SOUTH ATLANTIC COASTAL STUDY (SACS)

Georgia Appendix

FINAL REPORT

AUGUST 2022

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SECTION 1
Introduction

The South Atlantic Coastal Study (SACS) Main Report examines the SACS study area at a regional scale and applies the Coastal Storm Risk Management (CSRM) Framework (the Framework) developed by the North Atlantic Coast Comprehensive Study (NACCS). The eight SACS state and territory appendices execute the Framework and provide a more tailored analysis by considering specific conditions for each state or territory, including problems and opportunities, risk assessment, and comprehensive CSRM strategies. This Appendix provides details on the state of Georgia.

The Framework is a three-tiered evaluation defined by different scales, objectives to address risk, and input from stakeholders. The Tier 1 and Tier 2 analysis are completed as part of the SACS while Tier 3 efforts would be completed as follow-on analyses, either by the U.S. Army Corps of Engineers (USACE) or other agencies and stakeholders. By completing a tiered analysis, assumptions and data requirements become more refined with each tier as described:

- Tier 1 presents a large-scale application of the Framework in the evaluation of exposure, hazards, vulnerability, and potential risk for the study area. For consistency across state and territory boundaries, national datasets were used to complete the Tier 1 analysis. The Main Report describes Tier 1 methods and general output. Georgia-specific Tier 1 information is provided in this appendix.

- The Tier 2 analysis for Georgia is provided in this appendix. Additional state and regional data sources are used to refine potential risk areas identified in Tier 1. Focus areas were selected from the highest risk locations, and detailed Focus Area Action Strategies (FAAS) (which are attached to this appendix) were developed to serve as examples of how to develop strategies that lower risk in populated areas, areas of concentrated economic development, and areas with vulnerable environmental and cultural resources.

- Tier 3 (not completed by the SACS) will be a local-scale analysis incorporating in-depth analysis and benefit-cost evaluations of CSRM plans in support of plan formation and project design.

The purpose of this appendix is to provide Georgia stakeholders with useful information and resources. The organization of this appendix and alignment with the Framework is shown in **Table 1-1**.

Table 1-1: Appendix Organization and Alignment with the Coastal Storm Risk Management Framework

Report Section	Content	CSRM Framework Step
Section 1: Introduction	Objective of the document and organization of the report	Step 1: Initiate Analysis
Section 2: Agency Coordination and Collaboration	Overview of the collaborative efforts of the SACS study including stakeholder engagement, workshops, informational sessions, and federal partners	Step 1: Initiate Analysis
Section 3: Overview of Existing and Future Conditions	Provides geographic, climatic, and political context for the analysis and an overview of existing and expected future conditions	Step 2: Characterize Conditions
Section 4: Risk Assessment	Application of the Tier 1 Risk Assessment and development of the Georgia-specific Tier 2 analysis used to identify high-risk areas	Step 3: Analyze Risk and Vulnerability
Section 5: Managing Risk	Overview of resources to support Georgia resiliency efforts, including federal directives, resources, and funding to help communities better leverage needed resources	Step 4: Identify Possible Solutions
Section 6: Institutional and Other Barriers	Identification of institutional and other barriers impeding further risk management efforts	Step 4: Identify Possible Solutions
Section 7: Recommendations to Address Risks	Recommendations of actions to address the risks identified in Section 4	Step 5: Evaluate and compare solutions

SECTION 2
Agency Coordination and Collaboration

The SACS was conducted in coordination with other federal agencies and applicable state, local, and tribal officials to ensure that all information, observations, and recommendations are consistent with other plans to be developed. Agency coordination and collaboration occurred in tasks documented in all preceding sections of this report.

2.1 Field Workshops

Initial coordination and collaboration for Planning Reach GA_05 began on February 1, 2019, with the regional SACS Vision Meeting that was held to introduce the SACS to a diverse attendee list representing federal, state, local, and non-government interests. Following this introductory meeting, as the Tier 1 Risk Assessment data was further developed, Vision meetings were held on May 10, 2019 and June 17, 2019 to update stakeholders on the progression of SACS, gather local knowledge and feedback, and discuss problems and opportunities within the planning reach. On October 30, 2019, the in-person Georgia Field Workshop was held in Tybee Island, Georgia. Participants were divided into breakout sessions focused on the following topics: (1) existing/future conditions, problems, and opportunities, (2) draft focus areas, (3) existing/planned risk management strategies and projects, and (4) institutional and other barriers to reducing risk. Stakeholders provided input via written questionnaires and facilitated discussion.

2.2 Focus Area Visioning Meetings

Stakeholder engagement for the Chatham County and Glynn County Focus Areas were primarily facilitated through a series of three virtual workshops. Focus Area Kick-off Webinars were held for Chatham County on July 14, 2020 and Glynn County on July 13, 2020 to develop a shared vision statement for the focus area, refine problem statements and focus area boundaries, and prepare stakeholders for the strategy development workshop. Focus Area Strategy Development Webinars were held on August 19, 2020 for Chatham County and August 21, 2020 for Glynn County to overview questionnaire feedback, present results from the Tier 2 Economic Risk Assessment, conduct breakout session technical discussions, and develop integrated risk management strategies. The Focus Area Wrap-up Webinars were held for Chatham County on November 2, 2020 and Glynn County on November 19, 2020 and presented an overview of the overall strategy and gathered additional input before finalization. There were pre-meetings and post-meetings associated with each workshop to ensure objectives were in alignment with stakeholders. Numerous engagements occurred through one-on-one communication with key stakeholders to gain insight on existing and planned projects in the planning reach, as well as potential partnership opportunities during the development of the FAAS and the Georgia Appendix.

2.3 Additional Stakeholder Coordination

Throughout the development of the state and territory appendices and FAAS, USACE held additional virtual workshops to engage specific subgroups of stakeholders, including two SACS Environmental Webinars, a SACS Cultural Stakeholder Webinar, and a SACS Military Installation Webinar. These workshops were intended to further enhance the outreach and risk communication that the SACS tool can provide to all agencies outside of USACE. The USACE Command Team and District Project Managers also held quarterly webinar updates for stakeholders to provide information on various SACS products and answer stakeholder questions.

The USACE Savannah District team engaged key federal, state, and local government stakeholders, as well as several state universities and non-governmental organizations (NGOs) as part of the agency coordination and collaboration associated with the development of the Georgia State Appendix and FAAS. Federal engagement included: Federal Emergency Management Agency (FEMA), U.S. Environmental Protection Agency (EPA), National Oceanic and Atmospheric Administration (NOAA), U.S. Geological Survey (USGS), U.S. Fish and Wildlife Service (USFWS), and U.S. National Park Service (NPS). State engagement included: Georgia Department of Natural Resources (GADNR)-Coastal Resources Division (CRD), GADNR-Environmental Protection Division (EPD), GADNR-Historic Preservation Division (HPD), Georgia Department of Transportation, Georgia Department of Community Affairs, Georgia Ports Authority (GPA), Jekyll Island Authority, and South Carolina Department of Health Environmental Control. Local government engagement included: Chatham County, Glynn County, City of Savannah, City of Tybee Island, and the City of Brunswick. State university engagement included: Georgia Southern University, Savannah State University, and the University of Georgia. NGO engagement included: Coastal States Organization, One Hundred Miles, Manomet, The Nature Conservancy (TNC), Coastal Georgia Historical Society, Gullah Geechee Corridor, and the Savannah River Keeper.

SECTION 3
Overview of Existing and Future Conditions

3.1 Study Area

Georgia has approximately 110 miles of coastline extending from the Savannah River inlet in the north to the St. Mary's River inlet in the south. The Georgia coast is typified by rough parallel barrier island shores and their associated ebb-tidal delta, nearshore sand shoal, inlet, estuary, and expansive salt marsh environments, which provide a protective barrier to the mainland. Major river estuaries within the study area include (from north to south) the Savannah, Ogeechee, Altamaha, Satilla, and St. Mary's Rivers. Georgia's coastal marshlands encompass approximately 378,000 acres in a 4- to 6-mile band behind the barrier islands, which makes up nearly one-third of all remaining salt marsh on the eastern United States coast (GADNR n.d.-a). Thriving in the waters of the estuaries, the marshes have been identified as one of the most extensive and productive marshland systems in the United States and serve as a buffer between the mainland and the ocean's impacts from wind and storm events. The urban Savannah harbor and industrial Brunswick harbor stand out against the largely undeveloped expanses of coastal Georgia.

The Georgia coast is in the approximate center of the inward curved coastline known as the Georgia Bight, which extends from Cape Fear, North Carolina to Cape Canaveral, Florida. At high tide, water is pushed toward the center of the Georgia Bight, forcing the water to pile up and increase in elevation along the Georgia coastline. This creates unique tidal extremes in Georgia, with high and low tidal change of 6 to 10 feet. In comparison, 2-foot tides are common within southern Florida and northern North Carolina (University of Georgia [UGA] n.d.).

The primary barrier islands in Georgia from north to south include Tybee, Little Tybee, Wassaw, Ossabaw, St. Catherines, Blackbeard, Sapelo, Wolf, Little St. Simons, Sea, St. Simons, Jekyll, Little Cumberland, and Cumberland Islands (**Figure 3-1**). This region is unique because its barrier islands lack commercial development. Access to the islands has been historically limited because of the lateral and vertical extent of the estuarine marshes. Of the 14 islands listed above, only four—Tybee, Sea, St. Simons, and Jekyll Islands—are significantly developed and accessible to vehicle traffic. All or part of the 14 barrier islands receive special protection from the federal government by their designation as units in the USFWS Coastal Barrier Resources System. Wassaw, Blackbeard, Wolf, and Egg Islands are National Wildlife Refuges (NWRs). Little Tybee and Ossabaw Islands are owned by the state of Georgia and are managed as heritage trusts. Most of Sapelo Island is owned by the state of Georgia, and a portion is designated the Sapelo Island National Estuarine Research Reserve. Wolf and Egg Islands are, in addition to NWRs, designated as National Wilderness Areas and managed by the USFWS. Jekyll Island is administered as a Georgia state park, with restrictions on private development. Cumberland Island is designated a national seashore and is managed by the NPS (USACE 2013a).

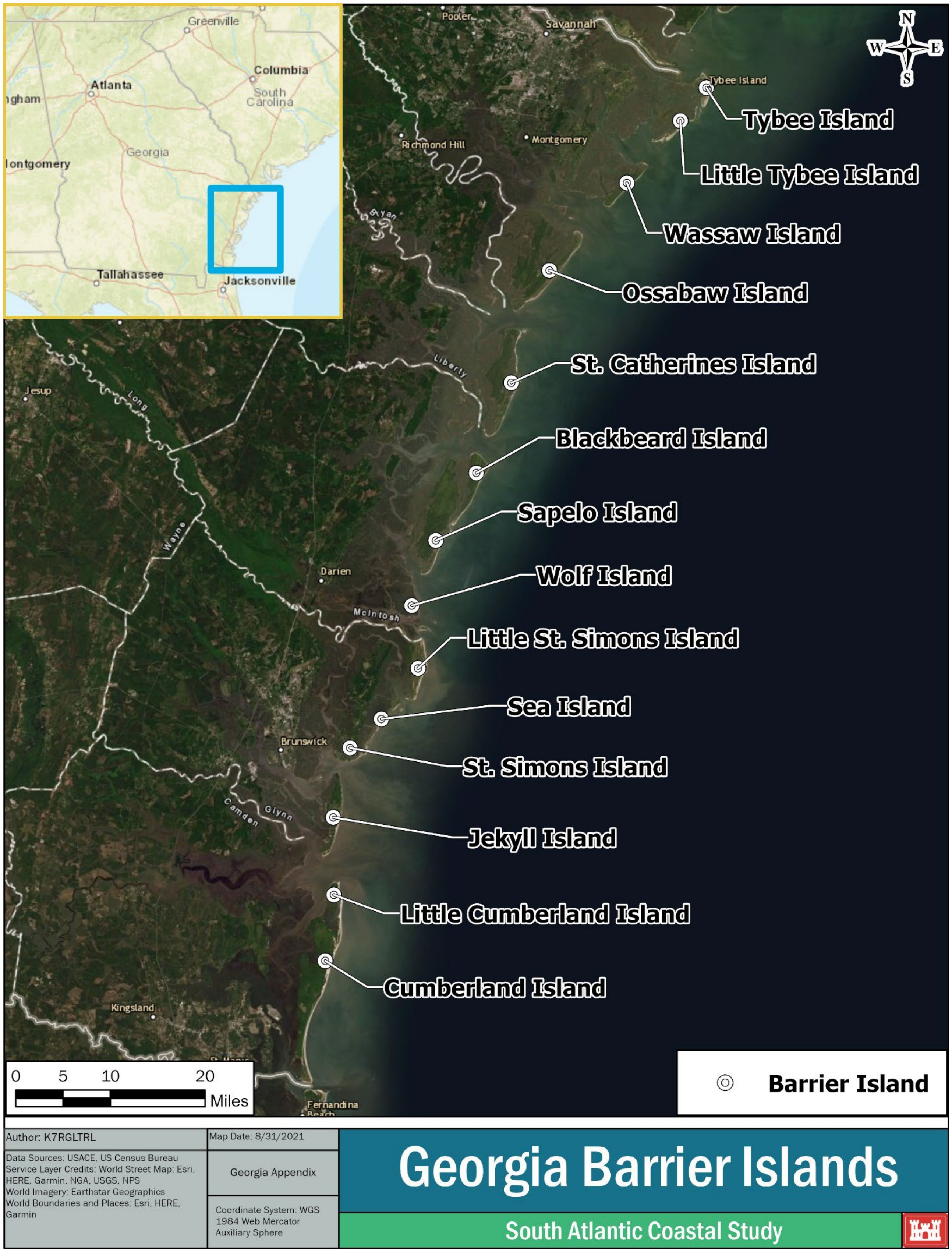


Figure 3-1: Georgia Coastal Barrier Islands

Tybee Island is the only Georgia barrier island or coastal beach that is authorized as a federal CSRM project. The project provides periodic beach renourishment within the limits of the federal project to protect property and infrastructure on the island from hurricane and storm damage. A supplemental renourishment was conducted in 2018 to add material that was lost because of Hurricane Matthew in 2016 and Hurricane Irma in 2017. After these storms, multiple areas of the dune complex were completely eroded and left susceptible to future storms. In spring 2019, the City of Tybee Island replaced and enhanced portions of these eroded dune fields. In early 2020, a full template beach renourishment incorporating resilience features was completed, with the City of Tybee Island repairing the remaining dune field with advanced renourishment material.

3.2 Problems and Opportunities Overview

Identifying problems and opportunities is a key initial step in the planning process. The problems and opportunities statements within this section encompass both current and future conditions and are not meant to preclude the consideration of any alternatives to solve the problems and achieve the opportunities.

Stakeholder input, project delivery team experience, district leadership input, and the tiered SACS analyses guided the development of broad problem statements related to the state's coastal vulnerabilities to increased hurricane and storm damage as a result of sea level rise, as well as opportunities to address those problems. Throughout multiple meetings and workshops beginning in the Spring of 2019, USACE engaged with federal, state, and local government officials, local experts from universities, and nonprofit organizations to discuss problems and opportunities throughout the Georgia study area. These statements are based on information gained through these collaborative efforts.

3.2.1 Problems

All problems listed are expected to increase in both intensity and magnitude as sea levels rise, depending on the vulnerability and resilience of the exposed population, infrastructure, and environmental and cultural resources. Problems were identified by SACS stakeholders, including:

- Coastal storm damages (from inundation, erosion, and wave attack) are increasing in populated areas, areas of concentrated economic development, areas with natural features providing environmental benefits and natural attenuation of coastal storm risk, and areas with socially vulnerable populations.
- Critical infrastructure, such as water and wastewater treatment plants, hospitals, schools, and roads, are at risk from storm-related hazards and compound flooding, putting people and property at risk.
- Population and development are increasing in coastal Georgia, leading to loss of natural buffers in areas exposed to coastal storm hazards.
- Unaddressed erosional damages from previous coastal storms are exacerbated over time resulting in continual and increasing risk to people and property.

- Nationally important cultural resources and natural habitats are being negatively impacted from coastal-storm driven inundation and erosion.

3.2.2 Opportunities

Resilience is the ability to anticipate, prepare for, and adapt to changing conditions and withstand, respond to, and recover rapidly from disruptions (EP 1100-1-5 [USACE 2020a]). Preparing for potential future circumstances is the first step to developing a resilient community. Opportunities to increase resilience were identified by SACS stakeholders, including:

- Identify gaps in current coastal resilience efforts.
- Gather additional data on coastal processes to inform CSRM efforts.
- Prioritize regional management of projects through Regional Sediment Management (RSM) and other opportunities that support conservation of natural and fiscal resources.
- Promote a range of potential measures, including structural, nonstructural, nature-based, and state and local ordinances which incorporate future sea level rise.
- Leverage studies being conducted by cities, counties, and the state. Studies conducted at the local level provide local knowledge of coastal storm risk to communities. Using these studies to help identify priorities of key stakeholders will support successful implementation of strategies in the SACS.
- Reduce the loss of coastal wetlands, beach, and dune systems that promote natural storm damage reduction and provide wildlife habitat.

3.3 Political Boundaries

There are 13 congressional districts within the state of Georgia that are based on decennial census population counts and population parity of approximately 710,000 individuals for each district. Two congressional districts (Districts 1 and 12) are partially located within Planning Reach GA_05. Except for Bulloch and Effingham Counties, the planning reach is largely represented by Georgia District 1 (**Figure 3-2**).

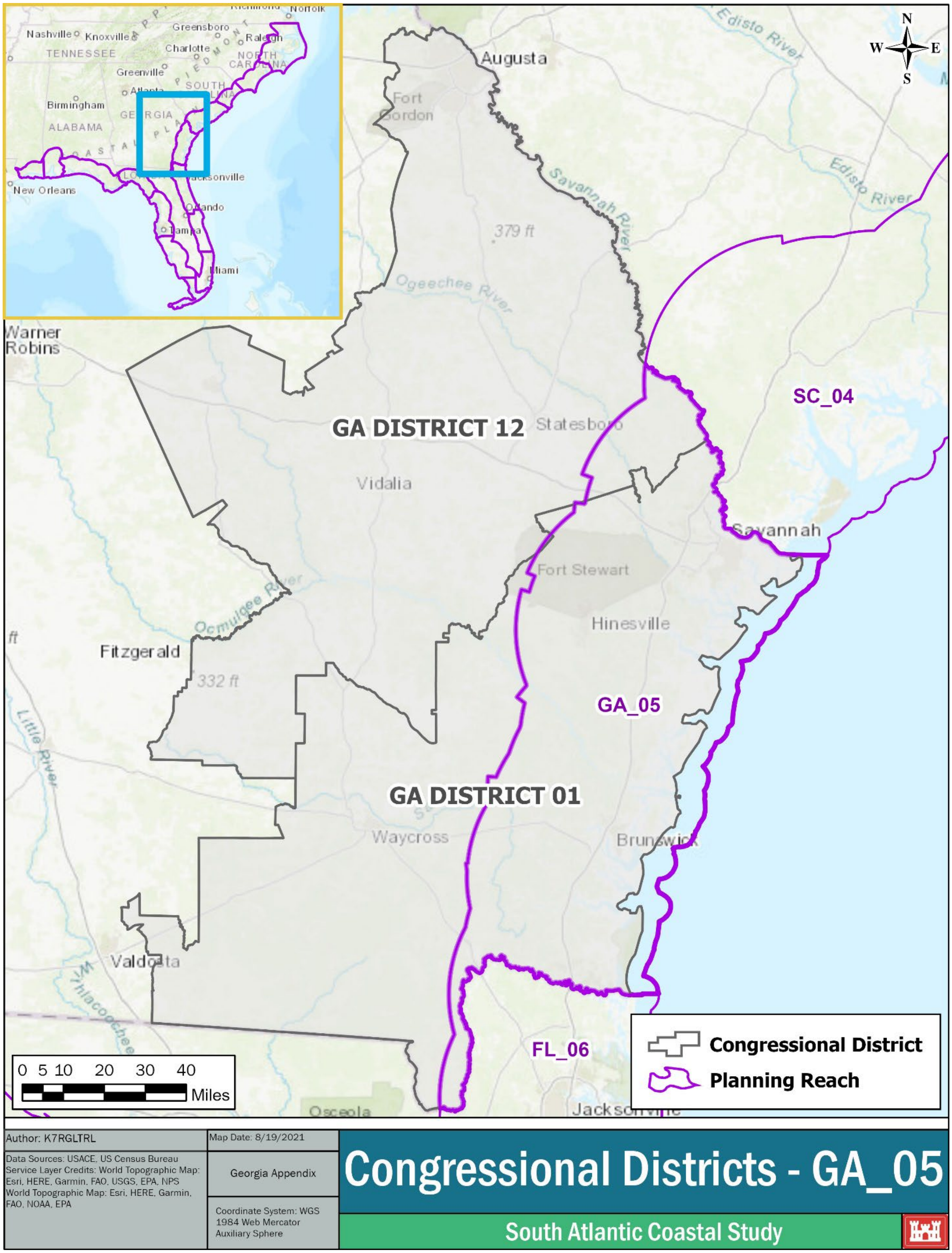


Figure 3-2: Georgia Congressional Districts

3.3.1 State Agencies

The state of Georgia has multiple governmental agencies and initiatives related to CSRM. The primary state agency working on coastal resources preservation and development permitting is the GADNR-CRD. The Georgia Emergency Management and Homeland Security Agency is the primary state agency working on planning for response to coastal storm events. The agency's missions and relation to CSRM is described below. At the regional and city level, non-governmental organizations, academia, as well as county and city governmental agencies serve at the forefront of CSRM within the state of Georgia.

- **GADNR Coastal Resources Division:** The mission of the GADNR-CRD is to balance coastal development and protection of the coast's natural assets, sociocultural heritage, and recreational resources for the benefit of present and future generations. The GADNR-CRD uses three main mechanisms of authority for activities in the jurisdictional marsh and shore areas and to regulate structures and activities that impact public trust lands that fall under jurisdiction of these regulations. The Coastal Marshlands Protection Act regulates activities and water-dependent structures in jurisdictional marshlands. The Shore Protection Act regulates activities and structures in jurisdictional beach and shore areas. The Revocable License authority of the state of Georgia allows for structures to occupy public trust lands' water bottoms.

  The Georgia Coastal Management Program (GCMP) was approved by NOAA in 1998, with the GADNR-CRD, serving as the lead agency to determine federal consistency with the Coastal Zone Management Act (CZMA) and the enforceable policies of the GCMP. The GCMP mission is to balance economic development in Georgia's coastal zone with preservation of natural, environmental, historic, archeological, and recreational resources for the benefit of Georgia's present and future generations. The GCMP also provides technical assistance to local governments, property owners, developers, and the public to provide expertise on coastal issues, minimize environmental impacts, clarify regulatory requirements, and identify agency contacts. The GCMP and Federal Consistency provisions are applicable in the counties of Brantley, Bryan, Camden, Charlton, Chatham, Effingham, Glynn, Liberty, Long, McIntosh, and Wayne.

- **Georgia Emergency Management and Homeland Security Agency:** The mission of the Georgia Emergency Management and Homeland Security Agency is to protect life and property against man-made and natural disasters by directing the state's efforts in the areas of prevention, preparedness, mitigation, response, and recovery. The agency works with local, state, federal, volunteer, and private agencies to respond to disasters or emergencies that require a coordinated response. Georgia Emergency Management and Homeland Security Agency also helps develop comprehensive hazard mitigation plans and projects to protect people and property from exposure to natural hazards.

3.4 Planning Reaches

SACS planning reaches were derived from three datasets and visual edits based on coastal geomorphology and professional judgment. These three datasets include:

1. TNC ecoregions, which are areas that TNC prioritized for conservation.
2. State and county boundaries.
3. Category 5 Sea, Lake, and Overland Surges from Hurricanes (SLOSH) Maximum of Maximum (MOM) inland limit of inundation (Zachry et al. 2015; Jelesnianski et al. 1992).

The overall SACS effort has multiple planning reaches, which are lengths of coastline that were evaluated as part of the study. Planning Reach GA_05 is the focus of this Georgia Appendix (**Figure 3-3**).

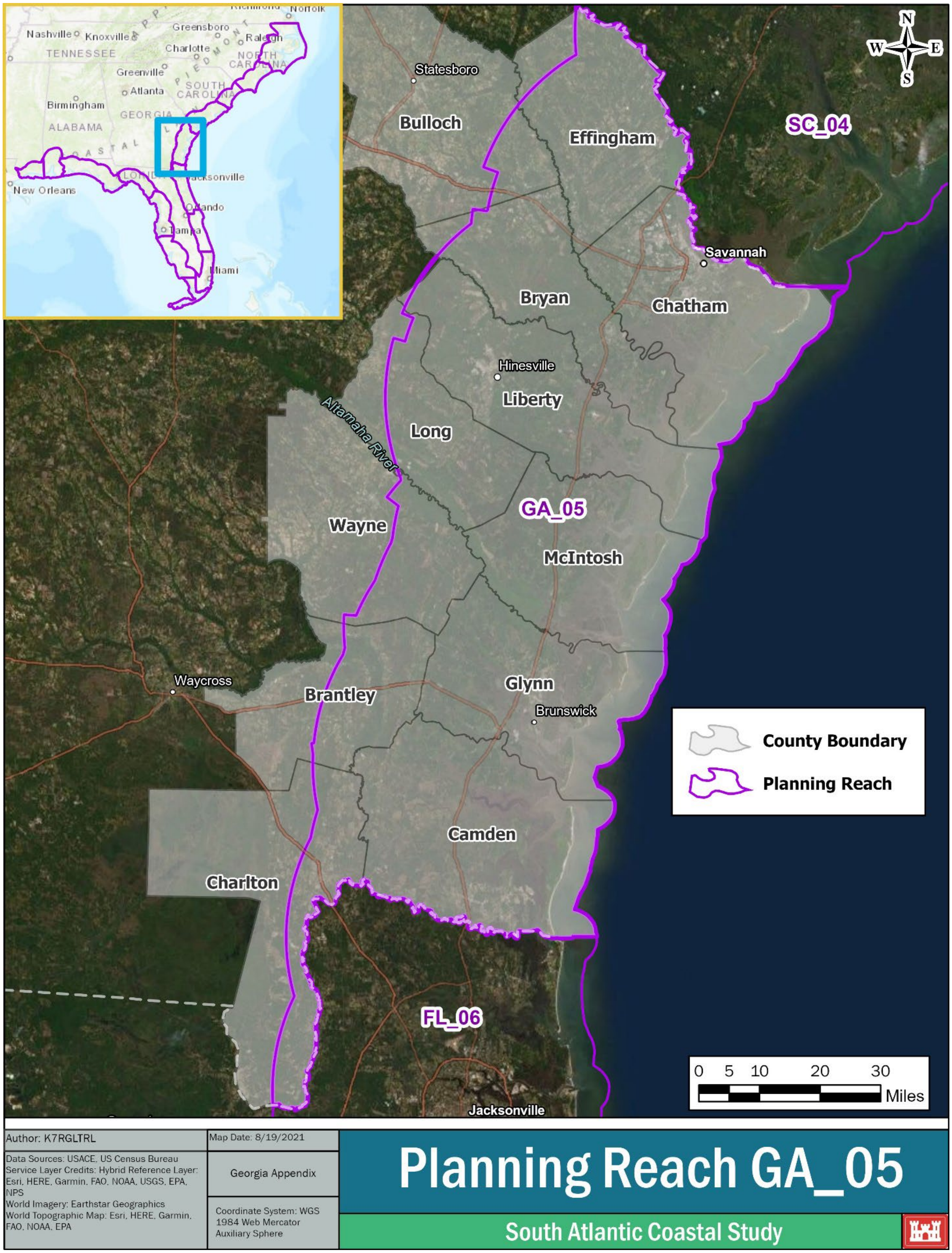


Figure 3-3: Planning Reach GA_05

3.5 Counties and Population within Planning Reach

Planning Reach GA_05 fully encompasses six coastal counties (Chatham, Bryan, Liberty, McIntosh, Glynn, and Camden Counties) and partially encompasses six inland counties (Effingham, Bulloch, Long, Wayne, Brantley, and Charlton Counties). There are two metropolitan statistical areas within coastal Georgia (Savannah and Brunswick) and one micropolitan statistical area (St. Marys).

Metropolitan and micropolitan statistical areas are areas with a substantial population center and adjacent communities with a high degree of economic and social integration to that population center. Metropolitan statistical areas have a principal urban area with a population of at least 50,000, while micropolitan statistical areas have an urban cluster with a population of at least 10,000 but less than 50,000 (OMB 2010).

The principal urban area in the Savannah metropolitan statistical area is the city of Savannah, Georgia, and includes Bryan, Chatham, and Effingham Counties. The principal urban area in the Brunswick metropolitan statistical area is the city of Brunswick, Georgia, and includes Glynn, Brantley, and McIntosh Counties.

The Georgia Governor's Office of Planning and Budget estimates that the population within Planning Reach GA_05 has increased from approximately 700,900 to 777,400 from 2010 to 2020, an increase of approximately 10.9 percent (**Table 3-1**). Future projections show that there could be a population increase of 44 percent between 2020 and 2065 for the coastal counties.

Table 3-1: Population Change Estimates for Coastal Georgia

County	Population in 2010[1]	Population in 2020[2]	Percent Change (2010 to 2020)	Percent Change (2010 to 2018)	Population in 2065[2]	Population Change (2020 to 2065)	Percent Change (2020 to 2065)
Brantley County	18,411	19,344	5.1%	2.6%	26,152	6,808	35.2%
Bryan County	30,233	40,443	33.8%	26.1%	91,573	51,130	126.4%
Bulloch County	70,217	80,592	14.8%	10.1%	140,013	59,421	73.7%
Camden County	50,513	54,975	8.8%	6.3%	67,506	12,531	22.8%
Charlton County	12,171	13,385	10.0%	6.5%	16,710	3,325	24.8%
Chatham County	265,128	290,550	9.6%	9.1%	373,753	83,203	28.6%
Effingham County	52,250	65,869	26.1%	19.0%	155,084	89,215	135.4%
Glynn County	79,626	86,002	8.0%	7.0%	104,510	18,508	21.5%
Liberty County	63,453	61,771	-2.7%	-3.1%	60,932	-839	-1.4%
Long County	14,464	19,846	37.2%	31.3%	32,503	12,657	63.8%

County	Population in 2010[1]	Population in 2020[2]	Percent Change (2010 to 2020)	Percent Change (2010 to 2018)	Population in 2065[2]	Population Change (2020 to 2065)	Percent Change (2020 to 2065)
McIntosh County	14,333	14,585	1.8%	0.0%	19,710	5,125	35.1%
Wayne County	30,099	29,988	-0.4%	-1.0%	31,550	1,562	5.2%
Total	700,898	777,350	10.9%	8.75%	886,592	342,646	44.1%

[1] 2010 Census Bureau decennial census data.

[2] 2020 and 2065 population estimates are provided by the Georgia Governor's Office of Planning and Budget.

3.6 Watersheds within Planning Reach

A watershed is defined as the geographic area within the boundary of a drainage divide. The hydrologic unit code (HUC) 8 watershed identifies the watershed boundary at the subbasin level, similar to medium-sized river basins. Planning Reach GA_05 includes all or portions of nine HUC-8 watersheds that drain east to the Atlantic Ocean (**Figure 3-4**). From north to south, the planning reach includes the Lower Savannah, Lower Ogeechee, Canoochee, Ogeechee Coastal, Altamaha, Little Satilla, Cumberland-St. Simons, Satilla, and St. Marys HUC-8 watersheds.

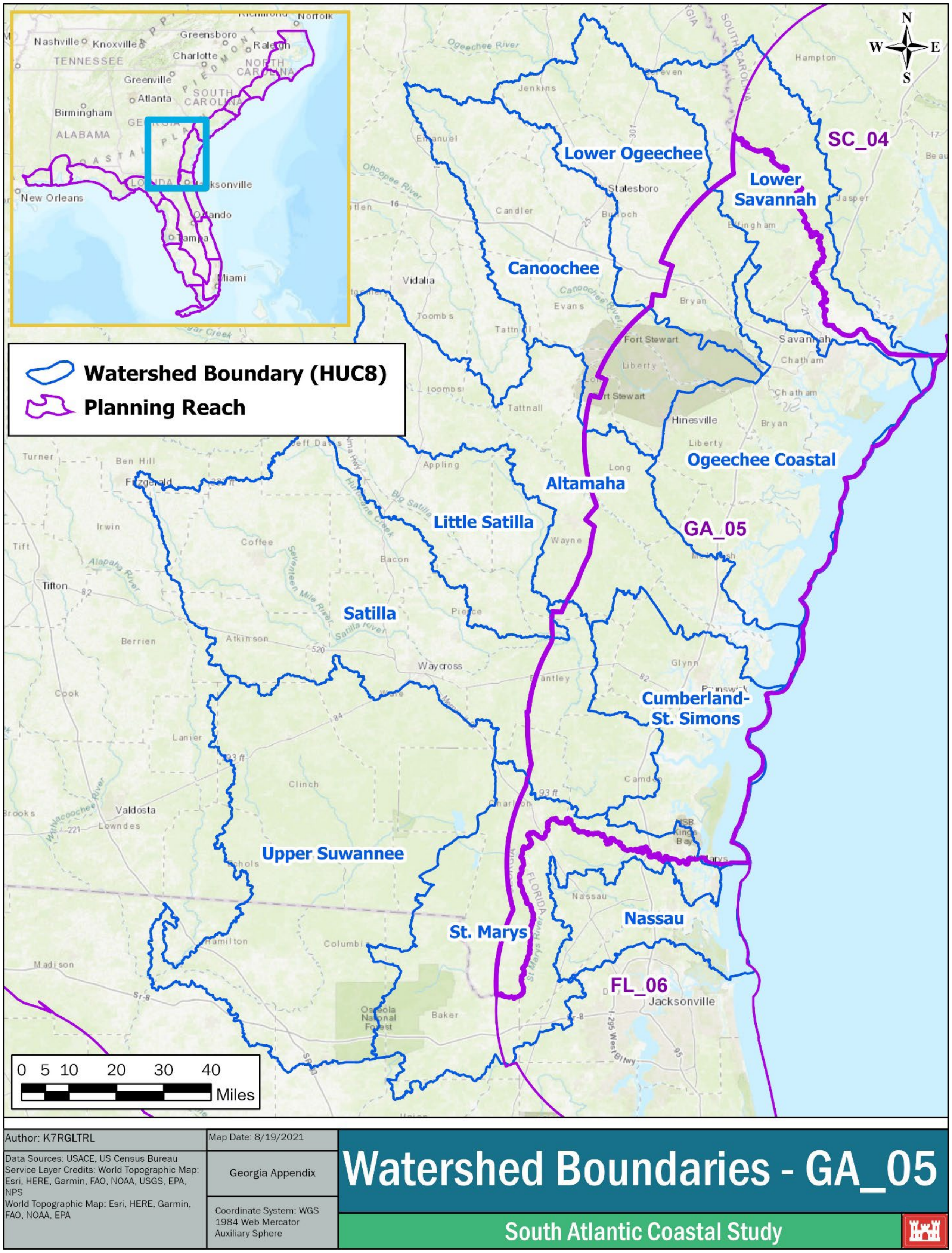


Figure 3-4: Georgia Watershed Boundaries

3.7 Shoreline Characteristics

Based on the NOAA Environmental Sensitivity Index (ESI) guidelines, USACE developed a grouping of generalized shoreline types to support coastal planning applications. The list of USACE generalized shoreline types aggregated from NOAA's ESI guidelines is in **Table 3-2**. Of the 10 USACE generalized shoreline types used in the analysis for the SACS, nine are found in Georgia.

Table 3-2: USACE and National Oceanic and Atmospheric Administration Environmental Sensitivity Index Shoreline Types

Number	USACE Generalized Shoreline Type	NOAA ESI Shoreline Types	Found In Georgia?
1	Mangroves	Mangroves	No
2	Manmade Structures (Exposed)	Exposed, Solid Man-Made Structures and Riprap	Yes
3	Manmade Structures (Sheltered)	Sheltered, Permeable, Rocky Shores and Sheltered Riprap	Yes
4	Rocky Shores (Exposed)	Exposed, Rocky Shores, Gravel Beaches, and Boulder Rubble	Yes
5	Rocky Shores (Sheltered)	Sheltered Scarps (Bedrock/Mud/Clay) and Sheltered, Rocky, Rubble Shores	Yes
6	Sandy Beaches (Exposed)	Fine to Medium Grained Sand Beaches, Coarse Grained Sand Beaches, Mixed Sand and Gravel Beaches, and Exposed Tidal Flats	Yes
7	Sandy Beaches (Sheltered)	Sheltered Tidal Flats	Yes
8	Scarps and Steep Slopes	Scarps and Steep Slopes (Sand)	Yes
9	Wetland/Marshes/Swamps (Exposed)	Exposed, Wave-Cut Platforms (Bedrock/Mud/Clay) and Exposed Scarps and Steep Slopes (Clay)	Yes
10	Wetlands/Marshes/Swamps (Sheltered)	Vegetated Low Banks, Hyper-Saline Tidal Flats, Salt and Brackish Water Marshes, Freshwater Marshes, Swamps, and Scrub and Shrub Wetlands	Yes

The shoreline type analysis identified the length and percentage for each type of shoreline found within Planning Reach GA_05. All shorelines, including wetlands along and into river floodplains, were captured in this characterization (**Figure 3-5**). "Sheltered" is defined as low-energy shorelines sheltered from wave and tidal energy, except during unusual or infrequent events, and "exposed" is defined as shorelines regularly exposed to large waves or strong tidal currents during all seasons. This analysis shows that the Georgia shoreline consists predominantly of sheltered wetlands (94 percent), two percent of exposed sandy beaches, and the remainder of shoreline types each contribute about one percent or less to the total shoreline composition (**Table 3-3**).

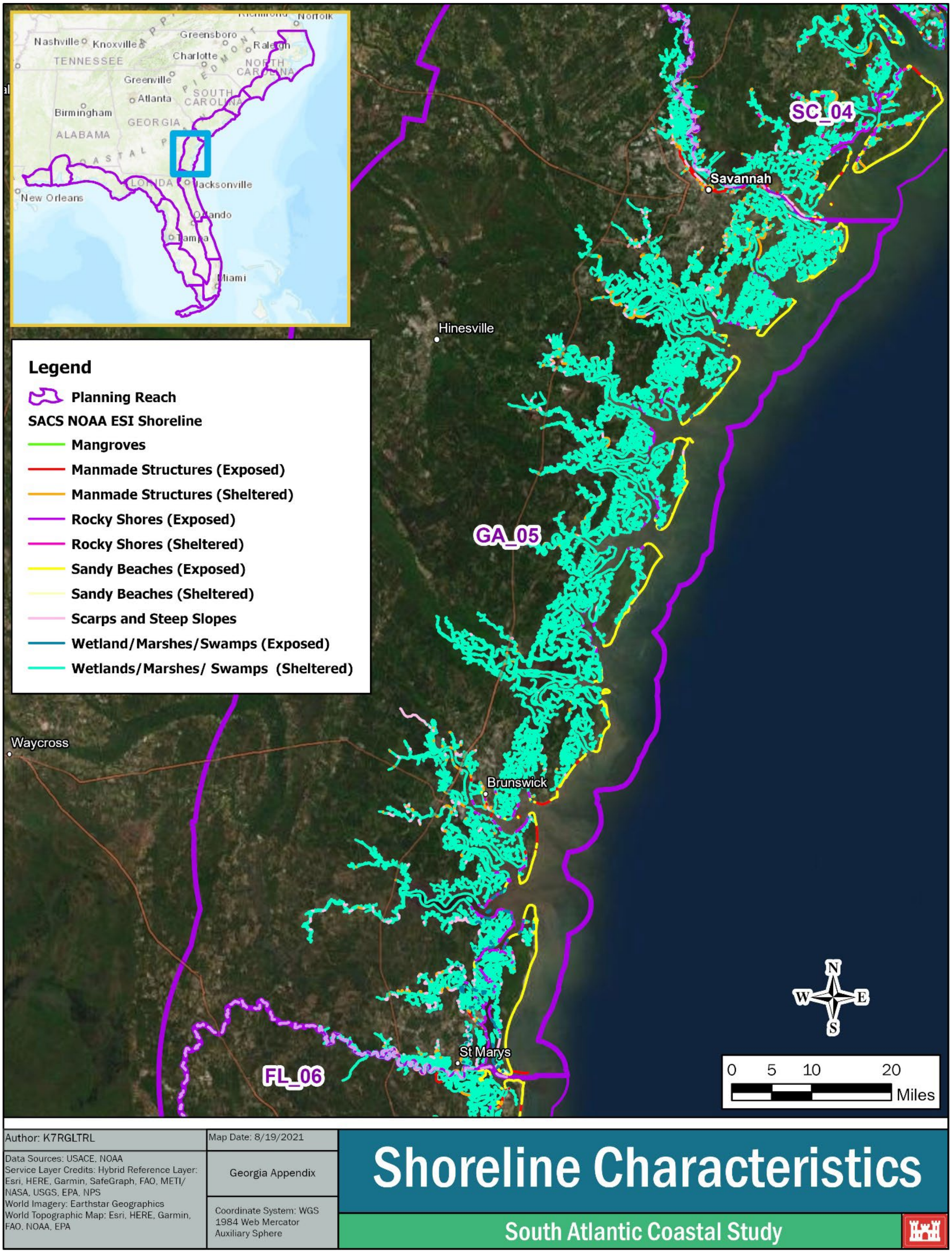


Figure 3-5: Shoreline Characteristics

Table 3-3: National Oceanic and Atmospheric Administration Environmental Sensitivity Index Aggregated Shoreline Characteristics for Planning Reach GA_05

Shoreline Type	Length (Miles)	Percent of Georgia Shoreline
Mangroves	0	0.00%
Manmade Structures (Exposed)	36.3	0.50%
Manmade Structures (Sheltered)	73.31	1.02%
Rocky Shores (Exposed)	74.57	1.04%
Rocky Shores (Sheltered)	0.72	0.01%
Sandy Beaches (Exposed)	144.16	2.01%
Sandy Beaches (Sheltered)	0.55	0.01%
Scarps and Steep Slopes (Sand)	71.07	0.99%
Wetland/Marshes/Swamps (Exposed)	30.14	0.42%
Wetlands/Marshes/Swamps (Sheltered)	6755.94	94.00%

Georgia Coastal Hazards Portal:
https://gchp.skio.uga.edu/

In addition to the USACE shoreline classification efforts, the coastal rivers and estuaries in Georgia have been characterized by the University of Georgia's Skidaway Institute of Oceanography. These data are available through the Georgia Coastal Hazards Portal, a web-based interactive tool to assess specific exposure to coastal hazards (Skidaway Institute of Oceanography n.d.). This characterization includes the Atlantic Intracoastal Waterway (AIWW); the Satilla, St. Marys, Altamaha, Ogeechee, Crooked, and Savannah Rivers; White Oak Creek; and the Brunswick, Sapelo, South New Port, Medway, Little Ogeechee, and Wilmington Estuaries. University of Georgia analysis of shoreline characteristics shows a combination of low-lying marsh with occasional mudflat and oyster habitat with man-made development and shoreline armoring located in populated areas such as Savannah, Brunswick, St. Simons, and Jekyll Island.

3.8 Overview of Storm History and Sea Level Rise Projections

3.8.1 Storm History

The Georgia coastline is influenced predominantly by tropical systems that occur during the summer and fall. Nor'easters during the late fall, winter, and spring also have an effect, but to a lesser degree. Although hurricanes typically generate larger waves and storm surge, Nor'easters impact the shoreline because of their longer duration and higher frequency of occurrence.

Georgia is in an area of significant hurricane activity. **Figure 3-6** and **Figure 3-7** show historical tracks of hurricanes and tropical storms from 1852 to 2020, as recorded by the National Hurricane Center (NHC) and is available from NOAA (NOAA 2021). The shaded circles in **Figure 3-6** and **Figure 3-7** indicate a 200-mile radius drawn from the center of the state and a 50-mile radius drawn from the center of the coastline, respectively. Based on NHC records, 212 hurricanes and tropical storms have passed within the 200-mile state radius over the 168-year period of record and 90 hurricanes and tropical storms have passed within a 50-mile radius of the central Georgia coastline (**Table 3-4**). While storms passing near the coast have the most direct impact, strong storms at greater distances are still capable of producing significant wind and flooding damage.

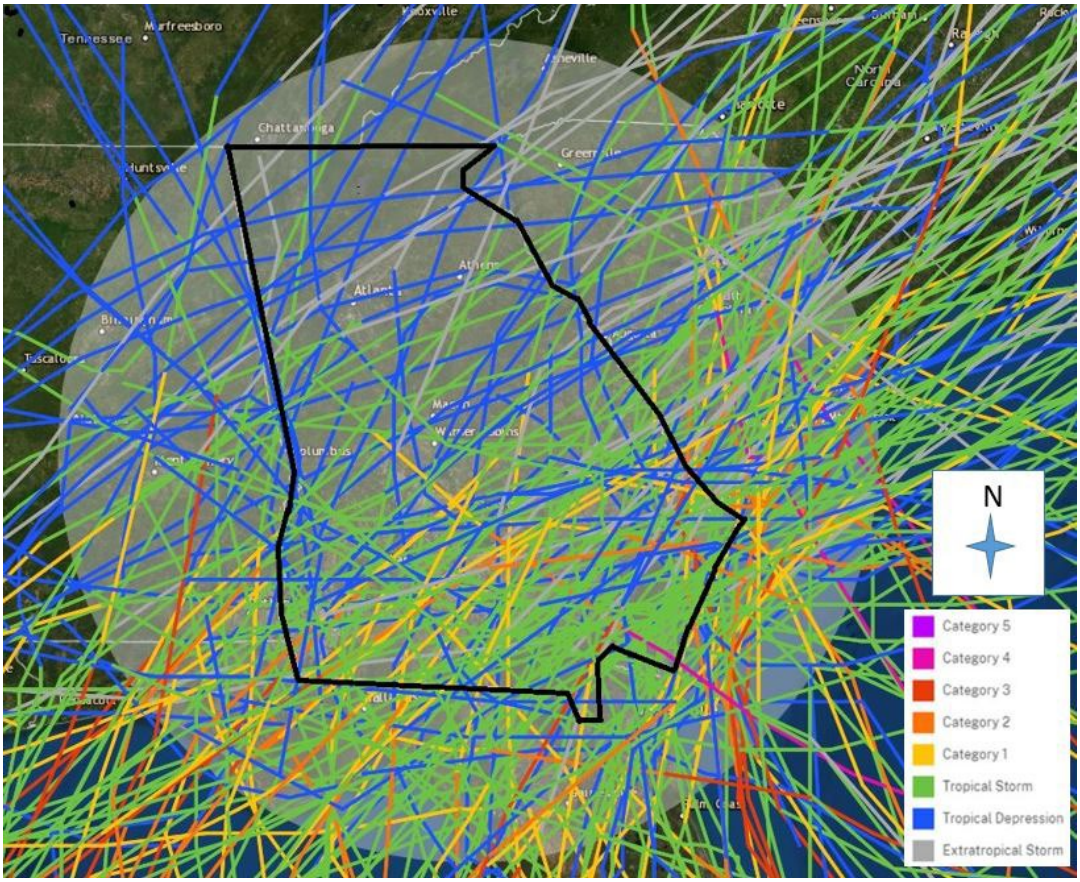


Figure 3-6: Historical Storm Tracks from 1852 – 2020 – Hurricanes and Tropical Storms (200-mile radius – not to scale) (NOAA 2021)

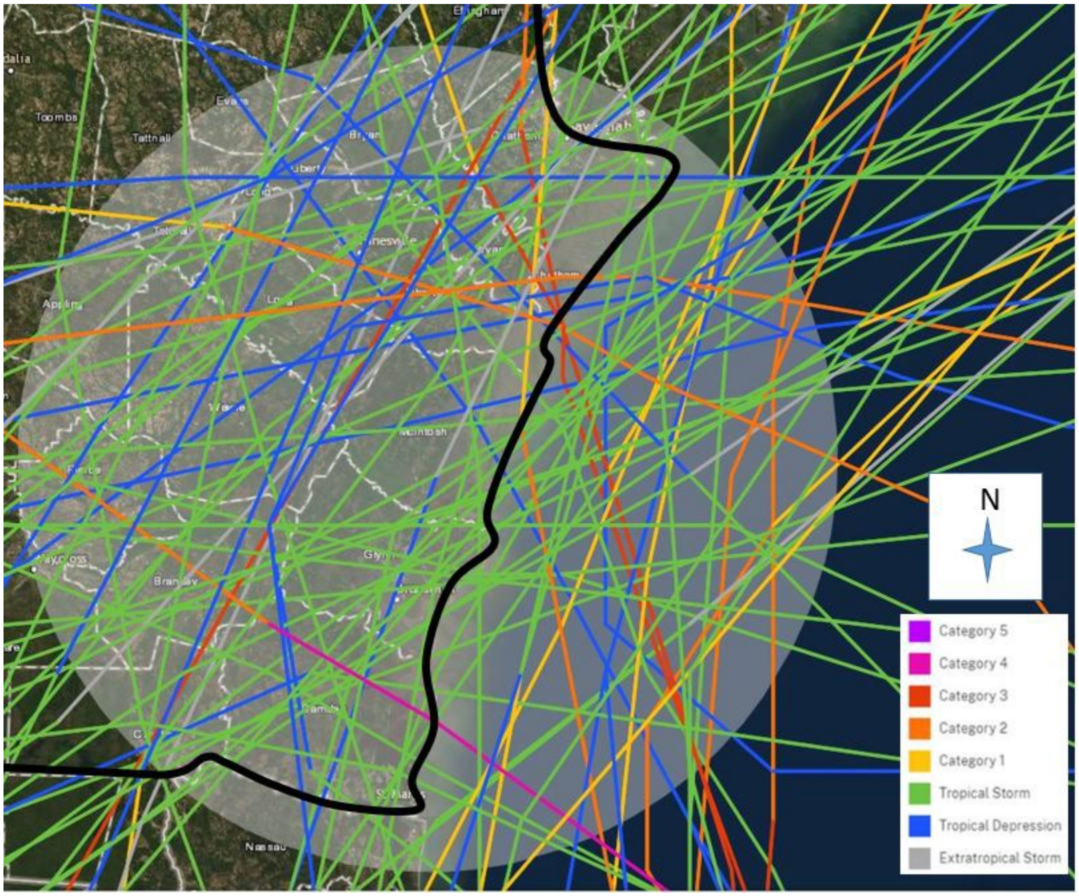


Figure 3-7: Historical Coastal Storm Tracks from 1852 - 2020 – Hurricanes and Tropical Storms (50-mile radius – not to scale) (NOAA 2021)

Typically, tropical storms are generated during the summer and fall seasons. Hurricane season extends from June 1 through November 30. Georgia's historical tropical storms (as defined in **Table 3-4**) follow this typical pattern with a few exceptions of storms occurring in May. **Figure 3-8** shows the historical distribution of storms by month from May through November. Historically, tropical storms and tropical depressions are the most prevalent storm types impacting coastal Georgia, accounting for 73 percent of recorded events. Tropical storm occurrence peaks between August and October. Tropical depressions occur throughout the May to November timeframe, with the majority occurring (historically) in September. Hurricanes, accounting for 20 percent of recorded storm events, peak between August and October. No tropical storms of record occurred outside of the May through November seasonal window. Several extratropical (ET) storms are also recorded, accounting for seven percent of storm events. These are storms that typically originate as tropical events but have downgraded to non-tropical events with characteristics such as a cold air core that are more aligned with Nor'easters than hurricanes. September is statistically the most active month for (tropically originating) Extratropical Storms, Tropical Depressions, Tropical Storms, and Category 1 Hurricanes in Georgia. Nor'easters generally occur during winter and early spring. There is currently no available database that records these storms, even though these long duration storm events are capable of producing heavy precipitation, damaging winds, and large high energy waves.

Table 3-4: Historical Coastal Georgia Storms 1853 to 2020

Year	Month	Name	Type[1]	Year	Month	Name	Type	Year	Month	Name	Type
1853	Oct	Unnamed	H2	1911	Aug	Unnamed	TD	1972	Sep	Dawn	TD
1854	Sep	Unnamed	H3	1912	Jul	Unnamed	TS	1976	May	Unnamed	TS
1860	Aug	Unnamed	TS	1912	Sep	Unnamed	TD	1976	Sep	Unnamed	TS
1868	Oct	Unnamed	TS	1915	Aug	Unnamed	TS	1979	Sep	David	H1
1871	Aug	Unnamed	TS	1916	May	Unnamed	TS	1981	Jul	Unnamed	TD
1871	Oct	Unnamed	TS	1916	Oct	Unnamed	TS	1981	Aug	Unnamed	TS
1873	Jun	Unnamed	TS	1919	Oct	Unnamed	TS	1984	Sep	Isidore	TS
1873	Sep	Unnamed	TS	1923	Jun	Unnamed	TD	1985	Oct	Isabel	TS
1874	Sep	Unnamed	H1	1924	Sep	Unnamed	TS	1988	Aug	Chris	TS
1877	Sep	Unnamed	TS	1924	Sep	Unnamed	ET	1994	Nov	Gordon	TD
1878	Oct	Unnamed	TS	1928	Sep	Unnamed	H1	1996	Oct	Josephine	ET
1880	Sep	Unnamed	TS	1932	Sep	Unnamed	TS	2000	Sep	Gordon	TD
1881	Aug	Unnamed	H2	1944	Oct	Unnamed	TS	2002	Oct	Kyle	TS
1882	Oct	Unnamed	TS	1945	Sep	Unnamed	TS	2003	Jul	Unnamed	TD
1884	Sep	Unnamed	TS	1946	Oct	Unnamed	TS	2004	Aug	Bonnie	TD
1885	Aug	Unnamed	TS	1947	Sep	Unnamed	ET	2007	Jun	Barry	TD
1885	Aug	Unnamed	H2	1947	Oct	Unnamed	TS	2012	May	Beryl	TD
1885	Sep	Unnamed	TS	1947	Oct	Unnamed	H2	2013	Jun	Andrea	TS
1888	Sep	Unnamed	TS	1950	Oct	Love	TD	2016	Jun	Colin	TS
1888	Oct	Unnamed	H1	1953	Sep	Unnamed	TD	2016	Sep	Hermine	TS
1893	Jun	Unnamed	TS	1953	Sep	Florence	ET	2016	Sep	Julia	TS
1893	Aug	Unnamed	H3	1954	Jul	Unnamed	TS	2016	Oct	Matthew	H2
1894	Sep	Unnamed	H1	1957	Jun	Unnamed	TS	2017	Aug	Unnamed	TS
1896	Sep	Unnamed	H2	1960	Jul	Brenda	TS	2018	Sep	Florence	H1
1898	Oct	Unnamed	H4	1964	Aug	Cleo	TS	2018	Oct	Michael	H4
1900	Oct	Unnamed	ET	1966	Jun	Alma	TS	2019	Aug	Dorian	H3
1906	Oct	Unnamed	TS	1968	Jun	Abby	TS	2019	Oct	Nestor	ET
1907	Jun	Unnamed	TS	1968	Sep	Unnamed	TD	2020	May	Bertha	TS
1907	Sep	Unnamed	TS	1970	May	Alma	TD	2020	Jul	Fay	TD
1910	Oct	Unnamed	TS	1972	May	Alpha	TS	2020	Aug	Isaias	H1

[1] TD – Tropical Depression, TS – Tropical Storm, ET – Extratropical Storm, H1 – Category 1 Hurricane, H2 – Category 2 Hurricane, H3 – Category 3 Hurricane, H4 – Category 4 Hurricane

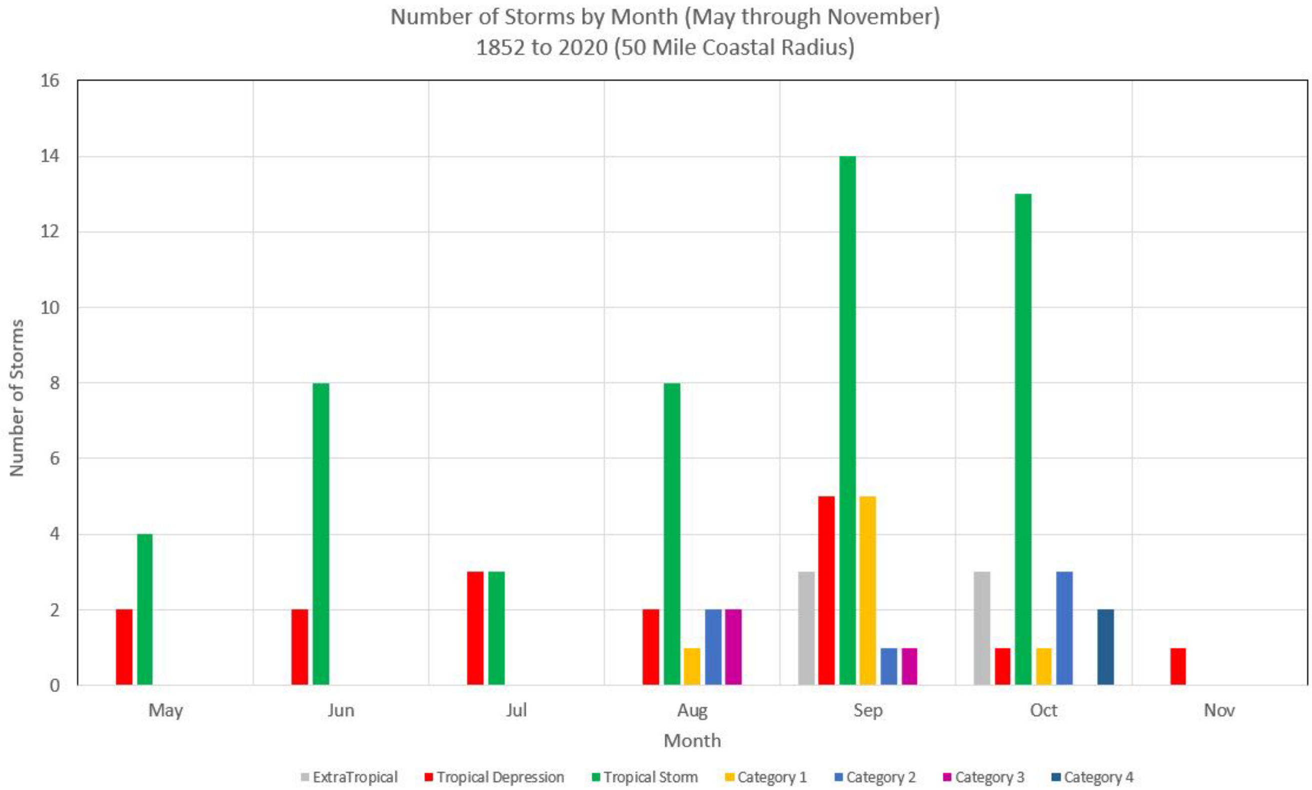


Figure 3-8: Historical Coastal Storm Distribution by Month

3.8.1.1 Storm Surge

Storm surge is defined as the rise of the ocean surface above its astronomical tide level due to storm forces. Surges occur primarily because of atmospheric pressure gradients and surface stresses created by wind blowing over a water surface. Strong onshore winds pile up water near the shoreline, resulting in super-elevated water levels along the coastal region and inland waterways. In addition, the lower atmospheric pressure that accompanies storms contributes to a rise in water surface elevation. Extremely high wind velocities coupled with low barometric pressures (such as those experienced in tropical storms, hurricanes, and very strong Nor'easters) can produce very high, damaging water levels. In addition to wind speed, direction, and duration, storm surge is influenced by water depth, length of fetch (distance over water), and frictional characteristics of the nearshore sea bottom. An increase in water depth may increase the potential for coastal flooding and allow larger storm waves to attack the shore.

During intense storm activity, waves erode sediment from shorelines, beaches, and dune systems, and storm surge can flood coastal and inland properties. The higher the storm surge elevation, the more flooding (and subsequently, more erosion, wave, and flood damage) is expected to occur.

The Georgia coastline has an average elevation of approximately 10.0 to 12.0 feet North American Vertical Datum of 1988 (NAVD88). FEMA has completed a Flood Insurance Study (FIS) for each of the coastal counties in Georgia, which provides storm surge elevations for 0.2-, 1-, 2-, and 10-percent annual exceedance probability (AEP) storms (FEMA 2018a, FEMA 2018b, FEMA 2018c, FEMA 2018d, FEMA 2018e, FEMA 2017). **Table 3-5** provides surge levels versus storm frequency for Georgia's coastal counties. FEMA determines surge along multiple transects for each county. Values presented here represent county averages. The storm surge elevations presented include the effects of astronomical high tide and wave setup. The storm tide consists of the actual level of sea water resulting from the normal high tide combined with the storm surge.

Table 3-5: Georgia Storm Tide Elevations

Annual Exceedance Probability	Total Storm Tide Level (Feet NAVD88)					
	Chatham	Bryan	Liberty	McIntosh	Glynn	Camden
10%	6.1	6.0	6.0	5.9	5.7	5.7
2%	8.4	8.3	8.3	8.1	7.8	7.8
1%	9.6	9.4	9.4	9.2	8.9	8.9
0.2%	11.8	11.6	11.6	11.3	10.9	10.9

3.8.1.2 Mean Tide Range

NOAA operates and maintains one active tide gauge (Fort Pulaski) and a database of 21 additional historical tide gauges with datum information along coastal Georgia (**Table 3-6**). Mean tide range (the difference between mean high water and mean low water), varies little along the coast, including in sounds, rivers, and tributaries. The minimum mean tide range is 5.9 feet (St. Marys River located in Camden County), and the maximum mean tide range is 8.0 feet (Turtle River in Glynn County). St. Simons and Jekyll Islands are located at the inward-most point of the Georgia Bight and experience the most severe tidal ranges. On average, the mean tide range for coastal Georgia is 6.9 feet.

Table 3-6: Tide Gauges and Datums: Georgia Coastline

Station ID	Station Name	Mean Higher High Water (feet)	Mean High Water (feet)	Mean Tide Level (feet)	Mean Sea Level (feet)	Mean Low Water (feet)	Mean Lower Low Water (feet)	NAVD 88 (feet)
8670870	Ft. Pulaski	7.50	7.13	3.67	3.82	0.21	0.00	4.05
8671314	Halfmoon Reef, Halfmoon River	7.60	7.20	3.71	3.80	0.22	0.00	---
8671315	Priest Landing, Wilmington River	7.90	7.51	3.87	3.99	0.23	0.00	---
8671086	Skidaway Institute, Skidaway River	8.37	7.97	4.11	4.27	0.24	0.00	---
8672667	Range A Light, Bear River	7.94	7.57	3.89	4.14	0.21	0.00	---
8672875	Sunbury, Sunbury Channel	7.86	7.51	3.87	4.24	0.22	0.00	---
8673171	South Ossabaw Island, Bear River	7.51	7.16	3.67	3.83	0.19	0.00	---
8673381	Halfmoon Colonels Island, Timmons River	7.95	7.58	3.91	4.39	0.23	0.00	---
8674301	Daymark No. 135, South Newport River	7.47	7.11	3.66	3.79	0.21	0.00	---
8674975	Daymark No. 156, Head of Mud River	8.11	7.72	3.97	4.20	0.22	0.00	---
8675622	Old Tower, Sapelo Island, Doboy Sound	7.43	7.04	3.63	3.67	0.21	0.00	---
8675761	Daymark No. 185, Rockdedundy River Entrance	7.51	7.14	3.68	3.75	0.21	0.00	---
8676329	Mackay River, Intracoastal Waterway, Buttermilk Sound	7.43	7.11	3.68	3.94	0.24	0.00	---
8677344	St. Simons Island	7.20	6.83	3.52	3.57	0.21	0.00	---
8677406	Howe Street Pier, Brunswick	7.72	7.35	3.79	4.01	0.22	0.00	---
8676808	Crispen Island, Turtle River	8.48	8.14	4.16	4.56	0.19	0.00	---
8678124	Raccoon Key Spit	7.12	6.77	3.49	3.56	0.21	0.00	---
8678322	Bailey Cut, Satilla River	7.31	7.02	3.62	3.93	0.23	0.00	---
8679511	Kings Bay	7.01	6.64	3.43	3.56	0.21	0.00	---
8679758	Dungeness, Seacamp Dock	6.78	6.43	3.31	3.43	0.20	0.00	---
8679945	Beach Creek	6.47	6.10	3.14	3.20	0.18	0.00	---
8679964	St. Marys, St. Marys River	6.39	6.06	3.13	3.30	0.20	0.00	---

3.8.2 Sea Level Rise

The SACS addresses sea level change in accordance with the guidance document USACE Engineering Regulation (ER) 1100-2-8162, Incorporating Sea Level Change in Civil Works Programs (USACE 2019a). This guidance document refers to “sea level change” (rather than sea level rise) because of its applicability throughout the nation, including locations where sea levels are falling are a result of land uplift. Within the entire SACS study area, sea levels are rising. Therefore, the SACS products refer to “sea level rise” to clearly communicate the sea level change trend occurring throughout the SACS study area. Rates were calculated for compliant gauges within Georgia and the adjacent Florida coast using the USACE Sea Level Change Curve Calculator Version 2021.12 (USACE 2021). This calculator uses the methodology described in Engineer Regulation (ER) 1100-2-8162, Incorporating Sea Level Changes in Civil Works Programs (USACE 2019a).

To incorporate the direct and indirect physical effects of projected future sea level change on design, construction, operation, and maintenance of coastal projects, the USACE has provided guidance in ER 1100-2-8162 and Engineering Pamphlet (EP) 1100-2-1 (USACE 2019a). ER 1100-2-8162 provides both a methodology and a procedure for determining a range of sea level change (SLC) estimates based on global sea level change rates, the local historic sea level change rate, the construction (base) year of the project, and the design life of the project. Three estimates are required by the guidance, a Low (Baseline) estimate representing the minimum expected sea level change, an Intermediate estimate, and a High estimate representing the maximum expected sea level change. These estimates are referenced to the midpoint of the latest National Tidal Datum epoch, 1992. ER 1100-2-8162 provides a detailed explanation of the procedure, equations employed, and variables included to account for the eustatic change, as well as site specific uplift or subsidence to develop corrected rates.

The state of Georgia has one National Ocean Service (NOS) gauge (Fort Pulaski, Georgia) with a data record that is compliant with USACE guidance (>40 years) which is located at the Georgia and South Carolina border (**Figure 3-9**). A compliant gauge is also available at Fernandina Beach, Florida near the Florida and Georgia border. **Table 3-7** summarizes the sea level trends at these two gauges. The historical trend of the mean sea level (MSL) from NOAA based on data through 2020 along with the 95 percent confidence interval and the equivalent change over 100 years are displayed along with the USACE Sea Level Calculator estimates for the year 2120 for the Low, Intermediate, and High sea level change scenarios (in feet, NAVD88). Sea level change values for the USACE scenarios have an origin year of 1992 and use the 2020 NOAA sea level change rates. The observed rates vary between 0.0072 feet/year (2.18 millimeters/year) at Fernandina Beach, Florida to 0.0111 feet/year (3.39 millimeters/year) at Fort Pulaski, Georgia.

Output from the USACE Sea Level Change Curve Calculator for Fernandina Beach, Florida and Fort Pulaski, Georgia are shown in **Figure 3-10** and **Figure 3-11**, respectively. These two gauges bound the expected range of sea level change in the state. Estimates for 2120 at Fernandina Beach, Florida are 0.39, 1.84, and 6.46 feet NAVD88 under the USACE Low, Intermediate, and High sea level change scenarios. For the same scenarios the estimates at Fort Pulaski, Georgia are 1.19, 2.65, and 7.27 feet NAVD88 demonstrating some of the variation in estimates across the state. **Figure 3-12** and **Figure 3-13** show tidal datums and extreme water levels for Fernandina Beach, Florida and Fort Pulaski, Georgia, respectively. Included in these figures are return period estimates based on an extreme value analysis of observed water levels at the gauge location computed by NOAA.

Table 3-7: USACE Sea Level Calculator Summary for Compliant Georgia Area Gauges

	Gauge 8670870	Gauge 8720030
Location	Fort Pulaski	Fernandina Beach
Period of Record	1935 - 2020	1897 – 2020
National Oceanic and Atmospheric Administration (NOAA) 2020 Relative Sea Level (RSL) Trend (feet/year)	0.0111	0.0072
NOAA 2020 95% Confidence Interval (feet/year)	0.00089	0.00056
Equivalent Change over 100 years (feet)	1.11	0.72
USACE Low Scenario 2120 (ft, NAVD88)	1.19	0.39
USACE Intermediate Scenario 2120 (ft, NAVD88)	2.65	1.84
USACE High Scenario 2120 (ft, NAVD88)	7.27	6.46
Conversion NAVD88 ft to 1992 MSL ft	0.23	0.53

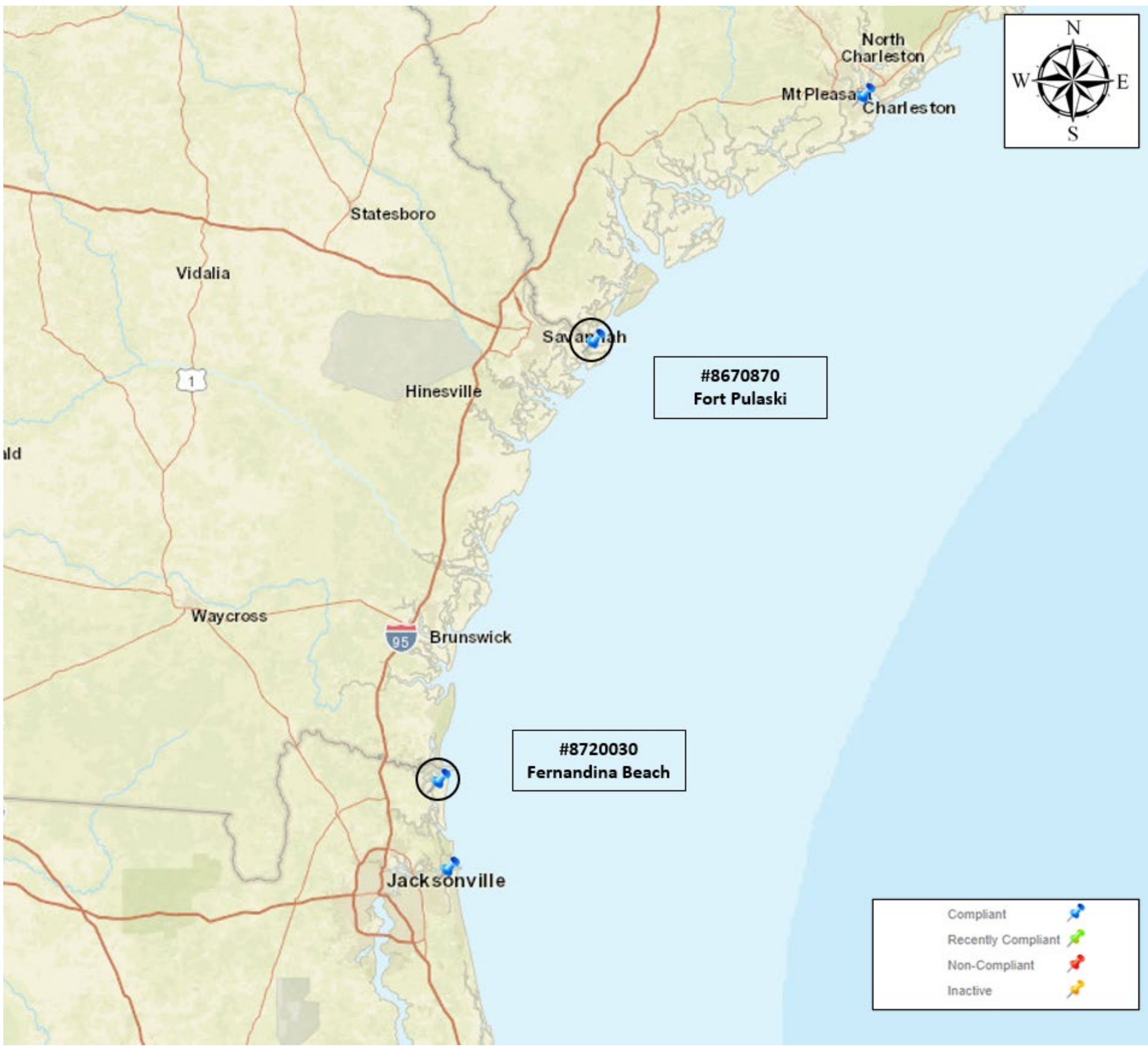


Figure 3-9: Georgia Area National Ocean Service Gauges (USACE 2021)

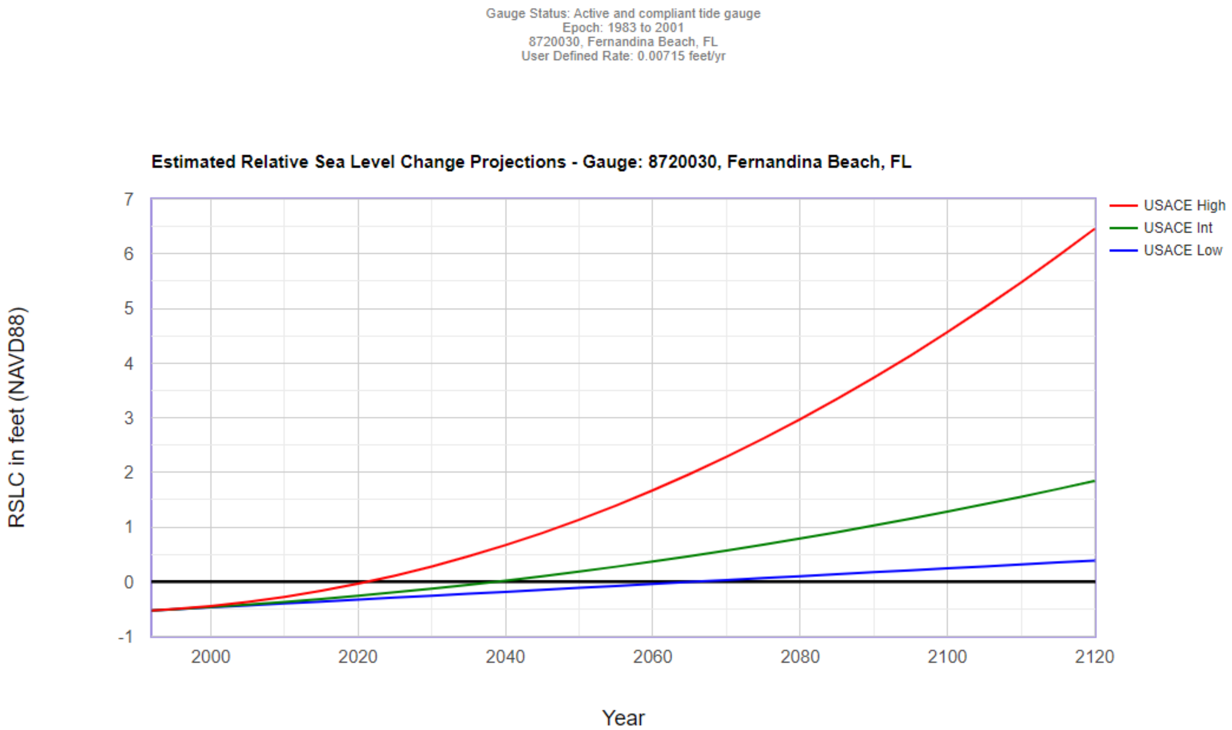


Figure 3-10: Sea Level Change Curve Calculator Output for Fernandina Beach, Florida, Showing Three USACE Scenarios

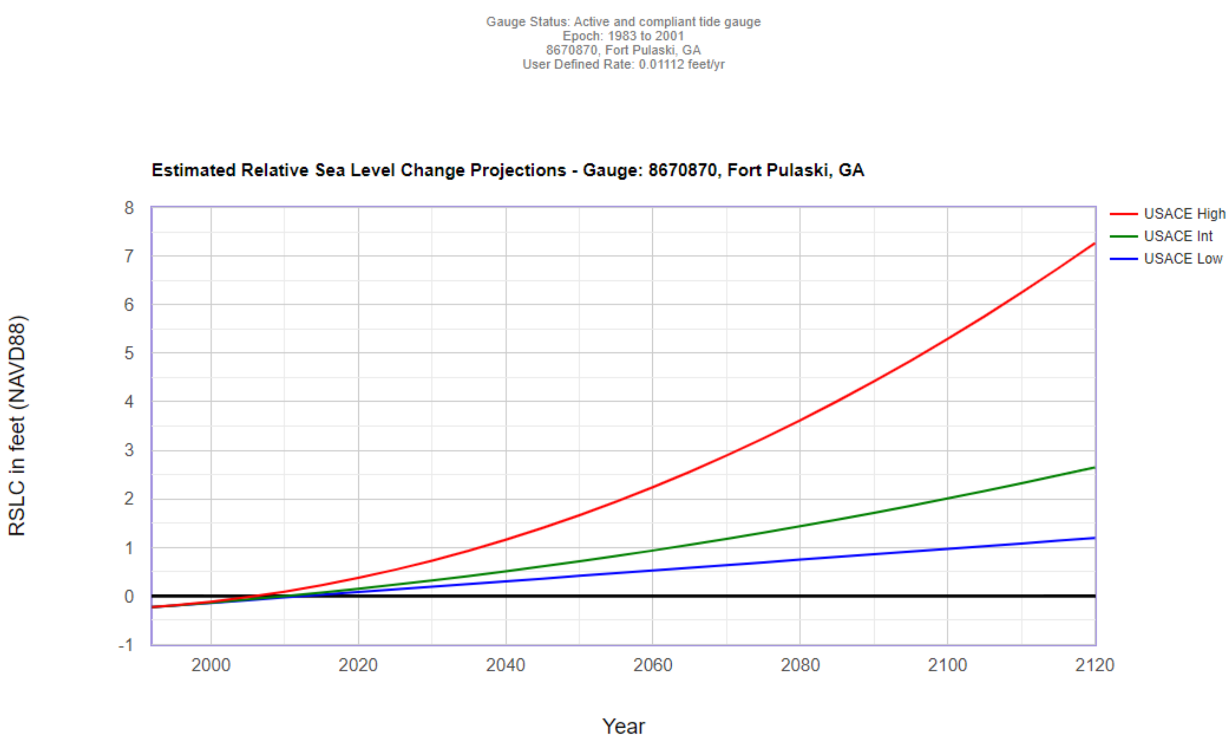


Figure 3-11: Sea Level Change Curve Calculator Output for Fort Pulaski, Georgia, Showing Three USACE Scenarios

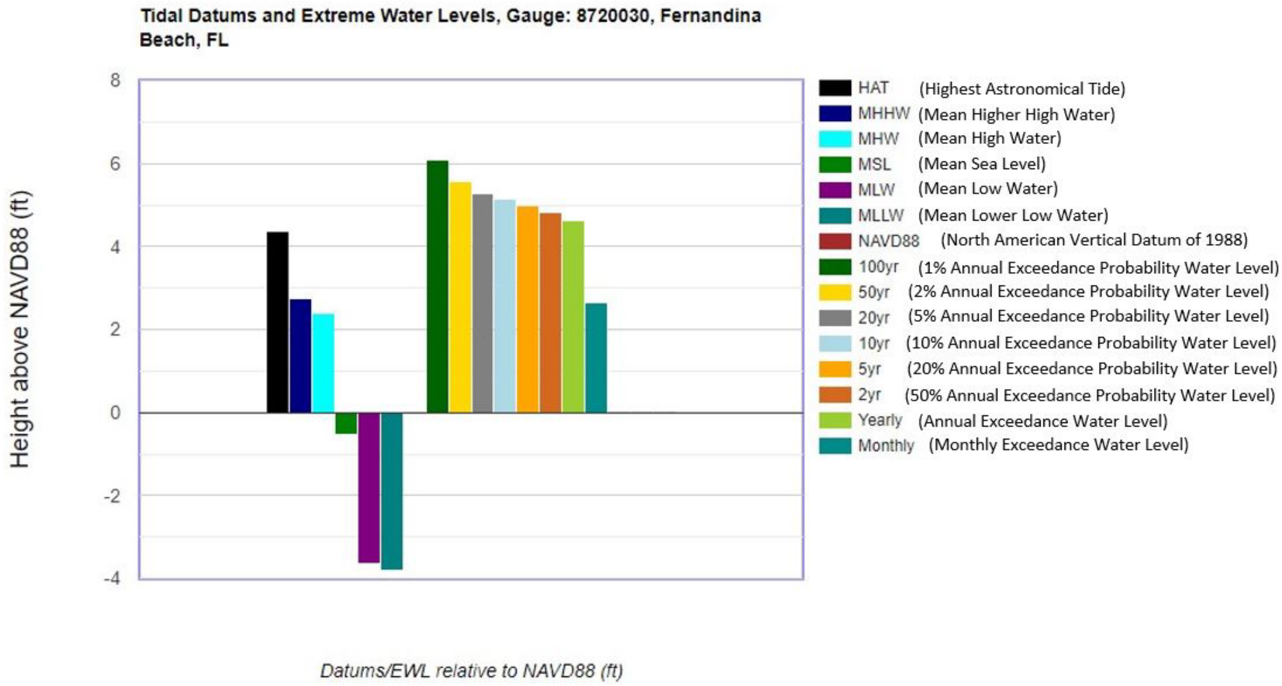


Figure 3-12: Sea Level Change Curve Calculator output for Fernandina Beach, Florida, showing Tidal Datums and Extreme Water Levels

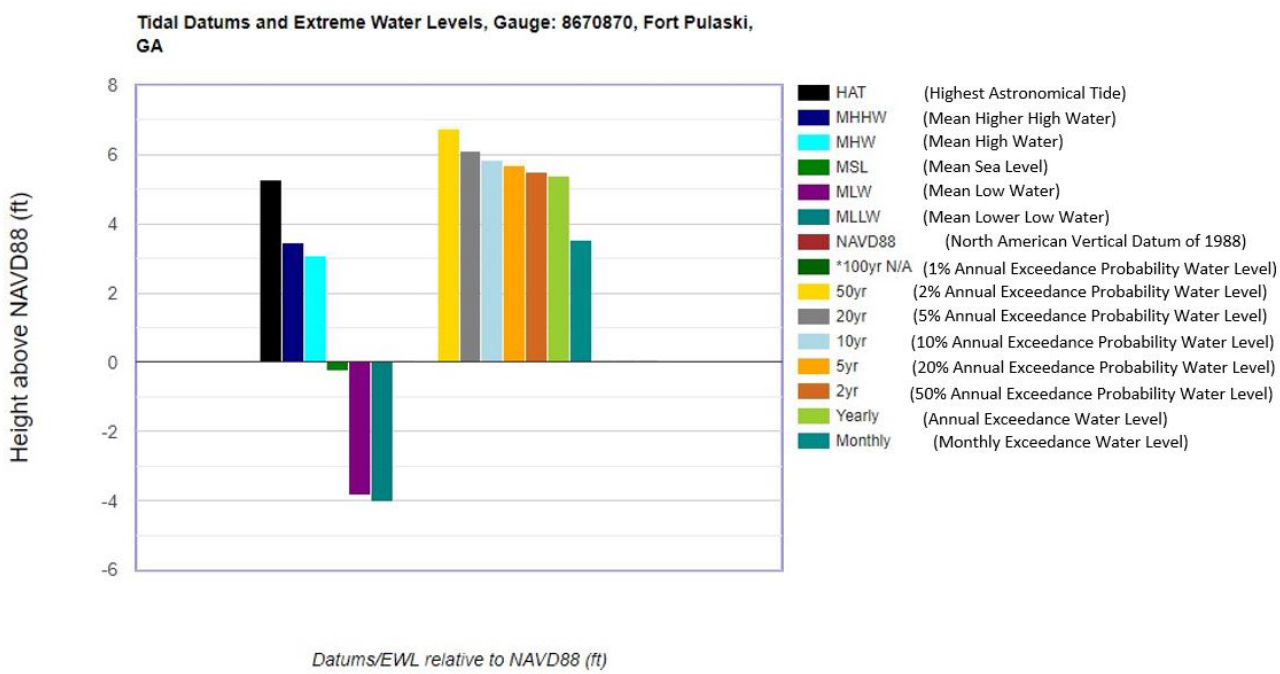


Figure 3-13: Sea Level Change Curve Calculator Output for Fort Pulaski, Georgia, Showing Tidal Datums and Extreme Water Levels

3.8.3 Sea Level Tracker

The USACE Sea Level Tracker tool allows users to view trends in historic sea level change at compliant gauge locations. Actual mean sea level at the gauge location can be visualized and compared with the three USACE sea level change scenarios presented above. The Sea Level Tracker plots for the two gauge locations previously discussed, Fernandina Beach, Florida and Fort Pulaski, Georgia, are shown in **Figure 3-14** and **Figure 3-15** using the same scenarios and rates discussed in the previous section. For both locations the 19-year moving average (dark blue) is tracking along the USACE Intermediate scenario while the shorter period 5-year moving average (light blue) is tracking between the Intermediate and the High scenarios. As shown in the below figures, historically there has been considerable short-term variability in measured sea levels. Therefore, the 19-year moving average, covering a long period of measurements is typically considered to be the most representative of the long-term sea level trend. USACE guidance considers all sea level change scenarios equally probable.

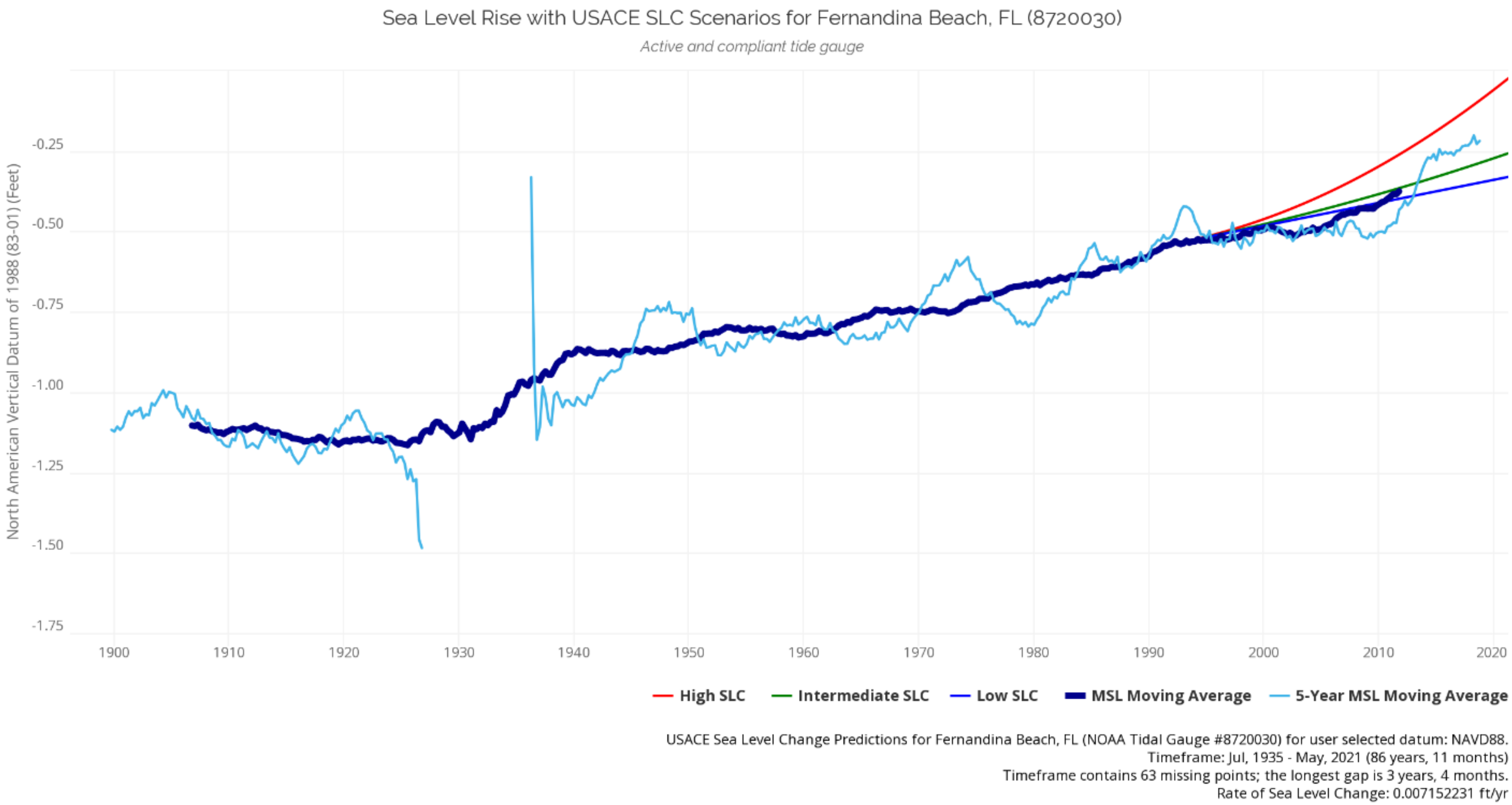


Figure 3-14: Sea Level Tracker for Fernandina Beach, Florida

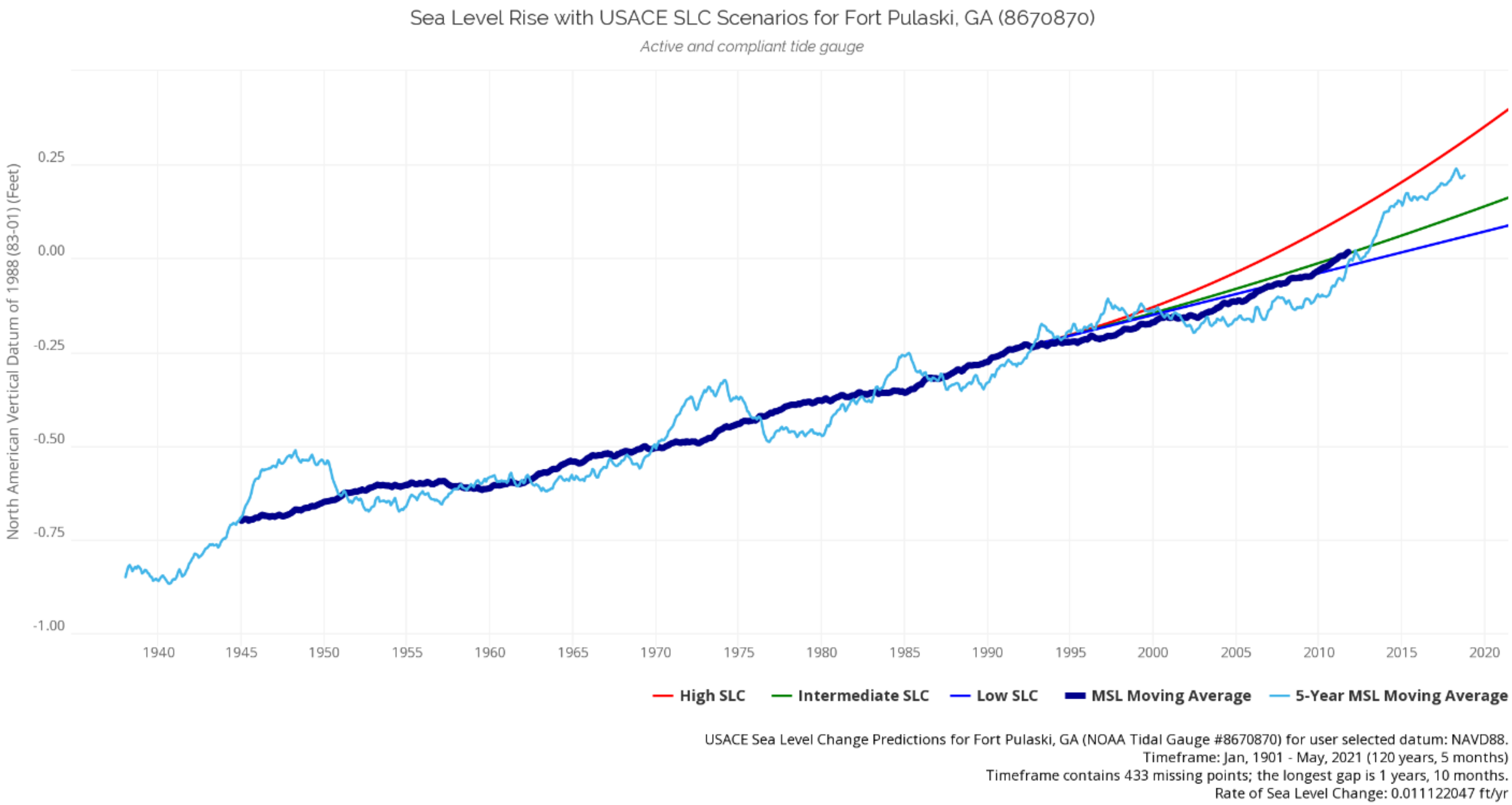
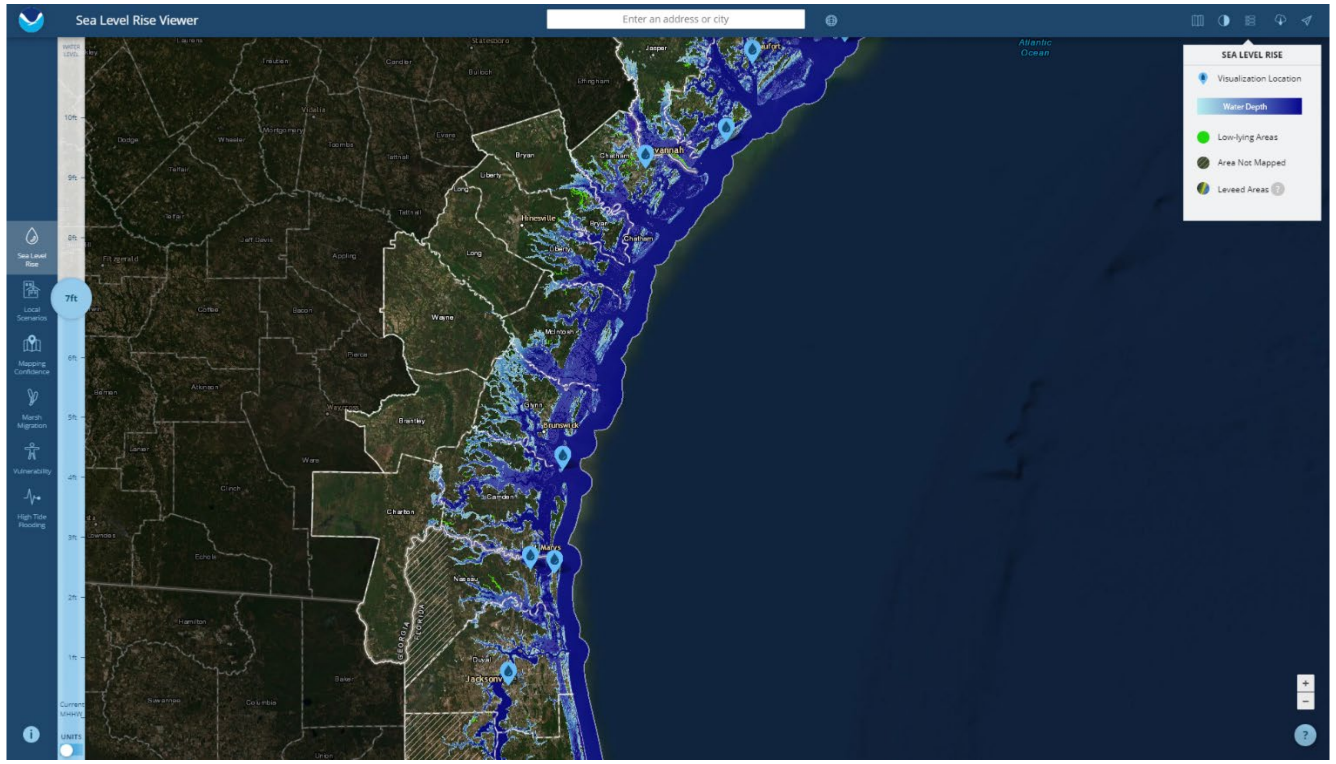


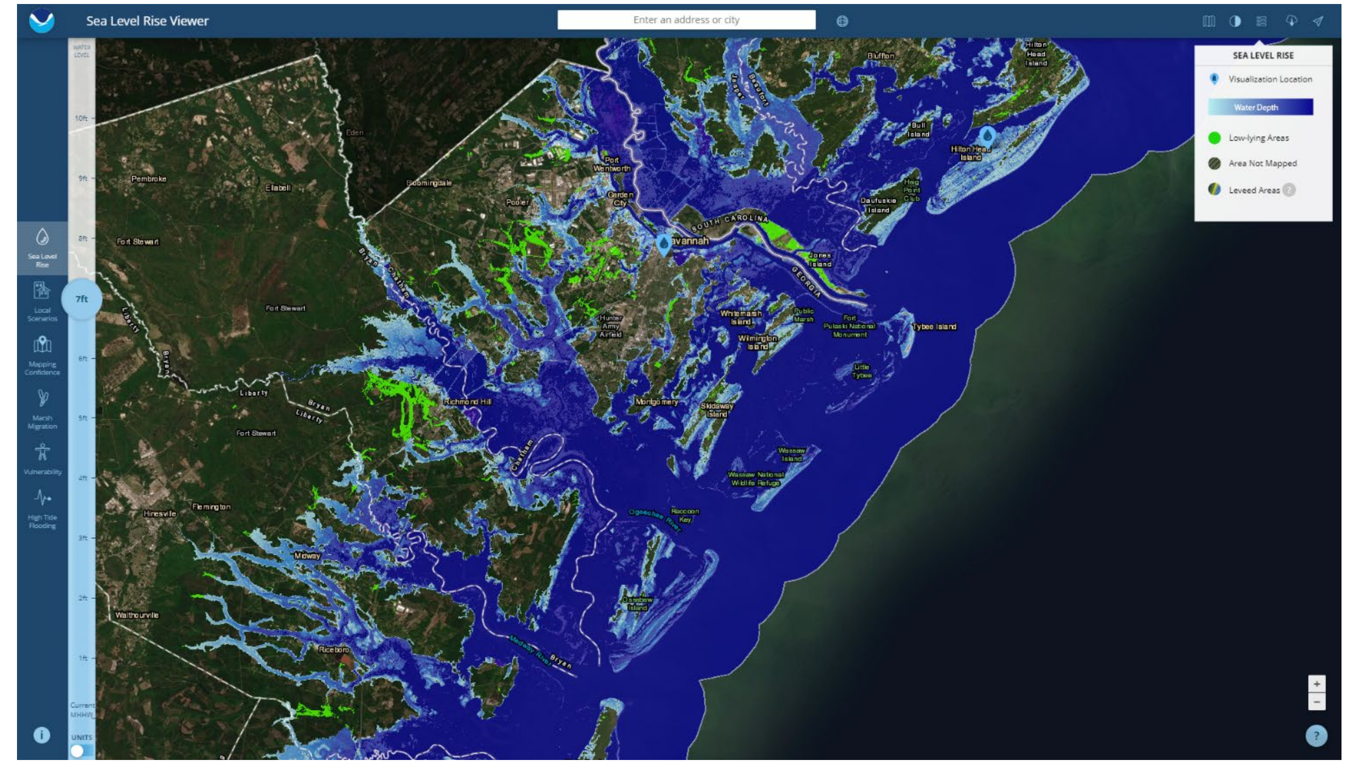
Figure 3-15: Sea Level Tracker for Fort Pulaski, Georgia

3.8.4 NOAA Sea Level Rise Viewer

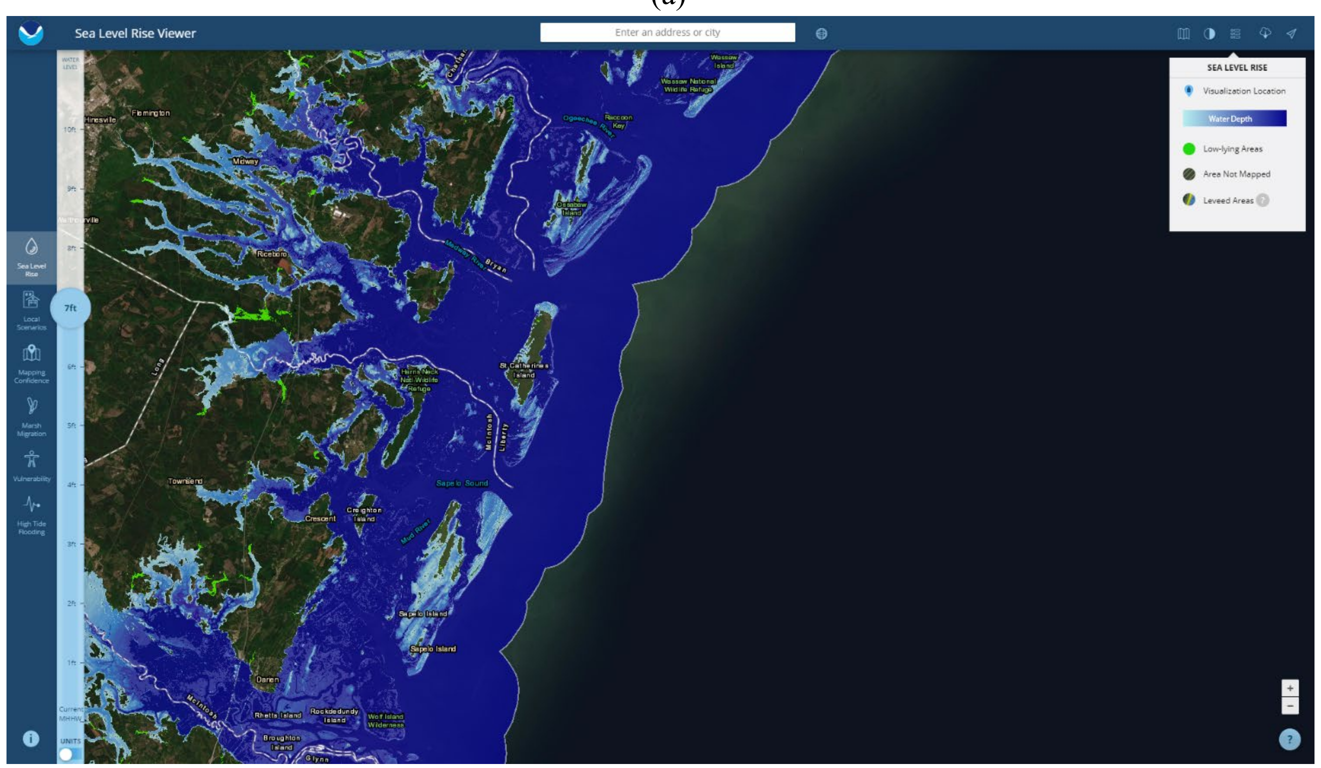
The NOAA Sea Level Rise Viewer is a tool used to simulate the inundation footprint due to elevated sea levels relative to local mean higher high water. Based on the USACE Sea Level Change Curve Calculator, the expected sea level rise using the USACE High Scenario is between about 6.5 and 7.5 feet in 2120. The NOAA Sea Level Rise Viewer tool was used at multiple locations across the state of Georgia to demonstrate the potential impacts of the USACE High Scenario estimate on coastal communities by applying 7 feet of sea level rise. The results for all of coastal Georgia, the Savannah area on the north coast, the central coast, and the Brunswick area and south coast are provided as examples in **Figure 3-16**. This figure shows that under the USACE High Scenario, the extent of the inundation footprint varies across the state, but it covers many highly populated areas as well as cultural and environmental resources. Also, of note is that there is large scale inundation of many of the barrier islands making the entire coast more susceptible to other hazards like storm surge and wave attack.



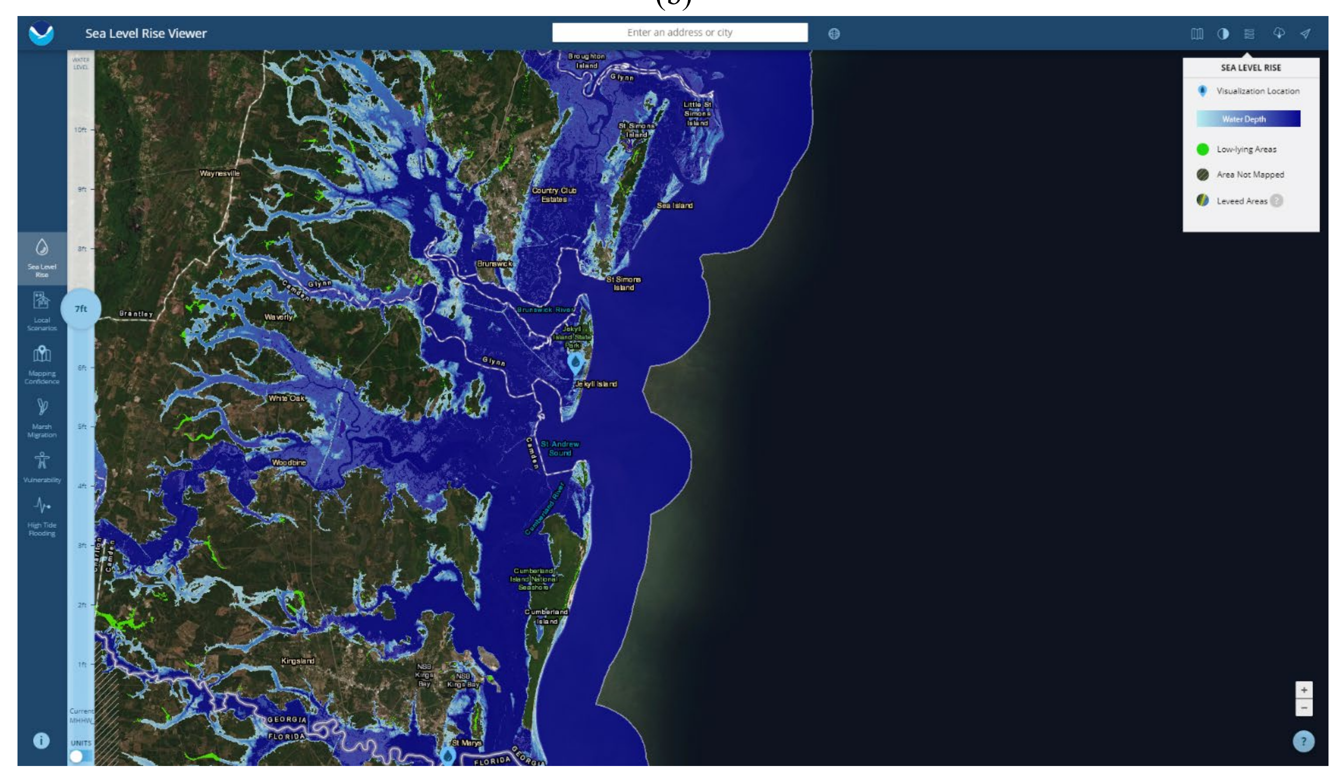
(a)



(b)



(c)



(d)

Figure 3-16: National Oceanic Atmospheric Administration Sea Level Rise Viewer Shown for all of (a) Coastal Georgia, (b) Savannah and the North Coast), (c) the Central Coast, and (d) Brunswick and the Southern Coast, with an Estimated 7-Foot Sea Level Rise Relative to Mean Higher High Water

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SECTION 4
Risk Assessment

The following sections detail hazard, exposure, and vulnerability information used to complete Tier 1 and Tier 2 Risk Assessments for Planning Reach GA_05. The goal of the Tier 1 Risk Assessment was to broadly identify locations where coastal storm flooding causes risk under existing conditions and where that risk is expected to increase by sea level rise using national-level datasets. The Tier 2 Risk Assessment provides additional detail of the flood risk using state- and local-level datasets and by adding quantified damages estimates for infrastructure using FEMA's Hazus Flood Model, which is a standardized methodology that is used to estimate physical, economic, and social impacts of disasters and allows for the visualization of spatial relationships between populations and infrastructure and the hazard being modeled. The analysis included only coastal flooding and omitted any riverine flooding contributions to flood water elevations.

The SACS refers to risk and vulnerability as defined in Engineering Regulation (ER) 1105-2-101. The ER clearly states that flood risk can be conceptualized as a function of the hazard, performance, exposure, vulnerability, and consequences, as depicted in **Figure 4-1**. As such, risk can be reduced by modifying these components (i.e., by reducing vulnerability or exposure).

ER 1105-2-101 broadly defines risk as a situation or event in which something of value is at stake, and its gain or loss is uncertain. Risk is typically expressed as a combination of the likelihood and consequence of an event. Consequences are measured in terms of harm to people, cost, time, environment, property, and other metrics.

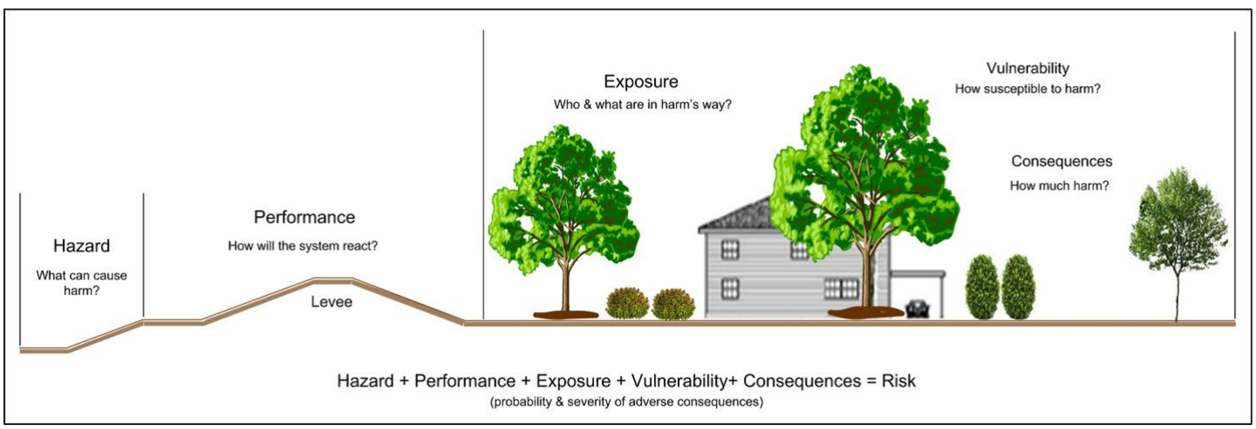


Figure 4-1: Risk Conceptualized

Definitions of risk components as utilized in the SACS include:

Hazard – In a general sense, hazard is anything that is a potential source of harm to a valued asset (human, animal, natural, economic, and social) (USACE 2014).

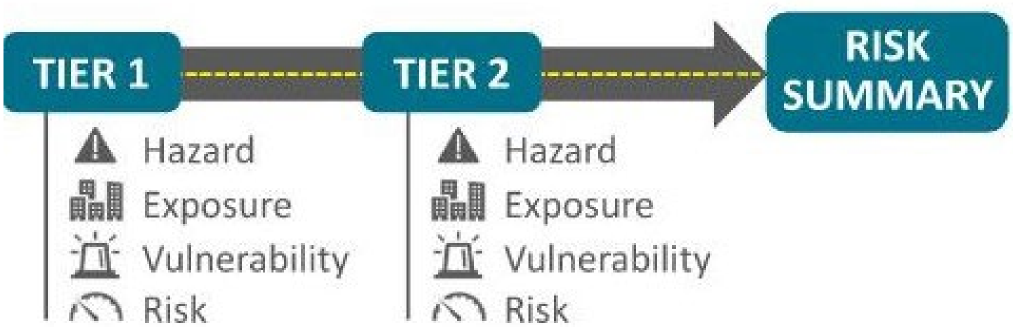
Performance – System's reaction to the hazard, and its features and the capability to contain or manage the hazard for the full range of possible events. In the context of the SACS, performance can include multiple built or natural environments that contribute to how well the system reacts to a hazard.

Exposure – Describes who and what may be harmed by the flood hazard. Exposure incorporates a description of where the flooding occurs at a given frequency, and what assets exist in that area.

Vulnerability – Susceptibility of harm to human beings, property, and the environment when exposed to a hazard. Depth-damage functions, depth-mortality functions, and other similar relationships can be used to describe vulnerability.

Consequence – Harm that results from a single occurrence of the hazard. Consequences are measured in metrics such as economic damage, acreage of habitat lost, value of crops damaged, and lives lost.

Risk – Combination of likelihood and harm to people, property, infrastructure, and other assets.



This icon will serve as a guide through the Risk Assessment sub-sections. A red color indicates the risk component currently being assessed for a given Planning Reach.

In addition to planning reaches and county designations, several results from Tier 1 and Tier 2 analyses are reported by geographic types defined by the U.S. Census Bureau, mainly census places and census blocks. The following description of these areas is sourced from the University of Pittsburgh's census information guide (University of Pittsburgh 2020) (**Figure 4-2**).

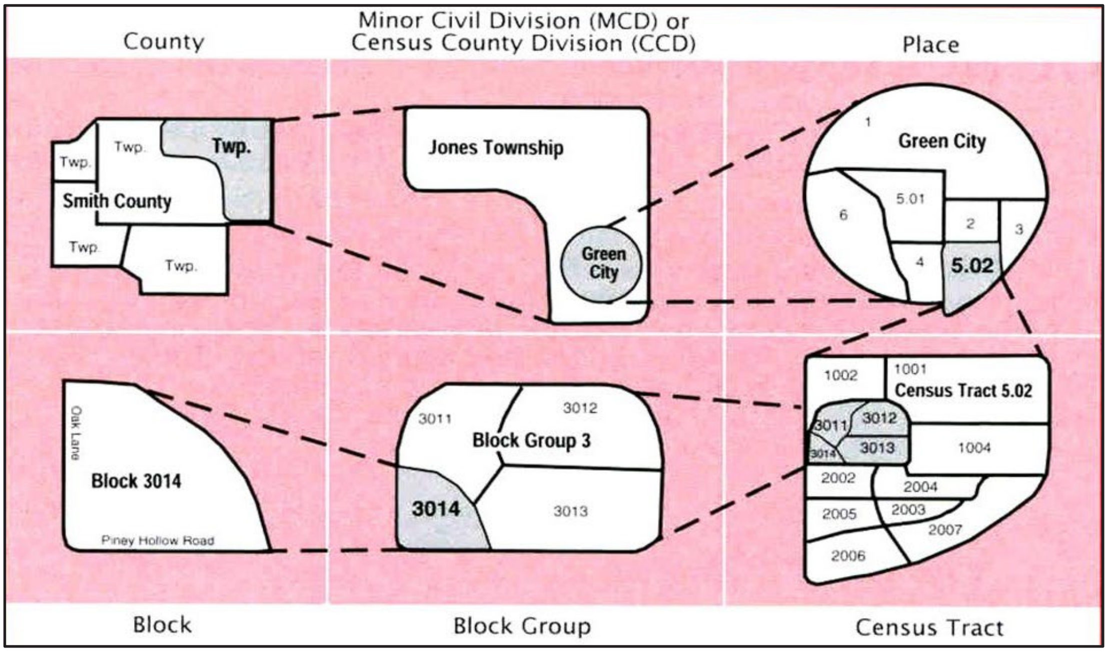
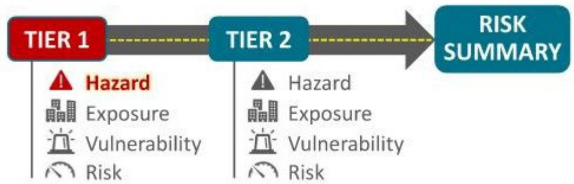


Figure 4-2: Understanding the Relationship Among U.S. Census Bureau Geographic Entities (University of Pittsburgh 2020)

- **Counties** and equivalent areas are the primary divisions of most states, Puerto Rico, and the island areas. They include counties in 48 states; parishes in Louisiana; boroughs and census areas in Alaska; municipios in Puerto Rico; independent cities in Maryland, Missouri, Nevada, and Virginia; and other entities in the island areas.
- **Census places** are concentrations of population, such as cities that have legally prescribed boundaries, powers, and functions.
- **Census tracts** generally contain between 1,000 and 8,000 people with an optimum size of 4,000 people. Census tract boundaries are delineated with the intention of being stable over many decades, so they generally follow relatively permanent visible features. However, they may follow governmental unit boundaries and other invisible features in some instances. The boundary of a state or county is always a census tract boundary.
- **Census blocks** are statistical areas bounded by visible features, such as streets, roads, streams, and railroad tracks, and by invisible boundaries, such as selected property lines and city, township, school district, and county limits and short line-of-sight extensions of streets and roads.

4.1 Planning Reach GA_05 Risk Assessment



4.1.1 Tier 1 Hazards

In a general sense, a "hazard" is anything that is a potential source of harm to a valued asset (human, animal, natural, economic, and social) (USACE 2014a). The Tier 1 Risk Assessment provides a consistent regional assessment of coastal flood risk caused by storm surge and sea level rise for the SACS study area scale. This is because, of all coastal storm hazards, storm surge inundation has the greatest potential to negatively impact populations and infrastructure. FEMA states that, "Floods are the most common and costly national disasters in the United States." (FEMA 2019a).

Tier 1 flood hazards include the following list of water levels. Additional descriptions are provided in the Geospatial Appendix.

- 10-percent AEP water levels from the U.S. Army Engineer Research and Development Center Coastal and Hydraulics Laboratory (ERDC/CHL).
- 1-percent AEP water levels imported from the FEMA National Flood Hazard Layer (NFHL).
- Category 5 Hurricane Maximum of Maximum (MOM) hazard from NOAA's Sea, Lake, and Overland Surges from Hurricanes (SLOSH) model (Zachry et al. 2015; Jelesnianski et al. 1992).

In Tier 1, 3 feet of sea level rise was added to the 1-percent and 10-percent AEP flood hazard layers to simulate future flooding events. Three feet of sea level rise was not added to the Category 5 MOM due to the uncertainty of SLOSH modeling for such major events, as well as the extremely low probability of occurrence. The spatial extent of the 1-percent and 10-percent AEP events plus 3 feet of sea level rise fall within the bounds of spatial extent of the Category 5 MOM.

The timeframe of when 3 feet of sea level rise is projected to occur is dependent on the projection scenario and specific location within the SACS study area. **Figure 4-3** shows projected sea level change relative to a start year of 2020. The average of all active and compliant gauges (record lengths of greater than 40 years) throughout the SACS study area is plotted as the solid-colored line for each scenario. The shaded areas around each line show the variability range across the SACS study area.

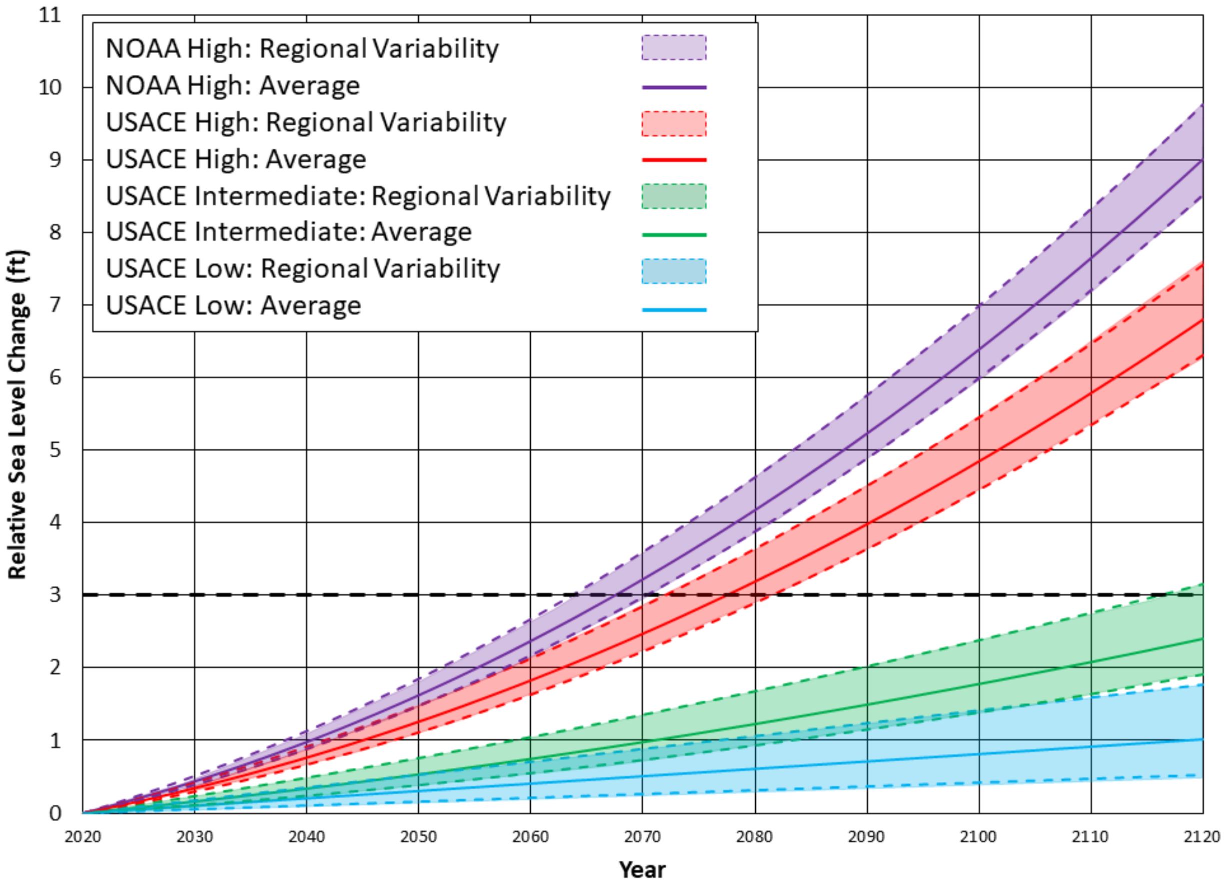


Figure 4-3: Mean Regional Sea Level Rise Projections for All Compliant Gauges Relative to 2020 Throughout the SACS Study Area

Figure 4-4 displays the existing (2020) and future flood hazards for Planning Reach GA_05, which includes the 10-percent AEP flood, the 1-percent AEP flood, and the Category 5 MOM. The Georgia coastline is dominated by low lying barrier islands and undeveloped marsh. Current flooding significantly impacts the barrier islands along the exposed Atlantic shoreline and extends into the back bay regions via channels and rivers. Marsh regions between and behind islands are typically inundated by flood events that exceed the 10-percent AEP flood level. Roadways and developed regions in low lying parts of the barrier islands and along channels and rivers begin to experience extensive flooding for events that exceed the 25-percent AEP flood level.

In the future condition with 3 feet of sea level rise, the inundation extent is increased in many of the coastal, back bay, and riverine areas showing the extent to which sea level rise would exacerbate existing coastal flooding hazards. It is expected that under the future condition, developed portions of the barrier islands would flood extensively for events that exceed the 10-percent AEP flood level. Coastal and inland flooding would increase significantly for all flood levels, particularly in the undeveloped regions that dominate the central coastline of the state and riverine areas. The extent of flooding is expected to vary significantly depending on natural topography as well as developed areas that may be elevated or include flood prevention measures.

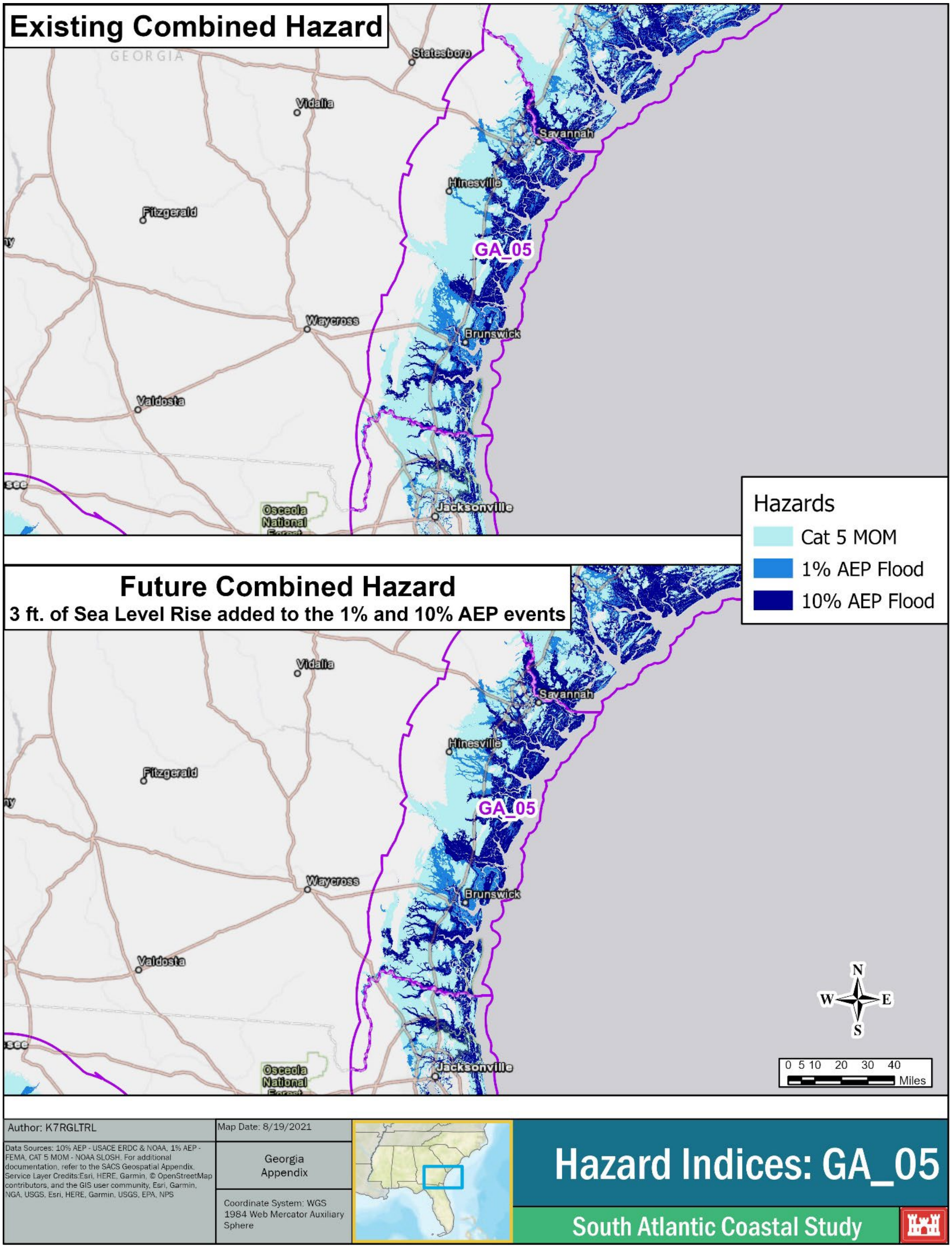
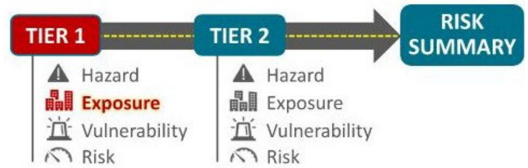


Figure 4-4: Existing and Future Hazard Indices for Planning Reach GA_05 from the 10-Percent Annual Exceedance Probability Flood, the 1-Percent Annual Exceedance Probability Flood, and the Category 5 Maximum of Maximum

4.1.2 Tier 1 Exposure



Exposure describes who and what may be harmed by the flood hazard. Exposure incorporates a description of where the flooding occurs at a given frequency and what exists in that area (ER 1105-2-101). At the broad Tier 1 scale, exposure was defined by the study area and not by individual hazard footprints. The Tier 1 analysis focused on the following categories and criteria to define exposure indices:

- **Population and Infrastructure Exposure Index:** Population density includes the number of people within an aerial extent across the study area. Infrastructure includes the critical infrastructure that supports the population and communities. These factors were combined to reflect overall exposure of the built environment.

- **Environmental and Cultural Resources Exposure Index:** This exposure index captures important habitat and selected cultural resources that would be affected by storm surge. Cultural resources were selected through both quantitative means, such as determining which cultural resources were located in areas of greater exposure, and qualitative means, such as literature review and stakeholder input.

- **Social Vulnerability Exposure Index:** Social vulnerability characterization includes certain segments of the population that may have more difficulty preparing for and responding to coastal flood events. Although this category is related to the vulnerability of the population within the study area, rather than actual exposure given the definition above, this category was maintained as an exposure index to maintain consistency with the NACCS.

The methodology and data used are described in the Main Report, Tier 1 Risk Assessment Viewer Overview tab, and the Geospatial Appendix. The three independent exposure indices identify the relative density of populations, infrastructure, environmental and cultural resources, and socially vulnerable populations within the existing condition. This information is important because it provides a better understanding of where there are facilities, populations and resources that could be exposed to harm by flood hazards.

The three independent exposure indices were weighted and added together to develop one Composite Exposure Index (CEI) to convey overall exposure. Weighting used in the NACCS methodology was 80/10/10 (80-percent population and infrastructure; 10-percent environmental and cultural resources; and 10-percent social vulnerability). The SACS weighting was modified from the NACCS to 60/30/10 (60-percent population and infrastructure; 30-percent environmental and cultural resources; 10-percent social vulnerability). This revised weighting better reflects the study authority and conditions in the study area for the following reasons:

- Lowering the weight of the Population and Infrastructure Exposure Index to 60 percent better reflects demographic differences in the coastal zone from the northeast. The southeast has lower urban population and development densities regionally and overall.

- Increasing the weight of the Environmental and Cultural Resources Exposure Index to 30 percent is consistent with authorizing language and better reflects the potential risk to vulnerable environmental resources that provide significant coastal storm risk management.

Figure 4-5 provides a visual overview of the three individual Tier 1 exposure indices for Planning Reach GA_05, as well as the CEI. Areas of red and amber indicate higher densities of populations, infrastructure, environmental and cultural resources, habitat, and socially vulnerable populations. Results of the specific exposure indices that contribute to the CEI are discussed in further detail in Sections 4.1.2.1 through 4.1.2.4.

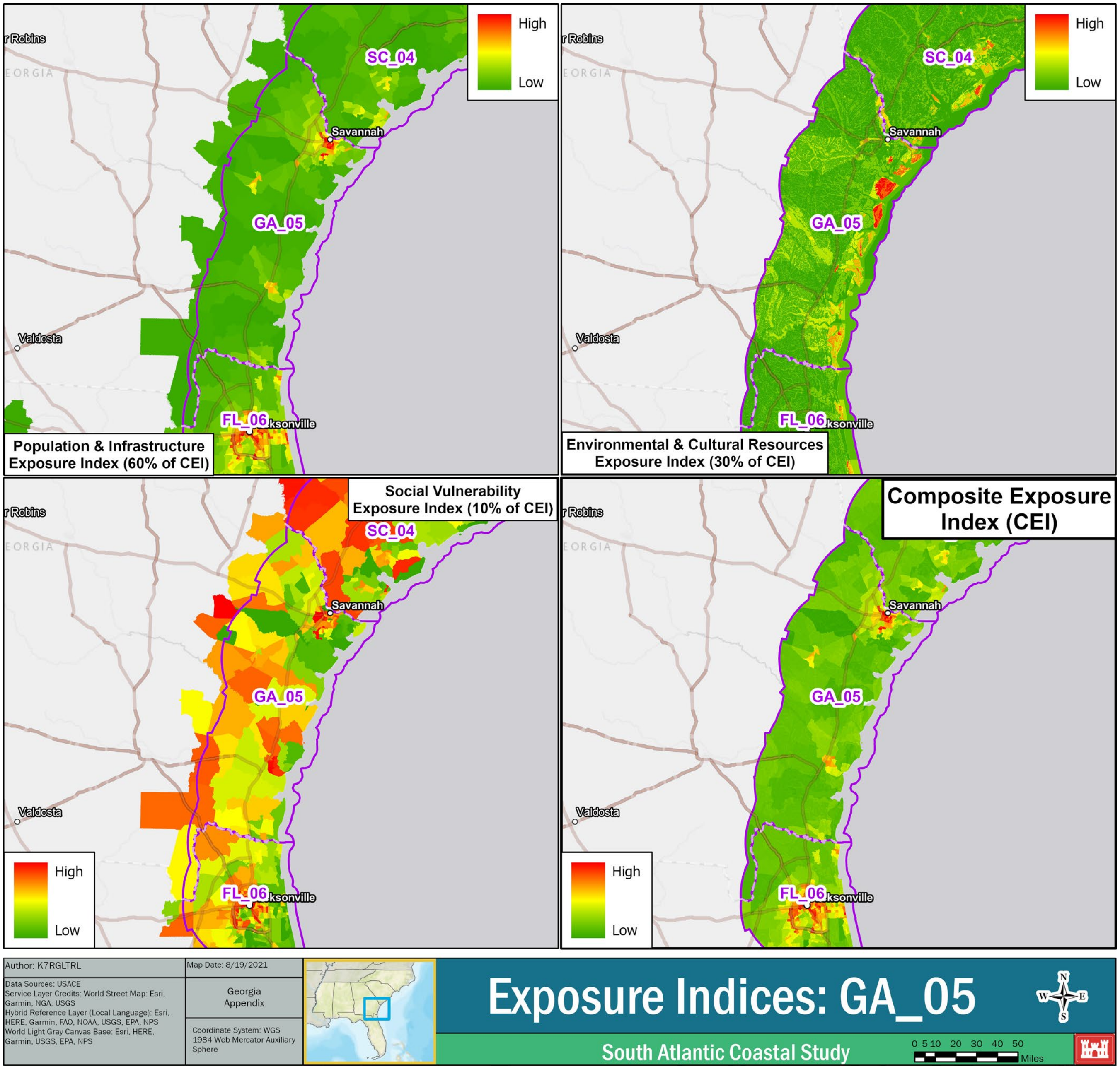


Figure 4-5: Exposure Indices in Planning Reach GA_05: Population and Infrastructure Exposure (Top Left), Environmental, Cultural, and Habitat (Top Right), Social Vulnerability (Bottom Left), and Composite Exposure (Bottom Right) under Current Conditions

4.1.2.1 Population and Infrastructure Exposure

The Tier 1 Population and Infrastructure Exposure Index used publicly available national and regional population and infrastructure datasets to reflect overall exposure of the built environment from coastal flood risk within the existing condition. The Population and Infrastructure Exposure Index datasets are detailed in Section 2.2.1 of the Geospatial Appendix. The population and infrastructure features were combined to reflect overall exposure from coastal flood risks as identified in **Figure 4-5**. **Figure 4-6** displays the Tier 1 individual Population (left) and Infrastructure (right) Exposure Indices for the planning reach. Population density includes the number of persons within an aerial extent across the study area; while infrastructure includes critical infrastructure that supports the population and communities. Areas of red and amber indicate areas of higher population density and infrastructure, while green indicates relatively low densities of population and infrastructure.

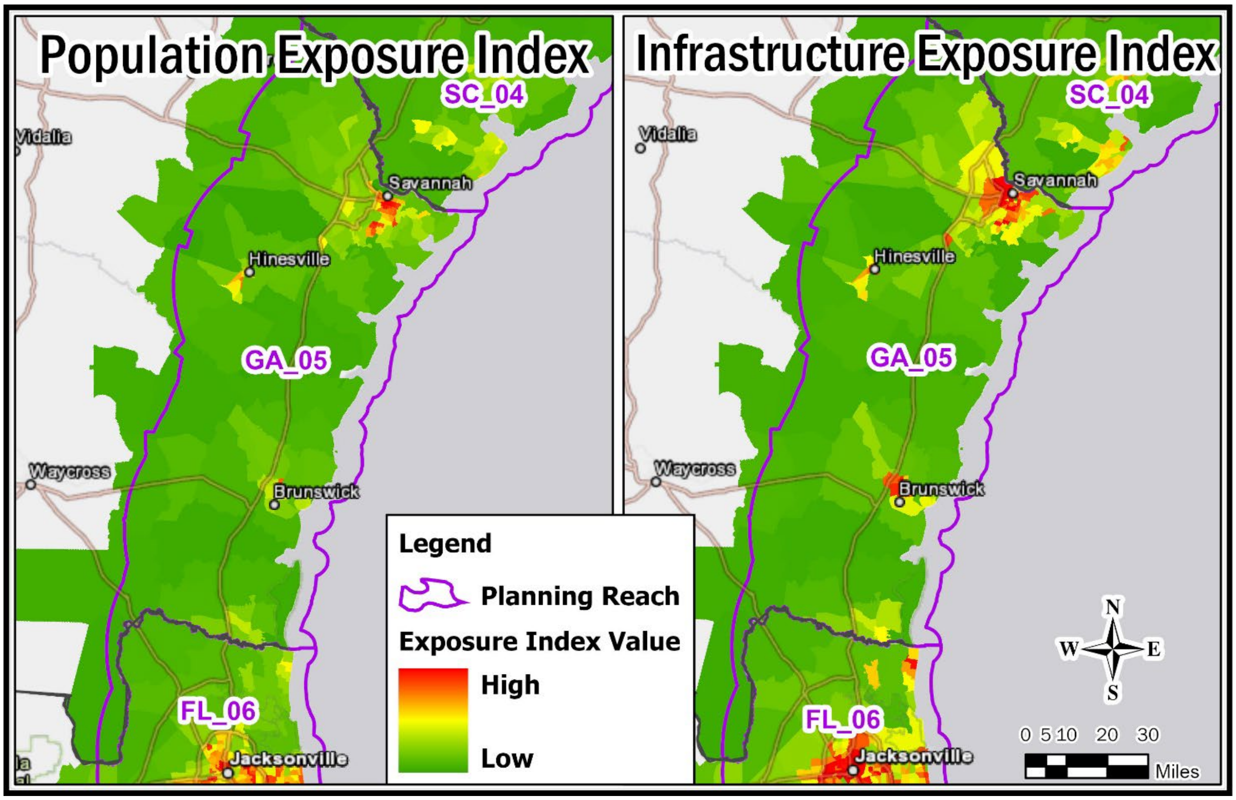


Figure 4-6: Tier 1 Population (left) and Infrastructure (right) Exposure Indices for Planning Reach GA_05 Under Existing Conditions

Based on the population and infrastructure exposure analysis, several hotspots of dense populations and infrastructure were identified within both coastal and inland areas. The city of Savannah in Chatham County has the highest population and supporting infrastructure within the planning reach, with corresponding high-exposure ratings identified in the Population and Infrastructure Exposure Index. Portions of unincorporated and adjacent Chatham County communities such as Garden City, Skidaway Island, White Bluff, Whitemarsh Island, and Wilmington Island were also classified as medium to high exposure, indicating denser populations and critical infrastructure potentially exposed from coastal flood risks caused by storm surge and sea level rise. Within the Savannah metropolitan statistical area, the city of Richmond Hill in Bryan County was identified as having medium-high exposure. Approximately 80 miles south of Savannah, portions of the city of Brunswick and unincorporated and adjacent communities such as Dock Junction and Country Club Estates within Glynn County were identified as areas with medium to medium-high exposure. The planning reach includes major ports in Savannah and Brunswick, with the Port of Savannah located in an area identified as medium to high exposure and Port of Brunswick in an area of lower exposure.

4.1.2.2 Environmental Exposure

The Tier 1 Environmental and Habitat Exposure Index used publicly available national and regional datasets to capture important habitat that would be affected by storm surge within the existing condition. The Environmental and Habitat Exposure Index datasets are detailed in Section 2.2.2 of the Geospatial Appendix. The habitat, environmental, and cultural features were combined to reflect overall exposure from coastal flood risks as identified in **Figure 4-5**. **Figure 4-7** displays the Tier 1 individual Environmental (left) and Habitat (right) Exposure Indices for the planning reach.

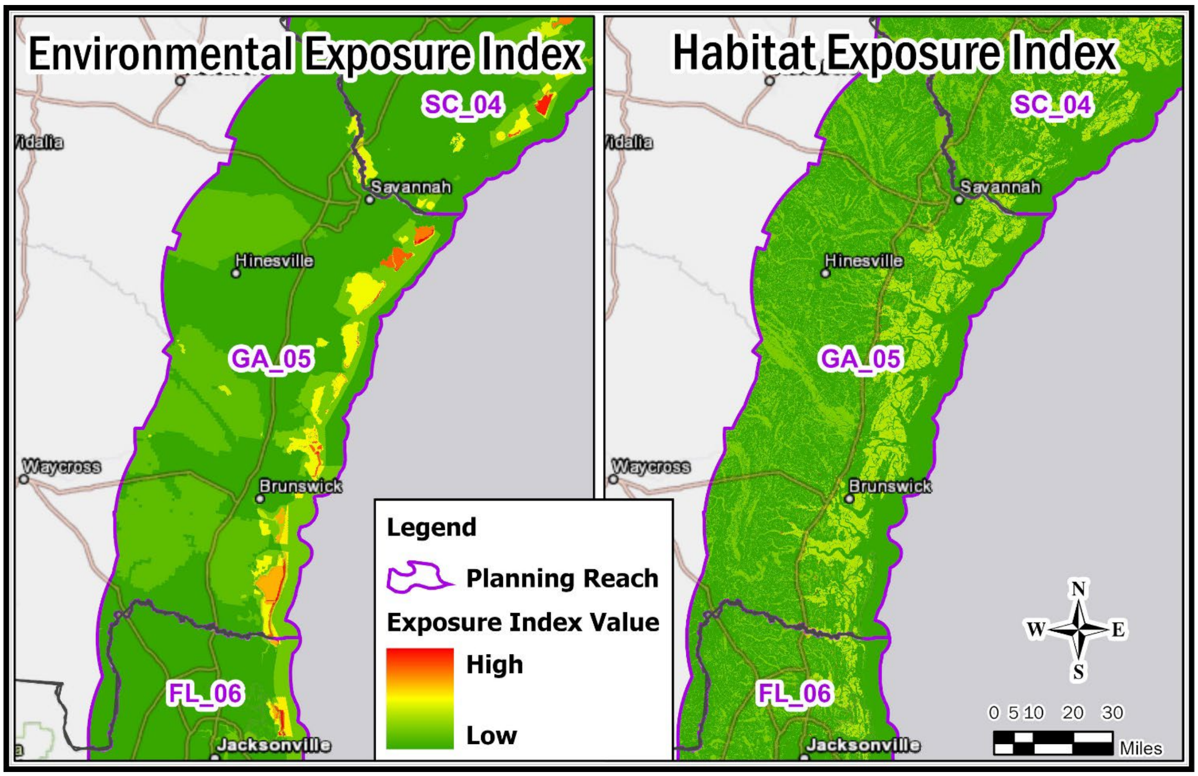


Figure 4-7: Tier 1 Environmental (Left) and Habitat (Right) Exposure Indices for Planning Reach GA_05 Under Existing Conditions

Notable densities of environmental resources, (indicated by red, amber, and yellow) are found in the barrier islands along Georgia's coast that consist of high marsh and hammocks (habitats not routinely inundated by tides), intertidal beaches, and coastal inlets (**Figure 4-7**). Reduction in this protective buffer would subsequently have direct impacts to successional wetlands and marshes (fresh and saltwater), those species dependent on barrier island habitats.

As shown in **Table 4-1**, many of the areas identified as medium-high to high exposure are barrier islands along the coastline, which contains a mixture of valuable habitat such as mudflats, low-lying saltmarsh, hammocks, high marsh, and maritime forests. The Georgia barrier islands provide valuable habitat for a wide range of fish and wildlife species as well as containing designated critical habitat for protected species including piping plover, loggerhead sea turtles, and West Indian manatees. Inundation exposure from coastal flood risks caused by storm surge and sea level rise can impact currently designated critical habitat for species such as the piping plover and the loggerhead sea turtle, by causing a loss of available nesting and foraging habitat.

Table 4-1: Tier 1 Environmental and Cultural Resources Exposure Index High to Medium Exposure Locations Under Existing Conditions

County	Designated Critical Habitat	High	Medium-High	Medium
Chatham	Little Tybee Island beach: piping plover	Little Tybee Island, Wassaw Island	–	Little Tybee Island, Wassaw Island
Bryan	–	–	–	Ossabaw Island
Liberty	St. Catherines Island beach	–	St. Catherines Island	N/A
McIntosh	Certain beaches: piping plover and loggerhead sea turtles	–	Blackbeard Island	Sapelo Island Wolf/Egg/Little Egg Islands
Glynn	Certain beaches: piping plover	Little St. Simons Island Jekyll Island	Little St. Simons Island Jekyll Island	–
Camden	Certain beaches: piping plover, loggerhead sea turtles, and West Indian manatee (nearshore)	–	Cumberland Island	Cumberland Island

4.1.2.3 Cultural Resource Exposure

The Tier 1 Cultural Resources Exposure Index used publicly available national and regional data sets, such as the National Register of Historic Places (NRHP) national database and Georgia's Natural, Archaeological and Historic Resources Geographic Information System (GNAHRGIS), to capture selected cultural resources that would be affected by storm surge within the existing condition. The Cultural Resources Exposure Index datasets are detailed in Section 2.2.2 of the Geospatial Appendix. Cultural resources were selected based on qualitative means (i.e., were located in areas of higher exposure) and quantitative means (i.e., stakeholder input). The habitat, environmental, and cultural features were combined to reflect overall exposure from storm surge as identified in **Figure 4-5**. **Figure 4-8** displays the Tier 1 individual Cultural Resource Exposure Index for the planning reach.

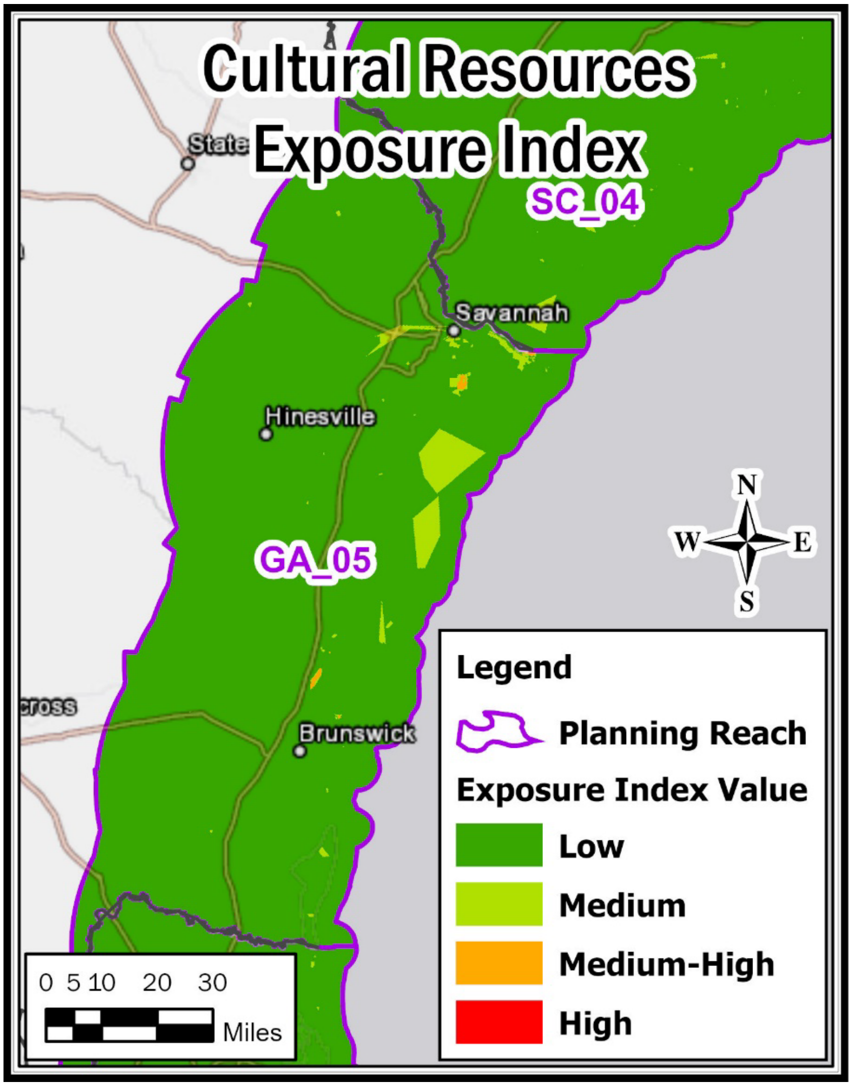


Figure 4-8: Tier 1 Cultural Resources Exposure Index for Planning Reach GA_05 Under Existing Conditions

Results of the Cultural Resource Exposure Index analysis shows that this planning reach holds several areas with medium to low densities of cultural resources throughout the planning reach (**Table 4-2**). Resources that have low to medium cultural resource exposure include prehistoric and historic archeological sites/structures within several of the coastal counties, as well as national monuments, a historical plantation, and historic districts. All of these cultural resources have the potential to be exposed within the future conditions by the projected 3 feet of sea level rise, threatening to negatively impact historically significant archeological sites and historic districts within the planning reach. The table below is not all-inclusive. Selected cultural resources located in these areas are included to serve as examples of the types of resources that may be present. The selection of these resources was based on a qualitative assessment of stakeholder feedback and the significance assigned to these historic resources and archaeological sites (typically National Register eligibility).

Table 4-2: Tier 1 Low to Medium Exposure Cultural Resources Locations Under Existing Conditions

County	Medium	Low
Chatham	Ft. Pulaski National Monument (north of Tybee Island)	Savannah Historic District; Savannah's historic cemetery; Ossabaw Island Historic District—39 square miles of prehistoric and historic archeological sites
Bryan	–	Fort McAllister
Liberty	–	St. Catherines Island Historic District—35 square miles of prehistoric and historic archeological sites; a 94-acre historic plantation
McIntosh	–	Sapelo, a 427-acre historic district; a post-Civil War African American settlement; Gullah Geechee Cultural Heritage Corridor; Ft. King George Historic Site
Glynn	Ft. Frederica Hofwyl-Broadfield Plantation	Colonial Brunswick (289 acres); Jekyll Island Club historic structures
Camden	–	Cumberland Island (700 acres) historic district; 21 buildings; nine archeological sites

4.1.2.4 Social Vulnerability Exposure

The Tier 1 exposure analysis helped identify areas with relatively high social vulnerability within the Planning Reach GA_05 in both coastal and inland areas as identified in red and orange in **Figure 4-9**. The primary data set used for the Social Vulnerability Exposure Index is the Centers for Disease Control (CDC) Social Vulnerability Index (SVI). The Social Vulnerability Index datasets are detailed in Section 2.2.3 of the Geospatial Appendix. The CDC uses 15 census-derived factors on a percentile index to create a generalized SVI at the census tract level. The SVI groups the 15 census-derived factors into four themes (socioeconomics, household composition/disability, minority/language, and housing/transportation) that summarize the extent to which the area is socially vulnerable to disaster. The 15 census-derived factors and their groupings are:

- Socioeconomic status (below poverty, unemployed, income, no high school diploma).
- Household composition and disability (aged 65 or older, aged 17 or younger, older than age 5 with a disability, single-parent households).
- Minority status and language (minority, speak English “less than well”).
- Housing type and transportation (multi-unit structures, mobile homes, crowding, no vehicle, group quarters).

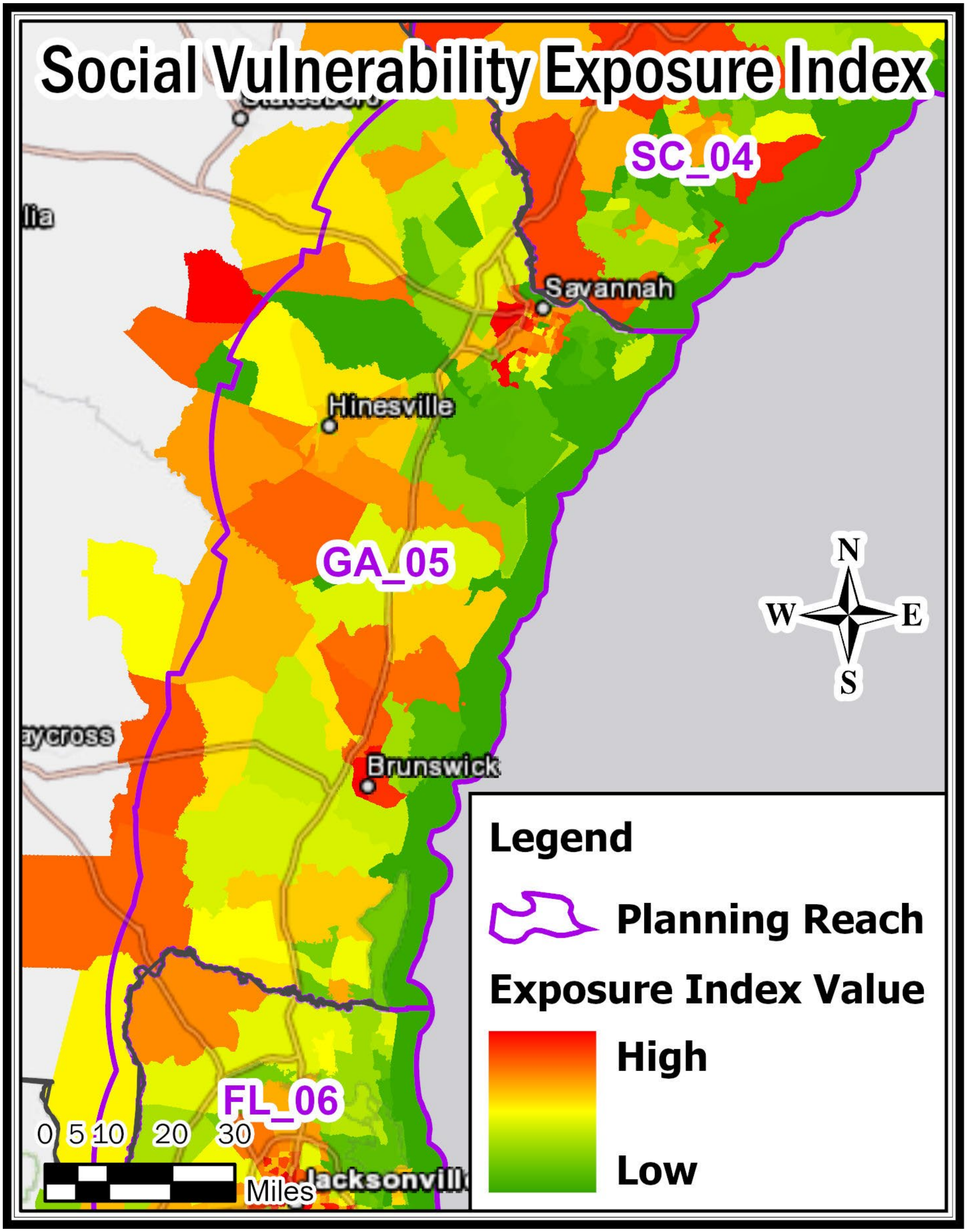


Figure 4-9: Tier 1 Social Vulnerability Exposure Index for Planning Reach GA_05 Under Existing Conditions

Within the coastal counties, areas identified with high social vulnerability are predominately located in Chatham and Glynn Counties, medium-high in McIntosh County, and medium in Camden County. As identified in **Figure 4-9**, the highest exposure values (shown in red) correlated with the more densely populated cities of Savannah and Brunswick. Notably, many barrier island communities are identified as having lower social vulnerability, while inland communities approaching the western terminus of the planning reach are largely within the moderate to moderate-high range.

An overall SVI score is calculated at the county level with possible scores ranging from 0 (lowest vulnerability) to 1 (highest vulnerability). Except for Bryan County, the overall scores for the Georgia coastal counties indicate a moderate to high level of social vulnerability. The major factors contributing to high vulnerability within these counties was further assessed by the scoring of the four themes identified in **Table 4-3** in conjunction with the 2010 Census demographic data.

Table 4-3: Centers for Disease Control Social Vulnerability Index Ranking for Coastal Counties

CDC SVI Score	Chatham County	Bryan County	Liberty County	McIntosh County	Glynn County	Camden County
Overall	0.6858	0.3403	0.8106	0.5817	0.7851	0.5540
Socioeconomic	0.5349	0.3833	0.7170	0.7650	0.5294	0.4798
Household Composition/Disability	0.2639	0.4979	0.6323	0.8691	0.8389	0.4467
Minority/Language	0.8526	0.6441	0.8599	0.505	0.8147	0.5842
Housing/Transportation	0.8424	0.1480	0.6988	0.0958	0.8045	0.6523

Socioeconomic aspects of particular concern that may affect a community’s ability to mitigate, evacuate, and recover from coastal flood hazards include mobile home residents, age, household income, vehicle availability, and crowded households.

Table 4-4 compares 2010 Census-derived demographic data for Planning Reach GA_05 to the national average. Excluding Chatham County, Georgia’s coastal counties have significantly higher percentage of mobile home residents than the state and national averages. McIntosh County has a CDC housing/transportation SVI Score of nearly 1, with approximately 40 percent of the county’s residents residing in mobile homes. These highly vulnerable residents may need help locating and securing safe shelter for themselves and their families in the event of a coastal storm.

Most coastal counties have poverty levels above the national average except for Bryan County. The low-income segment of the population may not have access to the physical or fiscal resources necessary to facilitate an evacuation. In Chatham County, a significant portion of the population (approximately 9 percent) does not own a vehicle, which may also necessitate transportation assistance to evacuate.

The age breakdown of the population reflects a larger number of people over age 65 living in McIntosh and Glynn Counties. With age comes the potential for prior hurricane experience, depending on the length of residence in the area. This experience could positively or negatively impact their evacuation decision making and behavior. Past behavioral studies have shown that persons over 65 are more reluctant to evacuate than younger populations (USACE 2013b).

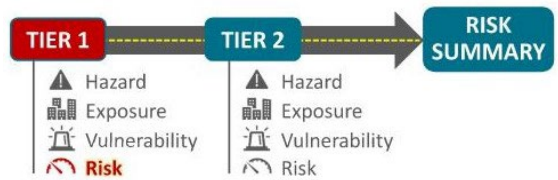
Table 4-4: Demographics by Coastal County (U.S. Census Bureau 2021, USACE 2013c)

Category	Demographics of Coastal Counties	National Average	Chatham County	Bryan County	Liberty County	McIntosh County	Glynn County	Camden County
Population	Population	308,745,538	265,128	30,233	63,453	14,333	79,626	50,513
Density	Persons per Square Mile	88.4	621.7	69.3	129.5	33.8	189.7	82.4
Age	Median Age	37.2	34.0	35.7	27.9	44.4	39.4	33.5
Age	Persons Under 18 Years	24.0%	22.6%	29.3%	30.2%	21.5%	24.2%	27.0%
Age	Persons Over 65 Years	13.0%	12.4%	9.0%	6.3%	17.3%	15.0%	9.0%
Race	White	72.4%	52.8%	80.2%	47.1%	61.5%	67.6%	74.7%
Race	African American	12.6%	40.1%	14.2%	42.2%	35.9%	26.0%	19.4%
Race	Asian	4.8%	2.4%	1.6%	2.0%	0.3%	1.2%	1.4%
Race	American Indian and Alaska Native	0.9%	0.3%	0.3%	0.6%	0.4%	0.3%	0.5%
Race	Native Hawaiian and Pacific Islander	0.2%	0.1%	0.1%	0.6%	0.1%	0.1%	0.2%
Race	Other	6.2%	2.2%	1.1%	2.9%	0.6%	3.0%	1.1%
Race	Two or More Races	2.9%	2.1%	2.5%	4.7%	1.2%	1.8%	3.0%
Housing Status	Occupied	88.6%	86.4%	90.7%	82.9%	64.8%	78.0%	85.5%
Housing Status	Owner-Occupied	65.1%	57.7%	75.0%	54.2%	78.4%	63.5%	65.4%
Housing Status	Renter-Occupied	34.9%	42.3%	25.0%	45.8%	21.6%	36.5%	34.6%
Housing Status	Vacant	11.4%	13.6%	9.3%	17.1%	35.2%	22.0%	14.5%
Income	Persons Below Poverty Level	15.3%	16.6%	11.0%	17.8%	16.6%	15.2%	15.3%
Income	Unemployed	10.8%	6.9%	5.8%	11.3%	8.1%	7.2%	9.5%
Other	High School Education or Higher	85.6%	87.4%	88.4%	88.7%	75.1%	86.1%	89.1%
Other	Households Without Vehicles	9.1%	8.6%	3.9%	5.9%	5.4%	6.2%	4.5%
Other	Mobile Home Residents	6.6%	4.7%	16.3%	19.7%	39.2%	11.5%	15.6%

4.1.3 Tier 1 Vulnerability

Vulnerability is the susceptibility of harm to human beings, property, and the natural environment when exposed to a hazard. For example, a structure made of cardboard is vulnerable when it comes in contact with an inch of water, but a brick structure isn't; that brick structure is not vulnerable (to damage) under that level of flooding. As the Tier 1 Risk Assessment relies on national level datasets and requires a consistent approach, the broad assumption made regarding vulnerability is that any exposed resources impacted by a flood hazard are vulnerable. That is, any asset, populations, or resources that are touched by the Tier 1 hazard footprint are considered vulnerable to a negative impact. While this is a broad assumption, it is relevant to the Tier 1 purpose, which provides an understanding of where the vulnerable 'hotspots' may be located across the region and where the likelihood may increase with sea level rise.

4.1.4 Tier 1 High-Risk Locations



Tier 1 Risk Assessment Viewer: https://sacs.maps.arcgis.com/apps/MapSeries/index.html?appid=c54beb5072a04632958f2373eb1151cf

The CEI and coastal flood inundation hazards were used to identify potential areas at risk. The Framework defines risk as a function of exposure and probability of hazard occurrence. The Tier 1 Risk Assessment involved applying what was learned from the Tier 1 Hazard analysis and the identification of where the exposed assets, populations, and resources are located, and considering how probable the conditions will be to actually cause harm. The outputs of this assessment were used to define risk. The Geospatial Appendix describes how each of the inundation hazards (Category 5 MOM, 1-percent AEP flood, 10-percent AEP flood) and sea level rise were combined with the CEI to generate potential risk data presented in the Tier 1 Risk Assessment.

To identify Tier 1 high-risk locations, the Composite Risk Index (CRI) was intersected with U.S. Census Bureau place boundaries using zonal statistics. U.S. Census Bureau census places were used to define the boundaries of high-risk locations. Two thresholds were applied to determine if a census place exhibited potential high risk in either the existing condition, future condition with sea level rise, or both. The combination of medium-high and high composite risk needed to cover at least:

1. 50 acres of the census place for the continental U.S. This is a conservative threshold, approximately equal to an area extending 1 mile along a shoreline and two blocks inland.
2. 0.5 percent of the total area of a census place.

If a census place met both thresholds, the area was considered to be potentially at high-risk. Twenty-three census places in five counties (Chatham, Bryan, McIntosh, Glynn, and Camden) met those criteria. Fifteen census places are in Chatham County, one in Bryan County, one in McIntosh County, four in Glynn County, and two in Camden County. Tier 1 high-risk locations for the entire Planning Reach GA_05 are summarized in **Table 4-5** and the existing and future conditions (3 feet of sea level rise) CRI results are displayed in **Figure 4-10**.

Table 4-5: Planning Reach GA_05 Tier 1 High-Risk Locations (Census Places)

County	Census Place	Identified as Existing Condition High-Risk Location	Identified as Future Condition High-Risk Location
Bryan	Richmond Hill	X	X
Camden	Kingsland	X	X
Camden	St. Marys	X	X
Chatham	Dutch Island	X	X
Chatham	Garden City	X	X
Chatham	Georgetown	X	X
Chatham	Isle of Hope	X	X
Chatham	Montgomery	X	X
Chatham	Pooler	X	X
Chatham	Port Wentworth	X	X
Chatham	Savannah	X	X
Chatham	Skidaway Island	X	X
Chatham	Talahi Island	X	X
Chatham	Thunderbolt	X	X
Chatham	Tybee Island	X	X
Chatham	Vernonburg	N/A	X
Chatham	Whitemarsh Island	X	X
Chatham	Wilmington Island	X	X
Glynn	Brunswick	X	X
Glynn	Country Club Estates	X	X
Glynn	Dock Junction	X	X
Glynn	St. Simons	X	X
McIntosh	Darien	X	X

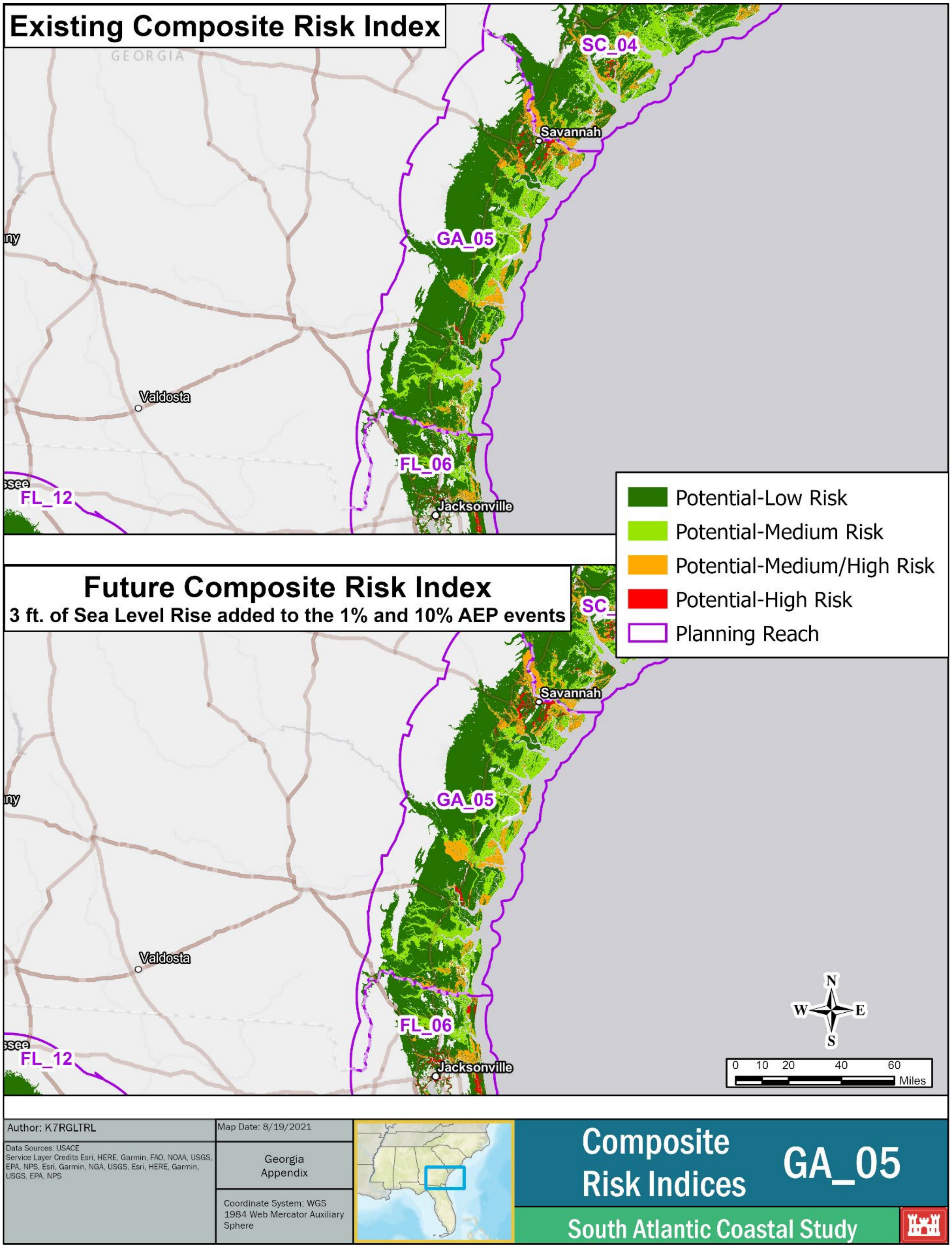


Figure 4-10: Existing and Future Composite Risk Indices for Planning Reach GA_05

When viewed at a larger scale, more detail can be observed when assessing the change in risk between the existing and future condition. As identified in the Chatham County example below, with the addition of 3 feet of sea level rise in the future condition, the expansion of medium-high (amber) and high (red) composite risk areas are notable adjacent to the riverine channels of the Savannah, Little Ogeechee and Skidaway Rivers and their numerous tributaries (**Figure 4-11**).

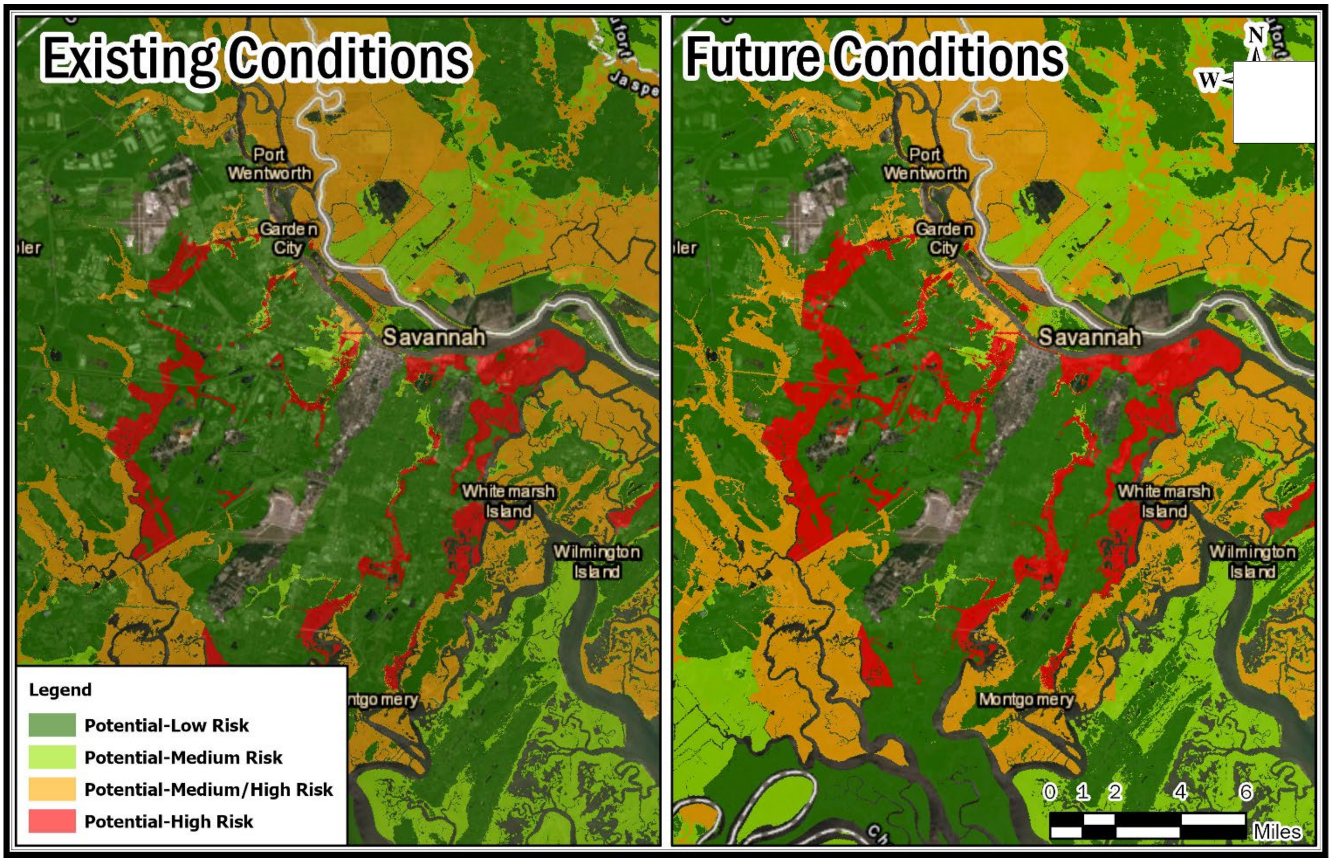


Figure 4-11: Existing and Future Composite Risk Indices for Chatham County

The mean CRI and the area of a place exhibiting potential medium-high- and high-risk are both important factors. Additionally, significant CRI increases with 3 feet of sea level rise in the future condition are important considerations. These factors represent different ways of approximating the existing and future potential risk within each census place.

Figure 4-12 displays the existing and future mean CRI ratings for medium-high- and high-risk locations per census place in Planning Reach GA_05. The mean CRI indicates the relative risk from inundation to populations, infrastructure, and environmental and cultural resources. With sea level rise, Vernonburg meets the high-risk thresholds described above. All other locations identified as high-risk in the future condition were also classified as high-risk within the existing condition.

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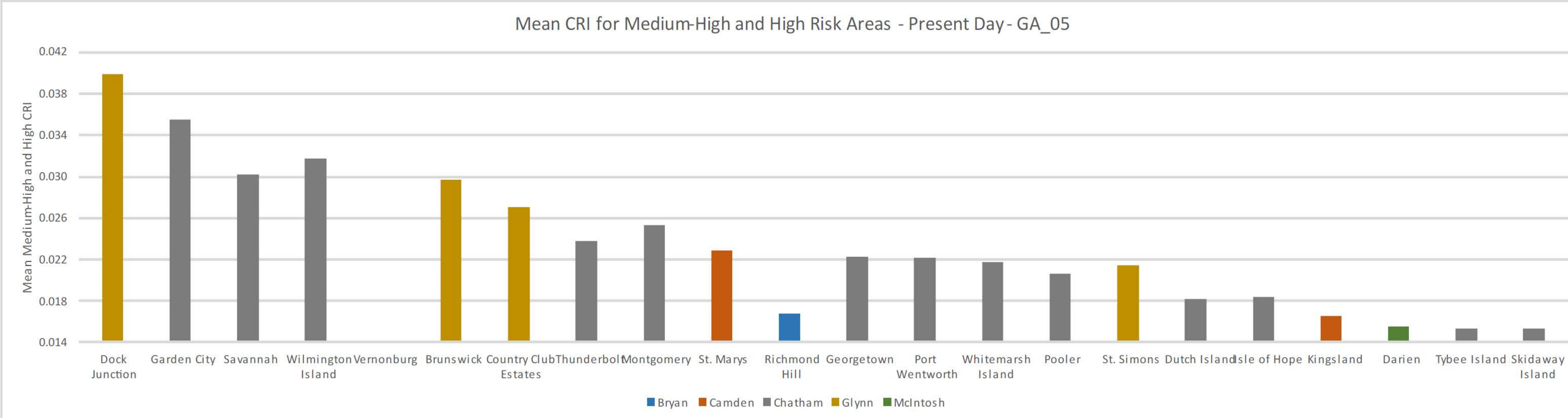

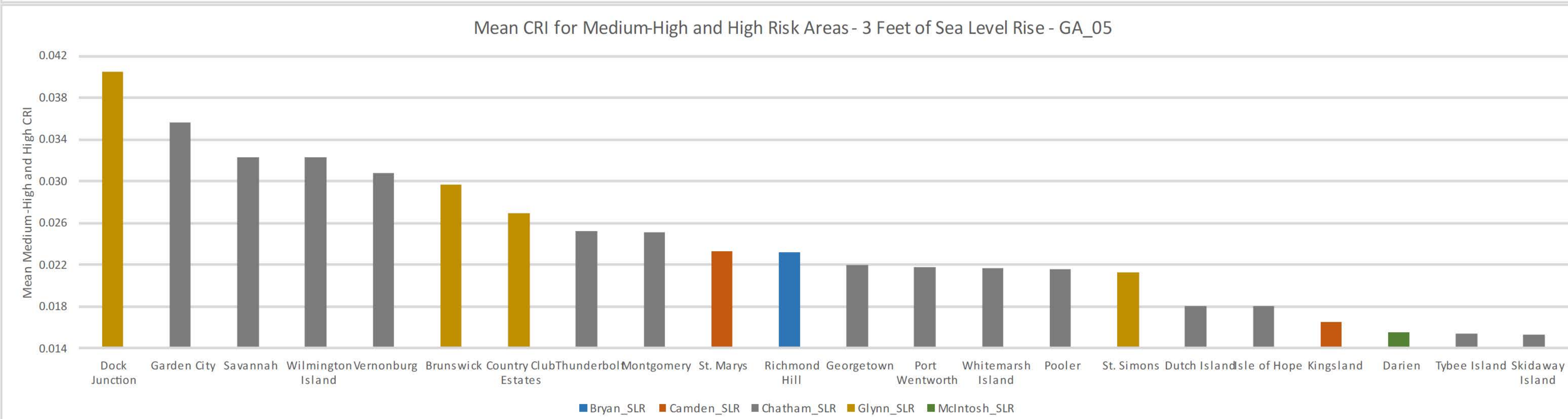

Figure 4-12: Planning Reach GA_05 Existing (top) and Future (bottom) Mean Composite Risk Index for Medium-High and High-Risk Areas

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The mean CRI provides information on the potential risk of storm surge inundation to populations, infrastructure, and environmental and cultural resources. However, it is also important to understand the acreage that is of medium-high- and high-risk to understand the spatial scale of the potential risk in the existing and future conditions. **Figure 4-13** displays the acres of medium-high- and high-risk locations per census place with the future risk displayed in a lighter shade. With sea level rise, the number of medium-high- and high-risk census places increases from 22 to 23, as Vernonburg has more than 50 acres that are medium-high- and high-risk projected under future conditions. As shown in **Table 4-6**, the increase in acreage of medium-high- and high-risk area under future conditions ranges from 4 to 3,143 acres per census place. Census places with greater than a 51 percent increase in acreage are highlighted in light blue in **Table 4-6**.

Table 4-6: Tier 1 – Change in Acreage for Medium-High and High-Risk Composite Risk Index

Census Places	Total Acres	No Sea Level Rise (Acres)	With Sea level Rise (Acres)	Change (Acres)	Percent Change
Dock Junction	6,766	929	1,606	677	72.87%
Garden City	9,267	2,185	3,593	1,408	64.44%
Wilmington Island	6,100	855	1,019	164	19.18%
Savannah	69,501	6,568	9,711	3,143	47.85%
Brunswick	16,169	1,454	1,968	514	35.35%
Country Club Estates	3,043	195	289	94	48.21%
Montgomery	3,894	1,739	1,998	259	14.89%
Thunderbolt	1,020	402	489	87	21.64%
St. Marys	15,998	2,727	3,768	1,040	38.17%
Georgetown	5,658	1,897	2,429	532	28.04%
Port Wentworth	10,520	1,343	2,338	995	74.09%
Whitemarsh Island	4,258	1,842	2,313	471	25.57%
St. Simons	11,208	4,036	5,037	1,001	24.80%
Pooler	17,836	561	1,592	1,031	183.78%
Isle of Hope	1,459	424	669	246	57.78%
Dutch Island	1,960	1,149	1,248	98	8.62%
Richmond Hill	10,460	750	1,120	370	49.33%
Kingsland	28,688	287	599	312	108.71%
Darien	15,378	2,789	2,803	14	0.50%
Tybee Island	1,951	465	509	44	9.46%
Skidaway Island	11,436	83	87	4	4.82%
Talahi Island	939	213	220	7	3.29%
Vernonburg	269	0	65	65	N/A[1]

[1]Percent change is undefined and base condition is 0.

It is important to consider the area of a census place potentially at risk relative to the total area because census places represent population centers and areas of economic activity. For example, the total acreage at risk may be relatively small, but if a large percentage of a census place is at risk from storm surge inundation, the ability of that census place to support populations and economic activity may also be at risk without adequate planning and actions. **Figure 4-14** displays the percentage of the entire census place location covered by medium-high- and high-risk acreage for Planning Reach GA_05 with the future risk displayed in a lighter shade.

For Planning Risk GA_05, three census places (Montgomery, Whitemarsh Island, and Dutch Island) have over 50 percent of their area rated as medium-high- and/or high- potential future risk, all of which are located within Chatham County. Four additional census places have over 40 percent of their area rated as medium-high and/or high potential risk in the future risk, three of which are in Chatham County (Thunderbolt, Georgetown, and Isle of Hope), and one in Glynn County (St. Simons).

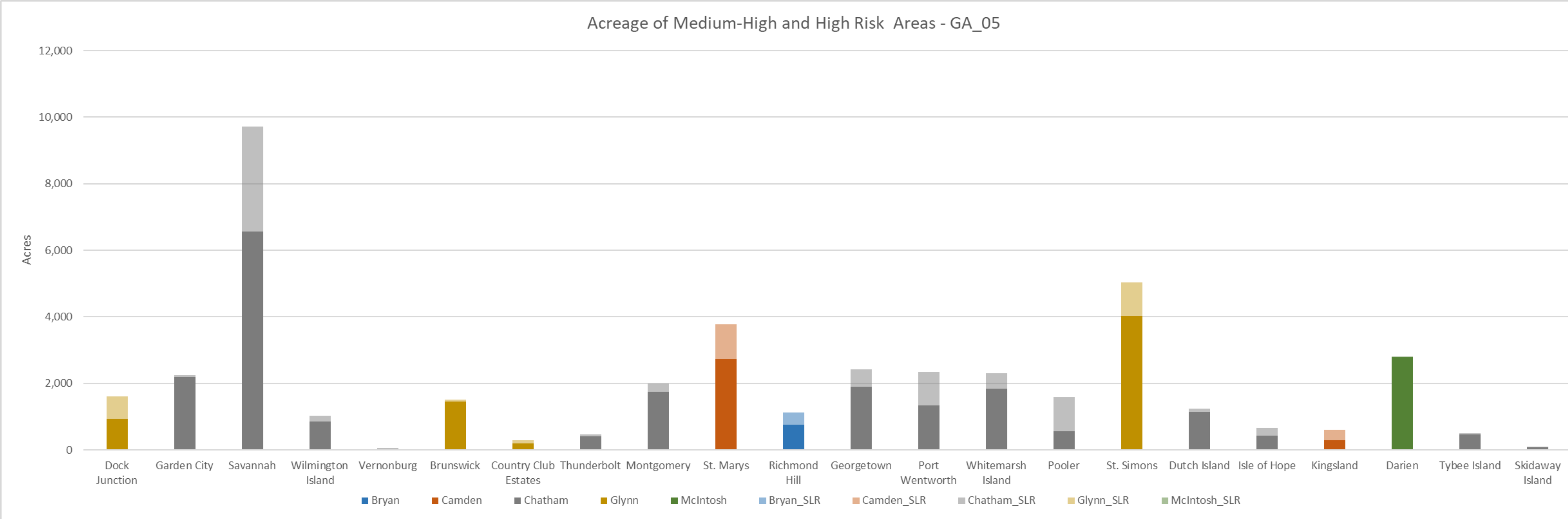

Figure 4-13: Planning Reach GA_05 Existing and Future Acreage with Potential Medium-High and High-Risk; Sea Level Rise Indicates the Future Condition, Which Includes 3 Feet of Sea Level Rise (SLR)

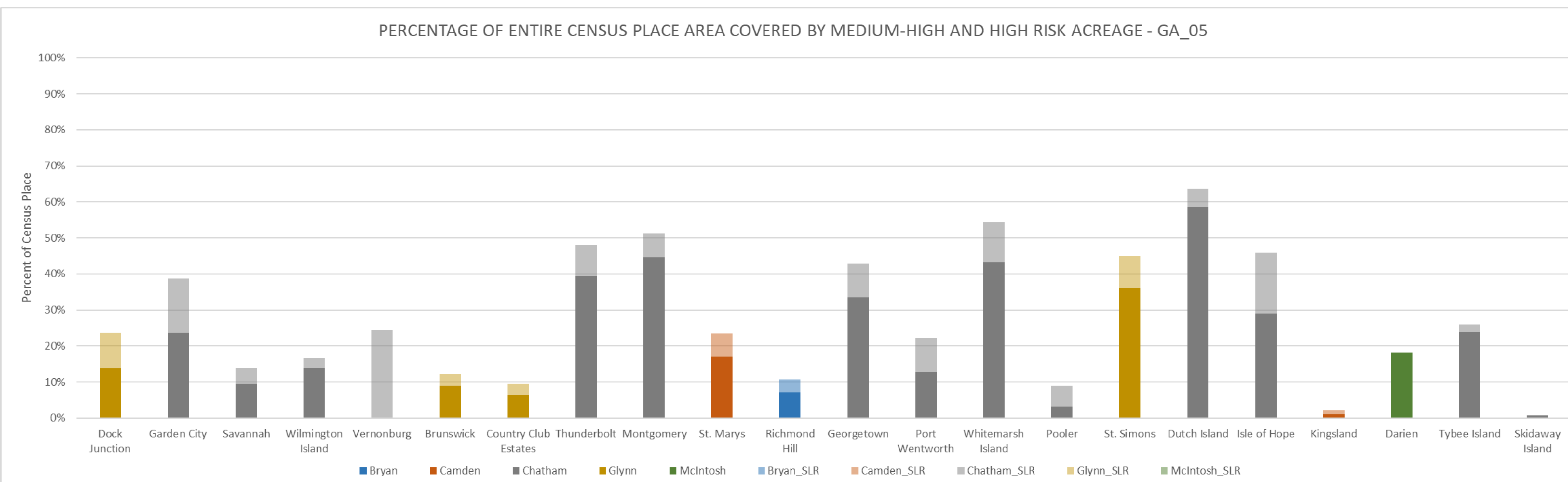

Figure 4-14: Planning Reach GA_05 Existing and Future Percentages of Census Place Areas Rated as Medium-High and/or High-Risk; Sea Level Rise Indicates the Future Condition, Which Includes 3 Feet of Sea Level Rise (SLR)

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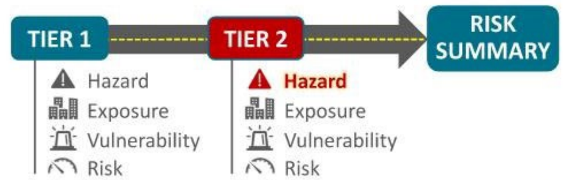
4.1.5 Tier 2 Hazards



The Tier 2 Risk Assessment includes additional data sources to further refine potential risk areas identified in Tier 1. This includes state-level data with additional or more refined flood data, shoreline erosion data, and other information relevant to specific areas (**Table 4-7**). The following sections describe the primary hazards (inundation, erosion, and wave attack) for the Tier 2 analysis.

Secondary hazards that will be discussed but are not considered in detail as part of the Tier 2 analysis include wind, compound flooding, saltwater inundation, and saltwater intrusion.

Table 4-7: Summary of Tier 2 Hazards

Primary Hazards	Description of Hazard	Tier 1	Tier 2
Inundation	Inundation was assessed in Tier 1 but was re-examined using FEMA's Hazus Flood Model data and preliminary Flood Insurance Rate Maps for the annual exceedance probability inundation in Tier 2.	X	X
Wave Attack	Wave attack is the impact of waves on shorelines that can be hazardous to natural shorelines, engineered structures, and cultural resources.		X
Erosion	Coastal erosion is hazardous to natural shorelines such as marshes and sandy beaches. Erosion can lead to increased susceptibility of cultural and environmental resources, and infrastructure.		X
Secondary Hazards	**Description of Hazard**	**Tier 1**	**Tier 2**
Wind	High winds during hurricanes can damage both infrastructure and environmental resources.		X
Compound Flooding	Compound flooding is a combination of hazards that create greater impacts. A combination of inundation, precipitation, nuisance flooding, and high groundwater table elevations can create greater flooding than storm surge alone.		X
Saltwater Inundation and Intrusion	Saltwater inundation and intrusion can degrade environmental resources and freshwater sources.		X

4.1.5.1 Inundation

Inundation refers to flooding due to the overflow of water onto land that would otherwise remain dry. Inundation can be caused by tidal flooding, also known as sunny day or nuisance flooding, or by storm surge which is a rise in coastal water levels due to low-pressure weather systems such as tropical storms and hurricanes. Inundation of low-lying areas can lead to flooding of streets, residential buildings, and commercial properties, resulting in significant structural and monetary damage and in extreme cases loss of life. Such flooding can undermine foundations of critical infrastructure, inhibit gravity-based drainage systems, disrupt utilities including electrical and communication services, and spread chemical or other contaminants. Inundation impacts can be exacerbated by changing geography such as subsidence, poorly planned development, and sea level rise. Most of the coastal communities in the Eastern Seaboard and along the Gulf Coast are vulnerable to inundation.

For the Tier 2 Risk Assessment, the inundation hazard was further assessed using the FEMA Hazus Flood Model to develop a more refined outlook of the potential damages caused by inundation in both the existing and future conditions. Water level data from FEMA's FIS reports for coastal counties in Georgia was used as input to the FEMA Hazus Flood Model. The FIS is a county-wide study that investigates the existence and severity of flood hazards within local communities. For the existing condition, infrastructure damages are based on the 10-, 2-, 1-, and 0.2-percent AEP storm events. For the future condition damages, 3 feet of sea level rise is added to these events. For additional information regarding the application of the FEMA Hazus Flood Model, please see the SACS Tier 2 Economic Risk Assessment report.

In addition to FEMA data, data at defined save points throughout the study area are available from the USACE Coastal Hazards System (CHS) web portal. CHS is a national coastal storm hazard data resource for probabilistic coastal hazard assessment results and statistics, storing numerical and probabilistic modeling results including storm surge, astronomical tide, waves, currents, and wind. At each defined point, hydrodynamic and wave model results are available for all of the simulated storms that make up the probabilistic storm suite for the study along with AEP curves for water level, wave height, and wave period. While dense in spatial coverage for typical model output, the save point locations correspond with a small fraction of the overall hydrodynamic model mesh nodes. The unstructured grid model resolution varies but approaches a minimum of approximately 30 meters (approximately 98 feet) to best resolve coastal features. Timeseries output for a given storm event is typically not saved at all mesh nodes due to data limitations; however, data necessary to define the stillwater level AEP such as peak water level for each storm is saved. For SACS, the AEP stillwater levels at the model mesh nodes were computed to allow for a higher resolution and better visualization of the values throughout the state. The inundation depth at the hydrodynamic model mesh nodes were calculated for various AEPs, present day, and two sea level change scenarios (SLC0 = 0.00 feet, SLC1 = 2.73 feet and SLC2 = 7.35 feet) imposed on the 1-percent AEP event, shown in **Figure 4-15** through **Figure 4-17**.

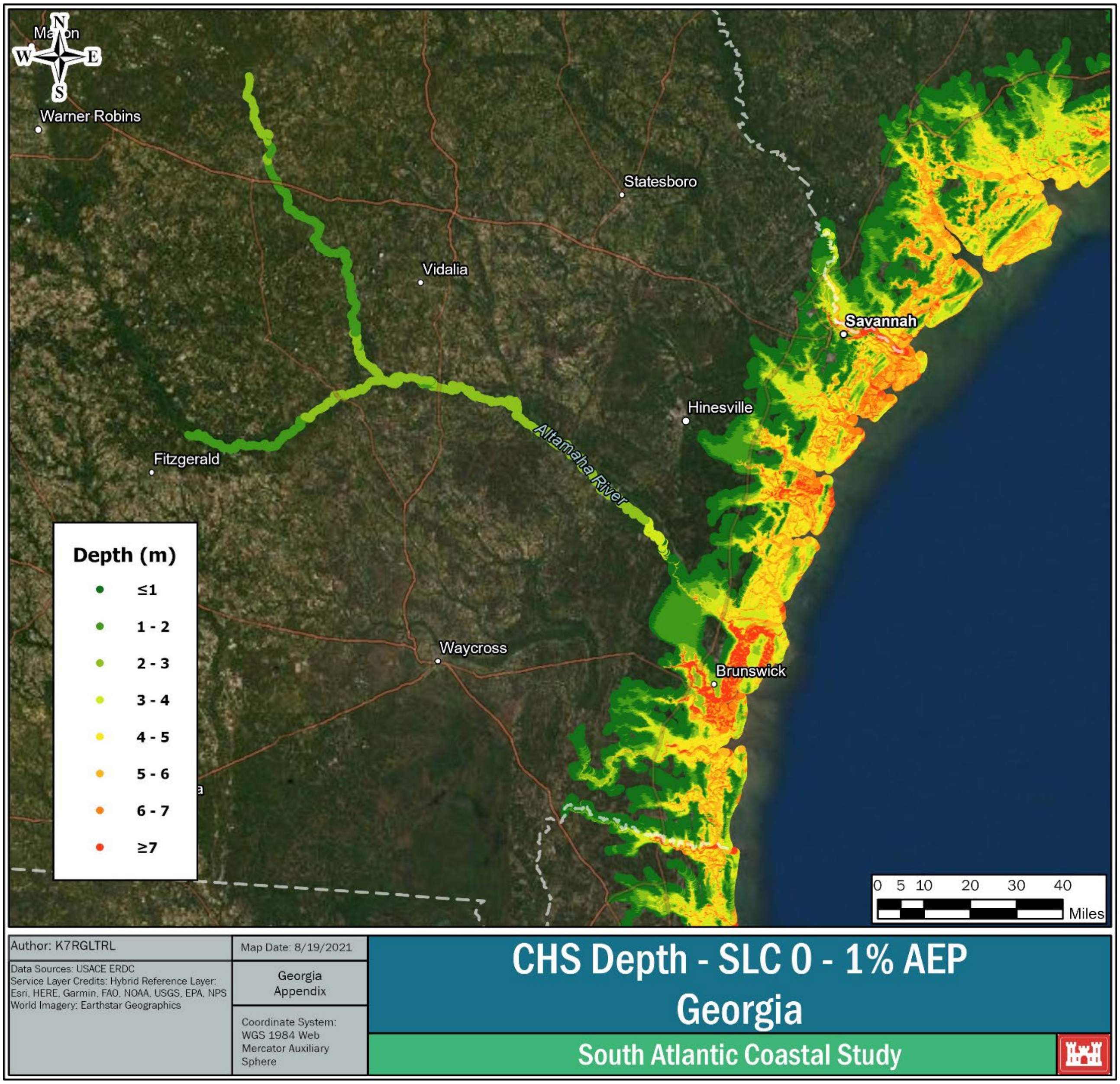


Figure 4-15: Coastal Hazards System 1-Percent Annual Exceedance Probability Stillwater Level (SLC0)

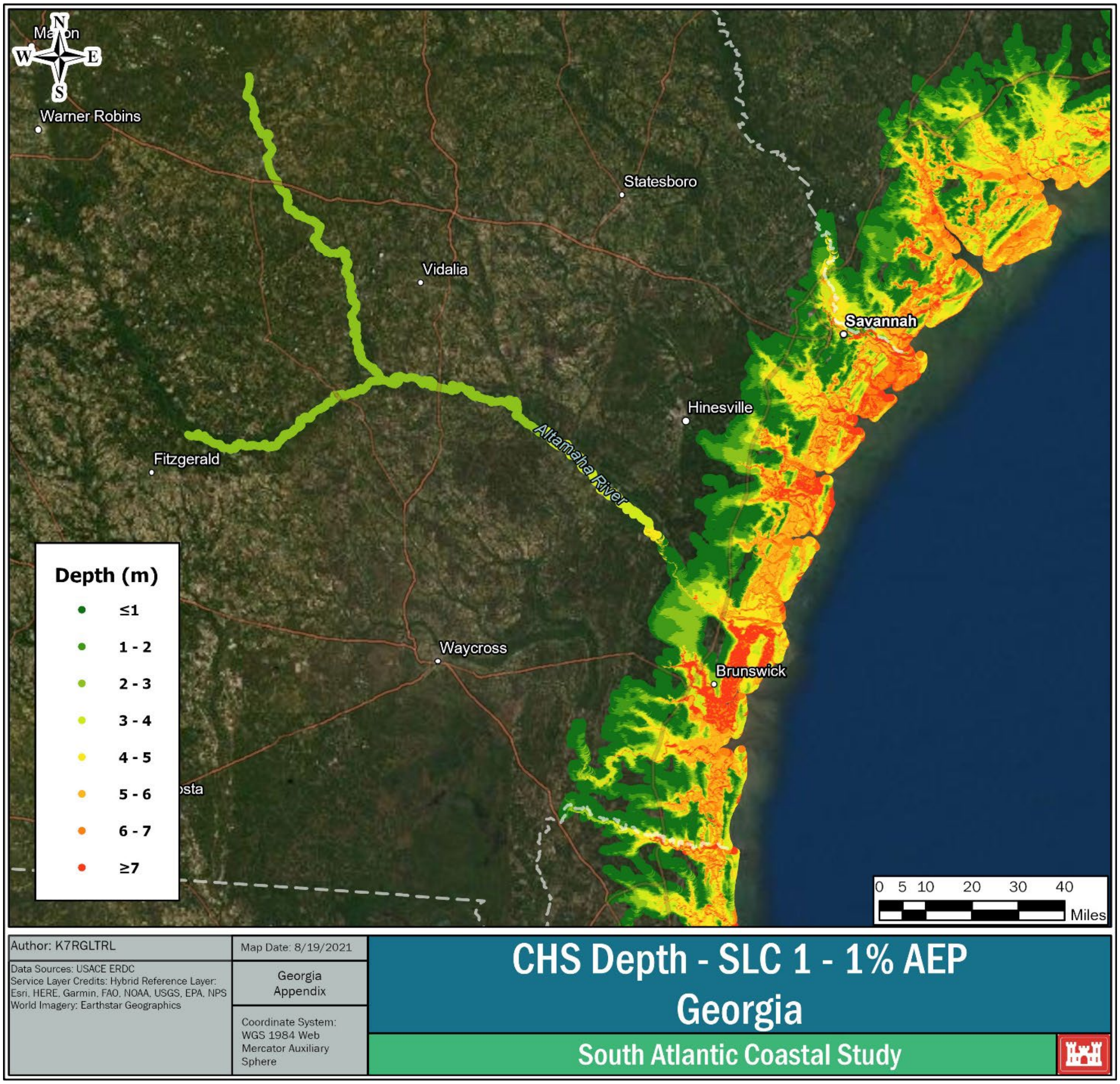


Figure 4-16: Coastal Hazards System 1-Percent Annual Exceedance Probability Stillwater Level with 2.73 Feet of Sea Level Rise (SLC1)

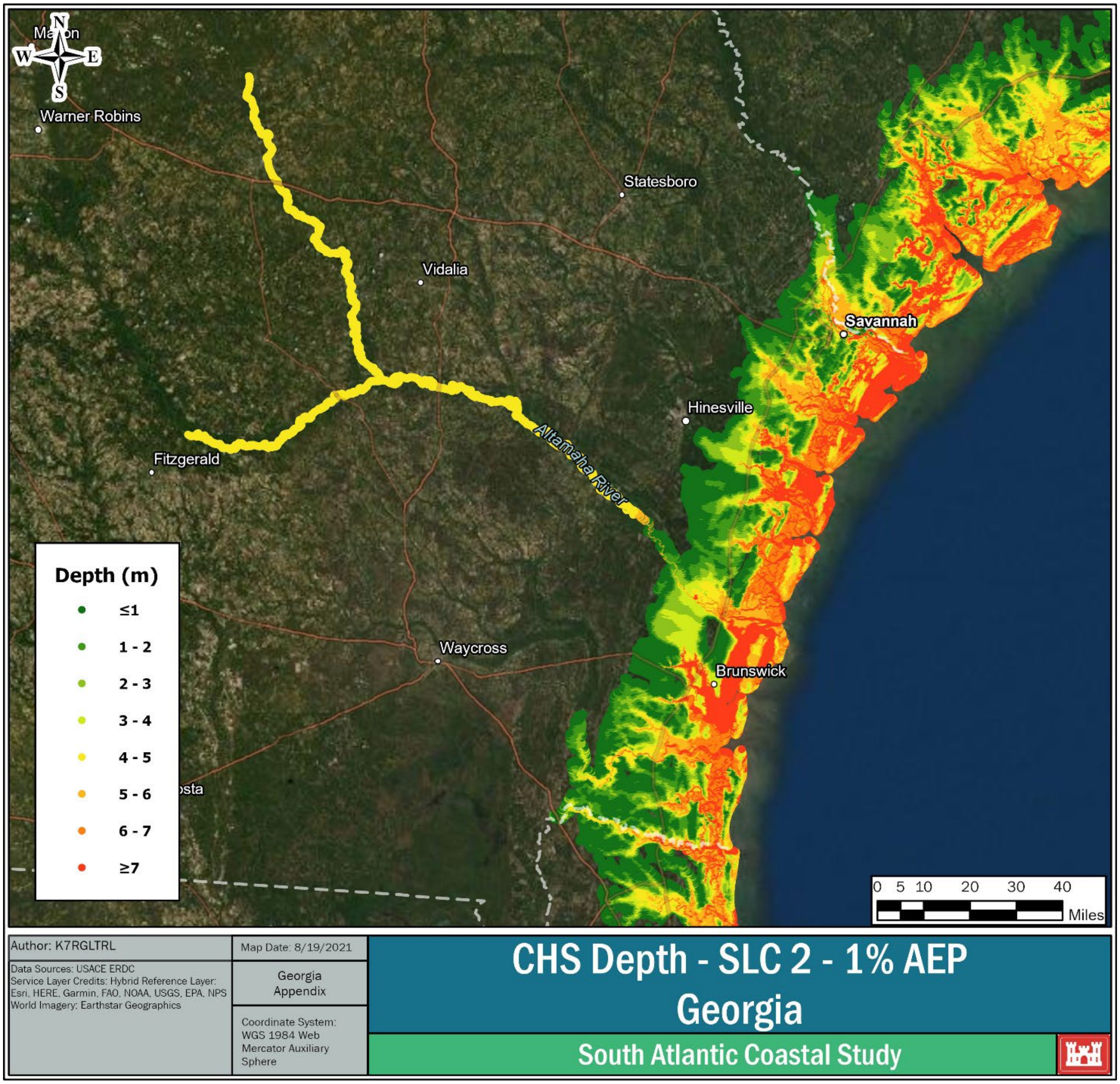


Figure 4-17: Coastal Hazards System 1-Percent Annual Exceedance Probability Stillwater Level with 7.35 Feet of Sea Level Rise (SLC2)

Another source of coastal storm inundation data used is the 2013 Coastal Georgia Hurricane Evacuation Study (USACE 2013c). The Coastal Georgia Hurricane Evacuation Study provides the lateral extent of inundation for a tropical storm through the Category 5 MOM within the Georgia coastal counties and the potential threat to populations and infrastructure. Impacts of inundation can also cause potential threats to cultural resources, such as inaccessibility and damage to archaeological sites and potentially significant water damage to historic properties. More information about the Coastal Georgia Hurricane Evacuation Study can be found in Section 5.2, Hurricane Evacuation Planning.

4.1.5.2 Wave Attack

Wave attack is the impact of waves on the shoreline and is considered one of the main coastal damage mechanisms. The repeated impact of waves on shorelines or structures can create damage over time under normal wave conditions and is exacerbated during storm conditions when waves become larger and more frequent. Wave attack is a hazard for all coastal regions but is a greater threat for areas with prominent infrastructure and population, or cultural and environmental resources. It can damage or destroy engineered structures such as seawalls, revetments, or bulkheads through direct wave impacts on a structure or by scouring the foot of the structure and undermining it. Wave attack can cause significant damage to archaeological sites through erosion and the uprooting of trees, as well as structural damage and flooding to historic properties. Wave attack also damages nonstructured shorelines such as beaches and marshes by causing erosion of the sediment that makes up these coastal environments. On beaches, wave attack can erode berm and dune systems.

In addition to frontal erosion, wave attack can lead to wave run-up and overtopping on dunes and coastal structures, which can scour the backside of dunes or structures and cause them to fail. Wave attack can also damage or destroy dune and marsh grasses, which anchor their respective systems in place, and leave the remaining system more susceptible to additional erosion. As sea level rises, wave attack can be exacerbated in some areas. Wave heights are a direct function of water depth. As the water depth increases, larger waves are able to form. Areas of natural shorelines with sufficient room to migrate and adapt will not likely see additional impacts from wave attacks as sea level rises because the shoreline will naturally adapt but in areas with permanent shorelines (seawalls, revetments, etc.) increased depths could see wave heights and damages increase. Structures that are sufficient to withstand current conditions may no longer be able to withstand future wave conditions and may need to be replaced.

The energy dissipation that occurs as waves enter the nearshore zone and break is an important component of sediment transport along the shoreline. Incident waves, in combination with tides and storm surge, are important factors influencing the behavior of the shoreline. Wave data are obtainable from the long-term USACE Wave Information Studies (WIS) hindcast database for the Atlantic coast of the U.S. (Hubertz 1992). This 35-year record extends from 1980 through 2014 and consists of a time-series of wave events at 3-hour intervals for stations located along the east and west coasts of the U.S. as well as the Gulf of Mexico and Great Lakes. Average offshore wave heights sorted by wave direction for the Georgia coast are presented in **Table 4-8**. These average wave heights represent wave conditions along the open coast. Because of sheltering, wave heights in the back bay, marsh regions, sounds, and rivers are substantially smaller, on the order of 1 foot or less (excluding extreme storm events). Overall, the barrier islands are highly susceptible to damage from waves as sea levels rise. The back bays and tidally influenced river systems are also susceptible, but to a lesser degree.

Table 4-8: Mean Wave Heights: Georgia Coastline

Wave Direction (from)	WIS Station No. 63368 (1980–2014)	
	Percentage Occurrence (%)	Average Significant Wave Height[1] (feet)
North	1.4	3.1
Northeast	3.1	3.5
East	44.3	3.7
Southeast	41.8	3.3
South	5.0	3.4
Southwest	1.5	3.5
West	1.3	3.5
Northwest	1.7	3.3

[1]Significant Wave Height: As defined by NOAA, is approximately equal to the average of the highest one-third of the waves, as measured from the trough to the crest of the waves.

High wave energy can result in accelerated erosion, and wave overtopping of coastal features and can extend inundation inland. The Coastal Hazards System (CHS) analysis developed by USACE models wave heights for a range of storm events for both existing and future conditions. **Figure 4-18** shows modeled wave heights for the 1-percent AEP event at the Georgia coastline and a comparison between existing and increase in wave heights caused by sea level rise. Along the coast, modeled 1-percent AEP wave heights average 0–6.6 feet (0–2 meters), but offshore wave heights average 6.6–19.9 feet (2–6 meters) with instances of greater than 19.9 feet (6 meters). Sea level rise is anticipated to cause an increase in wave heights throughout the county’s coastal communities. This increase translates to an increased likelihood and severity of erosion and wave runup and overtopping.

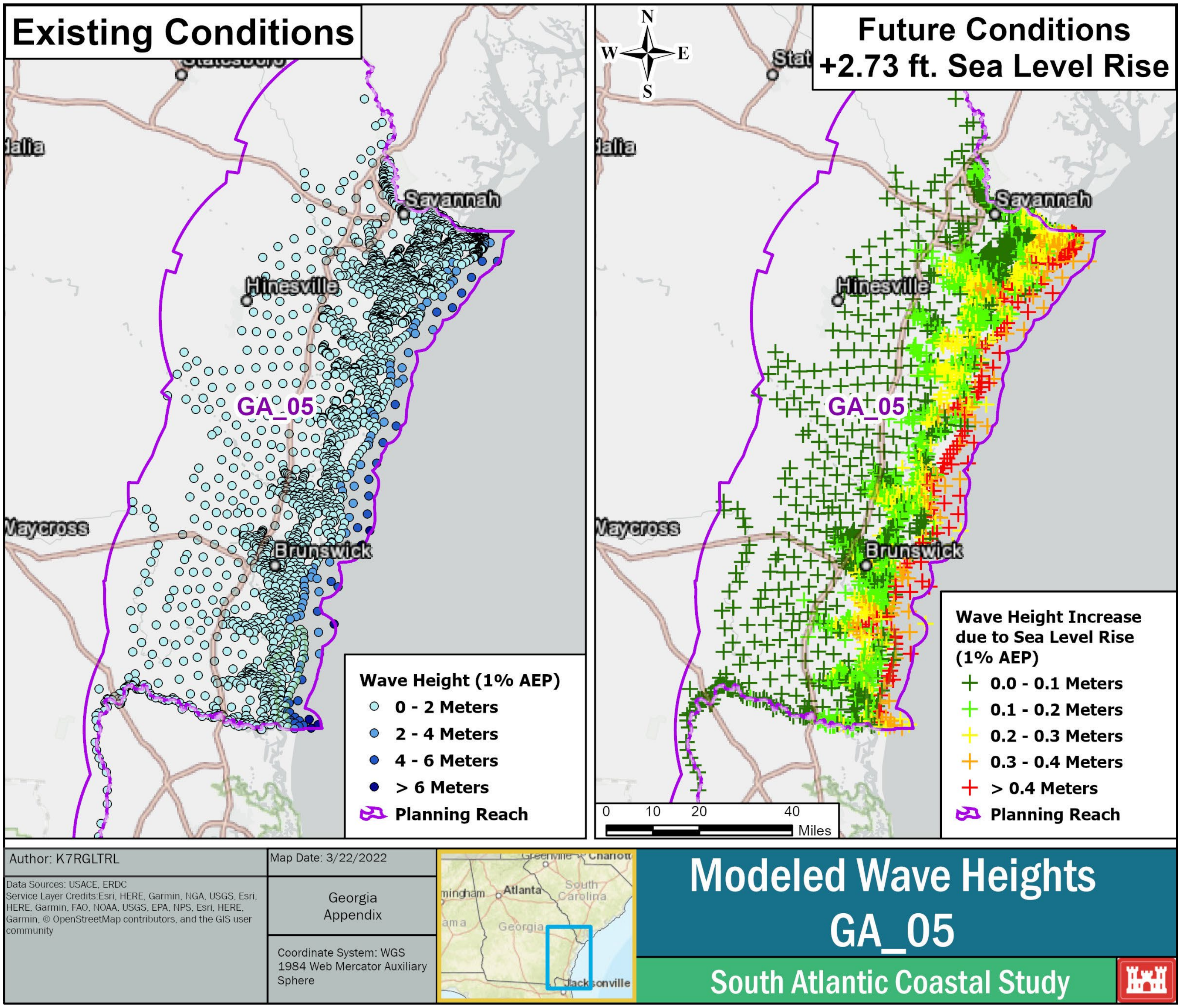


Figure 4-18: Coastal Hazards System Evaluation of Wave Heights for the 1-Percent Annual Exceedance Probability Event

4.1.5.3 Erosion and Shoreline Change

Coastal erosion is a threat to coastal environments, cultural and environmental resources, and infrastructure. Coastal Georgia is made up almost entirely of barrier beaches, sand beaches, salt marsh, mud flats, and deltas. This composition makes the Georgia coastline highly susceptible to impacts due to sea level rise. Shoreline profiles along the Georgia barrier islands are similar in both dune and foreshore dimensions. On average, dunes are characterized by seaward slopes of approximately 0.1 (1 vertical:10 horizontal) and foreshore slopes of approximately 0.05 (1 vertical:20 horizontal). Shoreline change along coastal Georgia is typical of barrier islands of the Atlantic Coast, with areas of erosion and accretion varying over relatively short distances.

Long-term shoreline change for the Atlantic coast is available graphically on the USGS Coastal Change Hazards Portal (USGS n.d.), which displays the long-term change rates discussed below.

USGS Coastal Change Hazards Portal: https://marine.usgs.gov/coastalchangehazardsportal/

- Chatham County (**Figure 4-19a**): At the north end of the state, the barrier islands of Chatham County (Tybee, Little Tybee, Wassaw, and Ossabaw) show long-term accretion, predominantly at the ends of the island, with stretches of central shoreline that are generally stable or accretional. Erosion on these islands occurs in hot spots to the north or south of the central shore. Hot spot erosion can be more than -6.6 feet per year (-2 meters per year). Much of the general stability of Tybee Island may be attributed to the presence of a federal beach renourishment project.

- Bryan County (**Figure 4-20a**): Bryan County shoreline consists of the marshland bordering St. Catherines Sound. While sedimentation varies in the adjacent inlet that separates the barrier islands of Chatham County to the north and Liberty County to the south, the marsh shoreline remains relatively stable because of the presence of vegetation.

- Liberty County (**Figure 4-20a**): Liberty County shoreline is dominated by St. Catherines Island. Unlike the barrier islands to the north, St. Catherines Island experiences significant erosion over the majority of its shoreline with only small areas of stability or accretion at the northern end and near the central shoreline. Long-term erosion along north St. Catherines Island and at the southern tip of the island is greater than -6.6 feet (-2 meters) per year. South St. Catherines Island is characterized by slightly more moderate long-term erosion rates between -3.3 feet (-1 meter) and -6.6 feet (-2 meters) per year.

- McIntosh County (**Figure 4-20b**): McIntosh County shoreline is dominated by Sapelo Island to the north with the much smaller Wolf Island to the south. Sapelo Island shows patterns of long-term erosion that are similar to the barrier islands of Chatham County. The north and south ends of the island are accretional at a rate of greater than +6 feet (+2 meters) per year. The central portion of the island is mildly accretional at a rate of between +3.3 feet (+1 meter) to +6.6 feet (+2 meters) per year in some areas and stable (-3.3 feet to +3.3 feet) in others. An erosional hot spot (-3.3 to -6.6 feet per year) occurs along the shoreline just south of the island's centerline. Wolf Island, located between Deboy Sound to the north and Altamaha Sound to the south, is highly erosional over its entire shoreline with erosion rates of greater than -6.6 feet (-2 meters) per year.

- Glynn County (**Figure 4-20b**): Glynn County shoreline is comprised of three barrier islands: Little St. Simons Island, St. Simons Island, and Jekyll Island. Little St. Simons is the northern-most island in the county and has a long-term pattern of accretion (greater than +6.6 feet per year) over most of its shoreline. The north end shows mild (-3.3 feet per year) to moderate (-3.3 to -6.6 feet per year) erosion in the long-term. A hot spot of high erosion, losing more than -6.6 feet (-2 meters) per year, is just south of the island's central shoreline. St. Simons Island, which has a developed shoreline, has a pattern of erosion that is mildly erosional with regions of accretion over the length of the island. Two hot spots of high erosion are documented at the northern tip of the island and the south end of the island at the entrance to St. Simons Sound. Jekyll Island, also developed, shows mild long-term erosion over the length of the island with accretion of +3.3 feet (+1 meter) to +6.6 feet (+2 meters) per year at the southern tip. The development of St. Simons and Jekyll Island has resulted in local efforts to stabilize the shoreline and reduce erosion impacts.

- Camden County (**Figure 4-20c**): Bordering the state of Florida, the Camden County shoreline is dominated by Cumberland Island. Undeveloped, Cumberland Island is generally stable (-3.3 feet to +3.3 feet) to accretional (+3.3 feet to +6.6 feet per year) over most of the shoreline with a significant erosional hot spot (greater than -6 feet per year) at the north end and moderate erosion localized at the central shoreline.

Long-term shoreline change rates are reflective of changes to shoreline position over an extended period. **Figure 4-20** shows graphically how the developed barrier island shorelines of Tybee, Sea, St. Simons, and Jekyll Islands have changed in the past century. With few exceptions, development typically results in a more stable shoreline position. To protect infrastructure, the position of the shoreline is often held either directly with structures such as seawalls and revetments or indirectly with jetties, groins, and beach renourishment meant to control the amount of erosion to a localized area. However, preventing shoreline retreat beyond a certain point does not necessarily maintain a healthy dune system or beach berm. This can create negative impacts to wildlife habitat. Additionally, interrupting the natural sediment transport regime in one area can exacerbate erosion in downdrift areas as the flow of sediment is reduced or cut off. Developed shorelines must be managed to minimize the negative impacts while still maintaining a suitable level of protection to the local community. Erosion poses significant threats to historic properties and cultural resources, especially on barrier islands. Shoreline changes may aid in the preservation of cultural resources, but it can also lead to the loss of site integrity.

The USGS has determined probabilities of long-term shoreline change due to sea level rise. This probability is calculated using information about rates of relative sea level rise, wave height, tidal range, coastal geomorphology, coastal slope, and historical rates of shoreline change (Gutierrez et. al. 2014). In this instance, probability of shoreline retreat is defined by three categories: high shoreline retreat (greater than -6.6 feet per year), medium shoreline retreat (between -3.3 and -6.6 feet per year), and stable shoreline change (between -3.3 feet and +3.3 feet of shoreline change per year). **Figure 4-21** shows graphically the probabilities of each category of shoreline retreat for the Georgia coastline. Probability of shoreline retreat is relatively constant along the Georgia coastline, with a slight elevation in probability occurring near the southern border of the state. The magnitude of shoreline retreat (stable, medium, high) shares nearly equal probability for any given region, making an accurate estimate difficult without additional information. In general, there is significant chance of high shoreline retreat along the Georgia coastline, particularly in the vicinity of Camden County.

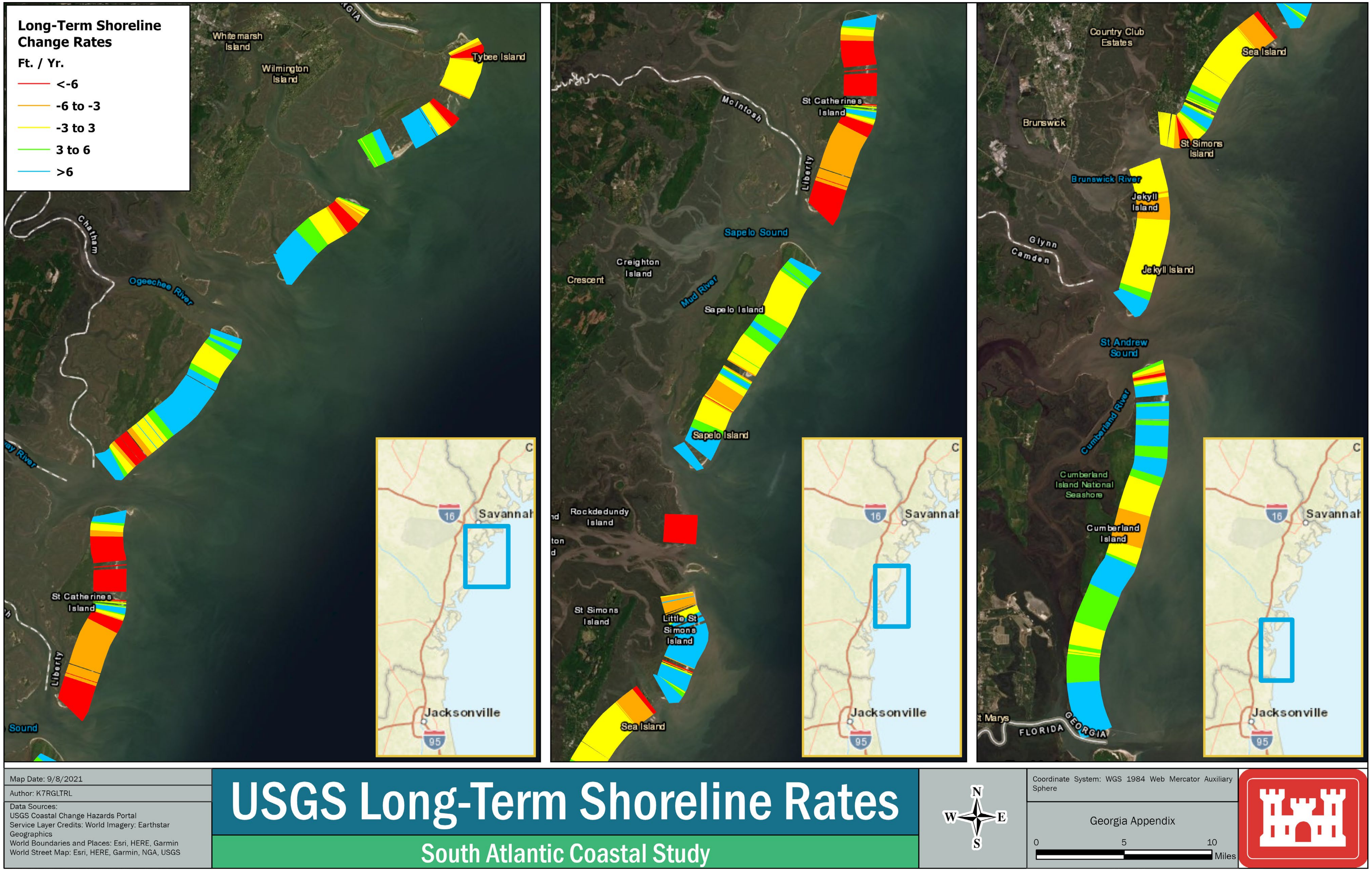


Figure 4-19: Long-Term Shoreline Change Rates: for (a) Left Image – Chatham, Bryan, and Liberty Counties (b) Middle Image – McIntosh and Glynn Counties (c) Right Image Camden County (USGS n.d.; Coastal Change Hazards Portal)

Figure 4-20: Historical Shoreline Positions for (a) Left Image – Tybee Island (b) Middle Image – St. Simons and Sea Island (c) Right Image – Jekyll Island (USGS n.d.; Coastal Change Hazards Portal)

Figure 4-21: Probability of (a) Left Image – High Shoreline Retreat (b) Middle Image – Medium Shoreline Retreat (c) Right Image – Stable Shoreline Change (USGS n.d.; Coastal Change Hazards Portal)

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4.1.5.4 Wind

In Georgia, high winds during tropical systems can severely damage infrastructure, including roofs, mobile homes, and, if strong enough, entire buildings. High winds can also impact environmental resources and cultural resources by downing and defoliating trees and other vegetation and contribute to wave attack on both natural and engineered structures, including historic structures. **Table 4-9** describes some of the potential damages associated with tropical systems based on the Saffir-Simpson scale for wind speeds. **Figure 4-22** shows wind speed building codes for Atlantic and Gulf Coasts, which includes the Planning Reach GA_05. Structures within the state are required to follow the wind design criteria based on the zone where they are located.

Table 4-9: Damage Description Based on Wind Speeds

Tropical System Category Saffir-Simpson Scale	Wind Speeds (miles per hour)	Typical Damage Description
Tropical Depression	>39	Heavy rains and strong winds can cause minor flooding and property damage.
Tropical Storm	39–73	Minor damage will occur to many mobile homes. Framed homes may sustain mostly minor damage to roof shingles and siding.
Category 1 Hurricane	74–95	Primarily shrubbery and trees are damaged, unanchored mobile homes are damaged, some signs are damaged, and no real damage is done to structures.
Category 2 Hurricane	96–110	Some trees are toppled, some roof coverings are damaged, and major damage is done to mobile homes.
Category 3 Hurricane	111–129	Large trees are toppled, some structural damage is done to roofs, mobile homes are destroyed, and structural damage is done to small homes and utility buildings.
Category 4 Hurricane	130–156	Extensive damage is done to roofs, windows, and doors; roof systems on small buildings completely fail; and some curtain walls fail.
Category 5 Hurricane	>156	Roof damage is considerable and widespread, window and door damage is severe, there are extensive glass failures, and some complete buildings fail.

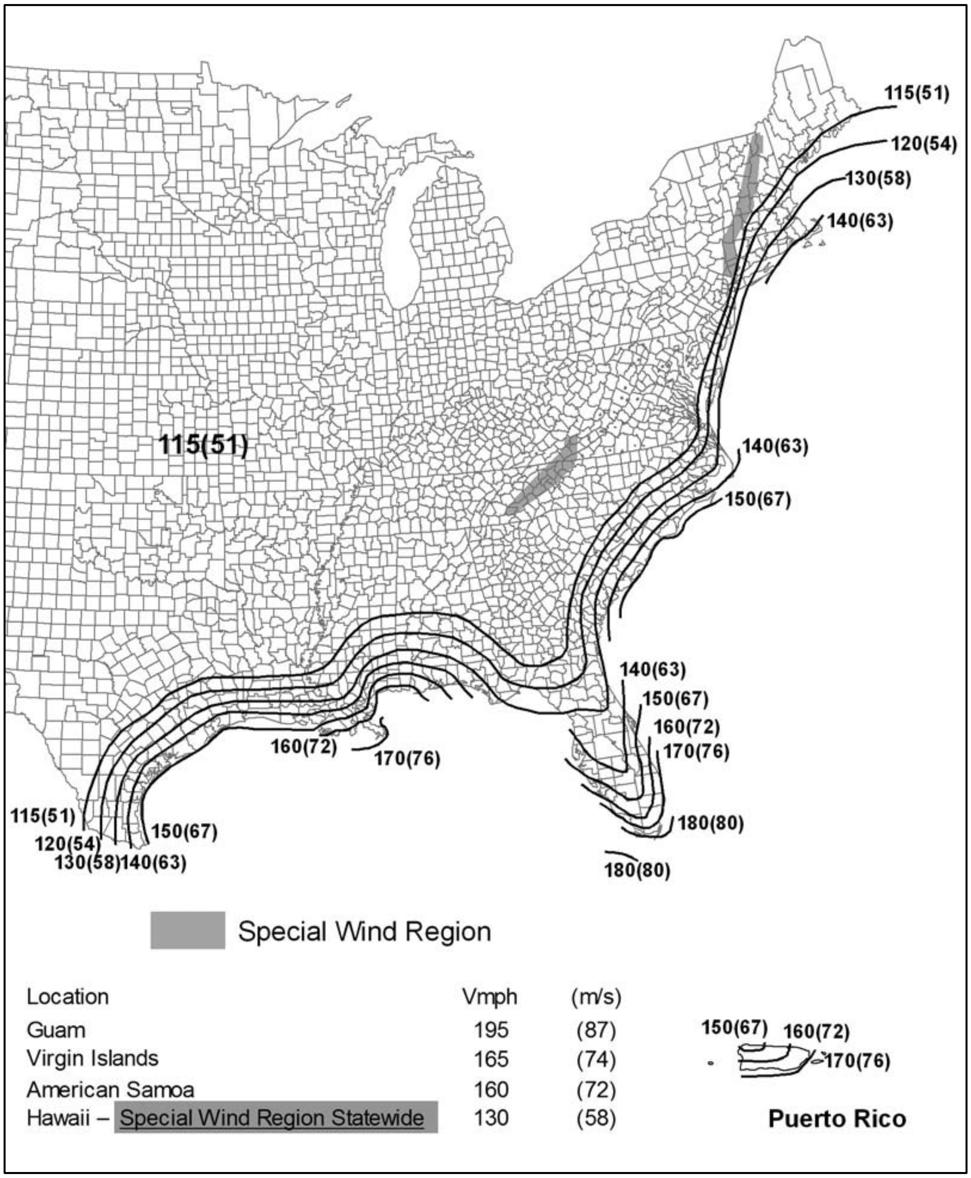


Figure 4-22: Basic Wind Speeds for Occupancy Category II Building and Other Structures (American Society of Civil Engineers 2010)

4.1.5.5 Compound Flooding

Compound flooding occurs when a combination of inundation, precipitation, astronomical tides, and high groundwater table elevations occur simultaneously, resulting in potentially greater impacts, as shown in **Figure 4-23**. The interplay between these hazards was apparent in the cities of Savannah and Brunswick and their adjacent barrier island communities during Hurricane Irma (2017) when elevated water levels in the rivers and streams due to heavy upstream precipitation and excessive overland flows occurred simultaneously with multiple high tide cycles and storm surge from prolonged onshore winds. The combination of these factors resulted in catastrophic flooding in many coastal Georgia towns and cities. Chatham and Glynn Counties are particularly prone to a combination of these hazards because of the high population density among the principal cities and adjacent communities, high groundwater table elevation, bisecting riverine systems, low-lying barrier islands, and aging storm water and sewer control structures. Cultural resources and historic properties are not always considered as essential resources to protect during these types of storm events due to the focus on human life and safety. Flooding can be especially damaging to historic properties and associated artifacts.

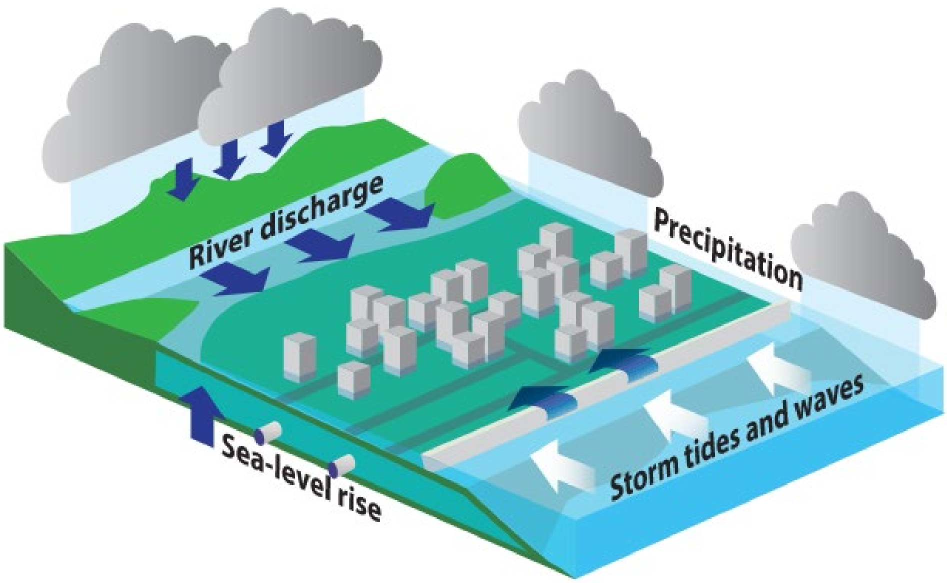


Figure 4-23: Components of Compound Flooding

4.1.5.6 Saltwater Inundation and Intrusion

Saltwater inundation is the movement of saltwater onto land or freshwater resources from storm surges or high tides that submerge areas low in elevation for a short duration of time. Salinity stress has been observed to cause major mortalities within coastal forests and freshwater wetlands by a single inundation event. During Hurricane Matthew in 2016, storm surge pushed into river inlets and low-lying areas near Savannah, inundating and causing saltwater damage to many estuaries and bird refuges in and around the Savannah NWR (Stewart 2017). Impacts from saltwater intrusion to environments and economies will continue to increase over time because of sea level rise.

Salinity and inundation are primary factors in controlling plant composition of coastal marshes. Without active management, freshwater tidal wetlands affected by saltwater intrusion are expected to transition to oligohaline or brackish tidal marsh (Tully et al. 2019). The ability of existing wetlands to adapt to sea level rise will depend mostly on the topography of the coastal zone and the amount of space landward that has not been developed and is available for wetland migration. Many cultural and historic resources are also located in and/or protected by coastal marshes that provide a buffer from other threats that may cause harm, such as wave attack. The loss of these marshes causes greater exposure to various resources.

Saltwater intrusion has been documented in coastal regions across the globe including the Georgia coastal plain. A total of 24 counties in southeast Georgia are subject to the Coastal Georgia Water and Wastewater Permitting Plan for Managing Salt Water Intrusion (GADNR 2006). Groundwater pumping or withdrawals in coastal regions can lead to saltwater intrusion. As a result of hydrogeological studies focused on saltwater intrusion, the Coastal Permitting Plan placed restrictions on groundwater withdrawals from the Upper Floridan aquifer, particularly for permit holders in the coastal counties of Chatham, Bryan, Liberty, Glynn (City of Brunswick T-shaped zone), and parts of Effingham County that are most susceptible to saltwater intrusion. The restrictions are zonal and include three subregions in addition to red zones that identify locations with the most extreme restrictions, as identified in **Figure 4-24** (GADNR 2006). While groundwater development was a primary driver of saltwater intrusion in the Upper Floridan aquifer, the downward saltwater migration from surficial sources through the upper confining units pose a future threat to the aquifer that is projected to increase with sea level rise.

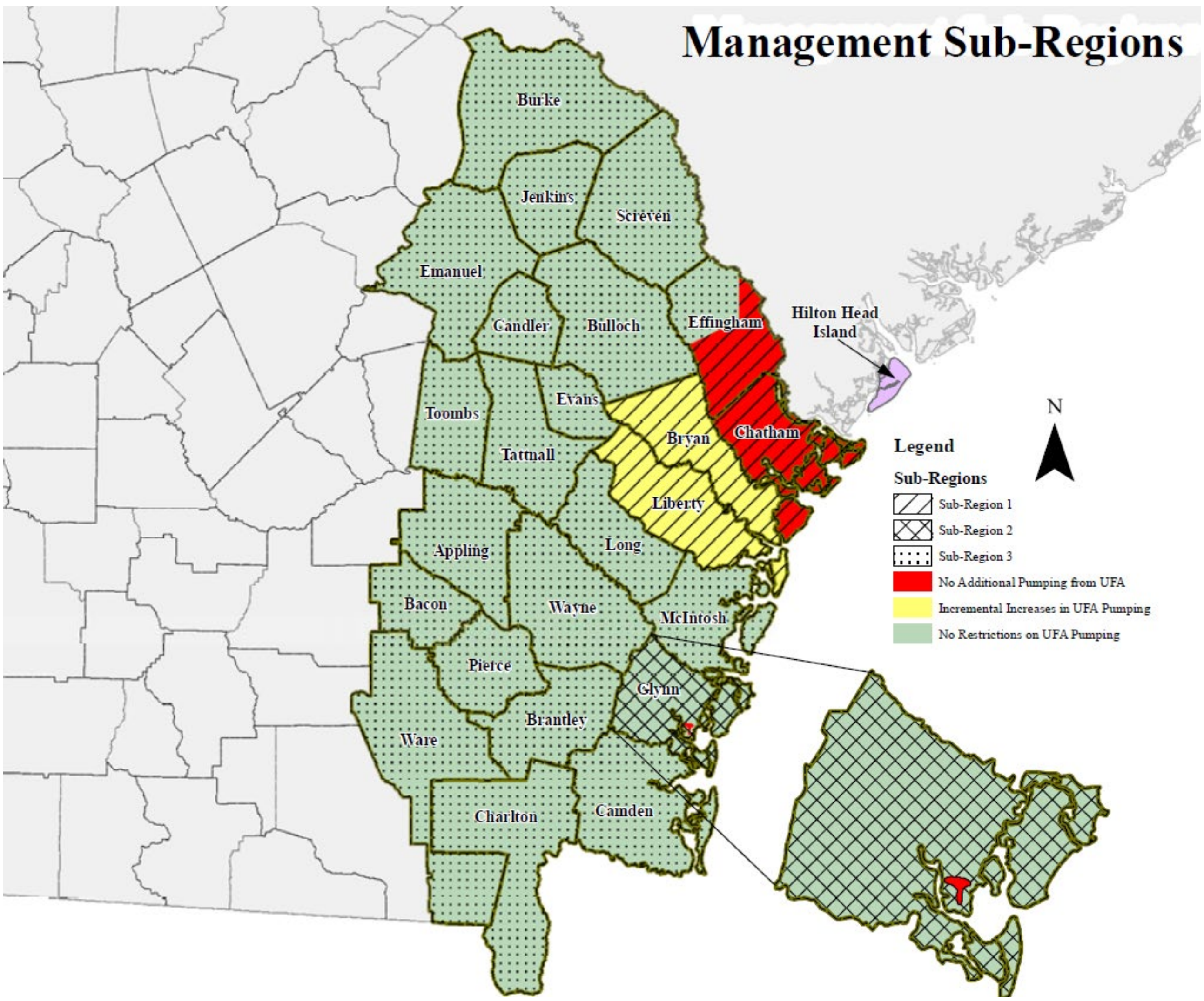
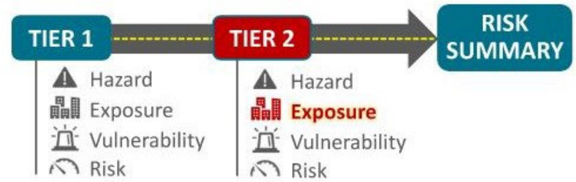


Figure 4-24: Sub-Regions Associated with the Coastal Georgia Water & Wastewater Permitting Plan for Managing Salt Water Intrusion into The Upper Floridan Aquifer (GADNR 2006)

4.1.6 Tier 2 Exposure



Exposure to coastal storm hazards was further assessed in Tier 2 in terms of population and infrastructure, environmental, and cultural resources. The Tier 2 analysis for population and infrastructure used data from the USACE National Structure Inventory, the EPA Integrated Climate and Land Use Scenario (ICLUS), and the 2013 Coastal Georgia Hurricane Evacuation Study to develop a more refined outlook of the potential population and infrastructure exposed to hazards for the existing and future conditions.

The Tier 2 environmental exposure assessment identified and described the natural areas within Planning Reach GA_05 potentially exposed to the Tier 2 coastal flood hazards. The GADNR's Wetlands of Coastal Georgia – Results of the National Wetlands Inventory and Landscape-level Functional Assessment (GADNR 2012) and the Natural Environments of Georgia (Wharton 1978) were used to inform exposure of environmental resources. The Environmental Technical Report contains exposure tables of upland and wetland natural areas in Georgia with rare species and critical habitat present.

The Tier 2 Resources Addendum used the Georgia Natural, Archaeological, and Historic Resources Geographic Information System (GNAHRGIS) and stakeholder input to refine exposure due to flood hazards in the 1-percent and 10-percent AEP flood scenarios in the current and future conditions with 3 feet of sea level rise.

4.1.6.1 Population and Infrastructure Exposure

Tier 2 population and infrastructure exposure was first assessed using data from the National Structure Inventory, developed by the USACE Hydrologic Engineering Center and FEMA. **Figure 4-25** displays infrastructure data from the USACE National Structure Inventory that is within the footprint of the 0.2-percent AEP event floodplain with 3 feet of sea level rise (USACE n.d.-a). The pie chart in **Figure 4-25** shows the proportional relationship in value between the general infrastructure types.

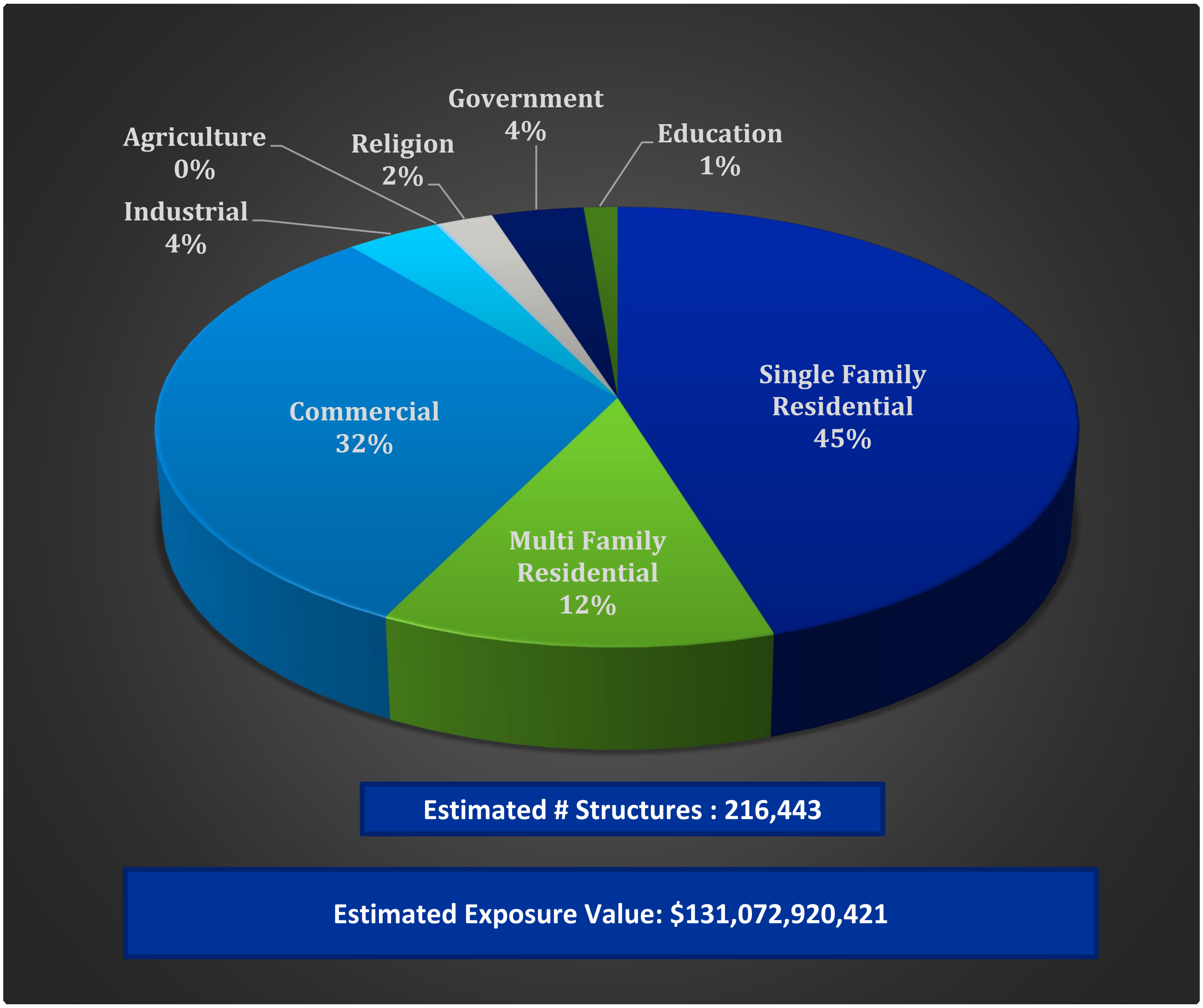


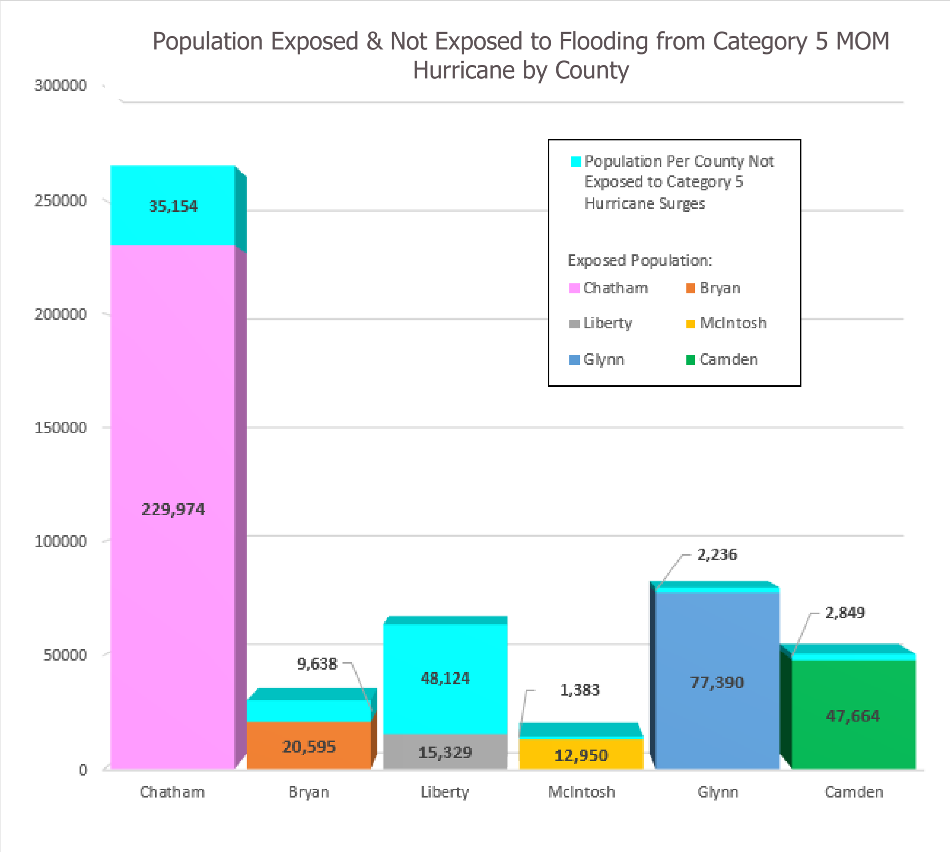
Figure 4-25: Planning Reach GA_05 Estimated Exposure Value (USACE n.d.-a)

The estimated average exposed population is approximately 550,000 people and there are approximately 216,000 structures exposed, with an estimated exposure value of over $131 billion. The greatest value is estimated to be single-family and multi-family residential infrastructure, consisting of approximately 190,300 structures with an exposure value of $75.2 billion dollars (**Table 4-10**).

Table 4-10: Planning Reach GA_05 Exposure by General Occupancy

General Occupancy	Number of Structures	Percent of Structures	Estimated Exposure Value ($ Million)	Percent of Exposed Value
Single-Family Residential	174,646	81%	59,210	45%
Multi-Family Residential	15,717	7%	15,999	12%
Commercial	19,512	9%	41,396	32%
Industrial	3,029	1%	4,902	4%
Agriculture	448	0%	190	0%
Religion	1,673	1%	2,833	2%
Government	961	0%	4,789	4%
Education	457	0%	1,755	1%
All	**216,443**	**100%**	**131,073**	**100.0%**

Within the current condition, the total permanent population potentially exposed from a Category 5 MOM hurricane surge in the coastal counties is approximately 404,000, while 99,000 are not projected to be exposed. Eighty-seven percent of Chatham County, 68 percent of Bryan County, 24 percent of Liberty County, 90 percent of McIntosh County, 97 percent of Glynn County, and 94 percent of Camden County are potentially exposed to a Category 5 MOM hurricane surge (**Figure 4-26**) (USACE 2013c). Within the top bar chart in **Figure 4-26**, light blue identifies the number of permanent residents not exposed to a Category 5 MOM surge.



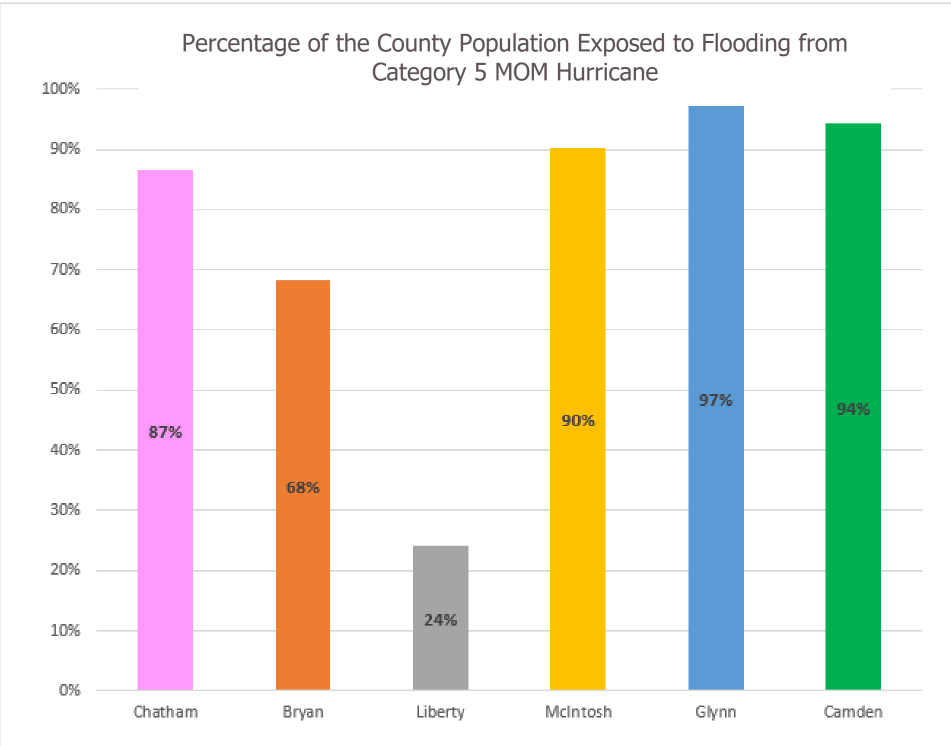


Figure 4-26: Population Exposed to Category 5 Maximum of Maximum Hurricane Surges (USACE 2013c)

Approximately 57 percent of the exposed population along the Georgia coast resides in Chatham County (265,128), where 87 percent of residents (229,974) are exposed to coastal storm surge resulting from a Category 5 MOM hurricane. With the projected increases in population and housing density and with the inclusion of 3 feet of sea level rise, the exposed population in the coastal counties are likely to rise from 2020 to 2100.

Assessing future growth trends in population can indicate whether there will be an increase in people and associated infrastructure exposed to future hazard conditions. Forecasted population and housing density data were used to evaluate growth trends in coastal Georgia for this study.

EPA's ICLUS database analyzes and produces spatially explicit projections of population and land use based on various climate change scenarios. The project incorporates a variety of modeling factors, including migration, immigration, fertility, land use changes, transportation networks, and climate scenarios. ICLUS provides a variety of spatial data outputs that can be used to better understand the impacts of climate change as well as assess the impacts and dynamics of land use and population changes across the continental U.S. landscape. ICLUS version 2 was used for population projections across the continental portion of the SACS study area. These data were published in 2018 and are based on 2010 Census data. ICLUS used fertility, mortality, and immigration rates to project population on a decadal basis out to 2100 (U.S. Environmental Protection Agency 2021). For the SACS, the conservative climate change scenario Shared Socioeconomic Pathways (SSP)2 was used, and population percentage changes from 2020 to 2100 were calculated. In the SSP2 scenario, the U.S. experiences a medium level ("Middle of the Road"), of population growth, driven by medium levels of fertility, mortality, and international migration. The ICLUS project aggregated these projections to either the metropolitan statistical area, micropolitan statistical area, or county boundary.

Figure 4-27 displays the expected population percentage change by metropolitan and micropolitan statistical areas for 2020 to 2100 for Planning Reach GA_05. Results from the ICLUS scenario SSP2 population projection for 2020 to 2100 show a greater than 100 percent increase in population in the Hinesville-Ft. Stewart and Brunswick, Georgia metropolitan areas, a 50 percent to 75 percent increase in population for the St. Marys and Jesup, Georgia, micropolitan statistical areas, and a 25 percent to 50 percent increase in the Savannah, Georgia metropolitan statistical area.

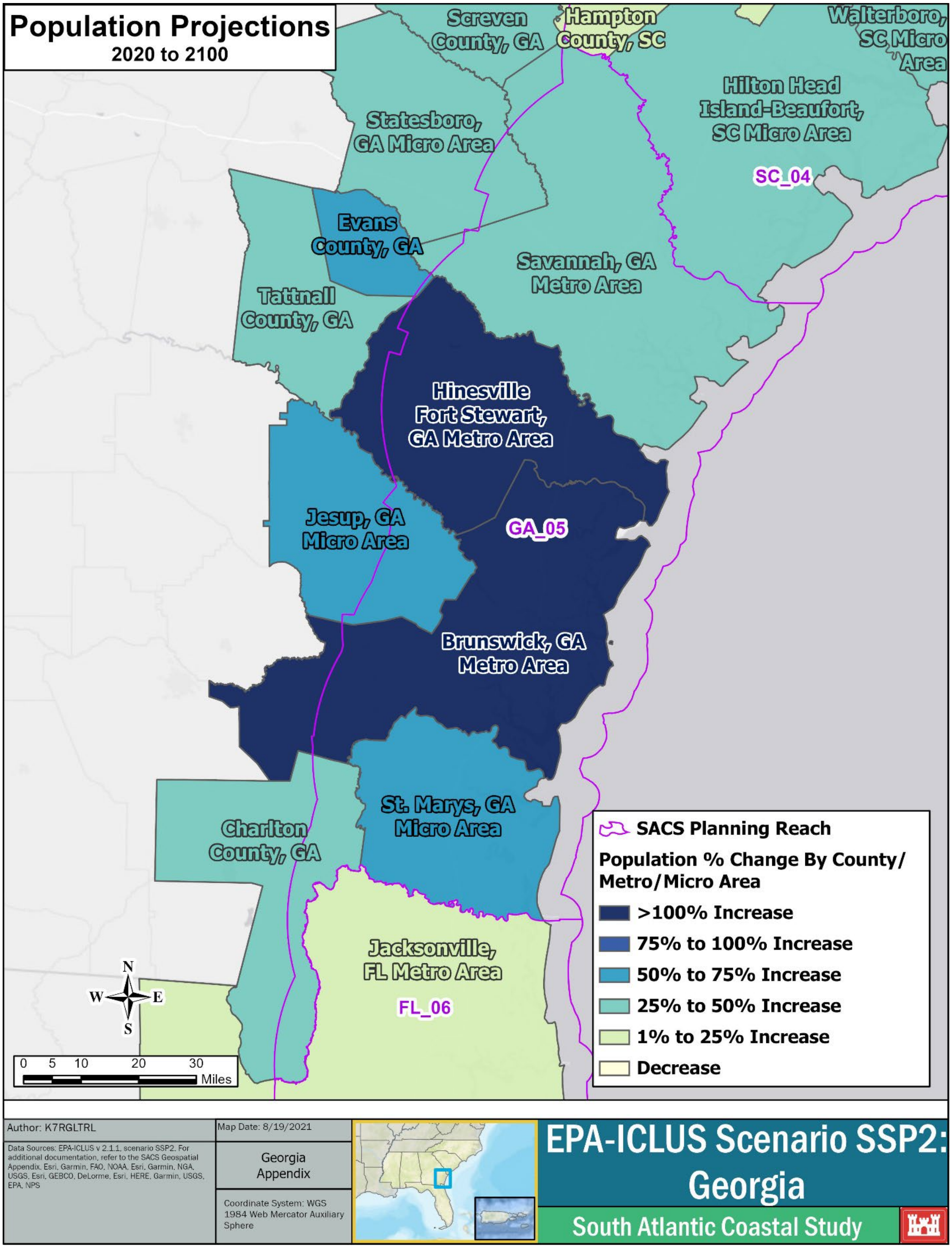


Figure 4-27: Integrated Climate and Land Use Scenarios: Projected Population Percentage Change from 2020 to 2100 for Planning Reach GA_05

Figure 4-28 shows the forecasted increase in development derived from ICLUS data for Georgia using the B2 scenario for housing density increase from 2020 to 2100. The B2 scenario is adapted from the Intergovernmental Panel on Climate Change (IPCC) Special Report on Emissions Scenarios (SRES 2000). Within the SRES B2 scenario, fertility, mortality, and migration rates are assumed to be moderate. The “B” scenarios place more emphasis on environmental protection and the “2” scenario places assumes intermediate levels of economic development and less rapid and more diverse technological change. Housing density data are based on open, undeveloped space. ICLUS data were computed at a national level and do not include all local land use or planning/development considerations. As a result, some residential density increases may be shown in areas of open space that are not developable, as designated by the ICLUS model input parameters, such as a cemetery or other green space. The housing density projections provide useful insight into general trends of increased population and development density in coastal areas, serving as a starting point for more refined analyses at a smaller scale. The USACE 1-percent and 10-percent AEP flood scenarios with 3 feet of sea level rise inundation were added to demonstrate the exposure from coastal storm inundation and sea level rise to future development by 2100. Areas of clustered deep red can be identified within the Savannah and Brunswick, Georgia metropolitan statistical areas as well as the St. Marys, Georgia micropolitan statistical area, which correspond to projected future development and population density.

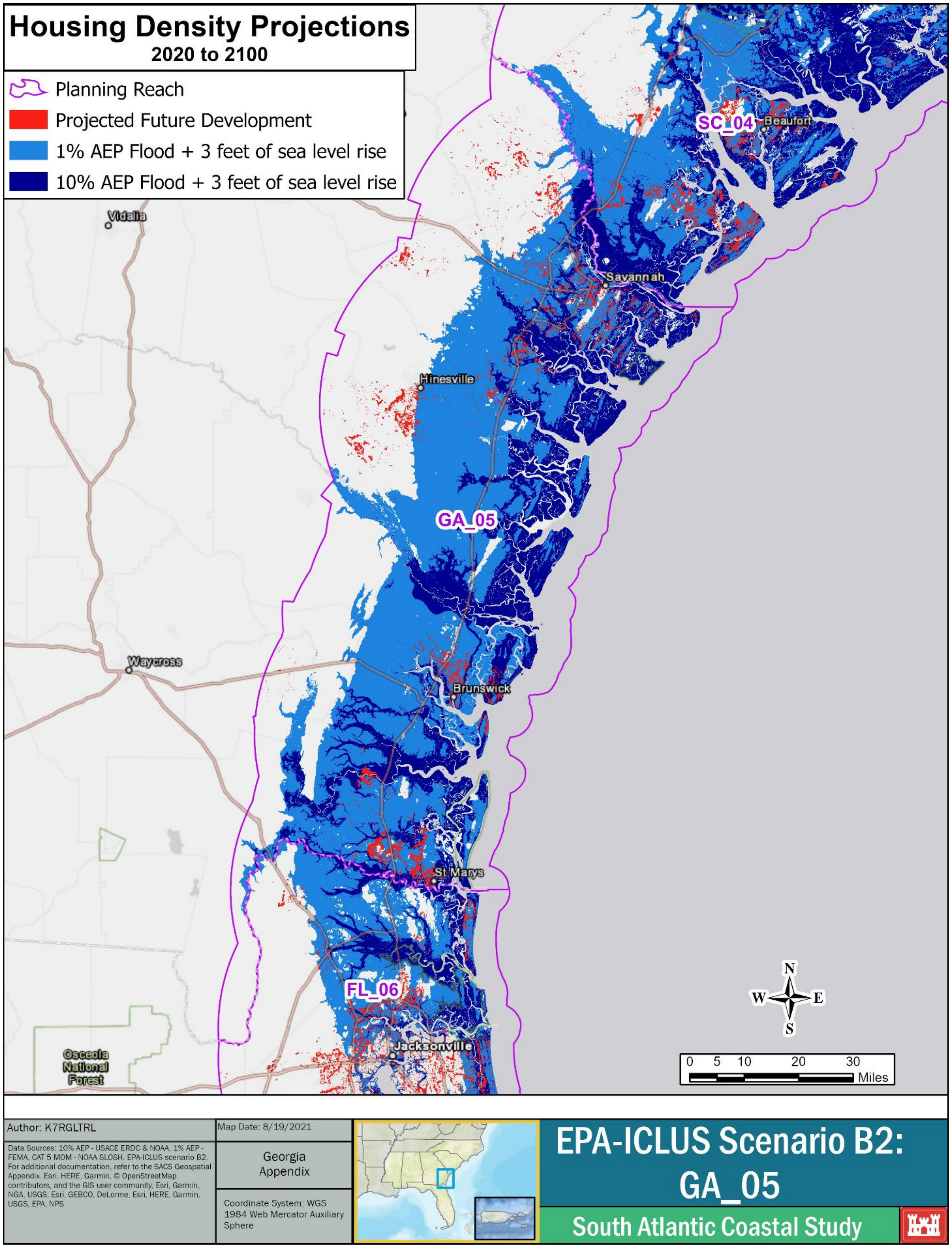


Figure 4-28: Integrated Climate and Land Use Scenarios: Projected Housing Density Projections from 2020 to 2100 for Planning Reach GA_05

4.1.6.2 Environmental Exposure

The Tier 2 Exposure Overview (Section 4.1.6) provides information on the data used to identify natural areas that may be exposed to coastal storm hazards and sea level rise within the planning reach. This data was used as part of the Priority Environmental Area (PEA) selection process, with the majority of identified natural areas located within federal, state, private, and local municipal conservation parcels, parks, preserves, and refuges.

A Natural Areas Exposure Table (SACS Environmental Technical Report, Appendix A) was developed for each county within coastal Georgia that identifies the natural area types, provides a brief description of the natural areas, lists any federal and state protected species that the natural area could support, and identifies whether the natural area is designated critical habitat by USFWS, the location of the critical habitat, and the species the critical habitat is designated for. Identification of the natural areas was based on the Georgia Department of Natural Resources-Wetlands of Coastal Georgia-Results of the National Wetlands Inventory and Landscape-level Functional Assessment (GADNR 2012) and The Natural Environments of Georgia (Wharton 1978). The SACS Environmental Technical Report provides more details on environmental exposure.

Within the GA_05 Planning Reach, estuarine emergent wetlands (e.g., saltmarsh and oyster flats/beds), and palustrine forested wetlands (e.g., forested freshwater wetlands), were identified as the most prevalent land cover types exposed to hazards in this reach. Estuarine emergent wetlands are prevalent within the back bay areas of Tybee, Jekyll, St. Simons, Cumberland, and several other barrier islands, from Chatham County to Camden County, as well as bordering the majority of the AIWW through the reach. Palustrine (freshwater) forested wetlands found within several natural areas including Blue Sky Preserve, Harris Neck NWR and Altamaha Wildlife Management Area (WMA), as well as other natural areas lying landward of bordering estuarine wetlands, are also prevalent from Chatham County to Camden County. Additional natural areas exposed to the Tier 2 hazards within this reach include east-facing unconsolidated shorelines, palustrine scrub-shrub and emergent vegetation habitat and estuarine scrub-shrub wetlands and forested wetland habitat. They also include upland communities such as grassland/herbaceous, scrub-shrub, evergreen forest, mixed forest, and deciduous forest communities.

A more detailed description of the Tier 2 natural resources exposure characterization for Planning Reach GA_05 can be found in the Environmental Technical Report.

4.1.6.3 Cultural Resource Exposure

Exposed cultural resources were broadly defined as being within the 1-percent and 10-percent AEP flood zone because of the potential impacts of repeated and frequent inundation. Geospatial analysis of several datasets determined which cultural resources were located in the 1-percent and 10-percent AEP flood zone. Exposure of cultural resources to coastal storm hazards was evaluated using information and datasets from the NPS, the USGS, and the GNAHRGIS. While the same datasets were used to identify a broad expanse of exposed cultural resources in Tier 1, these datasets were used in Tier 2 to pinpoint the resources located in these areas that are characterized as presenting higher exposure rates.

- **National Register of Historic Places (NRHP):** The data were developed by the NPS to protect historic and archeological resources (U.S. National Parks Service 2020). The NRHP has a comprehensive inventory of cultural resources that are deemed worthy of preservation. The data is available in GNAHRGIS and can provide spatial data of where historic points and historic places (polygons) occur relative to different types of hazards.

- **Geographic Names Information System Historical Features:** The data were developed by the USGS to maintain uniform feature name usage throughout the government. The Geographic Names Information System contains information about historical features and cultural resources (U.S. Geological Survey 2021). The data are available in Georgia's Natural, Archaeological and Historic Resources Geographic Information System (detailed below) and provide spatial data of where physical, cultural, political, and historical points occur relative to different types of shorelines and hazards.

- **Georgia's Natural, Archaeological and Historic Resources Geographic Information System (GNAHRGIS):** Additional cultural resources data from GNAHRGIS was used to refine exposure for cultural resources in Tier 2. GNAHRGIS is comprised of two databases (Georgia Archeological Site File at the University of Georgia and the Georgia Department of Natural Resources n.d.).
  - Georgia Archaeological Site File data
  - GADNR-HPD Historic Resources Survey data

GNAHRGIS combines data from the state's archaeological and built environment (i.e., historic resources) to provide researchers with an online source for cultural resources information. This dataset identifies known historic resources (buildings, structures, archaeological sites, landscape features, and districts) that are eligible for listing, but not listed on the NRHP; resources that require additional evaluation for NRHP eligibility; and resources that are not eligible for listing on the NRHP that would be exposed to hazards. Archaeological sites (historic and prehistoric) that would be exposed due to hazards are also identified using this dataset.

The SACS future 1-percent and 10-percent AEP combined hazard layer (existing AEP hazard plus 3 feet of sea level rise) was used to demonstrate the exposure from coastal storm inundation and sea level rise in the future condition (**Table 4-11**, **Table 4-12**). Cultural and historic resources located within these hazard areas are categorized as being at a higher exposure value than resources located outside of these defined boundaries. Exposed cultural resource areas identified within the state appendices are not meant to be all-inclusive. Publicly available data for historic resources are discussed below and within the FAAS reports. Specific archaeological site information is not publicly reportable but was analyzed to determine the volume of sites located in areas subject to inundation in the existing and future conditions with the addition of 3 feet of sea level rise. The publicly available data and confidential data are sometimes reported separately in the reports, which is primarily due to how the data is reported in the different databases. The figures will only contain locational information for publicly available data (i.e., no archaeological site locational information).

Table 4-11: Exposed Archaeological Sites (Confidential Locational Data)

County	Existing Exposure Number of Sites			Future Exposure (3-Foot Sea Level Rise) Number of Sites		
	1-Percent Annual Exceedance Probability (AEP)	10-Percent AEP	10-Percent and 1-Percent AEP Totals (per county)	1-Percent AEP	10-Percent AEP	10-Percent and 1-Percent AEP Totals (per county)
Camden	157	76	233	61	208	269
Chatham	340	573	913	187	761	948
Glynn	210	90	300	165	143	308
Liberty	86	131	217	84	152	236
McIntosh	98	122	220	51	191	242
Total	891	992	1,883	548	1,455	2,003

Table 4-12: Exposed Historic Resources Sites (Publicly Available Data)

County	Existing Exposure Number of Sites			Future Exposure (3-Foot Sea Level Rise) Number of Sites		
	1-Percent Annual Exceedance Probability (AEP)	10-Percent AEP	10-Percent and 1-Percent AEP Totals (per county)	1-Percent AEP	10-Percent AEP	10-Percent and 1-Percent AEP Totals (per county)
Camden	92	22	114	23	119	142
Chatham	461	157	618	281	353	634
Glynn	2,523	285	2,808	2,292	591	2,883
Liberty	12	0	12	12	6	18
McIntosh	8	13	21	7	14	21
Total	3,096	477	3,573	2,615	1,083	3,698

In the current conditions, 3,573 historic resources were identified within the 1-percent and 10-percent AEP flood zones. With the addition of 3 feet of sea level rise, an additional 125 resources are potentially exposed for a total of 3,698 historic resources. **Figure 4-29** compares existing and future conditions, showing that the future conditions lead to a higher exposure for cultural resources. In the current conditions, 1,883 archaeological sites were identified within the 1-percent and 10-percent AEP flood zones. With the addition of 3 feet of sea level rise, an additional 120 archaeological sites are potentially exposed for a total of 2,003 archaeological sites.

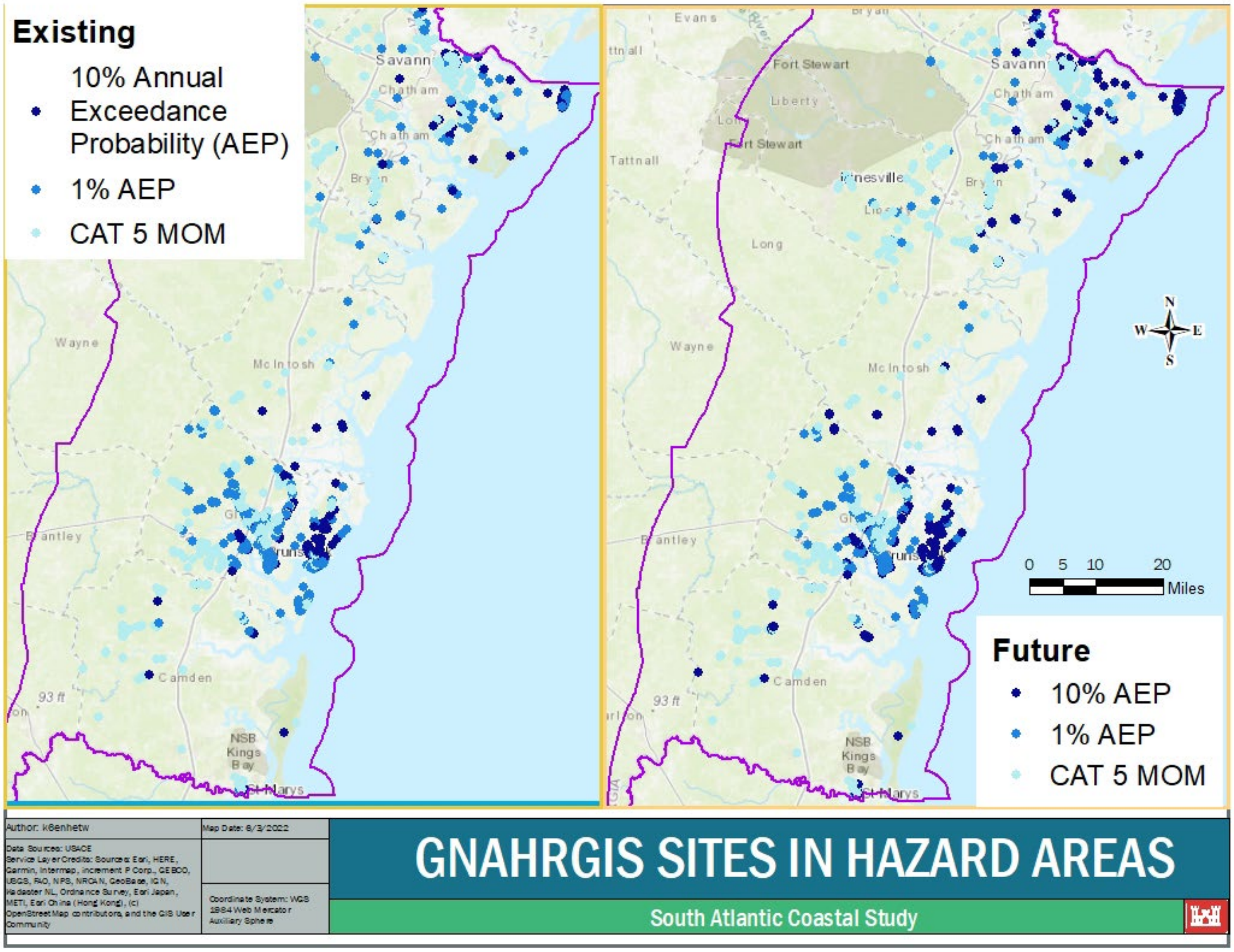


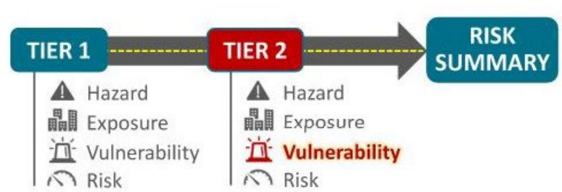
Figure 4-29: Publicly Available Data for Historic Resources Recorded in the Georgia Natural, Archaeological, and Historic Resources Geographic Information System Located in the Existing (left) and Future Conditions (right) 1-Percent and 10-Percent Flood Scenarios (With 3-Foot Sea Level Rise)

The existing and future exposure for archaeological and historic resources for all coastal counties are discussed in greater detail below, as these counties are deemed to have higher exposure due to their proximity to the coast and exposure to coastal storm surge. Specific cultural resource areas are categorized by county in **Table 4-13**. It is important to note that this table is not all-inclusive and is meant to communicate the types of cultural resources that may be found in these areas. A selection of historic properties and districts are highlighted due to their National Register status and stakeholder input regarding their historical significance and concern for continued preservation due to their higher exposure rating. General information is also included regarding the presence of archaeological sites in areas of higher exposure.

Table 4-13: Exposed Cultural Resources Areas by County

County	Location	Exposed Cultural Resource Area
Bryan	Richmond Hill	Ft. McAllister
Camden	Cumberland Island	Cumberland Island, Dungeness Historic District, Little Cumberland Island, Duck House, and historic and prehistoric archaeological sites subject to erosion (Crooked River State Park)
Chatham	Moon River District	Pin Point Gullah Geechee Community
Chatham	Cockspur Island	Ft. Pulaski National Monument, Cockspur Island Lighthouse, and historic and prehistoric archaeological sites subject to erosion
Chatham	Tybee Island	Back River Historic District, Tybee Island Strand Cottages Historic District, Ft. Screven Historic District, and historic and prehistoric archaeological sites subject to erosion. Includes Little Tybee.
Chatham	Ossabaw Island	Historic and prehistoric archaeological sites subject to erosion
Chatham	Savannah	Savannah Historic District (River Street)
Chatham	Isle of Hope	Wormsloe Plantation, Isle of Hope Historic District, Gullah-Geechee sites, and historic and prehistoric archaeological sites subject to erosion
Glynn	St. Simons	Ft. Frederica National Monument, St. Simons Lighthouse and Lighthouse Keepers' Building, U.S. Coast Guard Station at St. Simons Island, Hamilton Plantation slave cabins, and historic and prehistoric archaeological sites subject to erosion
Glynn	Brunswick	Brunswick Old Town Historic District, Hofwyl-Broadfield Plantation
Glynn	Jekyll Island	Jekyll Island Historic District and National Historic Landmark, Jekyll Island Club, Indian Mound Cottage (Rockefeller Cottage), Faith Chapel, and historic and prehistoric archaeological sites subject to erosion
Liberty	Midway	Ft. Morris
Liberty	St. Catherines Island	National Historic Landmark and historic and prehistoric archaeological sites subject to erosion
McIntosh	Darien	Ashantilly, Ft. King George
McIntosh	Sapelo Island	Sapelo Island Lighthouse, Hog Hammock, and historic and prehistoric archaeological sites subject to erosion
McIntosh	Blackbeard Island	Historic and prehistoric archaeological sites subject to erosion

4.1.7 Tier 2 Vulnerability



Vulnerability in Planning Reach GA_05 was refined during the Tier 2 analysis using the USGS Coastal Vulnerability Index and a refined environmental and cultural resources analysis. The USGS Coastal Vulnerability Index was used to help show which areas within the coastal counties of Georgia were most vulnerable to sea level rise and to what degree (very low, low, moderate, high, and very high). The USGS Coastal Vulnerability Index is a measure of the relative vulnerability of the coastline to changes due to future changes in sea level. This method does not produce results that can be directly equated to physical effects but does highlight regions where various effects of sea level rise (inundation, erosion, and waves) are expected to be greatest.

A Tier 2 Environmental Resources Vulnerability Analysis was conducted to determine the degree to which natural areas are susceptible to loss or degradation when exposed to coastal storm hazards and sea level rise. Please see the Environmental Technical Report for more information.

A qualitative assessment of cultural resource vulnerability was conducted for historic structures located on barrier islands, along the coast, and in low lying areas due to Tier 2 hazards (storm surge inundation, erosion, and wave attack).

4.1.7.1 U.S. Geological Survey Coastal Vulnerability Index

The USGS Coastal Vulnerability Index characterization used in this assessment ranks coastal vulnerability based on six quantifiable physical variables: geomorphology, coastal slope, relative sea level rise, shoreline erosion/accretion, mean tidal range, and mean wave height (Thieler and Hammar-Klose 1999).

Table 4-14 shows the six physical variables ranked on a linear scale from 1 to 5 in order of increasing vulnerability due to changing sea level. Values are presented in metric units. The databases include both quantitative and qualitative information, resulting in a vulnerability ranking based on data value ranges and non-numerical geomorphology (ranked according to relative resistance to erosion). Coastal Vulnerability Index characterizations for the Atlantic coast, developed from Theiler and Hammar-Klose, can be accessed graphically online through the USGS Coastal Change Hazards Portal (USGS n.d.).

Details of the analysis are available from the USGS at https://pubs.usgs.gov/of/1999/of99-593/.

Table 4-14: Ranking of Coastal Vulnerability Index (Thieler and Hammar-Klose, 1999)

Metric	Very Low	Low	Moderate	High	Very High
Geomorphology	• Rocky, cliffed coasts • Fiords • Fiards	• Medium cliffs • Indented coasts	• Low cliff • Glacial drift • Alluvial plains	• Cobble beaches • Estuary • Lagoon	• Barrier beaches • Sand beaches • Salt marsh • Mud flats • Deltas • Mangrove • Coral reefs
Coastal Slope	> .2	.2 - .07	.07 - .04	.04 - .025	< .025
Relative seal-level change (meters/year [m/yr])	< 1.8	1.8 – 2.5	2.5 – 2.95	2.95 – 3.16	> 3.16
Shoreline erosion/ accretion rate (m/yr)	> 2.0	1.0 – 2.0	-1.0 – +1.0	-1.1 – -2.0	< -2.0
Shoreline erosion/ accretion	Accretion	Accretion	Stable	Erosion	Erosion
Mean ride range (m)	> 6.0	4.1 – 6.0	2.0 – 4.0	1.0 – 1.9	< 1.0
Mean wave height (m)	< .55	.55 - .85	.85 – 1.05	1.05 – 1.25	> 1.25

Figure 4-30 to **Figure 4-32** show the Coastal Vulnerability Index for the Georgia coastline along the six coastal counties (north to south): Chatham and Bryan (**Figure 4-30**), Liberty and McIntosh (**Figure 4-31**), and Glynn and Camden (**Figure 4-32**). **Table 4-15** tabulates these data by county and region. A region may contain shorelines with one or more Coastal Vulnerability Index rankings.

The areas with the highest vulnerability are generally high-energy coastlines where the regional coastal slope is low, typically where the shoreline type is a barrier island. The barrier islands of Georgia are predominantly characterized as having moderate to high Coastal Vulnerability Index rankings, while inlets, sounds, and rivers are characterized as having low to high Coastal Vulnerability Index rankings. Tybee Island, St. Catherine Island, parts of St. Simons Island, and parts of Cumberland Island are particularly vulnerable and are characterized as having a very high Coastal Vulnerability Index. In these locations, the predominant variable is the geomorphology, but local coastal slope and exposure to high energy waves also contribute to their high vulnerability. In general, all coastal areas of Georgia should be considered as vulnerable to sea level rise.

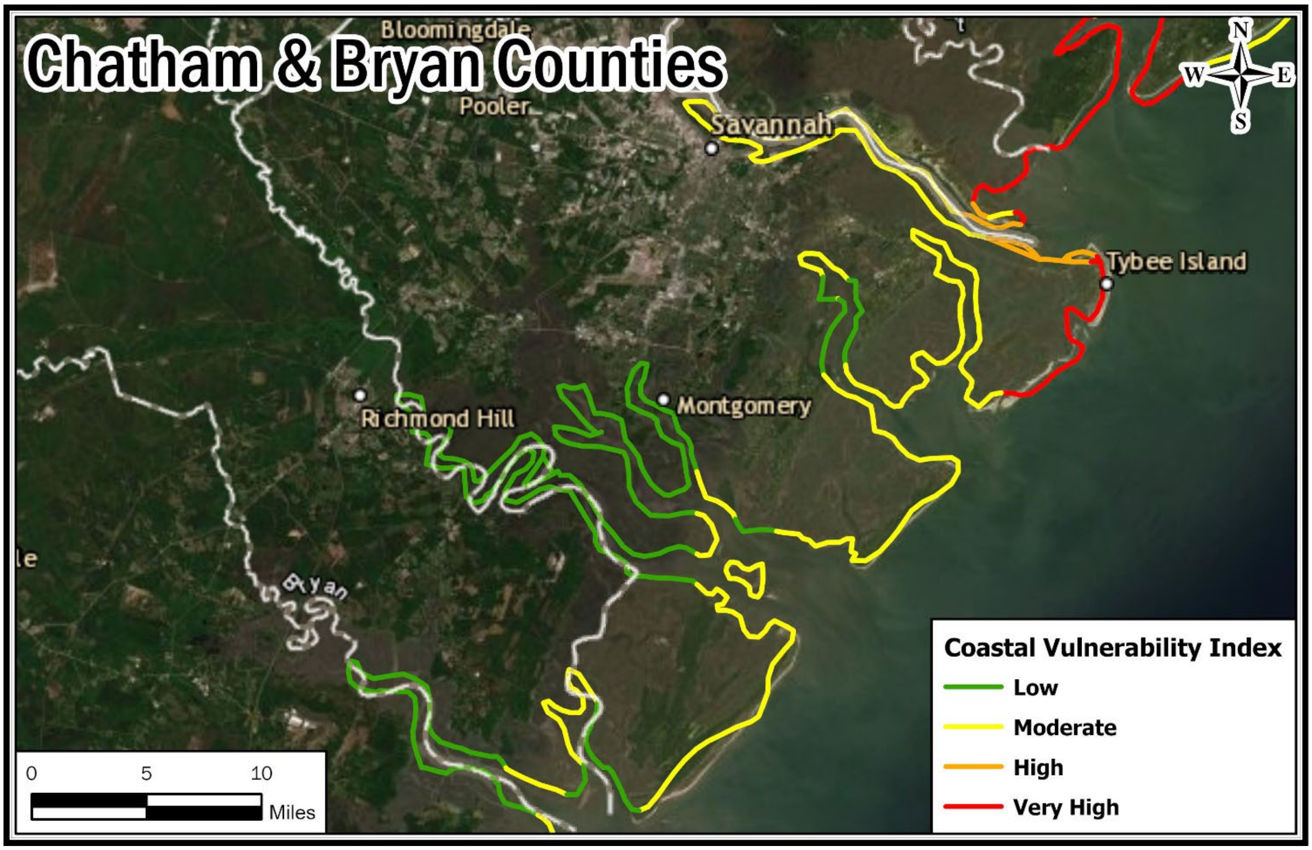


Figure 4-30: Coastal Vulnerability Index (Chatham and Bryan Counties) (USGS n.d.; Coastal Change Hazards Portal)

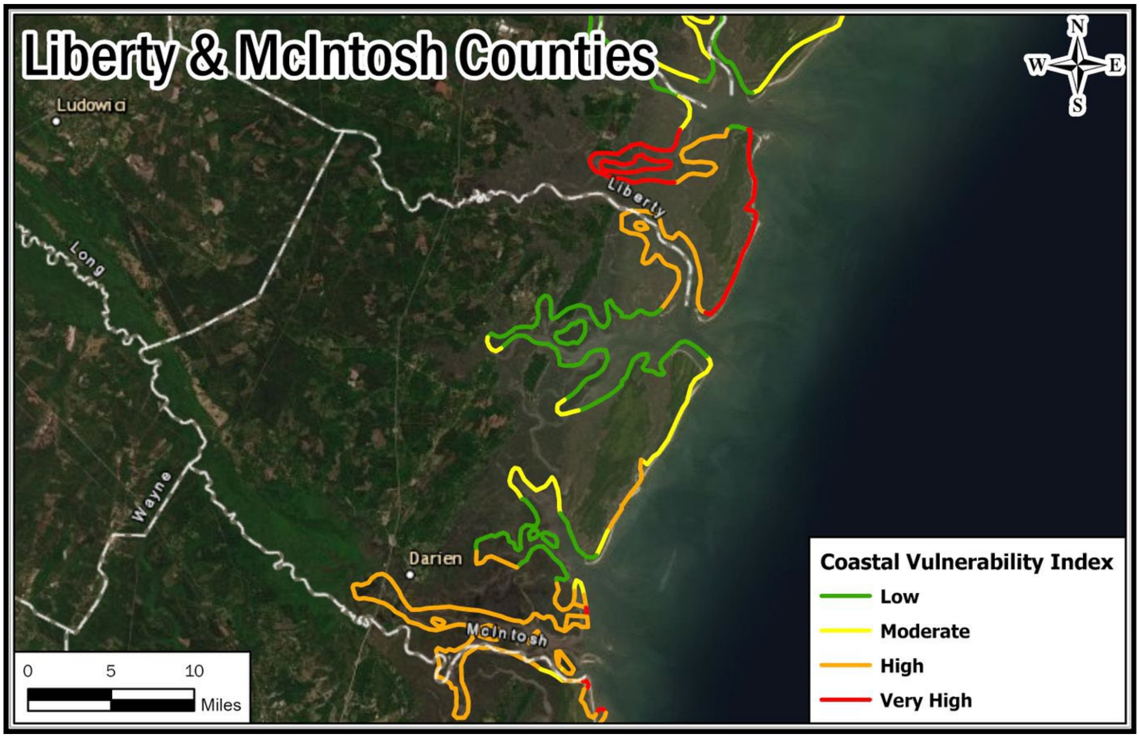


Figure 4-31: Coastal Vulnerability Index (Liberty and McIntosh Counties) (USGS n.d.; Coastal Change Hazards Portal)

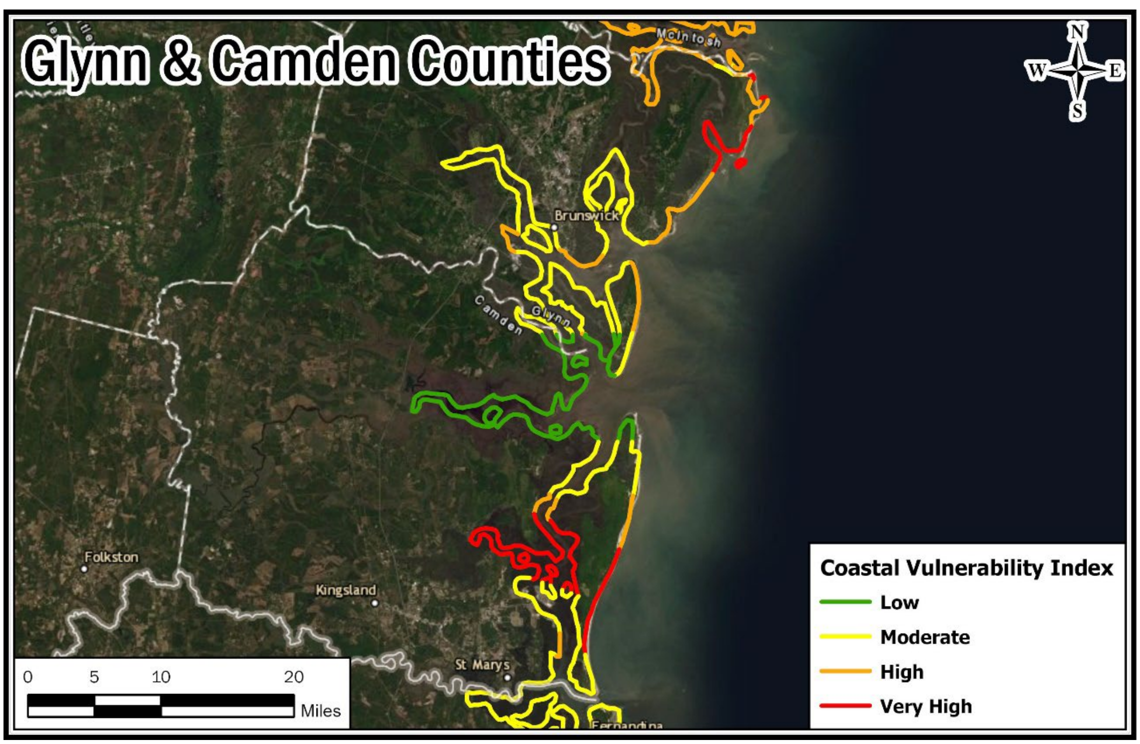


Figure 4-32: Coastal Vulnerability Index (Glynn and Camden Counties) (USGS n.d.; Coastal Change Hazards Portal)

Table 4-15: Coastal Vulnerability Index – All Coastal Counties

County	Region Description	Vulnerability to Sea Level Rise				
		Very Low	Low	Moderate	High	Very High
Chatham	Savannah River			X	X	
	Tybee Island					X
	Little Tybee					X
	Wassaw Sound		X	X		
	Wassaw Island			X		
	Ogeechee River			X		
	Ossabaw Island			X		
Bryan	St. Catherines Sound		X	X		
	Bear River		X	X		
	Medway River		X	X		
Liberty	Timmons River				X	X
	North Newport River				X	X
	St. Catherines Island					X
	South Newport River				X	X
McIntosh	Sapelo Sound and tributaries		X			
	Sapelo Island			X	X	
	Deboy Sound		X	X		X
	Wolfe Island			X	X	X
	Altamaha Sound and River				X	
Glynn	Little St. Simons Island				X	X
	Hampton River					X
	St. Simons Island					X
	St. Simons Sound			X		X
	Brunswick River			X	X	
	Jekyll Island			X	X	
	Jekyll Sound			X		
Camden	St. Andrew Sound		X			
	Satilla River		X			
	Cumberland River			X	X	X
	Cumberland Island			X	X	X
	Cumberland Sound			X		

4.1.7.2 Environmental Resources Vulnerability

For the Tier 2 Environmental Resources Vulnerability Analysis, several factors were used to evaluate natural resources and habitat and their vulnerability to coastal storm hazards and sea level rise. The natural areas identified as part of the Tier 2 exposure analysis were categorized across the study area using NOAA's Coastal Change Analysis Program (C-CAP) classes that best characterized each natural area. The vulnerability of each C-CAP class located within the planning reach was assessed to the hazards of sea level rise, storm surge inundation, saltwater intrusion, erosion, and wind.

Vulnerability scores were assigned to each C-CAP class in Georgia. A weighted scoring system was developed to rate the vulnerability of each C-CAP class to the hazards, and a formula was developed to numerically classify the total vulnerability of each C-CAP class (1 - low, 2 - medium, or 3 - high). The results of the Tier 2 Environmental Resources Vulnerability Analysis for Planning Reach GA_05 can be found in **Figure 4-33**.

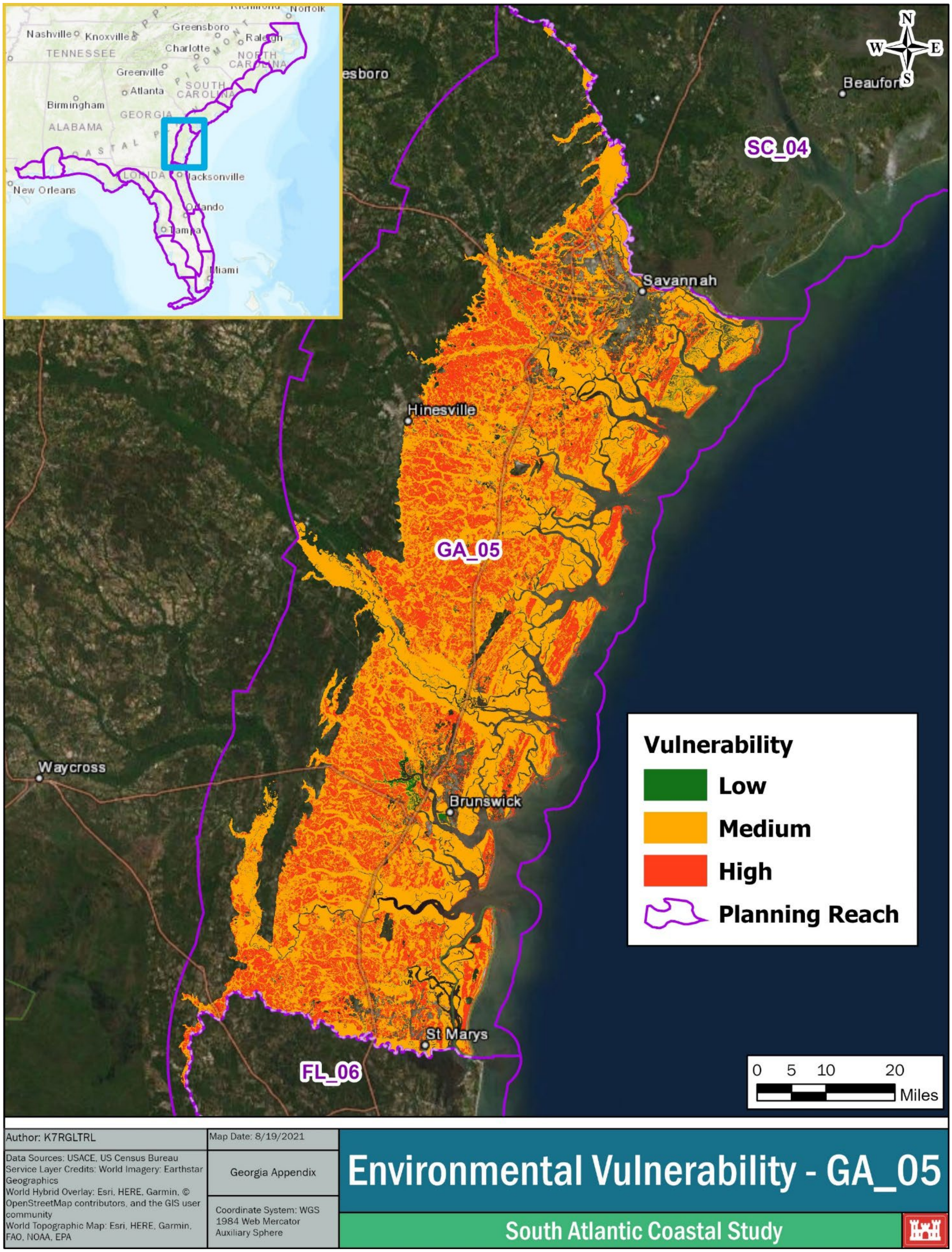


Figure 4-33: Tier 2 Environmental Resources Vulnerability in the GA_05 Planning Reach.

The following C-CAP natural areas were the most vulnerable:

- **Unconsolidated Shore:** This includes Georgia's beaches, dunes, barrier islands, intertidal mudflats, and non-vegetated mudflats. Environmental consequences include loss of foraging, refuge, and nursery habitat due to sea level rise and erosion for commercially important essential fish habitats (snapper-grouper, shrimp), other invertebrates (blue crabs, oyster), as well as a loss of foraging and refuge habitat for wading birds (wood stork, eastern black rail). For example, the stretch of beach on the southern end of Cumberland Island was considered high vulnerability.

- **Evergreen Forest:** This includes bottomland hardwood forest and dry coniferous forest and mixed hardwood. Environmental consequences from sea level rise and erosion include the permanent conversion of habitat, reduction in species diversity, invasive species recruitment, and increased fragmenting of habitat. For example, the western interior of Sapelo Island contains areas that are considered as high vulnerability.

- **Deciduous Forest:** This includes maritime forest and coastal hardwood. Environmental consequences from sea level rise and erosion include the permanent conversion of habitat, reduction in species diversity, invasive species recruitment, and increased fragmenting of habitat. For example, the western section of Guale Preserve contains several areas that are considered as high vulnerability.

A detailed list of vulnerability scores and descriptions of the methodology used to identify the level of vulnerability of environmental resources are available in the SACS Environmental Technical Report.

4.1.7.3 Cultural Resource Vulnerability

Based on a qualitative assessment of vulnerability, historic structures and archaeological sites located on barrier islands face vulnerability due to storm surge inundation, erosion, and wave attack (See **Table 4-16**). Storm surge inundation along the coast and reaching up rivers to low lying areas will flood historic properties and damage buildings. Damage may include, but is not limited to, structural damage and destruction of historic materials (e.g., furniture, textiles, archives). The aftermath of a storm can pose long-term issues, such as the development of mold, mildew, and other potentially toxic residues. Erosion and wave attack pose threats to historic properties and both terrestrial and submerged archaeological sites. Significant structural damage can be caused to historic properties by wave attack. Erosion can eliminate surface evidence of archaeological sites, wear away site layers, and displace materials from various cultural layers making recovery and interpretation challenging if not impossible. Erosion will impact features more severely due to the disturbed nature of the soil, while leaving intact topographic layers less damaged. Strong currents cause hydrographic change that can displace submerged cultural resources, including historic wrecks, as well as obscure or damage these resources due to storm debris. Currents and even wind can uproot trees and other vegetation, which can serve as a major source of disturbance and destruction for both historic properties and archaeological sites.

Table 4-16 below indicates if the exposed cultural resource area is vulnerable to the Tier 2 hazard. This table is not all-inclusive and is meant to communicate the types of cultural resources that may be found in these areas and the types of vulnerability that they may face. A selection of historic properties and districts are highlighted due to their National Register status and stakeholder input regarding their historical significance and concern for continued preservation due to their higher exposure rating. General information is also included regarding the presence of archaeological sites in areas of higher exposure.

Table 4-16: Vulnerability of Exposed Cultural Resources Areas to the Tier 2 Hazards for the Georgia Planning Reach

Exposed Cultural Resource Area		Tier 2 Hazards		
		Storm Surge Inundation	Erosion	Wave Attack
Richmond Hill	Ft. McAllister	Y	Y	Y
Cumberland Island	Cumberland Island	Y	Y	Y
Cumberland Island	Dungeness Historic District	Y	Y	N
Cumberland Island	Little Cumberland Island	Y	Y	Y
Cumberland Island	Duck House	Y	Y	N
Cumberland Island	Historic and Prehistoric Archaeological Sites	Y	Y	Y
Moon River District	Pin Point Gullah Geechee Community	Y	Y	N
Cockspur Island	Ft. Pulaski National Monument	Y	Y	Y
Cockspur Island	Cockspur Island Lighthouse	Y	Y	Y
Cockspur Island	Historic and Prehistoric Archaeological Sites	Y	Y	Y
Tybee Island	Back River Historic District	Y	Y	Y
Tybee Island	Tybee Island Strand Cottages Historic District	Y	Y	Y
Tybee Island	Historic and Prehistoric Archaeological Sites	Y	Y	Y
Ossabaw Island	Historic and Prehistoric Archaeological Sites	Y	Y	Y
Savannah	Savannah Historic District (River Street)	Y	Y	Y
Isle of Hope	Wormsloe Plantation	N	Y	N
Isle of Hope	Isle of Hope Historic District	Y	Y	N
Isle of Hope	Gullah-Geechee sites	Y	Y	N
Isle of Hope	Historic and Prehistoric Archaeological Sites	Y	Y	N
St. Simons	Ft. Frederica National Monument	Y	Y	N
St. Simons	St. Simons Lighthouse and Lighthouse Keepers' Building	Y	Y	Y
St. Simons	U.S. Coast Guard Station at St. Simons Island	Y	Y	Y
St. Simons	Hamilton Plantation slave cabins	Y	Y	N
St. Simons	Historic and Prehistoric Archaeological Sites	Y	Y	Y
Brunswick	Brunswick Old Town Historic District	Y	Y	N
Brunswick	Hofwyl-Broadfield Plantation	Y	Y	N
Jekyll Island	Jekyll Island Historic District and National Historic Landmark	Y	Y	N
Jekyll Island	Jekyll Island Club	Y	Y	N
Jekyll Island	Indian Mound Cottage (Rockefeller Cottage)	Y	Y	N
Jekyll Island	Faith Chapel	Y	Y	N
Jekyll Island	Historic and Prehistoric Archaeological Sites	Y	Y	Y

Exposed Cultural Resource Area		Tier 2 Hazards		
		Storm Surge Inundation	Erosion	Wave Attack
Midway	Ft. Morris	Y	Y	N
St. Catherines Island	National Historic Landmark	Y	Y	Y
St. Catherines Island	Historic and Prehistoric Archaeological Sites	Y	Y	Y
Darien	Ashantilly	Y	Y	N
Darien	Ft. King George	Y	Y	N
Sapelo Island	Sapelo Island Lighthouse	Y	Y	Y
Sapelo Island	Hog Hammock	Y	Y	N
Sapelo Island	Historic and Prehistoric Archaeological Sites	Y	Y	Y
Blackbeard Island	Historic and Prehistoric Archaeological Sites	Y	Y	Y

Within this planning reach, there are several historic districts, historic forts, plantation sites, historic lighthouses, and archaeological sites along the coast and on barrier islands that are susceptible to damages from coastal storm hazards, including storm surge inundation, erosion, and wave attack. The most susceptible is Ft. Pulaski National Monument and all associated features on Cockspur Island, as well as the historic lighthouses. While some historic districts have protections, such as sea walls, in place to minimize vulnerability, many of the historic structures are vulnerable to storm surge inundation and the associated damage that it brings. Cumberland Island, Savannah, and Isle of Hope are a few examples of historic districts that could be severely impacted by storm surge inundation, especially if protection measures fail or are not sufficient to protect against more extreme storm episodes. Damage caused by storm surge inundation in these areas may result in significant economic damage, as historic tourism is a primary economic driver in areas such as this. Historic and archaeological sites on barrier islands such as Cumberland, Cockspur, Tybee, St. Simons, Jekyll, St. Catherines, Sapelo, and Blackbeard Islands are susceptible to damages primarily from erosion and wave attack. Previous studies by the GADNR Historic Preservation Division (HPD) and Skidaway Institute of Oceanography have documented archaeological sites that are in danger of, or are presently, being lost to erosion within Georgia's barrier islands (Skidaway Institute of Oceanography 2017). Vulnerable sites identified by the GADNR HPD included prehistoric Indian shell middens, prehistoric Indian artifact and shell scatter, and burial sites, among other archaeological sites subject to erosion.

4.1.8 Tier 2 High-Risk Locations Overview

Risk can be assessed after determining hazards, exposure, and vulnerability. High-risk locations were developed from data presented in the hazard, exposure, and vulnerability sections of this appendix. The Tier 2 Risk Assessment identified other potential high-risk areas that were not identified during the Tier 1 Risk Assessment as well as reaffirmed and better defined the risk picture for many previously identified Tier 1 high-risk locations.

Tier 2 high-risk areas in Georgia were determined through a set of specific screening criteria. To be considered high-risk, a location must meet at least one of the following criteria:

1. A location with a future FEMA Hazus Flood Model flood damage rating of medium- to high-risk.
2. Identified as a Priority Environmental Area (PEA).
3. Identified as a location with at-risk Cultural Resources.
4. A shoreline location with a long-term erosional trend greater than -6.6 feet per year.

4.1.8.1 Tier 2 Economic Risk Assessment

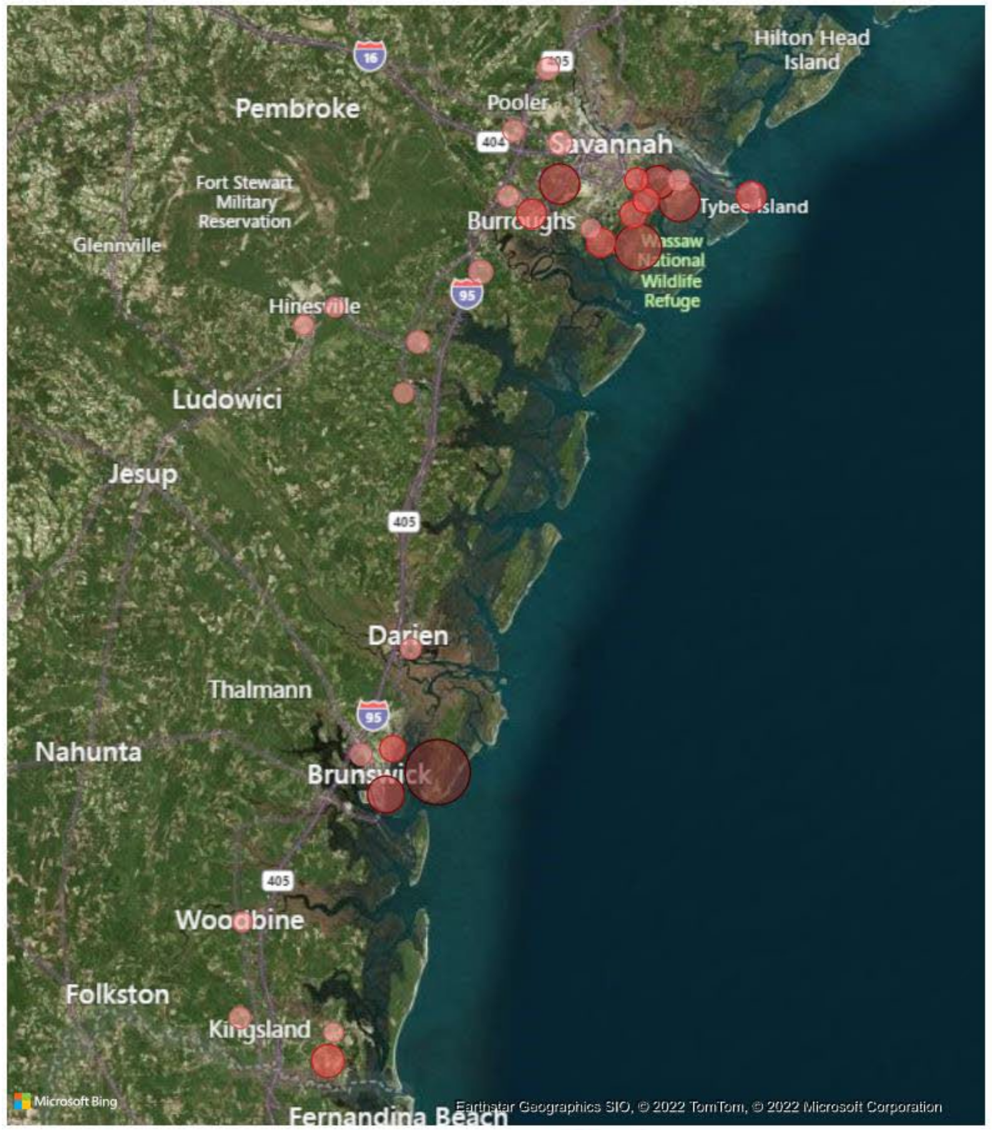
The Tier 2 Economic Risk Assessment is an estimate of storm surge inundation risk to public and private property and some critical infrastructure within Planning Reach GA_05. This includes all coastal and riverine areas within the zone of tidal influence in Georgia. The risk is expressed as the expected annual damages (EAD) to structures and their contents described in dollars under existing sea level conditions (low) and the EAD assuming up to 3 feet of sea level rise (high). EAD are presented in a geospatial format that can be aggregated to the census block, census tract, census place, county, SACS planning reach, and state level. For detailed descriptions of the FEMA Hazus Flood Model methodology used for this assessment, please see the SACS Tier 2 Economic Risk Assessment report.

> The SACS Tier 2 Economic Risk Assessment web application can be accessed at: (https://sacs.maps.arcgis.com/apps/opsdashboard/index.html#/b488a3f8a07442fd82ee1947c0020709)

Figure 4-34 provides a snapshot of the Tier 2 Economic Risk Assessment for Georgia. Each red circle on the map denotes separate census places. The map included in **Figure 4-34** displays the distribution of economic risk from low to high by census place. The bar charts highlight the census places with the greatest economic risk in Georgia, with quantifications of the existing (green shading) and future risks, including sea level rise (black shading) and the change (i.e., delta) between the two (red shading). Economic risks displayed are not cumulative. The distribution of existing and future economic risks is further broken down by census block, counties with the greatest risk, population center category (i.e., rural, census place, or estate), and focus areas. The total EAD for the Planning Reach GA_05 are approximately $134 million in the existing condition and $383 million in the future conditions with 3 feet of sea level rise. The Tier 2 Economic Risk Assessment indicates that most estimated existing and projected future economic risk within Planning Reach GA_05 is within Chatham and Glynn County, representing greater than 80 percent of estimated EAD. **Figure 4-34** depicts the dispersion of damages between the census places that are described in greater detail below.

State/Territory Name

Georgia



Risk Rating ● High ● Low ● Low-Med ● Med ● Med-High

Census Places with the Greatest Risk

Existing Risk by Census Block

EC_CB_Risk Rating	# Census Blocks	Acres	Existing Risk
1-Low	4690	976,306	$29,720,948
2-Low-Med	242	104,433	$42,033,603
3-Med	56	46,918	$29,447,963
4-Med-High	14	18,569	$19,551,772
5-High	4	6,082	$12,931,472
Total	**5006**	**1,152,309**	**$133,685,758**

Future Risk by Census Block

FC_CB_Risk Rating	# Census Blocks	Acres	Future Risk
1-Low	4271	818,441	$58,922,110
2-Low-Med	498	189,965	$87,623,797
3-Med	168	69,918	$93,648,922
4-Med-High	49	47,030	$64,754,258
5-High	20	26,954	$78,443,350
Total	**5006**	**1,152,309**	**$383,392,437**

$134M
Existing Risk

$383M
Future Risk

5006
# of Census Blocks

1,152,309
# of Acres Impacted

8
# of Counties Impacted

30
Census Places Impacted

1
# of Planning Reaches

Counties with the Greatest Risk

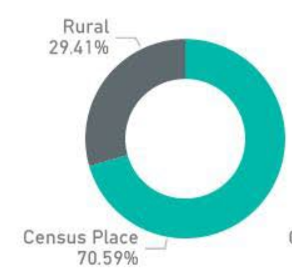
County	% of Existing Risk	% of Future Risk
Chatham	54.32%	51.82%
Glynn	28.95%	30.83%
Camden	6.77%	7.23%
Bryan	3.76%	4.19%
Liberty	3.45%	3.79%
McIntosh	2.74%	2.14%

Existing Return Period Event Consequences by Focus_Area

Focus_Area	EC_DL_10Yr	EC_DL_50Yr	EC_DL_100Yr	EC_DL_500Yr	Existing Risk
Brunswick / Glynn County	$139,988,000	$419,713,784	$628,669,110	$1,425,719,537	$38,698,980
City of Savannah / Chatham County	$307,554,000	$765,949,155	$1,205,214,224	$2,504,602,407	$72,644,411

Future Return Period Event Consequences by Focus_Area

Focus_Area	FC_DL_10Yr	FC_DL_50Yr	FC_DL_100Yr	FC_DL_500Yr	Future Risk
Brunswick / Glynn County	$580,533,828	$1,355,662,402	$1,872,728,886	$2,853,896,517	$118,204,100
City of Savannah / Chatham County	$993,007,688	$2,208,700,782	$3,201,005,648	$5,135,735,593	$198,735,299



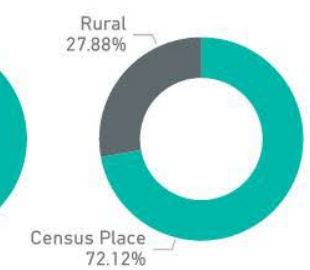


Figure 4-34: Tier 2 Economic Risk Assessment Dashboard

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The risk classification thresholds identified in **Table 4-17** were based on the Planning Reach GA_05 specific lower and upper bounds of the FEMA Hazus Flood Model-derived damages. The damage range was statistically classified into five classes (low, low-medium, medium, medium-high, high) using the Jenks optimization method, also referred to as the Jenks natural breaks classification method. For Planning Reach GA_05, a risk classification of high was defined as a census place with EAD above approximately $10,455,000, medium-high above approximately $5,072,000, and medium above approximately $1,156,700.00.

Table 4-17: Federal Emergency Management Agency Hazus Flood Model Risk Classification Thresholds for Planning Reach GA_05

Risk Classification	Lower Bound	Upper Bound
Low	$0	$405,404
Low-Med	$405,405	$1,156,700
Med	$1,156,701	$5,071,574
Med-High	$5,071,575	$10,455,369
High	$10,455,370	$17,655,097

Table 4-18 displays the county distribution of locations identified with a risk rating of medium to high in the future conditions, considering 3 feet of sea level rise. Understanding the spatial distribution of economic risk from coastal floods under existing and future sea level rise conditions can help inform communities on which potential actions should be implemented to mitigate the potential economic risks.

Table 4-18: Tier 2 Economic Risk Assessment Medium, Medium-High, and High-Risk Locations in the Future Condition Categorized by County

County	Census Place	Existing EAD	Existing Risk Rating	Future EAD	Future Risk Rating	Percent Increase in EAD in Future Condition
Bryan	Richmond Hill (East of Keller) [1]	$2,407,000	Medium	$8,382,000	Medium-High	248.23%
Bryan	Richmond Hill	$1,079,000	Low-Medium	$4,790,000	Medium	343.93%
Camden	St. Marys	$4,797,000	Medium	$15,688,000	High	227.04%
Camden	Kingsland	$569,000	Low-Medium	$2,115,000	Medium	271.70%
Chatham	Skidaway Island	$10,455,000	Medium-High	$31,769,000	High	203.86%
Chatham	Wilmington Island	$7,724,000	Medium-High	$25,118,000	High	225.19%
Chatham	Savannah	$7,635,000	Medium-High	$23,912,000	High	213.19%
Chatham	Whitemarsh Island	$6,766,000	Medium-High	$15,976,000	High	136.12%
Chatham	Montgomery	$5,072,000	Medium	$11,070,000	High	118.26%
Chatham	Tybee Island	$4,768,000	Medium	$11,867,000	High	148.89%
Chatham	Georgetown	$4,725,000	Medium-High	$11,615,000	High	145.82%
Chatham	Dutch Island	$3,481,000	Medium	$7,251,000	Medium-High	108.30%
Chatham	Isle of Hope	$3,111,000	Medium	$9,201,000	Medium-High	195.76%

County	Census Place	Existing EAD	Existing Risk Rating	Future EAD	Future Risk Rating	Percent Increase in EAD in Future Condition
Chatham	Henderson	$355,000	Low	$1,816,000	Medium	411.55%
Chatham	Pooler	$259,000	Low	$2,047,000	Medium	690.35%
Chatham	Garden City	$1,157,000	Low-Medium	$4,885,000	Medium	322.21%
Chatham	Port Wentworth	$749,000	Low-Medium	$2,838,000	Medium	278.91%
Chatham	Talahi Island	$748,000	Low-Medium	$1,938,000	Medium	159.09%
Chatham	Thunderbolt	$2,426,000	Medium	$4,542,000	Medium	87.22%
Glynn	St. Simons	$17,655,000	High	$53,731,000	High	204.34%
Glynn	Brunswick	$6,219,000	Medium-High	$20,107,000	High	223.32%
Glynn	Country Club Estates	$2,887,000	Medium	$7,460,000	Medium-High	158.40%
Glynn	St. Simons (North Frederica area) [1]	$2,653,000	Medium	$8,907,000	Medium-High	235.73%
Glynn	Dock Junction	$811,000	Low-Medium	$2,301,000	Medium-High	183.72%
Liberty	Midway – (East of Interstate 95) [1]	$2,334,000	Medium	$3,969,000	Medium-High	70.05%
Liberty	Midway	$348,000	Medium	$2,814,000	Medium-High	70.05%

[1]Identifies unincorporated locations that are not classified under existing census places but project significant EAD as part of the Tier 2 Economic Risk Assessment.

St. Simons Island was exclusively identified as high-risk under the existing conditions. St. Simons Island was also notably projected as having the highest economic risk within Planning Reach GA_05, with EAD of $18 million in the existing condition and $54 million in the future condition. Based on these projections, this area appears to be particularly susceptible to coastal storm risks and sea level rise.

In the future condition with 3 feet of sea level rise, all of the existing medium-high- to high-risk areas more than double in EAD, with many places tripling in projected economic risk (St. Marys, Skidaway Island, Savannah, St. Simons, Brunswick). Many of the areas that were classified as medium risk in the existing condition, now become medium-high- to high-risk locations, while medium-high-risk areas largely transition to high-risk with the addition of a 3-foot sea level rise. The increase in risk within the future condition is not exclusive to the coastline. Located in northwestern Chatham County, Pooler is projected to have the highest percent increase in EAD in the future condition within Planning Reach GA_05, a nearly sevenfold increase in EAD.

As identified in **Table 4-18** and displayed **Figure 4-35**, most future medium- to high-risk locations are located within the greater Savannah and Brunswick metropolitan statistical areas. Chatham County encompasses fifteen of the twenty-six locations with a projected future risk rating of medium to high, Glynn County has five medium- to high-risk locations, while Bryan, Camden, and Liberty Counties each contain two medium- to high-risk locations. These places largely correlate with areas identified as high-risk under the Tier 1 Risk Assessment and identify locations that may require additional analysis and studies to identify CSRM measures that can reduce the vulnerability of the infrastructure to coastal storm risks and sea level rise.

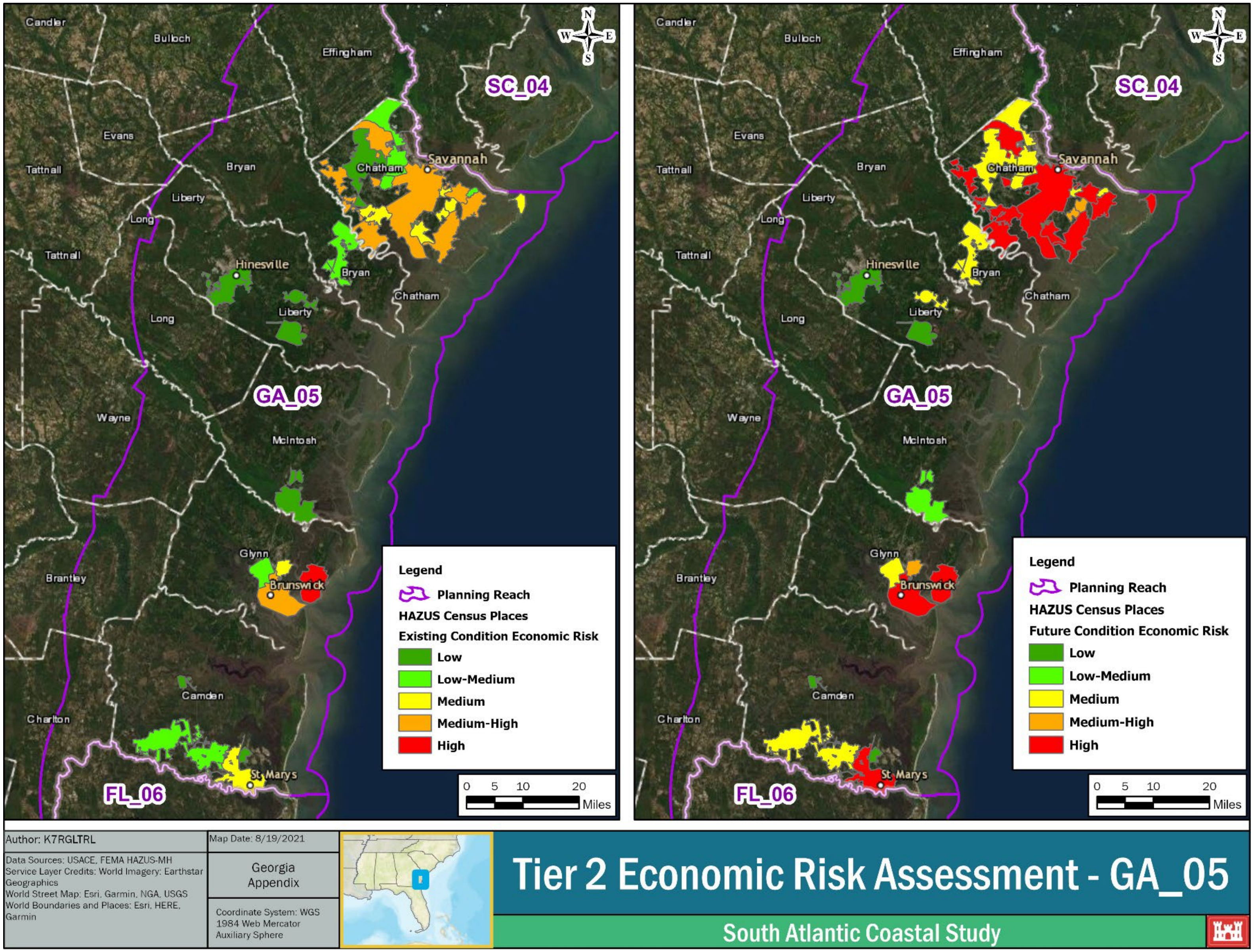


Figure 4-35: Tier 2 Economic Risk Assessment – Existing Risk Locations (left) and Future Risk Locations with a 3-Foot Sea Level Rise (right)

4.1.8.2 Priority Environmental Areas

The Tier 2 Risk Assessment affirmed many of the high- and medium-high-risk natural resource areas identified for Planning Reach GA_05 in the Tier 1 Risk Assessment, while providing more specificity of the resources at risk. For example, the Tier 2 Risk Assessment indicates that the saltmarsh, intertidal flats, wetlands, and maritime forest of the Altamaha Wildlife Management Area and the maritime forests, coastal hardwood forest, and saltmarsh of Harris Neck NWR are at risk (**Figure 4-36**). These areas and several more are included in the full list of PEAs for the Planning Reach GA_05 (**Table 4-19**).

The SACS Environmental Analysis StoryMap and Geoportal explains the methodology used to determine exposure, vulnerability, and risk to these environmental resources. https://sacs.maps.arcgis.com/apps/MapSeries/index.html?appid=f0aa02dd2aa54b4aab34b4bccea3c3d5

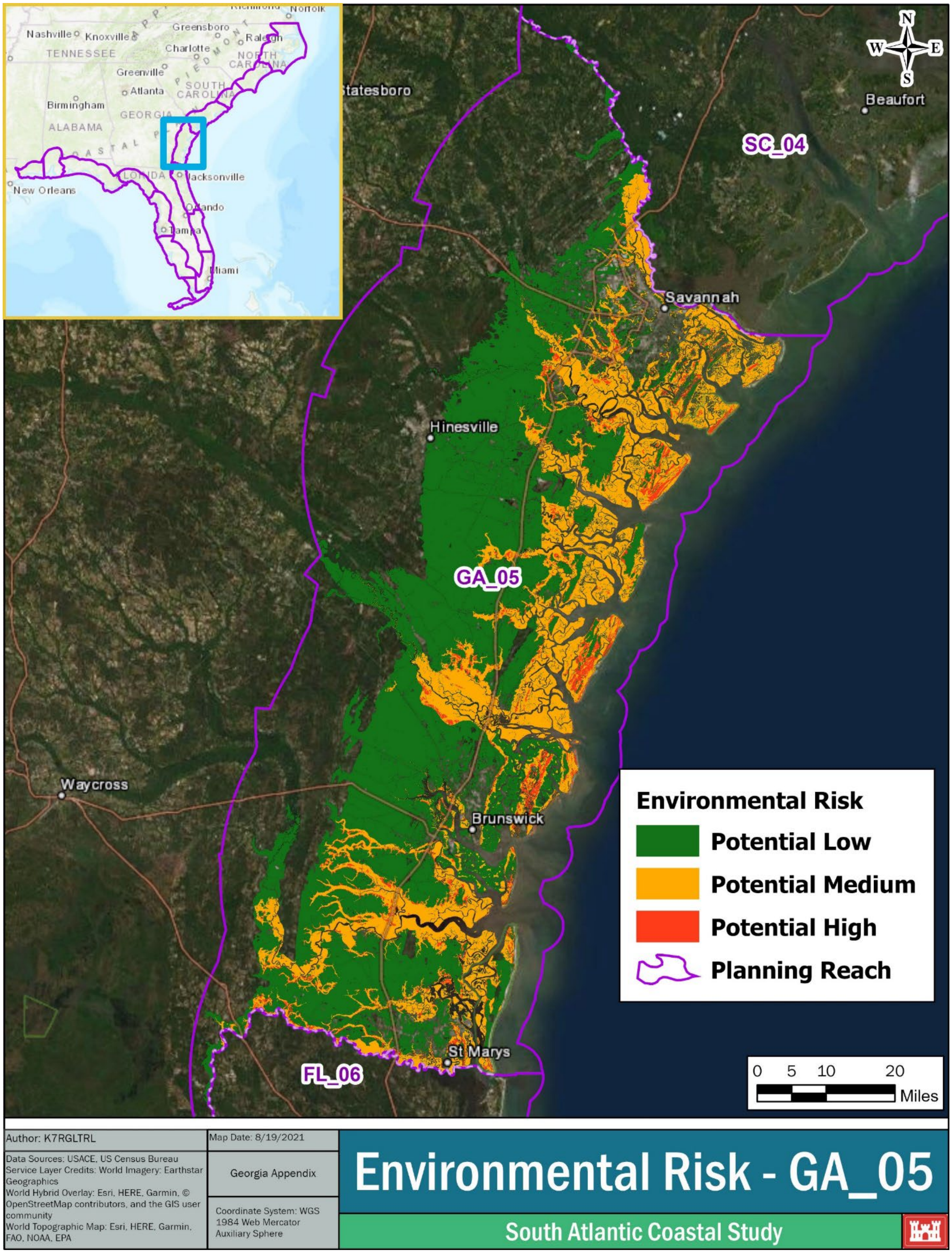


Figure 4-36: Tier 2 Environmental Resources Inundation Risk in GA_05

Table 4-19: Planning Reach GA_05 Priority Environmental Areas

Priority Environmental Area	County	Priority Environmental Area	County
Blythe Island City Park	Glynn	Ft. McCallister State Park	Bryan
Jekyll Island State Park	Glynn	JF Gregory Park	Bryan
Little St. Simons Island	Glynn	Ft. Morris State Historic Site	Liberty
St. Simons Island- Sea Island	Glynn	St. Catherines Island	Liberty
Canons Point/Guale Preserve	Glynn	Cay Creek Wetlands Center	Liberty
Hofwyl Plantation State Park	Glynn	Harris Neck National Wildlife Refuge	McIntosh
Tybee Island North Beach	Chatham	Blackbeard Island NWR	McIntosh
Little Tybee Island	Chatham	Sapelo Island/ National Estuarine Research Reserve	McIntosh
Skidaway Island State Park	Chatham	Altamaha Waterfowl Management Area	McIntosh
Ossabaw Island	Chatham	Wolf Island/Egg National Wildlife Refuge	McIntosh
Wassaw Island National Wildlife Refuge	Chatham	Crooked River State Park	Camden
Blue Sky Preserve	Chatham	Cumberland Island National Seashore	Camden
Ogeechee Canal	Chatham		

The PEAs are natural areas or features at medium- to high-risk to storm surge inundation and sea level rise. PEAs support priority biological resources (defined in the USFWS SACS Planning Aid Report as federally listed threatened and endangered species, waterbird nesting colonies, breeding and wintering shorebirds, or other managed species) and are considered high priorities for others including state and federal agencies and non-governmental organizations (for example, USFWS critical habitats or national wildlife refuges, Audubon Important Bird Areas, state heritage preserves and wildlife management areas, areas of national and state environmental significance, etc.). These areas can be considered by stakeholders when looking for environmental resources to conserve and/or manage. Designation as a PEA by USACE does not create a special legal protection or status of the area and does not change how the area is regulated under federal and state laws.

PEAs were identified throughout Planning Reach GA_05 as shown in **Figure 4-37**. The methodology used to identify the PEAs and a description of coastal Georgia's 24 PEAs are described in the SACS Environmental Technical Report.

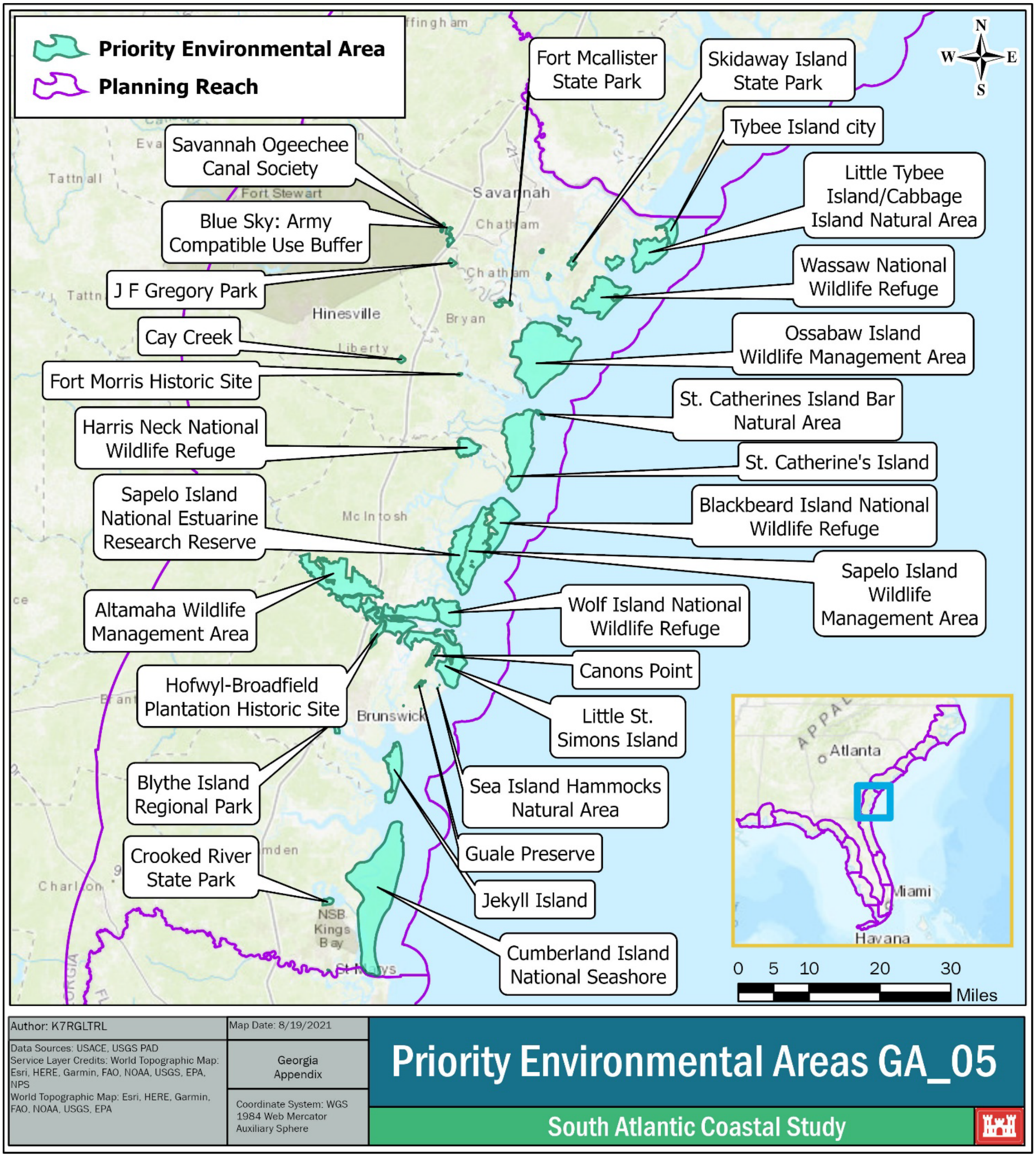


Figure 4-37: Map of Planning Reach GA_05 Priority Environmental Areas

4.1.8.3 At-Risk Cultural Resource Areas

Based on a qualitative assessment of risk, historic resources and archaeological sites on barrier islands and in low lying areas are highly susceptible to damage from storm surge inundation, erosion, and wave attack, especially as the risk for sea levels rise increases. These areas are considered as at-risk cultural resources areas due to the fact that all structures would be vulnerable to the hazards and are therefore considered to be most at risk. The northern and southern tips of barrier islands tend to be hot spots for erosion, so any historic properties and/or archaeological sites in these areas would be at most risk of damage and destruction from storm surge inundation, erosion, and wave attack.

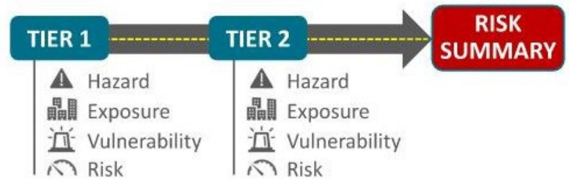
While threats may be posed to cultural resources, including historic resources and archaeological sites, due to development on barrier islands, such as Tybee, St. Simons, and Jekyll Islands, storm protection measures that are put in place to protect those developed areas can aid in the protection of archaeological sites. For example, cultural resources on Tybee Island benefit from periodic beach renourishment and other projects aimed at protecting property and infrastructure from storm damage. Storm events pose a greater risk on lesser developed barrier islands, such as Blackbeard, Cumberland, Ossabaw, Sapelo, and St. Catherines Islands, that have limited or no protective measures present. Undeveloped marsh regions between and behind islands where many resources are located are typically inundated by flood events that exceed the 10-percent AEP flood level.

Damage to historic properties can sometimes be repaired, but this can be costly and may lack support if more essential recovery efforts are needed in the area to restore infrastructure. Archaeological sites are non-renewable resources that cannot be replaced once lost. Loss of historic properties and archaeological sites not only means a loss to the historical record that helps us to understand and explain past lifeways, but it can also mean a loss to local tourism. Visitors are drawn to this planning reach due to the many historical districts and historic forts. Damage caused by storms has in some instances meant the complete loss of all or portions of historic properties. Years of costly repairs can close these sites indefinitely until the site can be restored and are deemed safe for visitors. The loss of archaeological sites could pose a significant hit to the academic community and thereby limiting research into and interpretation of prehistoric and historic sites in this reach.

4.1.8.4 Shoreline Retreat Areas (Erosional Hotspots)

As identified in Section 4.1.5.3, the USGS Coastal Change Hazards Portal was utilized to identify long term erosional hotspots along the coastline of Planning Reach GA_05. Specific hotspot locations, which were classified by above average erosional rates (greater than -6.6 feet (-2 meters) per year) were located in portions of the barrier islands in the following coastal counties: Chatham (Tybee, Little Tybee, Wassaw, Ossabaw), Liberty (St. Catherines), McIntosh (Wolfe), Glynn (St. Simons, Little St. Simons) and Camden (Cumberland).

Erosional rates and potential impacts are highly localized. Only hot spot locations in Chatham County (Tybee Island) and Glynn County (St. Simons Island) corresponded with barrier islands with significant development and population centers, where increased erosion can directly impact infrastructure and threaten coastal communities. A unique characteristic of the Georgia coastline is the expansive network of coastal wetlands and undeveloped barrier islands. Undeveloped barrier island coastlines are unconstrained and subject to natural accretional and erosional patterns, and coastal wetland systems are able to naturally migrate as the island's morphology changes. Most at risk from erosion in these undeveloped barrier islands are archaeological resources and nesting habitats.



4.1.9 Summary of Georgia High-Risk Locations

Table 4-20 displays the Planning Reach GA_05 high-risk locations identified through the Tier 1 and Tier 2 analyses. The table notes in which tier the location was identified as at risk, EAD from flooding hazards as projected by FEMA's Hazus Flood Model, and results of the Tier 2 environmental resources, cultural resources, and erosional analyses.

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Table 4-20: Tier 1 and 2 High-Risk Locations

Planning Reach GA_05		Tier 1		Tier 2								
		Tier 1 Risk Assessment		Tier 2 Economic Risk Assessment				At-Risk Cultural Resource Areas		At-Risk Environmental Resources		Shoreline Retreat Areas (Erosional hotspots)
County	Census Place or Location Name	Identified as Existing High-Risk Location	Identified as Future High-Risk Location	Existing Economic Risk (Expected Annual Damages, FY18 dollars)	Tier 2 Economic Risk Assessment Rating	Future Economic Risk (Expected Annual Damages, FY18 dollars)	Tier 2 Economic Risk Assessment Rating	Identified as Area with Cultural Resource at Risk	Cultural Resource Name	Identified as Area with Priority Environmental Area or Resource at Risk	Environmental Resource Name	Erosional hotspot Location (Barrier Island coastlines with long term erosional rates greater than -6.6 feet per year)
Bryan	Richmond Hill	X	X	$1,079,000	Low-Medium	$4,790,000	Medium					
Bryan	Richmond Hill (Keller East) [1]			$2,407,000	Medium	$8,382,000	Medium-High	X	Ft. McAllister	X	Ft. McCallister State Park	
Camden	Cumberland Island			$0	Low	$0	Low	X	Dungeness Historic District, Little Cumberland Island Lighthouse, Duck House, and historic and prehistoric archaeological sites, including Crooked River State Park (9CM118)	X	Cumberland Island National Seashore	Northern portion of Cumberland Island shoreline
Camden	Kingsland	X	X	$569,000	Low-Medium	$2,115,000	Medium					
Camden	St. Marys	X	X	$4,797,000	Medium	$15,688,000	High			X	Crooker River State Park	
Chatham	Cockspur Island			$0	Low	$0	Low	X	Ft. Pulaski, Cockspur Island Lighthouse, and historic and prehistoric archaeological sites			
Chatham	Wassaw Island[1]			$0	Low	$0	Low			X	Wassaw Island	Northern portion of Wassaw shoreline
Chatham	Little Tybee Island[1]			$0	Low	$0	Low			X	Little Tybee Island	Northern portion of Little Tybee shoreline
Chatham	Vernonburg		X	$34,000	Low	$133,000	Low					
Chatham	Henderson			$355,000	Low	$1,816,000	Medium					
Chatham	Ossabaw Island[1]			$14,000	Low	$27,000	Low	X	Historic and prehistoric archaeological sites at risk of erosion	X	Ossabaw Island	Northern portion of Wassaw shoreline
Chatham	Pooler	X	X	$259,000	Low	$2,047,000	Medium					
Chatham	Garden City	X	X	$1,157,000	Low-Medium	$4,885,000	Medium					
Chatham	Port Wentworth	X	X	$749,000	Low-Medium	$2,838,000	Medium					
Chatham	Talahi Island	X	X	$748,000	Low-Medium	$1,938,000	Medium					
Chatham	Georgetown	X	X	$4,725,000	Medium	$11,615,000	High					
Chatham	Wilmington Island	X	X	$7,724,000	Medium-High	$25,118,000	High					

Planning Reach GA_05		Tier 1		Tier 2								
		Tier 1 Risk Assessment		Tier 2 Economic Risk Assessment				At-Risk Cultural Resource Areas		At-Risk Environmental Resources		Shoreline Retreat Areas (Erosional hotspots)
County	Census Place or Location Name	Identified as Existing High-Risk Location	Identified as Future High-Risk Location	Existing Economic Risk (Expected Annual Damages, FY18 dollars)	Tier 2 Economic Risk Assessment Rating	Future Economic Risk (Expected Annual Damages, FY18 dollars)	Tier 2 Economic Risk Assessment Rating	Identified as Area with Cultural Resource at Risk	Cultural Resource Name	Identified as Area with Priority Environmental Area or Resource at Risk	Environmental Resource Name	Erosional hotspot Location (Barrier Island coastlines with long term erosional rates greater than -6.6 feet per year)
Chatham	Whitemarsh Island	X	X	$6,766,000	Medium-High	$15,976,000	High					
Chatham	Thunderbolt	X	X	$2,426,000	Medium	$4,542,000	Medium					
Chatham	Dutch Island	X	X	$3,481,000	Medium	$7,251,000	Medium-High					
Chatham	Montgomery	X	X	$5,072,000	Medium	$11,070,000	High	X	Pin Point Gullah Geechee Community			
Chatham	Skidaway Island	X	X	$10,455,000	Medium-High	$31,769,000	High			X	Skidaway Island State Park	
Chatham	Isle of Hope	X	X	$3,111,000	Medium	$9,201,000	Medium-High	X	Wormsloe Plantation, Isle of Hope Historic District, Gullah Geechee sites, and historic and prehistoric archaeological sites			
Chatham	Tybee Island	X	X	$4,768,000	Medium	$11,867,000	High	X	Tybee Island Back River Historic District, Tybee Island Strand Cottages Historic District, Ft. Screven Historic District, and historic and prehistoric archaeological sites	X	Tybee North Beach	Northern portion of Tybee shoreline
Chatham	Savannah	X	X	$7,636,000	Medium-High	$23,915,000	High	X	Savannah Historic District (River Street)	X	Blue Sky Preserve and Savannah-Ogeechee Canal Museum and Nature Center	
Glynn	Little St. Simons[1]			$12,000	Low	$13,000	Low			X	Little St. Simons	Portion of shoreline south of Little St. Simons center line
Glynn	Sea Island[1]			$650,000	Low-Medium	$1,136,000	Low-Medium			X	Sea Island/Sea Island Spit	
Glynn	Jekyll Island[1]			$174,000	Low	$705,000	Low-Medium	X	Jekyll Island Historic District and National Historic Landmark, Jekyll Island Club, Indian Mound Cottage (Rockefeller Cottage), Faith Chapel, and historic and prehistoric archaeological sites		Jekyll Island – north, mid, and south sections of island	
Glynn	Dock Junction	X	X	$811,000	Low-Medium	$2,301,000	Medium					

Planning Reach GA_05		Tier 1		Tier 2								
		Tier 1 Risk Assessment		Tier 2 Economic Risk Assessment				At-Risk Cultural Resource Areas		At-Risk Environmental Resources		Shoreline Retreat Areas (Erosional hotspots)
County	Census Place or Location Name	Identified as Existing High-Risk Location	Identified as Future High-Risk Location	Existing Economic Risk (Expected Annual Damages, FY18 dollars)	Tier 2 Economic Risk Assessment Rating	Future Economic Risk (Expected Annual Damages, FY18 dollars)	Tier 2 Economic Risk Assessment Rating	Identified as Area with Cultural Resource at Risk	Cultural Resource Name	Identified as Area with Priority Environmental Area or Resource at Risk	Environmental Resource Name	Erosional hotspot Location (Barrier Island coastlines with long term erosional rates greater than -6.6 feet per year)
Glynn	Country Club Estates	X	X	$2,887,000	Medium	$7,460,000	Medium-High					
Glynn	St. Simons (N Frederica)[1]			$2,653,000	Medium	$8,907,000	Medium-High	X	Ft. Frederica National Monument, archaeological sites at risk of erosion		Cannon's Point/Guale Preserve	
Glynn	St. Simons	X	X	$17,655,000	High	$53,731,000	High	X	St. Simons Lighthouse and Lighthouse Keepers' Building, U.S. Coast Guard Station at St. Simons Island, Hamilton Plantation slave cabins, and historic and prehistoric archaeological sites		St. Simons Island	Shorelines at northern tip and south end of St. Simons Island
Glynn	Brunswick	X	X	$6,219,000	Medium-High	$20,107,000	High	X	Brunswick Old Town Historic District, Hofwyl-Broadfield Plantation, and historic and prehistoric archaeological sites		Blythe Island County Park and Hofwyl-Broadfield Plantation Historic Site	
Liberty	Midway			$348,000	Low	$2,814,000	Medium					
Liberty	St. Catherines Island			$0	Low	$0	Low	X	St. Catherines Island National Historic Landmark and historic and prehistoric archaeological sites		St. Catherines Island	Majority of St. Catherines Island shoreline
Liberty	Midway (East of Interstate 95)[1]			$2,334,000	Medium	$3,969,000	Medium-High	X	Ft. Morris			
McIntosh	Townsend			$0	Low	$0	Low				Harris Neck NWR	
McIntosh	Darien	X	X	$405,000	Low	$848,000	Low-Medium	X	Ashantilly, Ft. King George		Altamaha Wildlife Management Area	
McIntosh	Sapelo Island[1]			$578,000	Low-Medium	$1,446,000	Low-Medium	X	Sapelo Island Lighthouse, Hog Hammock, and historic and prehistoric archaeological sites		Sapelo Island National Estuarine Research Reserve	Portion of shoreline south of Sapelo Islands center line
McIntosh	Wolf Island[1]			$0	Low	$0	Low				Wolf Island National Wildlife Refuge	Majority of Wolf Island shoreline
McIntosh	Blackbeard Island[1]			$0	Low	$0	Low	X	Historic and prehistoric archaeological sites at risk of erosion		Blackbeard Island NWR	

[1] Unincorporated places (not associated with a census place) that met the criteria of high-risk

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SECTION 5
Managing Risk

5.1 Coastal Program Guide – Georgia

The SACS Coastal Program Guide (CPG) provides information on broad federal directives, resources, and funding opportunities to help communities better leverage resources needed on a disaster-wide, state-/territory-wide, or community-wide basis (USACE 2022a). Many states and territories have additional resources available for local projects. While the CPG provides additional details, several resources specific to Georgia are described below:

- **Nonpoint Source Implementation Grant – Section 319(h):** GADNR-EPD administered competitive grant to fund eligible projects that propose to reduce pollutant loads and result in measurable water quality improvements to impaired waters throughout the State.
- **Coastal Incentives Grant Program:** GADNR-CRD cooperates with other agencies in implementing Georgia's Coastal Management Program. The Coastal Incentive Grant program awards funding to qualified coastal county and municipal governments, regional commissions, state-affiliated research or educational institutions, or state agencies to support local projects and coastal research.
- **Georgia Heritage Grant Program:** GA-HPD administered grant program that provides seed money for the preservation of historic properties and archaeological sites throughout the state. The Program offers matching funds on a statewide competitive basis to local governments and nonprofit organizations for the preservation of Georgia Register-eligible historic properties. Currently, this grant program is funded solely from preservation license plate sales revenue.
- **Georgia Outdoor Stewardship Program:** GADNR administered program that offers funding to support parks and trails, and to protect and acquire lands critical to wildlife, clean water, and outdoor recreation.
- **Georgia Conservation Tax Credit Program:** GADNR administered financial incentive program for landowners interested in donating land or conservation easements to help protect Georgia's natural resources.
- **Georgia Land & Water Conservation Fund:** GADNR administered grant program that helps state and local governments acquire and develop recreation lands and rehabilitate outdoor recreation facilities.
- **Georgia Sea Grant:** Sea Grant works with coastal communities across the U.S., Puerto Rico, the Virgin Islands, and Caribbean region to improve community resilience to coastal storms. Sea Grant projects include vulnerability assessments, resilience planning, and social science initiatives to learn from past storms and prepare for future storms.

- **OneGeorgia Authority:** Helps improve rural Georgia's economic vitality by funding infrastructure development, land acquisition, and other projects that support economic development. Local governments, government authorities, lending institutions, and airport authorities are eligible to apply.

5.1.1 Continuing Authorities Program

The USACE Continuing Authorities Program (CAP) is a group of nine legislative authorities under which USACE can plan, design, and implement certain types of water resources projects without additional project-specific congressional authorization. The purpose of the CAP is to plan and implement projects of limited size, cost, scope, and complexity. **Table 5-1** lists the CAP authorities and their project purposes.

Table 5-1: USACE Continuing Authorities Program

Authority	Project Purpose
Section 14, Flood Control Act of 1946, as amended	Protect public works and nonprofit public services from streambank and shoreline erosion
Section 103, River and Harbor Act of 1962, as amended (amends Public Law 79-727)	Perform Coastal Storm Risk Management
Section 107, River and Harbor Act of 1960, as amended	Improve navigation
Section 111, River and Harbor Act of 1968, as amended	Prevent or mitigate shore damage caused by federal navigation projects
Section 204, Water Resources Development Act of 1992, as amended	Beneficially use dredged material/ regional sediment management
Section 205, Flood Control Act of 1948, as amended	Implement flood risk management
Section 206, Water Resources Development Act of 1996, as amended	Restore aquatic ecosystem
Section 208, Flood Control Act of 1954, as amended (amends Section 2, Flood Control Act of August 28, 1937)	Remove obstructions to clear channels for flood control
Section 1135, Water Resources Development Act of 1986, as amended	Modify projects to improve the environment

5.1.2 Floodplain Management Services

Under the authority provided by Section 206 of the 1960 Flood Control Act (PL 86-645), as amended, USACE can provide the full range of technical services and planning guidance needed to support effective floodplain management. USACE has an opportunity under the Floodplain Management Services (FPMS) Program to request funds for the USACE to participate in interagency nonstructural FPMS projects that focus on reducing flood risk.

Table 5-2: Floodplain Management Services

Study Cost	Final Design/Construction Costs
Floodplain Management Services assistance to state, regional, local government, or Native American Indian tribes is 100-percent federally funded. Other federal agencies and private parties must pay 100 percent of the costs of all Floodplain Management Services efforts.	The program does not give USACE the authority to complete detailed final designs or construction activities.

USACE runs a program that establishes interagency flood risk management teams for states, known as the Silver Jackets. The Georgia Silver Jackets is an intergovernmental team of federal, state, and local agencies that collaborate on flood management issues and share information and resources related to flooding and mitigation, integrating mitigation and recovery efforts, and leveraging available resources.

The mission of the Georgia Silver Jackets team is to:

- Facilitate strategic, integrated life-cycle mitigation actions to reduce the threat, vulnerability, and consequences of flooding in the state of Georgia.
- Create or supplement a mechanism to collaboratively solve issues and implement or recommend solutions.
- Identify and implement ways to leverage available resources and information among agencies.
- Increase and improve flood risk communication and outreach.
- Inform the U.S. Army Corps of Engineers District Commander and state-level agency directors during response and recovery activities; and Integrate mitigation into recovery actions.

5.1.3 Planning Assistance to States

Under the authority provided by Section 22 of the Water Resources Development Act of 1974 (PL 93-251), as amended, USACE can help states, local governments, other non-federal entities, and eligible Native American tribes prepare comprehensive plans for the development, utilization, and conservation of water and related land resources. The Planning Assistance to States program is cost shared on a 50-percent federal, 50-percent non-federal basis up to $500,000 annually.

5.2 Hurricane Evacuation Planning

HURREVAC, short for hurricane evacuation, is a web-based decision support tool developed by the NHP for use by local, state, and federal agencies. Emergency management officials use the tool to translate forecast data to chart the progress of a storm. HURREVAC provides real-time analysis of potential consequences of current storms to help emergency management officials make the difficult decisions when to issue evacuation orders based on clearance times from the onset of tropical storm force winds. The clearance time developed in the transportation analysis is the time is takes for every person to evacuate safely before the arrival of tropical storm force winds. HURREVAC provides “earliest likely” and “most reasonable” arrival time of tropical storm force winds, giving a range of times for emergency managers to plan and make decisions. HURREVAC also predicts wind arrival times.

HURREVAC can also predict the MOM of the hurricane and the Maximum Envelope of Water (MEOW) for multiple scenarios of the approaching storm based on hurricane category and direction of approach. These factors greatly influence the consequences of a hurricane event and the storm surge communities can expect. In addition to current storms, HURREVAC also houses information from past storms for post-storm evaluations and lessons learned.

The 2013 Coastal Georgia Hurricane Evacuation Study: Technical Data Report (USACE 2013c) is the culmination of a multi-year study effort by the National Hurricane Program, a partnership between FEMA, USACE, and the NOAA NHC to thoroughly identify the hurricane vulnerability, public behavior, and response timing parameters associated with potential hurricanes in Georgia. The Georgia TDR was developed to evaluate the major factors that must be considered in hurricane preparedness and to provide Georgia emergency management officials with information needed to support hurricane evacuation decision-making. State and county agencies can use the information presented in the TDR to supplement and/or revise their hurricane evacuation plans and operational procedures, enabling them to respond to future hurricane threats more effectively. The study area for the Georgia TDR is similar to Planning Reach GA_05 and focused on the coastal counties of Chatham, Bryan, Liberty, McIntosh, Glynn, and Camden and the inland coastal counties of Effingham, Long, Wayne, Brantley, and Charlton. The inland coastal counties of Effingham, Long, Wayne, Brantley, and Charlton were included as a part of the study area because small portions of these counties have the potential to be inundated by storm surge.

The Coastal Georgia Hurricane Evacuation Study is presently being updated based on new available datasets and information. The updated study will help counties update and revise their hurricane evacuation plans and develop operational procedures and guides for future hurricane threats.

5.3 Existing Coastal Storm Risk Management Projects and Programs

The SACS Sand Availability and Needs Determination (SAND) report (USACE 2020c) provides a list of federal and non-federal CSRM projects within the state of Georgia. The sand needs analysis for the Savannah District includes one federal and two non-federal beach nourishment projects that meet the requirements for this study. In addition to the SAND report, USACE's Coastal Systems Portfolio Initiative provides a general list of federal projects and their current condition (USACE n.d.-b). A listing and brief description of these federal and non-federal projects are described in Sections 5.3.1 through 5.3.2 below. The SAND report also identified the 50-year sand needs and availability for all counties in Georgia with beach nourishment projects. Identifying potential sand deficits can aid in prioritizing further offshore sand investigations. **Figure 5-1** summarizes the 50-year sand needs and availability for the Savannah District area of responsibility. The "percentage of sand need available" in **Figure 5-1** illustrates the ratio of sand available compared to the sand needs for Chatham and Glynn counties. If this percentage is greater than 100 percent, it indicates a sand surplus; if less than 100 percent, a sand deficit is identified.

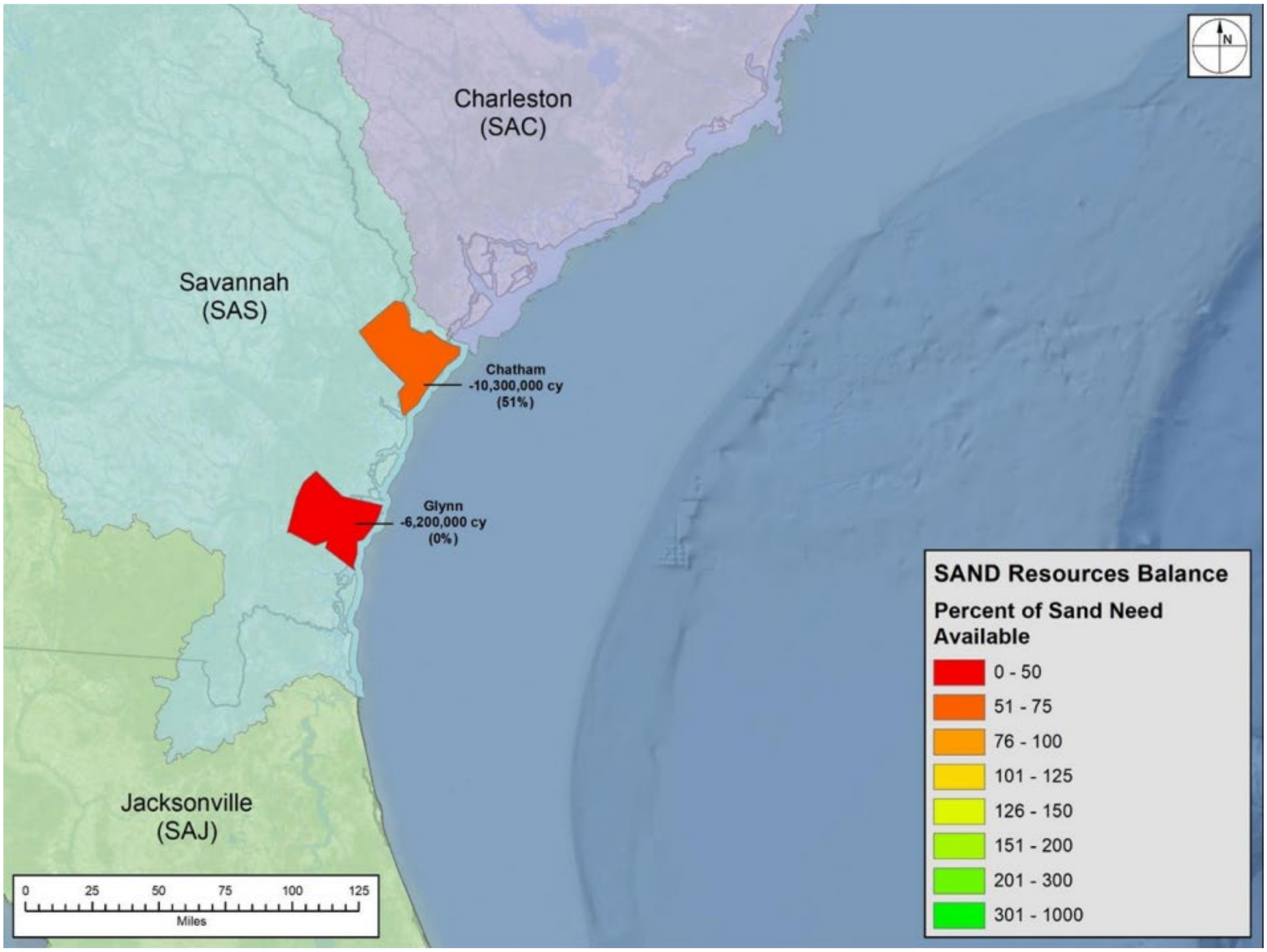

Figure 5-1: Savannah District Balance Volume and Percent of Sand Needs Available (USACE 2020c)

In additional to the list of projects provided in the most recent SAND report, the SACS effort included outreach to receive input from local officials, experts, and stakeholders through in-person and virtual workshops. A list of identified CSRM projects, including those projects identified by local stakeholders during SACS workshops is provided in **Table 5-3**. Sections 5.3.1, 5.3.2, and 5.3.3 provide additional information on selected projects along the Georgia coast.

Table 5-3: Summary of Existing/Ongoing Federal and Non-federal Efforts to Support Coastal Storm Risk Management within Georgia

Project	Planning Reach	Project Area	Agency/Organization	Comments
Tybee Island Shoreline Protection Project	GA_05	Chatham County	U.S. Army Corps of Engineers (USACE), Georgia Ports Authority (GPA), City of Tybee Island, Academia, National Fish and Wildlife Foundation (NFWF)	Sand Availability and Needs Determination (SAND) Report verified sand need of 21,000,000 cubic yards along 3.5 miles of shoreline. Additional details are provided in Section 5.3.1.
McQueen's Trail Continuing Authorities Program (CAP) Section 103 Coastal Storm Risk Management (CSRM) Project	GA_05	Chatham County	Chatham County and USACE	Additional details in Section 5.3.2.
Georgia Hurricane Evacuation Study	GA_05	State of Georgia	USACE	–
Chatham County Stormwater System Sea Level Rise Vulnerability Assessment: Coastal Watershed Management Plan	GA_05	Chatham County	Chatham County and Georgia Department of Natural Resources (GADNR)	Additional detail provided in the Chatham County Focus Area report
Smart Sea Level Sensors Project	GA_05	Chatham County	Chatham County or City Governments	Chatham County uses approximately 46 sea level sensors to track tides and collect data for future city planning.
Fort Pulaski erosion protection berm maintenance and monitoring	GA_05	Long and Cockspur Islands	Fort Pulaski (FOPU), GADNR, USACE	USACE has placed beach-quality sand to build a berm, which is being monitored for longevity and effectiveness.
Fort Pulaski drainage improvements and structural assessment of existing stormwater infrastructure	GA_05	Long and Cockspur Islands	FOPU, USACE	Identification of sediment quantities and disposal areas as part of Phase 1 of the ongoing Fort Pulaski Drainage Improvement Project.
Tybee Island Repetitive Loss Structure Elevations	GA_05	Tybee Island	Chatham County or City Governments, Federal Emergency Management Agency (FEMA)	–
Tybee Island Back Bay Flooding Study	GA_05	Tybee Island	NFWF, Chatham County, Academia	–
North Beach Dune Construction and Beach Nourishment	GA_05	Tybee Island	Local Government, USACE, GPA	Sediment was obtained via regional sediment management practices for this effort.

Project	Planning Reach	Project Area	Agency/Organization	Comments
St. Simons Island Rock Revetment Maintenance Project (Johnson Rocks)	GA_05	Glynn County	Glynn County, St. Simons Island, OneGeorgia Authority	Additional details provided in Section 5.3.2
Sea Island	GA_05	Glynn County	Sea Island Acquisition, LLC	Additional details provided in Section 5.3.2
Jekyll Island Shoreline Rehabilitation	GA_05	Glynn County	Jekyll Island Authority (JIA)	Additional details provided in Section 5.3.2
Glynn County Critical Infrastructure Flood Risk Study and Mitigation Alternatives Development	GA_05	Glynn County Focus Area	Georgia Power, Georgia Emergency Management Agency (GEMA), FEMA, USACE, Jekyll Island Authority (JIA), Georgia Environmental Finance Authority	–
Glynn County Shoreline Assessment and Implementation Resiliency Plan	GA_05	Glynn County	Glynn County or City Governments	–
Jekyll Marsh Thin-Layer Placement (TLP) Pilot Program	GA_05	Jekyll Island	USACE (O&M), GPA, JIA, GADNR Coastal Resources Division (CRD), EPA, National Oceanic and Atmospheric Association (NOAA)	This pilot program leverages regional sediment management practices.
Northloop Trail and Historic District Repairs and Erosion Protection	GA_05	Jekyll Island	JIA, GADNR, USACE	–
Expand Back River Artificial Oyster Bed Project	GA_05	St. Simons Island	GADNR CRD	In May 2020, 3,700 bags of recycled shells were placed on the east bank of the Back River near the F.J. Torras Causeway.
Frederica Road Flood Study and Drainage Improvements	GA_05	St. Simons Island	Glynn County or City Governments	–
Gould's Inlet Armoring and Shoreline Protection Maintenance	GA_05	St. Simons Island	Glynn County or City Governments	–

5.3.1 Federal Projects

Tybee Island Shoreline Protection Project (Chatham County): With only one beach nourishment project, the total sand need for Chatham County is 21,000,000 cubic yards to support the 50-year sand needs. The primary federal CSRM project in Georgia is the Tybee Island Shoreline Protection Project. This 3.5-mile-long project was initially constructed in 1974 with a 50-year project life and periodic nourishments to occur every seven years. The authorized project consists of nourishment of 13,200 linear feet of beach between two terminal groins (referred to as Oceanfront Beach); construction of a groin field along 1,100 linear feet of shoreline from the southern terminal groin around the south tip to the mouth of Tybee Creek (referred to as Back River) including periodic nourishment (referred to as South Tip Beach); and construction of a groin field and nourishment of 1,800 linear feet of the eastern bank of Tybee Creek to the city fishing pier (referred to as Back River Beach). Over the past 20 years, Tybee was renourished four times with interim nourishments to account for storm damage. Additional detail and chronology of the renourishment efforts are described in **Table 5-4**. The project will reach the end of its 50-year project life at the end of 2024 and work is ongoing to determine whether the project will remain authorized beyond that time.

Table 5-4: Chronology of Recent Beach Renourishment and Erosion Control Efforts for Tybee Island

Year	Action
1975	800-foot north end terminal groin was constructed.
1975-1976	Initial nourishment was completed, which involved placing sand on the beach between north end terminal groin and 18th Street (13,200 linear feet).
1986-1987	600-foot south end terminal groin was constructed between 18th and 19th Street. North end terminal groin was rehabilitated. Sand was placed between the groins and on 1,400 linear feet of shoreline south of south end groin.
1993	Beach material was placed on the beach by USACE and Georgia Port Authority (GPA) from Savannah Harbor deepening. The source of sand was the navigation channel.
1994	South tip groin field was constructed by GPA with state of Georgia funds.
1995	Material was placed between South End Groin and 13th Street by GPA. Sand was placed within south tip groin field by GPA. The original borrow area was the source of sand.
2000	Back River groin field was constructed. Initial nourishment of Back River, renourishment of south tip, and renourishment of oceanfront were completed. The original borrow area was the source of sand.
2008	Oceanfront Beach and Back River were renourished with material from the borrow area extension (BAE) in 2008.
2015	Oceanfront Beach and Back River renourished with material from BAE in 2008.
2016	270,000 cubic yards of material were lost to erosion from Hurricane Matthew.
2017	156,000 cubic yards of material were lost to erosion from Hurricane Irma.
2018	Supplemental Oceanfront Beach renourishment with material from BAE in 2008 due to impacts from Hurricane Irma and Matthew.
2019-2020	Oceanfront Beach and Back River renourishment with material from BAE in 2019.

5.3.2 Non-Federal Projects

St. Simons Island (Glynn County): In 2020, USACE's Regulatory Division verified use of a nationwide permit for Glynn County to perform maintenance on a rock revetment project from the 1960s and 1970s, which extends over 11,000 linear feet of shoreline. The rock revetment, known as the Johnson Rocks, is located on the beachfront from Gould Street to Massengale Park and adjacent to the Gould's Inlet parking lot on St. Simons Island. The proposed project would raise the elevation of the revetment by one foot and maintain the existing project footprint. Construction commenced late 2020.

Sea Island (Glynn County): Originally constructed in 1968, Sea Island has a sand need of 3,500,000 cubic yards to support the 50-year sand needs. In 2018, USACE's Regulatory Division issued a permit to a private developer on Sea Island to construct and maintain a new groin south of the existing southern groin and place sand along approximately 17,000 linear feet of beach located between an existing north groin and the new groin. The proposed nourishment plan would consist of approximately 1.3 million cubic yards of beach-quality sand from an offshore borrow area and would include creating an artificial dune system. Construction of the project was completed in 2019.

Jekyll Island Shoreline Rehabilitation (Glynn County): In 2019, Jekyll Island Authority completed construction of a shoreline rehabilitation project, which included rehabilitating the rock revetment and placing sand along approximately 16,000 feet of oceanfront from the Driftwood Beach access trail to approximately 2,000 feet south of Captain Wylly Road. The initial post-construction annual monitoring topographic survey was completed in June 2021 and the shoreline rehabilitation project remains in similar condition to final construction conditions documented in December 2019. The terrace berm has retained approximately 98-percent of material placed landward of the structure. The revetment structure remains at the same crest elevation and generally the same shape with no major settlement observed. A small net increase in the volume of sand seaward of the revetment was documented with no major scour events observed. The shoreline rehabilitation has maintained the uplands as designed with no recession of uplands behind the revetment as was common prior to Phase 1 completion.

5.3.3 Federal Project Performance Evaluation

CSRM projects typically do not provide a specific level of protection. As a result, many projects, particularly those that derive protection from beach nourishment, have a high-risk of exceeding design parameters (e.g., overtopping of a designed dune) during the project life cycle. This is because the greatest return on investment has typically been accomplished by eliminating or greatly reducing risk of coastal storm damages resulting from higher frequency storm events (e.g., more frequent than a 2.5-percent AEP event) and accepting moderately reduced risk of coastal storm damages from lower frequency major storm events.

As described in Section 5.3.1, the primary federal CSRM project in Georgia is the Tybee Island Shoreline Protection Project. The project performance was assessed and rated on how the project performed in relation to design conditions as well as low frequency major storm events.

Project Performance Rating Under Design Conditions:

1. **Failure**: No or minimal storm damage reduction benefits were derived.
2. **Average or above average design performance**: An acceptable number of expected storm damage reduction benefits were derived. Exemplifies acceptable or above average project design and performance.
3. **Well above average design performance**: Most expected storm damage reduction benefits were derived. Exemplifies exceptional project design and performance.

Given the criteria above, the overall project performance is rated as 2. During significant storm events, areas lacking dunes experienced localized flooding, increased erosion, and increased susceptibility to future storm events.

Project Performance Rating During Low Frequency Major Storms:

Low frequency storms referenced in this document may meet criteria provided in ER 500-1-1 (USACE 2001) for an extraordinary storm or, based on the professional judgment of USACE district engineers, are storms that exceeded project design criteria but may not have been evaluated for extraordinary storm designation or documented in Project Information Reports. Based on the analysis of recorded water levels and wave heights, Hurricane Matthew was classified as an extraordinary storm event for Tybee Island, Georgia in terms of its potential to cause erosive damages.

- 1 to 2: **Failure:** No or minimal storm damage reduction benefits were derived. Hard structures were damaged because of design deficiency.
- 3 to 4: **Below average performance:** Minimal expected storm damage reduction benefits were derived. There was considerable-to-some damage to hard structures.
- 5: **Average performance:** An acceptable number of expected storm damage reduction benefits were derived. There was some damage to hard structures.
- 6 to 7: **Above average performance:** An acceptable amount of expected storm damage reduction benefits were derived. There was some-to-minimal damage to hard structures. Exemplifies acceptable performance.
- 8 to 9: **Well above average performance:** Most expected storm damage reduction benefits were derived. There was minimal damage to hard structures. Project provided incidental damage reduction.
- 10: **Exceptional:** All expected storm damage reduction benefits were derived. There was minimal or no damage to hard structures. Project provided incidental damage reduction. Exemplifies exceptional project performance.

Given the criteria above, the project performance during Hurricane Matthew is rated as 5, which indicates that there was an acceptable number of expected storm damage reduction benefits derived from the project.

5.4 Regional Sediment Management Strategies

RSM is a systematic approach to manage sediments in a manner that maximizes natural and economic efficiencies to contribute to sustainable water resource projects, environments, and communities. Economic value is demonstrated by integrating dredged material from navigation projects with other projects—for example, a navigation project using a CSRM project as a dredged material placement area or an ecosystem restoration project using a navigation project's dredged material as a sediment source.

The RSM Optimization Update (USACE 2020b) documents placement strategies for all routine navigation projects throughout the South Atlantic Division, including costs. This explains all RSM strategies that have been implemented in the South Atlantic Division to promote implementation and lessons learned from those strategies. Some of the specific projects are cited in FAAS documents and below. **Table 5-5** shows the federal navigation projects in the USACE Savannah District area of responsibility and value associated with RSM strategies.

Table 5-5: Total Dredge Volume and Value of Regional Sediment Management Implemented in Georgia (Navigation Projects) (USACE 2020b)

Project	[1] Total Dredged Volume (Cubic Yards)	Percent Managed by Regional Sediment Management Strategies	Annual Regional Sediment Management Value ($ Million)
Savannah District Total	9,800,000	11%	$800,000
Savannah Harbor	7,100,000	4%	$400,000
Brunswick Harbor	1,800,000	0%	$-
AIWW	900,000	89%	$400,000

[1]Total dredge volume calculated as the sum of all material dredged from the navigation project per dredge cycle

Over the last several years, USACE Savannah District has sought opportunities to apply RSM strategies and beneficially use dredged material from the Savannah Harbor Navigation Project, Brunswick Harbor Navigation Project, and the AIWW Project.

The placement of beach- and nearshore-quality material from the Savannah Harbor Navigation Project on Tybee Island has the potential to provide significant value. Implementing this RSM strategy could provide up to $1.1 million in annual value to the Tybee Island CSRM project and would likely eliminate or dramatically reduce the need for a traditional beach renourishment project. As identified in the SAND report, Jones Oysterbed Dredged Material Containment Area (DMCA), which contains an estimated 5.6 million cubic yards of beach quality material is suitable for multiple placement opportunities in Chatham County.

In Chatham County, opportunities for beneficial use of dredged material include placement at Ft. Pulaski National Monument as well as creating an offshore bird island. The Ft. Pulaski Shoreline Stabilization Project was completed in 2015 and consisted of restoring 1.5 miles of shoreline along the north shore of Cockspur Island using 0.27 million cubic yards of dredged material from the Savannah Harbor Navigation Project. This project provided up to $2.0 million of shore protection value per placement opportunity to the NPS.

As part of mitigation requirements for continued maintenance dredging of federally-authorized navigation channels, Savannah District has created, and currently maintains, several bird islands both within the boundaries of the upland DMCAs and offshore. In Chatham County, the creation of the Tomkins Bird Island, just north of the Savannah River, provides valuable bird habitat for a variety of species including the federally listed least tern. Following completion in 2005, over 35,000 nests were observed from brown pelicans, royal terns, sandwich terns, gull-billed terns, laughing gulls, and black skimmers over the succeeding 5 years of monitoring. Nests have continued to number in the thousands in subsequent years. The bird island also provides additional capacity at the existing Savannah Harbor DMCAs as the bird island serves as a placement option.

In addition to these two major RSM focuses, additional opportunities exist for beneficial use of beach-quality and non-beach-quality dredged material. For example, non-beach-quality material could be used for ecosystem restoration purposes, including additional island habitat creation (bird islands) and thin-layer placement to enhance and restore marsh habitat.

In Glynn County, Hampton River Inlet Shoals and Black Banks River Shoals were previously used as RSM sources. However, both have been expended because they have filled in with silty material and were deemed unusable for a 2018 beach nourishment. As identified in the SAND report, there are currently no offshore sand sources or RSM sources with volume estimates in the county. While suitable beach quality material is limited in the area because of percent silt content, emerging RSM implementation strategies and pilot studies have been employed in Glynn County. A thin-layer placement pilot project was completed in 2019 at Jekyll Island. Approximately 5,000 cubic yards of non-beach-quality material was dredged from Jekyll Creek and placed over an adjacent 5-acre area of saltmarsh using a thin-layer spray technique. The goal of this pilot project is to enhance marsh resilience by raising the marsh elevation and promoting new growth of marsh grasses while combating marsh subsidence and sea level rise.

To support RSM strategies, several layers of data are available for viewing in the SACS Geoportal. These include the location of dredged material management areas, where maintenance dredging occurs, and potential placement areas. The SAND Borrow Areas layer identifies available sand resources and can be used to prioritize permitting and geotechnical testing of offshore borrow areas to maintain adequate sand supply. The borrow areas are separated based on different borrow categories, including proven borrow areas with a 90-percent confidence factor, potential borrow areas with a 70-percent confidence factor, and unverified plus sources with a confidence factor ranging from 5 to 30 percent. The unverified plus category areas are areas where beach-quality sand most likely exists, but additional geotechnical testing would be required. The unverified and unusable categories have a 0-percent confidence factor.

5.5 Coastal Storm Risk Management Measures and Costs

The SACS Measures and Cost Library (MCL) was developed in compliance with Section 1204 of the Water Resources Development Act of 2016 (WRDA 2016) and with implementation guidance released on November 16, 2017, which directs that the SACS shall include a framework to identify flood and CSRM measures and the associated rough order of magnitude (ROM) cost estimates.

The MCL encompasses a range of planning reach-specific unit costs for different management measures. A management measure is a feature or activity at a site that addresses one or more of the planning objectives. A variety of measures should be considered in a CSRM planning phase of a study. For the MCL, the user inputs additional information such as the location, site variability, length, and/or size of the measure to estimate the range of total costs and annualized life cycle costs. Descriptions of common CSRM measures included in the MCL are:

- **Nonstructural:** Various nonstructural alternatives, including buyouts/relocations, elevating structures, and flood-proofing are all considered viable measures for the damage zones located along the coast of Georgia.

- **Structural:** Measures such a beach fills, breakwaters, groins, seawalls, and dikes may be examined. Constructing a structural feature prevents waters from reaching residential property, businesses, and roads. Analysis of a beach fill, wall, or dike system will focus on those areas with a population density or commercial activity level sufficient to allow economic justification.

- **Natural and Nature-Based Features (NNBF):** NNBF refer to the intentional use of natural and engineered features to produce engineering functions in combination with ecosystem services and social benefits. Natural coastal features take a variety of forms, including reefs (e.g., coral and oyster), barrier islands, dunes, beaches, wetlands, and maritime forests (e.g., mangroves).

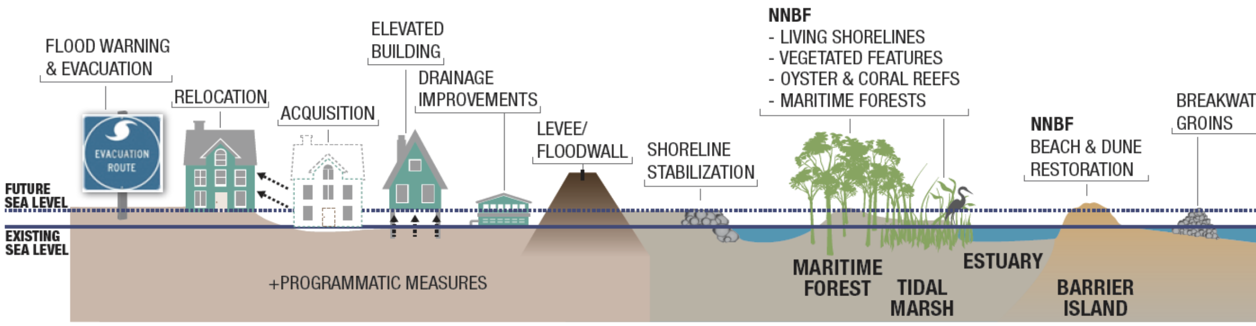

Figure 5-2: Measures to Improve Resilience and Sustainability in the Coastal Environment (USACE 2015b)

The following tables display ROM cost ranges based on unit inputs from the SACS MCL specific to Planning Reach GA_05. **Table 5-6** provides ROM cost ranges for structural coastal storm risk management measures, **Table 5-7** displays natural and natural-based features, and **Table 5-8** displays nonstructural measures. Detailed descriptions of each measure are located in the Measures & Cost Library Report (USACE 2022c).

Table 5-6: Structural Management Measures from the SACS Measures and Cost Library and Associated Annual Cost/Unit

Measure	Coastal Storm Risk Management Function	Applicability by Wave Energy	Unit	Total Mobilization and Demobilization Cost Range		Total Construction Cost Per Unit Range ($/Unit)	
Groins	Primary - Erosion/ Secondary - Wave Attack	High Energy (Waves > 3 feet)	$/LF	$150,000	$400,000	$2,107	$11,241
Seawall	Primary - Wave Attack/ Secondary - Inundation, Erosion	High Energy (Waves > 3 feet)	$/LF	$500,000	$750,000	$9,481	$18,328

Measure	Coastal Storm Risk Management Function	Applicability by Wave Energy	Unit	Total Mobilization and Demobilization Cost Range		Total Construction Cost Per Unit Range ($/Unit)	
Revetment	Primary - Wave Attack/ Secondary- Erosion	High Energy (Waves > 3 feet)	$/LF	$180,000	$430,000	$7,947	$21,405
Bulkhead	Primary - Erosion/ Secondary - Wave Attack	Mixed Wave Energy (Waves 1.5 to 3 feet)	$/LF	$160,000	$185,000	$1,580	$2,764
Breakwaters	Primary - Wave Attack/ Secondary - Erosion	High Energy (Waves > 3 feet)	$/LF	$400,000	$1,200,000	$5,966	$24,762
Floodwalls	Primary - Inundation	Mixed Wave Energy (Waves 1.5 to 3 feet)	$/LF	$500,000	$500,000	$5,473	$8,828
Deployable Floodwalls	Primary - Inundation	Low Wave Energy (Waves < 1.5 feet)	$/LF	$13,768	$17,000	$1,855	$2,796
Levees/Dikes	Primary - Inundation	Mixed Wave Energy (Waves 1.5 to 3 feet)	$/LF	$181,000	$226,150	$735	$2,175
Surge Barrier	Primary - Inundation	High Energy (Waves > 3 feet)	$/LF	$2,000,000	$187,500,000	$181,250	$285,183
Beach Nourishment (Initial Construction)	Primary - Inundation, Wave Attack, Erosion	High Energy (Waves > 3 feet)	$/LF	$2,500,000	$6,000,000	$1,258	$7,050
Beach Nourishment (Renourishment)	Primary - Erosion/ Secondary - Wave Attack	High Energy (Waves > 3 feet)	$/LF	$2,500,000	$6,000,000	$628	$3,375
Nearshore Nourishment	Primary - Inundation, Wave Attack	High Energy (Waves > 3 feet)	$/LF	$450,000	$450,000	$455	$2,329
Road Elevation	Primary - Inundation, Wave Attack	High Energy (Waves > 3 feet)	$/LF	$10,000	$150,000	$7,565	$13,909
Ringwalls	Primary - Inundation, Wave Attack, Erosion	High Energy (Waves > 3 feet)	$/LF	$10,000	$150,000	$2,064	$2,437

LF: linear foot

Table 5-7: Natural and Nature-Based Management Measures from the SACS Measures and Cost Library and Associated Annual Cost/Unit

Measure	Coastal Storm Risk Management Function	Applicability by Wave Energy	Unit	Total Mobilization and Demobilization Cost Range		Total Construction Cost Per Unit Range ($/Unit)	
Barrier Island	Primary - Inundation, Wave Attack, Erosion	High Energy (Waves >3 feet)	$/AC	$4,500,000	$10,400,000	$231,105	$1,131,163
Tidal Flats	Primary - Erosion/ Secondary - Wave Attack	Mixed Wave Energy (Waves 1.5 to 3 feet)	$/SF	$400,000	$500,000	$96	$235
Wetland	Primary - Wave Attack /Secondary - Erosion	Mixed Wave Energy (Waves 1.5 to 3 feet)	$/AC	$400,000	$1,500,000	$198,002	$1,276,032
Maritime Forest	Primary - Wave Attack /Secondary - Erosion	Low Wave Energy (Waves <1.5 feet)	$/AC	$10,000	$100,000	$2,075	$11,175
Wet Pine Savannah	Primary - Wave Attack/ Secondary - Erosion	Low Wave Energy (Waves <1.5 feet)	$/AC	$10,000	$100,000	$2,075	$11,175
Mangroves	Primary – Wave Attack/ Secondary – Inundation, Erosion	Mixed Energy (Waves 1.5–3 feet)	$/LF	$10,000	$150,000	$1,895	$3,088
Living Shoreline Vegetation	Primary - Erosion/ Secondary - Wave Attack	Low Wave Energy (Waves <1.5 feet)	$/LF	$10,000	$150,000	$22	$2,234
Submerged Aquatic Vegetation	Primary - Erosion/ Secondary - Wave Attack	Low Wave Energy (Waves <1.5 feet)	$/AC	$100,000	$300,000	$173,000	$585,500
Coral Reef Breakwater	Primary - Wave Attack/ Secondary - Erosion	Mixed Wave Energy (Waves 1.5 to 3 feet)	$/LF	$400,000	$1,200,000	$2,703	$8,074
Oyster Reef Breakwater	Primary - Wave Attack/ Secondary - Erosion	Mixed Wave Energy (Waves 1.5 to 3 feet)	$/LF	$100,000	$300,000	$973	$4,063
Living Shoreline Reefs	Primary - Wave Attack/ Secondary - Erosion	High Energy (Waves > 3 feet)	$/LF	$250,000	$1,200,000	$6,125	$19,313
Living Shoreline Sills	Primary - Wave Attack/ Secondary - Erosion	Mixed Wave Energy (Waves 1.5 to 3 feet)	$/LF	$250,000	$1,200,000	$1,805	$8,530

AC: acre
SF: square foot
LF: linear foot

Table 5-8: Nonstructural Management Measures from the SACS Measures and Cost Library and Associated Annual Cost/Unit

Measure	Coastal Storm Risk Management Function	Applicability by Wave Energy	Unit	Total Mobilization and Demobilization Cost Range		Total Construction Cost Per Unit Range ($/Unit)	
Buyout & Acquisition	Primary - Inundation, Wave Attack, Erosion	High Energy (Waves >3 feet)	$/Asset	–	–	$323,139	$729,501
Building Elevation	Primary - Inundation	High Energy (Waves >3 feet)	$/Asset	–	–	$131,650	$298,166
Dry Flood Proofing	Primary - Inundation	Low Wave Energy (Waves <1.5 feet)	$/Asset	–	–	$38,353	$101,094
Wet Flood Proofing	Primary - Inundation	Low Wave Energy (Waves <1.5 feet)	$/Asset	–	–	$10,323	$14,215
Relocation	Primary - Inundation	High Energy (Waves >3 feet)	$/Asset	–	–	$214,163	$307,094
Flood Warning Systems	Primary - Inundation	High Energy (Waves >3 feet)	–	–	–	–	–
Flood Insurance	Primary - Inundation	High Energy (Waves >3 feet)	–	–	–	–	–
Floodplain Mapping	Primary - Inundation	High Energy (Waves >3 feet)	–	–	–	–	–
Flood Emergency Preparedness Plans	Primary - Inundation, Wave Attack, Erosion	High Energy (Waves >3 feet)	–	–	–	–	–
Land Use Regulations	Primary - Inundation, Wave Attack, Erosion	High Energy (Waves >3 feet)	–	–	–	–	–
Zoning	Primary - Inundation, Wave Attack	High Energy (Waves >3 feet)	–	–	–	–	–
Evacuation Plans	Primary - Inundation, Wave Attack	High Energy (Waves >3 feet)	–	–	–	–	–
Risk Communication	Primary - Inundation, Wave Attack, Erosion	High Energy (Waves >3 feet)	–	–	–	–	–
Risk Analysis	Primary – Inundation, Wave Attack, Erosion	High Energy (Waves >3 feet)	$/Study	–	–	–	–
Land Conservation	Primary - Inundation, Wave Attack, Erosion	High Energy (Waves >3 feet)	–	–	–	–	–

5.6 Focus Area Selection

Focus areas are locations that are highly vulnerable to current and future storm damages and that warrant additional analysis in the appendix. The focus areas selected for Planning Reach GA_05 were Chatham County and Glynn County (**Figure 5-3**), which stand out as the highest-risk areas based on the Tier 1 and Tier 2 Risk Assessments. Stakeholders provided direct input on focus area selection during the 2019 Field Workshop and were engaged throughout the focus area selection process to maximize local knowledge in the area and to promote collaboration toward achieving coastal storm risk resilience. The geographic extent of the focus areas was the projected Category 5 MOM inundation extent in each county. The focus areas include a diverse range of high-risk locations that includes densely populated principal cities of metropolitan areas, ocean-facing shorelines, and back bay environments along rivers, bays, and tributaries.

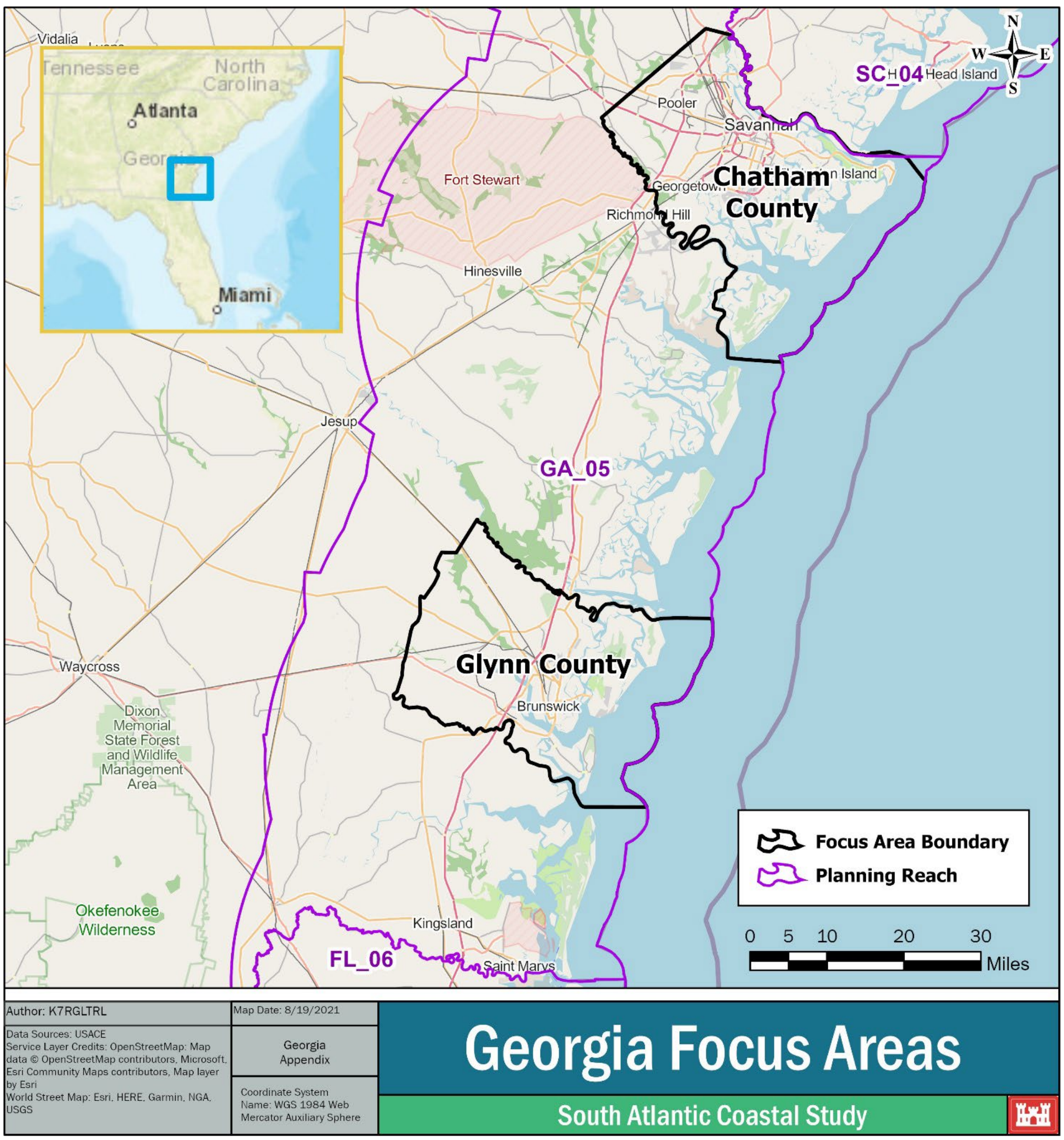

Figure 5-3: Planning Reach GA_05 Focus Area Locations

5.7 Focus Area Action Strategies

The FAAS for Chatham County and Glynn County use a "watershed approach" as per EC 1105-2-411 (USACE 2012b) and use a comprehensive strategy organized around a shared stakeholder vision to address problems.

A watershed approach:

- Works collaboratively with a broad range of stakeholders to help solve problems in an integrated and sustainable manner.
- Uses system approaches to understand the connection between natural and man-made systems.
- Analyzes water resources problems on larger geographic scales.
- Crosses diverse political, geographic, physical, institutional, technical, and stakeholder considerations.
- Seeks interdependent, long-term holistic solutions rather than piecemeal approaches and provides a blueprint for continued involvement in the watershed, regardless of the entity that might ultimately implement the proposed actions.

The FAAS were developed to exemplify how to develop strategies that lower risks in populated areas, areas of concentrated economic development, and areas with vulnerable environmental and cultural resources. Georgia's two focus areas are briefly described. Detailed FAAS are included as attachments to this appendix.

5.7.1 Chatham County Focus Area

The Chatham County Focus Area is a distinctive region with national historic significance and high economic impacts. It is the northern-most of Georgia's coastal counties and consists of 632 square miles bounded by the Atlantic Ocean to the east, the Savannah River to the northeast, and the Ogeechee River to the southwest. It includes the incorporated municipalities of Savannah, Tybee Island, Thunderbolt, Port Wentworth, Garden City, Pooler, and Bloomingdale and census-designated places including Dutch Island, Georgetown, Henderson, Isle of Hope, Montgomery, Skidaway Island, Talahi Island, Whitemarsh Island, and Wilmington Island.

Tier 1 analysis results indicated potential storm surge inundation risks to Chatham County that are expected to substantially increase as a result of sea level rise, within both the barrier island and inland communities. Infrastructure includes a major port facility and related commerce infrastructure, a U.S. Coastguard installation, a U.S. Army airfield, major medical facilities, and potentially exposed critical infrastructure including important hurricane evacuation routes. The Tier 1 Risk Assessment was used to identify 15 census places in Chatham County that showed the greatest existing and future risk. Overall, most high-risk Tier 1 analysis locations were identified within Chatham County, representing 15 of 23 high-risk census places. Based on the GHES 2013, approximately 57 percent of the exposed population along the Georgia coast resides in Chatham County, where 87 percent of the county population resides within the Category 5 MOM hurricane storm surge area. Chatham County contains many nationally significant cultural resources (Ft. Pulaski, Ft. Jackson, Savannah Historic and Victorian Districts, and Wormsloe Historic Site) and draws millions of visitors each year to the city, which increases the potentially exposed population within the county.

The Tier 2 Economic Risk Assessment indicates that greater than 50 percent of the existing and future economic risk within Planning Reach GA_05 is expected in Chatham County.

Stakeholder engagement for the Chatham County Focus Area was primarily facilitated through three virtual Focus area Vision Meetings: the Focus Area Kick-off Webinar held on July 14, 2020; the Focus Area Strategy Development Webinar held on August 19, 2020, and the Focus Area Wrap-up Webinar held on November 2, 2020. Through the input and feedback from key stakeholders, a shared vision and actionable coastal storm risk management strategies were developed for the FAAS.

Specific actions to address problems and realize opportunities in Chatham County were developed in coordination with stakeholders. While these actions vary in scale and purpose, collectively, they advance the shared vision and include:

- Renewing federal participation in Tybee Island shore protection.
- Beneficially using dredged material on the north shore of Tybee Island.
- Beneficially using dredged material on McQueen's Island Trail.
- Sustaining and increasing efforts to acquire and raise repetitive loss properties.
- Expanding the Smart Sea Level Sensors Project.
- Performing a comprehensive drainage improvements study in the City of Savannah.
- CSRM solutions should be evaluated for storm risk management benefits to cultural resources and socially vulnerable communities.

Each of these actions is described in more detail in the attached FAAS report.

5.7.2 Glynn County Focus Area

The Glynn County Focus Area is in southeastern Georgia and is home to the historic port city of Brunswick and the four barrier islands that make up the Golden Isles (Jekyll Island, St. Simons Island, Sea Island, and Little St. Simons Island). Glynn County has a total area of approximately 585 square miles and is bounded by the Atlantic Ocean to the east, the Altamaha River to the north, and the Little Satilla River to the south. St. Simons Island is the largest and most populous of the Golden Isles, and the most developed of Georgia's barrier islands.

Similar to Chatham County, the Tier 1 analysis results indicated potential storm surge inundation risks to Glynn County that are expected to substantially increase as a result of sea level rise within both the barrier islands and inland communities. Infrastructure includes a major port facility and related commerce infrastructure, major medical facilities, and potentially exposed critical infrastructure that serves both the city of Brunswick and the Golden Isles. Overall, four high-risk Tier 1 CRI locations were identified within Glynn County, representing four of 23 census places identified as high-risk. The Golden Isles barrier islands have high tourist occupancy during hurricane season, which increases the potentially exposed population within the county.

The Tier 2 Economic Risk Assessment indicates that greater than 30 percent of the existing and future economic risk within Planning Reach GA_05 is expected in Glynn County. The census place with the highest economic risk within Planning Reach GA_05 was identified as St. Simons Island.

Stakeholder engagement for the Glynn County Focus Area was primarily facilitated through three virtual Focus Area Vision Meetings: the Focus Area Kick-off Webinar held on July 13, 2020, the Focus Area Strategy Development Webinar held on August 21, 2020, and the Focus Area Wrap-up Webinar held on November 19, 2020. Through the input and feedback from key stakeholders, a shared vision and actionable coastal storm risk management strategies were developed for the FAAS.

Like in Chatham County, specific priority actions to address problems and realize opportunities in Glynn County were developed in coordination with stakeholders. While these actions vary in scale and purpose, collectively, they advance the shared vision and include:

- Initiating federal participation in St. Simons Island coastal storm risk management.
- Performing a county-wide assessment of road flooding.
- Performing a comprehensive wastewater infrastructure improvements study.
- Sustaining and expanding a pilot-study to characterize beneficial use sediment in the AIWW.
- Improving risk communication.
- Expanding the CRS Open Spaces Explorer Application.
- Beneficially using dredged material from Brunswick Harbor on Jekyll Island.
- Protecting and preserving coastal wetlands.

Each of these actions is described in more detail in the attached FAAS report.

5.8 Strategies to Address Remaining High-Risk Areas

To ensure that all high-risk areas are considered for follow-on efforts, **Table 5-9** identifies the high-risk locations within the planning reach that were not included within the focus areas. The high-risk locations were based off the Tier 1 Risk Assessment, the Tier 2 Economic Risk Assessment, and include areas containing valuable environmental or cultural resources at risk from coastal storms as sea levels rise. Each X in the columns indicates the identified risk for each place listed in the table. The threshold values to identify risk for each column are detailed in Section 4.1.8 of this appendix.

Table 5-9: Remaining High-Risk Locations in Planning Reach GA_05

Remaining High-Risk Locations (Planning Reach GA_05)		Tier 1 Risk Assessment		Tier 2 Economic Risk Assessment		Tier 2- Cultural and Environmental Resources		Tier 2- Shoreline Retreat Areas
County	Census Place	Identified as Existing High-Risk Location	Identified as Future High-Risk Location	Existing Condition Tier 2 Economic Risk Assessment Rating	Future Condition Tier 2 Economic Risk Assessment Rating	At-Risk Cultural Resource Area	Priority Environmental Area	Erosional Hotspot
Bryan	Richmond Hill	X	X	Low-Medium	Medium			
Bryan	Richmond Hill (Keller East)[1]			Medium	Medium-High	X	X	
Camden	Cumberland Island			Low	Low	X	X	X
Camden	Kingsland	X	X	Low-Medium	Medium			
Camden	St. Marys	X	X	Medium	High		X	
Liberty	Midway			Low	Medium			
Liberty	St. Catherines Island			Low	Low	X	X	X
Liberty	Midway (East of Interstate 95)[1]			Medium	Medium-High	X		
McIntosh	Townsend			Low	Low		X	
McIntosh	Darien	X	X	Low	Low-Medium	X	X	
McIntosh	Sapelo Island[1]			Low-Medium	Low-Medium	X	X	X
McIntosh	Blackbeard Island[1]			Low	Low	X	X	
McIntosh	Wolf Island[1]			Low	Low	X	X	X

[1]Unincorporated places (not associated with a census place) that met the criteria of high-risk

As identified in **Table 5-9**, portions of Camden, Bryan, Liberty, and McIntosh Counties were identified as high-risk in one or more category. These locations may be particularly susceptible to coastal storm hazards as a result of sea level rise. Within the St. Marys micropolitan area, the Tier 1 Risk Assessment and Tier 2 Economic Risk Assessments jointly identify St. Marys and Kingsland as high-risk locations. Of the remaining high-risk areas, St. Marys has the highest EAD in the future condition with the addition of 3 feet of sea level rise at approximately $15,700,000.

The FAAS are intended to exemplify how to reduce risk for other high-risk areas within the SACS study area by developing tools and action strategies. The focus areas were selected based on characteristics that made them unique and applicable to other areas. Strategies to address these additional risk areas not addressed in the FAAS documents are:

1. **Identify the problem**
    - Section 3.2 of this Appendix identifies problems and opportunities for the state of Georgia. These problems will exacerbate as sea levels rise. Understanding the most important problems for the area will help refine the action strategy development. When identifying the problem, it is important to specify who/what is impacted, the spatial extent of the impact, and the primary drivers of the impact. Identifying corresponding opportunities (i.e.: conditions, resources, and factors that could contribute favorably to a project) while addressing the problem is also part of this first step.
2. **Identify the objectives**
    - Objectives are specific actions meant to alleviate the identified problems and take advantage of opportunities within a project. Action strategies are intended to meet the project's objectives while working within the constraints
3. **Utilize exposure tools**
    - The SACS Geoportal has several exposure tools that can be used to assess potential risk to populations, infrastructure, and environmental and cultural resources from coastal storm hazards as sea levels rise. The data layers in the Geoportal include both products developed during the SACS, as well as products developed by other agencies/stakeholders. The exposure layers in the SACS Geoportal are listed below and their specific usage is detailed in Section 4.1 as part of the Planning Reach GA_05 Risk Assessment. Comprehensive layers can be used to view exposure to all resources.

      Comprehensive layers:

        - SACS Tier 1 CRI – broadly identifies locations where coastal storm flooding causes risk that will be increased by sea level rise.
        - SACS Tier 1 Hazards – identifies the extent of storm surge hazards under existing and future conditions.
        - SAND Needs, SAND RSM, SAND Borrow Areas – used to assess the future coastal resilience of beaches within the region and to develop long-term strategies for reducing damages from sea level rise effects.

Population and Infrastructure layers:

- SACS Tier 1 Population and Infrastructure Exposure Index – Identifies populations at-risk to coastal storm hazards and areas of concentrated economic development and infrastructure.
- SACS Tier 1 Social Vulnerability Exposure Index – Identifies social vulnerability at the census tract level based on 15 social factors, including poverty, lack of vehicle access, and crowded housing.
- ICLUS (EPA) – Identifies projections of populations and land-use based on climate change scenarios and pathways.
- SACS Tier 2 Economic Risk Assessment – Estimates economic risk from storm surge inundation to public and private property and some critical infrastructure under existing and future conditions.

Environmental and Cultural Resources layers:

- SACS Tier 1 Environmental and Cultural Resources Exposure Index – Identifies the density of habitat, environmental, and cultural features.
- NOAA C-CAP Land Cover Classifications – Identifies land cover for the coastal areas of the U.S.
- SACS NOAA ESI Shorelines – Identifies generalized shoreline types based on an understanding of the physical and biological character of the shoreline environment.
- SACS Environmental Resources Vulnerability – Provides a comprehensive regional assessment of vulnerability and risk to environmental resources across the SACS study area.
- SACS Environmental Resources Inundation Risk – Identifies the environmental resources potentially at risk from inundation in the future condition.
- NRHP (NPS) – Identifies the location of cultural resources on the list of the Nation's historic places worthy of preservation.
- Geographic Names Information System Historical Features (USGS) – Identifies information about the official names for places, features, and areas in the U.S.

4. Develop array of alternatives

- After identifying the problem and planning objectives, and assessing potential risk based on exposure tools, alternatives can be developed to mitigate risks based on shoreline types, wave energy, exposure to resources at risk, and extent of acceptable residual risk in the future condition. Alternatives should include a no action alternative, a nonstructural alternative, a structural alternative, and a NNBF alternative. These different types of measures can be combined to create a final array of alternatives.

- ***SAND Report*****:** The SAND Report data can be used to look at high-risk places along the Atlantic Ocean or Gulf-facing shorelines. If erosion and wave attack are damaging infrastructure or loss of habitat along exposed sandy beach shorelines, then beach and dune nourishment and creating a more robust berm and dune system can help mitigate these risks. The SAND Needs layer identifies areas that need future beach nourishment projects. Sand sources can be identified through the SAND RSM and SAND Borrow Areas layers to create a more resilient coastal system. Alternatives can include beach nourishment, dune enhancement, and accompanying RSM strategies.

- ***Planning of Future Development*****:** Opportunities exist to improve land use planning to limit future infrastructure damages while conserving natural buffer areas for flood storage and providing environmental and cultural resource benefits. ICLUS, developed by EPA, is based on future population growth and open undeveloped space. The B2 housing density scenario increases from 2020 to 2100. The SRES B2 scenario represents a regionally-oriented world of moderate population growth. The ICLUS layer is available in the SACS Geoportal and can be compared to the combined hazard plus sea level rise layer from the Tier 1 Analysis where 3 feet of sea level rise was added to the existing 1-percent and 10-percent AEP floods. The dark blue color depicts the 10-percent AEP flood, which is the most important because of its high probability of occurrence. Three feet of sea level rise is projected to occur between 50 and 100 years based on USACE Intermediate and High Scenarios, so this is an appropriate time frame to project future development.

  By making the base layer more transparent, or by turning layers on and off, we can identify areas where future development overlaps with the 10-percent AEP flood in the future condition. The tools discussed can be used to develop nonstructural alternatives such NS-15 (Land Conservation), NS-11 (Zoning) and NS-10 (Land Use Regulations). The ICLUS data can help make future planning decisions; however, ICLUS data was computed at a national level and does not include all local land use or planning/development considerations.

- ***Conservation and/or Restoration*****:** There are several data layers in the SACS Geoportal that can be used to identify environmental resources to target for land conservation and restoration. The opportunities include reducing the loss of important habitat to maintain natural storm damage reduction benefits and improve planning of future development. The SACS Environmental Resources Inundation Risk layer was created to identify the environmental resources potentially at risk from inundation in the future condition with 3 feet of sea level rise. The ICLUS layer can be compared to this layer to identify areas where projected future development may overlap with resilience hubs and at-risk environmental resources. These at-risk environmental resources are predicted to retreat landward, but future development could impede the landward migration as sea levels rise. These tools can be used to create alternatives for nonstructural measures regarding land conservation, zoning, and land use (NS-10, NS-11, NS-15); as well as NNBF for restoration purposes including NNBF-3 (Wetland), NNBF-6 (Mangroves), and NNBF-8 (SAV).

5. Evaluate and compare alternatives

- When evaluating alternatives, it is important to determine whether the measure addresses the problem while meeting the objectives of the project. Measures are often combined (nonstructural, structural, and NNBF) to meet the most objectives. The final alternatives should be compared to the no action alternative to determine if a project is feasible.

- ***Tier 2 Economic Risk Assessment Dashboard*****:** The dashboard was created using the FEMA Hazus Flood Model to estimate annualized damages to infrastructure from coastal storm inundation. EAD were estimated in the existing condition and in the future condition by adding 3 feet of sea level rise to the model. The data is available at both the census place and census block level, but the census block level gives a higher resolution of data and allows the user to analyze the spatial extent of impact as a more refined level.

  The map on the left of **Figure 5-4** shows the existing condition damages and the map on the right shows the future condition damages with 3 feet of sea level rise. The census blocks that correspond to the spatial extent of the problem should be selected within the mapper. The legend in the lower right-hand corner of the dashboard depicts the damage range per census block, with dark red indicating higher projected EAD to pale yellow for lower economic risk. The bar graphs under the existing and future EAD totals show the threshold of the dollar damage based on probabilistic storm events (10-, 2-, 1-, and 0.2-percent AEP storms).

- ***SACS Geoportal*****:** There is a measurement function in the SACS Geoportal that can enable the user to determine the length or area required of a measure. Most structural measures and some NNBF measures have measurements in dollars per linear foot, some NNBF measures have measurements in dollars per acre or dollars per square foot, while nonstructural measures are assessed in dollars per asset. These measurements can be assessed from the length measurement function (linear feet or miles) or the area measurement function (acres or square feet). The measurements can be inputted into the MCL to get a cost range for the measure of interest.

- ***MCL*****:** The overall purpose of the MCL is to match measures and cost to problems and opportunities. The MCL contains ROM costs that have been developed per unit for all structural and NNBF measures as well as some nonstructural measures. The costs are region-specific, so it is important to select the correct planning reach from the drop-down menu at the top of the tool (Planning Reach GA_05). The next step is to enter the measurements obtained from either the SACS Geoportal measurement functions discussed above, or from actual site reconnaissance visits. Once entered, the MCL will provide an annual cost range based over a 50-year period of analysis. Parameters within the tool can be revised by users with more site-specific knowledge, which allows users to reduce the uncertainty surrounding the estimate. **Figure 5-5** depicts the EAD after inputting the measurements for a variety of measures.

Figure 5-4: SACS Tier 2 Economic Risk Assessment Dashboard Depicting Annual Expected Damages Under Existing (Left) and Future (Right) Conditions in the City of St. Marys, Camden County

TABLE-1: Enter User Defined Parameters to Compute ROM Cost Ranges		
Select the planning reach and cost type from the drop down lists in column F.	Select the Planning Reach	GA_05
	Select the Type of Cost	Total First Construction Cost

TABLE-2: Enter User Defined Parameters to Compute ROM Cost Ranges		
Directions: Enter the units for the parameters in column F to estimate the ROM cost for the measures in table 3. The more parameters populated, the more cost ranges populated in Table-3.	Enter # assets to buyout:	
	Enter # assets to elevate:	
	Enter # assets to floodproof:	
	Enter # assets to relocate:	
	Enter length of road to elevate (LF):	1000
	Enter ringwall length (LF):	1000
	Enter groin length (LF):	2000
	Enter measure length (LF):	5000
	Enter breakwater length (LF):	2000
	Enter deployable wall length (LF):	500
	Enter surge barrier length (LF):	1000
	Enter measure area (AC):	70
	Enter measure area (SF):	20000
	Enter # nourishments:	4
	Enter # events:	1

TABLE-3: ROM MEASURE COST RANGES				
Measures & Categories			ROM Cost Range Based on User Input	
Measure Code	Measure Group Name	MeasureUnit	Total Cost Low	Total Cost High
S-1	Groins	$/LF	$4,240,000	$22,295,347
S-2	Seawall	$/LF	$46,700,000	$90,100,000
S-3	Revetment	$/LF	$38,900,000	$105,000,000
S-4	Bulkhead	$/LF	$7,850,000	$13,600,000
S-5	Breakwaters	$/LF	$12,000,000	$49,400,000
S-6	Floodwalls	$/LF	$27,200,000	$43,600,000
S-7	Deployable Floodwalls	$/LF	$914,000	$1,380,000
S-8	Levees / Dikes	$/LF	$3,750,000	$10,800,000
S-9	Surge Barrier	$/LF	$179,000,000	$465,000,000
S-10	Beach Nourishment	$/LF	$25,100,000	$107,000,000
S-11	Nearshore Nourishment	$/LF	$2,650,000	$11,800,000
S-12	Road Elevation	$/LF	$7,390,000	$13,700,000

Figure 5-5: Measures and Cost Library Example of Expected Annualized Damages Output Based on Measurements Entered

6. Action Strategy Development

- An action strategy should also consider prioritization and time frame of actions with identified lead stakeholders. Actions can be identified as needed, planned, or ongoing based on stakeholder input and knowledge and can range from supporting or expanding existing initiatives to identifying potential studies to address vulnerabilities to storm risks and sea level rise within the area. **Table 5-10** is an example of a basic action strategy table that could be developed for use with the remaining high-risk areas not addressed in the FAAS to guide the creation of the action strategy.

Table 5-10: Action Strategy Table Example

Focus Area – X Reach: GA_05 – Sub-area: Back Bay							
Measure/ Action	**Measure/ Action status (Implemented/ planned/needed)**	**Location**	**Description**	**Responsible Stakeholder**	**Summary of Specific Actions Needed to Implement**	**Time Frame: (short-, mid-, long-term) [1]**	**Priority: (high, medium, low) [2]**
Buy-out Acquisition	Needed	Back bay A Beach	–	Property owners, city, FEMA, U.S. Department of Housing and Urban Development	–	Long	High
Outreach	Implemented	–	–	–	–	Short	High
Analysis: sea level rise scenario impacts	Needed	Back bay	–	–	Agreement on sea level rise scenario(s)	Short	–
Bulkhead	Implemented	Numerous private properties	–	Property owners, local government (City, County), USACE (regulatory)	–	NA	Medium
Bulkhead	Needed	City parks	–	Respective cities	–	Short, mid	High
Wetland Enhancement	Needed	Near marinas	Thin layer placement to increase marsh elevation	City planning council, marinas	–	Mid, long	Low
Living Shoreline Vegetation	Planned	Private Properties	–	–	–	Short	Low

[1] Time frame: short = <2 years; mid = 2–10 years; long = > 10 years[1] Time frame: short = <2 years; mid = 2–10 years; long = > 10 years

[2] Prioritization is the process of deciding the relative importance or urgency of the potential actions and is area and stakeholder specific. A general scale of prioritization may assess risk to life or infrastructure, where High = Urgent or critical need; Medium = Required eventually (Important but medium to low urgency); Low = Nice to have (low urgency, medium to low importance).

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SECTION 6
Institutional and Other Barriers

Institutional barriers are barriers posed by agency silos and overlapping or competing missions that inhibit necessary coordination and collaboration among agencies/levels of government, and/or that otherwise impede the attainment of the SACS goals.

Other barriers are laws, regulations, and agency guidance/programs at federal, state, or local levels that:

- Contribute to vulnerability of coastal populations, ecosystems, and/or infrastructure.
- Work at cross purposes with policies and measures that reduce risk and/or increase resilience.
- Increase flood risk in the coastal zone (tidally influenced).
- Conflict with the goals to improve coastal resilience or reduce risk.
- Expose federal investments or increase financial exposure of federal taxpayers.
- Are public/political obstacles impeding the ability of decision-makers, at all levels of community and political governance, to support or make hard decisions, pursue innovative solutions, or lead change supportive of SACS goals.

These barriers are discussed in detail the *SACS Institutional and Other Barriers Report* (USACE 2022b). In local context, stakeholders within the Chatham County and Glynn County Focus Areas were asked to identify institutional and other barriers that they perceived, and the primary themes were:

- Lack of funding which limits local/state level staffing capacity and ability to implement comprehensive CSRM solutions.
- Limited political support and leadership to make difficult decisions regarding long-term CSRM solutions at all levels of government.
- Difficulties of individuals and communities in understanding their risk.
- Various rules and policies regarding federal and non-federal cost-sharing requirements that make innovation difficult.
- A USACE Federal Standard for dredged material disposal that requires the “least cost” option that is environmentally acceptable and meets engineering standards is perceived to lead to missed opportunities for beach nourishment and other beneficial use.

6.1 Risk Communication

A critical method to reduce risk and create resilient communities is to communicate risk to the individuals, community leaders, and decision-makers who are responsible for proactive land use, evacuation planning, and implementing effective mitigation actions.

Public acceptance of risk management measures, difficulties of individuals and communities in understanding their risk, and lack of community engagement about risk management options were cited as obstacles during stakeholder discussion.

For example, some coastal communities, even though impacted by recent storm events, are reluctant to endorse CSRM measures that may increase recreational benefits and flood risk management measures to their shorelines. Concerns broadly vary from viewshed impacts to increased tourism as potential detrimental effects of CSRM measures.

6.2 Financial Ability of Sponsors

The issue of funding and resources was an often-repeated challenge identified during all avenues of stakeholder engagement, including the statewide planning reach-level meetings and the Focus Area Visioning Meetings. The consecutive impacts and damages from Hurricane Matthew in 2016 and Hurricane Irma in 2017 compounded the time and costs associated with full physical and economic restoration of coastal communities. To address immediate risks to people and infrastructure, including the associated costs of debris removal, budget and staff prioritization were necessary to meet these needs.

Beyond budgets and staffing, policies or authorities can cause unintended economic stressors, limit the ability to pool resources or incentivize good CSRM, or make executing programs difficult in a certain window of time or at a particular geographic scale. As described in Section 5.3, perceived least cost Federal Standard impedes potential opportunities for local, state, and federal collaboration.

6.3 Barriers to Implementing Regional Sediment Management

Stakeholders in Planning Reach GA_05 have noted that financial, institutional, and other barriers often prevent implementation of RSM strategies. While RSM practices can benefit the Georgia coastline, RSM practices are not currently maximized. Sediment quality has been identified by stakeholders as the largest issue regarding the potential use of operations and maintenance (O&M) dredged material for beach nourishment. Beach nourishment projects require suitable sand that mimics the natural beach. This serves two purposes: first, the public prefers sand that looks similar to what they are accustomed to seeing at their beach; and second, sediment characteristics including color and grain size can affect sea turtle nesting. Nearshore placement followed by natural migration of sand onto the beach is an alternative to direct beach placement, which should be further explored in Planning Reach GA_05. In addition, there is the perception among some stakeholders that the

USACE Federal Standard for dredged material requires the “least cost” option that is environmentally acceptable and meets engineering standards leads to missed opportunities for beneficial use. In reality, the policy allows for flexibility to consider a broader range of value as outlined in the Water Resources Development Act of 2020 (WRDA 2020), encourages beneficial use, and provides opportunities for stakeholders to pay the additional cost above the least cost option to execute other dredged material placement strategies. Stakeholders are encouraged to discuss potential beneficial uses with USACE.

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SECTION 7 Recommendations

The following recommendations (**Table 7-1**) result from the analyses detailed within this appendix and from coordination with stakeholders throughout Georgia. As part of the Tier 2 analysis, efforts were made to develop specific and detailed recommendations to address coastal storm risk within the selected focus areas as described in each FAAS. Importantly, several recommendations initially developed for focus areas are also applicable throughout all coastal areas of Georgia. Other high-risk areas not located within a focus area may also have had recommendations developed.

All recommendations for Georgia are shown in **Table 7-1** and represent important components of an overall regional strategy for the full SACS study area. As described in the Main Report, the SACS regional strategy focuses on maintaining and adapting projects and programs that are successfully addressing coastal storm risk while advancing emerging methods. The regional strategy also emphasizes the importance of advancing coordination and collaboration on complex issues, such as land use and development practices, to manage increased coastal storm risk as a result of sea level rise throughout the SACS study area. Recommendations are made for either multiagency action, USACE action, or consideration by the United States Congress (Congress) to advance specific actions resulting from analyses presented in this report and from coordination with stakeholders.

Recommendations are organized into six categories, as shown in **Figure 7-1,** and three implementation time frames (near-, mid-, and long-term). Importantly, follow-on study efforts should incorporate an integrated approach to the maximum extent practicable, including consideration of structural, nonstructural, and NNBF measures, as well as the shared responsibility of all stakeholders to contribute to coastal storm risk management. Implementation timing is influenced by the degree of stakeholder collaboration needed, technical complexity of the recommendation, current momentum toward implementation, and other factors needed to implement the recommendation. Implementation time frames include:

Figure 7-1: Recommendation Categories

- **Near-Term Implementation (<5 years):** These recommendations are generally less complex and have significant stakeholder momentum toward implementation. The recommendations generally maintain and adapt actions that are recognized to successfully manage coastal storm risk.

- **Mid-Term Implementation (5-10 years):** These recommendations may be more technically complex and/or require additional stakeholder coordination and collaboration for implementation. They advance ongoing and emerging efforts to address coastal storm risk.
- **Long-Term Implementation (>10 years):** These recommendations typically require significant stakeholder coordination and—from technical, political, or social perspectives—may be the most challenging to implement on a regional scale. Importantly, coordination and collaboration on these recommendations should not be delayed. The long-term time frame is reflective of the time to implementation based on lead time needed to advance these recommendations, which include complex issues such as land use, zoning, and building codes. Given the uncertainty surrounding impacts from sea level rise and other factors (e.g., development trends), long-term recommendations may require reconsideration prior to implementation.

Based on its shoreline length relative to other states and territories in the SACS study area, five priority recommendations were made for Georgia. Priority recommendations can manage a significant amount of risk and have a high implementation potential based on stakeholder interest and other factors. State and territory prioritization was heavily based on stakeholder coordination, assigning higher priority to recommendations that leveraged ongoing or planned actions to manage coastal storm risk, were supported by stakeholder consensus, and/or had an overall higher potential for implementation within Georgia.

Table 7-1: Recommendations for the State of Georgia (Priority Recommendations in Yellow)

Authority Category	Implementation Timing	Recommendation For	Recommendation	Description	Next Step to Implementation
Activities and Areas Warranting Further Analysis	Near-Term (<5 years)	Multi-Agency Action	Improve risk communication in Glynn County	Community-based education on coastal storm risks and sea level rise within the county should be promoted through increased public outreach. As part of the Focus Area Visioning Meetings, stakeholders identified that the proposed implementation of Coastal Storm Risk Management (CSRM) measures such as beach nourishment has been a long-standing issue of contention within the Golden Isles. Without the support of the community, resiliency and risk management efforts are unlikely to be prioritized and progressed. Stakeholders are encouraged to use the publicly available SACS tools (e.g., Geoportal, Tier 2 Economic Risk Assessment) to assist in risk communication, and the SACS Coastal Program Guide to locate additional opportunities for funding. Potential lead stakeholders would include the Brunswick-Glynn County Emergency Management Agency and local governments. *This recommendation is applicable throughout all coastal counties within the planning reach.	Stakeholder Collaboration
Activities and Areas Warranting Further Analysis	Near-Term (<5 years)	Multi-Agency Action	Expand the Community Rating System (CRS) Open Spaces Explorer Application	The CRS Explorer Application should be expanded to Glynn County. The CRS Open Spaces Explorer identifies parcels that currently qualify for Open Space Preservation (OSP) credit and calculates the points they provide, assists in identifying future open space in the floodplain, and serves as a flood risk communication tool for residents and decision makers. Non-federal participants are encouraged to use the SACS Coastal Program Guide to locate additional opportunities to fund this effort. Potential lead stakeholders include The Nature Conservancy, local governments, and Georgia Department of Natural Resources (GADNR). *The CRS Explorer Application is presently in-use by Camden County. Expansion of, or similar efforts to the CRS Explorer Application are applicable and recommended throughout all coastal counties within the planning reach.	Stakeholder Collaboration

Authority Category	Implementation Timing	Recommendation For	Recommendation	Description	Next Step to Implementation
Activities and Areas Warranting Further Analysis	Near-Term (<5 years)	USACE	Floodplain Management Services (FPMS) (Silver Jackets) Camden County Coastal Hazards System (CHS) Study	Continued support for an ongoing study utilizing CHS data and methods to generate water surface grids for National Oceanic and Atmospheric Administration (NOAA) Intermediate High Sea Level Rise projections for 2050, 2075, and 2100 for a 10-percent and 1-percent annual exceedance probability (AEP) event for Camden County, GA. The modeled data will better capture storm surge inundation in back bay areas than the current approaches. Risks to population, infrastructure, and environmental and cultural resources are expected to increase with projected population growth and sea level rise. Inundation data for 2050, 2075, and 2100 will be intersected with a variety of infrastructure data to identify highly vulnerable areas within the county. *Similar efforts can be conducted for other coastal counties within the planning reach to refine projected short- and long-term risks associated with sea level rise.	Funding
Activities and Areas Warranting Further Analysis	Near-Term (<5 years)	USACE	Floodplain Management Services (FPMS) (Silver Jackets): Georgia Coastal Resilience Workshop	Conduct workshops for planners and engineers that will provide targeted training on tools developed by state and federal agencies to assess, communicate, and address risk to Georgia communities posed by coastal storm risk and sea level rise. Additional components of the workshops will include coastal permitting requirements and hazard mitigation grant and funding opportunities. The aim of the workshops is to maximize future use of SACS data and tools where applicable and improve coastal storm risk management through shared instruction with state and federal agencies.	Stakeholder Collaboration

Authority Category	Implementation Timing	Recommendation For	Recommendation	Description	Next Step to Implementation
Activities and Areas Warranting Further Analysis	Mid-Term (5–10 years)	Multi-Agency Action	Expand the Smart Sea level Sensors project	The Smart Sea Level Sensors project is an ongoing partnership between Chatham Emergency Management Agency, City of Savannah, and Georgia Tech. Chatham County uses approximately 46 sea level sensors to track tides and collect data for future city planning. The sea level sensor network should be expanded to refine projected short- and long-term risks associated with sea level rise throughout the focus area and provide real-time data on coastal flooding to assist with emergency planning and response. Non-federal stakeholders are encouraged to use the SACS Coastal Program Guide (CPG) to locate additional opportunities to fund this effort. *Expansion of, or similar efforts to the Sea Level Sensors Project are applicable and recommended throughout all coastal counties within the planning reach.	Funding
Activities and Areas Warranting Further Analysis	Mid-Term (5–10 years)	Multi-Agency Action	Sustain and increase efforts to buyout/acquire and raise repetitive loss properties	As part of the Chatham County Focus Area Visioning Meetings, the continued acquisition and raising (when possible) of repetitive loss properties was identified as a successful method to reduce vulnerability to populations and residential structures. A repetitive flood loss property is one for which two or more claims of $1,000 or more have been paid by the National Flood Insurance Program (NFIP) within any 10-year period since 1978. Expanded eligibility of properties located within known flood hazards (not just with repetitive loss properties) is recommended. Non-federal participants are encouraged to use the SACS Coastal Program Guide to locate additional opportunities to fund these efforts. *This recommendation is applicable throughout all coastal counties within the planning reach.	Funding

Authority Category	Implementation Timing	Recommendation For	Recommendation	Description	Next Step to Implementation
Activities and Areas Warranting Further Analysis	Long-Term (>10 years)	Multi-Agency Action	Protect and preserve coastal wetlands	Glynn County is situated on a low coastal plain with vast expanses of tidal marsh that surround most of the river corridors within the county. Continued preservation and legal protections of these natural features within the focus area will provide environmental benefits, reduce onshore storm impacts, and provide natural attenuation and infiltration of stormwater. Stricter local regulations on wetland development are encouraged. Potential lead stakeholders would include Glynn County, all local municipalities, and the GADNR. *This recommendation is applicable throughout all coastal counties within the planning reach.	Guidance/Policy
Address Barriers Preventing Comprehensive Risk Management	Mid-Term (5–10 years)	Multi-Agency Action	Coastal Storm Risk Management (CSRM) solutions should be evaluated for storm risk management benefits to cultural resources and socially vulnerable communities in accordance with Section 116 of the Water Resources Development Act (WRDA).	Pin Point Heritage Museum and adjacent properties in historical Gullah/Geechee neighborhood experiencing reoccurring flooding issues from storm surges, which will increase with sea level rise. According to January 2021 guidance requiring USACE to estimate benefits more equitably for Regional Economic Development (RED) and Other Social Effects (OSE), a study should be initiated to investigate CSRM solutions to protect this socially vulnerable and historical community.	Identify Non-Federal Sponsor (USACE Study)

Authority Category	Implementation Timing	Recommendation For	Recommendation	Description	Next Step to Implementation
Recommendations on Previously Authorized USACE Construction Projects	Near-Term (<5 years)	Congress	Renew federal participation in Tybee Island CSRM	The current authorization for federal participation in the Tybee Island Georgia Shore Protection Project is anticipated to end in 2024. Alternatives for continued protection of Tybee Island should be evaluated, including the potential to expand the current project footprint to include new areas at risk from coastal storms and sea level rise such as the North Beach, back bay areas, and U.S. Highway 80. This study would complement ongoing actions including a National Fish and Wildlife Foundation (NFWF)-sponsored grant to address the complicated flooding issues along the back bay portion of Tybee Island. To implement this recommendation, a non-federal sponsor (such as the City of Tybee Island) would need to request participation from USACE. Multi-stakeholder coordination and leveraging of applicable existing data would be required. Continued collaboration to discuss these opportunities is recommended.	Stakeholder Collaboration
Regional Sediment Management Practices	Near-Term (<5 years)	USACE	Sustain and expand Atlantic Intracoastal Waterway (AIWW) operation and maintenance efforts to characterize beneficial use material	Near-shore and non-beach quality dredged material within the focus area should be beneficially used when feasible. Current USACE Regional Sediment Management (RSM) efforts include a study to characterize shoaled material and identify appropriate beneficial uses of dredged sediment along the AIWW. A consistent inventory of material quality and suitability should be shared with stakeholders to promote beneficial use of the dredged material. Continued sediment characterization efforts and collaboration to discuss opportunities with stakeholders such as Jekyll Island and St. Simons Island is recommended. *Characterization efforts can be expanded throughout the AIWW to inform sediment suitability for beneficial use and to engage potential stakeholders.	Funding

Authority Category	Implementation Timing	Recommendation For	Recommendation	Description	Next Step to Implementation
Regional Sediment Management Practices	Near-Term (<5 years)	USACE	Beneficially use dredged maintenance material from the Savannah Harbor on McQueen's Island Trail	Suitable dredged material should be placed on the McQueen's Trail shoreline to reduce erosion damage and restore recreational access to McQueen's Trail. The site is located adjacent to the Savannah Harbor navigation channel, which is routinely dredged for operations and maintenance (O&M). Chatham County is encouraged to continue coordinating with USACE on implementation and cost sharing requirements of this beneficial use action.	Funding
Regional Sediment Management Practices	Near-Term (<5 years)	USACE	Beneficially use dredged maintenance material from the Brunswick Harbor on northern shoreline, Jekyll Island	The northern portion of Jekyll Island has experienced severe damage from recent coastal storms while the central and southern portions of the island have been historically understudied in terms of beach and dune processes. There is potential for RSM to provide beneficial use of sediment to address erosion and storm damage. The Jekyll Island Authority is encouraged to continue coordinating with USACE on the feasibility of this action.	Funding
Regional Sediment Management Practices	Mid-Term (5–10 years)	USACE	Beneficially use dredged maintenance material from the Savannah Harbor on northern shoreline of Tybee Island	Beach and near-shore quality dredged material should be placed on the northern shoreline of Tybee Island to provide CSRM and environmental benefits. The City of Tybee Island is encouraged to continue coordinating with USACE on implementation and cost sharing requirements of this action.	Funding
Study Efforts (follow-on USACE feasibility study)	Long-Term (>10 years)	Congress	Federal participation in St. Simons Island CSRM	Alternatives for protection of St. Simons Island should be evaluated in a new study. This study would complement on-going studies and actions in the focus area, which includes a two-phase countywide Shoreline Assessment and Implementation Resiliency Plan and the repair of the historical ocean-facing rock revetment known as the Johnson Rocks. To implement this recommendation, a non-federal sponsor (such as Glynn County) would need to request participation from USACE. Multi-stakeholder coordination and leveraging of applicable existing data into follow-on actions would be required. Continued collaboration to discuss these opportunities is recommended.	New Study Authority

Authority Category	Implementation Timing	Recommendation For	Recommendation	Description	Next Step to Implementation
Study Efforts (follow-on studies)	Long-Term (>10 years)	Multi-Agency Action	Perform a comprehensive drainage improvements study in the City of Savannah	The city of Savannah has historically suffered from stormwater and compound flooding issues, which will increase with sea level rise. Many of the flood prone areas identified in the City of Savannah Flood Hazard Mitigation Plan are located outside of the special flood hazard zones. Federal Emergency Management Agency (FEMA) flood hazard maps do not typically account for flood hazards caused by small depressions in the terrain where stormwater collects; a situation that is exacerbated by impervious surfaces. While management of stormwater does not directly address coastal storm surge, it is a complementary activity. As highlighted by stakeholders, there is an opportunity to prioritize low impact development and green infrastructure retrofits to address these issues and prevent damage to existing and future populations and infrastructure as a result of coastal storms and sea level rise. Potential lead stakeholders would include the city of Savannah, Chatham Emergency Management Agency (CEMA), and the GADNR. *This recommendation is also applicable to other urban locations with aging infrastructure such as Brunswick and St. Marys.	Identify Likely Lead Stakeholder(s)

Authority Category	Implementation Timing	Recommendation For	Recommendation	Description	Next Step to Implementation
Study Efforts (follow-on studies)	Long-Term (>10 years)	Multi-Agency Action	Perform a comprehensive wastewater infrastructure improvements study in Glynn County	There are several areas where critical infrastructure, including water and wastewater systems, are exposed to coastal storm hazards and are vulnerable to sea level rise. Academy Creek wastewater treatment plant (WWTP) (Brunswick), Dunbar Creek WWTP (St. Simons Island), and Jekyll Island WWTP are examples of wastewater systems located in highly vulnerable locations that have been emphasized during stakeholder engagements. Adaptation options for water infrastructure should be further explored to identify applicable measures to address at-risk infrastructure. This study should leverage findings from the Brunswick-Glynn County Joint Water & Sewer Commission, 2017 Glynn County Climate Resilience Adaptation Report and the Glynn County Shoreline Assessment and Implementation Resiliency Plan. Continued collaboration to discuss these opportunities and identify potential partnerships and lead stakeholders is recommended.	Identify Likely Lead Stakeholder(s)
Study Efforts (follow-on studies)	Long-Term (>10 years)	Multi-Agency Action	Perform a countywide assessment of road flooding in Glynn County	Many vital roadways located within the low-lying coastal floodplains are susceptible to flooding from riverine and tidal flooding. With respect to sea level rise projections, potential short-term and long-term measures and solutions should be identified to address these at-risk roadways. The F.J. Torras Causeway, Riverside Drive, Frederica Road, and Ocean Boulevard are examples of affected roads that have been emphasized during stakeholder engagements. This recommendation addresses the problem of nuisance flooding impacting roads in low-lying areas. Initial coordination should take place between stakeholders needed for engagement in this type of study. Potential lead stakeholders would include Georgia Department of Transportation (GDOT) and Glynn County. Continued collaboration to discuss these opportunities and identify potential partnerships is recommended. *This recommendation is applicable throughout all coastal counties within the planning reach.	Identify Likely Lead Stakeholder(s)

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SOUTH ATLANTIC COASTAL STUDY (SACS)

Chatham County Focus Area

FINAL REPORT

AUGUST 2022

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1. Introduction

This Focus Area Action Strategy (FAAS) identifies action strategies to reduce risk to coastal storms and increase resilience in the Chatham County area of Georgia. The South Atlantic Coastal Study (SACS) key products and analyses were leveraged to assess existing and future conditions and quantify existing and potential risks. Agency stakeholders were engaged, throughout the development of the Chatham County FAAS, to elicit feedback on problems and opportunities, identify and prioritize specific institutional and other barriers, and identify potential action strategies to improve resilience. The participating stakeholders included federal agencies (United States Geological Survey [U.S. Geological Survey], National Oceanic and Atmospheric Administration [NOAA], Fish and Wildlife Service [FWS]), State Agencies (Georgia Department of Transportation [GDOT], Georgia Department of Natural Resources Environmental Protection Division [GA-EPD], Georgia Coastal Resources Division [GA-CRD], Georgia Emergency Management and Homeland Security Agency [GEMHSA]), non-governmental organizations (NGO's) (Savannah River Keeper, Manomet, The Nature Conservancy [TNC], Coastal States Organization), academic institutions (University of Georgia Skidaway Oceanographic Institute, Georgia Southern University, Georgia Institute of Technology), and county and local agencies within the focus area (City of Savannah, Chatham County, City of Tybee Island, Georgia Ports Authority).

The FAAS was developed according to the Coastal Storm Risk Management (CSRM) Framework, an iterative process with three tiers of analysis that gains resolution each time it is implemented. Under the Tier 1 regional analysis, national datasets were utilized to assess potential risk across the entire SACS study area, as documented in the SACS Main Report. For the Tier 2 analysis, more refined data and analyses unique to each individual state or territory were incorporated. The Tier 2 analysis for Chatham County is documented within the Georgia Appendix. The FAAS is refinement within the Tier 2 analysis of the SACS study framework, incorporating data and knowledge unique to the local area to identify risks to coastal storm events and develop potential strategies to address the risks.

This FAAS is carried out as part of SACS, which was authorized by Section 1204 of the Water Resources Development Act of 2016 as described in the Main Report. The FAAS refers to ongoing, planned, and needed actions to manage coastal storm risk based on stakeholder coordination conducted during Focus Area Vision Meetings, a series of interactive webinars held between July and December 2020. The status and description of actions provided in this report represents a snapshot in time, and specific actions may have been modified or the status may have been changed from the description provided. However, final recommendations resulting from stakeholder coordination on specific actions were updated to represent the most recent information as of June 2022.

1.1 Study Area

The Chatham County Focus Area is a distinctive region with national historic significance and high economic value. It is the northernmost of Georgia's coastal counties and consists of 632 square miles bounded by the Atlantic Ocean to the east, the Savannah River to the northeast, and the Ogeechee River to the southwest (**Figure 1**). It includes the incorporated municipalities of Savannah, Tybee Island, Thunderbolt, Port Wentworth, Garden City, Pooler, and Bloomingdale, and census-designated places including Dutch Island, Georgetown, Henderson, Isle of Hope, Montgomery, Skidaway Island, Talahi Island, Whitemarsh Island, and Wilmington Island. The focus area includes numerous nationally significant historic areas including Ft. Pulaski, Ft. Jackson, Wormsloe Historic Site, and the Savannah Historic and Victorian Districts, which draw millions of visitors per year to the area. Tybee Island is the only easily accessible beach on the northern Georgia coast and contains approximately 5 miles of public beach access. Georgia's coast is designated as a landscape of hemispheric importance for shorebirds and the Western Hemisphere Shorebird Reserve Network declared it as a critical site for the survival of threatened shorebirds.

Focus areas were selected based on Tier 1 high-risk areas, stakeholder feedback, and by verifying a range of environments and risk factors that were represented across all 21 focus areas selected within the SACS. Draft focus areas were presented to stakeholders at the 2019 Georgia Field Workshop. Based on provided feedback and additional analysis, two focus areas were selected for Georgia: Chatham County and Glynn County.

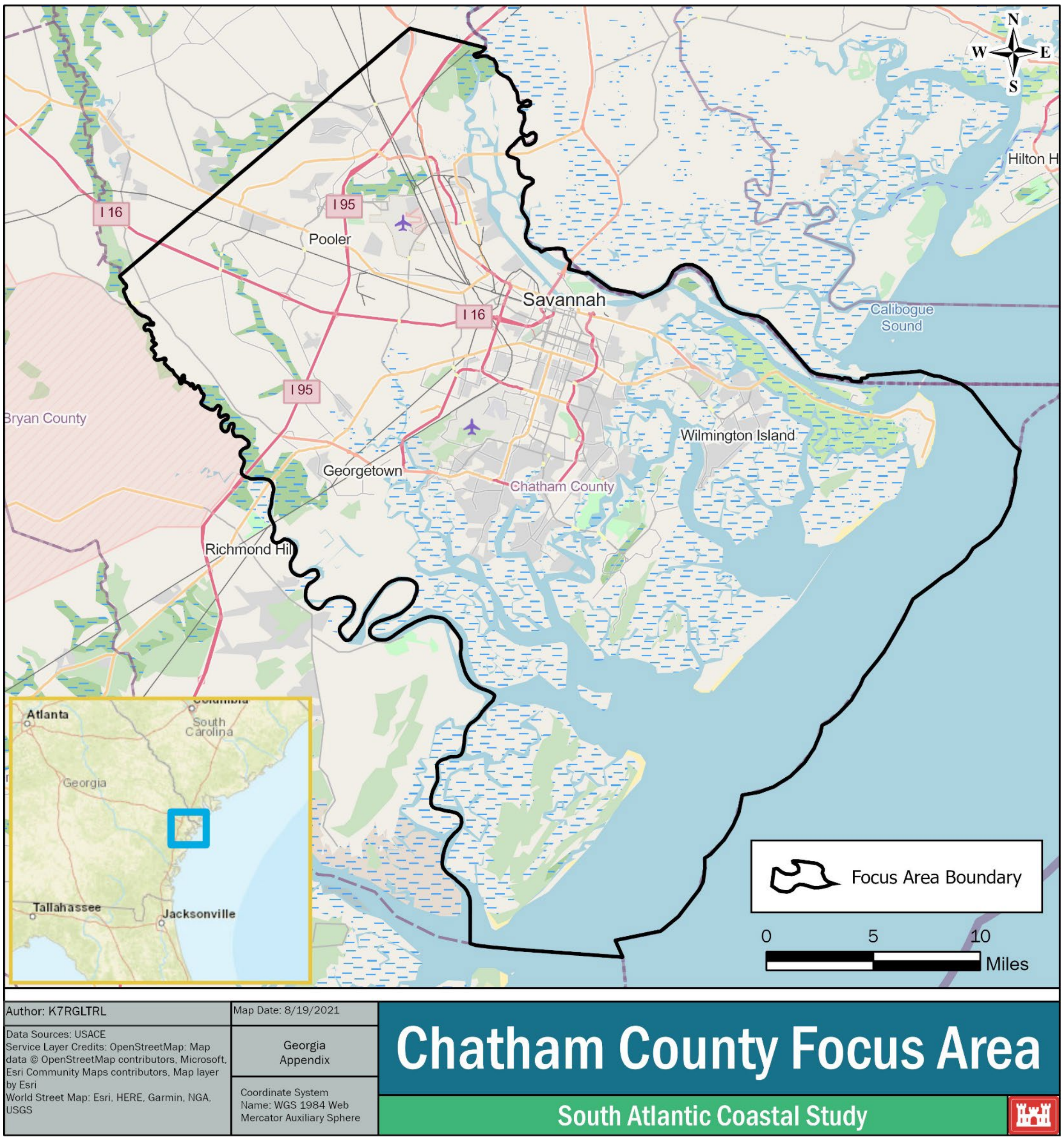

Figure 1: Chatham County Focus Area Boundary

1.2 Prior Reports and Efforts by Stakeholders within the Focus Area

Table 1 presents prior and ongoing stakeholder efforts within the Chatham County Focus Area to address coastal storm risks and impacts from sea level rise.

Table 1: Stakeholder Efforts in the Focus Area

Agency/Stakeholder	Report/Tool/Project	Year Completed
City of Tybee Island/U.S. Army Corps of Engineers (USACE)	Tybee Island Shore Protection Project (TISPP)	Ongoing (Last beach nourishment in 2019)
City of Tybee Island	Back Bay Study (National Fish and Wildlife Foundation [NFWF])	Ongoing
Chatham County	West Chatham Regional Watershed Study	Ongoing
Chatham County	The Smart Sea Level Sensors Project	Ongoing
USACE	Georgia Hurricane Evacuation Study	Ongoing
One Hundred Miles	Chatham County COAST Initiative	Ongoing
Chatham County/USACE	McQueen's Island Trail Coastal Storm Risk Management (CSRM) Study	2021
Chatham County	Multi-Jurisdictional Pre-Disaster Hazard Mitigation Plan	2020
Chatham County	Chatham County Stormwater System Sea Level Rise Vulnerability Assessment: Coastal Watershed Management Plan	2020
City of Tybee Island/USACE	TISPP, Hurricanes Harvey, Irma, Maria Supplemental re-nourishment.	2019
Federal Emergency Management Agency (FEMA)	Chatham County Flood Insurance Study	2018
FEMA	Chatham County Flood Insurance Rate Map (FIRM)	2018
City of Tybee Island	Tybee Island Sea Level Rise Adaptation Plan	2016
Chatham County	Comprehensive Plan Update	2016
Chatham Emergency Management Agency (CEMA)	Chatham County Redevelopment Plan	2016
U.S. National Park Service (NPS)/USACE	Fort Pulaski Shoreline Stabilization Project	2015
University of Georgia (UGA), Skidaway Institute of Oceanography/ Stetson University	Sea Level Rise and Sub-County Population Projections in Coastal Georgia	2015
City of Savannah	Floodplain Mitigation Plan	2015
City of Savannah	Natural Floodplain Protection Plan	2015
City of Savannah	Repetitive Loss Area Analysis	2015
CEMA	Chatham County Disaster Recovery Plan	2015
Coastal Regional Commission of Georgia	Hazard and Resilience Plan for the Coast of Georgia	2014
Georgia Department of Natural Resources (GADNR) Coastal Resources Division	Post-Disaster Recovery and Redevelopment Planning: A Guide for Georgia Communities	2014

Agency/Stakeholder	Report/Tool/Project	Year Completed
Georgia Conservancy/ Georgia Institute of Technology	Retreat. Adapt. Defend. Designing Community Responses to Sea Level Rise in Five Coastal Georgia Communities	2013
Georgia Conservancy/ Georgia Institute of Technology	Tracking the Effects of Sea Level Rise in Georgia's Coastal Communities: Chatham, Liberty, and McIntosh Counties	2012
GADNR Coastal Resources Division, GADNR Historic Preservation Division/UGA, Skidaway Institute of Oceanography	Threatened Archaeological, Historic, and Cultural Resources of the Georgia Coast: Identification, Prioritization, and Management Using Geographic Information Service (GIS) Technology	2008
NPS/UGA, Skidaway Institute of Oceanography	Rates and Processes of Shoreline Change at Ft. Pulaski National Monument	2008

Overall, these prior reports, on-going projects, and completed projects provided the team with a baseline understanding of coastal storm risks and flood risk management within Chatham County. Stakeholder coordination highlighted several studies completed by USACE and other stakeholders that could be particularly valuable for ongoing and future efforts when addressing coastal storm risk.

1.3 Shared Vision

The shared vision statement was developed and revised using input from key stakeholders in the focus area. The overall goal of this Chatham County FAAS is to incrementally contribute to the shared vision statement developed for this watershed study:

> "Build partnerships and strengthen relationships with Chatham County stakeholders to develop forums and work collaboratively to reduce coastal storm risks and impacts from sea level rise to provide safe, healthy, and thriving communities while protecting and restoring the environment."

The shared vision statement is broad enough to encompass the various goals and objectives of individual partners and stakeholders, but with a detailed description to allow for subsequent development of specific planning objectives and associated metrics. The study framework and associated activities will support the shared vision.

2. Problems and Opportunities

Identifying problems and opportunities is a key initial step in the planning process. The problems and opportunities statements encompass both current and future conditions and are not meant to preclude the consideration of any alternatives to solve the problems and explore ways to unlock opportunities.

2.1 Problems

The following problems were identified as the most significant throughout the focus area and may not be exhaustive of all problems. These problems will increase in both intensity and magnitude as sea levels rise depending on the vulnerability and resilience of the exposed population, infrastructure, and environmental resources. Example locations of where the problem is evident are listed. However, these are example locations and in general, the problems are evident throughout the focus area unless noted otherwise.

- Coastal storm damages (from inundation, erosion, and wave attack) are increasing in populated areas, areas of concentrated economic development, and areas with socially vulnerable populations. For example, reoccurring flooding affects communities located throughout the focus area such as Pin Point and Burnside as well as major transportation routes such as President Street within the city of Savannah. Low-income housing and socially vulnerable populations can be at particular risk within the city of Savannah.

- Critical infrastructure, such as water and wastewater treatment plants, hospitals, schools, and roads (including evacuation routes), are at risk from storm-related hazards and compound flooding, putting people and property at risk. For example, U.S. Highway 80, which is the only connection between Tybee Island and the mainland, has been inundated and impassible during major storm events such as Hurricanes Matthew and Irma. Critical infrastructure, such as tide gates and pump stations, are at risk from storm damages and inundation throughout the focus area.

- Nationally important cultural resources and natural habitats are being negatively impacted from coastal-storm driven inundation and erosion. For example, areas of high erosion have been identified within the barrier islands including Tybee, Little Tybee, Wassaw, and Ossabaw. Hurricanes Matthew and Irma caused major recorded beach erosion on Tybee Island, prompting an emergency supplemental renourishment. At Cockspur Island, shoreline erosion and inundation has repeatedly damaged Cockspur Island and Fort Pulaski.

- Population and development are increasing in coastal Georgia, leading to loss of natural buffers in areas exposed to coastal storm hazards. For example, increased recreational construction in the inland sea island communities and increased commercial and recreational construction in western Chatham County locations such as Pooler and Henderson. Growth in tourism and seasonal populations in the City of Savannah and Tybee Island increases annually. Development can reduce natural buffers and increase impervious surfaces, which can compound effects from storm surge inundation and precipitation during coastal storms.

2.1.1 Institutional and Other Barriers

As described in the *SACS Institutional and Other Barriers Report* (USACE 2022b), "Institutional and other barriers" impede the attainment of SACS goals and limit the ability to provide comprehensive CSRM. Several barriers were identified within the Chatham County Focus Area by agency stakeholders:

- Lack of funding which limits local/state level staffing capacity and ability to implement comprehensive CSRM solutions
- Various rules and policies regarding federal and non-federal cost-sharing requirements that make innovation difficult
- A USACE Federal Standard for dredged material disposal that requires the "least cost" option that is environmentally acceptable and meets engineering standards is perceived to lead to missed opportunities for beach nourishment and other beneficial use.

The most common barrier identified is lack of funding. Grant opportunities are detailed in another component of SACS, the Coastal Program Guide, which discusses funding opportunities at the national and state levels. **Table 15**, later in this document, includes potential funding sources for identified measures.

2.2 Opportunities

While there are several coastal storm-related problems in the focus area, numerous opportunities exist to address them as exemplified by ongoing efforts within Chatham County. Stakeholders identified several opportunities that include conditions, resources, and factors to contribute favorably to the Chatham County Focus Area, including:

- Gather additional data on coastal hazards, exposure, and vulnerability to refine current and future CSRM efforts.
- Build partnerships and strengthen relationships with Chatham County stakeholders.
- Enhance outreach and risk communication to all stakeholders in the focus area, including the public.
- Prioritize regional management of projects through Regional Sediment Management (RSM) and other opportunities that support conservation of natural and fiscal resources.
- Promote a range of potential measures, including structural, nonstructural, nature-based, and state and local ordinances that incorporate future sea level rise.
- Reduce the loss of coastal wetlands, beach, and dune systems that promote natural storm damage reduction and provide wildlife habitat.
- Align with and leverage studies being conducted by State and Chatham County stakeholders. Studies conducted at the local level provide local knowledge of coastal storm risks to communities. Using these studies to help identify priorities of key stakeholders will support successful implementation of strategies in the SACS.

3. Objectives and Constraints

Objectives are specific actions meant to alleviate the identified problems and take advantage of opportunities within a project. Constraints are conditions that limit the extent a project can meet its objectives, address the identified problems, and/or take advantage of opportunities. Action strategies formulated during this study are intended to meet the project's objectives while working within the constraints.

3.1 Objectives

Objectives were determined based on feedback from stakeholders, including responses to a questionnaire and participation in the Focus Area Strategy Development Webinar, and reflect the shared vision statement from Section 1.3. The objectives listed here are general statements that refer to the specific problem types and areas noted in Section 2.1 of this report. Objectives and goals of the FAAS are included in this section.

Objective:

- The overall planning objective is to develop a strategy to manage coastal storm risk to people and economic, environmental, and cultural resources within the focus area.
- Reduce risk from coastal storm inundation, sea level rise, and erosion to populations, infrastructure, and environmental resources.

Goals:

- Identify the areas at highest risk from coastal storm hazards, which are exacerbated by sea level rise.
- Identify opportunities to manage coastal storm risks to people and infrastructure in the focus area.
- Coordinate with stakeholders to develop strategies that address coastal storm risks in the focus area, including the geographic location, timing, potential lead stakeholders, funding sources, and specific needed actions.

3.2 Constraints

A constraint limits the extent of the planning process. To the maximum extent practicable, the SACS analysis will minimize information, observations, and recommendations that may be inconsistent with coastal storm risk management plans developed by other federal and applicable state and local agencies and tribes within the study area.

4. Existing and Future Conditions

There are several organizations that are actively working to address the impacts of coastal storm hazards as sea levels rise in the Chatham County Focus Area (**Table 1**). This section focuses on the performance of existing projects and provides an inventory and forecast of current and future hazards, exposure, vulnerability, and risk in the focus area.

4.1 Hazards

In a general sense, a hazard is anything that is a potential source of harm to a valued asset (human, animal, natural, economic, and social) (USACE 2014). Hazards addressed by the SACS are predominantly storm related and are divided into two categories: primary and secondary. Primary hazards are those directly addressed in the SACS and include inundation, wave attack, and erosion. Secondary hazards are those that the SACS does not specifically address but are important in the focus area. These include wind damages, saltwater intrusion, and compound flooding from a combination of storm surge, precipitation, astronomical tides, and a high water table. Sea level rise can uniquely exacerbate other hazards, impacting the future of all coastal communities.

Recent storm events that have significantly impacted the focus area include Hurricane Matthew in 2016 and Hurricane Irma in 2017. Hurricane Matthew caused widespread power outages, an estimated $500 million in damages, and three fatalities in Georgia. Within Chatham County, the northern tip of Tybee Island experienced hurricane-force winds, while the rest of the county experienced sustained tropical storm-force winds. The NOAA National Ocean Service (NOS) tide gauge at the Ft. Pulaski National Monument (No. 8670870) (**Figure 2**) recorded a peak water level of 5.05 feet above mean higher high water (MHHW), which is a significant record compared to the prior record of 3.4 feet MHHW established during the Cape Sable Hurricane, which made landfall near Savannah, Georgia on October 15, 1947. The maximum storm surge (defined as the height above normal tide levels) reached just over 7.5 feet at Ft. Pulaski. Storm surge inundation penetrated inland to Lovell Avenue on Tybee Island and flooded U.S. Highway 80 in multiple locations. In Savannah, storm surge inundation flooded hotels, restaurants, and adjacent infrastructure along River Street, a historically significant component of the Savannah Historic District. Storm surge pushed into river inlets and low-lying areas near Savannah, causing saltwater damage to many estuaries and bird refuges in and around the Savannah National Wildlife Refuge.

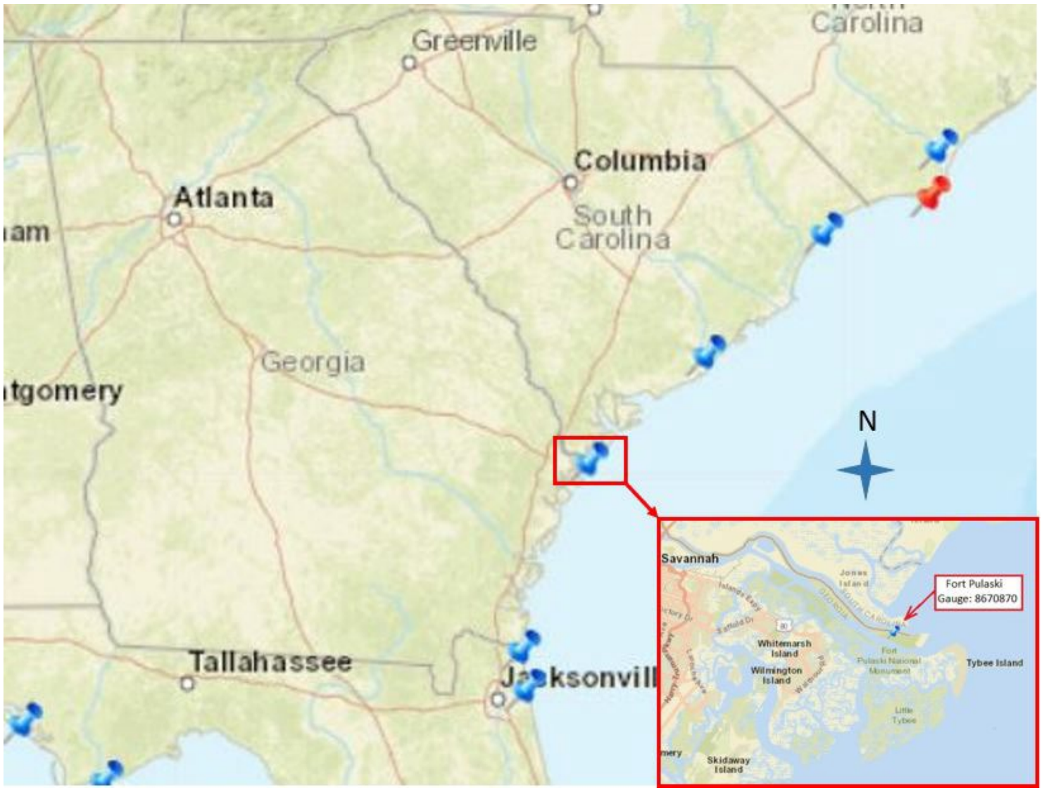

Figure 2: Ft. Pulaski National Ocean Service Gauge No. 8670870 (not to scale) (NOAA 2021)

While Hurricane Matthew caused significant beach erosion at Tybee Island in 2016, Hurricane Irma greatly exacerbated this erosion along the Tybee Island beachfront. The NOS gauge at Ft. Pulaski recorded a peak water level of 4.7 feet MHHW for Hurricanes Irma. Significant coastal and back bay flooding were observed during both events in Tybee Island and the adjacent marsh communities. The frequency of storms contributes to the magnitude of the damage. Storms occurring in the same or consecutive seasons can not only subject a region to the same types of hazards and damages but can also impact ongoing recovery efforts from the previous storm, compounding the time and cost associated with full physical and economic restoration of the community.

4.1.1 Primary Hazards

Primary hazards are CSRM hazards that the SACS specifically addresses, including inundation, wave attack, and erosion. For the Chatham County Focus Area, the primary hazards are present and considered the most relevant to the study.

4.1.1.1 Inundation

Inundation is one of the primary hazards that affects the majority of the Chatham County Focus Area. The most vulnerable areas to inundation are the ocean-facing communities on Tybee Island, back bay communities, and riverine communities, due to their proximity to the Atlantic Intracoastal Waterway (AIWW) and the coast, low elevation, and aged infrastructure. Inundation in the context of the SACS refers to flooding originating from the coast in the form of storm surge and does not include riverine flooding originating from the upland or inundation due to excessive rainfall.

Inundation predominantly occurs in the low-lying coastal portions of this region and is caused by storm surge from hurricanes and, to a lesser degree, long nor'easter events. Inundation occurs when waves, combined with storm surge, surpass dunes on the coast of Tybee Island. Inundation also occurs on the landside of the island because storm surge floods the marshlands by penetrating the Back River through the inlet south of the island and Wassaw Sound. Storm surge also leads to flooding along the Savannah River where it penetrates inland along the river channel and tributaries.

The Category 5 Maximum of Maximum (Category 5 MOM) hazard from NOAA's Sea, Lake, and Overland Surges from Hurricanes (SLOSH) model shows that most of the focus area is subject to inundation from a Category 5 hurricane (Zachry et al. 2015; Jelesnianksi et al. 1992). Lesser storms are less impactful, but cause localized flooding in lower elevation natural, commercial, and residential areas. The lateral extent of the Category 5 MOM, 1-percent annual exceedance probability (AEP) flood, and 10-percent AEP flood is identified in **Figure 3**, while **Figure 4** shows the FIS flood levels and measurement transects for North Chatham County for a 1-percent AEP event. **Table 2** provides the county average storm surge elevations based on the FEMA Flood Insurance Study (FIS) For Chatham County (FEMA 2018).

Table 2: Federal Emergency Management Agency Flood Insurance Study (FIS) Average Storm Surge Elevations for Chatham County. (North American Vertical Datum of 1988 [NAVD88]) (FEMA 2018)

Annual Exceedance Probability (AEP)	Storm Surge Elevation
10%	6.1 ft
2%	8.4 ft
1%	9.6 ft
0.2%	11.8 ft

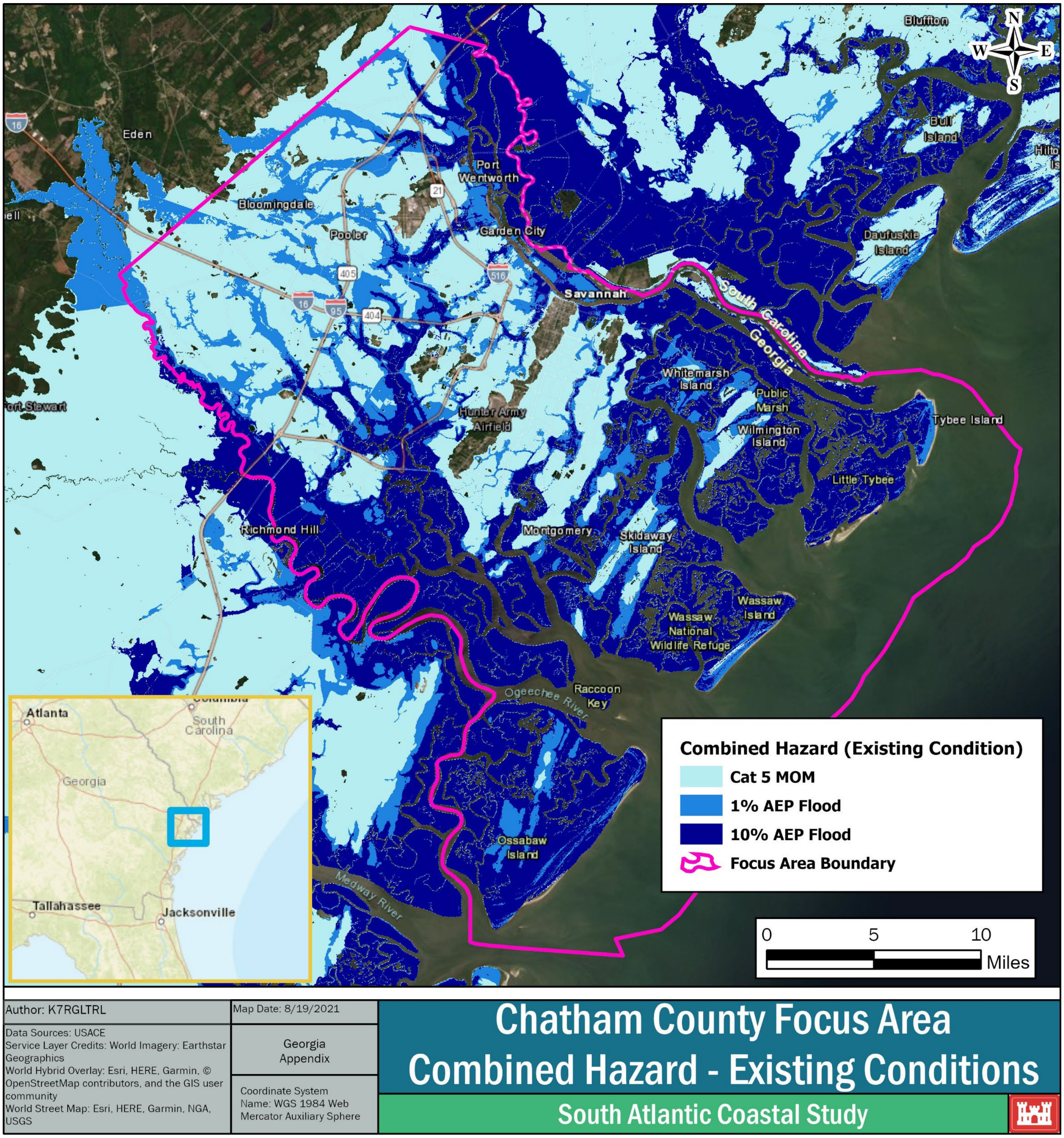

Figure 3: Combined Hazards Overlay for Chatham County (1-Percent Annual Exceedance Probability, 10-Percent Annual Exceedance Probability, and Category 5 Maximum of Maximum)

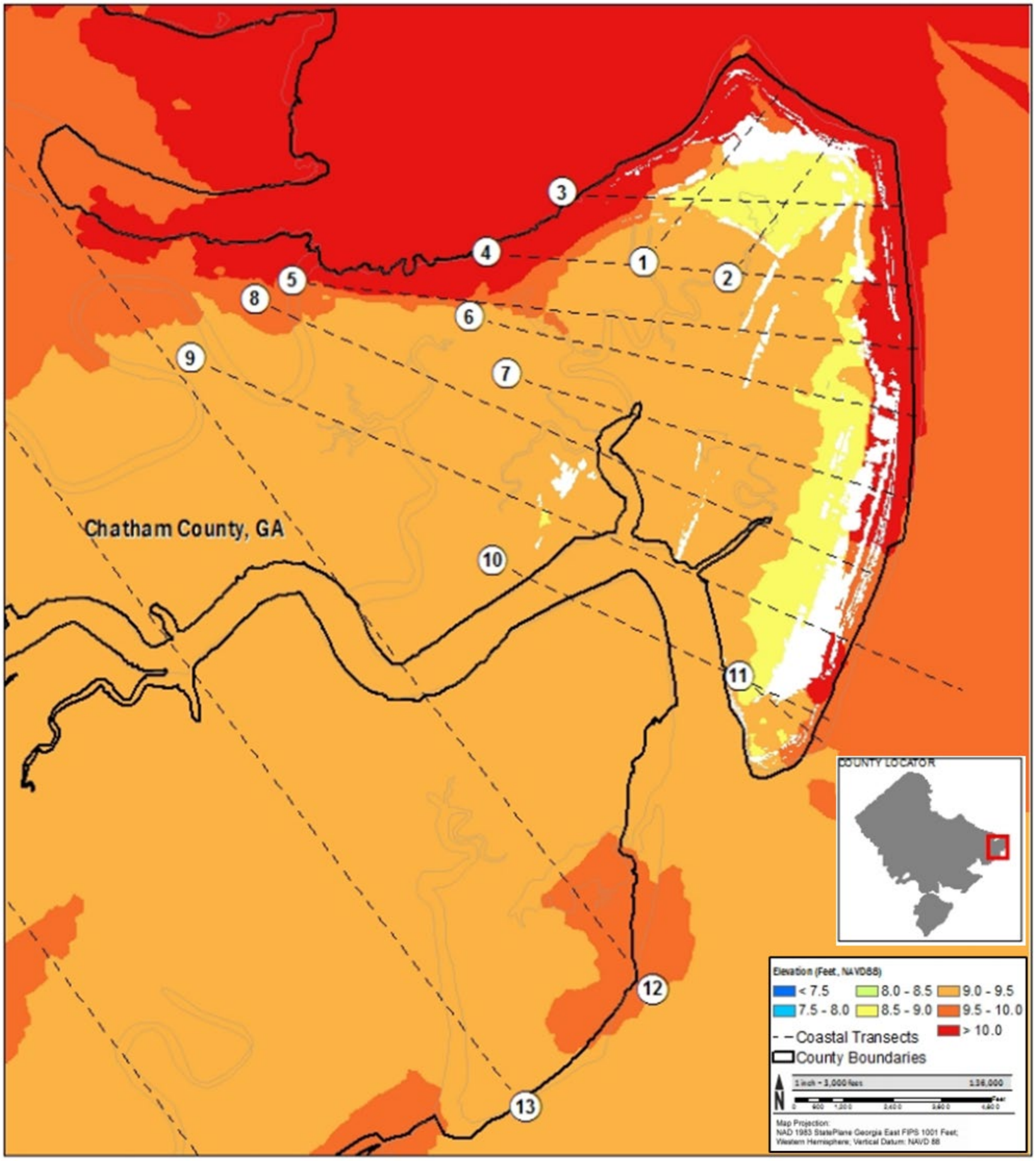

Figure 4: 1-Percent Annual Exceedance Probability Flood Levels, North Chatham County (FEMA 2018)

4.1.1.2 Wave Attack

Waves cause damage through the force that they impart directly upon structures, habitats, and shorelines. Waves also generate alongshore and cross-shore currents at shorelines that can mobilize and erode sediment. In the context of the SACS, wave attack refers to the process of destructive waves impacting a shoreline and leading to increase erosion along that shoreline. Erosion is addressed in Section 4.1.1.3.

The highest wave energy occurs along Tybee Island where shorelines are exposed to the open ocean. The USACE Wave Information Studies (WIS) provide hindcast data at locations along the Atlantic coast (Hubertz 1992). Data derived from the WIS Station 63368, located 16 miles east of Tybee Island (**Figure 5**), shows that typical deep-water waves at Tybee Island average approximately 3.4 feet, with lower waves occurring in the summer (minimum average of 2.9 feet) and higher waves occurring in the fall and winter (maximum average of 4.0 feet). During storms, waves can be significantly higher (i.e., contain more energy). Maximum nearshore waves during Hurricane Matthew and Hurricane Irma were estimated at over 10 feet and 11 feet, respectively. These high energy waves caused significant shoreline erosion. The waves were carried on water levels elevated by storm surge, overtopped dunes, and propagated landward to directly impact infrastructure.

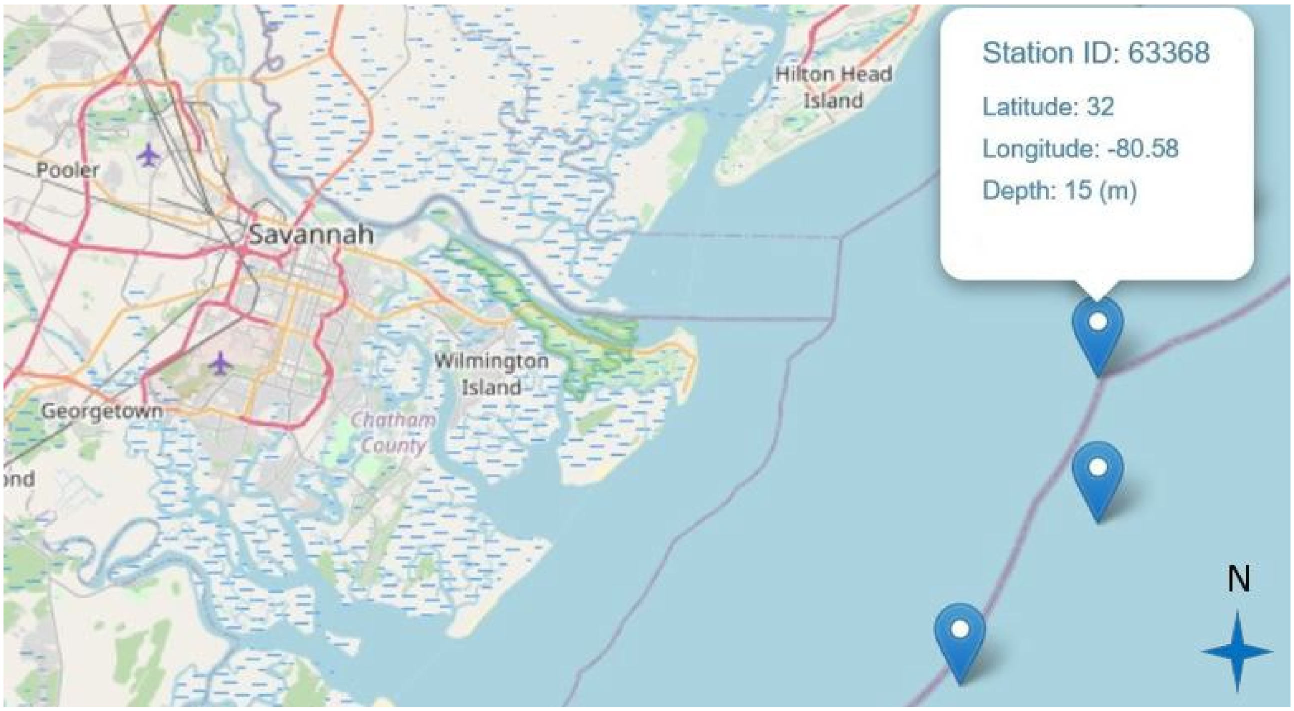

Figure 5: Wave Information Study Station 63368 (not to scale) (Hubertz 1992)

The Coastal Hazards System (CHS) analysis, developed by USACE, models wave heights for a range of storm events for both existing and future conditions (USACE, 2021). **Figure 6** shows modeled wave heights for the 1-percent AEP event in the Chatham County focus area. The Figure shows existing and a future condition with the addition of 2.73 feet of sea level rise. Along the coast, the modeled 1-percent AEP wave heights average 0–6.6 feet (0–2 meters), and offshore wave heights average 6.6–19.9 feet (2–6 meters). Open ocean waves do not currently penetrate far into the Savannah River or the marsh channels west of Tybee Island. Locally generated wind waves along the river and channels are approximately less than 1 foot, causing little impact. Currently, the highest waves in the Savannah River are ship wakes. While their impact is mostly erosional, repetitive loading from frequent ship passages can impact exposed infrastructure.

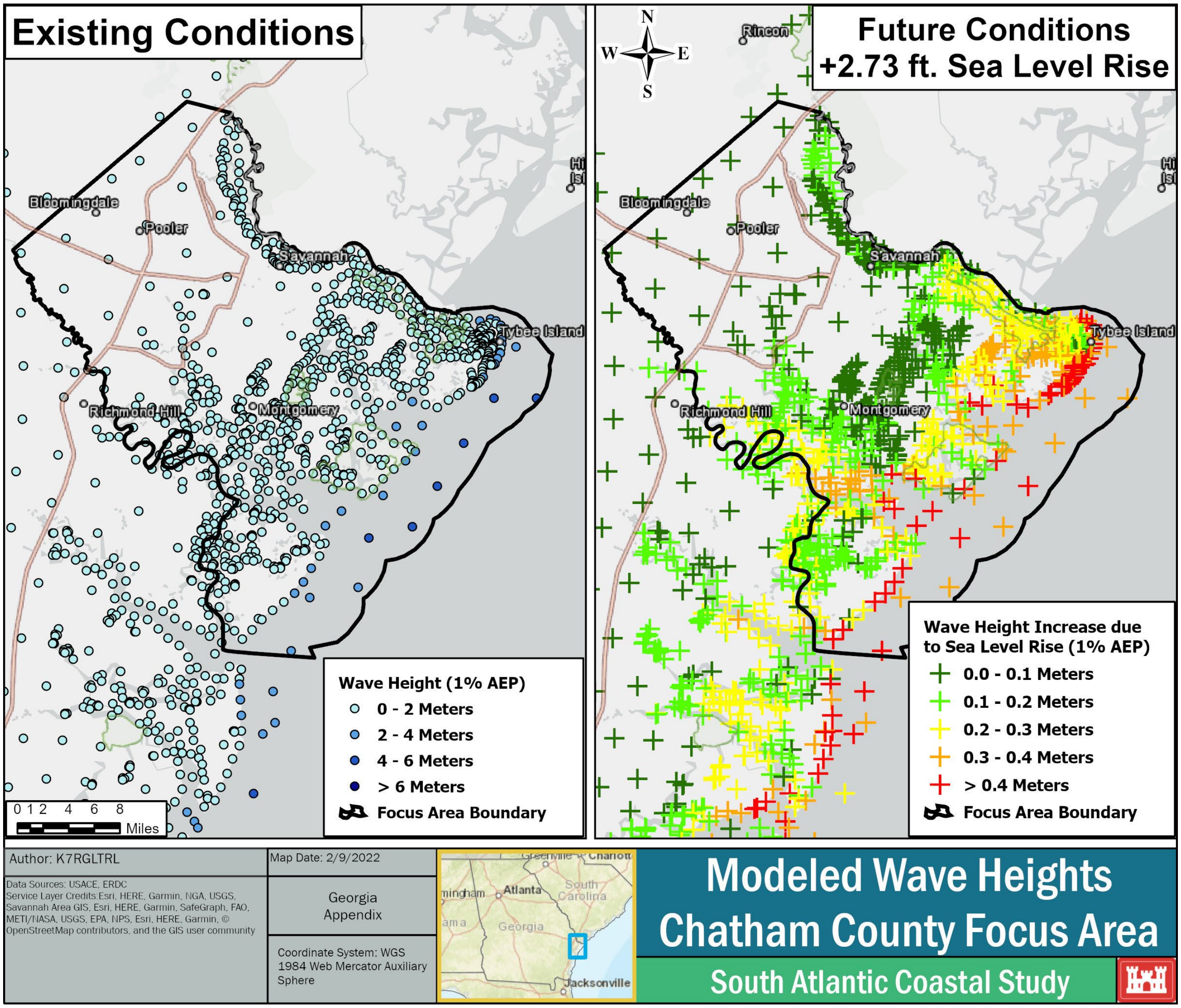

Figure 6: Coastal Hazards System Existing (Left) and Future Condition Wave Height Increases (Right) for 1-Percent Annual Exceedance Probability Event

4.1.1.3 Erosion

Erosion occurs when waves and currents remove sediment from shorelines. It can increase vulnerability of cultural resources, environmental resources, and infrastructure.

At the open ocean, erosion along the Tybee Island shoreline is predominantly wave-driven in the form of longshore and cross-shore currents. Waves approach the shore at an angle break, dislodging sediment and transporting it alongshore. Sediment moves north and south along the shoreline daily, depending on the direction of the incident waves. During storm events, when waves have higher energy, sediment is transported offshore where it forms bars. Once the storm has passed, the bars dissipate, and sand migrates back to the shoreline. During extreme storm events, however, the force of the waves can remove sand far enough offshore that it is lost to the system entirely. This is typical of hurricanes and leads to unrecoverable erosion damage.

The barrier islands of Chatham County (Tybee, Little Tybee, Wassaw, and Ossabaw) do not erode uniformly from one part of the island to another and show long-term accretion, predominantly at the ends of the island, with stretches of central shoreline that are generally stable or accretional (**Figure 7**). Erosion on these islands occurs in hot spots to the north or south of the central shore. Hotspot erosion can be more than -6.6 feet per year (-2 meters per year), according to the U.S. Geological Survey Coastal Change Hazards Portal (U.S. Geological Survey [USGS] n.d.-a). The general shoreline stability (relatively low erosion overall) of Tybee Island may be attributed to a federal beach renourishment project. Without the federal project Tybee Island is highly erosional due to inlet effects from the entrance to the Savannah River north of the island.

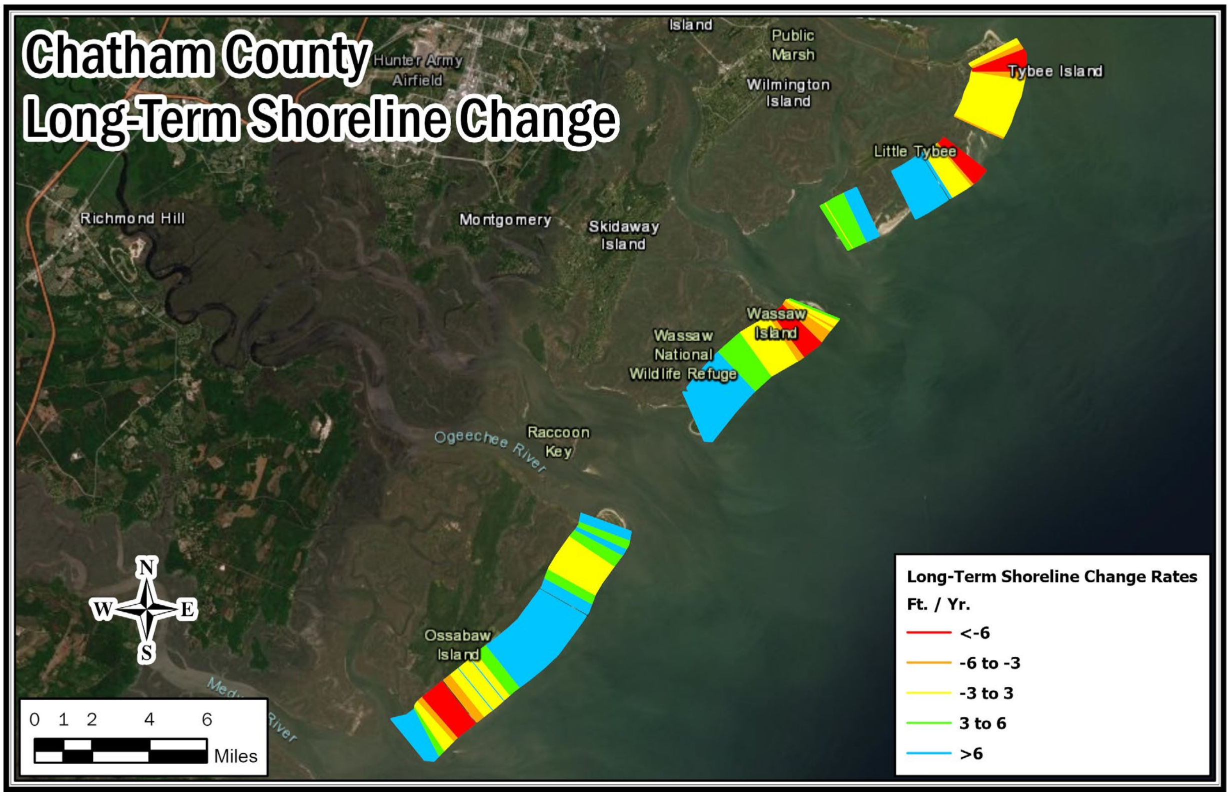

Figure 7: Long-Term Shoreline Change in Chatham County (U.S. Geological Survey 2017a)

In the back bay regions of Chatham County's barrier islands, erosion and accretion occur along riverbanks and marsh channels. Back bay shoreline change is predominantly caused by currents generated by flood and ebb tides. Regions that experience boat or ship traffic, such as the Savannah River, also experience erosion due to ship wake from the frequent passage of vessels.

In 2008, GADNR commissioned a study of threatened archaeological, historical, and cultural resources of the Georgia coast (GADNR 2008). As part of this study, shoreline change along the bay side of coastal barrier islands was investigated. GADNR found that bay side coastlines are highly dynamic over time, showing patterns of both accretion and erosion. **Figure 8** represents these patterns for Chatham County. Mean rates of erosion and accretion are provided in **Table 3**.

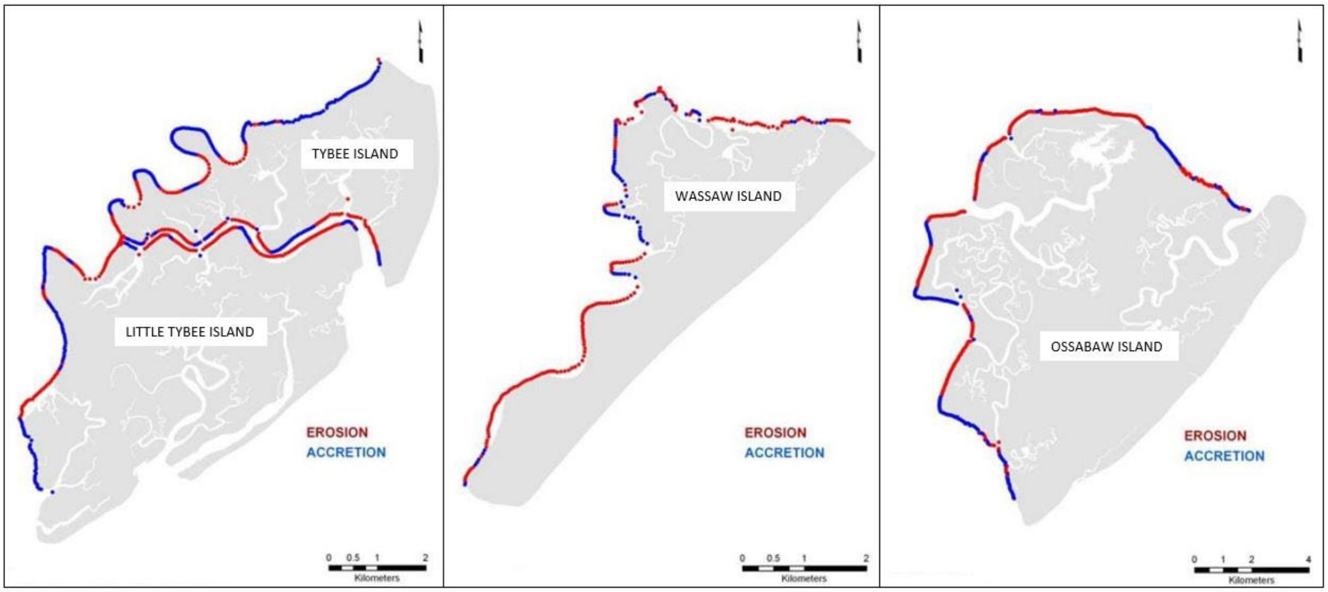

Figure 8: Back Bay Shoreline Change Patterns, Chatham County Barrier Islands (GADNR 2008)

Table 3: Mean Back Bay Erosion and Accretion Rates, Chatham County Barrier Islands (GADNR 2008)

Time Period of Analysis	Barrier Island	Mean Erosion (Feet per year)	Mean Accretion (Feet per year)
1863–2003	Tybee Island	-1.2	2.0
1863–2003	Little Tybee Island	-1.7	4.0
1858–2004	Wassaw Island	-5.4	10.0
1858–2004	Ossabaw Island	-1.7	1.7

4.1.2 Secondary Hazards

Secondary hazards are CSRM hazards that the SACS does not specifically address, including wind damage, compound flooding, and saltwater inundation and intrusion. While the SACS does not specifically address these hazards, they are still important to discuss and can impact the focus areas. Nuisance, stormwater, and compound flooding are significant issues within the focus area. Many of these secondary hazards exacerbate the hazards of inundation, wave attack, and erosion.

4.1.2.1 Wind Damage

Typical daily winds in this region range from approximately 5 to 15 miles per hour and have no significant impact. During storm events, however, high winds can damage both infrastructure and environmental resources. Nor'easters typically produce gale force winds of 40 miles per hour or greater. Hurricanes can generate sustained windspeeds of 74 miles per hour (Category 1) to 157 miles per hour or greater (Category 5). During Hurricane Matthew, Chatham County received sustained tropical storm-force winds with wind gusts of up to 95 miles per hour documented in Tybee Island, resulting in widespread tree and power line damage. Wind is a primary driver of storm surge, by pushing water toward the shore with the force of the winds moving cyclonically around the storm.

4.1.2.2 Compound Flooding

Compound flooding is a combination of hazards that create a greater flooding risk. In Chatham County, this can be a combination of storm surge, precipitation, high tides, stormwater, and high groundwater elevations. Storm surge and wind are major components of compound flooding. The SACS did not evaluate other sources of inundation; however, precipitation, stormwater, tides, and groundwater can contribute significantly to flooding though increased runoff volumes; the elevation of ocean, river, and groundwater levels above banks; containment structures and drainage systems; and the overwhelming of outflow systems. Within the city of Savannah, development has greatly increased the impervious surface area, thus reducing the area where infiltration to groundwater can occur. Excessive surface and stormwater runoff further increases the flood hazards within the city.

4.1.2.3 Saltwater Inundation and Intrusion

Saltwater inundation is the movement of saltwater onto land from storm surges or high tides that submerge areas low in elevation for a short duration of time. Tidal marshes and estuaries experience short-term inundation events as part of the natural cycle and have minimal effect to local salt-tolerant vegetation under normal circumstances. However, with the addition of sea level rise, an increase in the frequency of short-term saltwater inundation events in tidal marshes and estuaries is predicted. Consequently, this may cause an increase in root zone salinization, which can degrade or ultimately kill less salt-tolerant species, such as cattails (Typha latifolia) and giant cutgrass (Zizaniopsis milacea) which cannot survive salinity concentrations greater than 0.5 parts per thousand (ppt) (USDA, 2000). Within the low and middle marshes of Chatham County, *Spartina alterniflora* is the dominant salt-tolerant species, but growth becomes impaired if salinity levels exceed 33 ppt. In addition to salinity tolerances, water elevation and inundation can impair common high marsh species found within the area, such as *Juncus roemerianus* which has similar salt tolerance as Spartina; however, it cannot survive periods of regular inundation exceeding one hour (NPS, 2005b). During Hurricane Matthew, storm surge pushed into river inlets and low-lying areas near Savannah, inundating and causing saltwater damage to many estuaries and bird refuges in and around the Savannah National Wildlife Refuge (Stewart 2017). The ability of existing wetlands to adapt to sea level rise will depend mostly on the topography of the coastal zone and the amount of space landward that has not been developed and is available for wetland migration. The loss of wetlands can exacerbate other hazards such as surge and wind damage because the frictional effects of the wetlands will be reduced.

Saltwater intrusion is the long-term movement of saltwater into groundwater (freshwater aquifers) and surface water through sea level rise. Saltwater intrusion into freshwater aquifers can lead to reduced supplies of freshwater for both the natural environment and for the populations that depend on aquifers for their water supplies. The primary source of fresh drinking water for public use in Chatham County is the Upper Floridan aquifer. In 2006, the GADNR Environmental Protection Division released the *Coastal Georgia Water and Wastewater Permitting Plan for Managing Salt Water Intrusion* (GADNR 2006). To halt the intrusion of saltwater into the Upper Floridan aquifer, all of Chatham County and parts of Effingham County were placed into the sub-region 1 red zone, which significantly restricted and reduced withdrawals from the Upper Floridan aquifer, required implementation of water conservation and reuse measures, encouraged use of alternative water supply sources, and continued chloride monitoring efforts in coastal wells (GADNR 2006). While groundwater development was a primary driver of saltwater intrusion in the Upper Floridan aquifer, the downward saltwater migration from surficial sources through the upper confining units pose a threat to the aquifer that is projected to increase with sea level rise.

4.1.3 Sea Level Rise Effects on Coastal Hazards

Flood hazards due to sea level rise extends beyond areas exposed to the open ocean, encompassing much of low-lying regions of Chatham County. Much of the coastal, bay, and riverine shorelines of Chatham County are generally low-lying and densely populated, making the region highly susceptible to the potential effects of sea level rise. Without adaptation strategies, sea level rise is projected to enhance the effects of the previously discussed hazards. Sea level rise can increase the risk of inundation by increasing water surface elevation, including storm surges, and can reduce the natural buffers in the Chatham County Focus Area that protect infrastructure by drowning and eroding coastal wetlands.

It is projected that an average of 3 feet of sea level rise will occur throughout the entire SACS study area within 50 to 100 years, as determined by the USACE High and Intermediate scenarios, respectively. To represent this future condition, the Tier 1 analysis incorporated sea level rise by adding 3 feet to the storm surge hazards (1-percent and 10-percent AEP events). Similarly, future condition risk in the Tier 2 Economic Risk Assessment assumes up to 3 feet of future sea level rise in its expected annual damages and damages per AEP event projections.

While the addition represents sea level rise estimates, it must be emphasized that 3 feet of additional water could come from multiple sources, such as pluvial (rainfall) and fluvial (rivers and streams) flooding in combination with sea level rise. As such, this assessment is not meant to tie the future hazard to a specific year but to highlight the hazard when a surge event is added to the combined total water level of 3 feet.

The extent of flooding of the 1-percent and 10-percent AEP event expands inland with the addition of sea level rise. Rising seas can allow for larger waves to form closer to the shore and to penetrate further inland on flood waters, causing increasing damage to coastal shoreline and the overtopping of coastal features. As displayed in **Figure 6**, an increase in wave height is anticipated throughout the focus area within the future condition, with greater increases along the barrier islands and estuaries

Sea level rise also exacerbates saltwater intrusion and lifts the water table closer to the ground surface. The rising water table takes up room in the soil and reduces the amount of available space in the ground to absorb runoff during storms. This can increase the amount of runoff that the sewer systems must handle, which can lead to drainage issues and increased flooding. A system of tide gates and pump stations within Chatham County currently protects against extensive tidal backflow during high tide events into the stormwater system, and also facilitate drainage during large rainfall events that coincide with high tides. Many of these structures are vulnerable to tidal flooding that can impact functionality during storm events, which is projected to increase with sea level rise.

4.1.3.1 Relative Sea Level Rise

NOAA Gauge No. 8670870 in Ft. Pulaski, Georgia indicates a mean relative sea level trend of 3.25 millimeters per year, or 0.0107 feet per year, with a 95-percent confidence interval of +/- 0.27 millimeters per year, or 0.0009 feet per year, based on monthly mean sea level data over an 82-year record. When this trend is adjusted according to USACE guidance for Intermediate and High Scenarios (see Section 3.8.2 of the Georgia Appendix for additional details), the trend becomes 7.48 millimeters per year, or 0.0245 feet per year, and 20.9 millimeters per year, or 0.0685 feet per year, respectively. Currently, sea level rise in the region is trending to the USACE Intermediate and High Scenarios. A detailed discussion of relative sea level rise is provided in the Georgia Appendix; however, these trends were evaluated using the USACE Sea Level Tracker (USACE 2018). Long-term predictions of sea level rise indicate that Chatham County will be highly vulnerable to sea level-related hazards.

4.2 System Performance

After assessing the hazards affecting the Chatham County Focus Area, it is important to look at how existing projects are mitigating risk from coastal storm hazards.

Performance is the system's reaction to the hazard. The system performance refers to the system's features and the ability to contain/manage the coastal storm hazard for all possible events. There are several shore protection projects and RSM projects that improve the system performance throughout the Chatham County Focus Area.

4.2.1 Coastal Storm Risk Management Projects

CSRM projects, which include beach nourishment and shore protection structures, have better equipped the coast and barrier islands to reduce coastal storm damages and mitigate risk from sea level rise. Beach nourishments often require periodic maintenance to achieve adequate storm damage reduction benefits. A wide, nourished beach system absorbs wave energy, protects upland areas from flooding, and mitigates erosion.

The primary federal CSRM project within the focus area is the TISPP, which consists of periodic beach nourishment along approximately 15,000 feet of shoreline. A detailed description of this project and other related federal and non-federal projects are in Section 4.3 of the Georgia Appendix. Throughout the project, the TISPP has performed as authorized and designed, except during periods with consecutive multiple significant storm events (e.g., 2016 to 2017). During significant storm events, areas lacking dunes experienced localized flooding, increased erosion, and vulnerability to future storm events. In response, the City of Tybee has supplemented the federal project by adding dunes to areas that were previously breached by storm surge. Historically, Tybee Island had several erosion control measures and structures implemented on the island with records going back to 1882 for the construction of three rock groins at the north end of the island. Sequential historical construction of numerous groins, seawalls, and revetments have been implemented to prevent erosion with varied results. Many of these structures have been destroyed by storm events or have been selectively removed because they impeded preferred CSRM measures, such as beach nourishment and dune construction and enhancement.

Chatham County has numerous public and private properties with armored shorelines. Most commonly, rock revetments or bulkheads are employed to combat tidal creek erosion. Approximately 30 percent of all parcels within the county abutting estuarine wetland or water habitat are armored (Peterson et al. 2019).

4.2.2 Regional Sediment Management Strategies

RSM strategies within the Chatham County Focus Area are described in the 2020 South Atlantic Division Regional Sediment Management Optimization Update (RSM Optimization Update). **Figure 9** shows Savannah Harbor's material placement strategies. Additional data on RSM can also be found in the South Atlantic Division Sand Availability and Needs Determination Summary Report (SAND Report). Borrow areas of proven and potential sand sources and RSM locations are in the SACS Geoportal and on the SAND Dashboard (USACE 2020c).

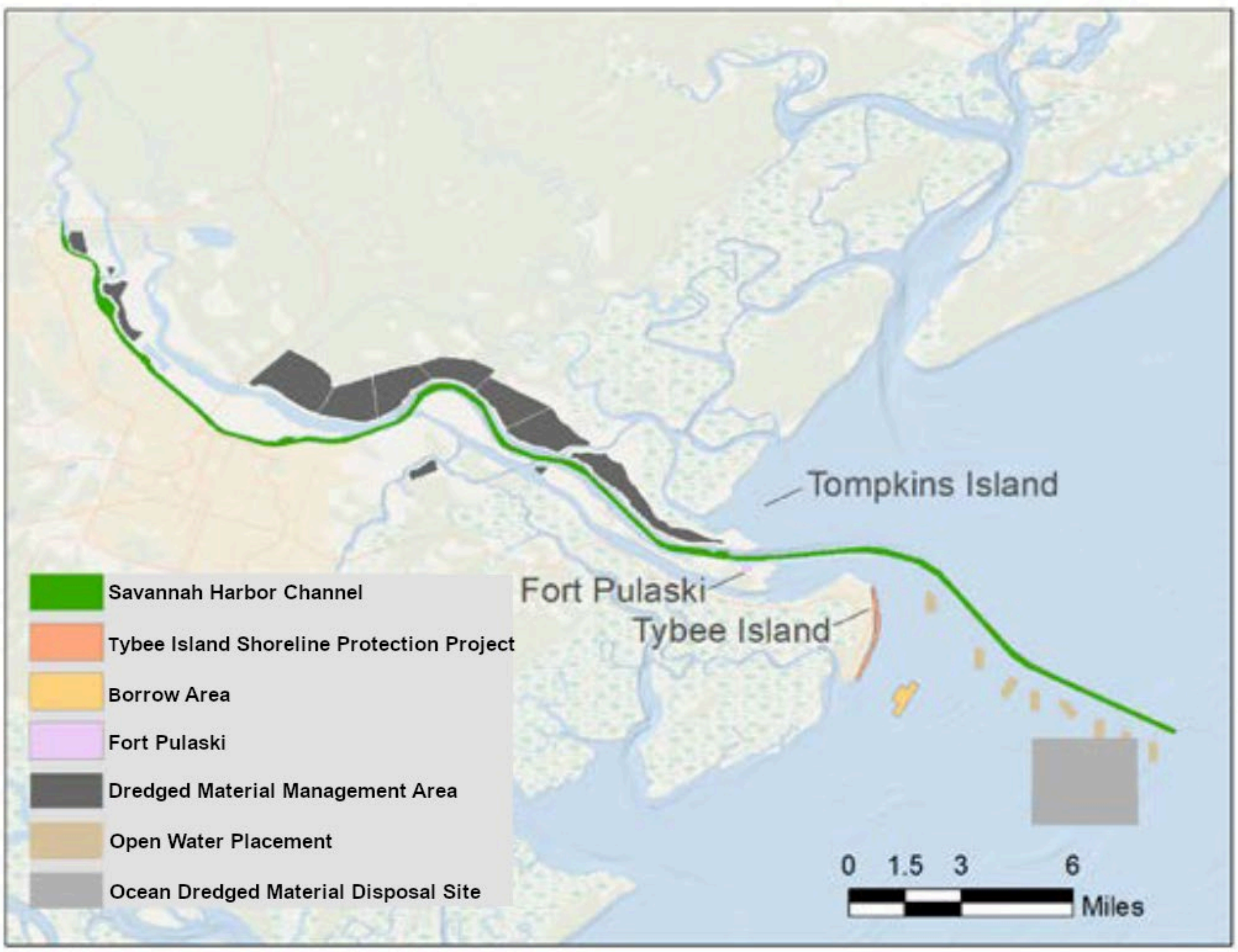

Figure 9: Savannah Harbor Material Placement Strategies Map (USACE 2020b)

Within Chatham County, the Savannah Harbor Navigation Project produces approximately 7.1 million cubic yards of dredged material per dredge cycle (every 1 to 2 years). Approximately 300,000 cubic yards of beach-quality sand is dredged every two years and an additional 300,000 cubic yards of nearshore-quality material is dredged annually. Within the Savannah Harbor river system, there is an annual RSM value of approximately $3.9 million, with beneficial use comprising approximately 4 percent of the dredged material. Opportunities for beneficial use of dredge material include placement at Ft. Pulaski National Monument, McQueen's Island Trail, Tomkins Bird Island, and the TISPP.

A notable RSM effort within the focus area is the Ft. Pulaski Shoreline Stabilization Project, which was completed in 2015 and restored 1.5 miles of shoreline along the north shore of Cockspur Island using 270,000 cubic yards of dredged material from the Savannah Harbor Navigation Project. This project provided up to $2.0 million of shore protection value per placement opportunity to the NPS.

Other potential RSM opportunities include placing beach- and nearshore-quality material from the Savannah Harbor Navigation Project at the TISPP, which could provide significant value to the flood risk management program. Implementation of this RSM strategy could provide up to $1.1. million in annual value to the flood risk management program. Combining the navigation and flood risk management projects would likely eliminate or dramatically reduce the need for a traditional beach resources project.

As part of the Focus Area Visioning Meetings and subsequent stakeholder engagements, potential RSM opportunities were discussed and further analyzed for placement of dredged material from the Savannah Harbor Navigation Project on the north shoreline of Tybee Island and McQueen's Island Trail to provide flood risk and environmental benefits to the area. At Tybee Island, this type of project would be similar to a traditional beach nourishment event, but the material used for this project would come from the federal channel instead of a designated offshore borrow site. As a result of this discussion, a series of potential alternatives were developed with estimated rough order of magnitude (ROM) costs and quantities by the Savannah District. The material could be dredged from the inner harbor entrance to the federal channel (**Figure 10**) and transferred to the placement site or transferred from existing deposits on Jones Oysterbed Island. Approximate material locations are identified by station numbers in **Figure 10**, **Figure 11**, and **Figure 12**. Station numbers are measured in feet from the harbor entrance, each representing 1000 feet within the federal channel. A prescribed volume of 200,000 cubic yards is assumed for all scenarios. The draft alternatives include:

- **Alternative #1** – Place 0.2 million cubic yards (MCY) from inner harbor dredging via hydraulic cutterhead dredge. Inner harbor material would be dredged from approximately Station 10.2 to Station 3.5 and pumped to the placement site at North Beach Tybee Island.
- **Alternative #2** – Place 0.2 MCY from the entrance channel via hopper dredge. Entrance channel material would be dredged from approximately Station -0.2 (EC) to Station -9 (EC) and pumped to the placement site at North Beach Tybee Island.
- **Alternative #3** – Place 0.2 MCY from the Jones Oysterbed Island (JOI) upland disposal area. Beach quality sand deposits would be slurried and pumped to the placement area.
- **Alternative #4** – Consider nearshore placement of Alternatives 1 or 2. Objectives of the nearshore placement of dredged material vary from placing the material in the littoral zone to feed the littoral system, to designing and constructing nearshore berm or mound systems.

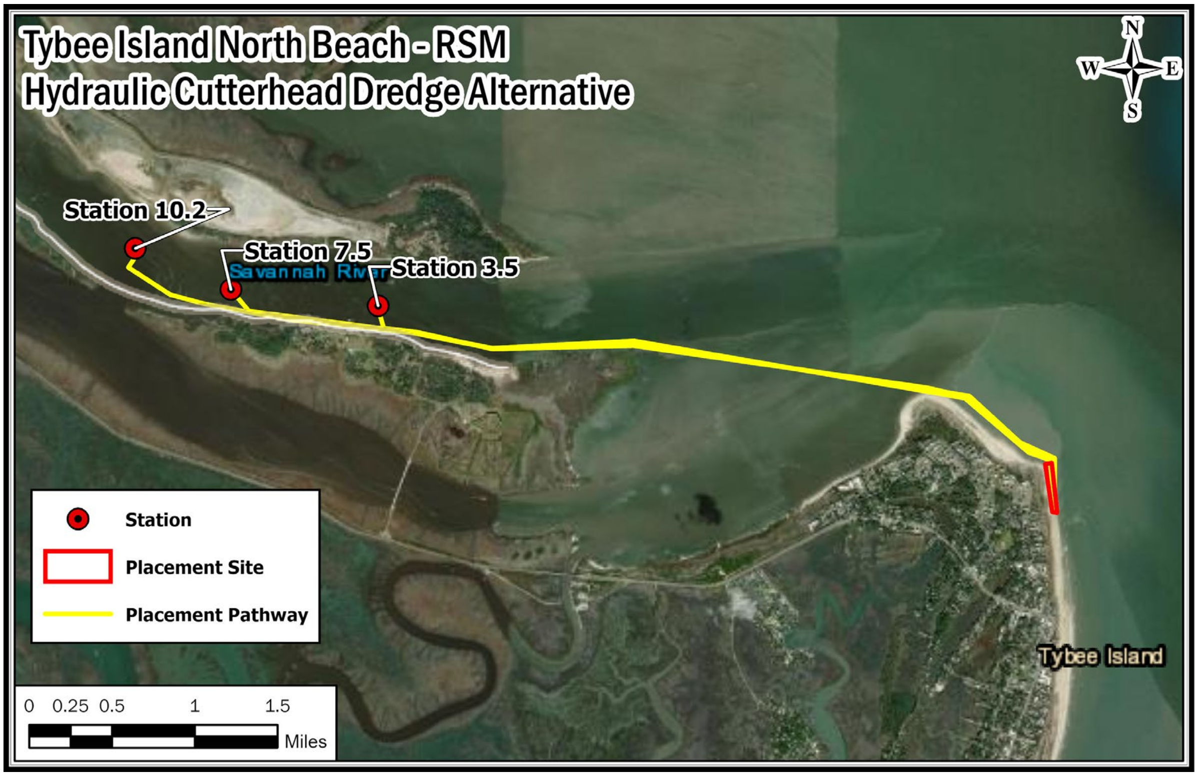

Figure 10: Tybee North Beach Regional Sediment Management – Hydraulic Cutterhead Dredge Alternative

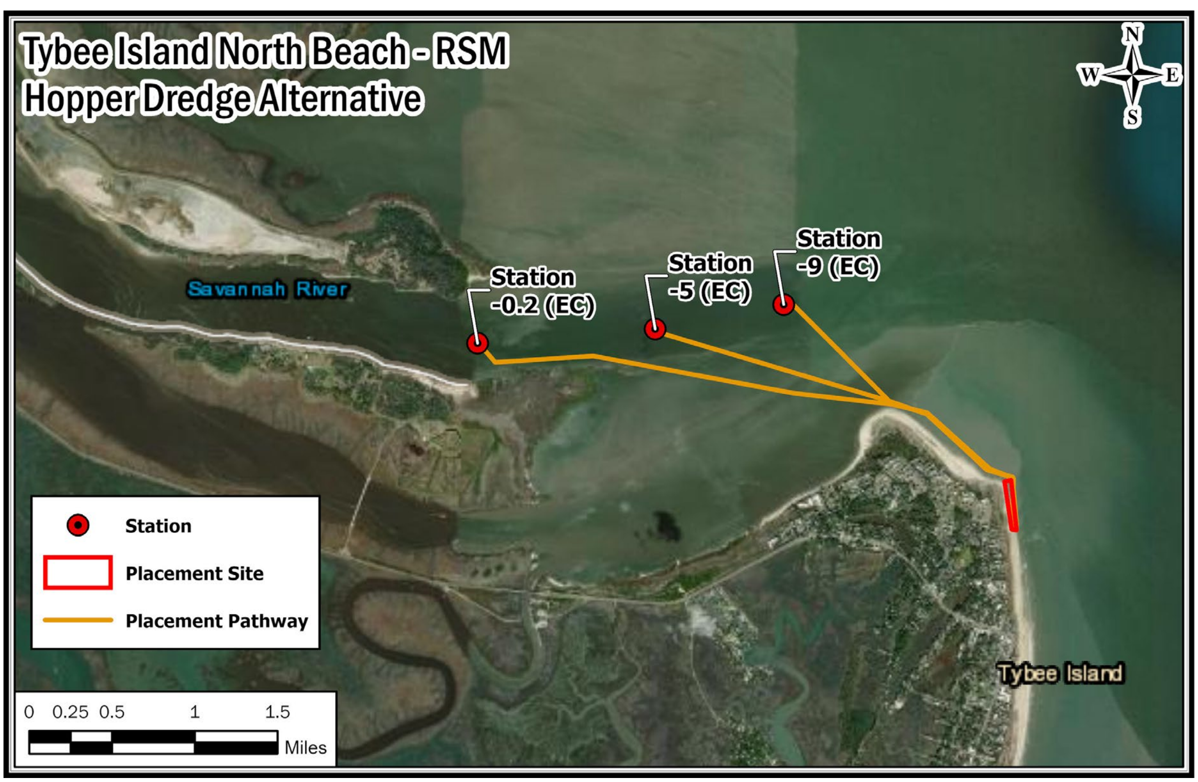

Figure 11: Tybee North Beach Regional Sediment Management - Hopper Dredge Alternative

Figure 12: Tybee North Beach Regional Sediment Management - Jones Oysterbed Island Alternative

Additional opportunities exist for beneficial use of beach quality and non-beach quality dredged material within the focus area. Non-beach quality material can be used for ecosystem restoration purposes including island habitat creation (bird islands) and marsh creation and restoration efforts using thin-layer placement. The island creation at Tompkins Island, just north of the Savannah River, provides valuable bird habitat for a variety of species, including federally listed least tern nesting habitat. The bird island also provides additional capacity at the existing Savannah Harbor dredged material containment areas because the bird island serves as an offloading option.

The nearshore and beach quality material can be used for shoreline nourishment projects. General ROM costs, material quantities, and material source qualities can be developed with stakeholder interest as identified in the Tybee Island North Beach example.

4.3 Exposure

Exposure describes who and what may be harmed by the hazard and may include population, infrastructure, and environmental and cultural resources. The following section identifies exposure in the focus area.

4.3.1 Exposed Population

The population of Chatham County is approximately 265,000, according to the 2010 U.S. Census data, and approximately 50 percent of the population is located within the boundaries of the city of Savannah (**Figure 13**). The exposed population consists of all residents in potential storm surge areas, residents of mobile homes, and all tourists. Per data derived from the 2013 Coastal Georgia Hurricane Evacuation Study (**Table 4**), approximately 57 percent of the exposed population along the Georgia coast resides in Chatham County and 87 percent of the county population resides within the Category 5 MOM hurricane storm surge area. Slightly over 8 percent, or nearly 23,000 people, reside within the strong tropical storm inundation area. The largest percent increase in vulnerable population occurs between the Category 2 and Category 3 surge areas (approximately 107,000 people) as the storm surge inundation risk encompasses major portions of the city of Savannah and expands outside of the major riverine networks (USACE 2013a). In addition, the total number of seasonal visitors and tourists to Chatham County, which can increase the county population by more than 20 percent, continues to grow annually, which increases the exposed population.

Table 4: Exposed Population in Chatham County (USACE 2013a)

Surge Area	Total Resident Population Exposure	Mobile Home Population (Subset of Total Residential Population) Exposure	Tourist Population (100-Percent Occupancy) Exposure	Total Resident Population and Tourists
Tropical Storm	22,828	348	5,604	28,432
Category 1	38,691	875	9,978	48,669
Category 2	69,915	3,305	15,684	85,599
Category 3	176,527	6,674	27,243	203,770
Category 4	216,540	8,756	36,915	253,455
Category 5 Maximum of Maximum (MOM)	229,974	8,989	39,609	269,583
Outside of Surge Area	35,154	1,563	12,165	47,319

Assessing future growth trends in population can indicate whether there will be an increase in people and associated infrastructure exposed to future hazards. Results from the U.S. Environmental Protection Agency's (EPA) Integrated Climate and Land Use Scenarios (ICLUS) population projection for 2020 to 2100 project an increase in population within the Savannah, Georgia metro area of 25 to 50-percent. Future population projections, developed by the Georgia Governor's Office of Planning and Budget, project a population increase of 28.6-percent from 2020 to 2065 for Chatham County. With the projected increase in population and sea level rise, the exposed population in Chatham County is expected to rise. More detail on exposed population can be found in the Georgia Appendix.

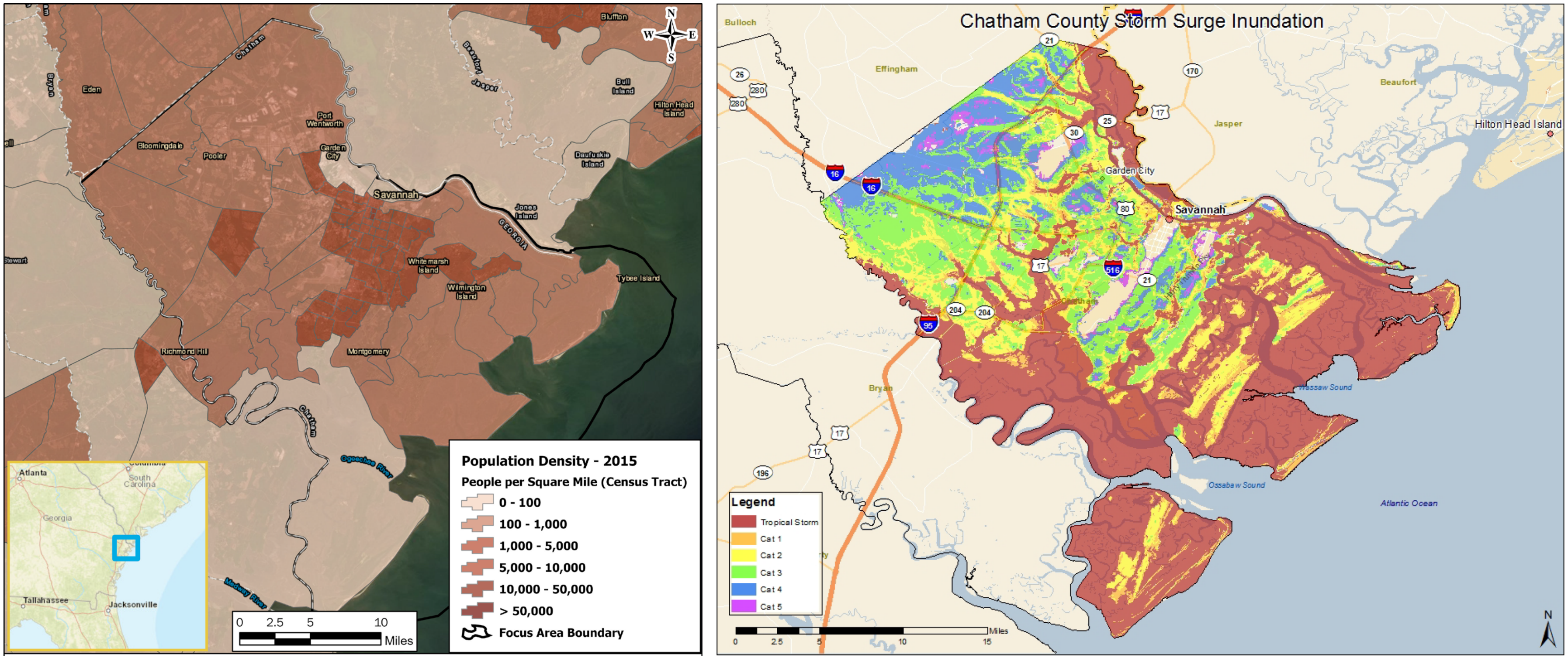

Figure 13: Chatham County Population by Census Block (2010 Census Bureau Decennial Census Data) along with a Storm Surge Inundation Map (Tropical Storm – Category 5 Maximum of Maximum (USACE 2013a)

4.3.2 Exposed Infrastructure

Parcel data from the Chatham County tax assessor, local emergency management, and National Geospatial-Intelligence Agency NAVTEQ was used to determine the inventory of structures and critical facilities in the county that are exposed to a Category 5 MOM storm surge (USACE 2013a). The total number of structures was estimated to be approximately 131,000 with the following breakdown by type, shown in **Table 5**.

Table 5: Exposed Infrastructure in Chatham County (USACE 2013a)

Structure Type	Total Number of Structures	Percent of Total Structures
Residential	104,348	79.8
Tourist	13,203	10.0
Commercial	5,969	4.7
Mobile Homes	3,669	2.8
Industrial	3,492	2.7

The exposure of critical facilities is concerning because they provide essential services and support functions that affect the livelihood of the community and are needed for emergency response activities before, during, and after an emergency. Critical facilities, according to FEMA, include hospitals, medical facilities, police stations, fire stations, primary communication facilities, shelters, emergency operations centers, power stations, and other utilities (FEMA 2017). Other critical facilities considered in the Chatham County exposure assessment include schools, nursing homes, hazardous materials (HAZMAT) locations, water/sewer treatment facilities, and local government offices. Critical cultural facilities are defined by Chatham County and include highly visible and visited properties such as museums, historic properties that are listed or eligible for listing on the National Register of Historic Places, such as historic homes, as well as archives. **Figure 14** identifies critical infrastructure elements within the projected tropical storm through the Category 5 MOM inundation area within Chatham County. This is not an inclusive list and only includes information provided by local governments and the above-referenced data sources. The following number and types of critical facilities are vulnerable to Category 5 MOM storm surge in Chatham County, shown in **Table 6**.

Table 6: Exposed Critical Facilities in Chatham County (USACE 2013a)

Structure Type	Total Number of Facilities
Water	394
Hazardous Materials (HAZMAT)	124
Safety	52
Government	49
Schools	48
Cultural	32
Transportation	18

In addition, Chatham County has several low-lying roads that provide critical access to coastal communities and are particularly exposed to coastal storms and sea level rise. U.S. Highway 80 provides the only road access to Tybee Island and serves as the only hurricane evacuation route for the island. U.S. Highway 80 is the focus of multiple actions in the focus area carried out by other stakeholders. It is also associated with an ongoing Continuing Authorities Program (CAP) Section 103 CSRM study. Other examples include the Burnside Island causeway (**Figure 15**), Laroche Avenue, Skidaway Road, and U.S. Highway 17 at the Ogeechee River.

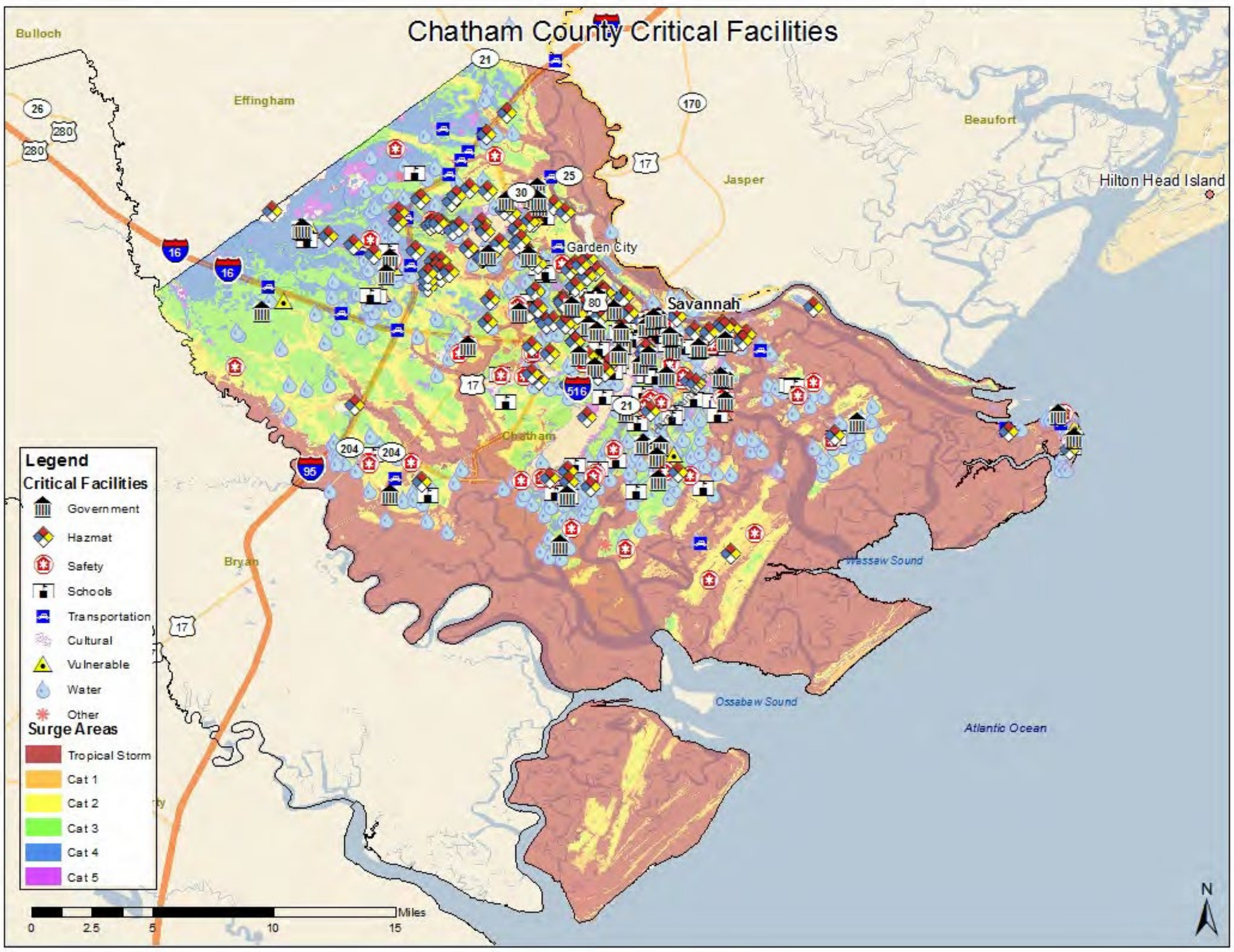

Figure 14: Chatham County Critical Facilities in Storm Surge Inundation Areas (Tropical Storm – Category 5 Maximum of Maximum) (USACE 2013a)

Figure 15: Burnside Island Causeway – Hurricane Irma (Photo Credit: Lindy Claborn / WJCL)

4.3.3 Exposed Environmental and Cultural Resources

The Chatham County Focus Area is rich with important and unique environmental and cultural resources. Plentiful food sources, multiple habitat types, tidal influence, and ocean access have resulted in rich biodiversity in coastal Georgia and a long history of human inhabitation. Important cultural resources are listed or eligible for listing on the National Register of Historic Places. Coastal storms and sea level rise continue to expose environmental and cultural resources to risk of alteration or loss.

Sections 4.3.3.1 and 4.3.3.2 summarize the environmental and cultural resources exposure identified in the Chatham County Focus Area. Potential CSRM measures to protect these resources are discussed in Section 5.1. Additional details can be found in the Georgia Appendix and Environmental Technical Report (USACE 2022a) and the Tier 2 Cultural Resources Appendix.

4.3.3.1 Environmental Resources

Diverse habitats in the focus area located within the Category 5 MOM inundation footprint include east-facing unconsolidated shorelines, dune habitat, palustrine and estuarine scrub-shrub wetlands, forested wetlands, emergent vegetation habitat, and saltmarsh. They also include mixed hardwood and coastal hardwood communities. **Figure 16** identifies the approximate distribution of the primary habitats located within the focus area based on the NOAA Coastal Change Analysis Program (C-CAP) land cover classification system. Wetlands of Chatham County total approximately 103,000 acres and cover 36 percent of the county land area. The dominant wetland habitat type within the focus area is estuarine emergent wetland, which is found throughout the intertidal zone of the barrier islands and within and adjacent to the tidal waterways and estuarine environments (GADNR 2012).

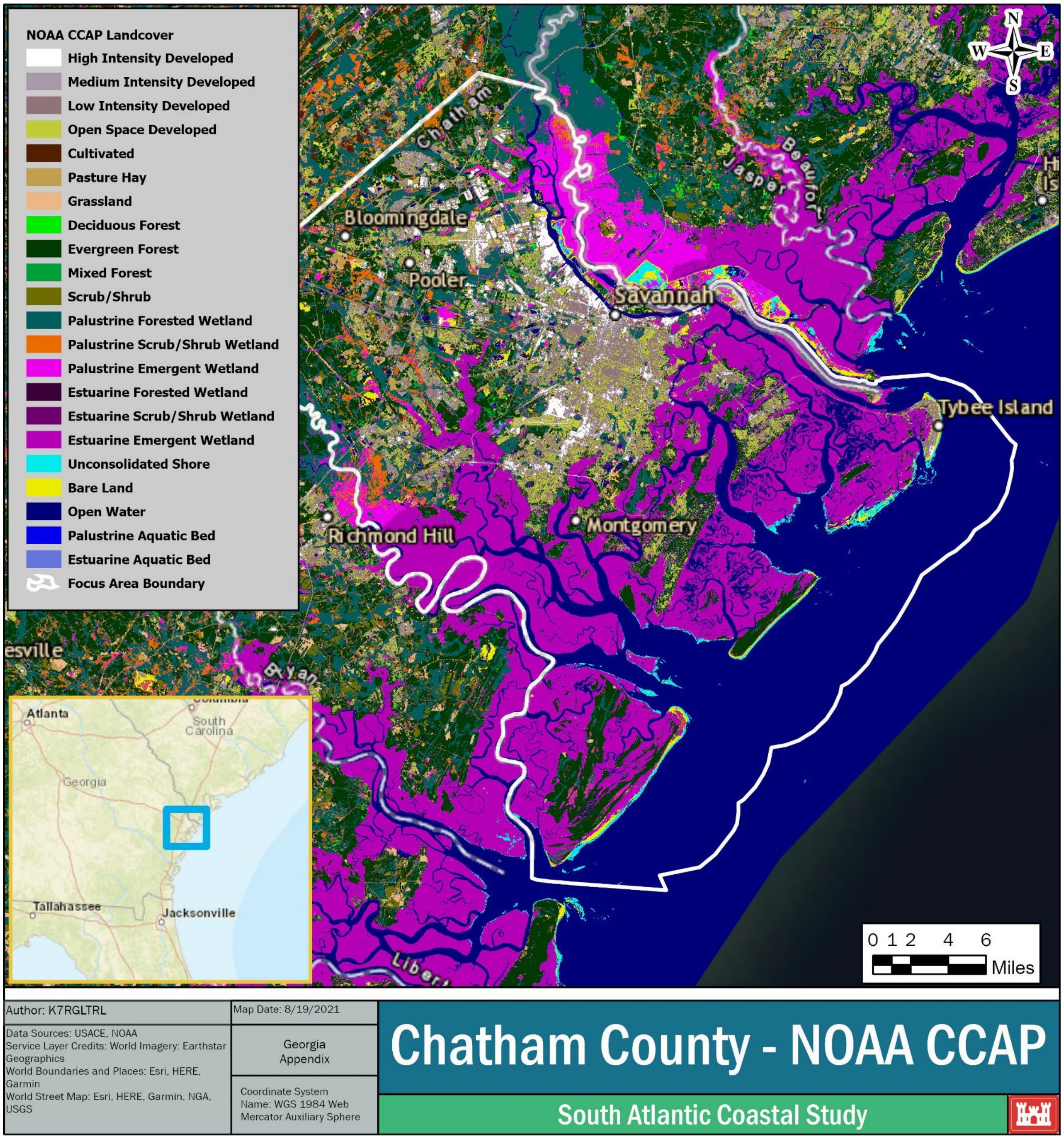

Figure 16: Coastal Change Analysis Program (C-CAP) Land Cover Classifications in Chatham County

Throughout the focus area vicinity, numerous environmental resources are exposed to increased coastal storm hazards as a result of sea level rise. While environmental resources have evolved with coastal storms, exposure due to sea level rise combined with other factors (e.g., development density and water quality impacts), create ongoing stresses to resources, thus making them more susceptible to the shocks of coastal storms. Critical habitat within the focus area is particularly susceptible to these inundation hazards as the physical or biological features are essential to conservation of the Endangered Species Act (ESA) listed species which are identified at the time of listing. Within Chatham County, the Savannah River and Ogeechee River (also bordering Bryan County) are designated by the NOAA National Marine Fisheries Service as critical habitat for the ESA-listed

Atlantic sturgeon, which is federally listed as endangered. Coastal beach habitat along north Tybee Island, Little Tybee, Wassaw Island, and Ossabaw Island have been designated by the U.S. Fish and Wildlife Service as foraging critical habitat for over-wintering piping plovers (ESA listing- threatened). With the exception of Tybee Island, these beaches have also been designated nesting critical habitat for loggerhead sea turtles (ESA listing-threatened). **Figure 17** displays the critical habitat for both species in Chatham County.

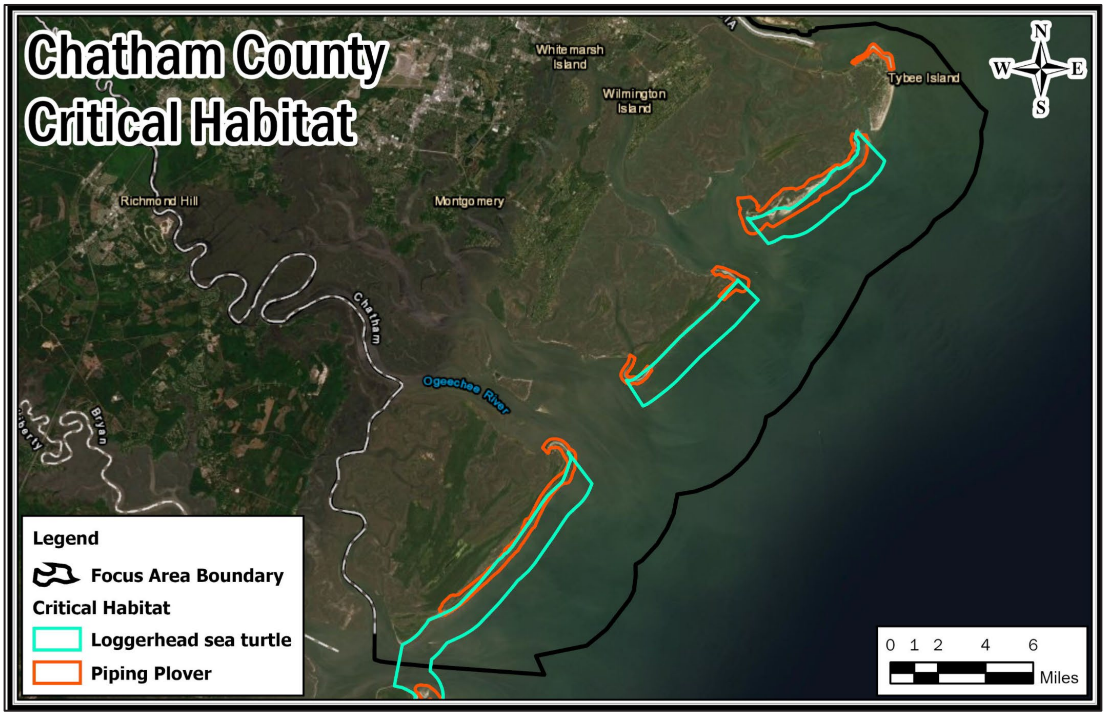

Figure 17: Critical Habitat for Loggerhead Sea Turtle and Piping Plover in the Chatham County Focus Area

Additional discussion of environmental exposure methodology and a detailed table of habitats within Planning Reach GA_05 can be found in Appendix A of the Environmental Technical Report (USACE 2022a).

4.3.3.2 Cultural Resources

Cultural resources were identified using information and datasets from the NPS, the U.S. Geological Survey, and Georgia's Natural, Archaeological and Historic Resources GIS (GNAHRGIS) (U.S. National Parks Service 2020, U.S. Geological Survey 2021, Georgia Archeological Site File at the University of Georgia and the Georgia Department of Natural Resources n.d.). Data gathered from these databases are current as of June 2021, and any cultural resources added after that point will not be represented in this analysis throughout the report. A query of GNAHRGIS revealed that 5,720 historic resources are listed for Chatham County, with high concentrations of the resources located in downtown Savannah, the outskirts of Savannah on Isle of Hope, Cockspur Island, and on the barrier islands of Tybee and Ossabaw. There are 1,582 cultural and historic resources identified as being in the future condition (3-foot sea level rise) 1-percent and 10-percent AEP flood zones. This includes 948 archaeological sites and 634 historic resources.

A selection of five cultural resource areas were identified within, or partially within, the Chatham County Focus Area, which were identified as high risk due to the hazards of inundation, erosion, and wave attack (see **Table 7**). These are Savannah, Isle of Hope, Cockspur Island, Tybee Island, and Ossabaw Island. Cultural resources within those areas were selected through both quantitative means, such as determining which cultural resources were located in areas of greater exposure, and qualitative means, such as literature review and stakeholder input. **Table 7** is not all-inclusive and is meant to communicate the types of cultural resources that may be found in these areas. A selection of historic properties and districts are highlighted due to their National Register status and stakeholder input regarding their historical significance and concern for continued preservation due to their higher exposure rating. General information is also included regarding the presence of archaeological sites in areas of higher exposure.

Table 7: Cultural Resources Areas Exposed to Storms and Sea Level Rise in the Chatham County Focus Area

Cultural Areas	Exposed Cultural Resources
Savannah	Savannah Historic District (River Street), Pin Point Gullah Geechee Community (Moon River), and approximately 103 historic and prehistoric archaeological sites subject to erosion.
Isle of Hope	Wormsloe Plantation, Isle of Hope Historic District, Gullah-Geechee sites, and approximately 15 historic and prehistoric archaeological sites subject to erosion.
Cockspur Island	Ft. Pulaski National Monument, Cockspur Island Lighthouse, and approximately 4 historic and prehistoric archaeological sites subject to erosion.
Tybee Island	Back River Historic District, Tybee Island Strand Cottages Historic District, Ft. Screven Historic District, and approximately 7 historic and prehistoric archaeological sites subject to erosion. Includes Little Tybee.
Ossabaw Island	Approximately 214 historic and prehistoric archaeological sites subject to erosion.

These resources are discussed in greater detail below. Exposed cultural resource areas identified within the FAAS report are not meant to be all-inclusive. Publicly available data for historic resources are discussed below. Specific archaeological site information is not publicly reportable but was analyzed to determine if archaeological sites were exposed to coastal hazards.

Savannah

The Savannah Historic District was designated as a National Historic Landmark District in November 1966 and continues to be the largest National Historic Landmark District in the U.S. (NPS n.d.-b and Historic Savannah Foundation n.d.-b). The highest concentrations of historic structures in Savannah are related to the initial settlement (late 1700s) and 19th century construction periods. A few important sites include the Juliette Gordon Low Historic Landmark and District (NRHP-listed October 1966), Eastside Historic District (NRHP-listed November 2002), Fairway Oaks-Greenview Historic District (NRHP-listed March 2009), Bonaventure Cemetery (NRHP-listed February 2001), and the Central of Georgia Railroad Terminal, a National Historic Landmark listed in June 1978. These structures were built on some of the highest elevations in the city and are generally not inundated during major storm events. River Street has been impacted by storm surge from previously named storms. River Street runs along the southern edge of the Savannah River for approximately 2 miles and includes the stone and brick former cotton warehouses of Factors Row, including the Queen Anne Revival Savannah Cotton Exchange (1887). As the lowest point of the historic district, this area experiences storm surge-related flooding issues, which will increase with sea level rise. Of the 300 archaeological sites located in Savannah, approximately 103 are located in the 1-percent and 10-percent APE flood zones and are therefore at greater exposure to coastal storm hazards, including erosion and wave attack.

The Pin Point area, located southeast of Savannah on the banks of the Moon River, is a historic Gullah Geechee neighborhood that includes a museum and adjacent properties related to a rural settlement founded by freed slaves after the Civil War. Designated as a local historic district by the Chatham County Savannah Metropolitan Planning Commission, Pin Point is an area that experiences reoccurring compound and storm surge flooding issues, which will increase with sea level rise (Georgia Conservancy 2009).

Isle of Hope

Isle of Hope, situated approximately 11 miles southeast of Savannah, is a coastal-riverside community developed over 100 years beginning in the early nineteenth century (NPS n.d.-a and Historic Savannah Foundation n.d.-a). The island served as an escape for the Savannah elite during the summer months from the intense heat and malaria outbreaks. The Isle of Hope Historic District was NRHP-listed in September 1984 and includes historic structures such as the Isle of Hope United Methodist Church. Wormsloe Historic Site, formerly known as Wormsloe Plantation, was NRHP-listed in April 1973. Located in a dense maritime forest, the plantation was constructed in the mid-1700s. The island is home to numerous prehistoric sites and holds significant important to the Gullah-Geechee culture (NPS 2005a). Of the 23 archaeological sites located on Isle of Hope, approximately 15 are located in the 1-percent and 10-percent APE flood zones and are therefore at greater exposure to coastal storm hazards, including erosion and wave attack. The island is surrounded by a tidal salt marsh on all sides and transitions from a peninsula to island at high tide. Flooding and erosion are the main hazards associated with sea level rise in the area.

Cockspur Island

Cockspur Island is mostly comprised of Fort Pulaski, which was designated as a National Monument in October 1924 and NRHP-listed in October 1966. Fort Pulaski was built starting in 1829 as part of a series of fortified structures to protect against foreign invasion after the War of 1812 (NPS 2003). The fort was used primarily during the Civil War under the authorities of both the Confederate and Union forces and served as a fort, prisoner of war camp, and as a safe haven for formerly enslaved people. The historic Cockspur Lighthouse is situated in the Fort Pulaski National Monument on an islet off the southeastern tip of the island (USGS n.d.). The island has experienced significant storm damage. Fort Pulaski is exposed to erosion and inundation, and the lighthouse has been destroyed several times because of storm surges. Ongoing preservation efforts at Fort Pulaski seek to reverse storm damage to the pre-2015 conditions through drainage improvements to clean the existing historic ditching network and repair critical flood control infrastructure. As described in Section 4.2.2, USACE placed beach-quality material along the northern side of the island, which helped to halt the accretion of saltwater marshes from encroaching on the island and helped preserve several historic structures and fortified earthworks from erosion. Of the 10 archaeological sites located on Cockspur Island, approximately four are located in the 1-percent and 10-percent APE flood zones and are therefore at greater exposure to coastal storm hazards, including erosion and wave attack.

Tybee Island

Tybee Island contains over 900 structures that are 50 years old or older, including the Tybee Island Back River Historic District (NRHP-listed August 1999), Tybee Island Strand Cottages Historic District (NRHP-listed April 1999), and Fort Screven Historic District (City of Tybee Island n.d.). These resources are located behind the existing dunes and flood protections that are in place and are protected from inundation except during major storm events and storm surges. Of the 12 archaeological sites located on Tybee Island, approximately seven are located in the 1-percent and 10-percent APE flood zones and are therefore at greater exposure to coastal storm hazards, including erosion and wave attack. The most commonly faced risks in the area are associated with flooding and erosion due to storm surge and sea level rise. Extensive flooding and erosional impacts to the shoreline and back bay have been documented during the previous named storms.

Ossabaw Island

Ossabaw Island was NRHP-listed in 1966 and is a designated heritage preserve in the state of Georgia (NPS 1996). The island has over 230 recorded archaeological sites and has preserved evidence of human presence extending approximately 4,000 years through the European occupation. The island is home to numerous prehistoric sites marked by shell middens and over 12 known burial mounds. Nearly all standing structures on the island have archaeological components. The island contains multiple archaeological sites that are exposed to erosion, as documented by the GADNR Historic Preservation Division. Of the 233 archaeological sites located on Ossabaw Island, approximately 214 are located in the 1-percent and 10-percent APE flood zones and are therefore at greater exposure to coastal storm hazards, including erosion and wave attack. Standing structures are exposed due to storm surge and sea level rise.

4.3.3.3 Environmental and Cultural Resource Uncertainty

There are multiple sea level rise scenarios for Georgia that suggest sea level rise will continue to increase, although specific scenarios will identify a variation of low-high sea level rise projections. Uncertainty reinforces the need for adaptable strategies and the importance of scenario planning, rather than using specific, deterministic single values for future sea level rise. If protective measures are not, habitat types with limited tolerance to salinity may migrate inland, be displaced by others, or be lost due to inundation or erosion. Cultural resources may be subjected to increased erosive forces, increased saline conditions, and potential inundation due to of coastal storm damage and sea level rise.

4.4 Vulnerability

Vulnerability is the susceptibility of harm to human beings, property, the environment, and cultural resources when exposed to a hazard.

The SACS Main Report, Georgia Appendix and Environmental Technical Report (USACE 2022a) describe how vulnerability was incorporated in Tier 1 and Tier 2 analyses. Brief descriptions of additional vulnerability information available for the focus area is provided in Sections 4.4.1 to 4.4.4.

4.4.1 Social Vulnerability

Social vulnerability refers to the potential negative effects on communities caused by external stresses on human health. Such stresses include natural or human-caused disasters, or disease outbreaks.

4.4.1.1 Social Vulnerability Index

The Centers for Disease Control and Prevention Social Vulnerability Index (CDC SVI) was used to further evaluate social vulnerability within the focus area by assessing overall SVI percentile rankings at the census tract scale. The CDC SVI depicts the social vulnerability of communities by assigning an SVI percentile ranking that ranges from 0 (lowest vulnerability) to 1 (highest vulnerability) based on a national comparison. The overall CDC SVI ranking for Chatham County is 0.6858, which indicates a moderate to high level of vulnerability within the focus area. As described within the hazards section, nearly the entire focus area is at risk of inundation from a Category 5 hurricane. At a more refined scale, census tracts primarily located within the city of Savannah and adjacent unincorporated communities have significantly higher CDC SVI rankings (>.7501) than the neighboring island communities to the east, indicating a high level of social vulnerability (**Figure 18**). Additional detail on the CDC SVI can be found in the Georgia Appendix.

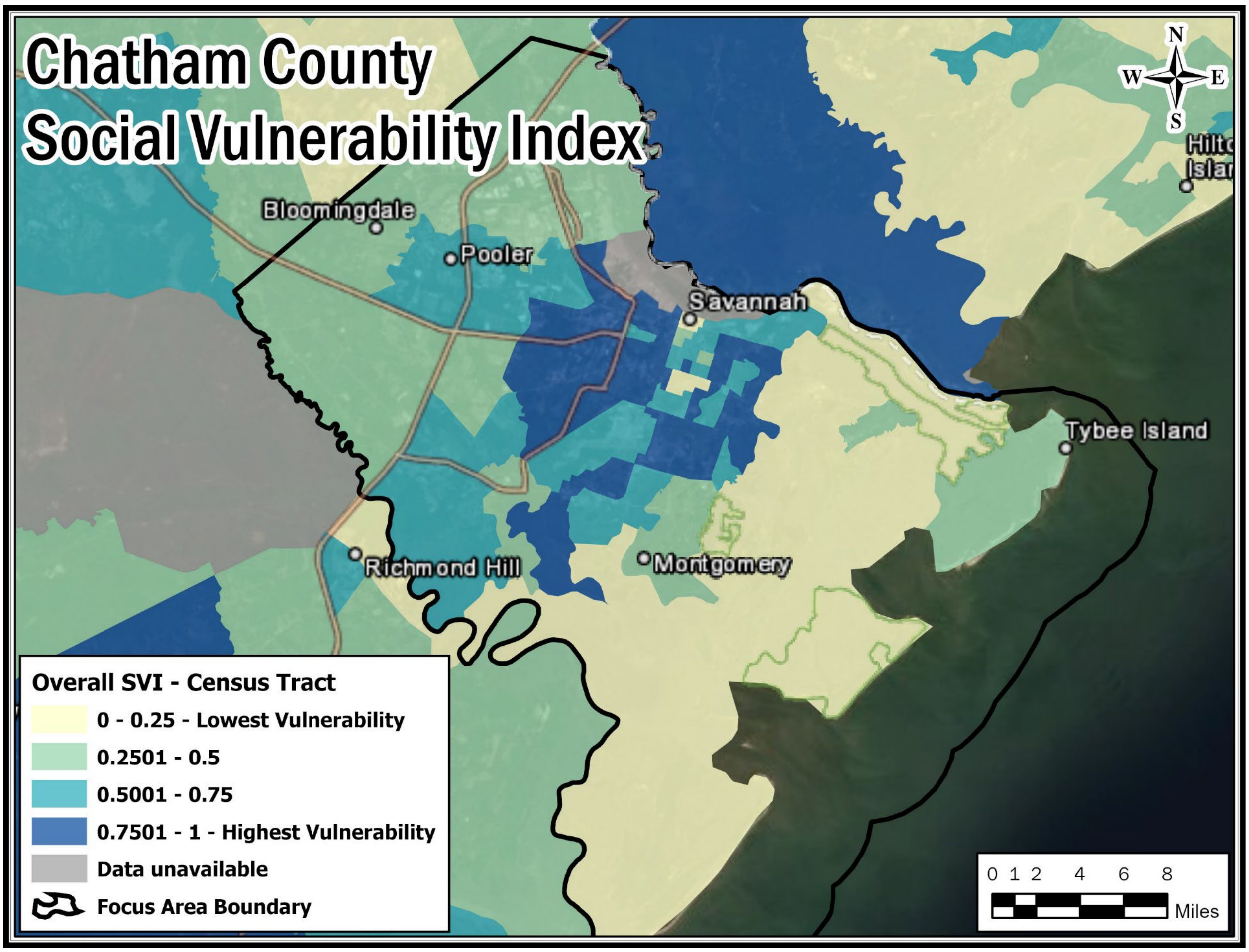

Figure 18: Chatham County Centers for Disease Control Social Vulnerability Index Ranking by Census Tract (CDC 2018)

4.4.1.2 Vulnerable Populations

The 2013 Coastal Georgia Hurricane Evacuation Study and 2010 Census Demographic Profile data provide a broad overview of demographics within the focus area. Compared to national averages, the population of Chatham County has fewer elderly residents (12.4 compared to 13.0 percent), a higher poverty level (16.6 compared to 15.3 percent), fewer mobile home residents (4.7 compared to 6.6 percent) and a similar number of households without vehicles (8.6 compared to 9.1 percent). Chatham County has a very high population density at 621.7 people per square mile, which is seven times the national average of 88.4 people per square mile. The racial profile of Chatham County is more diverse than both the nation and the state, with greater ethnic variety in the population.

Socioeconomic aspects of concern that may affect a community's ability to mitigate or evacuate from coastal storm hazards include mobile home residents, age, household income, vehicle availability, and crowded households. In Chatham County, 16.6 percent of the population lives below the poverty level. More than 20 percent of residents within the city of Savannah are below the poverty level, and approximately 13.7% of the city residents lack vehicle access (according to the 2016 Census American Community Survey estimates), which makes these population groups particularly vulnerable to coastal storm hazards. These residents may need transportation assistance from local or county government to evacuate from a coastal storm threat.

4.4.1.3 Environmental Justice

USACE conducted an evaluation of Environmental Justice (EJ) by determining whether the study area contains a concentration of minority and/or low-income populations.

As defined in Executive Order 12898 and the Council on Environmental Quality (CEQ) guidance, a minority population occurs where one or both of the following conditions are met within a given geographic area:

- The American Indian, Alaskan Native, Asian, Pacific Islander, Black, or Hispanic population of the affected area exceeds 50 percent; or
- The minority population percentage of the affected area is meaningfully greater than the minority population percentage in the general population or other appropriate unit of geographic analysis.

An affected geographic area is considered to consist of a low-income population where the percentage of low-income persons:

- is at least 50 percent of the total population; or
- is meaningfully greater than the low-income population percentage in the general population or other appropriate unit of geographic analysis.

The EPA EJSCREEN is an environmental justice mapping and screening tool that provides EPA with a nationally consistent dataset and approach for combining environmental and demographic indicators (EPA 2020). EJSCREEN users choose a geographic area; the tool then provides demographic and environmental information for that area. For the purposes of this evaluation, only demographic information was applied.

The low-income population is defined as the percent of a block group's population in households where the household income is less than or equal to twice the federal "poverty level."

The minority population is defined as the percent of individuals in a block group who list their racial status as a race other than white alone and/or list their ethnicity as Hispanic or Latino. That is, all people other than non-Hispanic white-alone individuals. The word "alone" in this case indicates that the person is of a single race, not multiracial.

Using the EJScreen tool, the study area was user-defined (**Figure 19**) to calculate the average percentages for EJ criteria. The result is a population-weighted average, which equals the block group indicator values averaged over all residents who are estimated to be inside the study area. **Table 8** compares the average percentages for the study area, the State of Georgia, and the United States.

Based on the information provided by the EJScreen tool, the average minority population is approximately 51-percent of the total population and approximately 35-percent of the population in the study area are considered low-income. When assessed at a county level geographic scale, Chatham County meets EJ community requirements because the minority population percentages are above 50-percent. It should be noted that 2019 Census Bureau estimates show greater than 50-percent of the City of Savannah population is Black or African American, while demographics for unincorporated Chatham County, Bloomingdale, Garden City, Pooler, Port Wentworth, Thunderbolt, and Tybee Island vary considerably.

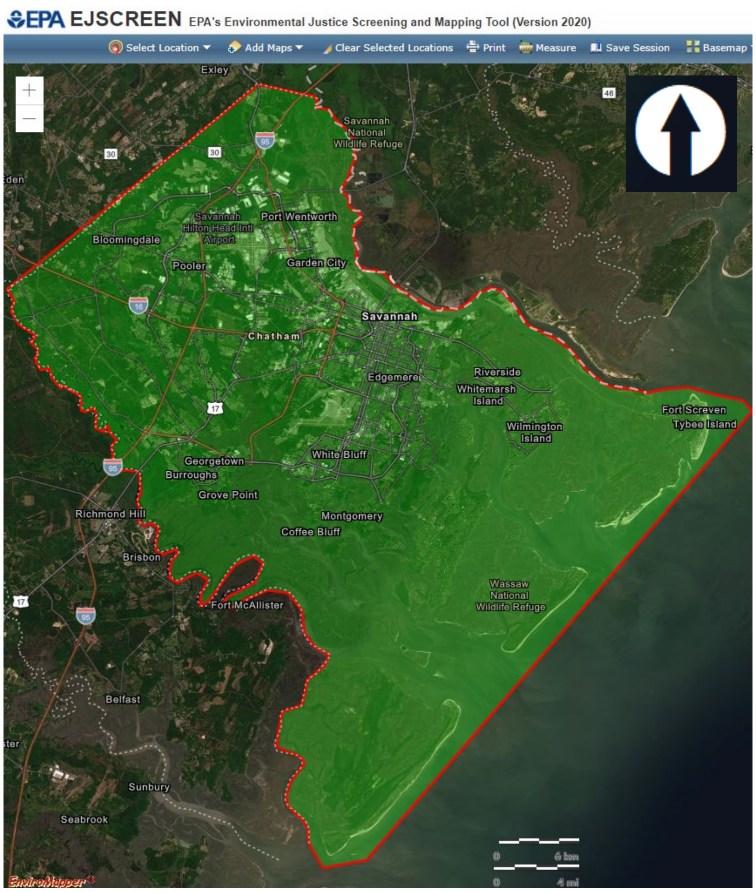

Figure 19: User Defined U.S. Environmental Protection Agency EJScreen Tool Analysis Boundary (EPA 2020)

Table 8: U.S. Environmental Protection Agency EJScreen Tool Environmental Justice Criteria Percentages (EPA 2020)

Population Type	User Defined Project Area %	Georgia Average %	U.S. Average %
Minority Population	51	47	39
Low Income Population	35	36	33

4.4.2 Stormwater Infrastructure Vulnerability

Chatham County recently completed the 2020 Chatham County Stormwater System Sea Level Rise Vulnerability Assessment. A system of tide gates and pump stations within Chatham County currently protect against extensive tidal backflow during high tide events into the stormwater system, and also facilitates drainage during large rainfall events that coincide with high tides. Many of these structures are presently vulnerable to tidal flooding that can impact functionality during storm events, which is projected to increase with sea level rise.

The vulnerability assessment results indicate that up to 3 percent of inland stormwater drainage structures in unincorporated Chatham County are currently vulnerable to daily tidal inundation, with 8 percent vulnerable at least once a year during the year's highest annual tide event. Based on sea level rise projections for 2100, these results increase to 19% of structures in unincorporated Chatham County being vulnerable to tidal flooding on a daily basis, with 30% being vulnerable at least once a year during the highest annual tide.

Results for the city of Savannah indicate that approximately 0.3 percent of stormwater inlets are presently vulnerable to daily tidal inundation, with 1 percent vulnerable at least once a year during the year's highest annual tide event. Based on sea level rise projections for 2100, these results increase to 9 percent of inlet structures being vulnerable to tidal flooding daily, and 15 percent being vulnerable at least once a year during the highest annual tide.

4.4.3 Environmental Resources Vulnerability

An Environmental Resources Vulnerability Analysis was conducted for Planning Reach GA_05 to determine the degree to which natural areas are susceptible to loss or degradation when exposed to coastal storm hazards and sea level rise. From this analysis, a vulnerability table was created that assessed the numerical level of vulnerability of NOAA's Coastal Change Analysis Program (C-CAP) named natural habitats against the hazards of sea level rise, storm surge inundation, saltwater intrusion, erosion, and wind damage. Based on the results of this assessment, a weighted formula was developed to assign a vulnerability rating of each C-CAP class (low, medium, or high) for each state and territory in the SACS study area (**Table 9**). **Figure 20** reflects the results of the vulnerability scoring for each C-CAP habitat that is found within the focus area.

Table 9: Coastal Change Analysis (C-CAP) Classes Vulnerability Rating

Coastal Change Analysis Program (C-Cap) Habitat	Vulnerability Rating
Estuarine scrub/shrub wetlands	Low
Open water (tidal/non-tidally influenced rivers, lakes & ponds).	Low
Mixed forest	Medium
Grassland/herbaceous	Medium
Scrub/shrub	Medium
Palustrine scrub-shrub wetlands	Medium
Palustrine emergent wetlands	Medium
Palustrine forested Wetlands	Medium
Estuarine emergent wetlands (salt marsh, oyster flats/beds)	Medium
Estuarine aquatic bed	Medium
Palustrine aquatic bed	Medium
Open space (rural open undeveloped uplands)	High
Evergreen forest	High
Deciduous forest	High
Unconsolidated shore (intertidal mudflats, non-vegetated mudflats, beaches/barrier islands)	High

In addition to rating the vulnerability of the natural habitats to the hazards identified above, the ability for the natural habitat to adapt to these conditions was also assessed. Low tolerances of certain habitats to water and soil chemistry changes due to saltwater inundation, intrusion, and impediments to migration were identified as important vulnerability considerations. Anthropogenic activities, such as increased residential and commercial development in the coastal plain, and the construction of structural coastal storm risk management infrastructure (e.g., sea walls), can produce barriers that impede inland migration of natural resources.

Please see Appendix B of the Environmental Technical Report (USACE 2022a) for a more detailed summary of the resource vulnerability table and scoring criteria.

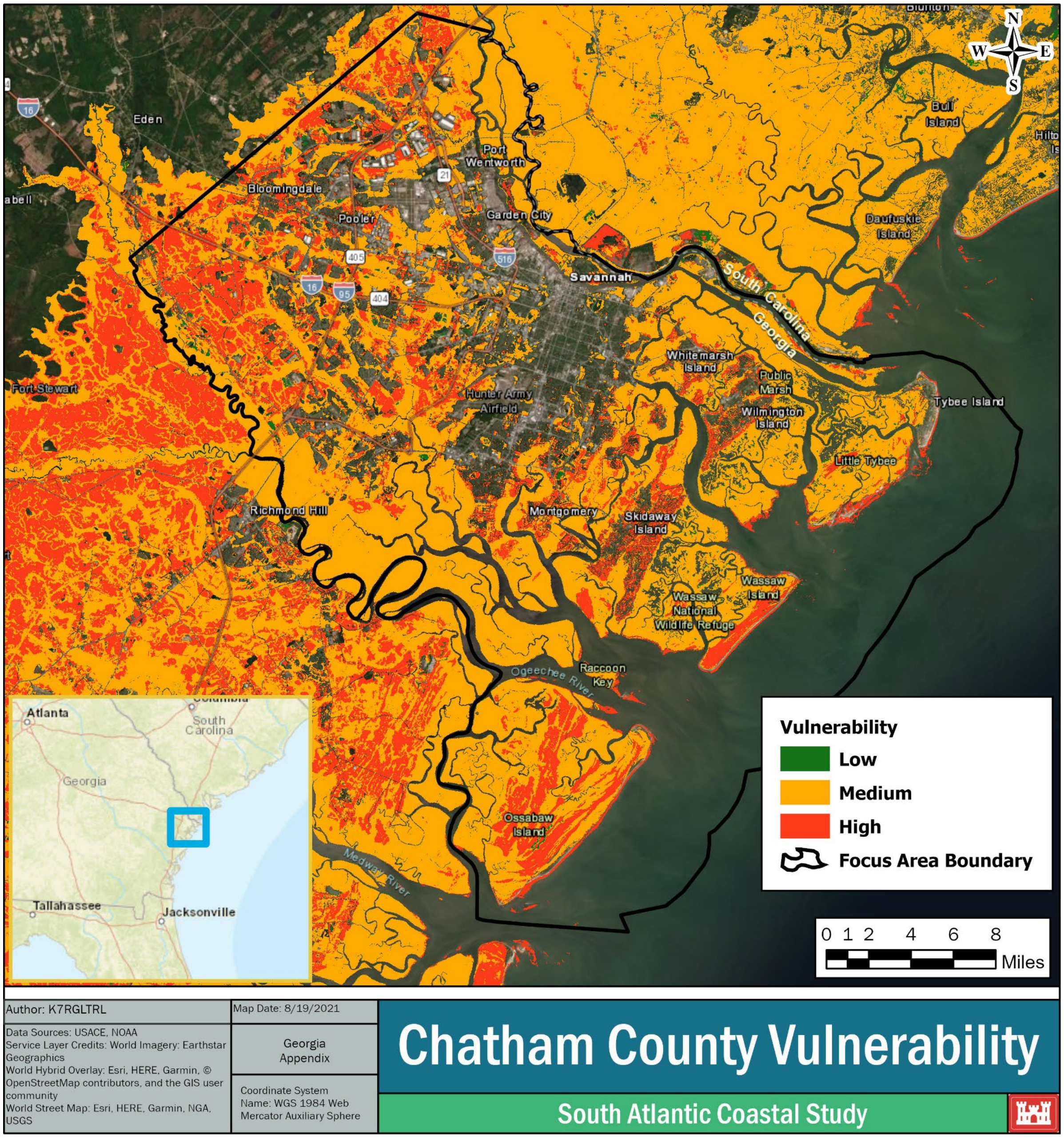

Figure 20: Chatham County Environmental Resources Vulnerability Rating for Coastal Change Analysis Program (C-CAP) Habitats

4.4.4 Cultural Resources Vulnerability

Based on a qualitative assessment of vulnerability, historic structures and archaeological sites located on barrier islands, along the coast, and in low lying areas face vulnerability due to storm surge inundation, erosion, and wave attack (**Table 10**). While other census areas in Chatham County contain cultural resources, the census areas of the Moor River District, Cockspur Island, Tybee Island, Ossabaw Island, Savannah, and Isle of Hope were selected for closer review due to the number of important resources (i.e., listed, or eligible to be listed in the National Register) and the greater exposure to hazards that may impact these resources. Storm surge inundation along the coast and reaching up rivers to low lying areas will flood historic properties and damage buildings. Damage may include, but is not limited to, structural damage and destruction of historic materials (e.g., furniture, textiles, archives). The aftermath of a storm can pose long-term issues, such as the development of mold, mildew, and other potentially toxic residues. Erosion and wave attack pose threats to historic properties and both terrestrial and submerged archaeological sites. Significant structural damage can be caused to historic properties by wave attack. Erosion can eliminate surface evidence of archaeological sites, wear away site layers, and displace materials from various cultural layers making recovery and interpretation challenging if not impossible. Erosion will impact features more severely due to the disturbed nature of the soil, while leaving intact topographic layers less damaged. Strong currents cause hydrographic change that can displace submerged cultural resources, including historic wrecks, as well as obscure or damage these resources due to storm debris. Currents and wind can uproot trees and other vegetation, which can serve as a major source of disturbance and destruction for both historic properties and archaeological sites.

Exposed cultural resources were qualitatively assessed for vulnerability based on degree of exposure to coastal hazards and sea level rise, structural considerations, and the nature of the cultural resource. **Table 10** presents exposed cultural resources and the potential vulnerability to the Tier 2 hazards. This table is not all-inclusive and is meant to communicate the types of cultural resources that may be found in these areas and the types of vulnerability that they may face. A selection of historic properties and districts are highlighted due to their National Register status and stakeholder input regarding their historical significance and concern for continued preservation due to their high exposure rating. General information is also included regarding the presence of archaeological sites in areas of high exposure.

Table 10: Vulnerability of Exposed Cultural Resources Areas to the Tier 2 Hazards for the Chatham County Focus Area

Exposed Cultural Resource Area		Tier 2 Hazards		
		Storm Surge Inundation	Erosion	Wave Attack
Moon River District	Pin Point Gullah Geechee Community	Y	Y	N
Cockspur Island	Ft. Pulaski National Monument	Y	Y	Y
Cockspur Island	Cockspur Island Lighthouse	Y	Y	Y
Cockspur Island	Historic and Prehistoric Archaeological Sites	Y	Y	Y
Tybee Island	Back River Historic District	Y	Y	Y
Tybee Island	Strand Cottages Historic District	Y	Y	Y
Tybee Island	Historic and Prehistoric Archaeological Sites	Y	Y	Y
Ossabaw Island	Historic and Prehistoric Archaeological Sites	Y	Y	Y
Savannah	Historic District (River Street)	Y	Y	Y
Isle of Hope	Wormsloe Plantation	N	Y	N
Isle of Hope	Historic District	Y	Y	N
Isle of Hope	Gullah-Geechee Sites	Y	Y	N
Isle of Hope	Historic and Prehistoric Archaeological Sites	Y	Y	N

Within the Chatham County Focus Area, there are several historic districts, historic forts, plantation sites, historic lighthouses, and archaeological sites along the coast and on barrier islands that are susceptible to damages from coastal storm hazards, including storm surge inundation, erosion, and wave attack. The most susceptible is Ft. Pulaski National Monument and all associated features on Cockspur Island, including the lighthouse. While some historic districts have protections, such as sea walls, in place to minimize vulnerability, many of the historic structures are vulnerable to storm surge inundation and the associated damage that it brings. Savannah, Tybee, and Isle of Hope are examples of historic districts that could be severely impacted by storm surge inundation, especially if protection measures fail or are not sufficient to protect against more extreme storm episodes. Historic and archaeological sites on barrier islands within the focus area, such as Ossabaw, Cockspur, Tybee Islands, are susceptible to damages primarily from erosion and wave attack. Previous studies by the GADNR Historic Preservation Division (HPD) and Skidaway Institute of Oceanography have documented archaeological sites that are in danger of, or are presently, being lost to erosion within Georgia's barrier islands (Skidaway Institute of Oceanography 2017). Vulnerable sites identified by the GADNR HPD included prehistoric Indian shell middens, prehistoric Indian artifact and shell scatter, and burial sites, among other archaeological sites subject to erosion.

4.5 Risk Assessment

Risk is broadly defined as a situation or event where something of value is at stake and its gain or loss is uncertain. Risk is typically expressed as a combination of the likelihood and consequence of an event. Consequences are measured in terms of harm to people, cost, time, environmental harm, property damage, and other metrics (USACE 2019).

Table 11 identifies the high-risk places in the Chatham County Focus Area based on the Tier 1 and Tier 2 Risk Assessments, which are detailed in the Georgia Appendix. The census place of Tybee Island was identified as high risk for all criteria. The rest of the locations were identified as high risk in one or more criteria, including the environmental, cultural resources and the erosional analysis.

Table 11: High-Risk Places in the Chatham County Focus Area

Census Place or Location	Tier 1 Risk Assessment Future High-Risk Location	Tier 2 Economic Risk Assessment Future High-Risk Location	At-risk Cultural Resource Area	Priority Environmental Area	Shoreline Retreat Areas (Erosional hotspots)
Dutch Island	X	X	X		
Garden City	X	X			
Georgetown	X	X			
Henderson		X			
Isle of Hope	X	X	X		
Little Tybee Island[1]				X	X
Montgomery	X	X	X		
Ossawbaw Island[1]			X	X	X
Pooler	X	X			
Port Wentworth	X	X	X		
Savannah	X	X	X	X	
Skidaway Island	X	X	X		

Census Place or Location	Tier 1 Risk Assessment Future High-Risk Location	Tier 2 Economic Risk Assessment Future High-Risk Location	At-risk Cultural Resource Area	Priority Environmental Area	Shoreline Retreat Areas (Erosional hotspots)
Talahi Island	X	X			
Thunderbolt	X	X	X		
Tybee Island	X	X	X	X	X
Vernonburg	X		X		
[1]Wassaw Island			X	X	X
Whitemarsh Island	X	X			
Wilmington Island	X	X			

[1]Unincorporated places (not associated with a census place) that met the criteria of high-risk

These high-risk locations were used as a starting point to develop action strategies to reduce existing and future risk from coastal storm hazards and their increase from sea level rise. This was further refined by a diverse group of stakeholders who identified specific areas within these census places with problems and needs. Action strategies were then developed for these areas.

4.5.1 Tier 1 Risk Assessment

The Tier 1 Risk Assessment used a composite index of national-level datasets to determine coastal storm and sea level rise risk on the southeast coast. The methodology of the Tier 1 Risk Assessment is described in the Main Report and in the Georgia Appendix. The Tier 1 Risk Assessment was used to identify 15 census places in Chatham County that showed the greatest existing and future composite risk (**Figure 21**). Among these census places, approximately 19,700 acres were classified as either medium-high risk or high risk under existing conditions. With the addition of a 3-foot sea level rise in the future condition, this number rose to 28,280 acres, an increase of 43 percent. The census places with the greatest percentage of land considered high risk under future conditions are Dutch Island (64 percent), Whitemarsh Island (54 percent), and Montgomery (51 percent). Of the high-risk locations identified within the Tier 1 Risk Assessment, Vernonburg was the only area not identified as high-risk within the existing conditions; however, approximately 24 percent of the land is considered high-risk within the future conditions. While not ocean-facing, these locations are low-lying, highly developed, and are intersected by extensive tidal riverine and saltmarsh habit. Increases in high-risk acreage are not exclusive to the inland sea islands, but also include the locations westward of Savannah, such as the city of Pooler.

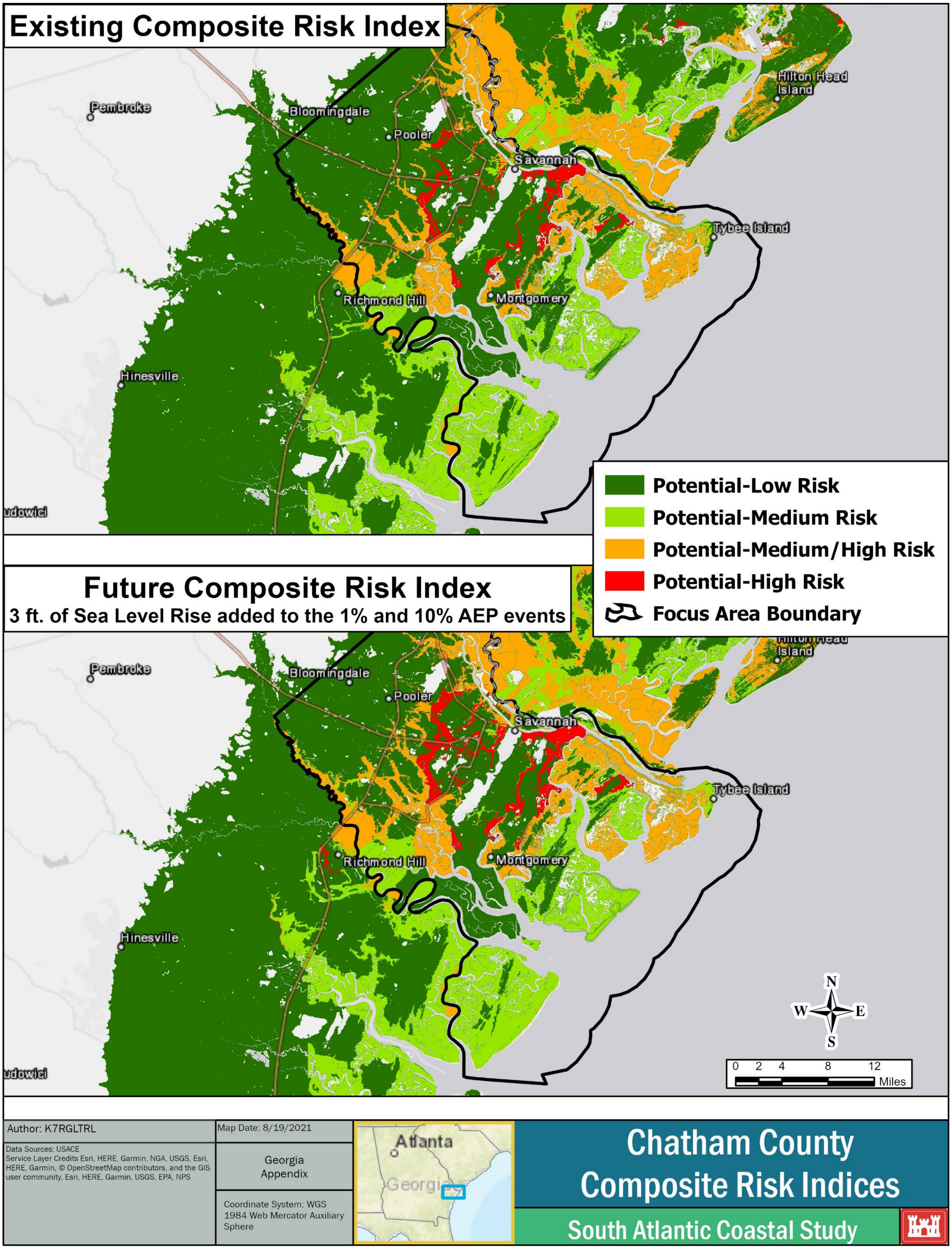

Figure 21: Existing and Future Condition Composite Risk in Chatham County

4.5.2 Tier 2 Economic Risk Assessment

As part of the Tier 2 Economic Risk Assessment, current and future expected annual damages (EAD) from coastal storm hazards were estimated using the FEMA Hazus Flood Model. The total EAD for the Chatham County Focus Area are approximately $73 million in the existing condition, and approximately $199 million in the future conditions with 3 feet of sea level rise. The Tier 2 Economic Risk Assessment indicates that more than half of the projected economic risks within Planning Reach GA_05 are located within the Chatham County Focus Area, encompassing 55 percent of the total EAD under the existing condition and 52 percent of the total EAD under the future condition. **Figure 22** provides a snapshot of the Tier 2 Economic Risk Assessment for the focus area. Each circle on the map denotes separate census places and displays the distribution of economic risk from low to high. Bar charts on the figure highlight the census places with the greatest economic risk, with quantifications of the existing (green shading) and future risks, including sea level rise (black shading). Economic risks displayed are not cumulative. The data depicts where EAD are occurring as result of the hazard of inundation, and where the EAD are expected to increase in the future condition if no action is taken. The data can help inform communities on which potential actions should be implemented to mitigate the potential economic risks. The highest EAD within Chatham County are predicted to occur in the inland sea island communities of Skidaway, Wilmington Island, and Whitemarsh Island, as well as the city of Savannah. Skidaway Island notably experiences the highest projected EAD under the existing and the future conditions within the focus area.

Figure 22 also contains the estimated damages from hazard events based on the event's AEP. For example, for the 1-percent AEP event (100 year event), estimated damages under existing conditions are $1.2 billion, and under future conditions, estimated damages are $3.2 billion. These damage estimates include damages to physical structures and infrastructure caused by coastal inundation. These estimates do not include damages from flooding from inland runoff or compound flooding. The estimates also do not consider economic losses resulting from temporary or permanent business closures. Following a natural hazard event or impacts to the local economy from lost or reduced tourism, estimated damages under both existing and future conditions would be significantly higher.

For Planning Reach GA_05, a high-risk area included any location with a future risk rating of medium to high. A risk rating of high was defined as any location with estimated EAD above $10,455,000, medium-high above approximately $5,072,000, and medium above approximately $1,157,000. The Tier 2 Economic Risk Assessment identified seven locations within Chatham County with a future risk rating of high—Skidaway Island, Wilmington Island, Savannah, Whitemarsh Island, Montgomery, Georgetown, and Tybee Island—two locations, Isle of Hope and Dutch Island, were identified with a future risk rating of medium-high—and six locations, Henderson, Pooler, Garden City, Port Wentworth, Talahi Island, and Thunderbolt with a future risk rating of medium.

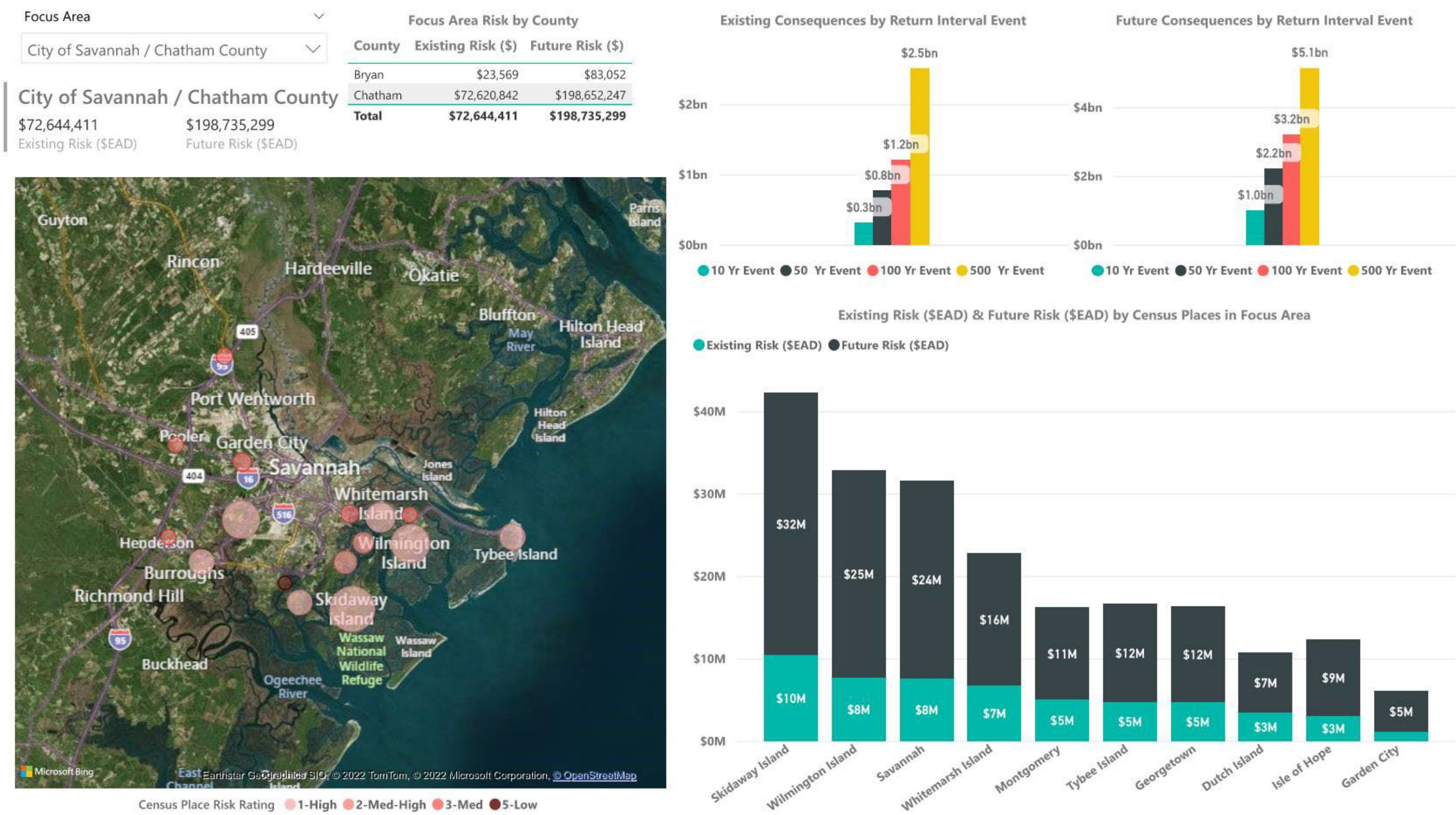

Figure 22: Tier 2 Economic Risk Assessment Dashboard

As part of the FAAS, the Tier 2 Economic Risk Assessment was further evaluated at the census block level to better understand the economic risk picture within the focus area (**Figure 23**). During the Focus Area Visioning Meetings, stakeholders provided feedback on locations with projected high economic risks in the existing and future conditions. Areas of specific concern were identified within many of the island communities including Isle of Hope, Whitemarsh, Wilmington Skidaway and Tybee, as well as the more inland areas of Henderson, Georgetown and Pooler due to their projected EAD under the future condition with 3 feet of sea level rise.

Data derived from the Tier 2 Economic Risk Assessment realizes the opportunity of gathering additional data on coastal hazards and vulnerability to refine current and future CSRM efforts. High risk locations identified above are directly correlated with problems within the focus area identified in Section 2.1. This information, in conjunction with the suite of SACS products and tools, was used to develop draft action strategies.

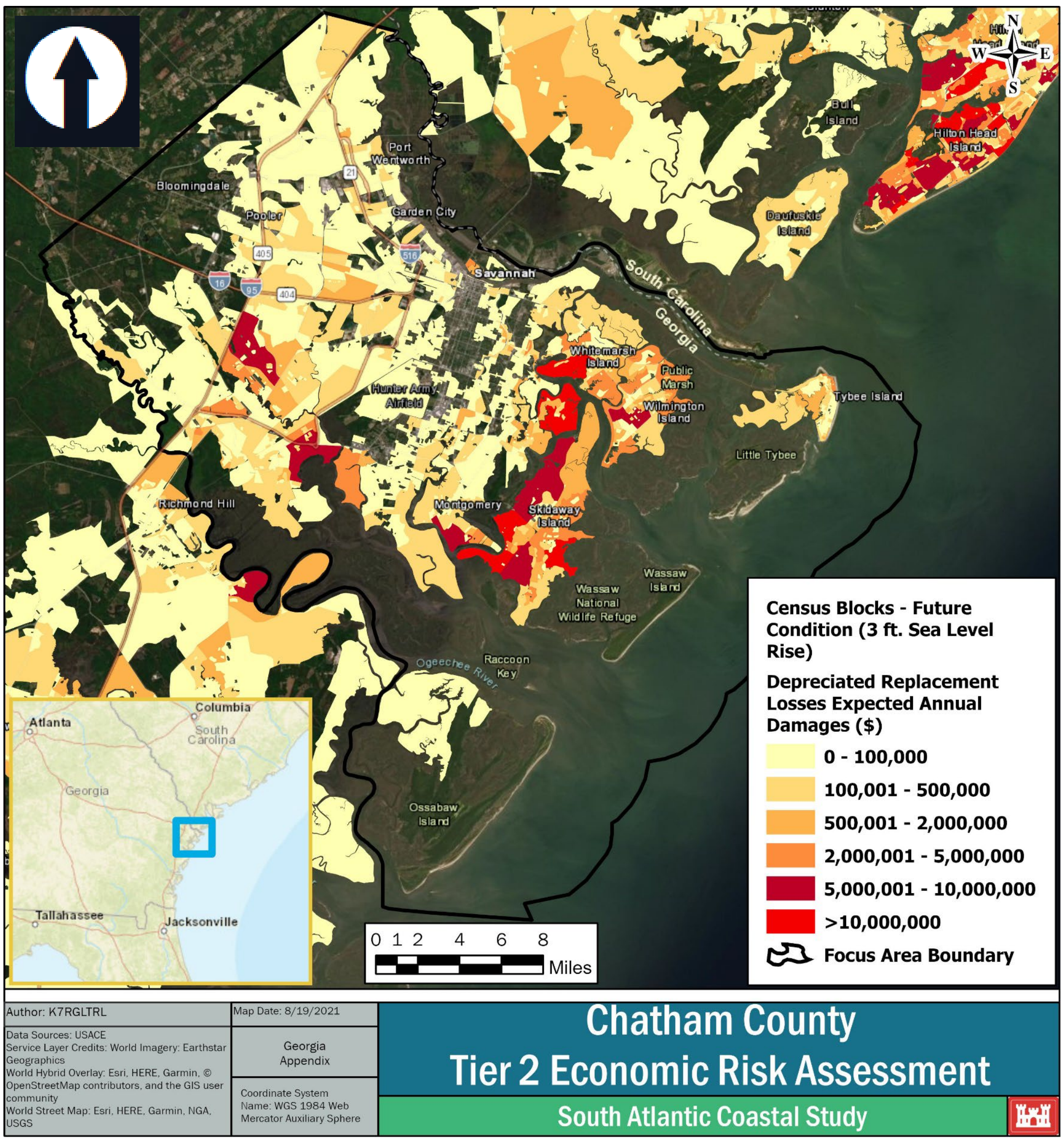

Figure 23: Tier 2 Economic Risk Assessment Future Risk Locations (Census Blocks) with 3-Foot Sea Level Rise in Chatham County

4.5.3 Priority Environmental Areas

A total of seven PEAs were identified for the Chatham County Focus Area. The PEA tables for each state and territory are located in the Environmental Technical Report (USACE 2022a). PEAs are natural areas or features at medium to high risk to storm surge inundation and sea level rise. PEAs support priority biological resources (defined in the U.S. Fish and Wildlife Service SACS Planning Aid Report as federally listed threatened and endangered species, waterbird nesting colonies, breeding and wintering shorebirds, or other managed species) and are considered high priorities for others including state and federal agencies and non-governmental organizations (for example, USFWS critical habitats or national wildlife refuges, Audubon Important Bird Areas, state heritage preserves and wildlife management areas, areas of national and state environmental significance, etc.). These areas can be considered by stakeholders when looking for environmental resources to conserve and/or manage. Designation as a PEA by USACE does not create a special legal protection or status of the area and does not change how the area is regulated under federal and state laws. The following PEAs were identified for the Chatham County Focus Area as having medium to high risk from the primary hazards.

Tybee Island – North Beach

Tybee Island is the northernmost Georgia barrier island and lies approximately 18 miles east of the city of Savannah. It contains approximately 3 miles of ocean-facing beach, 1.5 miles of north-facing beach, sand dunes, scrub shrub thicket, mixed forest, brackish and freshwater marshes, tidal flats, and tidal wetlands. North Beach contains habitat for a variety of different animals including reptiles, birds, and mammals. Notably, North Beach contains critical habitat for the threatened ESA-listed piping plover (*Charadrius melodus*). Multiple shorebird species also use this beach for foraging and nesting. The western section of the island contains saltmarsh habitat that is also important for many shorebirds and marine fish and invertebrates. This area is considered highly susceptible to coastal storm hazards and sea level rise.

Little Tybee Island

Located just south of Tybee Island, Little Tybee Island, once privately owned, was acquired by the State of Georgia with a conservation access allowed to the Nature Conservancy. The island has approximately 3.5 miles of beach with a total of 6,505 acres, only 600 of which are non-marsh or upland. Salt marshes and tidal creeks comprise almost 90 percent of the preserve and support a rich estuarine ecosystem unique for its pristine natural conditions. The island also contains beach/dune habitat and upland mixed forests. Scattered interior freshwater ponds provide habitat for migratory birds. The shoreline is fringed by extensive sand flats and mudflats that are exposed at low tide. Little Tybee contains important habitat for a variety of animals, including critical habitat for the ESA-threatened piping plover (*Charadrius melodus*) and the loggerhead sea turtle (*Caretta caretta*). It also provides important habitat for other ESA-threatened species, including eastern black rail (*Laterallus jamaicensis*) and wood stork (*Mycteria americana)*. Multiple shorebird and sea turtle species also use the island's beaches for nesting and foraging. This area is considered highly susceptible to coastal storm hazards and sea level rise.

Skidaway Island State Park

Skidaway Island State Park is located just southeast of Savannah and borders a portion of the AIWW, known as the Skidaway narrows. This park is approximately 600 acres of tidal/non-tidal saltmarsh, freshwater ponds, longleaf and loblolly pine forest, mixed forest, palustrine forested wetlands, scrub shrub, maritime hammocks, and estuarine scrub and marsh. An extensive riverine system surrounds a section of the park to the north. Managed by GADNR, the park provides important habitat for ESA species, including the threatened eastern black rail (*Laterallus jamaicensis*) and wood stork (*Mycteria americana)*. Other animals include the American alligator (*Alligator mississippiensis*), white-tailed deer (*Odocoileus virginianus*), raccoon (*Procyon lotor*), several shorebird species, and rare migrating birds such as the Painted Bunting (*Passerina ciris*). Additionally, the park provides habitat and management opportunities for waterfowl and other migratory birds. Increased salinity from inundation could increase the die-off of freshwater wetland systems. Topsoil erosion from storm damage in scrub areas would increase die-off and depletion of plant and animal species.

Ossabaw Island

Ossabaw Island is Georgia’s third largest barrier island with 26,000 acres. Ossabaw is bordered by the Ogeechee River to the north, Saint Catherine’s Sound to the south, the Atlantic Ocean to the east, and the Bear River/AIWW to the west. Nearly 9,000 acres of high ground is comprised of maritime forest, coastal hardwood, scrub shrub, longleaf pine savannahs, interior freshwater ponds, and palustrine forested wetlands. The remainder is comprised of tidal wetlands and wide beaches on the Atlantic Ocean side. Ossabaw not only provides critical habitat for threatened piping plover (*Charadrius melodus*) and the loggerhead sea turtle (*Caretta caretta*), but also provides important habitat for other ESA species, including the endangered red-cockaded woodpecker (*Leuconotopicus borealis*), the threatened eastern black rail (*Laterallus jamaicensis*), wood stork (*Mycteria americana)*, eastern indigo snake (*Drymarchon couperi*) and the threatened and endangered (T&E) candidate, the gopher tortoise (*Gopherus polyphemus*). Other animals include the American alligator (*Alligator mississippiensis*), white-tailed deer (*Odocoileus virginianus*) and raccoon (*Procyon lotor*). Additionally, the refuge provides habitat and management opportunities for several shorebird species, breeding and migrating waterfowl and other rare migratory birds such as the Painted Bunting (*Passerina ciris*). This area is considered highly susceptible to coastal storm hazards and sea level rise.

Wassaw Island National Wildlife Refuge

Wassaw Island, one of Georgia's barrier islands, was designated a National Wildlife Refuge on October 20, 1969. Wassaw is approximately 14 miles southeast of Savannah and at its closest point is 3.25 miles southeast of popular Skidaway Island, separated by marsh and tidal creeks. The refuge is bordered by the Wilmington River and Wassaw Sound to the north and the Vernon River and Ossabaw Sound to the south. With a total area of 10,053 acres, 24 percent of Wassaw is comprised of maritime forest, coastal hardwood, scrub shrub, slash pine/live oak stands, palustrine forested wetlands, sand dunes, and approximately 7 miles of undeveloped beaches. The remaining 76 percent is comprised of saltmarsh. Managed by the USFWS, Wassaw not only provides critical habitat for threatened piping plover (*Charadrius melodus*) and the loggerhead sea turtle (*Caretta caretta*), but also provides important habitat for other ESA species including the threatened eastern black rail (*Laterallus jamaicensis*), wood stork (*Mycteria americana)*, eastern indigo snake (*Drymarchon couperi*), frosted flatwood salamander (*Ambystoma cingulatum),* and the T&E candidate, the gopher tortoise (*Gopherus polyphemus*). Other animals include the American alligator (*Alligator mississippiensis*), white-tailed deer (*Odocoileus virginianus*), and raccoon (*Procyon lotor*). Additionally, the refuge provides habitat and management opportunities for several shorebird species, breeding and migrating waterfowl, and other rare migratory birds, such as the Painted Bunting (*Passerina ciris*). This area is considered highly susceptible to coastal storm hazards and sea level rise.

Blue Sky Preserve

The Blue Sky Preserve is located off of Ft. Argyle Road in the southwest section of Chatham County. Blue Sky is approximately 650 acres and is comprised of tidal rivers, freshwater tidal marsh, "Blackwater" rivers, bottomland hardwood forest, and forested depressional wetlands that cover approximately 550 acres of the total area. The major tree species in this area are blackgum, cypress, and tupelo. The remainder of the property is a mix of scrub shrub, natural pine, and natural pine/hardwood stands. Managed by Chatham County, the preserve provides important habitat for threatened species including wood stork (*Mycteria americana)*, eastern indigo snake (*Drymarchon couperi*), frosted flatwood salamander (*Ambystoma cingulatum)* and the T&E candidate, the gopher tortoise (*Gopherus polyphemus*). Other animals include the American alligator (*Alligator mississippiensis*), white-tailed deer (*Odocoileus virginianus*), and raccoon (*Procyon lotor*). Additionally, the preserve provides habitat and management opportunities for several wading bird species, breeding and migrating waterfowl, and other uncommon migratory birds such as the painted bunting (*Passerina ciris*) and prothonotary warbler (*Protonotaria citrea*). Increased salinity from inundation could increase the die-off of freshwater wetland systems. Topsoil erosion from storm damage in scrub areas would increase die-off and depletion of plant and animal species.

Savannah-Ogeechee Canal

The Savannah-Ogeechee Canal Museum and Nature Center is located off Ft. Argyle Road in the southwest section of Chatham County, very close to the previously discussed Blue Sky Reserve. The nature center park is approximately 200 acres and is comprised of tidal rivers, freshwater tidal marsh, "Blackwater" rivers, bottomland hardwood forest, coastal hardwood, and forested depressional wetlands. The major tree species in this area are blackgum (*Nyssa sylvatica*), cypress (*Taxodium distichum*), and other tupelo species. Managed In cooperation with Chatham County's Department of Parks, Recreation, and Cultural Affairs, the Savannah-Ogeechee Canal Society is working to turn the canal into a multipurpose linear park. The park provides important habitat for threatened species, including wood stork (*Mycteria americana)*, eastern indigo snake (*Drymarchon couperi*), frosted flatwood salamander (*Ambystoma cingulatum)* and the T&E candidate, the gopher tortoise (*Gopherus polyphemus*). Other animals include the American alligator (*Alligator mississippiensis*), white-tailed deer (*Odocoileus virginianus*), and raccoon (*Procyon lotor*). Additionally, the preserve provides habitat and management opportunities for several wading bird species, breeding and migrating waterfowl, and other uncommon migratory birds such as the painted bunting (*Passerina ciris*) and prothonotary warbler (*Protonotaria citrea*). Increased salinity from inundation could increase the die-off of freshwater wetland systems. Topsoil erosion from storm damage in scrub areas would increase die-off and depletion of plant and animal species.

4.5.4 At-Risk Cultural Resource Areas

Based on a qualitative assessment of risk, historic structures and archaeological sites on barrier islands and in low lying areas are highly susceptible to damage from storm surge inundation, erosion, and wave attack, especially as the risk from sea level rise increases. These areas are considered at-risk cultural resources areas due to the fact that all structures would be vulnerable to the hazards. The northern and southern tips of barrier islands tend to be hot spots for erosion, so any historic properties and/or archaeological sites in these areas would be at risk of damage and destruction from storm surge inundation, erosion, and wave attack.

While threats may be posed to cultural resources, such as historic resources and archaeological sites, due to development on barrier islands, storm protection measures that are put in place to protect those developed areas can aid in the protection of archaeological sites. For example, cultural resources on Tybee Island benefit from periodic beach renourishment and other projects aimed at protecting property and infrastructure from storm damage, which in turn also protects cultural resources from erosion and wave attack. Storm events pose a greater risk on lesser developed barrier islands, such as Ossabaw and Cockspur Islands, that have limited or no protective measures present. Undeveloped marsh regions between and behind islands where many resources are located are typically inundated by flood events that exceed the 10-percent AEP flood level.

Damage to historic properties can sometimes be repaired, but this can be costly and may lack support if more essential recovery efforts are needed in the area to restore infrastructure. Archaeological sites are non-renewable resources that cannot be replaced once lost. Loss of historic properties and archaeological sites not only means a loss to the historical record that helps us to understand the past; it can also mean a loss to local tourism. Visitors are drawn to this planning reach due to the many historical districts and historic forts. Damage caused by storms has in some instances meant the complete loss of all or portions of historic properties. Years of costly repairs can close these sites indefinitely until the site can be restored and are deemed safe for visitors. The loss of archaeological sites could pose a significant hit to the academic community and thereby limiting research into and interpretation of prehistoric and historic sites in this reach.

4.5.5 Shoreline Retreat Areas (Erosional Hotspots)

As discussed in Section 4.1.1.3, the USGS Coastal Change Hazards Portal was utilized to identify long term erosional hotspots along the Chatham County coastline. Specific hotspot locations, which were classified by above average erosional rates (greater than -6.6 feet (-2 meters) per year) were located in portions of Tybee Island, Little Tybee Island, Wassaw Island, and Ossabaw Island. Among the areas identified above, Tybee Island is the only barrier island with significant development and population centers, where increased erosion can directly impact infrastructure and threaten coastal communities. Section 4.2.2 outlines potential RSM strategies to address an erosional hotspot in the northern portion of Tybee Island. The undeveloped barrier island coastlines of Wassaw, Little Tybee and Ossabaw are unconstrained by development and CSRM measures and subject to natural accretional and erosional patterns.

5. Action Strategy Development

To address coastal storm risks, stakeholders participated in the Chatham County Focus Area Vision Meetings, a series of interactive webinars facilitated using SACS tools and products to identify completed, ongoing, and needed actions to address coastal storm risks within the focus area. The Vision Meetings in addition to one-on-one correspondence with key stakeholders led to a list of 41 potential actions related to coastal storm risk and sea level rise in the focus area. Actions were generally classified into the following coastal themes to better organize and prioritize actions:

- Shoreline stabilization/protection (Supports problem statement 1,2, and 3)
- Land use, zoning, and policy (Supports problem statement 4)
- Drainage improvements (Supports problem statement 1,2, and 3)
- Land conservation and preservation (Supports problem statement 3 and 4)
- Risk communication (Supports all problem statements)
- Critical infrastructure protection (Supports problem statement 2)
- Cultural resource protection (Supports problem statement 3)
- Environmental resource protection (Supports problem statement 3 and 4)

In the following sections, the process and outcomes of identifying and screening possible solutions to these actions are identified, evaluated, and compared. Specific examples are used to illustrate the use of the CSRM Framework and a complete table showing the FAAS is in Section 5.3.

5.1 Identify Possible Solutions

There are several SACS key products that can be used to help identify measures and possible solutions. The Measures and Cost Library (MCL) can be used to identify suitable measures based on wave energy. Planning level ROM cost estimates and the Tier 2 Economic Risk Assessment can be used to identify potential economic benefits. The 2020 RSM Optimization Update and SAND Report can be used to identify opportunities for RSM strategies and suitable sand sources. In general, measures are organized into structural, nonstructural, and natural and nature-based features (NNBF). A detailed list of CSRM measures, their function, and applicability by wave energy, can be found in Section 5.5 of the Georgia Appendix and the MCL report.

The broad measures identified herein (structural, nonstructural, and NNBF) could be further developed to target specific areas for CSRM. Example environmental and cultural resource protection measures are identified at the end of **Table 12**. The goal of alternatives development is to achieve the objectives by combining one or more measures while avoiding constraints. Measures identified will be further evaluated, screened, and used in combination (as appropriate) to determine area-specific project viability to meet the planning objectives.

Table 12: General Focus Area Themes and Potential CSRM Measures

Chatham County Focus Area Themes	Potential Measures		
	Structural	Nonstructural	Natural and Nature-Based Features
Shoreline stabilization/protection	• Build seawall/revetment • Build detached breakwaters • Build floodwalls and bulkheads • Perform beach nourishment	• Relocate utilities and critical infrastructure • Implement building codes and zoning • Elevate structures • Retreat the shoreline	• Build dunes • Create living shorelines (oyster sills, vegetation) • Restore wetland/marsh
Land use, zoning, and policy	• N/A	• Wetland buffers • Revise building codes • Perform an acquisition or buyout • Conduct coastal zone management	• N/A
Drainage improvements	• Improve stormwater system • Install portable floodwalls to flood/tide gates	• Floodproof structures • Increase storage • Preservation • Redesign services and utilities • Conduct surface water/stormwater management	• Perform green stormwater management
Land conservation and preservation	• N/A	• Preservation (Coastal wetlands, Upland buffers) • Perform a strategic acquisition • Engage and educate the public	• N/A
Risk communication	• N/A	• Implement early warning systems • Educate and engage the public • Prepare emergency plans/hazard mitigation plans • Resiliency studies	• N/A
Critical infrastructure protection	• See Coastal storm risk management measures	• See Coastal storm risk management measures	• See Coastal storm risk management measures
Cultural resource protection	• Build breakwater structures • Conduct RSM (erosional areas)	• Elevate or relocate structures • Conduct study/excavation of sites	• Create living shorelines
Environmental resource protection	• Perform beach nourishment (habitat protection and expansion)	• Conduct stormwater management • Preservation • Conduct local permitting	• Create living shorelines • Restoration – wetland/ marsh • Conduct RSM (thin-layer placement – marsh resilience)

Project-specific measures shown in Sections 5.2 and 5.3 have been provided through stakeholder input or were derived from previous studies and engagement. Some measures may be beyond the authority of USACE to implement. However, it was important to consider all viable measures regardless of current authority of the lead organization. For example, multiple stakeholders indicated that acquisition and raising (when possible) of repetitive loss properties (those with two or more claims of $1,000 or more paid by the National Flood Insurance Program within a 10-year period) as a successful method to reduce vulnerability to populations and residential structures. These efforts have been actualized through FEMA and the Georgia Emergency Management Agency, and local municipalities including City of Savannah and City of Tybee Island. In addition, local stakeholders in Chatham County are leading an ongoing study called the Smart Sea Level Sensors project which uses a network of approximately 46 sea level sensors to track tides and collect data. This type of robust data collection network is an invaluable tool for evaluating hazards associated with sea level rise that could be expanded throughout Planning Reach GA_05 to make informed local planning decisions. Potential measures that could be evaluated as part of future study phases are also included.

5.2 Evaluation and Comparison of Solutions

After identifying the problem and creating an inventory and forecast of current and future hazards, exposure, vulnerability, and risk, project-specific alternatives can be developed to reduce or mitigate risks based on shoreline types, exposure to resources at risk, and extent of residual risk in the future condition. When evaluating alternatives, it is important to determine whether the measure addresses the problem while meeting the objectives. A reconnaissance-level economic feasibility assessment can be conducted using the suite of SACS tools by providing stakeholders with risk management measures and costs to develop alternatives and strategies and comparing those costs to FEMA Hazus Flood Model-derived damages to evaluate measures. A FAAS-specific reconnaissance-level economic feasibility assessment is in Section 5.2.1.

5.2.1 Planning Level Cost Estimates

The FAAS planning level cost estimate demonstrates how vulnerabilities in other high-risk locations within the focus area can be assessed. Back bay flooding is a major problem identified by stakeholders and similar flooding issues are prevalent throughout many of the inland island communities of Chatham County, which is correlated with areas of high economic damages projected by the FEMA Hazus Flood Model (Skidaway Island, Wilmington Island, Whitemarsh Island, Montgomery, Dutch Island, and Isle of Hope).

The Tybee Island back bay location on the southwest side of the island abutting Tybee Creek and Horse Pen Creek is an area of interest that was identified from the Tier 2 Economic Risk Assessment and was emphasized during stakeholder engagement. The MCL was used to perform a reconnaissance-level economic feasibility analysis to evaluate the feasibility of flood and erosion reduction measures in an area prone to frequent storm surge inundation. Because of site-specific factors (e.g., hydrodynamics) and to better assess risk and appropriate CSRM measures (**Figure 24**), the area of interest was divided into two locations: Location 1 – between Alley Street and Venetian Drive, and Location 2 – Venetian Drive to 12th Street. With stakeholder-derived inputs, the MCL tool was used to evaluate the cost of potential measures, while the Tier 2 Economic Risk Assessment tool was used to evaluate potential economic benefits accrued by reducing physical and economic losses to structures and their contents within the area (**Figure 25**). Note, the Tier 2 Economic Risk Assessment tool is designed to aid stakeholders in screening for and identifying areas that warrant further investigation; the tool does not account for nonphysical damages. As described in MCL documentation, owing to the regional nature of the data being developed, it is unattainable to address the full scope and site-specific issues prevalent in all CSRM projects. Also unaddressed is the influence that combined measures may have on the effectiveness of the individual components. The MCL is intended as a starting point to identify applicable measures and their associated costs as part of developing conceptual alternatives. The alternatives identified using the MCL should be further explored in a detailed analysis. Expert opinions and detailed engineering investigations will be needed to determine the effectiveness of the MCL and assess if data modification is necessary to account for site-specific considerations.

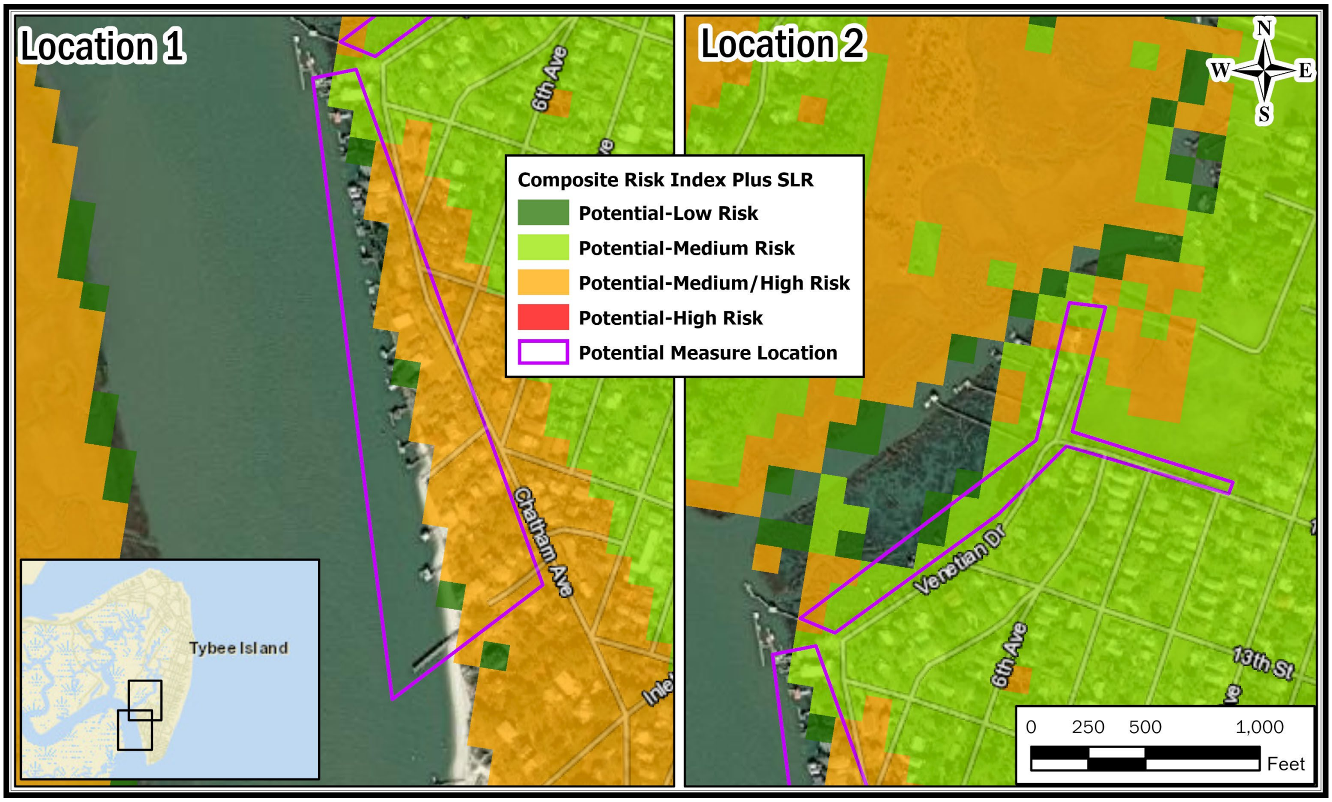

Figure 24: (Left) Tier 1 Composite Risk Index Showing Medium-High Risk for Tybee Island Back Bay Location 1; (Right) Tier 1 Composite Risk Index Showing Medium-High to Low Risk for Tybee Island Back Bay Location 2

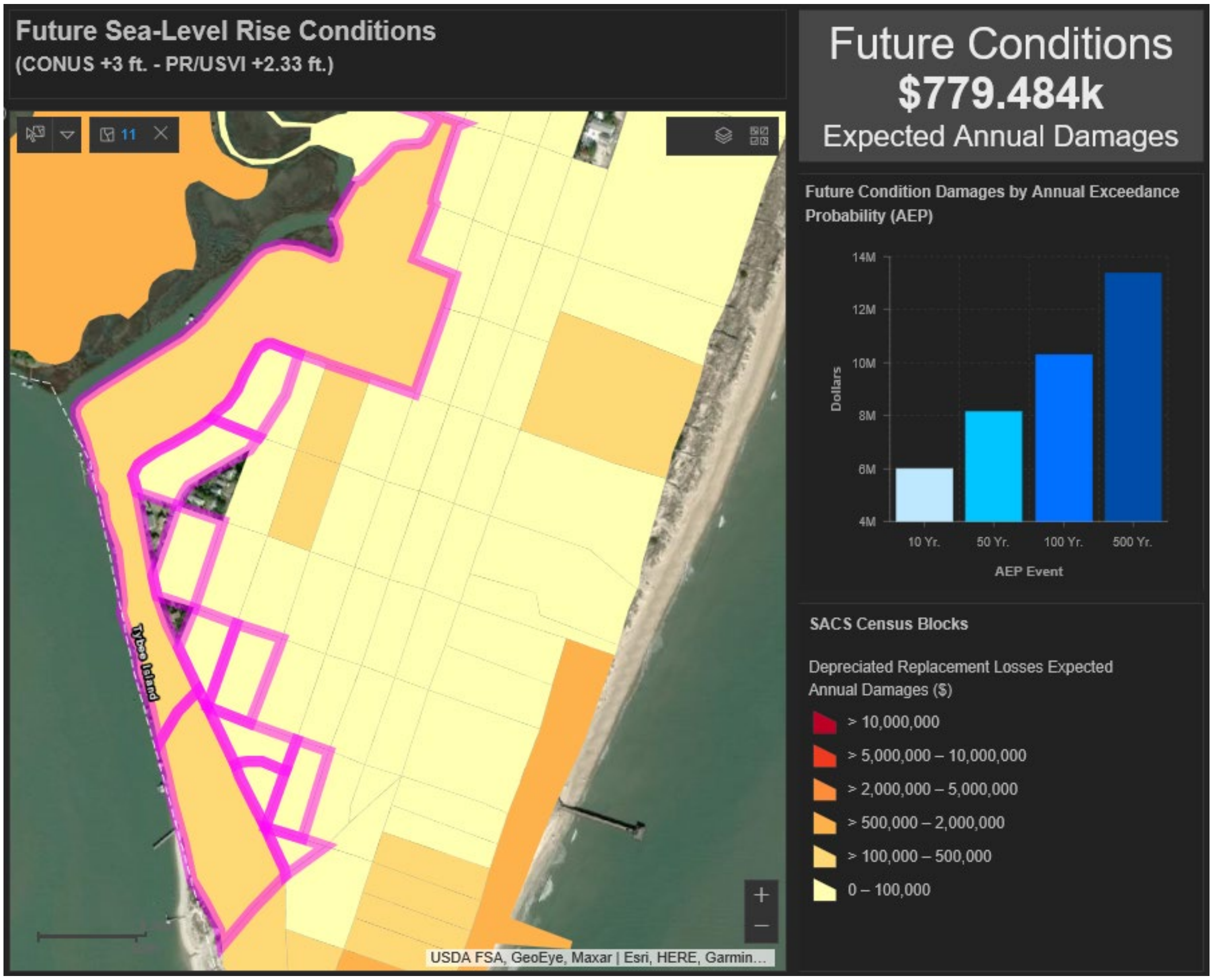

Figure 25: Tier 2 Economic Risk Assessment Showing Estimated Future Conditions of Approximately $780,000 in Expected Annual Damages

Potential structural, nonstructural, and NNBF measures were determined after identifying the problem and assessing potential risk using SACS tools and stakeholder input (**Table 13**). The MCL report includes an extensive and descriptive list of CSRM measures, including measure-performance designation based on a measure's ability to reduce inundation, wave attack, and erosion harm as a primary, secondary, or nonrelevant function of the measure. It is important to note that not all CSRM measures provide the same level of flood risk or erosion reduction benefits. In some circumstances, an NNBF measure may be unable to replicate the risk management provided by traditional structural and nonstructural measures; yet it may provide important environmental and social benefits, such as supporting species habitat, water quality, or public enjoyment. Potential wave energy of the area was considered when assessing the example draft measures identified for each location.

Table 13: Initial Measures for Tybee Back Bay - Measure Performance & Applicability

Location 1 (Alley Street to Venetian Drive)	Location 2 (Venetian Drive)
1. No Action (without project condition)	
2. Structural Solution (S)	
a. Seawall (S-2) Primary function: reduce wave attack. Secondary function: reduce inundation and erosion impacts. **b. Revetment** (S-3) Primary function: reduce wave attack. Secondary function: reduce erosion impacts and possibly reduce wave contribution to storm surge flooding if built to sufficient height.	**a. Road elevation** (S-12): Primary function: reduce inundation impacts. Can act as an impedance to floodwater movement in exposure area.
3. Natural and Nature-Based Features (NNBF)	
a. Living Shoreline – Sills (NNBF-12): Primary function: reduce wave attack. Secondary function: reduce erosion impacts through wave energy dissipation. Large storm surges may still lead to overtopping and some wave transmission.	**a. Living Shoreline – Vegetation** (NNBF-7) Primary function: reduce erosion and wave attack in areas with relatively low wave energy conditions. **b. Wetland Restoration** (NNBF-3) Primary function: reduce wave attack and erosion impacts. Dense vegetation and shallow waters within wetlands can dissipate wave energy, slow the advance of storm surge, and slightly reduce the surge landward of the wetland or slow its arrival time.
4. Nonstructural (NS)	
a. Buyout Acquisition (NS-1): Primary function: reduce inundation, wave attack, and erosion impacts to assets because it removes assets from exposure.	**a. Buyout Acquisition** (NS-1): Primary function: Reduce inundation, wave attack, and erosion impacts to assets because it removes assets from exposure.

The MCL tool provides an ROM cost estimate range for the selected measures, including high and low values, equivalent annual costs (EAC), and the total first construction cost (**Table 14**). Costs given in the MCL are based on a Class 5 estimate using broad-based assumptions, historical data, and incomplete technical details (AACE International 2020). Prices can vary from -20 percent to +50 percent. EAC is the annual cost range based over a 50-year analysis period. Preliminary analysis shows potential benefits of approximately $370,000 (from avoiding or minimizing the existing condition EAD) to approximately $780,000 (the future condition EAD in any given year if no CSRM measures were implemented). This preliminary analysis shows that multiple measures have the potential to be economically justifiable at the lower end of the cost range when assessing future condition EAD, and that more detailed analysis could be warranted in this area. It is recommended that follow-on analyses be completed to evaluate multiple measures more fully (including real estate, environmental, cultural resources, and maintenance costs and non-monetized benefits) and address coastal storm risk comprehensively. Alternatives could be developed using stand-alone CSRM measures or a combination of measures in tandem (e.g., buyout and acquisition) by implementing one or more structural and NNBF measures to reduce the flood and erosion risks at this location.

Table 14: Measures and Cost Library -Derived Costs for Tybee Back Bay

FAAS Area	Measure	Unit(s)		ROM Cost Range (EAC)	ROM Total First Construction Cost
Alley Street to Venetian Drive	Living Shoreline – Sills	Linear Feet	2,500	$172,000–$813,000	$4,640,000–$21,900,000
Alley Street to Venetian Drive	Seawall	Linear Feet	2,500	$874,000–$1,680,000	$23,600,000–$45,400,000
Alley Street to Venetian Drive	Revetment	Linear Feet	2,500	$724,000–$1,950,000	$19,500,000– $52,600,000
Alley Street to Venetian Drive	Buyout Acquisition	Number of Assets	35	$419,000–$946,000	$11,300,000–$25,500,000
Tybee Island, Venetian Drive	Living Shoreline – Vegetation	Linear Feet	2,250	$2,160–$187,000	$58,300–$5,050,000
Tybee Island, Venetian Drive	Wetland Restoration	Acres	4	$43,400–$240,000	$1,170,000–$6,480,000
Tybee Island, Venetian Drive	Elevate Road	Linear Feet	2,250	$616,000–$1,140,000	$16,600,000–$30,700,000
Tybee Island, Venetian Drive	Buyout Acquisition	Number of Assets	5	$59,800–$135,000	$1,620,000–$3,650,000

5.2.2 Impacts of Sea Level Rise

As discussed in Section 4.1.3, sea level rise will increase exposure to hazards for low-lying coastal areas, including this focus area. Sea level rise is fundamentally incorporated into the FAAS and was considered carefully by stakeholders when identifying specific problems and needs. Site-specific considerations for each project area beyond those already addressed in the SACS would likely be addressed during Tier 3 follow-on activities with stakeholders.

While historically, residents of Georgia's coastal communities have thought of coastal hazards in terms of single-event hurricanes or coastal storms, it is important to also consider the long-term, sustained effects of sea level rise on real property, natural habitats, and the ability to sustain growth in the regional economy. In the future, strategies will need to shift from addressing a single immediate concern to planning and executing comprehensive solutions that address multiple points of vulnerability. These strategies will rely on extensive coordination with local authorities and will require the integration of innovative solutions with existing and planned sea level rise mitigation efforts. Sea level rise scenarios are particularly important for design considerations for measures such as road elevation, seawall, living shorelines, and floodwalls. Some structural measures, like barriers and seawalls could potentially be adaptable to sea level rise by increasing structure elevations over time. This type of action requires sufficient available land to verify a stable design. NNBF and blended hybrid solutions that incorporate both NNBF and structural measures were identified as preferred future CSRM strategies by stakeholders to increase habitat along the shorelines while also ensuring proper shoreline stabilization. NNBF measures such as living shorelines and marsh enhancement may require adaptive material placement and elevation strategies to sustain targeted habitat types as sea level rises. For example, thin-layer placement can be utilized to maintain targeted coastal wetland elevations.

5.2.3 Potential Benefits and Impacts

The FAAS includes a focused array of potential actions, that were evaluated and refined based on location, potential lead stakeholders, potential solutions, a time frame for implementation, and potential funding sources. These elements are essential to make actionable recommendations and were coordinated closely with stakeholders. Potential benefits of the FAAS can be evaluated either individually as specific solutions to identified problems, or collectively as a system of solutions that align with and address the shared vision. This report does not prioritize individual actions that make up the FAAS, although these actions could be prioritized to maximize finite resources. Prioritization could be based on several factors, including benefit-cost, time frame of incurring negative effects, or by availability of authorities and funding. As shown with the Tybee Island back bay example from Section 5.2.1, there are SACS tools that can be used to help facilitate planning and prioritization. The FAAS provides a consistent platform to evaluate stakeholder-identified problems and needs in the focus area.

While proposed CSRM measures may reduce risks related to sea level rise and storm damages, they can cause adverse effects for cultural and environmental resources. For example, structural measures may prevent natural marsh migration, while nourishment material, if not carefully screened, can include larger quantities of fines that can cause the beach face to harden or darken, impacting sea turtle nesting habitat. Relocating or altering a historic structure is an example of a potential adverse effect because it impacts the integrity of the structure. Any implemented measures would need to comply with Section 106 of the National Historic Preservation Act, including soliciting feedback from the consulting parties associated with these important resources, to ensure the preservation and integrity of these resources.

5.3 Focus Area Action Strategy

Table 15 is the FAAS for the Chatham County Focus Area, which was developed in partnership with key stakeholders. The strategy combines ongoing, planned, and needed actions based on prioritization, timing, and sequencing to advance the shared vision and address risk from coastal storm events for the Chatham County focus area.

This report does not seek to create a strategy separate from the significant and ongoing efforts in the focus area, but to support those of the region and develop initial considerations for future federal and non-federal efforts. While many of the individual localities have unique and pressing issues associated with coastal storm risk and sea level rise that are described within **Table 15**, commonality throughout the focus area can be found among stakeholders to address problems and expand upon known working initiatives that are reducing risk in the focus area. Individual actions can be incorporated into more comprehensive plans that use the collective expertise of the diverse stakeholder groups.

A unique attribute of the Georgia coastline and of Chatham County is the expansive network of undeveloped coastal wetlands. Continued protection and enhancement of these natural features is a focus area-wide strategy that provides numerous benefits to the area, including attenuating wave energy, slowing inland water transfer, and increasing infiltration. Within the state of Georgia, Chatham County stakeholders are at the forefront of identifying ongoing changes and preparing coastal communities for future sea level rise and coastal flooding events. In 2016, Georgia's first sea level rise adaptation plan was published for the City of Tybee Island. In 2018, as part of the SMART Sea Level Sensors project, sea level sensors began to be deployed throughout flood vulnerable areas of Chatham County to provide real-time measurements of water levels to aid in emergency planning and response. This innovative and expansive network of sea level sensors continues to expand, with the addition of rain gauges and additional sensors in vulnerable communities. Continued implementation of these proactive studies and projects provides valuable information in quantifying the short- and long-term risks associated with sea level rise and preparing for a more resilient Chatham County and Georgia coast.

Coordination with stakeholders and USACE teams conducting multiple studies in the focus area indicated that USACE is in a unique position to provide information and assistance to advance innovative planning, design, and implementation of emerging coastal storm risk management measures to address problems and further opportunities described in this report. For example, implementation and expansion of RSM was identified as a strategy that could support many ongoing and future initiatives, including supporting marsh resilience by restoring or maintaining tidal marsh elevation relative to sea level rise.

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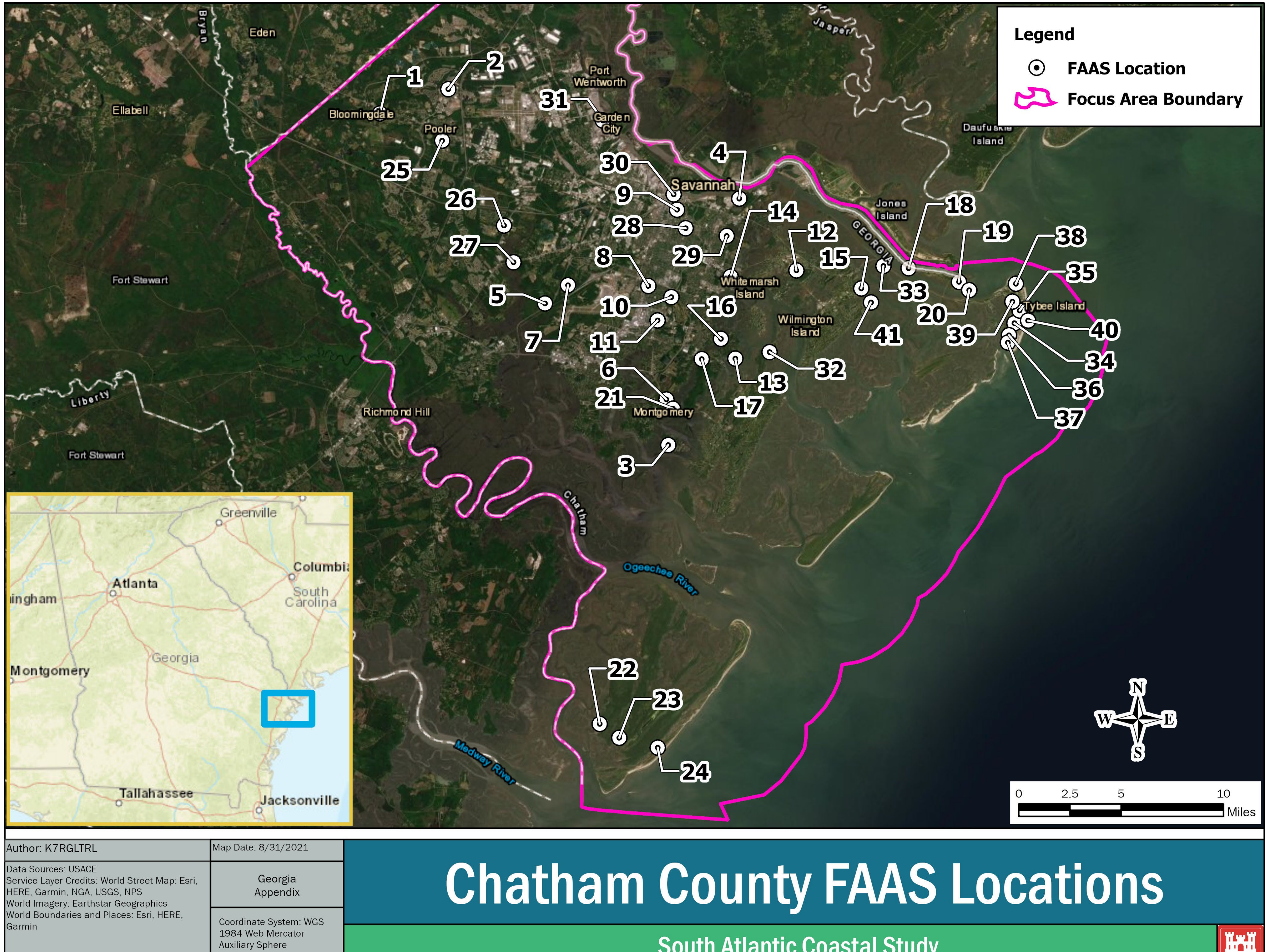

Figure 26: Chatham County Focus Area Action Strategy Locations Referenced in Following Table

Table 15: Chatham County Focus Area Action Strategy Table

Map Location	Theme	Description/Purpose	Location	Potential Lead Stakeholder(s)	Summary of Key Actions Needed to Implement	Status (ongoing, planned, needed)	Time Frame[1]	Potential Funding Source
1	Drainage improvements	Address nuisance flooding at low-lying homes in Bloomingdale.	Bloomingdale	Local County or City Governments, Federal Emergency Management Agency (FEMA)	Identify vulnerable and repetitive loss properties from past storms. Coordinate with FEMA and the Natural Resources Conservation Service (NRCS) to find funding sources to institute buyout or elevation in high-risk areas. Conduct measures to address drainage improvements for inland flooding.	Needed	Mid	Local, FEMA, NRCS
2	Drainage improvements	West Chatham Regional Watershed Study – As land development continues to push west, appropriate provisions need to ensure that stormwater runoff can be adequately managed and conveyed without increasing water levels damaging downstream properties.	Bloomingdale, Pooler, Garden City	Local County Government	Phase 1 of the study includes hydrologic and hydraulic analysis in the Little Ogeechee River and watershed to better understand existing drainage conveyance. Recommend conveyance improvements.	Planned	Short	Local
3	Critical infrastructure protection, Drainage improvements, Shoreline stabilization/protection	Address Burnside flooding issues associated with storm surge and nuisance flooding. Burnside causeway is impassable during major storm events due to inundation. Adjacent Burnside community also prone to storm surge impacts.	Burnside Island	Local County or City Governments, FEMA, USACE	Burnside causeway is the only roadway on and off Burnside Island, making it a critical evacuation route for residents. Measures may include road elevation and levees/dikes.	Needed	Short	FEMA, Georgia Department of Transportation (GDOT), County
4	Shoreline stabilization/protection	Develop a comprehensive shoreline management plan for residential/industrial areas to identify Coastal Storm Risk Management (CSRM) options and recommend hardening where needed, opportunities for Natural and Nature-based Features (NNBF) and/or retreat where appropriate.	Entire Focus Area (Shoreline and Riverine locations)	Local County or City Governments, Georgia Department of Natural Resources (GADNR) Coastal Resources Division (CRD), Academia	Identify key stakeholders to lead the studies. Find sources to fund the project.	Needed	Mid	Local, FEMA, National Oceanic and Atmospheric Administration (NOAA), Environmental Protection Agency (EPA), GADNR CRD
5	Drainage improvements	Study low-impact development/green infrastructure retrofits in heavily developed areas of Chatham County.	Entire Focus Area (Savannah, Garden City, Port Wentworth, Georgetown)	Local County or City Governments, Chatham County - Savannah Metropolitan Planning Commission	Identify areas for absorbing inundation and/or lessening input of stormwater in areas likely to be inundated using low-impact development/green infrastructure retrofits. Provide recommendations for conveyance of compound flood waters and stormwater with a focus on low-impact development/green infrastructure where applicable.	Needed	Long	Local, FEMA, GADNR
6	Critical infrastructure protection, Shoreline stabilization/protection, Drainage improvements	Elevate lift stations above the FEMA Base Flood Elevation (BFE), including electrical components. Multiple lift stations susceptible to tidal flooding are identified in the Chatham County Stormwater System Sea Level Rise Vulnerability Assessment: Coastal Watershed Management Plan.	Entire Focus Area	Local County or City Governments	Identify funding sources, including federal hazard mitigation grant programs such as Building Resilient Infrastructure and Communities, Flood Mitigation Assistance, and the Hazard Mitigation Grant Program. Determine appropriate base flood elevations and consider sea level rise projections in elevation.	Planned	Mid	Local, FEMA
7	Land conservation and preservation	Promote conservation organizations acquiring flood prone areas for community green space.	Entire Focus Area	Local County or City Governments, Metropolitan Planning Commission (MPC)	Identify funding sources for acquisition. Identify conservation organizations.	Needed	Long	Local
8	Land use, zoning, and policy	Update land use rules to limit development in low-lying areas.	Entire Focus Area	Local County or City Governments	Incorporate sea level rise planning into future construction and planning efforts. New development should maintain natural land buffers to allow marsh migration as sea levels rise. Land buffers with valuable environmental resources should be targeted for conservation/preservation. Stricter state/local regulation is needed on wetland development.	Needed	Long	Local

Map Location	Theme	Description/Purpose	Location	Potential Lead Stakeholder(s)	Summary of Key Actions Needed to Implement	Status (ongoing, planned, needed)	Time Frame[1]	Potential Funding Source
9	Land use, zoning, and policy	Update building codes to make codes stricter in high-risk areas.	Entire Focus Area	Local County or City Governments	Stricter codes can be adopted for high-risk areas along tidally influenced shorelines. New codes may include raising the base floor elevation or limiting development in flood-prone areas.	Needed	Long	Local
10	Risk communication	Provide bilingual outreach to the community about flood risks and hurricane evacuation.	Entire Focus Area	Local County or City Governments	Because of changing demographics within Chatham County, bilingual outreach is necessary to inform all residents of flood and hurricane risks.	Planned	Short	Local
11	Risk communication	Conduct a Georgia hurricane evacuation study to provide local government officials with information that could help them make hurricane evacuation decisions and provide emergency management officials with information for effective planning.	Entire Focus Area	USACE	The most recent Georgia hurricane evacuation study was completed in 2013. Efforts to complete the updated study are ongoing.	Ongoing	Short	USACE
12	Critical infrastructure protection, Drainage Improvements, Shoreline stabilization/protection	There are several areas where critical infrastructure (stormwater systems) is exposed to coastal storm hazards and vulnerable to sea level rise. The Chatham County Stormwater System Sea level rise Vulnerability Assessment: Coastal Watershed Management Plan was recently completed and identifies specific vulnerable infrastructure.	Entire Focus Area (Specific Assessment for Savannah, Unincorporated Chatham County)	Local County or City Governments, GADNR	Find sources to fund recommendations. Upgrade City of Savannah's Kayton pump station to maintain functionality. Conduct routine maintenance of existing tide gate systems within Savannah and Chatham County. Install additional tide gates in areas where tidal infiltration is already occurring. Develop and include sea level rise in future design and upgrades. Increase usage of green infrastructure to reduce impervious cover and stormwater storage capacity.	Ongoing	Short	Local
13, 14	Risk communication	The Smart Sea Level Sensors Project installed water level sensors throughout Chatham County to inform flood risk and vulnerability.	Entire Focus Area	Local County or City Governments	Chatham County installed approximately 50 water level sensors from Interstate 95 to Tybee Island. Data collection will be complemented by a suite of modeling tools to inform flood risk and vulnerability to assess short- and long-term coastal flooding risk and inform planning for flood mitigation strategies. Potential to expand program to include shoreline sensors.	Ongoing	Short	Local
15	Environmental resource protection, Shoreline stabilization/protection	Non-beach-quality material dredged from the Savannah Harbor can be beneficially used for marsh restoration to increase the adaptive capacity of the marsh to sea level rise.	Entire Focus Area (Back Bay Locations, Shoreline and Riverine Locations with Tidal Marsh)	Local County or City Governments, USACE, GADNR	Identify location requiring enhancement or restoration. Determine Regional Sediment Management (RSM) strategy best suited for the project, i.e., thin-layer placement. Coordinate with agencies to identify suitable material from federal navigation project operations and maintenance (O&M).	Needed	Long	Local, USACE
16, 17	Critical infrastructure protection, Shoreline stabilization/protection	Provide freeboards for low lying causeways in Savannah. Laroche Avenue and Skidaway Road are examples of causeways that require modifications due to high water surface elevations and clearance issues.	Isle of Hope	Local County or City Governments, FEMA, GDOT	Critical evacuation routes for Isle of Hope residents. Determine appropriate height to elevate structure above the base flood elevation.	Needed	Mid	Local
18	Cultural resource protection, Shoreline stabilization/protection	Protect upland cultural resources along the north channel of the Savannah River. Fort Pulaski is at risk due to erosion and inundation. USACE has previously placed beach-quality O&M material to protect the historic structure.	Long and Cockspur Islands	Fort Pulaski (FOPU), GADNR, USACE	First berm was built in 2015 from O&M sand from the navigation channel and is currently being monitored for effectiveness and longevity.	Ongoing	Short	National Park Service (NPS), USACE
19	Cultural resource protection, Shoreline stabilization/protection	Conduct Fort Pulaski drainage improvements to maintain existing historic ditching network and repair critical stormwater infrastructure. Preserving cultural resources while protecting them from storm risks and sea level rise is a unique challenge.	Long and Cockspur Islands	FOPU, USACE	Identify sediment quantities and disposal areas as part of Phase 1 of the ongoing Fort Pulaski drainage improvement project. Conduct a structural assessment of critical stormwater infrastructure.	Ongoing	Short	FOPU, NPS
20	Cultural resource protection, Shoreline stabilization/protection	Review structural integrity and plans for future resilience of the Cockspur Island lighthouse.	Long and Cockspur Islands	USACE, NPS	Identify a timeline for continued resilience work such as beneficial use material placement and structural assessments.	Planned	Mid	USACE

Map Location	Theme	Description/Purpose	Location	Potential Lead Stakeholder(s)	Summary of Key Actions Needed to Implement	Status (ongoing, planned, needed)	Time Frame[1]	Potential Funding Source
21	Cultural resource protection, Shoreline stabilization/protection	Protect Pin Point Heritage Museum and adjacent properties in historic Gullah/Geechee neighborhood from reoccurring flooding issues from storm surge, which will increase with sea level rise.	Pin Point	Local County or City Governments, FEMA	Elevate repetitive loss properties when applicable. Elevation is an option to maintain historic value of asset while reducing damages from coastal hazards. Identify potential CSRM measures to address inundation and erosion hazards	Needed	Short	Local, USACE
22, 23	Environmental resource protection, Cultural resource protection, Shoreline stabilization/protection	Repair and elevate critical causeway necessary for management of Ossabaw Island.	Ossabaw Island	GADNR	Find sources to fund the repair and elevation of impaired causeway. Determine appropriate height to elevate structure. Potential beneficial use of O&M material.	Needed	Short	State of Georgia, Ossabaw Island Foundation
24	Cultural resource protection, Shoreline stabilization/protection	Aid in the preservation of threatened archaeological sites at risk of irrevocable loss due to the hazard of erosion on Ossabaw Island.	Ossabaw Island	GADNR, Academia, USACE	Find sources to fund the project. Determine appropriate measures to preserve archaeological sites, i.e., bank stabilization or excavation of cultural resources. Potential beneficial use of O&M material.	Needed	Mid	State of Georgia, Ossabaw Island Foundation
25	Drainage improvements	Address nuisance flooding issues at low-lying homes in Pooler.	Pooler	Local County or City Governments, FEMA	Identify vulnerable and repetitive loss properties from past storms. Coordinate with FEMA to find funding sources to institutes buyout or elevation in high-risk areas. Determine measures to address drainage improvements for inland flooding.	Needed	Mid	Local, FEMA
26	Critical infrastructure protection, Drainage improvements	Address repetitive flooding issues due to storm surge at important emergency operations center.	Savannah	Local County or City Governments, FEMA, USACE	Determine measure to address the hazards or storm surge to preserve critical infrastructure. Measures may include building elevation, dry and wet flood proofing. Conduct a study to identify flooding pathways.	Needed	Short	Local, FEMA
27	Critical infrastructure protection, Shoreline stabilization/protection, Drainage improvements	Address flooding issues at U.S. Highway 17 (Ogeechee Road) bridge, which is vulnerable to storm surge and nuisance flooding. During normal high tide scenario, water reaches within 18 inches of overtopping the roadway.	Savannah	Local County or City Governments, USACE	Determine measures to address inundation hazard to preserve critical infrastructure. Measures may include structure elevation	Needed	Mid	Local, FEMA, GDOT
28	Drainage improvements	Address flooding issues at apartment block with socially vulnerable population where property owner is resistant to buyout and acquisition.	Savannah	Local County or City Governments, FEMA, U.S. Department of Housing and Urban Development (HUD)	Identify potential drainage improvements to address localized flooding. Find sources to fund the project.	Needed	Short	Local, HUD
29	Land use, zoning, and policy, Shoreline stabilization/protection	Address storm surge risks to marsh and riverine adjacent homes near the Vernon River (e.g., Montgomery, Vernonburg, Coffee Bluff neighborhoods)	Savannah	Local County or City Governments, FEMA	Identify vulnerable and repetitive loss properties from past storms. Coordinate with FEMA for funding sources to institute buyout or elevation in high-risk areas. Multiple CSRM measures may be applicable (e.g., bulkhead, berm, or living shoreline) to protect homes from inundation.	Needed	Mid	Local, FEMA
30	Cultural resource protection, Drainage Improvements, Shoreline stabilization/protection	Inhibit flooding along historic River Street. Historic, commercial, and residential structures along the Savannah River on River Street are at risk to storm surge inundation. During Hurricane Matthew and Irma, extensive flooding impacted this area.	Savannah	Local County or City Governments, USACE, FEMA	Conduct a study to address Savannah Historic District (River Street) flooding issues. Identify possible measures to mitigate inundation hazards such as increasing the height of existing seawall, rapid deployable floodwalls, or implementing hybrid structures combining structural and natural solutions.	Needed	Mid	Local
31	Critical infrastructure protection, Drainage Improvements, Shoreline stabilization/protection	Preserve Port Authority operations that are vulnerable to storm surge and sea level rise.	Savannah	Georgia Ports Authority (GPA)	Conduct a study to identify flooding pathways and assess sea level rise effects on existing port infrastructure. Identify measures to preserve port authority operations. Measures may include elevating existing bulkhead or constructing bulkhead in areas lacking adequate flood reduction measures.	Needed	Long	GPA

Map Location	Theme	Description/Purpose	Location	Potential Lead Stakeholder(s)	Summary of Key Actions Needed to Implement	Status (ongoing, planned, needed)	Time Frame[1]	Potential Funding Source
32	Drainage improvements, Shoreline stabilization/protection	Inhibit storm surge inundation at Skidaway Institute of Oceanography.	Skidaway Island	Local County or City Governments, FEMA, USACE	Find sources to fund the project. Increase height of bulkhead to 3 feet or more above mean higher high water to protect campus from storm surge.	Needed	Mid	UGA
33	Shoreline stabilization/protection	Identify RSM opportunities to provide CSRM benefits to McQueen's Island Trail. McQueen's Island Trail is actively eroding in areas lacking expansive marsh buffer or structural CSRM measures which impedes recreational access.	Tybee Island	Chatham County, USACE	Place beach quality material from federal navigation projects on McQueen's Island Trail for shoreline protection.	Needed	Short	Local/USACE, GDOT
33	Critical infrastructure protection, Shoreline stabilization/protection	Provide long-term solution for U.S. Highway 80 flooding issues (erosion, storm surge and nuisance flooding). U.S. Highway 80 has repetitive inundation issues at low lying locations and is generally impassable during major storm events.	Tybee Island	GDOT, Chatham County	U.S. Highway 80 is the only roadway on and off Tybee Island, making it a critical evacuation route. Measures may include broader road elevation and levees/dikes. Recent county led efforts include elevating select low-lying locations of U.S. Highway 80.	Needed	Mid	Local, GDOT
34	Land use, zoning, and policy	Increase eligibility for home raising for properties located within the high-risk locations (not only repetitive loss properties).	Tybee Island	Local County or City Governments, FEMA	Identify vulnerable properties built in high-risk locations such as FEMA special hazard zones. Coordinate with FEMA to find funding sources to institute buyout and home raising in these locations.	Needed	Mid	Local, FEMA, GADNR.
35	Land use, zoning, and policy	Continue efforts to elevate repetitive loss properties in Tybee Island.	Tybee Island	Local County or City Governments, FEMA	Identify vulnerable and repetitive loss properties from past storms. Coordinate with FEMA to find funding sources to institute buyout and elevation for repetitive loss properties in high-risk areas.	Ongoing	Short	Local/FEMA,
36	Shoreline stabilization/protection, Drainage improvements	Ongoing study focused on back bay flooding at Tybee Island.	Tybee Island	Local Government, Academia	Ongoing NFWF study launched initial measures for the assessment and identification of integrated design strategies to increase resilience to storm and flood events.	Ongoing	Short	Local, NFWF
37	Shoreline stabilization/protection	Identify RSM opportunities to provide CSRM benefits to back bay shorelines on Tybee Island	Tybee Island	Local County or City Governments, USACE, GADNR, Academia	Study using beach and near shore quality material from federal navigation projects on back bay shorelines for shore protection.	Needed	Short	Local, USACE
38	Shoreline stabilization/protection	Protect North Beach from further erosion through RSM (placing dredged material on beach) to build dunes and nourish beach.	Tybee Island	Local Government, USACE, GPA	Place beach quality material from federal navigation projects on North Beach for shore protection. Continue coordination with non-federal partner.	Ongoing	Mid	Local, USACE
39	Land use, zoning, and policy, Land conservation and preservation	Preserve and restore coastal wetlands in tandem with buyouts and acquisition of high-risk repetitive loss properties to address back-bay flooding issues.	Tybee Island	Local Government, USACE, GPA	Conserving existing NNBF (such as coastal wetlands) is the most sustainable solution with the lowest level of effort. Thin-layer placement in future could elevate marsh and maintain storm reduction benefits. Identify vulnerable and repetitive loss properties from past storms. Coordinate with FEMA for funding sources to institute buyout or elevation in high-risk areas.	Needed	Mid	Local, USACE
40	Shoreline stabilization/protection	Conduct a Comprehensive Tybee Island Shoreline Protection Study – A new study can evaluate alternatives to protect Tybee Island and expand the footprint of the current federal project to include new areas at risk of coastal storm and sea level rise damages including the North Beach, back bay areas, and U.S. Highway 80.	Tybee Island	Local Government, USACE, GPA, Academia, National Fish and Wildlife Foundation (NFWF)	Identify potential alternative measures to mitigate inundation and erosion hazards in Tybee Island. Align with and leverage National Coastal Resilience Fund (NCRF) grant supported study which examines back bay vulnerability to develop strategies.	Ongoing	Short	Local, NFWF, USACE, NCRF

Map Location	Theme	Description/Purpose	Location	Potential Lead Stakeholder(s)	Summary of Key Actions Needed to Implement	Status (ongoing, planned, needed)	Time Frame[1]	Potential Funding Source
41	Land use, zoning, and policy, Shoreline stabilization/protection	Protect low-lying, riverine-adjacent homes from storm surge on the inland sea islands	Wilmington Island, Whitemarsh Island	Local County or City Governments, GADNR	Identify vulnerable and repetitive loss properties from past storms. Coordinate with FEMA for funding sources to institute buyout or elevation in high-risk areas Multiple CSRM measures may be applicable (e.g., bulkhead, berm, or living shoreline) to protect homes from inundation. Similar back bay flooding issues were identified throughout the inland sea island communities of Chatham County.	Needed	Mid	Local, FEMA

[1]Time frame: short = <2 years; mid = 2–10 years; long = > 10 years

6. Recommendations

The focus area action strategy was developed to advance the shared vision and manage increased coastal storm risk as a result of sea level rise in the Chatham County Focus Area as shown in **Figure 27**. The shared vision is the overarching goal of the FAAS, broadly representing problems and opportunities stakeholders wish to address in the focus area. Resultingly, FAAS goals and objectives support the shared vision. SACS key products and other stakeholders' shared tools and data were used to support FAAS goals and objectives by assessing risk and identifying ongoing, planned, and needed actions to communicate and address the risk.

Figure 27: Focus Area Action Strategy Supports the Focus Area's Shared Vision

Recommendations are made for either multi-agency action, USACE action, or consideration by the United States Congress (Congress) to advance specific actions resulting from analyses presented in this report and coordination with stakeholders throughout the focus area. Recommendations are organized into six categories, as shown in **Figure 28**, and three implementation timeframes (near-, mid-, and long-term). Importantly, follow-on study efforts should incorporate an integrated approach to the maximum extent practicable, including consideration of structural, nonstructural, and NNBF measures, as well as the shared responsibility of all stakeholders to contribute to coastal storm risk management. Implementation timing is influenced by the degree of stakeholder collaboration needed, technical complexity of the recommendation, current momentum toward implementation, and other factors needed to implement the recommendation. Implementation timeframes include:

Figure 28: Recommendation Categories

- **Near-Term Implementation (<5 years):** These recommendations are generally less complex and have significant stakeholder momentum toward implementation. The recommendations generally maintain and adapt actions that are recognized to successfully manage coastal storm risk.
- **Mid-Term Implementation (5-10 years):** These recommendations may be more technically complex and/or require additional stakeholder coordination and collaboration for implementation. They advance emerging efforts to address coastal storm risk.
- **Long-Term Implementation (>10 years):** These recommendations typically require significant stakeholder coordination before implementation and may be the most challenging to implement on regional scales from technical, political, or social perspectives. Importantly, coordination and collaboration on these recommendations should not be delayed. The long-term timeframe is reflective of the time to implementation based on immediate action to advance these recommendations which include complex issues such as land-use, zoning, and building codes. Given the uncertainty surrounding impacts from sea level rise and other factors (e.g., development trends), long-term recommendations may require reconsideration prior to implementation.

Table 16 provides the recommendations for the Chatham County focus area.

Table 16: Recommendations for the Chatham County Focus Area

Authority Category	Implementation Timing	Recommendation For	Recommendation	Description	Next Step to Implementation
Activities and Areas Warranting Further Analysis	Mid-Term (5-10 years)	Multi-Agency Action	Expand the Smart Sea level Sensors project	The Smart Sea Level Sensors project is an ongoing partnership between Chatham Emergency Management Agency, City of Savannah, and Georgia Tech. Chatham County uses approximately 46 sea level sensors to track tides and collect data for future city planning. The sea level sensor network should be expanded to refine projected short- and long-term risks associated with sea level rise throughout the focus area and provide real-time data on coastal flooding to assist with emergency planning and response. Non-federal stakeholders are encouraged to use the SACS Coastal Program Guide (CPG) to locate additional opportunities to fund this effort. *Expansion of, or similar efforts to the Sea Level Sensors Project are applicable and recommended throughout all coastal counties within the planning reach.	Funding
Activities and Areas Warranting Further Analysis	Mid-Term (5-10 years)	Multi-Agency Action	Sustain and increase efforts to buyout/acquire and raise repetitive loss properties	As part of the Chatham County Focus Area Visioning Meetings, the continued acquisition and raising (when possible) of repetitive loss properties was identified as a successful method to reduce vulnerability to populations and residential structures. A repetitive flood loss property is one for which two or more claims of $1,000 or more have been paid by the National Flood Insurance Program (NFIP) within any 10-year period since 1978. Expanded eligibility of properties located within known flood hazards (not just with repetitive loss properties) is recommended. Non-federal participants are encouraged to use the SACS CPG to locate additional opportunities to fund these efforts. *This recommendation is applicable throughout all coastal counties within the planning reach.	Funding

Authority Category	Implementation Timing	Recommendation For	Recommendation	Description	Next Step to Implementation
Address Barriers Preventing Comprehensive Risk Management	Mid-Term (5-10 years)	Multi-Agency Action	Coastal Storm Risk Management (CSRM) solutions should be evaluated for storm risk management benefits to cultural resources and socially vulnerable communities in accordance with Section 116 of the Water Resource Development Act (WRDA).	Pin Point Heritage Museum and adjacent properties in historical Gullah/Geechee neighborhood experiencing reoccurring flooding issues from storm surges, which will increase with sea level rise. According to January 2021 guidance requiring USACE to estimate benefits more equitably for Regional Economic Development (RED) and Other Social Effects (OSE), a study should be initiated to investigate CSRM solutions to protect this socially vulnerable and historical community.	Identify Non-Federal Sponsor (USACE Study)
Recommendations on Previously Authorized USACE Construction Projects	Near-Term (<5 years)	Congress	Renew federal participation in Tybee Island CSRM	The current authorization for federal participation in the Tybee Island Georgia Shore Protection Project is anticipated to end in 2024. Alternatives for continued protection of Tybee Island should be evaluated, including the potential to expand the current project footprint to include new areas at risk from coastal storms and sea level rise such as the North Beach, back bay areas, and U.S. Highway 80. This study would complement on-going actions including a National Fish and Wildlife Foundation (NFWF)-sponsored grant to address the complicated flooding issues along the back bay portion of Tybee Island. To implement this recommendation, a non-federal sponsor (such as the City of Tybee Island) would need to request participation from USACE. Multi-stakeholder coordination and leveraging of applicable existing data would be required. Continued collaboration to discuss these opportunities is recommended.	Stakeholder Collaboration

Authority Category	Implementation Timing	Recommendation For	Recommendation	Description	Next Step to Implementation
Regional Sediment Management Practices	Near-Term (<5 years)	USACE	Beneficially use dredged maintenance material from the Savannah Harbor on McQueen's Trail	Suitable dredged material should be placed on the McQueen's Trail shoreline to reduce erosion damage and restore recreational access to McQueen’s Trail. The site is located adjacent to the Savannah Harbor navigation channel which is routinely dredged for operations and maintenance (O&M). Chatham County is encouraged to continue coordinating with USACE on implementation and cost sharing requirements of this beneficial use action.	Funding
Regional Sediment Management Practices	Mid-Term (5-10 years)	USACE	Beneficially use dredged maintenance material from the Savannah Harbor on northern shoreline of Tybee Island	Beach and near-shore quality dredged material should be placed on the northern shoreline of Tybee Island to provide CSRM and environmental benefits. The City of Tybee Island is encouraged to continue coordinating with USACE on implementation and cost sharing requirements of this action.	Funding

Authority Category	Implementation Timing	Recommendation For	Recommendation	Description	Next Step to Implementation
Study Efforts (follow-on studies)	Long-Term (>10 years)	Multi-Agency Action	Perform a comprehensive drainage improvements study in the City of Savannah	The City of Savannah has historically suffered from stormwater and compound flooding issues, which will increase with sea level rise. Many of the flood prone areas identified in the City of Savannah Flood Hazard Mitigation Plan are located outside of the special flood hazard zones. Federal Emergency Management Agency (FEMA) flood hazard maps do not typically account for flood hazards caused by small depressions in the terrain where stormwater collects; a situation that is exacerbated by impervious surfaces. While management of stormwater does not directly address coastal storm surge, it is a complementary activity. As highlighted by stakeholders, there is an opportunity to prioritize low impact development and green infrastructure retrofits to address these issues and prevent damage to existing and future populations and infrastructure as a result of coastal storms and sea level rise. Potential lead stakeholders would include the city of Savannah, Chatham Emergency Management Agency (CEMA), and the GA-DNR. *This recommendation is also applicable to other urban locations with aging infrastructure such as Brunswick and St. Mary's.	Identify Likely Lead Stakeholder(s)

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SOUTH ATLANTIC COASTAL STUDY (SACS)

Glynn County Focus Area

FINAL REPORT

AUGUST 2022

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1. Introduction

This Focus Area Action Strategy (FAAS) identifies action strategies to reduce risk to coastal storms and increase resilience in the Glynn County area of Georgia. The South Atlantic Coastal Study (SACS) key products and analyses were leveraged to assess existing and future conditions and quantify existing and potential risks. Agency stakeholders were engaged throughout the development of the Glynn County FAAS to elicit feedback on problems and opportunities, identify and prioritize specific institutional and other barriers, and identify potential action strategies to improve resilience. The participating stakeholders included Federal agencies (United States Geological Survey [USGS], National Oceanic and Atmospheric Administration [NOAA], Fish and Wildlife Service [FWS]), State Agencies (Georgia Department of Transportation [GDOT], Georgia Environmental Protection Division [GA-EPD], Georgia Coastal Resources Division [GA-CRD], Georgia Emergency Management and Homeland Security Agency [GEMHSA], Georgia Department of Community Affairs), non-governmental organizations (NGO's) (Manomet, The Nature Conservancy [TNC]), academic institutions (University of Georgia Skidaway Oceanographic Institute, Georgia Southern University, Georgia Institute of Technology), county and local agencies within the focus area (City of Brunswick, Glynn County, Jekyll Island Authority, Georgia Ports Authority), and one historical society (Coastal Georgia Historical Society).

The FAAS was developed according to the Coastal Storm Risk Management (CSRM) Framework, an iterative process with three tiers of analysis that gains resolution each time it is implemented. Under the Tier 1 regional analysis, national datasets were utilized to assess potential risk across the entire SACS study area, as documented in the SACS Main Report. For the Tier 2 analysis, more refined data and analyses unique to each individual state or territory were incorporated. The Tier 2 analysis for Glynn County is documented within the Georgia Appendix. The FAAS is a refinement within the Tier 2 analysis of the SACS study framework, incorporating data and knowledge unique to the local area to identify risks to coastal storm events and develop potential strategies to address the risks.

This FAAS is carried out as part of SACS, which was authorized by Section 1204 of the Water Resources Development Act of 2016 as described in the Main Report. The FAAS refers to ongoing, planned, and needed actions to manage coastal storm risk based on stakeholder coordination conducted during Focus Area Vision Meetings, a series of interactive webinars held between July and December 2020. The status and description of actions provided in this report represents a snapshot in time, and specific actions may have been modified or the status may have been changed from the description provided. However, final recommendations resulting from stakeholder coordination on specific actions were updated to represent the most recent information as of June 2022.

1.1 Study Area

The Glynn County Focus Area is in southeastern Georgia and is home to the historic port city of Brunswick and the four barrier islands that make up the Golden Isles—Jekyll Island, St. Simons Island, Sea Island, and Little St. Simons Island, shown in **Figure 1**. Glynn County has a total area of approximately 585 square miles and is bounded by the Atlantic Ocean to the east, the Altamaha River to the north, and the Little Satilla River to the south. St. Simons Island is the largest and most populous of the Golden Isles and the most developed of Georgia's barrier islands.

This unique coastal setting includes public beach access on Jekyll Island and St. Simons, while Little St. Simons Island and Sea Island are privately owned with limited public access. Seasonal tourism continues to increase in Glynn County, with more than 2.5 million visitors annually and most visitors headed toward the Golden Isles. Georgia's coast is designated as a landscape of hemispheric importance for shorebirds and the Western Hemisphere Shorebird Reserve Network declared it as a critical site for the survival of threatened shorebirds.

Focus areas were selected based on Tier 1 high-risk areas, stakeholder feedback and ensuring a range of environments and risk factors were represented across all 21 focus areas selected within the SACS. Draft focus areas were presented to stakeholders at the 2019 Georgia Field Workshop. Based on provided feedback and additional analysis, two focus areas were selected for Georgia: Chatham County and Glynn County.

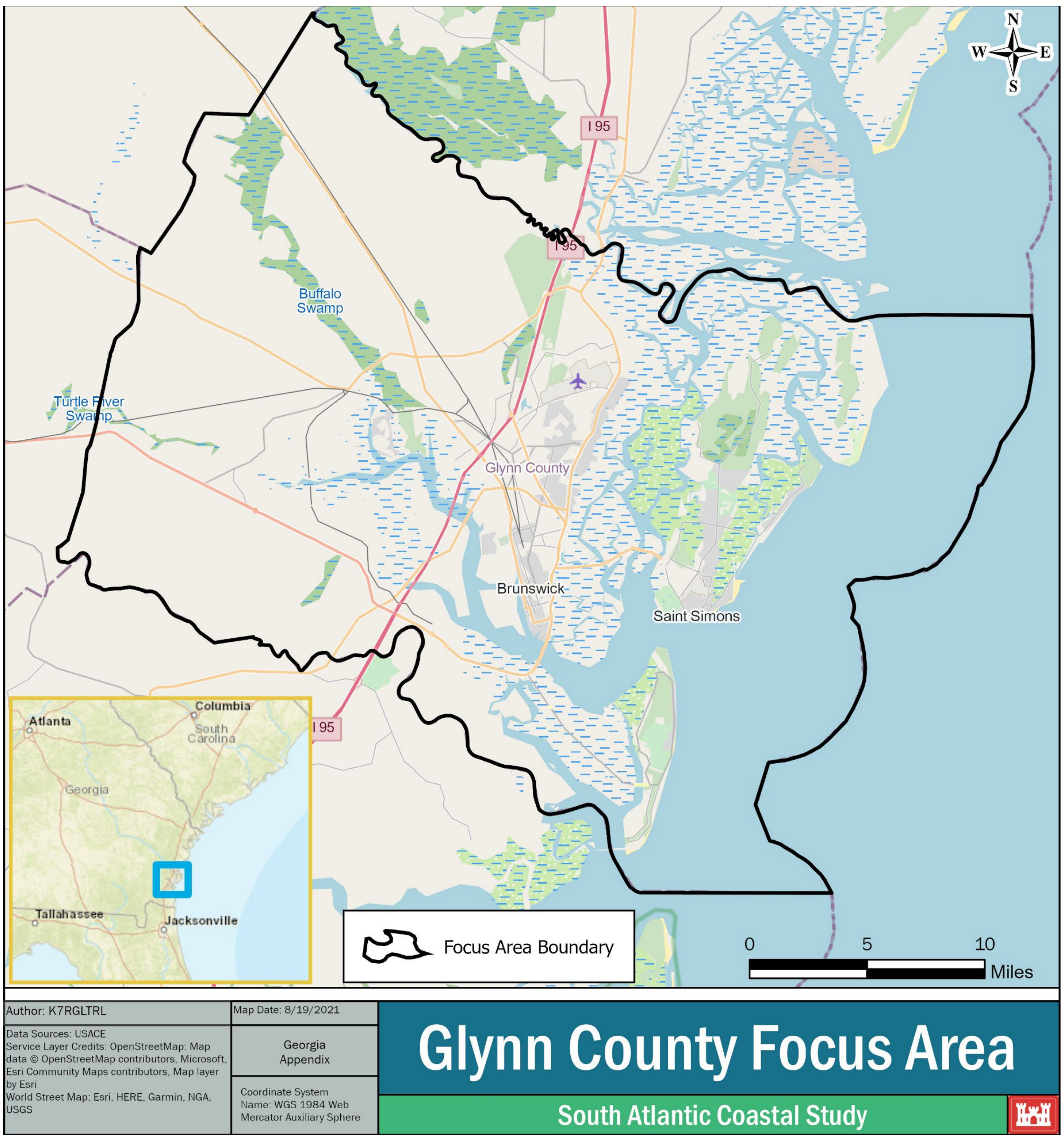

Figure 1: Glynn County Focus Area Boundary

1.2 Prior Reports and Efforts by Stakeholders within the Focus Area

Table 1 presents prior and ongoing stakeholder efforts within the Glynn County Focus Area to address coastal storm risks and impacts from sea level rise.

Table 1: Stakeholder Efforts in the Focus Area

Agency/Stakeholder	Report/Tool/Project	Year Completed
Glynn County	Shoreline Assessment and Implementation Resiliency Plan for Glynn County	Ongoing
Glynn County	County's Water Resources Protection Ordinance Update	Ongoing
USACE	Georgia Hurricane Evacuation Study	Ongoing
Jekyll Island	Jekyll Island Conservation Plan	Ongoing
Glynn County, St. Simons Island, OneGeorgia Authority	St. Simons Island Rock Revetment Maintenance Project (Johnson Rocks)	2021
Georgia Department of Natural Resources (GADNR) Coastal Resources Division (CRD)	Back River Artificial Oyster Bed Project	2020
Jekyll Island	Jekyll Island Shoreline Rehabilitation Project	2019
GADNR CRD/USACE	Jekyll Marsh Thin-Layer Placement Pilot Study (Regional Sediment Management [RSM])	2019
Federal Emergency Management Agency (FEMA)	Glynn County Flood Insurance Study	2018
FEMA	Glynn County Flood Insurance Rate Map (FIRM)	2018
University of Georgia (UGA), City of Brunswick	Howard Coffin Park Bioretention Cell Demonstration Project	2018
Glynn County	Comprehensive Plan	2018
Sea Island Acquisition, LLC	Sea Island groin construction and beach nourishment	2018
Glynn County	Disaster Recovery and Redevelopment Plan. Pre- and Post-Disaster Strategies for Managing Long-Term Recovery	2017
Glynn County	Climate Resilience Adaptation Report. Long-term Climate Resilience Adaptation Strategies for the Joint Water & Sewer Commission	2017
Glynn County	Glynn County Flood Mitigation Plan	2015
University of Georgia, Skidaway Institute of Oceanography/ Stetson University	Sea-Level Rise and Sub-County Population Projections in Coastal Georgia	2015
Coastal Regional Commission of Georgia	Hazard and Resilience Plan for the Coast of Georgia	2014
GADNR CRD	Post-Disaster Recovery and Redevelopment Planning: A Guide for Georgia Communities	2014
Georgia Conservancy/ Georgia Institute of Technology	Retreat. Adapt. Defend. Designing Community Responses to Sea Level Rise in Five Coastal Georgia Communities	2013
GADNR CRD, GADNR Historic Preservation Division (HPD)/ UGA, Skidaway Institute of Oceanography	Threatened Archaeological, Historic, and Cultural Resources of the Georgia Coast: Identification, Prioritization and Management Using GIS Technology	2008

Overall, these prior reports and on-going and completed projects provided the team with a baseline understanding of coastal storm risks and flood risk management within Glynn County. Stakeholder coordination highlighted several studies completed by USACE and other stakeholders that could be particularly valuable for ongoing and future efforts when addressing coastal storm risk.

1.3 Shared Vision

The shared vision statement was developed and edited using input from key stakeholders in the focus area. The overall goal of this Glynn County FAAS is to incrementally contribute to the shared vision statement developed for this watershed study:

> "Glynn County stakeholders share a vision to work collaboratively mitigating coastal storm risks and sea level rise in order to provide for safe, healthy, and thriving communities while protecting and restoring the environment."

The shared vision statement is broad enough to encompass various goals and objectives of individual partners and stakeholders, and with a detailed description to allow for subsequent development of specific planning objectives and associated metrics. The study framework and associated activities will support the shared vision.

2. Problems and Opportunities

Identifying problems and opportunities is a key initial step in the planning process. The problems and opportunities statements encompass both current and future conditions and are not meant to preclude the consideration of any alternatives to solve the problems and explore ways to unlock the opportunities.

2.1 Problems

The following problems were identified as the most significant throughout the focus area and may not be exhaustive of all problems. These problems will increase in both intensity and magnitude as sea levels rise depending on the vulnerability and resilience of the exposed population, infrastructure, and environmental resources. Example locations of where the problem is evident are listed. However, these are example locations and in general, the problems are evident throughout the focus area unless noted otherwise.

- Coastal storm damages (from inundation, erosion, and wave attack) are increasing in populated areas, areas of concentrated economic development, and areas with socially vulnerable populations. For example, reoccurring flooding affects communities located throughout the Brunswick peninsula as well as major transportation routes such as Glynn Avenue and Riverside Drive. Low-income housing and socially vulnerable populations can be at particular risk within the City of Brunswick.

- Critical infrastructure, such as water and wastewater treatment plants, hospitals, schools, and roads, are at risk from storm-related hazards and compound flooding, putting people and property at risk. For example, F.J. Torras Causeway, which is the only connection between St. Simons, Sea Island, and the mainland, has been inundated and impassable during major storm events such as Hurricanes Matthew and Irma. Critical infrastructure, including water and wastewater treatment plants, are at risk from storm damages and inundation throughout the focus area. Impacts to these systems could negatively affect economic and social functions as well as public health and safety.

- Nationally important cultural resources and natural habitats are being negatively impacted from coastal-storm driven inundation and erosion. For example, areas of high erosion have been identified within the barrier islands including St. Simons, Little St. Simons, Jekyll, and Sea Island spit. During high tide, the southern shoreline of St. Simons Island is regularly inundated up to the breakwater. At Ft. Frederica, shoreline erosion has claimed historical perimeter walls and active erosion along the shoreline of the Mackay River continues to threaten historic building foundations.

- Population and development are increasing in the focus area, leading to loss of natural buffers in areas exposed to coastal storm hazards. For example, residential construction in southern Glynn County and mixed-used development in the southern tip of the Brunswick peninsula have increased. Growth in tourism and seasonal populations in the Golden Isles increases annually. Development can reduce natural buffers and increase impervious surfaces, which can compound effects from storm surge inundation and precipitation during coastal storms.

2.1.1 Institutional and Other Barriers

As described in the *SACS Institutional and Other Barriers Report* (USACE 2022b), "Institutional and other barriers" impede the attainment of SACS goals and limit the ability to provide comprehensive CSRM. Several barriers were identified within the Glynn County Focus Area by agency stakeholders:

- Lack of funding which limits local/state level staffing capacity and ability to implement comprehensive CSRM solutions

- Limited political support to make difficult decisions regarding long-term CSRM solutions

- Difficulties of individuals and communities in understanding their risk

- Public acceptance of risk management measures

The most common barrier identified is lack of funding. Grant opportunities are detailed in another component of SACS, the Coastal Program Guide, which discusses funding opportunities at the national and state levels.

Table 14, later in this document, includes potential funding sources for identified measures.

2.2 Opportunities

While there are several coastal storm-related problems in the focus area, numerous opportunities exist to address them as exemplified by ongoing efforts within Glynn County. Stakeholders identified several opportunities that include conditions, resources, and factors to contribute favorably to the Glynn County Focus Area, including:

- Gather additional data on coastal hazards, exposure, and vulnerability to refine current and future CSRM efforts.
- Build partnerships and strengthen relationships with Glynn County stakeholders.
- Enhance outreach and risk communication to all stakeholders in the focus area, including the public.
- Prioritize regional management of projects through RSM and other opportunities that support conservation of natural and fiscal resources in the focus area.
- Promote a range of potential measures, including structural, nonstructural, nature-based, and state and local ordinances that incorporate future sea level rise.
- Reduce the loss of coastal wetlands, beach, and dune systems that promote natural storm damage reduction and provide wildlife habitat.
- Align with and leverage studies being conducted by State and Glynn County stakeholders. Studies conducted at the local level provide local knowledge of coastal storm risks to communities. Using these studies to help identify priorities of key stakeholders will support successful implementation of strategies in the SACS.

3. Objectives and Constraints

Objectives are specific actions meant to alleviate the identified problems and take advantage of opportunities within a project. Constraints are conditions that limit the extent a project can meet its objectives, address the identified problems, and/or take advantage of opportunities. Action strategies formulated during this study are intended to meet the project's objectives while working within the constraints.

3.1 Objectives

Objectives were determined based on feedback from stakeholders, including responses to a questionnaire and participation in the Focus Area Strategy Development Webinar and reflect the shared vision statement from Section 1.3. The objectives listed here are 'umbrella' statements that refer to the specific problem types and areas noted in the Problems Section of this report. Objectives and goals of the FAAS are provided in this section.

Objective:

- The overall planning objective is to develop a strategy to manage coastal storm risk to people and economic, environmental, and cultural resources within the focus area.
- Reduce risk from coastal storm inundation, sea level rise, and erosion to populations, infrastructure, and environmental resources.

Goals:

- Identify the areas at highest risk from coastal storm hazards, which are exacerbated by sea level rise.
- Identify opportunities to manage coastal storm risks to people and infrastructure in the focus area.
- Coordinate with stakeholders to develop strategies that address coastal storm risks in the focus area, including the geographic location, timing, potential lead stakeholders, funding sources, and specific needed actions.

3.2 Constraints

A constraint limits the extent of the planning process. It is a statement of things or situation the alternative plans should avoid. Constraints are designed to avoid undesirable changes between expected future conditions without the proposed project and expected future conditions post project construction. Constraints include:

- To the maximum extent practicable, this analysis will minimize information, observations, and recommendations that may be inconsistent with coastal storm risk management plans developed by other federal and applicable state and local agencies and tribes in the study area.

4. Existing and Future Conditions

There are several organizations that are actively working to address the impacts of coastal storm hazards as sea levels rise in the Glynn County Focus Area (**Table 1**). This section focuses on the performance of existing projects and provides an inventory and forecast of current and future hazards, exposure, vulnerability, and risk in the focus area.

4.1 Hazards

In a general sense, a hazard is anything that is a potential source of harm to a valued asset (human, animal, natural, economic, and social) (USACE 2014). Hazards addressed by the SACS are predominantly storm related and are divided into two categories: primary and secondary. Primary hazards are those directly addressed in the SACS and include inundation, wave attack, and erosion. Secondary hazards are those that the SACS does not specifically address but are important in the focus area. These include wind damages, saltwater intrusion, and compound flooding from a combination of storm surge, precipitation, astronomical tides, and a high-water table. Sea level rise can uniquely exacerbate other hazards, impacting the future of all coastal communities.

Recent storm events that have significantly impacted the focus area include Hurricane Matthew in 2016 and Hurricane Irma in 2017. Hurricane Matthew caused widespread power outages, an estimated $500 million in damages, and three fatalities in Georgia. Within Glynn County, Hurricane Matthew produced significant rainfall, flooding, and coastal erosion, which caused an estimated $11 million in damages. A historic peak water level of 3.18 feet above mean higher high water (MHHW) was recorded at the US Geological Survey (USGS) Brunswick River at St. Simons Island, Georgia gauge (No. 02226180). Note this gage was formerly the NOAA National Ocean Service (NOS) tide gauge at St. Simons Island Pier (No. 8677344). Flooding within the city of Brunswick rendered roads impassable and temporarily severed access to St. Simons Island along the F.J. Torras Causeway, which limited the ability for first responders and emergency management personnel to access barrier island communities in Glynn County.

Hurricane Irma produced nearly 10 inches of rain within southeast Georgia, which was compounded by a Nor’easter bringing heavy precipitation to the area just days prior. The previously held record at the USGS tide gauge (**Figure 2**), associated with Hurricane Matthew, was exceeded during Hurricane Irma, with a recorded peak water level of 3.93 feet above MHHW. The maximum storm surge (the height above normal tide levels) reached just over 6.9 feet at St. Simons Island Pier. Extensive coastal flooding occurred within St. Simons Island, Brunswick, and the communities along the Satilla River.

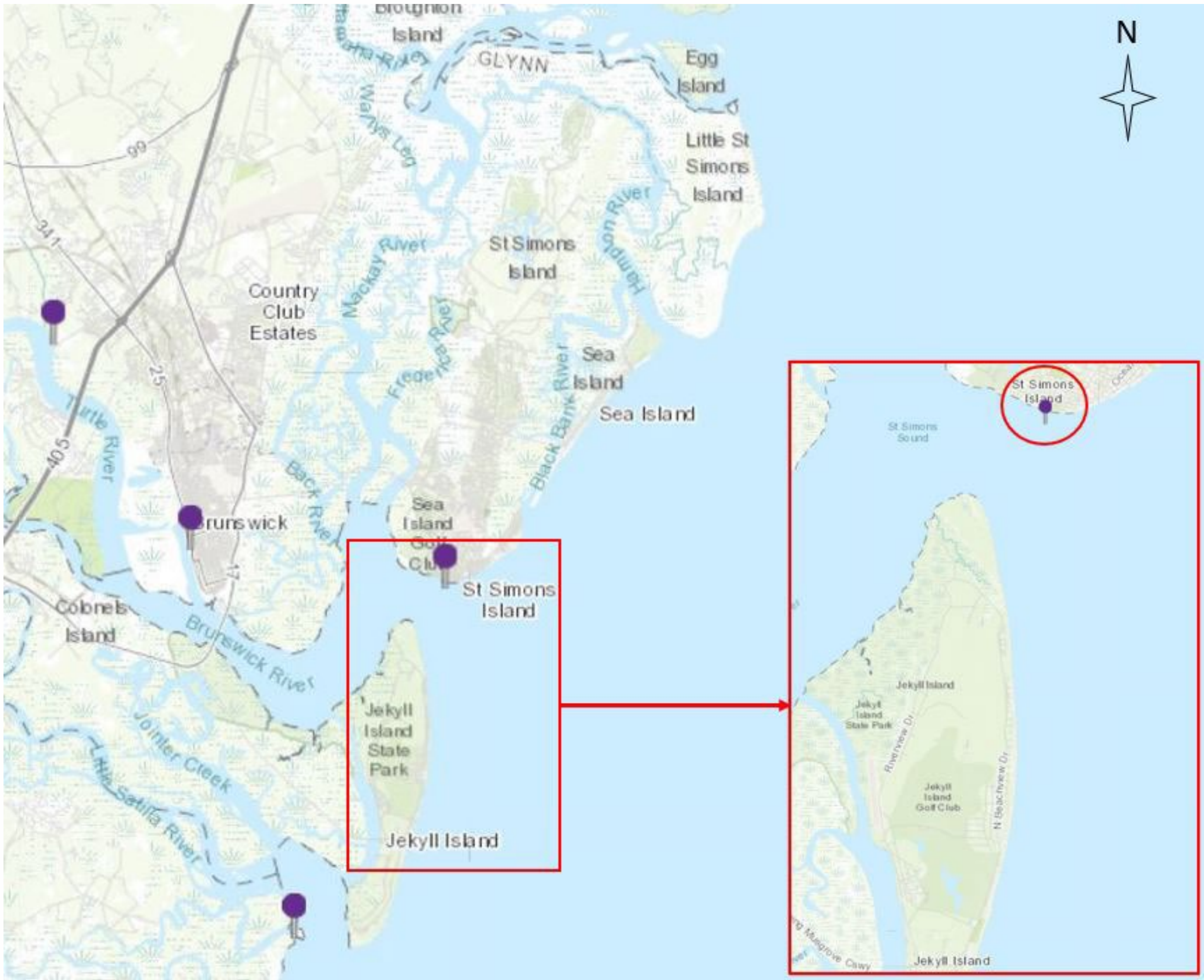

Figure 2: Brunswick River at St. Simons Island, Gauge No. 02226180 (not to scale) (USGS 2021a)

The frequency of storms contributes to the magnitude of the damage. Storms occurring in the same or consecutive seasons can impact ongoing recovery efforts from the previous storm, compounding the time and cost associated with full physical and economic restoration of the community.

4.1.1 Primary Hazards

Primary hazards are CSRM hazards that the SACS specifically addresses, including inundation, wave attack, and erosion. For the Glynn County Focus Area, the primary hazards are present and considered the most relevant to the study.

4.1.1.1 Inundation

Inundation is one of the primary hazards that affects the majority of the Glynn County Focus Area. The areas most likely to experience inundation hazards are the ocean-facing Golden Isle communities, back bay communities, and riverine communities, due to their proximity to the Atlantic Intracoastal Waterway (AIWW) and the coast, low elevation, and aged infrastructure. Inundation in the context of the SACS refers to flooding originating from the coast in the form of storm surge and does not include riverine flooding originating from the upland or inundation due to excessive rainfall.

Inundation predominantly occurs in the low-lying coastal portions of this region and is caused by storm surge from hurricanes and, to a lesser degree, long nor'easter events. Inundation occurs when waves, combined with storm surge, surpass dunes on the coast of St. Simons and Jekyll Islands. Inundation also occurs landward of the Golden Isles due to storm surge penetrating the inlets at St. Simons Sound, Jekyll Sound, and Altamaha Sound and flooding the marshlands.

The Category 5 Maximum of Maximum (MOM) hazard from NOAA's Sea, Lake, and Overland Surges from Hurricanes (SLOSH) model shows that nearly the entire focus area is subject to inundation from a Category 5 hurricane (Zachry et al. 2015; Jelesnianski et al. 1992). Lesser storms are less impactful, but cause localized flooding in lower elevation natural, commercial, and residential areas. The lateral extent of the Category 5 MOM, 1-percent annual exceedance probability (AEP) flood, and 10-percent AEP flood is identified in **Figure 3**, while **Figure 4** shows FIS flood levels and measurement transects for Glynn County for a 1-percent AEP event. **Table 2** provides the county average storm surge elevations based on the FEMA Flood Insurance Study (FIS) for Glynn County (FEMA 2018).

Table 2: Federal Emergency Management Agency (FEMA) Flood Insurance Study (FIS) Storm Surge Elevations for Glynn County. (North American Vertical Datum of 1988 [NAVD88]) (FEMA 2018)

Annual Exceedance Probability (AEP)	Storm Surge Elevation
10%	5.7 ft
2%	7.8 ft
1%	8.9 ft
0.2%	10.9 ft

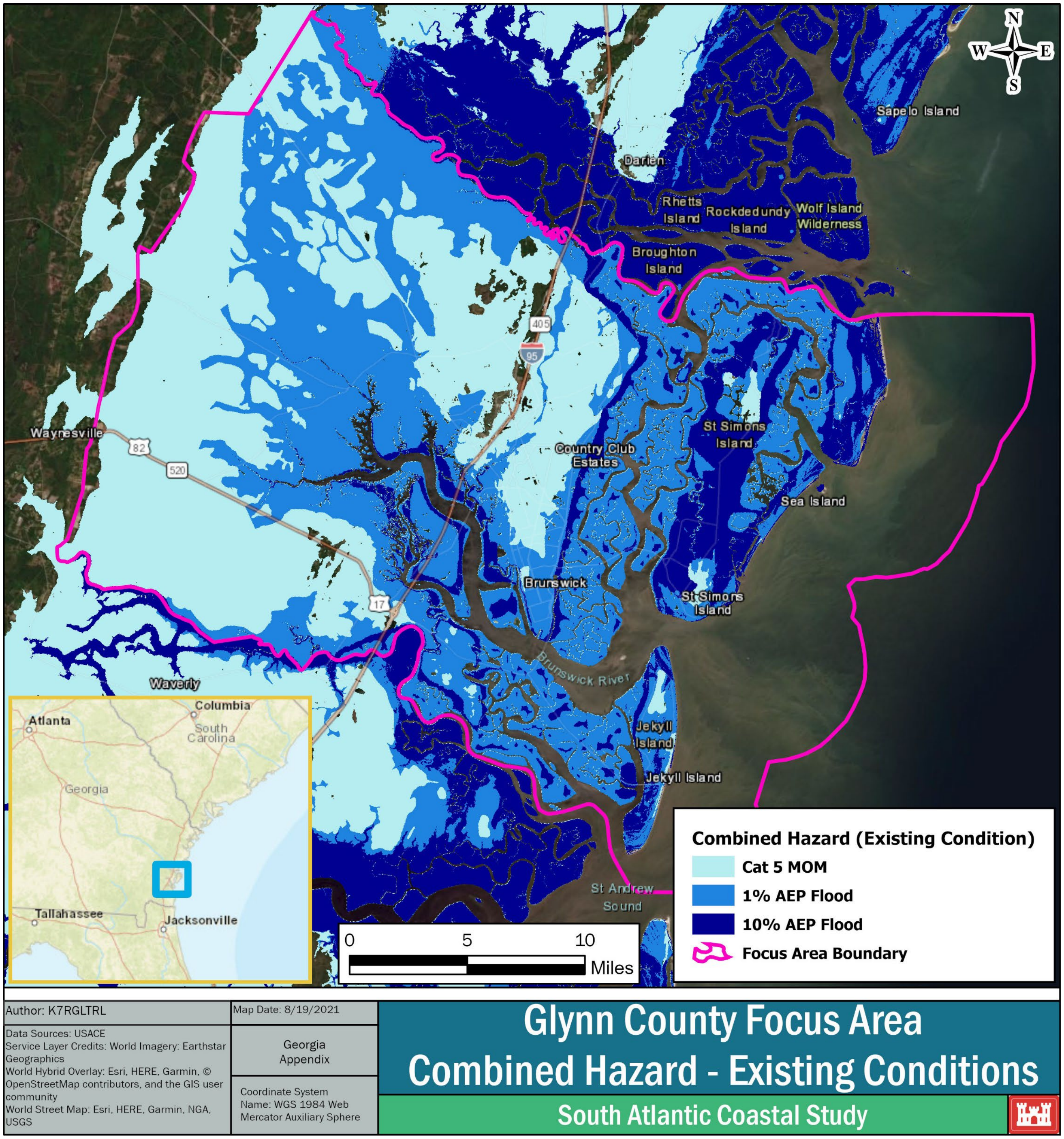

Figure 3: Combined Hazards Overlay for Glynn County (1-Percent Annual Exceedance Probability, 10-Percent Annual Exceedance Probability, and Category 5 Maximum of Maximum)

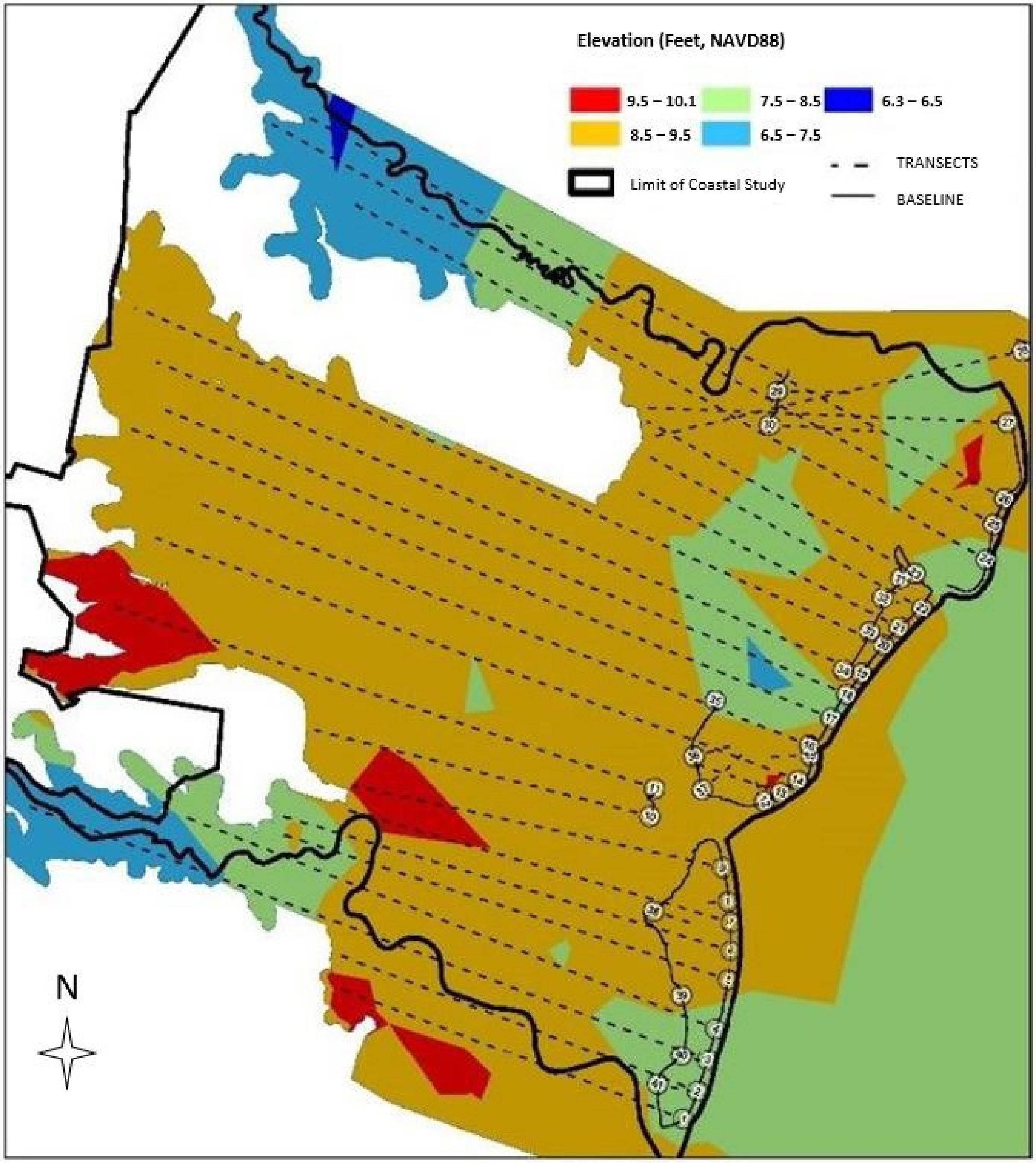

Figure 4: 1-Percent Annual Exceedance Probability Flood Levels, Glynn County (Federal Emergency Management Agency 2018) (Not to Scale)

4.1.1.2 Wave Attack

Waves cause damage through the force that they impart directly upon structures, habitats, and shorelines. Waves also generate alongshore and cross-shore currents at shorelines that can mobilize and erode sediment. In the context of the SACS, wave attack refers to the process of destructive waves impacting a shoreline and leading to increase erosion along that shoreline. Erosion is addressed in Section 4.1.1.3.

The highest wave energy occurs along St. Simons Island, Little St. Simons Island, Sea Island, and Jekyll Island where shorelines are exposed to the open ocean. The impact of waves on these shorelines can be hazardous to both natural shorelines and engineered structures. Southern St. Simons Island is particularly susceptible to wave attack because it lacks natural protections such as an expansive dune system. The USACE Wave Information Studies (WIS) provides hindcast data at locations along the Atlantic coast (Hubertz, 1992). Data derived from the WIS Station 63391, located 15 miles east of St. Simons Island (**Figure 5**), shows that typical deep-water waves at St. Simons Island average approximately 3.4 feet, with lower waves occurring in the summer (3.1 feet) and higher waves occurring in the fall and winter (4.6 feet). During storms, waves can be much higher (i.e., contain more energy). These high-energy waves can cause extensive shoreline erosion and, when carried on water levels elevated by storm surge, overtop dunes, and propagate landward to directly impact infrastructure.

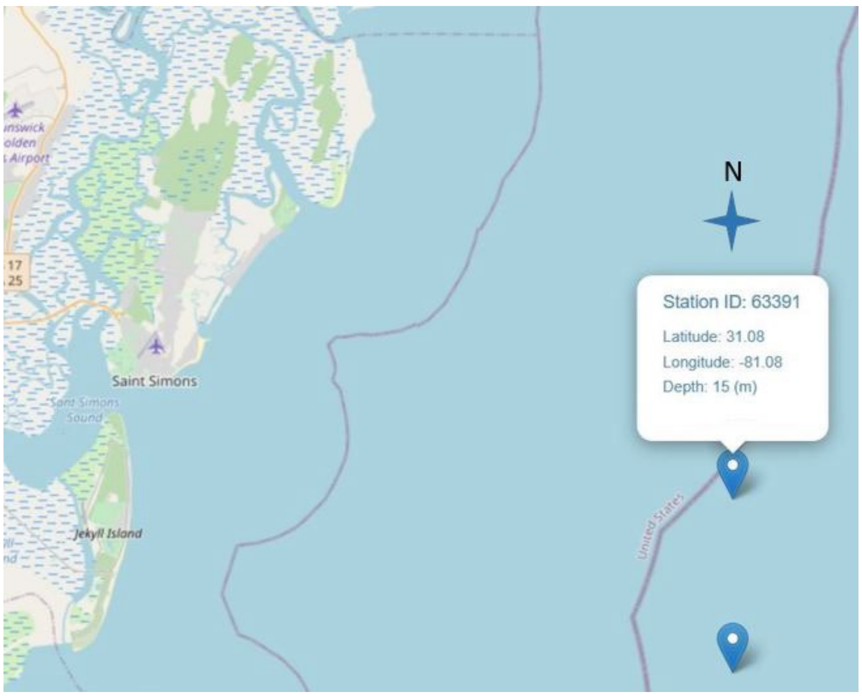

Figure 5: Wave Information Study Station 63391 (not to scale) (Hubertz 1992)

The Coastal Hazards System (CHS) analysis developed by USACE models wave heights for a range of storm events for both existing and future conditions (USACE 2020a). **Figure 6** shows modeled wave heights for the 1-percent AEP event in the Glynn County focus area in the existing and future condition with addition of 2.73 feet of sea level rise. Along the coast, modeled 1-percent AEP wave heights average 0–6.6 feet (0–2 meters), but offshore wave heights average 6.6–19.9 feet (2–6 meters). Open ocean waves do not currently penetrate far into the Brunswick River or the marsh channels north and south of the Brunswick peninsula. Some direct wave attack can occur at the eastern edge of the Brunswick peninsula from waves traveling westward through the inlet to St. Simons Sound. Currently, the highest, most frequent waves in the Brunswick River are ship wakes. While their impact is mostly erosional, repetitive loading from frequent ship passages can impact exposed infrastructure.

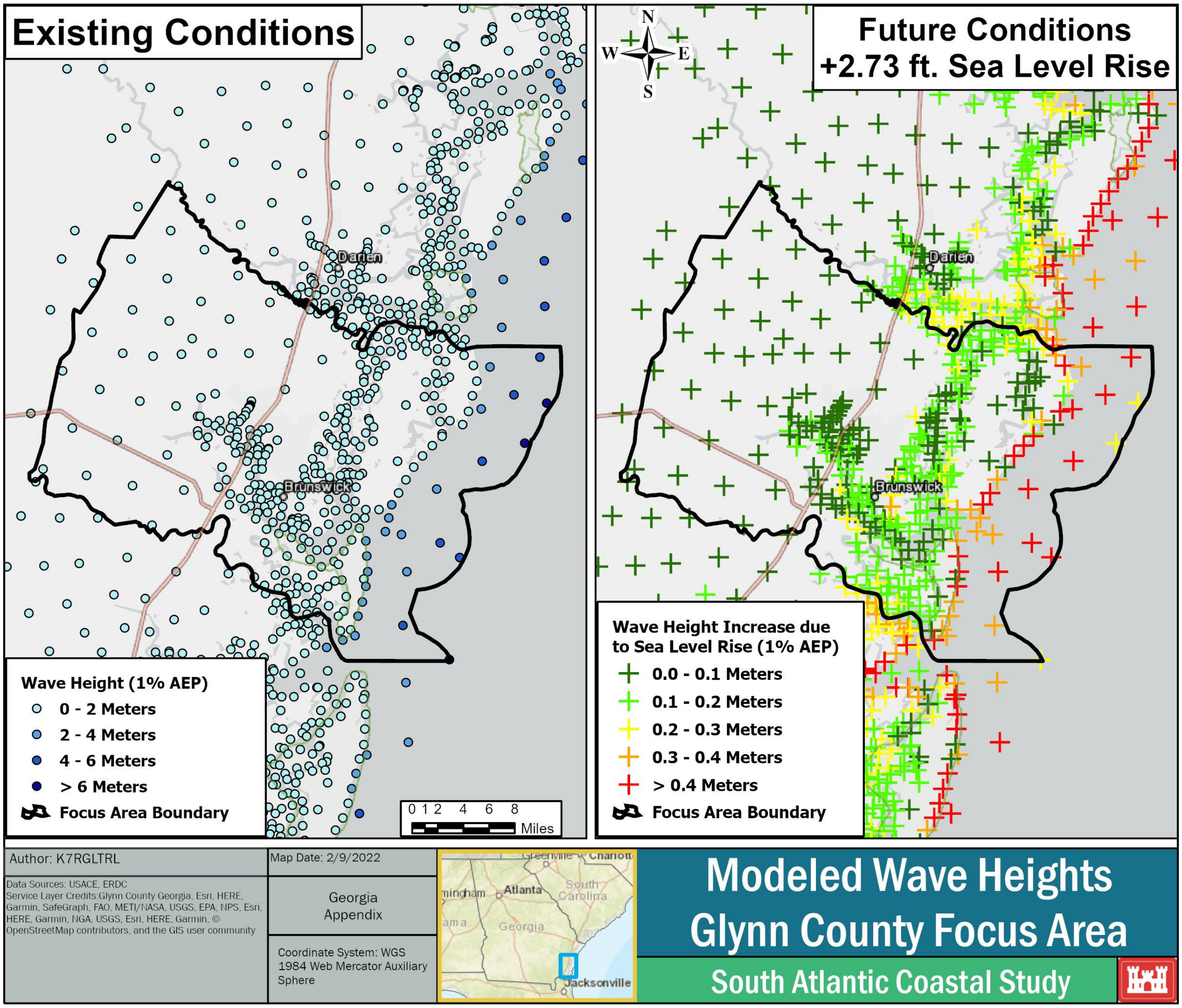

Figure 6: Coastal Hazards System Existing (Left) and Future Condition (Right) Wave Heights Increases for 1-Percent Annual Exceedance Probability Event

4.1.1.3 Erosion

Erosion occurs when waves and currents remove sediment from shorelines. It can increase vulnerability of cultural resources, environmental resources, and infrastructure.

At the open ocean, erosion along St. Simons and Jekyll Island shorelines is predominantly wave-driven in the form of longshore and cross-shore currents. Waves approach the shore at an angle break, dislodging sediment and transporting it alongshore. Sediment moves north and south along the shoreline daily, depending on the direction of the incident waves. During storm events, when waves have higher energy, sediment is transported offshore where it forms bars. Once the storm has passed, the bars dissipate, and sand migrates back to the shoreline. During extreme storm events, however, the force of the waves can remove sand far enough offshore that it is lost to the system entirely. This is typical of hurricanes and leads to unrecoverable erosion damage.

The Glynn County shoreline is comprised of four barrier islands (Little St. Simons Island, St. Simons Island, Sea Island, and Jekyll Island). The barrier islands do not erode uniformly from one part of the island to another as described below. Little St. Simons Island is the northern-most island in the county and has a long-term pattern of accretion (greater than +6.6 feet/year) over most of its shoreline (**Figure 7**). The north end shows mild (-3.3 feet per year) to moderate (-3.3 to - 6.6 feet per year) erosion in the long term. A hot spot of high erosion, losing more than -6.6 feet (-2 meters) per year, is just south of the island's central shoreline. Sea Island and St. Simons Island, which have developed shorelines, have a mild erosion pattern with regions of accretion throughout the islands. Two hot spots of high erosion are at the northern tip of Sea Island and the south end of St. Simons Island at the entrance to St. Simons Sound. Jekyll Island shows mild long-term erosion throughout the island with accretion of +3.3 feet (+1 meter) to +6.6 feet (+2 meter) per year at the southern tip. The development of St. Simons and Jekyll Islands has resulted in local efforts to stabilize the shoreline and reduce erosional impacts.

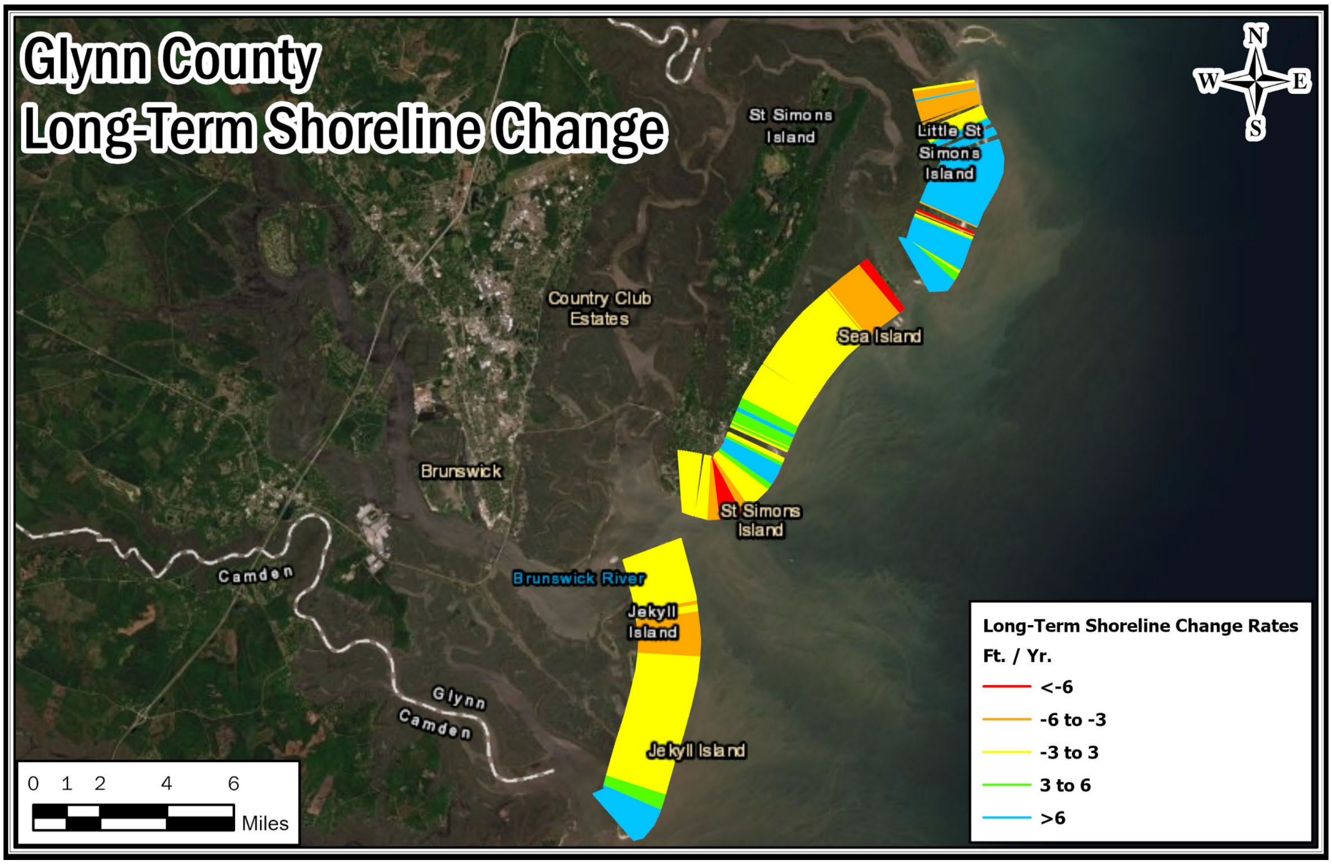

Figure 7: Long-Term Shoreline Change in Glynn County (USGS 2017)

In the back bay regions of Glynn County, erosion and accretion occur along riverbanks and marsh channels. Back bay shoreline change is predominantly caused by currents generated by flood and ebb tides. Regions that experience boat or ship traffic, such as the Brunswick River, also experience erosion due to ship wake from the frequent passage of vessels.

In 2008, GADNR commissioned a study of threatened archaeological, historical, and cultural resources of the Georgia coast (GADNR 2008). As part of this study, shoreline change along the bay side of coastal barrier islands was investigated. GADNR found that bay side coastlines are highly dynamic over time, showing patterns of both accretion and erosion. **Figure 8** represents these patterns for Glynn County. Mean rates of erosion and accretion are provided in **Table 3**.

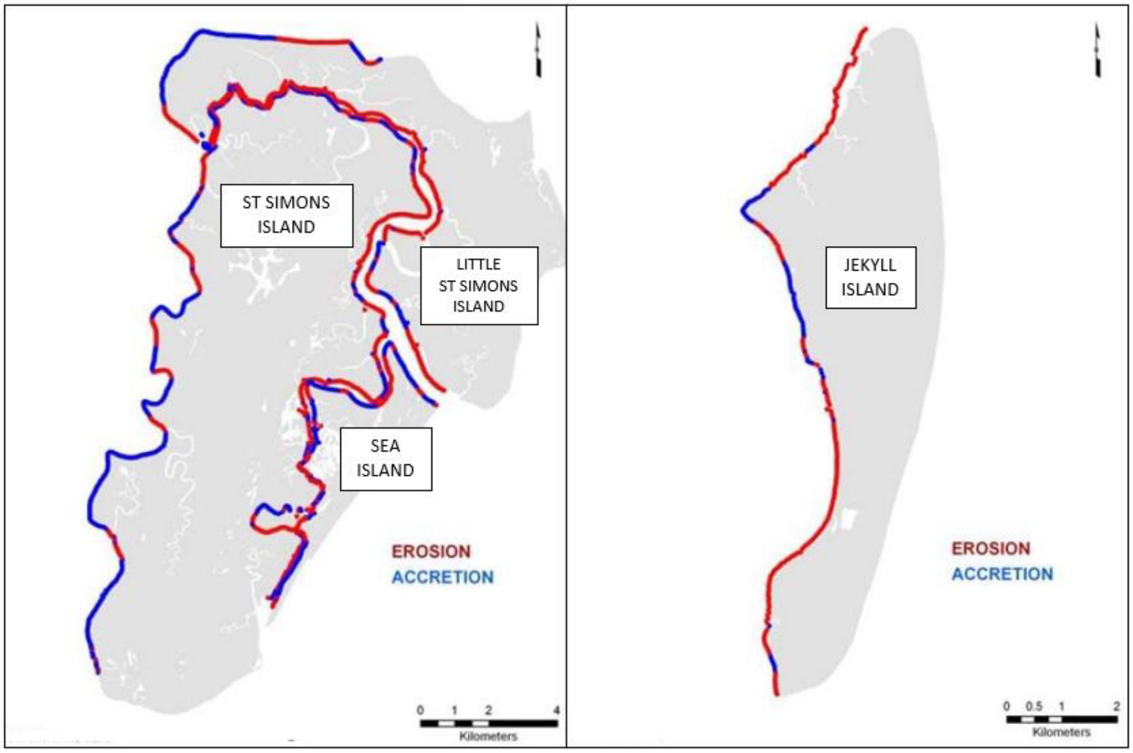

Figure 8: Back Bay Shoreline Change Patterns, Glynn County Barrier Islands (Georgia Department of Natural Resources 2008)

Table 3: Mean Back Bay Erosion and Accretion Rates, Glynn County Barrier Islands (Georgia Department of Natural Resources 2008)

Time Period of Analysis	Barrier Island	Mean Erosion (Feet per year)	Mean Accretion (Feet per year)
1869–2003	Little St. Simons Island	-1.8	6.5
1869–2003	Sea Island	-2.8	2.2
1869–2003	St. Simons Island	-1.1	1.2
1855–2003	Jekyll Island	-1.5	2.1

4.1.2 Secondary Hazards

Secondary hazards are CSRM hazards that the SACS does not specifically address, including wind damage, compound flooding, and saltwater inundation and intrusion. While the SACS does not specifically address these hazards, they are still important to discuss and can impact the focus areas. Nuisance, stormwater, and compound flooding are significant issues within the focus area. Many of these secondary hazards exacerbate the hazards of inundation, wave attack, and erosion.

4.1.2.1 Wind Damage

Typical daily winds in this region range from approximately 5 to 15 miles per hour and have no significant impact. During storm events, however, high winds can damage both infrastructure and environmental resources. Nor'easters typically produce gale force winds of 40 miles per hour or greater. Hurricanes can generate sustained windspeeds of 74 miles per hour (Category 1) to 157 miles per hour or greater (Category 5). Wind is a primary driver of storm surge, by pushing water toward the shore with the force of the winds moving cyclonically around the storm.

4.1.2.2 Compound Flooding

Compound flooding is a combination of hazards that create greater flooding impacts. In Glynn County, this can be a combination of storm surge, precipitation, high tides, stormwater, and high groundwater elevations. Storm surge and wind have been previously detailed are major components of compound flooding. The SACS did not evaluate other sources of inundation; however, precipitation, tides, and groundwater can contribute significantly to flooding through increased runoff volumes; the elevation of ocean, river, and groundwater levels above banks; containment structures and drainage systems; and the overwhelming of outflow systems. Within the city of Brunswick, development has greatly increased the impervious surface area, thus reducing the area where infiltration to groundwater can occur. Excessive surface and stormwater runoff further increases the flood hazards within the city.

4.1.2.3 Saltwater Inundation and Intrusion

Saltwater inundation is the movement of saltwater onto land from storm surges or high tides that submerge areas low in elevation for a short duration of time. Tidal marshes and estuaries experience short-term inundation events as part of the natural cycle and have minimal effect to local salt-tolerant vegetation under normal circumstances. However, with the addition of sea level rise, an increase in the frequency of short-term saltwater inundation events in tidal marshes and estuaries is predicted. Consequently, this may cause an increase in root zone salinization, which can degrade or ultimately kill less salt-tolerant species, such as cattails (*Typha latifolia*) and giant cutgrass (*Zizaniopsis millacea*). These species cannot survive in salinity concentrations greater than 0.5 parts per thousand (ppt) (USDA 2000). Within the low and middle marshes of Glynn County, *Spartina alterniflora* is the dominant salt-tolerant species, but growth becomes impaired if salinity levels exceed 33 ppt. In addition to salinity tolerances, water surface elevation and inundation can impair common high-marsh species found within the area, such as *Juncus roemerianus,* which has similar salt tolerance as Spartina; however, it cannot survive periods of regular inundation exceeding 1 hour (NPS 2005). The ability of existing wetlands to adapt to sea level rise will depend mostly on the topography of the coastal zone and the amount of space landward that has not been developed and is available for wetland migration. The loss of wetlands can exacerbate other hazards such as storm surge and wind damage because the frictional effects of the wetlands will be reduced.

Saltwater intrusion into freshwater aquifers can reduce freshwater supply for both the natural environment and the populations that depend on aquifers for their water supplies. The primary source of fresh water for industrial and public use in Glynn County is the Upper Floridan aquifer. Since the 1950s, saltwater intrusion has been identified and monitored within an area of several square miles in downtown Brunswick. In 2006, the GADNR Environmental Protection Division released the *Coastal Georgia Water and Wastewater Permitting Plan for Managing Salt Water Intrusion (GADNR*

2006). To halt further intrusion of saltwater into the Upper Floridan aquifer, locations with the highest potential for saltwater intrusion were delineated and placed within the red zone, where significant reductions and restrictions to withdrawals from the Upper Floridan aquifer are required. Within the city of Brunswick, the red zone restrictions encompass an approximately 2-mile saltwater-contaminated zone of the Upper Floridan aquifer. Additional restrictions for Glynn County include implementation of water conservation and reuse measures, and continued chloride monitoring efforts in wells throughout the area (GADNR 2006). While groundwater development was a primary driver in saltwater intrusion in the Upper Floridan aquifer, the downward saltwater migration from surficial sources through the upper confining units pose a threat to the aquifer that is projected to increase with sea level rise.

4.1.3 Sea Level Rise Effects on Coastal Hazards

Flood hazards due to sea level rise extends beyond areas exposed to the open ocean, encompassing much of low-lying regions of Glynn County. Much of the coastal, bay, and riverine shorelines of Glynn County are generally low-lying and moderate to densely populated, making the region highly susceptible to the potential effects of sea level rise. Without adaptation strategies, sea level rise is projected to enhance the effects of the previously discussed hazards. Sea level rise can increase the risk of inundation by increasing water surface elevation, including storm surges, and can reduce the natural buffers in the Glynn County Focus Area that protect infrastructure by drowning and eroding coastal wetlands.

It is projected that an average of 3 feet of sea level rise will occur throughout the entire SACS study area within 50 to 100 years, as determined by the USACE High and Intermediate scenarios, respectively. To represent this future condition, the Tier 1 analysis incorporated sea level rise by adding 3 feet to the storm surge hazards (1-percent and 10-percent AEP events). Similarly, future condition risk in the Tier 2 Economic Risk Assessment assumes 3 feet of future sea level rise in its expected annual damages and damages per AEP event projections.

While the addition represents sea level rise estimates, it must be emphasized that 3 feet of additional water could come from multiple sources, such as pluvial (rainfall) and fluvial (rivers and streams) flooding in combination with sea level rise. As such, this assessment is not meant to tie the future hazard to a specific year but to highlight the hazard when a surge event is added to the combined total water level of 3 feet.

The extent of flooding of the 1-percent and 10-percent AEP event expands inland with the addition of sea level rise. Rising seas can allow for larger waves to form closer to the shore and to penetrate further inland on flood waters, causing increasing damage to coastal shoreline and the overtopping of coastal features. As displayed in **Figure 6**, an increase in wave height is anticipated throughout the focus area within the future condition, with greater increases along the Golden Isles and estuaries

Sea level rise also exacerbates saltwater intrusion and lifts the water table closer to the ground surface. The rising water table takes up room in the soil and reduces the amount of available space in the ground to absorb runoff during storms. This can increase the amount of runoff that the sewer systems must handle, which can lead to drainage issues and increased flooding.

4.1.3.1 Relative Sea Level Change

NOAA Gauge No. 8670870 in Fort Pulaski, Georgia is the nearest gauge with open ocean exposure that documents sea level trend. Gauge No. 8670870 indicates a mean relative sea level trend of 3.25 millimeters per year, or 0.0107 feet per year, with a 95-percent confidence interval of +/- 0.27 millimeters per year, or 0.0009 feet per year, based on monthly mean sea level data over an 82-year record. When this trend is adjusted according to USACE guidance for Intermediate and High scenarios (see Section 2.7 of the Georgia Appendix for additional details), the trend becomes 7.48 millimeters per year, or 0.0245 feet per year, and 20.9 millimeters per year, or 0.0685 feet per year, respectively. Currently, sea level rise in the region is trending to the USACE Intermediate and High scenarios. A detailed discussion of relative sea level rise is provided in the Georgia Appendix.

Long-term predictions of sea level rise indicate that Glynn County will be highly susceptible to sea level-related hazards.

4.2 System Performance

After assessing the hazards affecting the Glynn County Focus Area, it is important to look at how existing projects are mitigating risk from coastal storm hazards.

Performance is the system's reaction to the hazard. The system performance refers to the system’s features and the ability to contain/manage the flood hazard for all possible events. There are several shore protection projects and RSM projects that are improving the system performance throughout the Glynn County Focus Area.

4.2.1 Coastal Storm Risk Management Projects

CSRM projects, which include beach nourishment and shore protection structures, have better equipped the coast and barrier islands to reduce coastal storm damages and mitigate risk from sea level rise. Beach nourishments often require periodic maintenance to achieve adequate storm damage reduction benefits. A wide, nourished beach system, absorbs wave energy, protects upland areas from flooding, and mitigates erosion.

Glynn County has numerous public and private properties with armored shorelines. Most commonly, rock revetments or bulkheads are employed to combat tidal creek erosion. Approximately 37 percent of all parcels within the county abutting estuarine wetland or water habitat are armored, representing the highest percentage of armored parcels within Georgia’s coastal counties (Peterson et al. 2019).

There are no active federal CSRM projects within the focus area; however, there are several non-federal CSRM projects, including beach nourishment on Sea Island, rock revetment repair and beach nourishment on Jekyll Island, and repair and improvement of rock revetment along the ocean-facing portion of St. Simons Island. A detailed description of these projects and other related federal and non-federal projects can be found in Section 5.3 of the Georgia Appendix. These projects demonstrate how shoreline protection projects perform under very dynamic conditions and often require significant maintenance, repair, and redesign to sufficiently reduce storm damage. It is important to consider sea level rise when designing these projects to ensure that they function as intended over the project lifecycle.

4.2.2 Regional Sediment Management Strategies

RSM strategies within the Glynn County Focus Area are described in the 2020 South Atlantic Division Regional Sediment Management Optimization Update (RSM Optimization Update). Additional data on RSM can also be found in the South Atlantic Division Sand Availability and Needs Determination (SAND) Summary Report (USACE 2020c). Borrow areas of proven and potential sand sources and RSM locations are in the SACS Geoportal and on the SAND Dashboard.

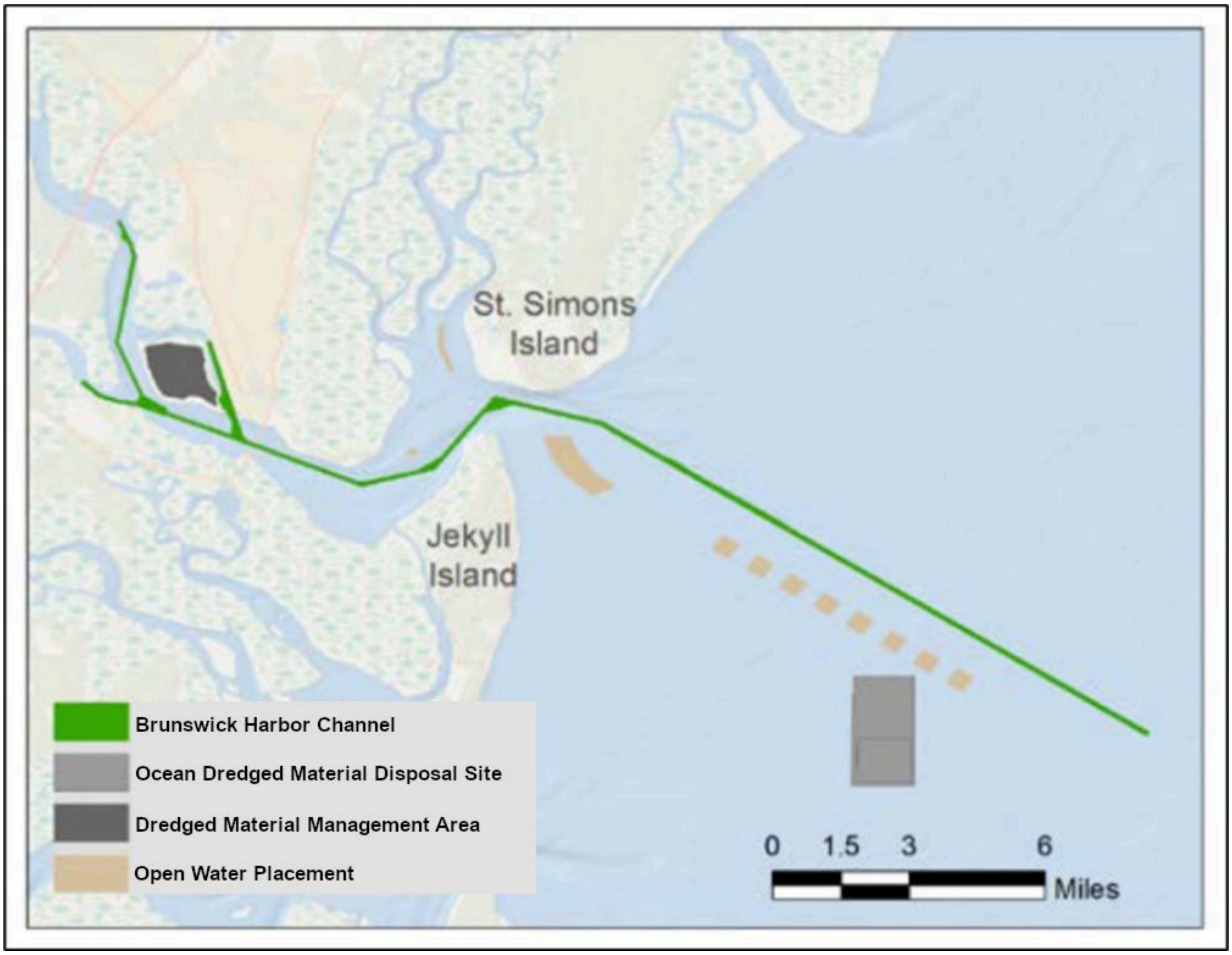

Figure 9: Map of Brunswick Harbor Channel and Material Placement Locations (USACE 2020b)

Within Glynn County, there are two federally maintained navigation channels: Brunswick Harbor Channel and the AIWW. For the Brunswick Harbor Navigation Project, all of the dredged material goes either to the dredged material management area (DMMA) or the offshore placement site (**Figure 9**).

While most of the 1.8 million cubic yards dredged from the Brunswick Harbor Navigation Project per dredge cycle (annually) is comprised mostly of silt and mud, a significant volume is suitable for nearshore placement. Approximately 1.5 million cubic yards of nearshore quality material is dredged from the Entrance Channel and placed at the Ocean Dredged Material Disposal Site (ODMDS) annually. Nearshore placement south of the project channel is a more cost-effective placement option that does not use capacity at the dredged material management areas (DMMA) or the offshore placement site and provides sediment to the downdrift coastal system. As part of the Focus Area Visioning Meetings and subsequent stakeholder engagements, potential RSM opportunities were discussed and further analyzed for placement of beach- and nearshore-quality dredged material from the Brunswick Harbor Navigation Project on the north shoreline of Jekyll Island to provide flood risk and environmental benefits to the area. Placement of nearshore-quality material at the nearshore feeder berm could provide $0.9 million in annual value to the USACE NAV program. If placed in the littoral zone, it could provide up to $11.3 million in value to the erosional shoreline along the northern half of Jekyll Island.

Approximately 530,000 cubic yards from the Brunswick Harbor Navigation Project was used to create the Brunswick Bird Island in 2008. Placement at the island provided direct value to the navigation program based on pumping distance to the placement site and capacity saved at established dredged material management areas. Other opportunities for bird habitat development or other beneficial use projects with environmental and economic benefits should be explored in Glynn County as they are supported by stakeholders and resource management agencies.

A notable RSM effort within the focus area is the Jekyll Marsh Thin-Layer Placement Pilot Project. In 2019, approximately 5,000 cubic yards of non-beach quality material was dredged from Jekyll Creek and placed over an adjacent 5-acre area of salt marsh using a thin-layer spray technique. The goal of this pilot project is to enhance marsh resilience by raising the marsh elevation and promoting new growth of marsh grasses while combating marsh subsidence and sea level rise. This pilot project is currently being monitored by scientists from Georgia Southern University and the University of South Carolina over a three-year period to document how the thin-layer placement of sediments ultimately affects marsh health. If proven successful, thin-layer placement of dredged material in shallow, lower energy areas of rivers, estuaries, and marshes may provide a cost-effective and environmentally beneficial disposal method of this non-beach quality dredged material throughout the Georgia planning reach.

In addition to the thin-layer placement project completed in 2019, AIWW-dredged material was used for open water disposal which is another placement strategy. Open water dispersal is a technique designed to keep the dredged sediment in the active sediment system by releasing it in a high-energy environment that will support broad dispersal of sediment into the coastal system. Initial results suggest the two placement strategies were successful and could be implemented in other locations in the South Atlantic Division.

Additional opportunities exist for beneficial use of nearshore- and non-beach-quality dredged material within the focus area. Non-beach-quality material can be used for ecosystem restoration within the focus area, including island habitat creation, marsh creation, and additional restoration efforts using thin-layer placement. The nearshore-quality material can be used for shoreline protection and beach nourishment projects. Rough order of magnitude (ROM) costs, quantities of material, and qualities of material sources can be developed with stakeholder interest.

4.3 Exposure

Exposure describes who and what may be harmed by the hazard and may include population, infrastructure, and environmental and cultural resources. The following section identifies exposure in the focus area.

4.3.1 Exposed Population

The population of Glynn County is approximately 80,000, according to the 2010 U.S. Census data. Approximately 20 percent of the county population is located within the boundaries of the city of Brunswick, 16 percent within St. Simons Island, and the remainder are dispersed throughout the coastal and riverine communities of the county (**Figure 10**). The exposed population consists of all residents in a potential storm surge area, residents of mobile homes, and all tourists. Per data derived from the 2013 Coastal Georgia Hurricane Evacuation Study (**Table 4**), Glynn County has the highest proportion of its population located in a surge area of all of the coastal counties in Georgia. Approximately 97 percent of the county population is located within the Category 5 MOM surge area (77,000 people) and 69 percent (55,000 people) of the county population are located within the Category 2 surge area. The total number of seasonal visitors and tourists to Glynn County can increase the county population by 35 percent or more (USACE 2013a). Seasonal visitors and tourists are primarily located within the Golden Isles, where many coastal communities are within the potential tropical storm and Category 1 surge areas.

Table 4: Exposed Population in Glynn County (USACE 2013a)

Surge Area	Total Resident Population Exposure	Mobile Home Population (subset of total residential population) Exposure	Tourist Population (100-Percent Occupancy) Exposure	Total Resident Population and Tourists
Tropical Storm	10,456	571	1,752	12,208
Category 1	20,426	878	9,984	30,410
Category 2	55,105	4,017	19,884	74,989
Category 3	70,048	5,294	23,823	96,871
Category 4	73,914	4,285	24,543	98,457
Category 5 MOM	77,390	5,776	27,999	105,389
Outside of Surge Area	2,236	96	0	2,236

Assessing future growth trends in population can indicate whether there will be an increase in people and associated infrastructure exposed to future hazards. Results from the U.S. Environmental Protection Agency's (EPA) Integrated Climate and Land Use Scenarios (ICLUS) projection for 2020 to 2100 project an increase in population within the Brunswick, Georgia metro area of more than 100 percent. Future population projections, developed by the Georgia Governor's Office of Planning and Budget, project a more modest population increase of 21.5 percent from 2020 to 2065 for Glynn County. With the projected increase in population and sea level rise, the exposed population in Glynn County is expected to rise. More detail on exposed population can be found in the Georgia Appendix.

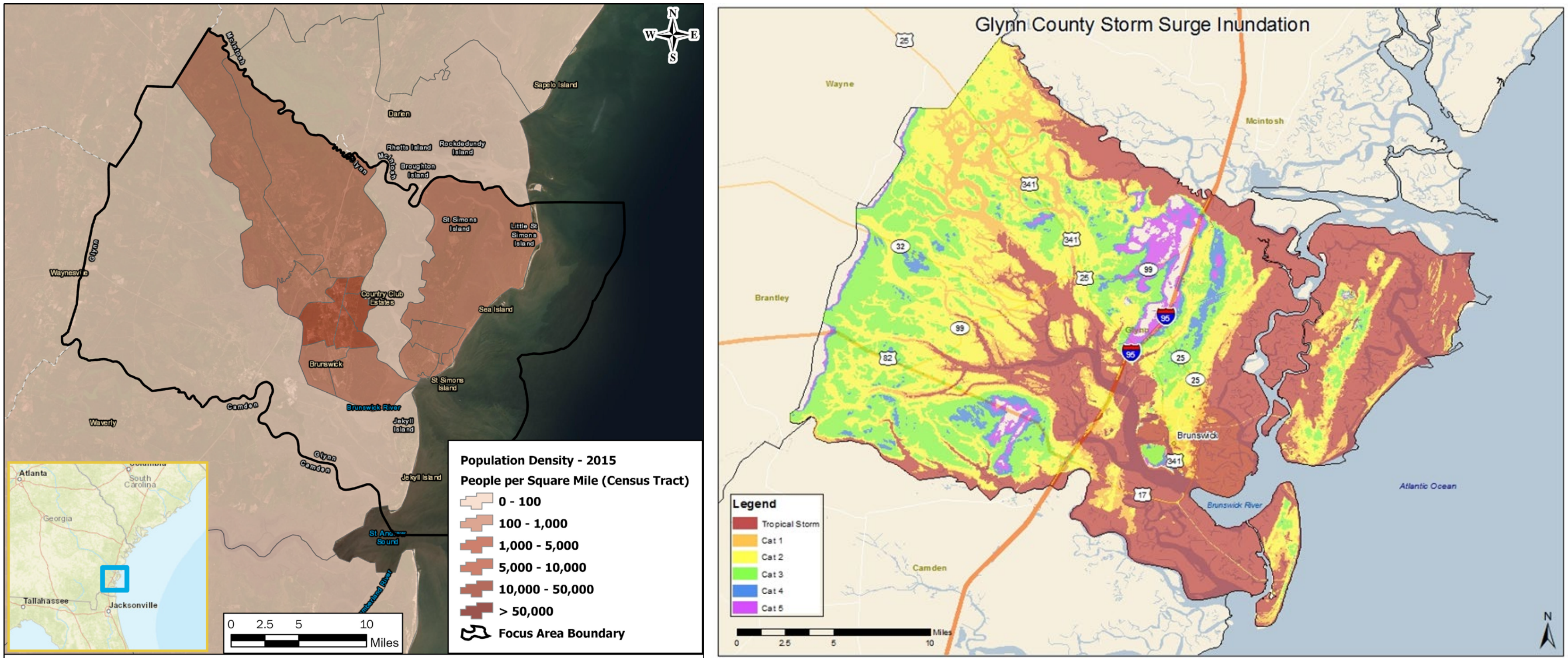

Figure 10: Glynn County Population by Census Block (2010 Census Bureau Decennial Census Data) along with a Storm Surge Inundation Map (Tropical Storm – Category 5 Maximum of Maximum) (USACE 2013a)

4.3.2 Exposed Infrastructure

Parcel data from the Glynn County tax assessor, local emergency management, and National Geospatial-Intelligence Agency NAVTEQ was used to determine the inventory of structures and critical facilities in the county that are exposed to a Category 5 MOM Storm Surge (USACE 2013a). The total number of exposed structures was estimated to be approximately 52,000 with the following breakdown by type, shown in **Table 5**.

Table 5: Exposed Infrastructure in Glynn County (USACE 2013a)

Structure Type	Total Number of Structures	Percent of Total Structures
Residential	34,907	67.8
Tourist	9,333	18.1
Commercial	4,841	9.4
Mobile Homes	2,348	4.6
Industrial	89	0.2

The exposure of critical facilities is concerning because they provide essential services and support functions that affect the livelihood of the community and are needed for emergency response activities before, during, and after an emergency. Critical facilities, according to FEMA, include hospitals, medical facilities, police stations, fire stations, primary communication facilities, shelters, emergency operations centers, power stations, and other utilities (FEMA 2017). Other critical facilities considered in the Glynn County exposure assessment include schools, nursing homes, hazardous materials (HAZMAT) locations, water/sewer treatment facilities, and local government offices. **Figure 11** identifies critical infrastructure elements within the projected tropical storm through the Category 5 MOM inundation area within Glynn County. This is not an inclusive list and only includes information provided by local governments and the above-referenced data sources. The following number and types of critical facilities are exposed to Category 5 MOM storm surge inundation in Glynn County, shown in **Table 6**.

Table 6: Exposed Critical Facilities in Glynn County (USACE 2013a)

Structure Type	Total Number of Facilities
Schools	35
Fire Stations	10
Medical	10
Police	7

Approximately 50 percent of the identified facilities are located within the 1-percent AEP flood zone, which highlights the impacts inundation hazards can have on the focus area. Glynn County has several roads that are low-lying and provide critical access to coastal communities. The most notable is F.J. Torras Causeway, which provides the only road access to St. Simons and Sea Island. Other examples include Riverside Drive, Ocean Highway 17 (**Figure 12**), Lanier Boulevard, and Crispin Boulevard.

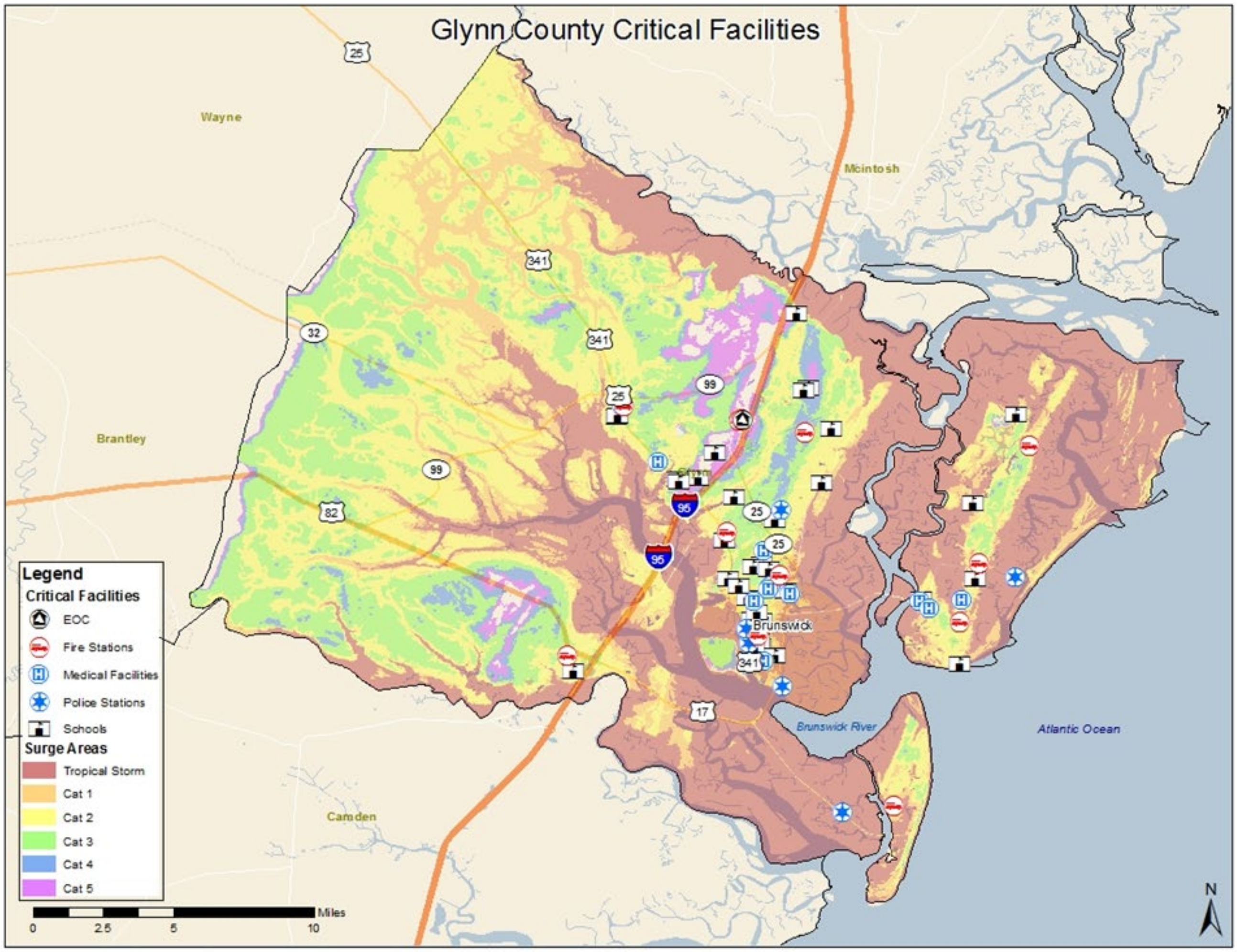

Figure 11: Glynn County Critical Facilities in Storm Surge Inundation Areas (Tropical Storm – Category 5 Maximum of Maximum) (USACE 2013a)

Figure 12: Highway 17 in Brunswick – Hurricane Irma (Adkison 2017)

4.3.3 Exposed Environmental and Cultural Resources

The Glynn County Focus Area is rich with Important and unique environmental and cultural resources. Plentiful food sources, multiple habitat types, tidal influence, and ocean access have resulted in rich biodiversity in coastal Georgia and a long history of human inhabitation. Important cultural resources are considered to be those that are listed or eligible for listing on the National Register of Historic Places. Coastal storms and sea level rise continue to expose environmental and cultural resources to alteration or loss.

Sections 4.3.3.1 and 4.3.3.2 summarize the environmental and cultural resources exposure identified in the Glynn County Focus Area. Potential CSRM measures to protect these resources are discussed in Section 5.1. Additional details can be found in the Georgia Appendix and Environmental Technical Report (USACE 2022a) and Tier 2 Cultural Resources Appendix.

4.3.3.1 Environmental Resources

Diverse habitats in the focus area located within the Category 5 Maximum inundation footprint include east-facing unconsolidated shorelines, dune habitat, palustrine and estuarine scrub-shrub wetlands, forested wetlands, emergent vegetation habitat, and salt marsh. They also include mixed hardwood and coastal hardwood communities. **Figure 13** identifies the approximate distribution of the primary habitats located within the focus area based on the NOAA Coastal Change Analysis Program (C-CAP) land cover classification system. Wetlands of Glynn County total approximately

125,000 acres and cover 42 percent of the county land area. The dominant wetland habitat type within the focus area is estuarine emergent wetland, which is found throughout the intertidal zone of the barrier islands and within and adjacent to the tidal waterways and estuarine environments (GADNR 2012).

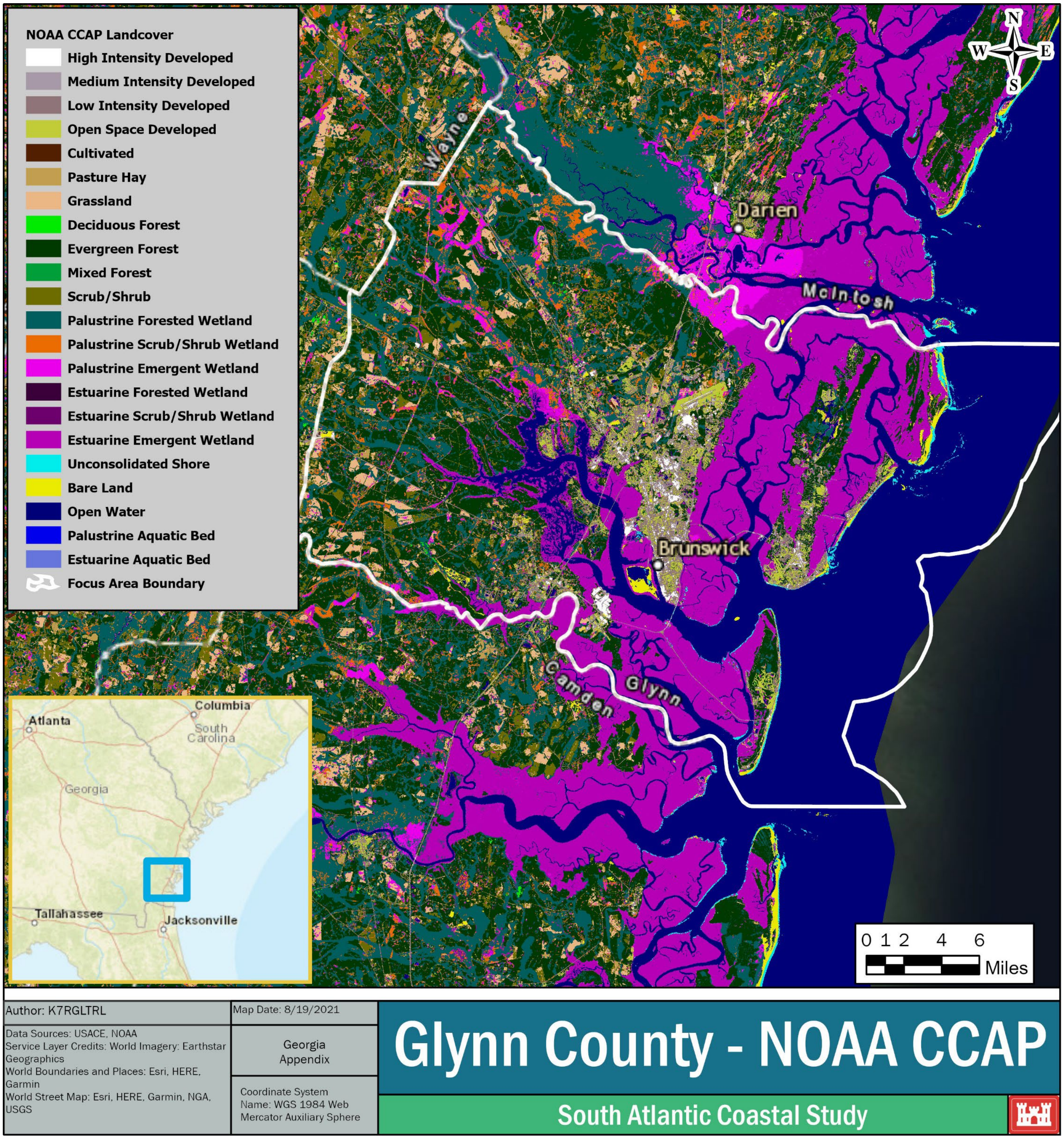

Figure 13: Coastal Change Analysis Program (C-CAP) Land Cover Classifications in Glynn County

Throughout the focus area vicinity, numerous environmental resources are exposed to increased coastal storm hazards as a result of sea level rise. While environmental resources have evolved with coastal storms, exposure due to sea level rise combined with other factors (e.g., development density and water quality impacts), create ongoing stresses to resources, thus making them more susceptible to the shocks of coastal storms. Critical habitat within the focus area is particularly susceptible to these inundation hazards as the physical or biological features are essential to conservation of the Endangered Species Act (ESA) listed species which are identified at the time of listing. Within Glynn County, coastal beach habitat along Little St. Simons, St. Simons, and Jekyll Island are designated by the U.S. Fish and Wildlife Service as foraging critical habitat for over-wintering piping plovers (ESA listing- threatened) **Figure 14** displays the critical habitat located within Glynn County.

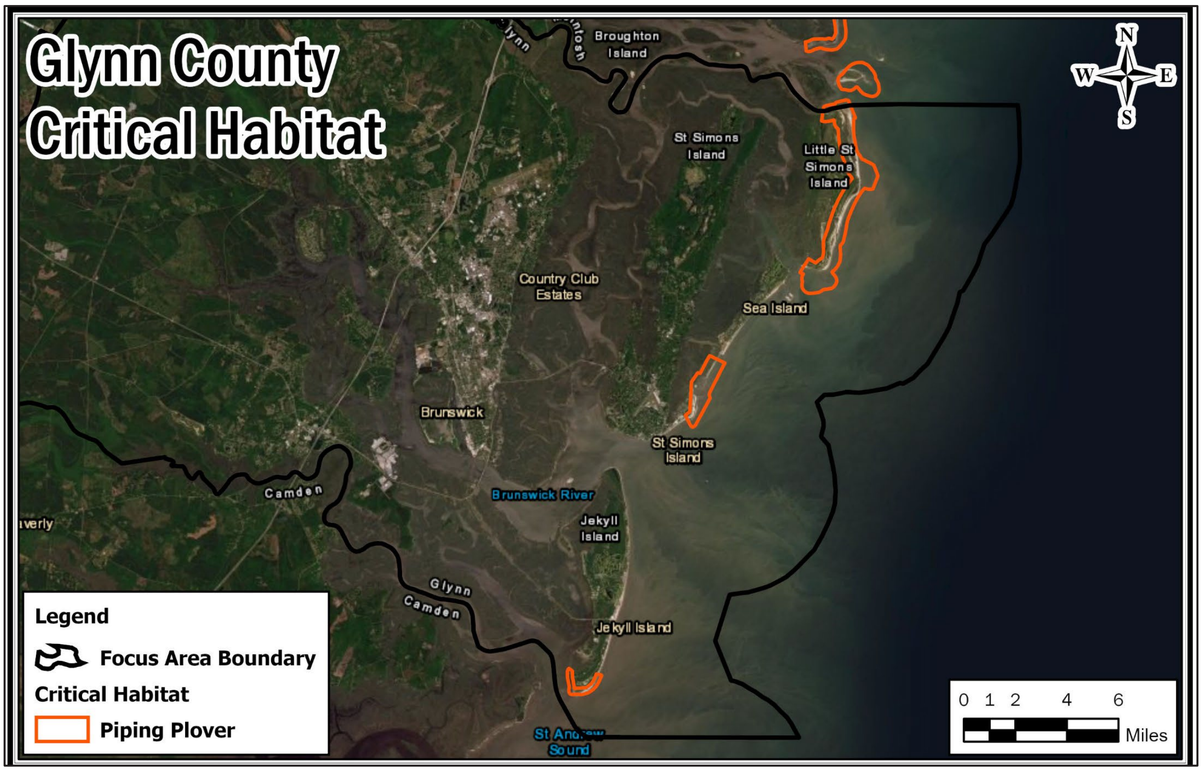

Figure 14: Critical Habitat for Loggerhead Sea Turtle and Piping Plover in the Glynn County Focus Area

4.3.3.2 Cultural Resources

Cultural resources were identified using information and datasets from the U.S. National Parks Service (NPS), the U.S. Geological Survey, and Georgia's Natural, Archaeological and Historic Resources GIS (GNAHRGIS) (U.S. National Parks Service 2020, U.S. Geological Survey 2021, Georgia Archeological Site File at the University of Georgia, and the Georgia Department of Natural Resources n.d.). Data gathered from these databases are current as of June 2021, and any cultural resources added after that point will not be represented in this analysis throughout the report. A query of GNAHRGIS revealed that approximately 3,400 historic resources are listed for Glynn County, with high concentrations of the resources located near the coasts of St. Simons and Jekyll Islands and near Brunswick. Of these resources, approximately 3,200 are located in the future condition (3-foot sea level rise) 1-percent and 10-percent AEP flood zones and are therefore at a higher exposure level.

A selection of three cultural resource areas were identified within, or partially within, the Glynn County Focus Area, which were identified as high risk due to the hazards of inundation, erosion, and wave attack (See **Table 7**). These are St. Simons Island, Jekyll Island, and Brunswick. Cultural resources within those areas were selected through both quantitative means, such as determining which cultural resources were located in areas of greater exposure, and qualitative means, such as literature review and stakeholder input. The table below is not all-inclusive and is meant to communicate the types of cultural resources that may be found in these areas. A selection of historic properties and districts are highlighted due to their National Register status and stakeholder input regarding their historical significance and concern for continued preservation due to their higher exposure rating. General information is also included regarding the presence of archaeological sites in areas of higher exposure.

Table 7: Cultural Resources Areas Exposed to Storms and Sea Level Rise in the Glynn County Focus Area

Cultural Areas	Exposed Cultural Resources
St. Simons	Ft. Frederica National Monument, St. Simons Lighthouse and Lighthouse Keepers' Building, U.S. Coast Guard Station at St. Simons Island, Hamilton Plantation slave cabins, and approximately 82 historic and prehistoric archaeological sites subject to erosion.
Brunswick	Brunswick Old Town Historic District, Hofwyl-Broadfield Plantation, and approximately 19 historic and prehistoric archaeological sites subject to erosion.
Jekyll Island	Jekyll Island Historic District and National Historic Landmark, Jekyll Island Club, Indian Mound Cottage (Rockefeller Cottage), Faith Chapel, and approximately 52 historic and prehistoric archaeological sites subject to erosion.

These resources are discussed in greater detail below. Exposed cultural resource areas identified within the FAAS report are not meant to be all-inclusive. Publicly available data for historic resources are discussed below. Specific archaeological site information is not publicly reportable but was analyzed to determine if archaeological sites are exposed to coastal storm hazards.

St. Simons Island

Over 400 historic resources located on St. Simons Island were constructed from the 1700s to the 1960s. The Fort Frederica National Monument was listed in the NRHP in October 1966 and is a town and fort complex built between 1736 and 1748 that is now at risk due to erosion and inundation (NPS n.d.-b, n.d.-c). The St. Simons Lighthouse and Lighthouse Keeper’s Building (NRHP-listed April 1972) are located at the southern end of the island (NPS 1972). Originally built in 1872, the lighthouse is one of only five remaining lighthouses in Georgia and still actively assists ships navigating into the St. Simons Sound. Resources located along the perimeter of St. Simons Island and along the southern end of the island, such as the lighthouse, are subject to flooding during coastal storm surges. St. Simons Island also boasts a rich Gullah Geechee cultural history and is part of the Gullah Geechee Cultural Heritage Corridor (Holladay 2016). The current projections for sea level rise in that area could permanently inundate portions of the historic Gullah Geechee communities. Storm surges and flooding are a threat to many of the historic buildings on the island. Of the 88 archaeological sites located on St. Simons Island, approximately 82 are located in the 1-percent and 10-percent APE flood zones and are therefore at greater exposure to coastal storm hazards, including erosion and wave attack.

Jekyll Island

Jekyll Island is a barrier island that has undergone the least net change of Georgia's currently inhabited barrier islands since the mid-1800s (Crook 1985). The island was used seasonally by the Guale and Mocama tribes, as evidenced by extensive shell middens. The Jekyll Island Historic District (NRHP-listed January 1972) is a 240-acre site with 34 contributing properties, including the Jekyll Island Club (historic hotel), Indian Mound Cottage (also referred to as the Rockefeller Cottage), and Faith Chapel (NPS n.d.-e). While there has been little change in overall dimensions of the island, it has migrated southward through erosion on the northern end and accretion on the southern end (Crook 1985). Resources on the island are particularly threatened by incremental sea level rise leading to higher average tides, coupled with more intense storm events. Of the 55 archaeological sites located on St. Simons Island, approximately 52 are located in the 1-percent and 10-percent APE flood zones and are therefore at greater exposure to coastal storm hazards, including erosion and wave attack.

Brunswick

Brunswick is one of two deep water ports on the coast of Georgia, and the area contains two historic districts that have been impacted by storms and compound flooding. The Brunswick Old Town (NRHP-listed December 1974) and the Brunswick Old Town Historic District (NRHP-listed April 1979) are associated with the site of the colonial British town of Brunswick that was founded in 1771 (NPS n.d.-a). The town contains many historic residential and public structures dating to the late 1800s, including the Hazelhurst-Taylor House, Mahoney-McGarvey House, and the Old City Hall. The Dixville Historic District (NRHP-listed December 2019), located along the southern tip of the Brunswick peninsula, was a neighborhood established in 1875 that grew into a thriving African American community in the 1910s. This location is susceptible to storm surge and compound flooding. Brunswick features a rich Gullah Geechee cultural history and benefits from heritage tourism related to this history (Holladay 2016). Other notable historic properties in Brunswick include the Hofwyl-Broadfield Plantation (NRHP-listed July 1976), a rice plantation dating between 1800 and 1915 that is in the marshlands of the Altamaha River and is now a Georgia state historic site (NPS n.d.-d). Of the 26 archaeological sites located on St. Simons Island, approximately 19 are located in the 1-percent and 10-percent APE flood zones and are therefore at greater exposure to coastal storm hazards, including erosion and wave attack.

4.3.3.3 Environmental and Cultural Resource Uncertainty

There are multiple sea level rise scenarios for Georgia that suggest sea level rise will continue to increase, although specific scenarios will identify a variation of low-high sea level rise projections. Uncertainty reinforces the need for adaptable strategies and the importance of scenario planning, rather than using specific, deterministic single values for future sea level rise. If protective measures are not implemented, habitat types with limited tolerance to salinity may migrate inland, be displaced by others, or be lost due to inundation or erosion. Cultural resources may be subjected to increased erosive forces, increased saline conditions, and potential inundation due to of coastal storm damage and sea level rise.

4.4 Vulnerability

Vulnerability is the susceptibility of harm to human beings, property, the environment, and cultural resources when exposed to a hazard.

The SACS Main Report and Georgia Appendix describe how vulnerability was incorporated in Tier 1 and Tier 2 analyses. The following subsections summarize components that increase the vulnerability of the area and provide additional vulnerability information available for the focus area.

4.4.1 Social Vulnerability

Social vulnerability refers to the potential negative effects on communities caused by external stresses on human health. Such stresses include natural or human-caused disasters, or disease outbreaks.

4.4.1.1 Social Vulnerability Index

The Centers for Disease Control and Prevention Social Vulnerability Index (CDC SVI) was used to further evaluate social vulnerability within the focus area by assessing overall SVI percentile rankings at the census tract scale. The CDC SVI depicts the social vulnerability of communities by assigning an SVI percentile ranking that ranges from 0 (lowest vulnerability) to 1 (highest vulnerability) based on national comparisons. The overall CDC SVI ranking for Glynn County is 0.7851, which indicates a high level of vulnerability within the focus area. At a more refined scale, census tracts primarily encompassing the city of Brunswick and the census-designated place of Dock Junction to the north have significantly higher CDC SVI rankings (>.7501) than neighboring coastal communities in Jekyll and St. Simons Islands, indicating a high level of social vulnerability (**Figure 15**). Additional detail on the CDC SVI can be found in the Georgia Appendix.

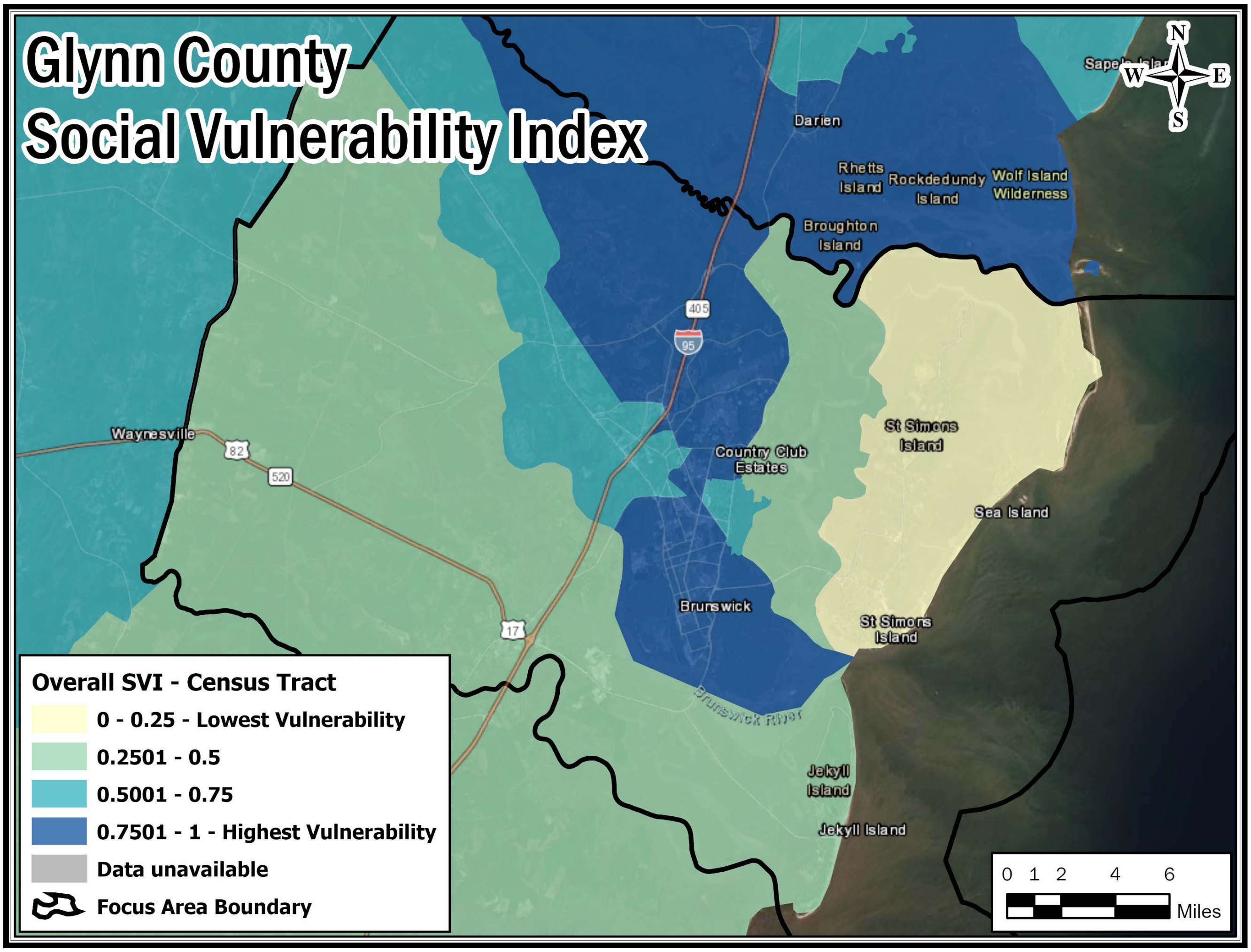

Figure 15: Glynn County Centers for Disease Control Social Vulnerability Index Ranking by Census Tract (CDC 2018)

4.4.1.2 Vulnerable Populations

The 2013 Coastal Georgia Hurricane Evacuation Study and 2010 Census Demographic Profile data provide a broad overview of demographics within the focus area. Compared to national averages, the population of Glynn County has more elderly residents (15 compared to 13.0 percent), similar children (24.2 compared to 24.0 percent), similar poverty level (15.2 compared to 15.3 percent), more mobile home residents (11.5 compared to 6.6 percent) and fewer households without vehicles (8.6 compared to 9.1 percent). Glynn County has a higher population density at 189.7 people per square mile, approximately twice the national average of 88.4. The racial profiles of Glynn County and the state are similar.

Socioeconomic aspects of concern that may affect a community's ability to mitigate or evacuate from coastal storm hazards include mobile home residents, age, household income, vehicle availability, and crowded households. Within the City of Brunswick, more than 30 percent of residents are below the poverty level and 11.5 percent of the Glynn County population resides in mobile homes. These population groups are particularly vulnerable to coastal storm risks. The age breakdown of the population reflects a larger number of people over age 65 living in Glynn County (15 percent). The number of residents over age 65 is significantly higher within the Golden Isles communities. Past behavioral studies have shown that the elderly residents are more reluctant to evacuate than younger populations (USACE 2013b).

4.4.1.3 Environmental Justice

USACE conducted an evaluation of Environmental Justice (EJ) by determining whether the study area contains a concentration of minority and/or low-income populations.

As defined in Executive Order 12898 and the Council on Environmental Quality (CEQ) guidance, a minority population occurs where one or both of the following conditions are met within a given geographic area:

- The American Indian, Alaskan Native, Asian, Pacific Islander, Black, or Hispanic population of the affected area exceeds 50 percent; or
- The minority population percentage of the affected area is meaningfully greater than the minority population percentage in the general population or other appropriate unit of geographic analysis.

An affected geographic area is considered to consist of a low-income population where the percentage of low-income persons:

- is at least 50 percent of the total population; or
- is meaningfully greater than the low-income population percentage in the general population or other appropriate unit of geographic analysis.

The EPA EJSCREEN is an environmental justice mapping and screening tool that provides EPA with a nationally consistent dataset and approach for combining environmental and demographic indicators (EPA 2020). EJSCREEN users choose a geographic area; the tool then provides demographic and environmental information for that area. For the purposes of this evaluation, only demographic information was applied.

The low-income population is defined as the percent of a block group's population in households where the household income is less than or equal to twice the federal "poverty level."

The minority population is defined as the percent of individuals in a block group who list their racial status as a race other than white alone and/or list their ethnicity as Hispanic or Latino. That is, all people other than non-Hispanic white-alone individuals. The word "alone" in this case indicates that the person is of a single race, not multiracial.

Using the EJScreen tool, the study area was user-defined (**Figure 16**) to calculate the average percentages for EJ criteria. The result is a population-weighted average, which equals the block group indicator values averaged over all residents who are estimated to be inside the study area. **Table 8** compares the average percentages for the study area, the State of Georgia, and the United States.

Based on the information provided by the EJScreen tool, the average minority population is approximately 36 percent of the total population and approximately 35 percent of the population in the study area are considered low-income. When assessed at a county level geographic scale, Glynn

County does not meet the EJ community minimum threshold because the minority population and low-income percentages are below 50 percent. It should be noted that 2019 Census Bureau estimates show greater than 50 percent of the City of Brunswick population is Black or African American, while demographics for unincorporated Glynn County, Jekyll Island, St. Simons Island, and Sea Island vary considerably.

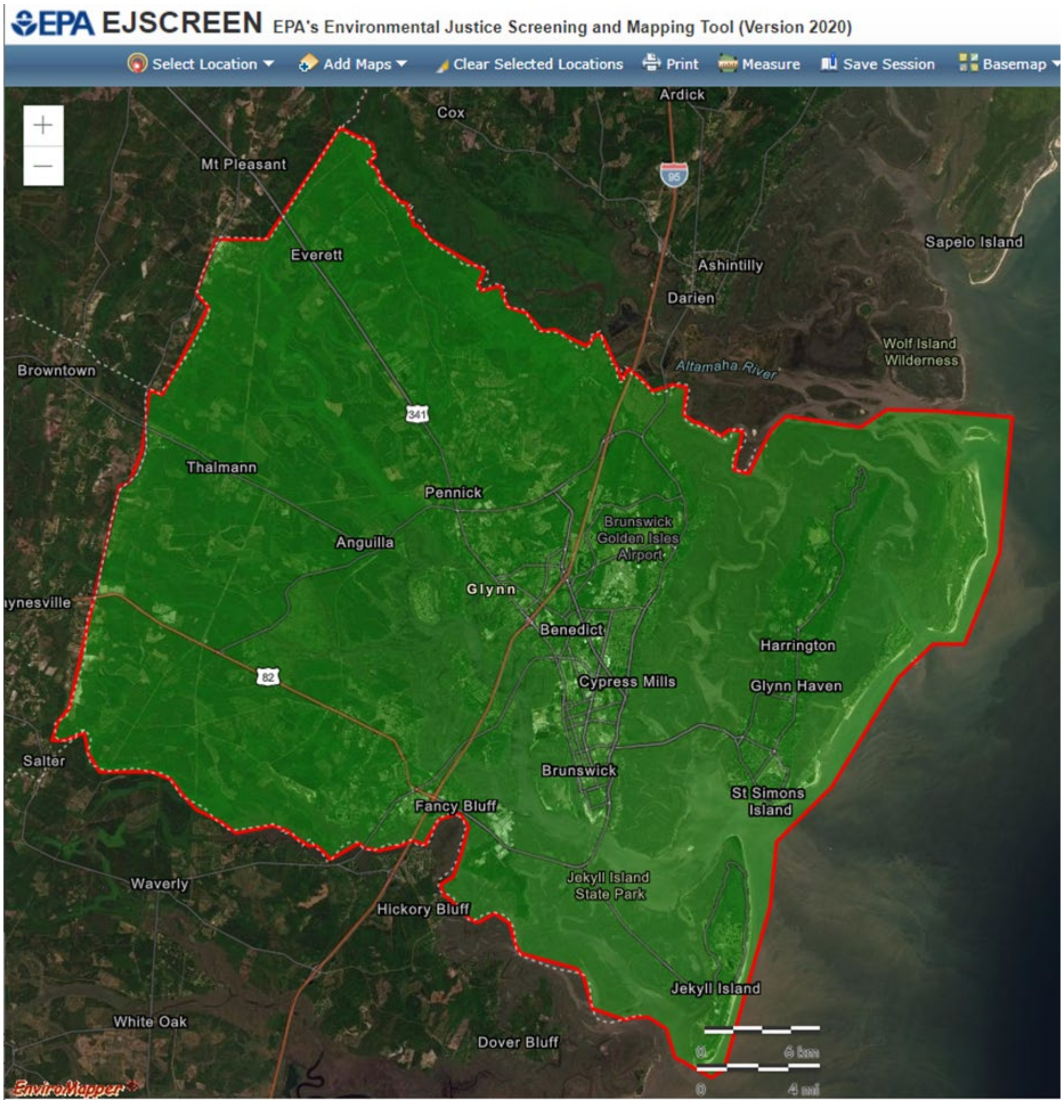

Figure 16: User-Defined U.S. Environmental Protection Agency (EPA) EJScreen Tool Analysis Boundary (EPA 2020)

Table 8: U.S. Environmental Protection Agency (EPA) EJScreen Tool Environmental Justice Criteria Percentages (EPA 2020)

Population Type	User Defined Project Area %	Georgia Average %	U.S. Average %
Minority Population	36	47	39
Low Income Population	38	36	33

4.4.2 Environmental Resources Vulnerability

A Tier 2 Environmental Resources Vulnerability Analysis was conducted for Planning Reach GA_05 to determine the degree to which natural areas are susceptible to loss or degradation when exposed to coastal storm hazards and sea level rise. From this analysis, a vulnerability table was created that assessed the numerical level of vulnerability of NOAA's Coastal Change Analysis Program (C-CAP) named natural habitats against the hazards of sea level rise, storm surge inundation, saltwater intrusion, erosion, and wind damage. Based on the results of this assessment, a weighted formula was developed to assign a vulnerability rating of each C-CAP class (low, medium, or high) for each state and territory in the SACS study area (**Table 9**). **Figure 17** reflects the results of the vulnerability scoring for each C-CAP habitat that is found within the focus area.

Table 9: Coastal Change Analysis Program (C-CAP) Classes Vulnerability Rating

Coastal Change Analysis Program (C-Cap) Habitat	Vulnerability Rating
Estuarine scrub/shrub wetlands	Low
Open water (tidal/non-tidally influenced rivers, lakes & ponds).	Low
Mixed forest	Medium
Grassland/herbaceous	Medium
Scrub/shrub	Medium
Palustrine scrub-shrub wetlands	Medium
Palustrine emergent wetlands	Medium
Palustrine forested Wetlands	Medium
Estuarine emergent wetlands (salt marsh, oyster flats/beds)	Medium
Estuarine aquatic bed	Medium
Palustrine aquatic bed	Medium
Open space (rural open undeveloped uplands)	High
Evergreen forest	High
Deciduous forest	High
Unconsolidated shore (intertidal mudflats, non-vegetated mudflats, beaches/barrier islands)	High

In addition to rating the vulnerability of the natural habitats to the hazards identified above, the ability for the natural habitat to adapt to these conditions was also assessed. Low tolerances of certain habitats to water and soil chemistry changes due to saltwater inundation and intrusion and impediments to migration were identified as important vulnerability considerations. Anthropogenic activities, such as increased residential and commercial development in the coastal plain, and the construction of structural coastal storm risk management infrastructure (e.g., sea walls), can produce barriers that impede inland migration of natural resources.

Please see Appendix B of the Environmental Technical Report (USACE 2022a) for a more detailed summary of the resource vulnerability table and scoring criteria.

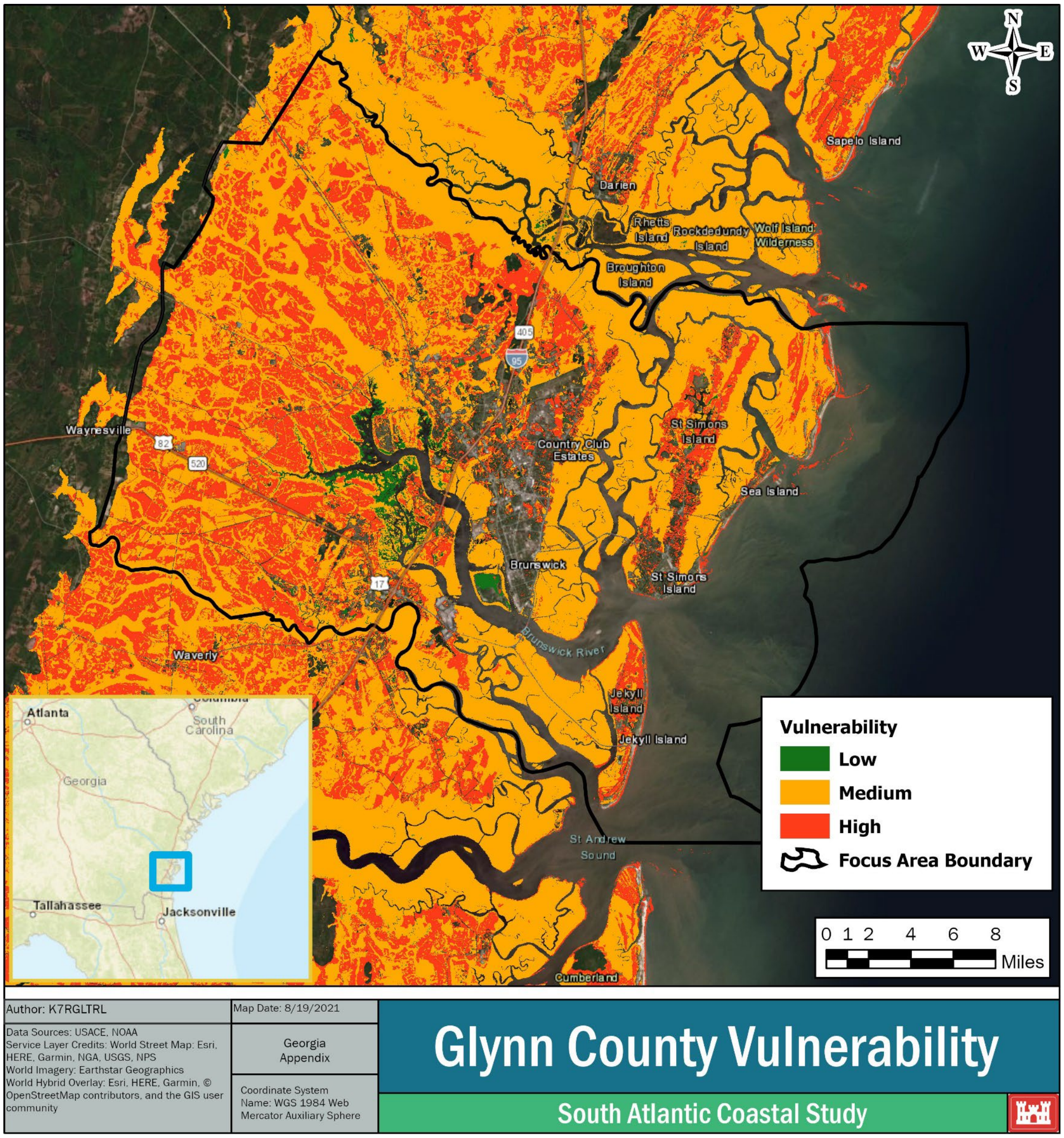

Figure 17: Glynn County Tier 2 Environmental Resources Vulnerability Rating for Coastal Change Analysis Program (C-CAP) Habitats

4.4.3 Cultural Resources Vulnerability

Based on a qualitative assessment of vulnerability, historic structures and archaeological sites located on barrier islands, along the coast, and in low lying areas face vulnerability due to storm surge inundation, erosion, and wave attack (**Table 10**). While other census areas in Glynn County contain cultural resources, the census areas of the St. Simons Island, Brunswick, and Jekyll Island were selected for closer review due to the number of significant resources (i.e., listed or eligible for listing on the National Register) and the greater exposure to hazards that may impact these resources. Storm surge inundation along the coast and reaching up rivers to low lying areas will flood historic properties and damage buildings. Damage may include, but is not limited to, structural damage and destruction of historic materials (e.g., furniture, textiles, archives). The aftermath of a storm can pose long-term issues, such as the development of mold, mildew, and other potentially toxic residues. Erosion and wave attack pose threats to historic properties and both terrestrial and submerged archaeological sites. Significant structural damage can be caused to historic properties by wave attack. Erosion can eliminate surface evidence of archaeological sites, wear away site layers, and displace materials from various cultural layers making recovery and interpretation challenging if not impossible. Erosion will impact features more severely due to the disturbed nature of the soil, while leaving intact topographic layers less damaged. Strong currents cause hydrographic change that can displace submerged cultural resources, including historic wrecks, as well as obscure or damage these resources due to storm debris. Currents and wind can uproot trees and other vegetation, which can serve as a major source of disturbance and destruction for both historic properties and archaeological sites.

Table 10 below indicates if the exposed cultural resource area is vulnerable to the Tier 2 hazard. This table is not all-inclusive and is meant to communicate the types of cultural resources that may be found in these areas and the types of vulnerability that they may face. A selection of historic properties and districts are highlighted due to their National Register status and stakeholder input regarding their historical significance and concern for continued preservation due to their higher exposure rating. General information is also included regarding the presence of archaeological sites in areas of higher exposure.

Table 10: Vulnerability of Exposed Cultural Resources Areas to the Tier 2 Hazards for the Glynn County Focus Area

Exposed Cultural Resource Area		Tier 2 Hazards		
		Storm Surge Inundation	Erosion	Wave Attack
St. Simons	Ft. Frederica National Monument	Y	Y	N
St. Simons	St. Simons Lighthouse and Lighthouse Keepers' Building	Y	Y	Y
St. Simons	U.S. Coast Guard Station at St. Simons Island	Y	Y	Y
St. Simons	Hamilton Plantation Slave Cabins	Y	Y	N
St. Simons	Historic and Prehistoric Archaeological Sites	Y	Y	Y
Brunswick	Old Town Historic District	Y	Y	N
Brunswick	Hofwyl-Broadfield Plantation	Y	Y	N
Brunswick	Historic and Prehistoric Archaeological Sites	Y	Y	N
Jekyll Island	Jekyll Island Historic District and National Historic Landmark	Y	Y	N
Jekyll Island	Jekyll Island Club	Y	Y	N
Jekyll Island	Indian Mound Cottage (Rockefeller Cottage)	Y	Y	N
Jekyll Island	Faith Chapel	Y	Y	N
Jekyll Island	Historic and Prehistoric Archaeological Sites	Y	Y	Y

Within the Glynn County focus area, there are several historic districts, historic forts, plantation sites, historic lighthouses, and archaeological sites along the coast and on barrier islands that are susceptible to damages from coastal storm hazards, including storm surge inundation, erosion, and wave attack. The most susceptible is Ft. Frederica National Monument and the St. Simons Lighthouse. While some historic districts have protections, such as sea walls, in place to minimize vulnerability, many of the historic structures are vulnerable to storm surge inundation and the associated damage that it brings. The Jekyll Island Historic District is an example of a historic district that could be severely impacted by storm surge inundation, especially if protection measures fail or are not sufficient to protect against more extreme storm episodes. Historic and archaeological sites on barrier islands within the focus area, such as St. Simons and Jekyll Islands, are susceptible to damages primarily from erosion and wave attack. Previous studies by the GADNR Historic Preservation Division (HPD) and Skidaway Institute of Oceanography have documented archaeological sites that are in danger of, or are presently, being lost to erosion within Georgia's barrier islands (Skidaway Institute of Oceanography 2017). Vulnerable sites identified by the GADNR HPD included prehistoric Indian shell middens, prehistoric Indian artifact and shell scatters, and burial sites, among other archaeological sites subject to erosion.

4.5 Risk Assessment

Risk is broadly defined as a situation or event where something of value is at stake and its gain or loss is uncertain. Risk is typically expressed as a combination of the likelihood and consequence of an event. Consequences are measured in terms of harm to people, cost, time, environmental harm, property damage, and other metrics (USACE 2019).

Table 11 identifies the high-risk places in the Glynn County Focus Area based on the Tier 1 and Tier 2 Risk Assessments, which are detailed in the Georgia Appendix. The census places of Brunswick and St. Simons Island were identified as high risk for all criteria listed in **Table 11**. St. Simons Island was the only census place within the GA_05 Planning Reach identified as high risk under the existing condition Tier 2 Economic Risk Assessment. The rest of the locations were identified as high risk in one or more criteria, including environmental and cultural resources and the erosional analysis.

Table 11: High-Risk Census Places in the Glynn County Focus Area

Census Place or Location	Tier 1 Risk Assessment Future High-Risk Location	Tier 2 Economic Risk Assessment Future High-Risk Location	At-Risk Cultural Resource Area	At-Risk Priority Environmental Area	Shoreline Retreat Areas (Erosional Hotspots)
Brunswick	X	X	X	X	
Country Club Estates	X	X			
Dock Junction	X	X			
Jekyll Island			X	X	
Little St. Simmons				X	X
St. Simons	X	X	X	X	X
St. Simons (North Frederica Area)[1]		X			

[1]Unincorporated places (not associated with a census place) that met the criteria of high-risk

These locations were used as a starting point to develop action strategies to reduce existing and future risk from coastal storm hazards and their increase from sea level rise. This was further refined by a diverse group of stakeholders who identified specific areas within these census places with problems and needs. Action strategies were then developed for these areas.

4.5.1 Tier 1 Risk Assessment

The Tier 1 Risk Assessment used a composite index of national-level datasets to determine coastal storm and sea level rise risk on the southeast coast. The methodology of the Tier 1 Risk Assessment is described in the Main Report and in the Georgia Appendix. The Tier 1 Risk Assessment was used to identify four census places in Glynn County that showed the greatest existing and future composite risk (**Figure 18**). Among these census places, approximately 6,600 acres were either medium-high risk or high risk under existing conditions. With the addition of a 3-foot sea level rise, this number rose to 8,900 acres, an increase of 34.5 percent. The census place with the greatest portion of land at risk under future conditions is St. Simons Island (approximately 45 percent), while farther inland abutting the East River, Dock Junction showed the greatest percent change in risk from existing to future conditions (approximately a 73-percent increase). Census places exhibiting relatively low existing risk with a significant increase in future risk (e.g., Dock Junction) may be particularly susceptible to increased hurricane and storm damage due to sea level rise because residents may not be fully aware of or preparing for the potential future risk.

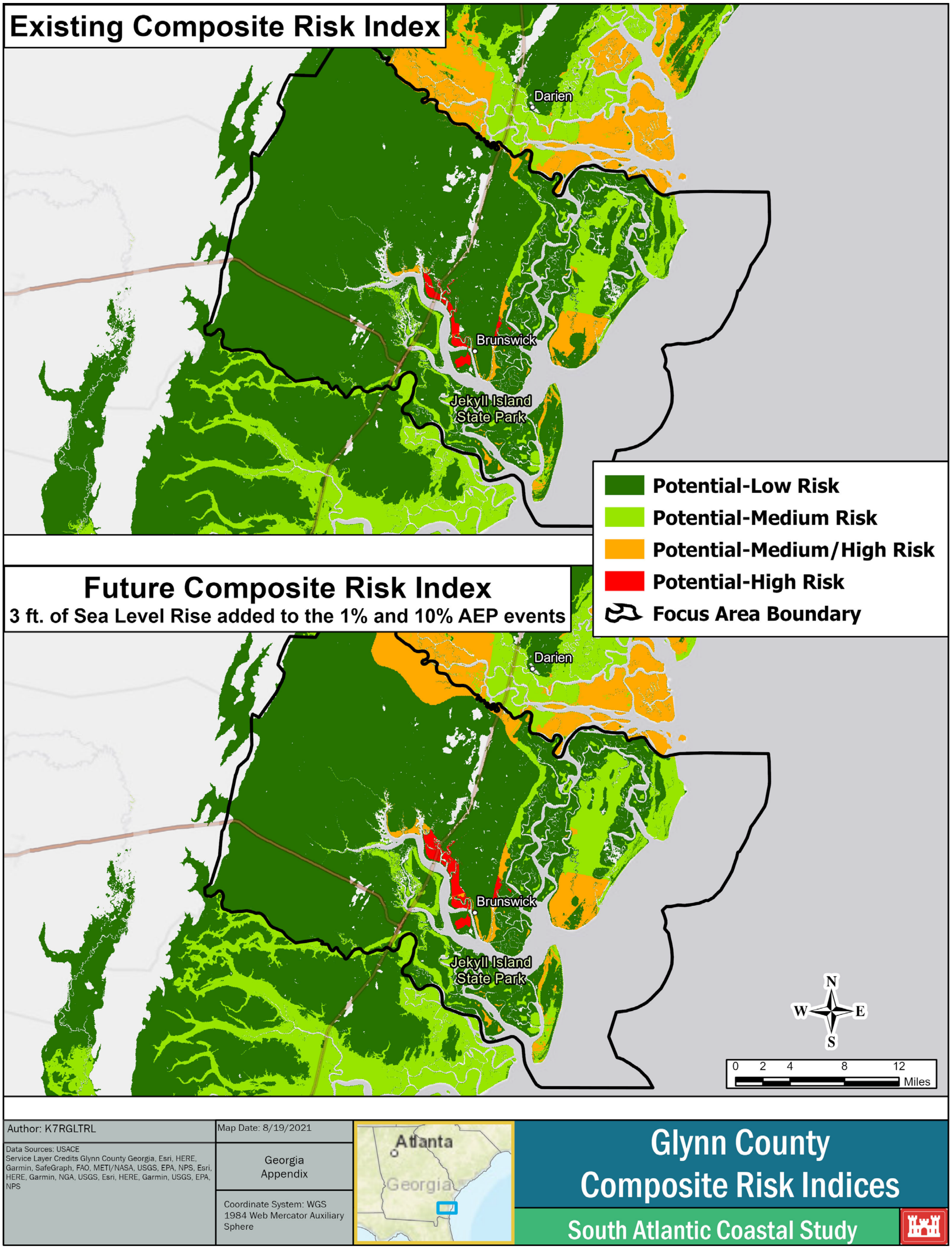

Figure 18: Existing and Future Condition Composite Risk in Glynn County

4.5.2 Tier 2 Economic Risk Assessment

As part of the Tier 2 Economic Risk Assessment, current and future expected annual damages (EAD) from coastal storm hazards were estimated using the FEMA Hazus Flood Model. The total EAD for the Glynn County Focus Area is approximately $39 million in the existing condition, and approximately $118 million in the future conditions with 3 feet of sea level rise. The Tier 2 Economic Risk Assessment indicates that the projected economic risks within Glynn County represent approximately 30 percent of the existing and future condition EAD within Planning Reach GA_05. **Figure 19** provides a snapshot of the Tier 2 Economic Risk Assessment for the focus area. Each circle on the map denotes separate census places and displays the distribution of economic risk from low to high. Bar charts on the figure highlight the census places with the greatest economic risk, with quantifications of the existing (green shading) and future risks, including sea level rise (black shading). Economic risks displayed are not cumulative. The data depicts where EAD are occurring as result of the hazard of inundation, and where the EAD are expected to increase in the future condition if no action is taken. The data can help inform communities on which potential actions should be implemented to mitigate the potential economic risks. The census place with the highest economic risk within Planning Reach GA_05 is St. Simons Island, with estimated EAD of $18 million under the existing condition and a projected $54 million under the future condition.

Figure 19 also contains the estimated damages from hazard events based on the event's AEP. For example, for the 1-percent AEP event (100 year event), estimated damages under existing conditions are approximately $630 million, and under future conditions, estimated damages are approximately $1.9 billion. These damage estimates include damages to physical structures and infrastructure caused by coastal inundation. These estimates do not include damages from flooding from inland runoff or compound flooding. The estimates also do not consider economic losses resulting from temporary or permanent business closures. Following a natural hazard event or impacts to the local economy from lost or reduced tourism, estimated damages under both existing and future conditions would be significantly higher.

For Planning Reach GA_05, a high-risk area included any location with a future risk rating of medium to high. A risk rating of high was defined as any location with estimated EAD above $10,455,000, medium-high above approximately $5,072,000, and medium above approximately $1,157,000. The Tier 2 Economic Risk Assessment identified two locations within Glynn County with a future risk rating of high—St. Simons and Brunswick—and three locations, Country Club Estates, Dock Junction, and the North Frederica Area of St. Simons was identified with a future risk rating of medium-high.

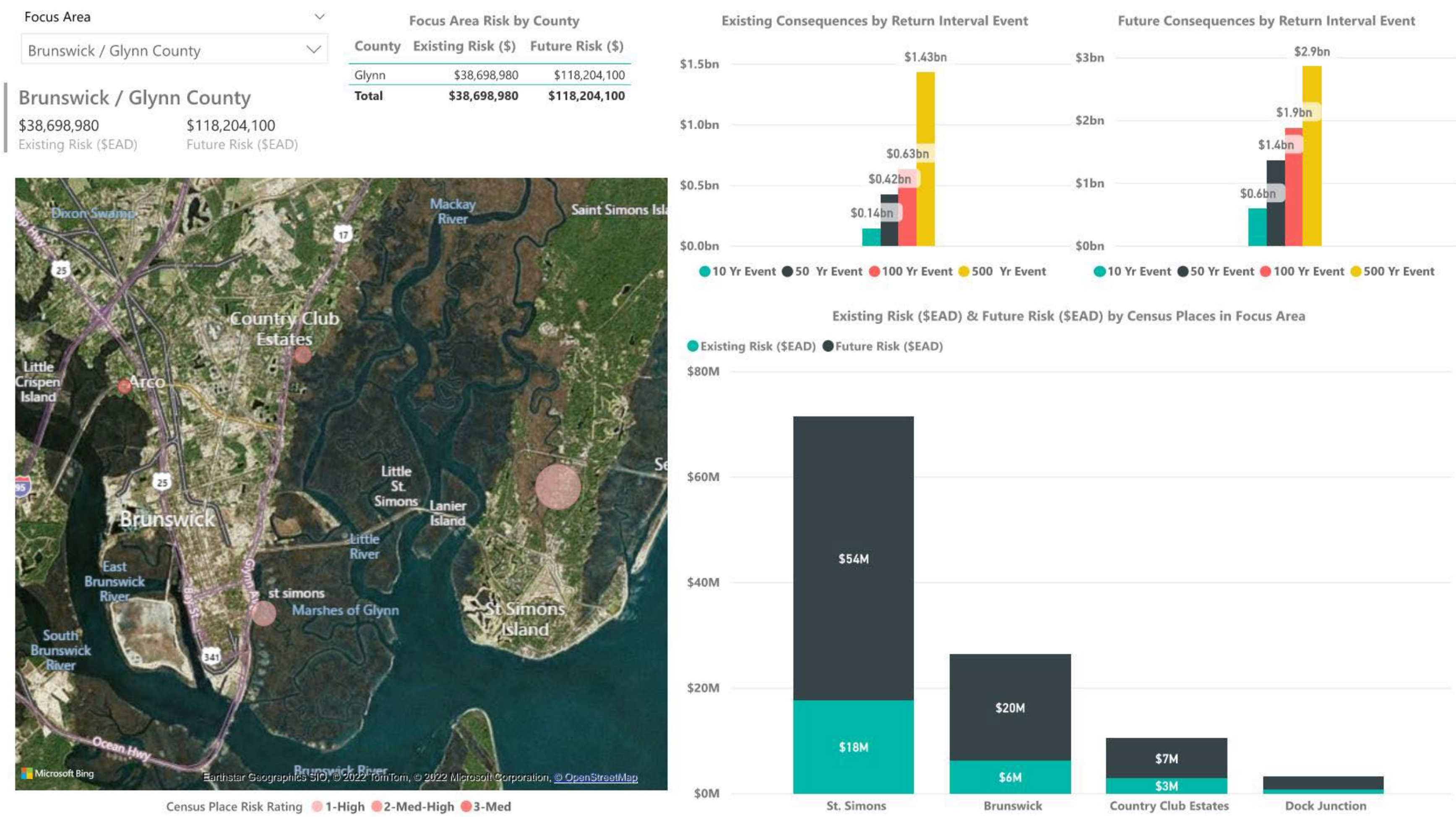

Figure 19: Tier 2 Economic Risk Assessment Dashboard

As part of the FAAS, the Tier 2 Economic Risk Assessment was further evaluated at the census block level to better understand the economic risk picture within the focus area (**Figure 20**). During the virtual Focus Area Visioning Meetings, stakeholders provided feedback on locations with projected high economic risks in the existing and future conditions. Areas of specific concern were identified within the city of Brunswick such as the Riverside Community and both ocean facing and back bay locations of St. Simons due to their projected EAD under the future condition with 3 feet of sea level rise. Data derived from the Tier 2 Economic Risk Assessment realizes the opportunity of gathering additional data on coastal hazards and vulnerability to refine current and future CSRM efforts. High risk locations identified above are directly correlated with problems within the focus area identified in Section 2.1. This information, in conjunction with the suite of SACS products and tools, was used to develop draft action strategies.

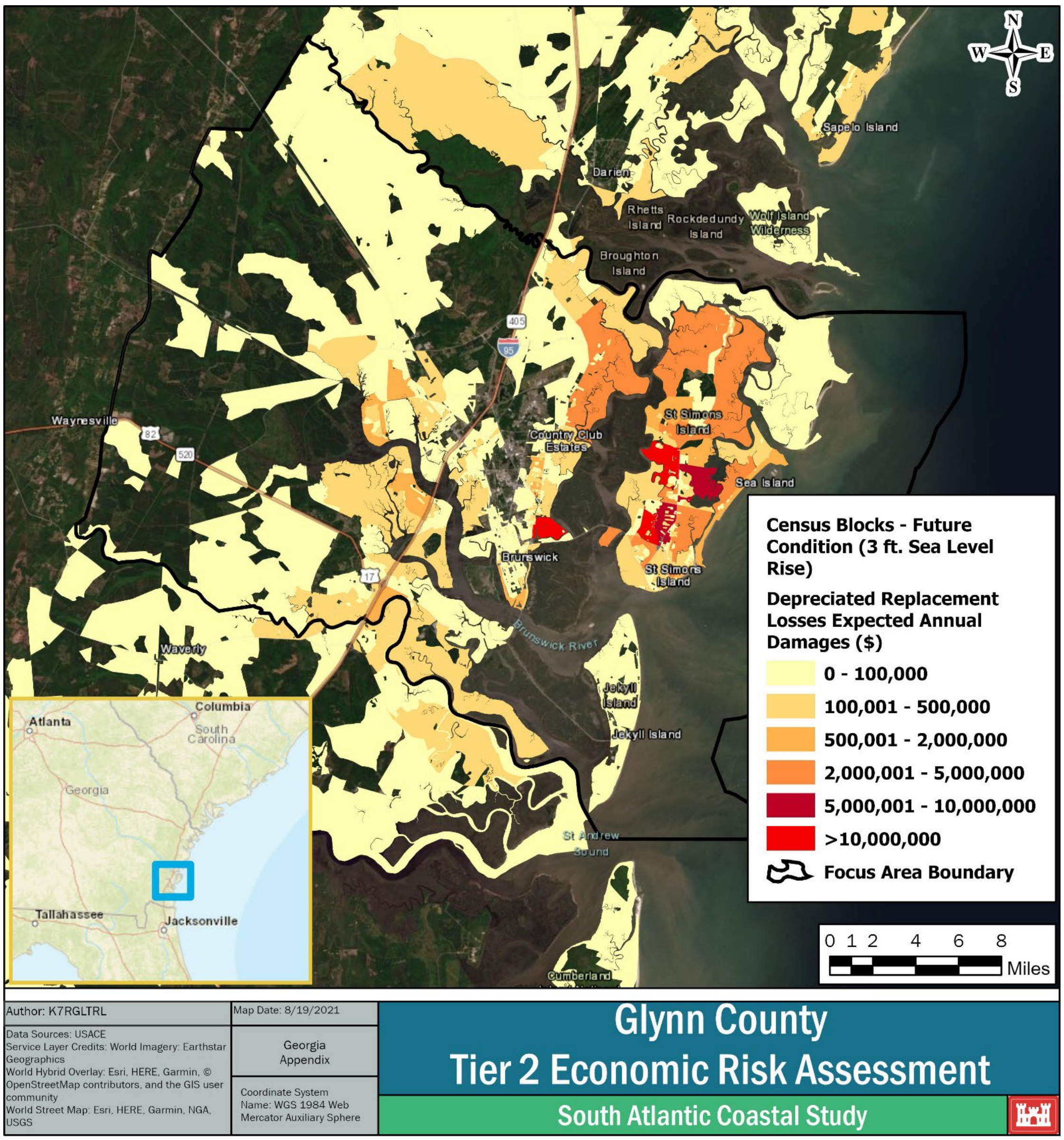

Figure 20: Tier 2 Economic Risk Assessment Future Risk Locations (Census Blocks) with 3-Foot Sea Level Rise in Glynn County

4.5.3 Priority Environmental Areas

A total of six priority environmental areas (PEAs) are identified within the Glynn County Focus Area. The PEA tables for each state and territory are located in the Environmental Technical Report (USACE 2022a). PEAs are natural areas or features at medium to high risk to storm surge inundation and sea level rise. PEAs support priority biological resources (defined in the U.S. Fish and Wildlife Service SACS Planning Aid Report as federally listed threatened and endangered species, waterbird nesting colonies, breeding and wintering shorebirds, or other managed species) and are considered high priorities for others including state and federal agencies and non-governmental organizations (for example, U.S. Fish and Wildlife Service critical habitats or national wildlife refuges, Audubon Important Bird Areas, state heritage preserves and wildlife management areas, areas of national and state environmental significance, etc.). These areas can be considered by stakeholders when looking for environmental resources to conserve and/or manage. Designation as a PEA by USACE does not create a special legal protection or status of the area and does not change how the area is regulated under federal and state laws. The following PEAs were identified for the Glynn County Focus Area.

Jekyll Island Park

Located just south of St. Simons Island and across St. Simons sound, Jekyll Island is the most southern-lying barrier island in Glynn County. It is 5,500 acres and contains approximately 10 miles of beach and shoreline. It is comprised of bottomland hardwood forest, scrub shrub, palustrine forested wetland, maritime forest/hammocks, estuarine scrub and marsh, freshwater marshes, tidal flats, and tidal wetlands.

This island provides important nesting habitat for the loggerhead sea turtle (*Caretta caretta*) and other sea turtle species. It also provides critical habitat for threatened piping plover (*Charadrius melodus*) on the south end. Several beach and dune areas also provide an important habitat for red knots, American oystercatchers and other wading birds and shorebirds. The salt marsh area directly to the west provides habitat for federally listed eastern black rail (*Laterallus jamaicensis*) and wood stork (*Mycteria americana*). Within the interior of the island, natural areas provide habitat for other animals, including the American alligator (*Alligator mississippiensis*), white-tailed deer (*Odocoileus virginianus*), and raccoon (*Procyon lotor*). Additionally, Jekyll Island provides habitat and management opportunities for several breeding wading bird species, breeding and migrating waterfowl, and other rare migratory birds, such as the painted bunting (*Passerina ciris*). This area is considered highly susceptible to coastal storm hazards and sea level rise.

Hofwyl-Broadfield Plantation State Historic Park

Located near historic Brunswick, this park lies on the northern section of Glynn County, bordering McIntosh County. Of the approximately 2,000 total acres, the park contains approximately 1,300 acres of longleaf pine savannah, bottomland hardwood, scrub shrub, and mixed forest with the remainder comprised of palustrine forested wetlands, palustrine scrub, emergent wetland, and tidal/non-tidal marsh. An extensive marsh system surrounds the northern sections and feeds into the south Altamaha River.

Managed by the GADNR, the park provides important habitat for the federally listed wood stork *(Mycteria americana)*, eastern indigo snake (*Drymarchon couperi*) and the threatened and endangered candidate, the gopher tortoise (*Gopherus polyphemus*). Other animals include red-headed woodpeckers (*Melanerpes erythrocephalus*), fox squirrel (*Sciurus niger*), American alligator (*Alligator mississippiensis*), white-tailed deer (*Odocoileus virginianus*), and raccoon (*Procyon lotor*). Additionally, the preserve provides habitat and management opportunities for several wading bird species, breeding and migrating waterfowl and other uncommon migratory birds, such as the painted bunting (*Passerina ciris*). Increased salinity from inundation could increase the die-off of freshwater wetland systems. Topsoil erosion from storm damage in scrub areas would increase die-off and depletion of plant and animal species.

Canons Point/Guale Preserve

Located on the north end of St. Simons Island, Cannon's Point Preserve is an approximately 600-acre wilderness preserve linked to the lower Altamaha River delta to the north. Of the 600 acres, the tract contains approximately 500 acres of extremely important mature maritime forest. Other habitats include bottomland hardwood, scrub shrub, interior freshwater ponds, palustrine forested wetlands, and non-tidal/tidal wetlands. Guale Preserve is an adjacent 250-acre tract of land to the southeast consisting of similar habitat. They are part of a peninsula system that has more than 6 miles of salt marsh, tidal creek, and river shoreline and contains the last intact maritime forest on the island.

Both preserves provide important habitat for the federally listed *wood stork (Mycteria americana)*, eastern indigo snake (*Drymarchon couperi*) and the T&E candidate, the gopher tortoise (*Gopherus polyphemus*). Other animals include red-headed woodpeckers (*Melanerpes erythrocephalus*), American alligator (*Alligator mississippiensis*), white-tailed deer (*Odocoileus virginianus*) and raccoon (*Procyon lotor*). Additionally, the preserve provides habitat and management opportunities for several wading bird species, breeding and migrating waterfowl and other uncommon migratory birds, such as the painted bunting (*Passerina ciris*). Increased salinity from inundation could increase the die-off of freshwater wetland systems. Topsoil erosion from storm damage in scrub areas would increase die-off and depletion of plant and animal species.

St. Simons Island/Sea Island

St. Simons Island and Sea Island are connected by a causeway and together are 13 miles long and 4 miles wide. St. Simons Island is part of the city of Brunswick's metropolitan area and is the only of Georgia's larger barrier islands that has never been privately owned, whereas Sea Island is a privately owned beach resort with hotels, private cottages, and residences. St. Simons Island consists of 27,300 total acres, including the surrounding marsh. It has 3 miles of beach and 12,300 upland acres comprised of maritime forest, coastal hardwood, bottomland hardwood, pasture, grassland, scrub shrub, and slash pine/live oak stands. The remainder is comprised of palustrine forested wetlands, non-tidal/tidal marsh, sand dunes, and unconsolidated shoreline.

Sea Island has approximately 5 miles of beach and 2,000 total acres, including the marsh. Because of its private ownership, there is no public access to the beach from the mainland. With a total area of 1,200 upland acres, Sea Island habitat *is* similar to that of St. Simons Island.

Both islands provide important nesting habitat for the threatened loggerhead sea turtle (*Caretta caretta*) and also provide critical habitat for threatened piping plover (*Charadrius melodus*). The Gould's Inlet area, separating St. Simons and Sea Island by Postell Creek, also provides an important habitat for the threatened red knot (*Calidris canutus rufa*) and other wading birds and shorebirds. The Bloody Marsh area directly to the west also provides habitat for the threatened eastern black rail

(*Laterallus jamaicensis*) and wood stork *(Mycteria americana)*. Within the interior of St. Simons and small sections of Sea Island, natural areas provide habitat for the threatened eastern indigo snake (*Drymarchon couperi*), and the T&E candidate, the gopher tortoise (*Gopherus polyphemus*). Other animals include American alligator (*Alligator mississippiensis*), white-tailed deer (*Odocoileus virginianus*), and raccoon (*Procyon lotor*). The refuge provides habitat and management opportunities for several shorebird species, breeding and migrating waterfowl and other rare migratory birds such as the Painted Bunting (*Passerina ciris*). This area is considered highly susceptible to coastal storm hazards and sea level rise.

Little St. Simons Island

Little St. Simons Island covers an area of 10,000 acres and contains 7 miles of shoreline. Little St. Simons Island is located slightly northeast of St. Simons Island and Sea Island. It is separated from these islands by the Hampton River and from the marshes of the mainland by Buttermilk Sound. The mouth of the Altamaha River opens directly north of the island. Most of the island's acreage is composed of salt marsh. The island also contains large stands of maritime and bottomland hardwood forest, pristine beach/dune habitat, and scattered interior freshwater ponds, which provide habitat for migrant passerines. The marsh shoreline is fringed by extensive mudflats that are in-part exposed at low tide.

This island is important nesting habitat for the threatened loggerhead sea turtle (*Caretta caretta*) and also provides critical habitat for threatened piping plover (*Charadrius melodus*)*.* Several beach and dune areas provide an important habitat for the American oystercatcher (*Haematopus palliates*), the threatened red knot (*Calidris canutus rufa*), and other wading birds and shorebirds. The salt marsh area directly to the west provides habitat for the threatened eastern black rail (*Laterallus jamaicensis*) and wood stork *(Mycteria americana)*. Within the interior of the island, natural areas provide habitat for ESA-listed species, including the threatened eastern indigo snake (*Drymarchon couperi*), frosted flatwood salamander (*Ambystoma cingulatum)* and the T&E candidate, the gopher tortoise (*Gopherus polyphemus*). Other animals include the American alligator (*Alligator mississippiensis*), white-tailed deer (*Odocoileus virginianus*), and raccoon (*Procyon lotor*). Additionally, the refuge provides habitat and management opportunities for several shorebird species, breeding and migrating waterfowl, and other rare migratory birds, such as the painted bunting (*Passerina ciris*). This area is considered highly susceptible to coastal storm hazards and sea level rise.

Blythe Island Regional Park

Blythe Island Regional Park is a 1,100-acre public park located west of downtown Brunswick, St. Simons Island, and Jekyll Island, and is bordered by the South Brunswick River and the Turtle River. The park is comprised of maritime and bottomland hardwood forest, forested depressional wetlands, scrub shrub, scrub shrub wetlands, freshwater lake, freshwater tidal marsh, and tidal marsh.

The park provides habitat for ESA-listed species, including the protected bald eagle (protected by the Bald and Golden Eagle Protection Act), threatened eastern black rail (*Laterallus jamaicensis*), *wood stork (Mycteria americana)*, eastern indigo snake (*Drymarchon couperi*), and the T&E candidate, the gopher tortoise (*Gopherus polyphemus*). Other animals include the great-horned owl (*Bubo virginianus*), American alligator (*Alligator mississippiensis*), white-tailed deer (*Odocoileus virginianus*), and raccoon (*Procyon lotor*). Additionally, the preserve provides habitat and management opportunities for several wading bird species, breeding and migrating waterfowl and other uncommon migratory birds such as the painted bunting (*Passerina ciris*) and prothonotary warbler (*Protonotaria citrea*). This area is considered highly susceptible to coastal storm hazards and sea level rise.

4.5.4 At-Risk Cultural Resource Areas

Based on a qualitative assessment of risk, historic structures and archaeological sites on barrier islands and in low lying areas are highly susceptible to damage from storm surge inundation, erosion, and wave attack, especially as the risk from sea level rise increases. These areas are considered at-risk cultural resources areas due to the fact that all structures would be vulnerable to the hazards. The northern and southern tips of barrier islands tend to be hot spots for erosion, so any historic properties and/or archaeological sites in these areas would be at risk of damage and destruction from storm surge inundation, erosion, and wave attack.

While threats may be posed to cultural resources, such as historic resources and archaeological sites, due to development on barrier islands, storm protection measures that are put in place to protect those developed areas can aid in the protection of archaeological sites. For example, cultural resources on Jekyll Island benefit from periodic beach renourishment and other projects aimed at protecting property and infrastructure from storm damage, which in turn also protects cultural resources from erosion and wave attack. Storm events pose a greater risk on lesser developed barrier islands, such as St. Simons Island, that has limited or no protective measures present. Undeveloped marsh regions between and behind islands where many resources are located are typically inundated by flood events that exceed the 10-percent AEP flood level.

Damage to historic properties can sometimes be repaired, but this can be costly and may lack support if more essential recovery efforts are needed in the area to restore infrastructure. Archaeological sites are non-renewable resources that cannot be replaced once lost. Loss of historic properties and archaeological sites not only means a loss to the historical record that helps us to understand the past, but it can also mean a loss to local tourism. Visitors are drawn to this planning reach due to the many historical districts and historic forts. Damage caused by storms has in some instances meant the complete loss of all or portions of historic properties. Years of costly repairs can close these sites indefinitely until the site can be restored and are deemed safe for visitors. The loss of archaeological sites could pose a significant hit to the academic community and thereby limiting research into and interpretation of prehistoric and historic sites in this reach.

4.5.5 Shoreline Retreat Areas (Erosional hotspots)

As discussed in Section 4.1.1.3, the USGS Coastal Change Hazards Portal was utilized to identify long term erosional hotspots along the Glynn County coastline. Specific hotspot locations, which were classified by above average erosional rates (greater than-6.6 feet (-2 meters) per year) were located in portions of St. Simons and Little St. Simons Islands. St. Simons contains significant development and population centers, where increased erosion can directly impact infrastructure and threaten coastal communities. The undeveloped barrier island coastline of Little St. Simons is unconstrained by development and CSRM measures and subject to natural accretional and erosional patterns.

5. Action Strategy Development

To address coastal storm risks, stakeholders participated in the Glynn County Focus Area Vision Meetings, a series of interactive webinars facilitated using SACS tools and products to identify completed, ongoing, and needed actions to address coastal storm risks within the focus area. The Vision Meetings in addition to one-on-one correspondence with key stakeholders led to a list of 36 potential actions related to coastal storm risk and sea level rise in the focus area. Actions were generally classified into the following themes to better organize and prioritize actions:

- Shoreline stabilization and protection (Supports problem statement 1,2 and 3)
- Land use, zoning, and policy (Supports problem statement 4)
- Drainage improvements (Supports problem statement 1,2, and 3)
- Land conservation and preservation (Supports problem statement 3 and 4)
- Risk communication (Supports all problem statements)
- Critical infrastructure protection (Supports problem statement 2)
- Cultural resource protection (Supports problem statement 3)
- Environmental resource protection (Supports problem statement 3 and 4)

In the following sections, the process and outcomes of identifying and screening possible solutions to these actions are identified, evaluated, and compared. Specific examples are used to illustrate the use of the CSRM Framework and a complete table showing the FAAS is in Section 5.3.

5.1 Identify Possible Solutions

There are several SACS key products that can be used to help identify measures and possible solutions. The Measures and Cost Library (MCL) can be used to identify suitable measures based on wave energy, and planning level ROM cost estimates and the Tier 2 Economic Risk Assessment can be used to identify potential economic benefits. The 2020 RSM Optimization Update and SAND Report can be used to identify opportunities for RSM strategies and offshore sand borrow areas. In general, measures are organized into structural, nonstructural, and natural and nature-based features (NNBF). A detailed list of CSRM measures, the function of CSRM, and applicability by wave energy, can be found in Section 5.5 of the Georgia Appendix and the MCL report.

The broad measures identified herein (structural, nonstructural, and NNBF) could be further developed to target specific areas for CSRM. Example environmental and cultural resource protection measures are identified at the end of **Table 12**. The goal of alternatives development is to achieve the objectives by combining one or more measures while avoiding constraints. Measures identified will be further evaluated, screened, and used in combination (as appropriate) to determine area-specific project viability to meet the planning objectives.

Table 12: General Focus Area Themes and Potential Coastal Storm Risk Management Measures

Glynn County Focus Area Themes	Potential Coastal Storm Risk Management (CSRM) Measures		
	Structural	**Nonstructural**	**Natural and Nature-Based Features**
Shoreline stabilization/protection	• Build seawall/revetment • Build detached Breakwaters • Build floodwalls and bulkheads • Perform beach nourishment	• Relocate utilities and critical infrastructure • Implement building codes and zoning • Elevate structures • Retreat the shoreline	• Build dunes • Create living shorelines (oyster sills, vegetation) • Restore wetland/marsh
Land use, zoning, and policy	• N/A	• Revise building codes • Perform acquisition/buyouts • Conduct coastal zone management	• N/A
Drainage improvements	• Improve stormwater system • Install portable floodwalls to flood/tide gates • Elevate roads	• Floodproof structures • Increase storage • Redesign services and utilities • Conduct surface water/stormwater management	• Perform green stormwater management
Land conservation and preservation	• N/A	• Preservation (Coastal wetlands, Upland buffers) • Make a strategic Acquisition • Engage and educate the public	• N/A
Risk communication	• N/A	• Implement early warning Systems • Engage and educate the public • Prepare emergency plans/hazard mitigation plans • Resiliency studies	• N/A
Critical infrastructure protection	• See Shoreline stabilization/protection measures	• See Shoreline stabilization/protection measures	• See Shoreline stabilization/protection measures
Cultural resource protection	• Build breakwater structures • Conduct RSM (erosional areas)	• Elevate or relocate structures • Study/excavate sites	• Create living shorelines
Environmental resource protection	• Perform beach nourishment (habitat protection and expansion)	• Develop a stormwater management plan • Coastal wetland preservation • Conduct local permitting	• Create living shorelines • Restore coastal wetlands • Conduct RSM (thin-layer placement – marsh resiliency)

Project-specific measures shown in Section 5.2 and 5.3 have been provided through stakeholder input or were derived from previous studies and engagement. Some measures may be beyond the authority of USACE to implement. However, it was important to consider all viable measures regardless of current authority of the lead organization. For example, nearby Camden County has developed a Community Rating System (CRS) Open Spaces Explorer Application which identifies areas that currently qualify for Open Space Preservation credit, calculates the points they provide, helps identify future open space in the floodplain, and serves as a flood risk communication tool for residents and decision-makers. Potential measures that could be evaluated as part of future study phases are also included.

5.2 Evaluation and Comparison of Solutions

After identifying the problem and creating an inventory and forecast of current and future hazards, exposure, vulnerability, and risk, project-specific alternatives can be developed to reduce or mitigate risks based on shoreline types, exposed resources, and extent of residual risk in the future condition. When evaluating alternatives, it is important to determine whether the measure addresses the problem while meeting the objectives of the project. A reconnaissance-level economic feasibility assessment can be conducted using the suite of SACS tools by providing stakeholders with management measures and costs to develop alternatives and strategies and comparing those costs to FEMA Hazus Flood Model-derived damages to evaluate measures. A FAAS-specific reconnaissance-level economic feasibility assessment can be found in Section 5.2.1.

5.2.1 Planning Level Cost Estimates

At-risk critical infrastructure and public facilities were identified as major problems during the Focus Area Visioning Meetings. The 2017 Glynn County Climate Resilience Adaptation Report provided resilience adaptation strategy recommendations for the Brunswick-Glynn County Joint Water & Sewer Commission's critical infrastructure of water and sewer assets (Glynn County 2017). The FAAS planning level cost estimate demonstrates how coastal hazards in other high-risk locations within the focus area can be assessed. In the focus area, there are several water treatment plants and wastewater treatment plants (WWTPs) that are exposed to coastal storm hazards and sea level rise. Similar CSRM measures are applicable at these locations. Specific facilities were identified within the City of Brunswick, St. Simons Island, and Jekyll Island.

The Dunbar Creek WWTP, located along the Dunbar Creek in St. Simons Island, was one of several critical infrastructure assets emphasized as high risk from stakeholder engagement and was rated as a Facility Priority 1 within the Glynn County Climate Resilience Adaptation Report (Glynn County 2017). The facility priority number corresponds to the type of hurricane surge vulnerability that a facility has; therefore, a facility with a priority rating of 1 is deemed vulnerable to a Category 1 hurricane. The MCL and Tier 2 Economic Risk Assessment tools were used to perform a reconnaissance-level economic feasibility analysis to evaluate flood and erosion reduction measures in an area with known flooding risks.

Specifically, the MCL tool was used to evaluate the potential measures costs, while the Tier 2 Economic Risk Analysis tool was used to evaluate potential economic benefits from the reduction of physical and economic losses within the area to structures and their contents (**Figure 21**, **Figure 22**). It is important to emphasize that the Tier 2 Economic Risk Assessment tool is a screening level tool for stakeholders to identify areas for further investigation and does not account for nonphysical damages. Other Social Effects (OSE) benefits were also considered because of the threats to public health and safety from flooding associated with the interrupted conveyance and treatment of sewage. OSE are primarily impacts that can be quantified but cannot be assigned monetary value. As described in the MCL documentation, because of the regional nature of the data being developed it is impossible to address the full scope and site-specific issues prevalent in all CSRM projects. The influence that combining measures may have on the effectiveness of the individual components is also not addressed. The MCL is intended as a starting point to identify applicable measures and their associated costs as part of developing conceptual alternatives. The alternatives identified using the MCL should be further explored in a detailed analysis. Expert opinion and detailed engineering investigation will be needed to determine the effectiveness of the MCL and if modification to the data is necessary to account for site-specific considerations.

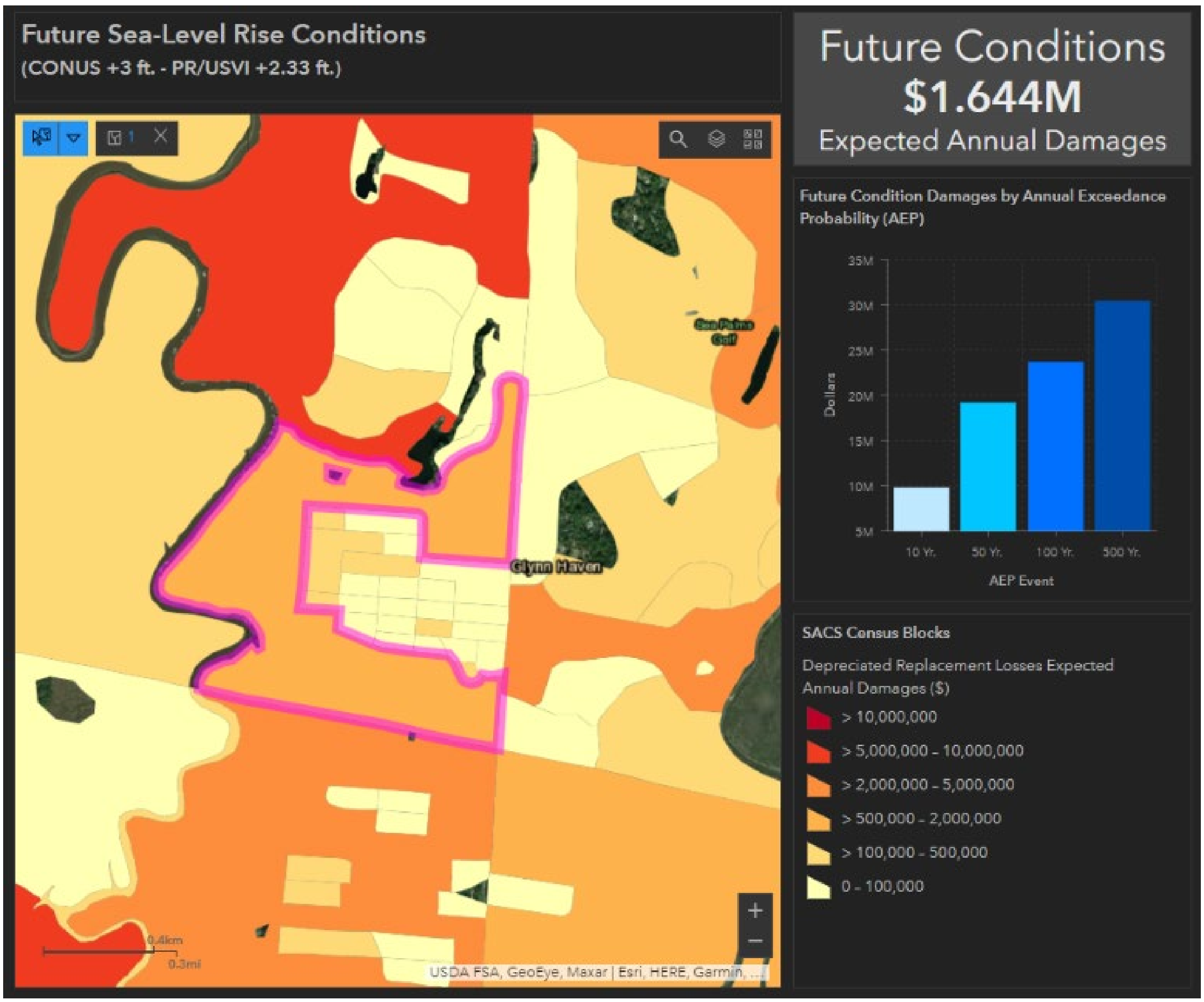

Figure 21: Tier 2 Economic Risk Assessment with Projected Future Conditions of Approximately $1.64 Million In Expected Annual Damages

After identifying the problem and assessing potential risk using SACS tools, stakeholder input, and strategies from the Glynn County Climate Resilience Adaptation Report, potential structural, nonstructural, and NNBF measures were identified to address CSRM risks such as storm surge inundation and erosion within WWTP footprint. Another component of the MCL report is a detailed and descriptive list of CSRM measures, which includes a measure-performance designation based on a measure's ability to reduce inundation, wave attack and erosion harm as primary, secondary, or nonrelevant function of the measure. As displayed in **Figure 22**, measures were separated by primary CSRM function, with yellow and red representing the approximate placement of applicable measures to address erosion and inundation risks. It is important to note that not all CSRM measures provide the same level of flood risk or erosion reduction benefits. In some circumstances, a NNBF measures may be unable to replicate the risk management provided by traditional structural and nonstructural measures but may provide important environmental and social benefits such as supporting species habitat, water quality, or public enjoyment.

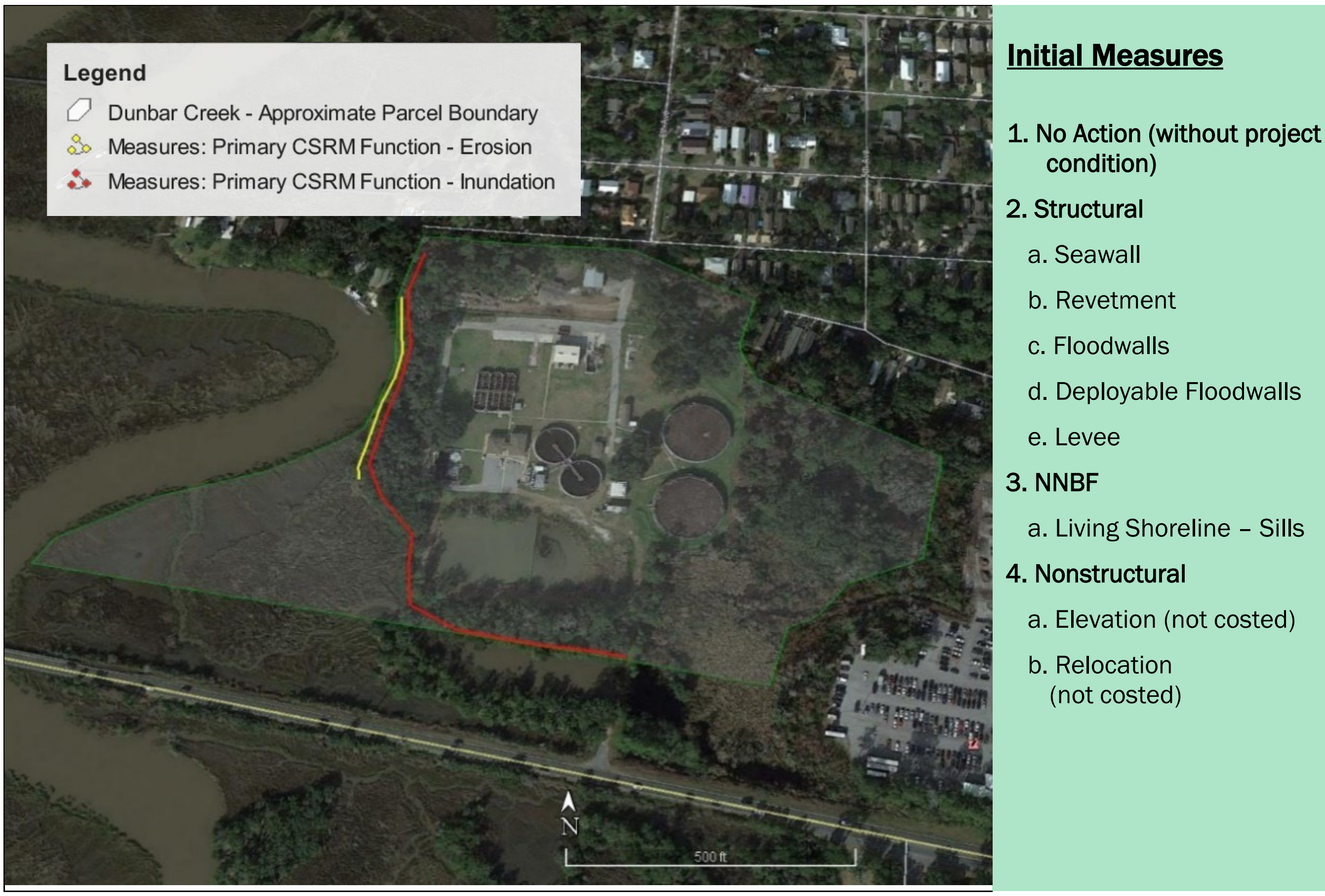

Figure 22: Dunbar Creek Wastewater Treatment Plant Approximate Coastal Storm Risk Management Measure Placement and Measures

The MCL tool provides an ROM cost estimate range for the selected measures including high and low values, equivalent annual costs (EAC), and the total first construction cost (**Table 13**). Costs given in the MCL are based on a Class 5 estimate using broad assumptions, historical data, and incomplete technical details (AACE International 2020). Prices can vary from -20 percent to +50 percent. EAC is the annual cost range based over a 50-year analysis period. As identified from the Tier 2 Economic

Risk Assessment, damages to property and infrastructure adjacent to Dunbar Creek show existing condition EAD of approximately $600,000 or the future condition EAD of approximately $1.64 million in any given year if no CSRM measures were implemented (**Figure 21**). Because of the spatial extent of the census block, smaller-scale issues may be harder to directly quantify with this product. This preliminary analysis, which considers economic damages and estimated construction first costs, shows that multiple measures have the potential to be economically justifiable at the lower end of the cost range and that more detailed analysis could be warranted in this area. It is recommended that follow-on analyses be completed to further evaluate multiple measures (including real estate, environmental, cultural resources, and maintenance costs and nonmonetized benefits) and address coastal storm risk comprehensively. Alternatives could be developed using standalone measures or a combination of measures, such as elevation in tandem with one or more of the structural and NNBF measures, to reduce the flood and erosion risks at this location. While measures were evaluated specifically to preserve the uninterrupted conveyance and treatment of sewage at the WWTP, broader measures can be evaluated to address coastal storm risks and sea level rise within the Dunbar Creek-adjacent neighborhoods.

Table 13: Measures and Cost Library-Derived Costs for Dunbar Creek Wastewater Treatment Plant

Primary Coastal Storm Risk Management Function	Measure	Unit(s)		Rough Order of Magnitude (ROM) Cost Range (Equivalent Annual Costs)	ROM Total First Construction Cost
Inundation[1]	Seawall	Linear Feet	1,300	$464,000–$888,000	$12,500,000–$24,000,000
Inundation[1]	Floodwalls	Linear Feet	1,300	$276,000–$433,000	$7,440,000–$11,700,000
Inundation[1]	Levees/Dikes	Linear Feet	1,300	$41,100–$110,000	$1,100,000–$2,980,000
Inundation[1]	Elevation	Number of Assets	–	Not currently costed	Not currently costed
Inundation[1]	Relocation	Number of Assets	–	Not currently costed	Not currently costed
Erosion/ Wave Attack[2]	Bulkhead	Linear Feet	440	$31,000–$50,700	$837,000–$1,370,000
Erosion/ Wave Attack[2]	Revetment	Linear Feet	440	$133,000–$356,000	$3,590,000–$9,610,000
Erosion/ Wave Attack[2]	Living Shoreline – Sills	Linear Feet	440	$37,900–$180,000	$1,020,000–$4,850,000

[1] *Approximate placement of erosion reduction measures displayed in yellow on Figure 22*
[2] *Approximate placement of inundation reduction measures displayed in red on Figure 22*

5.2.2 Impacts of Sea Level Rise

As discussed in Section 4.1.3, sea level rise will increase exposure to hazards for low-lying coastal areas, including this focus area. Sea level rise is fundamentally incorporated into the FAAS and was considered carefully by stakeholders when identifying specific problems and needs. Site-specific considerations for each project area beyond those already addressed in the SACS would likely be addressed during Tier 3 follow-on activities with stakeholders.

While historically, residents of Georgia’s coastal communities have thought of coastal hazards in terms of single-event hurricanes or coastal storms, it is important to also consider the long-term, sustained effects of sea level rise on real property, natural habitats, and the ability to sustain growth in the regional economy. In the future, strategies will need to shift from addressing a single immediate concern to planning and executing comprehensive solutions that address multiple points of vulnerability. These strategies will rely on extensive coordination with local authorities and will require the integration of innovative solutions with existing and planned sea level rise mitigation efforts. Sea level rise scenarios are particularly important for design considerations for measures such as road elevation, seawall, living shorelines, and floodwalls. Some structural measures, like barriers and seawalls could potentially be adaptable to sea level rise by increasing structure elevations over time. This type of action requires sufficient available land to verify a stable design. NNBF and blended hybrid solutions that incorporate both NNBF and structural measures were identified as preferred future CSRM strategies by stakeholders to increase habitat along the shorelines while also ensuring proper shoreline stabilization. NNBF measures such as living shorelines and marsh enhancement may require adaptive material placement and elevation strategies to sustain targeted habitat types as sea level rises. For example, thin-layer placement can be utilized to maintain targeted coastal wetland elevations.

5.2.3 Potential Benefits and Impacts

The FAAS includes a focused array of potential actions, lead stakeholders, solutions, needed actions, a time frame for implementation, and potential funding sources. These elements are essential to make actionable recommendations and were coordinated closely with stakeholders. Potential benefits of the FAAS can be evaluated either individually as specific solutions to identified problems, or collectively as a system of solutions that address the shared vision. This report does not prioritize individual actions that make up the FAAS, although these actions could be prioritized to maximize finite resources. Prioritization could be based on several factors, including benefit-cost, time frame of incurring negative effects, or by availability of authorities and funding. As shown with the Dunbar Creek WWTP example from Section 5.2.1, there are SACS tools that can be used to help facilitate planning and prioritization. The FAAS provides a consistent platform to evaluate stakeholder-identified problems and needs in the focus area.

While proposed CSRM measures may reduce risks related to sea level change and storm damages, they can cause adverse effects for cultural and environmental resources. For example, structural measures may prevent natural marsh migration, while nourishment material, if not carefully screened, can include larger quantities of fines that can cause the beach face to harden or darken, impacting sea turtle nesting habitat. Relocating or altering a historic structure is an example of a potential adverse effect because it impacts the integrity of the structure. Any implemented measures would need to comply with Section 106 of the National Historic Preservation Act, including soliciting feedback from the consulting parties associated with these important resources, to ensure the preservation and integrity of these resources.

5.3 Focus Area Action Strategy

Table 14 is the FAAS for the Glynn County Focus Area, which was developed in partnership with key stakeholders. The strategy combines ongoing, planned, and needed actions based on prioritization, timing, and sequencing to advance the shared vision.

This report does not seek to create a strategy separate from the significant and ongoing efforts in the focus area, but to support those of the region and develop initial considerations for future federal and non-federal efforts. While many of the individual localities, shown in **Figure 23,** have unique and pressing issues associated with coastal storm risk and sea level rise that are described in **Table 14**, commonality throughout the focus area can be found among stakeholders to address problems and expand upon known working initiatives that are reducing risk in the focus area. Individual actions can be incorporated into more comprehensive plans that use the collective expertise of the diverse stakeholder groups in the area.

A unique attribute of the Georgia coastline and of Glynn County is the expansive network of undeveloped coastal wetlands. Continued protection and enhancement of these natural features is a focus area-wide strategy that provides numerous benefits to the area, including attenuating wave energy, slowing inland water transfer, and increasing infiltration. Additionally, the Glynn County Focus Area is at the forefront of many innovative pilot and demonstration projects which include living shorelines, thin-layer placement and green infrastructure that provide ecosystem services not available through traditional shoreline protection techniques. Continued implementation and documentation of these projects allows to proactively explore whether these techniques can be used in the future to build a more resilient Glynn County and Georgia coast.

Coordination with stakeholders and USACE teams conducting multiple studies in the focus area indicated that USACE is in a unique position to provide information and assistance to advance innovative planning, design, and implementation of emerging coastal storm risk management measures to address problems and further opportunities described in this report. For example, identifying AIWW operation and maintenance (O&M) materials that could be beneficially used is a strategy to expand RSM opportunities within the focus area that would ultimately support many ongoing and future initiatives.

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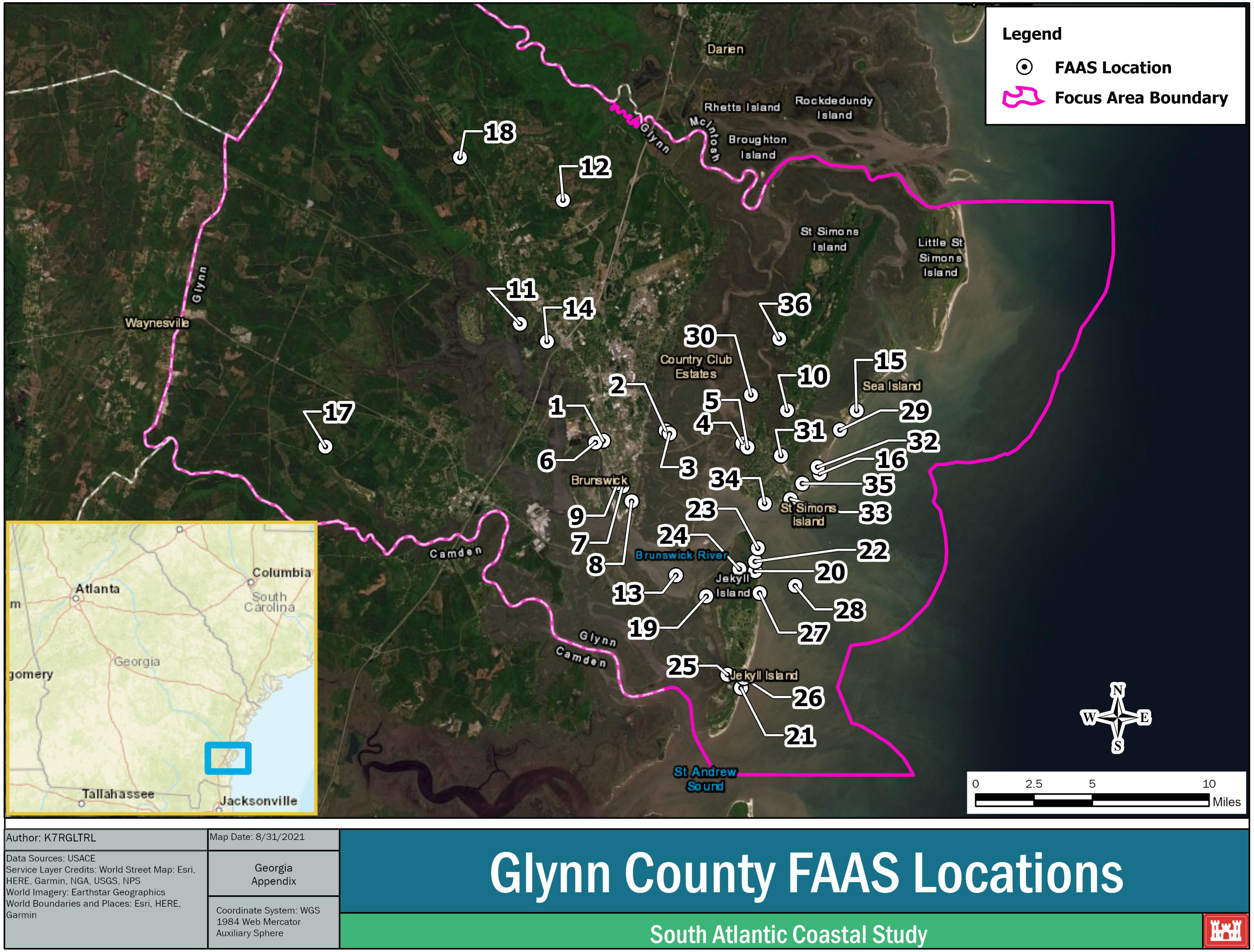

Figure 23: Glynn County Focus Area Action Strategy Locations Referenced in Following Table

Table 14: Glynn County Focus Area Action Strategy Table

Map Location	Theme	Description/Purpose	Location	Potential Lead Stakeholder(s)	Summary of Specific Actions Needed to Implement	Status (ongoing, planned, needed)	Timeframe[1]	Potential Funding Source
1	Drainage improvements, Shoreline stabilization/protection	Supplemental studies are needed to address stakeholder-identified areas in the City of Brunswick that have experienced repetitive flooding. This would complement the Tier 1 and Tier 2 Risk Assessments by using local stakeholder knowledge to further refine and characterize areas of high risk.	Brunswick	Local County or City Governments, Georgia Department of Natural Resources (GADNR) Coastal Resources Division (CRD), USACE	Higher-resolution investigations may be necessary to further refine specific high-risk areas within the county. SACS Geoportal tools can be used to support future efforts and are continually refined. An ongoing study, "Shoreline Assessment and Implementation Resiliency Plan" provides a broad listing of erosional and flood-prone areas within the city of Brunswick and the County-identified hot spots.	Ongoing	Short	Local, GADNR CRD, USACE (Planning Assistance to States)
2, 3	Drainage improvement, Land use, zoning, and policy	Riverside Drive is frequently flooded during normal rain events and experiences significant flooding during larger storm events and named storms. This road is the only way on and off the small island community abutting the Back River. The Riverside Drive community is highly vulnerable to storm surge.	Brunswick	Local County or City Governments, Georgia Emergency Management and Homeland Security Agency (GEMA), Federal Emergency Management Agency (FEMA), Georgia Department of Transportation (GDOT), U.S. Department of Housing and Urban Development (HUD)	Define flood risk and identify possible measures such as elevating the road and drainage improvements. Quantify benefits including use as a critical evacuation route. Identify vulnerable and repetitive loss properties from past storms. Coordinate with FEMA to find funding sources to institute buyouts and raise of repetitive loss properties in high-risk areas	Needed	Mid	Local, GEMA, FEMA, GDOT, HUD
4, 5	Critical infrastructure protection, Shoreline stabilization/protection	Address repetitive inundation issues at F.J. Torras Causeway and the intersection of Ocean Highway 17. F.J. Torras Causeway is the main roadway to St. Simons Island/Sea Island and an important evacuation route.	Brunswick	Local County or City Governments, GDOT	Define flood risk and identify possible measures such as elevating the road and drainage improvements. Quantify benefits including use as a critical evacuation route.	Needed	Short	Local, GDOT, GEMA, FEMA, USACE
6	Shoreline stabilization/protection	Address erosional concerns at multiple locations adjacent to Academy Creek (Palmetto and Greenwood Cemeteries, Selden Park, and Academy Creek wastewater treatment plant [WWTP]).	Brunswick	Local County or City Governments	Define nature and extent of erosion at Academy Creek and identify potential measures to address erosional concerns, which may include natural and nature-based features (NNBF) such as a living shoreline, riprap to stabilize the bank, or relocation of susceptible gravesites/structures.	Needed	Short	Local
7	Drainage Improvements, Cultural resource protection	Address flooding risk to historic, commercial, and residential structures in downtown Brunswick.	Brunswick	Local County or City Governments, GEMA, FEMA, HUD, GADNR Historic Preservation Division (HPD)	Elevate repetitive loss properties. Elevation is an option to maintain historic value of asset while reducing damages from coastal hazards. Conduct a study to address flooding risk with potential measures such as green stormwater infrastructure, property acquisition, floodproofing structures, or implementing planning development controls.	Needed	Long	Local, GEMA, FEMA, USACE
8	Drainage Improvements	Address nuisance flooding near Glynn Middle School and its adjacent infrastructure (recreational fields and parking). Lanier Boulevard has repetitive flooding issues.	Brunswick	Local County or City Governments, GDOT	Define flood risk and identify possible measures such as elevating the road and drainage improvements, property acquisition, and planning development controls. Quantify benefits and cost of improvements.	Needed	Mid	Local, GEMA, FEMA, USACE
9	Drainage improvements	Address nuisance flooding near Glynn Academy High School. Frequent flooding has inundated surrounding roadways and adjacent infrastructure, including parking lots for staff and students.	Brunswick	Local County or City Governments	Define flood risk and identify possible measures such as elevating key infrastructure and implementing drainage improvements.	Needed	Mid	Local, GEMA, FEMA, USACE

Map Location	Theme	Description/Purpose	Location	Potential Lead Stakeholder(s)	Summary of Specific Actions Needed to Implement	Status (ongoing, planned, needed)	Timeframe[1]	Potential Funding Source
10	Critical infrastructure protection, Shoreline stabilization/protection	There are several areas where critical infrastructure, including electrical substations and WWTPs, are exposed to coastal storm hazards and vulnerable to sea level rise. Jekyll Island Substation, Academy Creek WWTP (Brunswick), Dunbar Creek WWTP (St. Simons Island), and Jekyll Island WWTP are all located in highly vulnerable locations. Georgia Power has near-term plans to shift the footprint of Jekyll Island's substation landward.	Entire Focus Area	Georgia Power, GEMA, FEMA, USACE, Jekyll Island Authority (JIA), Georgia Environmental Finance Authority	Define the flood risk and identify applicable measures. Reach out to lead stakeholders to confirm interest in assessing the problem for the chosen high-risk location. The MCL can be used to develop screening level cost estimate for alternative measures to address the problem. Potential measures for the electrical substation may include elevation of the structure, bulkhead, etc.	Needed, Ongoing	Mid	Local, GEMA, FEMA, Georgia Power, USACE
11	Land use, zoning, and policy	There is high probability of increased development classified with a medium-high and high-risk rating in the Economic Risk Assessment. Increased development may also increase the overall risk in the area (decreased imperviousness and increased population density). The development of a subdivision may increase a medium-risk area to a high-risk area at the southern tip of Brunswick. Land use rules could be updated to limit development in low-lying areas.	Entire Focus Area	Local County or City Governments, FEMA	Stricter codes can be adopted for high-risk areas along tidally influenced shorelines. New codes may include raising the base floor elevation or limiting development in flood-prone areas. Implement stricter state/local regulation on wetland development. New development should maintain natural land buffers to allow marsh migration as sea levels rise. Land buffers with valuable environmental resources should be targeted for conservation/preservation.	Needed	Mid	Local, GEMA, FEMA, GADNR, HUD
12	Drainage Improvements	A county-wide study is needed to determine all county and locally maintained roads under a certain elevation that are subject to flooding and/or at risk to sea level rise.	Entire Focus Area	Local County or City Governments, GEMA, FEMA, GDOT	Identify all county and locally maintained roads that are subject to or at risk for flooding. Identify potential resiliency measures, such as elevation and sea level rise modeling, to determine appropriate height for roads and mitigation measures.	Needed	Mid	Local, GEMA, FEMA, GDOT
13	Environmental resource protection, Shoreline stabilization/protection	Non-beach-quality material from the Brunswick Harbor may be beneficially used for ecosystem restoration. These include Regional Sediment Management (RSM) strategies such as thin-layer placement to elevate marshes wetlands or island habitat creation for wildlife and environmental benefits. Examples include expanding/reinforcing the existing Bird Island and construction of additional bird islands.	Entire Focus Area	GADNR CRD, USACE (O&M), Georgia Ports Authority (GPA), Jekyll Island Authority (JIA), Local Country or City Governments	Find appropriate dredged material for habitat creation. Identify appropriate locations for additional habitat/bird islands. Determine costs to transport and place material.	Needed	Mid	Local, GADNR CRD, USACE, GPA, JIA
14	Drainage Improvements	Flooding/inundation occurs in socially vulnerable neighborhoods throughout the City of Brunswick and unincorporated Glynn County. Examples include reoccurring flooding adjacent to the terminus of Crispin Boulevard. Drainage improvements and continued buyouts and acquisition are necessary to protect people and property.	Entire Focus Area	Local County or City Governments, GEMA, FEMA, HUD	Identify vulnerable and repetitive loss properties from past storms. Coordinate with FEMA to find funding sources to institute buyouts and raise repetitive loss properties in high-risk areas. Conduct a study to define flood risk and identify potential measures such as NBBF and green stormwater infrastructure.	Needed	Long	Local, GEMA, FEMA
15, 16	Shoreline stabilization/protection	Conduct a shoreline assessment and implementation resiliency plan for Glynn County (phase 1 and 2).	Entire Focus Area	Local County or City Governments	The ongoing study, "Shoreline Assessment and Implementation Resiliency Plan," provides a broad listing of erosional and flood-prone areas within the city of Brunswick and the County-identified hotspots. Phase two of the Shoreline Assessment and Implementation Resiliency Plan will include a SLR and critical infrastructure assessment.	Ongoing	Short	Local
17	Land conservation and preservation	Identify locations for open space preservation. Preserve low-lying areas for increased flood resiliency.	Entire Focus Area	Local County or City Governments, GADNR CRD, National Oceanic and Atmospheric Administration (NOAA), The Nature Conservancy (TNC)	Conduct a study to identify areas for absorbing inundation. Development of an open space mapper can assist can potentially provide a Community Rating System rating improvement.	Planned	Mid	GADNR, USACE, NOAA
18	Risk Communication	Conduct a Georgia hurricane evacuation study to provide local government officials with information that could help them make hurricane evacuation decisions and provide emergency management officials with information for effective planning.	Entire Focus Area	USACE	The most recent Georgia hurricane evacuation study was completed in 2013. Efforts to complete the updated Georgia hurricane evacuation study are ongoing.	Ongoing	Short	USACE

Map Location	Theme	Description/Purpose	Location	Potential Lead Stakeholder(s)	Summary of Specific Actions Needed to Implement	Status (ongoing, planned, needed)	Timeframe[1]	Potential Funding Source
19	Environmental resource protection, Shoreline stabilization/protection	The Jekyll Marsh thin-layer placement pilot program supports coastal marsh and enhance coastal resilience. This RSM strategy could be expanded to other coastal wetland areas in the area.	Jekyll Island	USACE (Operations & Maintenance [O&M]), GPA, JIA, GADNR CRD, Environmental Protection Agency (EPA), NOAA	This is an on-going study. 5,000 cubic yards of O&M dredged material from the Atlantic Intercoastal Waterway (AIWW) was placed into marsh adjacent to Jekyll Creek using thin-layer placement methodology. Monitoring is being conducted to determine the effects of the thin-layer placement.	Ongoing	Short	USACE, GPA
20	Land use, zoning, and policy	Promote property buyouts/acquisitions of Vulnerable/repetitive loss properties on Jekyll Island adjacent to North Beachview Drive.	Jekyll Island	JIA, GADNR CRD, GEMA, FEMA	Vulnerable/repetitive loss properties adjacent to North Beachview Drive should be acquired and converted to natural open spaces for absorbing inundation and providing wildlife habitat.	Needed	Long	FEMA
21	Shoreline stabilization/protection	The central and southern portions of Jekyll Island have been historically understudied in terms of beach/dune processes. Conduct a study that identifies focal areas of concern on the south end of Jekyll Island and develops conceptual design of potential engineering solutions.	Jekyll Island	JIA, GADNR, USACE, GPA	Conduct a study to identify focal areas of concern in the southern portion of Jekyll Island. Identify beach-quality cost-effective sand sources for Jekyll Island. Potential to enhance existing dune system or create dunes in areas presently lacking to provide an inundation buffer to upland development.	Needed	Mid	JIA, State of Georgia, USACE
22, 23	Shoreline stabilization/protection	Address erosion in the northern portion of Jekyll Island while preserving the unique characteristics of the island. Identify potential RSM opportunities to support this effort. Strategy 1: Conduct Jekyll Island beach nourishment at the north end of island with possible sand sources at the channel entrance, including sediment traps/harbor/channel dredging/offshore. There is an RSM opportunity in the Jekyll Island northern littoral zone. Strategy 2: Sand placement along northern side of Jekyll Island using shoal attachment/nearshore placement/traditional renourishment (approximately 1 million cubic yards). Possible sand sources at the entrance channel include sediment traps/harbor/channel dredging/offshore.	Jekyll Island	JIA, GADNR, USACE, GPA	Strategy 1: This involves a 2,200-foot shoal attachment and nearshore placement for beach renourishment (approximately 400,000 cubic yards of sand). Evaluate sediment quality of potential beneficial use sources and determine benefit and cost of using that source. Strategy 2: This is a 10,000-linear foot north beach renourishment (approximately 1 million cubic yards of sand). Identify a source of beach-compatible sand. May require a sand search study. Any measures to address erosion in the northern portion of Jekyll Island must consider the preservation of the iconic shoreline of Driftwood Beach.	Needed	Mid	JIA, State of Georgia, USACE
24	Cultural resources protection, Shoreline stabilization/protection	Preserve at-risk historic and archaeological resources on Jekyll Island, e.g., preservation of Horton House and adjacent DuBignon Cemetery.	Jekyll Island	JIA, GADNR CRD, GADNR HPD	Identify potential measures to protect the archaeological sites. Measures may include NNBF such as living shorelines, or the addition of riprap to absorb shoreline wave energy and reduce erosion.	Needed	Short	JIA, State of Georgia, USACE
25	Shoreline stabilization/protection	Repair Northloop trail and historic district trail. Active erosion hazard is affecting access to outdoor recreation opportunities.	Jekyll Island	JIA, GADNR, USACE	Identify potential measures to protect trail stability. Measures may include elevating or relocating trail. Potential measures along shorelines may include living shorelines or riprap. These measures may also provide Coastal Storm Risk Management (CSRM) benefits to adjacent upland infrastructure.	Ongoing, Needed	Short	JIA, State of Georgia, USACE
26	Shoreline stabilization/protection	Address area of active erosion near South Beachview Drive that can impact the roadway. CSRM Measures are necessary to provide long term protection to the road.	Jekyll Island	JIA, USACE, GPA	Identify potential measures to protect South Beachview Drive from active erosional forces. Measures may include beach nourishment or construction of dunes.	Needed	Short	JIA, State of Georgia, USACE
27	Shoreline stabilization/protection	Use a study and sediment transport model to assess viability of near shore placement and engineered onshore shoal attachments at Jekyll Island.	Jekyll Island	JIA, USACE, Academia	Define the study area, determine boundary conditions, and develop different shore placement alternatives to be modeled.	Needed	Mid	JIA, State of Georgia, USACE
28	Shoreline stabilization/protection	Conduct a study to quantify the thickness of beach quality sand deposits seaward of Jekyll Island.	Jekyll Island	JIA, USACE, Academia	Perform sand search to characterize sand resources, including collection of geophysical data and geotechnical borings and evaluation of permitting requirements to develop identified resources that could be used without interference with the natural nearshore shoaling system.	Needed	Mid	JIA, State of Georgia, USACE

Map Location	Theme	Description/Purpose	Location	Potential Lead Stakeholder(s)	Summary of Specific Actions Needed to Implement	Status (ongoing, planned, needed)	Timeframe[1]	Potential Funding Source
29	Environmental resource protection, Shoreline stabilization/protection	Protect the undeveloped Sea Island Spit located at the southern end of Sea Island. This area contains important seabird habitat.	Sea Island	Local County or City Governments, GADNR CRD, Academia	Identify potential funding sources. Identify measures to protect or increase accretion at the sea island spit. Measures may include beach renourishment and offshore living shoreline/breakwater.	Needed	Short	Local, GADNR
30	Shoreline stabilization/protection	Expand Back River artificial oyster bed project, phase 1. There is potential to utilize NNBF measures similar to this in other areas of the county.	St. Simons Island	GADNR CRD	Phase 1 of project was completed May 2020. GADNR CRD placed approximately 3,700 bags of recycled shells on the east bank of the Back River near the F.J. Torras Causeway. This multipurpose project provides essential fish habitat, new oyster growth, and protects against riverbank erosion.	Ongoing	Short	DNR, Coastal Conservation Association Georgia
31	Drainage improvements	Flooding issues are on the Southern portion of Frederica Road in St. Simons Island and adjacent communities. Analyzing sea level rise scenarios to better address long-term solution to the flooding problems may be necessary.	St. Simons Island	Local County or City Governments	Define flooding and costal storm risk and identify measures to address the risk to critical infrastructure. Measures may include raising the road elevation or improving drainage.	Ongoing	Short	Local
32	Shoreline stabilization/protection	Maintain existing armoring and shoreline protection at Gould's Inlet. The public parking area and the public access point suffered from overwash during the last two major storm events. Additional protections, such as dune construction, may help the revetment minimize storm surge and inundation during storms. Area has become increasingly important shoreline bird habitat.	St. Simons Island	Local County or City Governments	This is an ongoing effort to maintain 1960s revetment structure along the St. Simons Island shoreline, including Gould's Inlet. Determine the benefit of additional measures such as dune construction in conjunction with revetment repair.	Ongoing	Short	Local
33	Shoreline stabilization/protection, Risk Communication	Protect the public beach access locations at St. Simons Island through the construction of protective dunes. Constructed dunes will also serve as a flood reduction strategy for adjacent upland homes and infrastructure and supplement the planned rock revetment repairs.	St. Simons Island	Local County or City Governments, GEMA, FEMA, USACE	Identify beach-quality cost-effective sand sources for St. Simons Island. Outreach to residents throughout the county may be helpful to better educate the community on flood risk benefits and recreational benefits of beach nourishment/dune creation. Establish dune system to provide an inundation buffer to upland development.	Needed	Mid	Local, USACE
34	Shoreline stabilization/protection, Risk Communication	Add beach nourishment/dune protection on the southern tip of St. Simons Island to provide much needed flood risk and recreational benefits.	St. Simons Island	Local County or City Governments, USACE, DNR	There is little interest by the public for beach nourishment in the area and past contention to CSRM proposals. Outreach to residents throughout the county may be helpful to better educate the community on flood risk benefits and recreational benefits of beach nourishment/dune creation.	Needed	Mid	Local, USACE
35	Shoreline stabilization/protection	There are active erosional areas impacting Ocean Boulevard. Recently completed efforts have included headwall and tide flap repairs. There is potential for NNBF and structural/hybrid measures vs. continued repairs of the headwall.	St. Simons Island	Local County or City Governments, GDOT, GEMA, FEMA, USACE	Identify measures to protect areas of Ocean Boulevard with erosional concerns. Measures may include repair of existing headwall, NNBF such as living shoreline, and additional structural features such as placement of riprap to repair areas of active erosion.	Needed	Short	Local, GDOT, GEMA, FEMA, USACE
36	Cultural resource protection, Shoreline stabilization/protection	Fort Frederica National Monument is at risk because of erosion and inundation. Archaeological resources can be irrevocably lost if no CSRM measures are implemented.	St. Simons Island	Local County or City Governments, USACE, GADNR, GADNR HPD	Identify potential measures to protect the Fort Frederica archaeological site. Measures may include NNBF such as living shorelines, or the addition of riprap to absorb shoreline wave energy and reduce erosion.	Needed	Short	National Park Service, USACE

[1] short = <2 years; mid = 2-10 years; long = > 10 years

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6. Recommendations

The focus area action strategy was developed to advance the shared vision and manage increased coastal storm risk as a result of sea level rise in the Glynn County Focus Area as shown in **Figure 24**. The shared vision is the overarching goal of the FAAS, broadly representing problems and opportunities stakeholders wish to address in the focus area. Resultingly, FAAS goals and objectives support the shared vision. SACS key products and other stakeholders' shared tools and data were used to support FAAS goals and objectives by assessing risk and identifying ongoing, planned, and needed actions to communicate and address the risk.

Figure 24: Focus Area Action Strategy Supports the Focus Area's Shared Vision

Recommendations are made for either multi-agency action, USACE action, or consideration by the United States Congress (Congress) to advance specific actions resulting from analyses presented in this report and coordination with stakeholders throughout the focus area. Recommendations are organized into six categories, as shown **Figure 25,** and three implementation timeframes (near-, mid-, and long-term). Importantly, follow-on study efforts should incorporate an integrated approach to the maximum extent practicable, including consideration of structural, nonstructural, and NNBF measures, as well as the shared responsibility of all stakeholders to contribute to coastal storm risk management. Implementation timing is influenced by the degree of stakeholder collaboration needed, technical complexity of the recommendation, current momentum toward implementation, and other factors needed to implement the recommendation. Implementation timeframes include:

Figure 25: Recommendation Categories

- **Near-Term Implementation (<5 years):** These recommendations are generally less complex and have significant stakeholder momentum toward implementation. The recommendations generally maintain and adapt actions that are recognized to successfully manage coastal storm risk.
- **Mid-Term Implementation (5-10 years):** These recommendations may be more technically complex and/or require additional stakeholder coordination and collaboration for implementation. They advance emerging efforts to address coastal storm risk.
- **Long-Term Implementation (>10 years):** These recommendations typically require significant stakeholder coordination before implementation and may be the most challenging to implement on regional scales from technical, political, or social perspectives. Importantly, coordination and collaboration on these recommendations should not be delayed. The long-term timeframe is reflective of the time to implementation based on immediate action to advance these recommendations which include complex issues such as land-use, zoning, and building codes. Given the uncertainty surrounding impacts from sea level rise and other factors (e.g., development trends), long-term recommendations may require reconsideration prior to implementation.

Table 15 provides the recommendations for the Glynn County focus area.

Table 15: Recommendations for the Glynn County Focus Area

Authority Category	Implementation Timing	Recommendation For	Recommendation	Description	Next Step to Implementation
Activities and Areas Warranting Further Analysis	Near-Term (<5 years)	Multi-Agency Action	Improve risk communication in Glynn County	Community-based education on coastal storm risks and sea level rise within the county should be promoted through increased public outreach. As part of the Focus Area Visioning Meetings, stakeholders identified that the proposed implementation of Coastal Storm Risk Management (CSRM) measures such as beach nourishment has been a long-standing issue of contention within the Golden Isles. Without the support of the community, resiliency and risk management efforts are unlikely to be prioritized and progressed. Stakeholders are encouraged to use the publicly available SACS tools (e.g., Geoportal, Tier 2 Economic Risk Assessment) to assist in risk communication, and the SACS Coastal Program Guide to locate additional opportunities for funding. Potential lead stakeholders would include the Brunswick-Glynn County Emergency Management Agency and local governments. *This recommendation is applicable throughout all coastal counties within the planning reach.	Stakeholder Collaboration

Authority Category	Implementation Timing	Recommendation For	Recommendation	Description	Next Step to Implementation
Activities and Areas Warranting Further Analysis	Near-Term (<5 years)	Multi-Agency Action	Expand the Community Rating System (CRS) Open Spaces Explorer Application	The CRS Explorer Application should be expanded to Glynn County. The CRS Open Spaces Explorer identifies parcels that currently qualify for Open Space Preservation (OSP) credit and calculates the points they provide, assists in identifying future open space in the floodplain, and serves as a flood-risk communication tool for residents and decision makers. Non-federal participants are encouraged to use the SACS Coastal Program Guide to locate additional opportunities to fund this effort. Potential lead stakeholders include The Nature Conservancy, local governments, and Georgia Department of Natural Resources (GADNR). *The CRS Explorer Application is presently in-use by neighboring Camden County. Expansion of, or similar efforts to the CRS Explorer Application are applicable and recommended throughout all coastal counties within the planning reach.	Stakeholder Collaboration
Activities and Areas Warranting Further Analysis	Long-Term (>10 years)	Multi-Agency Action	Protect and preserve coastal wetlands	Glynn County is situated on a low coastal plain with vast expanses of tidal marsh that surround most of the river corridors within the county. Continued preservation and legal protections of these natural features within the focus area will provide environmental benefits, reduce onshore storm impacts, and provide natural attenuation and infiltration of stormwater. Stricter local regulations on wetland development are encouraged. Potential lead stakeholders would include Glynn County, all local municipalities, and the GADNR. *This recommendation is applicable throughout all coastal counties within the planning reach.	Guidance/Policy

Authority Category	Implementation Timing	Recommendation For	Recommendation	Description	Next Step to Implementation
Regional Sediment Management Practices	Near-Term (<5 years)	USACE	Sustain and expand Atlantic Intracoastal Waterway (AIWW) operation and maintenance efforts to characterize beneficial use material	Near-shore and non-beach-quality dredged material within the focus area should be beneficially used when feasible. Current USACE Regional Sediment Management (RSM) efforts include a study to characterize shoaled material and identify appropriate beneficial uses of dredged sediment along the AIWW. A consistent inventory of material quality and suitability should be shared with stakeholders to promote beneficial use of the dredged material. Continued sediment characterization efforts and collaboration to discuss opportunities with stakeholders such as Jekyll Island and St. Simons Island is recommended. *Characterization efforts can be expanded throughout the AIWW to inform sediment suitability for beneficial use and to engage potential stakeholders.	Funding
Regional Sediment Management Practices	Near-Term (<5 years)	USACE	Beneficially use dredged maintenance material from the Brunswick Harbor on northern shoreline, Jekyll Island	The northern portion of Jekyll Island has experienced severe damage from recent coastal storms while the central and southern portions of the island have been historically understudied in terms of beach and dune processes. There is potential for RSM to provide beneficial use of sediment to address erosion and storm damage. The Jekyll Island Authority is encouraged to continue coordinating with USACE on the feasibility of this action.	Funding
Study Efforts (follow-on USACE feasibility study)	Long-Term (>10 years)	Congress	Federal participation in St. Simons Island CSRM	Alternatives for protection of St. Simons Island should be evaluated in a new study. This study would complement ongoing studies and actions in the focus area, which includes a two-phase countywide Shoreline Assessment and Implementation Resiliency Plan and the repair of the historical ocean-facing rock revetment known as the Johnson Rocks. To implement this recommendation, a non-federal sponsor (such as Glynn County) would need to request participation from USACE. Multi-stakeholder coordination and leveraging of applicable existing data into follow-on actions would be required. Continued collaboration to discuss these opportunities is recommended.	New Study Authority

Authority Category	Implementation Timing	Recommendation For	Recommendation	Description	Next Step to Implementation
Study Efforts (follow-on studies)	Long-Term (>10 years)	Multi-Agency Action	Perform a comprehensive wastewater infrastructure improvements study in Glynn County	There are several areas where critical infrastructure, including water and wastewater systems, are exposed to coastal storm hazards and are vulnerable to sea level rise. Academy Creek wastewater treatment plant (WWTP) (Brunswick), Dunbar Creek WWTP (St. Simons Island), and Jekyll Island WWTP are examples of wastewater systems located in highly vulnerable locations that have been emphasized during stakeholder engagements. Adaptation options for water infrastructure should be further explored to identify applicable measures to address at-risk infrastructure. This study should leverage findings from the Brunswick-Glynn County Joint Water & Sewer Commission, 2017 Glynn County Climate Resilience Adaptation Report, and the Glynn County Shoreline Assessment and Implementation Resiliency Plan. Continued collaboration to discuss these opportunities and identify potential partnerships and lead stakeholders is recommended.	Identify Likely Lead Stakeholder(s)
Study Efforts (follow-on studies)	Long-Term (>10 years)	Multi-Agency Action	Perform a county-wide assessment of road flooding in Glynn County	Many vital roadways located within the low-lying coastal flood plains are susceptible to flooding from riverine and tidal flooding. With respect to sea level rise projections, potential short-term and long-term measures and solutions should be identified to address these at-risk roadways. The F.J. Torras Causeway, Riverside Drive, Frederica Road, and Ocean Boulevard are examples of affected roads that have been emphasized during stakeholder engagements. This recommendation addresses the problem of nuisance flooding impacting roads in low-lying areas. Initial coordination should take place between stakeholders needed for engagement in this type of study. Potential lead stakeholders would include Georgia Department of Transportation (GDOT) and Glynn County. Continued collaboration to discuss these opportunities and identify potential partnerships is recommended. *This recommendation is applicable throughout all coastal counties within the planning reach.	Identify Likely Lead Stakeholder(s)

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