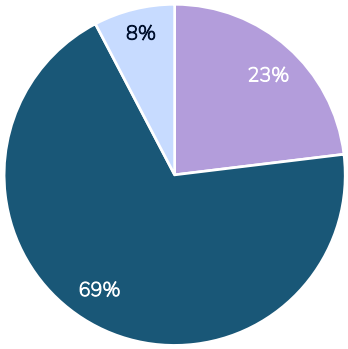


Figure 23: Plants & Animals

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 Figure 24.

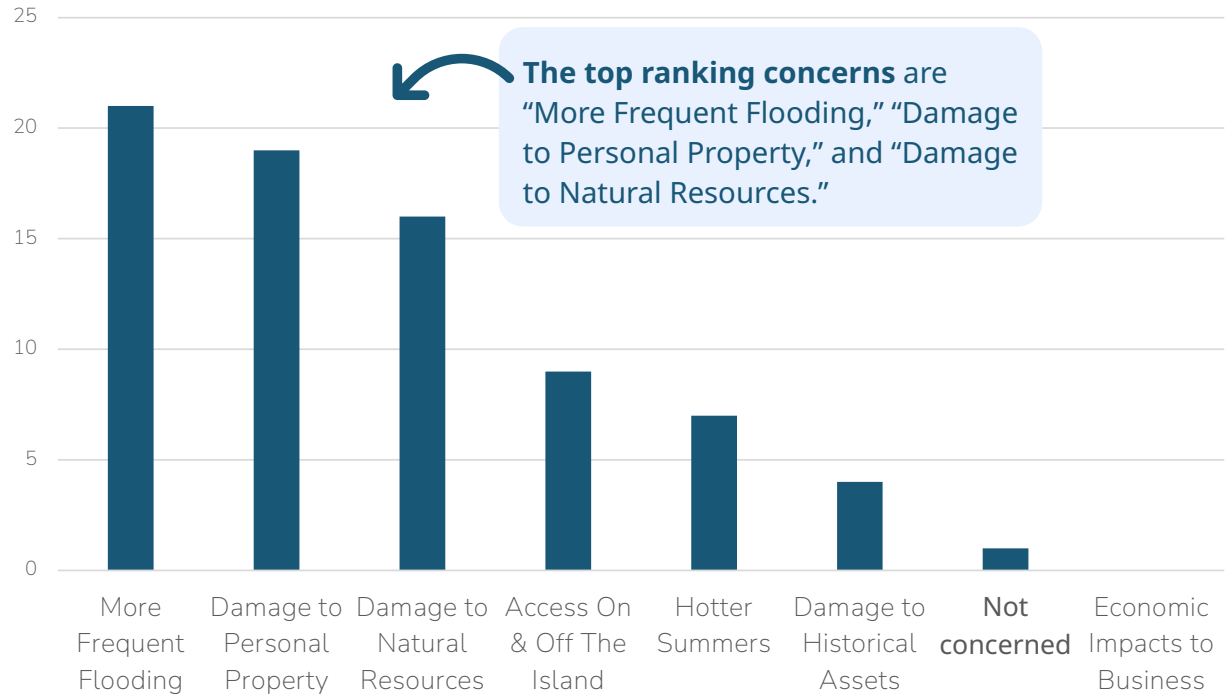


Figure 24: Top Concerns for Residents Related to SLR & Climate Change on the Island

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 Figure 25.

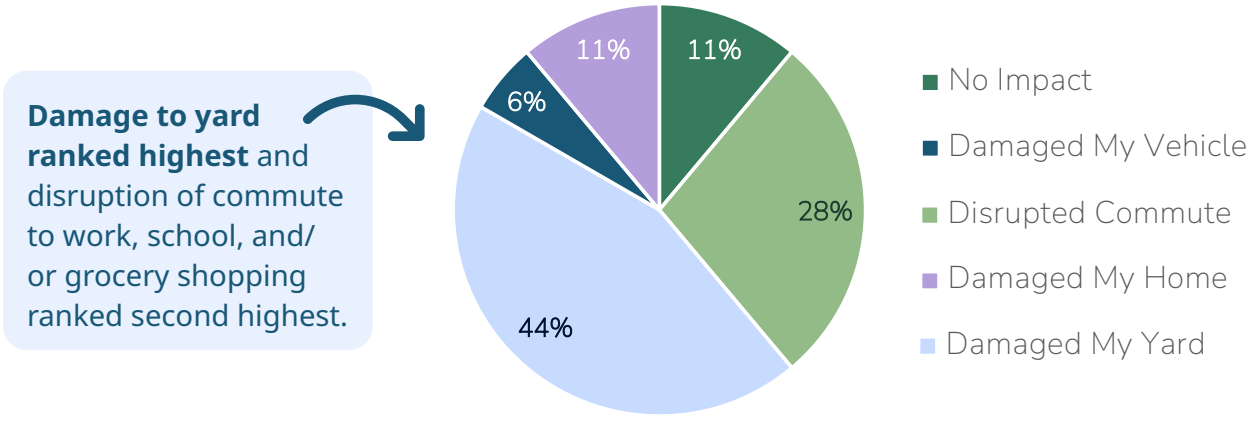
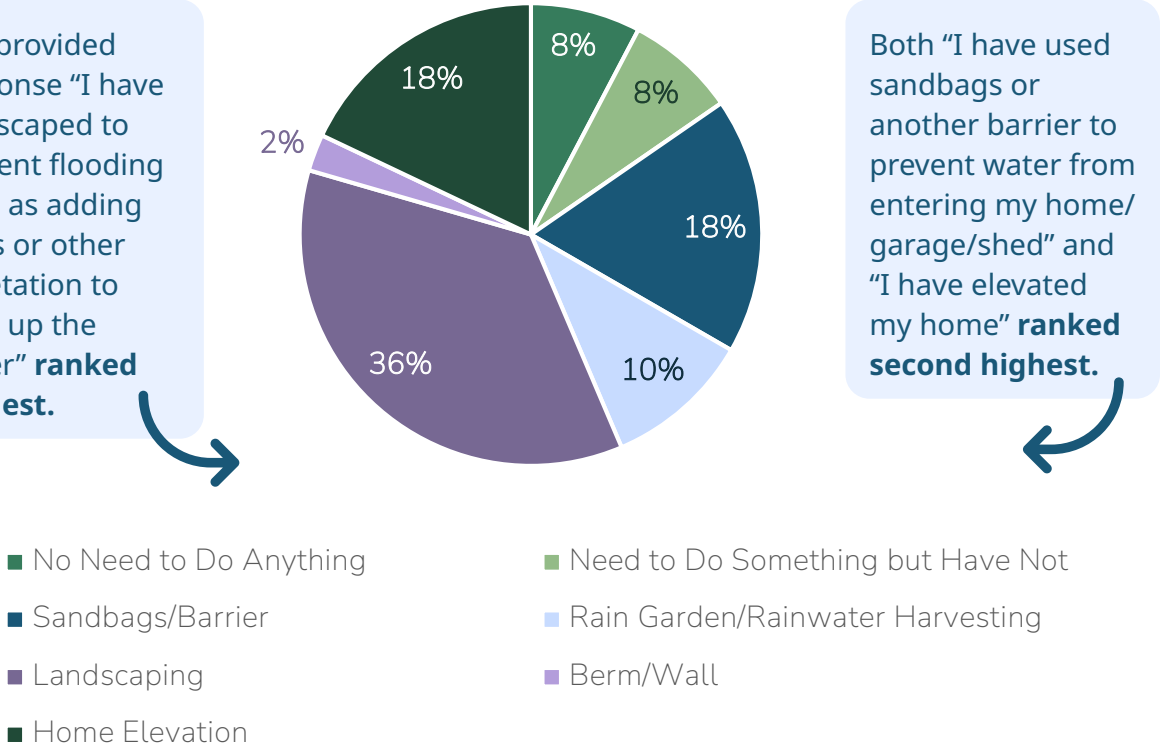


Figure 25: Personal Experience of Impacts From Tidal Flooding

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 Figure 26.

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.**

Figure 26: Personal Action to Combat Flooding

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 Nature-based Solutions 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 27: Participant at the first Community Engagement Session provides feedback on preliminary adaptation strategies.

Key takeaways from the first engagement session include:

- Nature-based Solutions (NBS) 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 28. 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 28: 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 29: The second Community Engagement Session provided community members an opportunity to provide feedback on adaptation strategy preferences.

Community Engagement Summary

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

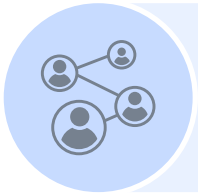
The information gathered during robust community engagement over the course of twelve months directly informed Plan recommendations. The initial interviews collected hours of interview data from over thirty stakeholders/decision-makers representing diverse sectors. Interviews provided a foundation for the vision and focus on the Plan. The community survey intended to emphasize the information gained from the stakeholder interviews but with a broader audience participation. The community engagement sessions provided an iterative approach to the Plan development as community members gave feedback at key milestones.

The consultant team also engaged with Sullivan's Island Town Council and the Sullivans Island Planning Commission including presentations at the Town Council Meeting on December 2, 2024, the Planning Commission Meeting on January 8, 2025 and May 14, 2025, the Town Council workshop on July 17, 2025, the Town Council meeting August 19, 2025, and the Town Council meeting on October 21, 2025. Each of these meetings were open to the public and public comment opportunities were provided. Presentations and discussions were made available on the Town's project website at *sullivansisland.sc.gov*.

The key takeaways included considerations regarding consensus building, local ordinance updates, natural resource protection, and community safety. 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. Ten Adaptation Strategies & Implementation Support



Engage and Involve

Ordinance and Policy Review

Nature-based Solutions

Open Space Planning and Nature-based Solutions

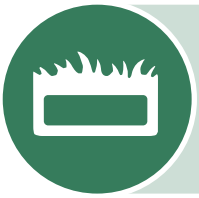
Residential-scale Nature-based Solutions

Business District Complete Street Adaptation

Marsh Management Protection

Maritime Forest

Dune System Management & Restoration



Underground Detention

Causeway Adaptation

Cost Estimate

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 30: 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.

Figure 31: Native plant landscaping on residential property, Sullivan's Island, SC

- **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.

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 3: 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.
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.

Task	Lead Entity	Support Groups	Details
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

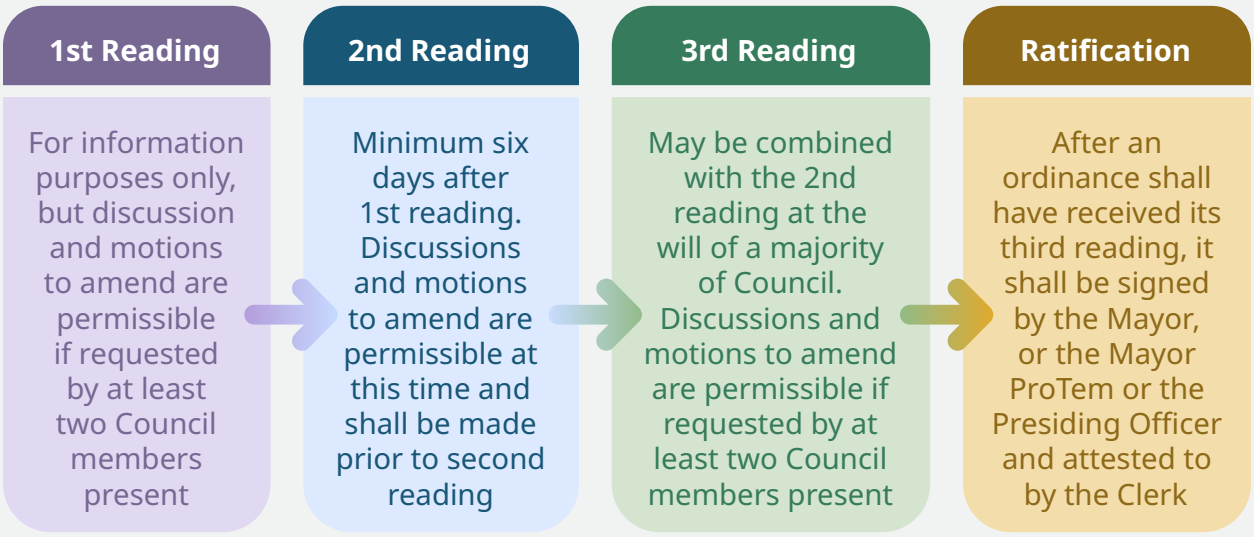
Description

Enacting new ordinances or updating the language in the Town of Sullivan's Island's current Code of 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 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 in the program 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 through enacting more stringent floodplain management requirements, such as increased freeboard elevations, updating building codes concerning floodproofing and venting, and revising stormwater management design standards to retain a larger volume of runoff. Incorporating higher standards of floodplain management within the Town's ordinances will not only help reduce flood risk and potential storm damage, but can also improve the Town's CRS rating, thus resulting in further discounted rates.

The Town's municipal ordinances were originally enacted in 1977 and have since undergone several substantial revisions. Most recently in 2002, the Town reviewed the existing zoning ordinances and proposed a series of 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 32 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 32: 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. Other benefits include:

Protection and Enhancement of Natural Resources:

Updating Stormwater Regulations to require the use of 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 updated or newly adopted ordinances, recommendations are grouped into four key areas that were broadly considered before developing specific recommendations that are tailored to the unique barrier island environment and drawn from other local examples. Additional recommended ordinances can be found throughout the other proposed strategies.

- **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.
- **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.
- **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.

- **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 the use of gravel for 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 utilize green infrastructure methods, such as green roofs or rain barrels, to collect and detain runoff (Sec 21-26B (3)).

   b. Consider adding language that any additional hard landscaping added during redevelopment (more than what was originally there) 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). Language should be considered requiring maintenance of previous pavements to counteract clogging of voids, ensuring they continue to function as infiltration areas.

3. **Consider updating the ordinance on stormwater management with an emphasis on Nature-based Solutions (NBS).**

   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". The Town should consider:

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

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

ii. Including Design Storms in the Standards.

- Incorporate language into the ordinance that at a minimum, the 25-year design storm should 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).
- 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 Nature-Based Solutions (NBS) and Low Impact Development (LID).

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

ii. Additionally, mitigation is required for impacts to floodplains and their storage capacity. Fill placed in the floodplain that reduces its storage capacity must be offset by creating compensatory floodplain storage at a ratio of 1.25:1. This means that for every cubic yard of fill material placed in a FEMA-regulated floodplain, 1.25 cubic yards of material must be excavated from the same flood zone.

Zoning and Land Use Ordinances

1. 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, the lawn area 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.

Figure 33: A native meadow full of Gaillardia, Coreopsis, Tradescantia. Image Source: Town of Sullivan's Island.

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.

2. Consider altering fill material limits for development.

a. Currently, the Town only allows one (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. To protect adjacent properties from flooding, recommendations for buffer widths should be included. Charleston County recently added language to their stormwater design manual requiring varying widths of vegetated buffers based on slope, with 4:1 slopes requiring a 3-foot-wide buffer for every additional one foot in height.

ii. If retaining walls are utilized, building codes should be reviewed and updated accordingly to distinguish between retaining walls for fill and sea-walls. Additional building code considerations should include safety measures depending on wall height (e.g., railing requirements).

Natural Resource Protection Ordinances

1. 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. In Mount Pleasant, for example, vegetated critical line buffers range from 15 feet to 50 feet, depending on location. 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. See the *Marsh Management Adaption* for more information on vegetated buffers.

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

a. The 2023 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, federally excluded wetlands from development impacts. Such language would also protect the dune systems from any impacts due to un-permitted footpaths. See the *Dune System Management and Restoration* strategy for more information on protecting the dune systems.

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

1. Consider implementing higher freeboard requirements in Special Flood Hazard Areas.

a. Consider revising the Town's Design Flood Elevation (DFE) to provide greater protection from flooding and sea level rise. Currently, the DFE is Base Flood Elevation (BFE) + 1 foot for new residential construction or substantial improvement (Sec 153.41 A). See Figure 34 for visualization.

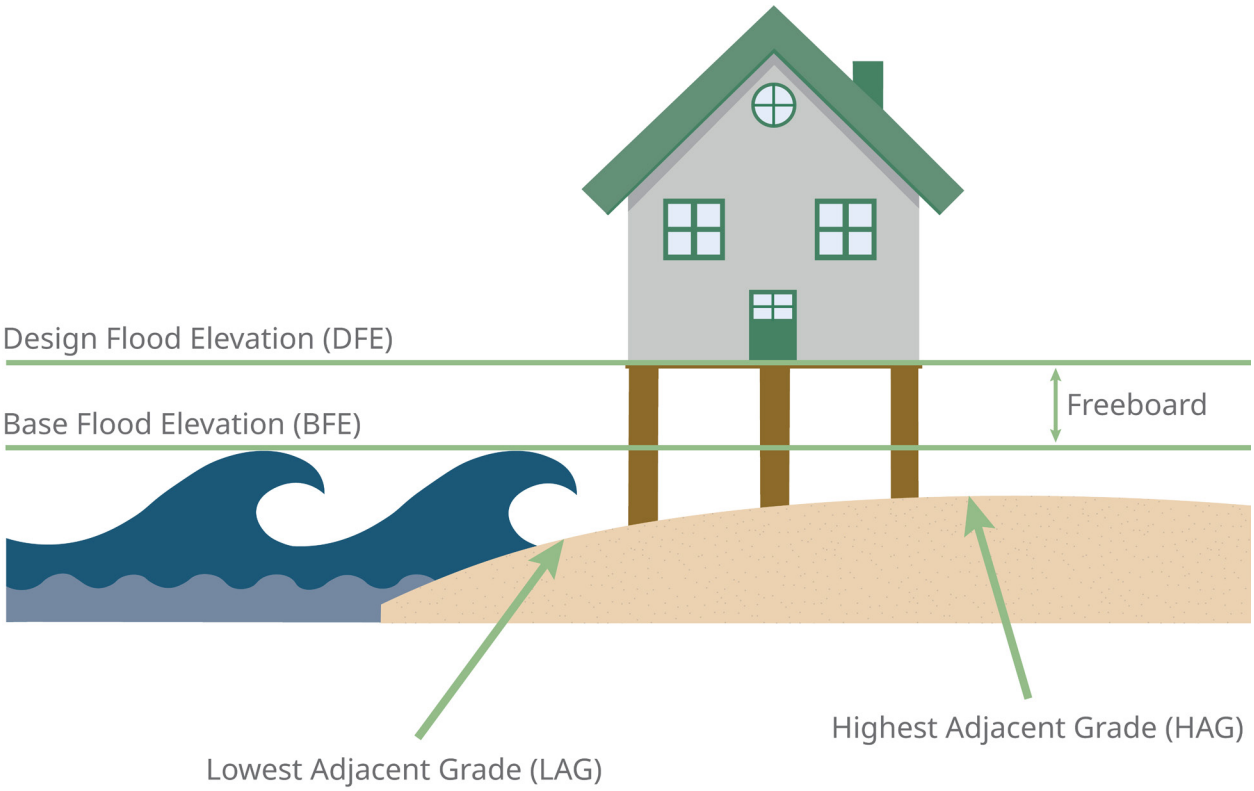


Figure 34: Visual representation of DFE, BFE, and Freeboard terminology

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)).

2. 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 density and size of openings 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 Overview

As defined by the National Oceanic and Atmospheric Administration (NOAA), nature-based solutions are **"infrastructure projects that intentionally use natural and nature-based habitats and processes to reduce risks and deliver multiple benefits."**

Nature-based solutions play a vital role in mitigating flood risk while also providing ecological and societal benefits. NBS are designed to assist in stormwater management by capturing, slowing, and filtering rainwater which reduces flooding, erosion, and downstream pollution. NBS use landscape-level systems to capture water that runs off impervious surfaces associated with the built environment.

When considering nature-based solutions (NBS), the following guidelines can help:

- **NBS are scalable.** These practices range from residential applications, such as rain gardens, to commercial-scale, such as the Middle Street Complete Street, to community-scale, such as invasive species removal and ecological restoration in open space areas.
- **Regardless of the size or scale, all practices are place-based.** NBS are designed for specific site conditions which consider soil, hydrology, adjacent land use, and community needs.

- **NBS are not an all or nothing approach.** These practices can work in conjunction with traditional grey infrastructure and build community resiliency. NBS help to reduce the strain on the centralized system of pipes, ditches, culverts, and storm drains.
- **NBS work with nature to restore pre-development hydrology.** NBS treat stormwater runoff close to the source which includes surface areas such as root tops, roadways, parking lots, and other built upon surfaces that do not allow water to infiltrate.
- **NBS yield the greatest benefit when used in combination with another NBS in a "treatment train" approach.** For example, a rainwater harvesting system that, when full, overflows into a rain garden. This approach provides water multiple opportunities to slow down and to infiltrate and reduce downstream flooding.

- **NBS 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, pollinators, and other wildlife.

Temperature regulation: Trees and green space lower the local temperature, mitigating the effects of urban heat islands.

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 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 35: Live Oak Canopy Intercepts Rain Fall and Assists with Reducing Community Flooding and Temperature Regulation. Image Source: Town of Sullivan's Island.

For additional information on Nature-based Solutions, the following South Carolina based resources are recommended:

- "Low Impact Development in Coastal South Carolina: a Planning and Design Guide" A free download is available at *www.scseagrant.org/sc-lid-guide.*
- "The Nature-Based Exchange Compendium- Guidelines for designing and implementing nature-based solutions based on a series of workshops hosted in South Carolina" A free download is available at *www.naturebasedexchange.org/compendium.*

All of the recommended strategies in this Plan incorporate NBS on some level; three of the ten recommended strategies have specific NBS focus and include open space planning, residential-scale, and the business district complete street.

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. 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.

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 36 depicts an example of the depths of each layer.

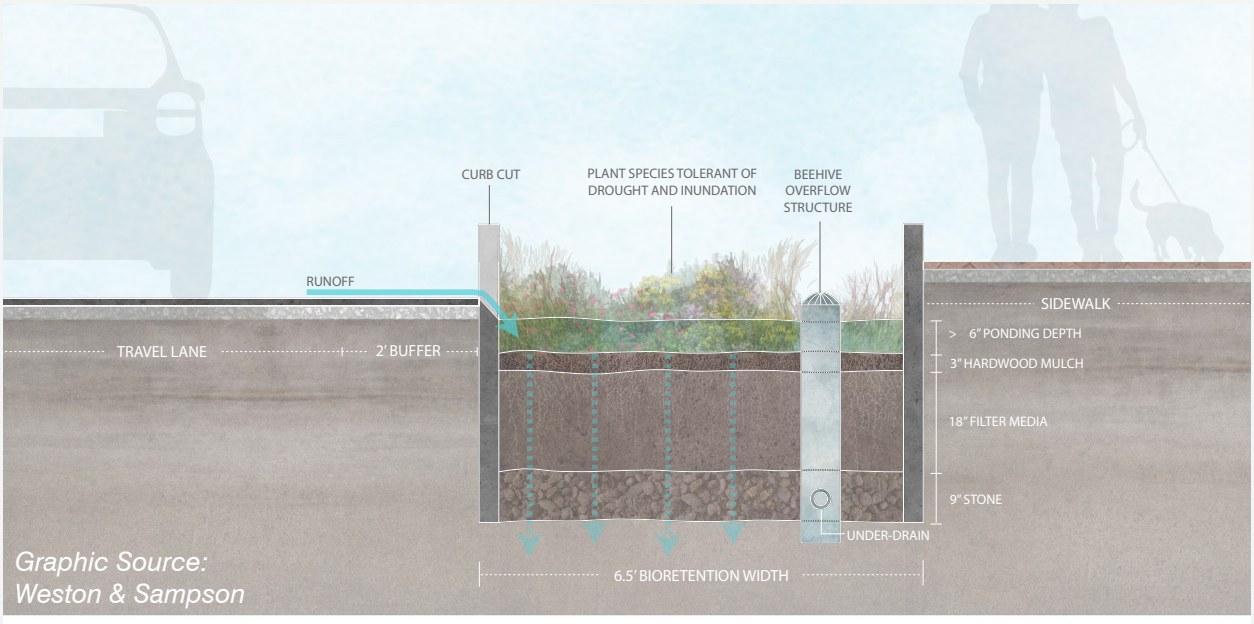


Figure 36: Bioretention

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.

Rain gardens function similarly to bioretention, and the terminology may even be used interchangeably at times. For the purposes of this Plan, **the difference between a "rain garden" and a "bioretention cell" are defined as follows:**

- A rain garden does not typically require an engineer to design it. A trained landscape designer, contractor, or home gardener can design and implement rain gardens.
- A rain garden is applied in site level applications including the home landscape, community centers, open space, and other areas that are not commercial in nature.
- A rain garden uses amended soil that is roughly two parts sand to one part compost; this is not a calculated engineered mix.
- In coastal South Carolina, rain gardens rarely incorporate an underdrain; whereas, underdrains are commonly incorporated in bioretention cells but not always.

Figure 37: A rain garden and rainwater harvesting system located at the Folly River Park work together to manage stormwater

Rainwater Harvesting System

Rainwater harvesting (RWH) is the capture and storage of rainfall for future use. RWH systems capture water flowing from roof surfaces during a storm event and the water is used for non-potable needs, such as irrigation or equipment washing, unless additional design considerations (and cost) are included for potable use. RWH can be an effective practice to conserve water, and address issues of erosion or standing water near the founding of a home or building.

RWH systems store water in tanks that vary in size from rain barrels, less than 100 gallons, to cisterns, larger tanks with volume capacity more than 100 gallons. Historic cisterns can still be seen on Sullivan's Island. Regardless of size, RWH systems include prefiltration features that work to filter out organics and sediment before the water enters the tank. Prefiltration features, including screened inlets, also prevent mosquitoes from entering the tank. On Sullivan's Island where a high-water table exists, cisterns and rain barrels will be located above ground.

Ideally the water is used, and the tank is drawn down, or emptied, in between rain events. Water exits the tank through a spigot or valve located towards the bottom of the tank. Most RWH systems are designed to use gravity to move the water. Rain barrels are often elevated on a secure platform to create pressure. Cisterns are not typically

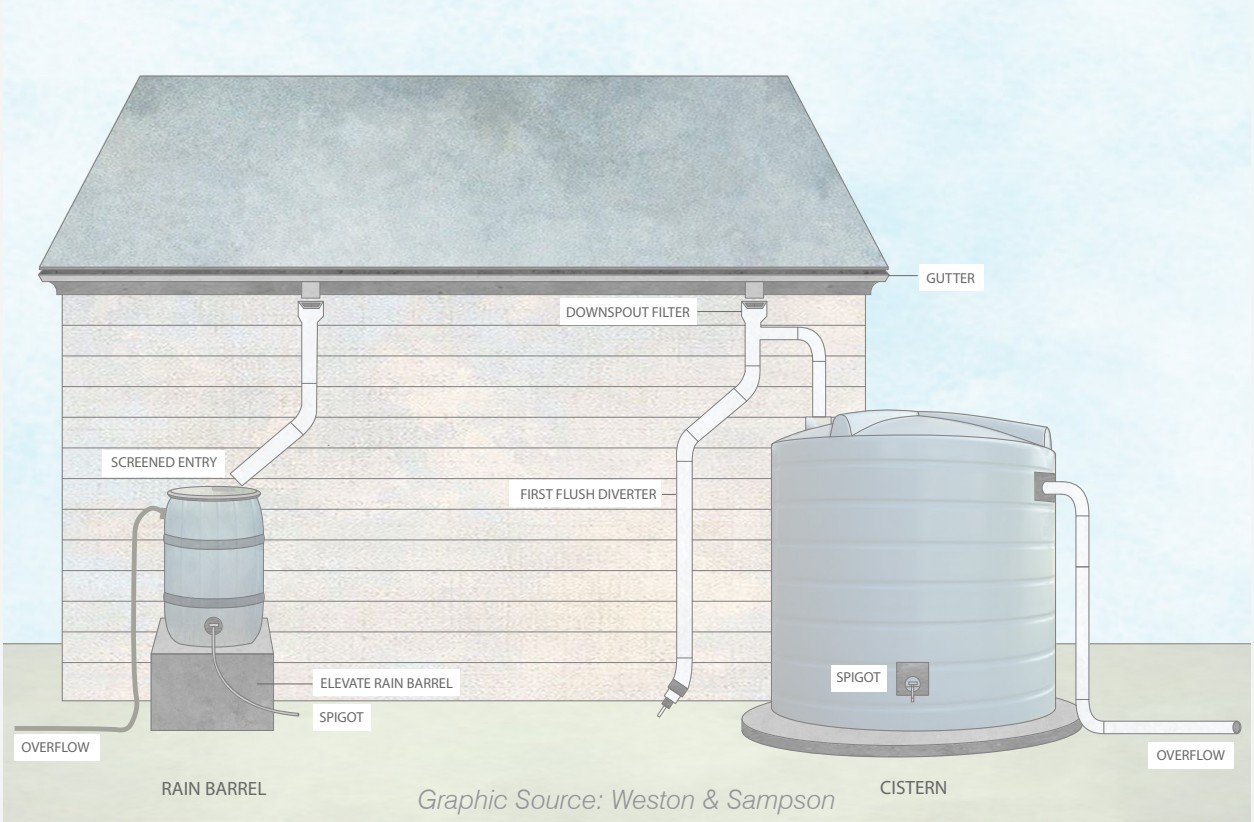


Figure 38: Rainwater harvesting system

elevated, but use a gravity fed system or pumps to move the water out of the tank. All tanks, regardless of size, must include an overflow located towards the top of the tank that allows the water to exit the tank when full. Overflow directs water away from the foundation of adjacent buildings.

Green Roof

A vegetated roof that insulates the building, reduces heat islands, and manages rainwater. Green roofs are part of the Sullivan's architectural vernacular. 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 39: 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).

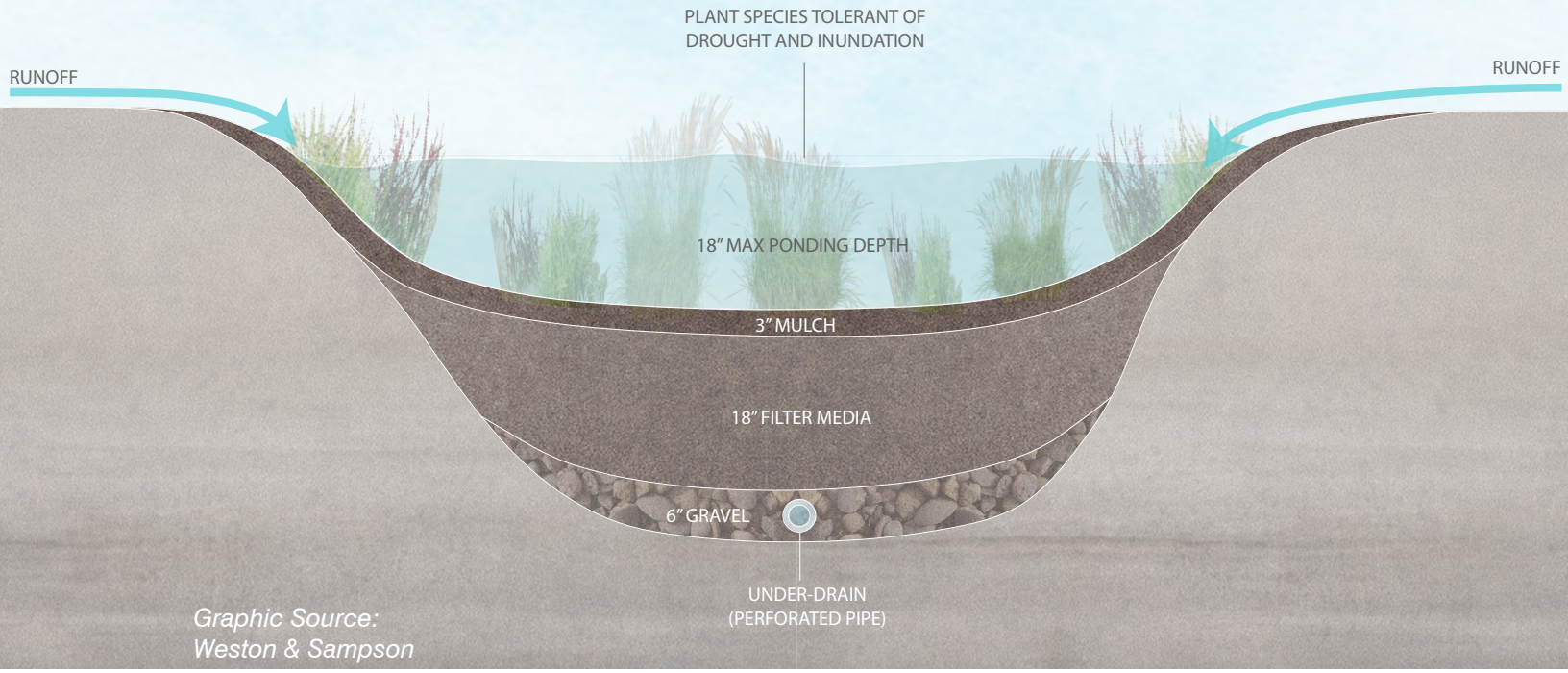


Figure 40: A bioswale

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 with engineered soils and the incorporation of native plant species will have the greatest water quality and quantity benefits. Bioswales can provide enhanced aesthetics and functionality for parking areas as well as be placed along driveways and property lines to manage water between adjacent properties.

Permeable Pavement

Permeable pavement can be incorporated into a site during initial construction or as a retrofit. Permeable pavement systems may include interlocking pavers, permeable concrete, uncompacted gravel, or any other materials through which water can pass through at an infiltration rate of 2.0 inches per hour, as defined by the Town. Interlocking pavers are utilized in residential settings for driveways and patios, and in commercial applications for parking areas. Water infiltrates through spaces between the pavers; the pavers themselves are not permeable. The water drains into an aggregate base designed to manage water. Porous concrete is another form of permeable pavement that can

Figure 41: Parking area with interlocking paver system and gravel located adjacent to Middle Street, Sullivan's Island.

be utilized in street gutters and sidewalks. Porous concrete allows water to infiltrate through spaces in the concrete. Porous concrete can be poured in place, or prefabricated. All permeable pavement systems must be maintained to function as intended. The surrounding area should be stabilized with vegetation, mulch, and other forms of ground cover to avoid sediment washing onto the area. Excess sediment will clog the system and reduce infiltration rates.

Living Shoreline

Living shorelines are an effective tool to help stabilize shorelines in tidal waters. Living shorelines in South Carolina may involve salt marsh planting and/or strategies to promote oyster growth including bagged oyster shell, manufactured wire reefs, and oyster castles. Living shorelines may also include the use of coir logs to help protect an existing marsh edge subject to erosion. Living shorelines are designed and sited based on the unique conditions of the site including sediment firmness, wave energy, slope, erosional features, the presence of oysters, and more. Desktop analysis and field observations will help determine the most appropriate living shoreline strategies for success.

Living shorelines can be used in combination with traditional shoreline erosion structures, including bulk heads and revetments. Living shorelines are designed to protect the marsh edge, whereas traditional grey infrastructure is designed to protect the upland edge. The ability of living shorelines to effectively protect the salt marsh and establish stable vegetation, reduces the stress on grey infrastructure to stabilize the uplands. Uplands with stable salt marshes adjacent are less susceptible to erosion than uplands with highly erosional salt marshes. If designed and sited correctly living shorelines will grow over time, and benefits associated with living shorelines will continue to increase including the creation of essential habitat, shoreline protection, sequestration of carbon, water quality benefits, and the buffering of boat wake. Living shorelines may also grow vertically to keep pace with rising sea levels.

In South Carolina, a permit is required to install a living shoreline. A regulatory pathway for living shorelines was established in South Carolina in 2021. To learn more about living shorelines and the associated regulatory process, visit *clemson.edu/living-shorelines*.

Figure 42: A recently installed living shoreline uses oyster castles to attract oyster growth, capture sediment, and support aquatic life. Beaufort, SC.

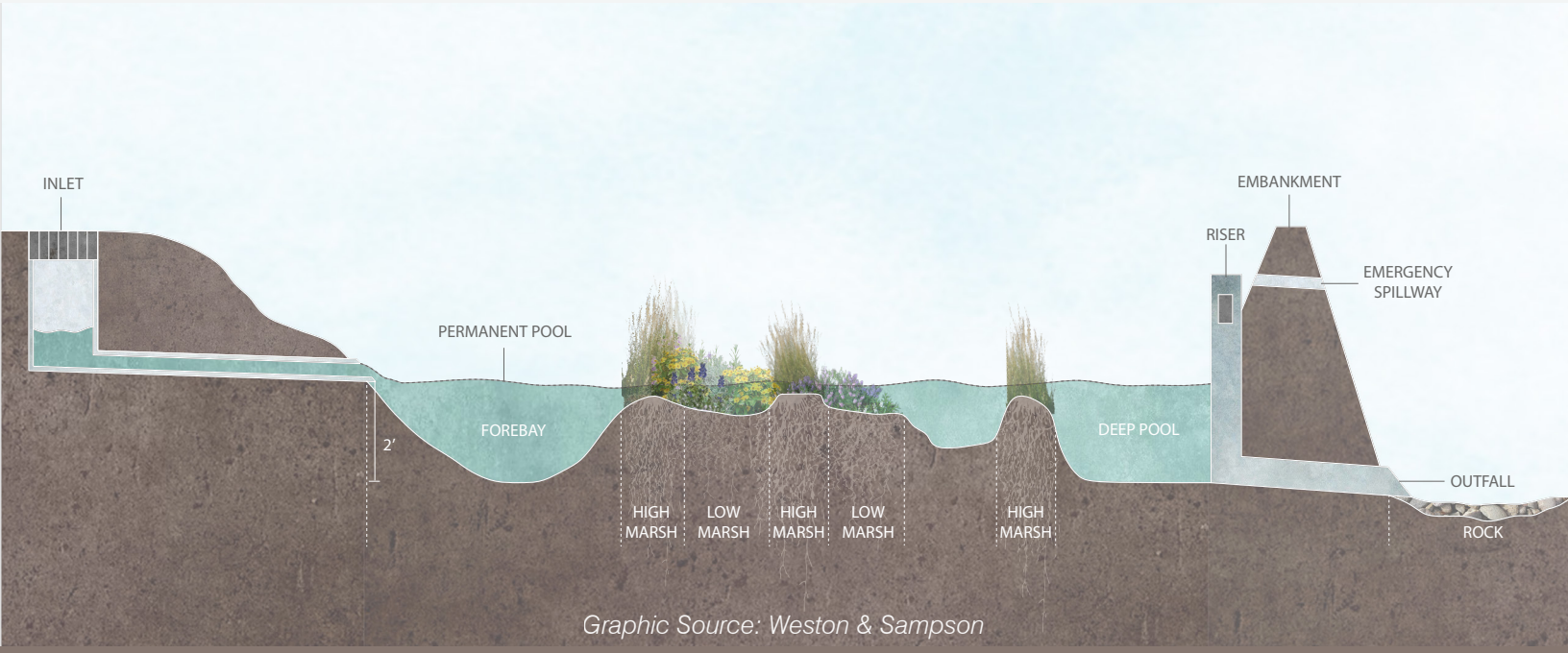
Constructed Wetland

Constructed wetlands are an effective practice for areas with a high-water table and poorly draining soils. Constructed wetlands provide water quality benefits. Compared to bioretention, stormwater runoff stays longer in constructed wetlands, this added time allows for pollutant removal benefits through settling, plant uptake, and microbial activity.

Constructed wetlands are highly site specific and are therefore variable in nature. Constructed wetlands will often include a forebay where water enters the wetland; the forebay provides a space for sediment to settle out and the maintenance of sediment removal is concentrated to this pace. High marsh and low marsh areas incorporate appropriate aquatic plant species that may include native perennials, grasses, and small trees. The high marsh zone will cover approximately 70% of the wetland surface and have a water depth of approximately 6 inches when the wetland is at permanent pool elevation. Deep pools are areas where water is ever present and provide habitat for fish and other aquatic life that will control mosquito larvae.

The contributing drainage area for constructed wetlands can range to upwards of 35 acres. The shape of the constructed wetland and incorporated features such as a riser, provide additional storage space above the permanent pool. During highwater events, a riser, emergency spillway, or other design features will allow water to exit the wetland.

Figure 43: Constructed Wetland



Graphic Source: Weston & Sampson

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 44 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).

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 4.

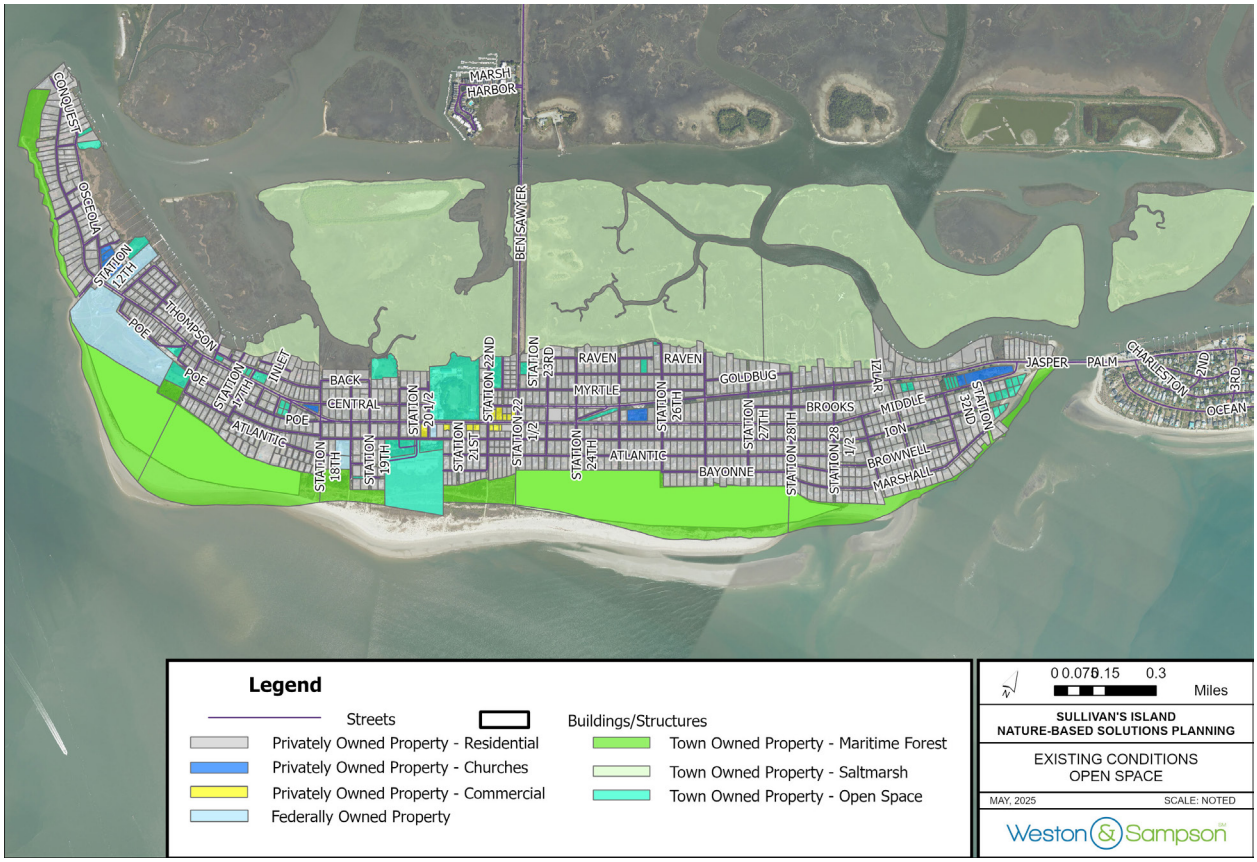


Figure 44: Open Space on Sullivan's Island Labeled by Owner and Land Use Type

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 D as well as the scoring for the practices.

The abundant open space on Sullivan's Island provides an opportunity for ecological conservation and the incorporation of nature-based solutions to assist with water management. A screening tool was developed using a GIS based-approach to site NBS specific to open space opportunities and existing conditions. When identifying potential NBS projects for open space areas, several data layers, including surface flow paths on a 1-acre and 0.5-acre scale, elevation (DEM), soils (hydrologic soil group), and land ownership (parcel data) were considered. A prioritization matrix was developed to prioritize the NBS opportunities using criteria which included flood reduction, feasibility, and other co-benefits as shown in Table 4.

Table 4: 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
	Priority Populations Benefitted (Environmental Justice)	Entire Study Area Priority Population	Part of Study Area Contains Priority Population	No Priority Populations Present	Low to Moderate Income Population by Tract / HUD Open Data Site
	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

**Note: Not measured on a scale of 1 to 3, see appendix for details*

The GIS screening analysis combined with the prioritization analysis resulted in a ranking of **33 proposed NBS projects** as depicted in Figure 45 and listed in Table 5. The result of this analysis are potential projects for future consideration; each of which ranked high for feasibility and in the maximum benefits to the community.

Table 5: 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

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

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

Figure 45: Potential NBS Locations

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

- **The identified projects are not meant to be an exhaustive list;** additional opportunities 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, sited along public properties; however, a larger living shoreline spanning private properties could be undertaken as a more comprehensive project.
- **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.

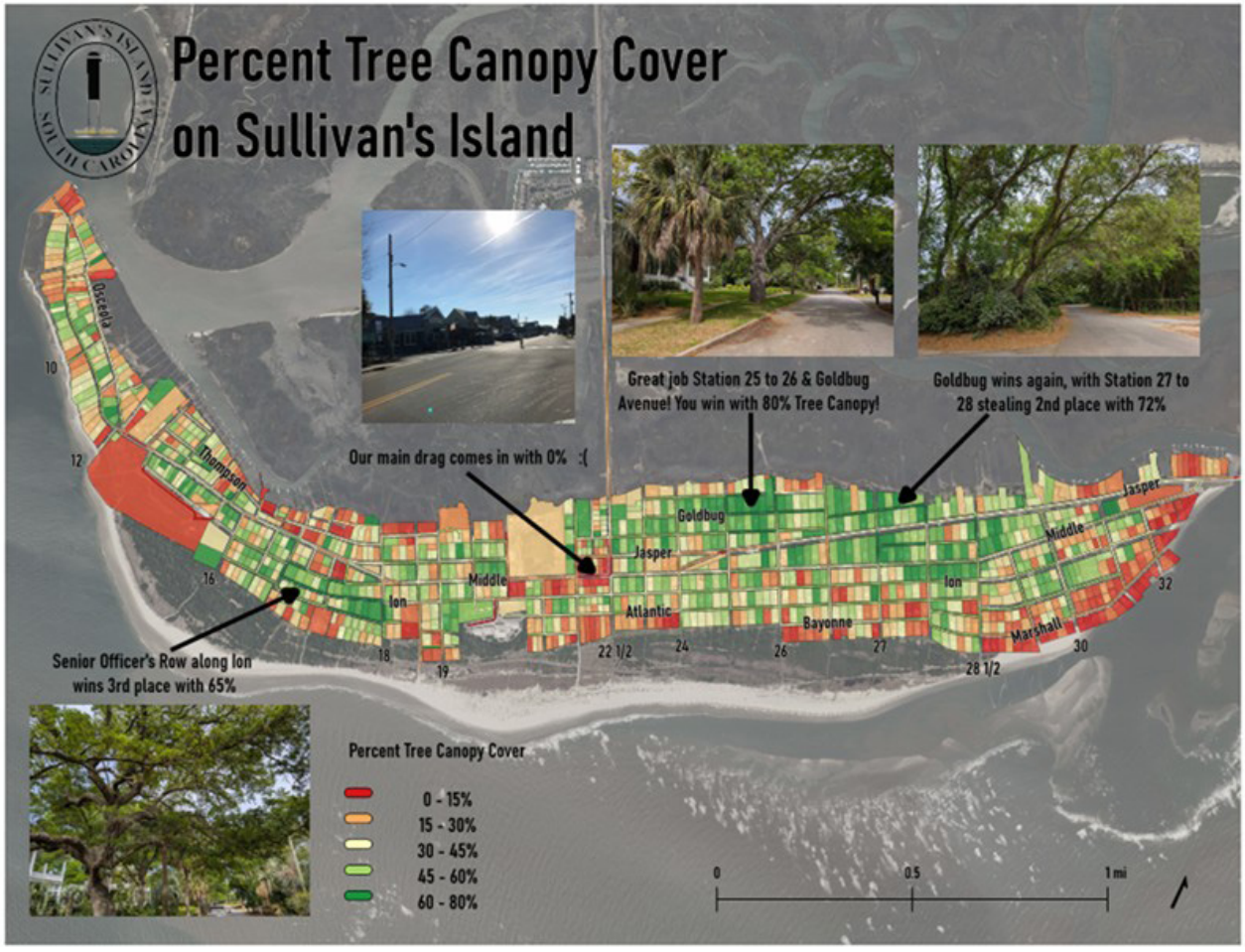


Figure 46: Sullivan's Island Percent Tree Canopy Cover

Figure 47: Sullivan's Island Dune System. Image Source: Town of Sullivan's Island.

- **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 46 depicts areas of the Island in need of increased tree canopy cover.

Residential-scale Nature-based Solutions

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 the conserve, protect, and adapt zones can be seen in Figure 48. 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 in stormwater runoff.

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 Recreation and Conservation (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.

Figure 48: Residential Zones for NBS Implementation

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; C/D soils 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 the Protect Zone may also consider home elevation or structural retrofits which serve as barriers to saltwater intrusion. Modifications to existing buildings can help to mitigate flood impacts and reduce damage to structures and personal belongings. Modifications include small-scale adjustments to existing spaces, such as installing a sump pump in a garage that regularly floods, to larger scale transformations, such as elevating a home on extended foundation or piles. The most appropriate option will depend on the vulnerability of a home and past flooding events experienced at the property.

Dry floodproofing involves modifying a space to keep water out of the building to minimize impacts during a flood event. Flood barriers are a common type of dry floodproofing and include sandbags, bladder dams, flood panels, and other specialized site-specific systems. These materials can be used to create a continuous barrier to keep water out of vulnerable areas of the home such as a crawlspace or garage.

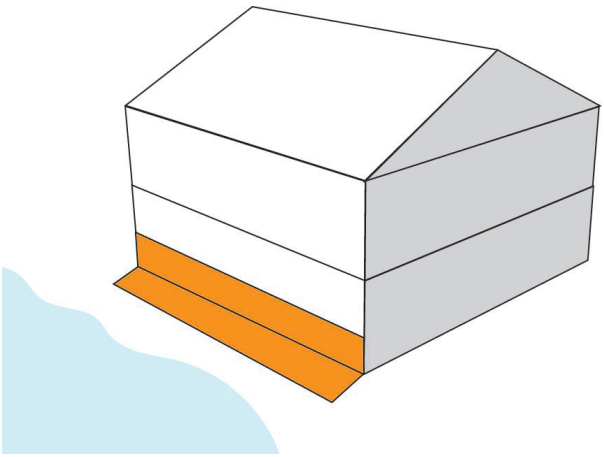


Figure 49: Dry floodproofing

Home elevation is the process of lifting a home and placing it on a new, elevated foundation. Home elevation may be an option for older homes on the Island that were built before BFE (base flood elevation) requirements. Interested property owners should check with the Town of Sullivan's Island to better understand the process and requirements for home elevation projects.

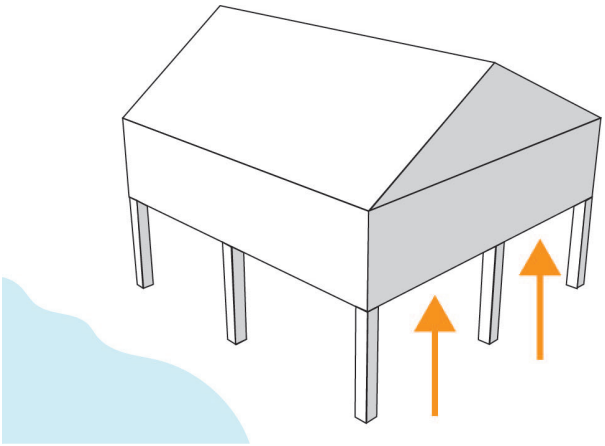


Figure 50: Home elevation

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.

Table 6 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.

Figure 51: Station 16 Beach. Image Source: Town of Sullivan's Island.

Table 6: 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	✿	✿	✿

Considerations by Practice 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.

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 of the impervious area 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.

Business District Complete Street Adaptation

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 52.**

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

Figure 52: Middle Street Nature Based Solutions Opportunities

Figure 53: Standing water on Middle Street hours after a rain event.

Figure 54: Existing permeable parking at Obstinate Daughter

as bioretention, permeable pavers, and porous concrete can help to manage water close to the source and reduce community flooding.

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. Traditional asphalt 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 Beach's Center Street, similar to Middle Street, is SCDOT-owned. In the case of the Center Street retrofits, SCDOT did not have issue with permeable pavers and rain gardens being incorporated, but SCDOT 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-of-way.

Some of the areas identified in Figure 52 for permeable pavement are located on private business property. In this case, the Town will need to work with property

Figure 55: Concrete ribbon separates a permeable parking area from travel lanes, Mount Pleasant, SC.

Figure 56: Interlocking permeable paver system that does not require aggregate between pavers, James Island, SC.

Figure 57: Stormcrete, a pre-cast pervious concrete system, is placed along road gutters in New York City, NY.

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 along Middle Street. 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 this beach community, a high volume of sandy sediment is expected as is the need for street sweeping which may dislodge permeable pavement aggregate over time.

A concrete ribbon separates the asphalt from the permeable paver system as seen in Figure 55. Although a concrete ribbon may not be necessary, one should be considered as it 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 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

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.

Figure 58: Bioswale installation using a product called "Bold & Gold" filtration media to assist with pollutant removal, Mount Pleasant, SC.

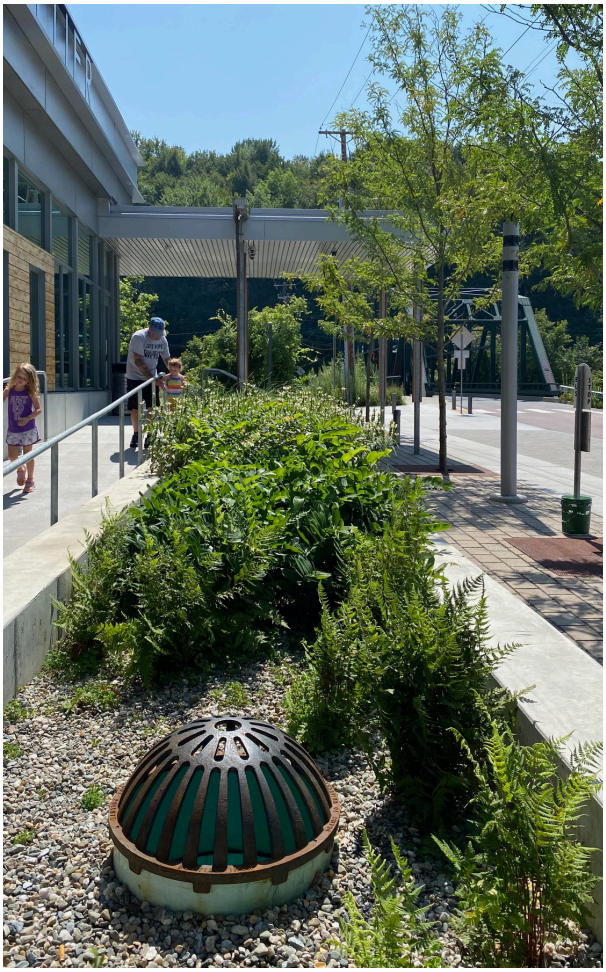


Figure 59: Example of a "Rain Garden in a Box," Burlington, VT

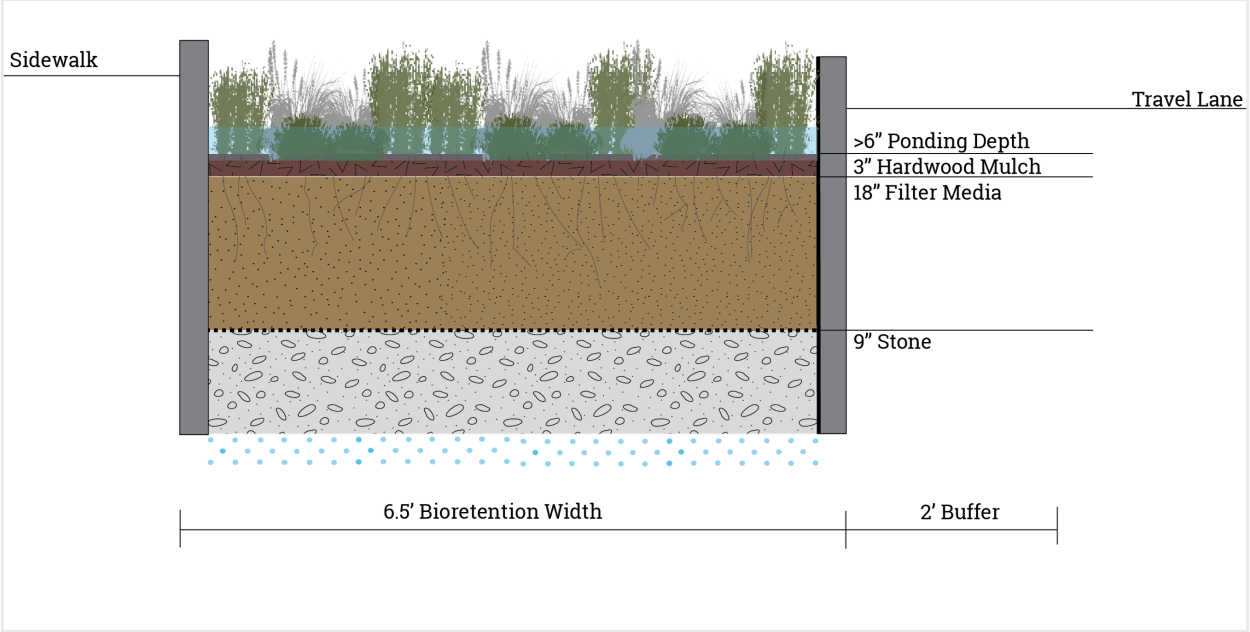


Figure 60: Bioretention depths

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. In the case of Sullivan's Island, native vegetation with deep roots 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. 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 Middle Street 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.

Green Roof

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 such as Middle Street surrounded by pavement and concrete, green roofs offer an opportunity to soften the space with vegetation that

Figure 61: Green roof located at the Clemson University Zucker Family Graduate Education Center, North Charleston SC.

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).

Tree and Native Species 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 Cabbage 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 capabilities. 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 this highly popular business district.

Figure 62: Native plants and tree planting along Middle Street adds beauty, water absorption, and cooling benefits.

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*) and black needlerush (*Juncus roemerianus*) are among the few plants that can thrive in these conditions.

Figure 63: Short-form Smooth Cordgrass with an enigmatic marker in the saltmarsh at Star of the West. Images Source: Elko Coastal Consulting and Town of Sullivan's Island.

Figure 64: The saltmarsh at low tide. Smooth Cordgrass in coastal SC. Images Source: Town of Sullivan's Island.

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 State 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 impacts from impervious surfaces associated with 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."*

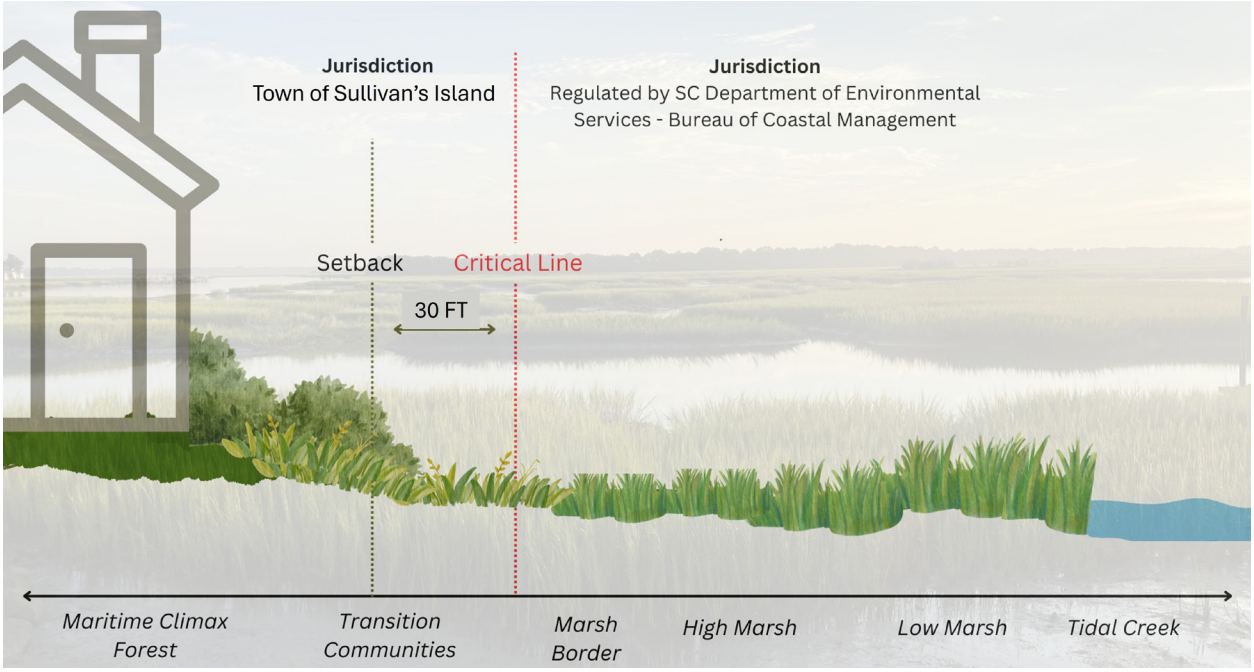


Figure 65: The critical line is a biophysical jurisdictional feature that will shift with the edge of the marsh as it migrates. Graphic Source: Elko Coastal Consulting, Inc.

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.

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 may drown if they are 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 the amount of impervious surfaces which in turn increases the amount of stormwater runoff that is entering the salt marsh; often this runoff carries pollution which has detrimental impacts to marsh health.
- **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.

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.

Figure 66: SC DNR Oyster Recycling and Enhancement Program (SCORE) marsh restoration with volunteers at Mingo Point, Kiawah Island.

Engage and Involve

As a component of the Engage & Involve overarching strategy, the following are opportunities and resources to support community outreach activities and raise awareness specific to the salt marsh understanding and stewardship.

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 66)
    - **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.

Monitor

Develop a companion marsh monitoring plan. Data and maps will inform future marshfront regulations for fill, berms, and siting 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 every five years 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). The critical line is often highly dynamic. SC-DES Bureau of Coastal Management officially designates the critical line, valid for five years or less if a major storm event occurs.
    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/impervious 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. **Coordinate activities with the Sullivan's Island Stormwater Master 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. Encourage site-level infiltration based practices on residential properties (see Residential-Scale NBS Strategy)

   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. Allow eco-friendly erosion control measures for nature-based stabilization.

   b. Allow solid 18" landscaping walls within 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.

3. **Refine property fill and new earthen berm allowances** based on data from the Stormwater Master Plan and the recommended marsh monitoring plan.

   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. Create conditions that would allow earthen berms within the 30-ft setback, in excess of 1 foot of fill, for lots with existing, low-lying building 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.

Figure 67: Envirolok on Sullivan's Island. Source: Elko Coastal Consulting.

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 limiting or excluding grass lawns which require regular maintenance such as herbicides, pesticides, fertilizers, and frequent mowing.
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. **Initiate a process for permitting the dredging of Cove Creek** to enhance access and foster appreciation of the salt marsh ecosystem.
2. **Collaborate with** the US Army Corps of Engineers and the SCDES Burea of Coastal Management Critical Area Program 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.
3. **Assess the feasibility** of pilot projects on public lands to provide hands-on demonstrations of best marshfront management practices (e.g., Figure 68).
4. **Formulate a long-term funding strategy** for future acquisition of distressed, undevelopable, and vulnerable marshfront property to protect for conservation and water absorption.
5. **Explore creative funding opportunities:**
    a. Offer mini grants to marshfront property owners to support the installation of nature-based solutions and living shorelines.
    b. Incentivize private restoration efforts amongst adjacent marshfront property owners (e.g., rain barrel giveaways).
    c. Track federal grant opportunities such as NOAA's National Coastal Resilience Fund and FEMA's pre-hazard mitigation grants.

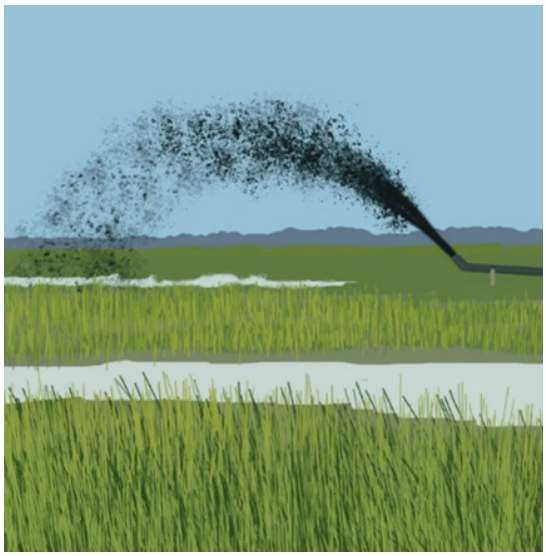


Figure 68: Conceptual sketch of thin layer placement to rebuild marsh elevation. Graphic Source: SC SeaGrant Consortium.

Maritime Forest

Description

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 69 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 upland homes and infrastructure. 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 stormwater before it enters the ocean and adjacent communities by trapping pollutants and sediments. The forest also provides 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 69: Maritime forest vegetation, Sullivan's Island, SC. Image Source: Town of Sullivan's Island.

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 7: 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

Monitor

Monitoring a maritime forest with trimming involves combining ecological assessment with careful vegetation management. 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 Sec. 21-71 ordinance are as follows:

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.

1. **Propose update to C. (2) to include the allowance for removal of invasive vegetation outside of the November 1st to February 28th specified seasonal window.**
2. **Adding 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 seedlings should be removed by mechanical means, including hand pulling.

   a. To further modify the language in the C. (3) ordinance, propose updating language associated with the trimming of the Southern Waxmyrtle and Eastern Baccharis.

   b. Consider limiting trimming to every other season.

3. **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.**
4. **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.**
5. **Species-specific disposal protocols should be established when removing invasive species to ensure that seeds and roots left behind do not proliferate.**

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.

Restore

Maritime forest restoration involves removing invasive species, replanting or encouraging native trees and understory plants, and protecting the habitat from erosion and disturbance. The goal is to restore the natural structure and biodiversity of these coastal forests, which provide critical wildlife habitat, storm protection, and water quality benefits. Restoration often includes community partnerships and volunteer planting efforts.

1. **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.**

    a. 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.

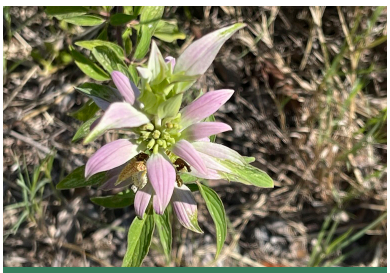
    b. Upon successful completion of the course, the individual would be provided with an invasive species removal license which could allow them to remove invasive species year-round. To further ensure the safe removal of invasive species, a maximum stem diameter can be specified.

NATIVE 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*)

2. **In some cases, removal of invasive species may necessitate restoration activities such as plantings or seed gathering.**

    a. Native species that can be used for restoration include Carolina Willow (*Salix caroliniana*), Yaupon Holly (*Ilex vomitoria*), Southern waxmyrtle (*Myrica cerifera*), Spotted Horse Mint (*Monarda punctata*), and American beautyberry (*Callicarpa americana*).

    b. 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.

Protect

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. The Nature Trail utilizes the existing dune ridges within the maritime forest as the pathway, see Figure 70. The dune ridges are naturally

Figure 70: Nature Trail at Station 16. Image Source: Town of Sullivan's Island.

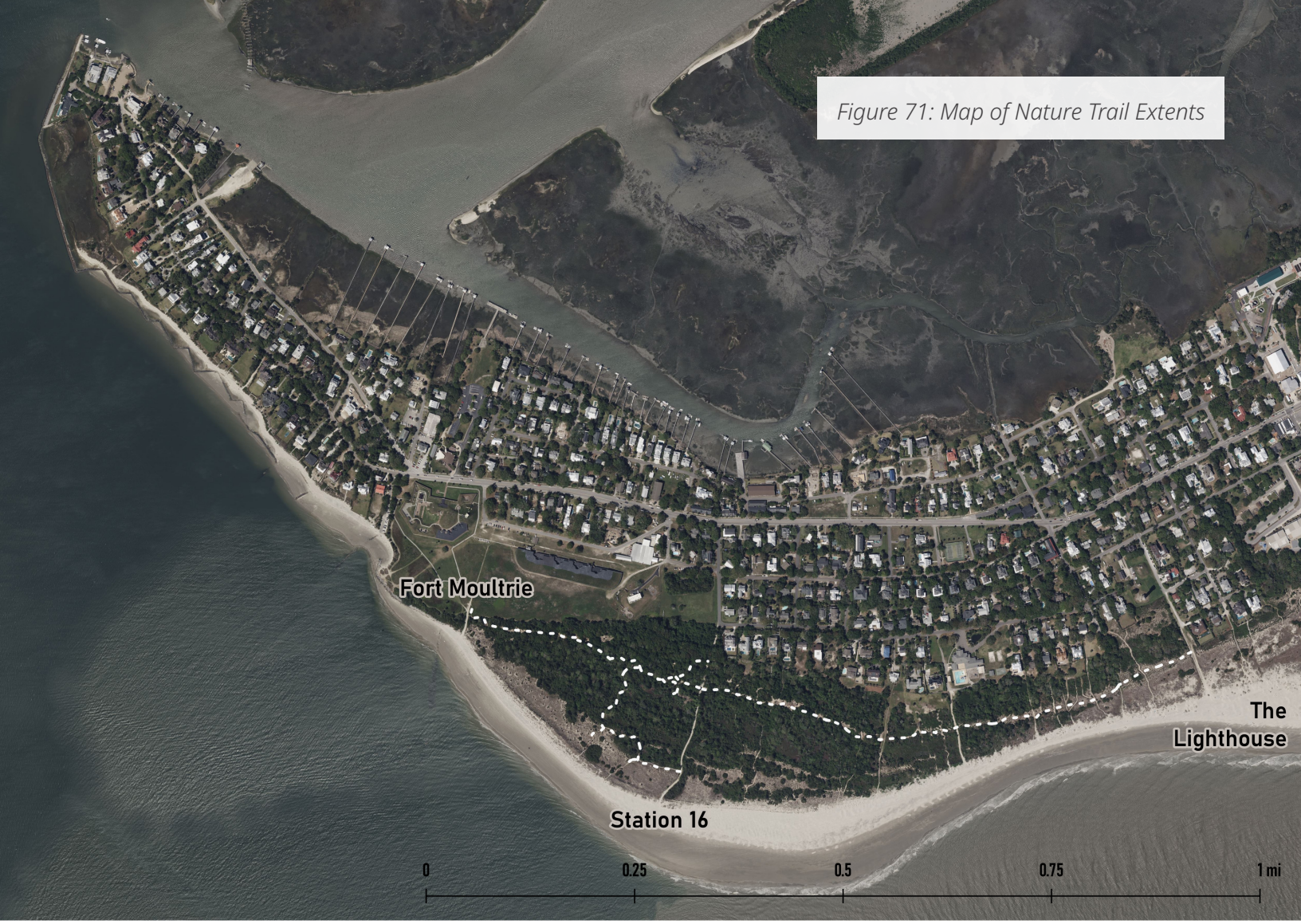


Figure 71: Map of Nature Trail Extents

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.

1. **As time and funding become available the Town may seek to expand the extents of the Nature Trail, the current extents of the trail are shown in the dotted white line on Figure 71.**

   The nature trail currently extends from Fort Moultrie, with access at Station 16, to the lighthouse past Station 18.

2. **Interpretive signage can be added to educate visitors and highlight native species and ecosystem processes.**

3. **Birdwatching and wildlife observation locations can be strategically located.**

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. Drumstick barrier islands like Sullivan's Island, Bull's Island, and Isle of Palms (Figure 72) 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. Due to the combination of this system of prograding ridges and the Island's location on the updrift side of the Charleston Harbor jetties, the beach and dunes on Sullivan's Island have generally been accretional. Dune management strategies recommended in this Strategy 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."*

Figure 72: Drumstick barrier islands on the South Carolina coast, Isle of Palms (Graphic Source Coastal Science & Engineering).

Annual monitoring of dune conditions is essential for understanding the evolving 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.

Over the last decade, the central beach has shown stability to accretion, with some erosion at the northeast and southwest ends of the Island. 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 73). 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 73: Town contractor moving sand from USACE Beneficial Use of Dredged Material (BUDM) project along the Sullivan's Island Breach Inlet shoreline in late 2024. (Image Source Coastal Science & Engineering).

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. 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. 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.

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.

Figure 74: Sand dunes overtaking wooden structures.

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 (Figure 74). Additionally, pieces of the structure destroyed during a storm can become projectiles, causing further damage and increasing cleanup efforts (Figure 75). 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 76).

Figure 75: 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 76: An example of an effective access path through dunes where no dune walkover is needed. Images Source: Elko Coastal Consulting.

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

As a component of the Engage & Involve overarching strategy, the following are opportunities and resources to support community outreach activities and raise awareness specific to dune preservation.

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.
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.

Figure 77: 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.). Image Source: Elko Coastal Consulting.

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 address 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. 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.

Figure 78: Concept to reduce individual, private access paths and funnel pedestrian traffic to public access (Example between Stations 23 and 26, aerial imagery date: March 2025).

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.** Where appropriate, 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, encourage use of public access paths.
  - **i.** Identify volunteer property owners willing to pilot a new access plan behind the secondary dune ridge (Figure 78). Work with property owners to install sand fencing to direct pedestrian access toward public paths at Station access points, encouraging beachgoers to stay off the primary dune.
  - **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 77 and Figure 78). In the interim, encourage the informal use of Nature Trail's proposed pathway.

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 79 and Figure 81).
    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.
4. **Formulate a long-term funding strategy for future acquisition** of 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 80) that leverages drainage relief for native vegetation irrigation at public accesses.

Figure 79: Example of sand fencing and vegetation to restore dune system on Folly Beach. Image Source: Elko Coastal Consulting.

Figure 80: Installation of the innovative Dune Infiltration System on Folly Beach, June 2025. Image Source: Elko Coastal Consulting.

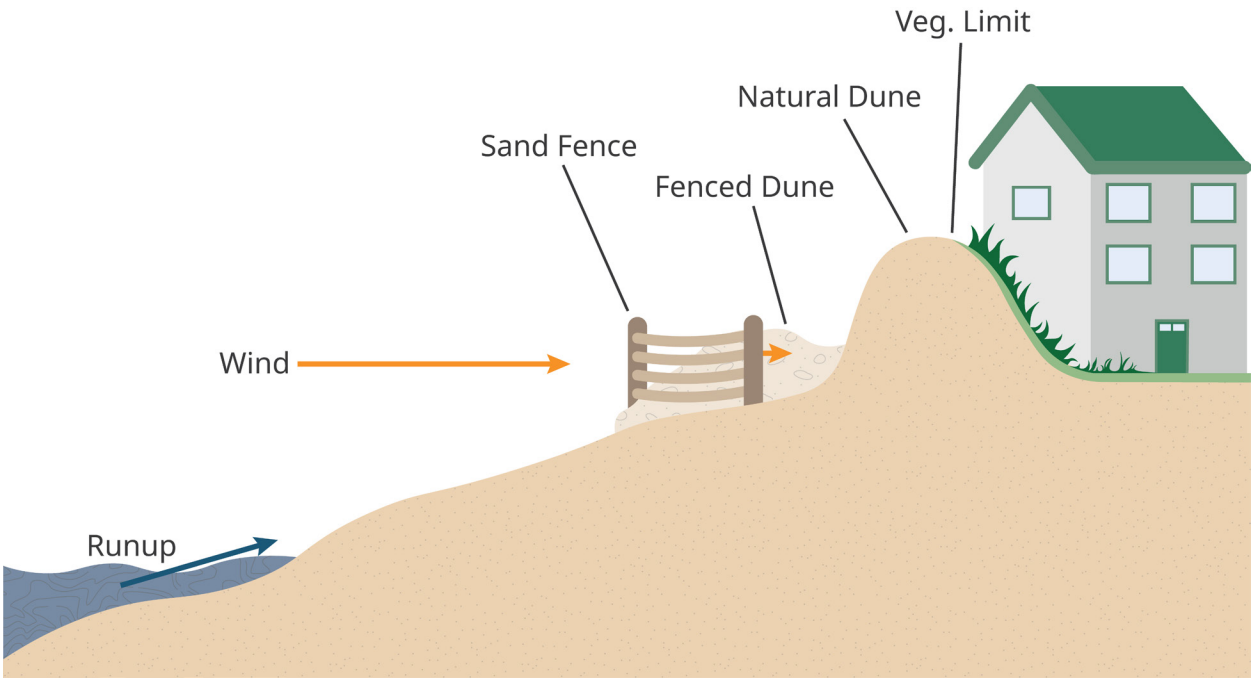


Figure 81: Schematic of dune restoration with sand fencing in Bogue Banks, NC

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 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 practices, 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 as part of a rain garden design. 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 and strain on the centralized drainage system, and filtering the water, thus decreasing pollutants.

With most underground storage designs, flood control infrastructure is underground and out of sight. The design pictured in Figure 83 uses a rain chain to funnel water into a pipe hidden by a decorative vase, as well as pervious pavers 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.

Underground storage is designed to replicate the site hydrology before the lot was developed, with most of the water going back into the ground instead of into a pipe that discharges downstream.

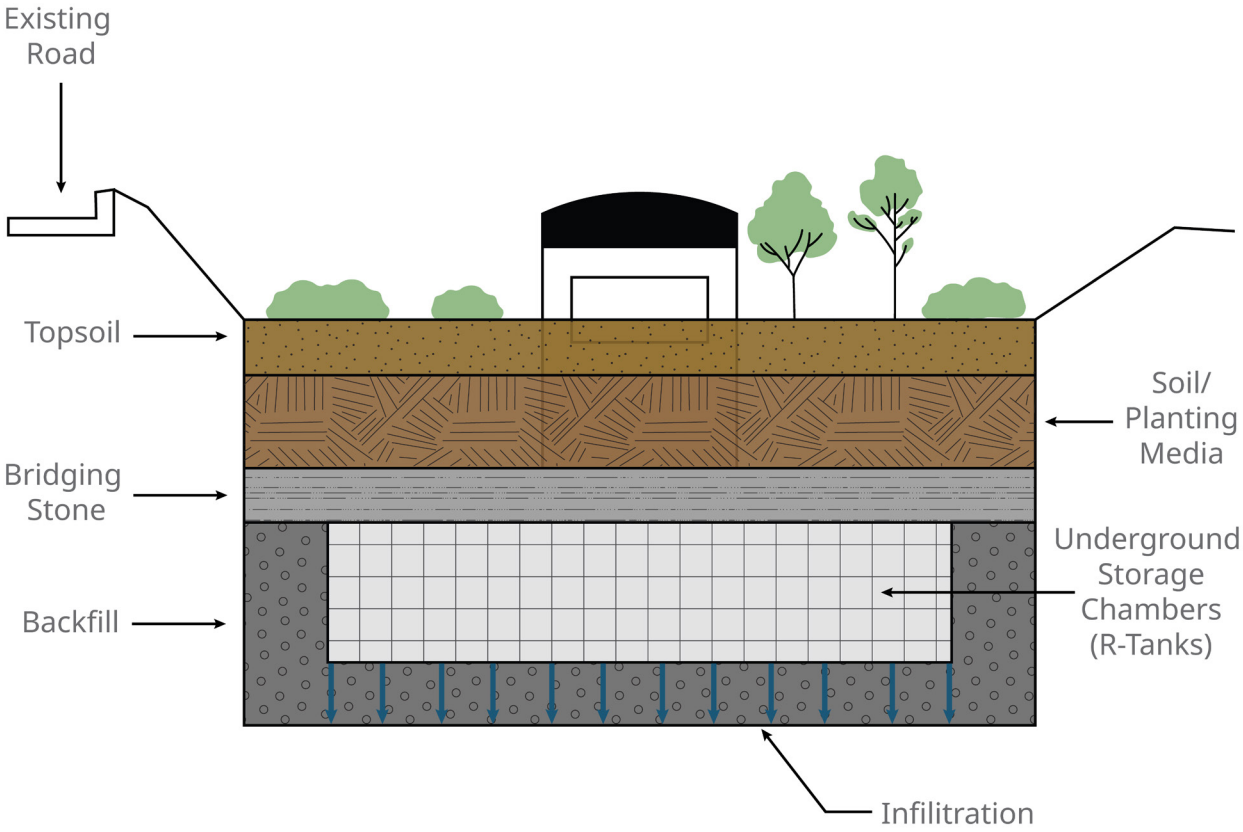


Figure 82: Profile of R-Tank Rain Garden Infiltration System (Graphic Source: McCormick Taylor)

Figure 83: Example of an underground detention treatment train. Image Source: Town of Sullivan's Island.

As water is allowed to infiltrate gradually by underground detention practices, potentially taken up by plants or trees or filtered through sand, water quality benefits are a bonus of this stormwater best management practice.

Benefits

Underground detention may be well suited for Sullivan's Island, where space is limited 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 some 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 landscaping, 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 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.

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. With proper design, the system will incorporate manholes to allow for easy cleanouts, inspection, and debris removal.

Considerations

Underground detention in coastal communities like Sullivans Island may have limitations in where they can be placed due to the high-water table and low ground elevation, therefore care should be taken when siting underground detention units. Underground storage tanks should be located 3 to 4 feet below the ground and be able to drain into a receiving drainage system or outfall. Under roadway storage is another option but may not be suitable for the Sullivan's 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 and brings the added benefit of relieving the public stormwater conveyance system as well as assisting with on-site water management. 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, applications to smaller sites distributed throughout the Island can provide a cumulative impact. For example, underlaying new driveways or garden paths with a gravel-packed storage layer can provide flood storage at the local scale.

As with any infrastructure, short- and long-term maintenance of underground detention should be considered. Maintenance plans should include provisions on clearing inlets as well as removing accumulated sediment and debris from the storage unit cells. Forebays, stilling basins and screens should be used to limit the maintenance burden.

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 Sullivan's Island with well-draining soils.

Modular underground storage systems, such as the R-tanks, 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. 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. If located within the SCDOT rights-of-way, 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 84). This space was identified in the Town's Island Wide Stormwater Master Plan and Infrastructure Improvement Strategy. Figure 85 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 84: Potential location for a rain garden with an underground detention system. (Source: McCormick Taylor).

Figure 85: 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 86). The existing roadway is comprised of a drawbridge over the Intercoastal Waterway (ICW) with leveed roadways across the marshlands on either side.

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 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.

Figure 86: Ben Sawyer Blvd Bridge over Intracoastal Waterway

Figure 87: 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.

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 and increased sea levels. This will help to 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 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, leading to accelerated accretion of adjacent marsh systems. With rising sea level, this accelerated siltation provides a tremendous benefit to marshfront properties, increasing the resilience of 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 run along the causeway can also be raised, which would result in less likelihood of damage during storm or flooding events impacting the causeway.

Figure 88: Location of Proposed Project Area

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.

When evaluating options for raising this crucial causeway, there are two alternatives that could be taken. These include raising the causeway end embankments using fill or removing the existing embankments and raising the causeway on piers. Figure 89 illustrates the two alternatives. The raised embankment alternative would result in a similar design as the existing causeway. Adjustments would be needed at the approach roadways including placing fill in the wetlands to accommodate the wider, higher bridge. Raising the embankments would offer new opportunities to implement nature-based practices such as incorporating bioswales to intercept and treat runoff (Figure 89). The

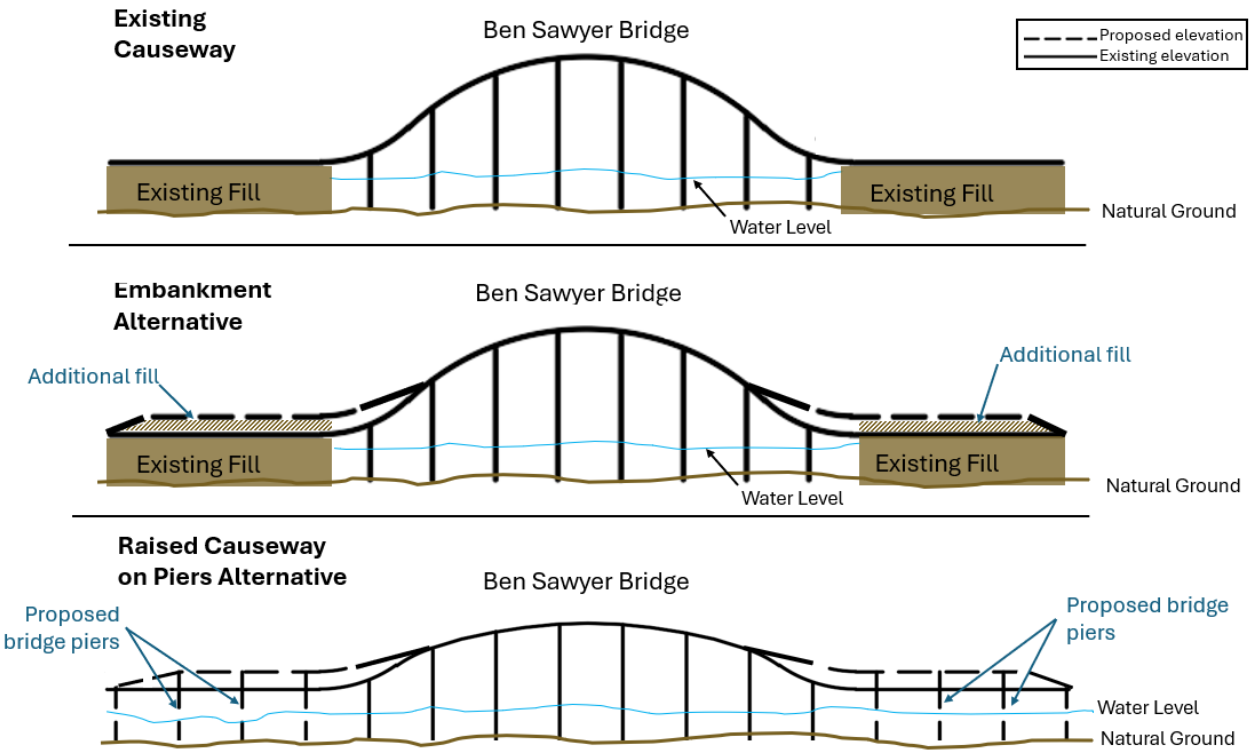


Figure 89: Sketch of adaptation measure approaches. Graphic Source: McCormick Taylor.

second alternative, raising the causeway on piers, would avoid the need to place fill material in sensitive areas, and would reclaim previously-filled marsh. However, this alternative would require careful planning to tie the longer causeway to the roadways on the Island.

The addition of a bioswale along the causeway in Alternative one presents an excellent opportunity to capture the tire particles, which are a microplastic of concern that have been documented locally in abundance by The Citadel and other research efforts. Runoff from roadways where small oil leaks occur from cars is especially well adapted to remediation through plants, as most hydrocarbons can 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 these pollutants out of the salt marsh where they are consumed by oysters, shrimp, and other forms of aquatic life that are then consumed by humans. Elevation of Ben Sawyer Boulevard would ensure accessibility to the Island while also offering additional environmental benefits to the surrounding salt marsh. The berm that was created to build the causeway would be removed and a traditional bridge would replace it.

The second alternative involves building an entirely new road at a higher elevation that acts as a fixed-span bridge along most of the existing causeway (Figure 90). This involves removing the existing embankment fill, resulting in increased tidal flow between the two sides of the saltmarsh allowing safer passage of marine life. However, it could potentially

Figure 90: Example of median bioswale. Image Source: McCormick Taylor.

cause a massive release of sediment from the northeastern side of the causeway, leading to erosion of the saltmarsh. The severity of these environmental impacts may make this option infeasible to implement.

Considerations

Tidal flow is restricted by the existing causeway, which causes sediment to settle out of the water column. Based on historic imagery and personal accounts, areas that were once open water have converted to salt marsh as sediment has accreted, and the marsh platform has elevated. **Marshes help with flood protection, water quality, and prevent erosion along shorelines.** By extending the bridge and opening more tidal flow to the marsh along the northern side of Sulivan's Island, sedimentation might be reduced which could lead to the conversion of open water in areas that are currently salt marsh.

Both approaches to raise the causeway would result in a need to widen the roadway footprint, thus impacts to the current marshlands are likely. Adding a fixed bridge on piers and removing the current embankment would result in flow altering sedimentation patterns and potentially resulting in the conversion of portions of salt marsh to open water. As sea levels are expected to continue to rise, sedimentation along salt marshes provides benefits for the long-term success of a salt marsh system through the natural build-up of marsh sediments and vegetation. By removing the causeway, sedimentation is reduced which ultimately could have adverse impacts in the face of rising sea levels.

However, by removing the embankment, tidal flow is improved and a more natural hydrologic character provides benefits for aquatic species. Removing the causeway fill also could benefit portions of the salt marsh that currently get covered in wrack that is trapped along the causeway during peak tides. **This is a complex system and additional research and planning is needed to determine potential impacts and benefits.**

Another consideration with either alternative is where the raised causeway would connect to existing roads on the island. The existing causeway is approximately elevated to 9 feet, and road elevations on the island are at an approximate elevation of 8 feet. The causeway slopes down onto the island by one foot to connect to the existing approach roadway. To avoid unsafe, steep-slope approaches, raising the causeway would require longer transitions from the causeway elevation to the Island elevation, which would connect to the island's roads farther seaward than the existing causeway. This could pose hurdles in terms of access and property rights as well as traffic patterns.

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 high-level 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 8: Strategy Development Cost Analysis

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

Business District Complete Street			
Item	**Unit Cost**	**Unit**	**Description**
Extensive Green Roof	$40.00	SF	Variable cost based on size, slope, complexity of the roof. Intensive Green Roofs are up to $200 to $400 a square foot
Urban Rain Garden	$15,000.00	EA	Includes URG T-walls, rain guardian fortress (pretreatment), beehive overflow, bold and gold media. Does not include stone, riprap, liner, mulch, and plants. A linear, stone, and riprap may be needed.
PowerBlock Permeable Pavers	$44.00	SF	Includes fabric, delivery, pallet fees. Does not include installation.
	$155.00	SF	Includes material, gravel subbase, excavation, and installation
Stormcrete	$35.00	SF	Includes panels, placement of panels, stone cost, and placement. Does not include installation and stone.
	$145.00	SF	Includes material, gravel subbase, excavation, and installation
Bioretention Cells	$35.00	SF	Includes potential need for control structures, curbing, storm drains and underdrains, extensive plantings

Business District Complete Street			
Item	**Unit Cost**	**Unit**	**Description**
Tree Plantings	$600.00	EA	7 ft tall tree on average, variable based on tree species.
Palmetto Tree Plantings	$850.00	EA	14 ft tall tree includes installation and tree staking, does not include delivery.
Bioswale	$60.00	LF	For bioswales 9-16' wide, per Terrascope.
Causeway			
Item	**Unit Cost**	**Unit**	**Description**
Bridge Replacement	$55,000,000.00	EA	Cost of replacing US 21 bridge in Beaufort County (2021).
Bioswale	$60.00	LF	For bioswales 9-16' wide, per Terrascope.
Dunes Adaptation			
Item	**Unit Cost**	**Unit**	**Description**
Educational Signage	$2,500.00	EA	Includes material and installation
Dune Walkover	$15,000 - $75,000	EA	Highly variable, and dependant on ADA compatability requirements and ramping
Sand Fencing	$25.00	LF	From Delaware DNREC, includes materials and construction.
Beach Nourishment	$15.00	CY	Price comes from 2024 Folly Beach, cost includes all steps of beach nourishment.

Engage and Involve			
Item	**Unit Cost**	**Unit**	**Description**
Program Branding (Marketing)	$7,500 - $25,000		Highly variable based on the level of content desired.
Guidebook Development	$12,000.00	1	Variable cost is based on a mid level guidebook specific to Sullivan's Island.
Maritime Forest			
Item	**Unit Cost**	**Unit**	**Description**
Invasive Plant Management	$1,100.00	Acre	Highly dependant on type of invasive and density. Price reflects primarly hand work and limits use of chemicals and machinery
Marsh Adaptive Management			
Item	**Unit Cost**	**Unit**	**Description**
Living Shoreline	$20,000.00	100 LF	Includes materials and installation, does not include designed drawings and permitting.
Envirolok	$60.00	SF	Area in SF refers to the proposed sloped surface area of the installation.
Open Space NBS			
Item	**Unit Cost**	**Unit**	**Description**
Bioretention Cells	$35.00	SF	Assumes no need for additional control structures.

Open Space NBS			
Item	**Unit Cost**	**Unit**	**Description**
Rain Garden	$15,000.00	EA	Includes URG T-walls, rain guardian fortress (pretreatment), beehive overflow, bold and gold media. Does not include stone, riprap, liner, mulch, and plants. A linear, stone, and riprap may be needed.
Extensive Green Roof	$40.00	SF	Variable cost based on size, slope, complexity of the roof. Intensive Green Roofs are up to $200 to $400 a square foot
Bioswale	$60.00	LF	For bioswales 9-16' wide, per Terrascope.
Living Shoreline	$20,000.00	100 LF	Includes materials and installation, does not include designed drawings and permitting.
Tree Plantings	$600.00	EA	7 ft tall tree on average, variable based on tree species.
PowerBlock Permeable Pavers	$44.00	SF	Includes fabric, delivers, pallet fees. Does not include installation.
	$155.00	SF	Includes material, gravel subbase, excavation, and installation
Stormcrete	$35.00	SF	Includes panels, placement of panels, stone cost, and placement. Does not include installation and stone.

Ordinance and Policy Review			
Item	**Unit Cost**	**Unit**	**Description**
Consulting	$210.00	HR	

Residential NBS			
Item	**Unit Cost**	**Unit**	**Description**
Tree Plantings	$150.00	EA	
Bioretention Cells	$5.00	SF	Assumes no need for additional control structures.
Bioswale	$60.00	LF	For bioswales 9-16' wide, per Terrascope.
Bog Gardens	$50.00	SF	
Rainwater Harvesting System	$2,500.00	EA	Heavily depedent on size, use, etc.
Green Roof	$25.00	SF	Variable cost based on size, slope, complexity of the roof.
Living Shoreline	$20,000.00	100 LF	Includes materials and installation, does not include designed drawings and permitting.
Vegetative Buffer Planting	$22,000.00	Acre	Highly variable if seed is utilized over plants, plants provide higher success rate, price quoted here reflects plants
PowerBlock Permeable Pavers	$44.00	SF	Includes fabric, delivers, pallet fees. Does not include installation.

Residential NBS			
Item	**Unit Cost**	**Unit**	**Description**
Stormcrete	$35.00	SF	Includes panels, placement of panels, stone cost, and placement. Does not include installation and stone.
	$145.00	SF	Includes material, gravel subbase, excavation, and installation

Underground Detention			
Item	**Unit Cost**	**Unit**	**Description**
R-Tank Underground Stormwater Storage	$17.00	CF	Includes installation and materials
ADS StormTech Chambers	$25.00	CF	Includes installation and materials

V. Conclusion

Sullivan's Island stands at a pivotal moment in its history - a community defined by breathtaking natural landscapes and abundant coastal heritage, yet facing unprecedented challenges from climate change and rising sea levels.

With visionary leadership and a commitment to safeguarding both its environment and way of life, the Town has embraced a proactive approach to resilience. This Sea Level Adaptation & Resilience Plan is not merely a response to threats; it is a bold blueprint for action, designed to ensure that Sullivan's Island continues to thrive for generations to come. By integrating science, community engagement, and innovative strategies, the Island sets a new standard for coastal resilience—demonstrating that with foresight and determination, even the most vulnerable communities can secure a vibrant, sustainable future.

The "do nothing" approach is not a viable option for Sullivan's Island. If no action is taken, including none of the stormwater infrastructure improvements outlined in the Island's Stormwater Master Plan, and none of the adaptive strategies and nature-based

Figure 91: Island Conditions in the Future 100-year Design Storm Event if No Action is Taken

solutions (NBS) proposed in this Plan, the impacts from flooding in 2050 during a 100-year design storm (10+ inches of rain in 24 hours) will be felt Island-wide. A rendering of these conditions is provided in Figure 91.

The Sullivan's Island Resilience & Sea Level Adaptation Plan provides an analysis of present and future conditions and site-specific recommendations for building resilience on the Island until the year 2050. These recommended adaptation strategies are on diverse scales, ranging from community-wide to site level opportunities, that honor the history of the Island and learn from past applications.

Methodology

The Sea Level Adaptation & Resilience Plan's recommendations are a result of a diversified research methodology that included plan review, community engagement, Geographic Information Systems (GIS) Analysis, and Hydrologic & Hydraulic (H&H) modeling. The **Plan Review** ensured that this plan is in alignment with regional partners, while also identifying informational gaps and opportunities to leverage. **Robust community engagement** included personal interviews, open house public engagement sessions before key presentations at Town Hall, and a community survey; all of which provided insight and direction on the unique conditions and needs of Island residents. **GIS Analysis** allowed for place-based suitability mapping to site nature-based solutions. And finally, **H&H Modeling** that the Town already had in place from the Stormwater Master Planning process was expanded to provide Island-wide coverage; this was a critical step in building a premier Sea Level Adaptation & Resilience Plan as this provides the ability to combine proposed conditions of both stormwater infrastructure improvements and resilience adaptation strategies.

Results

The resulting Sea Level Adaptation & Resilience Plan will help to guide decision makers and inform the community on resiliency efforts that are both place-based and actionable through 2050, specifically through the consideration and implementation of **the ten adaptation strategy recommendations:**

Engage & Involve provides options to build community support for climate resiliency by improving communication, encouraging environmental stewardship, and defining shared responsibilities.

Ordinance & Policy Review includes recommendations for local ordinance updates to strengthen resilience against flooding, storms, and sea level rise while protecting natural resources.

Open Space Planning identifies NBS opportunities in the Island's open spaces to include thirty-three potential projects that are ranked based on feasibility, cost, maintenance needs, and co-benefits.

Residential-scale NBS is focused on the implementation of NBS on residential properties that are identified based on site-specific factors including soil type, elevation, and tidal influence. The Island is mapped into three general zones including the conserve, protect, and adapt zones.

Business District Complete Street is focused on the Middle Street business district; NBS are recommended to improve drainage, reduce heat, and enhance aesthetics in this popular commercial area.

Marsh Management provides sustainable options for salt marsh management to help safeguard the integrity of the Island's salt marsh for current and future generations.

Maritime Forest includes management recommendations for the Island's maritime forest, a rare and valuable coastal ecosystem that provides storm protection, stabilizes dunes, and more.

Dune System Management & Restoration recommends adaptive dune management strategies to maintain a healthy, protective dune system that adapts to changing coastal conditions.

Underground Detention outlines how stormwater runoff can be stored underground and is a viable option for retrofit or new development projects; special considerations for use on a barrier island are provided.

Causeway Elevation provides a high-level overview of two elevation options to help inform long-range planning to maintain this essential access route in the face of sea level rise.

Next Steps

This Plan provides support for future planning efforts and opportunities to explore for future funding. The Plan's recommendations support future updates to the Town's Comprehensive Plan and the newly required resilience element mandated by the South Carolina Office of Resilience. This Plan may also qualify as a "Green Infrastructure Plan" for FEMA Community Rating System (CRS) credits that may reduce FEMA Flood Insurance rates for residents. Additionally, the recommendations provide the basis to qualify for funding through the FEMA Hazard Mitigation Grant Program, FEMA Flood Mitigation Assistance Grant Program, National Oceanic and Atmospheric Administration Transformational

Habitats, National Fish & Wildlife Foundation Emergency Coastal Resilience Fund, along with State and Local funding opportunities.

Funding for NBS can come from a variety of sources including Federal, State, and local partners. Recently, on a Federal level, the Inflation Reduction Act (IRA) was signed into law in 2022 which included the largest climate investment in US history of $369 billion towards clean energy, climate resilience, conservation, and environmental justice. The top programs to receive funding from IRA which support NBS design and implementation include NOAA, USDA NRCS, USDA Forest Service, EPA, and DOI.

On the State level, the SC Office of Resilience (SCOR), SC Department of Transportation (SC-DOT), and SC Department of Environmental Services (SC DES) are three agencies to monitor for funding opportunities, especially because these agencies are often responsible for funneling the funding from the IRA and Bipartisan Infrastructure Law (BIL) programs.

Considering that grant funding cycles are always changing, it is difficult to summarize the currently available opportunities as this information quickly becomes outdated. However, the National Wildlife Federation (NWF) has created an online Nature-based Solutions Funding Database which is regularly updated. This database only tracks federal funding and/or assistance for NBS. The database includes several filters that can be applied to help find the best opportunity, these include purpose, eligibility, support, type, cost sharing, and agency.

Key Websites

SCOR
https://scor.sc.gov/grants-activities

SC-DOT
https://www.scdot.org/projects/Grants-Information.html

SC DES
https://www.des.sc.gov/business/businesses-and-communities-go-green/environmental-loans-grants-businesses-communities

NWF NBS Funding Database
https://fundingnaturebasedsolutions.nwf.org/

Due to the highly dynamic and complex systems involved, it is recommended that this Plan is reviewed and updated every five years; the next recommended review is to take place in 2030.

In closing, the Town of Sullivan's Island has had the foresight to plan for the Island's future to maintain quality of life, the health of natural resources, and economic vitality. The Sea Level Adaptation & Resilience Plan provides guidance in future decision making and actionable strategies to increase resilience in the face of rising sea levels and climate change.

The Town of Sullivan's Island serves as a leader to prepare the community for coastal resilience and an example for other coastal communities who are facing similar challenges. Sullivan's Island is home to abundant natural beauty, a vibrant and engaged community, historic assets, and much more worth protecting and integrating with natural systems and resilience adaptations to benefit current and future generations.

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Appendix A

Hydrologic and Hydraulic Analysis

Hydrologic & Hydraulic Analysis

Methodology

The Town conducted a *Stormwater Master Plan and Infrastructure Improvement Strategy*, this final report was published in February 2025. 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.

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.**

The watershed boundaries were delineated using digital elevation model (DEM) topographic data. The original stormwater model had 812 watersheds and during this process 132 additional watersheds were added to the undeveloped portions of the island for **a total of 944 watersheds** (Figure A1). Watershed physical properties such as area, flow length, and slope were calculated using geospatial analysis.

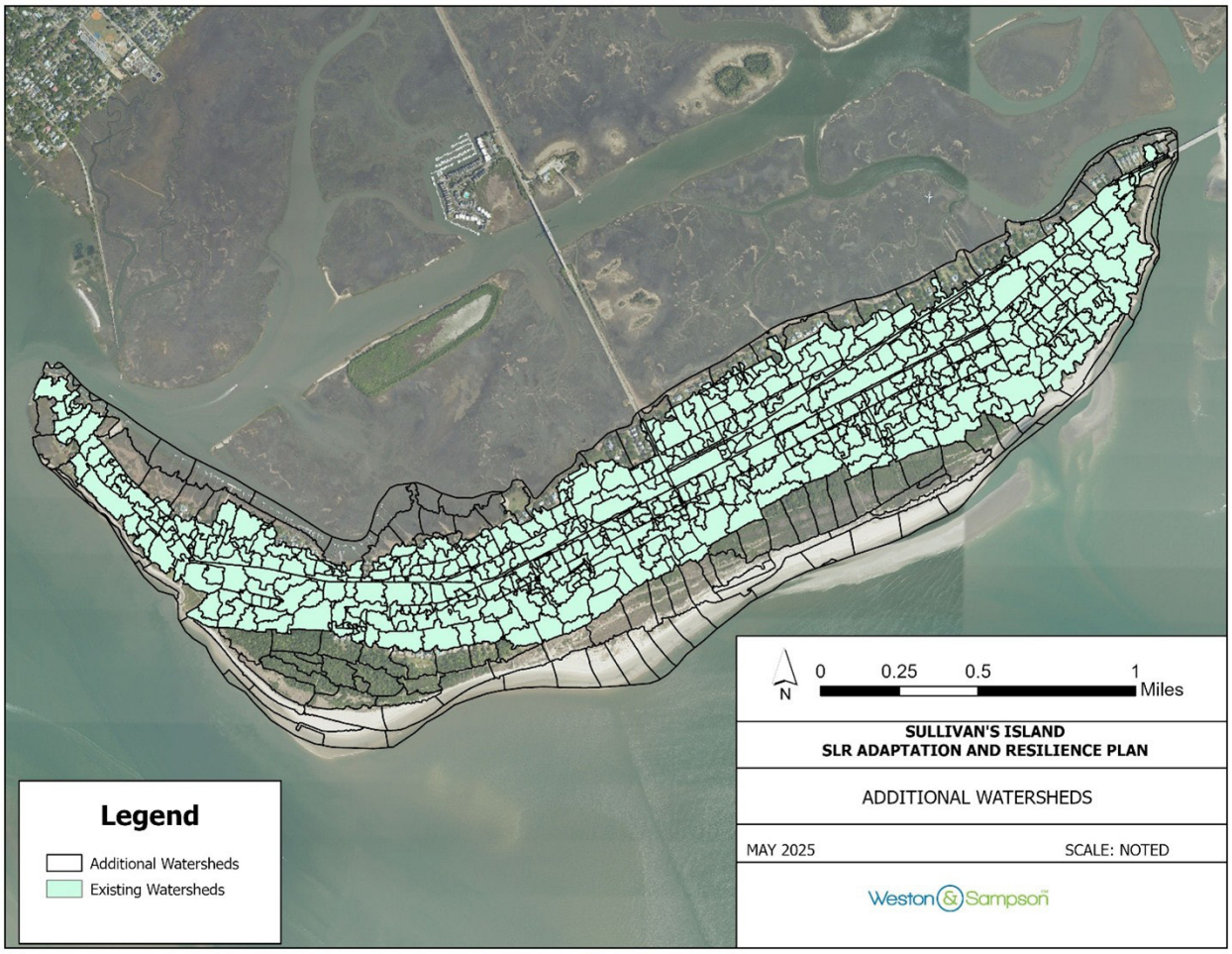

Figure A1: Additional Watersheds

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 A1 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 A1: 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 A2. The observed tidal data from the Charleston Harbor (NOAA Station 8665530) from the same storm period was used for tidal conditions.

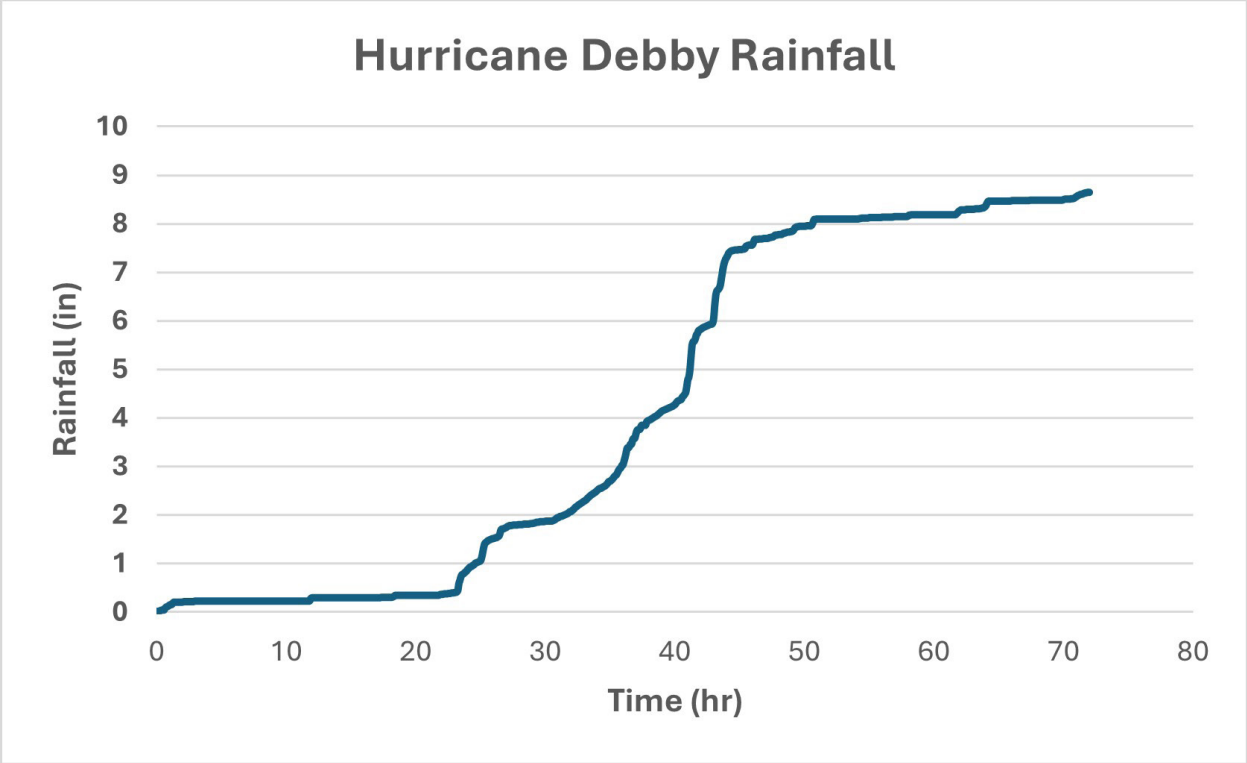

Figure A2: Hurricane Debby Rainfall Aug 4 - 7 from Summerville, SC USGS

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 A3 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.

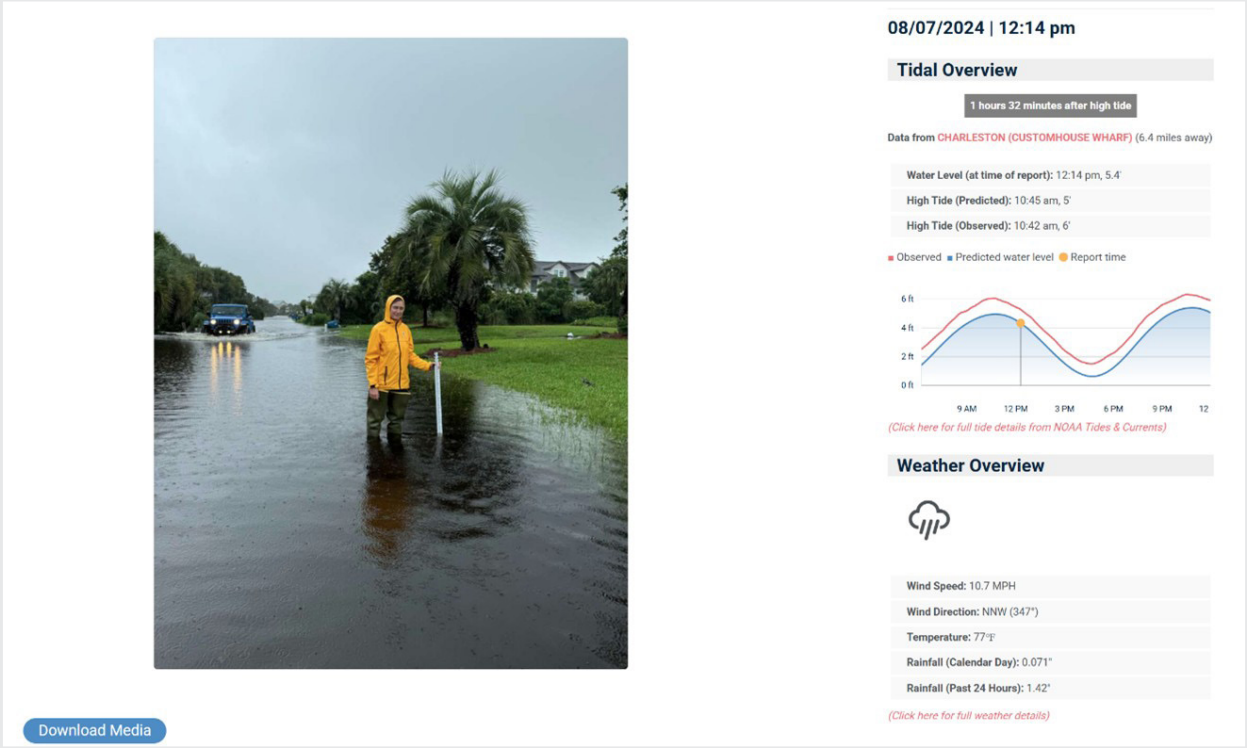

Figure A3: Sample of MyCoast Calibration data for Hurricane Debby

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 A2 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 Stormwater Master Plan, refer to that report for details on the development of the SC Long rainfall distributions. Some of the larger rainfall events from the Stormwater Master Plan, 25-year and 100-year, were not modeled as those events are considered too large for nature-based solutions to effectively mitigate.

Table A2: 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

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 the Sullivan's Island Sea Level Adaptation and Resilience Plan, the planning horizon of 2050 was selected to represent the typical lifespan of proposed nature-based solutions (approximately 25 years), and to reflected the span of a typical mortgage making the actions relevant to stakeholders.**

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.

Sea level rise projections account for some level of vertical land subsidence. Sea level rise estimates are typically not based on localized, higher-resolution data. The SI Stormwater Master Plan quanitified 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 the 2007 to 2020 vertical land motion data published by the 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 A2 the 33 NBS that were sited 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, six 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 NBS types that were modeled, a storage depth and impervous reduction was determined for each practice as show in in Table A3. The Low Impact Development in Coastal South Carolina: a Planning and Design Guide informed the process. The 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 A3: 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 A2 can be found in Appendix D. An example of this maximum flood depth map from scenario 2 is shown in Figure A5.

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 A4 below. The remaining comparison figures for scenarios 5-8 can also be found in Appendix D.

Runoff reductions were observed in all of the scenarios with NBS incorporated in the model in the subcatchments containing or adjacent to the NBS practices. These results are a good indication that some benefit would be achieved with the incorporation of the proposed NBS on the Island.

Figure A4: Percentage of Runoff Reduction from NBS for Existing Current Conditions 10 yr Rainfall

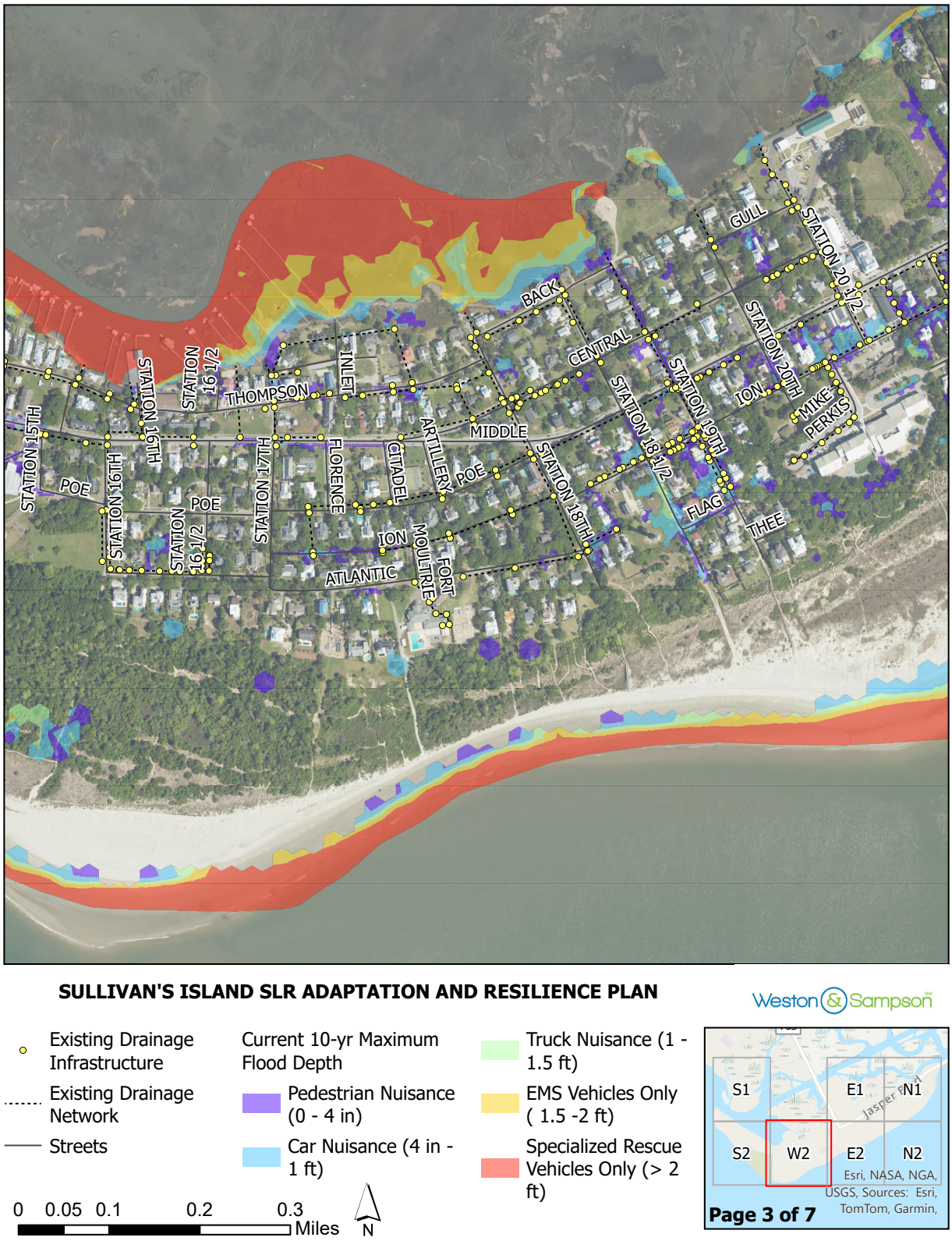

Figure A5: Maximum Flood Depth Example Map

Appendix B

Community Survey

Community Survey

Tell Us About Yourself

Please select the general location of your home address on this map. (*Digital Map Provided*)

How long have you lived on Sullivan's Island?

- ☐ Less than 5 years
- ☐ 6 to 10 years
- ☐ 11 to 25 years
- ☐ More than 25 years

Please select your favorite place on the Island on this map. (*Digital Map Provided*)

To what degree have you noticed changes to the following items in your time living on the Island? Mark **0** for No Change **1** Somewhat Changed **2** Dramatic Change

___ Construction

___ Beach Traffic

___ Flooding/Higher Tides

___ Frequency and Intensity of Storms

___ Shifting Sand (Erosion and/or Accretion)

___ Socioeconomic Demographics

___ Regulations Related to Development

___ Plants and Animals

Use this space to reflect on the anything you think has changed for the better or the worse:

What's on Your Mind?

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? **Pick three.**

- ☐ Not concerned
- ☐ More frequent flooding
- ☐ Hotter summers
- ☐ Economic impacts to business
- ☐ Access on and off the Island
- ☐ Damage to historical assets
- ☐ Damage to natural resources
- ☐ Damage to personal property

How have you been impacted by tidal flooding in your community? Tidal flooding can be caused by King Tides or storm events. **Select all that apply.**

- ☐ Tidal flooding has not impacted me.
- ☐ Tidal flooding has disrupted my commute to work, school, and/or grocery shopping
- ☐ Tidal flooding has damaged my yard
- ☐ Tidal flooding has damaged my vehicle
- ☐ Tidal flooding has damaged my home

What have you done to prevent tidal flooding or flooding from storm events on your personal property? **Select all that apply.**

- ☐ I have not needed to do anything
- ☐ I need to do something, but have not taken action yet
- ☐ I have used sandbags or another barrier to prevent water from entering my home/garage/shed
- ☐ I have planted a rain garden or collected rainwater in a rain barrel/cistern
- ☐ I have landscaped to prevent flooding such as adding trees or other vegetation to soak up the water
- ☐ I have constructed a berm, sea wall, or garden wall
- ☐ I have elevated my home
- ☐ Other?

  _____

Is there something else you would like us to know?

How Can We Help?

Nature-based Solutions can be used to help build community resiliency by providing benefits such as reducing impacts from flooding, stabilizing shorelines, and/or reducing air/ground temperatures. The following is a list of nature-based solutions. Which of these practices would you most like to see more of in your community if possible? **Please select your TOP FIVE.**

- ☐ **Rain Gardens**
  (landscaped depressions where plants and soil absorb water)
- ☐ **Rainwater Harvesting**
  (rain barrels and other tanks that capture rain for later use)
- ☐ **Permeable Pavement**
  (hard surfaces typically used in parking lots and sidewalks that allow water to soak in)
- ☐ **Constructed Wetlands**
  (water-loving plants placed in areas with high water tables)
- ☐ **Vegetative Buffers**
  (plantings along the upland edges of tidal marshes)
- ☐ **Living Shorelines**
  (practices that encourage the growth of oysters and salt marsh in tidal areas)
- ☐ **Conserved Land**
  (land that is not developed and absorbs water)
- ☐ **Green Roofs**
  (plants designed to live on top of roofs to capture rainfall)
- ☐ **Underground Detention**
  (chambers placed underground to allow rain to soak into the soil)
- ☐ **Tree Plantings**
  (to put water back into the sky and dry out the ground in between rains)
- ☐ **Downspout Disconnection**
  (directing runoff from rooftops and other impervious surfaces to areas where runoff can soak into the ground)

What should a successful Sullivan's Island Sea Level Rise Adaptation and Resilience Plan highlight to help make Sullivan's Island more resilient? **Please rank from most important to least.**

The plan should focus on

- ☐ Disaster Preparedness
- ☐ Providing expert recommendations for consensus building & decision making
- ☐ Consistency with other local resiliency planning efforts
- ☐ Protection and restoration of natural resources
- ☐ Protection of critical assets and infrastructure
- ☐ Recommendations for ordinance revisions
- ☐ Key in-the-ground projects identified for implementation

Appendix C

Policy Appendix

Policy Appendix

[1] Town of Kiawah Island Municipal Code (Sec 12-374):

"Impervious surface means any material which prevents, impedes or slows infiltration or absorption of stormwater directly into the ground at the rate of absorption of vegetation bearing soils, including buildings, asphalt, concrete, gravel and other surfaces as determined by the Planning Director "

Retrieved from: *https://library.municode.com/sc/kiawah_island/codes/zoning?nodeId=CH12LAUSPLZO_ARTIVDE_S12-374DE*

[2] City of Isle of Palms Municipal Code (Section 5-4-13 c):

"All newly installed hard landscaping, including, but not limited to, walkways, driveways, pool surrounds, and ground level patios, shall be constructed using pervious materials."

Retrieved from: *https://library.municode.com/sc/isle_of_palms/codes/code_of_ordinances?nodeId=COOR_TIT5PLDE_CH4ZO_ART1GEPR_S5-4-13MALOCOFLARRARESTDEADSERE*

[3] Southern Lowcountry Stormwater Ordinance and Design manual (Section 1.4.1):

"Design criteria in this Manual are applicable to any new development or redevelopment activity that meets one or more of the following criteria, or is a major substantial improvement, unless exempt pursuant to Section 1.4.2 below: 1. New development that involves the creation of 5,000 square feet of land disturbance. 2. Redevelopment that involves the creation, addition, or replacement of 5,000 square feet or more of land disturbance. 3. New development or redevelopment, regardless of size, that is part of a larger common plan of development, even though multiple, separate and distinct land disturbing activities may take place at different times and on different schedules. 4. A major substantial improvement of an existing property, which is defined as a renovation or addition to a structure that meets both of the following cost and size thresholds: a) construction costs for the building renovation/addition are greater than or equal to 50% of the pre-project assessed value of the structure as developed using current Building Valuation Data of the International Code Council, and b) project size where the combined footprint of structure(s) exceeding the cost threshold and any land disturbance is greater than or equal to 5,000 square feet"

Retrieved from: *SoLoCo-Design-Manual-and-Appendices.pdf*

[4] **Town of Mount Pleasants "Environmental Guidelines for Land Development"**

Document

Retrieved from: *https://www.tompsc.com/DocumentCenter/View/48520/2024---Enviromental-Guidelines-w-Appendices?bidId=*

[5] **City of Norfolk, Virginia Resiliency Ordinance**

Retrieved from: *https://www.norfolkva.gov/norfolkzoningordinance/#Norfolk-ZO/5_12_Resilience_Quotient.htm*

[6] **Town of Bluffton Interim Wetland Ordinance**

Retrieved from: *https://online.encodeplus.com/regs/bluffton-sc/doclibrary.aspx?id=d7a24819-570e-46a9-bed8-6c5036f27847*

[7] **FEMA/IBC Floodproofing/venting requirements**

Retrieved from: *https://www.fema.gov/pdf/rebuild/mat/sec6.pdf*

[8] **Town of Mount Pleasant Municipal Code (Sec 152.26 G) on floodproofing and venting**

Retrieved from: *https://codelibrary.amlegal.com/codes/mtpleasantsc/latest/mpleasant_sc/0-0-0-117835*

"The space below the lowest floor shall be either free of obstruction or constructed with non-supporting, breakaway, open latticework, open privacy slats or shutters, or insect screening intended to collapse under wind and water loads, without causing collapse, displacement or other structural damage to the elevated portion of the building or supporting foundation system. If used, the open latticework or open privacy slats or shutters ("open breakaway panels") must be made of wood or plastic no thicker than one inch (nominal), and at least 40% of the area of the panels formed with these materials must be open. The panels must completely span the areas between piers or other vertical structural supports, in accordance with division (H) below, and meet the following design specifications:

> *(1) Design safe loading resistance of each wall shall be not less than ten nor more than 20 pounds per square foot; or*
>
> *(2) If more than 20 pounds per square foot, a registered professional engineer or architect shall certify that the design wall collapse would result from a water load less than that which would occur during the base flood event, and the elevated portion of the building and supporting foundation system wall not be subject to collapse, displacement or other structural damage, due to the effects of wind and water loads acting simultaneously on all building components during the base flood event. Maximum wind and water loading values to be used in this determination shall each have 1% chance of being equaled or exceeded in any given year (100-year mean recurrence interval)."*